# dRICh Hits Readout in Fun4all

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dRICh Meeting
16 June 2021

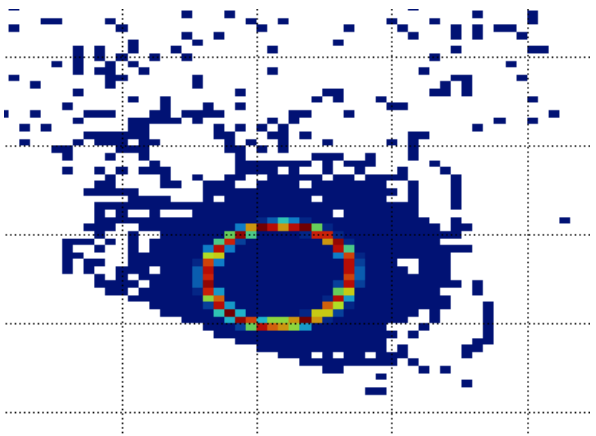
# Aerogel Radiator Fix

```
281         scaledN[i] = nn;
282 -       scaledA[i] = aeroA[i] * rho/density; // approx. larger the density, smaller the abs. length
283 -       scaledS[i] = aeroS[i] * rho/density; // approx. larger the density, smaller the abs. length
284
```

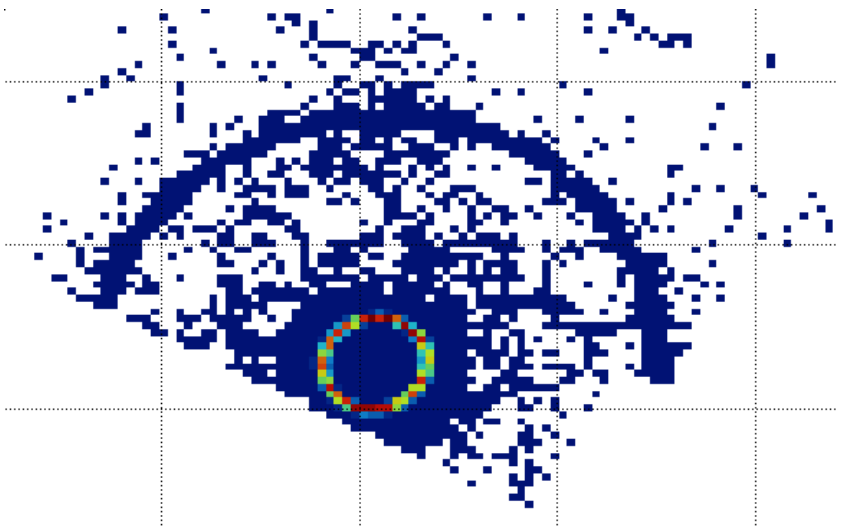
```
281         scaledN[i] = nn;
282 +       scaledA[i] = aeroA[i] * (rho*g/cm3)/density; // approx. larger the density, smaller the abs. length
283 +       scaledS[i] = aeroS[i] * (rho*g/cm3)/density; // approx. larger the density, smaller the abs. length
284
```

Bug fix from Evaristo → now both gas and aerogel have Cherenkov radiation

**Before**



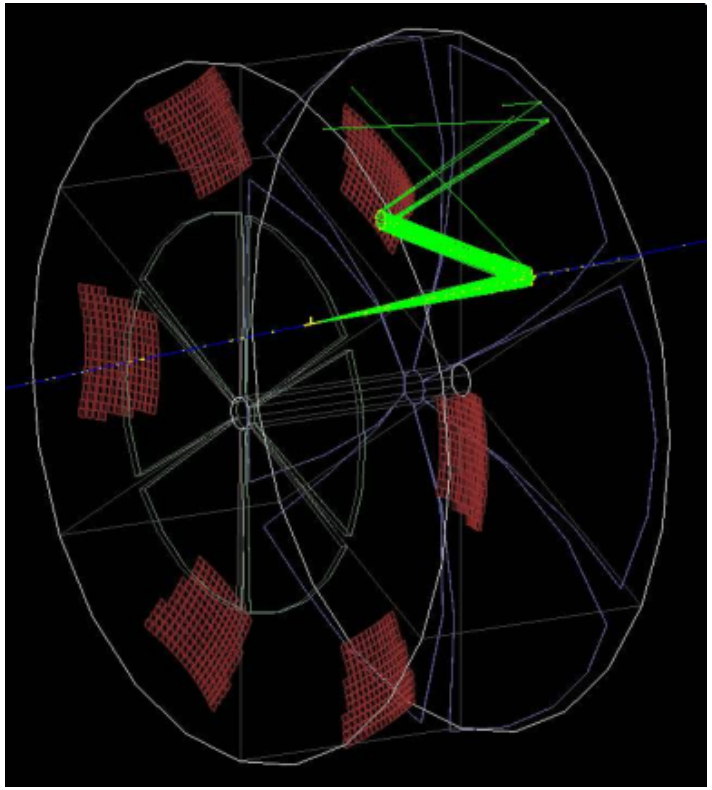
**After**



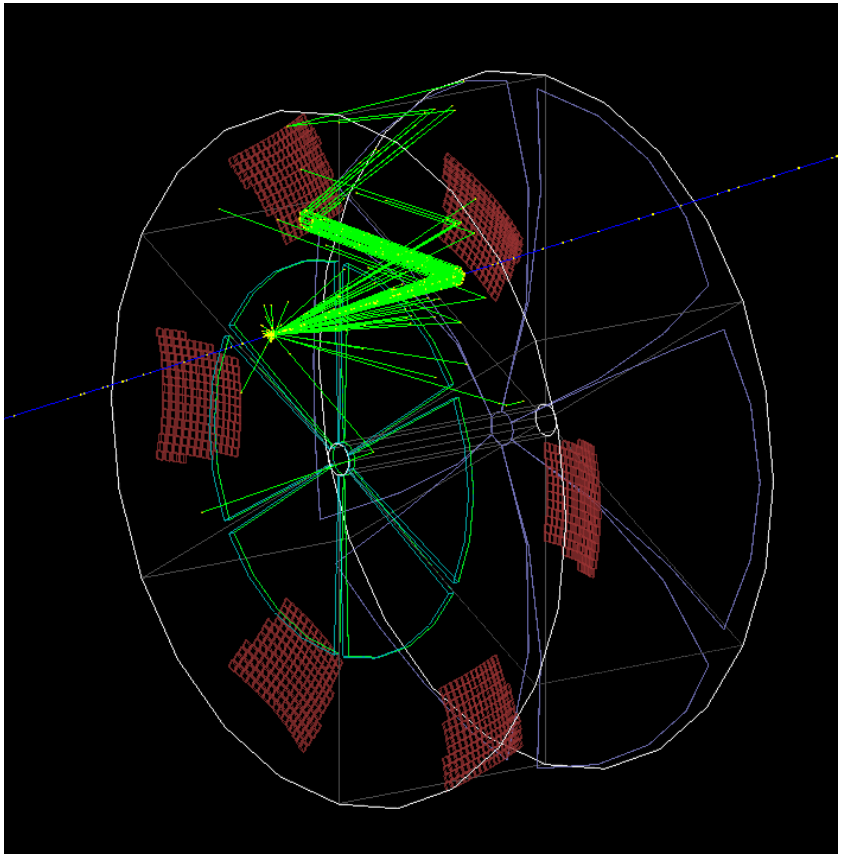
(1000 $\pi^+$s with same momentum)

