Science, Technology, and the Federal Budget

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for the OPM Science, Technology, and Public Policy Seminar

AAAS R&D Budget and Policy Program

http://www.aaas.org/spp/rd

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ADVANCING SCIENCE, SERVING SOCIETY

WHY THE BUDGET?

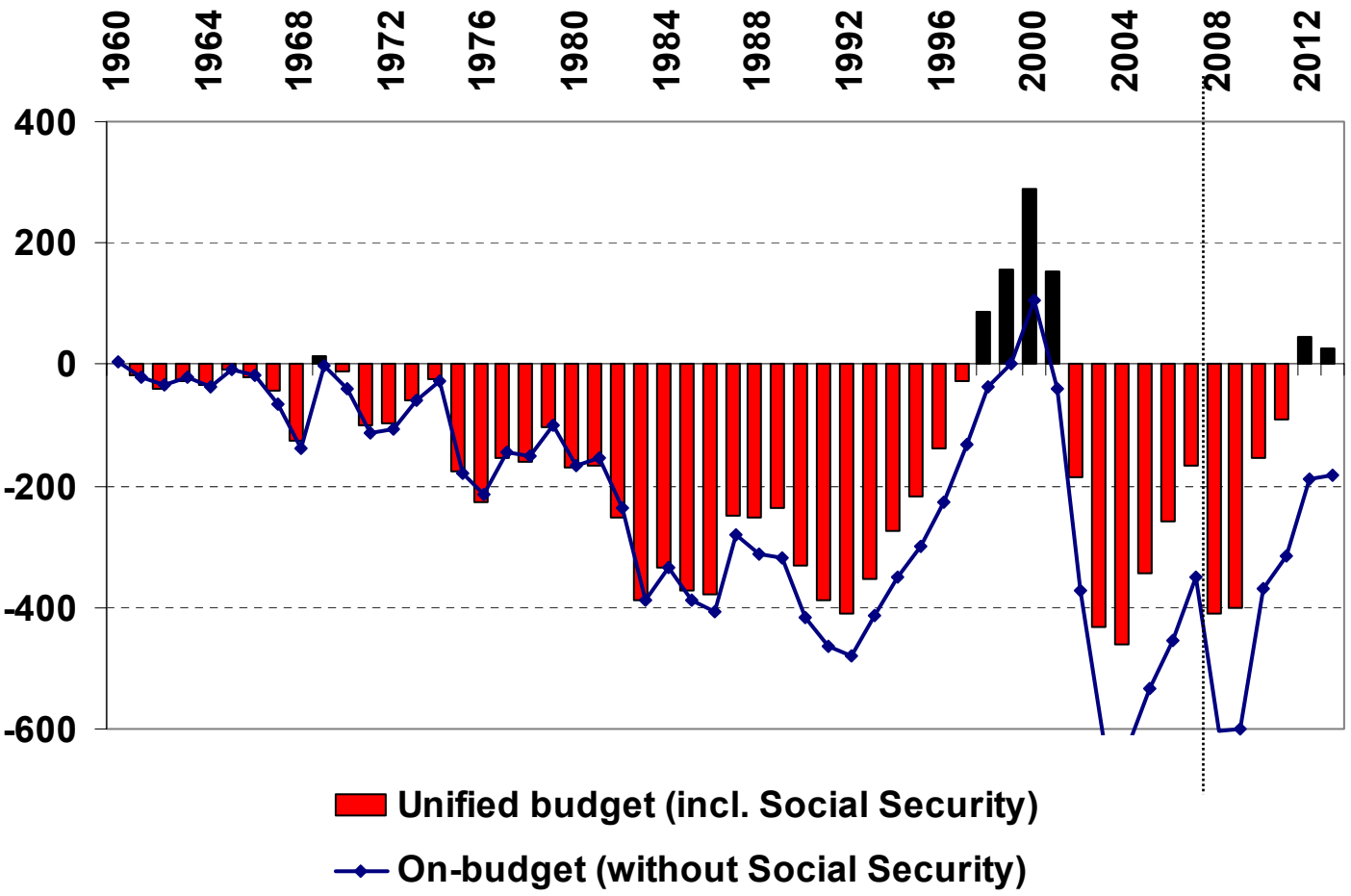
- The federal budget determines the health of U.S. science and engineering research and education.
- "The U.S. doesn't have a science policy, it has a budget policy for science." – Rep. George Brown
- Policy decisions and authorization bills may not be completed, but every year budget decisions are (eventually) made.
- The federal government funds 1/3 of all U.S. R&D and 60 percent of all university R&D.
- The budget process determines priorities for the federal R&D investment.

THE FY 2009 BUDGET SITUATION

- The federal government will have record budget deficits in 2008 and 2009.
- To help control the deficit, the President proposes to keep domestic appropriations flat in 2009. The congressional budget allows domestic appropriations to keep pace with inflation.
- Domestic appropriations barely kept pace with inflation in 2006, 2007, and 2008.
- Historically, federal R&D investments have closely tracked trends in discretionary spending.
- Entitlement spending will grow dramatically in the next few years as the baby-boom generation hits retirement age.
- Future war costs are a big unknown.

Federal Budget Deficit (or Surplus), FY 1960-2013

in billions of CONSTANT FY 2008 dollars



Data in fiscal years. Source: *Budget of the United States Government, FY 2009.* FY 2008 data are estimates. FY 2009-2013 data are President's budget proposals. FY 2009 - 2013 figures exclude Iraq and Afghanistan military costs.

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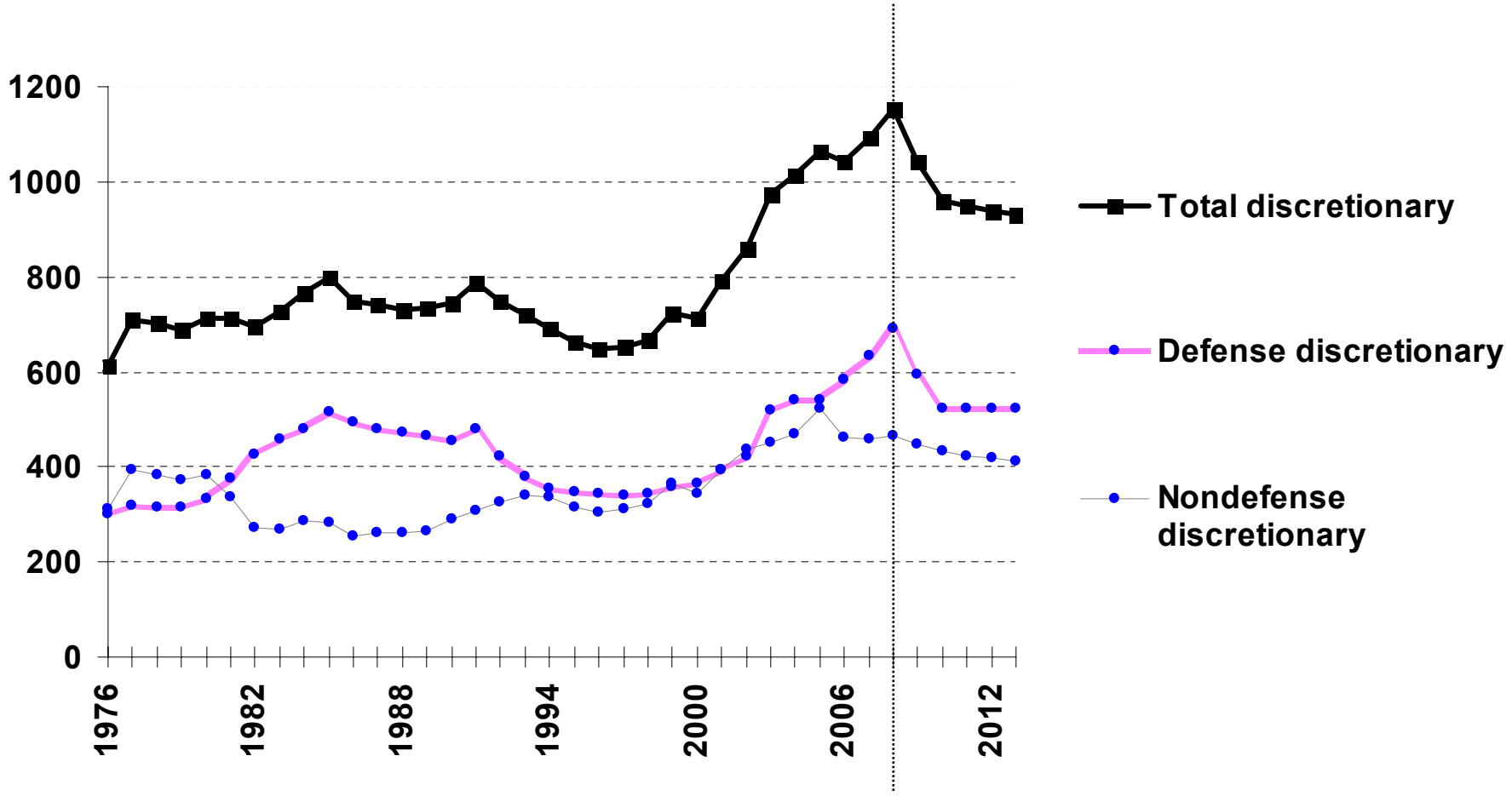
Trends in Discretionary Spending, FY 1976-2013

in billions of constant FY 2008 dollars



Data in fiscal years. Source: *Budget of the United States Government, FY 2009.* FY 2008 data are estimates. FY 2009-2013 data are budget projections. FY 2009-2013 figures exclude Iraq and Afghanistan military costs.

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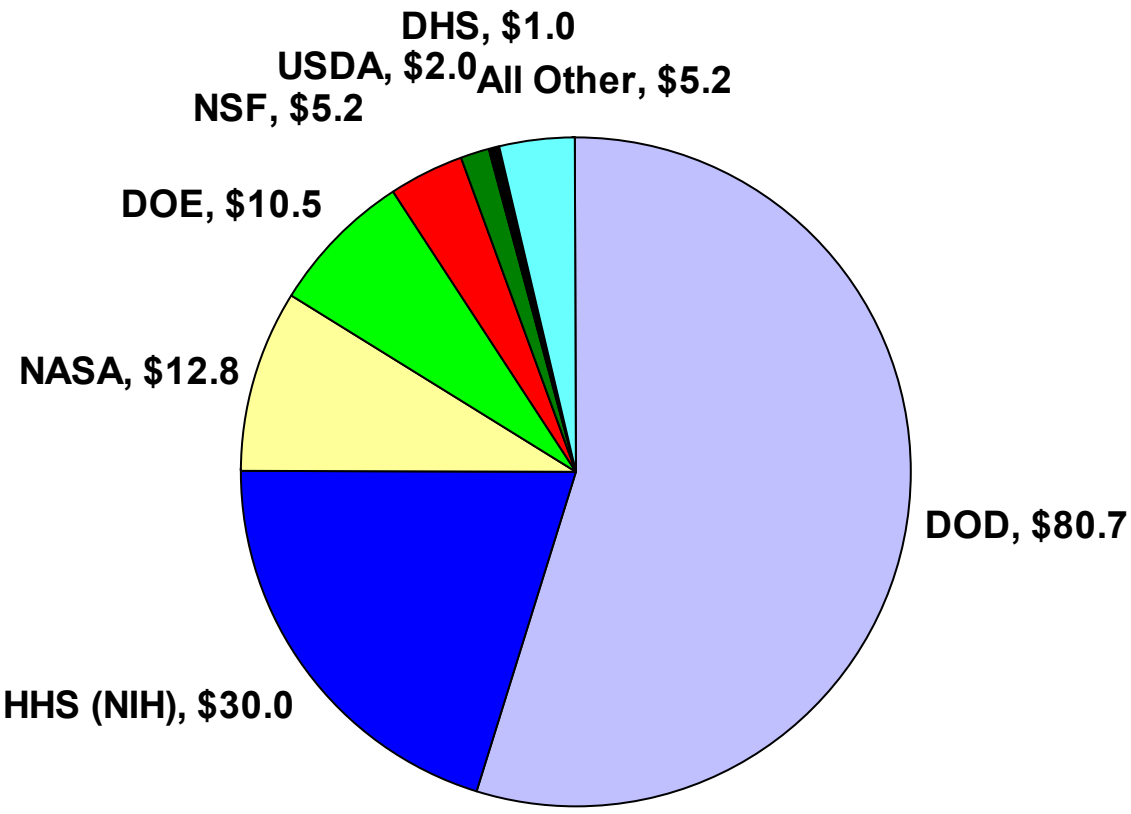
FEDERAL R&D IN THE BUDGET

- There is no “R&D budget.” Federal R&D spending comes from 24 federal departments and independent agencies scattered throughout the budget.
- R&D funding trends have closely mirrored trends in the overall discretionary budget.

