Status 2024-02-19

SPD Tracker group

February 23, 2024

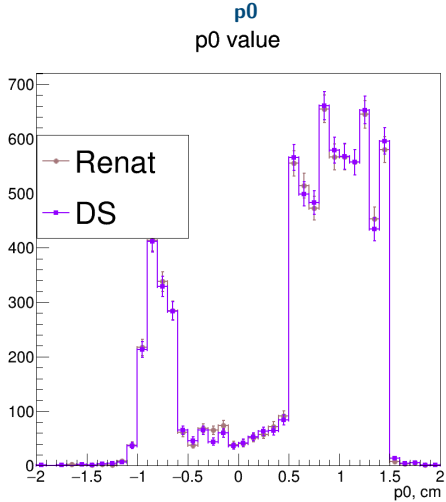
Contents

Tracking information

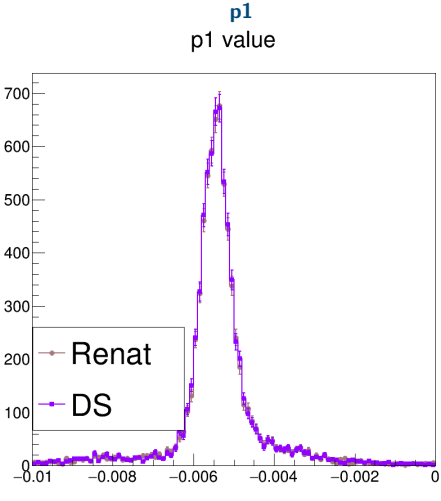
- Since end of 2022 we are using straw-stand software for:
  - Alignment (using linear 2-point fit)
  - Track reconstruction (using lsf)
- I created another procedure for fitting using pol1 LSF
  - Alignment information from straw-stand sw partially used
- While comparison with straw-stand sw I found:
  - There is no pol coefficient uncertainties
  - Used fitting with equal weights (no cluster position uncertainties used) !

Fit coefficients

p0



p1

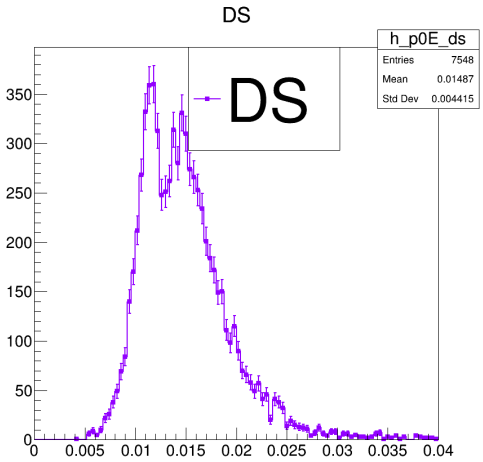


- There is no significant difference in values.
- All values in cm, for compatibility to straw-stand fit output. Will be changed to mm.

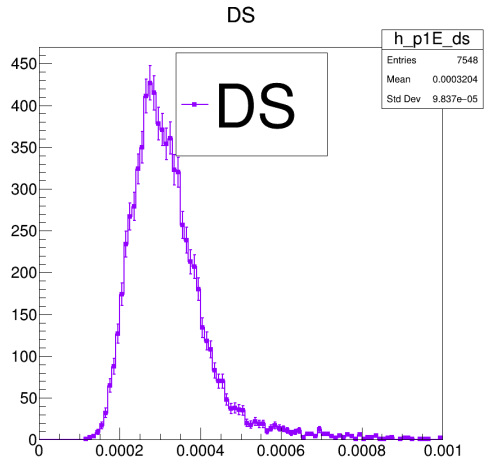
Fit coefficients uncertainties

Tracking was completed with uncertainty calculation:

p0 uncertainty



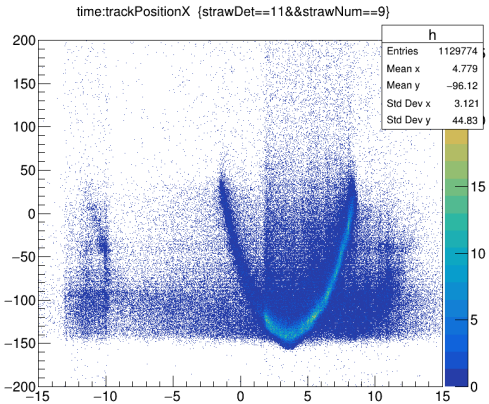
p1 uncertainty



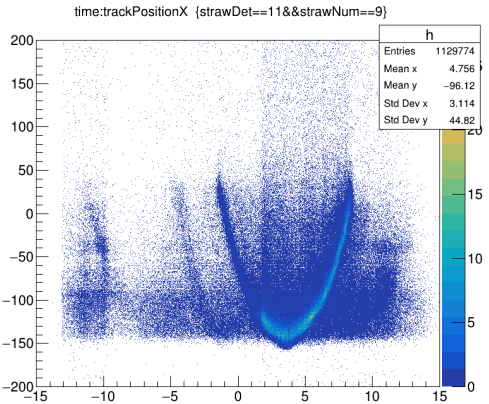
Fit with/without uncertainty

Straw 9 RT for fit with/without uncertainty:

