Looking at vertices in phase-3 data

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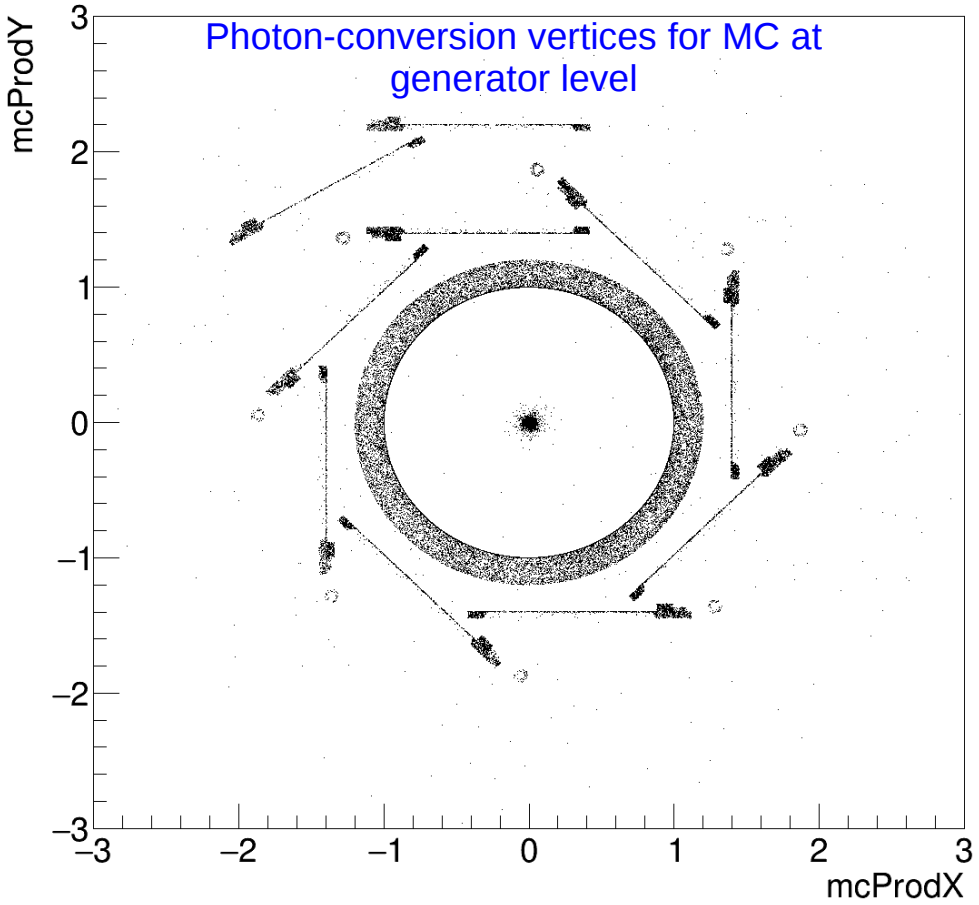
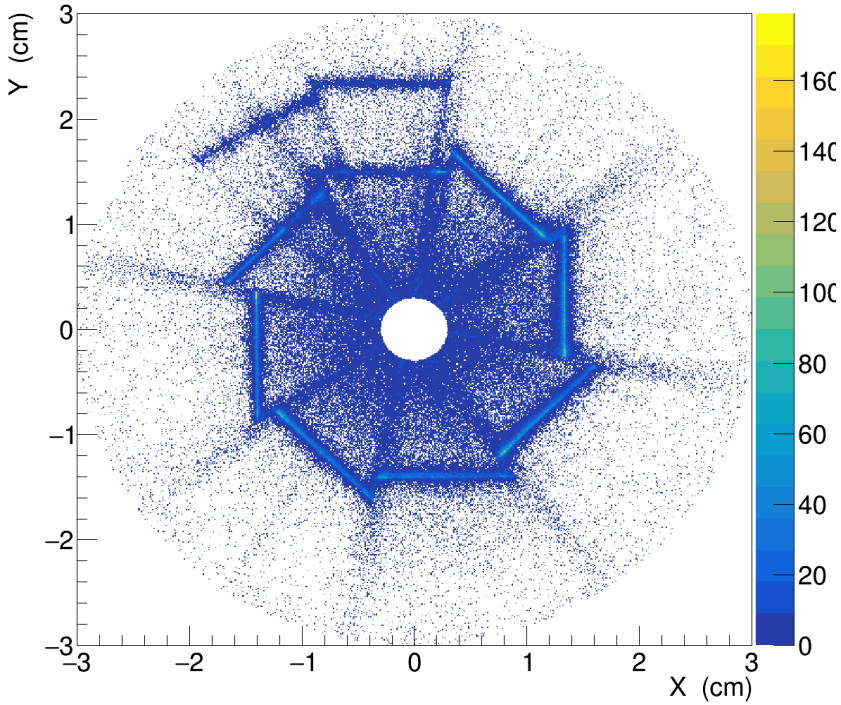


- The objective of the study was to use converted photon vertices to look at deviations of the PXD geometry from its design geometry.

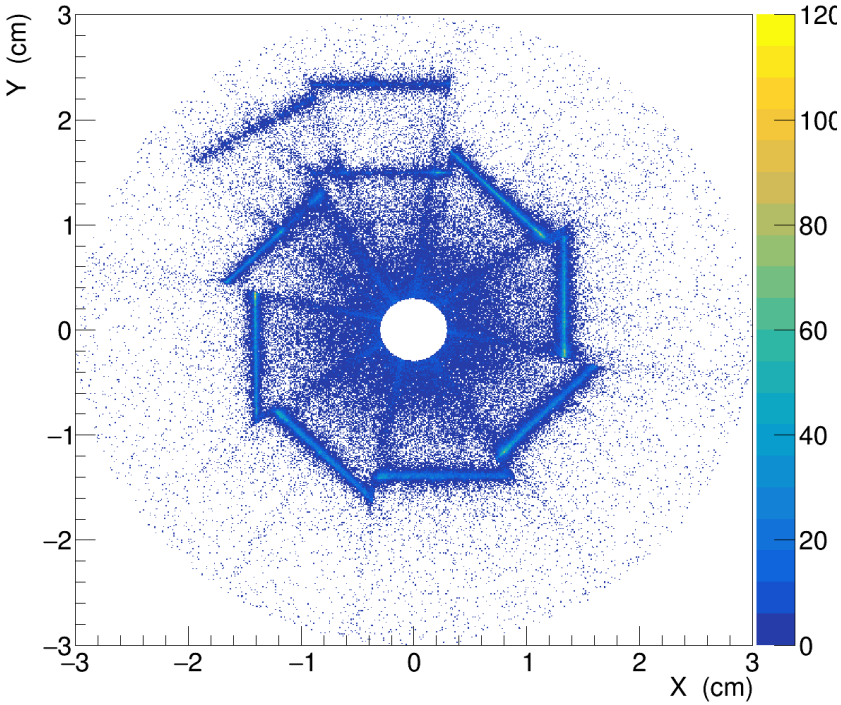
- In particular, we wanted to look at:

➔ Longitudinal deformations of the PXD ladders
➔ Displacements from ideal positions in the x-y plane, and
➔ Whether the carbon fiber cooling tubes were bending and touching any of the modules.

