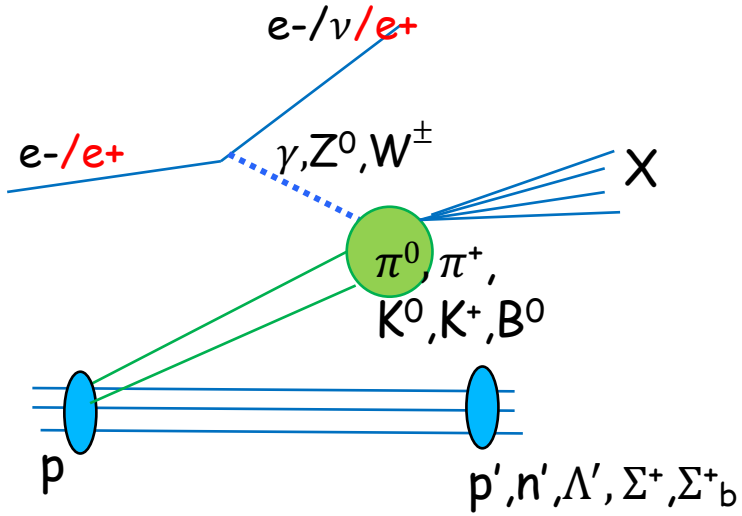
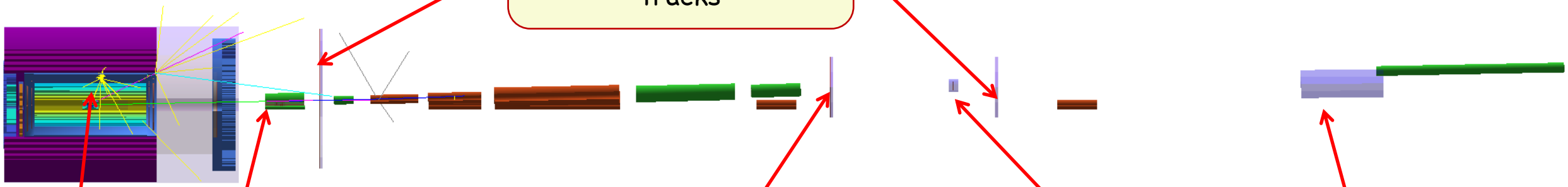
Lambda detection in FF area

Yulia Furletova

Pion/Kaon structure functions and further progress towards a flavor decomposition



e p -> (pion) -> e' + X + n



Virtual plane
For negative charged tracks

IP

B0 sensors:
-Rin ~ 3.4 cm
-Rout ~ 20 cm
- 50 x 50 um^2
Pixel pitch
Zpos= 5.9m
Xpos =15*cm

Off momentum tracker :
Rin ~ 10 *cm (?) ,
10x30cm (*)
500x500 um^2 pixel pitch

Zpos = 22.5 *m
Xpos = 75 *cm

(*) OFFM is larger to detect neg. tracks !!!(*)

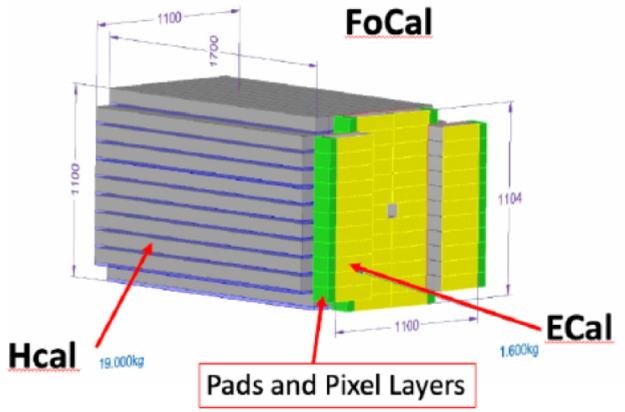
Roman Pots:
Rin ~ 10 σ
20x10cm^2
500x 500 um^2
pixel pitch

Zpos= 26.2*m
Xpos = 82 *cm

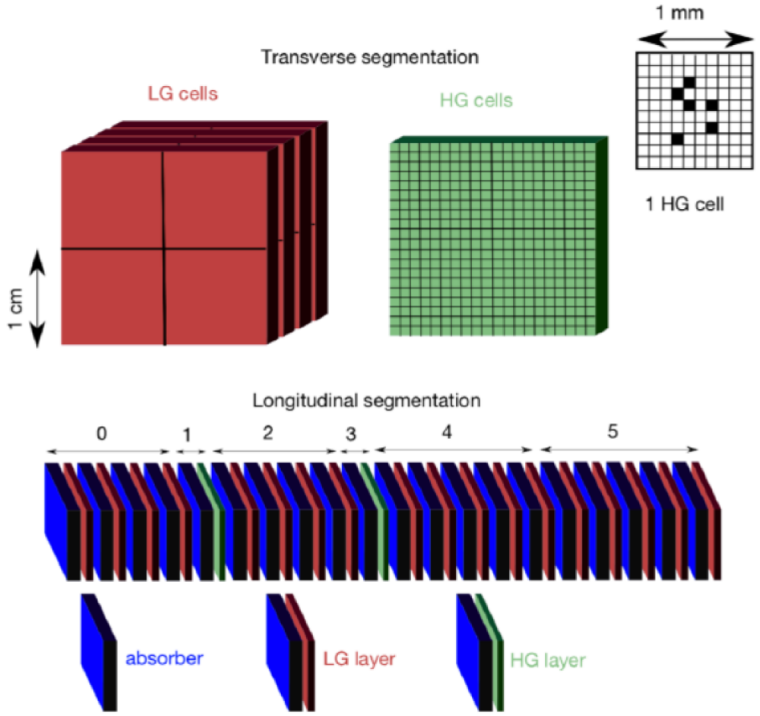
RP2:
Zpos = 28.2 *m
Xpos = 91 *cm

ZDC:
60x60cm
EMCAL
LG: 1x1cm^2
HG: 100x100um^2
HCAL: 10x10 cm
Zpos = 38*m
Xpos = 90*cm

ZDC (Y.Goto)

