Helix parameters particular features

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Outline of the presentation

Feature 1

Apparetly very high d0 and z0 due to name-changing of MCParticles *(effect understood)*

Feature 2

Anomalous peak in ω distribution with strage status assignment *(effect not understood)*

Presentation Warning:

I never talked to anyone about most of these features, discovered and studied as «summer work» parallel to my thesis writing. Therefore wrong interpretations may be present!

How I produced the plots that I'm going to show?

- Produced 900K Y(4S) events
- For each MCParticle: particle.getRelationFrom<SVDCluster>
- For each SVDCluster: cluster.getRelationsTo<SVDTrueHit>
- For each SVDTrueHit: evaluated track parameter from local **x, p**

No PXD hit used

All the information are from MC-truth!

There are hit-information of all the hits of each track, each entry is an hit*

* Entry = vector<hitXP>, therefore it is possible to require subset of hit per track, for example «only the first hit of the track»

Feature 1

(study on anomalous high track paramers casued by material interaction)

Helix Parameters reminder

- From single TrueHit informations (**x**, **p**) are evaluable all the paramters:

$$\omega \to \frac{B_3 q}{\sqrt{P_1^2+P_2^2}} \qquad (1)$$

$$\tan\lambda \to \frac{P_3}{\sqrt{P_1^2+P_2^2}} \qquad (2)$$

$$d_0 \to \operatorname{sgn}(B_3 q)\left(\sqrt{\left(\frac{P_2}{B_3 q}+X_1\right)^2+\left(X_2-\frac{P_1}{B_3 q}\right)^2}-\sqrt{\frac{P_1^2+P_2^2}{B_3^2 q^2}}\right) \qquad (3)$$

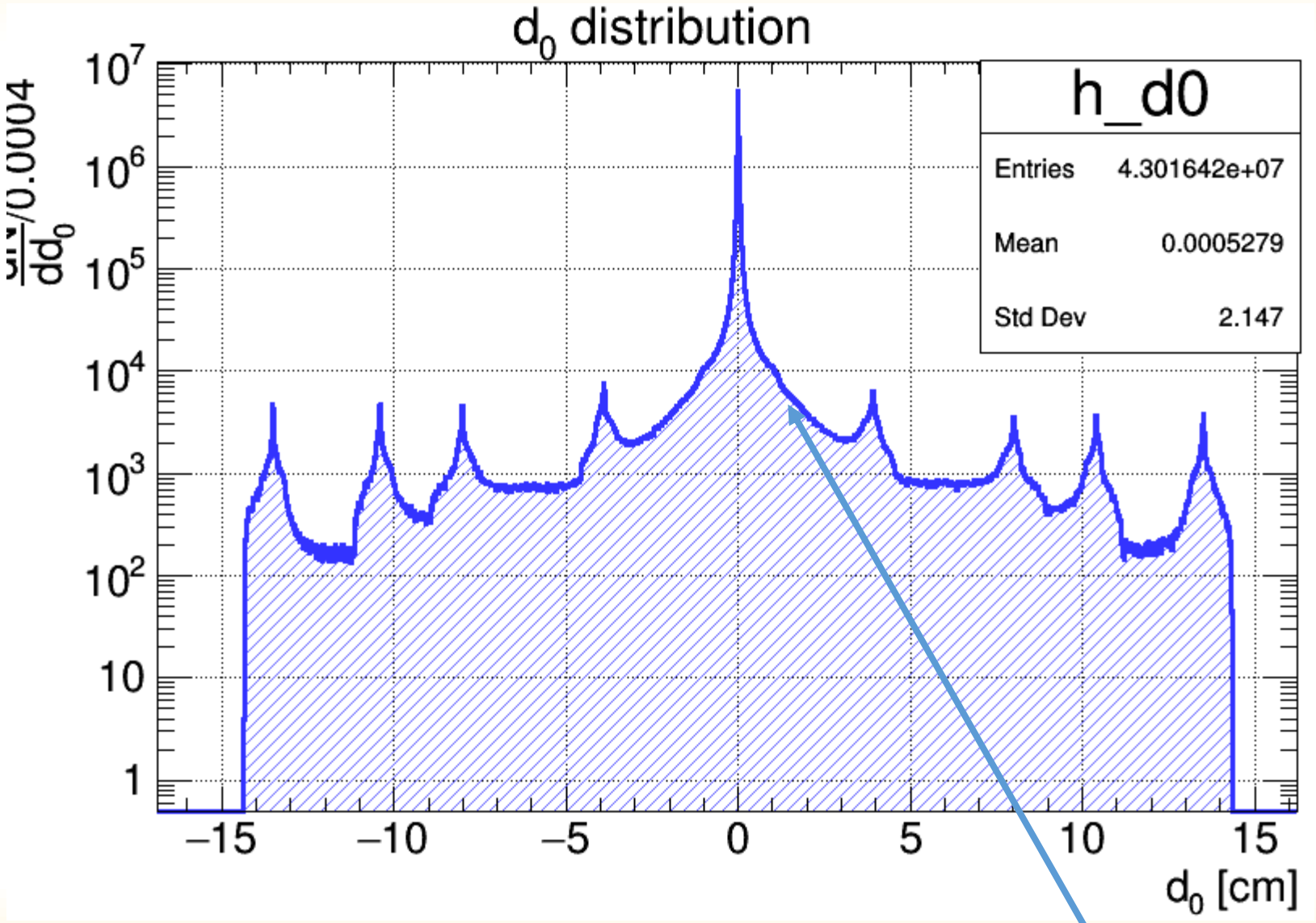
$$\chi \to \tan^{-1}\left(\operatorname{sgn}(B_3 q)\left(\frac{P_1^2+P_2^2}{B_3 q}+P_2 X_1-P_1 X_2\right),(-P_1 X_1-P_2 X_2)\operatorname{sgn}(B_3 q)\right)$$

