THE UNIVERSITY OF MICHIGAN

COLLEGE OF ENGINEERING
Department of Aeronautical and Astronautical Engineering

Technical Report

DOVAP DATA REDUCTION FOR IGY GRENADE AEROBEE ROCKETS SM 1.01—SM 2.10

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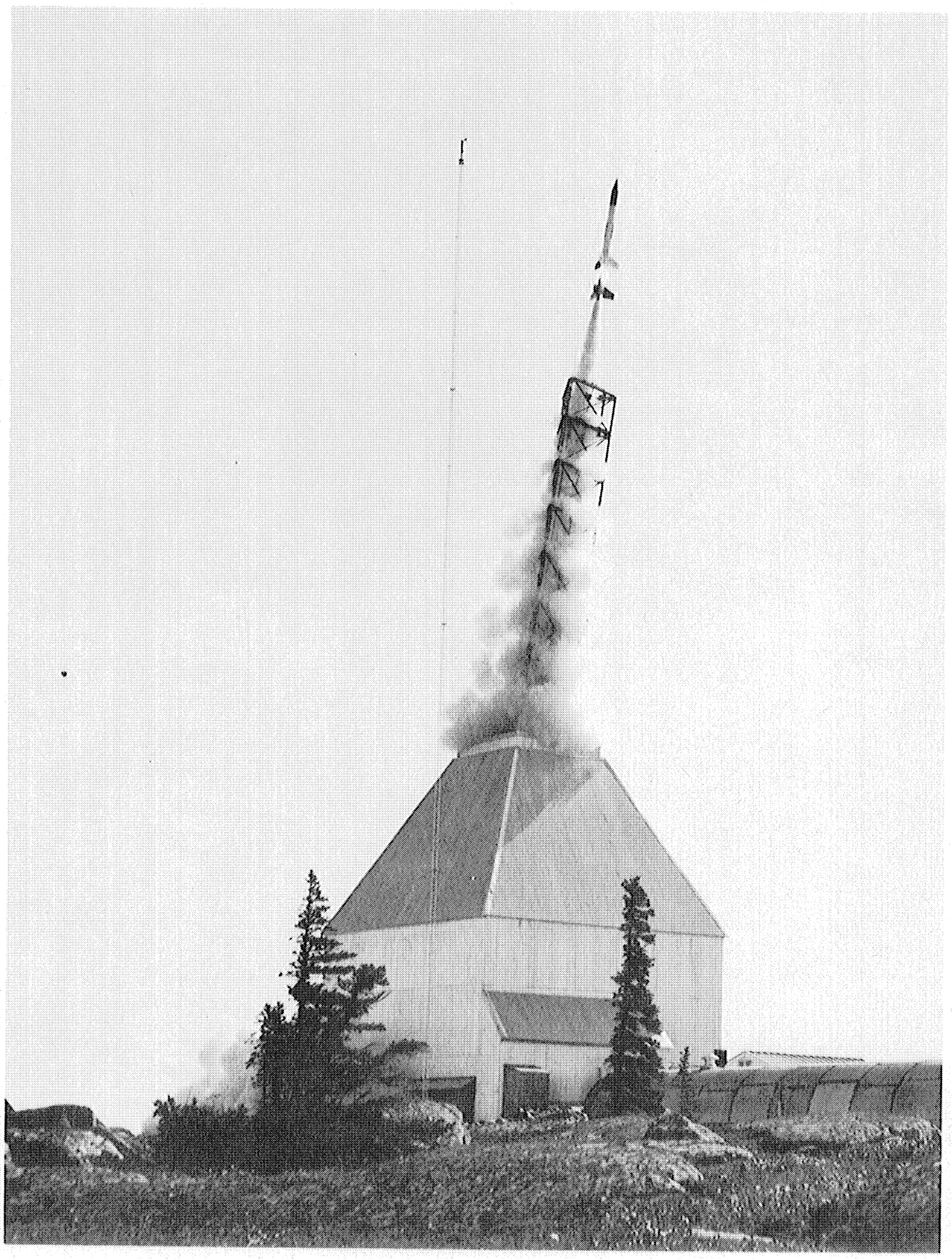

Launching of Aerobee SM1.04, 12 August 1957.

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ABSTRACT

The procedures employed to analyze the DOVAP tracking data for a series of ten grenade-Aerobee rockets fired at Fort Churchill, Canada, as part of the IGY rocket program, are described. Detailed descriptions are given of the DOVAP doppler-cycle counting method and of the procedure used to detect and eliminate false doppler cycles induced in the data by the motion of the rocket, i.e., its spin and change of orientation with respect to the ground station antenna systems. The solution of the rocket trajectory equations with the IBM 650 computer is discussed and the computer program is described. The data are presented in two appendices to the report.

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I. INTRODUCTION

Ten Aerobee rockets carrying the Signal Corps—University of Michigan grenade experiment for upper-air temperature and winds were recently fired at Fort Churchill, Canada, as part of the U. S. IGY rocket program. Grenades carried aloft by each missile were ejected and exploded along the upleg portion of the rocket path. Data recovered by the DOVAP tracking system during each flight were reduced to the spatial coordinates of grenade explosions above an array of microphones on the ground and to the trajectory of the rocket with respect to the aerobee launching tower. These coordinate data, the time of each explosion and the time of arrival of the sound waves at each of the microphones, are used to calculate average temperatures and winds in the atmospheric layers defined by the grenade explosions.[1]

The DOVAP (Doppler Velocity And Position) tracking system consisted of a transmitter, four receiving stations, a rocket-borne transponder, and a master monitoring and recording station (see Fig. 1). The transmitter radiated its frequency to the transponder and to each of the four receivers. The transponder doubled the received transmitter signal and re-transmitted it to the ground stations. At the same time, the ground stations received, doubled, and heterodyned the reference transmitter frequency with the frequency received from the rocket. The two frequencies differed because the motion of the rocket induced a doppler effect on the signal received and transmitted by the rocket. This difference of doppler frequency was recorded on magnetic tape and later transcribed onto 35-mm film together with range timing signals.

For a given receiving station j, each doppler cycle indicates an increase of one wavelength in the transmitter-rocket-receiver distance u_j where

$$u_j = r + r_j \quad , \tag{I-1}$$

where

r = transmitter-rocket distance, and
r_j = rocket-receiver j distance.

Each of the four u_j at a time t_i define an ellipsoid of revolution having as foci the transmitter and receiver j; the intersection of three such ellipsoids defines the position of the rocket in space, and four u_j permit overdetermination of the rocket position.

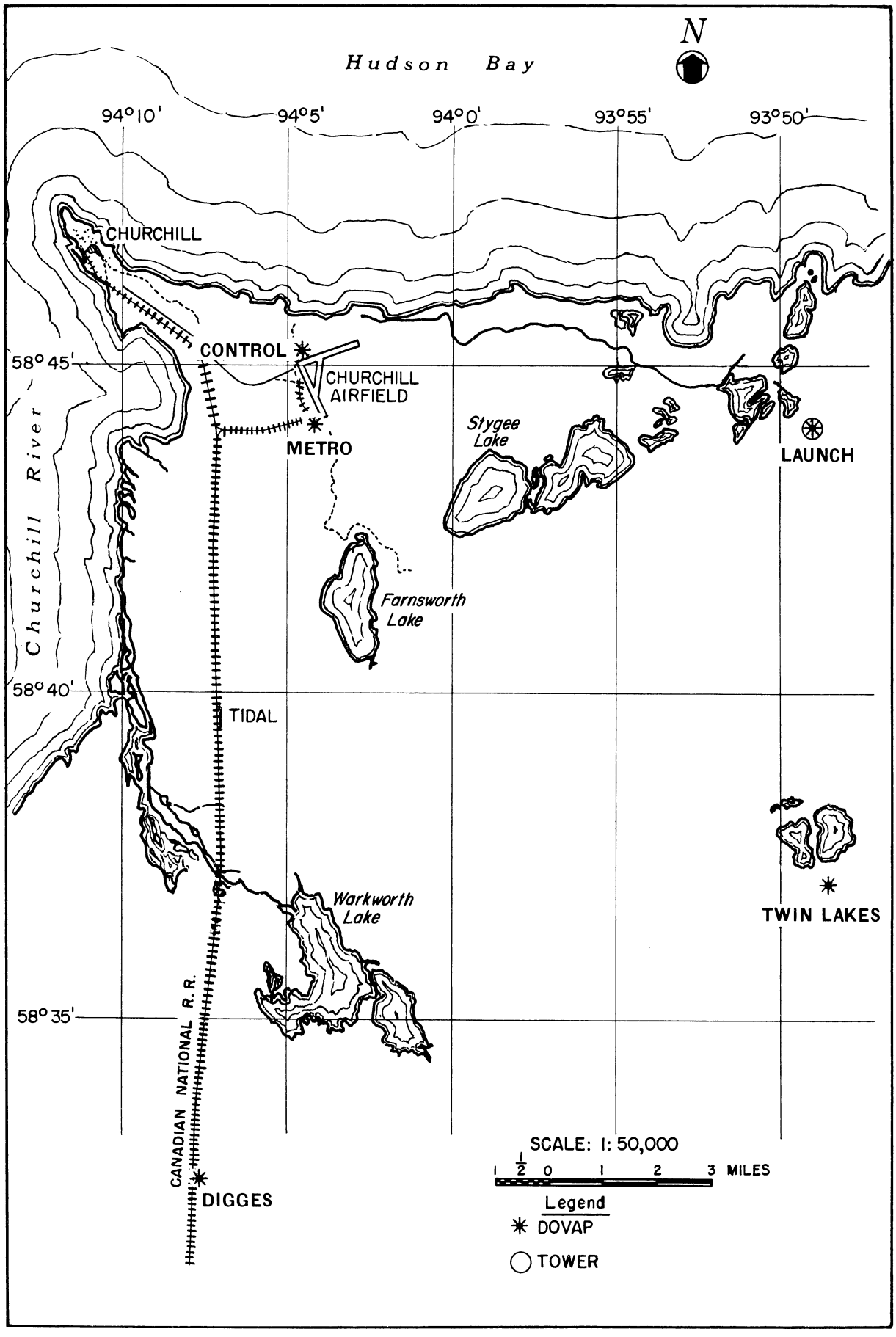


Fig. 1. Fort Churchill rocket range.

An initial missile position was found, independently of DOVAP, at a time t_o. Starting at t_o, the doppler cycles from each receiver were hand-counted on the films and the counts were recorded for each half-second of data time and for each grenade-explosion time. The overdetermined rocket position at time t_i was found by solving (see Section VII) four sets of three simultaneous equations of the form

$$u_j(t_i) = r(t_i) + r_j(t_i) = u_j(t_i-k) + \lambda \cdot \Delta N_j \qquad (I-2)$$

where j takes the values 1,2,3,4,

λ = wavelength of doubled transmitter frequency,
N_j = number of cycles in the time interval k,
k = 0.5 second for the rocket trajectory, and
k < 0.5 second for grenade explosion times t_i.

The average rocket position was calculated from the four position values and a least-squares solution of these data evaluated the internal consistency of the cycle counts by calculating the standard deviation of the average position.

The trajectory solution was programmed for the IBM 650 digital computer and the results for each of the rockets are listed in the Appendices. The ballistic camera tracking system was also used on four flights. A comparison of ballistic camera and DOVAP grenade position data will be made and reported on separately.

The definition of ΔN_j as shown above is not complete. A spinning rocket induces false cycles into the doppler data; abnormal sections of cycles immediately followed every grenade burst; and, since each antenna of the DOVAP system had its own phase pattern, the changing orientation of the rockets with respect to the ground station antennas created anomalous sections of cycles. These as well as other sources of false cycles had to be corrected for; the methods used to eliminate them are described in Sections IV, V, and VI. The above definition of ΔN_j should be changed to read

ΔN_j = number of corrected cycles in the time interval k.

The DOVAP transmitter frequency was monitored and recorded every minute in the interval -5 to +10 minutes during each firing. The wavelength used is calculated from

$$\lambda = \frac{2f_{avg}}{C_{avg}} , \qquad (I-3)$$

where f_{av} is the average of the frequencies recorded during the time for which the trajectory will be calculated, and C_{av} (equal to $299.748 \cdot 10^6$ meters per second) is the average of the velocity of light in a vacuum and of the velocity of light in air at mean sea level.

II. DOVAP TRACKING SYSTEM

The Ballistic Research Laboratories (BRL) were assigned the responsibility of instrumenting and operating ballistic instrumentation at the Fort Churchill IGY rocket range. The range requirements were to instrument DOVAP, DOVAP telemetry, and ballistic cameras.[2] BRL was also given the task of making a geodetic survey of the rocket range. Supporting facilities for this instrumentation, such as data-transmitting links, range timing, and frequency-monitoring equipment, were the responsibility of the White Sands Signal Corps Agency (WSSCA).

The DOVAP transmitter located in the rocket preparation building, generated a continuous-wave signal approximately 38 Mc. This frequency was radiated to the rocket from a left-hand, circularly polarized helical antenna[3] which insured that the receiving antenna on the rocket would receive the signal regardless of the polarizing effects due to rocket spin. The transmitter also radiated its frequency to the DOVAP receiving stations by means of a five-element, vertically polarized Yagi array which was directed at Digges, the most distant receiving station.

A T-10 transponder was used on each of the grenade Aerobees. It contained a 38-Mc receiver, a frequency doubler, a 76-Mc amplifier, a power output stage, and a telemetering stage. The rocket antennas were of the balanced rectangular loop type and were located a few inches on each side of the shroud line to fin 1 and diametrically opposite; and, except for pre-IGY rocket SM 1.01, they were mounted on the rocket skin at about its center of gravity. The single-channel FM telemeter unit was used to moniter the timer-initiated grenade ejection and firing sequence.

The DOVAP equipment at each of the three outlying receiving stations—Twin Lakes, Metro, and Digges—was similar. Each station was equipped with a pair of oppositely polarized helical antennas for receiving the transponder signal, a Yagi antenna at Digges and whip antennas at Twin Lakes and Metro for receiving the transmitter reference frequency, two dual-channel receivers for heterodyning the missile signal from each helix with the doubled reference frequency, a dual-channel recorder to record the doppler frequency from the left-hand helix along with range timing, and data-transmission equipment to send the right-hand helix doppler signal to the master DOVAP station to be recorded.

The fourth DOVAP receiving station, Launch, was located a few hundred feet from the rocket preparation and launching facility. This station was equipped with the normal array of DOVAP receiving equipment: a pair of oppositely polarized helical antennas, a whip antenna, and a pair of dual-channel receivers; in

addition, it served as the main monitor station for pre-flight checkout of DOVAP instrumentation in the rocket. A dipole antenna and a strip-chart recorder were used to furnish rocket spin-rate data as soon as the flight was over. And the dipole—whip antenna combination plus a third dual-channel receiver yielded a third set of Launch doppler data. A seven-channel tape recorder was used to record the doppler data from the left- and right-hand helices and the dipole, range-timing, and the telemetering signal. The doppler data from the two helices were also transmitted over the data-transmission link for recording at the master DOVAP station.

The master DOVAP station was located in the Defence Research Northern Laboratory (DRNL) building at Fort Churchill. It was the central monitoring, recording, and telemetering station for the DOVAP system.

III. PRELIMINARY DATA

The first step in the data-reduction process was to find, independently of DOVAP, an initial missile position at a time t_o to be used as a starting point for the DOVAP solution. The initial missile position was taken to be the position of the centerline of the rocket antennas with respect to a right-hand cartesian system tangent to the Clarke Ellipsoid at the DOVAP transmitter at the time t_o, at which an emergence detector switch near the top of the launching tower was activated. Figure 2 and Tables I and II summarize the data used to calculate t_o and the initial missile position.

Range-timing signals consisted of both 100-pps (pulses per second) and 2-pps pulses. The first 2-pps pulse following missile lift-off was blanked out and was taken as range zero time by all participating agencies. Missile lift-off to range zero time was called missile lift-off time, and missile lift-off to emergence switch activation time became tower-transit time. Therefore, t_o was the difference between tower-transit and missile lift-off times.

Three types of emergence switches were used. The leading edge of a fin on SM 1.01 broke a wire near the top of the tower. A lug on the booster actuated a microswitch for the next five rockets and energized a magnetic pickup device for the last four missiles. The tower locations of these emergence detectors are shown on Fig. 2.

Referring to Table I, the distance from the emergence switch activator on a rocket to its antenna centerline was added to the distance from the tower gimbal to the corresponding emergence switch location to yield the slant range from gimbal to antenna centerline. The tower-tilt data were used to convert the slant range to cartesian coordinates, and the distance from gimbal to the pit floor at the base of the tower was added to the coordinates to give the initial missile position with respect to the Aerobee launcher.

The geodetic survey report[4] submitted by BRL listed the cartesian spatial coordinates of the rocket-range facilities with various origins. For each of the systems the X-Y plane was tangent to the reference ellipsoid (Clarke 1866 at mean sea level 0.0) at the point of origin; each coordinate was given in meters to ten significant figures. With these data, the DOVAP system coordinates relative to the Aerobee launcher as origin were transformed into a coordinate system with the DOVAP transmitter as origin and having X positive north, Y positive west, and Z positive vertically upward from mean sea level.

The converted DOVAP system coordinates, listed in Table II, were used to translate the initial missile position with Aerobee launcher as origin (Table I)

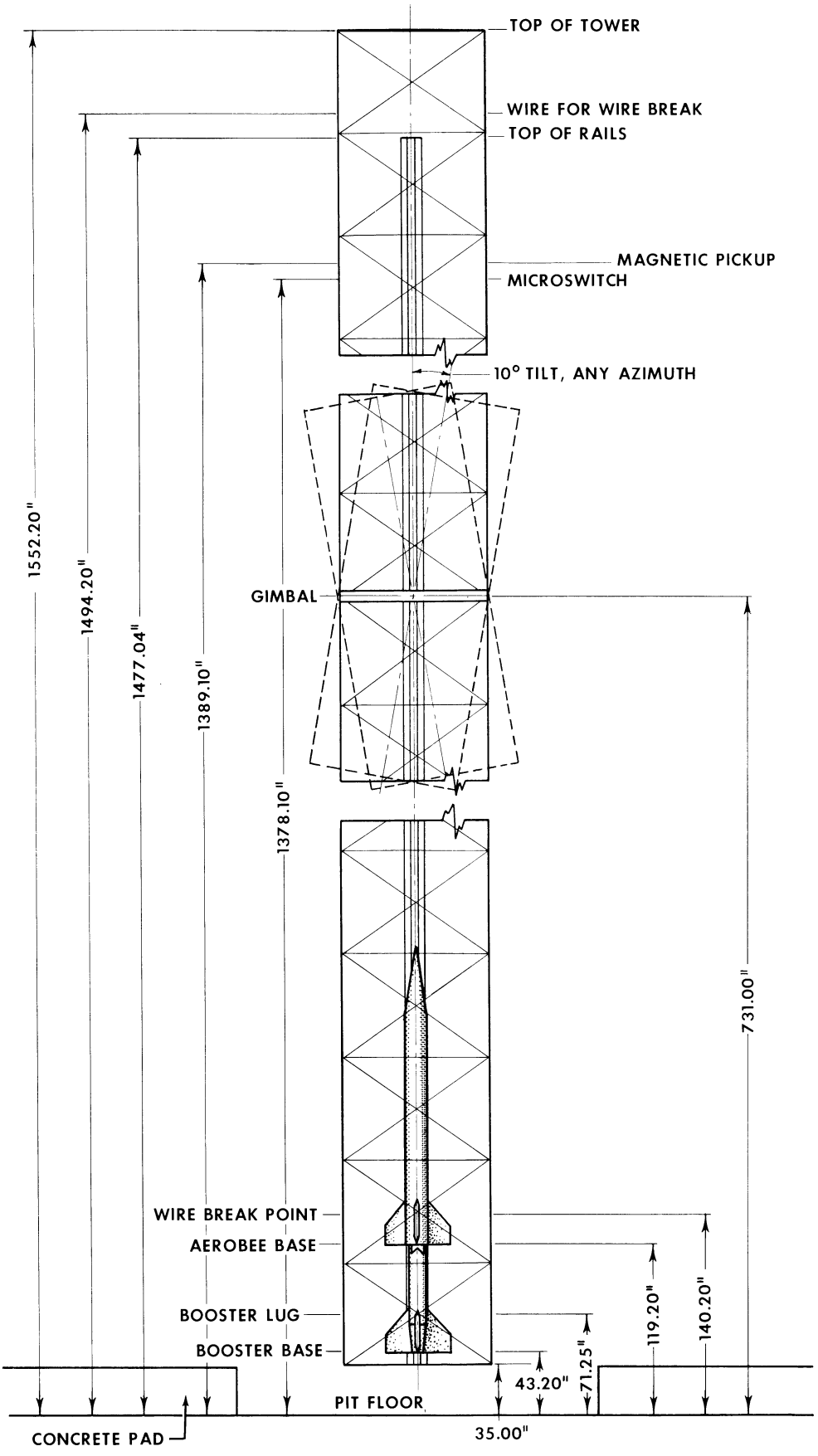


Fig. 2. Fort Churchill Aerobee launching tower.

TABLE I

DATA FOR CALCULATING t_o AND INITIAL MISSILE POSITION WITH AEROBEE TOWER AS ORIGIN

Rockets		SM 1.01	SM 1.02	SM 1.03	SM 1.04	SM 1.05	SM 2.06	SM 1.07	SM 1.08	SM 1.09	SM 2.10
Tower transit time		0.7794	0.7814	0.8100	0.8006	0.7700	0.8138	0.8110	0.8437	0.6864	0.8722
Missile lift-off time		0.1258	0.1898	0.1595	0.1951	0.4425	0.2015	0.2453	0.4187	0.2966	0.3335
t_o (sec)		0.6536	0.5916	0.6505	0.6055	0.3275	0.6123	0.5657	0.4250	0.3898	0.5387
Antenna centerline to activator		63.25"	140.0"	140.5"	140.0"	140.0"	153.5"	140.0"	140.25"	140.875"	148.0"
Emergence switch to gimbal		763.2"	647.1"	647.1"	647.1"	647.1"	647.1"	658.1"	658.1"	658.1"	658.1"
Antenna centerline to gimbal		68.87'	65.59'	65.63'	65.59'	65.59'	66.72'	66.51'	66.53'	66.58'	67.18'
Tower tilt		62 mils E	54 mils	89 mils	180 mils	104 mils	175 mils	110 mils	103 mils	63 mils	36 mils
6400 mils = 360° n° = CW(N)		137 mils S	149°	90°	135°	165°	172°	147°	120°	162°	147°
Antenna centerline with gimbal as origin	x(+N)	- 9.22'	- 2.98'	0.0	- 8.15'	- 6.46'	- 11.29'	- 6.01'	- 3.36'	- 3.91'	- 1.99'
	y(+W)	- 4.15'	- 1.79'	- 5.73'	- 8.15'	- 1.73'	- 1.59'	- 3.90'	- 5.82'	- 1.27'	- 1.29'
	z	60.17'	60.83'	60.67'	59.90'	60.18'	59.94'	60.53'	60.58'	60.81'	60.87'
Antenna centerline with pit floor as origin	x(+N)	- 9.22'	- 2.98'	0.0	- 8.15'	- 6.46'	- 11.29'	- 6.01'	- 3.36'	- 3.91'	- 1.99'
	y(+W)	- 4.15'	- 1.79'	- 5.73'	- 8.15'	- 1.73'	- 1.59'	- 3.90'	- 5.82'	- 1.27'	- 1.29'
	z	129.04'	126.42'	126.30'	125.49'	126.17'	126.63'	127.04'	127.11'	127.39'	128.05'

TABLE II

GEODETIC SURVEY DATA CONVERTED TO DOVAP SYSTEM COORDINATES

	Digges		Metro		Twin Lakes		Launch		Aerobee Tower	Transmitter
	LH	RH	LH	RH	LH	RH	LH	RH		
x(+N)	-70956.04'	-70964.04'	1550.01'	1577.26'	-42492.29'	-42469.39'	-144.03'	-162.43'	294.77'	0.0
y(+W)	58840.70'	58840.70'	47943.24'	47941.65'	- 1967.02'	- 1963.59'	349.81'	376.20'	-145.41'	0.0
z up	- 221.25'	- 221.25'	- 34.99'	- 34.99'	11.02'	11.02'	- 6.29'	- 6.57'	0.71'	69.50' MSL

	Initial Missile Position with Transmitter as Origin, u_j									
	SM 1.01	SM 1.02	SM 1.03	SM 1.04	SM 1.05	SM 2.06	SM 1.07	SM 1.08	SM 1.09	SM 2.10
x	285.55'	291.79'	294.77'	286.62'	288.31'	283.48'	288.76'	291.41'	290.86'	292.78'
y	- 149.56'	- 147.20'	- 151.14'	- 153.56'	- 147.14'	- 147.00'	- 149.31'	- 151.23'	- 146.68'	- 146.70'
z	129.75'	127.13'	127.01'	126.20'	126.88'	127.36'	127.75'	127.82'	128.08'	128.76'
u_D	92848.71'	92855.19'	92864.10'	92853.39'	92849.47'	92841.79'	92852.82'	92859.12'	92853.51'	92856.85'
u_M	48456.32'	48456.97'	48464.93'	48461.99'	48454.00'	48450.11'	48457.77'	48462.66'	48455.84'	48457.66'
u_{TL}	43141.05'	43150.57'	43157.48'	43143.26'	43144.09'	43135.39'	43146.06'	43151.67'	43149.02'	43152.79'
u_L	1051.53'	1056.46'	1065.38'	1055.85'	1051.13'	1044.16'	1054.81'	1060.99'	1055.02'	1058.25'
f	38.938780	38.030837	38.030795	38.030915	38.031087	38.030937	38.030785	38.030608	38.030530	38.030594
λ*	13.311528'	12.929287'	12.929301'	12.929261'	12.929202'	12.929253'	12.929305'	12.929365'	12.929392'	12.929370'

*λ = 3.2808333 C/2f where C = 299748 km per second, f = transmitter frequency in Mc per second.

to a position with transmitter as origin; then the slant range r_o from transmitter to initial missile position was calculated, and the slant ranges r_j from initial missile position to each of the four receiving stations were computed. Thus a set of $u_j(t_o) = r(t_o) + r_j(t_o)$ were found for each rocket: a set of four ellipsoids of revolution whose intersection was the initial missile position at time t_o and which provided the starting point for the corresponding trajectory solution

$$u_j(t_i) = u_j(t_i-k) + \lambda \cdot \Delta N_j \qquad \text{(I-2)}$$

where, in this case,

$(t_i-k) = t_o$, and
$k < 0.5$ second.

The remainder of the data required for the calculations consists of the wavelength λ and the cycle-count data ΔN_j. The wavelength for each flight was obtained from Eq. (I-3); values of average frequency and wavelength for each firing are shown in Table II. The ΔN_j data are the subject of discussion of the next three sections of this report.

IV. CYCLE COUNTING

Previous experience in the reduction of DOVAP data to a rocket trajectory had shown that counting doppler cycles by hand was the most tedious and time-consuming part of the process. Faced with the prospect of having to count millions of cycles from the proposed series of ten IGY grenade Aerobee rockets, we began an investigation of existing cycle-counting machines to determine which of the two counting methods would be the optimum one.

Both existing cycle-counting machines were in use at BRL. The Stroboscopic Film Reader[5] demonstrated that it could count cycles in the frequency range of 50-1000 cycles per second and to ± 0.1 cycle for any time interval. Film was passed through the Reader at a constant speed; a series of evenly spaced vertical lines was projected on the film by a variable-velocity slotted-wheel optical device. An operator varied the spacing between the lines in synchronism with the varying spacing between cycles. A counter attached to the wheel shaft recorded cycles as a function of shaft position with respect to range-timing signals associated with the channel being counted. It was estimated that a set of film from a grenade Aerobee firing could be counted with the Reader in two days. The cost of the Reader was about $43,000 without a digitizer and printout device.

The Putnam Cycle Counter,[6] which at that time had only recently been developed, promised to permit faster counting of cycles with the same ± 0.1 cycle accuracy. Film was passed through the Counter at a rate which depended on the number of cycles per unit time, and the position of the motor shaft was used as a measure of the cycle count. The estimated cost of the Putnam machine was $37,500, including the film transport mechanism.

While the investigation of the two machines was going on, a re-evaluation of the hand-counting method was made. A set of doppler film which had previously been counted was re-counted with special attention given to technique and elapsed time. It was concluded that with this method about three weeks would be required to count one set (eight channels) of film and that the cost to count data from the ten firings would be less than $20,000.[7] Further, except for anomalous sections of cycles which needed special interpretation in both methods, no systematic error would be introduced using the tested hand-counting technique. The decision was made to count the doppler cycles by hand.

For the purposes of the grenade experiment, grenade explosion times were needed in addition to time t_o. A pair of flash detectors on the ground scanned adjacent areas above the rocket range and recorded the grenade bursts as shown in Fig. 3. When signals from both detectors existed for any explosion, the

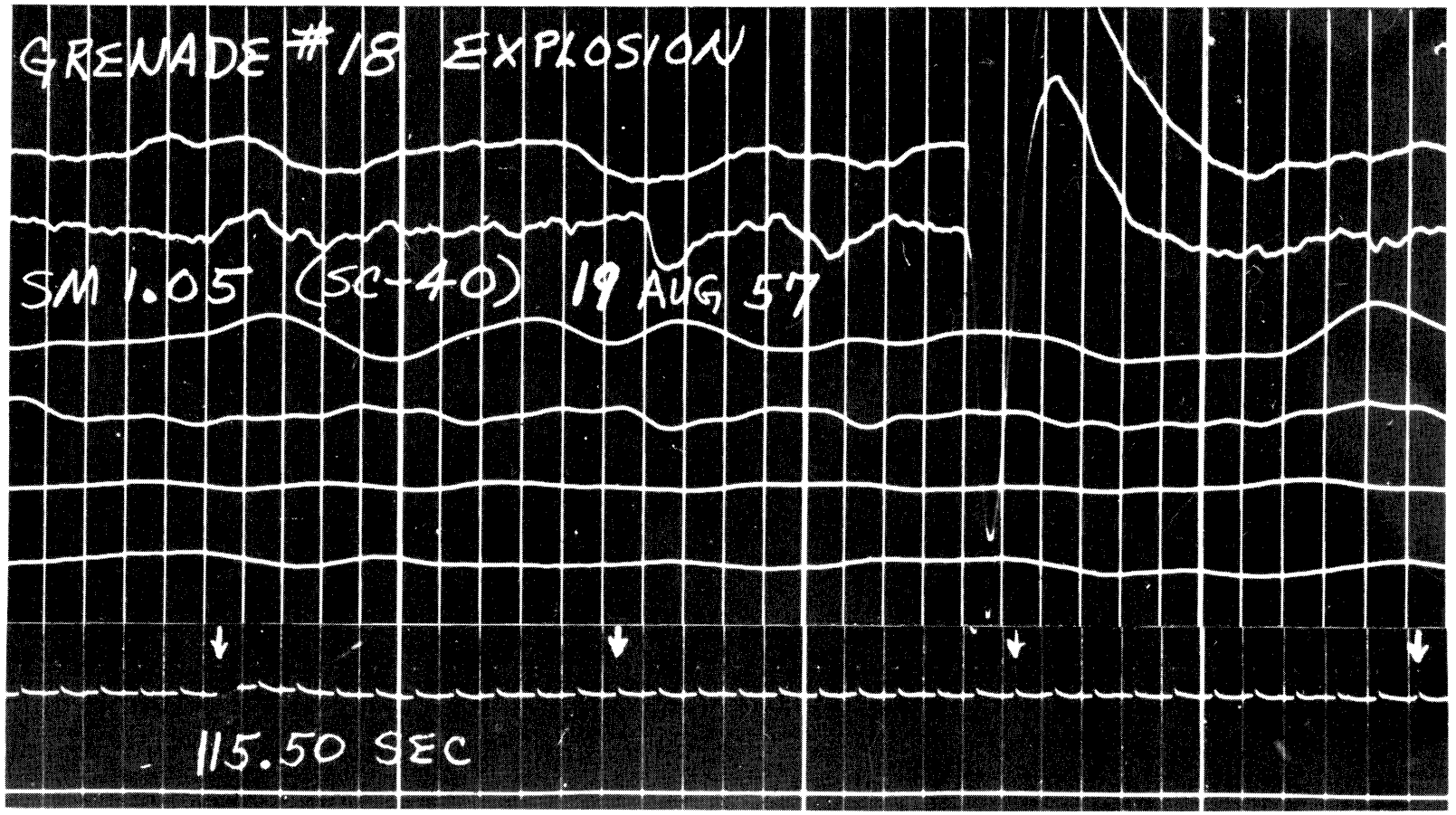


Fig. 3. Flash detector recording of a grenade explosion.

times to both were noted, the earlier time was read to four decimal places by at least four people, and the average value of the readings was taken to be the explosion time for that grenade. Four decimal places were necessary since grenades exploded in regions of the greatest cycle density—about six cycles per hundredth second—meant that, to satisfy the established ± 0.1 cycle accuracy requirement, the times would have to be read to better than ± 0.0002 second.

To insure that the flashes from the explosions would be detected whenever a rocket had to be fired through heavy cloud cover, three infrared-sensitive devices were located symmetrically about the circumference of rocket SM 1.01 to detect the flashes and to telemeter the information to the ground. However, when the DOVAP films for SM 1.01 were examined, it was found that the expanding products of the explosions had interfered with the electromagnetic radiation of the transponder in such a way (Fig. 4) that the flash times could be read to better than ± 0.001 second. The infrared devices were not flown on the remaining nine rockets; DOVAP served as a backup for the ground flash detectors. Table III shows the number of grenades carried by each rocket and lists the explosion times.

A set of five rolls of film of DOVAP data was received for each firing. Two rolls were copies of the DOVAP data recorded at DOVAP master station while the other three rolls were the doppler cycles from the left-hand helix plus range-timing signals recorded at each of the outlying receiving stations. In addition, a copy of the doppler cycles received at the Launch station dipole was attached to one of the two rolls of central station film (composite film). Only two rolls of film (composite) were received for SM 1.01 because no left-hand helices had been installed when this rocket was flown. Figures 5-9 show representative portions of each of the films.

The composite film (Fig. 5) shows doppler cycle channels for Launch station left- and right-hand helices (L_{lh}, L_{rh}), and Digges, Twin Lakes, and Metro right-hand helices (D_{rh}, TL_{rh}, M_{rh}). The dot-dash trace below L_{rh} was included to show at a glance the approximate phase relationship between the two Launch channels. The phase relation at any point was indicated by the ratio of dot (or dash) duration to that of the intervening dot (or dash) space and the interval of a transition from a continuous dash (360°) to a blank trace (0°) represented a difference of one cycle between the total number of cycles in the Launch channels in the interval. The phase data served as a check on the method (Section V) used to determine the number of false cycles introduced into the Launch doppler data by the spinning rocket.

Three range-timing channels are shown on the composite film. Each doppler channel evaluated in terms of the timing track had to be adjacent to it. This was made necessary by the method in which the doppler data and time signals were recorded on the magnetic tape and by the fact that the propagation time error between a DOVAP station and range timing was not the same for all stations. Consequently each doppler data track was shifted on the film with respect to range time to compensate for the propagation delays.

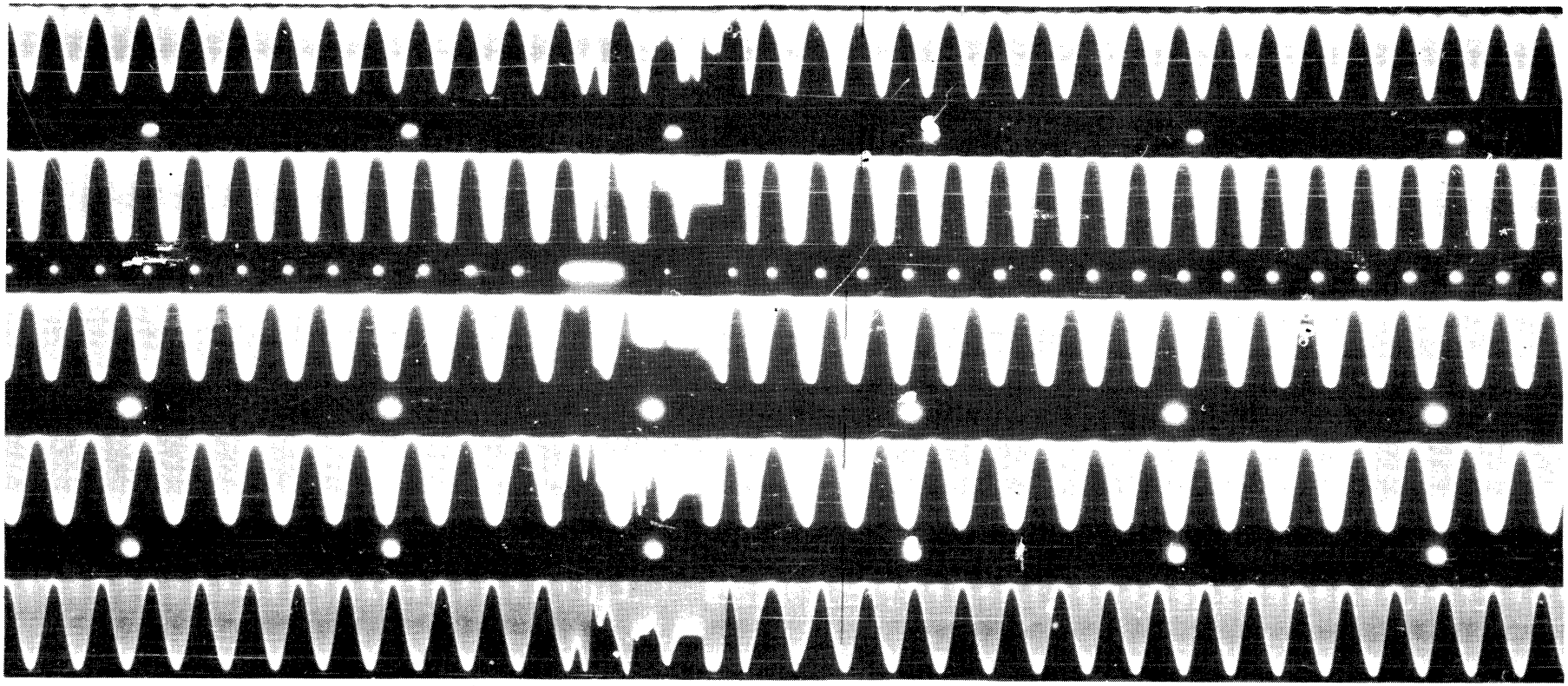


Fig. 4. DOVAP film at region of grenade burst.

TABLE III

GRENADE EXPLOSION TIMES

Grenade No.	SM 1.01	SM 1.02	SM 1.03	SM 1.04	SM 1.05	SM 2.06*	SM 1.07	SM 1.08	SM 1.09	SM 2.10
1	41.744	39.0358	38.3680	--	38.7668	41.9503	--	39.2831	38.6854	43.9582
2	45.204	42.0298	41.3773	41.6866	41.7730	45.7343	42.3572	42.3894	41.7814	46.3774
3	48.663	45.1531	44.4335	44.7869	44.8858	49.4440	45.5914	45.6181	44.9717	48.9072
4	52.188	48.4166	47.7373	48.0243	48.2113	53.2560	48.8208	48.9577	48.1783	--
5	55.650	51.7342	51.0017	51.3701	51.4937	57.1890	52.2612	52.2888	51.6035	54.0599
6	59.080	55.2460	54.4666	54.8197*	55.0334	61.2331	55.6803	55.7891	--	56.7322
7	62.560	58.8352	58.0455	--	58.6500	65.4614	59.3003	59.3840	58.6608	59.4905
8	--	62.4407	61.6446	62.0382*	62.3000	69.8003	71.0338	62.9762	62.2264	62.3377
9	69.527	66.2662	--	65.8629*	66.1715	74.3166	79.9684	66.7758	66.2478	65.2878
10	72.945	70.2945	69.4405	69.8587*	70.1842	79.0945	84.5194	70.8234	70.2326	68.2419
11	76.462	74.5227	73.7207	74.0596*	74.4957	84.0663	89.7604	75.0477	74.5319	71.2078
12	79.955	79.0256	78.1320	78.5164	78.9640	89.1821	95.3477	79.5152	79.1307	74.2415
13	83.371	83.7303	82.7256	83.1269	83.7406	94.6859	101.4408	84.1491	83.7179	77.3793
14	86.873	--	87.8266	88.2319	--	100.5521	108.1455	89.2134	88.8781	80.6485
15	90.373	94.3385	93.3013	93.8814	94.5359	106.7755	116.1500	94.7854	94.4032	84.0572
16	93.837	100.3767	99.3007	99.9588	100.4845	--	121.0941	100.7771	100.4068	--
17	97.350	107.2573	105.9615	106.8451	107.2339	121.1494	125.7996	107.4805	107.0338	91.1299
18	--	115.0386	113.7832	114.8679	115.1867	129.5989	132.7526	115.3818	115.0032	94.7446
19	**	124.6256	123.2545	124.8824*	124.8305	139.5436	185.8856	124.9132	124.5022	**

*Times taken from DOVAP film.
**No grenade in rocket.
--No explosion detected.

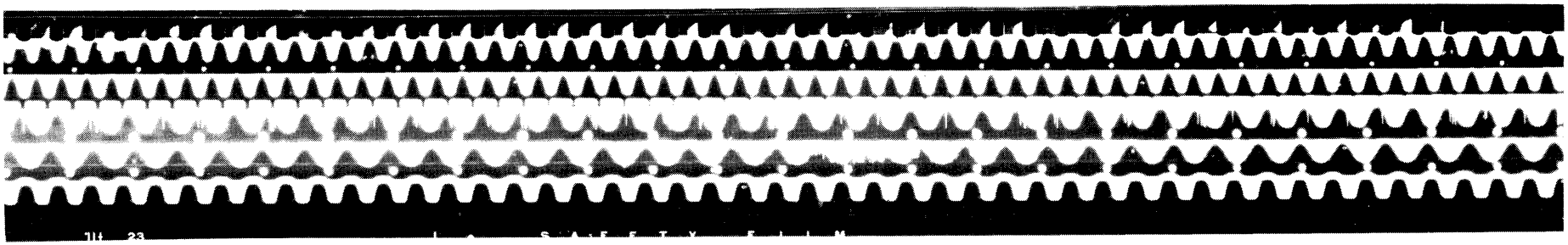


Fig. 5. DOVAP master station recording.

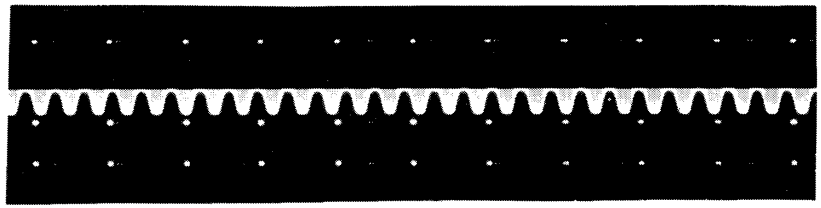


Fig. 6. Digges recording.

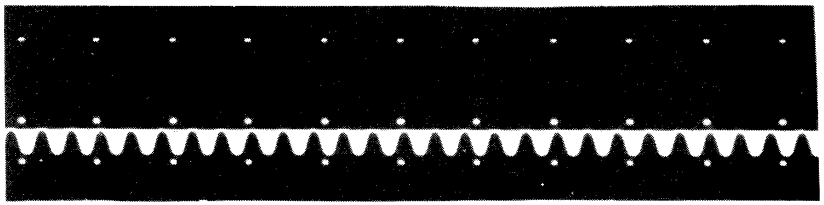


Fig. 7. Twin Lakes recording.

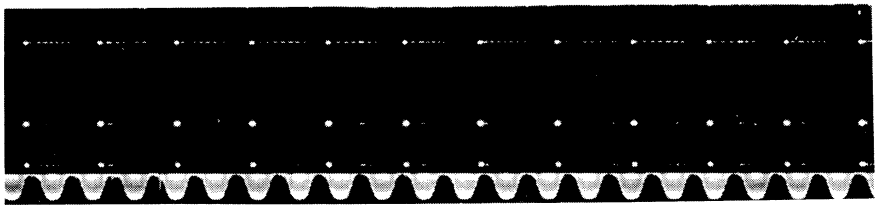


Fig. 8. Metro recording.

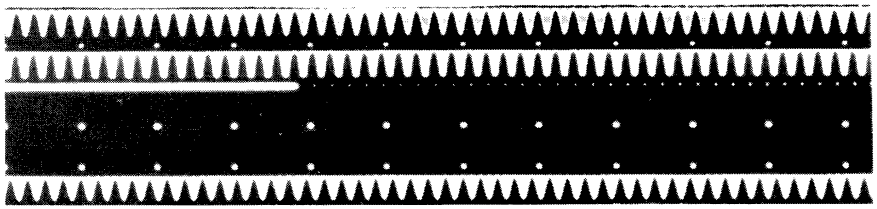


Fig. 9. Launch recording.

Every range-timing channel consisted of (1) a series of 100-pps marker pulses, (2) a marker pulse immediately followed by a few closely spaced dots (a 2-pps pulse), and (3) a 9-digit binary code, each digit of which was either a 2-pps pulse or just a marker pulse. The 2-pps pulses were to have been blanked out every ten seconds starting with the first missing 2-pps pulse (range zero time) after missile lift-off, and the binary codes should have occurred every five seconds after range zero time. However, on all films the first binary code occurred at 4.5 seconds and every five seconds thereafter, and the first 2-pps pulse blanked out after range zero time occurred at 9.5 seconds and every ten seconds thereafter.

The devices used to count doppler cycles are shown in Fig. 10. The film Reader consisted of a rectangular wooden box about 40 x 4 x 4 in. mounted on a wooden platform. An open slot ran lengthwise along the top of the box and was covered with a frosted glass plate which was slightly wider than 35-mm film. An idler was mounted at each end of the box and a film rewind mechanism was fastened to each end of the platform in line with the idlers and the glass plate. A fluorescent lamp was mounted inside the box and served to illuminate the film for easier reading.

The dividers were set to step over (count) the doppler cycles in lots of 5, 10, or 20 provided the divider points were spaced from one to two inches apart. It was found that if a wider spacing was used, the probability for error when counting cycles was appreciably increased, particularly prior to rocket burnout when the density of cycles and the rate of increase of cycles per unit time was the greatest. The optical comparator with its built-in scales was used to measure the fraction of a cycle which spanned a half-second marker. And the scale (millimeter) and slide rule were used whenever it was necessary to interpolate an abnormal set of cycles which spanned a half-second marker.

As soon as a set of films was received, a two-man team put the reels on Readers and checked range-timing channels for uniformity of 100-pps marker pulse spacing. Whenever a nonuniform section was found, the corresponding cycles in the doppler channel associated with this timing channel were also irregularly spaced so that the cycles had to be individually counted. And if a large part of a timing channel was nonuniform, a corrected copy of that film was requested. Of all the rolls of film received, only two timing channels had regions of uneven spacing, and of these only one, SM 2.06 TL_{1h}, needed to be replaced.

The next step prior to counting cycles was to locate and mark t_o time on each timing channel on the set of DOVAP films for that rocket firing. Since all times were given with respect to range zero time, time t_o was measured from the first missing 2-pps pulse. Grenade explosion times were also located and marked on each timing channel. And as a convenience when counting the cycles, the time at each second was written on each film with a grease pencil.

The method of counting doppler cycles as described in Ref. 7 and used to count SM 1.01 was to count individual cycles from t_o to a time at which divid-

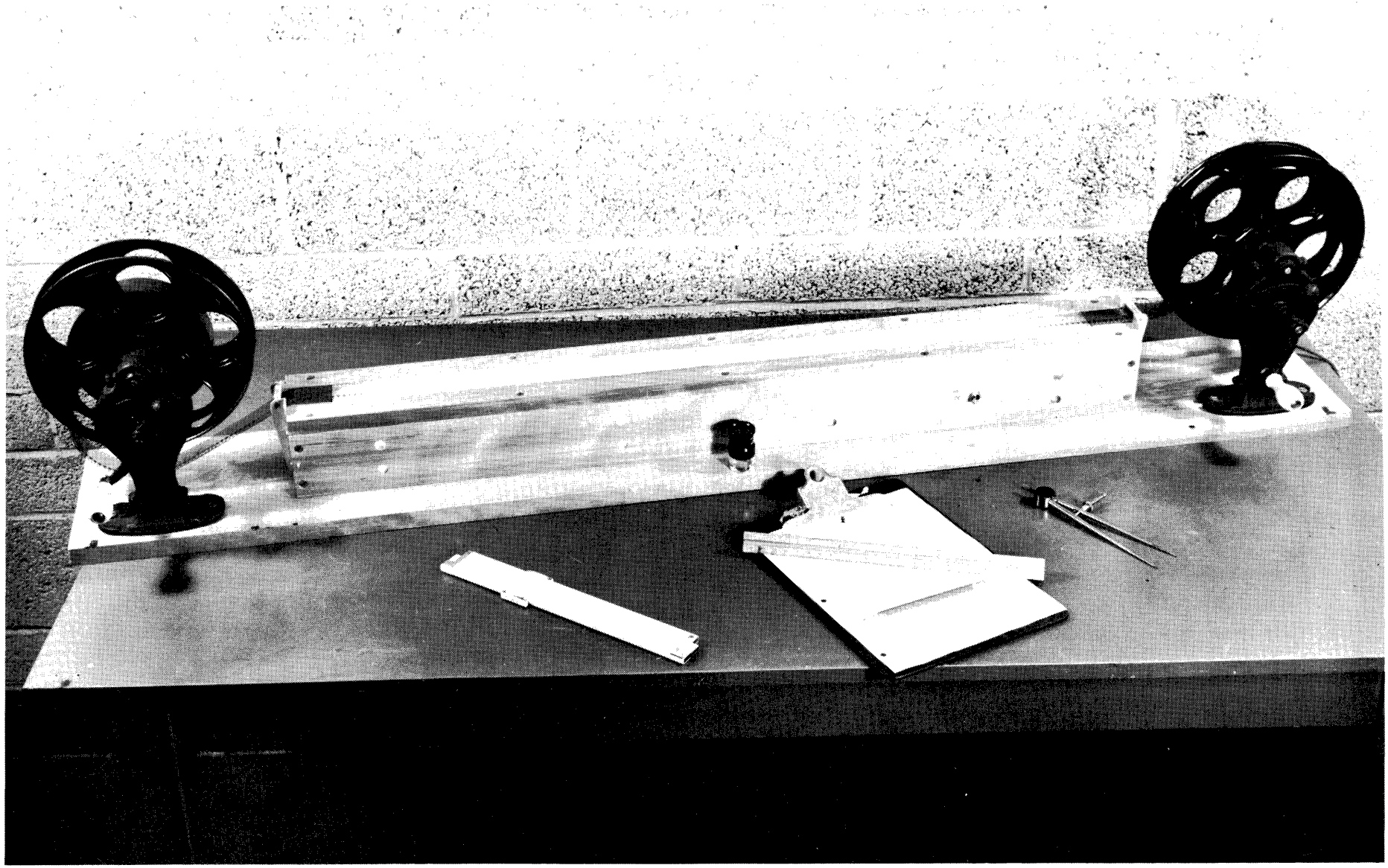


Fig. 10. Film reader and associated tools.

ers could be used. For the purpose of illustration, let this number of cycles be k. Then the rest of the cycles on the channel was divider-counted and the accumulated total count was written on the film at convenient points in multiples of 20, 50, 100, 200, or 500 cycles. Each operator then counted and recorded the number of cycles in each half-second interval by recording the total count nearest the half-second marker, and then counting the cycles from the total count mark to the half-second marker. The sum of the two counts plus k became the number of cycles from t_o to the time being considered. As soon as both operators had finished counting a channel, they compared their results point by point, resolved differences, recorded the corrected counts, and differenced successive pairs of counts to find the number of cycles in each half-seond interval.

The method of counting doppler cycles used for the remaining nine sets of data was comparatively simple and straightforward. Starting at 1.0 second, the fraction of the cycle which spanned the 1.0-second marker and lay in the 1.0-1.5-second interval was measured and recorded. Then the number of complete cycles in the interval was counted and recorded. Finally, the fraction of the cycle which spanned the 1.5-second marker and lay in the 1.0-1.5-second interval was measured and recorded. The sum of the two fractions and the number of whole cycles was recorded as the cycle count for that time interval. For any other interval, the number of complete cycles and the trailing fraction were counted in the same way; the leading fraction for this interval was the complement of the trailing fraction of the previous interval. This last statement represents the most significant difference in the two cycle-counting methods: there was no possibility of introducing systematic errors into the counts when fractions of cycles were measured by the second method. It took three days to count a channel of doppler cycles when either technique was used.

When both operators had finished counting a channel, they compared their results point by point. If their counts at any point differed by more than 0.1 cycle, the error could usually be traced to one of the following causes. In a region of well-formed and apparently evenly spaced ("countable") cycles, the trailing fraction could have been measured improperly, or the trailing fraction and its complement transposed, or the leading fraction improperly calculated. Whenever a 180° phase shift entered the doppler cycles smoothly over a small portion of the interval, a 1.0-cycle difference in the counts was caused by one of the operators using too wide a divider spacing to count the interval. In any case, the interval had to be re-counted to find the error and correct for it.

A sudden, deep 180° phase shift (Fig. 11) which appeared as a very noisy section in which from two to five countable cycles would normally be found occasionally caused a difference of 1.0 cycle. Every reasonable effort was made to count these few noisy cycles and, whether agreement on the count for this section was reached or not, the fact of the existence of the 180° phase shift was noted on the data sheet and the comparison of counts was continued. The reasons for leaving such a disturbed region before a correct count was obtained were that, even though both operators might get the same count, this did not

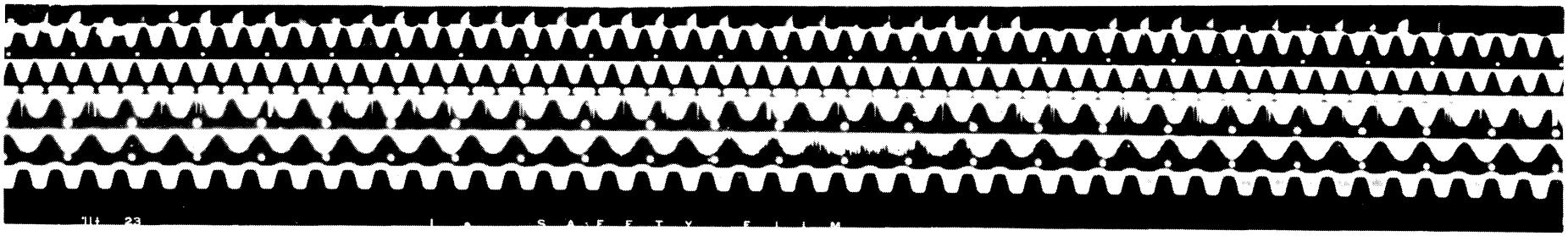


Fig. 11. Example of a deep null caused by a 180° phase shift.

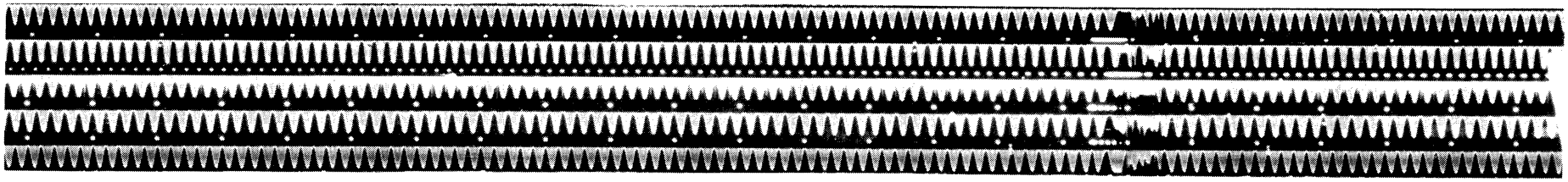


Fig. 12. The effect on doppler cycles of a grenade exploded at a low altitude.

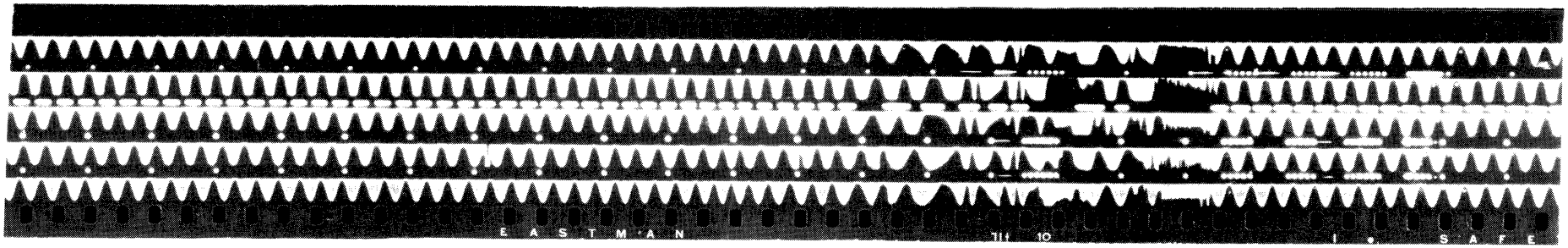


Fig. 13. The effect on doppler cycles of a grenade exploded at higher altitudes.

insure that the count was correct, and that when the cycle count data were plotted later in the data-reduction process, an error in one or both counts would show up as a sharp increase (or decrease) in the normally smooth curve presented by these data.

The expanding products of a grenade explosion which interfered with the signal transmitted from the rocket antennas appeared on the films as shown in Figs. 12 and 13. The first phase of the disturbance began less than 1 millisecond after the explosion time and consisted of secondary doppler cycles superimposed on the regular cycles, an effect very probably caused by multiple paths of transponder signal propagation. The second phase began less than 5 milliseconds after the grenade burst. It consisted of a region (5 milliseconds long for low-altitude bursts to about 50 milliseconds for the last upleg grenade explosion) of uncountable and noisy cycles produced when the rocket antennas were enveloped by the shock wave of the explosion. The third phase was an extended region of secondary doppler cycles superimposed on regular cycles which was due to the multiple propagation effects that occurred after the shock wave had passed by the antennas. The duration of this disturbance was about 10 milliseconds for the lowest altitude burst to more than half a second for the highest altitude explosions.

Two cycle counts were read and recorded for each grenade explosion. The first was taken in the regular way: the complement of the trailing fraction of the previous half-second interval was recorded as the leading fraction for the half-second interval in which the explosion time was marked, and this fraction was added to the number of integral cycles and the trailing fraction to the grenade-explosion time mark. The second cycle count, for the case of a disturbed region contained within a half-second interval and one that could be interpolated with a few divider steps, was taken as the difference between the count for the half-second interval and the first count.

Whenever the disturbed section for this case extended into the next time interval, the whole time interval was stepped over until the divider spanned the next half-second marker. The ratio of the divider-to-marker distance to the length of the divider span times the number of cycles for which the divider was set was taken as the trailing fraction for the interval. Again, the second cycle count was recorded as the difference of the full half-second count and the grenade count. And the complement of this trailing fraction was recorded as the leading fraction for the next interval. The divider interpolation method described thus far assumes that the divider would fall on the natural dividing line between cycles in the countable region which followed the disturbed section.

Whenever the uncountable region of doppler cycles which followed a grenade explosion extended over the greater part of a half-second interval, the divider interpolation method was complicated by the fact that slight adjustments had to be made in the divider spacing while stepping over the disturbed region because of the deceleration of the rocket. The countable cycles which immediately

followed the disturbed region were located and a representative divider spacing was established and carefully measured. Then a divider setting for the same number of cycles was made in the region just ahead of the explosion mark. The dividers were set to the average spacing of the two readings and the disturbed region was counted. These regions usually had to be counted several times before the counts of the operators would agree.

After the comparison of the counts for the channel had been completed, the region from 1.0 second to t_o remained to be counted and involved an extrapolation. The emergence switches were located at a distance from the top of the tower such that the rocket antennas were within the tower at time t_o and so were partially shielded. Therefore cycles did not become countable until a small fraction of a second after t_o. Starting at a point some 10 to 15 cycles beyond t_o and working toward t_o, the length of each successive cycle was measured and plotted against a uniform horizontal scale. When the length of the last full cycle ahead of t_o had been plotted, a curve which best fit the data was drawn and extended one full horizontal division beyond the last recorded point. The length of the extrapolated full cycle was read off the graph and the zero of the scale was set at the last full cycle (at t_1, say) ahead of t_o. The fraction of the cycle from t_1 to t_o was taken as the ratio of the distance to t_o to the length of the extrapolated full cycle, and the sum of this fraction, the number of whole cycles, and the complement of the previously measured leading fraction at 1.0 second, was recorded as the cycle count from t_o to 1.0 second. When the operators had compared their count for this interval, the cycle-counting procedures were repeated for the remaining seven channels of doppler data.

V. INTERMEDIATE DATA

A set of data sheets was prepared for each receiving station with columns headed Time, ΔN_{lh}, Geometry Correction, Corrected ΔN_{lh}, Anomalous Correction, ΔN_{rh}, $\Delta N'$, $1/2\ \Delta N'$, ΔN, and $\Delta^2 N$. Times were listed for every half-second from range zero time starting at the first recorded data point (usually 1.0 second). Grenade burst times were inserted in the proper half-second interval.

For each receiving station, the two counts of left-hand doppler cycles were averaged for each data point and the average values listed in ink in the ΔN_{lh} column and opposite the corresponding time. Then the pairs of right-hand counts were averaged and listed in the ΔN_{rh} column. Whenever there had been disagreement in the two counts at a data point, no number was recorded and the space on the data sheet was marked with brackets. Occasionally agreement on the cycle count was reached but the operators felt it was incorrect. In this case, the average count was recorded in pencil and the number bracketed. Before going further, the two columns of averaged cycle counts were checked.

