Update on ΔE-TOF calibration/analysis

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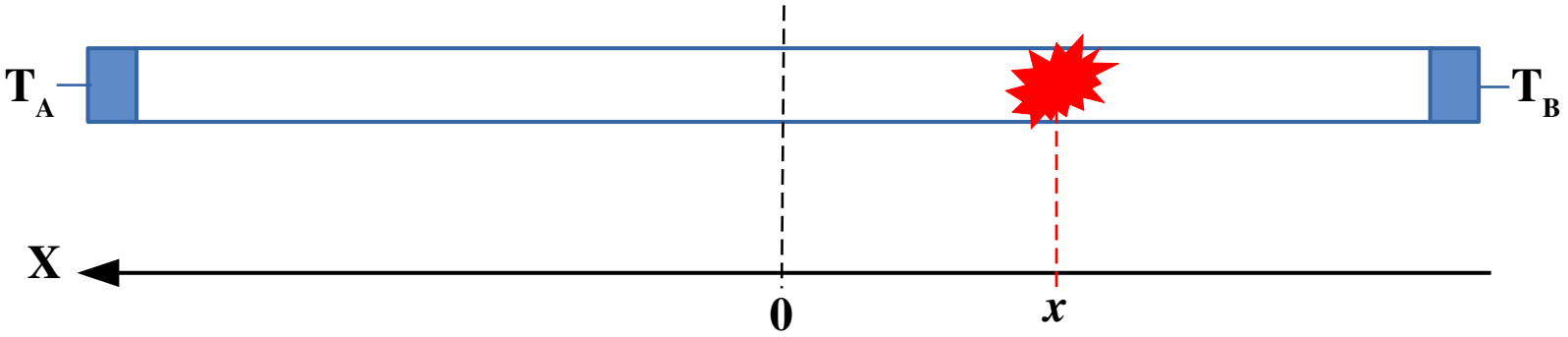
FOOT physics meeting

03/11/2021

Position calibration

Retrieve the hit position (in TW local reference frame) of particles from time measurements



$$x = \delta x - \frac{v_l \Delta T_{AB}}{2}$$

v_l is the speed of light in the bar

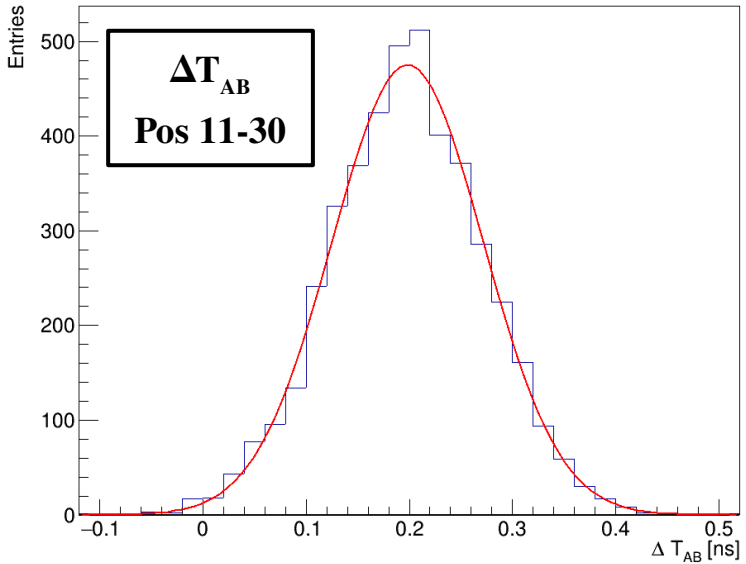
$\Delta T_{AB} = T_A - T_B$

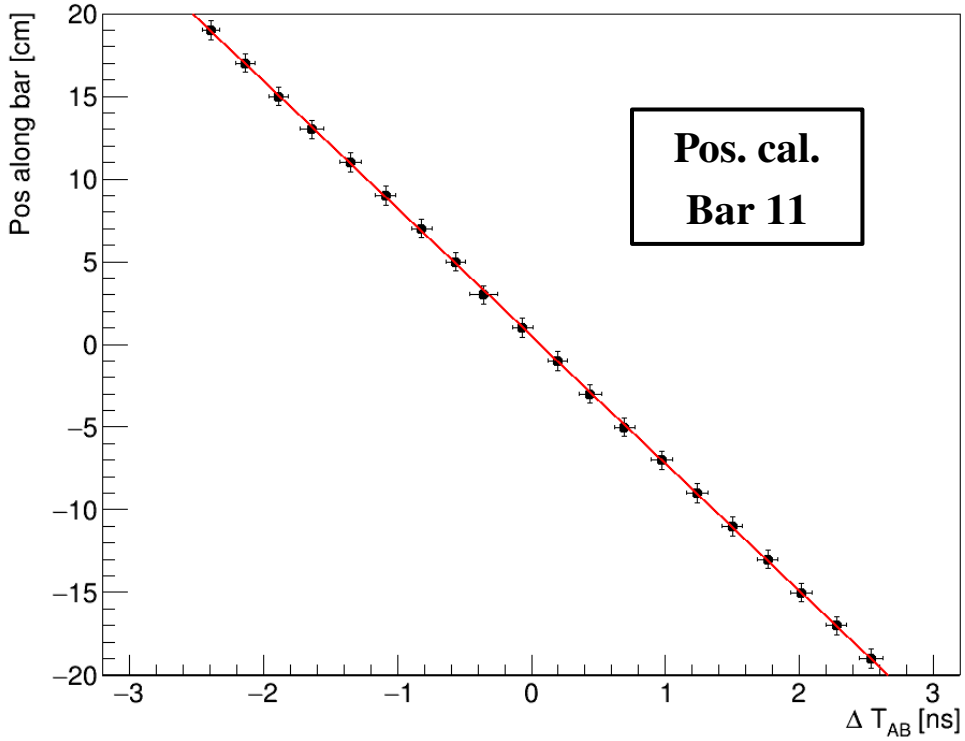
δx is an offset given by cables

The same applies to vertical bars (x→y)

Position calibration

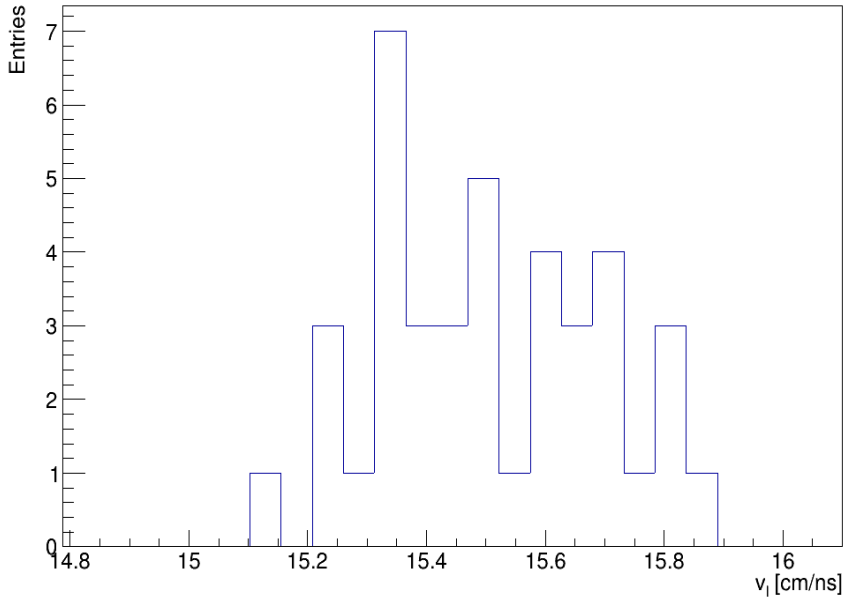
- TW scan (run 4277) → clean events (1 crossing)
- Calculate ΔT_{AB} of each bar
- Associate to TW position w/ crossing
- Fit all ΔT_{AB} histograms
- Perform linear fit of ΔT_{AB} vs Pos for each bar

