



Scintillator tile uniformity scans for Sc-ECAL

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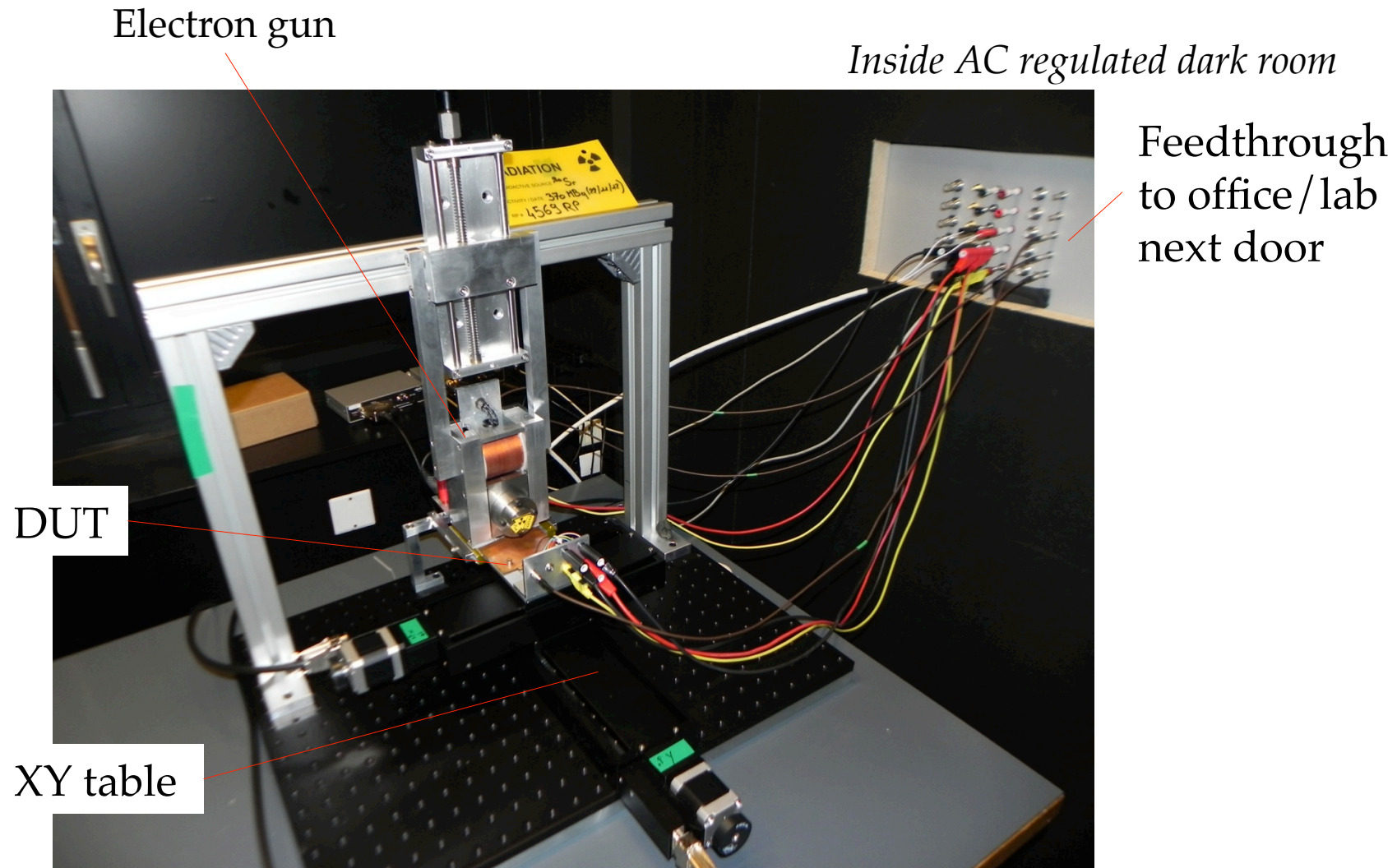
Uni Bergen: E. van der Kraaij

CALICE collaboration meeting – 09/2013

- Questions:
 - Optimum dimensions of the tiles? ← Simulation
 - How small / thin can the tiles be? ← Hardware
 - Longitudinal arrangement? Hybrid mode of Si / Sc?
 - Transversal arrangement?
- To answer these questions, we need:
 - SiPM & scintillator characterization: dark rate, afterpulses, saturation, temperature dependence, crosstalk
 - Study uniformity, study SiPM to tiles connection
 - ...
- Steps which have already been performed by CALICE –
First steps are for our understanding, not to reinvent the wheel.

