Run table

April TB

- Parameters: 1750 V, 1 mv/fC, 100 ns slope, 25 ns peaking time
- Threshold: 209.63 mV (213 DAC counts)

VMM run	APV run	481 scintillator counts	Number of spills	Comment
0814	407	$3.0 \cdot 10^5$	4	
0826	418	$5.5 \cdot 10^5$	111	
0818	411	$8 \cdot 10^4 \rightarrow 1.4 \cdot 10^5$	1921	

July TB

- Parameters: 1750 V, 1 mv/fC, 100 ns slope, 25 ns peaking time
- Threshold: 193.86 mV (190 DAC counts)

VMM run	APV run	481 scintillator counts	Number of spills	Comment
0087	43	$2.5 \cdot 10^5$	5	
0093	49	$2.4 \cdot 10^5$	110	
0103	59	$1.4 \cdot 10^5$	1675	

Main files marked with red

Merging statistics

April TB

Spill	processed	w/o pulser	w/ tracks	Mapped (all)	$N_{w/track}$ / $N_{wo/pulser}$, %	N_{Mapped} / $N_{w/track}$	N after fitting (good?)
0	4619	3631	600	200	16.52	33.33	191
3	5973	3665	631	188	17.22	29.79	187
92	5743	3437	632	191	18.39	30.22	187
Mean	5242.04	3584.97	616.32	163.94	17.19	26.63	176.84

July TB

Spill	processed	w/o pulser	w/ tracks	Mapped (all)	$N_{w/track}$ / $N_{wo/pulser}$, %	N_{Mapped} / $N_{w/track}$	N after fitting (good?)
0	6636	4321	502	137	11.62	27.29	130
3	6754	4444	508	93	11.43	18.31	93
92	6254	4546	509	199	11.20	39.10	136
Mean	6359.70	4413.82	510.03	137.03	11.56	26.89	149.83

July TB, fakes (VMM shifted to $\sim 5.25 ms$ from optimal position)

Spill	processed	w/o pulser	w/ tracks	Mapped (all)	$N_{w/track}$ / $N_{wo/pulser}$, %	N_{Mapped} / $N_{w/track}$
0	6636	4321	502	17	11.62	3.39
3	6754	4444	508	26	11.43	5.12
92	6254	4546	509	14	11.20	2.75
Mean	6445.90	4402.52	508.78	19.51	11.56	3.84

Summary

Merged events are not fakes, merging efficiency is comparable with April TB

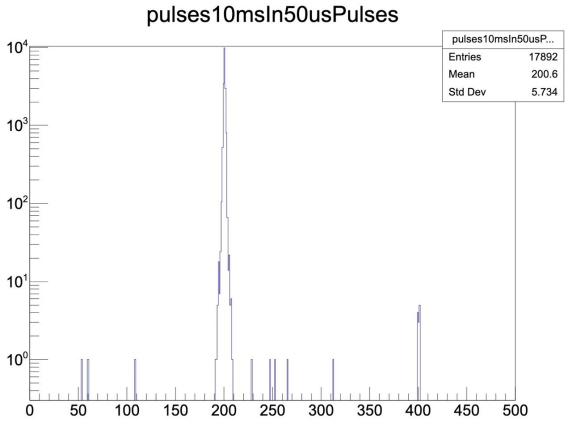
Pulser generators

Pulser generators during TB

- April TB: 2-channel generator
- July TB: 1-channel generator + scaler

From test checks:

- APV pulser comes in parallel with about 200'th VMM pulser.
  That means, **scaler** is working



Pulser selection and definition

Pulser selection

April TB:

- `pdo = 948 or pdo = 965`
- vmm channel: 63

July TB:

- `pdo = 1012`
- vmm channel: 1

Common

- Difference to previous pulser: $2000 \cdot k \pm 1$
- Maximum: 90 pulsers
- Merging window: $700\mu s$

Definition

- "*Inside*" pulsers - pulser group with "good" pulsers before and after
- "*Outside*" pulsers - pulser group with no "good" pulser after

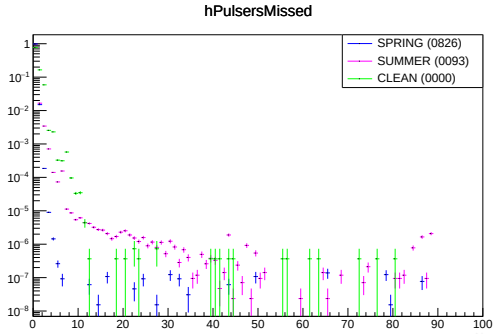
Missed pulses comparison

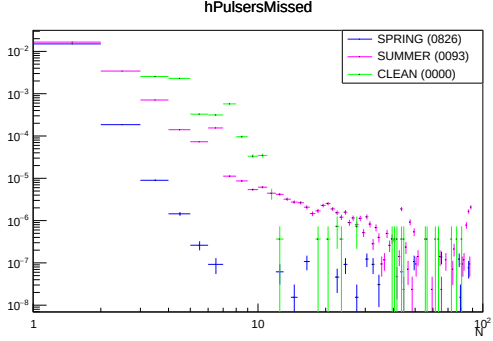
VMM channels used for the summer, spring and dry run

- SPRING – channel 63
- SUMMER – channel 1
- CLEAN – channel 60

Number of missed pulses in clear run:

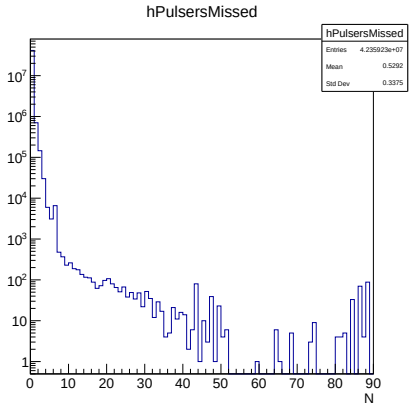
- 10 ms pulser: 0.1% missing
- 50 μs pulser:
  - 23% - more tthan 1 pulse
  - 6.5% - more than 2 pulses



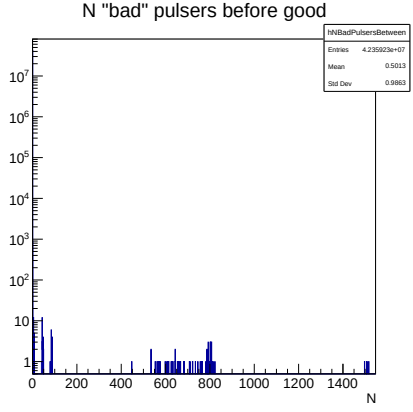


July TB: Missed pulsers

N missed pulsers from BCID difference



N "bad" pulsers found since previous good



Summary

- Spill 0: `Event 620015: 807 "bad" pulsers before. BCID difference to previous good is 2000, nPeriodsAdd calculated as 1`
- Two possibility: many noise events or possible source of merging problems

