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Scintillator FTBF Studies for CMS Endcap Backing Calorimeter

Jim Freeman

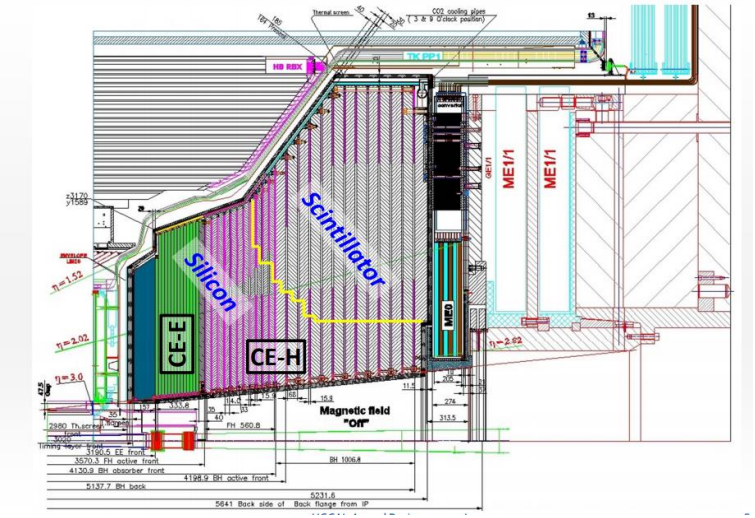
Jim Freeman, Don Lincoln, Paul Rubinov, (FNAL)

Sergey Uzunyan, Sasha Dychkant, Vishnu Zutshi (NIU)

Ping Tan (Rochester)

CMS BH Calorimeter

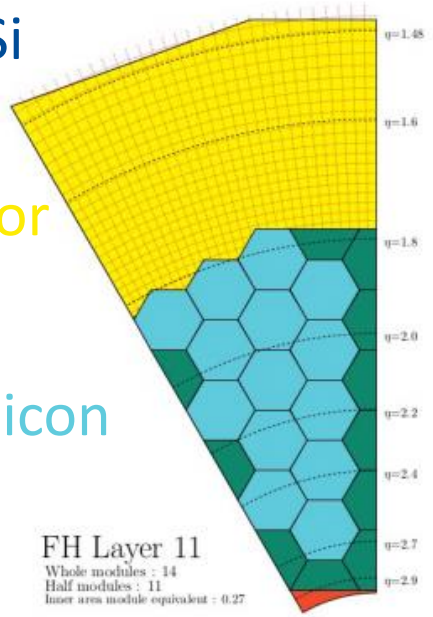
HGC calorimeter y-z view



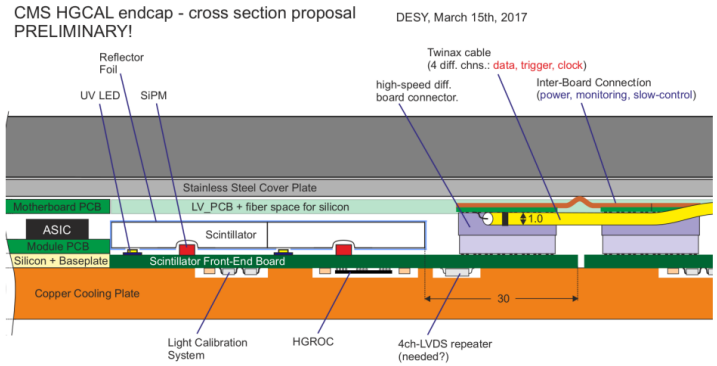
Mixed scint-Si "cassette"

