

GLOBAL SCIENCE: BRAVE NEW WORLD

The background is a collage of scientific images. At the top left is a blackboard with white chalk drawings of particle tracks. In the center is a portrait of Albert Einstein. To the right is a colorful, abstract representation of a particle detector or accelerator. At the bottom left is a close-up of a particle detector's internal structure, showing a series of stacked, cylindrical components. At the bottom right is an aerial view of a large circular particle accelerator facility, likely Fermilab, surrounded by green fields.

**2005 Aspen Winter Conference on Particle Physics:
The Highest Energy Physics**

16 February 2005

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New Rules

Three equally powerful regions: Americas, Europe and Asia

- Dominance is not possible or even desirable
- Local and global health of fields linked
- Redundancy is undesirable and wasteful
- Cooperation and collaboration are essential

Fine print: These apply to large-scale, discovery science and less so to smaller scale discovery science; probably not all to proprietary R&D

The Landscape

- US Federal Deficit of \$400B+
 - \approx nonDefense, Discretionary Spending
 - \approx 20% of Federal Budget
 - President's goal is to reduce deficit to \$200B by 2009 (increased slightly in 2006)
- National Priorities – don't map well to discovery science
 - War on Terrorism
 - Homeland Security
 - Economy (especially Deficit)
- China
 - #2 economy, growing at 9%+/yr
 - \$160B/yr trade surplus/yr
 - Driving commodity prices up

Science Funding: The Big Picture

World GDP: \$50T

- US: \$11T
- China: \$6T
- Japan: \$4.3T
- Germany: \$2.4T
- UK: \$1.8T
- France: \$1.7T

US: \$11T

- Fed Govt: \$2.5T
- Local/state: \$1T
- WalMart: \$0.26T
- Exxon: \$0.21T
- GM: \$0.20T
- NB: Debt: \$8T (ouch!)**

US Fed Budget: \$2.4T

- Mandatory: \$1.3T
- Defense: \$400B
- Interest on Debt: \$200B
- Discretionary: \$450B
- NB: Deficit: \$0.4T (20% ouch!)**

Basic Research

- NIH: \$27B
- NASA: \$5B (Earth+Space Science)
- NSF: \$5.6B (EPP Budget: \$0.9B)
- DOE/OS: \$3.5B
- NIST, NOAA, EPA, CDC, USGS, ...

R&D Budget: \$130B

- Defense: \$75B
- NonDefense: \$55B



Some Fiscal Perspective

- EPP budget amounts to about 1/4 of the budget for all of physical science
- \$7B ILC \approx 12% of US spending on nonDefense R&D \approx 2 x DOE/OS
- Design & Development \approx \$140M for 5yrs (50% of Fermilab budget)
- Operations of ILC \approx \$700M/yr \approx DOE HEP Budget

The ILC is not your mother's accelerator!

Balance Sheet for EPP

- Assets

- Greatest opportunities for profound discoveries in at least 50 years
- Expanded intellectual horizons (refresh)
- Strong program (almost \$0.9B US investment)
- Long and successful int'l collaboration
- Growing importance of Asian region
- Forward looking technology choice for ILC
- Workforce
 - Smart, clever, and driven
 - Trailblazers (big science, int'l, computing, ...)
 - Developing the ability to make hard choices

Grand Questions That Are Ripe

The background is a complex collage. On the left, there are faint, overlapping sketches of orbits and diagrams. In the center, a portrait of Albert Einstein is visible, looking directly at the viewer. To the right, there's a large satellite dish or antenna structure. Below that, a particle accelerator or similar scientific facility is shown. At the bottom right, there's a night view of a large stadium or arena with its lights on.

- What are space and time; where did they come from; and what is the space-time of our Universe like?
- How did the Universe begin and what shaped its present state?
- What is the complete list of Nature's basic building blocks and forces?
- Why is the Universe speeding up and what is its cosmic destiny?
- How are the two intellectual triumphs and pillars of 20th Century Physics – quantum theory and relativity theory – reconciled?
- What is the dark matter that holds our galaxy and all structures in the Universe together?

Balance Sheet for EPP (cont'd)

• Liabilities

- Intellectual competition – other fields have stunning opportunities too
 - biological sciences, astrophysics, computer science
- Growing timescales and costs of the necessary tools
- Ghost of the SSC still lurks
- Transitional time
 - Field is no longer expanding, probably contracting
 - Scope is changing (e.g., inclusion of big chunks of astrophysics)
 - In the process of evolving to one US HEP Lab
 - Still learning how to make tough choices
- Workforce
 - Face of EPP does not reflect the diversity of society
- No longer playing on a tilted field (special role in National Security is a thing of the past)

International Linear Collider

- This is discovery science. Period; end of story.
 - Trying to overemphasize the spin-offs will backfire -- there are more efficient ways to achieve applied science goals
- Be intellectually bold, but fiscally realistic
 - Old paradigms, unrealistic plans will not work in these new times
- One excellent, correct argument trumps 5 good, almost-correct arguments
 - Weakest argument will always be seized upon in any discussion: cf., MRI & SSC
- Five essential elements needed (may not be sufficient)
 - **“Drop dead” science case** (Quantum Universe a good start, early LHC discoveries essential)
 - **“Buy in” by broader science community and society** (NRC EPP2010, “Shapiro Report”)
 - **Technically readiness** (goal: test string; int’l R&D guided by enlightened self interest, some coordination by ILCSC, FALC)
 - **Management model in place** (FALC discussions)
 - **Sacrifices without guarantees** (e.g., BTeV)

Management Models

- Dominant partner, small contributions from others
 - IceCube, LIGO, ...
- Two strong partners; weak central management
 - ALMA (NRAO and ESO, 50/50 partners)
- Several significant partners; strong Finance Board
 - Gemini Observatory (US 50, UK 25, Canada, ...)
- “Local host, global participation;” strong local management
 - LHC
- Many significant partners
 - ITER??? Evolving toward local host, global participation??

NB: There is no International Science Funding Agency



EPP is a vibrant field with the greatest opportunities for profound discovery in the last 50 years.

The challenges are daunting, but if past performance is any indicator, EPP will meet the challenge.

