Lessons from Interagency Planning for Fusion Energy Sciences

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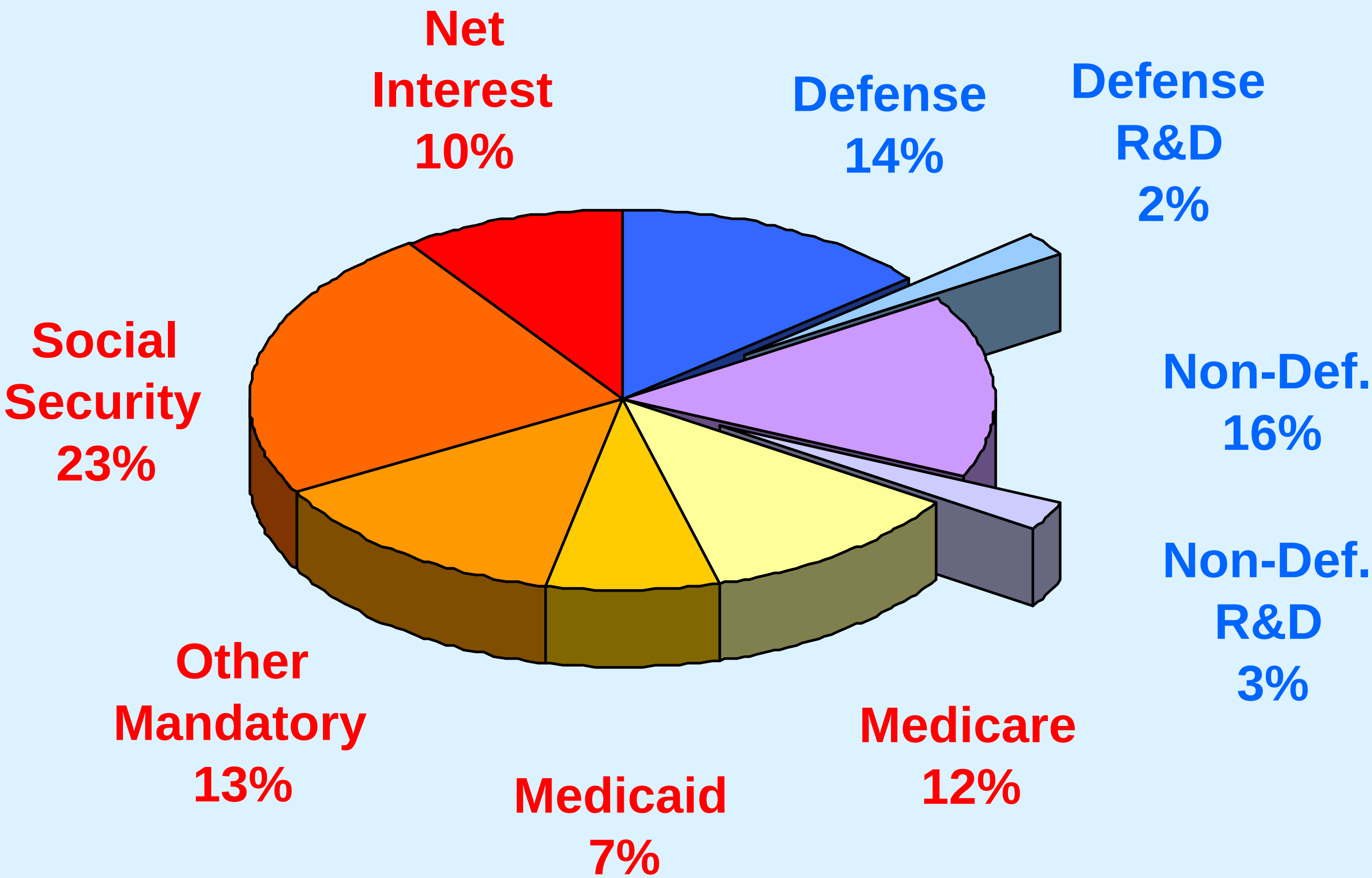
FY 2005 Proposed Budget ($2.4 Trillion OL)