The next operation was to spin-correct the data in the following way: $\Delta N_{lh} - \Delta N_{rh} = \Delta N'$, $\Delta N_{rh} - 1/2\ \Delta N' = \Delta N$, where $1/2\ \Delta N'$ is the amount of spin correction necessary. Justification for this method is found in the following analysis. Let F be the transmitter frequency radiated by the left-hand helix, let f_d be the induced doppler frequency, and let f_s be the frequency induced by the spinning rocket. Then:

frequency received by the transponder = $F - f_d \pm f_s$, and
frequency transmitted by the transponder = $2\ (F - f_d \pm f_s)$.

The frequency received by the helices on the ground is

left-hand helix (LH) = $2\ (F - f_d \pm f_s) \pm f_s$, and
right-hand helix (RH) = $2\ (F - f_d \pm f_s) \mp f_s$.

The heterodyned frequencies which correspond to the two possible directions of rocket spin are

LH: $F_d + 3f_s$, where F_d is the net doppler frequency,
RH: $F_d + f_s$,

and

LH: $F_d - 3f_s$,
RH: $F_d - f_s$.

Therefore, for the first case,

$$F_d + 3f_s - (F_d+f_s) = 2f_s, \qquad F_d + f_s - f_s = F_d \ , \tag{V-1}$$

and for the second case,

$$F_d - 3f_s - (F_d-f_s) = -2f_s, \qquad F_d - f_s - (-f_s) = F_d \ . \tag{V-2}$$

The procedure of spin-correction was to calculate the difference $\Delta N_{lh} - \Delta N_{rh} = \Delta N'$ for all data points and record the results. Taking half of each even-number $\Delta N'$ presented no problem; however, normal rounding of odd-number differences could have introduced a systematic error of more than a cycle into the spin-corrected cycle counts. Consequently successive pairs of odd-number $\Delta N'$ values were handled in the following way:

$$\Delta N_1' + \Delta N_2' = 2\,(1/2\ \Delta N_1' + 1/2\ \Delta N_2') \ . \tag{V-3}$$

When all the data points had been spin-corrected, the calculations were checked. All the steps above were repeated for the other three receiving stations.

False cycles were introduced into the doppler data by the motion of the rocket relative to the geometry of the helices at each receiving station. That is, the difference between the vectors from the helices to the rocket could change at a high enough rate to create an accumulation of several cycles of error in the doppler data from one of the two helices at each receiver. Since the right-hand helix had been chosen to represent its receiving station in all calculations, the doppler cycles from the left-hand helix were corrected for these false cycles in the following way. A trajectory was run off on the IBM 650 computer using the spin-corrected data up to 40 seconds. Although these data were imperfect, it was felt that a reasonably good trajectory would be obtained for determining the geometry corrections; it was also felt that most of the error due to the geometry of the pair of helices would be generated in the first 40 seconds of flight.

Let (r) = position vector of rocket with respect to tower,
(r_1) = vector from left-hand helix to rocket, and
(r_2) = vector from right-hand helix to rocket.

Then, starting at t_o, the total number of false cycles due to the geometry of the helices with respect to the rocket trajectory at any point was

$$(r_2)/\lambda - (r_1)/\lambda \ ,$$

and the number of cycles per unit time used for correcting the left-hand cycle counts was simply the difference between successive pairs of the last calculated values. The differenced values with the proper sign were recorded in the Geometry Correction column on the data sheet, the left-hand averaged cycle count was corrected, spin-corrections were recalculated, and the spin-corrected, geom-

etry-corrected doppler cycle counts were entered in the ΔN column. The data for the other receivers were corrected in the same way.

The ΔN data were plotted on graph paper large enough to be sensitive to four-digit numbers and to permit plotting an appreciable number of points before it became necessary to stagger the curves. The vertical scale was shifted vertically when necessary to separate the curves for easier viewing; the time base remained fixed for the four sets of cycle counts. When the corrected doppler cycle counts had been plotted for each of the four receiving stations, the data sheets, the original cycle counting sheets, and the films were re-examined at the times at which discontinuities appeared on the graph. Every effort was made to resolve the points for which no averaged cycle counts had been listed, the doubtful counts which had been penciled in on the data sheets, and the discontinuities on the graph. In any case, cycle counts were listed for every point on every set of doppler data sheets even if, as a last resort, they had to be selected from the graph.

Finally, the times at which nulls were detected by Launch dipole (Fig. 14) were read from the field-strength record and plotted together with the Σ 1/2 $\Delta N'$ data for each receiving station. All the films, the cycle-counting sheets, the doppler data sheets, and the two graphs, were then turned over to an editing group whose efforts were directed to the interpretation of anomalies in the doppler cycles due to the changing orientation of the rockets with respect to the DOVAP ground stations, and to a general refinement of the data.

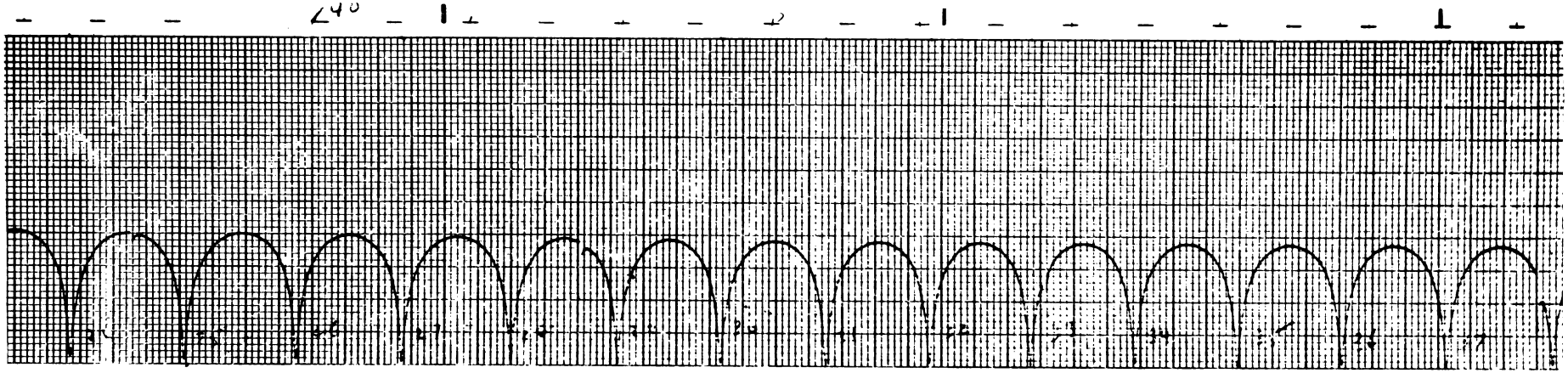


Fig. 14. Launch dipole field strength record, SM1.05.

VI. CORRECTION OF PHASE ERRORS

The process of correcting phase errors involves an examination of the tabulated cycle-count data, the corresponding ΔN and $\Delta N'$ plots, the film record, and other available data or information, to discover whether any phase changes are present in the DOVAP signal in addition to the doppler phase change due to the motion of the missile in its trajectory. Since we are interested only in the doppler phase change, the cycle counts must be corrected to eliminate errors arising from these other phase changes.

Virtually every change of phase observed on the films can be accounted for by one of the following causes:

A. Changes in missile antenna orientation with respect to ground array.

1. Missile spin with circular to linear antenna polarization.
2. Departures of transmitting and receiving helices from circularity.
3. Variation of phase with altitude angle along the lobe of the helices.

B. Grenade fireball.

1. Reflections.
2. Missile antenna detuning with ionization.

C. Voltage breakdown on missile antenna.[3]

The largest systematic phase changes encountered were due to changes in antenna orientation, particularly the usual missile spin shift.

Large phase shifts were also associated with the grenade bursts. The most serious of these last a considerable fraction of a second after the burst occurs. Such phase shifts could be due to antenna detuning caused by ionization in the fireball. Evidence for this, where DOVAP telemetry records are available, are sudden changes in antenna back power which occur at the same time as the grenade bursts. The phase changes at the grenade bursts are usually corrected during the cycle counting by stepping through the affected section with dividers. This amounts to an interpolation of the cycle count at the half-second interval where the phase change occurs.

Spurious phase shifts attributable to rf voltage breakdown on the missile antennas[3] were corrected in the same manner as those from grenade bursts. The presence of such phase shifts is evidenced by short, noisy sections on the record,

occurring at the same time on all channels, and, in addition, the waveform of the doppler cycle is usually distorted and irregular in such sections.

Early in some of the DOVAP records, there are intervals where the algebraic sign of the difference in the cycle count of left and right receiving helices at a down-range station differs from that for Launch. Since the sign of this difference, $\Delta N'$, is determined by the sense of missile rotation, this discrepancy is, at first sight, a little surprising. It might be suggested that, since the missile is launched at a slight angle with the vertical, some of the down-range stations will actually be looking at the uppermost hemisphere of the phase pattern of the missile transmitting antenna. Then, the $\Delta N'$ of these stations will necessarily be of opposite sign to that of Launch for a short period of time. However, for most of the cases where this reversal of sign occurs, the geometry of the situation makes such an explanation unacceptable. We will show later that the measured characteristics of the helical antennas at low-elevation angles account for this sign reversal.

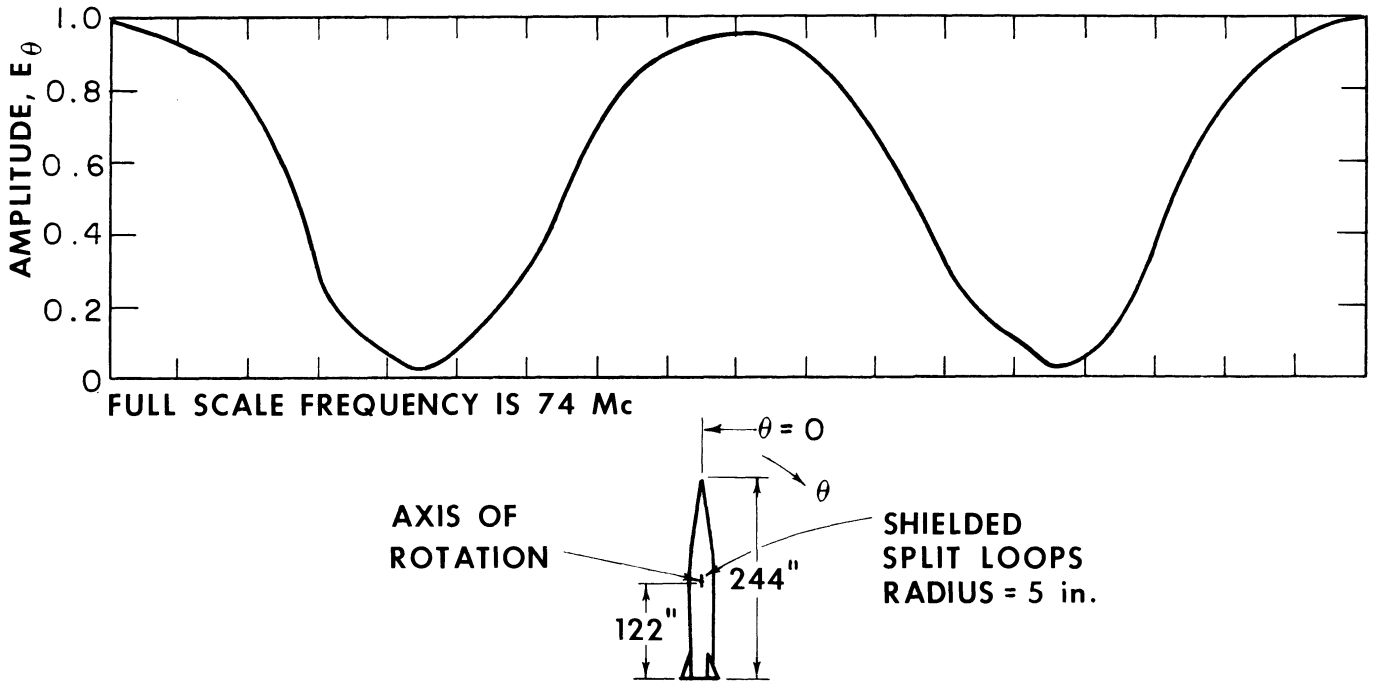
Since changes in antenna position and orientation give rise to the largest class of phase shifts (including the doppler shift itself), we will confine our attention to these phase shifts in the following discussion.

The DOVAP tracking system can be described simply as a system wherein the doppler phase modulation of a c.w. carrier is used to determine missile position. A 37-Mc (nominally) reference signal is radiated from a ground transmitter to the missile where it is doubled and re-transmitted to four ground receivers. We will refer to these two radiation paths as the 37-Mc and 74-Mc paths, respectively.

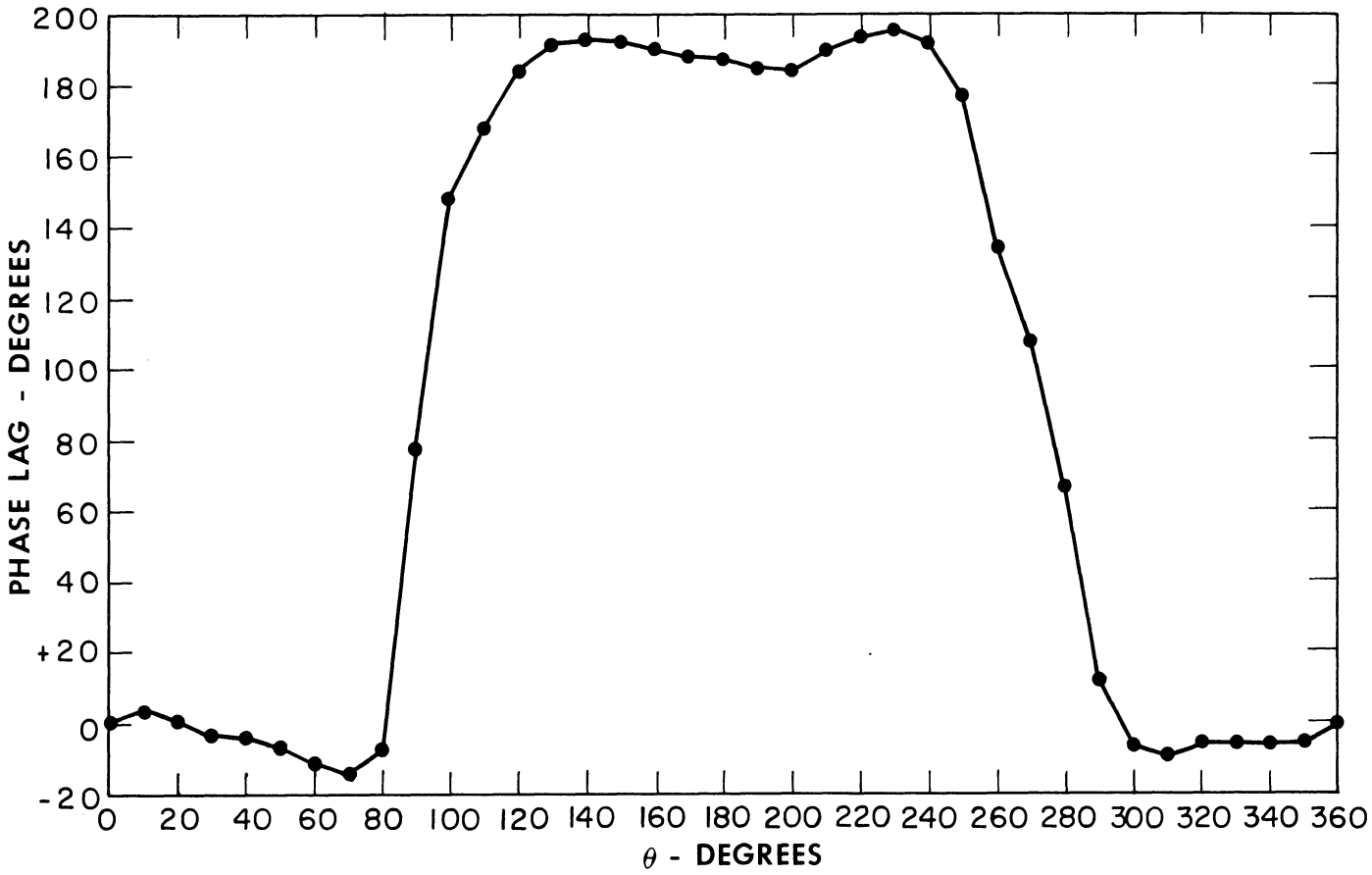
At Churchill,[3] the transmitting and receiving antennas are axial or beam mode helices. The transmitting antenna is a 1-3/4-turn helix with left-hand circular polarization. (Right-hand polarization means that the rotation of the electric vector is related to the direction of propagation in the same way as the rotation of a right-handed screw is related to its motion. Similarly, left-hand polarization has the same relationship to a left handed screw.) Each receiving station has a pair of 2-1/2-turn helices of opposite polarization. The field intensity or sensitivity pattern of both the transmitting and receiving helices is characterized by essentially a single lobe with a vertical maximun.

The 37-Mc receiving antenna and the 74-Mc transmitting antenna on the missile are both small rectangular loops, or "magnetic dipoles." The field intensity and phase patterns of such a loop are very similar to that of a short dipole oriented normal to the plane of the loop. The sensitivity pattern of such a loop can be represented as a cosine law. Both patterns have been measured on scaled antenna models by Stanford Research Institute (S.R.I.)[8] and are reproduced in Fig. 15.

Similar measurements have been made for the 74-Mc helix by S.R.I.[9] and are reproduced in Fig. 16 for both vertical polarization (in the plane of incidence

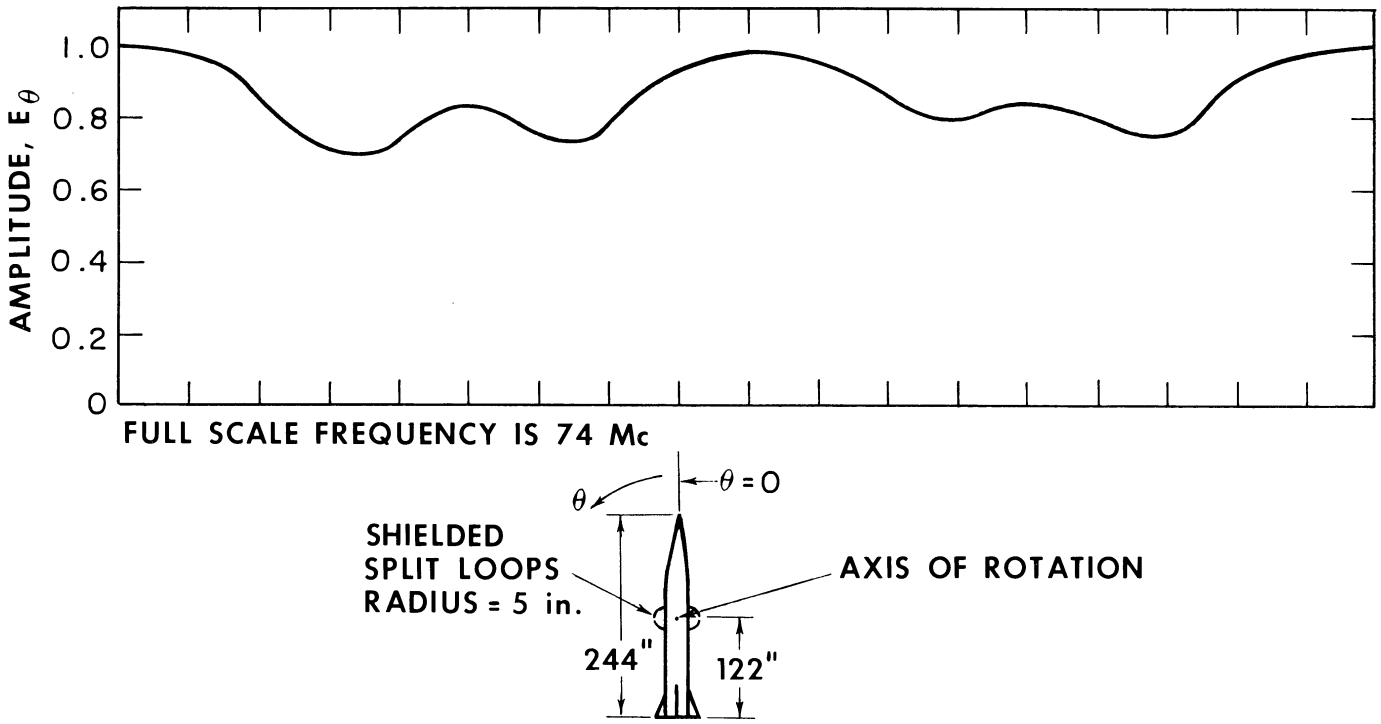


MISSILE ROTATED WITH AXIS IN PLANE OF ROTATION; LOOP PERPENDICULAR TO PLANE OF ROTATION

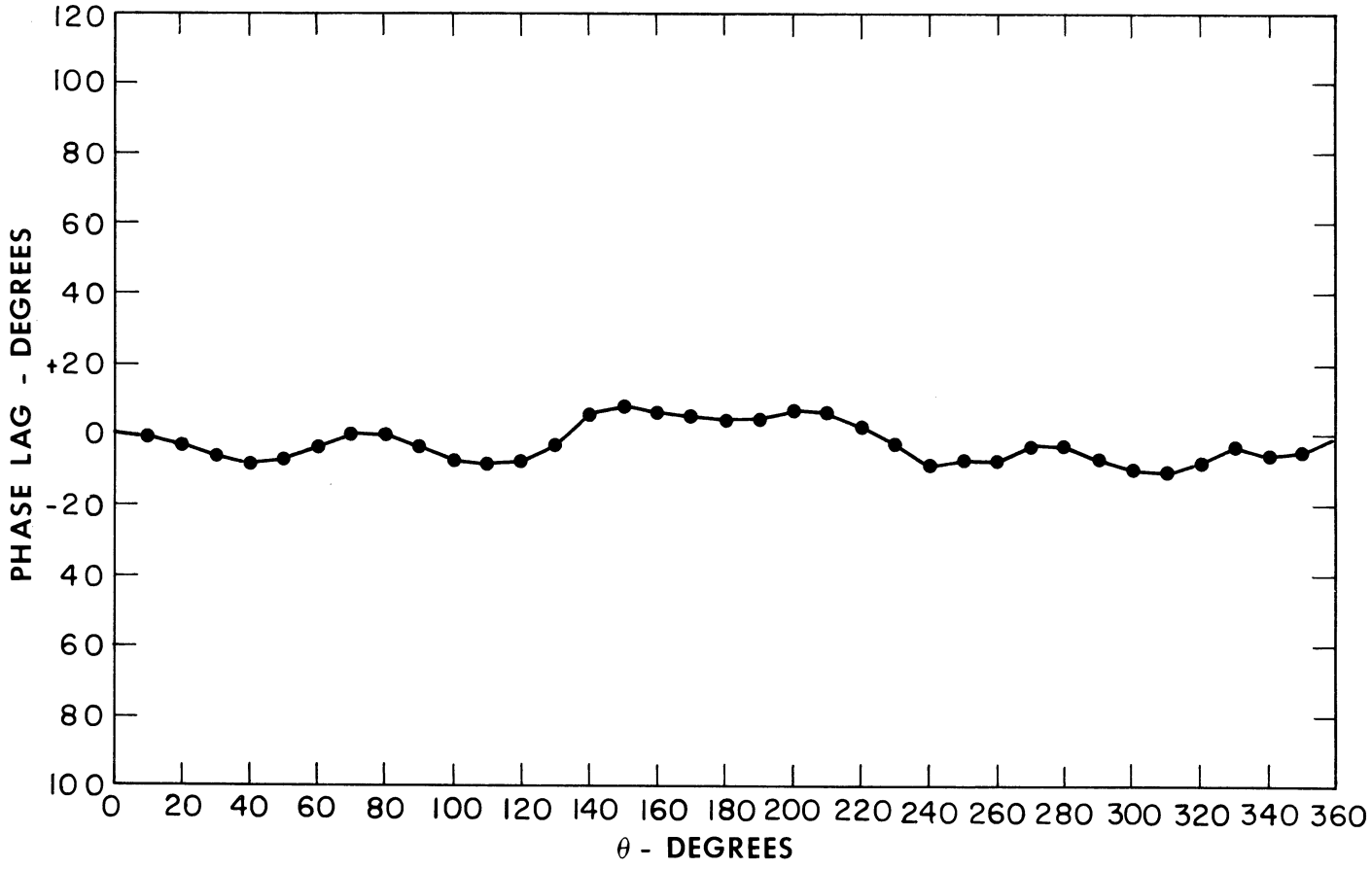


(a)

Fig. 15. Phase and amplitude patterns of loop antenna on Aerobee rocket.



MISSILE ROTATED WITH AXIS IN PLANE OF ROTATION; LOOP IN PLANE OF ROTATION



(b)

Fig. 15. (Concluded)

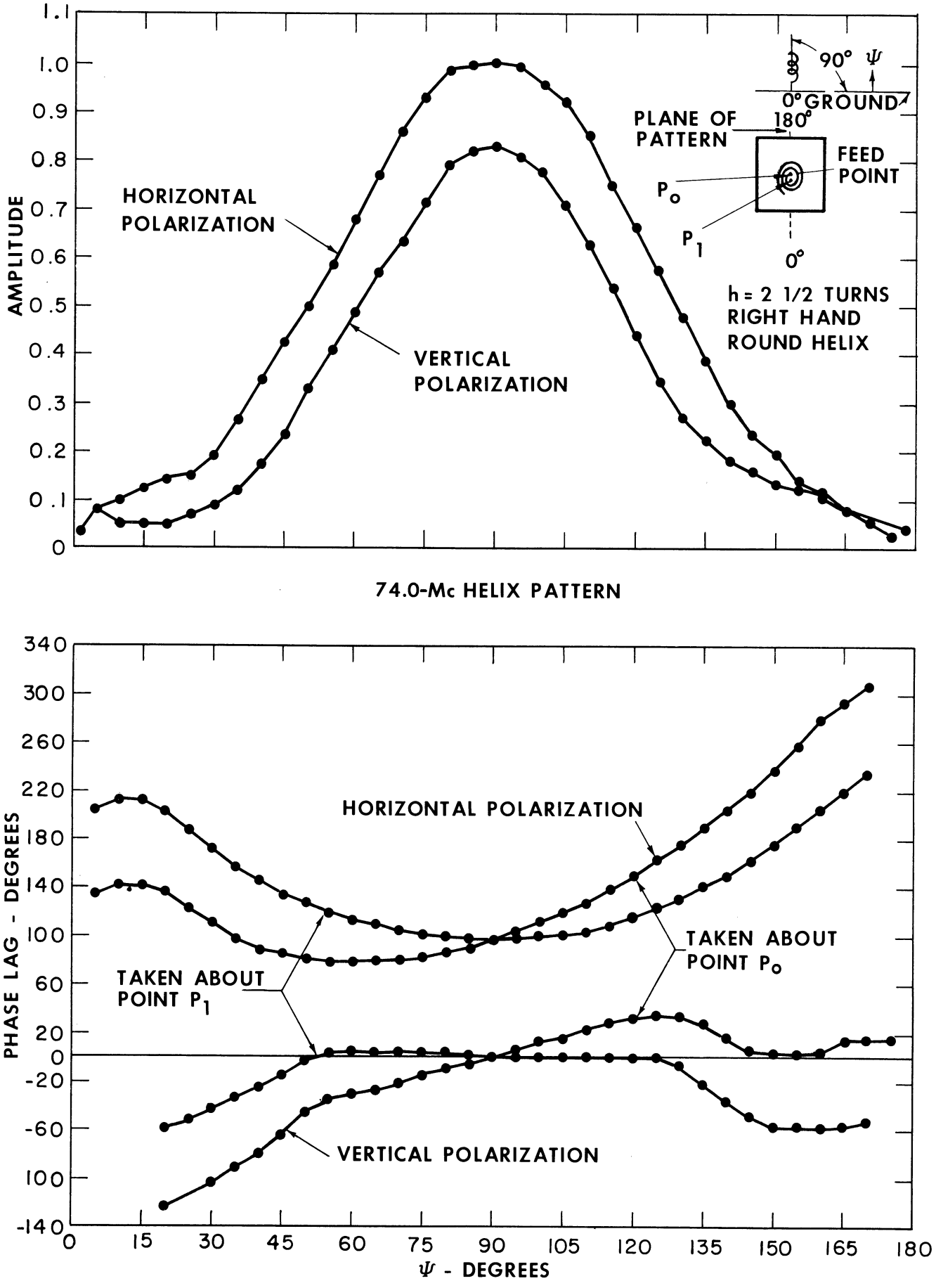


Fig. 16. Phase and amplitude patterns of 2-1/2 turn right-hand round helix.

defined by the incident ray and the normal) and horizontal polarization (normal to the plane of incidence). Since the 37-Mc helix has 1-3/4 turns, and the 74-Mc helix has 2-1/2 turns, while they both have the same scaled circumference, C_λ, and pitch, the 37-Mc helix is slightly less directive than the 74-Mc helix. Aside from this difference, the patterns of the two helices are essentially the same.

From Fig. 16, we see that for elevation angles of 0° to 90° there exists a phase difference of about 60° for vertical polarization and 120° for horizontal polarization. Consequently, as the missile assumes higher angles in its trajectory, a phase error will be introduced in the doppler count. The magnitude of this error is small enough compared to other phase errors so that correction is usually unnecessary.

At 90° elevation, the phase angle between signals induced by the two polarizations is nearly 90°, and the measured amplitudes are nearly equal. This approximates true circularity where the amplitudes are both equal and in quadrature phase. At lower elevation angles, the ellipticity (ratio of the semi-major to semi-minor axis of the polarization ellipse) increases.

Consider a linearly polarized antenna oriented at an arbitrary elevation angle, ψ, and radiating to a right-hand helix whose characteristics are those in Fig. 16. Let the linearly polarized antenna be a "short" dipole (or equivalently a magnetic dipole) rotating about an axis normal to its null axis. Since the amplitude pattern of a short dipole is essentially a cosine law, we can represent the electric vector at any look angle as being proportional to the projection normal to the direction of propagation of the dipole moment vector. The dipole moment vector, in turn, is proportional to a unit vector colinear with the null axis. Since we are interested in spin effects, it will be assumed that the only motion of the dipole is one of rotation. Without any loss of generality, we can also assume that, when the dipole is oriented for maximum coupling with vertical or horizontal polarization, the signal voltage at the helix will be numerically equal to the corresponding pattern amplitudes.

As a coordinate system for the description of this situation, let the z-axis be the direction of propagation, the x-z plane be the plane of incidence, and the y-axis completes the right-handed triad (x, y, z), as in Fig. 17.

The coordinate axis will be defined by unit vectors $\vec{i}$, $\vec{j}$, and $\vec{k}$. Let unit vectors $\vec{a}$ and $\vec{u}$ define, respectively, the null axis and the axis of rotation. Since $\vec{a}$ is normal to $\vec{u}$, $\vec{a} \cdot \vec{u} = 0$. The plane containing the axis of rotation and the direction of propagation will be defined by the normal $\vec{u} \times \vec{k}$. The intersection of this plane and the plane of rotation will be given by the vector $\vec{b}$, such that $\vec{b} \cdot \vec{u} = 0$ and $\vec{b} \cdot \vec{u} \times \vec{k} = 0$. Of the two possibilities for $\vec{b}$, choose the one so that $\vec{i} \cdot \vec{b} \geq 0$. θ will then be the angle measured clockwise as viewed from the origin, from $\vec{b}$ to $\vec{a}$, ϕ will be measured from $\vec{k}$ to $\vec{u}$, and if λ' is the angle taken with the usual positive sense in the x-y plane from $\vec{u} \times \vec{k}$ to $\vec{i}$, then $\lambda = -\lambda' + \pi/2$. The vertical, or x-component, of the plane polarized incident radiation is proportional to

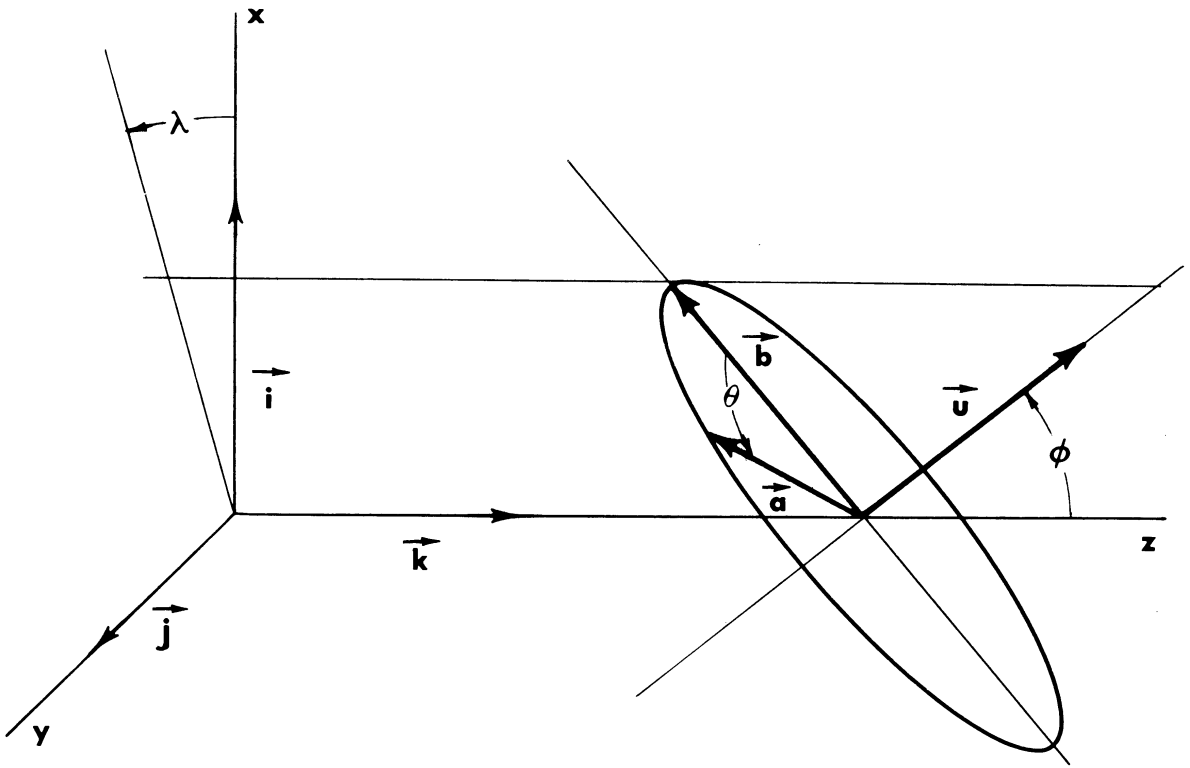


Fig. 17. Antenna coordinate system.

$$\cos\lambda\cos\phi\cos\theta - \sin\lambda\sin\theta \quad ,$$

while the horizontal, or y-component, is proportional to

$$\cos\lambda\sin\theta + \sin\lambda\cos\phi\cos\theta \quad .$$

Let A_1 be the pattern amplitude for vertical polarization; then since the field intensity has been defined on a per-unit-signal voltage basis, the voltage induced by the vertical component will be

$$V_1 = A_1(\cos\lambda\cos\phi\cos\theta - \sin\lambda\sin\theta)e^{j\omega t} \quad . \qquad \text{(VI-1)}$$

Similarly, if A_2 is the pattern amplitude for horizontal polarization, the voltage induced by the horizontal component will be

$$V_2 = A_2(\cos\lambda\sin\theta + \sin\lambda\cos\phi\cos\theta)e^{j(\omega t-\delta)} \quad , \qquad \text{(VI-2)}$$

where δ is the angle by which the voltage due to horizontal polarization lags the voltage due to vertical polarization. The total induced voltage is then

$$\vec{V} = \left[A_1(\cos\lambda\cos\phi\cos\theta - \sin\lambda\sin\theta) + A_2(\cos\lambda\sin\theta + \sin\lambda\cos\phi\cos\theta)e^{-j\delta}\right]e^{j\omega t} \quad . \qquad \text{(VI-3)}$$

The voltage phasor, A, is just the coefficient of $e^{j\omega t}$ or

$$\vec{A} = A_1(\cos\lambda\cos\phi\cos\theta - \sin\lambda\sin\theta) + A_2(\cos\lambda\sin\theta + \sin\lambda\cos\phi\cos\theta)\cos\delta - jA_2(\cos\lambda\sin\theta + \sin\lambda\cos\phi\cos\theta)\sin\delta \quad . \qquad \text{(VI-4)}$$

Suppose $\phi = 0$ and the helical antenna has circular polarization so that $A_1 = A_2 = 1$ and $\delta = \pi/2$; then

$$\vec{A} = \left[\cos(\lambda+\theta), -\sin(\lambda+\theta)\right] \quad . \qquad \text{(VI-5)}$$

Thus the phasor describes a complete rotation in a negative sense for every rotation of the dipole in a positive sense, or there is a loss of one cycle for every rotation of the dipole.

Now if the axis of rotation of the dipole is oriented vertically, then

$$\lambda = 0, \quad \phi = \frac{\pi}{2} - \psi$$

and

$$\vec{A} = A_1\sin\psi\cos\theta + A_2\sin\theta\cos\delta - jA_2\sin\theta\sin\delta$$

$$= (A_1\sin\psi\cos\theta + A_2\sin\theta\cos\delta, \; -A_2\sin\theta\sin\delta) \quad . \qquad \text{(VI-6)}$$

Using the S.R.I. data given in Fig. 16, analogue simulation of Eq. (VI-6) results in the phasor loci shown in Fig. 18. At low-elevation angles where the phase angle δ exceeds 180° the direction of rotation of the phasor is reversed. This accounts for the reversal of sign of the spin difference, $\Delta N'$, which is observed at the outlying stations early in many of the missile flights.

Thus far in our discussion we have included the case where the transmitting antenna is a small loop or magnetic dipole. Ideally the loop antennas installed on the missiles in the DOVAP system are of this type.[3] A pair of split half-loops mounted diametrically on the missile body and electrically continuous with it comprise the complete loop, with the plane of the loop containing the missile axis. The split half-loops are each fed at their centers with opposite phasing to provide a unifrom in-phase current around the entire loop. This current gives rise to a radiation mode, termed the transverse loop mode, whose vector moment, $\vec{M}_{TL}$, is normal to the plane of the loop. Imperfect phasing or balance of the feed to the half-loops can result in currents in the missile body with components parallel to the missile axis.[8] These currents give rise to an axial dipole radiation mode whose vector moment, $\vec{M}_A$, is parallel to the missile axis. Let us consider, then, the effect of the presence of such an axial mode.

As a simplifying assumption, let the phase centers of the two modes be coincident. If they are not, the phase angle between the two modes would need correcting, but the form of the result would be the same. Since the unit vector $\vec{u}$ in Fig. 17 defines the missile axis, the vector $\vec{M}_A$ will be proportional to $\vec{u}$. Let $K = M_A/M_{TL}$, and recall that we have defined the field components due to the transverse loop mode on a per-unit-signal voltage basis. Also let β be the angle the axial mode lags the transverse mode. Then the vertical field component will be proportional to

$$\tan \eta_2 = \tan \lambda \cos \phi$$

and the horizontal component proportional to

$$\eta = (\eta_1 - \eta_2)$$

Thus the signal voltage due to the axial mode is

$$\vec{V}' = (A_1 k \cos \lambda \sin \phi + A_2 k \sin \lambda \sin \phi \, e^{-j\delta}) e^{j(\omega t - \beta)} \quad . \qquad \text{(VI-7)}$$

Here the voltage phasor is

$$\begin{aligned} \vec{A}' &= (A_1 k \cos \lambda \sin \phi + A_2 k \sin \lambda \sin \phi \, e^{-j\delta}) \, e^{-j\beta} \\ &= A_1 k \cos \lambda \sin \phi \cos \beta + A_2 k \sin \lambda \sin \phi \cos (\delta+\beta) \\ &\quad - j\{A_1 k \cos \lambda \sin \phi \sin \beta \\ &\quad + A_2 k \sin \lambda \sin \phi \sin (\delta+\beta)\} \quad . \end{aligned} \qquad \text{(VI-8)}$$

The vector addition of this equation to Eq. (VI-4) for $\vec{A}$ will result in the phasor for the total signal voltage in the presence of an axial radiation and a transverse loop mode. We see that phasor loci of $\vec{A}$ are simply displaced from

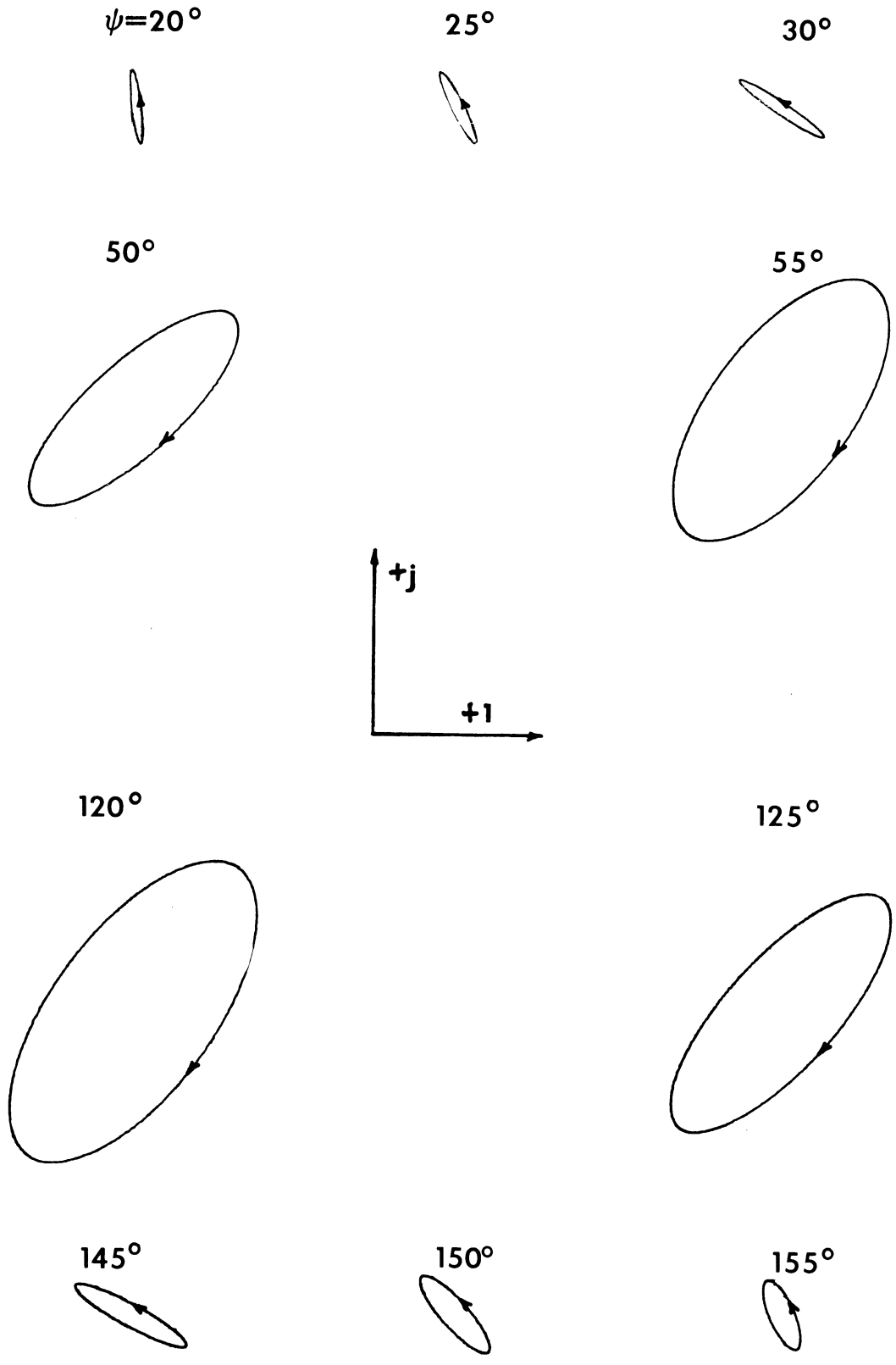


Fig. 18. Phasor loci for 74-Mc helix.

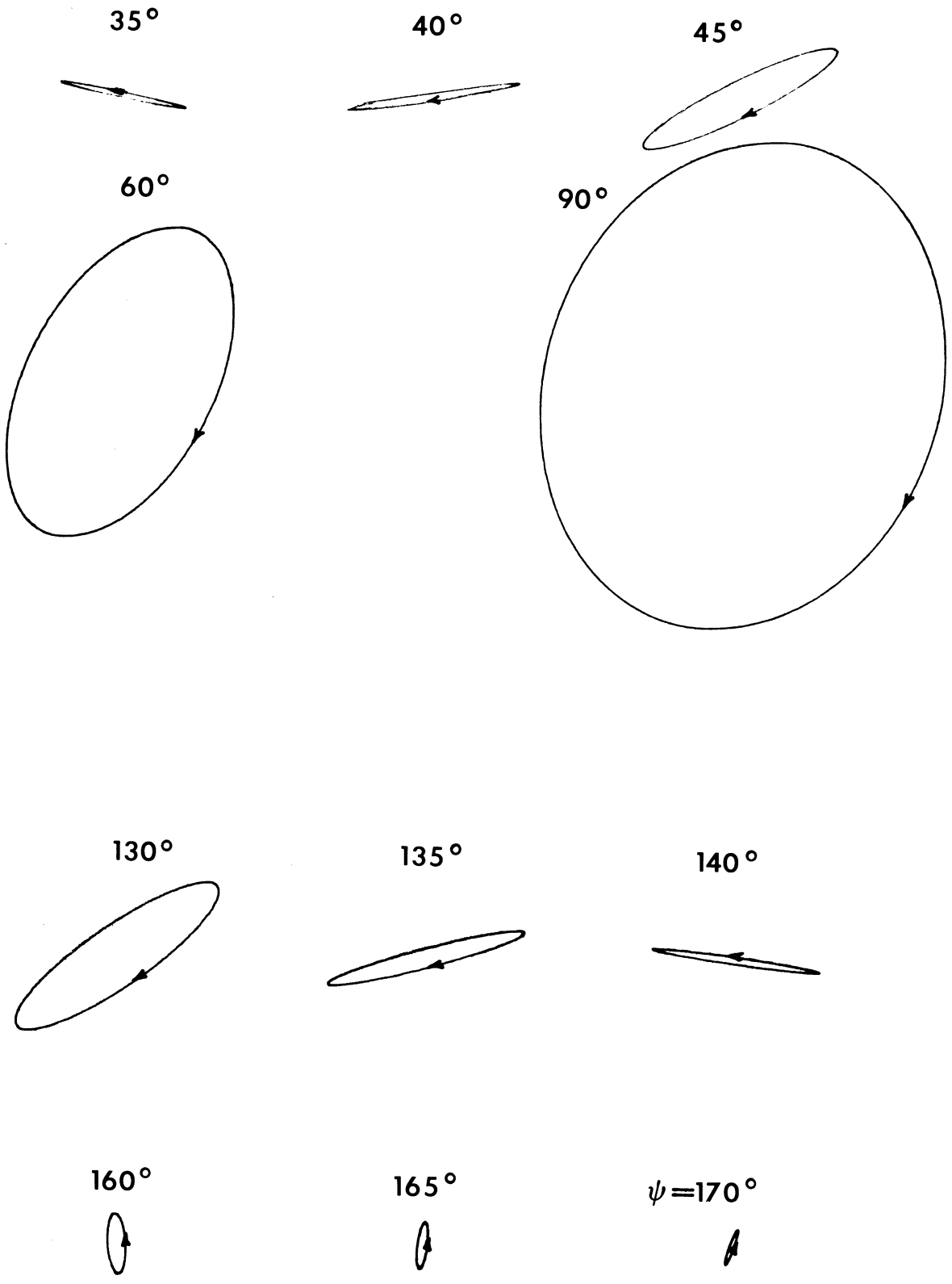


Fig. 18. (Concluded)

the origin by the vector $\vec{A}'$. It should be noticed that $\vec{A}'$ depends only on the orientation of the missile axis and is independent of the angle of rotation Θ. Let the missile axis be oriented vertically so that $\lambda = 0$, and $\phi = \pi/2 - \psi$; then

$$\vec{A}' = (A_1 k \cos \psi \cos \beta, - A_1 k \cos \psi \sin \beta) \quad . \tag{VI-9}$$

Since the left- and right-hand helices should differ only in the sense in which they are wound, and the x-axis in Fig. 17 is the axis of the helix, Equations (VI-4) and (VI-8) would apply to a left-hand helix in the left-hand coordinate system obtained by reflecting the y-axis of the original coordinate system. This amounts to asserting that the situation where a vertically polarized electric field is presented to a right-hand helix is indistinguishable from the situation where the same electric field is presented to a left-hand helix; also, as the plane of polarization of the electric field rotates from a vertical to a horizontal position through positive angles, the phase shift seen by a right-hand helix will be the same as that seen by a left-hand helix if the rotation were in the opposite sense. Reflecting the y-axis is equivalent simply to taking the sign of the horizontally polarized component in the opposite sense in the preceding discussion (or, equivalently, substituting $\delta + \pi$ for δ in (VI-4) and (VI-8). Consequently, with the coordinates of Fig. 17, the corresponding phasors for a left-hand helix will be

$$\begin{aligned} \vec{A} = {} & A_1(\cos \lambda \cos \phi \cos \Theta - \sin \lambda \sin \Theta) \\ & - A_2 (\cos \lambda \sin \Theta + \sin \lambda \cos \phi \cos \Theta) \cos \delta \\ & + jA_2 (\cos \lambda \sin \Theta + \sin \lambda \cos \phi \cos \Theta) \sin \delta \quad , \end{aligned} \tag{VI-4a}$$

and

$$\begin{aligned} \vec{A}' = {} & A_1 k \cos \lambda \sin \phi \cos \beta - A_2 k \sin \lambda \sin \phi \cos (\delta+\beta) \\ & - j\{A_1 k \cos \lambda \sin \phi \sin \beta - A_2 k \sin \lambda \sin \phi \sin (\delta+\beta)\} \quad . \end{aligned} \tag{VI-8a}$$

In particular, Eq. (VI-5) becomes

$$\vec{A} = [\cos (\lambda+\Theta), \sin (\lambda+\Theta)] \quad . \tag{VI-5a}$$

Thus the phasor $\vec{A}$ for a left-hand helix describes a complete positive rotation with each missile rotation.

In the derivation for the phasor $\vec{A}$, Eq. (VI-4), the projection of the unit vector $\vec{a}$ on the x-y plane in Fig. 17 was proportional to the electric vector, and the x and y components of this projection were in turn proportional to vertical and horizontal components of the electric field. As the missile rotates,

the terminus of this projection describes an ellipse in the x-y plane. This is illustrated in Fig. 19 with $\vec{a}'$ and $\vec{u}'$ as the projections of the unit vectors $\vec{a}$ and $\vec{u}$, respectively. Because of the way we defined the intensity of the electric field, the amplitude of the signal voltage due to each field component was just equal to the product of the pattern amplitude of the corresponding component of the projection of $\vec{a}$. We can write the vertical voltage amplitude as

$$A_1 (\cos \lambda \cos \phi \cos \theta - \sin \lambda \sin \theta) = a \sin (\gamma+\eta) \quad ,$$

where

$$a = A_1 \sqrt{\cos^2 \lambda \cos^2 \phi + \sin^2 \lambda}$$

$$\gamma + \eta = \theta + \eta_1 \quad ,$$

and

$$\tan \eta_1 = - \cot \lambda \cos \phi \quad ,$$

and the horizontal voltage amplitude as

$$A_2 (\cos \lambda \sin \theta + \sin \lambda \cos \phi \cos \theta) = b \sin \gamma \quad ,$$

where

$$b = A_2 \sqrt{\cos^2 \lambda + \sin^2 \lambda \cos^2 \phi}$$

$$\gamma = \theta + \eta_2 \quad ,$$

and

$$\tan \eta_2 = \tan \gamma \cos \phi \quad ;$$

hence

$$\eta = (\eta_1 = \eta_2) \quad ,$$

or

$$\tan \eta = - \frac{2 \cos \phi}{\sin 2\lambda \sin^2 \phi}$$

Consequently Eqs. (VI-4) and (VI-4a) become

$$\vec{A}_R = a \sin (\gamma+\eta) + b \sin \gamma \, e^{-j\delta} \quad , \qquad \text{(VI-10)}$$

and

$$\vec{A}_L = a \sin (\gamma+\eta) - b \sin \gamma \, e^{-j\delta} \quad . \qquad \text{(VI-10a)}$$

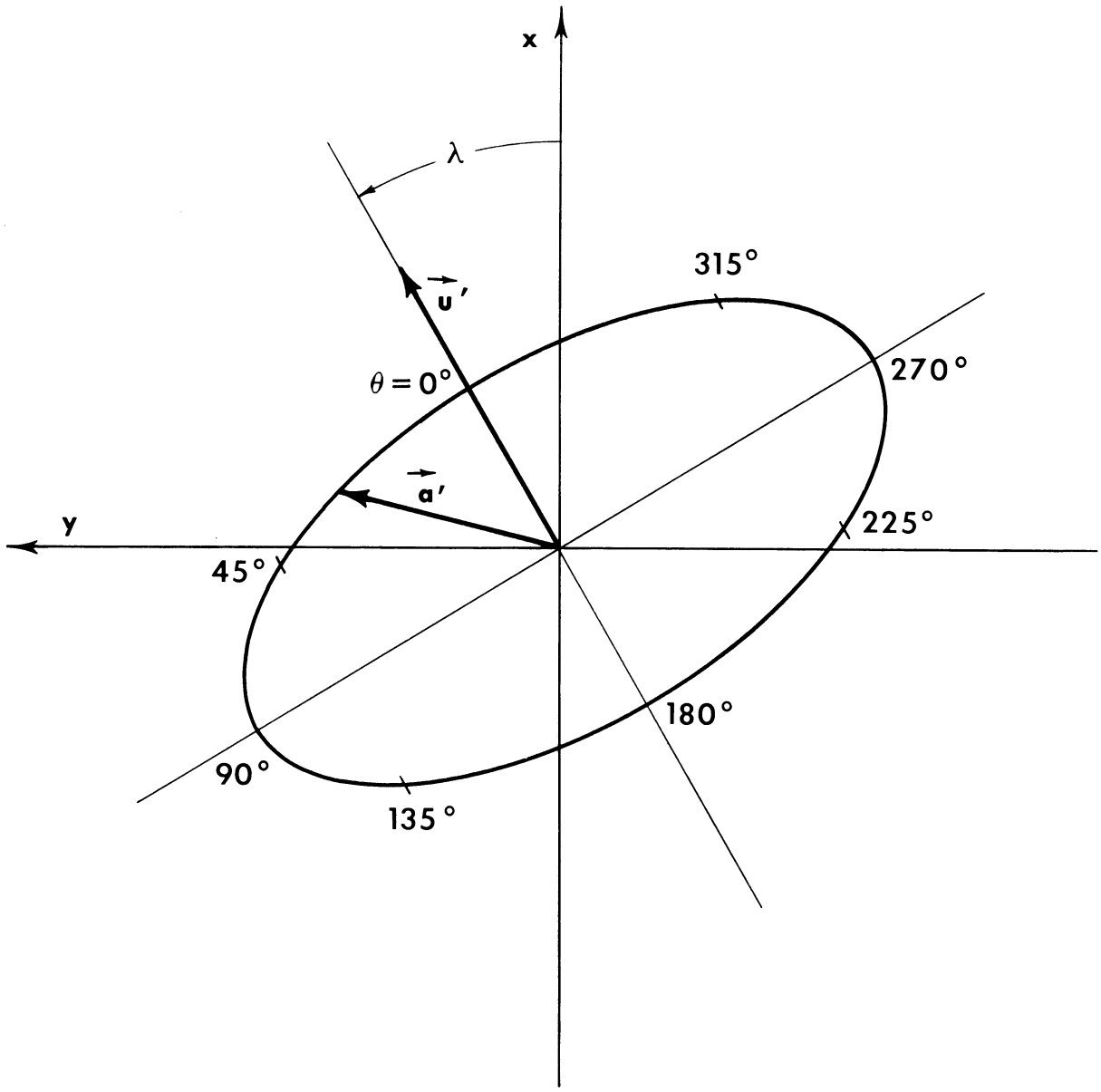


Fig. 19. Projection on the x-y plane.

Here the phasor $\vec{A}$ for right and left-hand helices are denoted by subscripts R and L respectively.

The vector quantities

$$[a \sin (\gamma+\eta), + b \sin \gamma]$$

and

$$[a \sin (\gamma+\eta), - b \sin \gamma]$$

in the complex plane represent ellipses of the same shape, one being the reflection of the other about the real axis. The first of these (Fig. 20) is the image, $\{\vec{a}' \; T_R\}$, of the elliptical locus of $\vec{a}'$ in the x-y plane under the mapping given by

$$(x, y) \xrightarrow{T_R} (A_1 x, A_2 y) \quad ,$$

while the second is the image, $\{\vec{a}' \; T_L\}$, of the mapping

$$(x, y) \xrightarrow{T_L} (A_1 x, - A_2 y) \quad .$$

Thus Eqs. (VI-10) and (VI-10a) suggest that we think of the loci of $\vec{A}_L$ and $\vec{A}_R$ as being the image, in turn, of these two ellipses in the oblique coordinate system defined by the unit vectors (1, 0) and $e^{-j\delta}$. This situation is illustrated in Fig. 21 for an arbitrary missile orientation.

When $\lambda = 0$, or $\lambda = n\pi/2$, the elliptical loci of $\vec{A}_L$ and $\vec{A}_R$ are coincident. In general, however, their shapes will be distinct (although their areas will be the same), and their major axes will have different orientations. Similarly, the x- and y-components of the projection, $\vec{u}'$, of the unit vector $\vec{u}$ on the x-y plane were proportional to the vertical and horizontal components of the electric field due to axial radiation mode. The amplitude of the signal voltage due to the vertical field component was

$$A_1 k \cos \lambda \sin \phi \quad ,$$

while the amplitude due to the horizontal component was

$$A_2 k \sin \lambda \sin \phi \quad ,$$

where k was the ratio of the magnitude of the axial dipole moment to the magnitude of the transverse loop moment. We can rewrite Eqs. (VI-8) and (VI-8a) as

$$\vec{A}_R' = (A_1 k \cos \lambda \sin \phi + A_2 k \sin \lambda \sin \phi \; e^{-j\delta}) e^{-j\beta} \quad , \qquad \text{(VI-11)}$$

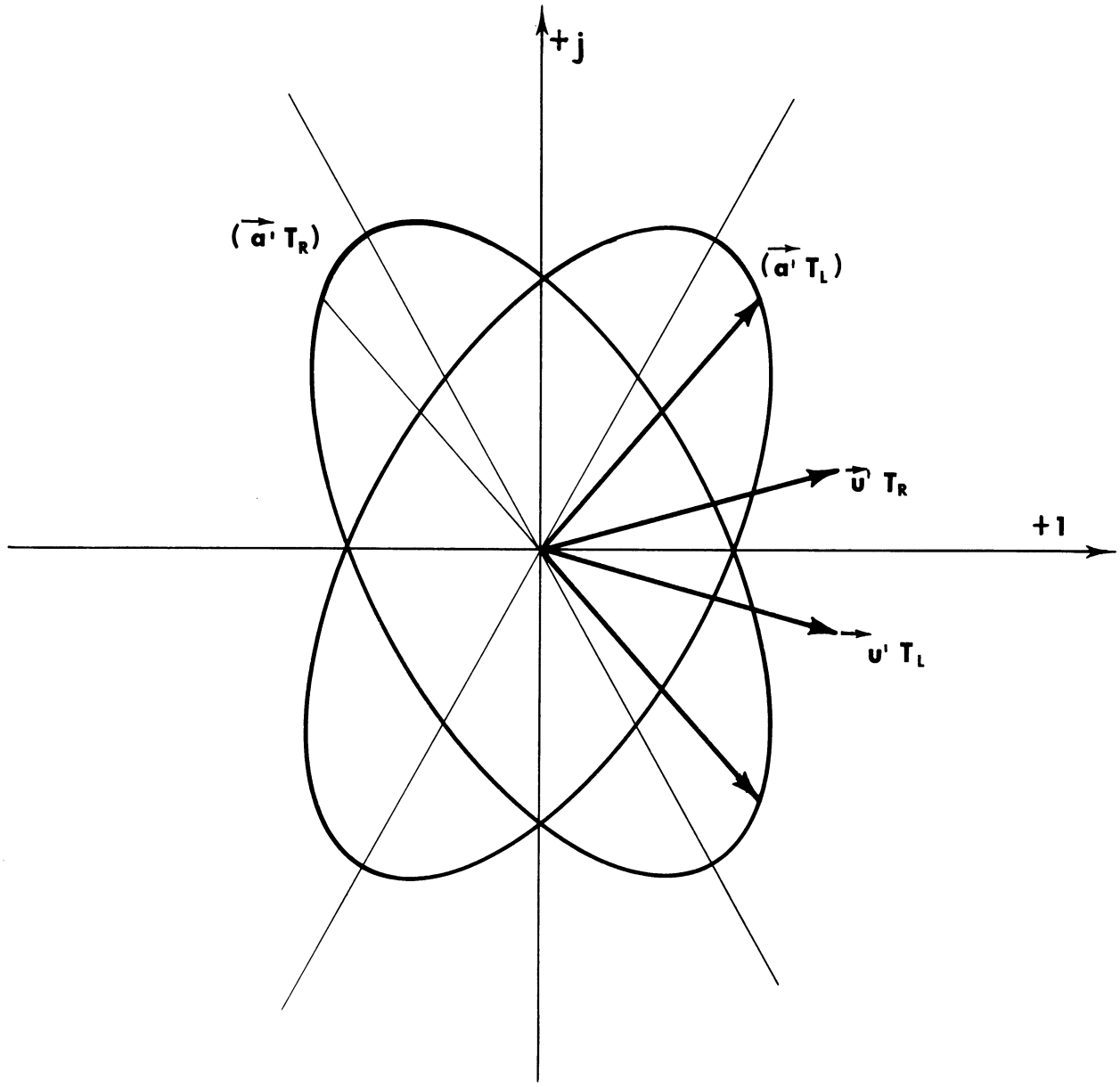


Fig. 20. Images of the vectors $\vec{a}'$ and $\vec{u}'$ in the complex plane.