fit with cluster position uncertainties



without cluster position uncertainties

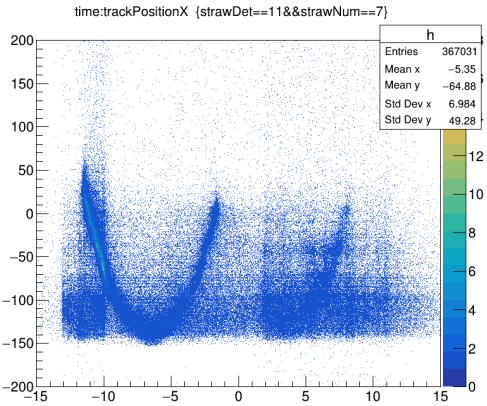


Additional RT-like lines on fit without uncertainties

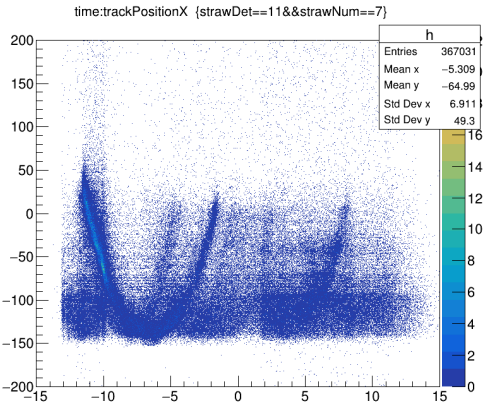
Fit with/without uncertainty

Straw 7 RT for fit with/without uncertainty:

fit with cluster position uncertainties



without cluster position uncertainties

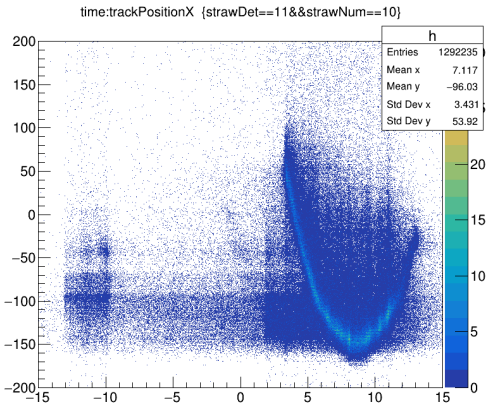


Additional RT-like lines on fit without uncertainties

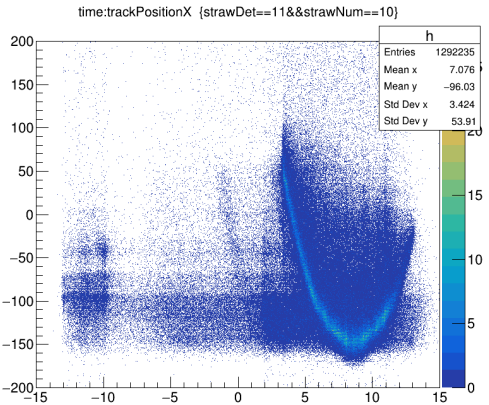
Fit with/without uncertainty

Straw 10 RT for fit with/without uncertainty:

