GLAST Large Area Telescope:

TKR Calibrations

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TKR

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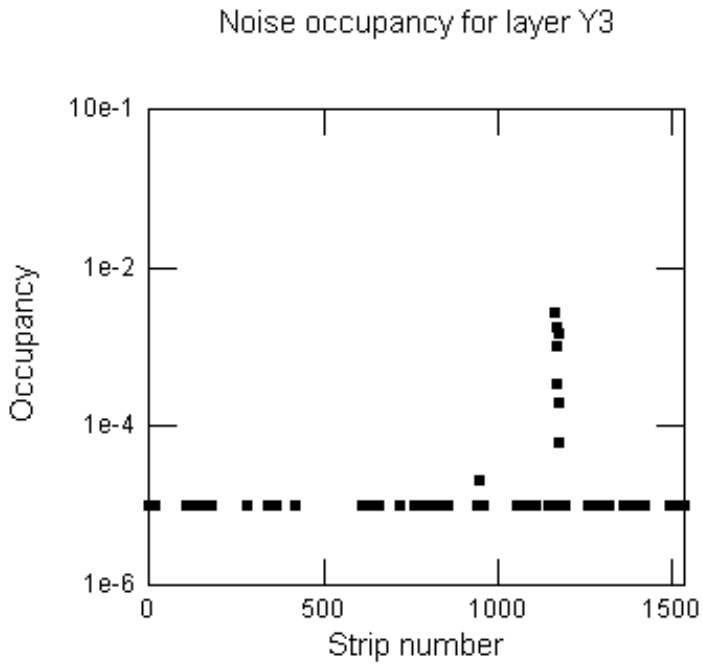
TKR Parameters to be Calibrated

- **Bad channels.**
  - Noisy channels.
    - Masked online to reduce excess data rate.
  - Dead/disconnected channels.
    - Not used for mask.
    - Used in offline analysis to account for missing hits.
- **GTFE DACs**
  - Calibration DAC (One DAC per GTFE)
    - Charge scale needs to be calibrated for each GTFE.
    - Channel level dispersion is expected to be small.
  - Threshold DAC (One DAC per GTFE)
    - Tuning of DAC to nominal threshold (1.4 fC ~ 0.27 MIP)
- **TOT**
  - TOT as a function of input charge (calibration DAC)

