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Sciences*

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Characterization and test beam results of novel triple-GEM readout structures

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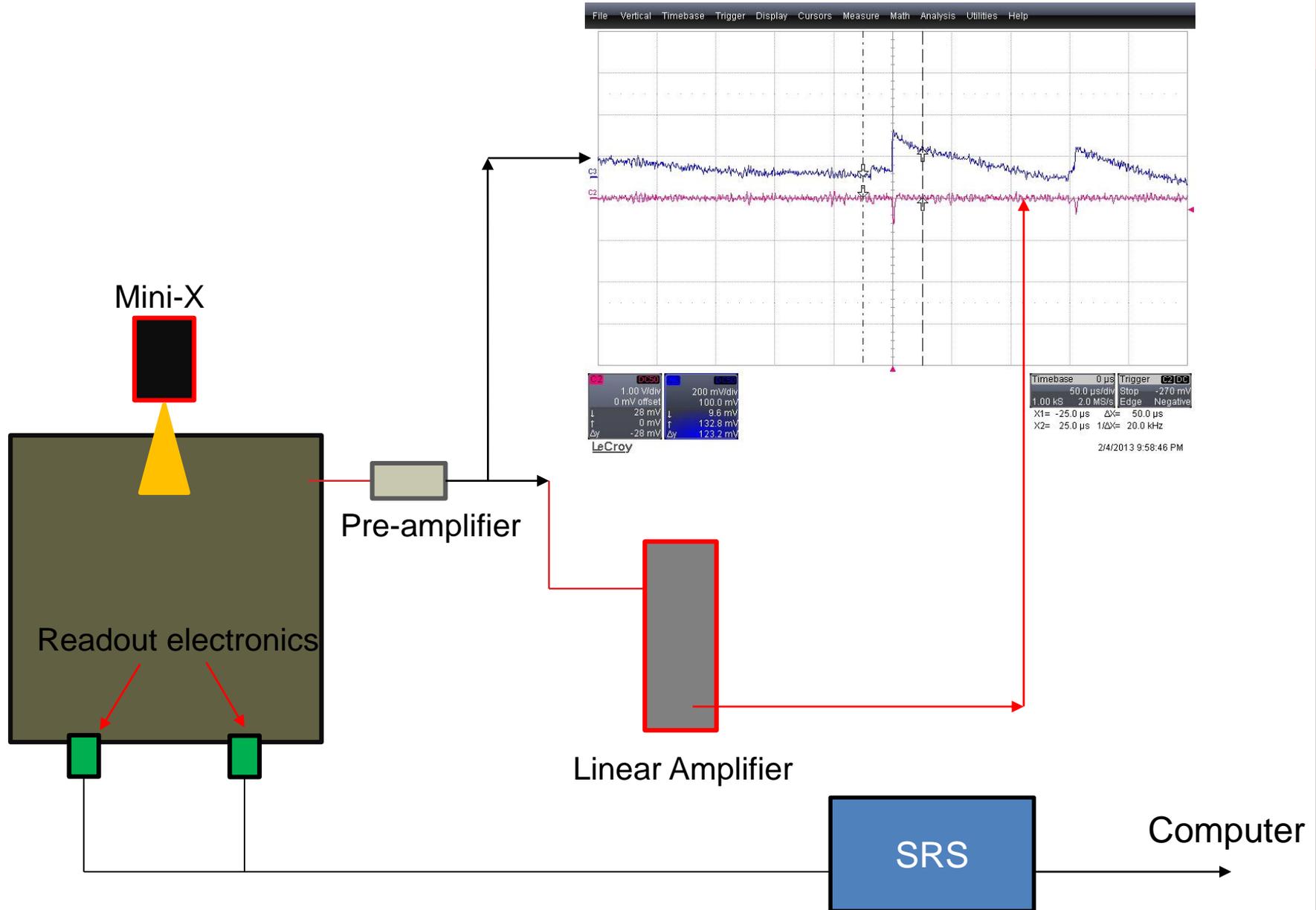
Florida Institute of Technology
Melbourne, FL

