GEM based TRD R&D Progress report - July 22, 2014

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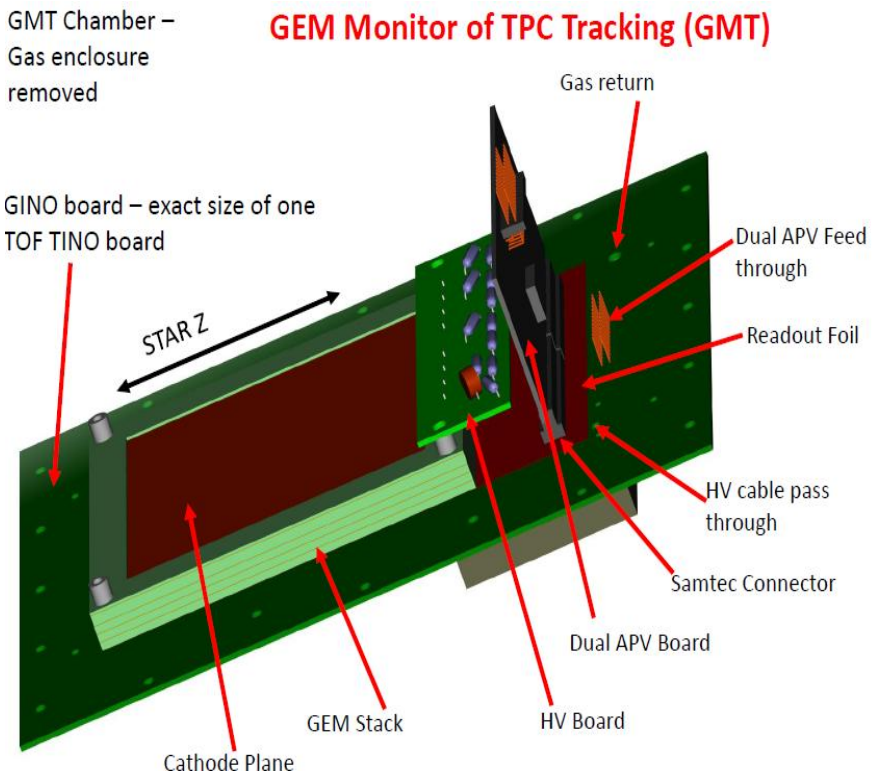
Outline

- GMT in STAR
- Large-size GEM/THGEM R&D (USTC)
- NIM A paper preparation
- Future plan

GMT

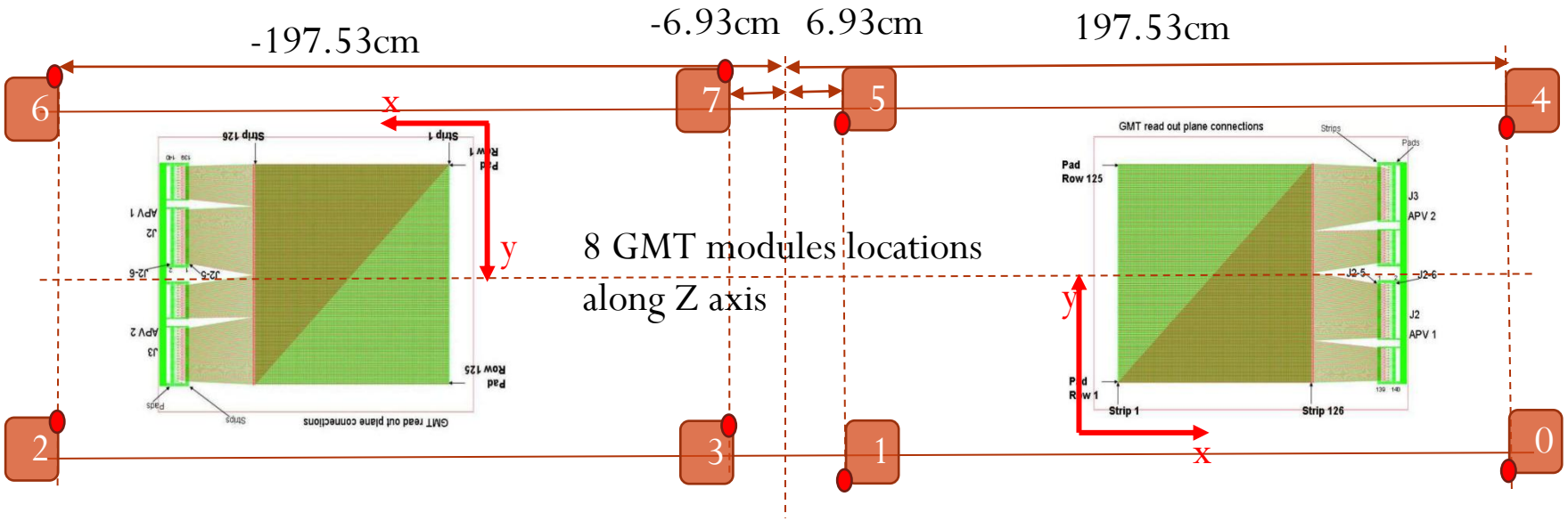
- GMT - GEM chambers to Monitor the TPC Tracking
  - TPC Calibration monitor
  - GEM tracker in STAR physics run
  - TPC+GEM tracking study (similar material as TPC endcap, after TPC electronics upgrade)

