ILC Test Beam Efforts

Vishnu Zutshi

NIU/NICADD

Outline

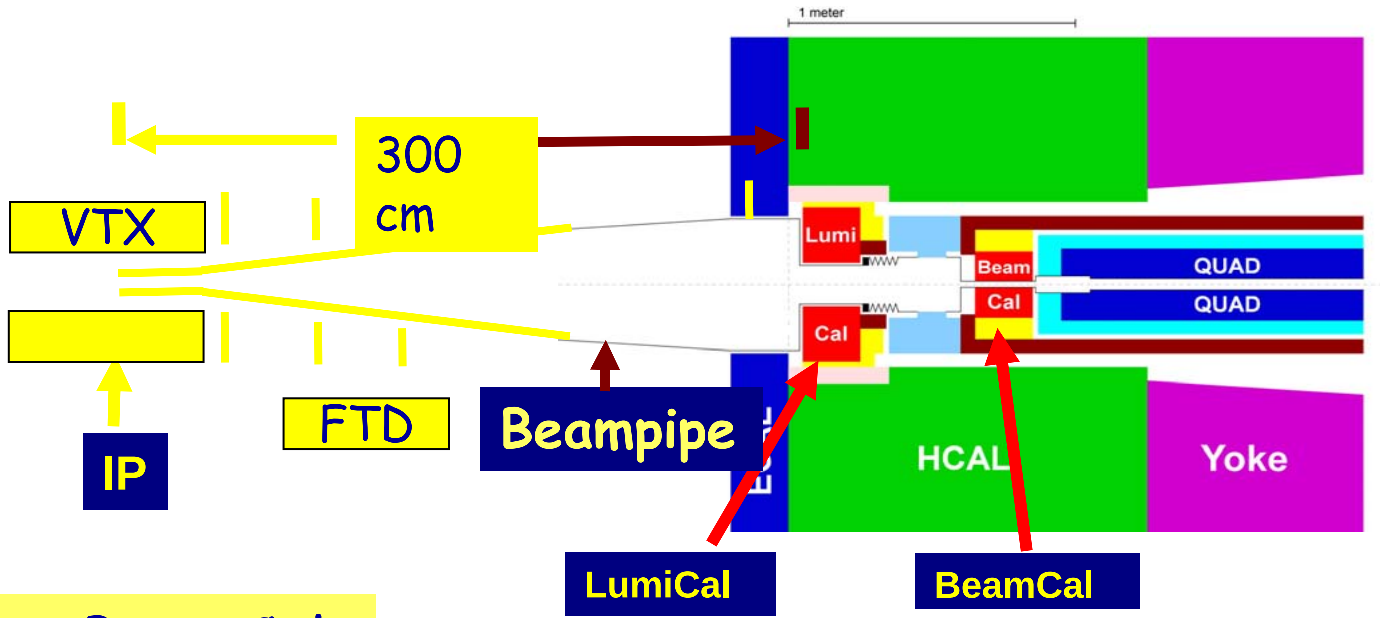
- LEP (luminosity, energy, polarization..)
- LC-TPC
- Calorimetry/Muon
- Fermilab Test Beam Facility

Testbeam plans for LEP instrumentation

Wolfgang Lohmann,
DESY

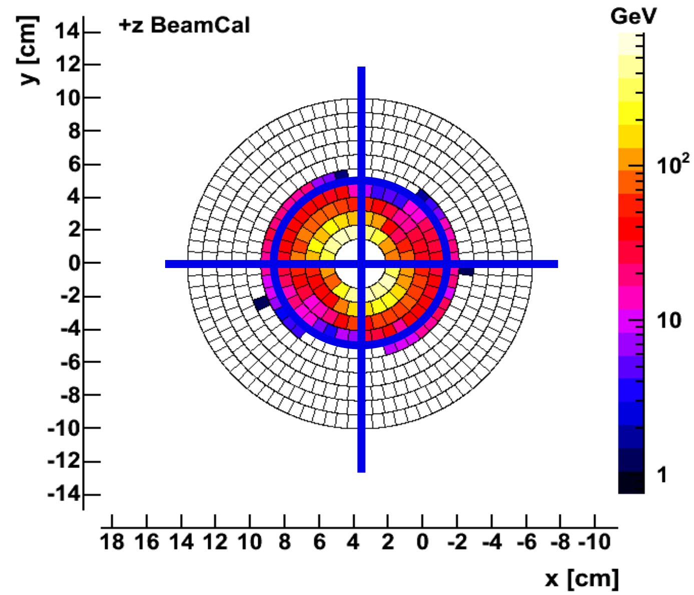
LEP: Luminosity, Energy, Polarisation measurement

Luminosity Measurement: Very forward alorimeters



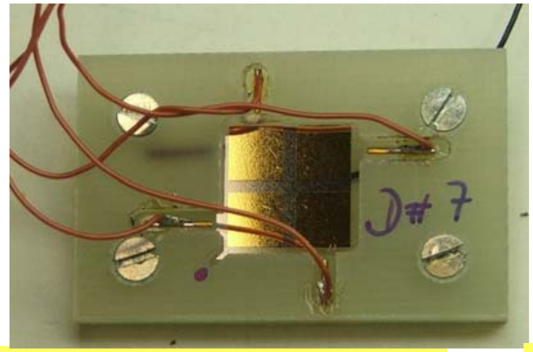
Challenge: BeamCal

- 15000 e^+e^- per BX,
  MeV range, total 10 – 20 TeV
- 10 MGy per year



→ -Radiation hard sensors
-linearity
-compact calorimeters

A sensor prototype;
1 cm2 CVD diamond



Radiation Hardness

Exposure to a ~10 MeV electron beam at DANILAC (TU Darmstadt)

April 2006,
Late 2006

Energy, electron current tunable:
2.5 – 120 MeV, 1 nA – 50 μA

→ O(MGy) per week

JINR Energy few MeV (Microtron)

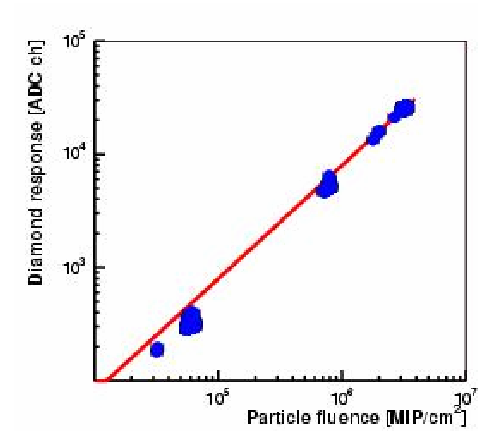
2006/2007

Linearity

CERN PS

Late 2006/2007

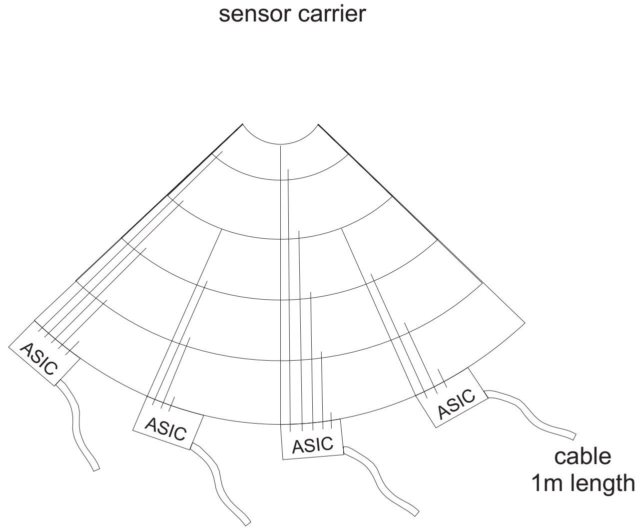
Energy (mixed beam): few GeV
10^3 – 10^6 particles in ~10 ns



Repeat and refine previous measurements (better flux calibration)

Compactness

Thin instrumented sensor plane prototypes



DESY

Late 2006/ 2007/2008

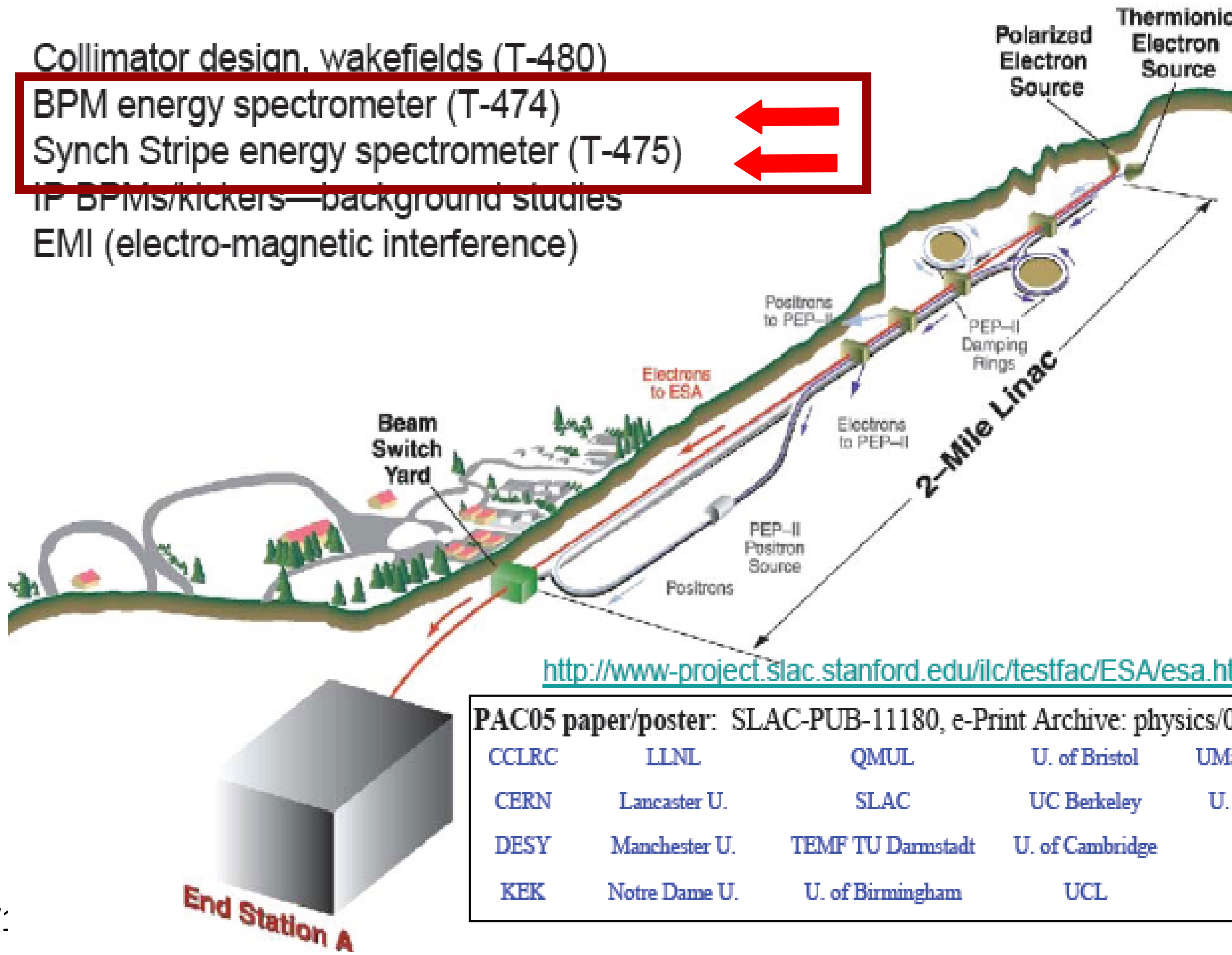
Few GeV electrons,
EUDET infrastructure

Goal: Test of assembled sensor planes, measurement of the performance …

Prepare the assembly of a prototype

ESA Testbeam Program

- Collimator design, wakefields (T-480)
- BPM energy spectrometer (T-474)
- Synch Stripe energy spectrometer (T-475)
- IP BPMs/kickers—background studies
- EMI (electro-magnetic interference)

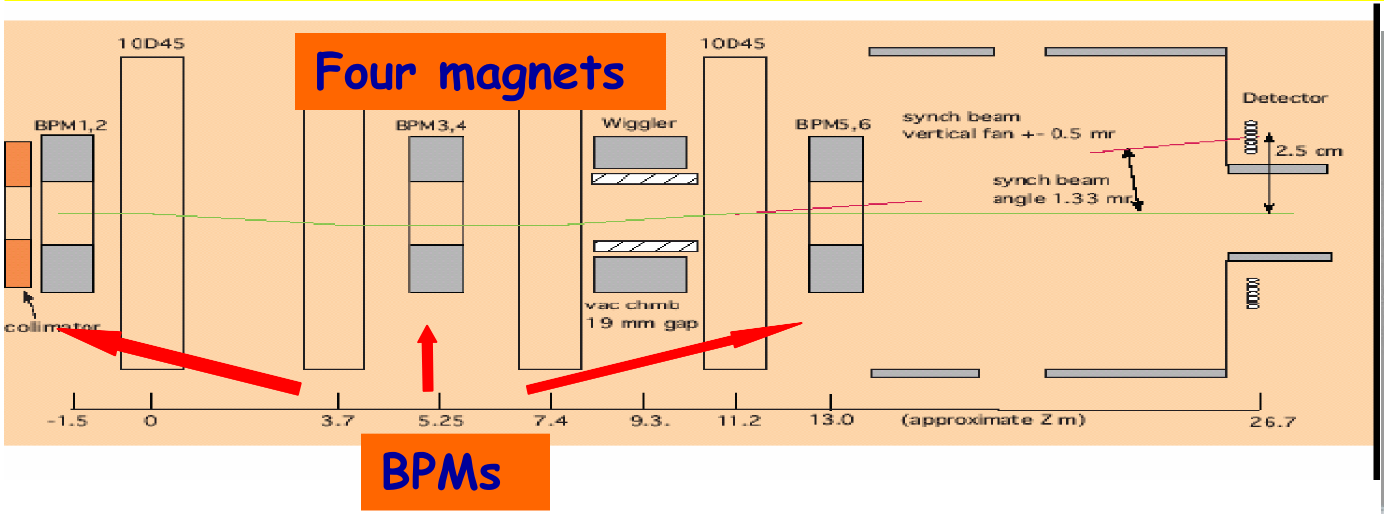


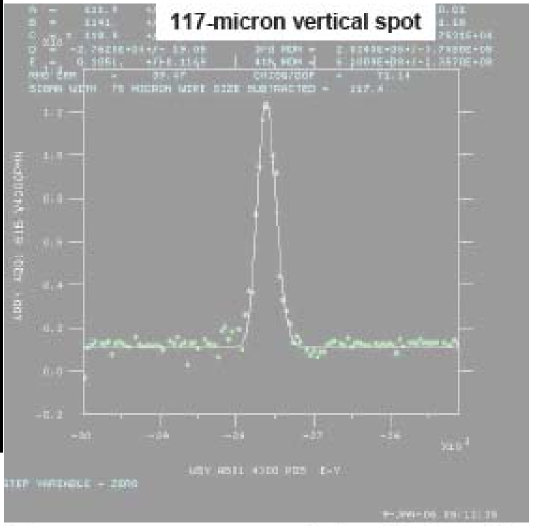
http://www-project.slac.stanford.edu/ilc/testfac/ESA/esa.html

PAC05 paper/poster: SLAC-PUB-11180, e-Print Archive: physics/0505171

CCLRC	LLNL	QMUL	U. of Bristol	UMass Amherst
CERN	Lancaster U.	SLAC	UC Berkeley	U. of Oregon
DESY	Manchester U.	TEMF TU Darmstadt	U. of Cambridge	
KEK	Notre Dame U.	U. of Birmingham	UCL	

Energy Measurement: BPM energy spectrometer





Wire scanner measurement of vertical spotsize

Beam Energy mapped to y position on detector plane
Order 1 GeV/mm sampled at 100 μm pitch

Use quartz fibers: low efficiency, but rad hard and some background tolerance. Large dynamic range with MAPMTs. 64 channels/PMT.

