The Way Forward

Vancouver, July 22, 2006

Fermilab, August 9, 2006

Pier Oddone

Outline

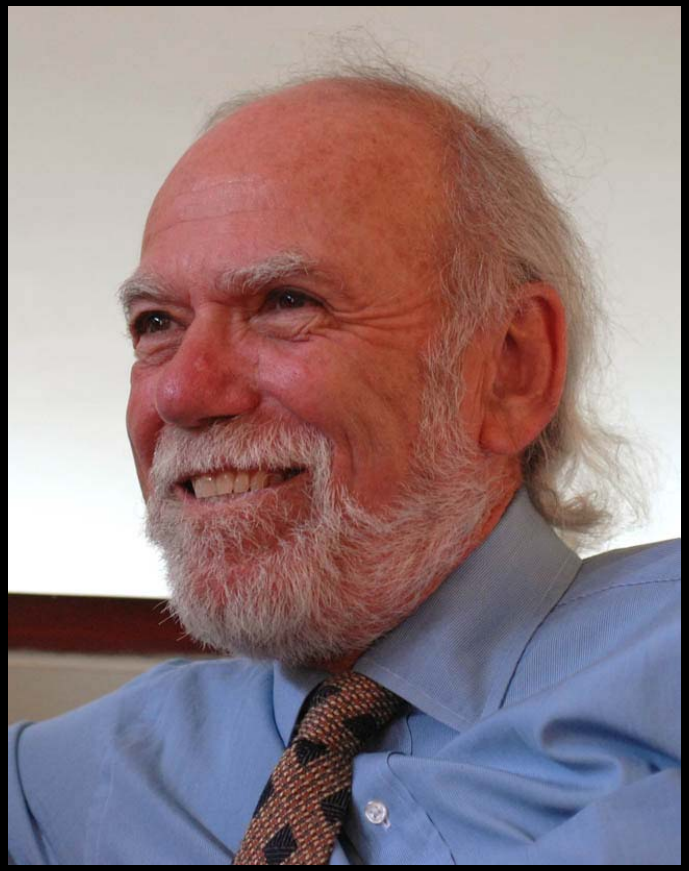
- Taking stock
- The way forward
- The way forward and Fermilab

It has been an extraordinary year…

- Great progress on the design/cost by GDE
- Important support in the three regions
  - US:
    - *“Raising above the Gathering Storm”*
    - President’s Competitiveness Initiative (ACI)
    - EPP2010: *“Revealing the Hidden Nature of Space and Time”*
    - P5 Initial recommendations
  - Europe:
    - European Strategic Plan
  - Japan:
    - Public Support by Diet Members for hosting ILC in Japan

One year anniversary of the GDE

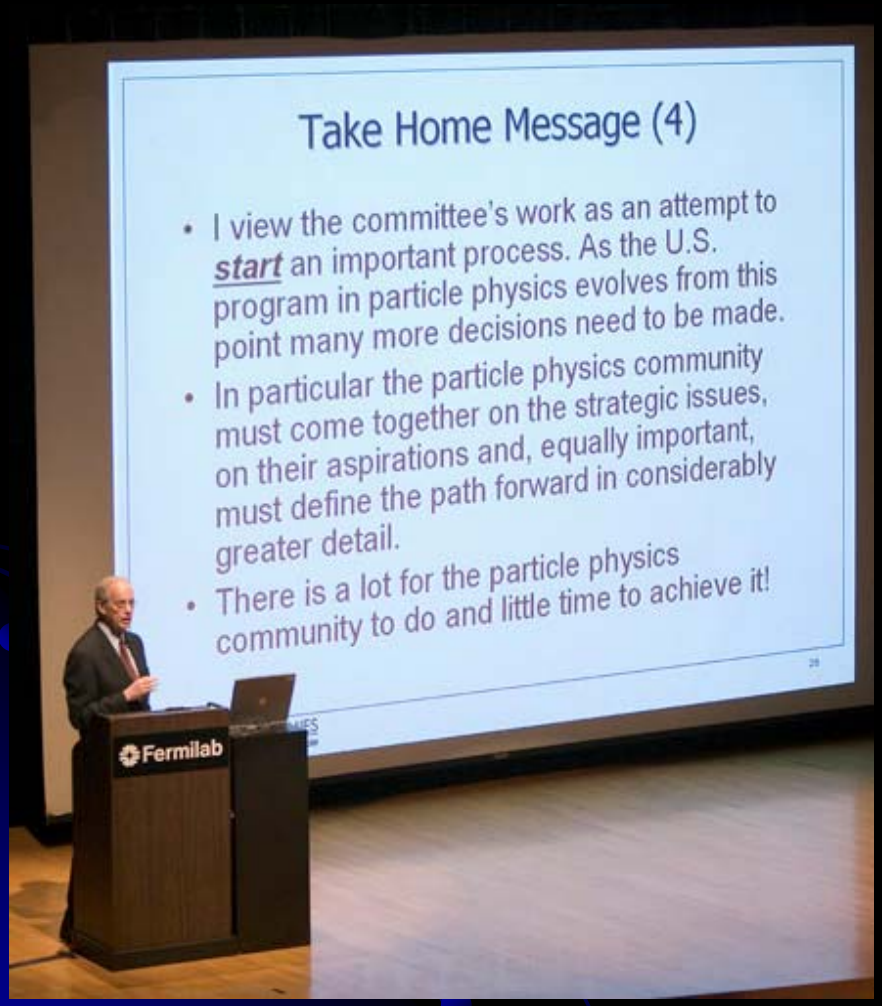
- Baseline Design: Frascati
- First roll-up: Vancouver
- On schedule for RDR!
- Developing plan for global R&D program



