

SiD Test Beam

SiD Workshop @ SLAC

Oct. 26 – 28, 2006

Jae Yu

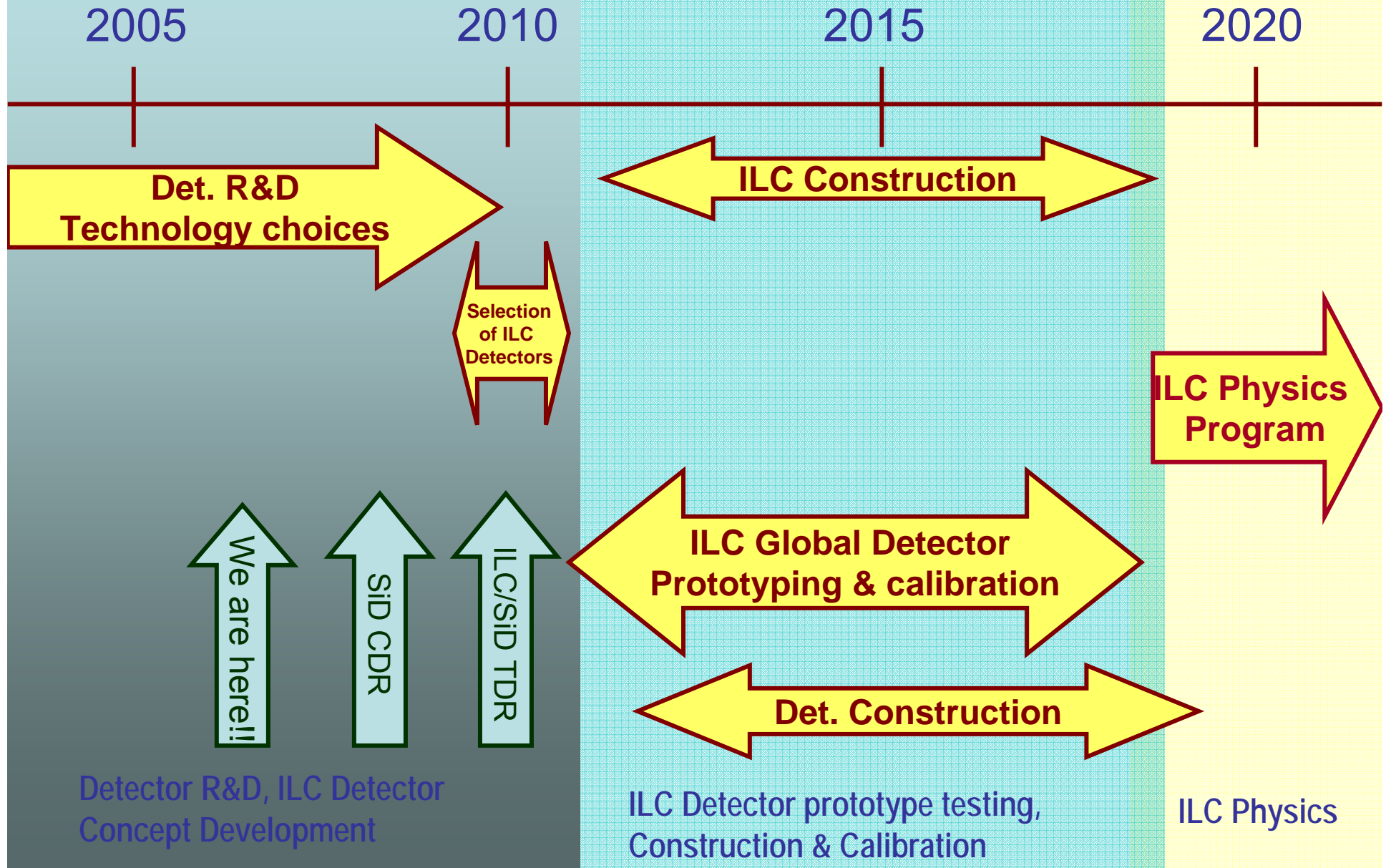
University of Texas at Arlington

- Introduction
- Facilities Update
- Current and Planned Beam Test Activities
- Program Planning
- Questions to ourselves
- Conclusions

Introduction

- Many detector R&D activities reaching the point for beam tests
 - Some good news on funding helps realizing beam tests
- SiD and other concept studies rapidly maturing
 - CDR anticipated in mid 2008!!
- PFA development speeding up
 - Hadronic shower behaviors need to be better understood
 - Models should be validated
- ILC Detector development time line should be “in synch” with accelerator TDR
 - Informed decision for detector technologies demands performance tests with beam

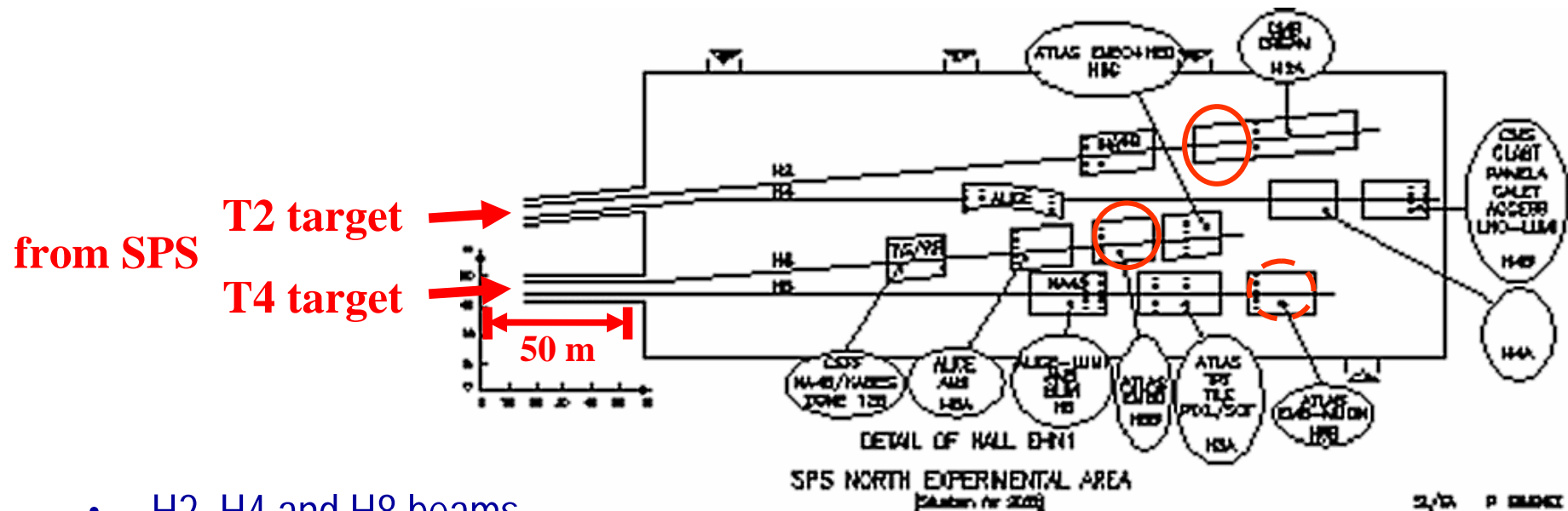
LC Detector Time Line



Facilities Update

- EUDET:
 - Provide much needed beam test infra for detector R&D
 - Utilizes DESY and CERN facilities
 - Funding cycle began Jan. 2006 and lasts for 5 years
 - Much infrastructure for beam tests support provided by this program, along with sizable human resources
- CERN:
 - Offers beam tests in North Beam Line area in 2006
 - Ending mid-Nov.
 - Schedule for 2007 is unclear but soon to be decided at the SPSC in Nov. 2006
 - Schedule after LHC turn on in late 2007 depends heavily on how LHC operation goes → SPS used to fill LHC