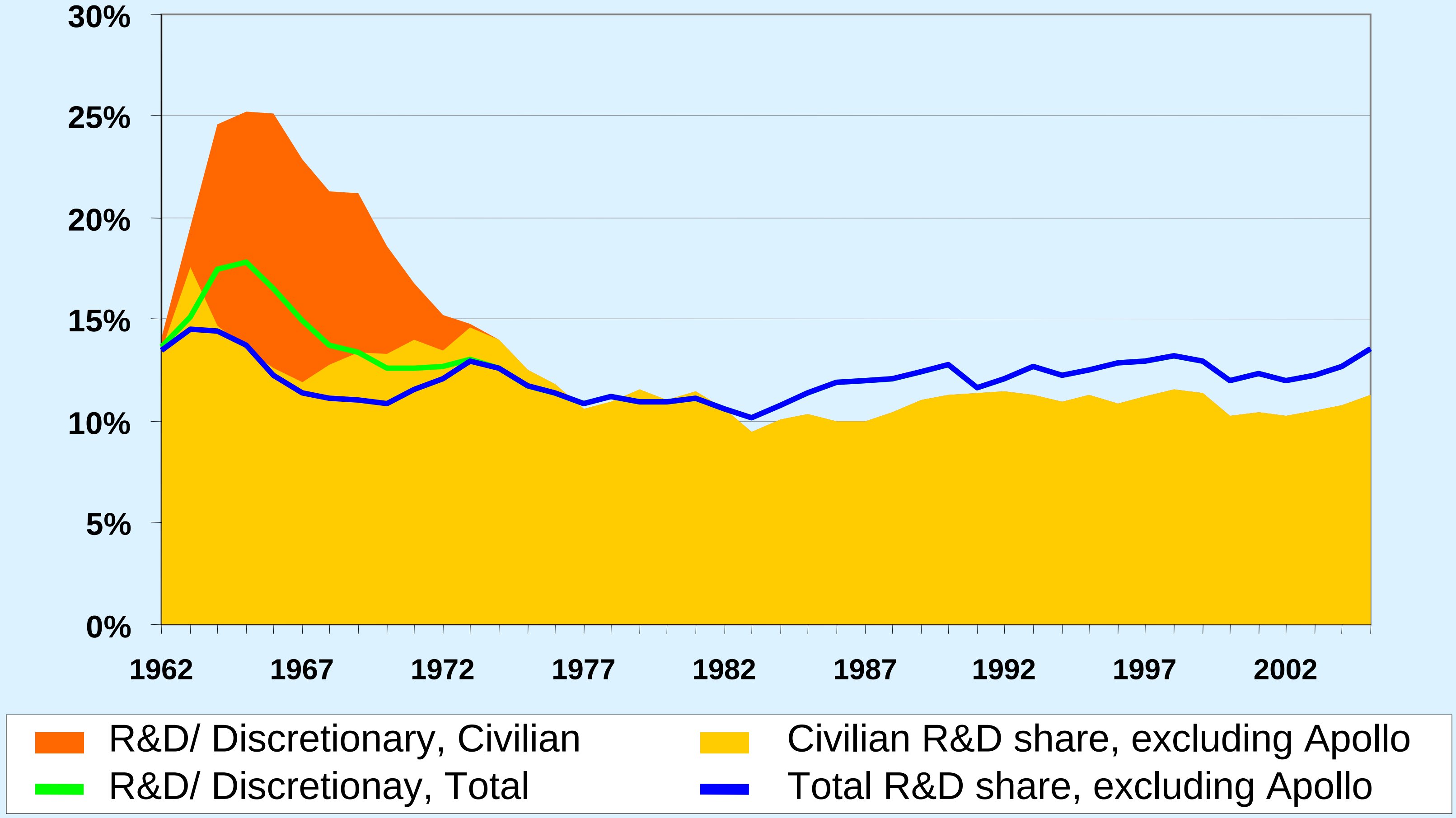
Mandatory Spending

Discretionary Spending

R&D = 14% of discretionary spending

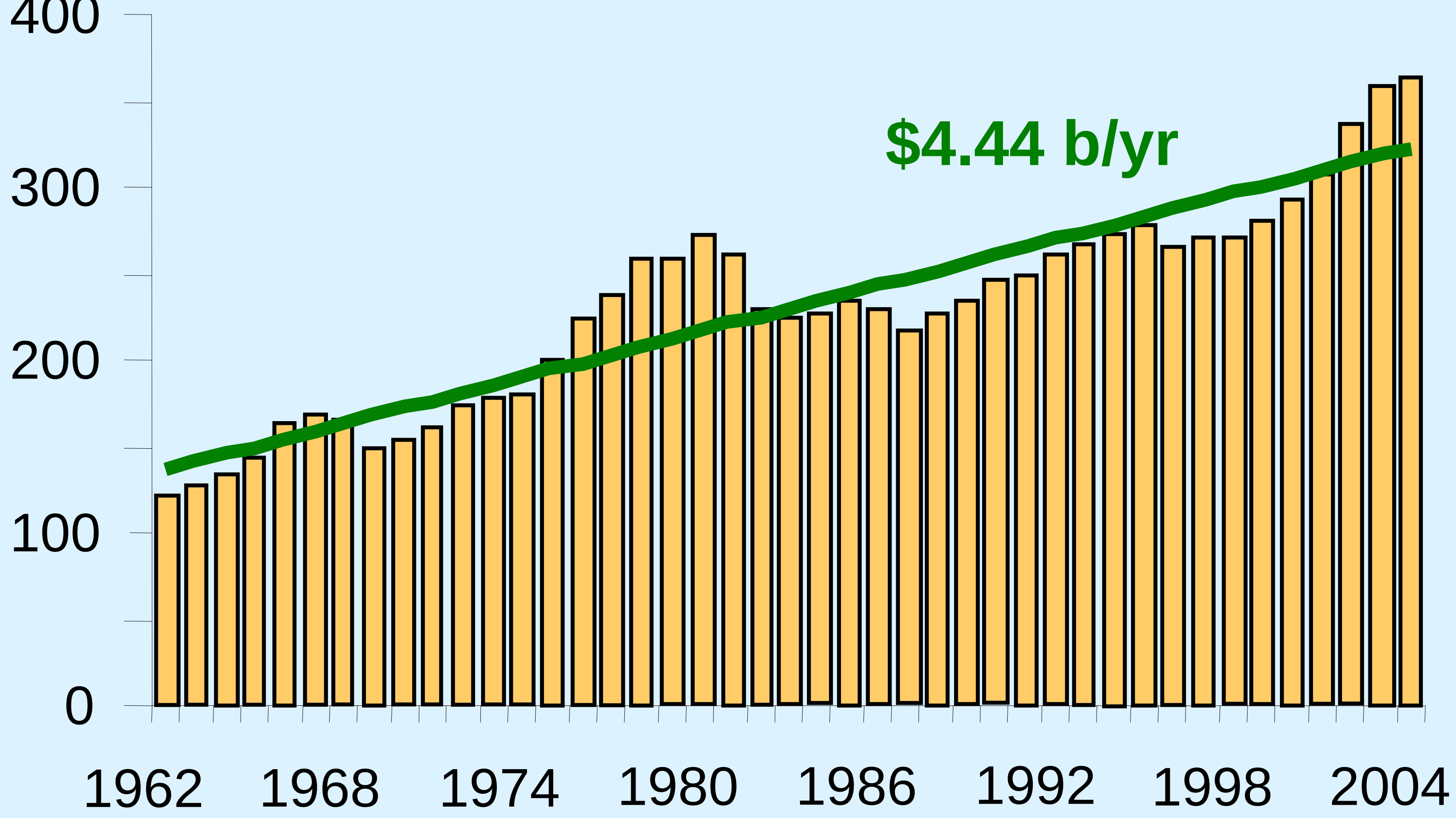
R&D as a Share of Discretionary Spending

It's approximately constant over the last 30 years!



Discretionary Budget ($b 1996)