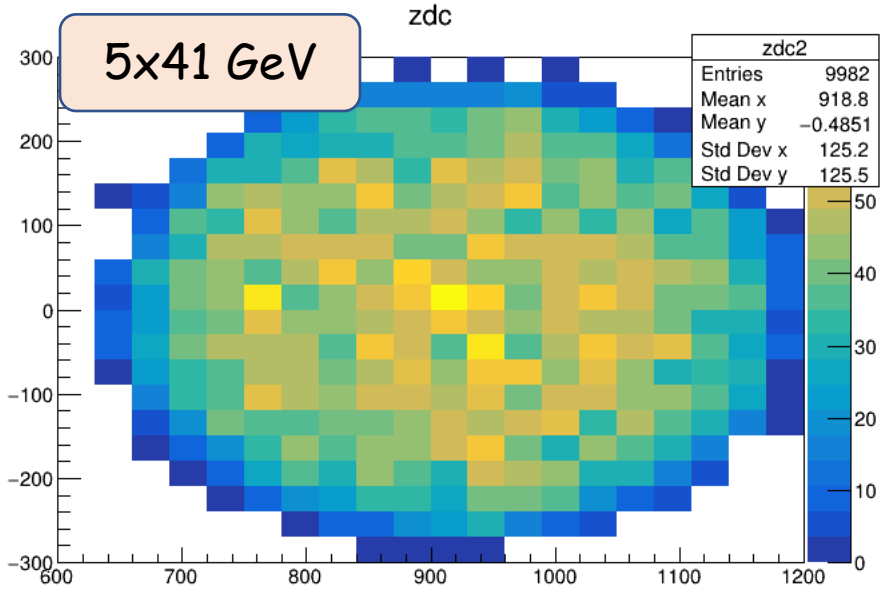


HCal: ~2K channels

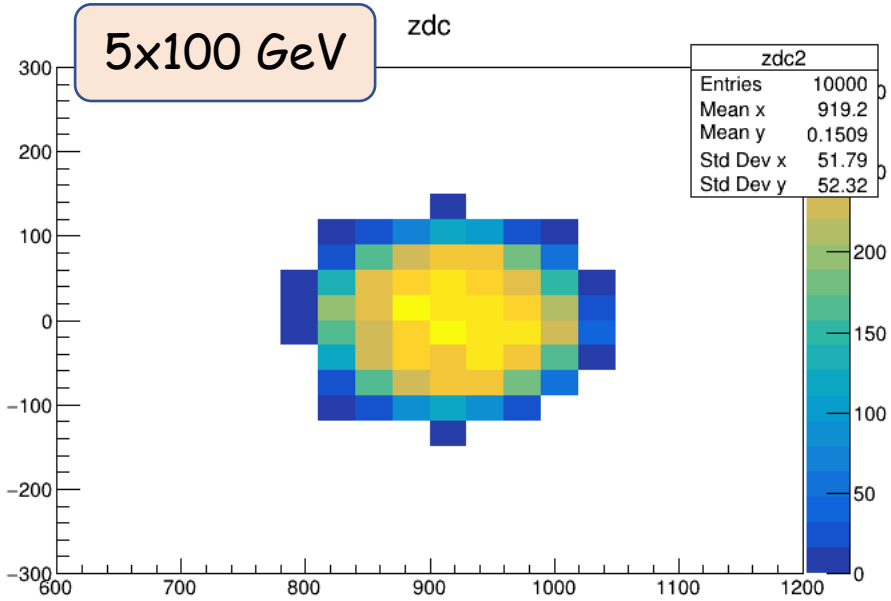


Neutron sample

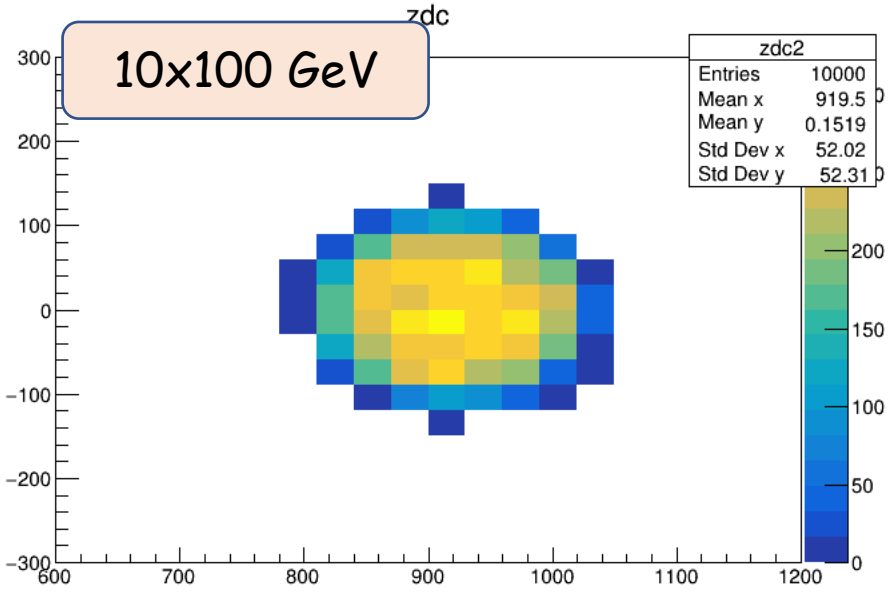
5x41 GeV



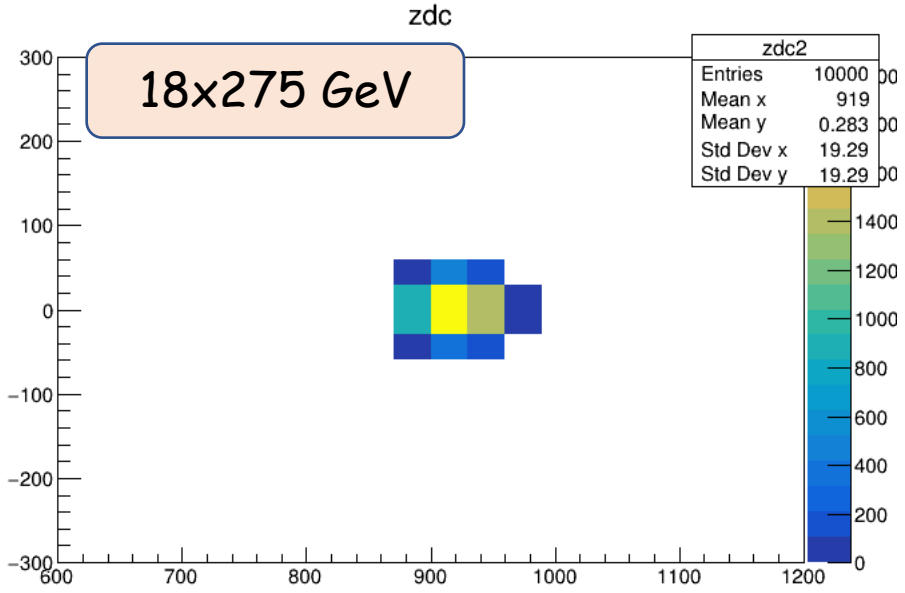
5x100 GeV



10x100 GeV



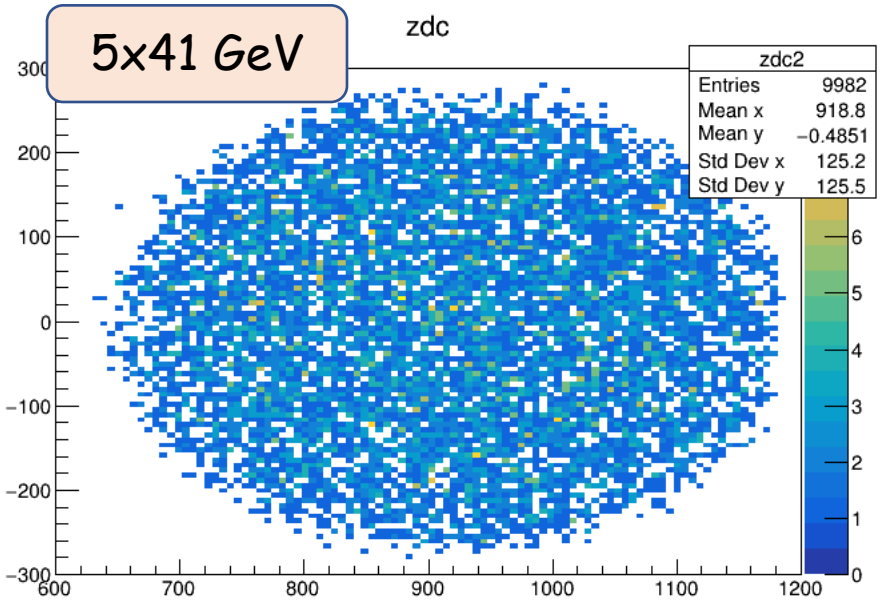
18x275 GeV



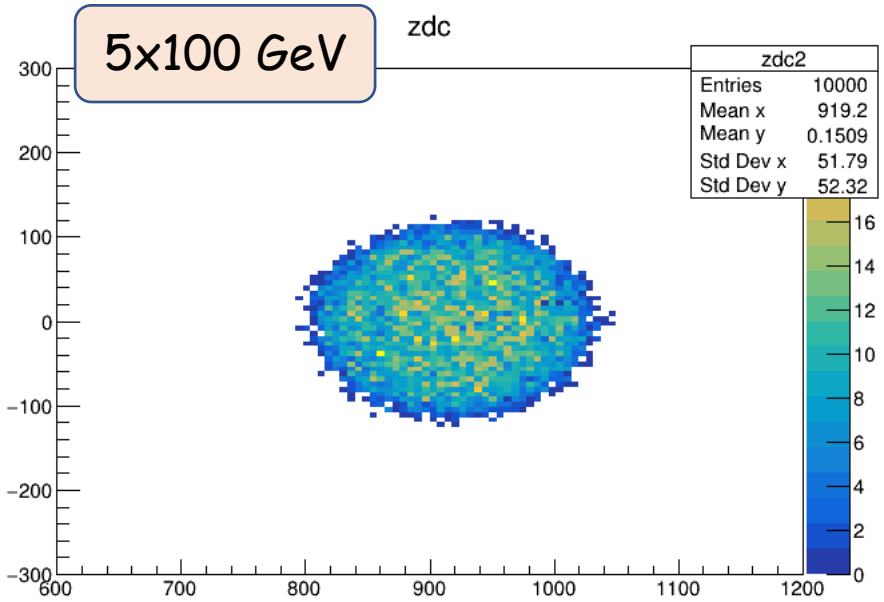
ZDC
60x60 cm
20bins => 3cm towers

Neutron sample

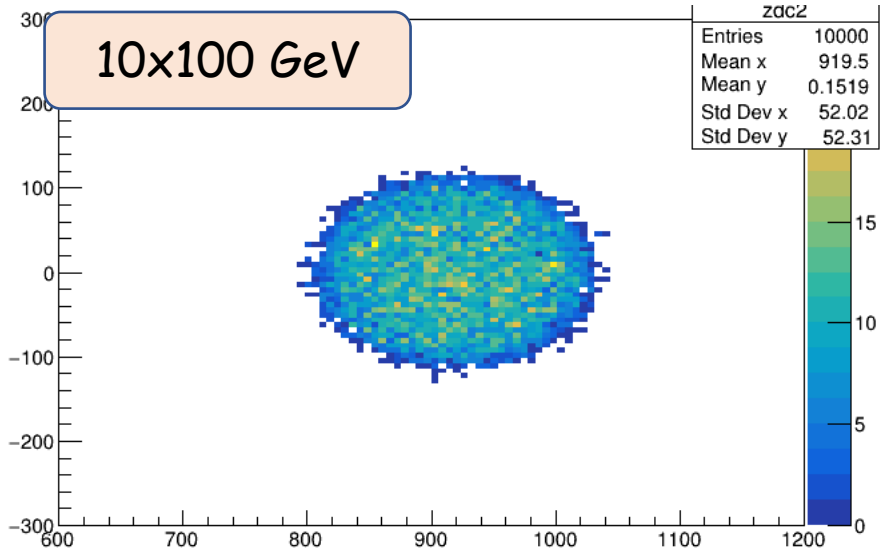
5x41 GeV



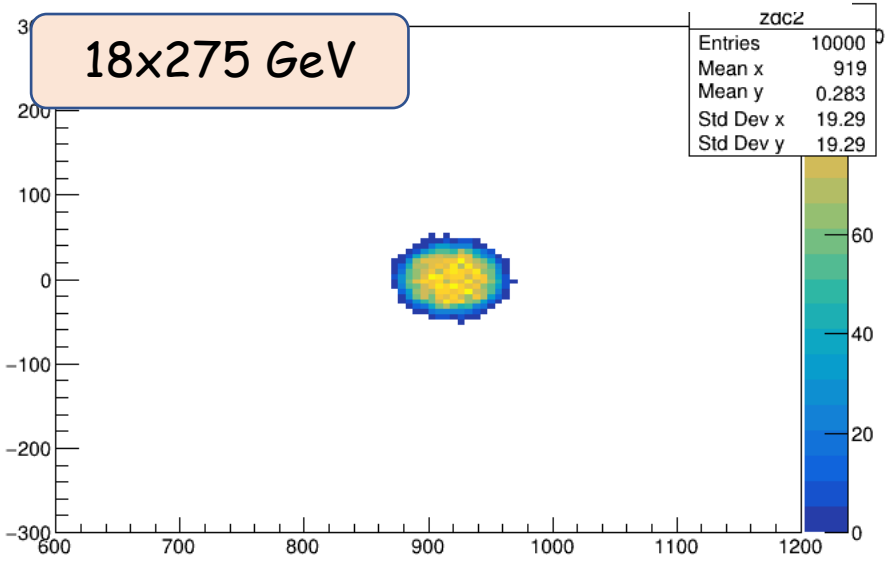
5x100 GeV



10x100 GeV

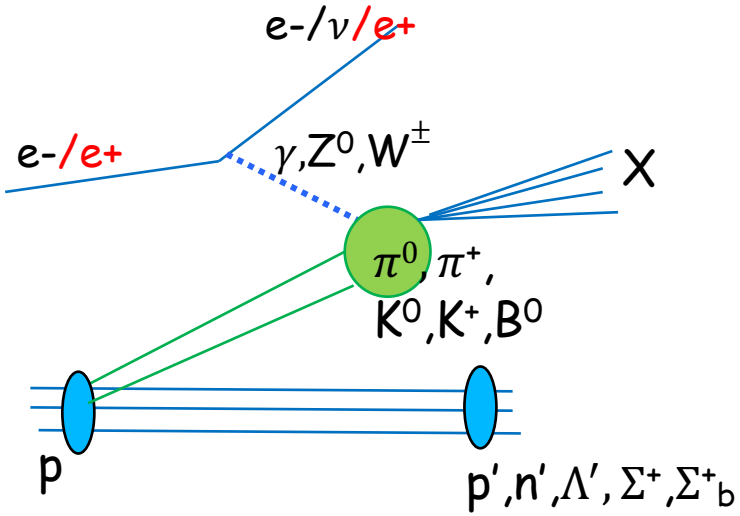


18x275 GeV



ZDC
60x60 cm
100bins =>
0.6cm towers

Pion/Kaon structure functions and further progress towards a flavor decomposition



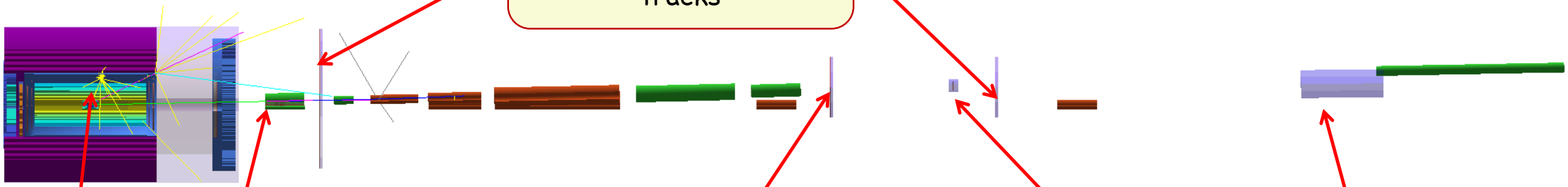
$$e\ p \rightarrow (K) \rightarrow e' + \Lambda + X$$

$\Lambda \hookrightarrow p + \pi^-$

$\Lambda \hookrightarrow n + \pi^0$

MC sample with Lambda's . Geant4 is decaying them during the transportation.

mode[0] = new
G4PhaseSpaceDecayChannel("lambda",0.639,2,"proton","pi-");
G4PhaseSpaceDecayChannel("lambda",0.358,2,"neutron","pi0");



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ZDC:
60x60cm
EMCAL
LG: 1x1cm^2
HG: 100x100um^2
HCAL: 10x10 cm
Zpos = 38*m
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Lambdas (275 GeV)

$\Lambda \rightarrow p + \pi^-$

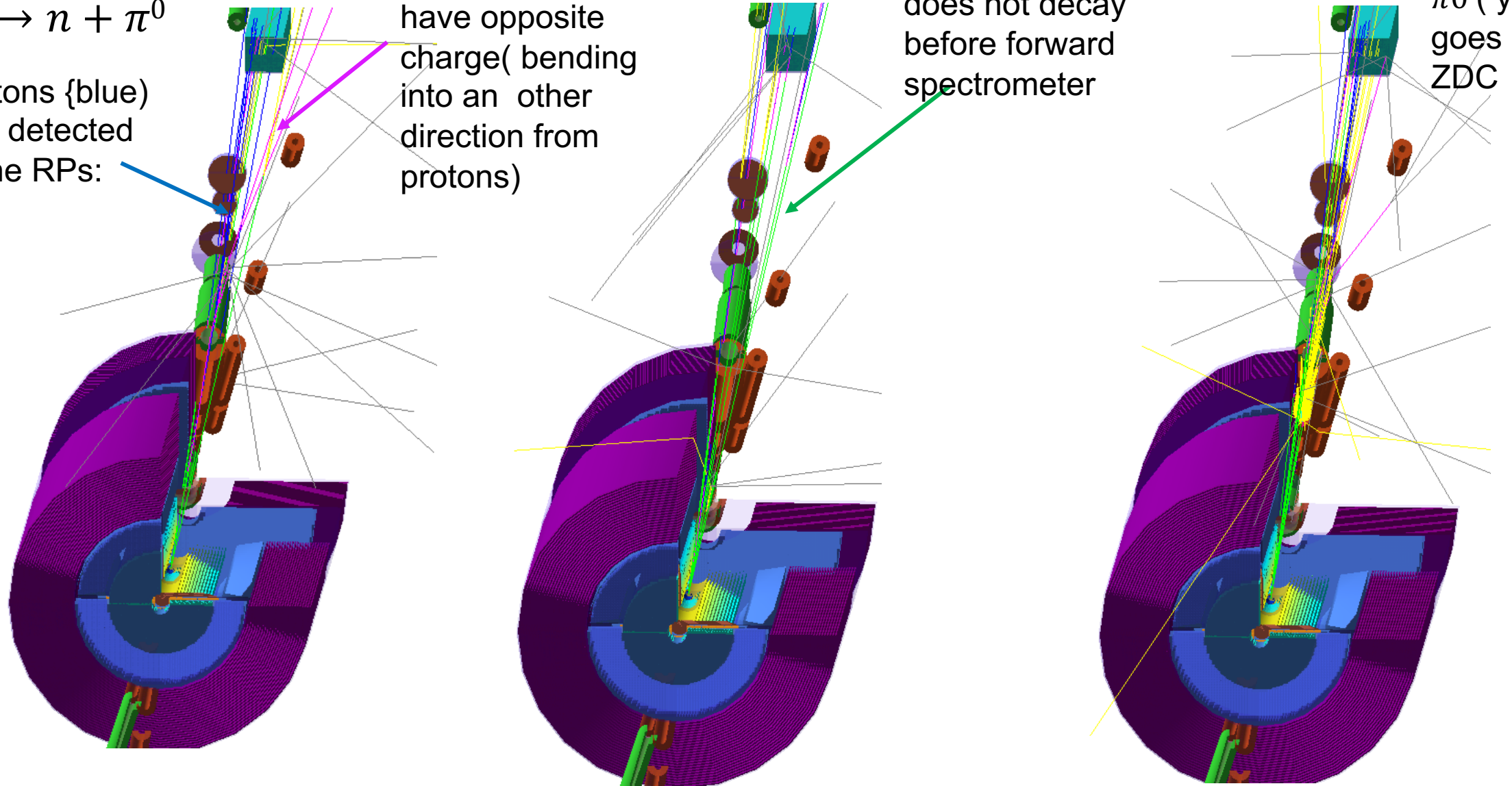
$\Lambda \rightarrow n + \pi^0$

Protons {blue) are detected in the RPs:

π^- {magenta) have opposite charge(bending into an other direction from protons)

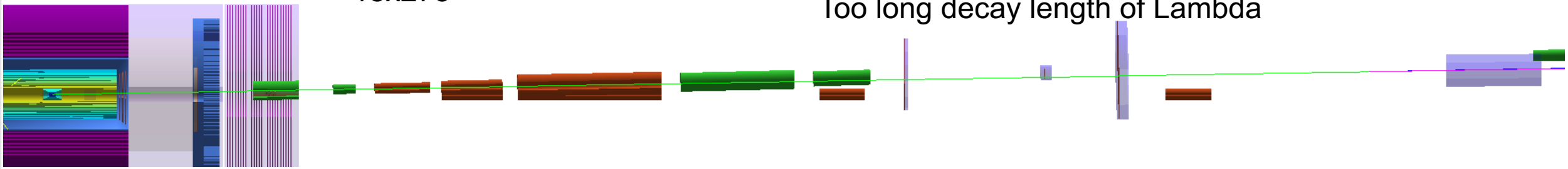
Ca 30% of Lambdas (green) at high energy does not decay before forward spectrometer

