

ECAL Reconstruction - 2019 Run

HPS Collaboration Meeting

May 2020

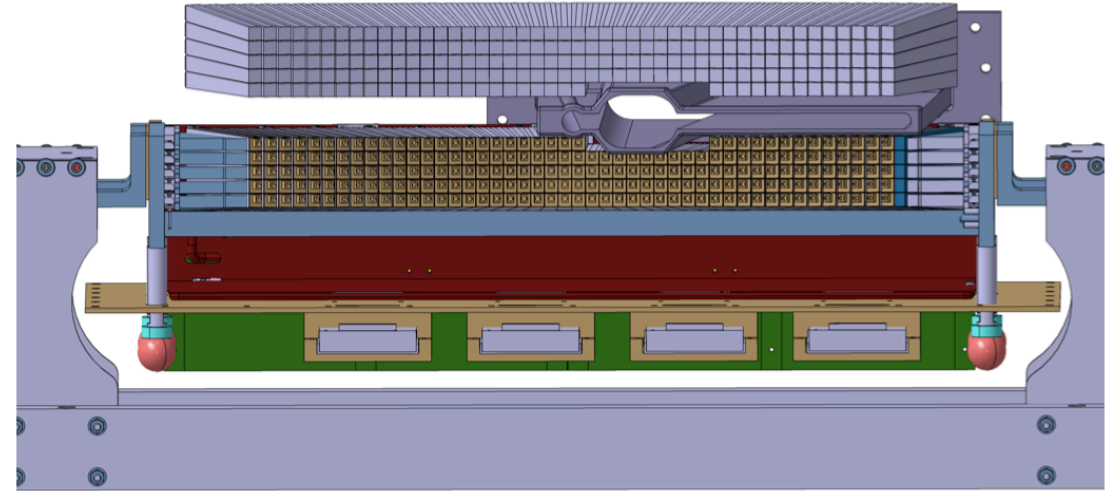
N. Baltzell

The logo for Jefferson Lab, featuring the text "Jefferson Lab" in a bold, sans-serif font. A red swoosh underline is positioned beneath the word "Jefferson".

Jefferson Lab

Overview - Reconstruction

- Global Alignment
- Hits
 - 250 MHz FADC waveform --> ns & GeV
 - "3-pole" pulse fitting:
 - first samples -> initialize pedestal
 - threshold crossing --> initialize time
 - fixed width, free pedestal, time, amplitude
 - fit range limited to $\sim 2/3$ pulse to avoid pileup
 - Per-crystal gains to convert to GeV
 - Per-crystal timing offsets
- Clusters
 - Find local maxima seeds, grow to above-threshold neighbors
 - Time assigned as its seed's time
 - Cluster position based on energy-weighting its hits
- Corrections
 - Time Walk (energy-dependent)
 - "Sampling" Fraction (charge- and energy- dependent)
 - Edge Losses (energy- and y - dependent)
 - Position Parallax (charge-, energy-, and x - dependent)



