Preliminary work towards study of calo resolution

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Introduction

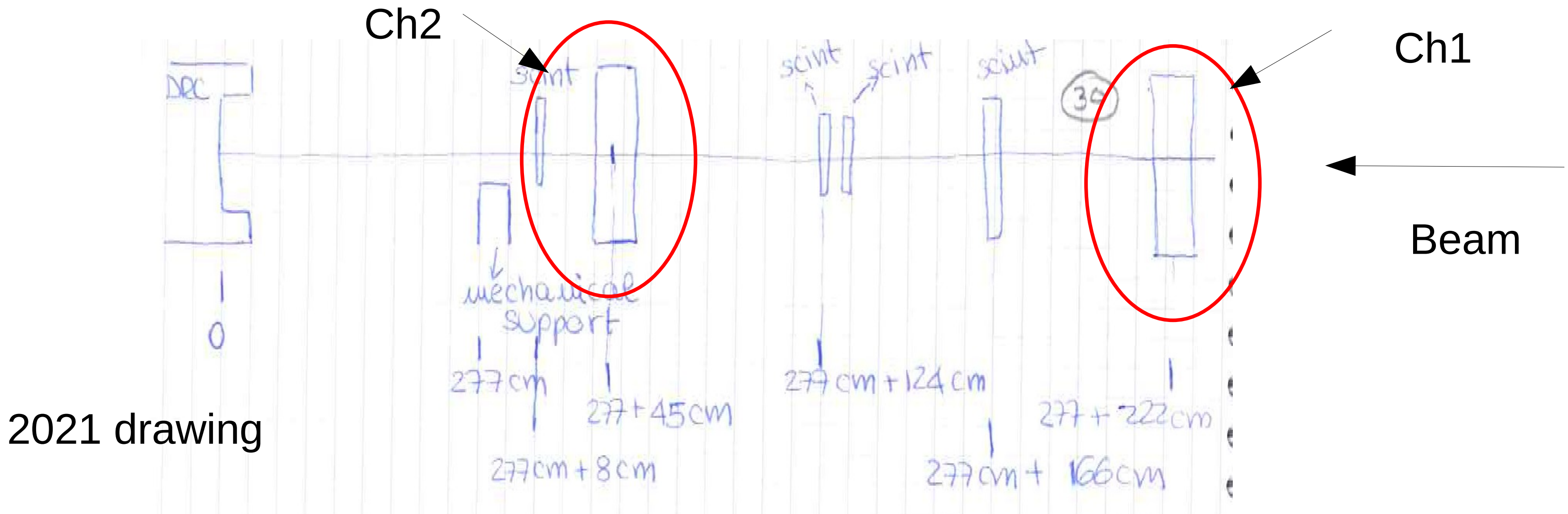
Some preliminary work on understanding how good the data are for measuring electron energy resolution

It follows on the heels of work I have been doing and documenting during data taking

Looking at following issues:

- How centered is beam on calo for energy scan runs
- Issues with the pedestals of photomultipliers

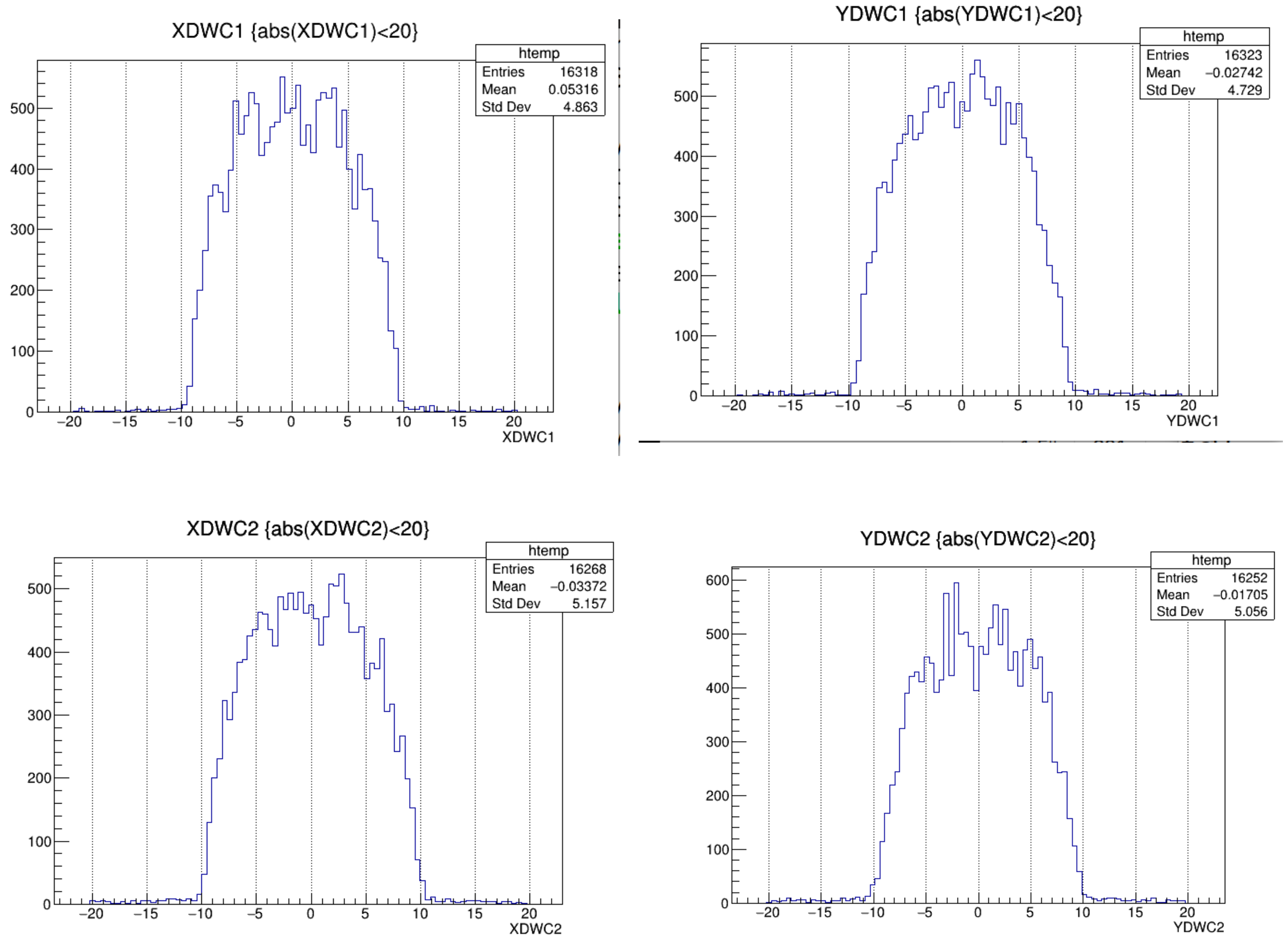
Drift wire chambers (DWCs)



