American Test Beam Plans

José Repond
Argonne National Laboratory

LCWS, Vancouver, Canada, July 19 – 22, 2006

Four efforts…

1) **Silicon – Tungsten ECAL**

   Brookhaven, Oregon, SLAC

2) **Resistive Plate Chambers (RPCs) for HCAL**

   Argonne, Boston, Chicago, FNAL, Iowa, ITEP Protvino

3) **Gas Electron Multipliers (GEMs) for HCAL**

   FNAL, UTA, Washington

4) **Scintillator strips for Tail Catcher/Muon Tracker**

   DESY, FNAL, NICADD, Northern Illinois

There are more, but not close to using test beams…

Overview of past Beam Use

2) RPC Tests in Fermilab's MT6 Test Beam

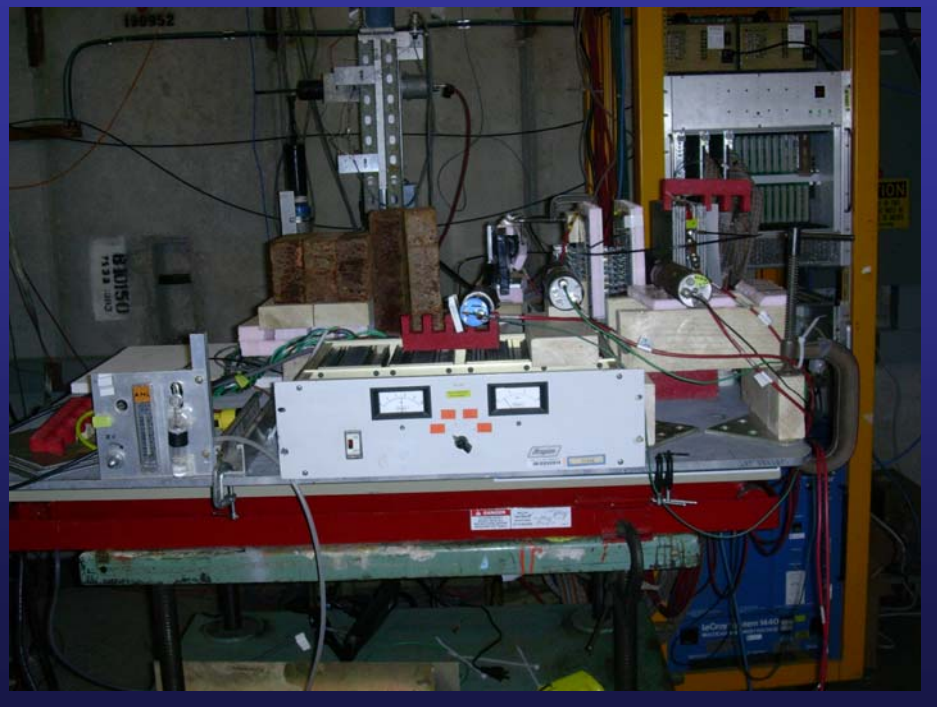
Signed MOU in December 2005

Dave Underwood spokesperson

T955

Started setting-up behind beam dump in January 2006

2 RPCs with 64 channels and VME readout (events in the two chambers can be correlated)
→ Chambers based on different design (1 vs 2 glass plates)
1 RPC with 32 channels and shift register readout (independent DAQ)
Beam telescope with 4 scintillation counters
→ Trigger area ~ 4 cm^2



Moved into beam on February 22

Took data for ~2 x 6 hours
Beam = 120 GeV/c protons
4 second spill every 2 minutes
Requested variation of beam intensity between 70 and 5000 Hz/cm^2
Also took data with block of steel in front of RPCs

Experiences at MT6

a) Safety

Trouble getting gas system approved by safety review committee
Committee requested - use of approved tanks
- use of gas fittings (worse) instead of water fittings (much better)
- detailed description of gas mixing procedure