“Raising above the gathering storm”

- National Academy Study: enormous resonance in Washington and elsewhere
- 900 neighbors showed up for Norm Augustine’s presentation at Fermilab!
- Key report that led to ACI: doubling of physical sciences budget in 10 years. HEP??

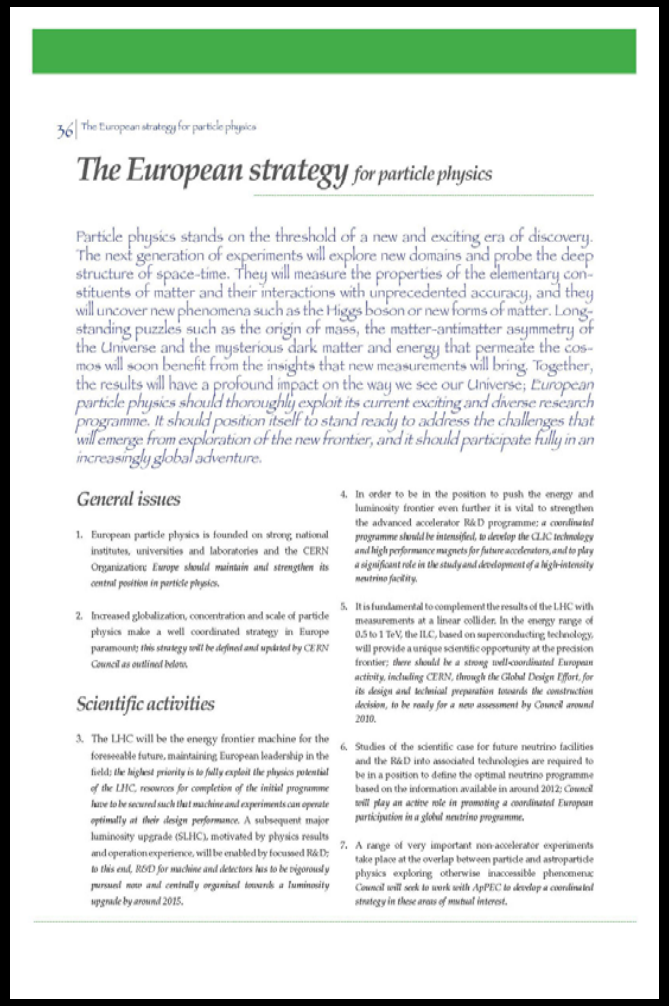
EPP2010 Report



- Extraordinarily supportive of elementary particle physics
- Extraordinarily supportive of the ILC and of hosting the ILC in the US
- Broad program with clear recommendations on priorities

European Strategic Plan

- LHC
- Accelerator R&D: beyond LHC
- ILC
- Global Neutrino Program
- Astrophysics with ApPEC
- Flavour Physics
- Nuclear Physics with NuPECC



36 | The European strategy for particle physics

The European strategy *for particle physics*

Particle physics stands on the threshold of a new and exciting era of discovery. The next generation of experiments will explore new domains and probe the deep structure of space-time. They will measure the properties of the elementary constituents of matter and their interactions with unprecedented accuracy, and they will uncover new phenomena such as the Higgs boson or new forms of matter. Long-standing puzzles such as the origin of mass, the matter-antimatter asymmetry of the Universe and the mysterious dark matter and energy that permeate the cosmos will soon benefit from the insights that new measurements will bring. Together, the results will have a profound impact on the way we see our Universe; *European particle physics should thoroughly exploit its current exciting and diverse research programme. It should position itself to stand ready to address the challenges that will emerge from exploration of the new frontier, and it should participate fully in an increasingly global adventure.*

General issues

1. European particle physics is founded on strong national institutes, universities and laboratories and the CERN Organization; *Europe should maintain and strengthen its central position in particle physics.*

2. Increased globalization, concentration and scale of particle physics make a well coordinated strategy in Europe paramount; *this strategy will be defined and updated by CERN Council as outlined below.*

