# ILC and Fermilab

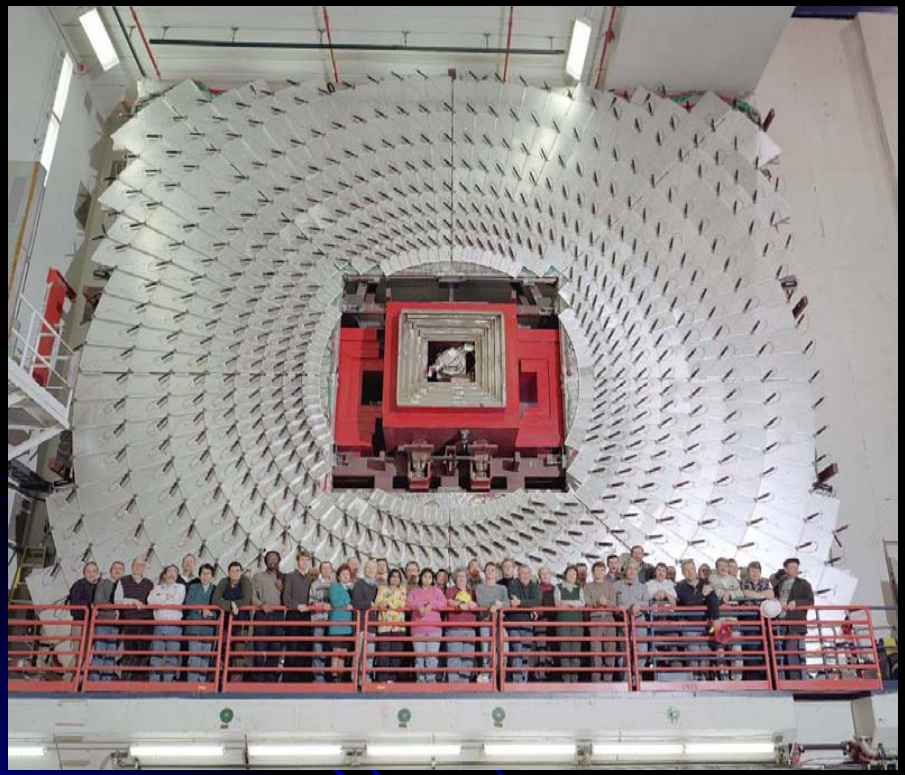
Fermilab, March 7, 2007

Pier Oddone

# Outline

- Provide the foundational discoveries
- R&D and EDR effort to make an “early” decision
- Establish the foundations to be a host
- Sustain the HEP accelerator based community for what could be a long march to the ILC

# Discovery at the energy frontier



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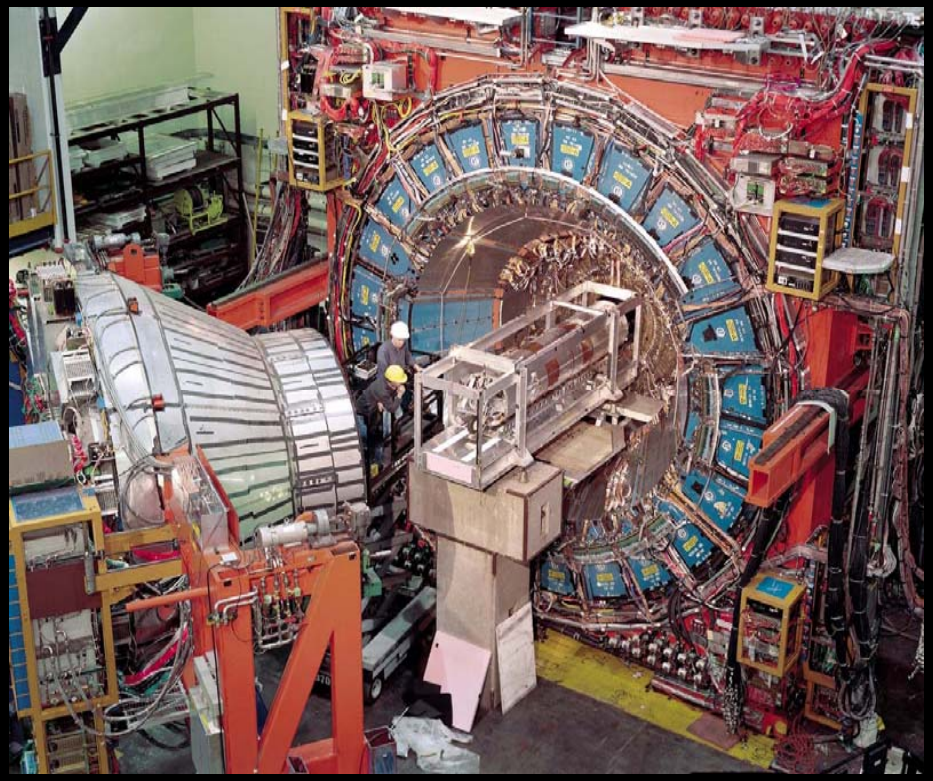
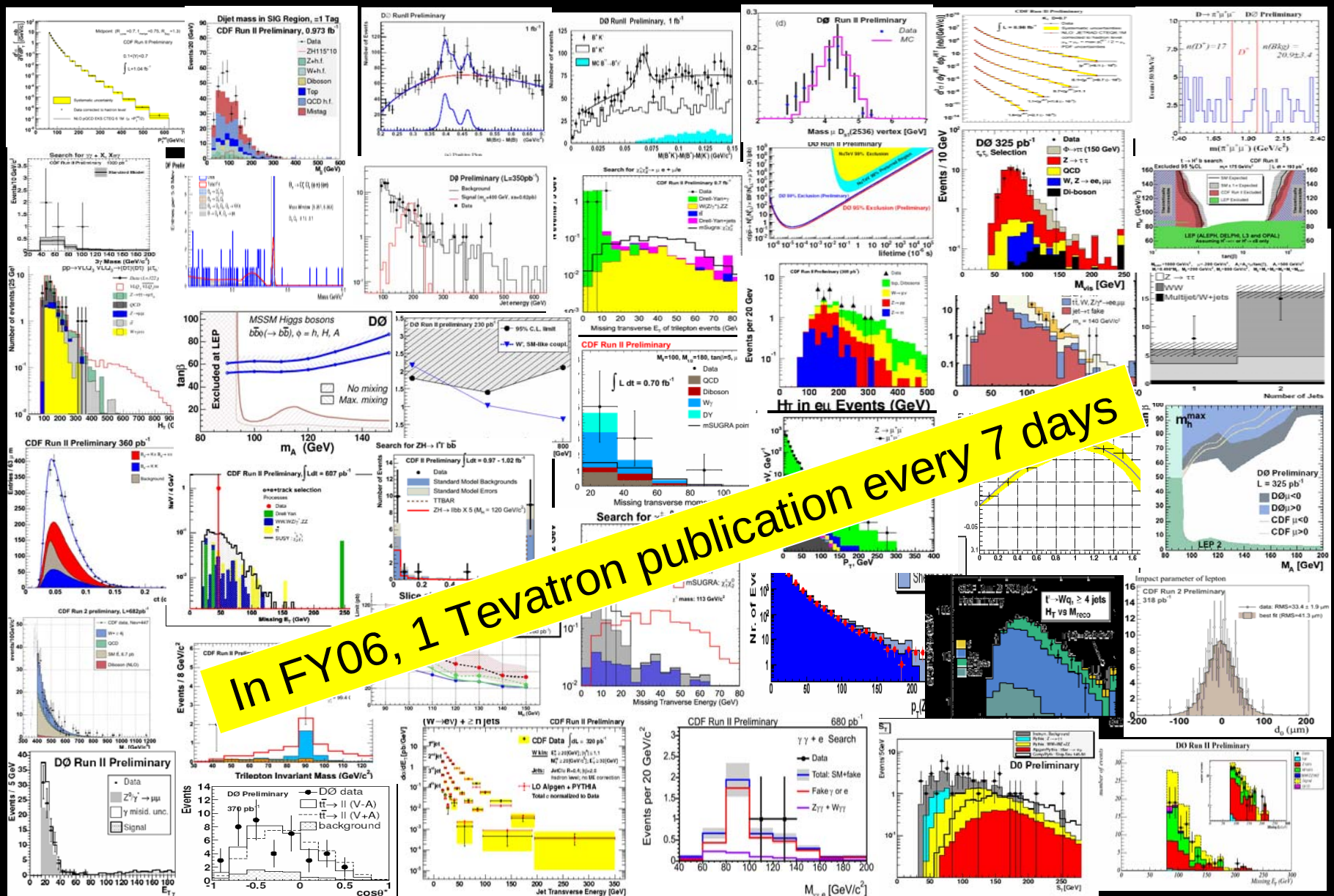
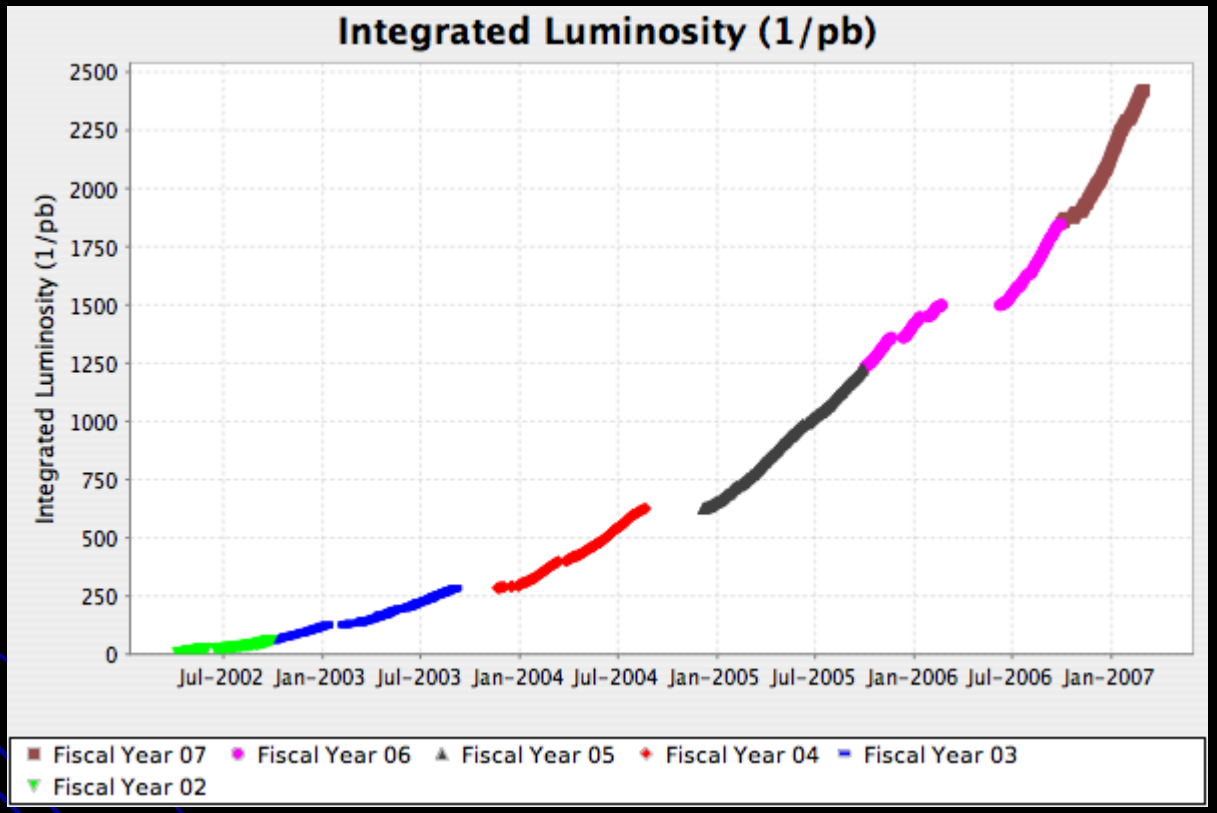


