SDHCAL report

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LNF
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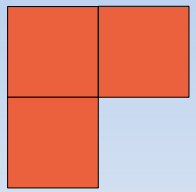
SDHCAL activities in/out AIDA

- Part of D9.7, D9.8, D9.9
  - «Integrated infrastructure for highly granular calorimeters: An integrated infrastructure allowing for testing in beam a complete calorimeter set-up with **different options for radiators, sensors or electronics.** (Task 9.5) [M40]
  - Infrastructure performance and utilization: Report on utilization and performances of the infrastructure tested in beams with different configurations. (Task 9.1) [month 46]
  - **Adequation of GEANT4 simulation of hadronic showers** in different media: Report on the comparison of GEANT4 simulations with highly granular calorimeter test beam results proposed in AIDA. (Task 9.5) [month 46]
- Part of Milestone MS42 (Gas system, control and bench structure): **Gas systems for µM and RPC now available**.
- Now Existing set-up:
  - 1 m³ with 48 layers of RPC + 4 layers of MicroMegas finely segmented (1×1 cm²) in a Stainless-Steel structure in power-pulsed, ILC mode.
  - Data taken in 2012 at CERN SPS partly supported by AIDA
    - Will be used for D9.9
      1) characterisation of sensors
      2) Digitization modelisation → Simulation
      3) Comparison with GEANT4 models

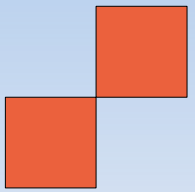
Mips Reconstruction

Courtesy of Y. Haddad (LLR)

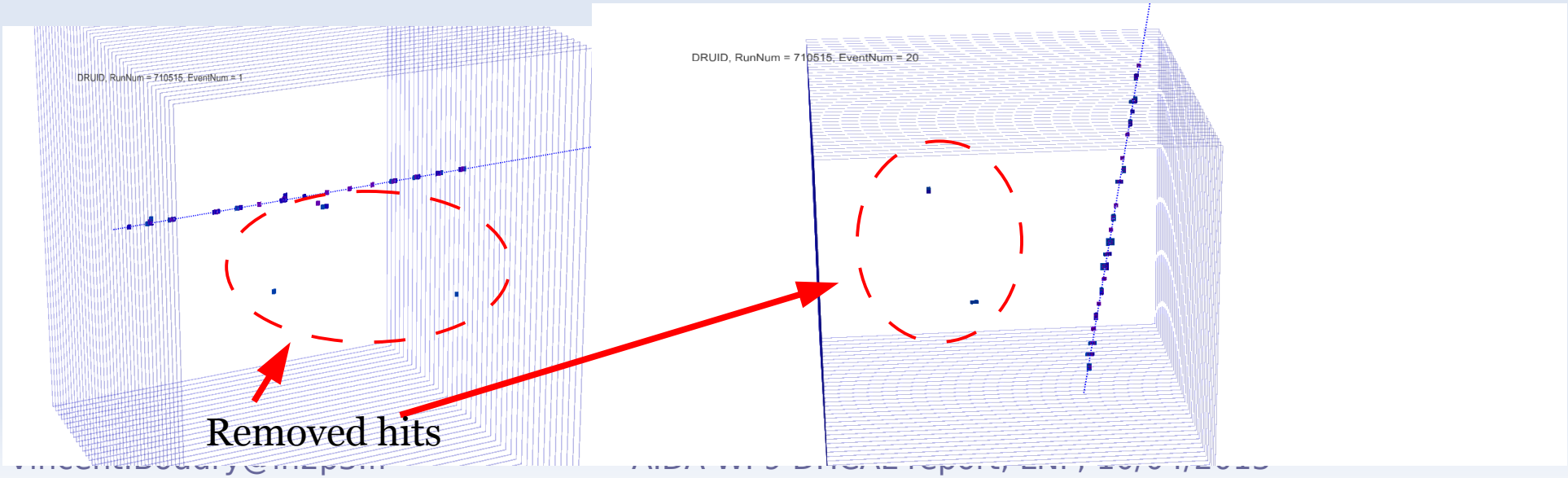
- Clustering of hits performed in each layer using closest neighbor clustering.
- The position of the cluster is taken as center of gravity of the contained hits.
- The error of the position is calculated as X and Y spread divided by √12
- Clean the event by removing the farther hits.
- The Mip's track reconstruction is based on the chi2 minimisation.
- The Tracks are supposed the straight lines in 3D space with 4 parameters



1 cluster with 3 hits



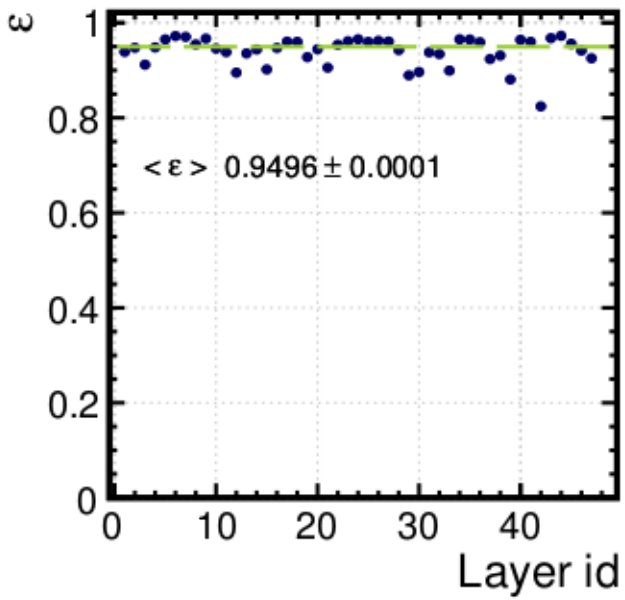
2 cluster with 1 hit each

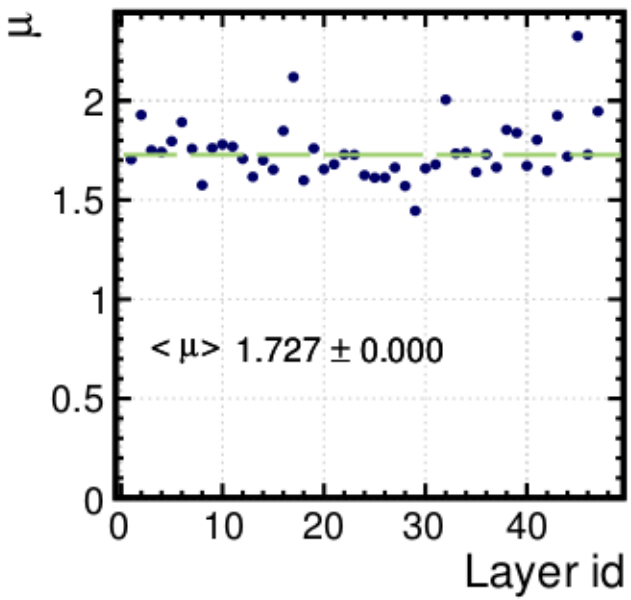


RPC Efficiency & Multiplicity estimation

Courtesy of Y. Haddad (LLR)

