Federal Science and Technology

The Issues

- The nature of federally-sponsored research
  - Basic vs. applied research
  - Curiosity-driven vs. strategic research
  - Newtonian vs. Baconian vs. Jeffersonian research
- A question of balance
  - Biomedical sciences vs. everything else…
  - Federal vs. corporate vs. foundation research

Some background

- Member, National Science Board (1984-1996)
  - Chair (1990-1994)
- Councilor,NAE (1994-2000)
- Member, NAS Committee on Science, Engineering,
  - And Public Policy (COSEPUP) (1997-2003)
  - Chair, FS&T Steering Group
- Chair, NAS Task Force on Information Technology
  - and the Future of the Research University
- Other: Chair, DOE Nuclear Energy Research Advisory Com
  - Chair, NRC Committee on Scholarship in Digital Age
  - Chair, Triana Review Committee (...oops…)

In the beginning...

1945: *Science, the Endless Frontier*, Vanevar Bush

The government-university research partnership

The National Science Foundation

The National Science Board

1950s -->

The evolution of the "research university"

Growth in the R&D budgets of mission agencies

Government-University Research Partnership

Bush Report: “Since health, well-being, and security are proper concerns of government, scientific progress is, and must be, of vital interest to government.”

Key features:

- Merit-determined, peer-reviewed research grants
- Investigator initiated
- Freedom of inquiry
- Single-investigator grant model

Federal Research Agencies

Basic Research Agencies:

National Science Foundation ($4.9 B)

National Institutes of Health ($26.8 B)

Mission Agencies:

Department of Defense ($4.8 B)

Department of Energy ($4.9 B)

National Aeronautics and Space Administration ($8.6B)

Department of Commerce ($0.8 B)

Department of Agriculture ($1.9 B)

Department of Education ($0.4 B)

(FY2003 FS&T Budget: Total $56.0 B)

The Process (for FY2004)

May-August, 2002:   Agencies develop funding requests

September-January 2002: OMB assembles request

February, 2003: President presents budget request

March, 2003-September 2003: Congress develops appropriation budgets through committee structures

October-November 2003: Conference Committees

November-December 2003: President signs bills

The Players

- White House: Agencies, OMB, OSTP, PCAST
- Congress:
  - Authorization committees
  - Appropriation committees
- Lobbyists
  - Scientific societies
  - Higher education
  - Special interests (including Hollywood)
  - The “marching army”

How are priorities really set?

Changing nature of social needs?

Military security (Cold War) -->

health care (aging population)

Federal policy?

(Sputnik, RANN, 21st Century Research Fund)

Congressional appropriation process?

Committee structure (e.g., HUD-Ind Agencies)

Lobbyists (earmarks)

The Press Report (1995)

NAS/NAE/IOM Report:

Allocating Federal Funds for Science and Technology

Goals:

- Make the research funding allocation process more coherent, systematic, and comprehensive
- Allocate funds to best people and best projects.
- Ensure that sound scientific and technical advice guides allocation process.
- Improve federal management of R&D activities.

Operational Elements of the Press Report

- Develop an alternative to the federal "R&D" budget category than more accurately measures spending on generating new knowledge: "The Federal Science and Technology budget" (FS&T)
- Propose a guiding principle for making resource allocation decisions in federally-sponsored research

Key Concept:
The Federal Science and Technology Budget

The FS&T budget reflects the real federal investment in the creation of new knowledge and technologies and excludes activities such as the testing and evaluation of new weapons systems.

For example, in FY2001:

Total Federal R&D Budget: $85.4 B

Total Federal FS&T Budget: $53.7 B

FS&T Budget includes

- Civilian and noncivilian research budgets for all agencies (including “6.1” and “6.2” at DOD)
- Development budget for all agencies except DOD and DOE. For the development of the later two agencies, only DOD “6.3” and the equivalent activities of the DOE atomic-energy defense program are included in the FS&T budget
- R&D facilities and major capital equipment for R&D

Principle for Allocation of Federal Research Funding

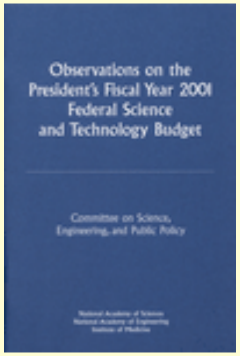
1. The United States should be among the leaders in all major fields of science and technology.

2. The United States should be the absolute leader in key science and technology areas of major importance.

Examples:

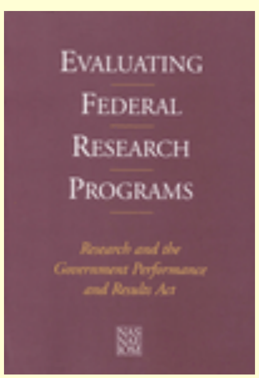
- U.S. should be absolute leader in biotech, infotech
- U.S. should be among leaders in high energy physics

Role of the National Academies



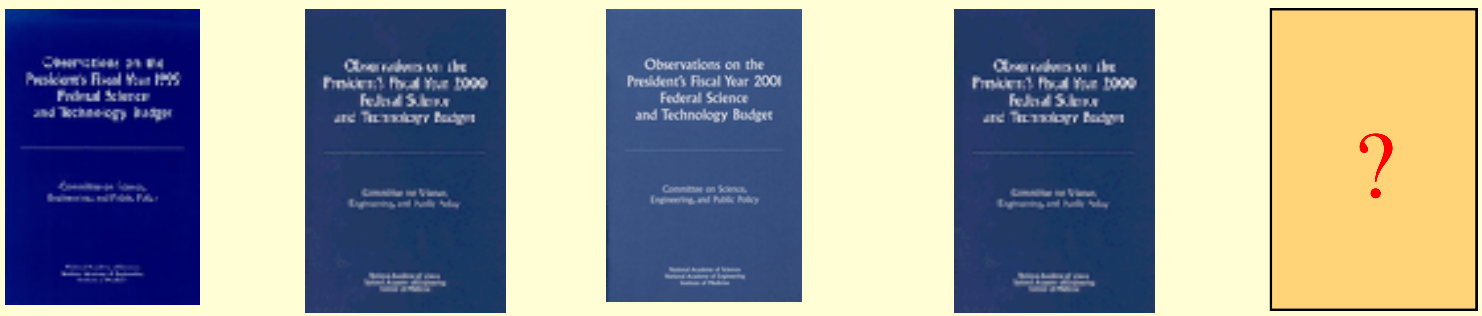
- Annual FS&T Analysis

- Developing methodology to do international benchmarking in various disciplines (e.g., materials science, mathematics, immunology)



- Working with federal government to include benchmarking in application of Government Performance Results Act (GPRA) to research programs of federal agencies

