Status of the SDHCAL simulation In ILD

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With contributions of lots of people.

SDHCAL simulation

- Simulation uses GEANT4 application
  - Prototype simulation done in a standalone GEANT4 application interfaced with LCIO
  - ILD simulation done in Mokka (model = ILD_O2_v05)
- Final part of simulation (the digitization) done at reco phase in a Marlin Processor (MarlinReco).
  - Digitisation developped from prototype simulation.
    - See Arnaud Steen talk
    - Step angle correction not available for ILD simulation.

Model ILD_O2_v05

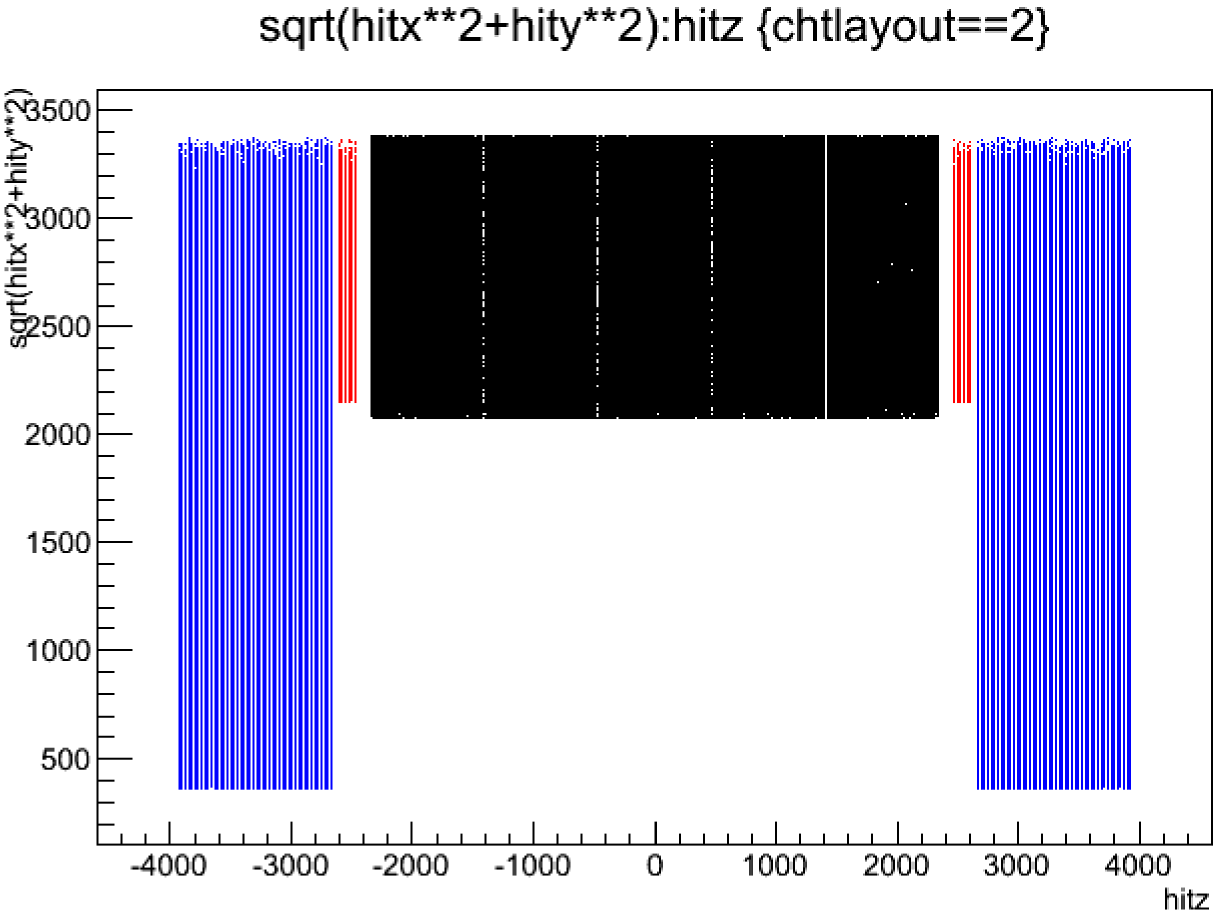
- The model was finalized in Mokka by Gabriel Musat at LLR.
- The model has been the basis of the SDHCAL à la Videau geometry studies for the DBD.
  - Standard Mokka config file and Marlin reco config file are available in ilcsoft config.
  - Reconstruction uses PandoraPFA with linear energy reconstruction formula : $E_{reco}=\alpha N_1+\beta N_2+\gamma N_3$
- tth, WW, ZZ MC data samples for full ILD are available

Check of model ILD_O2_v05

- First tests were done in Mokka with Geantino particle guns with verbose tracking.
- Other tests are done with single muons produced by Mokka.
  - Digitizer produces tuples to check calorimeter hits and Geant4 steps position.
  - In default ILCSOFT, for each cell, the middle position of each G4Step contributing to the hit is stored.
    - This allows playing with the cell size without resimulating everything.

