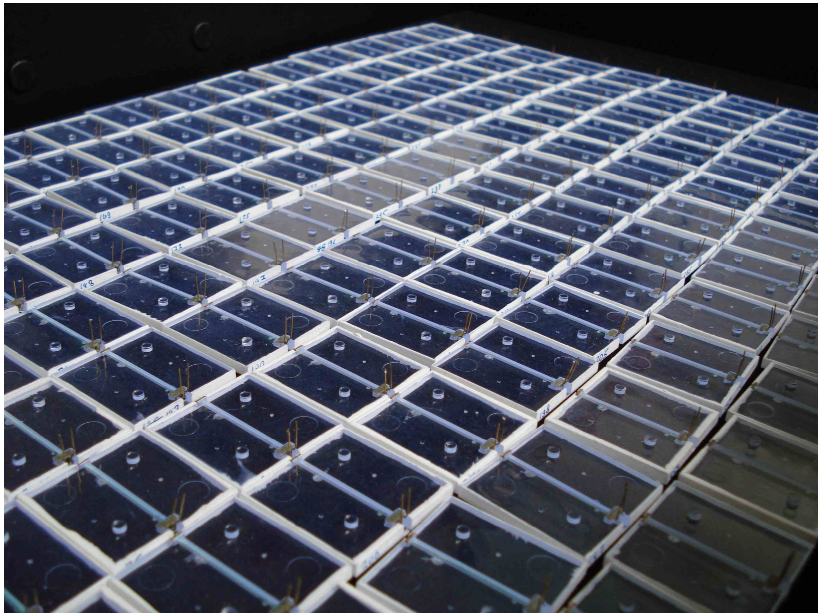
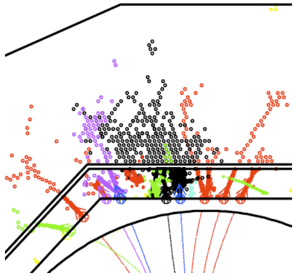
Future test beam options



Felix Sefkow

CALICE AHCAL main meeting

DESY, June 16, 2009

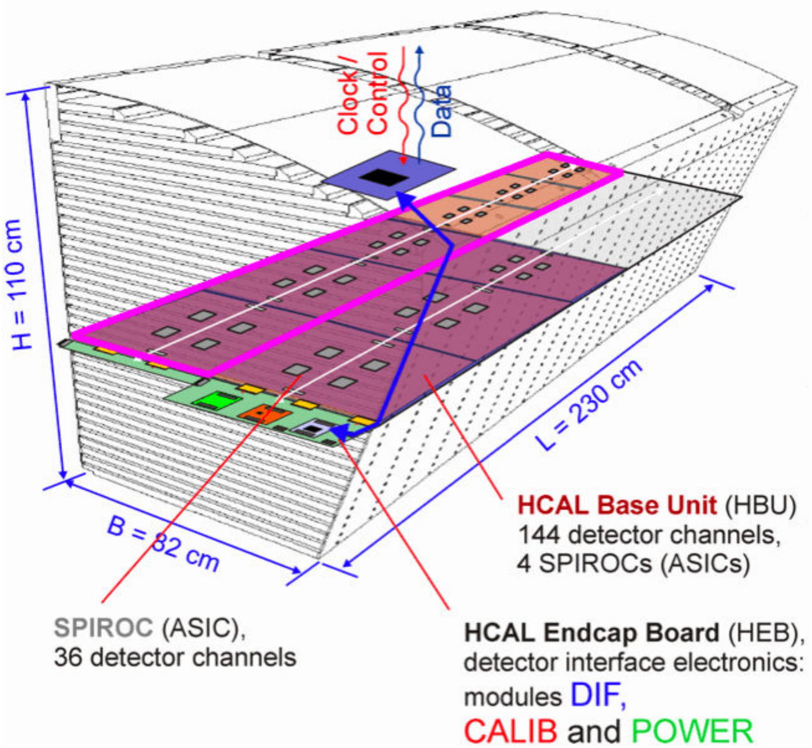


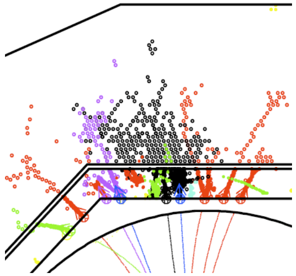
Outline

- Goals of a second generation AHCAL
- Prototype roadmap
- Integrated beam tests

Technical prototype

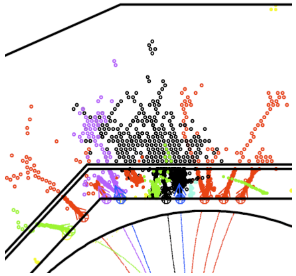
- Towards a scalable and compact detector
  - Realistic proposal: costing
- Embedded front end ASICS
- Mechanical structure with minimum dead space
- Options for scintillator and photo-sensor integration
- Technical challenge:
  - Stability with power pulsing and online zero suppression





Physics with 2nd generation PT

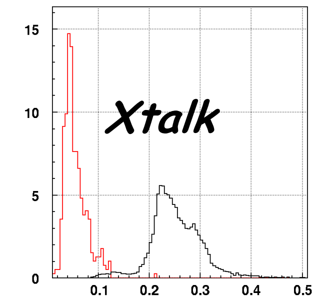
- Validation of shower models for a scintillator steel HCAL will be based on the physics prototype and its ever improving detector understanding
- What will the new prototype add?
- 1. Time measurement
  - Tagging of delayed neutrons ➔ triple readout
  - Validation of simulation and exploitation for 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
  - Potential of an integrated test with tracking being under study
- 3. Stainless steel: can measure showers in magnetic filed

