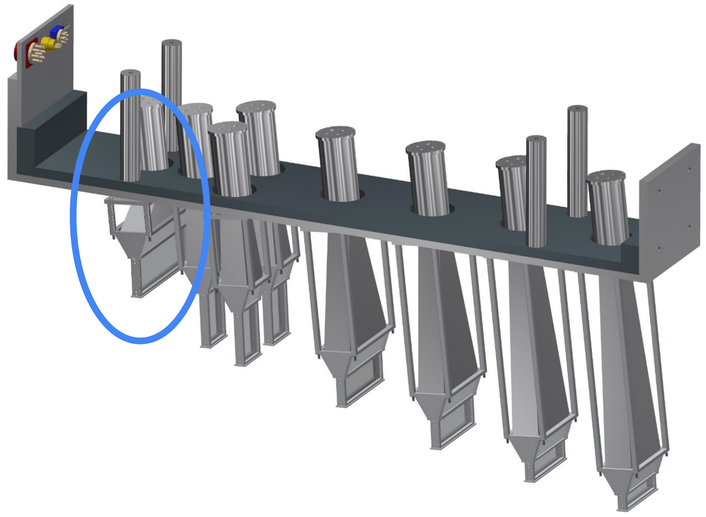
Ring 6 Design Update

Jon Mott, Chandan Ghosh, Tyler Kutz, KK

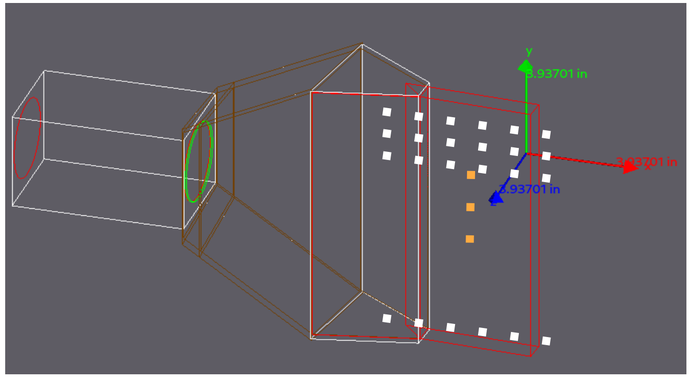


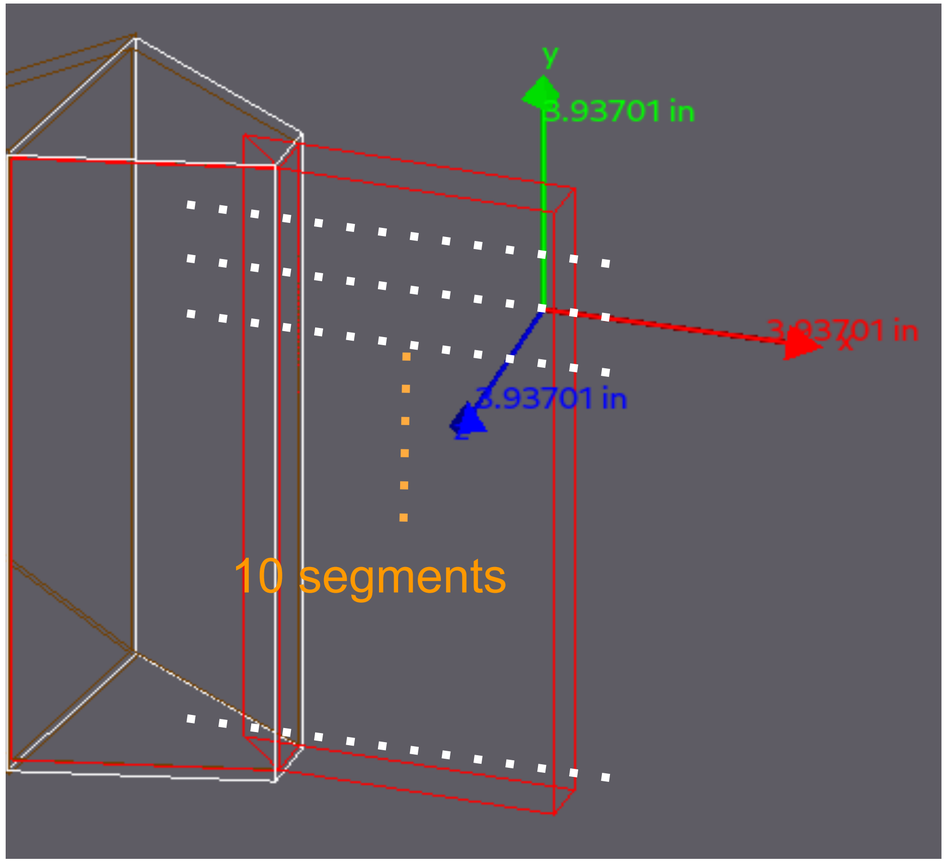
MOLLER Collab. Meeting June 22nd, 2022

Simulations studies of tile position dependence

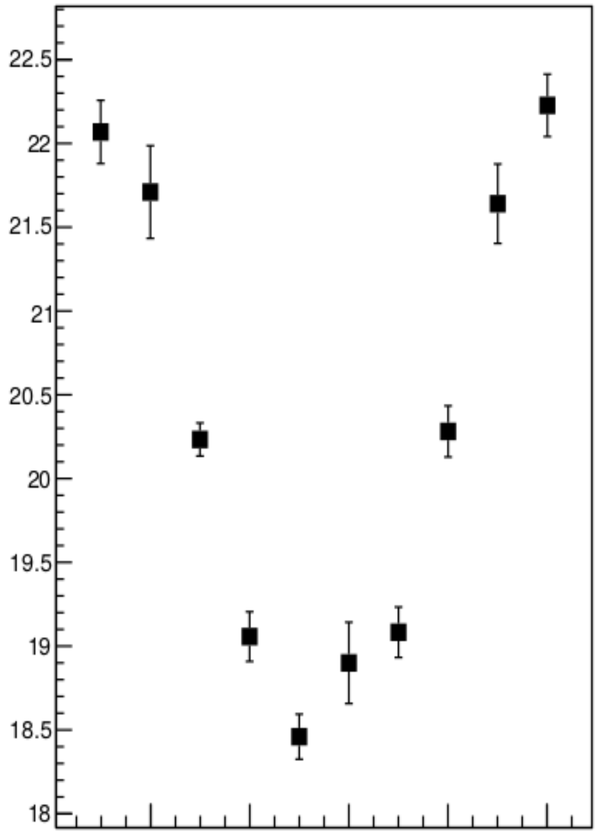
Jon Mott

- The quartz was divided into segments to study the electron hit position dependency
- There was significant variance in the PE yield (~4 PE's) between electrons from the center vs. the edge segments
- We decided to alter the geometry to minimize this variance

