SiD Calorimeter Meeting

Hadron Calorimeter

Tasks, Schedules, Milestones

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SiD Hadron Calorimeter

R&D Areas

1) Hardware (the "easy" part?!)

   - Digital approach (RPC, GEM)

   - Scintillator/SiPM (NIU/CALICE)

2) Simulation

   - Status, areas not studied, new combinations, test beam expectations,…

3) PFA

   - implications for HCal design, feedback to PFA

4) HCal in overall calorimeter design

DHCAL – RPC/GEM (J. Repond)

Staged approach

Ia R&D on RPCs
Concept of electronic readout system

⇨ **Tests with cosmic rays and in particle beams** — **Done**

Ib R&D on GEMs

⇨ **Tests with cosmic rays and in particle beams** — **Planned for 2006/7**

II Prototyping of RPCs and GEMs for prototype section (PS)
Prototyping of all components of electronic readout for PS

⇨ **Slice test in particle beam** — **Planned for 1/2007**

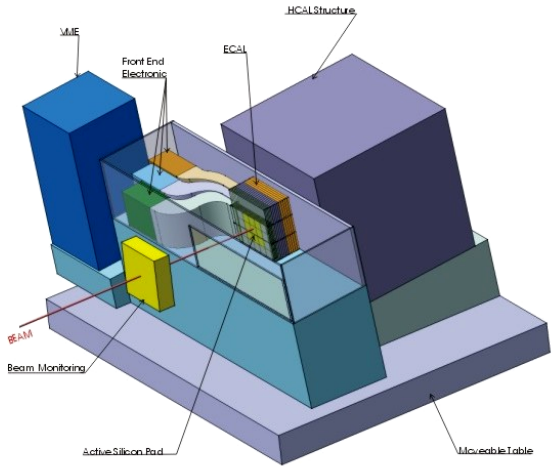
IIIa Construction of Prototype Section with RPCs

⇨ **Detailed test program in Fermilab test beam** — **Earliest in 2007**

IIIb Construction of Prototype Section with GEMs

Detailed test program in Fermilab test beam — **Earliest in 2008**

DHCAL – RPC/GEM (J. Repond)

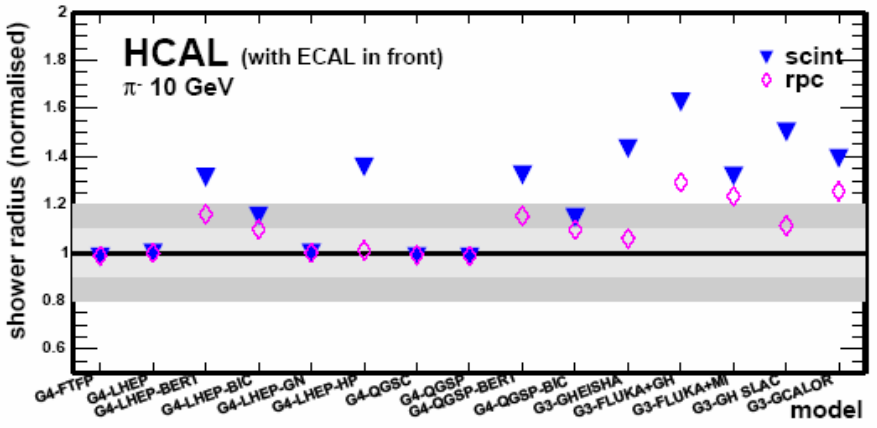


Prototype section (PS)

1 m^3 (to contain most of hadronic showers)
40 layers with 20 mm steel plates as absorber
Lateral readout segmentation: 1 cm^2
Longitudinal readout segmentation: layer-by-layer
Instrumented with Resistive Plate Chambers (RPCs) and Gas Electron Multipliers (GEMs)

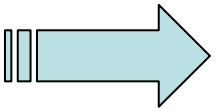
Motivation for construction of PS and beam tests

Validate RPC and GEM approach (technique and physics)
Validate concept of the electronic readout
Measure hadronic showers with unprecedented resolution
Validate MC simulation of hadronic showers
Compare with results from Scintillator HCAL



DHCAL – RPC/GEM (J. Repond)

HV	Identify module and test with chambers	Iowa
Gas mixing	Needs agreement from FNAL to do	Iowa
Beam telescope	Three 1x1 cm^2 plus one 19 x 19 cm^2 counter	UTA
Mechanical structure	Find solution acceptable for RPCs and GEMs	ANL
ASIC testing	Design and build test board, do tests	ANL, FNAL
Front-end boards	Design, prototype, test (Find out about wire bond limitations) → package chips	ANL
Data concentrators	Design, prototype, test	ANL, Chicago?
Data collectors	Define specifications to concentrators, to buffer	ANL, Boston
DAQ software	Investigate CALICE software and other options	ANL, Boston
Trigger and timing module	Find volunteer Implement into data collector?	Chicago? FNAL? Boston?