Neutrons {gray) and fraction of $\pi 0$ (yellow) goes into ZDC

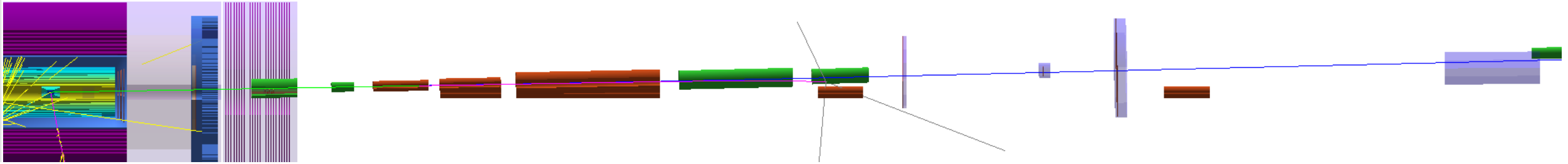


18x275

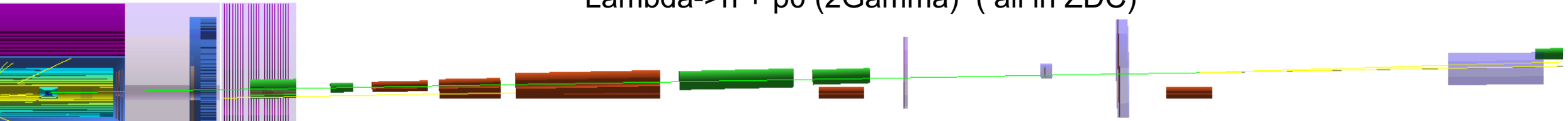
Too long decay length of Lambda



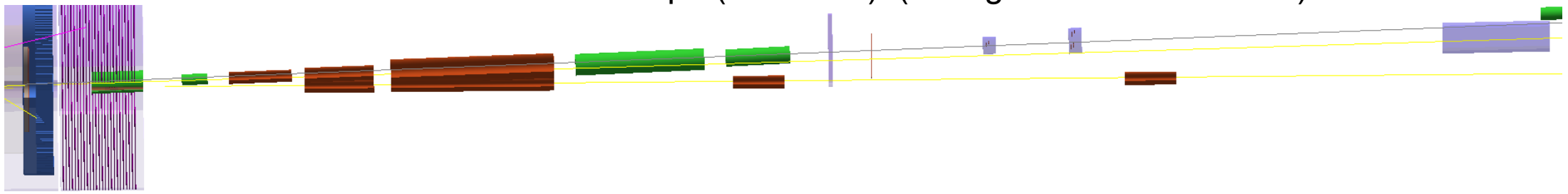
Lambda->p+pi- (pion was lost in Dipole)



Lambda->n + p0 (2Gamma) (all in ZDC)

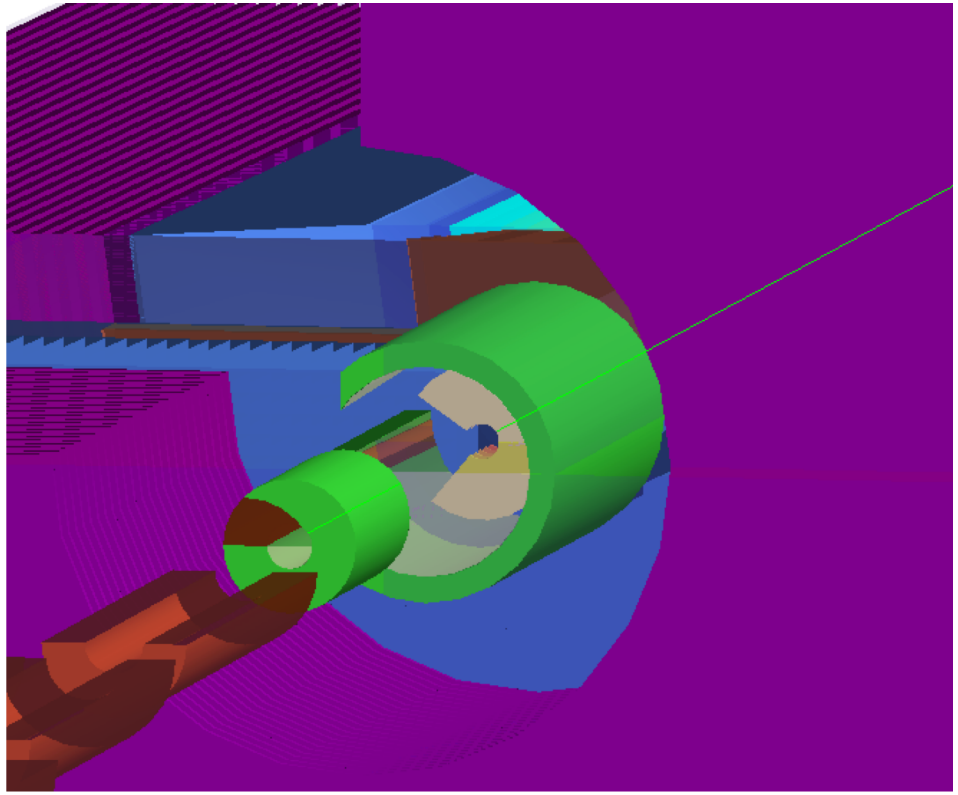


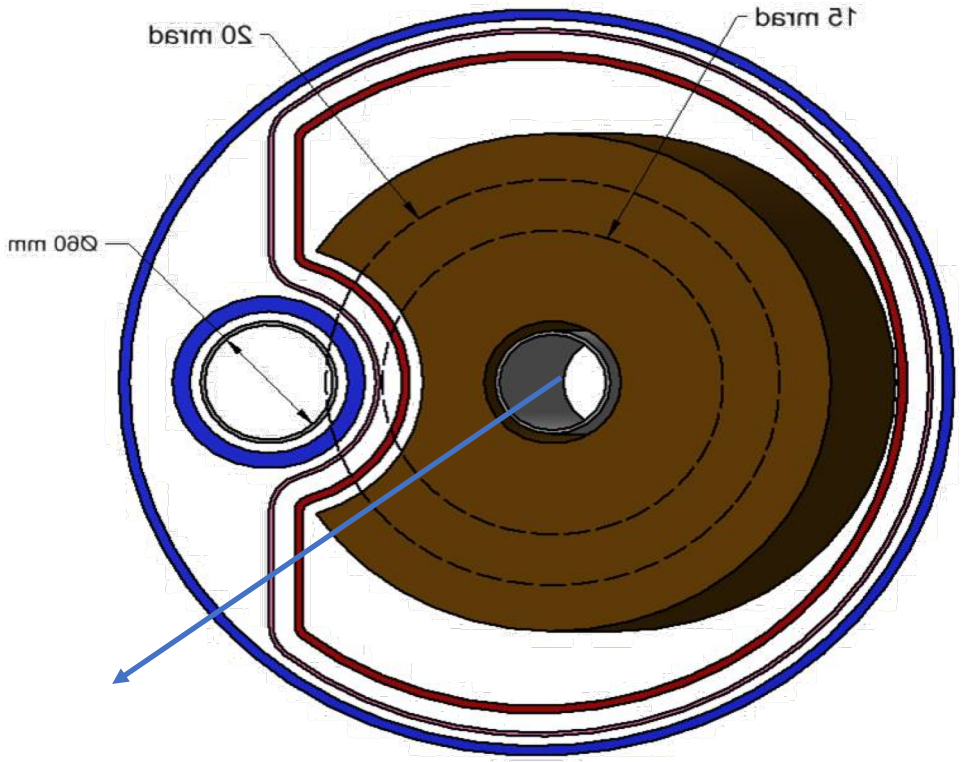
Lambda->n + p0 (2Gamma) (one gamma missed ZDC)

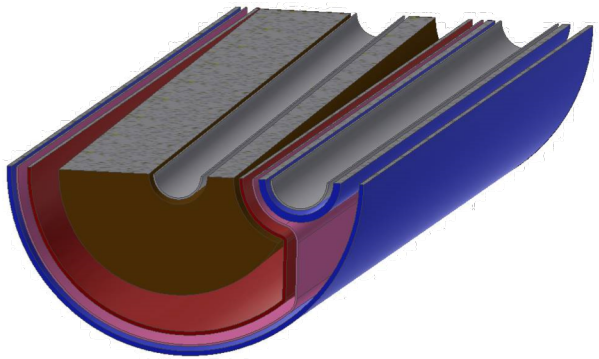


B0 detectors

shape of B0 tracker : asymmetric in φ due to the crossing angle and electron FFQ placement

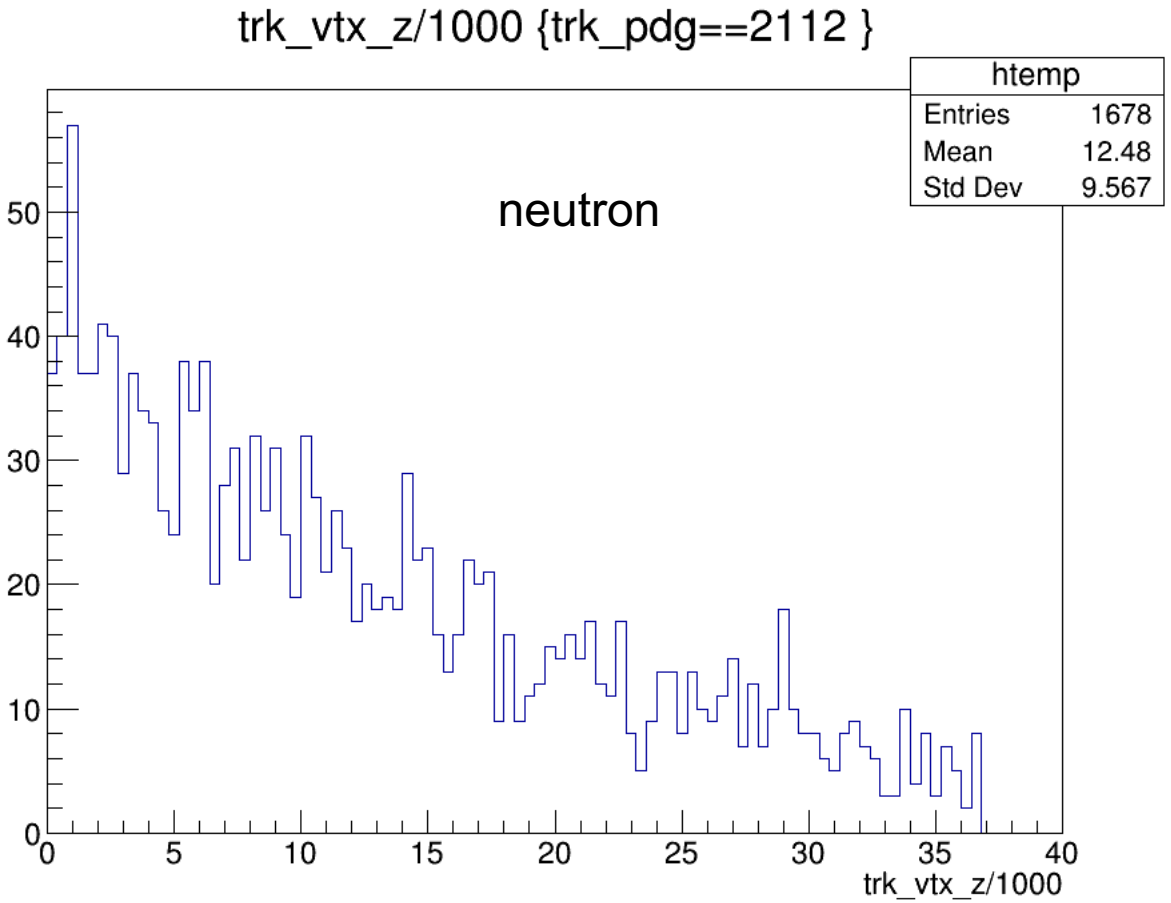


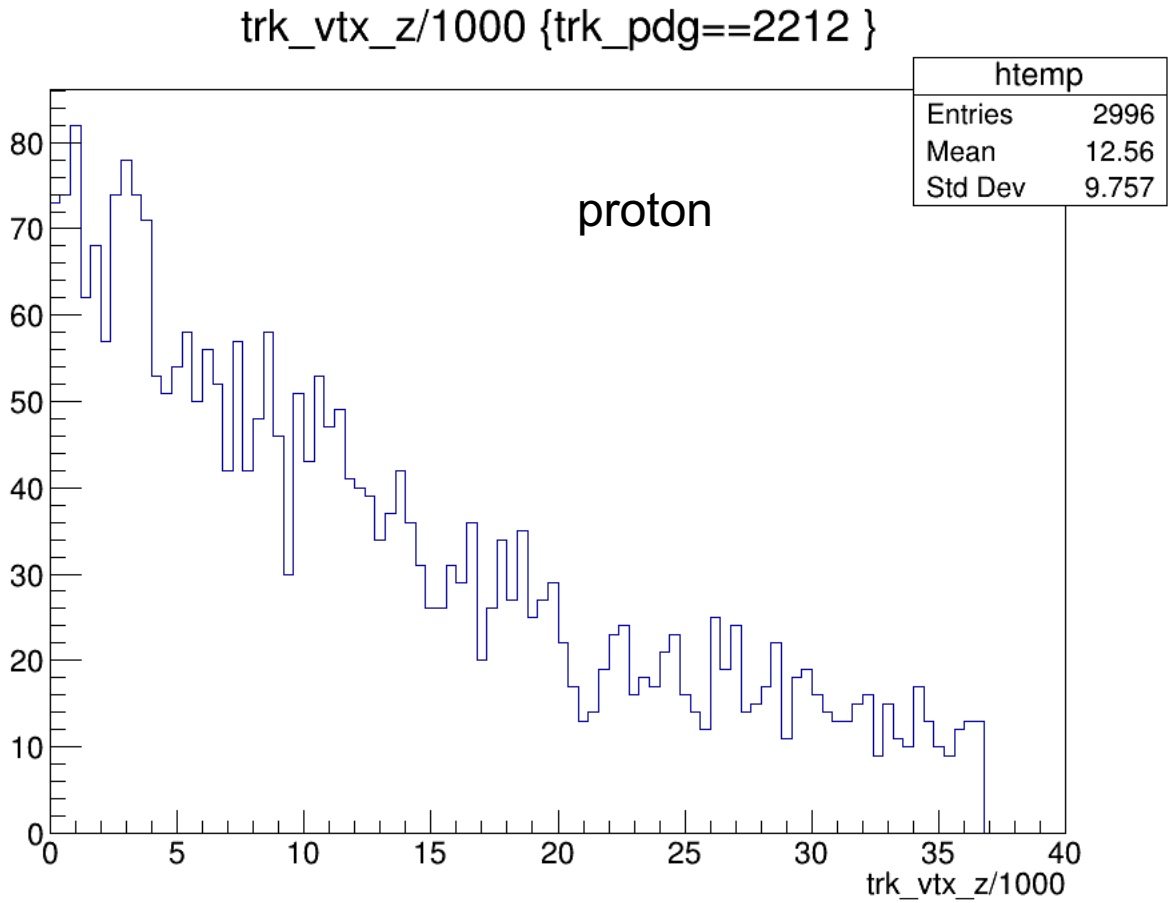




Decay Length (p/n vertex) (18x275)

mode[0] = new G4PhaseSpaceDecayChannel("lambda",0.639,2,"proton","pi-");
G4PhaseSpaceDecayChannel("lambda",0.358,2,"neutron","pi0");



