BEAM MONITOR UPDATES

Milano & Trento

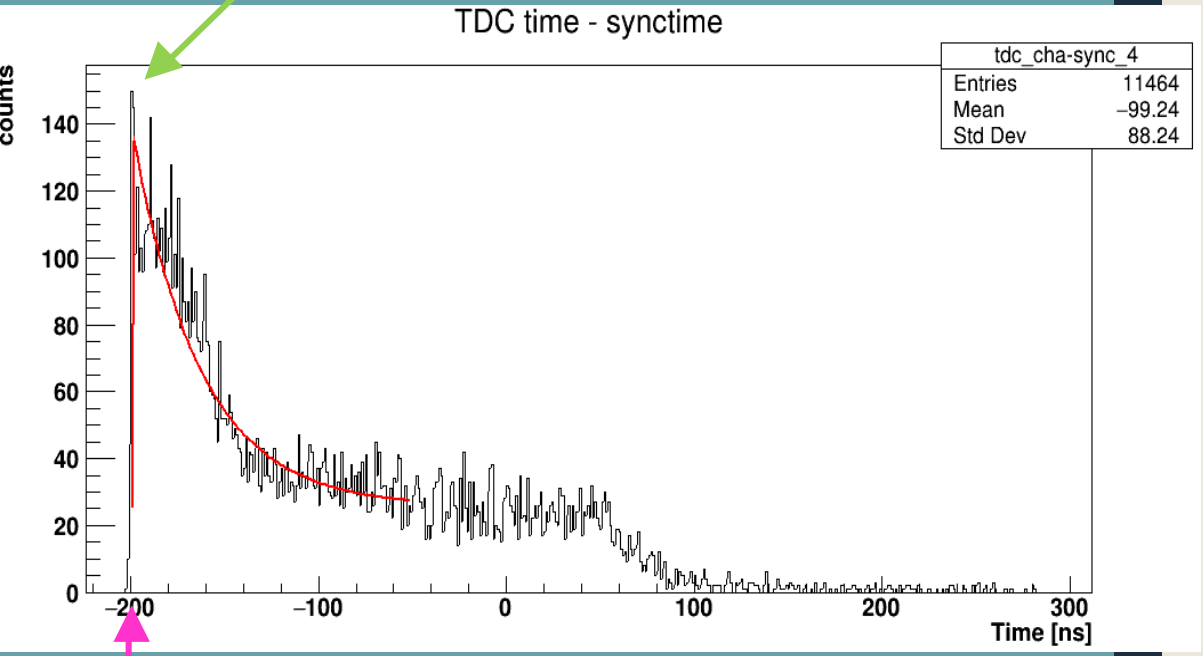
Meeting of the FOOT Performances Group

Outline

- T0 analysis
- ST rel calibration with MSD : updates
- Implementation of the Legendre Transform for track reconstruction
- To do list : road to Collaboration Meeting @ CNAO

T0 analysis

Peak point



Starting point

Four different choices:

- T0 starting point
- T0 peak point
- T0 peak/2 point (= (peak point – starting point)/2)
- T0 fit
  - *The calibration of the space-time relations in the KLOE drift chamber* paper
  - The time distribution for a single channel is fitted with the function

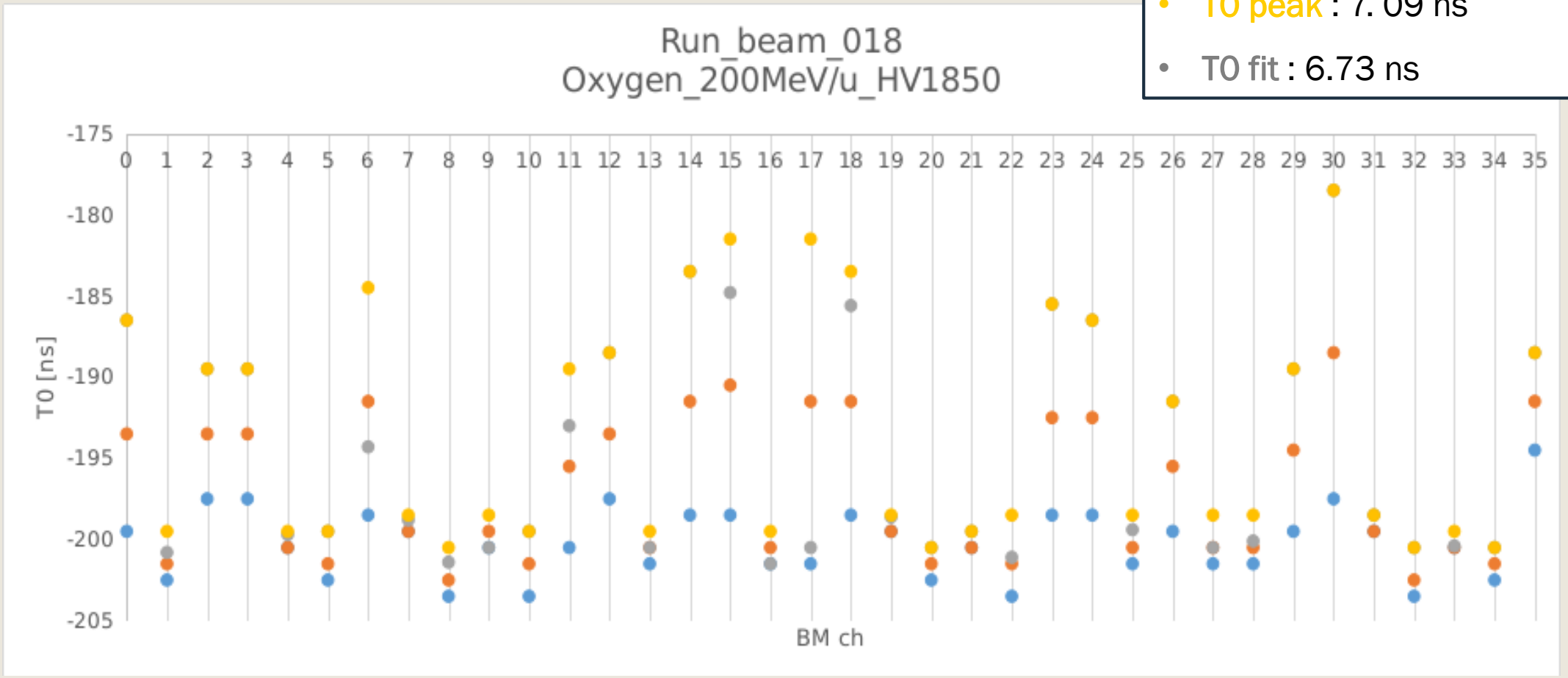
$$a + b\,\frac{e^{-d(t-t1)}}{1 + e^{-(t-t0)/c}}$$

