# NSF Elementary Particle Physics and Particle Astrophysics

## Report on NSF Funding

Presentation at the HEPAP Meeting

February 14, 2005


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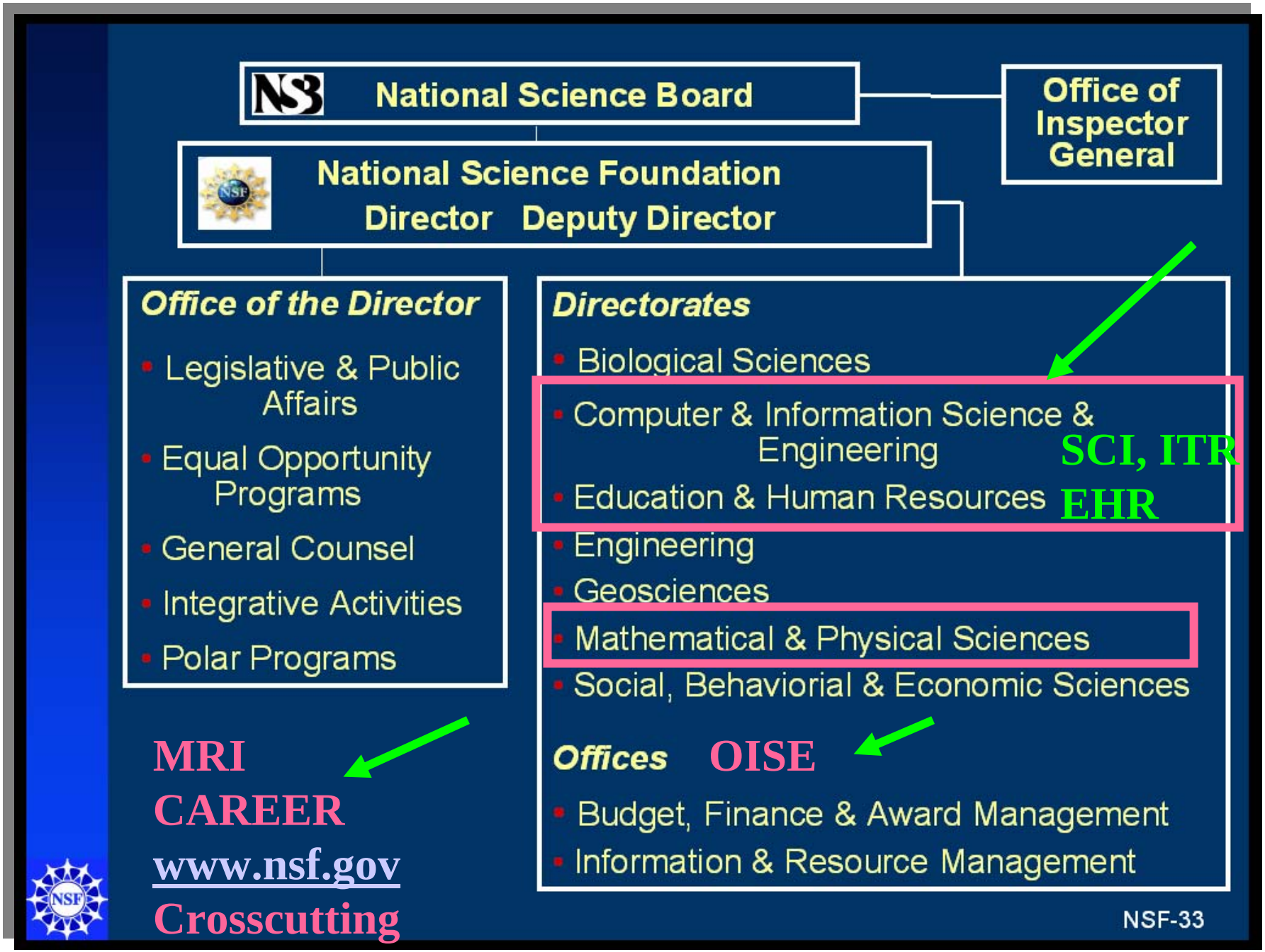
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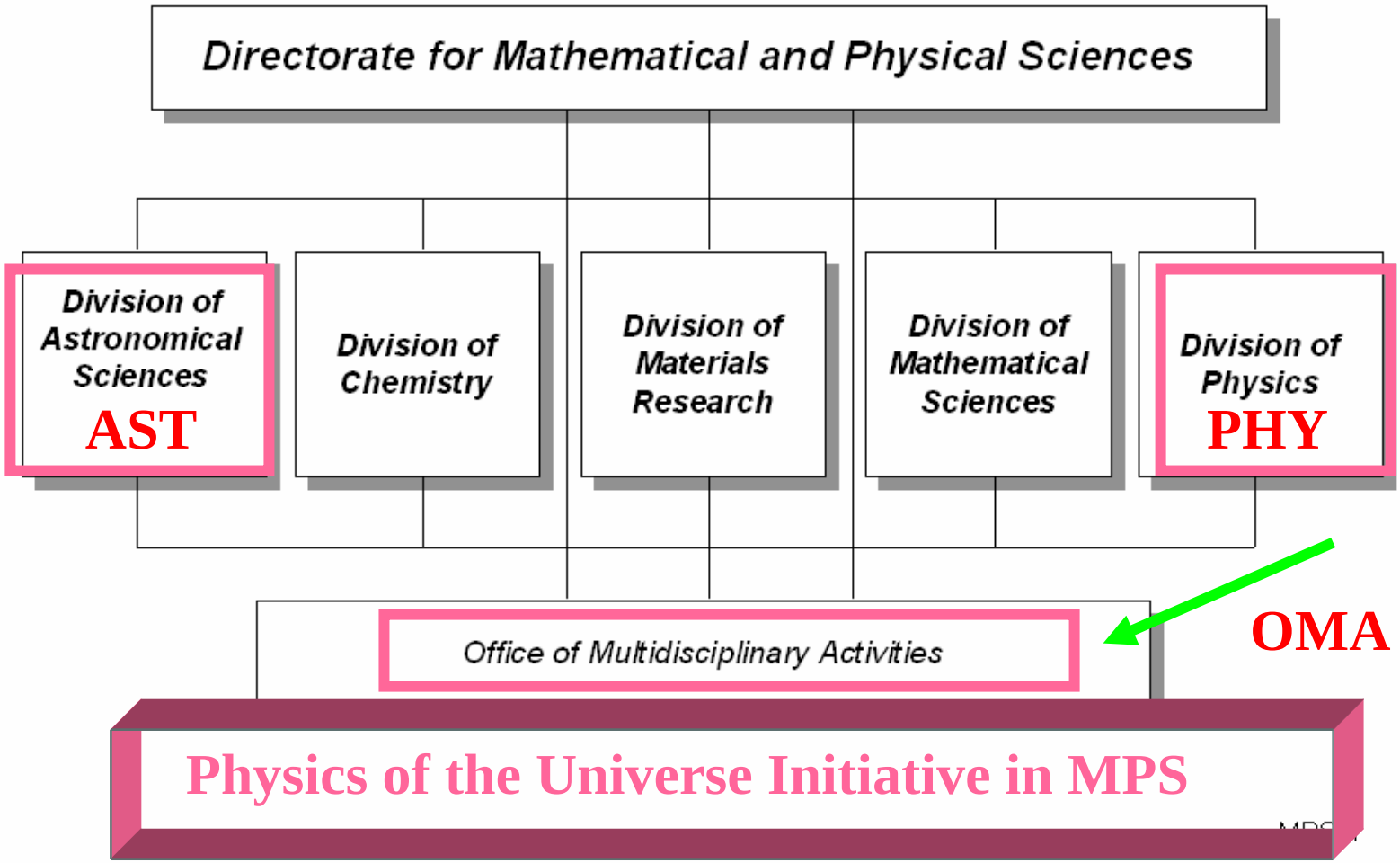
# Directorate for Mathematical and Physical Sciences