# Radiator Fix

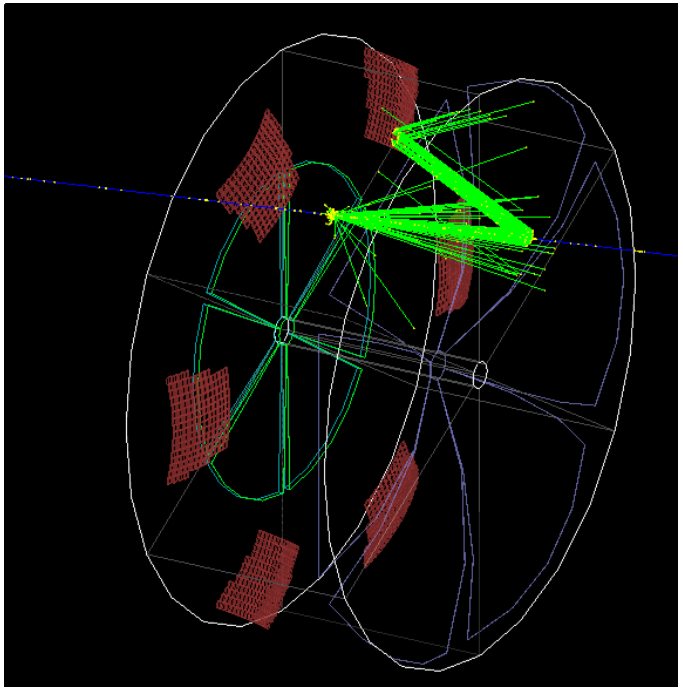
## Before Radiator Fix



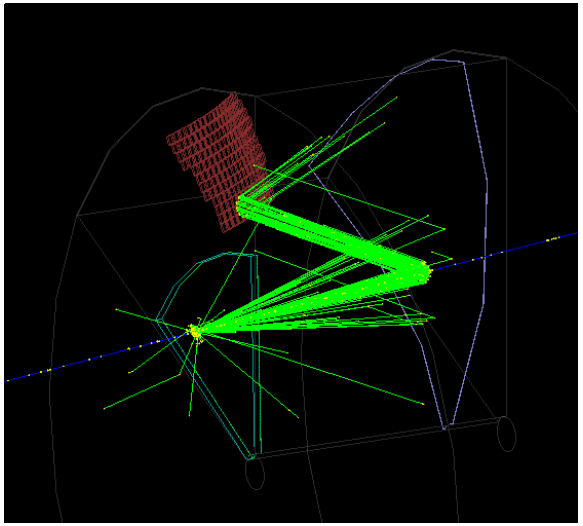
## After Radiator Fix

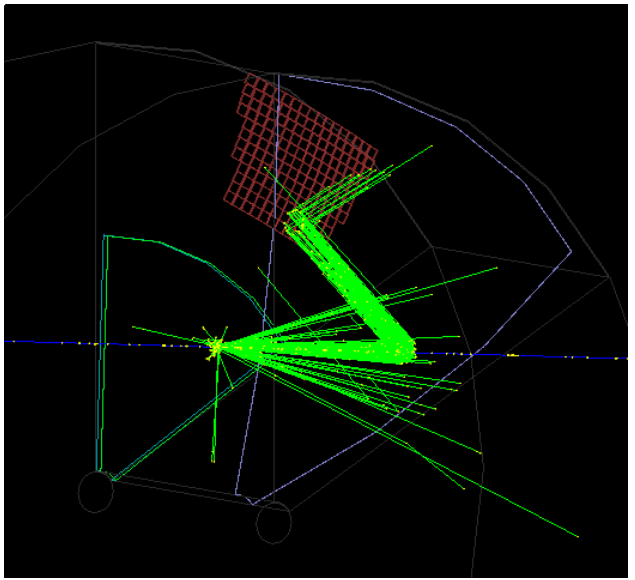


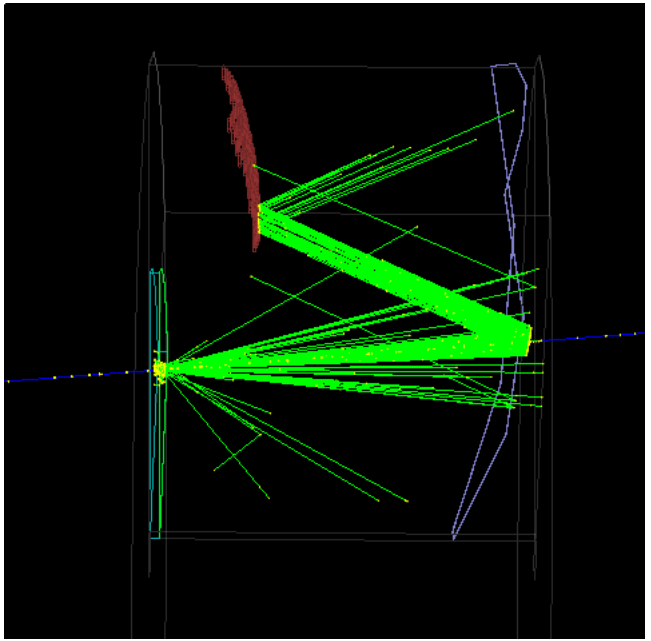
# More Pictures



view from behind

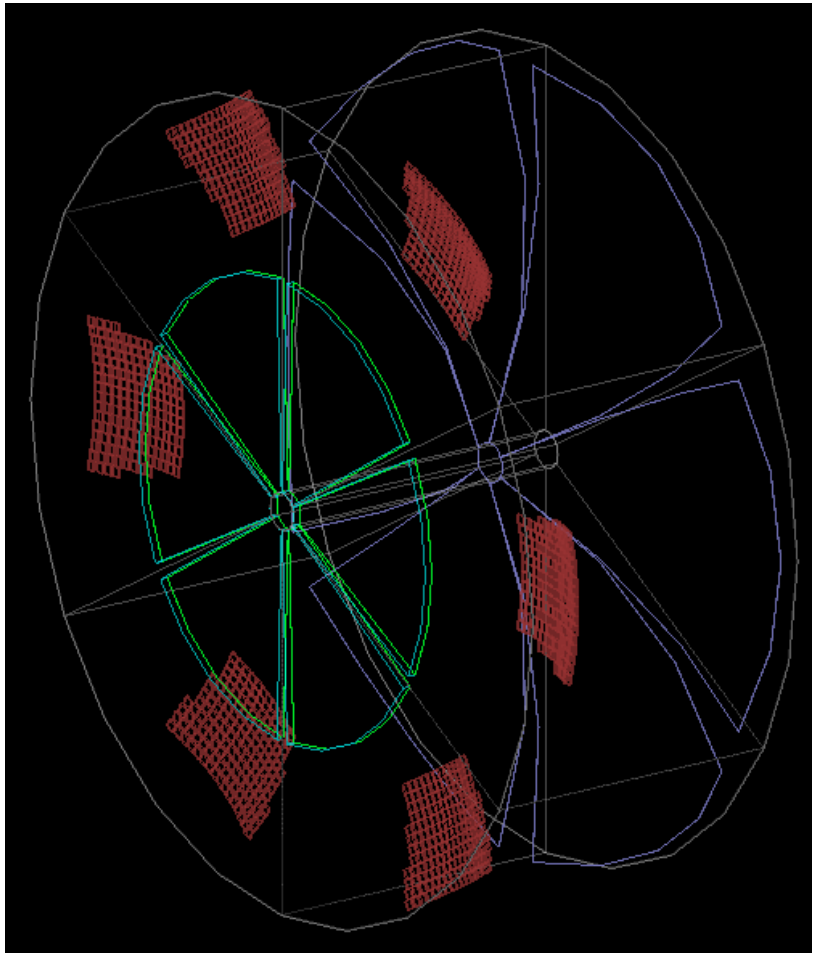


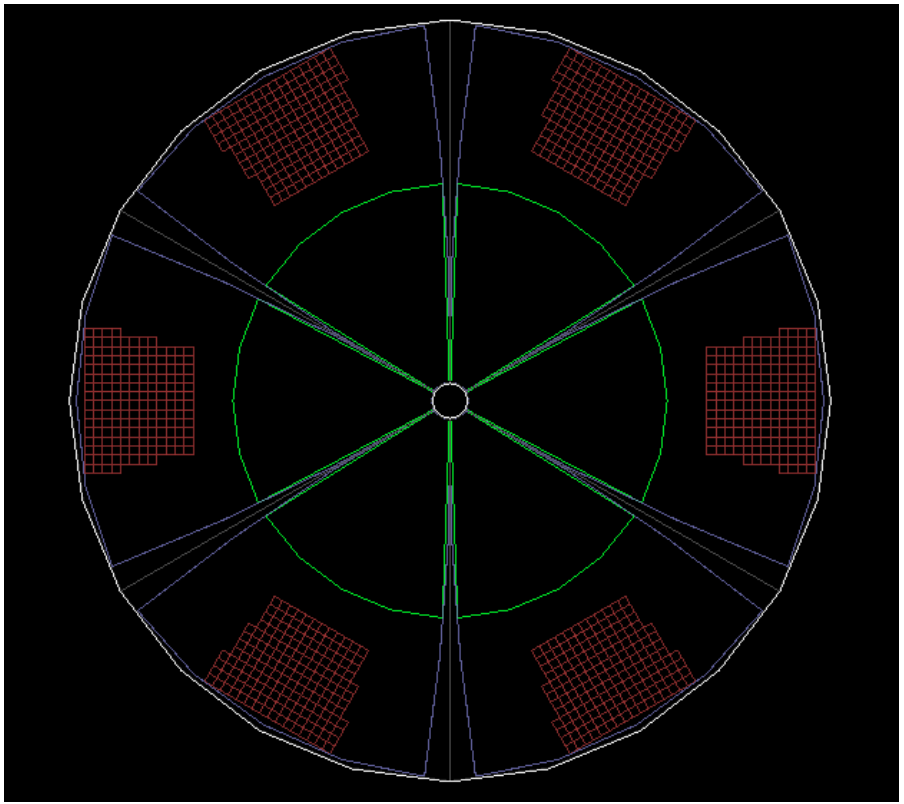




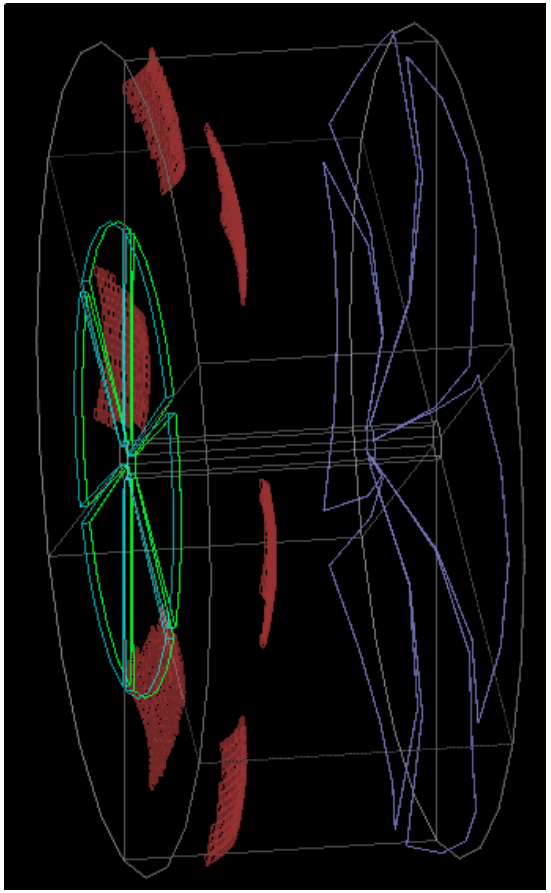
single petal views

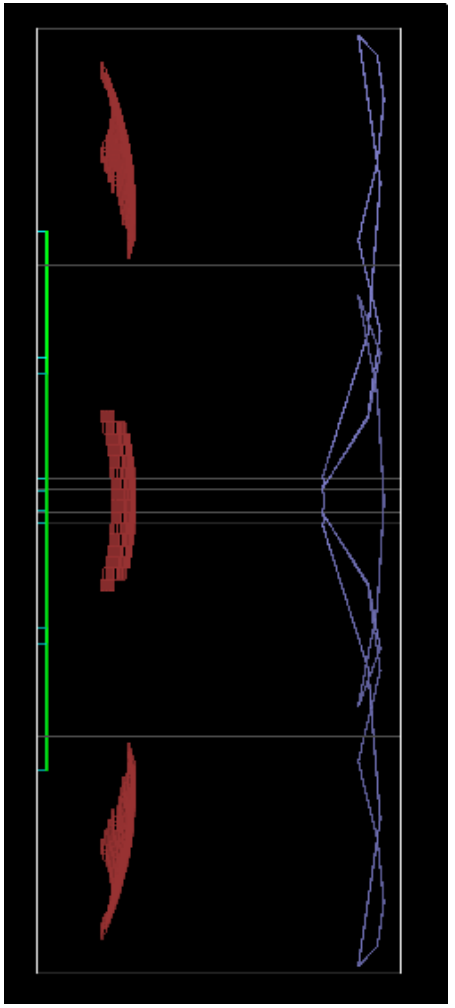
# Geometry Pictures





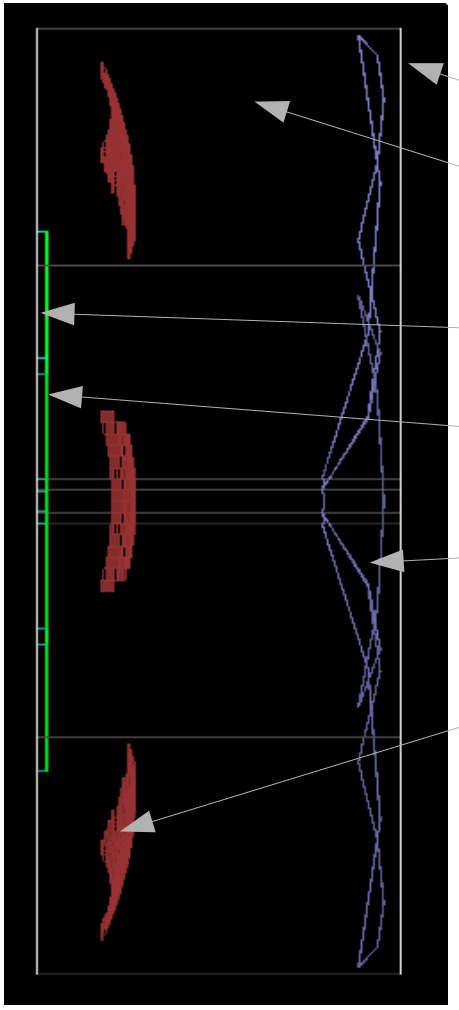
# Geometry Pictures





# Geometry Notes

## Volume Hierarchy



Vessel (white) – Aluminum volume

Petal (grey) [x6] – Gas volume

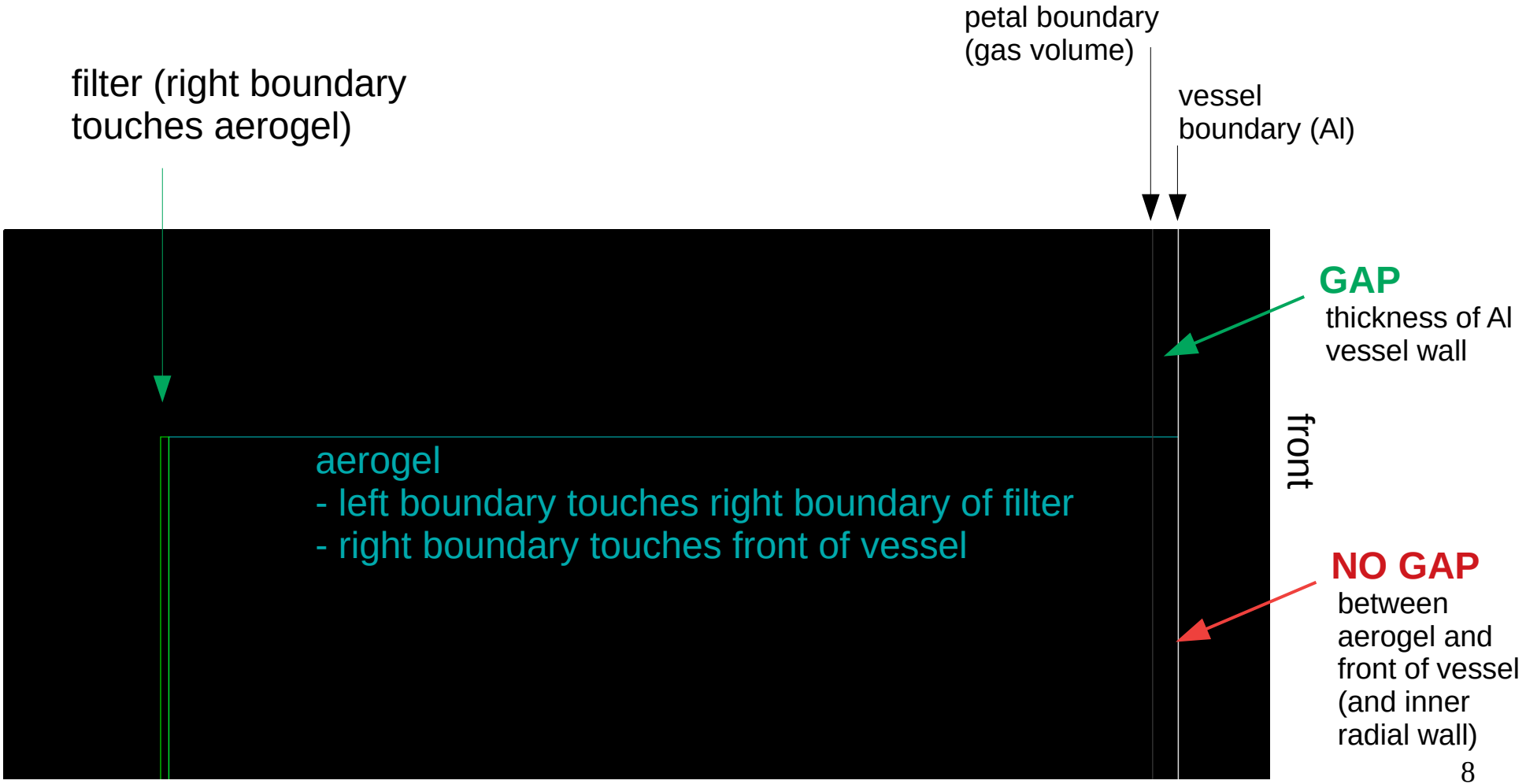
Aerogel (blue)

Filter (green)

Spherical Mirror (purple)

Photosensors (PSST) (red)