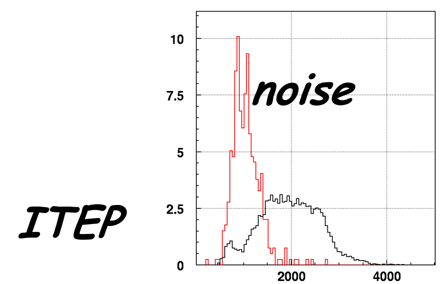


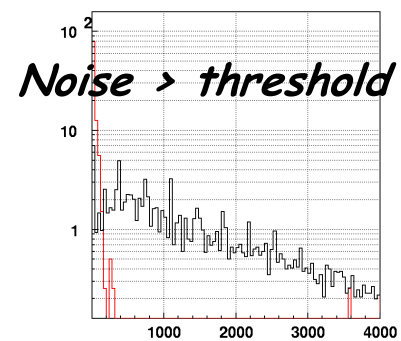
New tiles and SiPMs

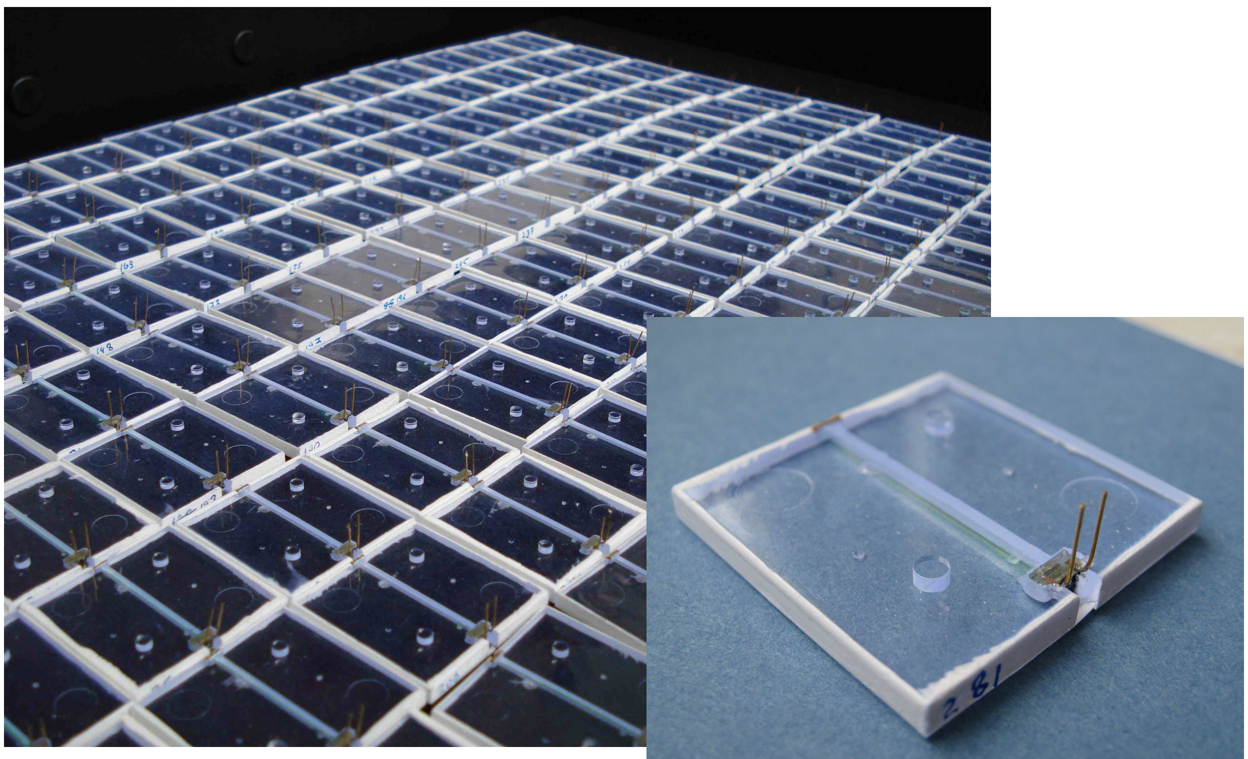
- First 144 tiles from ITEP
  - Larger set underway for 2m layer
- SiPMs (MRS-APDs) from CPTA