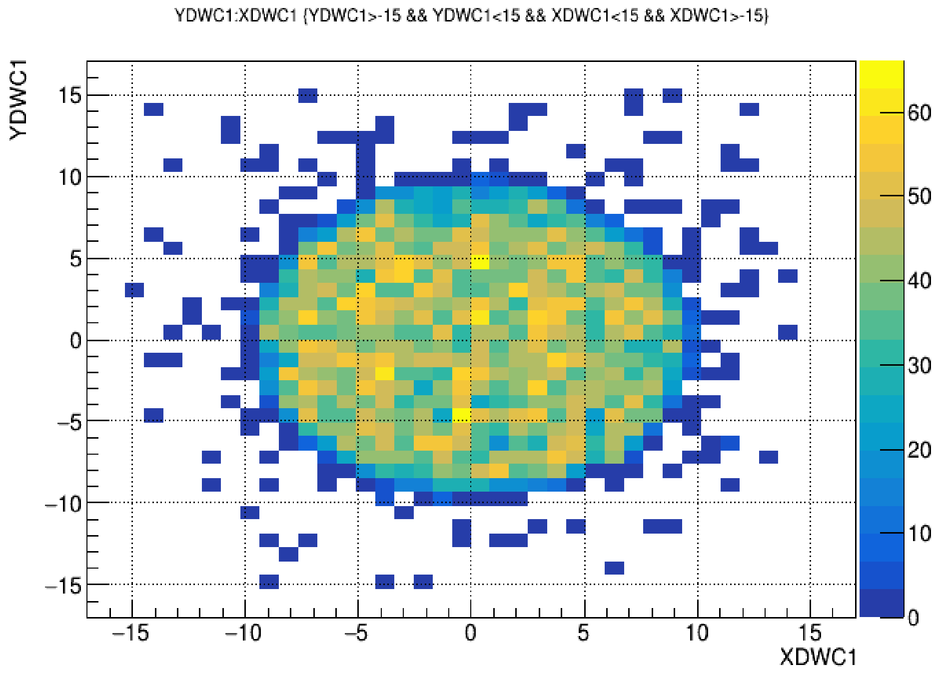
- Calibrate using injected charge measurements from Romualdo's logbook photo in mattermost
- Put new calibration coefficients in json
- Align such that beam between +10 and 10 mm for run 184 (20 GeV)
- Put that alignment as well in json, and modify code to use it, as requested by Lorenzo

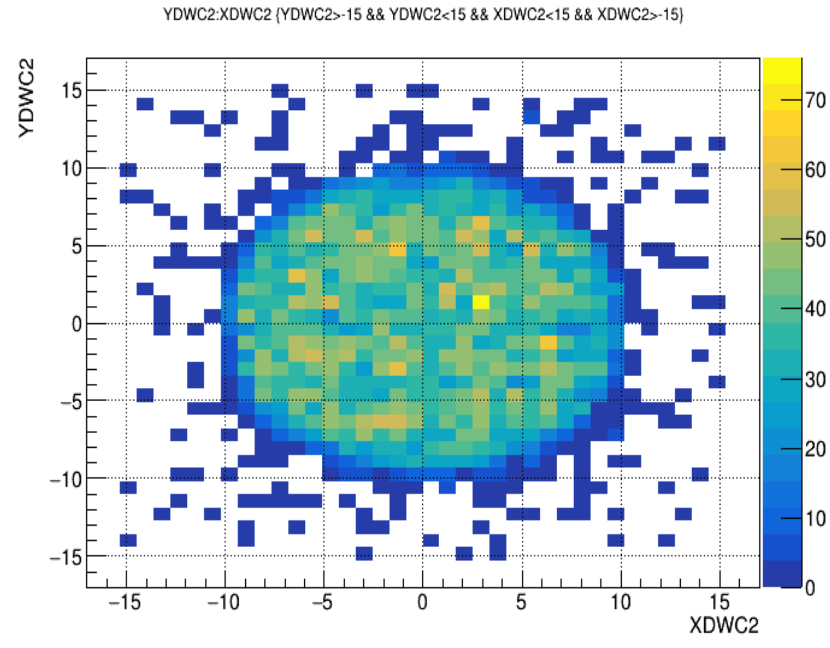
```
"DWC_tons" : [1.0],
"DWC_sl" : [0.02474,0.02497,0.02474,0.02437],
"DWC_offs" : [0.9578,0.6609,0.3959,-0.2193],
"DWC_z" : [4195.0,2455.0],
"DWC_cent" : [0.09,-4.99,3.82,-0.17]
```

Aligned DWC distributions



Beam spot in two chambers



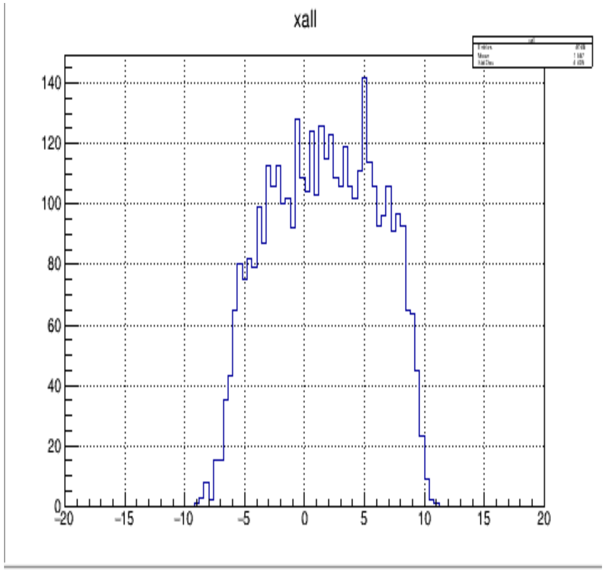


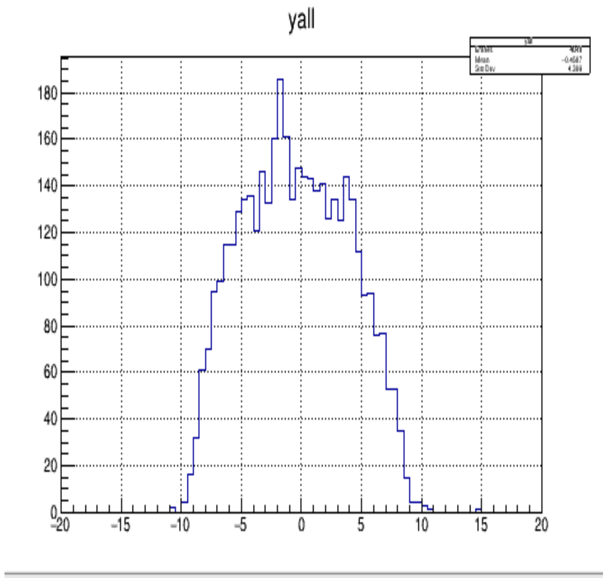
Beam spot determined by veto scintillator well reconstructed by chambers
→ Can cut at 10mm on radius of aligned cambers to clean the beam