Things to redo/revisit for 4.5 GeV beam energy

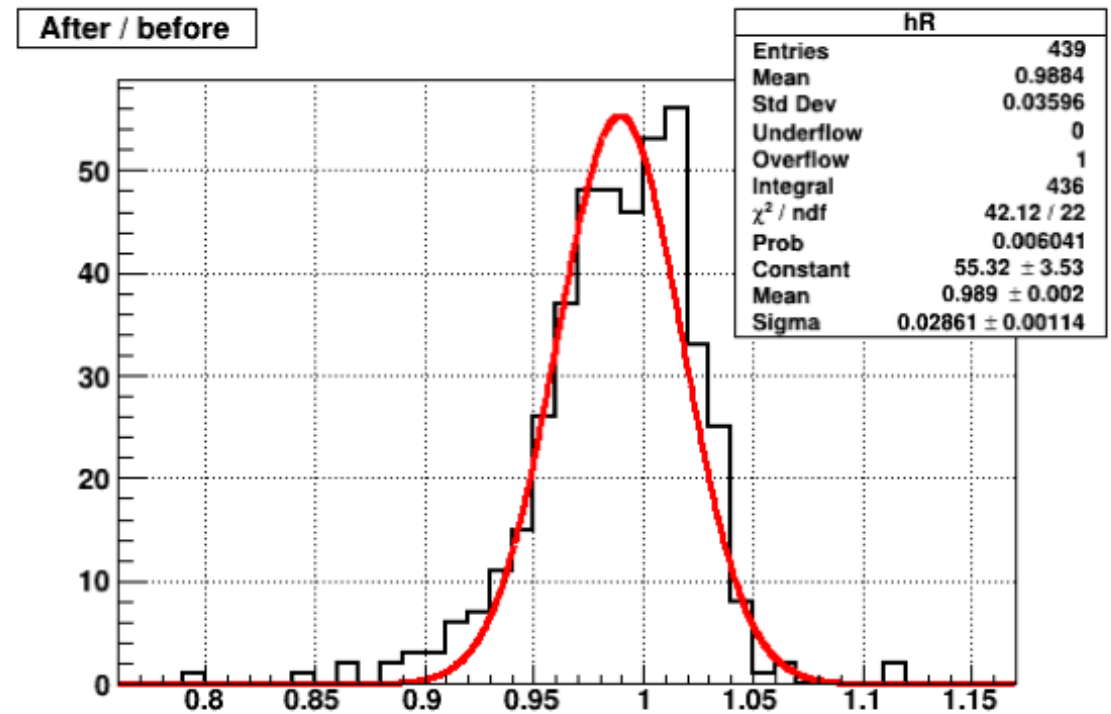
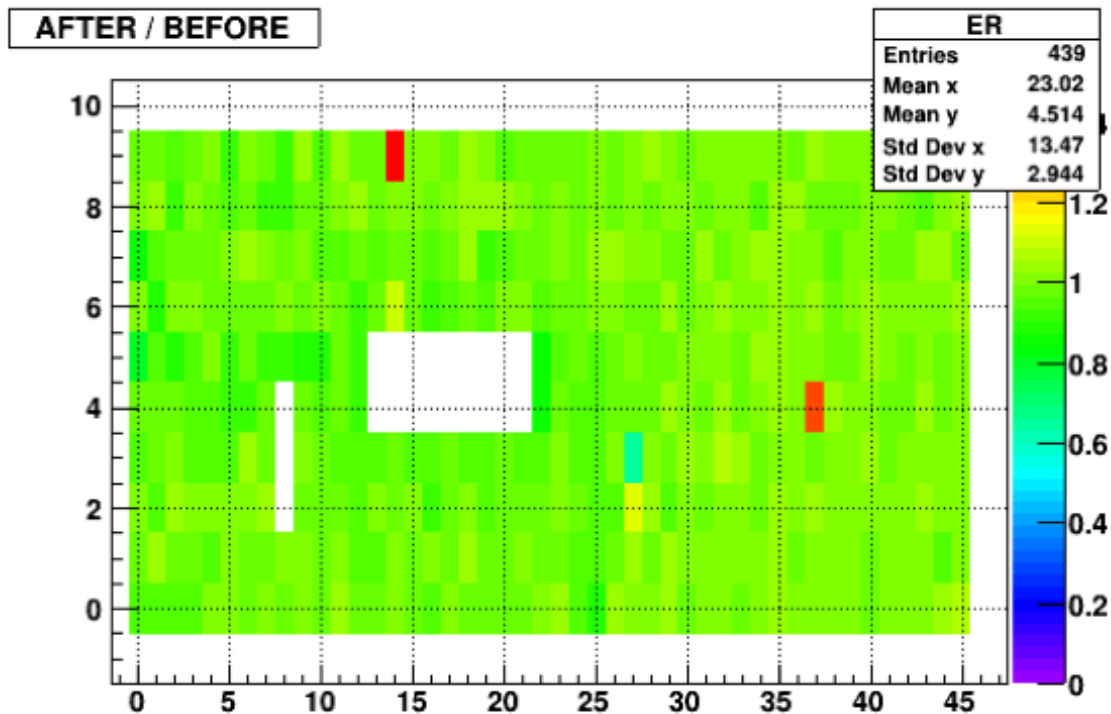
Alignment

- Surveys
 - ~mm shifts in x/y relative to the previous run
 - Implemented in 2019 v2 detector
 - global y and z shifts only
 - accounting for what must be some human error in the surveys
- Previously we've done final alignment based on the SVT

2019pre-2015			2019 post-pre		
dx (mm)	dy (mm)	dz (mm)	dx (mm)	dy (mm)	dz (mm)
0.70	-0.10	-54.58	-0.96000	0.28000	0.35000
1.13	-0.33	-54.72	-1.16000	0.16000	0.48000
0.54	0.31	-56.81	0.16000	0.41000	-0.55000
0.96	0.41	-57.23	-0.13000	-0.61000	-0.65000
-1.38	1.22	-53.83	-0.05000	-0.02000	-0.36000
-0.91	1.59	-53.78	-0.17000	-0.08000	-0.39000
-1.55	0.80	-55.41	-1.15000	-0.12000	2.09000
-1.02	0.62	-56.30	-1.84000	-0.06000	-0.20000
-0.19		-55.33	The 2 mm dz must be human error.		

