ECal FTBF Test

The SoLID EC Working Group

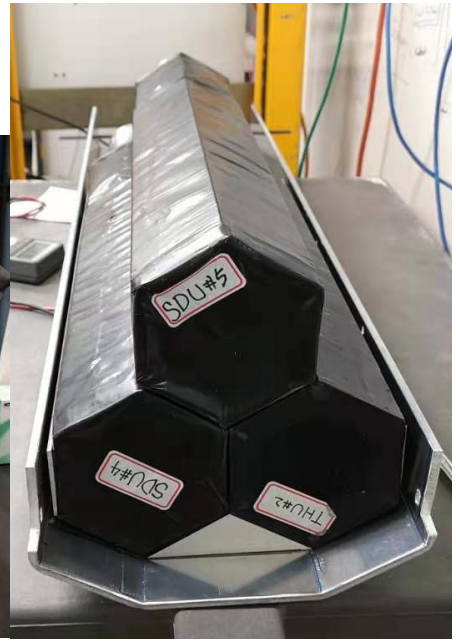
SoLID Collaboration Meeting

June 10-11, 2021

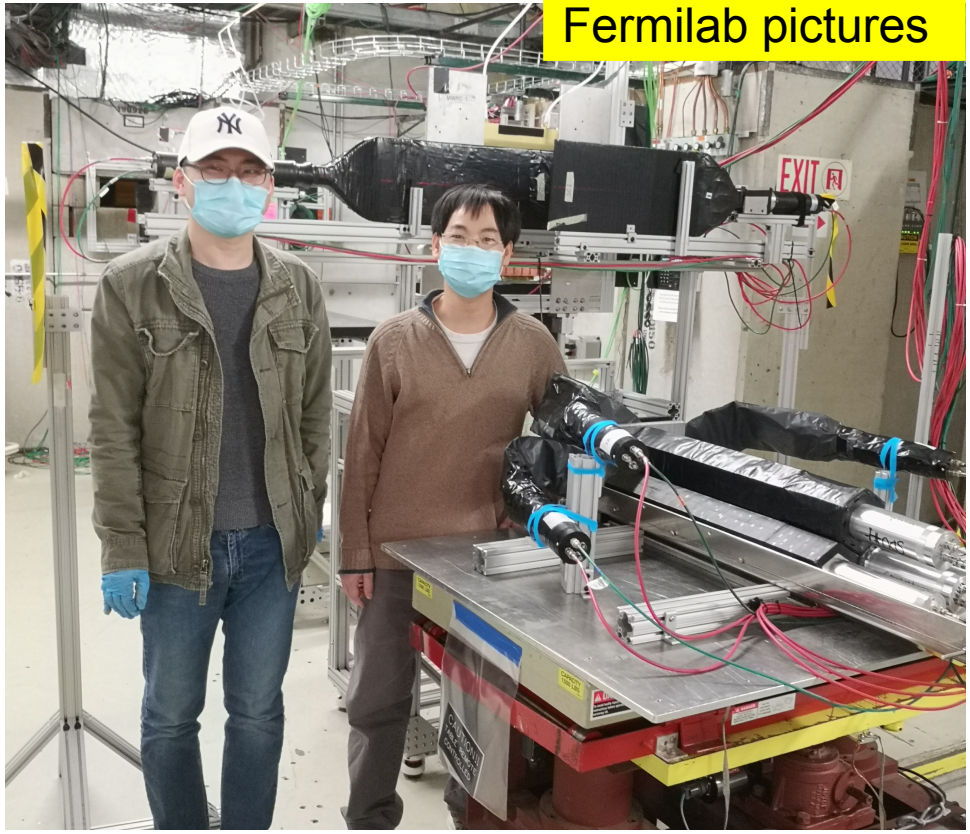
Testing at Fermilab Test Beam Facility

- Completed beam test from Jan. 13-27 (daytime during 1st week, night time 2nd week);
- Lead by Jixie Zhang, Xinzhan Bai (UVA)/ Alexandre Camsonne, David Flay (JLab)/ with local help from Paul Reimer, Manoj Jadhav, Junqi Xie (ANL);
- Analysis by Alexandre Camsonne, Zhenyu Ye (UIC), Jixie Zhang;
- Using 3 shashlyks (SDU4,SDU5,THU2), 3 preshowers, and 2 scintillators for triggering. 2X0 prelead and a 2cm Al plate are also in place. Main goal is to characterize calorimeter responses to GeV-level electrons.

