GRANITE - A NEW TELESCOPE FOR TeV GAMMA RAY ASTRONOMY

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The GRANITE project has as its goal adding a second 11 meter diameter collecting dish to the one that has operated successfully for a large number of years on Mt. Hopkins at the Whipple Observatory. The advantages of using two dishes in coincidence are:

1) A second dish provides stereo pattern recognition information which will allow better rejection of background cosmic rays.

2) The energy threshold will be reduced considerably by using the two dishes in coincidence thus reducing the energy gap between the Cerenkov imaging measurements and satellite observations. The lower energy threshold will increase the data rate by an order of magnitude.

The original intention was to build a second dish very much like the one presently at Mt. Hopkins. However budget constraints led us in the direction of using an existing dish which was surplus from a solar energy project. The manufacturer (McDonnell-Douglas) has supplied us with data showing that the rigidity of the structure and the tracking are sufficiently accurate (.1 degrees) for our needs. However the large size of the mirror facets result in astigmatic effects which preclude their use. Smaller hexagonal facets in the pattern shown in Fig. 1 are being fabricated as replacements. These facets are being made at Michigan with improvements on a technique first employed by M. Argoud to

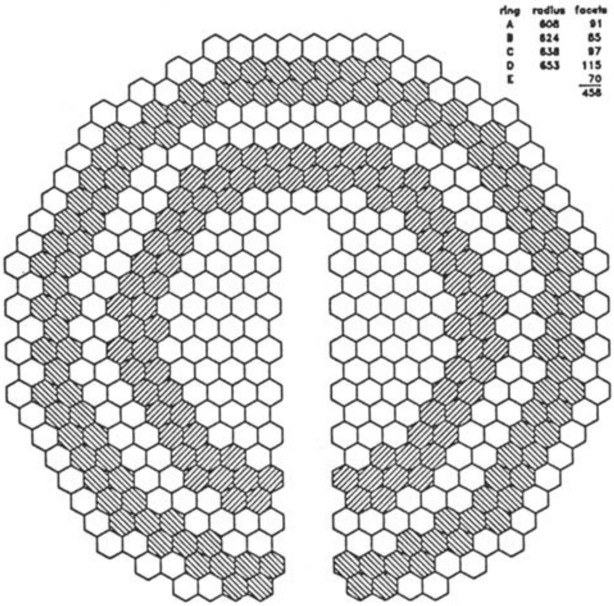

Figure 1

make the mirrors in the Sandia solar collectors (TBC). The angular resolution is designed to match that of the present dish.

The two dishes will be approximately 120 meters apart. The data taking rate at the anticipated 100 GeV energy threshold will be about one kilohertz. The second dish will initially be instrumented with a camera consisting of 37 5cm diameter photomultipliers. These will be replaced with a 109 tube array matching that in the present dish as quickly as possible. Pulse height and timing information from each dish will be correlated and recorded locally when operation begins so that the two dishes can be operated separately during start up. They will be tied together by the minimal timing signals needed to correlate events. At a later date, when money becomes available, the two data streams will be merged on line.

The present status of the project is:

1) The dish has been transported to the Mt. Hopkins base camp.

2) The foundation for the dish has been built on the mountain and the mount has been installed.

3) The structure to hold the new mirrors on the dish is to be installed in November 1990.

4) One half of the mirrors have been made and tested. Completion is scheduled for January 1991.

5) Prototype modules of electronics not available commercially have been built, tested and are now ready for production.

We plan to be in operation in September 1991.

Monte Carlo simulations of the two dish array have been done. The measured background reduction attained employing pattern recognition for one dish is almost two orders of magnitude. The additional reduction predicted for two dishes is another order of magnitude. Clearly, with such large numbers, some caution is advisable as to their believability. We use the Crab nebula to illustrate how the sensitivity of the detector would be improved over the present Whipple dish if the predictions are taken at face value:

	Present	Granite
Angular Resolution	.1°	.1°
For CRAB intensity		
Gammas/Cosmics	1/1	10/1
Gamma rate	1/min (400 GeV Thres)	10/min (100 GeV Thres)
For 5 std. dev. sig.	2hr.	5min.
For 0.1 CRAB intensity		
Gammas/Cosmics	1/10	1/1
Gamma rate	.1/min	1/min
For 5 std. dev. sig.	50hrs.	2hrs.

Looking beyond GRANITE how far can the technique reasonably be pushed? Defining reasonable arbitrarily to mean $10,000,000;

1) The gamma rate can be increased by a order of magnitude by simply building an array of dishes.

2) The array of detectors, because of better stereo and redundancy would allow rejection of cosmic ray background better, probably down to the level of the primary electron flux.

3) By improving and optimizing equipment a bit (smaller tubes, wavelength filters, light collection funnels on tubes, etc.) the threshold energy might be reduced a factor of 2 without building larger dishes.

4) One could attain better angular resolution by using an existing 5 meter optical telescope on a part time basis for improved optical and tracking accuracy. Since the electromagnetic shower has a diameter of 0.2 degree as seen from the ground, with this improved accuracy and a finer grained image pattern the center of the shower might be located to 0.02 degrees which would make possible mapping the source of the gamma flux within the Crab nebula.

However, all of this, still leaves one problem. The Čerenkov technique has an intrinsically narrow angular acceptance. A real question is: "Where shall I point the telescope in hopes of seeing interesting gamma sources?" The GRO and past satellite data is important in this respect as is physical intuition and a big dose of serendipity.

GOOD HUNTING!