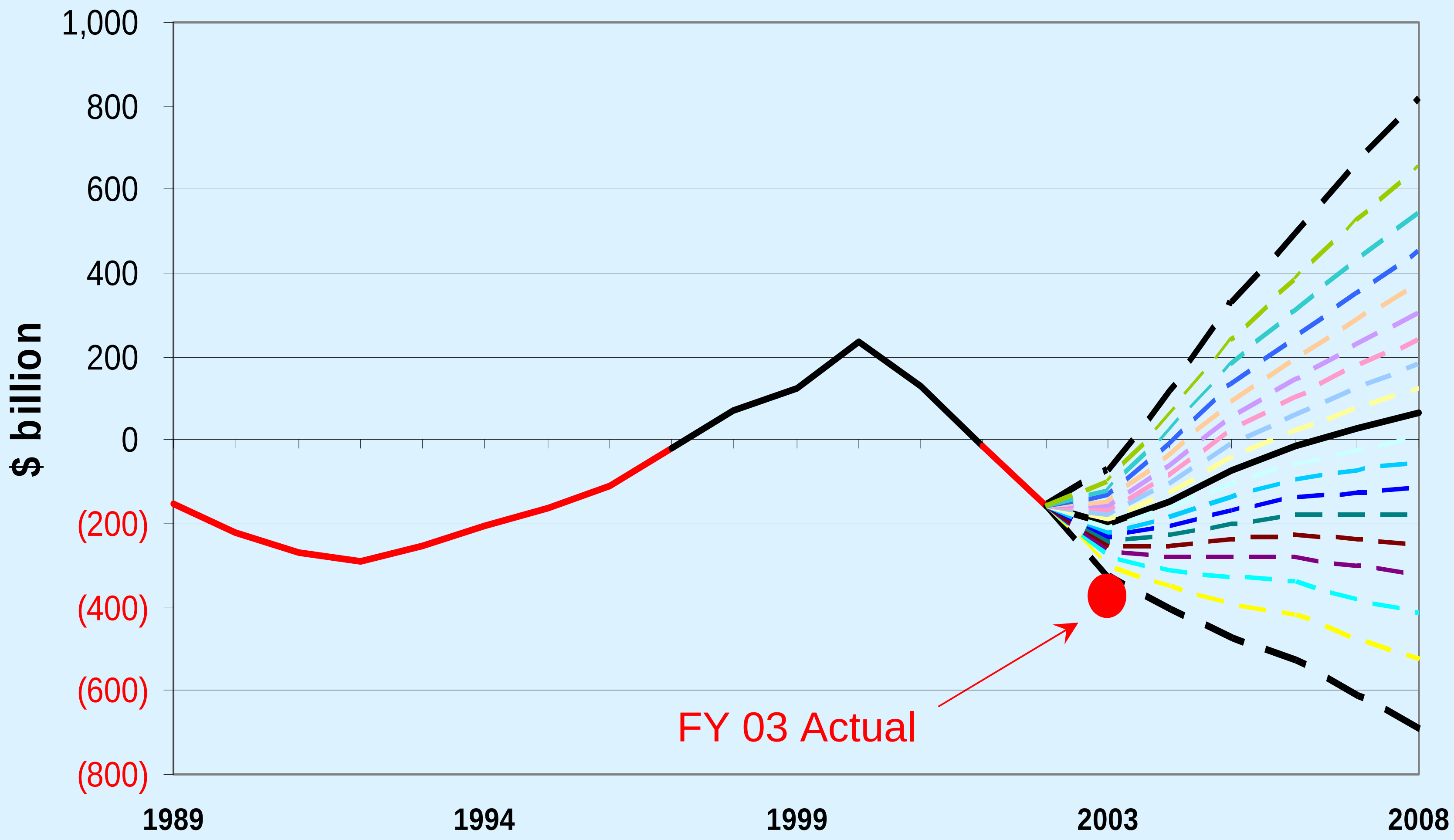
Overall Predictable Growth!



Therefore, R&D grows by about $500M ($1996) per year

CBO Baseline Surplus Forecast, January 2003

Great uncertainty looking forward



The Lesson We Draw from this…

I believe that **society will continue to support exploration of the traditional fields** of large and small, but will do so with **increasing insistence on careful planning, careful management, and widest possible sharing of costs for the necessary expensive equipment**.

John H. Marburger

AAAS, February 15, 2002

So, how do we approach making a case for investment?

FY 2005 OSTP/OMB Priorities Memo

1.) R&D for Homeland and National Security

2.) Nanotechnology

3.) Networking and Information Technology R&D

(includes scientific computing)

4.) Molecular-level understanding of life processes

- non-biomedical biology: plant genomics, animal genomics

5.) Environment and Energy

- climate change
- environmental observations
- hydrogen R&D

OMB/OSTP
R&D Investment Criteria

Quality

- Prospective Merit Review of Awards
- Retrospective Expert Review of Program Quality

Relevance

- Definition of Program Direction and Relevance
- Retrospective Outcome Review to Assess Program Design and Relevance

Performance

- Prospective Assessment of Program Inputs and Output Performance Measures
- Demonstration of Performance

Investment Criteria:
One Systematic Evaluation Process

	Quality	Relevance	Performance
Prospective	[1] Mechanism of Award (e.g., 10 CFR 605) [2] Justification of funding distribution among classes of performers	Planning & Prioritization	"Top N" Milestones (5 < N < 10)
Retrospective	[1] Expert reviews of successes and failures [2] Information on major awards	Evaluation of utility of R&D results to both field and broader "users"	Report on "Top N" Milestones

FESAC

GPRA-style "Metrics"

Our Guidance

…there is a need for a new emphasis on, and perhaps even a redefinition of, strategic planning

- **As a first principle of planning, machines and instrumentation must be subordinated to a broader view of the field**
- **A second principle of strategic planning must be to acknowledge the impact of one area upon another…**
- **A third important component of a new approach to strategic planning is the international dimension.**

