

Integrated Readout Layer

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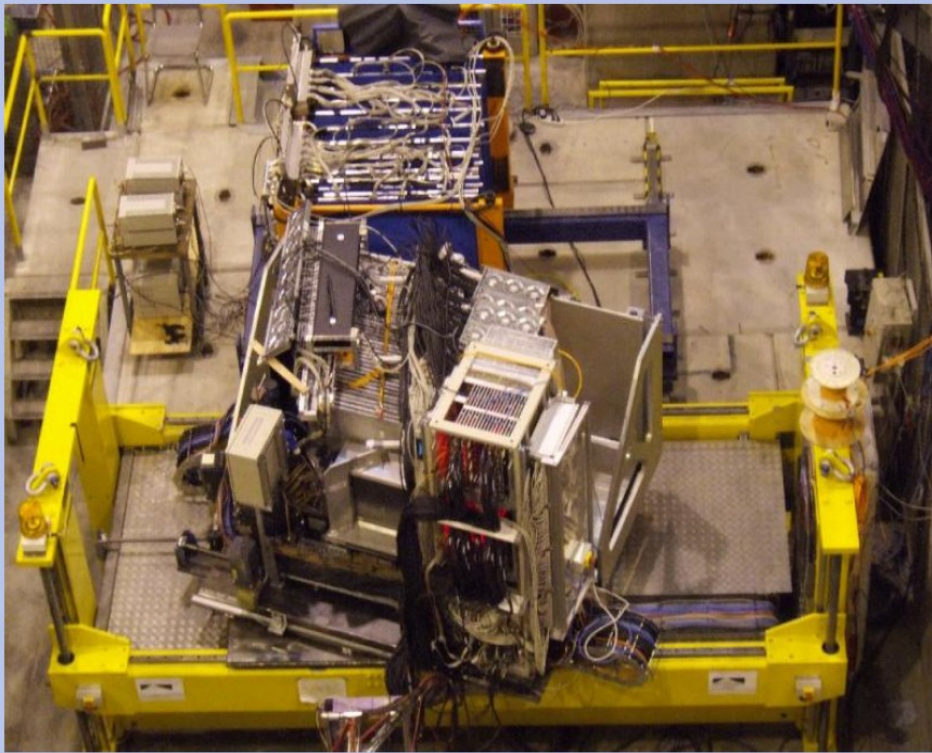
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Learning Today, Leading Tomorrow

Acknowledgements

- DESY & Fermilab (test beam, engineering, support...)

CALICE AHCAL Prototype



Clear establishment of the scintillator-SiPM active media as a viable calorimetry option in a PFA-based detector

However some scalability issues which has elicited different responses and proposals from within the collaboration....

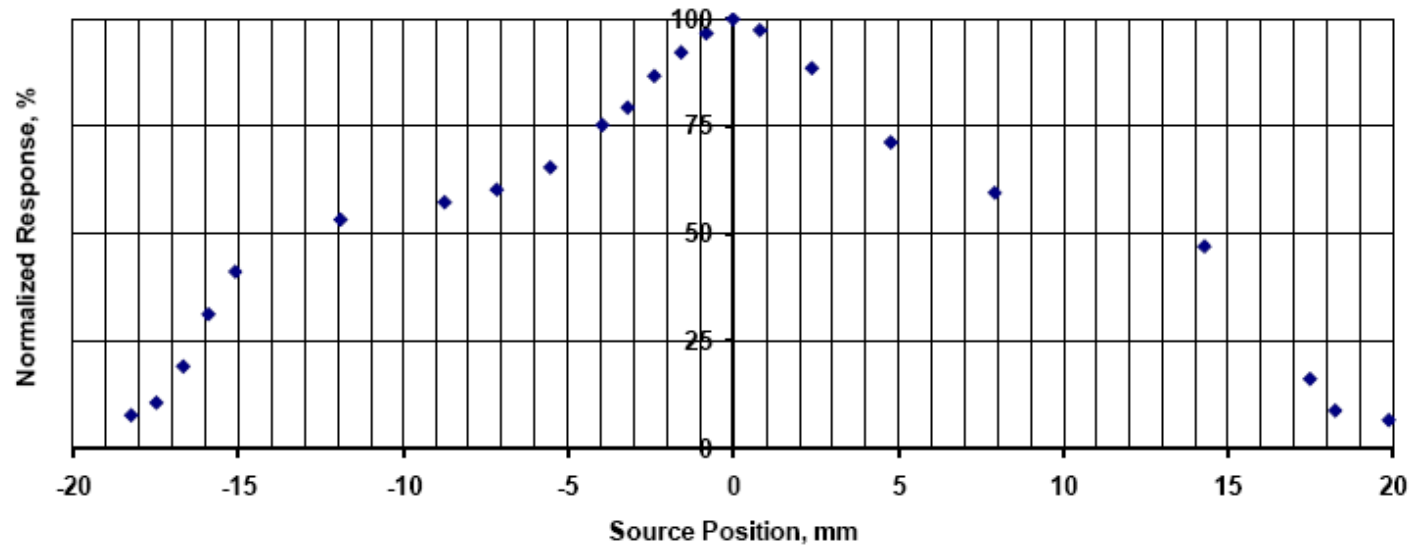
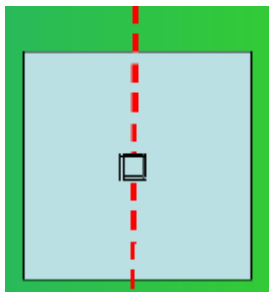
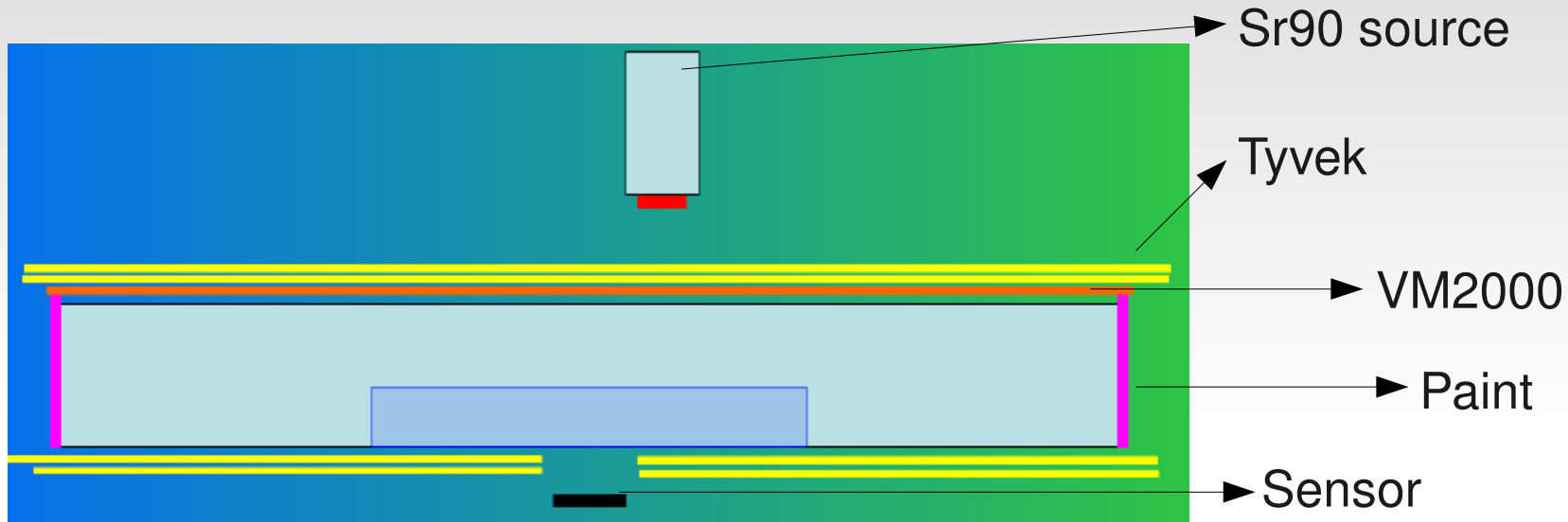
Integrated Readout Layer (IRL)

- Defined by making some interface choices:
 - **Scintillator – Sensor**
 - ➔ With WLS fiber or direct (i.e. fiber-less) coupling
 - **Sensor – PCB**
 - ➔ In tile or surface-mounted on PCB
 - **Scintillator – PCB**
 - ➔ Individual cells or 'mega-tiles'
 - **Scintillator – LED**
 - ➔ Light distribution or pulse distribution