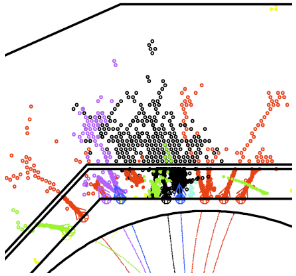
Improved properties w.r.t. PPT SiPMs





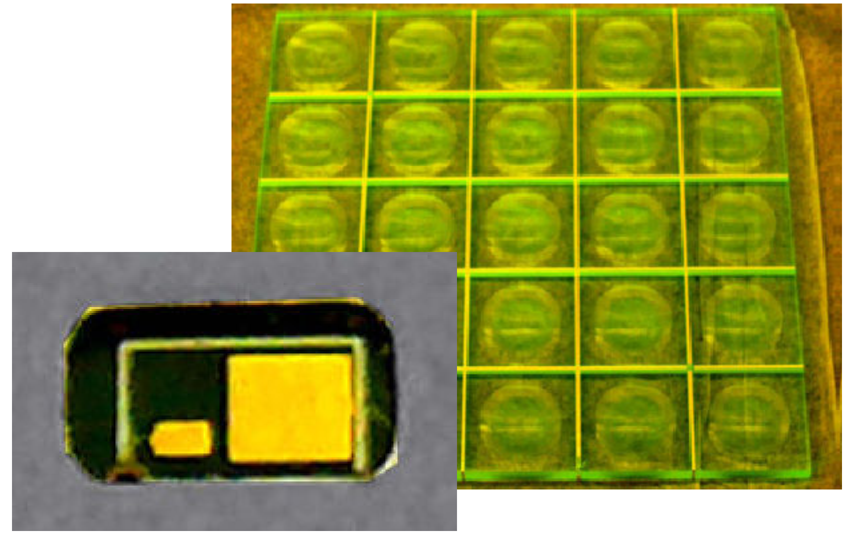




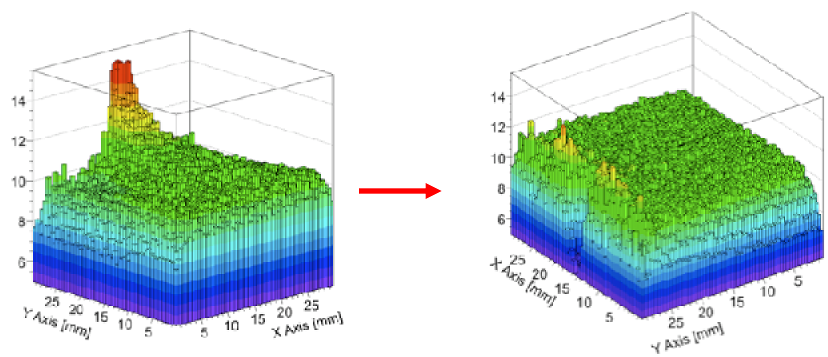


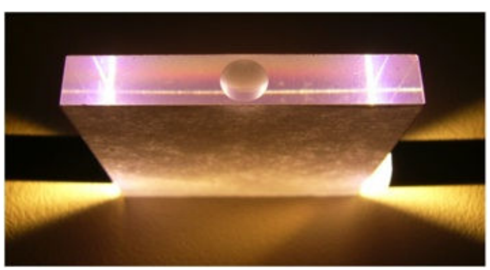
Other coupling schemes

- Surface-mounted MPPCs
- Scintillator cells with dimple to compensate non-uniformity
  - See NIM paper by NIU group
- Strips a la Sci ECAL
  - PFLOW study ongoing
- New idea from MPI group
  - Dimple for direct coupling from the side