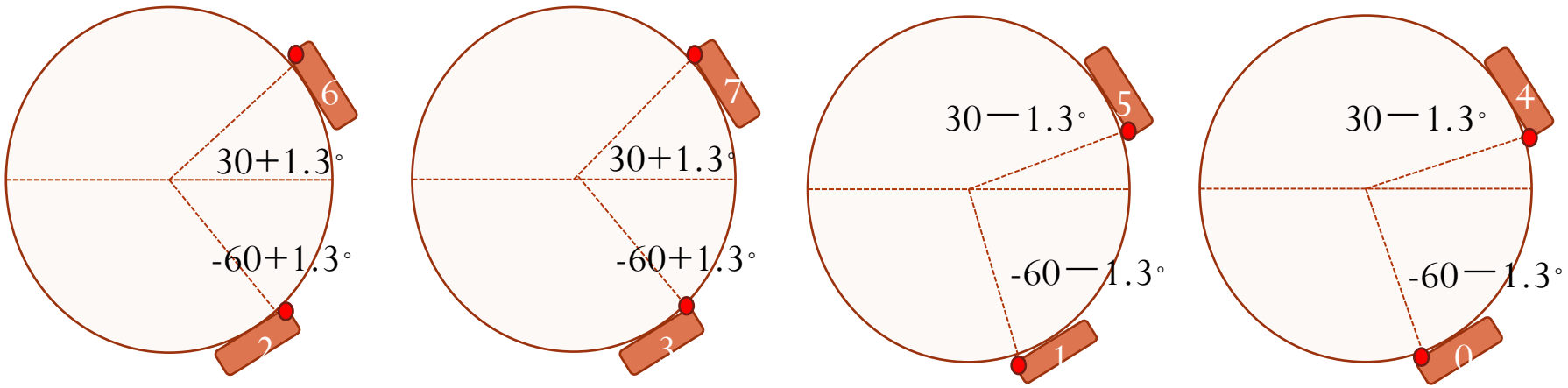


GMT modules inserted into the TOF trays at the TRD lab before installation in STAR (run 2014)

10*10 cm2 active area
Readout in x-y 2D direction
0.8mm pitch
128*2 FEE (APV) channel per GMT

GMT Global Position in STAR



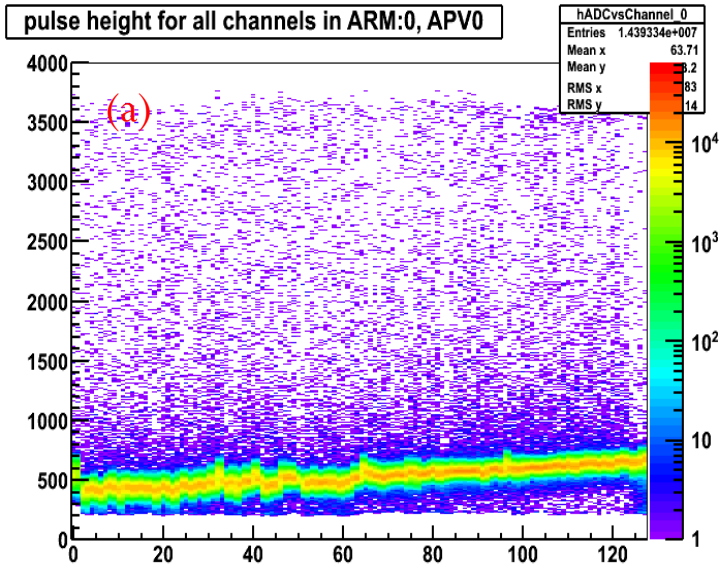


8 GMT modules locations in x-y plane

GMT Software in STAR

- Add GMT class in StEvent, StMuDSTMaker, StBFChain
- Build GMT Lib:
  - StGmtRawMaker/ deal with raw data from DAQ
  - StGmtClusterMaker/ get hit clusters and weighted position
  - StGmtMatchMaker/ TPC-GMT track-hit matching
  - StGmtUtil/ GMT related utility classes