Motivations

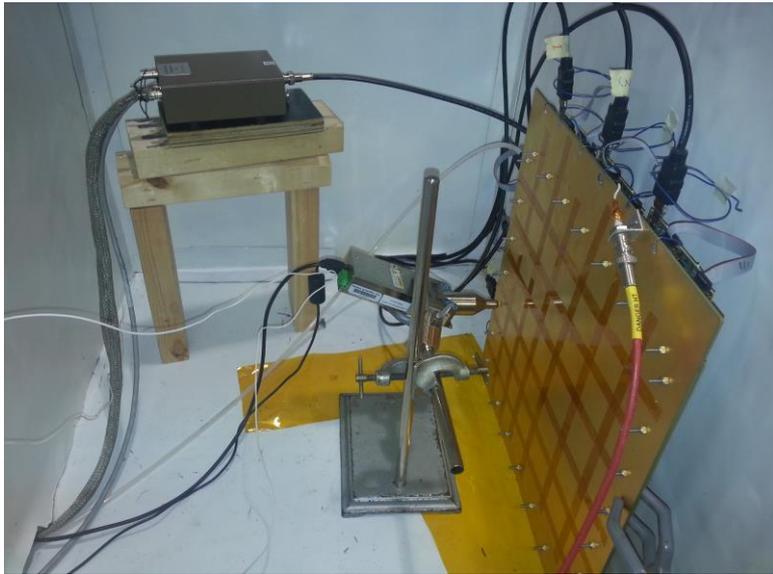
Characterization

- Before our detectors were transported to and tested at Fermilab National Accelerator Laboratory we wanted to understand their individual responses to irradiation.
- This testing process also gave us an ideal situation within which to test the limits of our Data Acquisition system and online monitoring abilities.