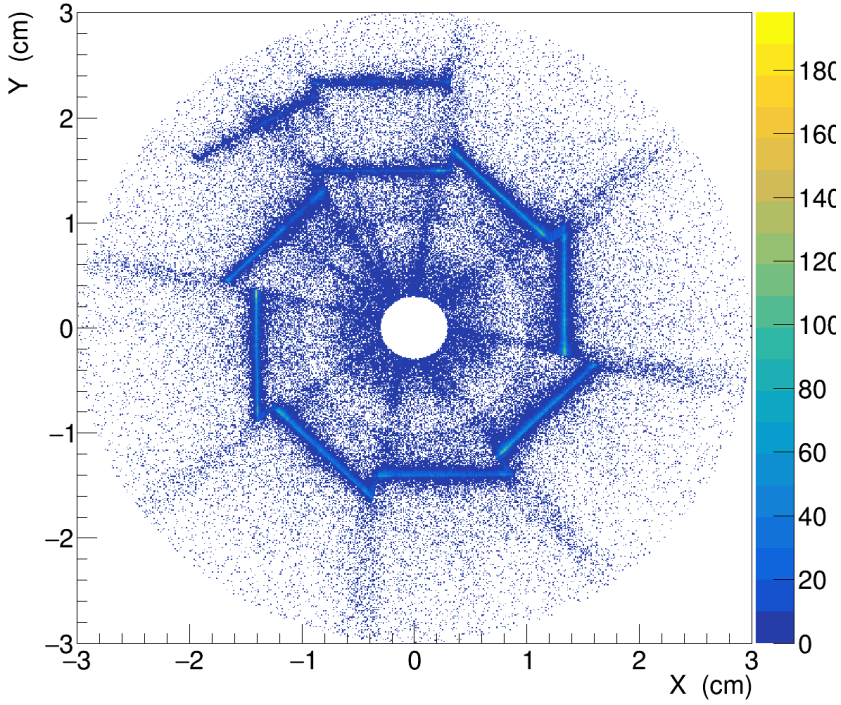
Kfit



Treefit

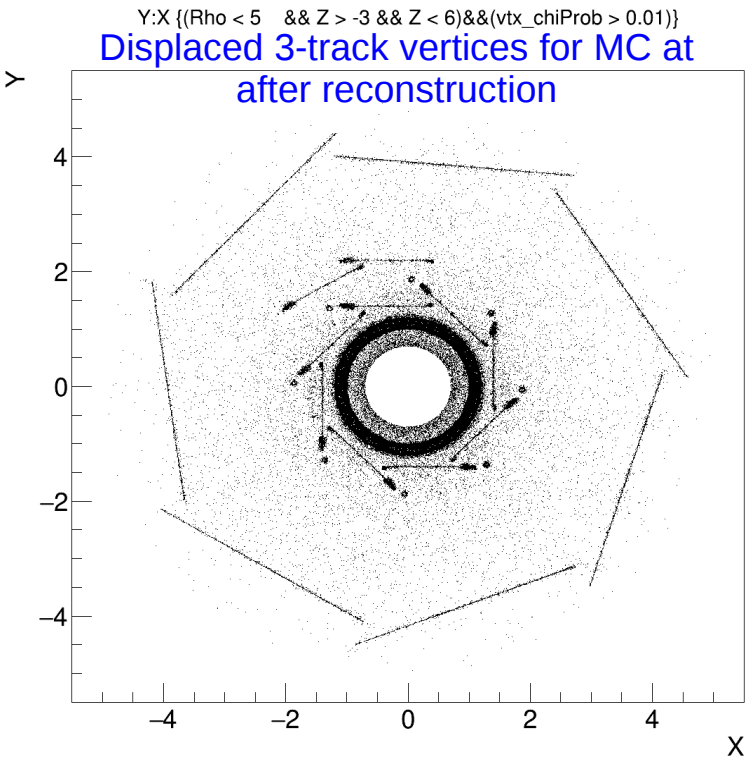


RAVE

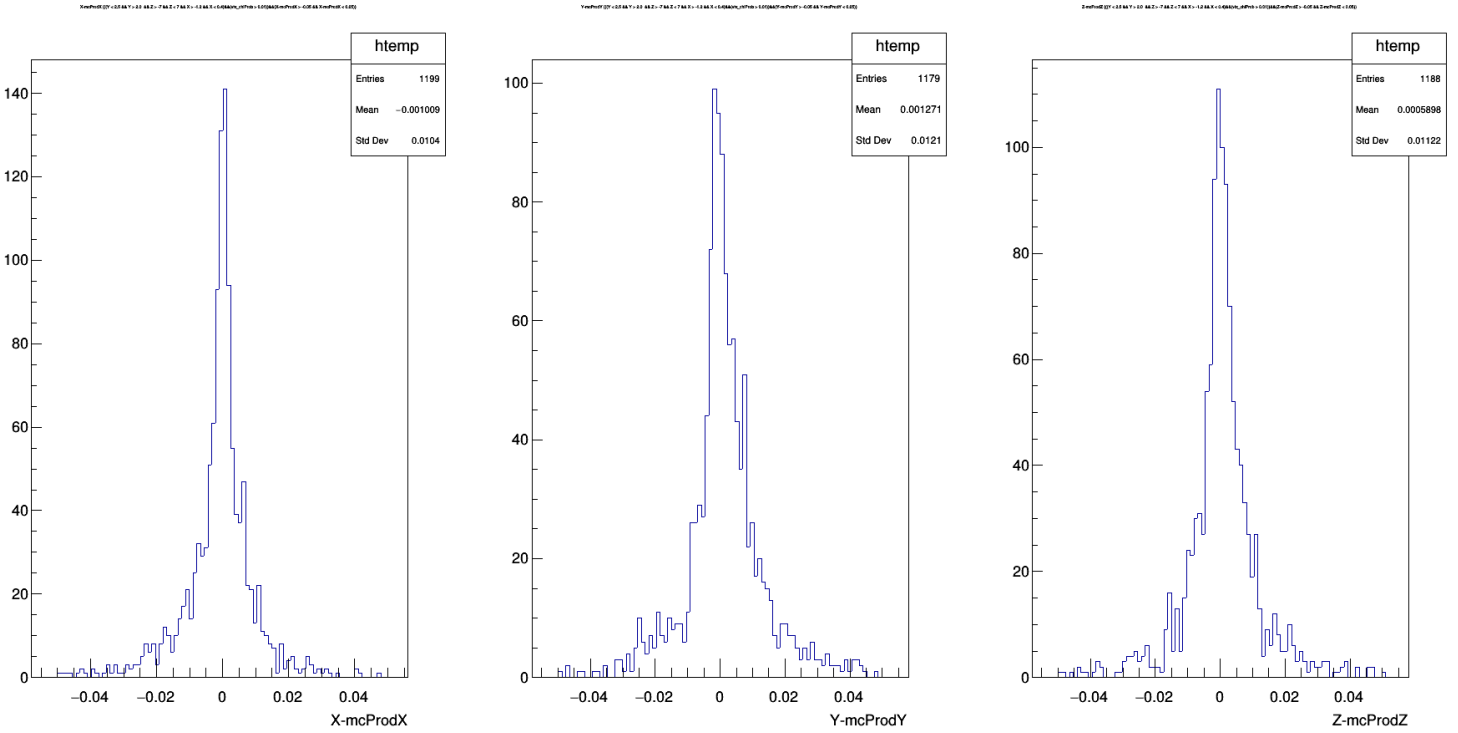


- RAVE seems to perform better than Kfit and Treefit for converted photons.
- Objects away from PXD sensitive region seem to be poorly resolved. In particular, the beam-pipe and carbon-fibre tubes are not visible.
- Overlapping sensor regions seem to have an artifact of what appears to be radially extended ‘beams’.
- The real vertex density seems to be strongly related to the sensitive region of the PXD. Vertices are absent for dead module 1.3.2

3-Track vertices
(From secondary hadronic interaction vertices)



- Taking a cue from other experiments, we try secondary hadronic interaction vertices.
- They have better resolving power due to larger opening angles compared to photon conversion vertices
- We look for displaced 3-track vertices having a pion mass hypothesis for all tracks
- Indeed detector components look much better resolved. Beam-pipe, cooling pipes and lateral end-of-stave of PXD modules are clearly visible



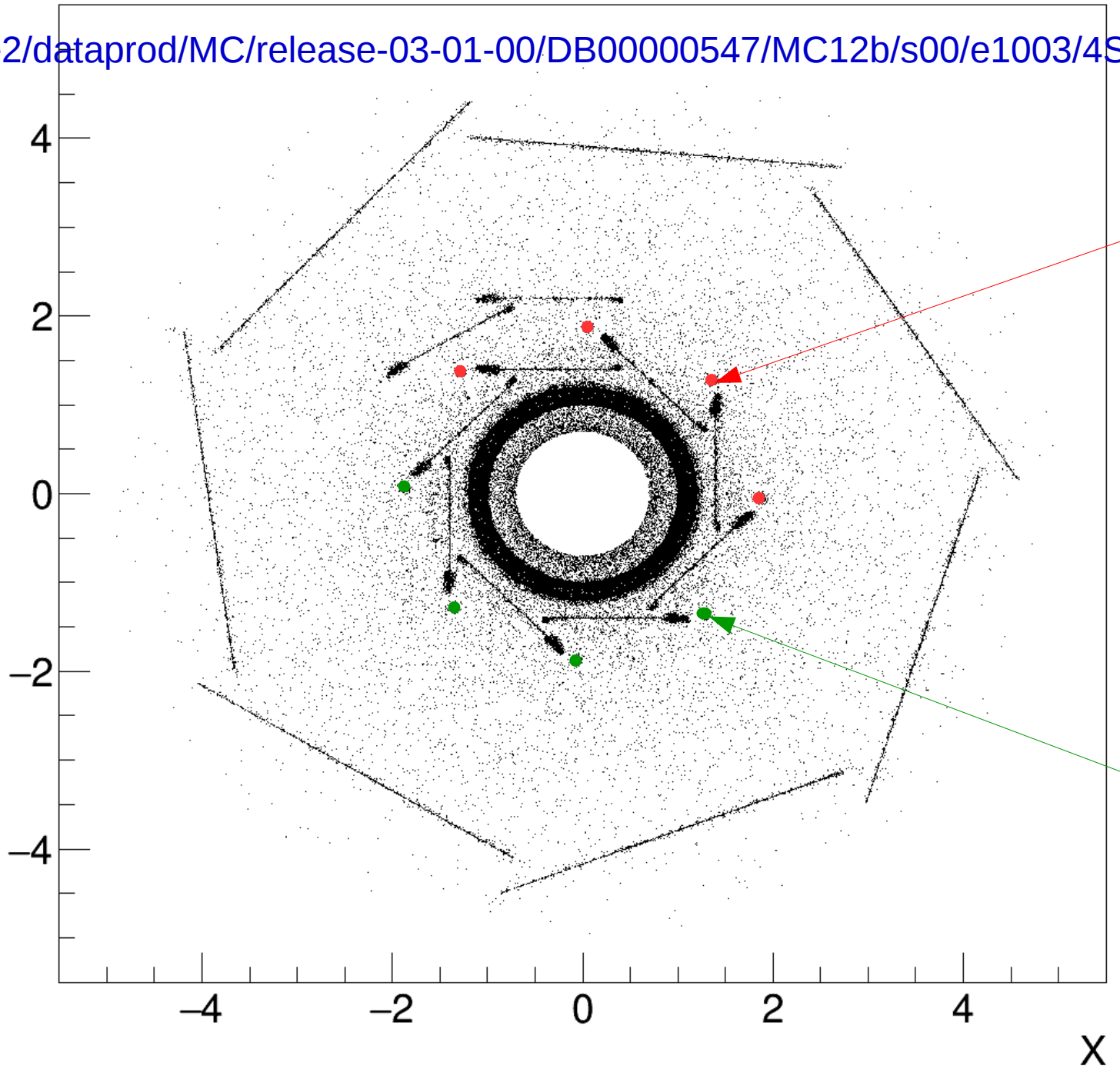
In MC, resolution in all three directions seem to be ~ 100 – 120 μm Near the PXD-beam pipe region

Y:X {(Rho < 5 && Z > -3 && Z < 6)&&(vtx_chiProb > 0.01)}

Generic MC :