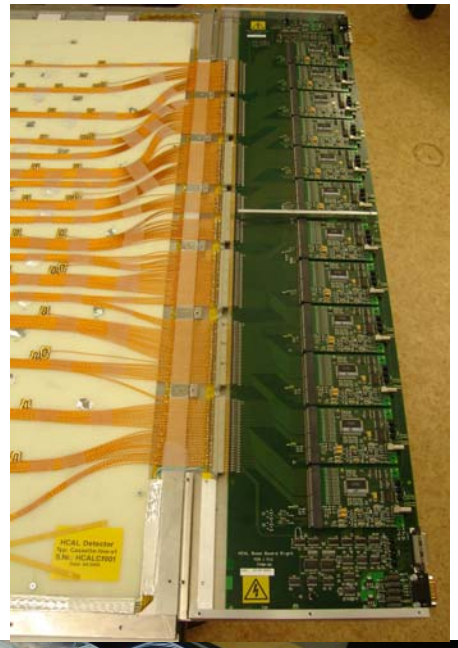


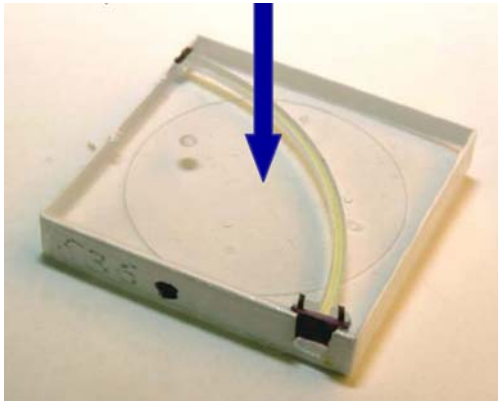
www.hep.anl.gov/repond/Lastname_081006.ppt

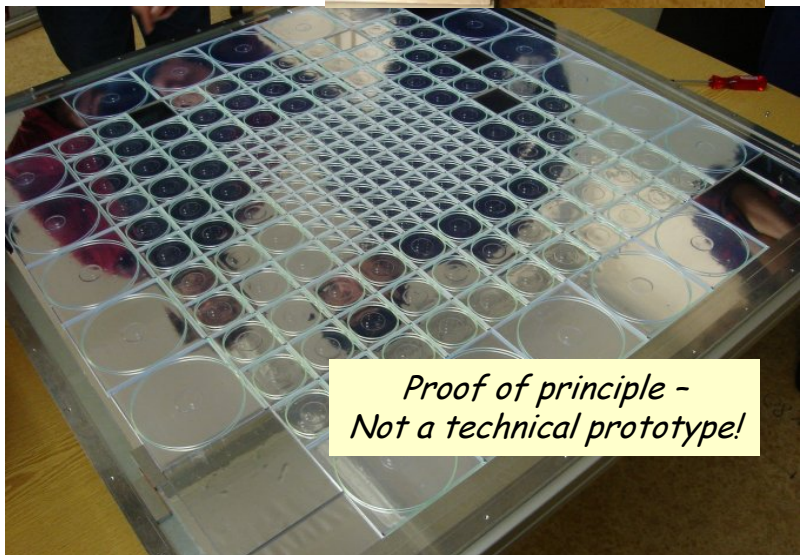
Note: The GEM component of the SLICE test will also test KPix v.3

HCAL testbeam prototype

- Scintillator HCAL construction at DESY
  - Mechanics
    - 1 cubic meter stack, cassettes, calibration light system
    - Assembly (with colleagues from ITEP, LPI, MEPHI)
  - FE electronics
    - With ASICs from LAL
  - Integration
    - 8000 Scintillator tiles and SiPMs (ITEP and MEPHI)
    - Calibration electronics (Prague)
    - DAQ (UK groups)
    - Tail catcher (Northern Illinois)