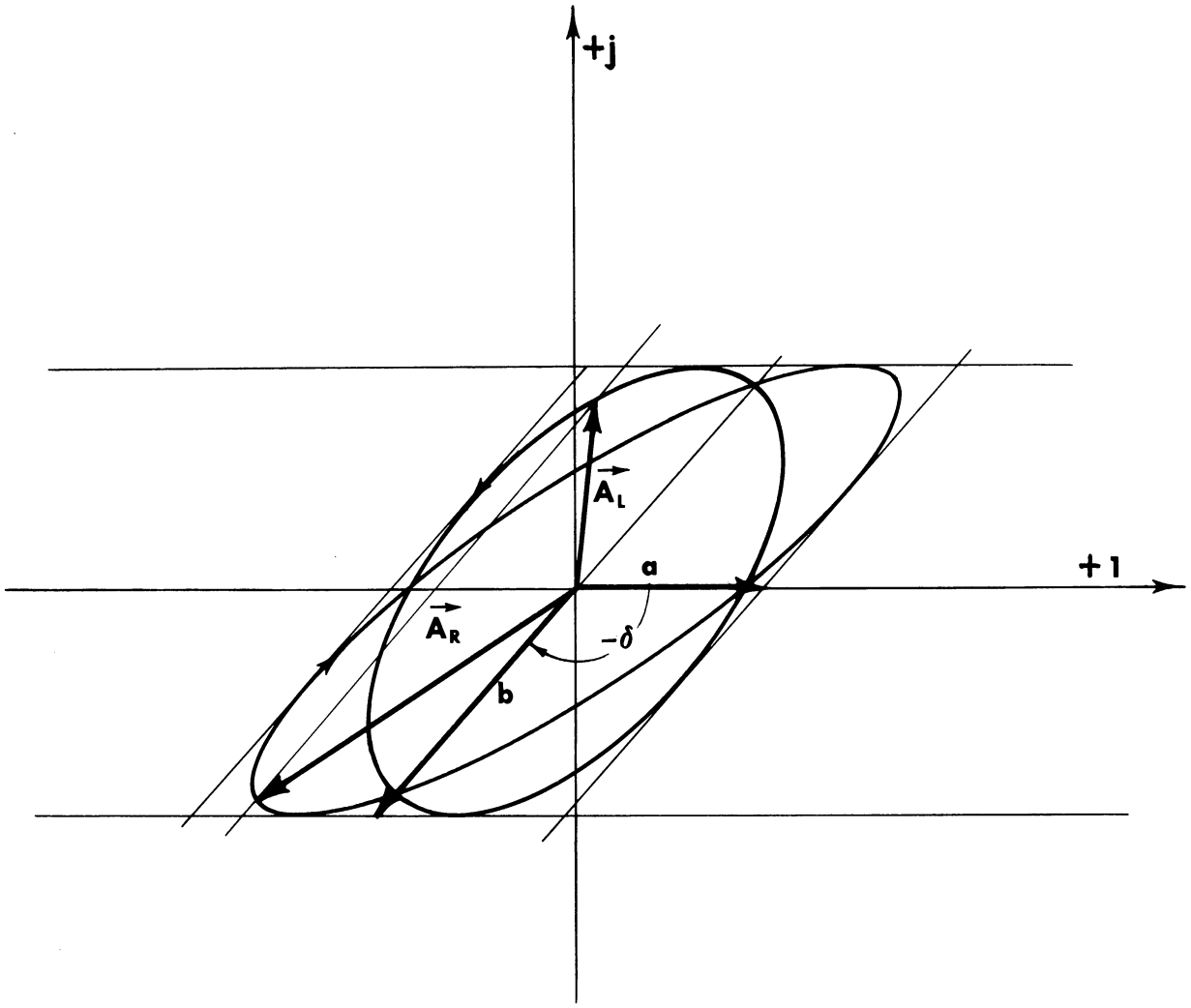


Fig. 21. Loci of the phasors $\vec{A}_L$ and $\vec{A}_R$.

and

$$\vec{A}_L' = (A_1 k \cos\lambda \sin\phi - A_2 k \sin\lambda \sin\phi\, e^{-j\delta}) e^{-j\beta} \quad . \qquad \text{(VI-11a)}$$

Thus if we map the vector

$$\vec{u}' = [\cos\lambda \sin\phi,\ \sin\lambda \sin\phi]$$

into the complex plane by the mappings T_R and T_L, as in Fig. 20, then Eqs. (VI-11) and (VI-11a) suggest that we think of the phasors $\vec{A}_L'$ and $\vec{A}_R'$ as the result of rotating the images of $\vec{u}'$ T_L and $\vec{u}' T_R$ in the oblique coordinate system with the basis vectors (1, 0) and $e^{-j\delta}$ through the angle $-\beta$ and multiplying their magnitudes by k. Figure 22 represents this situation.

Let $\vec{A}''$ be the vector sum of $\vec{A}$ and $\vec{A}'$; then $\vec{A} = \vec{A}'' - \vec{A}'$. Thus, if we place $\vec{A}$ and $-\vec{A}'$ at the origin, $\vec{A}''$ will complete the sum from the terminus of $-\vec{A}'$ to the terminus of $\vec{A}$. Labeling the phasors, as before, by subscripts L and R, respectively, for left and right helices, the relative phase-amplitude variation for both helices is depicted by Fig. 23 for some arbitrary missile orientation. The arrow on the locus indicates the direction of rotation of $\vec{A}$ with increasing θ.

It is interesting to notice that the origin for the phasor $\vec{A}_R''$ is displaced outside the locus by the phasor $-\vec{A}_R'$. Furthermore, $-\vec{A}_R'$ is essentially fixed since it is independent of θ, and depends only on the orientation of the missile axis. Consequently $\vec{A}_R''$ fails to describe a rotation about its origin as the missile makes a complete rotation, and the net phase shift becomes zero. Equations (VI-4) and (VI-8) show that, when $k > 0$, there will always be some angle ϕ for which this occurs. Early in the trajectory when the missile axis is nearly vertical, $\phi = \pi/2 - \psi$ and the phasors $\vec{A}$ and $\vec{A}'$ are given by Eqs. (VI-6) and (VI-9). The amplitude minimum will occur when θ is such that $\vec{A}$ is 180° out of phase with $\vec{A}'$. The condition on θ is then

$$\tan\theta = \frac{A_1 \sin\psi \sin\beta}{A_2 \sin(\delta-\beta)} \quad . \qquad \text{(VI-12)}$$

The amplitude minimum will be zero when the corresponding components of $\vec{A}$ are equal in magnitude to those of $\vec{A}'$ at this point. This happens when

$$k = \frac{A_2 \sin\psi \sin\delta}{\cos\psi \sqrt{\{A_1^2 \sin^2\psi \sin^2\beta + A_2^2 \sin^2(\delta-\beta)\}}} \quad . \qquad \text{(VI-13)}$$

when k exceeds the quantity on the right, the locus of the phasor fails to enclose the origin. Thus, if k is greater than zero, there will always be elevation angles ψ which satisfy this condition. At these points in the trajectory, an "anomalous spin" correction will be required.

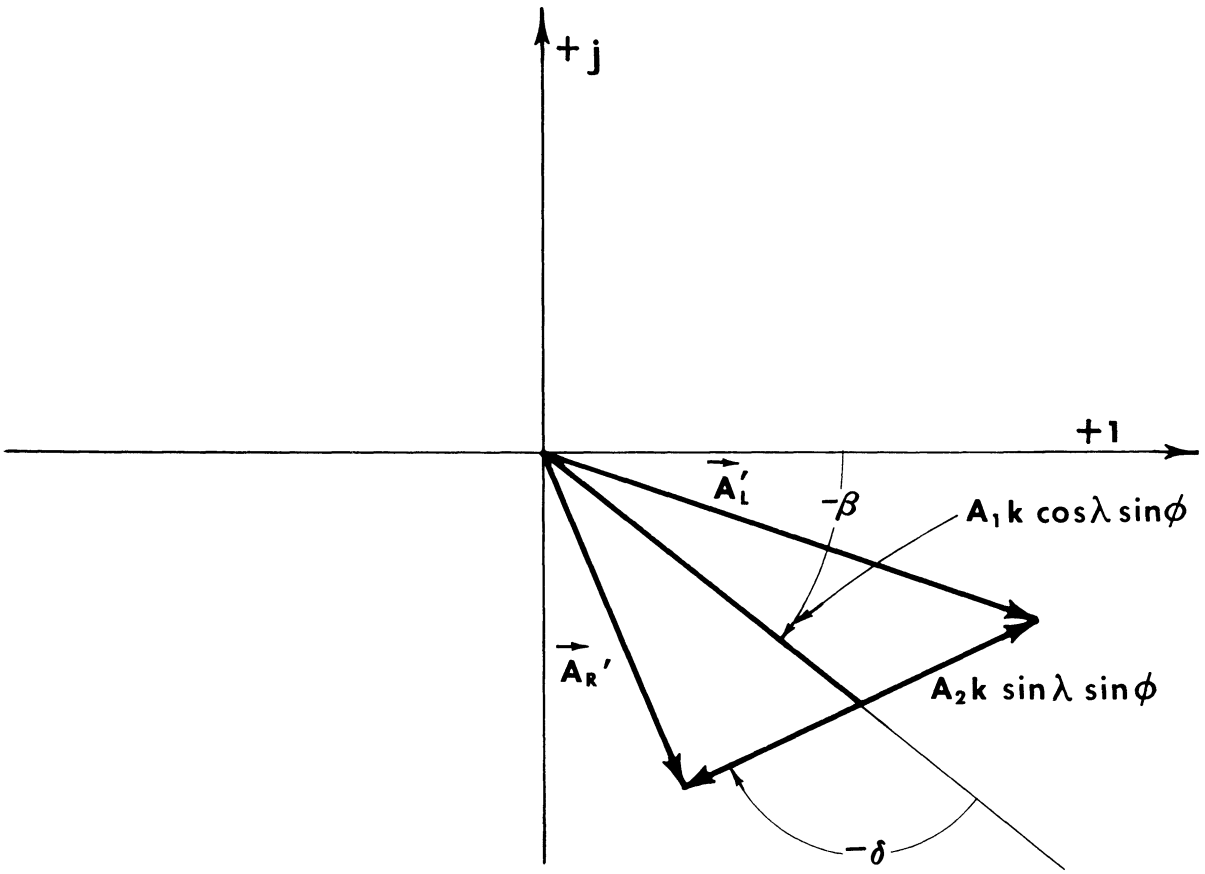


Fig. 22. Diagram of the phasors $\vec{A}_L'$ and $\vec{A}_R'$.

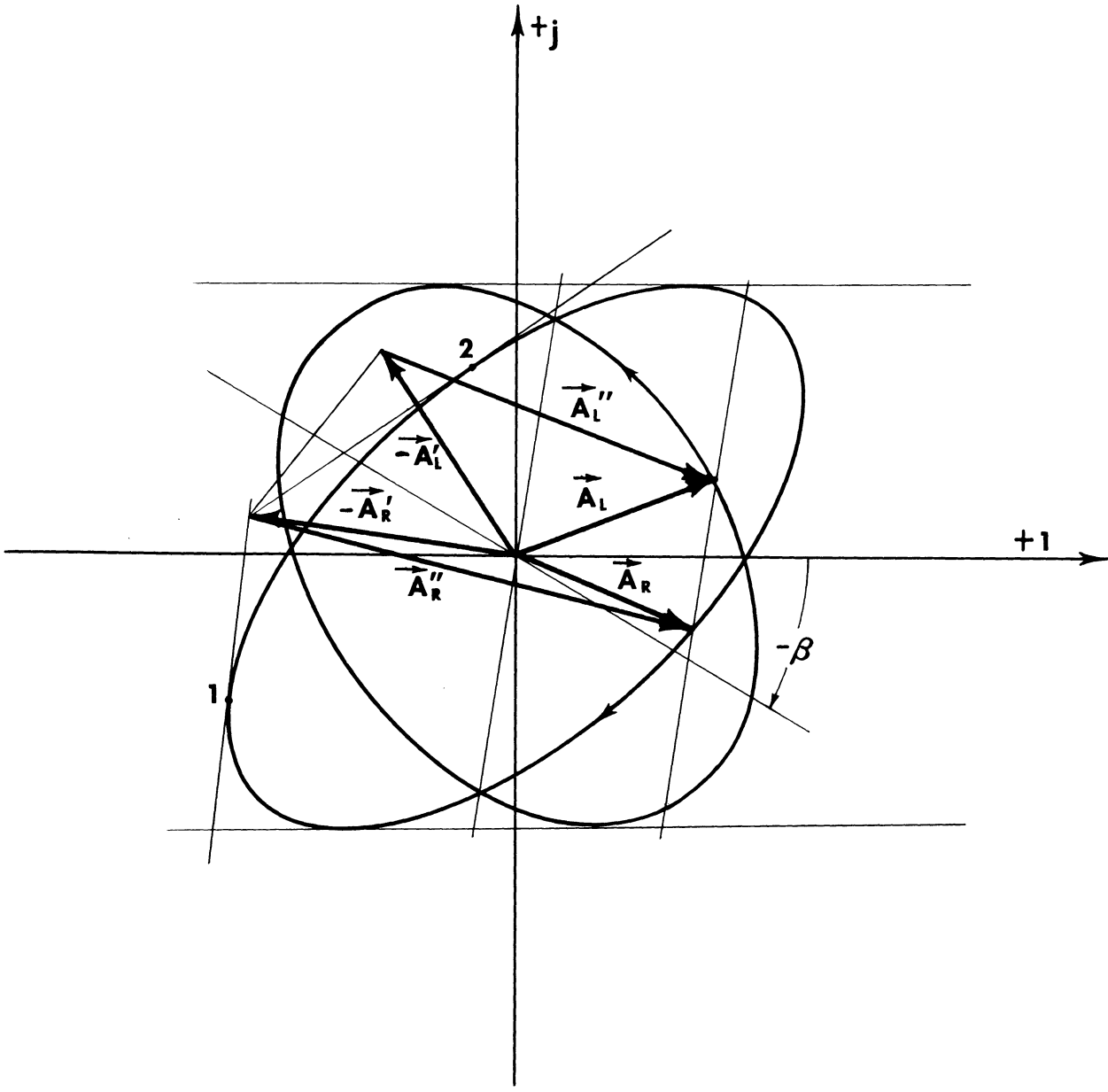


Fig. 23. Phasor diagram for total signal voltage.

Between the tangent points 1 and 2 on the locus, the right-hand phasor $\vec{A}_R$" moves through positive angles while θ ranges through the corresponding angles from θ_1 to θ_2, whereas for the remaining rotation $\vec{A}_R$" goes through negative angles, the net phase change being zero. As the terminus of the phasor $\vec{A}_R$" moves from points 1 to 2 on the locus, the phasor goes through an amplitude minimum. The portion of the locus between these points will be termed the "null region."

Before we discuss correction of anomalous spin phase, we should first introduce the normal spin correction. As missile orientation changes, there will in general be two extreme cases of normal spin-phase behavior. The first of these will be when the helical antenna looks nearly circular and $\phi = 0$, in which case Eq. (VI-5) holds and the phase angle varies linearly with θ. The other extreme will occur when $\phi = \pi/2$ and

$$\vec{A} = \sin\theta\,(-A_1 \sin\lambda + A_2 \cos\lambda \cos\delta,\ -A_2 \cos\lambda \sin\delta) \quad . \qquad \text{(VI-14)}$$

This is the case where the null axis will be aligned in the direction of propagation twice every rotation, that is, where $\sin\theta = 0$, and if θ is increasing there will be a sudden 180° phase loss at these points. These two situations are represented in Fig. 24.

In applying the normal spin correction, we will assume that spin phase varies linearly with rotation angle θ. This will result in a small periodic phase error in the corrected data whose amplitude in the worst case will be of the order of a half cycle.

Suppose that the 37-Mc path changes by ΔN_1 "doppler wavelengths" (wavelength at 74 Mc) during the time interval in question, while the missile rotates through an angle $\Delta\theta$. Because of reciprocity, the previous derivations apply also to the case with the helix transmitting to a loop antenna on the missile. Thus the total phase shift at 37 Mc will be

$$\frac{1}{2}\Delta N_1 + \Delta N_S \quad ,$$

where $\Delta N_S = \Delta\theta/2\pi$. This spin-phase shift is positive when $\Delta\theta$ is positive because the transmitting helix is left-handed. Upon doubling, the total phase change in cycles becomes $\Delta N_1 + 2\Delta N_S$. If the phase centers of the pair of receiving helices are at essentially the same point, then the change in the 74-Mc-path length will be the same to both antennas. Let this change be ΔN_2 doppler wavelengths; then for the left-hand helix the phase change will be

$$\Delta N_2 + \Delta N_S \quad ,$$

while for the right-hand helix the change is

$$\Delta N_2 - \Delta N_S \quad .$$

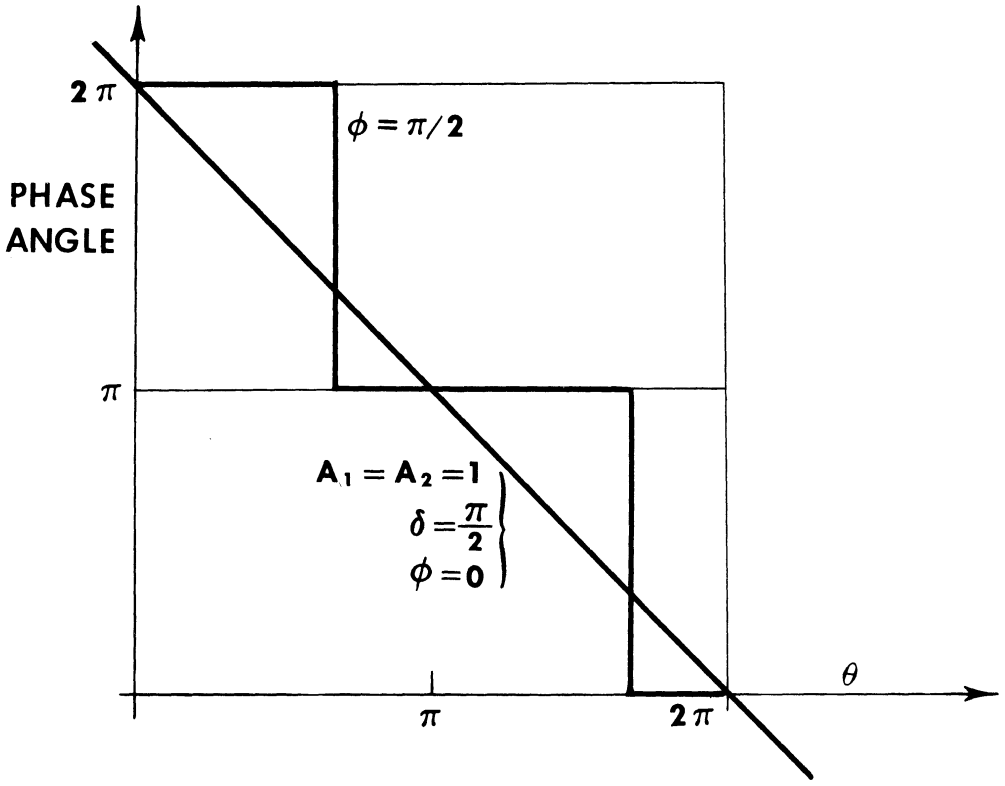


Fig. 24. Extreme cases of phase angle versus rotation angle.

Thus the total left-hand count is

$$\Delta N_{LH} = (\Delta N_1 + \Delta N_2) + 3\Delta N_S \quad , \tag{VI-15}$$

while the right-hand count is

$$\Delta N_{RH} = (\Delta N_1 + \Delta N_2) + \Delta N_S \quad . \tag{VI-16}$$

Subtracting the right-hand count from the left, we obtain

$$\Delta N' = \Delta N_{LH} - \Delta N_{RH} = 2\Delta N_S \quad ; \tag{VI-17}$$

thus $1/2\ \Delta N' = \Delta N_S$ and the doppler count $\Delta N = (\Delta N_1 + \Delta N_2)$ is given by

$$\Delta N = \Delta N_{RH} - \frac{1}{2}\Delta N' \quad . \tag{VI-18}$$

Equations (VI-17) and (VI-18) then represent the normal spin correction. Because we have made no assumption about the signs of the quantities involved, the form of the correction will hold regardless of the relative motion of the missile and the antennas.

If the orientation of the missile with respect to the transmitting antenna is such that the spin shift becomes anomalous, then the phase change $2\Delta N_S$ at 37 Mc will have an average value of zero over every missile rotation, and except for a periodic error of a fraction of a cycle, the left- and right-hand counts will be

$$\Delta N_{LH} = \Delta N + \Delta N_S$$

$$\Delta N_{RH} = \Delta N - \Delta N_S \quad .$$

Thus

$$\Delta N = \Delta N_{RH} + \frac{1}{2}\Delta N' \quad ,$$

where as before

$$\Delta N' = \Delta N_{LH} - \Delta N_{RH} \quad . \tag{VI-19}$$

Suppose, now, that the spin shift becomes anomalous at 74 Mc for both receiving antennas. Let α_1 and α_2 be the phase angles of the right and left phasors, respectively. If $\Delta\alpha_1$ and $\Delta\alpha_2$ are the change in phase angle for the time interval in question, then the cycle counts will be

$$\Delta N_{LH} = \Delta N + \frac{1}{2\pi}\Delta\alpha_2 + 2\Delta N_S$$

$$\Delta N_{RH} = \Delta N + \frac{1}{2\pi}\Delta\alpha_1 + 2\Delta N_S \quad . \tag{VI-20}$$

In this case we could take the spin corrected doppler count to be $\Delta N_{RH} - 2\Delta N_s$. However, as with the anomalous spin correction at 37 Mc, there would remain a periodic error. The amount of this error is indicated by Eq. (VI-20) to be either $\Delta\alpha_2/2\pi$ or $\Delta\alpha_1/2\pi$. In this case there is a simple alternative which will, in general, reduce this error. Consider the quantity

$$\Delta N_{RH} + \frac{1}{2}\Delta N' - 2\Delta N_s \quad ,$$

where $\Delta N' = \Delta N_{LH} - \Delta N_{RH}$. By Eq. (VI-20) this quantity is equal to

$$\Delta N + \frac{1}{2\pi} \cdot \frac{\alpha_1 + \Delta\alpha_2}{2} \quad .$$

Thus if we take for the spin corrected value

$$\Delta N = \Delta N_{RH} + \frac{1}{2}\Delta N' - 2\Delta N_s \quad , \qquad \text{(VI-21)}$$

the resulting error will be

$$\frac{1}{2\pi} \cdot \frac{\Delta\alpha_1 + \Delta\alpha_2}{2} \quad .$$

This error will also have an average value of zero for each missile rotation. Furthermore, since the inequality

$$|\Delta\alpha_1 + \Delta\alpha_2| \leq |\Delta\alpha_1| + |\Delta\alpha_2|$$

holds for all real numbers, the magnitude of this error will be less than or equal to the average magnitude of the errors

$$\frac{\left(\frac{|\Delta\alpha_1|}{2\pi} + \frac{|\Delta\alpha_2|}{2\pi}\right)}{2}$$

resulting when either of the quantities $(N_{LH} - 2\Delta N_s$ or $\Delta N_{RH} - 2\Delta N_s$ are used as a spin correction. Or, stated differently, the magnitude of the error resulting from the correction given by Eq. (VI-21) will be less than the magnitude of the error in the worst case when either $\Delta N_{LH} - 2\Delta N_s$ or $\Delta N_{RH} - 2\Delta N_s$ is used as a spin correction. Usually the correction given by (VI-21) is noticeably better than either of the latter corrections because as the phasors of both antennas move through the null regions or are both out of the null regions during the time interval in question, the phase errors $\Delta\alpha_1$ and Δa_2 will be of opposite sign. On the other hand, if the phasor of one antenna moves through the null region while the other does not, then the magnitude of the error resulting from (VI-21) will be less than the error made by the correction, $\Delta N - 2\Delta N_s$ of the channel whose phasor is in the null region.

Since $\Delta N'$ does not equal $2\Delta N_S$ in this situation, the quantity $2\Delta N_S$ must be determined from other sources. Because of range geometry, the doppler count of the Launch station at Churchill shows few, if any, anomalous regions and generally has the most uniform spin difference, which we will denote as $\Delta N_L'$. Using this value for $2\Delta N_S$, the correction becomes

$$\Delta N = \Delta N_{RH} + \frac{1}{2}\Delta N' - \Delta N_L' \qquad \text{(VI-22)}$$

If this spin difference is not available from Launch or any of the other stations, then the spin rate can be usually estimated from the polarization nulls appearing on the Launch dipole field strength record. Since these nulls are separated by 180° of missile rotation, the time between alternate nulls will be the period of rotation. Thus if the missile rotates through an angle $\Delta\theta$ in the time interval in question, then we take $2\Delta N_S$ as $2\Delta\theta/2\pi$ and the sign of the quantity is usually determined by examining previous or succeeding normal ΔN's, or by taking the sign of the phase change between left and right channels in regions not containing nulls.

If both the 37-Mc and 74-Mc spin-phase shifts are anomalous, then for the same reasons used in the justification of (VI-21) we will take as our spin corrected value

$$\Delta N = \Delta N_{RH} + \frac{1}{2}\Delta N' \quad . \qquad \text{(VI-23)}$$

It is interesting to observe that the spin correction given by Eq. (VI-22) is also applicable when the spin shift at 74 Mc is normal. In this case the average value of $\Delta N'$ and $\Delta N_L'$ must be equal since they accumulate to two cycles every missile rotation, and if we set $\Delta N' = \Delta N_L'$ (VI-22) becomes (VI-18).

When only one receiving antenna shows anomalous phase shifts, as is illustrated by Fig. 23, then this antenna will show no net phase shift; the other antenna will show a gain, if it is left-handed, or a loss, if it is right-handed, of one cycle with each missile rotation in the positive sense. If this occurs in an interval where the phase shifts are predominantly anomalous at 74 Mc, then by subtracting or adding a cycle to the normal channel once every missile rotation in the interval in which the amplitude minimum occurs and the rate of change of phase is maximum, the result will be precisely the same as if the phase shifts on both channels were anomalous; and we can then apply whichever of the two corrections, (VI-22) or (VI-23), is relevant.

The channel showing normal phase shifts will generally experience a deep amplitude minimum once every rotation accompanied by rapid phase shifts in the normal sense. The time interval in which this minimum occurs can usually be found by examining the second differences, $\Delta^2 N$, obtained by differencing succes-

sive ΔN counts. The accompanying phase shifts will be evidenced by distinct irregularities in the trend of the second differences. Thus if the left-hand helix shows normal phase shifts, we will subtract (or add, when the rotation of the missile is in the negative sense) a cycle to the count in the interval containing the amplitude minimum, and as a result the quantity

$$\Delta N' = (\Delta N_{LH} - N_{RH})$$

will be decreased by one cycle, and the spin corrected value would be

$$\begin{aligned} \Delta N &= \Delta N_{RH} + \frac{1}{2}(\Delta N' - 1) - \Delta N_L' \\ &= (\Delta N_{RH} + \frac{1}{2}\Delta N' - \Delta N_L) - \frac{1}{2} \end{aligned} \qquad \text{(VI-24)}$$

Similarly, when the spin phase at 37 Mc is anomalous

$$\Delta N = (\Delta N_{RH} + \frac{1}{2}\Delta N') - \frac{1}{2} \qquad \text{(VI-25)}$$

With normal phase shifts on the right-hand helix, we would add a cycle to the right-hand count and thus decrease $\Delta N'$ by a cycle. Upon application of the anomalous correction, we would obtain

$$\begin{aligned} \Delta N &= \Delta N_{RH} + 1 + \frac{1}{2}(\Delta N' - 1) - \Delta N_L' \\ &= (\Delta N_{RH} + \frac{1}{2}\Delta N' - \Delta N_L') + \frac{1}{2} \quad , \end{aligned} \qquad \text{(VI-26)}$$

or for the other case

$$\Delta N = (\Delta N_{RH} + \frac{1}{2}\Delta N') + \frac{1}{2} \quad . \qquad \text{(VI-27)}$$

On the other hand, if one of the receiving helices shows anomalous phase shifts in an interval characterized by predominantly normal phase shifts, then upon subtracting or adding a cycle, depending on whether the helix is right- or left-handed, to the count in the interval which corresponds to the null region, we can apply whichever of the corrections, (VI-18) or (VI-19), is relevant. Thus, when the left-hand receiver shows anomalous phase shifts, we would add a cycle to ΔN_{LH} and consequently increase $\Delta N'$ by one cycle. Applying the correction given by (VI-18), we obtain

$$\Delta N = (\Delta N_{RH} - \frac{1}{2}\Delta N') - \frac{1}{2} \qquad \text{(VI-28)}$$

while the correction given by (VI-19) results in

$$\Delta N = (\Delta N_{RH} + \frac{1}{2}\Delta N') + \frac{1}{2} \qquad \text{(VI-29)}$$

Similarly, when the right-hand receiver shows anomalous phase shifts, we obtain from (VI-18)

$$\Delta N = (\Delta N_{RH} - \frac{1}{2}\Delta N') - \frac{3}{2} \qquad \text{(VI-30)}$$

or from (VI-19) we obtain

$$\Delta N = (\Delta N_{RH} + \frac{1}{2}\Delta N') - \frac{1}{2} \quad . \qquad \text{(VI-31)}$$

Instead of actually adding or subtracting a cycle to the left- or right-hand data, the amounts indicated outside the parentheses in relations (VI-24) through (VI-31) are applied as a separate correction.

When the missile is at low-elevation angles early in the trajectory for the outlying stations, the receiving helices will behave as if their polarizations were reversed. Normally anomalous phase shifts will also occur at these elevation angles and the reversal in sign of the $\Delta N'$ will not be evidenced. If in this interval normal phase shifts occur on one channel, then corrections (VI-24) through (VI-31) must be made as if the right and left helices had reversed their roles. If both channels show normal but reversed phase shifts, then the correction given by (VI-22) is usually employed, for in this case $\Delta N' = -\Delta N_L'$ so that

$$\begin{aligned} \Delta N &= \Delta N_{RH} + \frac{1}{2}\Delta N' - \Delta N_L' \\ &= \Delta N_{RH} - \frac{3}{2}\Delta N_L' \quad , \end{aligned}$$

which is the normal spin correction for a left-hand helix. To discover which spin correction is applicable in a given interval, an examination of a plot of the cycle counts per half-second interval vs. time, a plot of the accumulated sum of half the spin difference $[\Sigma(\Delta N'/2)]$, vs. time, and the film records must be made. We have taken sections of these plots and the film records to illustrate each of these cases.

As we have already seen, when the spin phase is normal at both 37 Mc and 74 Mc, a spin-phase shift $2\Delta N_S$ occurs at 37 Mc and is common to both counts, whereas at 74 Mc the phase change due to spin is ΔN_S on the left-hand channel

and - ΔN_S on the right-hand channel, making the total counts

$$\Delta N_{LH} = (\Delta N + 2\Delta N_S) + \Delta N_S$$

$$\Delta N_{RH} = (\Delta N + 2\Delta N_S) - \Delta N_S \quad . \tag{VI-32}$$

If the phase shift at 74 Mc becomes anomalous, the contributions ΔN_S and $-\Delta N_S$ are essentially zero, and the counts are

$$\Delta N_{LH} = \Delta N_{RH} = \Delta N + 2\Delta N_S \quad . \tag{VI-33}$$

After burnout the slope of the ΔN plot is nearly constant so that, except for a scatter of the order of, at most, a half cycle, short sections of the data can be considered to lie on a straight line. Thus Eq. (VI-32) suggests that we can think of the quantity $(\Delta N + 2\Delta N_S)$ as being represented by a line which lies midway between the cycle counts when the spin phase is normal at both frequencies. When the spin phase becomes anomalous on both channels at 74 Mc, Eq. (VI-33) implies that the left- and right-hand counts will scatter about this line. Thus the line lying midway between the left- and right-hand data points when they are separated by the normal spin difference $2\Delta N_S$, or about which the left- and right-hand points scatter when both channels are anomalous at 74 Mc, represents the sum of doppler count, ΔN, and the phase change, $2\Delta N_S$, at 37 Mc due to spin. If the spin phase at 37 Mc is anomalous in some interval, the contribution $2\Delta N_S$ will have an average value of zero, and we would notice that the position of this line would be lower in such an interval by $2\Delta N_S$ than it would be in the sections of data surrounding the interval. These intervals can usually be found by laying a straightedge on the plot, or by simply sighting along it. Because all channels must necessarily be affected, such intervals are usually quite prominent.

Thus, for example, we see that in the plot of ΔN for SM 1.07 (Fig. 25), the spin phase at 37 Mc is anomalous after 121-1/2 seconds. It is of interest to notice that because the phase shift is normal at 74 Mc, the right-hand counts through 121-1/2 seconds lie on the same line as the left-hand counts after 121-1/2 seconds. In both cases, the counts correspond to the quantity $\Delta N + \Delta N_S$. This situation is represented by the dashed line on the data for the Twin Lakes station in Fig. 25.

A portion of the ΔN plot for SM 1.05 is shown in Fig. 26. In the neighborhood of 122 seconds, the phase shift becomes and remains anomalous at 74 Mc on all channels. After 122-1/2 seconds, the phase shift at 37 Mc is anomalous.

Since the spin difference $\Delta N'$ has an average value of $2\Delta\theta/2\pi$ over each missile rotation when the spin phase at 74 Mc is normal, a plot of Σ 1/2 $\Delta N'$ vs. time should represent the total number of missile rotations vs. time. With no spin anomalies at 74 Mc, the sum Σ 1/2 $\Delta N'$ should differ by no more than a half

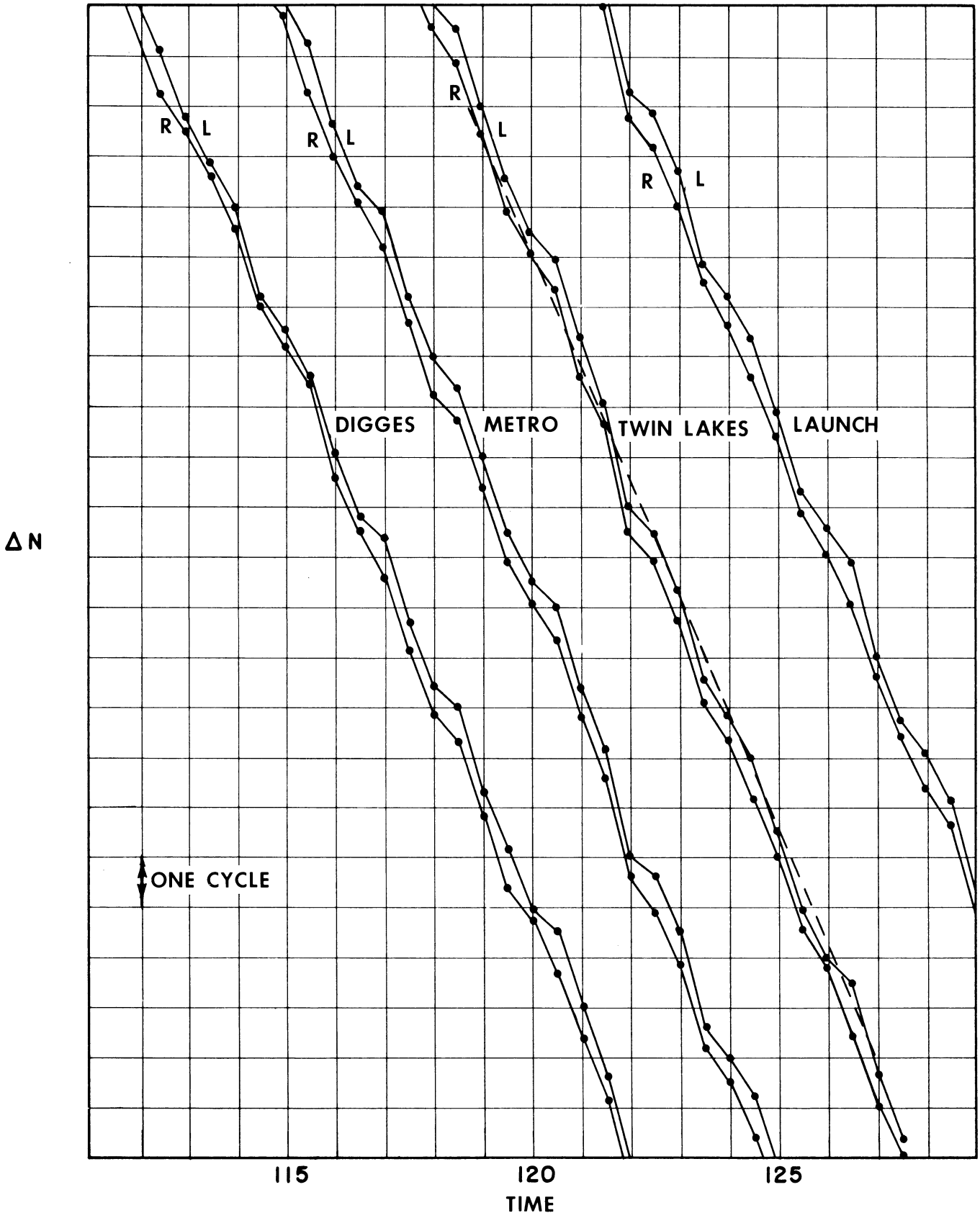


Fig. 25. Plot of ΔN versus time for SM1.07.

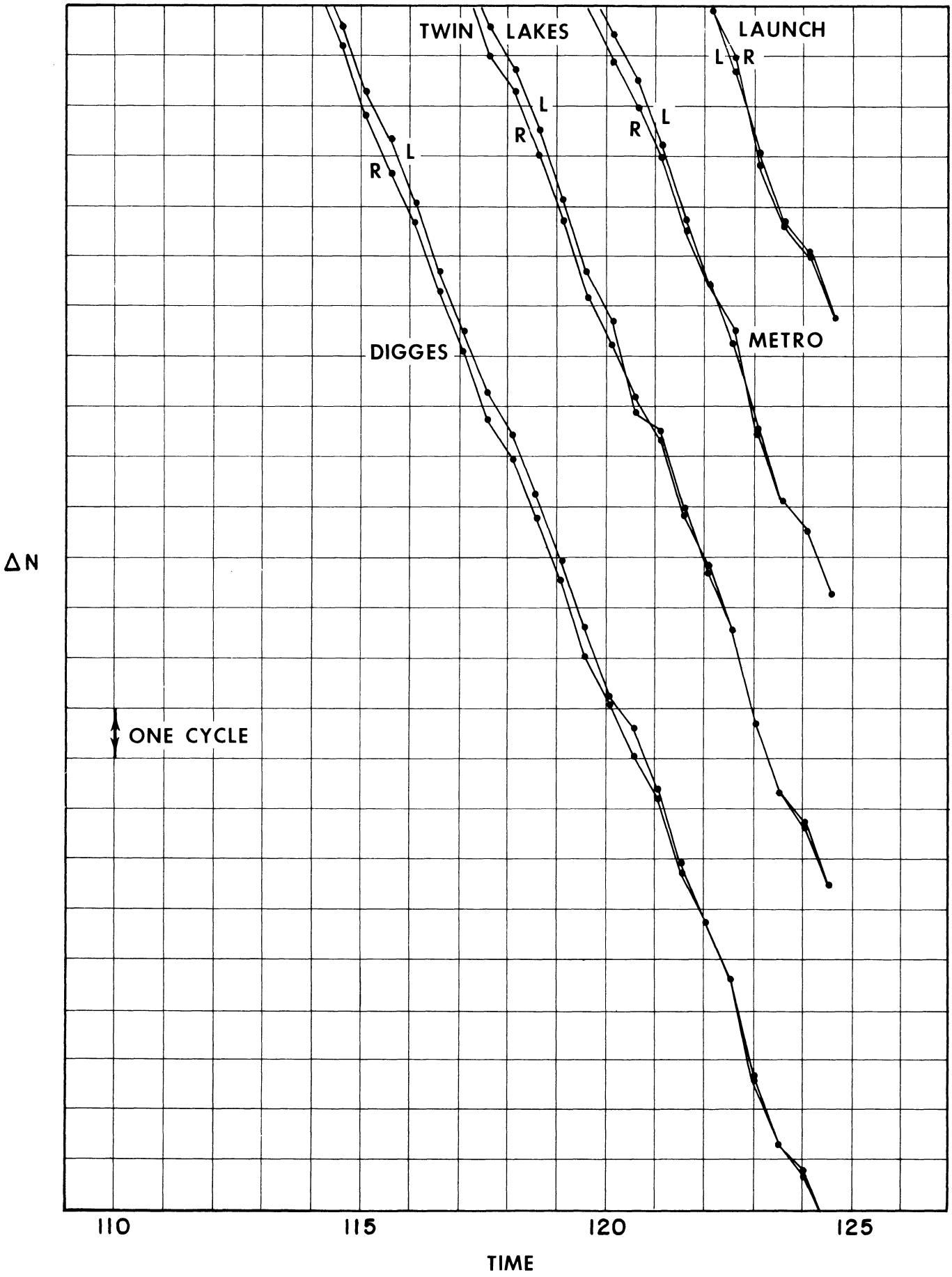


Fig. 26. Plot of ΔN versus time for SM1.05.

cycle for all stations, assuming that the data have already been geometry-corrected to eliminate any difference arising out of the distance between the phase centers of the receiving helices.

Discrepancies will arise when either or both receivers are affected by anomalous spin shifts at 74 Mc. When both receivers are affected, the slope of the corresponding Σ 1/2 $\Delta N'$ plot will be zero. This is illustrated by Metro in the portion of the Σ 1/2 $\Delta N'$ plot for SM 1.05 shown in Fig. 27, and by Digges for SM 1.07 shown in Fig. 28. While both of these cases occur early in the missile flight, this type of spin anomaly can occur at any time, as it does, for example, at 122 seconds on SM 1.05. A particularly conspicuous example of anomalous spin phase at 74 Mc on both left- and right-hand receivers occurs at 76 seconds on Twin Lakes for SM 2.06. Both the ΔN plot (Fig. 29) and the Σ 1/2 $\Delta N'$ (Fig. 30) indicate this condition clearly.

Figure 31 shows a later portion of the ΔN plot for SM 1.07. Here the phase shifts are anomalous at both frequencies on all channels. This example was selected because it also shows the periodic phase error introduced on all channels by the anomalous phase shifts at 37 Mc.

When only one receiver is affected by anomalous spin shifts at 74 Mc, the average slope of the Σ 1/2 $\Delta N'$ will be exactly half of what it would be if both phase shifts were normal. This situation is illustrated by Digges in Fig. 32 for SM 1.05, and by Digges and Twin Lakes in Fig. 33 for SM 1.07. SM 1.07 is an interesting example because after 164 seconds Digges shows normal phase shifts while Twin Lakes shows anomalous phase shifts on both channels at 74 Mc.

The phasor diagram corresponding to these two examples would be similar to that of Fig. 23. Two sections taken from the DOVAP film records of Twin Lakes left- and right-hand receivers for SM 1.07 corresponding to the plot of Fig. 33 are shown in Fig. 34. These sections were chosen because they illustrate clearly the type of situation depicted by the phasor diagram of Fig. 23. From 161-1/2 to 162 seconds, the left-hand channel shows an amplitude minimum accompanied by a rapid normal phase gain relative to the right-hand channel. In the interval from 162-1/2 to 163 seconds, the right-hand channel shows a shallow null with an anomalous phase shift which amounts to a phase gain relative to the left-hand channel.

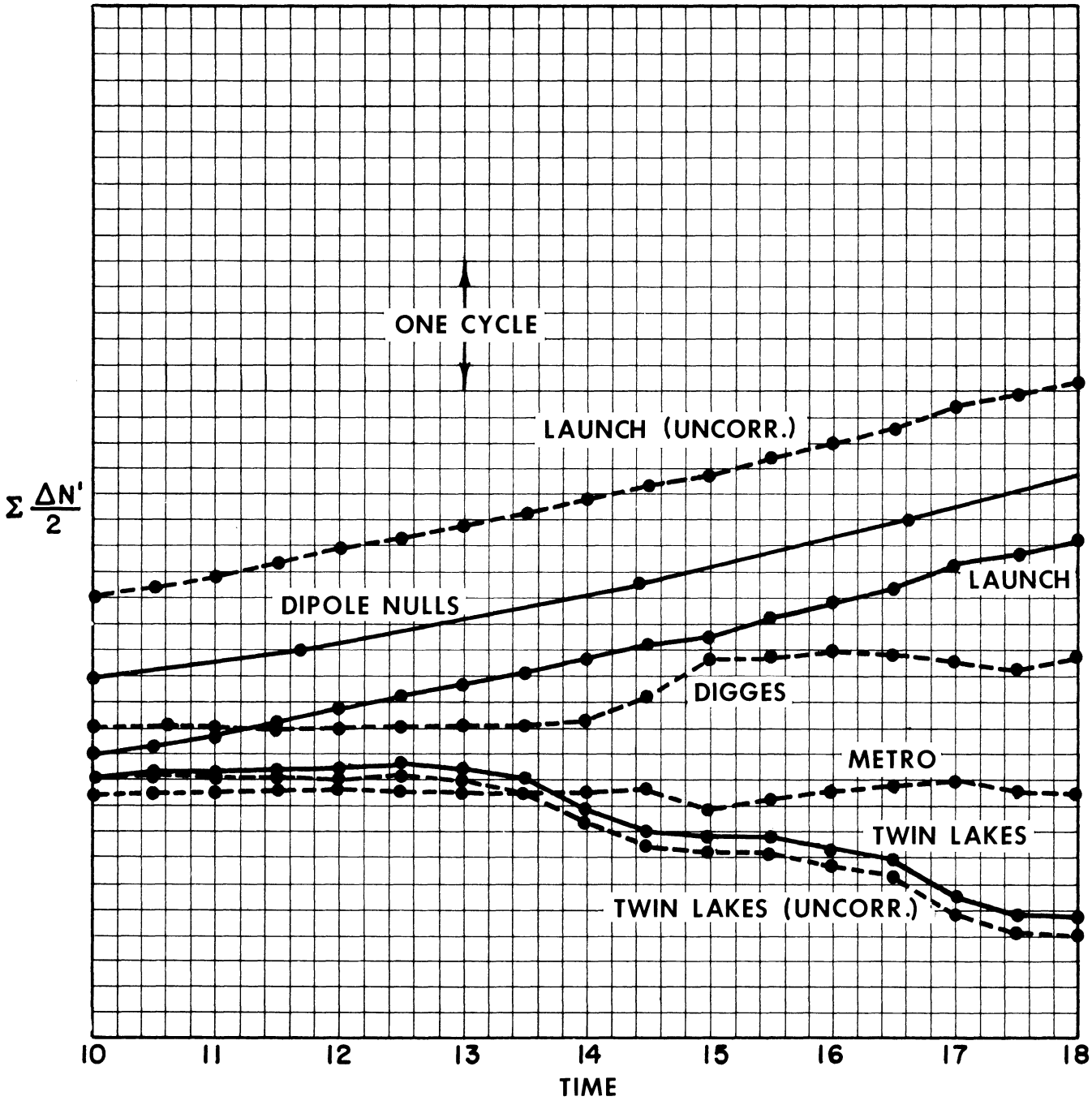


Fig. 27. Plot of Σ 1/2 $\Delta N'$ versus time for SM1.05.

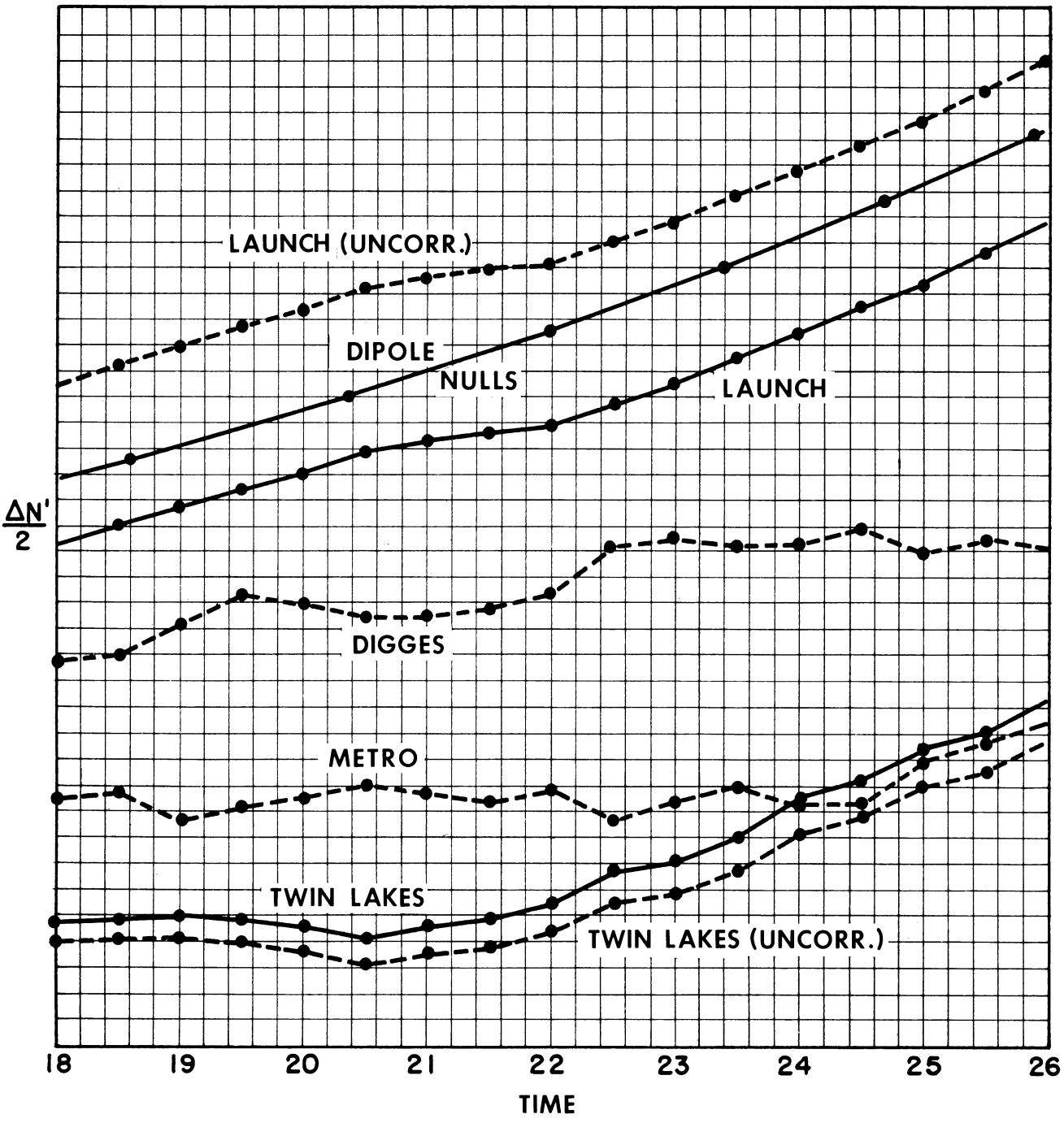


Fig. 27. (Concluded)

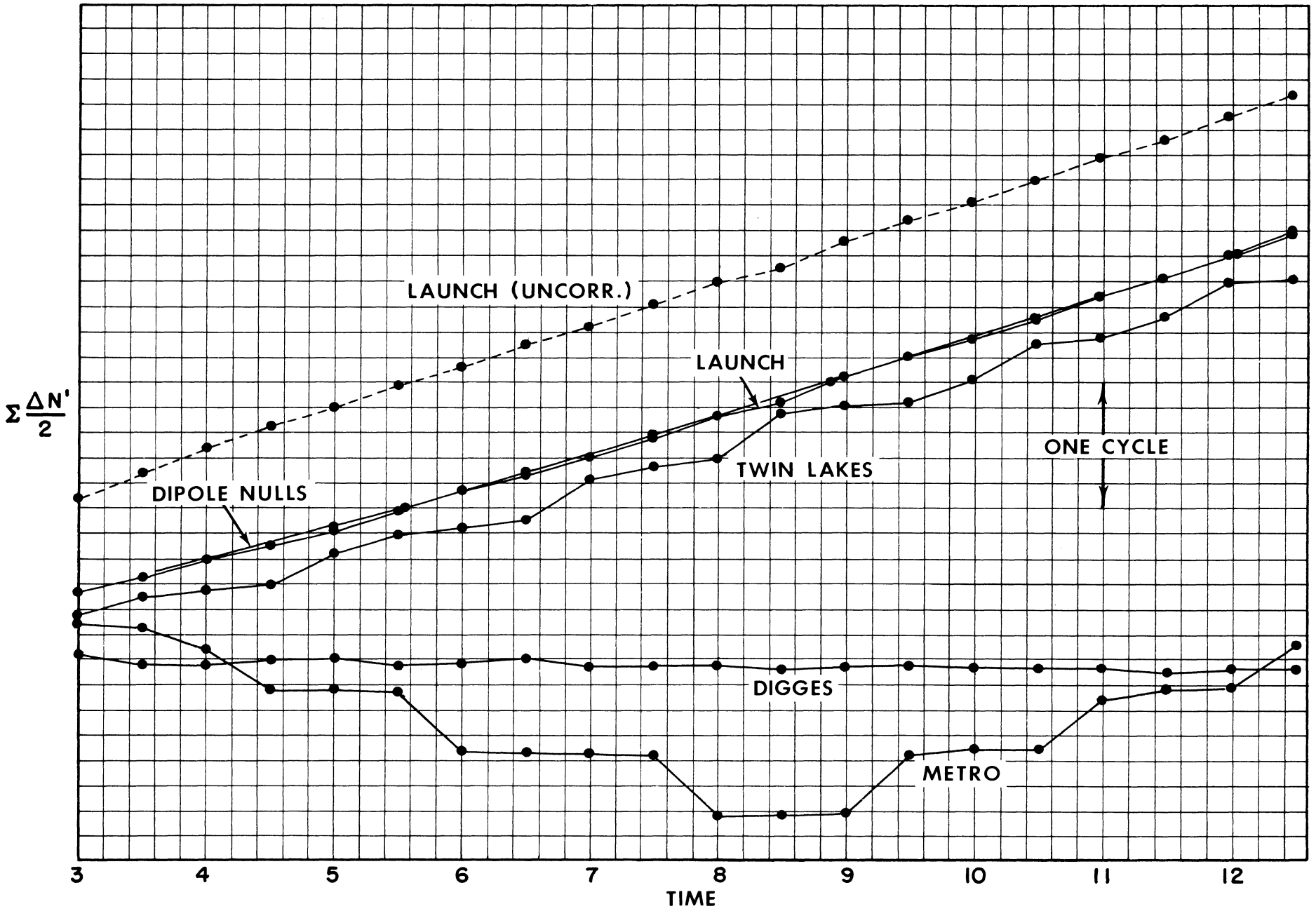


Fig. 28. Plot of Σ 1/2 $\Delta N'$ versus time for SM1.07.

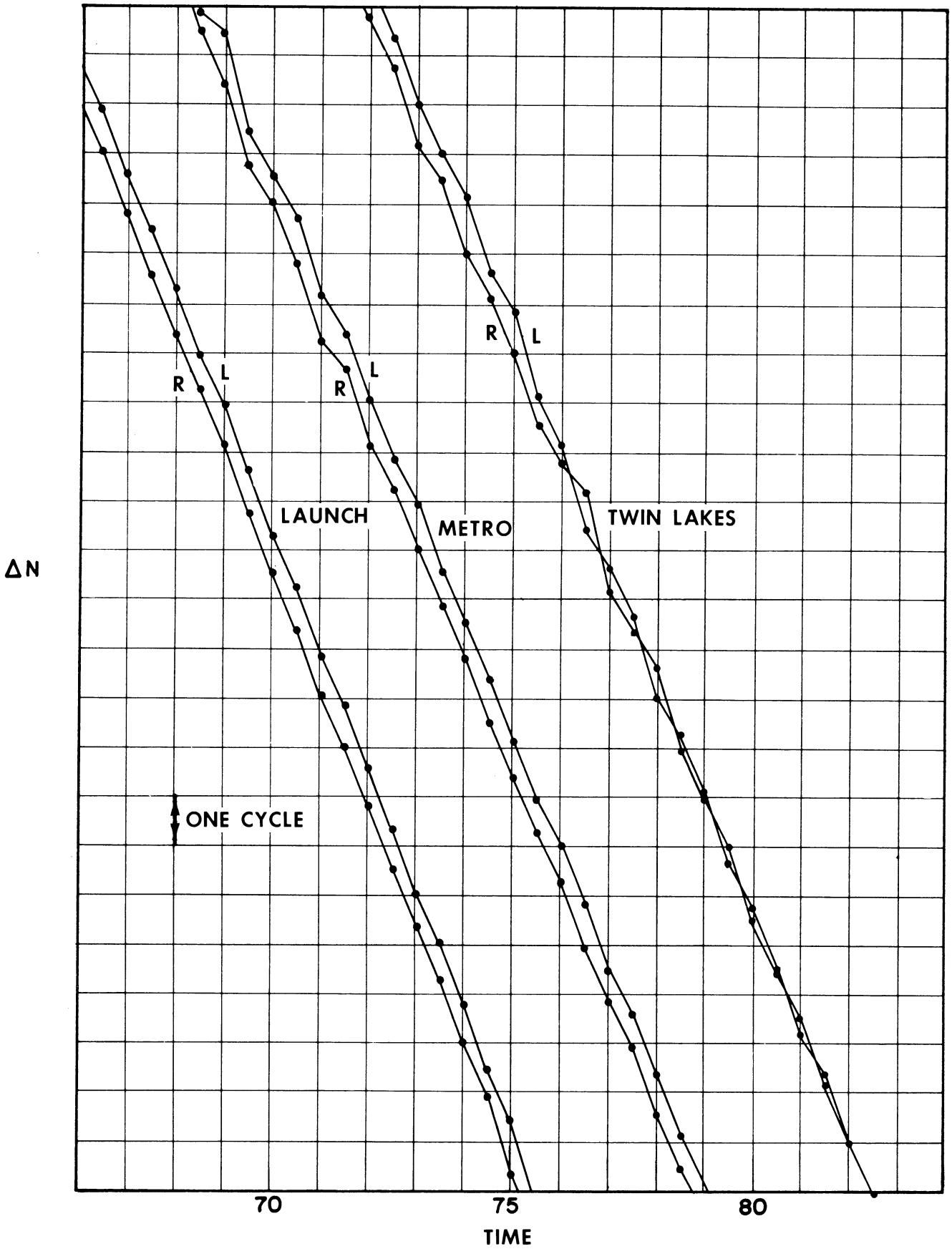


Fig. 29. Plot of ΔN versus time for SM2.06.

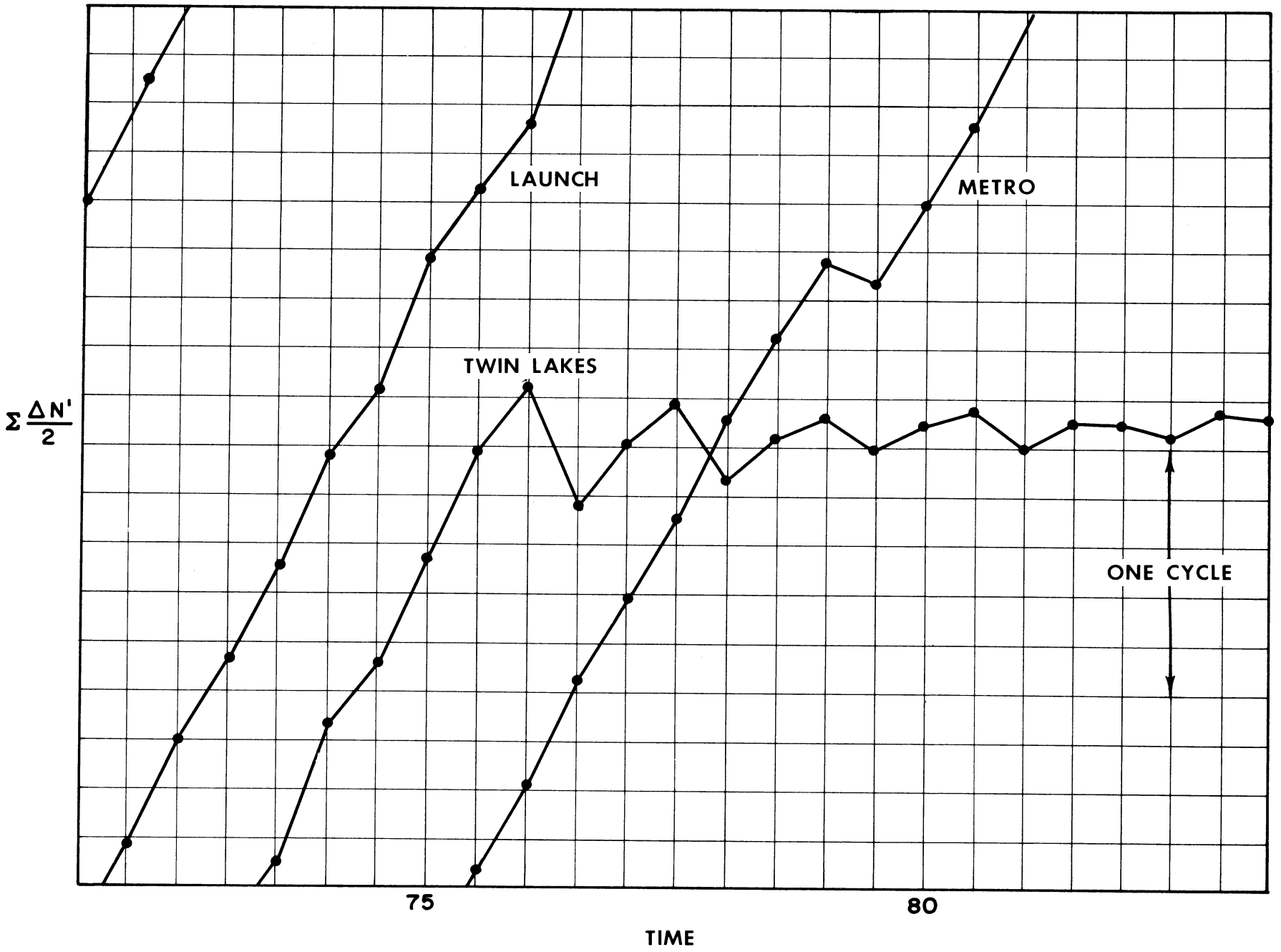


Fig. 30. Plot of Σ 1/2 ΔN' versus time for SM2.06.

