Realizing the Grand Opportunities in Elementary Particle Physics: NSF Update

Presentation to HEPAP

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Short Items, good news

- Dr. Arden Bement, Jr (Acting Director) nominated to be Director
- NRC EPP2010 Committee to have its first meeting on 30 November/1 December in Washington
- Linear Collider Technology Choice
  - Important step in moving toward a Linear Collider (allows focusing of R&D effort)
  - NSF will continue to work with DOE to fund the essential accelerator R&D

EPP 2010: Elementary Particle Physics in the 21st Century

Summary

In the 21st century, elementary particle physics is poised to address some of the most basic questions in science. Obtaining the answers to these questions will require a global effort of great scale and complexity. The committee is charged to construct a plan for U.S. participation in this effort. In particular, the committee will

- Identify, articulate, and prioritize the scientific questions and opportunities that define elementary-particle physics.
- Recommend a 15-year implementation plan with realistic, ordered priorities to realize these opportunities.

EPP2010:
Committee Membership

Harold T. Shapiro, Princeton University, *Chair*
Sally Dawson, Brookhaven National Laboratory, *Vice Chair*
Norman R. Augustine, Lockheed Martin Corp.
Jonathan A. Bagger, Johns Hopkins University, *BPA Liaison*
Philip N. Burrows, University of London
Sandra M. Faber, University of California Observatories
Stuart J. Freedman, University of California at Berkeley
Jerome I. Friedman, Massachusetts Institute of Technology
Joseph S. Hezir, EOP Group, Inc.
Norbert Holtkamp, Oak Ridge National Laboratory
Takaaki Kajita, University of Tokyo
Neal F. Lane, Rice University
Nigel Lockyer, University of Pennsylvania
Sidney R. Nagel, University of Chicago
Homer A. Neal, University of Michigan
J. Ritchie Patterson, Cornell University
Helen Quinn, Stanford Linear Accelerator Center
Charles V. Shank, Lawrence Berkeley National Laboratory
Paul Steinhardt, Princeton University
Harold E. Varmus, Memorial Sloan-Kettering Cancer Center
Edward Witten, Institute for Advanced Study

NRC Staff: Donald C. Shapero, Director and **Timothy I. Meyer,** Program Officer

Large Hadron Collider: Crtical Investment in Discovery Science and the Future of Elementary Particle Physics by DOE & NSF

- Stunning Science Potential
  - Higgs (origin of mass)
  - Supersymmetry
    - Discovery of the superworld
    - Test string theory
    - Dark matter and dark energy
  - Extend energy reach of Tevatron by 7X
    - Large “discovery space”
- Bargain Price
  - US investment is about 10%
  - US Participation is about 30%

DOE / NSF Partnership From the Beginning

The U.S. contributions to LHC construction, **fixed at $531M**, are organized into 3 projects

	Total	**DOE**	**NSF**
U.S. LHC Accelerator Project	$200M	$200M	0
U.S. ATLAS Detector Project	$164M	$103M	$61M
U.S. CMS Detector Project	$167M	$147M	$20M
US Total	$531M	$450M	$81M

LHC Operations, Maintenance and Computing – Essential to Realizing the Investment and Getting the Science Out

- NSF & MPS understand importance of O&M
- Must be ready for first collisions in 2007 – discoveries are likely to come early
- Joint Oversight Group facilitates cooperation between DOE & NSF (which has been excellent)
- Several previous plans, new personnel at NSF (me) and DOE (Robin)

3 to 1 ratio reflects investment in detectors and 4 to 1 ratio of DOE/NSF researchers

April 2002	FY00	FY01	FY02	FY03	FY04	FY05	FY06	FY07
NSF guidance ($M)	1.0	1.5	1.7	2.2	2.9	8.7	15.0	15.7
DOE guidance ($M)	2.3	3.3	5.1	6.7	8.8	26.0	45.0	47.0
Total guidance ($M)	3.3	4.8	6.8	8.9	11.7	34.7	60.0	62.7
Bottom up needs ($M)	3.3	4.8	7.8	18.6	28.2	46.6	59.9	70.5
Short fall (guidance-need)			-1.0	-9.7	-16.5	-11.9	0.1	-7.8

Initial estimates too low. 2 to 1 ratio large increase in NSF share reflects better budgets at NSF, but imbalance in DOE/NSF ratio.