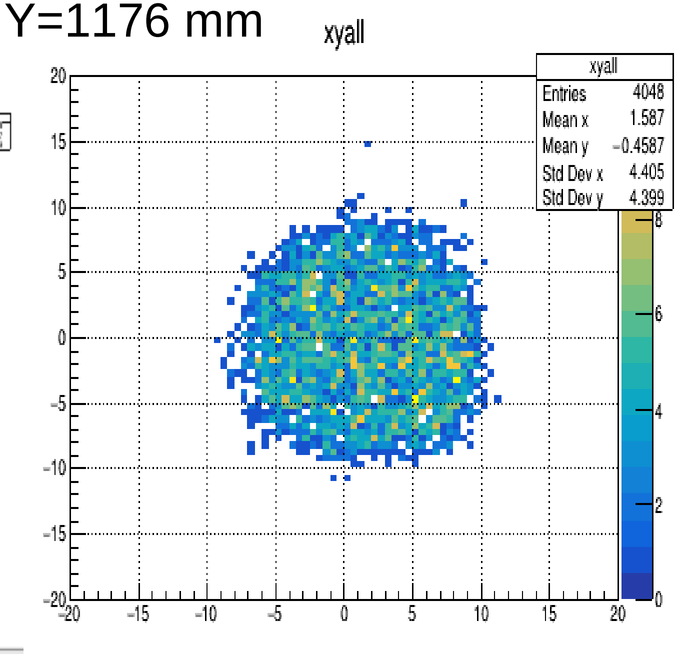
Beam alignment of calo response- Run 184

Run 184:

Vert angle=2.5 deg Hor angle=1.5 deg X=-4.1 mm   Y=1176 mm





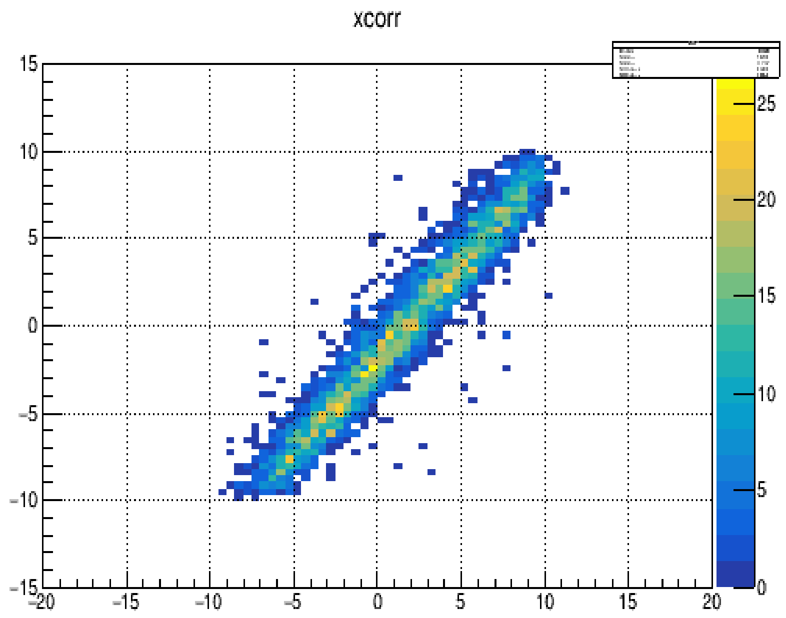


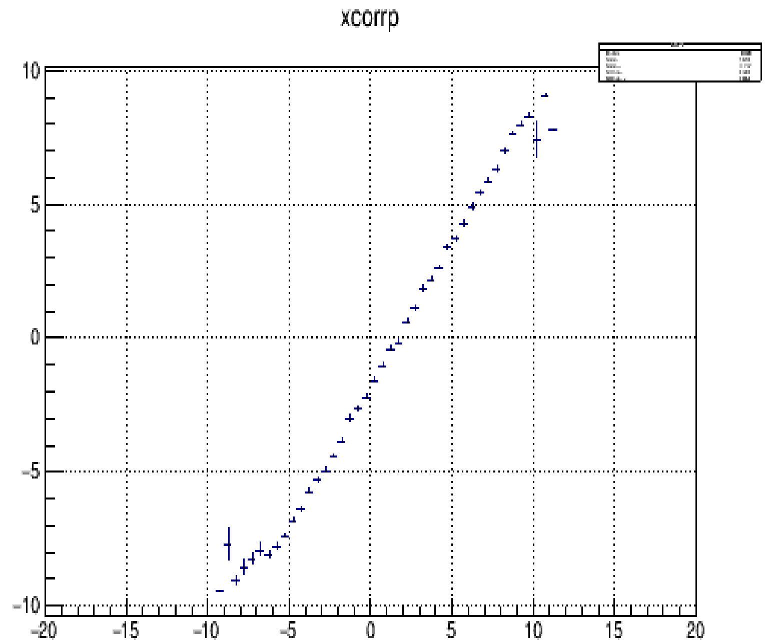
Barycenter of SiPM response for each event: position of shower maximum (biased by edge effects)