fit with cluster position uncertainties



without cluster position uncertainties

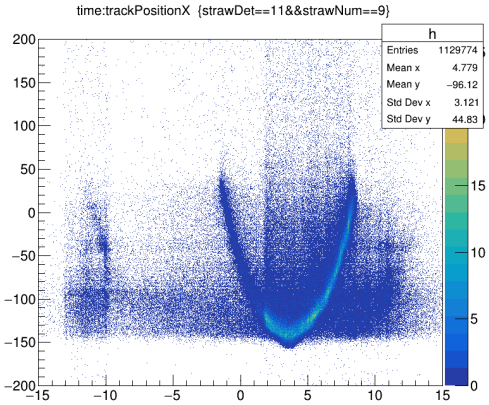


Additional RT-like lines on fit without uncertainties

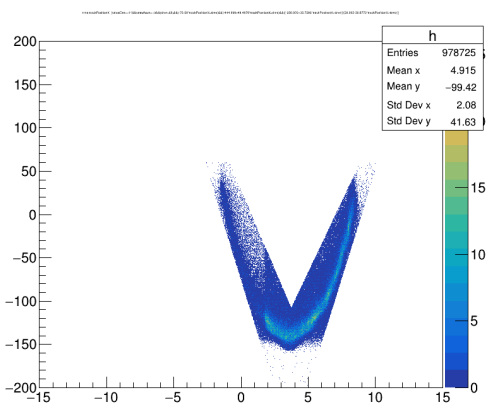
Events outside RT

Cut for select events within/outside RT

All events



RT-only cut



Events outside RT

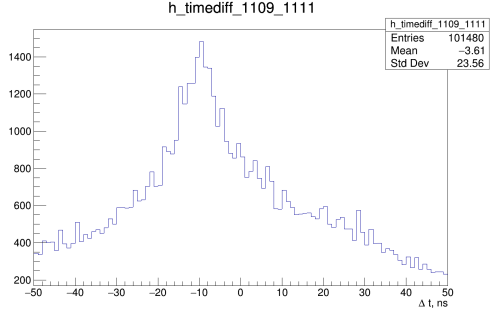
Calculated the percentage of events within RT for different merging window (maximal calculated time difference between scintillator hits in VMM and TIGER)

Window, ns	Fit with unc., %	Fit without unc., %
10	87.17	86.5
20	87.03	86.3
25	87.06	86.4
30	86.99	86.3
50	86.98	86.3
100	86.95	89.0
100, full stat	86.63	85.86

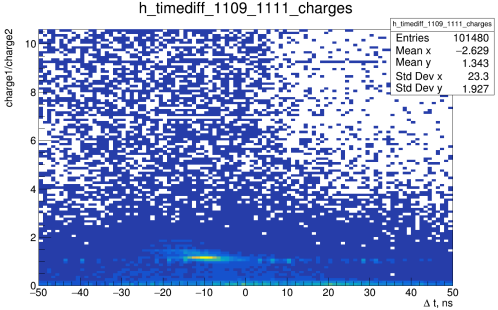
X-talks

I checked event data, I can see some x-talk-like hits to 10mm straw 9.
(clear x-talks – when I have large number of events with the same time on other straw)

Time difference between hits in 10mm straw 9 and 10mm 11



Charge ratio difference between hits in 10mm straw 9 and 10mm 11

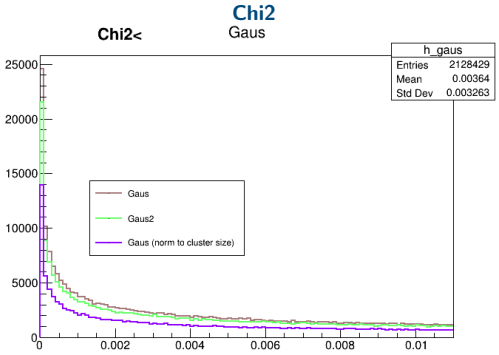


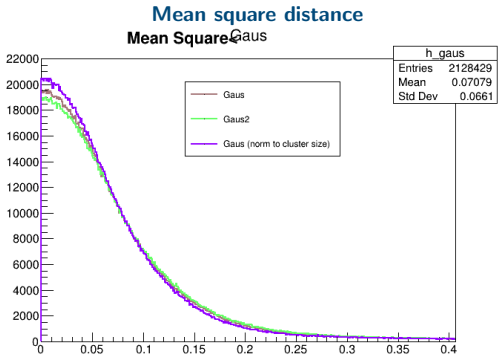
Clustering

Methods checked

- Gaus2 (**used up to 2024-02-19**)
  - Cluster center: $\bar{x} = \frac{\sum c_i x_i}{\sum c_i}$, where x – strip coord, c – charge
  - Uncertainty: $\sigma^2 = \frac{\sum (x_i - \bar{x})^2 \cdot c_i^2}{\sum c_i^2}$
- Gaus
  - Cluster center: $\bar{x} = \frac{\sum c_i x_i}{\sum c_i}$, where x – strip coord, c – charge
  - Uncertainty: $\sigma^2 = \frac{\sum (x_i - \bar{x})^2 \cdot c_i}{\sum c_i}$
- Gaus-scaled (**the most logically-defined, used now**)
  - Cluster center: $\bar{x} = \frac{\sum c_i x_i}{\sum c_i}$, where x – strip coord, c – charge
  - Uncertainty: $\sigma^2 = \frac{1}{N} \frac{\sum (x_i - \bar{x})^2 \cdot c_i}{\sum c_i}$
- Geom (geometrical mean, mean square minimization)
  - Cluster center: $\bar{x} = \frac{\sum x_i}{N}$, where x – strip coord
  - Uncertainty: $\sigma^2 = \frac{\sum (x_i - \bar{x})^2}{N}$
- Geom-scaled
  - Cluster center: $\bar{x} = \frac{\sum x_i}{N}$, where x – strip coord
  - Uncertainty: $\sigma^2 = \frac{1}{N} \frac{\sum (x_i - \bar{x})^2}{N}$