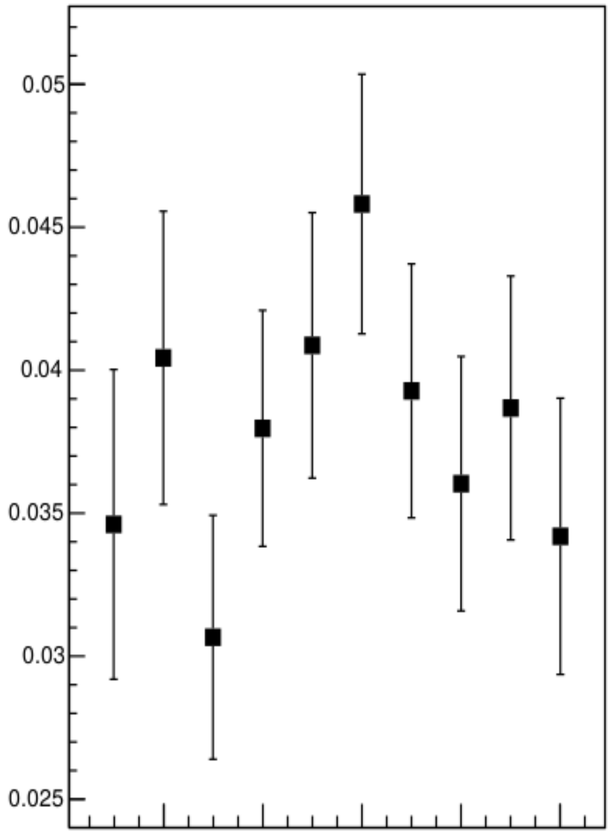




MP per segment



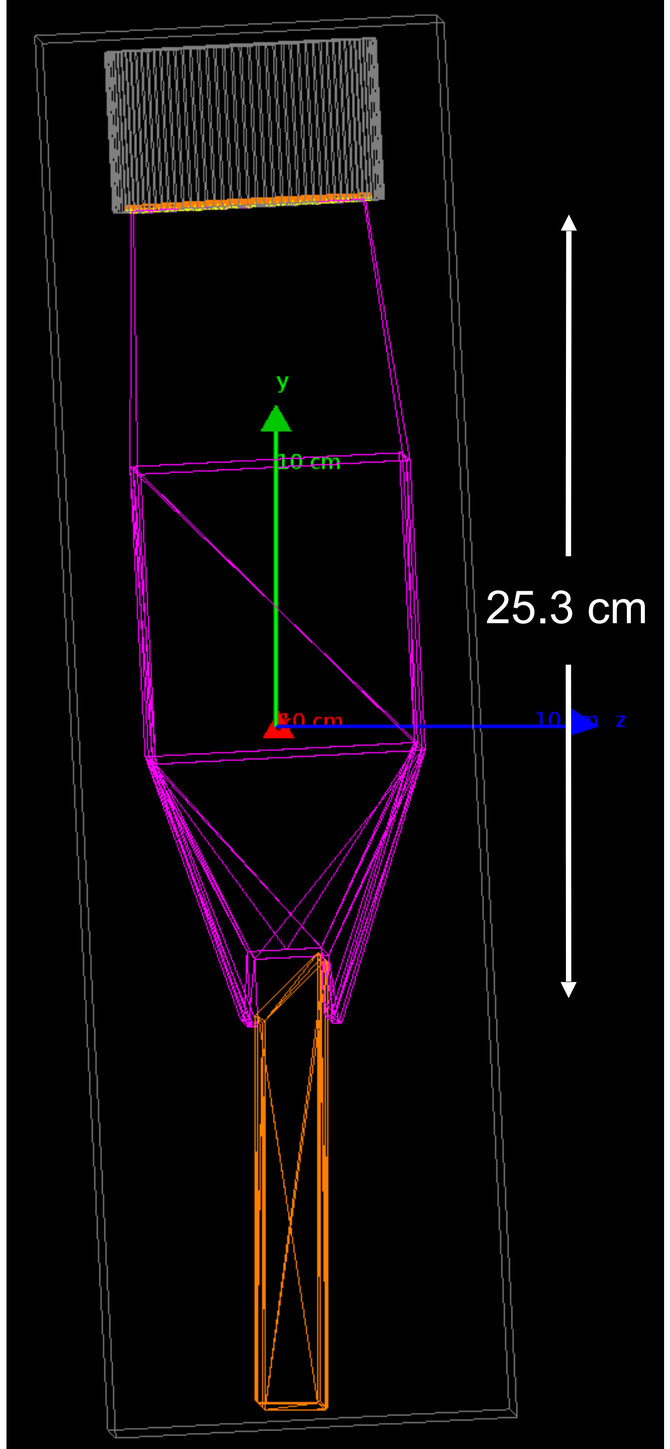
(sigma/MP)^2 vs. Cut



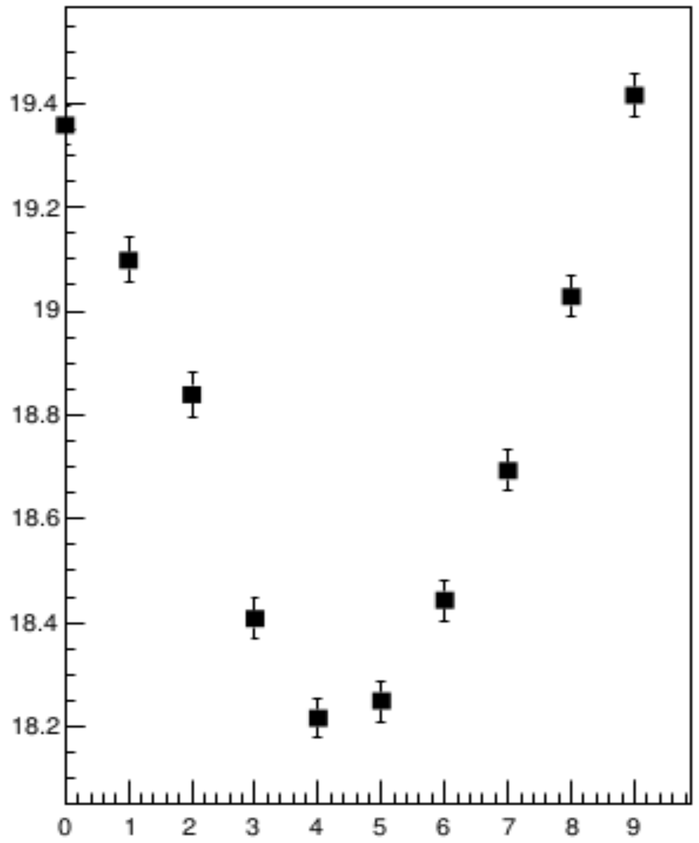
New R6 Geometry

Jon Mott

- A 9 cm straight section was added between the cones
- After optimization, this minimized the variance to ~1.2 PEs
- However, this also decreased the average PE yield of the detector from 20.3 to 18.9