  - Fermi-Dirac-like function (t0 = inflection point) + an exponential (rest of the distribution)

Example:
200MeV/u Oxygen
HV 1850 V

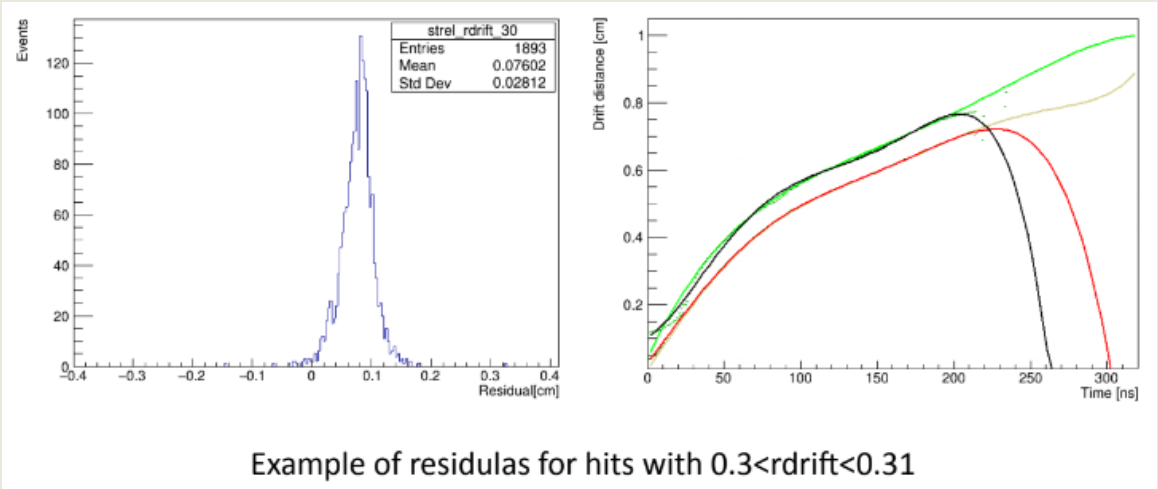
Standard deviation:

- T0 starting point : 2.12 ns
- T0 peak/2 : 4.38 ns
- T0 peak : 7. 09 ns
- T0 fit : 6.73 ns



Monte Carlo study for the BM s-t rel evaluation with external detector (last meeting)

- Calculate the residuals: difference between BM “fake” drift distance and the vertex extrapolated drift distance foreach hit
- Evaluate the new s-t rel



Example of residulas for hits with 0.3<rdrift<0.31

Green: “Real“ rdrift

Brown: Garfield rdrift

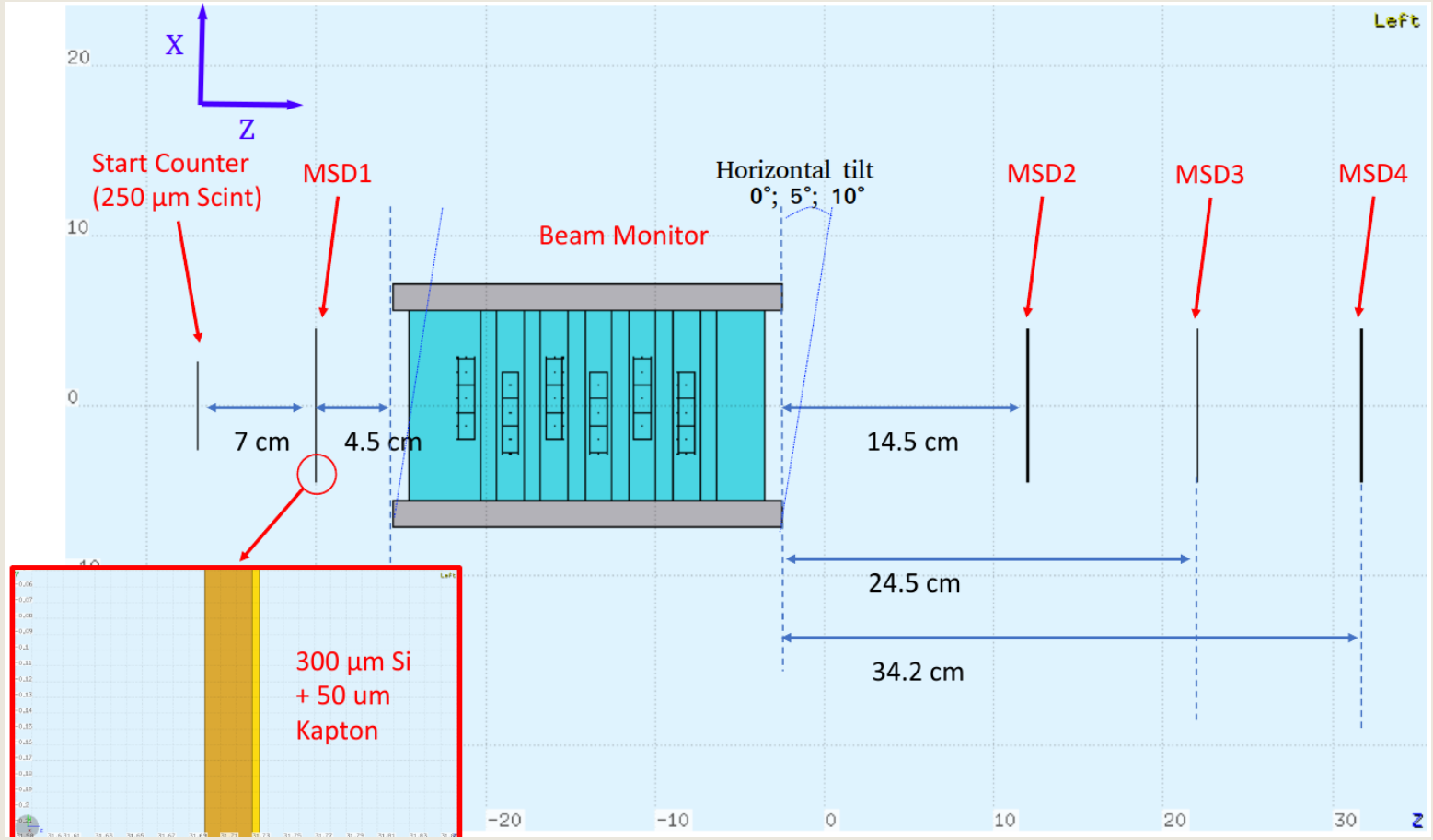
Red: rdrift used as input for the Bmtracking