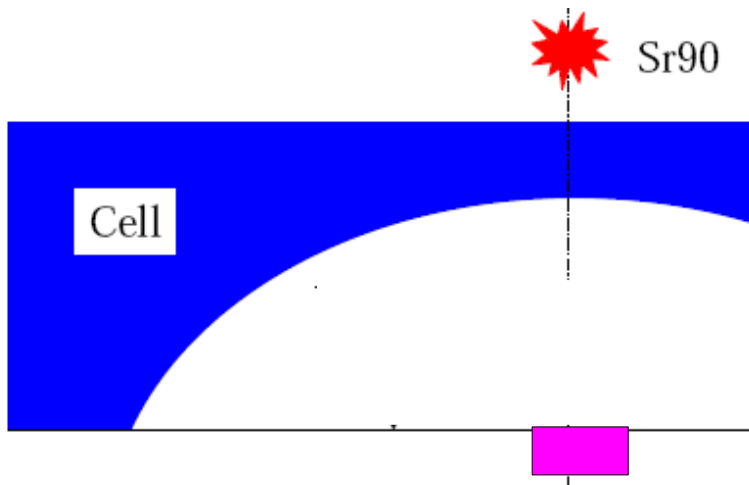
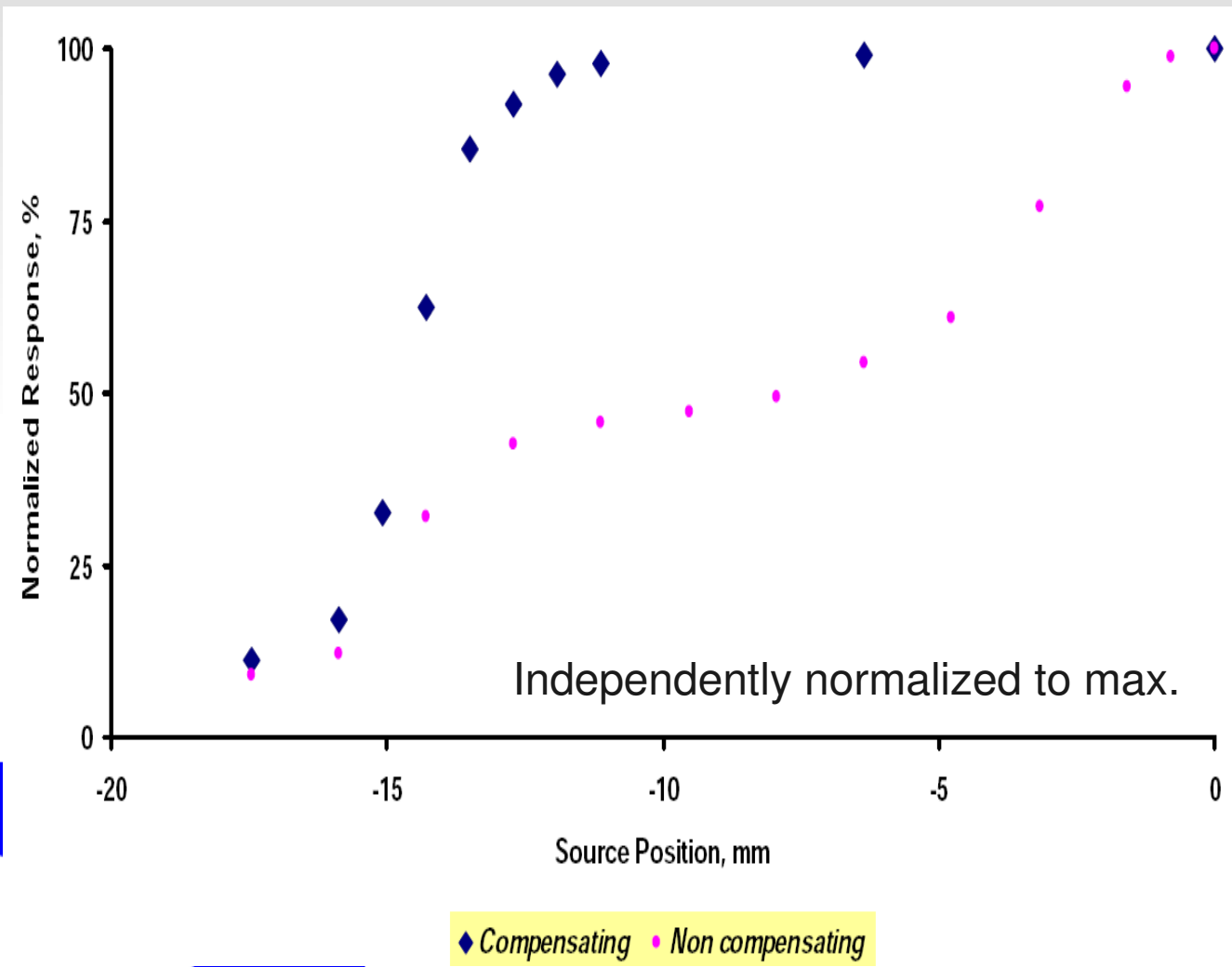
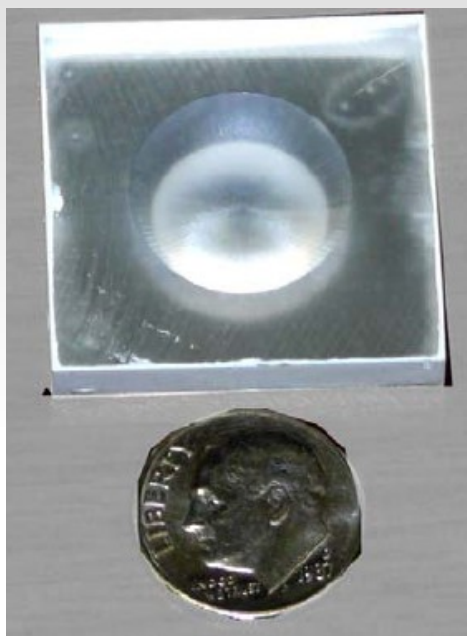
Direct Coupling

- Simplification in construction and assembly
- Greater electro-mechanical integrability
- Transverse segmentation flexibility
- Is there enough response and is the response uniform enough?
- Measurements done for 5 mm thick, 9 cm² tiles with 1 mm x 1 mm Hamamatsu MPPCs

DC Response Uniformity



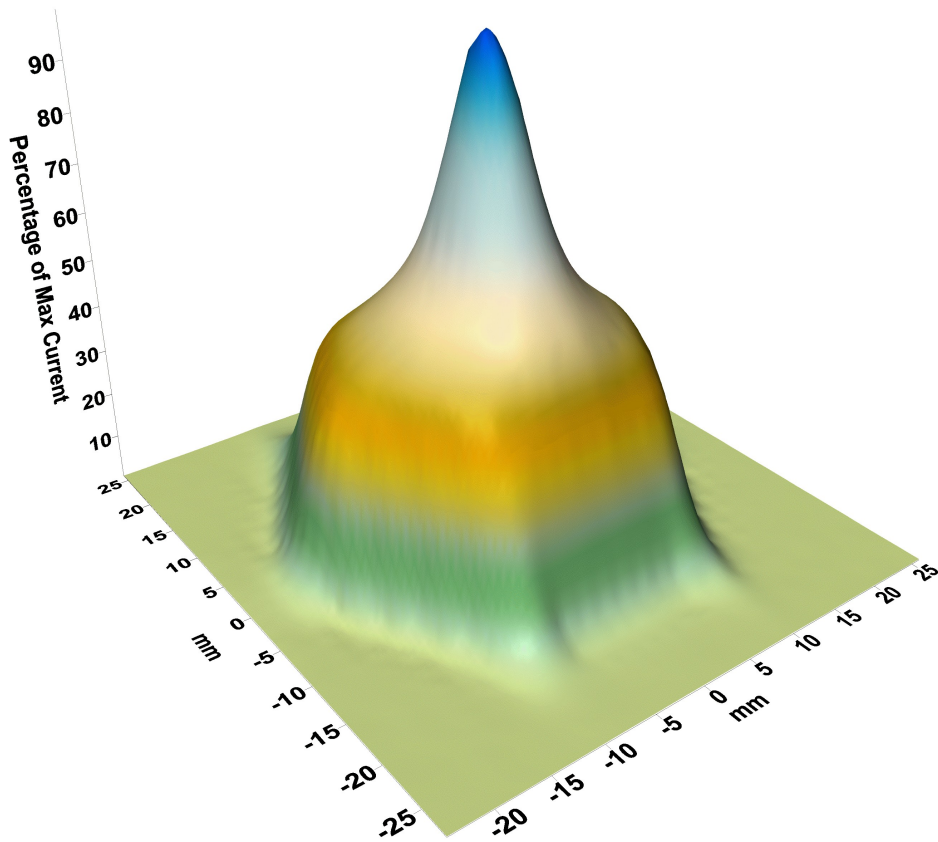
Dimpled Tile



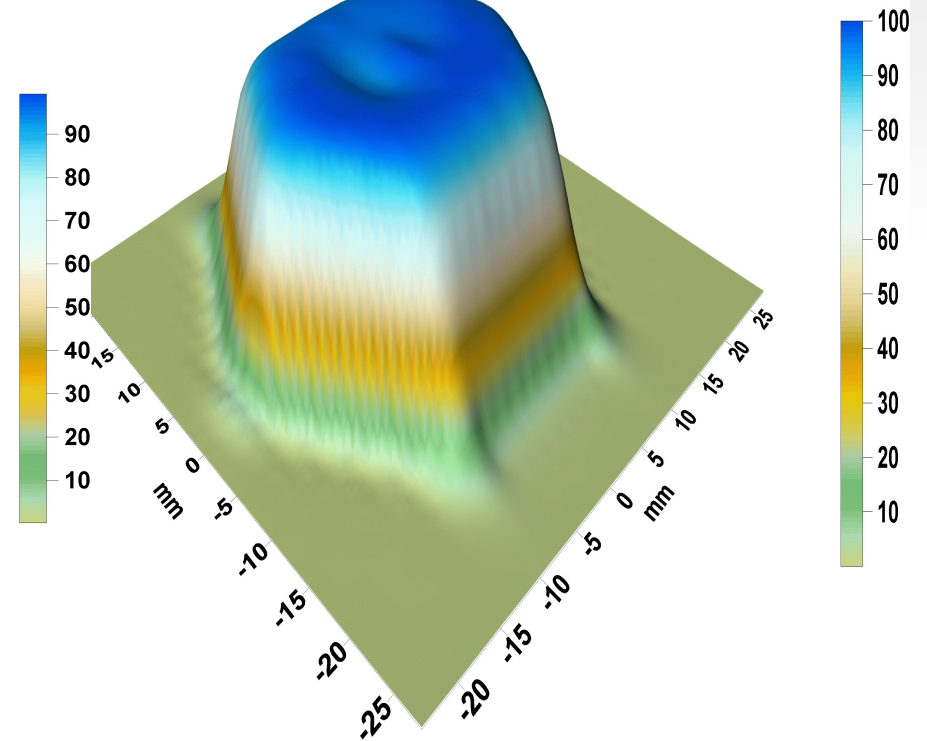
ng, ANL

Adequate Uniformity 7

2D Scan (Hexagonal Tile)