scintillator

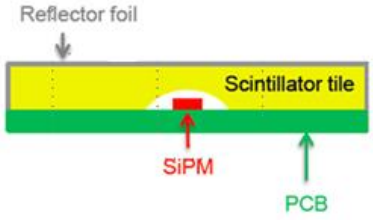
silicon

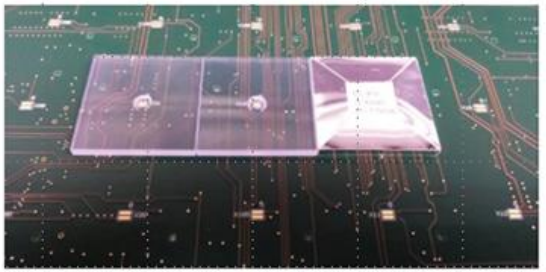


Cross section of scintillator cassette



SIPM-on-Tile





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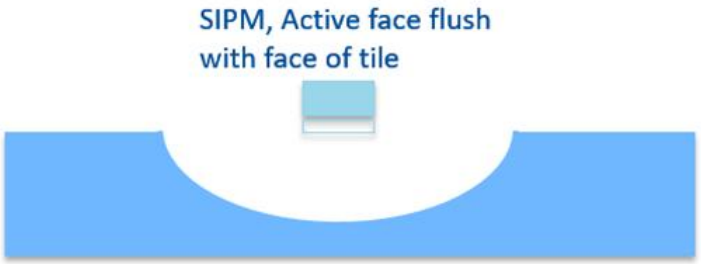
SIPM-on-Tile Design Questions

- uniformity/light yield
- vs size of tile
- vs size of SIPM
- vs thickness of scintillator
- different scintillator materials
- different covering/reflective material

Example of SIPM-on-tile

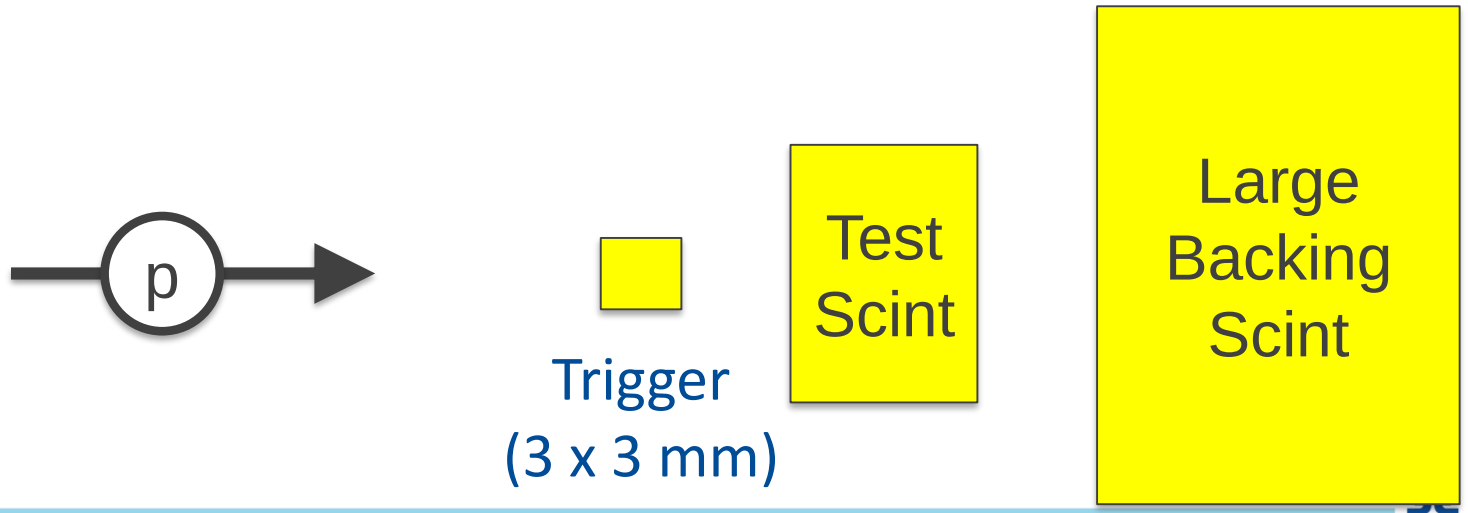
- Scintillator
  - 3 × 3 × 0.38 cm
  - SCSN81
  - Dimpled
  - Wrapped in foil
  - Edge painted with BC-610