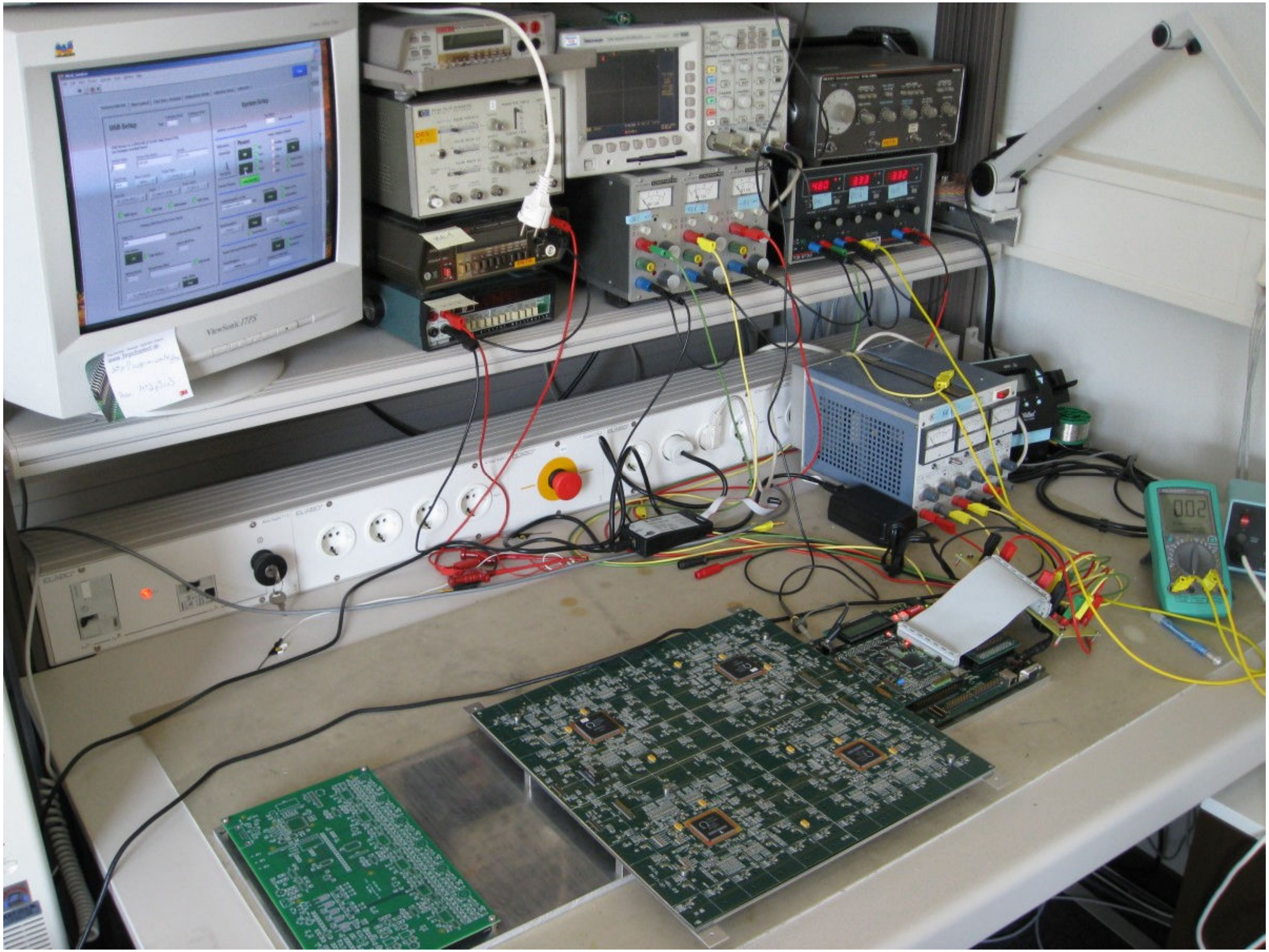
We have > 800 MPPCs of SciECAL type





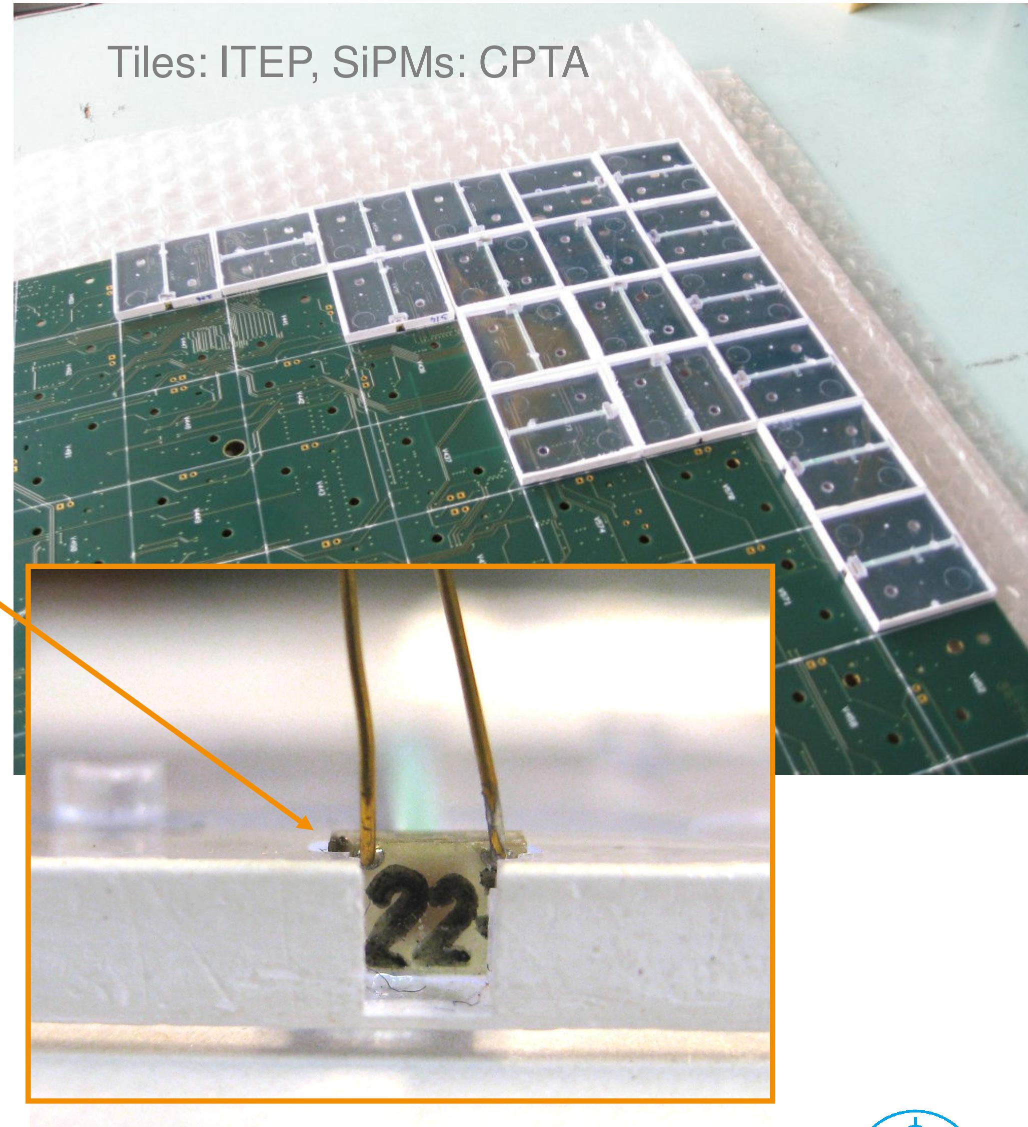
Future test beam

Prototype System Commissioning

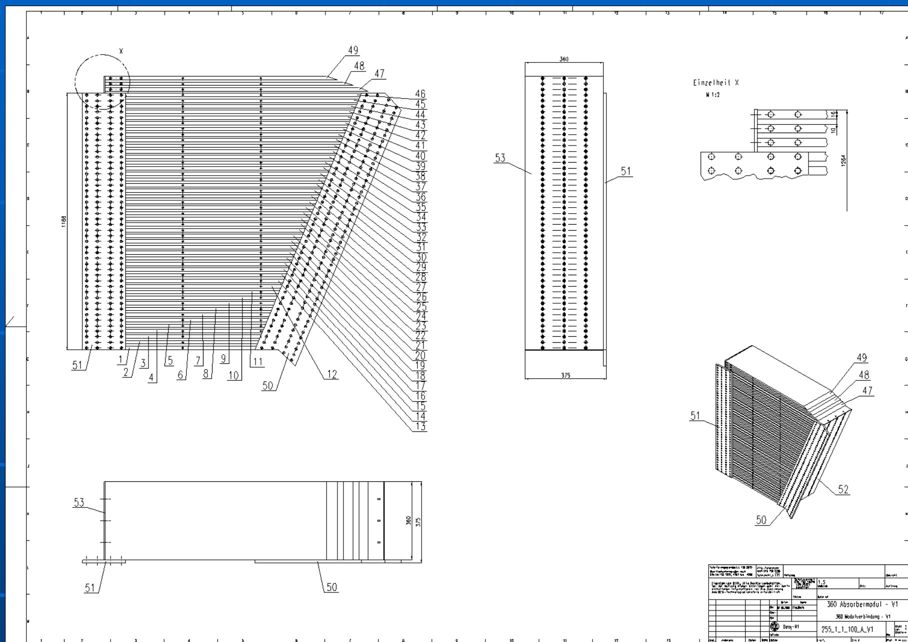


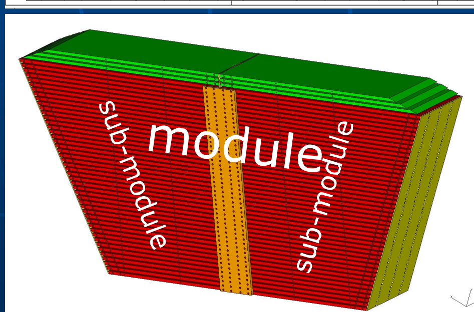
Tiles Interconnection Test

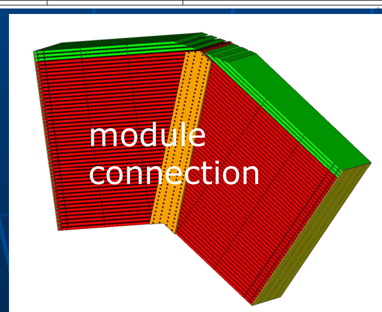
- Tiles not connected yet (HBU electrical test first).
- Test assembly shows:
  - Strong force to SiPM pins during assembly.
  - A few SiPMs cases are too large (only a few!).
  - Mirrors are too large, but can be cut.
  - Alignment concept (-pins) works!!