Scientific activities

3. The LHC will be the energy frontier machine for the foreseeable future, maintaining European leadership in the field; *the highest priority is to fully exploit the physics potential of the LHC, resources for completion of the initial programme have to be secured such that machine and experiments can operate optimally at their design performance.* A subsequent major luminosity upgrade (SLHC), motivated by physics results and operation experience, will be enabled by focussed R&D; *to this end, R&D for machine and detectors has to be vigorously pursued now and centrally organised towards a luminosity upgrade by around 2015.*

4. In order to be in the position to push the energy and luminosity frontier even further it is vital to strengthen the advanced accelerator R&D programme; *a coordinated programme should be intensified, to develop the CLIC technology and high performance magnets for future accelerators, and to play a significant role in the study and development of a high-intensity neutrino facility.*

5. It is fundamental to complement the results of the LHC with measurements at a linear collider. In the energy range of 0.5 to 1 TeV, the ILC, based on superconducting technology, will provide a unique scientific opportunity at the precision frontier; *there should be a strong well-coordinated European activity, including CERN, through the Global Design Effort, for its design and technical preparation towards the construction decision, to be ready for a new assessment by Council around 2010.*

6. Studies of the scientific case for future neutrino facilities and the R&D into associated technologies are required to be in a position to define the optimal neutrino programme based on the information available in around 2012; *Council will play an active role in promoting a coordinated European participation in a global neutrino programme.*

7. A range of very important non-accelerator experiments take place at the overlap between particle and astroparticle physics exploring otherwise inaccessible phenomena; *Council will seek to work with ApPEC to develop a coordinated strategy in these areas of mutual interest.*

EPP2010

- LHC
- ILC Global
- ILC Hosting
- Particle Astrophysics
- Global Neutrino Program
- Quark Flavour Physics

EUROPE

- LHC
- Accelerator R&D
- ILC
- Global Neutrino Program
- Astrophysics
- Flavour Physics
- Nuclear Physics

P5 Recommendations

- Highest priorities LHC and ILC
- Most of the available resources 60% to ILC R&D
- Maintain breadth of the field with other 40%
  - In FY08 run PEP II and start:
    - Dark Energy Survey (DES)
    - Cold Dark Matter Search Super CDMS-25kg
    - NOvA long base line neutrino program
    - Daya Bay reactor neutrino experiment
  - For the longer term, prepare SNAP and LSST

THIS IS A VERY POWERFUL

AND EXCITING PROGRAM

It will be an extraordinary next year!

- We will see the conclusion of the RDR
- It will open a huge range of discussions:
  - Global R&D plan: resources, milestones, schedule of industrial build-up
  - How to carry out the next step: the TDR
  - What is the best industrial model for building the ILC
  - What process for site selection
  - Can we select a site “early”
  - How should the ILC be organized
  - Roles of the existing laboratories in relation to ILC

The importance of the RDR

- Secretary Bodman: How much …….?
- The RDR is now key element: it determines whether DOE leadership states intent to bid-to-host and makes necessary investment in the R&D.

Everyone's question: where is the line?

- Most probably there does not exist "a line"
- EPP2010: assumed a "scale like the LHC"
- At a fundamental level in the US: do we want to contribute at the forefront of the field ?
- More importantly: it has to be a credible cost – low elasticity for cost increases (even in the review)

The next steps

- In my opinion, the most critical is to have an integrated international plan to complete the R&D: resources, funding, schedules, milestones

- Tensions will arise between: regional interests and what we should do together to get there.

  - The latter should have priority – but we should work together to take care of the former as much as possible. The vehicle is the GDE

Way Forward: ILC R&D

- Main Linac
  - Cavity processing technology for a reproducible cavity gradient of 35 MV/m.
  - Fabrication and operation of one ILC rf unit at ILC beam parameters, high gradient, and full pulse repetition rate
  - 10 MW Multi Beam Klystron
  - Low emittance beam transport
  - Large system test
- Damping Ring (KEK:ATF-I, existing e^+e^- collider)
  - Understanding of electron cloud
- Positron Production
- Beam at IP (KEK:ATF-II)

The next steps

- We need to increase understanding across the regions: very different pressures; different times at which resources are “freed up”.
- An aggressive posture to host the ILC in any region (like EPP2010) is good. Three is best!
- Working in other aspects of elementary particle physics globally will be critical. All regions should stay strong.

The next steps

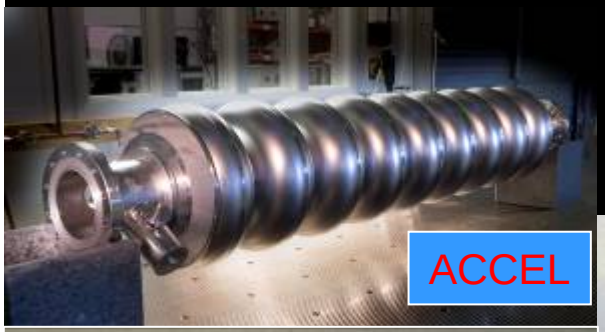
- Ultimately the physics reach will carry the day: need to continue efforts to develop and present the case broadly to many parties

Meanwhile at Fermilab…….