John H. Marburger

Remarks given at FERMI Lab Users Meeting, June 3, 2003

Examples

Physics of the Universe

Knitting diverse programs together

Quantum Universe

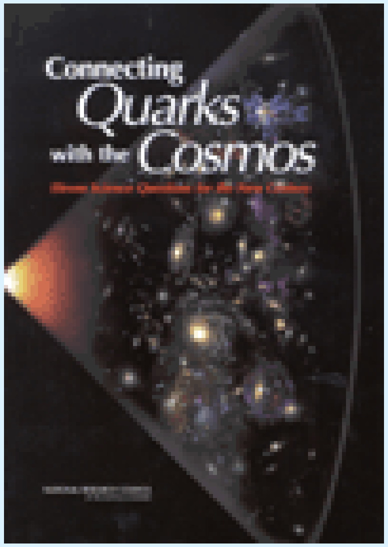
Making connections

Fusion

Providing a science-driven program concept

NRC's Quarks to the Cosmos Report

1. What is the Dark Matter?
2. What is Dark Energy?
3. How did the Universe Begin?
4. Did Einstein have the last word on gravity?
5. What are the masses of the neutrinos and how have they shaped our universe?
6. How do cosmic accelerators work and what are they accelerating?
7. Are protons unstable?
8. What are new states of matter at exceedingly high density and temperature? (HED)
9. Are there additional space-time dimensions?
10. How were elements from iron to uranium made?
11. Is a new theory of matter and light needed at the highest energies?



NSTC IWG on The Physics of the Universe

Co-chairs

Anne Kinney, Joe Dehmer, Robin Staffin (Peter Rosen)

Participation

NASA

Space Science

NSF

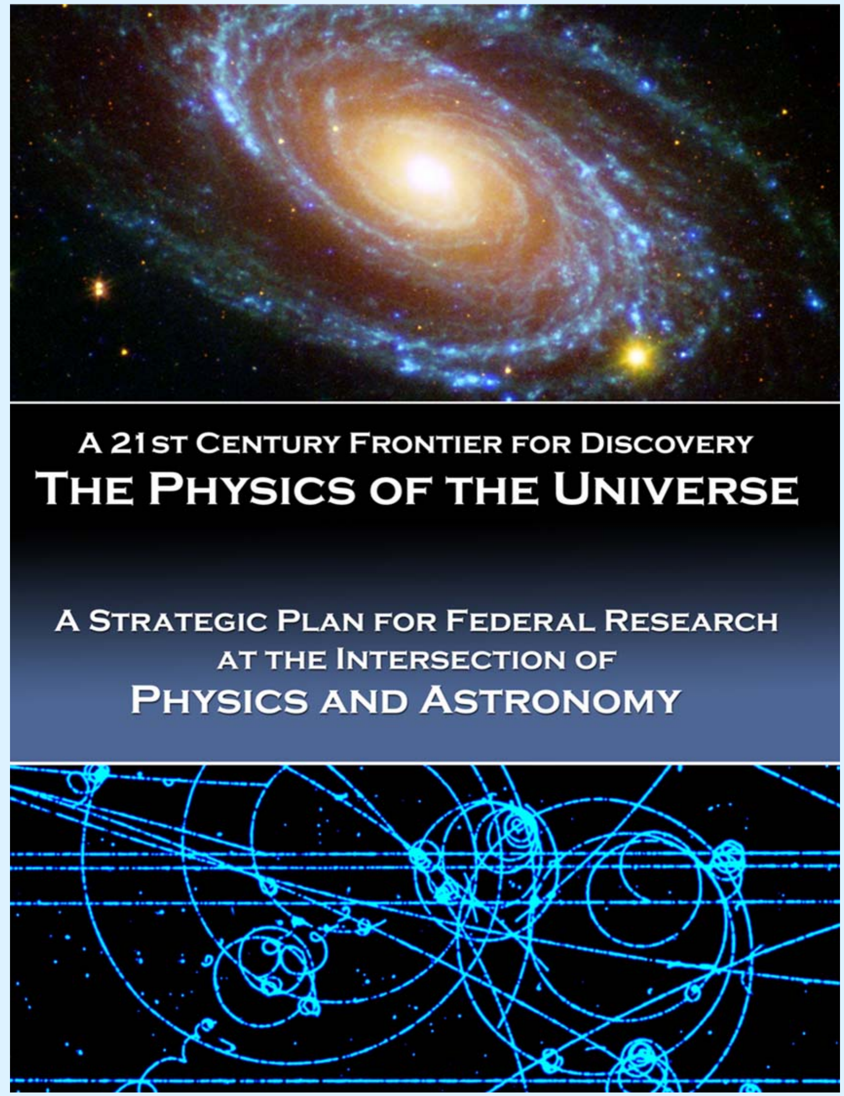
Astronomy, Physics and Office of Polar Programs