$$\varphi_0 \to \tan^{-1}(P_1,P_2)-\chi \qquad (4)$$

$$z_0 \to \frac{P_3 \chi}{B_3 q}+X_3 \qquad (5)$$

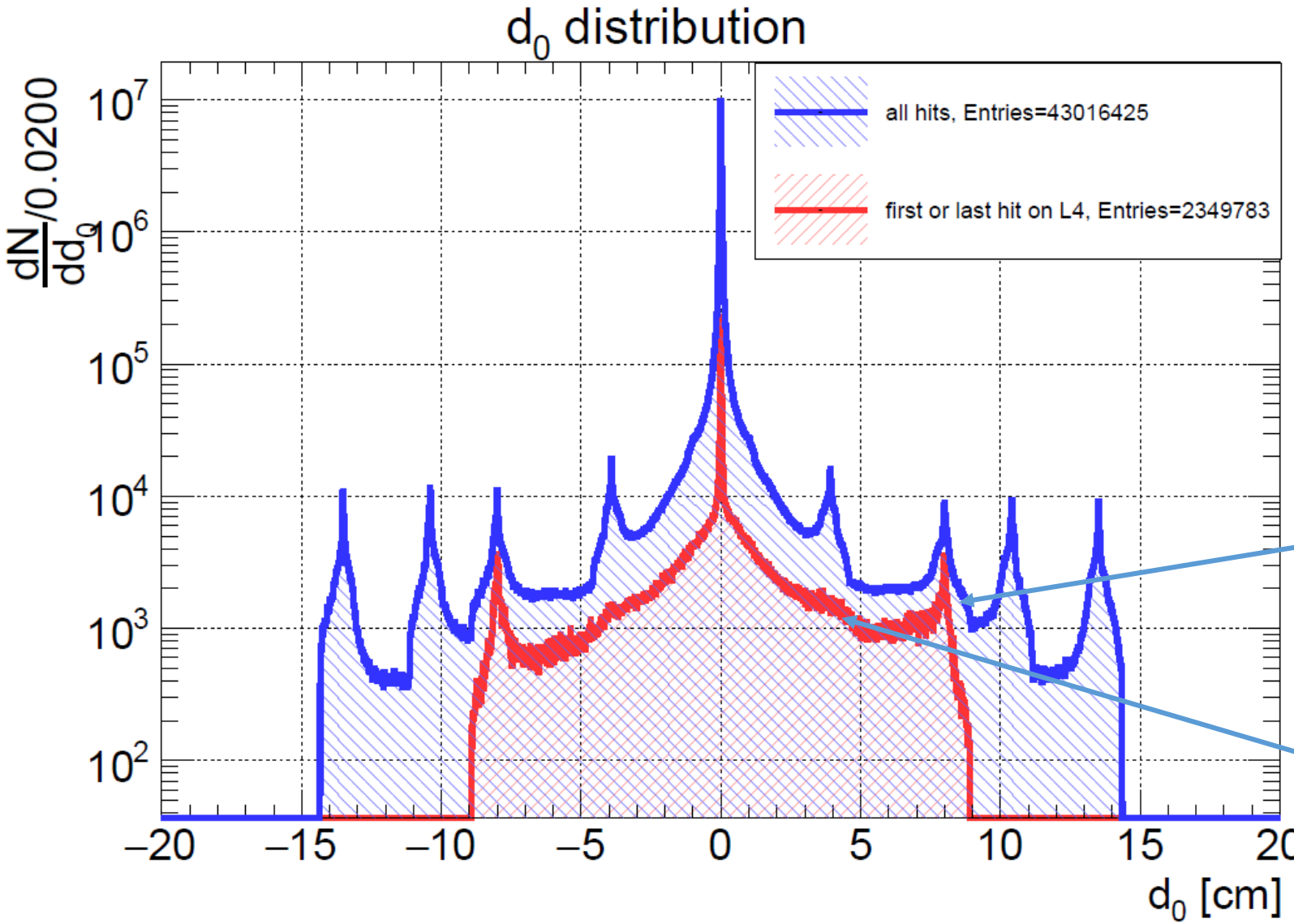
$$s \to -\frac{\sqrt{P_1^2+P_2^2}\chi}{B_3 q}$$

d0 distirbution



- Peaking structure at layers radii:
  - Last hit of primary particles (K, pi, e, mu, p) i.e. interaction with material and MC name-changing
  - First hit of secondary particles i.e. result of primary particle interaction
- In both cases d0 can result arficially high