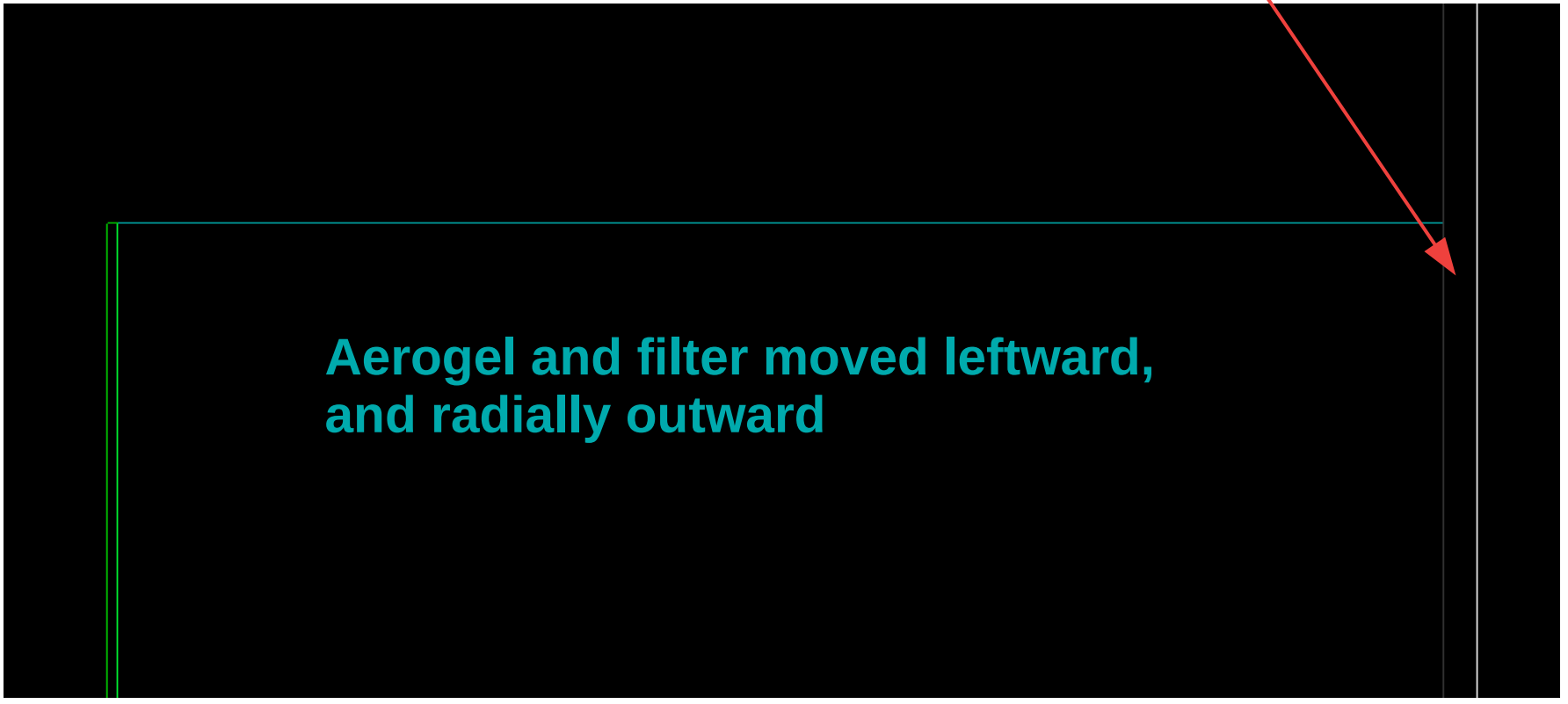
# Geometry Bug Fix



# Geometry Bug Fix

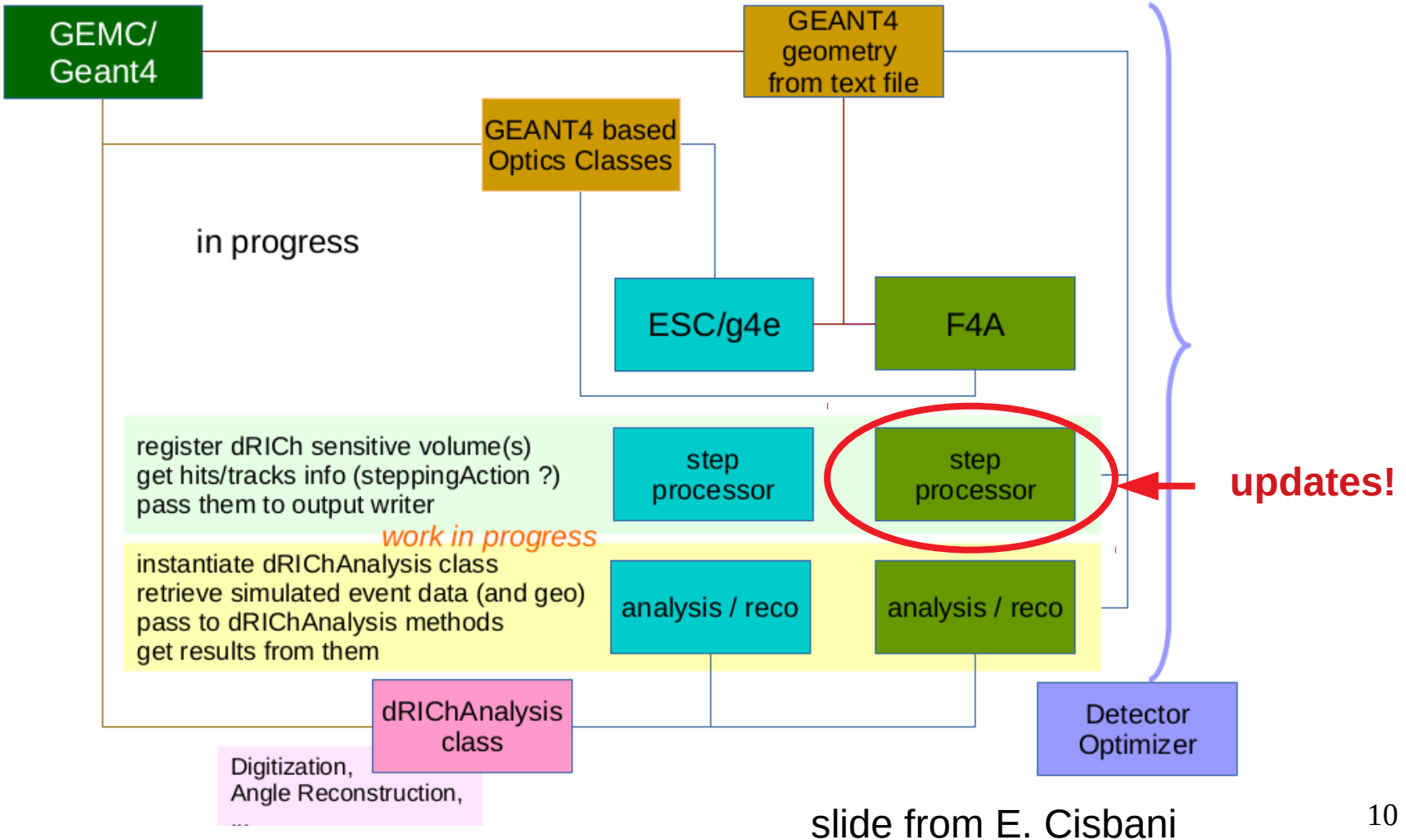
**After fix**

Nonzero vessel wall thickness on both entrance/exit walls (and radial walls)



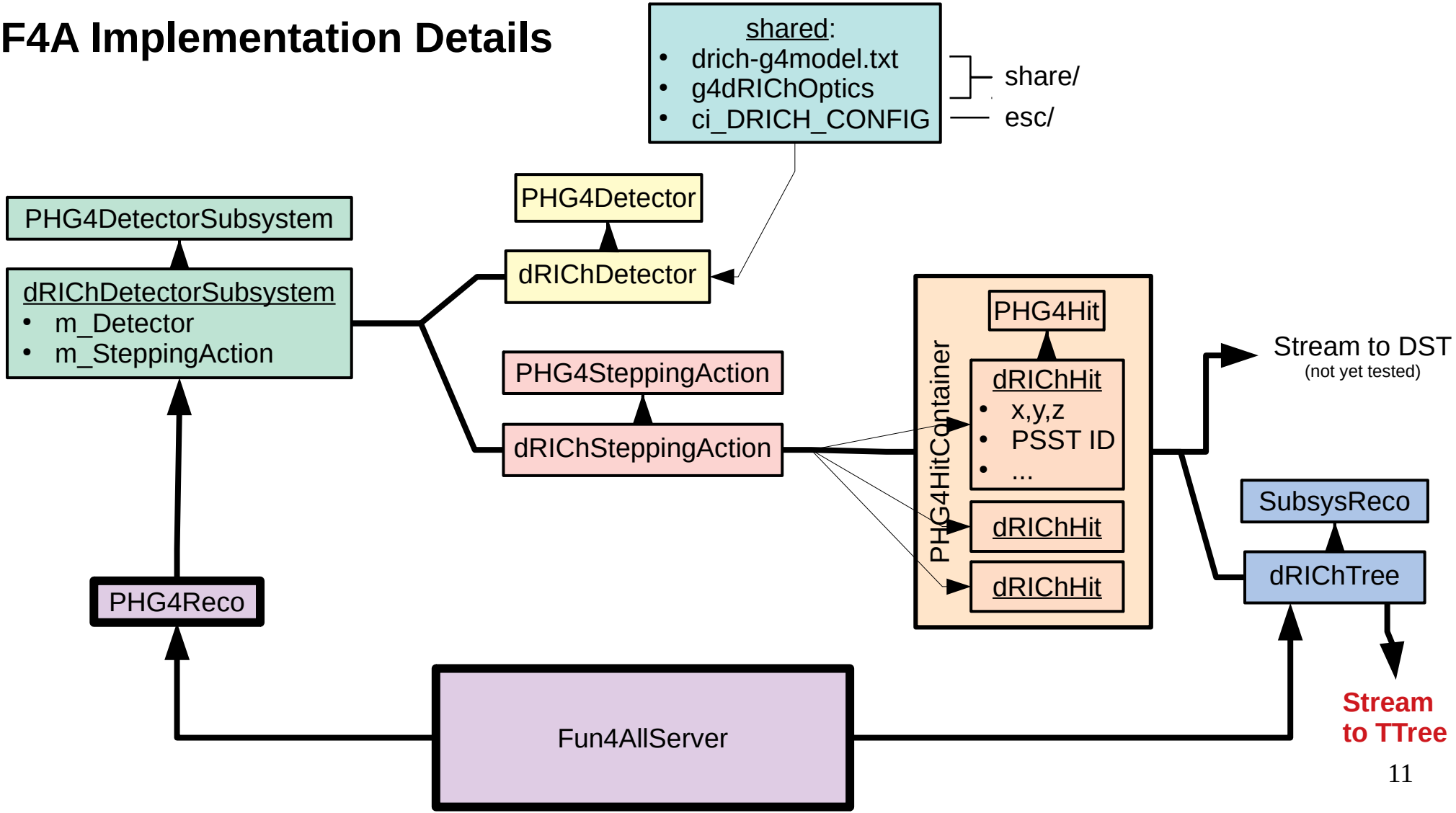
# Software Map

## Overall




slide from E. Cisbani

# F4A Implementation Details

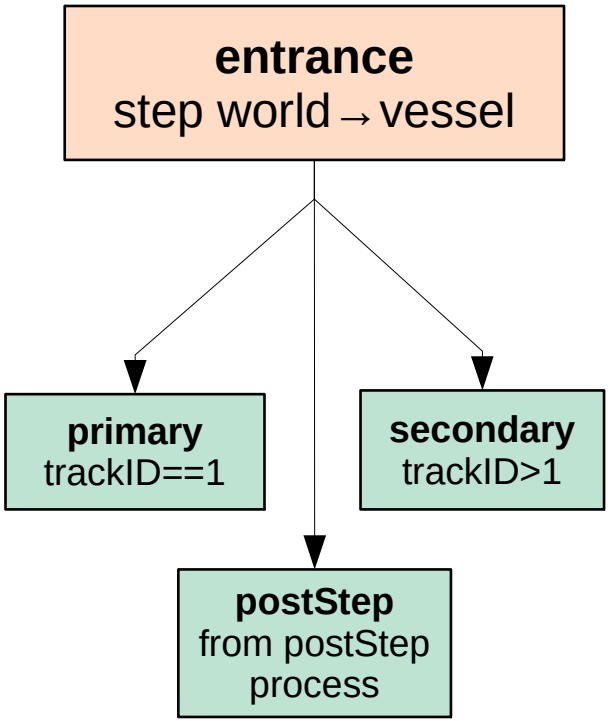


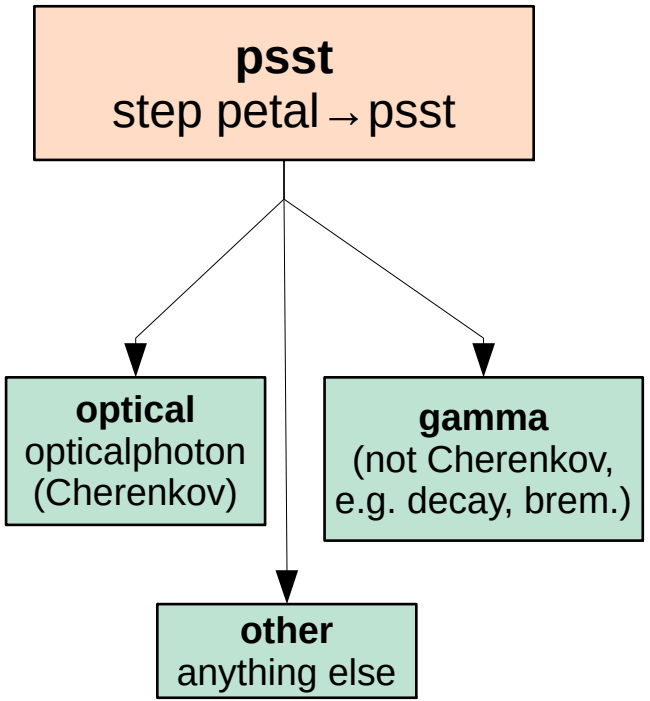
## TTree Branches

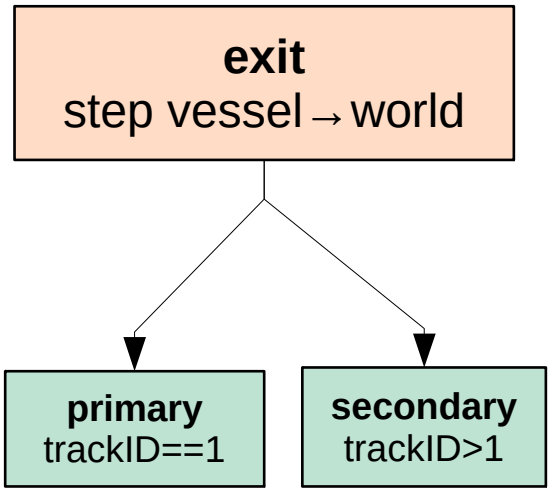
- indices
  - **evnum** – event number
  - **trackID** – unique ID for the track
  - **parentID** – trackID of the parent particle
- hit classification
  - **hitType** – string classifying the hit type
  - **hitSubtype** – further hit type classification
- unique ID for photosensor
  - **petal** – which petal the hit is in
  - **psst** – which photosensor (from copy number)
- particle type and production process
  - **pdg** – PDG encoding
  - **particleName** – string for particle name
  - **process** – physics process that produced the particle
- kinematics
  - **hitPos[3]** – hit position [x,y,z] (cm)
  - **hitP[3]** – hit momentum [px,py,pz] (GeV)
  - **hitPdir[3]** – hit momentum direction [x,y,z]
  - **hitVtxPos[3]** – vertex position [x,y,z] (cm)
  - **hitVtxPdir[3]** – vertex momentum direction [x,y,z]
- integrated values
  - **deltaT** – global time difference (ns)
  - **edep** – energy deposition (GeV)