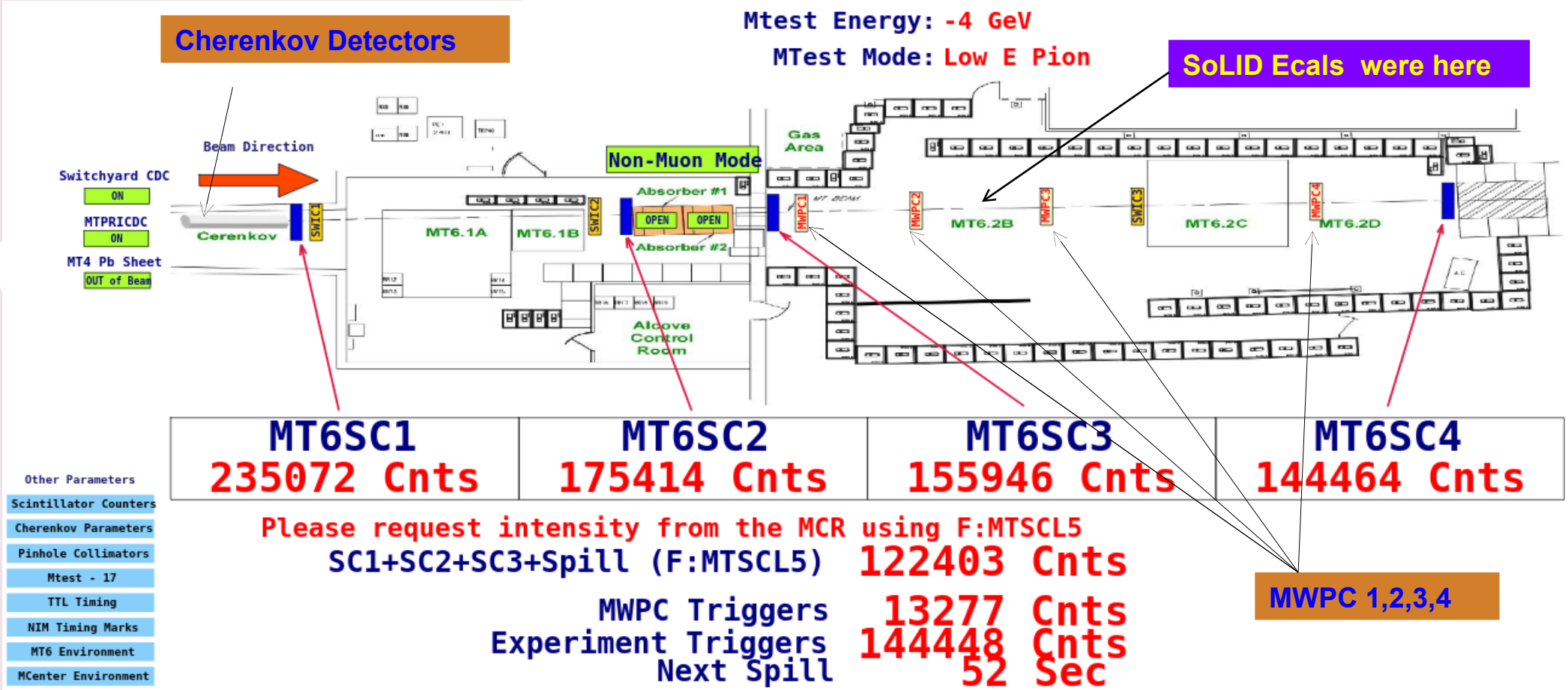
Test lab pictures



Fermilab pictures



FermiLab Test Beam Facility

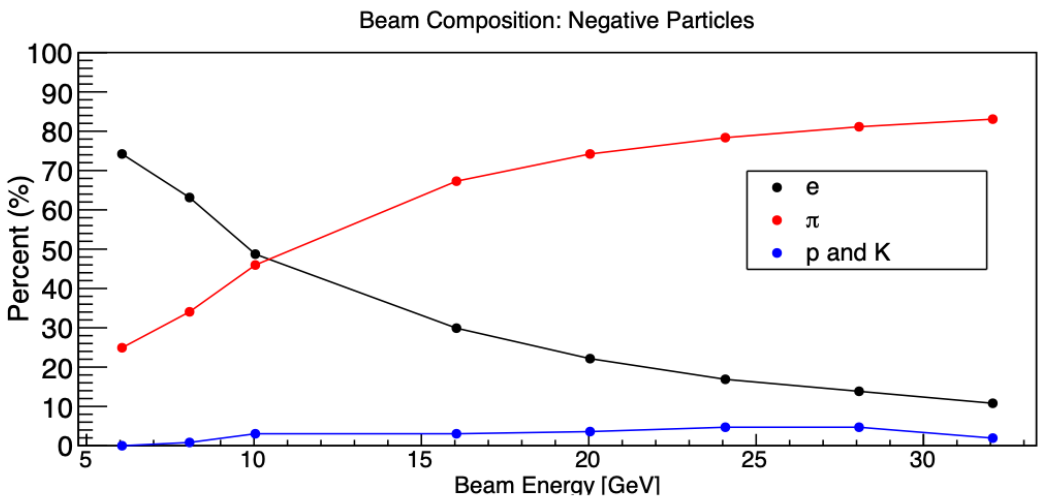


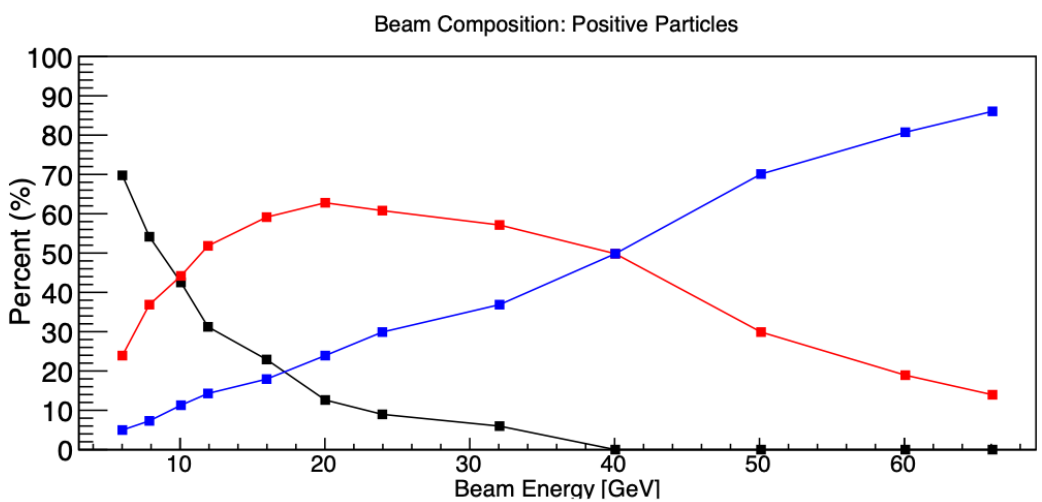
1. 4.2 second per spill, one spill per minute.
2. Inside one spill, particles are not evenly distributed, they are bucket by bucket
3. Use MWPC triggers (it is actually the L1A of MWPC daq, never exceed 15k per spill)
4. MT6SC1 could reach 400k particles per spill, MT6SC3 can reach 300k.
5. Beam profile is not good for momentum less than 12 GeV/c secondary beam.
6. DAQ crates was placed in the control room, connected through the existing patch panels ……

Testing at Fermilab Test Beam Facility

Beam energy (GeV)	total trigger	total electron trigger (online)
1	3.1M	3.0M
2	2.9M	2.7M
4	4.5M	3.9M
6	2.8M	2.1M
8	5.5M	3.4M
10	6.8M	3.6M
12	3.0M	1.3M
16	7.6M	2.3M