DOE

High Energy Physics, Nuclear Physics, Fusion Energy Science, and NNSA

OSTP

OMB



Quarks to the Cosmos Report Response

Analyses

- Identify the approaches to answering the questions
- Identify what are we doing now
- Identify what tools are needed to answer the questions
- Identify the “tall pole” policy issues in need of resolution

Tasks

- Define steward agencies for fields and tools.
- Define who will do what and when (as best we can).
- Cannot be all things to all people. **Must set priorities**.
- Ask to bring items up for a decision in a timely manner.

Setting Priorities

Step 1: Prioritize the Questions

The IWG based its prioritization of the eleven questions upon an assessment of each question's fit to the following criteria:

- Current potential for scientific advancement
- The timeliness or urgency of each question
- The technical readiness of projects necessary to advance the science of each question
- Existence of gaps in the overall suite of projects addressing the question

Step 2: Identifying Potential Activities

Step 3: Grouping of Related Elements

- Programmatic readiness to proceed

Inventory of Current Investments

Question 5. What Are the Masses of the Neutrinos and How Have They Shaped the Evolution of the Universe?

Project Name	*Steward*	*Participating Agencies*	*Scientific Approach*	*Status*
SuperK	Japan	DOE - High Energy Physics	Large volume Cherenkov Detector for proton decay, neutrino studies	Ongoing Project
K2K	Japan	DOE - High Energy Physics	Neutrino beam to SuperK detector to detect neutrino oscillations	Ongoing Project
SNO	Canada	DOE - Nuclear Physics, High Energy Physics	Large volume Cherenkov Detector to study solar and astrophysical neutrinos	Ongoing Project
KamLAND	Japan	DOE - High Energy Physics and Nuclear Physics	Large volume scintillation detector to look at antineutrinos from reactors	Ongoing Project
MiniBooNE	DOE - High Energy Physics	NSF - Physics DOE - Nuclear Physics, NNSA	Large detector that searches for neutrino oscillations using Fermilab accelerator	Ongoing Project
NUMI/MINOS	DOE - High Energy Physics	NSF - Physics DOE - NNSA	Study neutrino oscillations using neutrino beam from the Fermilab Main Injector	Under Construction
BOREXino	Italy	NSF - Physics and Astronomy	Study solar neutrinos using a large scintillation detector	Under Construction

Physics of the Universe Response

Table I. IWG Prioritization	
Quarks with the Cosmos Question	**Programmatic Investment Priority**
Ready for Immediate Investment Dark Energy Dark Matter Gravity Neutrinos	**Direction Known** Dark Energy Dark Matter, Neutrinos, & Proton Decay Gravity
Further Planning and/or R&D Needed High Density & Temperature Physics Origin of Heavy Elements Proton Decay The Big Bang	**Roadmap Future Investments or Exploit Existing Facilities** Origin of Heavy Elements Birth of the Universe using Cosmic Microwave Background High Density & Temperature Physics High Energy Cosmic Ray Physics
Ideas Needed or Investment Adequate Cosmic Accelerators Extra Dimensions New Theories of Light and Matter	

Question 6. How Do Cosmic Accelerators Work and What Are They Accelerating?