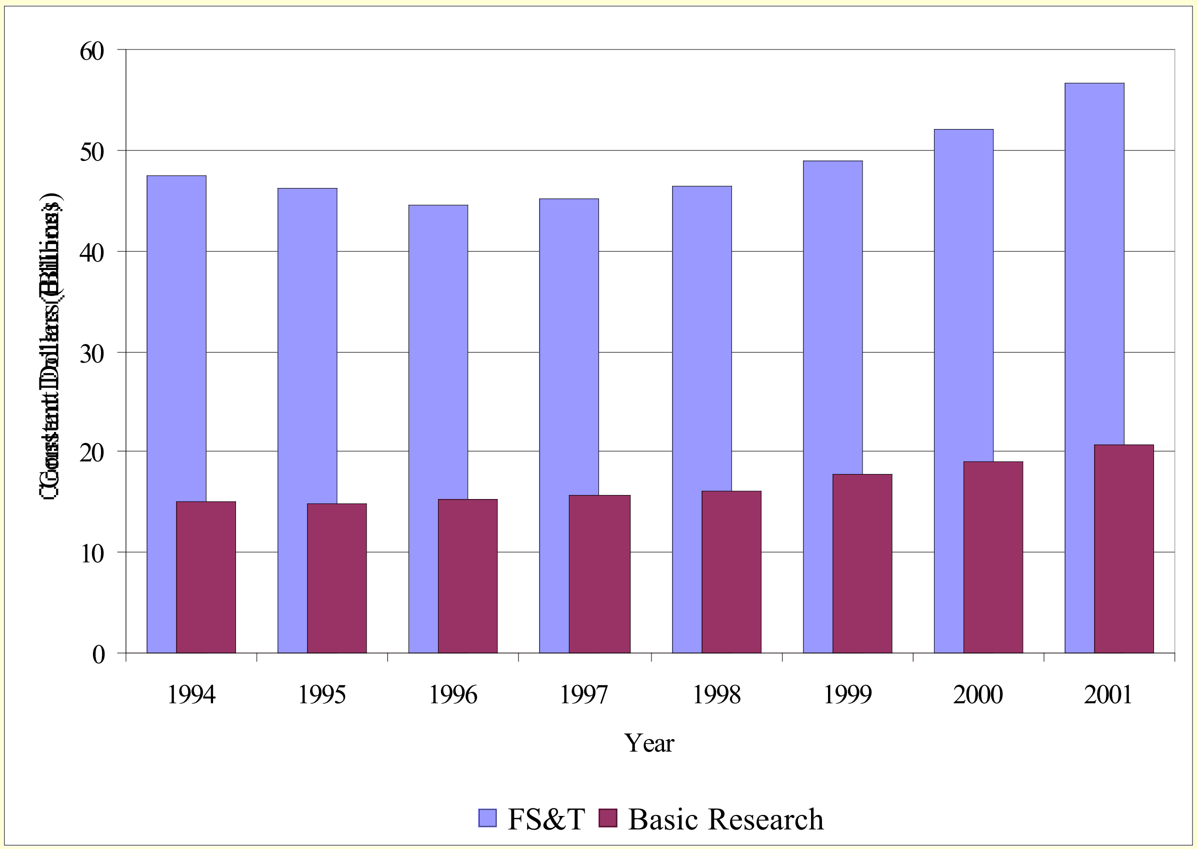
FS&T Reports to date



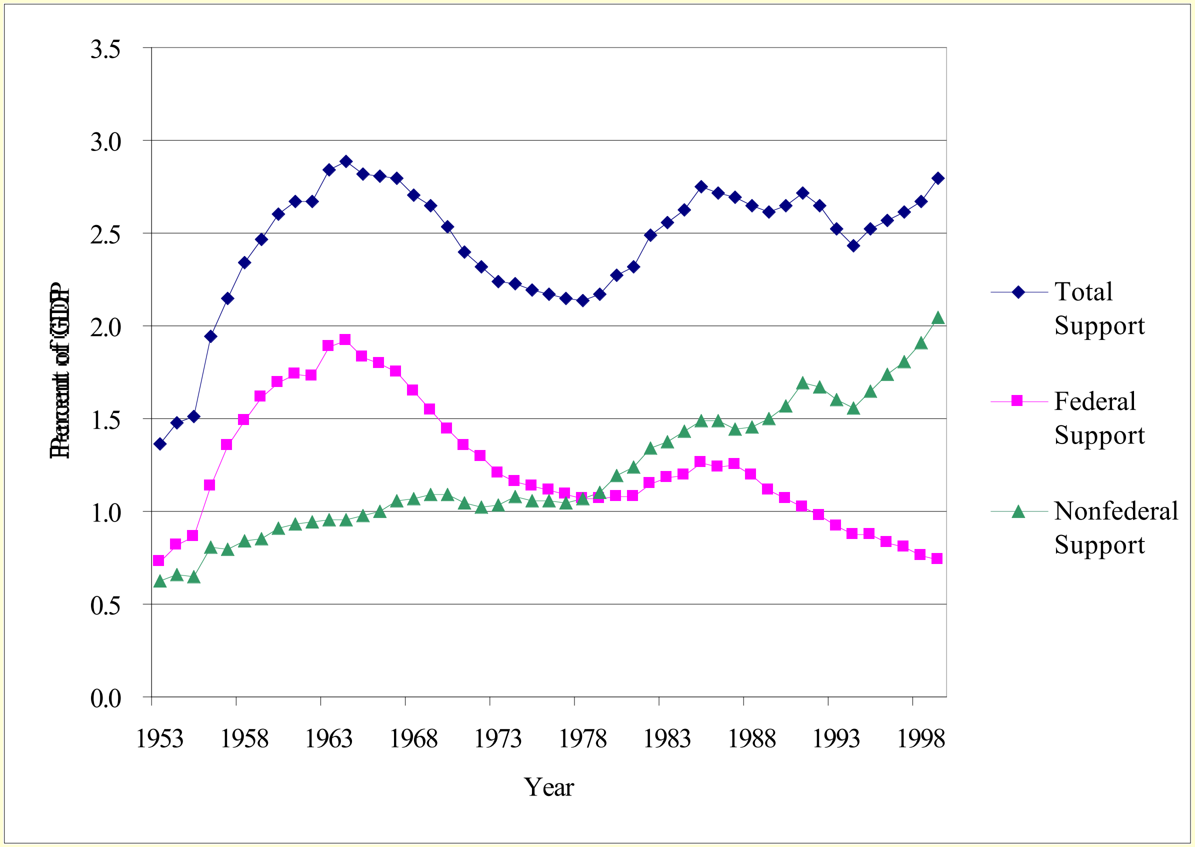
1999 2000 2001 2002 2003

FY2003 FS&T Report

Federal S&T Budget and Federal Support for Basic Research, FY 1994-FY2001



Federal, Non-Federal, and Total Support for R&D as a Percent of GDP, 1953-1999



General Observations

1. FS&T budget dropped significantly in early 1990s and has only recovered in past three years.

2. During the 1990s, the only big winner has been NIH (biomedical sciences); NSF has held its own; everybody else has lost (with DoD losing big time).

3. A serious imbalance has developed in federal funding among the physical sciences, engineering, social sciences, and life sciences.

4. The federal government's share of R&D has fallen far behind industry and no longer may be sufficient to sustain future economic growth of a technology-driven economy.

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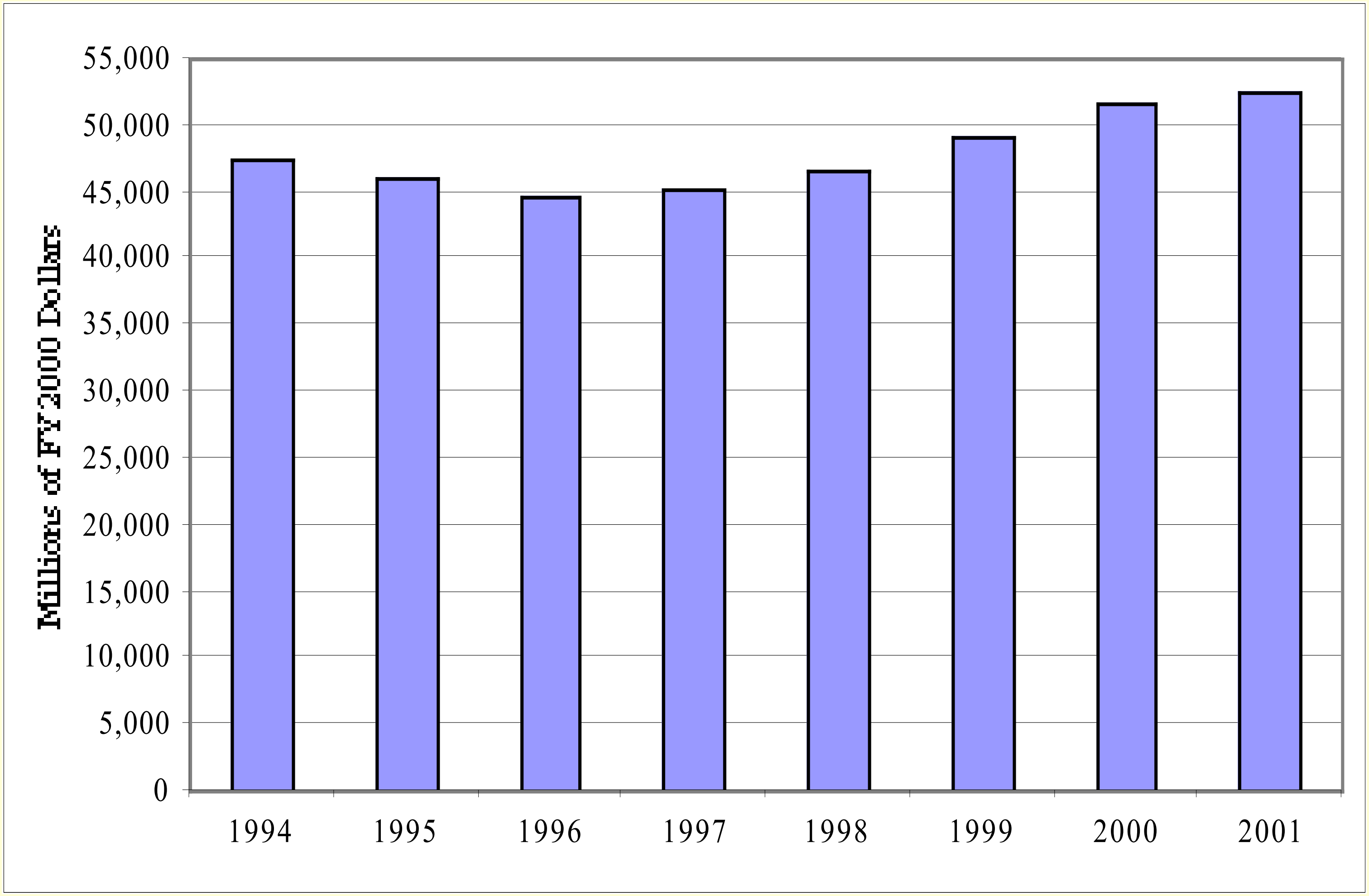
FS&T Budget: 1994-2001