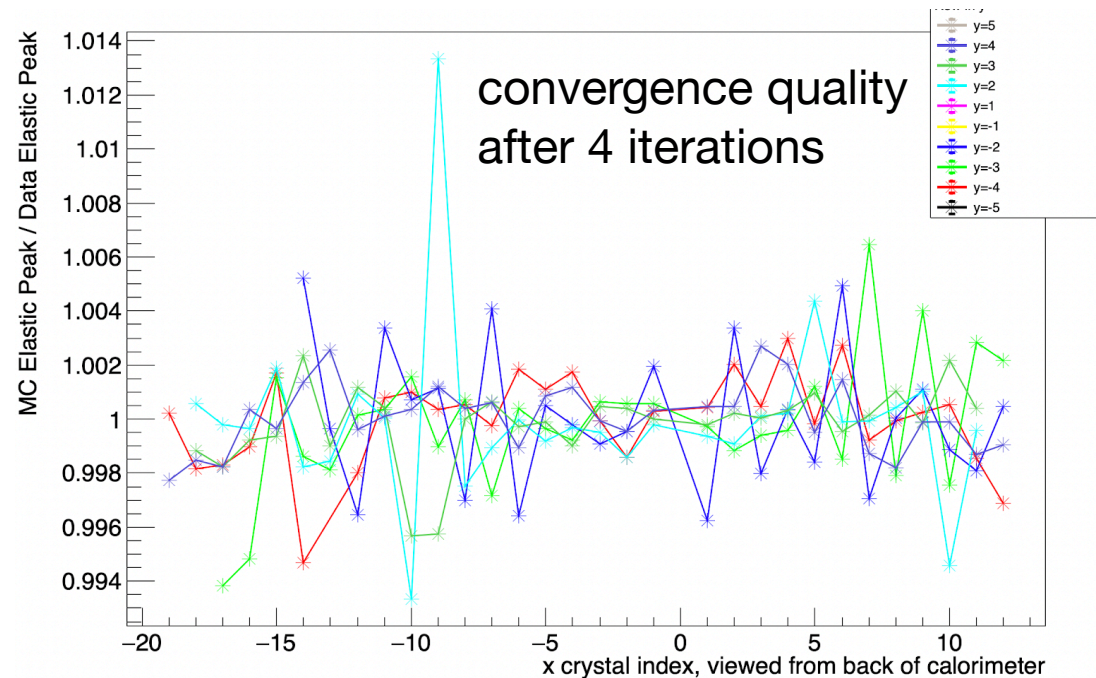
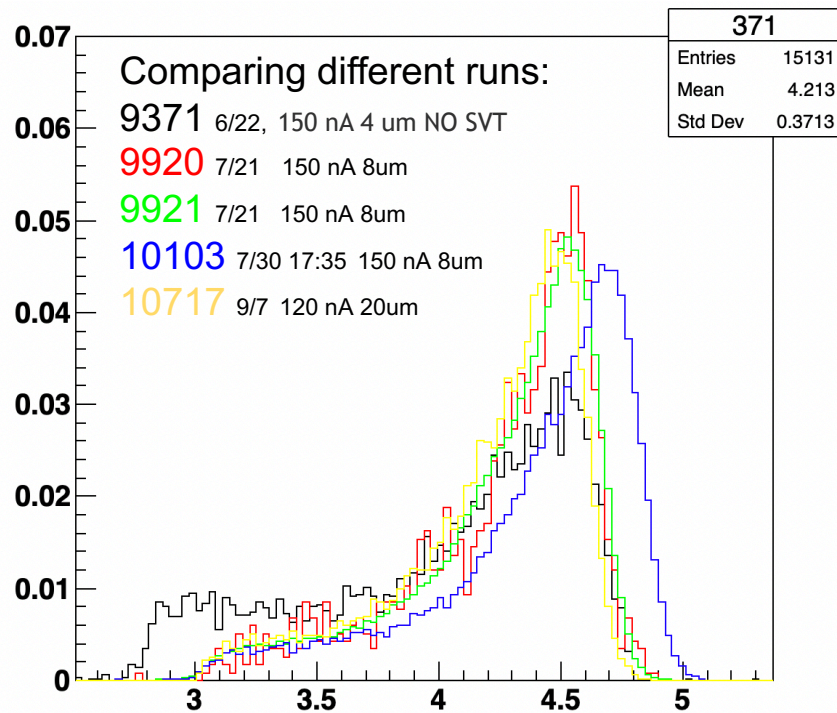
Gain Calibration - Cosmics

- Acquired weeks of cosmics before the run, and enough after the run for a comparison
- Generally similar, larger variation after the run, some evidence of gain drop
- With only cosmic gains, $\sim 4\%$ resolution on 4.5 GeV e^- and $e^- \gamma$, and within 10% of nominal beam energy