CDF

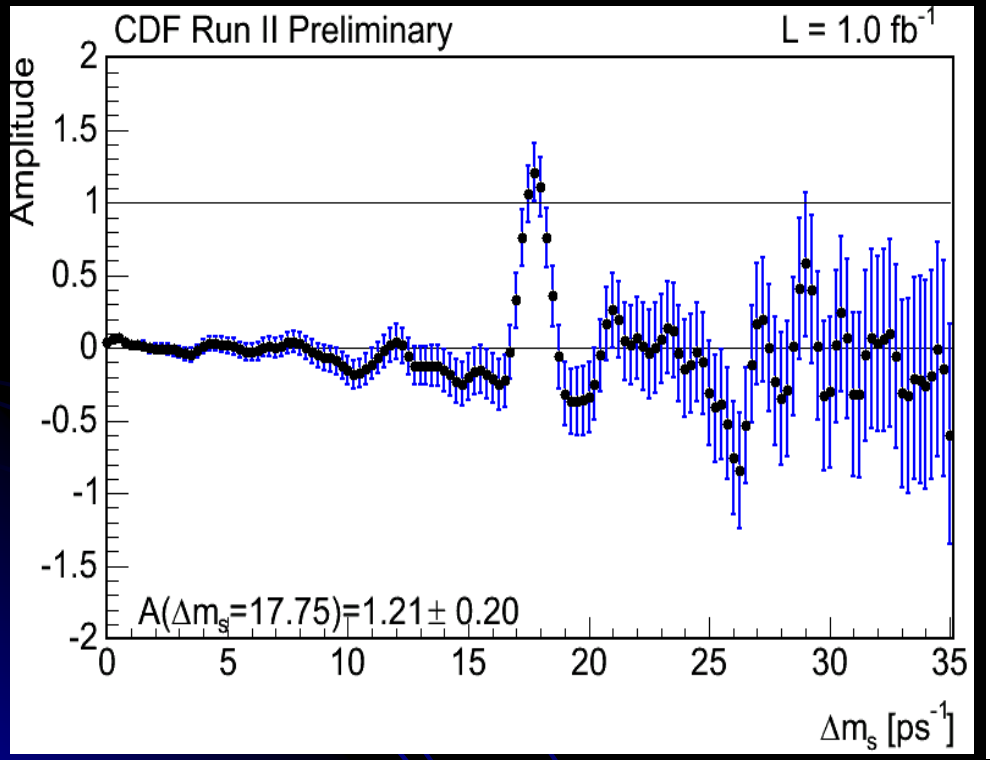
# Results in all accessible sectors

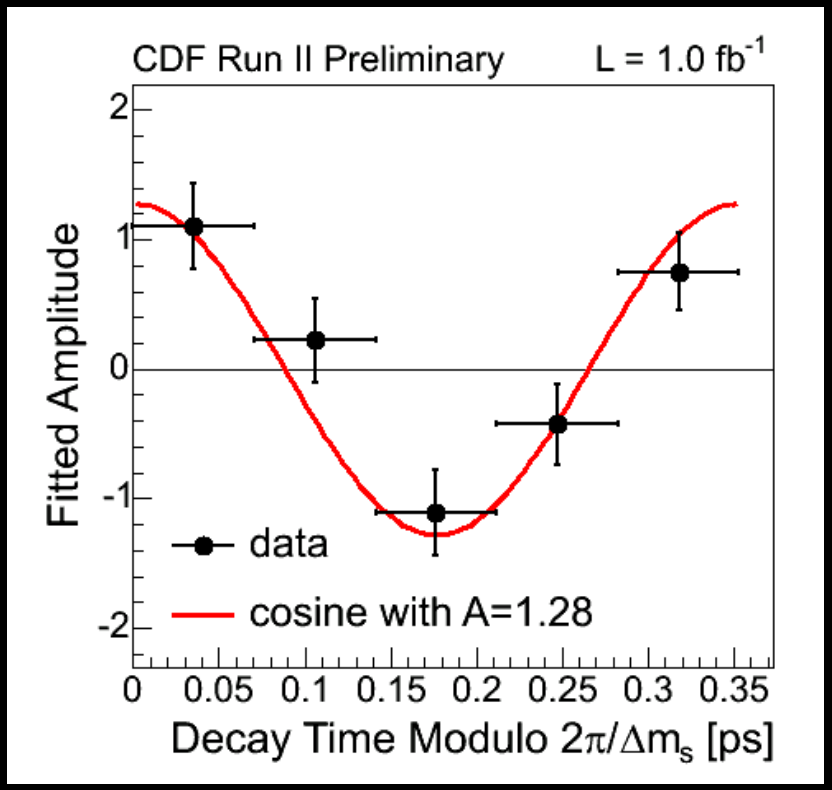


# Performance: Integrated Luminosity

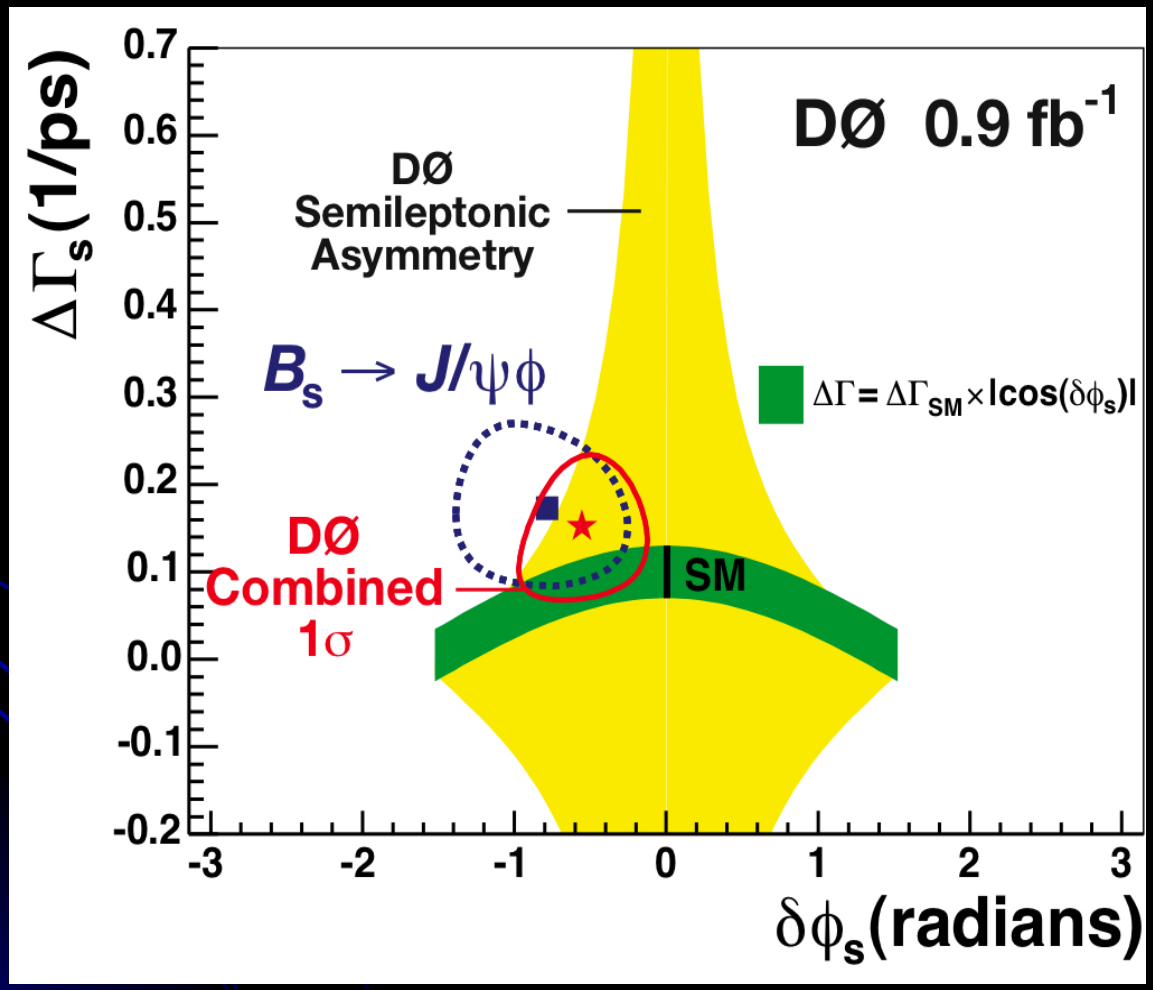


# Discoveries: Bs Oscillations

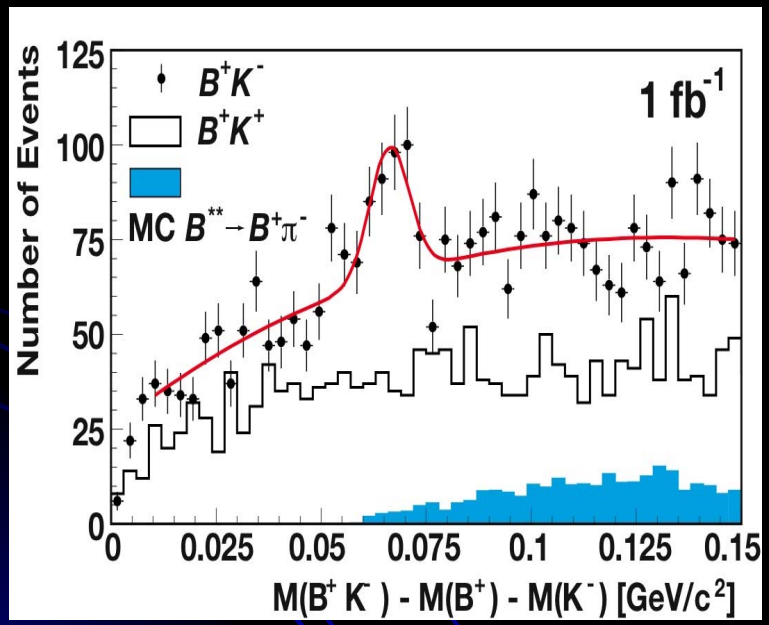


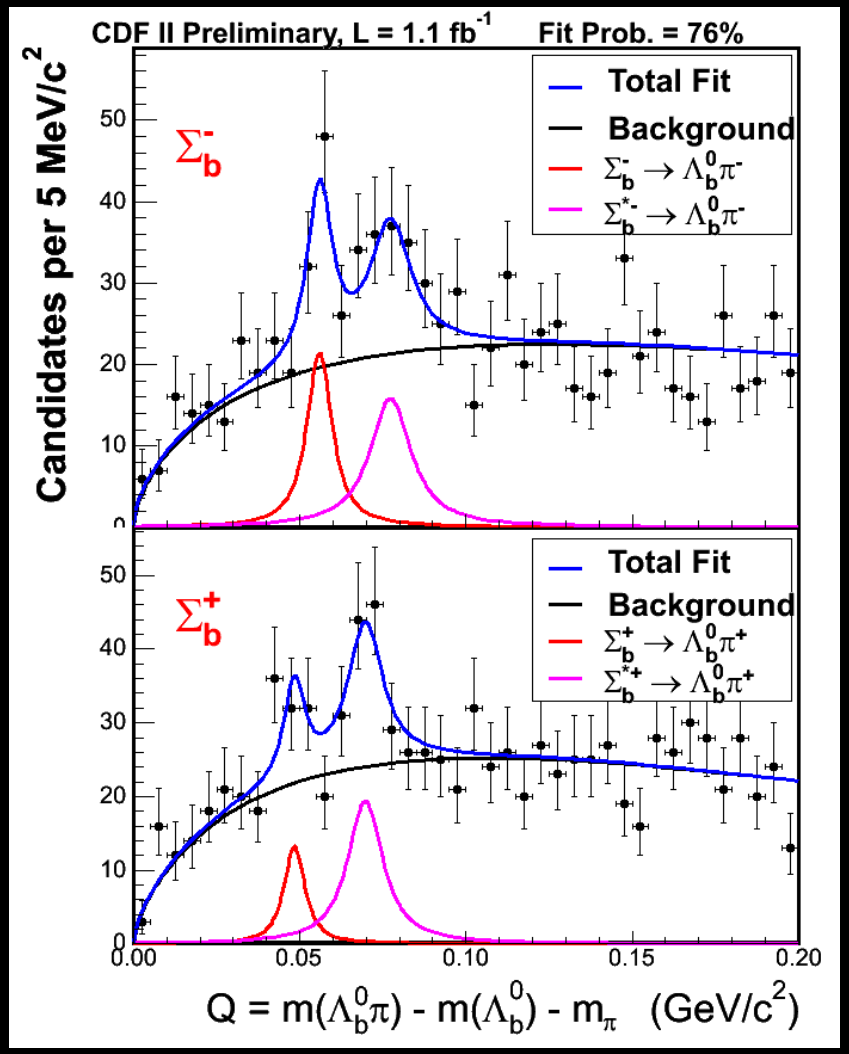



# Discoveries: CP Violation $B_s$ System

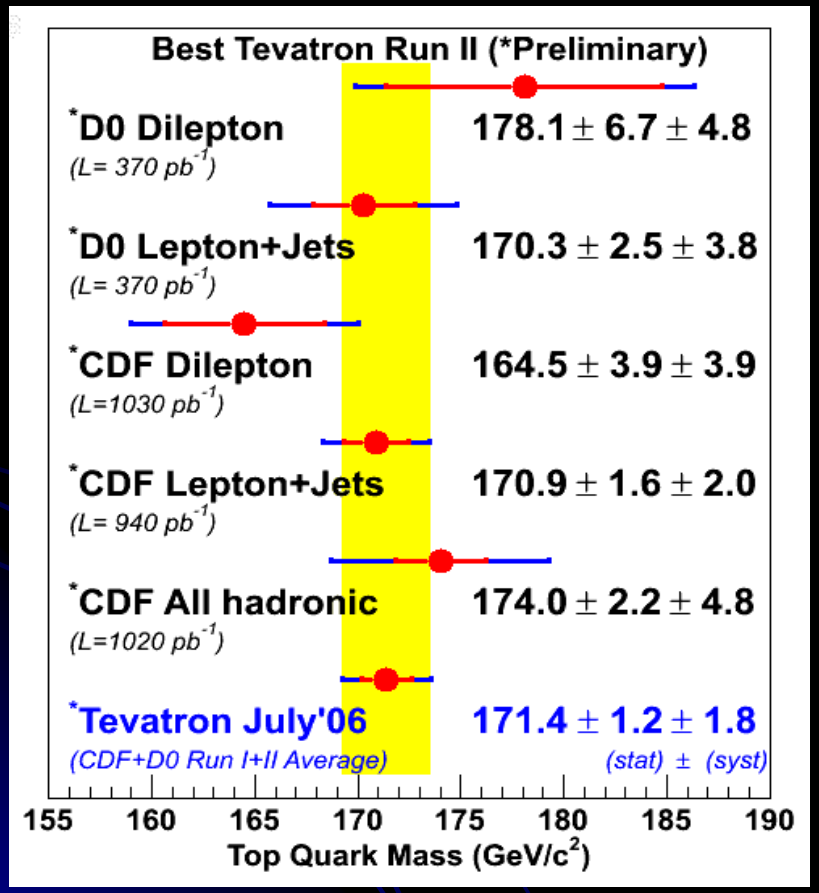


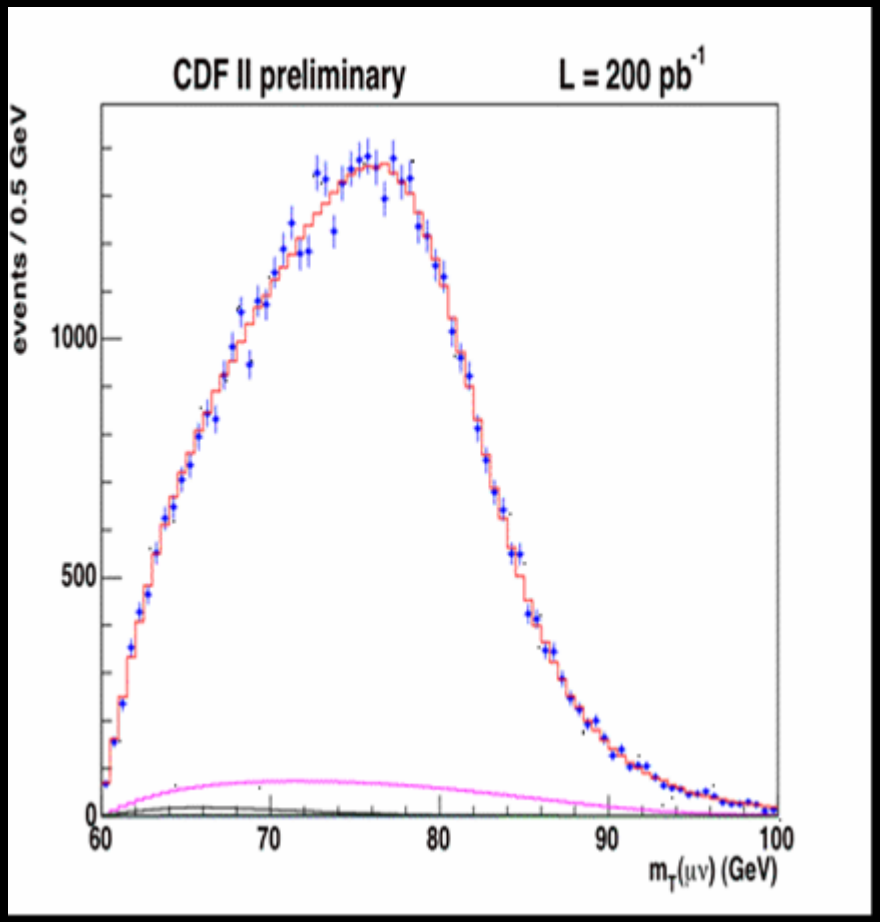