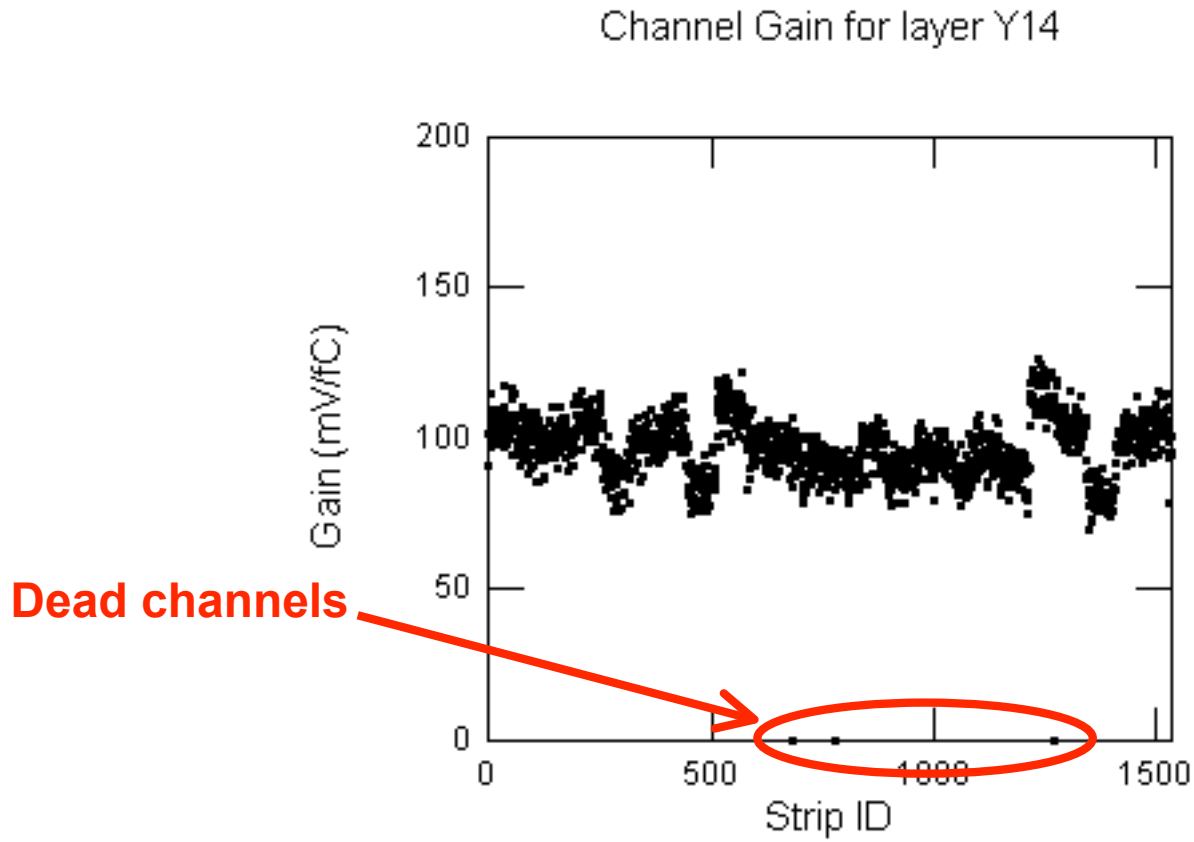
Noisy Strips

- High noise occupancy strips need to be identified and masked.
  - Specification
    - Trigger: < 5×10^{-5} (strip average)
    - Data: < 10^{-4} (strip average)
- Noise occupancy <10^{-2} will be sufficiently quite for offline analysis.
- For now, limit is set conservatively.
  - Any strip above 10^{-4} is masked.
- On orbit, noisy channel should be determined based on average GTRC data rate.
  - Retain as many strips as possible for offline use.
  - No fixed threshold



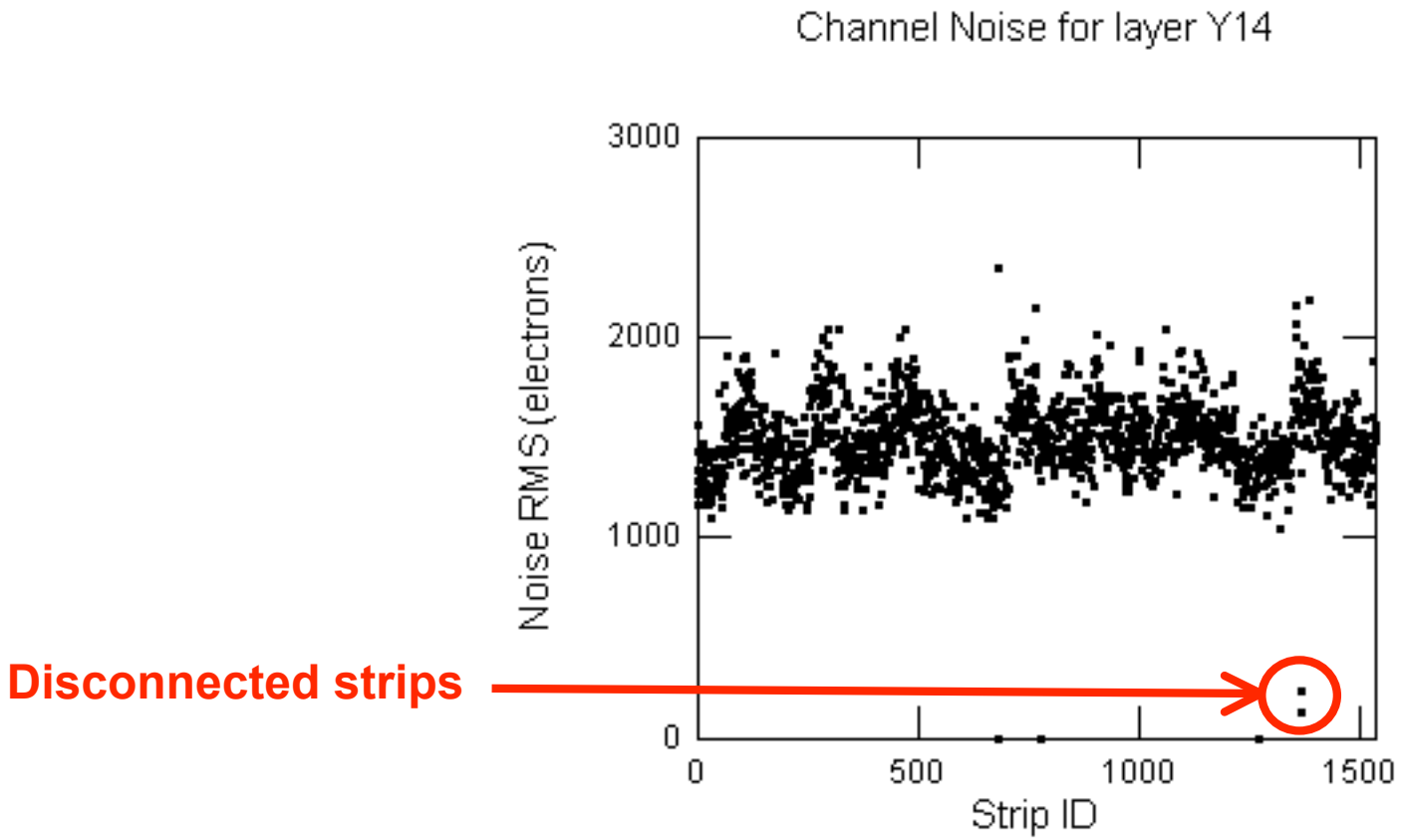
Dead Channels

- **Dead channels are dead amplifier channels.**
  - **No data from charge injection.**
  - **Shows up as zero gain channels in gain measurement.**