## Hits Classification

**`hitType`**



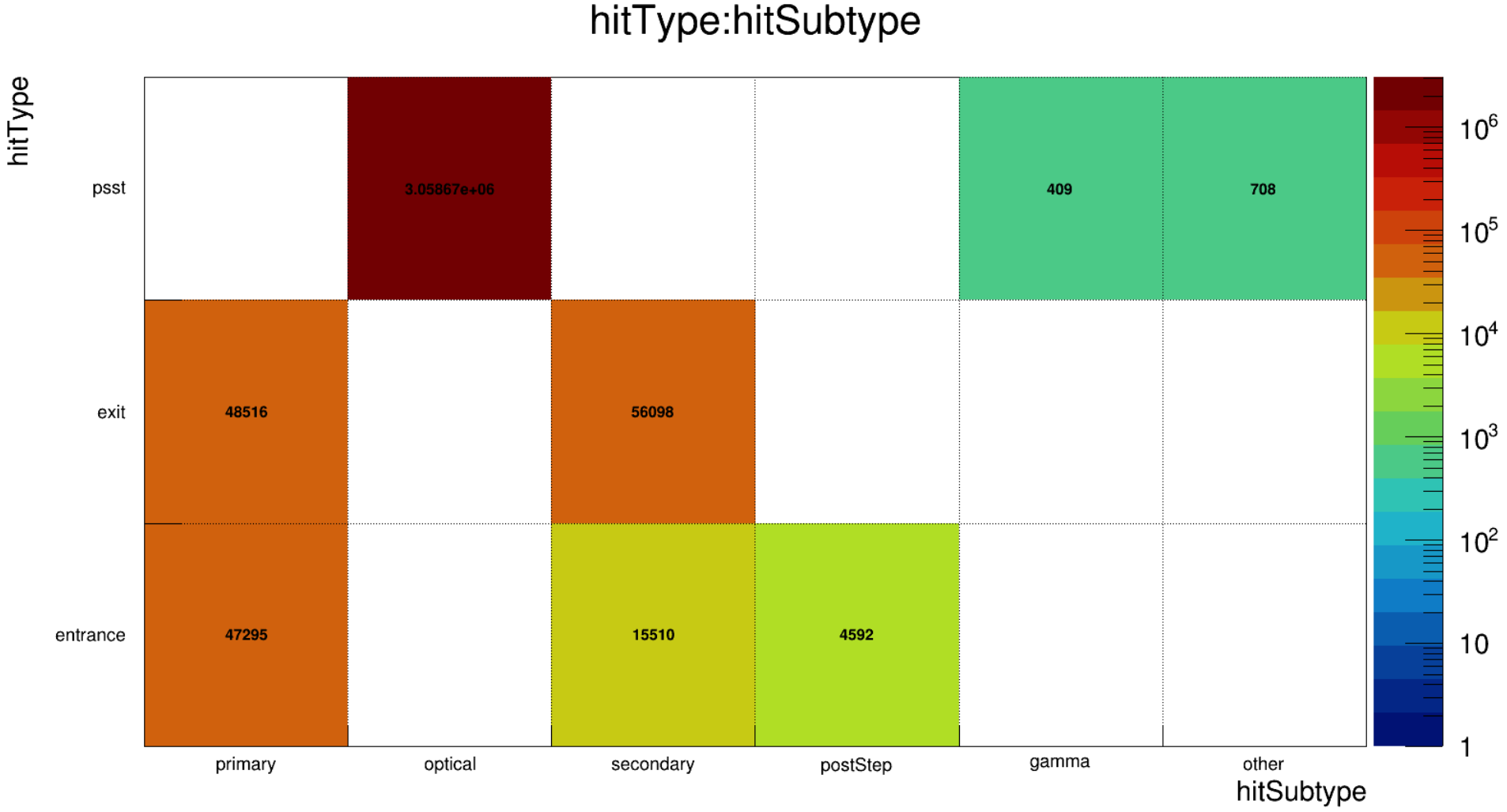

**`hitSubtype`**

# Simulation for Hits Readout Testing

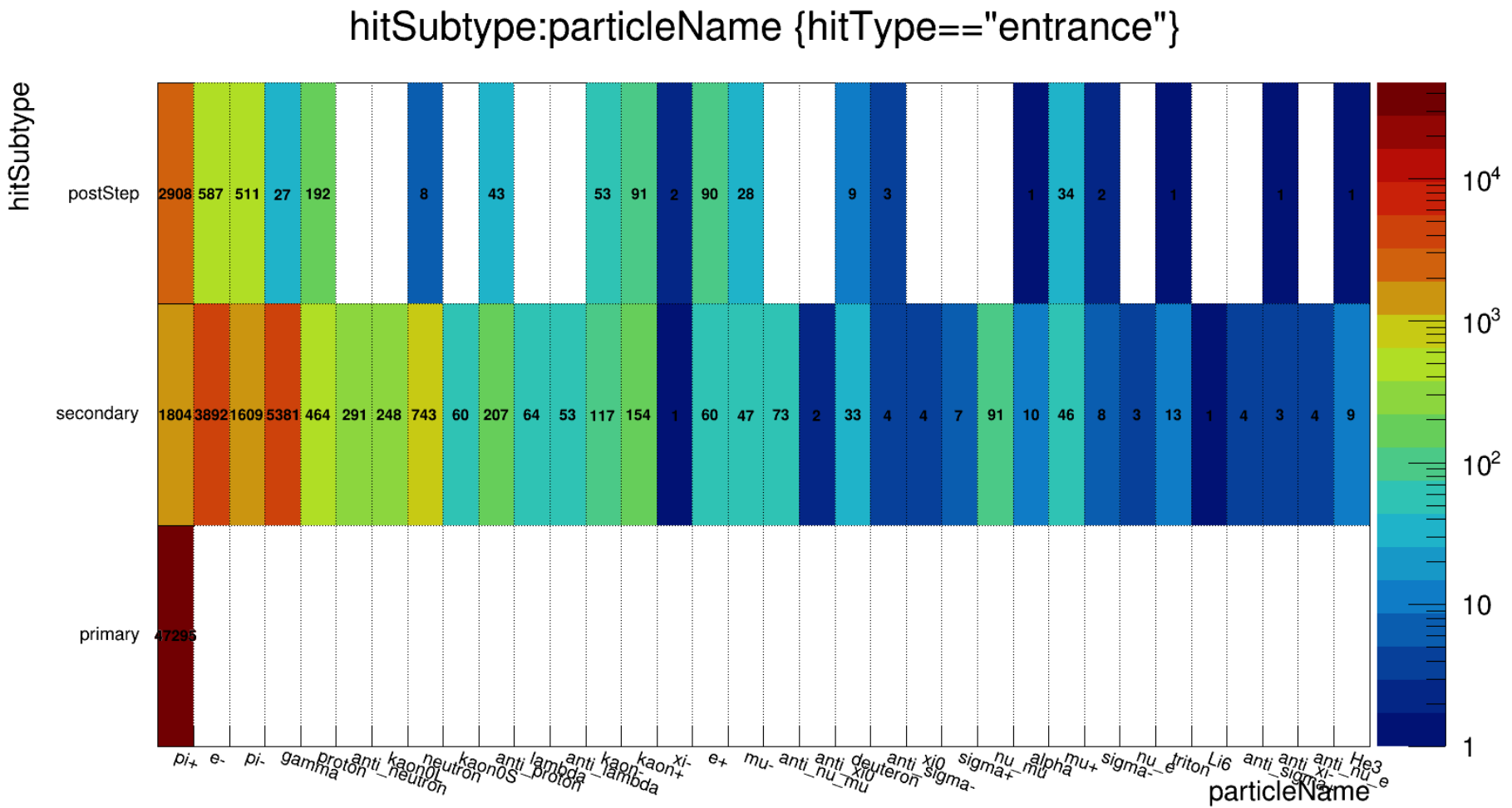
## Simulation test: throw 50k $\pi^+$s at the dRICh

- each pion thrown with the same momentum and direction, to accumulate statistics for a single type of event
- different things happen in each event, but in general we get 2 rings of Cherenkov photons on the photosensors
- some pions interact with the world volume prior to hitting the dRICh, causing secondary hits

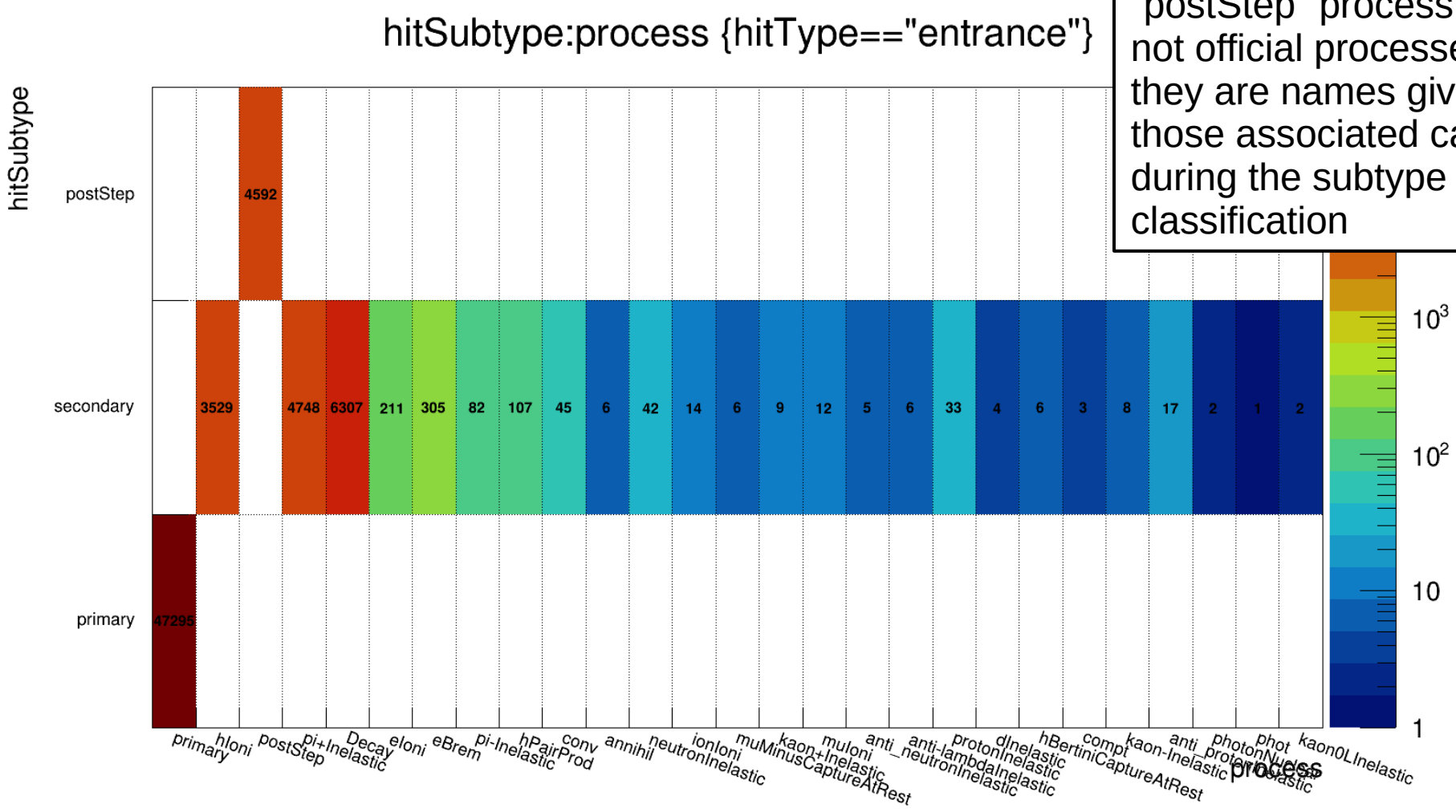
```
// particle gun: shoot particle in specified direction
PHG4ParticleGun *gun = new PHG4ParticleGun();
gun->set_name("pi+");
gun->set_vtx(0, 0, -1*m);
gun->set_mom(0.07*GeV, 0.07*GeV, 1*GeV);
f4a->registerSubsystem(gun);
```


hitType:hitSubtype
hitType
psst
exit
entrance
3.05867e+06
409
708
48516
56098
47295
15510
4592
primary
optical
secondary
postStep
gamma
other
hitSubtype
$10^6$
$10^5$
$10^4$
$10^3$
$10^2$
10
1

# Entrance hits: sub-type vs. particle

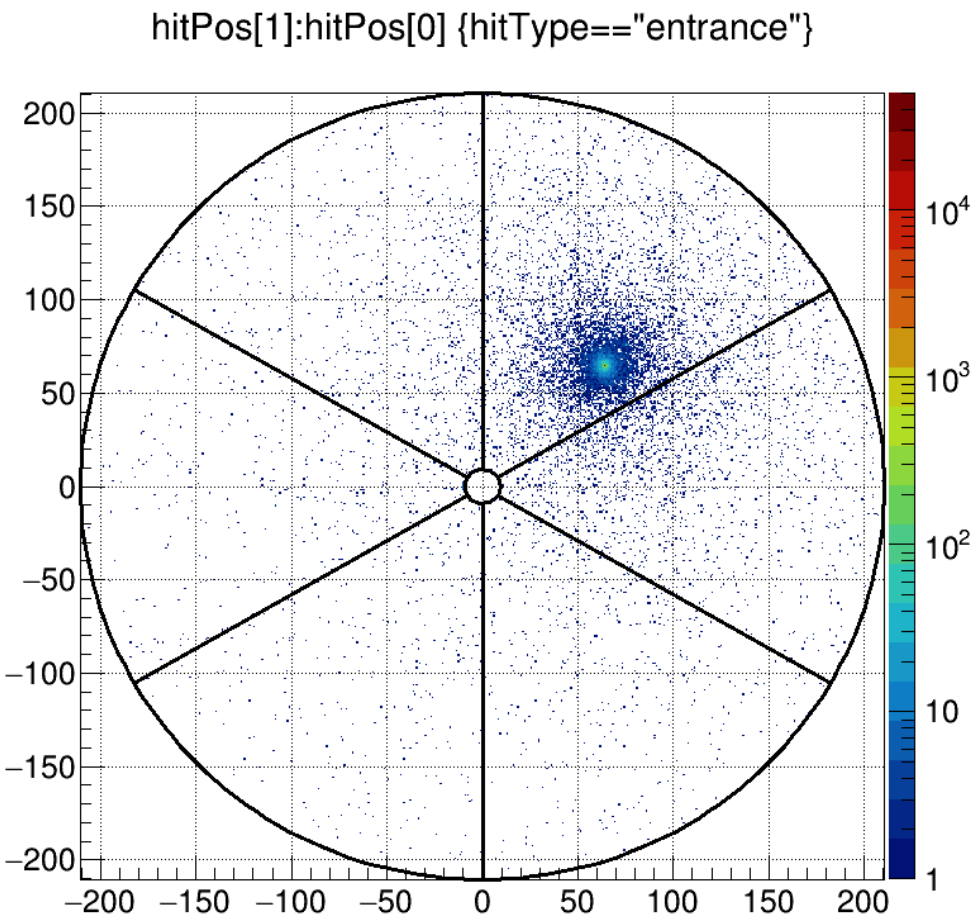


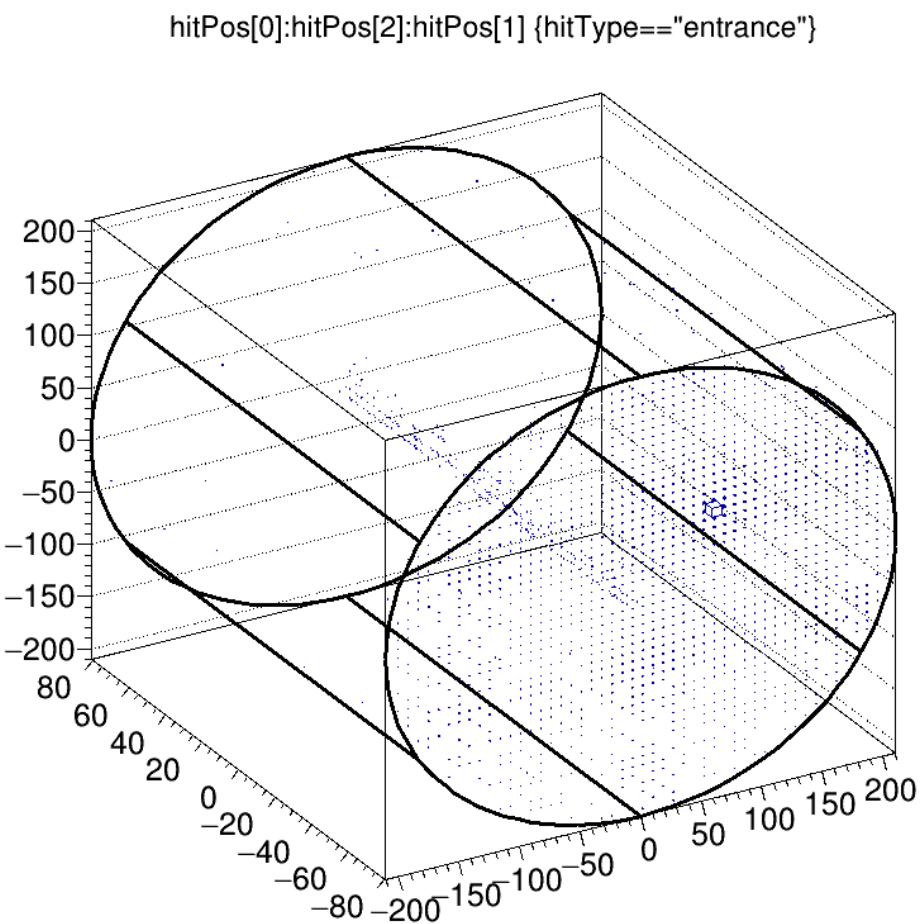
# Entrance hits: sub-type vs. process




Note: “primary” and “postStep” process are not official processes; they are names given to those associated cases during the subtype classification