FY04 Budget

Apr 2003 (Barebones)	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09
NSF guidance ($M)	1.6	5.0	10.0	15.0	20.0	25.0	25.0	25.0
DOE guidance ($M)	5.5	6.7	14.4	27.4	41.6	45.8	48.0	48.0
Total guidance ($M)	7.1	11.7	24.4	42.4	61.6	70.8	73.0	73.0
Bottom up needs ($M)	6.9	11.9	23.8	42.0	61.0	69.1	73.0	73.0
Short fall (guidance-need)		-0.2	0.6	0.4	0.6	1.7	0.0	0.0

Change in NSF's numbers reflects difficult FY04 budget, but won't get the job done

FY05 Budget

Feb 2004	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09
NSF guidance ($M)	1.6	5.0	7.0	9.0	14.0	19.0	24.0	25.0
DOE guidance ($M)	5.5	6.7	14.4	26.4	41.6	45.8	48.0	48.0
Total guidance ($M)	7.1	11.7	21.4	35.4	55.6	64.8	72.0	73.0
Bottom up needs ($M)	7.1	11.7	24.3	41.5	61.6	70.8	73.0	73.0
Short fall (guidance-need)			-2.9	-6.1	-6.0	-6.0	-1.0	0.0

Staffin/Turner Review

- Need for long-term commitment by both NSF and DOE to properly support LHC
- Previous funding plans predate both of us and have ambiguous status
- Aesook Byon-Wagner (DOE/HEP/OS) and Jack Lightbody (NSF/PHY) carried out a review and submitted report 5 May 2004
- Goal: DOE & NSF commit to a well understood funding profile

Staffin/Turner LHC Plan

- Needs for FY04 through FY06 clearly quantified

($M)	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09
Barebones profile	7	12	24	42	62	71	73	73
Leadership profile	7	12	29	47	67	73	73	73

- Needs beyond FY06 require further review and scrutiny

- DOE and NSF commitment in flat or increasing budgets

	FY 04	**FY05**	**FY06**	**FY07-FY09**
DOE	14.4M	26.4M	41.6M	TBD
NSF	9.3M	14.0M	18.0M	TBD
[FY05 Budget:	7.0M	9.0M	14.0M]	
TOTAL	23.4M	40.4M	59.6M	TBD

- Budgets beyond FY06 need further review
- Strive for a 3 to 1 DOE/NSF ratio in FY07 and beyond