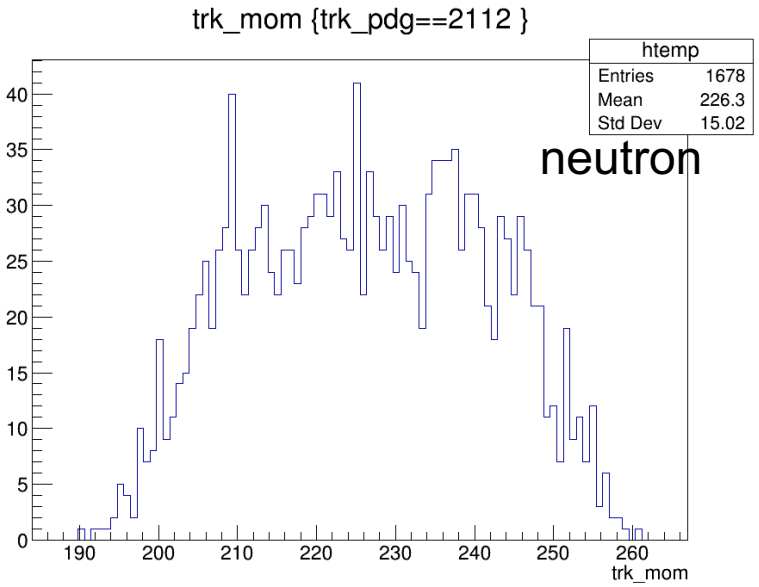


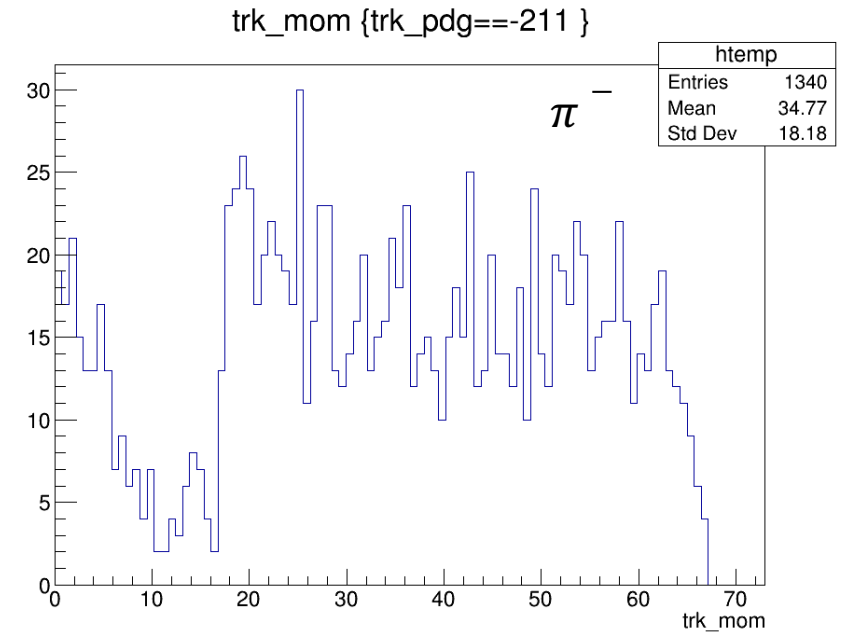
10k events total => 3580 neutrons => ~ 47%
Need to add pi0 efficiency

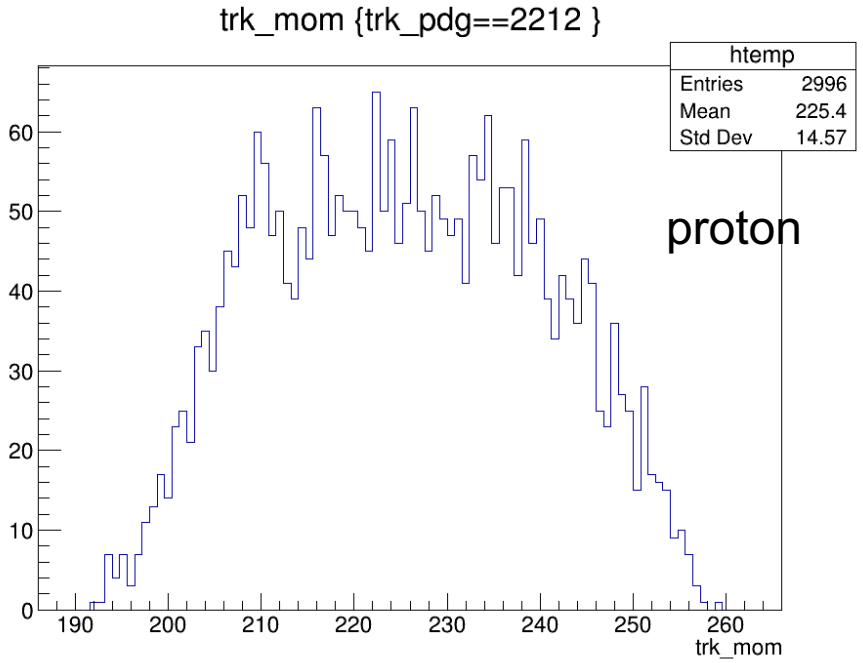
10k events total => 6390 protons => ~ 47%
Need to add pi- efficiency

Protons and neutrons (18x275)

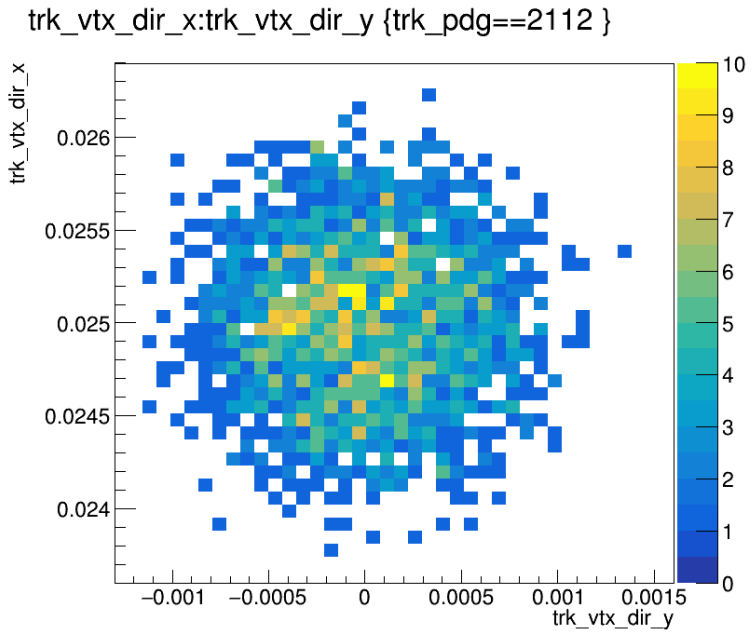
$$\Lambda \rightarrow p + \pi^-$$
$$\Lambda \rightarrow n + \pi^0$$

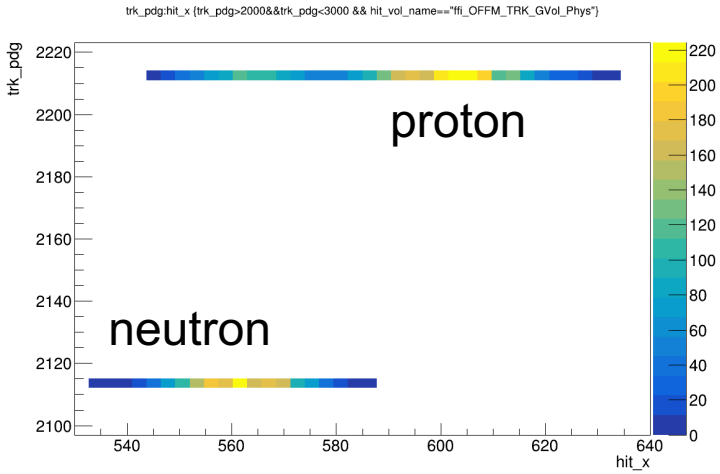






Angular distr for proton



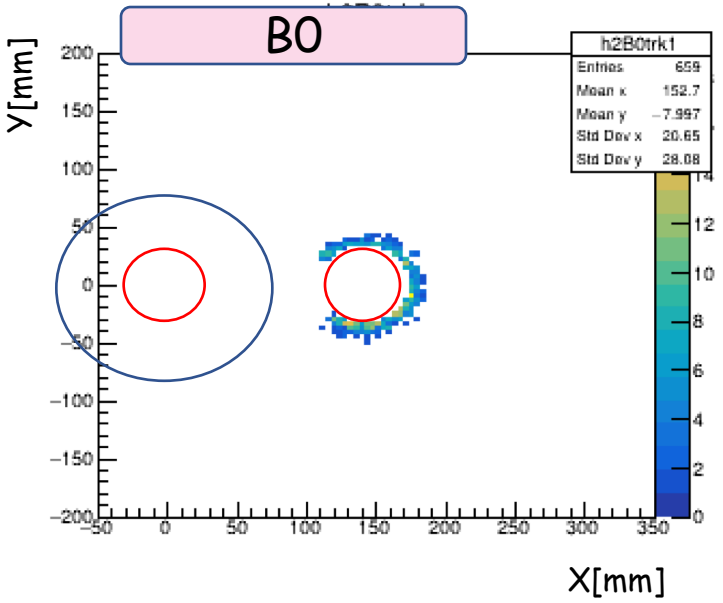


Color coding : Not normalized!