Total R&D by Agency: FY 2009 Proposed

Budget Authority in billions of dollars

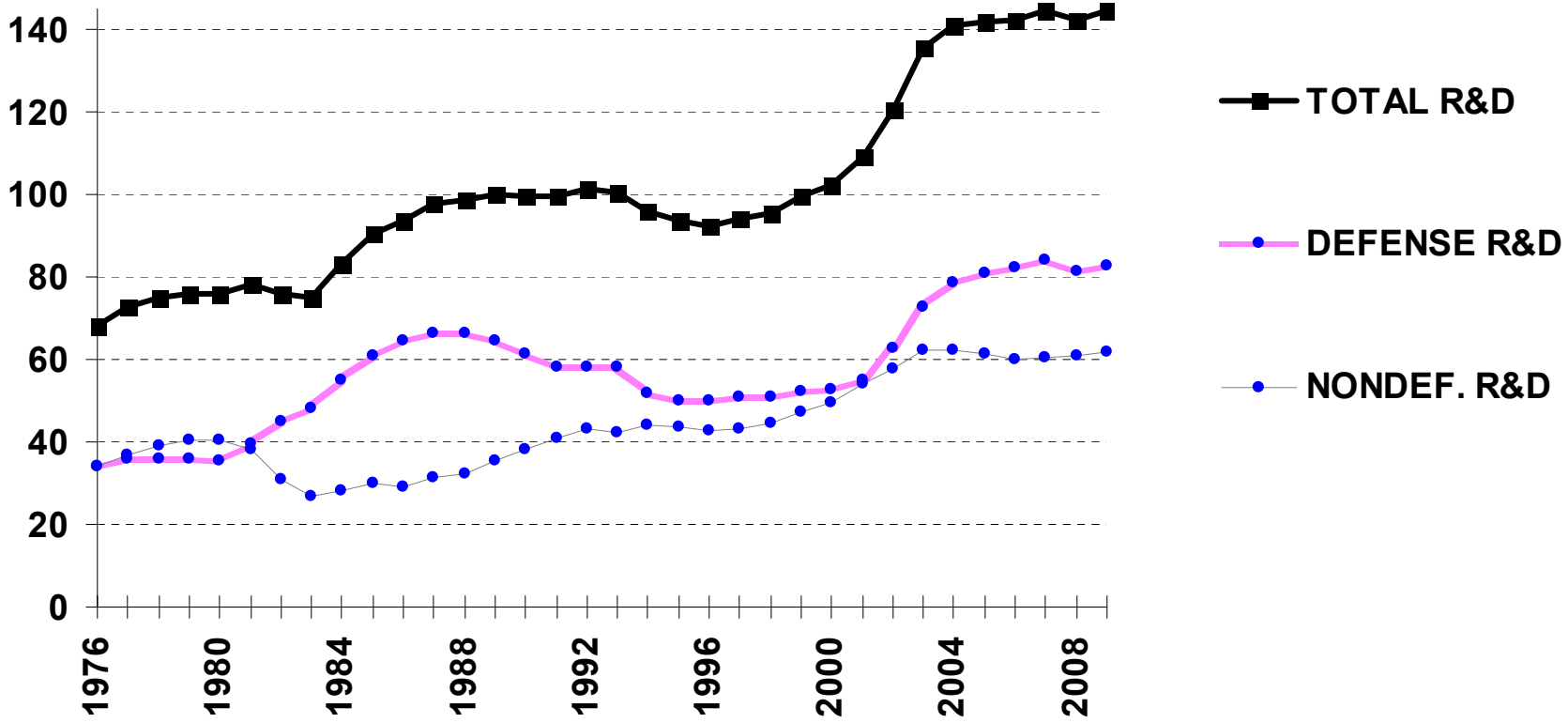


Total R&D = $147.4 billion (revised)

Source: AAAS, based on OMB R&D Budget Data and agency estimates for FY 2009.

Trends in Federal R&D, FY 1976-2009 *

in billions of constant FY 2008 dollars



Source: AAAS analyses of R&D in *AAAS Reports VIII-XXXIII.* * FY 2009 figures are latest AAAS estimates of FY 2009 request.
R&D includes conduct of R&D and R&D facilities.
MARCH '08 REVISED

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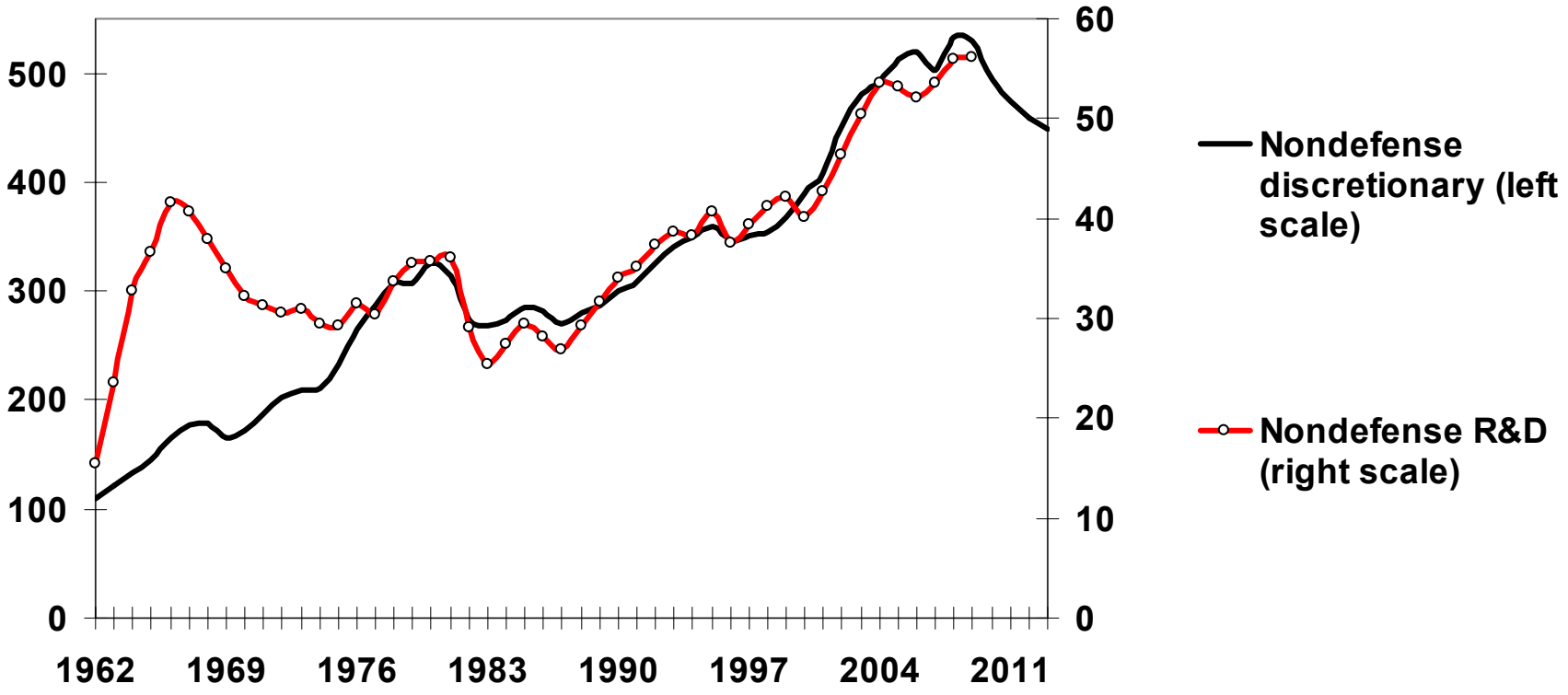
R&D and Discretionary Outlays (Nondefense), 1962-2013

in billions of constant FY 2008 dollars



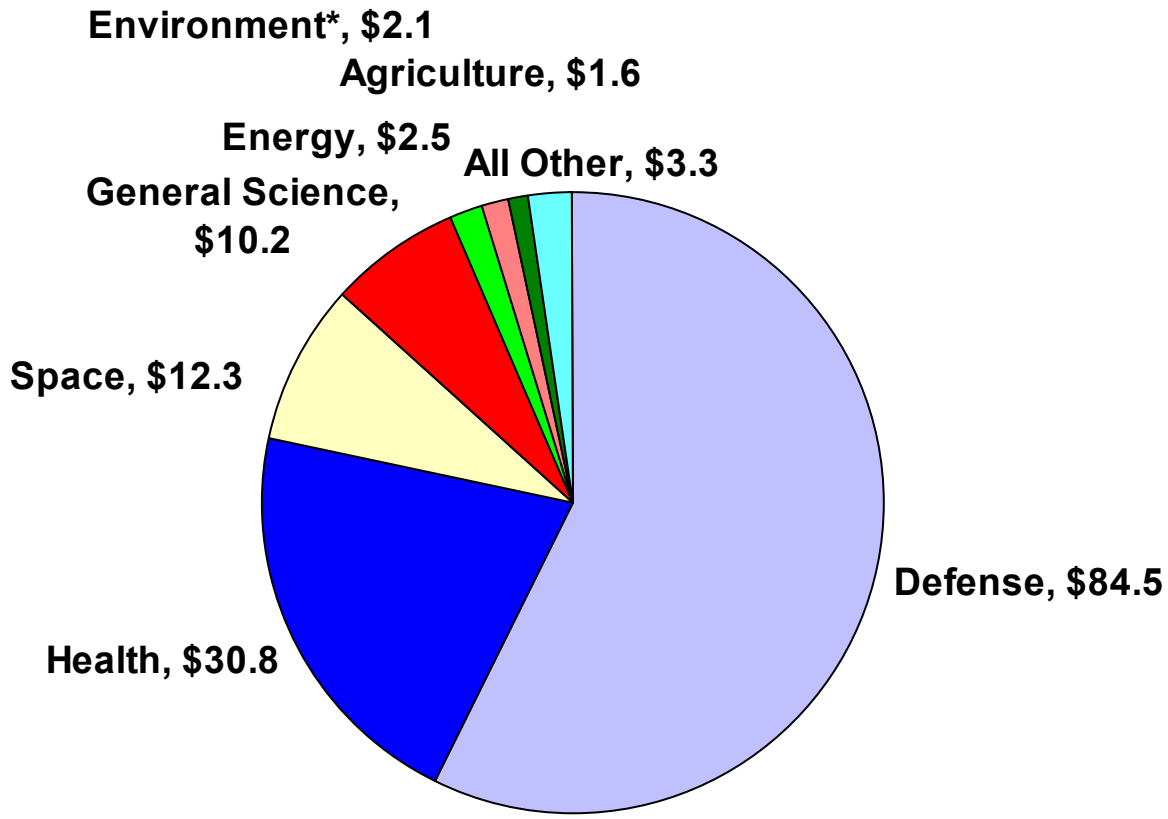
Source: AAAS, based on Budget of the U.S. Government FY 2009 Historical Tables. FY 2008 data are estimates. FY 2009-2013 data are budget projections.

FEDERAL R&D FOR NATIONAL MISSIONS

- In our mission-oriented system, each department funds only the R&D necessary to carry out its mission, and integrates R&D programs with other programs.
- “Innovation” or “funding basic research for future economic competitiveness” is not an explicit mission, though it is often stated as the primary rationale for federal support of research.
- Only NSF and DOE’s Office of Science have a science mission.
- Only NIST in Commerce has an “economic development” mission.
- The relative importance of missions varies over time, and thus R&D for various missions changes according to changing national needs.

Major Functional Categories of R&D

FY 2009 President's Budget



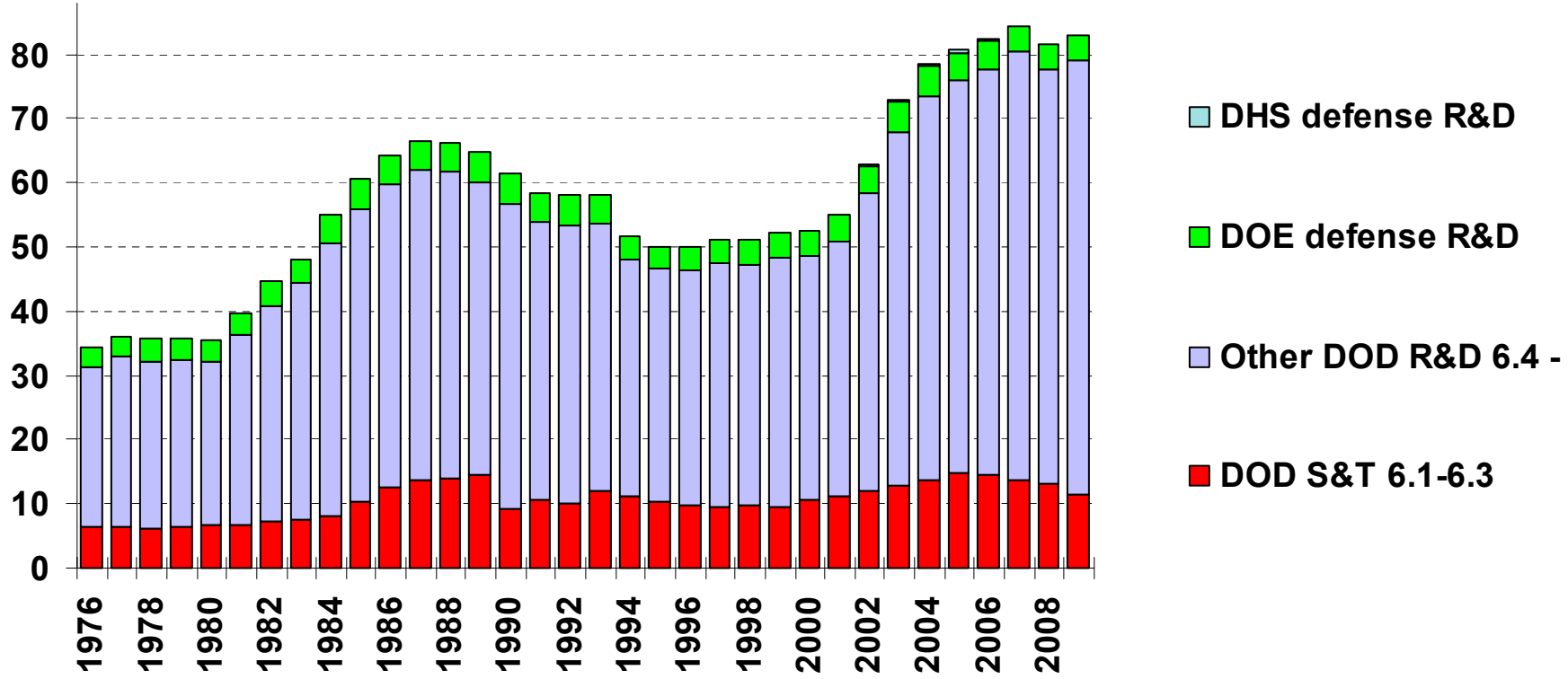
TOTAL R&D= $147.4 Billion (Revised)

* - includes natural resources R&D

Source: AAAS, based on OMB and agency budget data.