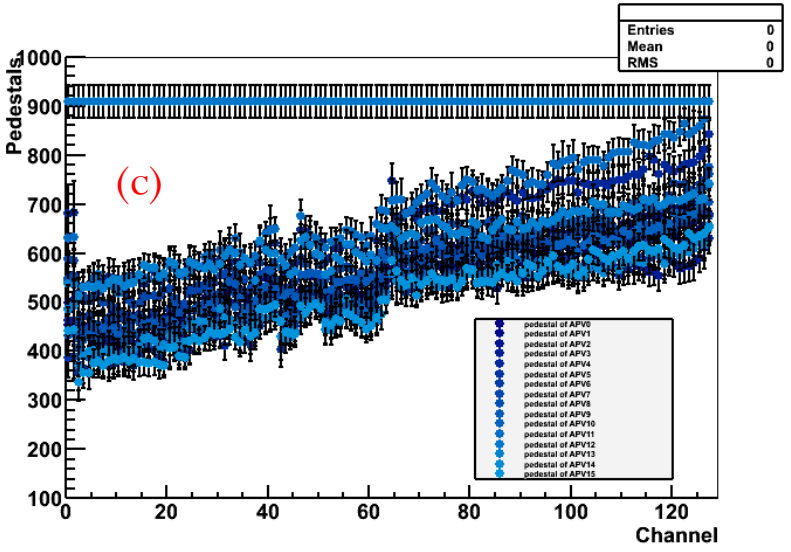
GEM Pedestal per Channel



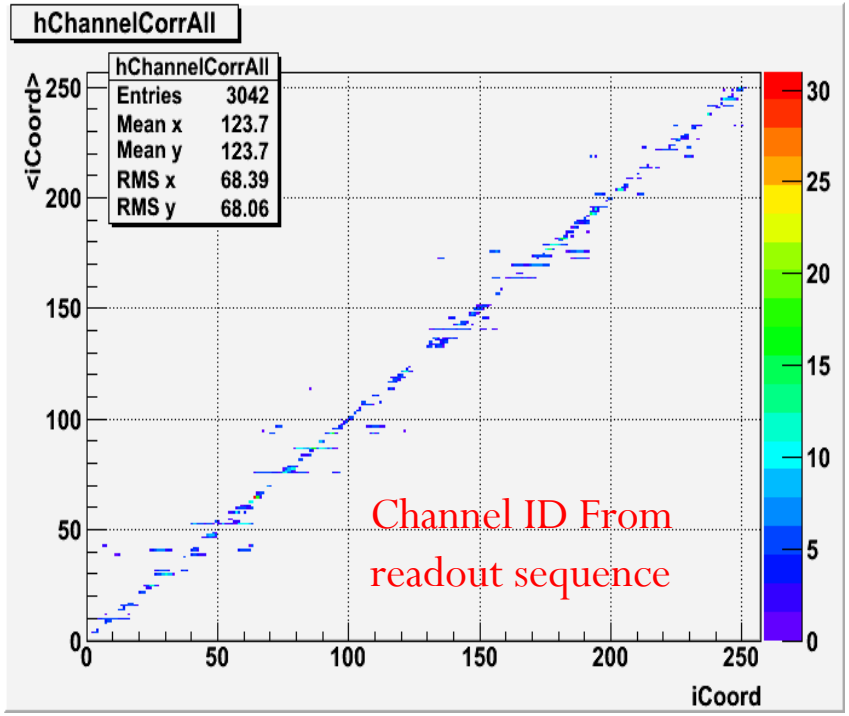
(a) Raw ADC vs Channel per GMT APV

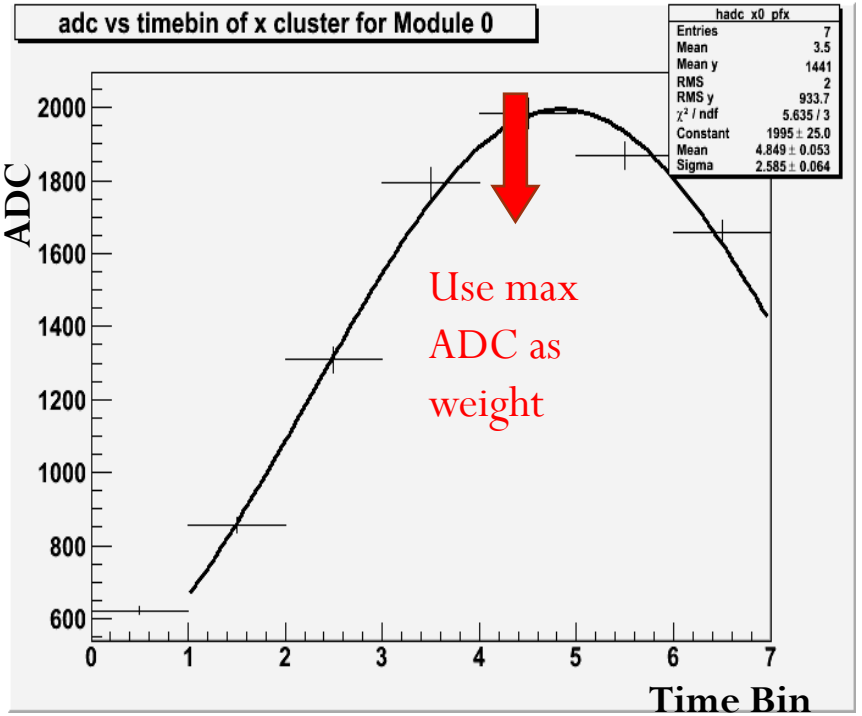
(b) Raw ADC per channel with gaussian fit to estimate its pedestal and width

(c) pedestal vs channel for 16 GMT APVs (one GMT module is offline)