d0 distirbution

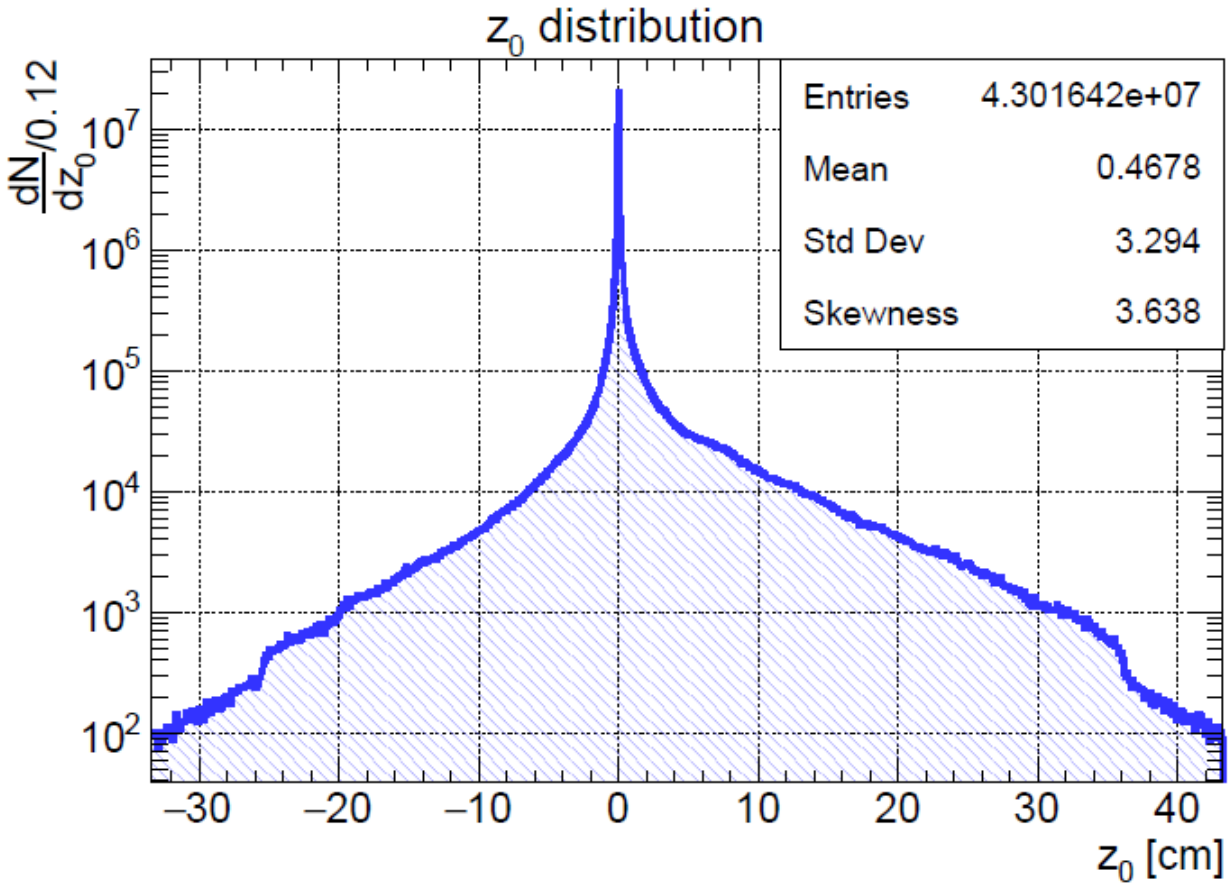


(Confirmation of precedent hypotesis)