Problematic spills

July TB, spill 2

Spill	processed	w/o pulser	w/ tracks	Mapped (all)	$N_{w/track}$ / $N_{wo/pulser}$, %	N_{Mapped} / $N_{w/track}$	N after fitting (good?)
2	6356	4044	450	17	11.13	3.78	

```
Event 1900789: 795 "bad" pulsers before. BCID difference to previous good is 2000, nPeriodsAdd calculated as 1
Event 1946751: 561 "bad" pulsers before. BCID difference to previous good is 1233, nPeriodsAdd calculated as 17
Event 1995503:  88 "bad" pulsers before. BCID difference to previous good is 1999, nPeriodsAdd calculated as 1
```

Problems with pulser calculation started from the beginning of run

July TB, spill 40

Spill	processed	w/o pulser	w/ tracks	Mapped (all)	$N_{w/track}$ / $N_{wo/pulser}$, %	N_{Mapped} / $N_{w/track}$	N after fitting (good?)
41	6777	4450	531	201	11.93	37.85	140

```
Event 30954169: 808 "bad" pulsers before. BCID difference to previous good is 1999, nPeriodsAdd calculated as 1
```

But that on 4th second only. Problem is: VMM pulser shifted $\sim$ 1.6ms by DAC time

April TB, spill 91

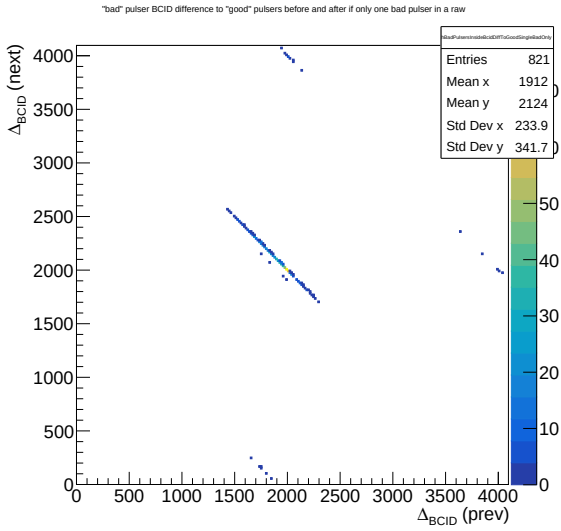
Spill	processed	w/o pulser	w/ tracks	Mapped (all)	$N_{w/track}$ / $N_{wo/pulser}$, %	N_{Mapped} / $N_{w/track}$	N after fitting (good?)
91	4611	3624	602	39	16.61	6.48	

Problem source is still unknown

July TB: Single "bad" pulses

Distance to previous/next "good" pulser for single "bad" pulsers:

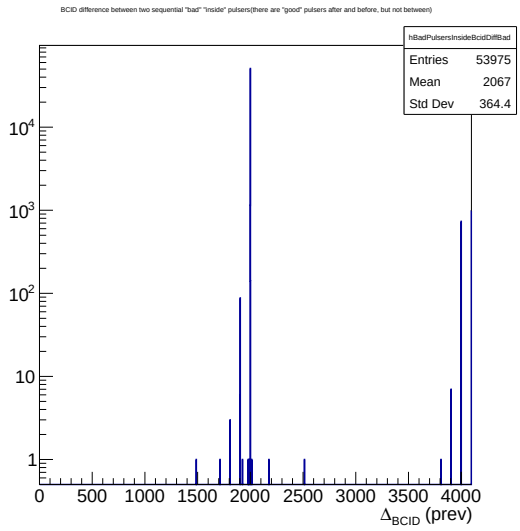
- The noise pulsers should be at line $X + Y = 2000$, but there are no such hits.
- Pulsers are around lines $X + Y = 4000/6000/8000$. That means that are a mistimed signals (with 0-2 pulser missed)



July TB: Inside "bad" pulses

Inside pulsers, BCID difference in group

Clearly seen events with 0-6 missed pulses. What are events with difference 0 (shown in bin 4096)



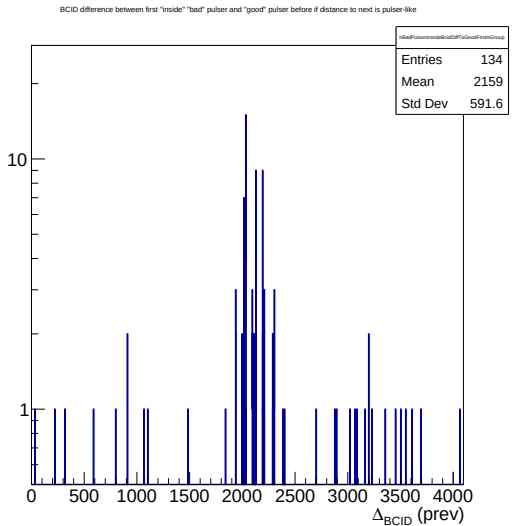
July TB: Inside "bad" pulses

Distance to previous "good" pulser from first "bad" pulser in a group

- ≤ 2 bad pulsers
- Distance to next "bad" pulser: $2000 \cdot k \pm 1$

Observations

- There is a event with BCID difference 1998
- Distance between start values: 2016 (214 pulses), 2032 (171 pulses), etc.
- But there are no such events around 4000



July TB: Inside "bad" pulses

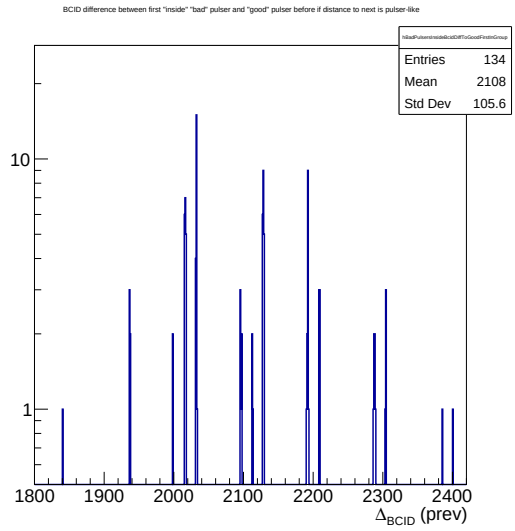
Left column

Distance to previous "good" pulser from first "bad" pulser in a group

- ≤ 2 bad pulsers
- Distance to next "bad" pulser: $2000 \cdot k \pm 1$

Observations

- There is a event with BCID difference 1998
- Distance between start values: 2016 (214 pulses), 2032 (171 pulses), etc.
- But there are no such events around 4000

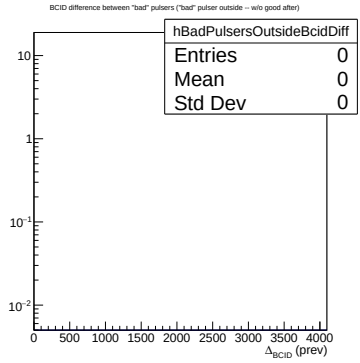


July TB: Outside "bad" pulses

Problem: there is no "outside" pulsers.