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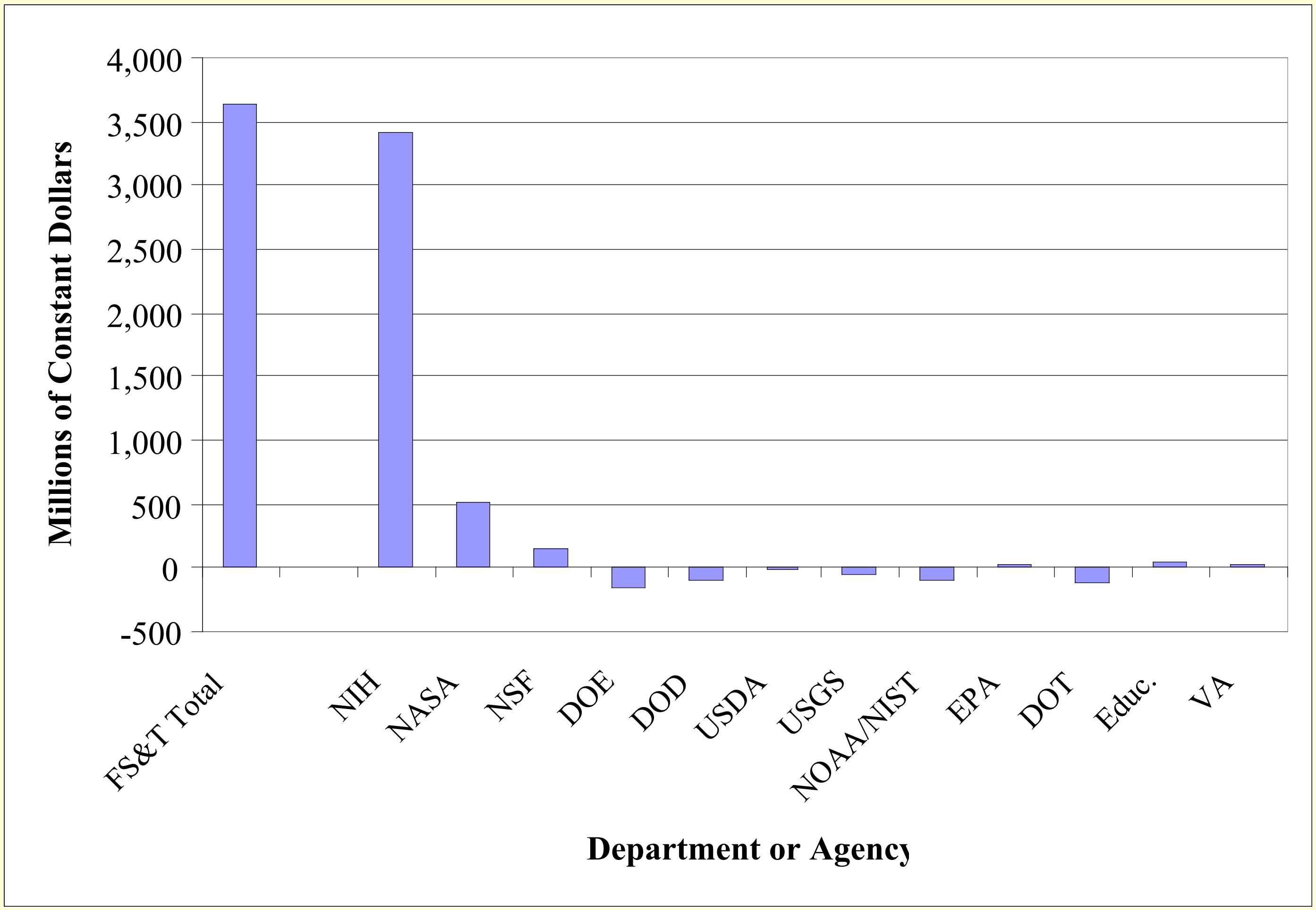
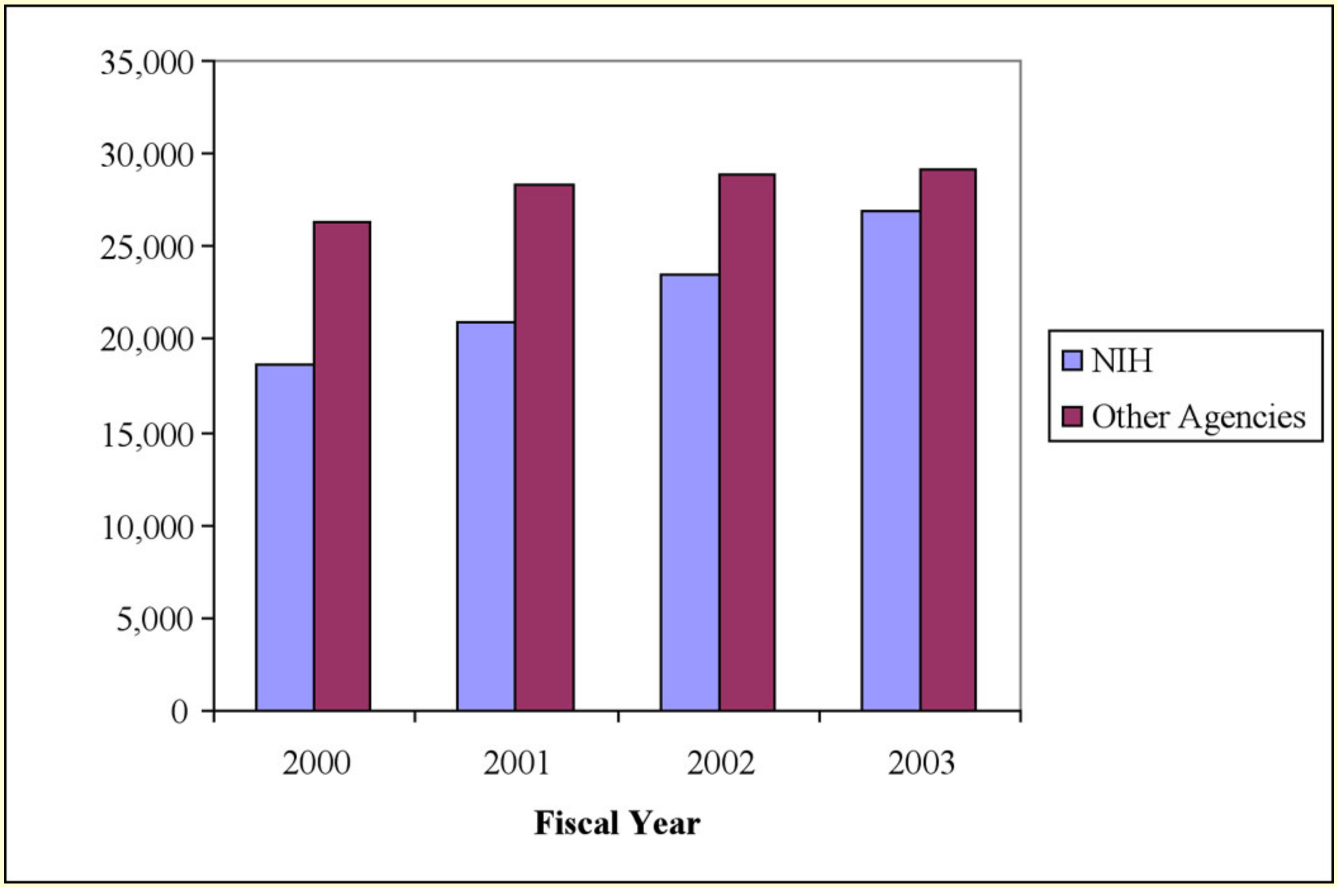
Proposed FS&T Budget Increases for FY03



Source: *Budget of the United States Government, Fiscal Year 2003*.

Federal Funding for FS&T at NIH and at All Other Agencies Combined (in $M)



Winners and Losers

Changes in FS&T budget: 1994 to 2000

NIH: $11.5 B --> $17.1 B (+ 49%)