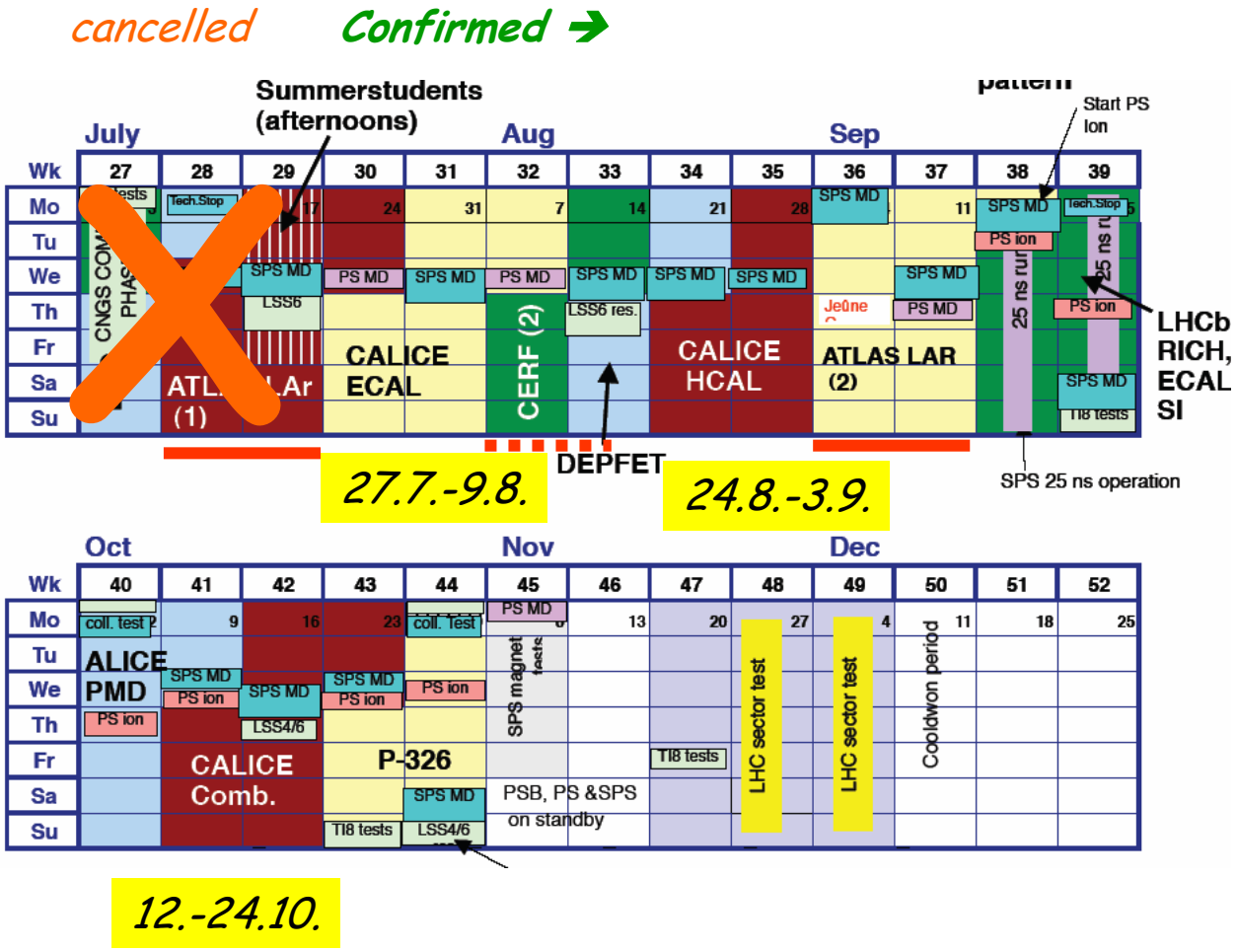






Preliminary testbeam schedule

- Draft schedule for CERN North Area beam line H6
- 3x main user
- Parasitic muon running
- SPS: smooth start-up after major repair
  - First beams in exp areas next week
  - Physics starts July 24th



AHCAL - Goals

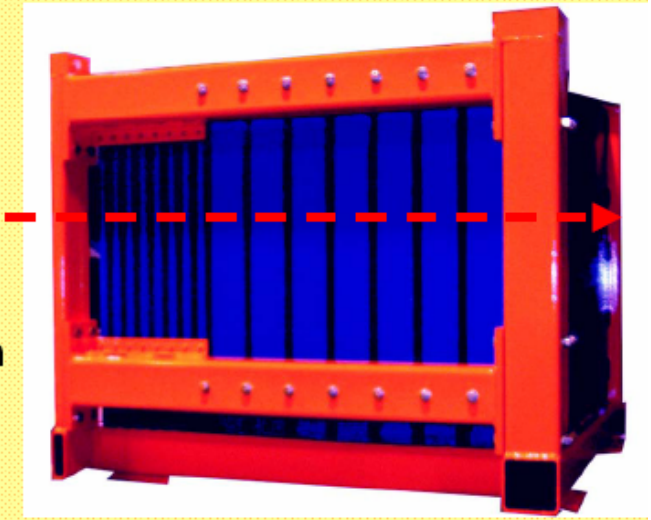
- "CALICE ECAL":
  - 6-50 GeV electrons and pions
  - ECAL: data MC comparisons
  - HCAL: establish detector system and calibration

- "CALICE HCAL":
  - 6-100 GeV electrons and pions (+, -)
  - HCAL: First coarse data MC comparisons with HCAL only
  - TCMT: establish system and calibration

- "CALICE combined":
  - 6-100 GeV electrons and pions (+,-)
  - ECAL + HCAL +TCMT: data MC comparisons
  - Possibly some HCAL standalone with more layers and inclined incidence

CALICE TCMT Prototype

The absorber has 8 layers of 2 cm thick and 8 layers of 10 cm thick steel.
Length is 142 cm.
Height is 109 cm.
Weight is about 10 tons.

