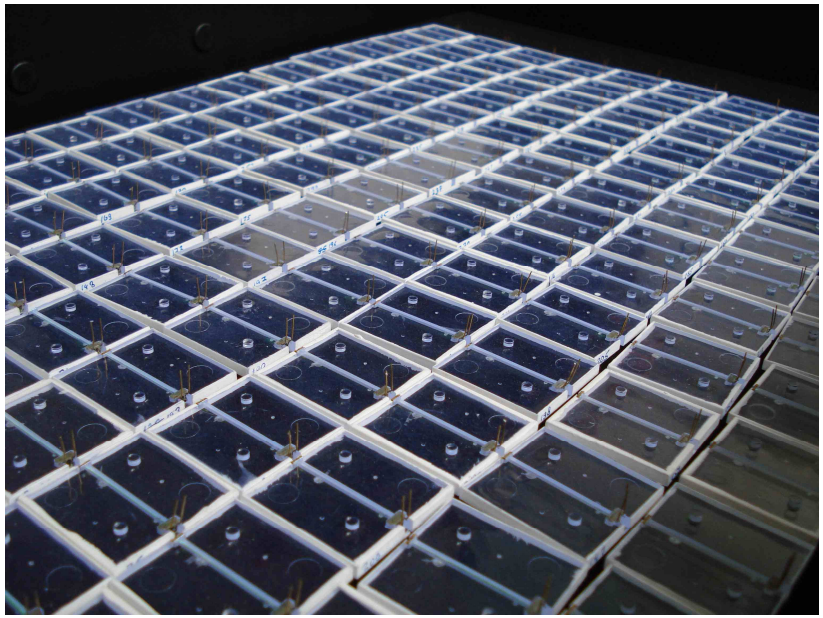
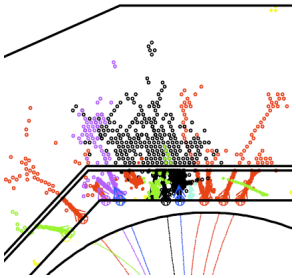
Scintillator HCAL future plans



Felix Sefkow

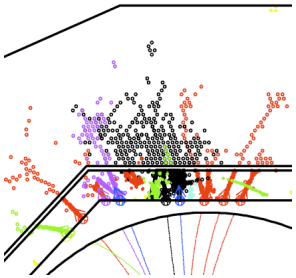
HCAL main meeting

DESY, December 10, 2009



Outline

- Goals of a second generation AHCAL
- Prototype roadmap
- The tungsten HCAL



More information

Report to the DESY PRC

The CALICE Collaboration*

November 1, 2009

Project	2010/1	2010/2	2011/1	2011/2	2012/1	2012/2
Phys. Prot. Si-W ECAL/DCHAL/TCMT	xx	xx	xx	-	-	-
Phys. Prot. W ECAL / W HCAL / TCMT		x	x	xx	xx	-
Tech. Prot. DHCAL	x	x	xx	xx	xx	xx
Tech. Prot. AHCAL	x	x	x	x	xx	xx
Tech. Prot. Si-W ECAL	-	x	x	xx	xx	xx
Phys. Prot. DECAL	x	x	x	x	x	x
Tech. Prot. Sc-W ECAL	-	-	-	-	-	x

Table 2: *The table indicate the envisaged testbeam activities until the end of 2012. The symbol – means "No activity planned", The symbol* x *means "Test of small units can be expected", The symbol* xx *means "Large scale testbeam planned".*

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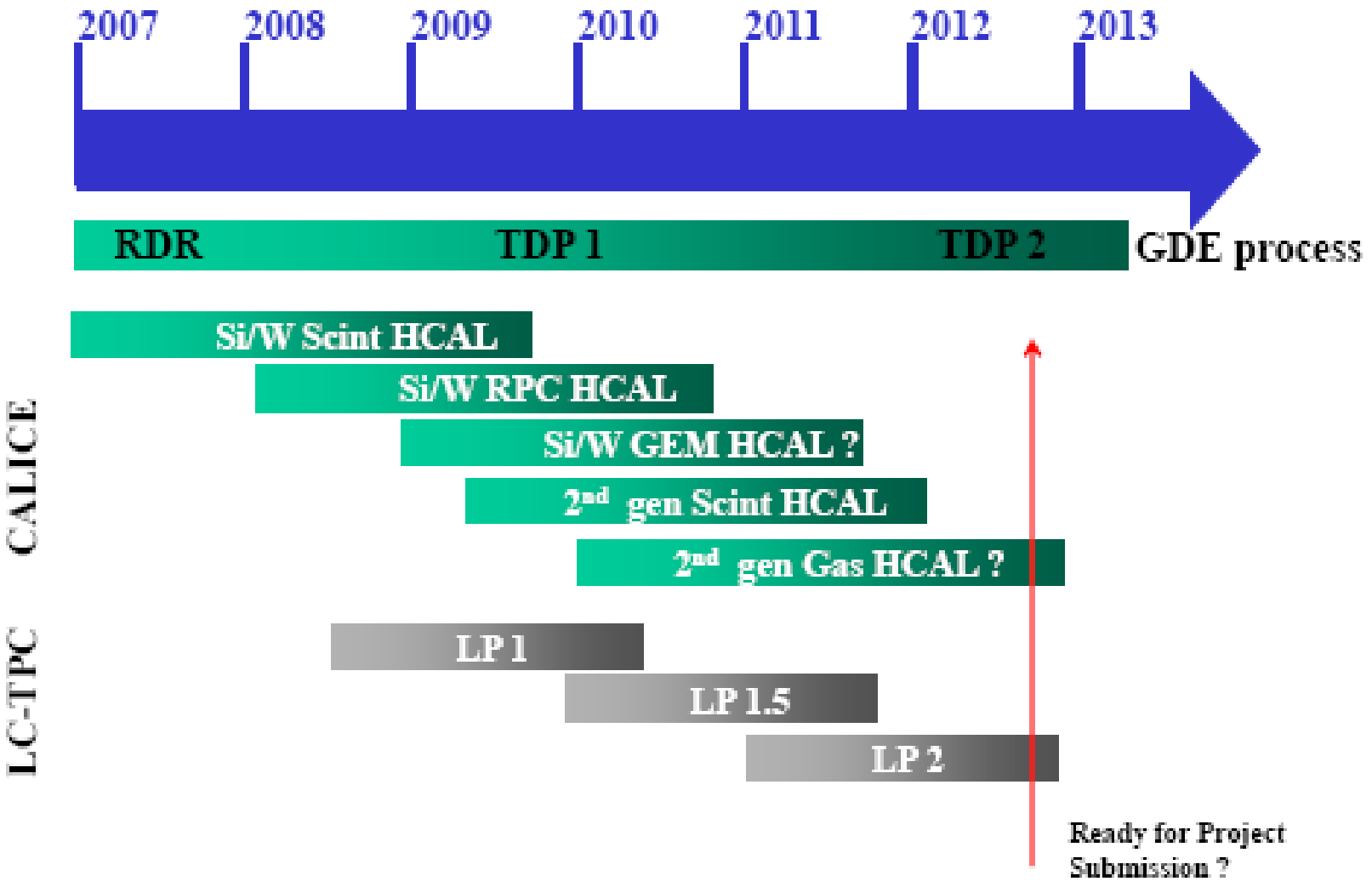
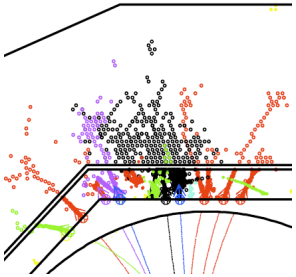
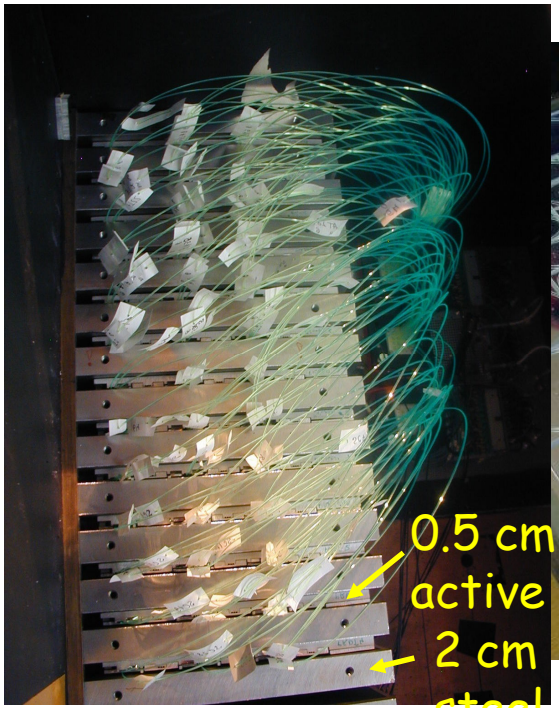
- https://twiki.cern.ch/twiki/pub/CALICE/CaliceCollaboration/CALICE_PRC09.pdf