Commissioning run in Jan., very successful; prepared for data taking in march 2006

Goal: Proof of principle of the beam momentum control at 10^{-4} accuracy

ESA Testbeam Program

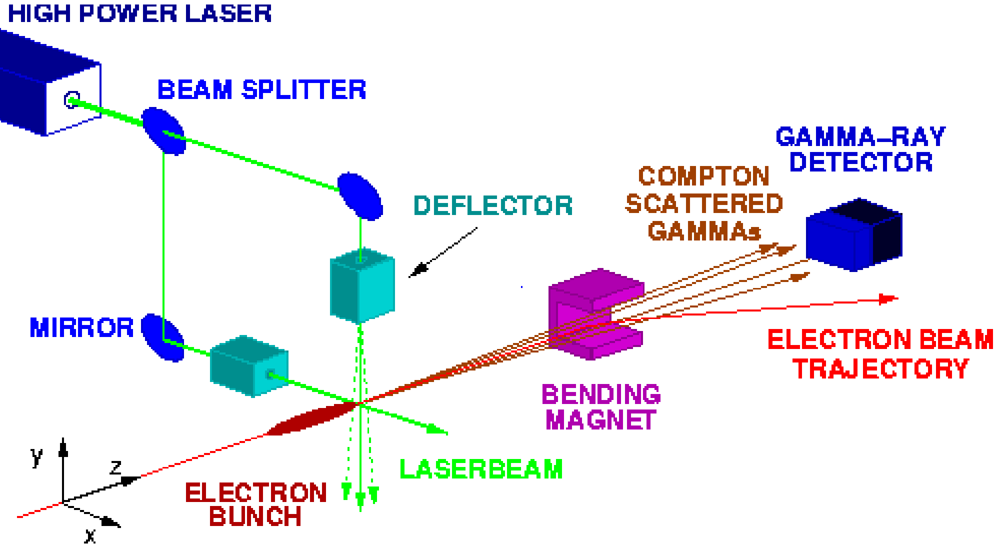
Future of SLAC testbeams:

-primary beam
 available up to 2008 (end of PEP-II era)
 later (LCLS era) under discussion;
 14 GeV (LCLS), up to 50 GeV
 but: ESA needs a new PPS system

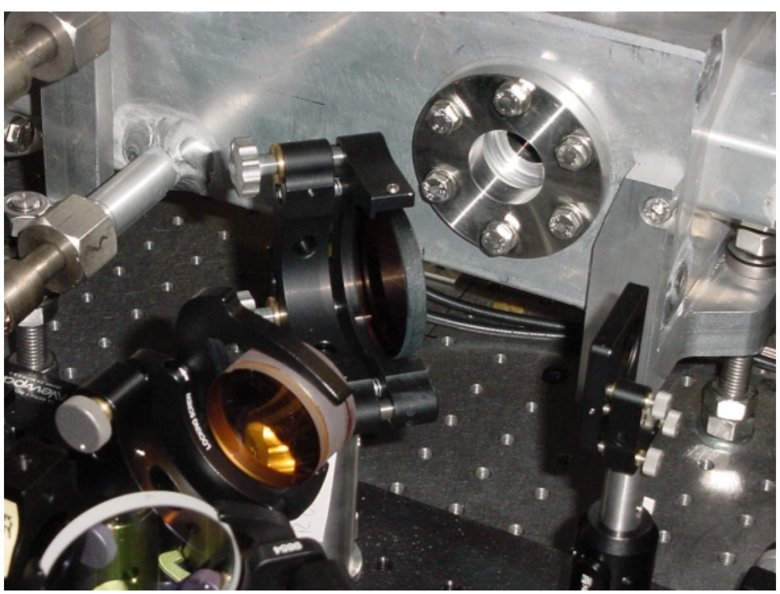
-secondary beams (e,g, pi, p), 1 – 25 GeV, 10 Hz) might be available

Beam Diagnostics with a Laserwire

Determination of the transverse profile of bunches with a Laserwire



Test set-up at PETRA (DESY)



Zutsh

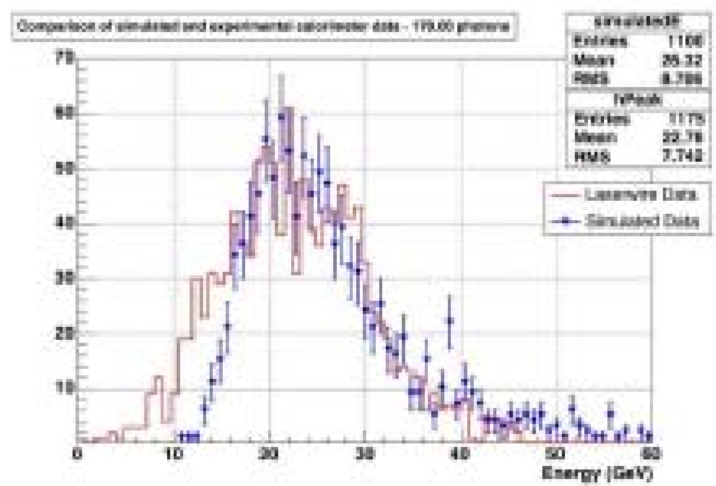
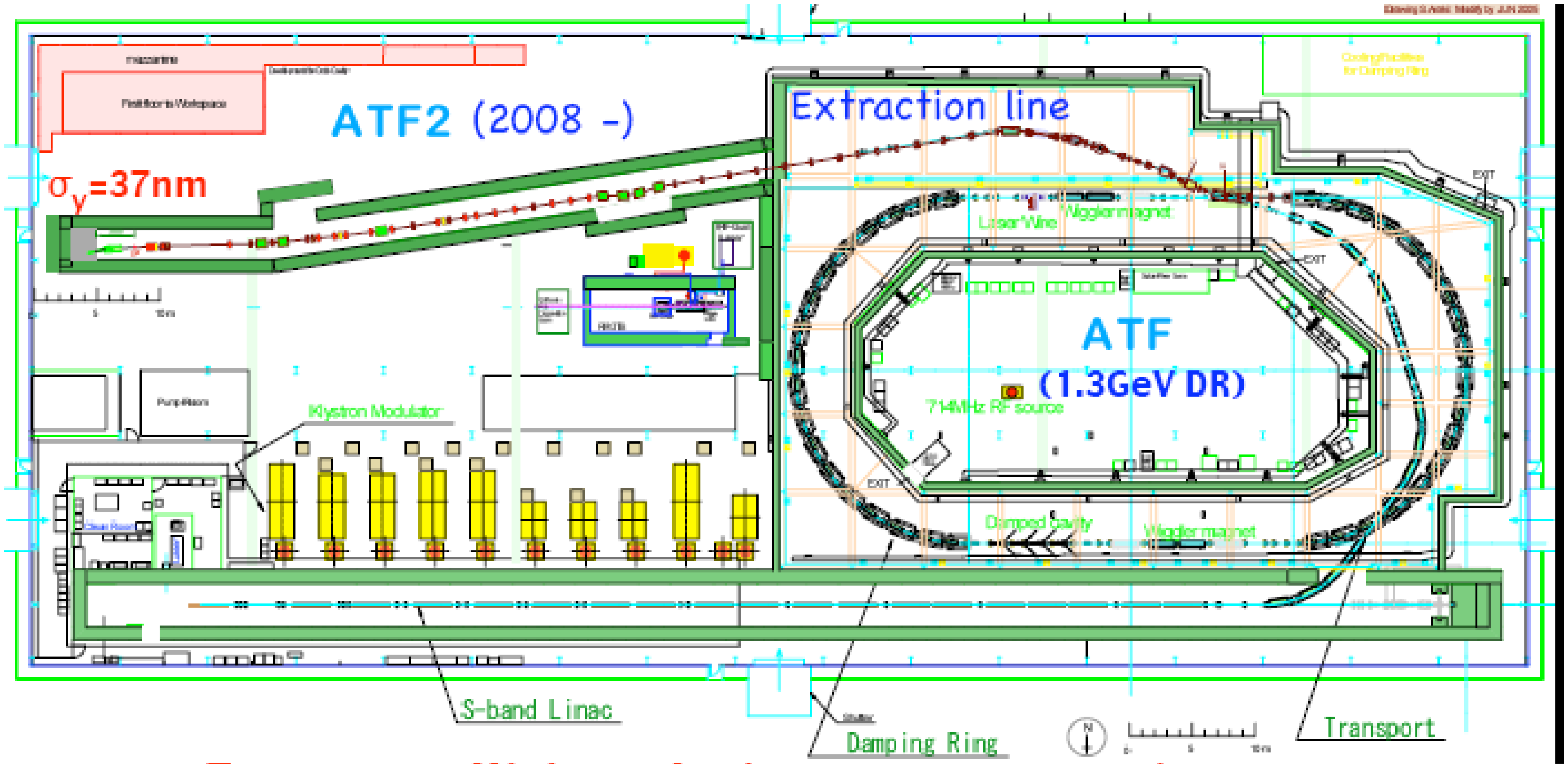


Figure 4: Calorimeter energy spectra for data and simulated events.

Beam Diagnostics with a Laserwire

2-dim scans	PETRAII	2006/2007
Laser wire calorimeter	DESYII ATF	2006 2006-2008
Emittance measurement with laser wire	ATF2	planned
Upgrade of the PETRA system	PETRAIII	2008

ATF Testbeam at KEK

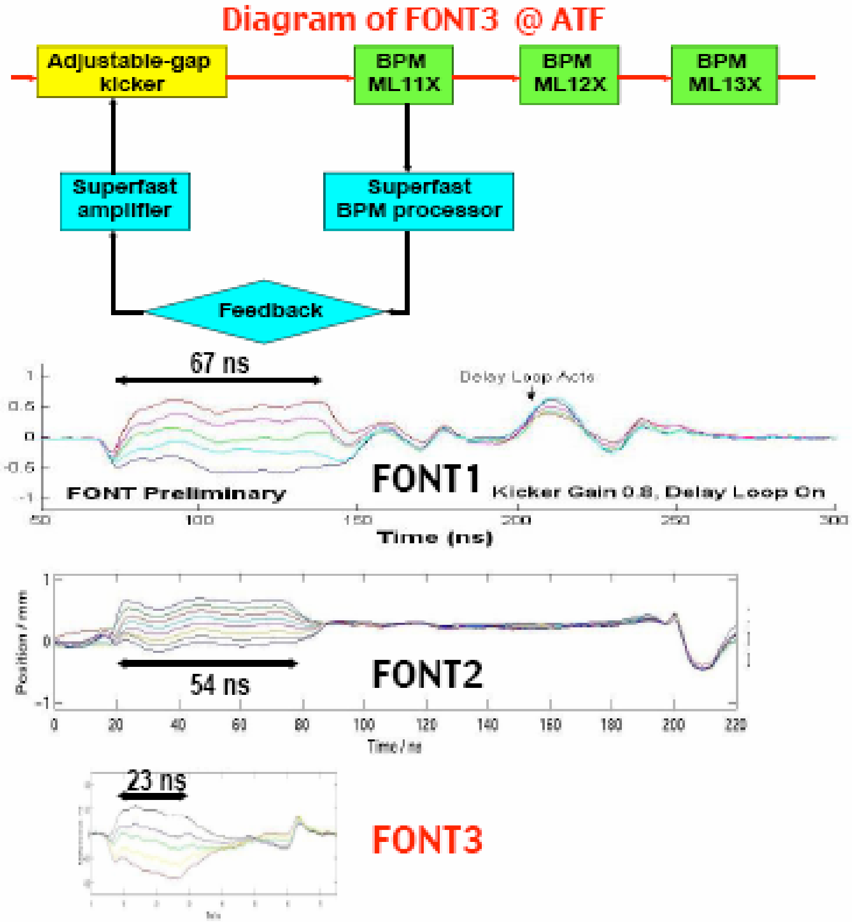


Goal: Ensure controlled collisions of nm beams!

ATF	1.3 GeV e-	beam size few μm	
ATF II	"	37nm	(2008)

ATF Testbeam at KEK

Intra-train Beam Feedback at ATF-EXT



FONT
(Feedback On Nanosecond Timescales)

- Queen Mary Univ.
- Daresbury Lab.
- Oxford Univ.
- SLAC
- KEK

FONT1/2 (2002-2004) … NLCTA
latency 54 ns 65MeV, 170ns, (87ps bs)

FONT3 (2004-2005) … ATF
latency 23 ns

FONT4 (2005-2006) … ATF

- Digital FB system
- Latency 100 ns

Vital component of ATF2 beam stabilisation systems

- Continuation of the nano-BPM research

EUDET testbeam infrastructure for TPC R&D studies

Katsumasa Ikematsu (DESY)

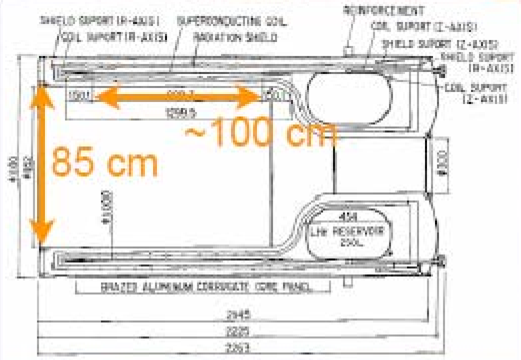
The 2006 International Linear Collider Workshop (LCWS06)
March 12, 2006 @Indian Institute of Science, Bangalore, India

- The EUDET TPC facility aims to provide an infrastructure to proceed TPC R&D studies for the ILC
  - Non-associated institutes are invited to contribute to the development of the infrastructure and to exploit it

- EUDET activities for the large TPC prototype studies
  - Development & building of a low mass field cage
  - Modular endplate system for large surface GEM & MicroMEGAS system
  - Prototyping of a compact new readout electronics for GEM & MicroMEGAS
  - HV and slow controls facility

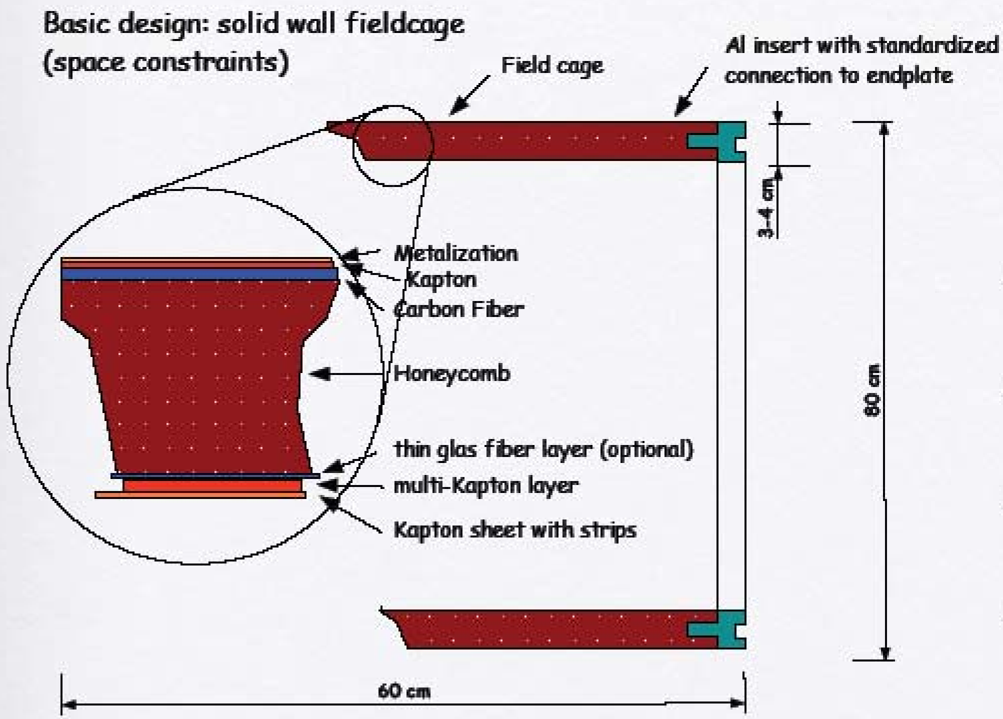
Superconducting magnet (PCMAG)