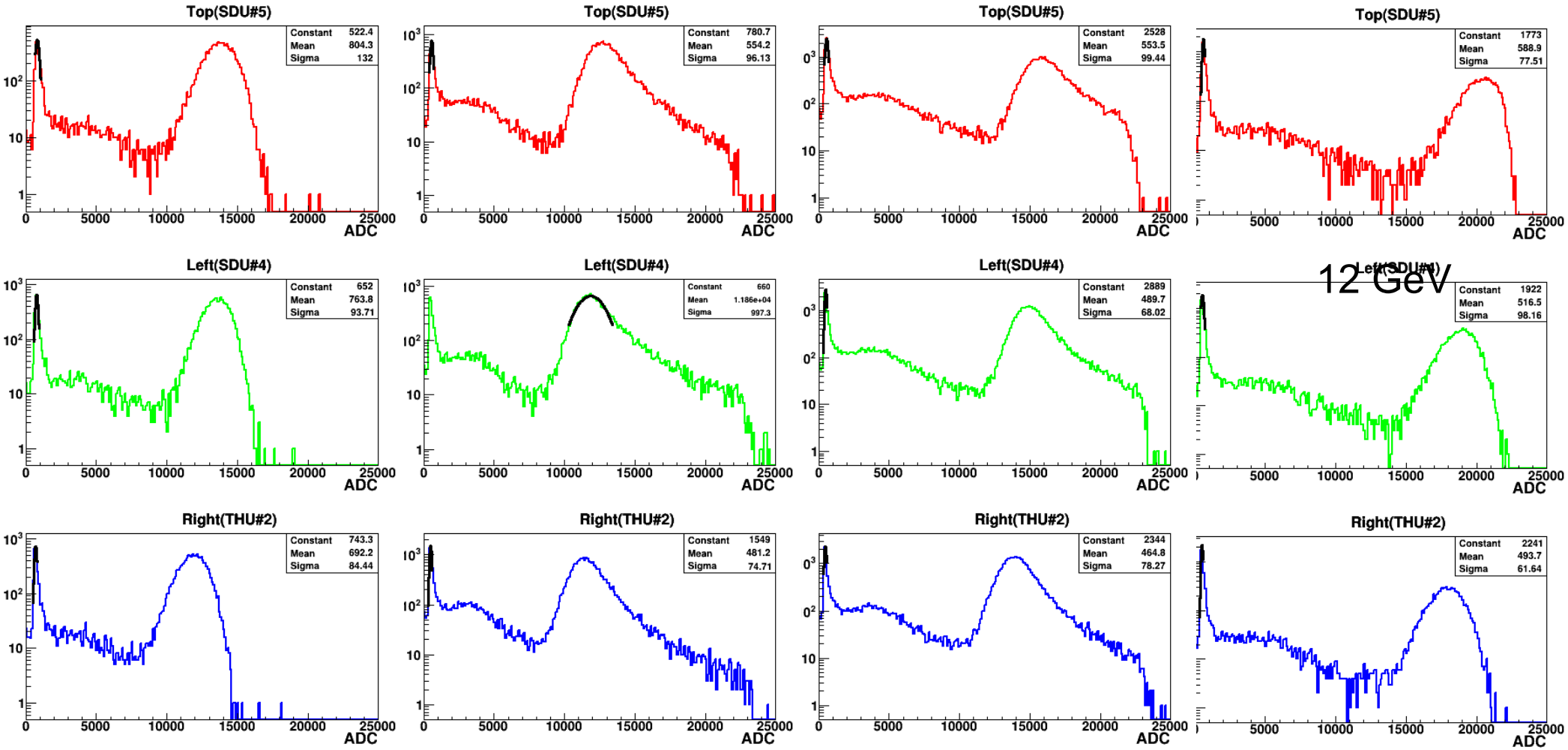
- Used FTBF Cherenkov for PID, and MWPC for positioning info.





Characterizing Light Yield

6 GeV 8 GeV 10 GeV 12 GeV



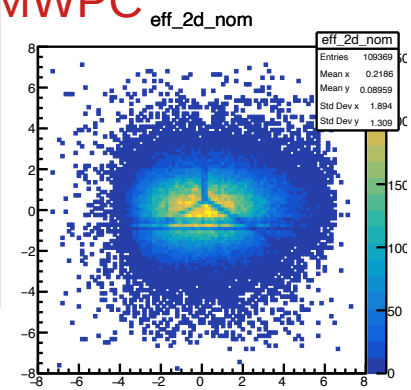
Data from calibration runs (beam centered at each block for gain matching)

Naive estimation: MIP = 60 MeV; Electron = 20% sampling → Electron/MIP = 750/60 per GeV of electron energy. The above ratio is roughly 10% below this value. Our light yield is within the lower end of LHCb's 2.6-3.5 p.e./MeV.