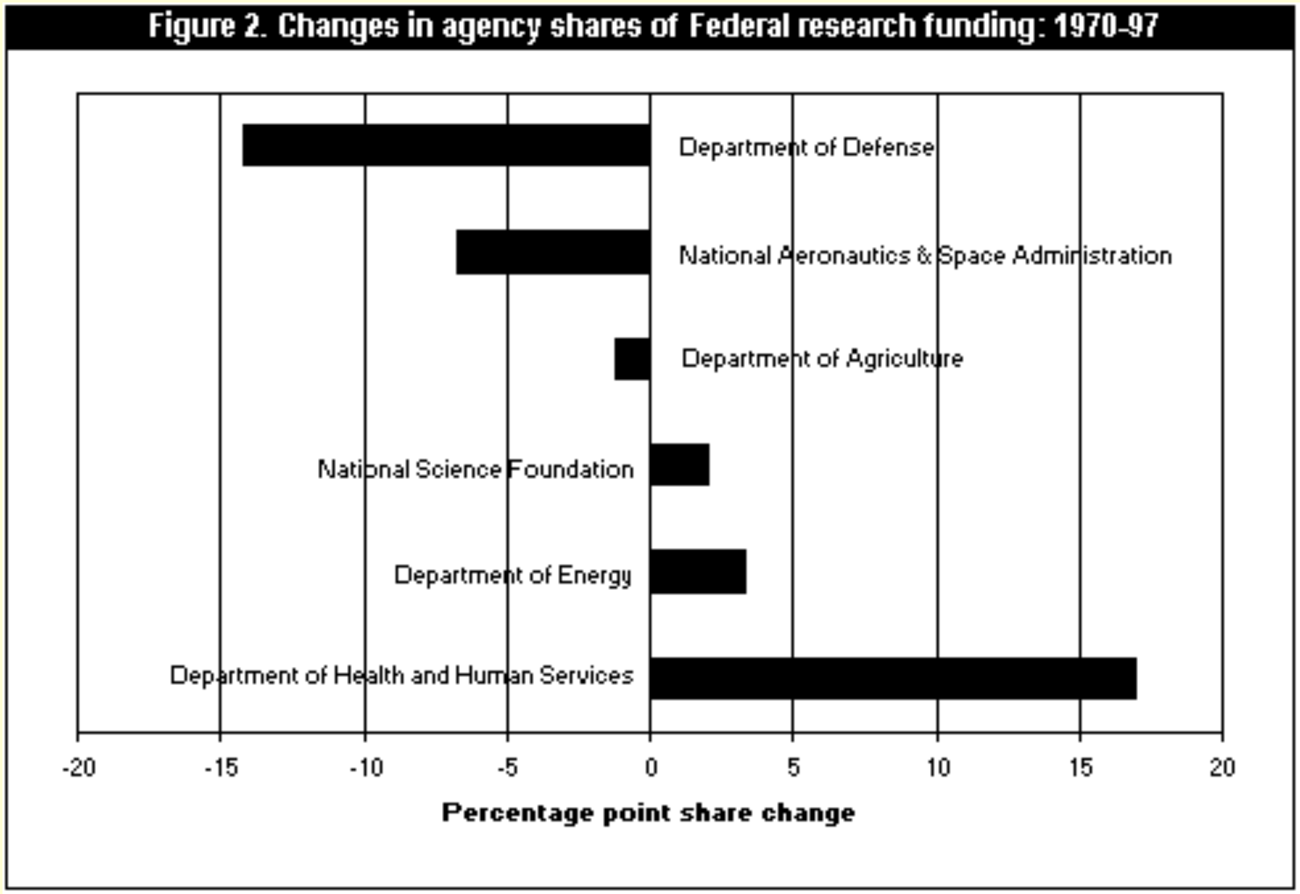
NSF: $2.4 B --> $2.8 B (+ 16%)*

DOD: $9.2 B --> $8.6 B (- 7%)

DOE: $6.5 B --> $6.3 B (- 1%)

NASA: $10.3 B --> $9.7 B (- 6%)

Changes in Agency Funding



SOURCE: National Science Foundation, Division of Science Resouces Studies, Survey of Federal Funds for Research and Development.

FY 2001 Observations (preliminary)

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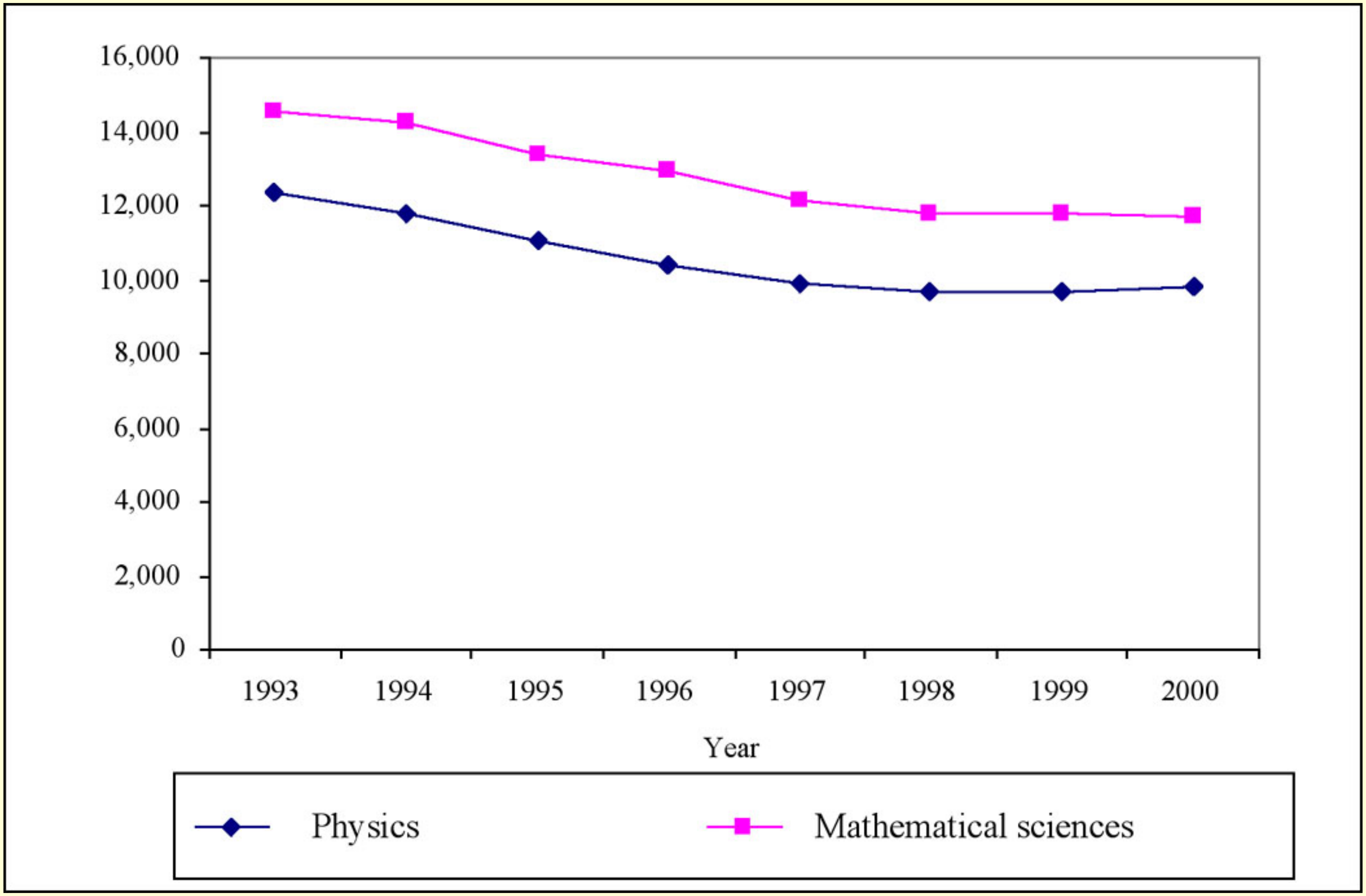
Impact of Changes in Mission Agency Budgets on Key Fields

- Major increase in NIH budget (48%); minor increase in NSF budget (16%)
- Decreases in DOD, DOE, NASA, and USDA FS&T Budgets
- Concern: The impact that projected decreases in the FS&T budgets of mission agencies could have on selected fields