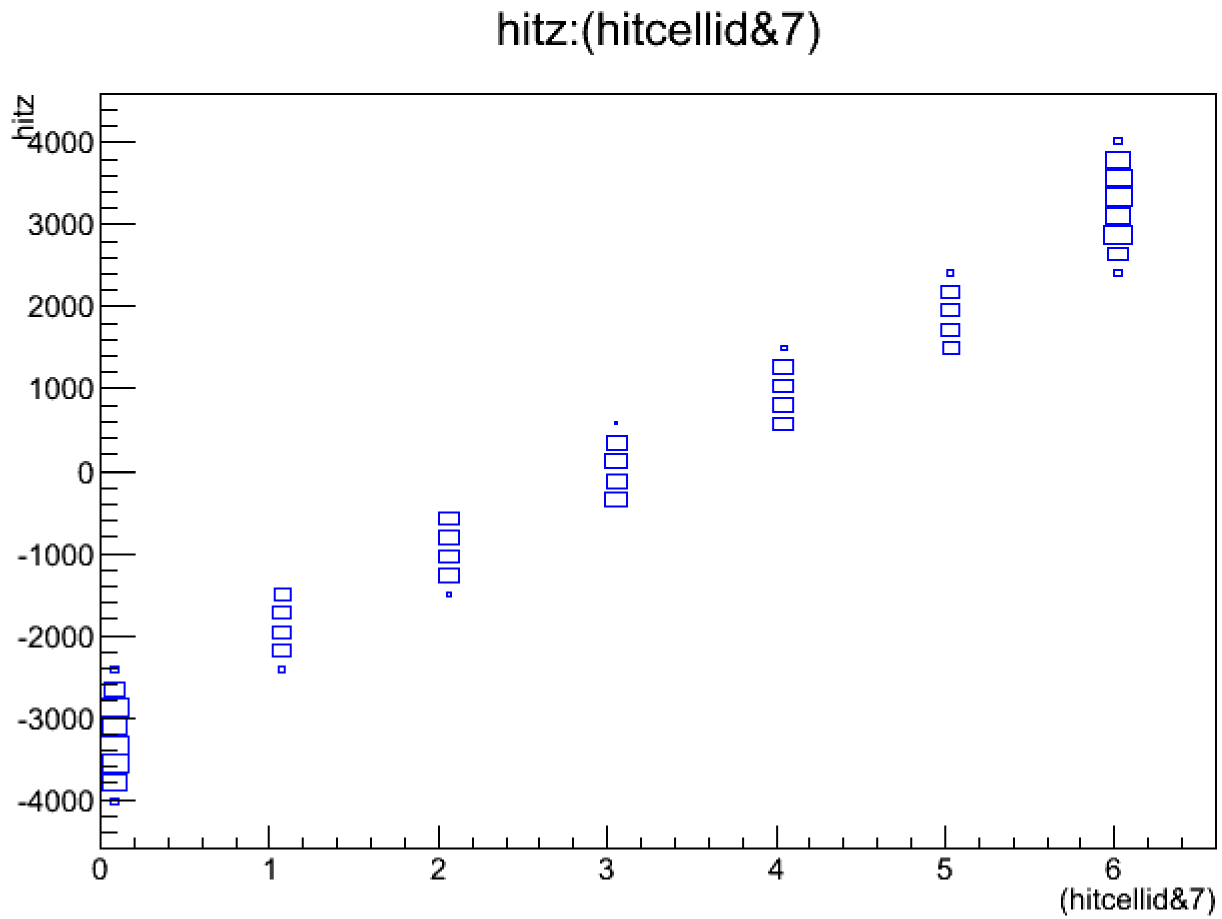
Global geometry

- Hit r vs z
  - blue=Endcap, red=ring, black=barrel



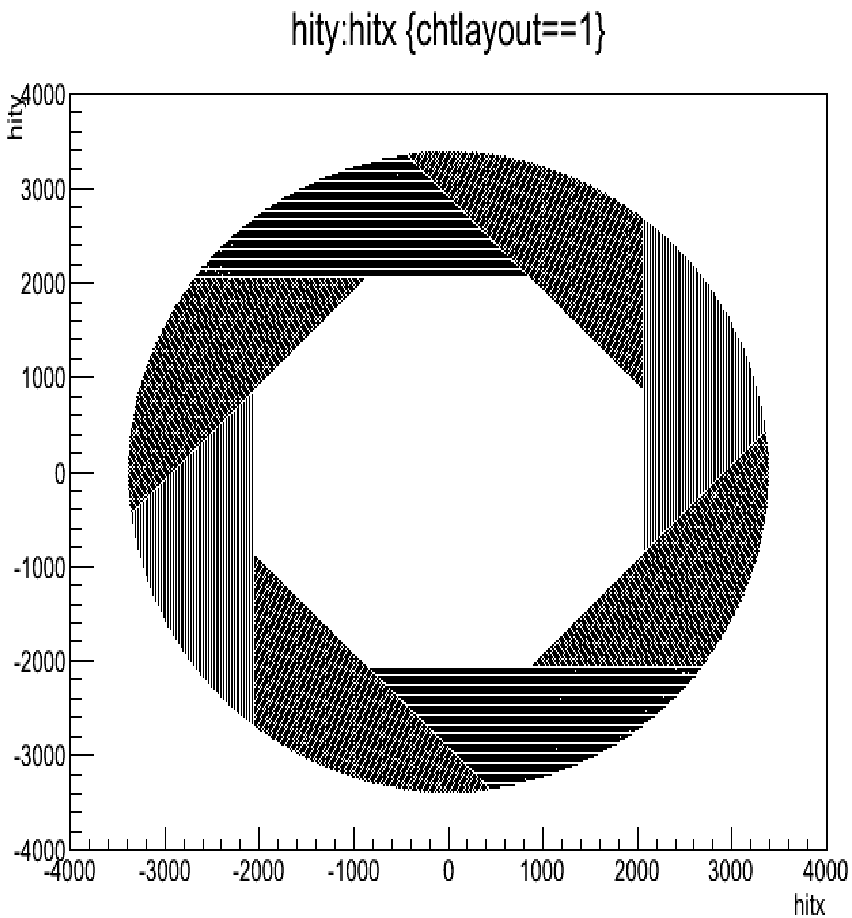
Global geometry

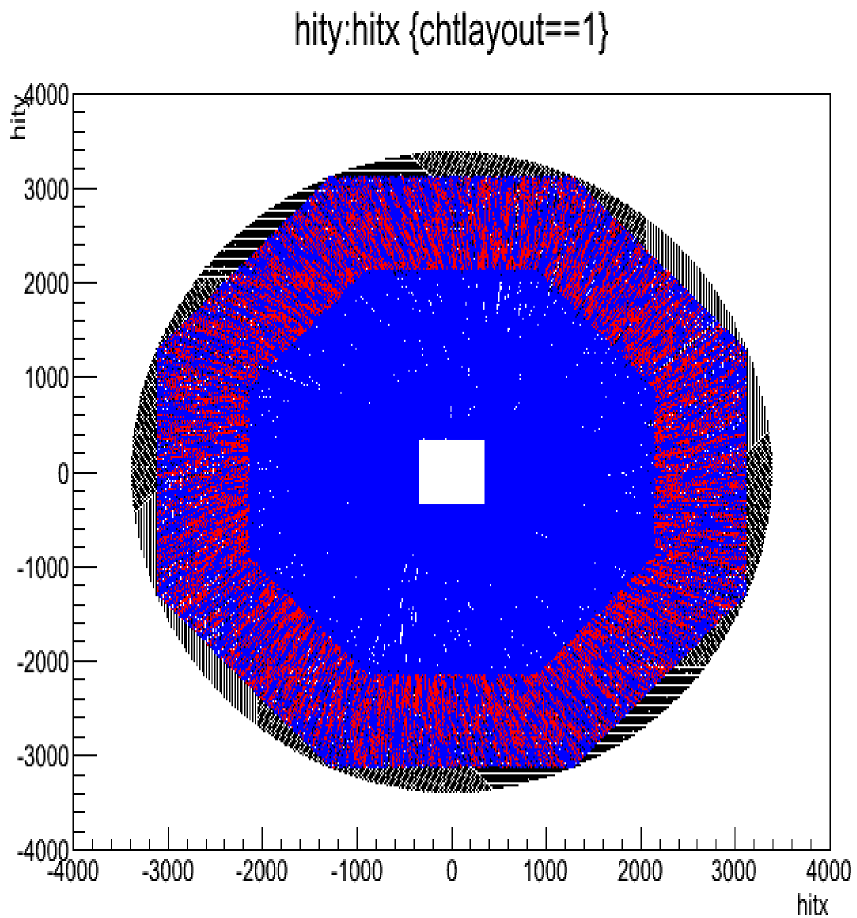
- Hit z vs module number in cellid



Global geometry

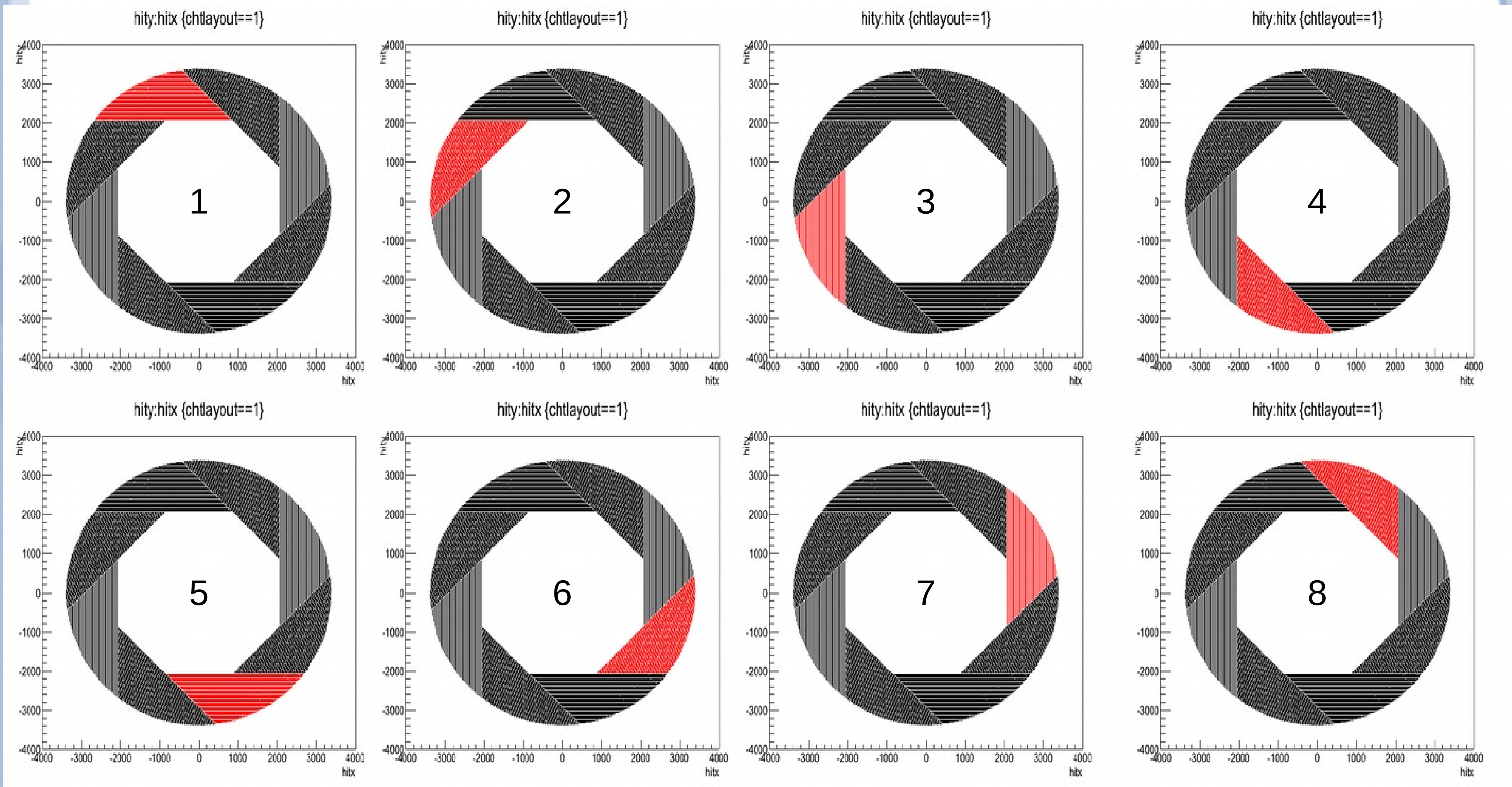
- Hit y vs x
  - blue=Endcap, red=ring, black=barrel