real size test setup vertical







2 short length (360 mm) absorber sup-modules mounted to a short length module

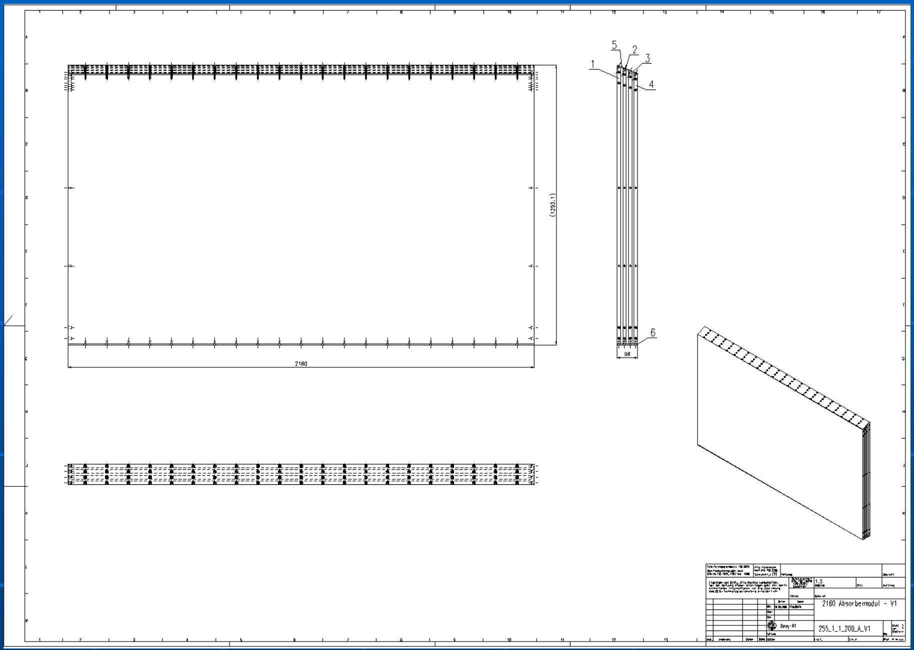
- delivery tolerances
  - flatness, thickness
- machining
  - tendering, processing, handling, tolerances, costs
- sub-module mounting
  - stacking and shape tolerances, module interconnection, stability
- sensitive layer installation
  - handling, tolerances, vertical and horizontal layer connection, cabling and cooling routing

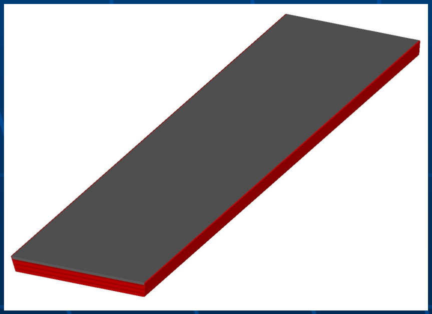
360 mm sub-module Nr.1

sub-module plates

- flatness measured from 4 raw plates 3000 mm x 1500 mm Order 2 batch 1 (not roller leveled)
- order 2 batch 1 water cut to individual size
- flatness measured for each plate
- machining started -> finish first week of July
- Sub-module Nr.1 mounting finish end of July
- First week of August start production of sub-module Nr.2 -> finish beginning of September

real size test setup horizontal





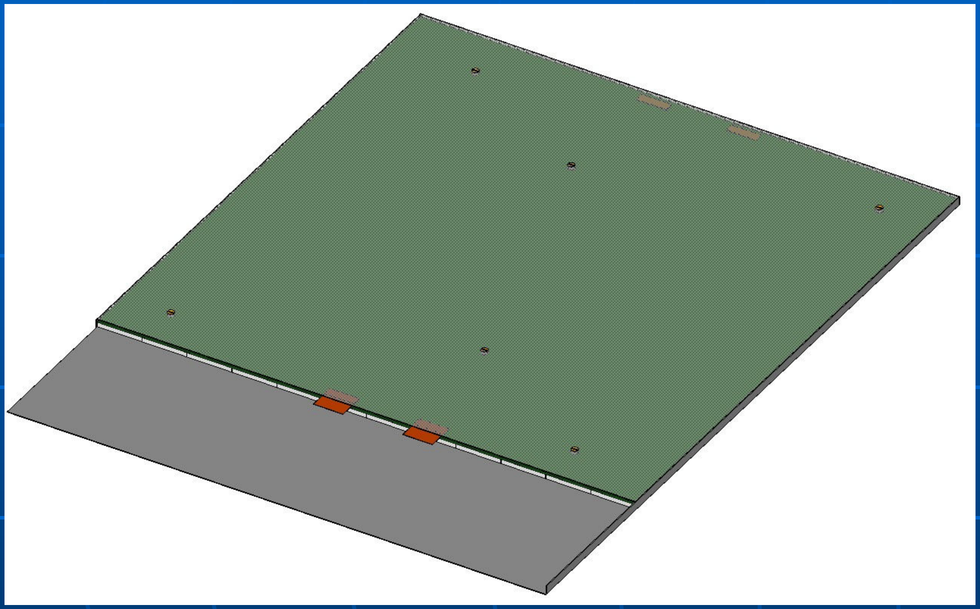
4 full length (2160 mm) absorber plates mounted to a fraction of a sub-module (far outer position)

- delivery tolerances
  - flatness, thickness
- machining
  - tendering, processing, handling, tolerances, costs
- sub-module mounting
  - stacking and shape tolerances, module interconnection, stability
- sensitive layer installation
  - handling, tolerances, vertical and horizontal layer connection, cabling and cooling routing