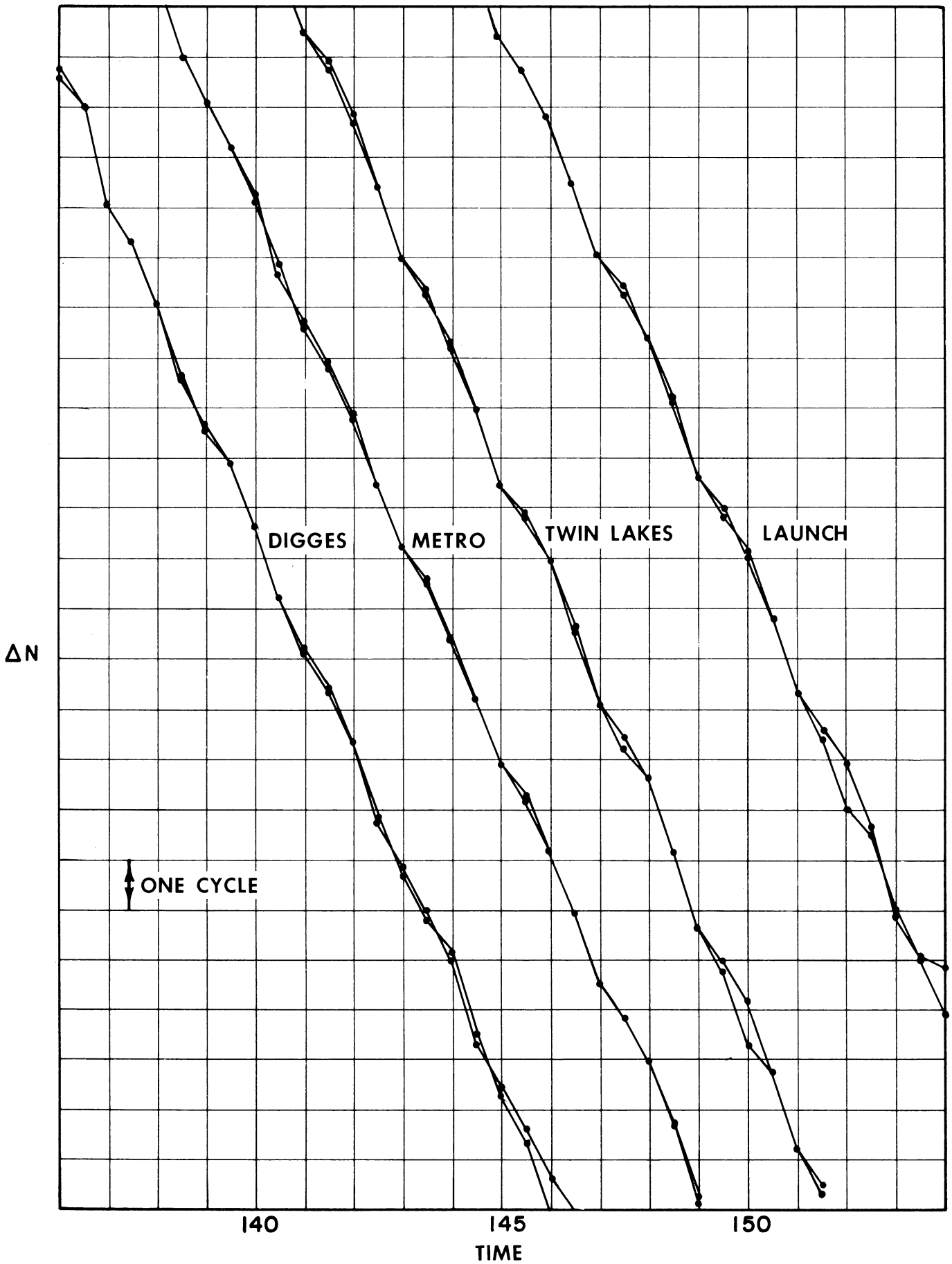


Fig. 31. Plot of ΔN versus time for SM1.07.

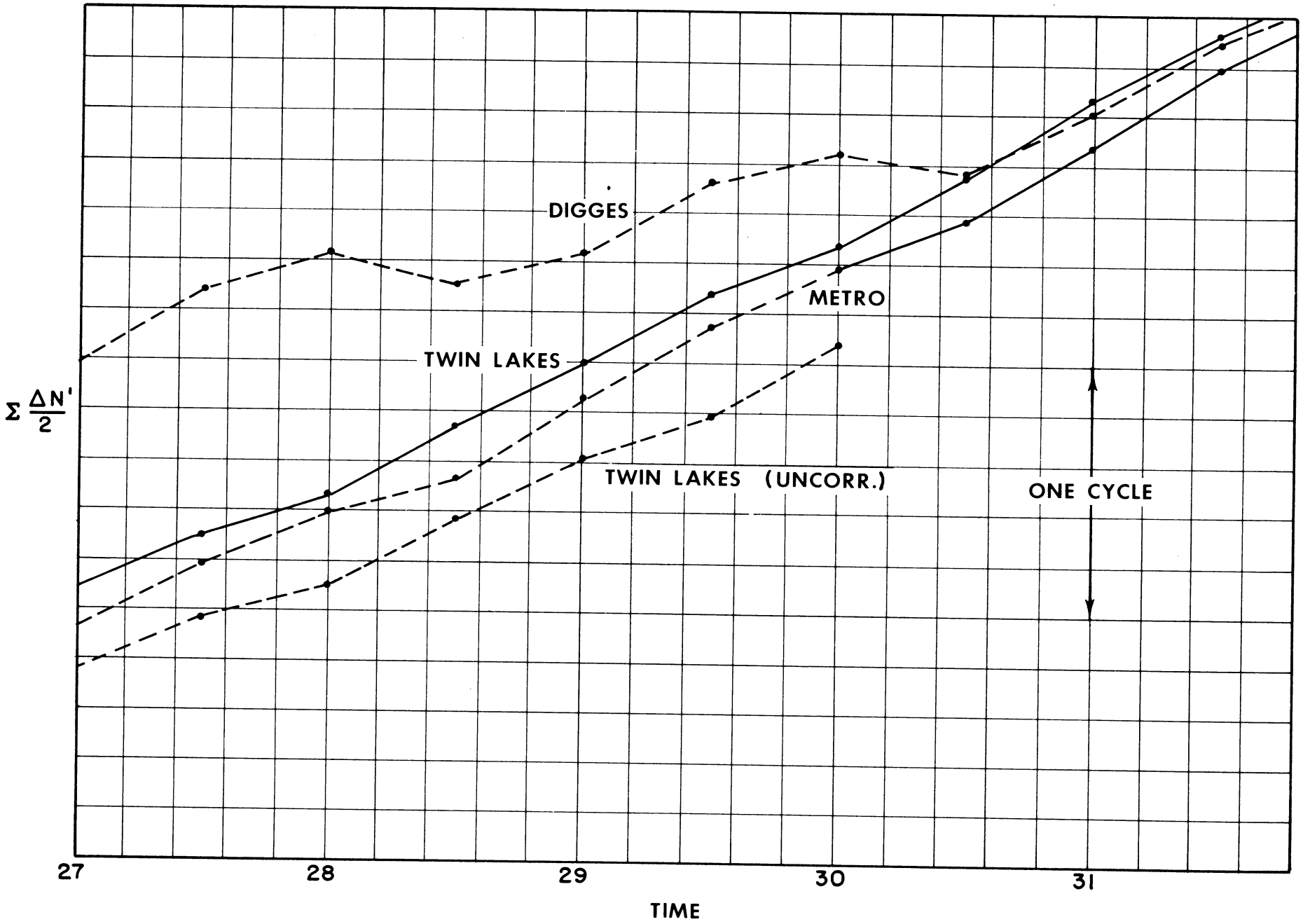


Fig. 32. Plot of $\sum$ 1/2 $\Delta N'$ versus time for SM1.05.

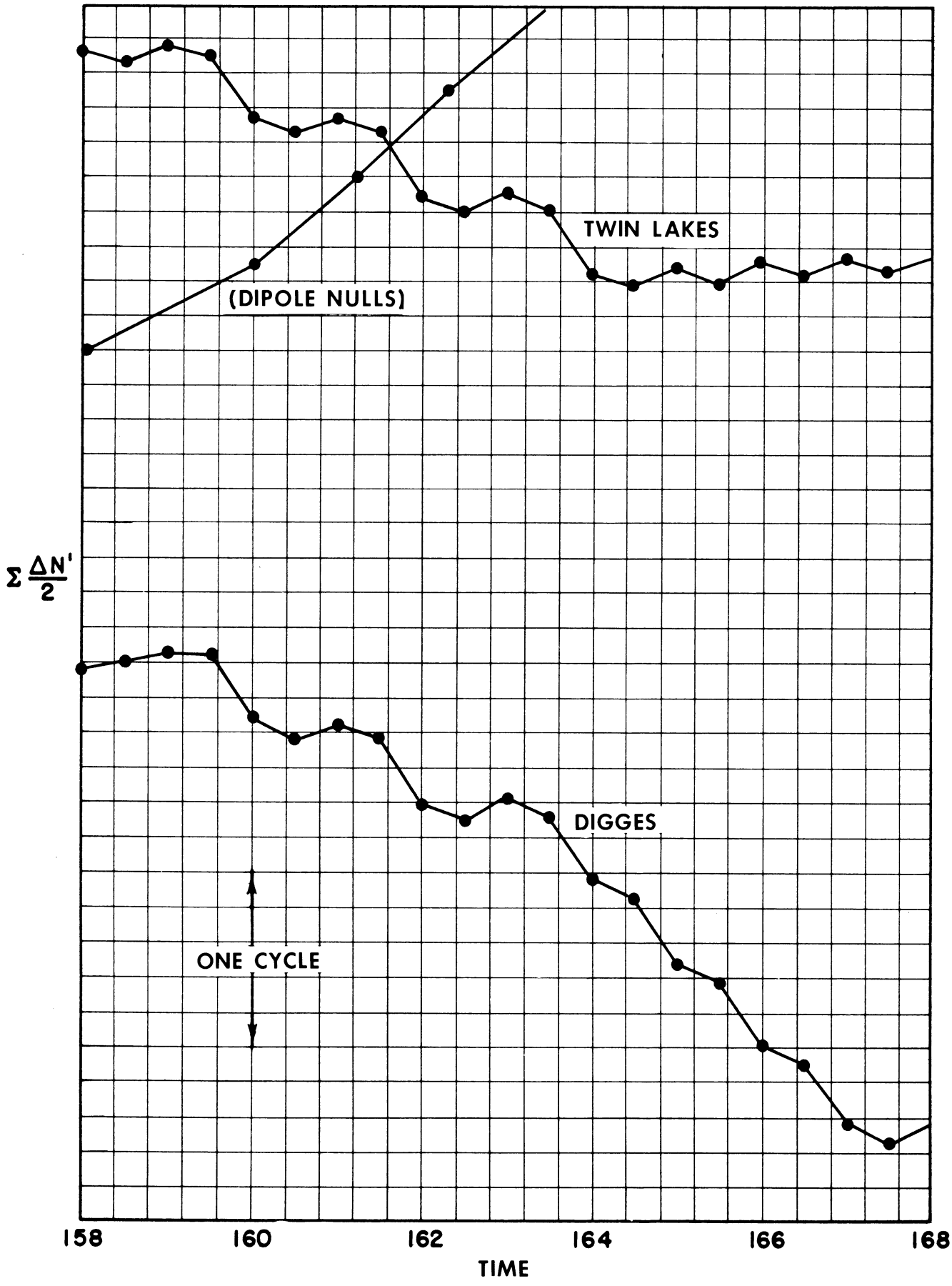


Fig. 33. Plot of Σ 1/2 $\Delta N'$ versus time for SM1.07.

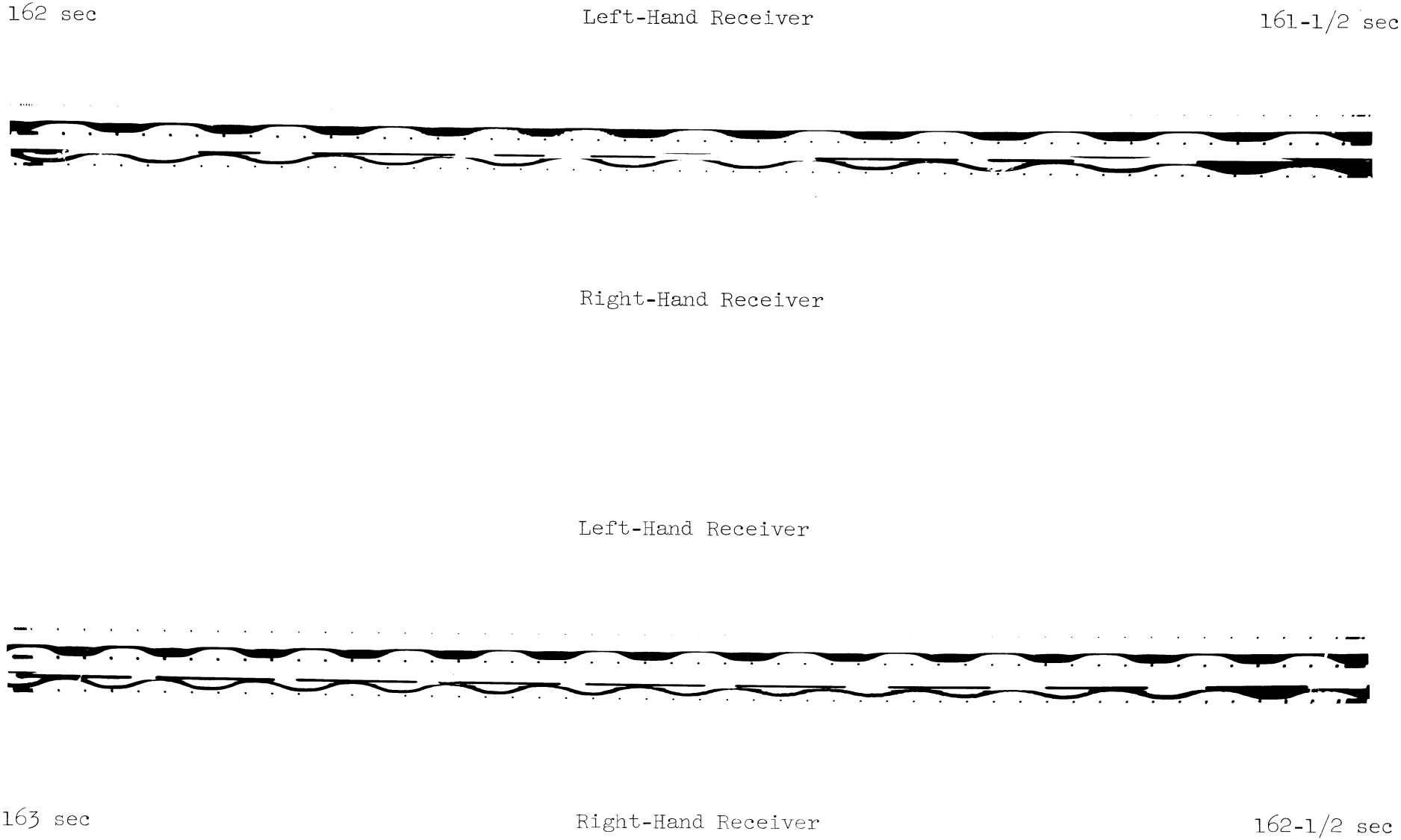


Fig. 34. Portion of the DOVAP film record for Twin Lakes, SM1.07.

VII. TRAJECTORY SOLUTIONS

The problem of determining the position of a missile from doppler data has been reported by B. Garfinkel.[10] The solution is shown below in summary form; the data of the problem are listed in Table II of this report.

Let

P_0 = coordinates of the DOVAP transmitter, and
P_j = coordinates of the DOVAP receivers, $j = 1,2,3,4$;

then

$$u_j = \vec{r} + \vec{r}_j = \overline{P_0P} + \overline{PP_j}, \quad j = 1,2,3,4 \quad , \tag{VII-1}$$

and $P(x,y,z)$ the unknown position of the missile. There are four combinations. Taking stations 3 at a time, call these combinations I, II, III, IV. For <u>each</u> combination of three receiving stations, a hand calculation of a set of constants was made using the positions of the right-hand helices in the converted DOVAP system as data. Details of the method follow.

Arrange P_1, P_2 and P_3 so that:

$$\overline{P_0P_1} > \overline{P_0P_2} > \overline{P_0P_3}, \quad \text{i.e.,} \quad r_1 > r_2 > r_3 \tag{VII-2}$$

Then calculate:

r_1^2, r_2^2, r_3^2

$\xi = \overline{P_1P_3}$; where ξ is the normalizing factor

$$(A) = \begin{pmatrix} x_1 & y_1 & z_1 \\ x_2 & y_2 & z_2 \\ x_3 & y_3 & z_3 \end{pmatrix} \quad , \quad \text{(normalized)} \tag{VII-3}$$

$$(B) = \begin{pmatrix} 1 & 0 & -1 \\ 0 & 1 & -1 \\ 0 & 0 & 1 \end{pmatrix} \cdot (A) = \begin{pmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{pmatrix} \tag{VII-4}$$

$$(S) = \begin{pmatrix} \ell_1 & \ell_2 & \ell_3 \\ m_1 & m_2 & m_3 \\ n_1 & n_2 & n_3 \end{pmatrix} \qquad \text{(VII-5)}$$

where

$$\begin{aligned} \ell_1 &= b_{11} \\ m_1 &= b_{12} \\ n_1 &= b_{13} \\ k_1 &= b_{12}b_{23} - b_{13}b_{22} \\ k_2 &= -(b_{11}b_{23} - b_{13}b_{21}) \\ k_3 &= b_{11}b_{22} - b_{12}b_{21} \\ k^2 &= k_1^2 + k_2^2 + k_3^2 \\ \ell_3 &= k_1/k \\ m_3 &= k_2/k \\ n_3 &= k_3/k \\ \ell_2 &= n_1m_3 - n_3m_1 \\ m_2 &= \ell_1n_3 - \ell_3n_1 \\ n_2 &= m_1\ell_3 - m_3\ell_1 \end{aligned} \qquad \text{(VII-6)}$$

Note: If $n_3 < 0$, change the signs of ℓ_3, m_3, n_3.

$$(B') = (B) \cdot (S) = \begin{pmatrix} 1.0 & 0 & 0 \\ b'_{21} & b'_{22} & 0 \\ b'_{31} & b'_{32} & b'_{33} \end{pmatrix} \qquad \text{(VII-7)}$$

$$z'_3 = b'_{33} \qquad \text{(VII-8)}$$

$$(\alpha) = \frac{1}{\xi^2} \begin{pmatrix} r_1^2 - r_3^2 \\ r_2^2 - r_3^2 \\ r_3^2 \end{pmatrix} = \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{pmatrix} \qquad \text{(VII-9)}$$

$$(\Phi) = \begin{pmatrix} \phi_{11} & 0 & 0 & \phi_{14} \\ \phi_{21} & \phi_{22} & 0 & \phi_{24} \\ \phi_{31} & \phi_{32} & \phi_{33} & \phi_{34} \end{pmatrix} \qquad \text{(VII-10)}$$

where

$$\begin{aligned} \phi_{11} &= \phi_{33} = 0.5 \\ \phi_{21} &= -\frac{b'_{21}}{2b'_{22}} \\ \phi_{22} &= \frac{1}{2b'_{22}} \\ \phi_{31} &= \frac{b'_{21}b'_{32} - b'_{22}b'_{31}}{2b'_{22}} \\ \phi_{32} &= -\frac{b'_{32}}{2b'_{22}} \\ \phi_{14} &= \phi_{11}\alpha_1 \end{aligned}$$

$$\phi_{24} = \phi_{21}\alpha_1 + \phi_{22}\alpha_2$$

$$\phi_{34} = \phi_{31}\alpha_1 + \phi_{32}\alpha_2 + \phi_{33}\alpha_3 \qquad \text{(VII-11)}$$

$$u_j(t_o) \text{ normalized.} \quad j = 1,2,3 \qquad \text{(VII-12)}$$

$$\lambda \text{ normalized.} \qquad \text{(VII-13)}$$

After these precomputations have been made, the solution of the trajectory problem for each combination of three receivers at time t_i is obtained as follows:

$$u_j(t_i) = u_j(t_i - k) + \lambda \cdot \Delta N_j \qquad \text{(VII-14)}$$

$$u_j = (r) + r_j \qquad \text{(VII-15)}$$

where

$k \leq 0.5$ second, $k < 0.5$ sec for grenade burst times,

λ = normalized wavelength of double-transmitter frequency,

ΔN_j = number of cycles in time interval k.

Compute

$$(U) = \begin{pmatrix} u_3 - u_1 & (u_3-u_1)u_1 \\ u_3 - u_2 & (u_3-u_2)u_2 \\ -u_3 & 0 \\ 0 & 1 \end{pmatrix} \qquad \text{(VII-16)}$$

and

$$(C) = (\Phi) \cdot (U) = \begin{pmatrix} C_{11} & C_{12} \\ C_{21} & C_{22} \\ C_{31} & C_{32} \end{pmatrix} \qquad \text{(VII-17)}$$

Start the solution with $\epsilon = 0$, then compute

$$\begin{aligned} r &= 0.5(u_3-\epsilon) \\ x' &= C_{11}\epsilon + C_{12} \\ y' &= C_{21}\epsilon + C_{22} \\ (z')^2 &= r^2 - (x')^2 - (y')^2 \\ \epsilon' &= \frac{z'_3 z' - C_{32}}{C_{31}} \end{aligned}$$

Is $|\epsilon' - \epsilon| \geq \delta$? where $\delta = 0.0000001$

Yes, recalculate r,x',y',z', using ϵ'

No, compute (VII-18)

$$(\mathbf{r}) = \xi(S) \cdot \begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} - (r_\ell) \qquad \text{(VII-19)}$$

where

$(\mathbf{r}_\ell)$ = position of launching tower with respect to transmitter.

$(\mathbf{r})$ = position of missile with respect to launching tower (MSL).

After calculating x,y and z for each combination I, II, III, and IV, calculate

$$(\mathbf{r})\ \text{avg} = \left(1/4\ \Sigma x_m,\ 1/4\ \Sigma y_m,\ 1/4\ \Sigma z_m \quad , m = \text{I,II,III,IV}\right) \qquad \text{(VII-20)}$$

$$\sigma(\mathbf{r})_m = (\bar{x}-x_m,\ \bar{y}-y_m,\ \bar{z}-z_m) \qquad \text{(VII-21)}$$

$$\sigma(\mathbf{r})\ \text{avg} = \sqrt{\frac{\Sigma[\sigma(r)_m]^2}{12}} \ . \qquad \text{(VII-22)}$$

The flow diagram for this calculation is shown in Fig. 35. Instructions for use of the IBM 650 program and the program (list of machine instructions) is given in Appendix A.

For purpose of the grenade-experiment temperature and wind calculations, it is necessary to calculate grenade-explosion position with respect to the center microphone at Twin Lakes. The second IBM trajectory solution is that for rotating and translating the spatial coordinates of missile position at the time of grenade explosions with the launching tower (MSL) as origin to a set of corresponding positions above a coordinate system tangent to the Clarke Ellipsoid having the center geophone of the microphone array at Twin Lakes as origin. Geographic positions taken from the geodetic survey were

ϕ_0 = latitude of launcher = 58° 44' 9.038"
ϕ_1 = latitude of center geophone = 58° 37' 11.646"
ψ_0 = longitude of launcher = 93° 49' 8.613"
ψ_1 = longitude of center geophone = 93° 48' 41.151"

Then

$$\Delta\phi = \phi_1 - \phi_0 \qquad \text{(VII-23)}$$

$$\Delta\psi = \psi_1 - \psi_0 \qquad \text{(VII-24)}$$

$\cos(\Delta\psi) \approx 1$ for the present case

$$(M) = \begin{pmatrix} \cos \Delta\phi & -\sin \phi_1 \sin \Delta\psi & -\sin \Delta\phi \\ \sin \phi_0 \sin \Delta\psi & 1 & -\cos \phi_0 \sin \Delta\psi \\ \sin \Delta\phi & \cos \phi_1 \sin \Delta\psi & \cos \Delta\phi \end{pmatrix} \qquad \text{(VII-25)}$$

Now

$$\begin{aligned} \sin \phi_0 &= 0.8547837 \\ \cos \phi_0 &= 0.5189844 \\ \sin \phi_1 &= 0.8537318 \\ \cos \phi_1 &= 0.5207131 \\ \sin \Delta\phi &= -0.0020236 \\ \cos \Delta\phi &= 0.9999980 \\ \sin \Delta\psi &= 0.0001332 \end{aligned} \qquad \text{(VII-26)}$$

and

$$(M) = \begin{pmatrix} 0.9999980 & 0.0001137 & 0.0020236 \\ -0.0001139 & 1 & 0.0000691 \\ -0.0020236 & -0.0000694 & 0.9999980 \end{pmatrix} \qquad \text{(VII-27)}$$

The center geophone coordinates taken from the geodetic survey data were

$$\begin{aligned} x(+N) &= -42371.959' \\ y(+W) &= -1454.364' \\ z &= 24.007\text{m corrected to } 23.877\text{m} = 78.336' \end{aligned}$$

In the rotated system, the translation became

$$\begin{pmatrix} x_{TL} \\ y_{TL} \\ z_{TL} \end{pmatrix} = (M) \cdot \begin{pmatrix} -42371.96' \\ -1454.36' \\ 78.34' \end{pmatrix} = \begin{pmatrix} -42371.88' \\ -1449.53' \\ 164.18' \end{pmatrix} \qquad \text{(VII-28)}$$

The solution of the rotation and translation problem is

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = (M) \cdot \begin{pmatrix} x \\ y \\ z \end{pmatrix}_{avg} - \begin{pmatrix} x_{TL} \\ y_{TL} \\ z_{TL} \end{pmatrix} , \qquad \text{(VII-29)}$$

where

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix}_{avg} = (\mathbf{r})avg \qquad \text{(VII-30)}$$

The altitude intervals between successive grenade explosions were computed by

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix}_{G_{n+1}} - \begin{pmatrix} x \\ y \\ z \end{pmatrix}_{G_n} = \begin{pmatrix} x \\ y \\ z \end{pmatrix}_{\Delta G} = (\Delta G) \qquad \text{(VII-31)}$$

where n = number of grenade

for the position given by each combination of three receivers.

Then

$$\sum_{I}^{IV} \begin{pmatrix} x \\ y \\ z \end{pmatrix}_{\Delta G} = \begin{pmatrix} \bar{x} \\ \bar{y} \\ \bar{z} \end{pmatrix}_{\Delta G} = (\Delta G)\text{avg} \qquad \text{(VII-32)}$$

and

$$\sigma(\Delta G) = (\Delta G)\text{avg} - (\Delta G) \text{ for each receiver combination} \qquad \text{(VII-33)}$$

Finally,

$$\sigma(\Delta G)\text{avg} = \sqrt{\frac{\sum_{I}^{IV} [\sigma(\Delta G)]^2}{12}} \; . \qquad \text{(VII-34)}$$

The flow diagram for this calculation is shown in Fig. 36. Instructions for use of the IBM 650 program and the program is given in Appendix B.

VIII. ERRORS

Although a complete evaluation of errors has not been made at the time of writing this report, it will be useful to list a few of the possible sources of significant error and to estimate the magnitude of error possible for the data given in the appendices. It is hoped that a more complete error analysis will be a part of the future work to be done on this data-reduction project (see Section IX, Conclusions and Recommendations).

Reference to Eqs. (I-2) and (I-3) i.e.,

$$u_j(t_i) = u_j(t_i-k) + \lambda \cdot \Delta n_j \qquad \text{(I-2)}$$

$$\lambda = \frac{2f\ avg}{C\ avg} \qquad \text{(I-3)}$$

will suggest the possible sources of error. It will be convenient to refer to the magnitude of an error in terms of the quantities u_j, either in feet or in an equivalent number of cycles. The relationship between errors in the u_j and errors in horizontal and vertical coordinates can then be estimated from the equations used in calculating the trajectories.

From the above equations we can see that possible sources of error fall into at least four categories:

(1) Error in initial position, i.e., in the values of u_j/t_o.
(2) Errors in timing, i.e., in the values t_i.
(3) Errors in cycle count, i.e., in the values of Δn_j. These may arise from several sources:
    (a) A mistake may be made in counting.
    (b) Phase errors introduced by missile spin and by change of attitude between missile and ground antenna systems may not be properly corrected.
    (c) Errors may occur in extrapolating over a bad section of the record.
    (d) There may be random phase shifts in the DOVAP equipment.
(4) Errors in wavelength λ, which may be due to:
    (a) Errors in f avg.
    (b) Errors in C avg.

Additional possibilities arise when we consider the fact that the equations themselves may not completely describe the physical situation. The equations do not account for the effects of:

(5) Multipath radiation.
(6) Curvature of transmission path due to refraction by the atmosphere.

The error of category (1) is completely negligible. It is estimated that the values of $u_j(t_o)$ have been counted accurately to within a few feet or a few tenths of a cycle. The errors of categories 2,5, and 6 are negligible as explained in Refs. 11 and 12. The net result of errors in these four categories can be considered to be a random error of a few tenths of a cycle, i.e., an error of a few feet in the u_j.

With the care taken in counting and editing and handling of the cycle-count data as described in Sections IV, V, and VI, it is estimated that random errors of the order of a half cycle may occur in the count for a 0.5-second interval inasmuch as the spin correction, although correct in total, may leave errors as high as a half cycle in any such interval. In addition, a systematic error of a few cycles may accumulate in the cycle-count data for all four stations.

The values of σ_x, σ_y, and σ_z listed for the data in the appendices enable one to evaluate the consistency of the counts from the four stations. These σ values are calculated from the difference between the average solution and each of the four individual solutions. R. B. Patton of BRL, Aberdeen Proving Ground, has calculated the relation between σ_x, σ_y, σ_z, and σ_n for points in space over the Ft. Churchill range.[13] The data is provided as a series of graphs of the ratio σ_x/σ_u, σ_y/σ_u, and σ_z/σ_u cos x,y, and z over the Ft. Churchill range. From these data of Patton's, it can be shown that the σ_x, σ_y, and σ_z values of the data in the Appendices correspond to values of σ_u less than 5 feet for all data except the very end of the data of SM 2.06 which has σ_u equal to 8 feet. The values of σ_u equal to 5 and 8 feet, respectively, correspond to random errors in the cycle counts of about 0.4 to 0.7 cycles, respectively.

The σ_x, σ_y, σ_z do not tell us anything about the possibility of systematic errors in all four of the sets of cycle-count data. As mentioned above, it is possible that systematic errors of as much as 2 cycles could exist in the cycle-count data (this is equivalent to a 25-foot error in the u_j). Such a systematic error in u_j would produce a vertical coordinate error as large as 25 feet and horizontal coordinate errors as large as 150 feet.

The error of category (4) above, error in wavelength λ, may introduce systematic errors in the u_j values as great as 15-20 feet at altitudes of 60 kilometers, according to the approximate analysis of Ref. 12. This source of error would produce a systematic error in vertical coordinate of 15-20 feet and in horizontal coordinate of 90-120 feet. It could be of the same sign or of sign opposite to the systematic error in cycle count.

The errors in layers between grenade explosions are very small, corresponding to random errors of less than ± 0.5 cycle. The corresponding errors in vertical and horizontal distance between two consecutive grenade explosions is less than ± 6 feet and ± 36 feet, respectively.

IX. CONCLUSIONS AND RECOMMENDATIONS

The DOVAP data for the ten rocket-grenade Aerobees SM 1.01 - SM 2.10 have been reduced to position (of antenna) versus time (see Appendix A). The position of the rocket antenna system with respect to the center microphone at Twin Lakes, at the time of each grenade explosion, has been calculated (see Appendix B); and the layers between successive grenade explosions have been calculated (see Appendix B) with an accuracy sufficient for the grenade experiment for upper-air temperatures and winds (± 36 feet in horizontal coordinates of a layer and ± 6 feet in vertical coordinates of a layer).

It is recommended that the data reduction for these ten Aerobee flights continue as follows:

(A) The data for SM 1.01, SM 1.02, SM 1.03 and SM 1.05 should be refined and a comparison of DOVAP, ballistic camera, and radar data for these four flights should be made.

(B) The data reduction for SM 2.10 should be carried out up to the peak of the rocket trajectory.

(C) Velocity and acceleration data should be calculated for all ten flights.

X. ACKNOWLEDGMENTS

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The frontispiece of this report is a U. S. Army photograph.

XI. REFERENCES

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APPENDIX A

ROCKET TRAJECTORIES WITH RESPECT TO FORT CHURCHILL AEROBEE LAUNCHER

These are the average solutions for each half second of time. Tabulations of the four individual solutions, from which these averages were obtained, can be obtained by request from The University of Michigan Research Institute.

The position data from 115.5 seconds through 124.5 seconds on SM 1.02 and from 54.0 seconds through 99.0 seconds on SM 1.04 are three-station data.

SM 1.01 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
1.0	23.07-	.42	1.93-	.43	310.62	1.32
1.5	61.80-	1.46	8.47-	1.58	545.45	2.69
2.0	118.32-	.79	10.55-	.84	871.26	1.07
2.5	184.57-	.28	11.00-	.29	1288.19	.31
3.0	260.40-	.96	9.00-	1.03	1759.94	1.02
3.5	343.13-	.76	11.21-	.80	2249.29	.75
4.0	427.58-	1.21	12.45-	1.27	2749.51	1.14
4.5	517.68-	2.15	11.60-	2.26	3261.84	1.95
5.0	608.36-	3.16	9.18-	3.31	3784.91	2.78
5.5	695.63-	.79	4.61-	.83	4314.41	.67
6.0	789.68-	.26	3.57-	.27	4853.83	.21
6.5	891.43-	2.56	3.41	2.68	5404.96	2.08
7.0	991.92-	3.99	6.69	4.19	5963.47	3.19
7.5	1094.86-	5.11	9.89	5.37	6532.24	3.99
8.0	1199.93-	5.31	13.85	5.59	7109.32	4.07
8.5	1311.26-	5.48	20.16	5.77	7694.05	4.11
9.0	1423.62-	6.85	29.96	7.22	8289.45	5.03
9.5	1537.19-	7.16	39.26	7.56	8895.58	5.15
10.0	1651.75-	6.19	54.26	6.54	9510.25	4.37

SM 1.01 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
10.5	1768.50-	5.36	64.46	5.67	10135.13	3.70
11.0	1891.80-	3.07	74.00	3.25	10769.22	2.08
11.5	2022.81-	6.52	93.53	6.91	11418.02	4.32
12.0	2150.62-	7.08	107.39	7.51	12076.19	4.60
12.5	2284.07-	9.48	122.09	10.07	12746.15	6.03
13.0	2417.74-	9.51	138.30	10.11	13425.99	5.92
13.5	2554.53-	9.45	157.66	10.06	14117.32	5.76
14.0	2695.92-	13.31	181.87	14.18	14821.35	7.94
14.5	2843.13-	15.14	208.86	16.14	15537.69	8.83
15.0	2990.96-	15.82	232.09	16.88	16263.75	9.02
15.5	3140.24-	15.78	257.45	16.85	17003.15	8.80
16.0	3291.19-	14.26	290.53	15.24	17754.39	7.78
16.5	3446.28-	14.87	320.47	15.91	18518.36	7.93
17.0	3607.51-	18.14	357.16	19.42	19297.33	9.44
17.5	3767.88-	20.19	391.89	21.63	20088.36	10.27
18.0	3932.61-	20.95	425.69	22.46	20891.91	10.41
18.5	4103.89-	23.34	457.89	25.05	21710.41	11.33
19.0	4274.56-	22.72	494.67	24.40	22542.64	10.76
19.5	4447.08-	21.12	530.23	22.70	23389.16	9.77

SM 1.01 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
20.0	4624.01-	19.03	571.22	20.47	24251.12	8.59
20.5	4804.12-	18.46	620.78	19.86	25129.09	8.13
21.0	4986.35-	18.27	669.08	19.67	26023.74	7.85
21.5	5179.25-	20.75	721.90	22.36	26935.99	8.69
22.0	5370.63-	20.35	773.55	21.94	27865.19	8.31
22.5	5562.83-	18.53	829.57	19.98	28810.64	7.38
23.0	5758.81-	15.62	883.60	16.86	29777.54	6.06
23.5	5960.35-	15.15	943.99	16.36	30762.07	5.73
24.0	6164.84-	13.86	1013.46	14.97	31768.42	5.10
24.5	6364.62-	16.62	1084.72	17.96	32798.73	5.96
25.0	6589.15-	11.44	1147.32	12.37	33844.35	3.99
25.5	6808.36-	9.37	1222.95	10.14	34915.73	3.19
26.0	7032.30-	8.25	1298.86	8.93	36009.95	2.73
26.5	7261.43-	5.45	1376.77	5.91	37127.12	1.76
27.0	7495.54-	4.48	1467.49	4.86	38271.83	1.41
27.5	7735.59-	2.11	1548.07	2.30	39440.84	.65
28.0	7982.74-	1.04	1642.30	1.13	40636.01	.31
28.5	8238.11-	.62	1737.82	.67	41859.13	.18
29.0	8497.78-	4.33	1834.11	4.69	43110.71	1.22

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
29.5	8763.24-	5.11	1941.40	5.54	44391.70	1.40
30.0	9035.04-	7.11	2046.27	7.70	45703.27	1.90
30.5	9317.83-	8.18	2158.53	8.87	47046.29	2.12
31.0	9610.27-	9.35	2275.02	10.14	48421.10	2.36
31.5	9912.40-	6.94	2405.13	7.52	49828.86	1.71
32.0	10217.54-	8.53	2532.51	9.26	51271.32	2.04
32.5	10537.84-	7.66	2667.73	8.31	52749.90	1.79
33.0	10861.87-	7.99	2807.00	8.67	54263.71	1.82
33.5	11198.14-	8.10	2953.11	8.79	55814.15	1.80
34.0	11537.19-	6.91	3103.25	7.51	57400.44	1.50
34.5	11891.59-	6.35	3257.45	6.90	59024.30	1.34
35.0	12250.76-	6.85	3417.37	7.44	60673.33	1.42
35.5	12616.94-	6.22	3580.77	6.76	62340.36	1.26
36.0	12984.33-	5.71	3747.44	6.21	64031.96	1.13
36.5	13359.38-	6.20	3915.77	6.74	65730.75	1.21
37.0	13731.07-	5.64	4082.91	6.13	67417.18	1.08
37.5	14102.15-	5.40	4251.62	5.87	69089.86	1.01
38.0	14471.99-	6.16	4419.21	6.70	70748.23	1.14
38.5	14841.23-	5.14	4582.25	5.59	72392.38	.94

SM 1.01 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
39.0	15209.08-	6.27	4748.41	6.83	74022.08	1.13
39.5	15573.84-	6.68	4911.92	7.27	75638.70	1.19
40.0	15939.83-	4.56	5077.11	4.97	77242.20	.80
40.5	16303.21-	5.66	5239.41	6.15	78833.02	.99
41.0	16667.95-	5.72	5403.17	6.23	80411.05	.99
41.5	17030.24-	6.16	5564.48	6.71	81977.32	1.06
42.0	17391.20-	4.27	5727.44	4.65	83530.90	.73
42.5	17748.46-	5.45	5891.37	5.93	85073.25	.92
43.0	18110.06-	4.39	6049.29	4.77	86603.91	.74
43.5	18468.92-	4.95	6209.29	5.39	88122.69	.83
44.0	18823.94-	4.01	6373.50	4.36	89631.31	.67
44.5	19181.76-	5.38	6534.11	5.86	91129.55	.90
45.0	19537.20-	5.00	6692.32	5.44	92617.49	.83
45.5	19893.78-	3.90	6851.19	4.24	94094.31	.65
46.0	20247.74-	3.93	7012.39	4.27	95560.68	.65
46.5	20606.05-	4.08	7168.36	4.44	97016.90	.68
47.0	20959.12-	4.52	7329.88	4.92	98464.16	.75
47.5	21314.20-	4.04	7486.87	4.40	99901.20	.67
48.0	21665.26-	2.36	7648.06	2.57	101329.73	.39

SM 1.01 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
48.5	22018.54-	2.79	7804.13	3.04	102747.86	.45
49.0	22372.55-	2.44	7962.86	2.66	104156.50	.40
49.5	22723.06-	1.41	8120.50	1.52	105555.45	.23
50.0	23072.84-	1.78	8278.89	1.94	106946.36	.29
50.5	23423.48-	.45	8437.18	.48	108327.76	.07
51.0	23778.65-	1.07	8594.73	1.16	109699.70	.17
51.5	24126.99-	.02	8754.51	.03	111062.56	.01
52.0	24478.07-	1.51	8911.51	1.65	112417.43	.25
52.5	24828.82-	1.12	9067.15	1.22	113762.45	.18
53.0	25178.13-	1.47	9226.27	1.60	115098.48	.25
53.5	25528.20-	1.01	9384.49	1.09	116426.62	.16
54.0	25879.49-	1.43	9542.06	1.56	117744.81	.24
54.5	26231.68-	2.82	9698.31	3.07	119055.19	.48
55.0	26580.22-	1.05	9853.46	1.14	120356.60	.18
55.5	26926.28-	2.18	10007.46	2.38	121650.53	.37
56.0	27276.68-	1.53	10170.16	1.67	122935.06	.26
56.5	27623.64-	1.68	10328.20	1.82	124209.82	.28
57.0	27972.85-	1.40	10486.03	1.53	125477.61	.24
57.5	28325.57-	.25	10641.83	.28	126735.35	.05

SM 1.01 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
58.0	28670.17-	1.20	10801.64	1.31	127986.21	.20
58.5	29020.53-	.27	10957.87	.31	129228.21	.05
59.0	29367.05-	.90	11114.99	.98	130462.71	.15
59.5	29715.05-	1.36	11267.75	1.48	131687.69	.24
60.0	30061.87-	.53	11428.52	.57	132903.49	.09
60.5	30408.36-	.12	11586.51	.13	134111.63	.03
61.0	30756.43-	.77	11743.07	.84	135311.75	.13
61.5	31103.00-	.07	11900.05	.08	136502.74	.02
62.0	31448.63-	.48	12057.11	.53	137687.32	.09
62.5	31796.73-	.09	12213.68	.10	138862.99	.02
63.0	32145.08-	.29	12368.11	.32	140028.86	.06
63.5	32491.91-	.15	12525.91	.17	141188.15	.03
64.0	32837.15-	.97	12683.55	1.06	142338.44	.17
64.5	33184.95-	.28	12841.10	.30	143480.45	.06
65.0	33531.68-	1.04	12998.43	1.15	144613.45	.18
65.5	33877.01-	.15	13156.00	.16	145739.77	.03
66.0	34223.79-	.24	13315.75	.25	146858.16	.05
66.5	34568.41-	.18	13470.74	.19	147967.45	.04
67.0	34911.19-	2.69	13625.54	2.94	149070.19	.50

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
67.5	35261.20-	2.10	13783.17	2.30	150163.38	.39
68.0	35607.11-	.31	13937.90	.34	151248.99	.06
68.5	35954.38-	.16	14099.43	.18	152326.58	.04
69.0	36296.37-	1.10	14257.55	1.20	153396.84	.21
69.5	36646.28-	2.43	14411.21	2.65	154457.37	.47
70.0	36993.54-	.49	14571.38	.54	155509.94	.10
70.5	37334.04-	1.76	14731.55	1.92	156555.44	.34
71.0	37680.77-	2.61	14885.35	2.86	157591.35	.51
71.5	38023.79-	2.73	15040.87	2.98	158620.61	.53
72.0	38370.03-	3.22	15200.39	3.52	159641.13	.63
72.5	38716.57-	2.73	15356.59	2.98	160653.10	.54
73.0	39063.98-	1.79	15517.95	1.97	161658.04	.34
73.5	39407.97-	2.73	15670.46	2.97	162653.81	.54
74.0	39748.38-	3.80	15828.89	4.14	163642.56	.75
74.5	40092.92-	3.29	15982.68	3.59	164622.25	.65
75.0	40440.30-	3.11	16139.91	3.39	165593.99	.62
75.5	40784.59-	3.00	16299.98	3.27	166557.52	.60
76.0	41128.70-	1.77	16455.82	1.93	167514.42	.36
76.5	41474.43-	3.42	16614.73	3.72	168462.22	.69
77.0	41817.84-	2.91	16772.32	3.16	169400.41	.59

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
77.5	42159.60-	3.55	16929.52	3.86	170331.51	.73
78.0	42503.87-	4.49	17089.76	4.89	171255.43	.92
78.5	42847.48-	4.33	17245.41	4.71	172171.14	.89
79.0	43193.56-	4.77	17399.65	5.20	173077.73	.98
79.5	43538.53-	3.49	17558.33	3.79	173977.02	.72
80.0	43880.08-	5.40	17724.46	5.89	174869.68	1.12
80.5	44221.97-	4.18	17877.29	4.54	175752.17	.87
81.0	44569.45-	5.29	18031.61	5.76	176625.65	1.10
81.5	44913.93-	3.72	18188.21	4.06	177492.75	.78
82.0	45259.30-	5.14	18347.24	5.61	178350.58	1.09
82.5	45604.43-	2.36	18505.87	2.56	179201.45	.50
83.0	45945.78-	3.16	18667.76	3.43	180044.53	.67
83.5	46290.45-	2.13	18823.17	2.31	180879.21	.46
84.0	46629.47-	3.84	18980.08	4.18	181706.02	.82
84.5	46973.17-	4.31	19136.76	4.69	182523.81	.93
85.0	47321.51-	3.53	19293.23	3.84	183331.93	.76
85.5	47658.45-	2.15	19455.45	2.33	184133.56	.47
86.0	47999.56-	2.82	19607.14	3.07	184929.07	.62
86.5	48341.99-	3.44	19765.92	3.75	185716.12	.76

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
87.0	48684.02-	3.45	19925.37	3.75	186493.01	.76
87.5	49022.97-	4.67	20083.18	5.09	187262.54	1.03
88.0	49369.25-	2.68	20242.48	2.91	188023.03	.60
88.5	49709.81-	4.11	20392.95	4.48	188777.12	.91
89.0	50052.57-	2.62	20550.78	2.85	189522.56	.59
89.5	50393.77-	3.28	20708.51	3.57	190260.16	.73
90.0	50734.49-	3.24	20866.47	3.52	190990.06	.73
90.5	51076.44-	3.43	21026.40	3.74	191711.69	.78
91.0	51416.23-	2.30	21179.73	2.51	192425.35	.53
91.5	51755.66-	3.99	21339.63	4.35	193129.84	.91
92.0	52097.70-	3.31	21496.69	3.61	193827.01	.76
92.5	52439.83-	6.13	21650.18	6.69	194515.35	1.40
93.0	52780.47-	3.96	21807.22	4.32	195197.24	.91
93.5	53120.99-	4.94	21965.59	5.39	195871.51	1.14
94.0	53463.63-	3.56	22121.11	3.88	196535.10	.83
94.5	53802.23-	3.07	22279.36	3.35	197191.79	.72
95.0	54141.63-	2.80	22439.31	3.06	197839.60	.66
95.5	54486.17-	5.34	22594.20	5.83	198479.72	1.25
96.0	54818.69-	4.20	22754.74	4.60	199114.38	.99

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
96.5	55161.44-	5.57	22903.90	6.09	199738.90	1.32
97.0	55502.59-	5.46	23063.13	5.97	200355.14	1.30
97.5	55847.62-	3.90	23220.96	4.26	200961.48	.93
98.0	56183.39-	4.27	23377.23	4.67	201562.22	1.02
98.5	56521.98-	6.17	23531.52	6.75	202155.07	1.48
99.0	56864.16-	6.22	23689.53	6.81	202738.15	1.50
99.5	57203.13-	4.09	23850.41	4.48	203315.19	1.00
100.0	57553.30-	1.06	24005.14	1.17	203881.54	.27
104.5	60614.02-	6.86	25406.29	7.50	208638.64	1.71
109.5	63997.08-	7.58	26982.81	8.29	213177.47	1.97
114.5	67360.15-	24.96	28512.45	27.31	216937.18	6.79
119.5	70630.75-	1.41	30038.22	1.54	219917.47	.39
124.5	73939.17-	12.07	31527.35	13.22	222105.42	3.58
129.5	77269.25-	3.19	33091.17	3.48	223494.07	.98
130.0	77610.70-	3.10	33248.78	3.39	223586.24	.95
130.5	77942.68-	2.70	33407.41	2.94	223675.42	.83
131.0	78279.79-	3.09	33562.87	3.37	223754.89	.96
131.5	78617.79-	1.69	33722.80	1.87	223823.94	.52
132.0	78954.15-	3.17	33881.56	3.47	223886.36	1.00

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
132.5	79288.63-	4.05	34039.93	4.46	223941.37	1.26
133.0	79625.21-	2.28	34198.66	2.51	223987.76	.71
133.5	79962.67-	3.13	34357.95	3.42	224026.64	.98
134.0	80299.77-	4.74	34516.52	5.18	224058.55	1.50
134.5	80630.63-	3.18	34678.45	3.49	224083.07	.99
135.0	80971.20-	3.57	34833.32	3.87	224097.40	1.13
135.5	81306.54-	3.12	34989.33	3.40	224105.17	.99
136.0	81641.52-	3.54	35149.07	3.83	224104.77	1.13
136.5	81977.72-	2.70	35306.98	2.92	224096.22	.85
137.0	82312.72-	2.43	35467.17	2.65	224081.39	.77
137.5	82646.64-	2.13	35623.18	2.30	224058.82	.67
138.0	82980.65-	.87	35780.80	.92	224027.38	.25
138.5	83314.35-	1.10	35938.24	1.29	223988.26	.42
139.0	83651.44-	.39	36097.98	.42	223940.33	.15
139.5	83988.21-	1.59	36259.06	1.69	223884.24	.49
140.0	84323.07-	.89	36415.58	1.04	223821.14	.36
140.5	84659.87-	.16	36575.24	.29	223750.97	.07
141.0	84993.73-	.38	36732.62	.39	223672.79	.06
141.5	85330.28-	.14	36890.69	.32	223585.34	.07

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
142.0	85664.94-	.14	37050.76	.31	223490.58	.07
142.5	86000.31-	.67	37208.82	.73	223388.17	.16
143.0	86335.85-	1.80	37366.36	1.93	223277.36	.56
143.5	86671.41-	.79	37525.57	.85	223158.99	.20
144.0	87005.66-	.63	37686.54	.80	223034.62	.30
144.5	87343.61-	.89	37842.85	.95	222900.59	.24
145.0	87678.48-	.30	37999.32	.47	222757.61	.18
145.5	88008.44-	.21	38163.47	.34	222609.09	.07
146.0	88344.80-	.17	38319.61	.35	222451.46	.10
146.5	88679.78-	1.67	38476.93	1.77	222285.43	.52
147.0	89017.93-	1.02	38638.91	1.09	222110.08	.29
147.5	89353.53-	2.15	38798.79	2.31	221932.40	.71
148.0	89686.09-	2.32	38956.33	2.49	221744.15	.77
148.5	90025.62-	1.67	39112.54	1.77	221544.02	.54
149.0	90359.71-	2.03	39271.70	2.16	221339.23	.66
149.5	90690.24-	.31	39433.11	.40	221126.70	.07
154.5	93910.38-	18.20	41037.14	20.06	218599.61	7.24
159.5	97258.18-	18.65	42618.09	20.55	215274.47	7.83
164.5	100600.50-	17.98	44200.97	19.83	211153.54	7.99

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
169.5	103928.98-	19.88	45784.00	21.92	206249.81	9.36
174.5	107252.06-	19.34	47367.21	21.34	200561.76	9.70
179.5	110576.67-	20.87	48948.95	23.05	194092.49	11.17
184.5	113884.86-	21.96	50515.61	24.27	186818.62	12.60
189.5	117189.17-	23.48	52088.49	25.96	178776.07	14.50
194.5	120482.91-	24.42	53650.65	27.03	169932.19	16.35
199.5	123768.44-	26.97	55215.05	29.88	160309.73	19.68
204.5	127044.10-	27.44	56764.92	30.44	149907.68	22.01
209.5	130313.09-	30.00	58307.37	33.33	138738.78	26.68
214.5	133561.42-	32.46	59838.38	36.13	126807.19	32.39
219.5	136800.76-	40.69	61374.96	45.37	114137.97	46.19
224.5	140002.27-	39.92	62863.14	44.61	100804.54	52.54
229.5	143152.56-	42.22	64321.63	47.29	86929.46	65.89
234.5	146197.15-	44.33	65713.66	49.76	72734.16	84.43
239.5	149088.72-	14.15	66977.62	15.95	58614.11	34.34

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
1.0	5.45-	.42	6.59-	.43	327.97	1.29
1.5	18.94-	.45	7.95-	.47	589.64	.82
2.0	41.37-	.81	1.14-	.85	958.64	1.12
2.5	73.36-	.94	11.63	.99	1431.69	1.11
3.0	108.35-	.85	27.79	.89	1940.05	.91
3.5	146.61-	.76	43.95	.79	2464.33	.77
4.0	185.20-	.72	60.40	.75	3002.75	.70
4.5	225.96-	.51	78.26	.53	3551.77	.48
5.0	267.18-	.34	97.07	.36	4111.47	.31
5.5	309.70-	.24	115.62	.25	4681.37	.21
6.0	353.32-	.07	134.76	.07	5261.17	.05
6.5	398.68-	.26	155.45	.27	5851.16	.22
7.0	445.59-	.37	176.48	.39	6451.54	.31
7.5	493.79-	.17	198.15	.18	7062.78	.14
8.0	544.28-	.25	220.49	.26	7683.95	.20
8.5	595.37-	.77	242.14	.80	8315.59	.60
9.0	647.96-	1.10	264.44	1.15	8958.85	.84
9.5	702.60-	1.51	287.74	1.57	9613.48	1.12
10.0	758.51-	1.55	311.88	1.62	10280.17	1.13

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
10.5	815.16-	1.13	337.13	1.18	10959.96	.80
11.0	875.90-	.41	363.31	.43	11652.68	.29
11.5	937.40-	.30	389.53	.31	12357.91	.20
12.0	1000.68-	.23	415.19	.24	13077.02	.15
12.5	1065.38-	.22	441.07	.23	13809.23	.15
13.0	1130.69-	.48	469.19	.51	14555.55	.31
13.5	1197.61-	.64	497.41	.67	15316.47	.40
14.0	1265.49-	.21	527.03	.22	16092.66	.13
14.5	1335.01-	.41	558.77	.43	16883.72	.24
15.0	1404.78-	.99	591.19	1.03	17690.20	.57
15.5	1477.60-	.87	624.45	.92	18511.53	.49
16.0	1552.80-	.94	659.85	.98	19349.24	.52
16.5	1629.46-	.64	695.77	.67	20202.59	.34
17.0	1708.40-	.94	734.72	.99	21073.92	.49
17.5	1790.14-	1.18	774.62	1.24	21962.31	.61
18.0	1873.62-	1.31	816.60	1.38	22869.23	.66
18.5	1959.58-	1.30	859.92	1.37	23793.77	.63
19.0	2048.82-	1.28	905.99	1.35	24737.41	.61
19.5	2140.02-	.97	952.34	1.02	25700.80	.45

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
20.0	2235.17-	.23	998.82	.24	26684.10	.11
20.5	2332.46-	2.23	1045.17	2.36	27687.45	.98
21.0	2432.63-	3.04	1094.33	3.22	28713.27	1.31
21.5	2538.06-	2.98	1145.02	3.16	29761.44	1.25
22.0	2646.78-	3.24	1196.23	3.44	30832.29	1.32
22.5	2758.05-	3.32	1247.21	3.52	31927.33	1.32
23.0	2872.19-	3.64	1299.80	3.87	33046.67	1.40
23.5	2989.17-	3.48	1353.00	3.70	34191.31	1.31
24.0	3108.74-	4.13	1406.96	4.39	35361.75	1.50
24.5	3229.37-	3.52	1463.65	3.74	36559.64	1.25
25.0	3351.78-	3.42	1522.72	3.64	37785.34	1.18
25.5	3476.27-	3.14	1583.25	3.35	39039.56	1.05
26.0	3603.36-	2.68	1646.02	2.86	40324.15	.87
26.5	3733.10-	2.68	1710.94	2.86	41639.73	.85
27.0	3864.85-	2.45	1780.23	2.61	42988.41	.75
27.5	4000.36-	1.92	1852.54	2.05	44370.38	.57
28.0	4137.18-	2.18	1928.59	2.34	45787.36	.63
28.5	4277.62-	2.16	2007.19	2.31	47240.57	.60
29.0	4420.16-	2.06	2089.78	2.21	48730.85	.56

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
29.5	4565.42-	1.67	2177.64	1.78	50260.06	.44
30.0	4714.71-	2.10	2269.45	2.25	51829.39	.53
30.5	4866.91-	2.88	2366.53	3.09	53440.21	.71
31.0	5021.53-	1.89	2468.58	2.03	55093.34	.45
31.5	5178.77-	2.02	2575.73	2.17	56790.94	.47
32.0	5342.03-	1.93	2685.41	2.08	58533.41	.43
32.5	5507.43-	3.06	2801.70	3.30	60323.10	.66
33.0	5672.96-	3.11	2922.05	3.35	62161.07	.65
33.5	5841.28-	3.21	3044.18	3.46	64049.79	.65
34.0	6013.54-	4.45	3170.92	4.79	65991.24	.87
34.5	6191.25-	4.13	3295.88	4.45	67985.73	.78
35.0	6372.50-	5.67	3424.87	6.12	70025.12	1.04
35.5	6554.78-	4.67	3551.69	5.04	72069.38	.83
36.0	6739.25-	4.45	3678.45	4.80	74098.12	.76
36.5	6926.69-	4.52	3804.28	4.88	76111.43	.75
37.0	7110.77-	3.85	3929.49	4.17	78109.67	.62
37.5	7296.48-	4.01	4053.77	4.33	80093.13	.63
38.0	7482.34-	4.65	4174.11	5.04	82061.83	.72
38.5	7667.93-	5.25	4298.85	5.68	84016.71	.79

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
39.0	7856.16-	6.06	4423.63	6.56	85958.71	.88
39.5	8040.48-	5.40	4543.25	5.83	87885.78	.77
40.0	8226.69-	6.09	4666.33	6.58	89800.48	.85
40.5	8413.32-	5.94	4790.41	6.42	91703.03	.80
41.0	8596.24-	5.69	4914.61	6.15	93593.87	.75
41.5	8782.47-	6.34	5038.85	6.85	95473.41	.82
42.0	8967.08-	6.34	5163.18	6.86	97341.35	.80
42.5	9149.88-	6.05	5285.62	6.54	99197.56	.75
43.0	9335.02-	7.07	5409.06	7.65	101043.39	.86
43.5	9517.33-	6.15	5530.84	6.65	102878.64	.74
44.0	9701.51-	7.26	5654.79	7.86	104704.04	.85
44.5	9882.67-	7.66	5777.65	8.29	106519.00	.88
45.0	10066.77-	8.04	5899.43	8.70	108324.47	.91
45.5	10247.29-	7.05	6025.37	7.63	110119.38	.79
46.0	10427.26-	6.62	6146.77	7.16	111904.28	.73
46.5	10610.90-	6.97	6269.55	7.55	113680.18	.75
47.0	10792.89-	7.68	6393.37	8.32	115446.44	.82
47.5	10973.64-	6.31	6514.01	6.84	117202.99	.66
48.0	11153.91-	6.02	6636.75	6.52	118950.73	.63