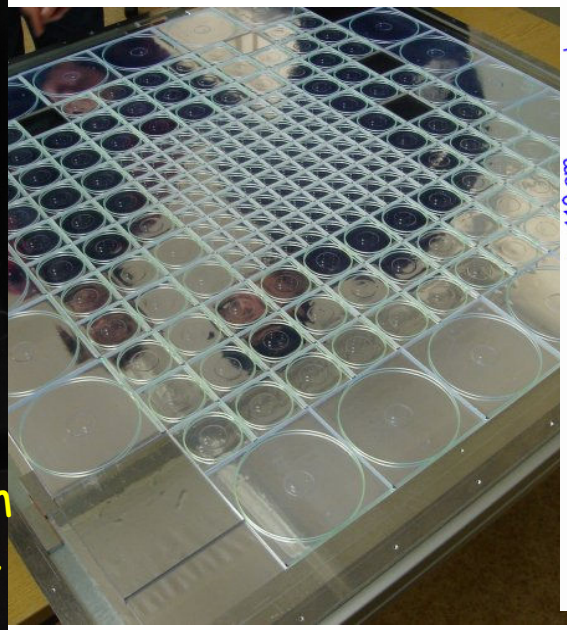
Schedule

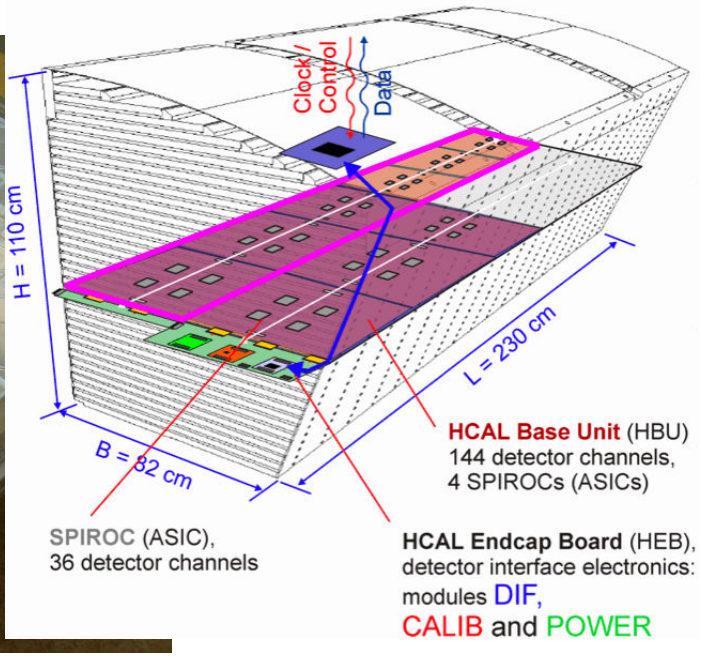

2007
2008
2009
2010
2011
2012
2013
RDR
TDP 1
TDP 2
GDE process
CALICE
Si/W Scint HCAL
Si/W RPC HCAL
Si/W GEM HCAL ?
2nd gen Scint HCAL
2nd gen Gas HCAL ?
LC-TPC
LP 1
LP 1.5
LP 2
Ready for Project Submission ?



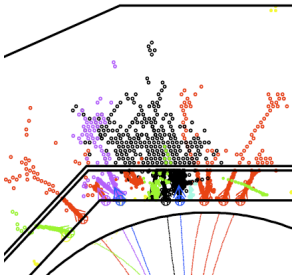
Scintillator SiPM technolgy







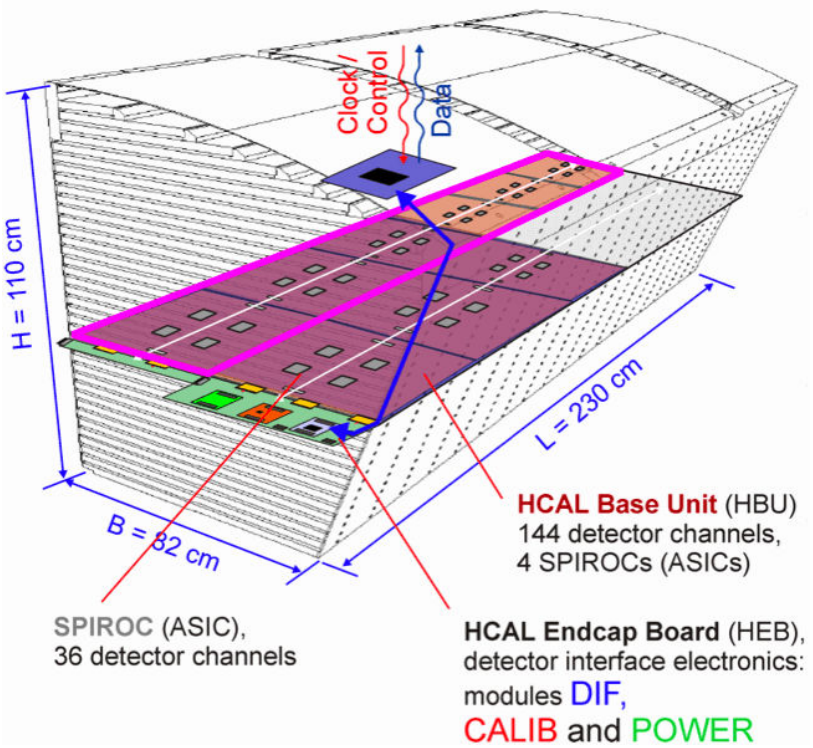
- 2003 2006 2010

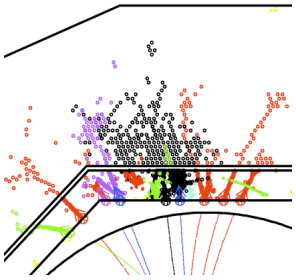


Technical prototype

- Towards a scalable and compact detector
  - Realistic proposal:
    - Dead spaces, tolerances
    - Costing
- Embedded front end ASICS
- Mechanical structure with minimum dead space
- Options for scintillator and photo-sensor integration

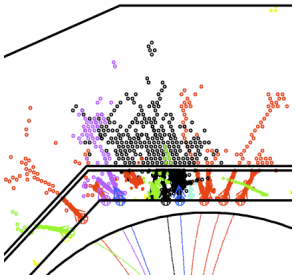
- Technical challenge:
  - Stability with power pulsing and online zero suppression





