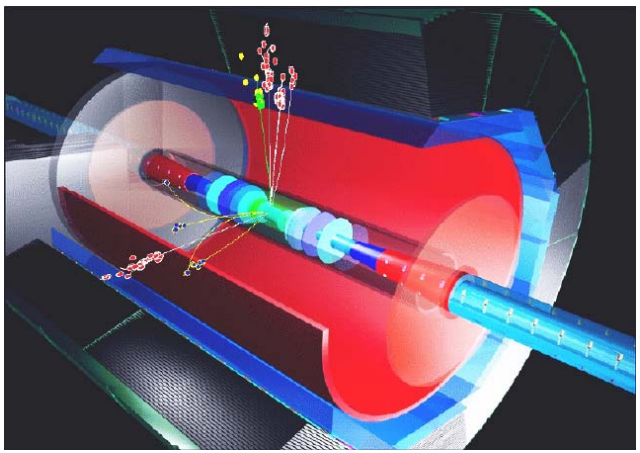
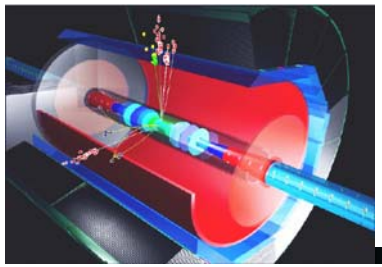


Scintillator HCAL

Felix Sefkow
DESY
CALICE collaboration

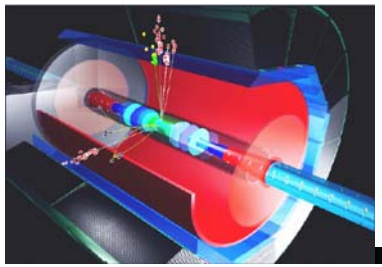
ALCPG workshop at Snowmass
August 23, 2005



Issues *

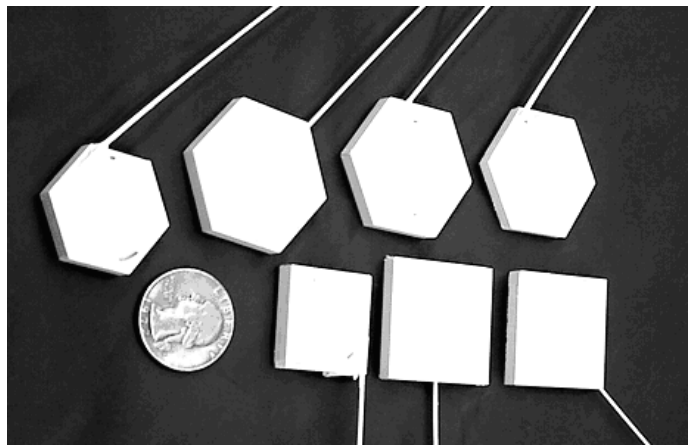
- Scintillators
- Photodetectors
- Technology implementation
- Physics performance

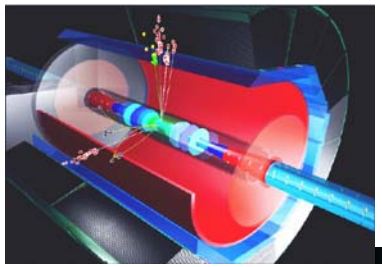
* Impossible to completely cover all issues in 10 minutes – see Dhiman Chakraborty's talk in the SiD session for a more comprehensive treatment