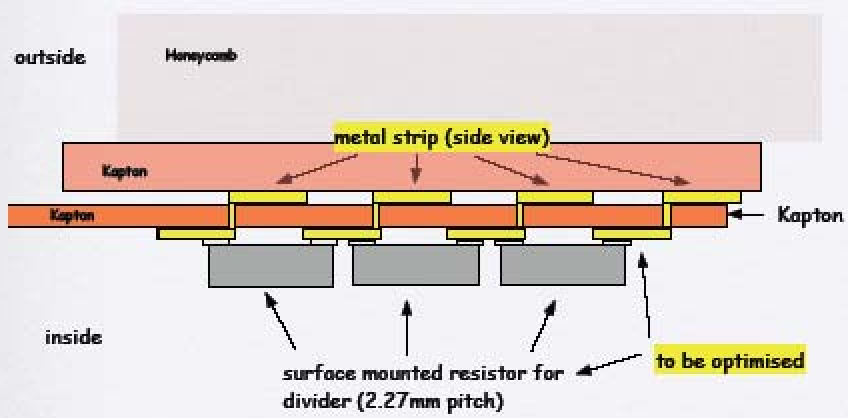
- B_{max} = 1.2 T, Ø = 85 cm, L_{eff} ~ 100 cm
- Provided from KEK for EUDET
- Originally developed for a balloon experiment in antarctica
  - Standalone operation (Persistent current mode, 250L LHe reservoir = refilling once a week)
  - Small material @half wall (0.13/0.19 X_0 for Coil/Coil+Cryostat) -> low multiple scattering
  - Light weight, No return yoke (~ 500 kg)
    - Movable -> Hadron beam @CERN or FNAL
    - Large stray field
- 2 year operation experience for small prototype TPC beam test @KEK 12GeV PS
  - Among Japan-Philippines-German-France-Canada TPC R&D groups
- Field homogeneity
  - Planning to 2D calculation & 3D field mapping



Katsumasa Ikematsu (DESY) / LCWS06

Field cage design





- layered construction, light weight, composite structure with honeycomb core, carbon fibre layer on the outside, possibly thin glas fibre on the inside
- Kapton foils for insulation on the inside
- field strips with pitch 2.7 mm (Cu strips)
- second row of field strips shifted by 1/2 period for shielding purposes
- resistive divider mounted on the inside of the field cage, inside the gas volume, from surface mount resistors
- 4 divider chains for redundancy and reduced heat load
- approx thickness of field cage wall: 3-4 cm
- thin Al layer on the outside as ground shield

Slow control system

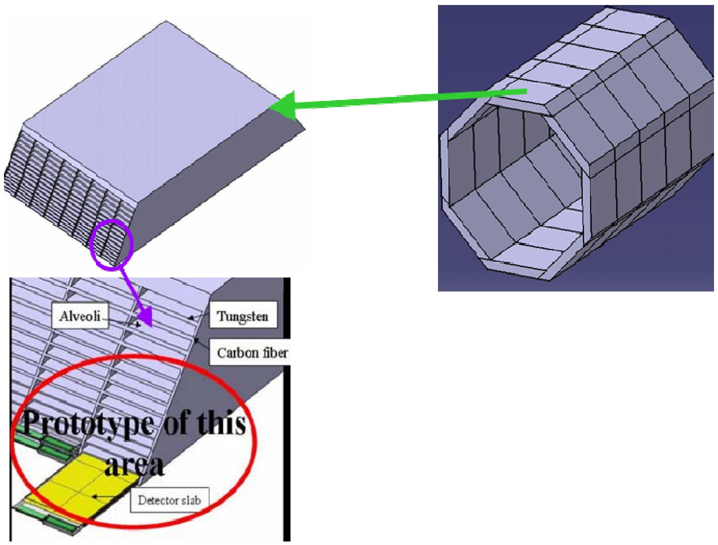
- Slow control parameters for TPC
  1. Gas parameters (p, gas flow, O_2, H_2O)
  2. Environmental conditions (p, T, humidity etc.)
  3. Electrical conditions (HV for drift field & GEMs)
  4. (Magnetic field)
- 1. & 2. installed in a rack
  - Use industrial standard for read out
- 3. & 4. controlled separately (for the moment)

Test Beam: Calorimetry/Muon

Vishnu V. Zutshi

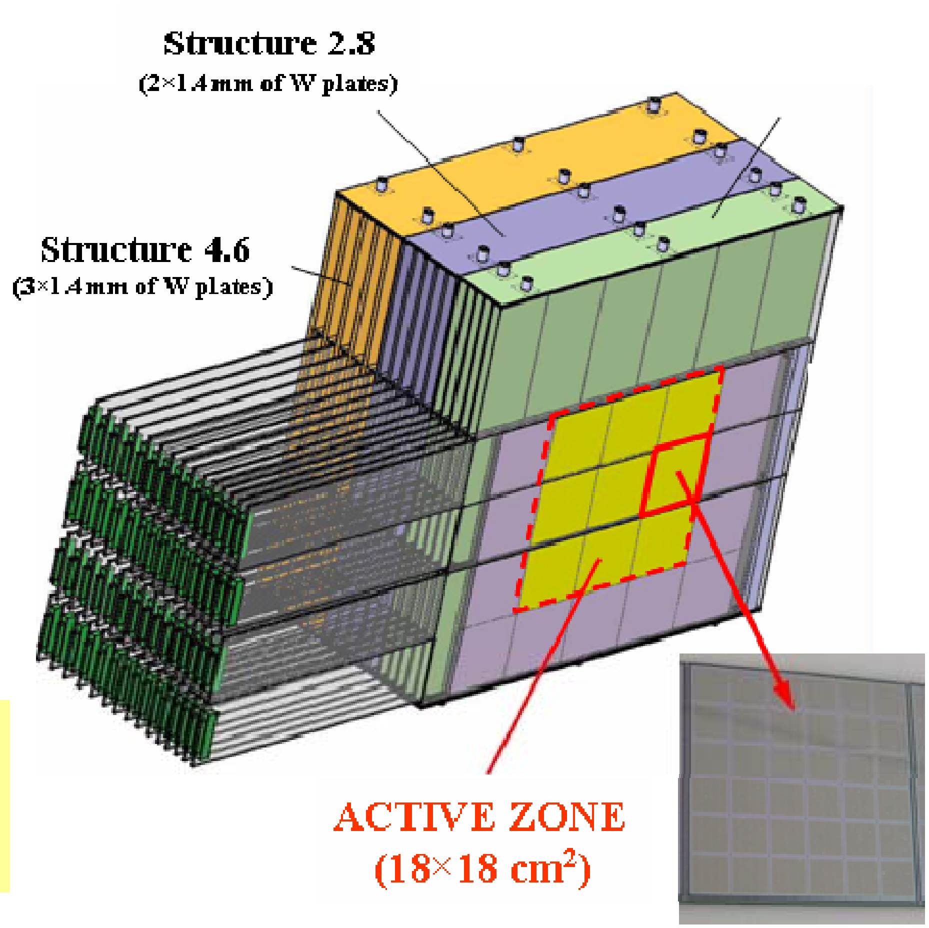
NIU/NICADD

CALICE Si-W ECAL

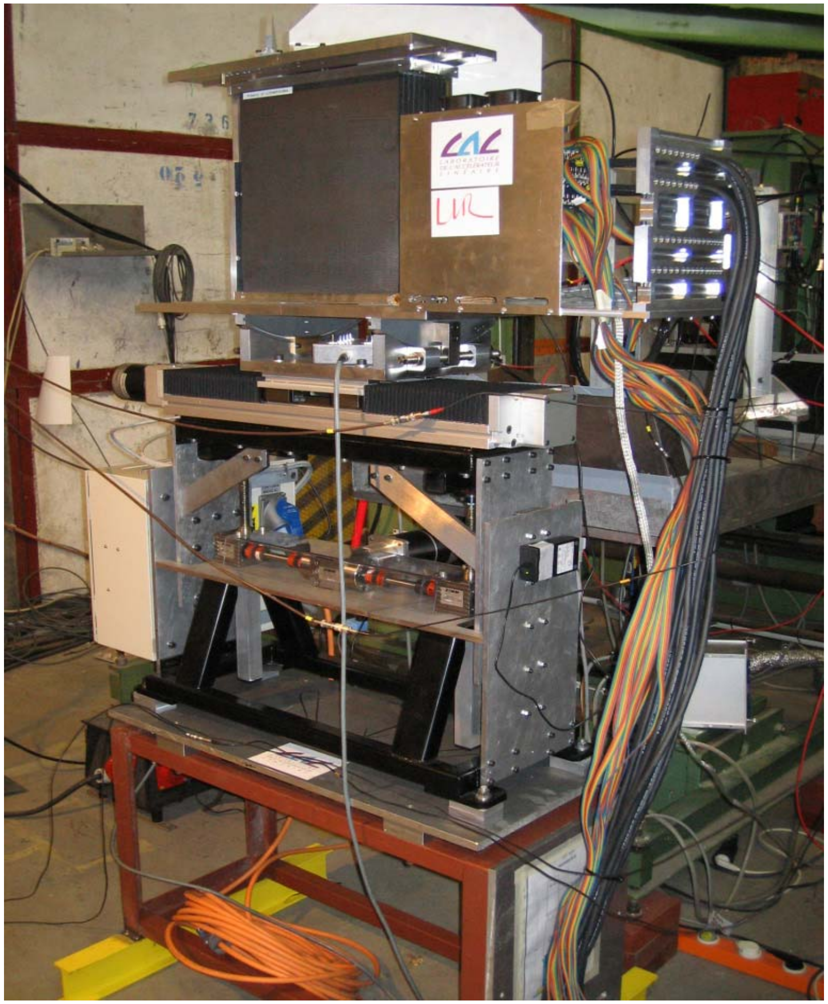


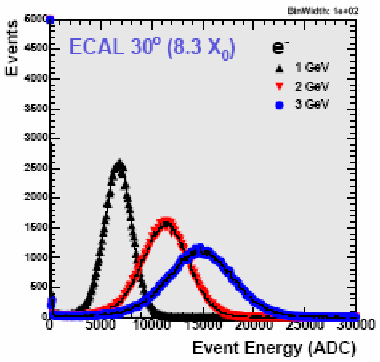
30 layer prototype
3 independent W-CFi structures
(1.4, 2.8 and 4.6mm W plates)
Detectors can be slid in the gaps

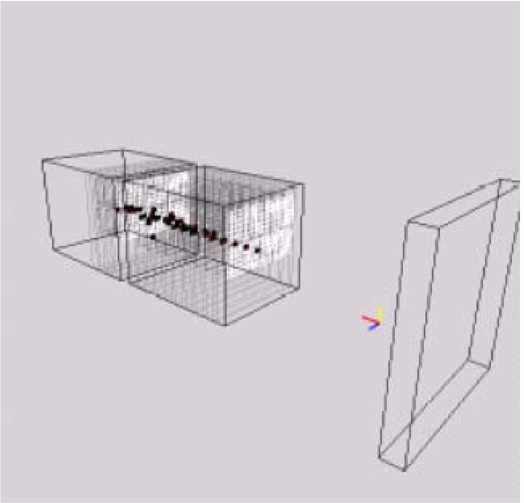
Active area: 3x3 wafers
Each wafer has 36 1cm x 1cm pads
Total channel count ~10k



CALICE Si-W ECAL



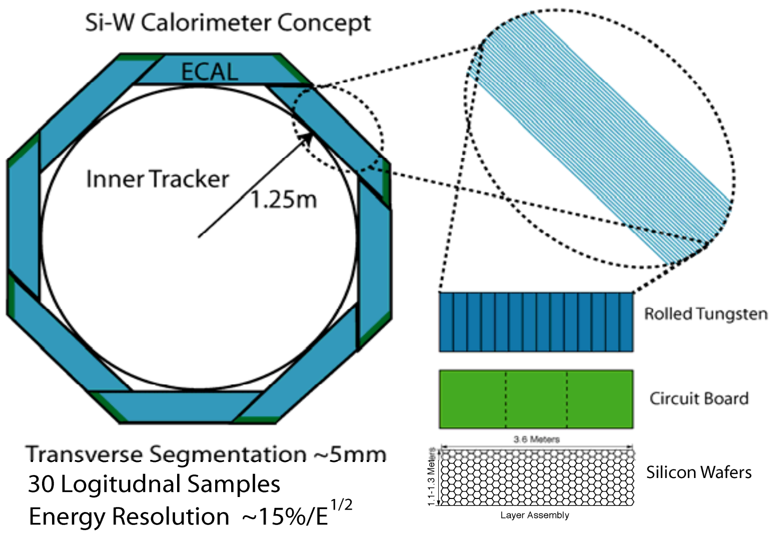


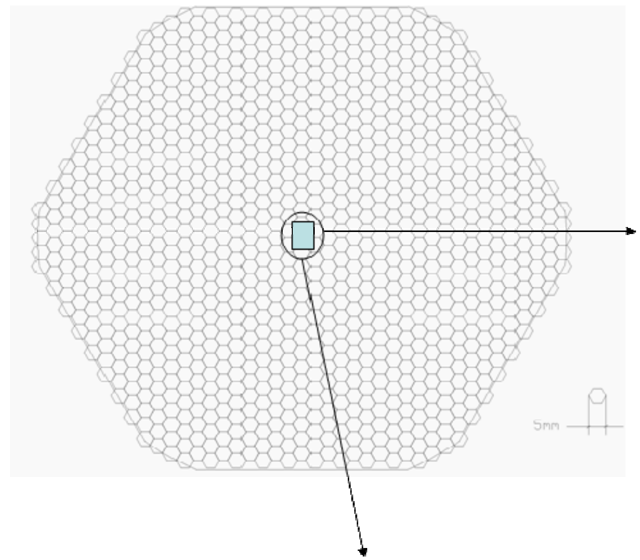


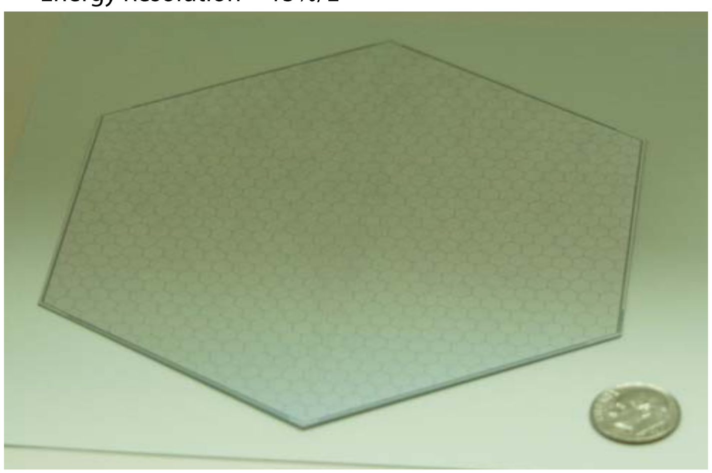
Test in Feb. 2005 at DESY
14 layers (~ 3k channels)
20x10^6 events collected

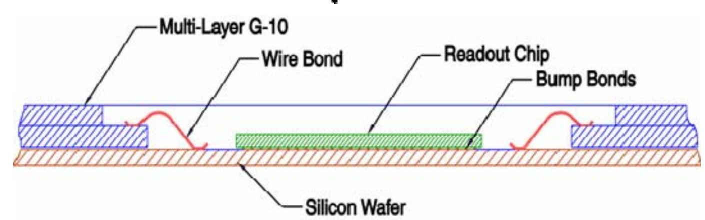
Longer run with full(er) detector in 2006 at CERN

Si-W ECal (SOB)