Trends in Defense R&D, FY 1976-2009 *

in billions of constant FY 2008 dollars



Source: AAAS analyses of R&D in annual R&D reports. * - FY 2009 figures are latest AAAS estimates of FY 2009 request. FY 2008 figures exclude pending supplementals. R&D includes conduct of R&D and R&D facilities. DOD S&T figures are not comparable for all years because of changing definitions.

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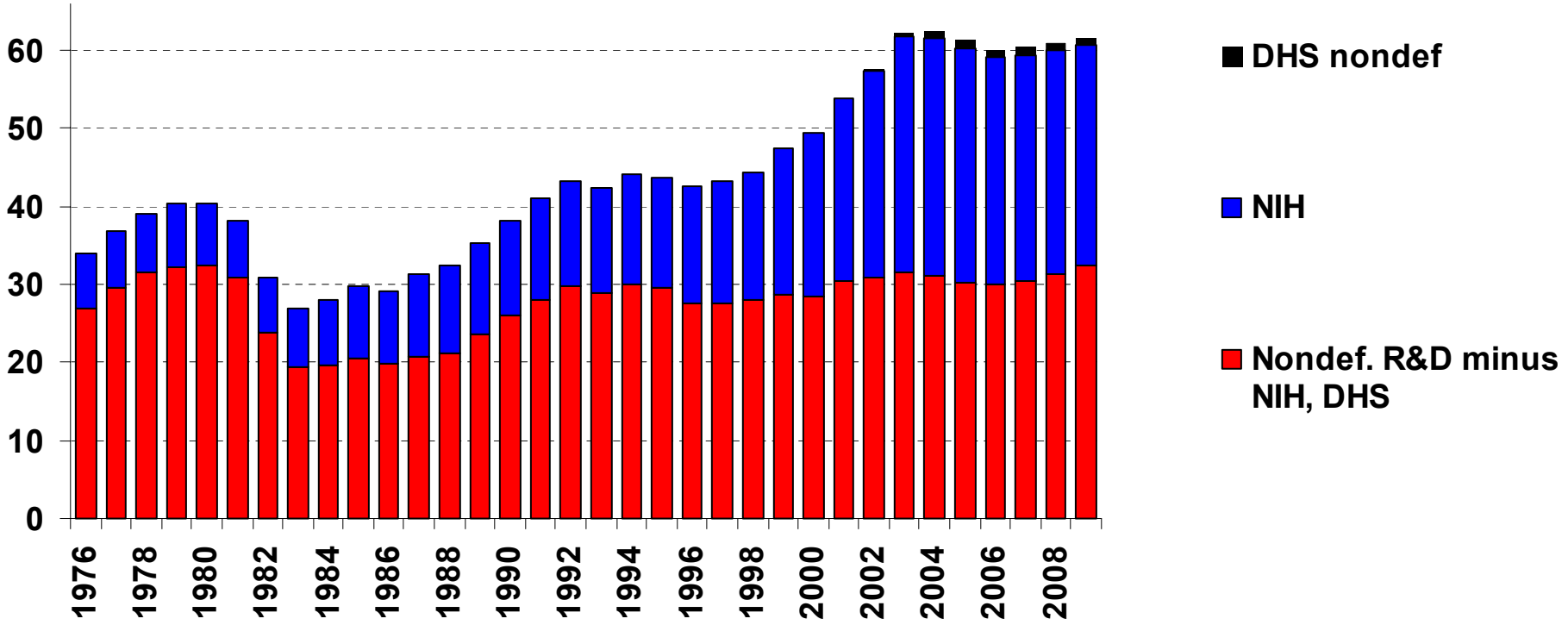
Selected Trends in Nondefense R&D, FY 1976-2009*

in billions of constant FY 2008 dollars



Source: AAAS analyses of R&D in *AAAS Reports VIII-XXXIII.* * FY 2009 figures are latest AAAS estimates of FY 2009 request.
R&D includes conduct of R&D and R&D facilities.

THEMES IN THE BUDGET: INNOVATION AND COMPETITIVENESS

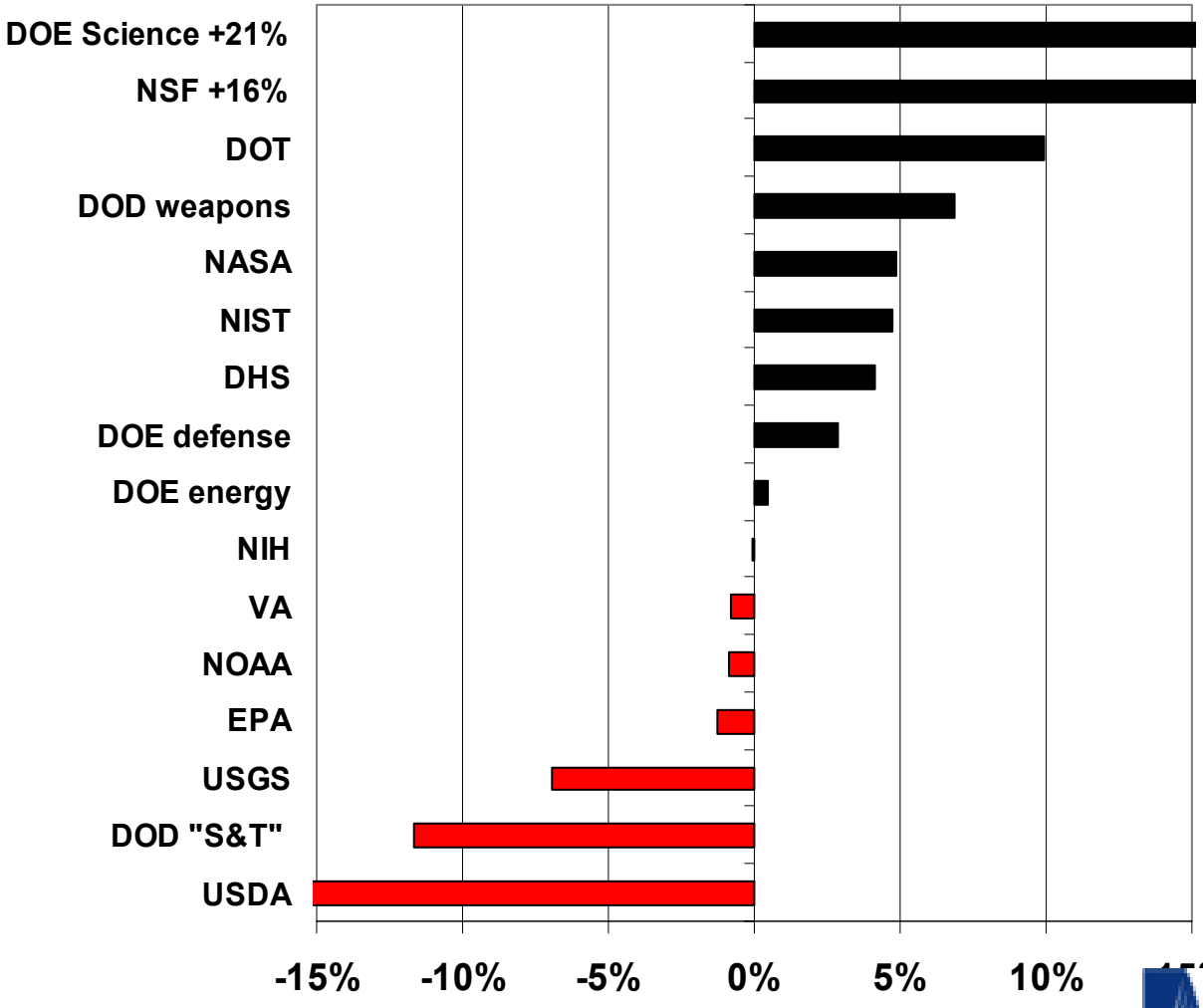
- In response to the “Gathering Storm” report and others, President Bush announced the American Competitiveness Initiative (ACI) in his 2006 State of the Union address.
- There are also several congressional responses, culminating in the America COMPETES Act of August 2007.
- For R&D investments, the theme is boosting federal support for basic research in the physical sciences (broadly defined).
- The plan: Doubling the budgets of NSF, DOE Office of Science, and the NIST laboratories over 7 to 10 years. But 2007 and 2008 appropriations leave the plan off track.

THE 2009 BUDGET FOR R&D

- The ACI continues for a third year, with large increases for NSF, DOE Science, and the NIST labs to catch up to a 10-year doubling track.
- Again, there would be large increases for DOD weapons and NASA spacecraft development, but also increases for most R&D programs.
- The NIH budget would be flat, agricultural and environmental R&D agencies would decline.

FY 2009 R&D Request

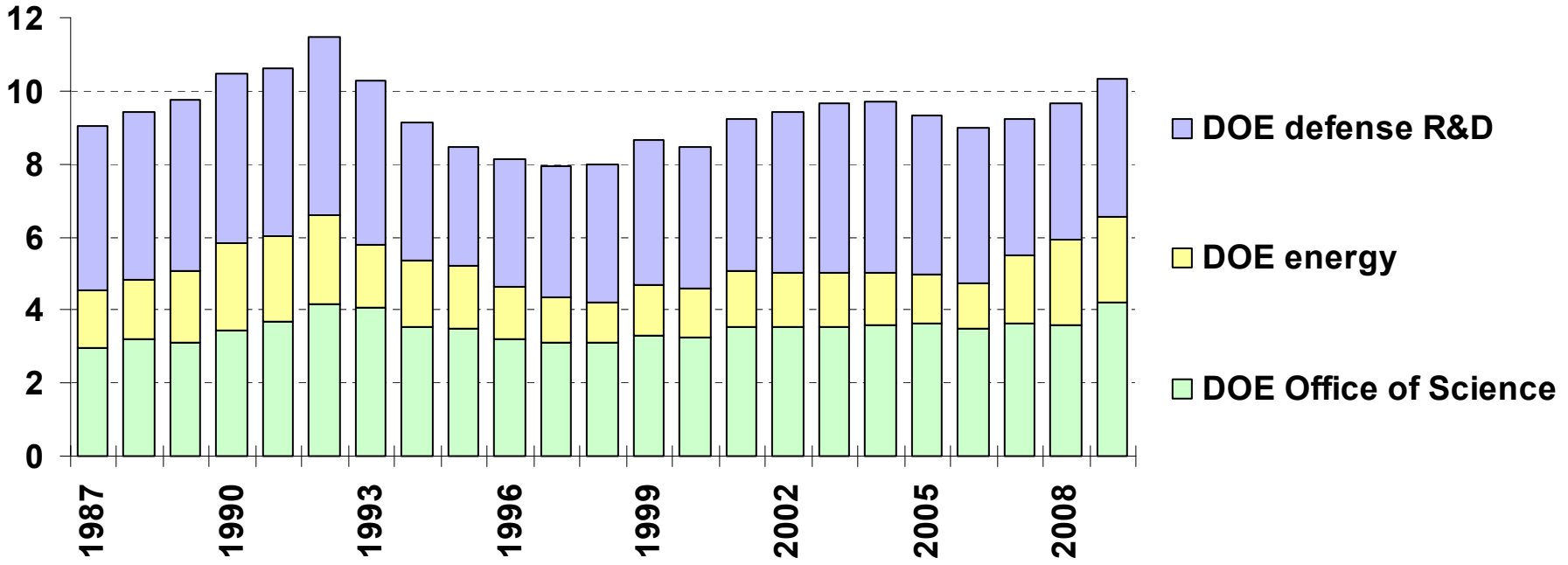
Percent Change from FY 2008



Source: AAAS, based on OMB R&D data and agency estimates for FY 2009.
DOD "S&T" = DOD R&D in "6.1" through "6.3" categories plus medical research.
DOD weapons = DOD R&D in "6.4" and higher categories.