Self-Triggered DAQ

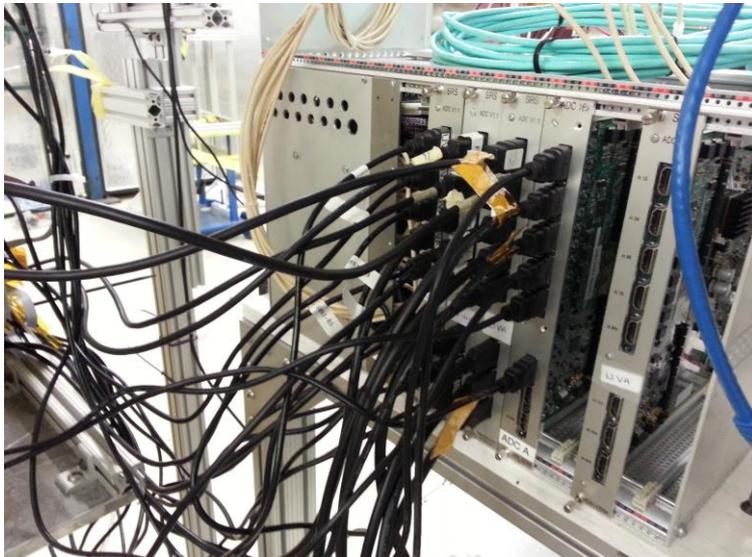


Self-Triggered DAQ

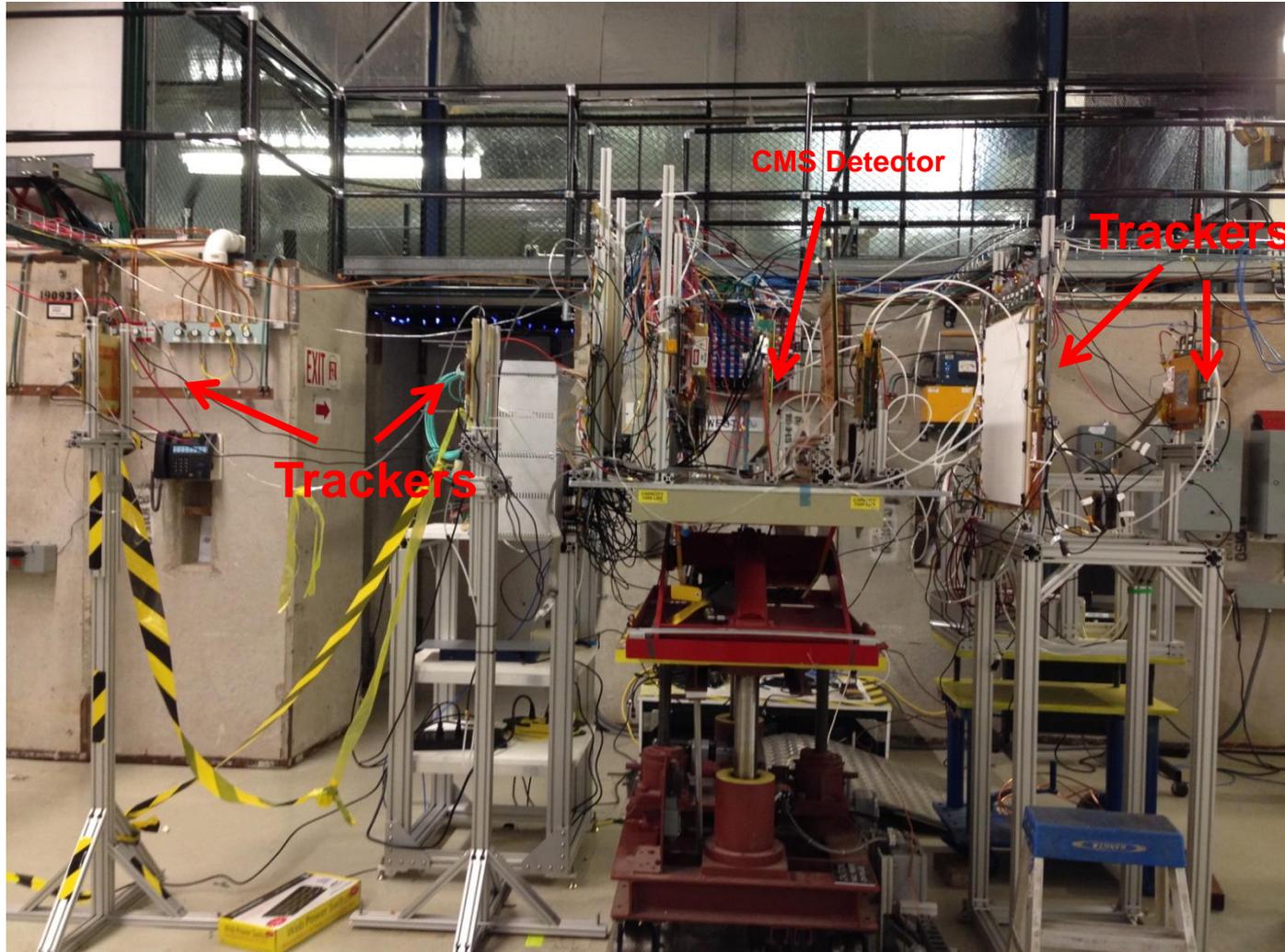


Use of an Amptek portable X-ray source allows us to irradiate selectively.

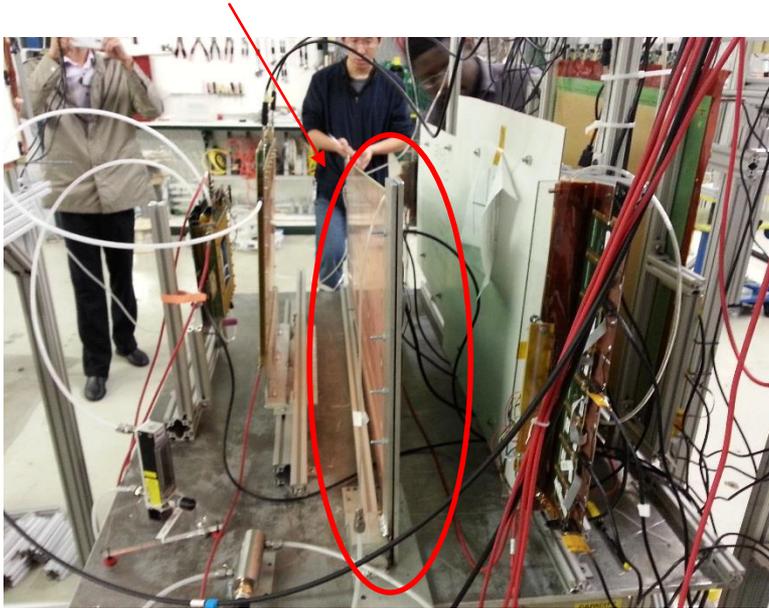
For situations where we wish to study gain uniformity, the source may be positioned several centimeters away from the surface of the detector to allow a cone of radiation roughly uniform in a 30 degree cone.