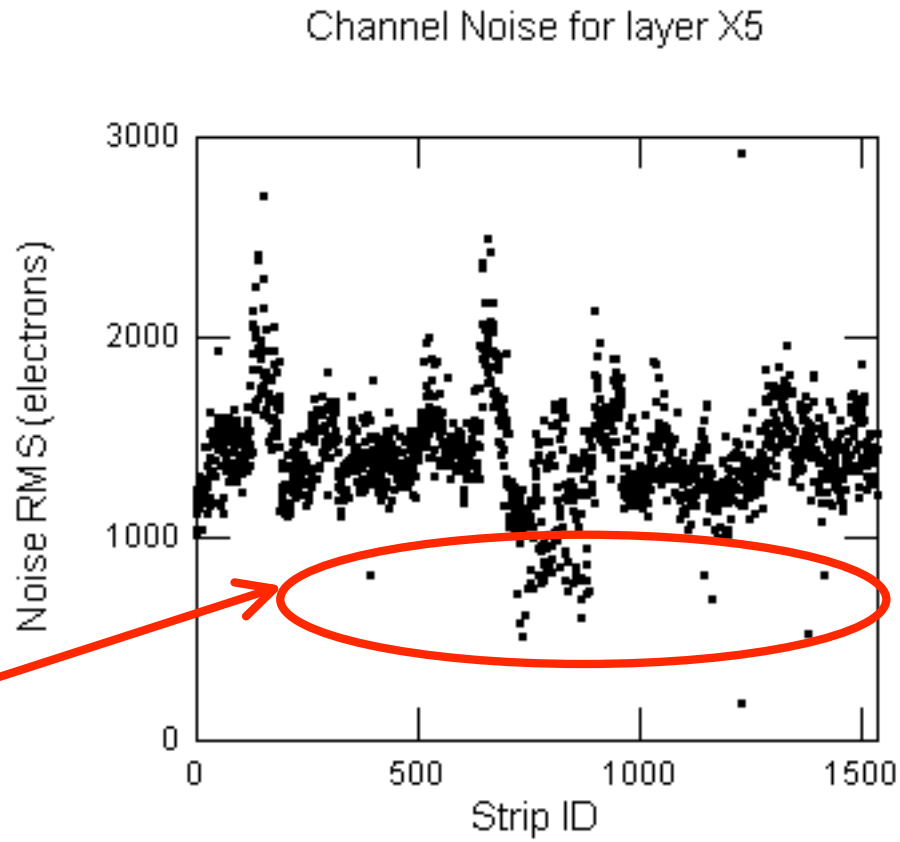
Disconnected Strips

- **Disconnected strips are due to broken connection between amplifier and silicon strip.**
  - **Shows up as very low noise channels.**
    - **Noise < 500 electrons.**



Partially Disconnected Strips (Noise)

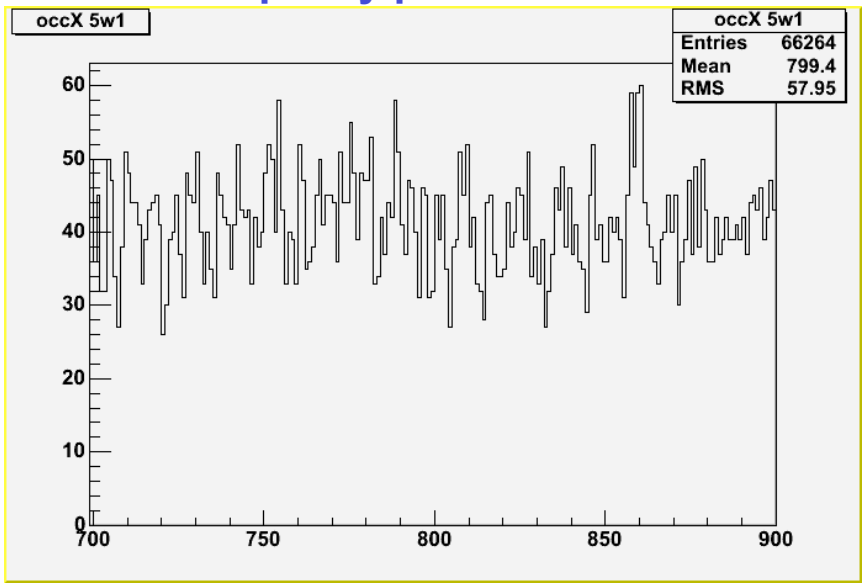
- **Partially disconnected strips are due to broken connection between SSDs.**
  - **Shows up as intermediate noise channels.**
    - **Not to easy to distinguish them from quite GTFEs.**