Trends in DOE R&D, FY 1987- 2009 *

in billions of constant FY 2008 dollars



Source: AAAS analyses of R&D in *AAAS Reports VIII-XXXIII.* * FY 2009 figures are latest AAAS estimates of FY 2009 request.
R&D includes conduct of R&D and R&D facilities.
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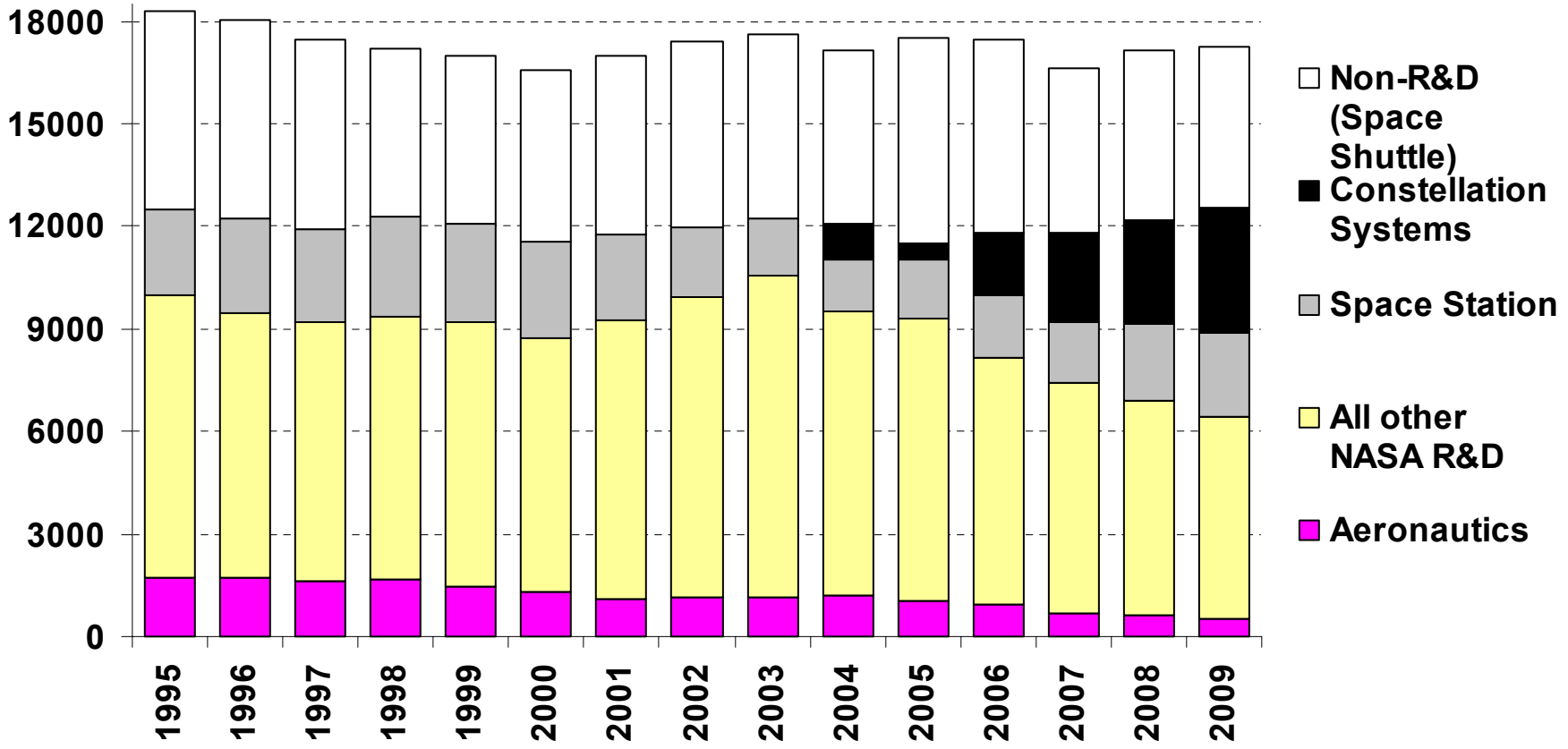
Trends in NASA R&D, FY 1995-2009 *

in millions of constant FY 2008 dollars



Source: AAAS analyses of R&D in *AAAS Reports VIII-XXXIII.* * FY 2009 figures are latest AAAS estimates of FY 2009 request. Program budgets include associated support costs.
R&D includes conduct of R&D and R&D facilities.

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SETTING PRIORITIES AND STRATEGIES

- In a decentralized, mission-oriented system, how does the U.S. set priorities when R&D areas cut across agency missions?

1/ Give one agency the mission, and put nearly all the R&D in that agency: NIH for biomedical research.

2/ Consolidate separate agency programs into a new agency and give it authority over other agencies: DHS for homeland security.

3/ Set up multi-agency initiatives with a coordinating office and interagency dialogues: nanotechnology, etc.

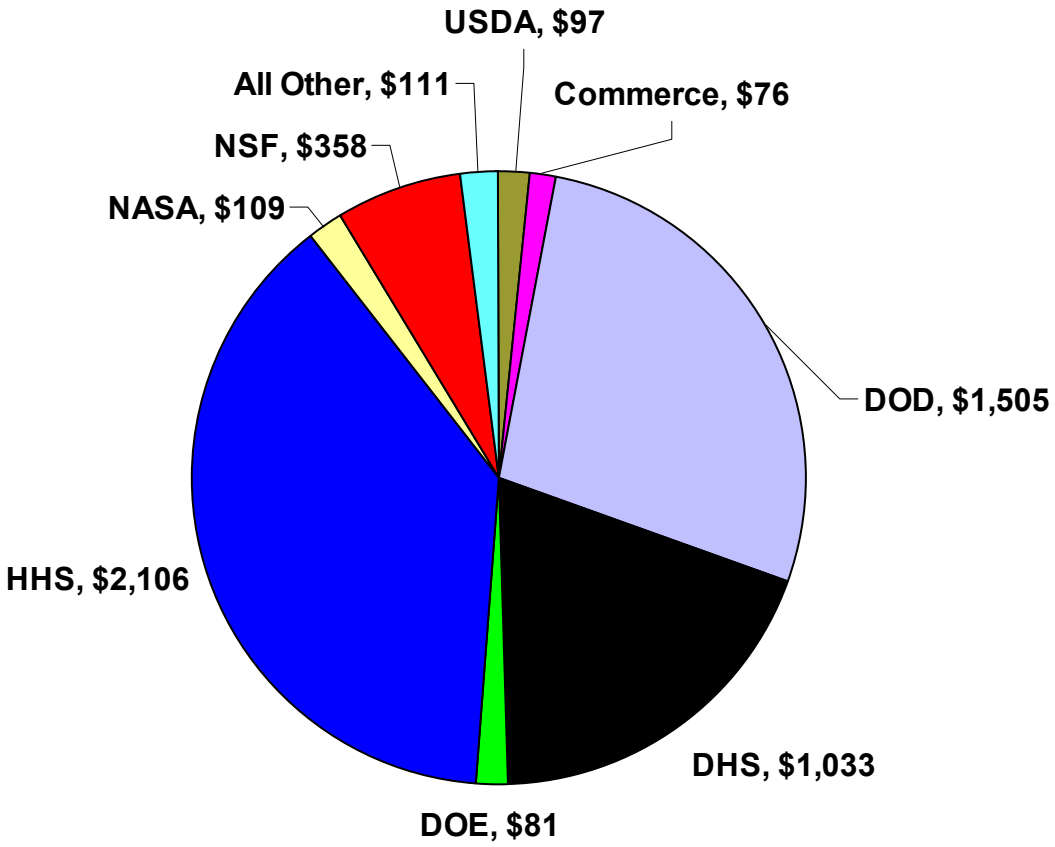
4/ Muddle through as best as we can: physical sciences, environmental R&D, social sciences.

HOMELAND SECURITY R&D IN THE BUDGET

- 'Homeland Security' is a collection of programs cutting across government missions such as health, defense, transportation, and justice.
- Total HS spending in FY 2009 could be $68.5 billion (up 5 percent), of which $5.5 billion goes to R&D.
- The majority of HS R&D investments are outside the Dept. of Homeland Security, but DHS theoretically has legal authority over the NIH biodefense investment.
- But HS R&D is now de-consolidating: programs and authority over biodefense are moving from DHS to HHS (Strategic National Stockpile, BARDA, Project Bioshield); DOD is taking a larger role again.

FY 2009 Federal Homeland Security R&D, by Agency

(requested budget authority in millions of dollars)



Total homeland security R&D: $5.5 billion

(includes conduct of R&D and R&D facilities)

Source: AAAS, based on Office of Management and Budget data.
Includes conduct of R&D and R&D facilities.

MULTI-AGENCY INITIATIVES

- Priority research areas that cut across agency lines.
- There's usually a coordinating office at the lead agency; the National Science and Technology Council is a coordinating mechanism.
- Agencies work together to coordinate research priorities and budgets, and produce strategic plans; the initiative and coordinating processes are authorized by law.

A/ Networking and Information Technology R&D

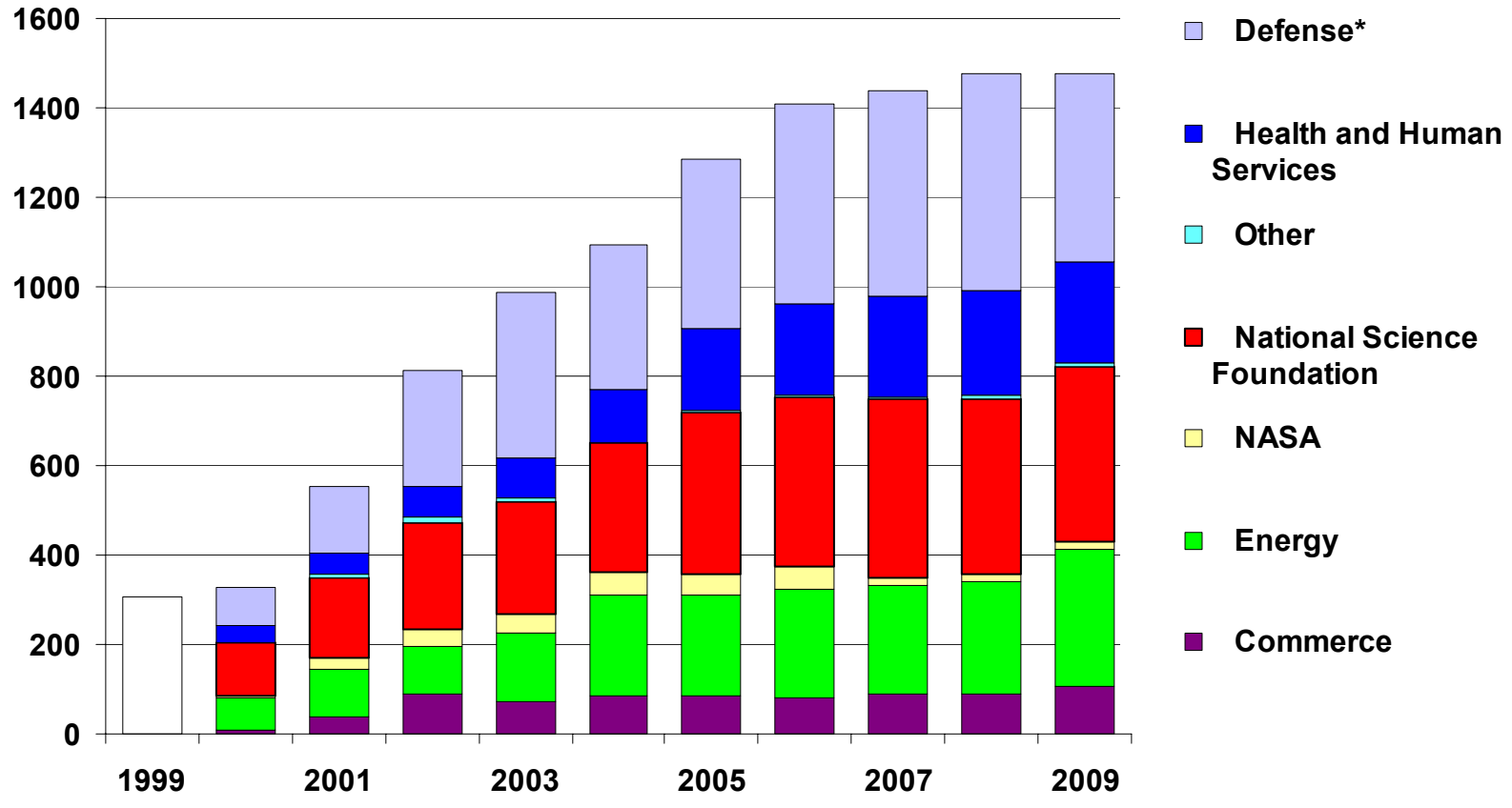
B/ Nanoscale Science and Engineering

C/ Climate Change Science Program

- But each agency's budget is decided separately based on overall budget constraints and agency-specific priorities.