- The local efficiency and multiplicity were measured by using the other chambers to reconstruct particle tracks and determining the expected hit position in the considered one.
- The multiplicity μ is defined as the number of fired pads within 2 cm of the expected position.
- The efficiency ε is the fraction of tracks with μ ≥ 1

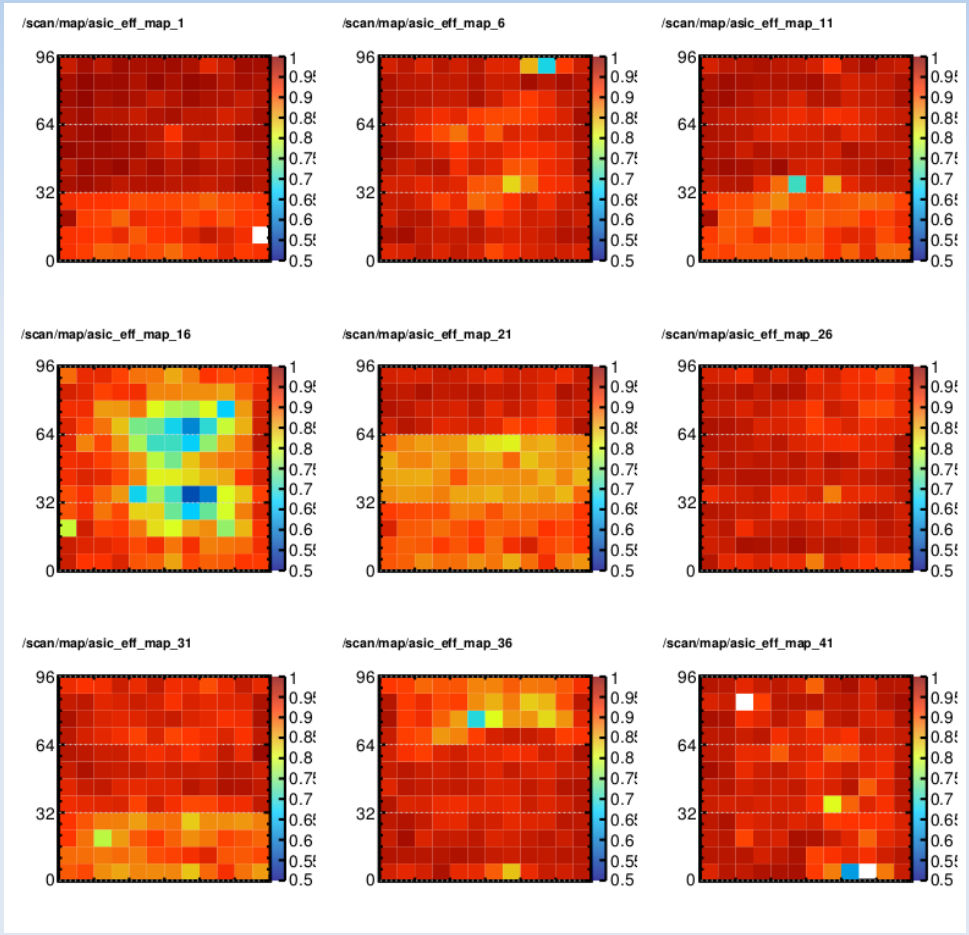


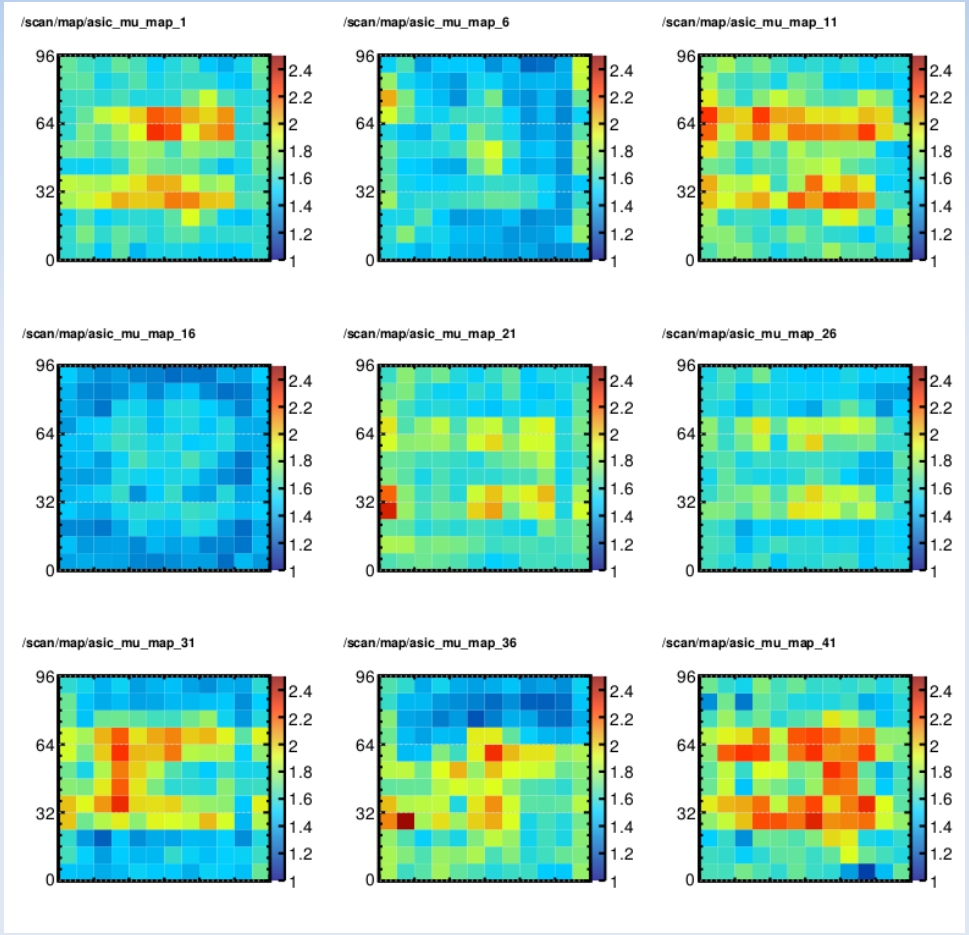


RPC: Efficiency & Multiplicity estimation

ASIC's efficiency & Multiplicity maps for few layers

Courtesy of Y. Haddad (LLR)