/group/belle2/dataprod/MC/release-03-01-00/DB00000547/MC12b/s00/e1003/4S/r00000/

1) u-ubar
2) d-dbar
3) s-sbar
4) c-cbar
5) Charged
6) Mixed
7) Tau-pair



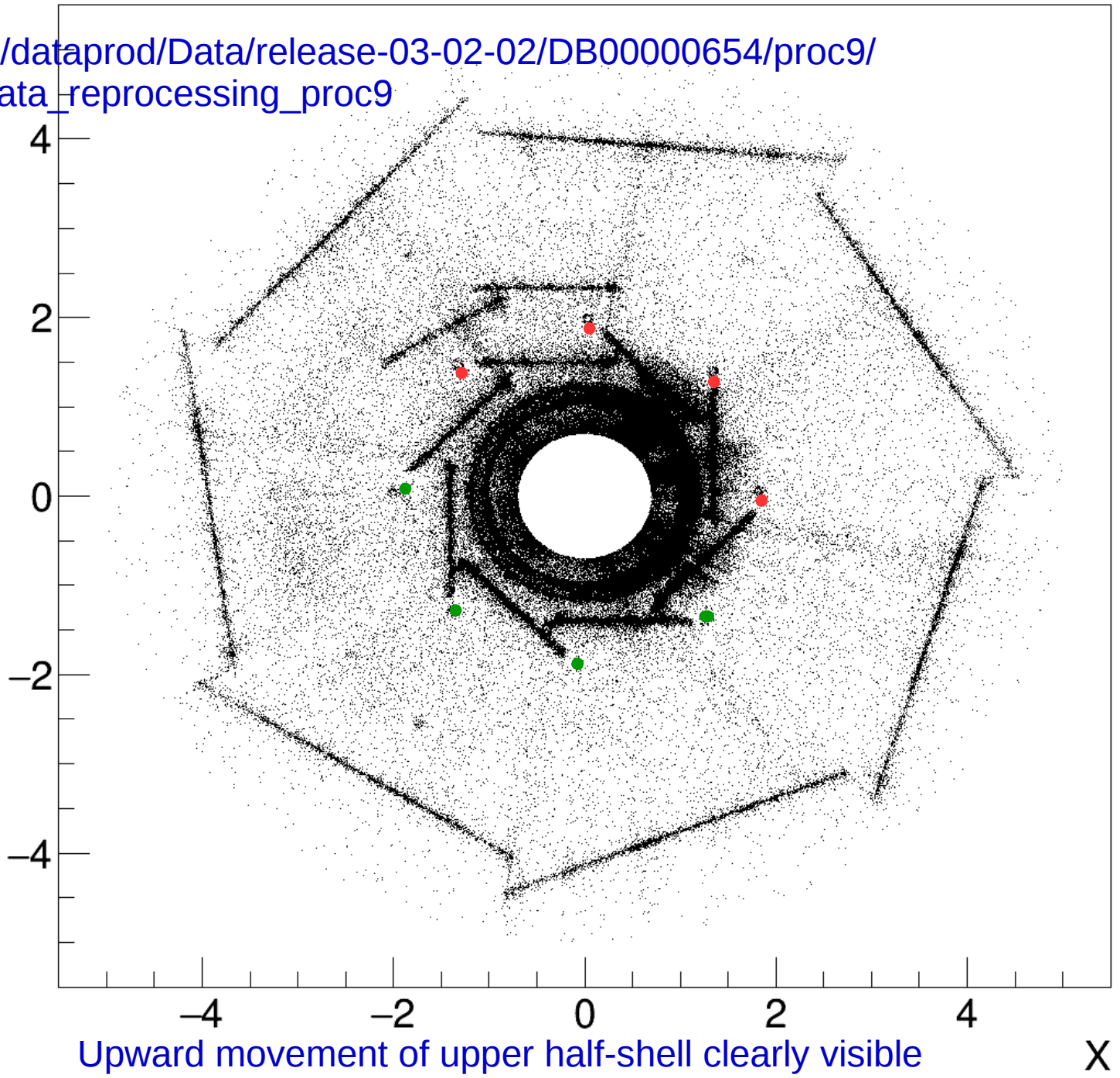
Upper half-shell carbon-fibre tube

Lower half-shell carbon-fibre tube

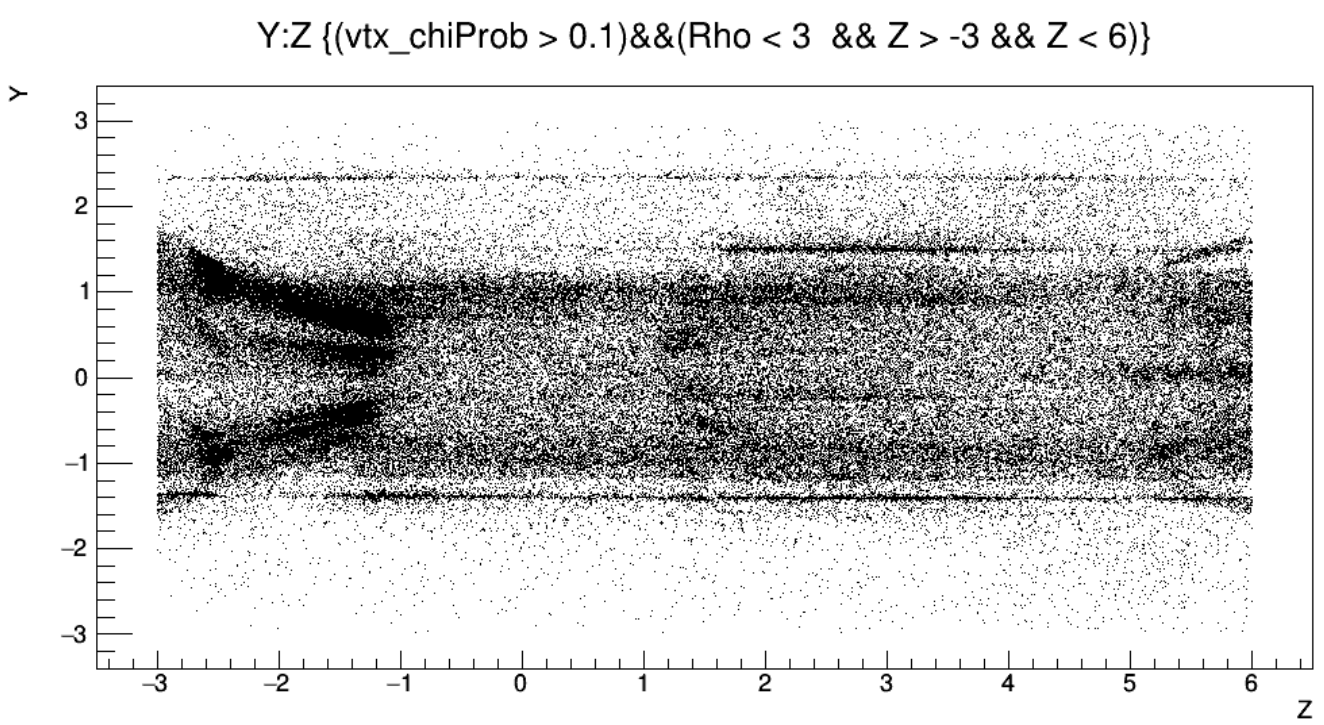
Data :

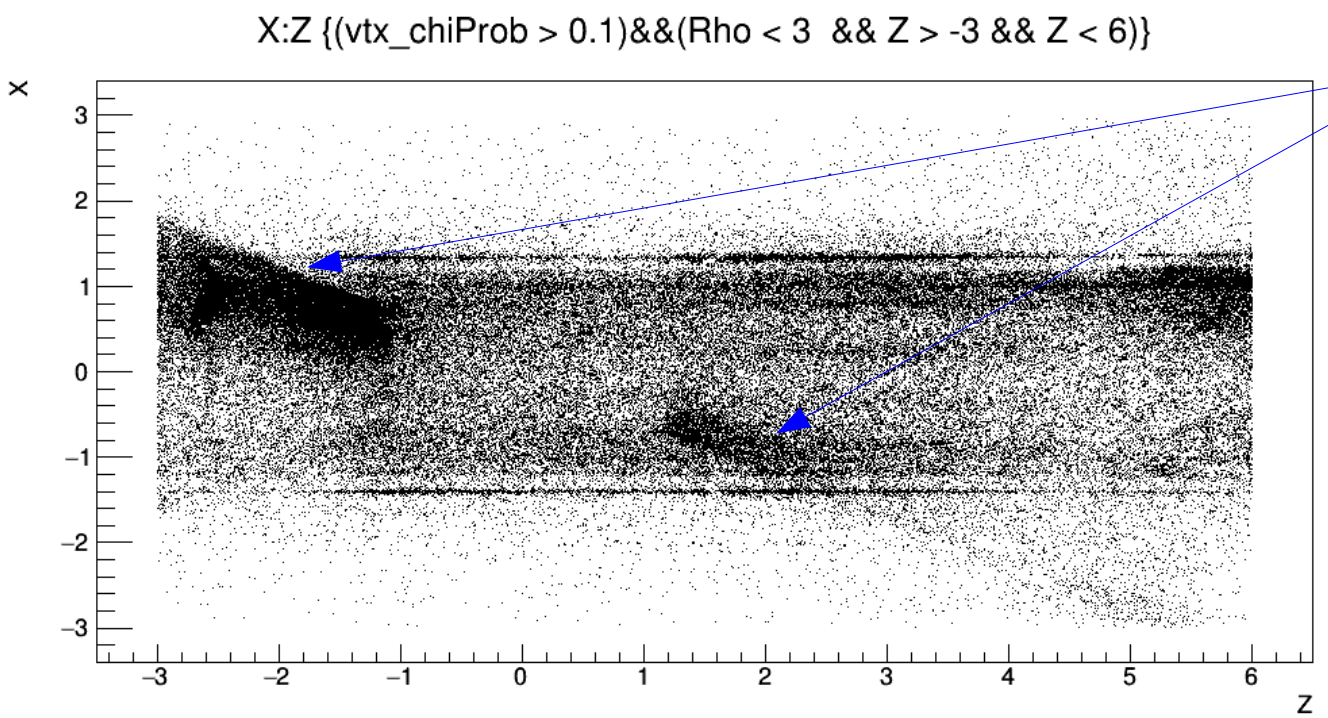
Y:X {(Rho < 5 && Z > -3 && Z < 6)&&(vtx_chiProb > 0.01)}

/group/belle2/dataprod/Data/release-03-02-02/DB00000654/proc9/
Global tag: data_reprocessing_proc9
Exp 7, Exp 8
“Good runs”



Upward movement of upper half-shell clearly visible

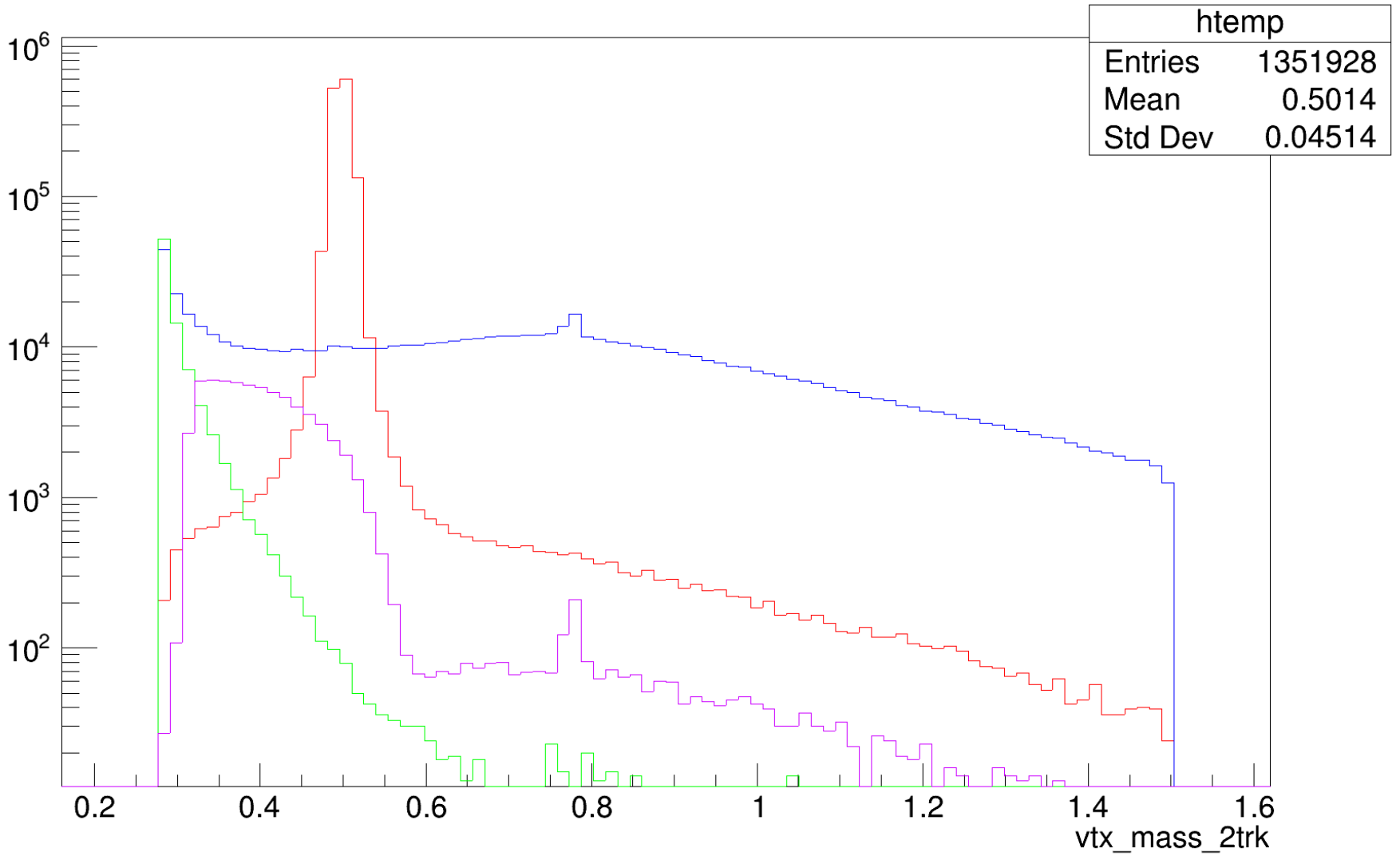




Hot regions **(?!)** Some form of scattering off the SCB faces?