Federal Nanoscale Science and Engineering R&D, by Agency

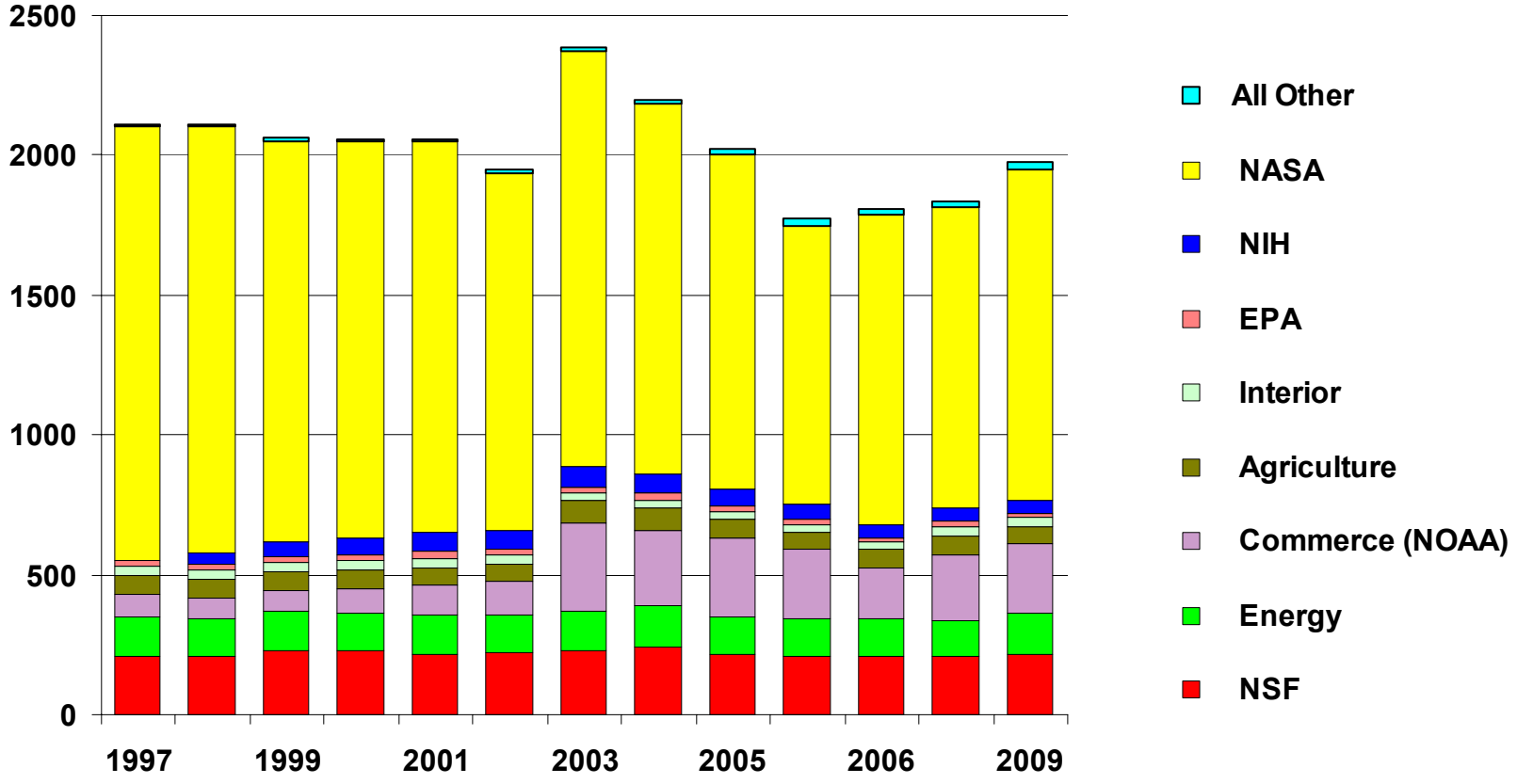
(budget authority in millions of constant FY 2008 dollars, FY 1999-2009)



Source: Office of Management and Budget data. * DOD changed its accounting starting in 2005, resulting in larger totals. Adjusted for inflation using OMB's GDP deflators. FY 2009 figures represent President's request.

Climate Change Science Program, by Agency

(budget authority in millions of constant FY 2008 dollars, FY 1997-2009)



Source: Office of Management and Budget and U.S. Global Change Research Program reports. FY 2009 figures represent President's request. NOAA and NASA figures back to 2003 have been recently revised to reflect program changes. Previous years' figures represent U.S. Global Change Research Program investments. FEB. '08

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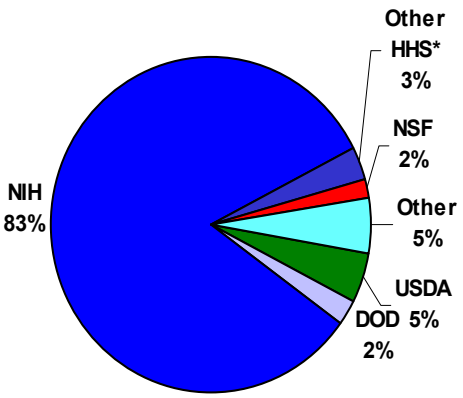
FOR MOST RESEARCH…

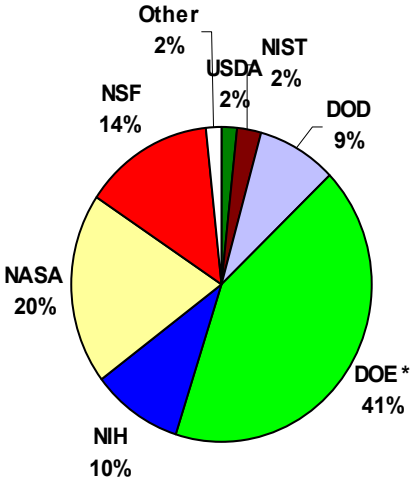
- Centralized control and policy-setting is nearly impossible in a fragmented, mission-oriented system in which multiple agencies contribute to a goal or to a discipline.
- Most disciplines are funded by multiple agencies in which no agency has a large enough share to set priorities.
- Environmental R&D, for example, is a national mission in which a dozen agencies are responsible (NASA, EPA, Interior, Corps, NOAA, etc.) but there is very little coordination and no agency has a lead in the health of the discipline.

Federal Funding of Research By Agency and Discipline, FY 2005

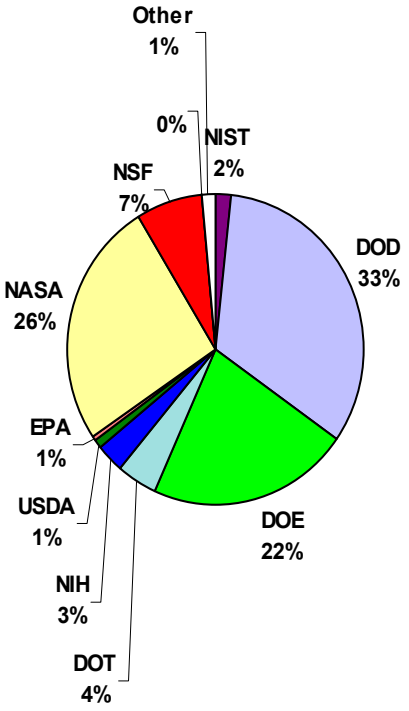
(preliminary obligations)



Life Sciences



Physical Sciences

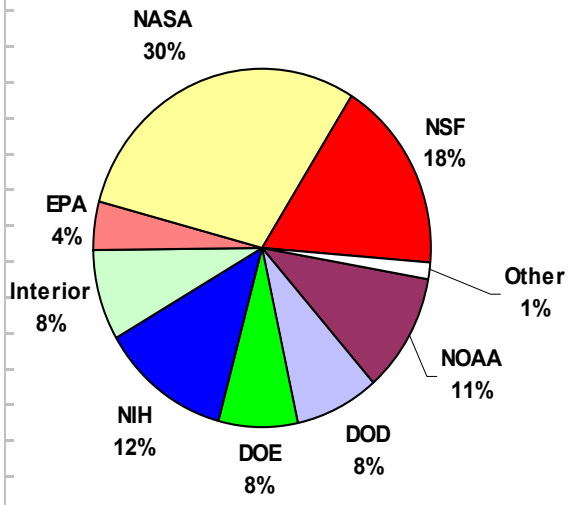


Engineering Sciences

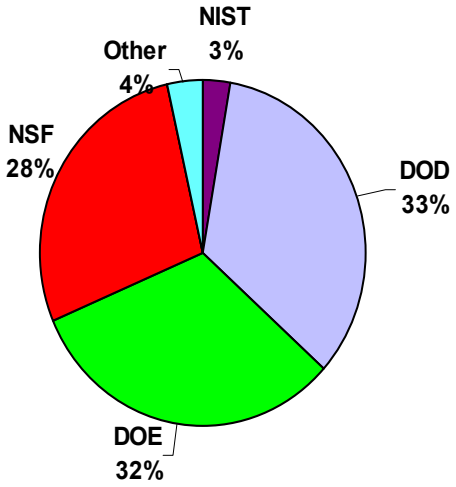
Source: National Science Foundation, *Federal Funds for Research and Development FY 2003, 2004 and 2005,* 2006. Data exclude development

Federal Funding of Research By Agency and Discipline, FY 2005

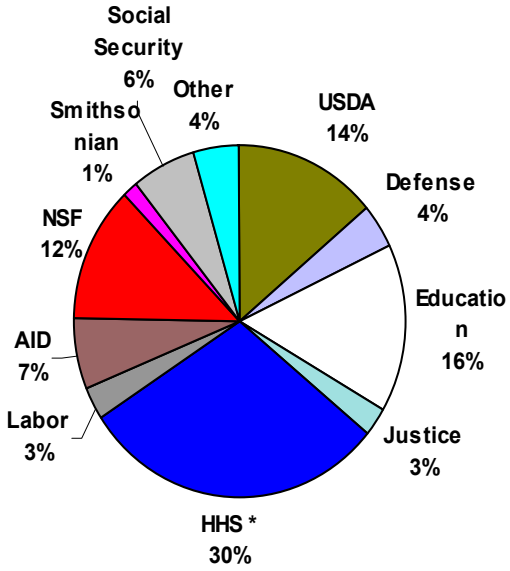
(preliminary obligations)



Environmental Sciences



Computer Sciences*



Social Sciences

Source: National Science Foundation, *Federal Funds for Research and*

PRIORITY-SETTING IN THE EXECUTIVE BRANCH

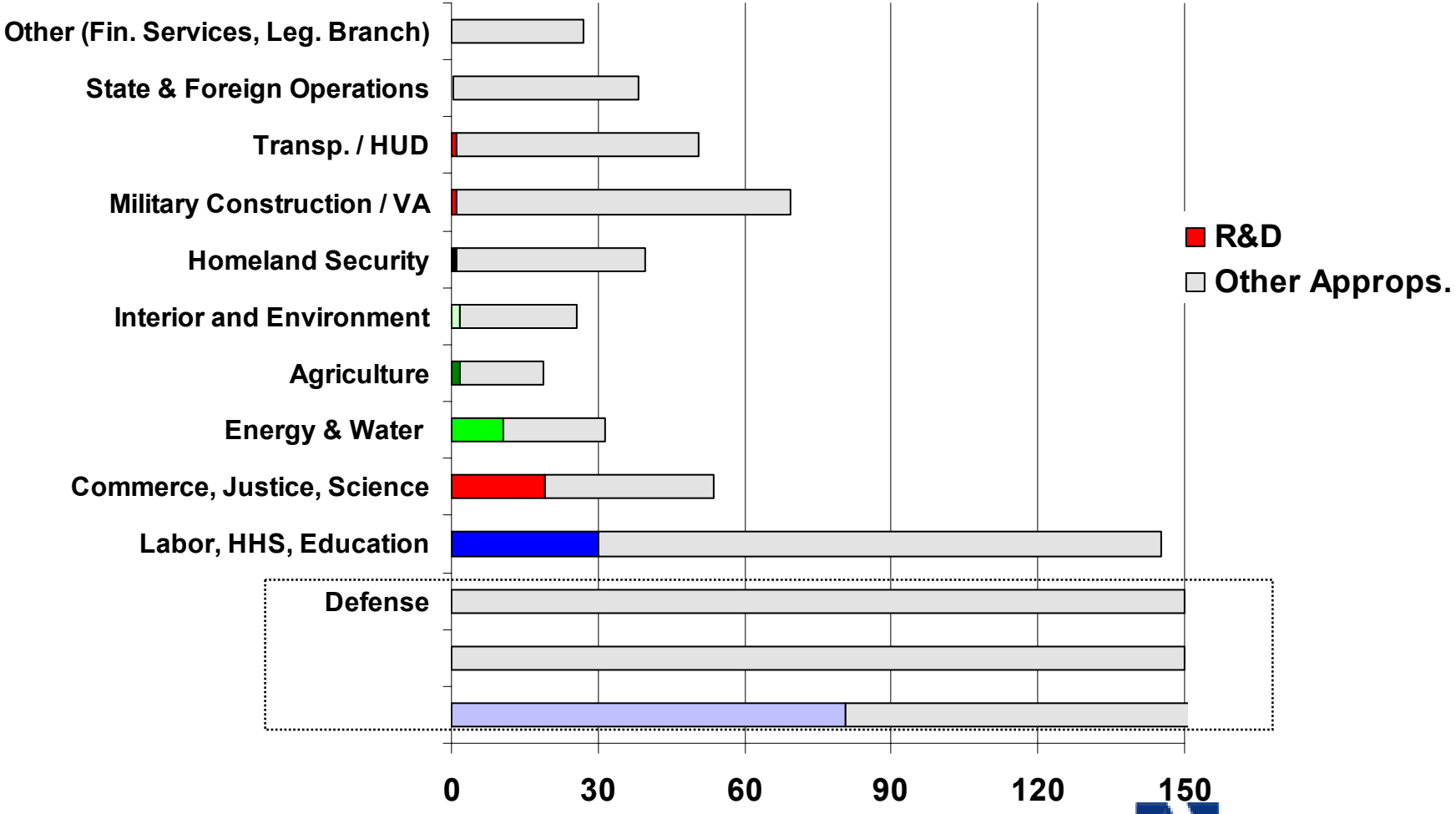
- The decentralized, mission-oriented system we have makes coordinating S&T policy difficult.
- The Office of Science and Technology Policy (OSTP) has the lead role, but it's a small office with no budget power.
- OSTP works with OMB in establishing interagency R&D priorities, and runs various National Science and Technology Council (NSTC) committees to coordinate interagency programs and cross-cutting issues (peer review system, science and math education, etc.).