# NSF Division of Physics

**I. Atomic, Molecular, Optical, and Plasma Physics**
**II. Biological Physics**
**III. Elementary Particle Physics (EPP)**
**IV. Gravitational Physics and LIGO**
**V. Education and Interdisciplinary Research**
**VI. Nuclear Physics**
**VII. Particle and Nuclear Astrophysics (PNA) (spinoff)**
**VIII. Theoretical Physics (TP)**

***Within TP are the <u>sub-areas</u> of :***

***Atomic Physics,***
***Elementary Particle Physics,***
***Mathematical Physics,***
***Nuclear Physics,***
***Cosmology and Astrophysics***

**Major Projects through MREFC (Major Research Equipment and Facilities Construction)**

MARIACHI

Mixed Apparatus for Radio Investigation of Atmospheric Cosmicray of High Ionization

MARIACHI HOME | MUSEUM | POSTERS | DETECTOR | LIBRARY

EHR; OISE; CISE;

AST; OMA; DOE; +?

Open Science Grid

RSVP

rare symmetry violating processes

ASPIRE

Astrophysics Science Project

PHYSICAL SCIENCES

INFORMATION TECHNOLOGY

EDUCATION

UNDERSTANDING THE UNIVERSE

Education & Outreach

QuarkNet

PPDG

C.R.O.P.


iVDgL

GriPhyN

Data Intens

CHEPREO

CENTER FOR HIGH ENERGY PHYSICS RESEARCH & EDUCATION OUTREACH

U.S. Department of Energy

and the

National Science Foundation

ATLAS

CMS

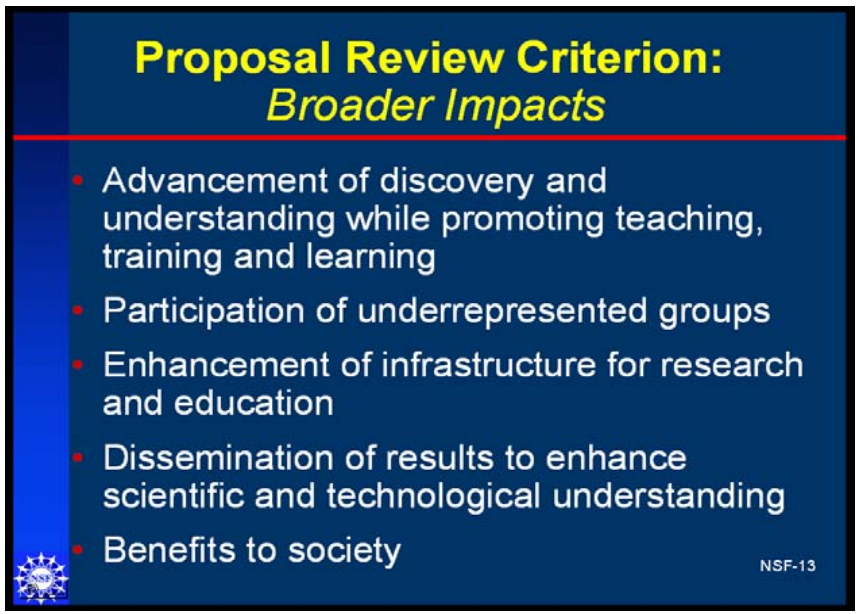
nsf

OMA

# Partnerships, Diversity and Broader Impacts

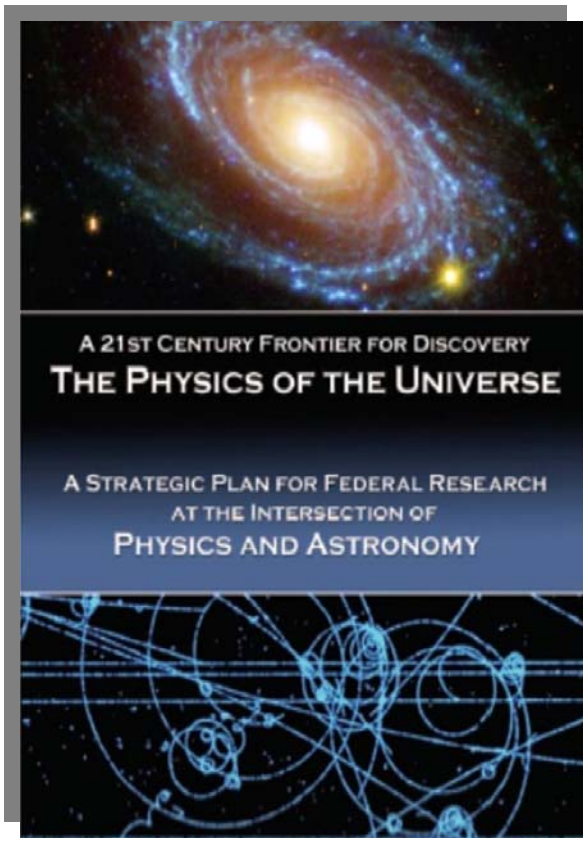
- **Partnerships** with other divisions in NSF
- NSF shares stewardship of EPP with DOE and works with DOE to realize the grand opportunities
- Spinoffs – Particle Astrophysics (with AST/OMA)
- **Cyberinfrastructure and the cyberscience it enables**, connecting with NSF's high priority activities in this area and related activities government-wide in Networking and Information Technology R&D.

# Partnerships, Diversity and Broader Impacts




- **Broaden participation** by integrating it with our research strengths (eg, LIGO, REUs, Hampton PFC, FIU CHEPREO)
- **Broader Impacts** (CROP, QuarkNet, ASPIRE, Mariachi, …)

# Partnerships, Diversity and Broader Impacts




- ***Physics of the universe,*** a set of activities that build on the National Science and Technology Council report of the same name and partner with the Department of Energy and NASA in exploring the mysteries of dark matter and dark energy, the earliest phases in development of the universe, the fundamental nature of time, matter and space, and the role of gravitation.