Electron events: C1>150, PShower>800

Nice beam spot: beam as defined by veto almost fully contained in central module

Correlation chamber 2-calo barycenter -X



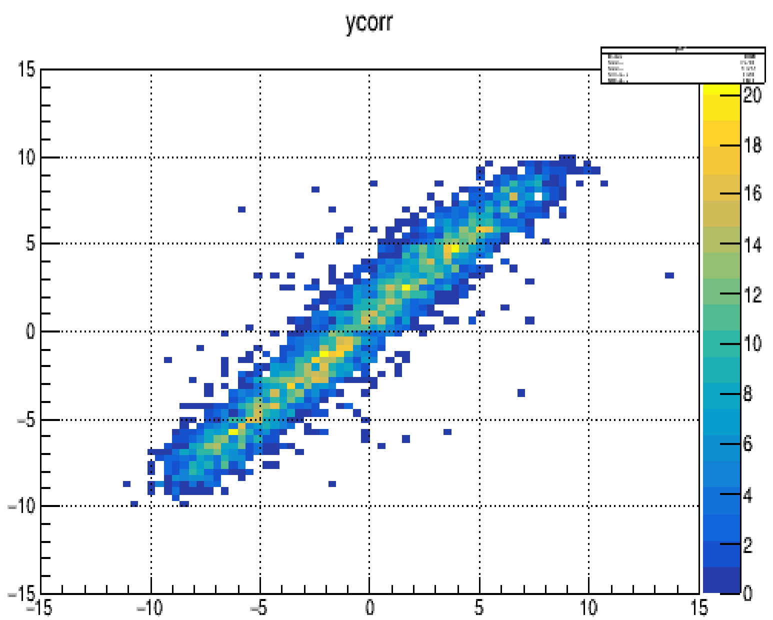


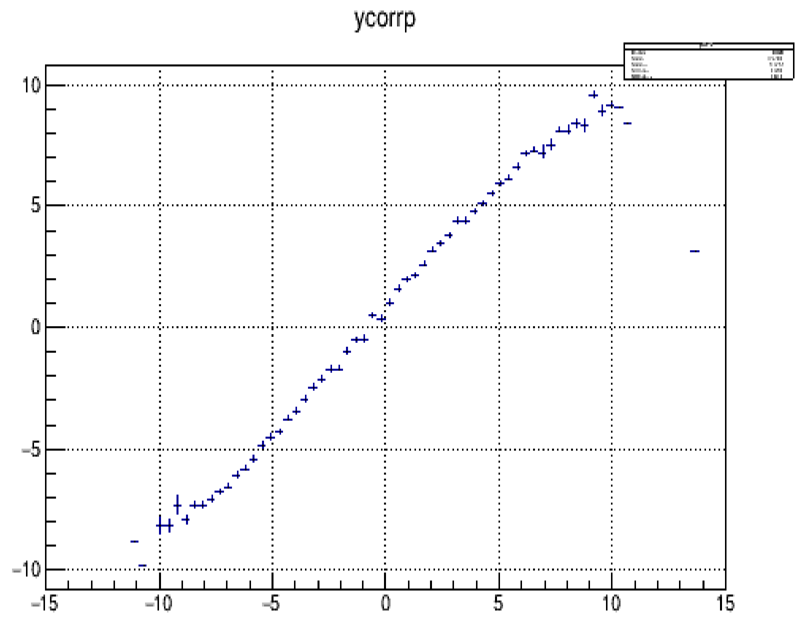
Run 184:

Vert angle=2.5 deg Hor angle=1.5 deg X=-4.1 mm   Y=1176 mm

X coordinate off by ~1.8 mm

Correlation chamber 2-calo barycenter-Y





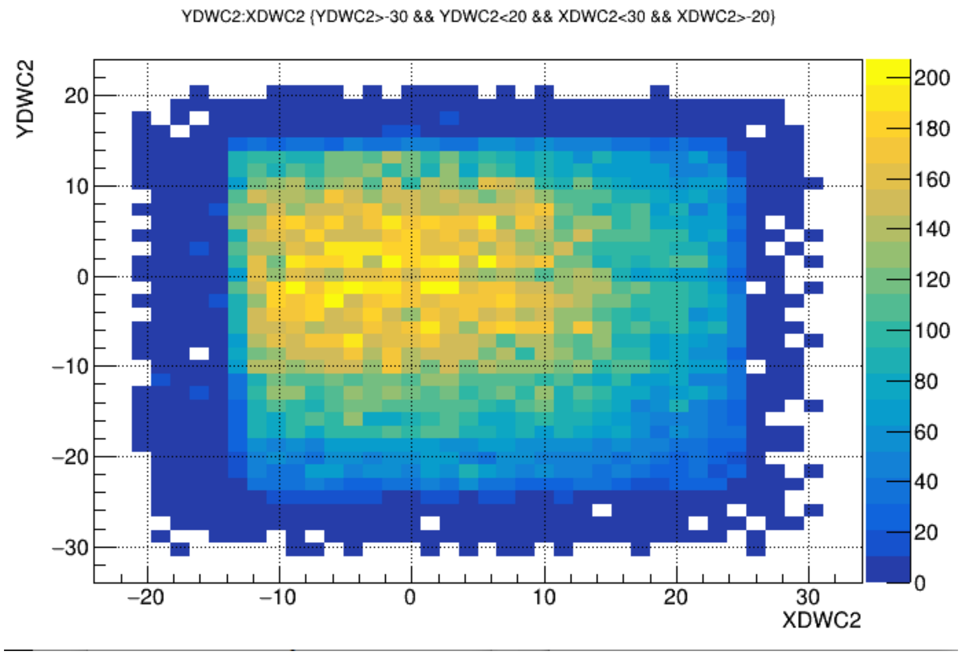
Run 184:

Vert angle=2.5 deg Hor angle=1.5 deg X=-4.1 mm   Y=1176 mm

Y-coordinate ~correct

Actual beam shape

Veto may be biasing beam shape: look at run 183 where no veto was applied

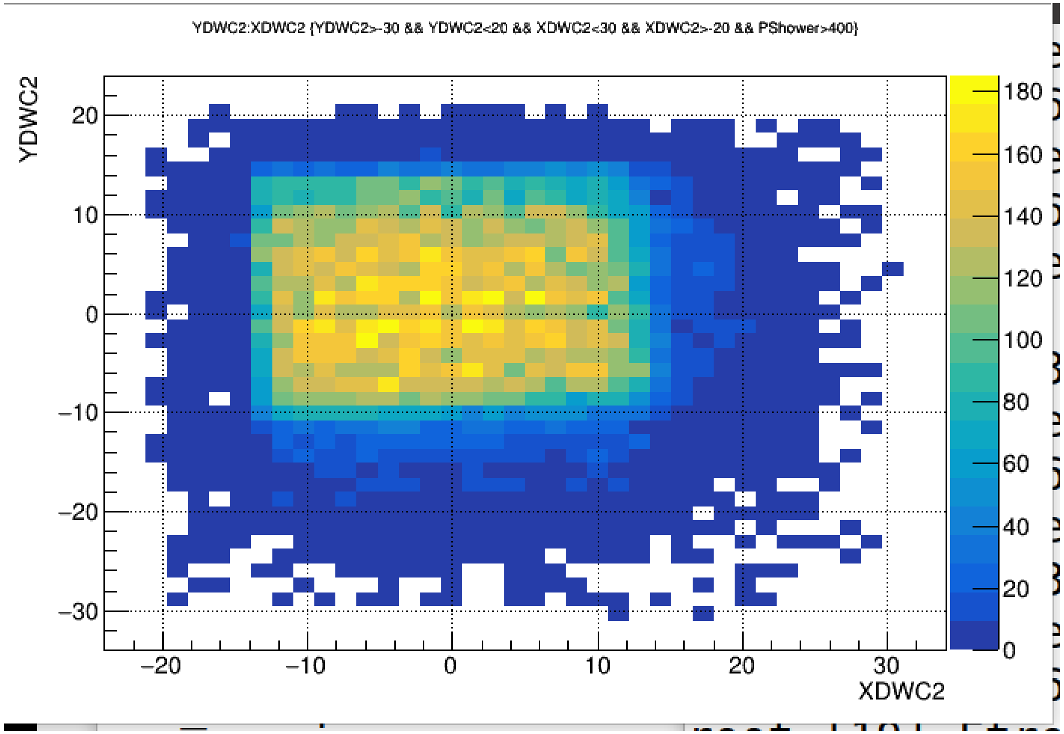


Run 183: no veto

Use chamber alignment defined in previous slides

Size of beam defined by trigger scintillators (~4x4 cm), and center of superposition of two scintillators off by ~5 mm wrt beam center