- SiPM
  - 1.3 × 1.3 mm
  - Hamamatsu
  - Flush with face of dimple



Beam Test

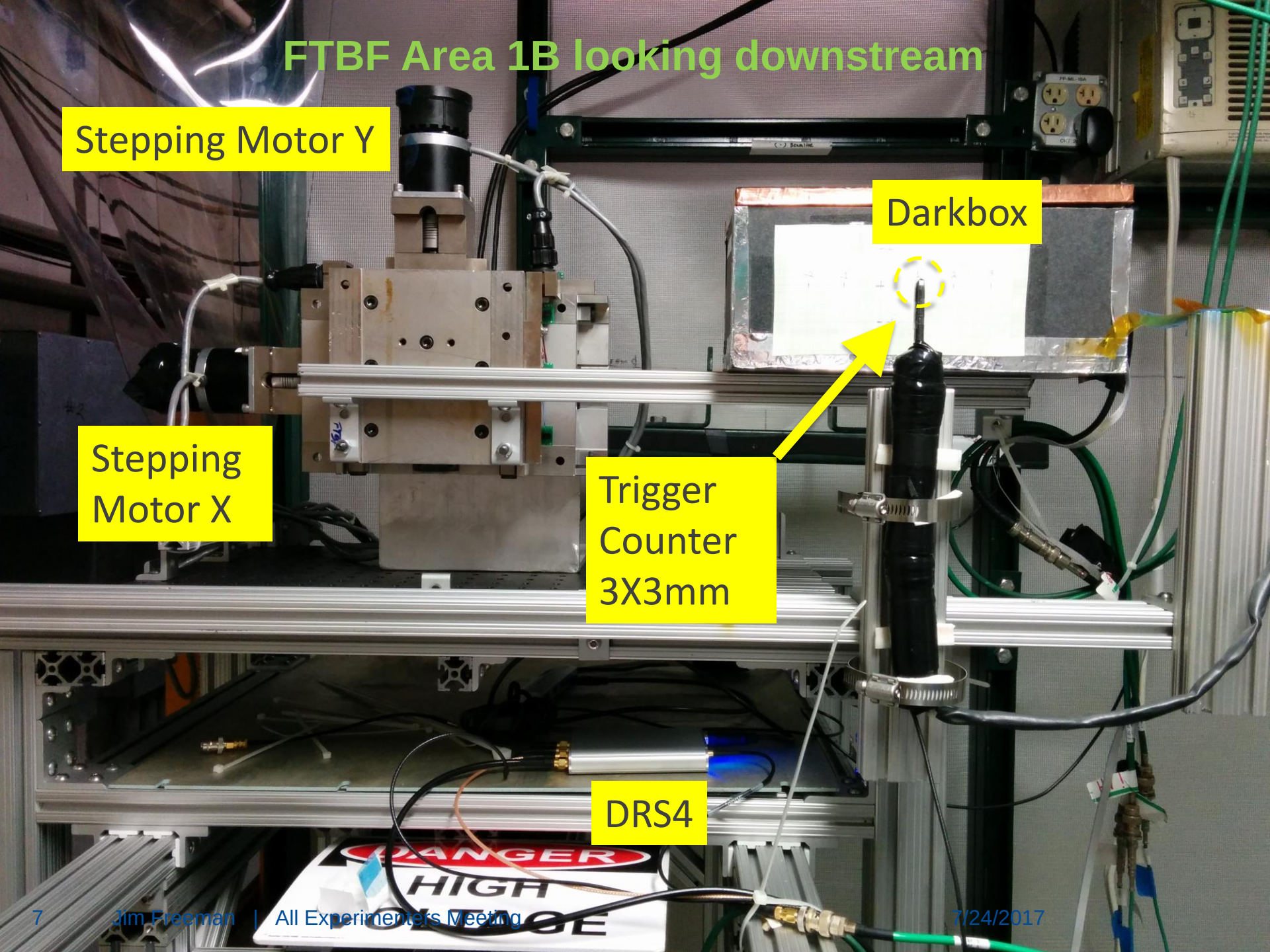
- Scintillator tests for backing calorimeter for HGCAL
- Fermilab test beam
  - MTest
  - 120 GeV protons
  - ~1E5 protons/spill
  - Spot size (6 mm radius?)
  - Parasitic test. (June, July)



Test Configuration

- Configuration:
  - 4 channel DRS4 [Essentially a digital oscilloscope].
  - SIPM mounted on ORKA boards
  - SIPM bias voltage (Keithley 2410)
  - SIPM-on-tile aligned to beam in dark box
  - 3mm × 3mm trigger counter fixed in the beam
  - DRS4 triggered with the 3x3 mm counter
  - X-Y stepping motor stage for position scanning