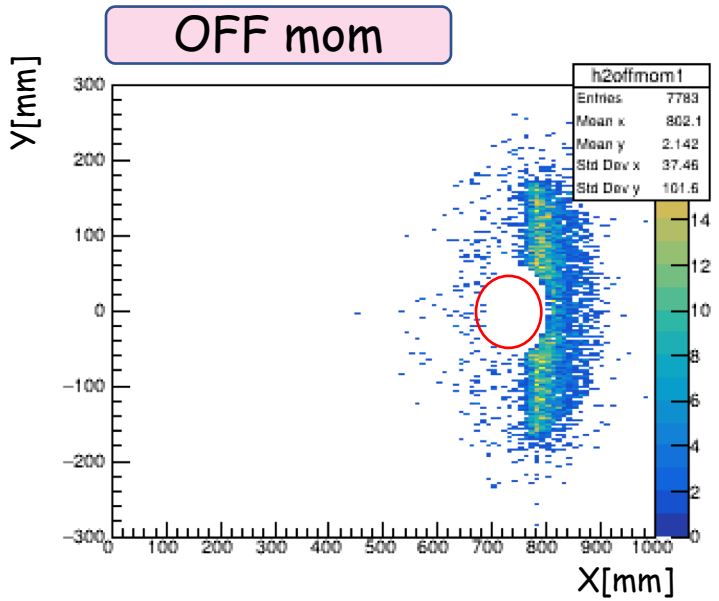
5x41 GeV

Protons

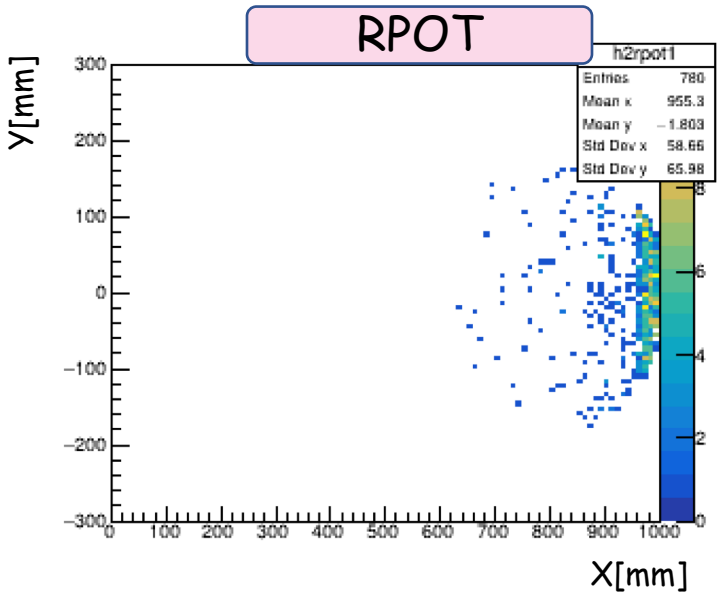
B0



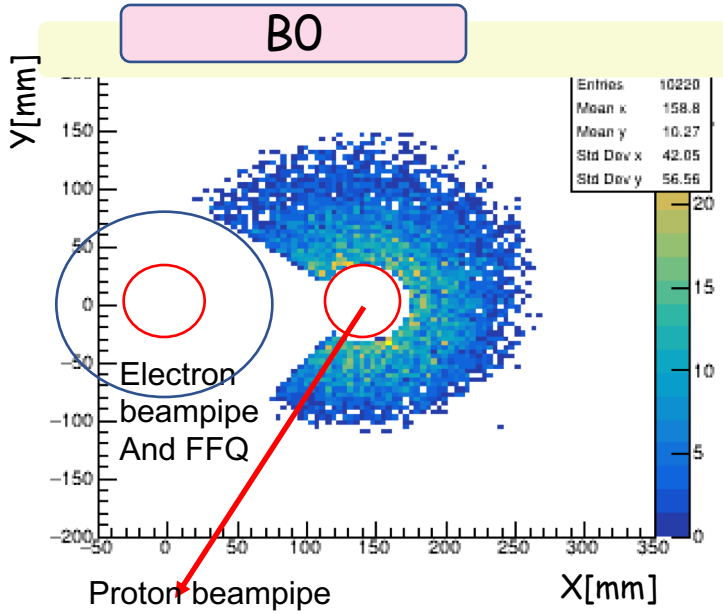
OFF mom



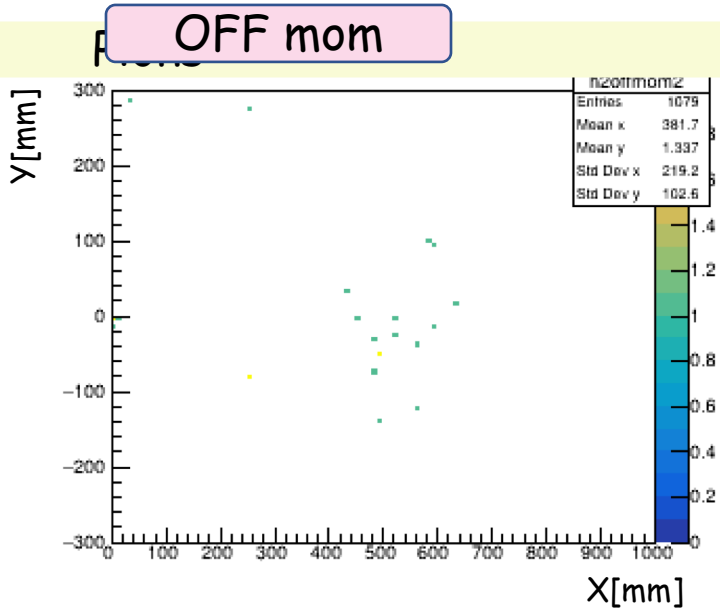
RPOT



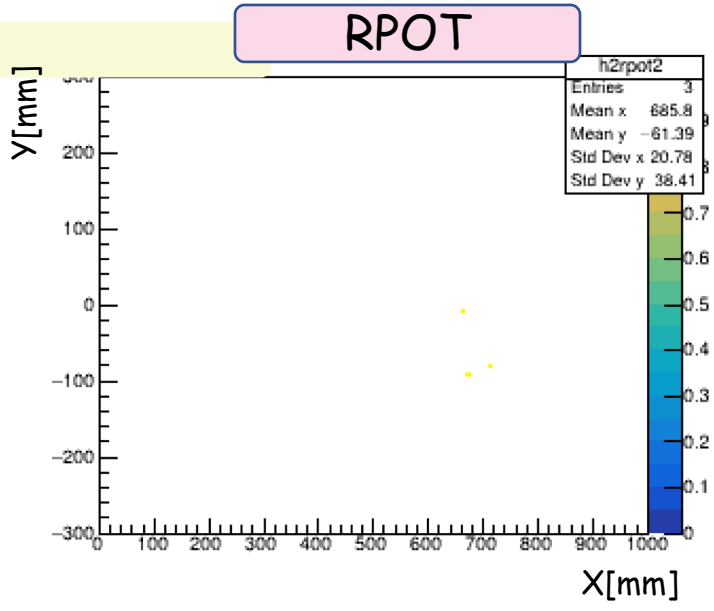
B0



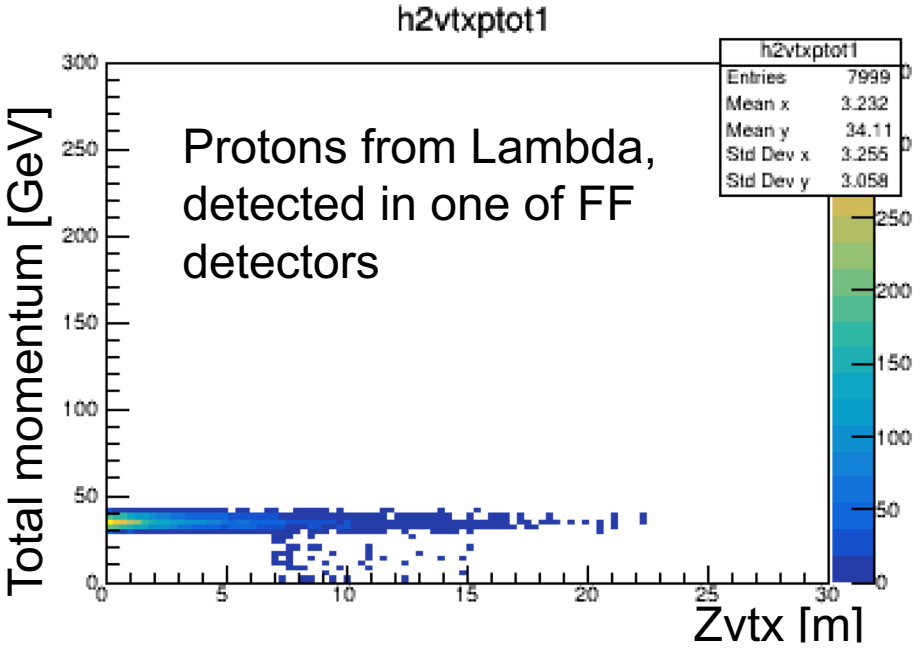
OFF mom

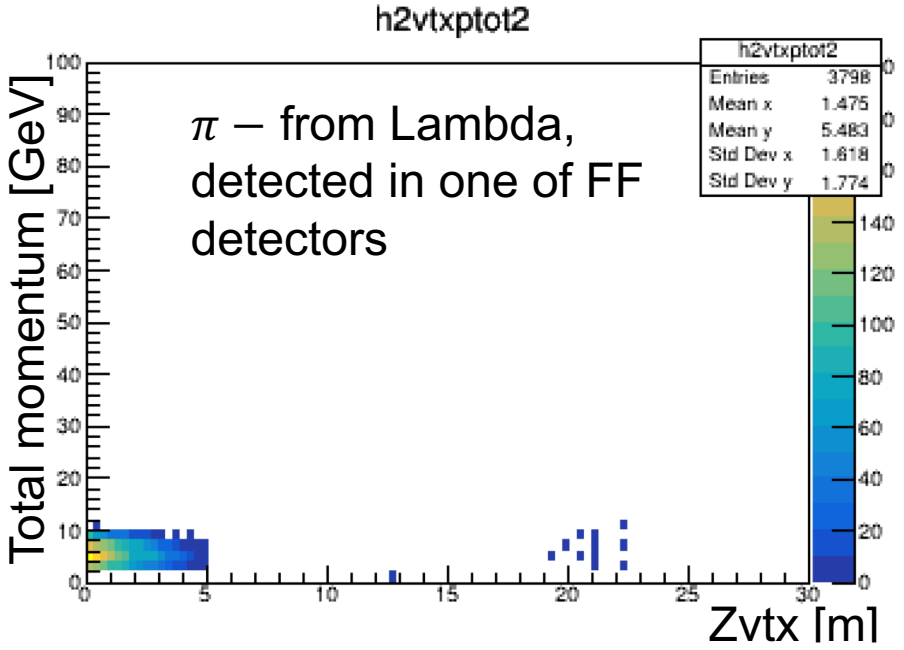


RPOT

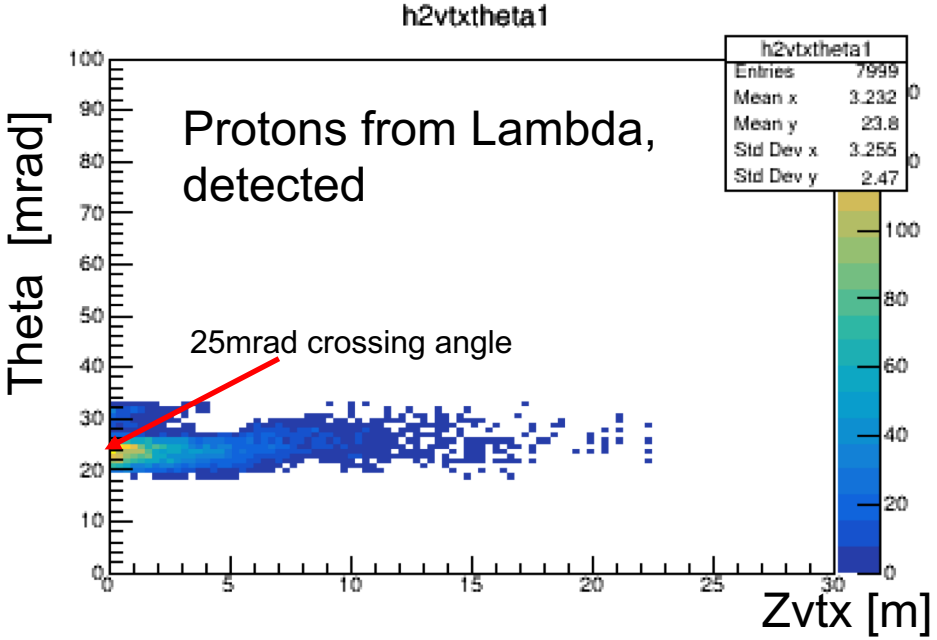


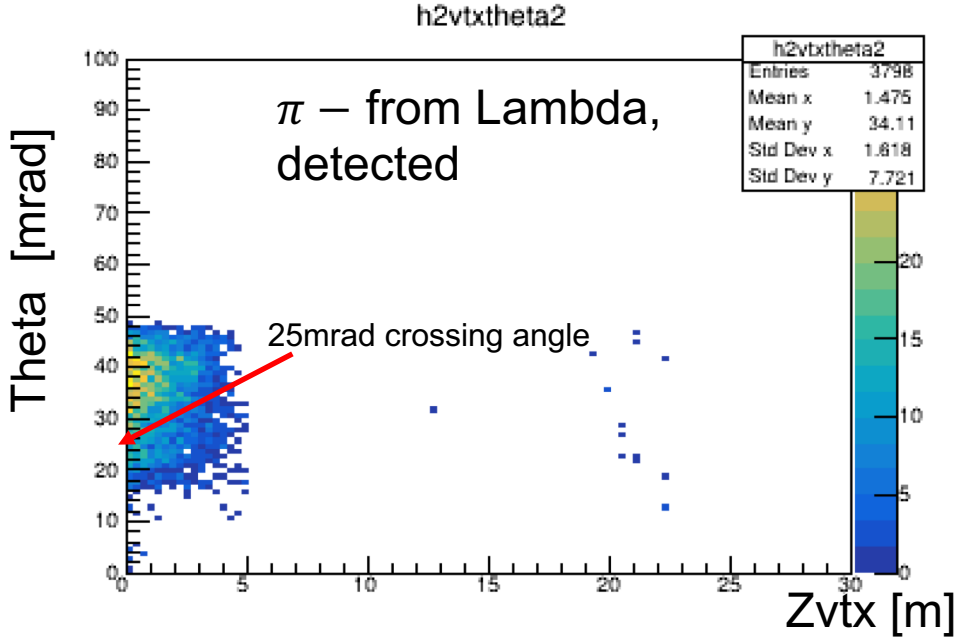
5x41 GeV in real detector

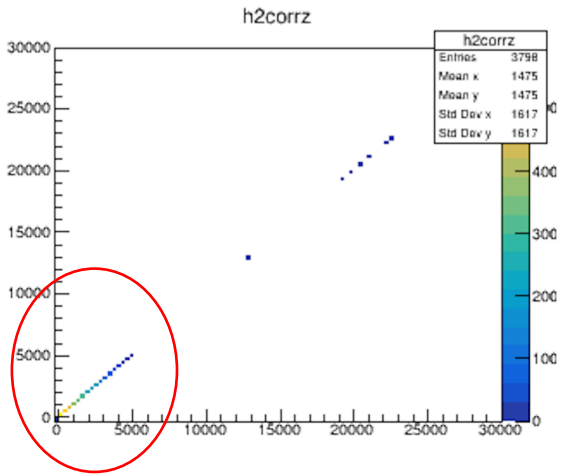




For this energy pions are detected mostly in B0 and protons in the Off-momentum detector.





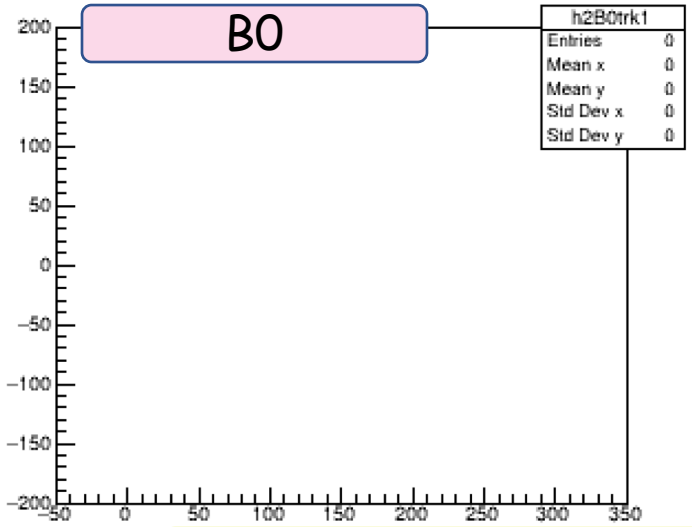


10x100 GeV

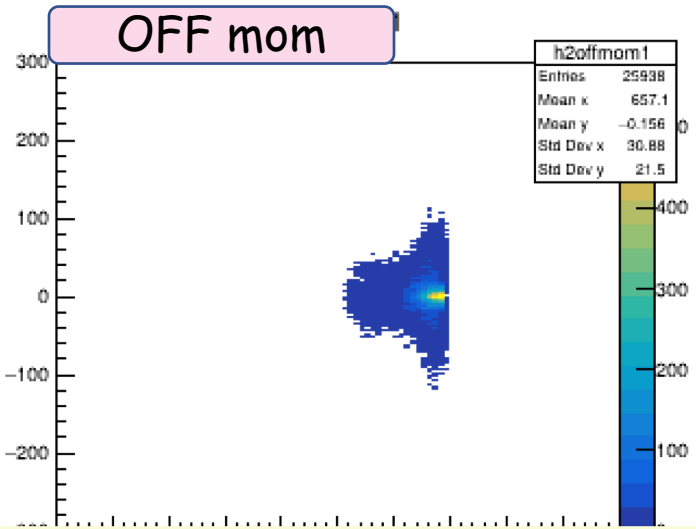
Color coding : Not normalized!