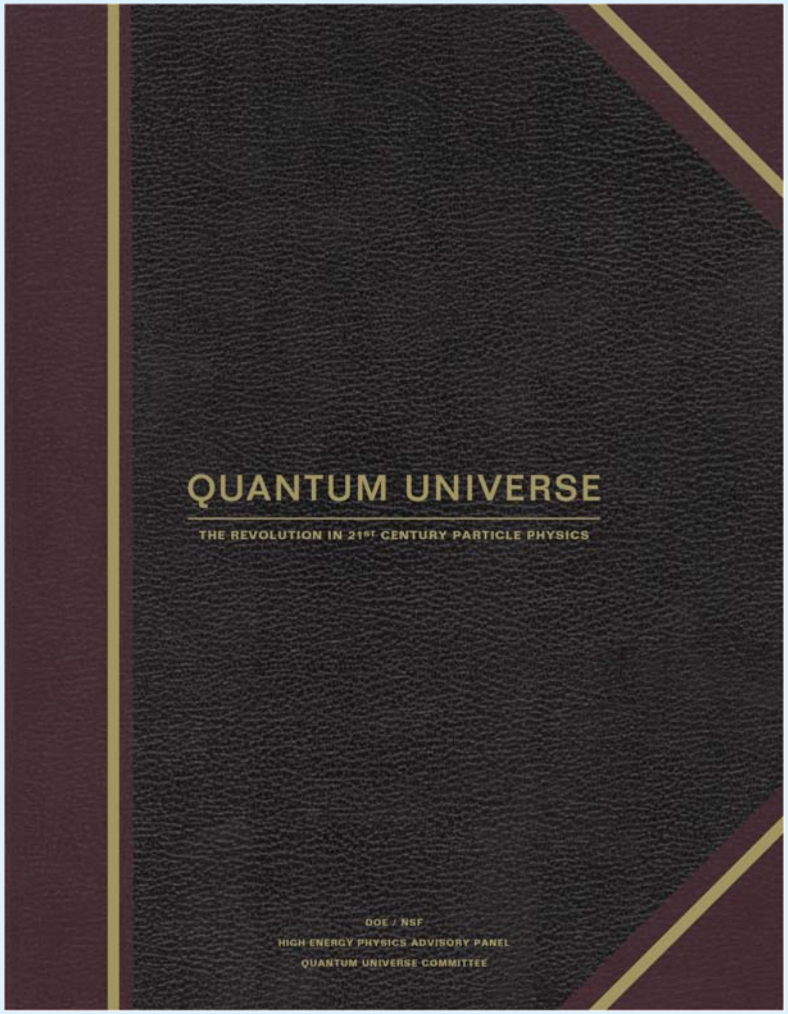
Findings

HEDP is an emerging field that provides crucial measurements that are relevant to interpreting astrophysical observations of the universe. The field has great promise that should be better coordinated across the various Federal agencies to capitalize on the emerging opportunities.

Recommendations

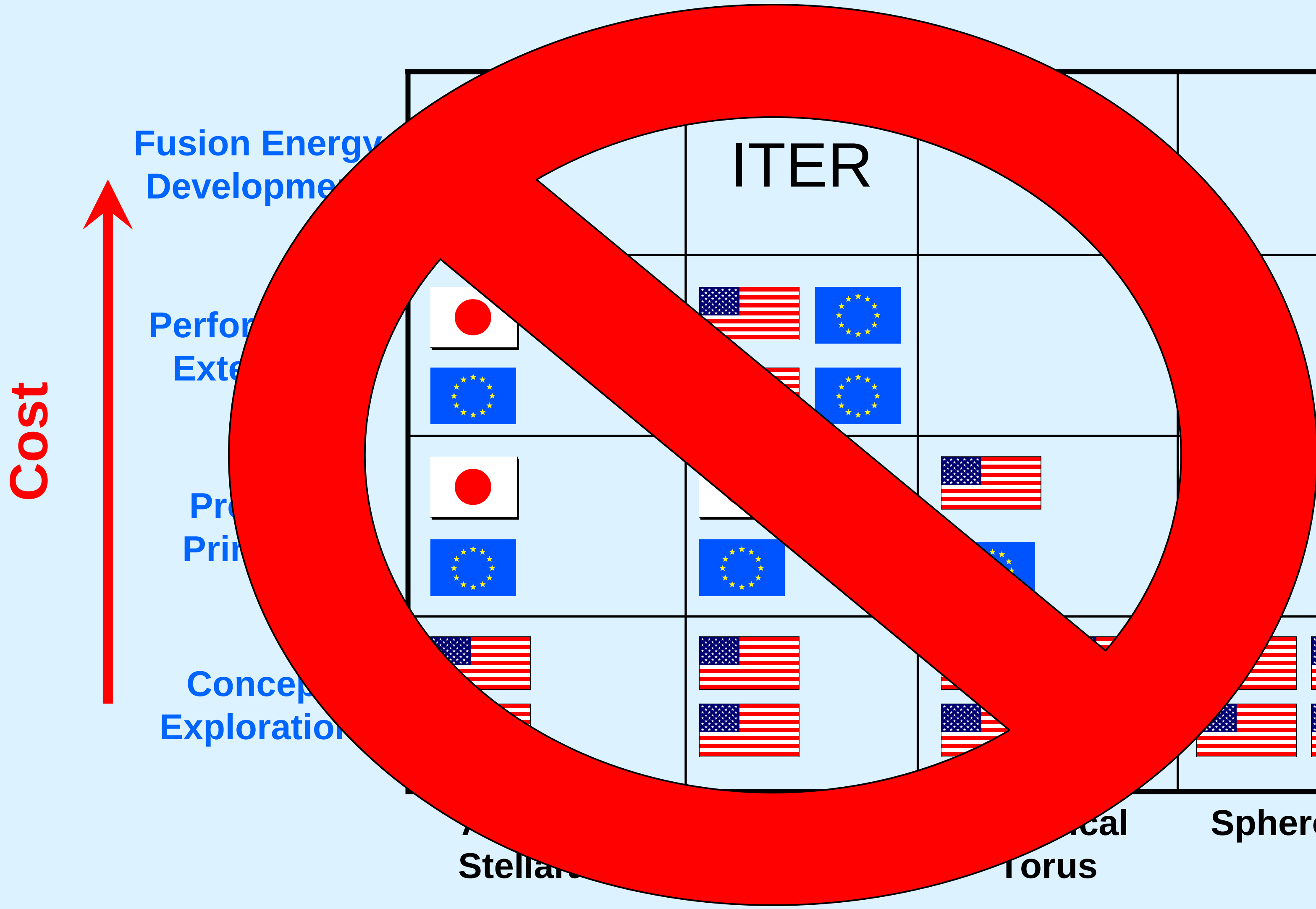
- In order to develop a balanced, comprehensive program, NSF will work with DOE, NIST, and NASA to develop a science driven roadmap that lays out the major components of a national HEDP program, including major scientific objectives and milestones and recommended facility modifications and upgrades.
- NNSA will add a high energy high-intensity laser capability to at least one of its major compression facilities in order to observe and characterize the dynamic behavior of high-energy-density matter.
- DOE and NSF will develop a scientific roadmap for the luminosity upgrade of RHIC in order to maximize the scientific impact of RHIC on HED physics.