MP per segment



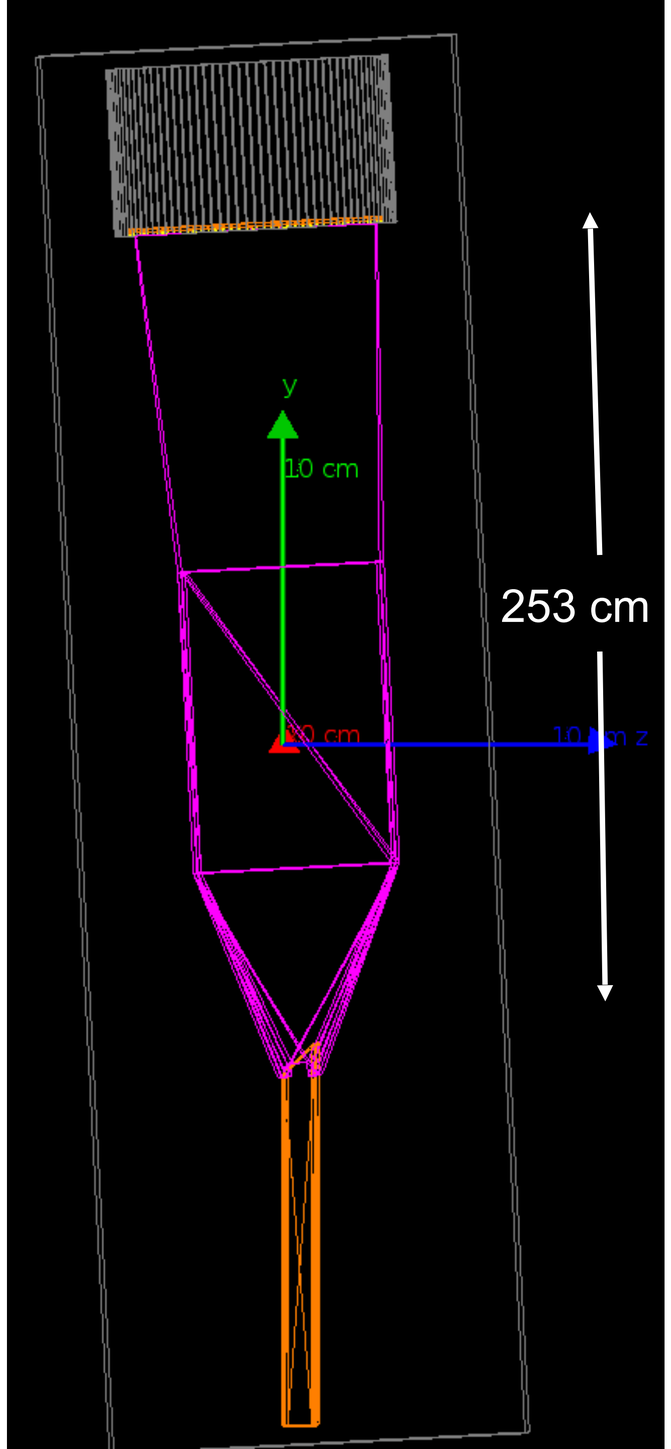
Cosmic Test Geometry

Jon Mott, Chandan Ghosh

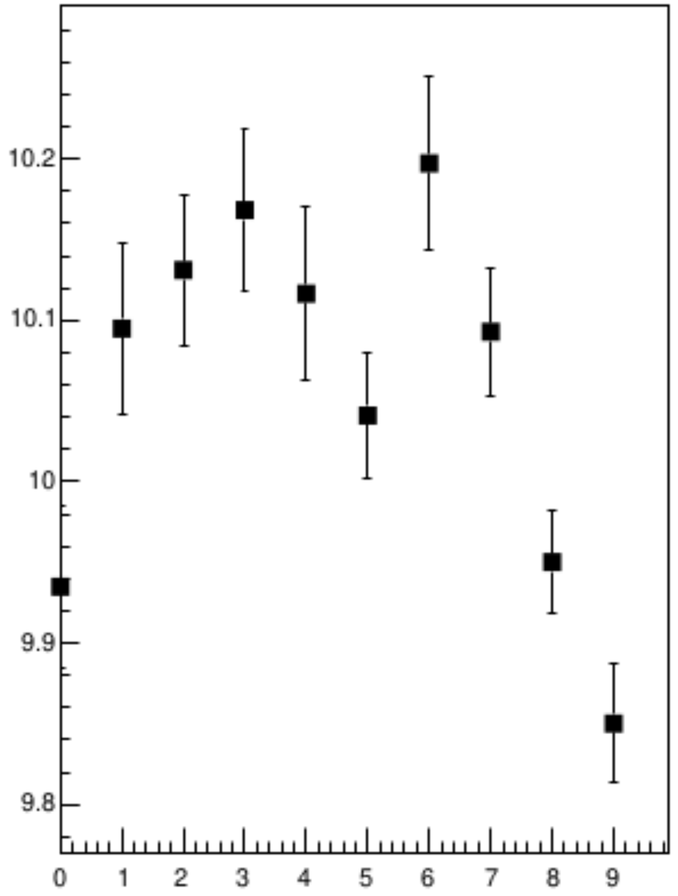
- Since we were limited by the quartz available to us (1 cm thick instead of 2 cm), we designed a second detector for cosmic tests with a PE yield of ~10

- The offsets between the LG and quartz (located where they intersect) were removed for ease of buildability

- A simple version was designed with foam board and mylar film to test the design