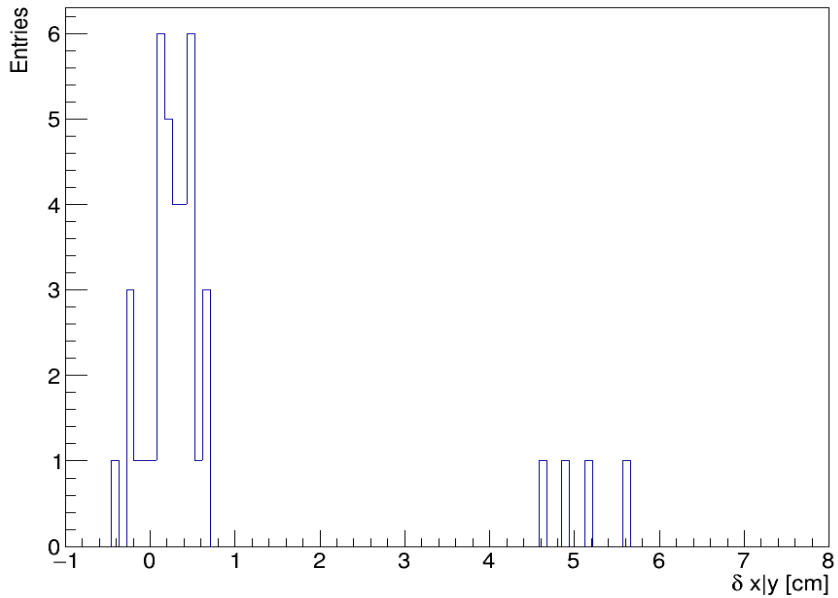




All bars calibrated!!

Position calibration: results





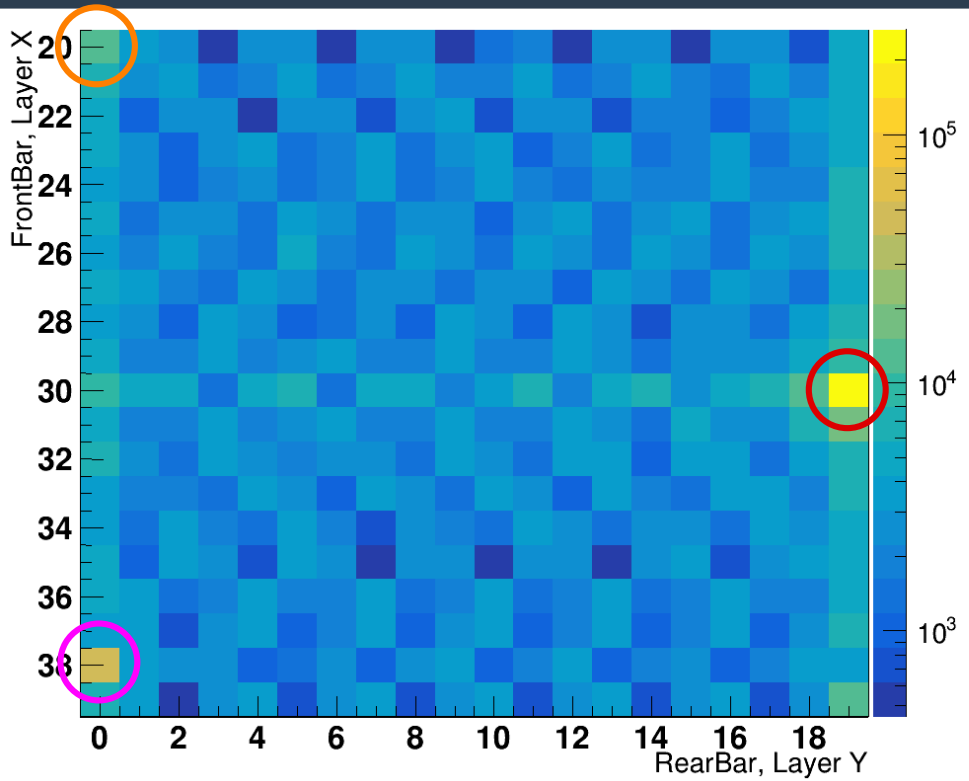
v_l = 15.51(σ=0.19) cm/ns

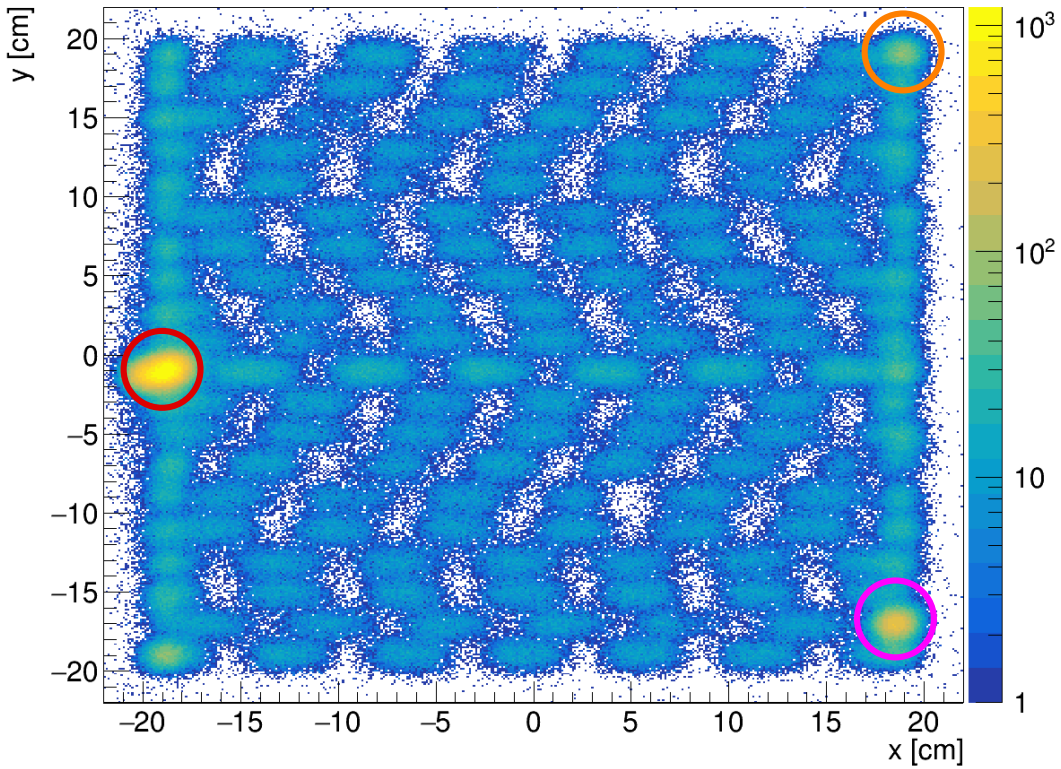
Max deviation btw bars → 5%

Position offset often ~ 0

Some very high values! (~5 cm)

Position reconstruction → TW scan



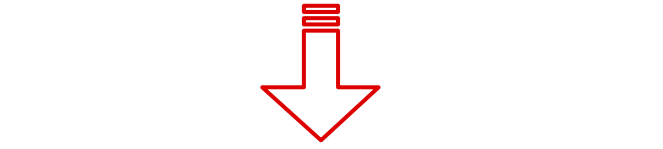


- New method guarantees time linearity!
- Recognizable spots (start, stop, block)