Spent weeks in trying to accommodate safety committee

b) Environment

February was particularly cold and wet
Freon liquefied in tanks and gas lines (when outside beam area)
Roof leaks → puddles, high humidity

c) Beam intensity

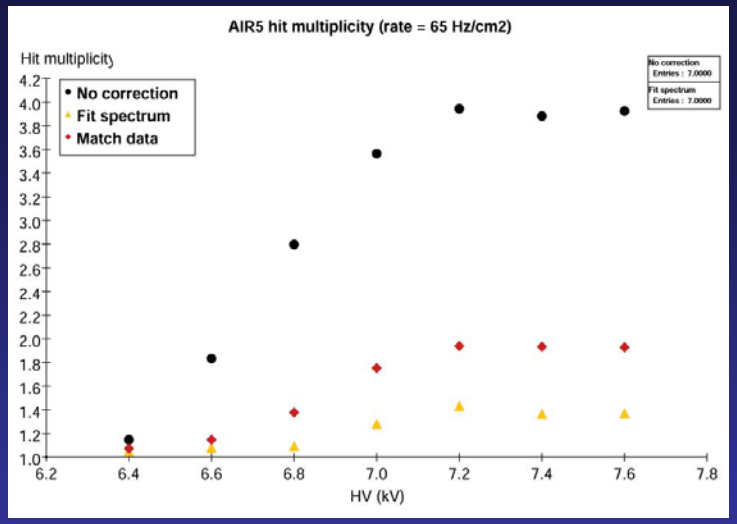
Easily adjusted to requested values
Usually new setting established between spills (no beam losses for data taking!)
→ Many thanks to FNAL beam crew for excellent performance

Results from MTBF

Used 120 GeV/c protons

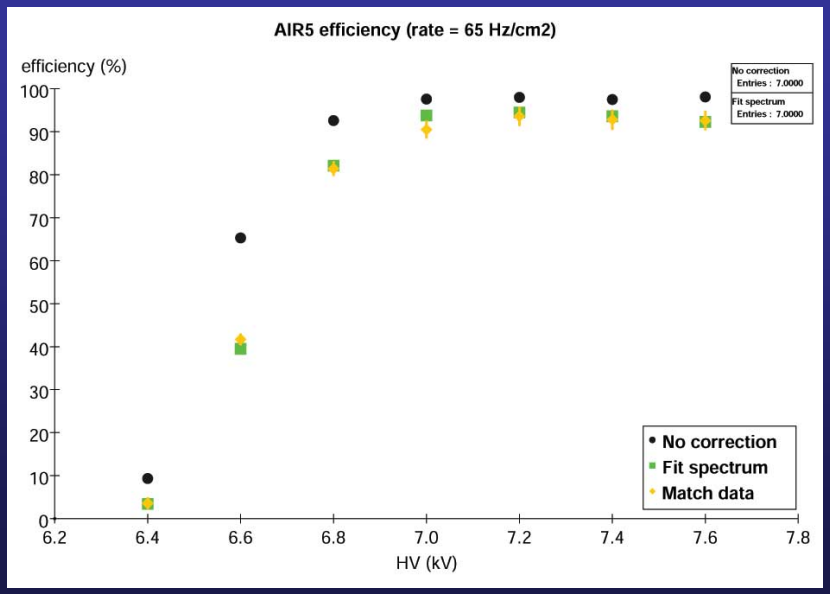
Set-up off beam axis → high particle multiplicity

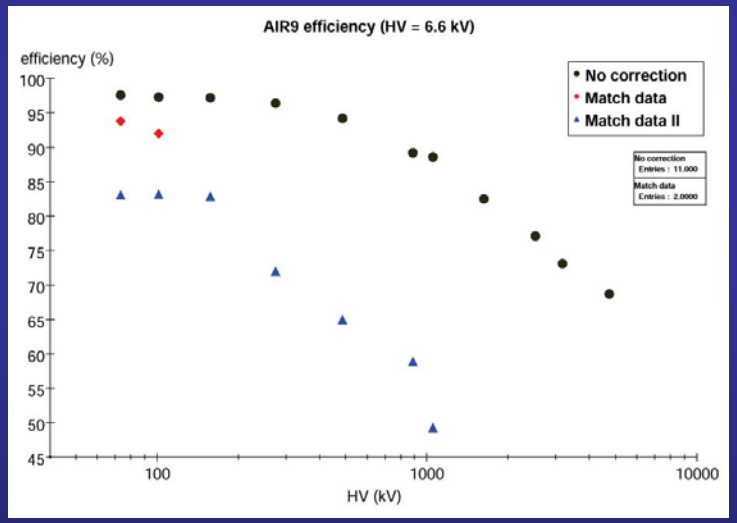
Unintentional!
Trigger selects events from upstream showers
Complicated correction procedure applied to determine efficiency and pad multiplicity