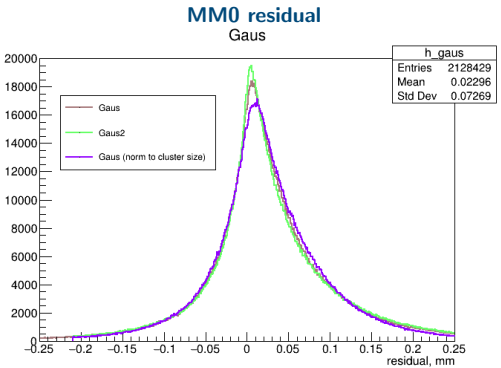
Comparison uncertainty calculation methods

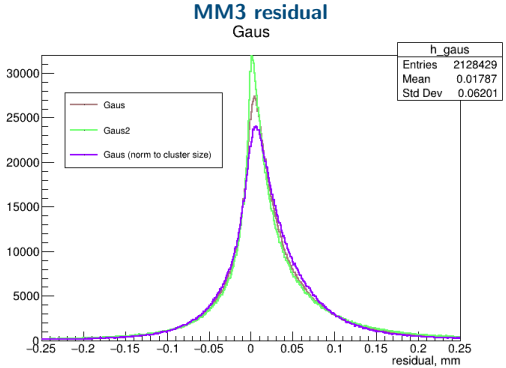




The most reasonable method (gaus-scaled) is the best?

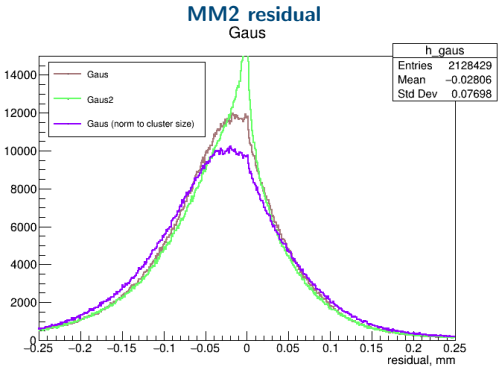
Comparison uncertainty calculation methods





The most reasonable method (gaus-scaled) is the best?

Comparison uncertainty calculation methods

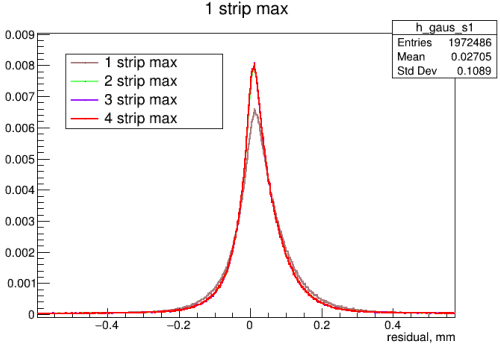


The most reasonable method (gaus-scaled) is the best?

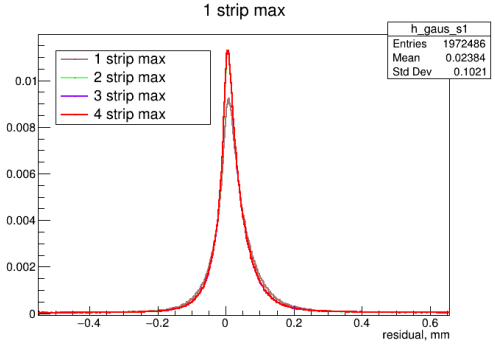
Comparison uncertainty: cluster

We require the maximal “empty” space inside cluster not greater 4 strips. Checking that value.
Gaus-scaled methor was used.

MM0 residual



MM3 residual



Comparison uncertainty: table

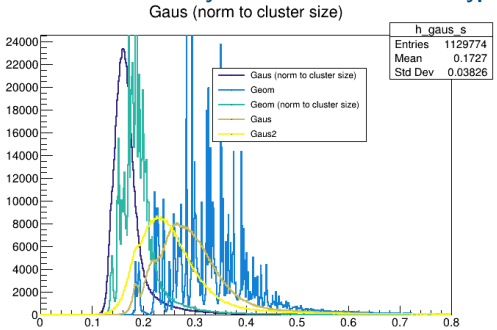
Residual at MM0

type	1 strip max	2 strip max	3 strip max	4 strip max
Gaus; Uncertainty $= \sigma_{gaus}$				peak 8μm $\sigma = 19\mu$m fit $[-0.01; 0.02]$ unsymmetrical peak
Gaus; Uncertainty $= \sigma_{gaus}/\sqrt{N}$	peak 15μm $\sigma = 33\mu$m fit $[-0.02; 0.04]$	peak 12μm $\sigma = 26\mu$m fit $[-0.01; 0.03]$	peak 11μm $\sigma = 26\mu$m fit $[-0.02; 0.03]$	peak 11μm $\sigma = 27\mu$m fit $[-0.02; 0.03]$
gaus2; Uncertainty $= \frac{\sum (x-\bar{x})^2 \cdot c^2}{\sum c^2}$				peak 7μm $\sigma = 17\mu$m fit $[-0.01; 0.02]$ unsymmetrical peak