- Beam spills are clearly visible
- Everything in [-20,20] for x|y

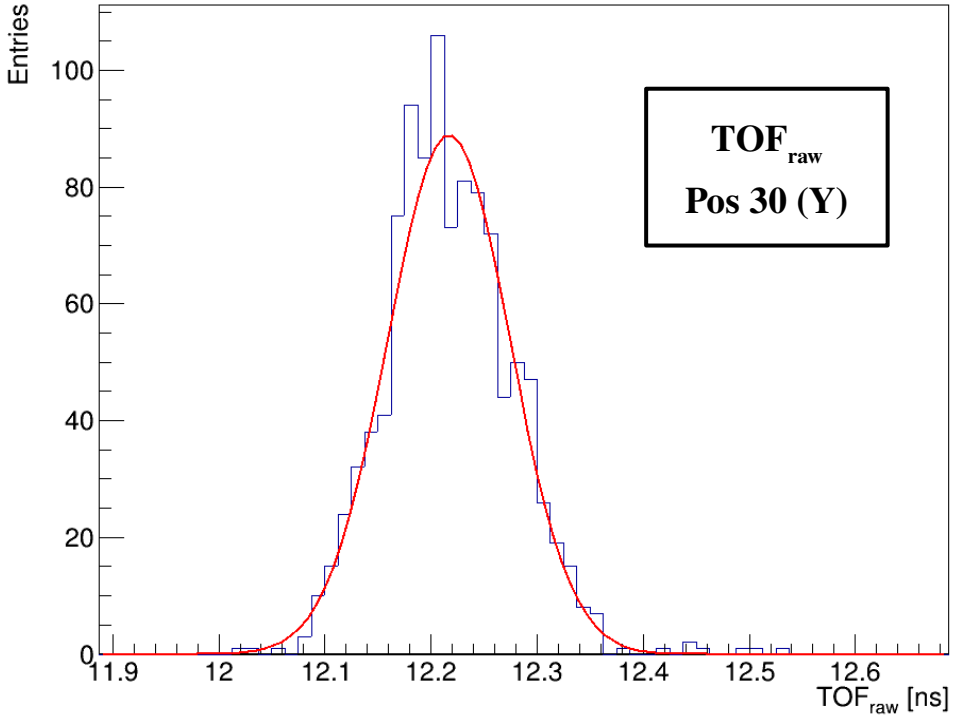
TOF calibration

- TW scan (run 4277) → clean events (1 crossing)
- Calculate raw TOF for each bar
- Associate to TW position w/ crossing
- Fit all raw TOF histograms
- Calculate distance from MC for each position



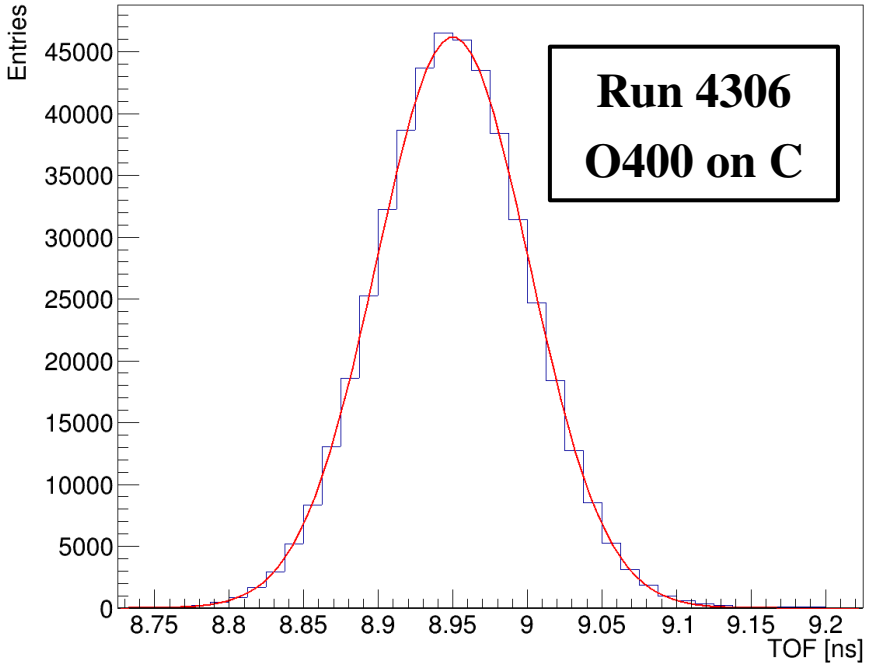
Most positions calibrated!!

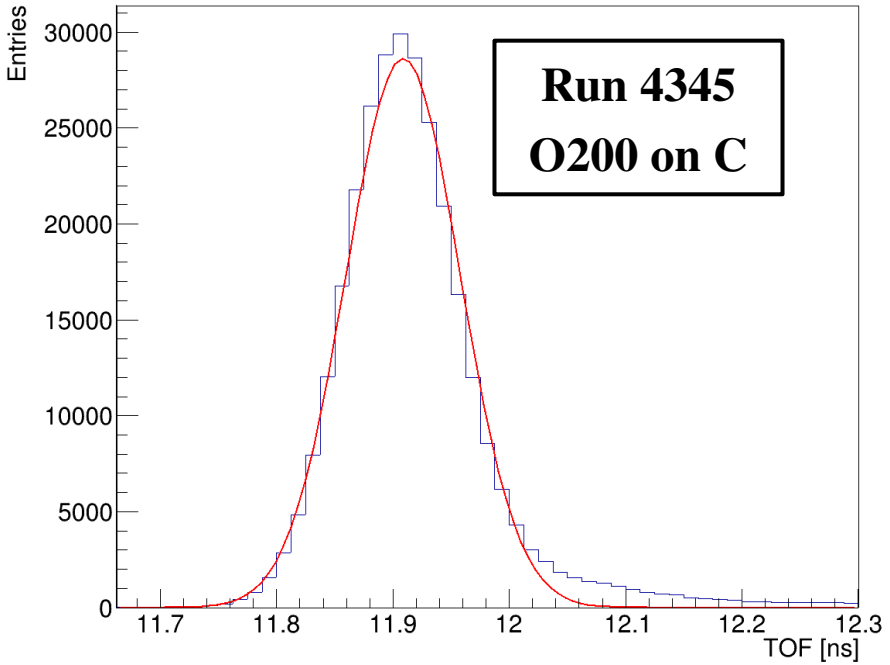
but...



- SC-TG TOF still has to be subtracted
- Low stat (<100) positions non calibrated

TOF calibration: results





σ = 51 ps → O400 (MB)

σ = 49 ps → O200 (MB)

Very good TOF resolution!

Energy calibration

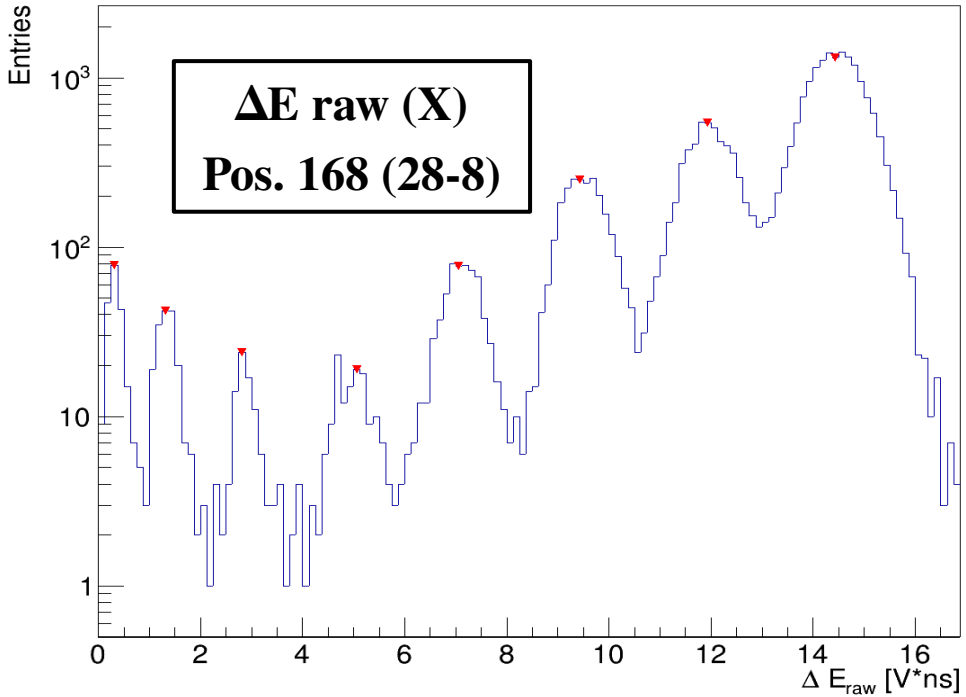
Problem

TW scan w/ only one energy (O400)