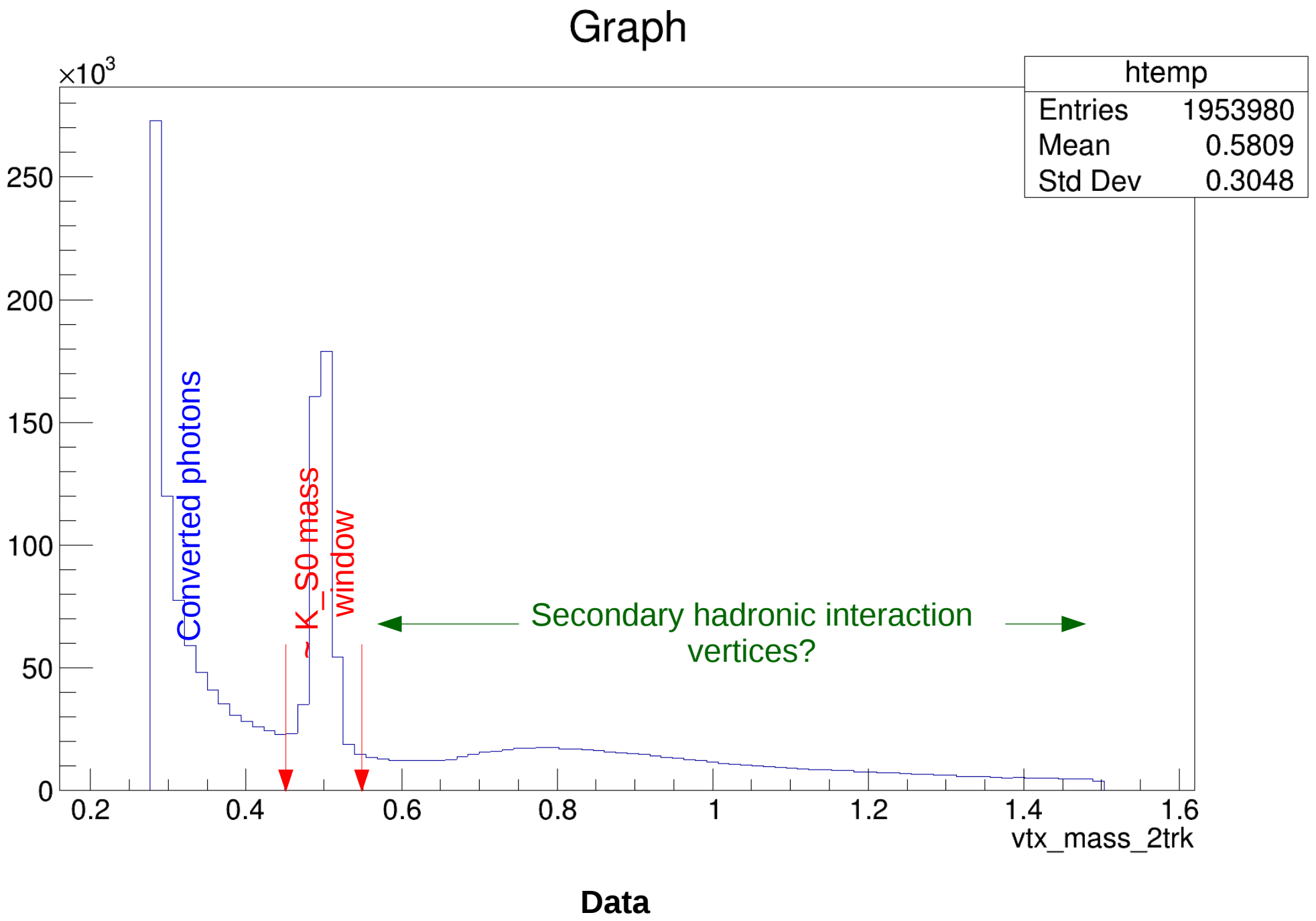
X-Z and Y-Z projections of the PXD

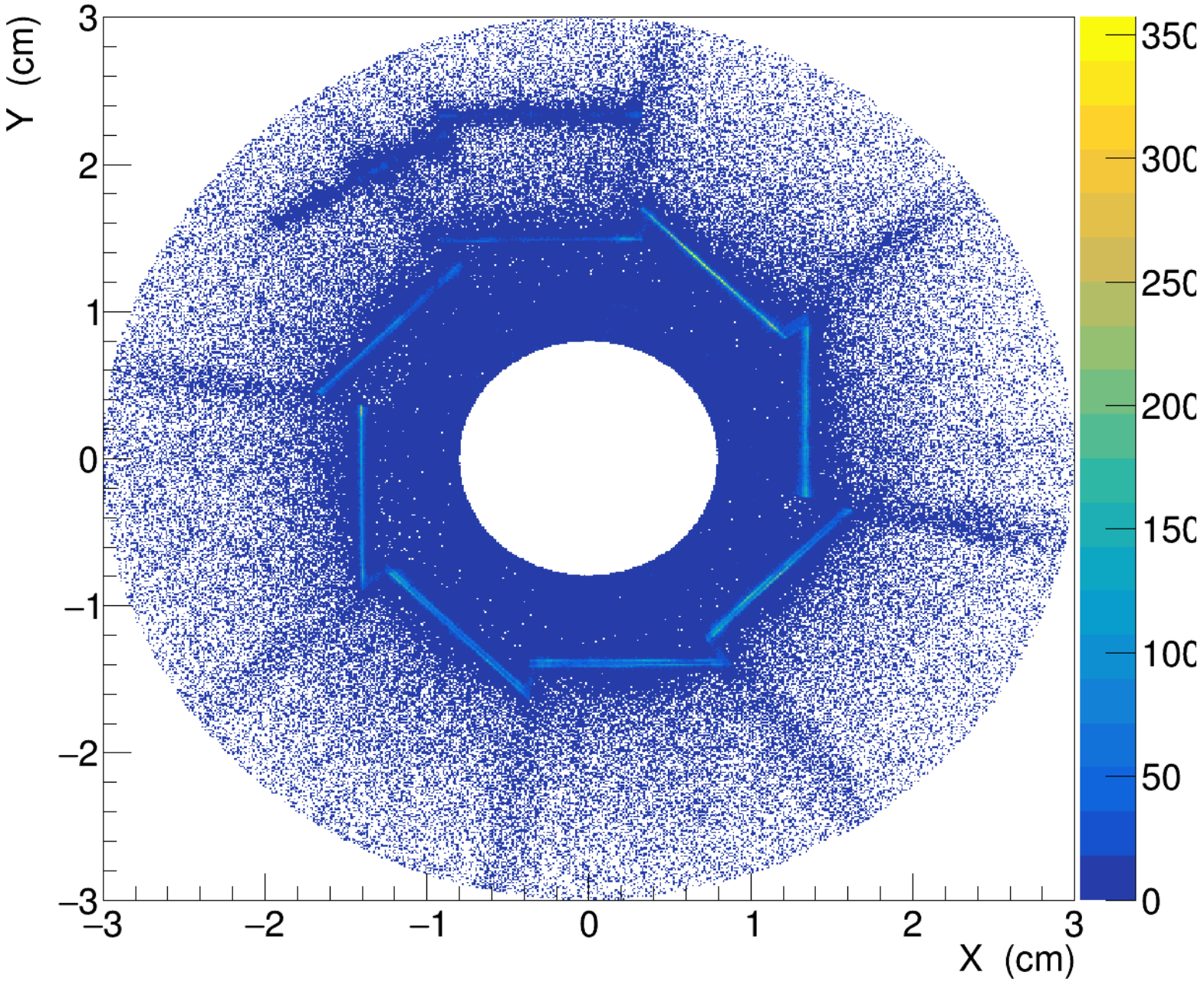
2-Track vertices



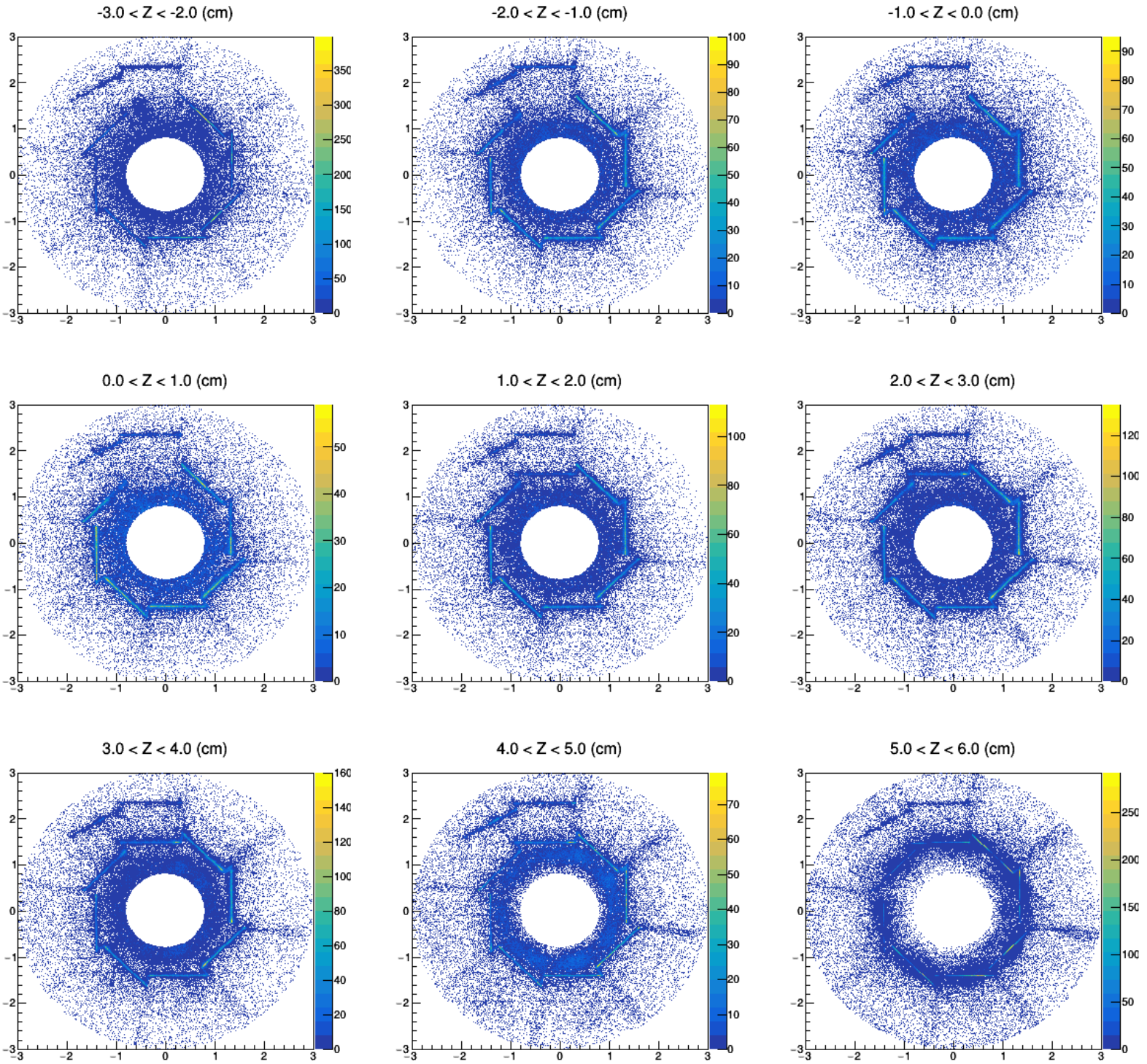
MC

Red – Atleast one daughter belonging to Kshort
Green – Atleast one daughter belonging to converted photon
Violet – Atleast one daughter belonging to Lambda(bar)
Blue – Everything else

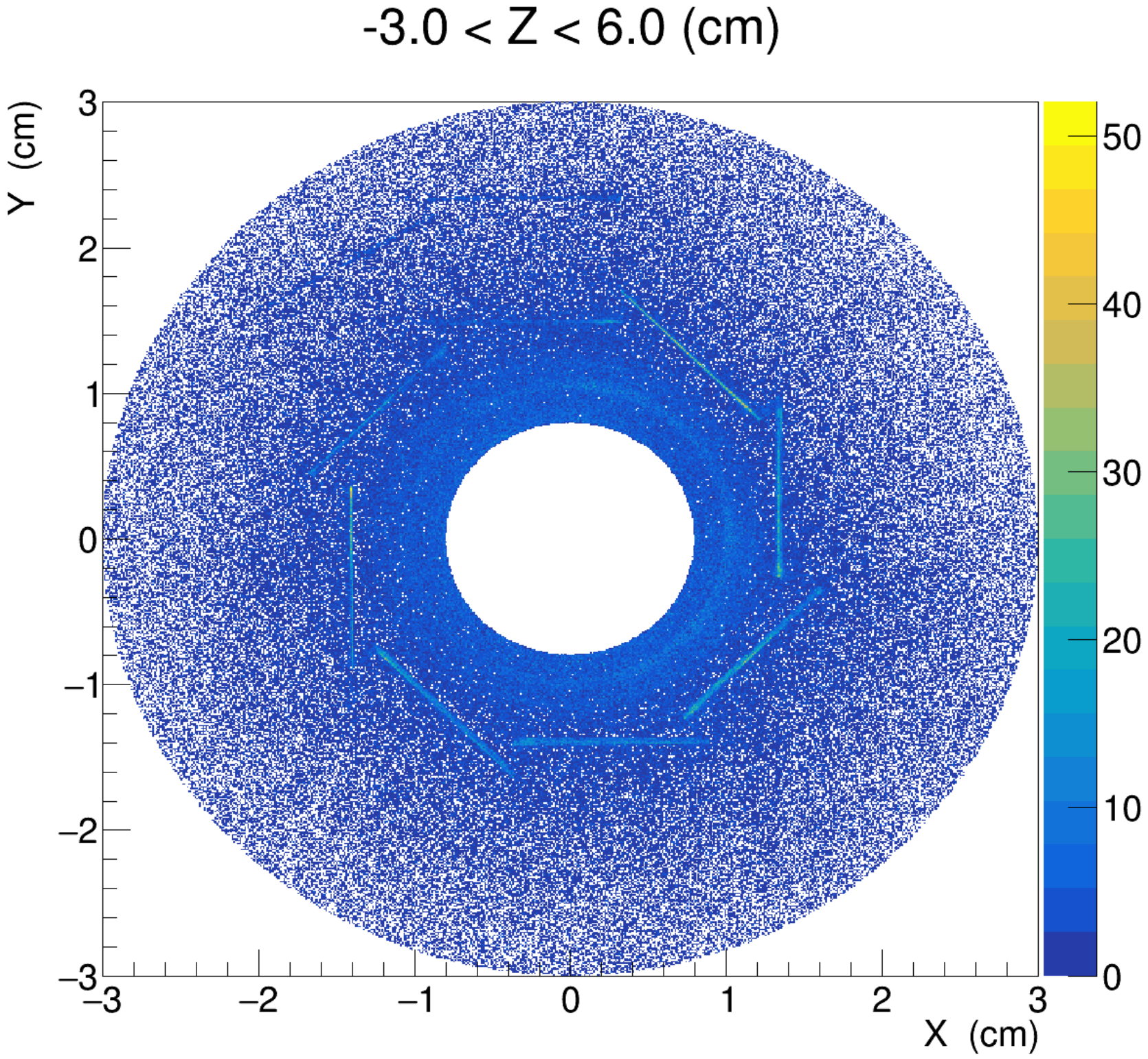

Graph
htemp
Entries 1953980
Mean 0.5809
Std Dev 0.3048
×10^3
250
200
150
100
50
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
vtx_mass_2trk
Converted photons
~ K_S0 mass window
Secondary hadronic interaction vertices?
Data