Why that can be:

- First pulser is not proportional to 2000 BCIDs, and the last one shifts the same value below.
- First pulser is not proportional to 2000 BCIDs, the all other pulsers are 2000, and we are waiting for BCID difference to last good is becomes ~2000.
- First pulser is proportional to 2000 BCIDs, but many pulsers missed, the all other pulsers are 2000, and we are waiting for BCID difference to last good is becomes ~2000.



How to check

Plot picture with $\Delta_{BCID}^{prev,first}$ and $\Delta_{BCID}^{next,last}$.

- First option should give diagonal line $\Delta_{BCID}^{prev,first} + \Delta_{BCID}^{next,last} = 2000$
- Second and third option – horizontal line $\Delta_{BCID}^{next,last} = 2000$.
- How to split that options?

July TB: behaviour of "bad" pulser group as a whole

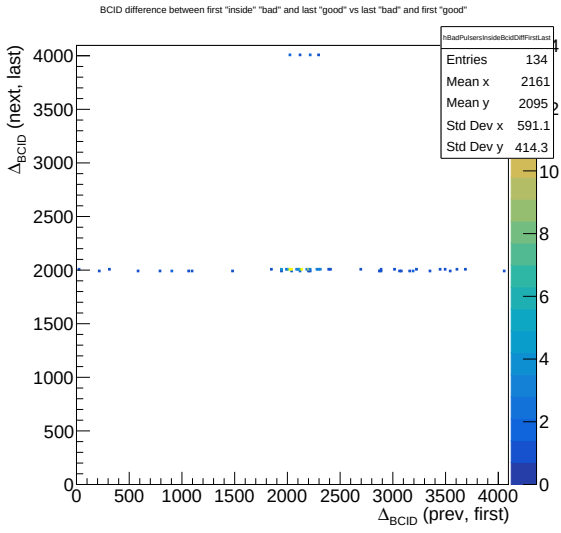
Plot with $\Delta_{BCID}^{prev,first}$ and $\Delta_{BCID}^{next,last}$

- horizontal line exists
- no diagonal line

Two option remains:

- First pulser is proportional to 2000 BCIDs
- First pulser is not proportional to 2000 BCIDs

All other pulsers are 2000 $\pm$ 1, and we are waiting for BCID difference to last good is becomes ~2000.
Since not all events are exactly 2000, we will find good event eventually

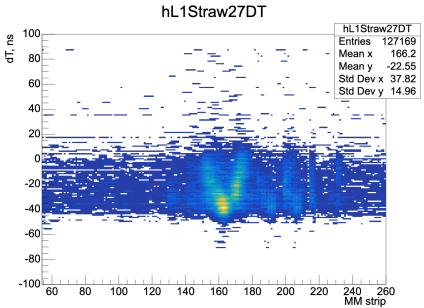


Summary

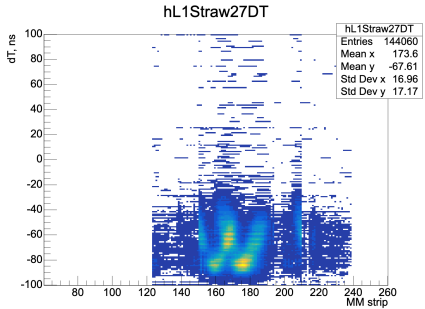
- Pulser efficiency not 100%
- During July TB, it seems, scaler worked. slide
- A lot of pulsers can be missed during single spill slide
- But there is no bad pulsers in $\sim$ 15 seconds after sthe spill slide
- Sometimes generator sends pulser signals at a wrong time slide
- But signals inside group of bad pulsers are usially in $\sim$ 2000 BCID slide
- But first pulsers in a group of "bad" distributed strangely slide
- "Bad" spill group growing untill BCID difference to the next becomes 2000-like. slide

Analysing

RT-plot for April TB, with double-counting



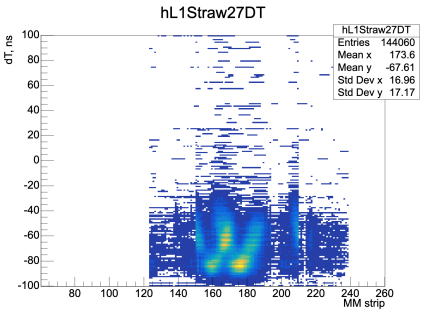
RT-plot for July TB, with double-counting



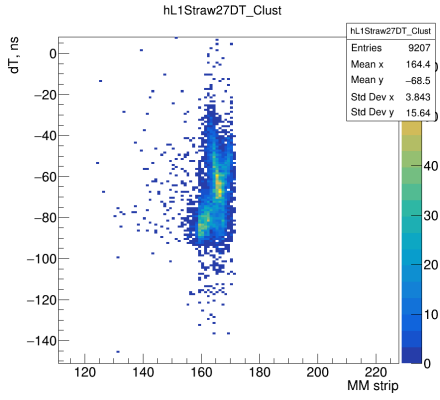
(the same code, that means wrong straw number)

Analysing

RT-plot for July TB, with double-counting



RT-plot for July TB, after calculation cluster center

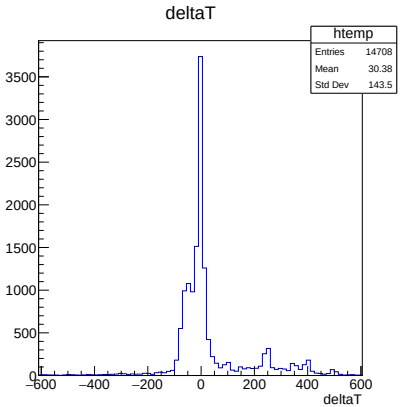


Summary

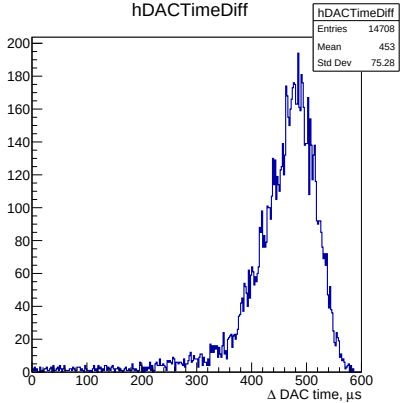
- This happens on each layer
- We will check what happening.