# Discoveries: New Heavy Baryons



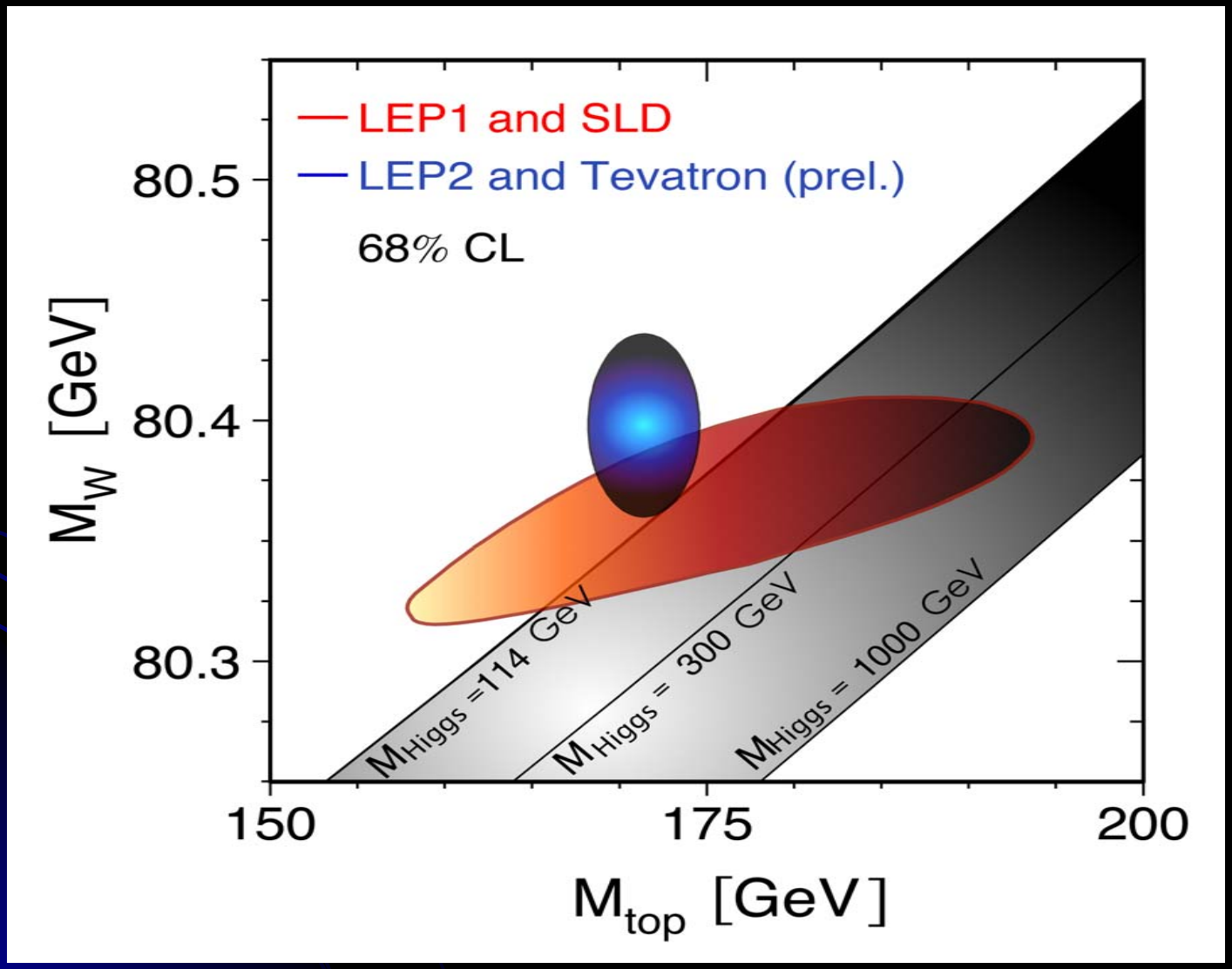



# Electroweak Symmetry Breaking: Top and W Mass Measurements

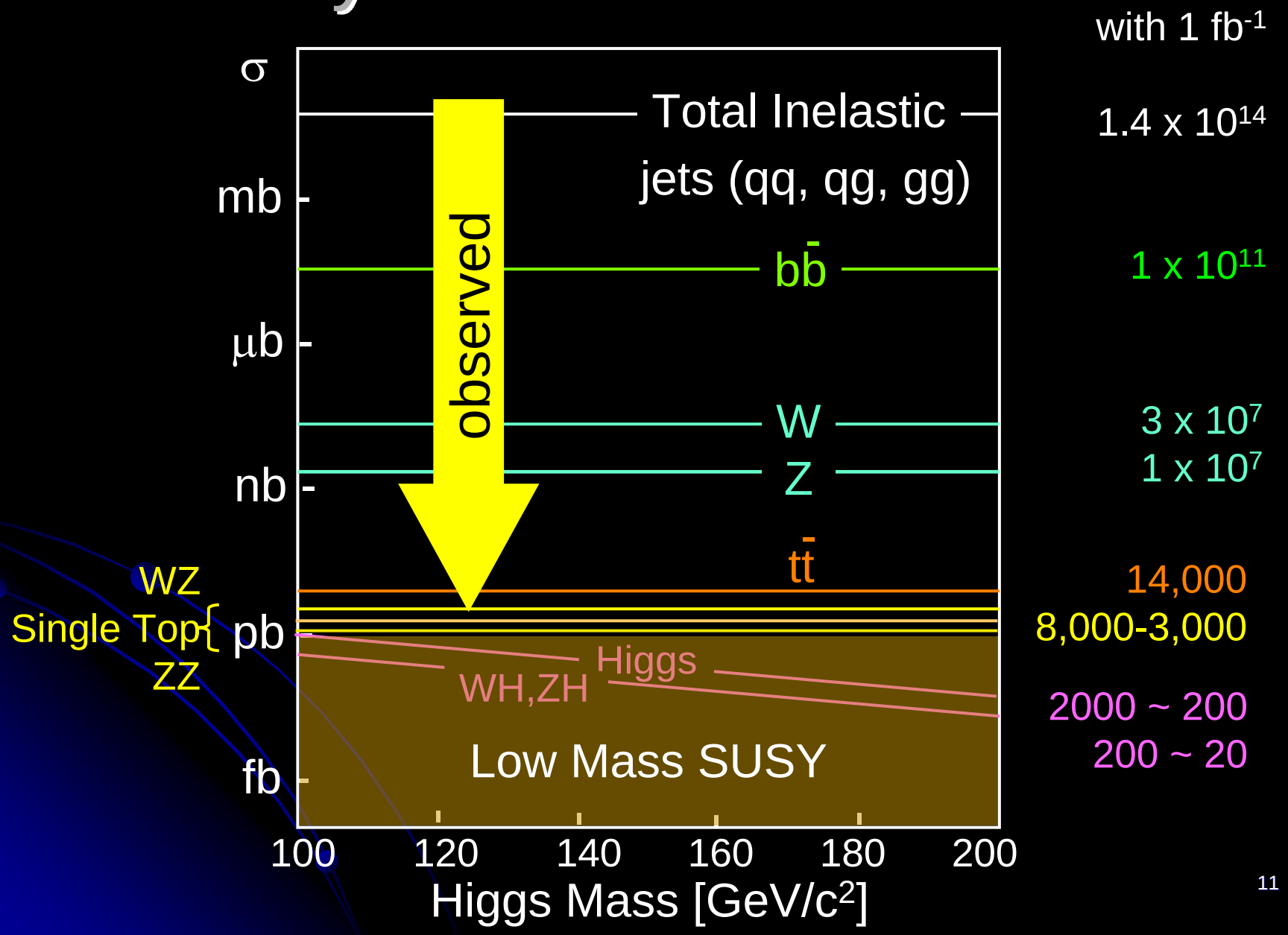


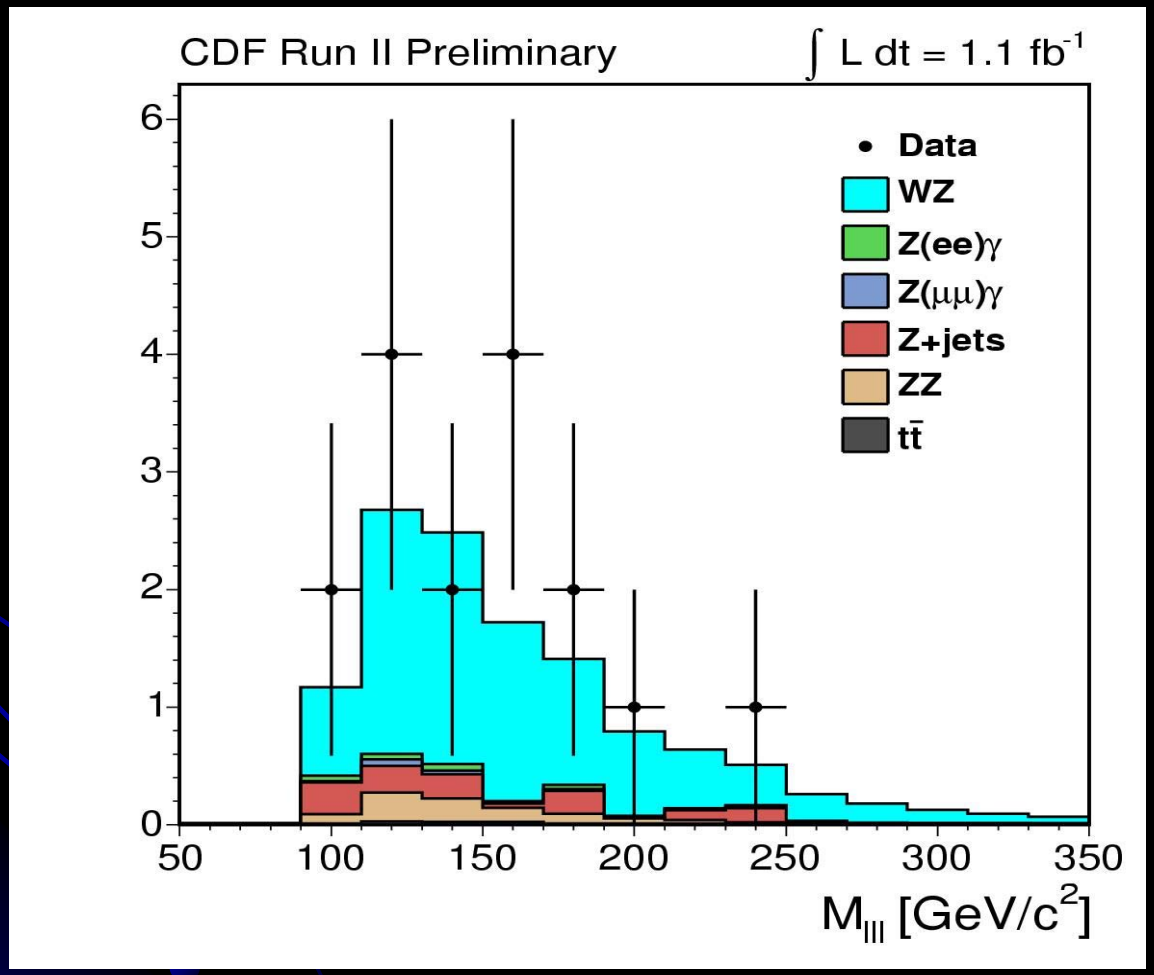
# Light Mass Higgs Preferred!



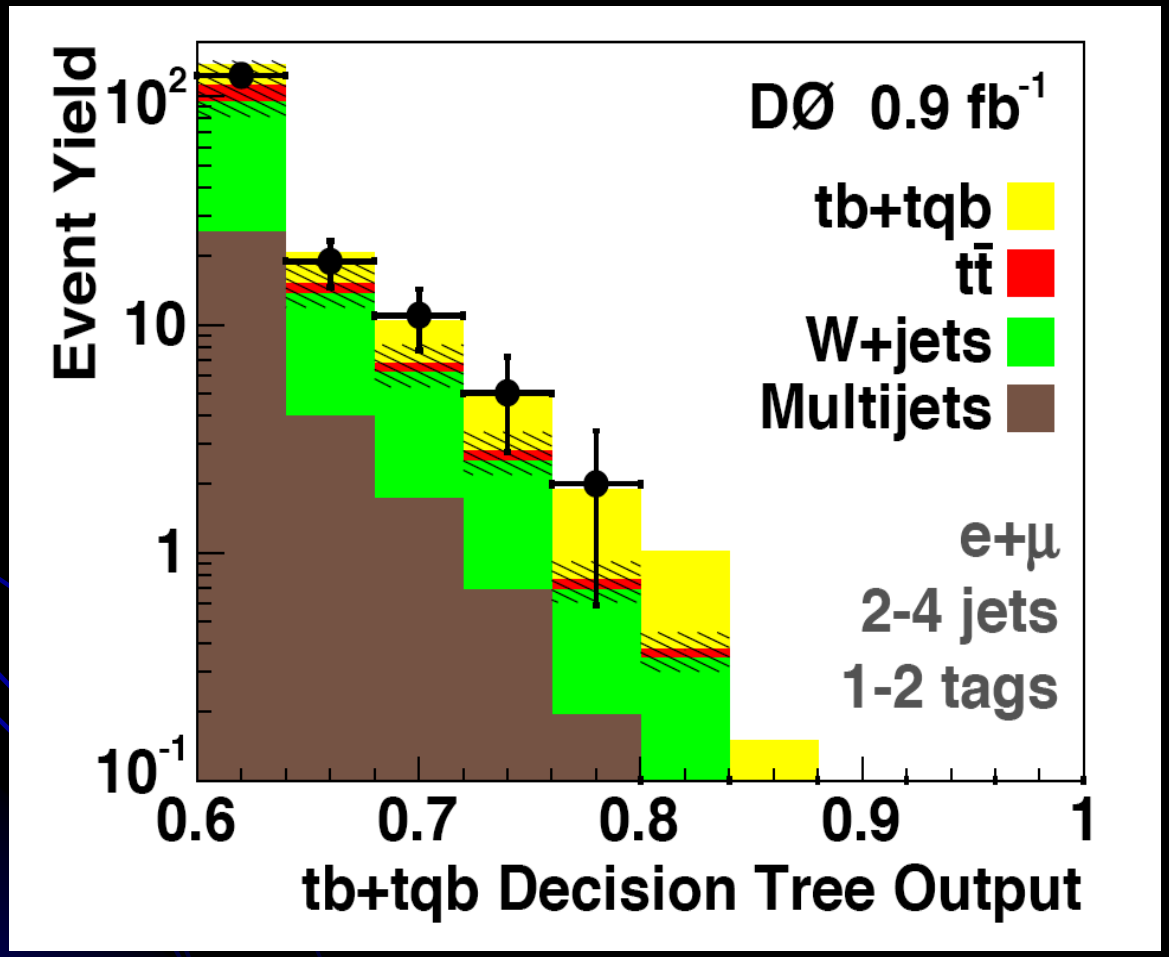
# Physics at the Tevatron



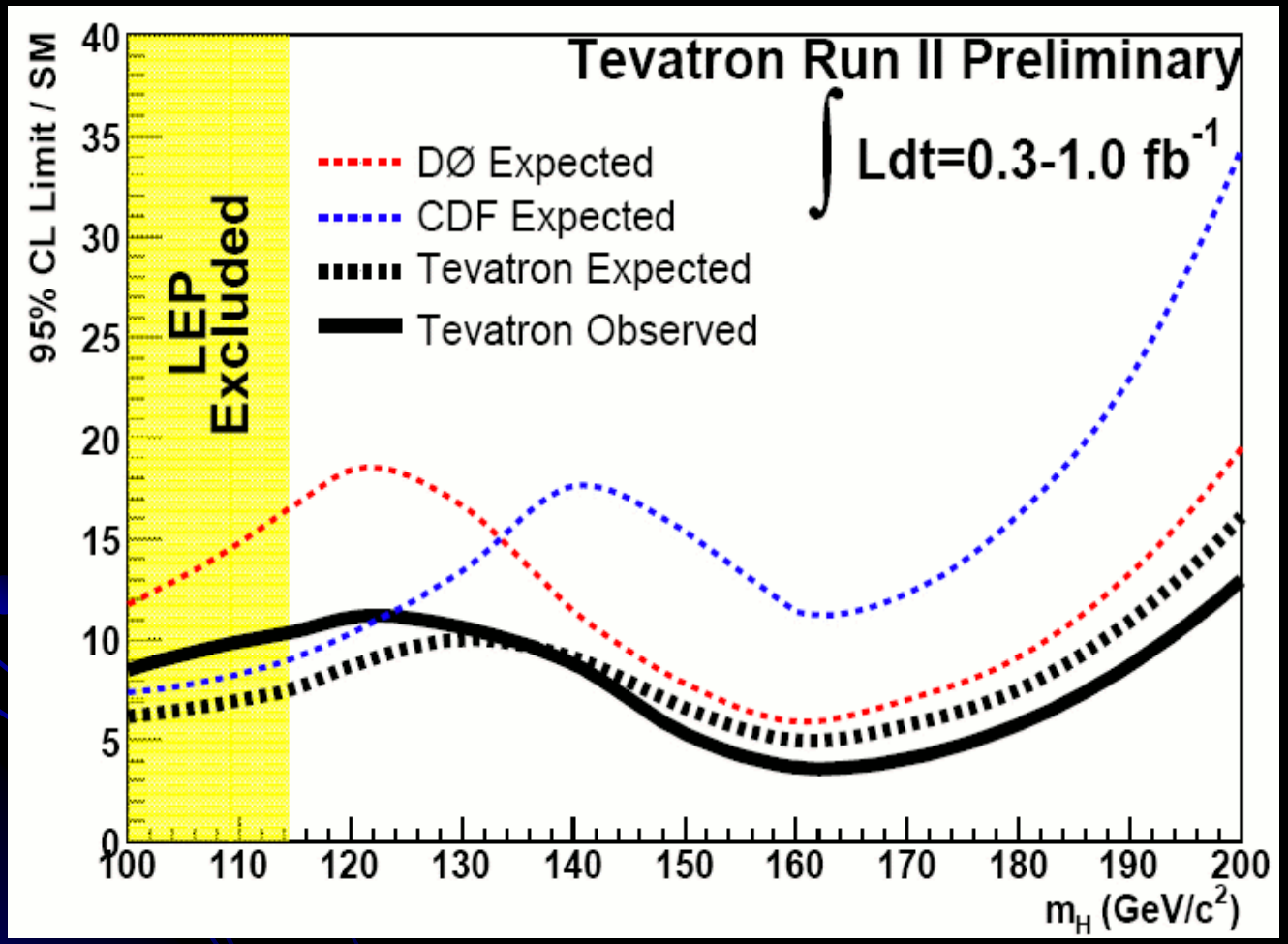
# Road to the Higgs: Discovery of WZ Production