Peak at layer 4 only

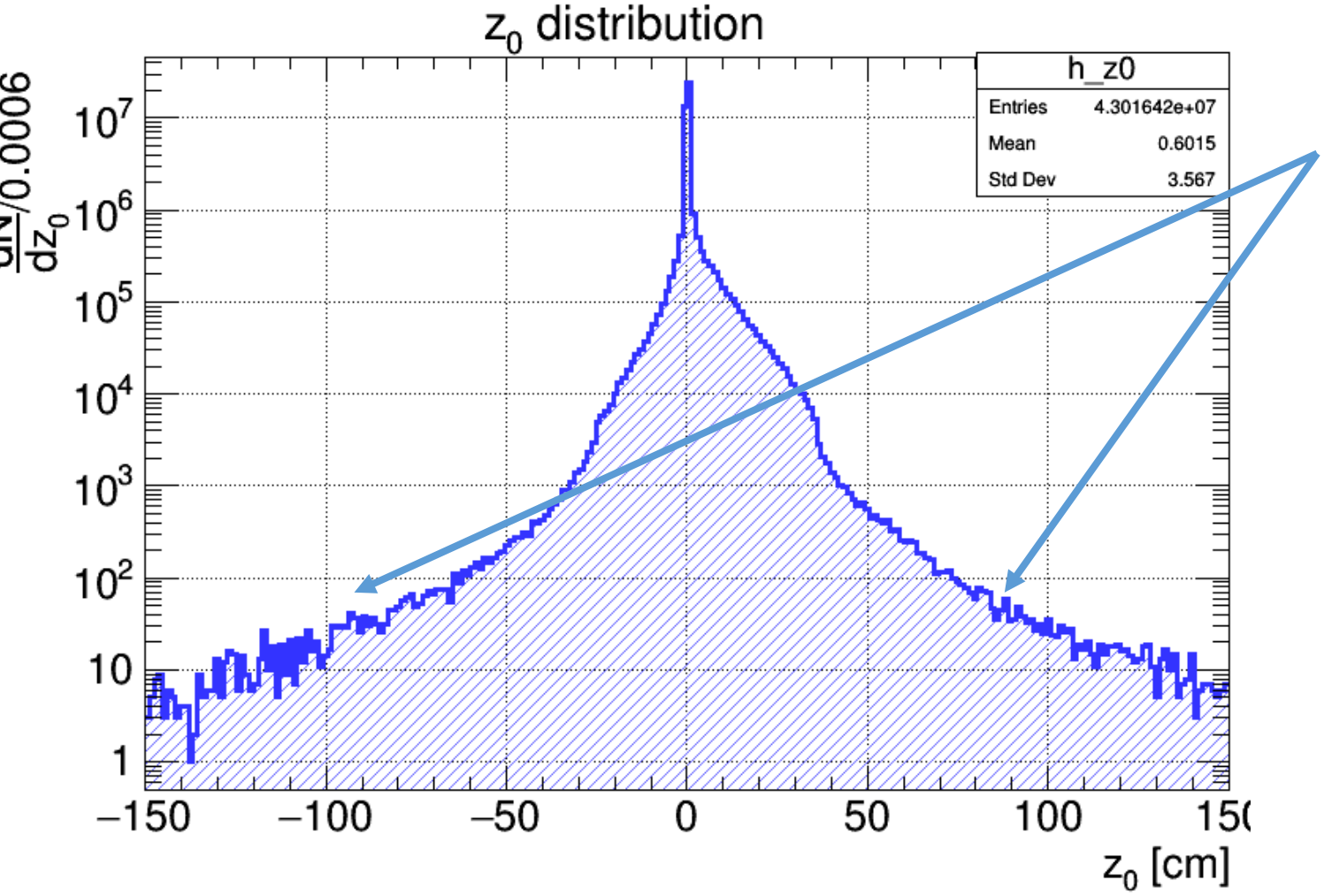
Small excess at layer 3
(MCparticle
with first hit in layer 3
and last in layer 4)

Z0 distribution



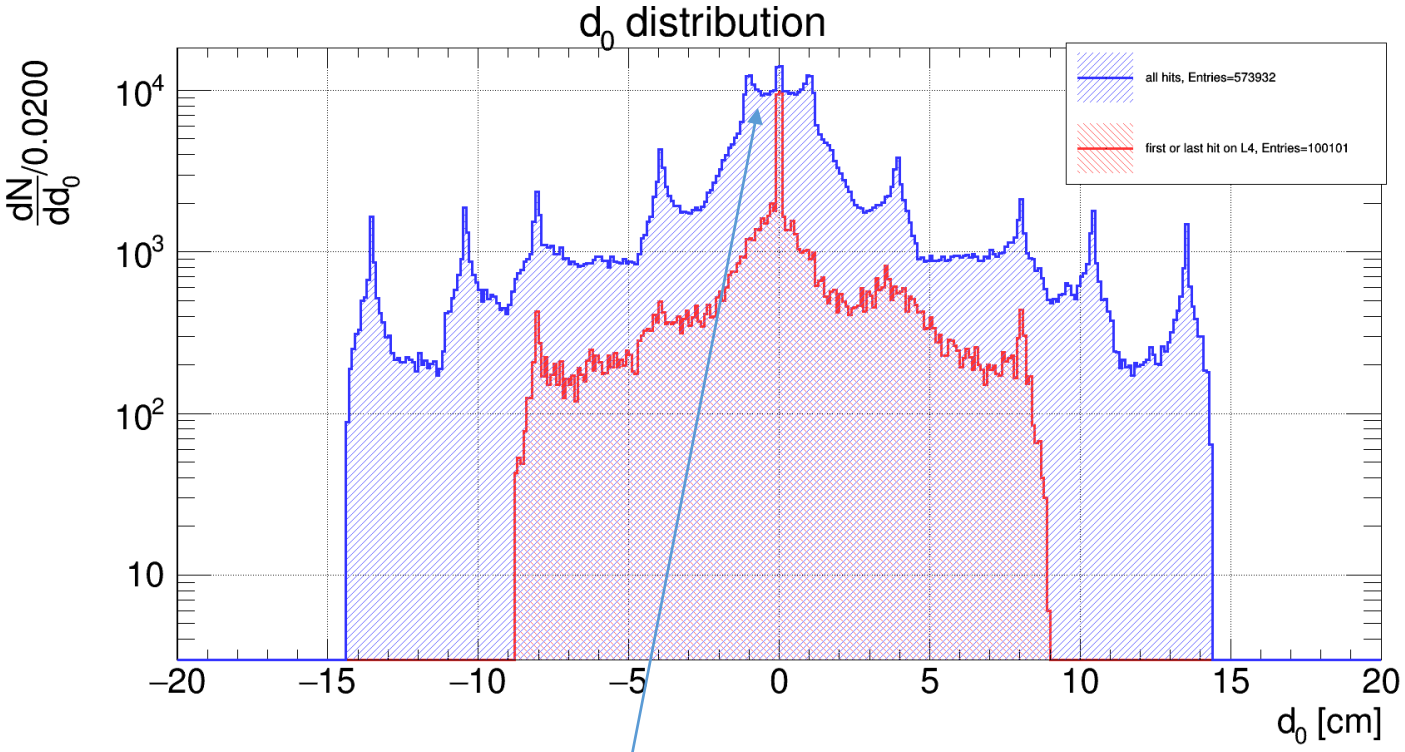
- As before, particles with last hit or first hit in layers produce high z0 value (layer material is continuos in z)
- Asymmetry coherent with CM boost + VXD geometry
- But…