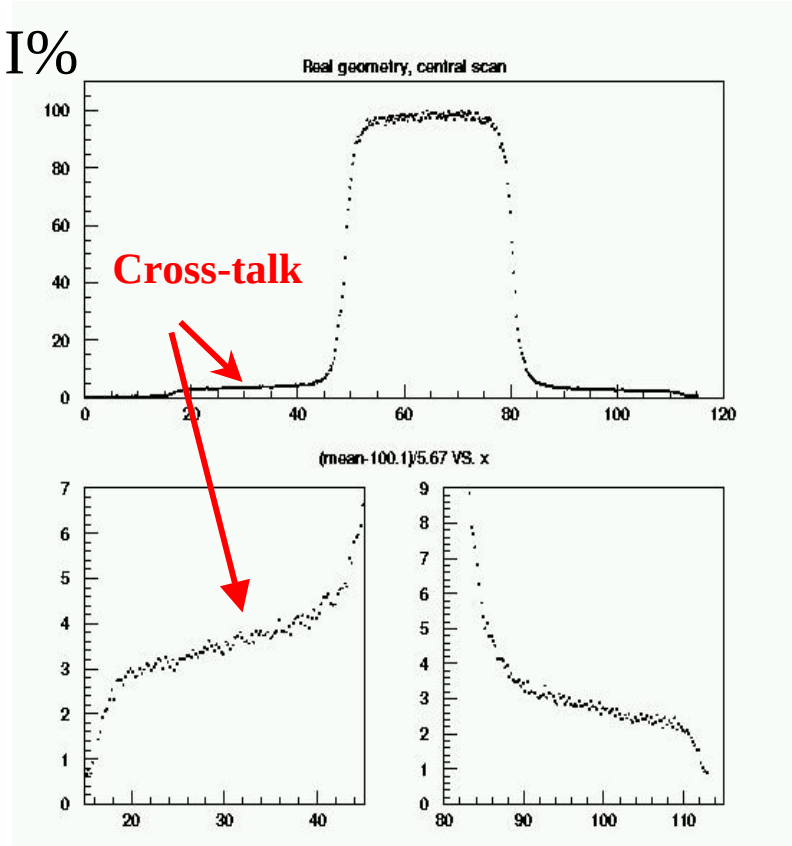
Scintillators

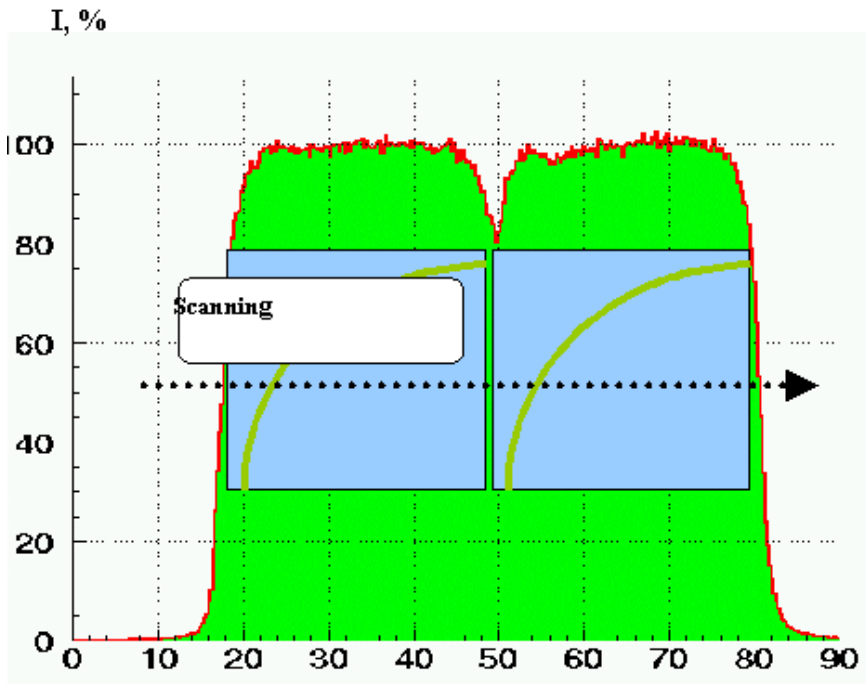
- Originally a baseline/backup solution
- Proven technology
- Robust, high rate capability
- sufficiently rad hard
  - 1 Mrad = 10 kGy or 10^{15} n
- Cheap (not a cost driver)
- Thoroughly optimized
  - Studies at NIU, ITEP, DESY/LPI, …



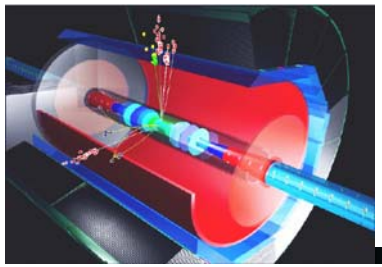


E.g. cross talk, uniformity



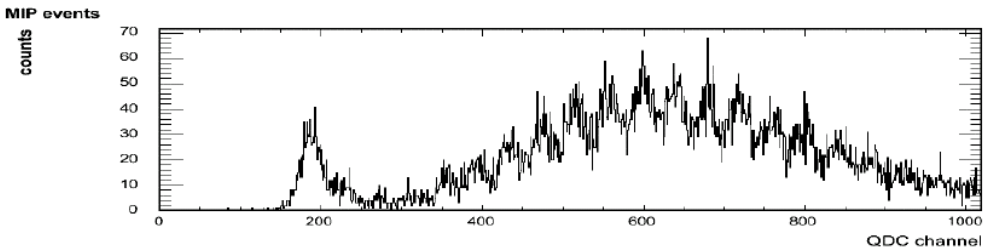


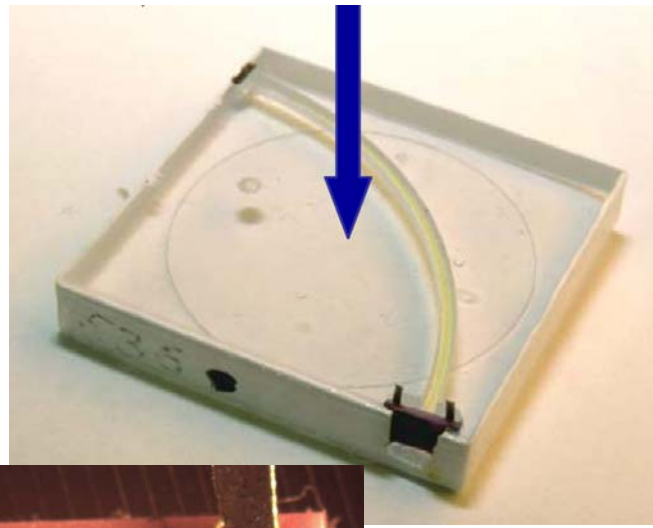
X talk 2.5% (neighbors, corners negligible)



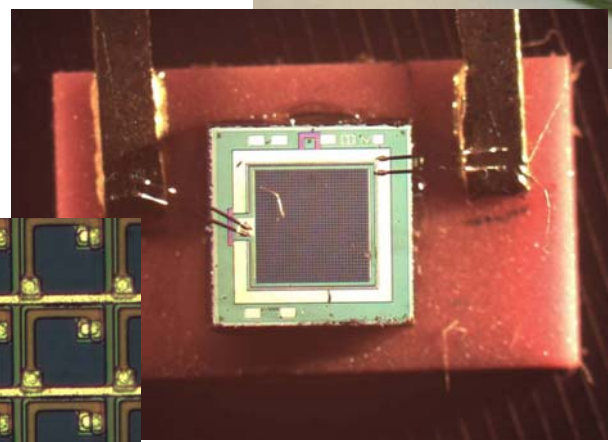
Silicon Photo-Multipliers

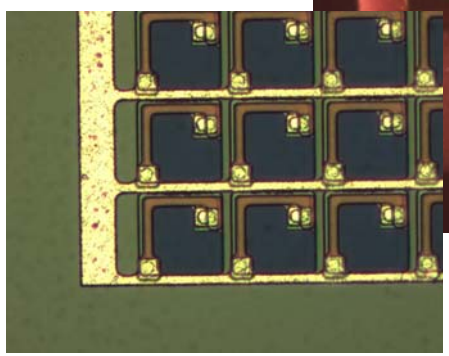
- Pixel Geiger Mode APDs
- Gain 10^6, bias ~ 50 V, size 1 mm^2