# Road to the Higgs: Evidence for Single-Top Production

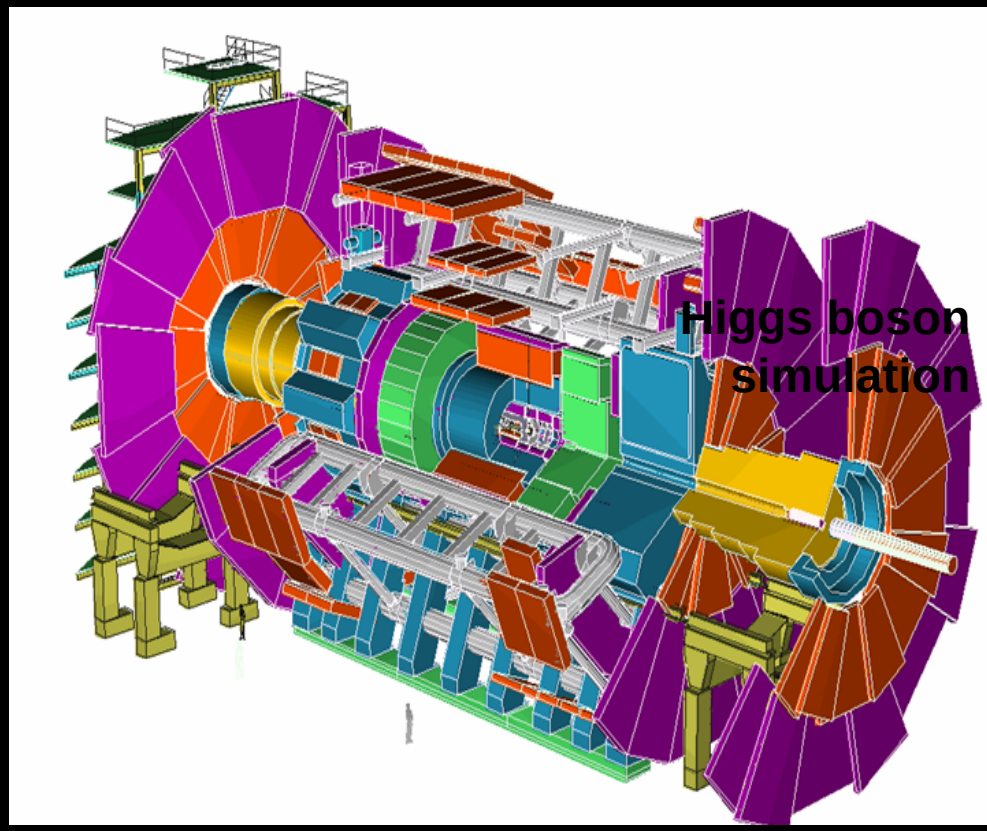


# Higgs Sensitivity



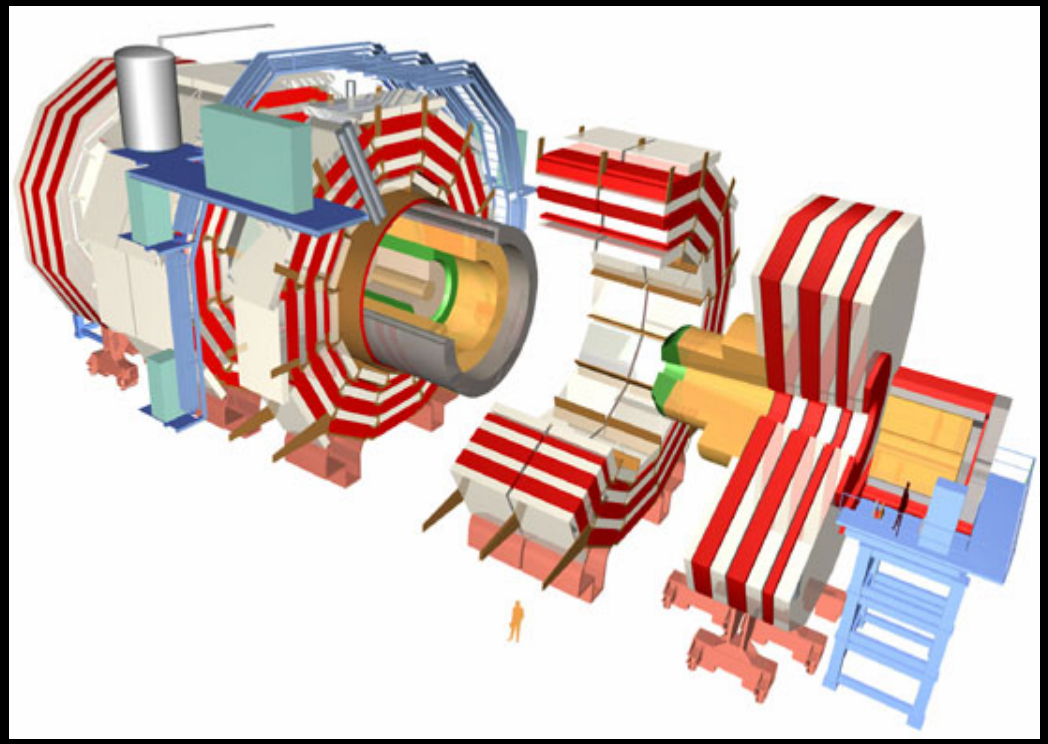
# The world moves to the LHC

ATLAS Collaborators




ATLAS

# LHC: CMS detector



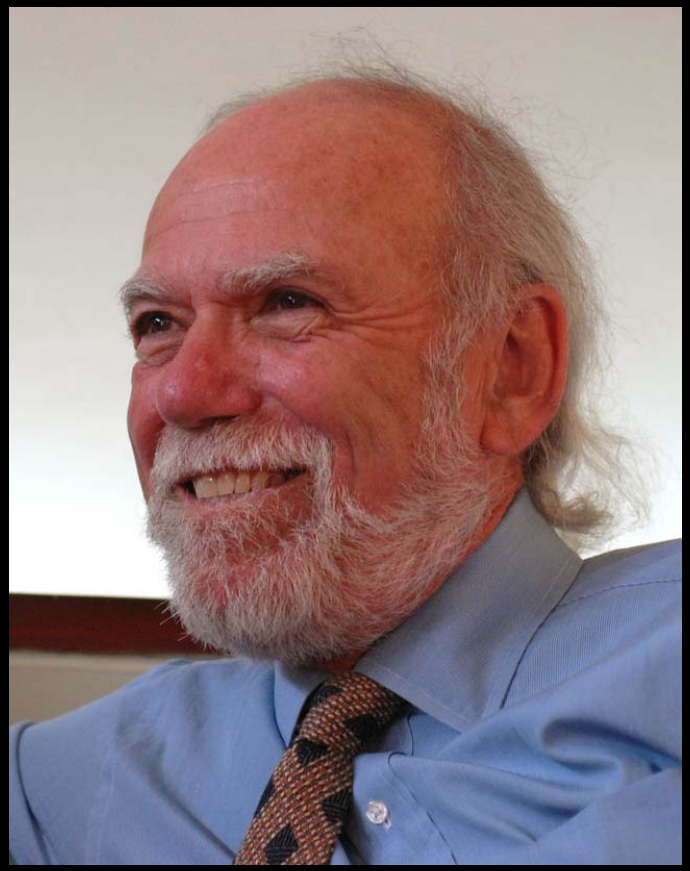
# FNAL Remote Operations Center

# US program and LHC

- Hugely important part of US particle physics
- Fermilab is the lead US lab for the LHC collider
- Fermilab is the only US lab in CMS: support US community
- Four US labs in ATLAS – We all will on common tools such as GRID computing
- BUT it is not enough for US to only participate in facilities abroad!

# GDE delivers

- Baseline Design: Frascati
- First roll-up: Vancouver
- RDR and value estimate: Beijing!
- Now developing plan for global R&D program and EDR



# Beijing, February 2007

Beijing Press Conference

# R&D + Engineering Design Report

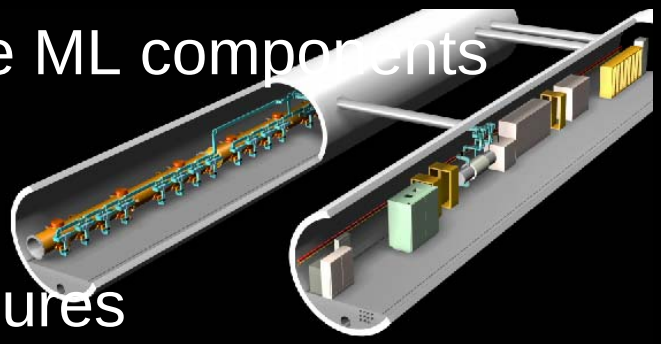
- The next phase of ILC – aim for EDR in 2009-10
- Provides detailed design and more accurate cost – supported by results of R&D
- BIG ISSUE: how much site specific design gets done in this phase?  Limited by funding and international site determination
- Big opportunity for Fermilab to contribute – strong engineering team

# Main issues in 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)

# Main ILC R&D activities at FNAL

- 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



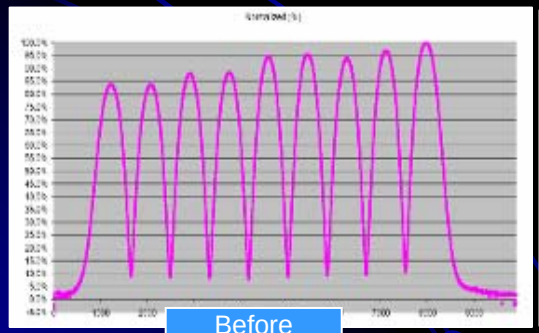
- Civil and Site Development activities:
  - Civil engineering of machine enclosures
  - Study U.S. sites on or near the Fermilab site
  - Estimate costs for conventional facilities

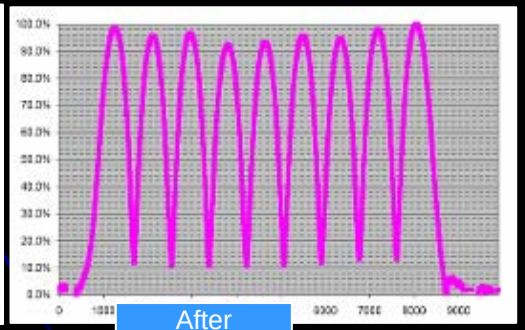
# Fermilab ILC R&D Collaborations

- 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,KEK
- Main Linac: Cryogenics:
  - DESY,CERN,TJNL,ANL,SLAC
- Main Linac Accelerator Physics
  - SLAC,KEK,CERN,DESY, Cornell

# US Cavity Fabrication

- Niobium QC:  Fermilab, Jlab
- Cavity Fabrication: Advanced Energy System, ACCEL, Zanon and Jlab (Cavity and Material R&D)



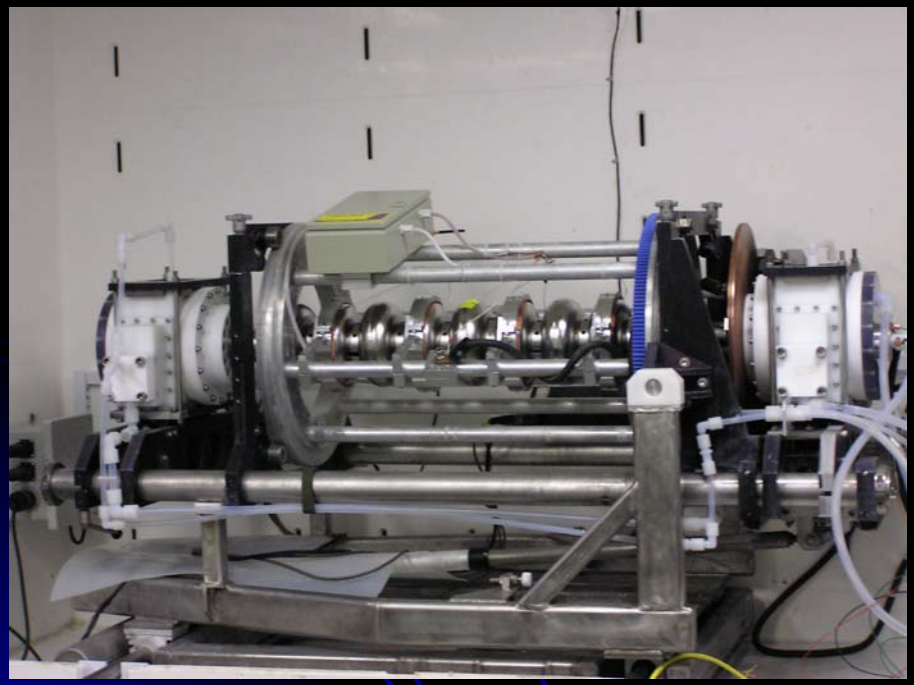

AES Cavity Field Flatness

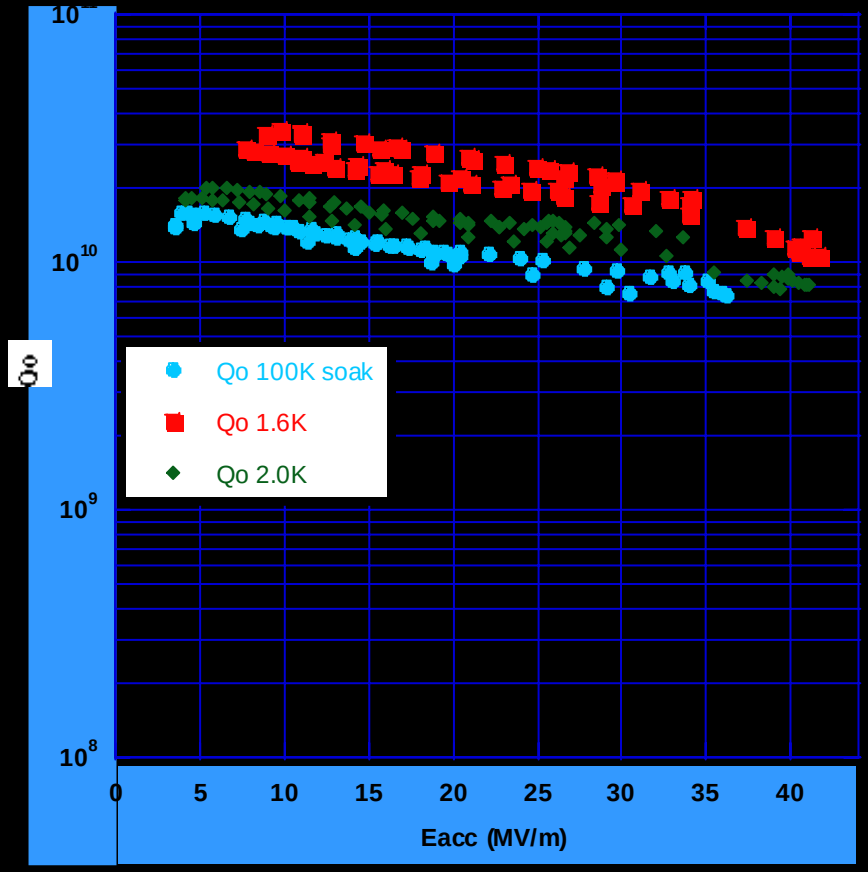
US Cavity Fabrication Plan

- FY05: 4 Cavities
- FY06: 23
- FY07: 16
- FY08: 24

# Jlab Result on Cavity:AC7

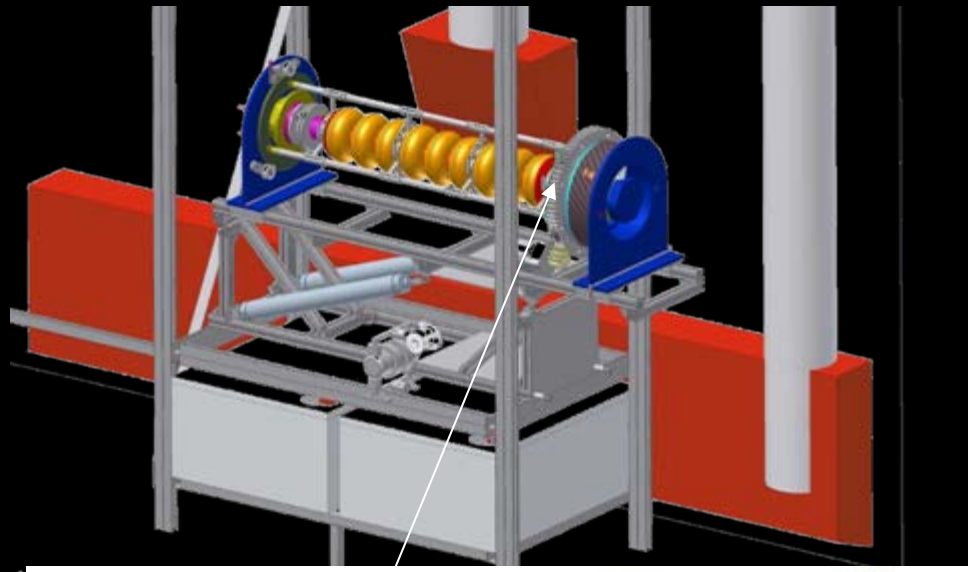
Jlab has commissioned  an Electro-polishing Facility for ILC cavities