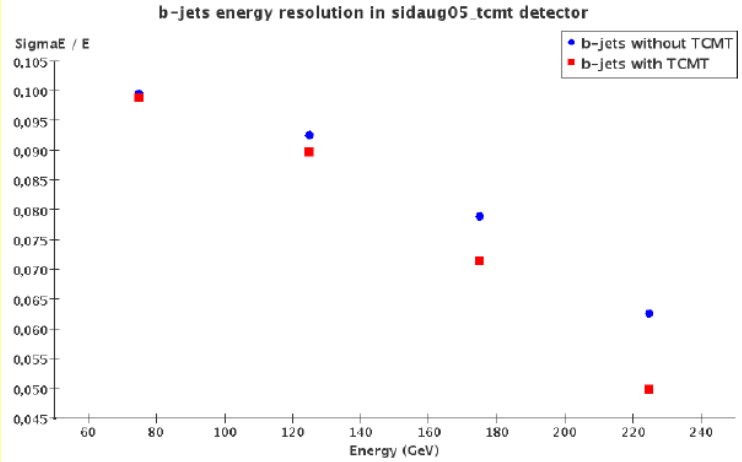


TCMT has 16 cassettes with about 1x1 m² active area, made from 5 cm extruded scintillator strips in alternating x-y orientation.

The construction involves DESY, NICADD at NIU, and Fermilab.

TCMT

TCMT Effect (Calorimeter Only)



HCal – Hardware Issues

- The schedule and nature of the hardware tests imparts a degree of inertia to the program…however:

- Is steel the "correct" choice for absorber; should we plan tungsten tests also?

- DHAL Readout. The Slice Test will use the DCAL chip, but we will also test the KPix v.3 (4?) chip(s) – could lead to an issue in 2007.

- Should we try to boost neutron sensitivity of DHCAL?

- What data (particle type, momenta, number of events,…) will yield the best information for developing the simulation(s), PFA,…

Hadron Calorimeter - Simulation

- Basic studies of HCal response to n, nbar etc. done

- What can be varied in simulations?

  -> Absorber material

  -> Active gap technology/thickness

  -> Depth

  -> (Inner radius)

  -> B-field

  -> plus energy cutoff(s), signal threshold(s)

* Many datasets exist – see Norman's slides

☛ Need to define a program of work on detailed simulations – optimize HCal design - who will do the work??

☛ How far should we push/interpret simulations before we have detailed test beam data??

Hadron calorimeter:

The hadron calorimeter is a Tungsten/RPC sampling calorimeter.

It is composed of 50 layers of

material thickness

Tungsten 0.75cm

PyrexGlass 0.11cm

RPCGas 0.12cm

PyrexGlass 0.11cm

Air 0.16cm

G10 0.25cm

Plus…similar GEM version available

Simulated HCal's

Hadron calorimeter:

The hadron calorimeter is a Steel/Scintillator sampling calorimeter.

It is composed of 34 layers of

material thickness

Steel235 2.0cm

Polystyrene 0.5cm

G10 0.3cm

+TCMT

Hadron Calorimeter - Simulation

- Test beam simulations:

  "Easy" geometry – but needs dimensional care (we are testing 1cm^2 cells!)

  How much can we learn from 2007 slice test(s)?

  How much will GEANT4 develop over the next 1-2 years?

  If CDR's are really expected in 2008, we need to be prepared for a fast cycle of simulation/data comparison, feedback to and optimization of PFA's, and demonstration of SiD capabilities.

☛ Need to have a schedule/identify people for all this soon!

Hadron Calorimeter - Simulation

Tasks:

- Systematic study of RPC/GEM/Scintillator/absorber/depth… options for range of particle types/energies (some of this exists – need to complete) – Norman/IPR.

- Detailed studies: ECal/HCal boundary; e.m. measurement in first layers of HCal;

- Test beam simulation ($1m^3$)/SLICE test?

- Neutron effects: gas/scintillator.

- Fixing PFA parameters for design choice optimization.

- Study HCal rates/segmentation/… for forward angles

HCal in overall calorimeter design

So far the HCal design has focused mainly on a concept for barrel modules (V.Guarino/ANL).

Extend to a complete HCal system ⊕ integrate into an overall calorimeter system design, with constraints from other subsystems in SiD.

HCal in SiD assembly process?

Cost compromises? Inner radius, depth, cell size,…?