Test Beam Results from the Forward Calorimeters

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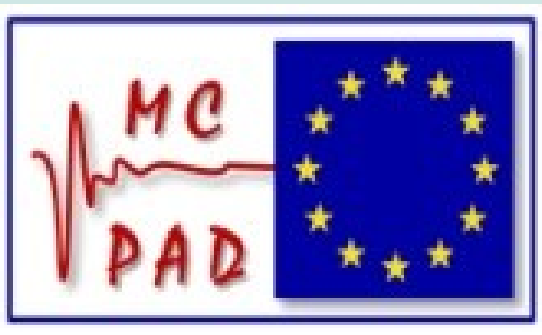
Joint ACFA Physics / Detector Workshop and GDE meeting on Linear Collider

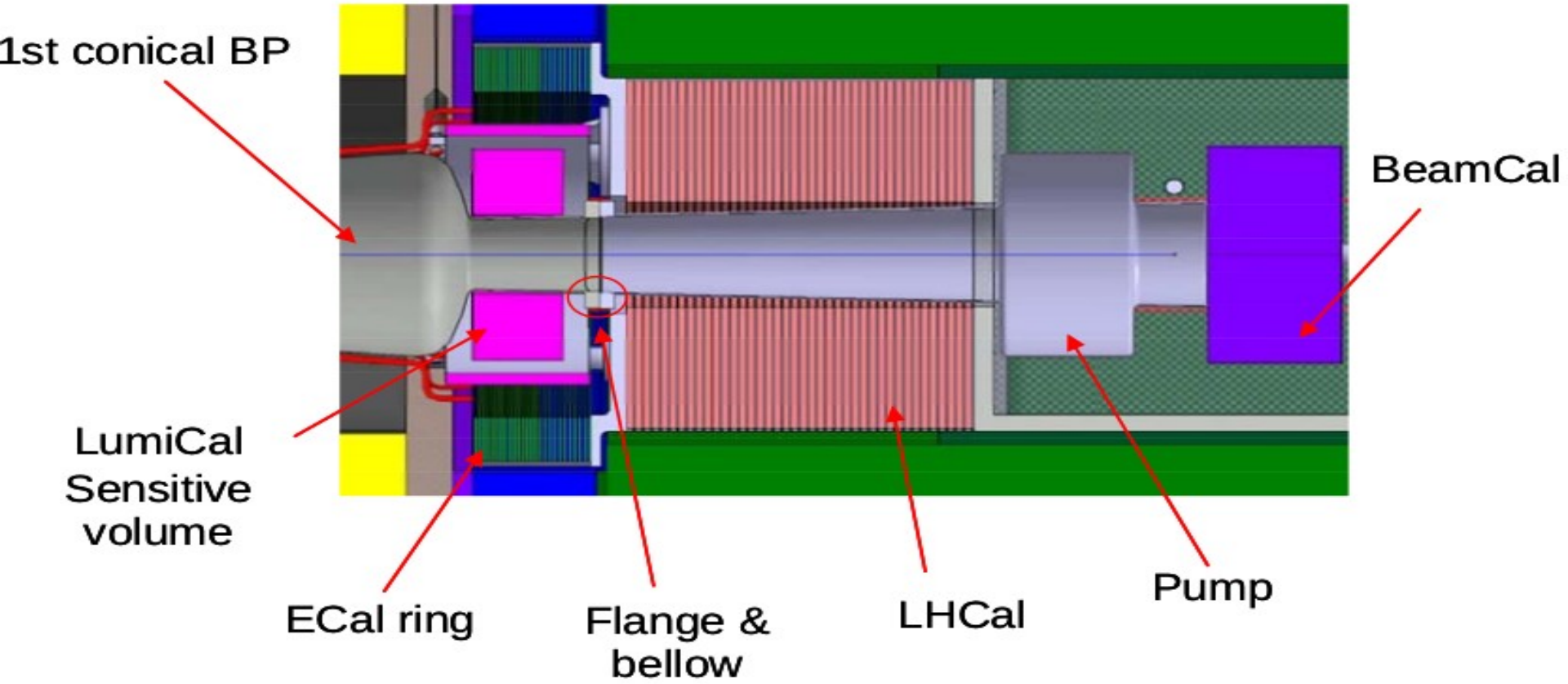
Labs involved : Argonne, Vinca Inst Belgrade, Bukharest IFIN, Institute of Space Science Romania, CERN, Univ. of Colorado, Cracow AGH-UST,Cracow INP, JINR Dubna, Royal Holloway, NCPHEP Minsk, Santa Cruz, Stanford University, SLAC, Tuhoku Univ., Tel Aviv Univ., DESY (Z.)



Outline

- Forward Calorimeters
- Test Beams Results
- AIDA very forward calorimeter design
  - Mechanical frame
  - Tungsten absorber support
  - Si and GaAs detector support
- Tungsten Manufacture & ASIC's & Sensors
- Conclusions

Forward calorimeters



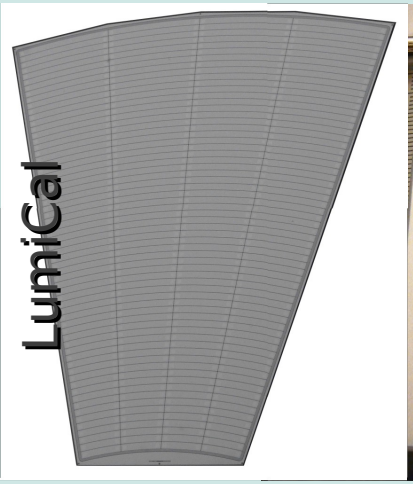
Precise luminosity measurement,

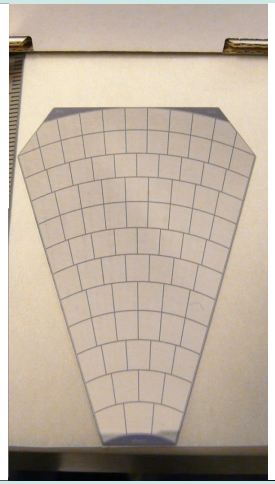
Hermeticity (electron detection at low polar angles),

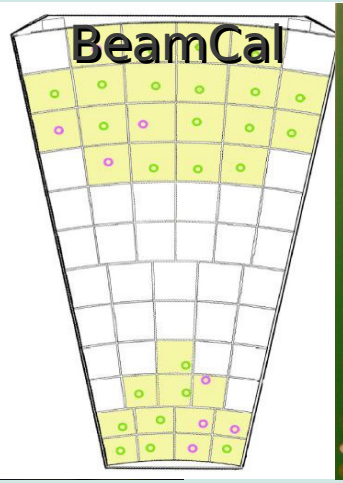
Assisting beam tuning (fast feedback of BeamCal data to machine)

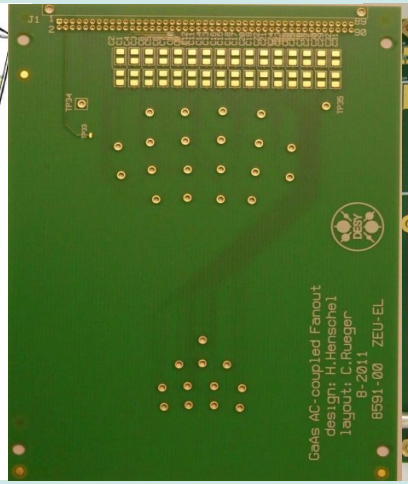
Challenges: radiation hardness (BeamCal), high precision (LumiCal) and fast readout (both)