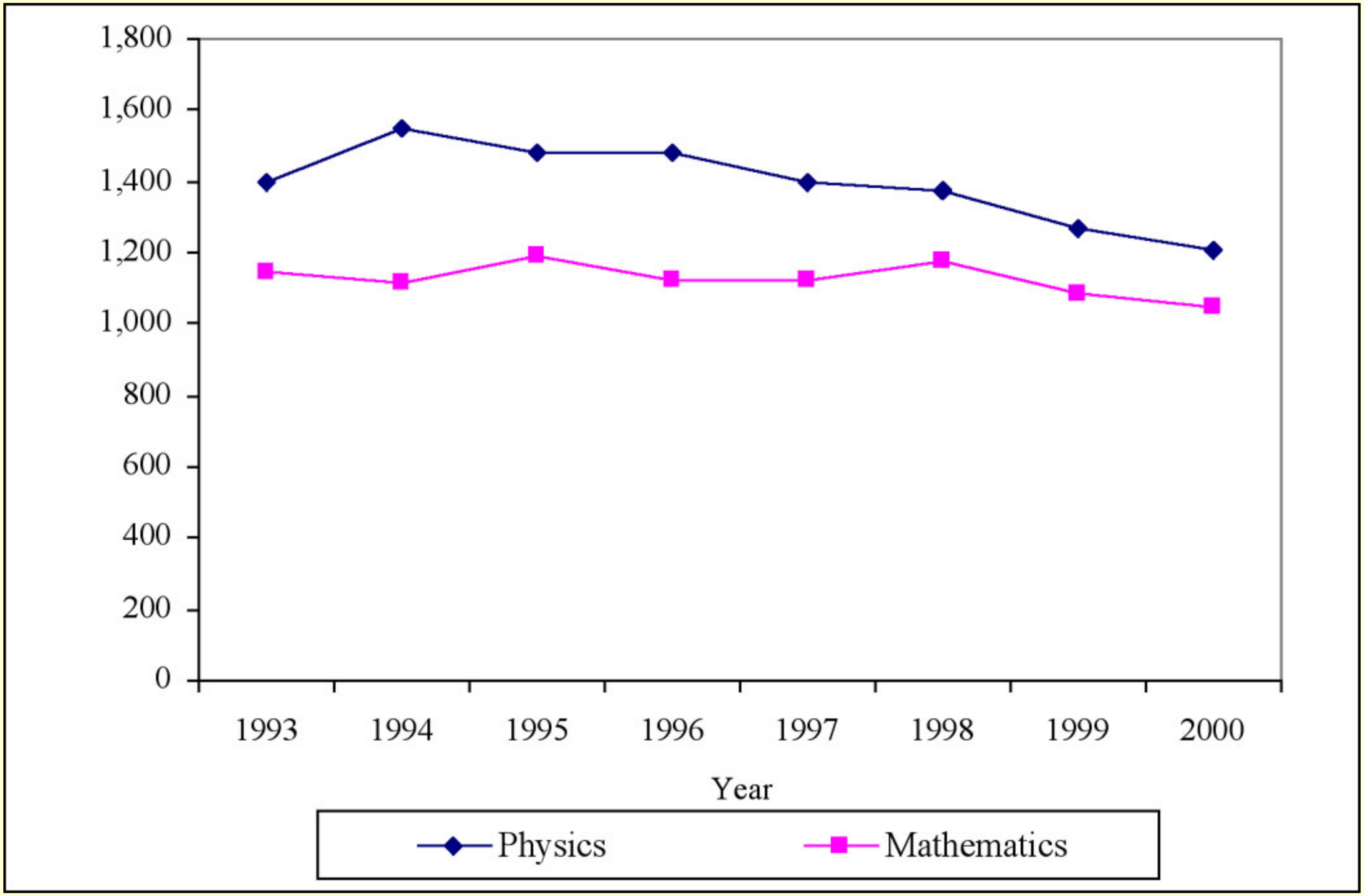
Fields with Majority of Support from Mission Agencies

- DOE: Physics (46%), Nuclear Engineering (100%)
- DOD: Computer Science (60%), Electrical and Mechanical Engineering (69%), Biological and Social Aspects of Psychology(66%), (also Mathematics (27%) and Materials Science and Engineering (38%))
- NASA: Astronomy (68%), Aeronautical and Astronautical Engineering (40%)
- USDA: Agriculture (99%)

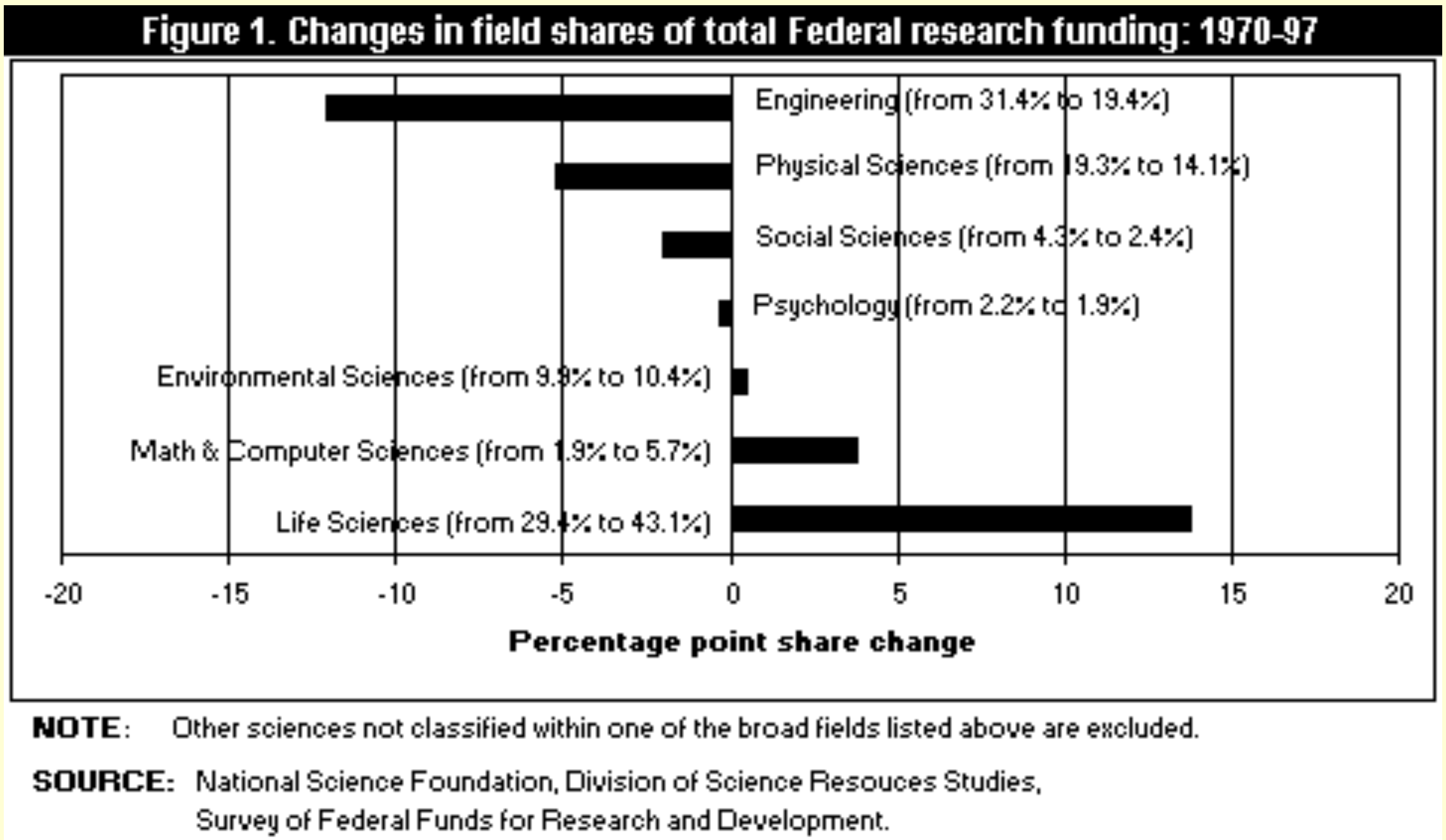
Graduate enrollments



PhD Graduation Rates



Changes in disciplinary funding



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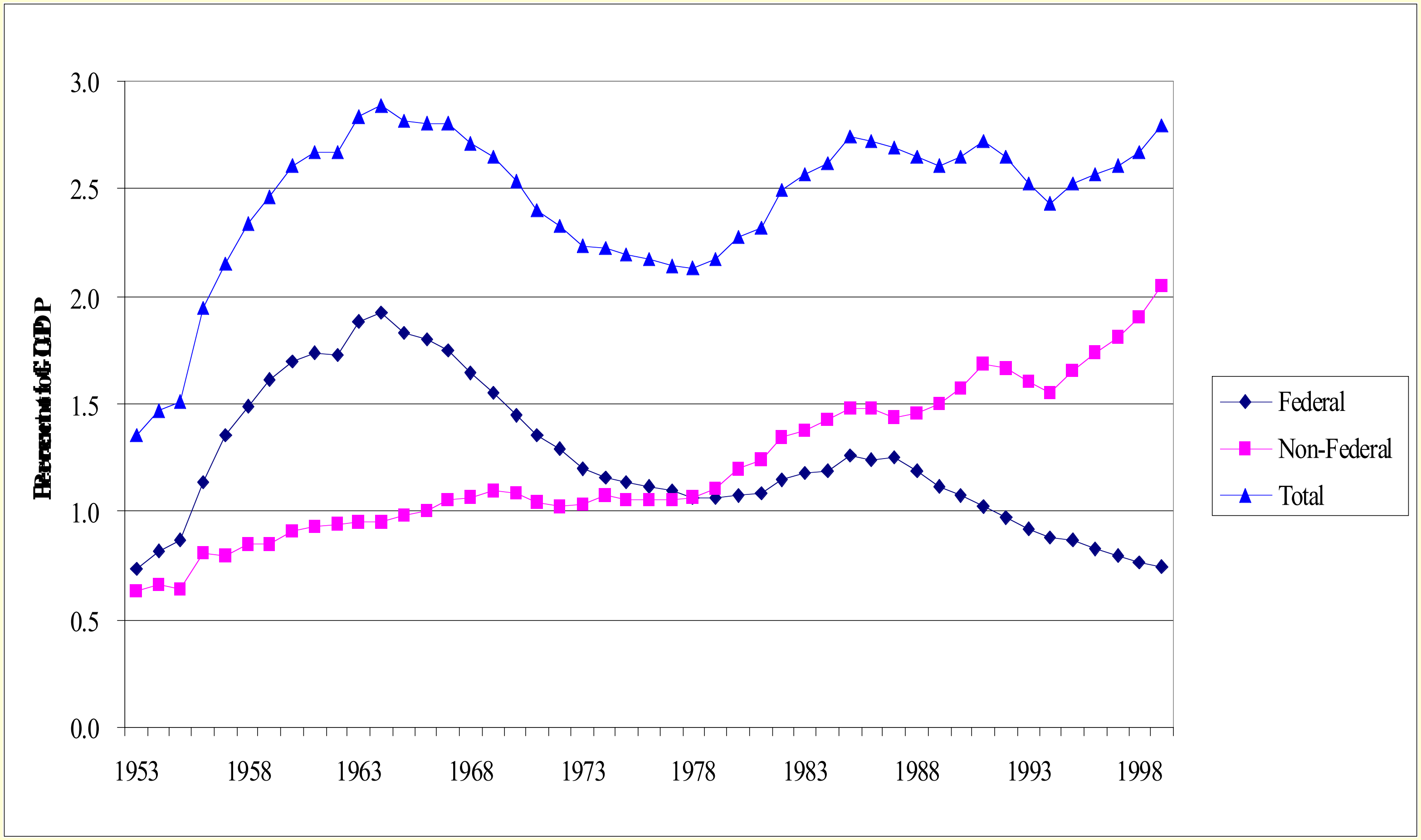
Federal vs. Non-Federal R&D