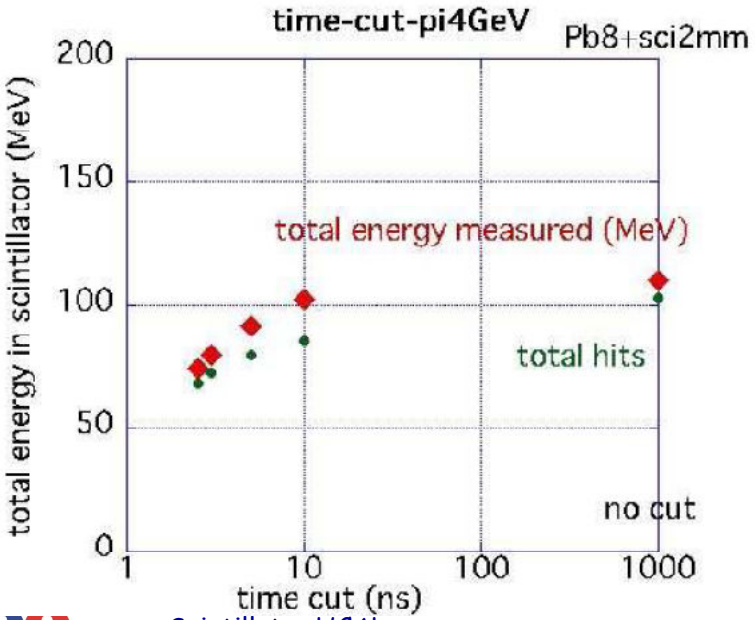
Physics with 2nd generation PT

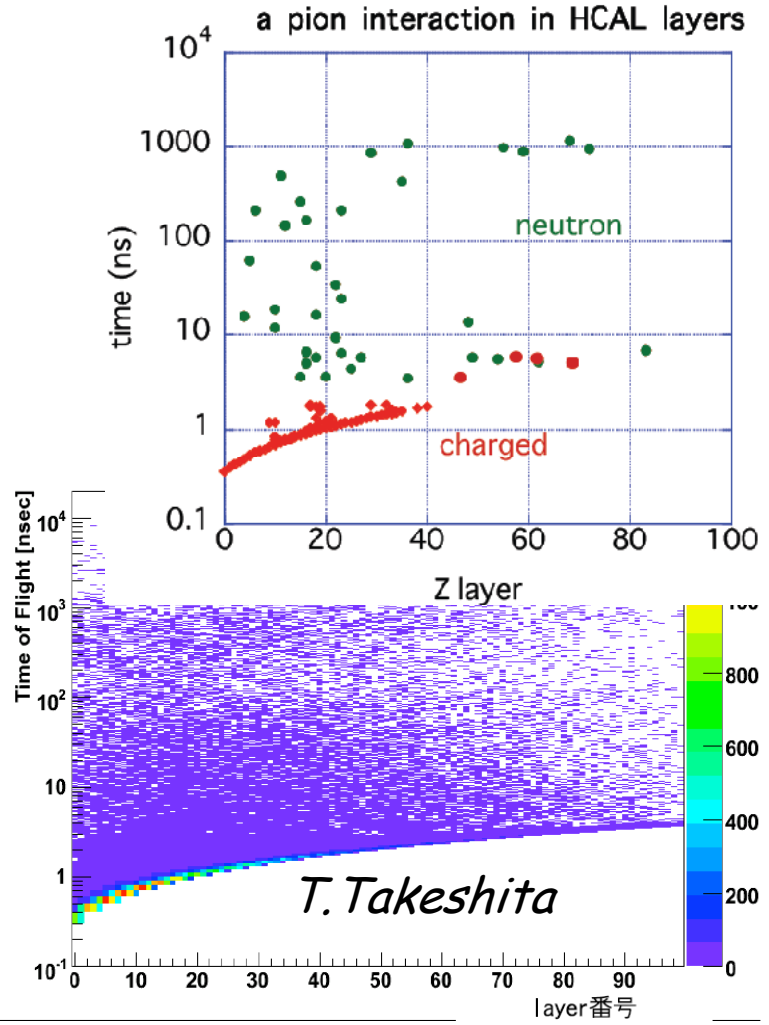
- Validation of shower models for a scintillator steel HCAL will be based on the physics prototype and its ever improving detector understanding
- What will the new prototype add?
- 1. Time measurement
  - Tagging of delayed neutrons ➔ triple readout
  - Validation of simulation and exploitation for particle flow
  - Needs to be modelled with actual electronics performance for different coupling schemes (WLS fibre or direct)
- 2. Larger acceptance with fine granularity
  - PFLOW studies with multi-particle events
- 3. Operation in magnetic field
  - Test shower model prediction, transverse propagation

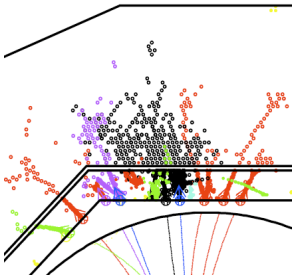


ScHCAL physics

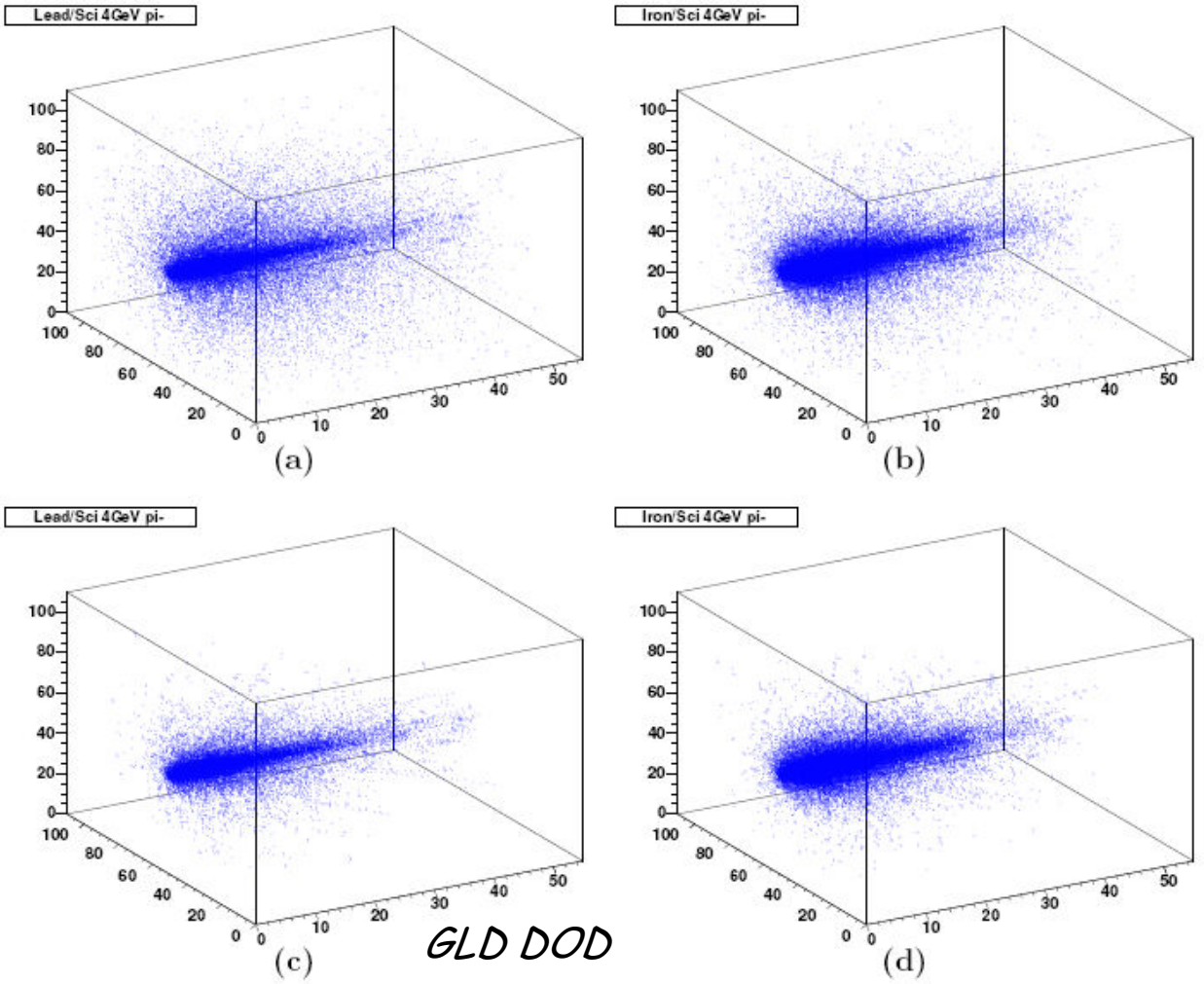
- Use time measurements to tag neutron hits
  - Clean up picture for PFLOW reconstruction ➔ cut at 5 ns
  - Keep late hits for energy resolution ➔ gate open for full bx