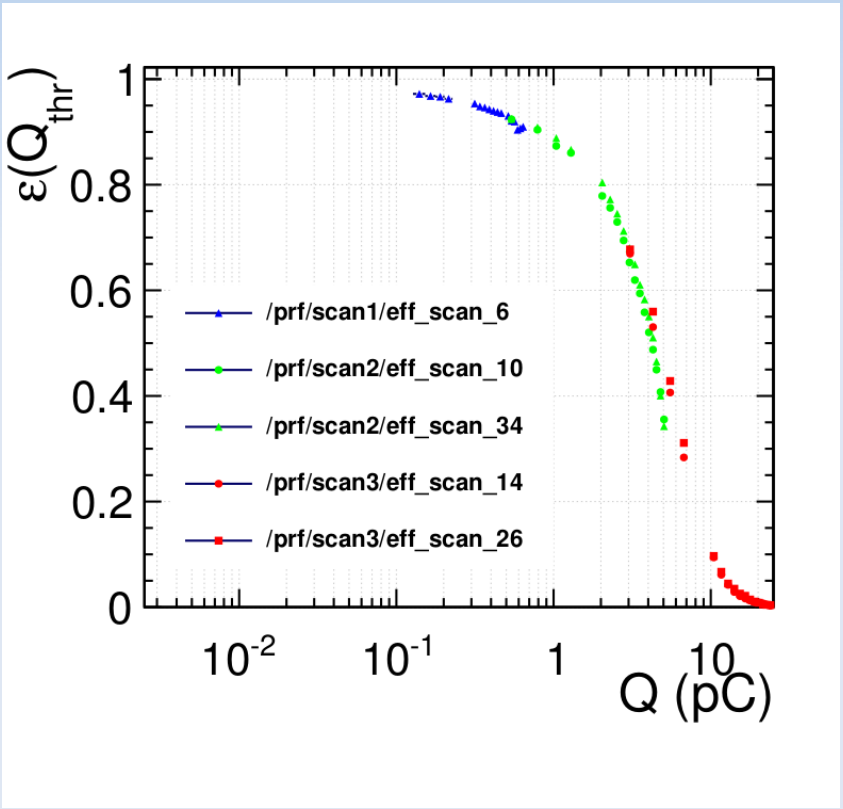


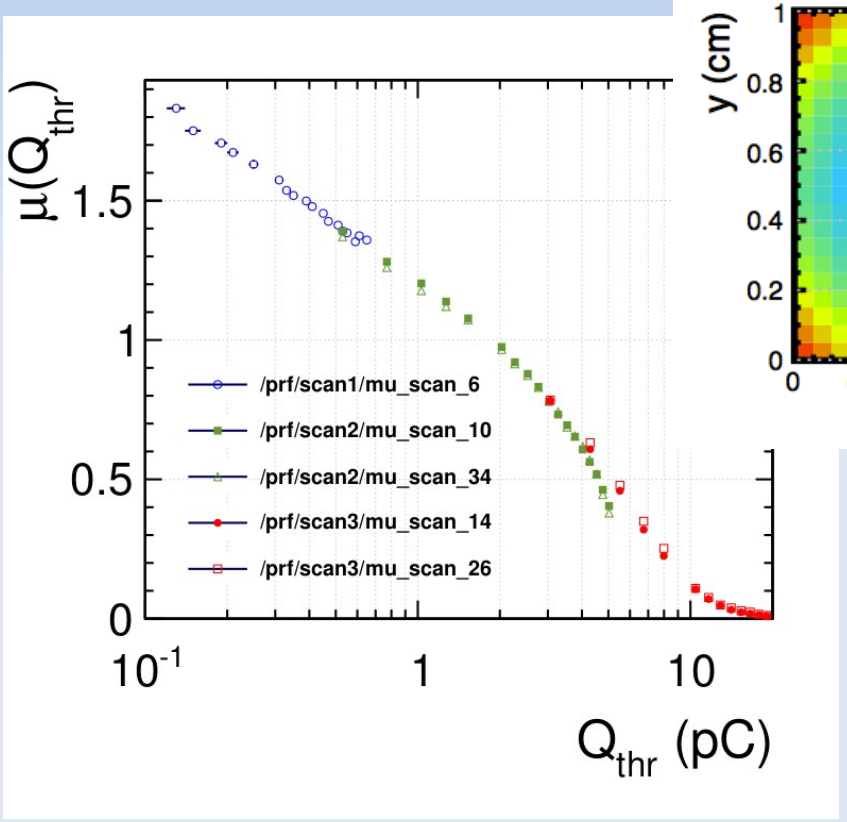


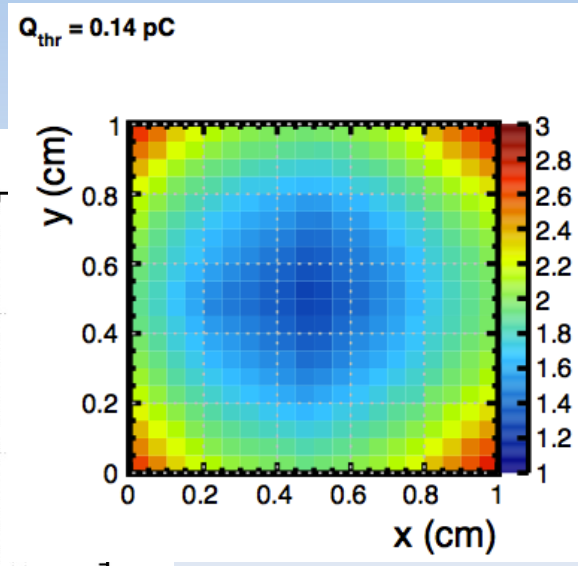
RPC Response estimation

Threshold Scan

Courtesy of Y. Haddad (LLR)