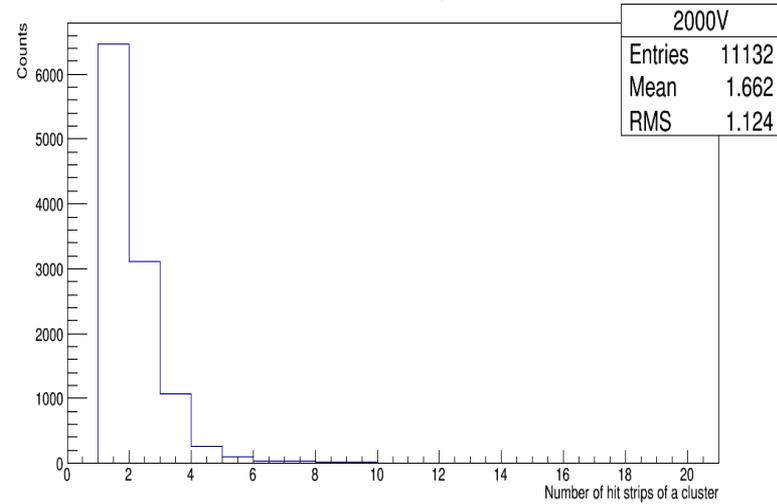
The Beam Line



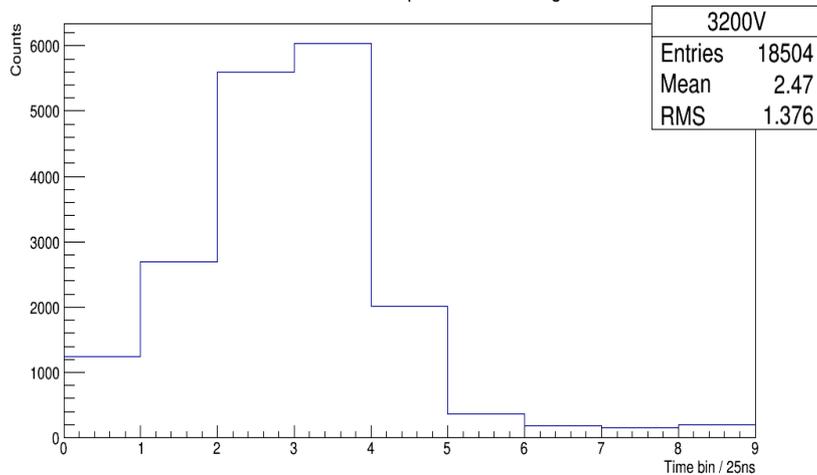
Beam Line Operation



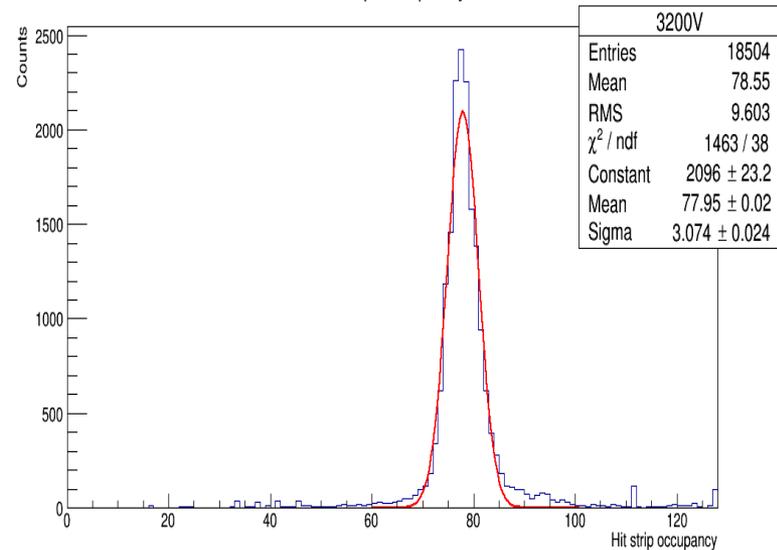
Number of hit strips of a cluster



Time bin of peak cluster charge



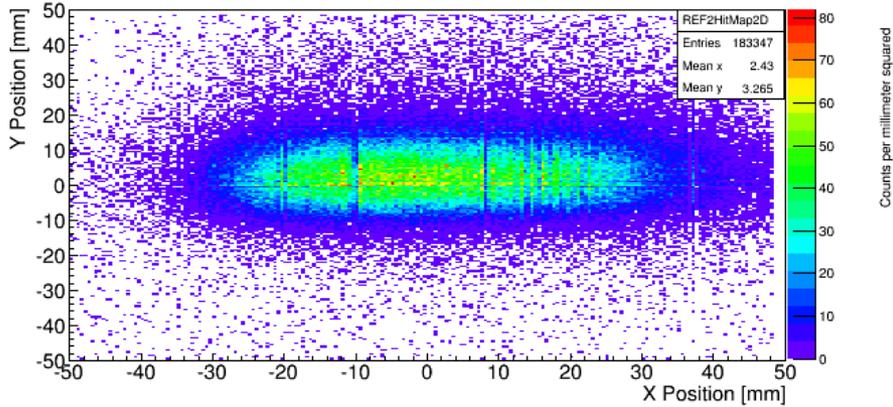
Hit strip occupancy



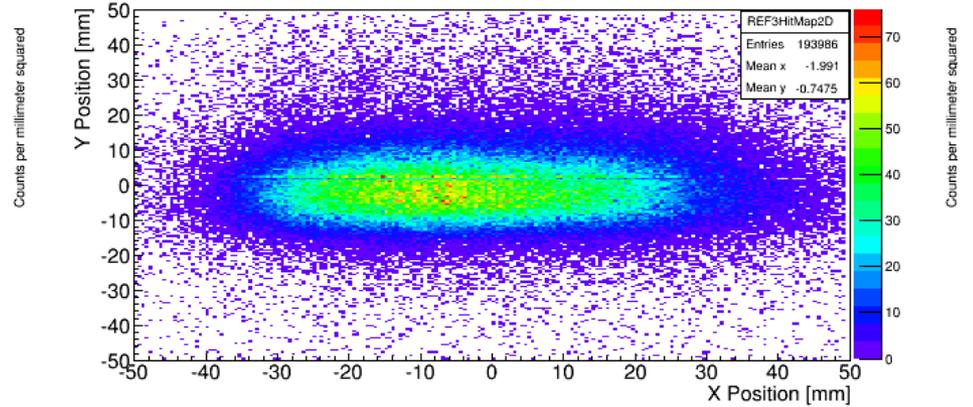