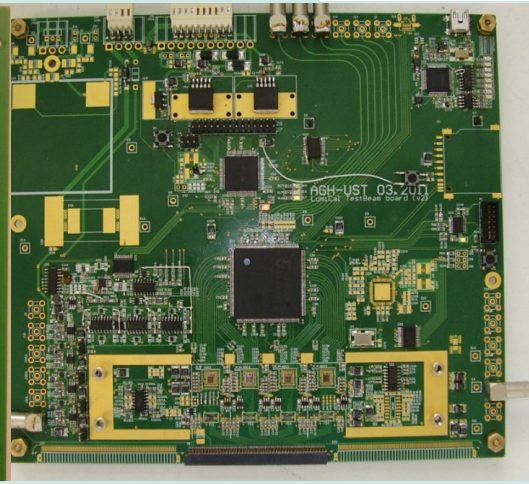
Prototypes





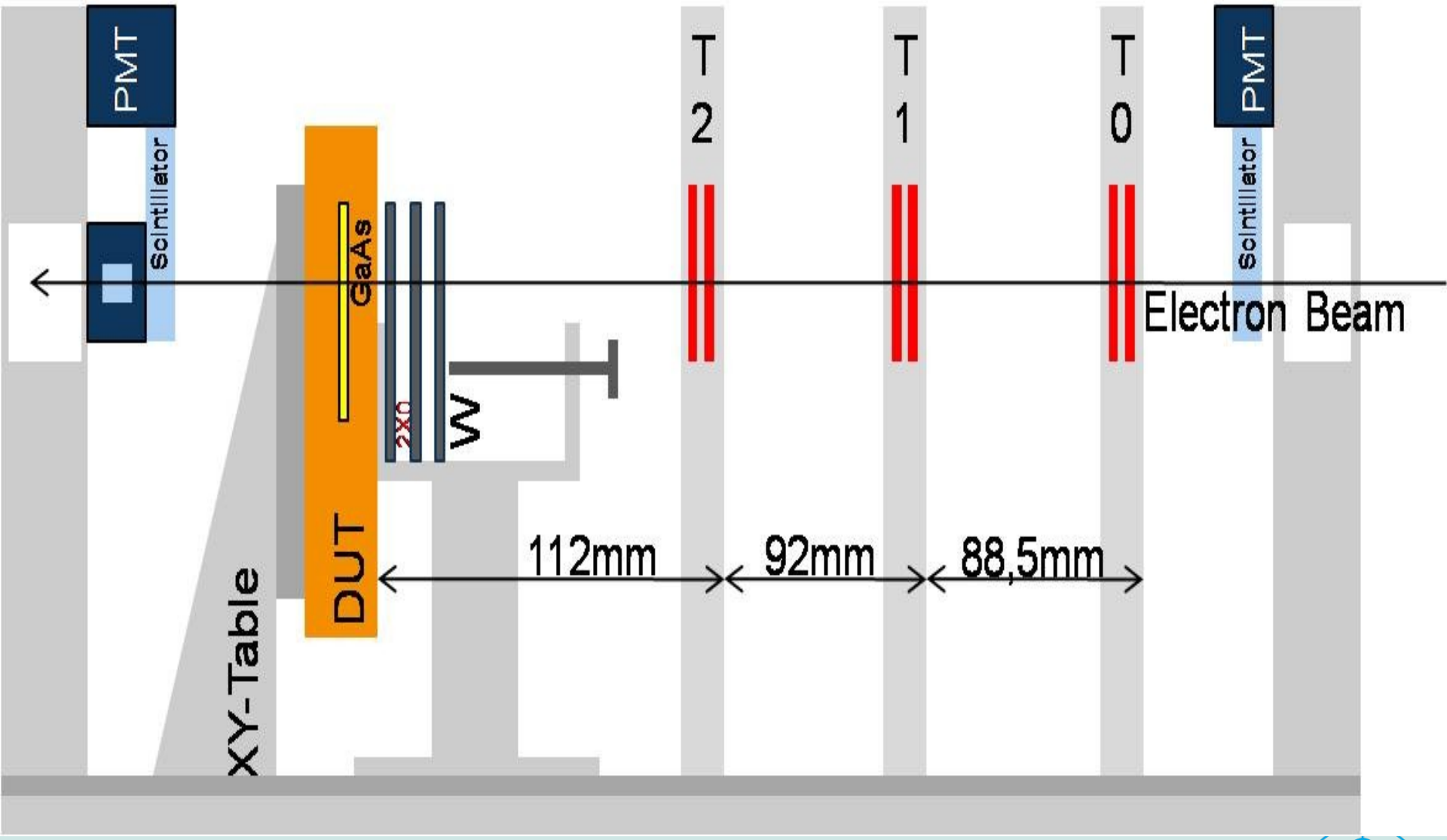




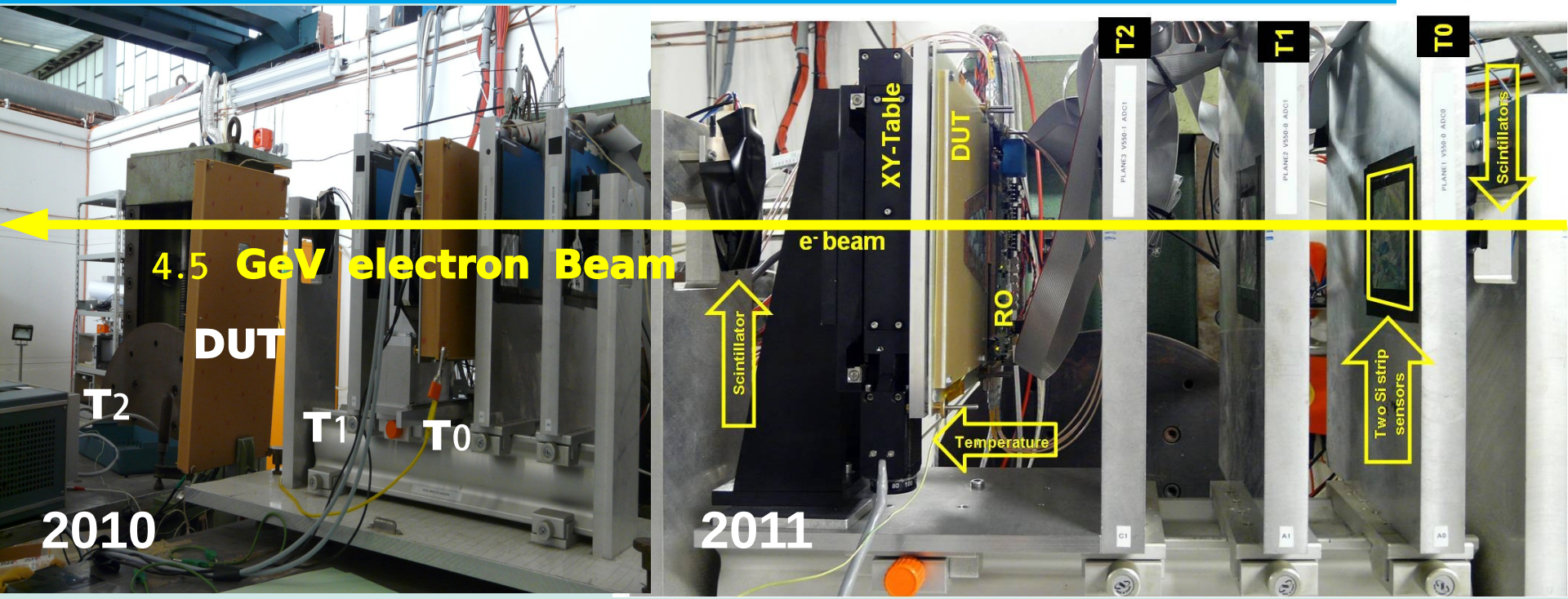


- Si (LumiCal) & GaAs (BeamCal) New Segmantatiom
- Fan Out (DC → AC)
- 4 8 channel FE ASIC's (AMS 0.35um) + 4 8 channel ADC ASIC's + FPGA concentrator (Xilinx Spartan 3E) + Power pulsing
- Connector between RO and Sensor board. 3 Read Out boards were equipped (LumiCal 2; BeamCal 1) All connect–able to each other
- ASIC's with two technologies