MP per segment

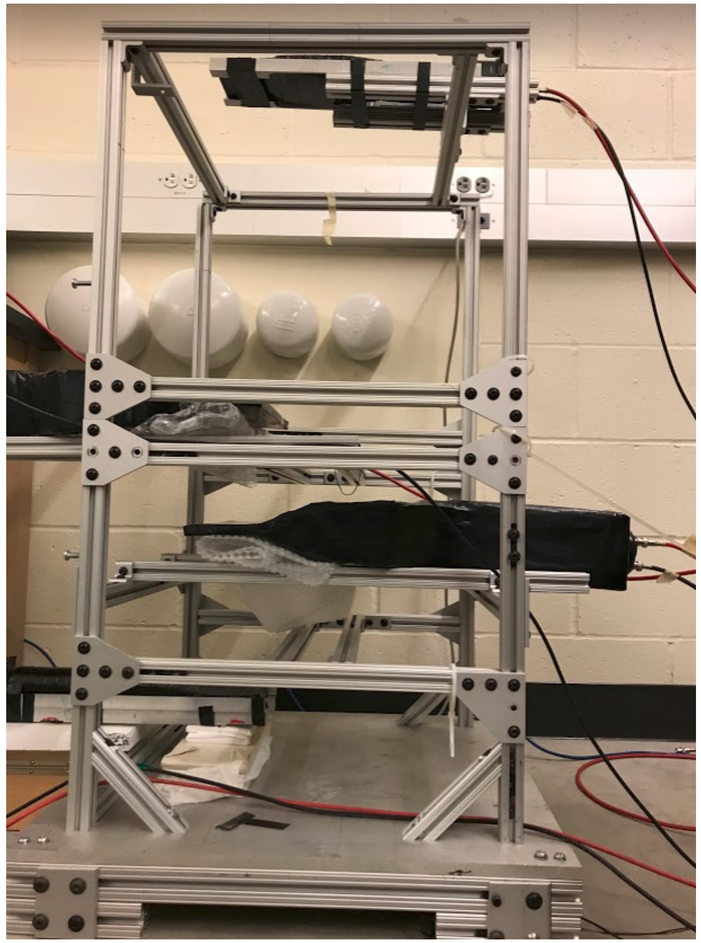


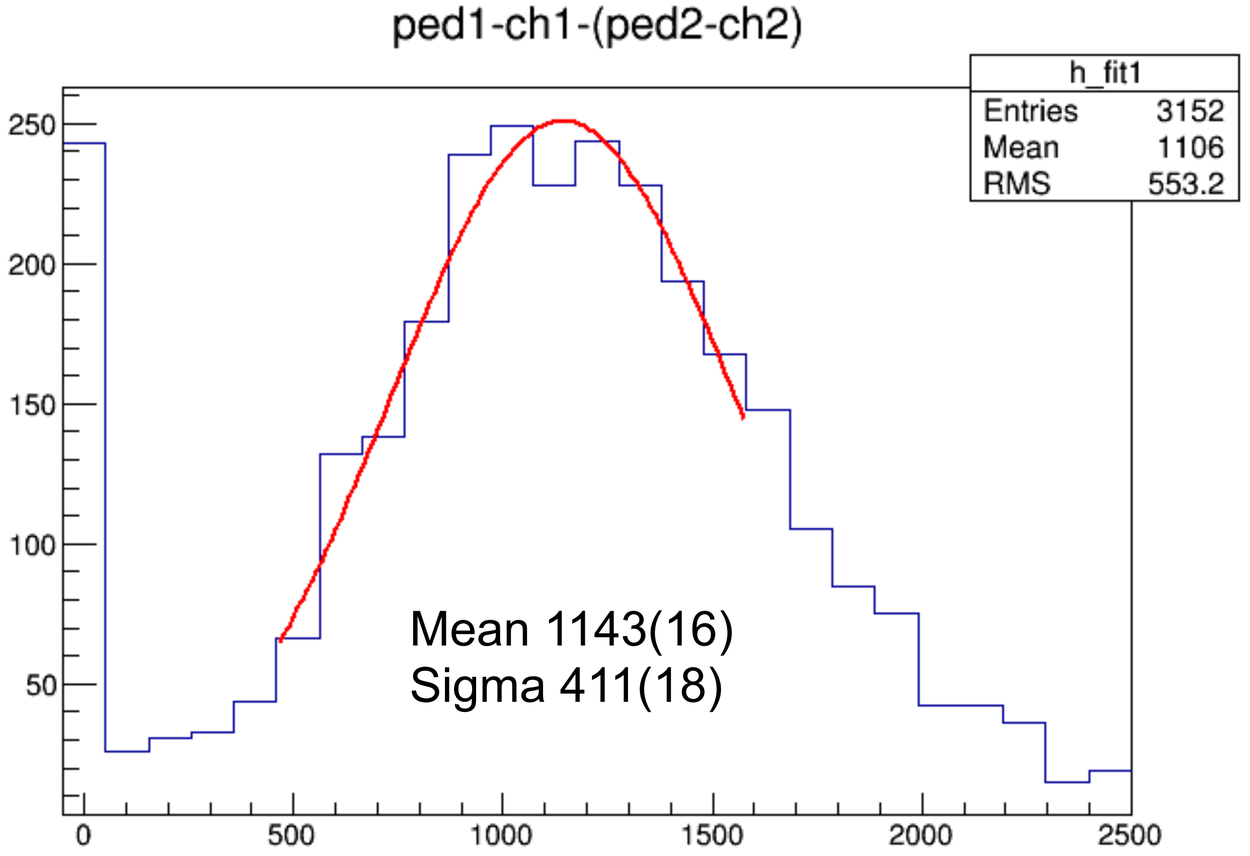
Performing the cosmic test

Jon Mott, Chandan Ghosh

Our cosmic tests predicted a PE yield of ~10

This was tested using two copies of the detector and multiple PMT’s





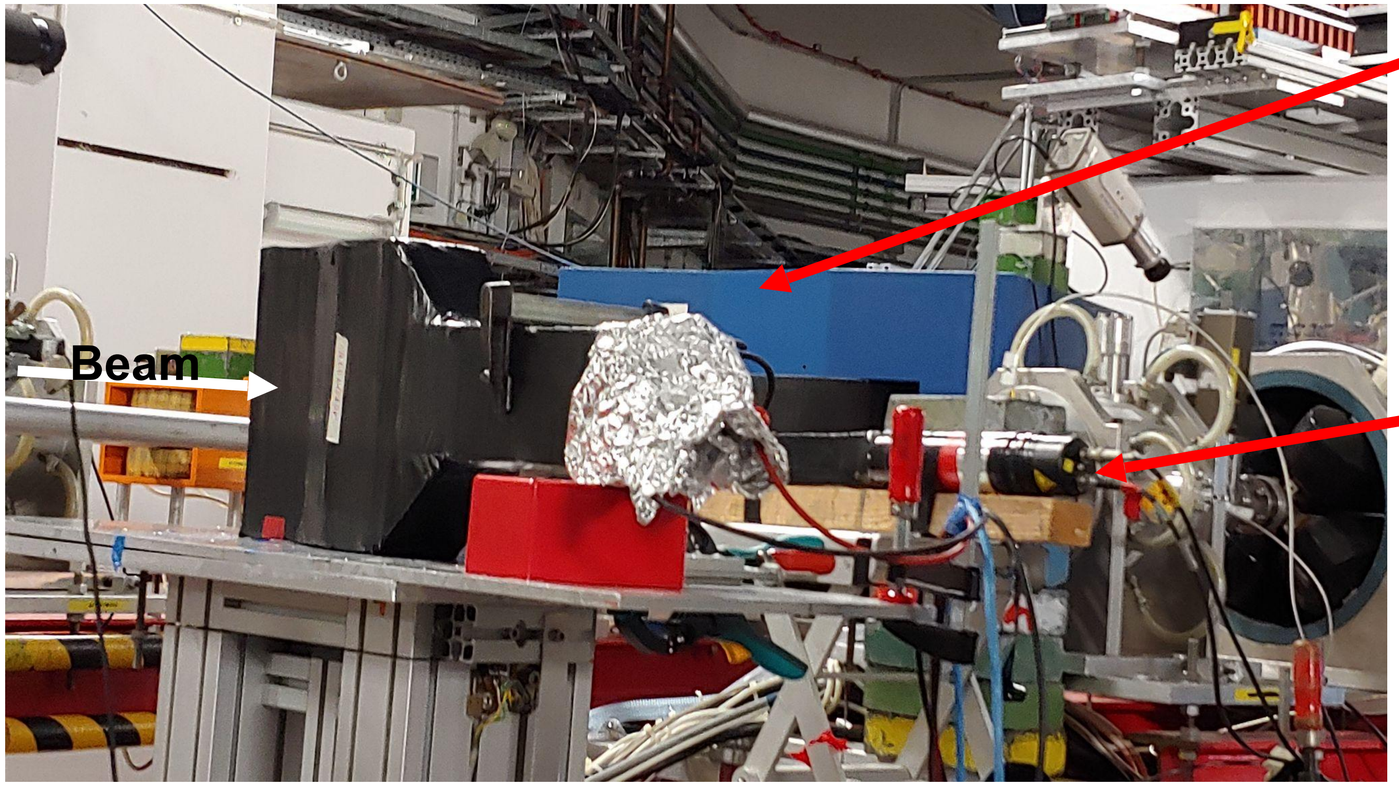
Mainz Beam Test: Detector Setup