CERN SPS North Area



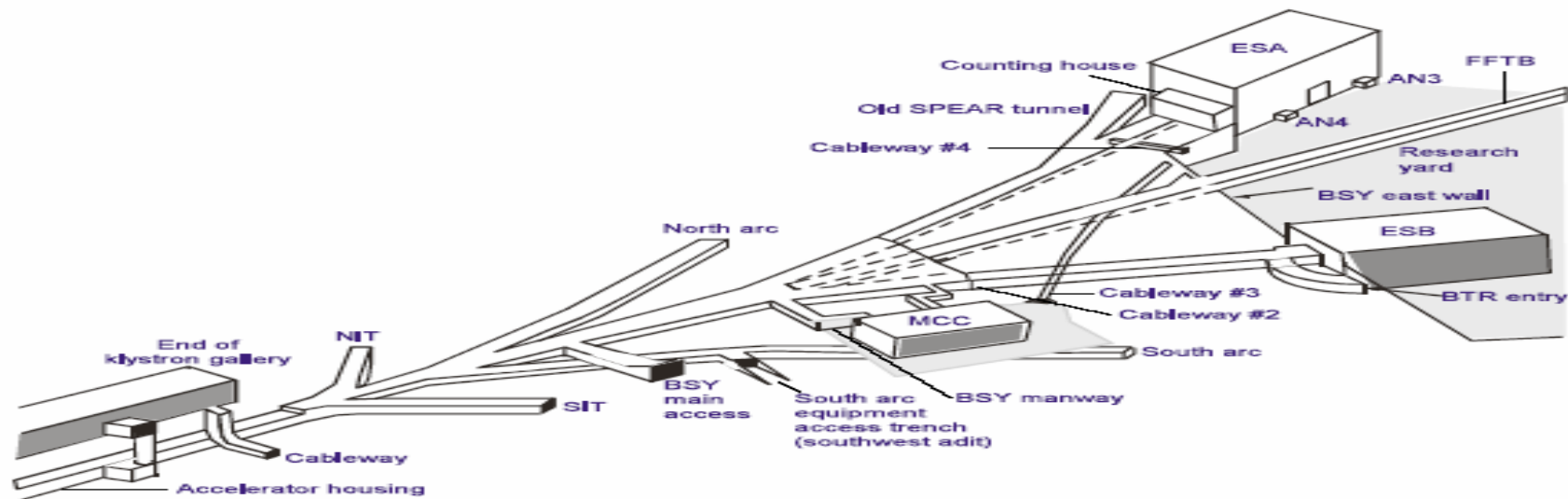
- H2, H4 and H8 beams
 - 10 - 400 GeV/c, up to 10^8 particles/spill (π^+)
 - H4 can be set-up for very clean electron beam (up to ~300 GeV/c)
 - H2 and H8 also have low energy tertiary beams (2 – 10 GeV/c)
- H6 beam
 - 5 – 205 GeV/c, up to 10^8 particles/spill (π^+) (at 5 GeV ~1000 particles / spill)
- Up to 3 experimental areas per beam line (parasitic muon runs possible)

Facilities Update – DESY and KEK

- DESY
 - Continue offering low energy electron beams up to 6GeV for beam tests
 - Many European R&D groups of all sub-detector types utilize this facility
 - Asian colleagues are also planning to use the facility as their initial testing ground
- KEK facility has been shutdown since end of 2005 but ..
 - A new proposal for 3GeV electron beam using bremsstrahlung photons from KEK-B HER
 - If successful, facilities could be available spring 2007

Facilities Update - SLAC

- SLAC → Ray A. will cover in more detail
 - ESA provides high current electron beams w/ momentum up to 28 GeV/c and secondary hadrons up to 16 GeV/c
 - Unique facility since the beam time structure can mimic that of ILC closely
 - Many BI and MDI activities at this facility
 - Continued operation beyond 2008 is unclear
 - Operations of LCLS



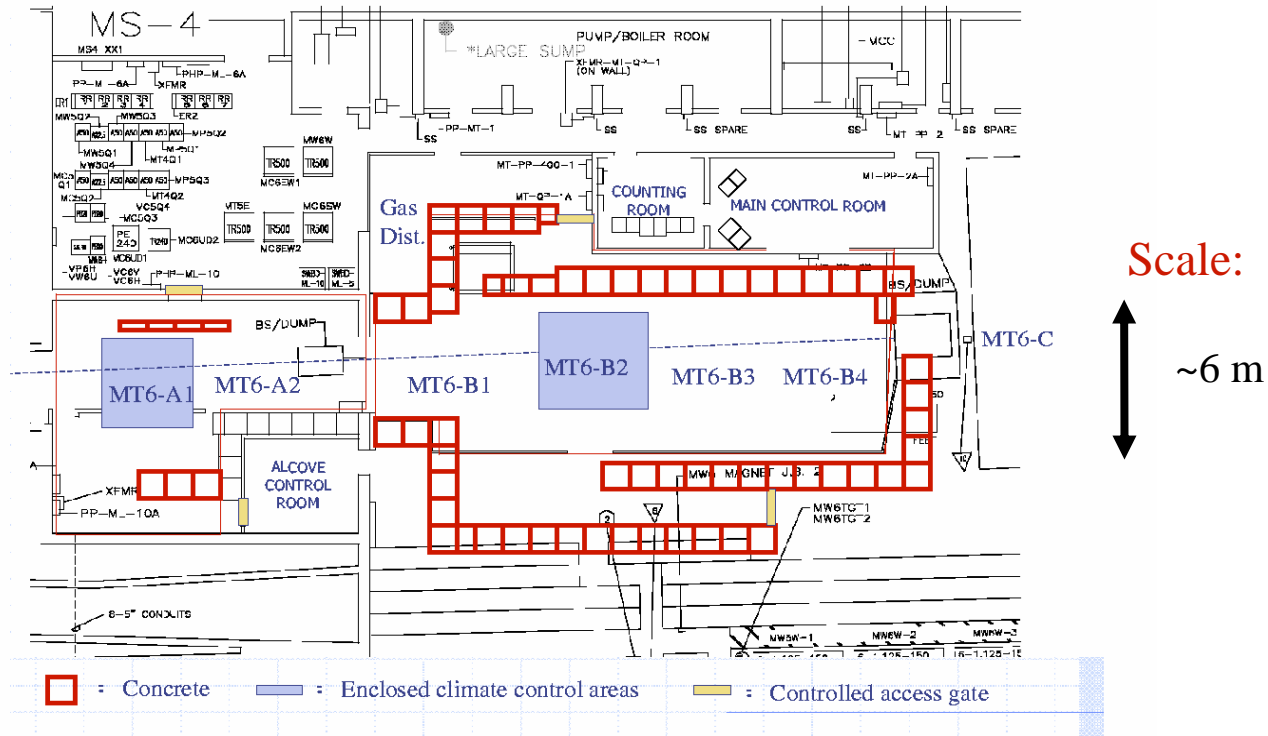
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Facilities Update

- FNAL:
 - Use 120GeV protons from MI as the primary
 - Secondary hadrons, electrons and muons from 2 – 66GeV and protons up to 120 GeV

MT6 Test Beam User Areas



- ◆ 2 beam enclosures, but cannot be operated independently.
- ◆ 6 user stations, with a 7th downstream of the beam dump. 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.