Preshower position

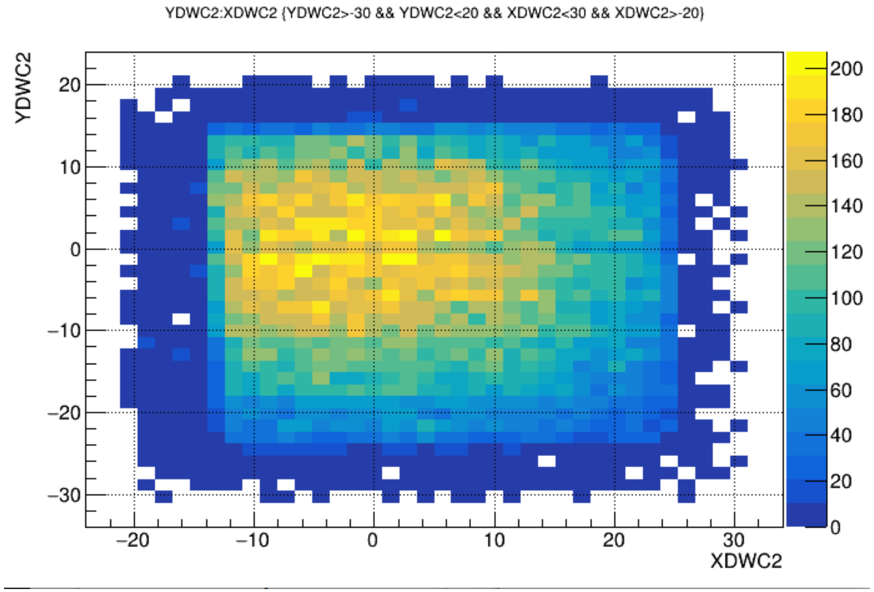


Run 183

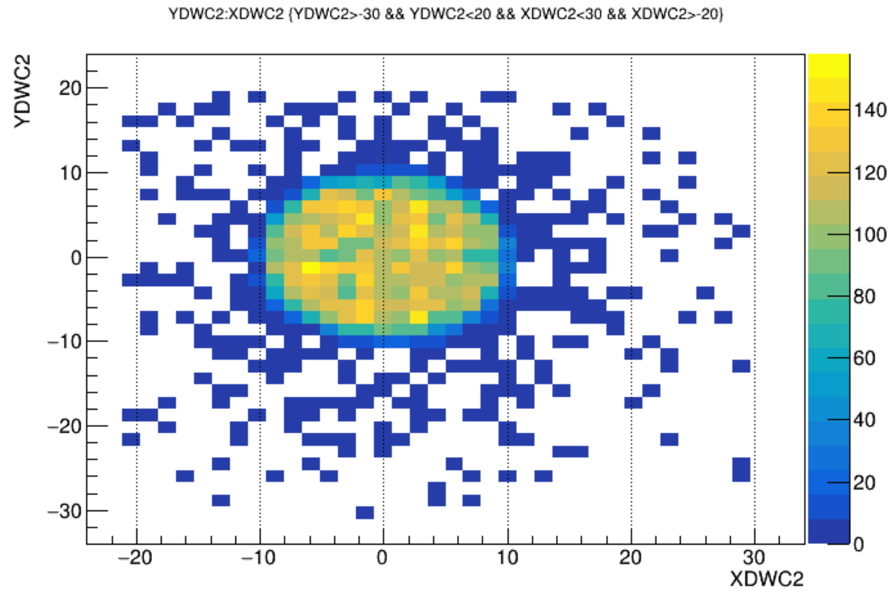
Require signal in Preshower (PShower>400)

Reasonable alignment with beam

Veto position



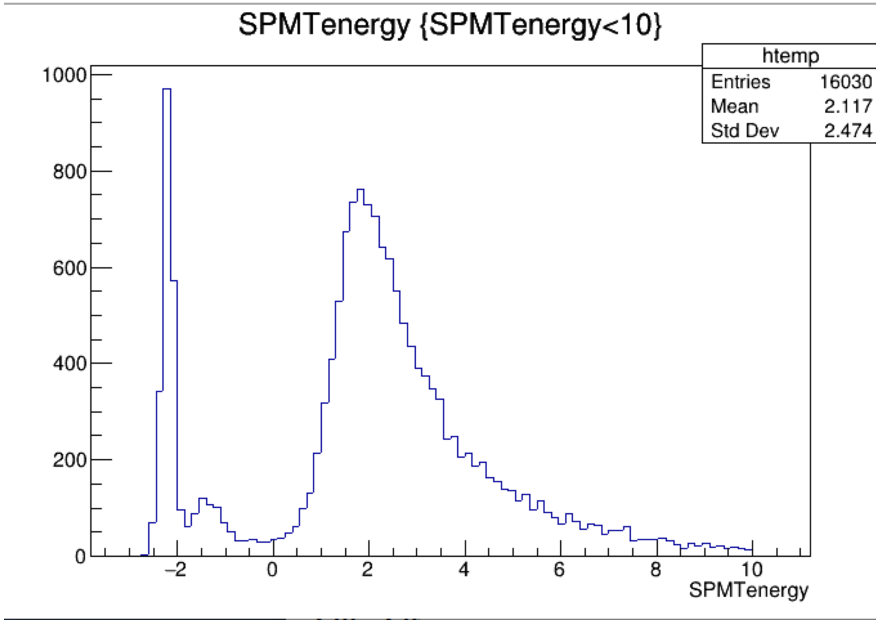
Run 183

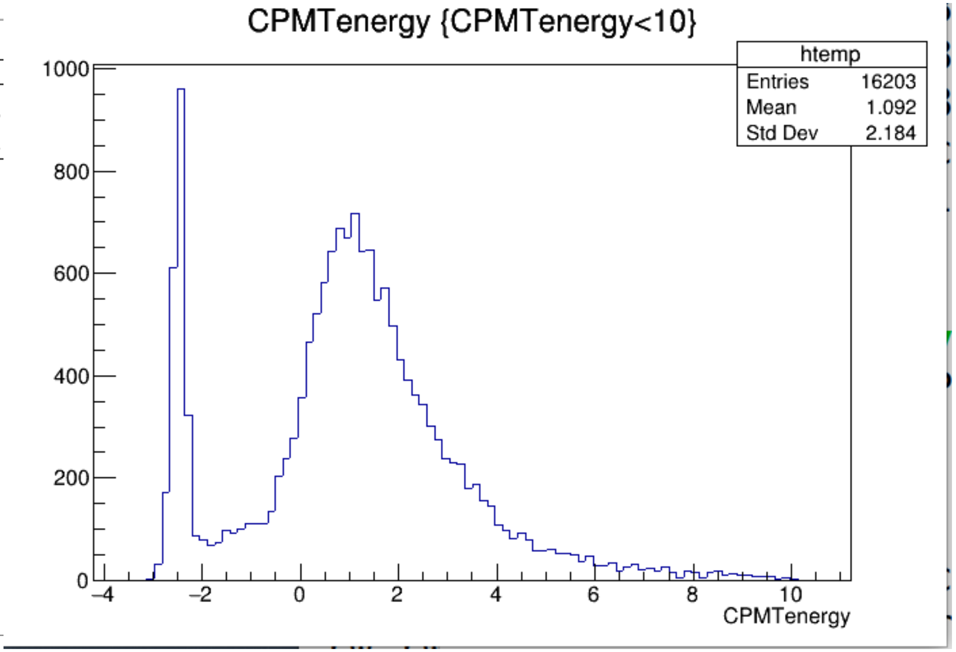


Run 184

Veto well aligned with center of beam as well

PMT pedestals





Official physics ntuples: run 184

pedestal of PMTs off by a total of ~2.5 GeV.