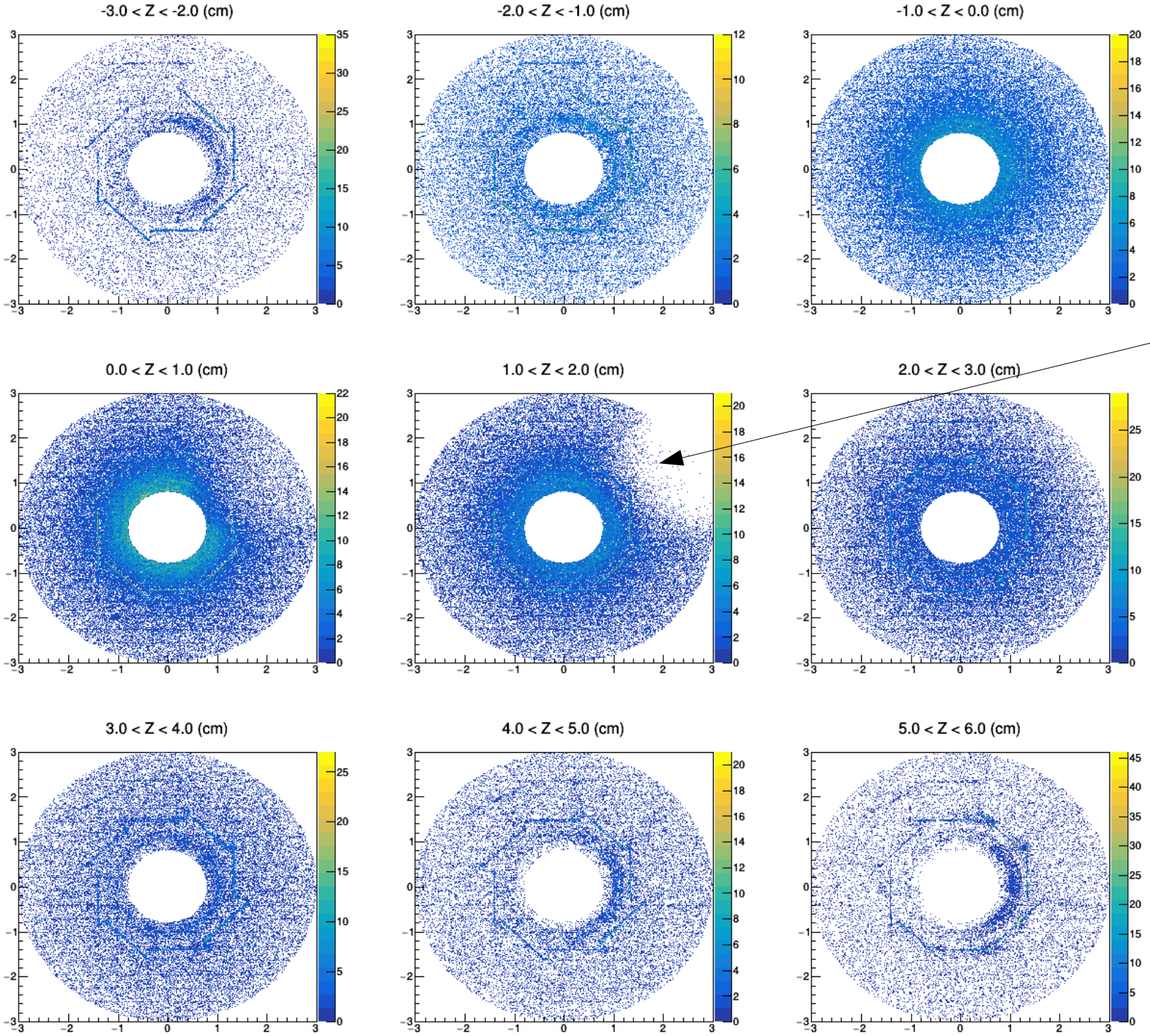


Invariant mass < 450 MeV : We recover the converted photon vertex density map



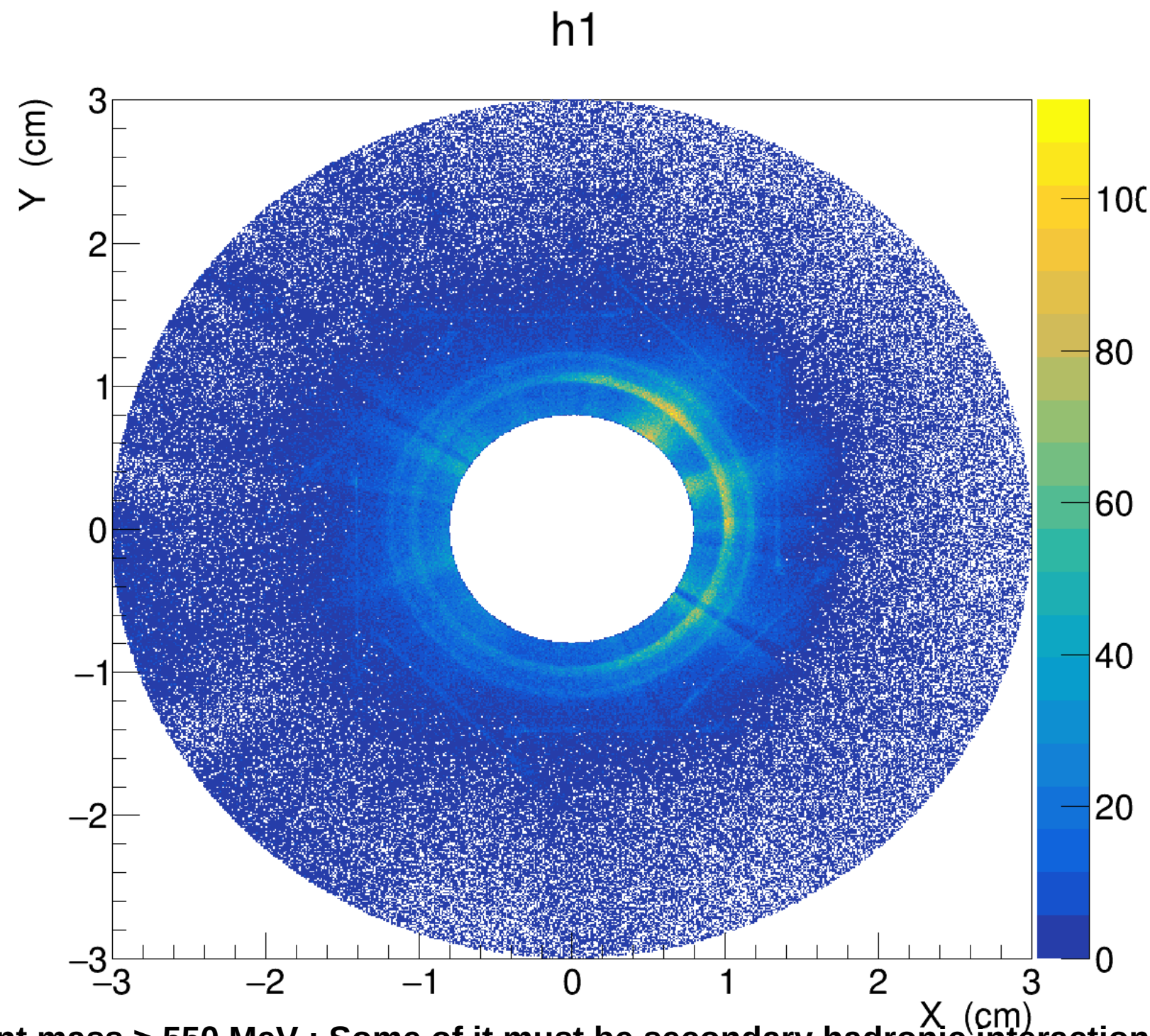
Invariant mass < 450 MeV : 1 cm z-slices


-3.0 < Z < 6.0 (cm)
Y (cm)
X (cm)
3
2
1
0
−1
−2
−3
−3
−2
−1
0
1
2
3
50
40
30
20
10
0
450 MeV < Invariant mass < 550 MeV : Kshort mass window



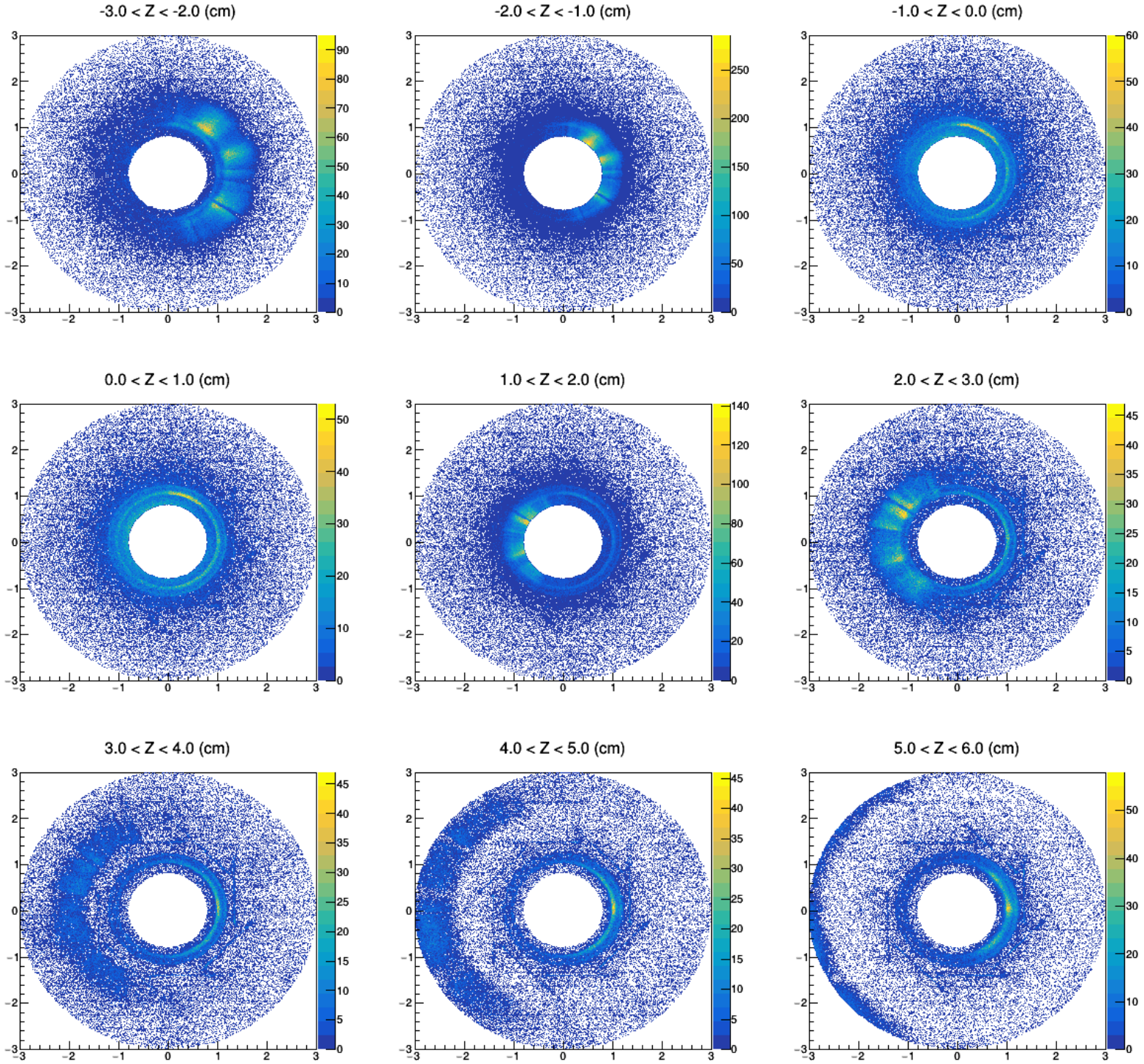
SVD L3 hit imposed on both tracks: depopulated region due to problematic SVD ASIC?