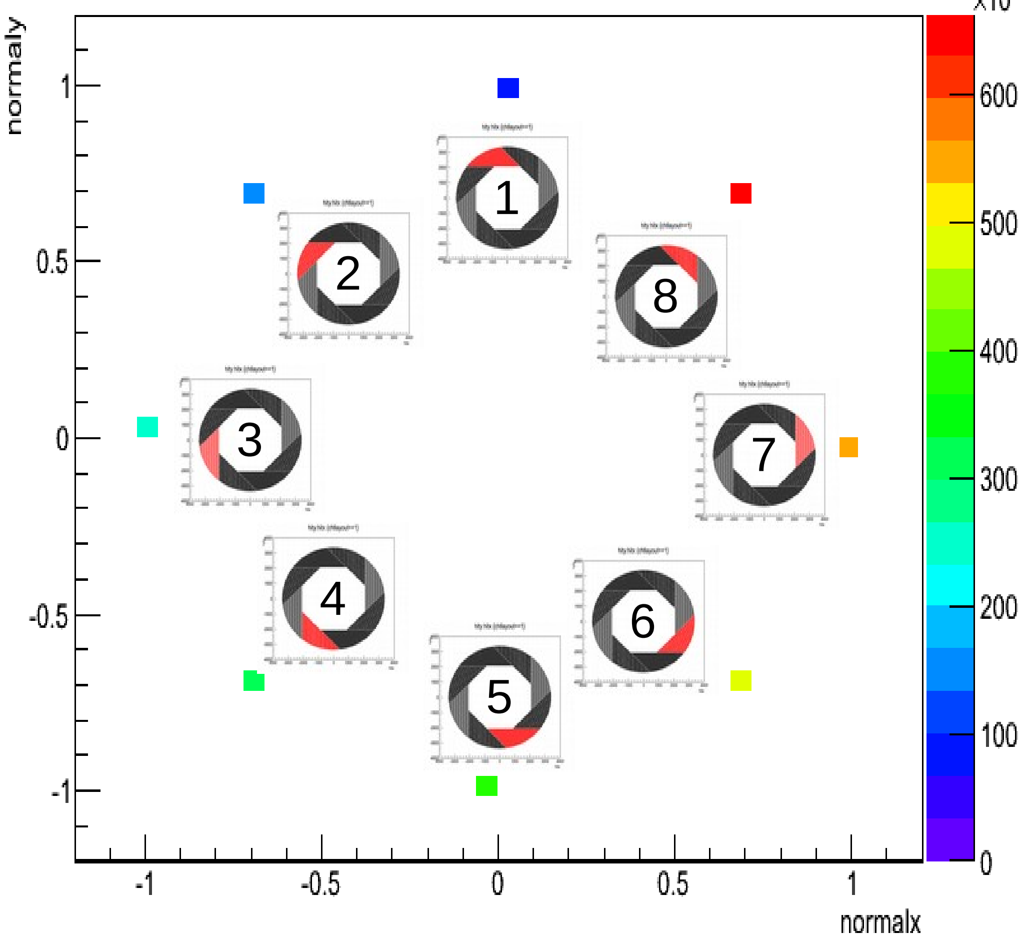
Barrel staves

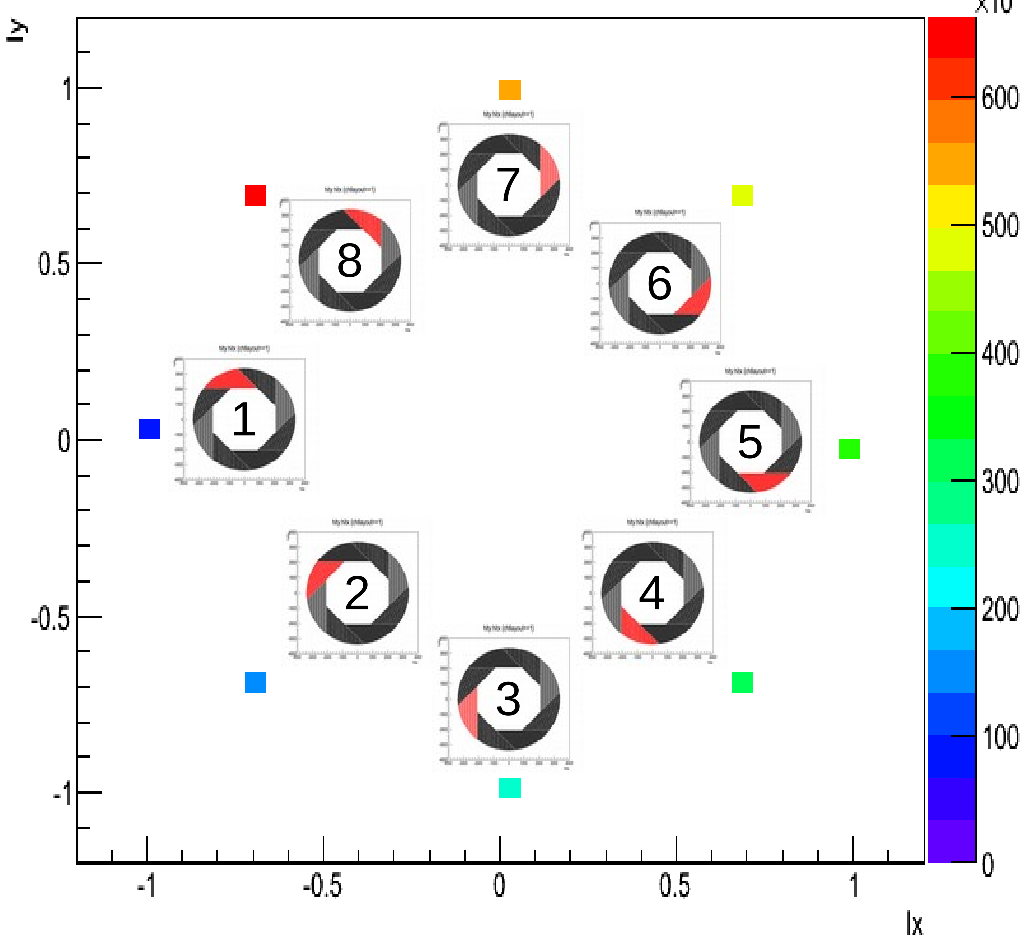
- Hit y vs x



Barrel staves

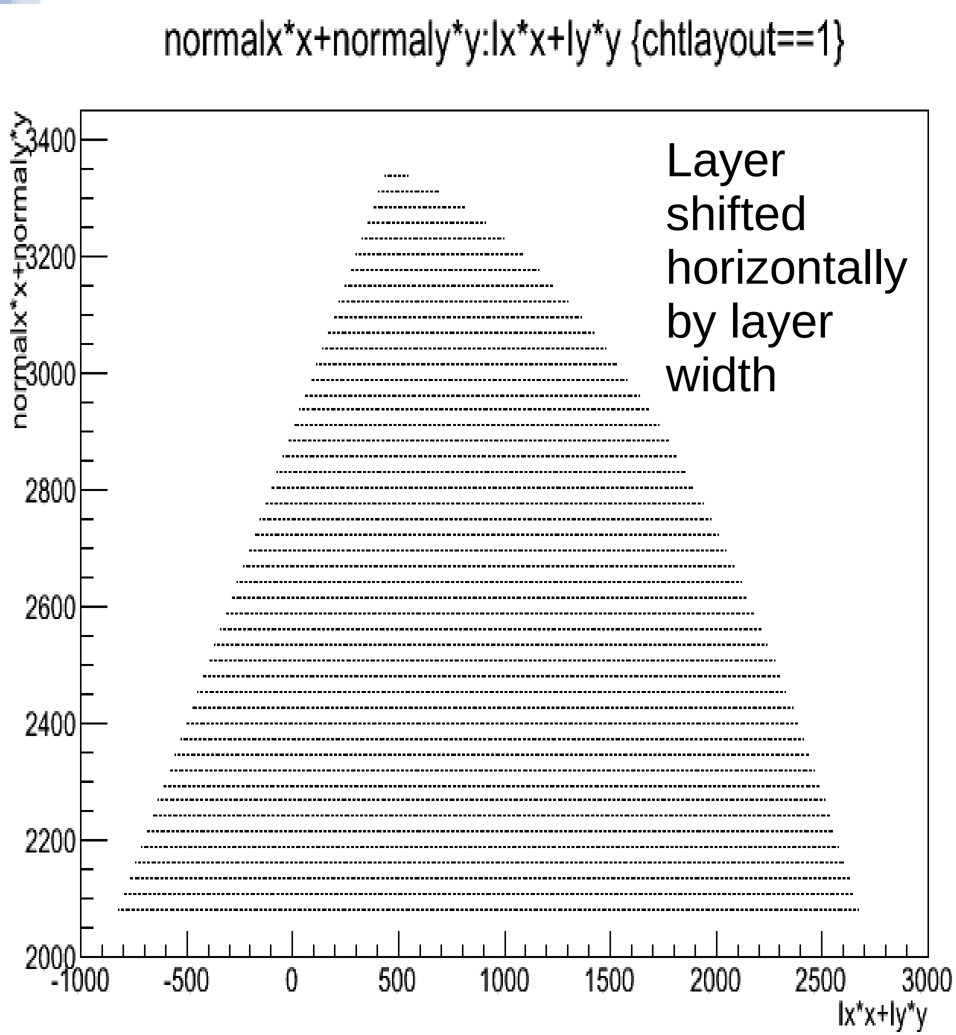
- Direction of increasing layer and I number

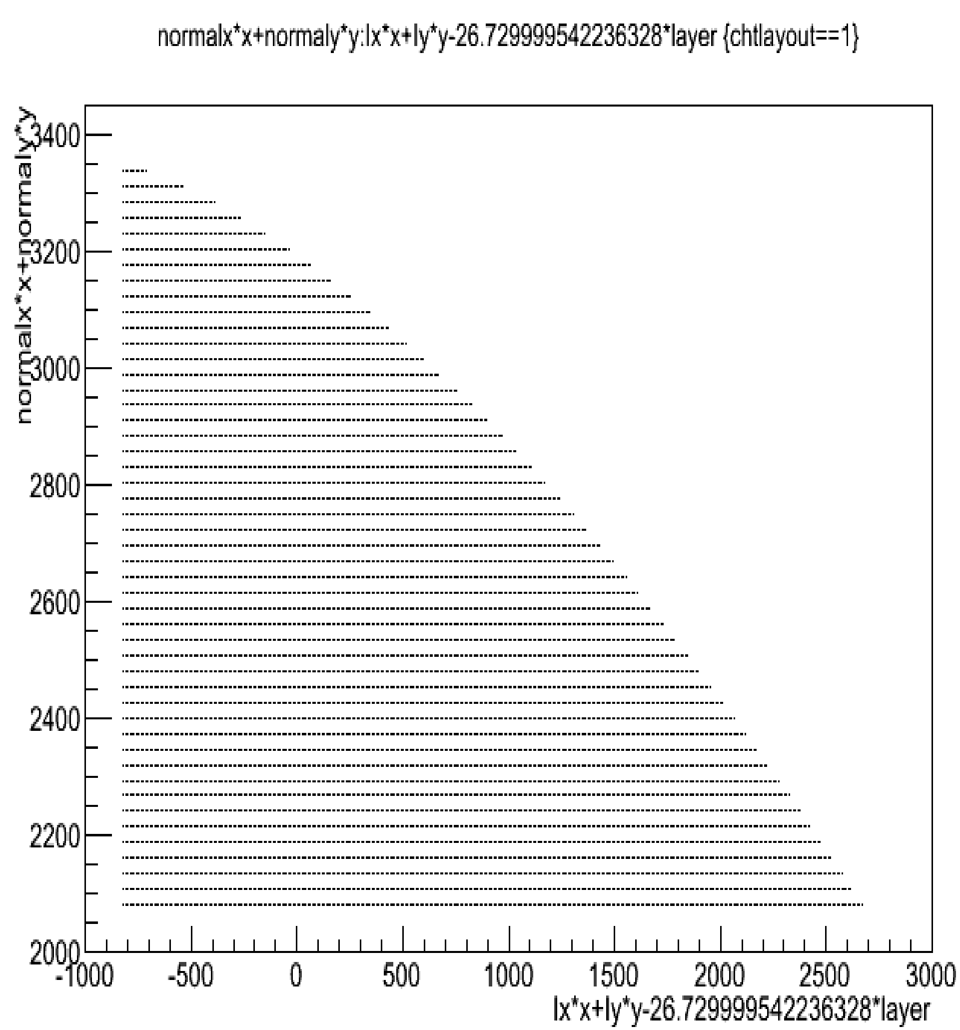




Barrel staves

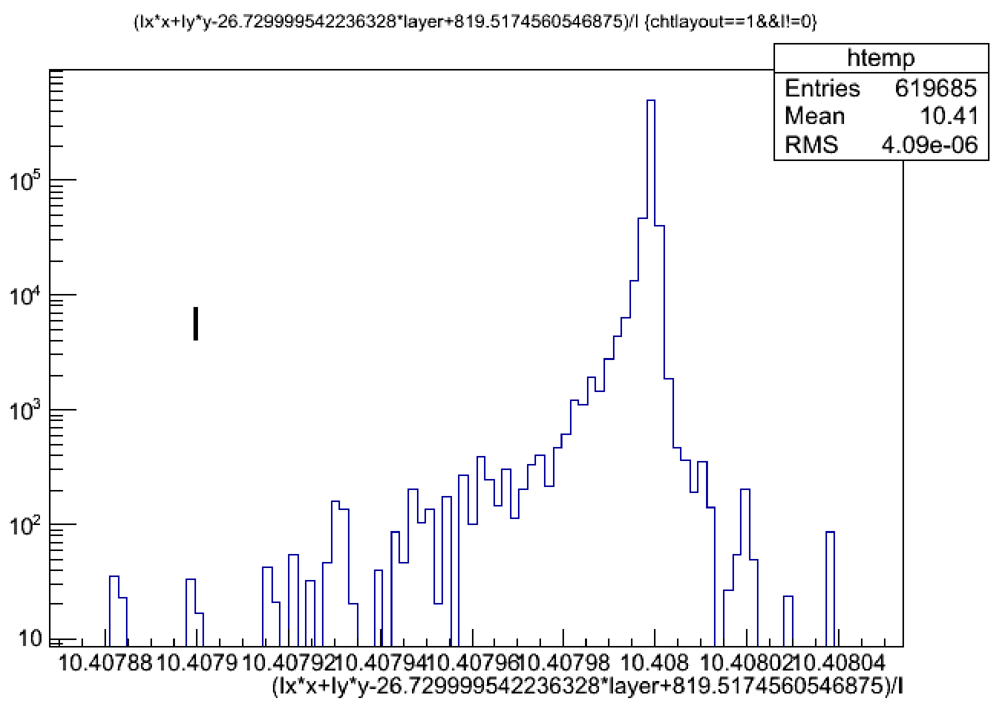
- All staves superimposed.