Control plots

Estimated time difference distribution

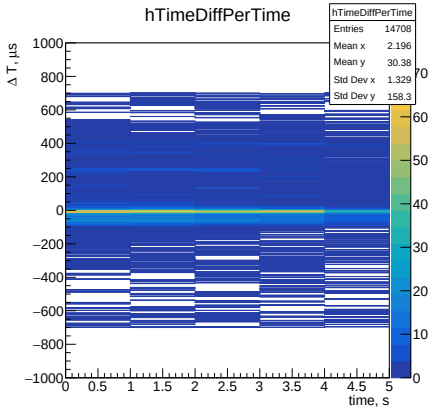


DAC time difference for merged hits



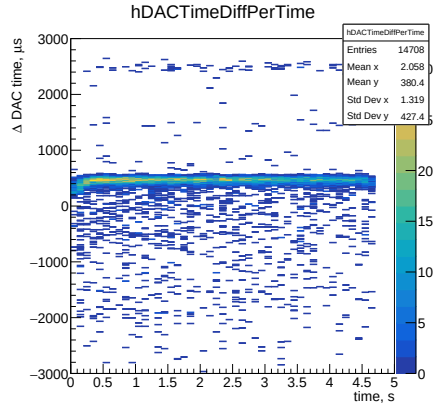
Control plots

Dependency of Estimated time difference of time since start for merged hits



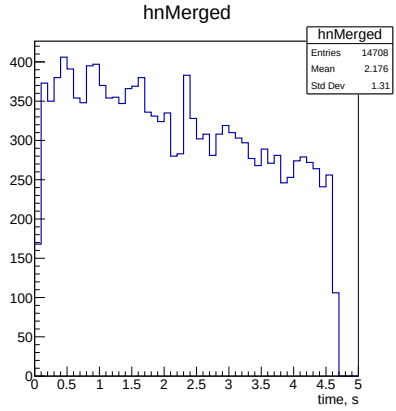
APV time - from trigger time

Dependency of DAC time difference of time since start for merged hits



Control plots

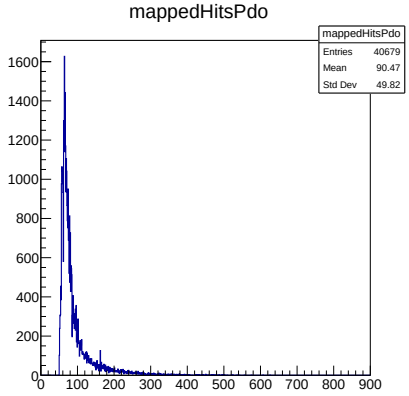
Number of merged events per time



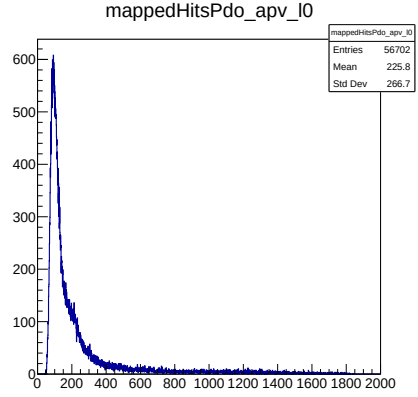
Control plots

IMPORTANT: APV plots rechecked 2022-12-20. Problem was with plot names only (l0 and l1 was switched)

PDO distribution of mapped hits in VMM DR



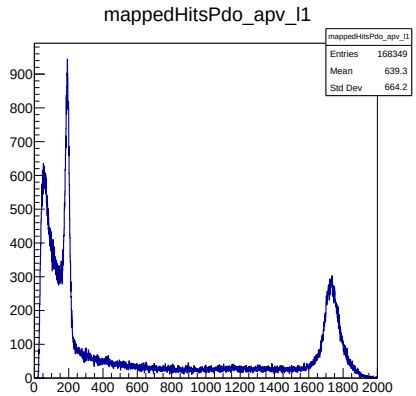
PDO distribution of mapped hits in APV, layer0



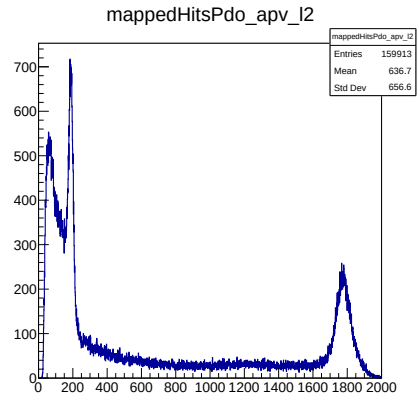
Control plots

IMPORTANT: APV plots rechecked 2022-12-20. Problem was with plot names only (l0 and l1 was switched)

PDO distribution of mapped hits in APV, layer1

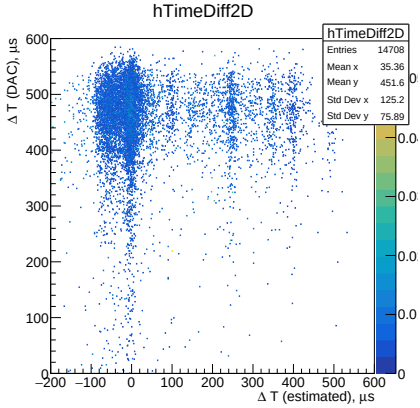


PDO distribution of mapped hits in APV, layer2



Control plots

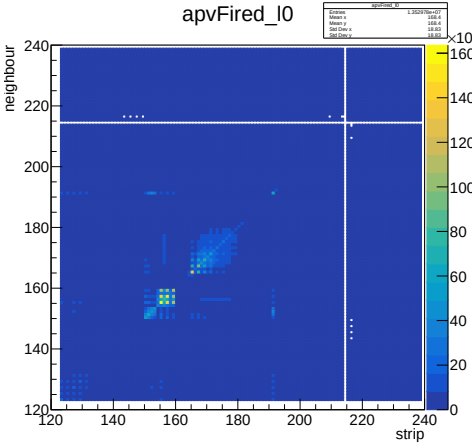
Dependency between DAC and estimated time difference

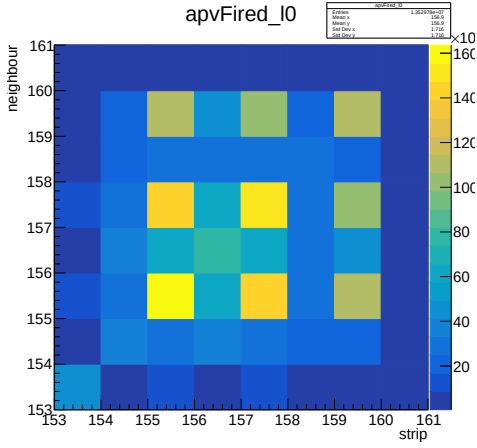


APV fired

Description:

For each strip set all strips in the same layer fired in the same event





APV fired

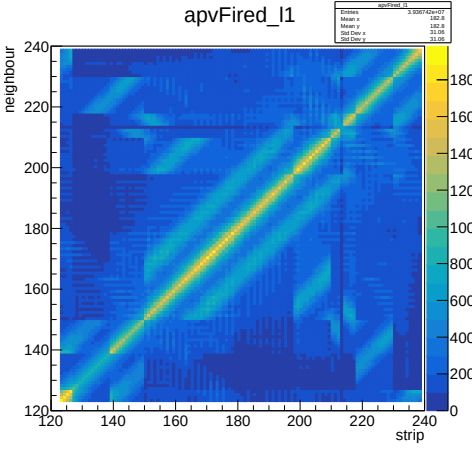
Comment

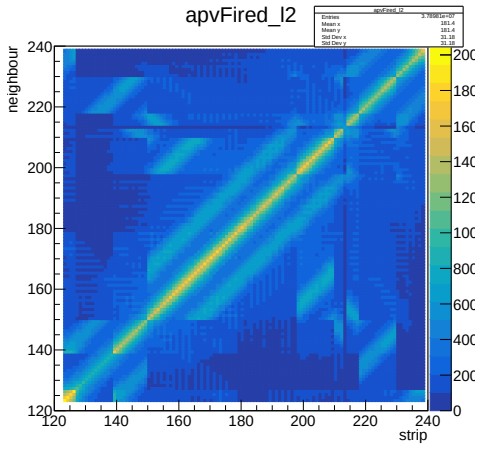
"strange" strip names (123, 149/150, 213/214, 360 is the important pins on connector)
Vitalii said, it looks like x-talks in connector.
But... what is 138? Other strips?
Need to add that strips to the connector picture