Beam Line Operation

20 GeV Beam

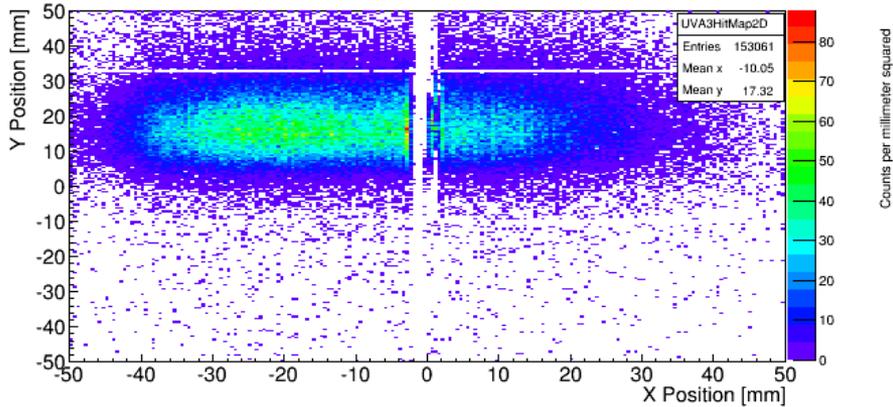
Hit map of UVA 10cm reference



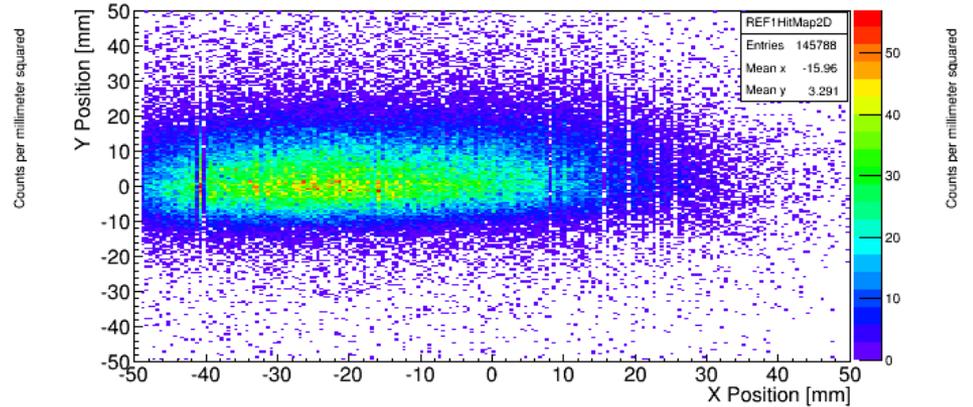
Hit map of UVA 10cm reference



Hit map of UVA 50cm reference



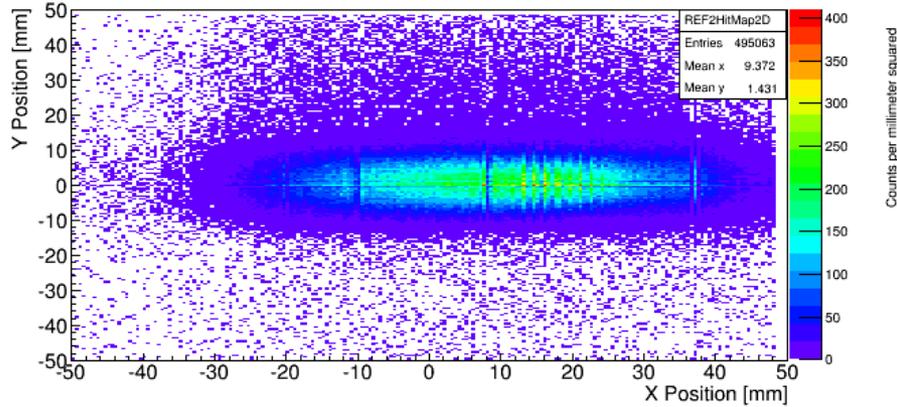
Hit map of FIT 10cm reference



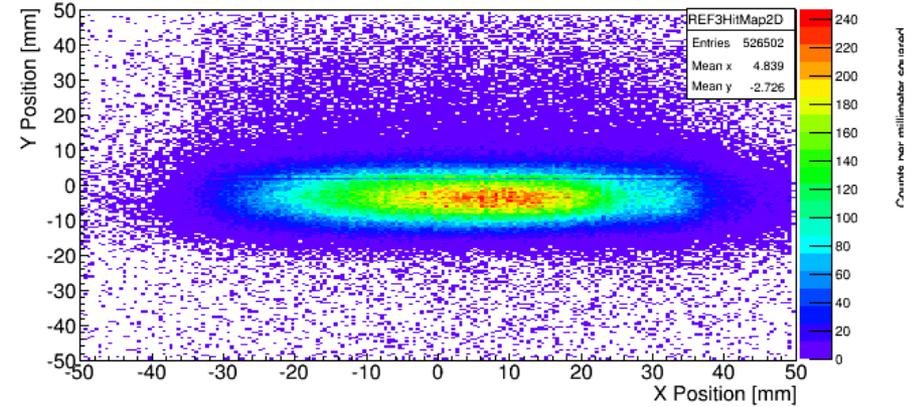