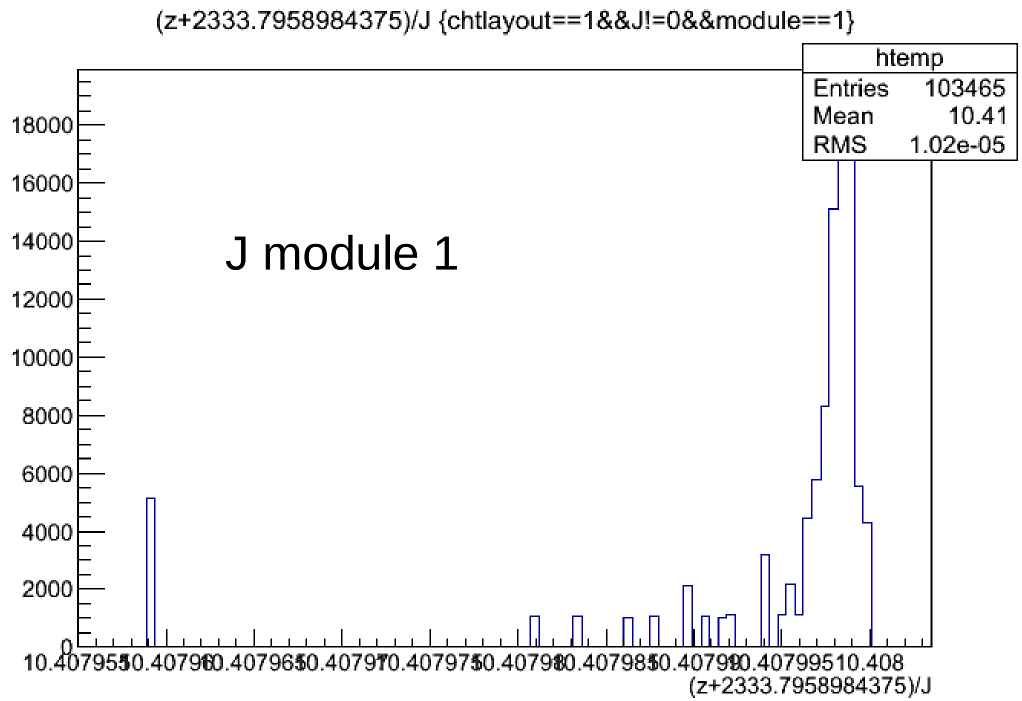


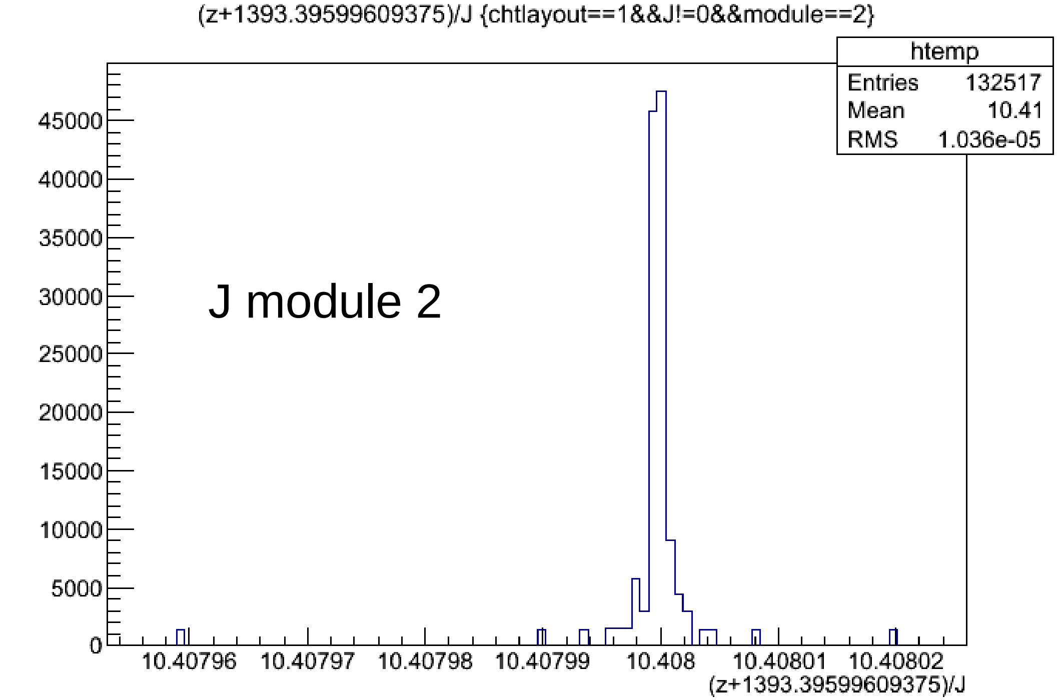


Barrel cells

- Determine position zero corresponding to I (resp J) =0
- Draw cell position – position zero divided by I (resp J)
- Should peak at CellSize+interPad=10.408



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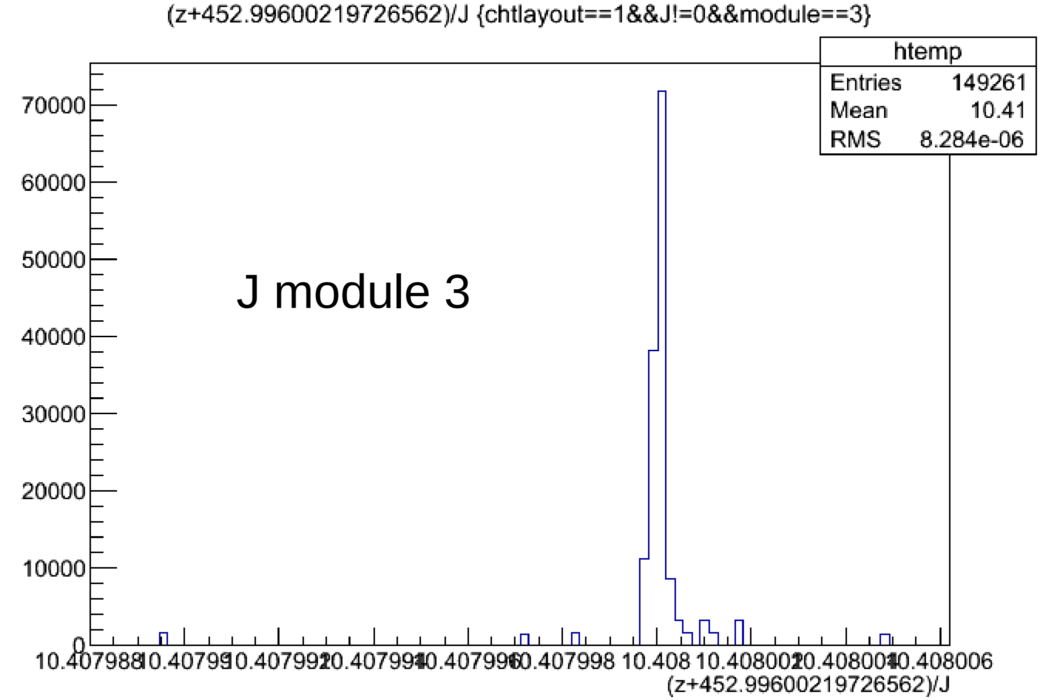
htemp
Entries 132517
Mean 10.41
RMS 1.036e-05
J module 2
(z+1393.39599609375)/J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htemp