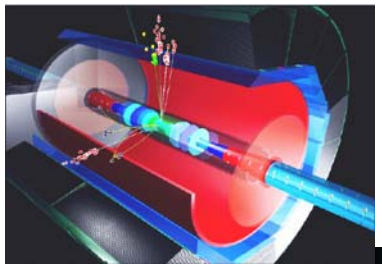




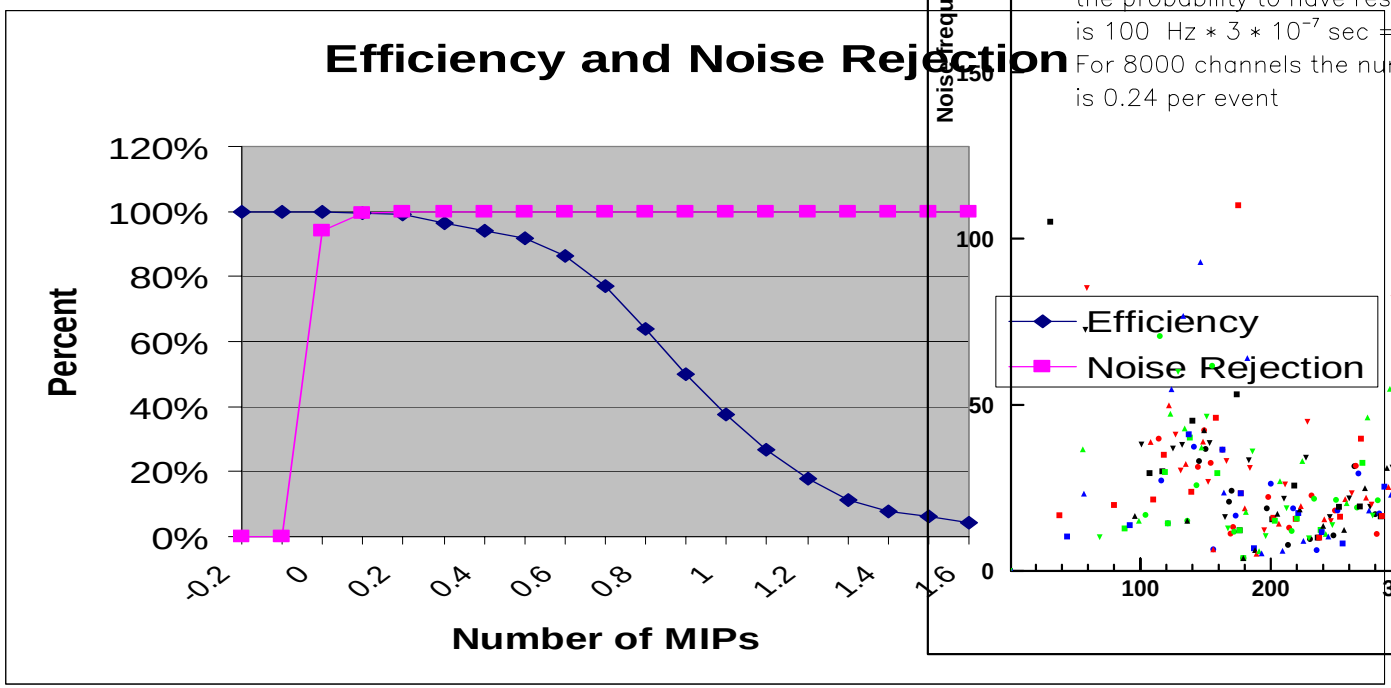
Auto-calibrating, but non-linear

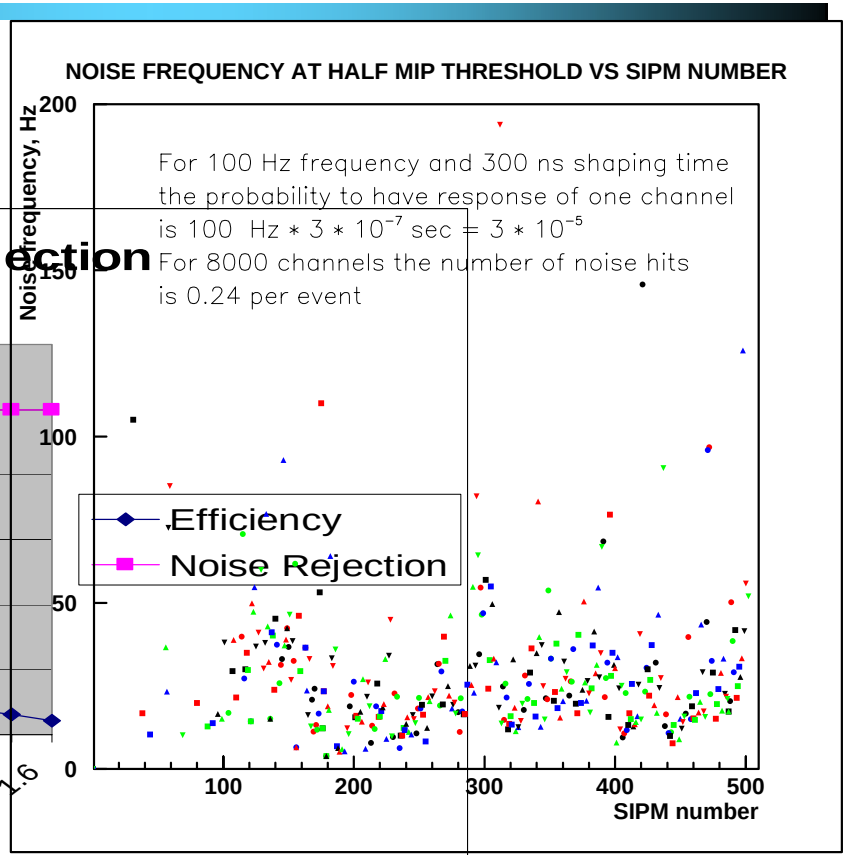




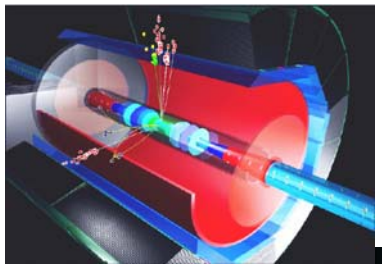


SiPM noise



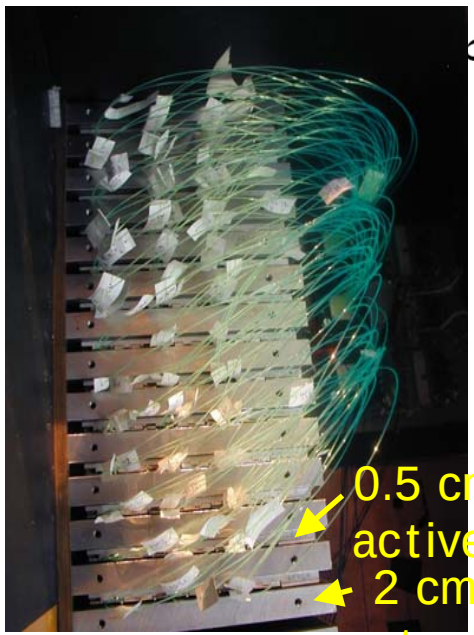


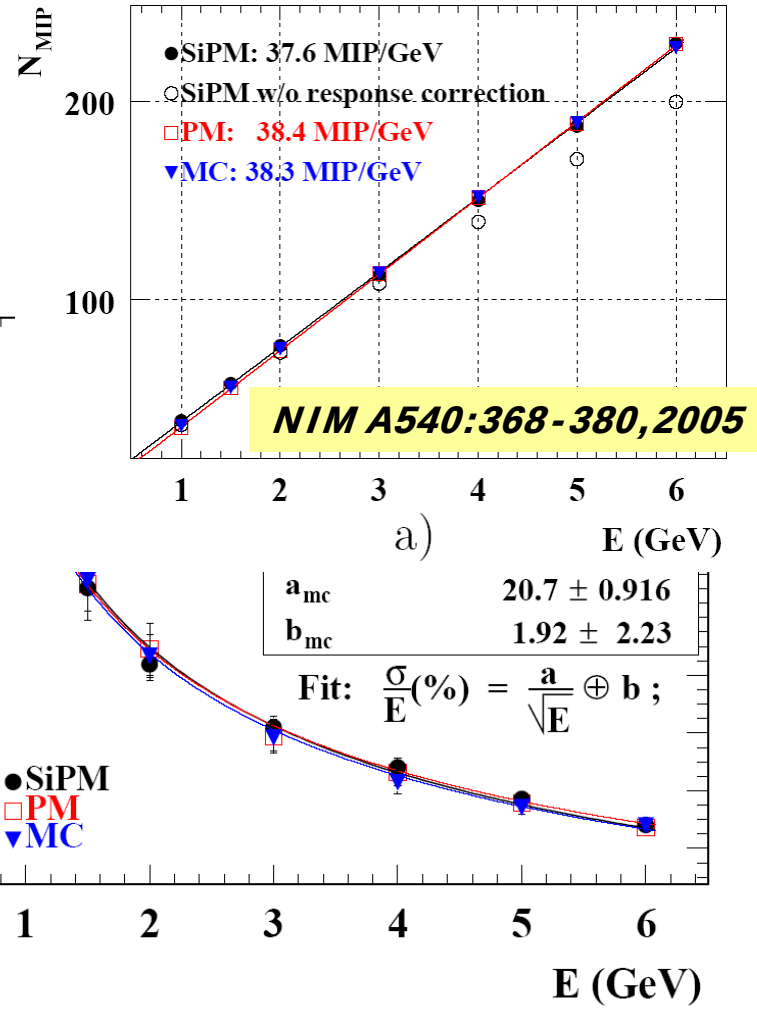
0.25 MIP threshold: efficient, quiet

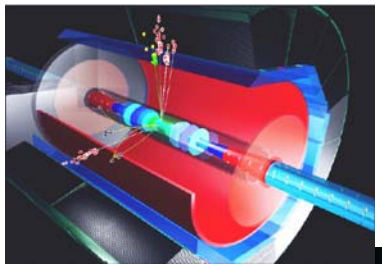


Testbeam results

- 100 SiPM channel "minical"