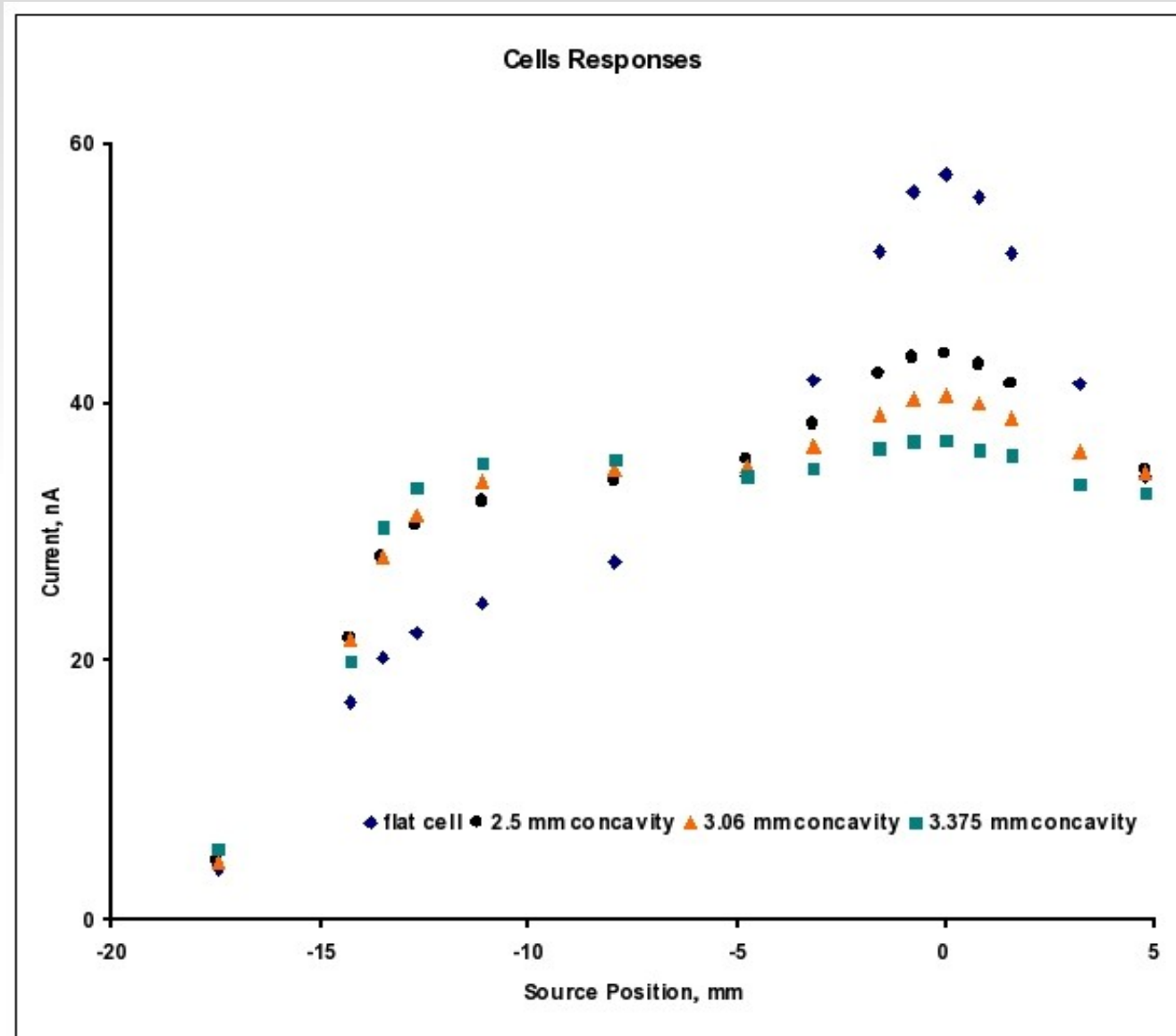
'Flat' Tile



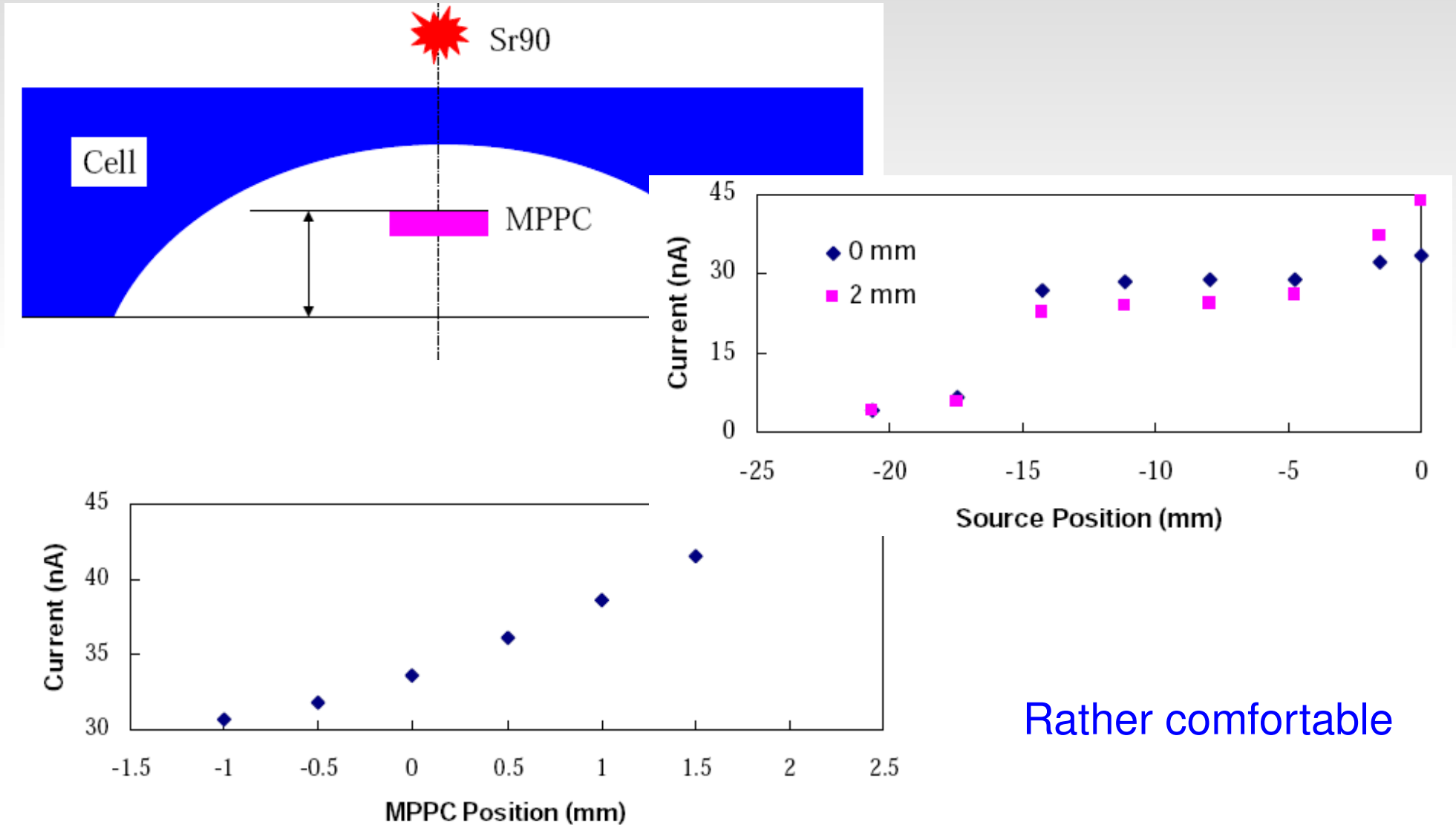
'Dimpled' Tile

Response Evolution

alternative design of concavity on side is described in:
F. Simon et al, NIM A 620, 2010