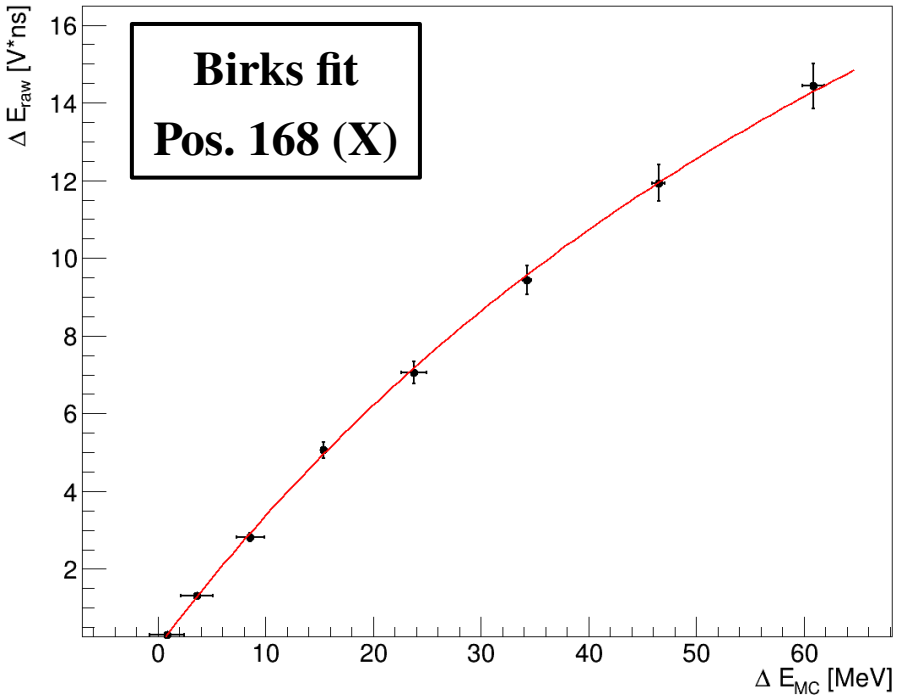
Solution

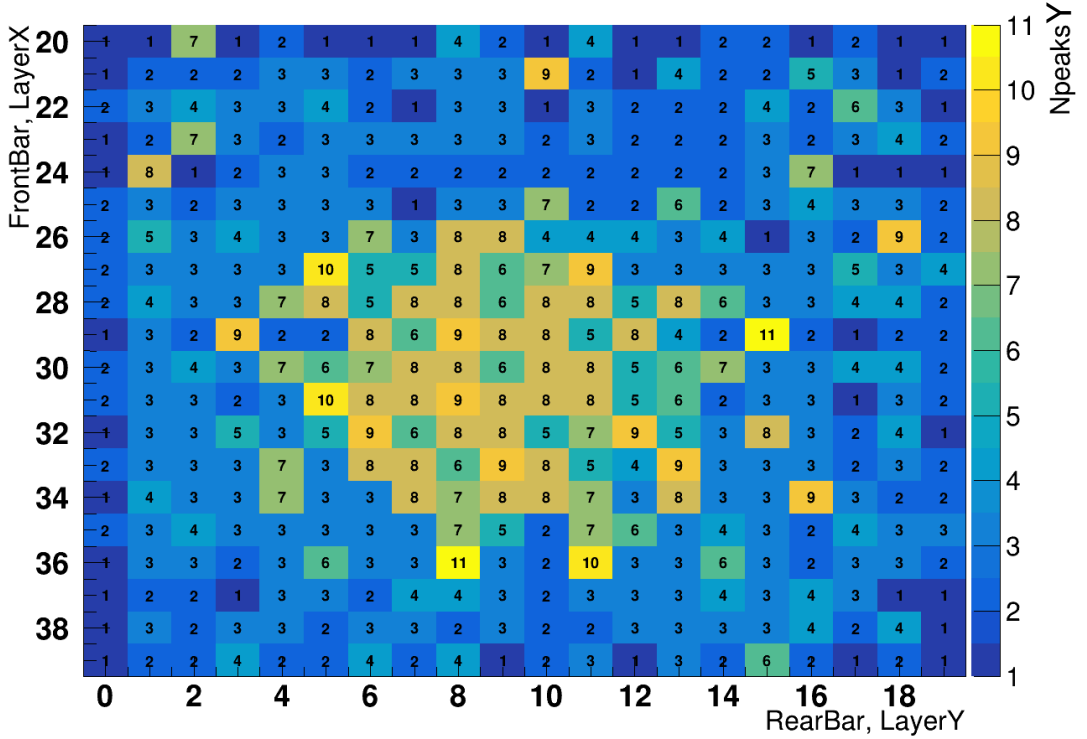
Calibrate w/ fragments

- Sample: O @ 400 MeV/u
  - TW scan
  - 5mm C (MB + frag.)
  - 10mm PE (MB+frag.)
- Calculate raw ΔE for each bar
- Associate to TW position w/ crossing
- Identify all raw ΔE peaks for each position
- Associate to ΔE_{MC} of corresponding fragments
- Fit w/ Birks curve



Energy calibration: results

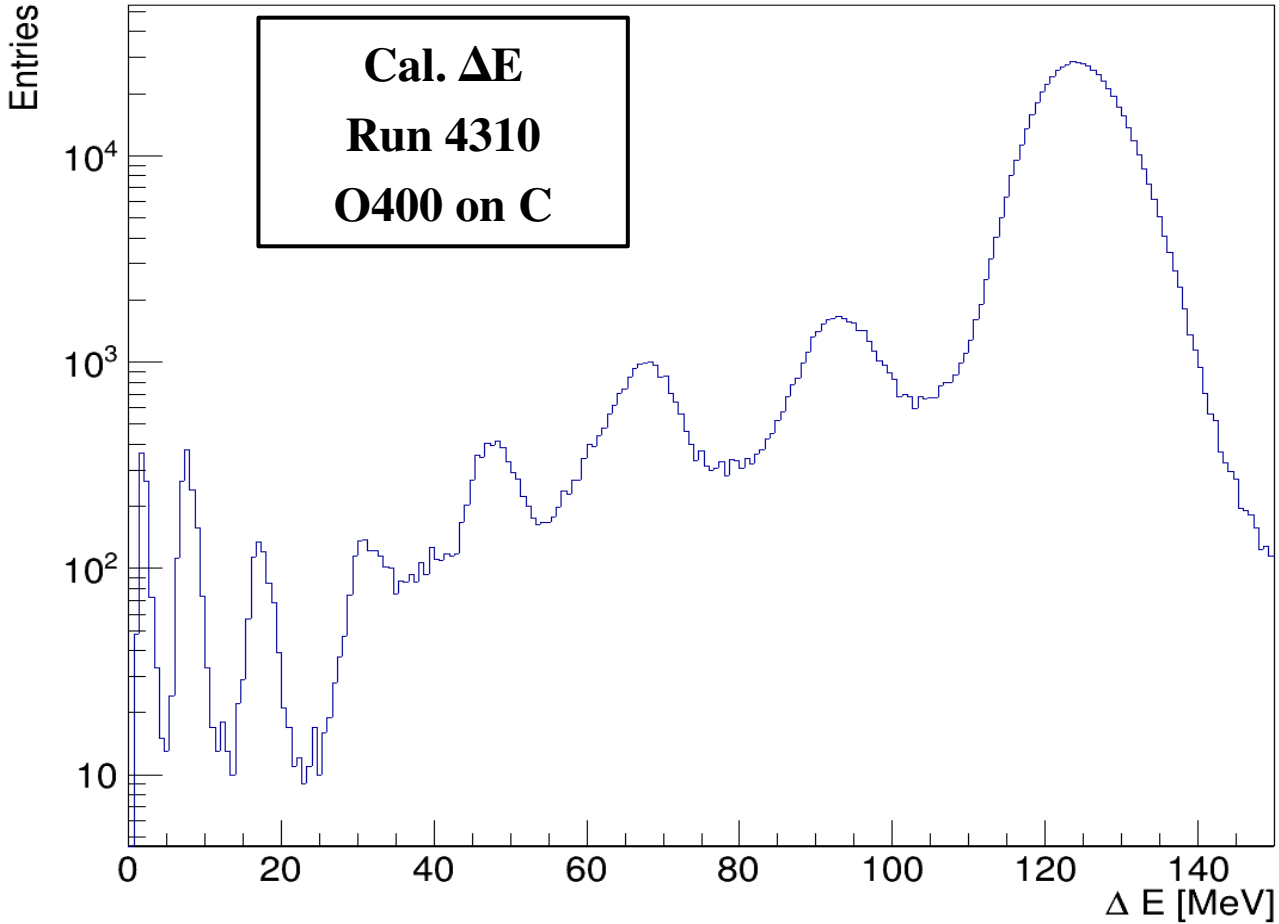




- Number of identified peaks similar in X-Y layers
- Some pos. w/ Npeaks > 8
- Pos. w/ 2-3 peaks usually unreliable (H-He+O)

Center mostly calibrated!