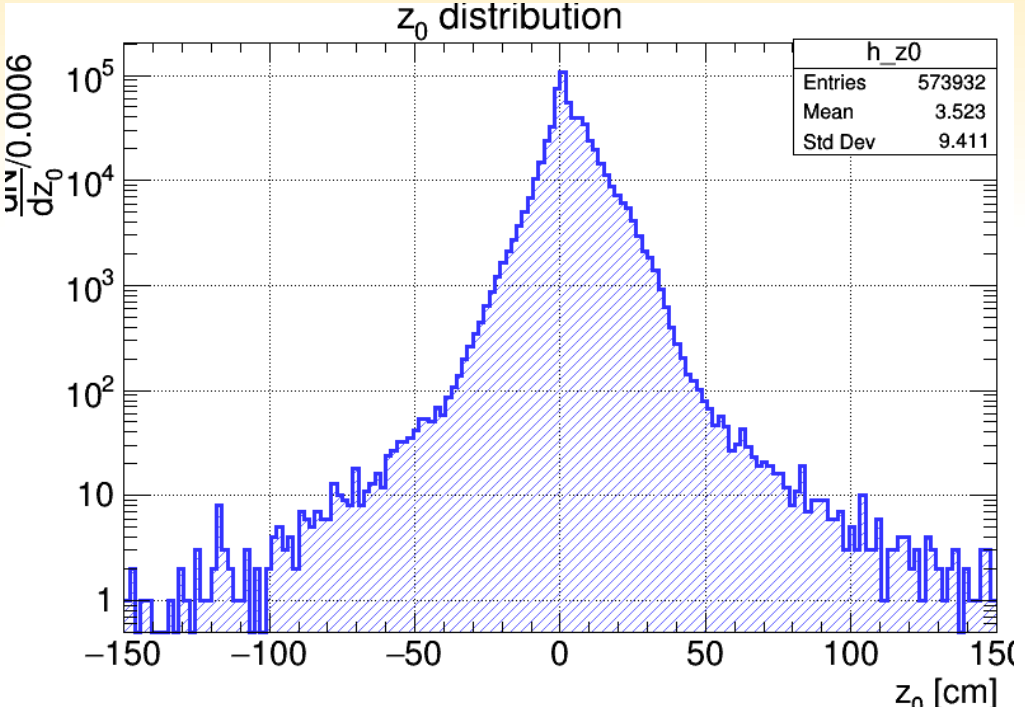
Z0 distribution

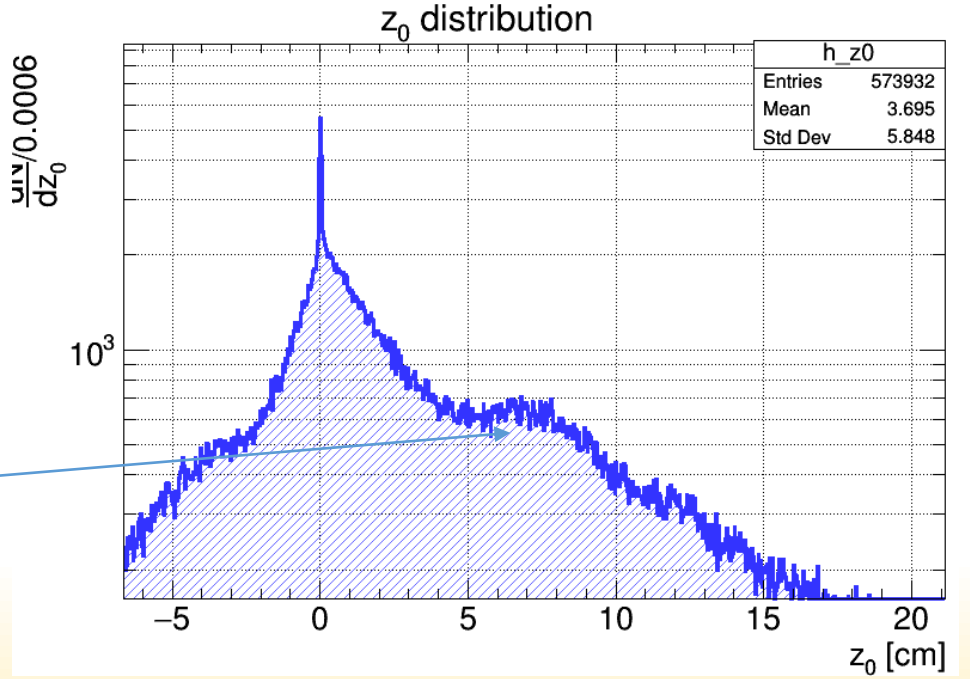


- Not reasonable long tails out of SVD volume
- Why?
- Back-scattering from outer detectors?