Need to:

- Reevaluate pedestals for run 184-193
- Understand evolution of pedestals with run number
- Understand validity of preliminary PMT equalisation

Technique

- Take run 184
- Create histo of 400 bins between 199.5 and 499.5
- For each ADC channel fill it with ADC value requiring TriggerMask==6
- Fit the histogram with a gaussian
- Take the mean of the gaussian as pedestal
- Cross-check that it makes sense looking at histo mean, RMS, chisquare of fit
- Replace in json file

Values in GIT

```
"PMTS_pd" : [367.255, 347.641, 400.174, 393.505, 386.969, 326.862, 357.394
, 362.666],
"PMTC_pd" : [403.88, 397.602, 388.997, 407.796, 335.588, 356.476, 380.858,
333.316],
```

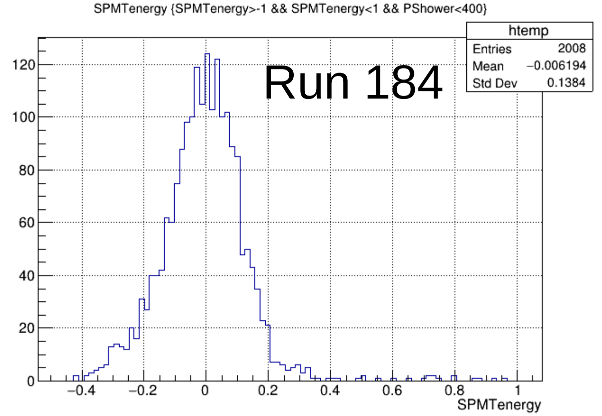
New

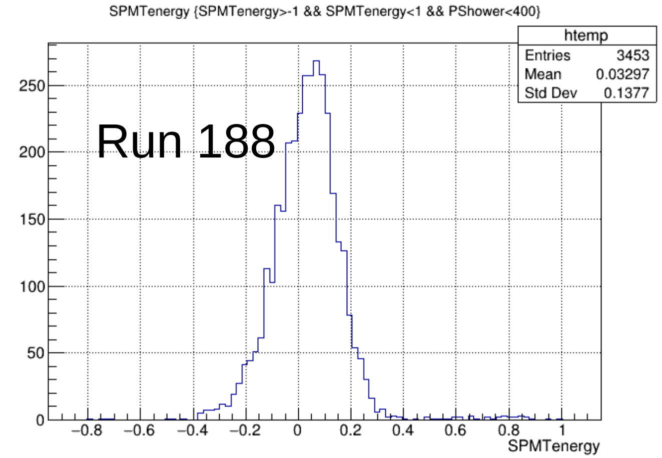
```
"PMTS_pd" : [356.583, 341.610, 393.873, 374.785, 381.912, 308.260, 350.186
, 355.788],
"PMTC_pd" : [392.861, 391.572, 382.512, 389.233, 331.440, 337.164, 373.751
, 326.063],
```

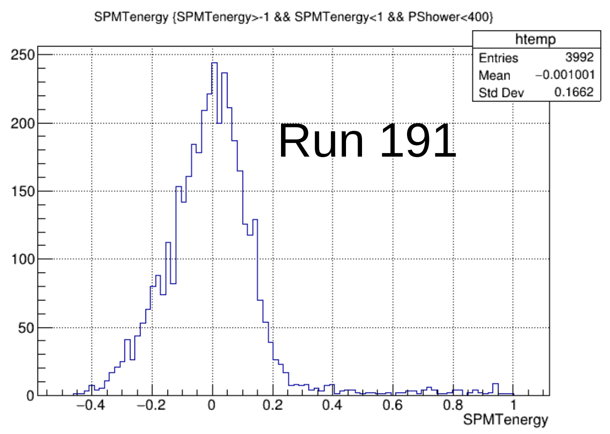
Stability in runs 184-193

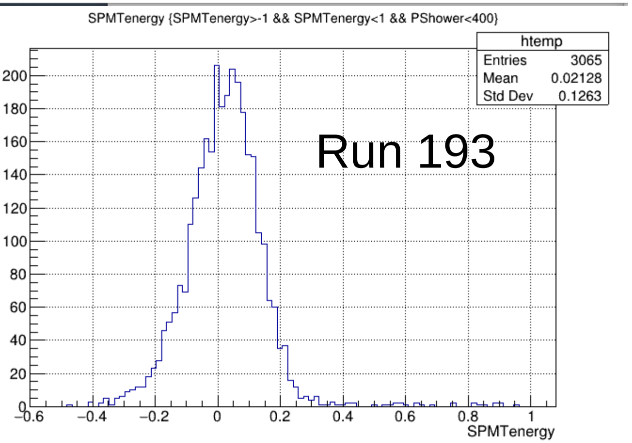
Produce runs 184-193 with new json, and evaluate position of calibrated pedestal for each run

```
Ftree->Draw("SPMTenergy","SPMTenergy>-1 && SPMTenergy<1 && PShower<400"
```