Energy calibration: results



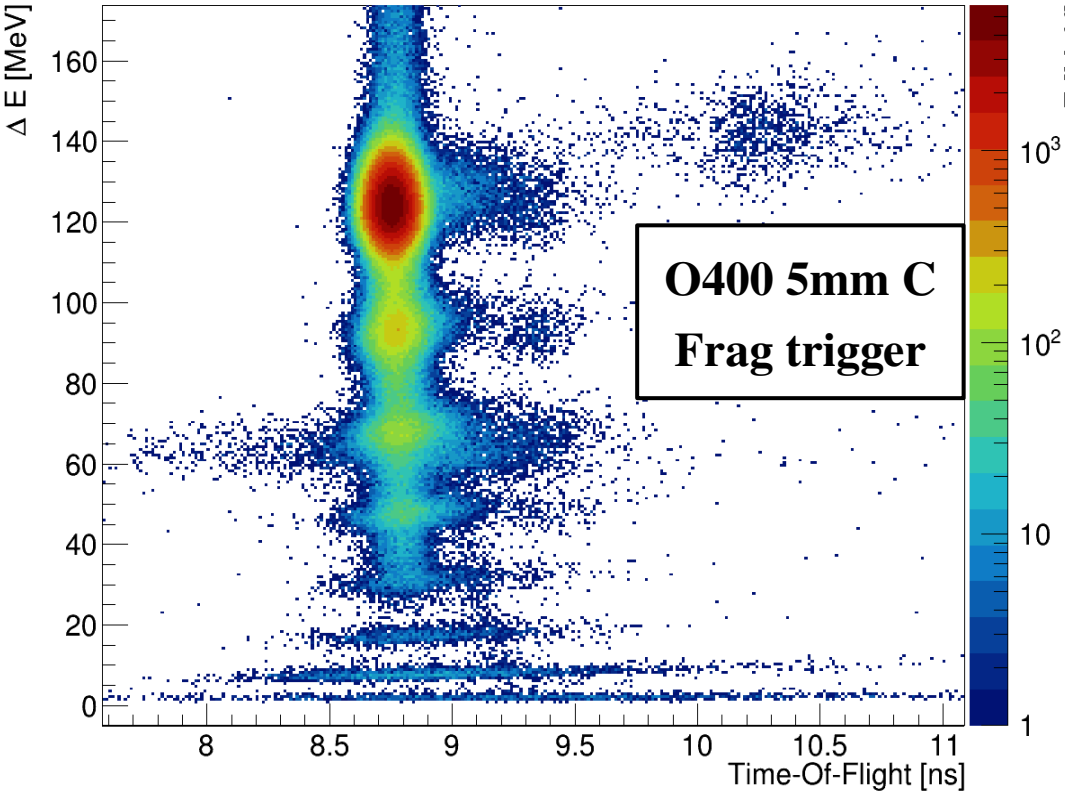
Energy resolution ~ 4%!

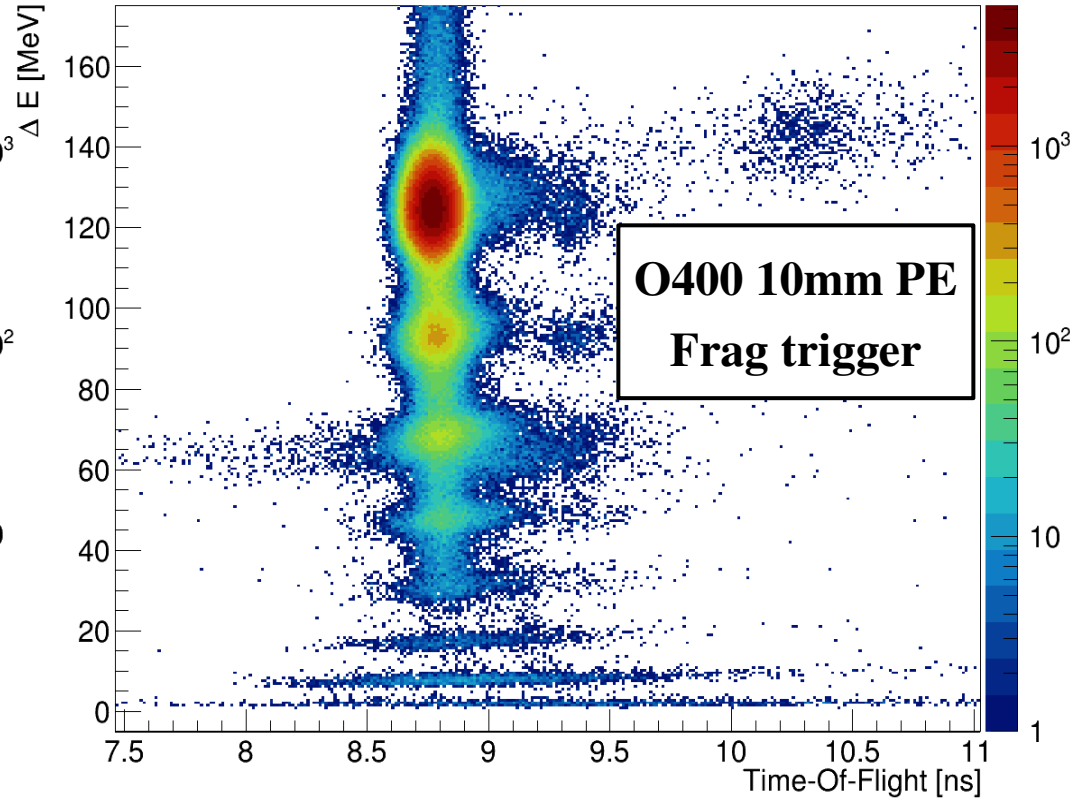
Fragment identification already good!

but...

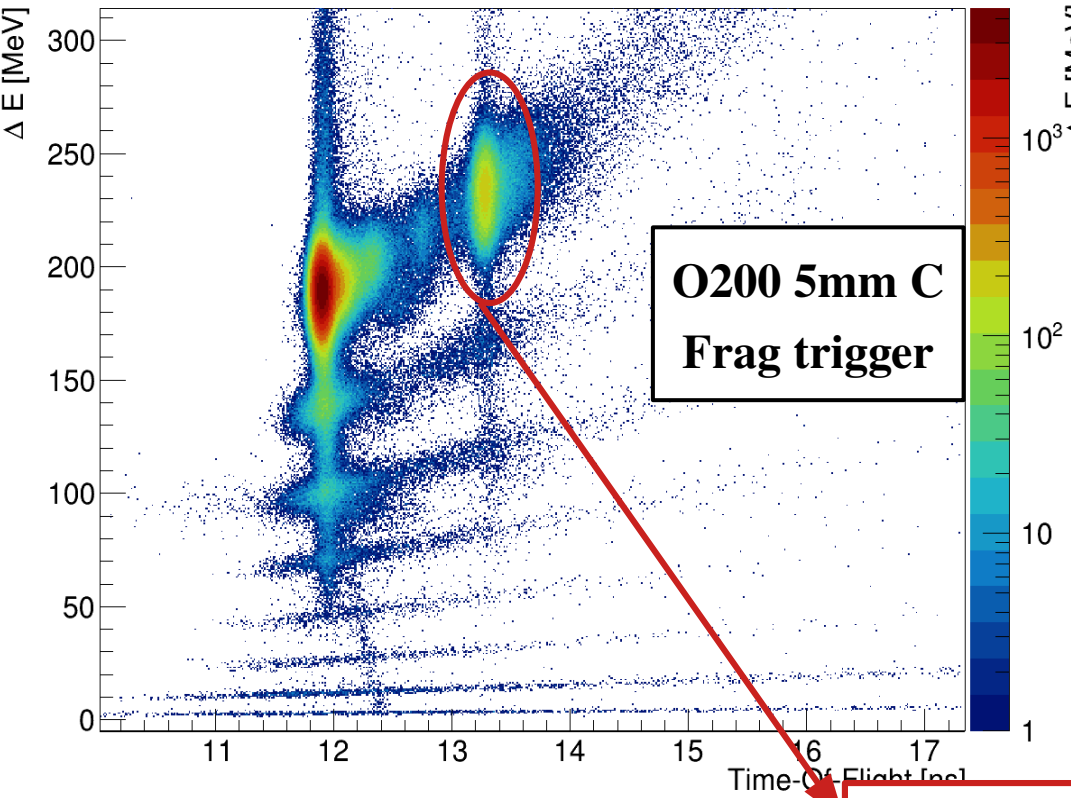
- Algorithm still needs some tuning
- Study scintillator saturation
- Use O200 data?
- Use NN cal. to improve stats?