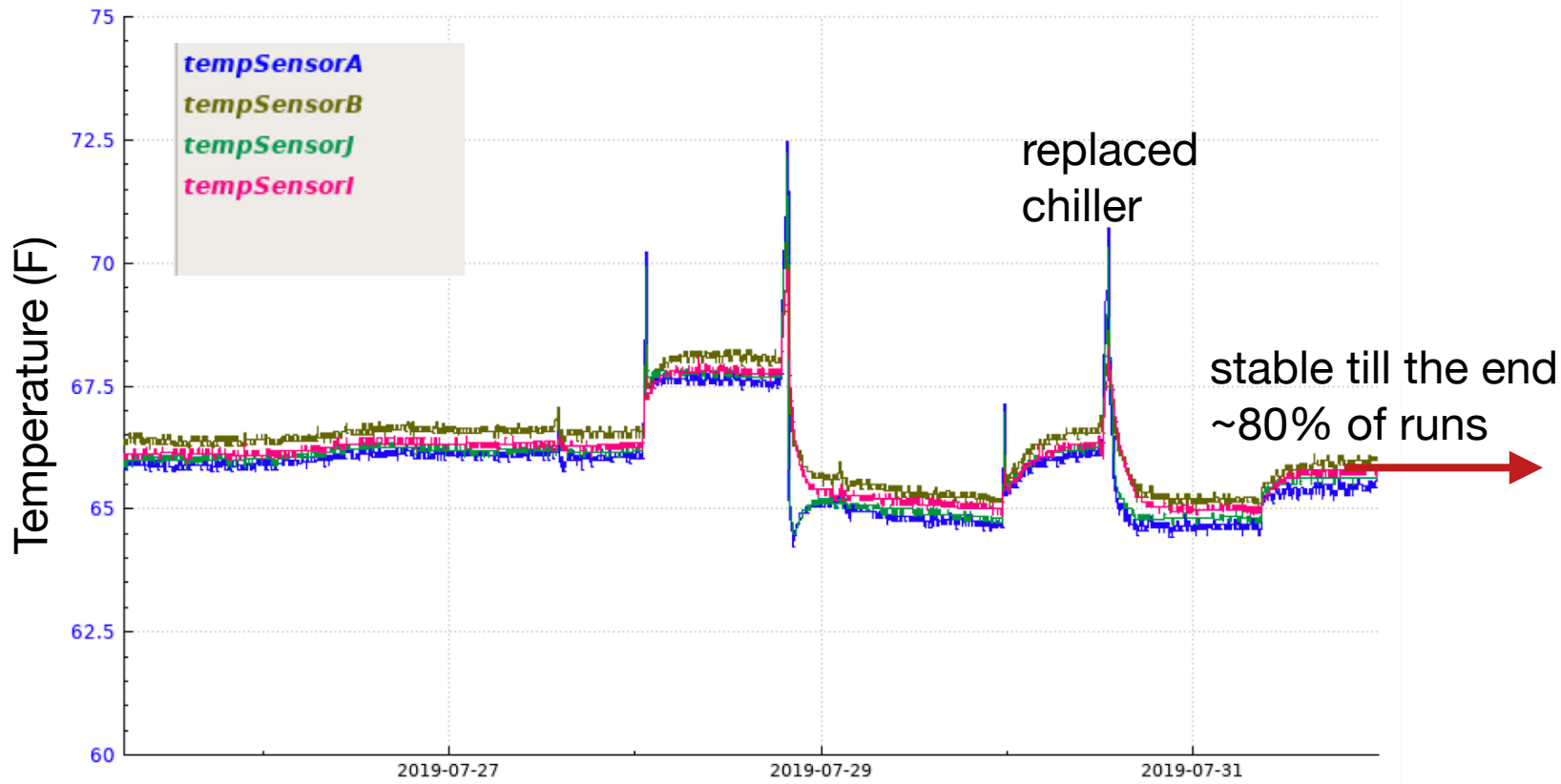
Gain Calibration - FEEs

- Calculate gain scale factors to put FEE peak at the MC value for each crystal
- Based on fitting data and MC with Crystal Ball function shape
- Same procedure and software used for 2015/2016 gain calibrations
- Iterative procedure, assigning gain to seed
- Started with dedicated FEE trigger runs
- Noticed a run-dependence, correlates well with temperature in terms of sign and magnitude ...