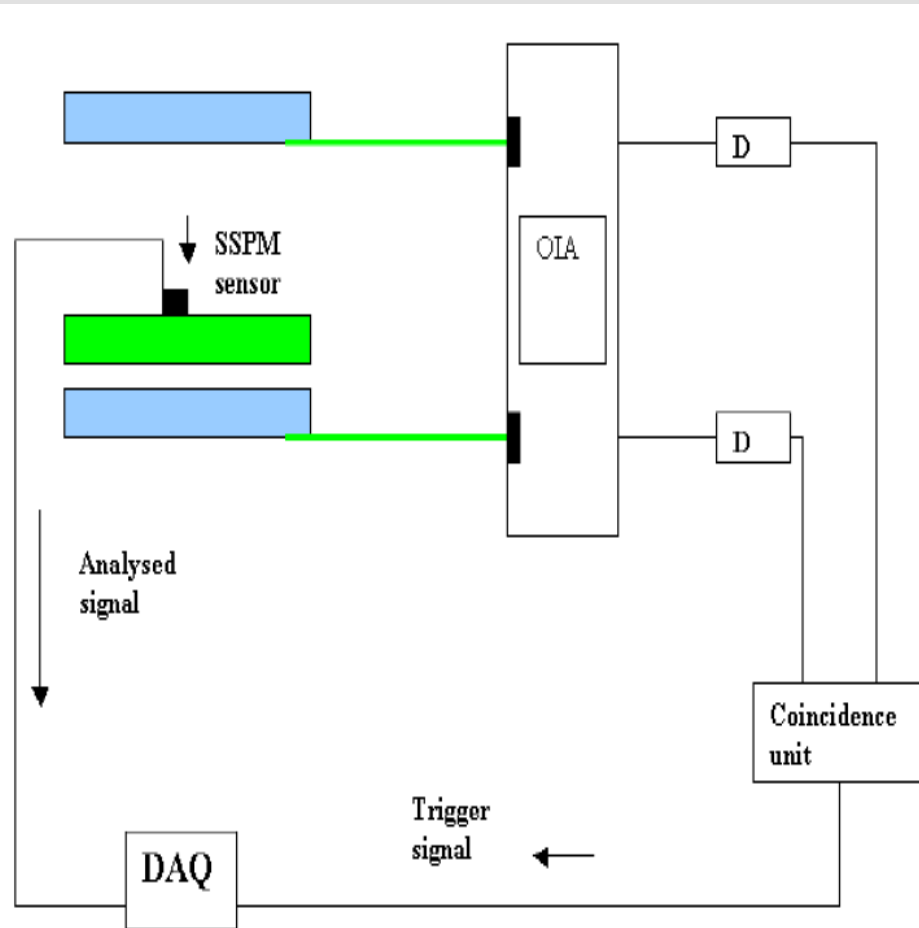


Tolerances

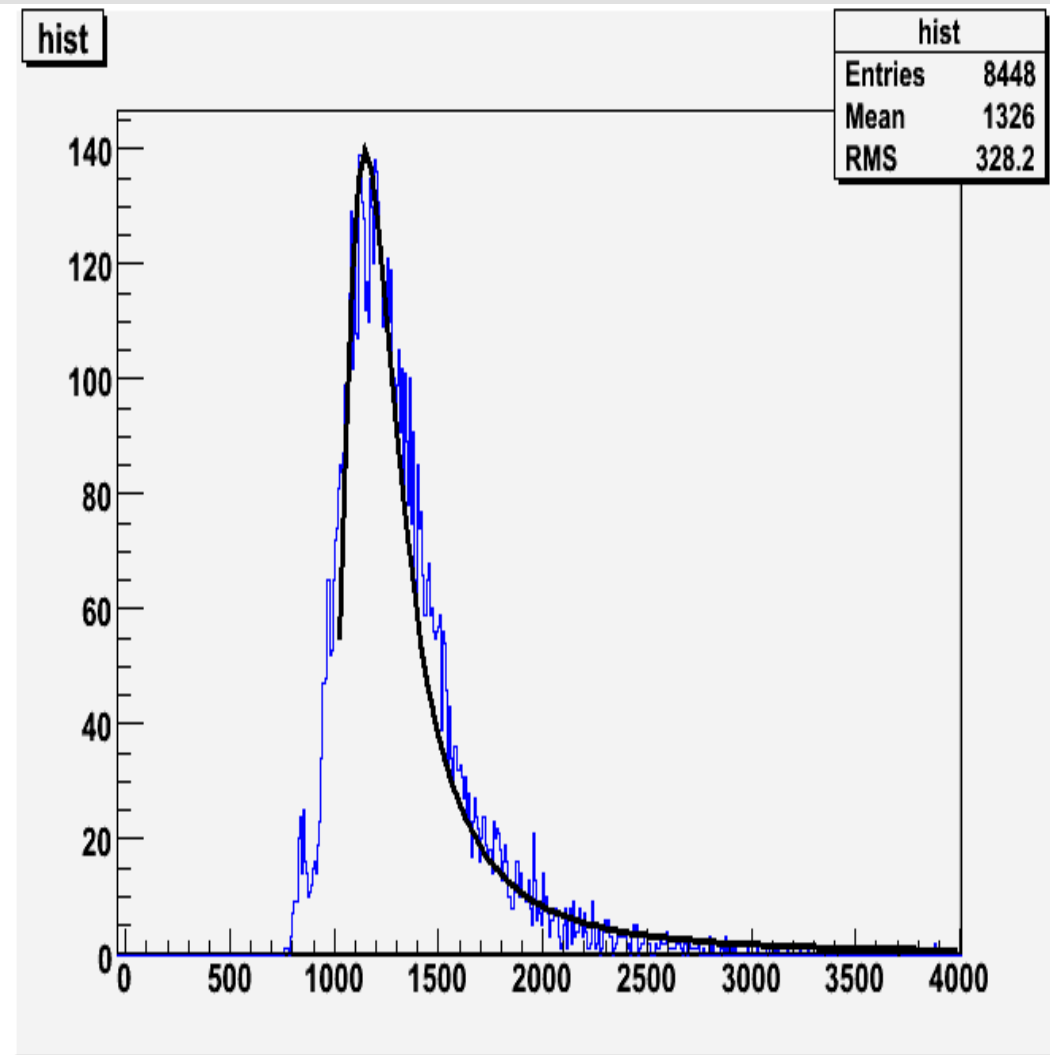


Rather comfortable

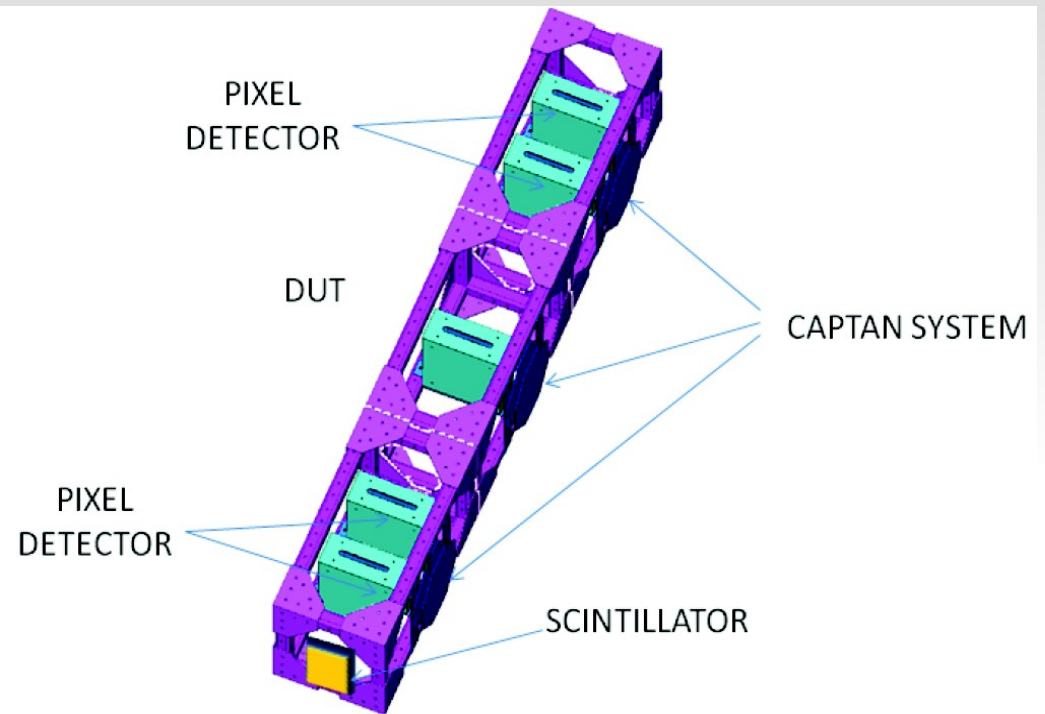
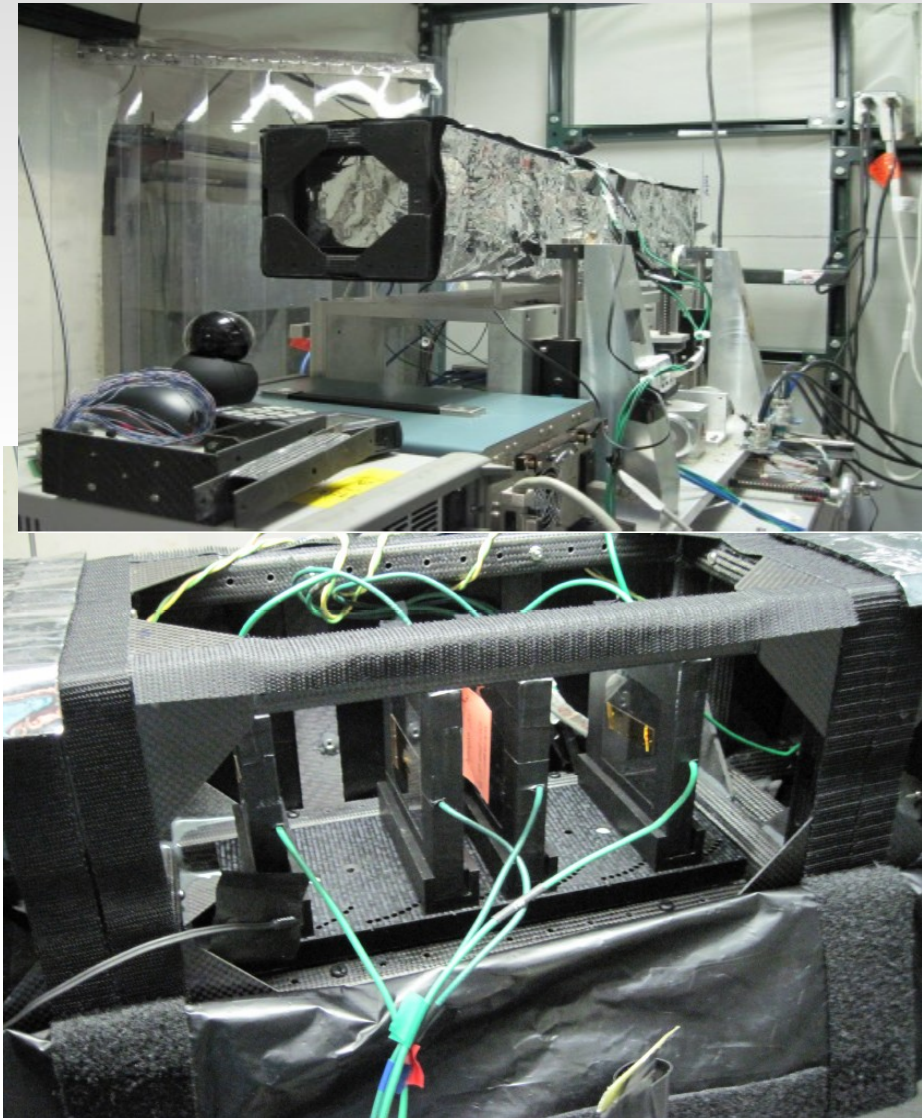
Response to Cosmics



Adequate Light Yield



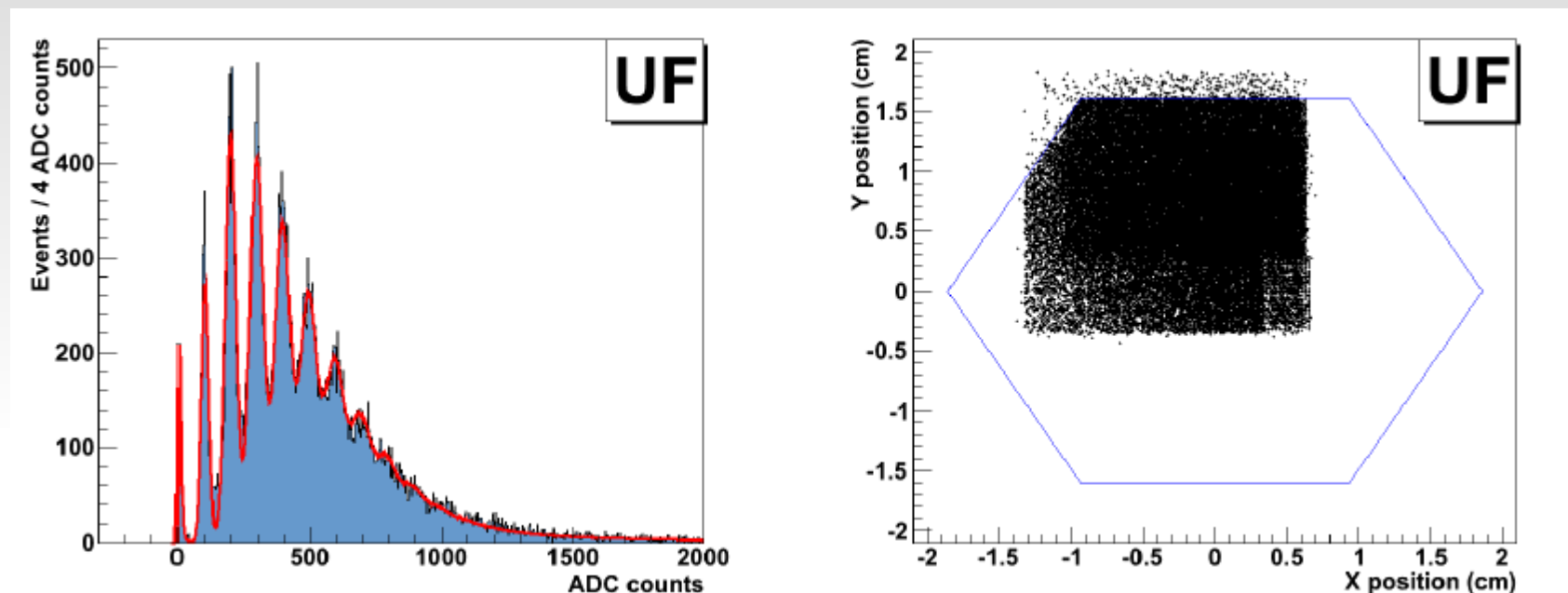
Testbeam Setup



Testbeam carried out at Fermilab with 120 GeV protons using facility pixel telescope (active area of $\sim 2\text{cm} \times 2\text{cm}$ with $\sim 40\mu\text{m}$ position resol).