⇒ All information to provide realistic RPC spatial & charge response for highly granular digital RPC calorimeter (same was done for MicroMegas earlier)

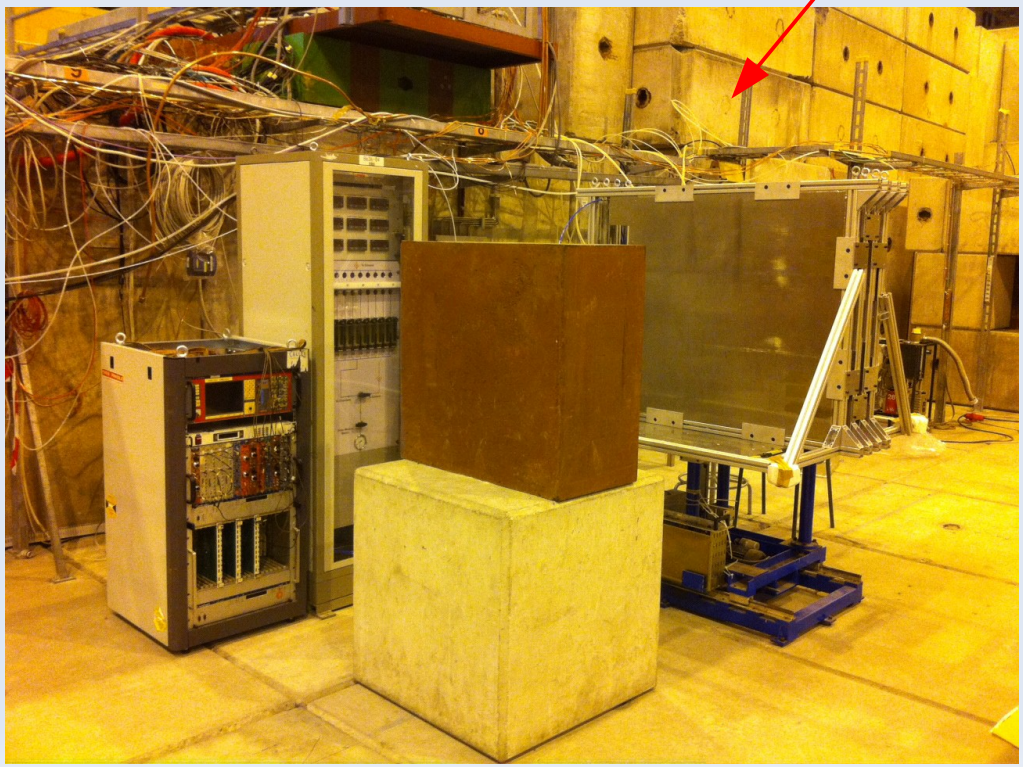
MicroMegas sensors

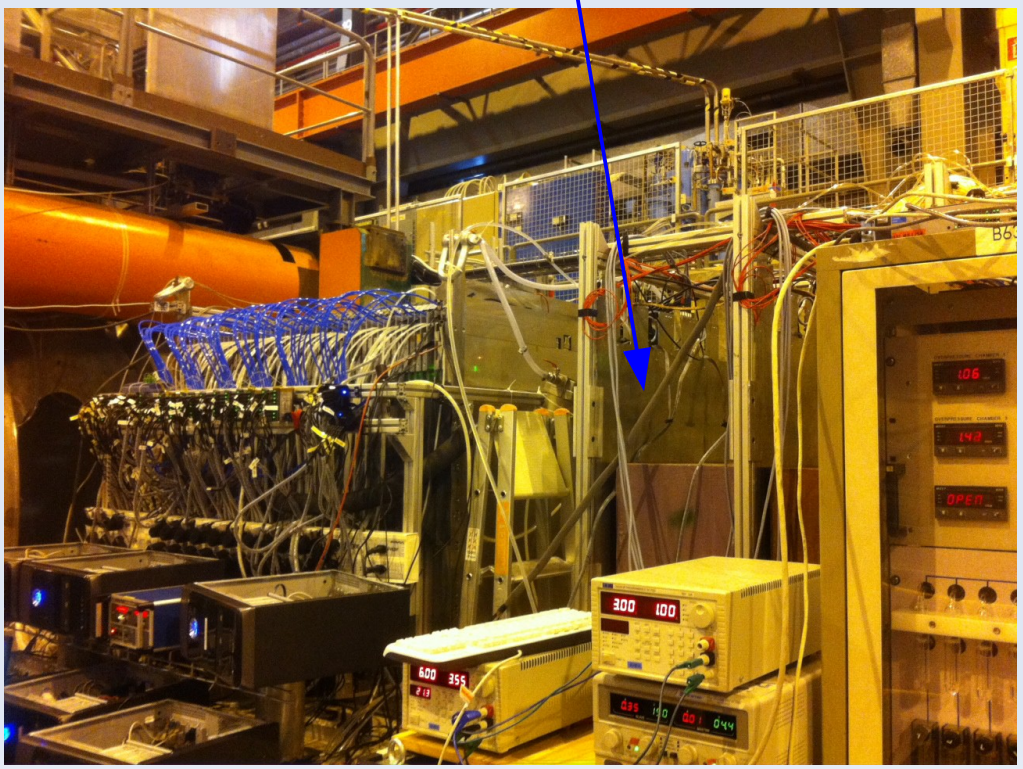
Courtesy of Max. Chefdeville (LAPP)

A 1x1 m2 Micromegas prototype
during assembly at LAPP

4 Micromegas prototypes at CERN in November 2012

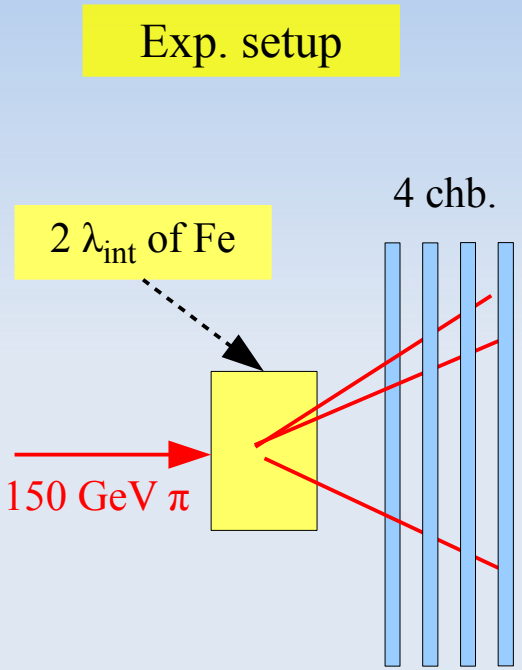
- standalone test in SPS/H4 behind an iron block
- test with (outside/inside) the SDHCAL in SPS/H2