Test Beam Set UP

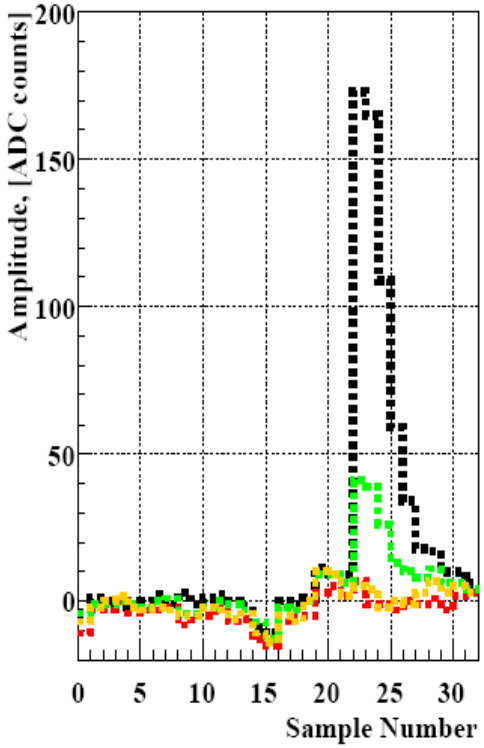


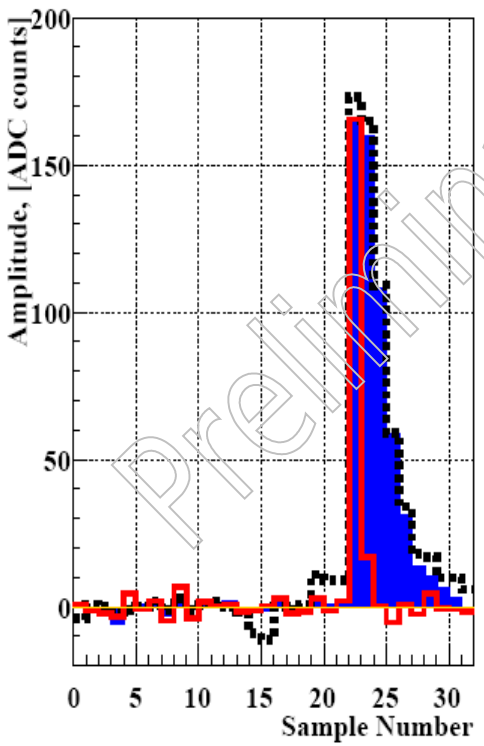
Test Beams

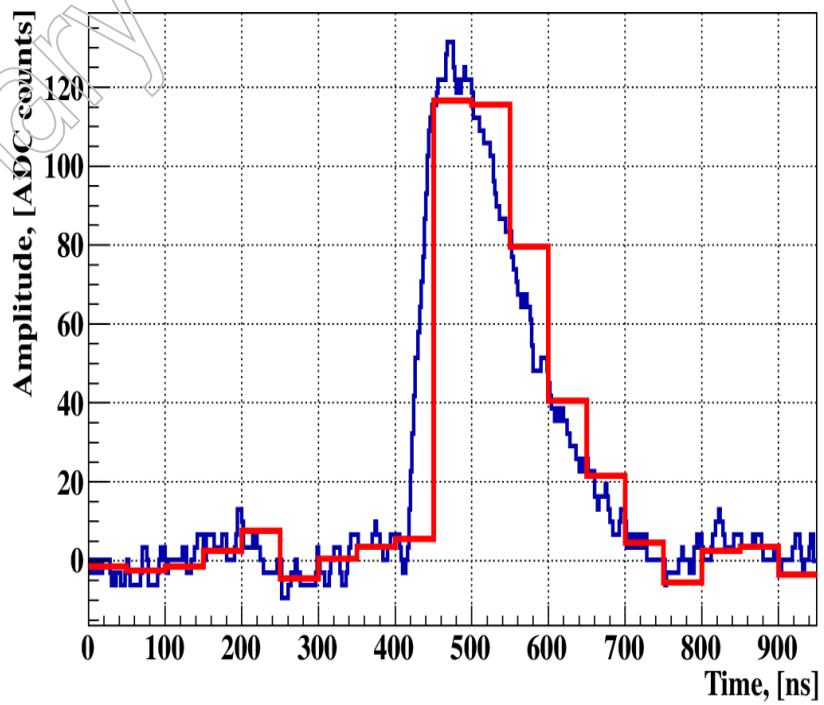


Test Beams DESY II 2010 – 2011(**Summer – Autumn**)
LumiCal & **BeamCal prototypes** + **Strip MVD ZEUS Telescope**
Validation of chain (**Sensor** + **Fan Out** + **FE ASIC's** + **CAEN ADC**)– 2010
Validation of chain (**Sensor** + **Fan Out** + **FE ASIC's** +**ASIC's ADC**)– 2011
Investigated on S/N ratio, CCE, position sensitivity, homogeneity for 32 **channel system, crosstalk. Behavior on the edges between pads,** 4 **gains operation** & **Multi-particle irradiation. Comparison with** 2010 **Test Beam Data.**
DAQ was implemented to EUDAQ for Telescope

Signal Analysis

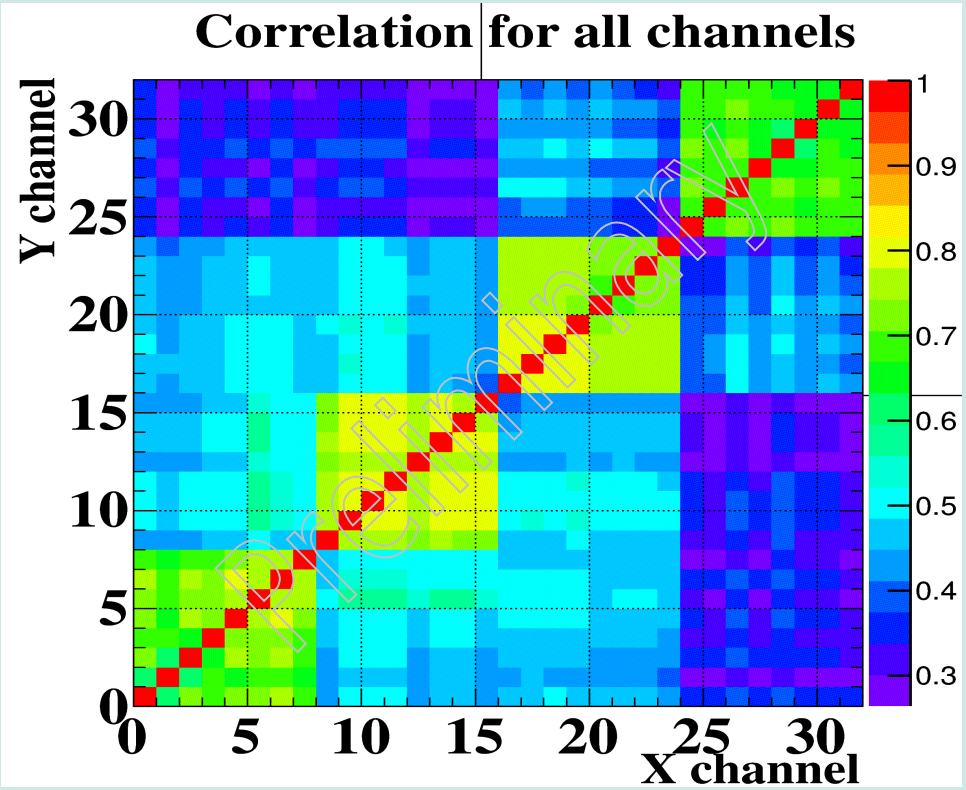


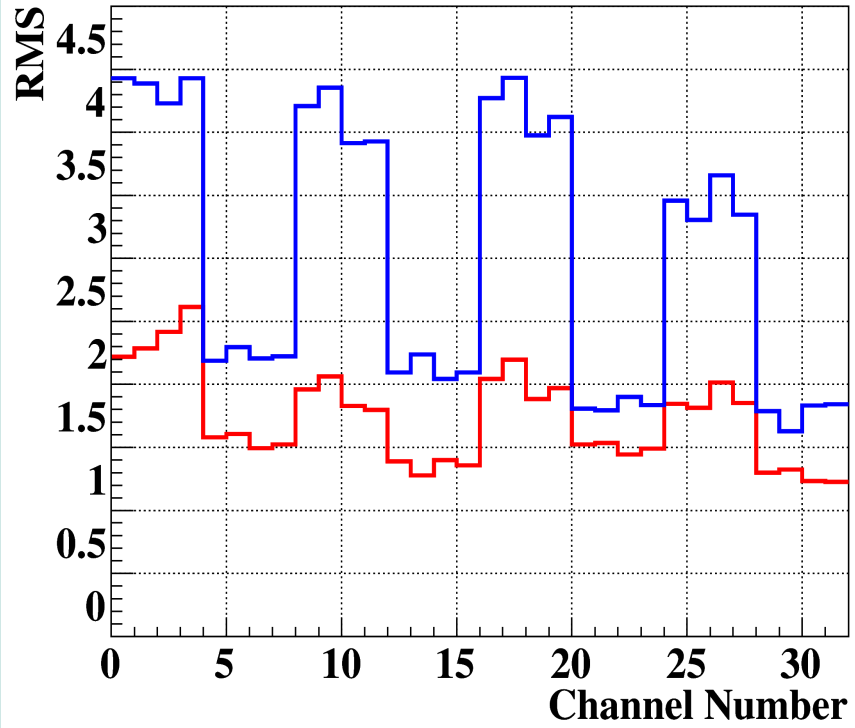




- Two ADC's were used (CAEN ADC – 2ns & on Board ASIC's ADC 50ns sampling (**ADC sampling rate is up to 20 MS/s**)
- 32 pads were read simultaneously (2011), 8 channels in 2010
- Two different front-end electronics - RC, FET
- CMN observed
- 3 Methods (Signal Amplitude, Signal Integral, Deconvolution Amplitude) & for two independent ADC's