Jon Mott, Tyler Kutz

Mainz Beam Test

Jon Mott, Tyler Kutz, Michael Gericke, Brynne Blaikie
Malte Wilfert, Boris Glaser, Rahima Krini, Tobias Rimke, Sebastian Baunack

- The focus of our tests was to determine the average PE yield of the detector as well as RMS
- Pulse-height data collected at various positions on the tile (scanning horizontally and vertically)
- Measurements were performed using two copies of our R6 model, multiple PMT, base and signal amplifier combinations, with various grid patterns



Upstream view of the detector. Foil was used to block out electronic interference

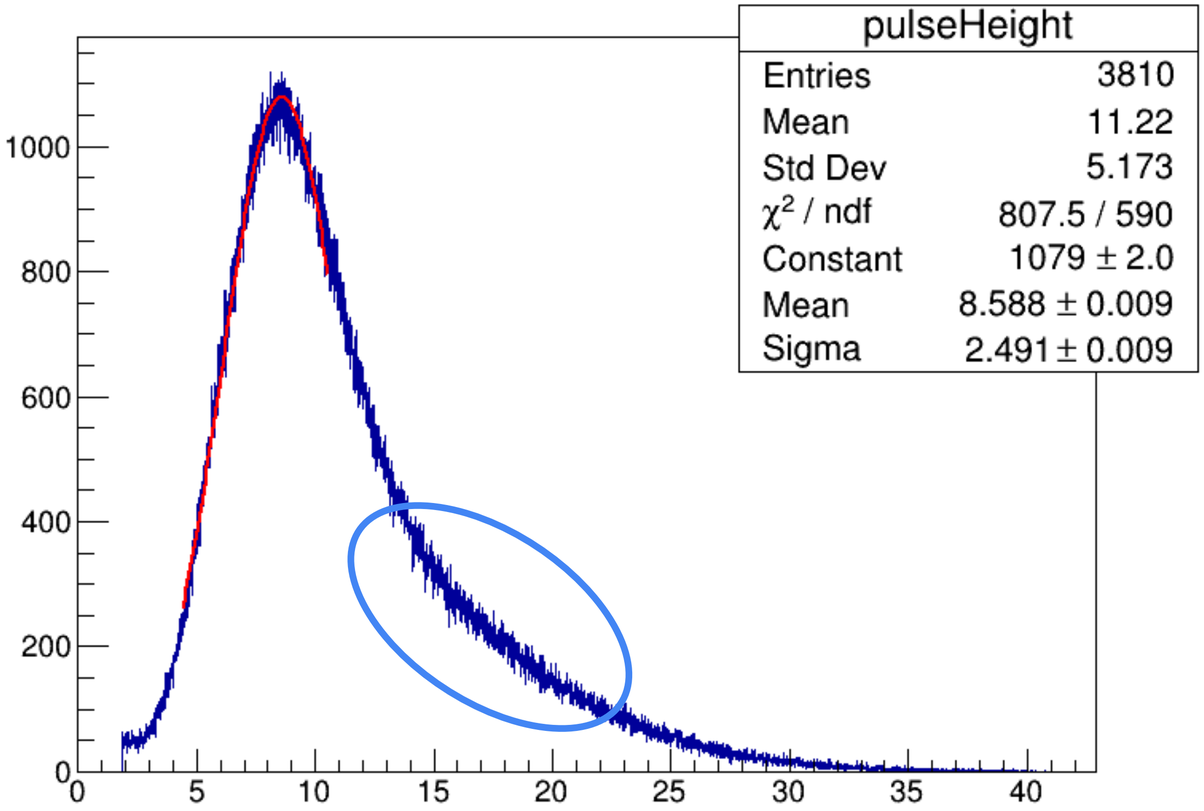
Scintillator provided by Mainz group to track coincidences