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
48.5	11337.86-	7.65	6760.89	8.29	120689.20	.78
49.0	11519.33-	7.69	6882.58	8.33	122417.96	.78
49.5	11696.58-	5.49	7005.37	5.94	124137.99	.55
50.0	11879.28-	7.13	7131.09	7.72	125849.07	.70
50.5	12060.57-	8.06	7250.40	8.73	127551.37	.79
51.0	12240.63-	6.74	7372.30	7.30	129245.27	.65
51.5	12422.67-	8.35	7497.46	9.05	130930.35	.80
52.0	12601.61-	6.70	7618.15	7.26	132606.44	.64
52.5	12782.34-	8.08	7744.37	8.76	134273.71	.76
53.0	12963.20-	8.95	7866.36	9.70	135932.17	.83
53.5	13142.24-	7.67	7988.84	8.31	137582.30	.70
54.0	13323.82-	8.17	8112.95	8.86	139224.13	.75
54.5	13502.60-	7.89	8235.18	8.55	140857.25	.72
55.0	13680.00-	9.17	8359.66	9.94	142482.30	.83
55.5	13860.30-	8.07	8483.51	8.74	144098.34	.72
56.0	14039.11-	7.71	8606.17	8.35	145705.98	.68
56.5	14220.74-	8.13	8728.65	8.80	147305.26	.72
57.0	14398.87-	7.91	8852.75	8.57	148896.04	.69
57.5	14581.20-	9.01	8974.83	9.76	150478.99	.79

SM 1.02 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
58.0	14759.75-	9.05	9097.97	9.80	152053.42	.79
58.5	14939.14-	7.66	9223.52	8.30	153619.63	.66
59.0	15115.66-	6.10	9345.01	6.60	155177.59	.53
59.5	15296.43-	7.60	9470.01	8.23	156727.10	.66
60.0	15472.59-	6.17	9593.74	6.68	158268.01	.53
60.5	15654.63-	7.45	9715.63	8.07	159801.12	.64
61.0	15835.09-	6.47	9840.37	7.00	161325.93	.55
61.5	16014.46-	6.65	9962.87	7.20	162842.76	.57
62.0	16191.08-	6.44	10088.96	6.97	164351.61	.55
62.5	16368.82-	6.67	10217.57	7.22	165852.53	.56
63.0	16549.11-	5.59	10338.47	6.04	167344.02	.47
63.5	16728.01-	5.71	10463.80	6.18	168827.76	.49
64.0	16903.21-	6.05	10588.67	6.55	170303.65	.51
64.5	17082.36-	5.66	10710.60	6.13	171771.53	.48
65.0	17263.25-	6.81	10832.87	7.37	173231.04	.57
65.5	17440.83-	7.29	10961.66	7.89	174682.85	.62
66.0	17618.10-	5.79	11083.32	6.26	176126.52	.49
66.5	17799.32-	7.61	11207.71	8.24	177561.62	.64
67.0	17976.65-	7.35	11331.05	7.96	178988.63	.62

SM 1.02

16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
67.5	18154.67-	8.09	11457.16	8.76	180407.36	.68
68.0	18331.72-	7.11	11582.78	7.69	181818.61	.60
68.5	18509.68-	6.15	11707.75	6.65	183221.39	.52
69.0	18691.57-	9.24	11830.26	10.01	184616.25	.78
69.5	18866.42-	5.52	11957.34	5.96	186003.55	.47
70.0	19044.42-	6.13	12078.71	6.63	187382.48	.52
70.5	19221.20-	5.27	12203.15	5.69	188753.11	.44
71.0	19400.29-	7.86	12330.69	8.50	190115.45	.66
71.5	19578.00-	6.21	12449.79	6.71	191469.64	.52
72.0	19756.75-	7.28	12581.08	7.87	192815.93	.62
72.5	19934.85-	7.59	12702.61	8.21	194154.35	.64
73.0	20110.66-	5.35	12828.11	5.77	195484.95	.45
73.5	20290.93-	8.27	12954.01	8.94	196807.44	.70
74.0	20471.48-	8.27	13077.98	8.95	198121.80	.70
74.5	20651.38-	7.98	13201.11	8.63	199427.64	.68
75.0	20824.17-	6.14	13326.41	6.63	200725.89	.52
75.5	21006.36-	6.18	13448.66	6.67	202015.92	.53
76.0	21181.50-	6.41	13575.97	6.92	203298.02	.55
76.5	21358.06-	5.65	13702.85	6.09	204572.07	.48

SM 1.02 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
77.0	21538.44-	7.11	13825.17	7.68	205838.13	.61
77.5	21714.93-	5.83	13946.45	6.29	207096.34	.50
78.0	21897.26-	5.90	14073.76	6.37	208346.31	.51
78.5	22074.68-	6.99	14198.20	7.54	209588.68	.61
79.0	22251.61-	5.83	14323.39	6.28	210823.52	.51
79.5	22427.72-	5.94	14449.41	6.39	212049.08	.52
80.0	22606.26-	7.66	14575.58	8.27	213266.82	.67
80.5	22783.58-	7.41	14701.22	8.00	214476.37	.64
81.0	22964.88-	9.39	14827.62	10.16	215678.23	.82
81.5	23140.93-	8.80	14948.32	9.51	216872.28	.77
82.0	23316.89-	9.95	15077.67	10.76	218058.68	.87
82.5	23494.69-	6.63	15201.76	7.15	219236.85	.58
83.0	23670.80-	8.07	15328.97	8.71	220407.10	.71
83.5	23853.09-	11.22	15455.45	12.14	221569.42	.99
84.0	24030.20-	11.76	15584.38	12.72	222723.51	1.04
84.5	24205.26-	10.65	15707.24	11.52	223869.34	.95
85.0	24381.03-	10.95	15834.49	11.85	225007.10	.98
85.5	24559.11-	10.67	15956.79	11.54	226136.84	.95
86.0	24733.68-	10.28	16085.45	11.13	227258.87	.93

SM 1.02 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
86.5	24914.19-	11.98	16208.68	12.97	228372.57	1.08
87.0	25093.92-	11.42	16334.06	12.36	229478.67	1.04
87.5	25270.80-	12.16	16461.34	13.17	230576.73	1.10
88.0	25453.24-	12.43	16584.50	13.45	231666.53	1.13
88.5	25629.17-	12.19	16715.88	13.19	232749.04	1.11
89.0	25802.35-	10.81	16842.02	11.69	233823.09	.99
89.5	25985.89-	14.62	16969.23	15.83	234888.36	1.34
90.0	26160.86-	13.69	17094.77	14.82	235946.32	1.26
90.5	26336.67-	11.72	17219.94	12.67	236996.39	1.08
91.0	26511.36-	9.55	17350.26	10.28	238038.36	.89
91.5	26686.62-	10.67	17480.21	11.49	239072.67	.99
92.0	26859.03-	8.87	17607.01	9.55	240098.70	.83
92.5	27037.58-	9.58	17730.28	10.33	241117.26	.89
93.0	27216.60-	7.74	17852.50	8.32	242127.58	.73
93.5	27392.91-	8.78	17984.74	9.44	243130.20	.83
94.0	27570.44-	9.61	18112.32	10.38	244124.59	.90
94.5	27752.49-	10.43	18233.42	11.27	245110.64	.99
95.0	27928.39-	9.15	18360.27	9.86	246088.48	.87
95.5	28102.48-	7.63	18486.73	8.24	247058.82	.73

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
96.0	28280.65-	8.68	18610.69	9.36	248021.13	.83
96.5	28459.28-	6.90	18734.98	7.44	248975.16	.67
97.0	28634.46-	9.13	18862.09	9.85	249921.51	.88
97.5	28812.96-	10.01	18989.68	10.81	250859.82	.97
98.0	28989.71-	11.96	19117.16	12.92	251790.51	1.16
98.5	29163.05-	10.57	19242.89	11.40	252713.52	1.03
99.0	29341.63-	9.76	19368.20	10.50	253628.44	.95
99.5	29516.13-	8.61	19492.37	9.21	254535.61	.84
100.0	29692.12-	9.91	19621.75	10.61	255434.66	.97
100.5	29863.33-	5.27	19747.40	5.54	256325.70	.52
101.0	30044.00-	12.89	19874.87	13.82	257207.54	1.28
101.5	30221.85-	13.55	20004.64	14.54	258082.07	1.34
102.0	30397.64-	11.65	20130.90	12.46	258948.95	1.16
102.5	30572.44-	11.22	20257.01	11.99	259807.92	1.11
103.0	30748.06-	12.12	20384.65	12.97	260658.92	1.21
103.5	30927.43-	12.49	20507.90	13.36	261501.92	1.25
104.0	31101.57-	10.98	20636.94	11.70	262337.20	1.10
104.5	31282.63-	11.58	20760.25	12.36	263164.63	1.16
105.0	31453.32-	10.59	20894.46	11.28	263984.41	1.06

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
105.5	31630.26-	12.02	21017.44	12.85	264796.08	1.21
106.0	31808.42-	12.44	21146.98	13.30	265599.77	1.26
106.5	31985.23-	12.44	21274.44	13.32	266395.71	1.26
107.0	32162.16-	14.18	21401.15	15.19	267183.79	1.45
107.5	32341.25-	17.79	21524.12	19.07	267963.33	1.83
108.0	32524.06-	21.47	21648.66	23.07	268734.60	2.22
108.5	32701.23-	21.30	21777.22	22.90	269498.02	2.22
109.0	32876.10-	20.75	21902.74	22.28	270254.22	2.17
109.5	33050.02-	21.11	22034.00	22.69	271001.81	2.21
110.0	33224.32-	20.59	22164.73	22.11	271741.82	2.16
110.5	33400.45-	22.56	22289.75	24.24	272473.98	2.38
111.0	33580.75-	24.74	22413.75	26.60	273198.22	2.63
111.5	33760.67-	25.36	22534.56	27.30	273914.57	2.70
112.0	33938.66-	26.11	22661.03	28.09	274623.39	2.79
112.5	34104.87-	23.74	22792.65	25.51	275324.36	2.54
113.0	34280.25-	25.57	22920.92	27.49	276017.46	2.76
113.5	34458.37-	25.67	23052.38	27.57	276702.10	2.78
114.0	34633.79-	26.34	23178.82	28.33	277379.37	2.85
114.5	34810.25-	27.53	23301.23	29.61	278048.92	2.99

SM 1.02 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
115.0	34989.04-	27.68	23427.05	29.76	278710.13	3.02
115.5	35235.17-		23418.64		279370.85	
116.0	35435.95-		23518.08		280018.20	
116.5	35571.83-		23656.43		280656.69	
117.0	35702.31-		23818.67		281286.57	
117.5	35899.55-		23931.99		281907.78	
118.0	36068.93-		24055.38		282521.72	
118.5	36242.07-		24193.60		283127.17	
119.0	36428.52-		24302.04		283724.55	
119.5	36598.34-		24434.74		284314.41	
120.0	36768.35-		24568.67		284896.25	
120.5	36945.10-		24693.36		285470.76	
121.0	37120.72-		24825.34		286036.95	
121.5	37293.53-		24951.23		286595.67	
122.0	37475.20-		25075.49		287146.04	
122.5	37648.20-		25199.34		287689.68	
123.0	37822.68-		25330.50		288224.63	
123.5	38000.96-		25447.97		288752.59	
124.0	38154.86-		25587.76		289273.59	

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
124.5	38346.70-		25689.29		289785.60	

SM 1.03

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
1.0	2.59-	.32	17.74-	.32	318.50	1.02
1.5	11.18-	.11	40.80-	.12	569.03	.23
2.0	33.55-	1.07	71.16-	1.15	917.50	1.63
2.5	68.14-	1.50	104.80-	1.59	1372.59	1.94
3.0	102.22-	1.85	137.58-	1.96	1877.12	2.21
3.5	146.66-	.87	167.89-	.92	2403.47	.98
4.0	190.59-	.78	204.91-	.82	2943.60	.84
4.5	238.39-	.10	243.52-	.11	3497.45	.11
5.0	287.87-	.59	282.66-	.62	4062.65	.58
5.5	338.61-	.81	323.52-	.85	4638.83	.78
6.0	391.43-	1.26	365.45-	1.32	5226.24	1.18
6.5	446.30-	1.34	408.37-	1.41	5824.57	1.23
7.0	502.43-	1.01	452.43-	1.06	6433.99	.90
7.5	561.54-	1.22	497.87-	1.28	7055.20	1.07
8.0	622.69-	1.09	544.55-	1.15	7687.89	.94
8.5	685.51-	1.02	592.19-	1.07	8332.47	.85
9.0	750.99-	.81	641.25-	.85	8989.81	.66
9.5	818.22-	.07	691.27-	.08	9659.68	.05
10.0	889.39-	.03	743.97-	.04	10342.80	.02

SM 1.03

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
10.5	962.12-	.15	797.39-	.15	11039.81	.12
11.0	1037.58-	.49	852.34-	.51	11750.74	.38
11.5	1116.88-	.43	908.48-	.45	12475.80	.32
12.0	1197.93-	.50	966.35-	.53	13215.44	.37
12.5	1283.56-	1.95	1027.72-	2.06	13969.19	1.41
13.0	1372.14-	2.32	1090.23-	2.47	14738.52	1.64
13.5	1462.73-	2.31	1153.55-	2.46	15523.73	1.60
14.0	1555.83-	2.01	1218.86-	2.13	16325.14	1.36
14.5	1651.08-	1.64	1286.11-	1.75	17143.02	1.09
15.0	1749.14-	.98	1354.43-	1.04	17977.48	.64
15.5	1849.95-	.02	1425.95-	.03	18829.26	.01
16.0	1952.01-	.28	1499.41-	.30	19698.91	.17
16.5	2056.10-	.59	1573.99-	.64	20585.97	.36
17.0	2164.34-	.88	1648.79-	.96	21491.80	.52
17.5	2274.01-	.75	1725.55-	.81	22415.99	.43
18.0	2385.22-	.26	1804.74-	.29	23359.34	.14
18.5	2498.50-	.62	1885.01-	.66	24322.15	.35
19.0	2616.35-	.69	1965.37-	.74	25305.10	.38
19.5	2737.28-	.53	2046.81-	.56	26308.94	.29

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
20.0	2860.82-	.91	2128.83-	.97	27334.59	.47
20.5	2989.03-	.70	2212.23-	.75	28382.30	.36
21.0	3121.44-	.55	2296.98-	.58	29452.96	.27
21.5	3257.84-	.54	2383.42-	.58	30547.23	.27
22.0	3399.03-	1.36	2471.83-	1.48	31666.47	.63
22.5	3543.96-	1.53	2559.62-	1.67	32810.62	.69
23.0	3691.95-	1.59	2647.90-	1.73	33981.14	.71
23.5	3844.82-	1.53	2737.27-	1.67	35178.89	.66
24.0	4002.66-	1.04	2828.28-	1.14	36405.19	.44
24.5	4165.48-	1.66	2921.05-	1.81	37660.74	.68
25.0	4333.55-	1.56	3014.52-	1.70	38946.98	.63
25.5	4508.77-	1.63	3109.77-	1.79	40263.80	.64
26.0	4692.30-	1.41	3206.12-	1.55	41611.59	.54
26.5	4885.14-	1.18	3304.12-	1.29	42991.29	.44
27.0	5088.47-	1.56	3400.81-	1.71	44404.00	.57
27.5	5302.78-	1.01	3499.51-	1.11	45851.10	.36
28.0	5529.36-	1.08	3598.75-	1.19	47333.76	.37
28.5	5768.29-	.66	3699.31-	.73	48853.44	.22
29.0	6021.99-	1.09	3801.56-	1.20	50410.91	.36

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
29.5	6289.43-	1.51	3906.47-	1.66	52007.98	.48
30.0	6571.99-	1.90	4016.69-	2.08	53646.11	.60
30.5	6865.74-	2.27	4130.50-	2.49	55326.73	.70
31.0	7175.27-	2.93	4248.95-	3.21	57051.37	.88
31.5	7496.56-	3.18	4372.75-	3.48	58820.80	.93
32.0	7833.13-	3.07	4502.21-	3.36	60636.60	.88
32.5	8186.34-	2.09	4634.99-	2.29	62501.39	.58
33.0	8552.54-	2.67	4770.92-	2.92	64416.16	.73
33.5	8935.14-	2.17	4909.66-	2.38	66383.26	.58
34.0	9328.03-	2.48	5053.02-	2.72	68385.49	.65
34.5	9720.35-	2.66	5194.89-	2.91	70376.83	.68
35.0	10114.04-	3.19	5338.34-	3.49	72351.29	.80
35.5	10505.33-	3.48	5476.83-	3.81	74309.10	.86
36.0	10895.27-	2.37	5613.95-	2.61	76250.52	.58
36.5	11286.26-	2.70	5753.58-	2.96	78175.61	.65
37.0	11677.71-	2.45	5891.57-	2.69	80084.88	.58
37.5	12069.08-	2.68	6028.07-	2.95	81979.58	.63
38.0	12456.74-	3.67	6162.82-	4.03	83860.51	.85
38.5	12845.25-	2.81	6298.28-	3.09	85724.75	.64

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
39.0	13235.33-	2.39	6432.08-	2.62	87578.40	.54
39.5	13622.84-	3.23	6565.63-	3.54	89419.36	.72
40.0	14008.57-	2.56	6697.46-	2.80	91248.29	.57
40.5	14396.28-	2.03	6832.03-	2.23	93064.68	.45
41.0	14779.76-	2.74	6963.81-	3.01	94869.87	.61
41.5	15162.65-	3.11	7093.49-	3.41	96664.12	.68
42.0	15547.21-	2.46	7224.39-	2.71	98446.30	.53
42.5	15930.75-	2.43	7354.29-	2.67	100217.94	.52
43.0	16314.57-	2.37	7484.00-	2.60	101979.26	.51
43.5	16697.08-	2.25	7613.24-	2.48	103730.08	.48
44.0	17078.74-	1.70	7740.97-	1.87	105471.05	.36
44.5	17461.62-	2.64	7869.75-	2.91	107202.04	.56
45.0	17843.01-	2.45	8000.85-	2.70	108921.31	.52
45.5	18222.10-	2.62	8126.06-	2.89	110632.62	.56
46.0	18603.58-	1.99	8255.06-	2.20	112333.40	.42
46.5	18983.38-	3.43	8382.26-	3.77	114025.00	.72
47.0	19362.77-	3.64	8509.18-	4.00	115707.56	.76
47.5	19746.98-	1.54	8636.43-	1.70	117380.65	.32
48.0	20124.32-	2.40	8762.73-	2.64	119044.70	.50

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
48.5	20505.76-	1.32	8889.31-	1.45	120698.88	.27
49.0	20883.07-	2.75	9014.42-	3.02	122344.67	.56
49.5	21263.18-	1.49	9139.55-	1.64	123981.25	.30
50.0	21643.55-	1.39	9266.39-	1.52	125608.51	.28
50.5	22020.87-	1.91	9393.52-	2.10	127227.20	.39
51.0	22401.22-	.25	9521.34-	.27	128836.27	.05
51.5	22777.82-	1.09	9646.59-	1.20	130436.96	.22
52.0	23155.56-	.93	9773.44-	1.02	132028.75	.18
52.5	23533.46-	.47	9899.30-	.52	133612.00	.09
53.0	23907.69-	1.97	10022.38-	2.17	135187.65	.40
53.5	24290.26-	.53	10150.13-	.59	136753.08	.10
54.0	24665.31-	1.11	10272.40-	1.21	138311.78	.22
54.5	25043.38-	1.00	10398.00-	1.09	139862.01	.22
55.0	25421.42-	.62	10521.13-	.69	141401.91	.14
55.5	25799.02-	.95	10646.57-	1.05	142933.85	.21
56.0	26174.38-	.22	10769.12-	.24	144458.17	.05
56.5	26552.93-	.62	10892.91-	.69	145973.78	.14
57.0	26931.21-	.88	11018.62-	.96	147480.67	.17
57.5	27309.72-	.03	11144.95-	.04	148979.28	.02

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
58.0	27686.25-	.93	11267.32-	1.02	150470.39	.18
58.5	28060.36-	1.24	11392.14-	1.36	151952.56	.25
59.0	28428.49-	1.70	11512.14-	1.87	153428.19	.35
59.5	28804.17-	2.13	11635.95-	2.33	154894.02	.43
60.0	29178.78-	2.91	11758.30-	3.18	156351.89	.60
60.5	29555.08-	2.73	11880.30-	2.99	157801.26	.57
61.0	29932.45-	1.71	12005.23-	1.87	159242.19	.35
61.5	30306.98-	.70	12123.32-	.76	160676.39	.14
62.0	30683.69-	.05	12246.86-	.05	162100.76	.01
62.5	31060.33-	.54	12368.21-	.59	163517.38	.11
63.0	31438.39-	.16	12491.81-	.18	164925.38	.05
63.5	31811.20-	1.11	12613.98-	1.21	166325.63	.23
64.0	32188.85-	.87	12736.28-	.95	167717.28	.18
64.5	32560.58-	1.54	12857.01-	1.70	169101.80	.33
65.0	32940.00-	.48	12981.42-	.53	170477.01	.09
65.5	33313.83-	.99	13102.77-	1.08	171845.02	.21
66.0	33688.73-	1.09	13224.61-	1.20	173204.36	.23
66.5	34064.90-	.94	13346.88-	1.04	174555.53	.20
67.0	34437.24-	1.99	13468.63-	2.18	175899.14	.42

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
67.5	34812.42-	.97	13589.78-	1.07	177234.83	.20
68.0	35188.44-	1.00	13714.90-	1.10	178561.75	.21
68.5	35562.89-	1.14	13836.10-	1.26	179881.30	.24
69.0	35939.88-	1.38	13955.99-	1.51	181192.72	.29
69.5	36317.01-	.11	14077.06-	.12	182495.81	.02
70.0	36689.22-	.96	14197.50-	1.04	183790.85	.20
70.5	37059.14-	1.36	14319.66-	1.49	185078.30	.29
71.0	37434.65-	2.57	14441.01-	2.81	186356.56	.56
71.5	37806.69-	2.02	14562.39-	2.21	187627.68	.43
72.0	38185.77-	2.10	14682.36-	2.30	188890.01	.46
72.5	38555.85-	3.43	14803.61-	3.76	190145.54	.75
73.0	38935.14-	1.97	14922.75-	2.16	191392.31	.43
73.5	39307.61-	.45	15042.83-	.49	192631.84	.09
74.0	39684.61-	.38	15163.56-	.41	193861.98	.08
74.5	40056.59-	1.77	15283.70-	1.94	195084.70	.39
75.0	40431.46-	2.34	15403.98-	2.57	196298.99	.52
75.5	40806.06-	2.71	15523.38-	2.98	197505.29	.60
76.0	41178.14-	3.03	15642.32-	3.33	198704.05	.68
76.5	41550.74-	2.68	15761.96-	2.94	199894.90	.60

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
77.0	41925.79-	3.55	15884.03-	3.90	201077.32	.80
77.5	42301.74-	1.81	16004.60-	1.99	202251.70	.40
78.0	42674.52-	2.97	16122.51-	3.26	203419.21	.67
78.5	43049.48-	1.68	16240.24-	1.84	204577.60	.38
79.0	43425.06-	.73	16361.13-	.80	205727.38	.16
79.5	43801.20-	.71	16481.30-	.77	206869.35	.15
80.0	44176.13-	.17	16598.68-	.19	208003.95	.05
80.5	44548.13-	.93	16715.36-	1.02	209131.08	.21
81.0	44919.34-	2.92	16836.96-	3.20	210249.62	.67
81.5	45292.07-	2.83	16956.93-	3.10	211360.41	.65
82.0	45663.16-	2.95	17074.81-	3.23	212463.96	.68
82.5	46036.75-	3.34	17198.27-	3.66	213558.29	.77
83.0	46409.39-	3.54	17315.43-	3.88	214645.28	.82
83.5	46785.35-	2.04	17433.19-	2.24	215723.46	.47
84.0	47160.27-	1.30	17550.34-	1.43	216793.65	.30
84.5	47533.39-	.53	17667.14-	.58	217856.13	.12
85.0	47906.66-	1.74	17786.87-	1.92	218910.43	.41
85.5	48279.88-	1.16	17902.02-	1.28	219957.33	.27
86.0	48650.68-	2.44	18021.70-	2.68	220995.79	.57

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
86.5	49021.93-	2.67	18138.67-	2.93	222026.97	.63
87.0	49393.08-	3.31	18257.27-	3.63	223050.07	.79
87.5	49766.36-	3.67	18376.83-	4.02	224064.73	.87
88.0	50139.01-	3.26	18493.69-	3.57	225071.36	.78
88.5	50514.94-	2.55	18614.13-	2.79	226068.87	.61
89.0	50884.87-	3.83	18727.77-	4.19	227060.49	.92
89.5	51256.57-	3.29	18847.21-	3.58	228042.81	.79
90.0	51633.83-	3.70	18968.78-	4.06	229016.23	.89
90.5	52003.89-	3.84	19080.56-	4.21	229984.59	.93
91.0	52372.91-	5.91	19199.43-	6.49	230944.04	1.44
91.5	52743.13-	5.95	19316.74-	6.54	231895.60	1.46
92.0	53112.90-	7.19	19431.99-	7.88	232839.50	1.76
92.5	53488.98-	6.56	19550.04-	7.21	233774.44	1.61
93.0	53861.62-	6.70	19665.43-	7.35	234701.68	1.66
93.5	54234.11-	3.02	19784.61-	3.33	235620.26	.75
94.0	54605.02-	5.62	19895.93-	6.17	236532.08	1.40
94.5	54979.62-	3.32	20013.53-	3.67	237434.21	.83
95.0	55355.02-	2.36	20131.63-	2.59	238327.84	.59
95.5	55724.52-	2.15	20250.12-	2.35	239214.61	.54

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
96.0	56095.99-	3.10	20366.85-	3.37	240093.11	.78
96.5	56463.65-	4.38	20484.87-	4.79	240964.64	1.10
97.0	56835.09-	4.75	20599.30-	5.21	241828.08	1.20
97.5	57207.10-	6.02	20718.03-	6.63	242683.04	1.53
98.0	57579.29-	3.40	20831.24-	3.76	243531.37	.86
98.5	57950.05-	5.38	20949.64-	5.93	244371.00	1.37
99.0	58327.63-	6.07	21065.78-	6.67	245201.66	1.55
99.5	58701.77-	4.84	21178.92-	5.35	246024.86	1.24
100.0	59075.42-	4.00	21293.98-	4.41	246839.84	1.02
100.5	59444.06-	3.51	21411.90-	3.88	247647.72	.89
101.0	59814.90-	3.81	21524.44-	4.20	248447.74	.98
101.5	60179.63-	6.12	21639.11-	6.72	249241.17	1.58
102.0	60552.40-	6.14	21753.18-	6.75	250024.70	1.60
102.5	60928.13-	2.33	21868.54-	2.58	250800.00	.60
103.0	61298.24-	5.87	21986.98-	6.45	251567.72	1.53
103.5	61670.93-	4.75	22102.37-	5.25	252327.84	1.24
104.0	62043.26-	4.09	22217.42-	4.52	253079.81	1.07
104.5	62418.94-	2.80	22329.26-	3.10	253823.92	.73
105.0	62792.24-	3.64	22443.08-	4.00	254560.48	.95

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
105.5	63164.47-	1.83	22556.40-	2.03	255288.88	.47
106.0	63535.93-	4.80	22667.62-	5.26	256010.14	1.27
106.5	63897.37-	3.04	22770.73-	3.34	256725.79	.80
107.0	64263.54-	1.69	22888.44-	1.84	257430.57	.44
107.5	64632.55-	1.40	23003.53-	1.48	258127.17	.36
108.0	64999.15-	3.52	23115.71-	3.83	258816.82	.94
108.5	65367.83-	3.67	23231.51-	4.01	259497.74	.98
109.0	65736.60-	2.41	23344.84-	2.61	260171.16	.64
109.5	66110.59-	3.19	23459.62-	3.45	260835.43	.85
110.0	66481.01-	.71	23569.87-	.75	261492.95	.18
110.5	66853.49-	2.25	23679.75-	2.44	262142.10	.60
111.0	67223.90-	2.66	23792.61-	2.90	262783.50	.72
111.5	67595.64-	1.49	23906.84-	1.61	263416.55	.40
112.0	67966.88-	2.89	24020.46-	3.14	264041.87	.79
112.5	68340.08-	4.39	24132.46-	4.80	264659.09	1.20
113.0	68711.06-	4.66	24246.29-	5.13	265269.09	1.29
113.5	69083.17-	3.34	24360.90-	3.67	265870.68	.92
114.0	69458.88-	2.17	24472.88-	2.37	266463.37	.59
114.5	69832.60-	3.87	24588.28-	4.21	267048.01	1.07

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
115.0	70204.57-	3.16	24703.62-	3.44	267624.79	.88
115.5	70577.12-	2.87	24819.19-	3.10	268193.46	.80
116.0	70953.92-	4.37	24940.97-	4.73	268752.77	1.23
116.5	71332.92-	6.18	25062.48-	6.74	269304.03	1.76
117.0	71696.10-	7.96	25163.03-	8.70	269853.52	2.27
117.5	72067.70-	8.37	25275.43-	9.12	270391.95	2.39
118.0	72434.61-	7.18	25388.84-	7.79	270923.70	2.06
118.5	72800.55-	5.55	25501.02-	6.01	271447.90	1.60
119.0	73161.71-	8.03	25607.52-	8.75	271965.05	2.32
119.5	73530.77-	6.54	25718.27-	7.11	272472.85	1.90
120.0	73901.45-	7.28	25830.75-	7.92	272971.92	2.12
120.5	74270.86-	5.53	25941.77-	6.01	273463.18	1.61
121.0	74642.66-	4.83	26053.44-	5.25	273946.21	1.42
121.5	75015.35-	3.26	26171.82-	3.49	274419.78	.96
122.0	75382.95-	4.91	26283.09-	5.34	274888.03	1.45
122.5	75751.58-	5.03	26395.18-	5.46	275348.20	1.49
123.0	76122.33-	5.06	26507.59-	5.52	275800.02	1.52

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
1.0	26.59-	.70	28.00-	.73	334.48	2.09
1.5	70.95-	.27	59.77-	.28	604.26	.49
2.0	139.25-	.91	96.89-	.97	980.16	1.25
2.5	222.50-	1.16	143.30-	1.23	1455.61	1.39
3.0	316.73-	1.17	191.53-	1.23	1967.76	1.29
3.5	414.81-	2.30	240.80-	2.43	2496.48	2.40
4.0	517.71-	1.25	294.06-	1.31	3034.91	1.25
4.5	625.35-	1.47	346.16-	1.56	3585.45	1.43
5.0	734.31-	1.79	398.33-	1.89	4146.99	1.68
5.5	846.86-	2.17	451.97-	2.30	4720.04	2.00
6.0	960.64-	1.22	505.52-	1.29	5303.44	1.10
6.5	1076.81-	.05	558.63-	.05	5897.38	.04
7.0	1200.71-	1.35	617.44-	1.43	6502.75	1.16
7.5	1331.47-	.49	672.19-	.52	7123.06	.41
8.0	1461.47-	.90	731.48-	.96	7754.38	.74
8.5	1590.52-	.55	790.52-	.59	8396.72	.45
9.0	1725.83-	.87	854.66-	.93	9052.89	.69
9.5	1874.89-	2.44	914.55-	2.61	9725.54	1.90
10.0	2027.28-	4.03	979.22-	4.33	10408.86	3.08

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
10.5	2177.20-	3.62	1046.67-	3.90	11106.54	2.72
11.0	2330.67-	1.74	1115.84-	1.88	11818.61	1.28
11.5	2497.77-	3.16	1184.81-	3.41	12546.96	2.28
12.0	2661.85-	3.81	1258.29-	4.12	13290.36	2.69
12.5	2826.16-	2.33	1330.11-	2.52	14049.58	1.61
13.0	3001.02-	2.56	1409.48-	2.78	14824.56	1.74
13.5	3179.42-	1.73	1497.95-	1.88	15610.93	1.16
14.0	3361.22-	1.42	1576.92-	1.54	16416.54	.93
14.5	3551.63-	2.96	1660.01-	3.23	17236.68	1.90
15.0	3751.92-	1.41	1742.19-	1.53	18074.05	.88
15.5	3947.11-	2.06	1825.44-	2.25	18927.96	1.27
16.0	4156.11-	.38	1910.89-	.42	19800.27	.23
16.5	4366.49-	3.97	2011.65-	4.34	20683.43	2.34
17.0	4583.03-	4.75	2102.85-	5.21	21587.77	2.75
17.5	4805.95-	3.54	2194.24-	3.88	22512.32	2.00
18.0	5036.19-	1.01	2287.52-	1.10	23455.33	.56
18.5	5269.03-	2.51	2384.72-	2.76	24416.06	1.36
19.0	5513.51-	1.85	2486.79-	2.03	25394.95	.98
19.5	5766.15-	1.60	2585.60-	1.76	26395.63	.83

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
20.0	6024.43-	1.92	2684.36-	2.11	27418.49	.97
20.5	6296.39-	3.91	2785.02-	4.31	28461.84	1.94
21.0	6563.51-	2.68	2897.86-	2.96	29526.56	1.30
21.5	6847.04-	3.61	3007.36-	3.99	30612.72	1.72
22.0	7134.20-	5.09	3117.03-	5.63	31725.41	2.38
22.5	7427.04-	3.51	3236.39-	3.88	32858.51	1.60
23.0	7728.39-	3.67	3355.14-	4.07	34018.84	1.64
23.5	8038.78-	2.95	3477.18-	3.26	35202.73	1.29
24.0	8353.89-	.04	3606.31-	.05	36414.23	.02
24.5	8673.24-	3.06	3737.98-	3.39	37652.53	1.29
25.0	9013.35-	1.02	3863.69-	1.12	38919.69	.42
25.5	9353.34-	2.97	3996.01-	3.29	40218.06	1.21
26.0	9701.82-	5.35	4135.77-	5.93	41543.52	2.13
26.5	10070.54-	3.71	4269.07-	4.11	42902.40	1.45
27.0	10436.83-	5.54	4411.43-	6.14	44293.98	2.13
27.5	10821.54-	6.00	4556.31-	6.65	45718.16	2.26
28.0	11219.45-	3.75	4699.42-	4.16	47176.72	1.39
28.5	11625.62-	3.00	4847.49-	3.34	48672.83	1.10
29.0	12042.85-	3.99	5001.98-	4.43	50205.73	1.43

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
29.5	12474.22-	2.65	5155.25-	2.94	51777.25	.94
30.0	12912.71-	4.32	5321.96-	4.79	53387.70	1.50
30.5	13370.96-	3.11	5485.72-	3.45	55038.37	1.07
31.0	13834.71-	2.87	5657.17-	3.19	56727.60	.97
31.5	14315.27-	3.45	5831.26-	3.83	58449.92	1.15
32.0	14799.27-	3.05	6007.66-	3.38	60191.56	1.01
32.5	15284.97-	2.88	6185.46-	3.19	61925.61	.94
33.0	15768.11-	3.64	6360.03-	4.04	63644.04	1.18
33.5	16249.46-	2.94	6534.68-	3.26	65341.37	.95
34.0	16726.62-	2.95	6707.80-	3.27	67021.01	.94
34.5	17201.82-	3.24	6879.23-	3.59	68682.46	1.02
35.0	17672.99-	3.02	7051.83-	3.35	70326.15	.95
35.5	18142.29-	3.91	7221.86-	4.34	71953.79	1.22
36.0	18609.99-	3.35	7391.43-	3.71	73565.49	1.04
36.5	19076.13-	4.13	7560.41-	4.58	75162.00	1.28
37.0	19539.85-	3.74	7726.81-	4.15	76743.91	1.15
37.5	20000.55-	3.29	7891.74-	3.65	78311.96	1.01
38.0	20460.44-	2.66	8057.54-	2.94	79865.55	.81
38.5	20918.17-	2.95	8223.68-	3.27	81406.06	.90

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
39.0	21375.46-	3.47	8389.59-	3.85	82933.34	1.06
39.5	21830.98-	3.21	8553.84-	3.56	84448.60	.97
40.0	22285.84-	3.56	8715.86-	3.95	85951.61	1.08
40.5	22738.33-	2.89	8877.56-	3.20	87442.80	.87
41.0	23188.23-	2.74	9040.93-	3.03	88921.98	.82
41.5	23639.96-	2.63	9202.99-	2.91	90389.61	.79
42.0	24089.43-	3.49	9365.34-	3.88	91846.49	1.05
42.5	24539.89-	3.60	9526.54-	4.00	93291.98	1.08
43.0	24990.84-	4.05	9686.69-	4.49	94726.73	1.22
43.5	25439.15-	4.12	9848.19-	4.56	96150.54	1.24
44.0	25886.58-	4.09	10008.34-	4.53	97564.42	1.23
44.5	26333.68-	4.30	10168.86-	4.76	98968.08	1.29
45.0	26781.47-	4.48	10327.11-	4.96	100361.81	1.34
45.5	27228.93-	4.18	10484.17-	4.63	101745.49	1.26
46.0	27672.97-	4.83	10641.63-	5.35	103119.72	1.45
46.5	28116.30-	5.50	10800.07-	6.09	104484.10	1.66
47.0	28559.20-	5.78	10959.29-	6.40	105839.23	1.75
47.5	29003.47-	6.17	11117.12-	6.83	107184.72	1.86
48.0	29447.20-	5.79	11274.54-	6.41	108520.70	1.75

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
48.5	29887.41-	6.26	11432.24-	6.93	109847.44	1.89
49.0	30327.12-	6.64	11590.21-	7.34	111165.07	2.01
49.5	30769.26-	5.83	11747.80-	6.46	112473.34	1.76
50.0	31209.77-	5.86	11903.38-	6.49	113772.82	1.78
50.5	31651.75-	6.13	12059.30-	6.79	115063.03	1.86
51.0	32090.38-	6.54	12216.45-	7.24	116344.82	1.99
51.5	32531.11-	7.42	12371.97-	8.22	117617.60	2.27
52.0	32969.82-	7.16	12526.63-	7.93	118881.62	2.19
52.5	33407.11-	7.22	12683.81-	7.99	120136.20	2.21
53.0	33843.51-	6.86	12839.64-	7.60	121382.67	2.11
53.5	34281.80-	7.79	12995.53-	8.63	122620.32	2.39
54.0	34705.84-		13137.03-		123855.28	
54.5	35143.40-		13292.17-		125075.32	
55.0	35579.86-		13445.92-		126287.42	
55.5	36019.80-		13602.48-		127489.29	
56.0	36459.38-		13758.39-		128682.94	
56.5	36896.90-		13912.70-		129869.12	
57.0	37334.92-		14065.76-		131046.75	
57.5	37771.22-		14216.92-		132216.49	

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
58.0	38208.06-		14370.04-		133377.54	
58.5	38644.80-		14521.96-		134530.41	
59.0	39081.20-		14671.91-		135674.87	
59.5	39516.39-		14823.31-		136810.68	
60.0	39953.72-		14975.21-		137937.92	
60.5	40390.78-		15125.46-		139056.64	
61.0	40826.12-		15277.35-		140167.35	
61.5	41261.76-		15428.05-		141270.36	
62.0	41695.69-		15578.75-		142365.03	
62.5	42130.58-		15729.16-		143451.06	
63.0	42564.43-		15880.21-		144528.40	
63.5	42996.24-		16026.45-		145598.85	
64.0	43432.62-		16177.54-		146659.20	
64.5	43869.81-		16328.82-		147711.05	
65.0	44300.88-		16476.93-		148756.82	
65.5	44734.28-		16627.62-		149793.43	
66.0	45167.60-		16779.17-		150821.20	
66.5	45601.84-		16931.17-		151840.11	
67.0	46035.01-		17083.56-		152851.53	

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
67.5	46468.98-		17233.02-		153855.24	
68.0	46906.80-		17384.09-		154849.30	
68.5	47341.00-		17535.20-		155835.90	
69.0	47771.92-		17685.61-		156815.77	
69.5	48205.65-		17836.96-		157786.29	
70.0	48639.59-		17989.48-		158748.46	
70.5	49073.77-		18143.80-		159702.39	
71.0	49502.94-		18293.70-		160649.88	
71.5	49930.44-		18443.02-		161589.61	
72.0	50361.18-		18592.86-		162520.81	
72.5	50794.25-		18744.15-		163442.97	
73.0	51227.89-		18894.44-		164356.75	
73.5	51660.20-		19042.47-		165263.16	
74.0	52093.90-		19191.67-		166160.99	
74.5	52525.32-		19338.04-		167051.28	
75.0	52957.07-		19486.23-		167933.06	
75.5	53389.96-		19635.38-		168806.66	
76.0	53821.90-		19785.51-		169672.39	
76.5	54253.09-		19936.59-		170529.62	

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
77.0	54680.60-		20079.03-		171381.41	
77.5	55115.24-		20228.18-		172222.61	
78.0	55545.26-		20374.39-		173057.36	
78.5	55978.99-		20521.62-		173882.50	
79.0	56412.81-		20669.00-		174699.38	
79.5	56841.34-		20813.11-		175510.55	
80.0	57272.81-		20961.02-		176311.74	
80.5	57707.80-		21109.76-		177103.92	
81.0	58137.90-		21257.42-		177889.78	
81.5	58568.84-		21407.61-		178666.82	
82.0	58999.93-		21556.59-		179435.83	
82.5	59429.82-		21709.37-		180196.67	
83.0	59856.25-		21861.25-		180950.82	
83.5	60277.01-		22012.59-		181697.97	
84.0	60692.80-		22159.67-		182439.10	
84.5	61108.38-		22301.30-		183173.26	
85.0	61532.16-		22442.89-		183897.65	
85.5	61959.87-		22587.17-		184611.95	
86.0	62391.14-		22734.24-		185316.43	

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
86.5	62819.67-		22881.48-		186013.24	
87.0	63251.04-		23024.96-		186702.00	
87.5	63680.26-		23172.73-		187382.80	
88.0	64109.79-		23320.14-		188055.26	
88.5	64536.47-		23463.97-		188721.25	
89.0	64964.88-		23610.16-		189377.53	
89.5	65393.29-		23755.39-		190025.28	
90.0	65818.67-		23896.65-		190667.18	
90.5	66240.26-		24036.69-		191302.61	
91.0	66659.64-		24181.68-		191929.35	
91.5	67086.46-		24339.78-		192543.50	
92.0	67508.97-		24499.57-		193150.10	
92.5	67932.91-		24661.71-		193747.83	
93.0	68352.59-		24826.35-		194338.42	
93.5	68783.94-		24984.84-		194918.45	
94.0	69208.85-		25131.12-		195494.47	
94.5	69639.09-		25278.54-		196061.18	
95.0	70071.01-		25430.23-		196619.18	
95.5	70499.05-		25574.81-		197171.09	

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
96.0	70925.98-		25721.86-		197714.99	
96.5	71349.98-		25863.04-		198252.78	
97.0	71778.73-		26007.32-		198781.26	
97.5	72205.46-		26154.14-		199301.70	
98.0	72633.85-		26299.86-		199813.97	
98.5	73059.11-		26444.50-		200319.14	
99.0	73485.02-		26589.83-		200815.80	
99.5	73907.90-	3.20	26734.14-	3.54	201306.13	1.27
100.0	74332.56-	4.25	26878.60-	4.70	201787.61	1.70
100.5	74757.03-	4.23	27020.80-	4.68	202261.09	1.70
101.0	75181.13-	3.59	27166.22-	3.97	202726.01	1.45
101.5	75604.35-	3.41	27313.51-	3.78	203183.10	1.38
102.0	76027.19-	2.93	27462.89-	3.25	203631.99	1.19
102.5	76449.16-	2.45	27610.07-	2.71	204073.62	1.00
103.0	76874.58-	1.17	27754.47-	1.30	204506.30	.48
103.5	77301.43-	.95	27899.68-	1.06	204930.64	.39
104.0	77726.30-	1.24	28041.76-	1.38	205348.08	.51
104.5	78151.19-	1.23	28187.15-	1.36	205756.75	.51
105.0	78578.46-	.91	28330.85-	1.01	206157.06	.37
105.5	79006.91-	1.99	28475.43-	2.19	206548.83	.82

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
106.0	79432.85-	.11	28625.65-	.13	206932.47	.05
106.5	79861.91-	.90	28770.26-	.99	207307.55	.38
107.0	80287.04-	1.17	28915.39-	1.30	207675.76	.49
107.5	80710.02-	2.54	29061.38-	2.82	208036.22	1.08
108.0	81129.66-	4.40	29209.48-	4.87	208389.30	1.87
108.5	81549.14-	6.14	29356.25-	6.79	208734.63	2.62
109.0	81974.12-	4.91	29501.83-	5.43	209070.58	2.10
109.5	82396.54-	4.11	29647.08-	4.55	209399.59	1.76
110.0	82818.47-	3.07	29792.64-	3.39	209721.04	1.32
110.5	83239.02-	1.59	29936.85-	1.77	210035.37	.69
111.0	83661.54-	.92	30083.45-	1.01	210340.87	.41
111.5	84083.53-	1.40	30227.25-	1.54	210638.74	.62
112.0	84512.95-	1.44	30369.86-	1.58	210926.41	.63
112.5	84937.76-	.42	30515.33-	.47	211206.80	.18
113.0	85360.15-	2.13	30661.64-	2.36	211480.35	.94
113.5	85782.50-	2.42	30807.85-	2.67	211745.99	1.06
114.0	86207.06-	2.55	30953.41-	2.82	212002.91	1.12
114.5	86628.34-	1.27	31097.63-	1.42	212253.55	.56
115.0	87051.14-	.42	31243.31-	.47	212494.75	.18

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
115.5	87473.95-	.69	31387.31-	.76	212728.24	.32
116.0	87893.51-	2.69	31530.91-	2.97	212955.11	1.23
116.5	88308.36-	4.63	31670.39-	5.13	213176.66	2.10
117.0	88724.61-	5.82	31811.63-	6.44	213389.41	2.66
117.5	89143.26-	6.61	31952.53-	7.31	213593.51	3.03
118.0	89561.88-	5.83	32097.00-	6.46	213789.06	2.68
118.5	89978.10-	3.00	32241.57-	3.33	213977.56	1.39
119.0	90394.14-	.81	32385.26-	.89	214158.44	.39
119.5	90811.47-	.45	32525.45-	.51	214331.49	.22
120.0	91228.89-	1.73	32664.58-	1.92	214496.72	.82
120.5	91645.28-	1.77	32801.92-	1.96	214654.81	.84
121.0	92066.35-	1.90	32940.58-	2.10	214803.05	.91
121.5	92488.29-	4.01	33079.39-	4.46	214943.31	1.90
122.0	92912.88-	6.74	33217.29-	7.47	215075.28	3.20
122.5	93336.97-	8.92	33357.42-	9.89	215199.12	4.25
123.0	93758.61-	9.01	33496.34-	9.97	215316.31	4.31
123.5	94179.58-	6.94	33639.86-	7.68	215425.12	3.34
124.0	94599.98-	4.32	33785.66-	4.79	215525.83	2.10
124.5	95018.91-	1.94	33935.79-	2.16	215618.33	.95

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
124.5	26910.06-	.27	4144.76-	.26	289127.48	.03
.5	11,29-	1.08	,34-	1.24	244.16	4.82
1.0	38,35-	4.16	,80-	4.62	447.17	9.38
1.5	65.04-	3.76	7.14-	4.11	750.51	5.89
2.0	99.45-	4.03	13.32-	4.33	1157.84	5.17
2.5	140.88-	3.11	19.71-	3.30	1652.89	3.55
3.0	181.91-	2.78	28.46-	2.93	2168.13	2.96
3.5	223.31-	2.58	38.36-	2.71	2695.87	2.63
4.0	266.24-	2.48	48.84-	2.60	3234.29	2.43
4.5	310.45-	2.48	59.56-	2.59	3781.47	2.36
5.0	355.99-	2.29	70.52-	2.40	4337.70	2.12
5.5	401.71-	2.30	82.98-	2.40	4903.77	2.08
6.0	449.13-	2.55	95.34-	2.67	5478.38	2.26
6.5	496.81-	2.53	109.11-	2.64	6063.64	2.19
7.0	545.18-	2.70	123.32-	2.82	6658.51	2.29
7.5	596.54-	2.65	137.37-	2.77	7263.66	2.20
8.0	648.39-	2.48	151.97-	2.59	7879.86	2.02
8.5	701.40-	2.23	166.93-	2.34	8507.09	1.79
9.0	754.79-	2.90	182.29-	3.03	9144.74	2.27

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
9.5	808.19-	2.93	199.07-	3.06	9795.70	2.25
10.0	863.02-	3.75	215.24-	3.93	10457.31	2.82
10.5	918.71-	3.50	231.52-	3.67	11132.87	2.59
11.0	975.40-	4.20	250.70-	4.41	11820.67	3.04
11.5	1036.11-	4.09	268.96-	4.31	12521.86	2.91
12.0	1098.77-	3.04	287.11-	3.20	13237.53	2.12
12.5	1163.02-	2.39	305.86-	2.51	13967.24	1.63
13.0	1227.51-	2.28	323.70-	2.40	14711.04	1.53
13.5	1292.24-	2.20	342.01-	2.32	15469.91	1.44
14.0	1357.96-	2.98	361.89-	3.14	16243.60	1.91
14.5	1426.66-	3.43	381.88-	3.62	17033.95	2.16
15.0	1495.21-	2.96	398.33-	3.13	17842.91	1.82
15.5	1563.39-	3.25	417.31-	3.43	18668.25	1.95
16.0	1633.02-	3.75	438.86-	3.96	19511.14	2.21
16.5	1706.30-	2.40	458.02-	2.53	20374.17	1.38
17.0	1781.22-	2.25	479.17-	2.38	21255.50	1.27
17.5	1856.06-	1.33	500.97-	1.41	22158.37	.73
18.0	1929.17-	1.82	523.62-	1.93	23080.99	.98
18.5	2003.27-	2.53	546.73-	2.68	24024.47	1.33

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
19.0	2080.51-	4.06	567.37-	4.32	24989.83	2.08
19.5	2160.47-	3.26	586.93-	3.46	25978.71	1.63
20.0	2239.68-	3.47	610.07-	3.69	26989.99	1.69
20.5	2317.10-	3.63	633.82-	3.86	28024.92	1.73
21.0	2396.15-	1.62	654.95-	1.72	29085.98	.75
21.5	2475.68-	.81	676.99-	.86	30170.85	.37
22.0	2554.77-	.79	699.53-	.83	31280.57	.35
22.5	2637.58-	2.16	719.67-	2.30	32417.15	.93
23.0	2718.66-	1.94	740.84-	2.06	33581.45	.81
23.5	2807.21-	.93	762.09-	.99	34773.37	.38
24.0	2895.92-	1.24	787.86-	1.32	35993.46	.50
24.5	2978.48-	1.43	810.81-	1.53	37242.85	.56
25.0	3066.11-	1.61	832.52-	1.71	38522.46	.61
25.5	3153.18-	.90	853.10-	.95	39833.01	.33
26.0	3243.52-	2.58	880.03-	2.76	41174.19	.93
26.5	3331.37-	4.53	897.52-	4.86	42549.19	1.58
27.0	3421.09-	4.78	921.63-	5.12	43958.41	1.62
27.5	3516.97-	3.63	941.40-	3.90	45403.27	1.20
28.0	3610.73-	3.81	961.37-	4.09	46884.55	1.22

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
28.5	3713.89-	2.51	984.02-	2.69	48403.76	.78
29.0	3808.45-	5.36	1004.03-	5.76	49961.68	1.63
29.5	3912.06-	4.59	1025.78-	4.93	51560.49	1.35
30.0	4014.47-	4.15	1045.68-	4.46	53201.31	1.19
30.5	4123.66-	3.45	1067.88-	3.71	54886.12	.96
31.0	4229.09-	5.70	1089.75-	6.13	56614.93	1.54
31.5	4342.66-	5.28	1110.96-	5.69	58390.77	1.39
32.0	4454.81-	5.91	1134.19-	6.36	60213.21	1.51
32.5	4575.40-	5.41	1155.66-	5.83	62083.84	1.34
33.0	4693.43-	6.25	1179.84-	6.74	63999.90	1.51
33.5	4817.60-	5.25	1198.66-	5.67	65958.26	1.23
34.0	4945.67-	6.08	1225.32-	6.56	67947.85	1.38
34.5	5069.63-	7.07	1247.93-	7.63	69958.97	1.57
35.0	5200.42-	6.62	1269.15-	7.15	71986.90	1.43
35.5	5327.84-	7.45	1297.64-	8.06	74003.26	1.56
36.0	5453.75-	7.64	1315.05-	8.26	76005.84	1.56
36.5	5582.39-	7.11	1339.08-	7.69	77992.89	1.42
37.0	5707.99-	7.73	1366.65-	8.36	79965.10	1.51
37.5	5836.35-	8.10	1384.60-	8.76	81923.78	1.54

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
38.0	5962.10-	8.09	1405.74-	8.76	83869.02	1.50
38.5	6087.41-	8.71	1432.66-	9.43	85800.30	1.58
39.0	6214.49-	8.80	1449.50-	9.53	87719.14	1.56
39.5	6340.27-	7.92	1472.20-	8.57	89624.84	1.38
40.0	6465.49-	8.97	1497.01-	9.72	91518.44	1.53
40.5	6589.91-	7.81	1515.29-	8.46	93400.37	1.30
41.0	6717.06-	9.22	1536.60-	9.99	95271.49	1.51
41.5	6840.22-	8.35	1561.23-	9.05	97130.64	1.34
42.0	6963.71-	8.21	1578.91-	8.90	98979.40	1.30
42.5	7089.71-	9.20	1599.68-	9.98	100817.24	1.43
43.0	7215.40-	8.13	1622.84-	8.81	102644.12	1.24
43.5	7336.71-	8.82	1641.80-	9.57	104460.97	1.33
44.0	7459.78-	8.66	1661.12-	9.39	106268.50	1.28
44.5	7585.71-	8.43	1682.49-	9.15	108065.83	1.23
45.0	7706.96-	8.56	1704.48-	9.29	109853.36	1.23
45.5	7831.78-	9.61	1726.82-	10.43	111630.65	1.35
46.0	7956.16-	9.06	1743.03-	9.83	113398.99	1.25
46.5	8077.54-	8.01	1765.23-	8.70	115158.04	1.10
47.0	8201.63-	8.61	1785.21-	9.34	116907.68	1.16

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
47.5	8324.36-	9.55	1803.84-	10.37	118648.01	1.27
48.0	8446.70-	8.74	1825.24-	9.49	120379.73	1.15
48.5	8572.00-	9.56	1847.43-	10.38	122101.68	1.24
49.0	8691.30-	9.64	1863.09-	10.47	123814.68	1.24
49.5	8815.05-	9.60	1885.66-	10.43	125518.96	1.21
50.0	8939.08-	11.09	1905.90-	12.04	127214.63	1.38
50.5	9060.24-	10.26	1922.57-	11.14	128901.47	1.27
51.0	9181.74-	10.81	1940.73-	11.74	130580.19	1.32
51.5	9309.83-	12.13	1968.52-	13.17	132249.88	1.46
52.0	9428.60-	9.72	1982.86-	10.55	133909.90	1.16
52.5	9550.07-	9.08	2001.27-	9.86	135562.25	1.07
53.0	9674.92-	9.68	2022.07-	10.51	137205.67	1.13
53.5	9796.14-	10.38	2040.15-	11.27	138841.03	1.20
54.0	9918.83-	9.87	2060.85-	10.72	140467.94	1.13
54.5	10042.12-	9.18	2079.18-	9.97	142086.72	1.04
55.0	10162.77-	11.29	2096.24-	12.27	143696.81	1.27
55.5	10282.01-	9.29	2116.09-	10.09	145298.17	1.03
56.0	10406.25-	9.27	2136.07-	10.07	146891.10	1.02
56.5	10524.97-	9.45	2152.43-	10.27	148475.76	1.04

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
57.0	10648.19-	11.10	2173.08-	12.07	150052.49	1.21
57.5	10775.56-	10.00	2193.44-	10.86	151620.89	1.08
58.0	10894.59-	10.58	2209.64-	11.50	153180.80	1.13
58.5	11015.93-	11.51	2228.01-	12.51	154733.40	1.22
59.0	11137.31-	10.48	2250.03-	11.39	156276.36	1.10
59.5	11261.26-	12.63	2264.98-	13.73	157811.48	1.32
60.0	11381.42-	12.51	2282.95-	13.60	159339.00	1.30
60.5	11504.71-	11.14	2303.48-	12.11	160857.33	1.15
61.0	11627.75-	12.89	2319.05-	14.02	162368.29	1.31
61.5	11746.45-	11.45	2336.64-	12.45	163871.44	1.16
62.0	11870.23-	11.75	2356.84-	12.78	165365.76	1.18
62.5	11996.26-	12.12	2372.66-	13.18	166852.29	1.21
63.0	12111.91-	8.75	2391.73-	9.51	168330.26	.88
63.5	12236.90-	11.34	2407.18-	12.33	169800.05	1.12
64.0	12360.88-	12.11	2425.80-	13.17	171262.12	1.19
64.5	12477.62-	11.32	2442.56-	12.31	172716.06	1.11
65.0	12601.46-	11.81	2462.40-	12.84	174161.56	1.15
65.5	12724.36-	11.60	2478.72-	12.61	175599.73	1.12
66.0	12846.76-	12.12	2495.54-	13.17	177029.42	1.16

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
66.5	12974.91-	12.53	2514.30-	13.63	178450.51	1.20
67.0	13088.48-	11.38	2526.55-	12.38	179864.07	1.09
67.5	13207.92-	12.57	2546.10-	13.68	181269.54	1.19
68.0	13337.35-	13.34	2568.82-	14.51	182666.15	1.25
68.5	13454.50-	13.87	2581.99-	15.09	184055.55	1.30
69.0	13578.46-	13.50	2595.28-	14.69	185436.97	1.26
69.5	13695.93-	11.22	2611.51-	12.20	186810.47	1.04
70.0	13817.19-	13.07	2626.32-	14.21	188175.84	1.20
70.5	13949.85-	9.60	2645.00-	10.44	189532.50	.89
71.0	14063.30-	13.32	2655.21-	14.49	190881.73	1.22
71.5	14176.56-	11.57	2675.65-	12.59	192222.81	1.06
72.0	14304.45-	15.78	2710.79-	17.17	193554.22	1.44
72.5	14431.82-	13.88	2704.81-	15.10	194879.22	1.26
73.0	14544.60-	12.48	2719.55-	13.58	196197.44	1.13
73.5	14663.61-	13.92	2752.51-	15.15	197505.13	1.25
74.0	14792.85-	16.13	2764.14-	17.55	198805.48	1.44
74.5	14903.72-	17.32	2784.39-	18.85	200099.08	1.54
75.0	15023.29-	20.25	2803.03-	22.04	201381.56	1.80
75.5	15140.56-	17.62	2820.19-	19.17	202658.00	1.56

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
76.0	15262.11-	18.08	2837.75-	19.67	203926.16	1.60
76.5	15385.21-	19.04	2851.70-	20.71	205187.09	1.68
77.0	15503.95-	18.50	2870.02-	20.13	206439.75	1.62
77.5	15627.80-	18.61	2883.12-	20.24	207684.16	1.63
78.0	15745.77-	17.28	2899.35-	18.80	208921.35	1.51
78.5	15867.58-	18.15	2918.50-	19.74	210149.75	1.58
79.0	15998.09-	17.45	2936.29-	18.98	211371.40	1.52
79.5	16110.86-	9.16	2948.16-	9.96	212584.43	.80
80.0	16232.01-	10.08	2964.60-	10.97	213788.63	.88
80.5	16351.28-	8.18	2983.06-	8.90	214984.99	.71
81.0	16477.15-	9.01	2996.67-	9.80	216173.27	.78
81.5	16598.19-	9.02	3012.02-	9.80	217354.15	.78
82.0	16714.15-	7.97	3026.83-	8.67	218526.62	.69
82.5	16837.61-	7.07	3041.25-	7.68	219691.44	.61
83.0	16958.14-	8.41	3056.34-	9.14	220848.26	.72
83.5	17078.04-	8.70	3072.26-	9.47	221997.41	.75
84.0	17201.75-	9.30	3089.38-	10.12	223137.61	.80
84.5	17323.87-	9.58	3099.99-	10.42	224269.48	.82
85.0	17439.00-	9.95	3112.07-	10.82	225394.71	.85

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
85.5	17559.54-	11.10	3129.48-	12.08	226510.90	.94
86.0	17684.44-	8.67	3145.11-	9.43	227618.86	.74
86.5	17810.85-	11.61	3156.40-	12.63	228719.24	.99
87.0	17923.51-	10.28	3169.88-	11.17	229813.11	.88
87.5	18044.45-	9.03	3183.72-	9.82	230897.57	.77
88.0	18169.97-	8.09	3207.59-	8.79	231973.33	.69
88.5	18292.53-	10.25	3212.09-	11.15	233042.57	.87
89.0	18413.53-	10.49	3226.84-	11.41	234104.44	.89
89.5	18521.44-	2.97	3236.96-	3.21	235157.32	.26
90.0	18649.62-	5.71	3259.85-	6.20	236200.10	.49
90.5	18774.73-	9.75	3268.49-	10.57	237236.81	.83
91.0	18895.41-	9.71	3283.93-	10.57	238266.41	.82
91.5	19002.14-	1.26	3295.14-	1.36	239287.23	.12
92.0	19133.54-	6.76	3317.33-	7.37	240298.68	.58
92.5	19258.41-	9.46	3329.02-	10.32	241303.92	.80
93.0	19380.16-	9.48	3340.98-	10.37	242301.99	.81
93.5	19488.31-	2.17	3352.30-	2.43	243291.27	.19
94.0	19611.68-	4.73	3377.45-	5.25	244271.63	.41
94.5	19736.28-	7.34	3384.90-	8.10	245245.41	.63