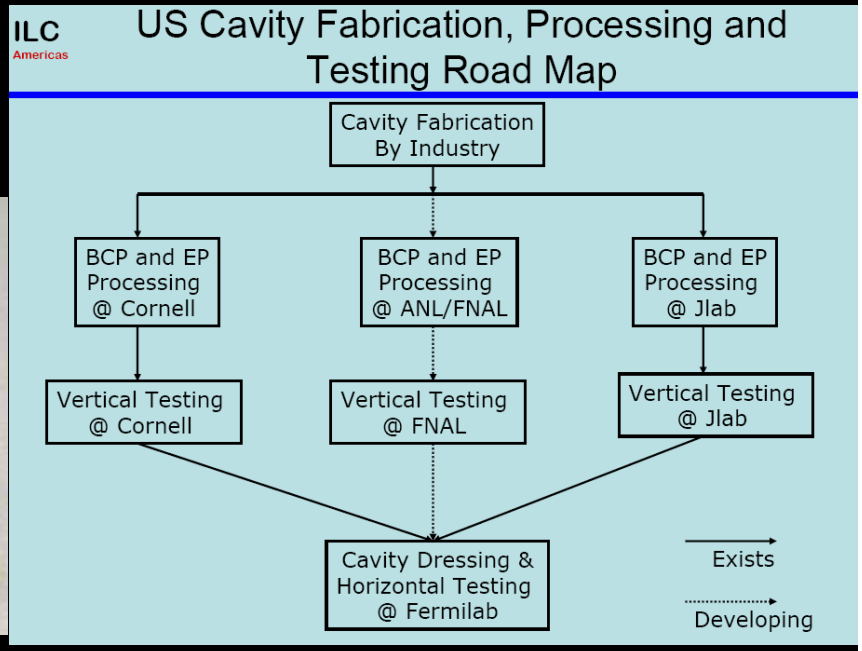
- Very strong shift of available resources last year to ILC. But we still have to run the Tevatron (9 accelerators!)
- Roughly $25M investment in people, infrastructure and R&D this fiscal year.
- We are creating several mechanisms to increase physicists involvement in broad collaborative efforts with the community.

Cavity R&D

- To speed progress on the ILC cavities gradient goal with the GDE have taken an approach that
  - Maximizes the utilization of existing U.S. SRF infrastructure
  - Develops Fermilab expertise and infrastructure in parallel

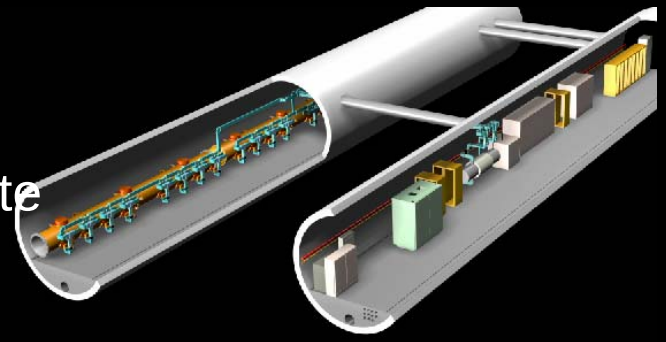


60 Cavities (by FY07)



Main ILC R&D activities

- Main Linac activities:
  - Accelerator physics design in support of the RDR
  - Demonstrate feasibility of all Main Linac technical components
  - Engineering design of ML technical systems
  - Estimates of the ML cost & methods for cost reduction
  - U.S. Industrialization of high volume ML components
- Civil and Site Development activities:
  - Civil engineering of machine enclosures
  - Study U.S. sites on or near the Fermilab site
  - Estimate costs for conventional facilities



- In FY07 we hope to begin a site specific ILC study

All done in broad collaborations

- Electron Source: BNL, NIU
- Damping Ring Design:
  - Accelerator Physics: ANL,LBNL
  - Development of fast kicker: UIUC & Cornell
  - ATF-II technical & collab board, Beam inst tests: KEK
- SCRF materials R&D: UW,NW, MSU, Cornell, DESY, KEK, NHMFL, etc

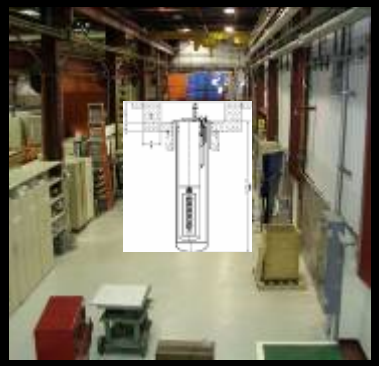
Fermilab ILC R&D Collaborations

- Main Linac: Cavity and Cryomodule
  - Cornell,ANL, TJNL,DESY,LANL,SLAC, U Penn, MSU,SNS,INFN,CERN,ORSAY, KEK, Rochester
- Main Linac: RF Power and Controls
  - SLAC,DESY,U Penn, LBNL,SNS,ANL
- Main Linac: Cryogenics:
  - DESY,CERN,TJNL,ANL,SLAC
- Main Linac Accelerator Physics
  - SLAC,KEK,CERN,DESY, Cornell