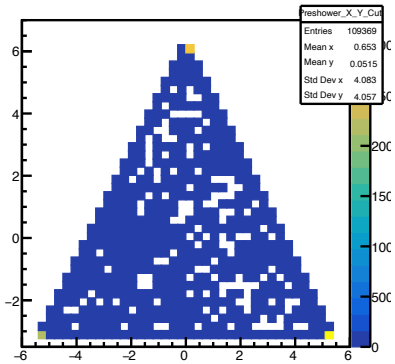
10GeV

Characterizing Position Resolution

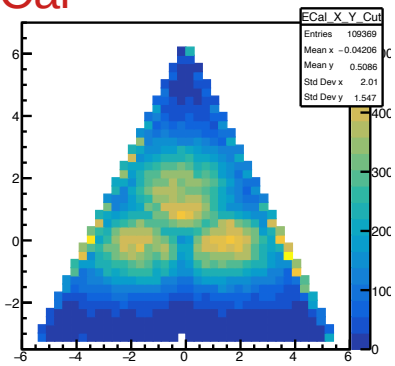
MWPC

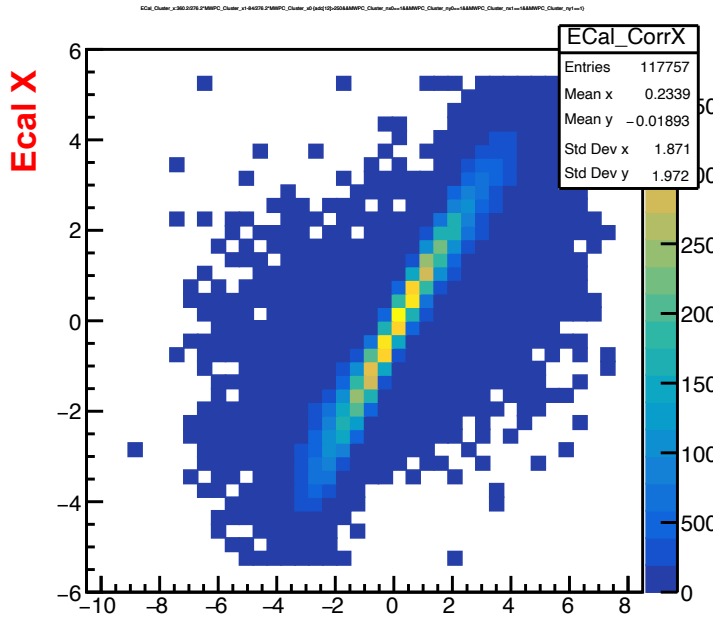


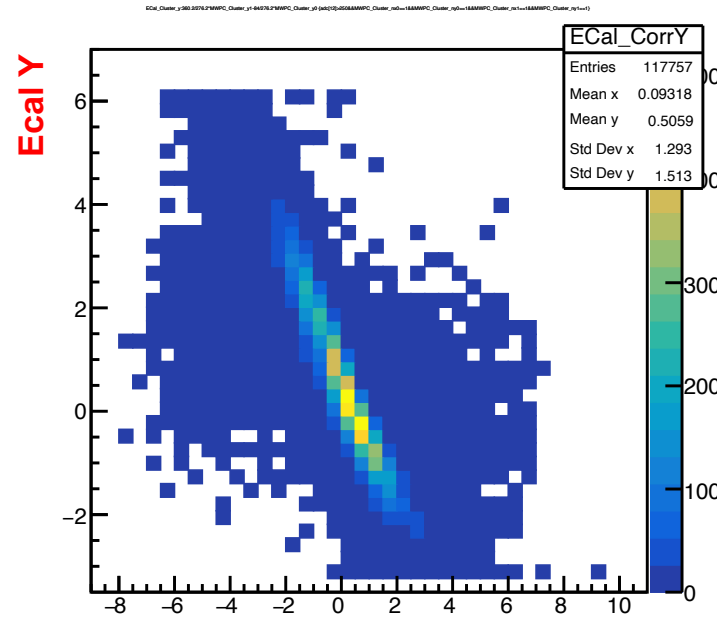
Preshower

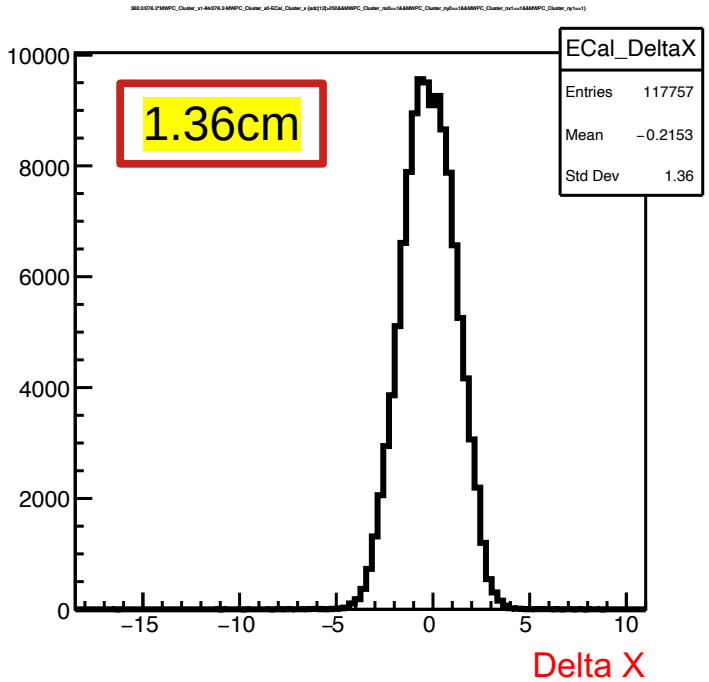


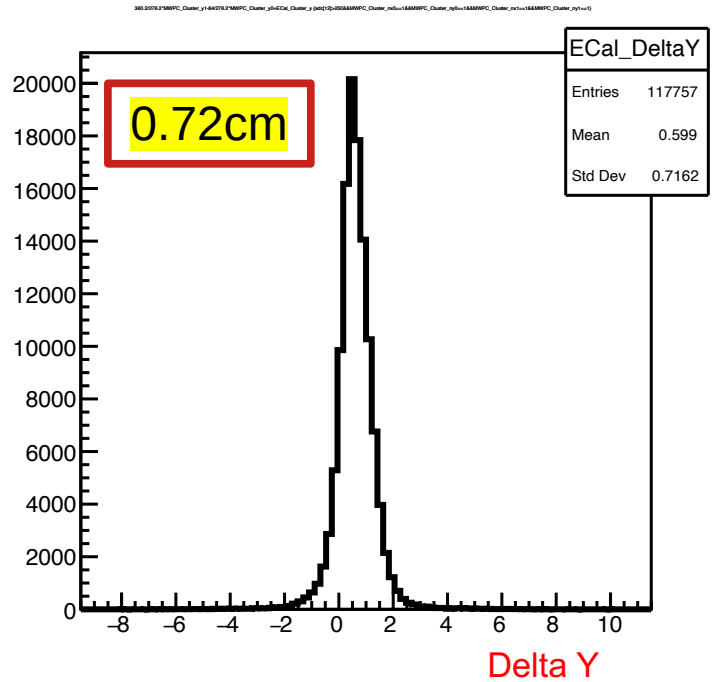
ECal









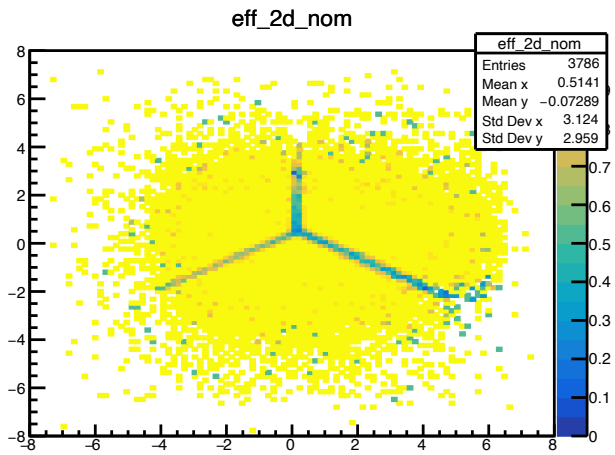


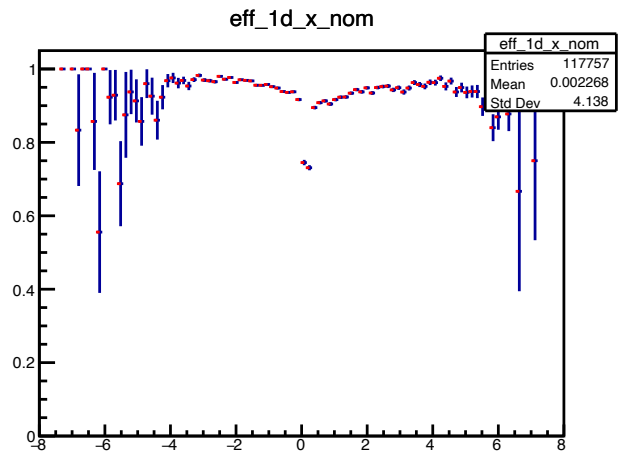
ADC>10000

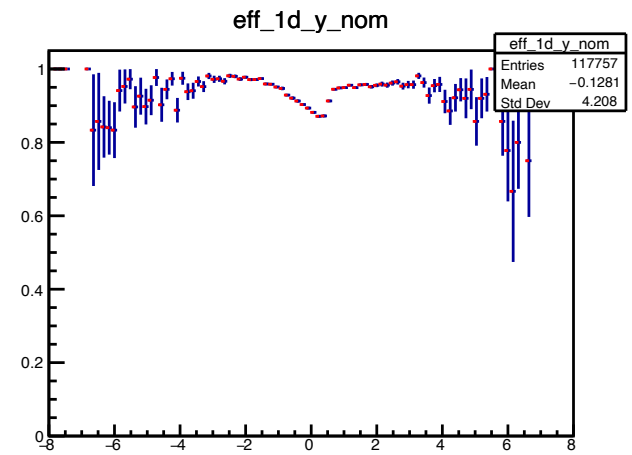
(beam coming with an angle in x → SoLID real situation?)