GMT Hits





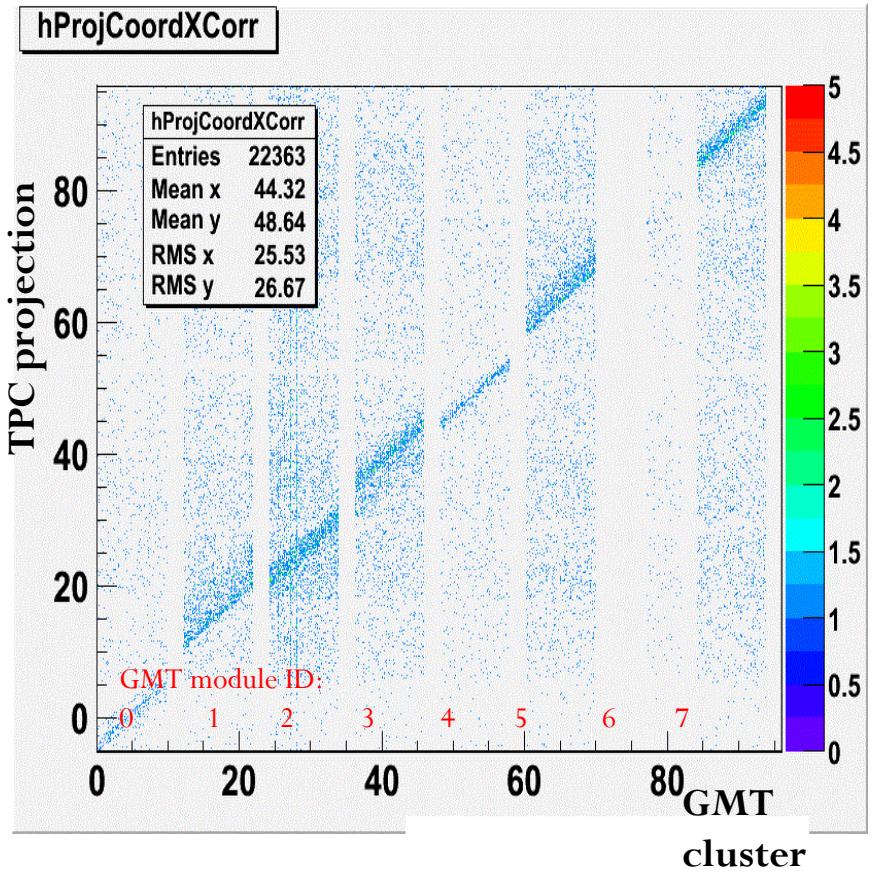
Mapping GMT channels ID with their physical positions in GMT module - GMT hit position vs average Cluster Hit Positions should be linear correlated if mapping correct

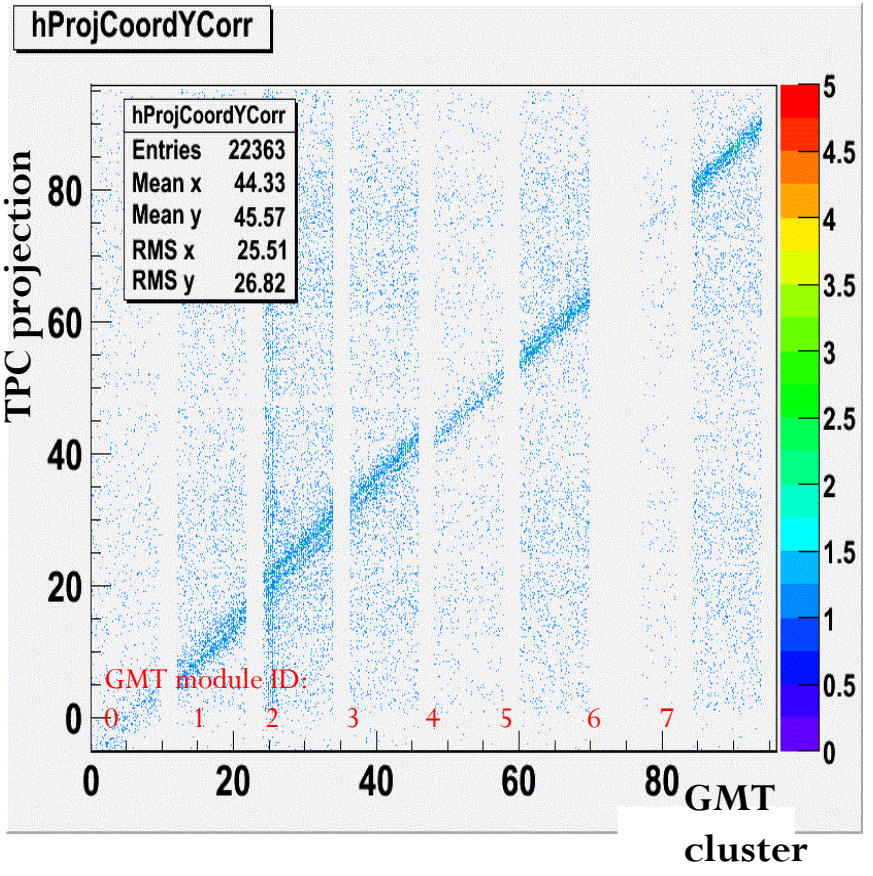
Use ADC cut to distinguish real signal from noise: (Raw ADC – pedestal – 8*σ)>0 ~ > 800

$$Weight(ADC) = ADC_{\max}$$

$$HitClusterPosition = \frac{\sum_{ch} HitPosition \times Weight(ADC)}{\sum_{ch} Weight(ADC)}$$