Administration Priorities for FY03

- Biomedical research has been identified as top priority (14.6% increase in NIH to $26.8 B) (although 40% of this for counter-terrorism)
- Space sciences: +11% to $333 M
- Nanotechnology: + 15.2% to $667 M
- Climate Change: + 3.2% to $1.7 B
- Education: + 12.3% to $423 M

What about everything else?

- While NIH will increase by 14.6%, the rest of the FS&T budget will be relatively flat (less than 1% increase in constant dollars)
- NSF budget increases primarily through interagency transfers; Research & Related Accounts actually decreases
- DOD: - 1.9%
- DOE: - 3.2% (DOE Science: - 0.4%)
- DOT: - 17.3%

Another way to look at it…

94% of the proposed increase in the FY03 FS&T budget is due to growth in NIH.

If the Adminstration's request is enacted, then 48% of the total FS&T budget would be due to NIH!

(And over 60% of all federal research dollars spent on university campuses would be in biomedical research.)

The Details

TABLE 1 Federal Science and Technology Budget, FY2000-FY2003 (millions of constant FY2002 dollars)

					Percent Change	
	2000 Actual	2001 Actual	2002 Est.	2003 Proposed	FY 2001-FY 2002	FY 2002-FY 2003
National Institutes of Health	18,640	20,887	23,433	26,852	12.2%	14.6%
NASA	7,333	7,960	8,113	8,619	1.9%	6.2%
Space Science	2,725	2,821	3,034	3,367	7.6%	11.0%
Earth Science	1,813	1,865	1,695	1,610	-9.1%	-5.0%
Biological and Physical Research	877	965	828	836	-14.2%	1.0%
Aero-space technology	1,918	2,310	2,556	2,806	10.7%	9.8%
National Science Foundation	4,081	4,534	4,795	4,947	5.7%	3.2%
Dept. of Energy	4,536	5,019	5,099	4,938	1.6%	-3.2%
Science Programs	2,949	3,289	3,240	3,227	-1.5%	-0.4%
Renewable Energy	320	378	386	401	2.1%	3.8%
Nuclear Energy	236	267	244	247	-8.5%	1.0%
Energy Conservation	603	633	641	579	1.3%	-9.7%
Fossil Energy R&D	428	453	588	485	29.9%	-17.5%
Dept. of Defense	4,748	5,053	4,961	4,864	-1.8%	-1.9%
Basic Research (6.1)	1,188	1,299	1,305	1,312	0.5%	0.6%
Applied Research (6.2)	3,560	3,754	3,656	3,552	-2.6%	-2.8%
Dept. of Agriculture	1,839	1,926	1,890	1,879	-1.9%	-0.6%
CSREES Research and Education	510	525	552	553	5.1%	0.2%
Economic Research Service	70	71	70	81	-0.7%	15.1%
Mandatory Research Grants	125	123	0	0	-100.0%	0.0%
Agricultural Research Service	905	957	1,017	996	6.3%	-2.1%
Forest Service	228	251	251	250	-0.2%	-0.6%
Dept. of the Interior (USGS)	886	938	950	888	1.3%	-6.5%
Dept. of Commerce	864	846	948	846	12.0%	-10.8%
NOAA (Oceanic/Atmospheric Research)	298	332	362	292	9.0%	-19.4%
NIST	566	514	586	554	14.0%	-5.5%
Environmental Protection Agency	714	762	750	783	-1.6%	4.4%
Dept. of Transportation	620	532	651	538	22.3%	-17.3%
Highway Research	512	396	448	414	13.3%	-7.7%
Aviation Research	108	137	203	125	48.2%	-38.5%
Dept. of Education	331	371	377	423	1.6%	12.3%
Special Education Res. and Innovation	67	79	78	77	-0.9%	-1.8%
NIDRR	90	102	110	108	7.6%	-1.8%
Res., Dev., and Dissemination	175	190	189	239	-0.6%	26.3%
Dept. of Veterans Affairs	336	371	373	402	0.5%	7.7%
FS&T Total	44,927	49,201	52,340	55,979	6.4%	7.0%
NIH	18,640	20,887	23,433	26,852	12.2%	14.6%
FS&T Total minus NIH	26,287	28,314	28,907	29,128	2.1%	0.8%
NIH as percent of FS&T Total	41.5%	42.5%	44.8%	48.0%	--	--

Source: *Budget of the United States Government, Fiscal Year 2003*

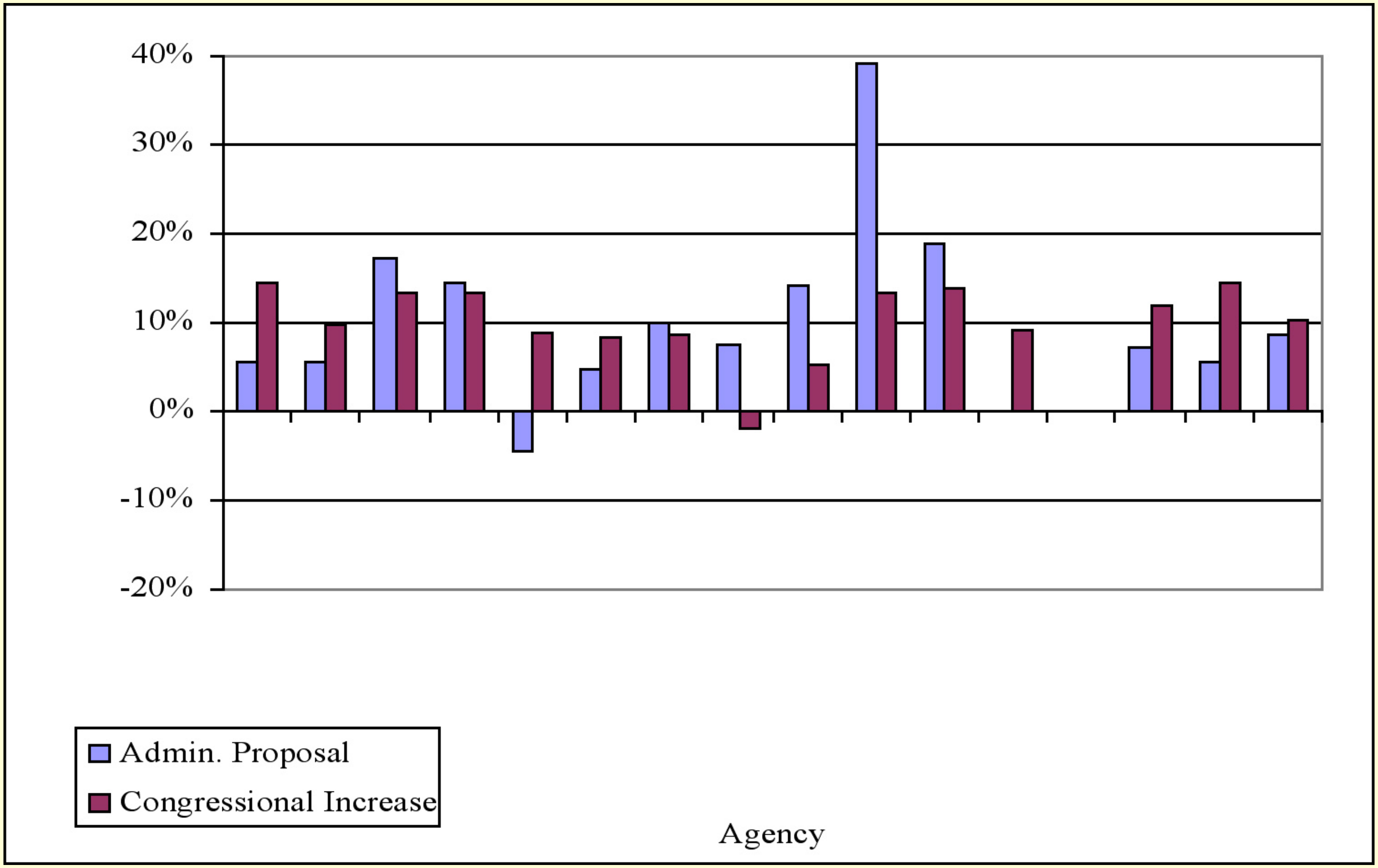
The Sorry Details

TABLE 2 Proposed Percentage Change in Constant Dollars in FS&T Spending by Agency and by Science Program, FY2002-FY2003