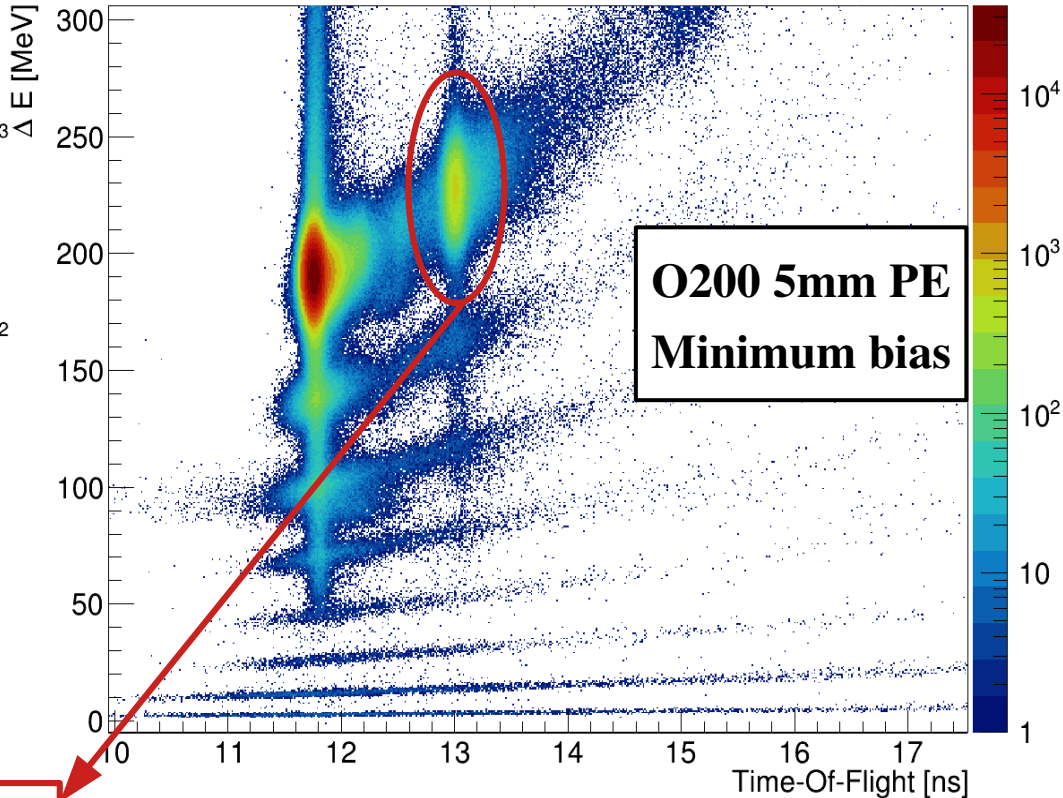
Charge Identification: O400





Charge Identification: O200

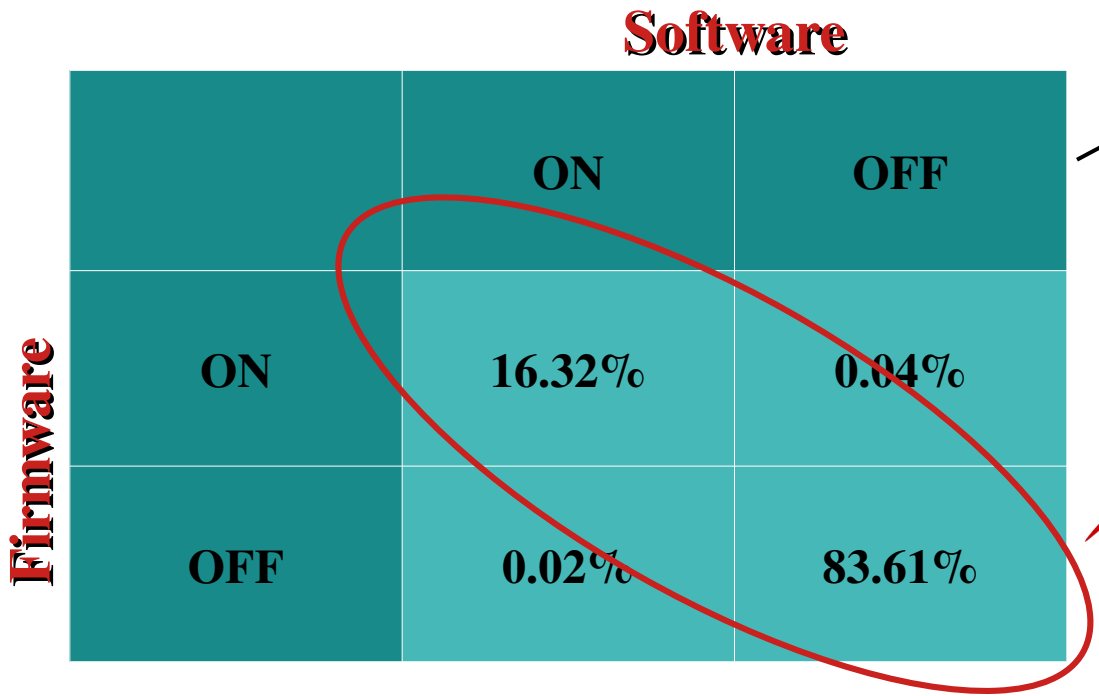




Trackers!!

In the meantime… Trigger!

Trigger closure test → Checked fragmentation trigger bit (fw) vs requirements (sw)