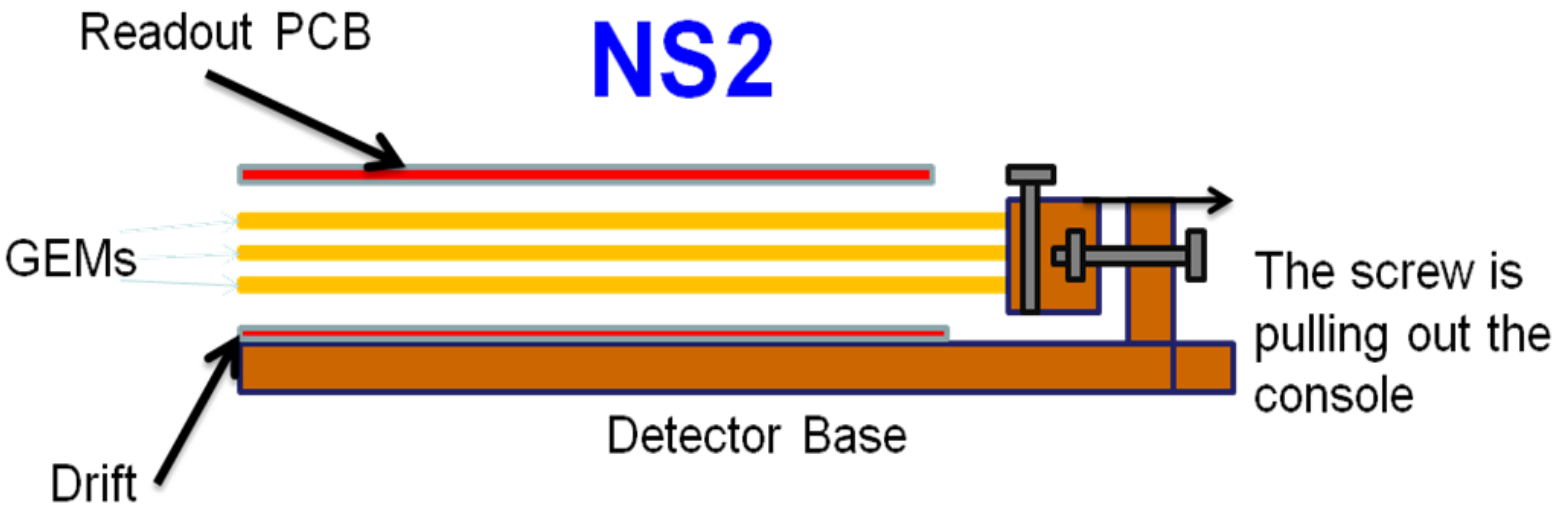
TPC – GMT matching





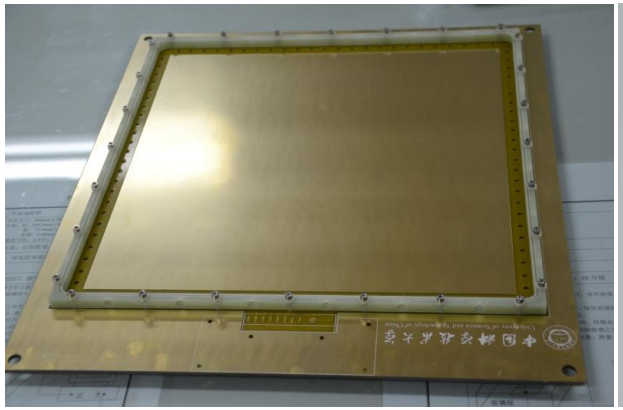
TPC Projection associated with GMT Hit Clusters per event in x, y direction,
Linear correlation observed, but still lots of noise there.
Next step is to match TPC track and GMT cluster one on one.

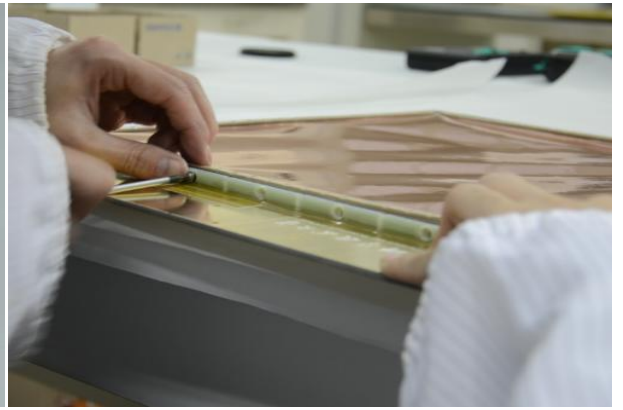
Large-size GEM construction with new self-stretching (NS2) method