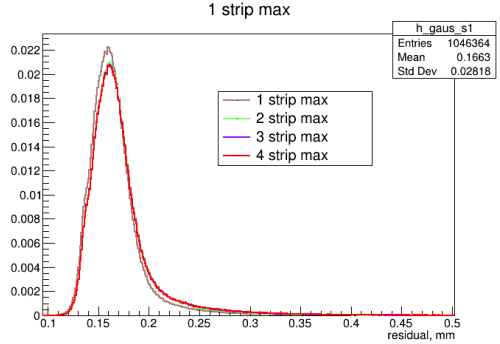
Propagated uncertainty

Calculated uncertainty on 10mm straw 9 plane:

Calculated uncertainty for different calculation types



Calculated uncertainty for different number of "empty" strips permitted (Gaus-scaled method)

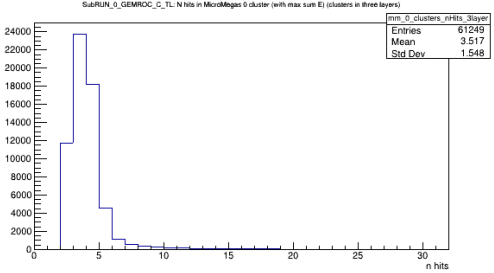


Finally, method selected:

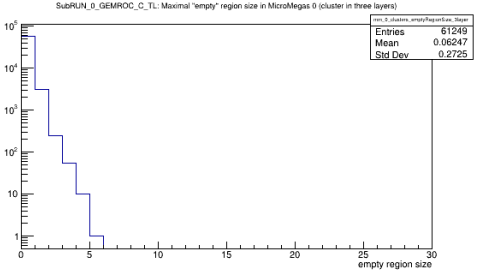
gaus, normalized to number of hits (gaus-scaled),
with 2 "empty" strips inside cluster permitted

Number of hits in cluster

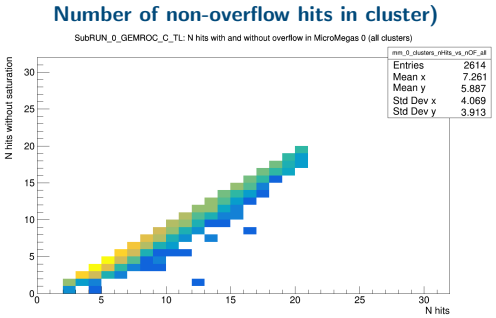
Cluster size at MM0 (with pseudotrack req.)



Size of “empty” region inside cluster, MM0



Overflow



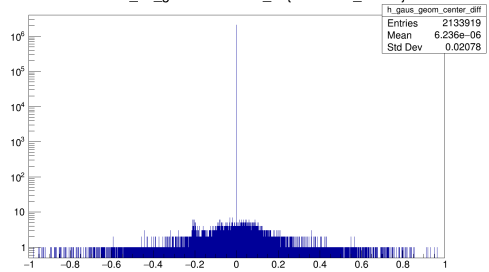
(only-overflow cluster not shown)

- Currently, overflow are hits with charge > 45 fC
- On previous plots overflow hits was removed from clusters
- Need to check the difference due to overflow removing procedure

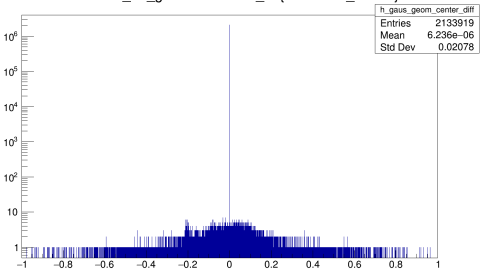
Finally, method selected:
gaus, normalized to number of hits (gaus-scaled),
with 2 “empty” strips inside cluster permitted

Overflow

MM0 cluster center difference between samples with/without overflow cut)



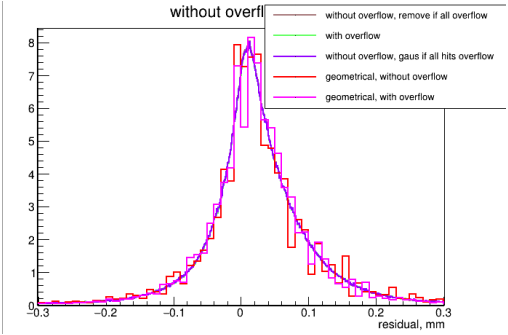
MM2 cluster center difference between samples with/without overflow cut)