# "Effective" Funding (>$100M) for Particle Physics in FY02 - FY05:

| | FY02 | FY03 | FY04 | FY05 |
|---|---|---|---|---|
| Accel.-based w. Cornell | $42.31 | 48.17 | 51.09 | 48.06 |
| Part. Astrophys (SPINOFF) | 9.05 | 11.70 | 12.68 | 14.68 |
| EP-Astro Theory | 10.84 | 12.07 | 9.23 | 9.31 |
| Total Base | $62.20 | 71.93 | 73.00 | 72.05 M |

*PLUS*

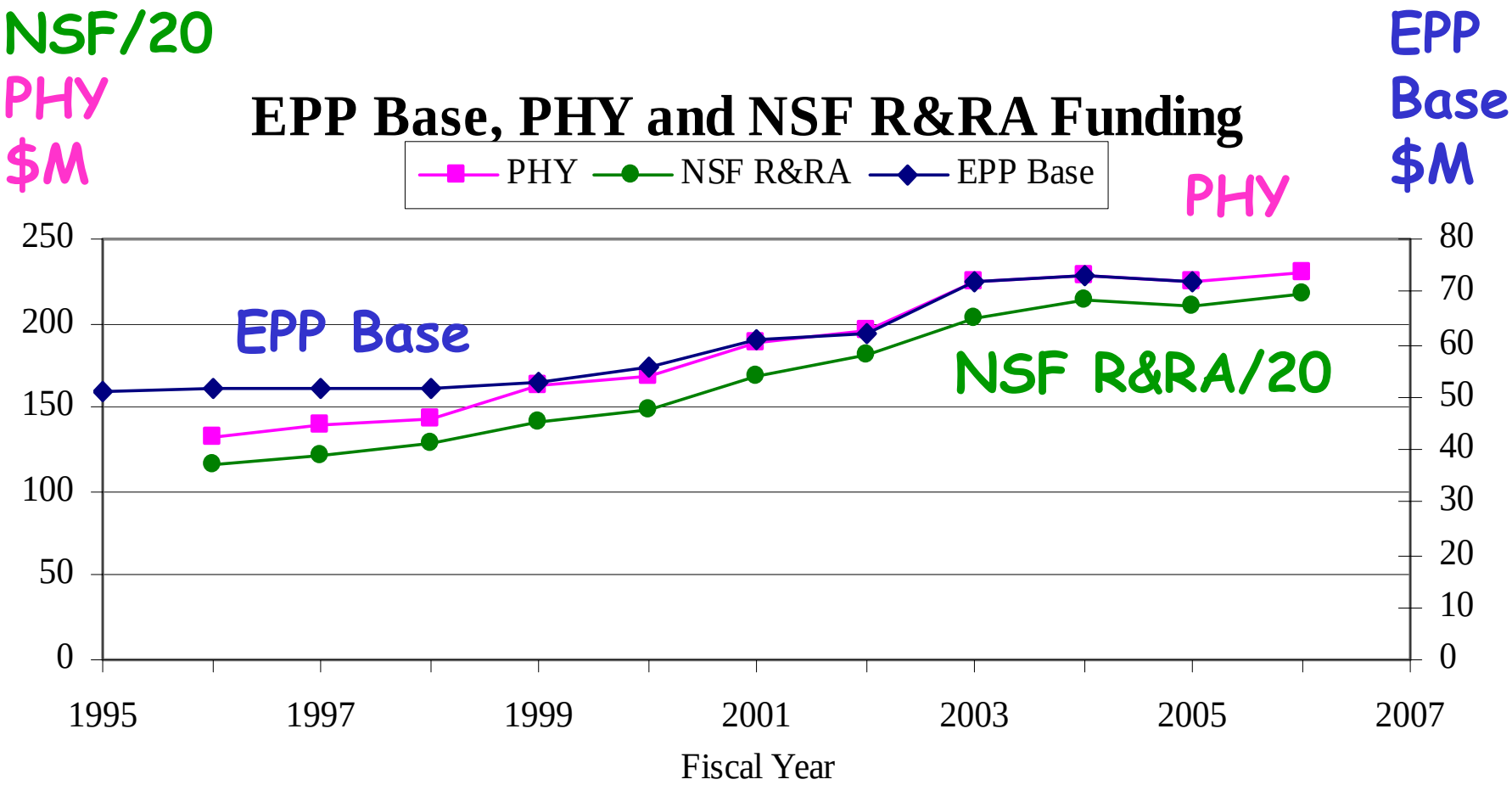
| EPP Allied Funding | | FY02 | FY03 | FY04 | FY05 | FY06 |
|---|---|---|---|---|---|---|
| PFC, etc | $ | 4.0 | 4.0 | 7.0 M | | |
| ITR | | 6.0 | 6.6 | 4.2 | | |
| MRI | | 3.2 | 1.7 | 0 | | |
| ESIE | | 0.7 | 0.7 | 0.29 | | |
| MREFC | | | | | | (Request) |
| LHC construction | $ | 16.90 | 9.69 | | | |
| IceCube | | 15.00 | 24.54 | 41.75 | 47.62 | 50.45 M |
| RSVP | | -- | -- | -- | 14.88 | 41.78 M |
| Subtotal | $ | 45.80 | 47.23 | 53.25 | 62.50 | 92.23 M |