Beam Line Operation

32 GeV Beam

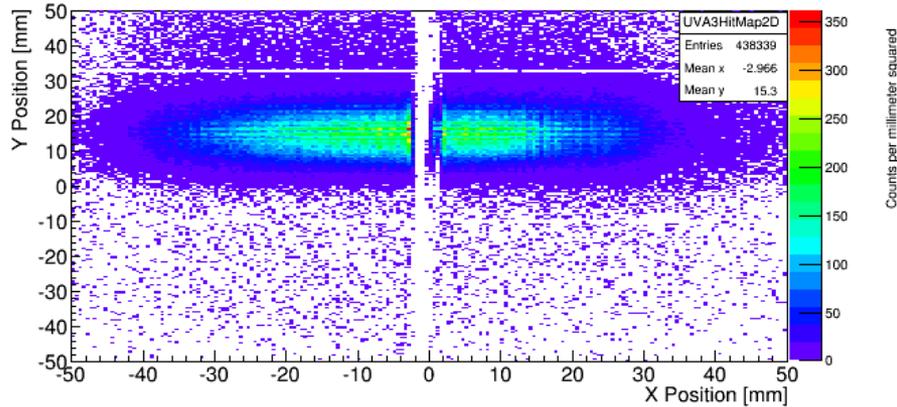
Hit map of UVA 10cm reference



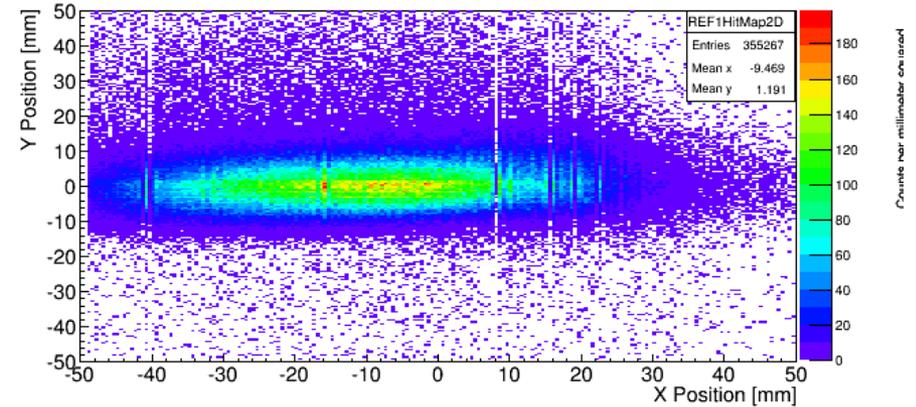
Hit map of UVA 10cm reference



Hit map of UVA 50cm reference



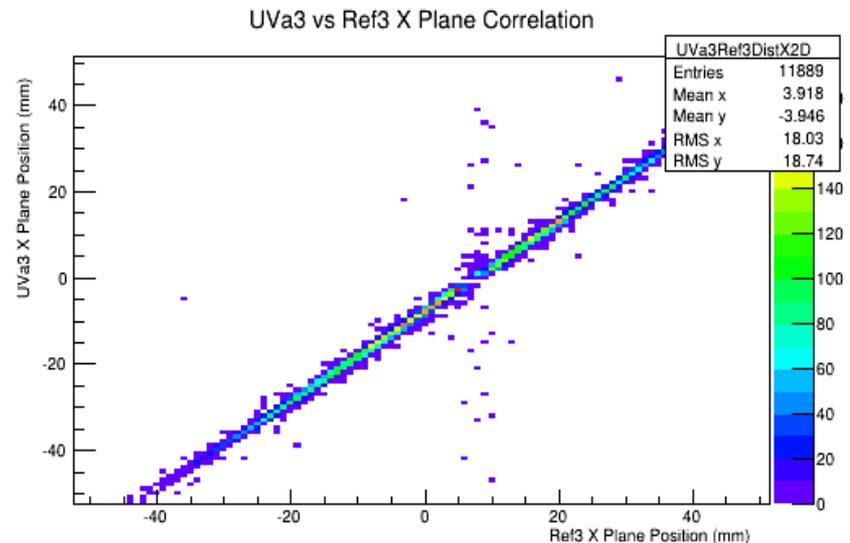
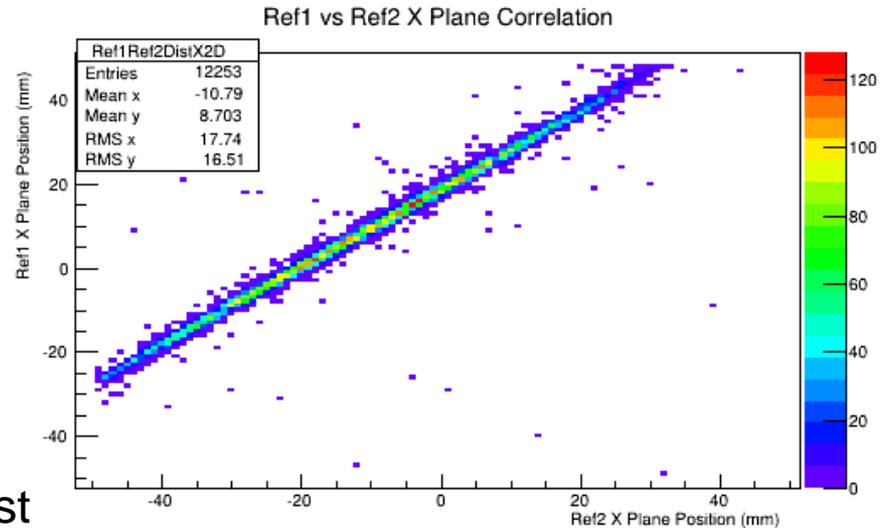
Hit map of FIT 10cm reference