This talk:

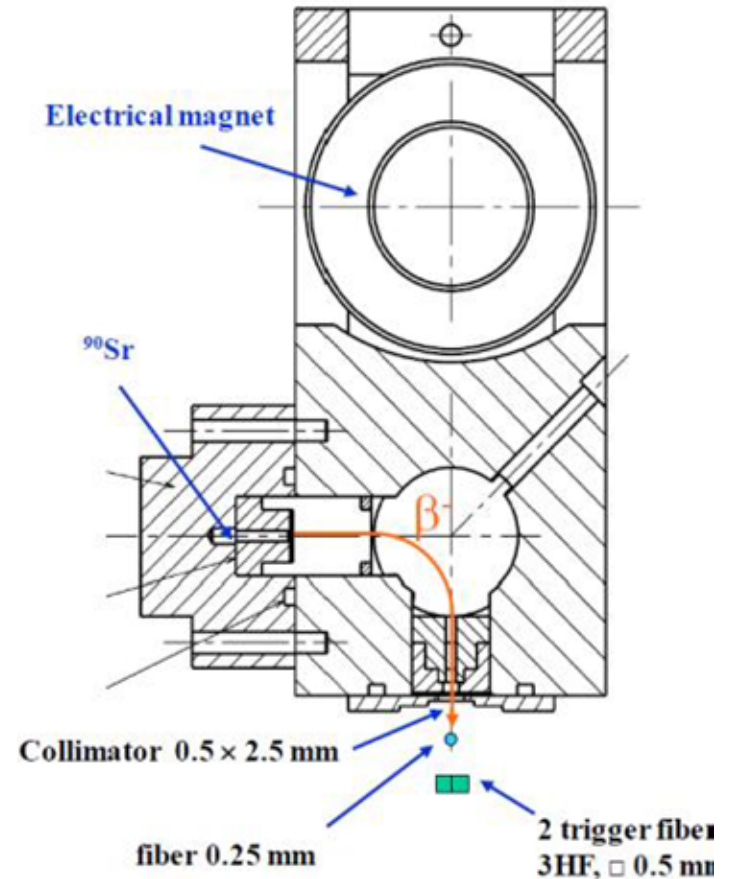
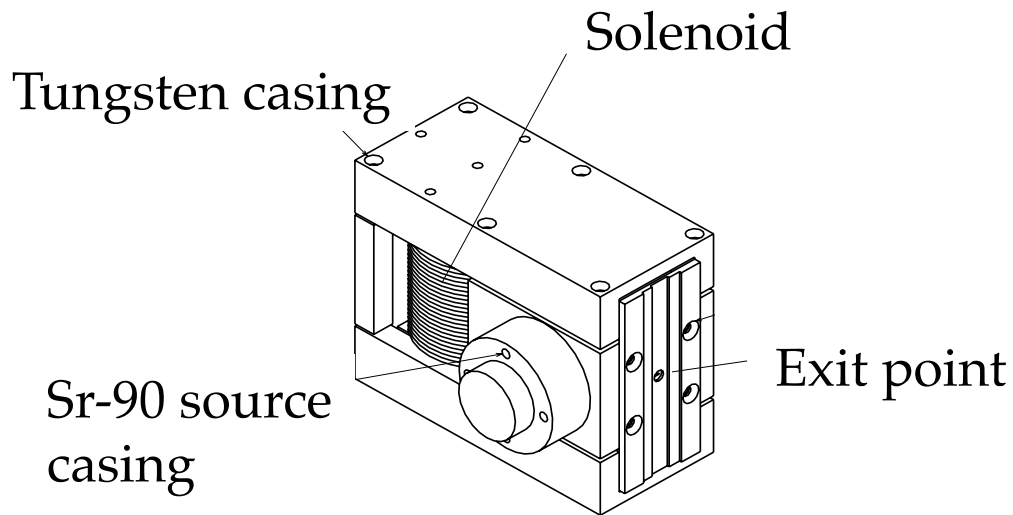
- Setup at CERN LCD/DT lab & first uniformity studies.