# NSF FY 00-06 Budget Summary

| | FY 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | %Diff |
|---|---|---|---|---|---|---|---|---|
| | ($ millions) | | | | | (CP) | (Request) | (06-05) |
| NSF | 3,923.4 | 4,459.9 | 4,774.1 | 5,369.3 | 5,652.0 | 5,472.8 | 5,605.0 | 2.42 |
| (R&RA) | 2,979.9 | 3,372.3 | 3,616.0 | 4,054.4 | 4,293.3 | 4,220.6 | 4,333.5 | 2.68 |
| MPS | 755.88 | 854.08 | 920.42 | 1040.70 | 1091.59 | 1069.86 | 1086.23 | 1.53 |
| PHY | 168.30 | 187.54 | 195.88 | 224.50 | 227.77 | 224.94 | 230.14 | 2.31 |
| EPP BASE | 55.48 | 61.15 | 62.20 | 71.93 | 73.00 | 72.05 | ← | -1.3% |

**"EPP BASE" = Theory + Astro + Accel. Based +Cornell**

# NSF FY 95-06 Budget Summary




**** EPP Base funding tracks with PHY (and R&RA) funding**

# PHY Priorities in FY05

- Facilities were cut this year, as LHC and NSCL increased
- Keeping the PI base program above 50% of the Division funds
- Theory
- POU (Physics of the Universe) (+$2M for PNA)

**The *LARGE HADRON COLLIDER (LHC)* will be the premier *Energy- Frontier* facility in the world, with vast discovery potential in elementary particle physics research.**

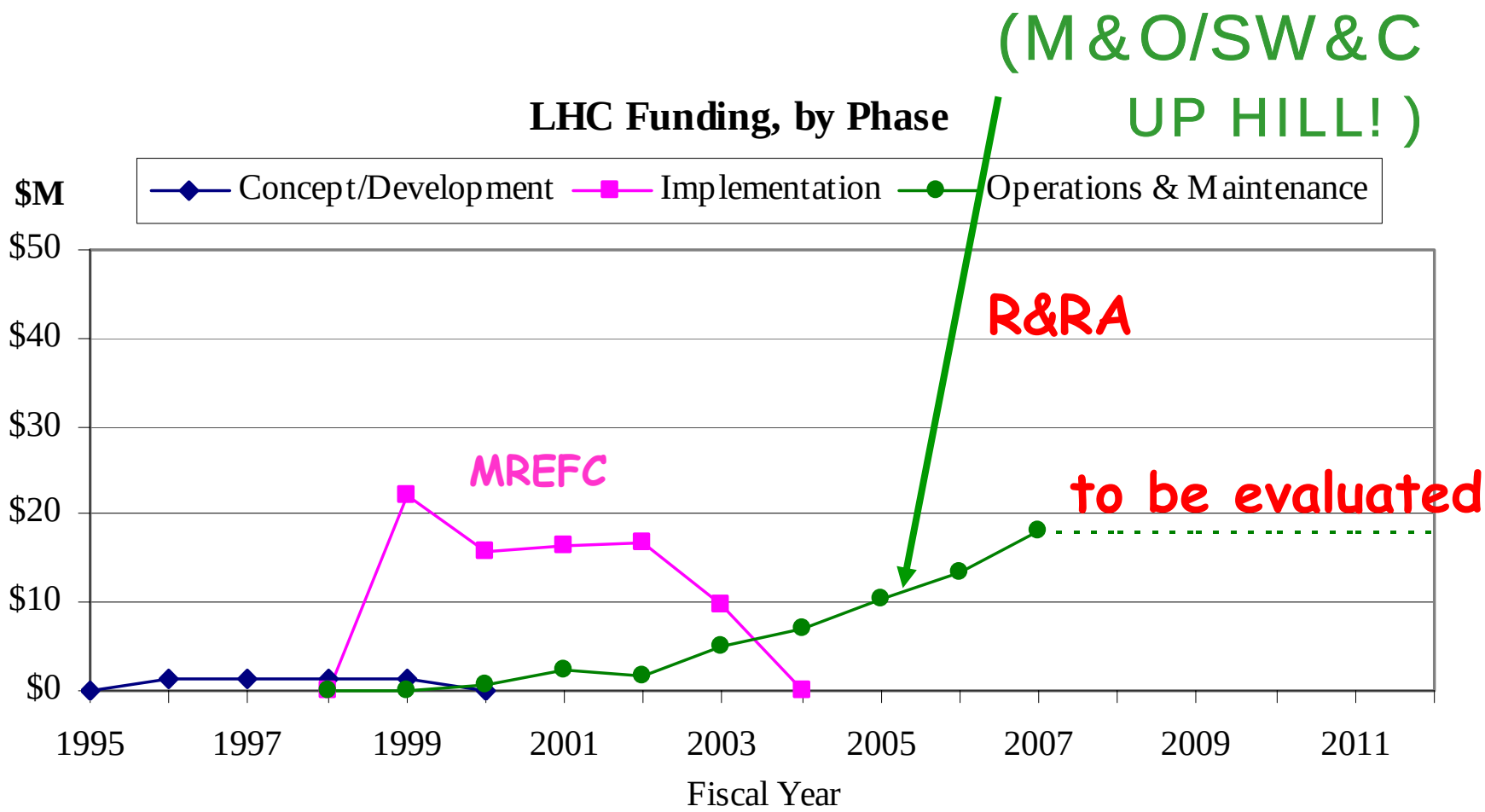
**A total of 34 international funding agencies participate in the *ATLAS* detector project, and 31 in the *CMS* Detector project**