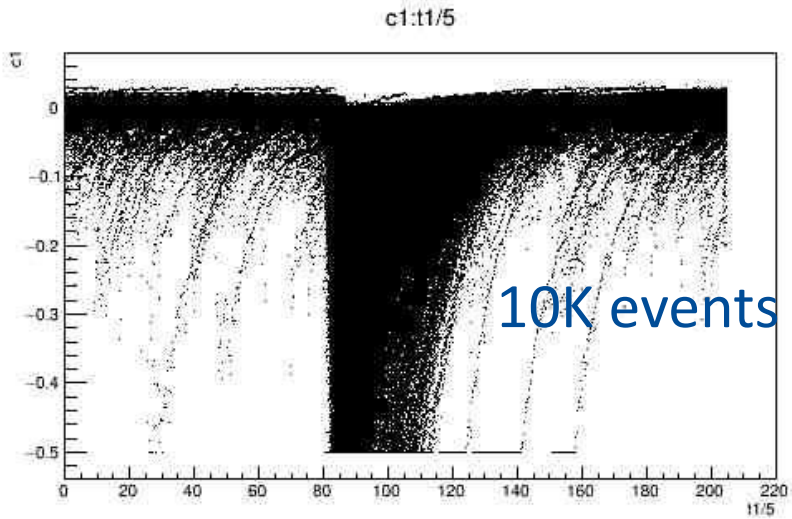
FTBF Area 1B looking downstream

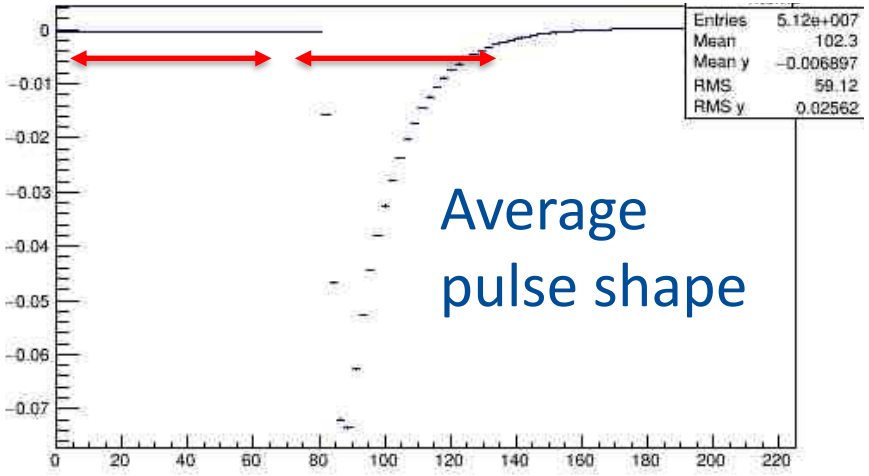


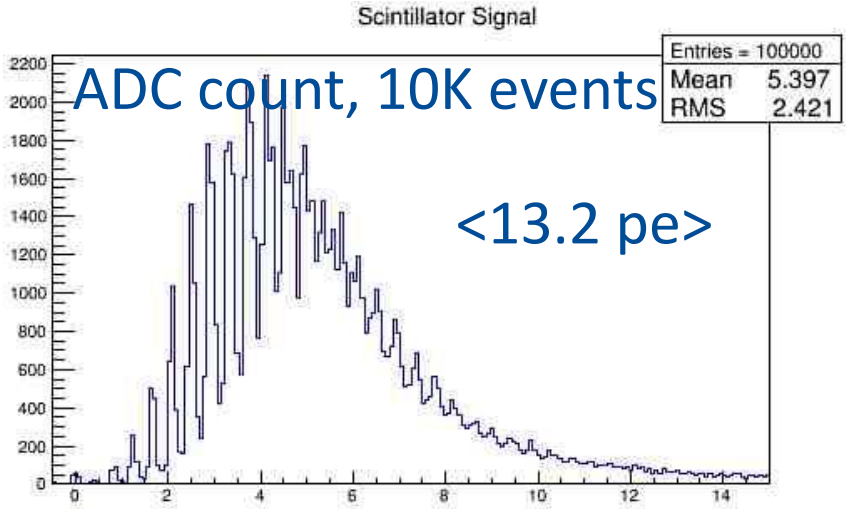
DRS4 Evaluation Board DAQ, FE electronics