Detector Misalignment

Before the implementation of fine alignment methods, the positions for corresponding events were plotted against each other.

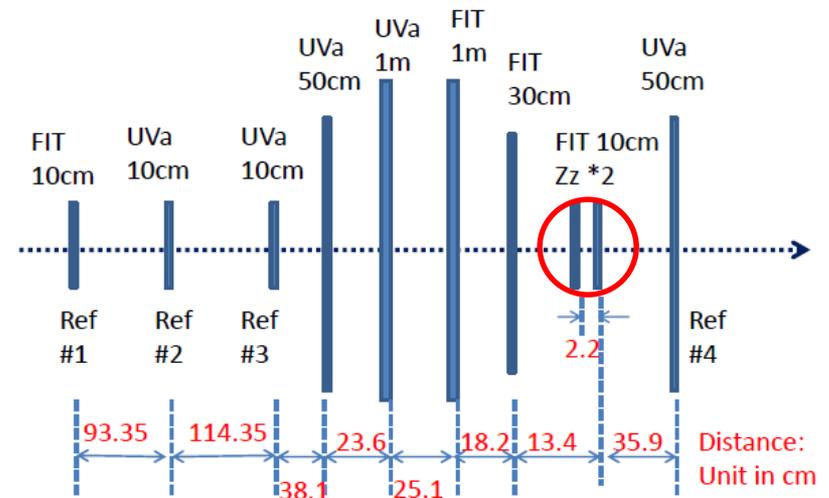
From these plots we can spot the shifts between detector planes.



Spatial Resolution

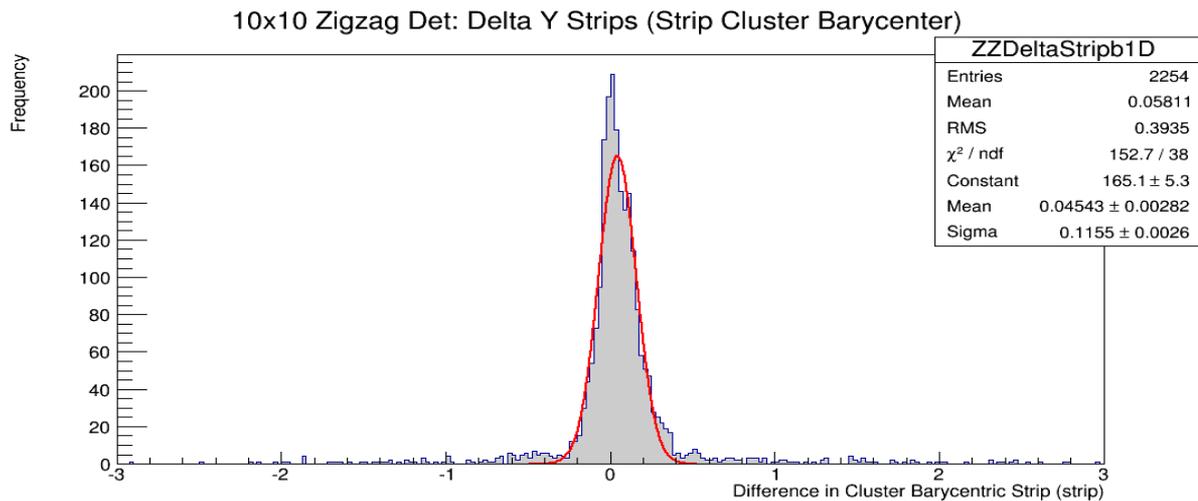
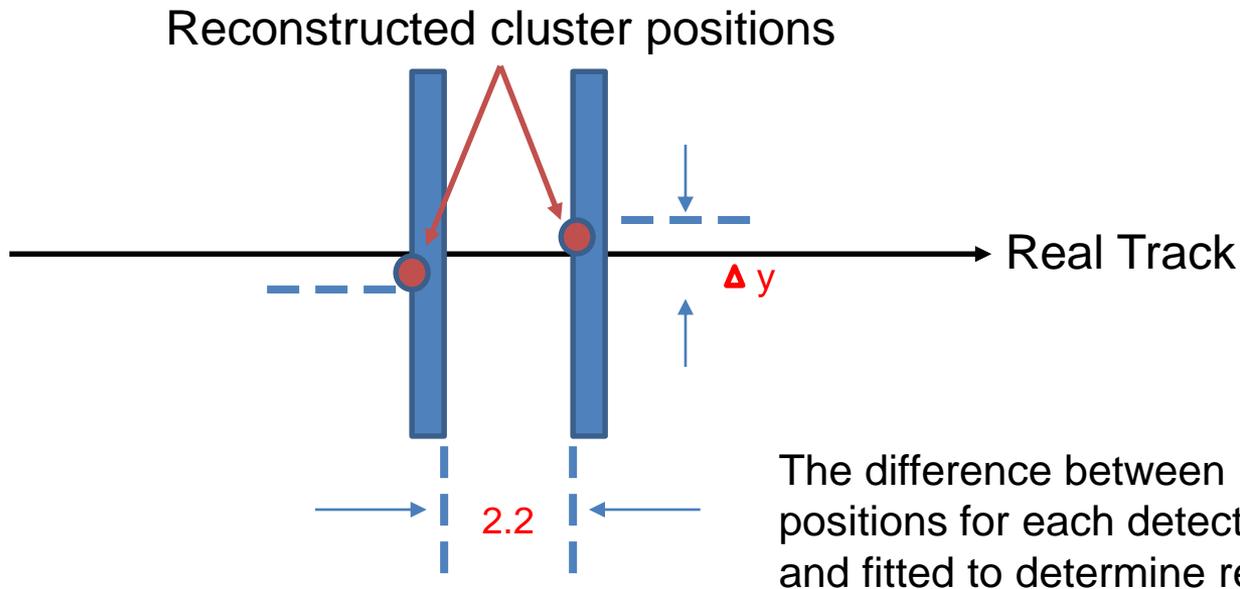