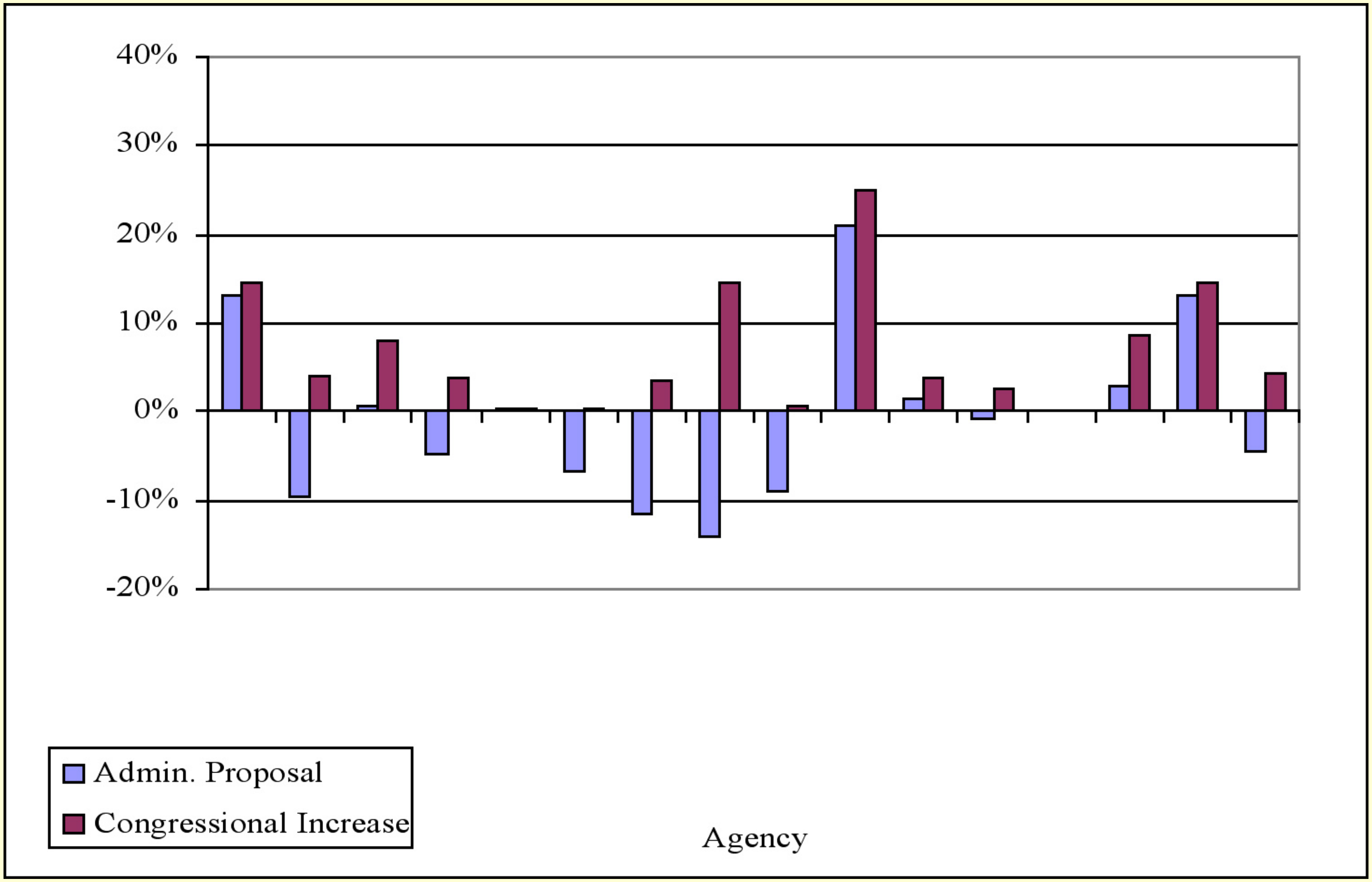
	Percent Change, FY2002-FY2003
AGENCIES	
Dept. of Health & Human Services (NIH)	14.6%
Dept. of Education	12.3%
Dept. of Veterans Affairs	7.7%
FS&T TOTAL	7.0%
NASA	6.2%
Environmental Protection Agency (EPA)	4.4%
National Science Foundation (NSF)	3.2%
FS&T minus NIH	0.8%
Dept. of Agriculture	-0.6%
Dept. of Defense	-1.9%
Dept. of Energy	-3.2%
Dept. of the Interior (USGS)	-6.5%
Dept. of Commerce	-10.8%
Dept. of Transportation	-17.3%
PROGRAMS	
USED Research, Development, and Dissemination	26.3%
USDA Economic Research Service	15.1%
NASA Space Science	11.0%
NASA Aero-space technology	9.8%
FS&T TOTAL	7.0%
DOE Renewable Energy	3.8%
DOE Nuclear Energy	1.0%
NASA Biological and Physical Research	1.0%
FS&T minus NIH	0.8%
DOD Basic Research (6.1)	0.6%
USDA CSREES Research and Education	0.2%
USDA Mandatory Research Grants	0.0%
DOE Science Programs	-0.4%
USDA Forest Service	-0.6%
U SED Special Education Research and Innovation	-1.8%
USED NIDRR	-1.8%
USDA Agricultural Research Service	-2.1%
DOD Applied Research (6.2)	-2.8%
NASA Earth Science	-5.0%
NIST	-5.5%
DOI U.S. Geological Survey	-6.5%
DOT Highway Research	-7.7%
DOE Energy Conservation	-9.7%
DOE Fossil Energy R&D	-17.5%
NOAA (Oceanic and Atmospheric Research)	-19.4%
DOT Aviation Research	-38.5%

Source: *Budget of the United States Government, Fiscal Year 2003*

The Clinton Approach (FY01)



The Bush Approach (FY02)



Some Hope

TABLE 5 Administration Proposal and Congressional Appropriations for the Federal Science and Technology Budget, FY 2001 Actual, FY 2002 Administration Proposal, and FY 2002 Congressional Appropriation (constant FY 2002 dollars)

	2001 Actual	2002 Proposed	Proposed Increase	2002 Est.	Actual Increase
National Institutes of Health	20,438	23,112	13.1%	23,433	14.7%
NASA	7,789	7,038	-9.6%	8,113	4.2%
National Science Foundation	4,437	4,472	0.8%	4,795	8.1%
Dept. of Energy	4,911	4,682	-4.7%	5,099	3.8%
Dept. of Defense	4,944	4,963	0.4%	4,961	0.3%
Dept. of Agriculture	1,885	1,759	-6.7%	1,890	0.3%
Dept. of the Interior (USGS)	918	813	-11.4%	950	3.5%
Dept. of Commerce	828	711	-14.1%	948	14.5%
Environmental Protection Agency	746	679	-9.0%	750	0.5%
Dept. of Transportation	521	631	21.1%	651	25.0%
Dept. of Education	363	368	1.4%	377	3.9%
Dept. of Veterans Affairs	363	360	-0.8%	373	2.8%
FS&T Total	48,143	49,588	3.0%	52,340	8.7%
NIH	20,438	23,112	13.1%	23,433	14.7%
FS&T Total-NIH	27,705	26,476	-4.4%	28,907	4.3%

Source: *Budget of the United States Government, Fiscal Year 2003*

The Process

Retrospective:

Shifting needs of society?

Federal policies addressing strategic needs?

Congressional sausage-making process?

Prospective:

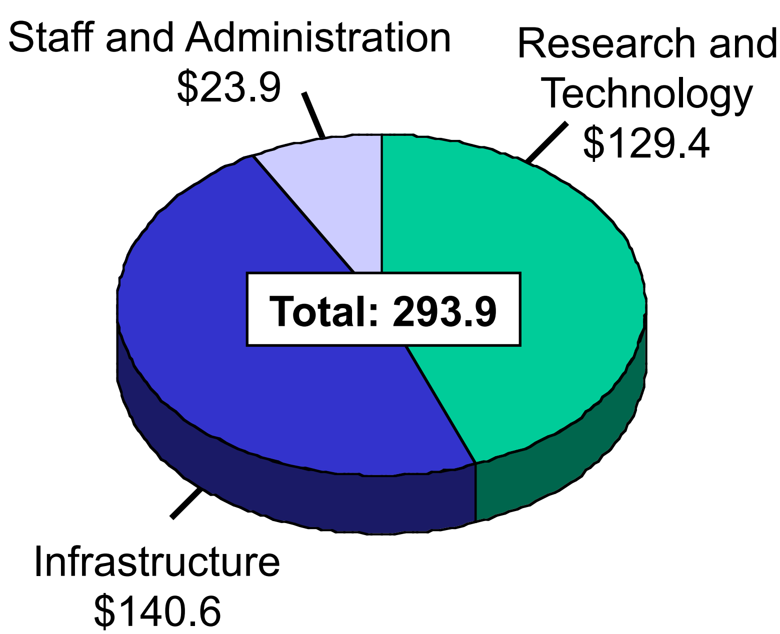
Press Report Approach (leadership)?