APV fired

Description:

For each strip set all strips in the same layer fired in the same event

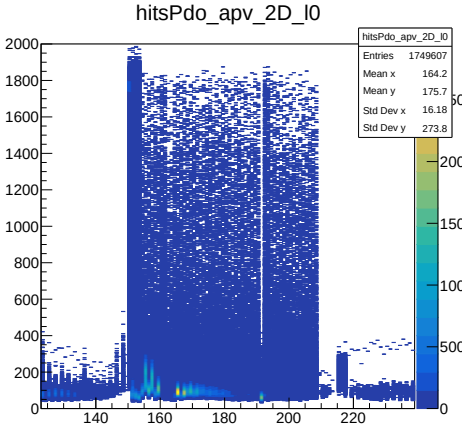




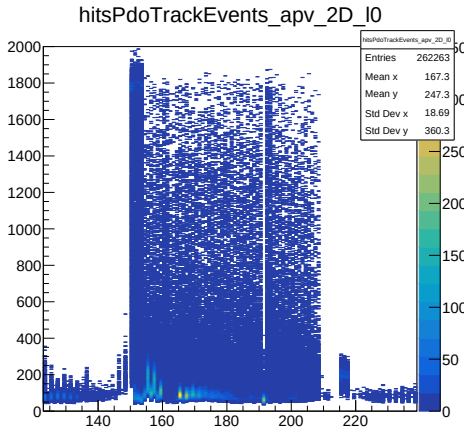
PDO for MM Layer 0

Hits for tracks selected in range [161-198]

For all hits in all events



For all hits in events with pseudotracks

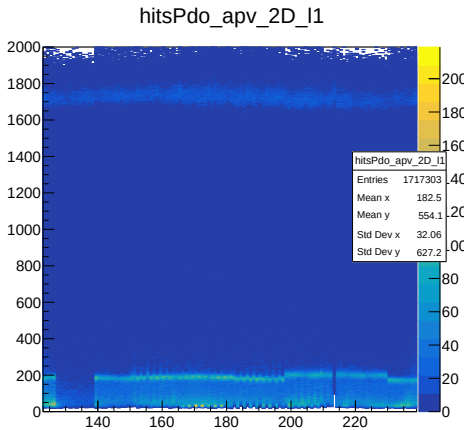


PDO for MM Layer 1

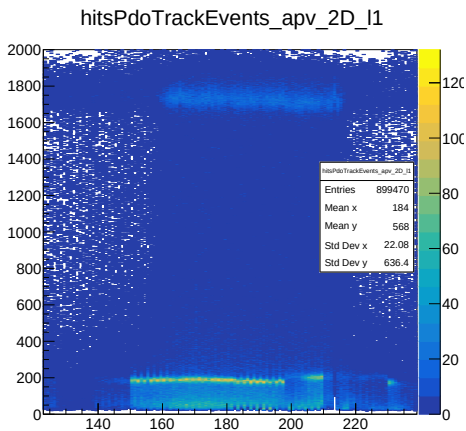
Hits for tracks selected in range [161-198]

Question to Vitalii: Can be X-talks in connector an explanation?

For all hits in all events



For all hits in events with pseudotracks

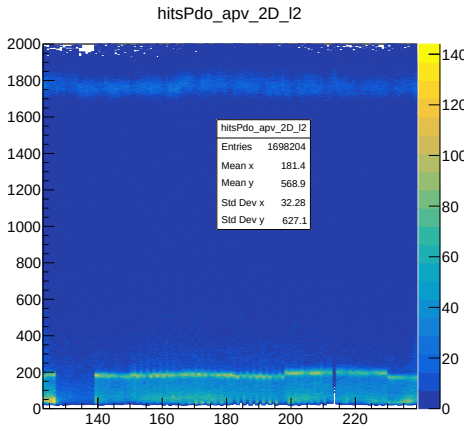


PDO for MM Layer 2

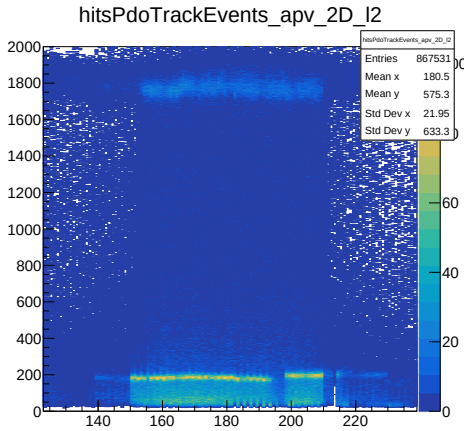
Hits for tracks selected in range [161-198]

Question to Vitalii: Can be X-talks in connector an explanation?

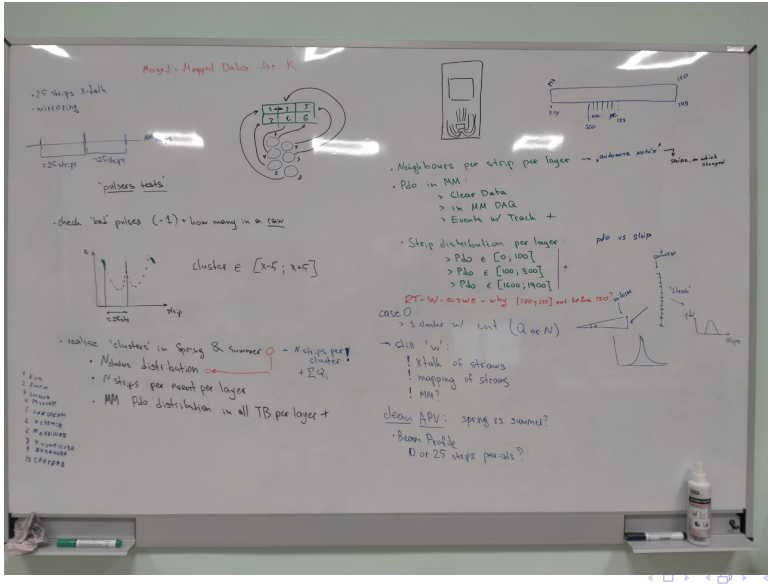
For all hits in all events



For all hits in events with pseudotracks



TODO


Merged - Mapped Data for K
• 25 strips X-talk
• mirroring
≈25 strips
≈25 strips
'pulsers tests'
• check 'bad' pulses (-1) + how many in a raw
cluster ∈ [X-5 ; X+5]
≈25 strips
strip
• realise 'clusters' in Spring & Summer
→ N strips per cluster!
+ ΣQi
• Nstations distribution
• N strips per event per layer
• MM Pdo distribution in all TB per layer +
• Neighbours per strip per layer
• Pdo in MM :
> Clear Data
> in MM DAQ
> Events w/ Track +
• Strip distribution per layer :
> Pdo ∈ [0 ; 100]
> Pdo ∈ [100 ; 300]
> Pdo ∈ [1600 ; 1900]
pdo vs strip
RT-W-curve - why [200 ; 210] not before 150?
case 0 :
> 1 cluster w/ cnt (Q or N)
→ still 'w' :
! Xtalk of straws
! mapping of straws
! MM?
clean APV : spring vs summer?
• Beam Profile
0 or 25 strips periods?