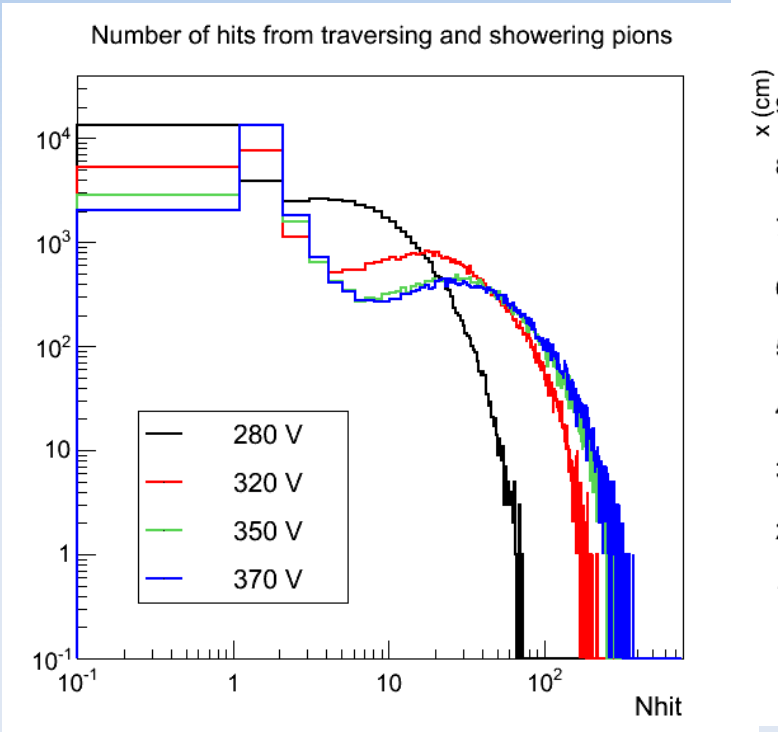


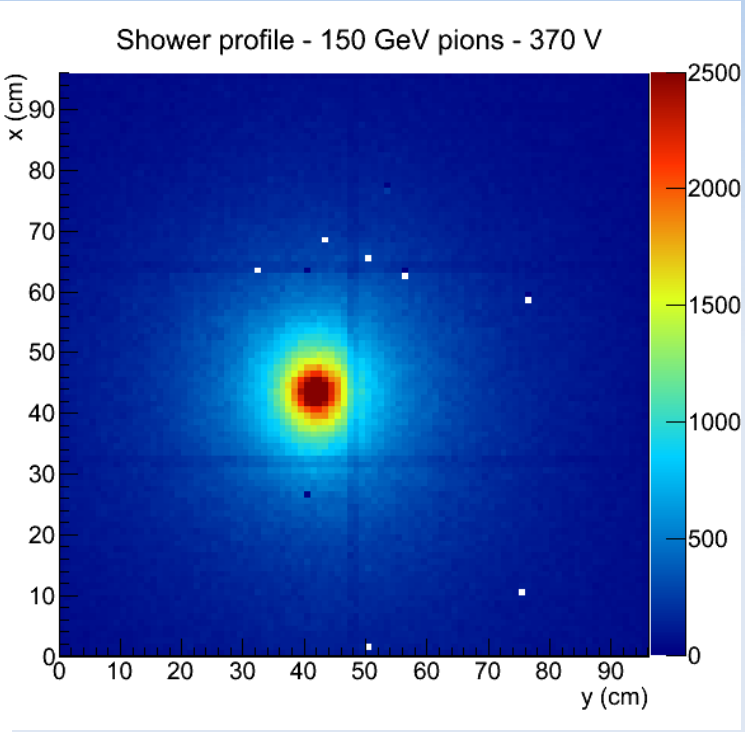


Results (1/2): tuning the detectors in SPS/H4

Courtesy of Max. Chefdeville (LAPP)







The number of hits from 150 GeV pions measured after 2 λ_{int} reaches a plateau at 360 V

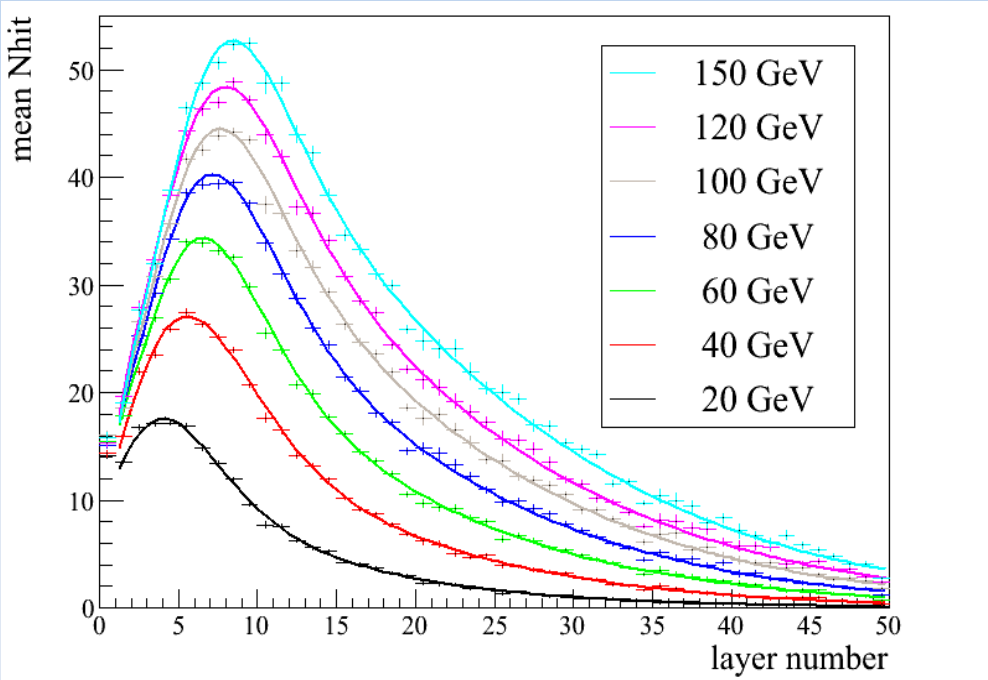
On this basis, an operating mesh voltage of 370 V was chosen (gas gain of ~ 1000 only!)