Pad multiplicity

MIP detection efficiency





MIP detection efficiency versus trigger rate

Results consistent with measurements done with cosmic rays

3) GEM Tests in KAERI Test Beam

Korea Atomic Energy Research Institute

Electron beam

2 – 10 MeV
High intensity 30 ps pulse of 10^{10} e^-

1 GEM

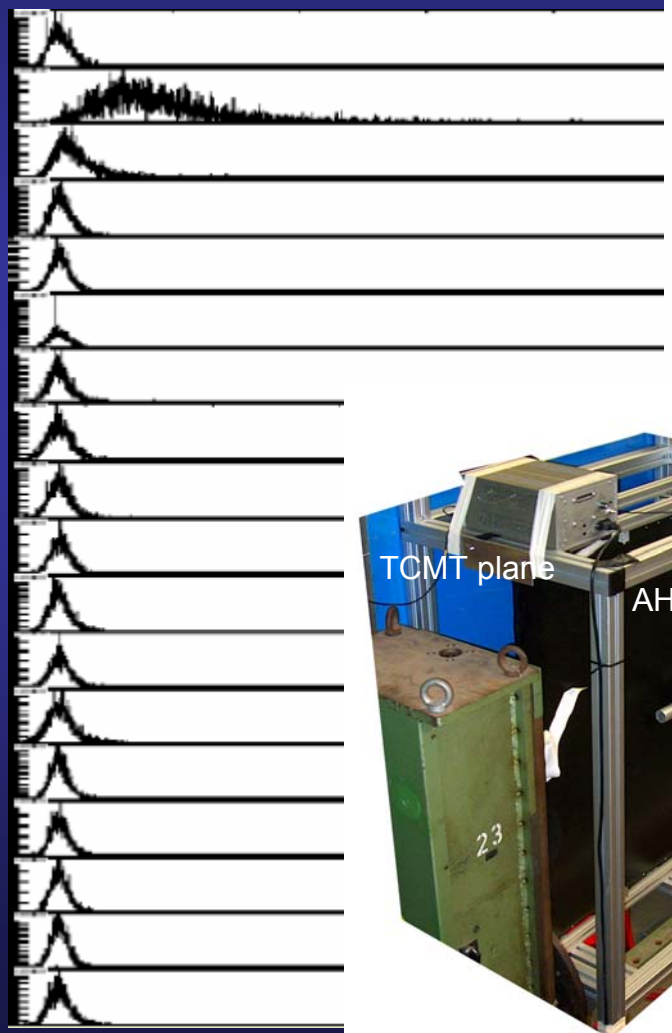
30 x 30 cm^2 chamber
2 x 2 pad readout
Each pad with an area of 1 cm x 1 cm