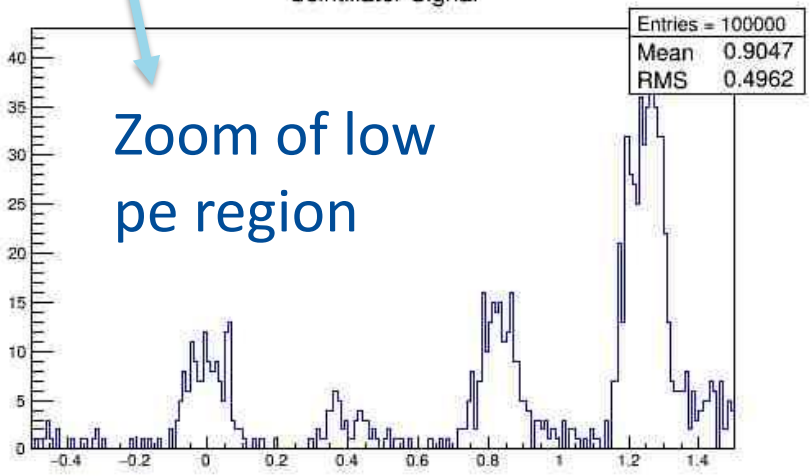
- Front end ORKA single channel SIPM amplifier (Sergey Los, Dave Christian) 3GHz / 13x amplifier
- DRS4 Waveform digitizer
  - Up to 5 GS/s
  - 700 MHz amplifier input
  - Modified firmware (Paul Rubinov) deadtime (busy signal out)
  - Integrated with FNAL NIM+ to read out with FTBF silicon tracker (Alan Prosser, Lorenzo Uplegger, Ryan Rivera) (most data triggered by 3x3m)
  - 1K events/spill
  - Binary to root conversion program (Caltech, FNAL)
  - Root files for analysis. Don Lincoln