Fermilab ILC Infrastructure: much to do

Eddy Current Scanner

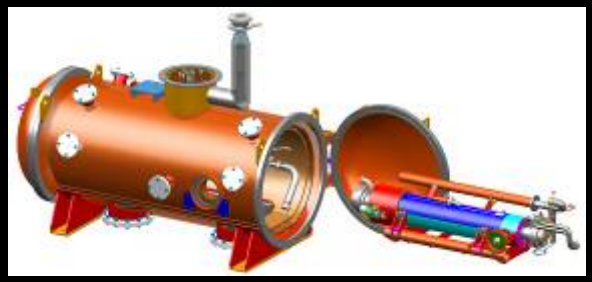
Cavity Vertical Test Stand



LLRF

Cavity String Assembly Clean Room Class 10/100

RF Measurement and Tuning

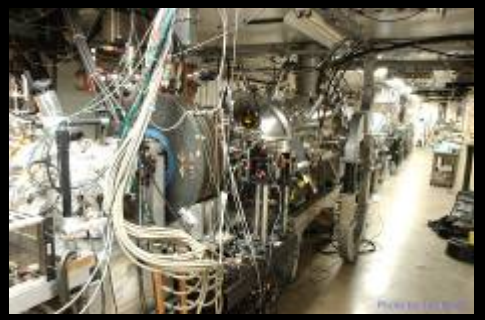


1.3 GHz Cavity at 2 K

Cryomodule Assembly @ MP9

Horizontal Test Stand

Fermilab Photo-injector



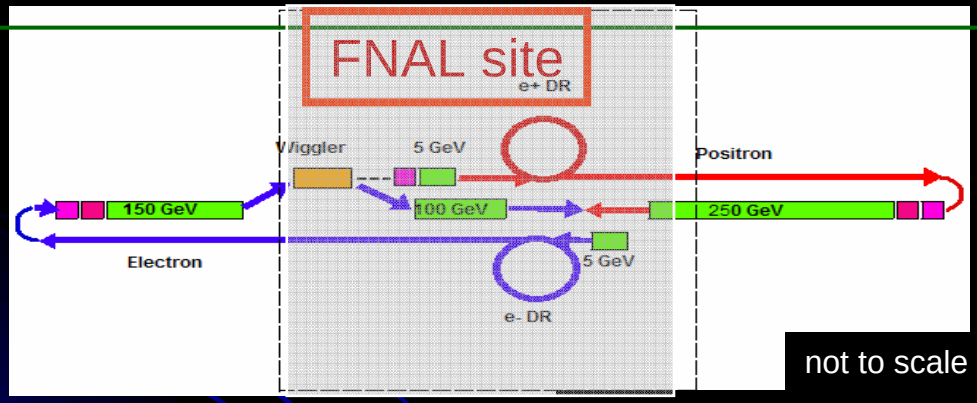
BCP Facility at ANL

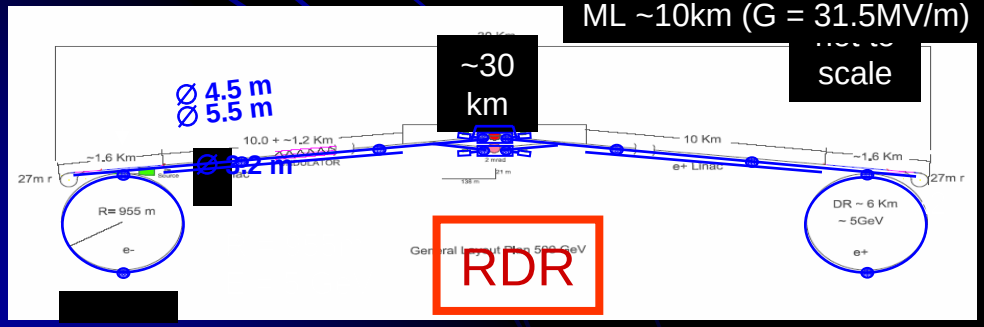
ILCTA @ Fermilab

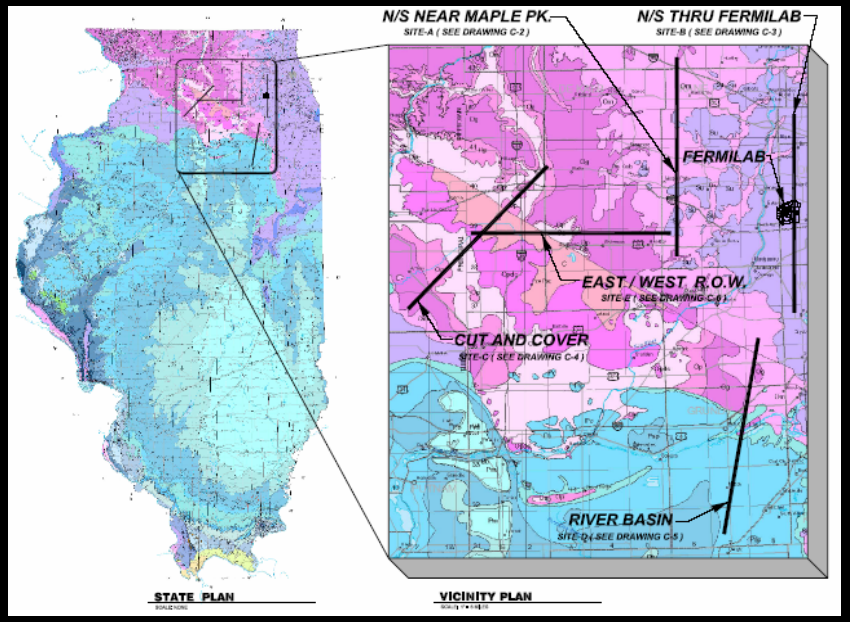
Civil and Site Development

Fermilab

- Goal: Determine the best possible site for an ILC in Illinois
- With the GDE we are developing the ILC Civil Design
  - Tunnel Design (diameter, # shafts, laser-straight vs curved)
- Site specific machine and Civil design will start in FY07
  - Geological, environmental, community impact studies







ILC Task Force

- Commissioned two month ago:
  - Fermilab's High Energy Physicists involvement
  - Collaboration with other labs and universities
- The entire task force has been meeting ~weekly
  - Review world-wide ILC R&D efforts
    - 20 scientists (9 FNAL, 11 outside)