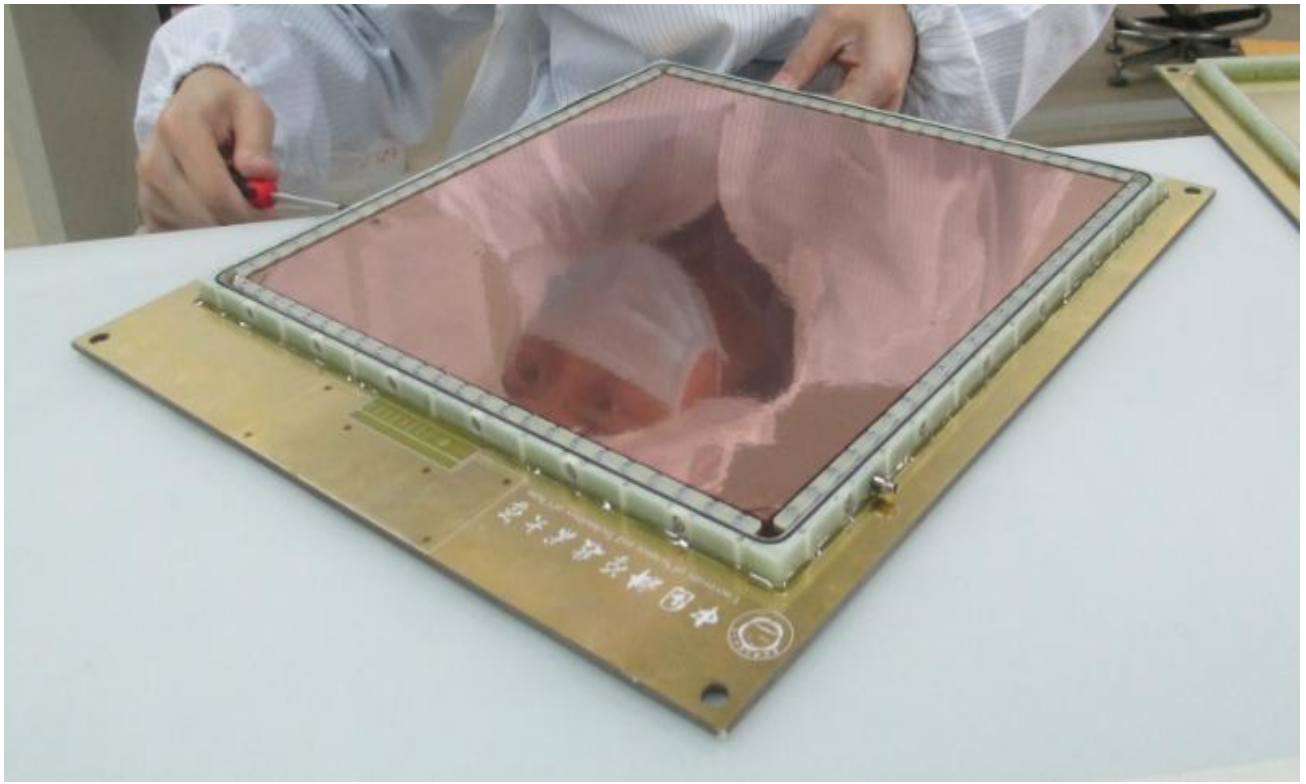


- **construction procedure easy and fast, usually limited to several hours**
- **no inner supporter, no dead zone**
- **replaceable, repairable, reduced cost**