DOE/NSF HEPAP Quantum Universe Report



- Ties EPP to the broader effort in discovery-oriented physical sciences, yet does not subordinate EPP to any other field
- Strong overlap with Physics of the Universe and Astronomy and Astrophysics Advisory Committee (AAAC) activities
- Very well received in DC

FESAC *Priorities & Balance*



FESAC Priorities Panel

Macroscopic plasma behavior

- **T1. How does magnetic field structure affect plasma confinement?**
- **T2. What limits the maximum pressure that can be achieved in laboratory plasmas?**
- **T3. How much external control versus self-organization will a fusion plasma require?**

Multi-scale transport behavior

- **T4. How does turbulence cause heat, particles, and momentum to escape?**
- **T5. How are large-scale electromagnetic fields and mass flows generated in plasmas?**
- **T6. How do magnetic fields in plasmas rearrange and dissipate their energy?**

Plasma boundary interfaces

- **T9. How can we interface a 100 million degree burning plasma to its room temperature surroundings?**

Waves and energetic particles

- **T10. How can heavy ion beams be compressed to the high intensities required for creating high energy density matter?**
- **T11. How do electromagnetic waves interact with plasma?**
- **T12. How do high energy particles interact with plasma?**

FESAC Priorities Panel

Fusion engineering science

T13. How does the challenging fusion environment affect plasma chamber systems?

T14. What are the ultimate limits for materials in the harsh fusion environment?

T15. How can systems be engineered to heat, fuel, pump, and confine steady-state or repetitively pulsed burning plasmas?

High-energy density implosion physics

T7. How can high energy density fusion plasmas be assembled and ignited in the laboratory?

T8. How do hydrodynamic plasma instabilities affect implosions to high energy density?

Emphasize this after burning plasmas have been created and controlled

More than just report doctoring!

Coordination of Advice

Two years ago, **the Office of Management and Budget required NASA and NSF to coordinate their planning for big telescopes, and not to treat space-based and land-based telescopes as two entirely separate species**. The result was the National Astronomy and Astrophysics Advisory Committee (NAAAC) now embedded in the language of the 2002 NSF reauthorization bill. **In my opinion, the Department of Energy should be included in this committee**, and its purview should include all the means of astronomical observation, including photons, neutrinos and gravitons. It makes no sense for DOE to be building space-borne instrumentation designed to probe the mystery of dark energy, for example, without strong coordination with NASA. Nor does it make sense for NASA to be flying space-based experiments relevant to particle physics without strong coordination with DOE. NSF and DOE currently draw on HEPAP expertise for program guidance. NASA should too.

John H. Marburger,

FERMI Users Meeting, June 2, 2003

Scientific Advisory Groups