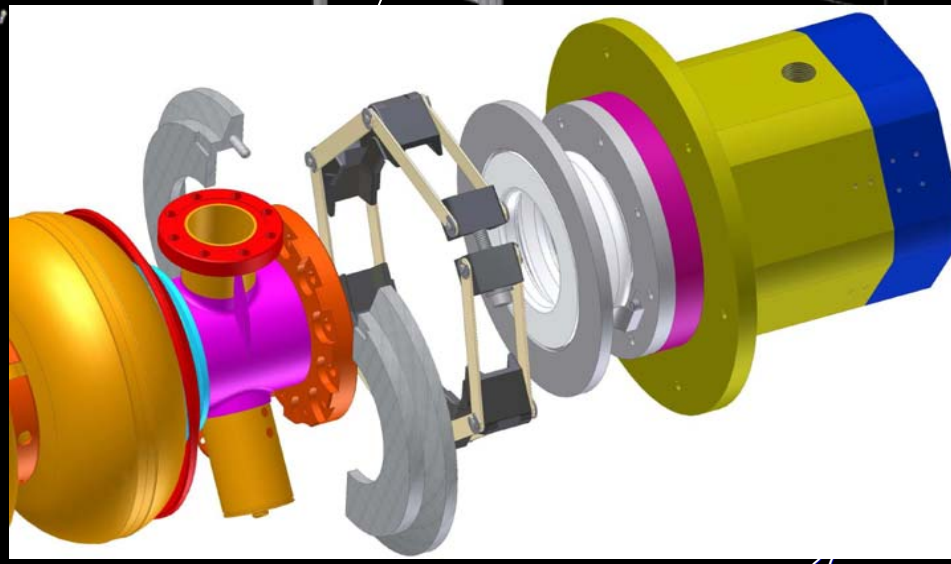





**Jlab: Electro-polish Development**

# Electro-polishing Facility at ANL: Technical Progress





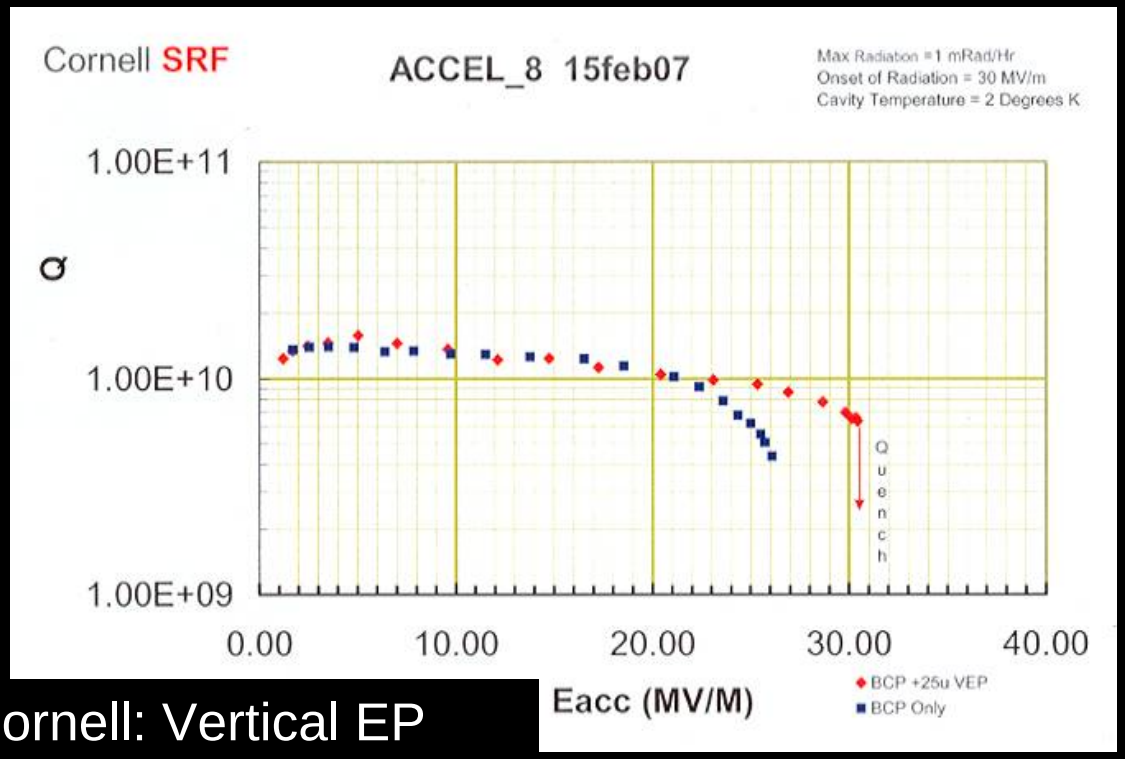
The technical design was reviewed on 2/12/07.

This facility is scheduled to be commissioned in the last quarter of FY07.

# Cornell Result on Cavity:AC8

Cornell is in process of commissioning a Vertical EP system for processign ILC Cavities.

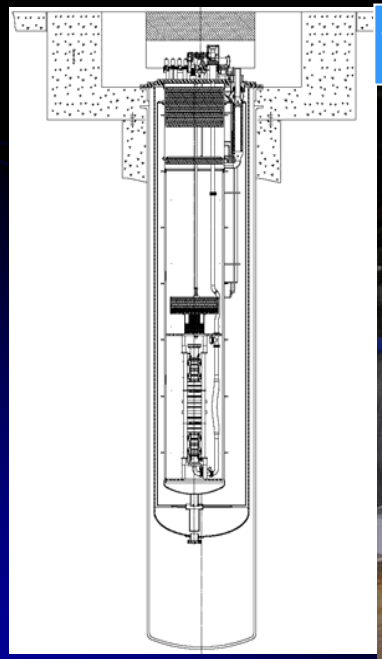
Recent results of 1st electropolishing are very positive.




Cornell: Vertical EP

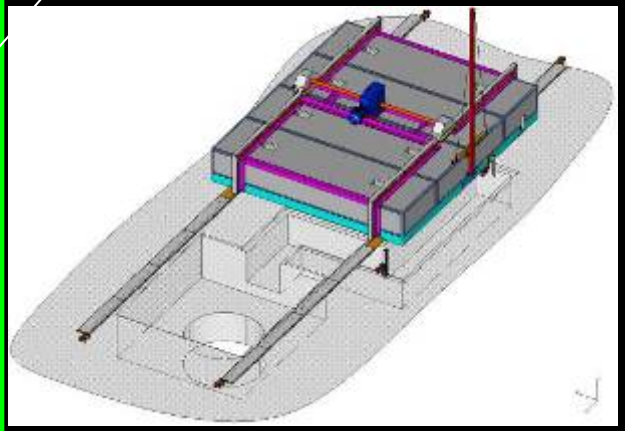
# Vertical Test Facility-1

- A Vertical Test Stand at Fermilab (IB1)
  - Capacity of 125 W at 2 K (250 W available for intermittent test)
  - Test Stand will be capable of testing ~50 Cavities/yr
  - Commissioning late summer 07



VTS Cryostat at Fermilab

VTS Pit

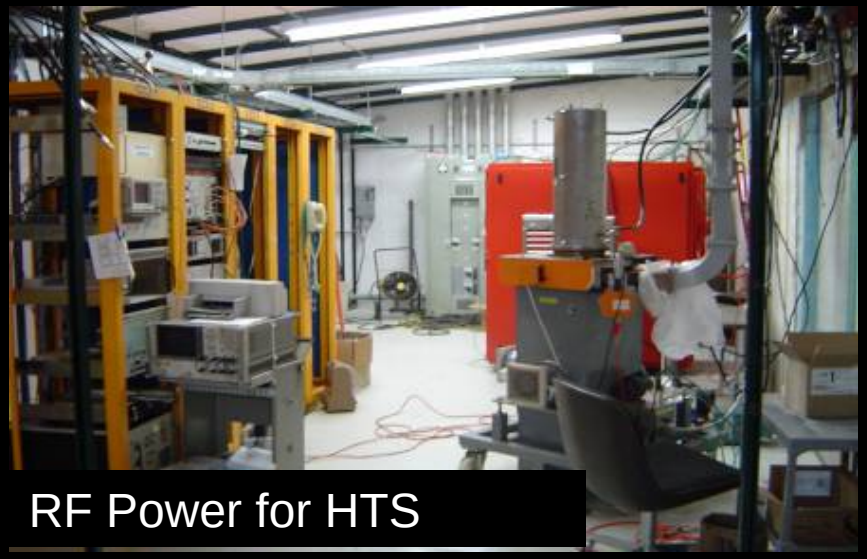


Schematic of Shielding

# Horizontal Test Stand

- Horizontal Test Stand  at Meson.
  - The maximum capacity of this test stand is ~24 cavities/yr.
- The commissioning of the HTS will happen with AC7 (9-cell, 41 MV/m) cavity.
  - Coupler from DESY
  - Tuner and He Vessel from INFN to Penn, Getting commissioned at Penn
  - Will be dressed at Jlab

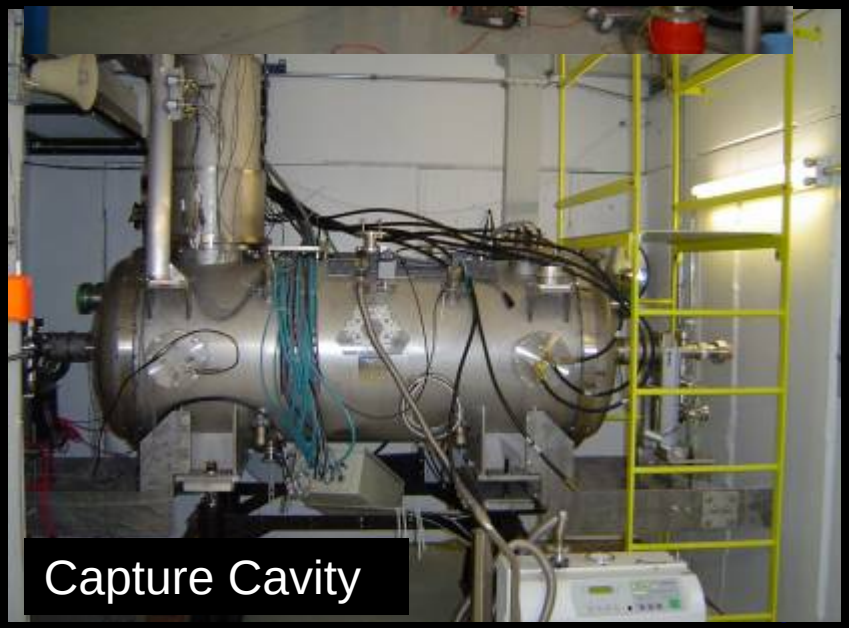
# Cavity Testing Infrastructure



RF Power for HTS

Cryogenics for HTS ready at 2 K

Cryogenics for HTS getting ready for 2 K



Capture Cavity

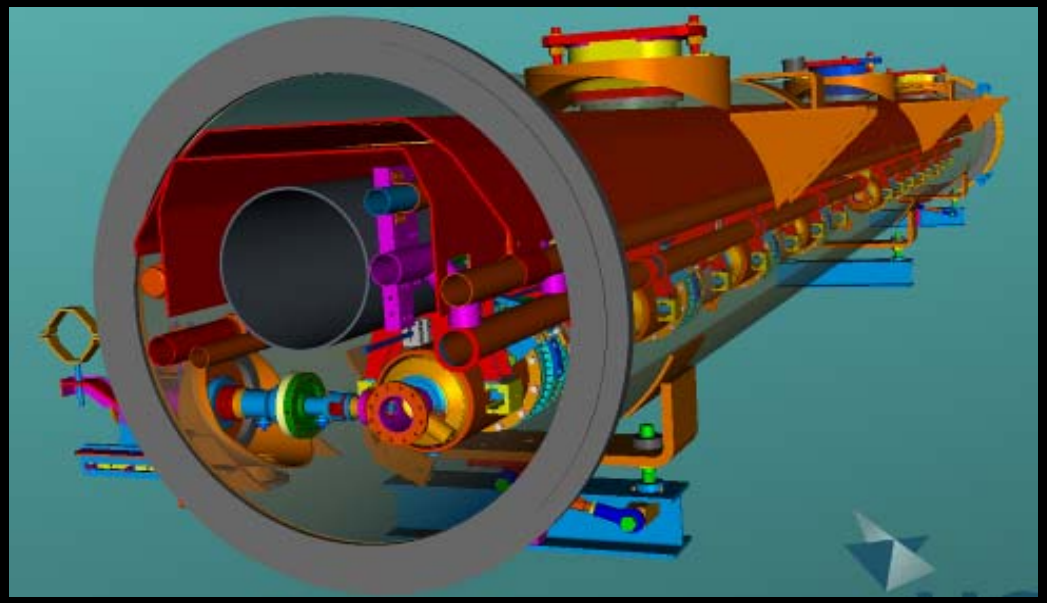
# Cryomodule Assembly Facility MP9 and ICB

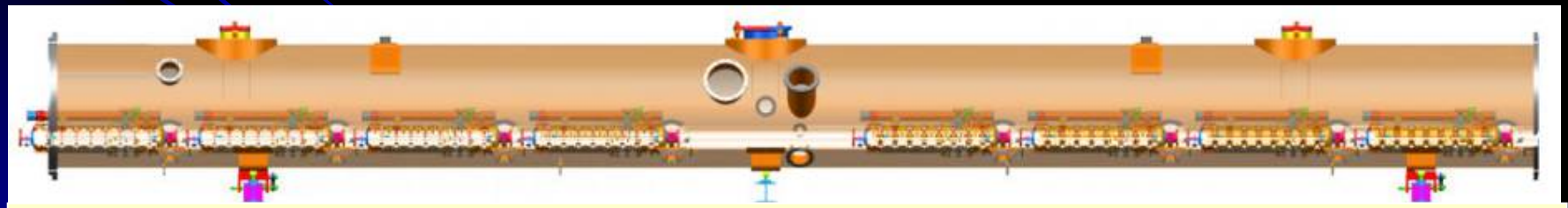
CAF infrastructure:

- **Clean Rooms (10,100,1000)**
- **String Assembly Fixtures**
- **Vacuum / Ultra Pure Gas Flow Equipment/ Hardware**
- **Ultrasonic Cleaner**
- **Ultra pure DI water**
- **Cavity Handling Cart / Fixture**
- **Cold Mass Assembly Fixture**