2160 mm sub-module plates 43 to 46

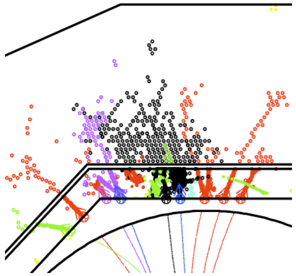
- flatness measured from 4 raw plates 2500 mm x 1500 mm Order 1 batch 1 (not roller leveled)
- order 1 batch 1 water cut to individual size
- flatness measured for each plate
- plates send to roller leveling -> finish mid of July
- flatness measurement -> end of July
- milling starts in beginning of August

sensitive layer housing



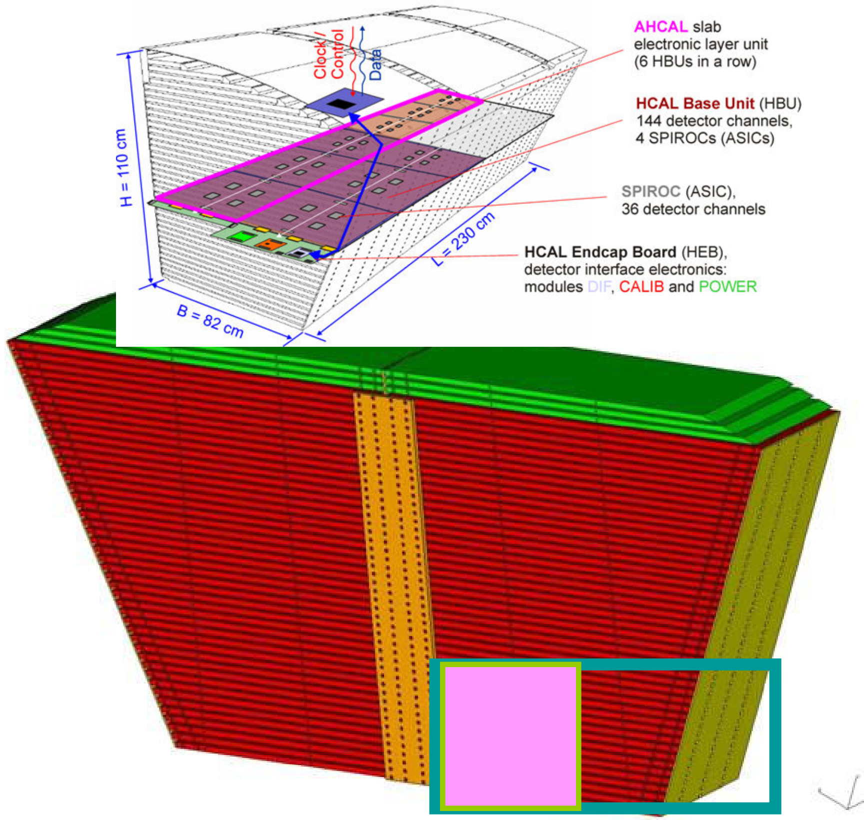
362x462x7 mm³ standard housing prototype available

- 362 mm x 462 mm standard housing
  - contains 1 HBU unit for 360 mm sub-module
  - 0.5 mm stainless steel
  - One side border per bottom/cover plates
  - 100 mm bottom plate extension for front end electronic
  - 6 point welded fixation/distance bolds per HBU unit
  - Cover plate fixed by 6 M2.5x4 screws per HBU unit
  - total thickness 7 mm +-0.1 mm
- 362 mm x 2260 mm standard housing
  - contains 6 HBU units for 2160 mm sub-module
  - other parameters see above



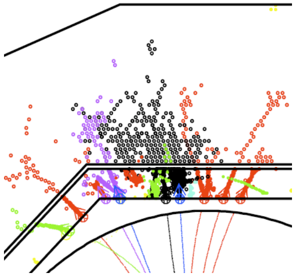
Prototype roadmap

- HBU0 test
  - DESY test beam this summer
- HBU redesign
  - SPIROC2 or SPIROC3 (?)
  - New tiles
- Full layer = 12 HBUs 2010
  - O(1000) tiles (1 slab = 6 HBUs by end 2009, rest 2010
  - 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 2010
  - Possibly at CERN with higher energy or ILC like time structure?
- Full module 2011-2012 if funded



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

Instrument half of this

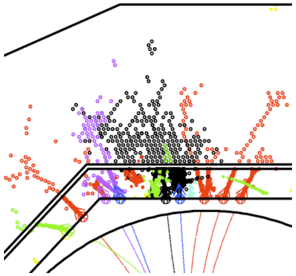


The "old" hardware

- Active scintillator layers and read-out:
  - Back to DESY this week
  - Re-installation as cosmic test stand without absorber for long-term and calibration studies
  - Could be used with different absorber structure, e.g. W

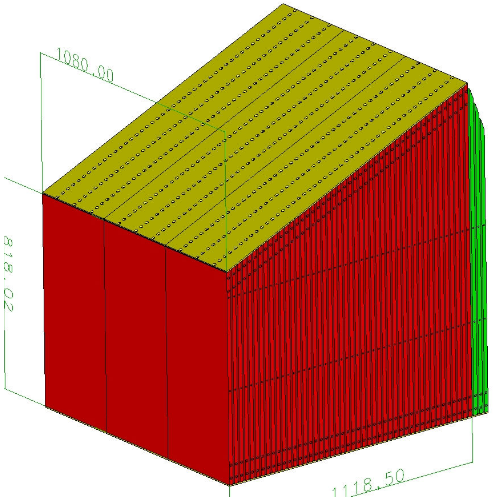
- Absorber stack
  - Booked for DHCAL RPCs
  - Reminder: adjustable gap etc, ideal for tests of alternative technologies (GEMs, Micromegas, strips,…)