If **primary** is required?







With the requirement of hits from primary tracks:

- Material name-changing effects still presents
- Well visible beampipe!
- Strange Z0 forward bump

Consequences and possible solutions

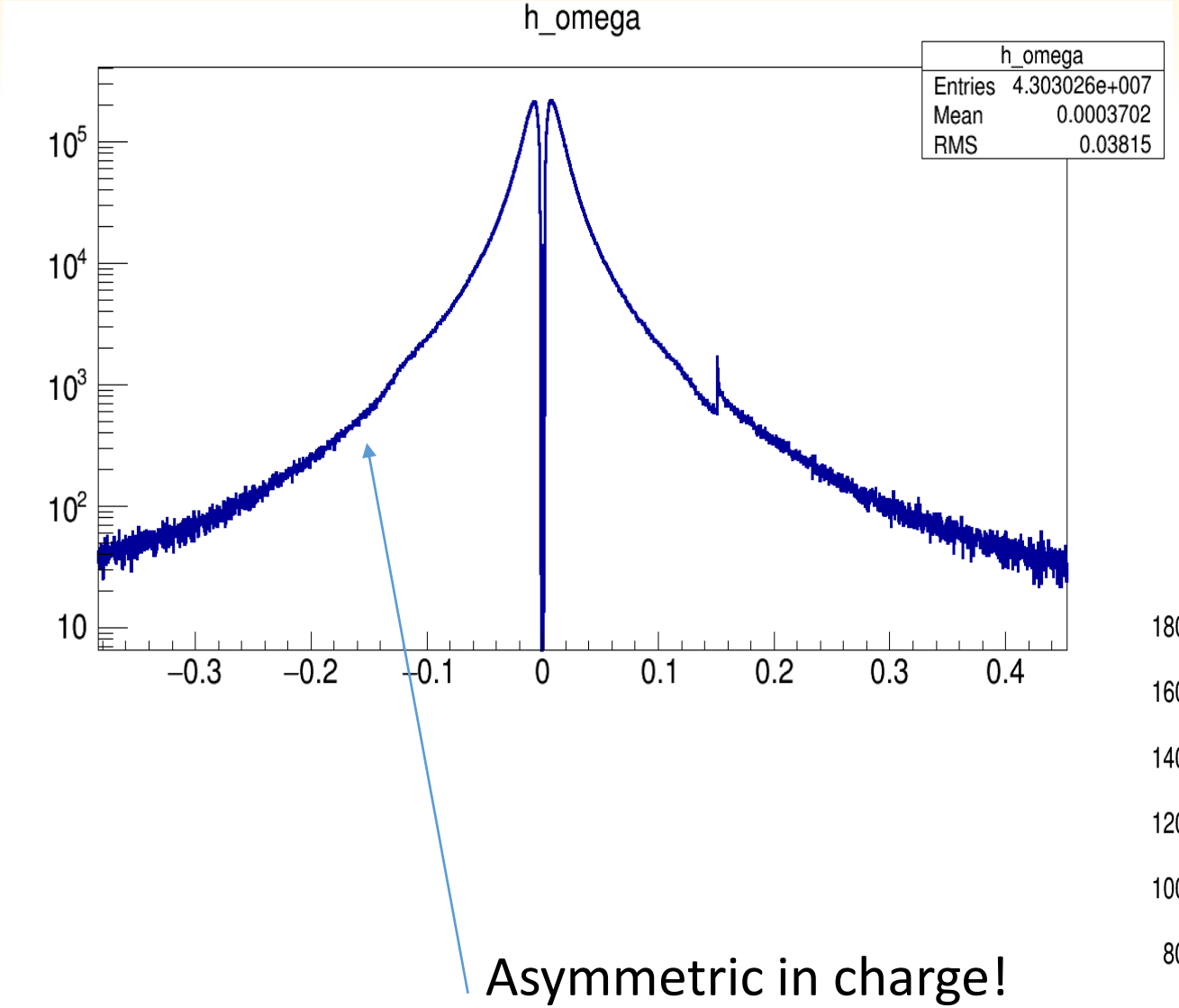
- All the methods, software tecniques and analysis that uses MC track parameters result biased by these «name changing» hits, with artificially high z0 and d0
- In my thesis main-work (training sample selection) I applied some «global cuts» on track parameter removing by hand:
  - |d0|> 1 cm
  - |z0|> 1 cm

  (1 cm has been chosen to avoid beampipe)
- My solution work but of course do not truly solve the problem. The best way would be to implement a tool to link two MC particles that correspond to the same actual particle (despite material interaction).
- For instance: «for each interaction if PDGID of outgoing particle is the same of the ingoing one rename it»