Protons

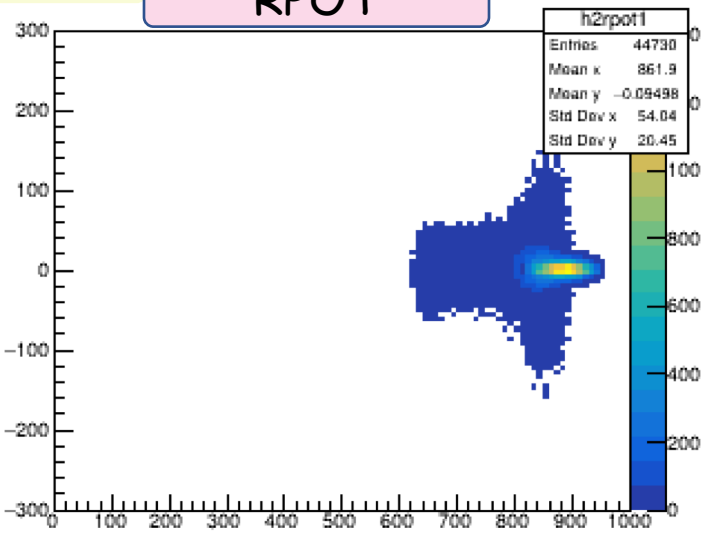
B0



OFF mom

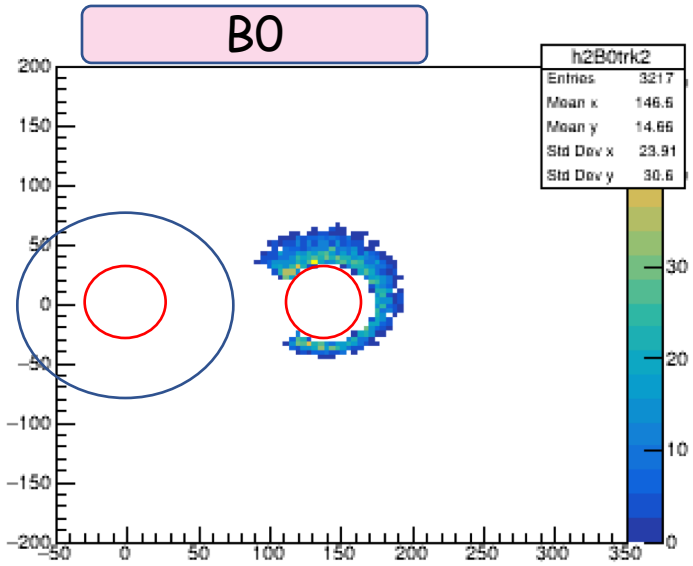


RPOT



Pions

B0



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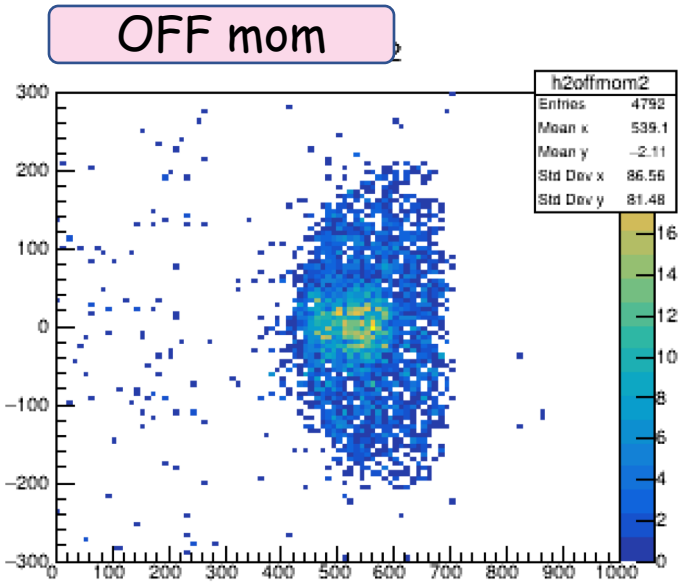
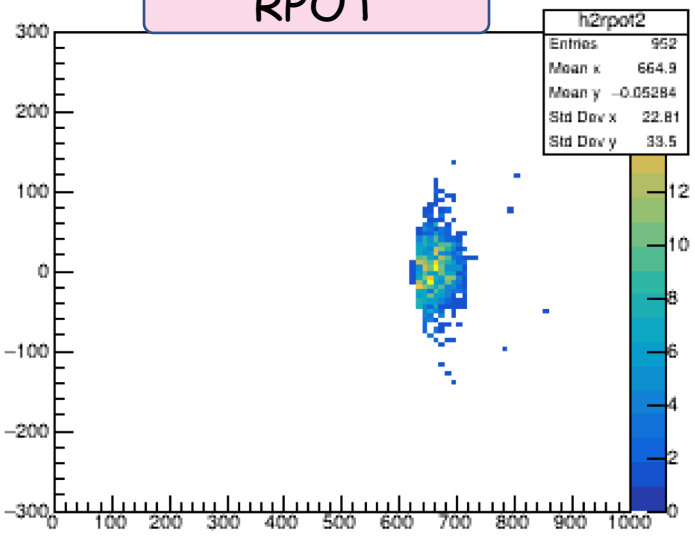


RPOT



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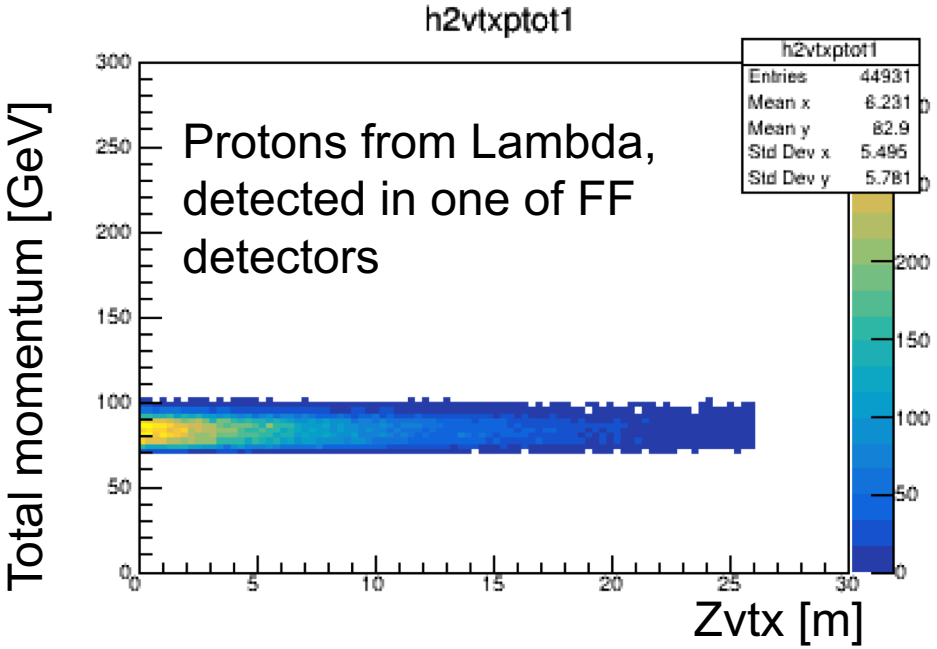
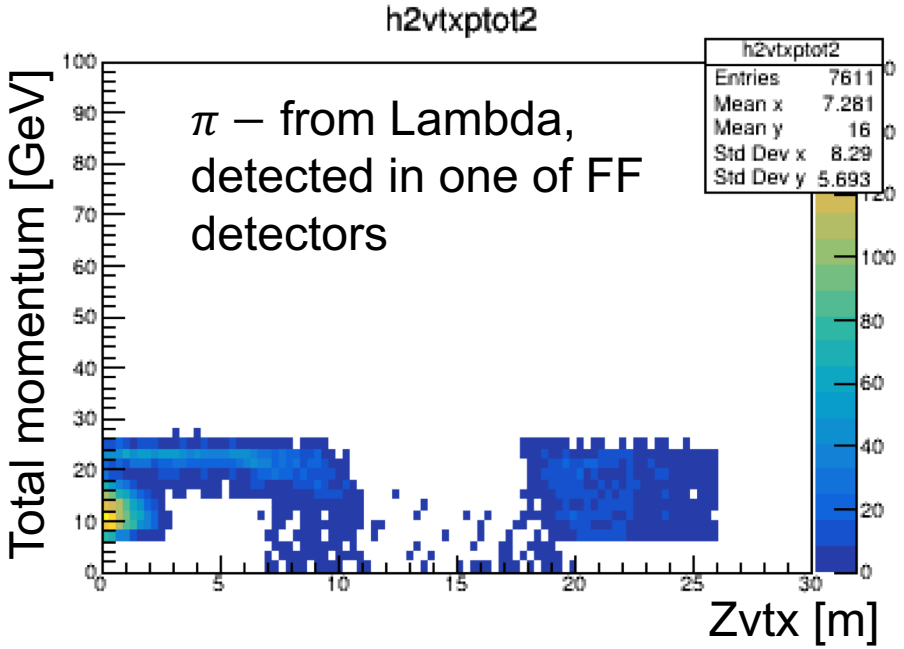
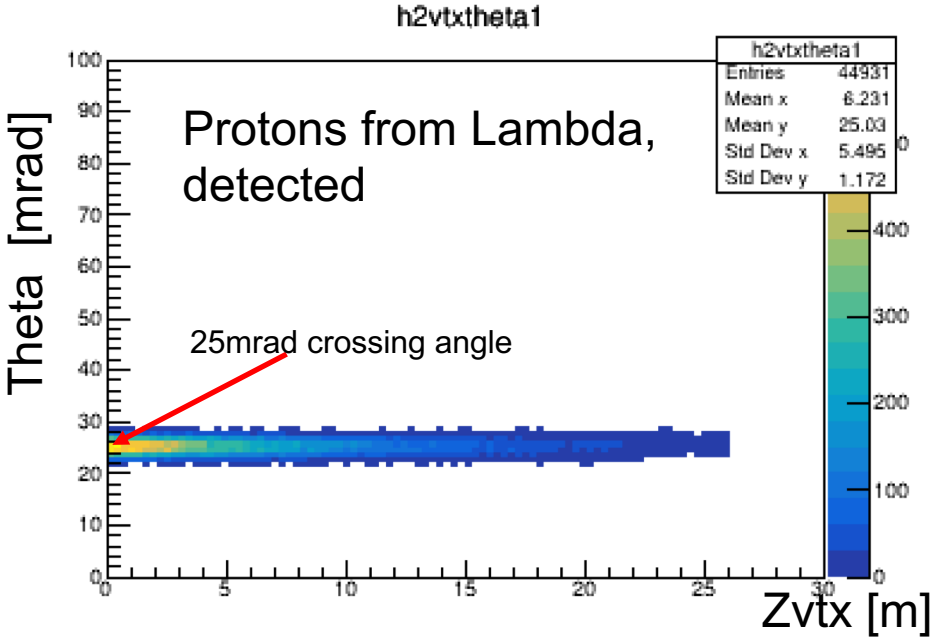
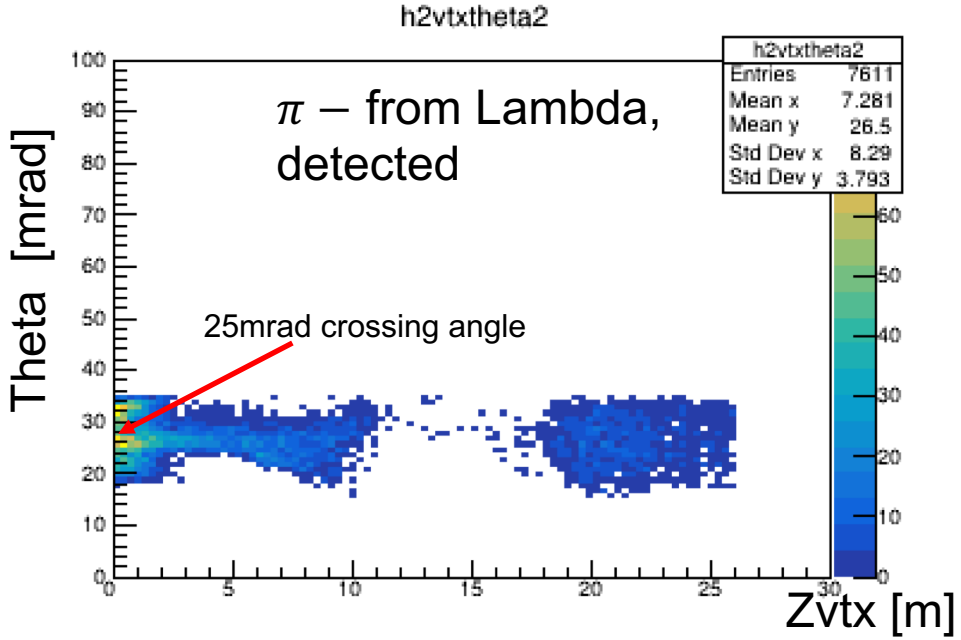


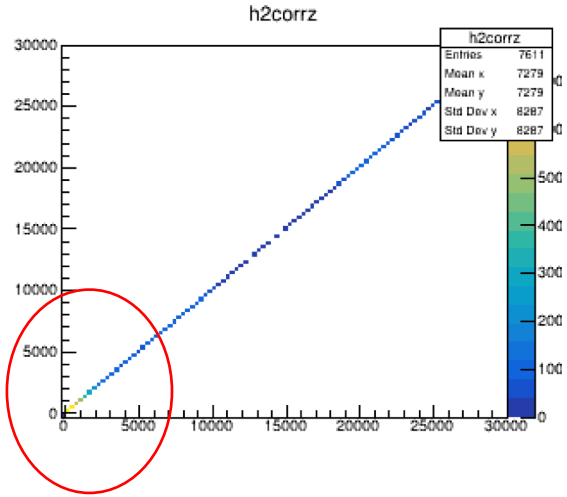


- For this energy pions are detected mostly in B0 and protons in the Off-momentum detector.