- Non-linearity can be corrected (at tile level)
  - Does not deteriorate resolution



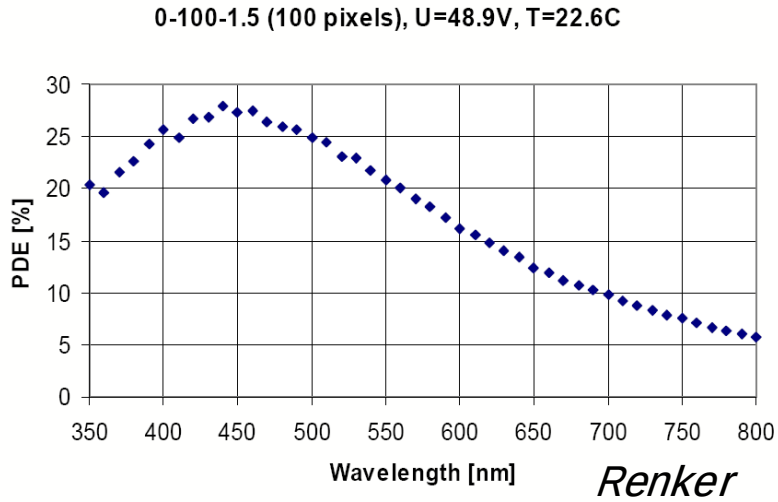




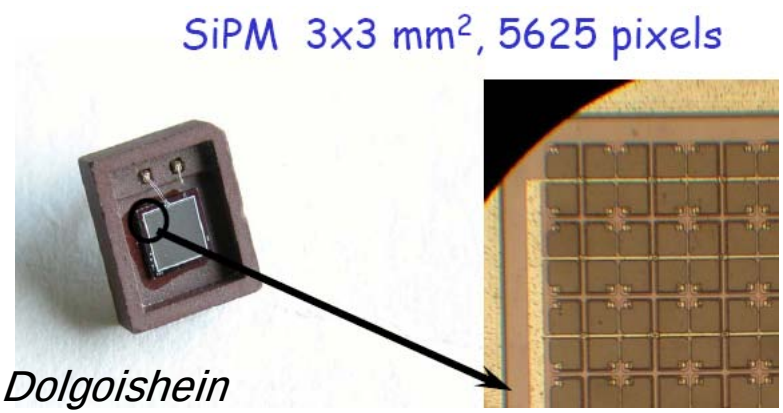
SiPM Developments

- Driven by bigger markets (PET)
- First tests with Hamamatsu devices reported at LCWS, more details at Beaune conference
  - Performance similar to MEPHI/PULSAR devices, but better sensitivity to blue light
- MEPHI has tested larger area SiPMs