Feature 2

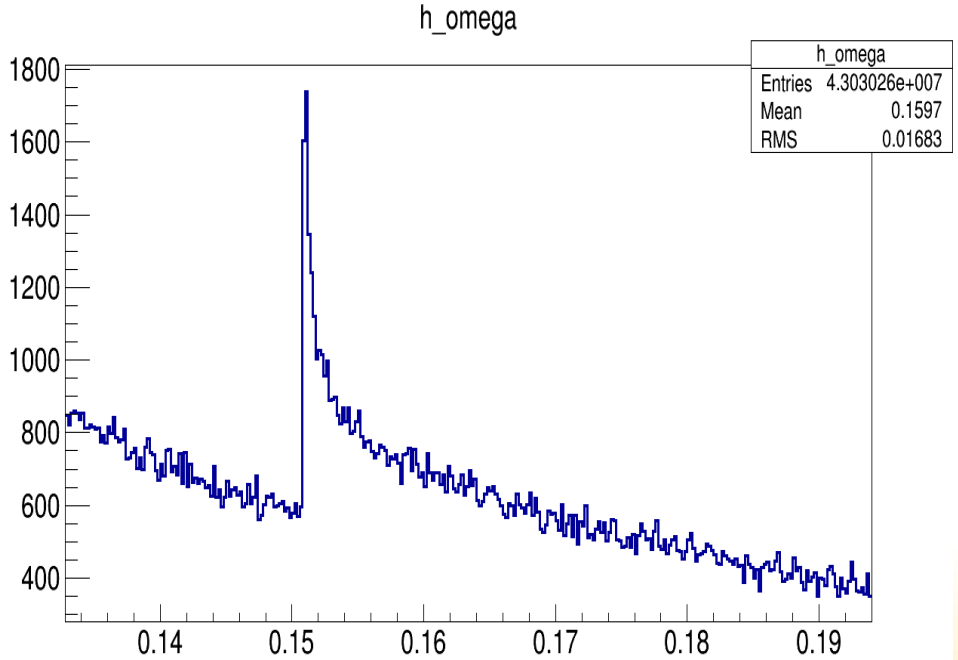
(peak discover in ω distribution *accidentally)*

Anomalous peak in ω distirbution



Asymmetric in charge!

- ω = 0.15 so R=6.6 cm (or p_t=30 MeV)
- Minimum radius to reach L6 (half of L6 radious), but over expected a dip not a peak!
- Produced by all long-lived particles (pi,K,p,mu,e) from PDGID MC-matched
- Produced in all SVD layers
- Used MCParticle status to understand it