- Movable stage
  - Has to return by April 2011
  - Can carry also other stacks

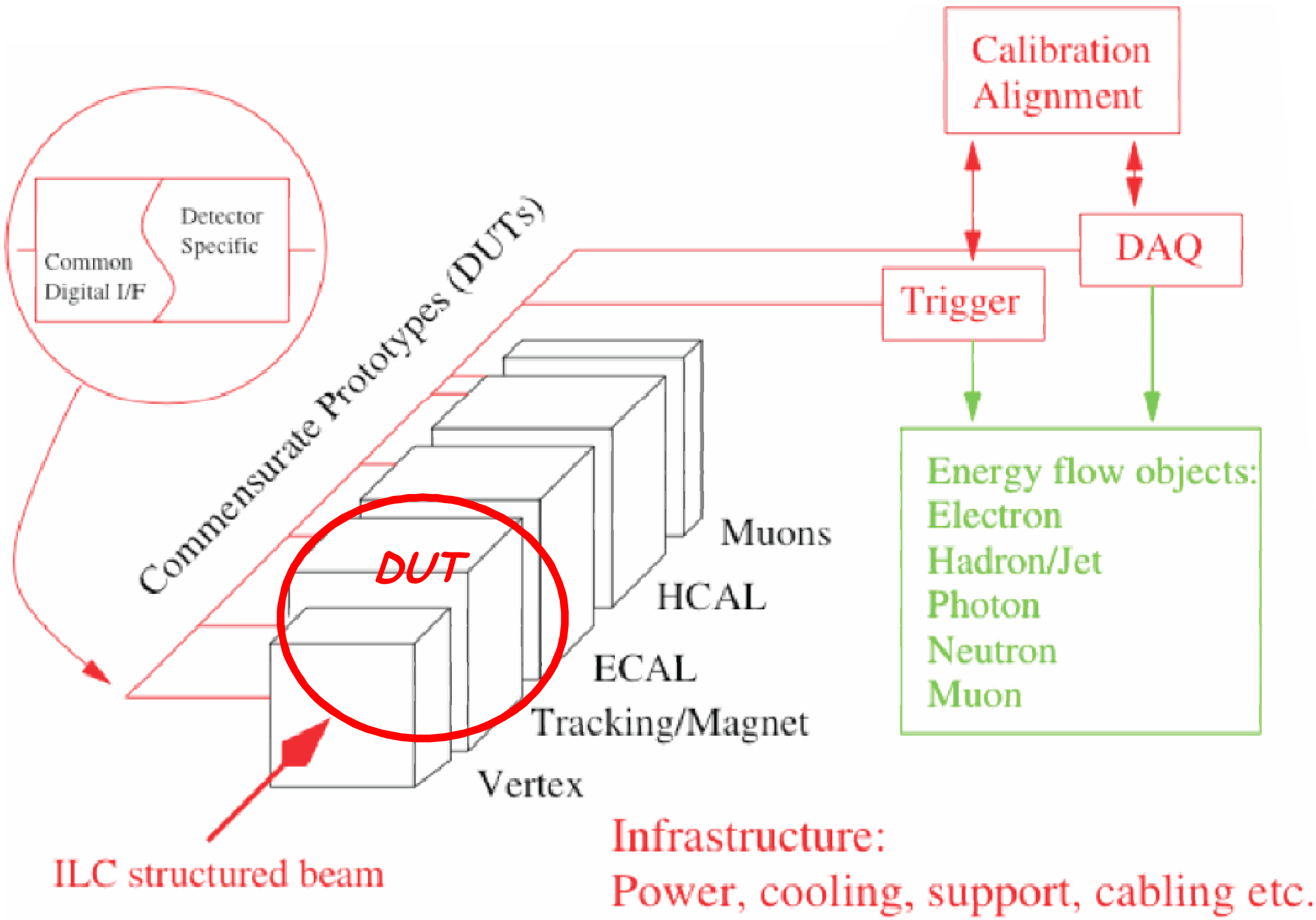


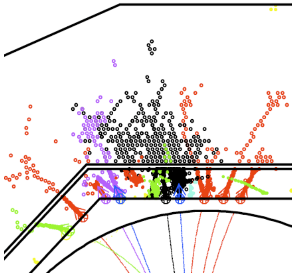
Status

- Right at the return from the physics prototype data taking campaign, we are embarking for new targets
- Beginning of 2nd generation data taking this summer 2009
- Full-size layer and minical in 2010
  - Possibly with different coupling options
- A technological demonstration of an integrated and compact scintillator HCAL option by 2011
- Ready to be extended to a full “module 0” then