    - Led by Mike Lindgren
    - Interim report (mid July)
  - Review Fermilab ILC R&D efforts

ILC-HEP Task Force

- Issues raised concerning university groups
  - Funding
    - Slow
    - How to increase/redirect base program funds to ILC?
  - Attracting graduate students and postdocs to ILC projects
    - Hardware (ILC R&D) + Data Analysis (e.g. CDF or DØ)
- Working groups:
  - Accelerator technologies and simulation – Kevin Pitts
  - Beam Instrumentation and machine interface – Ted Liu
  - Detector R&D, physics and simulation – Aurelio Juste
  - Test Beam Facilities – Jae Yu

Fermilab Group: Building the Momentum

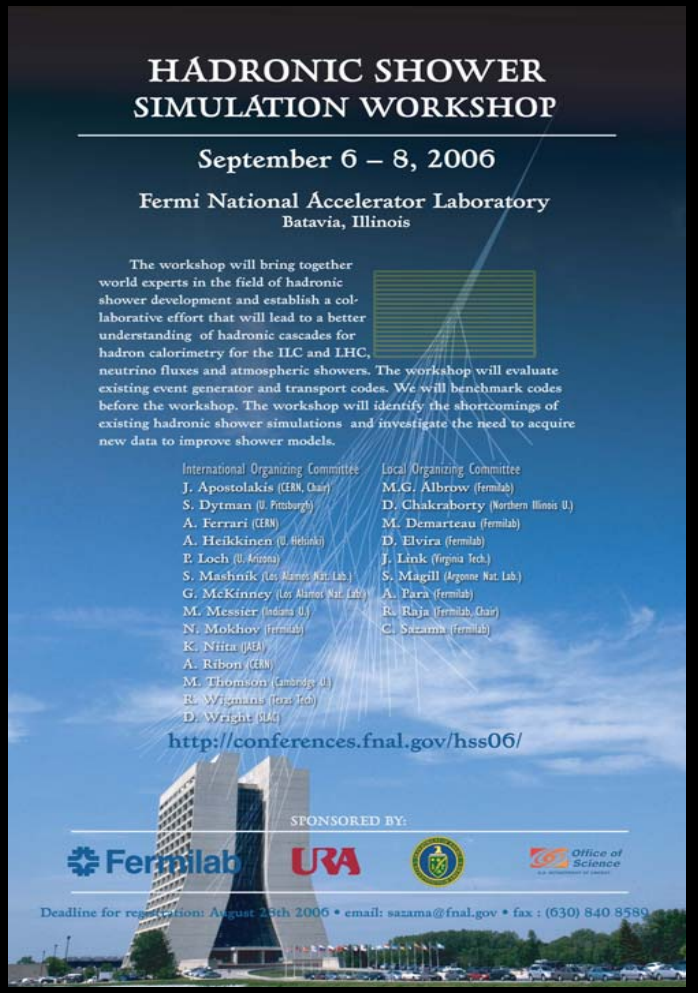
- Have created common interest internal group on ILC
- Seminar / lecture series
  - Joe Lykken and Bob Tschirhart to lead this effort
  - Possible topics are
    - ILC Physics
    - First years' LHC physics for the ILC
    - Polarization
    - Accumulating e^+e^- knowledge at Fermilab
    - Heavy flavor tagging issues
    - Jet energy resolution issues
- Weekly (Wednesday) lunch
  - exchange ideas, problems/solutions, and build a team sprit
- Complements the task force