Gain Calibration - Cooling Issue

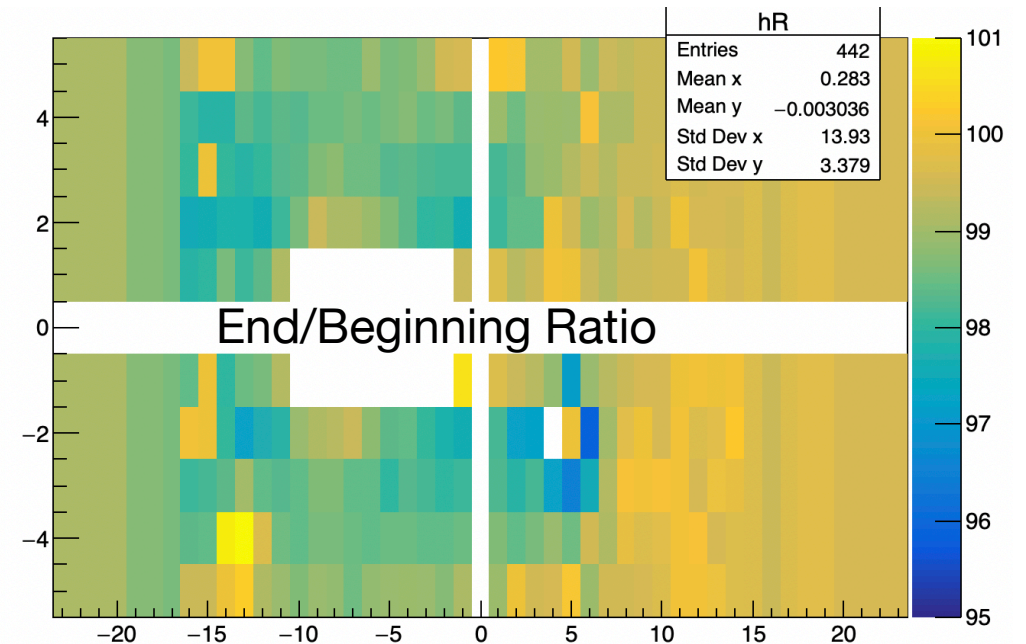
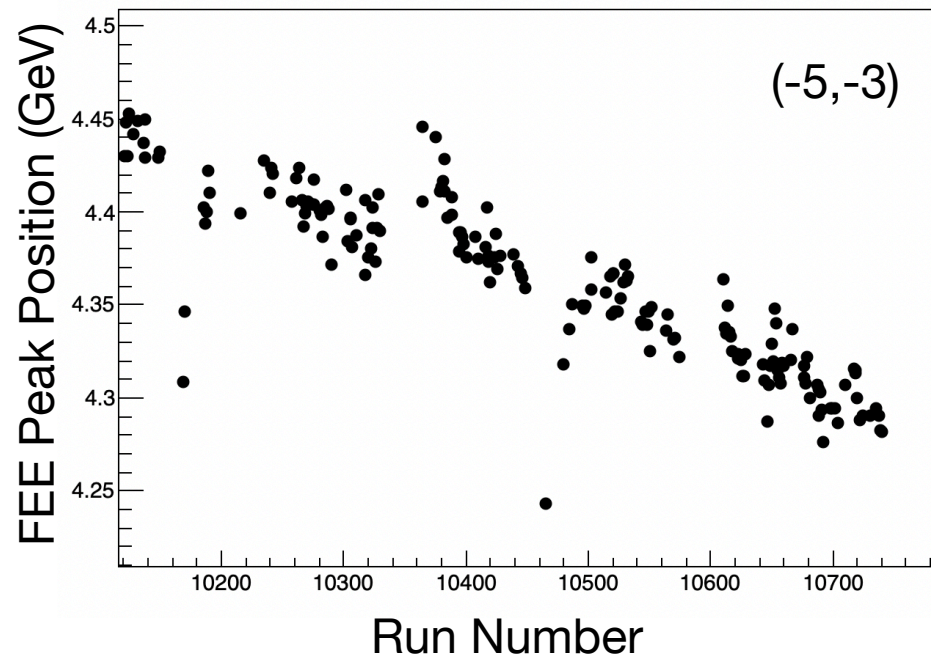
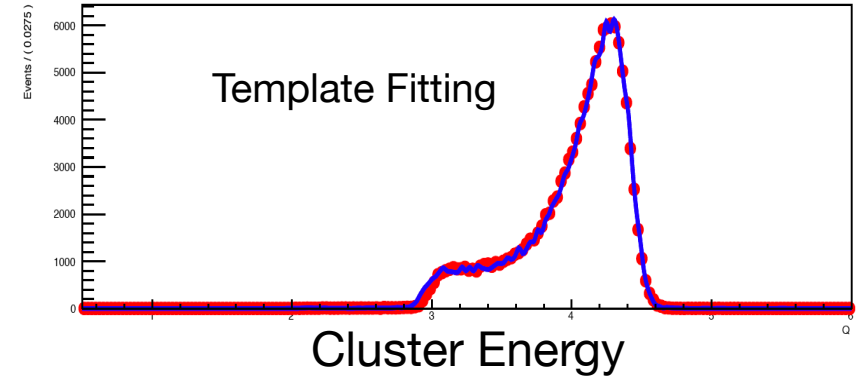
- After power outage during commissioning, chiller started to significant issues with cooling ability
- Eventually replaced it, before *most* production running, and after that no temperature stability issues
- Divided data after the power outage into 6 temperature periods, calibrated independently with FEEs