TODO

Next steps:

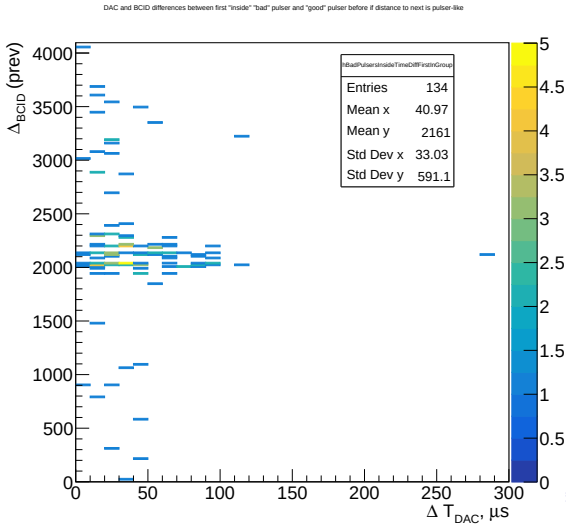
- Proper cluster construction (the same in Tiger was used)
- Add check dependence between first "bad" pulser (in a group with dt=2000) difference to previous with time DAC difference
- Check N hits (vmm) per event, should be mostly 2. Events with >=2 - X-talks in straw, 1 - inefficiency

First bad pulsers in group: time and BCID difference to last good

First bad pulsers in group: time and BCID difference to last good

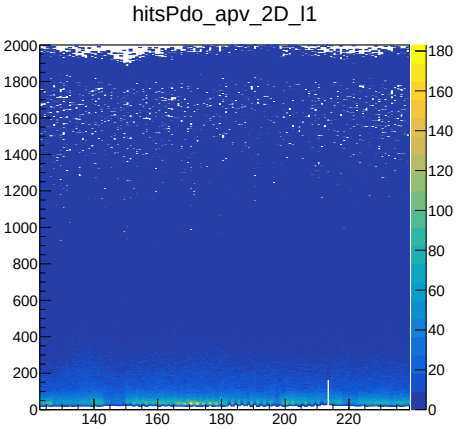
Observation

- Seems, bcid difference not straightly connected to time difference.
- So, some time shift, after that time diff pulser started to work starting from that bad pulse
- Need better statistics? (Maybe select all as 2000?)
- If there are 16 BCID a something hardware-related?