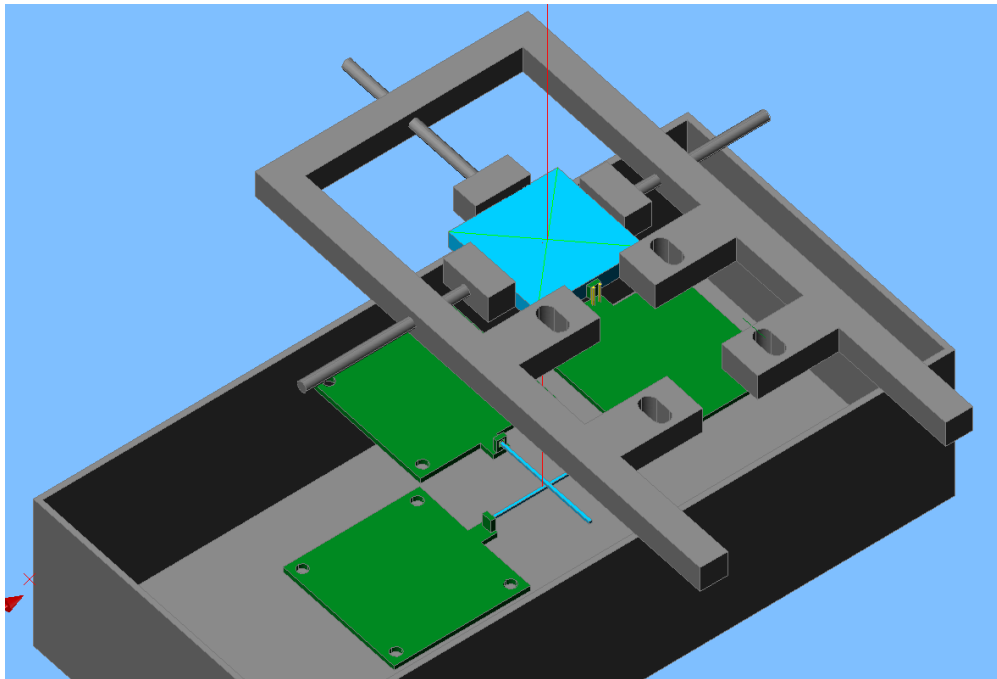
Electron source

350 MBq Sr-90 source

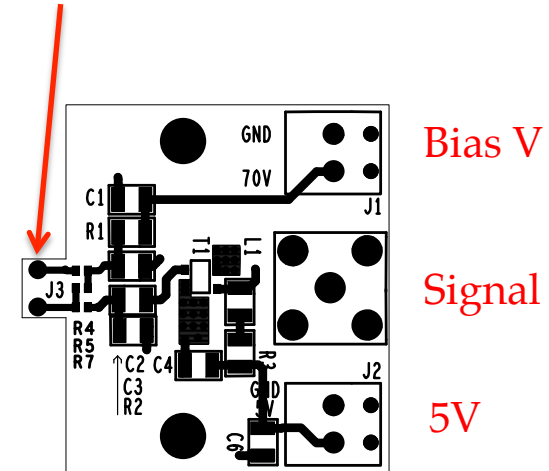
- Selectable electron energy $\sim 1 < E < \sim 2$ MeV



Trigger setup & readout circuit



SiPM connection



Same as MPI board, with Infineon BGA 614 amplifier, redesigned to 25x22 mm².

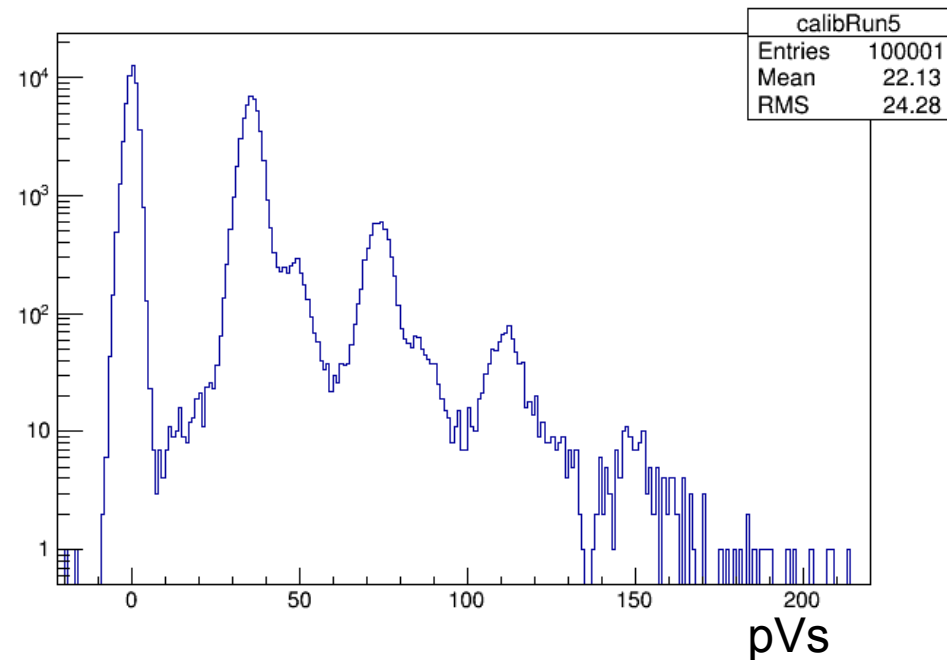
- Crossed scintillating fibers (20x1x1 mm³) as trigger, fixed underneath DUT.
- Positioned Hamamatsu MPPC (50 um pitch) on a nose, sticking out 2 mm beyond the edge, for readout of tiles with dimples
- Including Pt1000 probe near SiPM.

- Data acquisition:
 - Digital oscilloscope: 4 GHz 4-channel picoscope
 - LabView VI → readout trigger by trigger
 - Rate is limited by electron gun & tile thickness to O(20) Hz.