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
95.0	19852.96-	4.01	3404.44-	4.46	246210.25	.35
95.5	19963.04-	3.92	3417.62-	4.34	247167.31	.34
96.0	20097.12-	8.31	3450.92-	9.09	248113.35	.71
96.5	20225.00-	4.36	3452.03-	4.77	249055.28	.38
97.0	20342.91-	7.28	3461.13-	7.93	249990.20	.62
97.5	20463.45-	7.19	3479.47-	7.83	250913.96	.61
98.0	20580.82-	6.38	3494.07-	6.94	251831.36	.55
98.5	20705.85-	7.26	3505.68-	7.88	252741.67	.62
99.0	20822.64-	7.49	3519.15-	8.14	253643.75	.64
99.5	20949.20-	11.54	3532.84-	12.55	254537.00	.98
100.0	21068.20-	9.73	3545.94-	10.60	255422.82	.83
100.5	21188.57-	8.02	3557.95-	8.76	256301.32	.69
101.0	21290.47-	5.71	3568.70-	6.24	257172.74	.49
101.5	21404.20-	3.57	3587.06-	3.92	258033.60	.32
102.0	21527.79-	4.26	3598.12-	4.65	258886.58	.37
102.5	21649.20-	3.27	3612.34-	3.57	259733.03	.29
103.0	21768.50-	4.99	3621.52-	5.48	260571.50	.43
103.5	21886.61-	3.46	3638.57-	3.82	261401.07	.31
104.0	22008.25-	4.14	3652.36-	4.57	262222.20	.36

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
104.5	22126.57-	3.45	3665.58-	3.82	263037.26	.30
105.0	22254.93-	2.49	3678.92-	2.79	263844.04	.23
105.5	22375.16-	4.01	3687.75-	4.46	264644.26	.36
106.0	22482.53-	.80	3691.44-	.98	265435.86	.09
106.5	22599.93-	4.36	3695.41-	4.84	266218.07	.38
107.0	22733.10-	2.28	3735.55-	2.58	266990.97	.22
107.5	22837.17-	4.57	3740.79-	4.91	267758.71	.37
108.0	22962.39-	2.78	3755.19-	3.13	268516.72	.26
108.5	23084.71-	.45	3769.37-	.55	269266.97	.06
109.0	23206.97-	.30	3789.04-	.26	270009.12	.02
109.5	23331.84-	1.04	3796.45-	1.20	270745.04	.11
110.0	23445.36-	.34	3805.48-	.31	271472.45	.02
110.5	23566.52-	.76	3818.31-	.88	272190.56	.08
111.0	23683.49-	1.26	3832.88-	1.32	272901.53	.09
111.5	23807.54-	.27	3845.60-	.25	273605.15	.02
112.0	23933.22-	1.12	3855.70-	1.30	274301.25	.12
112.5	24043.24-	.27	3867.44-	.23	274988.12	.02
113.0	24172.82-	2.69	3885.36-	2.99	275665.92	.25
113.5	24288.83-	.96	3894.35-	1.08	276339.13	.10

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
114.0	24412.02-	2.03	3904.94-	2.26	277004.31	.19
114.5	24525.39-	1.36	3918.89-	1.45	277660.96	.10
115.0	24648.68-	.06	3933.11-	.14	278307.65	.03
115.5	24770.95-	10.43	3949.38-	11.30	278947.58	.89
116.0	24859.64-	10.39	3919.45-	11.22	279584.34	.88
116.5	24979.38-	12.47	3929.04-	13.51	280208.75	1.06
117.0	25094.11-	14.48	3941.64-	15.73	280824.71	1.24
117.5	25219.83-	12.69	3952.69-	13.75	281431.24	1.08
118.0	25336.47-	13.89	3964.91-	15.07	282032.80	1.19
118.5	25458.86-	13.70	3975.39-	14.85	282626.52	1.17
119.0	25575.84-	14.64	3986.09-	15.89	283212.14	1.26
119.5	25698.00-	12.60	4000.85-	13.64	283786.97	1.08
120.0	25816.66-	9.34	4017.91-	10.12	284355.75	.80
120.5	25955.57-	2.52	4050.95-	2.68	284915.37	.20
121.0	26074.00-	2.58	4062.70-	2.74	285470.92	.21
121.5	26192.28-	2.35	4073.04-	2.46	286016.74	.19
122.0	26303.30-	2.75	4081.51-	2.90	286555.40	.22
122.5	26422.67-	2.44	4096.42-	2.54	287085.95	.20
123.0	26547.65-	2.01	4108.61-	2.09	287606.66	.16

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
123.5	26670.88-	1.40	4117.88-	1.43	288118.97	.11
124.0	26792.65-	1.34	4129.56-	1.35	288627.11	.11

SM 2.06 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
1.0	27.92-	1.93	6.65-	2.19	291.64	6.79
1.5	66.75-	3.23	15.45-	3.58	534.65	6.22
2.0	111.33-	4.24	34.02-	4.61	862.48	6.12
2.5	166.81-	5.32	58.66-	5.70	1280.92	6.54
3.0	225.49-	5.46	88.47-	5.79	1733.63	6.15
3.5	285.56-	5.13	121.45-	5.42	2202.68	5.47
4.0	347.82-	5.11	157.21-	5.39	2686.54	5.24
4.5	411.46-	4.73	194.41-	4.98	3186.13	4.69
5.0	481.47-	5.19	235.35-	5.46	3698.98	5.01
5.5	547.24-	6.37	276.08-	6.70	4223.76	6.02
6.0	619.85-	2.41	310.70-	2.54	4764.94	2.22
6.5	694.67-	.65	353.87-	.69	5313.20	.59
7.0	770.87-	1.03	401.62-	1.08	5871.42	.90
7.5	846.66-	.94	450.96-	.99	6438.10	.81
8.0	925.84-	.12	503.42-	.13	7014.74	.10
8.5	1007.25-	.04	553.15-	.04	7603.58	.04
9.0	1084.89-	1.04	605.37-	1.09	8202.16	.86
9.5	1164.03-	1.89	662.75-	1.99	8811.65	1.53
10.0	1250.57-	.79	720.25-	.83	9433.68	.63

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
10.5	1339.39-	.05	781.20-	.06	10066.66	.04
11.0	1429.02-	.14	844.40-	.15	10710.51	.11
11.5	1524.17-	.52	908.90-	.56	11366.24	.40
12.0	1619.34-	.80	971.73-	.84	12035.23	.59
12.5	1714.70-	.94	1038.70-	1.00	12716.66	.69
13.0	1806.87-	1.92	1110.41-	2.05	13410.23	1.38
13.5	1910.45-	1.02	1181.78-	1.09	14117.88	.72
14.0	2015.52-	.57	1256.70-	.61	14838.47	.40
14.5	2122.97-	1.05	1335.32-	1.13	15572.24	.72
15.0	2235.34-	1.50	1413.17-	1.61	16319.25	1.00
15.5	2349.32-	.95	1490.99-	1.03	17081.61	.63
16.0	2463.52-	.56	1572.21-	.61	17858.29	.36
16.5	2580.22-	1.07	1655.20-	1.15	18650.40	.67
17.0	2701.27-	1.12	1744.02-	1.21	19455.91	.69
17.5	2826.40-	1.92	1833.26-	2.08	20276.68	1.16
18.0	2954.65-	1.23	1925.54-	1.33	21112.26	.73
18.5	3083.64-	1.77	2017.39-	1.91	21964.66	1.03
19.0	3214.26-	.93	2115.05-	1.01	22832.06	.53
19.5	3346.01-	.38	2216.16-	.41	23715.74	.21

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
20.0	3486.49-	.24	2319.85-	.26	24615.81	.13
20.5	3631.76-	.50	2422.00-	.54	25533.51	.27
21.0	3780.23-	1.26	2525.52-	1.37	26469.17	.67
21.5	3928.72-	.70	2634.33-	.76	27422.48	.36
22.0	4077.93-	.02	2748.03-	.02	28393.85	.01
22.5	4236.55-	.82	2862.76-	.89	29383.46	.41
23.0	4395.04-	5.26	2966.54-	5.74	30398.17	2.57
23.5	4561.15-	4.91	3082.11-	5.36	31428.61	2.35
24.0	4727.98-	4.27	3203.23-	4.66	32479.99	2.00
24.5	4900.67-	3.57	3327.31-	3.91	33551.80	1.64
25.0	5083.09-	4.56	3449.40-	4.99	34646.07	2.05
25.5	5267.84-	4.75	3573.24-	5.20	35764.24	2.10
26.0	5454.78-	4.61	3702.19-	5.04	36905.34	1.99
26.5	5646.06-	3.73	3836.79-	4.08	38070.90	1.58
27.0	5848.43-	4.70	3969.81-	5.15	39261.61	1.95
27.5	6053.57-	4.56	4105.84-	5.00	40479.69	1.86
28.0	6261.38-	4.47	4247.83-	4.90	41724.31	1.78
28.5	6477.83-	3.94	4395.07-	4.32	42995.65	1.54
29.0	6702.02-	4.77	4540.36-	5.23	44296.18	1.83

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
29.5	6928.91-	4.37	4691.24-	4.80	45625.99	1.65
30.0	7160.95-	4.19	4849.08-	4.59	46985.35	1.55
30.5	7404.86-	4.53	5008.52-	4.97	48375.74	1.64
31.0	7652.76-	3.97	5169.24-	4.35	49798.66	1.41
31.5	7903.98-	4.18	5338.37-	4.59	51254.24	1.46
32.0	8168.15-	4.37	5512.21-	4.79	52742.12	1.50
32.5	8437.82-	3.94	5685.58-	4.33	54265.83	1.33
33.0	8711.52-	4.13	5866.91-	4.53	55824.76	1.37
33.5	8996.89-	4.18	6055.45-	4.59	57420.14	1.36
34.0	9291.97-	3.23	6245.42-	3.55	59052.78	1.04
34.5	9590.51-	3.17	6440.34-	3.48	60725.01	1.00
35.0	9900.87-	3.09	6644.54-	3.39	62436.00	.96
35.5	10219.74-	2.89	6849.51-	3.18	64189.17	.88
36.0	10543.90-	2.95	7061.11-	3.24	65985.03	.89
36.5	10883.37-	2.96	7282.72-	3.25	67822.96	.88
37.0	11232.01-	.81	7506.95-	.88	69706.78	.24
37.5	11584.31-	1.21	7738.73-	1.32	71637.76	.35
38.0	11952.82-	.66	7978.49-	.72	73615.33	.19
38.5	12328.18-	.68	8218.70-	.75	75642.84	.20

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
39.0	12713.51-	1.08	8472.72-	1.19	77719.59	.30
39.5	13113.07-	.42	8728.93-	.46	79847.32	.12
40.0	13517.47-	.98	8990.41-	1.08	82023.68	.27
40.5	13937.45-	.71	9266.62-	.77	84242.10	.19
41.0	14362.11-	.43	9537.77-	.47	86496.44	.11
41.5	14788.91-	.20	9815.85-	.23	88778.49	.06
42.0	15228.95-	.23	10102.42-	.25	91081.87	.06
42.5	15669.97-	.24	10387.09-	.26	93407.82	.06
43.0	16119.43-	.89	10680.28-	.98	95755.51	.23
43.5	16570.39-	.31	10971.08-	.34	98120.44	.08
44.0	17023.68-	.65	11263.52-	.71	100492.71	.17
44.5	17484.08-	.67	11560.16-	.74	102862.69	.17
45.0	17939.03-	.97	11855.15-	1.07	105226.18	.24
45.5	18400.50-	.39	12153.72-	.43	107578.77	.10
46.0	18855.30-	1.80	12443.56-	1.98	109924.82	.45
46.5	19309.52-	.88	12740.07-	.98	112259.90	.22
47.0	19767.83-	2.78	13032.66-	3.06	114586.43	.69
47.5	20219.75-	.63	13323.26-	.70	116905.59	.16
48.0	20680.61-	2.43	13619.00-	2.68	119213.12	.60

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
48.5	21131.91-	1.15	13909.77-	1.28	121514.14	.29
49.0	21592.50-	.66	14207.93-	.73	123803.45	.17
49.5	22047.48-	2.88	14494.54-	3.16	126087.87	.70
50.0	22505.46-	1.33	14791.78-	1.45	128359.64	.32
50.5	22957.82-	2.69	15077.85-	2.94	130625.81	.65
51.0	23410.47-	.50	15372.81-	.54	132881.74	.12
51.5	23869.57-	2.81	15664.98-	3.08	135129.26	.68
52.0	24318.80-	.83	15954.21-	.90	137370.62	.20
52.5	24780.08-	2.93	16248.81-	3.20	139600.00	.71
53.0	25227.88-	1.43	16534.01-	1.56	141825.12	.34
53.5	25683.18-	6.73	16823.77-	7.38	144039.10	1.63
54.0	26141.83-	3.67	17118.70-	4.02	146244.22	.89
54.5	26599.65-	2.76	17418.74-	3.02	148440.28	.67
55.0	27052.44-	4.99	17701.62-	5.46	150631.12	1.21
55.5	27503.40-	1.32	17996.72-	1.44	152813.07	.32
56.0	27961.34-	4.10	18283.75-	4.49	154986.13	.99
56.5	28409.43-	2.72	18572.95-	2.97	157152.51	.66
57.0	28875.17-	3.15	18871.22-	3.45	159307.60	.76
57.5	29316.23-	2.80	19150.63-	3.06	161461.97	.68

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
58.0	29773.47-	9.86	19439.67-	10.81	163607.89	2.40
58.5	30227.25-	4.06	19733.05-	4.44	165746.03	.99
59.0	30675.45-	7.37	20018.65-	8.07	167877.79	1.79
59.5	31141.73-	6.70	20318.34-	7.33	169997.01	1.63
60.0	31584.86-	6.92	20602.07-	7.58	172113.77	1.69
60.5	32047.36-	9.20	20898.17-	10.08	174217.27	2.25
61.0	32508.35-	11.66	21200.34-	12.79	176312.17	2.85
61.5	32955.00-	11.99	21479.32-	13.15	178404.42	2.94
62.0	33418.72-	9.45	21775.55-	10.36	180483.73	2.32
62.5	33868.19-	15.50	22065.30-	17.00	182557.71	3.80
63.0	34323.80-	9.66	22351.08-	10.58	184624.08	2.37
63.5	34778.59-	15.19	22647.07-	16.65	186680.35	3.74
64.0	35228.80-	10.93	22927.62-	11.97	188732.09	2.69
64.5	35684.10-	14.58	23227.96-	15.98	190771.10	3.60
65.0	36131.14-	13.97	23506.56-	15.31	192807.97	3.44
65.5	36599.08-	13.91	23806.29-	15.25	194830.45	3.44
66.0	37045.47-	17.85	24091.81-	19.56	196848.10	4.42
66.5	37501.34-	10.82	24375.82-	11.86	198858.34	2.68
67.0	37950.36-	16.15	24666.04-	17.70	200859.44	4.00

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
67.5	38403.98-	15.84	24955.11-	17.35	202852.58	3.93
68.0	38868.81-	16.44	25252.81-	18.03	204834.41	4.10
68.5	39316.15-	18.97	25532.59-	20.80	206813.40	4.72
69.0	39771.90-	9.61	25820.04-	10.53	208783.84	2.40
69.5	40227.25-	20.39	26110.57-	22.35	210743.26	5.10
70.0	40676.73-	17.92	26397.89-	19.65	212696.89	4.48
70.5	41143.59-	19.57	26691.42-	21.45	214639.02	4.91
71.0	41588.55-	21.22	26969.44-	23.25	216578.03	5.32
71.5	42050.24-	17.60	27259.41-	19.29	218505.56	4.42
72.0	42498.08-	21.41	27543.74-	23.47	220427.85	5.39
72.5	42947.87-	20.44	27830.13-	22.40	222341.36	5.15
73.0	43411.08-	21.56	28126.70-	23.63	224242.71	5.44
73.5	43864.43-	23.71	28405.81-	25.99	226141.21	6.00
74.0	44309.59-	26.12	28701.78-	28.65	228030.20	6.62
74.5	44771.19-	23.32	28980.95-	25.57	229910.75	5.92
75.0	45214.48-	19.22	29258.36-	21.06	231786.61	4.89
75.5	45678.24-	23.17	29554.55-	25.37	233646.91	5.90
76.0	46134.07-	23.84	29840.10-	26.09	235503.81	6.08
76.5	46585.55-	19.83	30119.54-	21.70	237353.86	5.07

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
77.0	47038.79-	23.79	30411.80-	26.02	239192.95	6.09
77.5	47503.00-	29.44	30691.72-	32.24	241026.19	7.55
78.0	47947.61-	24.07	30983.59-	26.34	242850.72	6.18
78.5	48399.04-	24.38	31269.18-	26.70	244667.62	6.27
79.0	48867.71-	31.79	31549.85-	34.78	246476.27	8.18
79.5	49305.44-	23.60	31837.21-	25.81	248278.02	6.08
80.0	49760.06-	25.44	32120.94-	27.82	250070.65	6.56
80.5	50226.63-	31.95	32403.28-	34.98	251854.42	8.26
81.0	50667.54-	24.92	32692.06-	27.30	253631.69	6.46
81.5	51119.97-	26.11	32973.86-	28.61	255401.72	6.78
82.0	51595.39-	34.20	33259.48-	37.49	257160.05	8.91
82.5	52028.90-	27.47	33545.28-	30.12	258915.02	7.17
83.0	52480.92-	28.26	33828.97-	30.95	260661.25	7.38
83.5	52952.23-	38.62	34106.44-	42.33	262397.69	10.11
84.0	53387.79-	28.90	34395.41-	31.67	264128.37	7.58
84.5	53849.44-	19.02	34701.68-	20.82	265845.50	4.99
85.0	54291.01-	21.68	34980.21-	23.73	267560.21	5.70
85.5	54748.33-	27.98	35250.69-	30.62	269267.34	7.36
86.0	55200.86-	28.82	35531.73-	31.52	270965.56	7.59

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
86.5	55670.33-	38.21	35808.95-	41.86	272654.33	10.10
87.0	56107.36-	29.00	36101.66-	31.76	274335.98	7.67
87.5	56560.71-	30.12	36381.33-	32.99	276010.50	7.98
88.0	57016.49-	30.71	36667.00-	33.66	277675.84	8.16
88.5	57469.43-	30.66	36949.79-	33.64	279333.80	8.16
89.0	57921.59-	30.72	37232.00-	33.70	280984.48	8.20
89.5	58389.39-	35.19	37508.22-	38.59	282626.70	9.42
90.0	58868.32-	34.47	37759.06-	37.80	284264.64	9.24
90.5	59324.70-	34.83	38043.16-	38.23	285891.23	9.37
91.0	59778.50-	34.71	38323.92-	38.12	287510.19	9.35
91.5	60229.71-	33.59	38611.25-	36.93	289119.48	9.08
92.0	60684.08-	34.13	38889.20-	37.51	290722.48	9.24
92.5	61135.81-	33.87	39168.42-	37.26	292317.40	9.19
93.0	61591.53-	34.20	39452.46-	37.62	293903.67	9.31
93.5	62043.99-	34.28	39732.74-	37.73	295482.51	9.35
94.0	62497.52-	34.01	40013.71-	37.43	297053.29	9.29
94.5	62950.09-	34.14	40295.78-	37.59	298616.65	9.35
95.0	63382.46-	27.53	40562.20-	30.32	300178.46	7.55

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
1.0	17.97-	1.78	15.93-	2.02	346.56	5.38
1.5	53.72-	1.61	30.57-	1.78	633.57	2.88
2.0	110.05-	1.33	53.92-	1.42	1019.85	1.79
2.5	175.02-	.32	77.04-	.34	1499.23	.38
3.0	247.78-	.12	101.89-	.13	2007.20	.14
3.5	323.85-	.01	128.33-	.02	2525.76	.02
4.0	402.21-	.77	155.75-	.81	3055.45	.76
4.5	481.11-	.10	182.94-	.10	3594.48	.10
5.0	563.34-	.04	211.76-	.04	4144.65	.04
5.5	649.63-	.40	240.86-	.43	4705.82	.36
6.0	736.63-	.26	273.66-	.28	5277.31	.23
6.5	825.89-	.59	306.22-	.62	5858.27	.51
7.0	920.37-	.02	338.53-	.02	6450.07	.02
7.5	1017.04-	.05	372.76-	.05	7050.45	.04
8.0	1115.32-	.52	407.83-	.55	7658.66	.42
8.5	1217.15-	.17	441.78-	.18	8276.63	.13
9.0	1320.93-	.32	478.32-	.34	8900.55	.25
9.5	1421.28-	3.05	513.85-	3.23	9530.60	2.34
10.0	1529.25-	2.51	553.19-	2.67	10170.18	1.89

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
10.5	1644.44-	.53	592.14-	.57	10817.77	.40
11.0	1754.57-	2.39	628.82-	2.55	11470.47	1.73
11.5	1868.61-	2.91	669.97-	3.10	12130.27	2.07
12.0	1989.55-	.21	708.81-	.23	12798.65	.15
12.5	2104.85-	1.82	750.10-	1.95	13470.82	1.25
13.0	2223.40-	3.12	791.52-	3.34	14150.29	2.10
13.5	2350.63-	1.27	834.29-	1.36	14836.90	.84
14.0	2477.97-	1.86	877.54-	2.00	15528.14	1.21
14.5	2602.89-	3.29	919.10-	3.53	16225.10	2.09
15.0	2735.42-	.30	960.74-	.32	16930.35	.19
15.5	2866.07-	1.73	1007.55-	1.85	17639.01	1.06
16.0	2998.04-	4.25	1051.91-	4.58	18353.76	2.56
16.5	3136.43-	2.22	1097.24-	2.39	19077.30	1.31
17.0	3275.98-	2.23	1141.07-	2.41	19806.61	1.29
17.5	3414.40-	3.61	1186.01-	3.90	20542.59	2.05
18.0	3557.00-	2.66	1233.29-	2.87	21287.15	1.48
18.5	3699.44-	4.33	1276.59-	4.69	22038.14	2.37
19.0	3848.76-	3.94	1324.36-	4.27	22796.67	2.12
19.5	4002.11-	.14	1365.92-	.14	23565.03	.07

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
20.0	4152.70-	1.04	1409.59-	1.12	24339.64	.54
20.5	4307.28-	1.16	1458.27-	1.26	25122.59	.59
21.0	4465.15-	3.96	1508.05-	4.30	25914.16	1.97
21.5	4621.35-	3.02	1551.91-	3.27	26718.77	1.48
22.0	4784.10-	3.00	1600.38-	3.25	27533.28	1.44
22.5	4947.21-	1.79	1642.98-	1.94	28358.87	.84
23.0	5110.94-	3.28	1694.65-	3.57	29193.49	1.52
23.5	5277.03-	3.28	1736.23-	3.56	30040.72	1.48
24.0	5448.06-	1.62	1782.50-	1.76	30898.92	.72
24.5	5619.73-	2.86	1830.45-	3.11	31767.82	1.24
25.0	5792.33-	2.23	1875.31-	2.42	32649.84	.95
25.5	5970.61-	3.07	1924.16-	3.34	33543.54	1.29
26.0	6149.79-	2.71	1964.83-	2.96	34451.56	1.12
26.5	6332.64-	2.88	2014.25-	3.13	35372.43	1.16
27.0	6518.71-	2.78	2056.97-	3.03	36308.14	1.11
27.5	6707.68-	3.69	2106.41-	4.03	37258.16	1.44
28.0	6900.29-	3.01	2147.43-	3.29	38224.33	1.15
28.5	7095.43-	3.61	2197.58-	3.94	39205.94	1.36
29.0	7296.95-	2.10	2238.86-	2.29	40204.74	.77

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL.)	SIG Z
29.5	7501.11-	2.54	2288.45-	2.77	41219.94	.92
30.0	7708.38-	2.36	2330.60-	2.57	42253.69	.84
30.5	7922.58-	1.51	2378.32-	1.64	43305.70	.52
31.0	8137.19-	2.82	2427.41-	3.08	44376.06	.96
31.5	8359.37-	2.02	2473.59-	2.21	45466.39	.68
32.0	8585.01-	1.69	2523.22-	1.85	46576.28	.56
32.5	8814.35-	2.41	2571.23-	2.64	47706.60	.78
33.0	9052.73-	1.80	2621.52-	1.96	48857.64	.57
33.5	9290.28-	2.59	2670.91-	2.83	50032.72	.81
34.0	9537.51-	2.24	2720.62-	2.45	51230.67	.69
34.5	9790.58-	1.57	2771.37-	1.72	52452.52	.47
35.0	10044.90-	2.76	2822.84-	3.02	53698.29	.82
35.5	10310.66-	2.83	2875.00-	3.09	54969.59	.82
36.0	10580.07-	2.39	2925.04-	2.61	56269.30	.68
36.5	10855.25-	2.37	2980.53-	2.59	57594.20	.67
37.0	11137.75-	3.52	3033.78-	3.86	58946.16	.98
37.5	11423.76-	2.56	3088.59-	2.81	60325.15	.70
38.0	11721.22-	2.77	3143.24-	3.03	61733.61	.75
38.5	12023.72-	2.45	3198.75-	2.68	63172.41	.65

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
39.0	12330.79-	3.14	3254.68-	3.44	64642.25	.82
39.5	12649.43-	3.69	3311.92-	4.04	66139.10	.95
40.0	12971.10-	3.35	3366.04-	3.68	67665.86	.85
40.5	13302.01-	3.62	3423.38-	3.97	69219.50	.91
41.0	13634.96-	3.39	3477.79-	3.71	70796.60	.84
41.5	13974.94-	3.06	3539.44-	3.36	72385.79	.75
42.0	14319.08-	3.46	3595.68-	3.80	73989.58	.83
42.5	14665.55-	3.28	3655.97-	3.59	75611.13	.78
43.0	15020.91-	3.60	3711.83-	3.94	77255.98	.85
43.5	15380.35-	3.21	3773.07-	3.52	78929.35	.75
44.0	15749.82-	4.27	3829.05-	4.68	80626.64	.98
44.5	16118.55-	4.07	3890.58-	4.46	82336.67	.93
45.0	16491.77-	4.33	3946.14-	4.75	84042.59	.98
45.5	16861.84-	5.19	4007.39-	5.69	85738.98	1.17
46.0	17233.38-	4.97	4063.57-	5.45	87424.27	1.11
46.5	17603.54-	5.08	4122.48-	5.57	89099.23	1.13
47.0	17974.20-	5.28	4181.68-	5.79	90762.62	1.16
47.5	18342.26-	4.82	4240.44-	5.28	92416.29	1.05
48.0	18709.70-	4.79	4300.56-	5.25	94060.21	1.04

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
48.5	19079.97-	5.11	4358.54-	5.60	95693.83	1.10
49.0	19446.17-	5.86	4414.74-	6.42	97318.26	1.26
49.5	19813.25-	5.51	4473.97-	6.04	98931.92	1.18
50.0	20181.94-	6.44	4531.23-	7.05	100536.21	1.37
50.5	20548.49-	6.06	4588.48-	6.65	102131.41	1.29
51.0	20914.53-	5.57	4645.78-	6.11	103717.60	1.18
51.5	21280.31-	5.76	4704.74-	6.31	105294.24	1.21
52.0	21646.63-	5.21	4761.76-	5.70	106862.13	1.10
52.5	22010.81-	6.39	4819.91-	7.00	108421.03	1.34
53.0	22377.24-	6.49	4880.25-	7.11	109970.29	1.36
53.5	22742.61-	6.40	4934.98-	7.01	111511.11	1.34
54.0	23108.39-	6.25	4994.77-	6.85	113043.41	1.31
54.5	23475.87-	7.68	5048.40-	8.42	114566.94	1.60
55.0	23836.18-	6.22	5105.55-	6.81	116082.97	1.29
55.5	24205.42-	6.51	5161.67-	7.13	117589.42	1.35
56.0	24568.36-	6.43	5219.71-	7.04	119087.64	1.34
56.5	24936.32-	6.94	5277.77-	7.60	120576.87	1.44
57.0	25295.92-	6.85	5332.34-	7.50	122059.03	1.41
57.5	25660.09-	6.63	5392.54-	7.26	123532.20	1.37

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
58.0	26024.58-	6.82	5445.17-	7.46	124997.10	1.41
58.5	26389.24-	7.15	5504.00-	7.83	126453.83	1.48
59.0	26759.47-	8.75	5559.05-	9.58	127901.39	1.81
59.5	27118.17-	7.24	5616.10-	7.93	129341.71	1.50
60.0	27489.08-	8.33	5672.62-	9.13	130772.14	1.73
60.5	27844.68-	8.41	5725.48-	9.22	132197.36	1.75
61.0	28208.59-	9.24	5791.74-	10.12	133612.11	1.91
61.5	28573.37-	8.63	5842.34-	9.46	135019.09	1.79
62.0	28940.44-	9.73	5900.11-	10.66	136417.20	2.02
62.5	29307.36-	8.89	5954.27-	9.73	137808.11	1.84
63.0	29668.32-	8.81	6010.29-	9.64	139190.85	1.83
63.5	30029.87-	8.66	6065.30-	9.48	140565.97	1.80
64.0	30390.95-	8.09	6121.25-	8.85	141933.01	1.69
64.5	30755.71-	9.97	6176.91-	10.92	143291.68	2.08
65.0	31117.31-	9.29	6232.40-	10.17	144642.30	1.94
65.5	31482.73-	9.32	6287.70-	10.21	145984.85	1.95
66.0	31846.90-	8.93	6346.01-	9.78	147319.14	1.87
66.5	32209.84-	9.56	6399.79-	10.47	148645.85	2.00
67.0	32573.49-	9.50	6456.01-	10.39	149964.47	2.00

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
67.5	32938.86-	10.40	6509.06-	11.39	151275.02	2.19
68.0	33304.32-	11.05	6565.56-	12.11	152576.79	2.33
68.5	33667.79-	11.36	6621.78-	12.44	153871.31	2.40
69.0	34028.48-	10.61	6675.14-	11.62	155158.49	2.24
69.5	34387.84-	8.58	6729.43-	9.39	156438.08	1.81
70.0	34750.80-	8.93	6787.66-	9.79	157708.39	1.90
70.5	35113.08-	9.22	6843.59-	10.10	158972.02	1.96
71.0	35474.57-	7.33	6899.87-	8.03	160226.32	1.57
71.5	35839.99-	9.79	6951.00-	10.74	161472.27	2.10
72.0	36203.85-	9.83	7004.98-	10.78	162710.81	2.11
72.5	36564.70-	7.83	7060.66-	8.59	163940.89	1.69
73.0	36925.79-	8.39	7114.98-	9.21	165164.11	1.81
73.5	37294.93-	11.10	7167.64-	12.18	166377.87	2.40
74.0	37657.75-	11.77	7220.02-	12.91	167583.91	2.55
74.5	38021.04-	11.61	7277.09-	12.74	168782.31	2.52
75.0	38383.16-	9.63	7330.54-	10.56	169972.92	2.09
75.5	38742.25-	8.85	7383.37-	9.70	171156.43	1.93
76.0	39105.04-	10.38	7438.37-	11.38	172331.17	2.26
76.5	39465.63-	11.39	7491.03-	12.49	173498.62	2.49

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
77.0	39827.73-	10.65	7547.02-	11.68	174656.87	2.33
77.5	40190.50-	10.54	7596.90-	11.55	175808.23	2.32
78.0	40546.77-	8.24	7650.49-	9.03	176952.95	1.81
78.5	40913.76-	9.54	7710.64-	10.45	178085.92	2.10
79.0	41274.16-	9.67	7763.97-	10.59	179214.51	2.14
79.5	41638.46-	11.71	7821.46-	12.84	180332.02	2.60
80.0	42013.34-	11.88	7889.74-	13.03	181440.15	2.65
80.5	42375.16-	12.21	7948.34-	13.39	182539.69	2.72
81.0	42731.06-	13.37	7997.62-	14.66	183635.50	2.99
81.5	43095.09-	13.04	8054.49-	14.30	184722.06	2.92
82.0	43461.53-	12.89	8104.29-	14.14	185799.27	2.90
82.5	43819.50-	12.81	8155.11-	14.05	186871.35	2.89
83.0	44184.53-	12.44	8212.70-	13.64	187933.46	2.81
83.5	44544.06-	12.92	8260.04-	14.17	188989.28	2.92
84.0	44908.05-	14.15	8317.43-	15.52	190035.42	3.21
84.5	45276.37-	13.71	8370.18-	15.04	191073.45	3.12
85.0	45628.57-	12.07	8417.92-	13.24	192106.10	2.75
85.5	45993.75-	12.36	8474.61-	13.56	193127.53	2.83
86.0	46357.36-	14.53	8529.56-	15.94	194141.52	3.33

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
86.5	46718.21-	13.45	8581.26-	14.75	195148.75	3.09
87.0	47076.60-	13.17	8633.76-	14.45	196148.21	3.04
87.5	47440.29-	13.32	8689.08-	14.61	197138.64	3.08
88.0	47802.89-	14.31	8740.17-	15.70	198121.32	3.32
88.5	48159.41-	11.82	8792.54-	12.97	199097.65	2.75
89.0	48518.25-	11.76	8847.00-	12.89	200065.04	2.74
89.5	48885.04-	14.25	8902.04-	15.62	201023.42	3.33
90.0	49246.30-	14.68	8952.85-	16.09	201974.62	3.44
90.5	49601.52-	13.51	9003.97-	14.81	202919.01	3.17
91.0	49962.95-	12.56	9058.50-	13.76	203854.51	2.96
91.5	50325.25-	14.64	9109.18-	16.04	204780.78	3.46
92.0	50683.24-	13.17	9163.87-	14.43	205700.13	3.12
92.5	51042.63-	11.28	9215.92-	12.36	206612.76	2.68
93.0	51404.50-	13.14	9268.29-	14.40	207515.23	3.13
93.5	51766.84-	13.93	9319.78-	15.26	208410.56	3.32
94.0	52129.70-	12.74	9372.98-	13.96	209298.50	3.05
94.5	52486.30-	12.61	9423.63-	13.82	210177.99	3.03
95.0	52848.65-	13.74	9478.46-	15.06	211049.71	3.31
95.5	53208.42-	12.51	9527.58-	13.71	211913.92	3.02

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
96.0	53567.49-	13.05	9578.44-	14.30	212768.58	3.16
96.5	53928.28-	13.49	9632.43-	14.79	213616.78	3.28
97.0	54289.81-	13.60	9681.92-	14.90	214456.12	3.32
97.5	54647.22-	11.74	9734.03-	12.87	215287.22	2.87
98.0	55008.08-	14.03	9789.66-	15.39	216111.18	3.44
98.5	55371.38-	13.50	9840.02-	14.80	216926.35	3.32
99.0	55727.03-	12.64	9890.62-	13.86	217734.43	3.12
99.5	56086.25-	13.59	9942.97-	14.91	218535.19	3.37
100.0	56453.04-	14.80	9993.07-	16.23	219325.85	3.68
100.5	56805.77-	11.90	10043.82-	13.05	220111.26	2.96
101.0	57164.30-	12.62	10095.07-	13.84	220888.31	3.15
101.5	57528.55-	8.58	10157.17-	9.41	221653.34	2.15
102.0	57897.01-	8.98	10203.55-	9.86	222412.33	2.26
102.5	58247.09-	14.71	10244.82-	16.14	223166.12	3.71
103.0	58604.41-	14.24	10297.52-	15.62	223910.90	3.60
103.5	58968.06-	12.21	10352.01-	13.40	224645.72	3.10
104.0	59323.48-	14.91	10401.55-	16.36	225374.95	3.79
104.5	59681.94-	15.60	10450.87-	17.12	226095.15	3.98
105.0	60038.34-	15.18	10503.24-	16.66	226808.20	3.88

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
105.5	60401.84-	16.13	10553.20-	17.68	227511.91	4.14
106.0	60759.35-	15.67	10606.97-	17.16	228208.23	4.03
106.5	61116.85-	13.94	10657.09-	15.29	228898.15	3.60
107.0	61479.09-	13.81	10712.52-	15.12	229578.00	3.57
107.5	61834.07-	13.74	10760.04-	15.03	230251.78	3.57
108.0	62198.53-	15.88	10811.99-	17.41	230915.48	4.14
108.5	62545.90-	11.86	10857.65-	13.03	231576.51	3.10
109.0	62920.42-	14.07	10914.71-	15.45	232217.93	3.69
109.5	63272.28-	15.25	10960.86-	16.73	232860.97	4.01
110.0	63625.58-	13.86	11013.77-	15.22	233496.59	3.66
110.5	63985.96-	5.27	11061.48-	5.80	234119.33	1.38
111.0	64347.60-	14.19	11113.12-	15.59	234734.52	3.76
111.5	64698.96-	11.53	11164.60-	12.63	235347.88	3.06
112.0	65068.87-	15.52	11222.53-	17.04	235944.74	4.14
112.5	65423.96-	15.13	11264.45-	16.59	236537.49	4.04
113.0	65794.74-	24.90	11332.49-	27.27	237119.50	6.68
113.5	66189.59-	26.01	11397.80-	28.48	237688.33	7.00
114.0	66504.85-	14.18	11422.21-	15.50	238268.28	3.82
114.5	66847.84-	13.00	11466.35-	14.21	238834.79	3.51

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
115.0	67220.92-	5.92	11501.19-	6.45	239388.66	1.59
115.5	67575.77-	13.91	11571.31-	15.24	239931.59	3.78
116.0	67925.36-	15.60	11617.15-	17.08	240471.38	4.25
116.5	68278.25-	13.34	11669.41-	14.58	241003.39	3.65
117.0	68636.07-	11.82	11715.28-	12.95	241527.12	3.25
117.5	69002.47-	13.57	11775.02-	14.85	242037.22	3.74
118.0	69349.60-	14.90	11812.13-	16.29	242545.24	4.12
118.5	69707.28-	14.15	11863.35-	15.44	243045.02	3.92
119.0	70061.56-	12.32	11913.44-	13.46	243536.09	3.42
119.5	70421.32-	11.61	11964.54-	12.68	244015.19	3.24
120.0	70777.32-	16.22	12017.03-	17.75	244490.69	4.55
120.5	71136.88-	12.08	12060.00-	13.22	244959.29	3.39
121.0	71497.42-	13.11	12122.26-	14.36	245415.28	3.69
121.5	71847.85-	14.49	12160.96-	15.91	245868.77	4.10
122.0	72198.92-	14.84	12213.86-	16.31	246309.79	4.21
122.5	72559.90-	13.82	12261.17-	15.18	246744.66	3.93
123.0	72915.18-	13.30	12314.29-	14.64	247172.85	3.80
123.5	73269.81-	14.95	12361.69-	16.42	247589.91	4.28
124.0	73627.36-	12.18	12409.57-	13.37	248001.02	3.50

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
124.5	73979.83-	15.42	12466.97-	16.91	248406.21	4.45
125.0	74338.90-	15.23	12512.06-	16.70	248801.05	4.41
125.5	74690.37-	14.50	12564.45-	15.88	249187.27	4.21
126.0	75052.55-	9.43	12624.50-	10.32	249564.42	2.75
126.5	75408.64-	12.17	12671.28-	13.32	249937.72	3.57
127.0	75762.40-	16.09	12713.53-	17.62	250300.50	4.74
127.5	76120.67-	18.99	12764.34-	20.82	250654.08	5.61
128.0	76475.75-	18.41	12807.13-	20.20	251002.30	5.46
128.5	76839.30-	15.90	12864.96-	17.44	251341.37	4.73
129.0	77188.00-	19.08	12911.58-	20.97	251672.94	5.69
129.5	77545.00-	18.21	12968.72-	20.03	251995.25	5.45
130.0	77910.42-	10.67	13029.99-	11.77	252307.83	3.19
130.5	78286.16-	1.85	13096.07-	2.11	252611.92	.54
131.0	78637.01-	2.43	13154.25-	2.75	252910.52	.72
131.5	78995.15-	2.43	13210.21-	2.74	253201.63	.72
132.0	79375.41-	6.36	13257.83-	7.04	253480.27	1.92
132.5	79714.15-	4.74	13299.94-	5.24	253762.54	1.43
133.0	80058.97-	2.30	13353.54-	2.57	254030.72	.68
133.5	80413.12-	2.51	13407.35-	2.81	254291.39	.75

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
134.0	80768.40-	4.02	13451.65-	4.49	254547.18	1.22
134.5	81129.72-	4.23	13502.82-	4.71	254794.05	1.29
135.0	81482.86-	3.79	13553.66-	4.20	255030.45	1.16
135.5	81833.58-	1.95	13607.21-	2.18	255261.03	.59
136.0	82190.15-	2.95	13654.45-	3.26	255483.84	.91
136.5	82556.82-	1.20	13766.19-	1.32	255689.42	.40
137.0	82911.46-	.08	13820.30-	.16	255893.09	.02
137.5	83263.34-	.37	13869.98-	.41	256092.67	.09
138.0	83618.59-	1.49	13921.17-	1.65	256282.96	.50
138.5	83978.37-	.64	13965.40-	.71	256462.68	.23
139.0	84332.70-	.10	14018.82-	.20	256634.79	.01
139.5	84686.26-	.08	14069.65-	.16	256802.39	.02
140.0	85041.14-	.41	14118.62-	.48	256961.47	.11
140.5	85399.86-	1.29	14164.50-	1.44	257109.85	.45
141.0	85754.33-	.24	14218.30-	.32	257250.42	.10
141.5	86099.58-	5.04	14274.42-	5.58	257387.78	1.68
142.0	86453.50-	5.07	14323.74-	5.62	257515.69	1.70
142.5	86811.84-	6.91	14364.61-	7.62	257633.79	2.31
143.0	87166.83-	5.49	14420.85-	6.06	257742.13	1.85

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
143.5	87527.23-	6.03	14470.56-	6.66	257844.34	2.04
144.0	87875.82-	3.76	14520.26-	4.14	257942.55	1.29
144.5	88235.32-	6.17	14563.55-	6.79	258028.68	2.10
145.0	88589.68-	3.80	14617.54-	4.19	258105.81	1.30
145.5	88950.56-	4.96	14667.16-	5.46	258176.16	1.71
146.0	89308.16-	9.76	14706.23-	10.76	258240.90	3.34
146.5	89656.22-	5.81	14758.95-	6.45	258298.68	2.01
147.0	90009.31-	4.26	14814.92-	4.76	258344.42	1.48
147.5	90373.12-	5.53	14867.74-	6.20	258381.68	1.93
148.0	90726.55-	10.79	14905.77-	11.99	258416.76	3.75
148.5	91074.94-	6.17	14954.04-	6.91	258443.50	2.17
149.0	91429.00-	3.25	15011.48-	3.68	258457.10	1.16
149.5	91789.41-	3.67	15060.18-	4.17	258463.83	1.31
150.0	92146.34-	10.39	15099.83-	11.56	258466.81	3.67
150.5	92494.80-	4.84	15147.25-	5.46	258462.01	1.7[illegible]
151.0	92847.26-	2.09	15207.97-	2.41	258444.43	.7[illegible]
151.5	93203.89-	2.51	15258.01-	2.86	258420.03	.92
152.0	93552.49-	3.38	15307.93-	3.81	258390.89	1.23
152.5	93906.67-	7.84	15361.79-	8.73	258353.48	2.84

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
153.0	94265.42-	2.30	15404.41-	2.63	258306.04	.86
153.5	94617.45-	1.42	15452.67-	1.64	258250.61	.55
154.0	94970.41-	4.01	15503.81-	4.48	258190.12	1.49
154.5	95328.86-	4.43	15560.93-	4.97	258119.64	1.64
155.0	95666.06-	15.81	15607.79-	17.51	258046.19	5.80
155.5	96020.19-	15.29	15661.20-	16.91	257959.00	5.63
156.0	96361.32-	9.67	15721.11-	10.71	257867.23	3.58
156.5	96717.86-	8.15	15785.84-	9.05	257764.02	3.04
157.0	97055.99-	2.03	15832.92-	2.31	257658.49	.78
157.5	97406.86-	3.32	15878.11-	3.74	257541.55	1.26
158.0	97750.16-	7.83	15929.55-	8.67	257418.39	2.96
158.5	98121.73-	.16	15974.16-	.23	257280.11	.07
159.0	98488.01-	18.11	16062.24-	20.03	257130.18	6.87
159.5	98848.72-	19.99	16113.48-	22.11	256978.94	7.61
160.0	99230.52-	15.85	16170.48-	17.59	256813.99	6.08
160.5	99587.61-	14.03	16217.41-	15.59	256649.39	5.40
161.0	99907.35-	19.65	16262.96-	21.78	256489.54	7.58
161.5	100263.32-	19.32	16308.54-	21.43	256308.42	7.49
162.0	100645.99-	15.21	16364.17-	16.91	256110.86	5.93

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
162.5	101000.12-	15.32	16413.30-	17.03	255916.15	6.00
163.0	101323.51-	20.05	16456.67-	22.25	255723.80	7.88
163.5	101678.81-	19.40	16503.11-	21.53	255511.43	7.66
164.0	102059.71-	14.88	16558.98-	16.53	255282.78	5.91
164.5	102414.48-	15.12	16608.23-	16.78	255056.41	6.03
165.0	102759.11-	9.31	16668.97-	10.38	254822.50	3.73
165.5	103110.77-	9.15	16712.60-	10.22	254580.04	3.70
166.0	103474.10-	13.64	16750.44-	15.15	254328.87	5.52
166.5	103828.09-	14.23	16799.13-	15.82	254071.31	5.78
167.0	104171.46-	9.16	16860.86-	10.24	253806.10	3.76
167.5	104522.47-	8.69	16904.53-	9.69	253532.84	3.58
168.0	104887.34-	14.29	16940.41-	15.84	253249.23	5.89
168.5	105241.37-	14.27	16991.80-	15.82	252960.08	5.91
169.0	105608.17-	20.55	17027.54-	22.72	252663.20	8.54
169.5	105960.38-	19.90	17075.44-	22.03	252357.52	8.31
170.0	106313.61-	20.94	17123.24-	23.17	252046.10	8.78
170.5	106666.71-	19.80	17169.90-	21.91	251726.20	8.34
171.0	107016.78-	25.14	17226.32-	27.84	251402.44	10.63
171.5	107367.06-	25.53	17274.61-	28.24	251065.69	10.84

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
172.0	107717.04-	25.89	17330.34-	28.66	250721.99	11.04
172.5	108075.12-	27.26	17399.54-	30.14	250365.23	11.67
173.0	108419.34-	26.05	17463.14-	28.82	250009.62	11.21
173.5	108783.73-	30.04	17530.24-	33.22	249635.02	12.99
174.0	109133.59-	30.39	17586.34-	33.60	249257.95	13.20
174.5	109488.89-	33.43	17650.81-	36.97	248872.77	14.60
175.0	109845.36-	30.88	17709.21-	34.20	248479.67	13.56
175.5	110200.82-	29.87	17752.31-	33.10	248080.61	13.18
176.0	110550.37-	30.40	17803.77-	33.70	247671.64	13.48
176.5	110909.78-	31.42	17855.50-	34.85	247253.76	14.01
177.0	111254.36-	30.03	17897.42-	33.30	246834.75	13.46
177.5	111615.25-	30.59	17946.29-	33.94	246402.12	13.77
178.0	111961.46-	29.30	17992.76-	32.52	245964.05	13.27
178.5	112316.82-	29.93	18041.22-	33.24	245515.35	13.62
179.0	112666.90-	28.71	18087.50-	31.91	245061.83	13.13
179.5	113026.27-	27.92	18134.88-	31.05	244598.92	12.83
180.0	113371.19-	28.48	18181.38-	31.68	244131.23	13.17
180.5	113724.36-	28.38	18231.22-	31.58	243650.47	13.19
181.0	114077.35-	29.25	18277.61-	32.50	243164.18	13.67

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
181.5	114425.41-	27.80	18325.10-	30.91	242672.64	13.06
182.0	114779.88-	28.10	18370.31-	31.26	242171.84	13.27
182.5	115129.75-	28.30	18417.72-	31.51	241661.96	13.43
183.0	115486.63-	27.88	18466.45-	31.07	241141.21	13.31
183.5	115833.98-	28.21	18513.70-	31.47	240618.04	13.53
184.0	116189.93-	26.73	18559.28-	29.84	240084.87	12.90
184.5	116536.18-	26.54	18605.66-	29.62	239546.45	12.87
185.0	116889.72-	26.34	18653.94-	29.38	238994.90	12.84
185.5	117241.02-	26.61	18700.34-	29.66	238438.16	13.05

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
1.0	15.41-	.51	25.86-	.60	405.50	1.38
1.5	35.37-	.79	51.70-	.84	683.82	1.36
2.0	64.54-	.20	81.62-	.23	1053.08	.31
2.5	98.48-	1.51	114.84-	1.62	1512.44	1.91
3.0	138.12-	1.56	155.45-	1.66	2016.37	1.82
3.5	179.79-	1.22	197.70-	1.28	2532.86	1.35
4.0	222.39-	.83	240.53-	.87	3060.19	.88
4.5	267.26-	.44	284.69-	.47	3598.22	.46
5.0	313.60-	.61	330.00-	.65	4146.20	.61
5.5	360.46-	.03	375.62-	.03	4705.97	.04
6.0	411.37-	1.66	426.41-	1.74	5273.82	1.58
6.5	463.85-	2.85	476.72-	2.99	5853.61	2.65
7.0	516.44-	1.32	524.53-	1.39	6446.86	1.21
7.5	571.15-	.21	573.42-	.22	7051.16	.18
8.0	628.17-	3.20	625.91-	3.37	7667.95	2.79
8.5	683.95-	4.12	677.29-	4.35	8294.99	3.52
9.0	743.40-	2.14	735.17-	2.26	8930.65	1.79
9.5	806.28-	4.43	786.70-	4.68	9583.20	3.64
10.0	867.23-	4.20	843.88-	4.44	10246.52	3.39

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
10.5	927.41-	2.43	899.46-	2.57	10922.27	1.92
11.0	992.50-	3.30	959.71-	3.49	11612.65	2.56
11.5	1062.58-	8.42	1014.53-	8.93	12320.58	6.40
12.0	1134.15-	10.33	1076.62-	10.96	13040.17	7.70
12.5	1200.78-	8.13	1136.36-	8.64	13772.65	5.94
13.0	1273.73-	8.57	1203.08-	9.12	14520.81	6.14
13.5	1355.37-	9.51	1270.47-	10.13	15284.55	6.68
14.0	1433.47-	10.94	1337.66-	11.66	16064.84	7.52
14.5	1509.30-	10.02	1403.23-	10.69	16860.74	6.75
15.0	1589.46-	10.32	1475.61-	11.02	17673.17	6.81
15.5	1674.53-	12.46	1548.00-	13.32	18503.93	8.05
16.0	1767.98-	17.26	1615.82-	18.47	19354.08	10.91
16.5	1851.10-	15.29	1690.96-	16.37	20218.46	9.46
17.0	1943.67-	16.11	1768.66-	17.27	21103.05	9.76
17.5	2038.81-	20.44	1842.33-	21.94	22009.50	12.11
18.0	2133.09-	16.76	1925.46-	18.00	22930.65	9.71
18.5	2232.21-	17.48	2008.14-	18.79	23874.55	9.91
19.0	2330.77-	16.92	2097.51-	18.20	24839.01	9.38
19.5	2439.32-	15.34	2188.36-	16.52	25824.21	8.32

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
20.0	2545.06-	14.87	2274.74-	16.02	26833.90	7.88
20.5	2651.87-	13.54	2368.79-	14.60	27865.71	7.01
21.0	2766.67-	11.68	2463.85-	12.61	28921.67	5.91
21.5	2880.88-	11.63	2554.07-	12.56	30003.59	5.75
22.0	2998.51-	11.98	2652.46-	12.95	31111.18	5.78
22.5	3122.71-	10.06	2754.82-	10.88	32244.10	4.74
23.0	3247.19-	9.60	2852.62-	10.40	33405.85	4.42
23.5	3374.21-	6.88	2959.94-	7.45	34594.89	3.09
24.0	3505.68-	6.48	3060.11-	7.02	35815.34	2.84
24.5	3641.96-	7.48	3165.22-	8.12	37067.21	3.21
25.0	3781.24-	5.21	3278.63-	5.66	38348.75	2.18
25.5	3925.26-	4.31	3387.69-	4.69	39664.55	1.76
26.0	4070.89-	2.11	3504.33-	2.30	41013.34	.84
26.5	4222.90-	2.43	3614.23-	2.65	42398.93	.94
27.0	4381.84-	3.58	3731.03-	3.90	43820.68	1.35
27.5	4543.85-	2.81	3849.47-	3.06	45278.63	1.03
28.0	4713.57-	3.36	3968.61-	3.67	46775.35	1.21
28.5	4881.36-	2.04	4092.26-	2.23	48311.35	.71
29.0	5060.33-	3.51	4217.90-	3.82	49888.04	1.20

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
29.5	5243.05-	2.20	4348.34-	2.41	51505.00	.73
30.0	5427.06-	2.43	4474.70-	2.66	53166.69	.79
30.5	5616.92-	2.37	4611.39-	2.59	54872.35	.75
31.0	5817.67-	2.76	4748.36-	3.02	56623.41	.85
31.5	6021.91-	2.89	4883.49-	3.16	58422.18	.87
32.0	6227.25-	2.60	5023.93-	2.85	60270.05	.77
32.5	6445.18-	2.66	5170.17-	2.92	62167.25	.77
33.0	6669.48-	2.48	5316.86-	2.71	64112.78	.70
33.5	6895.98-	2.66	5461.49-	2.91	66105.37	.73
34.0	7127.14-	3.19	5616.02-	3.50	68130.33	.86
34.5	7365.30-	2.59	5769.67-	2.84	70175.90	.68
35.0	7603.99-	2.94	5920.21-	3.22	72241.90	.75
35.5	7841.04-	2.42	6078.98-	2.66	74306.22	.61
36.0	8082.10-	2.40	6230.21-	2.64	76357.46	.59
36.5	8320.41-	3.21	6380.66-	3.51	78396.66	.78
37.0	8556.73-	3.88	6538.89-	4.25	80421.73	.92
37.5	8799.33-	2.72	6689.10-	2.99	82433.72	.63
38.0	9035.60-	3.37	6840.01-	3.70	84433.87	.78
38.5	9270.10-	2.99	6996.45-	3.29	86421.37	.68

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
39.0	9510.58-	3.56	7146.53-	3.91	88397.37	.79
39.5	9745.22-	3.81	7296.33-	4.18	90362.83	.84
40.0	9978.33-	4.84	7450.95-	5.31	92316.03	1.05
40.5	10216.37-	4.75	7600.94-	5.20	94258.98	1.02
41.0	10451.10-	3.68	7751.50-	4.04	96191.79	.78
41.5	10683.77-	3.87	7906.44-	4.25	98114.17	.81
42.0	10922.56-	3.29	8055.69-	3.61	100026.51	.68
42.5	11155.78-	4.71	8204.02-	5.17	101930.06	.97
43.0	11389.80-	3.69	8359.05-	4.05	103822.63	.75
43.5	11626.93-	3.05	8508.74-	3.35	105705.07	.61
44.0	11856.33-	4.49	8657.47-	4.92	107580.25	.89
44.5	12094.17-	4.84	8811.74-	5.31	109444.68	.96
45.0	12326.01-	5.04	8958.78-	5.53	111300.60	.99
45.5	12557.99-	4.82	9107.34-	5.28	113148.34	.94
46.0	12793.26-	5.69	9260.18-	6.24	114985.62	1.10
46.5	13027.72-	5.05	9410.87-	5.54	116813.70	.97
47.0	13262.28-	6.21	9556.42-	6.82	118634.25	1.19
47.5	13493.42-	6.20	9708.30-	6.80	120445.77	1.18
48.0	13725.66-	6.57	9858.96-	7.20	122248.78	1.24

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
48.5	13961.02-	5.33	10005.47-	5.85	124043.47	1.00
49.0	14192.38-	7.02	10158.25-	7.70	125829.45	1.31
49.5	14427.50-	6.64	10308.77-	7.28	127606.12	1.23
50.0	14661.46-	5.78	10453.37-	6.34	129374.78	1.06
50.5	14892.45-	6.61	10602.65-	7.25	131135.88	1.21
51.0	15122.79-	6.90	10755.32-	7.57	132887.37	1.26
51.5	15361.15-	6.96	10900.23-	7.63	134631.45	1.27
52.0	15589.44-	7.10	11050.59-	7.78	136367.45	1.29
52.5	15821.24-	7.75	11203.57-	8.49	138094.27	1.40
53.0	16058.32-	7.88	11345.31-	8.64	139812.96	1.42
53.5	16285.34-	7.16	11492.92-	7.85	141524.00	1.28
54.0	16513.94-	8.70	11644.39-	9.53	143225.99	1.56
54.5	16755.51-	8.59	11789.40-	9.42	144919.80	1.53
55.0	16982.09-	8.46	11937.36-	9.28	146606.55	1.51
55.5	17212.10-	7.45	12089.16-	8.17	148284.40	1.32
56.0	17448.59-	9.51	12236.79-	10.42	149953.69	1.68
56.5	17678.73-	8.28	12382.84-	9.08	151614.91	1.46
57.0	17906.34-	8.53	12533.93-	9.35	153268.18	1.50
57.5	18152.08-	10.98	12688.86-	12.03	154911.32	1.93

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
58.0	18376.07-	8.61	12825.45-	9.44	156549.00	1.51
58.5	18608.08-	8.08	12975.23-	8.86	158177.73	1.41
59.0	18840.11-	9.09	13129.61-	9.96	159797.92	1.59
59.5	19076.10-	9.15	13269.45-	10.02	161410.94	1.59
60.0	19306.16-	9.34	13415.47-	10.24	163015.10	1.63
60.5	19540.88-	8.06	13566.98-	8.84	164610.00	1.40
61.0	19769.89-	8.65	13711.69-	9.48	166198.35	1.50
61.5	20000.69-	10.32	13858.84-	11.31	167779.05	1.79
62.0	20232.58-	9.12	14008.23-	10.01	169350.33	1.58
62.5	20463.41-	11.78	14151.83-	12.91	170914.35	2.05
63.0	20692.30-	11.98	14303.03-	13.12	172469.93	2.08
63.5	20926.87-	9.99	14447.60-	10.95	174017.34	1.73
64.0	21159.09-	11.71	14594.06-	12.83	175556.26	2.02
64.5	21396.52-	11.67	14743.98-	12.78	177086.04	2.02
65.0	21627.67-	11.51	14888.95-	12.60	178610.10	1.98
65.5	21860.64-	11.51	15036.15-	12.60	180125.19	1.99
66.0	22094.68-	11.80	15182.44-	12.92	181631.95	2.04
66.5	22324.81-	12.87	15327.86-	14.08	183131.33	2.23
67.0	22559.33-	11.41	15471.86-	12.49	184622.02	1.97

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
67.5	22785.46-	12.35	15618.64-	13.52	186105.12	2.13
68.0	23017.46-	11.94	15771.16-	13.06	187578.73	2.06
68.5	23251.86-	12.30	15913.94-	13.46	189045.53	2.12
69.0	23484.10-	11.78	16053.85-	12.88	190504.78	2.03
69.5	23712.27-	10.99	16200.95-	12.03	191956.02	1.89
70.0	23949.64-	11.92	16356.26-	13.05	193397.07	2.06
70.5	24181.89-	11.40	16496.21-	12.48	194832.01	1.97
71.0	24411.00-	12.09	16643.82-	13.23	196258.59	2.09
71.5	24641.73-	11.72	16791.87-	12.83	197676.19	2.02
72.0	24876.10-	10.26	16936.78-	11.23	199086.78	1.77
72.5	25107.87-	10.96	17081.66-	12.00	200489.34	1.89
73.0	25341.20-	10.23	17224.50-	11.20	201883.59	1.76
73.5	25572.59-	11.73	17375.05-	12.85	203269.33	2.03
74.0	25807.52-	10.28	17518.32-	11.26	204647.55	1.78
74.5	26037.71-	10.92	17665.83-	11.96	206017.89	1.89
75.0	26273.67-	10.00	17809.29-	10.96	207380.08	1.73
75.5	26501.75-	12.34	17952.85-	13.51	208735.24	2.14
76.0	26741.48-	9.50	18102.58-	10.41	210078.15	1.65
76.5	26962.64-	8.68	18239.41-	9.50	211418.91	1.51

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
77.0	27195.21-	9.02	18387.77-	9.88	212749.78	1.57
77.5	27430.42-	12.22	18535.56-	13.38	214071.00	2.13
78.0	27660.76-	11.15	18676.00-	12.21	215384.31	1.94
78.5	27883.18-	10.58	18822.52-	11.59	216691.82	1.84
79.0	28118.44-	8.96	18970.36-	9.82	217990.48	1.56
79.5	28348.69-	11.68	19115.58-	12.78	219281.04	2.04
80.0	28585.14-	10.24	19260.23-	11.21	220561.34	1.79
80.5	28816.54-	12.56	19406.46-	13.74	221835.61	2.20
81.0	29051.64-	8.72	19548.48-	9.54	223101.37	1.53
81.5	29275.26-	11.82	19691.52-	12.93	224360.90	2.07
82.0	29510.43-	10.29	19836.14-	11.27	225610.24	1.81
82.5	29744.28-	13.43	19984.78-	14.70	226852.53	2.37
83.0	29976.72-	8.82	20123.11-	9.65	228087.53	1.55
83.5	30200.88-	11.53	20267.26-	12.62	229315.16	2.03
84.0	30436.48-	11.01	20411.90-	12.05	230533.13	1.94
84.5	30662.25-	12.93	20558.52-	14.18	231743.51	2.29
85.0	30904.47-	9.16	20696.85-	10.06	232945.58	1.62
85.5	31122.02-	10.09	20836.21-	11.10	234141.80	1.79
86.0	31354.81-	11.82	20983.41-	12.95	235327.94	2.09