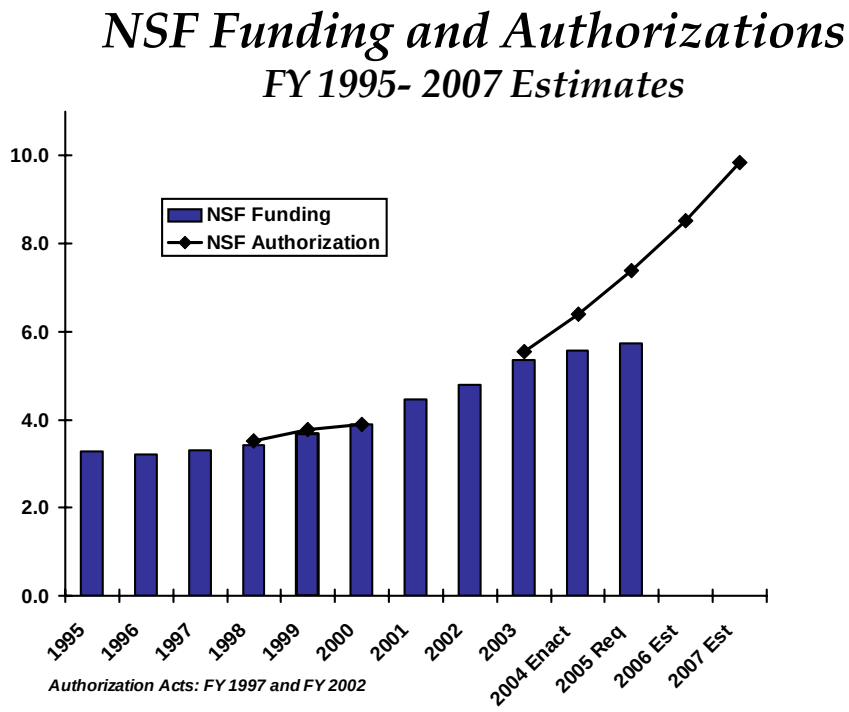
The Details

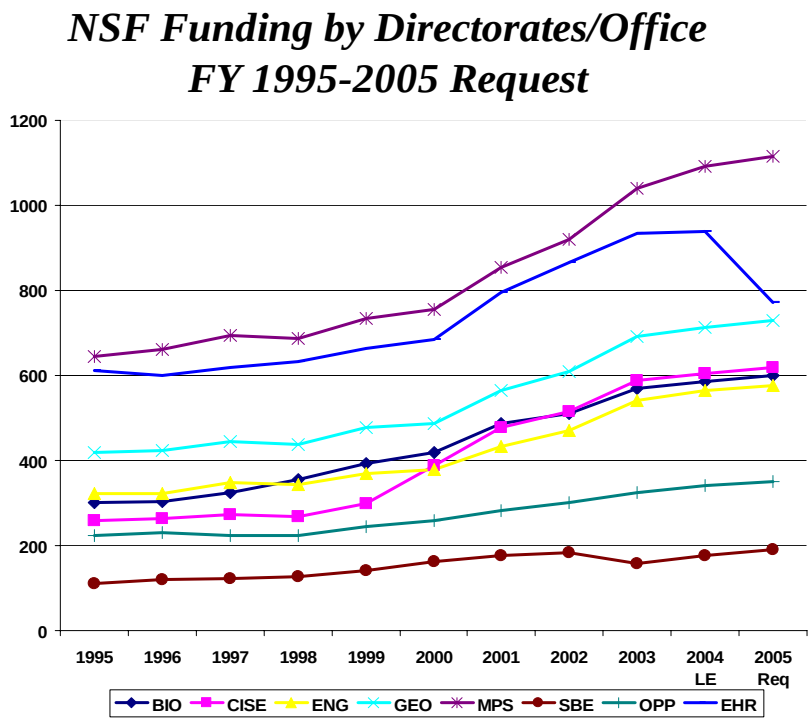
- NSF Awards Have Start and End Dates
- Current Anniversary Date is 1 August
- New Plan
  - 9 month award of 7M$ on 1 Aug 2004
    - Burn rate of 9.33M$/yr
  - 9 month award of 10.5M$ on 1 May 2005
    - Burn rate of 14M$/yr
  - 9 month award of 13.5M$ on 1 Feb 2006
    - Burn rate of 18M$/yr
  - 12 month award of 18M$ on 1 Nov 2006
- Equivalent to 12 month awards of 10.5M$ (8/04), 16M$ (8/05) and 18M$ (8/06)
- Working to identify additional funds from NSF CISE Directorate for tier 2 centers

Arriving at this plan involved the cooperative efforts of NSF, DOE and the US Atlas and CMS Collaborations working together to make sure we realize the full potential of the US investment in the LHC.

Thanks to all

NSF Funding





+68% since 1998, but leveling (out years from FY05 budget)

	2005	2006*	2007*	2008*	2009*
	5.77B$	5.666B$	5.674B$	5.723B$	5.749B$
vs 05:	-5%/0% House/Senate	-1.8%	-1.6%	-0.8%	-0.4%

It's the Deficit Stupid! (400B$+ or 20% of Budget)

- FY05
  - House mark: -5% from President's request (-2% from FY04), funding provided for RSVP and other new MREFC projects
  - Senate mark: President's request, but no new MREFC projects (i.e., no start for RSVP)
  - Likely to have continuing resolution until after the election

That being said, MPS still has a 1.1B$ budget and we intend to use it to fund great science in elementary-particle physics and other fields

MPS SCIENTIFIC THEMES

- *Charting the evolution of the Universe from the Big Bang to habitable planets and beyond*
- *Understanding the fundamental nature of space, time, matter, and energy*
- *Creating the molecules and materials that will transform the 21st century*
- *Developing tools for discovery and innovation throughout science and engineering*
- *Understanding how microscopic processes enable and shape the complex behavior of the living world*
- *Discovering mathematical structures and promoting new connections between mathematics and the sciences*
- *Conducting basic research that provides the foundation for our national health, prosperity, and security*

- Quantum Universe: Well done, very well done – having impact in Washington, around the country and around the world
- No good deed goes unpunished! We have a new, important task for HEPAP; address

The complementarity of a subTeV Linear Collider (LC) and the 14-TeV Large Hadron Collider (LHC)

Complementarity

Inevitably, the question will arise of why we need a second, *less* powerful accelerator to explore the energy frontier. To educate us and to clarify this issue more generally, we would like HEPAP to form a subpanel to address complementarity, paying particular attention to the following aspects of LC/LHC complementarity:

- In the context of physics discoveries (e.g., low-energy supersymmetry) made at the Tevatron or early at the LHC, what is the role of a subTeV Collider?
- In the context of physics discoveries made an LC, what is the role of the LHC
- In the context of "known physics" (e.g., electroweak physics), what are the synergies and complementaries of these two machines?

You should assume that the LC and LHC (with possible upgrades) will have a significant period of overlapping operation.

We are looking for a short document (20 pages), accessible to knowledgeable non-experts (e.g., members of the EPP2010 Study, OSTP Staff and ourselves). We ask that the report be completed by April 2005.

Finally, to further educate us as well as giving us an opportunity to refine and discuss the charge with you in more detail, we suggest a half-day session at the next HEPAP meeting devoted to Complementarity.