Calibration:

- With the gun off, acquire Single Photon spectrum run
- At the center of tile, define gain at nominal temperature

First tile scanned: 30x30x3 mm³ →



30x30x3mm³ scan result

Tile wrapped in ESR foil, SiPM pushed against opening (from top)

Scan tile in X and Y direction in steps of 1mm

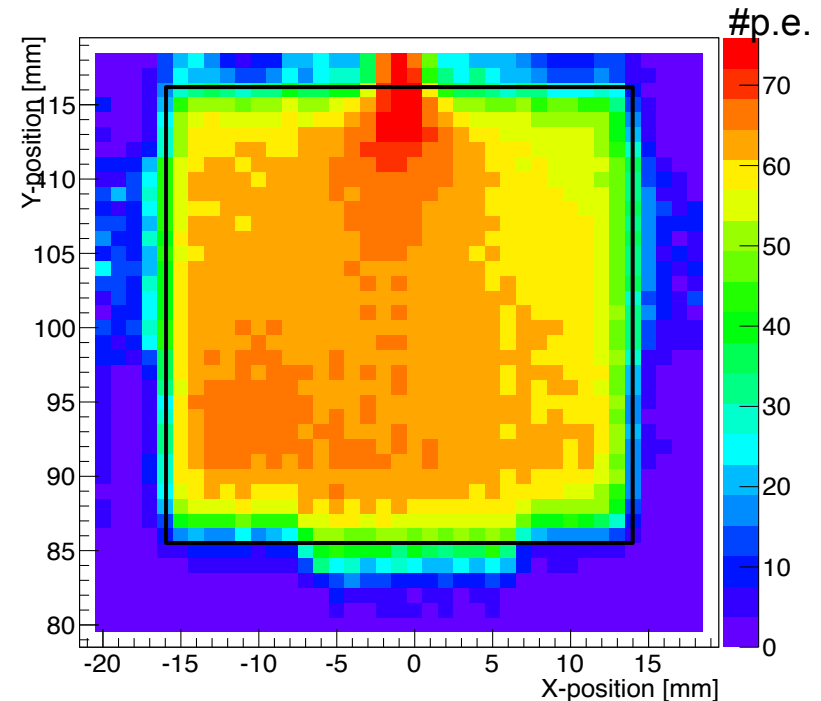
- Trigger on crossed-fibers coincidence

At each scan step (60s), record:

- Temperature
- Each triggered waveform integral

Assuming $dG/dT = 3.4\% / K$:

- Correct gain for T fluctuation
- Transform waveform into #pe
 - Response from plastic tile-holders left/right/down visible



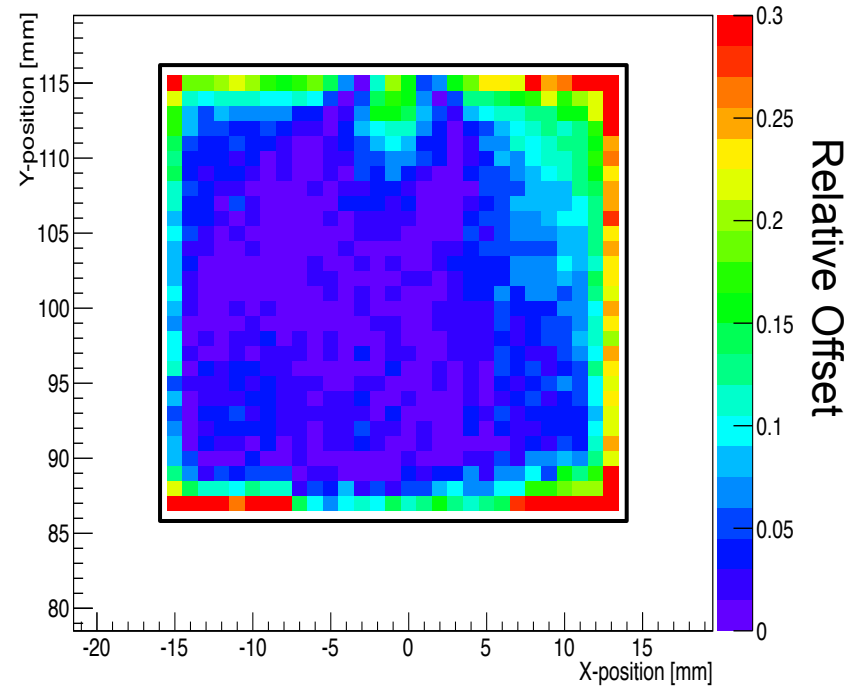
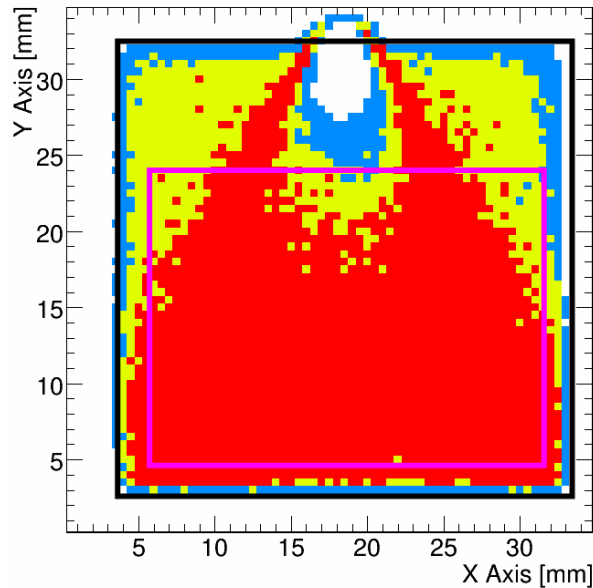
30x30x3 mm³:

- Average response ~ 60 p.e.
- Left-right asymmetry
 - Non-uniform wrapping?
 - Temperature?
 - SiPM to tile connection?

30x30x3mm³ scan result – relative offset

Tile wrapped in ESR foil, SiPM pushed against opening (from top)

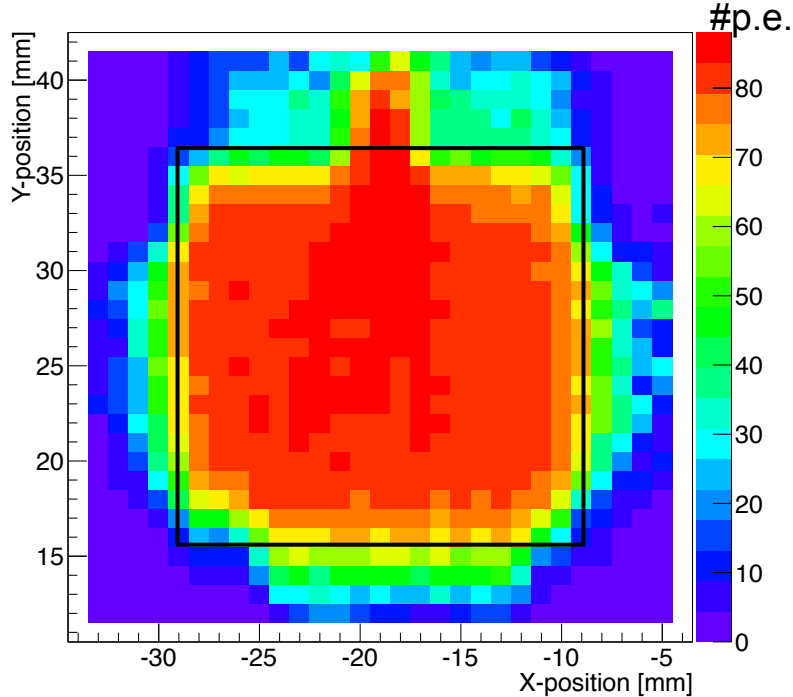
- Compared to T3B 30x30x5mm³:



30x30x3 mm³:

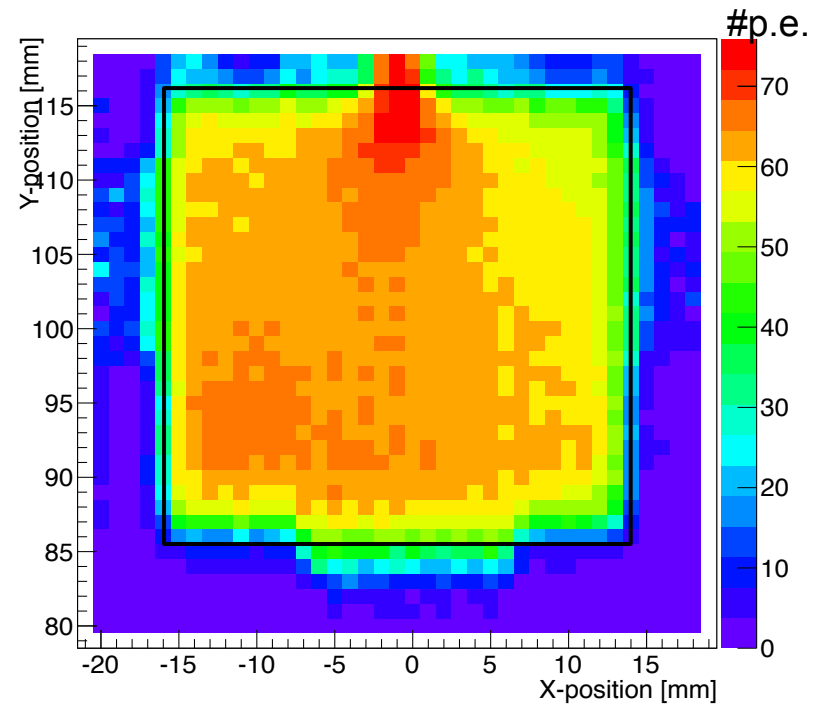
- The uniformity resembles the distribution as measured by T3B