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
86.5	31586.43-	12.84	21133.55-	14.07	236505.40	2.28
87.0	31823.70-	10.02	21269.65-	10.98	237676.05	1.78
87.5	32050.58-	9.92	21414.42-	10.84	238839.08	1.75
88.0	32278.77-	12.27	21558.74-	13.37	239995.04	2.18
88.5	32509.54-	9.87	21705.88-	10.76	241141.08	1.74
89.0	32749.05-	11.03	21846.84-	12.02	242279.40	1.96
89.5	32977.85-	2.84	22003.44-	3.10	243409.42	.48
90.0	33197.71-	11.83	22168.41-	12.91	244531.87	2.11
90.5	33432.42-	7.41	22302.57-	8.09	245647.25	1.30
91.0	33659.08-	11.47	22449.29-	12.53	246754.14	2.04
91.5	33892.72-	8.69	22592.14-	9.49	247852.22	1.54
92.0	34120.26-	9.60	22734.96-	10.49	248943.29	1.71
92.5	34348.04-	10.49	22878.83-	11.46	250026.92	1.88
93.0	34583.27-	11.43	23018.41-	12.45	251102.23	2.05
93.5	34812.35-	12.80	23163.37-	13.93	252169.95	2.30
94.0	35044.78-	10.52	23305.62-	11.43	253228.40	1.88
94.5	35271.98-	12.67	23447.55-	13.76	254280.51	2.28
95.0	35516.32-	12.24	23572.49-	13.29	255325.96	2.20
95.5	35769.51-	7.40	23704.48-	8.01	256360.92	1.31

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
96.0	36007.95-	9.71	23845.00-	10.51	257387.01	1.74
96.5	36233.99-	7.29	23980.80-	7.86	258406.45	1.29
97.0	36459.17-	7.13	24119.78-	7.70	259419.21	1.27
97.5	36687.17-	10.62	24265.85-	11.51	260423.56	1.93
98.0	36925.14-	6.94	24414.02-	7.49	261418.28	1.25
98.5	37156.07-	12.08	24557.12-	13.08	262405.35	2.20
99.0	37387.92-	9.58	24693.03-	10.35	263385.22	1.75
99.5	37611.85-	10.52	24831.80-	11.35	264358.66	1.92
100.0	37836.83-	12.72	24976.31-	13.76	265323.83	2.34
100.5	38070.00-	11.71	25120.35-	12.64	266280.23	2.15
101.0	38303.12-	13.04	25264.48-	14.11	267228.67	2.41
101.5	38541.37-	16.61	25411.95-	18.00	268168.14	3.09
102.0	38776.04-	15.16	25557.70-	16.41	269099.78	2.83
102.5	39006.48-	15.48	25696.55-	16.77	270024.64	2.89
103.0	39237.95-	14.70	25838.80-	15.89	270941.03	2.75
103.5	39464.18-	15.59	25977.39-	16.88	271851.25	2.93
104.0	39702.24-	13.46	26119.42-	14.56	272751.05	2.53
104.5	39928.36-	15.78	26261.46-	17.07	273643.94	2.98
105.0	40159.15-	15.63	26403.34-	16.92	274528.68	2.96

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
105.5	40391.98-	12.80	26542.34-	13.82	275406.05	2.41
106.0	40616.79-	15.62	26680.65-	16.94	276277.13	2.96
106.5	40850.37-	15.05	26822.49-	16.33	277138.27	2.86
107.0	41078.72-	15.64	26967.03-	16.97	277991.59	2.98
107.5	41311.67-	14.50	27091.91-	15.80	278839.06	2.77
108.0	41557.70-	13.98	27256.63-	15.24	279673.31	2.68
108.5	41788.66-	13.91	27438.97-	15.15	280500.58	2.66
109.0	42023.27-	10.67	27575.66-	11.60	281325.72	2.04
109.5	42248.68-	9.02	27715.88-	9.80	282142.00	1.71
110.0	42487.66-	7.98	27884.46-	8.65	282941.87	1.52
110.5	42705.19-	.64	28007.66-	.74	283742.11	.17
111.0	42925.68-	2.86	28149.64-	3.09	284535.00	.52
111.5	43157.12-	1.22	28288.50-	1.29	285318.53	.19
112.0	43384.90-	.95	28431.50-	.99	286093.55	.14
112.5	43617.66-	3.57	28606.37-	3.94	286853.70	.76
113.0	43837.32-	5.05	28722.67-	5.58	287615.23	1.06
113.5	44060.72-	3.97	28860.31-	4.38	288369.16	.85
114.0	44289.19-	4.67	29000.30-	5.14	289113.77	.99
114.5	44517.03-	3.20	29142.20-	3.54	289849.72	.69

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
115.0	44752.18-	3.98	29310.90-	4.39	290571.73	.85
115.5	44935.72-	11.86	29403.90-	12.96	291302.10	2.43
116.0	45141.11-	7.41	29535.06-	8.10	292017.39	1.54
116.5	45371.33-	2.13	29637.28-	2.31	292724.77	.38
117.0	45645.20-	21.88	29758.05-	23.95	293415.73	4.49
117.5	45876.29-	24.50	29895.31-	26.81	294102.49	5.04
118.0	46113.09-	22.73	30039.65-	24.86	294780.02	4.68
118.5	46332.62-	22.00	30171.78-	24.07	295453.79	4.55
119.0	46558.69-	21.76	30306.54-	23.83	296122.11	4.51
119.5	46788.38-	21.72	30449.59-	23.80	296777.68	4.52
120.0	47024.51-	21.48	30598.17-	23.53	297422.45	4.48
120.5	47244.47-	20.33	30728.28-	22.27	298065.11	4.26
121.0	47479.50-	19.09	30883.58-	20.91	298694.21	4.01
121.5	47704.39-	20.80	31006.76-	22.78	299315.32	4.38
122.0	47922.83-	19.78	31145.40-	21.64	299934.54	4.17
122.5	48168.26-	22.95	31284.89-	25.09	300544.34	4.85
123.0	48393.15-	21.83	31426.84-	23.90	301147.76	4.63
123.5	48624.69-	21.01	31563.35-	23.02	301746.73	4.47
124.0	48854.62-	21.63	31701.60-	23.67	302336.01	4.61

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
124.5	49080.33-	22.24	31844.27-	24.33	302914.95	4.74

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
1.0	21.13-	1.11	5.93-	1.20	450.31	2.50
1.5	53.16-	1.78	13.67-	1.91	775.57	2.73
2.0	94.16-	.87	19.85-	.94	1202.84	1.11
2.5	149.25-	.59	31.83-	.64	1704.01	.68
3.0	204.94-	.69	44.07-	.73	2221.04	.74
3.5	263.95-	.59	56.91-	.62	2750.55	.59
4.0	326.36-	.02	69.55-	.03	3291.21	.03
4.5	390.43-	.59	82.49-	.61	3843.41	.54
5.0	457.79-	.98	96.55-	1.02	4406.20	.89
5.5	527.77-	1.16	110.63-	1.22	4979.84	1.03
6.0	599.73-	1.70	125.42-	1.78	5565.58	1.47
6.5	674.27-	2.12	140.85-	2.21	6162.92	1.79
7.0	751.32-	2.34	156.83-	2.46	6772.02	1.94
7.5	828.60-	.72	170.89-	.75	7392.21	.58
8.0	909.98-	.31	186.56-	.33	8025.78	.24
8.5	994.65-	.13	203.39-	.14	8672.82	.10
9.0	1081.79-	.08	220.44-	.09	9333.47	.06
9.5	1171.60-	.08	238.09-	.08	10008.37	.05
10.0	1263.98-	.04	256.32-	.04	10697.62	.02

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
10.5	1358.05-	1.31	272.68-	1.38	11403.16	.93
11.0	1457.91-	2.23	290.47-	2.35	12123.33	1.55
11.5	1559.08-	1.71	311.56-	1.80	12858.20	1.17
12.0	1664.96-	1.72	332.34-	1.82	13609.76	1.15
12.5	1774.25-	1.71	353.73-	1.81	14377.72	1.12
13.0	1888.81-	2.53	377.14-	2.68	15162.63	1.62
13.5	2005.29-	1.99	398.77-	2.11	15964.35	1.24
14.0	2126.71-	1.94	421.32-	2.06	16783.65	1.18
14.5	2254.18-	2.14	444.04-	2.28	17620.90	1.28
15.0	2387.90-	1.04	469.14-	1.11	18475.40	.61
15.5	2526.62-	.68	493.17-	.73	19349.55	.39
16.0	2669.86-	1.09	516.20-	1.17	20243.93	.61
16.5	2818.21-	1.84	539.36-	1.96	21159.42	1.00
17.0	2972.89-	3.52	562.73-	3.77	22096.08	1.87
17.5	3130.76-	3.90	584.60-	4.18	23053.95	2.01
18.0	3293.98-	4.19	606.16-	4.49	24034.17	2.11
18.5	3463.18-	4.36	627.79-	4.69	25037.22	2.14
19.0	3638.01-	4.41	649.72-	4.74	26063.43	2.11
19.5	3820.62-	4.24	674.28-	4.56	27113.01	1.97

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
20.0	4010.47-	3.99	696.98-	4.30	28187.28	1.81
20.5	4206.91-	4.38	719.18-	4.72	29286.70	1.93
21.0	4409.05-	3.82	738.97-	4.12	30411.89	1.64
21.5	4620.05-	3.76	760.80-	4.07	31563.64	1.57
22.0	4840.05-	4.43	783.05-	4.79	32743.09	1.80
22.5	5071.96-	5.52	803.67-	5.98	33950.72	2.18
23.0	5310.33-	6.73	823.82-	7.29	35189.22	2.58
23.5	5554.33-	7.08	842.67-	7.67	36458.39	2.64
24.0	5803.82-	5.63	859.50-	6.11	37759.95	2.04
24.5	6064.52-	5.70	880.83-	6.19	39095.29	2.01
25.0	6332.00-	5.31	905.62-	5.77	40464.79	1.82
25.5	6609.66-	4.14	928.87-	4.50	41871.26	1.38
26.0	6896.45-	3.96	949.48-	4.30	43315.23	1.28
26.5	7191.89-	2.78	972.18-	3.03	44797.64	.88
27.0	7499.88-	3.28	994.41-	3.57	46320.77	1.00
27.5	7817.39-	3.60	1017.24-	3.92	47886.06	1.07
28.0	8141.09-	2.10	1039.89-	2.28	49494.30	.60
28.5	8477.78-	1.60	1063.59-	1.75	51147.37	.45
29.0	8826.05-	1.20	1088.23-	1.31	52847.22	.33

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
29.5	9189.32-	2.59	1109.70-	2.83	54595.54	.69
30.0	9558.60-	2.16	1133.11-	2.35	56394.49	.56
30.5	9939.94-	1.26	1158.11-	1.38	58245.38	.32
31.0	10332.88-	1.85	1182.87-	2.02	60150.85	.46
31.5	10740.35-	1.43	1209.94-	1.56	62112.19	.34
32.0	11158.00-	2.92	1237.44-	3.19	64128.01	.69
32.5	11588.33-	2.78	1266.12-	3.04	66193.19	.64
33.0	12025.66-	2.33	1295.72-	2.55	68283.15	.52
33.5	12461.43-	2.59	1324.87-	2.83	70364.21	.57
34.0	12897.26-	2.84	1356.19-	3.11	72430.43	.61
34.5	13329.98-	2.18	1384.71-	2.38	74481.72	.46
35.0	13762.99-	2.59	1415.56-	2.84	76517.71	.54
35.5	14194.52-	1.88	1445.59-	2.06	78539.35	.39
36.0	14624.75-	2.53	1474.79-	2.77	80547.07	.51
36.5	15055.14-	2.72	1505.24-	2.98	82541.17	.55
37.0	15482.69-	2.70	1534.80-	2.96	84522.48	.53
37.5	15909.99-	2.30	1563.29-	2.52	86491.56	.45
38.0	16336.93-	2.28	1592.26-	2.50	88448.30	.44
38.5	16763.05-	1.43	1623.07-	1.57	90393.29	.27

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
39.0	17188.67-	1.92	1650.25-	2.11	92326.69	.37
39.5	17614.54-	1.31	1678.89-	1.45	94247.85	.25
40.0	18038.48-	1.41	1705.89-	1.55	96158.49	.27
40.5	18464.57-	1.02	1734.70-	1.13	98057.91	.19
41.0	18891.63-	1.04	1762.09-	1.15	99946.85	.20
41.5	19315.73-	1.72	1790.71-	1.88	101825.54	.32
42.0	19744.17-	1.35	1818.04-	1.49	103693.66	.25
42.5	20168.97-	1.54	1847.67-	1.70	105551.73	.29
43.0	20595.76-	1.40	1875.33-	1.54	107399.69	.26
43.5	21020.86-	1.59	1900.66-	1.75	109238.72	.29
44.0	21447.05-	1.82	1929.10-	2.01	111068.17	.33
44.5	21872.85-	1.75	1957.94-	1.93	112887.90	.32
45.0	22298.98-	1.52	1984.79-	1.67	114699.42	.28
45.5	22724.64-	2.09	2009.91-	2.30	116500.48	.38
46.0	23151.32-	1.93	2037.52-	2.13	118292.77	.35
46.5	23579.03-	1.81	2062.47-	2.00	120076.43	.33
47.0	24005.17-	1.51	2087.36-	1.67	121851.36	.27
47.5	24431.35-	1.82	2111.26-	2.01	123617.76	.33
48.0	24857.46-	2.02	2137.80-	2.23	125375.30	.37

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
48.5	25282.35-	1.53	2160.70-	1.70	127124.31	.28
49.0	25707.47-	.97	2185.55-	1.08	128864.41	.17
49.5	26132.42-	2.52	2208.07-	2.77	130596.30	.46
50.0	26557.66-	1.36	2234.49-	1.51	132319.49	.25
50.5	26982.61-	.79	2256.03-	.88	134035.01	.15
51.0	27406.58-	.67	2279.79-	.76	135742.05	.12
51.5	27830.42-	.16	2301.44-	.19	137440.89	.03
52.0	28253.62-	1.55	2327.07-	1.72	139131.12	.28
52.5	28677.00-	.65	2349.04-	.73	140813.34	.12
53.0	29100.10-	1.73	2373.16-	1.92	142487.19	.32
53.5	29522.52-	1.93	2396.04-	2.14	144153.13	.35
54.0	29948.34-	1.51	2420.24-	1.68	145810.44	.28
54.5	30372.67-	2.85	2443.04-	3.15	147459.80	.52
55.0	30795.73-	1.33	2471.99-	1.48	149100.92	.25
55.5	31220.82-	1.75	2495.21-	1.95	150733.21	.33
56.0	31645.21-	2.90	2518.89-	3.21	152357.39	.54
56.5	32071.75-	2.16	2540.45-	2.40	153973.33	.40
57.0	32497.82-	4.00	2564.43-	4.41	155580.96	.75
57.5	32921.49-	3.94	2584.09-	4.34	157181.44	.74

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
58.0	33345.38-	4.74	2607.55-	5.22	158773.46	.89
58.5	33771.58-	4.92	2626.76-	5.42	160357.50	.93
59.0	34187.08-	3.75	2652.20-	4.14	161934.14	.71
59.5	34611.66-	4.03	2672.02-	4.44	163501.89	.76
60.0	35030.92-	3.25	2692.70-	3.59	165062.31	.62
60.5	35454.41-	4.51	2716.57-	4.97	166613.57	.86
61.0	35880.18-	2.97	2737.01-	3.28	168156.85	.57
61.5	36300.81-	2.33	2759.05-	2.59	169692.78	.45
62.0	36723.00-	3.31	2782.46-	3.66	171220.40	.63.
62.5	37145.78-	2.86	2802.63-	3.17	172739.95	.55
63.0	37569.29-	2.89	2826.04-	3.20	174250.82	.56
63.5	37992.12-	1.80	2846.41-	2.00	175754.06	.35
64.0	38413.16-	1.98	2867.01-	2.21	177249.54	.38
64.5	38837.62-	1.52	2888.83-	1.70	178736.47	.30
65.0	39257.59-	2.57	2911.39-	2.86	180216.05	.50
65.5	39678.21-	3.36	2932.26-	3.72	181687.57	.66
66.0	40101.77-	3.37	2952.89-	3.73	183150.57	.66
66.5	40522.21-	4.44	2975.51-	4.91	184605.93	.87
67.0	40945.61-	4.13	2995.50-	4.56	186052.77	.81

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
67.5	41365.44-	6.02	3015.61-	6.64	187492.18	1.19
68.0	41787.61-	6.02	3034.79-	6.63	188923.18	1.20
68.5	42210.07-	6.37	3056.60-	7.02	190346.24	1.27
69.0	42630.37-	6.65	3077.63-	7.31	191761.50	1.33
69.5	43052.24-	5.99	3097.26-	6.60	193168.69	1.20
70.0	43474.02-	6.67	3118.65-	7.34	194567.85	1.34
70.5	43893.33-	6.53	3136.99-	7.19	195959.46	1.31
71.0	44317.34-	6.18	3158.78-	6.82	197341.61	1.25
71.5	44737.80-	7.30	3178.06-	8.04	198716.63	1.48
72.0	45159.98-	6.45	3197.63-	7.11	200083.49	1.31
72.5	45583.03-	6.32	3217.71-	6.97	201442.00	1.29
73.0	46003.60-	7.54	3238.62-	8.30	202793.25	1.54
73.5	46425.73-	6.26	3255.72-	6.90	204136.55	1.28
74.0	46848.12-	7.05	3276.44-	7.77	205471.66	1.45
74.5	47278.46-	5.20	3296.93-	5.73	206796.81	1.07
75.0	47695.19-	6.97	3317.03-	7.67	208115.85	1.44
75.5	48115.30-	6.01	3336.17-	6.63	209426.57	1.25
76.0	48533.21-	6.51	3354.05-	7.18	210729.97	1.35
76.5	48959.38-	5.34	3374.39-	5.89	212024.14	1.11

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
77.0	49380.64-	6.15	3395.70-	6.78	213310.61	1.28
77.5	49804.12-	5.00	3414.25-	5.52	214589.49	1.05
78.0	50224.78-	5.63	3433.71-	6.21	215860.98	1.18
78.5	50648.06-	4.76	3454.40-	5.26	217123.75	1.01
79.0	51068.52-	6.12	3474.08-	6.74	218378.81	1.29
79.5	51492.37-	8.61	3492.28-	9.47	219626.27	1.83
80.0	51914.10-	8.85	3508.99-	9.73	220865.37	1.88
80.5	52334.67-	8.29	3528.49-	9.12	222096.46	1.77
81.0	52754.08-	10.40	3548.94-	11.44	223319.62	2.23
81.5	53176.26-	8.14	3562.86-	8.96	224535.01	1.75
82.0	53596.08-	10.99	3583.69-	12.08	225742.22	2.37
82.5	54015.67-	9.49	3601.85-	10.43	226941.71	2.05
83.0	54436.23-	12.13	3622.44-	13.33	228133.18	2.63
83.5	54858.64-	10.33	3637.85-	11.36	229316.58	2.24
84.0	55278.87-	12.25	3656.03-	13.49	230491.67	2.67
84.5	55700.23-	11.19	3676.13-	12.34	231658.57	2.45
85.0	56124.87-	10.66	3692.35-	11.76	232816.94	2.33
85.5	56543.16-	10.34	3711.60-	11.40	233968.45	2.27
86.0	56960.22-	13.84	3728.46-	15.25	235112.32	3.05

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
86.5	57381.76-	11.77	3748.73-	12.98	236247.59	2.60
87.0	57804.21-	11.33	3763.17-	12.52	237374.85	2.51
87.5	58224.32-	9.39	3779.24-	10.36	238494.79	2.08
88.0	58643.41-	10.45	3798.04-	11.52	239606.82	2.33
88.5	59067.29-	10.55	3817.12-	11.65	240710.14	2.36
89.0	59484.04-	13.60	3820.05-	14.95	241806.66	3.04
89.5	59901.12-	13.47	3845.63-	14.82	242895.09	3.02
90.0	60320.17-	13.22	3863.93-	14.55	243974.95	2.98
90.5	60739.08-	17.29	3885.92-	19.02	245046.59	3.91
91.0	61159.83-	12.66	3895.36-	13.95	246110.82	2.87
91.5	61578.99-	13.03	3915.57-	14.36	247166.67	2.96
92.0	61995.69-	12.45	3927.36-	13.72	248215.79	2.84
92.5	62414.37-	12.78	3944.31-	14.09	249256.16	2.92
93.0	62834.16-	9.90	3958.16-	10.95	250288.78	2.27
93.5	63252.99-	10.59	3975.32-	11.70	251313.67	2.43
94.0	63672.67-	11.84	3996.13-	13.09	252330.11	2.73
94.5	64095.25-	9.09	4009.07-	10.07	253339.31	2.10
95.0	64503.74-	14.19	4017.76-	15.66	254343.61	3.29
95.5	64921.95-	13.28	4036.17-	14.67	255336.14	3.09

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
96.0	65338.78-	15.16	4050.97-	16.70	256321.48	3.54
96.5	65760.84-	15.25	4070.86-	16.78	257297.32	3.57
97.0	66183.64-	11.91	4083.71-	13.13	258265.42	2.80
97.5	66599.62-	15.56	4103.23-	17.13	259226.95	3.67
98.0	67020.94-	13.93	4116.74-	15.32	260179.87	3.29
98.5	67441.57-	15.03	4137.17-	16.51	261124.65	3.56
99.0	67861.40-	18.33	4149.91-	20.12	262062.12	4.35
99.5	68279.02-	14.64	4168.02-	16.08	262991.82	3.49
100.0	68698.63-	15.32	4182.52-	16.82	263913.43	3.66
100.5	69124.63-	4.85	4186.52-	5.37	264827.32	1.16
101.0	69540.22-	2.75	4191.29-	3.08	265735.09	.66
101.5	69957.89-	18.02	4235.28-	19.84	266628.55	4.35
102.0	70379.46-	14.58	4247.88-	16.07	267517.60	3.53
102.5	70795.61-	18.83	4261.23-	20.72	268399.65	4.58
103.0	71217.10-	15.84	4275.56-	17.47	269272.98	3.86
103.5	71635.46-	16.75	4293.10-	18.48	270138.84	4.10
104.0	72051.72-	15.69	4309.09-	17.34	270997.52	3.85
104.5	72468.49-	17.09	4320.92-	18.89	271848.34	4.20
105.0	72887.71-	14.66	4337.62-	16.19	272690.44	3.62

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
105.5	73302.62-	15.21	4350.80-	16.80	273526.05	3.76
106.0	73721.97-	13.48	4366.77-	14.90	274352.38	3.34
106.5	74136.92-	15.36	4382.06-	16.94	275172.10	3.82
107.0	74557.32-	14.85	4396.42-	16.39	275982.67	3.70
107.5	74985.03-	20.60	4410.44-	22.63	276782.68	5.15
108.0	75403.76-	19.13	4443.94-	21.06	277576.47	4.80
108.5	75823.63-	18.21	4459.29-	20.05	278362.27	4.59
109.0	76238.68-	20.38	4473.56-	22.40	279141.53	5.15
109.5	76656.24-	20.47	4488.05-	22.47	279912.52	5.18
110.0	77073.76-	20.05	4503.96-	22.03	280675.51	5.09
110.5	77493.29-	21.59	4522.74-	23.70	281430.14	5.52
111.0	77908.68-	21.22	4533.92-	23.32	282178.15	5.44
111.5	78327.17-	20.15	4545.20-	22.14	282917.72	5.18
112.0	78744.35-	21.09	4563.73-	23.16	283649.12	5.44
112.5	79160.80-	23.00	4579.44-	25.27	284373.30	5.95
113.0	79579.64-	21.68	4591.08-	23.83	285089.08	5.62
113.5	79999.07-	22.25	4604.61-	24.45	285797.25	5.79
114.0	80416.25-	23.71	4618.81-	26.05	286497.72	6.19
114.5	80836.01-	23.77	4636.17-	26.11	287189.79	6.22

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
115.0	81253.48-	23.49	4648.88-	25.82	287874.02	6.16
115.5	81664.42-	24.78	4662.79-	27.23	288551.46	6.53
116.0	82079.52-	24.01	4677.60-	26.35	289219.85	6.34
116.5	82497.18-	21.61	4691.01-	23.75	289879.93	5.72
117.0	82912.97-	21.83	4702.97-	23.99	290533.31	5.80
117.5	83329.58-	22.74	4717.38-	24.99	291177.87	6.06
118.0	83743.44-	22.58	4727.11-	24.84	291815.59	6.04
118.5	84162.03-	21.90	4744.12-	24.10	292443.92	5.87
119.0	84579.73-	22.24	4756.60-	24.46	293064.92	5.98
119.5	84993.81-	21.14	4765.93-	23.27	293679.01	5.70
120.0	85408.72-	7.92	4775.45-	8.80	294286.52	2.14
120.5	85826.16-	10.23	4788.96-	11.36	294884.07	2.78
121.0	86243.30-	9.39	4802.31-	10.44	295474.19	2.55
121.5	86658.28-	9.07	4815.50-	10.10	296057.18	2.47
122.0	87076.52-	8.93	4831.70-	9.93	296631.37	2.44
122.5	87489.43-	4.01	4857.51-	4.55	297198.95	1.10
123.0	87902.45-	4.92	4885.46-	5.55	297758.17	1.35
123.5	88320.81-	10.49	4905.50-	11.64	298308.28	2.90
124.0	88736.78-	14.49	4926.74-	16.01	298851.03	4.02

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
124.5	89154.45-	18.78	4949.99-	20.69	299385.31	5.23

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
1.0	12.41-	3.62	2.19	4.05	347.24	10.76
1.5	20.77-	5.56	2.99-	6.11	599.57	10.44
2.0	29.60-	8.64	15.82-	9.32	942.70	12.75
2.5	46.82-	6.92	22.54-	7.37	1378.40	8.76
3.0	64.00-	5.07	29.75-	5.36	1833.96	5.89
3.5	83.27-	4.98	40.03-	5.24	2303.12	5.46
4.0	104.68-	5.04	51.98-	5.28	2786.42	5.30
4.5	127.52-	4.33	63.81-	4.53	3285.08	4.40
5.0	152.44-	1.45	67.84-	1.52	3799.52	1.43
5.5	180.91-	1.93	80.17-	2.01	4322.67	1.84
6.0	208.84-	1.01	91.31-	1.05	4856.86	.95
6.5	236.72-	.05	103.69-	.05	5401.78	.05
7.0	265.05-	.61	116.89-	.64	5956.08	.55
7.5	293.68-	1.26	130.84-	1.31	6520.49	1.10
8.0	322.45-	1.64	145.53-	1.70	7094.50	1.40
8.5	351.44-	1.59	160.22-	1.66	7678.33	1.34
9.0	381.69-	1.53	175.77-	1.59	8272.55	1.27
9.5	412.76-	1.47	191.29-	1.53	8877.14	1.19
10.0	444.94-	1.53	207.34-	1.59	9492.89	1.22

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
10.5	478.02-	1.45	223.59-	1.51	10119.77	1.13
11.0	512.12-	1.52	239.30-	1.58	10757.93	1.16
11.5	546.30-	1.64	255.76-	1.72	11408.02	1.24
12.0	582.48-	1.89	272.80-	1.98	12070.09	1.40
12.5	620.94-	2.07	289.60-	2.17	12744.48	1.50
13.0	660.25-	2.48	306.12-	2.60	13432.15	1.77
13.5	700.45-	2.64	323.05-	2.77	14132.34	1.84
14.0	741.57-	2.59	340.73-	2.72	14845.79	1.77
14.5	783.72-	2.86	358.41-	3.00	15573.03	1.91
15.0	826.76-	3.18	377.29-	3.34	16314.21	2.09
15.5	872.10-	3.58	395.65-	3.77	17069.72	2.30
16.0	918.77-	4.10	413.89-	4.32	17840.23	2.59
16.5	966.63-	4.46	432.62-	4.70	18624.89	2.75
17.0	1016.06-	4.75	451.87-	5.00	19425.32	2.87
17.5	1066.97-	5.27	470.81-	5.56	20241.20	3.12
18.0	1120.65-	5.69	489.79-	6.01	21073.06	3.29
18.5	1176.75-	6.05	508.30-	6.40	21921.22	3.42
19.0	1234.51-	6.33	527.47-	6.69	22786.47	3.50
19.5	1294.51-	6.54	547.11-	6.92	23668.63	3.54

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
20.0	1356.51-	6.63	566.84-	7.03	24568.22	3.51
20.5	1424.02-	5.44	588.78-	5.77	25484.86	2.82
21.0	1492.94-	5.88	606.97-	6.23	26421.23	2.97
21.5	1562.26-	5.72	622.47-	6.08	27376.81	2.82
22.0	1636.30-	6.74	640.38-	7.16	28352.20	3.25
22.5	1716.69-	6.16	660.73-	6.55	29346.58	2.90
23.0	1799.47-	6.28	679.11-	6.68	30362.19	2.88
23.5	1879.79-	4.63	690.19-	4.93	31398.73	2.08
24.0	1967.43-	5.97	705.21-	6.36	32457.81	2.61
24.5	2058.79-	7.63	720.35-	8.14	33538.70	3.25
25.0	2156.11-	8.18	737.96-	8.73	34642.69	3.40
25.5	2256.05-	7.57	754.43-	8.08	35770.70	3.07
26.0	2356.45-	6.43	768.00-	6.87	36923.19	2.54
26.5	2461.87-	7.37	782.30-	7.89	38101.51	2.84
27.0	2572.87-	6.75	797.77-	7.22	39306.07	2.53
27.5	2683.74-	6.59	809.13-	7.06	40538.41	2.40
28.0	2796.78-	5.50	822.42-	5.90	41798.88	1.96
28.5	2913.75-	5.95	837.70-	6.38	43088.41	2.06
29.0	3035.80-	5.56	855.72-	5.97	44407.41	1.87

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
29.5	3166.17-	7.66	869.23-	8.22	45757.87	2.51
30.0	3295.77-	5.91	886.11-	6.35	47138.78	1.89
30.5	3428.75-	5.29	903.25-	5.69	48551.57	1.64
31.0	3571.97-	7.34	913.55-	7.89	49999.30	2.22
31.5	3713.58-	6.16	927.49-	6.63	51480.61	1.81
32.0	3853.54-	4.88	941.62-	5.26	52997.22	1.40
32.5	3999.02-	5.79	960.28-	6.23	54550.01	1.61
33.0	4148.86-	5.62	984.01-	6.06	56139.42	1.52
33.5	4305.80-	5.57	1008.24-	6.01	57767.17	1.47
34.0	4471.90-	6.59	1031.66-	7.12	59434.42	1.69
34.5	4639.73-	4.65	1054.62-	5.03	61140.95	1.16
35.0	4812.44-	5.27	1078.34-	5.70	62888.94	1.28
35.5	4993.77-	6.01	1095.28-	6.50	64680.85	1.42
36.0	5171.33-	6.90	1112.05-	7.46	66517.03	1.59
36.5	5348.72-	5.55	1131.48-	6.00	68398.61	1.24
37.0	5529.35-	5.73	1155.25-	6.20	70327.42	1.25
37.5	5715.01-	4.89	1185.86-	5.29	72304.52	1.03
38.0	5910.67-	6.30	1220.78-	6.82	74330.94	1.30
38.5	6116.79-	6.48	1253.28-	7.03	76408.39	1.30

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
39.0	6326.24-	5.36	1286.72-	5.81	78537.00	1.05
39.5	6542.33-	5.73	1320.12-	6.22	80720.20	1.09
40.0	6762.65-	5.38	1346.67-	5.84	82959.19	.99
40.5	6980.42-	4.90	1368.63-	5.32	85254.57	.88
41.0	7195.95-	3.94	1398.23-	4.28	87604.87	.69
41.5	7412.44-	3.96	1437.01-	4.31	90004.71	.68
42.0	7631.62-	3.79	1479.02-	4.11	92439.18	.63
42.5	7856.78-	4.28	1526.86-	4.65	94889.33	.70
43.0	8081.85-	4.78	1572.80-	5.19	97352.03	.76
43.5	8310.00-	5.17	1620.40-	5.62	99818.32	.81
44.0	8543.32-	5.15	1668.16-	5.60	102277.55	.78
44.5	8772.28-	5.48	1712.38-	5.95	104727.52	.81
45.0	9004.68-	4.85	1759.89-	5.27	107169.07	.71
45.5	9230.31-	4.99	1799.91-	5.43	109603.44	.71
46.0	9457.92-	5.61	1843.91-	6.10	112029.02	.79
46.5	9686.47-	4.03	1889.14-	4.38	114445.20	.56
47.0	9911.78-	3.75	1936.21-	4.08	116852.34	.51
47.5	10137.14-	4.20	1979.64-	4.57	119251.53	.56
48.0	10362.23-	5.22	2027.74-	5.68	121641.96	.68
48.5	10591.92-	6.75	2073.99-	7.35	124024.64	.87

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
49.0	10820.93-	5.99	2120.34-	6.52	126398.49	.76
49.5	11045.67-	5.38	2163.72-	5.85	128763.23	.67
50.0	11271.30-	5.13	2205.83-	5.58	131120.31	.63
50.5	11498.91-	6.64	2248.72-	7.22	133469.51	.81
51.0	11730.44-	6.52	2297.44-	7.10	135809.81	.79
51.5	11955.88-	6.59	2339.92-	7.18	138142.59	.79
52.0	12178.93-	4.90	2381.02-	5.33	140466.15	.58
52.5	12406.83-	4.23	2427.83-	4.61	142782.19	.49
53.0	12634.35-	8.36	2474.25-	9.10	145089.54	.97
53.5	12859.99-	7.48	2517.09-	8.14	147389.45	.85
54.0	13090.31-	4.63	2563.66-	5.04	149680.23	.52
54.5	13314.36-	6.32	2602.58-	6.88	151963.37	.71
55.0	13541.06-	7.34	2642.86-	7.99	154238.38	.82
55.5	13767.58-	8.60	2688.31-	9.36	156504.90	.95
56.0	13992.92-	5.11	2732.52-	5.56	158763.36	.56
56.5	14220.33-	5.45	2776.34-	5.93	161014.21	.59
57.0	14444.75-	7.31	2818.70-	7.96	163256.99	.79
57.5	14674.64-	8.30	2870.23-	9.04	165490.32	.89
58.0	14898.13-	4.87	2908.63-	5.31	167716.67	.52

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TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
58.5	15124.16-	4.05	2948.80-	4.40	169935.12	.43
59.0	15351.70-	7.17	2997.18-	7.81	172145.09	.75
59.5	15578.97-	5.42	3040.28-	5.89	174347.23	.56
60.0	15807.36-	2.22	3082.45-	2.41	176540.33	.23
60.5	16025.78-	5.05	3127.37-	5.50	178725.79	.52
61.0	16257.89-	6.18	3169.44-	6.73	180903.31	.63
61.5	16486.13-	6.74	3211.75-	7.34	183072.94	.69
62.0	16712.41-	4.69	3251.40-	5.11	185234.35	.48
62.5	16936.59-	6.50	3291.92-	7.08	187387.46	.65
63.0	17161.57-	8.37	3331.22-	9.12	189532.98	.84
63.5	17392.67-	6.28	3377.18-	6.83	191669.88	.63
64.0	17617.42-	3.04	3412.66-	3.30	193799.33	.30
64.5	17844.49-	5.43	3455.23-	5.91	195920.42	.54
65.0	18063.38-	7.10	3496.51-	7.73	198034.33	.70
65.5	18296.66-	4.64	3536.98-	5.05	200139.40	.46
66.0	18522.17-	4.94	3573.18-	5.37	202236.53	.48
66.5	18746.89-	3.78	3619.22-	4.11	204324.91	.37
67.0	18967.83-	8.09	3657.83-	8.81	206406.61	.79
67.5	19199.14-	4.58	3699.03-	4.99	208479.79	.44

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
68.0	19426.19-	4.58	3742.41-	4.99	210544.78	.44
68.5	19646.08-	2.88	3786.56-	3.14	212600.97	.28
69.0	19870.11-	4.43	3824.35-	4.83	214650.28	.43
69.5	20102.69-	6.19	3869.08-	6.75	216690.96	.60
70.0	20332.58-	3.57	3908.39-	3.89	218723.97	.35
70.5	20554.39-	6.07	3947.11-	6.62	220749.29	.58
71.0	20779.29-	6.83	3987.30-	7.44	222766.63	.66
71.5	21001.39-	7.60	4030.28-	8.28	224775.33	.72
72.0	21231.13-	8.46	4074.66-	9.23	226775.90	.81
72.5	21460.86-	4.81	4114.50-	5.24	228768.30	.46
73.0	21684.50-	6.08	4148.07-	6.63	230753.16	.58
73.5	21905.38-	8.75	4189.73-	9.54	232730.09	.84
74.0	22130.78-	9.96	4234.62-	10.87	234701.04	.95
74.5	22370.67-	11.69	4256.54-	12.76	236660.66	1.12
75.0	22595.39-	13.22	4297.10-	14.40	238613.90	1.26
75.5	22816.23-	16.54	4341.32-	18.03	240559.43	1.58
76.0	23043.08-	16.89	4376.78-	18.40	242496.17	1.61
76.5	23268.08-	15.00	4410.54-	16.36	244426.08	1.43
77.0	23494.82-	12.20	4456.40-	13.29	246346.99	1.16

SM 2.10

16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
77.5	23719.31-	12.22	4501.69-	13.36	248259.49	1.17
78.0	23982.90-	12.64	4514.12-	13.71	250166.03	1.21
78.5	24216.11-	14.04	4549.86-	15.24	252062.13	1.34
79.0	24435.37-	13.15	4588.17-	14.27	253950.82	1.26
79.5	24659.14-	14.79	4627.71-	16.09	255831.93	1.42
80.0	24885.31-	12.65	4668.26-	13.77	257704.84	1.21
80.5	25111.36-	14.57	4704.51-	15.89	259570.63	1.40
81.0	25354.09-	13.46	4717.54-	14.71	261428.71	1.29
81.5	25576.47-	16.25	4737.67-	17.74	263279.31	1.55
82.0	25798.57-	11.06	4784.63-	12.04	265119.72	1.06
82.5	26029.33-	13.43	4817.22-	14.64	266952.46	1.29
83.0	26256.90-	13.01	4851.37-	14.19	268777.65	1.25
83.5	26480.48-	13.67	4892.11-	14.95	270594.12	1.32
84.0	26700.53-	13.09	4930.14-	14.35	272403.71	1.26
84.5	26925.94-	19.22	4959.17-	21.07	274205.44	1.85
85.0	27145.10-	17.14	4992.52-	18.82	275998.86	1.65
85.5	27367.55-	18.35	5026.70-	20.13	277784.56	1.77
86.0	27593.64-	16.61	5065.70-	18.25	279560.93	1.60
86.5	27819.18-	15.67	5113.06-	17.23	281329.89	1.52

TIME	X(N)	SIG X	Y(W)	SIG Y	Z(MSL)	SIG Z
87.0	28046.63-	18.09	5141.90-	19.83	283092.13	1.75
87.5	28275.61-	13.31	5185.54-	14.63	284844.16	1.29
88.0	28502.55-	23.87	5216.82-	26.14	286589.59	2.31
88.5	28721.18-	15.40	5257.30-	16.92	288328.07	1.49
89.0	28944.09-	17.24	5294.96-	18.96	290058.62	1.67
89.5	29169.81-	12.90	5334.16-	14.26	291780.17	1.26
90.0	29397.04-	13.98	5372.43-	15.39	293491.07	1.36
90.5	29624.89-	19.53	5409.27-	21.44	295195.95	1.90
91.0	29842.26-	14.82	5434.61-	16.32	296895.52	1.45
91.5	30056.46-	26.62	5472.20-	29.21	298586.73	2.59
92.0	30263.62-	25.27	5504.45-	27.75	300271.58	2.47
92.5	30490.75-	21.08	5511.62-	23.18	301946.71	2.06
93.0	30729.12-	17.29	5533.87-	19.10	303615.10	1.69
93.5	30955.72-	15.58	5564.50-	17.26	305272.49	1.53
94.0	31166.66-	9.70	5582.64-	10.86	306925.22	.96
94.5	31392.94-	19.59	5619.30-	21.65	308568.80	1.92
95.0	31612.03-	7.07	5667.86-	8.01	310203.57	.70

APPENDIX B

ROCKET POSITIONS ABOVE THE MICROPHONE ARRAY AT THE TIMES OF GRENADE EXPLOSIONS

Position data without standard deviations on SM 1.04 are three-station data.

SM 1.01 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
41.7440	25332.78	6.69	7103.35	7.29	82607.41	1.14
3.4600	2455.05-	4.23	1110.86	4.61	10489.17	.74
45.2040	22877.73	2.46	8214.21	2.68	93096.58	.41
3.4590	2426.95-	.38	1104.08	.42	9992.03	.08
48.6630	20450.78	2.85	9318.29	3.10	103088.61	.47
3.5250	2454.30-	1.75	1116.51	1.91	9720.50	.29
52.1880	17996.48	1.09	10434.79	1.18	112809.10	.18
3.4620	2412.56-	1.87	1089.60	2.05	9117.35	.32
55.6500	15583.92	2.97	115243.90	3.23	121926.45	.49
3.4300	2368.65-	1.99	1076.61	2.18	8626.68	.33
59.0800	13215.27	.98	12601.00	1.05	305531.30	.16
3.4800	2398.69-	1.12	1093.70	1.22	8348.99	.19
62.5600	10816.58	.14	13694.69	.17	138902.12	.03
6.9670	4793.70-	3.18	2188.06	3.48	15521.14	.60
69.5270	6022.87	3.32	15882.75	3.64	154423.26	.63
3.4180	2349.36-	1.22	1080.05	1.33	7037.67	.21
72.9450	3673.51	2.11	16962.80	2.32	161460.93	.41
3.5170	2407.02-	1.28	1105.51	1.38	6847.48	.26
76.4620	1266.49	3.38	18068.31	3.70	168308.40	.68
3.4930	2391.66-	.60	1100.41	.64	6403.07	.10

SM 1.01 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
79.9550	1125.17-	2.78	19168.72	3.05	174711.47	.58
3.4160	2335.87-	.84	1079.42	.91	5880.60	.16
83.3710	3461.04-	1.95	20248.14	2.14	180592.07	.42
3.5020	2385.91-	1.02	1098.92	1.11	5636.82	.23
86.8730	5846.95-	2.96	21347.05	3.25	186228.89	.64
3.5000	2385.62-	.87	1108.41	.95	5237.76	.17
90.3730	8232.57-	2.09	22455.46	2.30	191466.65	.47
3.4640	2352.81-	1.32	1084.73	1.44	4793.72	.29
93.8370	10585.38-	.77	23540.19	.86	196260.37	.18
3.5130	2375.56-	3.09	1102.62	3.38	4467.37	.73
97.3500	12960.94-	3.85	24642.81	4.24	200727.74	.91

SM 1.02

16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
39.0358	34678.56	5.00	5888.48	5.41	85947.95	.73
2.9940	1086.87-	2.52	741.54	2.72	11357.47	.24
42.0298	33591.69	7.52	6630.02	8.13	97305.42	.96
3.1233	1122.23-	.47	767.50	.52	11425.67	.11
45.1531	32469.47	7.98	7397.51	8.64	108731.09	.90
3.2635	1160.00-	.38	801.58	.41	11526.59	.15
48.4166	31309.47	7.60	8199.09	8.24	120257.68	.78
3.3176	1174.44-	.04	815.50	.05	11319.44	.10
51.7342	30135.04	7.63	9014.59	8.27	131577.12	.72
3.5118	1241.36-	1.01	866.48	1.09	11563.88	.10
55.2460	28893.68	8.64	9881.07	9.36	143140.99	.77
3.5892	1265.36-	1.12	885.96	1.21	11389.81	.15
58.8352	27628.32	7.52	10767.02	8.14	154530.80	.65
3.6055	1271.77-	1.39	893.15	1.51	11011.69	.15
62.4407	26356.55	6.13	11660.18	6.64	165542.49	.51
3.8255	1340.32-	1.54	953.08	1.67	11219.30	.13
66.2662	25016.23	7.67	12613.25	8.30	176761.78	.64
4.0283	1413.36-	2.34	1001.33	2.53	11302.20	.21
70.2945	23602.87	10.01	13614.58	10.83	188063.98	.83

SM 1.02 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
4.2282	1483.25-	2.69	1061.75	2.93	11299.14	.23
74.5227	22119.62	7.31	14676.34	7.90	199363.12	.61
4.5029	1580.39-	.75	1121.17	.82	11402.59	.07
79.0256	20539.24	6.57	15797.51	7.08	210765.71	.56
4.7047	1651.85-	5.59	1181.39	6.08	11219.17	.51
83.7303	18887.39	12.16	16978.90	13.16	221984.88	1.06
10.6082	3706.31-	3.76	2692.95	4.11	22698.51	.30
94.3385	15181.08	8.40	19671.84	9.05	244683.38	.79
6.0382	2112.07-	7.18	1516.04	7.71	11318.68	.73
100.3767	13069.02	15.58	21187.88	16.77	256002.06	1.52
6.8806	2411.70-	5.40	1762.46	5.95	11483.22	.49
107.2573	10657.31	10.18	22950.34	10.82	267485.28	1.03
7.7813	2723.43-	16.97	1960.67	18.39	11179.80	1.91
115.0386	7933.88	27.15	24911.01	29.20	278665.08	2.93

SM 1.03

16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
38.3680	29800.02	3.59	4803.21-	3.94	85097.19	.82
3.0093	2304.27-	.04	800.72-	.04	10994.25	.10
41.3773	27495.76	3.60	5603.93-	3.94	96091.43	.78
3.0562	2317.98-	1.07	787.58-	1.16	10752.49	.26
44.4335	25177.78	2.52	6391.51-	2.78	106843.92	.53
3.3038	2491.00-	.45	843.56-	.49	11204.59	.10
47.7373	22686.78	2.98	7235.07-	3.27	118048.51	.62
3.2644	2456.68-	3.31	825.03-	3.64	10674.87	.69
51.0017	20230.11	.34	8060.10-	.37	128723.38	.08
3.4649	2594.44-	1.06	864.16-	1.16	10921.19	.22
54.4666	17635.67	1.40	8924.25-	1.53	139644.57	.30
3.5789	2676.81-	1.15	891.35-	1.26	10854.21	.24
58.0455	14958.86	.25	9815.60-	.27	150498.77	.06
3.5991	2679.33-	.48	882.95-	.52	10487.56	.10
61.6446	12279.53	.23	10698.56-	.25	160986.33	.04
7.7959	5808.52-	.90	1894.22-	.99	21265.91	.20
69.4405	6471.01	1.13	12592.78-	1.24	182252.23	.24
4.2802	3182.31-	.78	1034.13-	.85	10840.16	.18
73.7207	3288.71	1.92	13626.91-	2.10	193092.39	.42

SM 1.03 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
4.4113	3282.21-	.67	1063.79-	.75	10555.22	.16
78.1320	6.50	2.59	14690.70-	2.84	203647.61	.58
4.5936	3412.49-	.35	1091.62-	.37	10331.54	.10
82.7256	3405.99-	2.93	15782.31-	3.21	213979.15	.67
5.1010	3760.04-	2.34	1203.49-	2.56	10681.52	.58
87.8266	7186.03-	5.27	16985.80-	5.78	224660.67	1.25
5.4747	4054.67-	.06	1275.09-	.07	10542.73	.06
93.3013	11240.69-	5.31	18260.89-	5.83	235203.40	1.30
5.9994	4448.64-	.26	1403.19-	.33	10448.63	.12
99.3007	15689.33-	5.57	19664.08-	6.16	245652.03	1.42
6.6608	4931.13-	1.67	1526.48-	1.87	10267.17	.40
105.9615	20620.46-	3.91	21190.56-	4.29	255919.19	1.02
7.8217	5768.40-	1.54	1760.20-	1.71	10265.16	.38
113.7832	26388.86-	2.36	22950.75-	2.58	266184.35	.64
9.4713	6996.81-	2.54	2140.78-	2.77	9832.83	.82
123.2545	33385.67-	4.90	25091.53-	5.34	276017.18	1.46

SM 1.04

16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
41.6866	18742.33	3.50	7804.59-	3.88	90819.86	1.05
3.1003	2760.97-	.33	995.39-	.37	8839.55	.12
44.7869	15981.36	3.83	8799.98-	4.24	99659.41	1.15
3.2374	2860.31-	2.38	1021.91-	2.63	8821.86	.72
48.0243	13121.05	6.21	9821.89-	6.88	108481.27	1.86
3.3458	2930.59-	.42	1046.39-	.47	8709.13	.17
51.3701	10190.47	6.63	10868.28-	7.34	117190.40	2.01
3.4496	2993.57-		1061.79-		8568.12	
54.8197	7196.90		11930.07-		125758.52	
7.2185	6268.30-		2195.94-		16610.95	
62.0382	928.60		14126.01-		142369.47	
3.8247	3303.45-		1147.41-		8097.63	
65.8629	2374.85-		15273.42-		150467.10	
3.9958	3450.83-		1203.51-		7946.40	
69.8587	5825.68-		16476.93-		158413.50	
4.2009	3612.84-		1268.95-		7796.03	
74.0596	9438.52-		17745.88-		166209.53	
4.4568	3833.18-		1315.67-		7648.94	
78.5164	13271.70-		19061.55-		173858.47	

SM 1.04 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
4.6105	3955.33-		1369.80-		7241.76	
83.1269	17227.03-		20431.35-		181100.23	
5.1050	4329.63-		1490.96-		7230.82	
88.2319	21556.66-		21922.31-		188331.05	
5.6495	4788.97-		1705.82-		7003.70	
93.8814	26345.63-		23628.13-		195334.75	
5.0774	5174.22-		1766.50-		6401.28	
99.9588	31519.85-	3.88	25394.63-	4.29	201736.03	1.55
6.8863	5841.37-	2.55	2003.65-	2.83	5827.45	1.00
106.8451	37361.22-	1.32	27398.29-	1.46	207563.48	.55
8.0228	6783.63-	.97	2330.64-	1.06	4881.07	.40
114.8679	44144.85-	.36	29728.92-	.40	212444.54	.15
10.0145	8385.67-	.97	2852.02-	1.02	3271.53	.46
124.8824	52530.51-	1.32	32580.94-	1.42	215716.08	.61

SM 1.05

16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
38.7668	36388.19	9.46	15.34	10.24	86673.79	1.70
3.0062	728.79-	.77	126.71-	.82	11318.20	.32
41.7730	35659.40	8.69	111.36-	9.42	97991.99	1.39
3.1128	745.99-	.07	128.79-	.09	11304.79	.16
44.8858	34913.41	8.66	240.15-	9.41	109296.78	1.25
3.3255	795.68-	.73	136.47-	.79	11664.65	.07
48.2113	34117.73	9.39	376.62-	10.20	120961.43	1.23
3.2824	782.81-	.25	127.49-	.27	11122.10	.09
51.4937	33334.93	9.63	504.11-	10.46	132083.52	1.16
3.5397	839.66-	.19	130.91-	.22	11576.53	.09
55.0334	32495.27	9.82	635.02-	10.67	143660.05	1.10
3.6166	863.53-	.89	138.85-	.97	11394.88	.06
58.6500	31631.75	10.71	773.87-	11.64	155054.93	1.13
3.6509	872.35-	1.77	132.49-	1.93	11066.52	.14
62.3009	30759.39	12.48	906.36-	13.56	166121.45	1.25
3.8706	913.67-	2.38	130.72-	2.59	11258.38	.29
66.1715	29845.73	10.10	1037.08-	10.98	177379.83	.96
4.0127	957.93-	1.79	131.74-	1.95	11160.46	.14
70.1842	28887.80	11.89	1168.81-	12.93	188540.29	1.09

SM 1.05 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
4.3115	1011.71-	4.43	147.89-	4.83	11413.96	.36
74.4957	27876.09	16.32	1316.71-	17.76	199954.24	1.44
4.4683	1061.41-	1.14	146.81-	1.24	11197.12	.10
78.9640	26814.68	17.46	1463.51-	19.00	211151.37	1.50
4.7766	1127.97-	8.78	150.40-	9.57	11266.03	.76
83.7406	25686.71	8.68	1613.91-	9.43	222417.39	.74
10.7953	2568.14-	.42	301.92-	.57	22772.63	.09
94.5359	23118.57	9.09	1915.84-	10.00	245190.02	.77
5.9486	1421.34-	.10	173.42-	.06	10961.46	.05
100.4845	21697.23	9.15	2089.26-	9.97	256151.48	.77
6.7494	1573.56-	6.78	176.24-	7.34	11081.87	.56
107.2339	20123.67	2.37	2265.49-	2.63	267233.34	.22
7.9528	1877.67-	4.88	197.14-	5.30	11199.71	.41
115.1867	18246.00	2.51	2462.63-	2.67	278433.05	.20
9.6438	2283.31-	.05	213.40-	.05	10912.41	.02
124.8305	15962.69	2.56	2676.03-	2.70	289345.46	.21

SM 2.06 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
41.9503	27368.99	.13	8618.03-	.14	90718.55	.03
3.7840	3392.25-	1.22	2211.97-	1.35	17834.61	.31
45.7343	23976.74	1.35	10830.00-	1.49	108553.16	.34
3.7097	3347.20-	1.43	2170.35-	1.58	17160.67	.34
49.4440	20629.55	2.78	13000.35-	3.06	125713.82	.68
3.8120	3429.11-	1.41	2215.96-	1.55	17134.90	.34
53.2560	17200.44	4.19	15216.32-	4.61	142848.72	1.02
3.9330	3559.05-	5.05	2306.01-	5.54	17165.63	1.22
57.1890	13641.39	.86	17522.33-	.93	160014.34	.20
4.0441	3630.60-	15.18	2329.80-	16.67	17132.64	3.69
61.2331	10010.79	14.33	19852.13-	15.74	177146.98	3.49
4.2283	3802.77-	1.70	2436.70-	1.88	17348.60	.41
65.4614	6208.02	12.63	22288.82-	13.87	194495.58	3.11
4.3389	3901.88-	4.48	2486.78-	4.93	17206.20	1.16
69.8003	2306.15	17.11	24775.61-	18.80	211701.78	4.26
4.5163	4065.71-	1.37	2586.04-	1.51	17266.77	.43
74.3166	1759.57-	18.48	27361.65-	20.30	228968.54	4.67
4.7779	4313.36-	9.97	2713.94-	10.94	17559.85	2.65
79.0945	6072.92-	28.45	30075.59-	31.25	246528.39	7.31

SM 2.06 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
4.9718	4442.46-	6.91	2819.87-	7.64	17507.32	1.68
84.0663	10515.38-	21.54	32895.46-	23.61	264035.72	5.63
5.1158	4571.09-	19.94	2842.40-	21.86	17204.93	5.39
89.1821	15086.47-	41.48	35737.86-	45.47	281240.65	11.03
5.5038	5004.85-	4.20	3072.40-	4.47	17577.49	.91
94.6859	20091.32-	37.28	38810.27-	41.00	298818.14	10.14
5.8662	5209.77-	12.13	3244.07-	13.30	17695.55	3.57
100.5521	25301.09-	49.41	42054.34-	54.30	316513.69	13.71
6.2234	5577.87-	60.16	3580.83-	65.73	17539.72	16.71
106.7755	30878.96-	10.75	45635.17-	11.44	334053.41	3.01

SM 1.07 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
42.3572	27959.29	3.60	2181.11-	3.95	75012.33	.86
3.2342	2344.36-	.99	377.45-	1.09	10905.72	.20
45.5914	25614.93	4.59	2558.55-	5.03	85918.05	1.03
3.2294	2360.87-	.34	377.90-	.37	10694.60	.11
48.8208	23254.06	4.92	2936.45-	5.40	96612.65	1.05
3.4404	2500.83-	1.71	394.70-	1.88	10945.28	.35
52.2612	20753.23	6.64	3331.16-	7.27	107557.93	1.38
3.4191	2476.51-	.49	390.65-	.55	10458.68	.16
55.6803	18276.72	6.15	3721.81-	6.73	118016.61	1.26
3.6200	2618.72-	1.61	410.90-	1.76	10641.95	.34
59.3003	15658.00	7.75	4132.70-	8.49	128658.56	1.59
11.7335	8462.75-	2.13	1304.47-	2.35	31560.18	.58
71.0338	7195.25	9.88	5437.17-	10.84	160218.74	2.09
8.9346	6436.96-	.56	963.14-	.60	21074.58	.28
79.9684	758.29	10.44	6400.31-	11.44	181293.33	2.30
4.5510	3288.88-	3.35	504.46-	3.68	9748.24	.81
84.5194	2530.59-	13.79	6904.76-	15.12	191041.57	3.11
5.2410	3758.90-	2.09	553.96-	2.30	10414.91	.41
89.7604	6289.49-	11.70	7458.72-	12.82	201456.47	2.71

SM 1.07 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
5.5873	4011.57-	.06	582.25-	.06	10138.89	.11
95.3477	10301.06-	11.66	8040.97-	12.77	211595.36	2.79
6.0931	4367.10-	2.79	628.41-	3.08	9921.54	.81
101.4408	14668.15-	14.45	8669.38-	15.85	221516.90	3.59
6.7047	4792.86-	.65	685.25-	.69	9553.94	.09
108.1455	19461.01-	13.80	9354.63-	15.16	231070.84	3.57
8.0045	5704.79-	.37	798.52-	.44	9537.40	.14
116.1500	25165.80-	13.49	10153.15-	14.74	240608.24	3.65
4.9441	3522.73-	2.87	490.65-	3.12	4875.42	.68
121.0941	28688.53-	10.62	10643.80-	11.63	245483.66	2.97
4.7055	3338.51-	3.67	483.07-	4.01	3919.98	1.17
125.7996	32027.04-	14.29	11126.87-	15.63	249403.64	4.13
6.9530	4973.41-	11.25	724.68-	12.26	4494.17	3.23
132.7526	37000.45-	3.04	11851.55-	3.38	253897.81	.90
53.1330	37655.95-	28.15	5414.86-	31.34	15818.79-	13.21
185.8856	74656.39-	25.11	17266.41-	27.97	238079.02	12.31

SM 1.08

16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
39.2831	32909.72	3.28	5775.48-	3.60	89366.79	.73
3.1063	1436.32-	1.81	938.83-	1.98	12001.40	.33
42.3894	31473.41	5.09	6714.30-	5.59	101368.18	1.04
3.2287	1484.58-	1.69	973.49-	1.85	12076.05	.29
45.6181	29988.83	6.78	7687.79-	7.43	113444.23	1.32
3.3396	1536.44-	.38	998.76-	.42	12099.72	.10
48.9577	28452.39	7.16	8686.55-	7.85	125543.95	1.33
3.3311	1529.72-	.91	992.73-	.99	11689.49	.15
52.2888	26922.68	8.07	9679.28-	8.84	137233.44	1.46
3.5003	1598.33-	.65	1040.77-	.72	11888.17	.12
55.7891	25324.35	8.72	10720.05-	9.56	149121.61	1.54
3.5949	1653.36-	.83	1050.05-	.90	11790.21	.15
59.3840	23670.99	9.55	11770.09-	10.46	160911.82	1.66
3.5922	1634.41-	1.37	1058.59-	1.50	11363.04	.24
62.9762	22036.58	10.91	12828.68-	11.96	172274.86	1.88
3.7996	1747.89-	1.10	1116.28-	1.18	11562.15	.19
66.7758	20288.70	12.01	13944.96-	13.14	183837.00	2.06
4.0476	1850.04-	1.26	1179.09-	1.37	11805.80	.22
70.8234	18438.66	10.76	15124.05-	11.77	195642.81	1.84

SM 1.08 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
4.2243	1947.48-	1.17	1232.22-	1.28	11756.02	.21
75.0477	16491.18	9.59	16356.26-	10.49	207398.83	1.65
4.4675	2028.65-	2.91	1299.42-	3.18	11815.11	.53
79.5152	14462.53	12.50	17655.68-	13.68	219213.93	2.18
4.6339	2122.28-	1.53	1335.44-	1.70	11578.99	.29
84.1491	12340.26	14.03	18991.12-	15.38	230792.92	2.46
5.0643	2329.47-	5.31	1447.65-	5.87	11872.45	.94
89.2134	10010.79	8.72	20438.77-	9.51	242665.37	1.53
5.5720	2528.39-	4.02	1618.77-	4.32	12121.74	.75
94.7854	7482.41	12.74	22057.53-	13.83	254787.11	2.28
5.9917	2774.05-	.54	1671.14-	.68	11933.15	.10
100.7771	4708.36	12.20	23728.68-	13.15	266720.26	2.23
6.7034	3073.63-	4.56	1891.48-	5.07	12005.84	.95
107.4805	1634.73	16.75	25620.16-	18.23	278726.10	3.18
7.9013	3595.00-	33.77	2320.26-	36.85	12323.88	6.63
115.3818	1960.28-	17.02	27940.41-	18.62	291049.97	3.45
9.5314	4330.21-	4.01	2540.90-	4.40	12276.00	1.02
124.9132	6290.48-	21.03	30481.31-	23.02	303325.97	4.46

SM 1.09

16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
38.6854	25637.91	2.41	173.81-	2.64	90981.73	.46
3.0960	2613.87-	.90	174.07-	.98	11771.89	.18
41.7814	23024.04	1.51	347.88-	1.66	102753.61	.28
3.1903	2695.60-	.32	173.64-	.35	11723.89	.07
44.9717	20328.44	1.19	521.52-	1.32	114477.50	.22
3.2066	2710.75-	.98	162.78-	1.08	11408.52	.18
48.1783	17617.69	2.17	684.30-	2.40	125886.01	.39
3.4252	2882.91-	1.21	158.60-	1.32	11797.84	.23
51.6035	14734.78	.96	842.90-	1.08	137683.85	.17
7.0573	5944.23-	3.01	327.56-	3.30	23085.90	.58
58.6608	8790.55	3.97	1170.46-	4.38	160769.74	.74
3.5656	2989.02-	2.75	152.66-	3.01	11049.95	.51
62.2264	5801.54	1.22	1323.12-	1.37	171819.69	.23
4.0214	3369.49-	4.96	176.56-	5.44	11970.64	.98
66.2478	2432.05	6.18	1499.67-	6.81	183790.33	1.21
3.9848	3340.20-	.85	161.13-	.93	11349.07	.20
70.2326	908.15-	7.03	1660.80-	7.74	195139.40	1.40
4.2993	3607.33-	.48	170.72-	.53	11672.87	.15
74.5319	4515.48-	7.51	1831.51-	8.26	206812.26	1.53

SM 1.09 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
4.5988	3842.05-	4.08	177.99-	4.47	11834.49	.82
79.1307	8357.53-	3.42	2009.50-	3.79	218646.75	.72
4.5872	3846.45-	8.28	159.71-	9.10	11130.97	1.81
83.7179	12203.98-	11.70	2169.21-	12.89	229777.72	2.52
5.1602	4319.48-	2.18	186.12-	2.41	11717.65	.42
88.8781	16523.46-	9.53	2355.33-	10.48	241495.37	2.11
5.5251	4602.92-	2.91	183.77-	3.25	11613.65	.74
94.4032	21126.38-	12.43	2539.10-	13.73	253109.02	2.85
6.0036	5003.31-	4.38	185.88-	4.74	11523.64	1.15
100.4068	26129.69-	16.81	2724.98-	18.47	264632.67	3.99
6.6270	5526.38-	2.92	198.48-	3.16	11390.87	.56
107.0338	31656.06-	13.89	2923.45-	15.31	276023.53	3.43
7.9694	6648.76-	9.54	246.33-	10.44	11854.21	2.67
115.0032	38304.82-	23.43	3169.78-	25.75	287877.74	6.10
9.4990	7873.19-	3.99	299.62-	4.34	11526.03	.75
124.5022	46178.01-	19.44	3469.40-	21.40	299403.76	5.36

SM 2.10 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
43.9582	34057.35	5.82	208.56-	6.32	101924.76	.89
2.4192	1086.10-	.10	219.23-	.11	11783.40	.11
46.3774	32971.25	5.73	427.79-	6.23	113708.16	.79
2.5298	1124.22-	1.03	221.29-	1.12	12108.19	.20
48.9072	31847.02	4.70	649.08-	5.11	125816.35	.60
5.1527	2289.98-	.78	454.72-	.85	23999.77	.18
54.0599	29557.04	3.91	1103.80-	4.26	149816.11	.43
2.6723	1185.06-	1.68	226.04-	1.83	12105.50	.17
56.7322	28371.98	5.59	1329.84-	6.09	161921.61	.60
2.7583	1233.75-	7.81	259.87-	8.51	12250.36	.79
59.4905	27138.23	13.41	1589.71-	14.60	174171.97	1.38
2.8472	1254.58-	6.36	229.07-	6.93	12387.30	.68
62.3377	25883.66	7.04	1818.78-	7.67	186559.27	.71
2.9501	1311.15-	2.07	241.54-	2.27	12560.02	.23
65.2878	24572.51	4.97	2060.32-	5.40	199119.29	.48
2.9541	1307.91-	3.24	231.78-	3.52	12296.66	.32
68.2419	23264.61	1.73	2292.10-	1.88	211415.95	.16
2.9659	1316.53-	6.64	247.32-	7.24	12064.90	.63
71.2078	21948.08	8.37	2539.42-	9.12	223480.85	.80

SM 2.10 16 MAR 1959

TIME	X(N)	SIG X	Y(W)	SIG Y	Z	SIG Z
3.0337	1345.18-	4.51	247.84-	4.92	12048.60	.44
74.2415	20602.90	3.86	2787.26-	4.20	235529.45	.36
3.1378	1390.59-	1.64	236.08-	1.81	12154.13	.15
77.3793	19212.32	5.50	3023.35-	6.01	247683.57	.51
3.2692	1506.04-	13.84	211.15-	15.12	12325.51	1.30
80.6485	17706.28	8.34	3234.50-	9.11	260009.09	.79
3.4087	1508.07-	5.25	220.44-	5.77	12491.17	.50
84.0572	16198.21	13.59	3454.94-	14.88	272500.26	1.29
7.0727	3127.90-	8.50	516.44-	9.36	24730.74	.83
91.1299	13070.32	22.08	3971.38-	24.24	297231.00	2.11
3.6147	1603.99-	3.77	213.61-	3.97	12034.59	.35
94.7446	11466.33	18.32	4184.98-	20.27	309265.59	1.77

APPENDIX C

IBM 650 TRAJECTORY PROGRAM

Instructions for the use of the IBM 650 trajectory program.