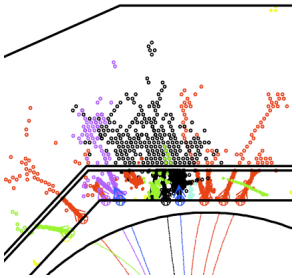


Showers with timing



GLD DOD

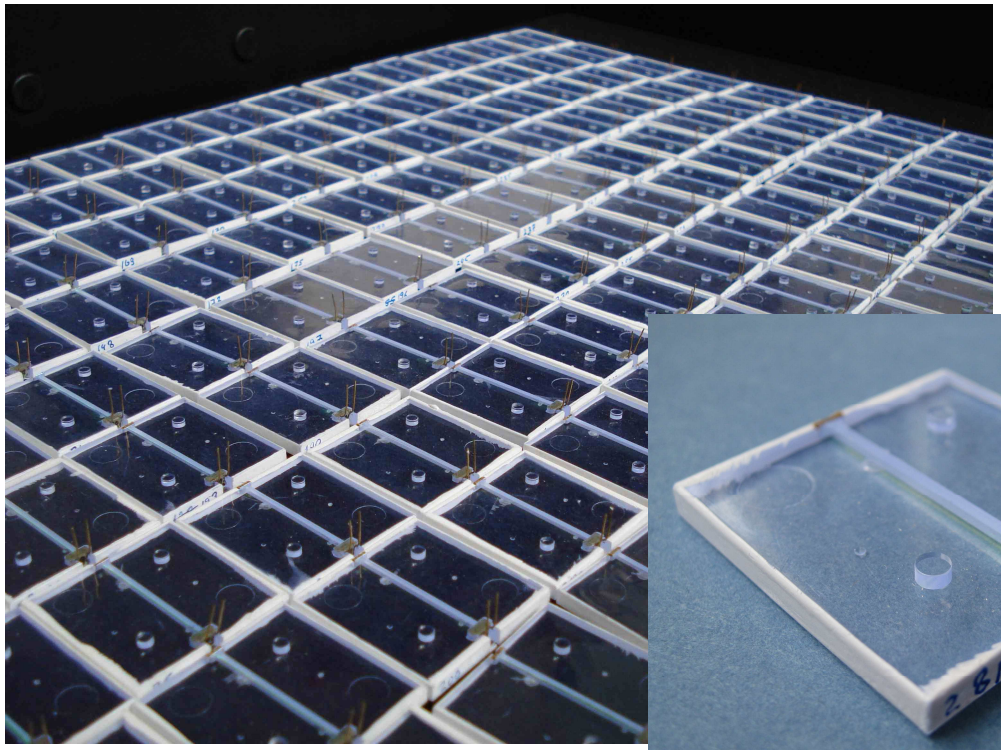
- Effect is stronger for Pb

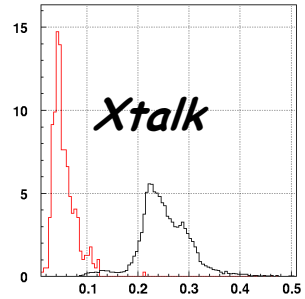


New tiles and SiPMs

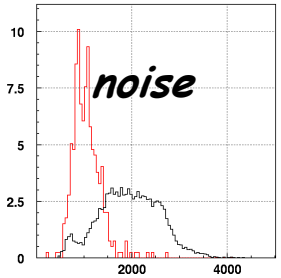
- First 144 tiles from ITEP
  - Larger set underway for 2m layer
- SiPMs (MRS-APDs) from CPTA