Nucl.Instrum.Meth. A659 (2011) 348-354

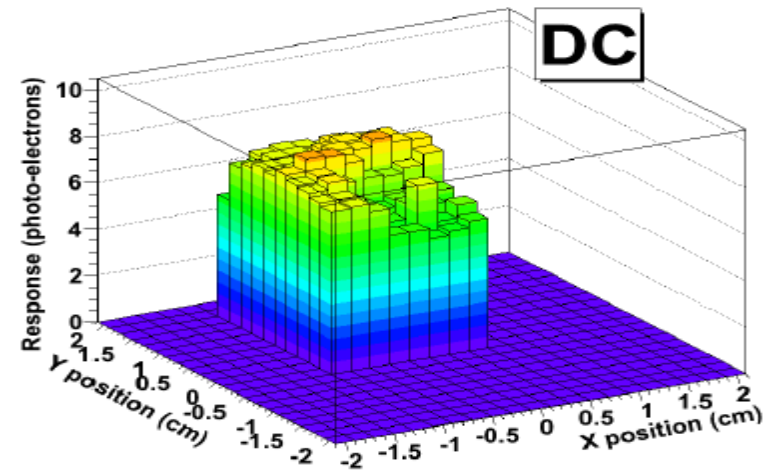
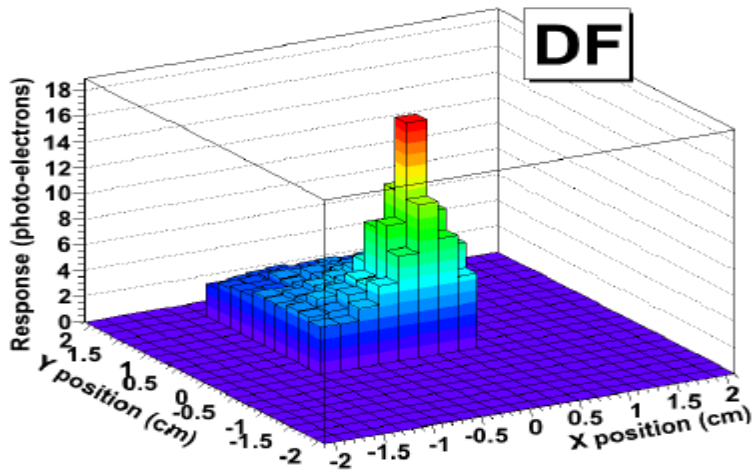
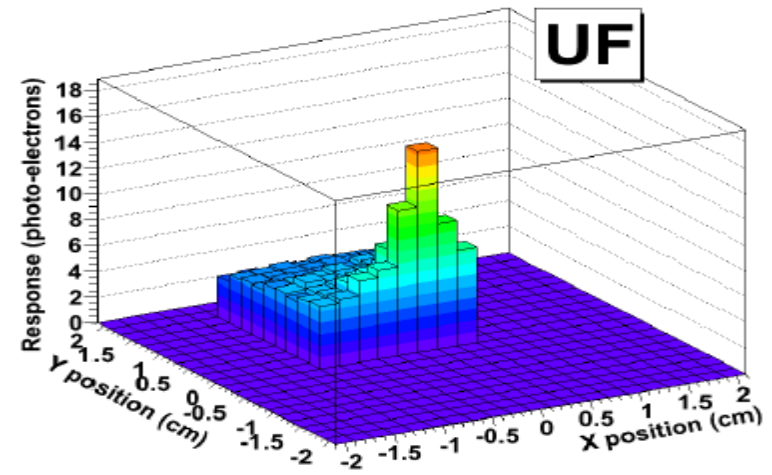
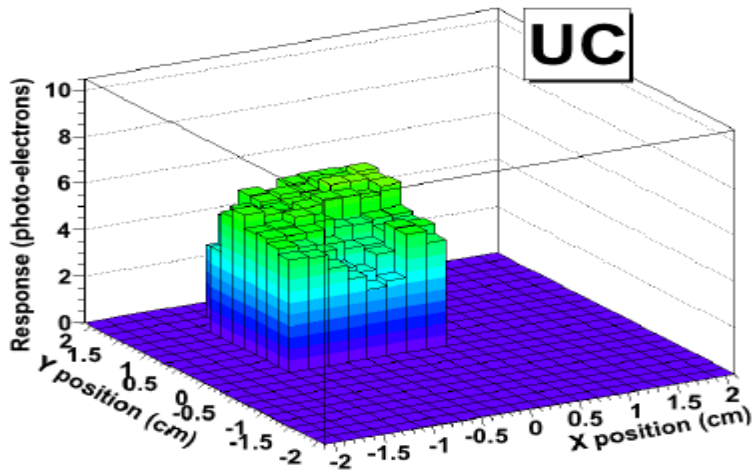
Tiles in the beam



Tile	Z (cm)	Thick. (mm)	Shape/ Depth (mm)	Scin. Type	MPPC (Hamamatsu)	Pixel #	Pixel Size (μm^2)
UC	-11.8	5.0	Con. 3.0	Cast	S10362-11-025C	1600	25 x 25
UF	-3.0	5.0	Flat	Ext.	S10362-11-050C	400	50 x 50
DF	0.2	5.0	Flat	Ext.	S10362-11-050C	400	50 x 50
DC	8.2	5.2	Con. 3.0	Cast	S10362-11-025C	1600	25 x 25

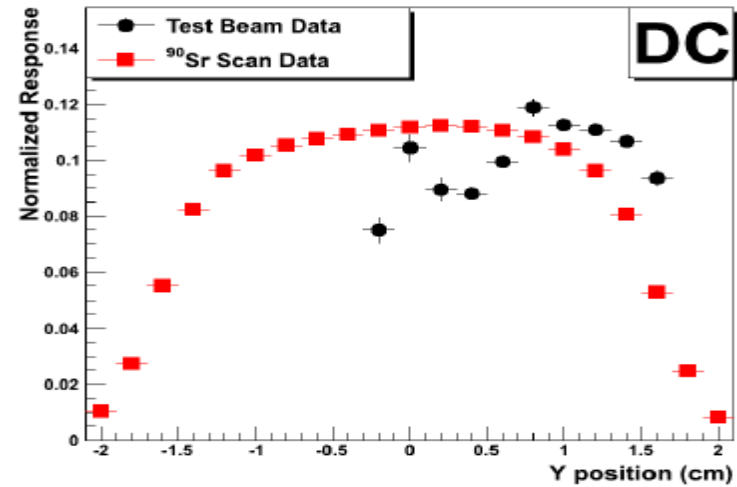
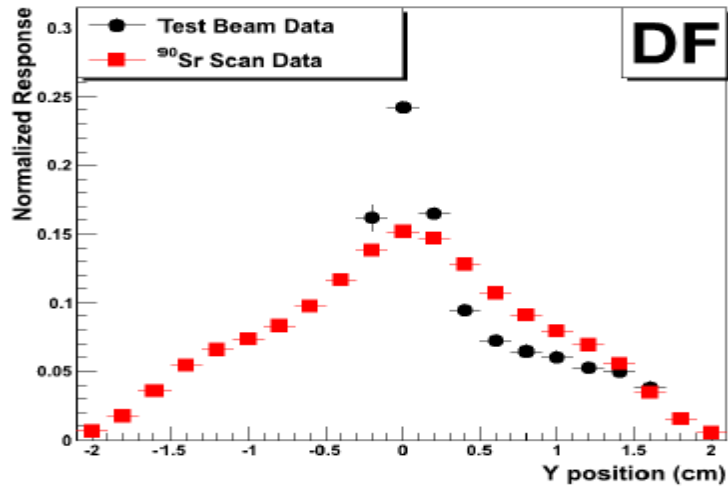
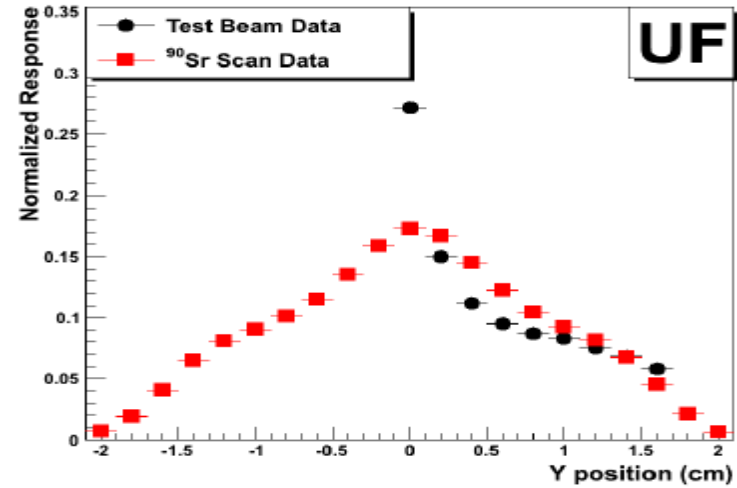
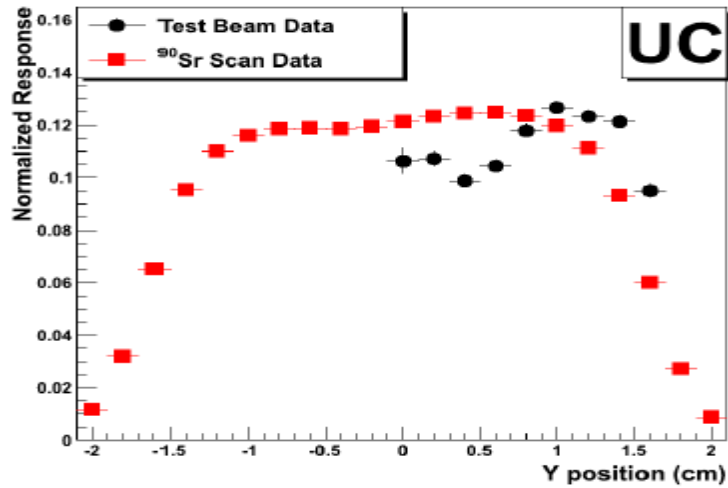
Tile Response