PRIORITY-SETTING IN CONGRESS

- Unfortunately, even these limited coordinating mechanisms don't translate well to Congress, except where only a single agency is involved (NIH or DHS).
- There are separations between the House and the Senate, and between authorizers and appropriators.
- Jurisdictions vary widely between committees, with strange results: a recent nanotechnology authorization excluded DOD and NIH, for example, because the House S&T Committee didn't have jurisdiction.
- The federal R&D investment is appropriated in 10 of the 12 appropriations bills, each of which is (usually) debated and enacted separately.

R&D and Non-R&D Funding by Appropriations Bill

FY 2009 Request, Billions of dollars budget authority



Source: AAAS, based on estimates of R&D in FY 2009 budget and Budget of the U.S. Government FY 2009. Defense bill is in three lines. Includes conduct of R&D and R&D facilities.

ALLOCATING FEDERAL R&D

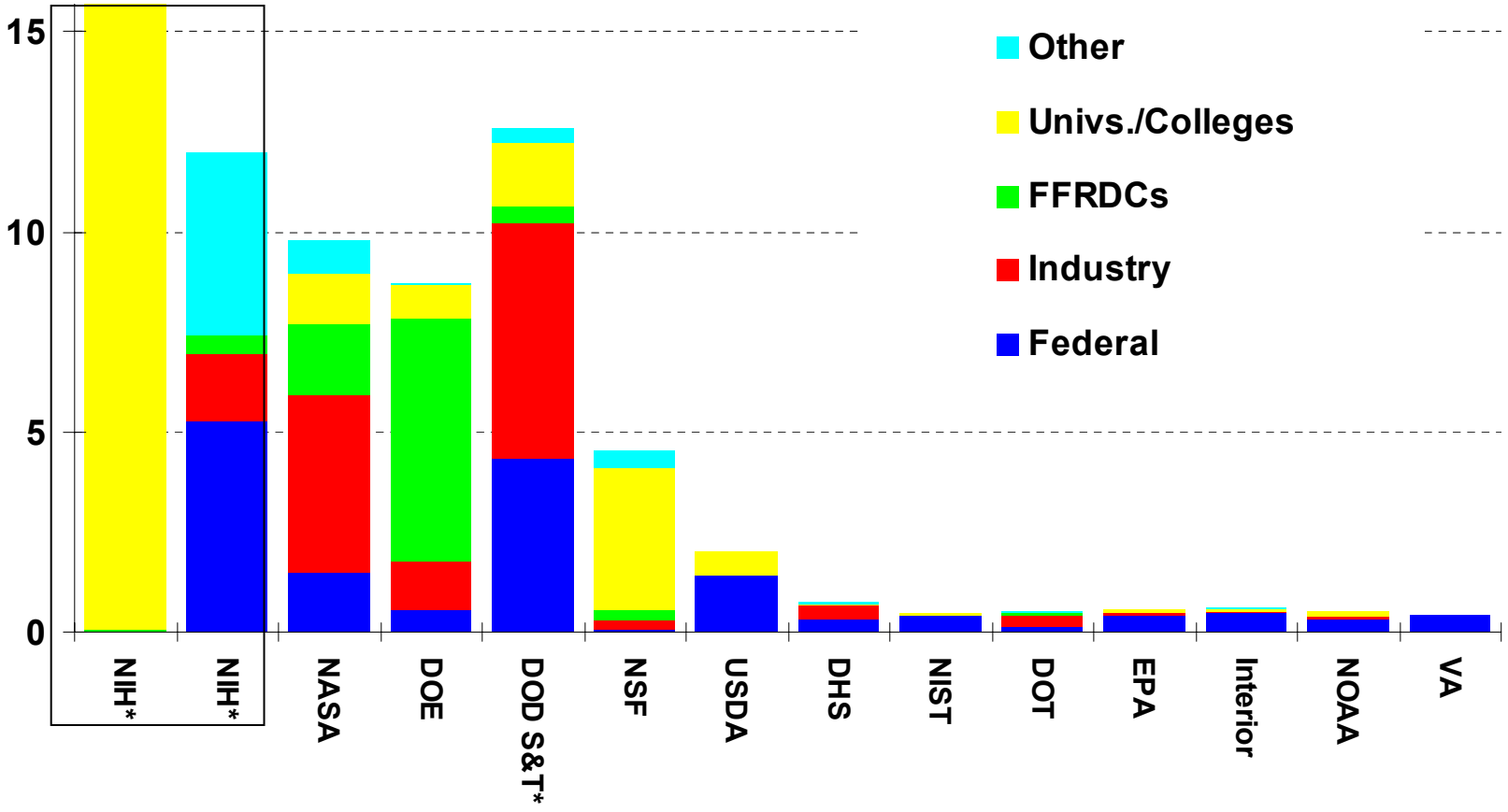
There are numerous ways of allocating federal R&D investments; each agency is different.

- Because of mission requirements, some agencies invest heavily in “D” (DOD), others almost exclusively in “R” (NSF), and others a mix (NASA). Some agencies rely heavily on intramural performers; others are almost exclusively extramural.
- Investigator-initiated, peer-reviewed competitively awarded research grants are a way to allocate funds for scientific excellence.
- Congressional earmarks are another way to allocate funds, for geographic and political considerations.
- Most agencies use a mix, including program managers, formula funds, sheltered competitions, internal allocations with limited external review, etc.

Federal R&D by Performer at Selected Agencies

billions of FY 2007 obligations (preliminary)

* NIH R&D - $27.8 billion.
Shown as two bars.



Source: AAAS, based on NSF, Federal Funds for Research and Development, Fiscal Years 2005, 2006, and 2007, 2008. R&D includes research, development, and R&D facilities. * - DOD R&D in "6.1" through "6.3" categories.

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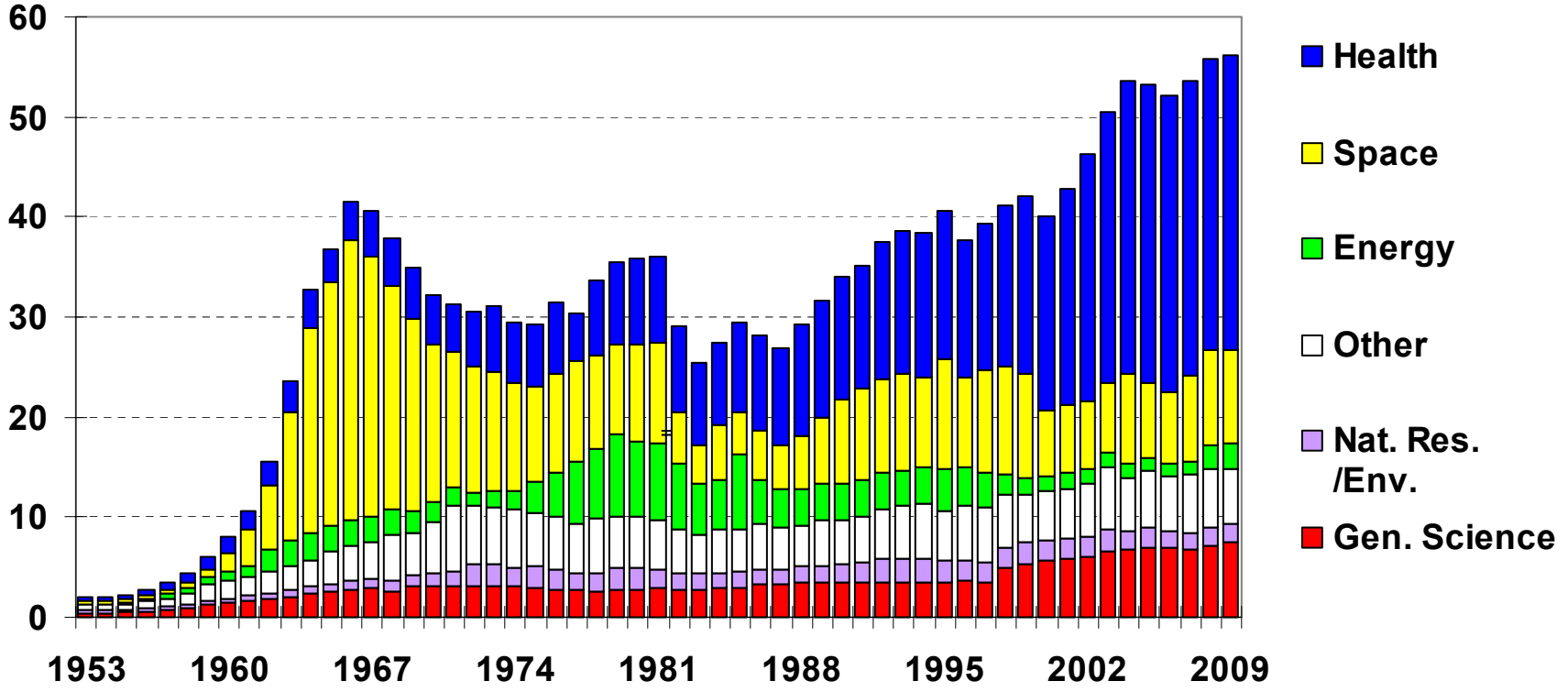
BUDGET MAKES POLICY

In the absence of explicit priorities and policies, scattered agency budget decisions make a *de facto* U.S. S&T policy :

- Over time, R&D investments change to reflect changes in national goals.
- Until recently, there was increasing funding for the biomedical sciences, stagnant funding for most other disciplines.
- Because the university-oriented NIH and NSF budgets have done well, there have been dramatic increases in support of university R&D.
- Over time, industry has come to play a greater role in U.S. R&D; industry spending determines the R&D intensity of the U.S. economy but the federal government remains the most important for RESEARCH. (There are very few policy tools for the federal government to affect industry spending.)