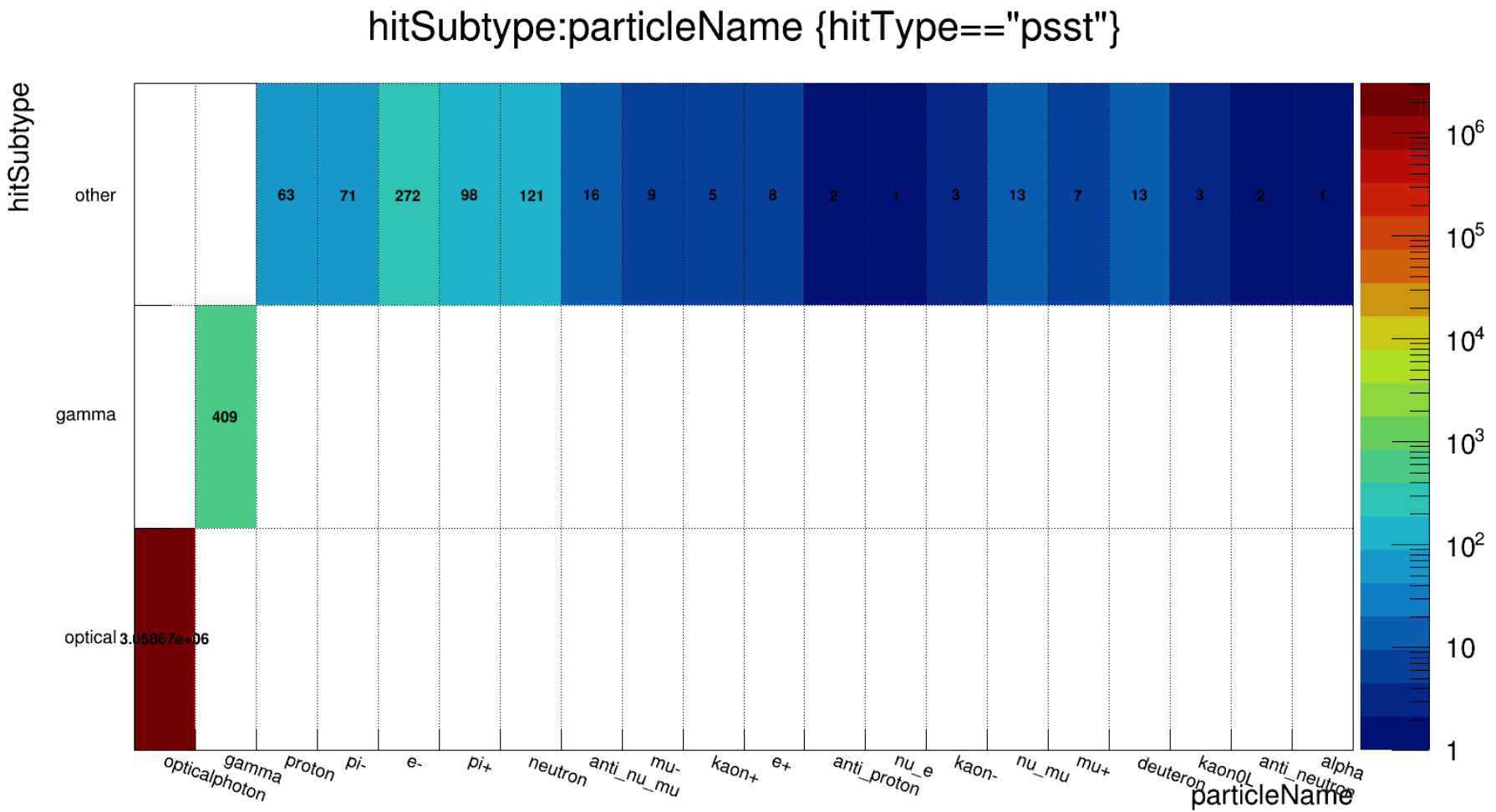
# Entrance hit positions



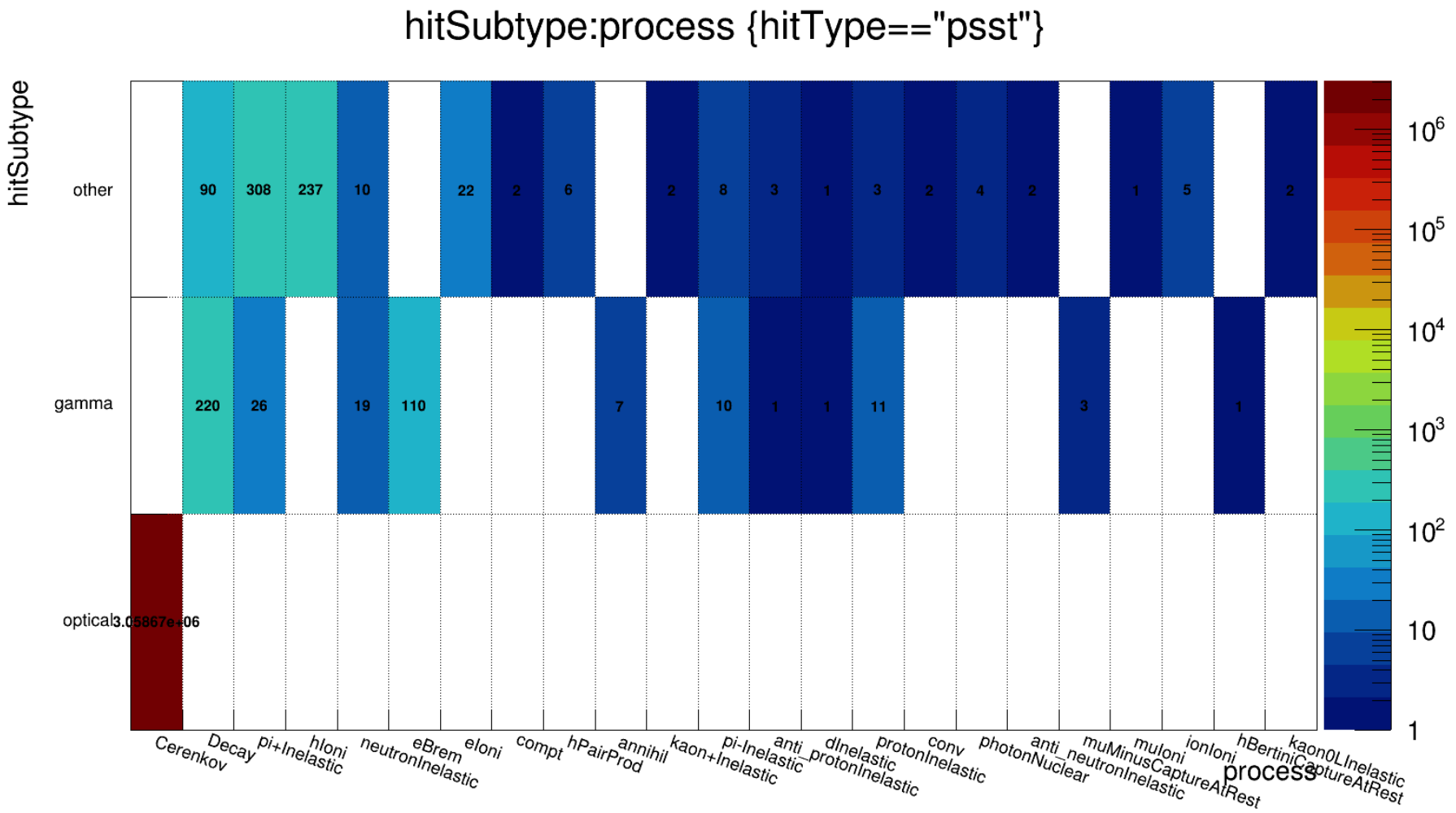




**shown with vessel geometry outline**

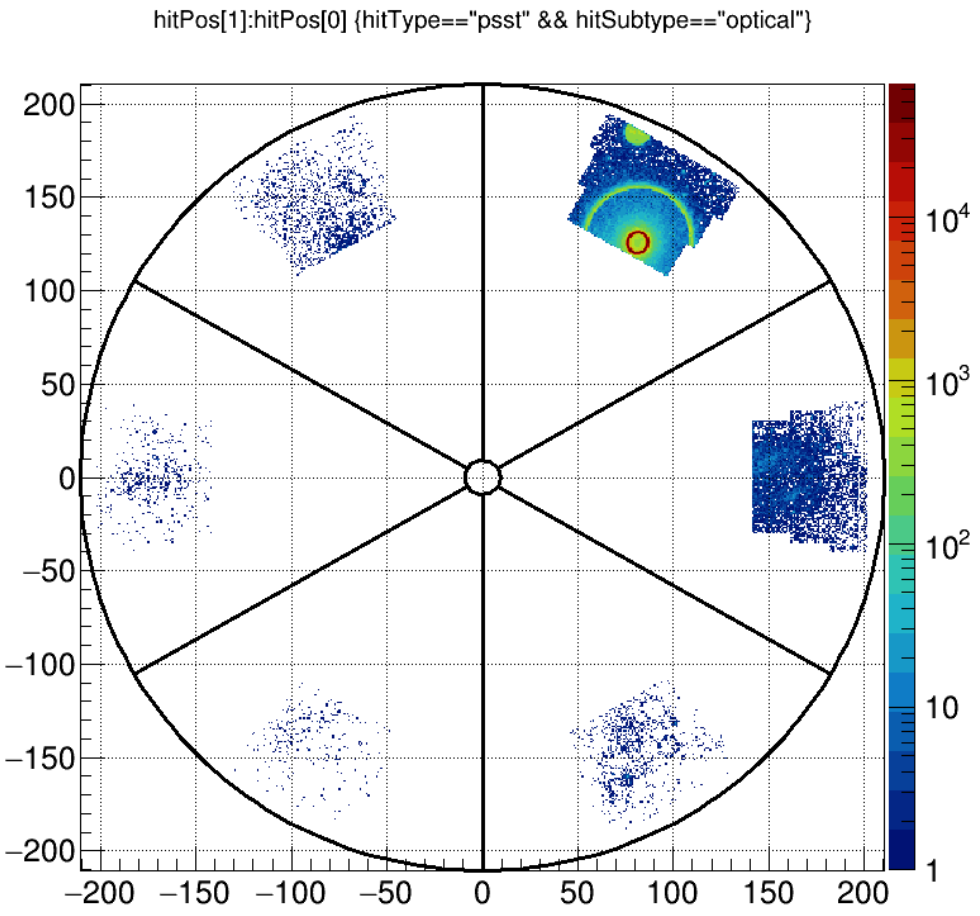
# Photosensor hits: sub-type vs. particle



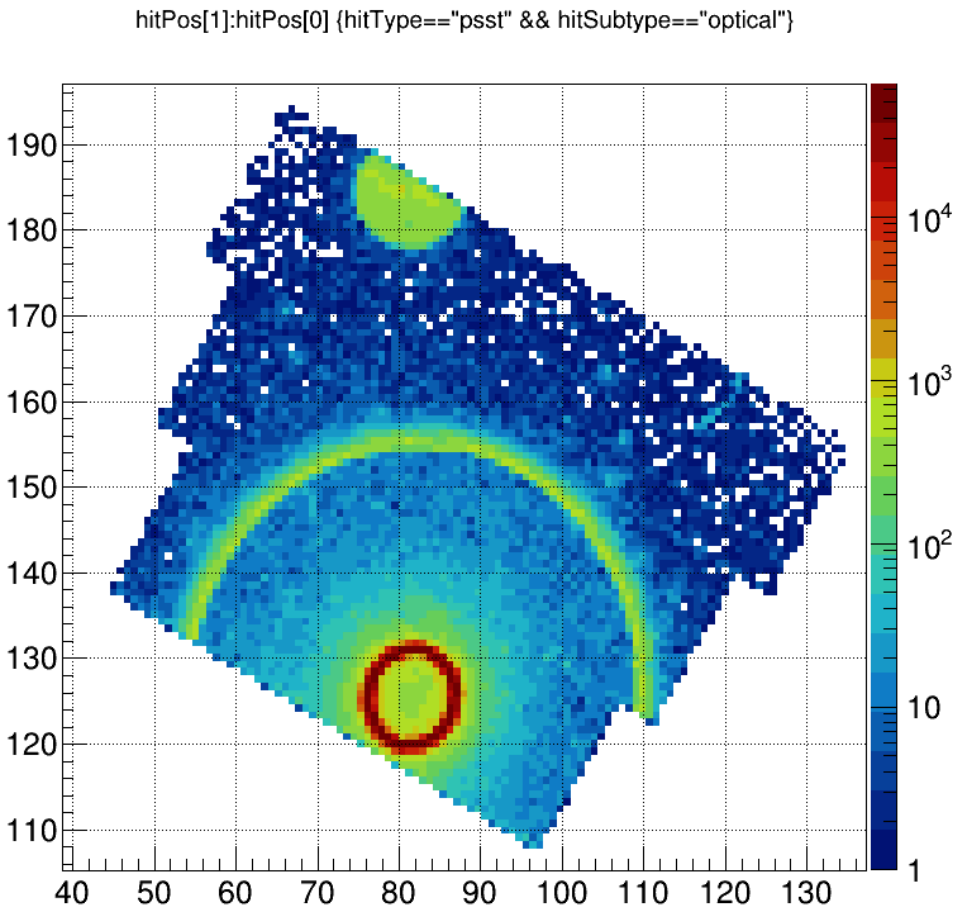
# Photosensor hits: sub-type vs. process