No difference in cluster centers

Overflow

MM0 residual for different overflow removing method)

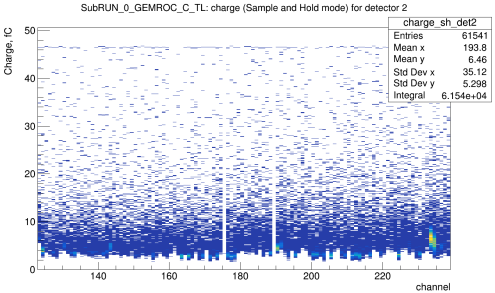


- No significant effect
- Then, overflow (charge > 45 fC) removing stays

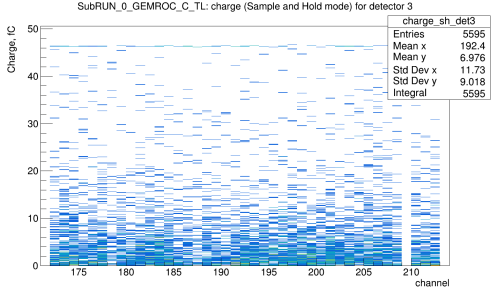
Charge at MMs

I compared charge in different MM on run TB-August-56

MM0 charge



MM1 residual

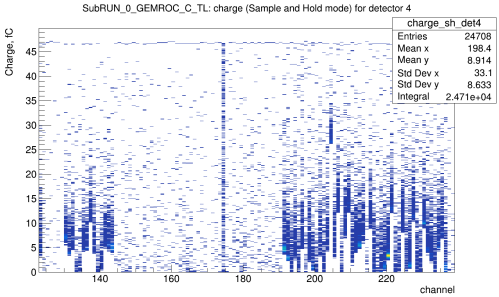


- Only MM1 tigers was fully calibrated on external pulser.
- Other tigers was calibrated on July, I believe

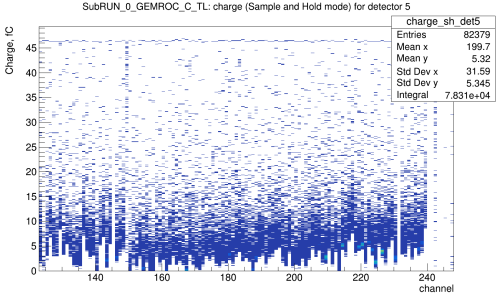
Charge at MMs

I compared charge in different MM on run TB-August-56

MM2 charge



MM2 residual



Need to check calibration on all tigers

Backup slides

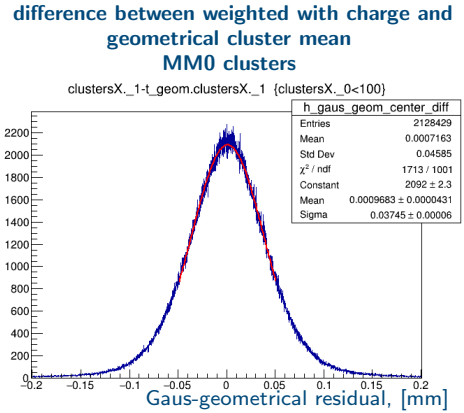
Error propogation

$$f(x) = p_0 + p_1 \cdot x$$

$$\Delta f(x0) = \sqrt{(\Delta p_0)^2 + (\Delta(p_1 x))^2}$$

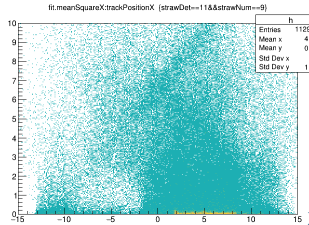
$$\Delta(p_1 x) = (p_1 x) \cdot \sqrt{\left(\frac{\Delta p_1}{p_1}\right)^2 + \left(\frac{\Delta x}{x}\right)^2} = \left|\frac{\Delta p_1}{p_1}\right| \cdot (p_1 x)$$