International Fellowships at Fermilab

- Improve connections to scientists and institutions world-wide.
- Bring ~6 students, postdocs, and scientists from foreign institutions to work at Fermilab for up to 3 years.
- URL: http://www.fnal.gov/pub/forphysicists/fellowships/international/
- In the initial years, the program has two main objectives.
  - Maximize results pouring out of the Tevatron experiments
  - Help Fermilab and the community further engage in ILC efforts

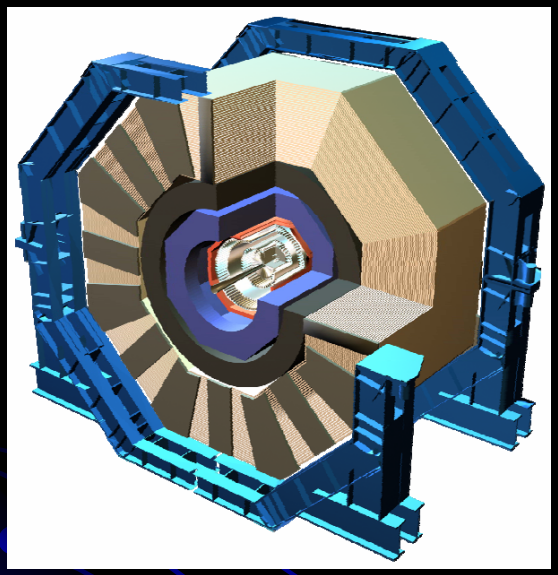
Hosting Various Workshops

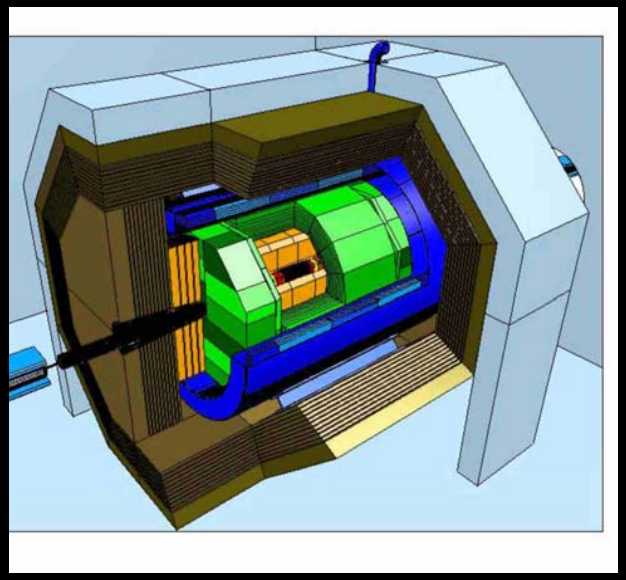
- Hadronic Shower Simulation Workshop
  - Sept. 6-8, 2006
- ILC - LHC Connections
  - “The LHC early phase for the ILC”
  - October 12-14, 2006
- ILC Testbeam workshop
  - October, 2006
- Pixel 2007
  - Use synergies with Astroparticle physics
  - Spring 2007
- Joint ALCPG and GDE
  - Summer/fall 2007

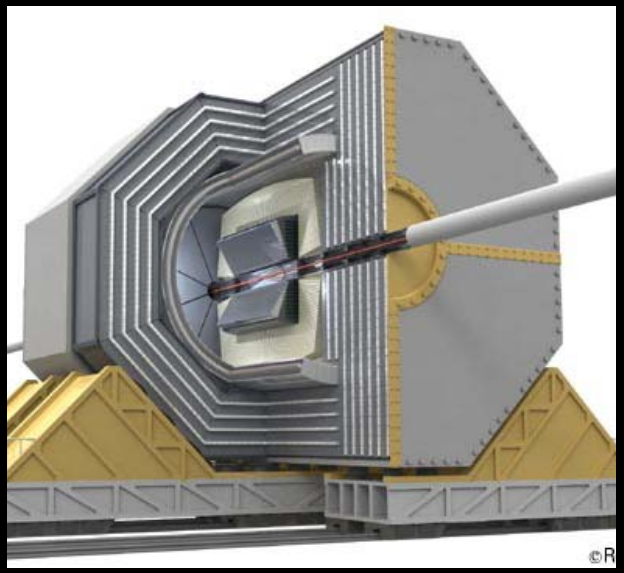


Creating a test beam for all concepts/collaborations

"SiD" "LDC" "GLD"