# Photosensor opticalphoton hit positions

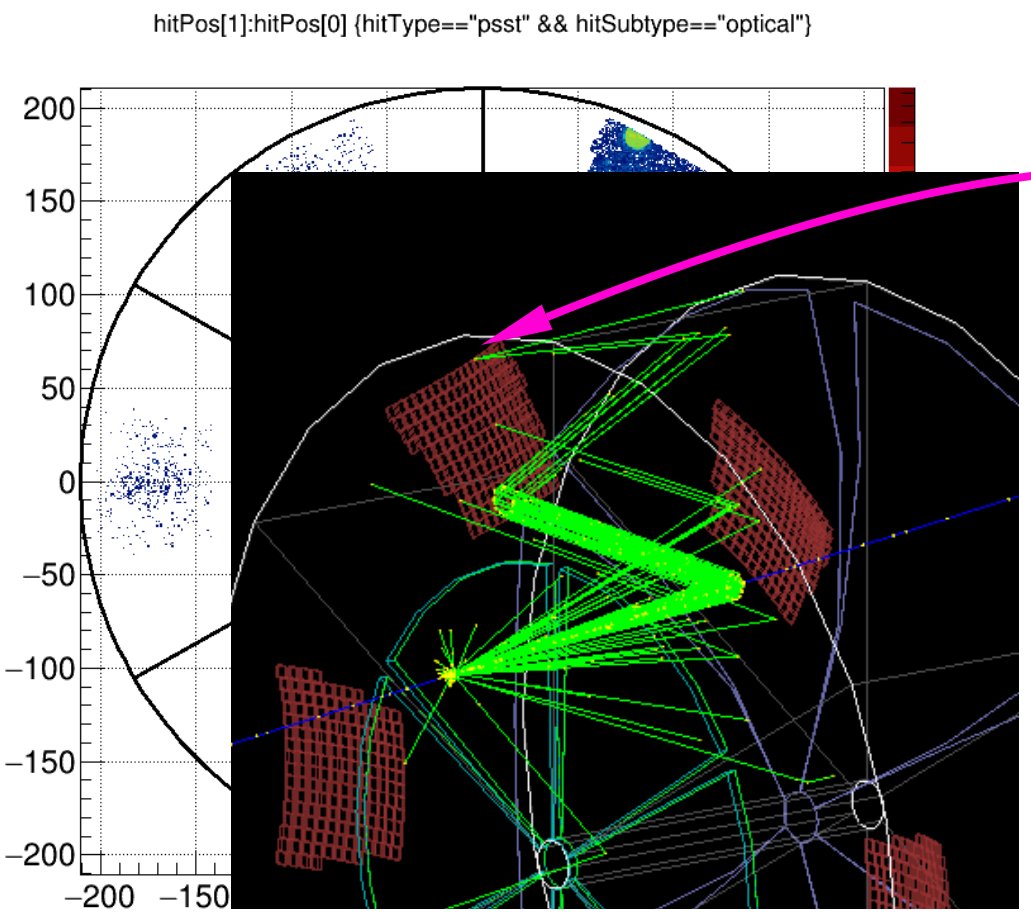



shown with vessel geometry outline

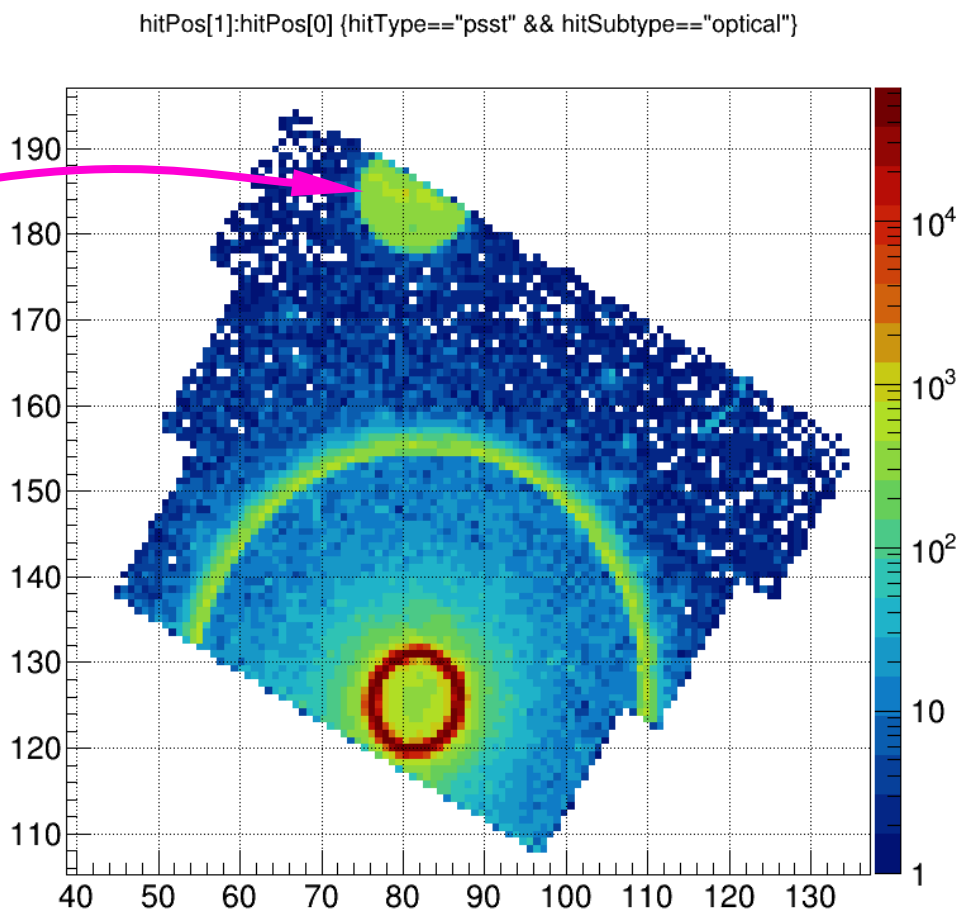



zoom in of primary petal

# Photosensor opticalphoton hit positions

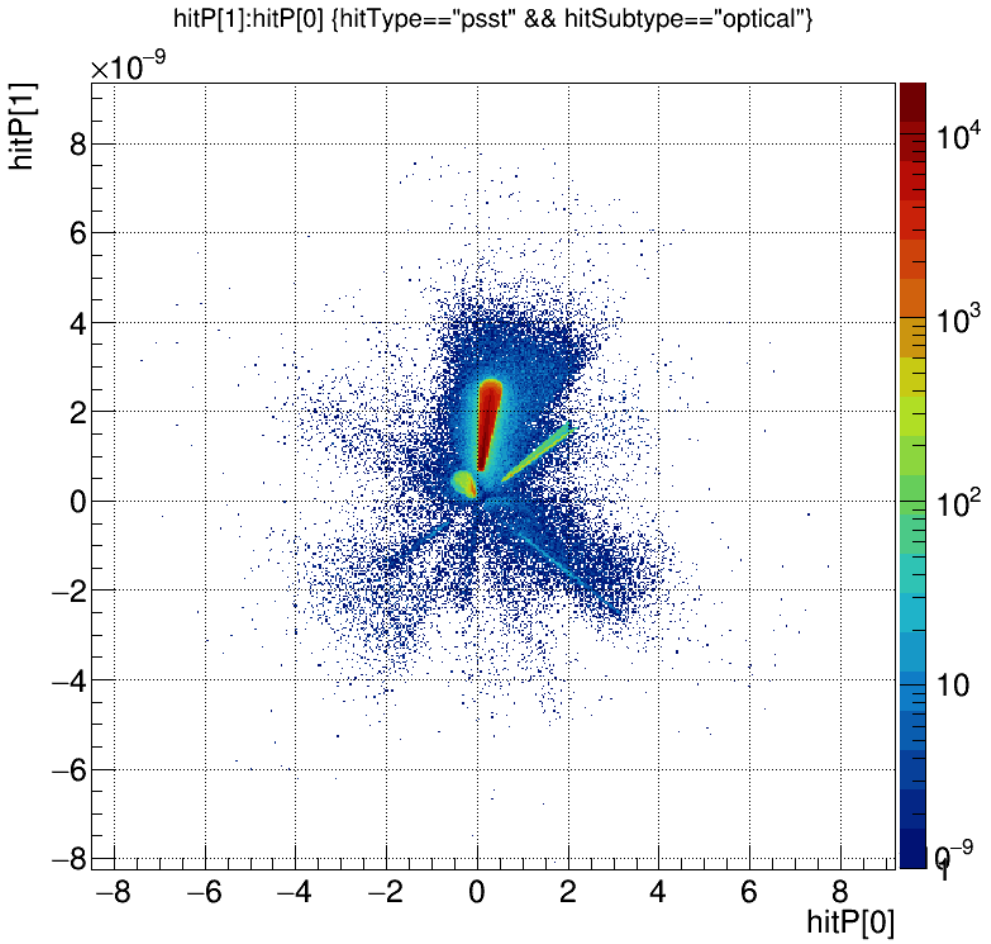


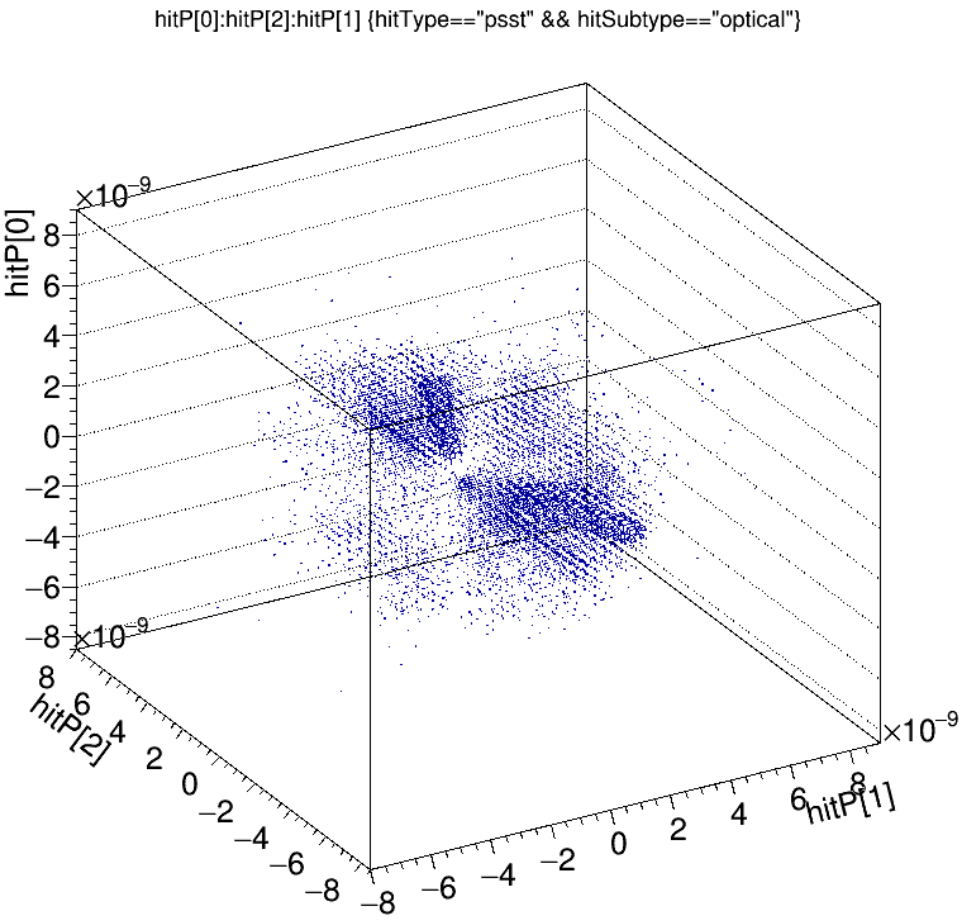

shown with vessel geometry outline




zoom in of primary petal

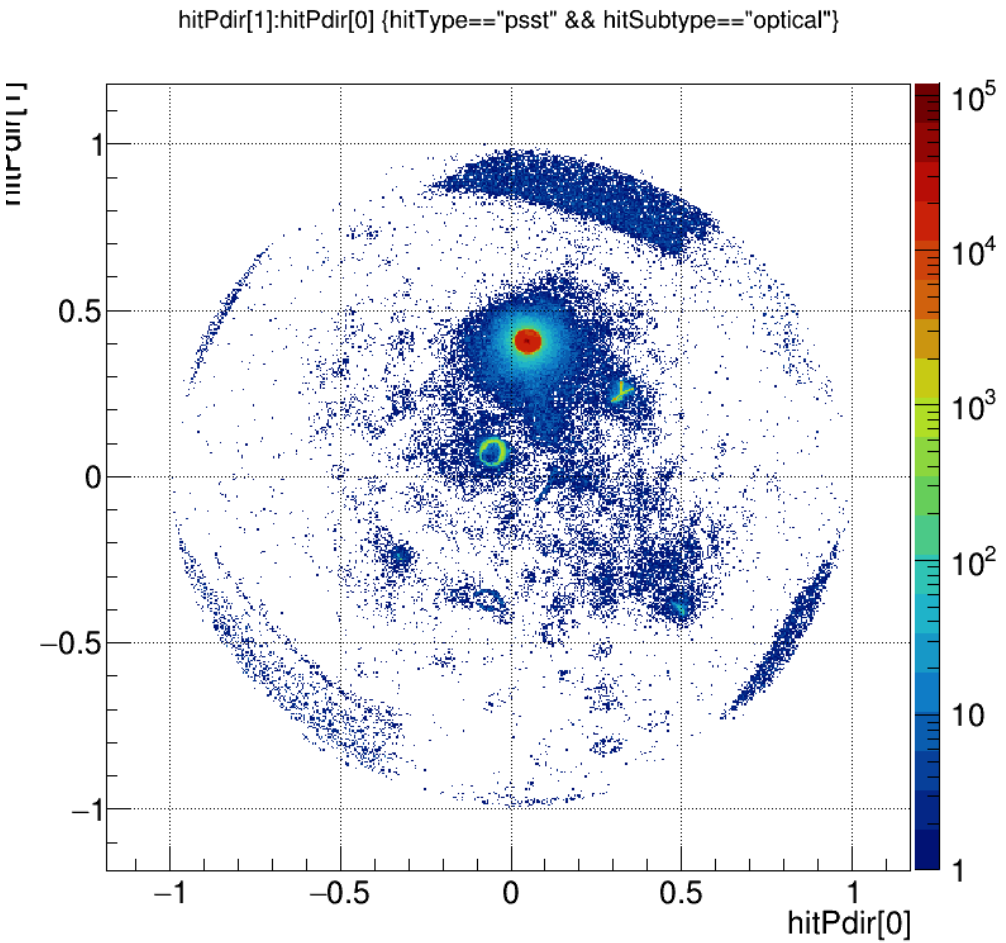
# Photosensor opticalphoton hit momentum

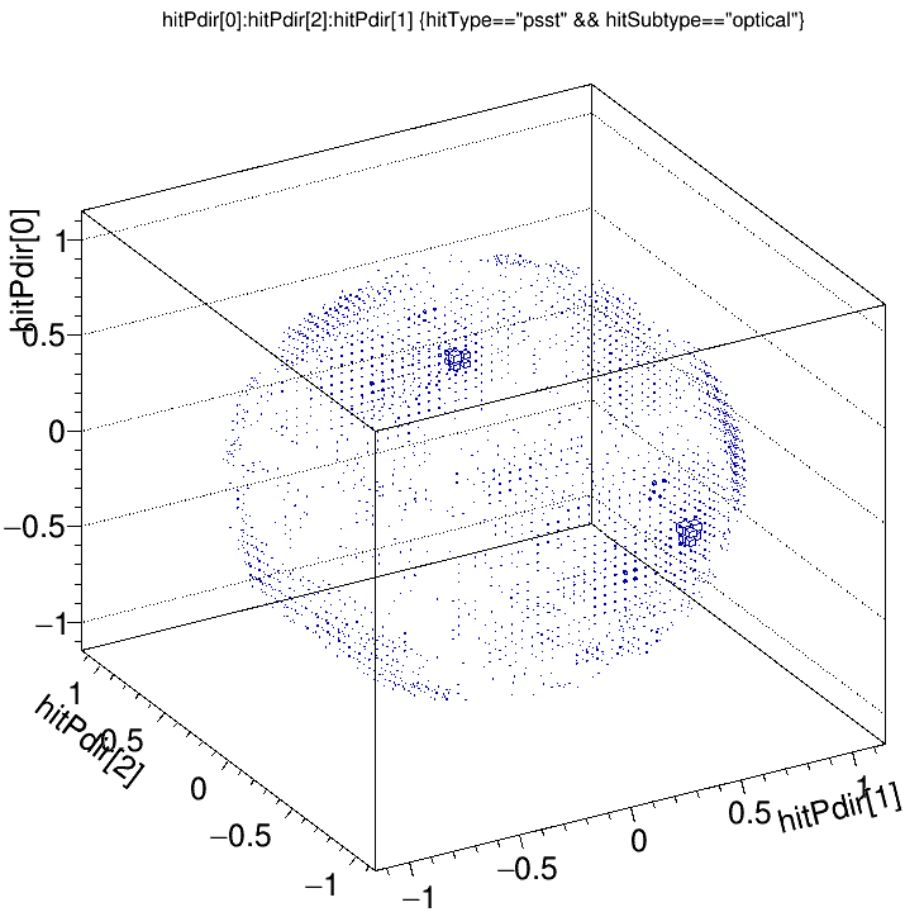



some PSST hits are from the “wrong” side – need some sort of shielding / electronics base in the geometry