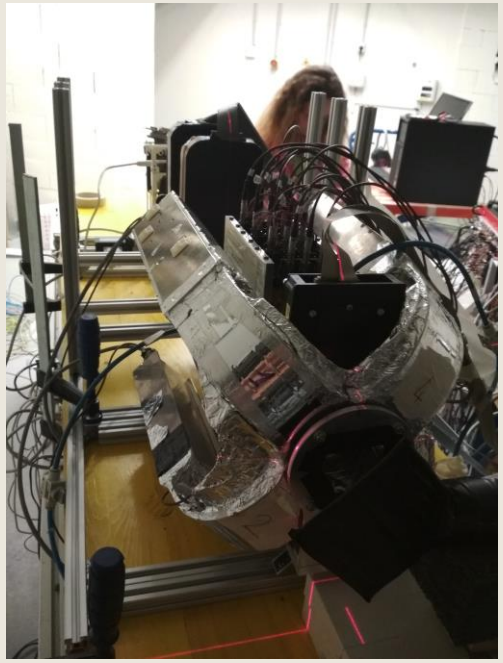
Black: new fitted rdrift

- The macro that evaluate the new st rel is working on MC data (tested also with small detector tilt and misallignment)
- It needs only the tracks from an external detector (and of the BM of course)
- S-t rel. with MSD + BM @ Trento with P ⟶ analysis ongoing (next slides)
- S-t rel. with Vertex+BM @ GSI with O ⟶ After msd analysis, if the vertex data are recovered, we can use them!

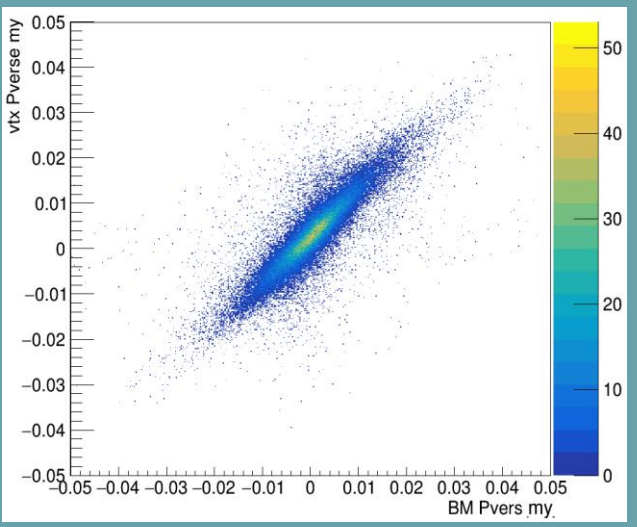
ST rel with MSD : experimental setup

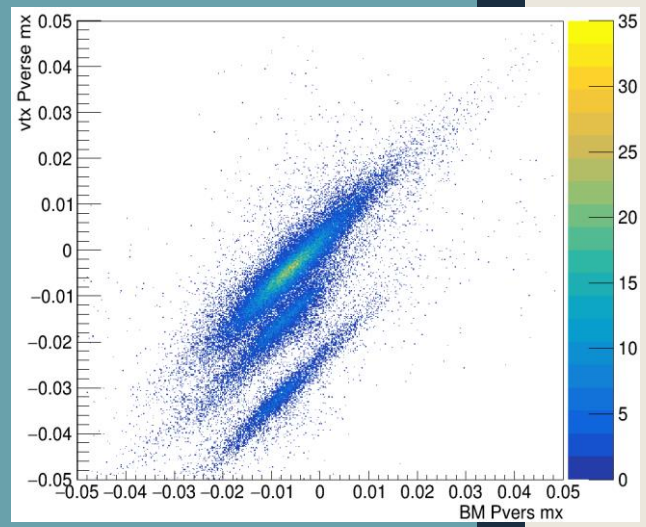
- Data acquisition in march 2019 (3 days) @ Protontherapy center (Trento)
  - MSD + BM + MARGHERITA

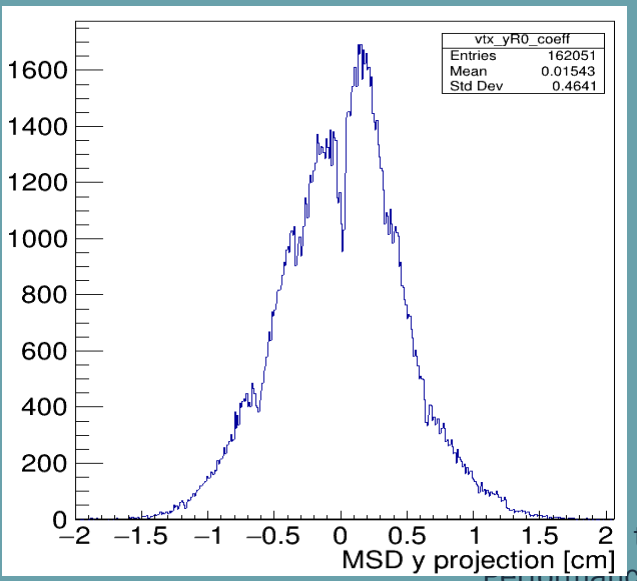


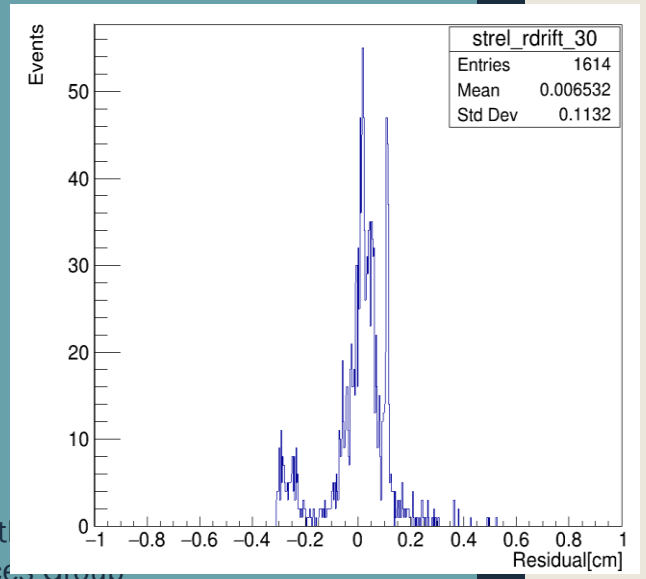


ST rel with MSD









Current situation:

- We got few problems with the hardware of the MSD
- Different noisy and dead strips
- 1 dead layer of MSD (in principle we can have up to 4 points on the X coord. and 3 points on Y coord.)
- Difficulties for the alignment
- Multiple Coulomb scattering

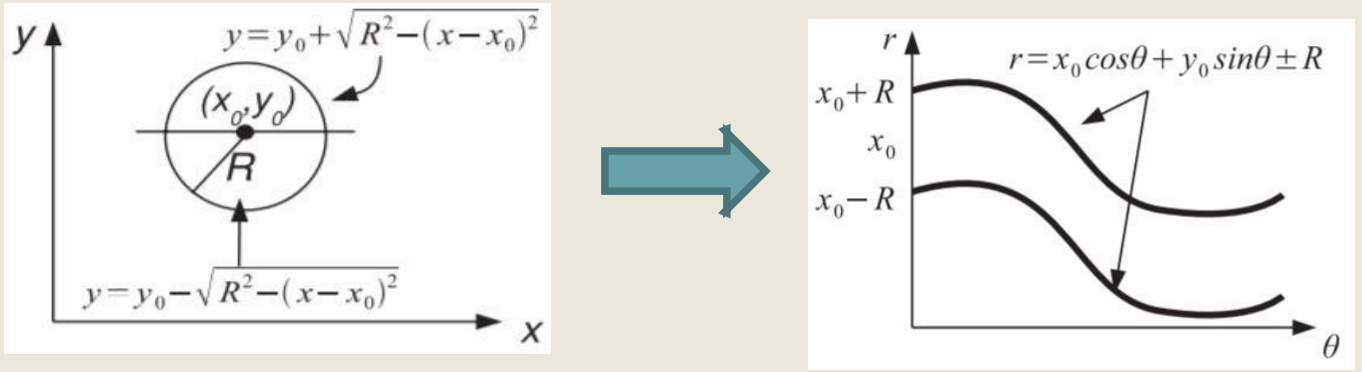
- Only the data collected in the last day are useful

  200000 evt.: 80 MeV, 0° tilt
  100000 evt.: 228 MeV, 0° tilt
  100000 evt.: 80 MeV, 5° tilt
  100000 evt.: 228 MeV, 5° tilt
  100000 evt: 228 MeV, 10° tilt

- We should work on the ST rel calibration with the Vertex from GSI data

Legendre Transform

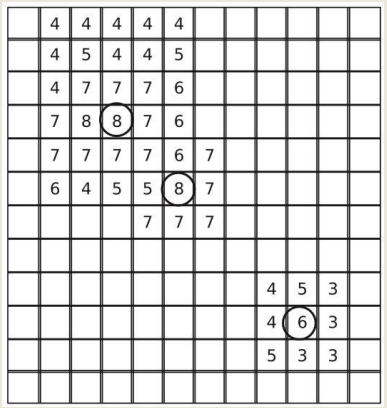
Each cell signal is depicted as a circle concentric with the anode wire: the method is based on the transform of each drift circle to the Legendre space.



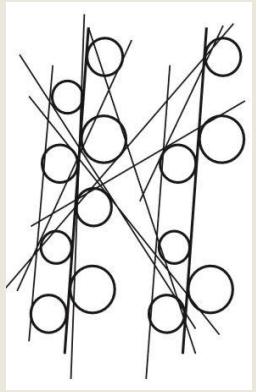
Each point in the Legendre space represents a tangent line to the circle.

The height of the peaks represents the number of circles that contribute to the charged particles tracks.

The points with the maximum contribution in the Legendre space represents the common tangent to the circles, i.e. the particle track.



After identifying the peak bins, the neighboring bins of each peak are tested, which results in clusters having the Legendre peaks at centers



- $Height_{neighbor\ bin} < Height_{central\ bin}$

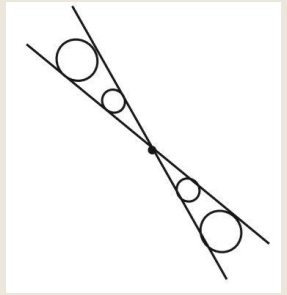
  The bin is **ignored** because it corresponds to a subset of the real segment

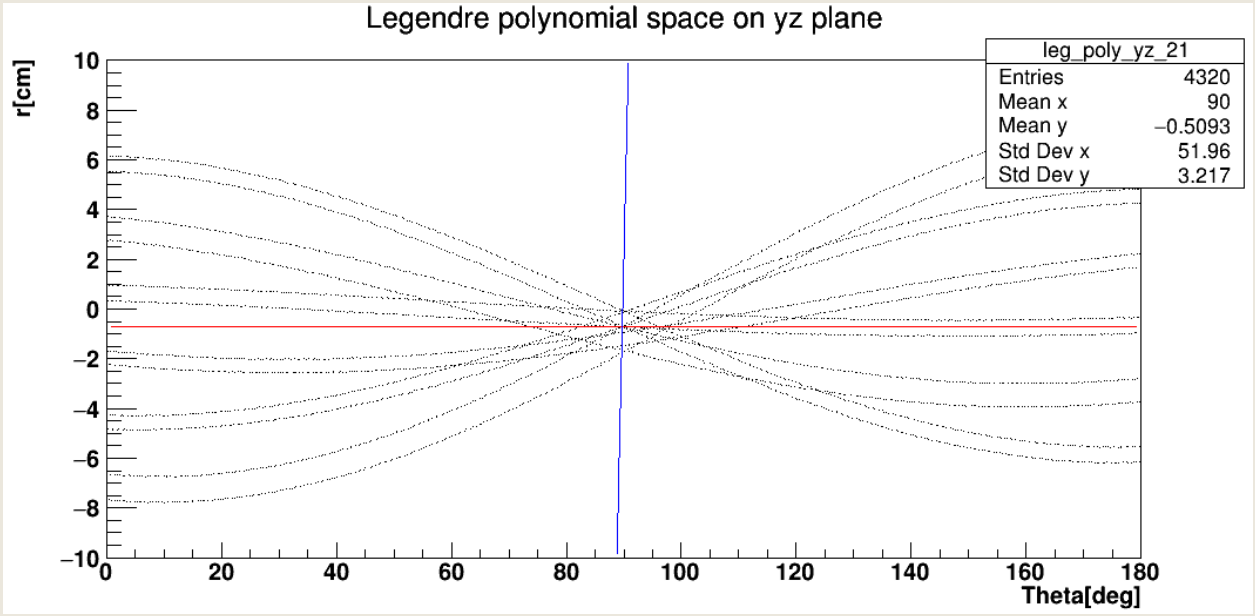
- $Height_{neighbor\ bin} = Height_{central\ bin}$ & $bins\ are\ adiacent$