The chamber response is very uniform
→ manufacturing technique of mesh and threshold settings under control

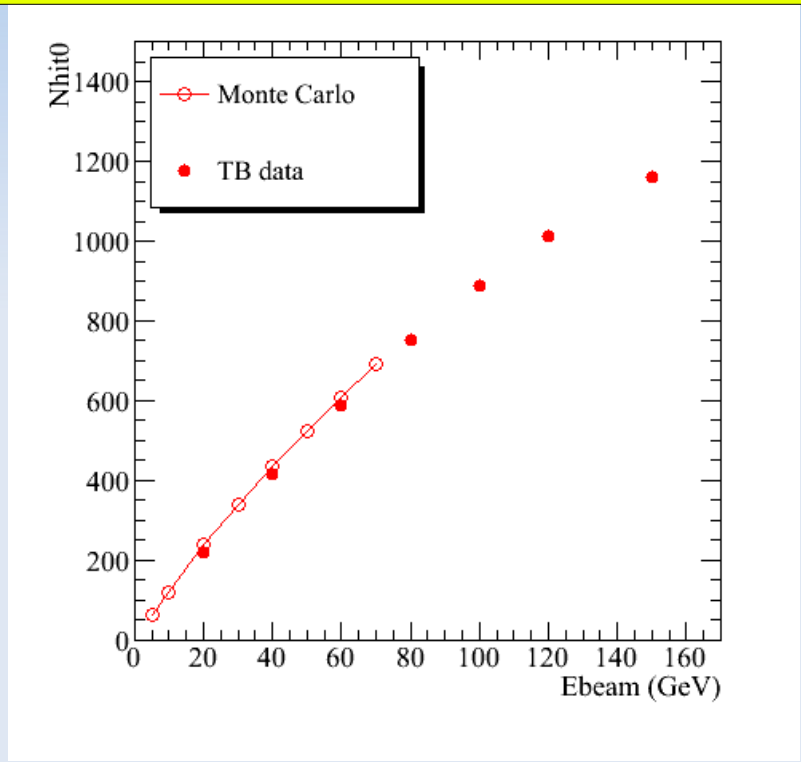
Results (2/2): calorimetry measurement in SPS/H2

Courtesy of Max. Chefdeville (LAPP)

Longitudinal profile of pions showers



Comparison data/Monte Carlo



Inside the SDHCAL: 46 RPCs + 4 Micromegas

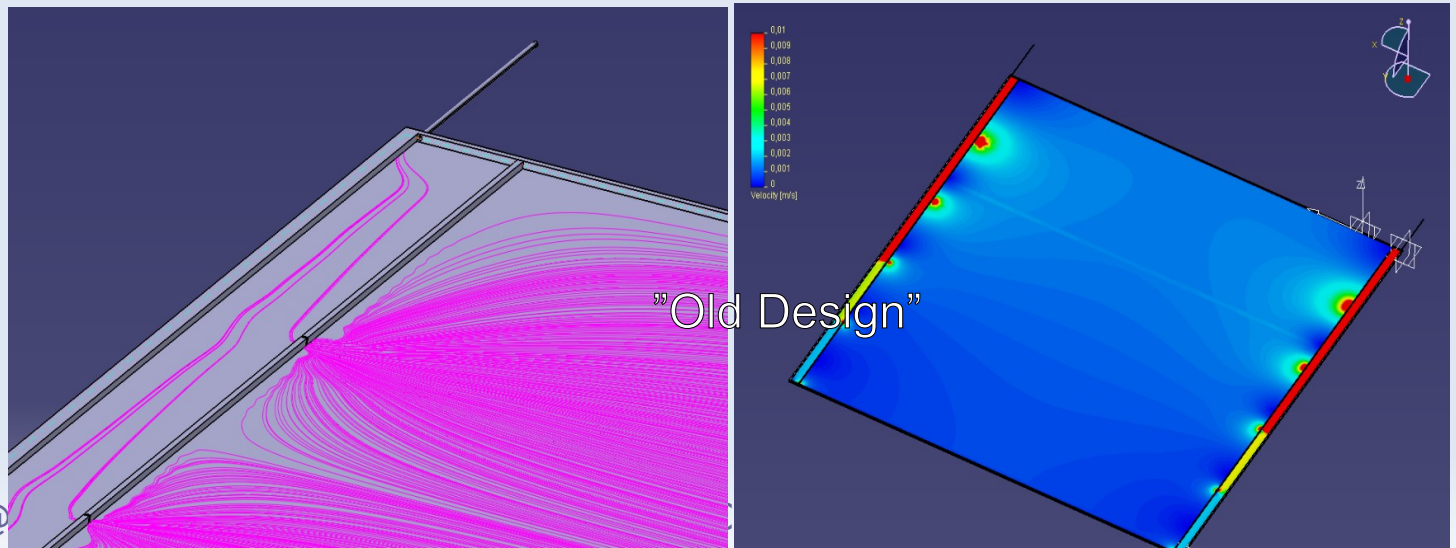
Use RPCs to identify the shower start and measure the number of hits in the Micromegas
→ Obtain shower profile with a virtual 50 layer Micromegas SDHCAL!

Calculate response of a virtual Micromegas calorimeter to pions by integration of the profile
→ Expected saturation is observed and compares well with Monte Carlo predictions!