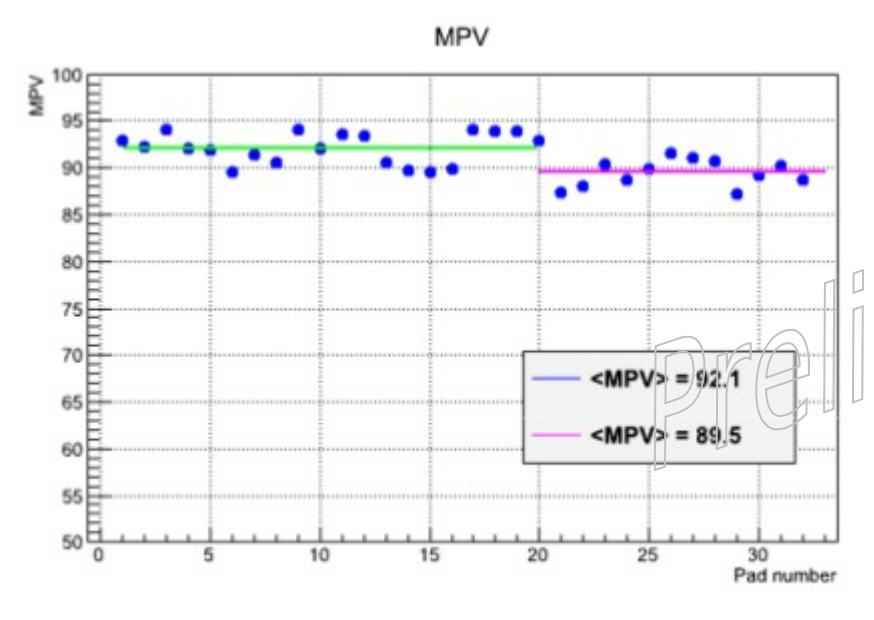
Common Mode Noise

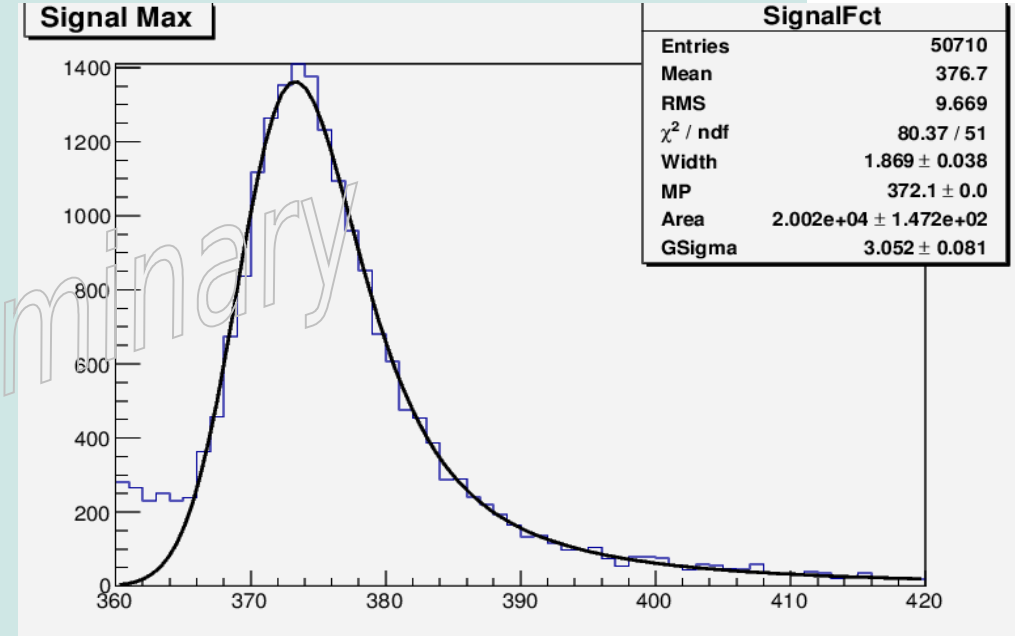




- Two different front-end electronics - RC, FET
- CMN over each ASIC's – CMN subtraction algorithm from non hit channels – Red Curve after CMN subtraction (Deconvolution mode requires noise reduction)
- S/N for 3 methods 2011 > 20 (preliminary)
- S/N ratio: RC ~ 20 – 26, FET ~13 – 20 (2010)