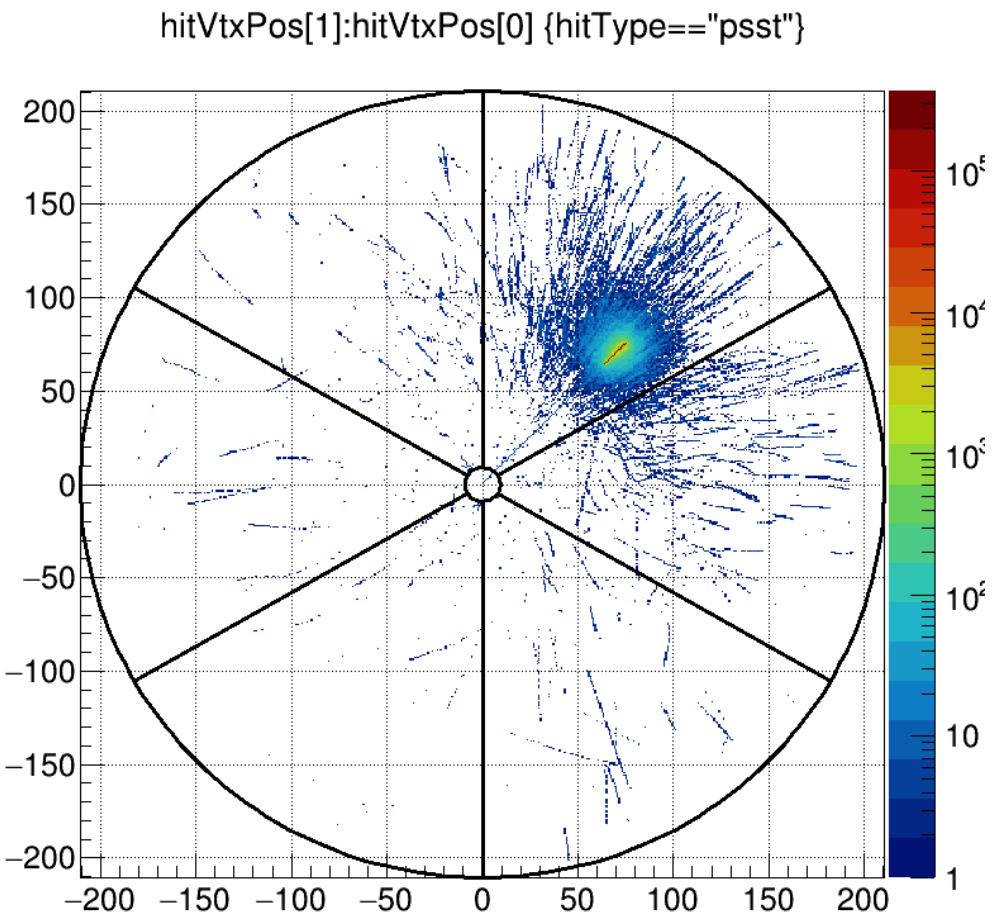
# Photosensor opticalphoton hit momentum direction

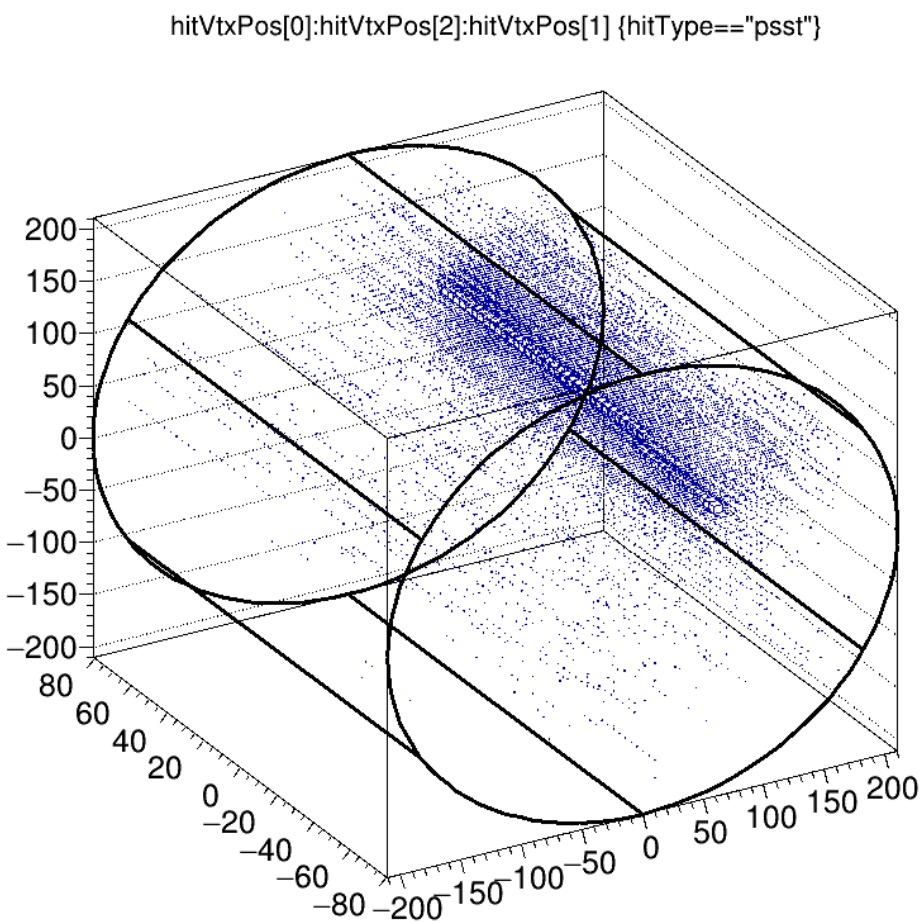



some PSST hits are from the “wrong” side – need some sort of shielding / electronics base in the geometry

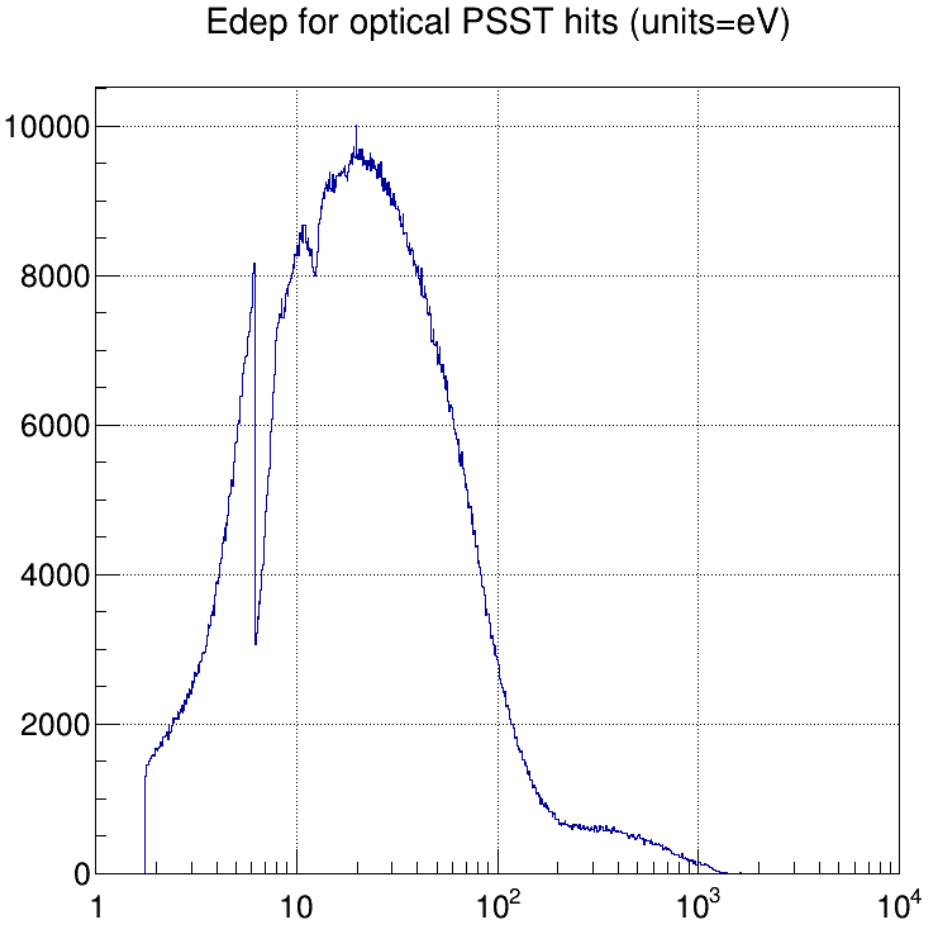
# Photosensor hit track vertices

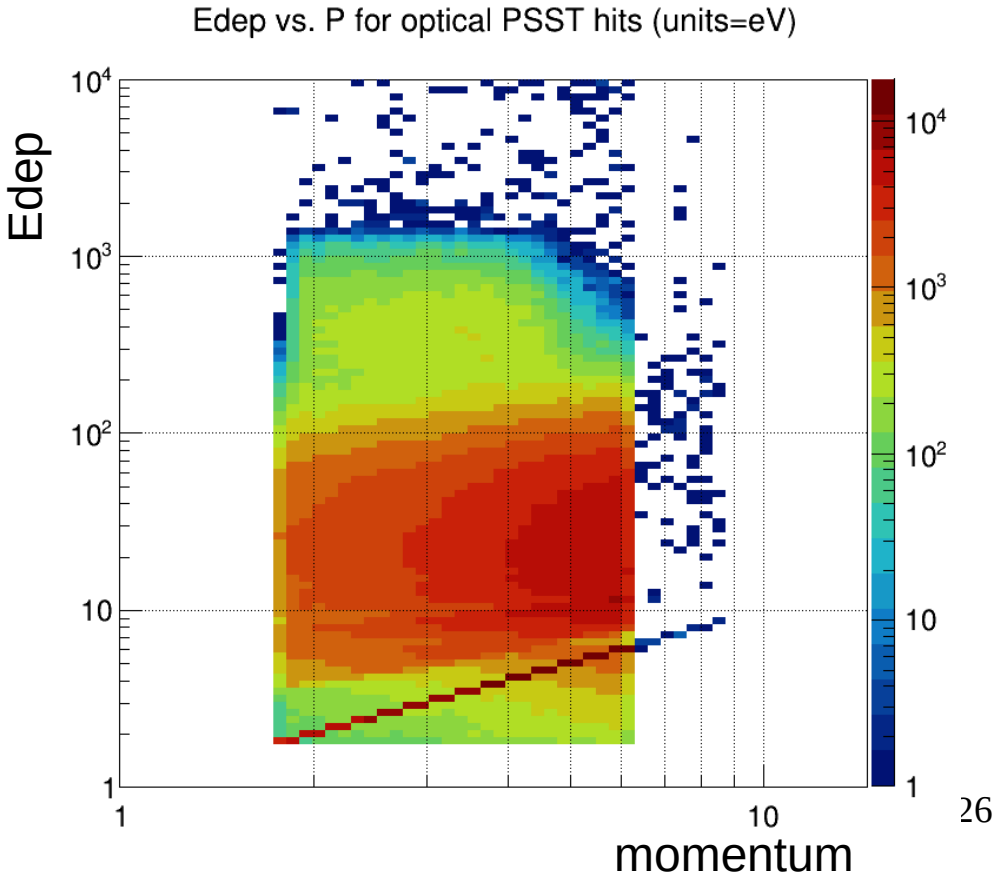


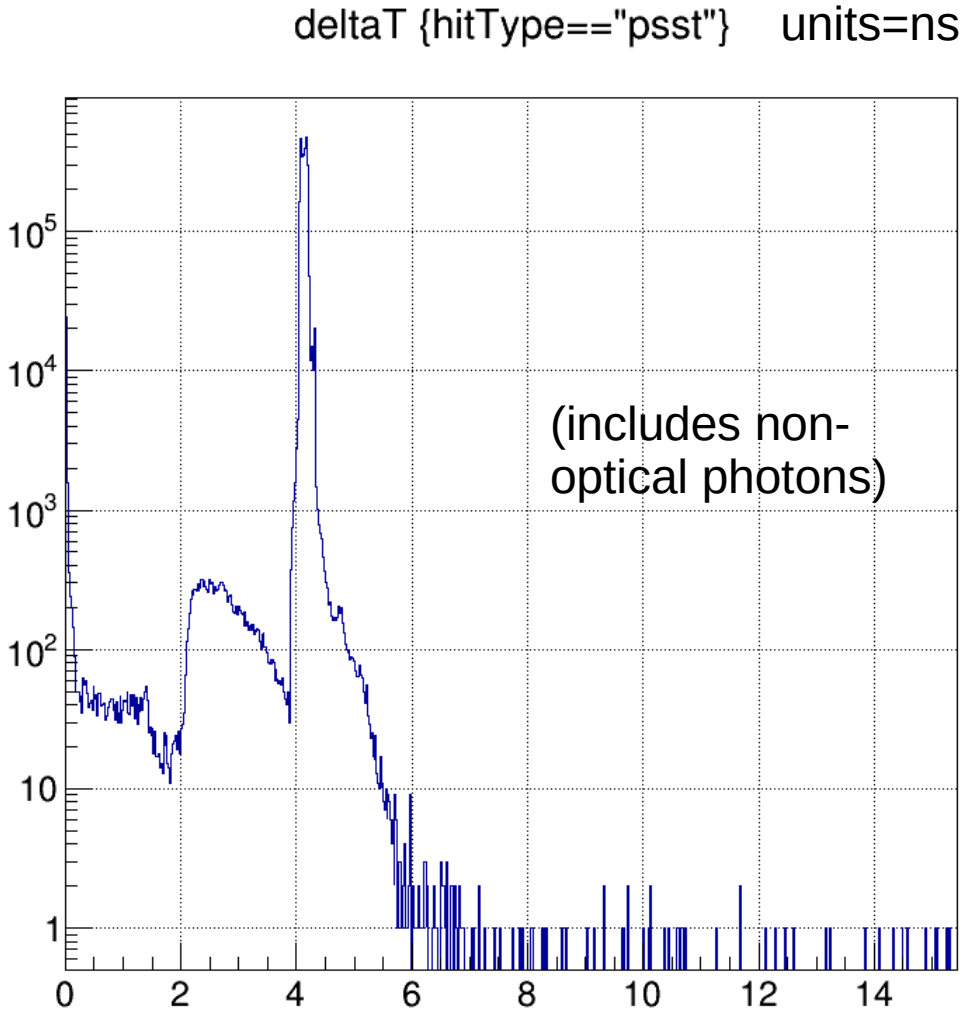
# Edep and Δtime from opticalphoton PSST hits