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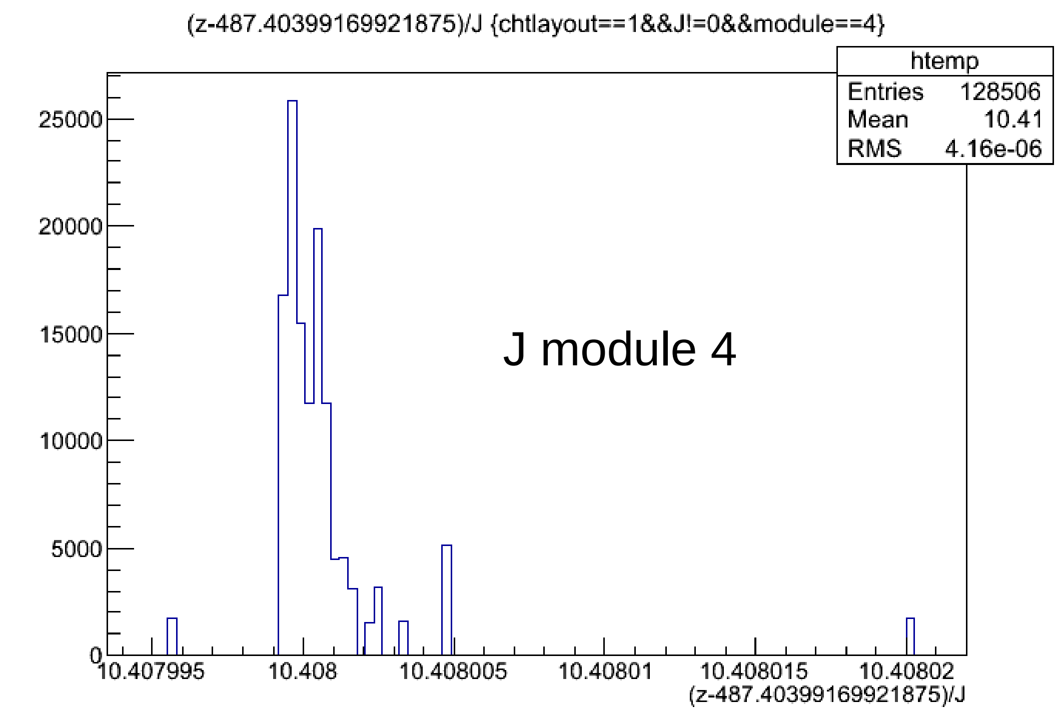
Mean 10.41
RMS 8.284e-06
J module 3
(z+452.99600219726562)/J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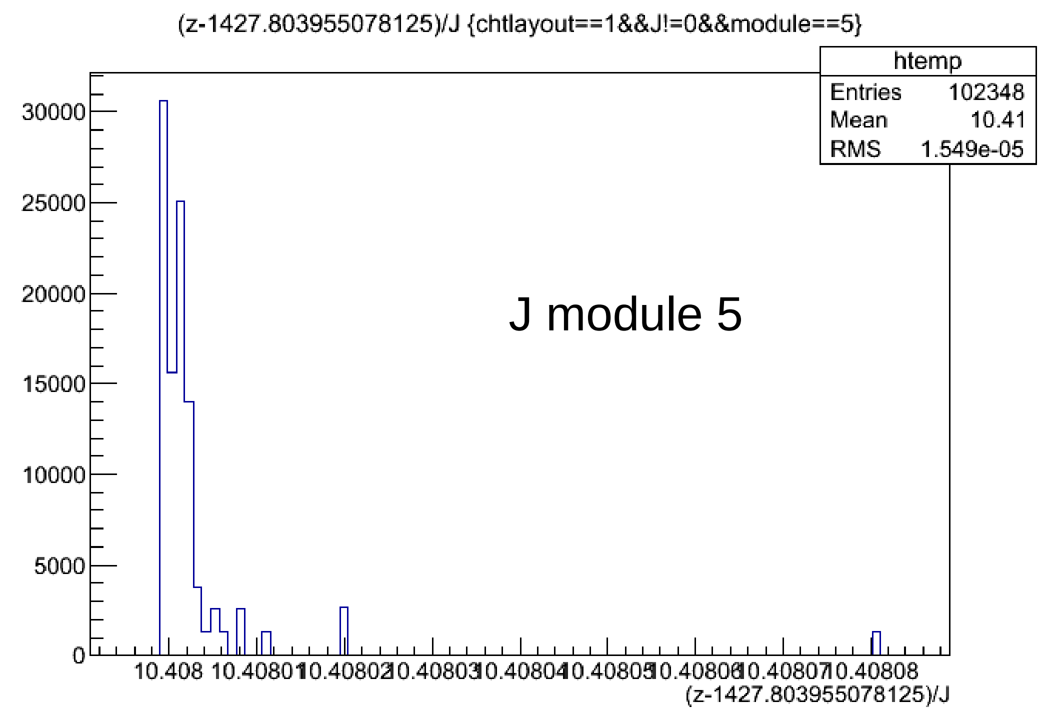
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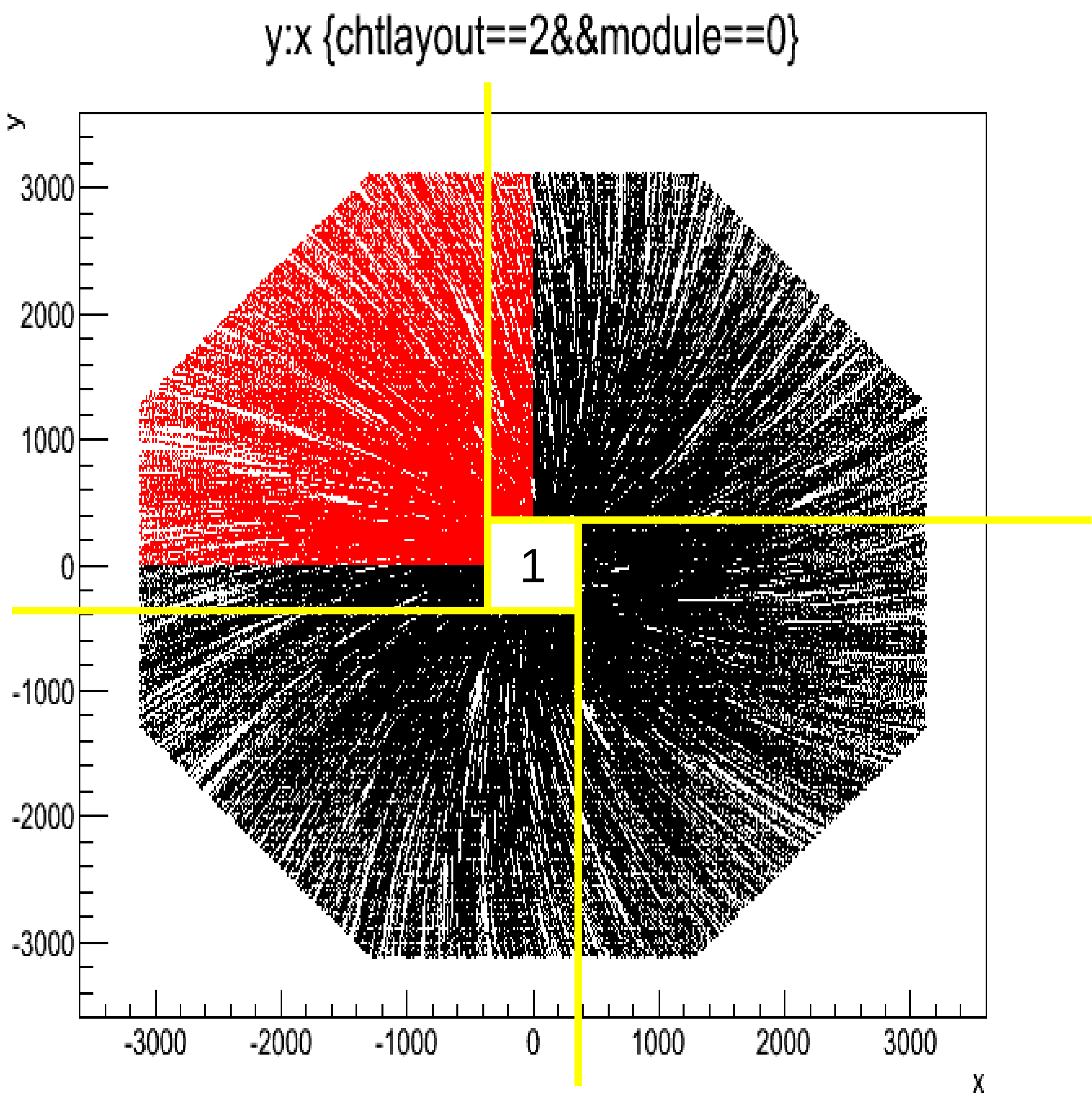
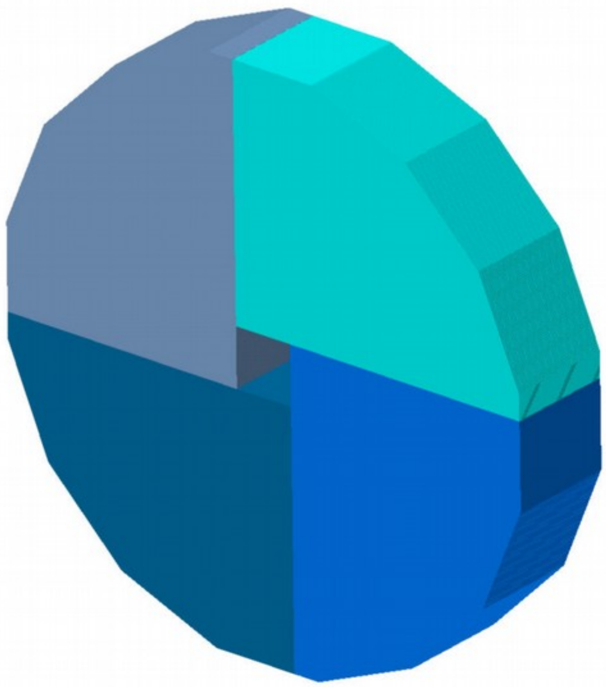
htemp
Entries 102348
Mean 10.41
RMS 1.549e-05
J module 5
(z-1427.803955078125)/J