450 MeV < Invariant mass < 550 MeV : 1 cm z-slices



Invariant mass > 550 MeV : Some of it must be secondary hadronic interaction vertices

- Beam pipe more well resolved compared to converted photons

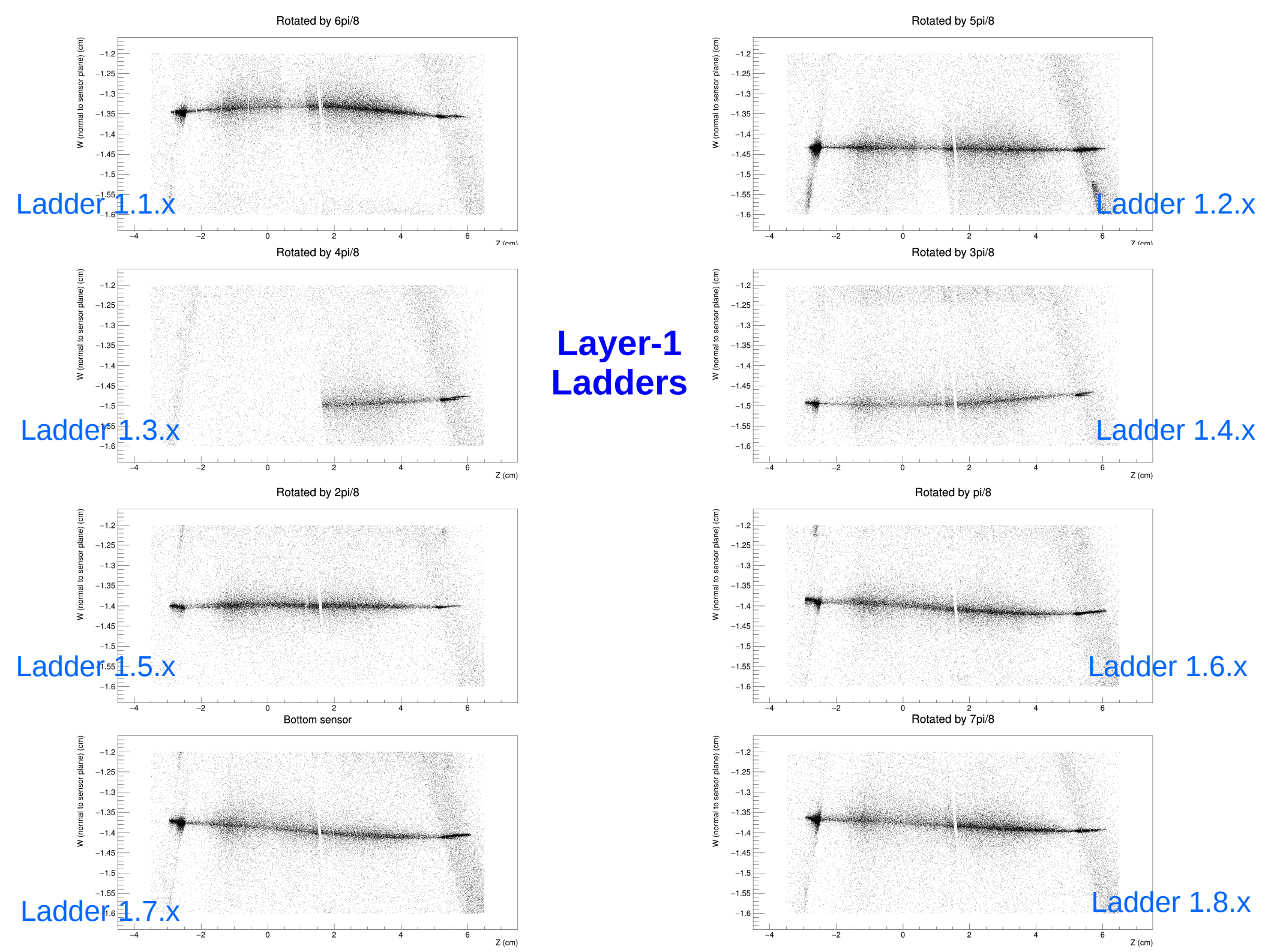


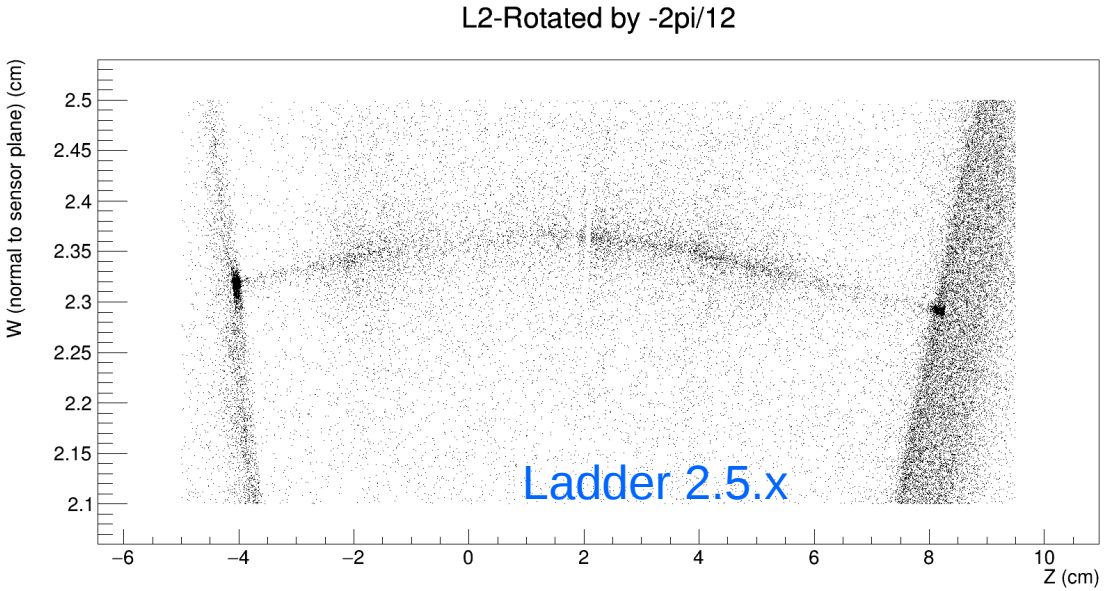
We see regions of more illumination go from right to left as we go along z.

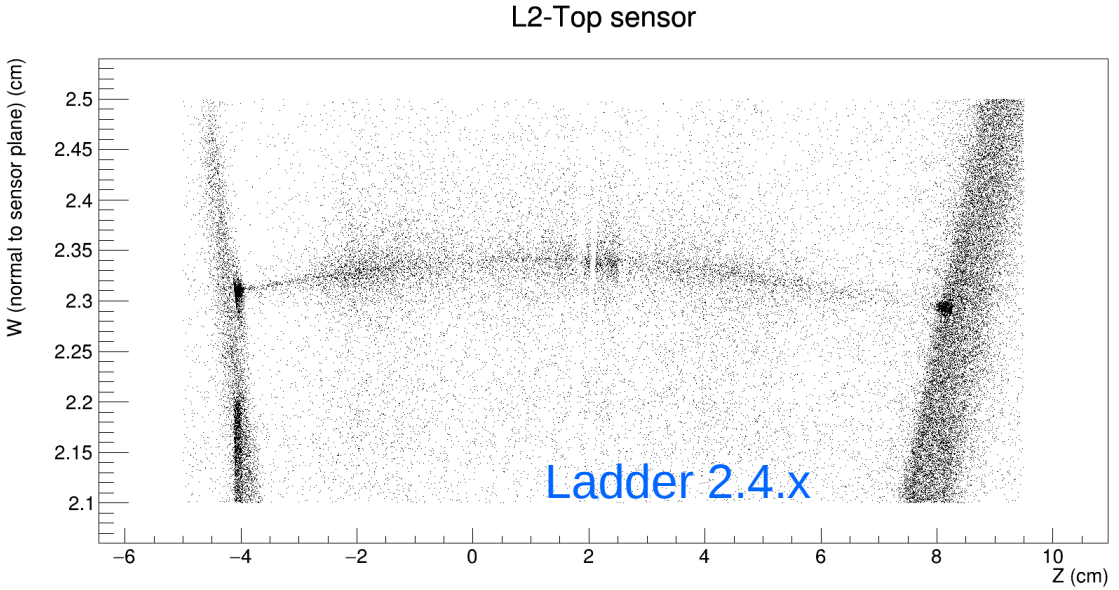
Same as the effect due to scattering off SCB face shown before?

Invariant mass > 550 MeV : 1 cm z-slices

Longitudinal projections of PXD ladders
from 2-Track vertices with
Invariant mass < 450 MeV
(Converted photons)


Rotated by 6pi/8
W (normal to sensor plane) (cm)
Z (cm)
Ladder 1.1.x
Rotated by 5pi/8
Ladder 1.2.x
Rotated by 4pi/8
Ladder 1.3.x
Layer-1
Ladders
Rotated by 3pi/8
Ladder 1.4.x
Rotated by 2pi/8
Ladder 1.5.x
Rotated by pi/8
Ladder 1.6.x
Bottom sensor
Rotated by 7pi/8
Ladder 1.7.x
Ladder 1.8.x

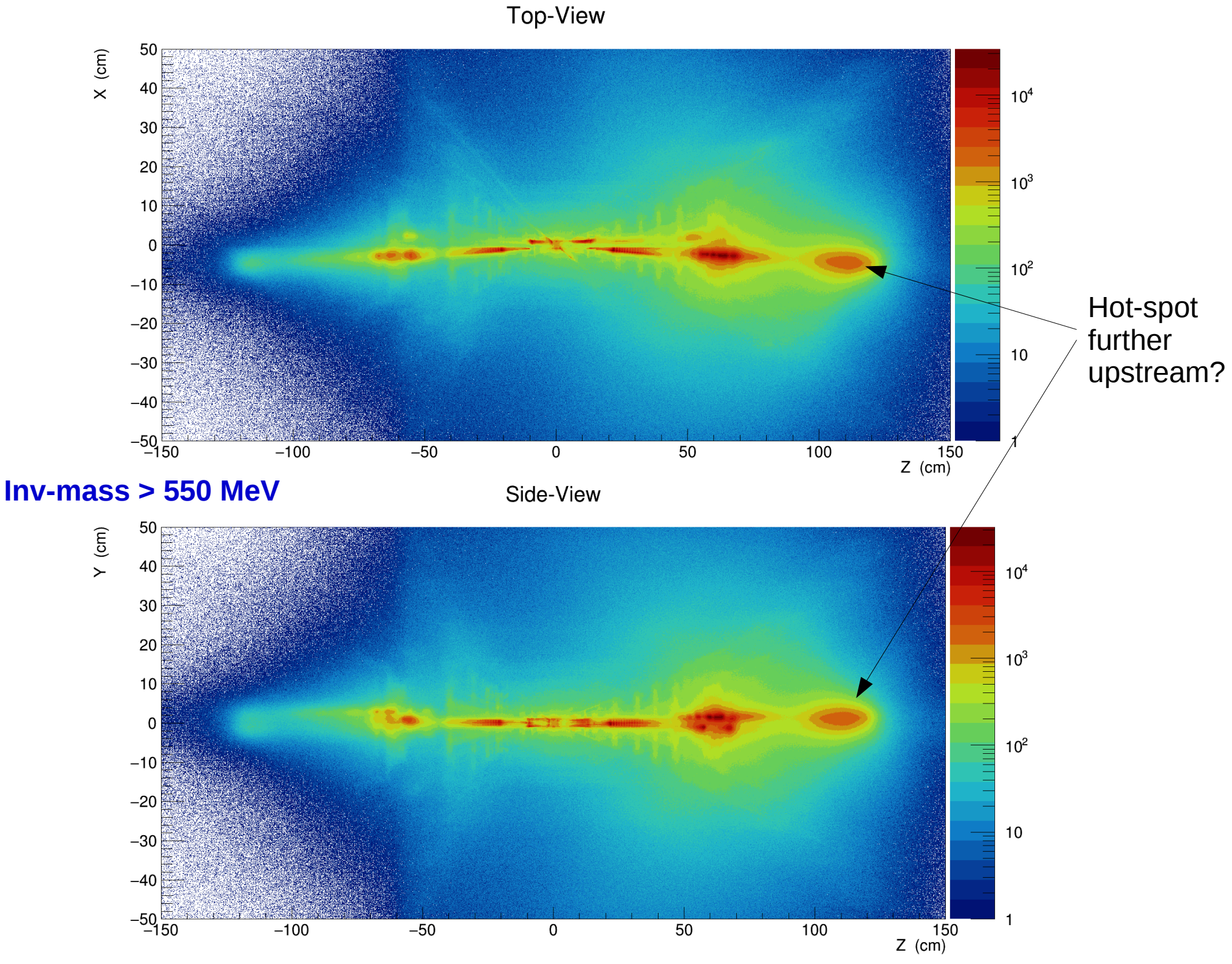




Layer-2 Ladders

- Almost all hits near PXD sensitive region contain PXD hits and are therefore directly biased by PXD alignment. Therefore the plots are essentially a reflection of PXD alignment