  The bin is **ignored** because it belongs to the same line

- $Height_{neighbor\ bin} = Height_{central\ bin}$ & smaller peaks between them

  The bin is **accepted** : line with different parameters from the central bin line but associated to the same number of circles, so it might correspond to an ambiguous line





- It will be useful to study the fragmentation inside the SC, because the algorithm works for multi-track events as well

- We need to study better what happens for multi-tracks event with Monte Carlo data and GSI data

To do list

- Legendre Transform algorithm validated on Monte Carlo data and GSI data
- ST rel calibration with the Vertex
- If Vertex calibration doesn’t work, we should try the autocalibration method to reconstruct the GSI data

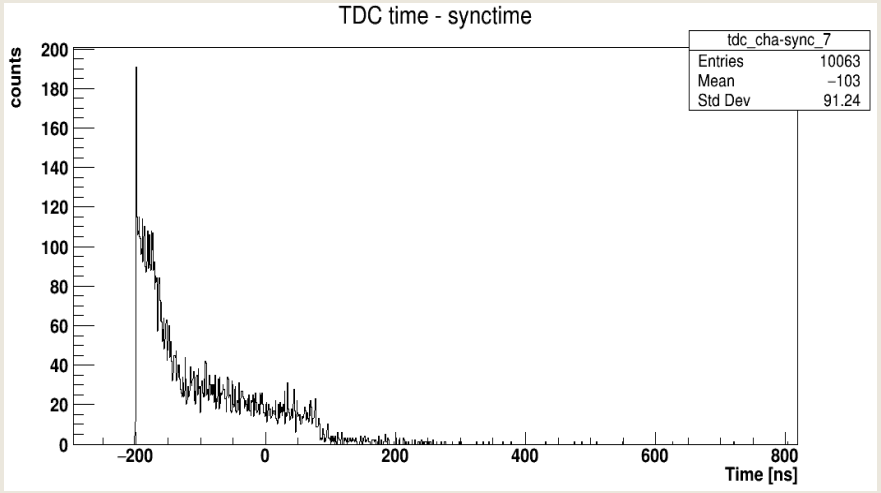
- What can we learn from GSI data? Efficiency, working point evaluation, look at raw signals

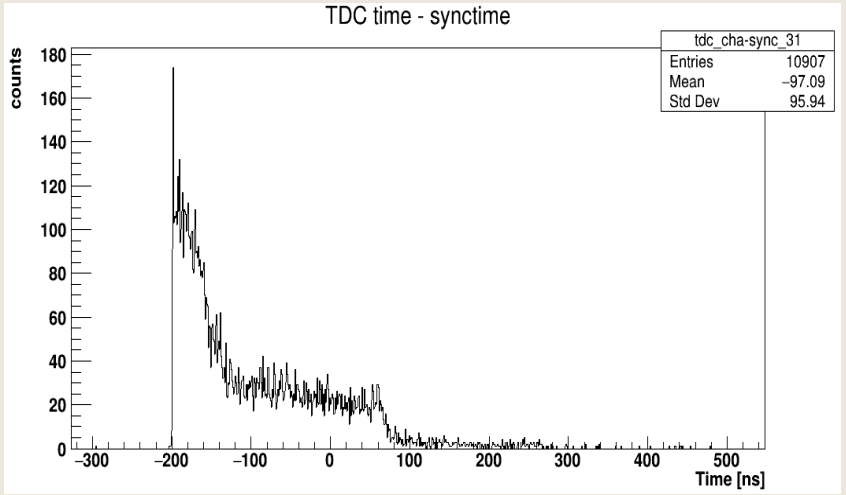

Thank you!