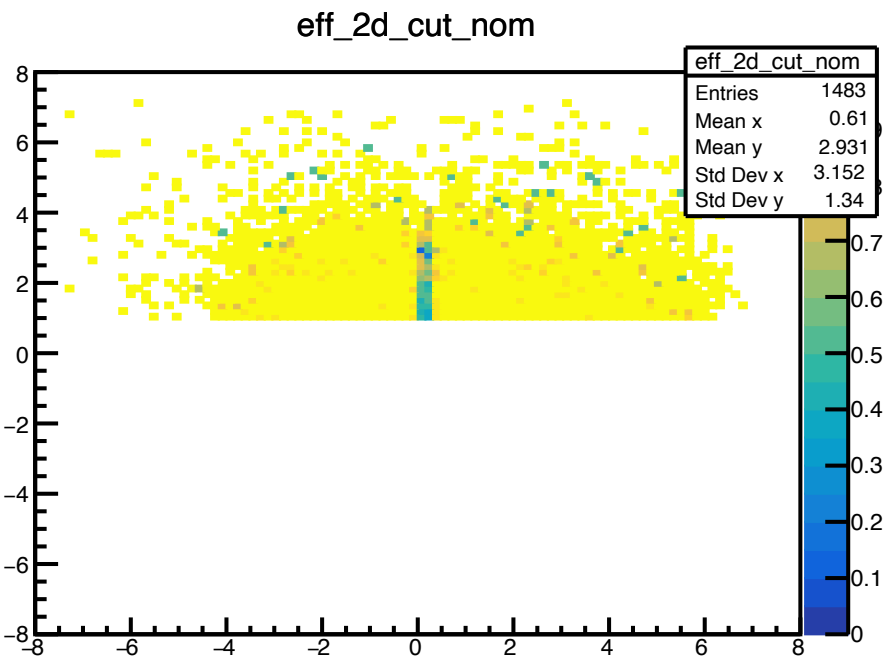
Gap between blocks

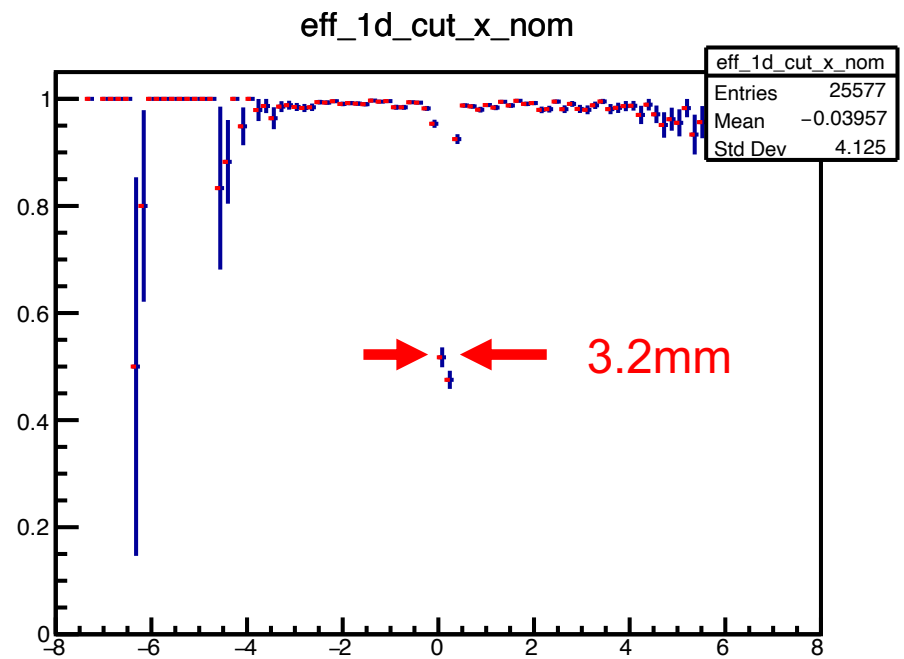
MWPC Eff= (ADC>10000)/all







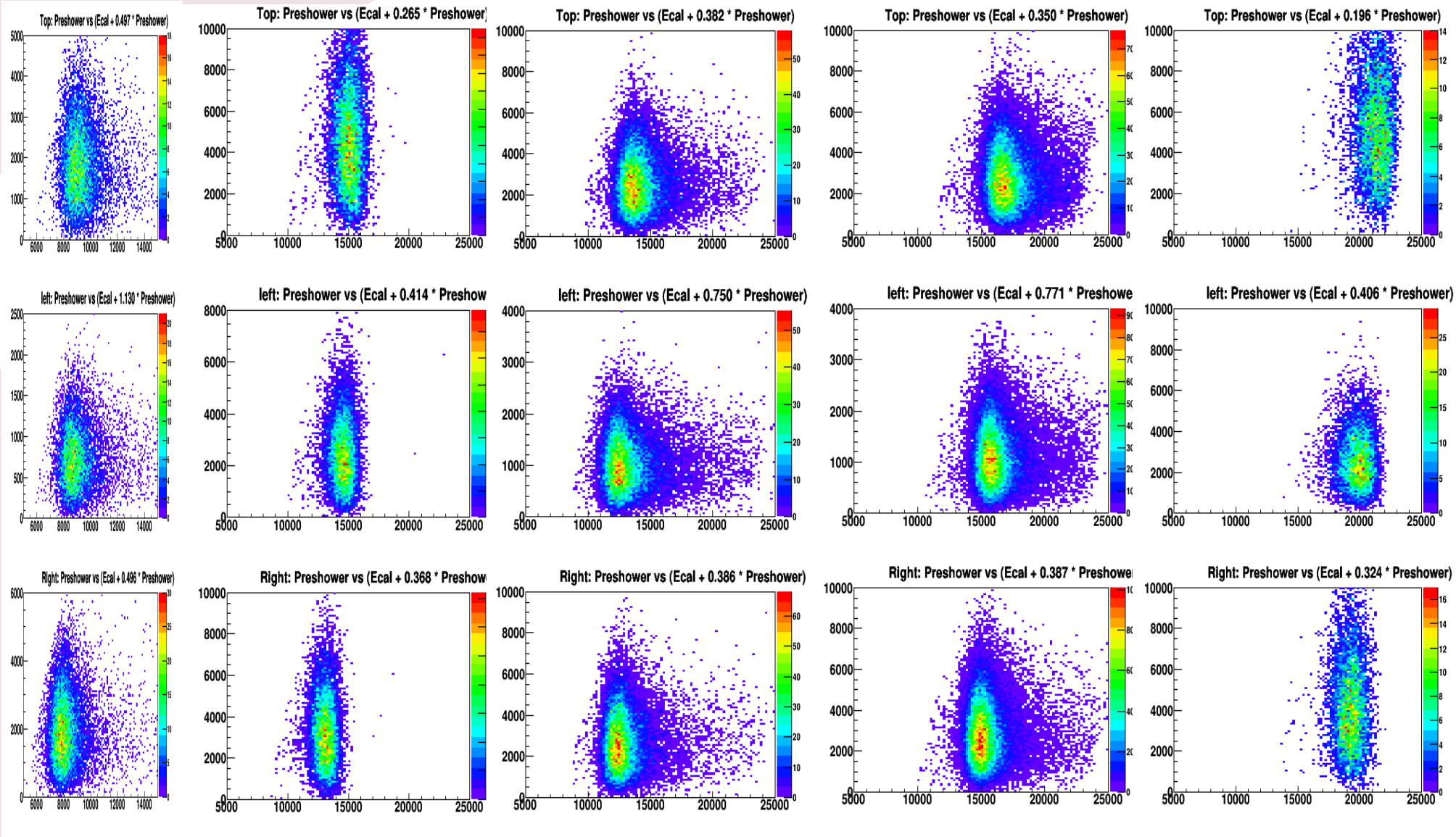




Energy Calibration