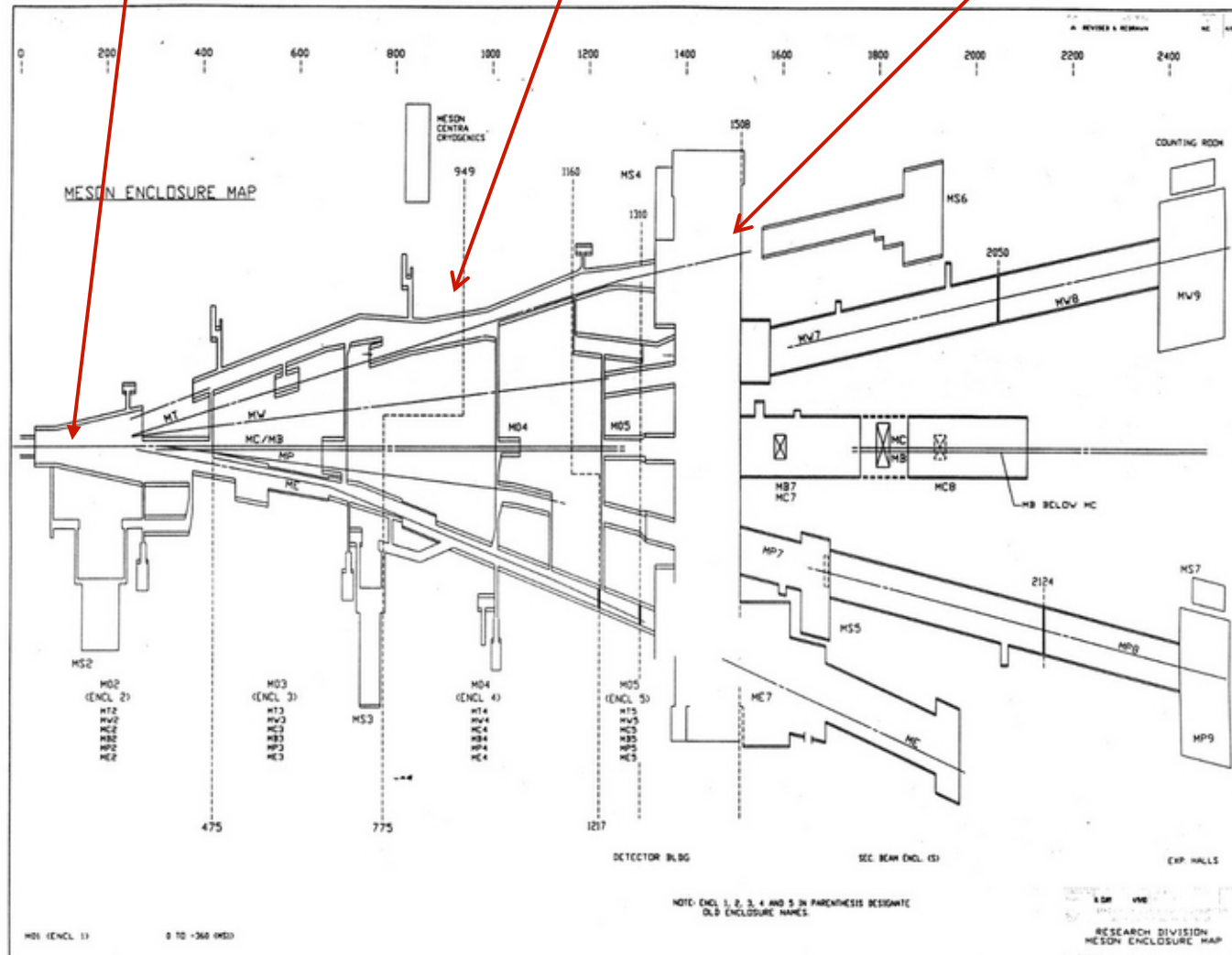
Recent Improvement and Upgrades at FNAL

- Fermilab AD implemented adjustable spill structure within the given proportion of duty factor @ 5% of the total
 - Allows for data taking rate optimization
 - Was running at one 6 sec spill every two minutes
- Upgrades to MTBF
 - To meet the needs for low energy ($\sim 1\text{GeV}$) e and hadrons at MTBF
 - Install a movable target downstream of the current target
 - Cut the target-to-detector distance from 1500' \rightarrow 600'
 - Implement a low energy particle transport system

Current 40 cm Al target

Proposed new target location

Meson Detector Building



Ramberg

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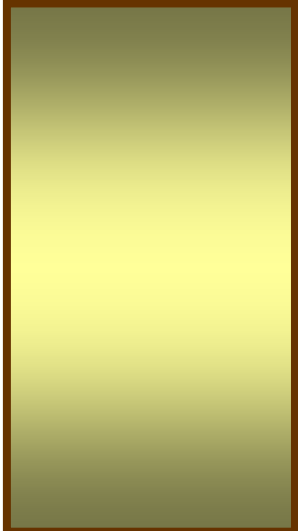
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Recent Improvement and Upgrades at FNAL

- Optimized beamline monitoring and particle I.D. to minimize material at MTBF
 - A additional differential Cerenkov counter
 - Beamline TOF
 - Tracking with a pixel silicon station and SciFi detectors
- Recent development of possible momentum tagged neutral hadron beams (n and K_L) at MCenter
 - Hadron calorimeter and simulation community excited about this
 - Provide direct means of testing HCAL for PFA

Measured rates in the MTBF beamline

Tune (GeV)	Rate in MT6/spill*	e ⁻ fraction	Resolution in ECAL
120		0	-
66		0	-
33		0.7 %	1.0 %
16		10 %	1.2 %
8		30 %	-
4		60 %	2.4 %

* (Rates are normalized to 2.4E12 protons in Main Injector; Spill is 6 s long w/ 4s flat top)

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.

Expected Improvements in Rates

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

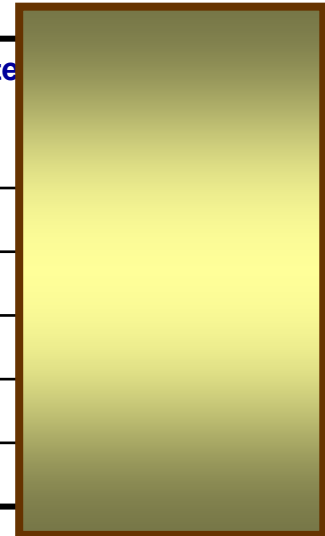
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+ Enhancement due to increased momentum bite (from 3/4% to 2%)

+ Enhancement due to increased aperture

=

Energy (GeV)	Present Hadron Rate MT6SC2 per 1E12 Protons
1	---
2	---
4	~700
8	~5K
16	~20K