**The U.S. participants are ~20% of the collaboration**

Necessary

*U.S. Department of Energy and the National Science Foundation*

# NSF US LHC RESEARCH PROGRAM




****DOE/NSF AGENCY AGREEMENT! Now more stable.**

****Possibly more funds through CISE Division: ITR, SCI**

# LHC Research Program

- Stability and more predictable timing
- Ramp-up:

| LHC Funding: | FY02 | FY03 | FY04 | FY05 | FY06 (request) | |
|---|---|---|---|---|---|---|
| MREFC | | | | | | |
| LHC constr. | $ 16.90 | 9.69 | M | | | |
| R&RA | | | | | | |
| Research Pgm | 1.60 | 5.00 | 7.00 | 10.50 | 13.50 | M |

- Reviews (with DOE-HEP) of FY07-09 guidance are underway this year

# LHC Research Program

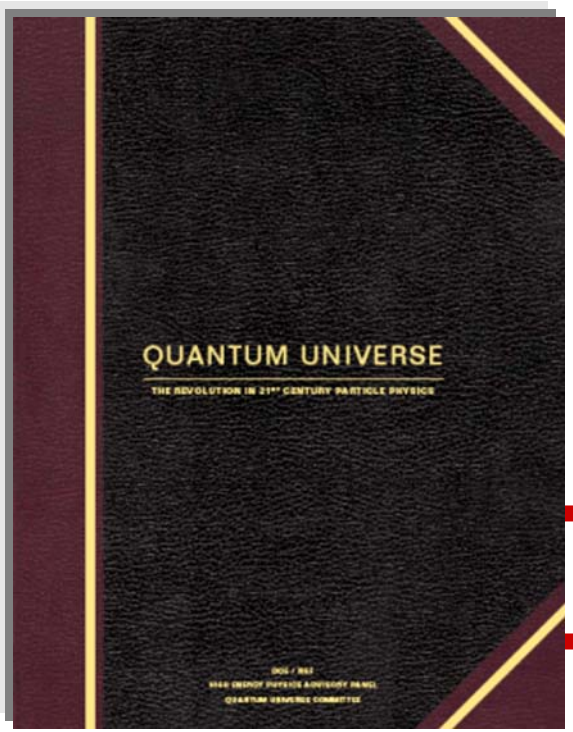
- Funding supported by NSF-CISE (and PHY):
- GriPhyN
- iVDGL
- UltraLight
- ITR for Grid activities
- Support for OSG-LCG-EGEE cooperation
- Issue: some of these are expiring soon
- Open Science Grid (OSG)