Jeffersonian vs. Newtonian vs. Baconian science?

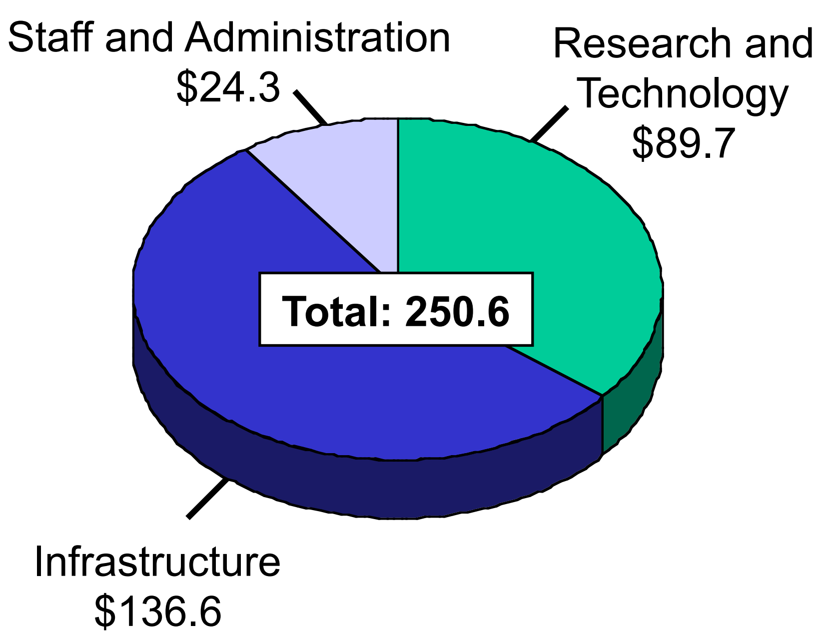
(Pasteur’s Quadrant)

Total Nuclear Energy Funding ($ in Millions)

FY 2002 Appropriation



FY 2003 Request



Continued Evolution of Nuclear Energy Budget

($ in Thousands)

	FY 2001 Adjusted Approp.	FY 2002 Current Approp.	FY 2003 Request
University Program	$ 11,974	$ 17,500	$ 17,500
NEPO	4,857	6,500	0
NERI	33,903	32,000	25,000
NET	7,483	12,000	46,500
ANMI	2,500	2,500	0
FFTF	38,439	36,439	36,100
Spent Fuel Pyroprocessing & Transmutation	68,698	77,250	18,221
Radiological Facilities Management	88,284	86,682	83,038
Program Direction	23,839	23,875	24,300
Adjustments	-2,872	-818	0
TOTAL	**$277,105**	**$293,928**	**$250,659**

Major Program Developments
Further Focussing on Nuclear R&D

6 **Radiological Facilities Management**
- RTG Manufacturing
- Research Reactor and Other Nuclear Infrastructure
- Isotope Production

6 **Nuclear Energy Protocol for Research Isotopes (NEPRI)**
- Requires peer review to establish annual list
- Requires advanced payment
- No more subsidy for research isotopes

Major Program Developments
Further Focussing on Nuclear R&D (cont.)

6 **Innovations in Nuclear Infrastructure and Education (INIE)**

- Implementation of NERAC recommendations
- Encourages close cooperation between universities, industry, and laboratories
- $5 million available in FY 2002

6 **Fast Flux Test Facility**

- Secretary of Energy decision in December 2001
- Proceeding with deactivation

Major Program Developments
Further Focussing on Nuclear R&D (cont.)

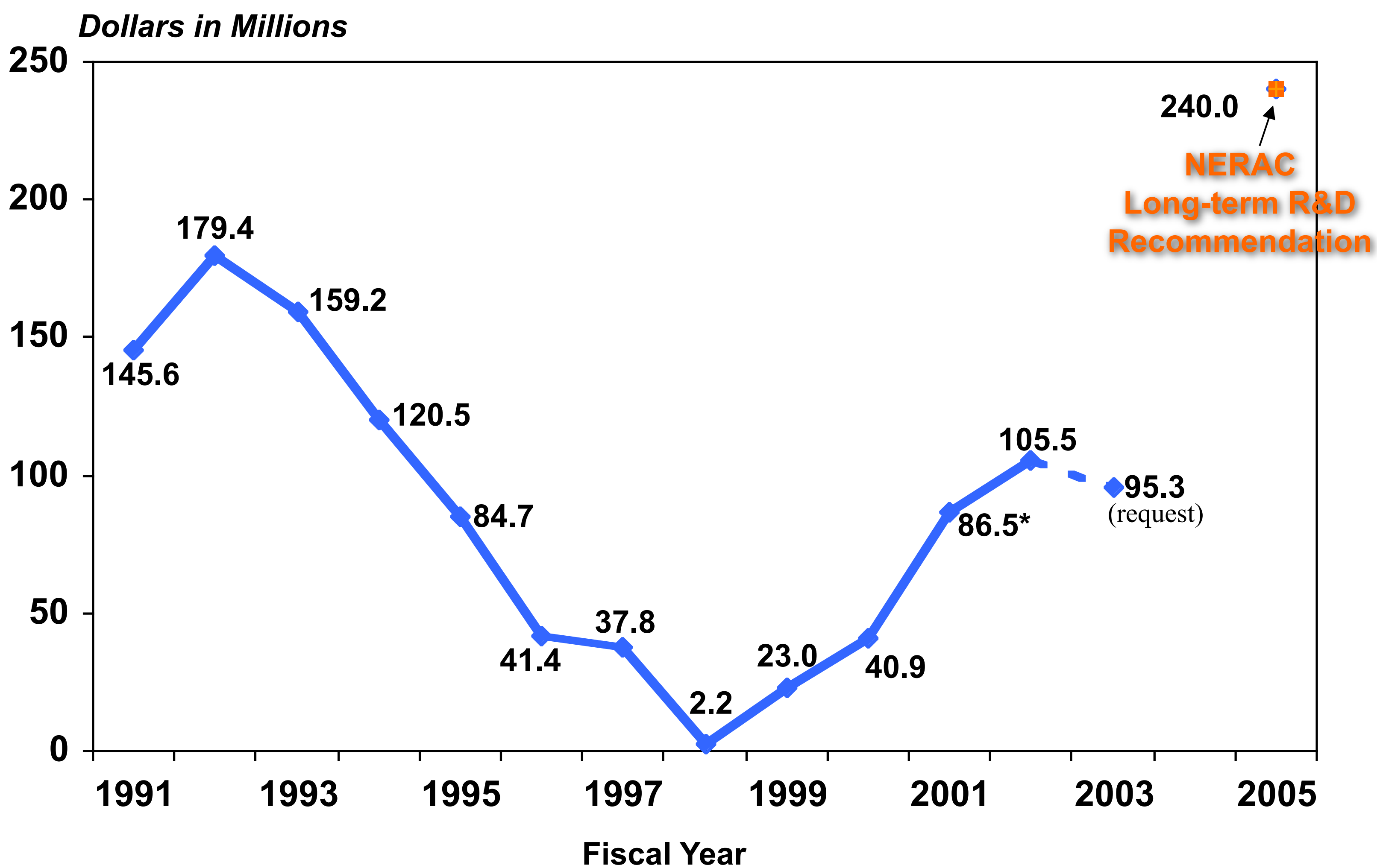
6 **Transmutation of Radioactive Wastes**

- Richter Committee recommendations
- Proposed R&D program: $500 M over five years)
- Demonstration program: Billions..

6 **Space Nuclear Power Systems**

- NASA program for FY03 ($850 M over five years)
  - Space nuclear power systems (Mars, Outer Planets)
  - Space nuclear propulsion

Research & Development Budget History



*Does not include $34 million of funding for the APT budget which was funded by DP in FY 2001.

COSEPUP Hearings

Participants: Key staff from OMB, Congress, NSF, NIH

1. Neither Congress nor Administration are capable of developing a strategic research budget. The budget is a political document. Hence science policy has to be politically driven. NIH growth has occurred because of exceptionally strong and effective lobbying.

2. It is not realistic to expect that the current science committee structure can be changed (e.g., shifting NSF out of HUD-Ind Ag). Lots of broken pickaxes on this, including Gringrich's.

COSEPUP Hearings (cont)

3. May be some opportunity to broaden the basic research mandates of federal agencies (e.g., NIH assuming more responsibility for research in physical sciences and engineering.)

4. Real key is for scientific community to get outside of the box, to move beyond Administration and Congress and build support for physical science and engineering similar to life sciences.

5. Congress seems increasingly aware of the linkage:

Basic Research → Attracts Best Minds → Trains Best Students → Start New Companies