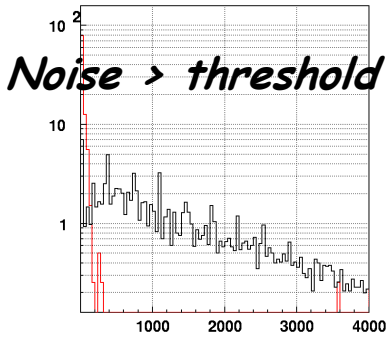
Improved properties w.r.t. PPT SiPMs





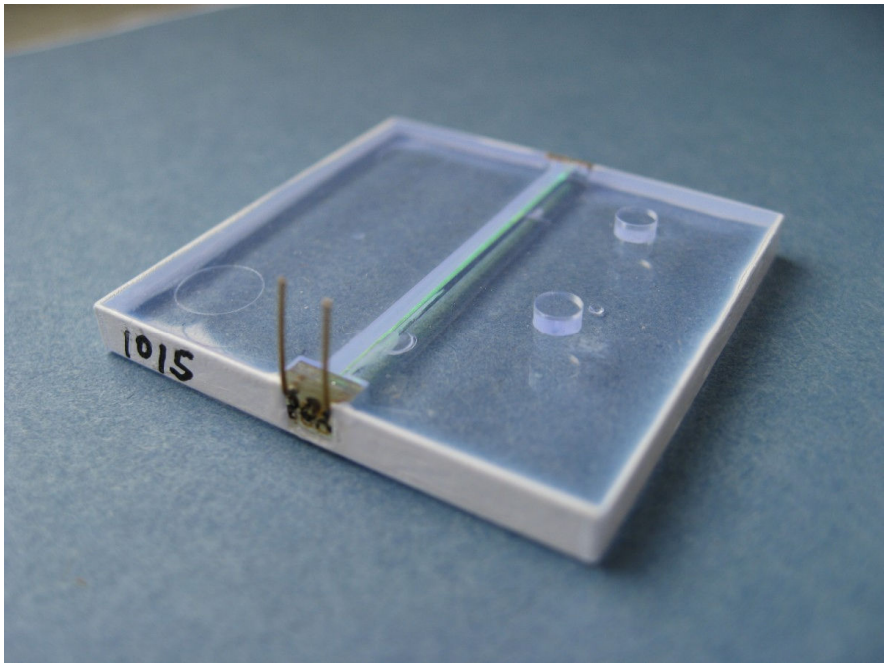
ITEP

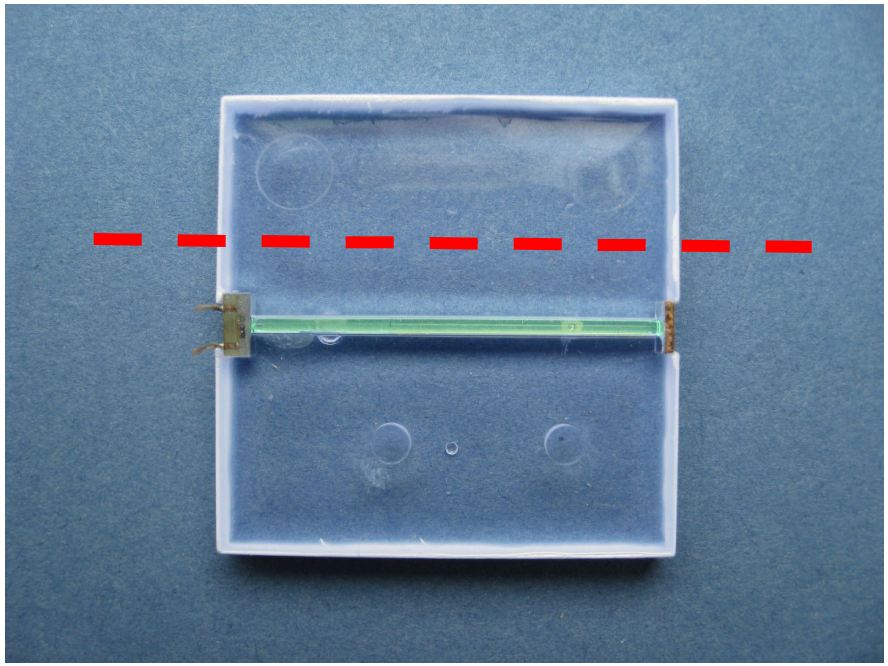




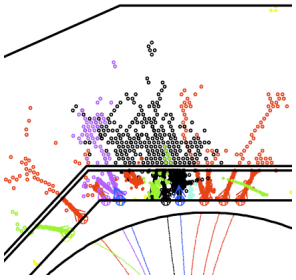
EUDET Tiles

12 tiles of new generation arrived from ITEP



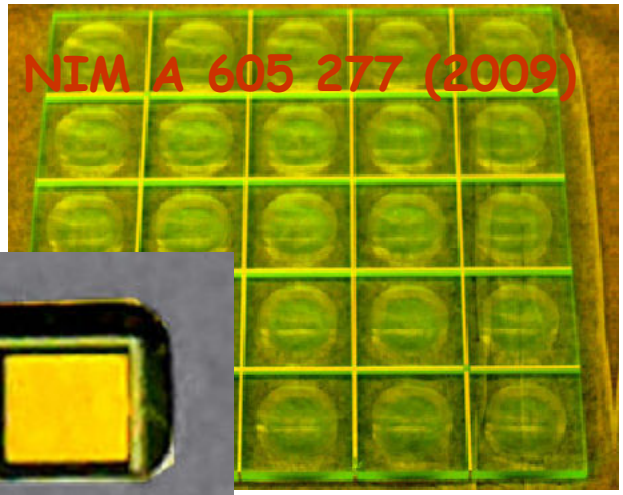


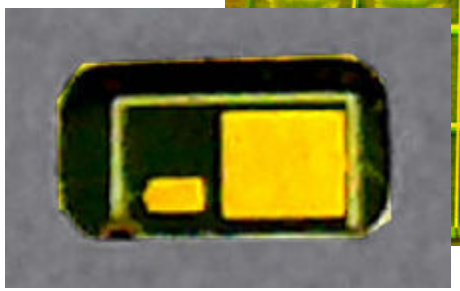
Tiles can be cut to accommodate varying layer width without affecting PCB grid



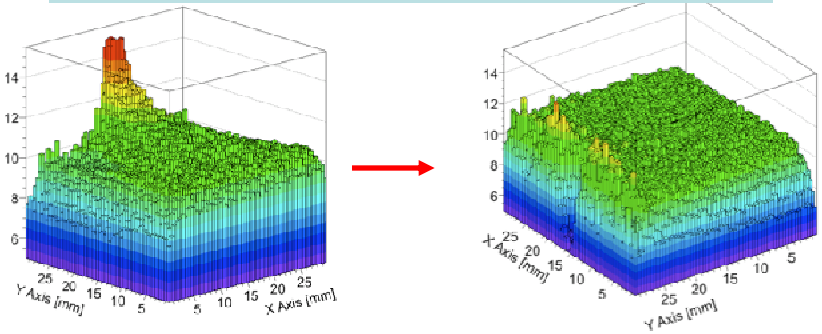
Other coupling schemes

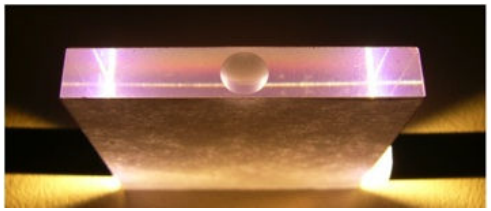
- Surface-mounted MPPCs
- Scintillator cells with dimple to compensate non-uniformity
  - See NIM paper by NIU group and D.Chakraborty's talk
- Strips a la Sci ECAL
- New idea from MPI group
  - Dimple for direct coupling from the side

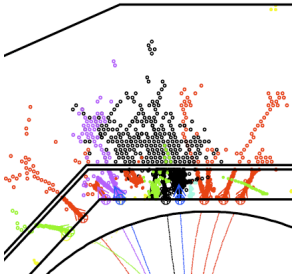




All require no or minimal modification to electronics board





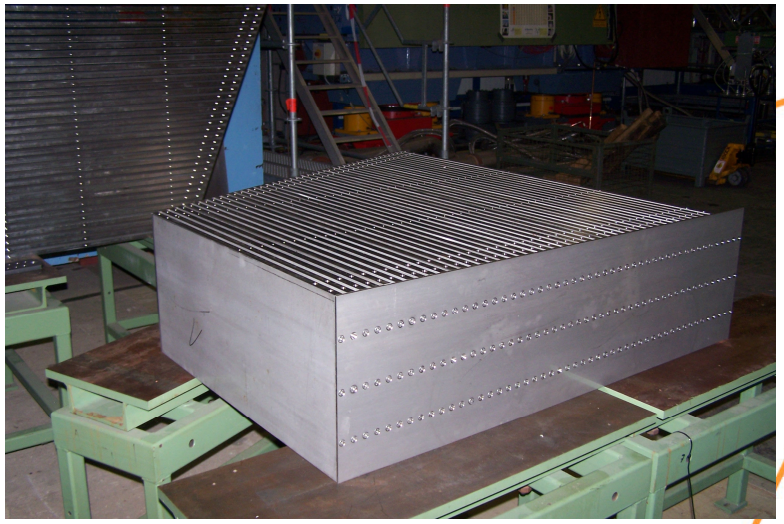


Electronics & Calibration

- See previous talks

Mechanical structure: vertical test

360 mm sub-module



Sub-module Nr.2 in horizontal position

gap size measured (front)

all layers can be equipped with cassettes!

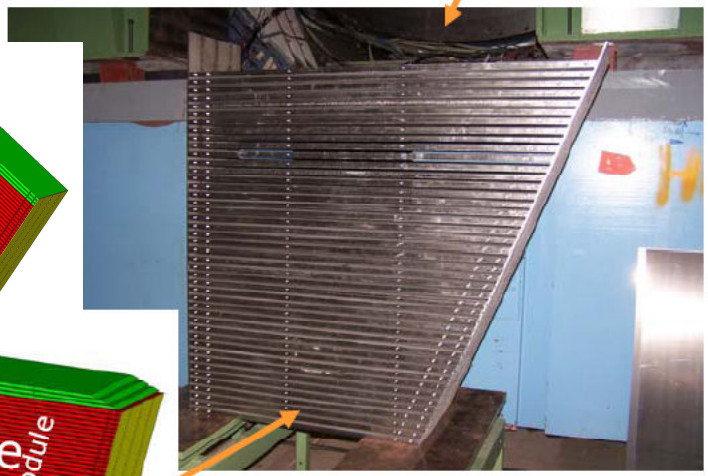
sub-module Nr.1 turned vertical

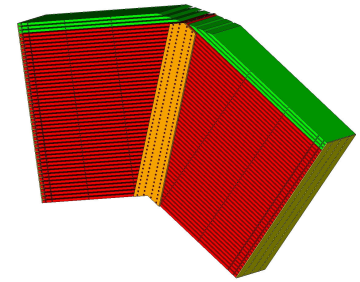
gap size checked by cassette prototype:

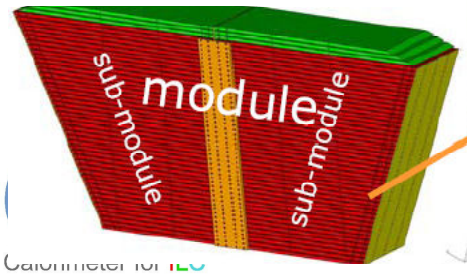
2 positions where the cassette does not fit into the gap

gaps must be measured also in depth

plate position must be measured







➔ **available**

Slides from K. Gadow

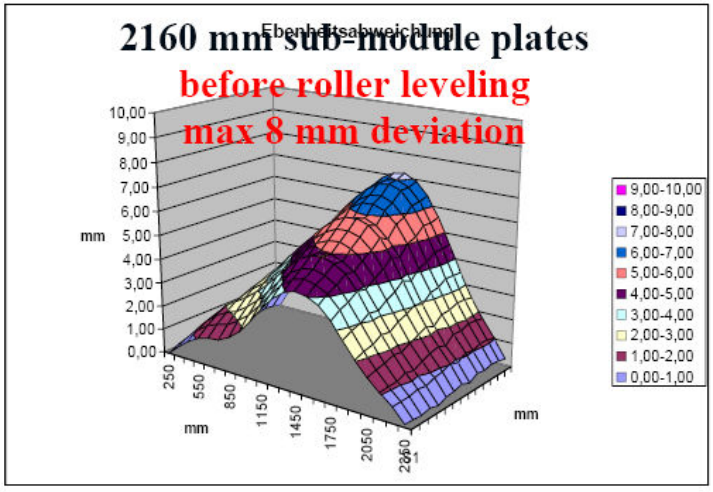
Mechanical structure: large module

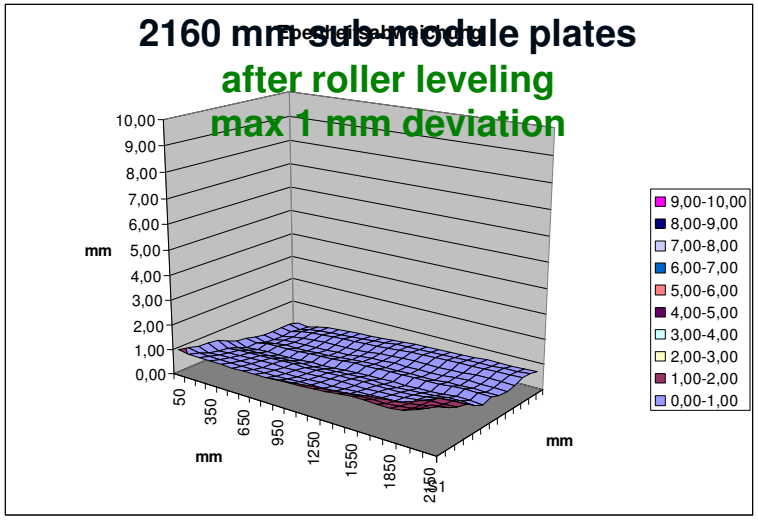
2160 mm sub-module plates
layer 43 to 46

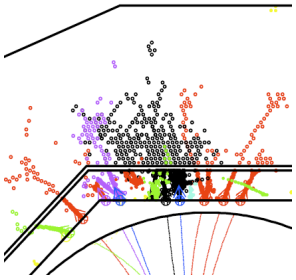
roller leveling done

flatness measurement done

➔ **available**

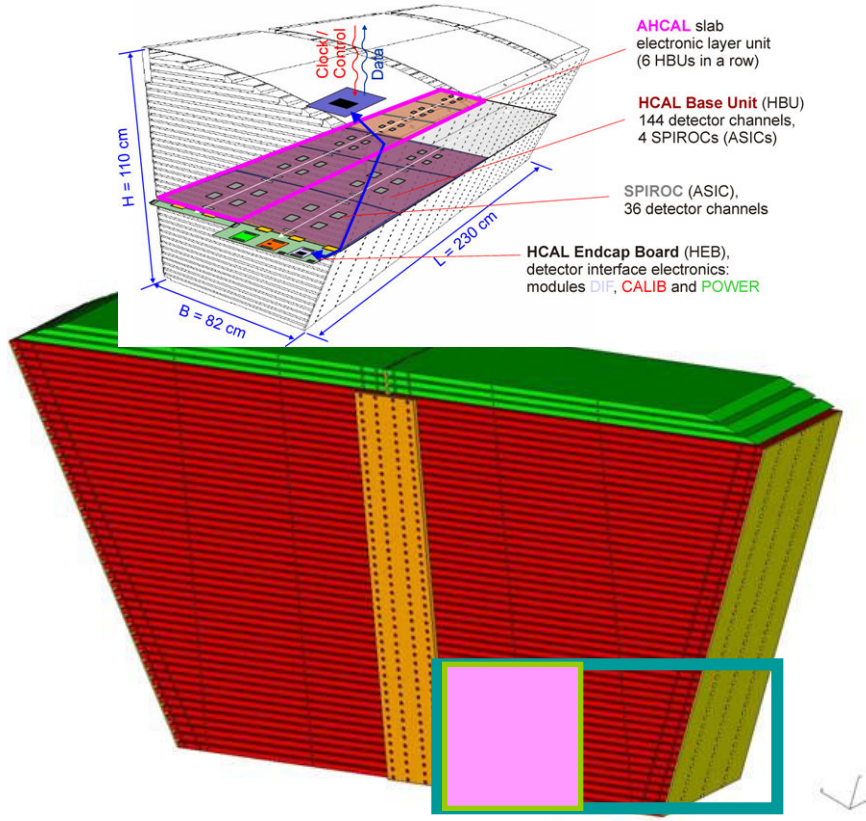






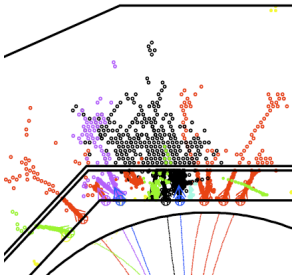
Prototype roadmap

- HBU0 test
  - DESY test beam this ***winter***
- HBU redesign
  - SPIROC2a
  - New tiles
- Full layer = 6-1212 HBUs 2010
  - O(1000) tiles (1 slab = 6 HBUs from ITEP
  - Can also be used to instrument an e.m. tower in the vertical cross section
- Compact re-design of layer end
- ➔ e.m. beam test at DESY in 2011
  - Possibly at CERN with higher energy or ILC like time structure?
- Full module 2012 if funded
  - Technically possible