Event-by-event pedestal subtraction. Sample tile









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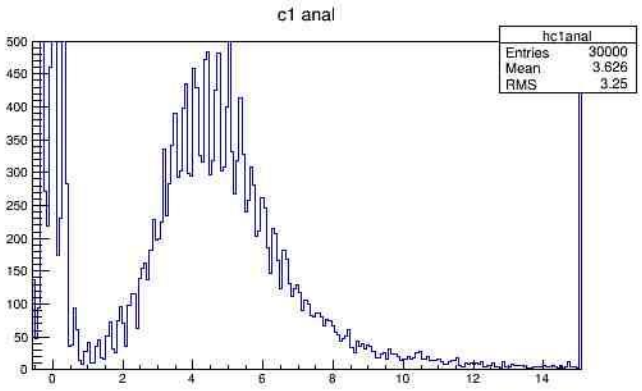
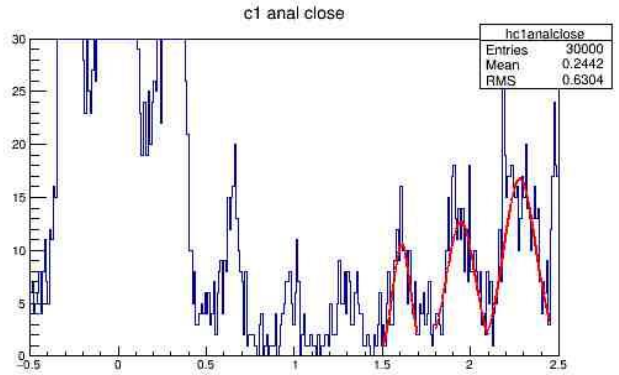
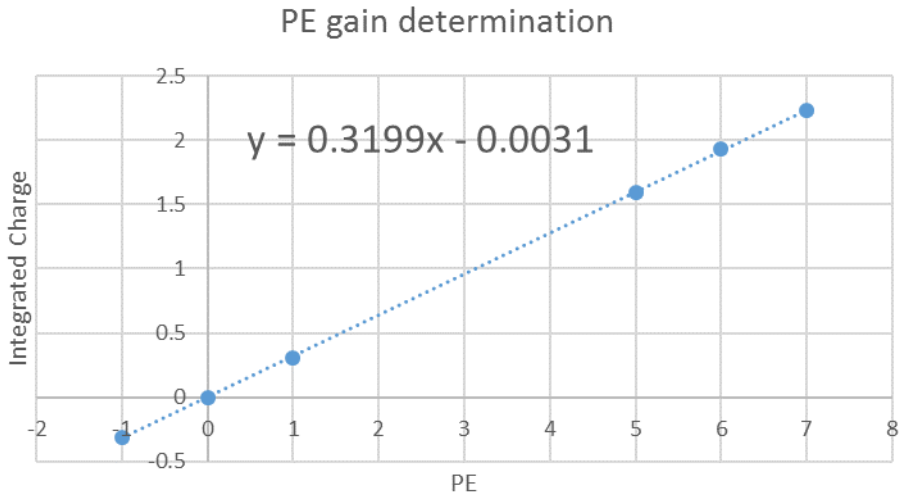
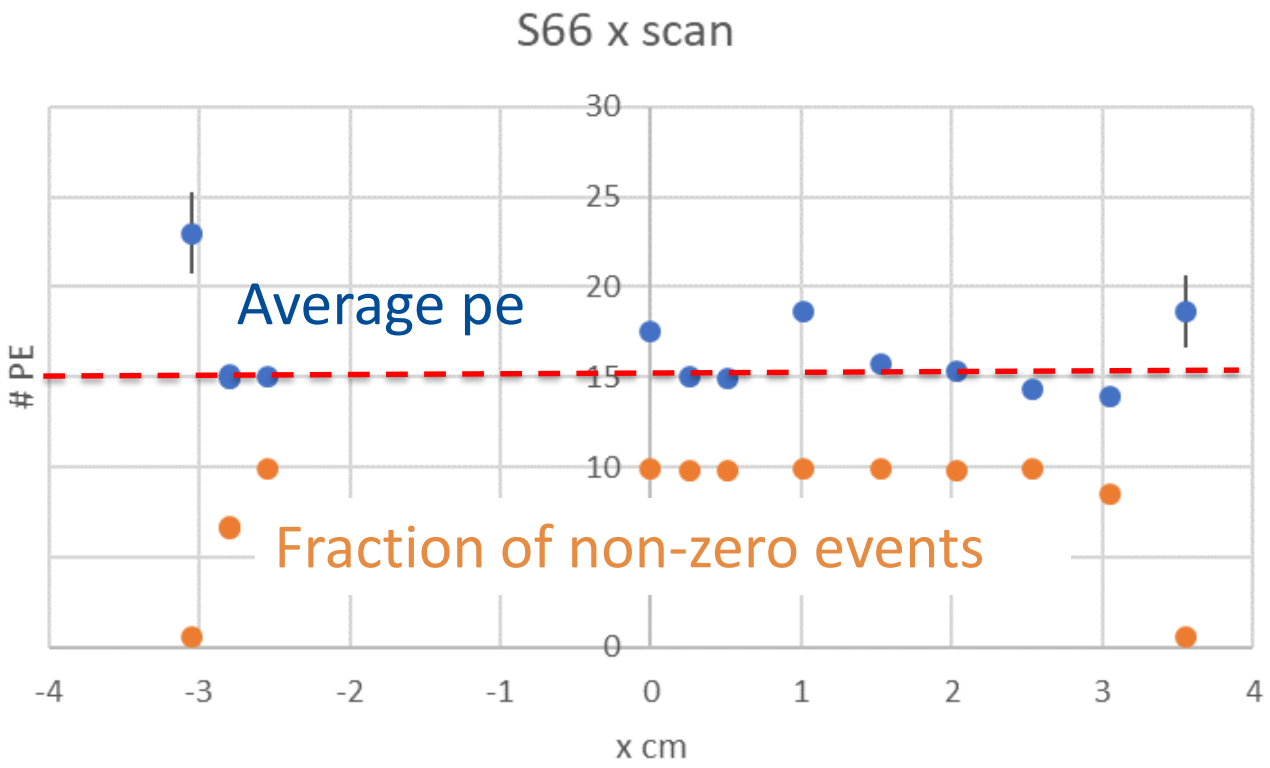
SIPM gain extraction. Measure SIPM gain run-by-run







Sample X scan 6x6 cm tile (~ 2K events/point. 120GeV proton)



Comment on ave pe: PE itself is not in doubt but to compare to other measurement need to correct SIPM PDE for overvoltage and temperature differences. Studies taken, analysis in progress.

Some of the SIPM-on-tile samples tested. Analysis in progress

Scintillator	Thickness (mm)	Size (cm)	SIPM (mm)
SCSN81	3.8	3×3	1.3
SCSN81	3.8	4×4	1.3
SCSN81	3.8	6×6	1.3
EJ200	3	3×3	1.3
EJ260	3	3×3	1.3
SCSN81	3.8	3×3	1.3
SCSN81	3.8	3×3	2.0
SCSN81	7.6	3×3	1.3
NIU Inject Mold	3	3×3	1.3
LS (FNAL polysiloxane)	3.8	3×3	1.3
MgO UV paint coating	3.8	3×3	1.3

~20 configurations, ~ 20 runs/configuration, ~ 2K 120GeV p / run