Before the implementation of track building into our data analysis the easiest way to calculate the resolution of our zigzag readout structures was to calculate the difference in returned position for our most closely spaced detectors



Detectors Arrangement at FNAL by FIT and U.Va

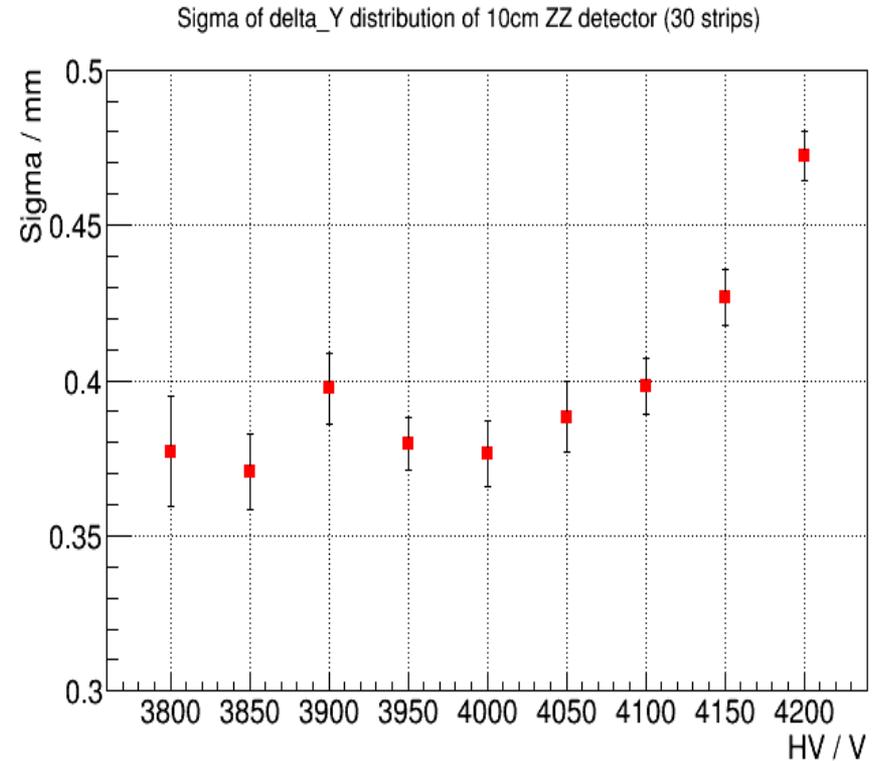
Delta-Y Calculation



Measured Resolution

As expected we see a decrease in spatial resolution with increasing detector high voltage.

In order to define a proper operating voltage for this readout structure we must find a balance between detector efficiency and spatial resolution



Conclusions

- All detectors, electronic systems, and readout designs performed successfully under commissioning at FIT.
- Initial results from our test beam studies show that all detectors are operating as expected, even with novel readout designs.
- Construction and testing for large-scale manufacturing of GE1/1 prototypes can commence with similar techniques.