Two tile sizes – both wrapped in ESR foil



20x20x2 mm³:

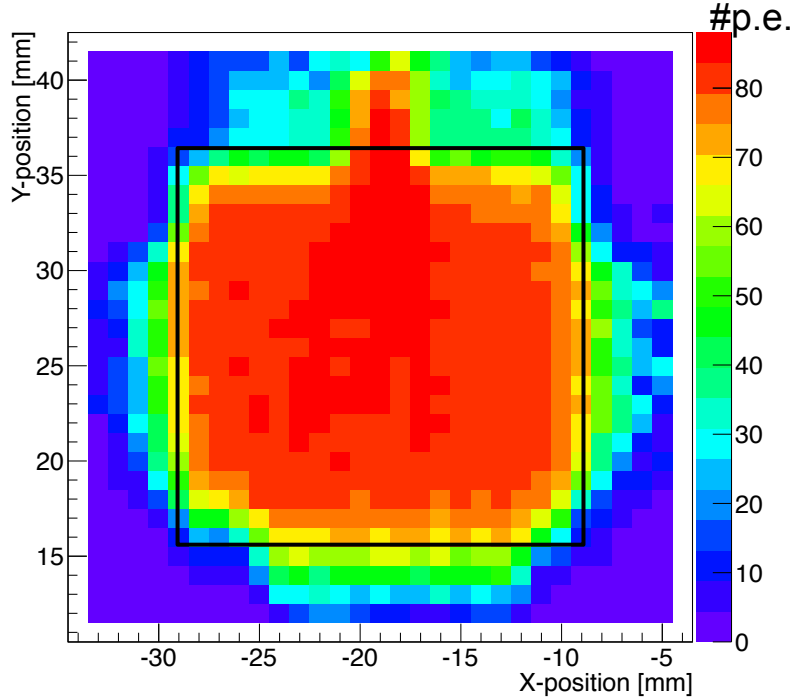
- Average response ~ 80 p.e.
 - SiPM:tileside ratio increased.
- Left-right asymmetry less pronounced
- Response near SiPM similar to average response



30x30x3 mm³:

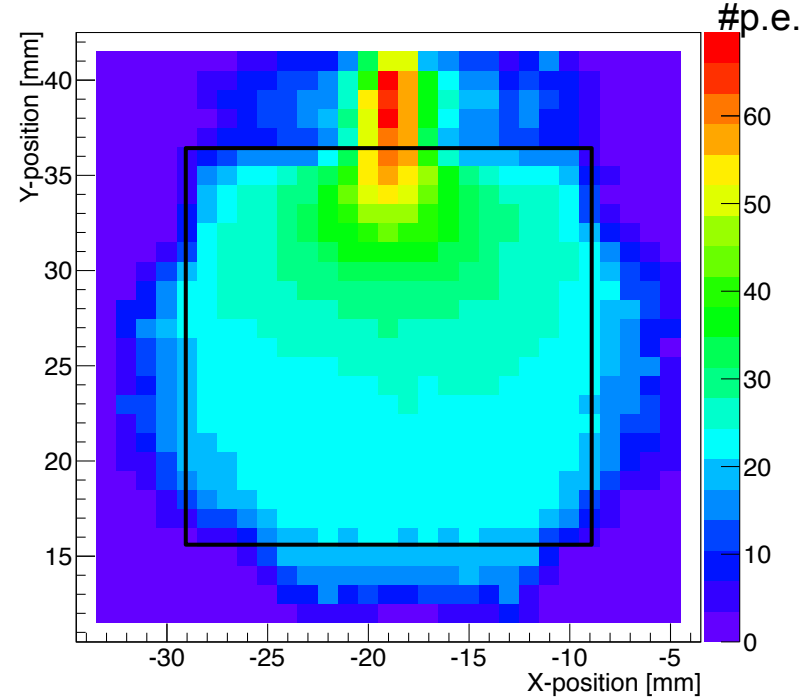
- Average response ~ 60 p.e.
- Left-right asymmetry
- Response near SiPM relatively high

ESR foil vs reflective paint – same tile size



20x20x2 mm³:

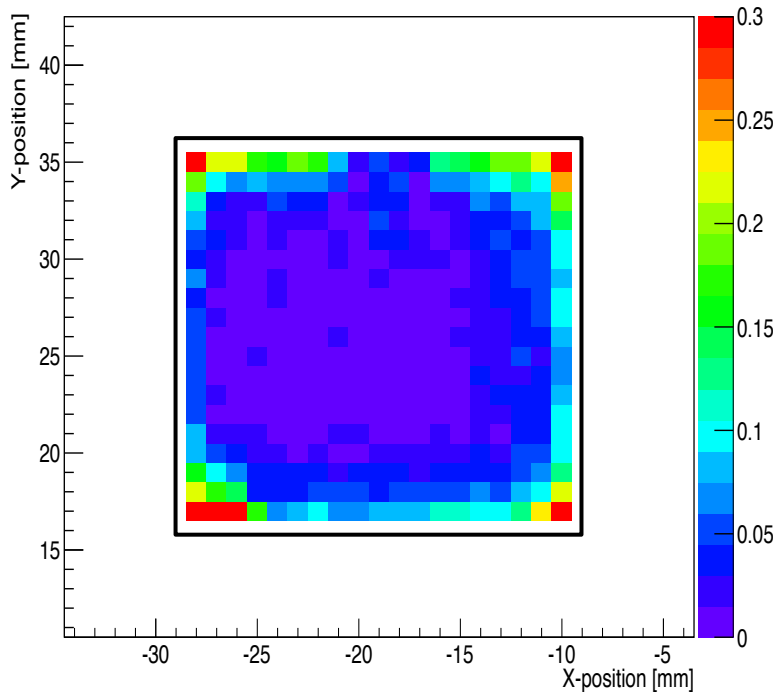
- ESR foil
- Average response ~ 80 p.e.



20x20x2 mm³ :

- Diffuse reflector paint
- Average response ~ 25 p.e.
- Less uniform response.

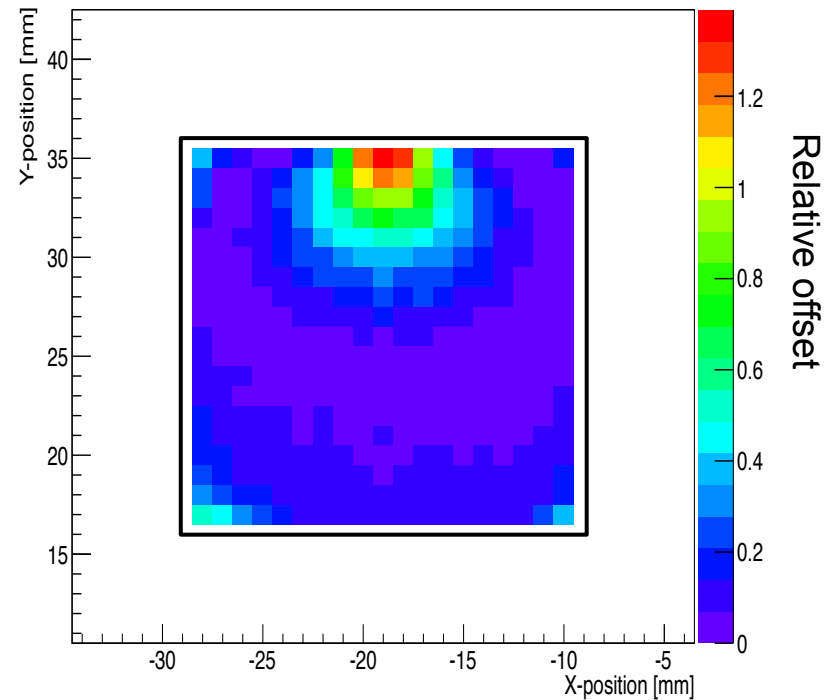
ESR foil vs reflective paint – relative offsets



20x20x2 mm³:

- ESR foil
- Average response ~ 80 p.e.
- Uniformity within ~15% (excl. edges)

Relative offset



20x20x2 mm³ :

- Diffuse reflector paint
- Average response ~ 25 p.e.
- Less uniform response.
- Uniformity within ~100%