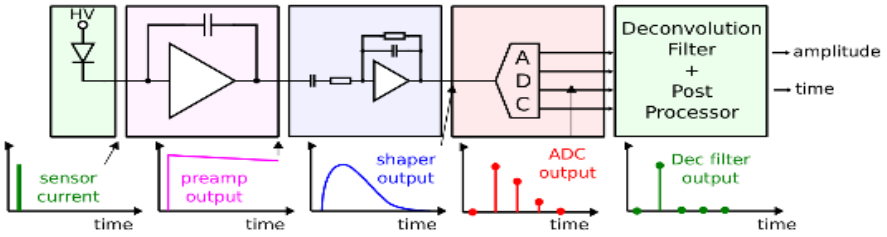
Sensor Homogeneity

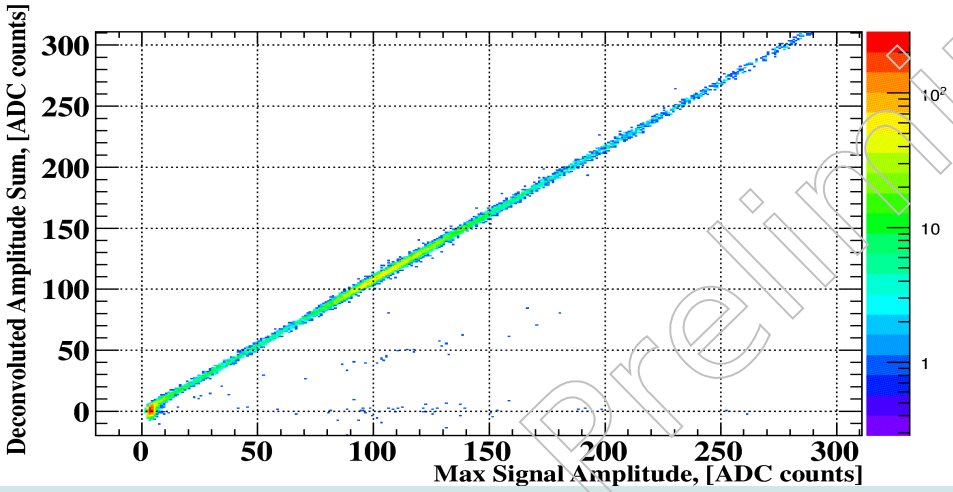


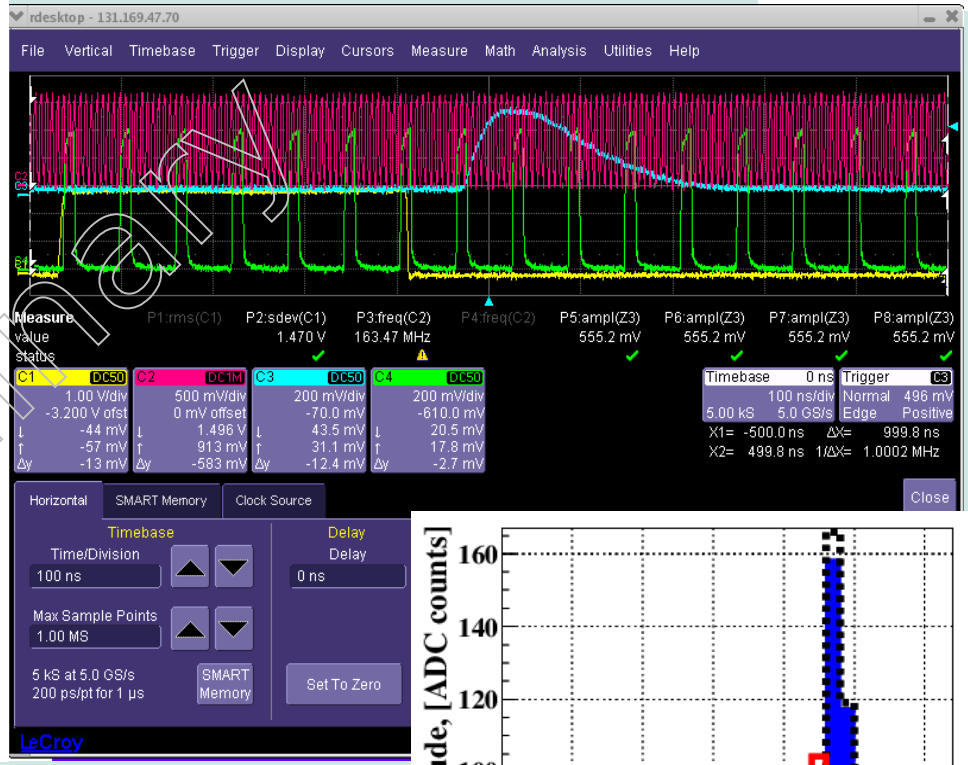


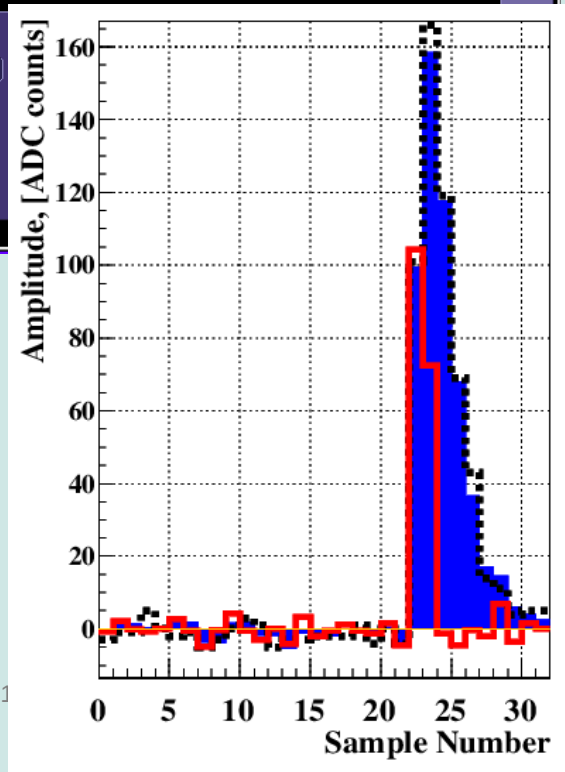
- Each of 4 FE ASIC's has two gains (difference by factor two)
- Amplitude spectrum, fitted by Landau Gauss convoluted function (T.Preda, V.Ghenescu, E.Theodorescu)

Deconvolution Mode (CLIC)



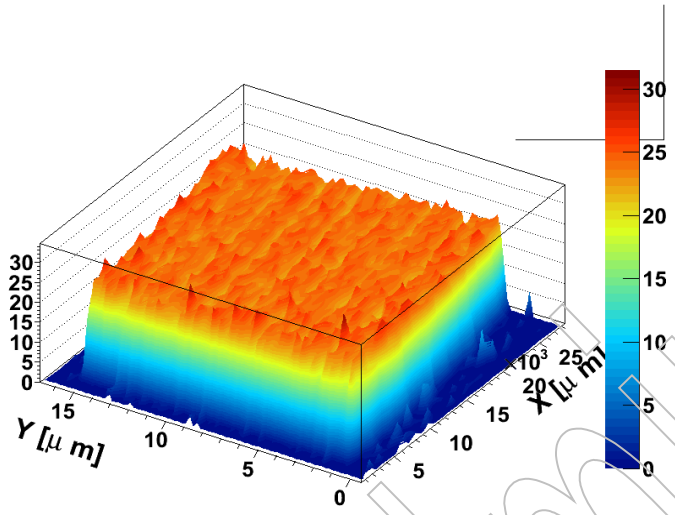


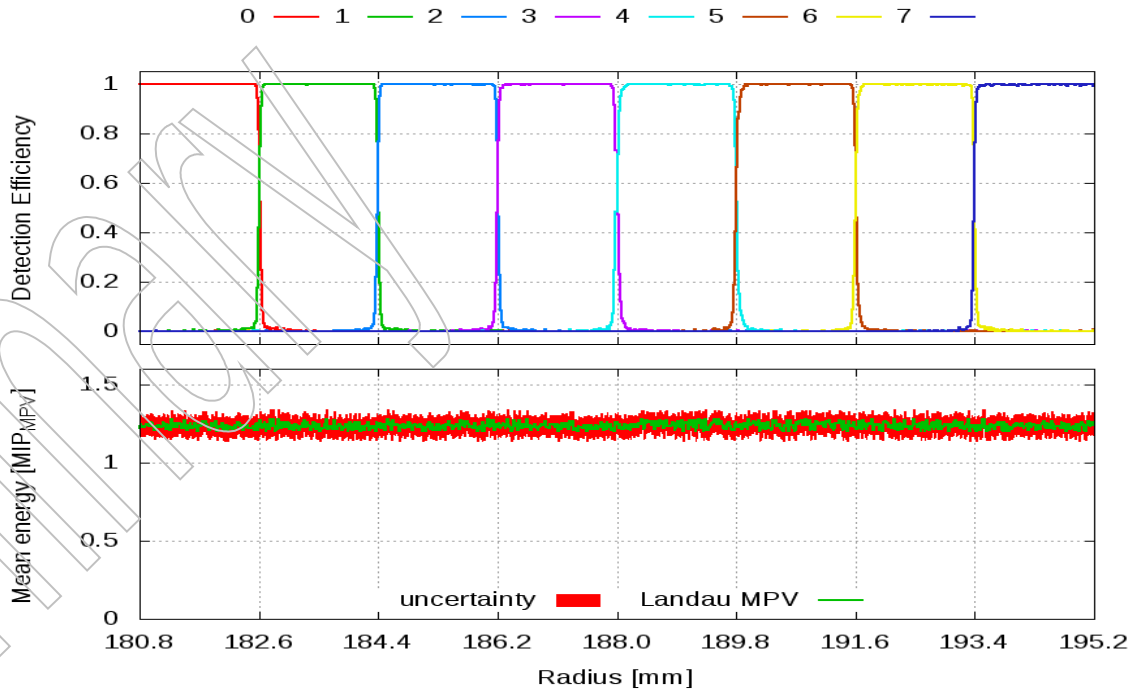


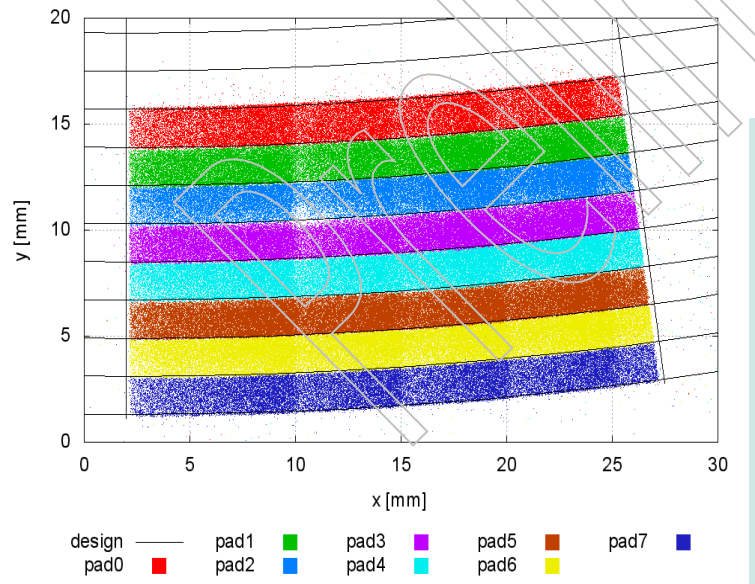


- > ADC Clock source
  - Internal (asynchronous with beam operation)
  - External (beam clock used to synchronize with beam)
- > Deconvolution Method shows proportionality to signal amplitude
- > All methods are proportional to each other (signal amplitude, integral and deconvoluted sum of non zero amplitudes)

