# Report from EPP 2010 Meeting

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4.2.2005

http://www7.nationalacademies.org/bpa/EPP2010_presentations.html

# EPP 2010

**Board on Physics and Astronomy**

## 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.

# Activities

A committee with membership drawn both from inside and outside the field of elementary-particle physics will be formed to carry out an in-depth assessment that will provide a 15-year plan for the future of the field. Town meetings and other events will be conducted to ensure broad community involvement in the process of formulating the plan. Scientific opportunities and objectives will be identified and priorities will be set. Prioritized implementation plans will be formulated to achieve stated scientific objectives. The assessment will build on a number of sources: recent work of subcommittees of the High Energy Physics Advisory Panel (HEPAP, a FACA committee advisory to the Department of Energy and the National Science Foundation), reports of committees of the National Research Council (NRC), and the Department of Energy's 20-year facilities plan for the Office of Science. The world effort in the field and the plans and views of Europe and Asia will be taken into consideration.

The study will be carried out by an independent NRC committee over a 2-year period. The committee will meet up to 5 times. Members of the committee will also participate in events that open the process to the community at large. Initial meetings of the committee will be devoted to briefings from leaders of NSF and DOE as well as leaders of assessment efforts carried out by HEPAP, the NRC, and the Division of Particles and Fields (DPF) and other divisions of the American Physical Society (APS). The focus of the effort will then shift to carrying out the charge to the committee and completion of the committee's report. In case of need, a reviewed prepublication report will be issued before the final publication. The final report will be prepared in an elegant, attractive and accessible format.

# Context

- FACA Report
- HEPAP P5
- The Quantum Universe
- DOE Report
- etc.

Forming P5, the Particle Physics
Project Prioritization Panel

Fred Gilman
HEPAP
Cornell
August 5, 2002

**The Particle Physics Roadmap**

The report of the HEPAP Subpanel on Long Range Planning for U.S. High-Energy Physics includes a 20-year roadmap for our field to chart our steps on the frontiers of matter, energy, space and time. Any such list of future facilities is a dynamic one. With time, decisions will be made to begin construction of some facilities and not of others on the current roadmap. Still other facilities may be added in response to new scientific and technical opportunities. Indeed several new projects in the neutrino area have been

**QUANTUM UNIVERSE**
The Revolution in 21st-Century Particle Physics

Executive Summary

*What is the nature of the universe and what is it made of?*
*What are matter, energy, space and time?*
*How did we get here and where are we going?*

Throughout human history, scientific theories and experiments of increasing power and sophistication have addressed these basic questions about the universe. The resulting knowledge has led to revolutionary insights into the nature of the world around us.

In the last 30 years, physicists have achieved a profound understanding of the fundamental particles and the physical laws that govern matter, energy, space and time. Researchers have subjected this "Standard

**A 21st Century Frontier of Discovery:**
**The Physics of the Universe**

**A Strategic Plan for Federal Research**
**at the Intersection of Physics and Astronomy**

A Report of the Interagency Working Group
on the Physics of the Universe

National Science and Technology Council
Committee on Science

*February 2004*

# Meetings & Members

## Committee and Staff Members

**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,** Queen Mary, University of London
**David J. Gross,** Kavli Institute for Theoretical Physics
**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
**Timothy I. Meyer,** Program Officer

### Past Meetings

September 23, 2004
Hilton Embassy Row, Washington, DC
Presentation to HEPAP by Sally Dawson

November 30, 2004 – December 1, 2004
Keck Center of the National Academies
Washington, DC 20001
Agenda Presentations

### Future Meetings

May 16, 2005 – May 17, 2005
Fermi National Accelerator Laboratory
Batavia, IL 60510
(agenda pending)

August 2-3, 2005
Laboratory for Elementary Particle Physics
Cornell University
Ithaca, NY 14853
(agenda pending)