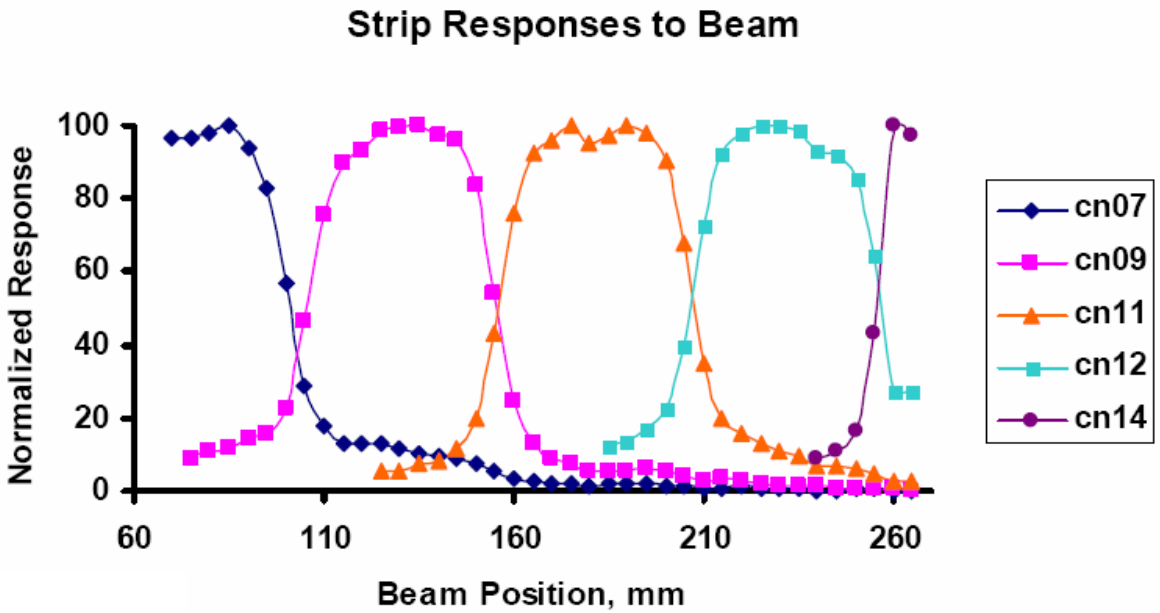
Exposure

$2 \cdot 10^{12}$ e^-/pad on GEM
Corresponds to $1.6 \cdot 10^{-2}$ mC/mm^2

No changes to GEM observed

4) TCMT Tests at DESY and FNAL





A) Tests at DESY

- Involved 1 layer with 18 readout channels
- 5mm thick strips with a width of 5 cm
- October – November 2006

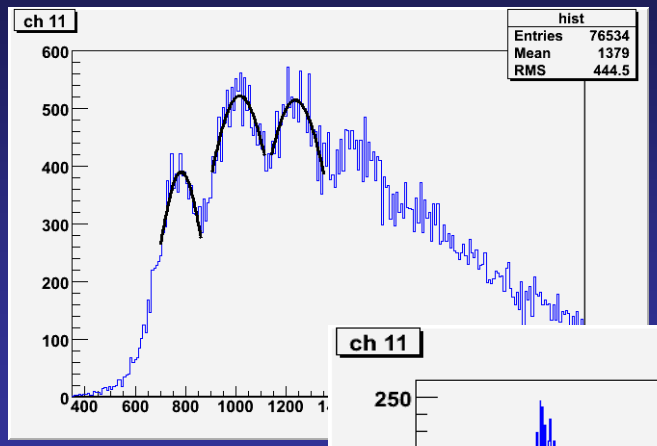
Measurements with 3 GeV/c electrons

- Clear signal in hit strip
- Performed transverse scans

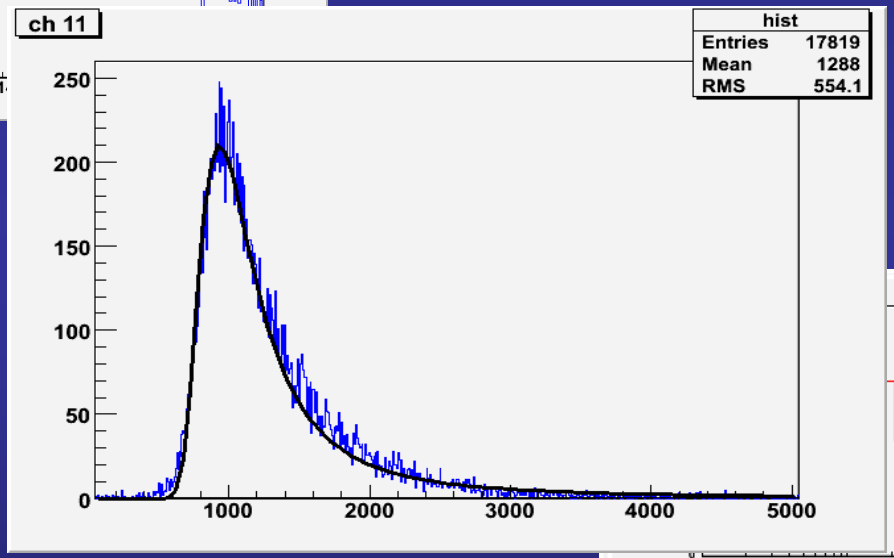
B) Tests at MT6

- Involved 1 layer with 18 readout channels
- With complete CALICE DAQ chain
- February 2006 (5 days)
- 120 GeV protons and 16 GeV/c pions, some muons