Position Reconstruction

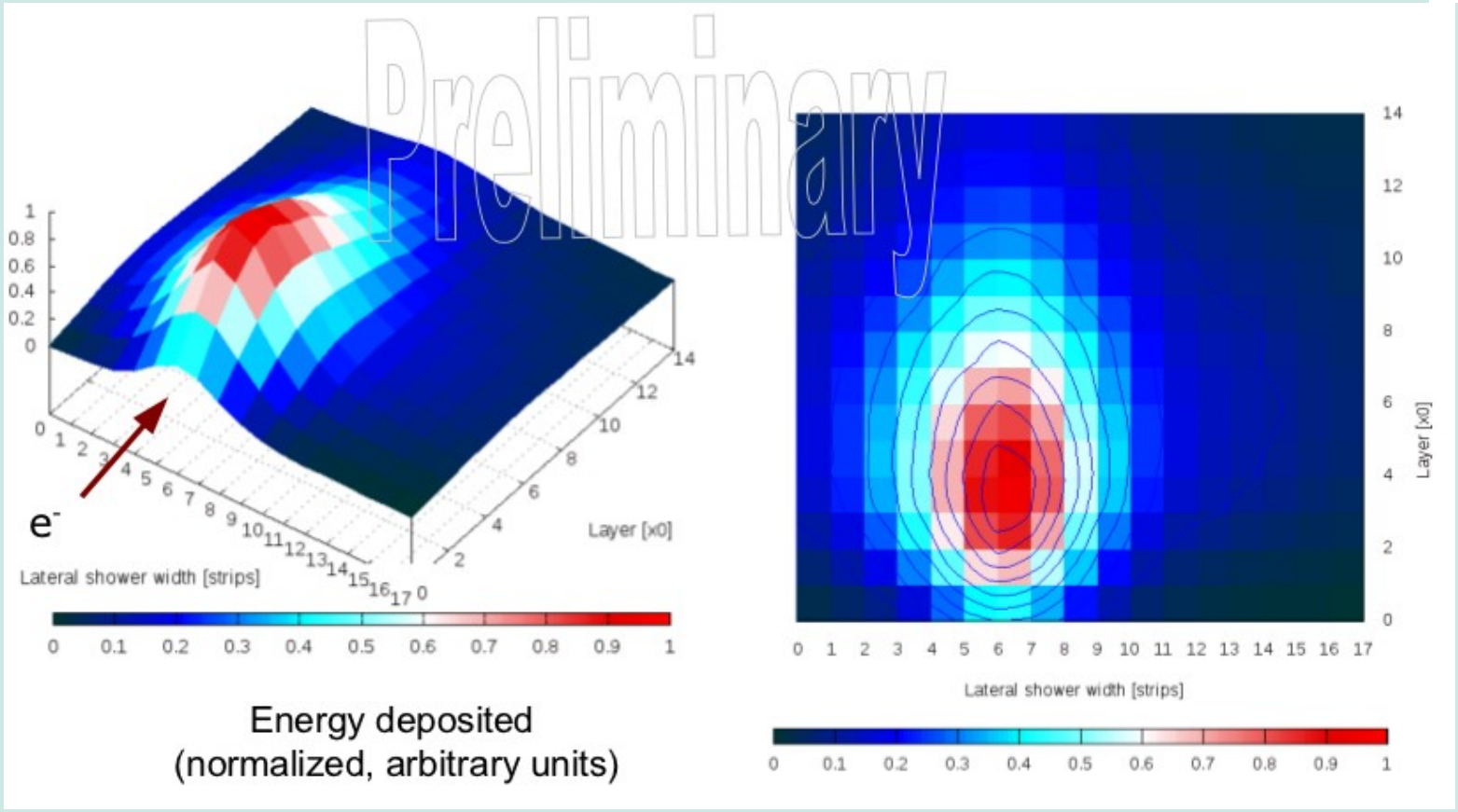






- Telescope & DUT
- Charge collection is uniform independent of radius
- The pads charge collection is uniform (plus some edge effects). There is decrease of charge collection of ~10% of 0.2 mm around the 0.1 mm gaps between pads

Shower Development



- Different number of Tungsten planes in front of LumiCal prototype
- Averaged energy in each pad plotted vs layer (TB_11)

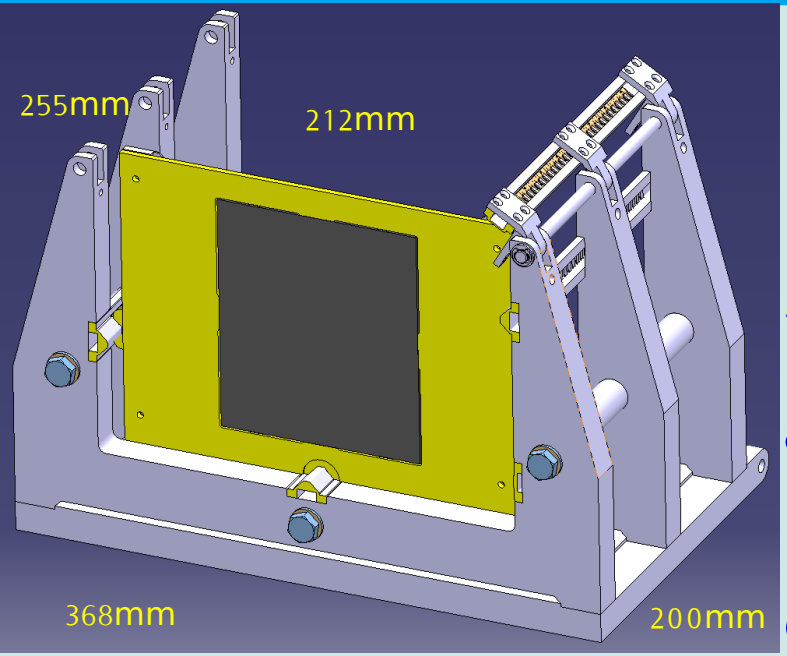
Tungsten Status (AIDA)

> AIDA infrastructure for FCAL can contains
Up to 30 tungsten layers.
In the first step it was decided to have 10 tungsten plates produced by two companies: MGSanders (5) and Plansee (5) to have possibility for comparison the quality of their products.

> These tungsten plates are buying by AGH-UST.

> Status:
- MGSanders company : The whole procedure related to realization such order was done. The delivery time for tungsten plates will be 2-3 months.
- Plansee company : The formal procedure required for order is almost finished. When it will be done the maximum delivery time in this case can be up to 15 weeks.

Mechanical Frame (AIDA)



>**General requirements:**

30 tungsten plates (+ sensor layers) have to be aligned in a compact structure.

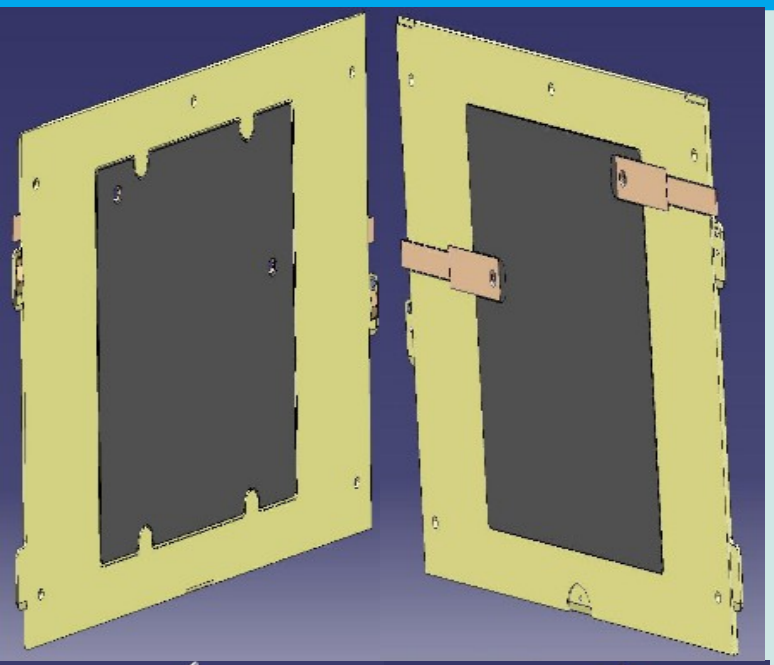
Three configurations: 2mm, 1mm, and 0.5mm gap, accuracy +/-50 microns, between each plate.