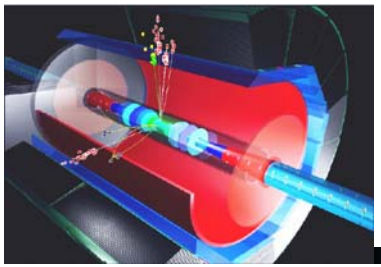
- Large area + blue sensitivity: eliminate WLS fibre and couple the SiPM directly to the tile edge
  - Big simplification!



Renker

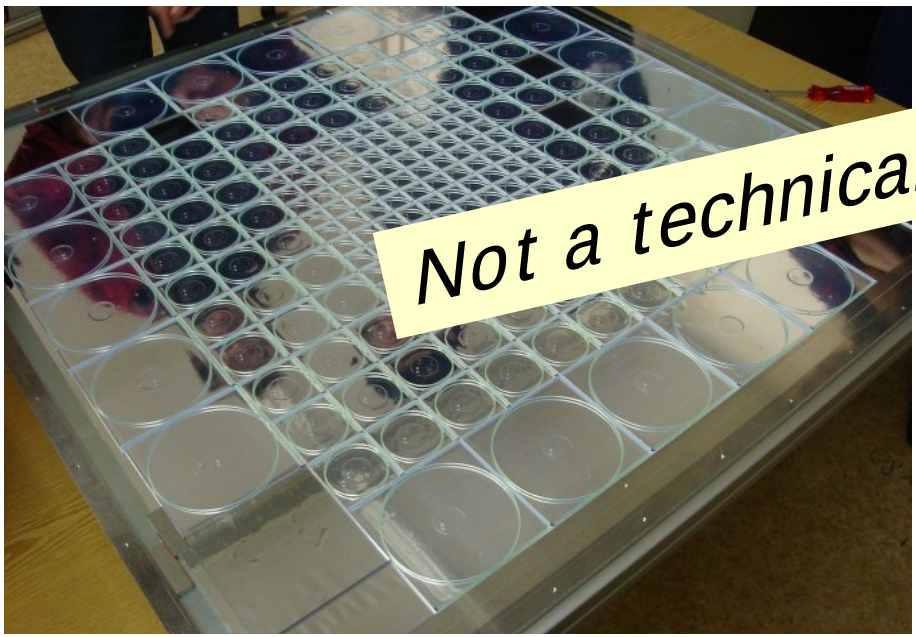


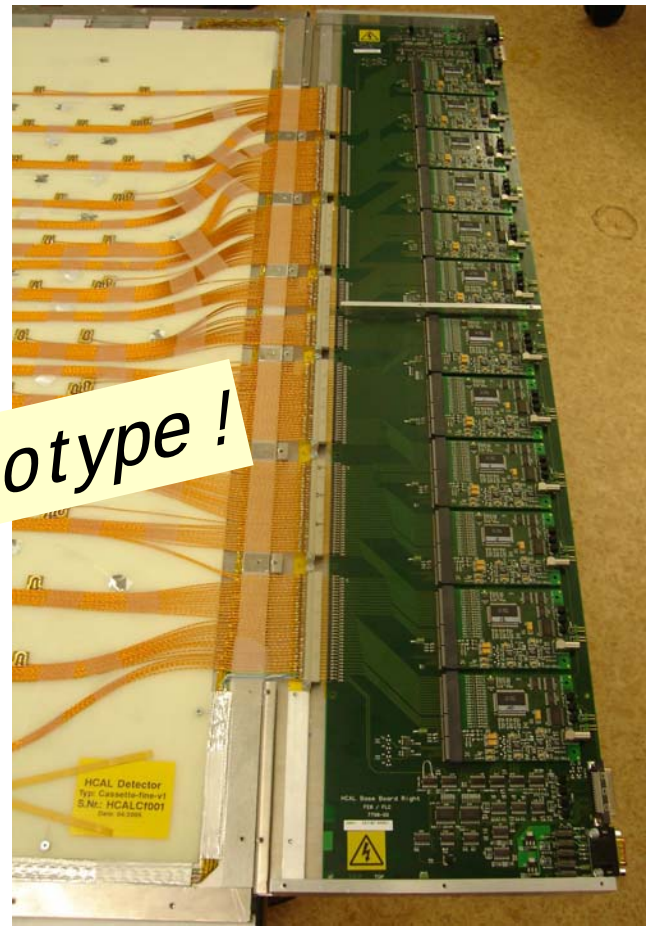
Dolgoishein



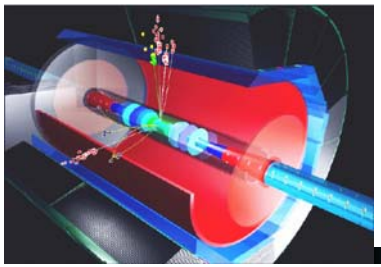
Technolgy Implementation

- In its infancy
- Still to develop
  - Front end electronics
  - Readout boards
  - Calibration system