Design of large GRPC

Courtesy of Imad Laktineh (IPNL)

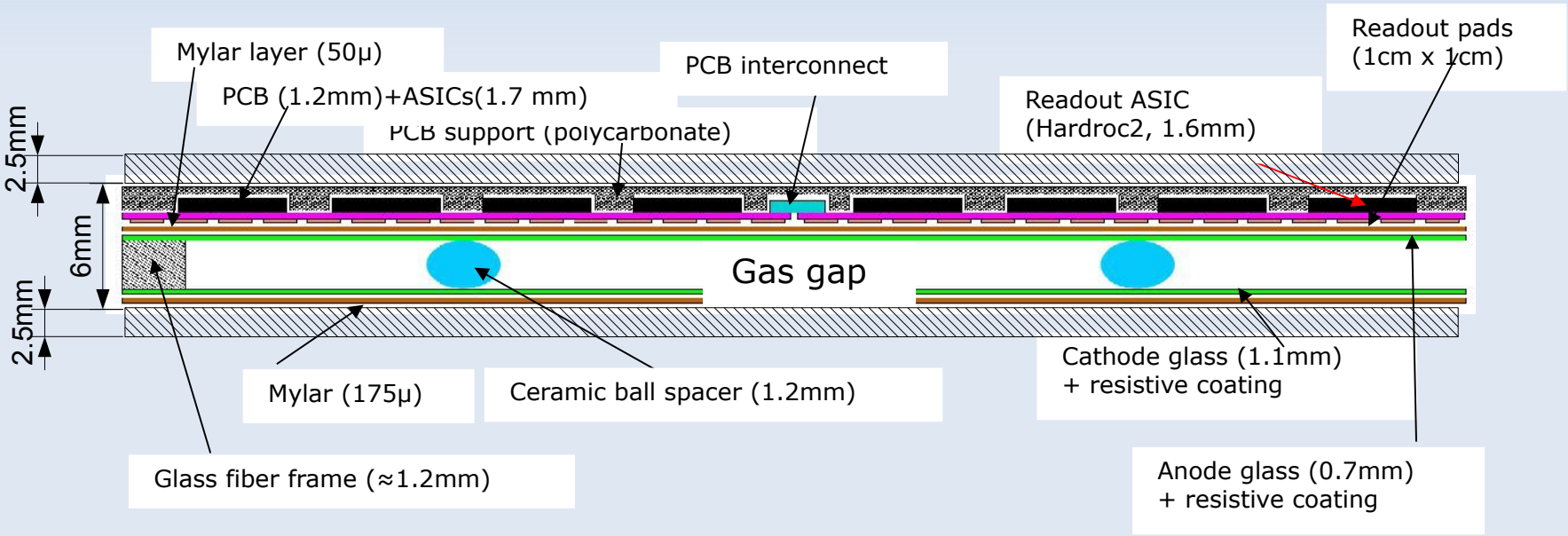
- With the completion of the technological SDHCAL prototype, the goal is to build few large GRPC (> 1 m^2)
- A mechanical structure as close as possible to the final ILD one is to be conceived with the aim to host the large GRPC.
  - The possibility to use electron beam wielding procedure is under study [CIEMAT]
- Detector as large as 2 m^2 are being designed.
  - Silk-screen print of the resistive coatings of large surfaces will be adopted (at the same company that realized the painting of the 1m2 detectors)
  - New gas distribution system inside the detector is under study (inlet and outlet on the same side)
- Construction of the first large GRPC to take place in fall 2013.

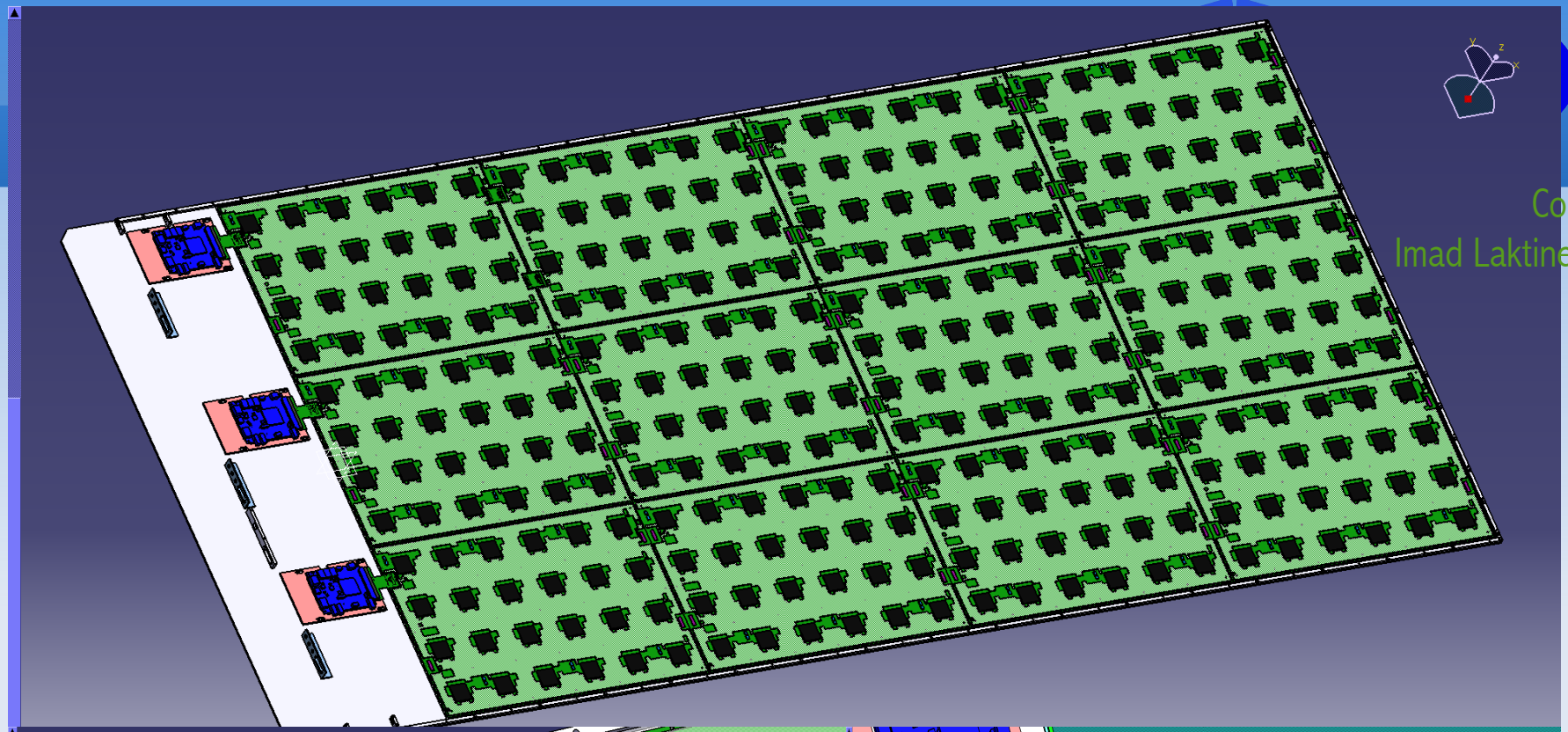


Readout electronics

Courtesy of Imad Laktineh (IPNL)

- Large PCB with new appropriate design to reduce the signal transfer perturbation is under study.
- The PCB should host with the third generation of HARDROC3 ASIC (I2C, circular memory,…) (see presentation of Nathalie Seguin-Moreau)
- Same cassette design as for the 1 m² is to be adopted.