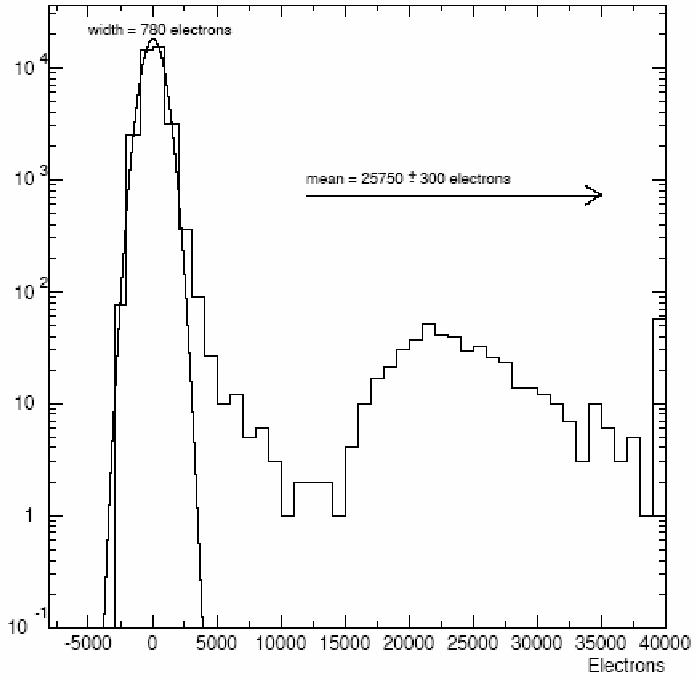




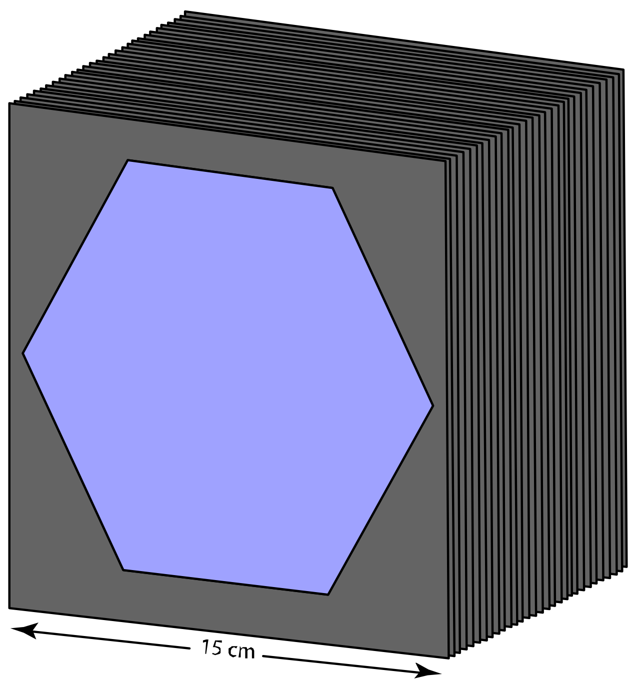


1 chip/wafer
Chip bump-bonded to wafer

Si-W ECAL (SOB)

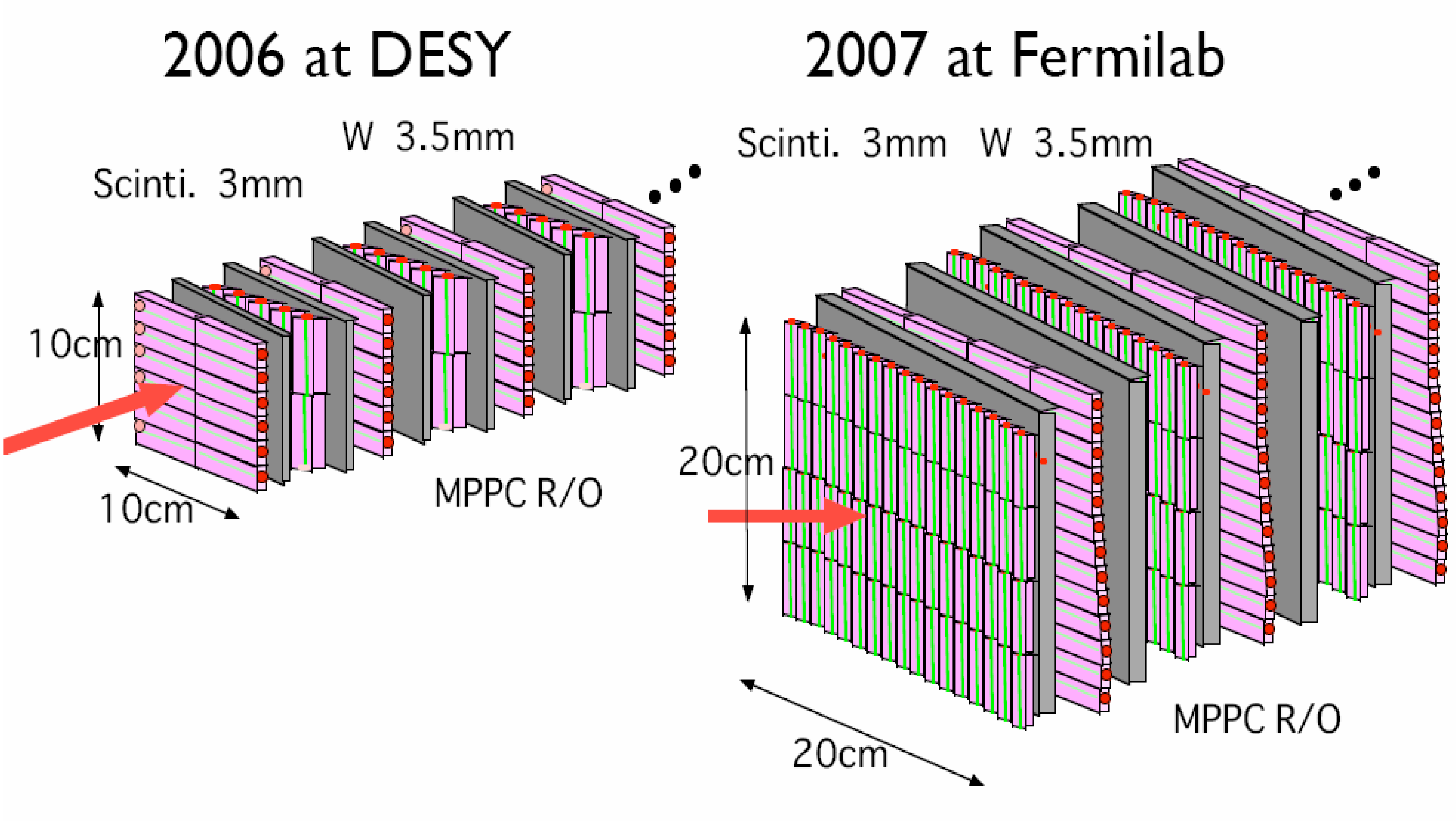


1 wafer/layer (750 pixels)
30 layers
2.5 and 5 mm Tungsten plates



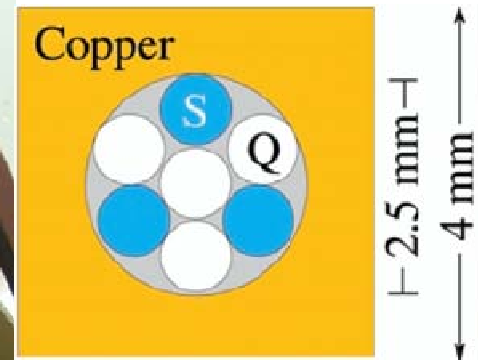
64-channel chip bump bonding
1K ch. prototyping funding dependent
One layer beam test in 2006
Full assembly in 2007 (?)

GLD Scint-W ECAL



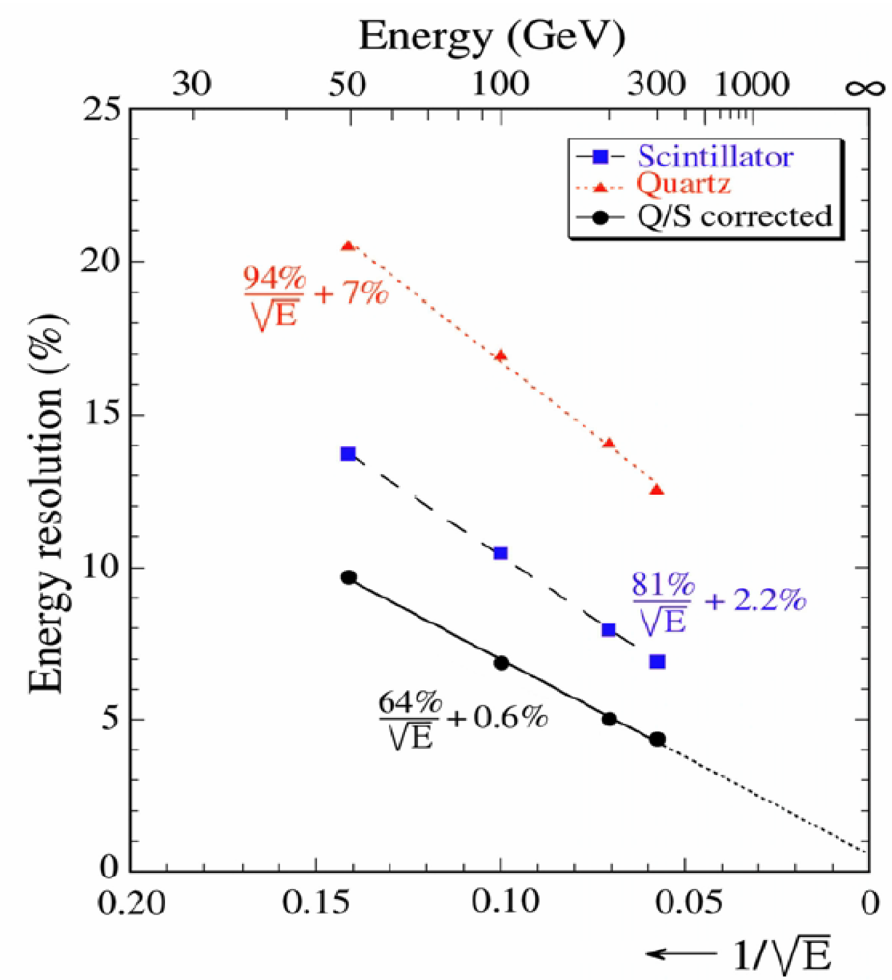
DREAM

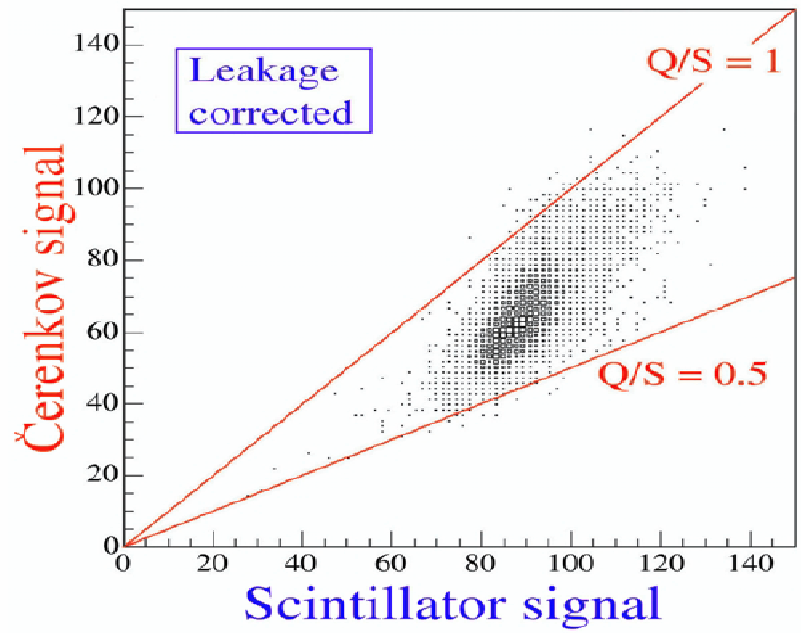
Measure the EM content
event by event



Copper absorber structure
Scintillating (dE/dX) and
Quartz fiber (Cerenkov)

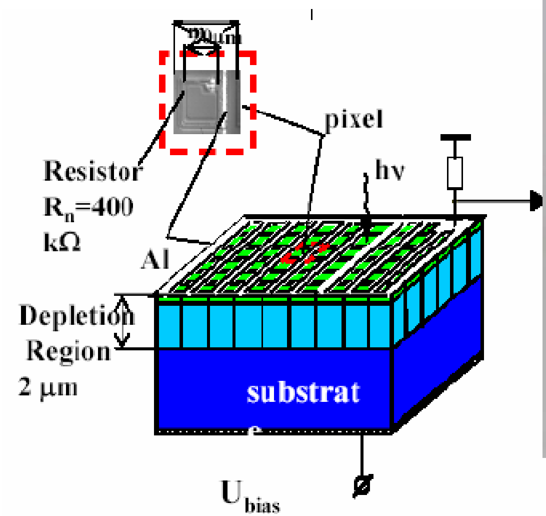
DREAM

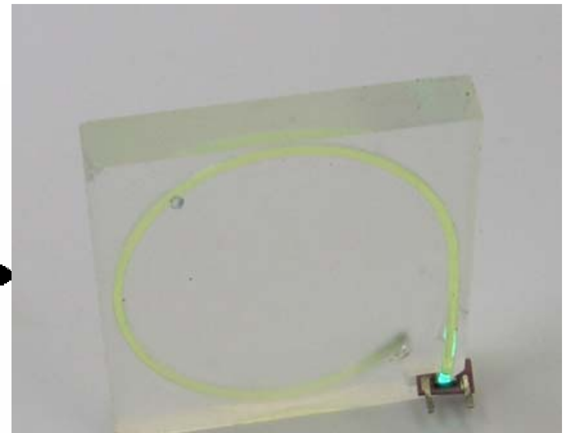


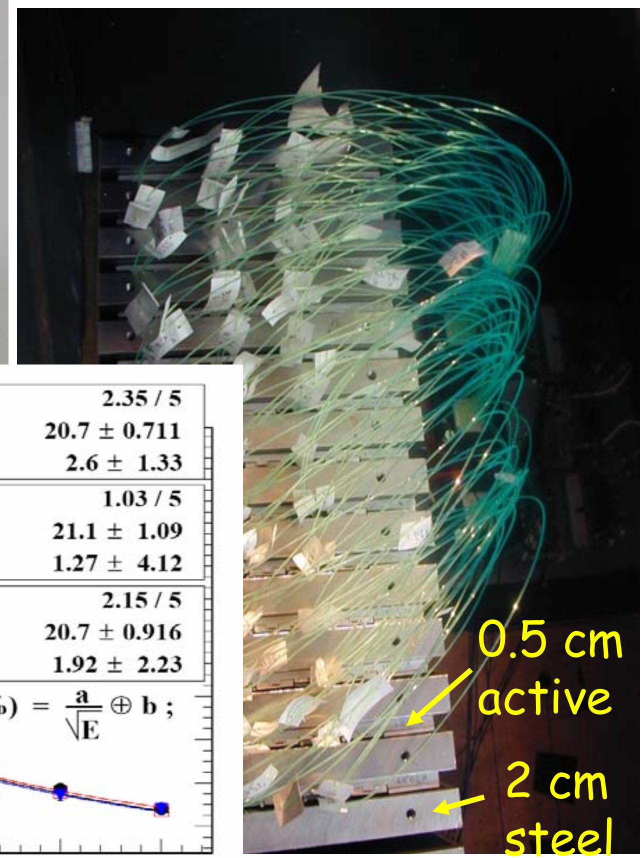


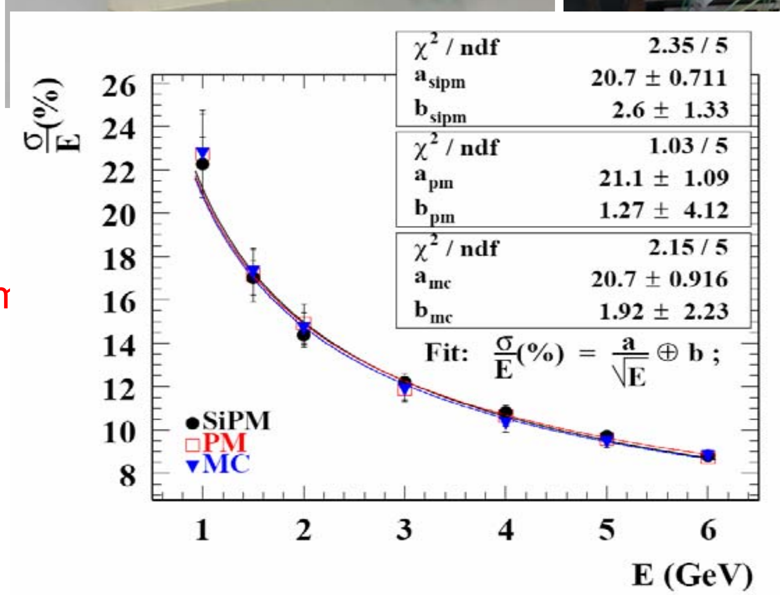
Investigate designs suitable for an ILC detector
Introduce non-hydrogenous Sci-Fi
2006-07 test beam timescale