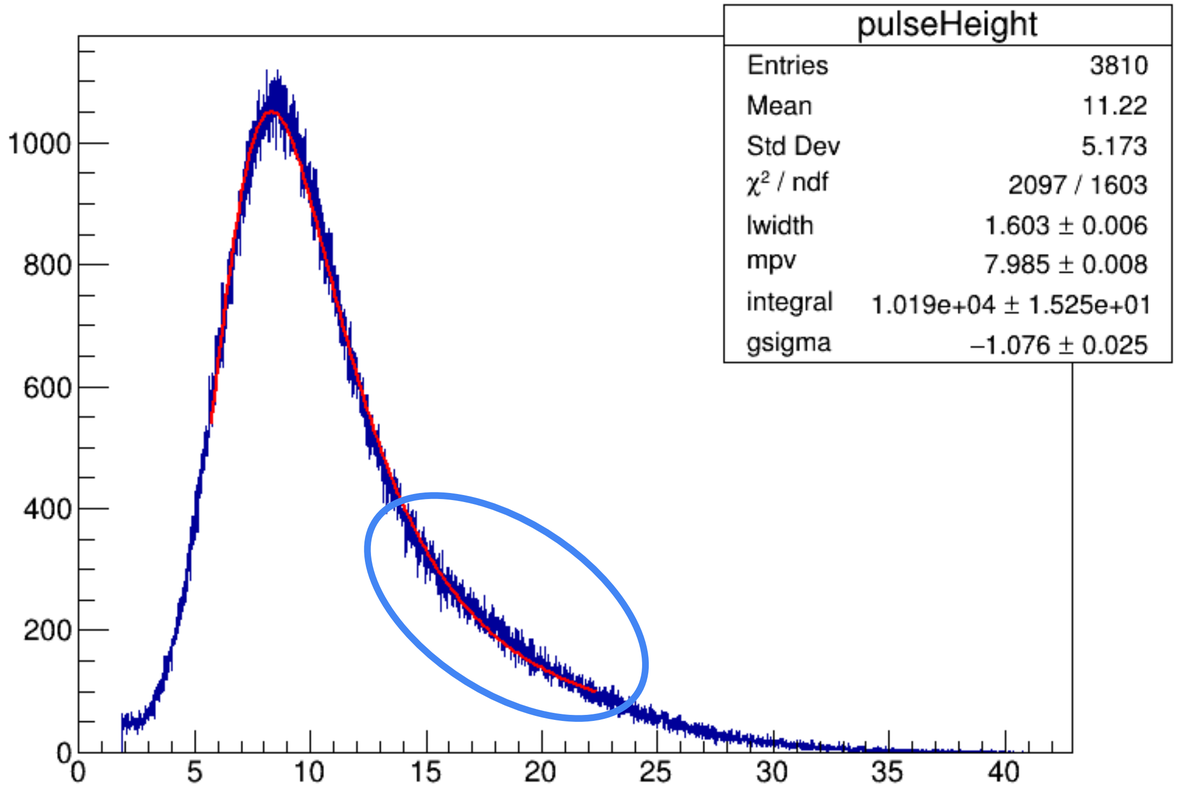
Pulse height data example

Both a gaussian fit and langau fit of the data are shown below.

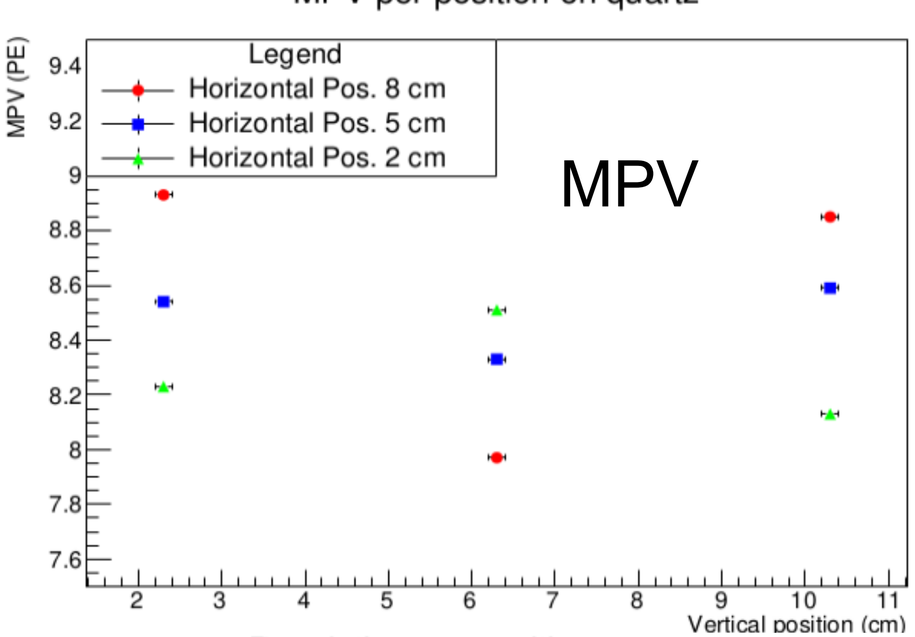
The langau fit has an unusually large tail, this is not expected given the thin window and the thickness of the tile. A special run with scintillator ADC data showed that there is a small amount of 2- and 3- electron events, which are likely biasing the Landau tail; more studies will be carried out with the full data set over the summer