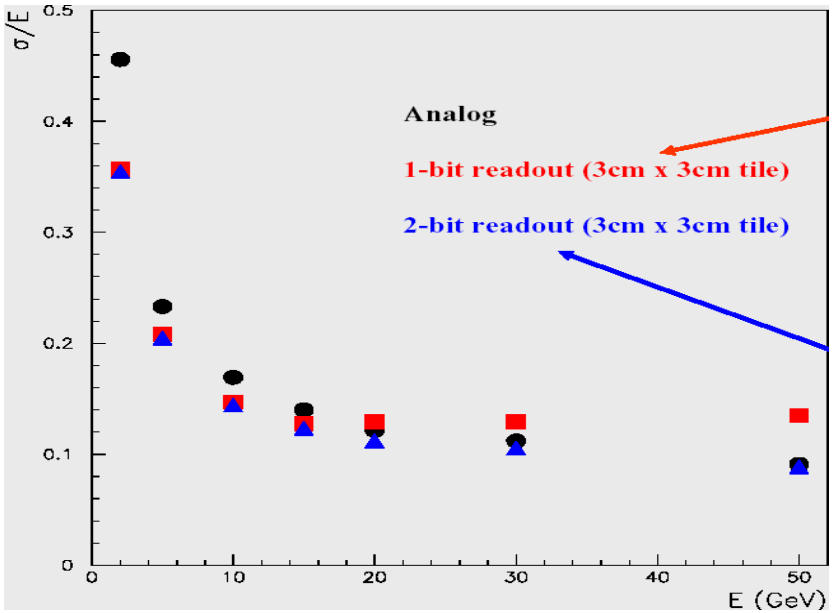


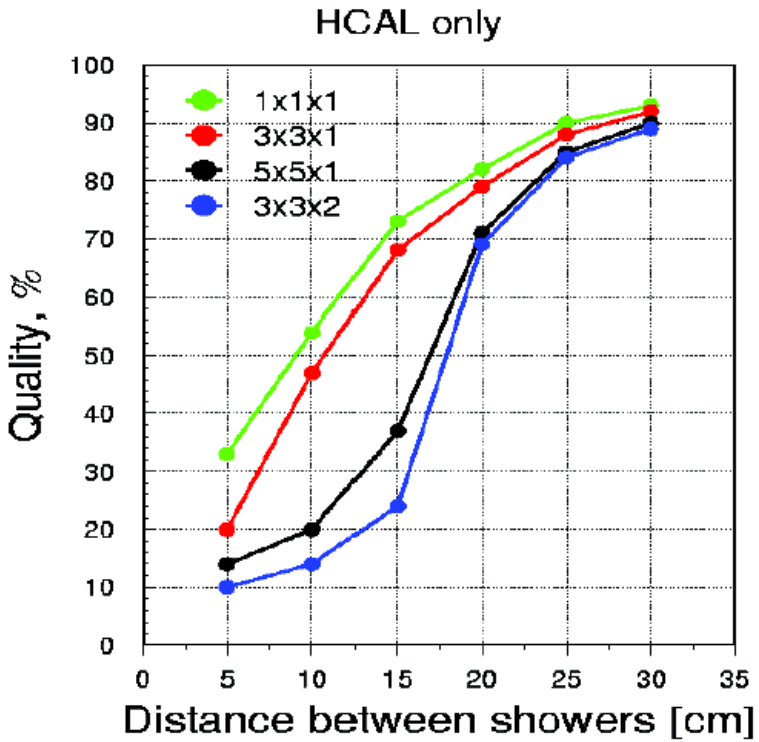
Not a technical prototype !



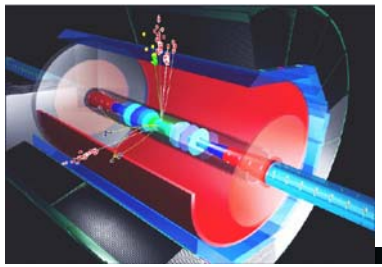
Granularity

- Scintillators: trade granularity against amplitude resolution





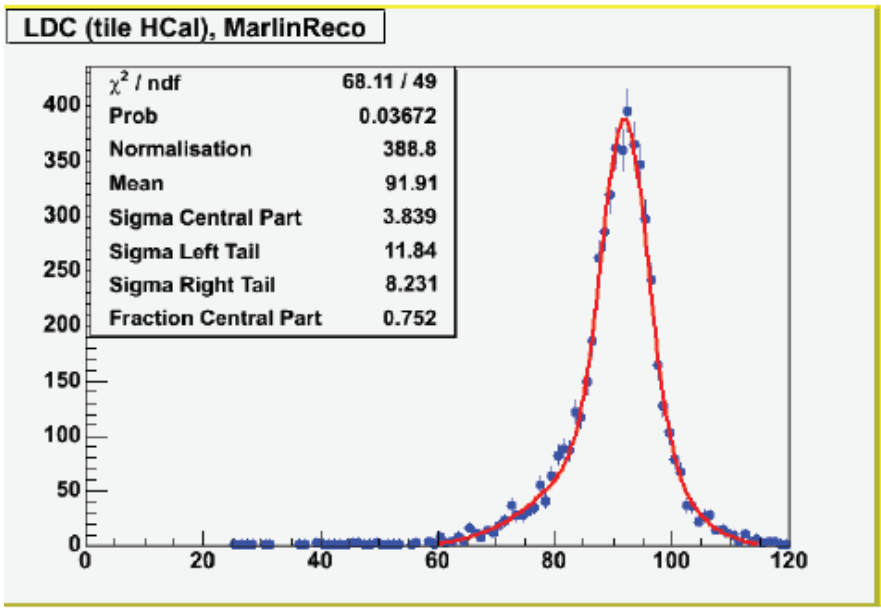
- 3cm tile size optimized for shower separation – and semi-digital readout