CALICE Scint. HCal



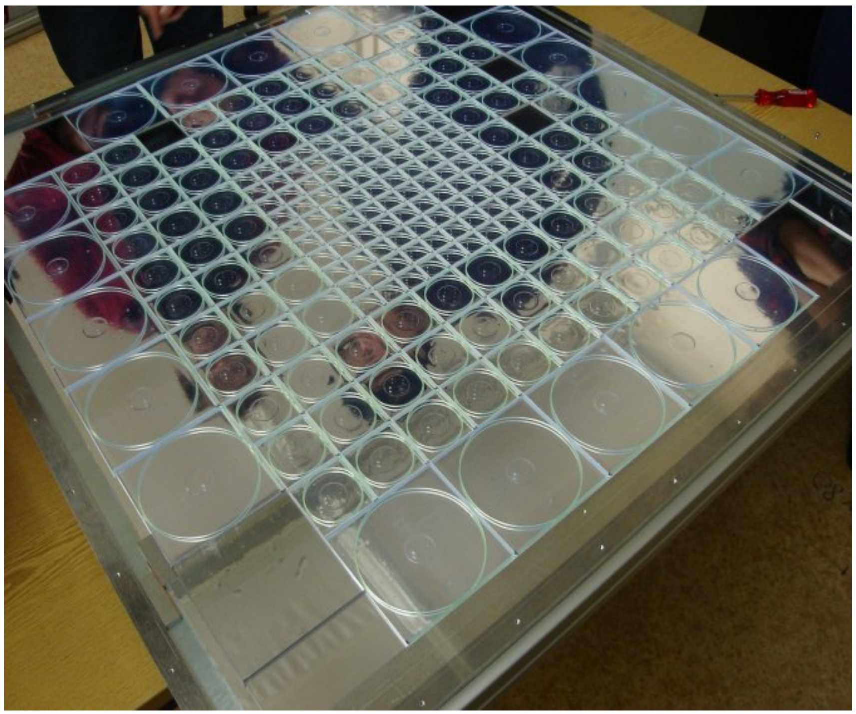


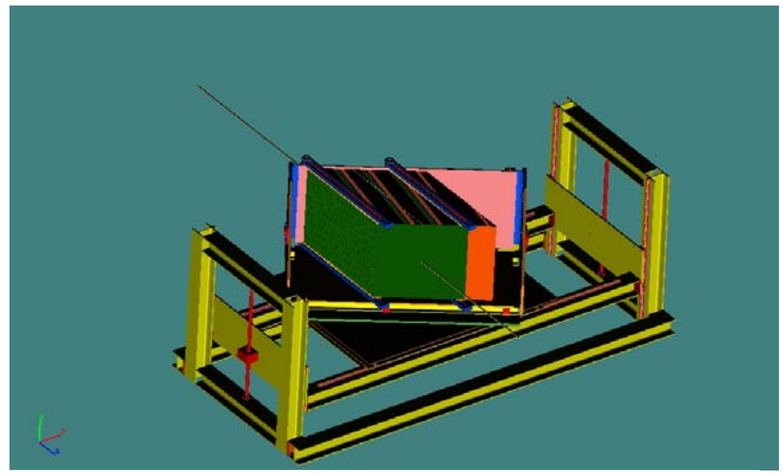


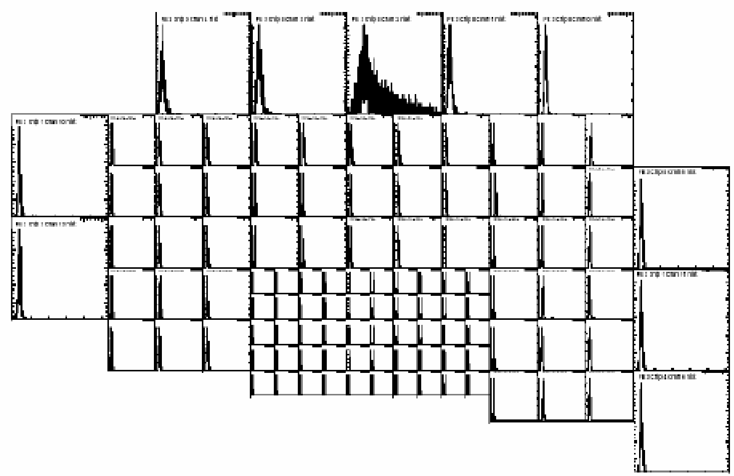


~1000 pixels on 1mm x 1mm
Bias voltage ~ 50-60V
Gain ~ 10^6
Quantum x geom ~ 12-15%

CALICE Scint. HCAL



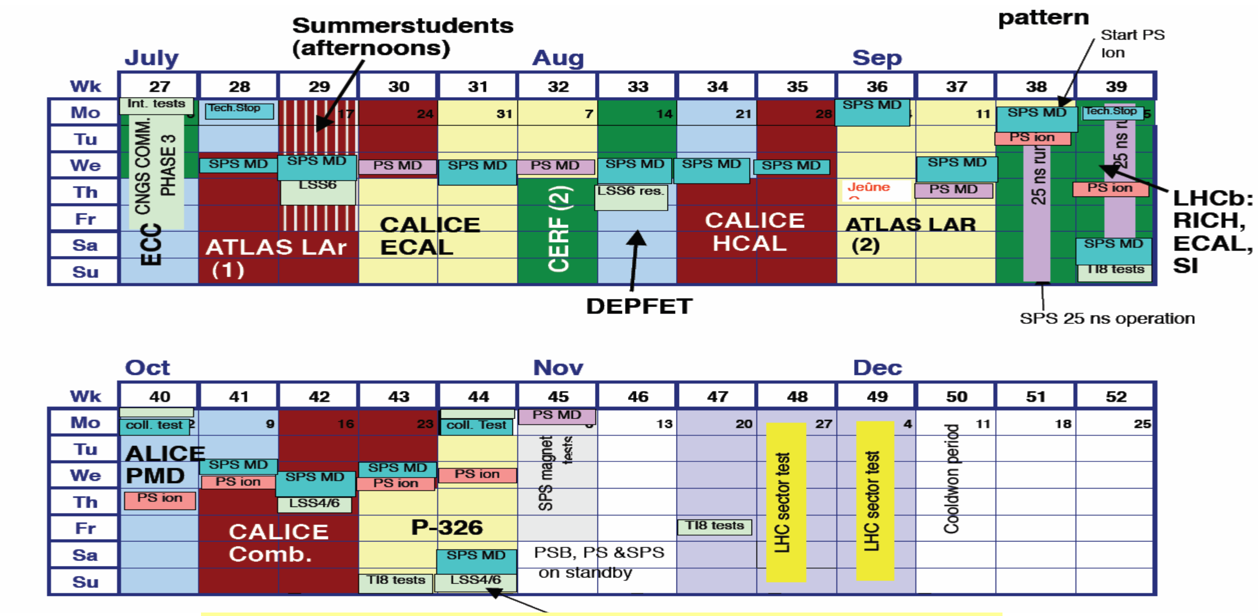




In the construction and assembly phase
Ongoing commissioning with beam
Will see beam at CERN in 2006

CALICE @ CERN

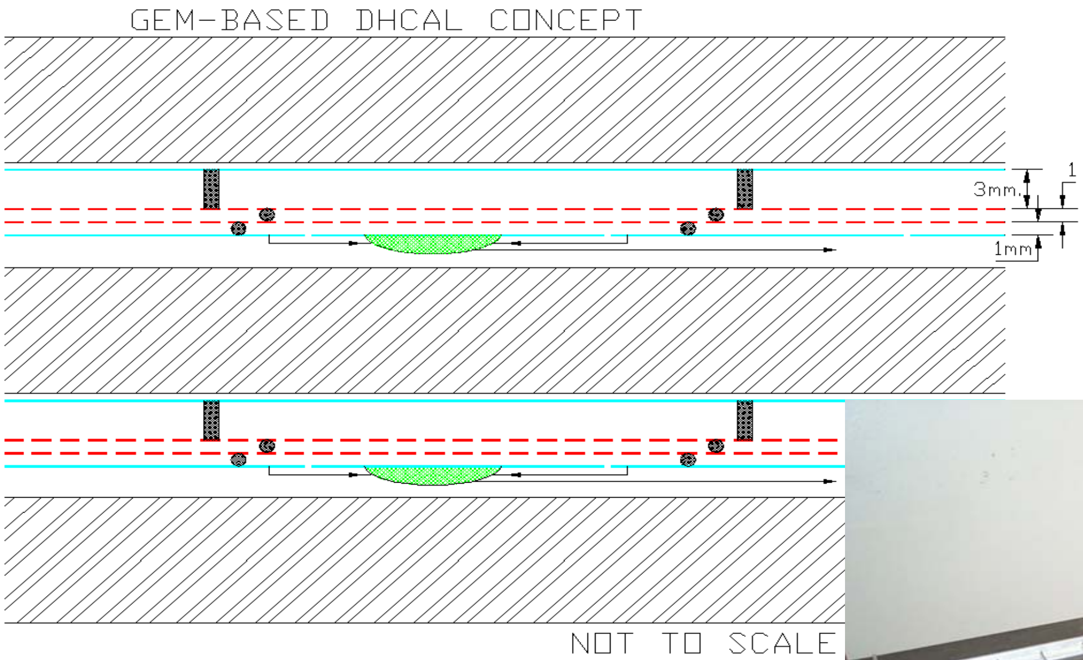
DRAFT



Total of 5.5 wks (request was 8)
'ECAL Running' July-Aug (2 wks)
'HCAL Running' Aug-Sept (1.5 wks)
'Combined' Oct. (2 wks)
Parasitic running not included

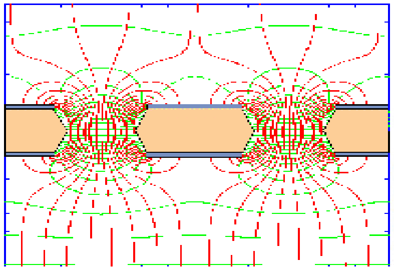
Setup is expected to move to Fermilab in 2007

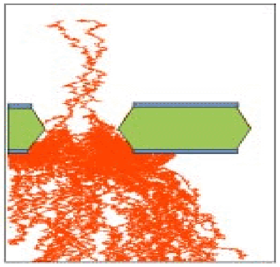
CALICE GEM HCal

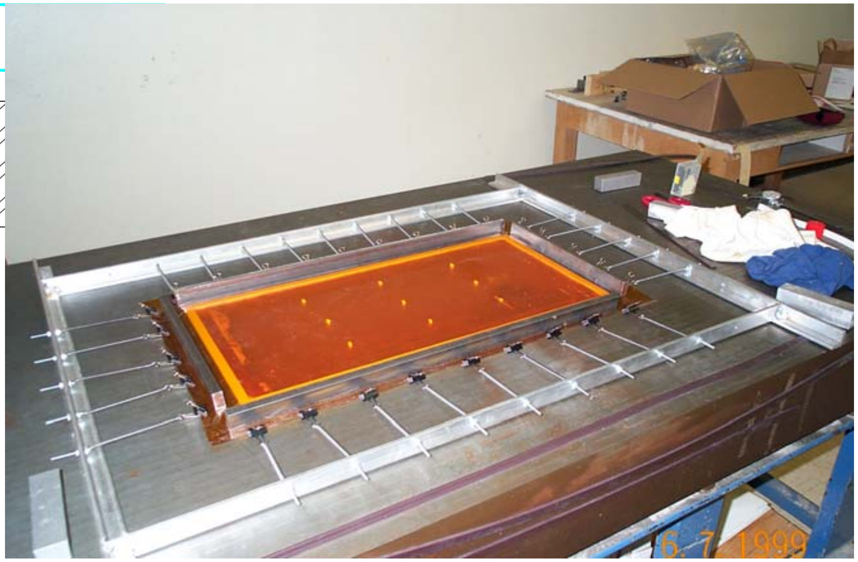


Ar/CO_2 gas mixture

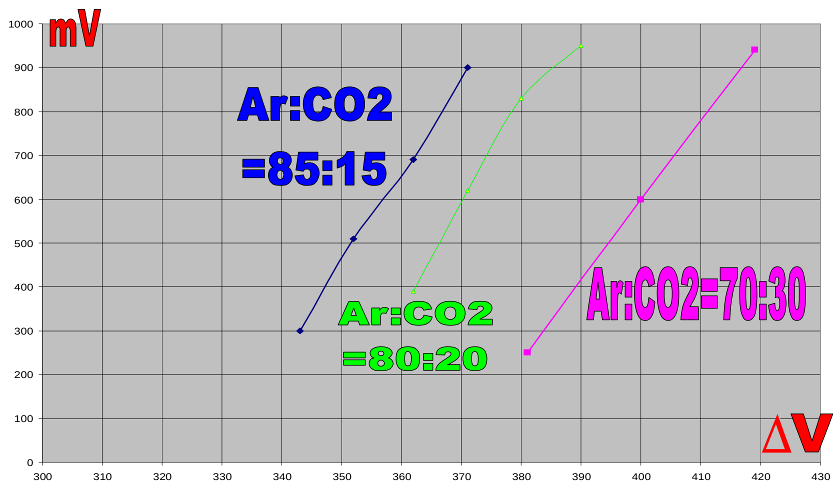
1cm x 1cm pads
1-bit readout



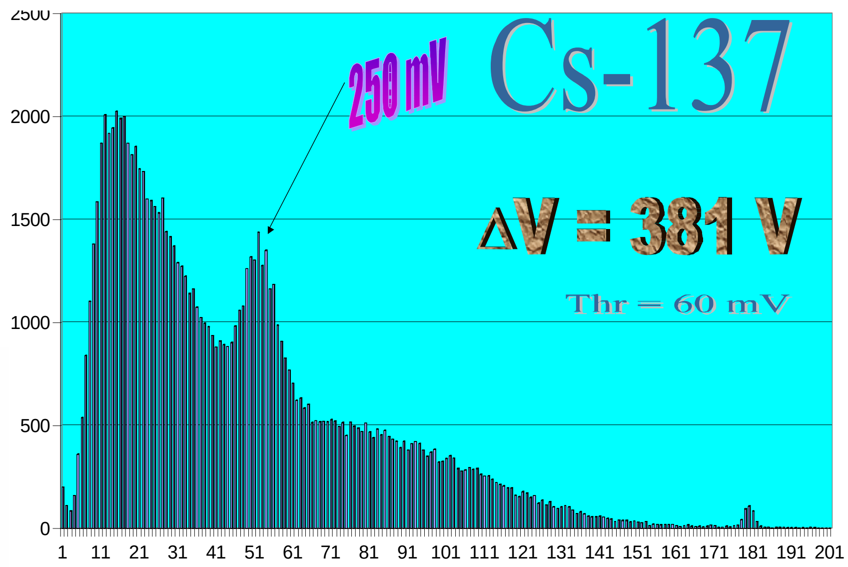


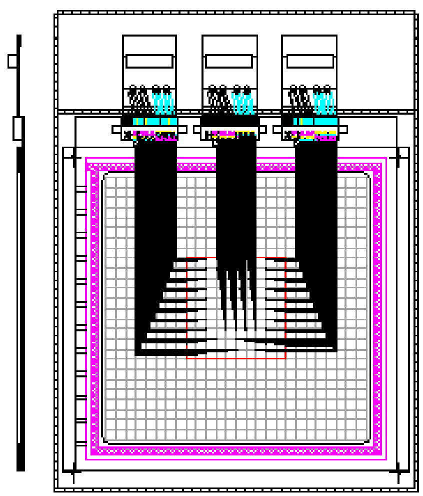


CALICE GEM HCAL



Signal size, cross-talk, efficiency studies with prototype detector



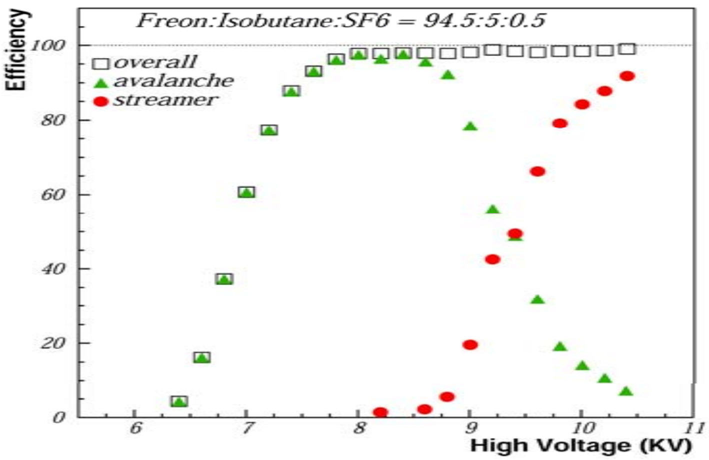


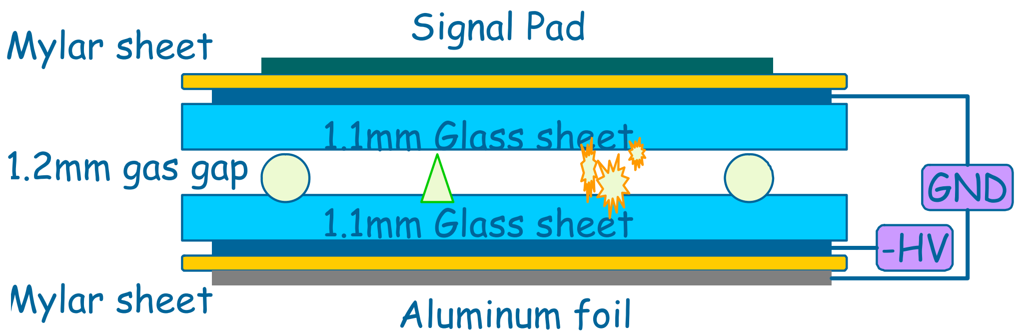
Exposure of 30cm x 30cm GEM foil to low E electron beam in Korea