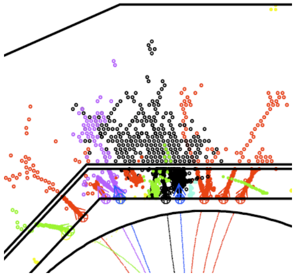
Integration: next step





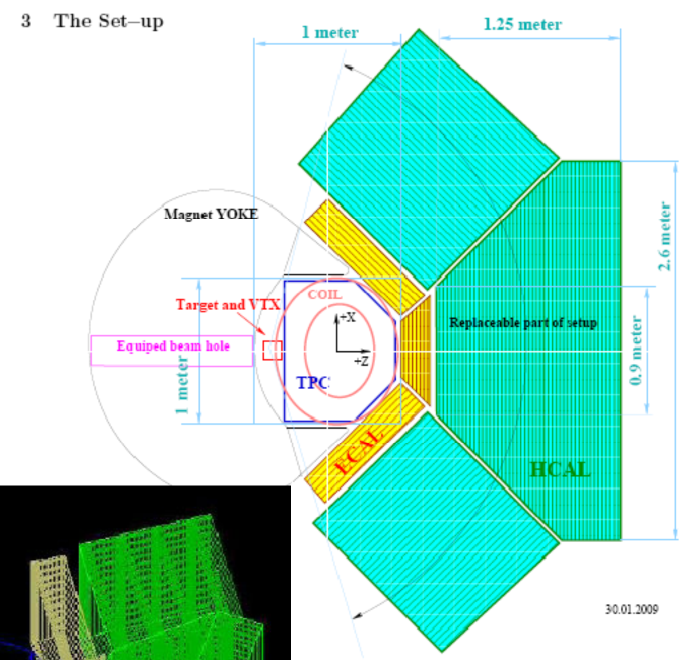
Vertical integration

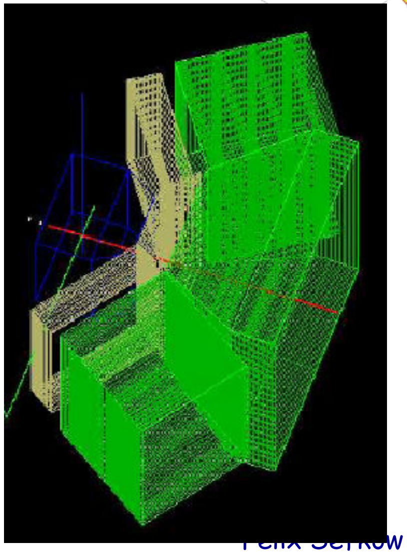
- Further test of particle flow: interplay of detector sub-systems
- Mechanical integration: “common rail”
- Common DAQ and slow control
- Common data processing and reconstruction
  - Grid infrastructure
- Devices under test interchangeable: flexible set-up
  - Well defined interfaces

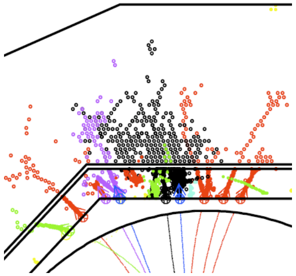


Integrated TB experiment

- Technological goal
  - Operational aspects of technological prototypes
  - Detector integration: DAQ, alignment,…
- Physics goal
  - Study of PFLOW with real multi-particle events
- Can this realistically be done?
  - Started simulation study with toy model



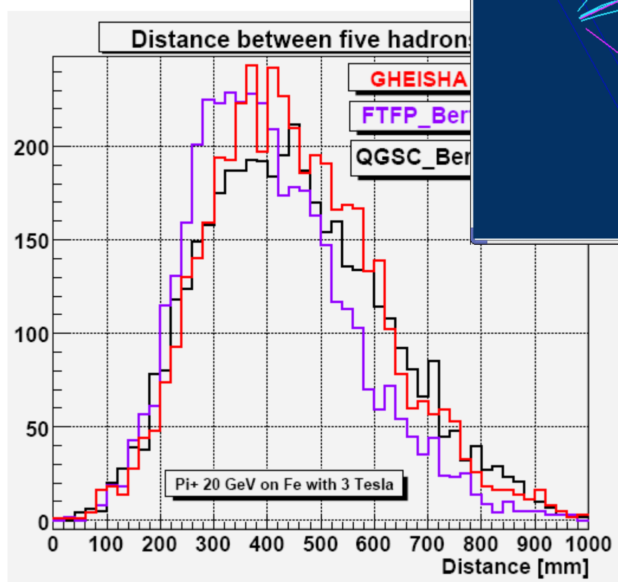


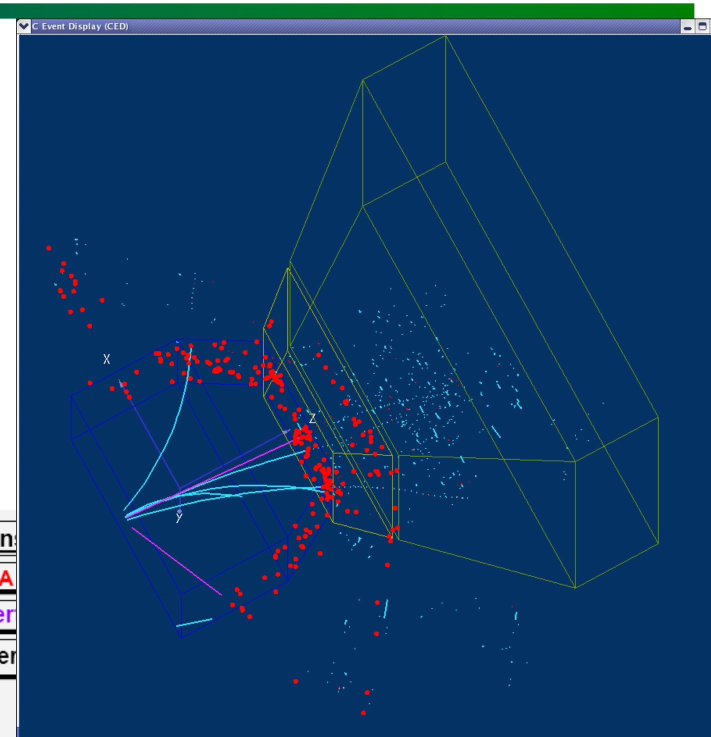


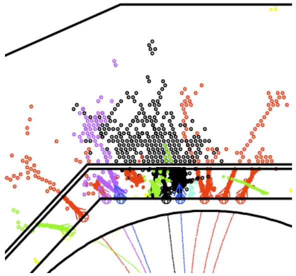
Simulations

- Investigate
  - Target losses
  - Acceptance losses
  - Particle separation
  - Model dependence
- Optimize geometry
- Try on realistic (i.e. existing) magnets

- NB: exclusive final states from nuclear targets → G4



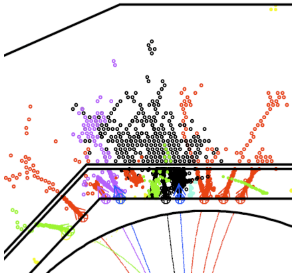




Open questions

- Study not finished
- It appears that PFA resolution dominated by acceptance losses unless detector very large (2x2m^2 front face)
- A real magnet has not been found yet, existing TPC magnet has cryostat and will produce s-shaped tracks

- What can be done with multi-particle events
  - With limited acceptance
  - With and without field
- Will need shower simulation to interpret results
  - Model uncertainties



Summary

- Technical demonstrator by 2010/2011
- Prototype possible 2012
- Calorimeter topics
  - New electronics, calibration, stability issues
  - Timing
  - Tungsten
- With additional infrastructure
  - Magnetic field
  - Kaons
- With integration
  - PFLOW studies, but no full test