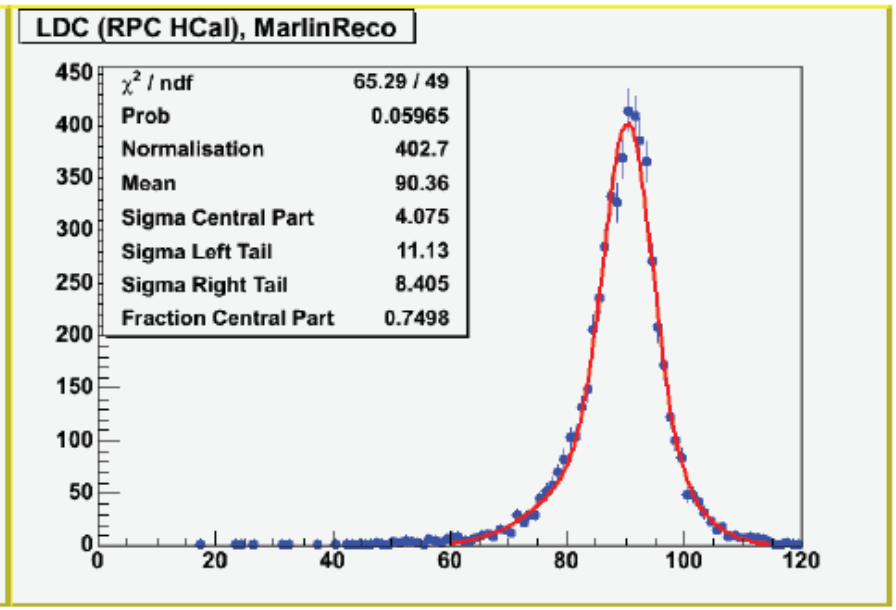
PFLOW performance

- By far not the final word, but state of the art

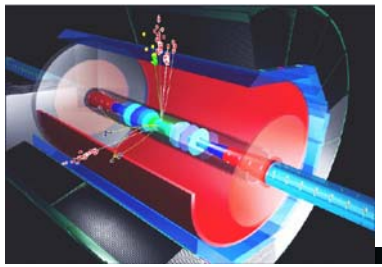
Analogue Tile HCal (3x3 cm^2 tile size)



Digital RPC HCal (1x1 cm^2 pad size)

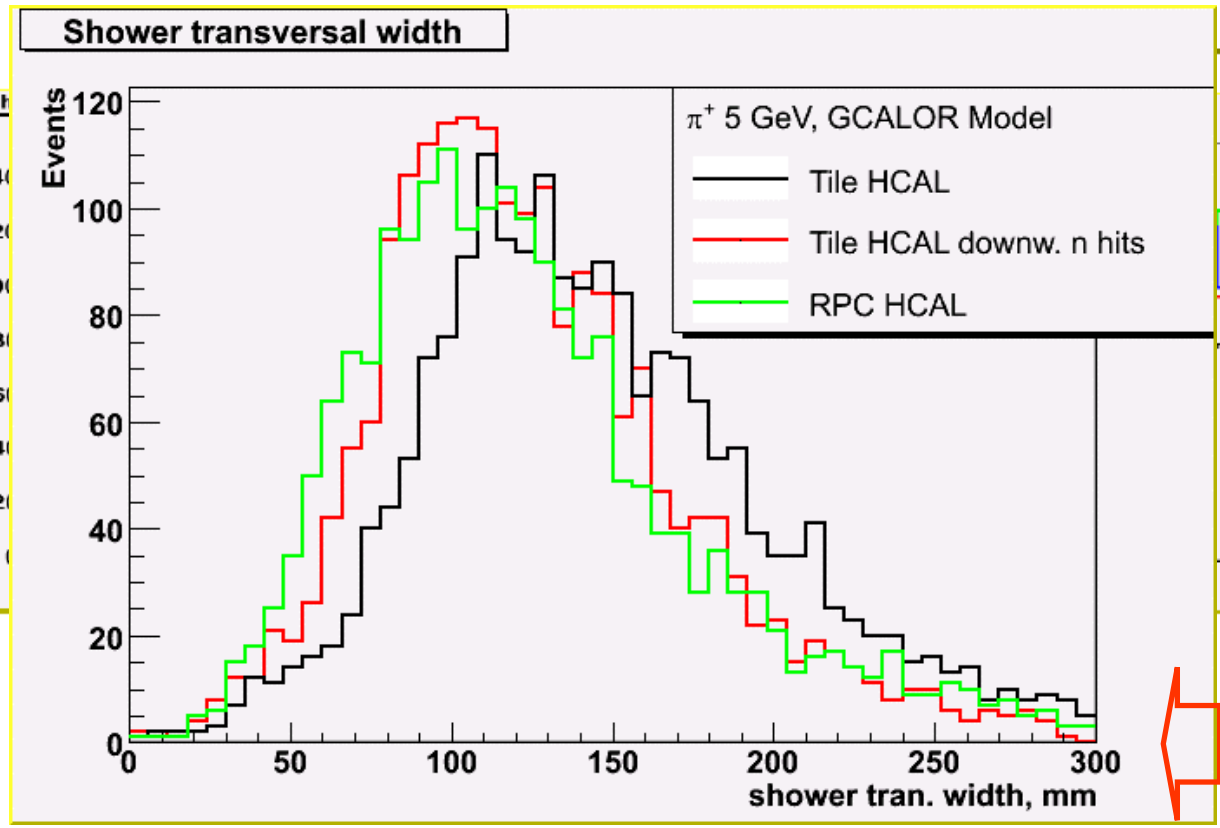


A. Raspereza



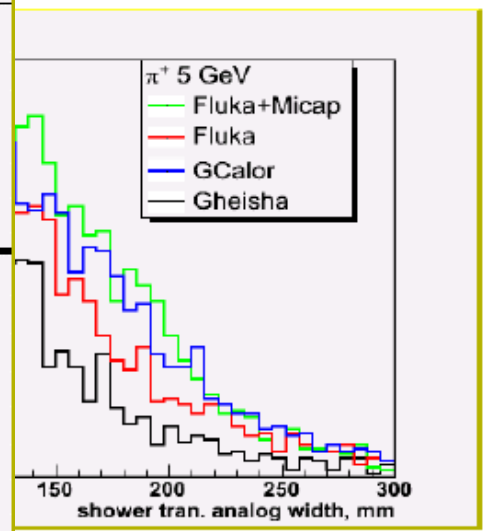
Imaging quality

- Shower in scintillator appears* wider than in gas
- Large model dependence of shower width