C = Concavity

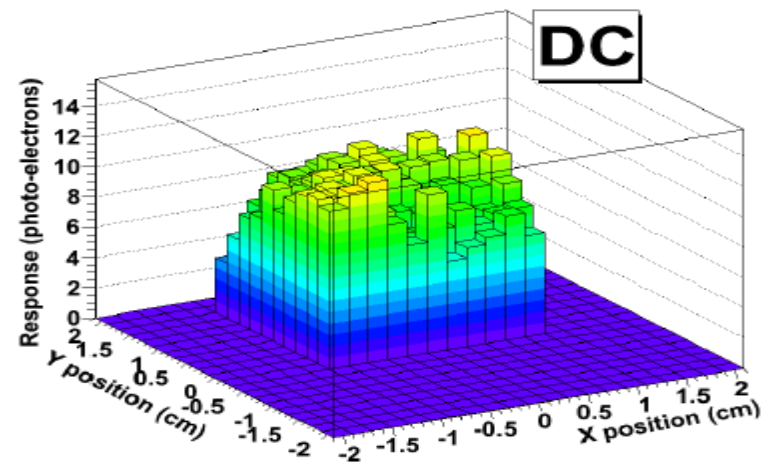
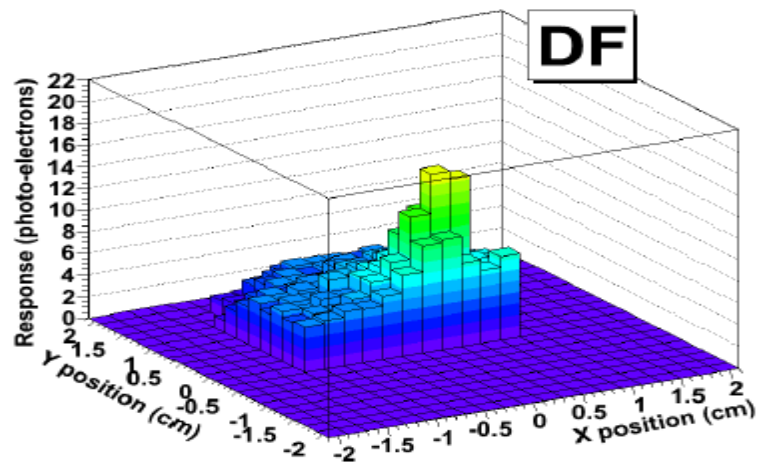
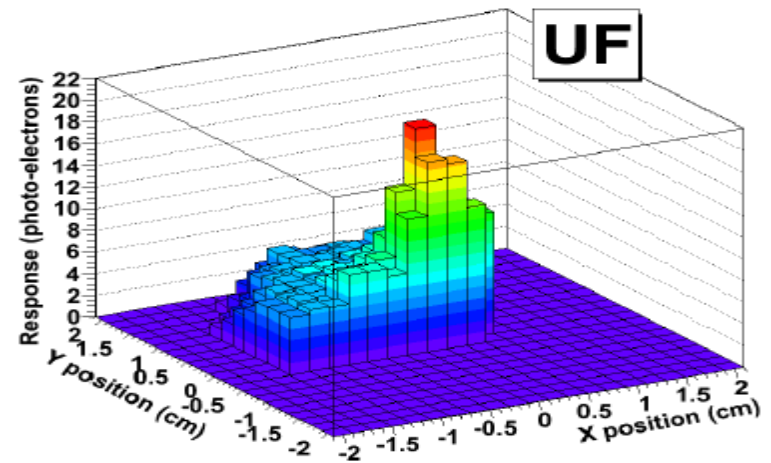
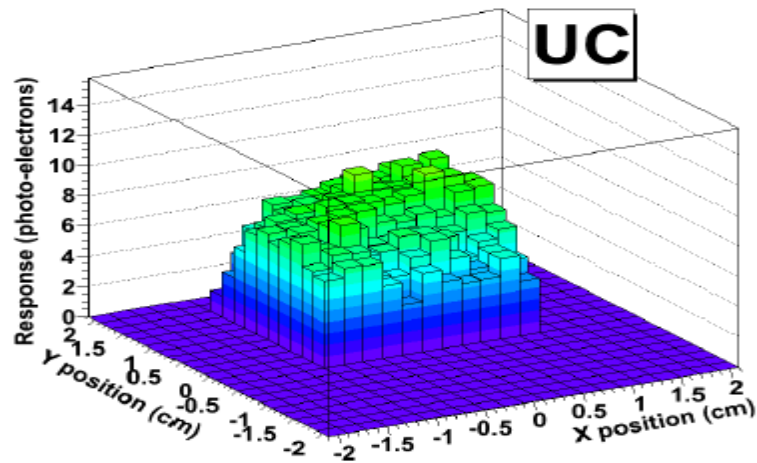


F = Flat

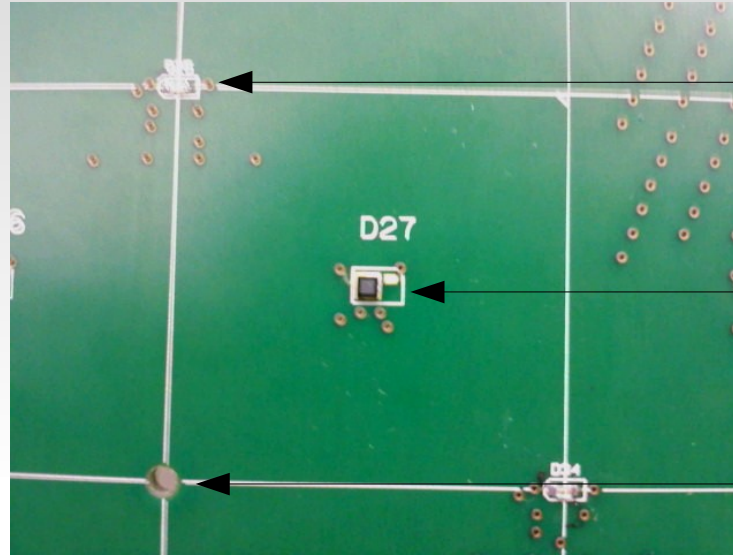
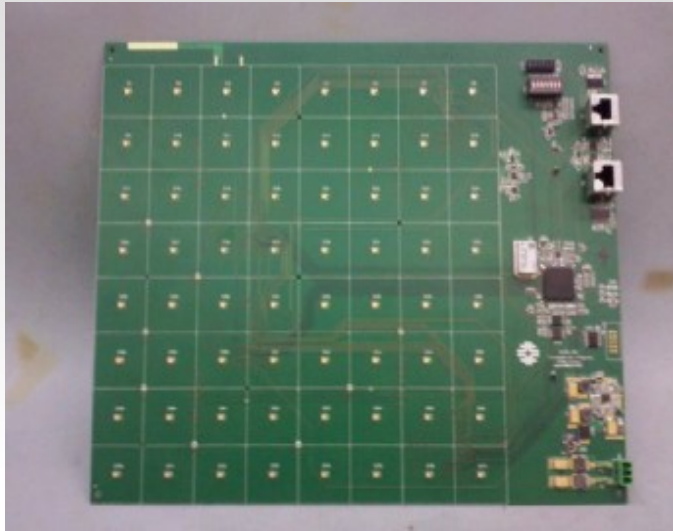
Beam vs. Source Scans



Response at 40°



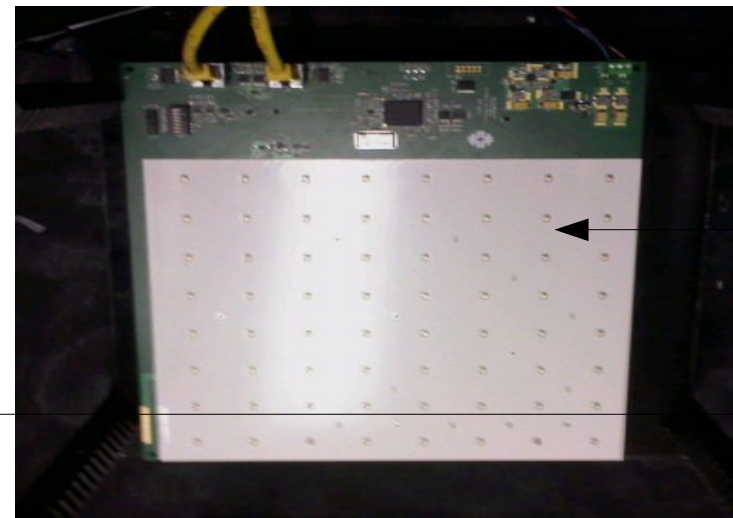
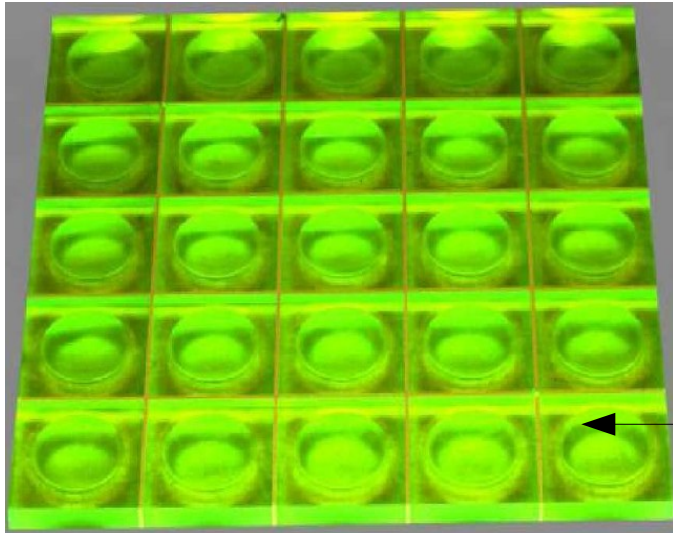
IRL Proof-of-Principle



S/M LED, 1per 4 tiles

Surface Mount
SiPM

Alignment pin

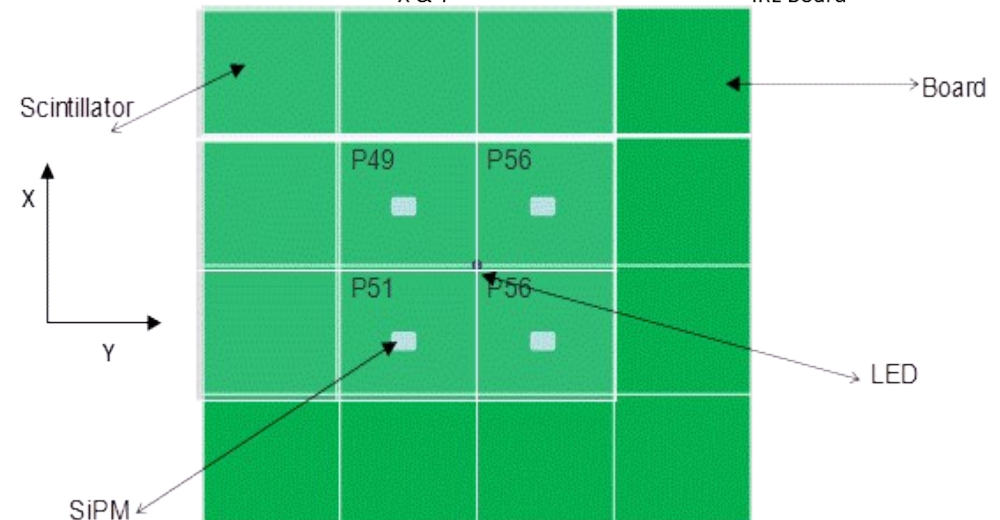
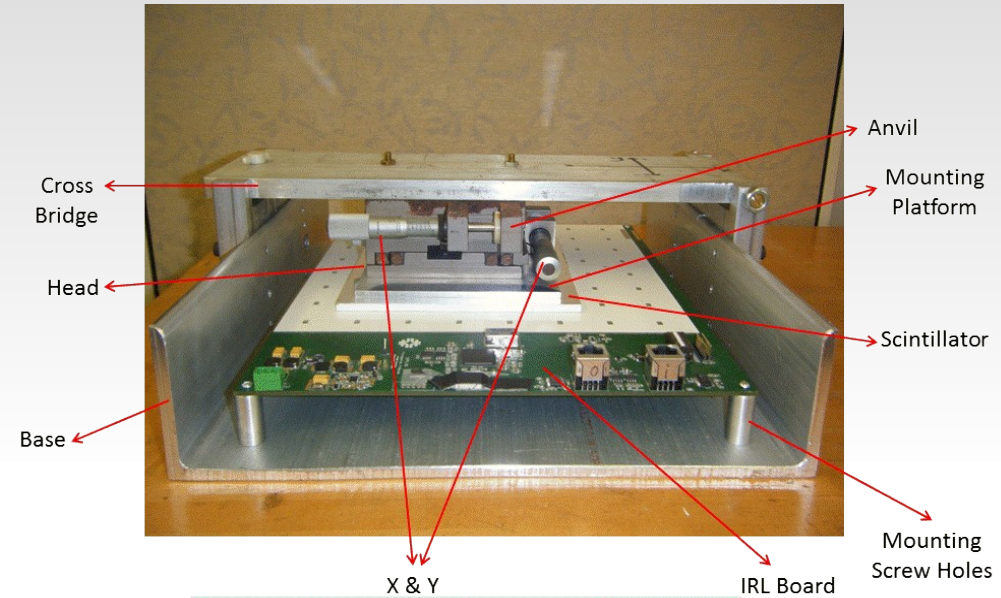
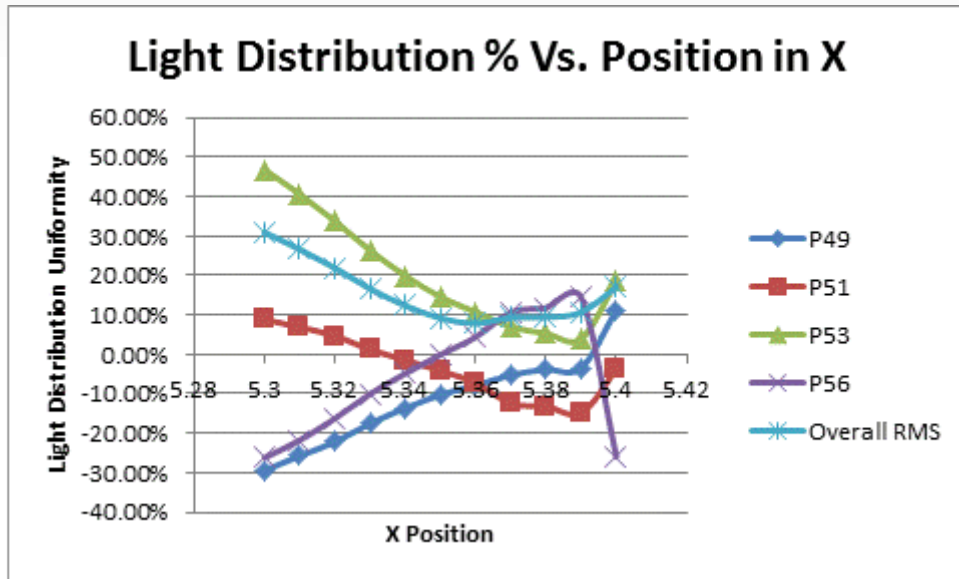