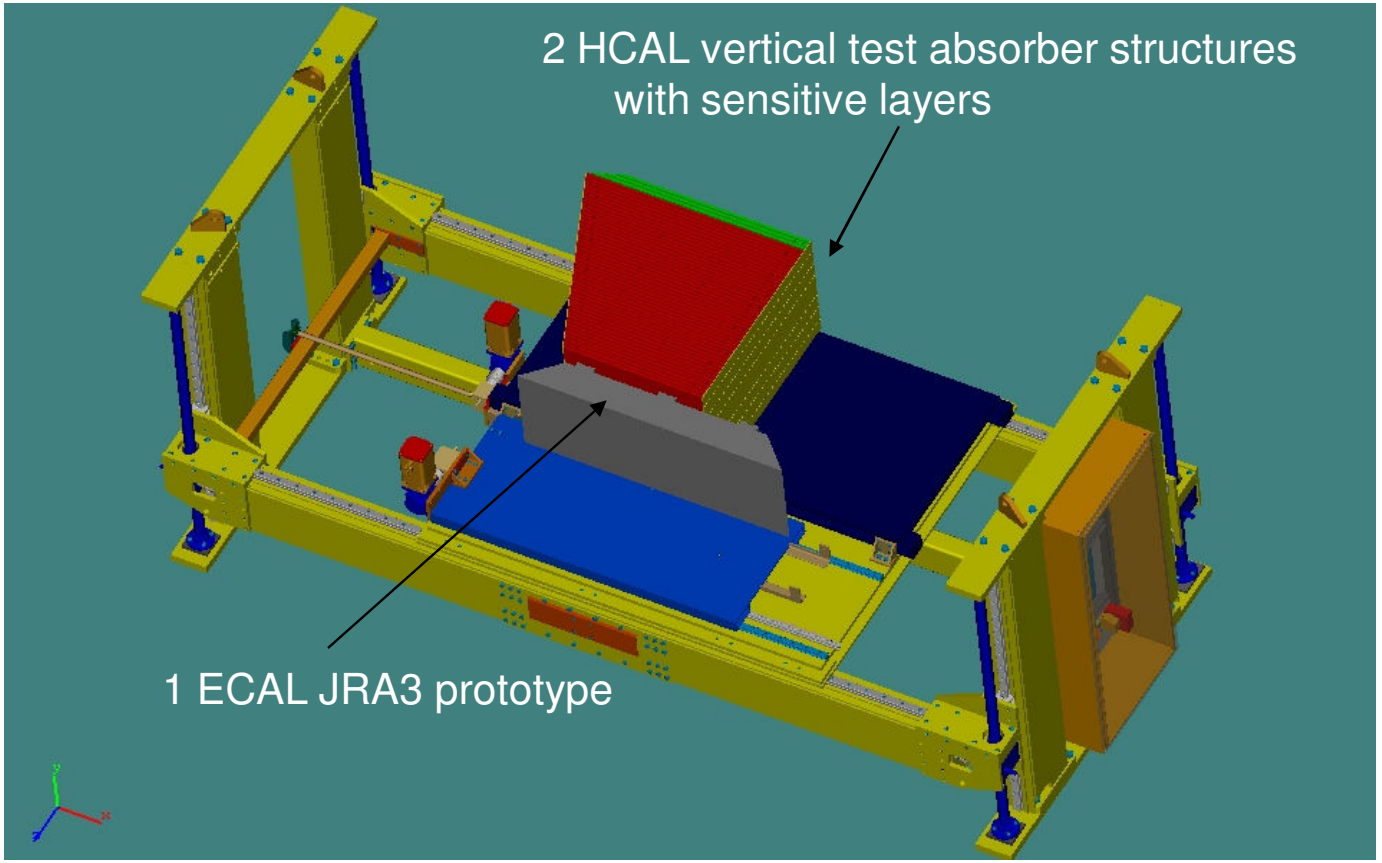


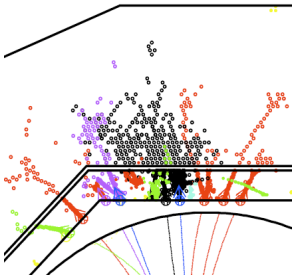
Keep 1/4 of steel plates (~1t)

Instrument half of this



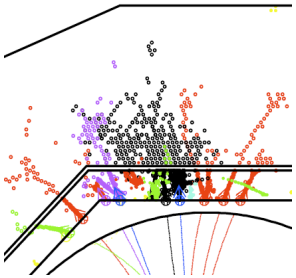
2nd generation combined test





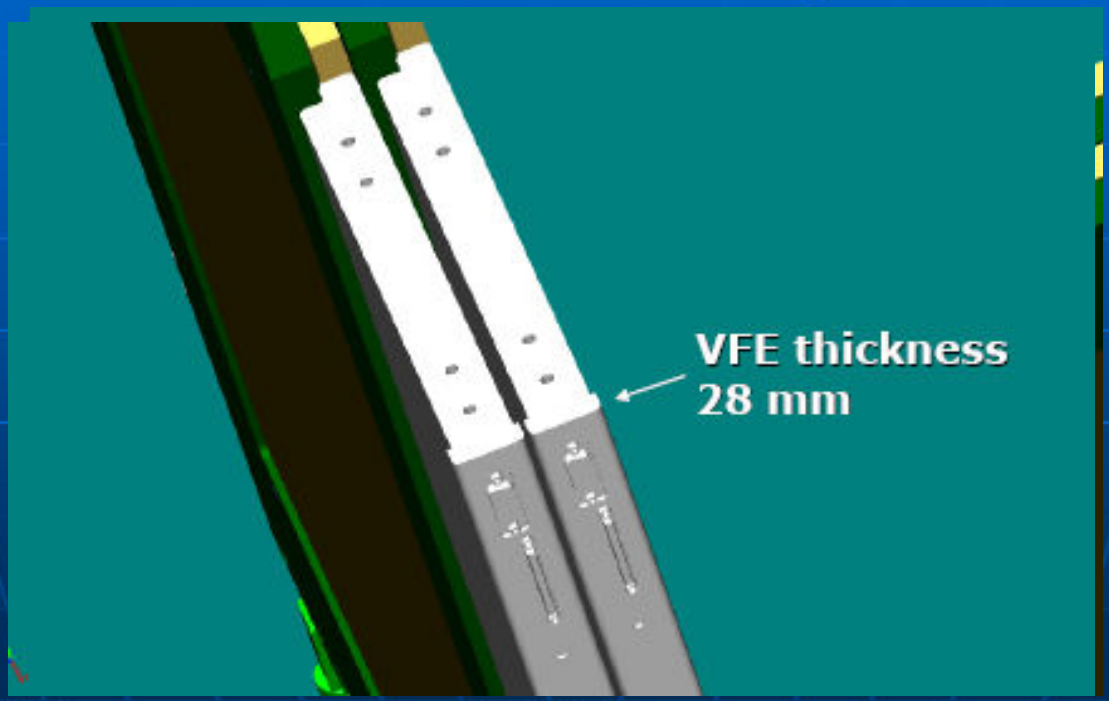
The "old" hardware

- Active scintillator layers and read-out:
  - Back at DESY
  - Re-installation as cosmic test stand without absorber for long-term and calibration studies
  - Prepare the system for tungsten tests
- Absorber stack
  - Booked for DHCAL RPCs
  - Reminder: adjustable gap etc, ideal for tests of alternative technologies (GEMs, Micromegas, strips,…)
- Movable stage
  - Has to return by April 2011
  - Can carry also other stacks

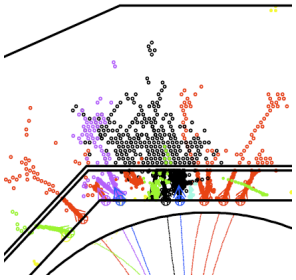


Tungsten plates

Tungsten absorber layers with AHCAL sensitive layers



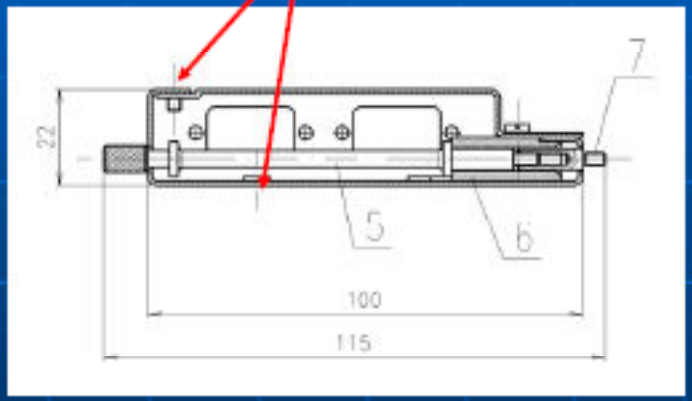
19.11.2009 K.Gadow - DESY 12



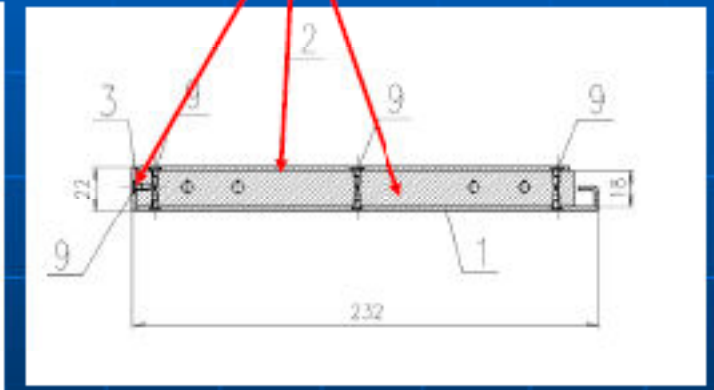
Modifications underway

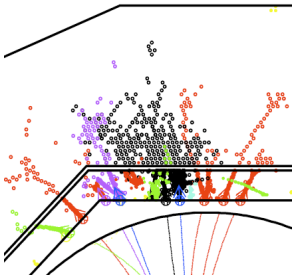
Housing modification

CMB housing
change screw type



VFE housing
machining of parts



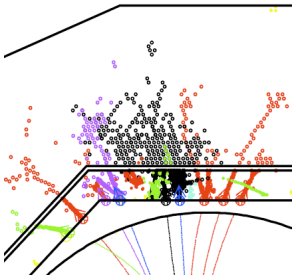


Tungsten road map

- Re-commission scintillator layers beginning of 2010
  - CERN group participating
- Run with 20 layers of tungsten at CERN PS in Sep 2010