# The Rare Symmetry Violating Processes Project:

**RSVP** is an NSF-supported, university-led particle physics project, using accelerator facilities developed by DOE

**KOPIO** aims to measure a rare decay of the neutral kaon that would be a major advance in the study of CP violation and the matter-antimatter asymmetry in the universe $K_L^0 \rightarrow \pi^0 \nu \bar{\nu}$


**MECO** is a search for the "forbidden" conversion of muons to electrons that aims to discover new physics beyond SM up to 3000TeV $\mu^- N \rightarrow e^- N$




Primary US Physics Program of Smaller Facilities

| | Unification | | | | Particle World | | | Birth of the Universe | |
|---|---|---|---|---|---|---|---|---|---|
| Question | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Mini-BooNE | | | | | | | X | | |
| MECO | X | | | | X | | | | |
| Reactor Experiments | | | | | | | X | | |
| CLEO-c | | | | | X | | | | |
| K0PI0 | | | | | | | | | X |
| Neutrinoless Double Beta Decay | | | | X | | | X | | |
| SDSS | | | | | | X | | | |
| LSST | | X | | | | X | | | |
| Underground Dark Matter Detectors | | | | | | X | | | |
| WMAP | | X | | | | X | | X | |
| CMB Polarization | | | | | | | | X | |
| Lattice Computational Facilities | | | | | X | | | X | |
| Precision Gravity | | | X | | | | | | |

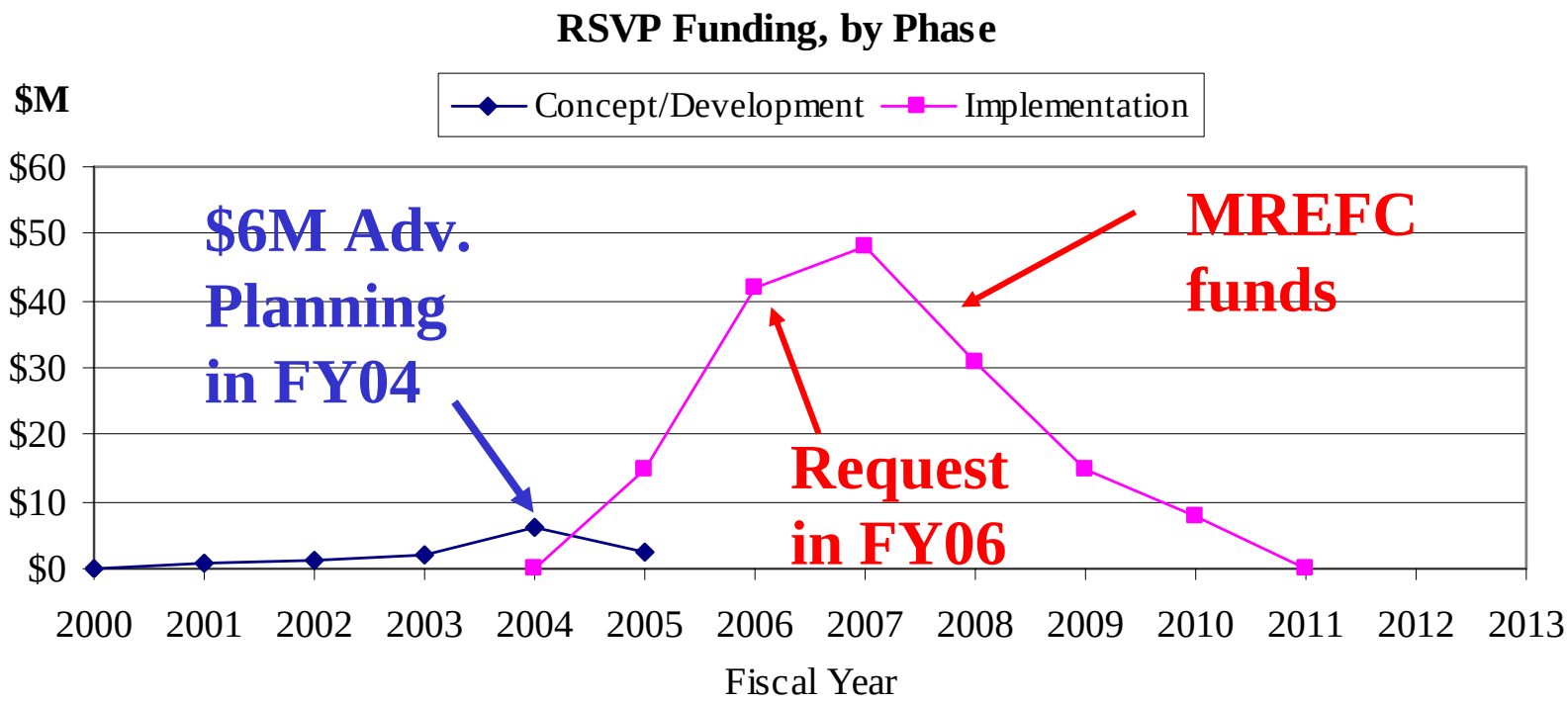
**1. Are there undiscovered principles of nature: new symmetries, new physical laws?**