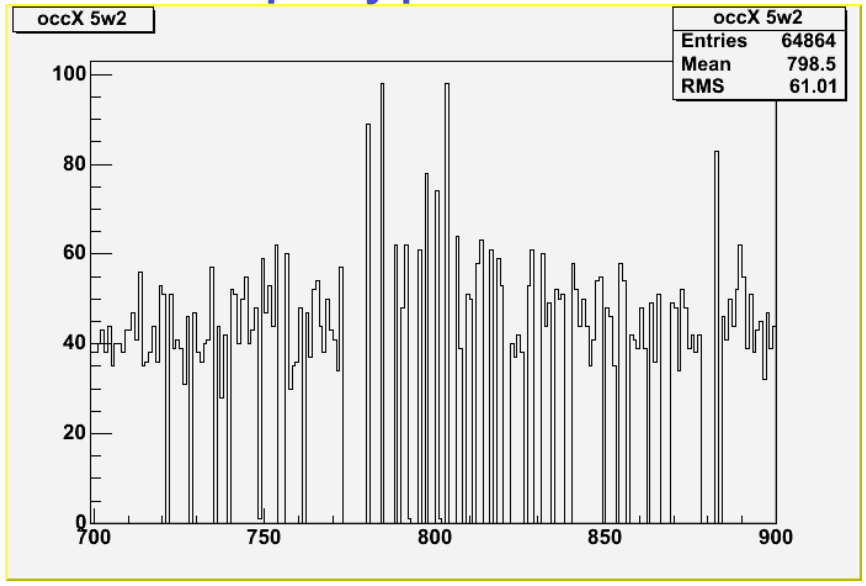
Partially Disconnected Strips (Occupancy)

- **It is easier to identify partially disconnected strips from strip occupancies.**
  - **Use track information to determine the associated SSD.**
  - **Occupancy drops to 0 if connection is broken.**
  - **Important to keep track of history.**

Occupancy plot for X5 SSD1



Occupancy plot for X5 SSD2



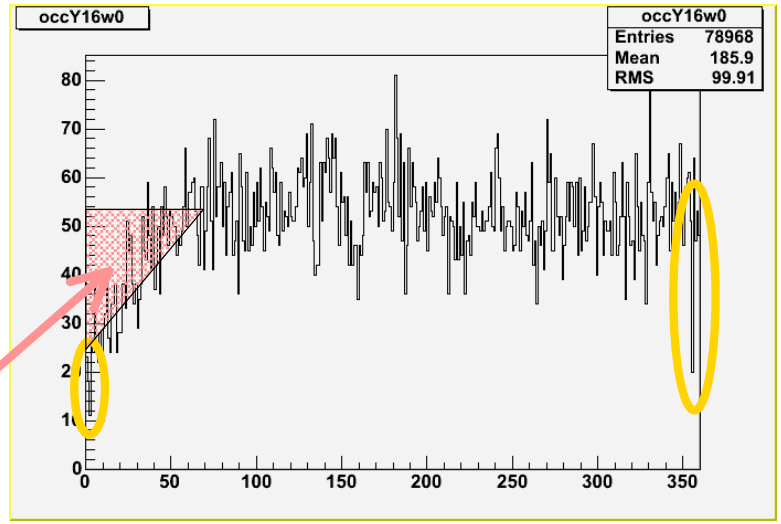
Intermittently Disconnected Strips

- **Intermittently disconnected strips make life more interesting.**

Layer	strip #	Occupancies			
		SSD0	SSD1	SSD2	SSD3
X2	1441	0	0	0	0
	1446	5	3	4	7
	1447	0	0	0	0
Y3	863	0	0	0	0
	870	17	9	20	8
	875	0	0	0	0
X16	1535	10	20	19	15
Y16	2	34	24	31	11
	35	8	14	14	20

- Occupancy is not sufficient to reliably identify intermittent strips.
- Efficiency is complimentary to occupancy
- Still work in progress

Occupancy plot for Y16 SSD3



Occupancy deficit at the edges of top and bottom 2 layers

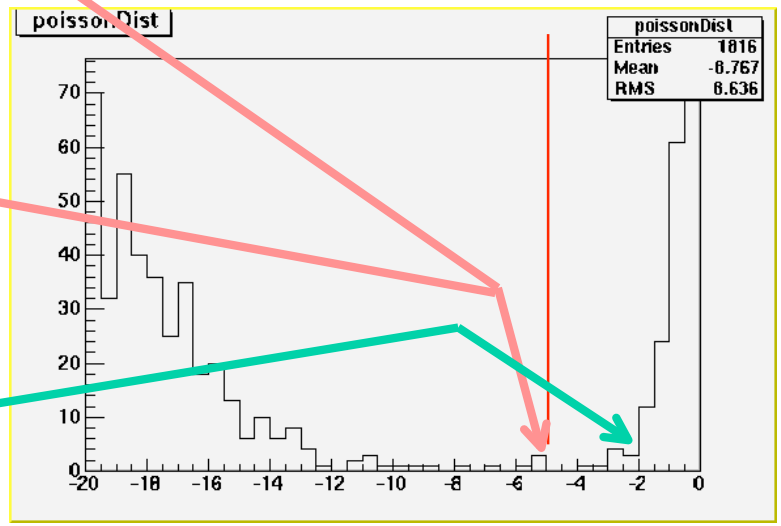
Intermittently Partially Disconnected Strips