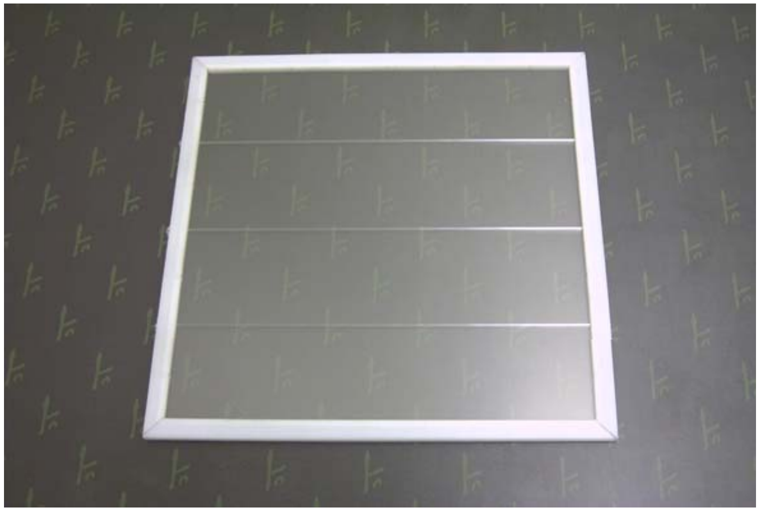
Completion of $1m^3$ prototype in 2007

CALICE RPC HCal

10 RPC's built for studying no. of gaps, resistivity, chamber configuration and size







40 layers
1cm x 1cm pads
64 channel custom ASIC
(1-bit readout)
Also used for GEM HCAL

Slice test in 2006
Full prototype constructed in 2007

CALICE RPC HCAL

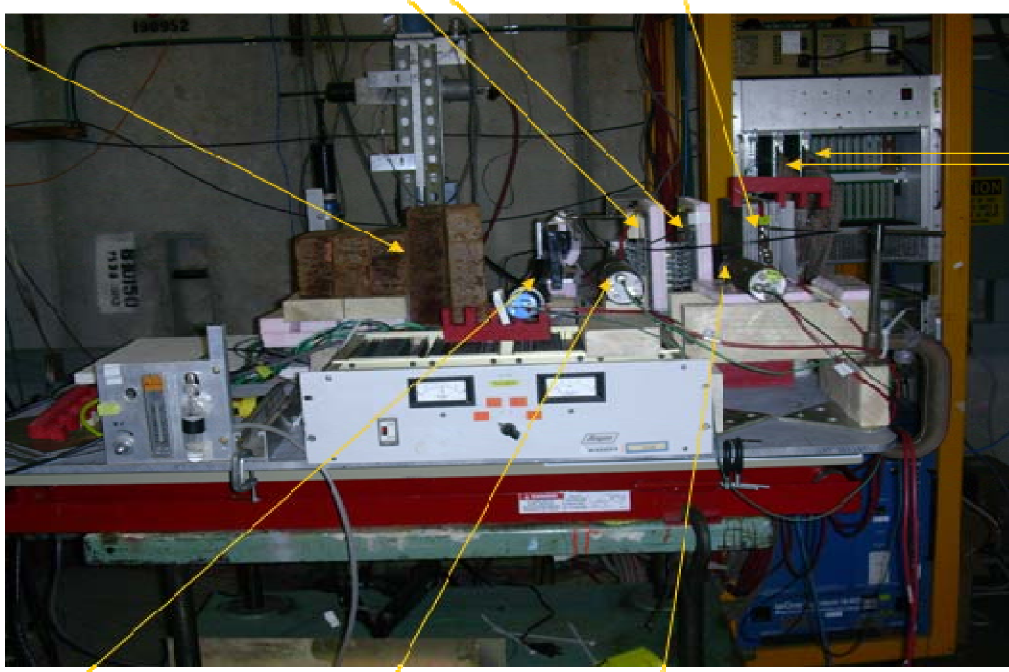
Iron blocks
(not used in most of our measurements)

RPC 1 & 2
8x8 digital readout

RPC 3
4x8 shift-register readout

Beam direction

tail catcher



VME readout board 1 & 2

For RPC 1 & 2

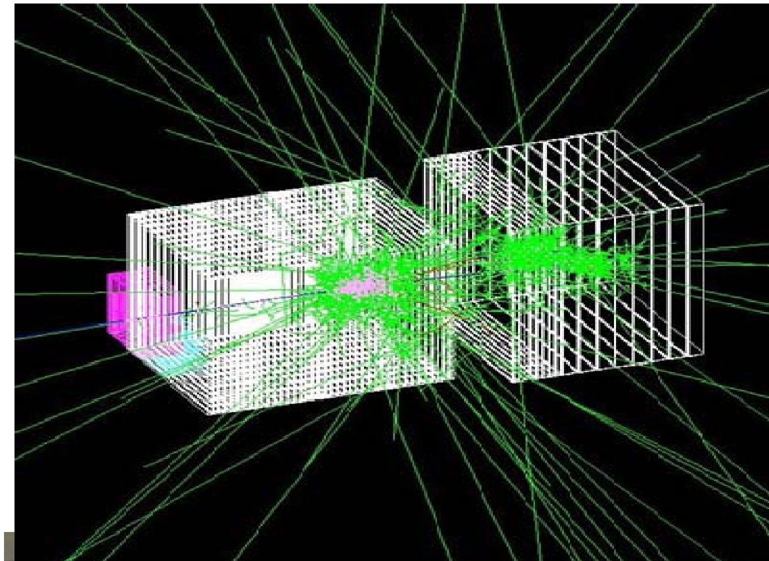
Counters 1 & 2
~5x5 cm^2 overlapping

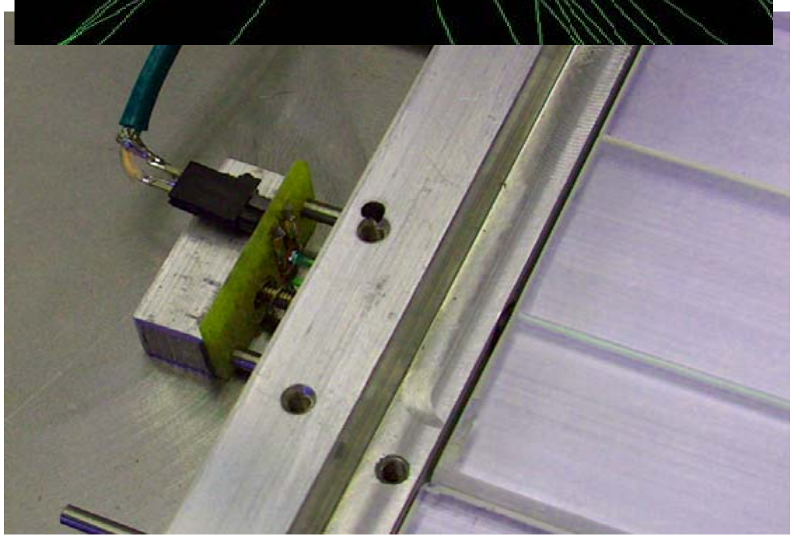
Counter 3
~5x5 cm^2

Counter 4
~2x2 cm^2

CALICE RPC HCAL

- Set-up behind beam dump Jan. 2006
- Moved into beam on Feb. 22nd
- Took data for 2 x 6 hrs.
- 120 GeV/c protons with beam intensity varying between 70 and 5000 Hz/cm^2
- Hope to have measurements of efficiency and pad multiplicity vs particle rate