**5. Why are there so many kinds of particles?**

**9. What happened to the antimatter?**

# RSVP FUNDING

- Oct 2000: Director included RSVP as a future MREFC (2002+)
- 04 Congress appropriated "$6M for cont'd advanced planning"




**FY 2005 start shown, as in FY 2005 President's budget.**

# RSVP STATUS

- RSVP Project Leadership has been established
- Major reviews of components have been performed

- Remaining issues:
- HEPAP sub-panel review of the science of RSVP
- Full baseline review this Spring 2005
- Status of AGS/RHIC?

# CESR

- Very productive, self-managed Lab; b now c phys.
- Phased close down for EPP with CLEO-c
- CLEO-c (we support 7 groups)
- CHESS (600-700 users)
- Award for ERL starting in FY05

| **Cornell Funding:** | FY03 (actual) | FY04 (actual) | FY05 (CP) | FY06 (request) |
|---|---|---|---|---|
| CESR CLEO-c $ | 19.49 | 18.00 | 16.62 | 14.71 M |
| ERL $ | | | 5.15 | 4.95 M |

# Other EPP Activities

- Tevatron experiments: D0 (10 groups), CDF (4)
- Neutrino projects: MiniBooNE (3), MINOS (2), K2K/Super-K (2)
- BaBar (2)
- BTeV (R&D) (3 groups)
- APPI program delayed, but small funding (~$0.3M) to: University Linear Collider Accelerator and Detector R&D (working closely with DOE in both areas: joint review process) and other accelerator projects

| | FY 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | %Diff |
|---|---|---|---|---|---|---|---|
| | ($ millions) | | | | | (CP) | (05-04) |
| EPP,acc | 22.69 | 24.87 | 22.52 | 25.60 | 20.09 | 18.64 | -7.2 |

# Particle Astrophysics

- In partnership with AST, OMA and DOE-HEP:
- AUGER (construction end in CY2006?)
- HiRes (data-taking until ~March 2006)
- VERITAS (started support in FY04)
- CDMS and other DM projects
- MILAGRO and STACEE
- DUSEL
- ACT (started supporting in FY05)
- POU funding (+$2M in FY05 from MPS)

| FY 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | %Diff |
|---|---|---|---|---|---|---|
| ($ millions) | | | | | (CP) | (05-04) |
| PA, NA 1.69 | 4.65 | 9.05 | 11.70 | 12.68 | 14.68 | 15.8 |

# Particle and Astro. Theory

- ~1% increase this year
- However, few new initiatives.
- New Lattice QCD Initiative (5-year Post Doc) will begin October 2005.

# Underground Science Laboratory Update

- **NAS BOARD ON PHYSICS AND ASTRONOMY, DEC 2002 *SUMMARY:***

**"A deep underground laboratory can house a new generation of experiments that will advance our understanding of the fundamental properties of neutrinos and the forces that govern elementary particles, as well as shedding light on the nature of the dark matter that holds the Universe together. Recent discoveries about neutrinos, new ideas and technologies, and the scientific leadership that exists in the U.S., make the time ripe to build such a unique facility."** http://www7.nationalacademies.org/bpa/Neutrinos_Sum.pdf

MPS/PHY is taking the lead for NSF, in partnership with the Directorates of Geosciences and Engineering, in working to implement a sequence of steps that might lead to the creation of such a laboratory

# Underground Science Laboratory Update

1. 04-595 (Deadline: September 15, 2004):
   This solicitation was to establish the site-independent scientific and engineering benchmarks against which the capabilities of the candidate sites for an UGL will be measured. (Made 1 award)

2. 05-506 (Deadline: February 28, 2005):
   This solicitation invites proposals to support the development of the conceptual design for the infrastructure, and an initial suite of experiments, for a DUSEL. (Expect to make 3-5 6-month awards, each of up to $0.5M, for a total of ~$1.5M)

3. (No number yet; Deadline: ??, 200?):
   A third solicitation is planned through which detailed technical designs will be developed for the most promising combinations of site and conceptual design resulting from solicitation #2. (Expect to award ?? in FY06?)

# Summary

- We are working with many partnerships to bring added value to EPP projects
- We are entering a new phase of operations with facilities (some with DOE)