#	From	To	Run range	Events
1	25/7 06:00	28/7 01:05	10004-10064	At the end, chiller stopped: https://logbooks.jlab.org/entry/3711089
2	28/7 02:00	28/7 19:30	10065-10069 (10070 junk?)	At the end: https://logbooks.jlab.org/entry/3711453
3	29/7 00:01	29/7 22:30	10072-10084 (10085 junk?)	https://logbooks.jlab.org/entry/3711954
4	30/7 00:01	30/7 11:30	10087-10093	At the end: new chiller replacement (https://logbooks.jlab.org/entry/3712197)
5	30/7 16:30	31/7 08:45	10101-10115	At the end: chiller temp changed from 15 to 15.5 according to MYA. Nothing on logbook.
6	31/7 08:44	end	10115-end	Golden Period

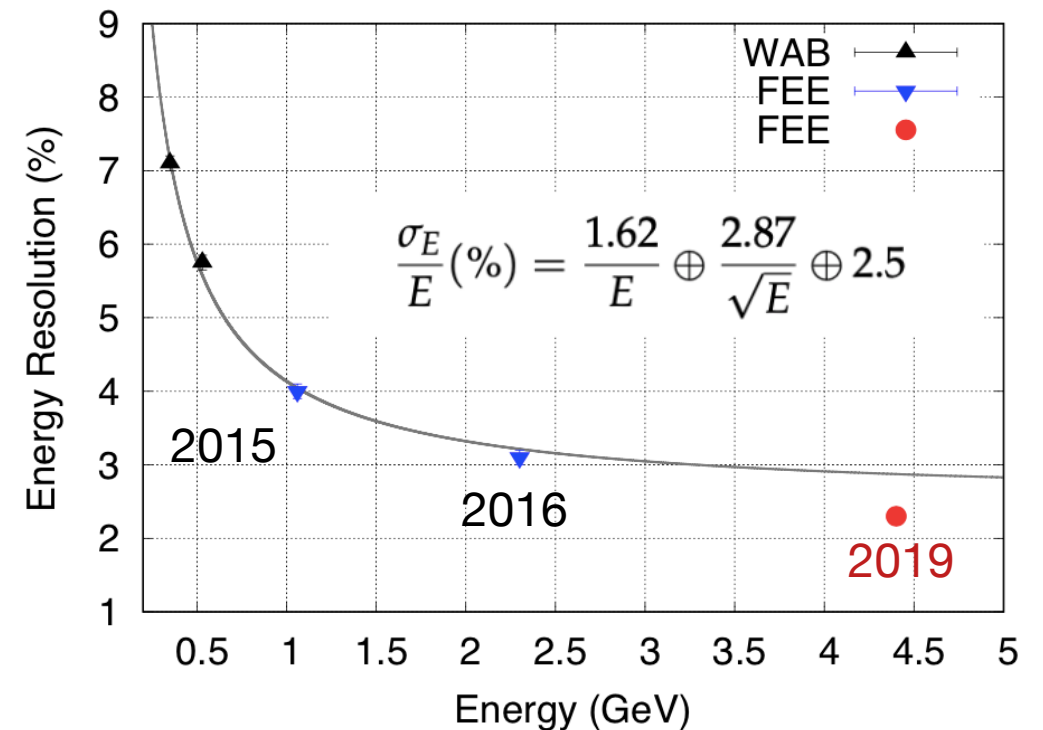
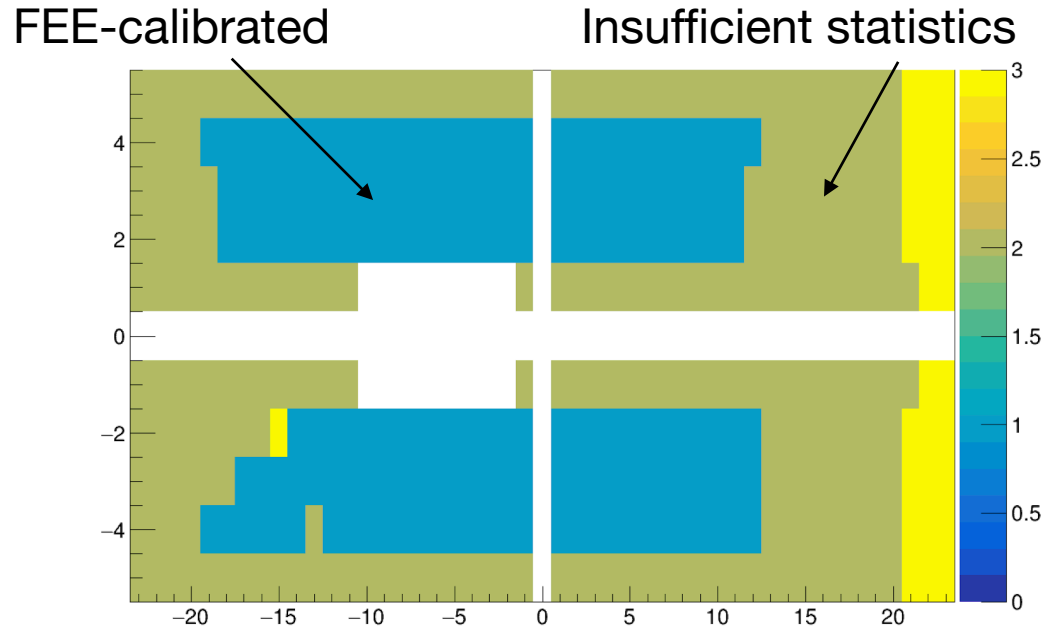
Gain Calibration - Time Evolution