Backup slides

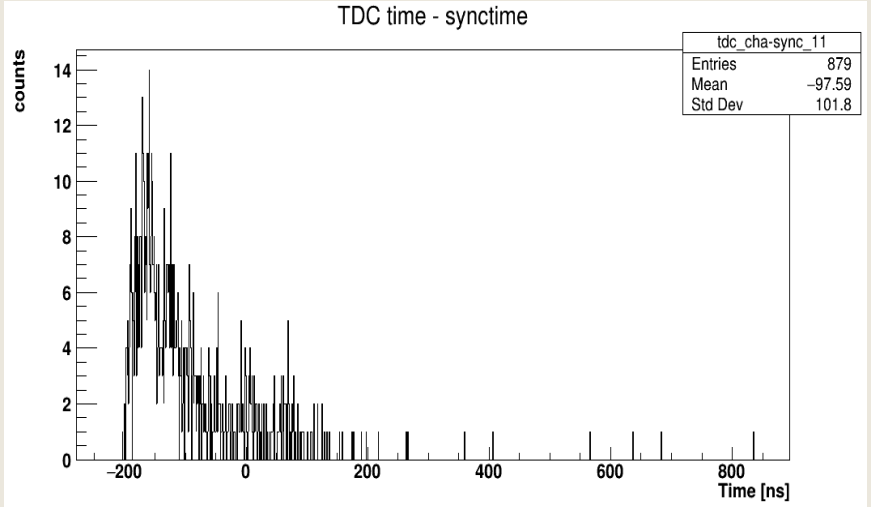
200 MeV/u Oxygen

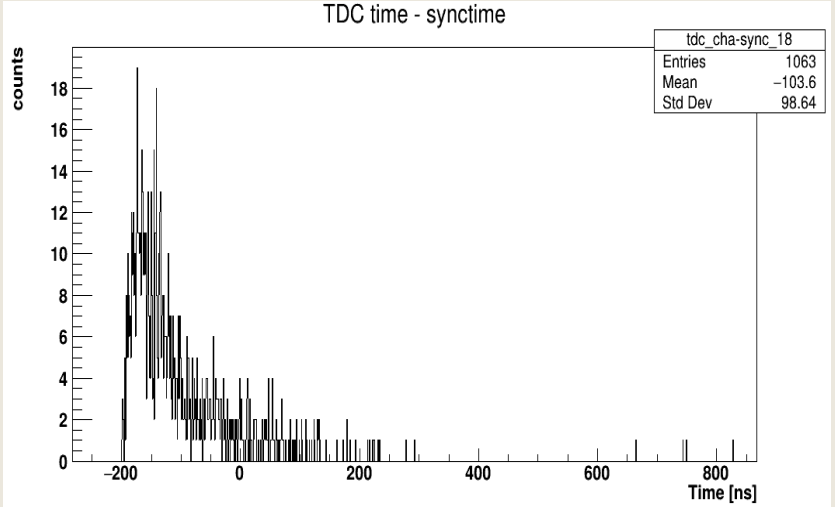
Good cases



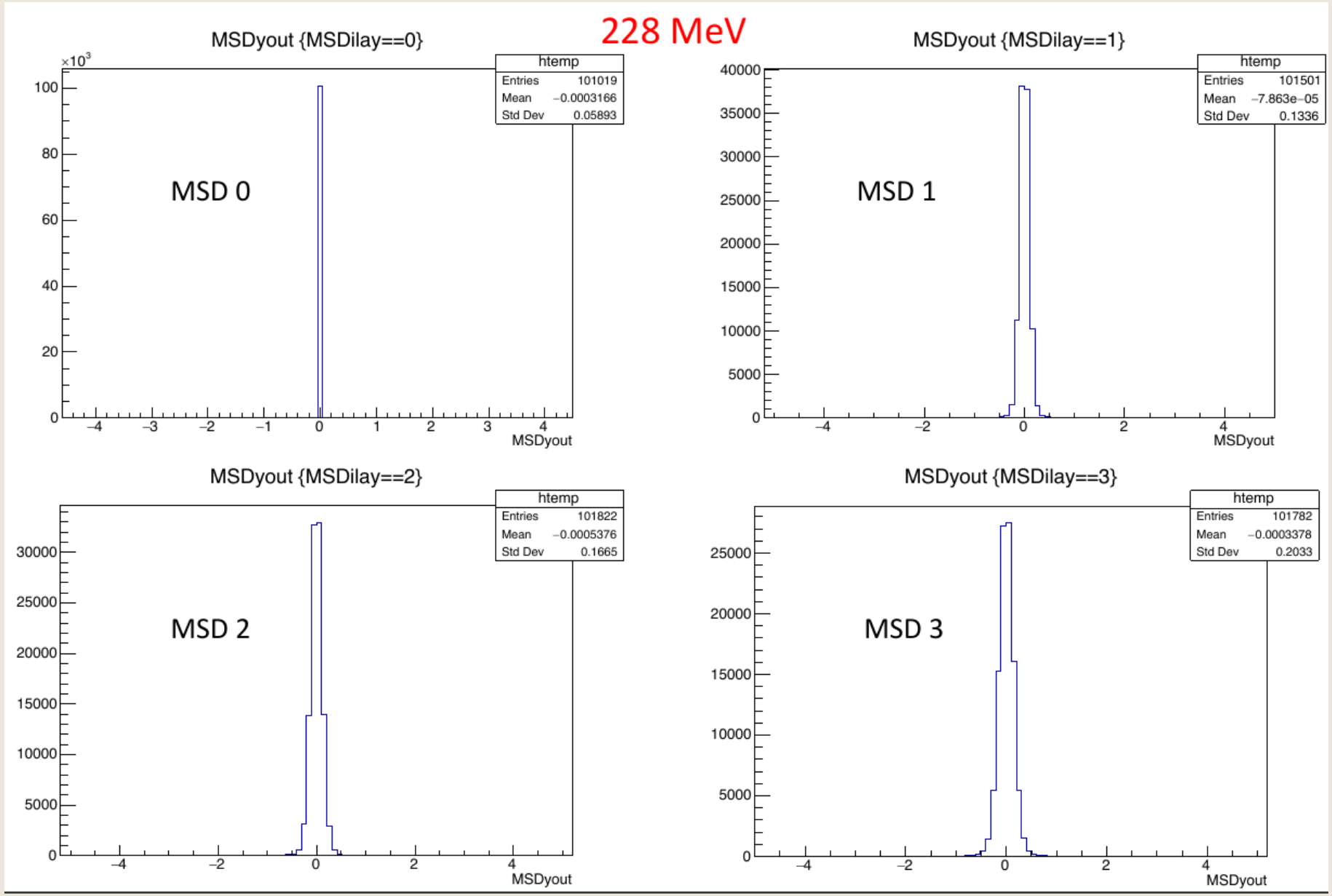


Bad cases

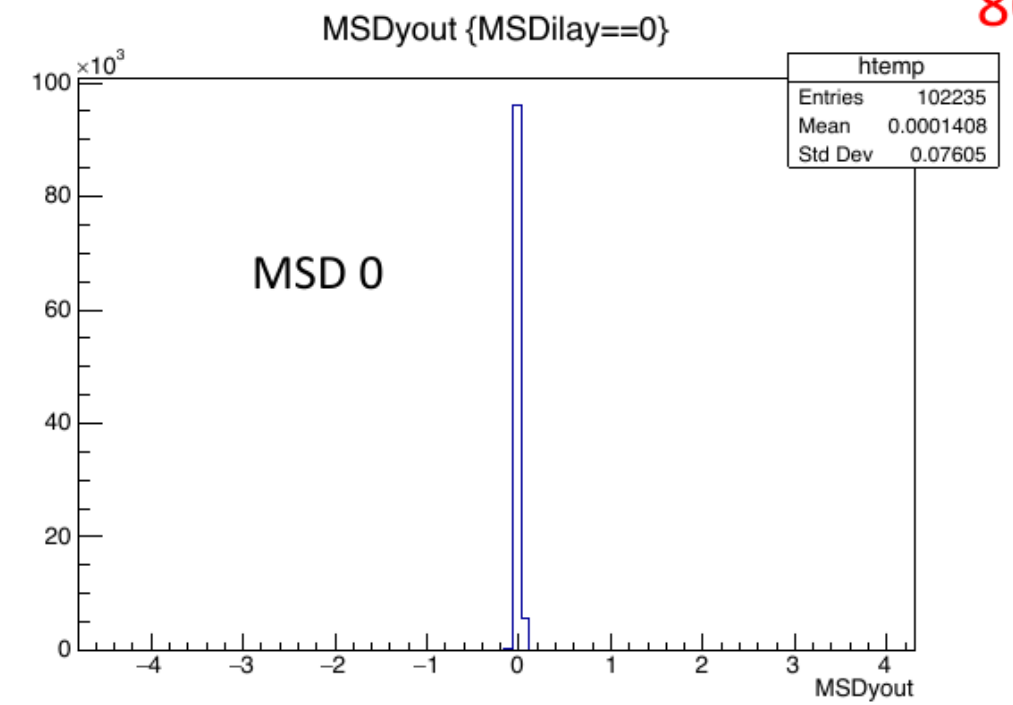


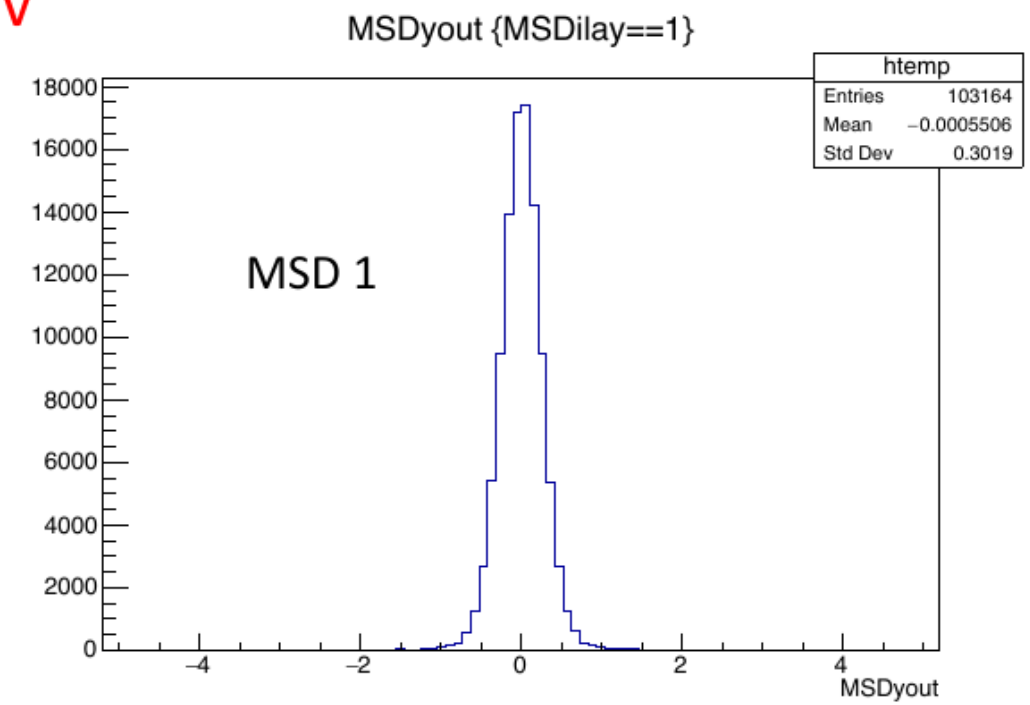


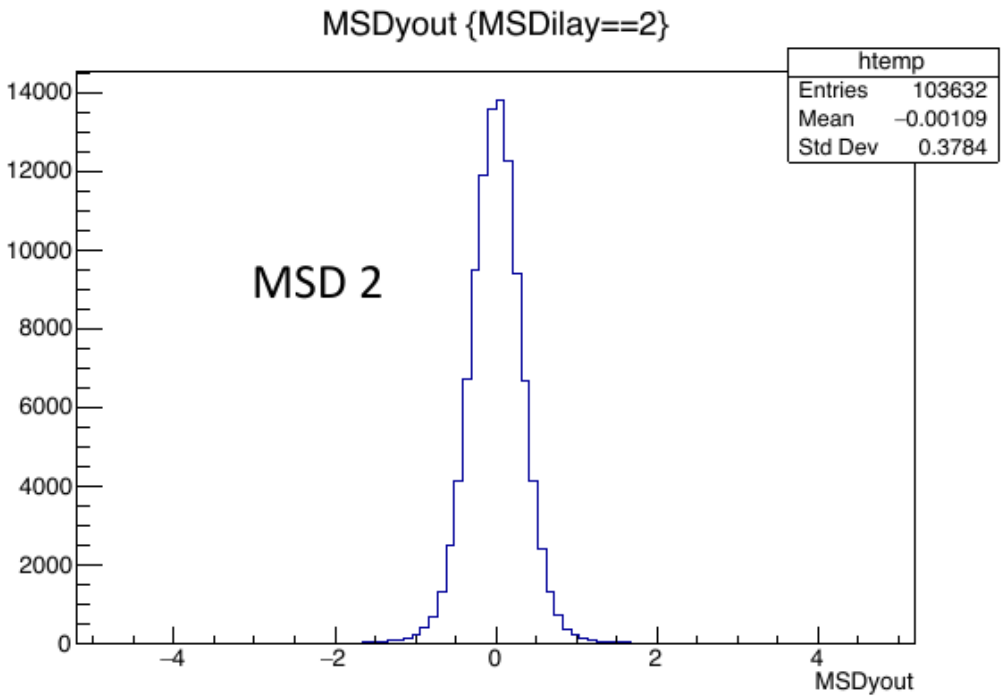
MSD Multiple Coulomb scattering