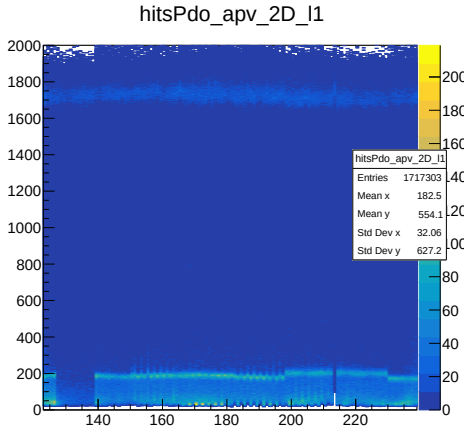


Comparison with April TB – PDO, Layer 1

April TB

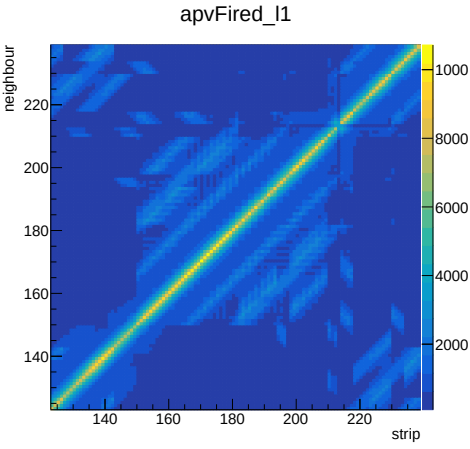


July TB

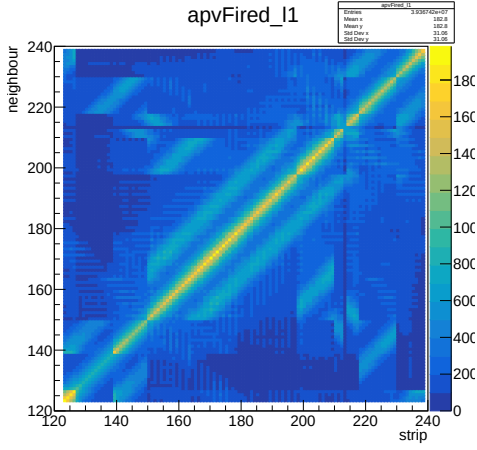


Comparison with April TB – apvFired, Layer 1

April TB

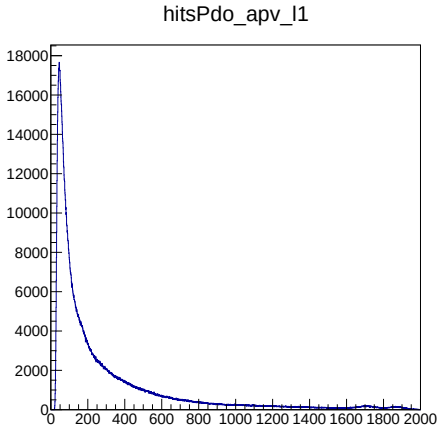


July TB

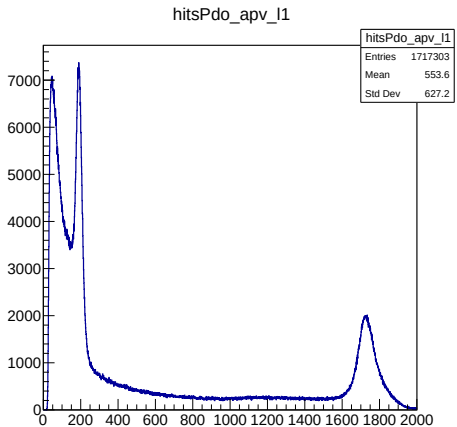


Comparison with April TB – PDO, Layer 1

April TB

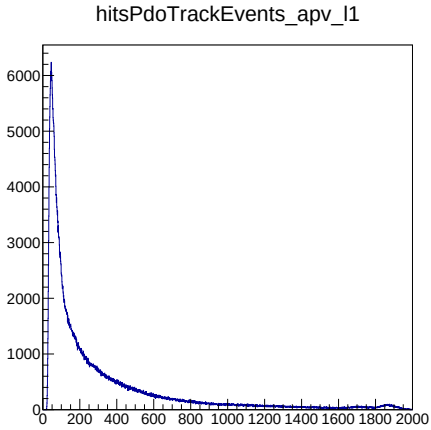


July TB

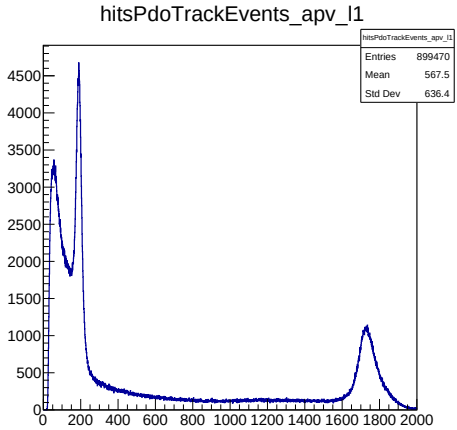


Comparison with April TB – PDO for tracks-only hits, Layer 1

April TB



July TB



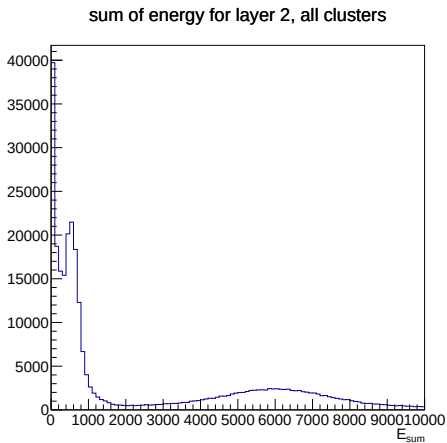
What done

1. Created clusters (the same way as for Tiger):
   - Distance between clusters $\leq$ 5 strips
   - Center estimated by strips weighted with pdo
   - Center estimation uncertainty the same way as for Tigers (TODO add formula):
2. Analysed

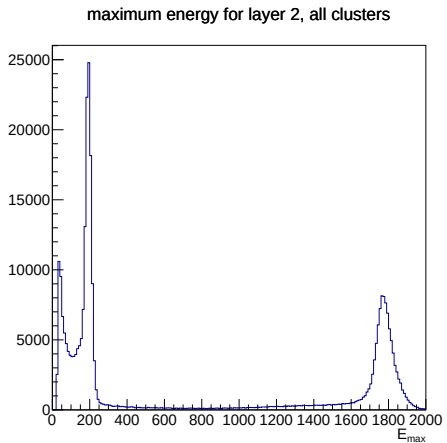
- Mean value $\overline{strip} = \frac{1}{\sum charge} \sum strip \cdot charge$
- Std.Dev: $\sigma = \sqrt{\frac{1}{N_{hits}} \sum \left(strip - \overline{strip}\right)^2}$
- Weighted Std.Dev:
  $\sigma_W = \sqrt{\frac{1}{\sum charge^2} \sum \left(\left(strip - \overline{strip}\right)^2 \cdot charge^2\right)}$

Clusters, layer 2

Max charge, all clusters

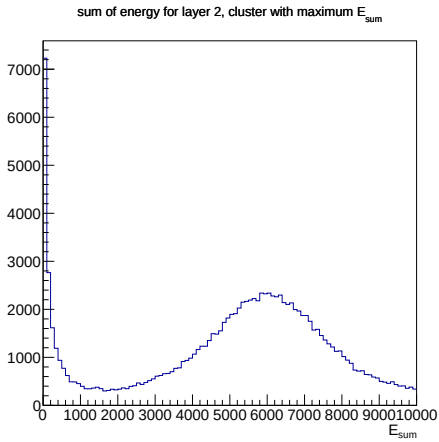


Claster charge sum, all clusters

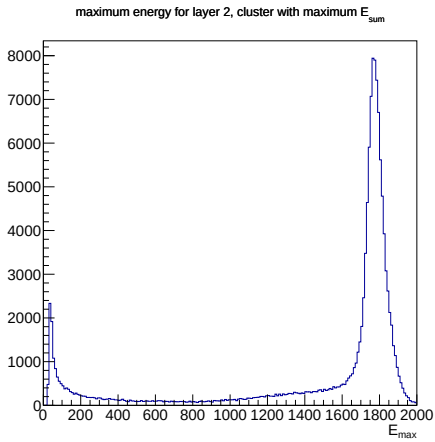


Clusters, layer 2

Max charge, cluster with maximal charge per layer



Claster charge sum, cluster with maximal charge per layer

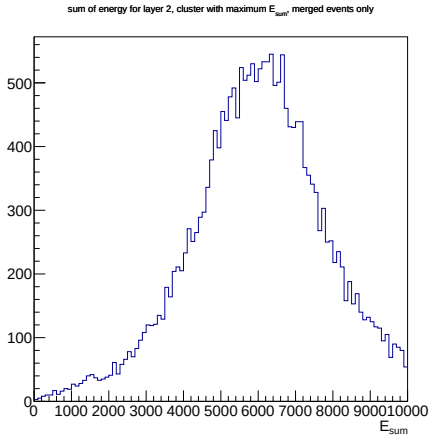


Observation

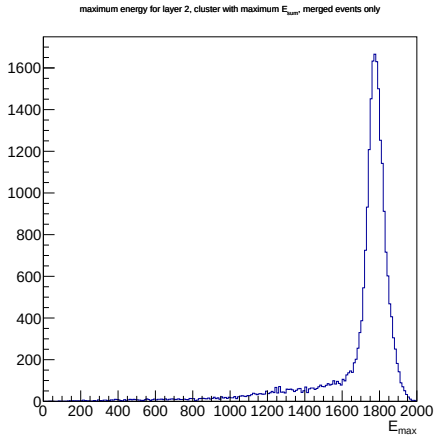
clusters constructed from X-talk-like hits removed!

Clusters, layer 2

Max charge, cluster with maximal charge per layer, merged events



Claster charge sum, cluster with maximal charge per layer, merged events

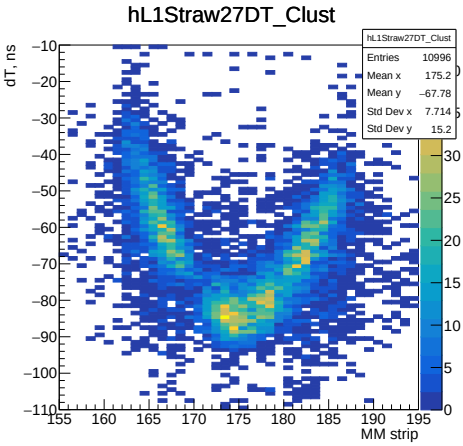


Observation

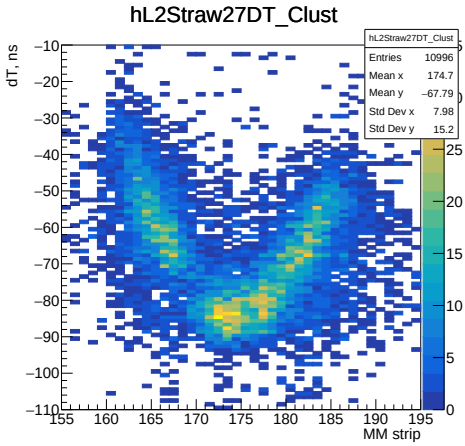
clusters constructed from X-talk-like hits removed!