# Proposed: CAF (MP9 and ICB) Upgrade

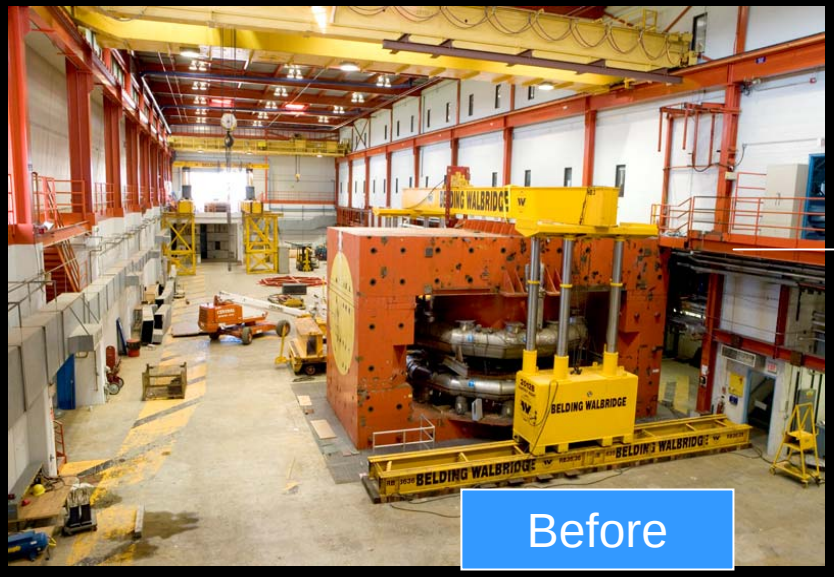
- CAF can be used for small scale mass production assembly area for cryomodules.
- To increase the assembly capacity to 1 cryomodules per month,

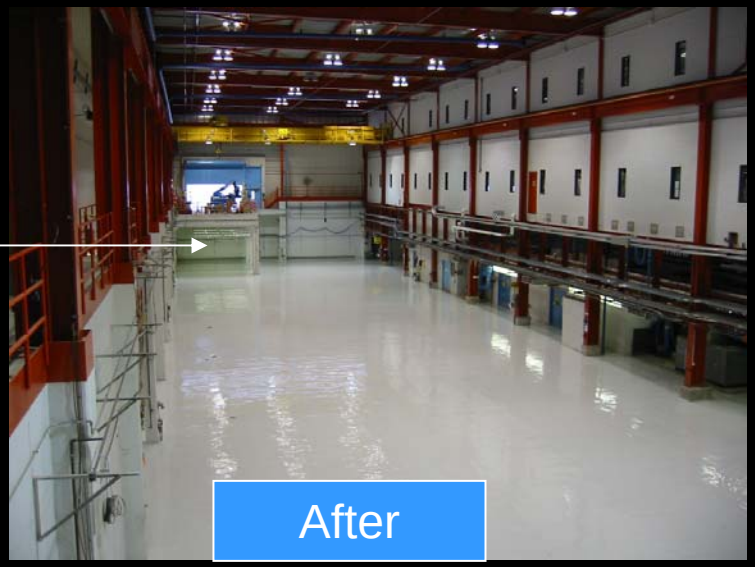


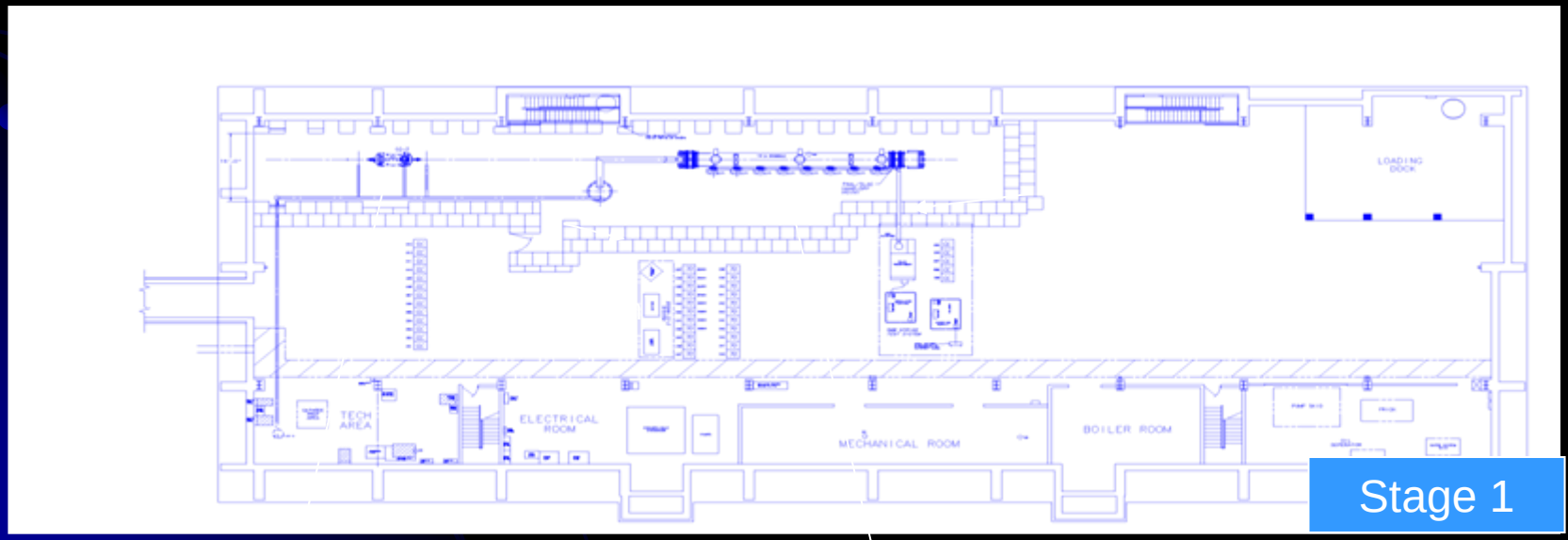


Cryomodule Assembly Facility (MP9 & ICB)

# RF Unit Test Facility

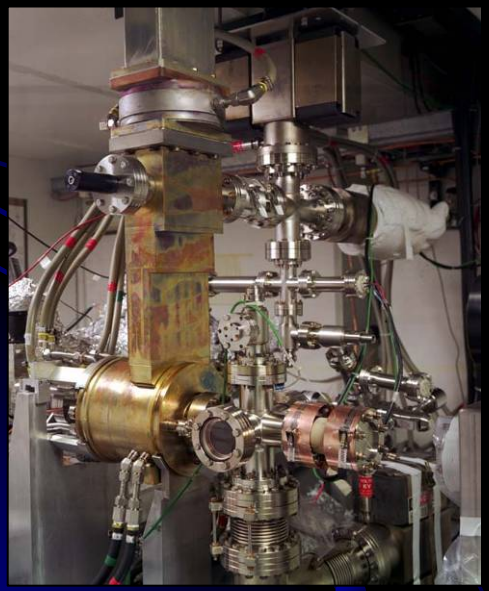


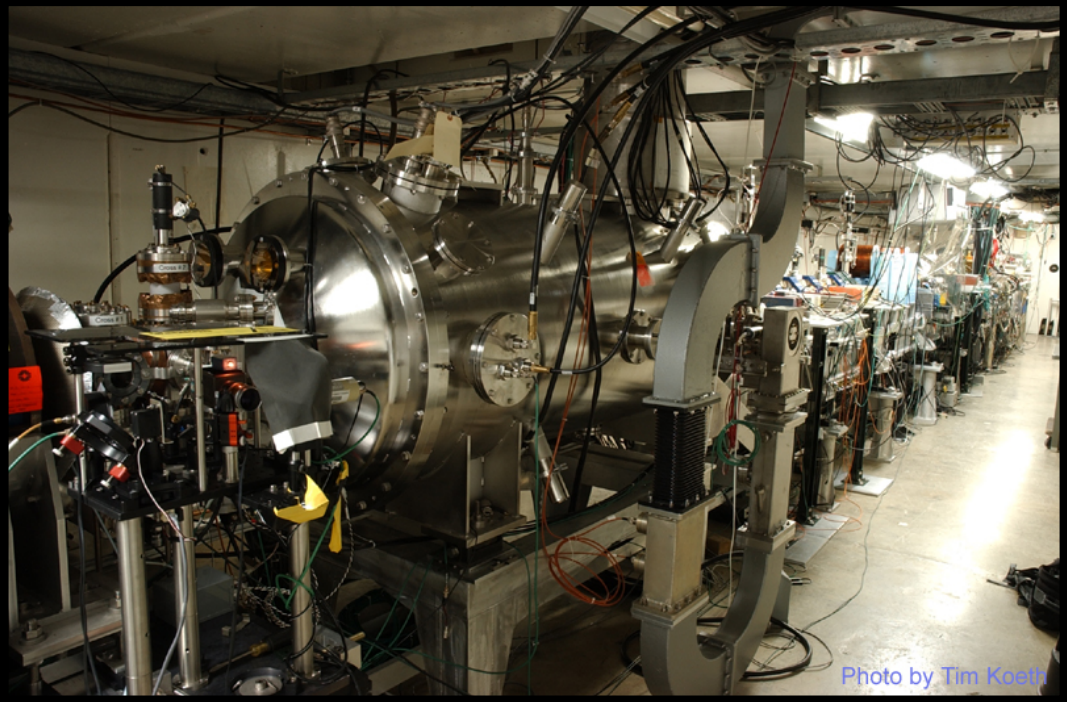



# A0 Photo Injector

- To be used as injector in the NML facility



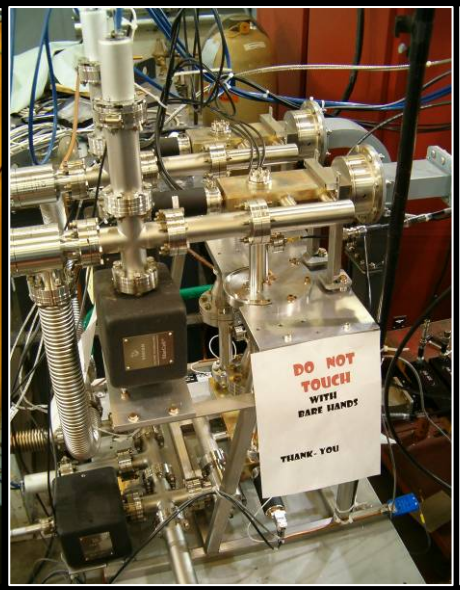
RF Gun prior to solenoid installation

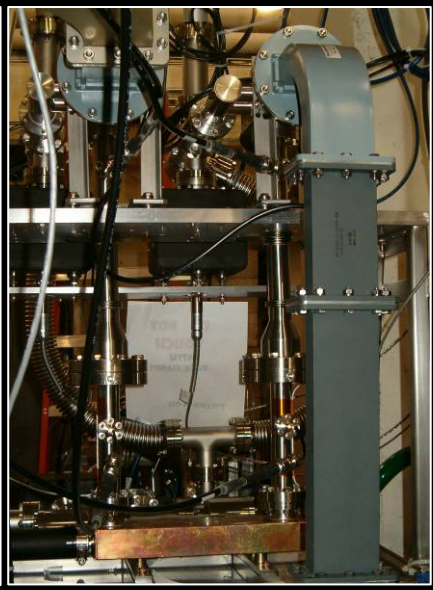



Capture Cavity and beamline

# Third-Harmonic RF Test Stand

3.9 GHz, 80 kW klystron and associated racks



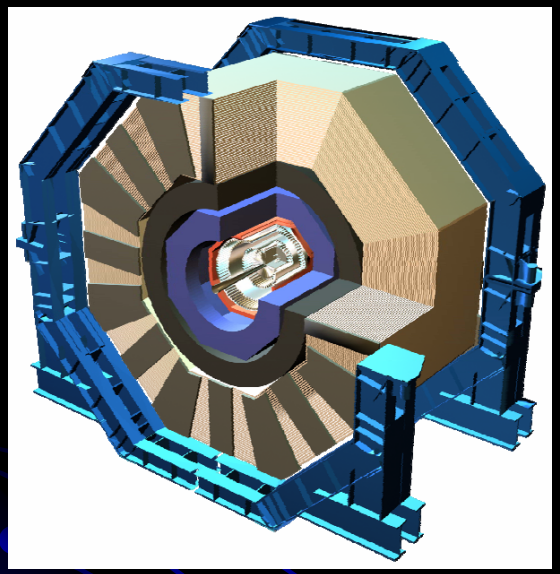



Power couplers under test

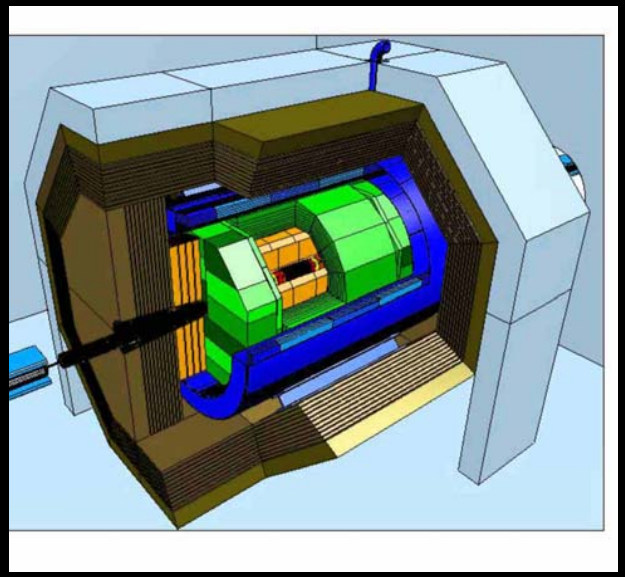
- Test stand presently located at A0 Lab where it is being used for power coupler testing and conditioning
- Will move to MDB in April to support third-harmonic cavity tests at horizontal test stand
- 2nd system will be procured and installed at NML in FY2009
- Power couplers presently tested up to 50 kW, 1 ms, 0.2 Hz

# Creating a test beam for all concepts/collaborations

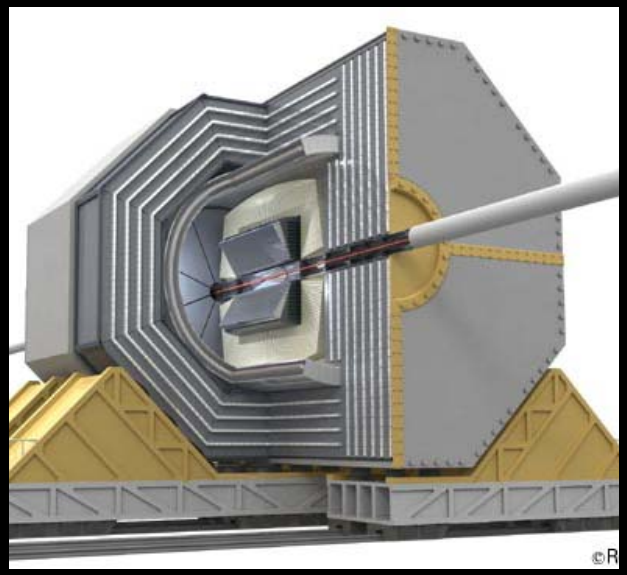
**"SiD"**



**"LDC"**

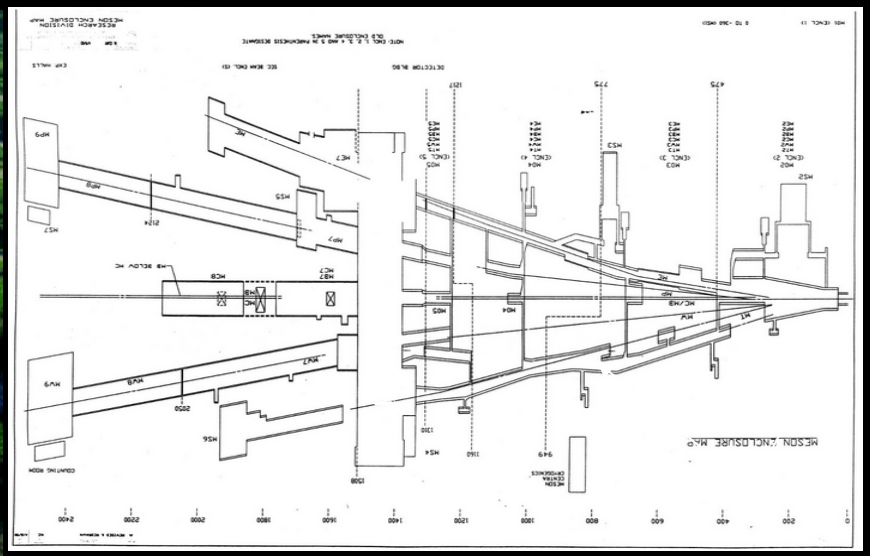


**"GLD"**



- 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

# Predicted Rates for Upgraded Beamline

Enhancement due to pion decay

| Energy (GeV) | Enhancement due to Pion Decay factor |
|---|---|
| 1 | 90 |
| 2 | 9.2 |
| 4 | 3.0 |
| 8 | 1.8 |
| 16 | 1.3 |