EndCaps Staves

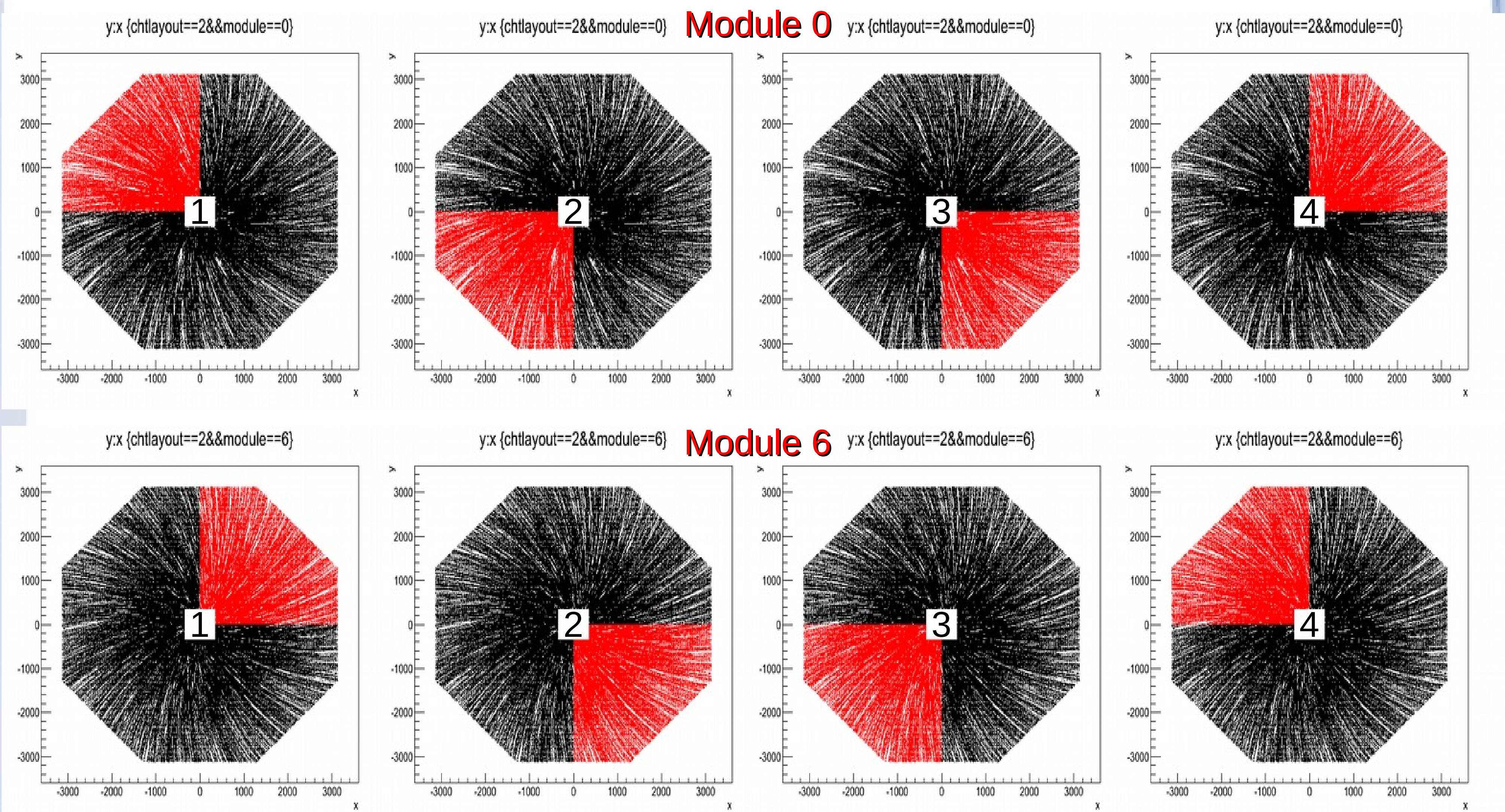
- Hit y vs x

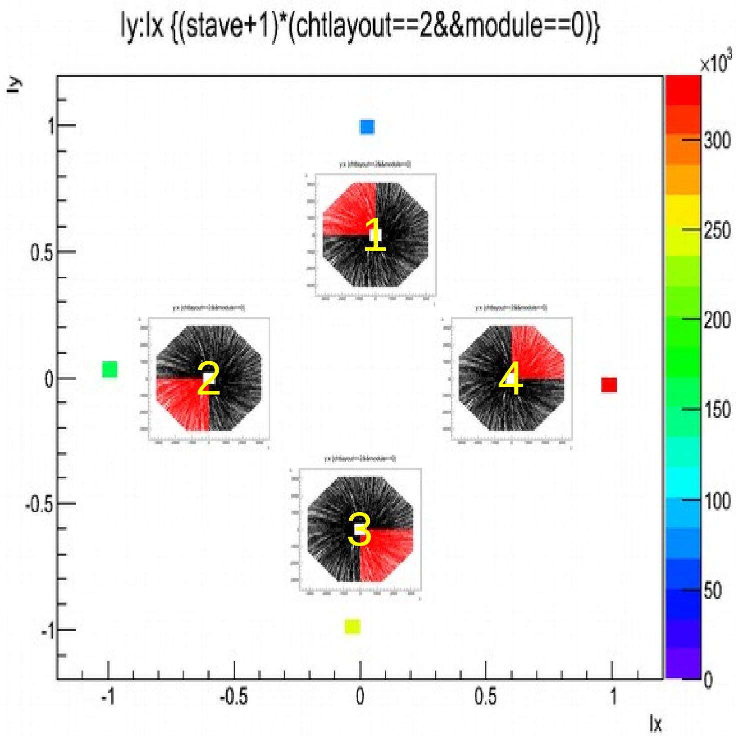




EndCaps Staves

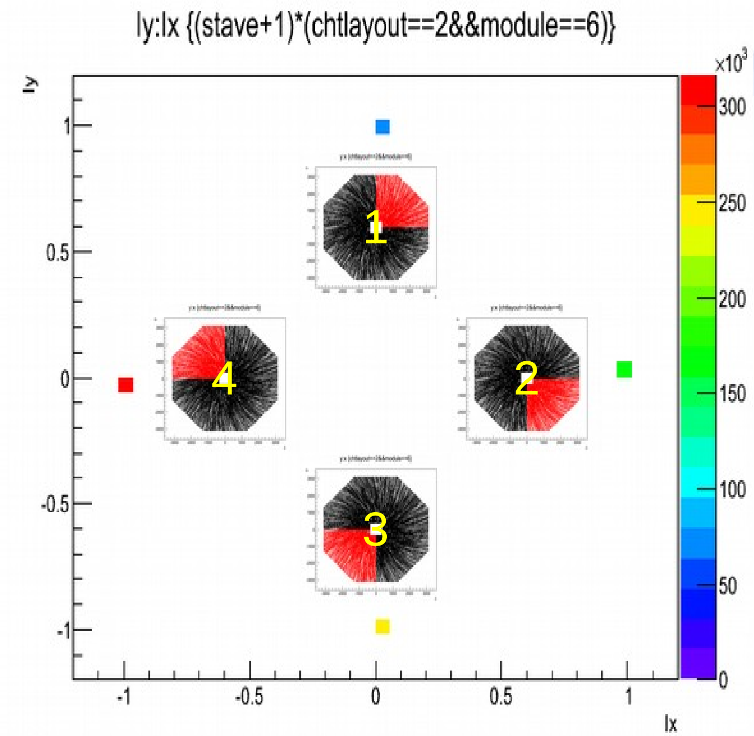
- Hit y vs x





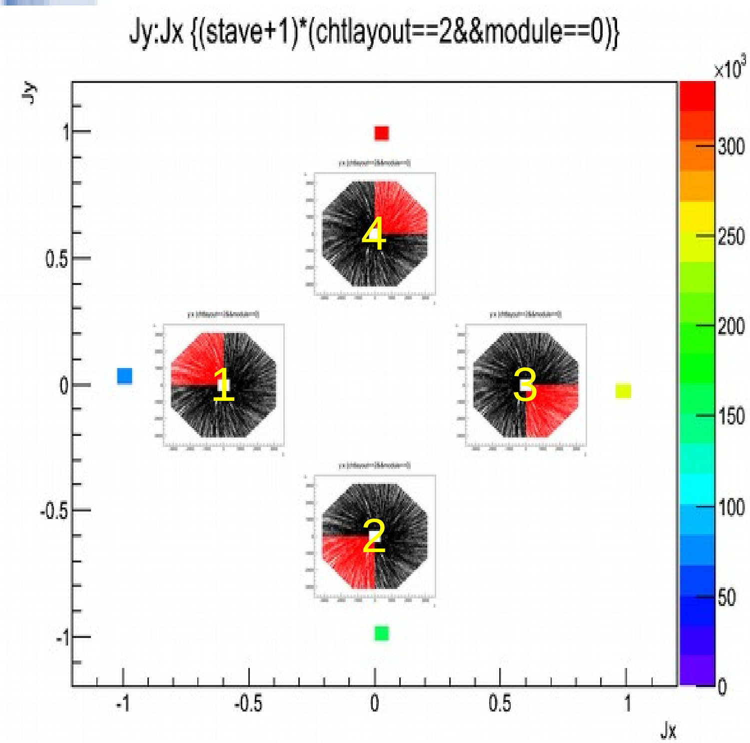
EC Staves

Direction of inceasing I

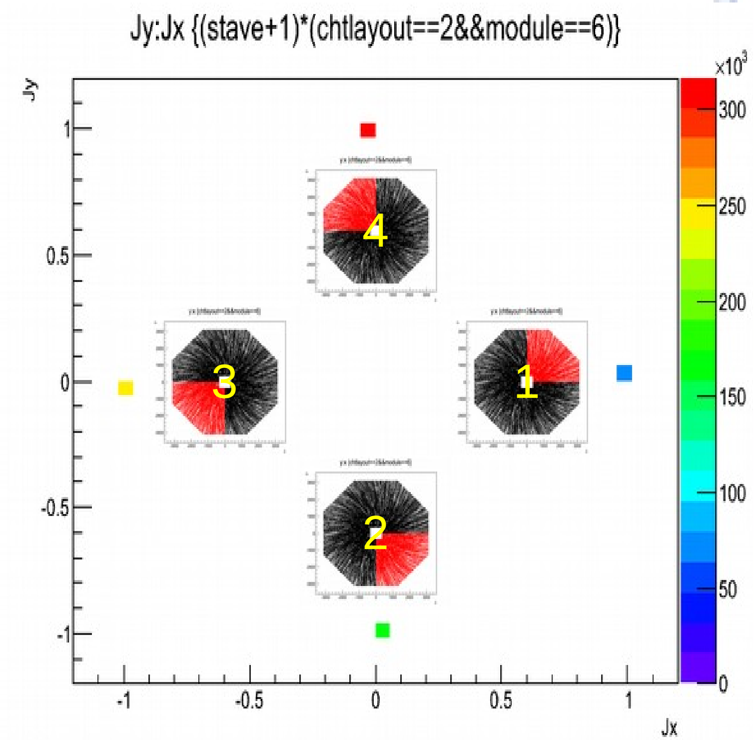


Module 0

Module 6

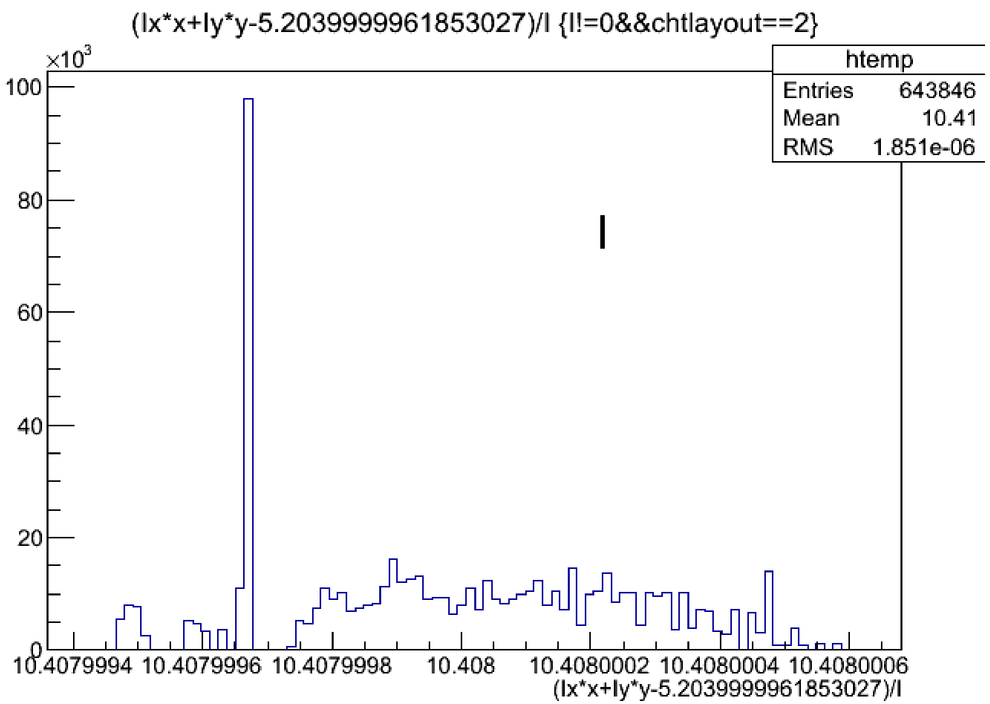


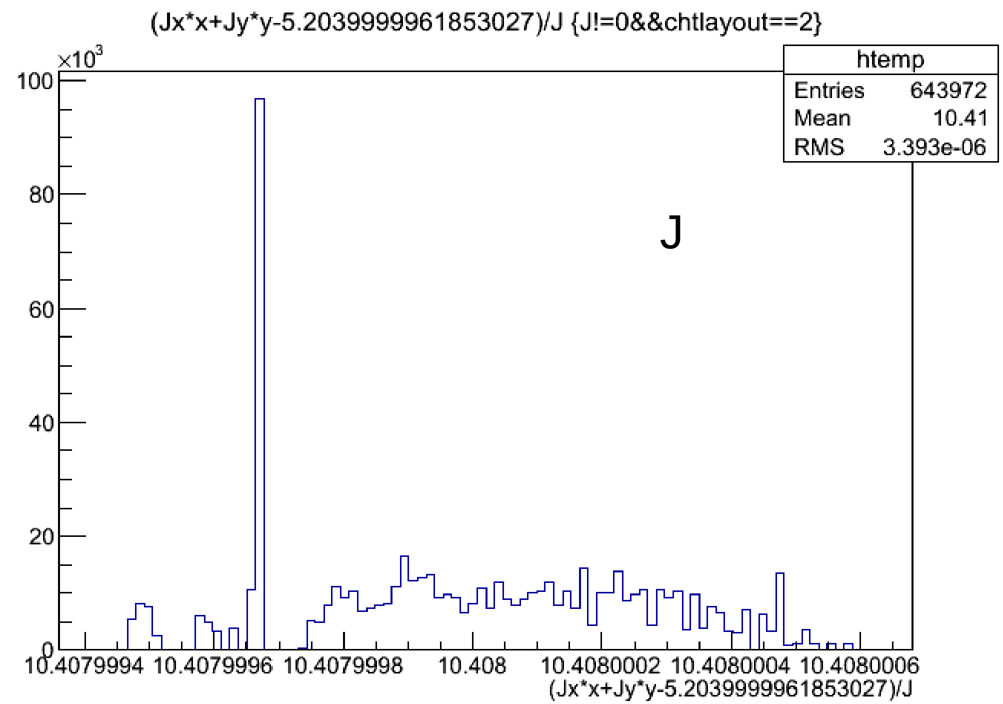
Direction of inceasing J



EndCaps cells