Results from MTBF

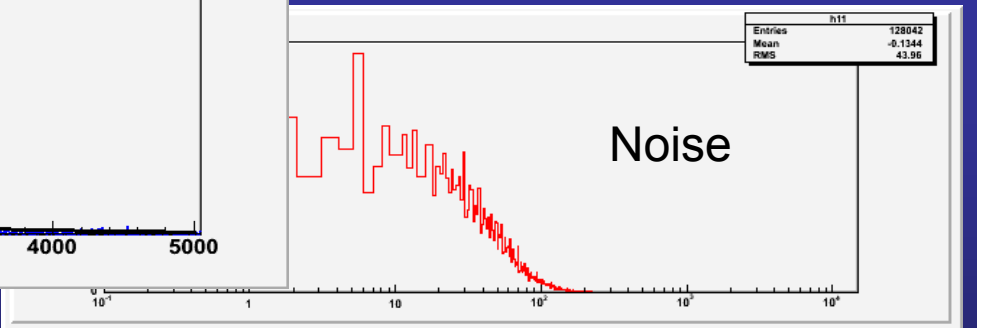


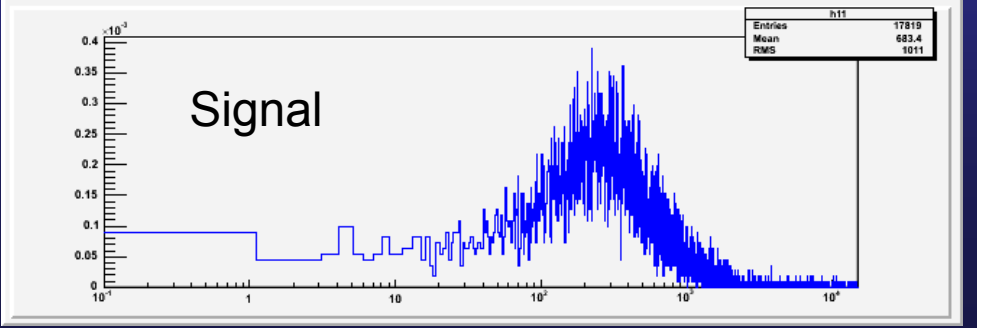
Calibration data showing single photoelectron separation



Raw ADC counts from 120 GeV protons

After subtracting pedestals

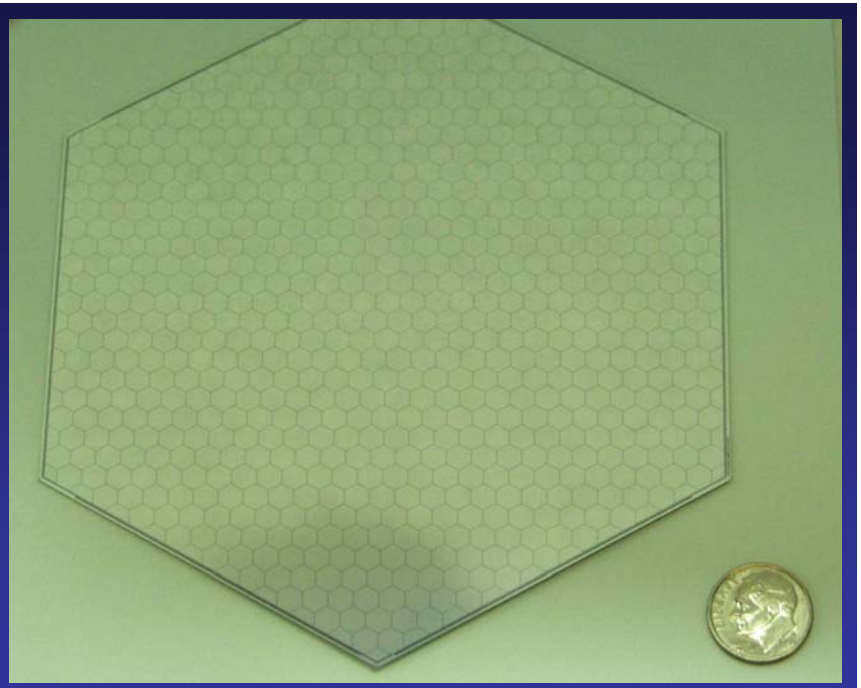




On average 10 – 12 photoelectrons/MIP

Future plans for Beam Use

1) Silicon – W Plans



A) Technical test

- Involves 1 – 2 layers
- Use KPiX-v2 with 64 readout channels
  (bump bonded)
- Tests in electron beam (SLAC)
- Planned for late 2006 or early 2007

B) Full module tests in electron beam

- Full depth module with 40 layers
- Use of 1024 channel KPiX chip
- Measurements of electro-magnetic response and resolution
- Planned for mid – late 2007 at SLAC

C) Full module tests in hadron beam

- Move module to FNAL
- Tests with the CALICE HCAL prototypes in FNAL test beams
- Planned for 2008?