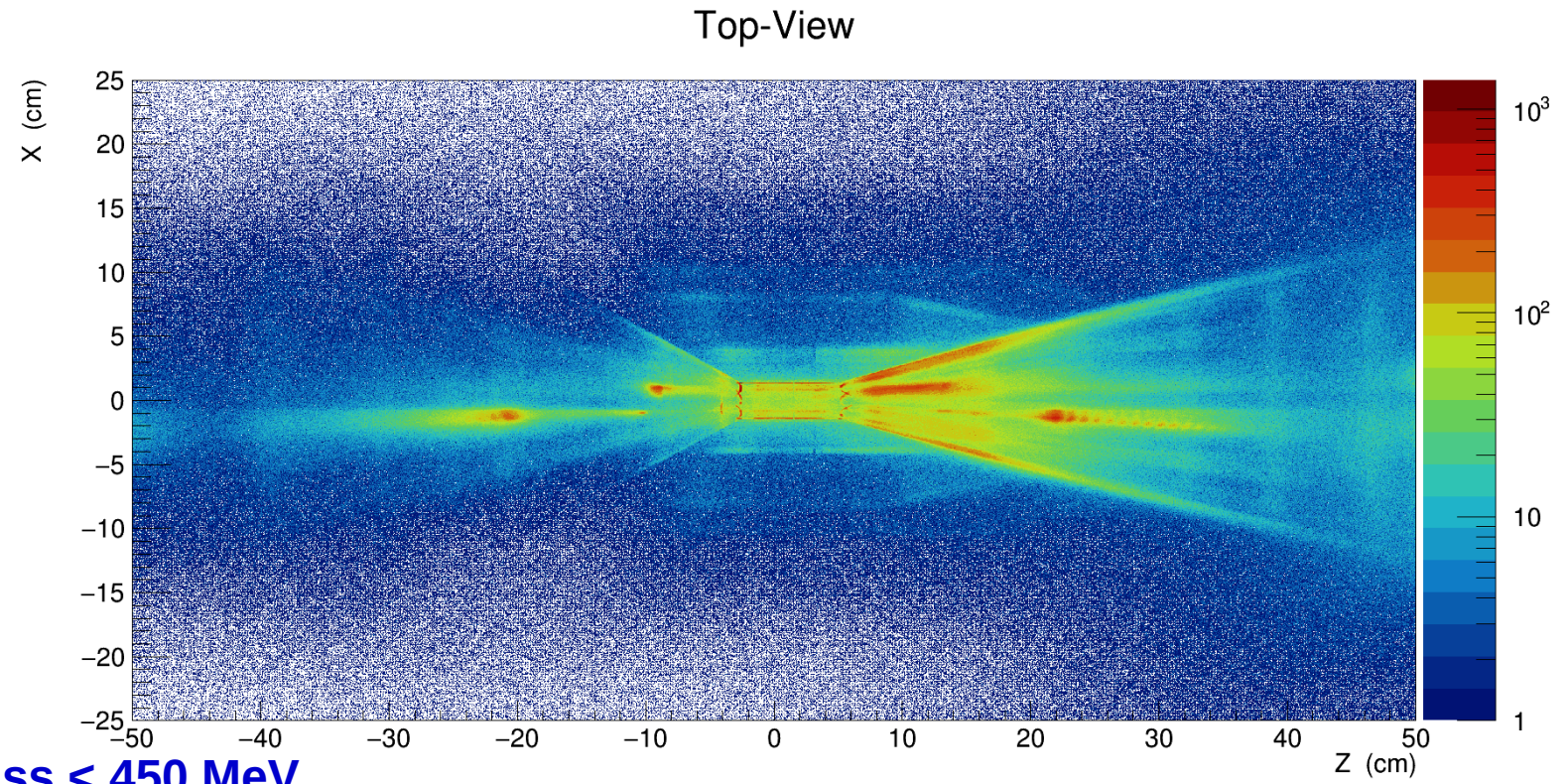
- Alignment parameters for PXD modules in the same ladder were estimated independent of each other. The deformations in w-direction agree very well between the two modules at the center of the ladder => Indicates that alignment procedure works very well!


Top-View
X (cm)
Z (cm)
Hot-spot
further
upstream?
Inv-mass > 550 MeV
Side-View
Y (cm)
Z (cm)

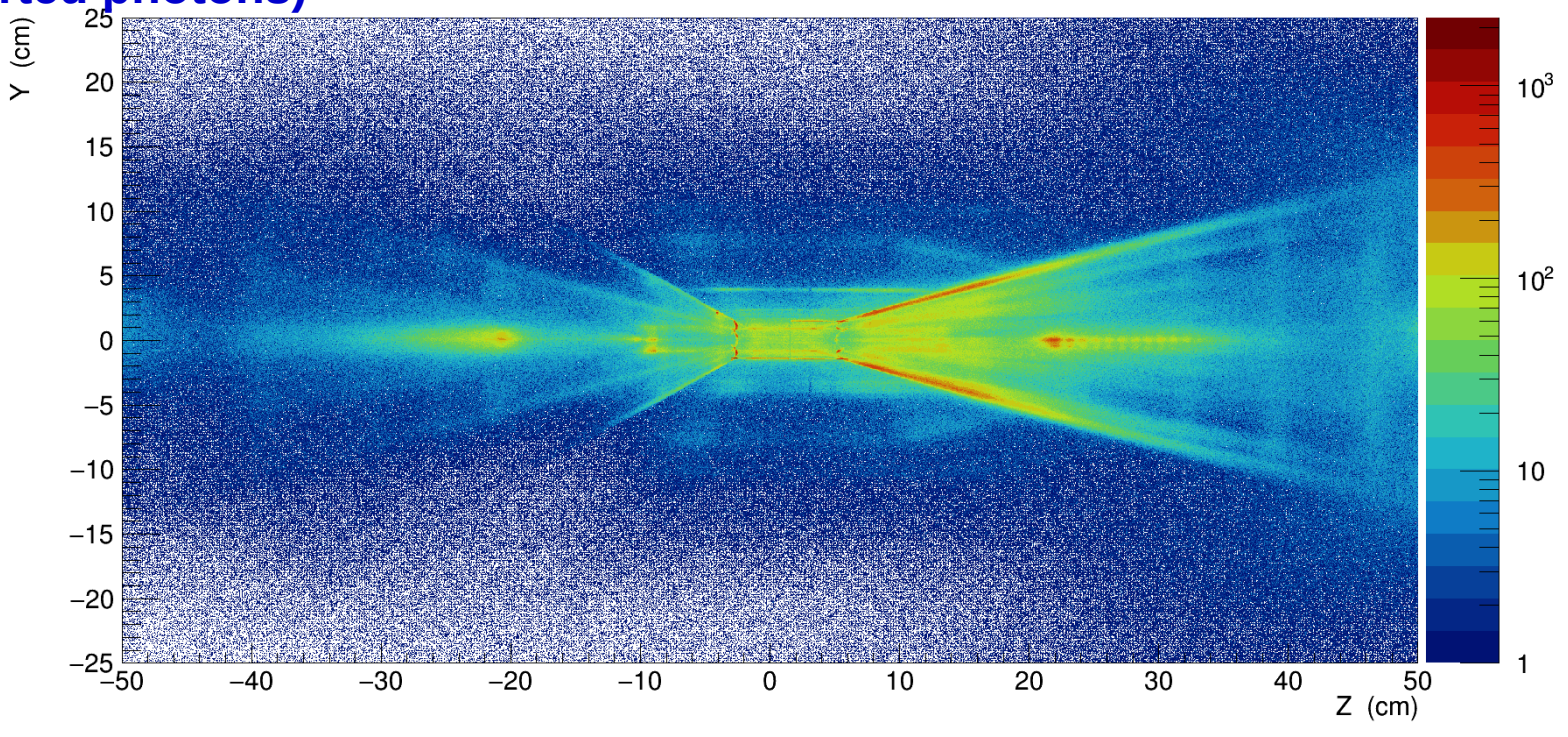
- We are at the moment trying an alternate method to improve the converted photon vertex, trying to remove the bias in the vertex position.

Thank you!

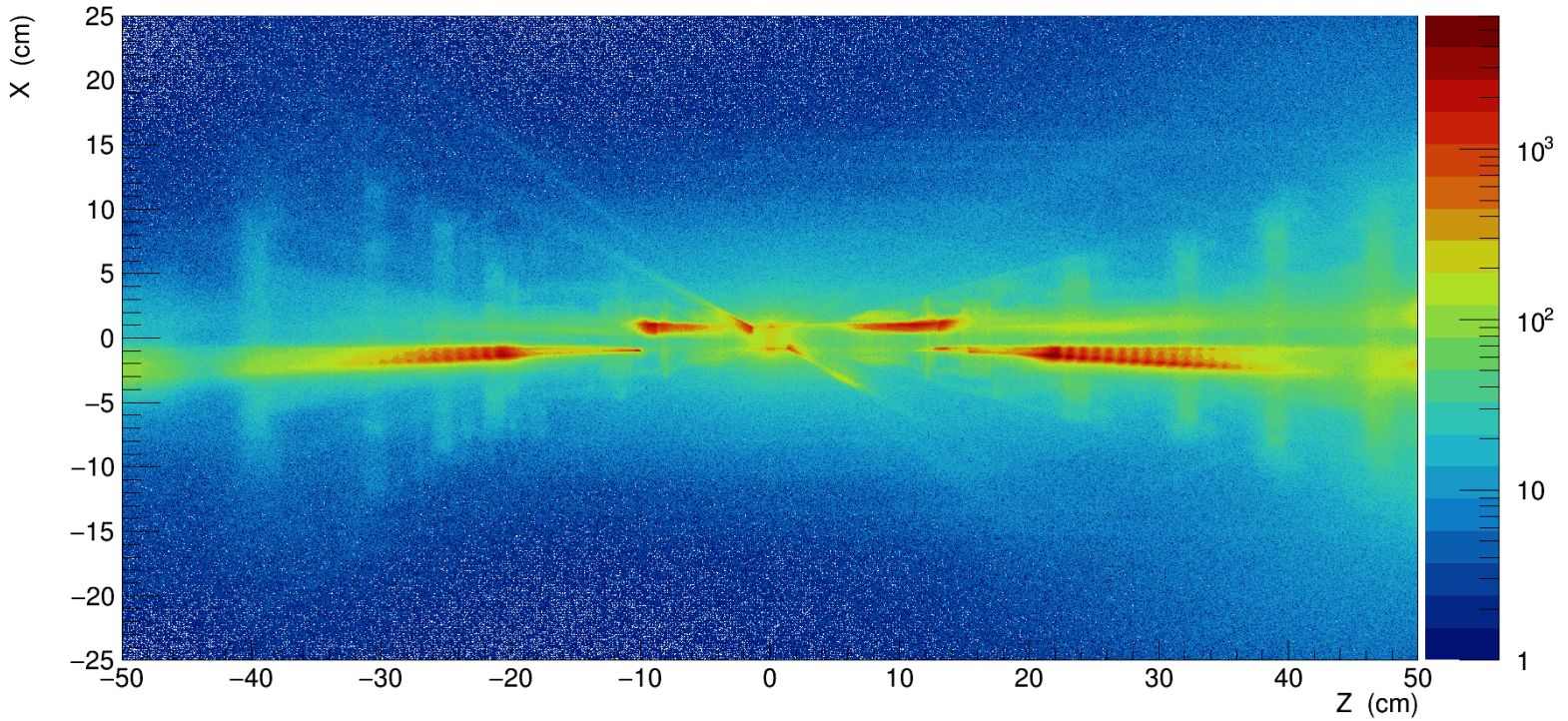
Backup(extra) slides



Inv-mass < 450 MeV
(Converted photons)