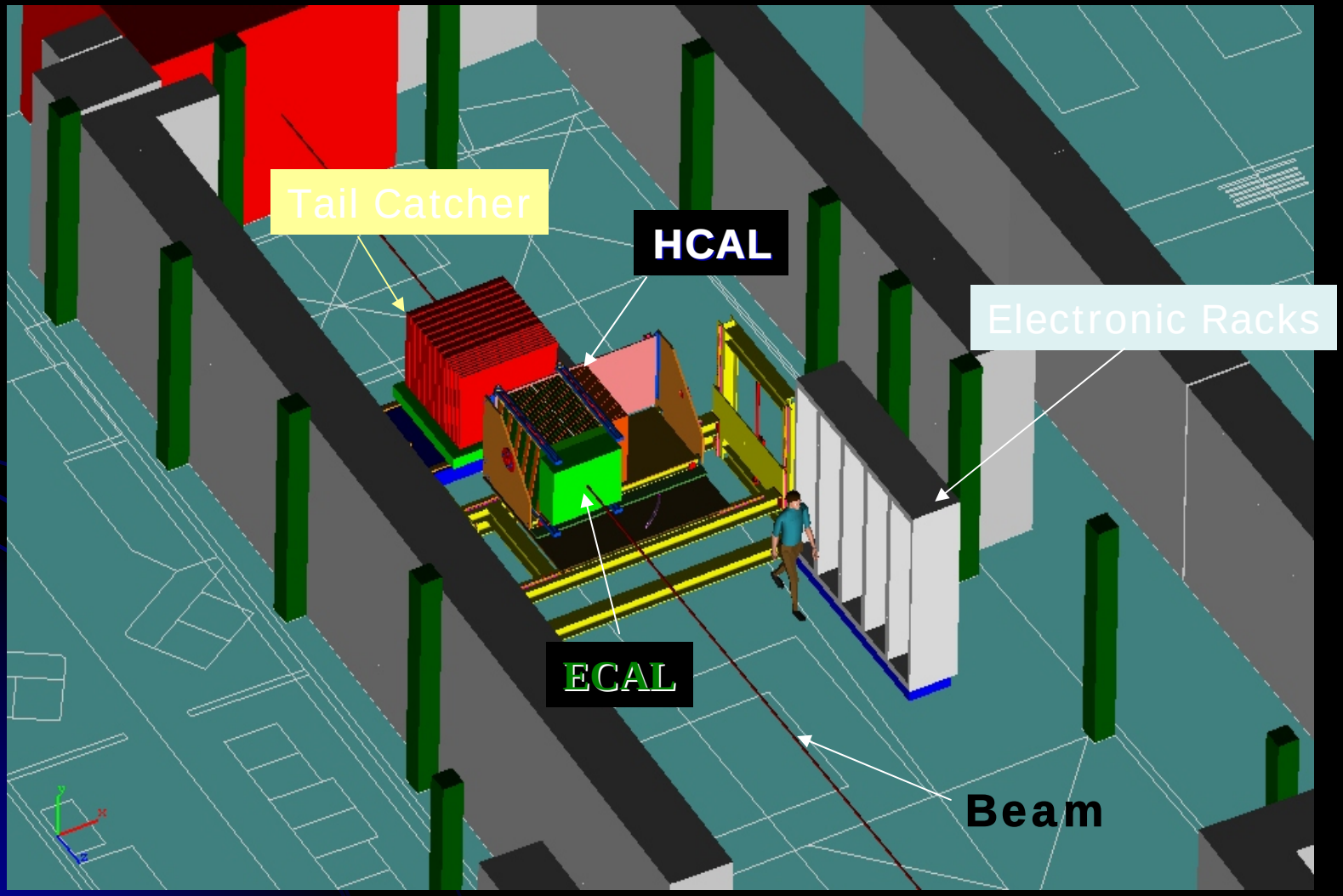
Enhancement due to material in beam

| Energy (GeV) | Hadron Enhancement | Electron Enhancement |
|---|---|---|
| 4 | 25 | ~90 |
| 8 | 6.4 | 14 |
| 16 | 2.5 | 6.3 |

- Enhancement due to increased momentum bite (from ¾% to 2%)
- Enhancement due to increased aperture

| Energy (GeV) | Present Hadron Rate MT6SC2 per 1E12 Protons | Estimated Rate in New Design (dp/p 2%) |
|---|---|---|
| 1 | --- | ~1500 |
| 2 | --- | ~50K |
| 4 | ~700 | ~200K |
| 8 | ~5K | ~1.5M |
| 16 | ~20K | ~4M |

# Example of CALICE Setup at MTBF



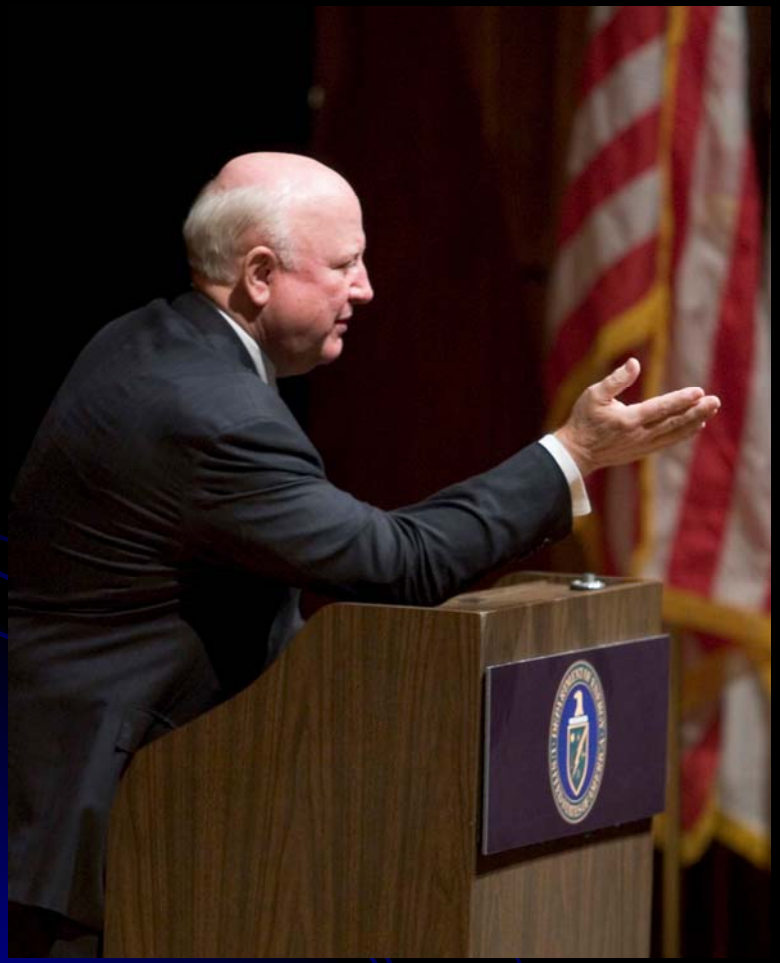
# Preparing to Host

- Site studies
- State support for Building: Industry-Universities-Laboratories R&D – pending capital bill in legislature
- Strong collaboration ANL, Illinois Universities
- Special role of University of Chicago
- URA R&D funds to strengthen Universities-Fermilab ties

# Working with the Community

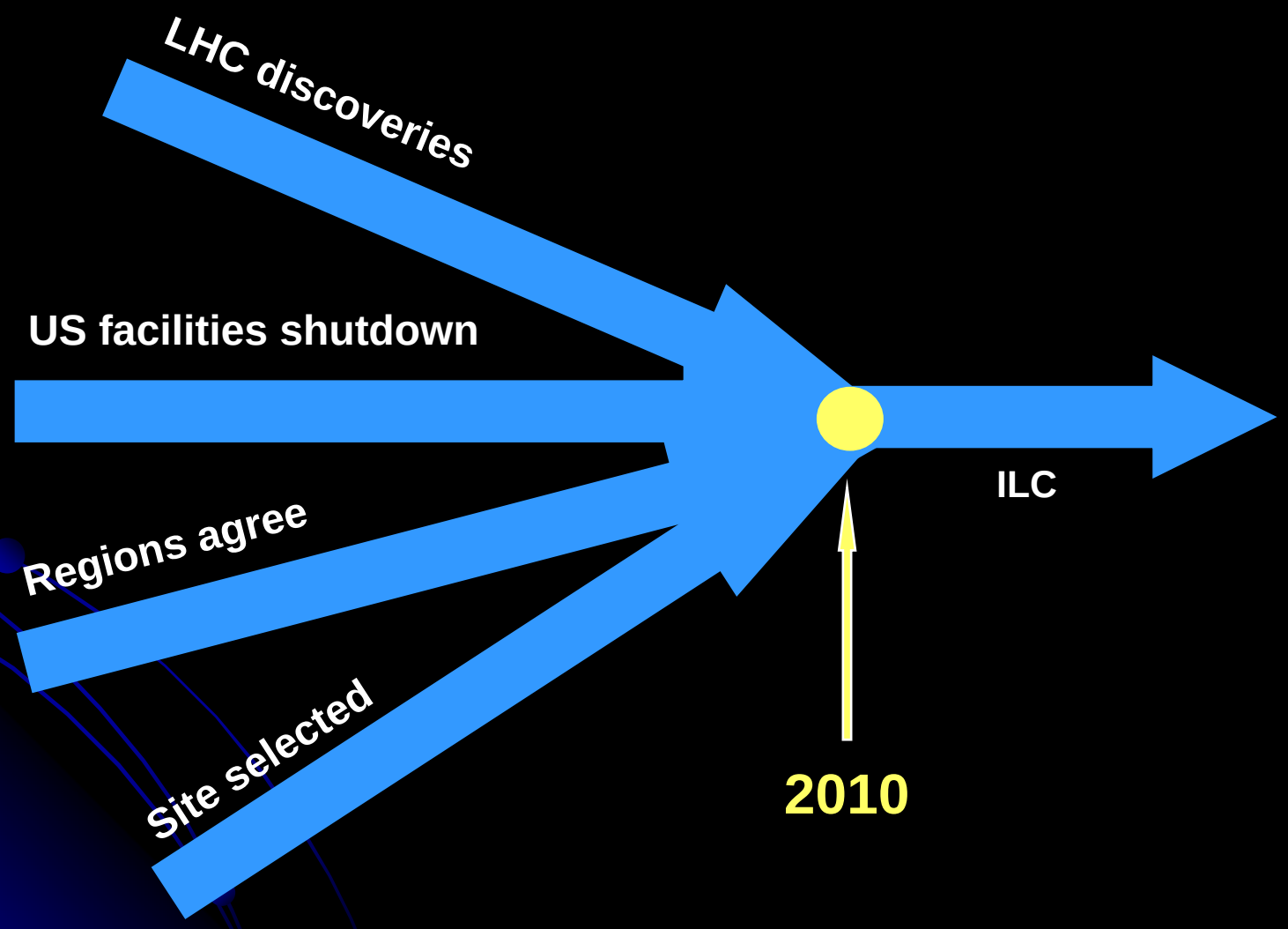
- Envoy Program
- Citizen's Task Force
- Outreach to many groups
- Publications

# The importance of the RDR

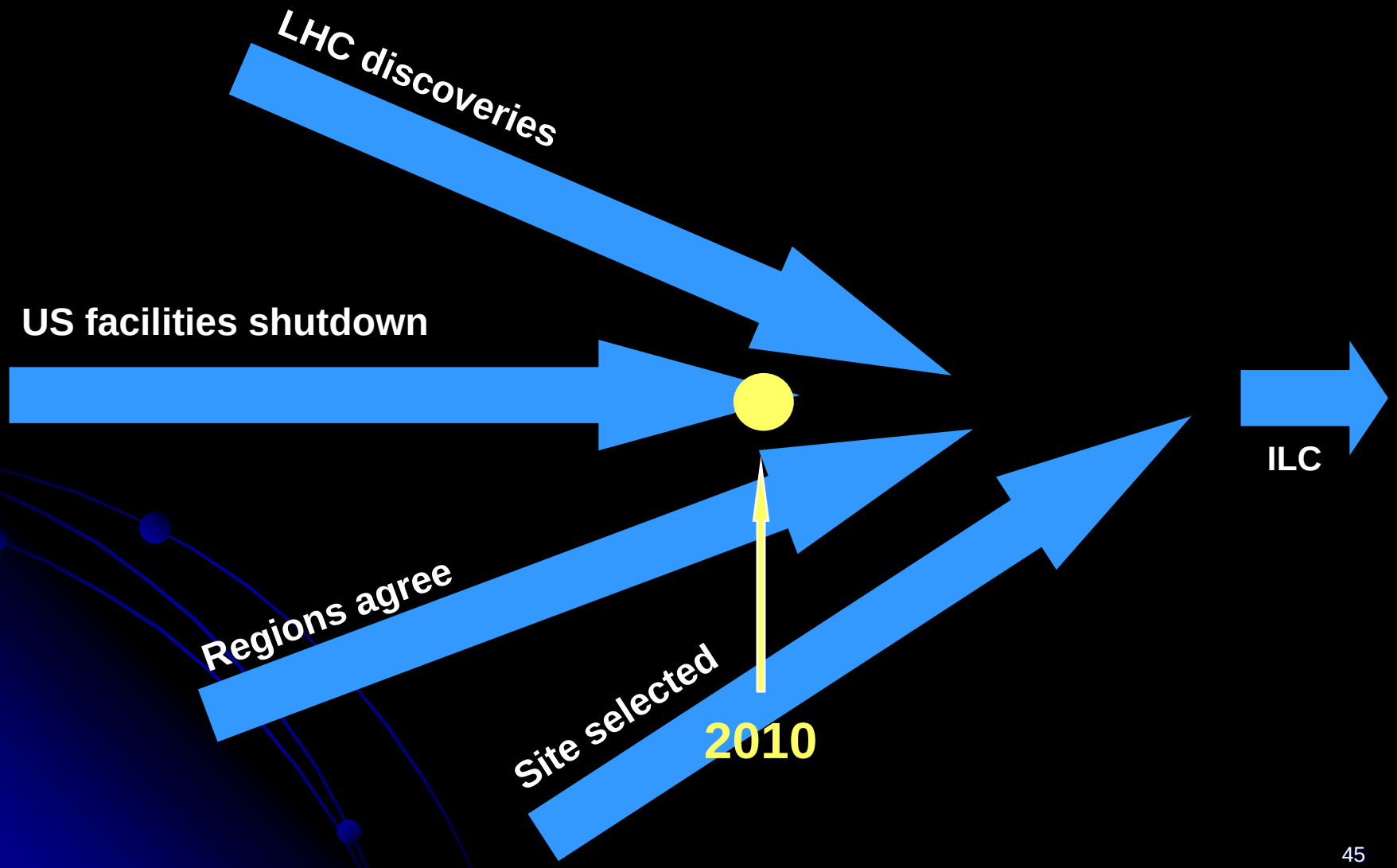


- Secretary Bodman: How much ?
- Answer =
  (1.8B +4.9B) ILCus
  +13 kFTEs
  + detector(s)
- Consequence: continue vigorous R&D and be cautious about time frame