Trends in Nondefense R&D by Function, FY 1953-2009

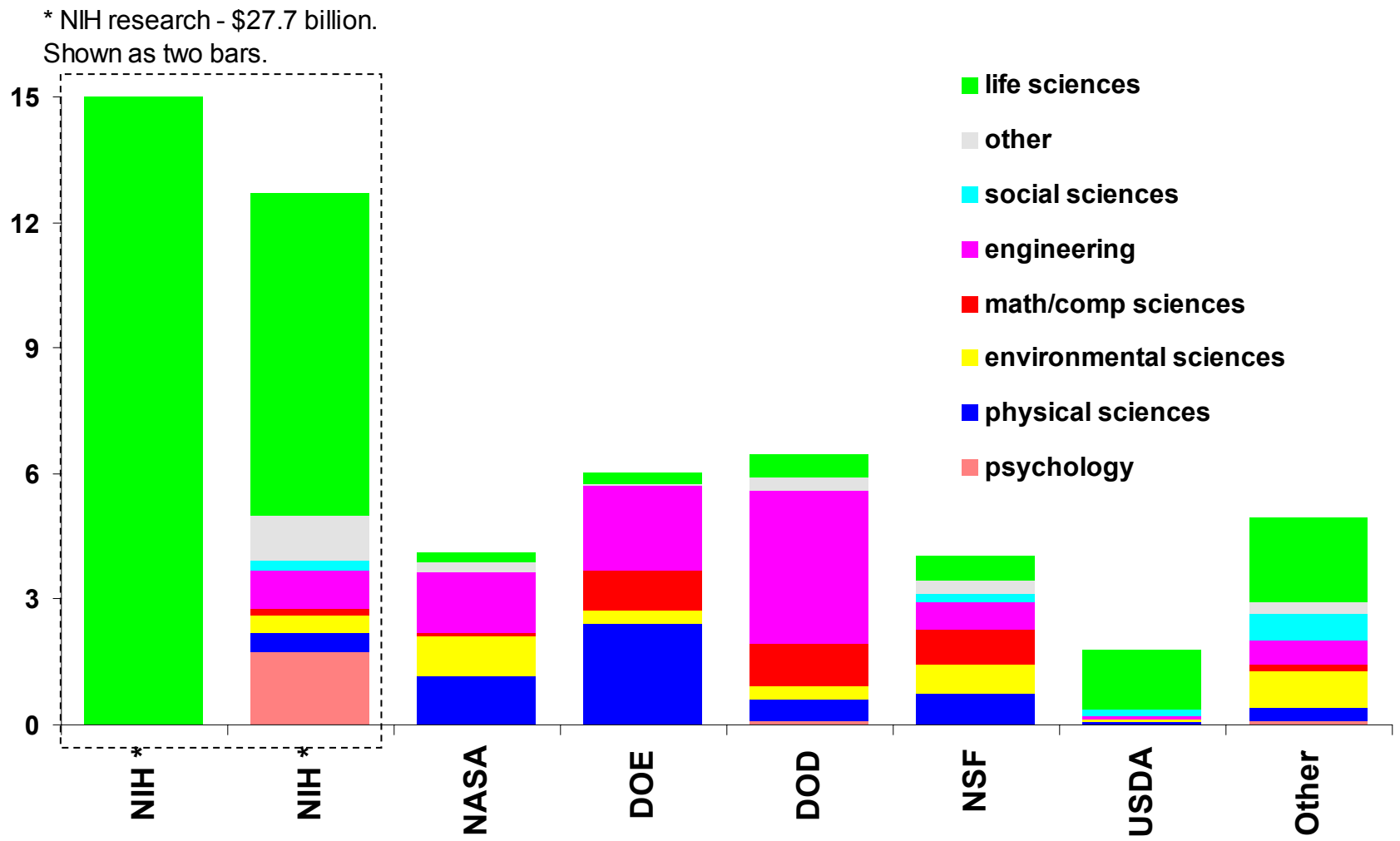
outlays for the conduct of R&D, billions of constant FY 2008 dollars



Source: AAAS, based on OMB Historical Tables in *Budget of the United States Government FY 2009.* Constant dollar conversions based on GDP deflators. FY 2009 is the President's request.

Note: Some Energy programs shifted to General Science beginning in FY 1998.

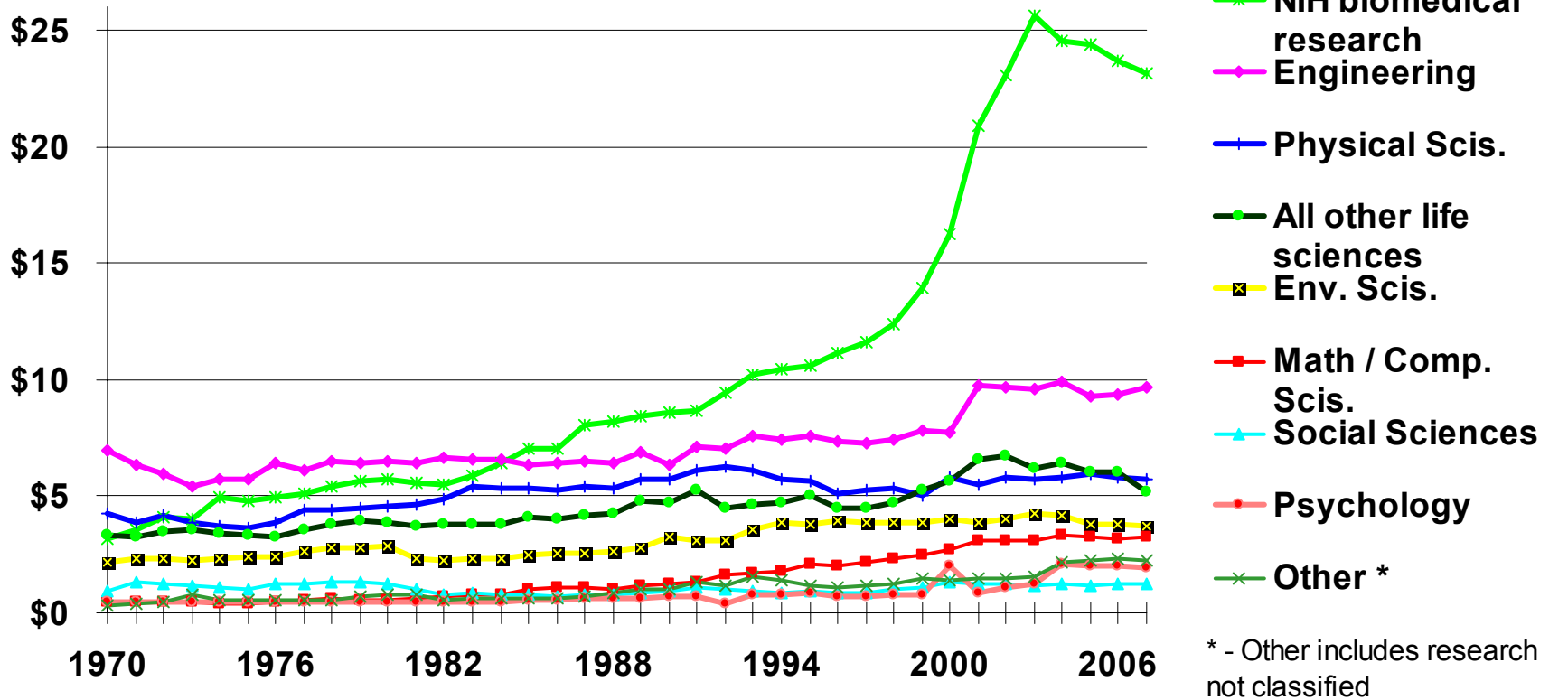
Federal Research by Discipline at Selected Agencies, FY 2007 (preliminary obligations in billions of dollars)



Source: National Science Foundation, *Federal Funds for Research and Development Fiscal Years 2005 , 2006 and 2007,* 2008. Development and R&D facilities excluded. FY 2007 data are preliminary.

Trends in Federal Research by Discipline, FY 1970-2007

obligations in billions of constant FY 2008 dollars



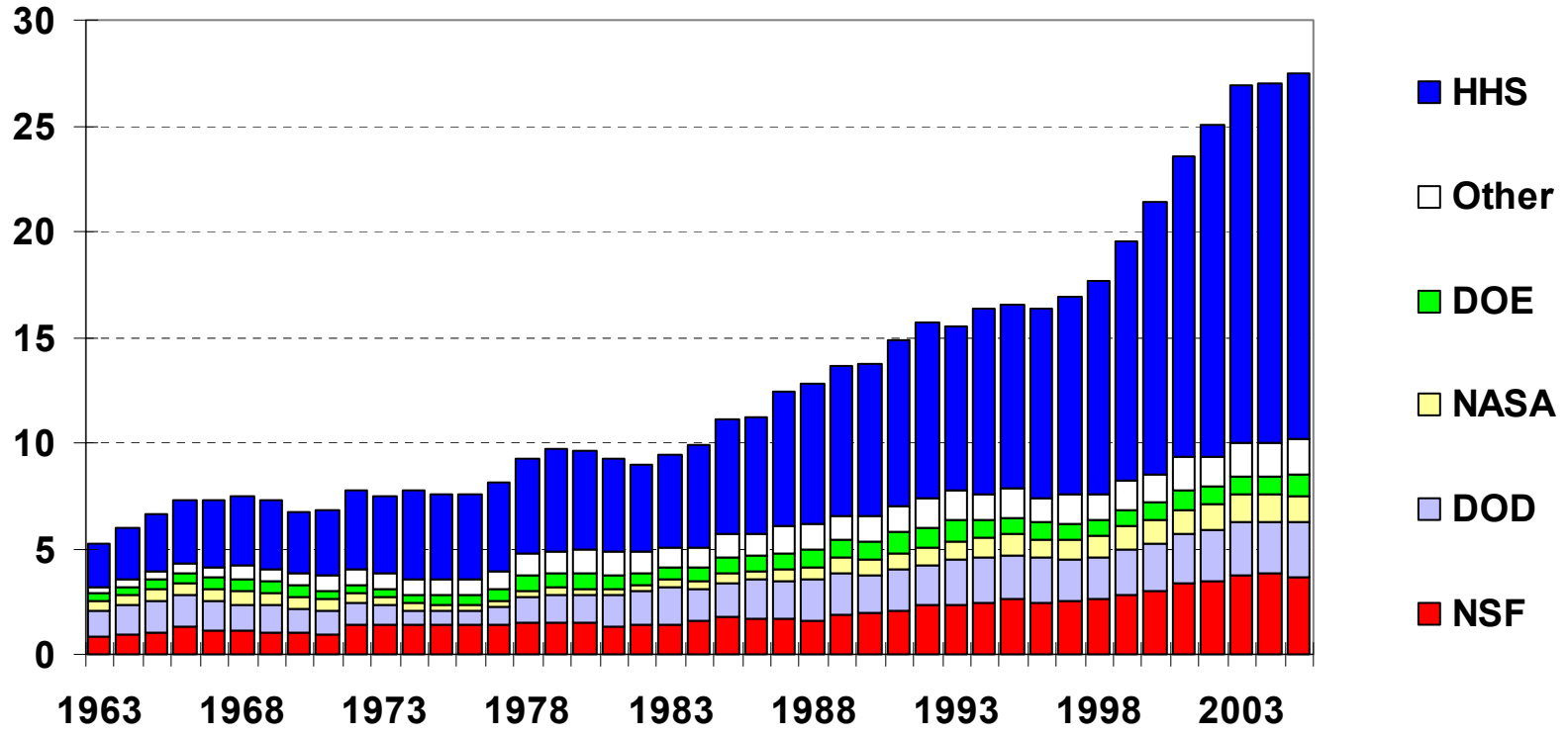
* - Other includes research not classified (includes basic research and applied research; excludes development and R&D facilities)

Life sciences - split into NIH support for biomedical research and all other agencies' support for life sciences.

Source: National Science Foundation, *Federal Funds for Research and Development FY 2005, 2006 , 2007,* 2008. FY 2006 and 2007 data are preliminary. Constant-dollar conversions based on OMB's GDP deflators.

Federal R&D Funding to Colleges and Universities FY 1963-2005

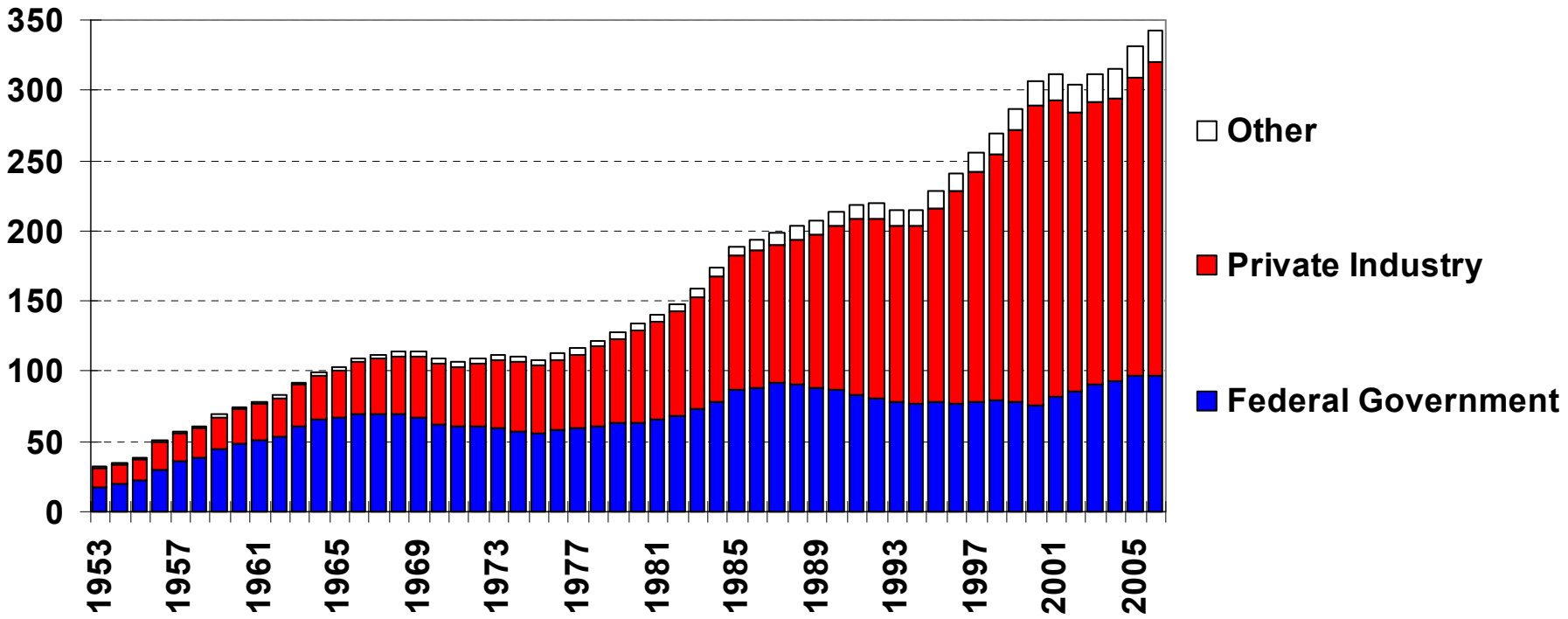
Obligations by agency in billions of constant FY 2008 $



Source: AAAS, based on NSF, *Federal Science and Engineering Support to Universities, Colleges, and Nonprofit Insitutions, FY 2005,* 2007.
R&D includes research, development, and R&D facilities support. Constant-dollar conversions based on OMB's GDP deflators.