2) RPC plans

A) Slice test

- Up to 10 chambers with a total of 2500 channels
- Almost final electronics as developed for Prototype Section
- Planned for January 2007 at MT6

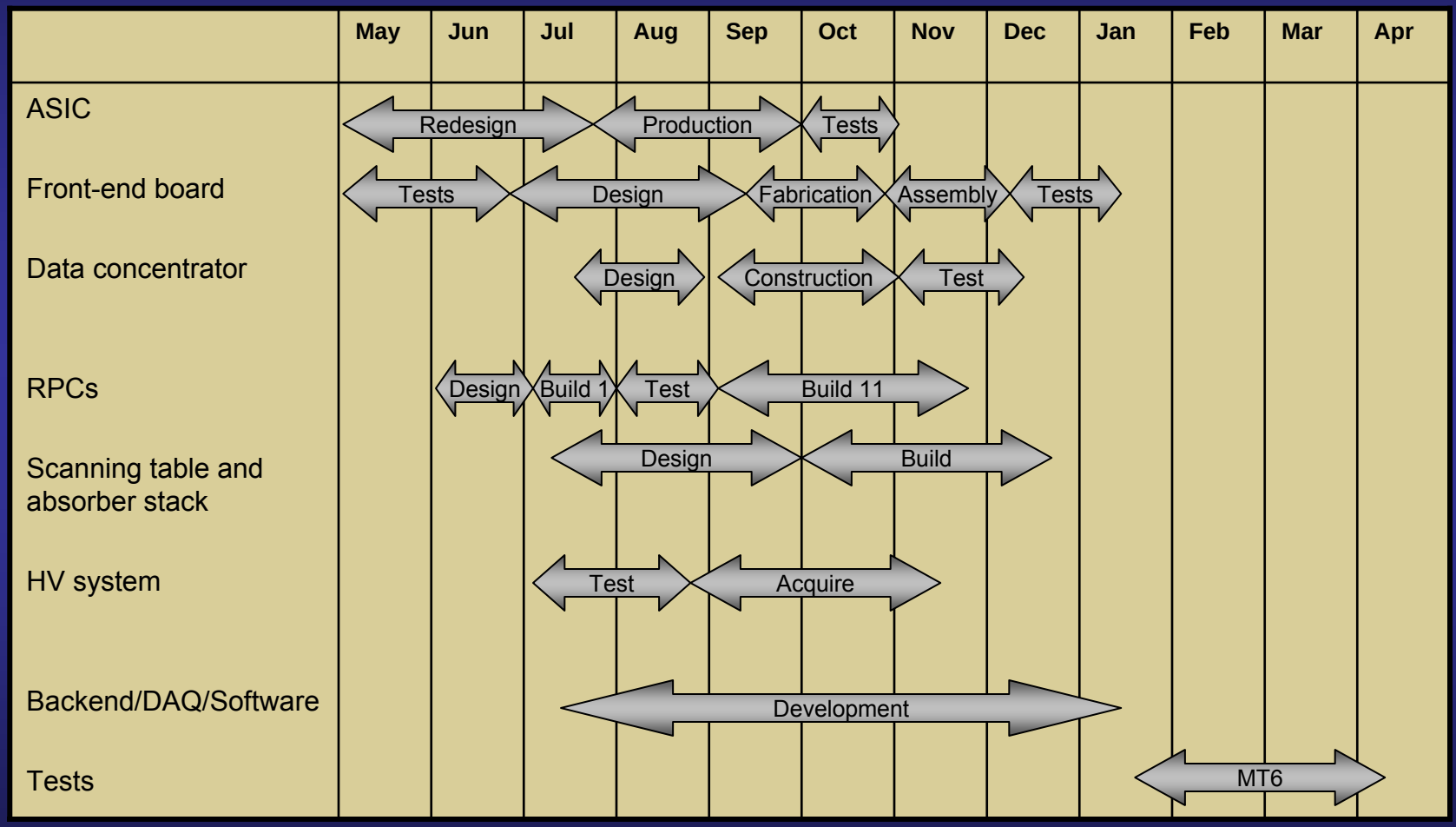
Organized effort to avoid problems encountered in first tests at MT6