- **Intermittently partially disconnected strips are slightly easier to identify. (although hard to pronounce…)**
  - **Occupancies in strips closer to amplifier can be used as references.**

Layer	strip #	Occupancies			
		SSD0	SSD1	SSD2	SSD3
Y3	496	39	34	8	7
	501	41	39	1	0
Y3	510	30	29	0	0
	514	37	25	5	0
	519	25	29	8	4
	523	26	36	1	1
Y3	537	45	45	1	0
	550	27	26	14	8
	556	34	24	0	0

$$F.O.M. = \log\left(\frac{f_p(occ,\mu)}{f_p(\mathrm{int}(\mu),\mu)}\right)$$

fp: Poisson probability function

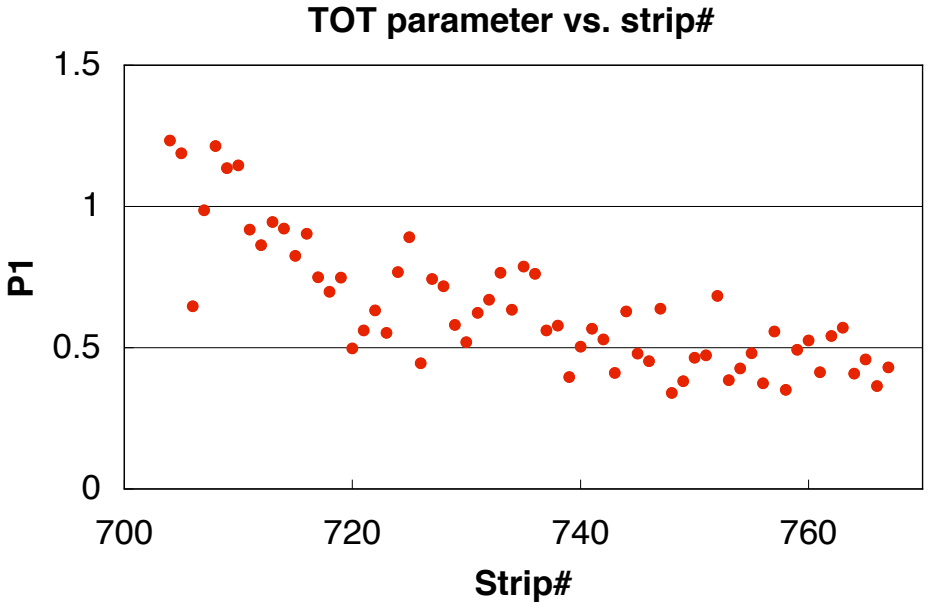


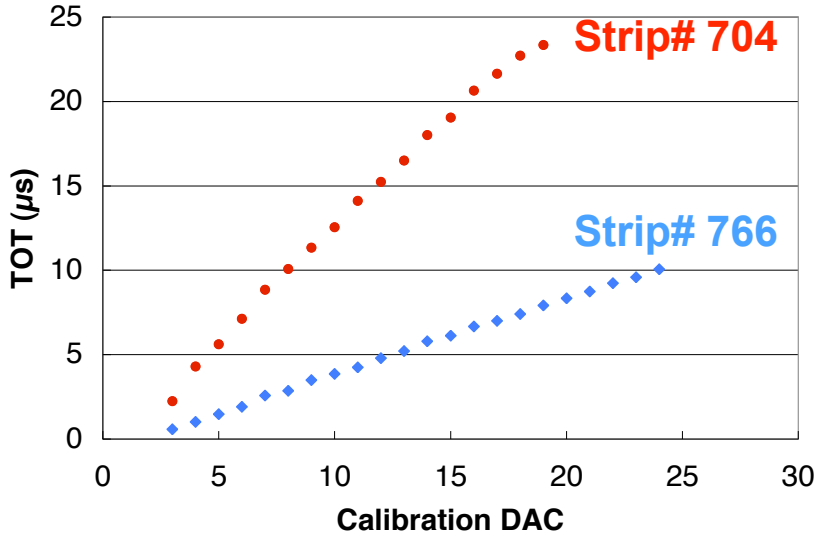
DAC/TOT Calibrations Overview

- **DAC/TOT calibration sequence**
  - **TOT-charge calibration.**
    - **Measure TOT vs. input charge and fit.**
    - **Pretend input charge (calibration DAC scale) is known.**
    - **Factor out channel dependence.**
  - **Charge scale calibration.**
    - **Muon MIP peak to calibrate input charge (calibration DAC) scale.**
  - **Threshold DAC calibration.**
  - **Second iteration of TOT-charge calibration.**
    - **TOT depends on threshold.**