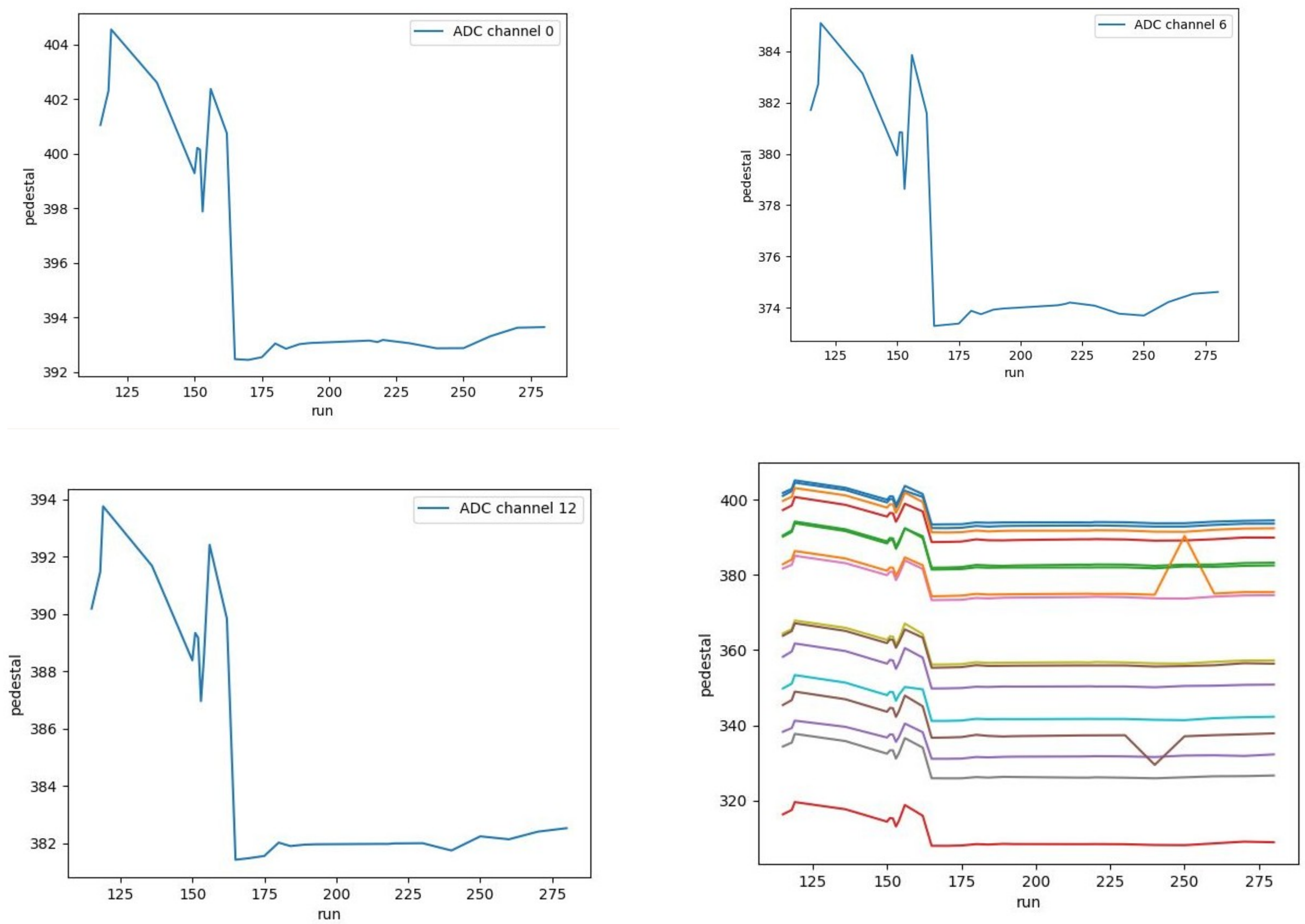




Reasonably stable: total pedestal moves around by ~100 MeV in range of runs of energy scan. Electronic noise ~100 MeV

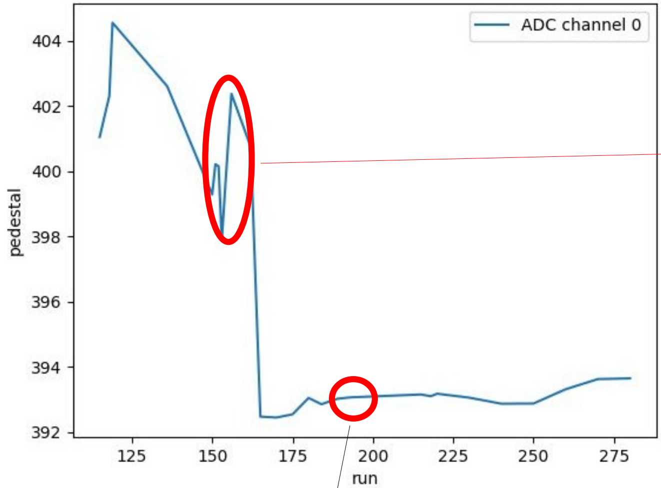
Pedestal evolution versus run number

Run on merged ntuples, and for each run/ADC channel evalutate pedestal in ADC counts as described above



Evolution of pedestal follows same pattern for all channels. Phase change round run 165

Who is who



Run #	Tower	N. Event	Comments
		(x1000)	
150	0	27	Position: x = -20.7 mm, y = 1170 mm
151	7	11	Position:, x = 20.7 mm, y = 1137 mm
152	8	10	Position: x = -53.7 mm, y = 1134 mm
153	5	12	Position: x = -53.7 mm, y = 1170 mm
154	3	13	Position: x = -53.7 mm, y = 1203 mm
155	2	12	Position: x = -20.7 mm, y = 1203 mm
156	1	12	Position: x = 13.7 mm, y = 1203 mm
157	4	13	Position: x = 13.7 mm, y = 1170 mm
158	6	13	Position:, x = 13.7 mm, y = 1134 mm

PMT equalisation runs

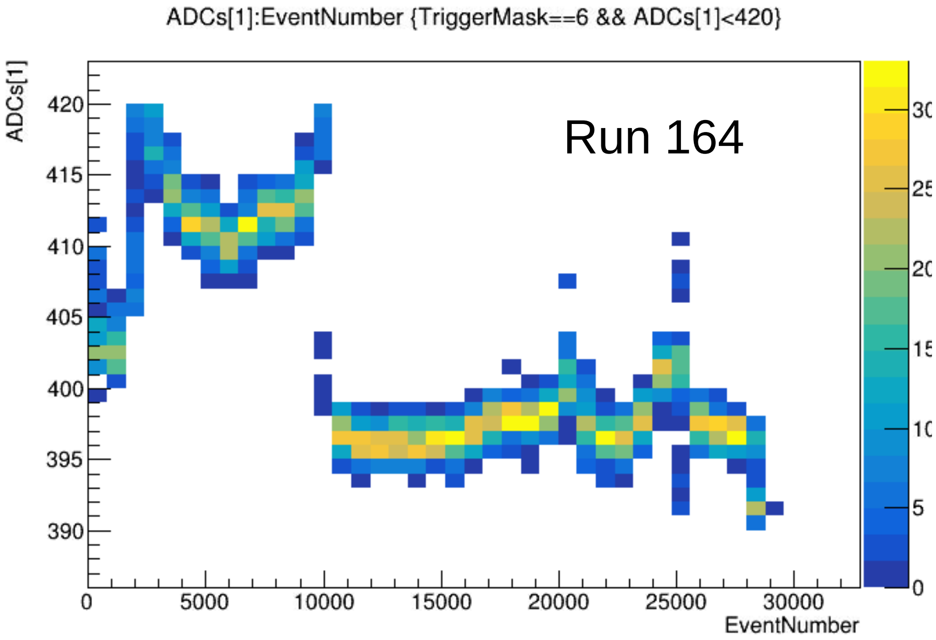
Energy	Run #	N. Event	
(GeV)		(x1000)	
20	184	15	
20	185	15	
40	186	25	C1&C2(CO2)@12 mBar, C
60	187	25	
80	188	30	
100	189	30	
120	190	30	
10	191	22	C1&C2(CO2)@12mBar (S
50	192	27	
30	193	25	