Reflector/spacer

Megatile

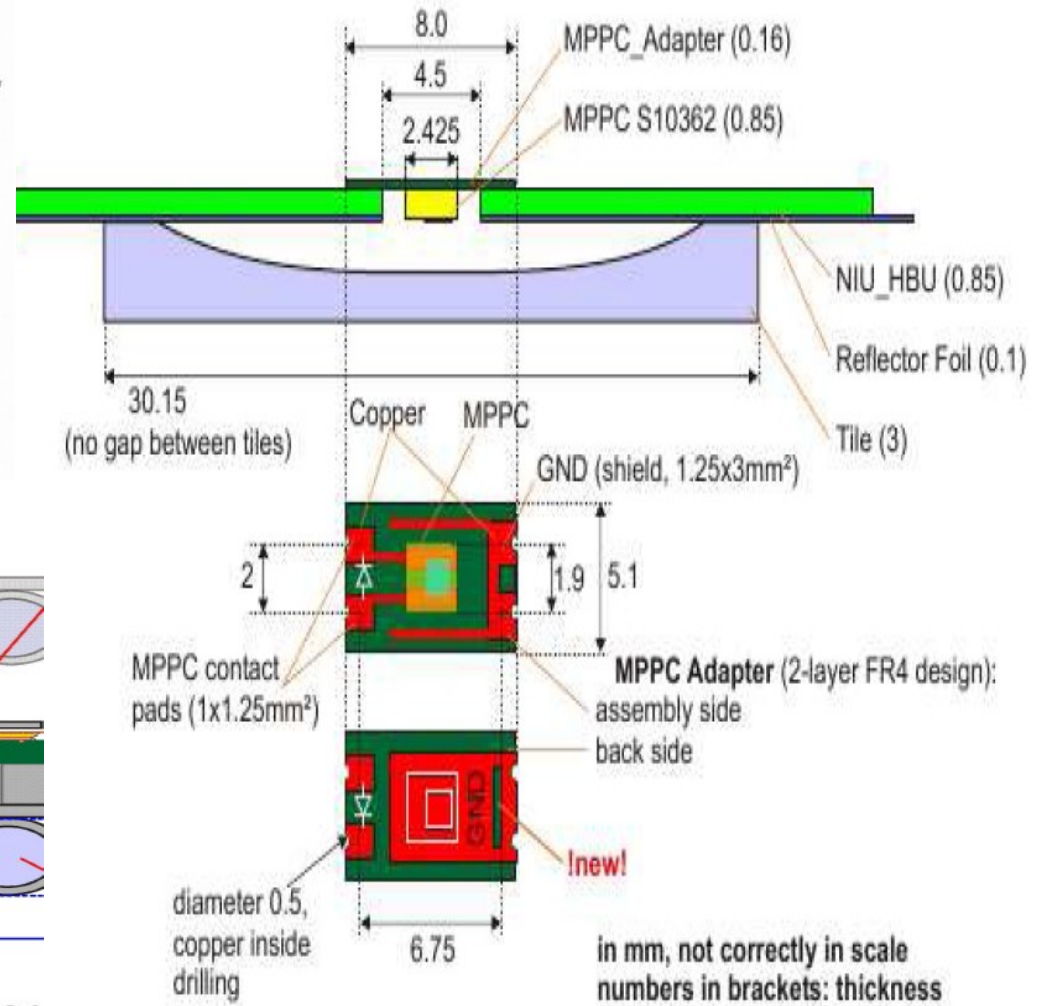
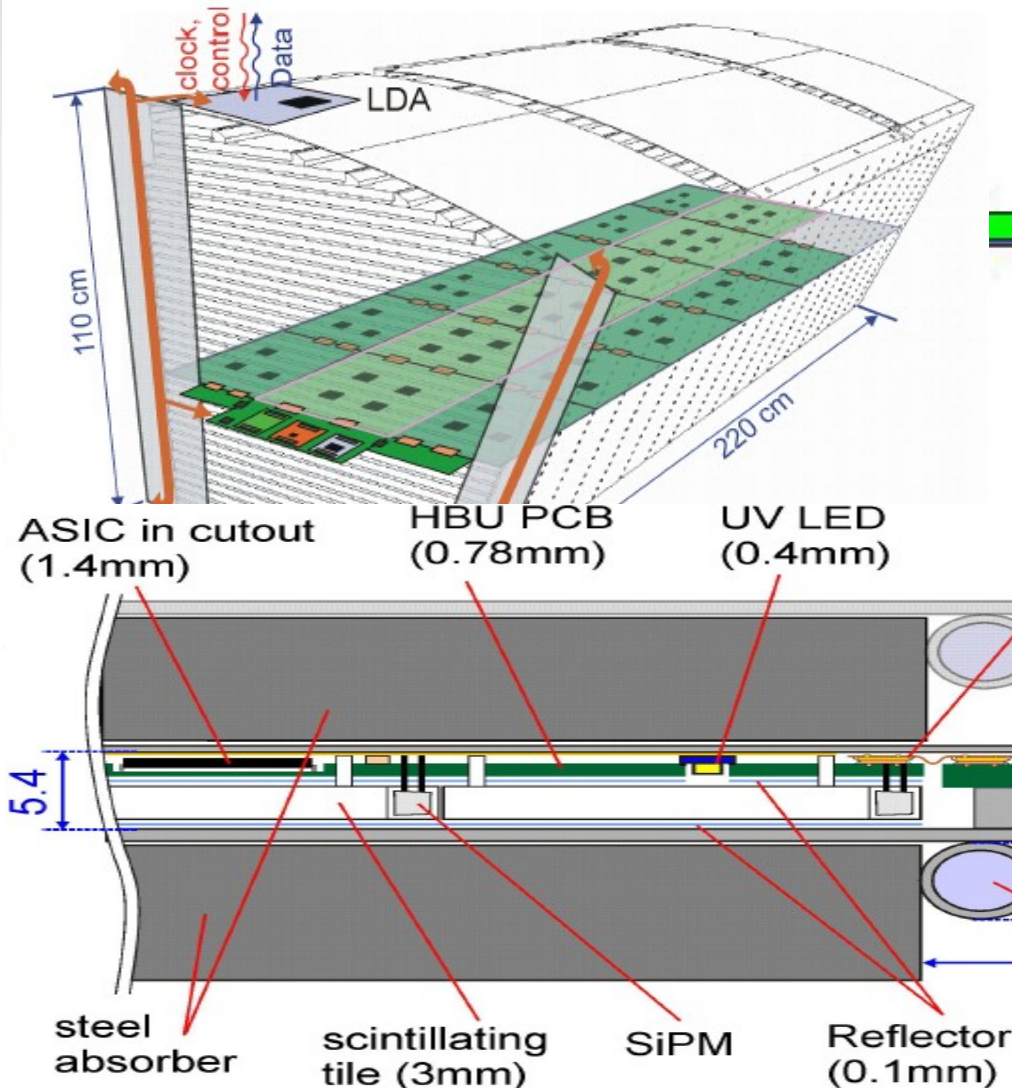
LED Distribution Uniformity

LED useful for gain calibration and saturation correction. This mean the light distribution should be within a factor of 2