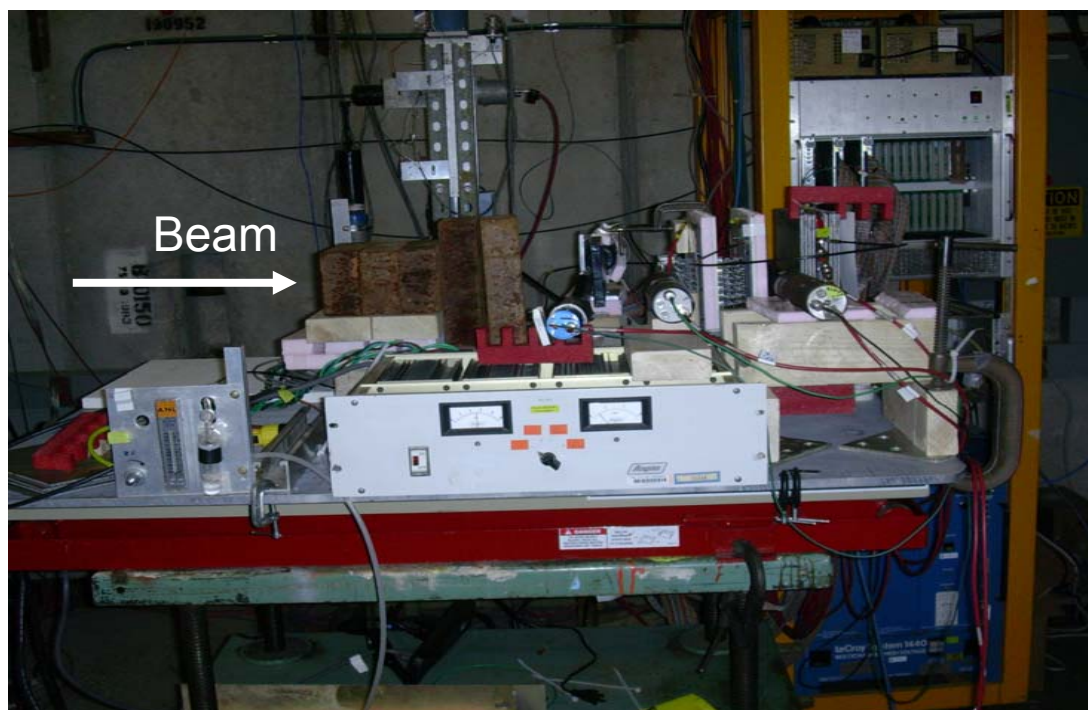
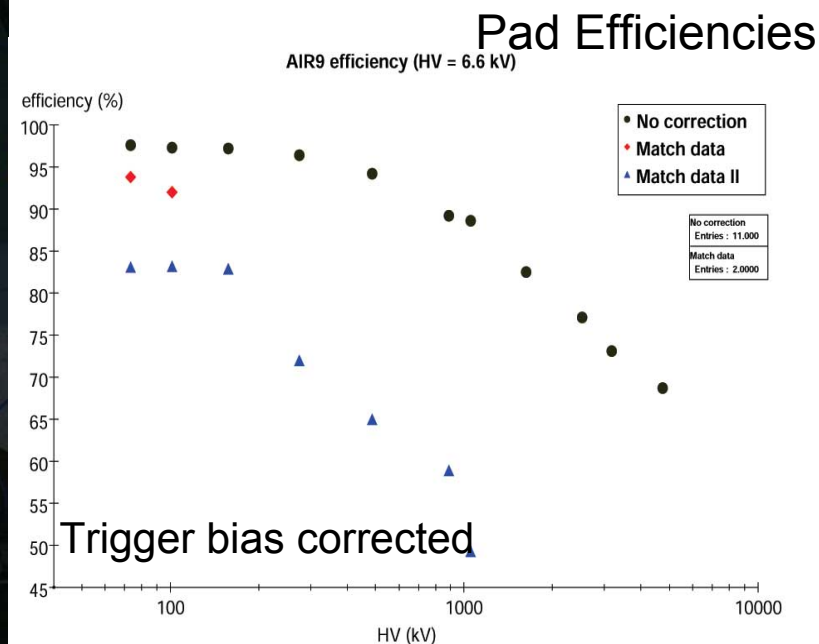
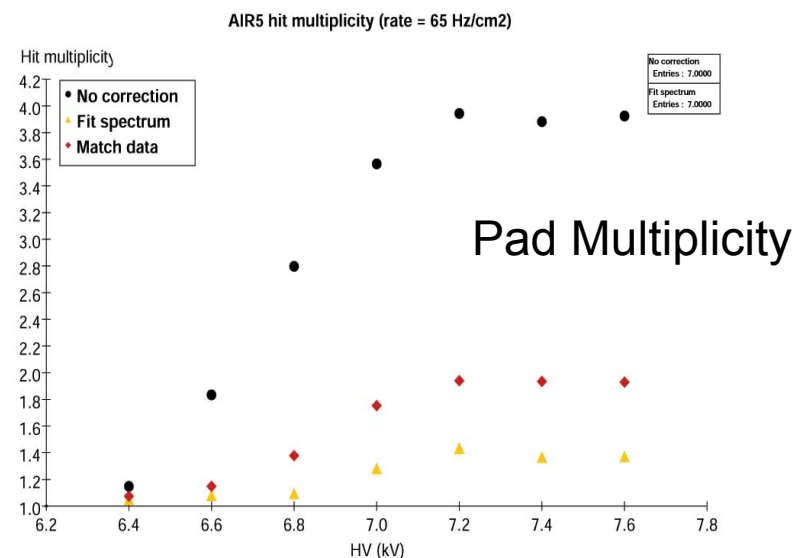
BI and MDI

- Large number of activities at SLAC ESA
 - Two periods of two weeks in 2006
 - T-474 BPM spectrometer
 - T-475 Synch stripe
 - T-480 Collimator wakefields
 - T-487 Bunch length diagnostics
 - T-488 FONT background test
 - EMI Studies
 - ILC Linac BPM prototypes
 - Expects two periods of two weeks each in 2007 and 2008
- Forward and luminosity calorimeter also active
- KEK ATF utilized for
 - ATF Laser wire, Nano BPM, FONT4, Shintake Monitor and Profile monitor

DHCAL – RPC

Repond

- T955 at FNAL's MTBF early 2006
- 3 RPC chambers tested with 120GeV P
- Took two 6 hour runs w/ rates 70 – 5000Hz
- Plans to beam test in
 - Fall 2006
 - Slice test in spring 2007
 - 1m³ prototype in mid – late 2007



DHCAL - GEM

White

- A 30cmx30cm GEM chamber has been exposed to high intensity, low E electron beam in KAERI, Korea
 - 2x2 readout pads active
 - Total exposure: 2×10^{12} e/pad
 - Corresponds to $1.6 \cdot 10^{-2}$ mC/mm²
 - No damage to chamber and its operations have been observed
- Plans to beam test at FNAL
 - In early 07 for chamber characterization
 - Slice tests in spring 2007
 - 1m³ prototype run in 2008