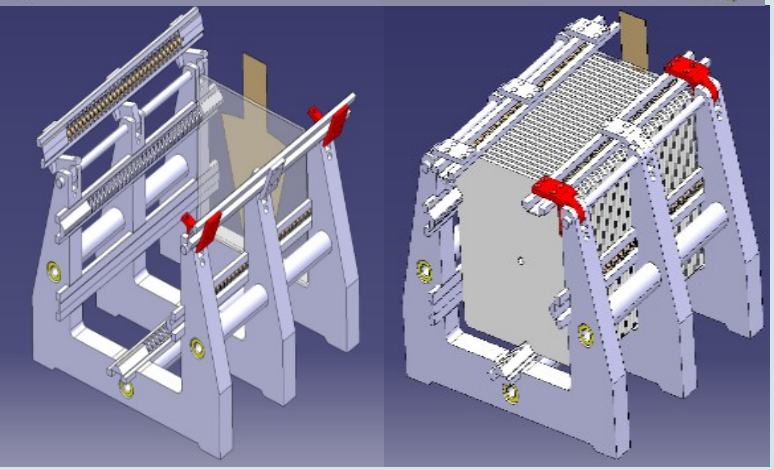
Removing or adding tungsten plates or sensor layers can be done easily

→**The Aluminium frame was developed and manufactured.**

CERN Physics Department –Detector Technology group

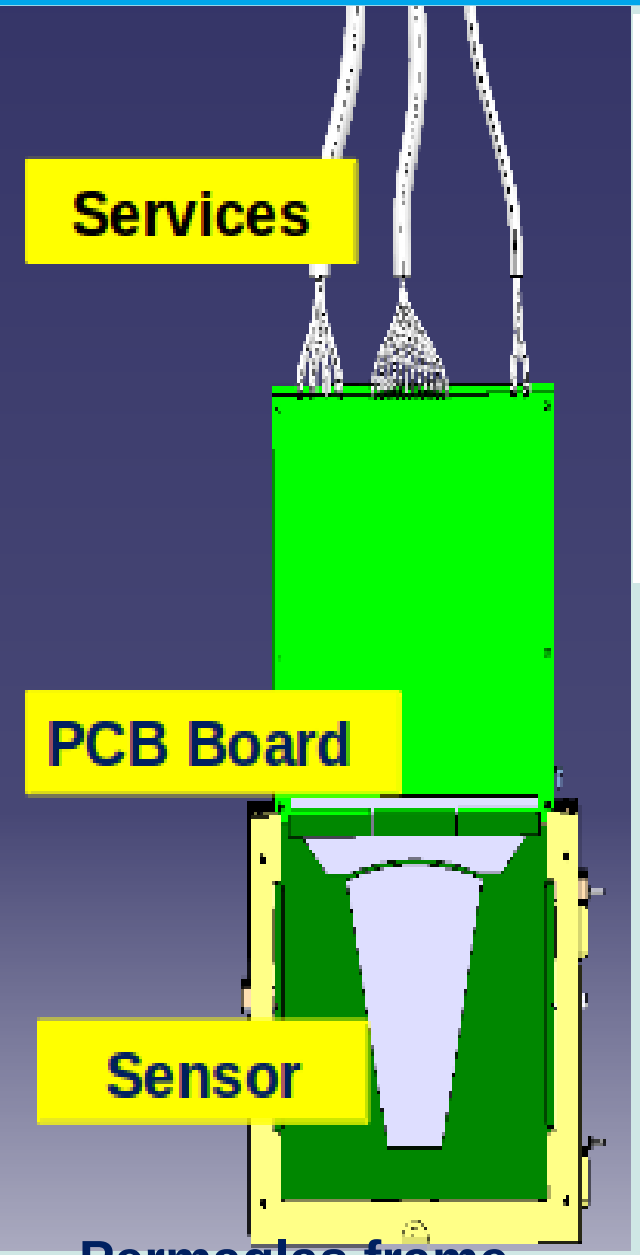
Tungsten Fixation (AIDA)

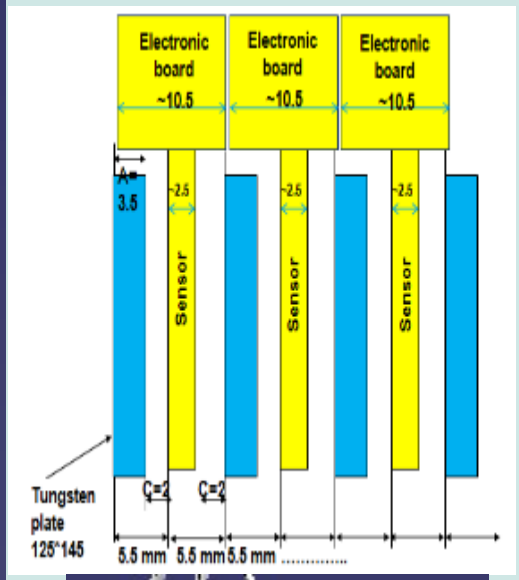


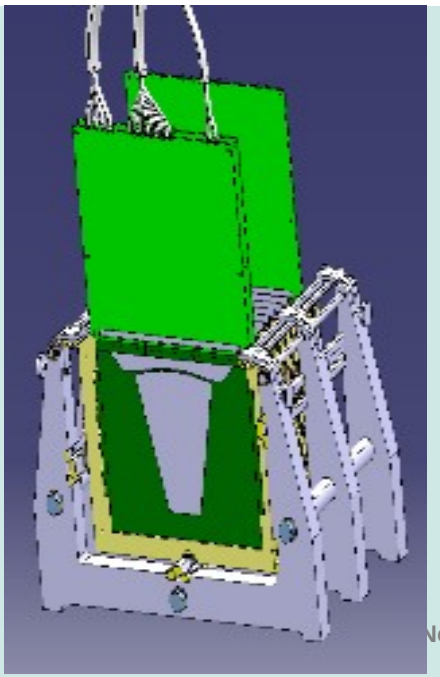


- The tungsten plate can be easily removed from the frame.
- 2mm and 1mm gap configurations are in a production phase. The final mounting should be realized in July 2012 (delivery date for first 10 tungsten plates)
- Ready for first beam tests before end 2012
- Ordering remaining tungsten plates asap.
- A concept exists for 0.5mm gap, but it has to be developed

Calorimeter Structure (AIDA)







- We use the same tungsten plates
- We could use the same Permaglas frame (in white in this picture)
- We glue the Si or GaAs detector + the read-out on the Permaglas frame
- We could realize a sliding kinematic between each tungsten plate, in order to reach the 0.5mm gap between each W plate.

Conclusions

LumiCal & BeamCal prototypes were tested at the 4,5GeV electron beam in 2010. Both detectors show perfect performance, S/N ~20

Functionality of the chain: ASIC's ADC + ASIC's FE + fan-out + sensors, positively verified on test beam

Beam test of 32 channel prototypes were successfully tested in 2011 including new ASIC's ADC with S/N > 20 and analysis is ongoing

Mechanical frame is ready, Si (40 sensors) and GaAs (15 sensors) sensor planes, W absorbers already requested. Similar pair of ASIC's in new technology ibm 130um. First 10-bit ADC prototype in was submitted in February 2012. First front-end prototype will be submitted in may 2012.

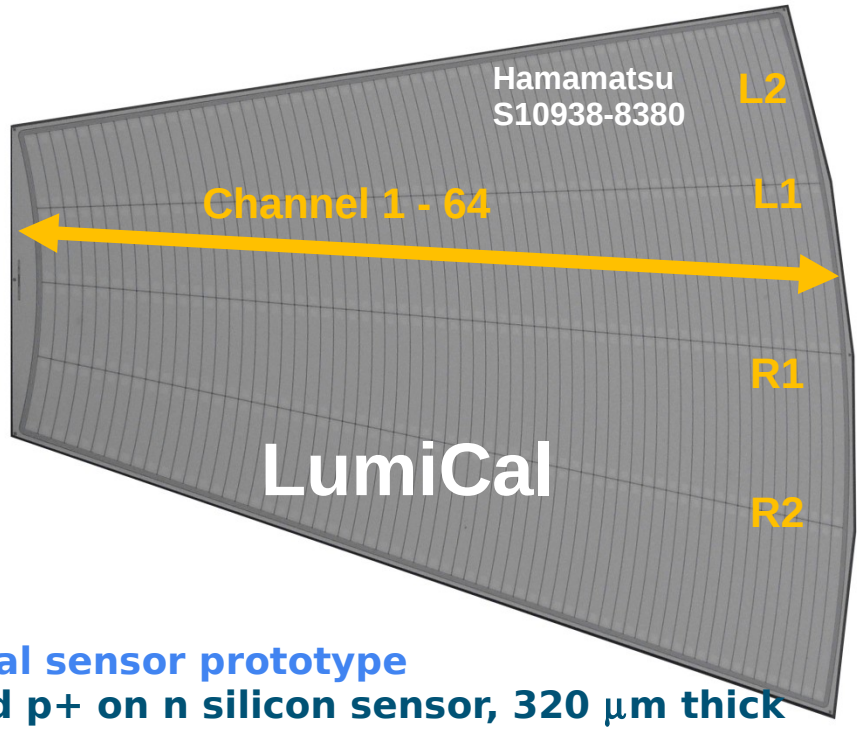
Waiting for next beam tests...