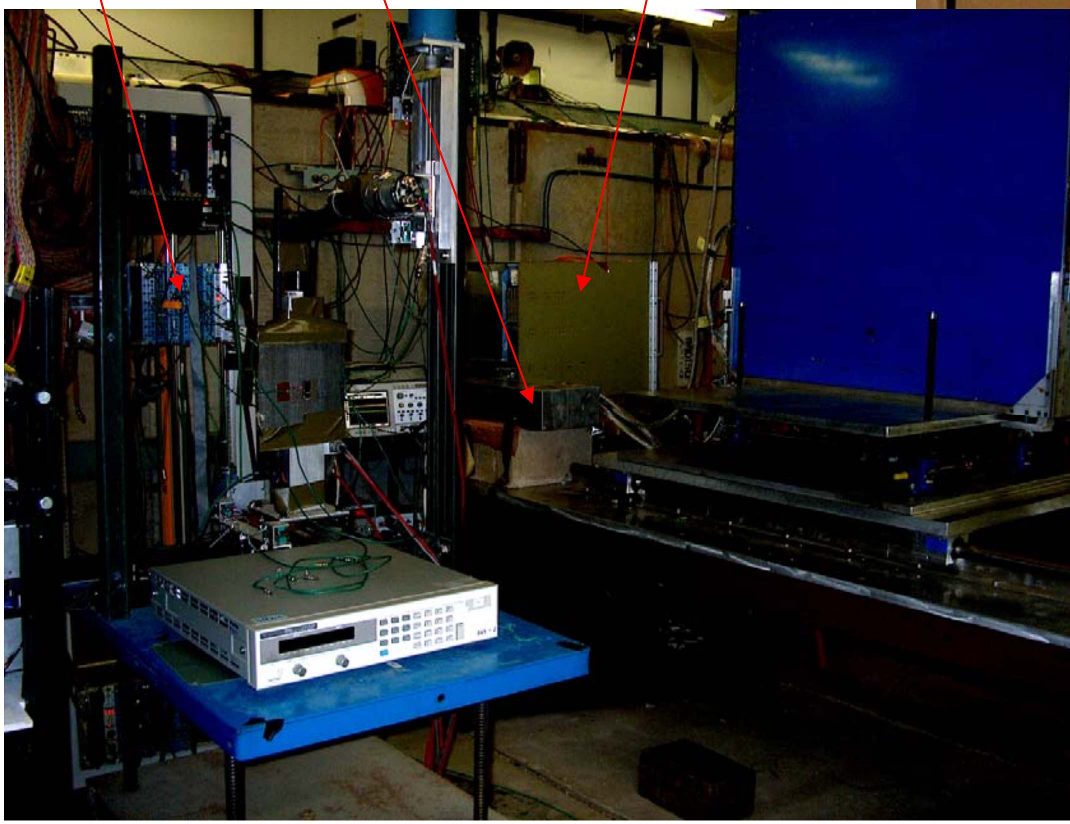


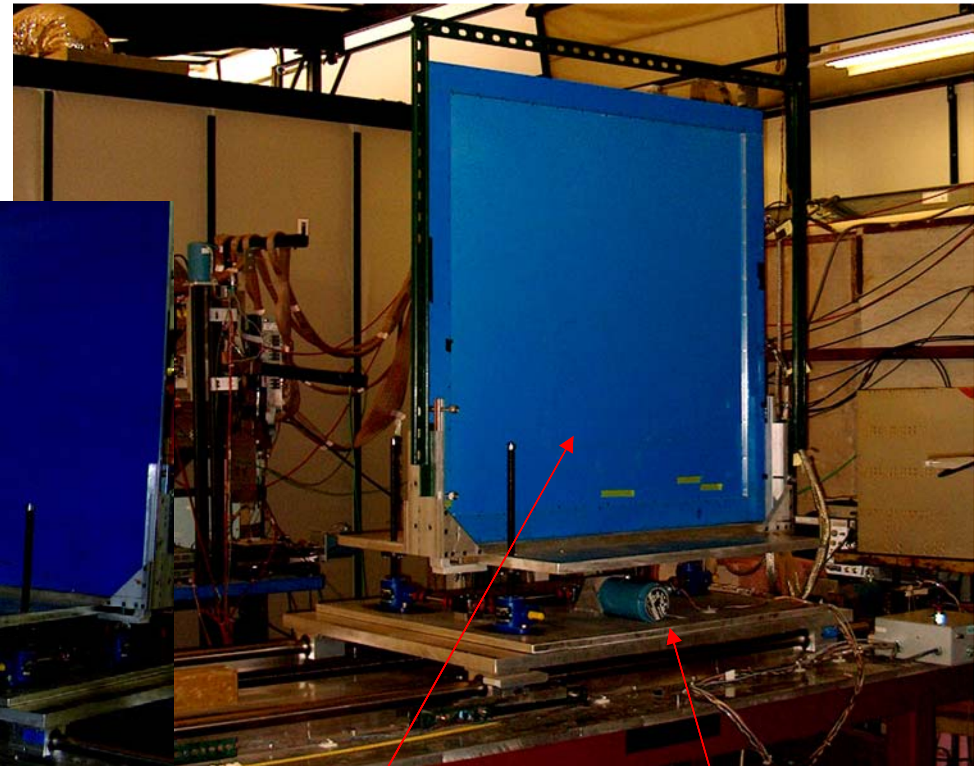


Scintillator strips with SiPM readout

In construction and assembly phase
Plan to see beam beginning mid-2006

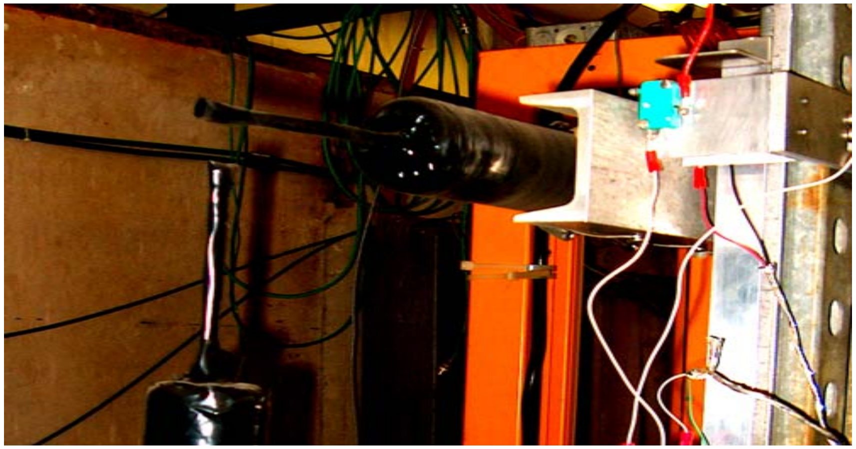
CALICE Tail-catcher/Muon Tracker

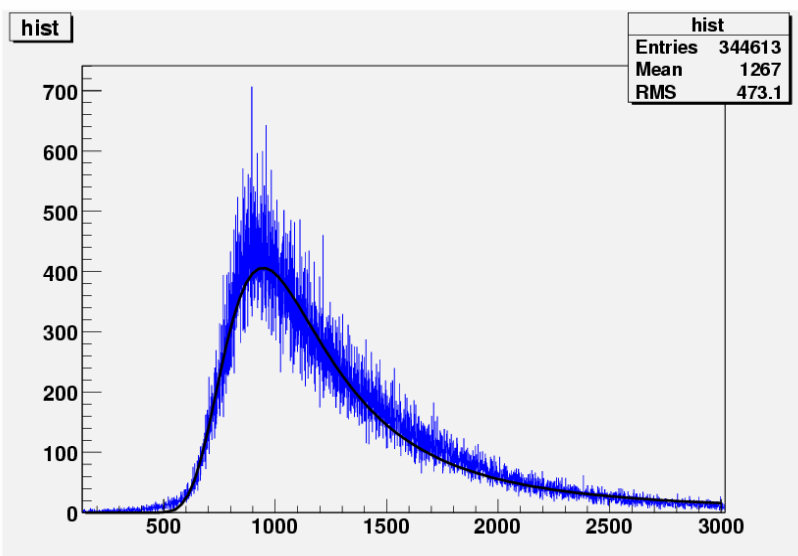




DESY-NIU participation

CALICE TCMT

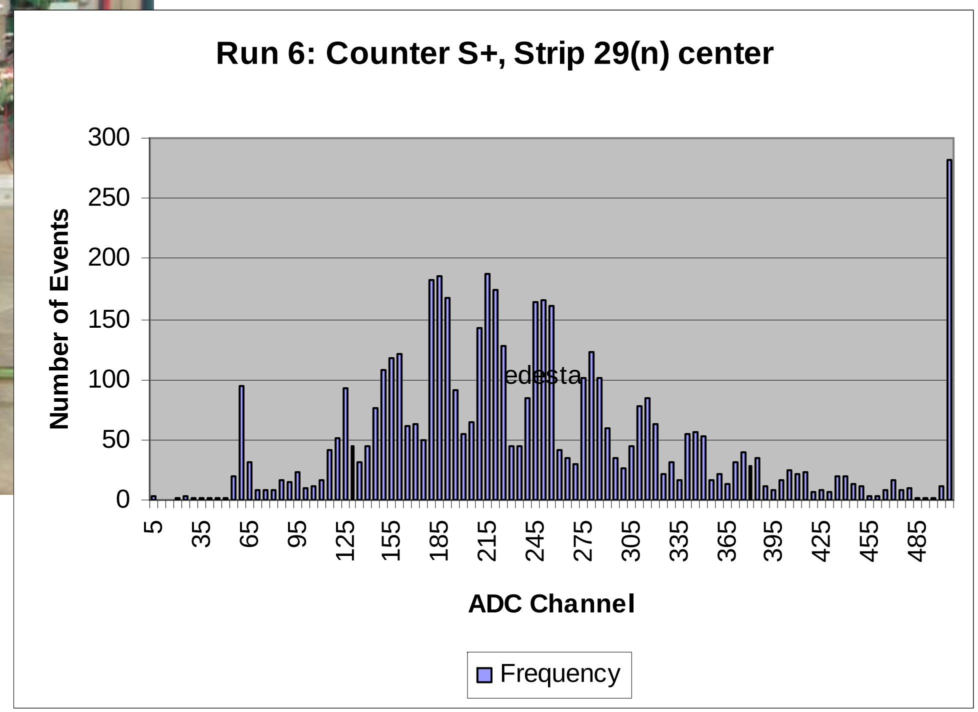




- Moved into the facility 3rd week of Feb.
- Took beam in the last week ~ 5 days
- Took 120 GeV/c protons, 16 GeV/c (mostly pions) and some beam dump muon runs
- ~ 1M events collected

Muon Counters

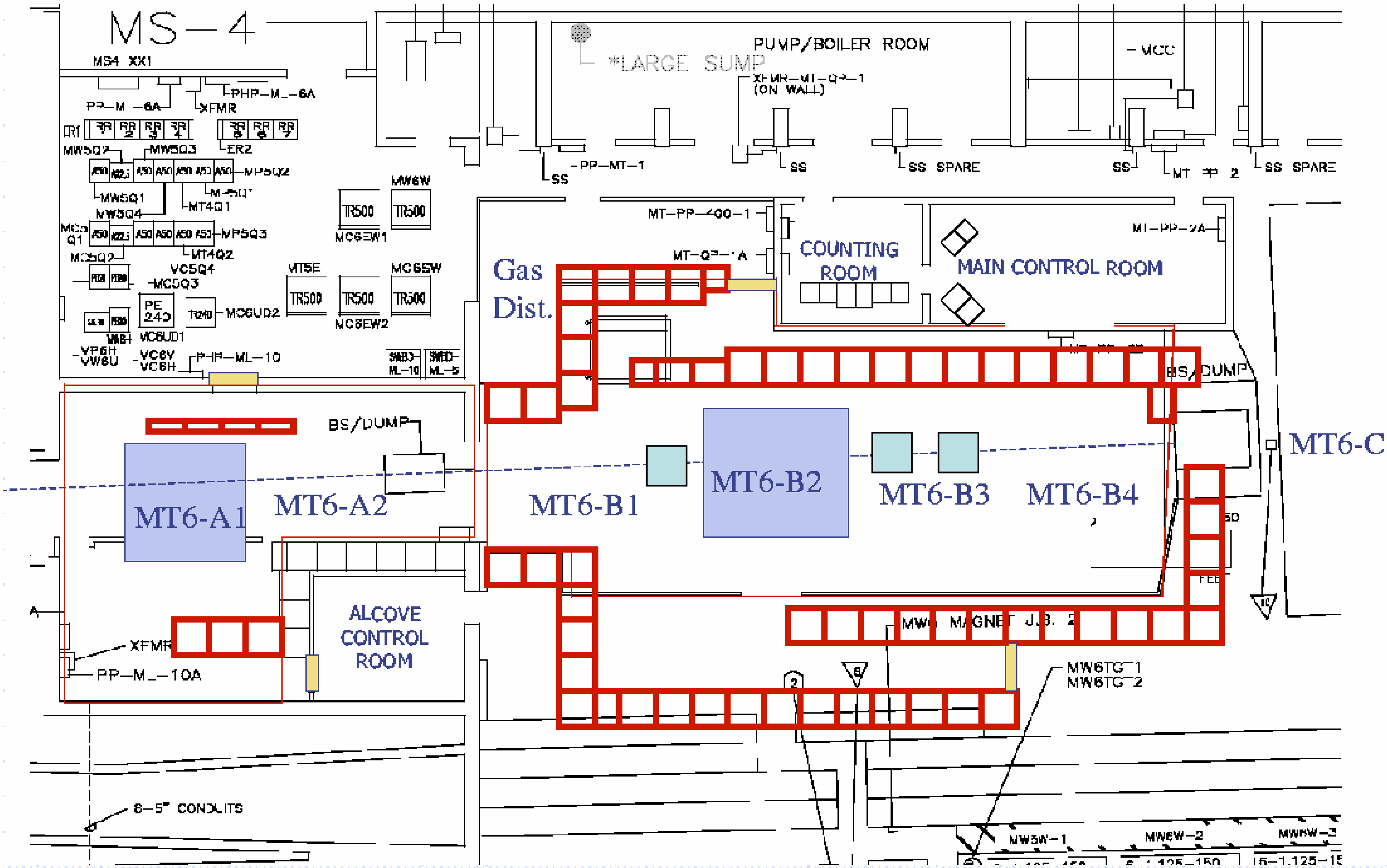
PMT (64 Channel) readout
24 active channels



1.5 m x 2.5m

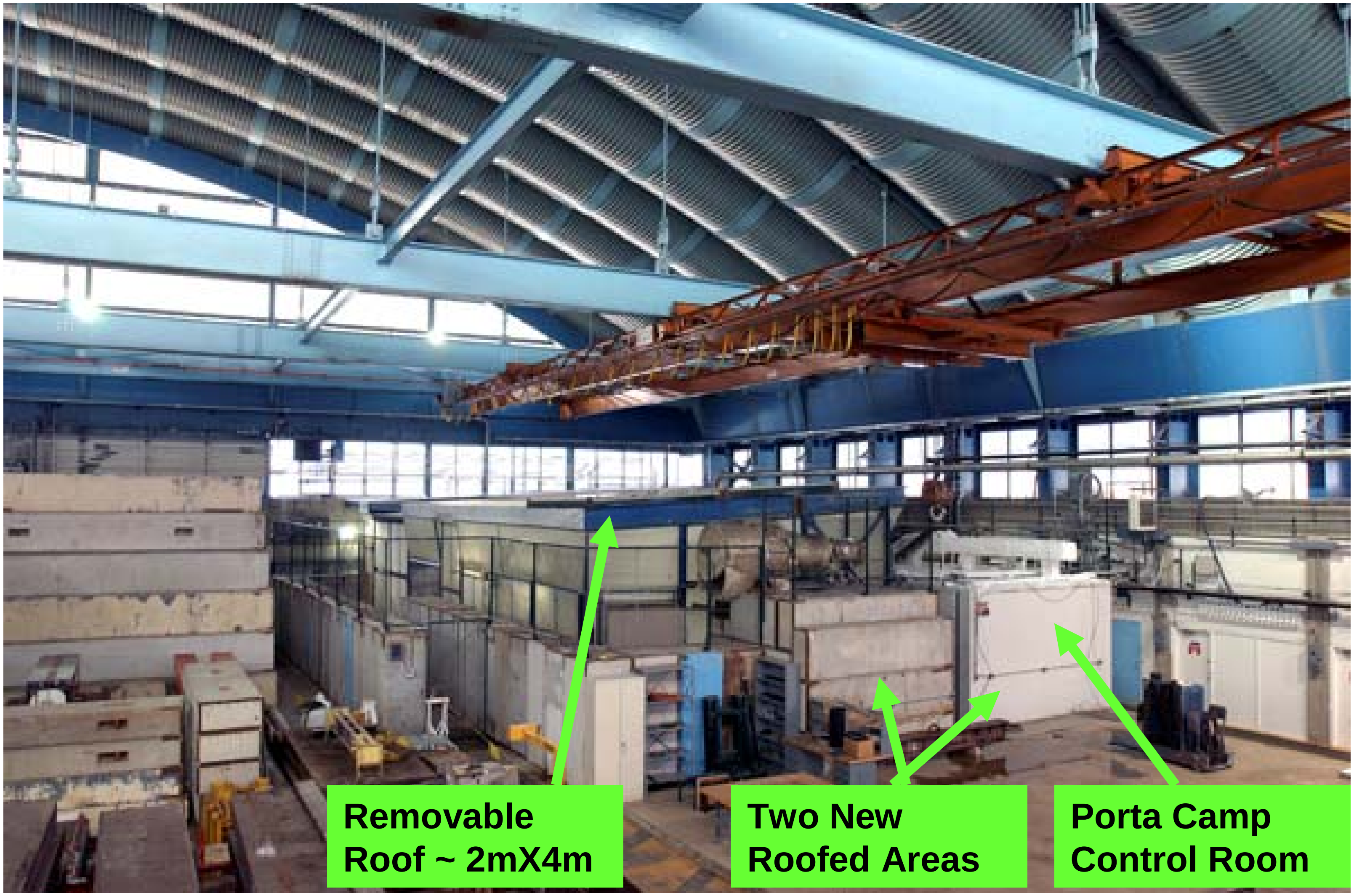
FNAL,IU,UND,WSU

MT6 Test Beam User Areas



: Concrete
: Enclosed climate control areas
: Controlled access gate

MESON LINE – THE BLUE & RED BUILDING – INSIDE VIEW



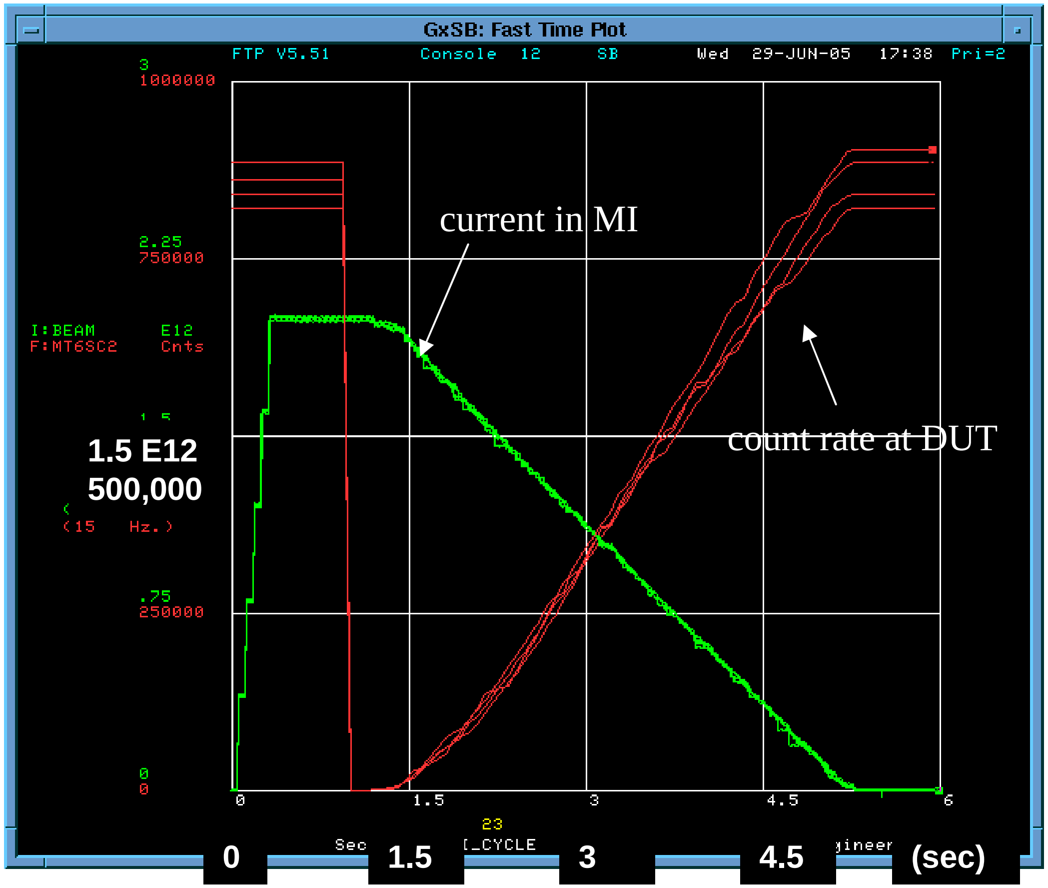
FERMILAB TEST BEAM
& THE ILC

***Brajesh Choudhary,* Fermilab**

LCWS 2006, IISc, Bangalore, India, 9th–13th March

presented by Marcel Demarteau

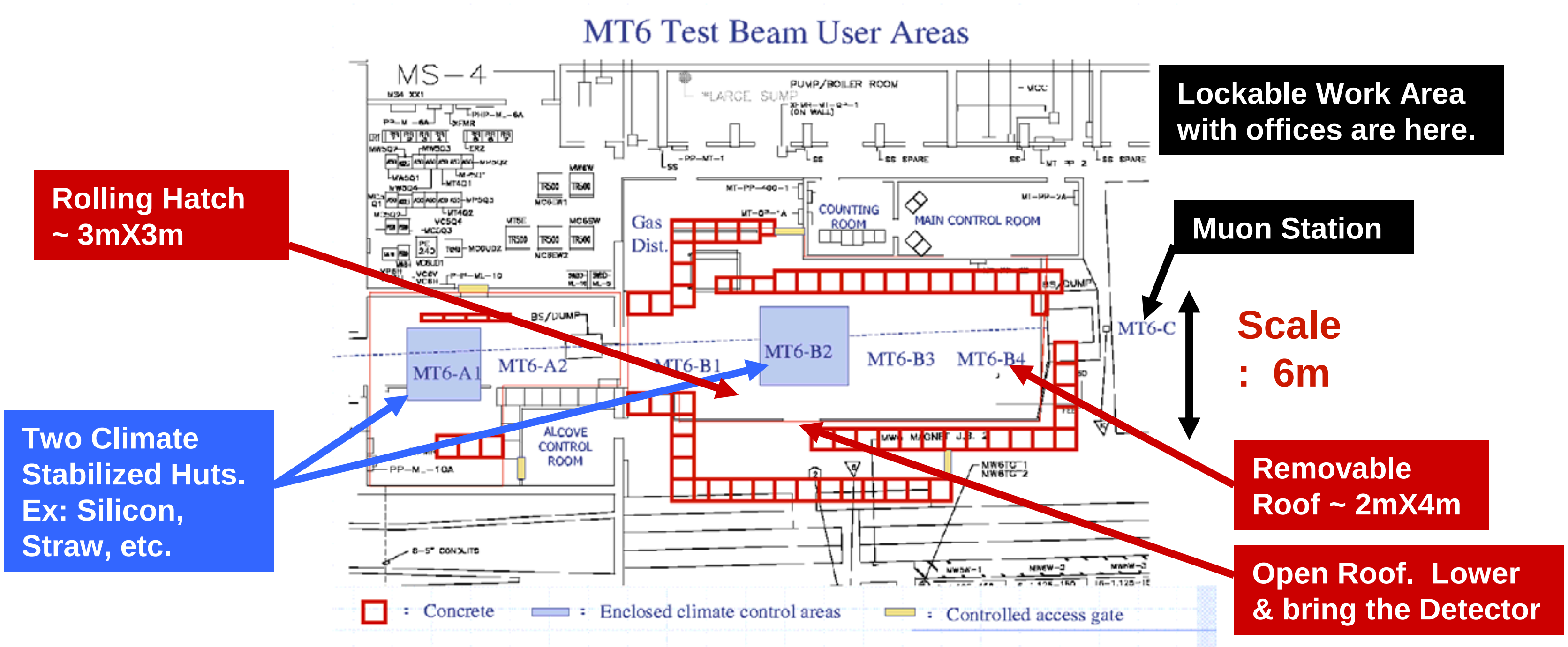
SY120 TIME STRUCTURE & RATE – 120 GeV



- Configuration:
  - 5 booster batches
    - 84 bunches/batch
  - One turn
    - Ibeam = 1.9 1012
  - Resonant extraction
  - 4s spill