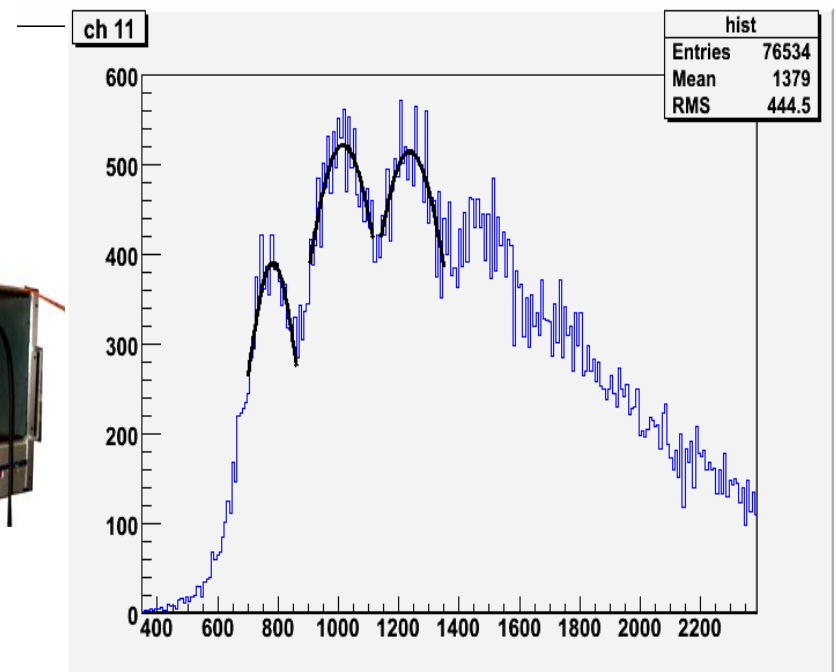
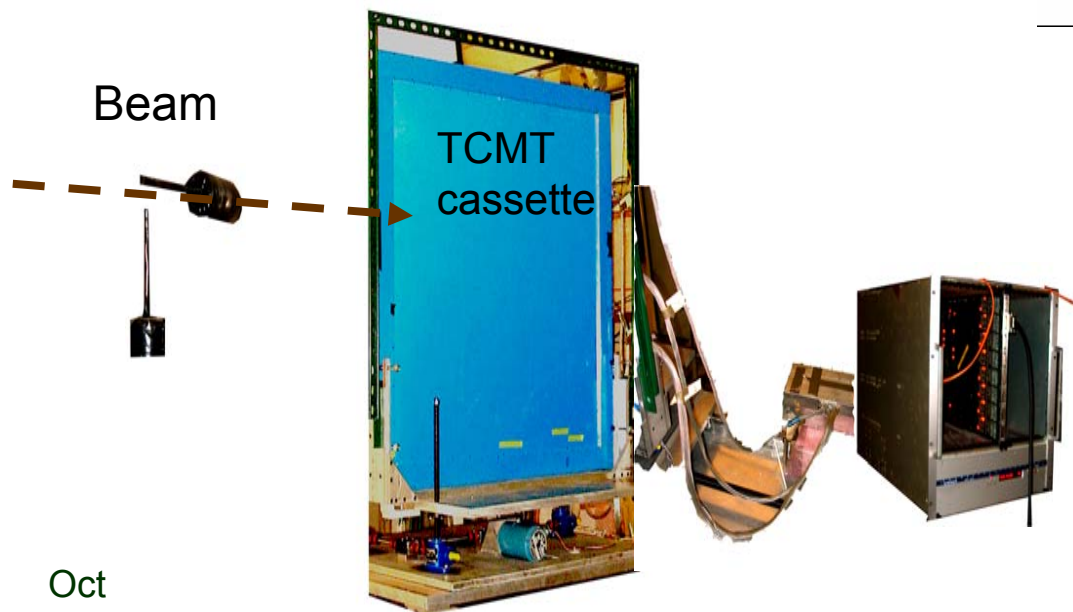
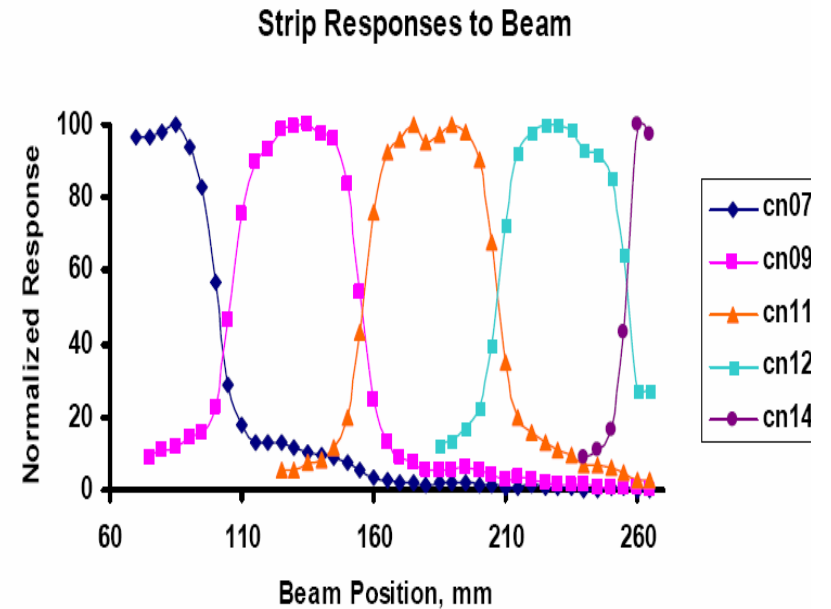
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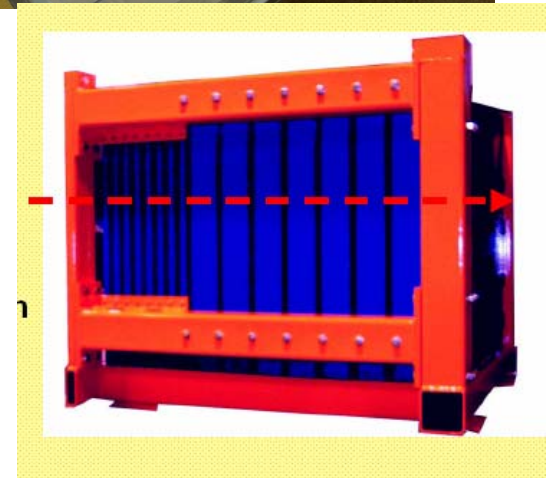
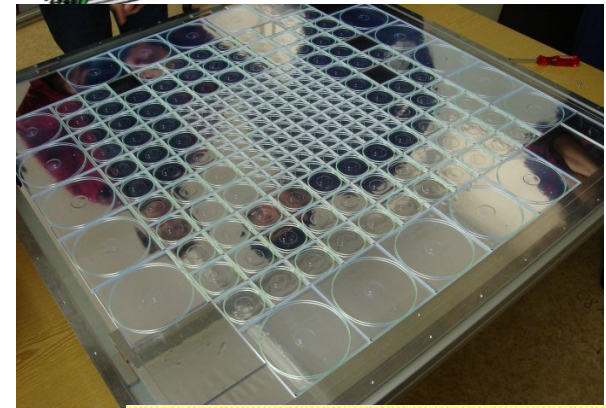
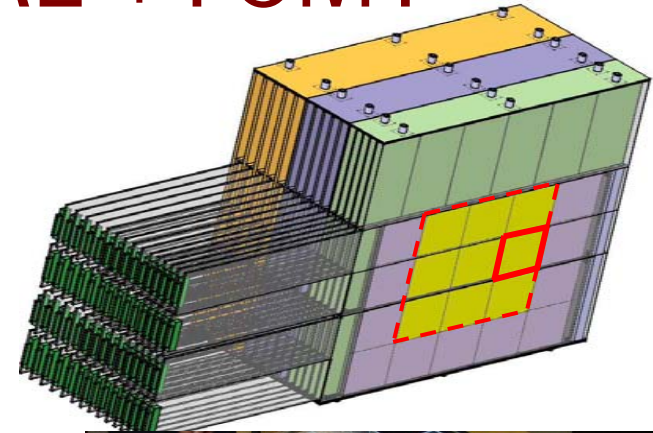
TCMT

- One cassette exposed to
 - 3GeV electron beam at DESY in Oct. 2005
 - T957 at MTBF in early 2006 with 120 GeV p , 16GeV π and muons
 - CALICE AHCAL at CERN in Aug. - Nov. 2006
- Plans to beam test
 - W/ CALICE AHCAL at CERN in summer 07



CALICE ECAL + AHCAL + TCMT

- Both ECAL and HCAL exposed to positron beam at DESY early 2006
- Full detector is taking data at CERN H6 beam line in Aug. – Nov. 2006
 - Detectors
 - Si-W ECAL: 30 layer full depth + half lateral coverage
 - AHCAL: 23 Layer full lateral coverage
 - TCMT: Full depth and lateral coverage (18 layers)
 - Of the total three run periods two were given
- Plan to request beam in June – Aug. 2007
 - 2 periods of hadrons and electrons
 - Complete commissioning and high E running
- Plans to move to FNAL for mid to low E runs