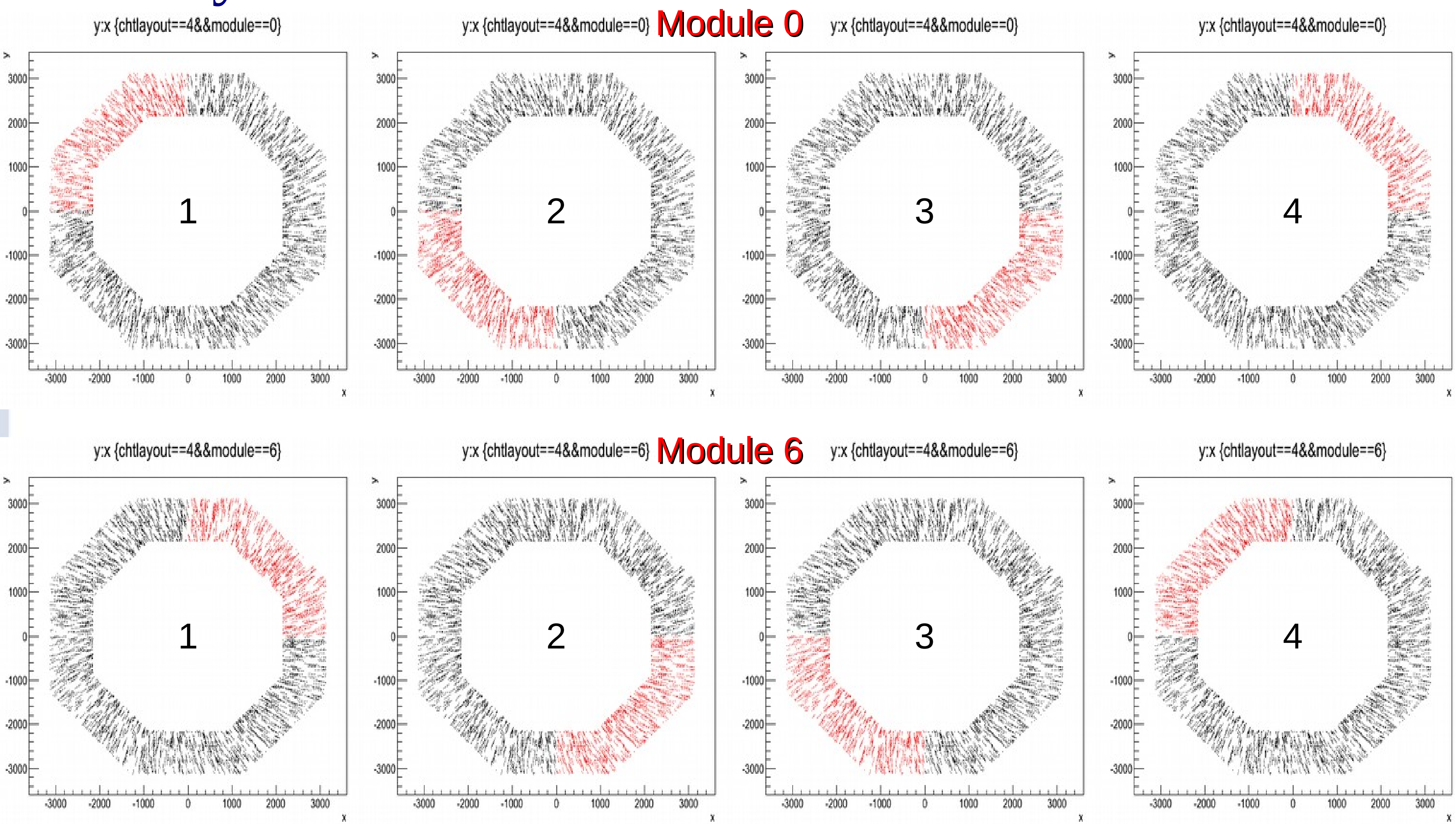
- Determine position zero corresponding to I (resp J) =0
- Draw cell position – position zero divide by I (resp J)
- Should peak at CellSize+interPad=10.408

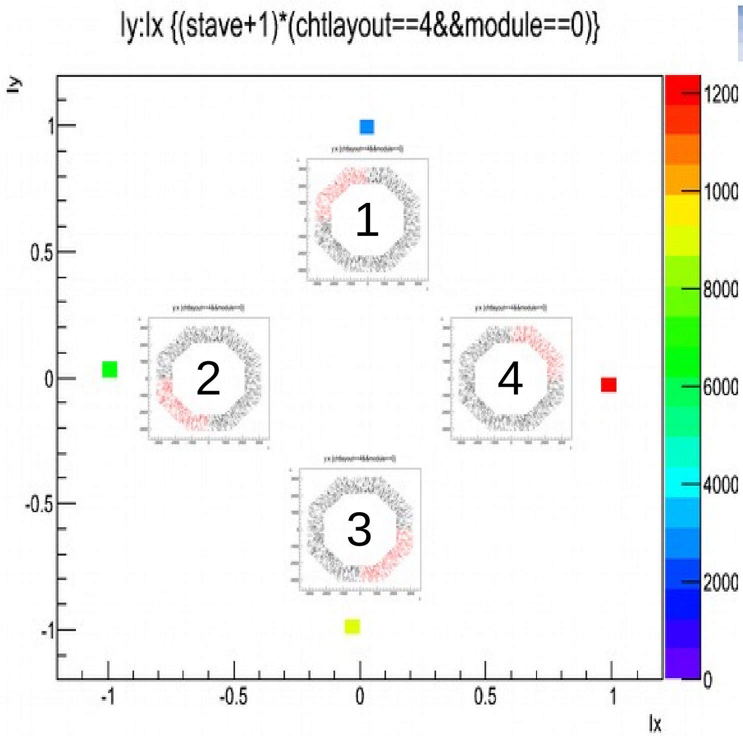




Ring Staves

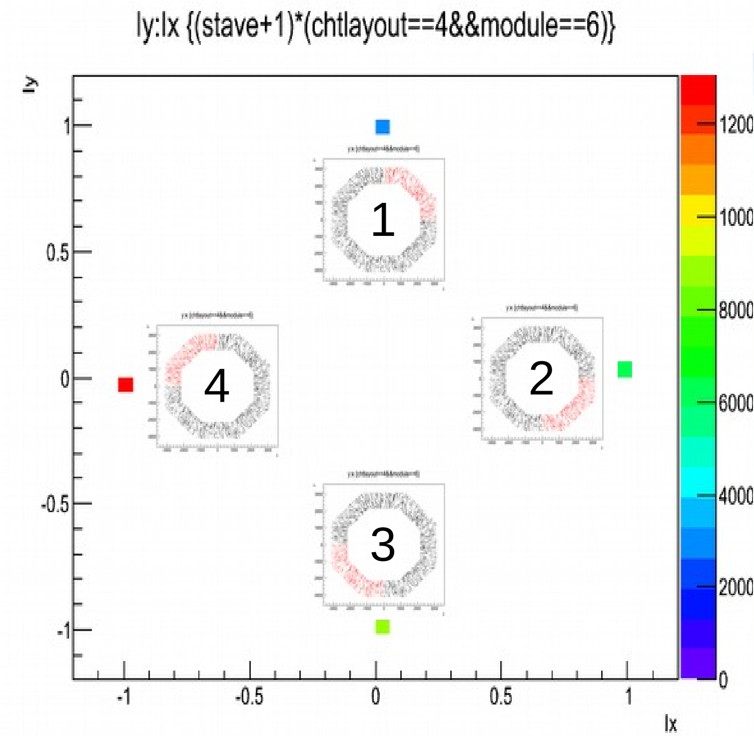
- Hit y vs x





Ring Staves

Direction of inceasing I



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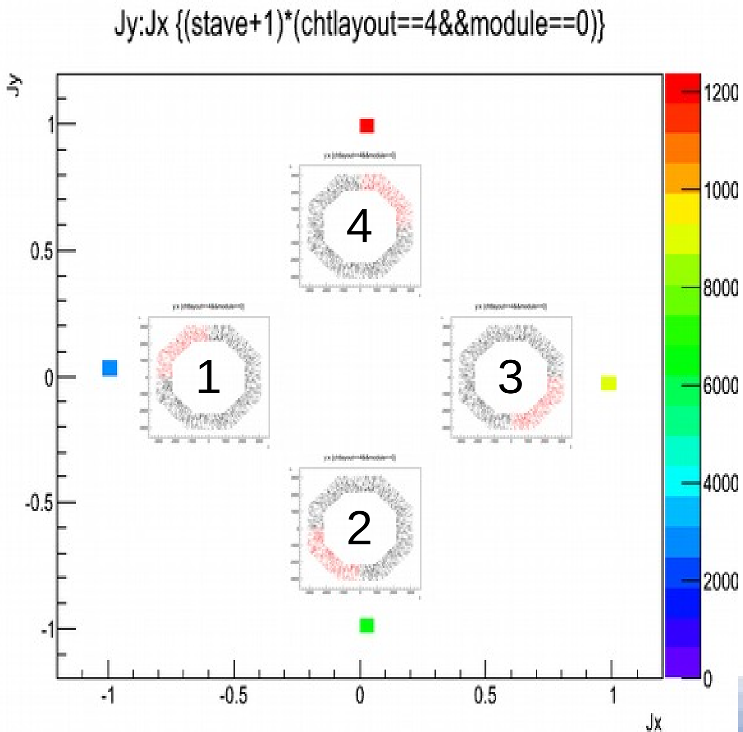
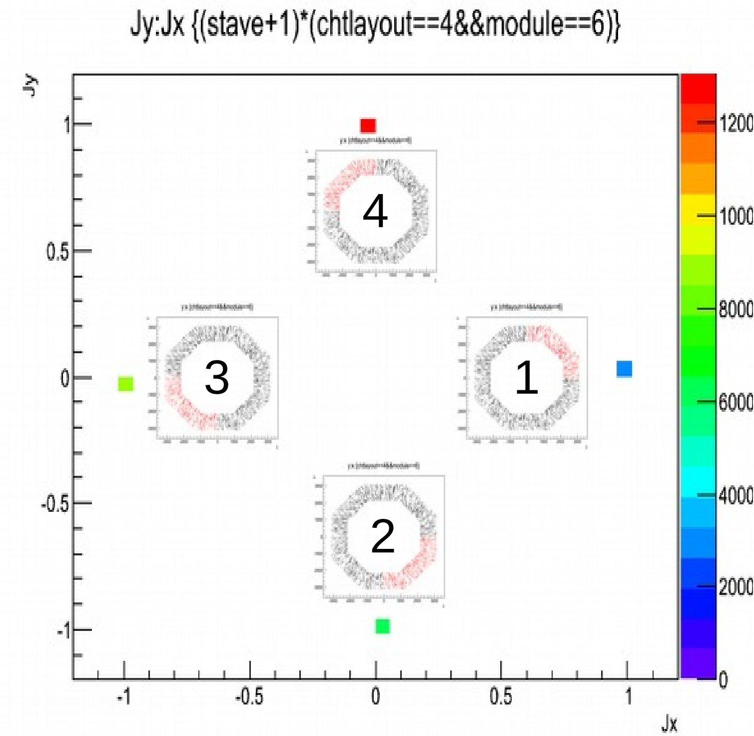