TOT-Charge Calibration

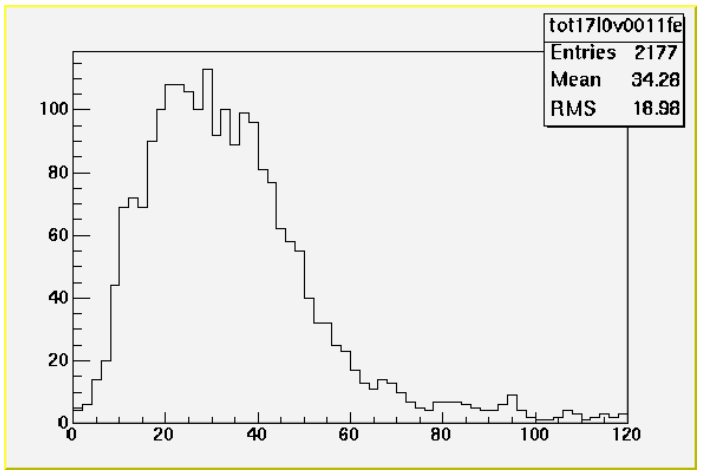
- **Charge injection test.**
  - **Measure TOT as a function of input charge.**
  - **Fit to second order polynomial.**
    - **Charge = p0 + p1*TOT + p2*TOT^2**
  - **Large dispersion of conversion parameters within GTFE.**
    - **Due to shaper circuitry limitation.**



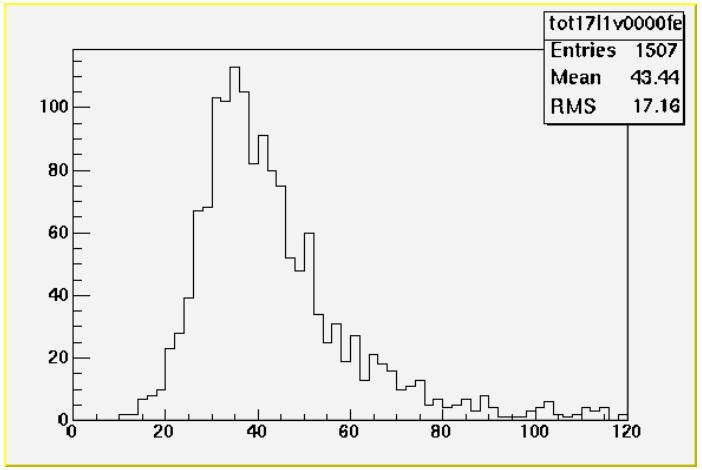


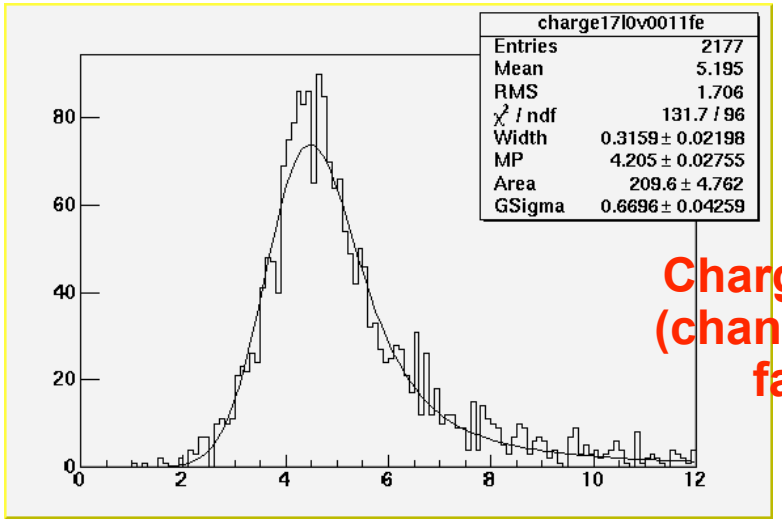
Charge Scale Calibration

- **Fit muon charge distribution for each GTFE.**
  - **Gaussian convolved Landau distribution.**