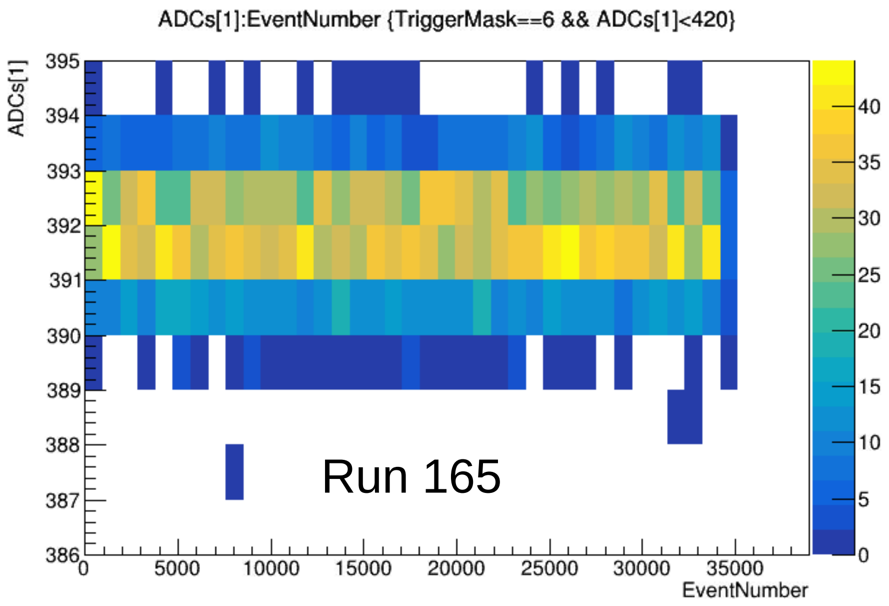
Best energy scan

Change of regime happens in the middle of the scan without preshower

When does pedestal get lower and ~stable?

```
CERNSPS2023->Draw("ADCs[1]:EventNumber","TriggerMask==6 && ADCs[1]<420","colz"
```

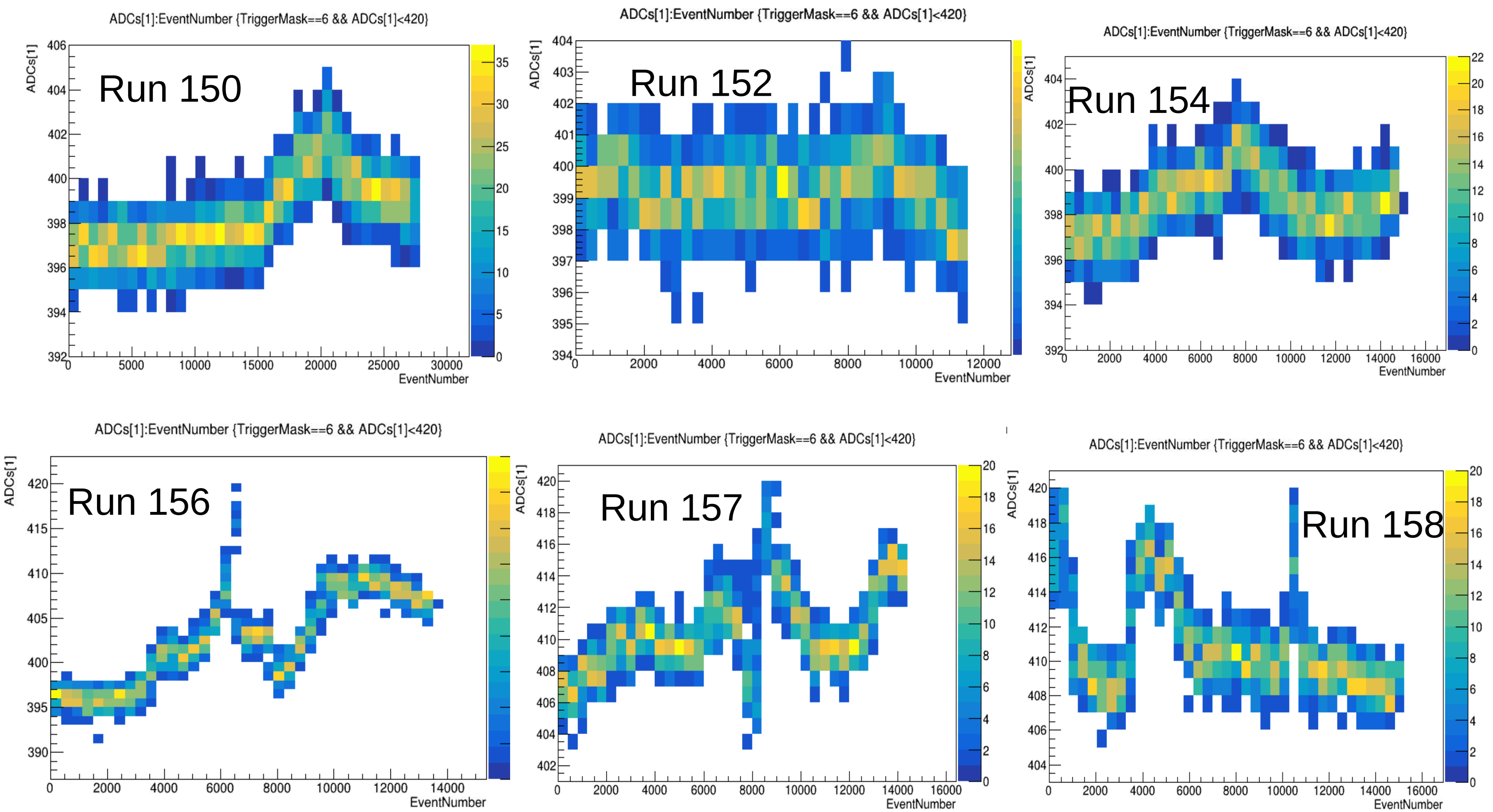




Run 184 value for this channel: 391.572

May be worth figuring out if anything special happened between runs 164 and 165.

PMT equalisation runs: ped vs event number




```
CERNSPS2023->Draw("ADCs[1]:EventNumber","TriggerMask==6 && ADCs[1]<420","colz")
```

We need to define how we best equalise PMTs in this situation

Conclusions on pedestals

PMT pedestals before Run 165 unstable

After run 165 ~8-10 counts lower and reasonably stable (only checked in detail on limited range of runs)

We need to define how to handle pedestals for runs before 165, if we need any of them for analysis

PMT equalisation runs (150-158) are among the least stable, need to discuss how to use them