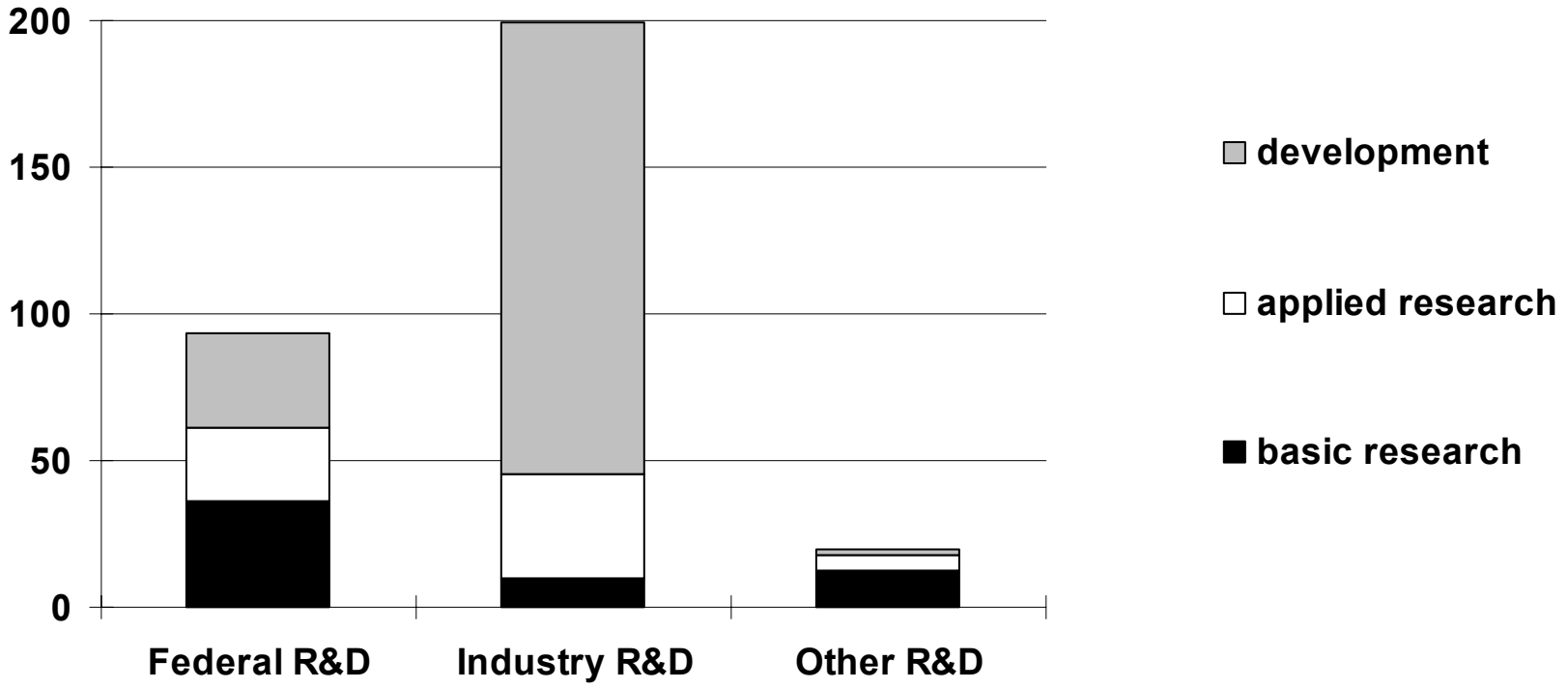
U.S. R&D Funding by Source, 1953-2006

expenditures in billions of constant 2006 dollars



Source: NSF, Division of Science Resources Statistics. (Data for 2005 and 2006 are preliminary.)

Character of Federal and Industry R&D
2004 Data, Expenditures in Billions

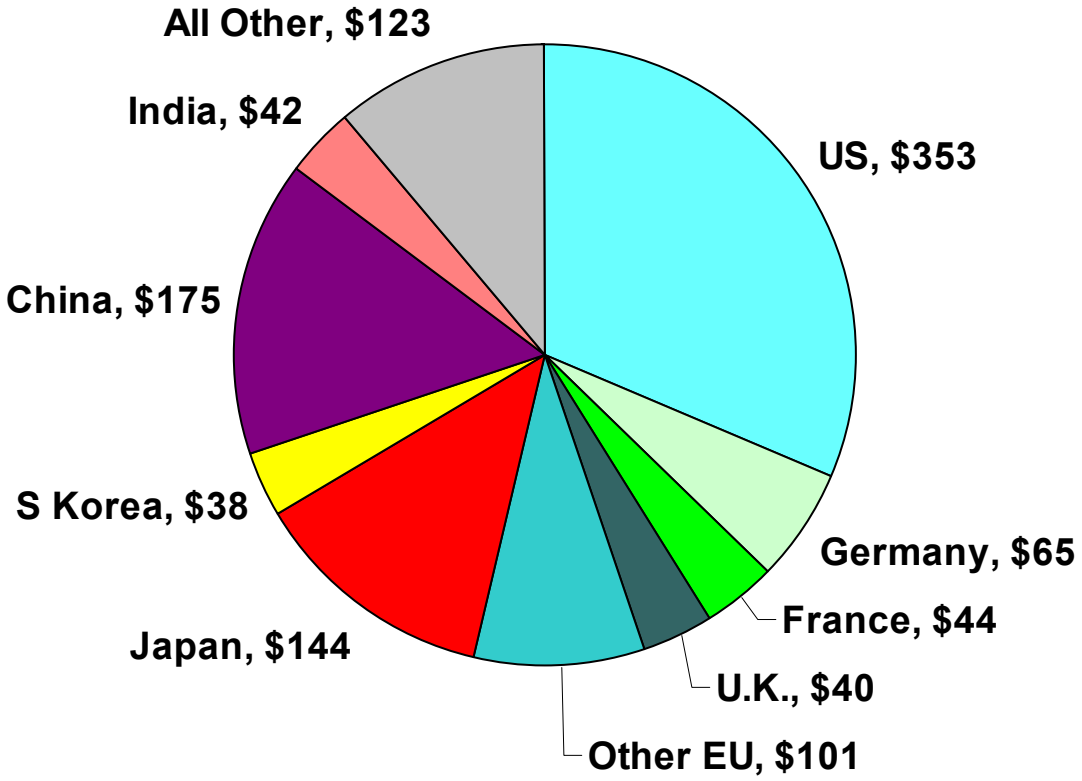


Source: NSF, Division of Science Resources Statistics. (Data for 2004 are preliminary.)

HOW DOES THE U.S. COMPARE?

- The U.S. is still the leading science and technology superpower in R&D investments, but the lead is shrinking.
- The U.S. R&D / GDP ratio compares favorably with other nations, but defense development is a big factor in the U.S.
- Other nations:
  - EU – A plan to reach 3% of EU GDP by 2010, but it won't happen.
  - Korea – R&D growing by 10%+ a year, R&D/GDP ratio surpasses U.S. ratio in 2004 and hits 3%.
  - China – R&D spending grew 20% in 2004 and 25% in 2005; basic research still small, but expanding rapidly.
  - India – Not big in R&D spending yet, but there are plans to boost its R&D capabilities to compete in high-tech industries.

Shares of Total World R&D, 2007



Total World R&D =
U.S. $1,124 billion**

Source: Battelle, Global R&D Report, 2007, from Battelle, OECD, and R&D Magazine data. Projections for 2007, by performer nation. * *- calculated using purchasing power parities, in millions of dollars.

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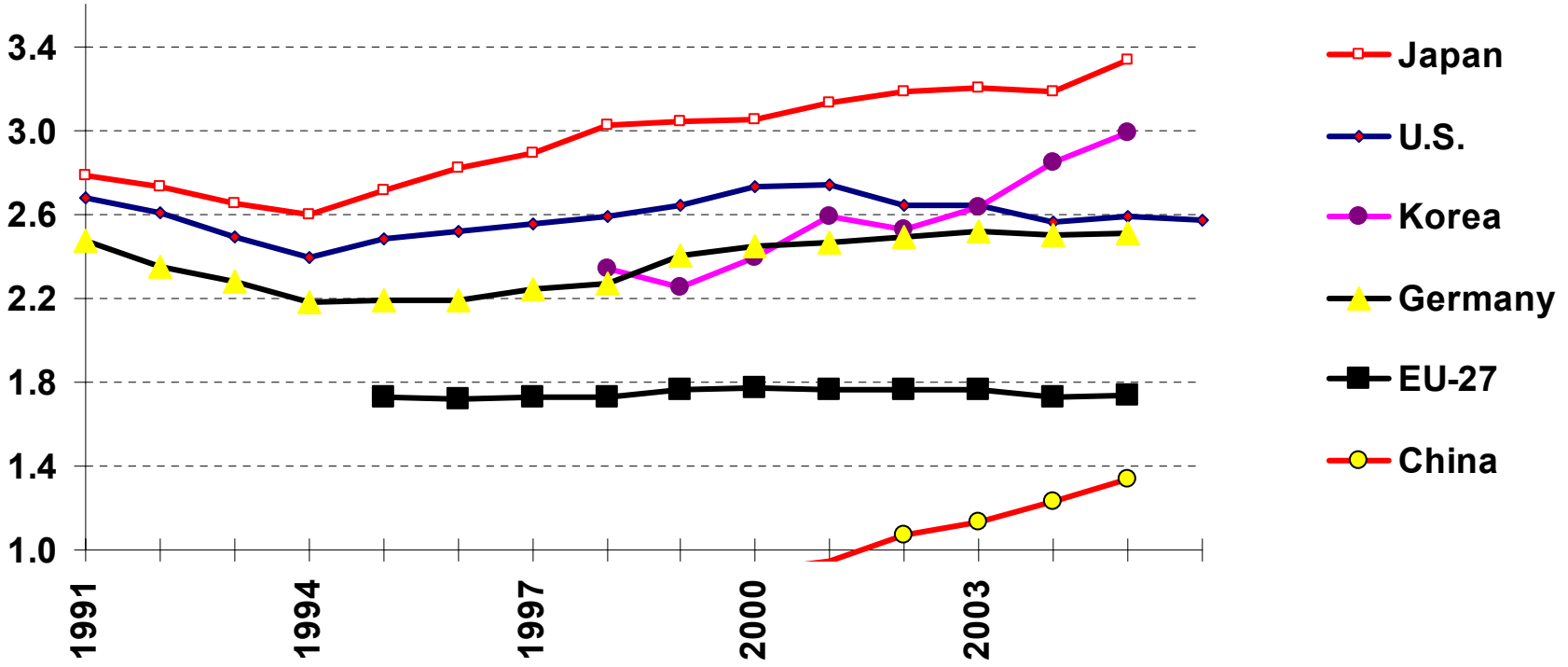
Total National R&D as % of GDP, 1991-2006



Source: National Science Foundation, National Patterns of R&D Resources and OECD, Main Science and Technology Indicators. Data not available for all nations for all years. DECEMBER '07 © 2007 AAAS

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WHERE IS FEDERAL R&D FUNDING HEADED?

- Congress is already planning on not finishing FY 2009 appropriations by October 1.
- The big budget battle between the President and Congress is over how much to spend on domestic discretionary programs, but the difference of $21 billion is between a slight cut and an inflationary increase.
- Even at a time when policymakers are concerned about U.S. leadership in science and technology eroding, and when proposed R&D increases are authorized in the America COMPETES Act and other legislation, the problem remains how to find the resources.
- Don’t expect increased funding for research: the broader budget choices policymakers make will constrain future investments in R&D, and it’s almost impossible to coordinate broad-based increases for research across the government.

FOR MORE INFORMATION…

The AAAS R&D web site is

www.aaas.org/spp/rd