Relative offset

Scan setup ready for ECAL tile study

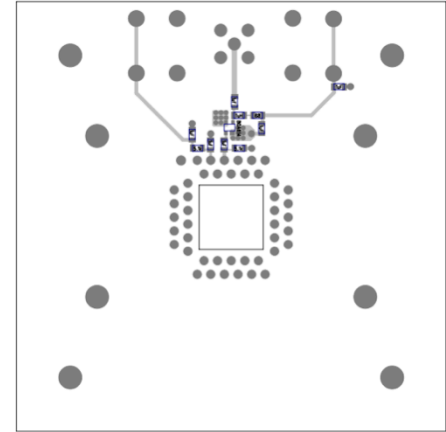
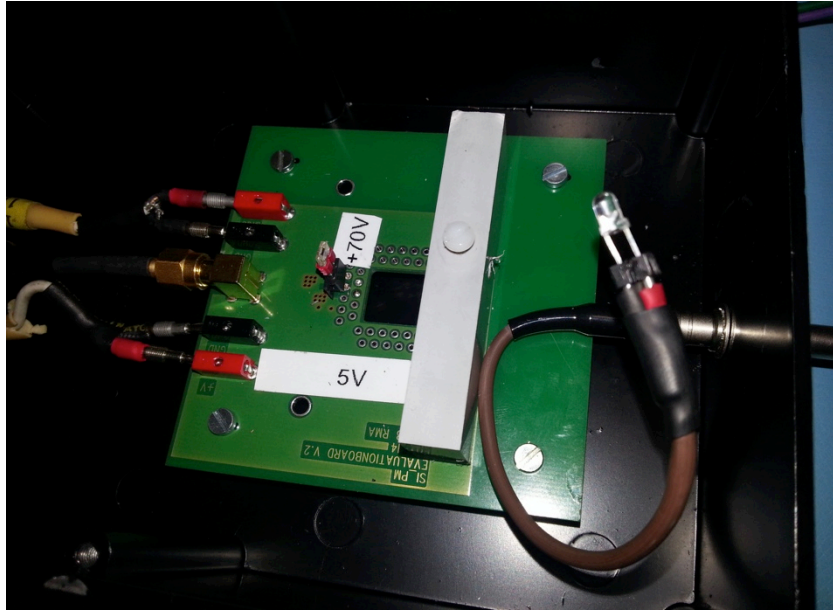
- Scanned three tiles, compared sizes and wrapping
 - Smaller tile has higher light yield & more uniform response
 - ESR foil results in better uniformity than diffuse paint
- Next:
 - Figure out left/right asymmetry
 - Test tiles of $15 \times 15 \times 2 \text{mm}^3$



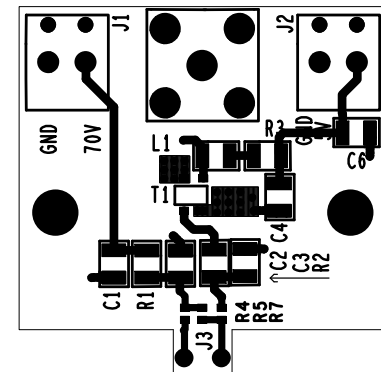
Backup

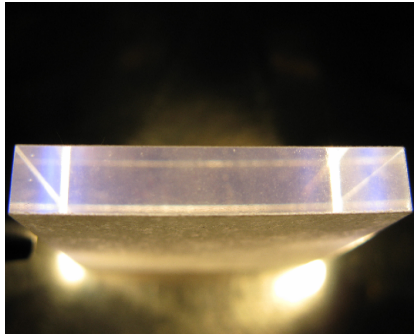
Readout circuit

PCB design for readout based on testboard used:



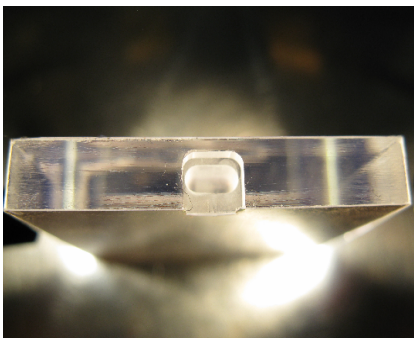
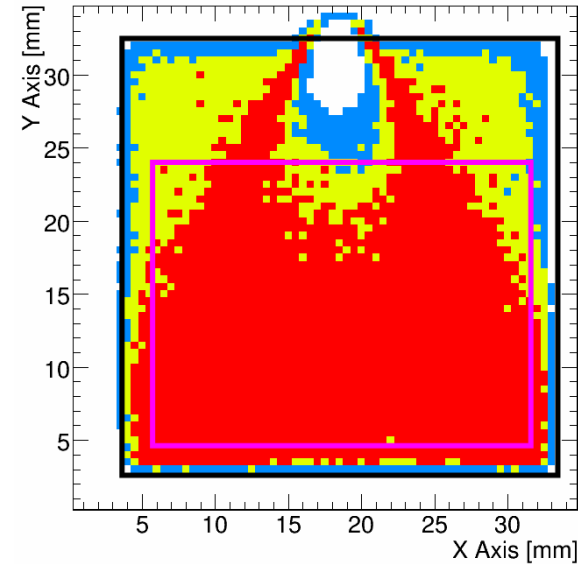
- Shrank to $2.5 \times 2.5 \text{ cm}^2$, with SiPM on 'nose'
- Including Pt1000 probe close to the SiPM





NO DIMPLE

Part of the Scintillator Tile	Deviation of overall mean:
91.7%	$\pm 20\%$
80.8%	$\pm 10\%$
57.8%	$\pm 5\%$



WITH DIMPLE

Part of the Scintillator Tile	Deviation of overall mean:
90.0%	$\pm 20\%$
84.1%	$\pm 10\%$
72.7%	$\pm 5\%$