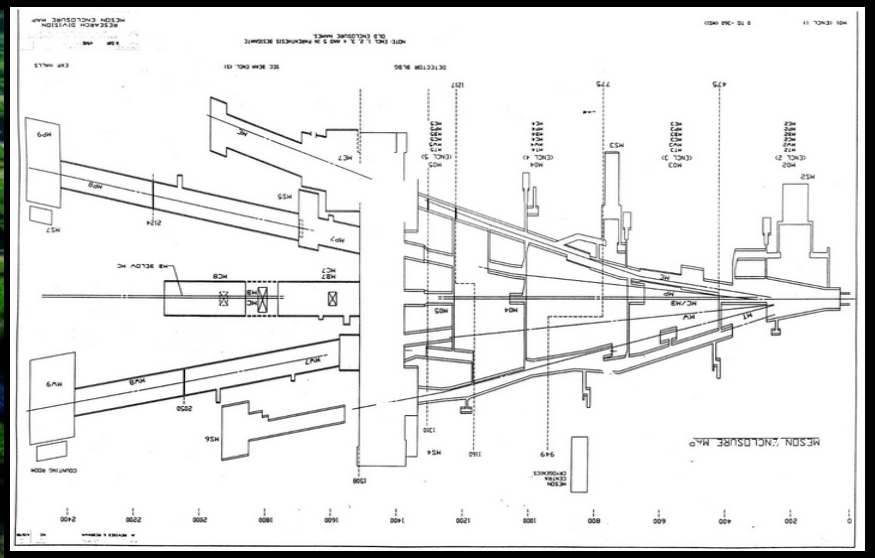






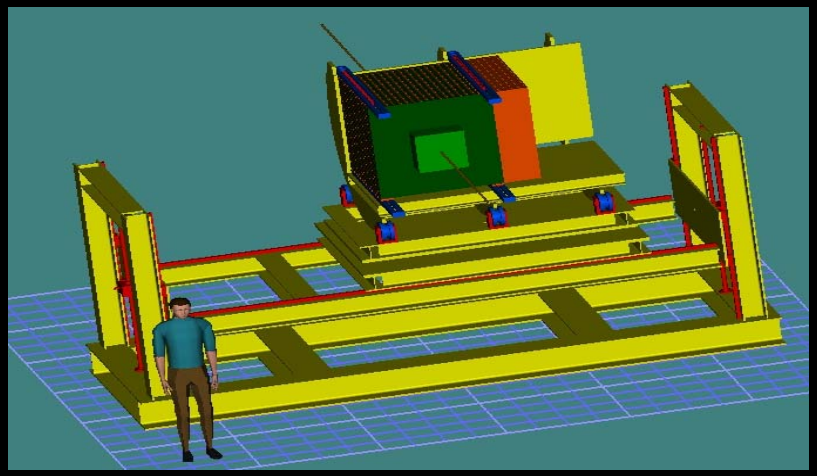
- Detector R&D done in multiple collaborations, some with FNAL, some independent
- Few test beams in the world today; Fermilab has the opportunity to contribute in a very significant way

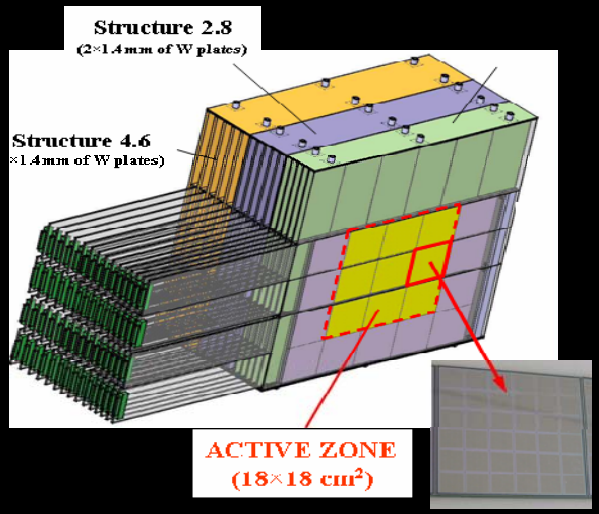
Testbeam Facility



- T926: RICE completed
- T927: BTeV Pixel completed
- T930: BTeV Straw completed
- T931: BTeV Muon completed
- T932: Diamond Detector Signed
- T933: BTeV ECAL completed
- T935: BTeV RICH completed
- T936: US/CMS Forward Pixel data
- T941: Uiowa PPAC Test completed
- T943: U. Hawaii MA PS Detector completed
- T950: Kaon Vacuum Straw Tracker analyzing
- T951: ALICE EMCAL Prototype Test analyzing
- T953: U. Iowa Cerenkov Light Tests analyzing
- T955: RPC Detector Tests (ANL) Taking data
- T956: ILC Muon Detector (Indiana) Taking data
- T957: ILC Tail Catcher (NIU) Taking data

Test Beam





- Still a Wilsonian, pioneer's effort: cold/hot/rain – we will improve it
- Testbeam facility MTest; also possibilities with MCenter (MIPP)
- MTest will be upgraded for broader p band; better particle id.
- Proposal for multi-year test program for high performance calorimeters
- Use of MIPP spectrometer is a possibility; particle id/ tpc

The way forward

- Many positive accomplishments over the Last Year
- We have momentum: let’s build it up!
- Keep in mind: we build TOGETHER