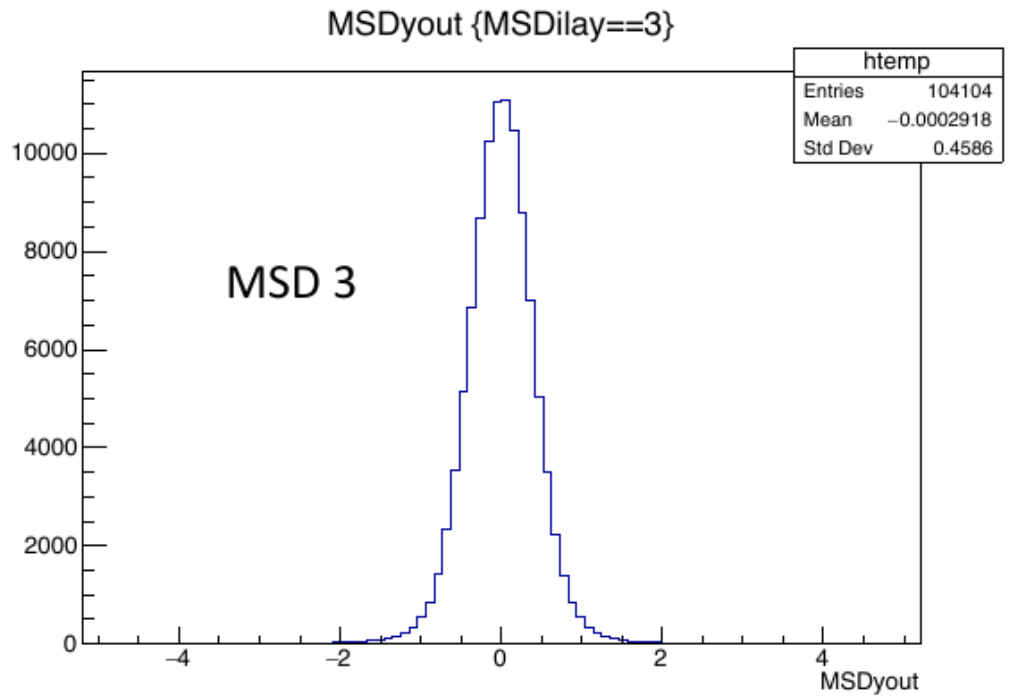


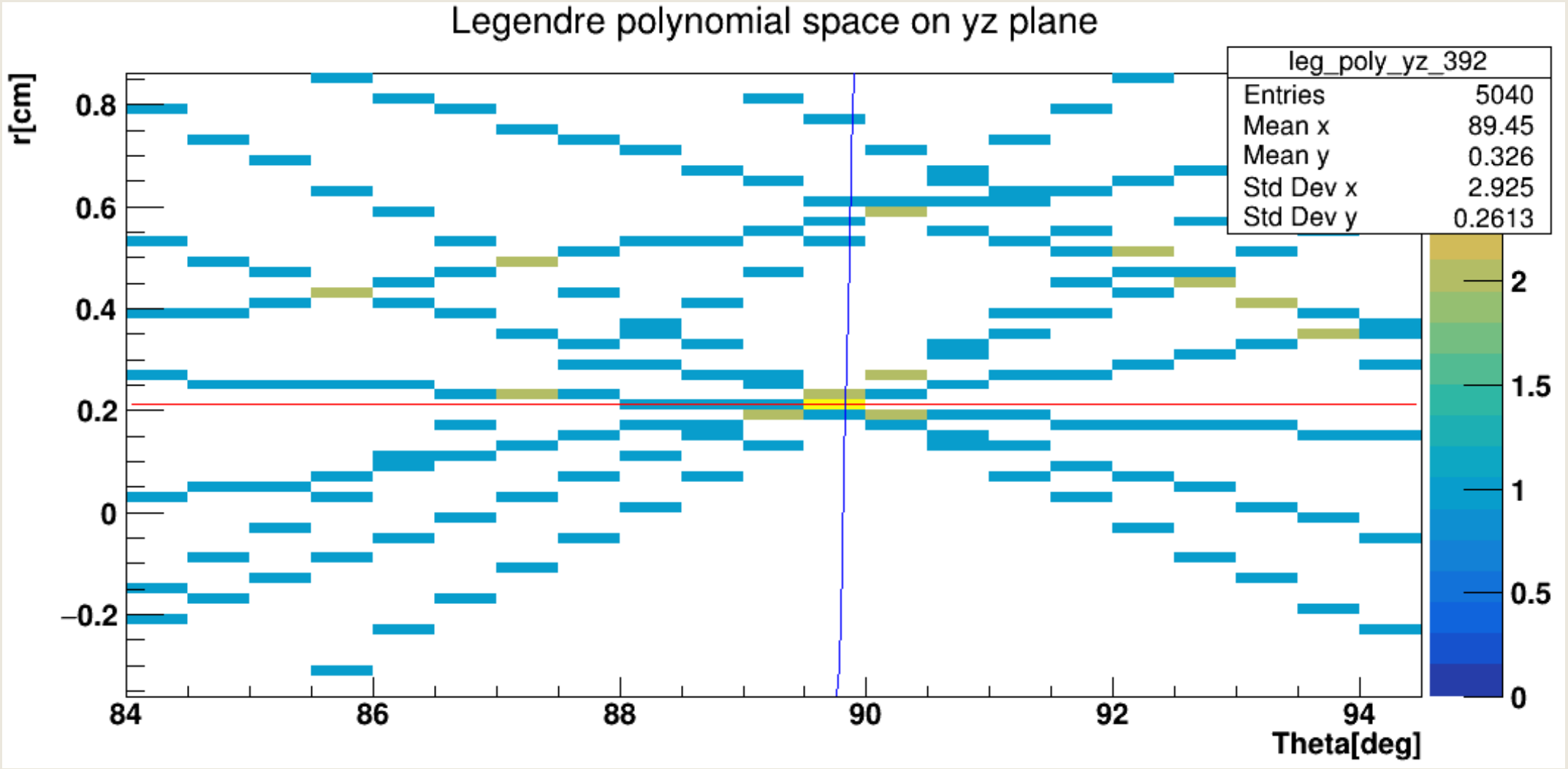
80 MeV


MSDyout {MSDilay==0}
htemp
Entries 102235
Mean 0.0001408
Std Dev 0.07605
MSD 0
MSDyout


MSDyout {MSDilay==1}
htemp
Entries 103164
Mean −0.0005506
Std Dev 0.3019
MSD 1
MSDyout


MSDyout {MSDilay==2}
htemp
Entries 103632
Mean −0.00109
Std Dev 0.3784
MSD 2
MSDyout


MSDyout {MSDilay==3}
htemp
Entries 104104
Mean −0.0002918
Std Dev 0.4586
MSD 3
MSDyout


Legendre polynomial space on yz plane
leg_poly_yz_392
Entries 5040
Mean x 89.45
Mean y 0.326
Std Dev x 2.925
Std Dev y 0.2613
r[cm]
0.8
0.6
0.4
0.2
0
−0.2
84
86
88
90
92
94
Theta[deg]
2
1.5
1
0.5
0

Multi-track events