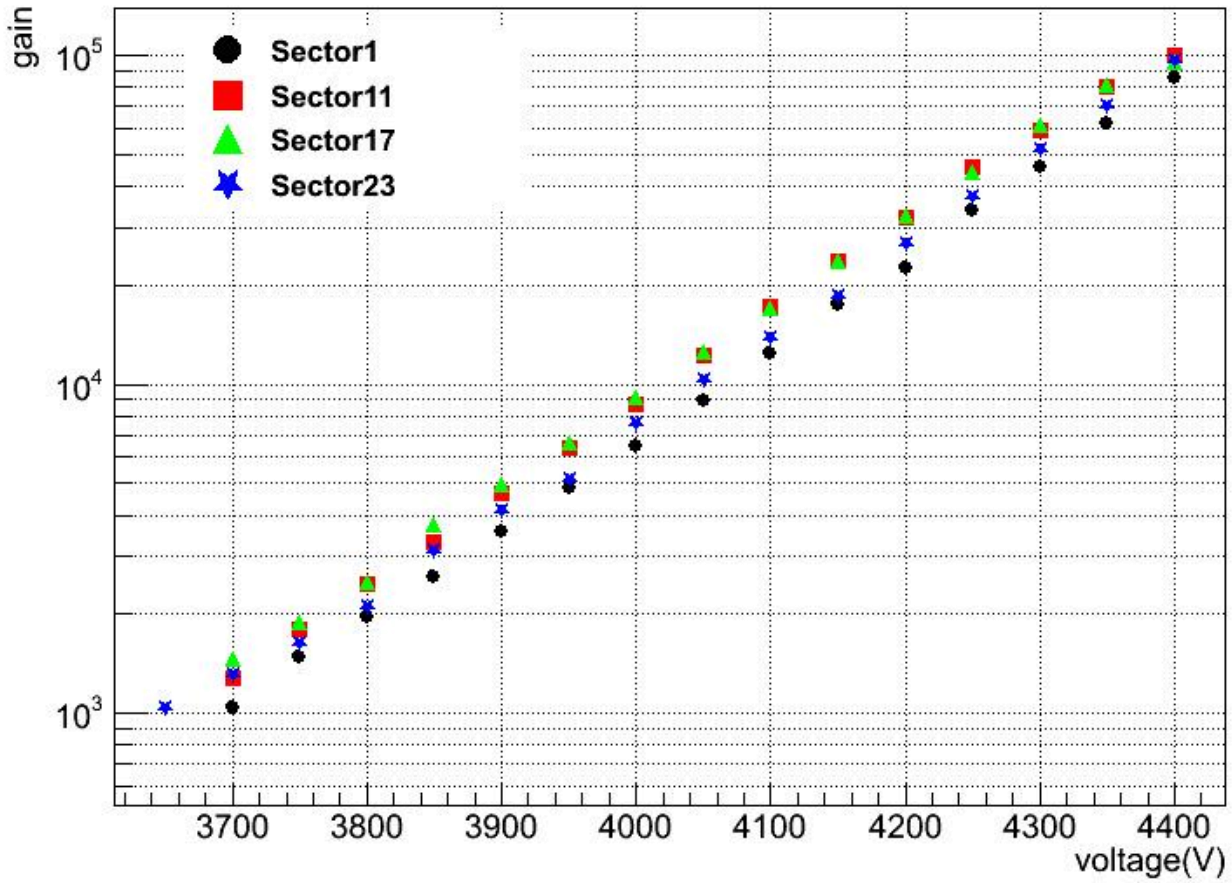
Photos in construction







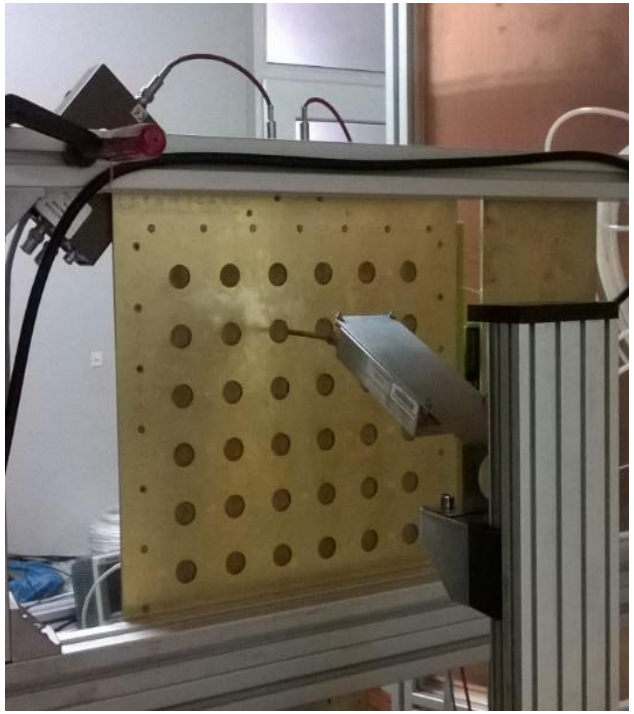
Gain test



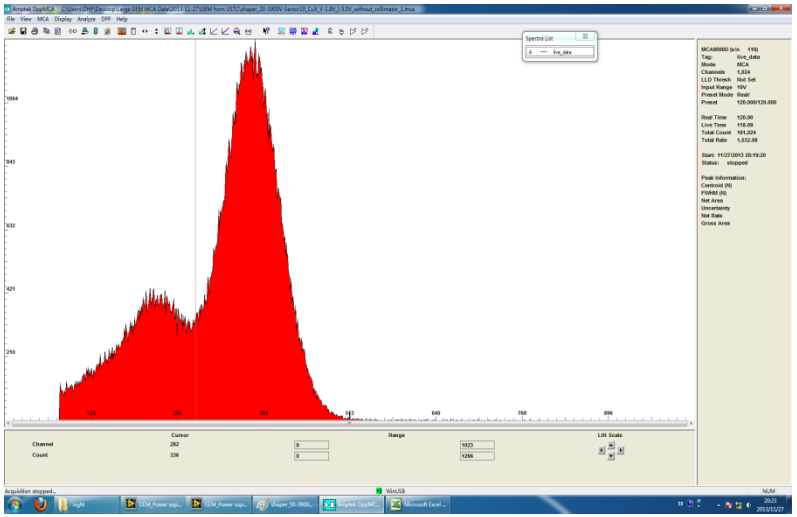
gain ~10^5 at 4400V

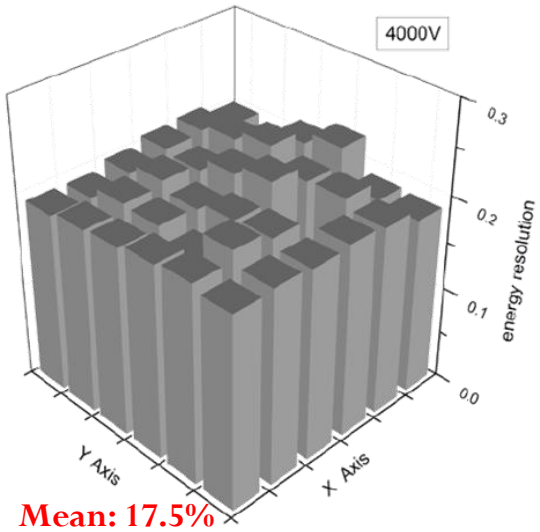
70%Ar+30%CO_2

Gain and energy resolution uniformity



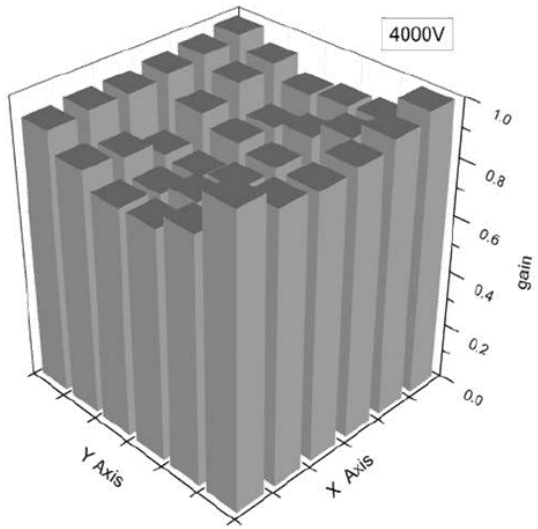
8KeV Cu X-ray





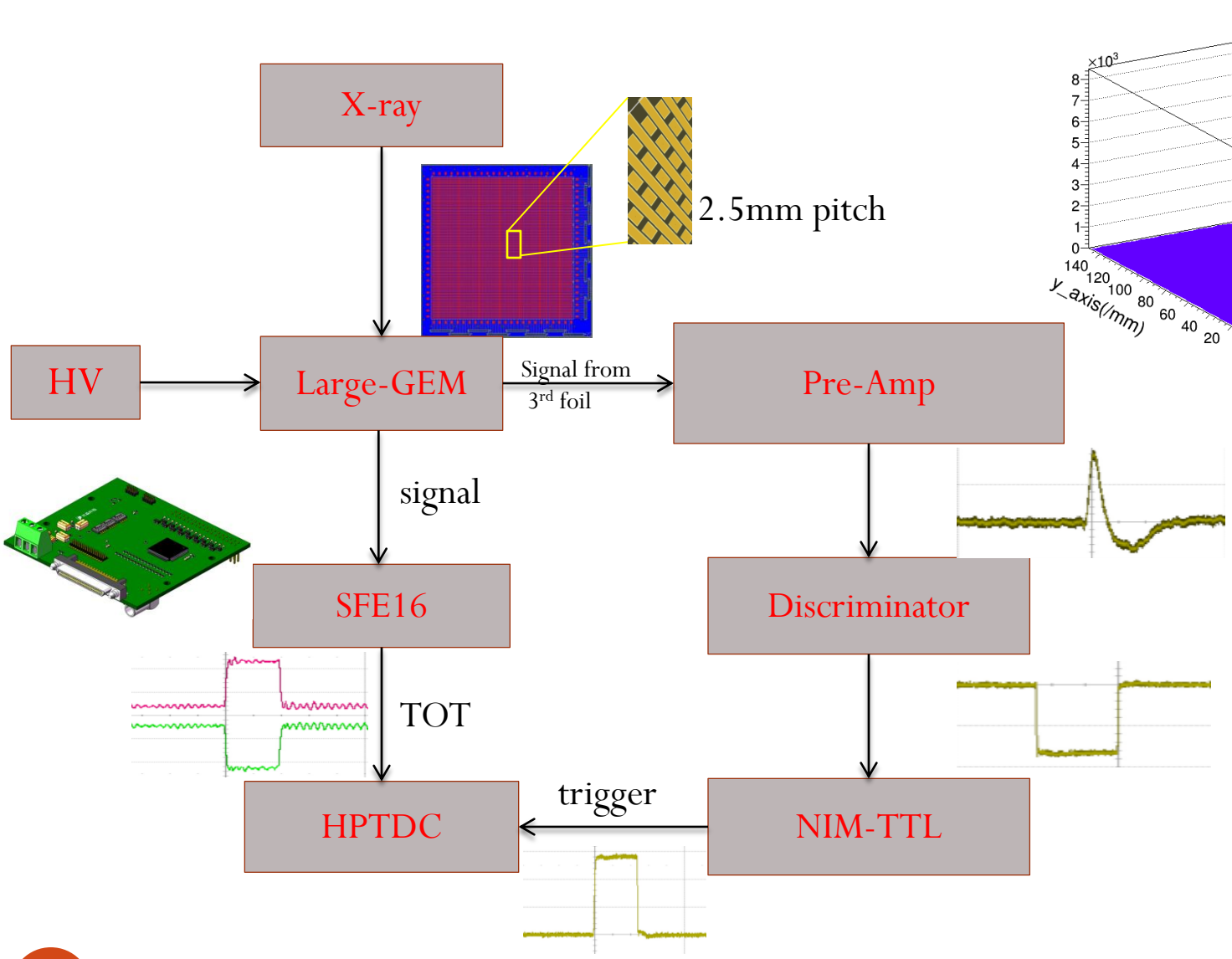
Mean: 17.5%

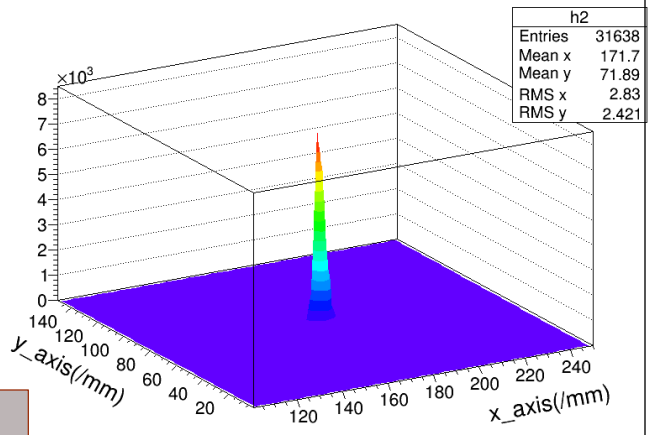
standard deviation=5.2%



standard deviation=7.6%

Spatial resolution test (ongoing)





Prepare a NIM A paper

Cosmic ray test of Mini-drift Thick Gas Electron Multiplier for Transition Radiation Detector

Abstract

A thick-gas electron multiplier (TGEM) with an area of 10 cm × 10 cm having 11.3 mm ionization gap has been tested along with two regular gas electron multipliers (GEM) in a cosmic-ray test stand set up at Brookhaven National Laboratory (BNL). This TGEM is proposed as part of a transition radiation detector (TRD) for identifying electrons at an electron ion collider (EIC) detector. Through this cosmic ray test, we obtain an efficiency larger than 94% for the TGEM and spatial resolution better than 300 μm at the working high voltage(-3.65 kV). Thanks to its outstanding spatial resolution and thick ionization gap, the TGEM has excellent track reconstruction capabilities. The gain uniformity and stability of TGEM are also presented.

Key Words: EIC, TRD, TGEM, Cosmic ray test

Summary and Plan

- GMT is already in STAR taking data, analysis underway
- Large-size GEM with NS2 method is constructed and tested at USTC, under continuous optimization
- A first technical paper is being prepared, intended for submission on NIM A

- Will do
  - Put similar GMTs at endcap (mini-drift TRD)
  - Using GMT to study tracking and material impact
  - Continue with simulations of eSTAR option
  - Large-area GEM/THGEM construction