Use University II board

Set console switches to 70 1951 9000 +,

Programmed:	Stop
Half Cycle:	Run
Address:	Any
Control:	Run
Display:	Distributor or Program Register
Overflow:	Sense
Error:	Stop

There is a trajectory program deck for each rocket.

First card:	Drum zero
Deck:	5-word load cards
Last card:	Transfer to data card

The data cards which are stacked behind the program deck are:

8-word, 10-digit format with

Word 1:	Time in fixed point to one decimal place
Word 2:	ΔN_D in floating point
Word 3:	Zero
Word 4:	ΔN_M in floating point
Word 5:	Zero
Word 6:	ΔN_{TL} in floating point
Word 7:	Zero
Word 8:	ΔN_L in floating point

The number of blanks needed are

$5(n+G)$ where n = number of data points
G = number of grenade points

IBM 650 running time:

Between 9 and 10 seconds per data point

There are no programmed stops in the program.

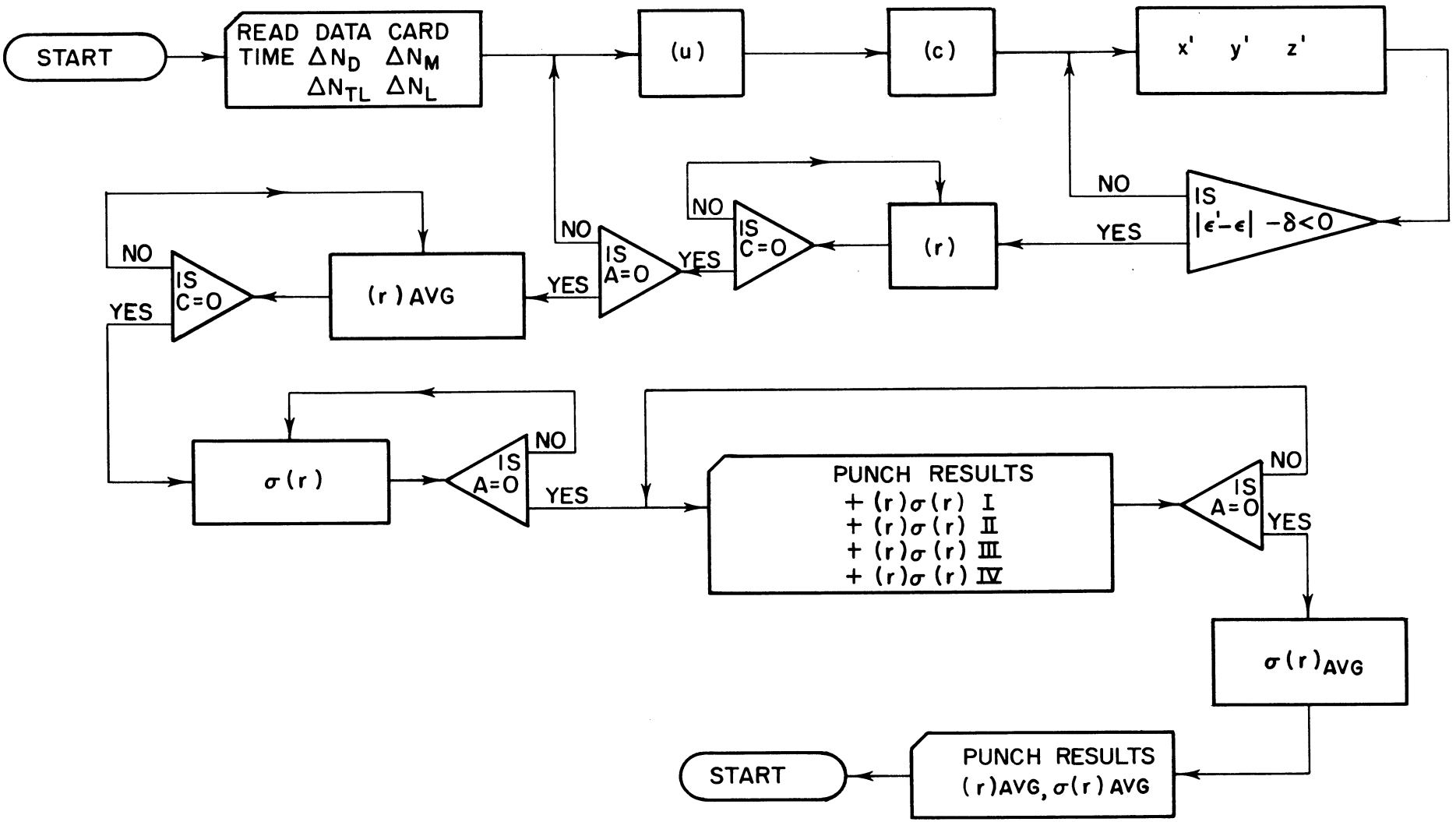

Fig. 35. Trajectory solution flow diagram.

```
 2    0960 45    0967  8001+    0010 NZE   0017  F8001
 3    0967 46    0970  0964+    0017 BMI   0020   0014
 4    0964 24    0968  0971+    0014 STD   0018   0021
 5    0971 20    0977  0956+    0021 STL   0027   0006
 6    0956 65    0959  0963+    0006 RAL   0009   0013
 7    0963 10    8001  0972+    0013 AUP  F8001   0022
 8    0972 19    0977  0965+    0022 MPY   0027   0015
 9    0965 65    8003  0974+    0015 RAL  F8003   0024
10    0974 10    0977  0981+    0024 AUP   0027   0031
11    0981 16    8002  0989+    0031 SLO  F8002   0039
12    0989 64    8001  0980+    0039 DVR  F8001   0030
13    0980 16    8001  0988+    0030 SLO  F8001   0038
14    0988 46    0950  0958+    0038 BMI   0000   0008
15    0950 15    8001  0957+    0000 ALO  F8001   0007
16    0957 15    8001  0966+    0007 ALO  F8001   0016
17    0966 10    0969  0973+    0016 AUP   0019   0023
18    0973 30    0001  0979+    0023 SRT  F0001   0029
19    0979 16    8002  0987+    0029 SLO  F8002   0037
20    0987 19    8001  0974+    0037 MPY  F8001   0024
21    0958 15    8001  0968+    0008 ALO  F8001   0018
22    0959 50                   0009  50 F0000   F0000
23    0977 00                   0027  00 F0000   F0000
24    0969 00    0000  0050+    0019  00 F0000   F0050
25    0970 69    0968  9201+    0020 LDD   0018  F9201
```

Square root subroutine
Fixed point
(relocatable)

```
27    0900 24    0903  0906+    0000 STD   0003   0006
28    0906 46    0909  0910+    0006 BMI   0009   0010
29    0910 30    0002  0917+    0010 SRT  F0002   0017
30    0917 44    0921  0922+    0017 NZU   0021   0022
31    0921 20    0925  0916+    0021 STL   0025   0016
32    0916 16    8002  0928+    0016 SLO  F8002   0028
33    0928 30    0008  0943+    0028 SRT  F0008   0043
34    0943 20    0901  0904+    0043 STL   0001   0004
35    0904 10    0907  0911+    0004 AUP   0007   0011
36    0911 64    0914  0902+    0011 DVR   0014   0002
37    0902 20    0908  0912+    0002 STL   0008   0012
38    0912 60    0901  0905+    0012 RAU   0001   0005
39    0905 64    0908  0920+    0005 DVR   0008   0020
40    0920 16    8001  0926+    0020 SLO  F8001   0026
41    0926 45    0930  0934+    0026 NZE   0030   0034
42    0930 46    0933  0934+    0030 BMI   0033   0034
43    0933 15    8001  0939+    0033 ALO  F8001   0039
44    0939 15    8001  0911+    0039 ALO  F8001   0011
45    0934 65    0925  0929+    0034 RAL   0025   0029
46    0929 15    0932  0936+    0029 ALO   0032   0036
47    0936 30    0008  0942+    0036 SRT  F0008   0042
48    0942 14    0914  0937+    0042 DIV   0014   0037
49    0937 15    8003  0919+    0037 ALO  F8003   0019
50    0919 20    0925  0931+    0019 STL   0025   0031
51    0931 44    0935  0941+    0031 NZU   0035   0041
52    0935 60    0908  0913+    0035 RAU   0008   0013
53    0913 30    0001  0927+    0013 SRT  F0001   0027
54    0927 19    0923  0938+    0027 MPY   0023   0038
55    0938 31    0010  0918+    0038 SRD  F0010   0018
56    0918 35    0002  0924+    0018 SLT  F0002   0024
57    0924 15    0925  0940+    0024 ALO   0025   0040
58    0940 60    8002  0903+    0040 RAU  F8002   0003
59    0941 65    0908  0915+    0041 RAL   0008   0015
60    0915 31    0002  0918+    0015 SRD  F0002   0018
61    0922 65    8003  0903+    0022 RAL  F8003   0003
62    0907 00    0000  0001+    0007  00 F0000   F0001
```

Square root subroutine
Floating point
(relocatable)

```
63   0914 00   0000   0002+ 2  0014   00 F0000   F0002
64   0932 50                2  0032   50 F0000   F0000
65   0923 03   1622   7766+ 2  0023   03 F1622   F7766
66   0909 44   4444   4444+ 2  0009   44 F4444   F4444
67   0903 00                2  0003   00 F0000   F0000
68   0925 00                2  0025   00 F0000   F0000
69   0901 00                2  0001   00 F0000   F0000
70   0908 00                2  0008   00 F0000   F0000
82   0436 00   0000   0080+
83   0486 00   0000   0080+    0486   00   0000    0080
84   0536 00   0000   0080+    0536   00   0000    0080
85   0586 00   0000   0080+    0586   00   0000    0080
86   0636 00   0000   0080+    0636   00   0000    0080
87   0686 00   0000   0080+    0686   00   0000    0080
89   0011 70   0650   0050+  ST       RCD  0650
90   0050 69   0651   0004+         LDD  0651
91   0004 24   0477   0030+         STD  0477
92   0030 69   0652   0005+         LDD  0652
93   0005 24   0751   0054+         STD  0751
94   0054 24   0801   0104+         STD  0801
95   0104 24   0851   0154+         STD  0851
96   0154 69   0654   0007+         LDD  0654
97   0007 24   0701   0204+         STD  0701
98   0204 24   0802   0055+         STD  0802
99   0055 24   0852   0105+         STD  0852
100  0105 69   0656   0009+         LDD  0656
101  0009 24   0702   0155+         STD  0702
102  0155 24   0752   0205+         STD  0752
103  0205 24   0853   0006+         STD  0853
104  0006 69   0658   0061+         LDD  0658
105  0061 24   0703   0056+         STD  0703
106  0056 24   0753   0106+         STD  0753
107  0106 24   0803   0156+         STD  0803
108  0156 81   0200   0012+         RSA  0200
109  0012 83   0206   0018+         RSB  0206
110  0018 89   0006   0024+         RSC  0006  P2
111  0024 60   2904   0059+  P2     RAU  0904A
112  0059 39   2901   0001+         FMP  0901A
113  0001 32   2905   0031+         FAD  0905A
114  0031 21   2905   0008+         STU  0905A
115  0008 60   2904   0109+         RAU  0904A
116  0109 39   2902   0002+         FMP  0902A
117  0002 32   2906   0033+         FAD  0906A
118  0033 21   2906   0159+         STU  0906A
119  0159 60   2904   0209+         RAU  0904A
120  0209 39   2903   0003+         FMP  0903A
121  0003 32   2907   0083+         FAD  0907A
122  0083 21   2907   0010+         STU  0907A
123  0010 33   2905   0081+         FSB  0905A
124  0081 21   0036   0039+         STU U11
125  0039 39   2905   0255+         FMP  0905A
126  0255 21   0060   0013+         STU U12
127  0013 60   2907   0111+         RAU  0907A
128  0111 33   2906   0133+         FSB  0906A
129  0133 21   0038   0041+         STU U21
130  0041 39   2906   0206+         FMP  0906A
131  0206 21   0110   0063+         STU U22    P3
132  0063 60   0036   0091+  P3     RAU U11
133  0091 39   2908   0058+         FMP  0908A
```

Data output format
8-word, 10-digit

Read data card

t_i → punch band (0477)

ΔN_j data reordered into
4 sets of 3 $\Delta N_{1,2,3}$

Set index accumulators A,B,C

(U)

```
134   0058 21   0062  0015+          STU C11
135   0015 60   0060  0065+          RAU U12
136   0065 39   2908  0108+          FMP  0908A
137   0108 32   2909  0035+          FAD  0909A
138   0035 21   0040  0043+          STU C12
139   0043 60   0036  0141+          RAU U11
140   0141 39   2910  0160+          FMP  0910A
141   0160 21   0014  0017+          STU T1
142   0017 60   0038  0093+          RAU U21
143   0093 39   2911  0161+          FMP  0911A
144   0161 32   0014  0191+          FAD T1
145   0191 21   0046  0049+          STU C21
146   0049 60   0060  0115+          RAU U12
147   0115 39   2910  0210+          FMP  0910A
148   0210 21   0064  0067+          STU T2
149   0067 60   0110  0165+          RAU U22
150   0165 39   2911  0211+          FMP  0911A
151   0211 32   0064  0241+          FAD T2
152   0241 32   2912  0089+          FAD  0912A
153   0089 21   0044  0047+          STU C22
154   0047 60   0036  0291+          RAU U11
155   0291 39   2913  0113+          FMP  0913A
156   0113 21   0068  0021+          STU T3
157   0021 60   0038  0143+          RAU U21
158   0143 39   2914  0114+          FMP  0914A
159   0114 21   0118  0071+          STU T4
160   0071 61   2907  0261+          RSU  0907A
161   0261 39   2915  0215+          FMP  0915A
162   0215 32   0068  0045+          FAD T3
163   0045 32   0118  0095+          FAD T4
164   0095 21   0100  0053+          STU C31
165   0053 60   0060  0265+          RAU U12
166   0265 39   2913  0163+          FMP  0913A
167   0163 21   0168  0121+          STU T5
168   0121 60   0110  0315+          RAU U22
169   0315 39   2914  0164+          FMP  0914A
170   0164 32   0168  0145+          FAD T5
171   0145 32   2916  0193+          FAD  0916A
172   0193 21   0048  0051+          STU C32     P4
173   0051 60   0062  0117+  P4      RAU C11
174   0117 39   2917  0167+          FMP  0917A
175   0167 32   0040  0217+          FAD C12
176   0217 21   0022  0025+          STU X1
177   0025 39   8001  0028+          FMP  8001
178   0028 21   0032  0085+          STU T6
179   0085 60   0046  0101+          RAU C21
180   0101 39   2917  0267+          FMP  0917A
181   0267 32   0044  0171+          FAD C22
182   0171 21   0026  0029+          STU Y1
183   0029 39   8001  0082+          FMP  8001
184   0082 21   0086  0139+          STU T7
185   0139 60   2907  0311+          RAU  0907A
186   0311 33   2917  0243+          FSB  0917A
187   0243 39   0096  0146+          FMP HALF
188   0146 69   8003  0052+          LDD  8003
189   0052 39   8001  0305+          FMP  8001
190   0305 33   0032  0259+          FSB T6
191   0259 33   0086  0213+          FSB T7
192   0213 69   0016  0900+          LDD          0900
```

(c)

---

r, x', y', z', ϵ'

```
193   0016 21   0020   0023+          STU Z1
194   0023 39   2918   0218+          FMP  0918A
195   0218 33   0048   0075+          FSB C32
196   0075 34   0100   0150+          FDV C31
197   0150 21   0254   0057+          STU T10
198   0057 33   2917   0293+          FSB  0917A
199   0293 69   0254   0107+          LDD T10
200   0107 24   2917   0070+          STD  0917A
201   0070 67   8003   0027+          RAM  8003
202   0027 60   8002   0135+          RAU  8002
203   0135 33   2919   0195+          FSB  0919A
204   0195 46   0098   0051+          BMI P5      P4
205   0098 60   2920   0125+  P5      RAU  0920A
206   0125 39   0022   0072+          FMP X1
207   0072 21   0076   0079+          STU T8
208   0079 60   2921   0175+          RAU  0921A
209   0175 39   0026   0126+          FMP Y1
210   0126 21   0080   0183+          STU T9
211   0183 60   2922   0077+          RAU  0922A
212   0077 39   0020   0120+          FMP Z1
213   0120 32   0076   0103+          FAD T8
214   0103 32   0080   0157+          FAD T9
215   0157 39   2923   0073+          FMP  0923A
216   0073 33   2924   0151+          FSB  0924A
217   0151 02   0304   0127+          UFA UN
218   0127 30   0002   0233+          SRT  0002
219   0233 21   4684   0037+          STU  0684B
220   0037 10   6684   0189+          AUP  0684C
221   0189 21   6684   0087+          STU  0684C
222   0087 50   0005   0343+          AXA  0005
223   0343 52   0002   0099+          AXB  0002
224   0099 58   0002   0355+          AXC  0002
225   0355 48   0098   0309+          NZC P5
226   0309 50   0035   0365+          AXA  0035
227   0365 52   0044   0221+          AXB  0044
228   0221 89   0006   0177+          RSC  0006
229   0177 40   0024   0131+          NZA P2
230   0131 81   0200   0137+          RSA  0200
231   0137 83   0206   0393+          RSB  0206   P6
232   0393 60   6684   0239+  P6      RAU  0684C
233   0239 19   0042   0263+          MPY QRTR
234   0263 21   6684   0187+          STU  0684C
235   0187 58   0002   0443+          AXC  0002
236   0443 48   0393   0097+          NZC P6
237   0097 89   0006   0153+          RSC  0006   D1
238   0153 60   0678   0283+  D1      RAU  0678
239   0283 11   2678   0333+          SUP  0678A
240   0333 21   2679   0132+          STU  0679A
241   0132 19   8001   0405+          MPY  8001
242   0405 15   0679   0383+          ALO  0679
243   0383 20   0679   0182+          STL  0679
244   0182 60   2679   1283+          RAU  0679A
245   1283 35   0004   0493+          SLT  0004
246   0493 21   2679   0232+          STU  0679A
247   0232 60   0680   0185+          RAU  0680
248   0185 11   2680   0235+          SUP  0680A
249   0235 21   2681   0034+          STU  0681A
250   0034 19   8001   0207+          MPY  8001
251   0207 15   0681   0285+          ALO  0681
```

$|\epsilon'-\epsilon| - \delta < 0$?

(r)

Reset index accumulators A,B

$(r)_{avg}$

Reset index accumulator C

$\sigma(r)$

```
252  0285 20  0681  0084+        STL  0681
253  0084 60  2681  0335+        RAU  0681A
254  0335 35  0004  0147+        SLT  0004
255  0147 21  2681  0134+        STU  0681A
256  0134 60  0682  0237+        RAU  0682
257  0237 11  2682  0287+        SUP  0682A
258  0287 21  2683  0136+        STU  0683A
259  0136 19  8001  0359+        MPY  8001
260  0359 15  0683  0337+        ALO  0683
261  0337 20  0683  0186+        STL  0683
262  0186 60  2683  0387+        RAU  0683A
263  0387 35  0004  0197+        SLT  0004
264  0197 21  2683  0236+        STU  0683A
265  0236 71  2677  0227+        PCH  0677A
266  0227 69  0130  0983+        LDD  ZERO
267  0983 24  0477  0180+        STD  0477
268  0180 50  0050  0286+        AXA  0050
269  0286 40  0153  0090+        NZA  D1
270  0090 81  0200  0196+        RSA  0200  D2
271  0196 65  0679  1033+  D2    RAL  0679
272  1033 35  0002  0289+        SLT  0002
273  0289 14  0092  0203+        DIV  TWLV
274  0203 69  0256  0960+        LDD        0960
275  0256 31  0006  0123+        SRD  0006
276  0123 35  0004  1083+        SLT  0004
277  1083 20  0679  0282+        STL  0679
278  0282 65  0681  0385+        RAL  0681
279  0385 35  0002  0341+        SLT  0002
280  0341 14  0092  0253+        DIV  TWLV
281  0253 69  0306  0960+        LDD        0960
282  0306 31  0006  0173+        SRD  0006
283  0173 35  0004  0985+        SLT  0004
284  0985 20  0681  0184+        STL  0681
285  0184 65  0683  0437+        RAL  0683
286  0437 35  0002  0543+        SLT  0002
287  0543 14  0092  0303+        DIV  TWLV
288  0303 69  0356  0960+        LDD        0960
289  0356 31  0006  0223+        SRD  0006
290  0223 35  0004  1133+        SLT  0004
291  1133 20  0683  0336+        STL  0683
292  0336 71  0677  0277+        PCH  0677
293  0277 69  0130  1183+        LDD  ZERO
294  1183 24  0678  0181+        STD  0678
295  0181 24  0679  0332+        STD  0679
296  0332 24  0680  1233+        STD  0680
297  1233 24  0681  0234+        STD  0681
298  0234 24  0682  0735+        STD  0682
299  0735 24  0683  0011+        STD  0683  ST
304  0708 50  0000  0050+   0708  50  0000  0050
305  0709 50  7773  9050+   0709  50  7773  9050
306  0710 46  0331  0049+   0710  46  0331  0049
307  0711 56  4039  8050+   0711  56  4039  8050
308  0712 49  6720  3050+   0712  49  6720  3050
309  0713 40  5720  0048-  - 0713  40  5720  0048
310  0714 20  8650  0048-  - 0714  20  8650  0048
311  0715 50  0000  0050+   0715  50  0000  0050
312  0716 57  4780  0048-  - 0716  57  4780  0048
     0717 00
314  0718 13  4700  0047-  - 0718  13  4700  0047
```

$\sigma(r)$

Punch t_i, (r), $\sigma(r)$: 4 cards

Reset index accumulator A

$\sigma(r)_{avg}$

Punch $(r)_{avg}$, $\sigma(r)_{avg}$: 1 card

Return to START

For each rocket datum, insert 4 cards:
λ, u_j for combination I

Constants and parameters
for I: M,TL,L

315	0719	10	0000	0044+		0719	10	0000	0044
316	0720	36	5502	0049+		0720	36	5502	0049
317	0721	99	9331	8050-	-	0721	99	9331	8050
318	0722	38	3400	0047+		0722	38	3400	0047
319	0723	47	5972	6055+		0723	47	5972	6055
320	0724	29	4770	0053+		0724	29	4770	0053
321	0725	99	9331	7050+		0725	99	9331	7050
322	0726	36	5504	0049+		0726	36	5504	0049
323	0727	58	3400	0047+		0727	58	3400	0047
324	0728	47	5972	6055+		0728	47	5972	6055
325	0729	14	5410	0053-	-	0729	14	5410	0053
326	0730	59	7100	0047-	-	0730	59	7100	0047
327	0731	36	1800	0047+		0731	36	1800	0047
328	0732	99	9999	8050+		0732	99	9999	8050
329	0733	47	5972	6055+		0733	47	5972	6055
330	0734	69	5000	0052-	-	0734	69	5000	0052
335	0758	50	0000	0050+		0758	50	0000	0050
336	0759	50	3973	0050+		0759	50	3973	0050
337	0760	54	1579	1050-	-	0760	54	1579	1050
338	0761	15	9730	5351+		0761	15	9730	5351
339	0762	20	3471	8050-	-	0762	20	3471	8050
340	0763	30	8750	0048-	-	0763	30	8750	0048
341	0764	32	4730	0048+		0764	32	4730	0048
342	0765	50	0000	0050+		0765	50	0000	0050
343	0766	24	0600	0048-	-	0766	24	0600	0048
	0767	00							
345	0768	55	9000	0046-	-	0768	55	9000	0046
346	0769	10	0000	0044+		0769	10	0000	0044
347	0770	77	1086	8050-	-	0770	77	1086	8050
348	0771	63	6729	9050-	-	0771	63	6729	9050
349	0772	19	9300	0047+		0772	19	9300	0047
350	0773	91	8205	4055+		0773	91	8205	4055
351	0774	29	4770	0053+		0774	29	4770	0053
352	0775	63	6725	7050+		0775	63	6725	7050
353	0776	77	1080	4050-	-	0776	77	1080	4050
354	0777	39	1340	0048+		0777	39	1340	0048
355	0778	91	8205	4055+		0778	91	8205	4055
356	0779	14	5410	0053-	-	0779	14	5410	0053
357	0780	23	3800	0048-	-	0780	23	3800	0048
358	0781	31	4450	0048+		0781	31	4450	0048
359	0782	99	9992	3050+		0782	99	9992	3050
360	0783	91	8205	4055+		0783	91	8205	4055
361	0784	69	5000	0052-	-	0784	69	5000	0052
366	0808	50	0000	0050+		0808	50	0000	0050
367	0809	50	3973	0050+		0809	50	3973	0050
368	0810	38	3020	0050+		0810	38	3020	0050
369	0811	12	1504	2051-	-	0811	12	1504	2051
370	0812	54	4929	0049+		0812	54	4929	0049
371	0813	12	0780	0048-	-	0813	12	0780	0048
372	0814	24	6990	0048-	-	0814	24	6990	0048
373	0815	50	0000	0050+		0815	50	0000	0050
374	0816	18	8150	0048-	-	0816	18	8150	0048
	0817	00							
376	0818	64	4000	0046-	-	0818	64	4000	0046
377	0819	10	0000	0044+		0819	10	0000	0044
378	0820	77	1086	8050-	-	0820	77	1086	8050
379	0821	63	6725	3050-	-	0821	63	6725	3050
380	0822	24	6430	0048-	-	0822	24	6430	0048
381	0823	91	8205	4055+		0823	91	8205	4055

For each rocket datum, insert 4 cards:
λ, u_j for combination II

Constants and parameters
for II: D,TL,L

For each rocket datum, insert 4 cards:
λ, u_j for combination III

Constants and parameters
for III: D,M,L

```
382   0824 29   4770   0053+     0824   29   4770   0053
383   0825 63   6725   7050+     0825   63   6725   7050
384   0826 77   1090   1050-   - 0826   77   1090   1050
385   0827 68   7500   0047+     0827   68   7500   0047
386   0828 91   8205   4055+     0828   91   8205   4055
387   0829 14   5410   0053-   - 0829   14   5410   0053
388   0830 23   3800   0048-   - 0830   23   3800   0048
389   0831 10   3900   0048-   - 0831   10   3900   0048
390   0832 99   9996   8050+     0832   99   9996   8050
391   0833 91   8205   4055+     0833   91   8205   4055
392   0834 69   5000   0052-   - 0834   69   5000   0052
397   0858 50   0000   0050+     0858   50   0000   0050
398   0859 74   1897   2050+     0859   74   1897   2050
399   0860 21   6981   3050+     0860   21   6981   3050
400   0861 54   9859   7050-   - 0861   54   9859   7050
401   0862 26   1790   7050+     0862   26   1790   7050
402   0863 24   7903   1050-   - 0863   24   7903   1050
403   0864 32   1719   8050+     0864   32   1719   8050
404   0865 50   0000   0050+     0865   50   0000   0050
405   0866 13   2209   2050-   - 0866   13   2209   2050
      0867 00
407   0868 14   3820   0048+     0868   14   3820   0048
408   0869 10   0000   0044+     0869   10   0000   0044
409   0870 42   4341   5050-   - 0870   42   4341   5050
410   0871 90   5499   7050-   - 0871   90   5499   7050
411   0872 21   4470   0048-   - 0872   21   4470   0048
412   0873 67   1502   8055+     0873   67   1502   8055
413   0874 29   4770   0053+     0874   29   4770   0053
414   0875 90   5495   7050+     0875   90   5495   7050
415   0876 42   4346   2050-   - 0876   42   4346   2050
416   0877 28   1480   0048+     0877   28   1480   0048
417   0878 67   1502   8055+     0878   67   1502   8055
418   0879 14   5410   0053-   - 0879   14   5410   0053
419   0880 34   5890   0048-   - 0880   34   5890   0048
420   0881 74   7600   0047-   - 0881   74   7600   0047
421   0882 99   9993   7050+     0882   99   9993   7050
422   0883 67   1502   8055+     0883   67   1502   8055
423   0884 69   5000   0052-   - 0884   69   5000   0052
424   0096 50   0000   0050+   HALF   50   0000   0050
425   0042 25                  QRTR   25   0000   0000
426   0130 00                  ZERO   00   0000   0000
427   0092 00   0000   0012+   TWLV   00   0000   0012
428   0304 00   0000   0056+   UN     00   0000   0056
```

For each rocket data, insert 4 cards:
λ, u_j for combination IV

Constants and parameters
for IV: D,M,TL

Additional constants

APPENDIX D

IBM 650 PROGRAM FOR DATA WITH RESPECT TO MICROPHONE ARRAY

Instructions for the use of the IBM 650 grenade position, layer and σ (with respect to Twin Lakes) program.

Use University II board

Set console switches to 70 1951 9000 +

Programmed:	Stop
Half Cycle:	Run
Address:	Any
Control:	Run
Display:	Distributor or Program Register
Overflow:	Sense
Error:	Stop

There is one program deck to be used for all 10 missiles:

First Card:	Drum zero
Deck:	Five-word load cards
Last Card:	Transfer to data card

The data cards which are placed immediately following the transfer to data card are the trajectory and σ program result cards for the grenade times only. They are in the 8-word 10-digit format:

Word 1:	Time in fixed point to 4 decimal places
Word 2:	X(N) in feet fixed point 2 decimal places
Word 3:	σX in feet fixed point 2 decimal places
Word 4:	Y(W) in feet fixed point 2 decimal places
Word 5:	σY in feet fixed point 2 decimal places
Word 6:	Z(MSL) in feet fixed point 2 decimal places
Word 7:	σZ in feet fixed point 2 decimal places
Word 8:	All zeros

The number of blanks required are 5(2G-1) where G = number of grenades.

IBM 650 running time approximately 5 minutes.

There are no programmed stops in the program.

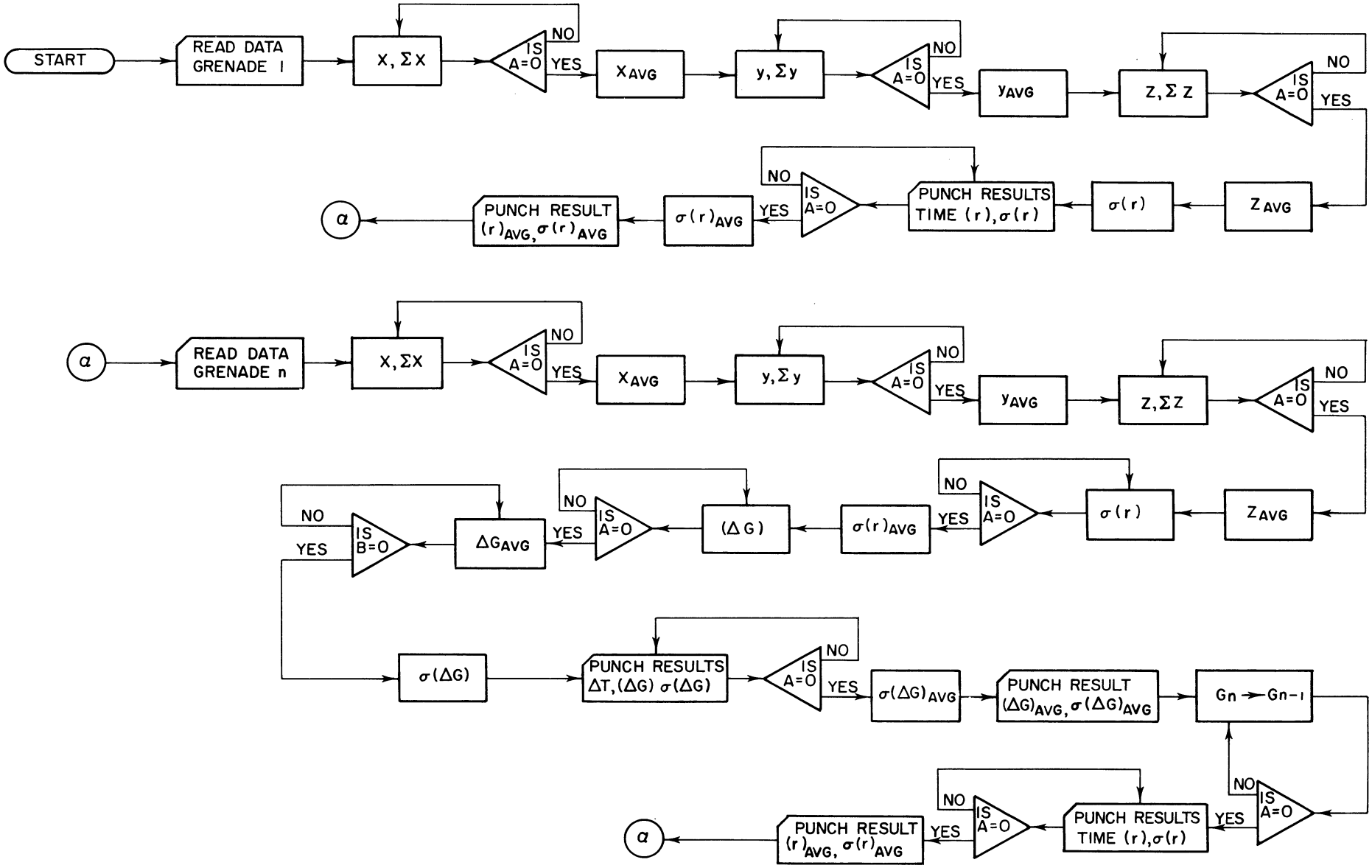

Fig. 36. Grenade position and layer program (Twin Lakes) flow diagram.

```
 2    0710 45   0717  8001+    0010 NZE  0017  F8001
 3    0717 46   0720  0714+    0017 BMI  0020   0014
 4    0714 24   0718  0721+    0014 STD  0018   0021
 5    0721 20   0727  0706+    0021 STL  0027   0006
 6    0706 65   0709  0713+    0006 RAL  0009   0013
 7    0713 10   8001  0722+    0013 AUP F8001   0022
 8    0722 19   0727  0715+    0022 MPY  0027   0015
 9    0715 65   8003  0724+    0015 RAL F8003   0024
10    0724 10   0727  0731+    0024 AUP  0027   0031
11    0731 16   8002  0739+    0031 SLO F8002   0039
12    0739 64   8001  0730+    0039 DVR F8001   0030
13    0730 16   8001  0738+    0030 SLO F8001   0038
14    0738 46   0700  0708+    0038 BMI  0000   0008
15    0700 15   8001  0707+    0000 ALO F8001   0007
16    0707 15   8001  0716+    0007 ALO F8001   0016
17    0716 10   0719  0723+    0016 AUP  0019   0023
18    0723 30   0001  0729+    0023 SRT F0001   0029
19    0729 16   8002  0737+    0029 SLO F8002   0037
20    0737 19   8001  0724+    0037 MPY F8001   0024
21    0708 15   8001  0718+    0008 ALO F8001   0018
22    0709 50                 0009  50 F0000   F0000
23    0727 00                 0027  00 F0000   F0000
24    0720 00   0000  9201+    0020  00 F0000   F9201
25    0719 00   0000  0050+    0019  00 F0000   F0050
26    0718 00                 0018  00 F0000   F0000
51    0136 00   0000  0080+    0136  00  0000   0080
52    0186 00   0000  0080+    0186  00  0000   0080
53    0236 00   0000  0080+    0236  00  0000   0080
54    0286 00   0000  0080+    0286  00  0000   0080
55    0336 00   0000  0080+    0336  00  0000   0080
57    0436 00   0000  0080+    0436  00  0000   0080
58    0486 00   0000  0080+    0486  00  0000   0080
59    0536 00   0000  0080+    0536  00  0000   0080
60    0586 00   0000  0080+    0586  00  0000   0080
61    0636 00   0000  0080+    0636  00  0000   0080
63    0011 70   0101  0001+ ST     RCD  0101
64    0001 70   0151  0051+        RCD  0151
65    0051 70   0201  0351+        RCD  0201
66    0351 70   0251  0651+        RCD  0251
67    0651 70   0301  0701+        RCD  0301
68    0701 69   0101  0004+        LDD  0101
69    0004 24   0127  0030+        STD  0127
70    0030 81   0200  0036+        RSA  0200  B2
71    0036 60   2302  0007+ B2     RAU  0302A
72    0007 19   0010  0080+        MPY M11
73    0080 21   0034  0037+        STU T1
74    0037 60   2304  0009+        RAU  0304A
75    0009 19   0012  0032+        MPY M12
76    0032 10   0034  0039+        AUP T1
77    0039 21   0034  0087+        STU T1
78    0087 60   2306  0061+        RAU  0306A
79    0061 19   0014  0084+        MPY M13
80    0084 10   0034  0089+        AUP T1
81    0089 11   0042  0047+        SUP XTL
82    0047 21   2303  0006+        STU  0303A
83    0006 10   0059  0013+        AUP T2
84    0013 21   0059  0062+        STU T2
85    0062 50   0050  0018+        AXA  0050
86    0018 40   0036  0022+        NZA B2
```

Square root subroutine
Fixed point
(relocatable)

Data output format
8-word, 10-digit

Read 5 data cards

$t_i \rightarrow$ punch band (0127)

Reset index accumulator A

x_I
x_{II}
x_{III} } G_1
x_{IV}
$\overline{x}$

```
 87   0022 60   0059   0063+          RAU T2
 88   0063 19   0016   0086+          MPY QRTR
 89   0086 31   0002   0045+          SRD  0002
 90   0045 20   0328   0031+          STL  0328
 91   0031 81   0200   0137+          RSA  0200
 92   0137 69   0040   0043+          LDD ZERO
 93   0043 24   0059   0112+          STD T2       B3
 94   0112 60   2302   0057+  B3      RAU  0302A
 95   0057 19   0060   0680+          MPY M21
 96   0680 10   2304   0359+          AUP 0304A
 97   0359 21   0064   0017+          STU T3
 98   0017 60   2306   0111+          RAU  0306A
 99   0111 19   0114   0684+          MPY M23
100   0684 10   0064   0019+          AUP T3
101   0019 11   0072   0027+          SUP YTL
102   0027 21   2305   0008+          STU  0305A
103   0008 10   0161   0015+          AUP T4
104   0015 21   0161   0164+          STU T4
105   0164 50   0050   0020+          AXA  0050
106   0020 40   0112   0024+          NZA B3
107   0024 60   0161   0065+          RAU T4
108   0065 19   0016   0686+          MPY QRTR
109   0686 31   0002   0095+          SRD  0002
110   0095 20   0330   0033+          STL  0330
111   0033 81   0200   0139+          RSA  0200
112   0139 69   0040   0093+          LDD ZERO
113   0093 24   0161   0214+          STD T4       B4
114   0214 60   2302   0357+  B4      RAU  0302A
115   0357 19   0360   0780+          MPY M31
116   0780 21   0734   0187+          STU T5
117   0187 60   2304   0659+          RAU  0304A
118   0659 19   0162   0082+          MPY M32
119   0082 10   0734   0189+          AUP T5
120   0189 21   0734   0237+          STU T5
121   0237 60   2306   0211+          RAU  0306A
122   0211 19   0264   0784+          MPY M33
123   0784 10   0734   0239+          AUP T5
124   0239 11   0092   0097+          SUP ZTL
125   0097 21   2307   0660+          STU  0307A
126   0660 10   0113   0067+          AUP T6
127   0067 21   0113   0066+          STU T6
128   0066 50   0050   0122+          AXA  0050
129   0122 40   0214   0026+          NZA B4
130   0026 60   0113   0117+          RAU T6
131   0117 19   0016   0736+          MPY QRTR
132   0736 31   0002   0145+          SRD  0002
133   0145 20   0332   0035+          STL  0332
134   0035 81   0200   0041+          RSA  0200
135   0041 69   0040   0143+          LDD ZERO
136   0143 24   0113   0116+          STD T6       B5
137   0116 60   0328   0083+  B5      RAU  0328
138   0083 11   2303   0657+          SUP  0303A
139   0657 24   2328   0081+          STD  0328A
140   0081 21   0786   0289+          STU T7
141   0289 19   8001   0212+          MPY  8001
142   0212 15   0115   0069+          ALO T8
143   0069 20   0115   0068+          STL T8
144   0068 60   0786   0091+          RAU T7
145   0091 35   0004   0751+          SLT  0004
```

Reset index accumulator A

y_I, y_{II}, y_{III}, y_{IV}, $\overline{y}$ } G_1

Reset index accumulator A

z_I, z_{II}, z_{III}, z_{IV}, $\overline{z}$ } G_1

Reset index accumulator A

σr_I, σr_{II}, σr_{III}, σr_{IV} } G_1

```
146   0751 21   2329  0682+          STU  0329A
147   0682 60   0330  0085+          RAU  0330
148   0085 11   2305  0759+          SUP  0305A
149   0759 24   2330  0683+          STD  0330A
150   0683 21   0038  0141+          STU  T9
151   0141 19   8001  0314+          MPY  8001
152   0314 15   0167  0021+          ALO  T10
153   0021 20   0167  0070+          STL  T10
154   0070 60   0038  0193+          RAU  T9
155   0193 35   0004  0003+          SLT  0004
156   0003 21   2331  0834+          STU  0331A
157   0834 60   0332  0287+          RAU  0332
158   0287 11   2307  0261+          SUP  0307A
159   0261 24   2332  0685+          STD  0332A
160   0685 21   0090  0243+          STU  T11
161   0243 19   8001  0166+          MPY  8001
162   0166 15   0119  0023+          ALO  T12
163   0023 20   0119  0172+          STL  T12
164   0172 60   0090  0195+          RAU  T11
165   0195 35   0004  0005+          SLT  0004
166   0005 21   2333  0836+          STU  0333A
167   0836 71   2327  0077+          PCH  0327A
168   0077 50   0050  0733+          AXA  0050
169   0733 40   0116  0337+          NZA  B5
170   0337 81   0200  0293+          RSA  0200   B6
171   0293 65   0115  0169+  B6      RAL  T8
172   0169 35   0002  0025+          SLT  0002
173   0025 14   0028  0088+          DIV  TWLV
174   0088 69   0191  0710+          LDD          SQRT
175   0191 31   0006  0757+          SRD  0006
176   0757 35   0004  0217+          SLT  0004
177   0217 20   0329  0732+          STL  0329
178   0732 65   0167  0071+          RAL  T10
179   0071 35   0002  0677+          SLT  0002
180   0677 14   0028  0138+          DIV  TWLV
181   0138 69   0241  0710+          LDD          SQRT
182   0241 31   0006  0807+          SRD  0006
183   0807 35   0004  0267+          SLT  0004
184   0267 20   0331  0884+          STL  0331
185   0884 65   0119  0073+          RAL  T12
186   0073 35   0002  0029+          SLT  0002
187   0029 14   0028  0188+          DIV  TWLV
188   0188 69   0291  0710+          LDD          SQRT
189   0291 31   0006  0857+          SRD  0006
190   0857 35   0004  0317+          SLT  0004
191   0317 20   0333  0886+          STL  0333
192   0886 71   0327  0777+          PCH  0327
193   0777 69   0040  0343+          LDD  ZERO
194   0343 24   0115  0118+          STD  T8
195   0118 24   0167  0120+          STD  T10
196   0120 24   0119  0827+          STD  T12     B7
198   0827 70   0401  0801+  B7      RCD  0401
199   0801 70   0451  0851+          RCD  0451
200   0851 70   0501  0901+          RCD  0501
201   0901 70   0551  0951+          RCD  0551
202   0951 70   0601  1001+          RCD  0601
203   1001 60   0401  0055+          RAU  0401
204   0055 24   0127  0830+          STD  0127
205   0830 11   0101  0355+          SUP  0101
```

Punch t_i, x, σx, y, σy, z, σz: 4 cards: G_1

Reset index accumulator A

$\sigma\bar{r}$ } G_1

Punch $\bar{x}$, $\sigma\bar{x}$, $\bar{y}$, $\sigma\bar{y}$, $\bar{z}$, $\sigma\bar{z}$: 1 card: G_1

Read 5 data cards

$t_i \rightarrow 0127$

$\Delta t \rightarrow 0427$

```
206   0355 21   0427   0880+          STU  0427
207   0880 81   0200   0936+          RSA  0200   B8
208   0936 60   2602   0907+   B8     RAU  0602A
209   0907 19   0010   0930+          MPY  M11
210   0930 21   0934   0387+          STU  T13
211   0387 60   2604   0809+          RAU  0604A
212   0809 19   0012   0782+          MPY  M12
213   0782 10   0934   0339+          AUP  T13
214   0339 21   0934   0437+          STU  T13
215   0437 60   2606   0311+          RAU  0606A
216   0311 19   0014   0984+          MPY  M13
217   0984 10   0934   0389+          AUP  T13
218   0389 11   0042   0147+          SUP  XTL
219   0147 21   2603   0056+          STU  0603A
220   0056 10   0859   0163+          AUP  T14
221   0163 21   0859   0262+          STU  T14
222   0262 50   0050   0168+          AXA  0050
223   0168 40   0936   0272+          NZA  B8
224   0272 60   0859   0213+          RAU  T14
225   0213 19   0016   0986+          MPY  QRTR
226   0986 31   0002   0245+          SRD  0002
227   0245 20   0328   0681+          STL  0328
228   0681 81   0200   0487+          RSA  0200
229   0487 69   0040   0393+          LDD  ZERO
230   0393 24   0859   0312+          STD  T14    B9
231   0312 60   2602   0957+   B9     RAU  0602A
232   0957 19   0060   0980+          MPY  M21
233   0980 10   2604   0909+          AUP  0604A
234   0909 21   0364   0367+          STU  T15
235   0367 60   2606   0361+          RAU  0606A
236   0361 19   0114   1034+          MPY  M23
237   1034 10   0364   0219+          AUP  T15
238   0219 11   0072   0877+          SUP  YTL
239   0877 21   2605   0058+          STU  0605A
240   0058 10   0411   0165+          AUP  T16
241   0165 21   0411   0414+          STU  T16
242   0414 50   0050   0170+          AXA  0050
243   0170 40   0312   0074+          NZA  B9
244   0074 60   0411   0215+          RAU  T16
245   0215 19   0016   1036+          MPY  QRTR
246   1036 31   0002   0295+          SRD  0002
247   0295 20   0330   0783+          STL  0330
248   0783 81   0200   0439+          RSA  0200
249   0439 69   0040   0443+          LDD  ZERO
250   0443 24   0411   0464+          STD  T16    B10
251   0464 60   2602   1007+   B10    RAU  0602A
252   1007 19   0360   1030+          MPY  M31
253   1030 21   1084   0537+          STU  T17
254   0537 60   2604   0959+          RAU  0604A
255   0959 19   0162   0832+          MPY  M32
256   0832 10   1084   0489+          AUP  T17
257   0489 21   1084   0587+          STU  T17
258   0587 60   2606   0461+          RAU  0606A
259   0461 19   0264   1134+          MPY  M33
260   1134 10   1084   0539+          AUP  T17
261   0539 11   0092   0197+          SUP  ZTL
262   0197 21   2607   0760+          STU  0607A
263   0760 10   0263   0417+          AUP  T18
264   0417 21   0263   0216+          STU  T18
```

x_I
x_{II}
x_{III} } $G_{2\text{-}19}$
x_{IV}
$\overline{x}$

y_I
y_{II}
y_{III} } $G_{2\text{-}19}$
y_{IV}
$\overline{y}$

z_I
z_{II}
z_{III} } $G_{2\text{-}19}$
z_{IV}
$\overline{z}$

```
265   0216 50   0050   0322+          AXA  0050
266   0322 40   0464   0076+          NZA  B10
267   0076 60   0263   0467+          RAU  T18
268   0467 19   0016   1086+          MPY  QRTR
269   1086 31   0002   0345+          SRD  0002
270   0345 20   0332   0735+          STL  0332
271   0735 81   0200   0341+          RSA  0200
272   0341 69   0040   0493+          LDD  ZERO
273   0493 24   0263   0266+          STD  T18      B11
274   0266 60   0328   0833+  B11     RAU  0328
275   0833 11   2603   1057+          SUP  0603A
276   1057 24   2328   0781+          STD  0328A
277   0781 21   1136   0589+          STU  T19
278   0589 19   8001   0362+          MPY  8001
279   0362 15   0265   0269+          ALO  T20
280   0269 20   0265   0218+          STL  T20
281   0218 60   1136   0391+          RAU  T19
282   0391 35   0004   1051+          SLT  0004
283   1051 21   2329   0882+          STU  0329A
284   0882 60   0330   0785+          RAU  0330
285   0785 11   2605   1009+          SUP  0605A
286   1009 24   2330   0883+          STD  0330A
287   0883 21   0238   0441+          STU  T21
288   0441 19   8001   0514+          MPY  8001
289   0514 15   0517   0121+          ALO  T22
290   0121 20   0517   0220+          STL  T22
291   0220 60   0238   0543+          RAU  T21
292   0543 35   0004   0053+          SLT  0004
293   0053 21   2331   1184+          STU  0331A
294   1184 60   0332   0637+          RAU  0332
295   0637 11   2607   0511+          SUP  0607A
296   0511 24   2332   0835+          STD  0332A
297   0835 21   0140   0593+          STU  T23
298   0593 19   8001   0316+          MPY  8001
299   0316 15   0319   0123+          ALO  T24
300   0123 20   0319   0372+          STL  T24
301   0372 60   0140   0395+          RAU  T23
302   0395 35   0004   0655+          SLT  0004
303   0655 21   2333   1186+          STU  0333A
304   1186 50   0050   0142+          AXA  0050
305   0142 40   0266   0046+          NZA  B11
306   0046 81   0200   0002+          RSA  0200     B12
307   0002 65   0265   0369+  B12     RAL  T20
308   0369 35   0002   0075+          SLT  0002
309   0075 14   0028   0288+          DIV  TWLV
310   0288 69   0491   0710+          LDD          SQRT
311   0491 31   0006   1107+          SRD  0006
312   1107 35   0004   0567+          SLT  0004
313   0567 20   0329   0932+          STL  0329
314   0932 65   0517   0171+          RAL  T22
315   0171 35   0002   0927+          SLT  0002
316   0927 14   0028   0338+          DIV  TWLV
317   0338 69   0541   0710+          LDD          SQRT
318   0541 31   0006   1157+          SRD  0006
319   1157 35   0004   0617+          SLT  0004
320   0617 20   0331   1234+          STL  0331
321   1234 65   0319   0173+          RAL  T24
322   0173 35   0002   0079+          SLT  0002
323   0079 14   0028   0388+          DIV  TWLV
```

σx_I
σx_{II}
σx_{III}
σx_{IV}
$\sum_{I}^{IV} (\sigma x)^2$
} $G_{2\text{-}19}$

$\sigma \bar{r}$ } $G_{2\text{-}19}$

```
324   0388 69   0591   0710+          LDD         SQRT
325   0591 31   0006   1207+          SRD   0006
326   1207 35   0004   0667+          SLT   0004
327   0667 20   0333   1236+          STL   0333
328   1236 69   0040   0643+          LDD ZERO
329   0643 24   0265   0268+          STD T20
330   0268 24   0517   0270+          STD T22
331   0270 24   0319   0422+          STD T24     B13
335   0422 60   2603   1257+   B13    RAU   0603A
336   1257 11   2303   1307+          SUP   0303A
337   1307 21   2628   0831+          STU   0628A
338   0831 10   0628   0933+          AUP   0628
339   0933 21   0628   0881+          STU   0628
340   0881 60   2605   1059+          RAU   0605A
341   1059 11   2305   1109+          SUP   0305A
342   1109 21   2630   0983+          STU   0630A
343   0983 10   0630   0885+          AUP   0630
344   0885 21   0630   1033+          STU   0630
345   1033 60   2607   0561+          RAU   0607A
346   0561 11   2307   0611+          SUP   0307A
347   0611 21   2632   0935+          STU   0632A
348   0935 10   0632   0687+          AUP   0632
349   0687 21   0632   0985+          STU   0632
350   0985 50   0050   0641+          AXA   0050
351   0641 40   0422   0445+          NZA B13
352   0445 81   0200   1101+          RSA   0200
353   1101 83   0006   1357+          RSB   0006     B14
354   1357 60   4634   0639+   B14    RAU   0634B
355   0639 19   0016   1286+          MPY QRTR
356   1286 31   0002   0495+          SRD   0002
357   0495 20   4634   0787+          STL   0634B
358   0787 52   0002   0693+          AXB   0002
359   0693 42   1357   0247+          NZB B14
360   0247 83   0006   0353+          RSB   0006     B15
361   0353 60   0628   1083+   B15    RAU   0628
362   1083 11   2628   1133+          SUP   0628A
363   1133 21   0438   0691+          STU T25
364   0691 19   8001   0564+          MPY   8001
365   0564 15   0767   0221+          ALO T26
366   0221 20   0767   0320+          STL T26
367   0320 60   0438   0743+          RAU T25
368   0743 35   0004   0653+          SLT   0004
369   0653 21   2629   0982+          STU   0629A
370   0982 60   0630   1035+          RAU   0630
371   1035 11   2630   1085+          SUP   0630A
372   1085 21   0190   0793+          STU T27
373   0793 19   8001   0366+          MPY   8001
374   0366 15   0419   0223+          ALO T28
375   0223 20   0419   0472+          STL T28
376   0472 60   0190   0545+          RAU T27
377   0545 35   0004   0805+          SLT   0004
378   0805 21   2631   1284+          STU   0631A
379   1284 60   0632   0837+          RAU   0632
380   0837 11   2632   0887+          SUP   0632A
381   0887 21   0192   0595+          STU T29
382   0595 19   8001   0318+          MPY   8001
383   0318 15   0271   0125+          ALO T30
384   0125 20   0271   0124+          STL T30
385   0124 60   0192   0297+          RAU T29
```

(ΔG)

$(\Delta G)_{avg}$

$\sigma(\Delta G)$

```
386  0297 35  0004  1407+          SLT  0004
387  1407 21  2633  1336+          STU  0633A
388  1336 71  2627  0977+          PCH  0627A
389  0977 50  0050  1183+          AXA  0050
390  1183 40  0353  0937+          NZA  B15
391  0937 81  0200  0843+          RSA  0200   B16
392  0843 65  0767  0321+  B16     RAL  T26
393  0321 35  0002  1027+          SLT  0002
394  1027 14  0028  0488+          DIV  TWLV
395  0488 69  0741  0710+          LDD          SQRT
396  0741 31  0006  1457+          SRD  0006
397  1457 35  0004  0817+          SLT  0004
398  0817 20  0629  1032+          STL  0629
399  1032 65  0419  0273+          RAL  T28
400  0273 35  0002  0679+          SLT  0002
401  0679 14  0028  0538+          DIV  TWLV
402  0538 69  0791  0710+          LDD          SQRT
403  0791 31  0006  1507+          SRD  0006
404  1507 35  0004  0867+          SLT  0004
405  0867 20  0631  1334+          STL  0631
406  1334 65  0271  0175+          RAL  T30
407  0175 35  0002  0931+          SLT  0002
408  0931 14  0028  0588+          DIV  TWLV
409  0588 69  0841  0710+          LDD          SQRT
410  0841 31  0006  1557+          SRD  0006
411  1557 35  0004  0917+          SLT  0004
412  0917 20  0633  1386+          STL  0633
413  1386 71  0627  1077+          PCH  0627
414  1077 69  0040  0893+          LDD  ZERO
415  0893 24  0767  0370+          STD  T26
416  0370 24  0419  0522+          STD  T28
417  0522 24  0271  0174+          STD  T30
418  0174 24  0628  0981+          STD  0628
419  0981 24  0630  1233+          STD  0630
420  1233 24  0632  1127+          STD  0632   B17
422  1127 69  2603  0356+  B17     LDD  0603A
423  0356 24  2303  0656+          STD  0303A
424  0656 69  2605  0358+          LDD  0605A
425  0358 24  2305  0658+          STD  0305A
426  0658 69  2607  0810+          LDD  0607A
427  0810 24  2307  0860+          STD  0307A
428  0860 50  0050  0416+          AXA  0050
429  0416 40  1127  0420+          NZA  B17
430  0420 69  0401  0054+          LDD  0401
431  0054 24  0101  0354+          STD  0101
432  0354 81  0250  0910+          RSA  0250   B18
433  0910 71  2377  1177+  B18     PCH  0377A
434  1177 50  0050  1283+          AXA  0050
435  1283 40  0910  0827+          NZA  B18    B7
437  0040 00                ZERO   00  0000   0000
438  0016 00  0000  0025+  QRTR    00  0000   0025
439  0028 00  0000  0012+  TWLV    00  0000   0012
440  0010 99  9998  0000+  M11     99  9998   0000
441  0012 00  0113  7000+  M12     00  0113   7000
442  0014 00  2023  6000+  M13     00  2023   6000
443  0060 00  0113  9000-  -M21    00  0113   9000
444  0114 00  0069  1000+  M23     00  0069   1000
445  0360 00  2023  6000-  -M31    00  2023   6000
446  0162 00  0069  4000-  -M32    00  0069   4000
```

Punch Δt, (ΔG), $\sigma(\Delta G)$: 4 cards

$\sigma(\Delta G)_{avg}$

Punch $(\Delta G)_{avg}$, $\sigma(\Delta G)_{avg}$: 1 card

$(G)_{n+1} \rightarrow (G)_n$

$t_{n+1} \rightarrow t_n$

Punch t_{n+1}, (G), $\sigma(G)$: 5 cards: $G_{2\text{-}13}$

Constants

447	0264	99	9998	0000+	M33	99	9998	0000
448	0042	00	0423	7188-	XTL	00	0423	7188
449	0072	00	0014	4953-	YTL	00	0014	4953
450	0092	00	0001	6418+	ZTL	00	0001	6418