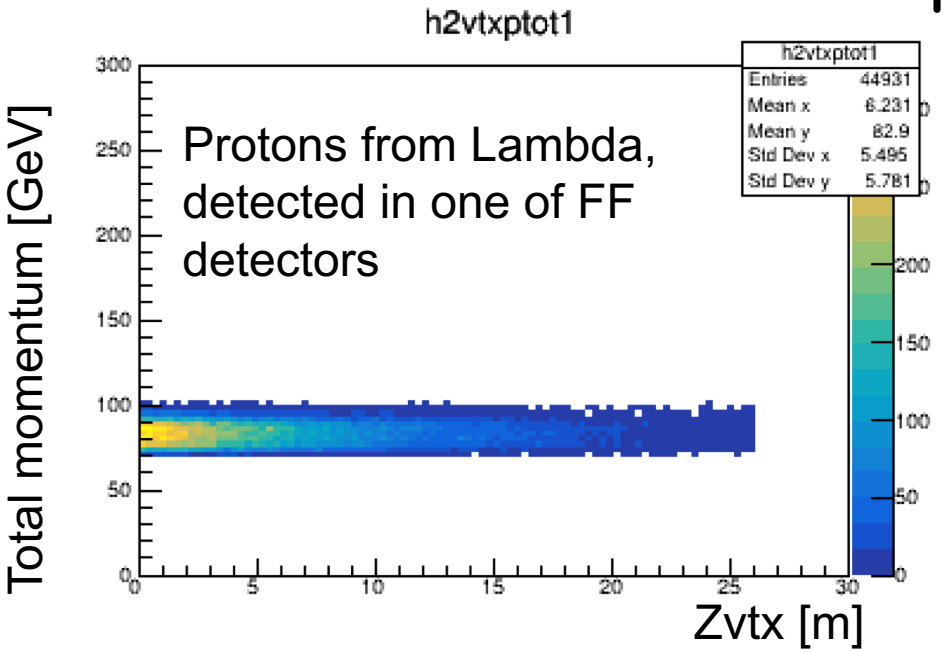
- Different normalization from other beam energy samples

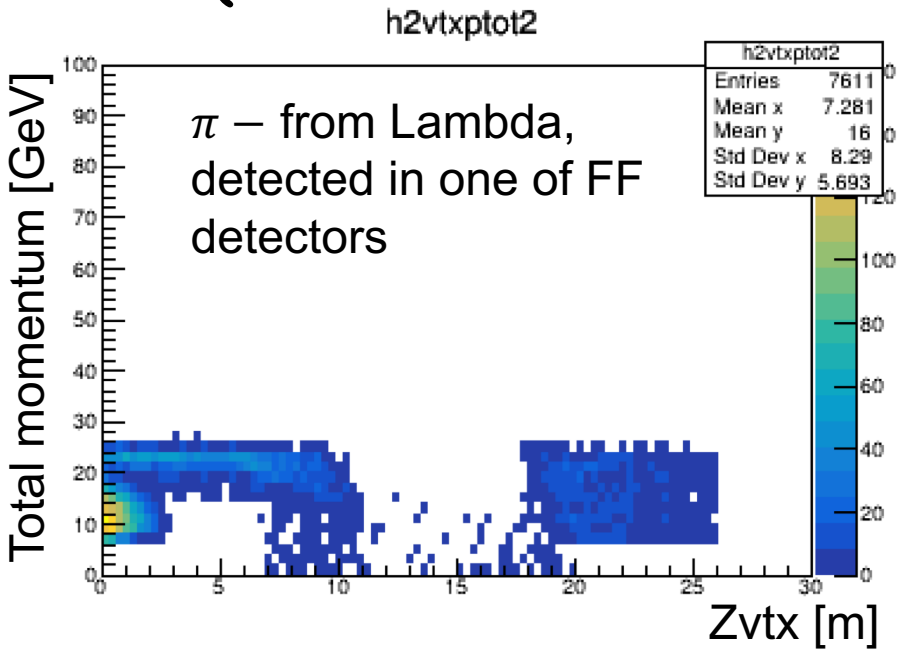




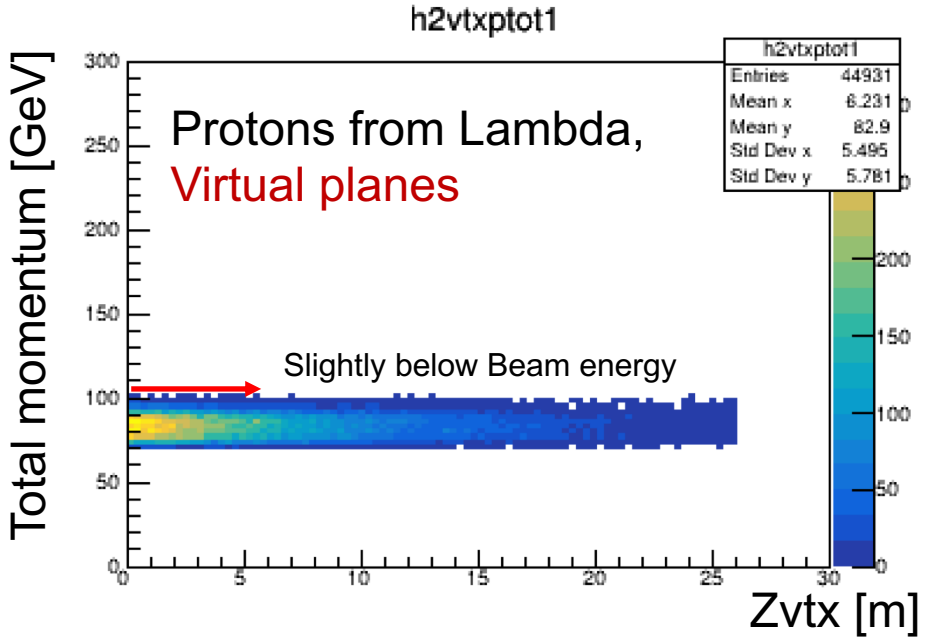


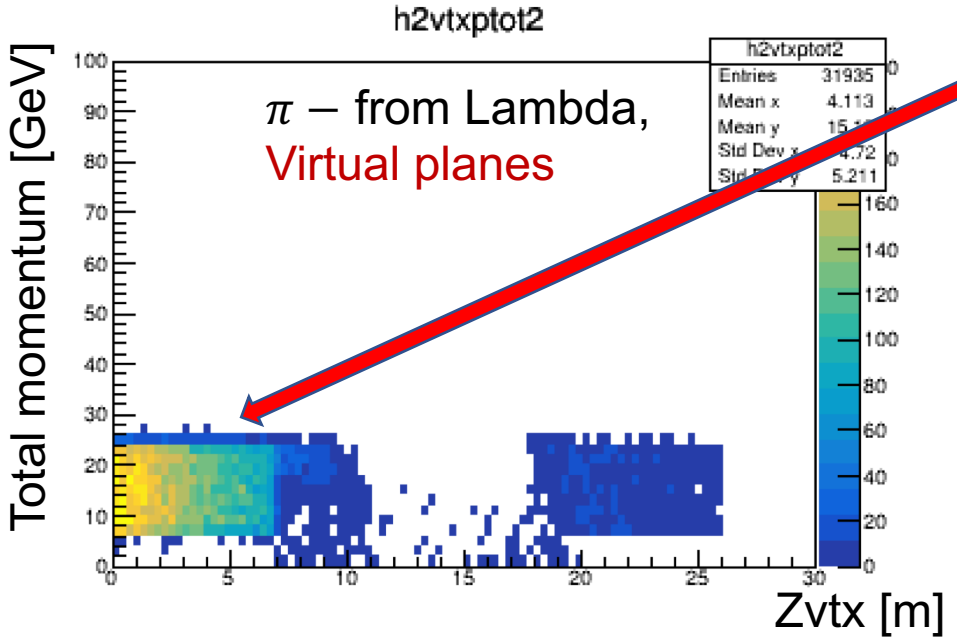
Real detectors vs virtual planes (Momentum vs Zvtx)





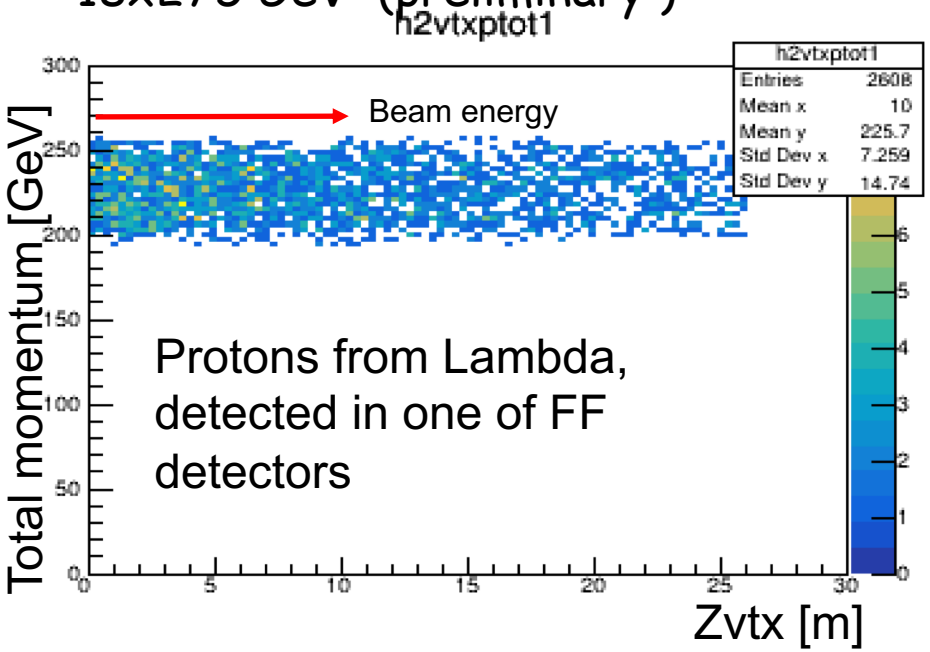
10x100 GeV

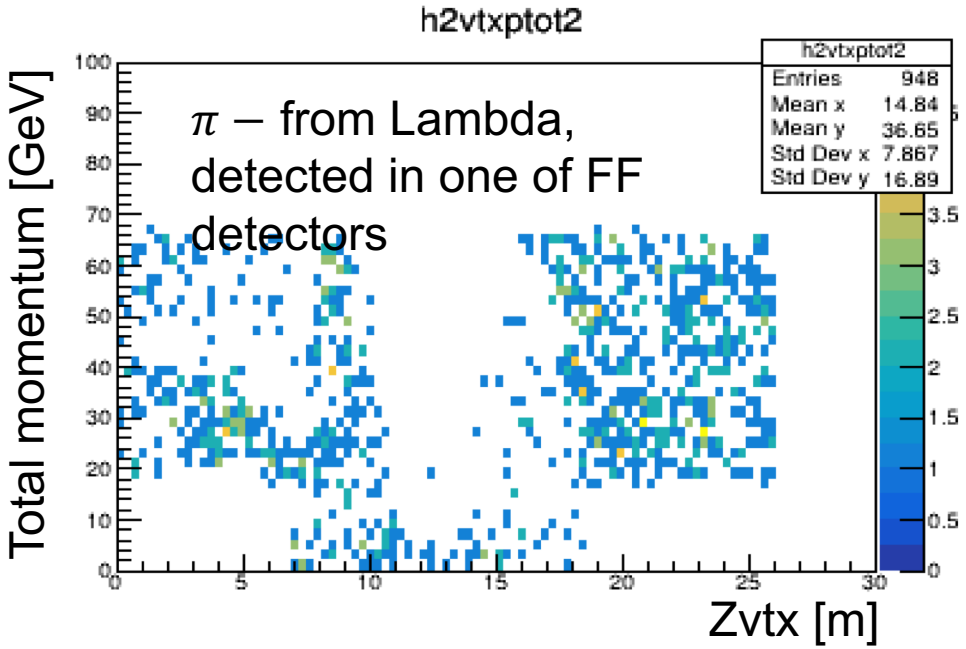




Includes B0 tracker up to 0 (no beampipe)

18x275 GeV (preliminary)

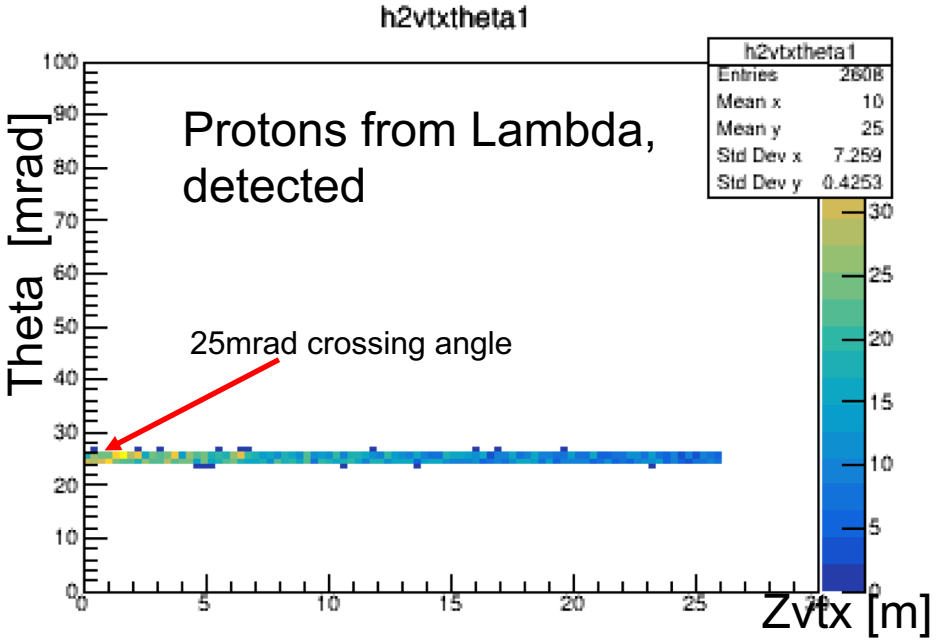


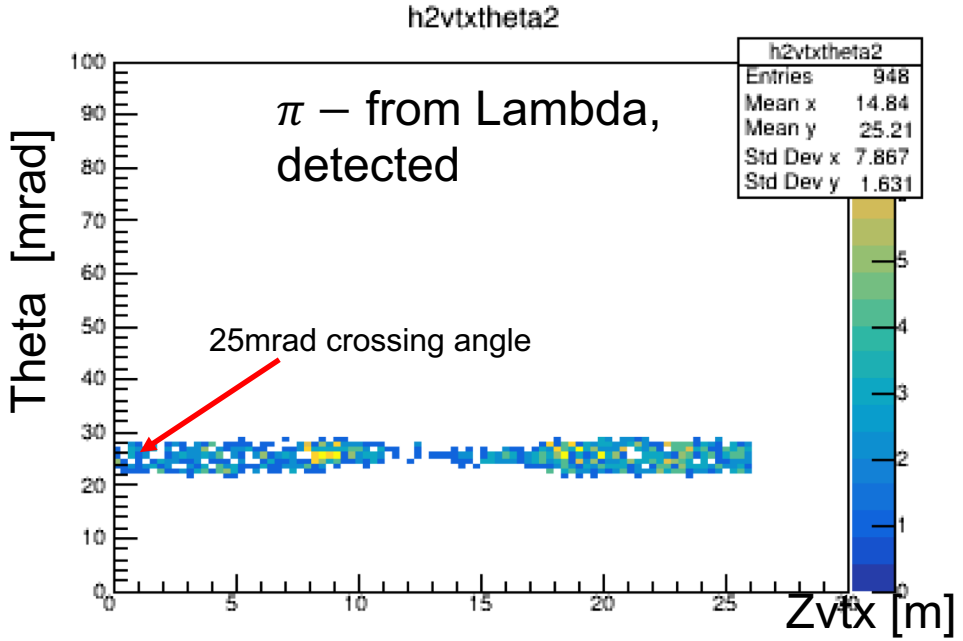


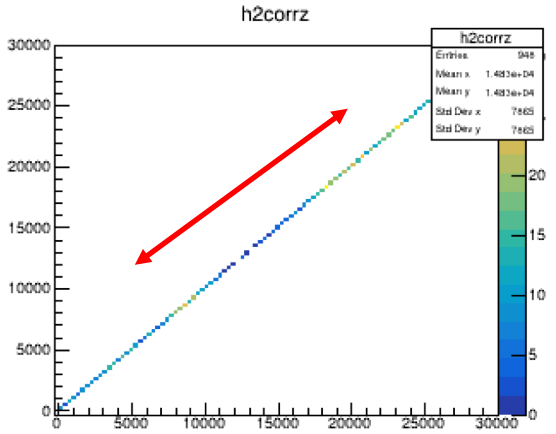
-Lambda's decay vertex is large

- Therefore detecting only particles in RP and OFFMom (with large momentum spread)