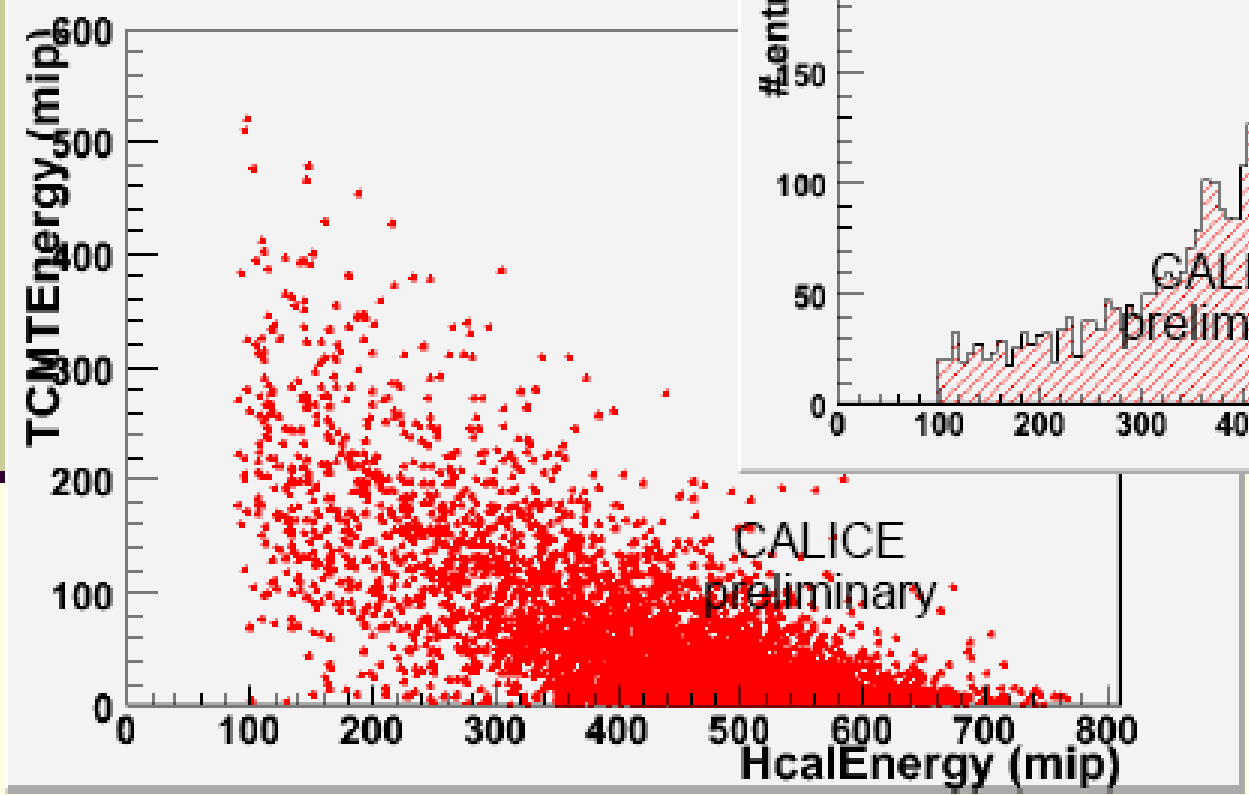


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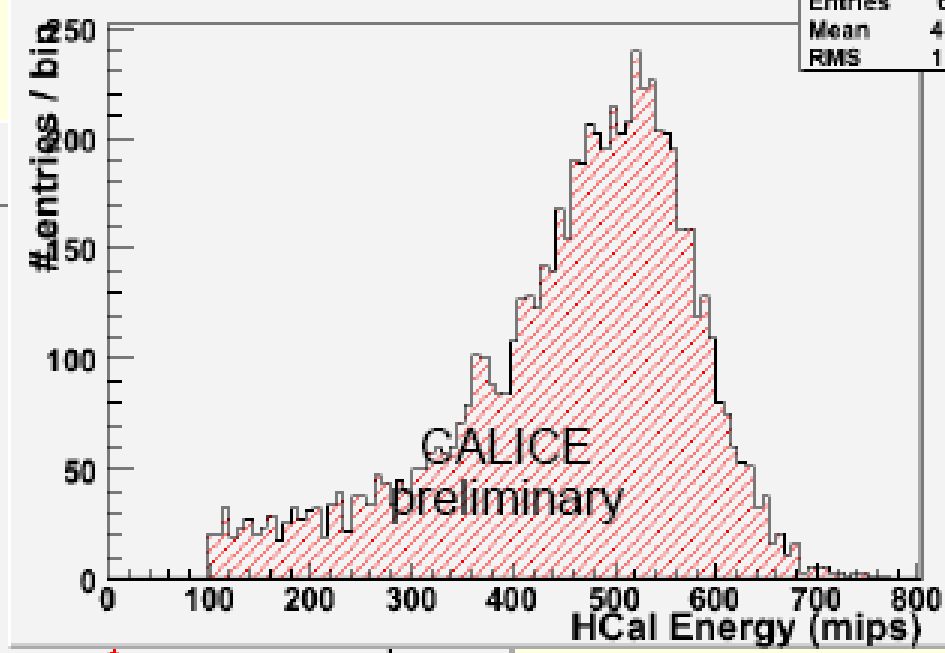
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30 GeV pions: Hcal x TCMT correlation