# The golden “moment”



# Quadruple coincidence may not happen



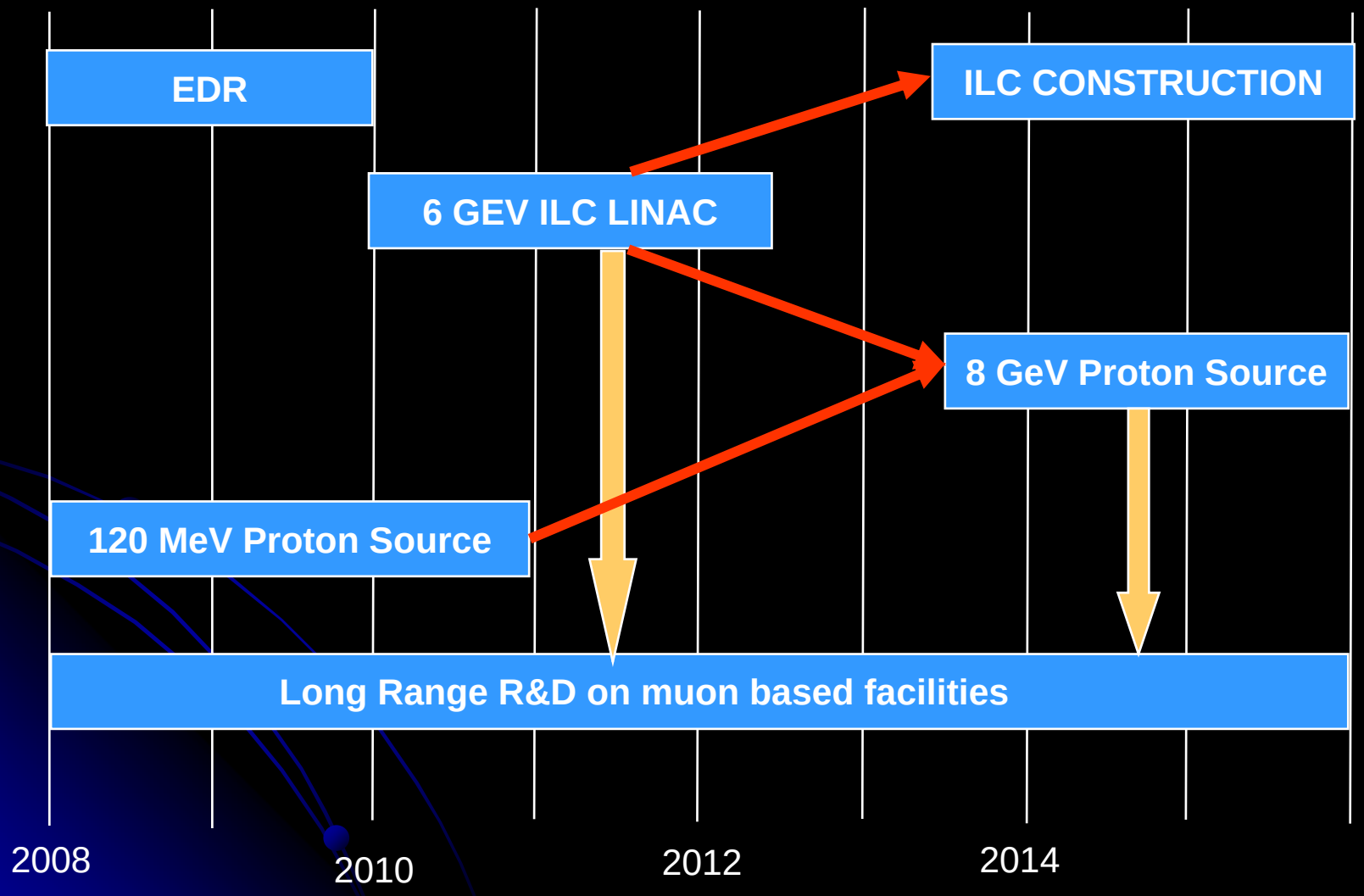
# Then what?

- Accelerator activity greatly reduced in 2010
- ILC activity limited before decision to build
- ILC R&D could integrate to too much $ (standing army problem)

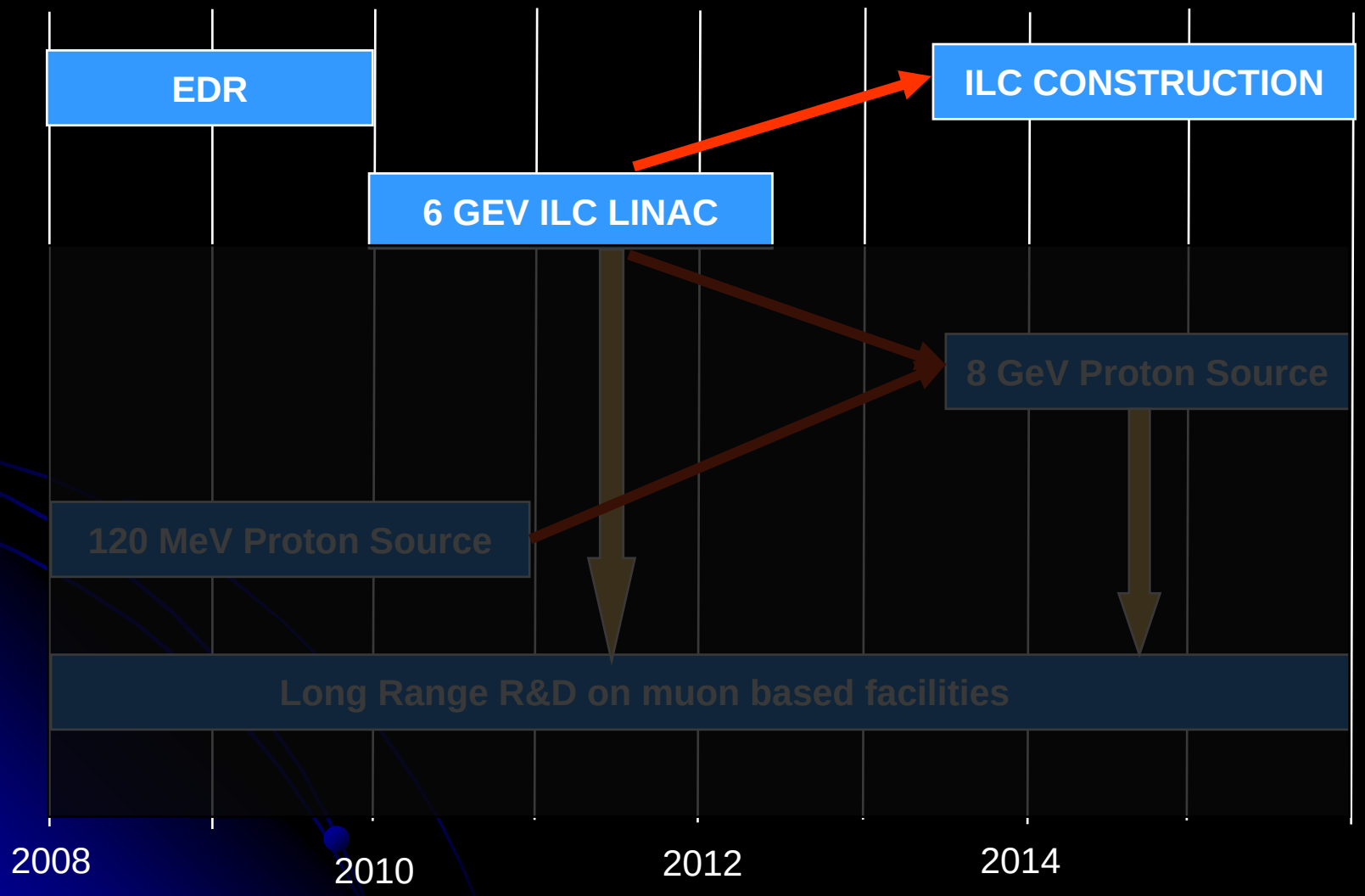
# The problem to solve

- How to sustain ILC activities over a possibly longer period before decision to build
- How to create alternative discovery opportunities that might be needed
- I am establishing steering group with broad participation under Young-Kee Kim to generate strategic plan for accelerator program

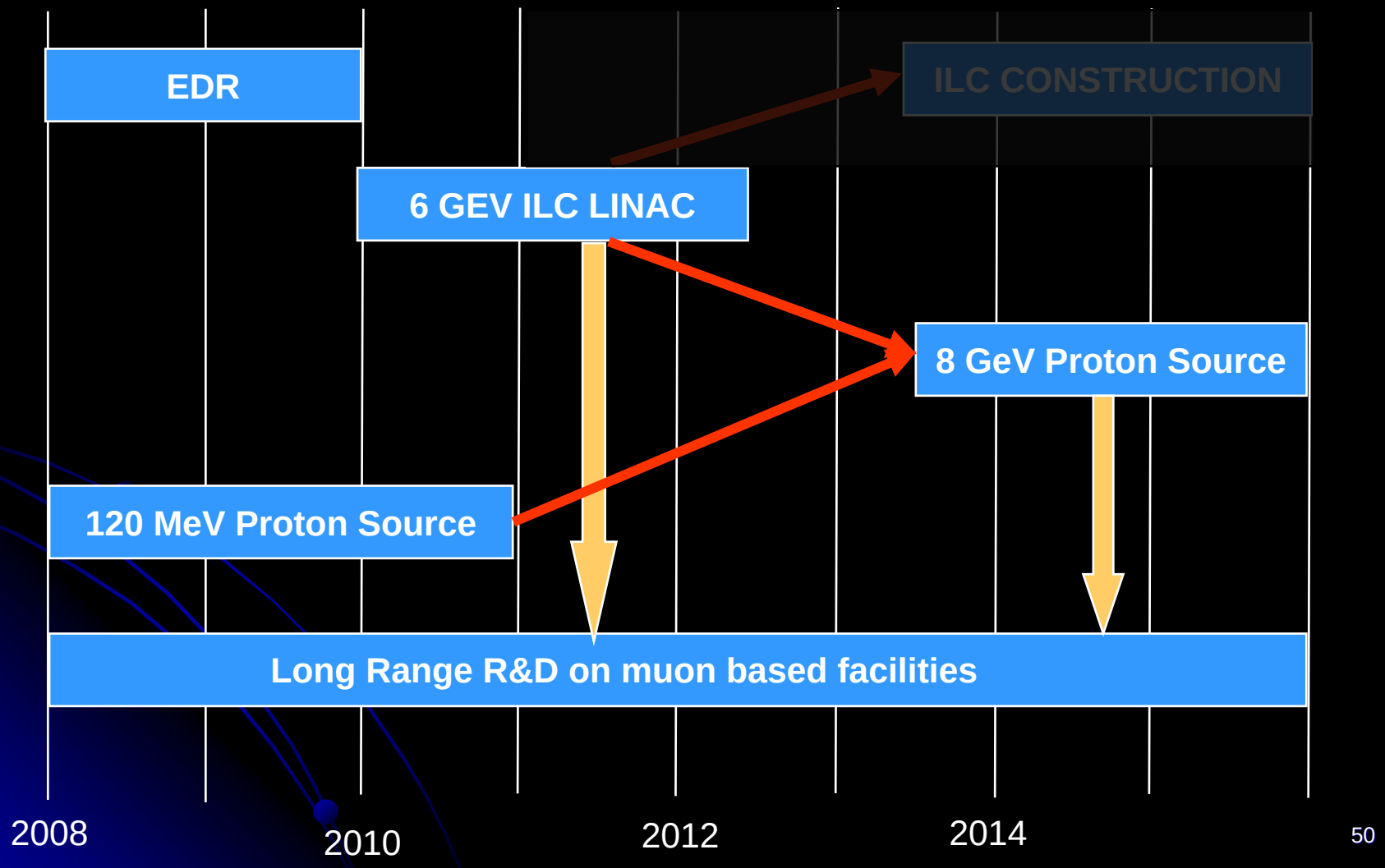
# A possible outcome



# The preferred route



# A possible outcome



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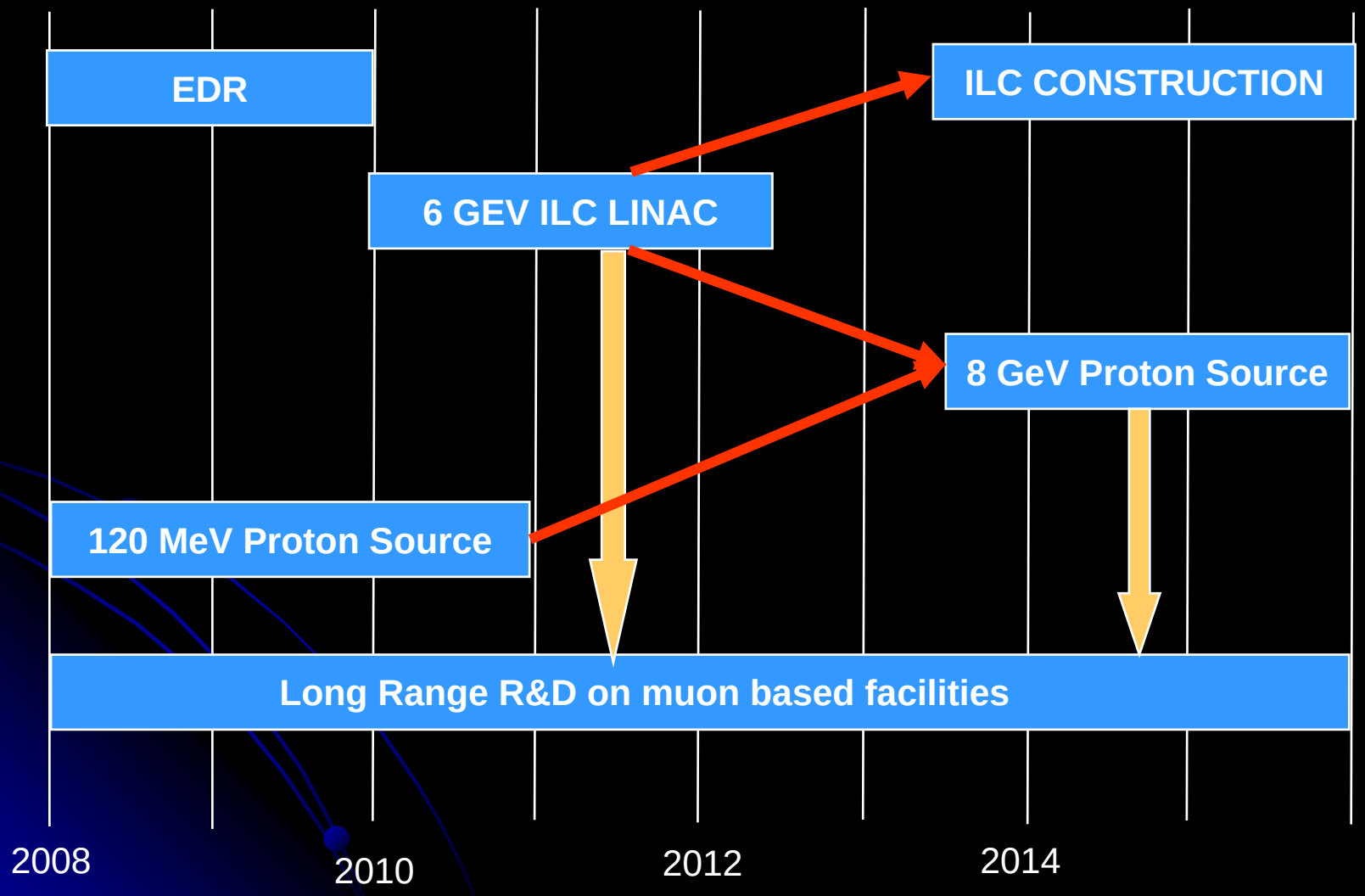

# The way forward

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