Consider splitting “optical” subtype to:
– opticalGas
– opticalAerogel

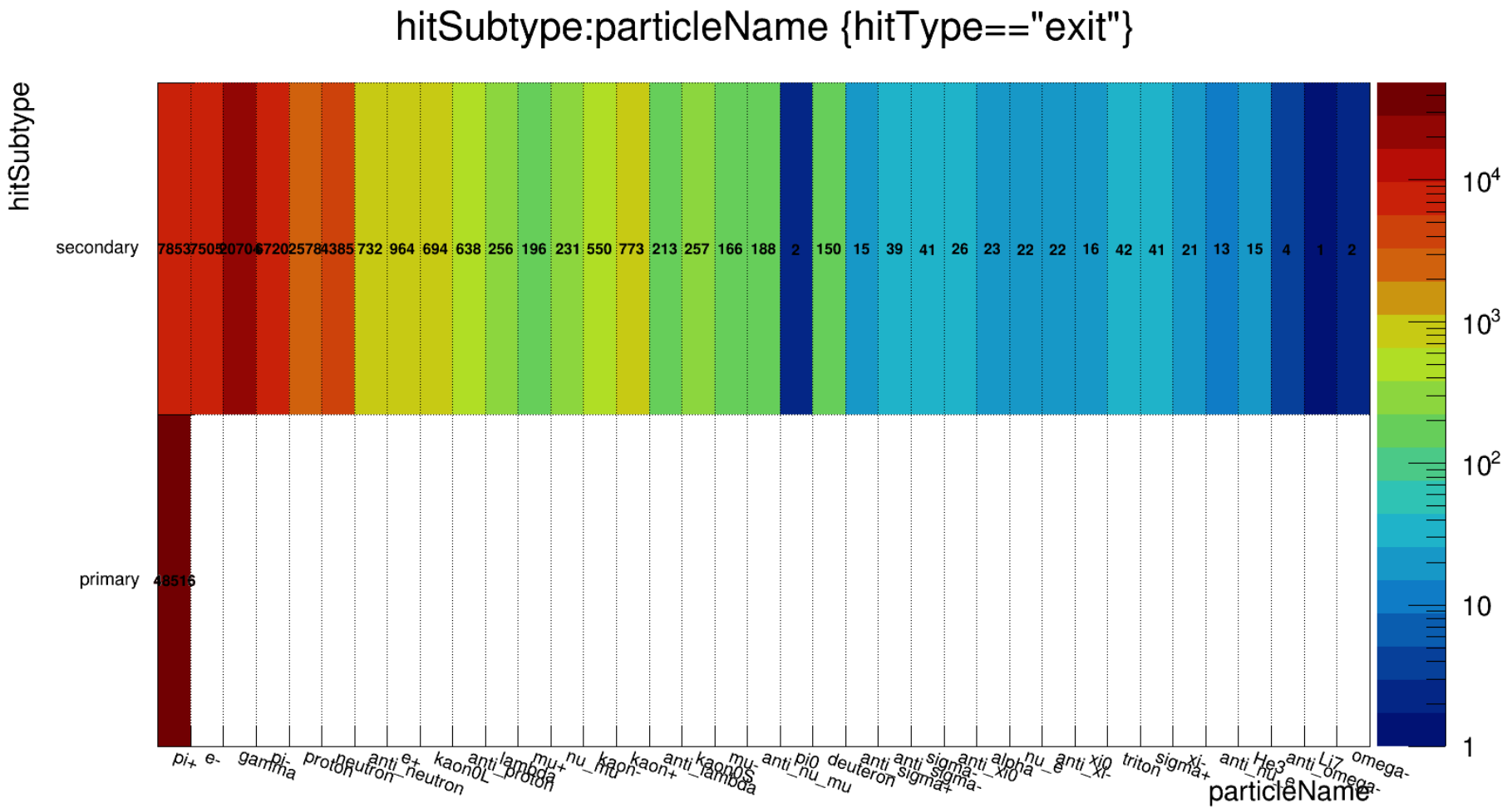


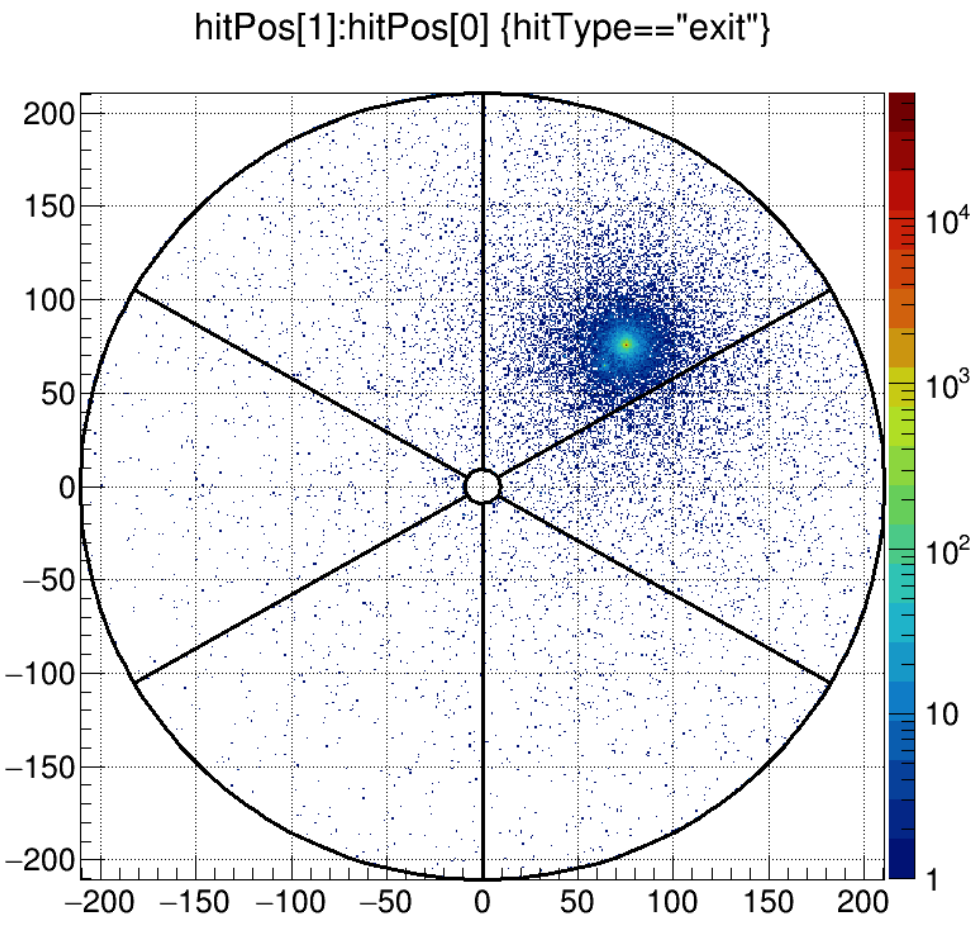
# Δtime from PSST hits

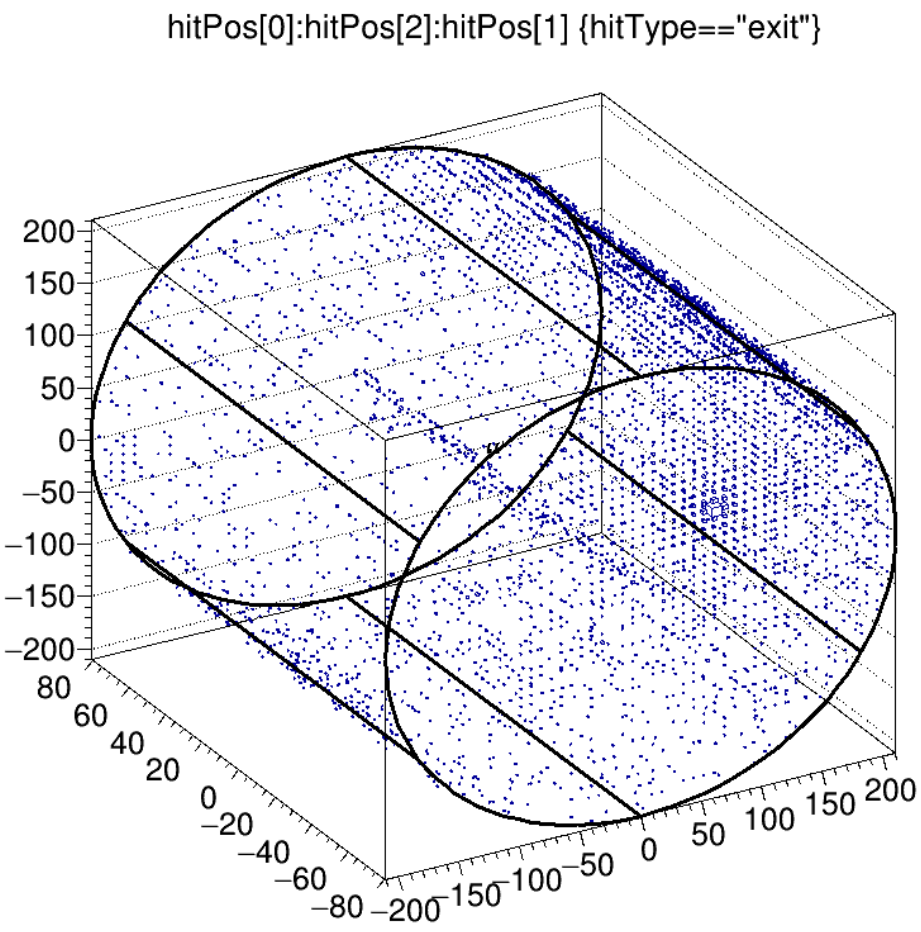


# Exit hits: sub-type vs. particle



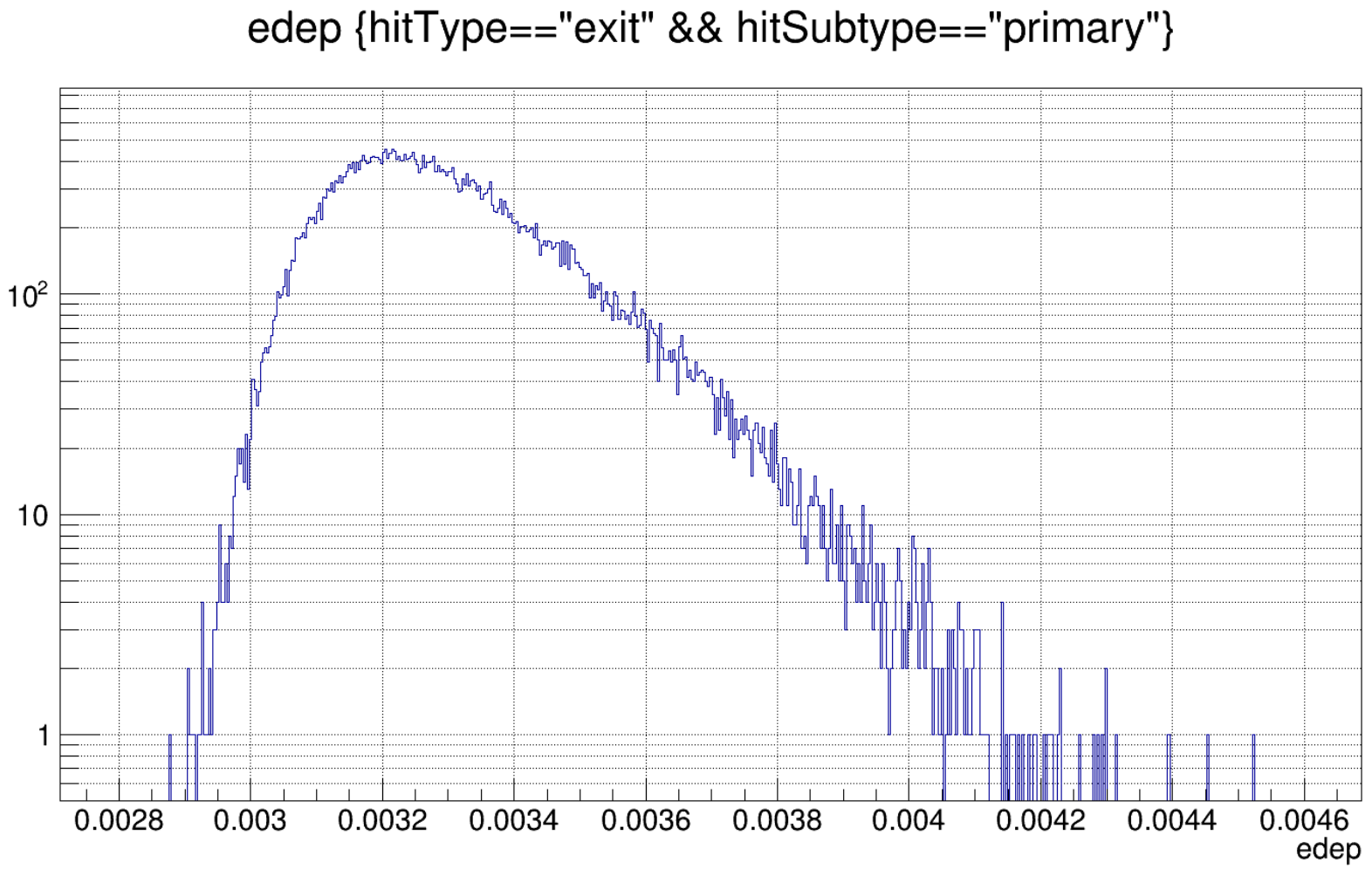
# Exit hit positions




**shown with vessel geometry outline**

# Exit hit Edep (units=GeV)



## Outlook and Plans

- Much development in the hits readout
  - 3 hit types, further classified into subtypes
- Short term tasks:
  - Very slow memory leak – need to fix
  - Mirror geometry → would mirror hits be useful?
  - Consider splitting PSST optical hits to “opticalGas” and “opticalAerogel”
- Integration with Full Simulations
  - **ATHENA**
    - Need to port to dd4hep → ask the ATHENA Software Group!
    - Better to do this sooner rather than later…
  - CORE
    - We have the f4a implementation, but would need help from someone in CORE for the integration (Barak?)
  - ECCE?