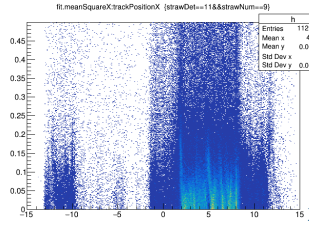
Geometrical and weighted mean



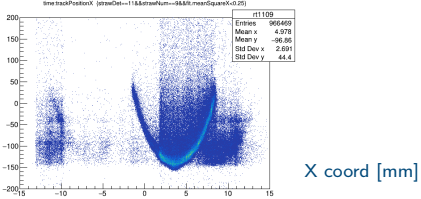
Filtering RT by mean square

Mean square distribution for 10mm straw 9

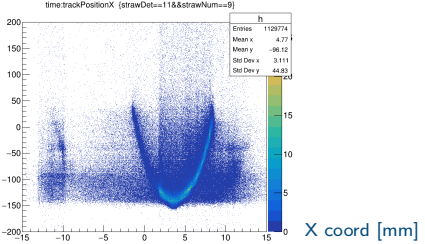




10mm straw 9 RT with mean square < 0.25mm



Reminder: without cut

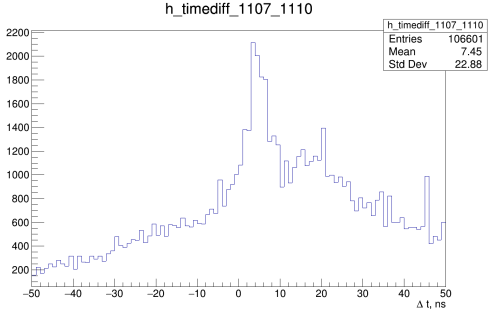


After filtering we still have some “noise” inside RT

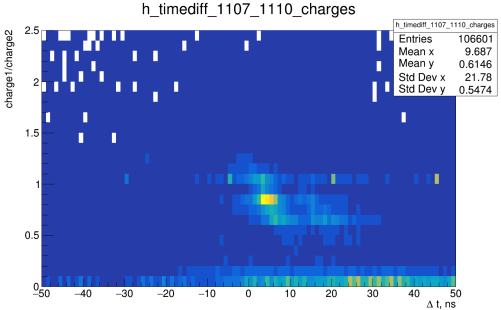
X-talks

I checked event data, I can see some x-talk-like hits to 10mm straw 9.
(clear x-talks – when I have large number of events with the same time on other straw)

Time difference between hits in 10mm straw 7 and 10mm 10



Charge ratio difference between hits in 10mm straw 7 and 10mm 10

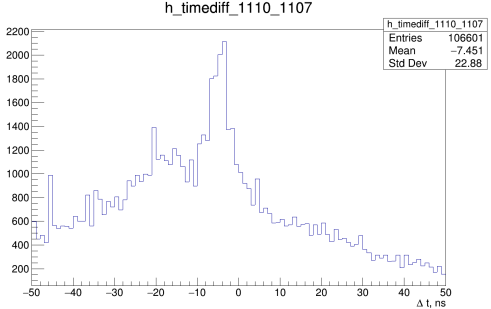


X-talk from other place to both, straw 7 and 10?

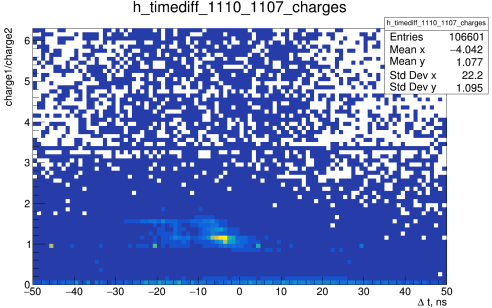
X-talks

I checked event data, I can see some x-talk-like hits to 10mm straw 9.
(clear x-talks – when I have large number of events with the same time on other straw)

Time difference between hits in 10mm straw 10 and 10mm 7



Charge ratio difference between hits in 10mm straw 10 and 10mm 7

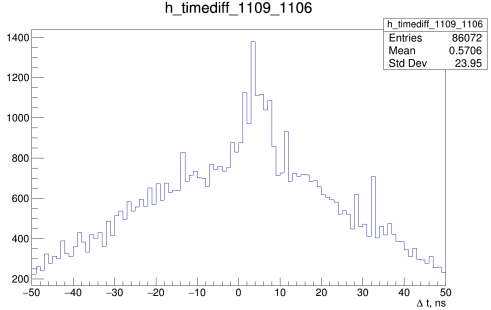


X-talk from other place to both, straw 7 and 10?

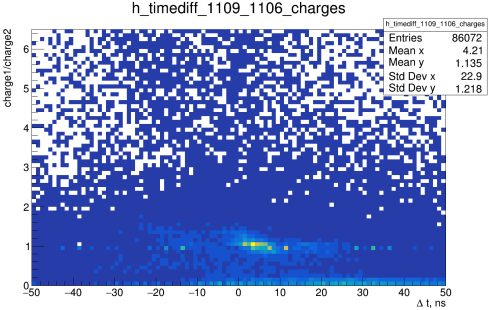
X-talks

I checked event data, I can see some x-talk-like hits to 10mm straw 9.
(clear x-talks – when I have large number of events with the same time on other straw)