# Agenda

Plenaries

**Monday, January 31, 2005**

| | | |
|---|---|---|
| 7:30 am | *Breakfast* | Redwood Room |
| CLOSED SESSION 8:00 am | **Budget and policy context**<br>**Plans for this meeting** | H. Shapiro, S. Dawson |
| OPEN SESSION 8:30 am | **Science accessed by the LHC** | I. Hinchcliffe, LBNL |
| 9:00 am | **Discussion** | |
| 9:15 am | *Break* | |
| 9:30 am | **Science reach of a linear collider and why it matters** | J. Hewett, SLAC<br>H. Murayama, Berkeley |
| 10:45 am | **Discussion** | |
| 11:00 am | *Break* | |
| CLOSED SESSION 11:15 am | **Committee discussions** | S. Dawson, J. Bagger |
| OPEN SESSION 12:30 pm | *Lunch* | |
| 1:15 pm | **Opportunities for and relevance of studying *b* physics** | R. Cahn, LBNL |
| 1:45 pm | **Discussion** | |
| 2:00 pm | **Opportunities for and relevance of studying neutrinos** | B. Kayser, Fermilab |
| 2:30 pm | **Discussion** | |
| 2: 45 pm | *Break* | |
| 3:00 pm | **Connections to astrophysics and cosmology** | S. Kahn, SLAC/KIPAC |
| 3:30 pm | **Discussion** | |
| 3:45 pm | **Visions for the SLAC future** | J. Dorfan, SLAC |

# Agenda

Town Meeting and Deliberations

| | | |
|---|---|---|
| 4:15 pm | **Discussion** | |
| 4:30 pm | *Break* | |
| 4:45 pm | **Public comments and discussion** | J. Jaros & W. Carithers, APS/DPF (organizers) |
| 5:45 pm | *Public reception — open to all* | SLAC Breezeway |
| 7:00 pm | *End of reception* | |
| 7:30 pm | *Dinner — committee members and invited speakers only* | Stanford Faculty Club |

## Tuesday, February 1, 2005

| | | |
|---|---|---|
| 7:00 am | *Breakfast* | Redwood Room |
| 7:30 am | **Tour of SLAC** | |
| CLOSED SESSION 9:00 am | **Committee deliberations** | |
| 10:30 am | *Break* | |
| CLOSED SESSION 10:45 am | **Committee deliberations** | |
| 12:30 pm | *Adjourn & Lunch* | |

# I Hincliffe: LHC

- Intense activity on accelerator construction, detector construction and software. The schedule is very tight, but some of us cannot wai any longer!
- LHC will dominate High Energy physics in the next 15 years
- LHC will open up new high energy frontier, find Higgs, measure many of its properties. Change the face of theoretical physics
- In addition, LHC is a QCD factory, b-factory and top factory
- If supersymmetry exists, it's a susy factory, many sparticles will be discovered and masses measured. The underlying model will be tightly constrained
- Rich physics needs 4000 physicists for 15 years to exploit it

# J Hewitt: ILC

## Power of the ILC

- Observe the Physics of the TeV scale with detailed precision in a model independent way
- Explore the TeV Scale with a different probe

Together the LHC and ILC will identify the full nature of the Physics at the TeV scale!

# H Murayama: ILC

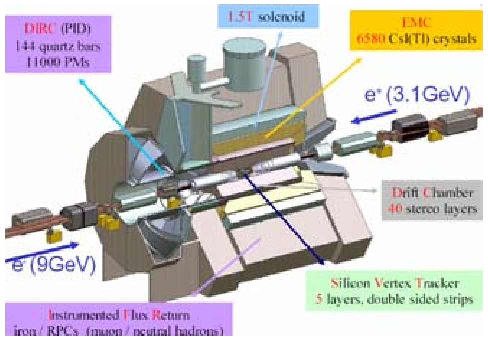
## LHC vs ILC

(oversimplified)

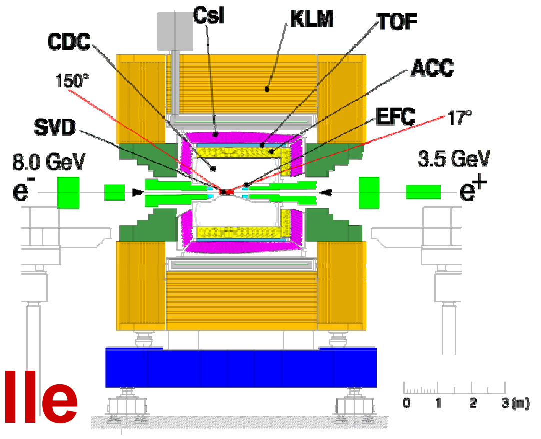
| | | |
|---|---|---|
| total energy | 14TeV | 0.5-1 TeV |
| usable energy | a fraction | full |
| beam | proton (composite) | electron (point-like) |
| signal rate | high | low |
| noise rate | very high | low |
| analysis | specific modes | nearly all modes |
| events | lose info along the beams | capture the whole |
| status | under construction | needs to finish design |