Merged data RT-curve

Straw 27 vs layer1

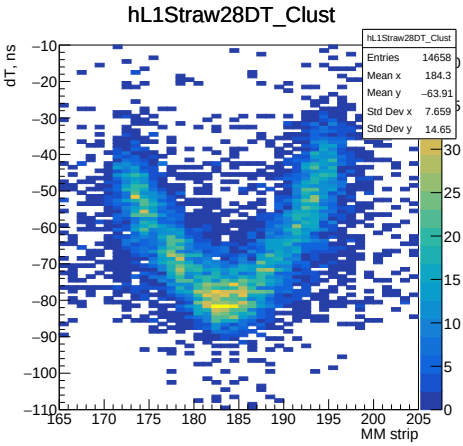


Straw 27 vs layer2

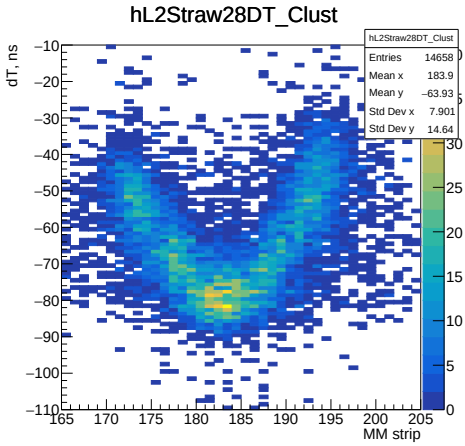


Merged data RT-curve

Straw 28 vs layer1

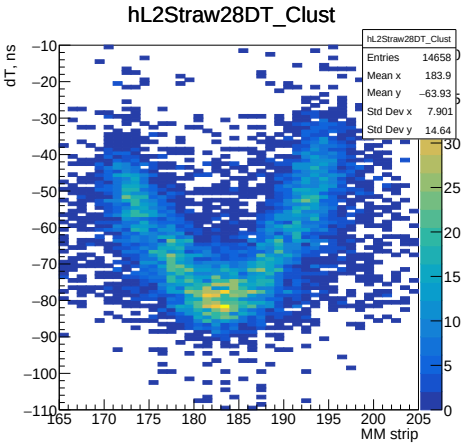


Straw 28 vs layer2

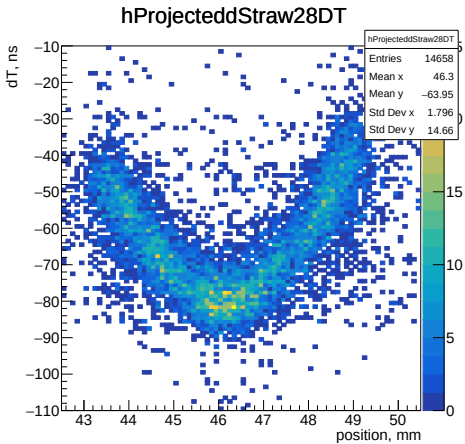


One Layer vs projected: straw 28

Straw 28 vs layer2

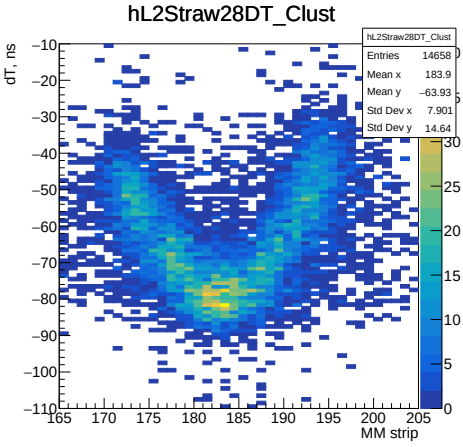


Straw 28 vs projected position (2-points)

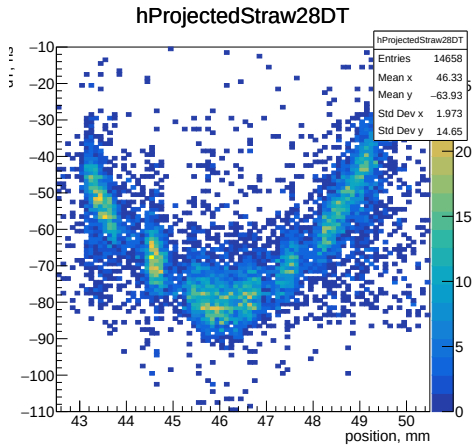


One Layer vs projected: straw 28

Straw 28 vs layer2



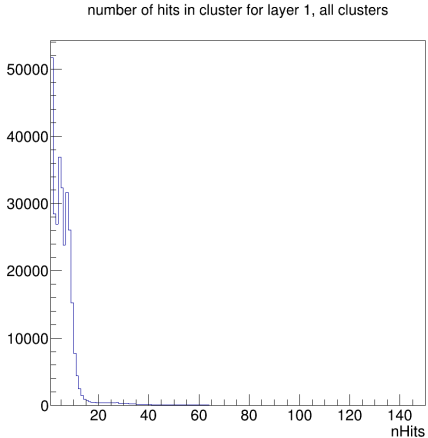
Straw 28 vs projected position (3-points, vmm hits used)

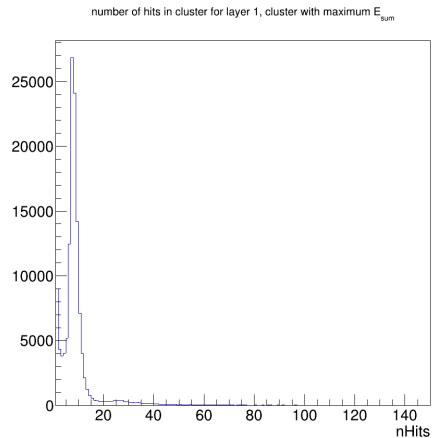


TODO

- Check what happens with double read-out layer
- Check & Correct initial algnment
- Check BCIDs for bad pulsers on larger statistics
- Map & merge large statistics
  - Check our standard run 103&59
  - Split files by spills (on PNPI cluster?)

Additional


number of hits in cluster for layer 1, all clusters
50000
40000
30000
20000
10000
0
20
40
60
80
100
120
140
nHits


number of hits in cluster for layer 1, cluster with maximum E sum
25000
20000
15000
10000
5000
0
20
40
60
80
100
120
140
nHits