4 GeV 6 GeV 8 GeV 10 GeV 12 GeV

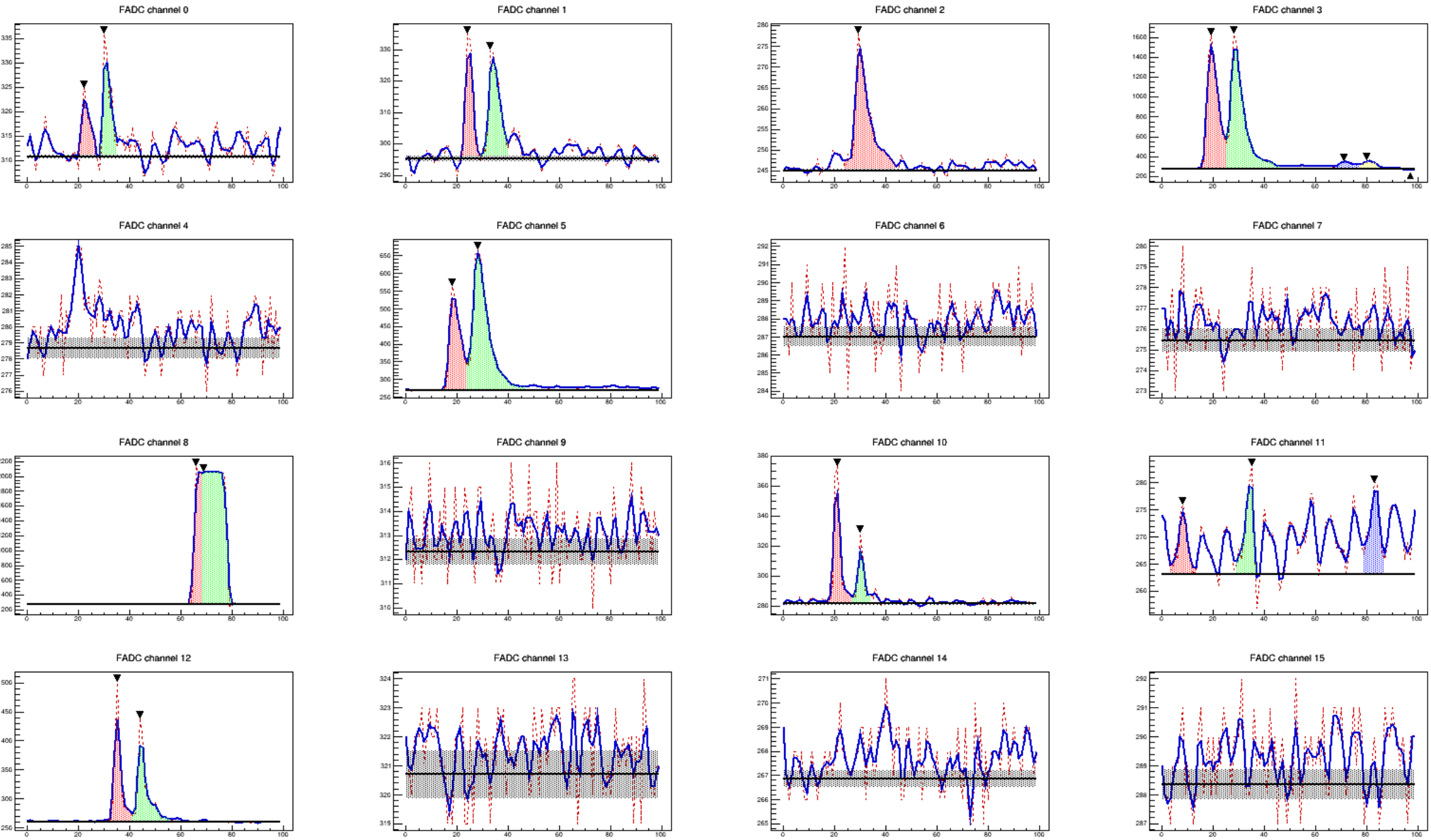
Preshower



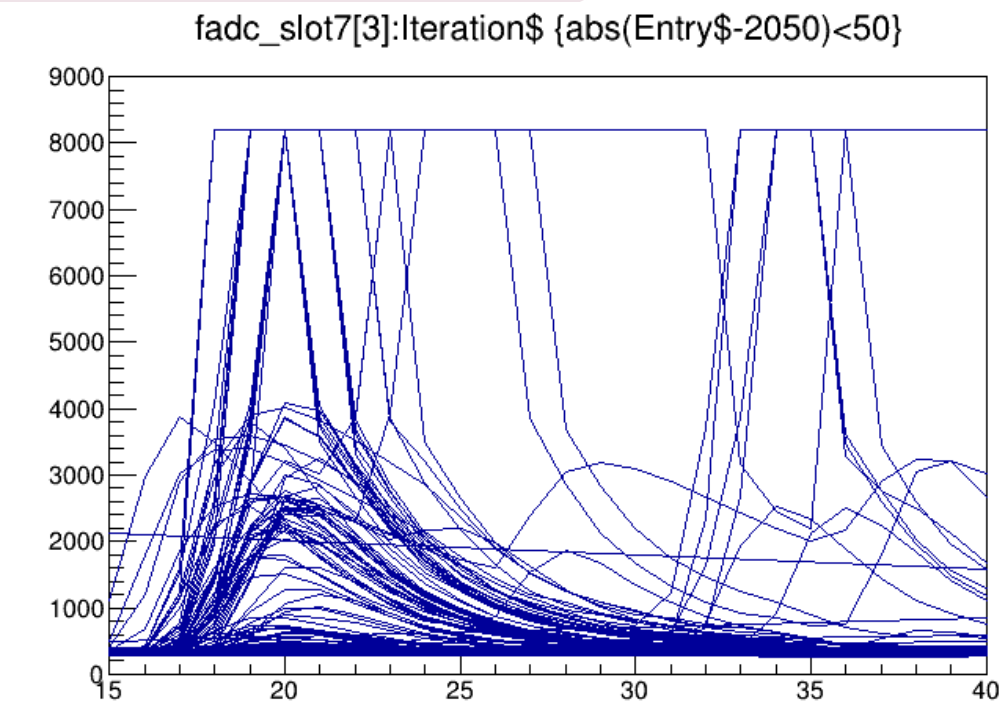
Shower + c * preshower

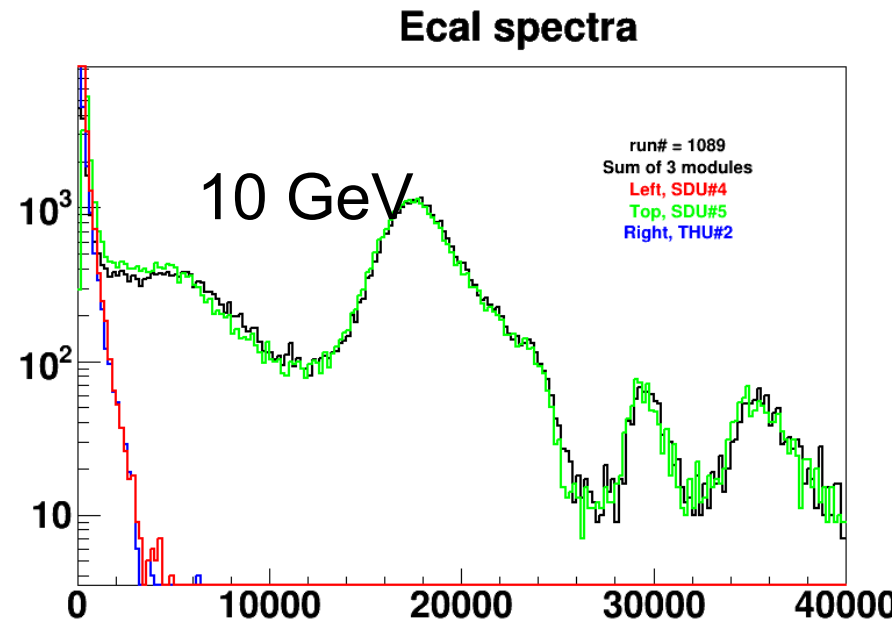