# R Cahn: BaBar

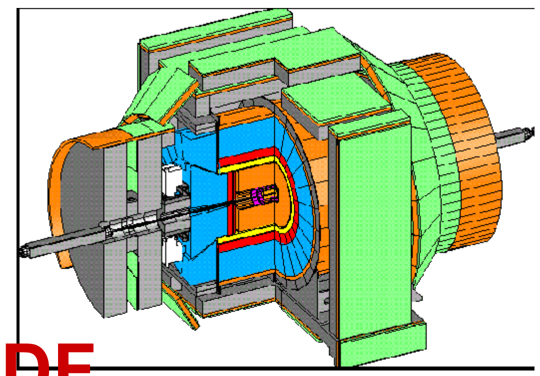
## B Physics:
## Why Is Everyone Doing It?



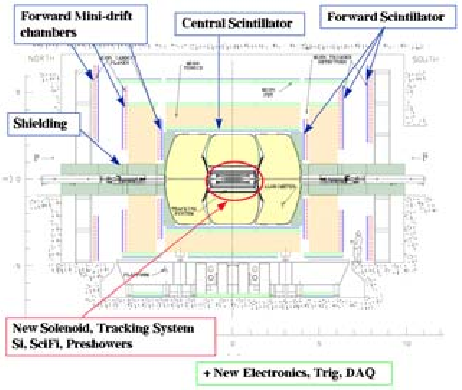

BaBar




Belle



CDF

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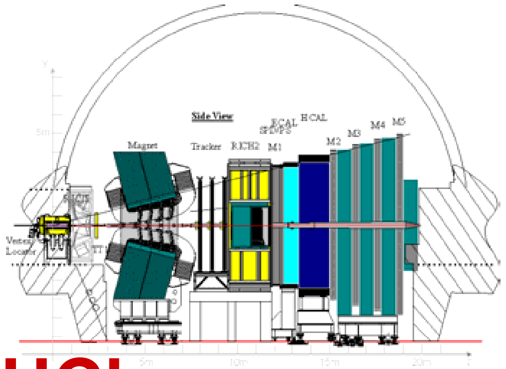
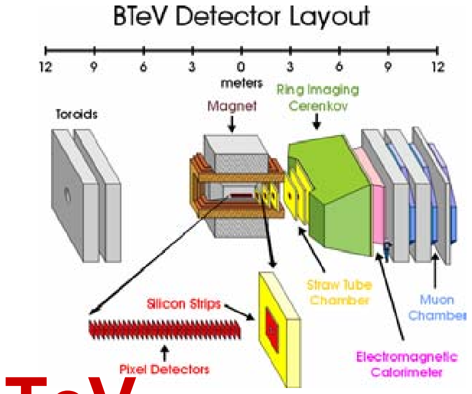
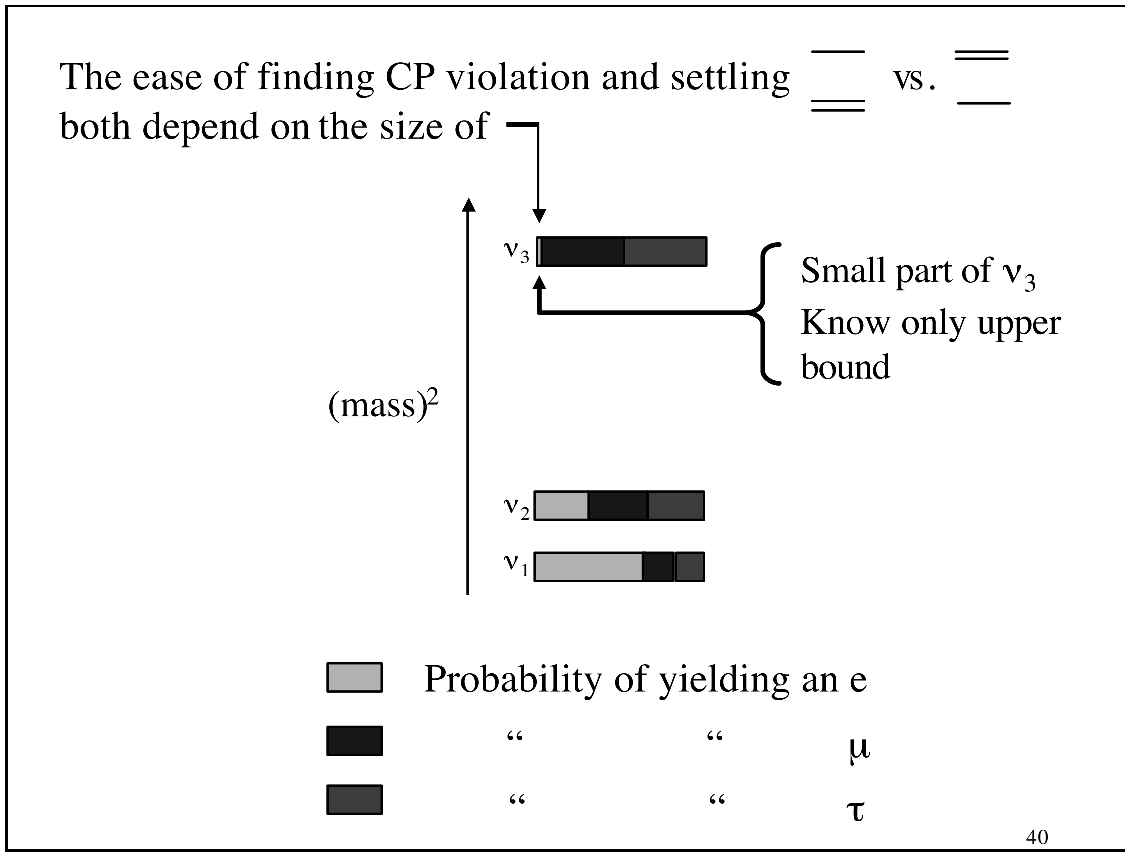