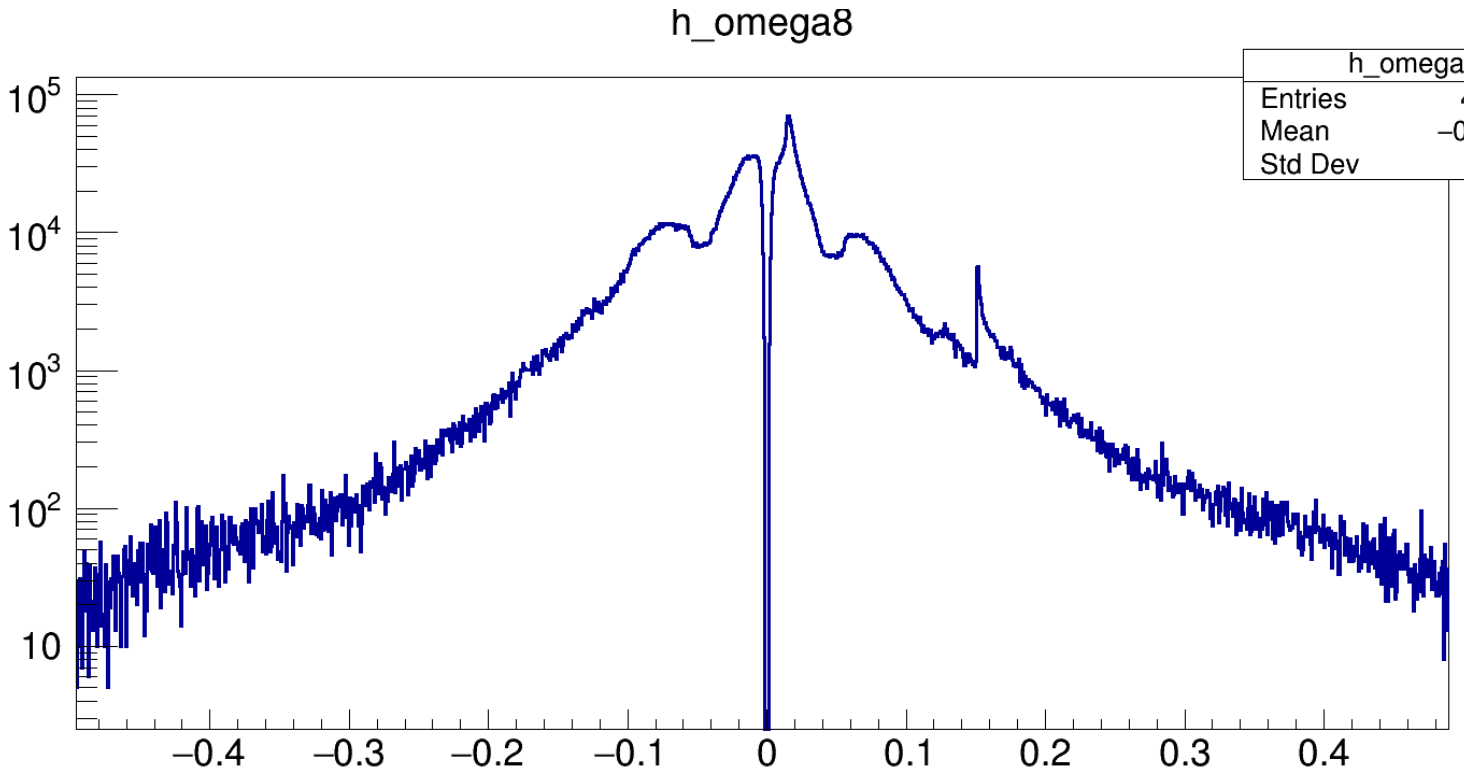


MCParticle-Status Reminder

- bit 0: Particle is primary particle. For example, All the particles from the generator.
- bit 1: Particle is stable, i.e., not decaying in the generator.
- bit 2: Particle left the detector (the simulation volume).
- bit 3: Particle was stopped in the detector (the simulation volume).
- bit 4: Particle is virtual and not going to Geant4. Exchange boson, off-shell, unknown to Geant4, etc.
- bit 5: Particle is initial such as e+ or e- and not going to Geant4
- bit 6: Particle is from initial state radiation
- bit 7: Particle is from finial state radiation
- bit 8: Particle is an radiative photon from PHOTOS

  * All particles which come from the generator are flagged as primary.
  * All particles created by Geant4 are flagged as secondary

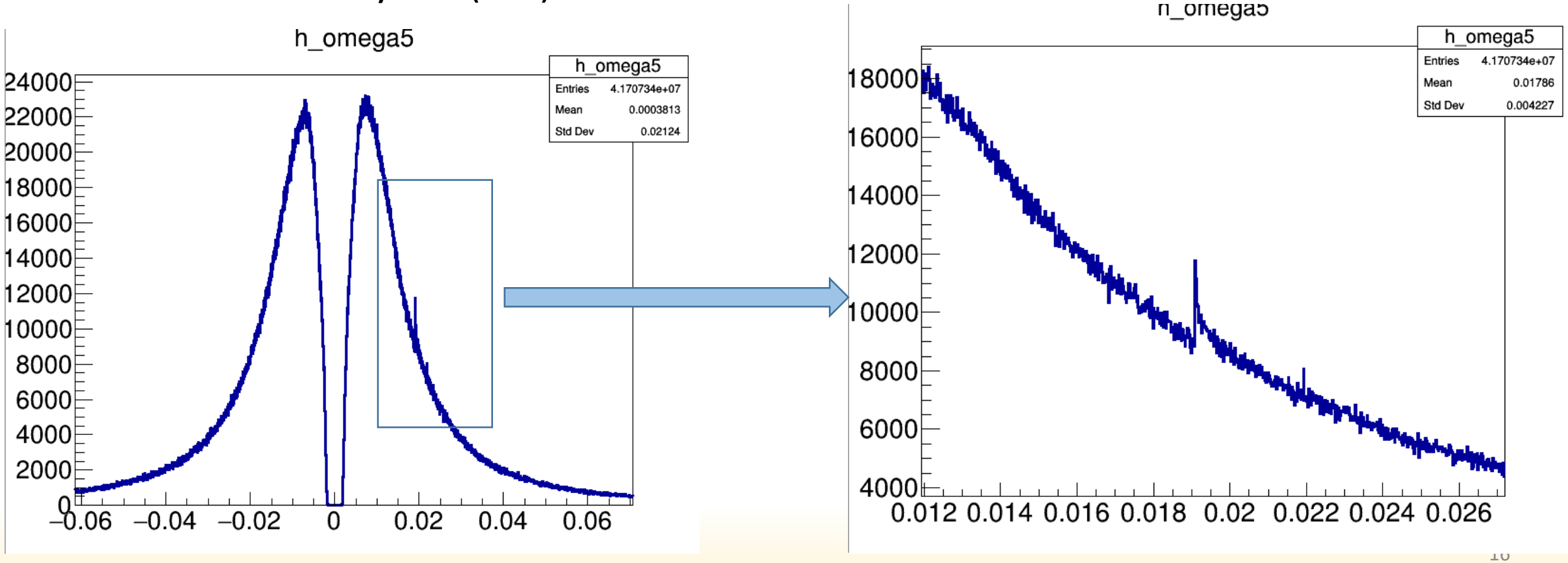
MCParticle-Status analysis



- Peak remain only for status 8 (radiative photon from PHOTOS)
- It makes no sense:
  - the PDGID of these hits result different (p,pi,mu,e,K)
  - the charge=0 has been removed by hand
- Radiative photon are assigned to mother MCparticle?

MCParticle-Status analysis

- Status: 0,1,2,3 (primary, stable, left detector, stopped) has reasonable shape
- Another peak appear for status 4,5,6,7, at ω = 0.19 so R=5.26 cm, minimum radius to reach layer 5 (???)



Conclusions

- Physical origin of these these peaks?
- Idea about PHOTOS photon assignment?
- Bug in the MCParticle status?