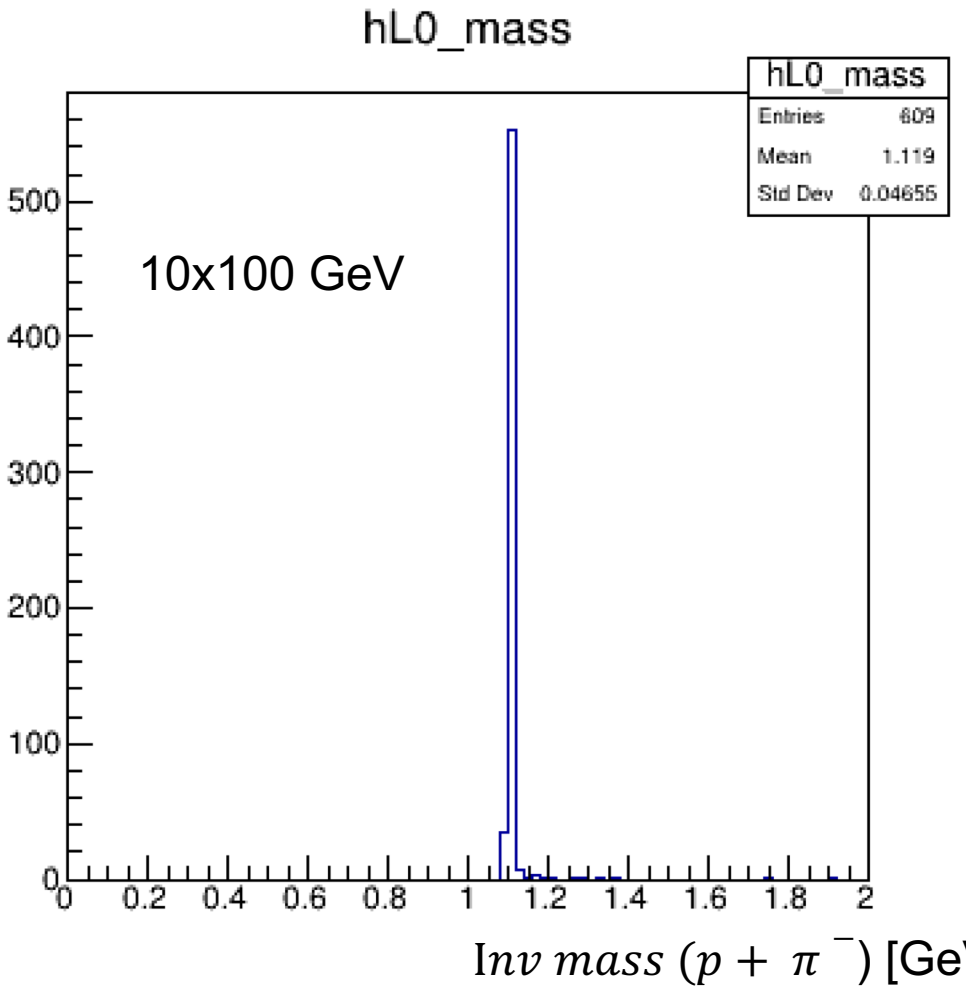
- Different normalization from other beam energy samples





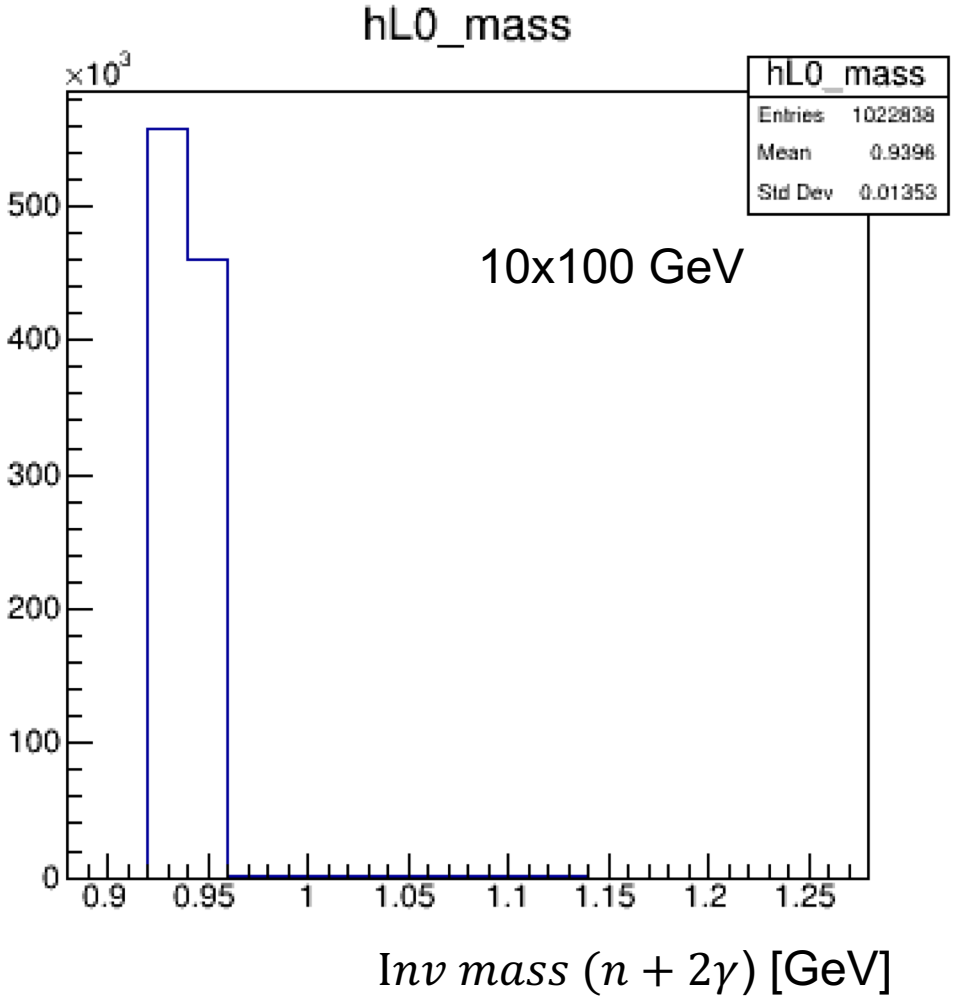


$\Lambda \rightarrow p + \pi^-$



$\Lambda \rightarrow n + \pi^0$

A lots of gammas, but they are not forming a Lambda peak (needs more investigations)



$\Lambda \rightarrow p + \pi^-$

```
mode[0] = new
G4PhaseSpaceDecayChannel("lambda",0.639,2,"proton","pi-");
G4PhaseSpaceDecayChannel("lambda",0.358,2,"neutron","pi0");
```

From 10,000 total lambda events only 6390 events decays to charged particles $\Lambda \rightarrow p + \pi^-$ (Branching ratio)

	5x41		**10x100**		**18x275 (preliminary)**	
Detected	Protons	Pions	Protons	Pions	Protons	Pions
B0	225	3311	-	414	-	-
OFF Mom	2526	378	541	687	2700	861
RPOTs	260	2	6233	124	2662 ?	291 ?
Total detected	2606	1267	6261	1045	2608	948
Total Lambdas reconstructed	1267 (~20%)		1045 (~16%)		948 (15%) ?	

Note, that particles have displaced vertex along Z (meters)

Conclusions

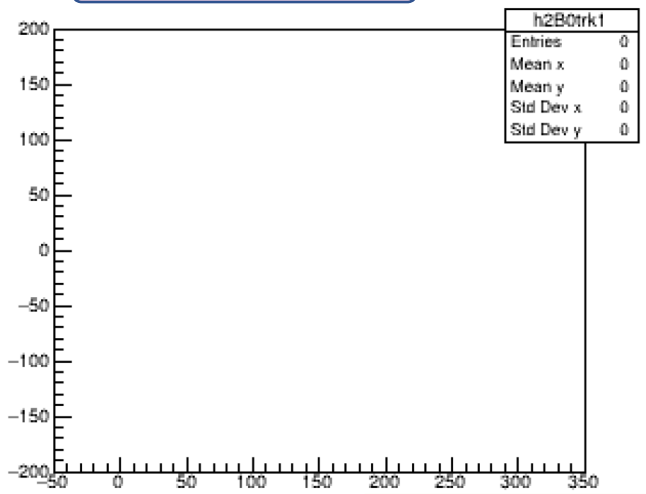
- Ca 20 % detection efficiency for $\Lambda \rightarrow p + \pi^-$ for low energies.
- Need to reduce proton- beampipe radius at B0 location
- Off momentum detector –need to be symmetric in φ (to detect opposite charge),also important to reduce beampipe radius
- For high energy beam settings: lambdas decay length is very high (meters!), momentum is high and very low theta => How to reconstruct momenta?
- Need to find a proper detector placement.
- Todo:
  - Momentum vs Zvtx for different sub-detectors
  - Zvxt cut < 2m

18x275 GeV

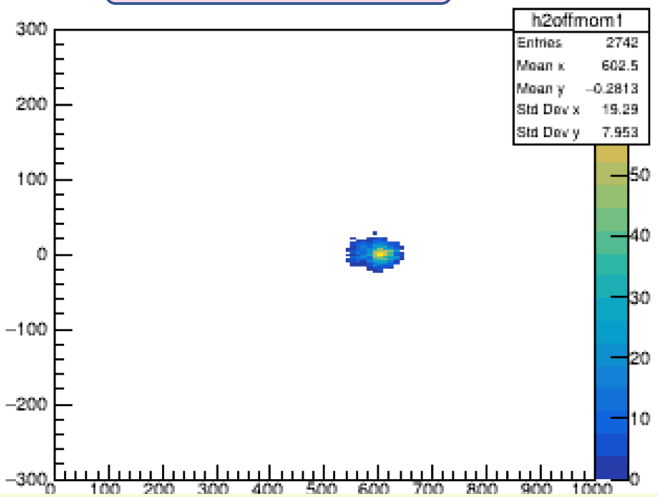
Preliminary ….

Protons

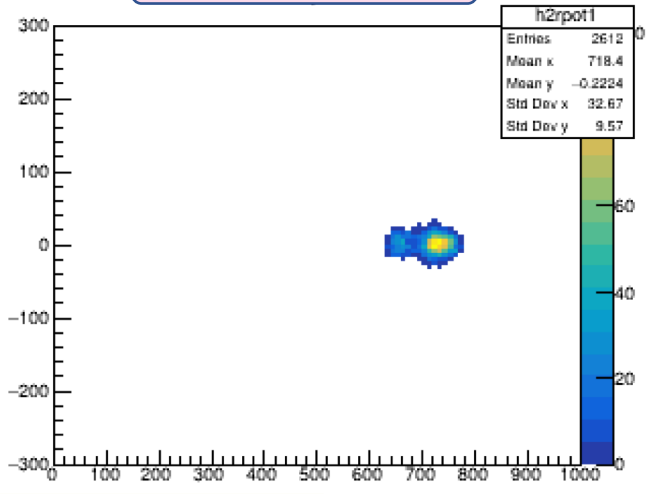
B0



OFF mom

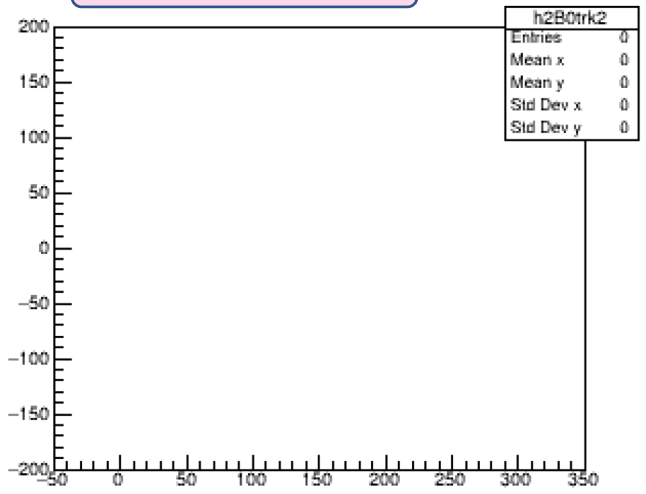


RPOT

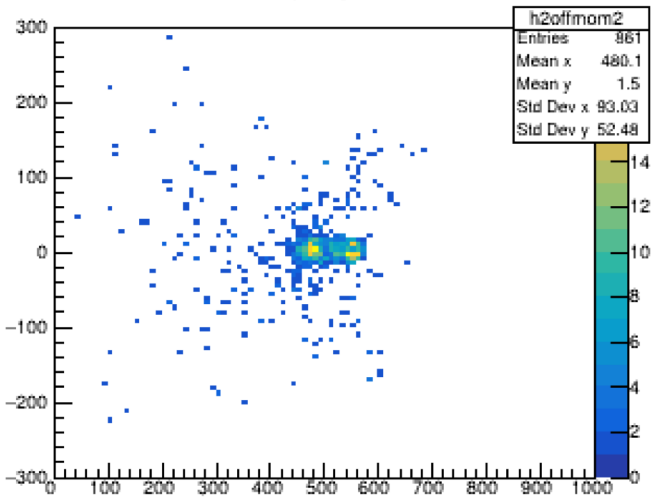


Pions

B0



OFF mom



RPOT