LHCb




BTeV

# B Kayser: Neutrino




## Components of The Program

- An expeditiously deployed reactor experiment twenty times more sensitive to the small part of $\nu_3$ than previous experiments.
- A timely accelerator experiment with comparable sensitivity to the small part of $\nu_3$, and with sensitivity to the character of the mass spectrum.
- A proton accelerator delivering approximately ten times as many neutrinos as current ones, and an appropriately large neutrino detector giving substantial sensitivity to CP violation.

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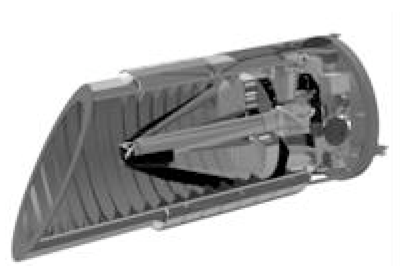
# S Kahn: KIPAC

## Next Steps in Dark Energy - SNAP

* Further precision in SN 1a measurements will require going to space. We need to obtain a large sample of SNe at both high and low redshift to reduce both statistical and systematic errors. At z > 1, the light from SN 1a's is redshifted out of the band visible from the ground.

* This mission will require very careful attention to systematics. Small uncertainties in the calibration of the instrumentation can significantly affect the results.

* NASA and DOE are collectively studying a Joint Dark Energy Mission



## Summary

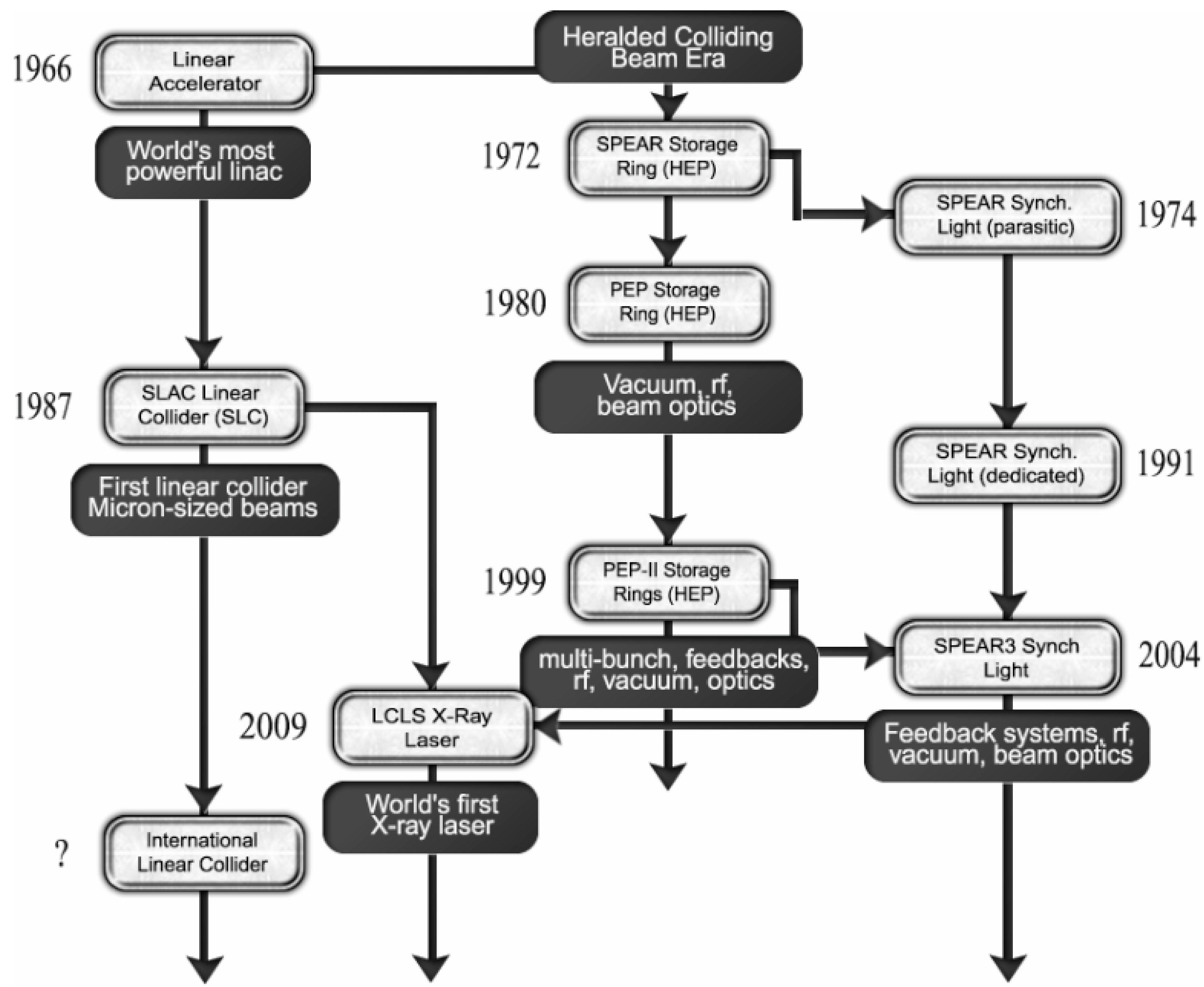
* The traditional separation between "particle physics" and astrophysics is likely to seem more and more artificial, as we proceed forward into the next phase of experiments.

* The recent success of the concordance cosmological model has raised some of the most pressing questions in particle physics. Addressing these questions experimentally is essential for high energy physics as well as for astrophysics.