hTCMTEnergy vs HcalEnergy



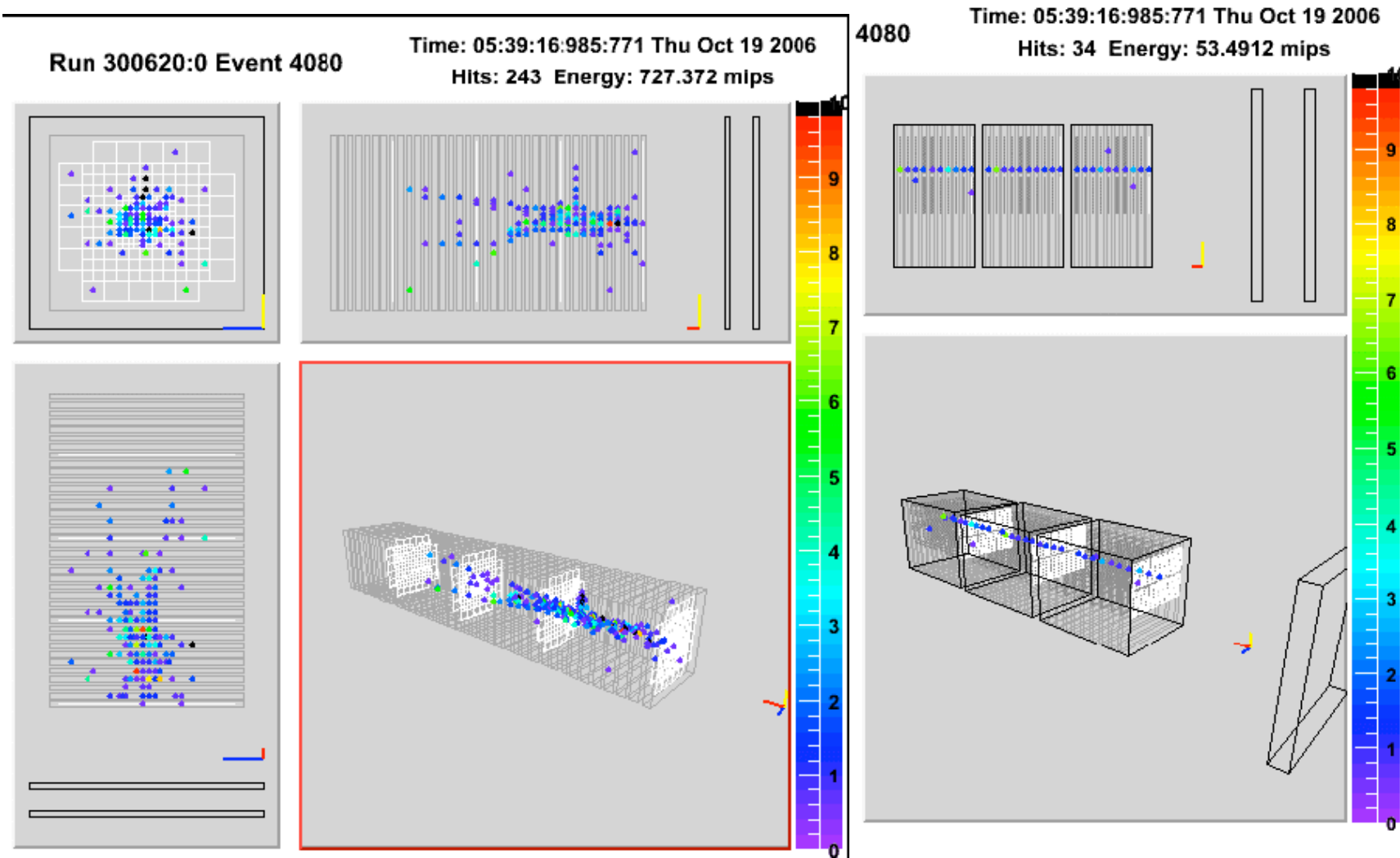
hHcalLiveEnergy



hHcalLiveEnergy	
Entries	6913
Mean	456.9
RMS	129.7

Note on Hcal:
36/38 layers,
15 of them instrumented
(August run)

20 GeV Hadron Shower



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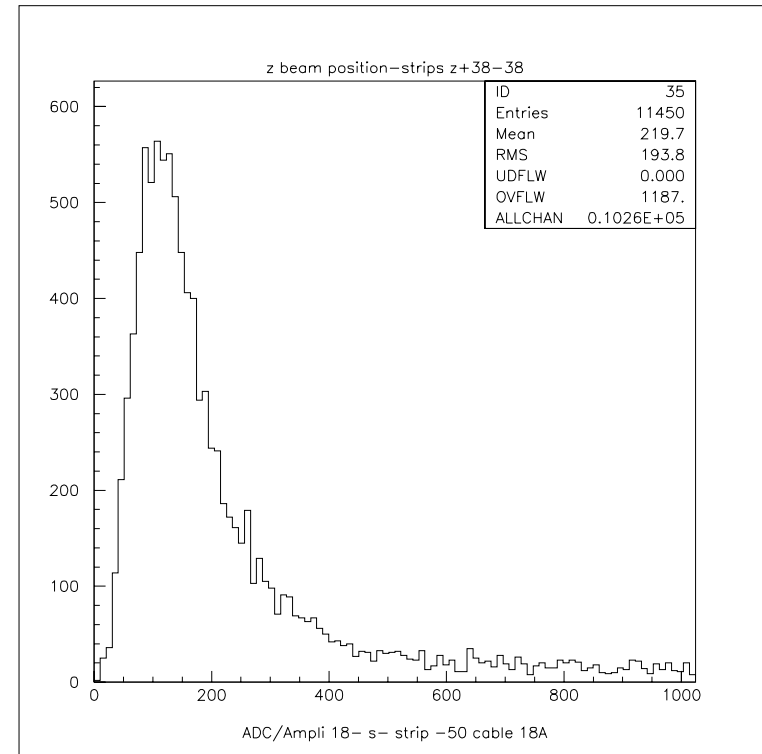
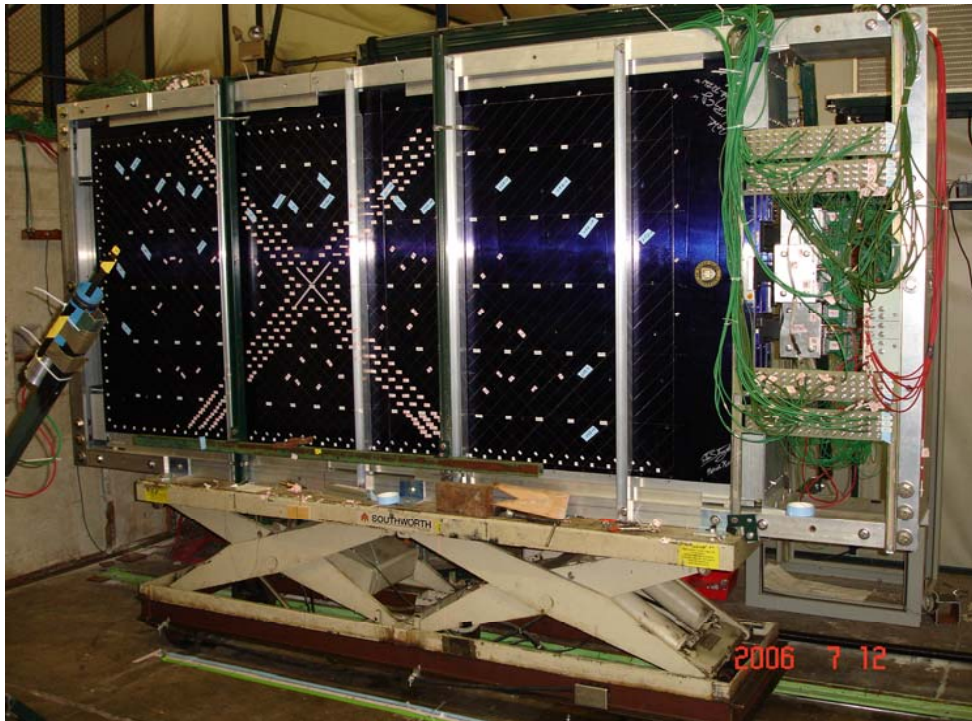
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Muon Activities

Band

- RPC or extruded scintillator
- Scintillator activities
 - Completed the initial runs at MTBF (FNAL T956)
 - FNAL+IU+WSU+ND scintillation counter
 - Plans to take
 - Longer duration run in 2007



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Vertex Detectors

- These groups need high E particles to minimize multiple scatterings
- Asian FPCCD group
 - Basic property study to be done at 3GeV electron test beam at KEK (if approved) after 2007
 - Radiation damage study to be done at 140MeV e beam at Tohoku U. in 2007 – 2009
- LBNL group has been using LBNL radiation facility for CMOS and SOI sensor tests
 - Will need high energy (>50GeV) pion beams
 - One week in late 2007 and two periods of one week in 2008
- FNAL-Perdue-Cornell 3D & SOI group
 - Plans to being test beam work in 2007
 - Expects to maintain ~ 3 weeks/quarter through 2010

Vertex Detectors

- CAP CMOS sensors by Hawaii and KEK
 - Expects two periods of one week in 2007
 - One 2wk+1wk in 2008 and 2009
 - All this at FNAL
- Chronopixel group also plans to use FNAL
- LCFI collaboration to test CCD at DESY and FNAL
 - Utilize EUDET infrastructure
- DEPFET program plans
 - Two periods of runs at CERN in 2006
 - Study detailed charge collection and position resolution
 - Two periods of 2 wks of high E beams in 2007 and 2008
 - Plans to use CERN and DESY beams
 - More thinned prototype in 2009
 - One period of 2wk high E beam