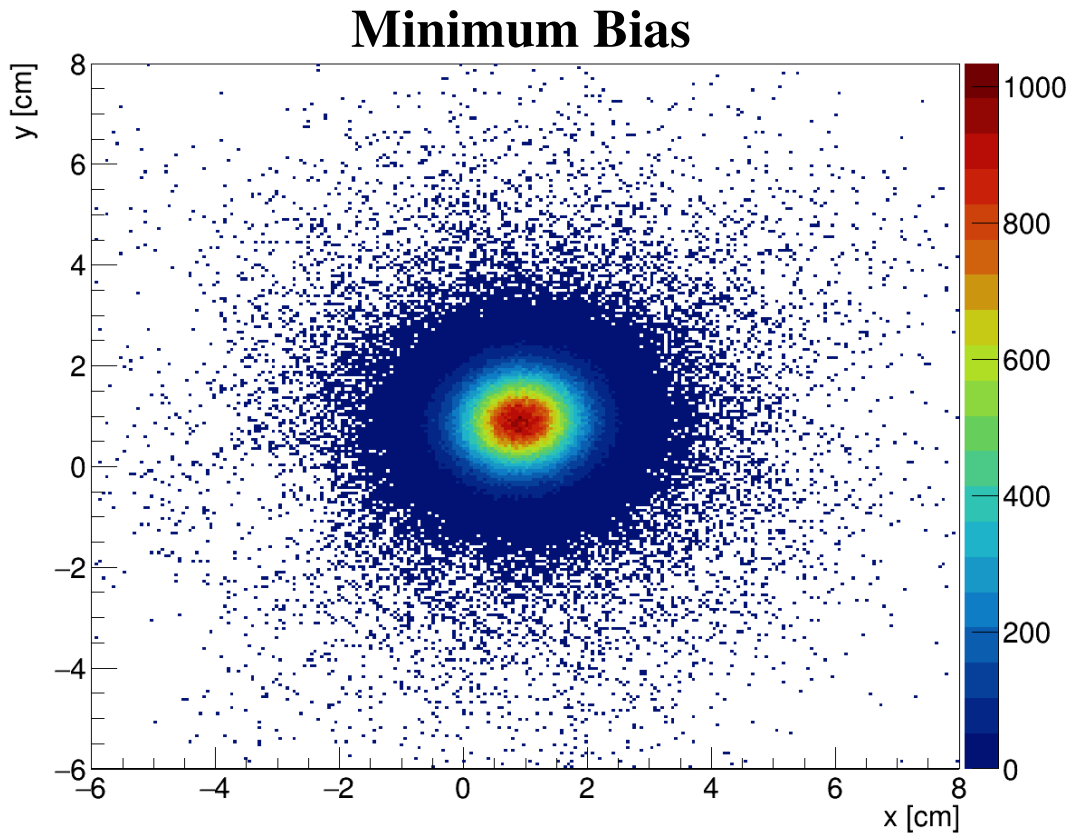


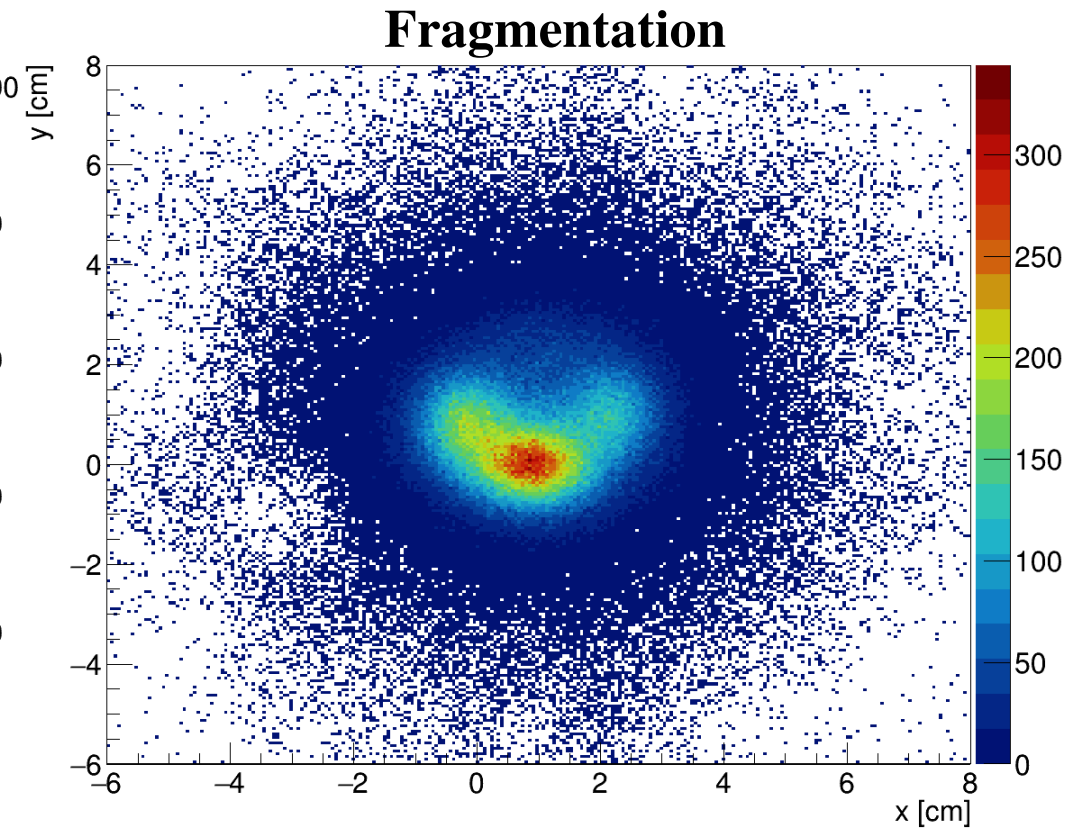
Run 4306 (~600k events)
O400 on 5mm C (MB)

99.93% matching!!

Thanks to Lorenzo M. for the trigger threshold calibration!