* A suite of impressive "particle astrophysics" experiments is already on the drawing board. The particle physics community needs to learn how to prioritize these initiatives against their traditional accelerator-based experiments.

* Further cooperation between particle physicists and astrophysicists will not be free of problems. Issues associated with interagency collaboration and the differences between the cultures should not be minimized. But the potential rewards certainly make it worthwhile to try to overcome these barriers.

# J Dorfan: SLAC




**Reinvention & innovation with SLAC accelerator facilities**

# Town Meeting

- Dark Matter: B Cabrera
- Super B factory: G Dubois-Feldmann
- Cosmology…: N Roe
- High Field SC: P Gorham
- ILC
  + Physics Importance: B Schumm
  + Techn.: T Raubenheimer
  + International: E Elsen

**Linear Collider**

- Probably the most technologically advanced accelerator yet conceived
  – Accelerate beams using high gradient superconducting cavities
  – Generate beams with extremely high brilliance
  – Focus beams to spots of roughly 500 x 5 nm
  – Diagnostics and controls to maintain collisions
- Demonstrated feasibility of the required technology
  – TESLA Test Facility at DESY demonstrated the rf technology
  – ATF at KEK demonstrated the small emittance beams
  – FFTB at SLAC demonstrated the focusing
  – SLC at SLAC developed and demonstrated the diagnostics and controls concepts and the linear collider operation