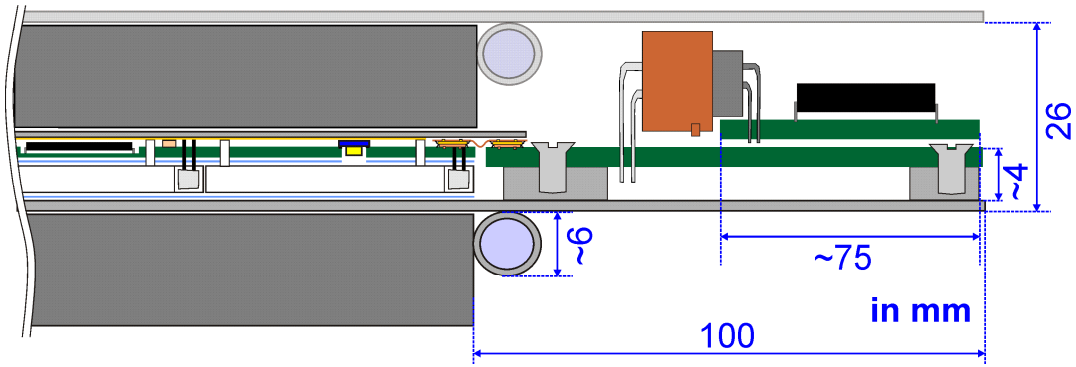
- Full stack (~ 40 layers) in 2011
  - Integrated in movable stage

- 2012 or later: 2nd generation scintillator modules
  - 160 HBUs, ~ 23'000 channels
  - Compact layers
  - Time measurements
- Dual use: EUDET steel module and tungsten structure



CLIC issues

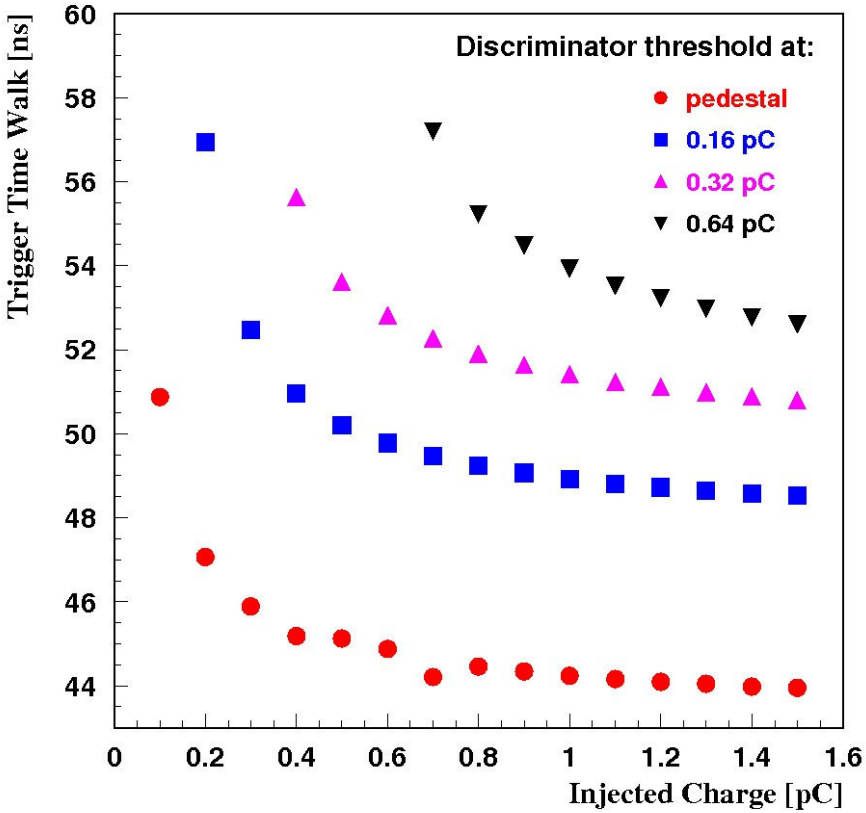
- Density: jet energy performance at high energy limited by leakage ➔ study denser absorber material: tungsten
  - Test G4 simulation including neutron timing
  - Particle flow with different λ / X_0 testure
  - Even more aggressive integration demands



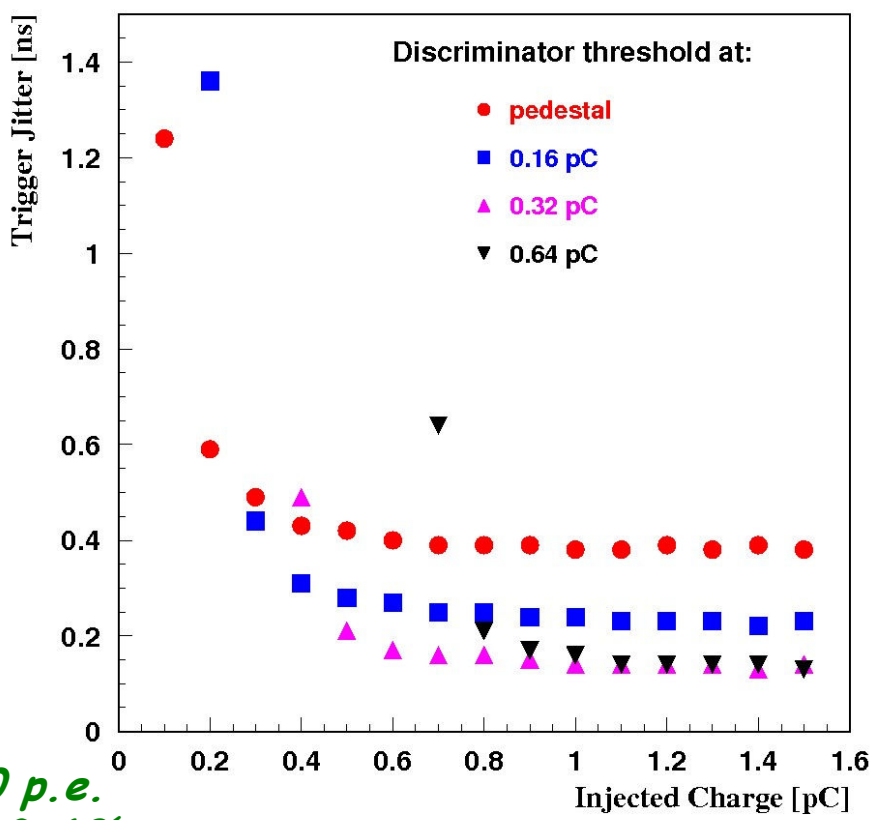
- Time stamping
  - SPIROC TDC provides O(ns) resolution
  - Scintillators and sensors to be optimized

SPIROC1 Analogue Tests

Trigger time walk



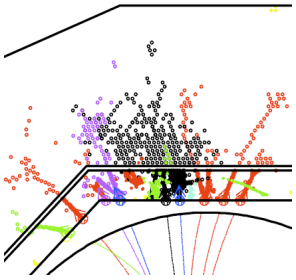
Trigger jitter



10 p.e.
@ G=10⁶

Large time-walk at small charges
=> Problematic in calibration mode

Results consistent with Orsay



Summary

- Right at the return from the physics prototype data taking campaign, we are embarking for new targets
- Beginning of 2nd generation data taking early in 2010
- Full-size layer in 2010
- "mincal" 2 in 2011
- A technological demonstration of an integrated and compact scintillator HCAL option by 2012
  - Possibly with different coupling options
- Ready to be extended to a full "module 0" then
- Almost perfect synergy with tungsten project