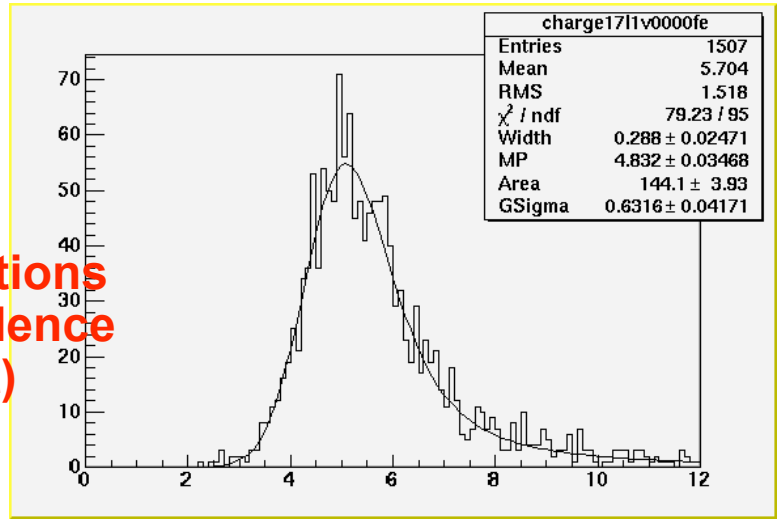


Raw TOT Distributions



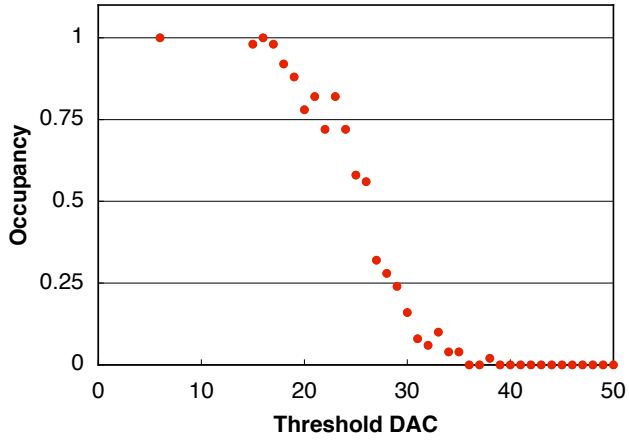


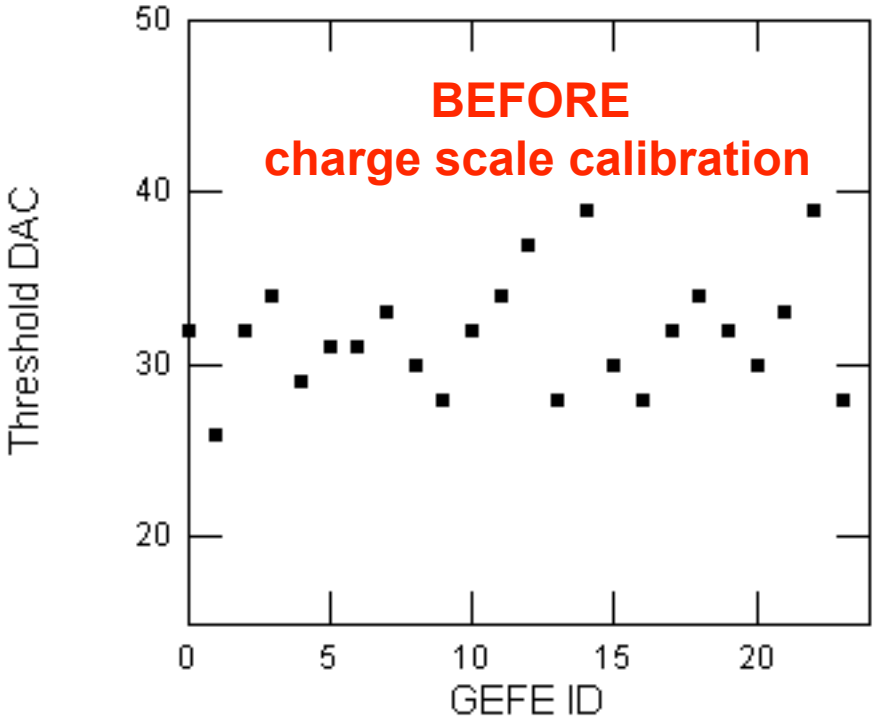
Charge Distributions (channel dependence factored out)