- Linear drop in gains with time/run# through the golden period, presumably beam-induced
- Effect correlated with rate, e.g. largest near the beam pipe and negligible at large-x
- Extracted run-dependent corrections, single channel when possible, otherwise local groups of channels
- Using template fitting and skims of all FEE triggers throughout production runs
- Up to a ~2% effect from beginning to end of golden period



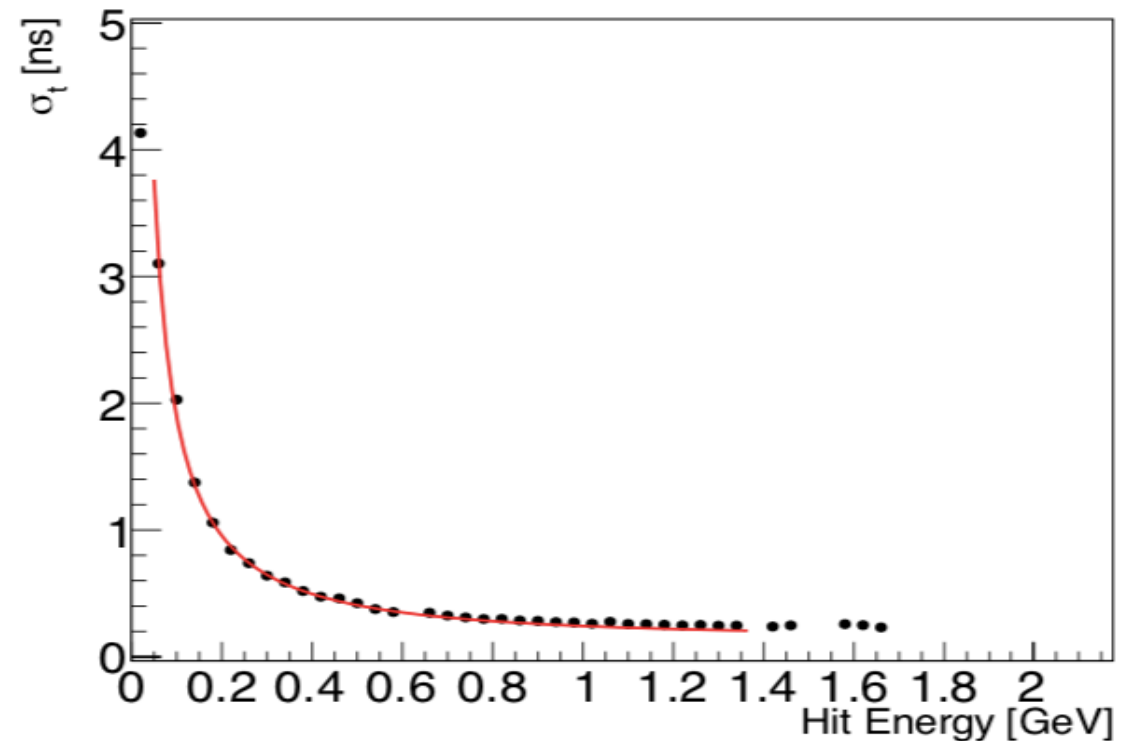
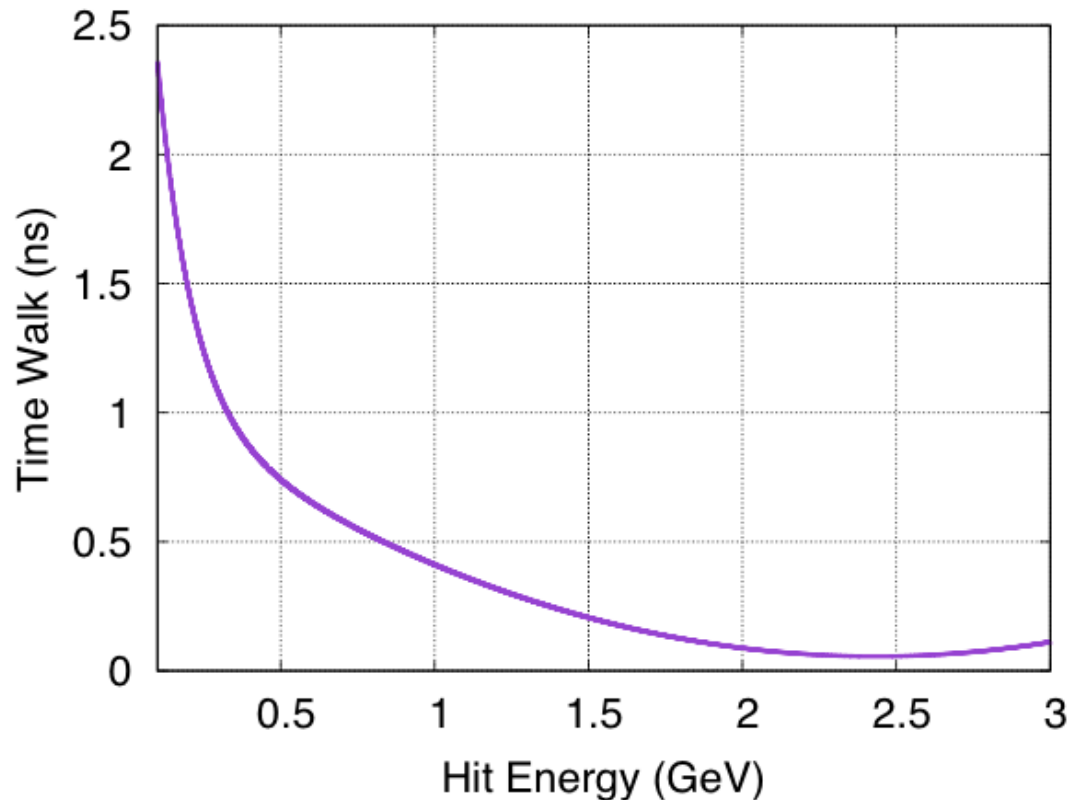
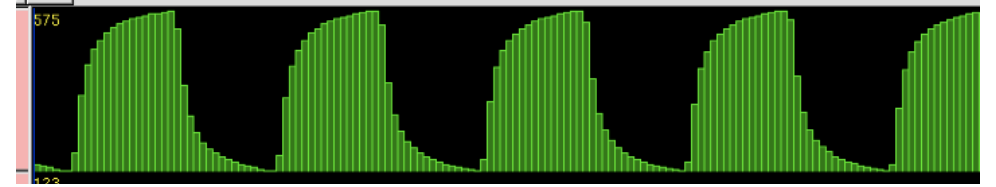
Gain Calibration - FEEs