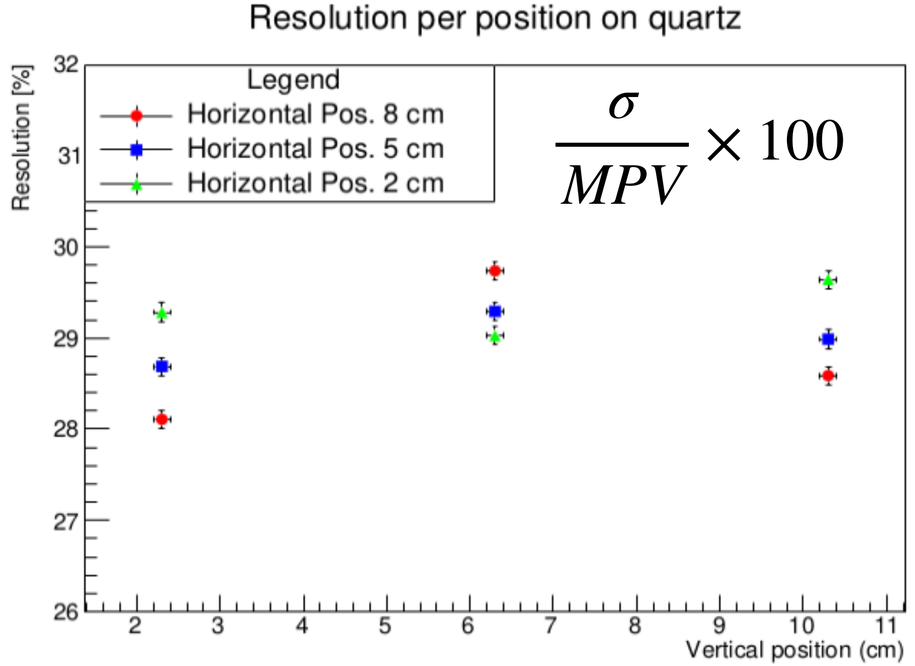
The plots are from one point on a 3x3 grid of positions on the tile. The results are summarized in the next slide



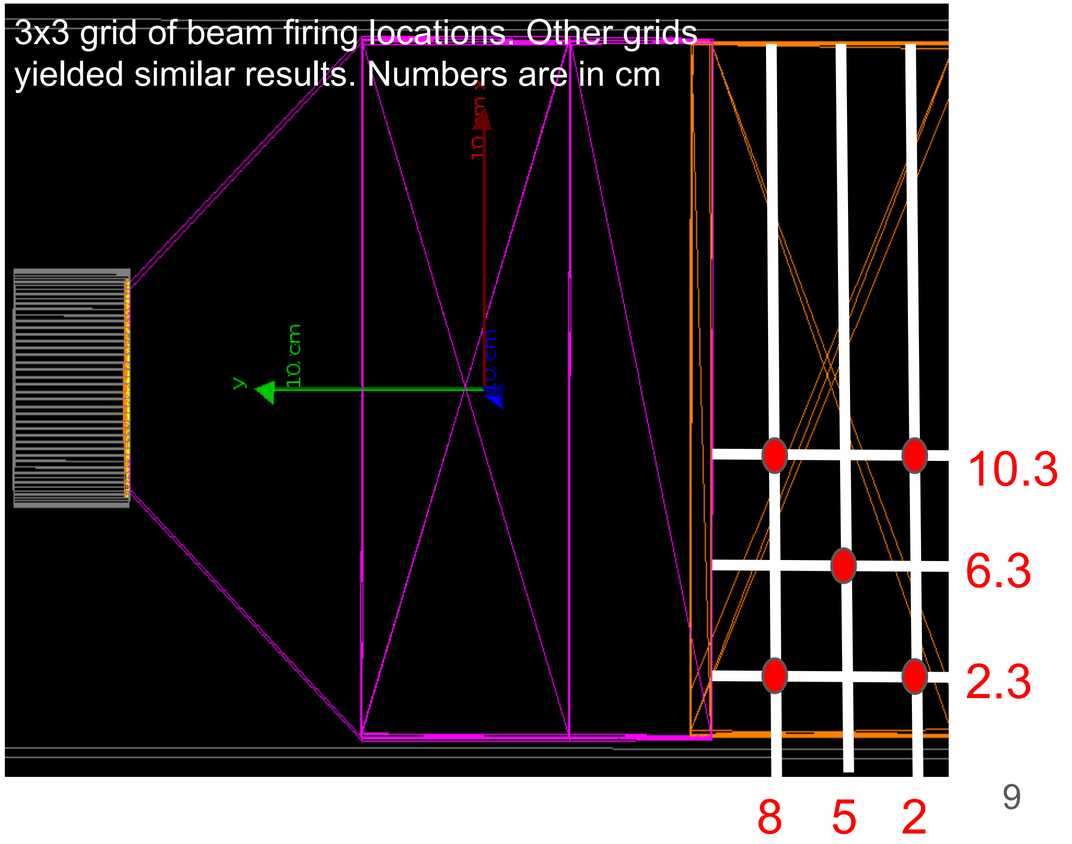


Beam Test Results





- Using a 3x3 grid, we observe that the p.e. yield is ~ 8 to 9, roughly in line with the expectation of 10.
- The resolution of 29% would point to a p.e. yield more in line with 10, possibly the gain calibration is off by 10%
- We do not yet have a reliable RMS/mean measurement but we might be able to infer it after more detailed analysis



Summary and Next Steps

- We have validated the basic ring 6 geometry, with a p.e. yield in agreement with expectations
- The position dependence of the tile response is significantly less than 1 p.e. for a 1 cm tile (with 10 p.e. yield)
- We were unable to get a simple RMS/mean estimate yet
- We believe that we have enough information to optimize our final ring 6 tile thickness; will likely choose a thickness between 2 and 2.5 cm.
- The goal is to achieve an RMS/mean of less than 0.3, resulting in excess noise of ~ 5%, which is sufficient given the ring 6 requirements
- We can now proceed with a full mechanical design of ring 6 and build a prototype with similar characteristics to the nearly final ring 5 mechanical design
- Our goal at UMass is to build a prototype segment structure that can hold all 6 ring prototypes with couplings to the holding structure as similar as possible to the main detector structure design