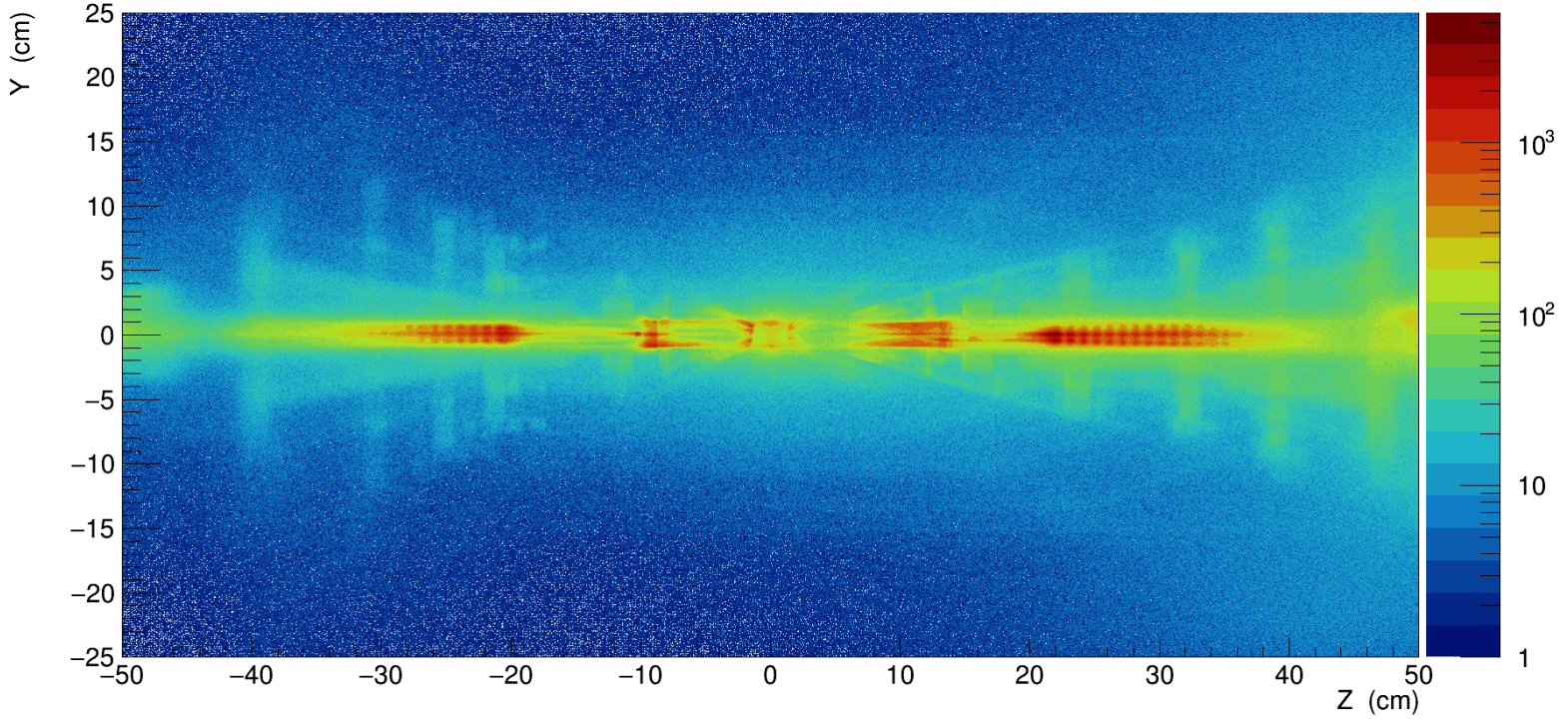


Top-View

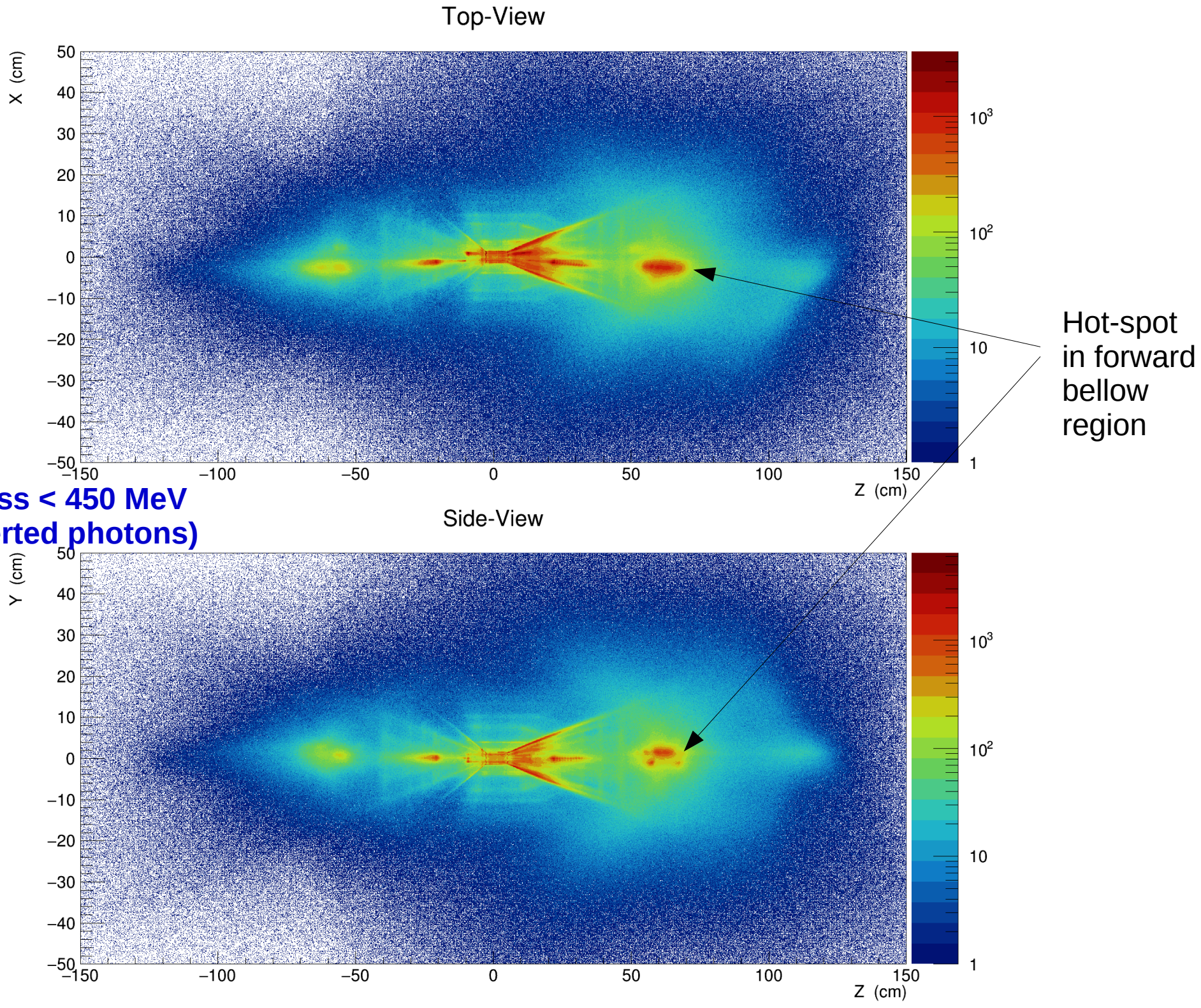


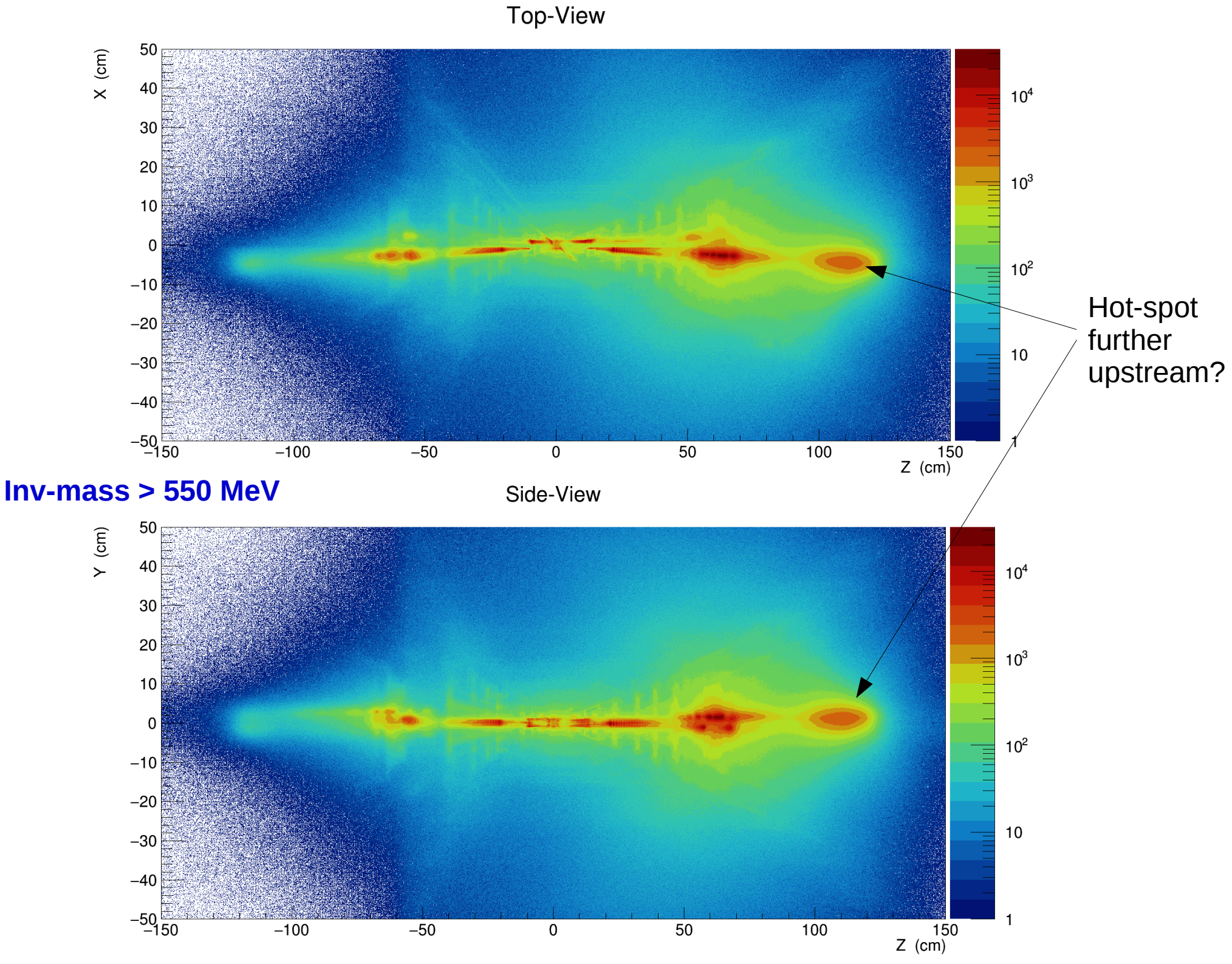
Inv-mass > 550 MeV

Side-View



Even more zoomed out longitudinal projections from 2-Track vertices


Top-View
X (cm)
Z (cm)
Hot-spot in forward bellow region
Inv-mass < 450 MeV
(Converted photons)
Side-View
Y (cm)
Z (cm)


Top-View
X (cm)
Z (cm)
Hot-spot
further
upstream?
Inv-mass > 550 MeV
Side-View
Y (cm)
Z (cm)