Courtesy of
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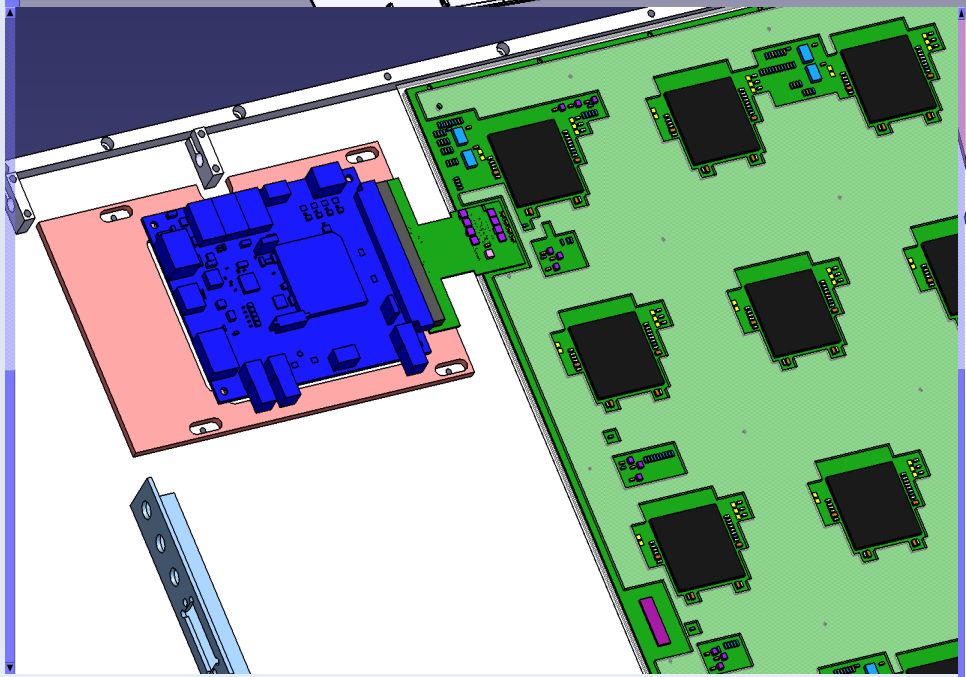

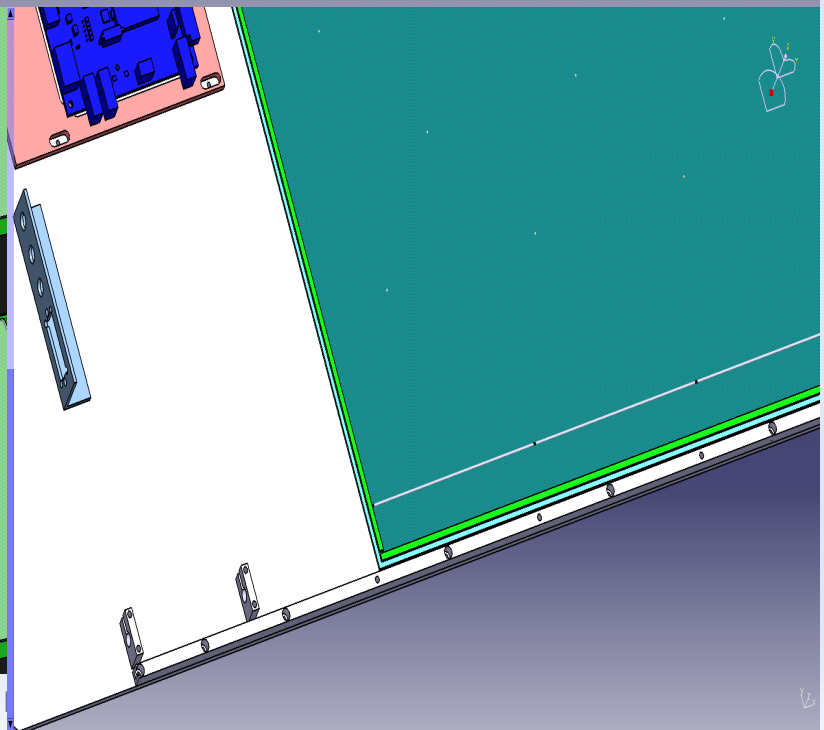

Outlook

- «Middle of the river» status
  - TB activity completed in 2012
    - → analysis on-going
  - Future work (new readout chips, structure) just started.

- Subset of all DHCAL activities: Close to sensors & modelisation
  - Global resolution studies,
  - Hadronic shower structure analysis

- Still a lot to do
  - TB of long slabs to be foreseen in 2014 (DESY)

Back-up

Use of AIDA funds at LAPP

- LAPP project
  R&D on large area Micromegas chamber for digital hadron calorimetry at a future linear collider
  - Prototype of 1x1 m2 with 9216 pads of 1x1 cm2
  - Front-end electronics (MICROROC chip) integrated on PCB + Bulk mesh manufacturing technique
    → total thickness < 1cm

- Status
  - 4 Micromegas prototypes of 1x1 m2 have been constructed in 2011-2012
    and tested in particle beams inside the DHCAL steel structure in 2012
  - 2013: analysis of testbeam data, Monte Carlo simulation and publication of results

- Use of AIDA funds
  - Development of a Micromegas (MICROROC) and RPC (HARDROC) compatible data acquisition system
    for the SDHCAL prototype in collaboration with the IPNL group
    (firmware of the FPGA of the various boards (DIF, DCC, SDD))
    → **travel expanses of one engineer**
  - Test-beam at CERN of the 4 Micromegas prototype standalone (2 weeks)
    and inside the SDHCAL (2 weeks) with 46 RPCs in November 2012
    → **travel expanses of the whole LAPP group**