Tracking Groups

- Collaboration between regional efforts increasing
- High precision TPC groups
 - Requires high field, large bore magnet
 - TPC groups built and tested several small prototypes (30cm)
 - Building large prototype
 - To test at DESY EUDET facility in 2007 – 1TeV large bore solenoid
 - GEM and Micromegas end plate solutions to be tested till end of 2008 at DESY
 - SiTPC to be ready by the end of 2008
 - Testing at higher momenta to follow – Plan to use FNAL
- Si microstrip groups
 - SiLC group plans 1 – 2 Mo of high E beam exposure through 2010
 - At FNAL and at CERN
 - Some US Si tracker activities anticipated starting late 2007

Planning

- Technology choices for detector concept studies should complete by late this decade
- Many detector groups anticipate to run in late 2007 and 2008 time scale
 - Available facilities for calorimeters with hadrons limited
 - FNAL's MTBF
 - CERN → LHC commissioning highest priority; Not clear what the test beam plan is in 2007 and beyond
 - SLAC ESA schedule not clear beyond 2008
- Intensified prototype testing and calibration expected starting early next decade
- A calorimeter and muon plans and requirements documented in 2005
 - FNAL-TM 2291

Total of 11 Projects in TM-2291

Calorimeter	Project	Lead institution
ECAL	Silicon-Tungsten (CALICE)	LLR
	Silicon-Tungsten (US)	SLAC, Oregon
	Scintillator-Tungsten	Shinshu
	Scintillator-Tungsten	Colorado
	Scintillator-Silicon-Tungsten	Kansas
	Scintillator-Silicon-Lead	Padova
HCAL	Scintillator-Steel	DESY
	RPC-Steel	ITEP, ANL
	GEM-Steel	UTA
Muon-detectors/tail catcher	Scintillator-Steel	DESY/FNAL/NIU
	RPC-Steel	Frascati

28 institutions from 3 regions

Planning

- Need an updated planning document for anticipated activities in the next 3 – 5 years
- Discussed with Fermilab on ILC person's participation in beam test planning committee
 - Optimize ILC activities and incorporate them into the schedule
- Fermilab ILC Task Force recommendations includes
 - Increased resources to ILC test beams
 - Serious investigation into increasing capacity of the facility
 - e.g., Utilization of Neutrino area



MC
MT

NWA

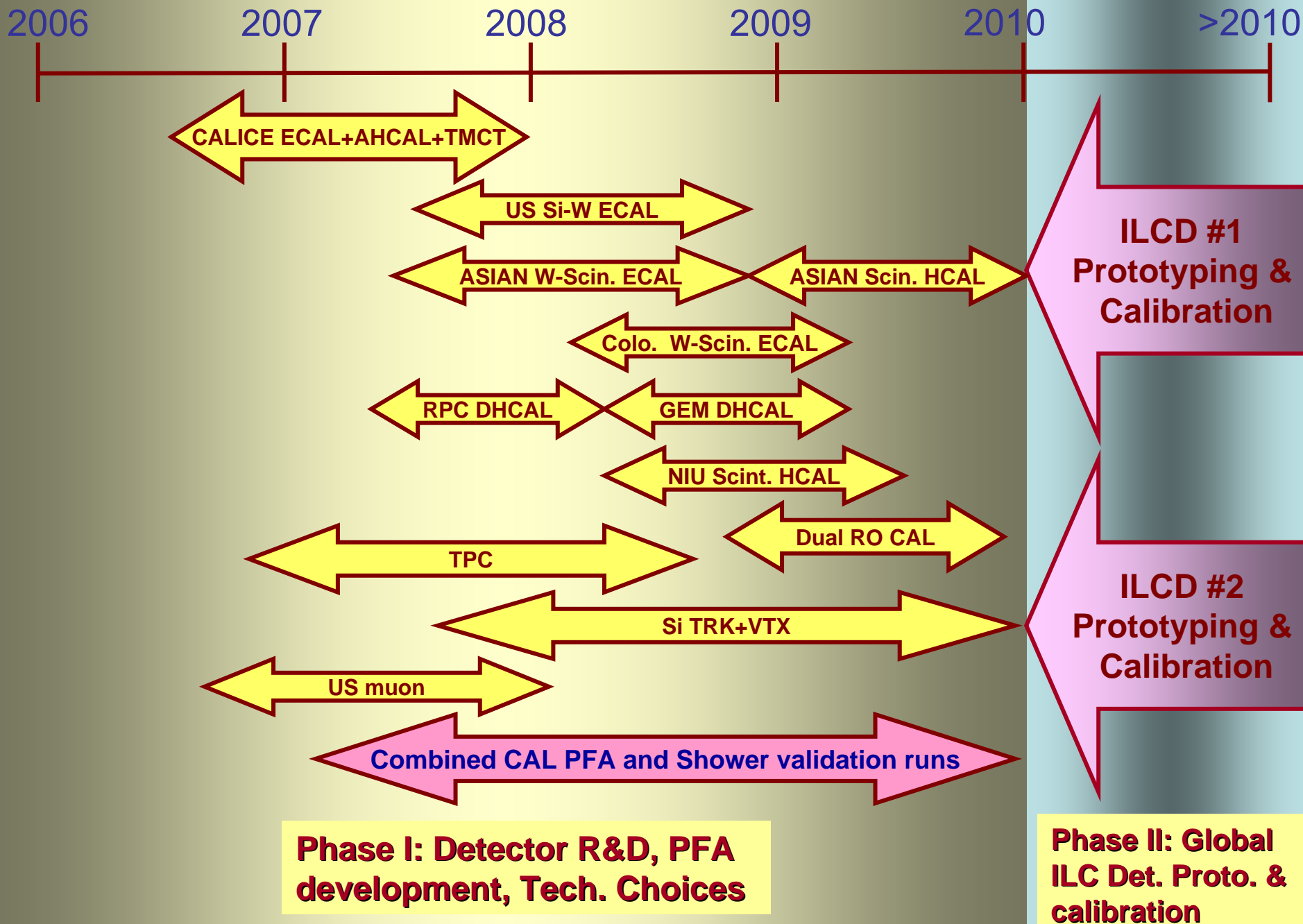
Lab-E

KTeV

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Timeline of Beam Tests



Now the questions to ourselves

- What do we want to learn from full scale test beam?
 - We know that we will learn performances of new technologies
 - Can we answer questions on optimization?
- But perhaps more important questions are ..
 - What do we learn from test beam w/ full 1m³ calorimeter for PFA?
 - How can we learn what we want to learn?
 - What are the experimental measurements to accomplish the goals?

In an attempt to answer these questions...

- An ILC Detector Test Beam Workshop will be held at Fermilab
 - Dates: Wednesday Jan. 17 – Friday, Jan. 19, 2007
- The goals of the workshop are
 - To review the current status and plans of facilities
 - Review the current and planned test beam activities
 - Discuss and plan for the future beam test activities
 - What have we learned from LHC beam tests?
 - What can we learn from test beam activities?
 - What should the future beam test activities focus?
 - Put together a team to write document to provide critical input to facility managers, users and the development of the road-map document

Conclusions

- A lot of beam test activities are in progress and are planned
 - Still calorimeter driven but other detectors seem to be picking up as well
- Some good news in funds to support large scale beam test activities
- Intensity of beam test activities is already growing
- Better communication between detector developers and simulation experts
- Efforts in better coordination and planning necessary
- Hope to see most of you at the ILC TB workshop!!