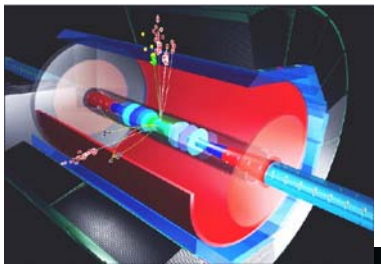


HCAL

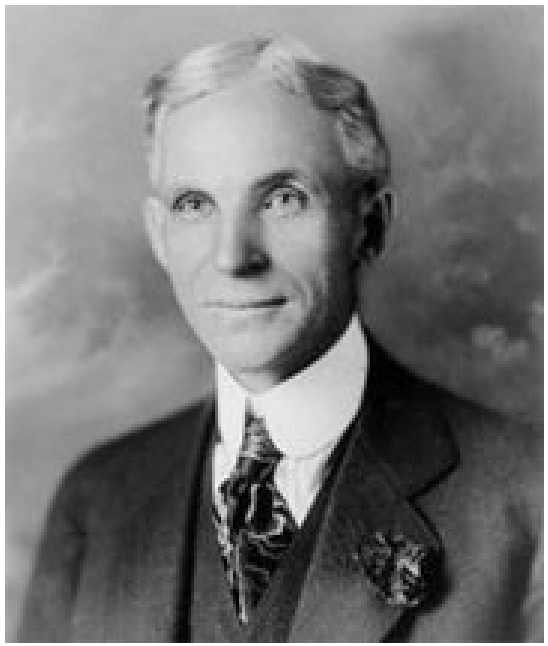
** unweighted*



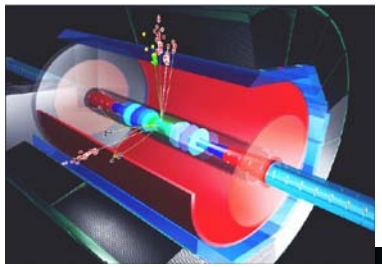
Use the weights which optimize hadron energy resolution



Making decisions

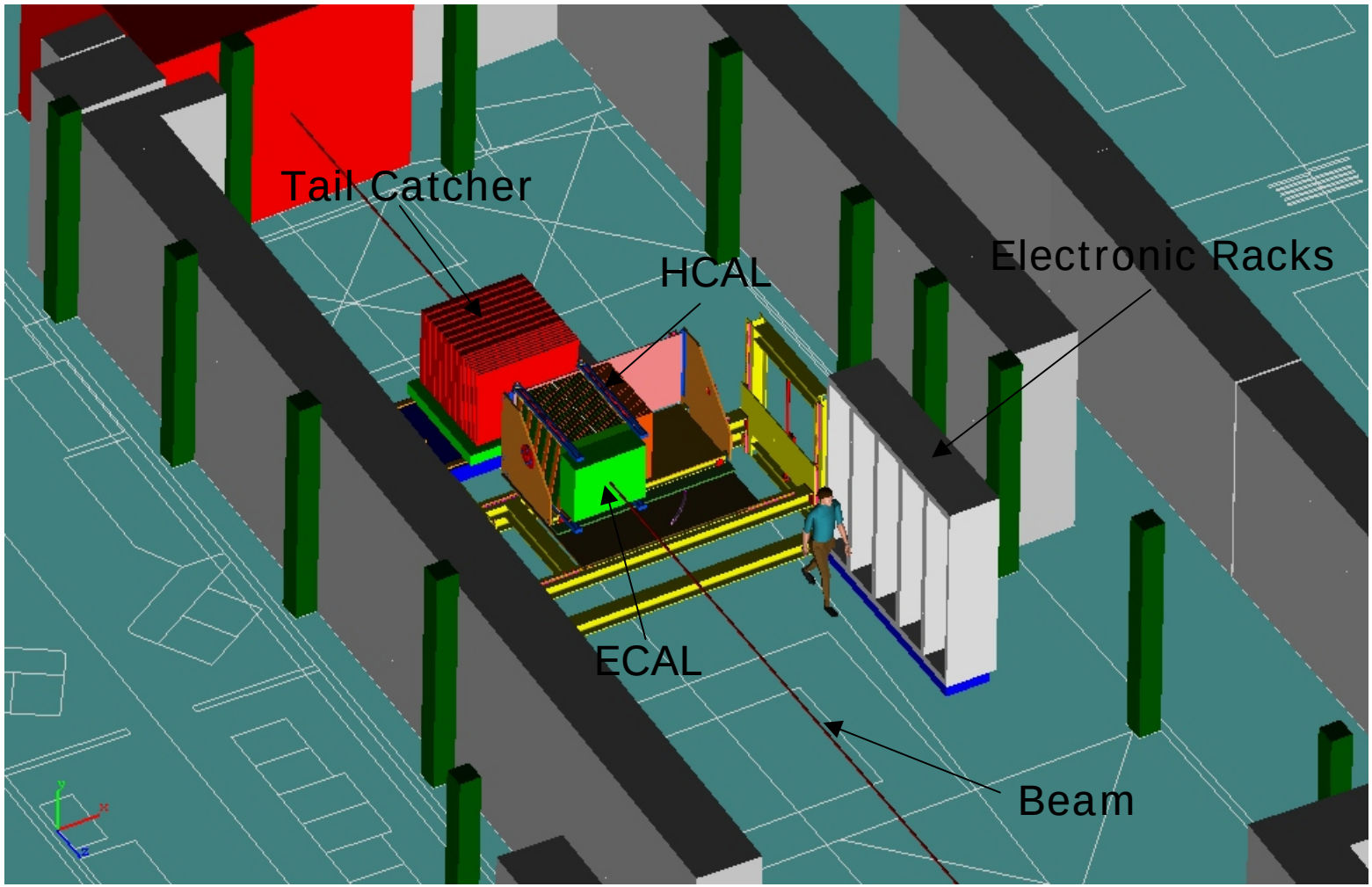


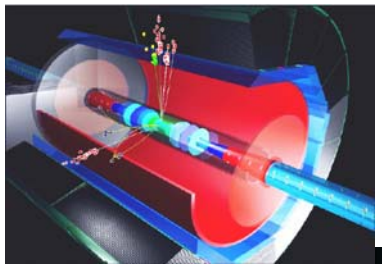
Henry Ford I



Testbeam

RPCs,, GEMs, and Scint





Summary

- Scintillators are proven, robust and well optimized
- SiPMs open the possibility for highly granular “imaging” calorimeters – and have a promising development potential
- The calorimeter technology implementation has only begun
- Performance comparison with gaseous HCALs is highly model-dependent
- The confrontation of technologies is a BIG (testbeam) effort