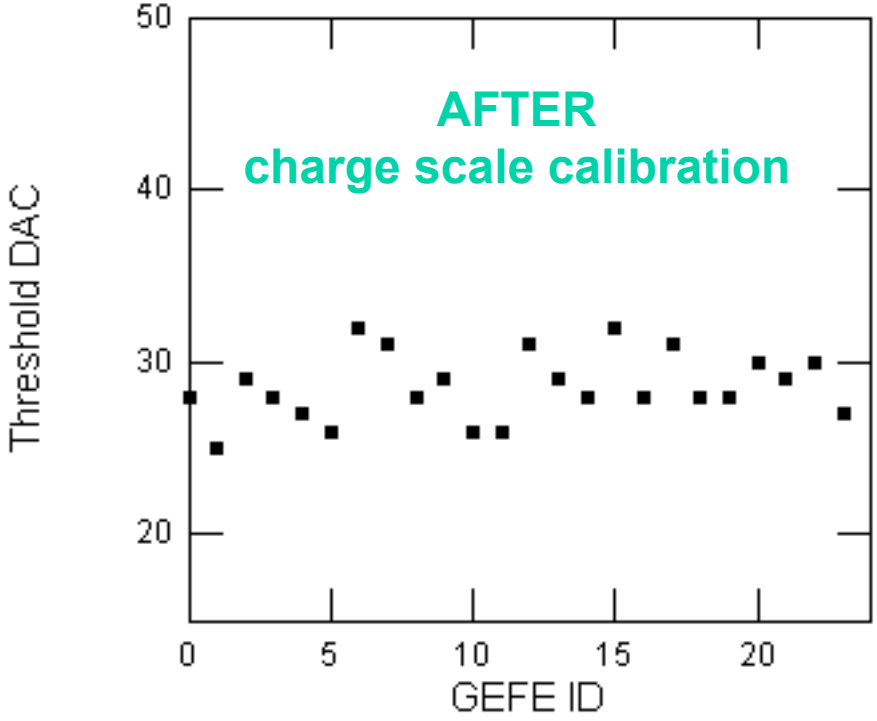


Threshold DAC Calibration

- **Scan threshold DAC for a given input charge (1.4 fC ~ 0.27 MIP)**

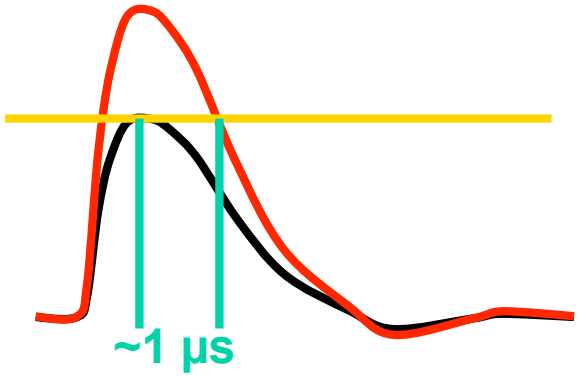






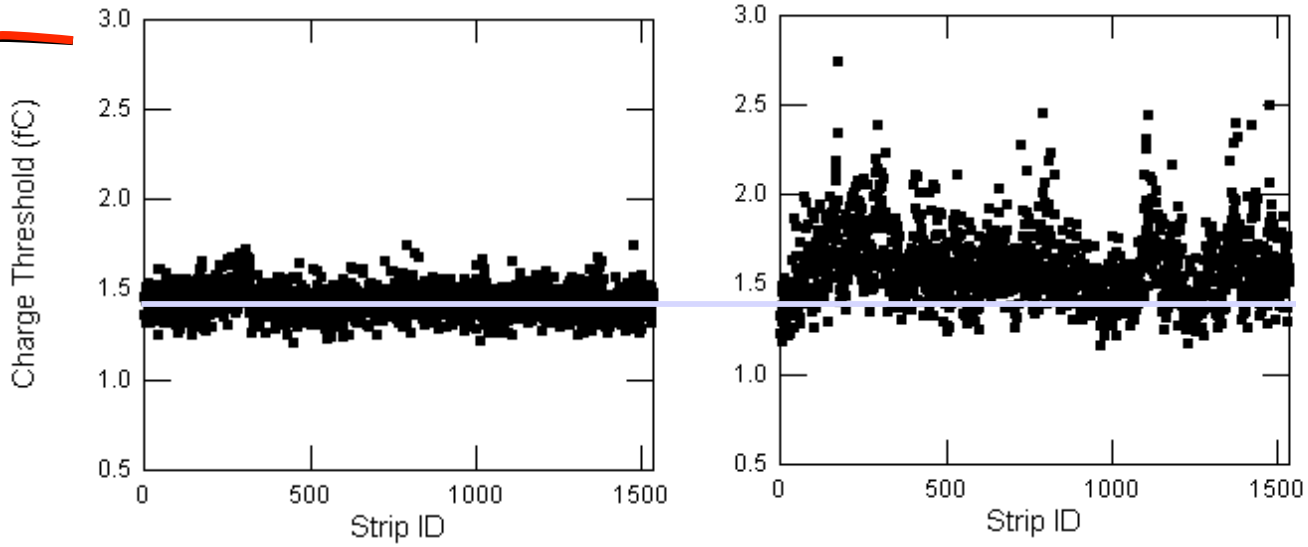
Effective Data Threshold

- **Effective data threshold is higher than the trigger threshold.**
  - **Trigger threshold: charge required to trigger at pulse peak.**
  - **Data threshold: charge required for data capture at TACK.**
    - **TACK: ~1 μs after the trigger request.**



Trigger threshold
Mean: 1.43 fC
RMS(GTFE): 4.0%
RMS(Layer): 6.2%

Data threshold
Mean: 1.58 fC
RMS(GTFE): 8.0%
RMS(Layer): 15.0%



Conclusions

- **Bad strips**
  - Identification of noisy, dead, disconnected strips is well understood.
  - Identification of partially disconnected strips is in a good shape.
  - Identification of intermittently disconnect strips (partial or not) is a challenge.
    - Reasonable solution exists.

- **DAC/TOT calibrations.**
  - Procedure in place.
  - Appear to be working as expected.
  - Needs more studies to understand the effect.
  - Data threshold dispersion is large.