- After FEE calibration, preliminary resolution at 4.5 GeV is ~2%, which is roughly as projected by our published resolution curve
- Coverage is less than at our previous 1 or 2 GeV beam energies
 - at large scattering angles, not surprisingly
 - 1st row becomes difficult to fit, but not the case in pure 4 GeV FEE simulations
 - currently cosmics gains are used where FEEs do not reach, as in previous runs, with appropriate scaling factors
- Additional methods would be needed to extend high-energy calibration coverage
 - new FEE technique assigning non-seeds, tracks, WABs ...



Timing

- RF pulses extracted
 - hardware mapping changes resolved, software in master branch
- 2016 time walk correction revisited
 - it's fine except above 2.3 GeV, above which we can just truncate the correction
- Single channel offsets in progress, must pick up the pace and finish this month ...
 - generally resolutions looking very similar to previous runs



Summary - Calibration Status

- Weekly calibration meetings, Tuesdays @ 11:00:
 - <https://confluence.slac.stanford.edu/pages/viewpage.action?pageId=263756689>
- Alignment (Nathan)
 - survey implemented in v2 detectors
 - to be supplemented/revisited with final tracking alignment
- Energy (Andrea & Luca)
 - single-channel gains
 - FEEs done, complemented by cosmics
 - in conditions database in ~35 run ranges
 - may later be extended to WABs or tracks for more non-cosmic coverage if necessary
 - **simulations performed for "sampling" fractions and edge loss corrections, extraction soon**
- Timing (Nathan)
 - 2019 RF hardware changes implemented in software
 - time-walk checked against 2016 parameterization
 - **preliminary offsets extracted, finalize this month**
- Position corrections
 - **next ...**