Next Step

M. Reinecke, DESY



03/19/14

V. Zutshi, CALICE Meeting, ANL

19

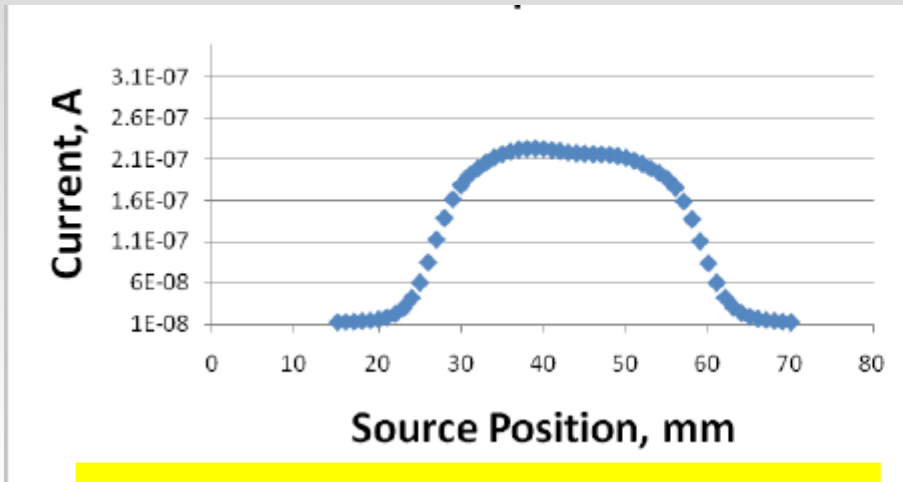
See talk by Kurt Francis

Injection Molded Tiles

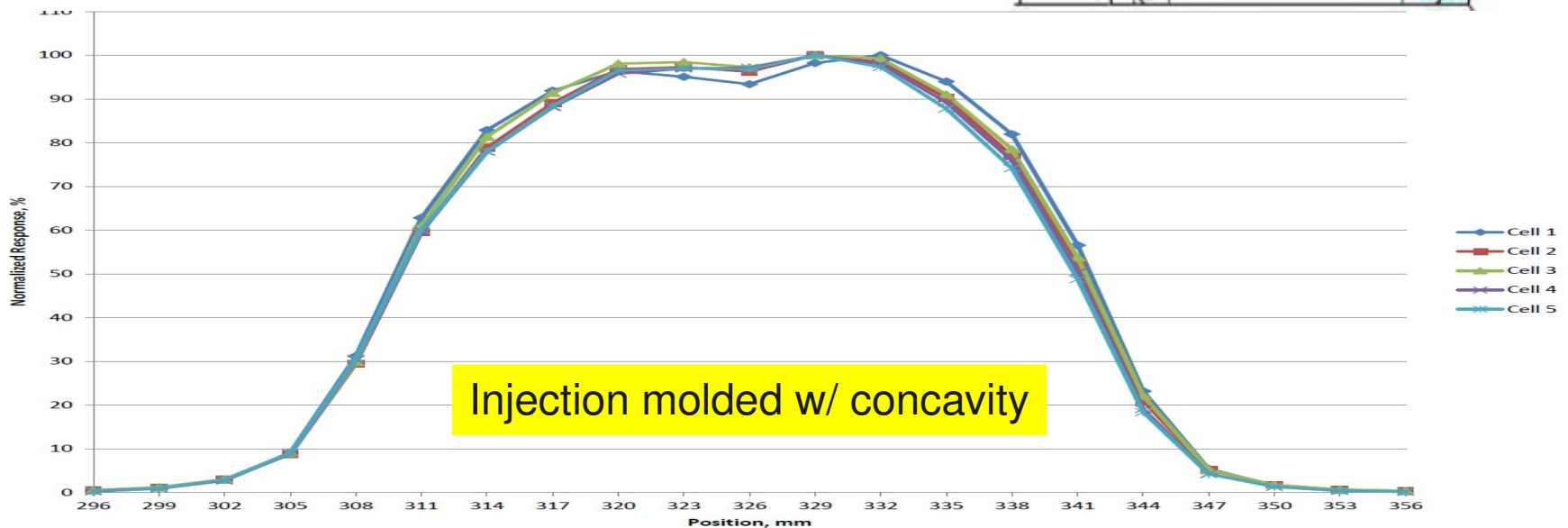
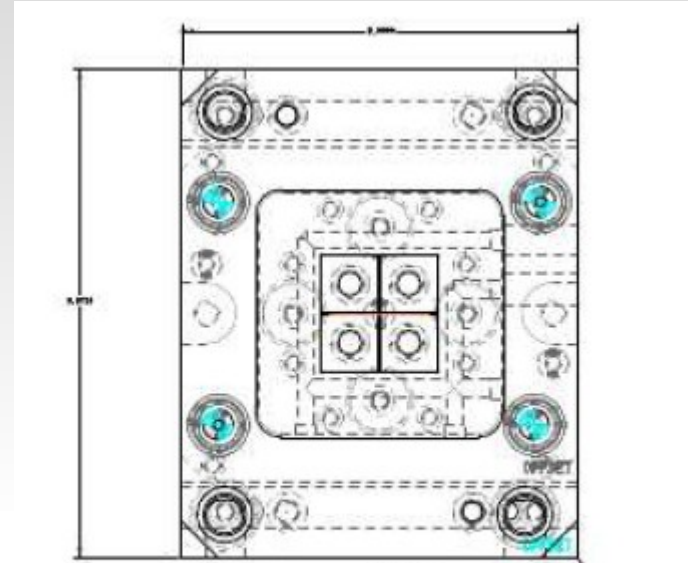


Promises to be cost effective in large quantities
Large phase space of production conditions, finishes etc.
Took a staged approach....

From Tiles to Arrays

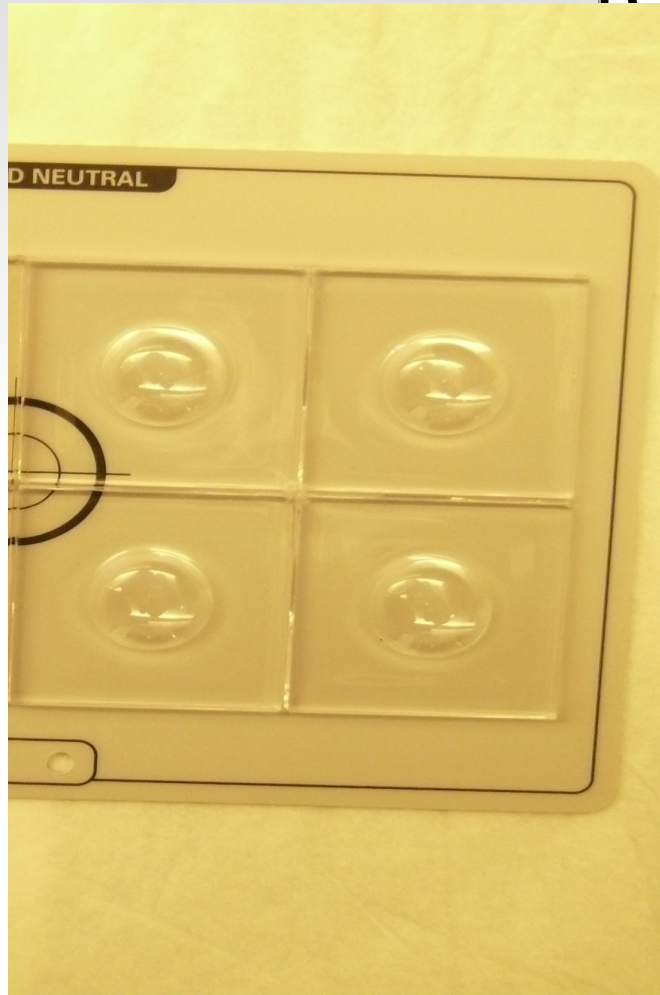


Injection molded flat, then machined

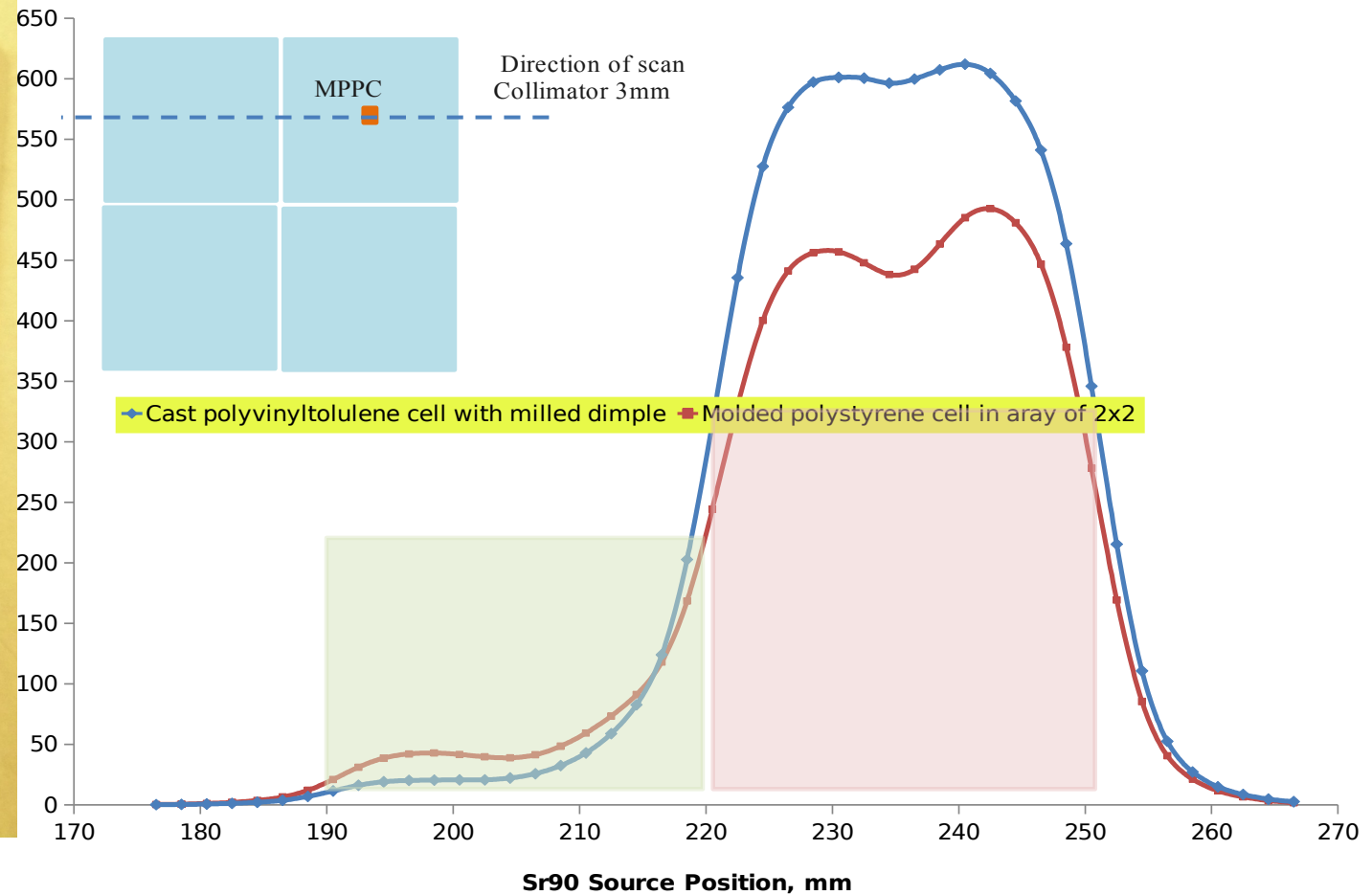


Injection molded w/ concavity

Injection Molded Array



Cell has a spherical dimple. Molded polystyrene cell is in 2x2



Continued R&D

- Board (SM_HBU):
 - Layout optimized for surface mount sensor design
 - Mounting of sensor (holes, recesses,...)
- Scintillator:
 - Mass production strategies
 - Megatile optimal dimensions
 - Details of reflector treatment

Continued R&D

- Assembly:
 - Sensor placement on board
 - Sensor-board-megatile alignment
 - Module design for insertion into stack
- Quality Assurance:
 - Surface-mount sensor characterization & burn-in
 - Megatile tolerances

Summary

- Bright prospects for surface-mount-sensor with megatile design
- Proof-of-principle already exists for key aspects of the concept
- Clear path as far as R&D steps required to it to its full realization