- Current operation: single slow spill of 6 sec with a 4 sec flat top every 2 min.
  - Dutry cycle set by Fermilab management
  - 4 s flattop limit due to cooling of MI magnets
  - If MI completely dedicated to SY, to 20, 3sec cycles/minute (0.6s flattop)

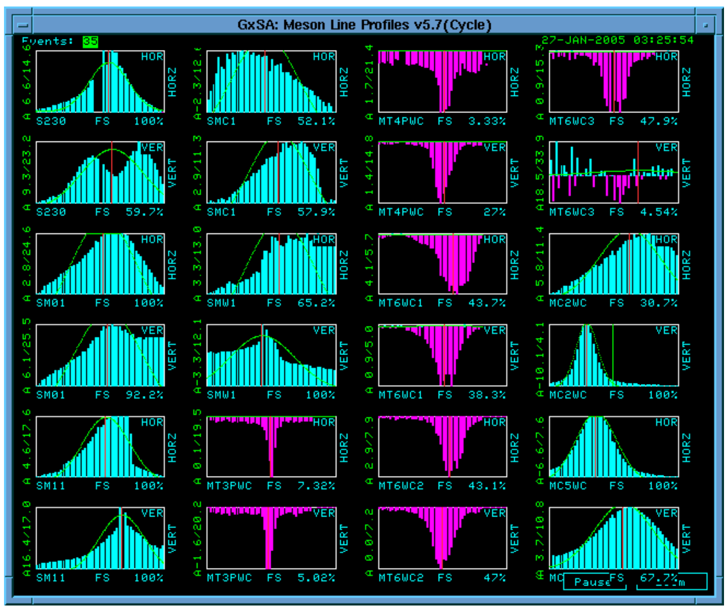
MTEST BEAM USER'S AREA



- ✓ 2 beam enclosures, but currently operated as single one (more shielding needed)
- ✓ 6 user stations, with a 7th downstream of the beam dump. Can be easily used for muon data.
- ✓ An experiment can take up more than one station.
- ✓ 2 climate stabilized huts with air conditioning.
- ✓ 2 separate control rooms.
- ✓ Outside gas shed + inside gas delivery system brings 2 generic gas lines, 1 nitrogen line and 2 exhaust lines to each of the user areas
- ✓ Lockable work area with 3 offices for small scale staging or repairs, plus 2 open work areas.

OPERATIONAL CHARACTERISTICS OF MTEST LINE

- 120 GeV protons impact on 40 cm long block of Aluminum as a production target.
- There are two operational modes of the test beamline:
  - Proton Mode: Tune beamline for 120 GeV protons that get transmitted through the target
  - Secondary Mode: Vary the tune of the beamline according to the momentum desired. Maximum secondary momentum is 66 GeV while minimum momentum achieved so far is 3 GeV. Lower momenta under study
- Spot sizes can be made as small as 2-5 mm rms and as large as 5 cm rms with 120 GeV protons
- Momentum spread – From Calorimeteric studies – 1-2% peak in the electron data.



Typical SWIC profiles while delivering 120 GeV beam (1 mm wire spacing: ~ 7 mm RMS)

PRESENT RATE IN THE MTEST BEAMLINE

Particle Energy (GeV)	Protons/spill from the Main Injector	Rate measured @MT6SC2	Beam Condition (Batches, Bunches, Turns)	MT6SC2 rate normalized to 1E12 protons/spill from MI	Electron Fraction
120	2E12	850-900K	5, 84, 1	~400-450K	---
66	2.1E12	205K	2, 84, 3	~100K	---
33	2.1E12	61K	2, 84, 3	~30K	~0.7%
16	2.1E12	42K	2, 84, 3	~20K	~10%
8	2.1E12	11K	2, 84, 3	~5K	~30%
4	1.5E12	1050	2, 84, 2	~700	~60%
3	1.5E12	250	2, 84, 2	~160	Mostly Electrons

Shielding limits in various sections of MTEST are:

2E12 protons/2.9sec from M02 to M03 pinhole collimator

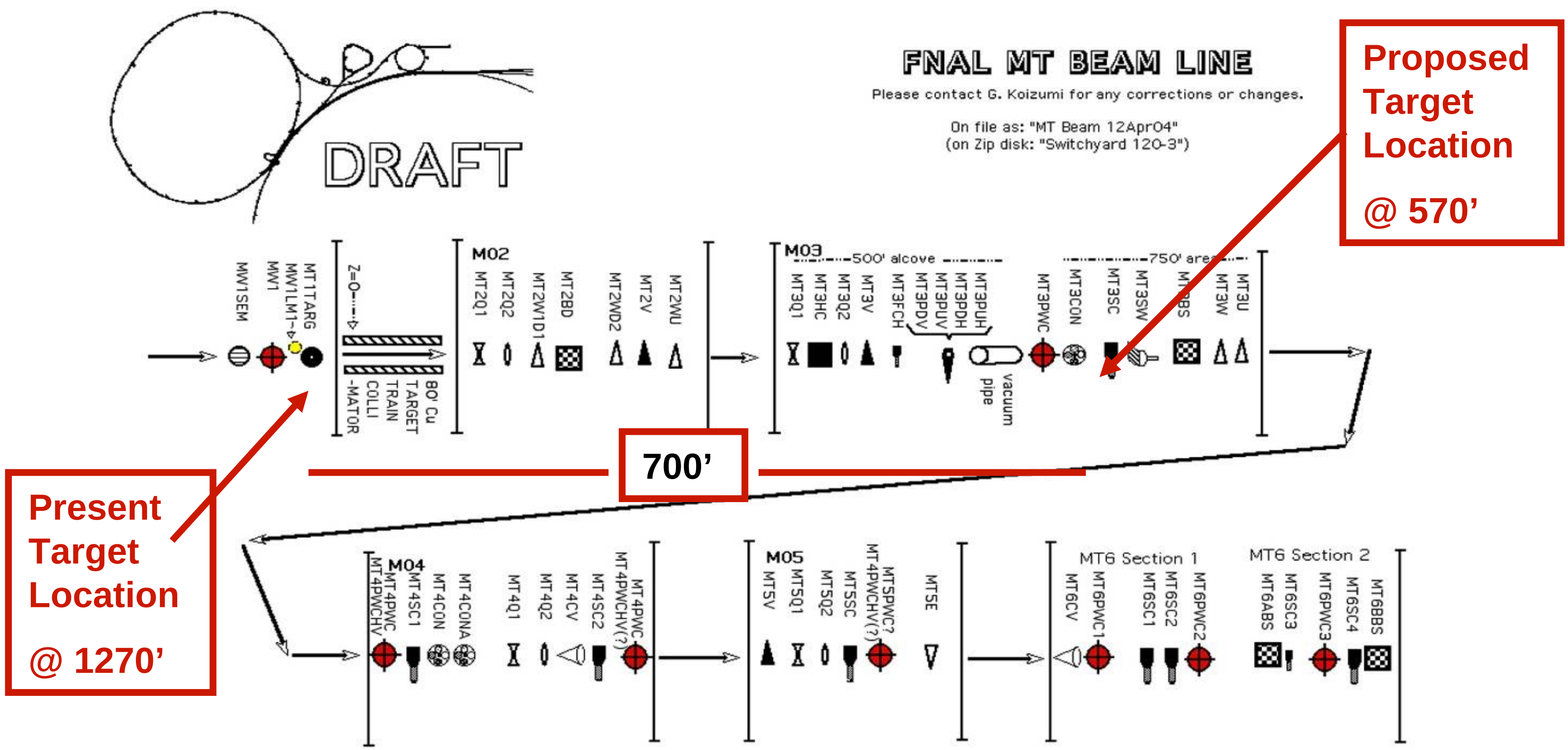
2E7 particles/2.9sec from M03 pinhole collimator and downstream

7E5 particles/2.9sec in the MT6 experimental area.

POSSIBLE IMPROVEMENTS TO THE CURRENT BEAM

- Improvements to rate:
  - Duty Cycle:
    - Currently: SY runs with a 5% duty cycle: 1 spill every 2 minutes.
    - The laboratory is currently re-evaluating the duty cycle and its allocation per 24 hours, and a 10% duty cycle may be possible: gain by factor 2
  - Spill Structure
    - Currently: 6 sec cycle with 4 sec flat top
    - The laboratory is currently re-evaluating the possibility to go to two 3s long spill every minute. Gain by a factor of 2 if not limited due to DAQ rate.
  - Beam Intensity
    - Quoted rates are for 1E12 ppp in the MI. One can easily go to 2.0-2.5 E12 ppp. Gain by a factor of 2.0 to 2.5.
- Reduction of the amount of material in the beamline
    - Gain varies with beam configuration
- Move of target further downstream by ~700’

TARGET MOVE


FNAL MT BEAM LINE
Please contact G. Koizumi for any corrections or changes.
On file as: "MT Beam 12Apr04"
(on Zip disk: "Switchyard 120-3")
DRAFT
Proposed Target Location
@ 570'
Present Target Location
@ 1270'
700'
M02
M03
M04
M05
MT6 Section 1
MT6 Section 2
500' alcove
vacuum pipe
80' Cu TARGET TRAIN COLLI-MATOR

GAIN FROM MOVING PRIMARY TARGET DOWNSTREAM TO MT3CON

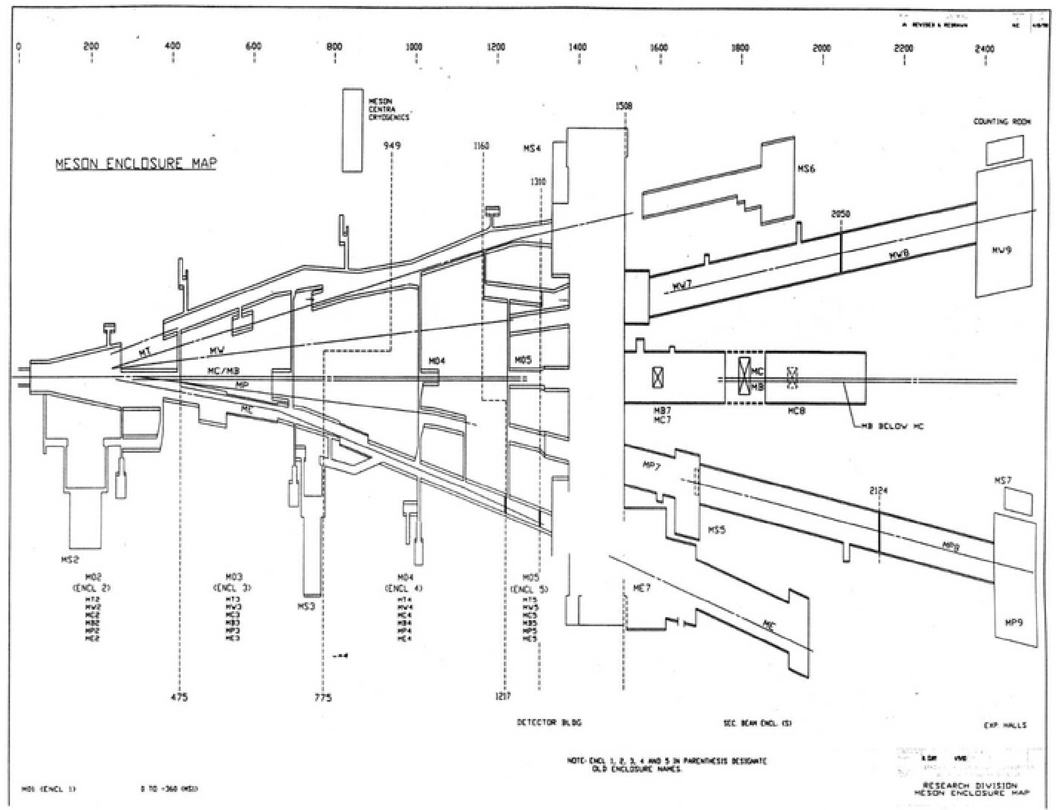
- Moving the target 700' downstream to MT3CON will
  - ► Reduced amount of the material in the secondary beamline
  - ► Reduced the loss due to decays at lower momentum
  - ► Increased the fraction of pions at lower momentum compared to present rate

Energy (GeV)	Present MT6SC2 Rate for 1E12 PPS from MI	Rate Improvements	Gain due to Pion Decay factor	Gain due to reduced material in the shorter Beamline	Available gain due to momentum bite and phase space	Possible Gain due to Shorter Beamline	Possible Overall Gain
1	---	Possible Gain by a factor of 8 to10 due to I_{beam}: 2.0-2.5x Rep rate 2x Spill struct. 2x	45	---	Approximately 4 to 20: Momentum bite increase by 1 - 5x And phase space increases by 4x		
2	---		6.8	---			
3	~150		3.6	4.0		50 - 250	> 400 - 2000
4	~700		2.6	3.5		35 - 170	> 250 – 1200
8	~5K		1.6	2.0		12 - 60	> 100 – 500
16	~20K		1.3	1.5		7 - 30	> 50 – 250
33	~30K		1.1	1.0		4 - 20	> 35 – 200
66	~100K		1.0	1.0		4 - 20	> 30 – 150

MESON CENTER

- MCenter currently houses the MIPP (Main Injecter Particle Production) experiment
  - Measures the particle production in various targets for different particles within a range of momenta
  - Data could be useful for the understanding of hadronic shower development and, as such, for the development of PFA

- The MCenter beamline is currently unscheduled. Lab management is entertaining the possibility of the use of the MCenter as an additional test beam area
- MCenter:
  - high flux
  - Low momenta



“ We are open to any suggestion from the user community. We would appreciate feedback on requirement and specifications from the user community.”

- url for Test Beam at Fermilab: http://www-ppd.fnal.gov/MTBF-w
- Test Beam Coordinator: Erik Ramberg - ramberg@fnal.gov
- MTest Beamline Physicist : Brajesh Choudhary - brajesh@fnal.gov
- ILC Detector R&D coordinator: Marcel Demarteau - demarteau@fnal.gov

Summary

- The ILC test beam effort continues to build
- Activity in beam monitoring, tracking, calorimetry and muon
- Increasing need for commonly exploitable test beam infrastructure (EUDET)
- Labs responding to the users need