- Independent HV supplies for each chamber
- Minimize material in front of detector (He bag?)
- Proper mechanical structure
- Low pressure gas supply (avoid liquefying)
- Gas manifold (avoid pressure changes due to leaky chambers)
- Integration of beam information into data stream
- Proper beam telescope

Goals/purpose of slice test

- Track MIPs through 10 chambers
- Measure efficiency, pad multiplicity, rate capability
- Prove viability of proposed system for extrapolation to prototype section
- Prove concept of single-bit readout (comparison to MC expectations)

Time Scales for Slice Test



DHCAL Meeting at ANL in 2nd week of August

B) Prototype section

- 120 chambers with a total of ~400,000 channels
- Electronics tailored to test beam needs

  No power pulsing
  100 ns time bins
  (Only) 64 channels/ASIC
  Thickness not optimized

- Planned for CY 2007 – 8 at MT6

Assuming funding available in FY 2007

- Construct 120 chambers + spares
- Produce 8,000 DCAL chips
- Produce FE-boards, data concentrators, super concentrators
- Backend still to be defined (several options)
- Build gas mixing station and manifold…
- Move to MT6 by the end of 2007

Goal/purpose of tests with prototype section

- Prove viability of hadron calorimetry with RPCs
- Perform precision measurements of hadronic showers
- Provide data base to compare to models of hadronic showers
- Gain experience for developing hadron calorimetry for the ILC detector

3) GEM plans

A) FNAL beam tests

- Two 30x100 cm^2 chambers with 96 readout channels (multi-bit)
- Planned for Fall 2006

Goals/purpose of FNAL tests

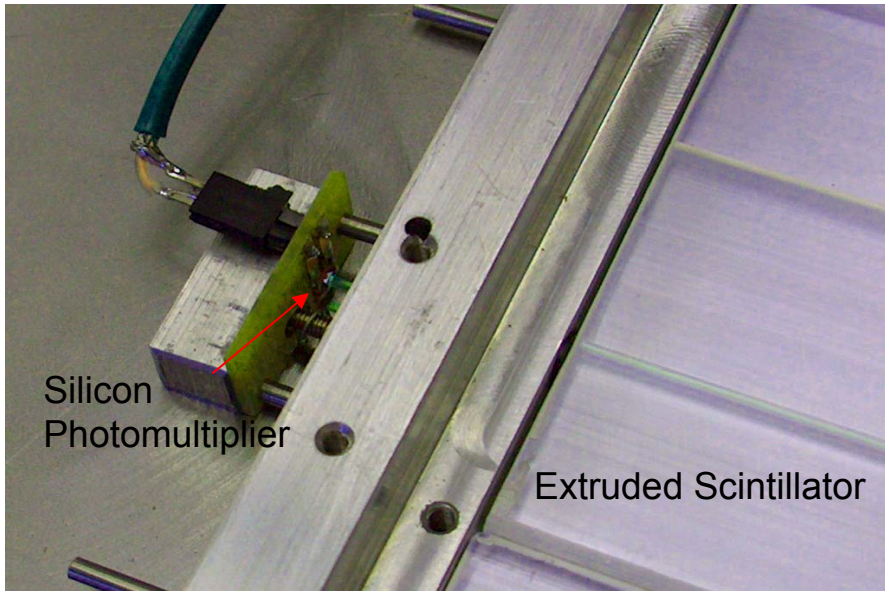
- Establish data taking with new PCI based ADC DAQ card
- Measure response of chambers to EM and HAC showers
- Measure response to μ beam and MIP response

B) Slice test

- Together with RPC effort
- Test of 1 – 5 chambers
- Early 2007

C) Prototype section

- 120 chambers
- Same electronics as RPC tests
- In ~ 2008


Silicon
Photomultiplier
Extruded Scintillator

FNAL Test Beams

Test Beams at FNAL

Current status: MTBF

Protons 120 GeV/c, 5 – 66 GeV/c
Pions 5 – 66 GeV/c
Electrons 4 – 16 GeV/c
Particle ID provided by Čerenkov counters

Planned improvements

Move target downstream: provide pions and electrons with p ~ 1 GeV/c

Use of MCenter?

Currently occupied by the MIPP experiment
Use MIPP to provide tagged neutrons and K_L^0

$p + H_2 \rightarrow p + \pi^+ + n$
$K^- + H_2 \rightarrow p + \pi^- + K_L^0$

↳ Particles to be measured by HCAL within the PFA paradigm