Direction of inceasing J



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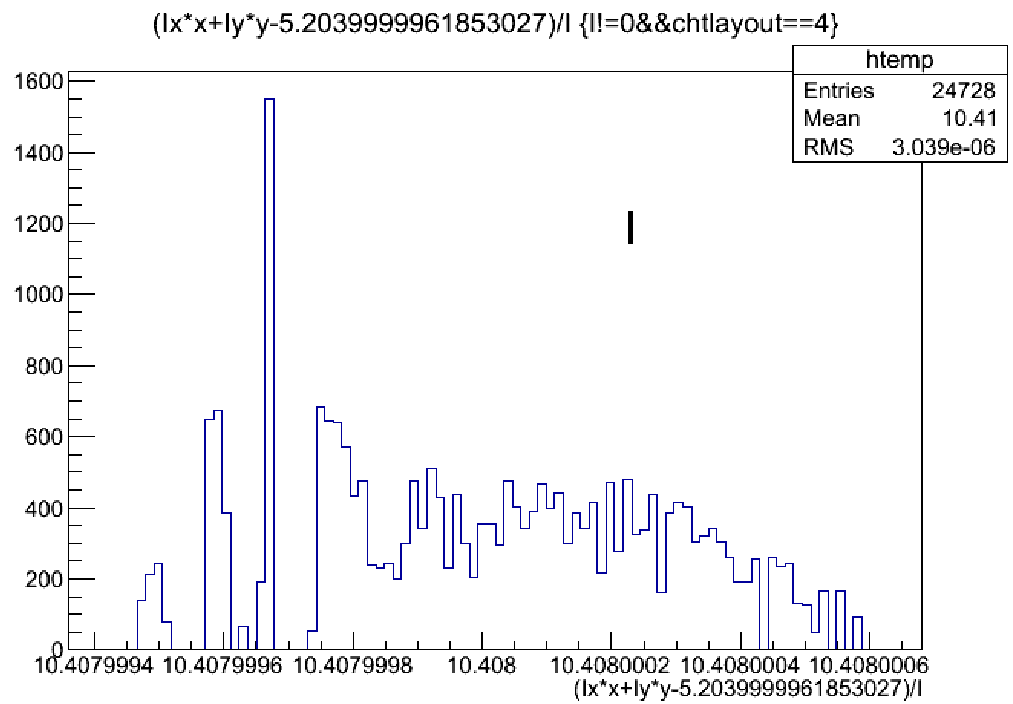
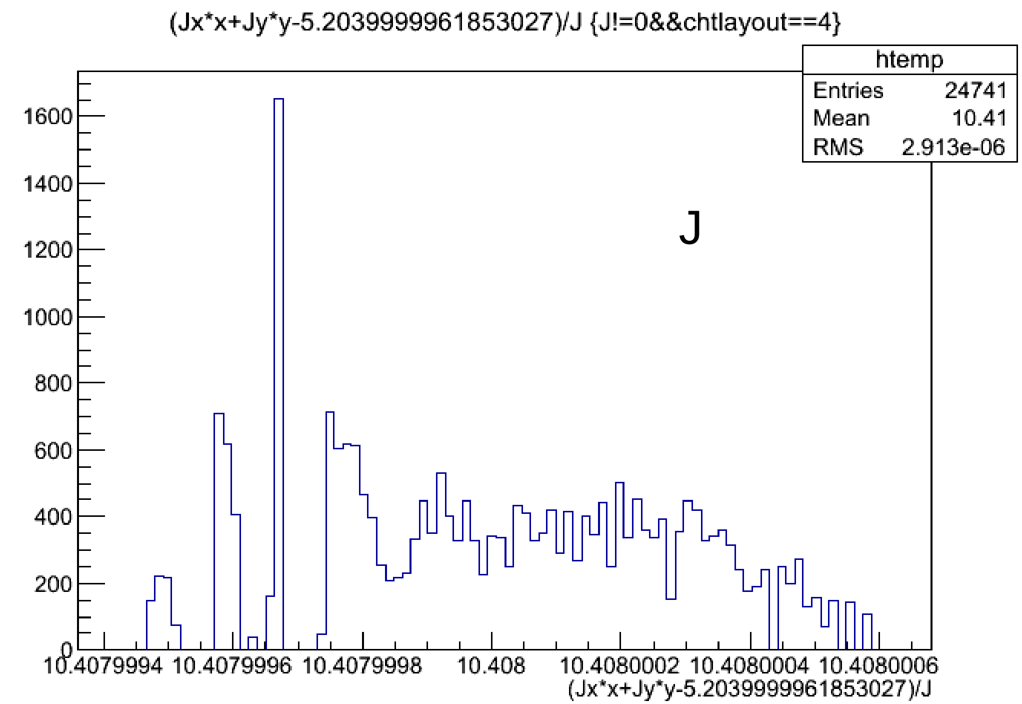
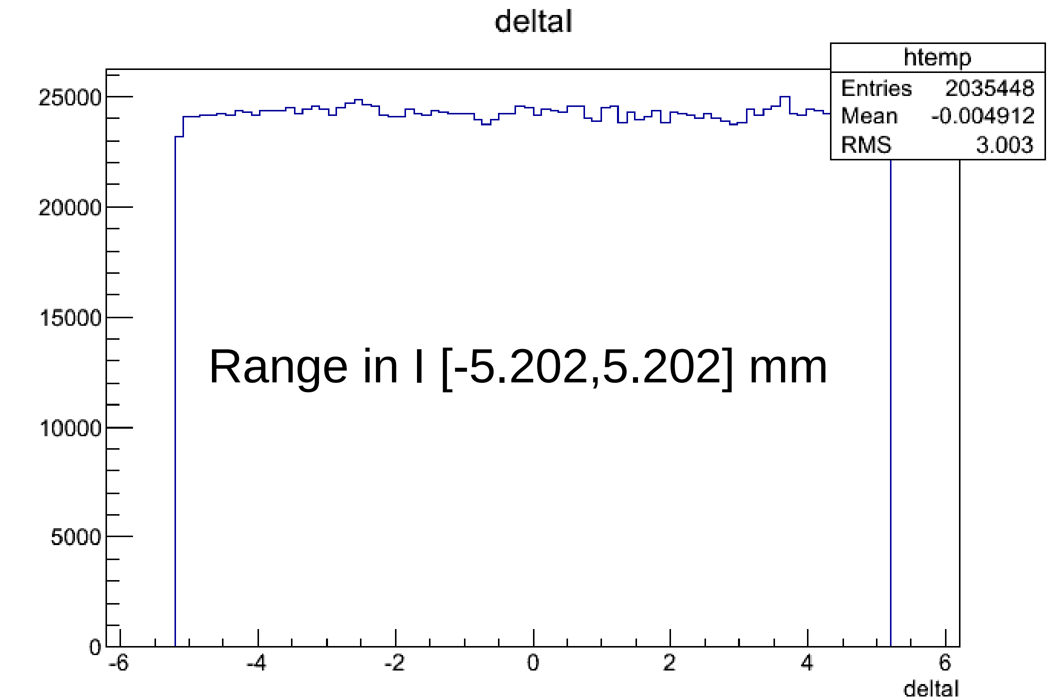
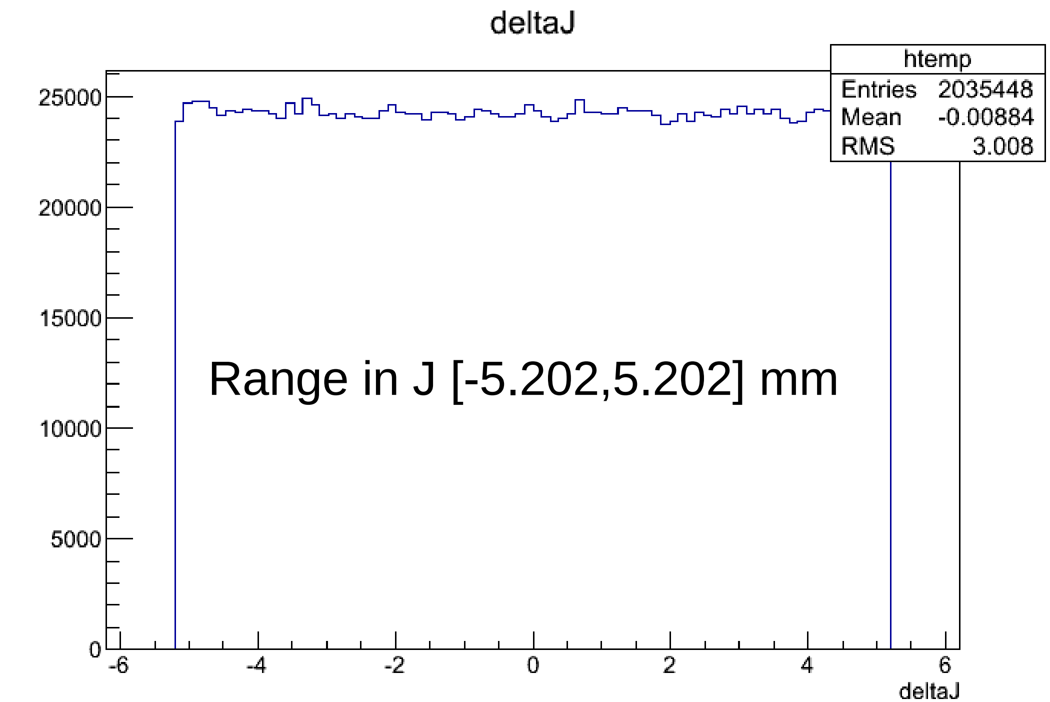


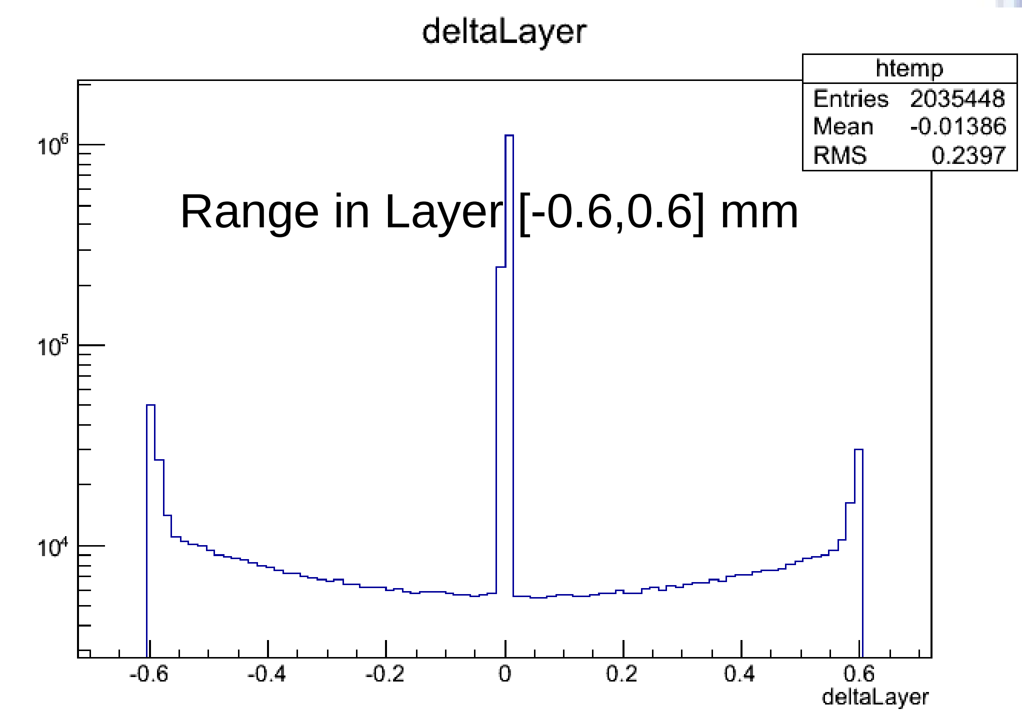


Digitisation

- Compare step position with hit position in 3 directions : I, J and K=layer
  - Plots are for the **whole detector**







Future DD4HEP

- Moving SDHCAL ILD simulation to DD4HEP is planed.
- The digitizer provides necessary tools to check the new simulation.

Conclusion

- Mokka Model ILD_O2_v05 is the current basis for physics analysis
    - PandoraPFA based reconstruction with linear SDHCAL energy reconstruction available.
- Preparation of ArborPFA based reconstruction with non linear energy reconstruction ongoing.
- Plan to move to DD4HEP-based SDHCAL simulation.