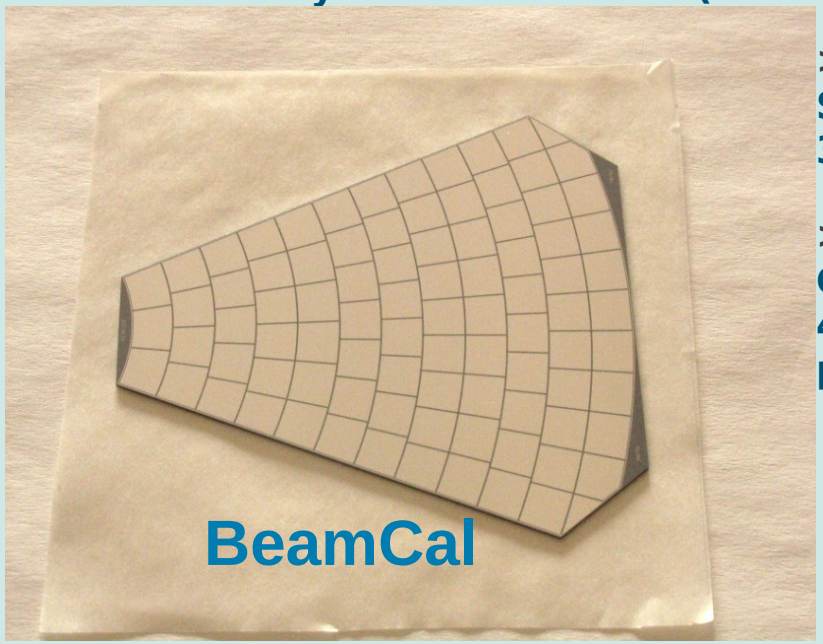
Back UP Slides

Thank You for Attention!

Forward Calorimeter sensors

- > Precise luminosity measurement
- > Hermeticity - electron detection at low polar angles
- > Assisting beam tuning (fast feedback of BeamCal data to machine)
- > Challenges:
  - radiation hardness (BeamCal)
  - fast readout (both)
- > 30 Layers
  - Tungsten absorber:
  - Sensor layers ->GaAs or Di (BeamCal), Si

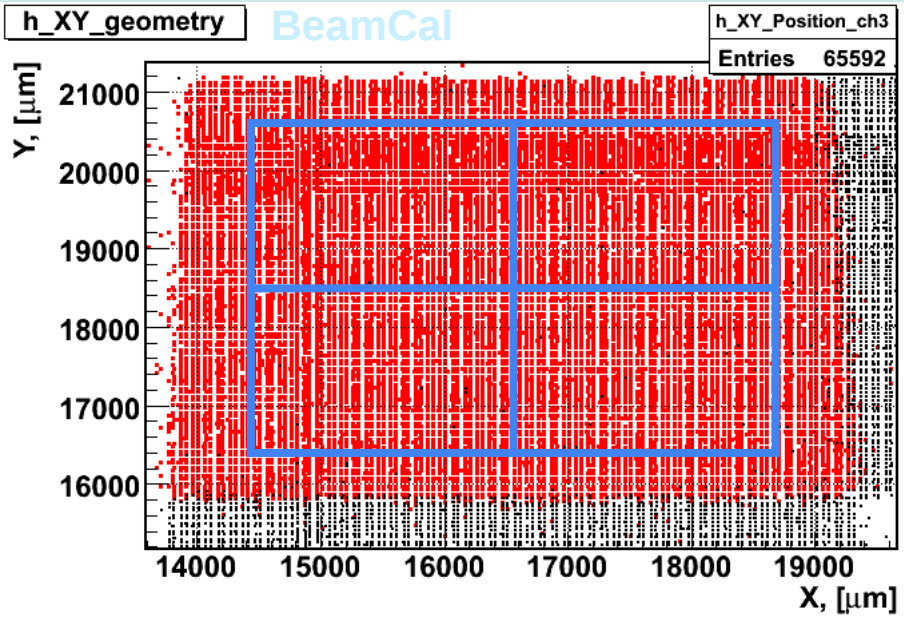


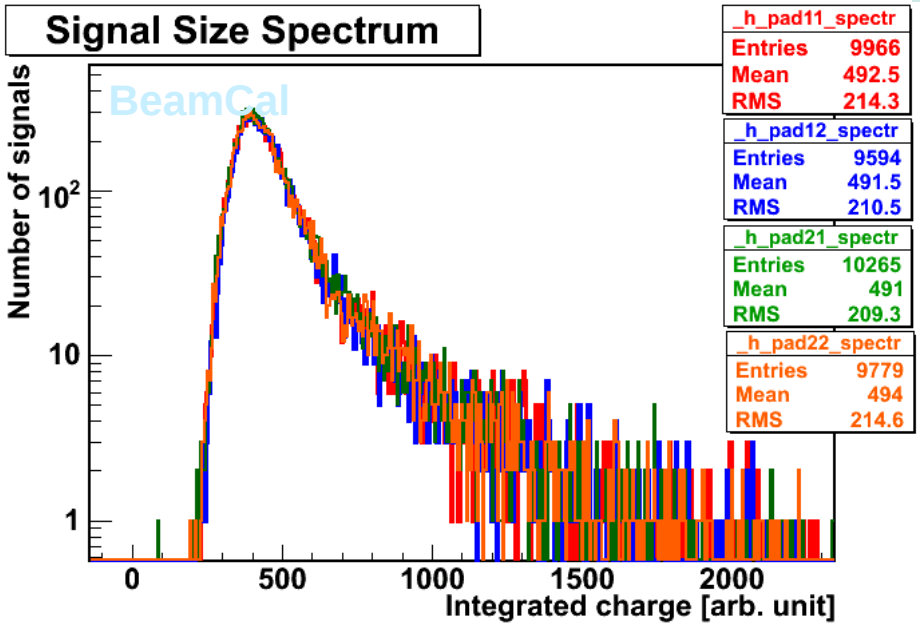


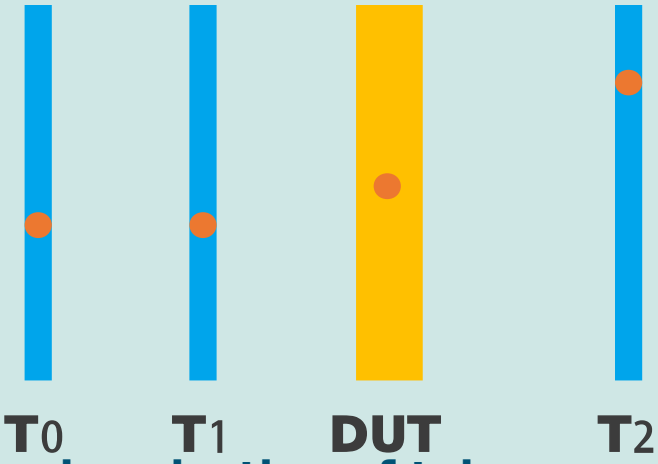
> LumiCal sensor prototype
Standard p+ on n silicon sensor, 320 μm thick
30 deg tiles, contains 4 sectors (each 64 pads)

> BeamCal sensor prototype
GaAs plate with Al metallization, 500 μm thick
45 deg tiles, segmented into 12 rings, ~5x5 mm2 pads

Charge collection uniformity







- > Synchronization of telescope and DUT
- > Telescope alignment was checked
  - 3 Telescope planes were fitted
  - Residual ~10 μm
  - > Pad structure corresponds 5x5mm2 + gap ~200 μm
- > 4 independent pads areas show identical charge collection
- > high efficiency of charge collection