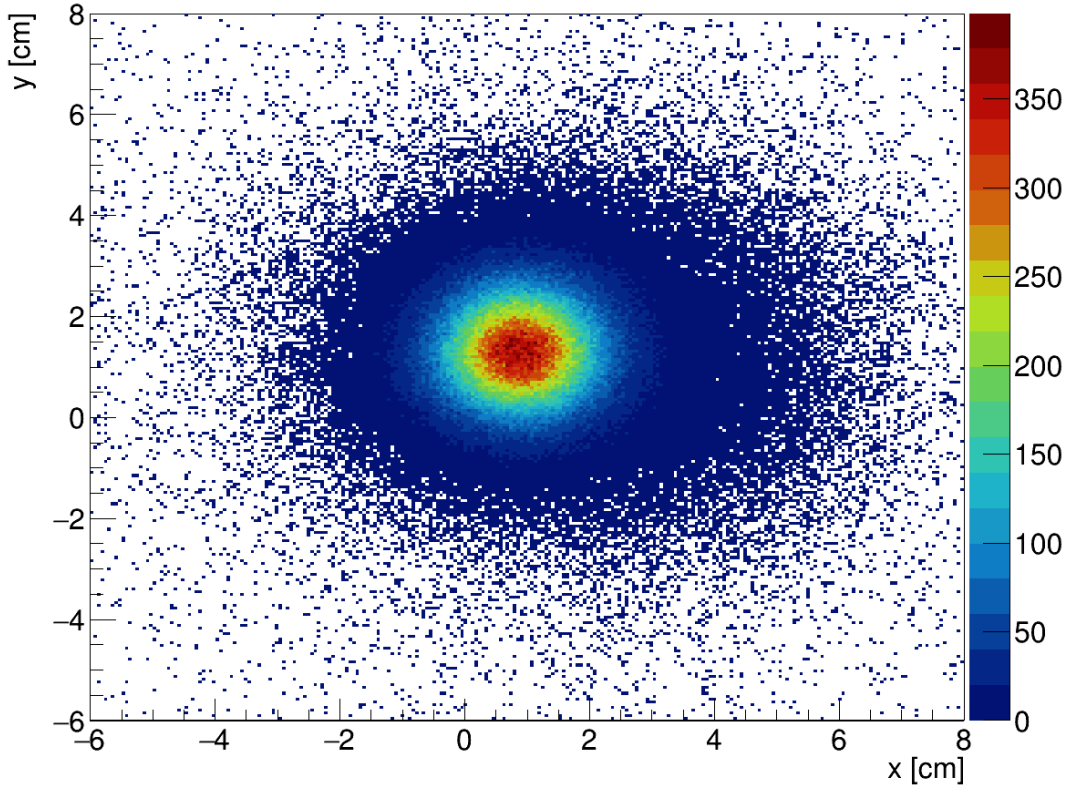
TW beam spot O400: MB vs Frag



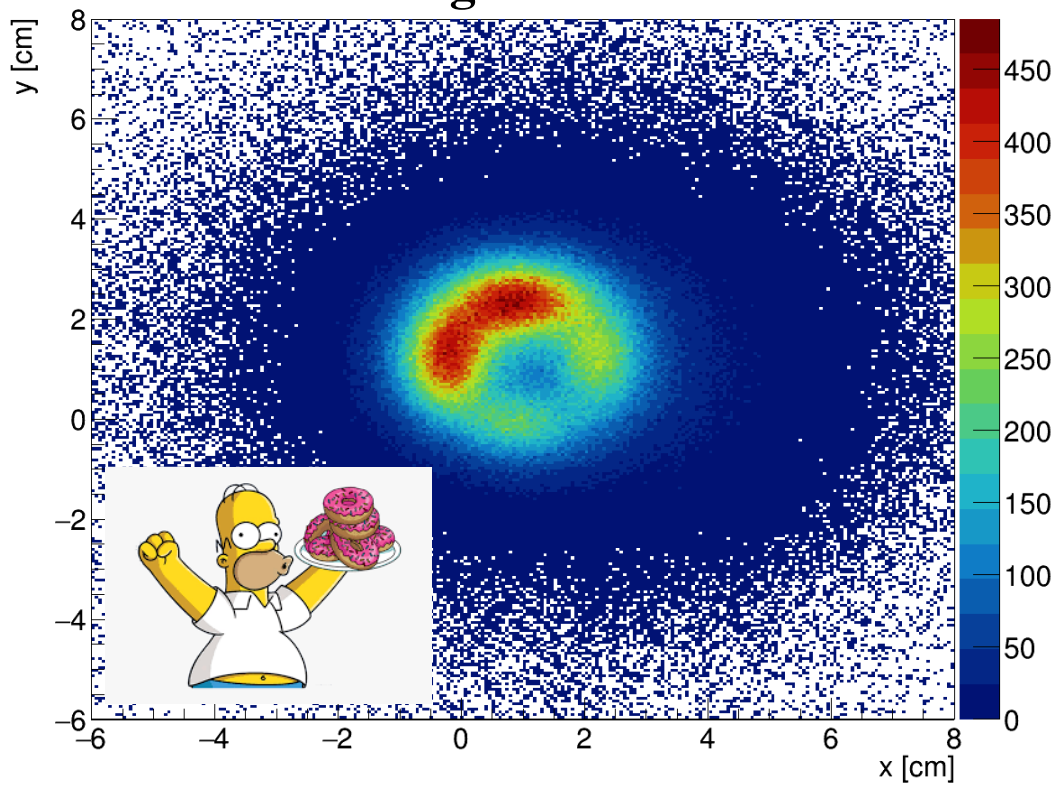


TW beam spot O200: MB vs Frag

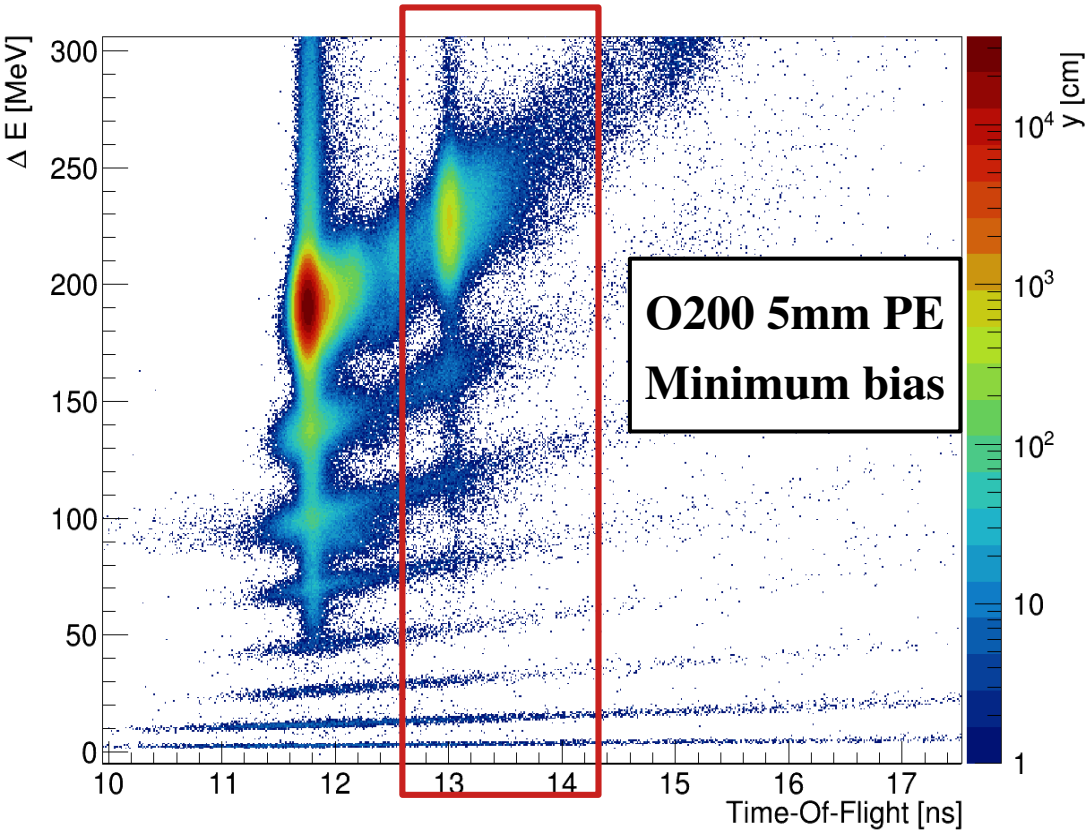
Minimum Bias

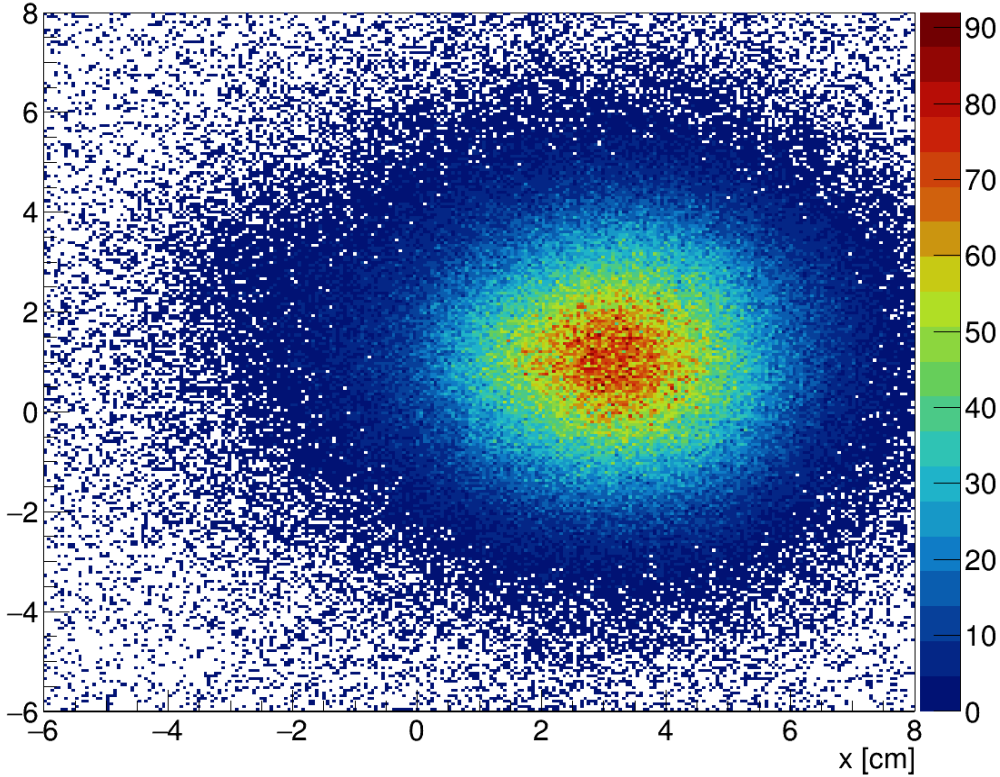


Fragmentation



TW beam spot O200: MB weird events





Beam spot is significantly shifted

Conclusions

Calibration:

- All three calibrations performed
- Still some tuning to be done, but working → **re-check everything**
- ΔE and TOF cals. already in SHOE format, Position to be implemented

Charge identification:

- Calibration works fine for both O400 and O200
- Good charge separation for all fragments
- Some background to remove → **Solid clustering algorithm strongly needed!**

Trigger:

- Perfect matching between firmware response and trigger requirements
- Rome group currently working on trigger efficiencies

Thank you for your attention