Time difference between hits in 10mm straw 9 and 10mm 6



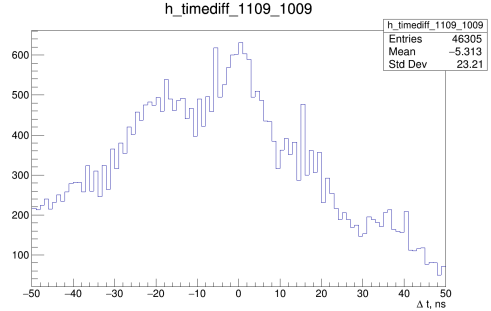
Charge ratio difference between hits in 10mm straw 9 and 10mm 6



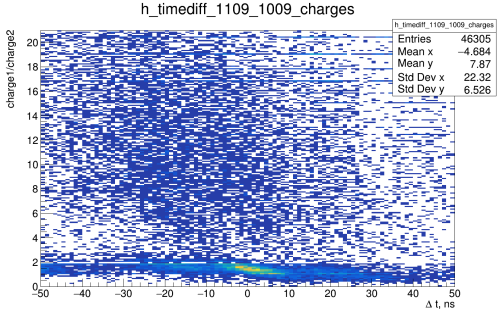
X-talks

I checked event data, I can see some x-talk-like hits to 10mm straw 9.
(clear x-talks – when I have large number of events with the same time on other straw)

Time difference between hits in 10mm straw 9 and 20mm 9



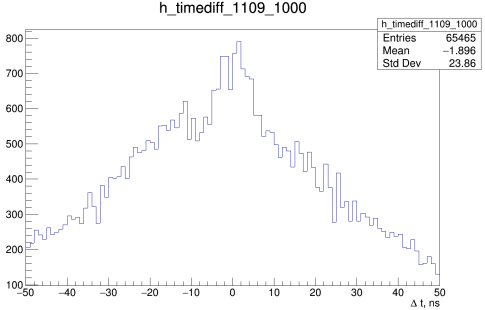
Charge ratio difference between hits in 10mm straw 9 and 20mm 9



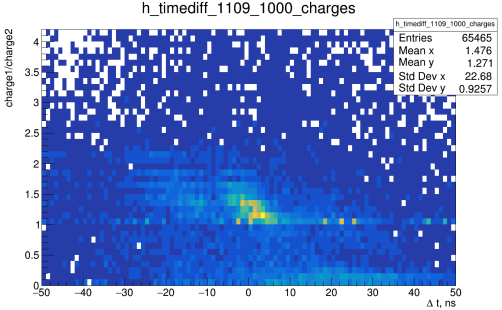
X-talks

I checked event data, I can see some x-talk-like hits to 10mm straw 9.
(clear x-talks – when I have large number of events with the same time on other straw)

Time difference between hits in 10mm straw 9 and 20mm 0



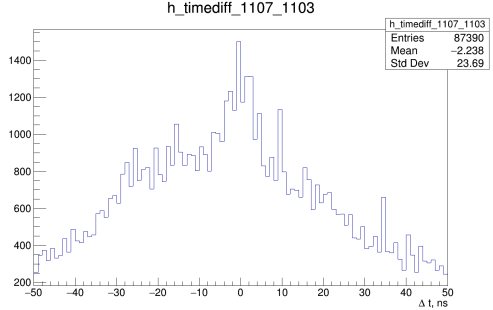
Charge ratio difference between hits in 10mm straw 9 and 20mm 0



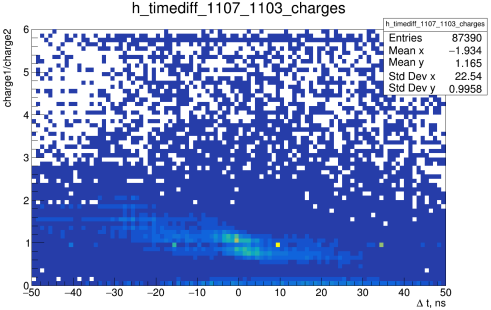
X-talks

I checked event data, I can see some x-talk-like hits to 10mm straw 9.
(clear x-talks – when I have large number of events with the same time on other straw)

Time difference between hits in 10mm straw 7 and 10mm 3



Charge ratio difference between hits in 10mm straw 7 and 10mm 3

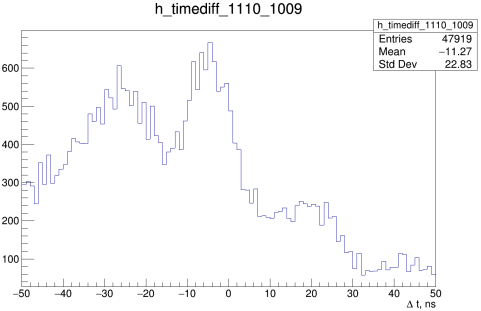


X-talks

I checked event data, I can see some x-talk-like hits to 10mm straw 9.

(clear x-talks – when I have large number of events with the same time on other straw)

Time difference between hits in 10mm straw 10 and 20mm 9



Charge ratio difference between hits in 10mm straw 10 and 20mm 9