Clearly, something other than the energy resolution of ECal is contributing to the width

Example of Multiple Peak Event

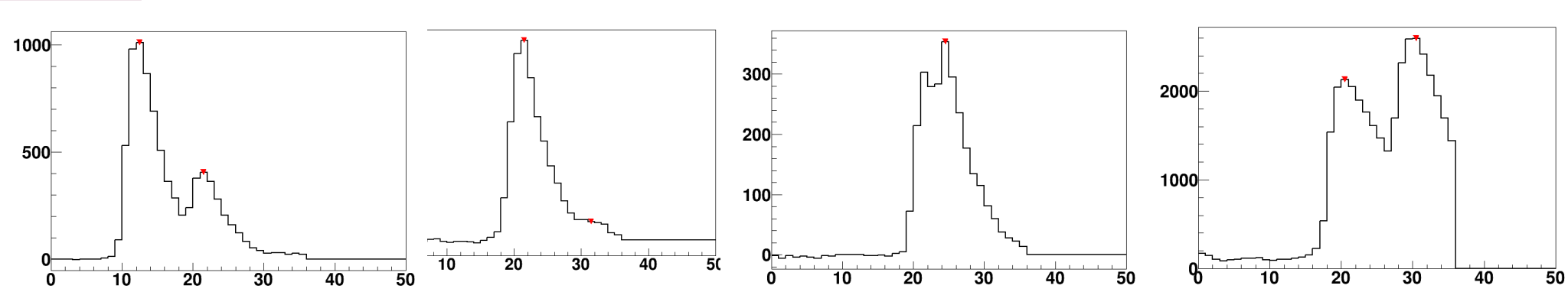


Pileup example:



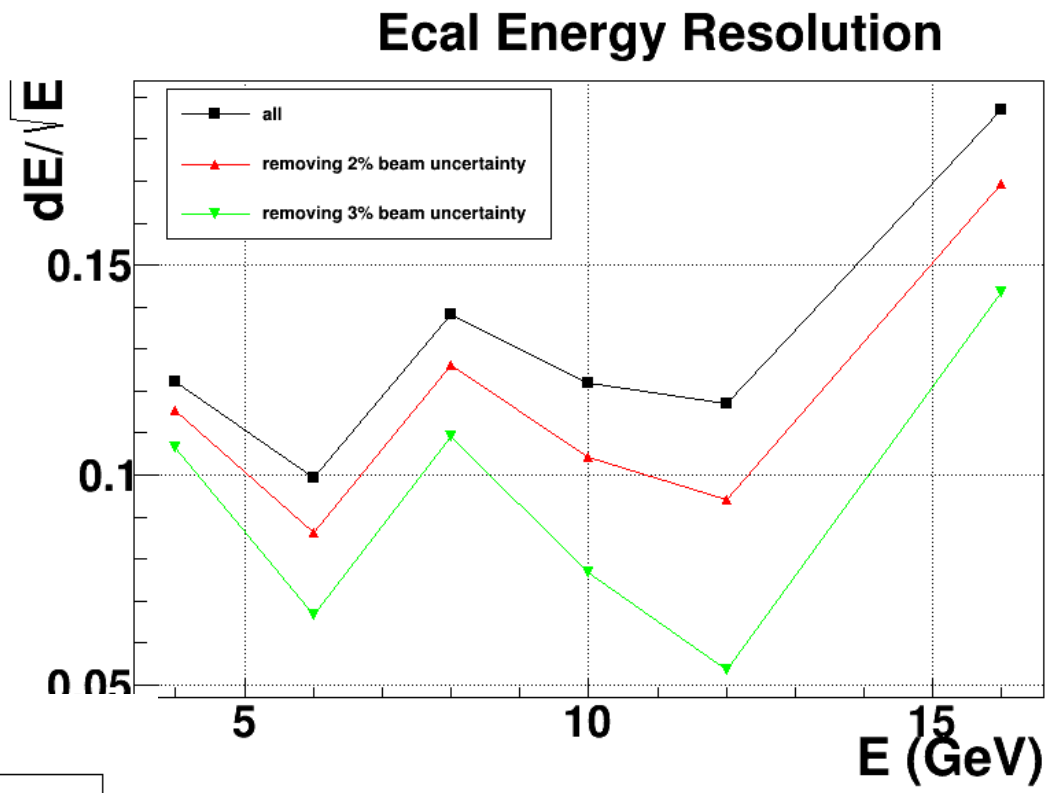


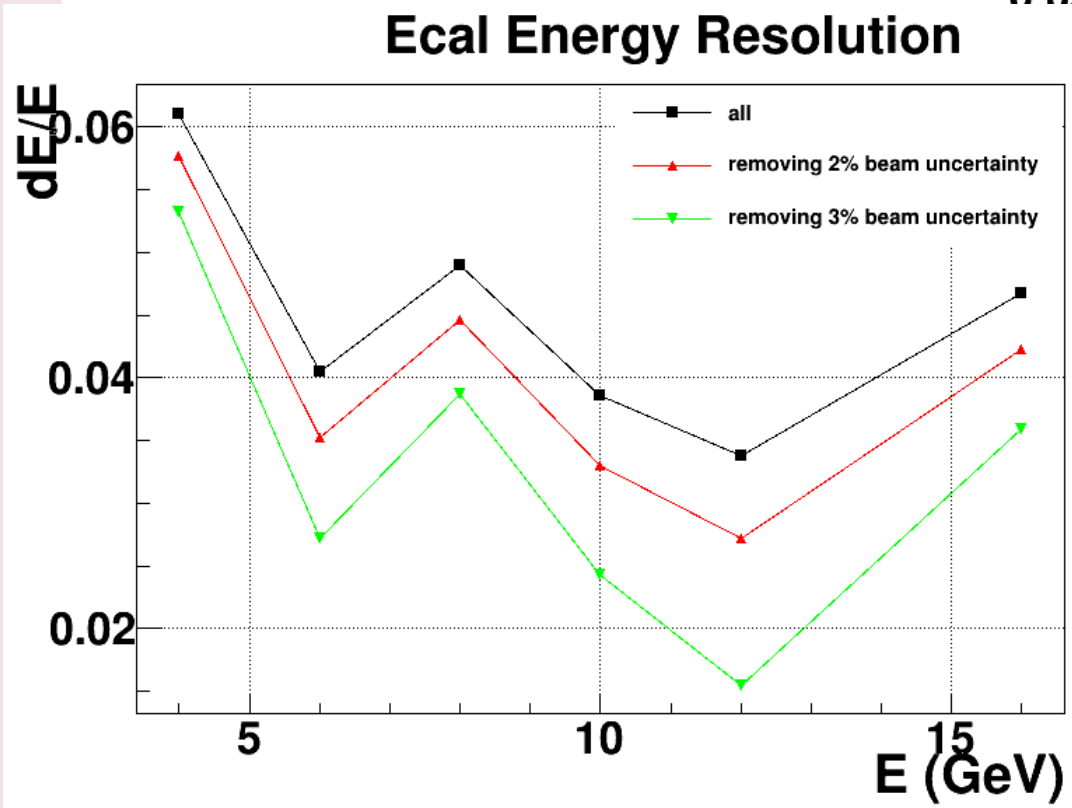
Top block: only 100 events shown



Energy Resolution

- Beam energy itself has a 3% spread, or 1.5% for smaller beam sizes.
- Focus on 6 GeV and 12 GeV points, reaching (7-9)%/sqrt(E).
- Sim: for 4cm radius beam size: 0.5% + 7%/sqrt(E) + 4%/E





Summary of FTBF Test Data

- First beam test of SoLID ECal preshower + shashlyk successfully completed at FTBF in Jan 2021
- Position resolution reaching <1cm in Y (larger in X due to FTBF beam direction). More simulation needed to characterize particle incident angle effect for SoLID real situation.
- Light yield ~10% below naive calculation.
- Energy resolution affected significantly by signal pileup. If focusing on 6 GeV and 12 GeV points
  - reaching (7-9)%/sqrt(E) depending on beam energy spread subtraction;
  - simply rejecting events with apparent double peaks does not improve result visibly;
  - compare to simulation:0.5% + 7%/sqrt(E) + 4%/E (4cm radius beam size);
  - SULI intern working on waveform separation analysis this summer
- Writing report, more beam test ? → see next talk

Backup Slides