IPN
INSTITUT DE PHYSIQUE NUCLÉAIRE
ORSAY

Studies of STT response for π^- and e^- with PANDAroot

Binsong MA
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Goals

→ Validation of PANDAroot simulations for electromagnetic channels:

- Tracking efficiency for electrons and pions:

  mainly checked for muons up to now

- Momentum reconstruction:

  study of momentum resolution for electrons with Kalman filter:

  pb of radiation, is another method needed?

- e/ π discrimination using dE/dx
  - Use simulations to check/improve the parameterization of dE/dx
  - Use prototype results to validate the simulations

→ Feasibility studies for TDA measurement in pbar p → $\pi^0 e^+ e^-$

STT structure

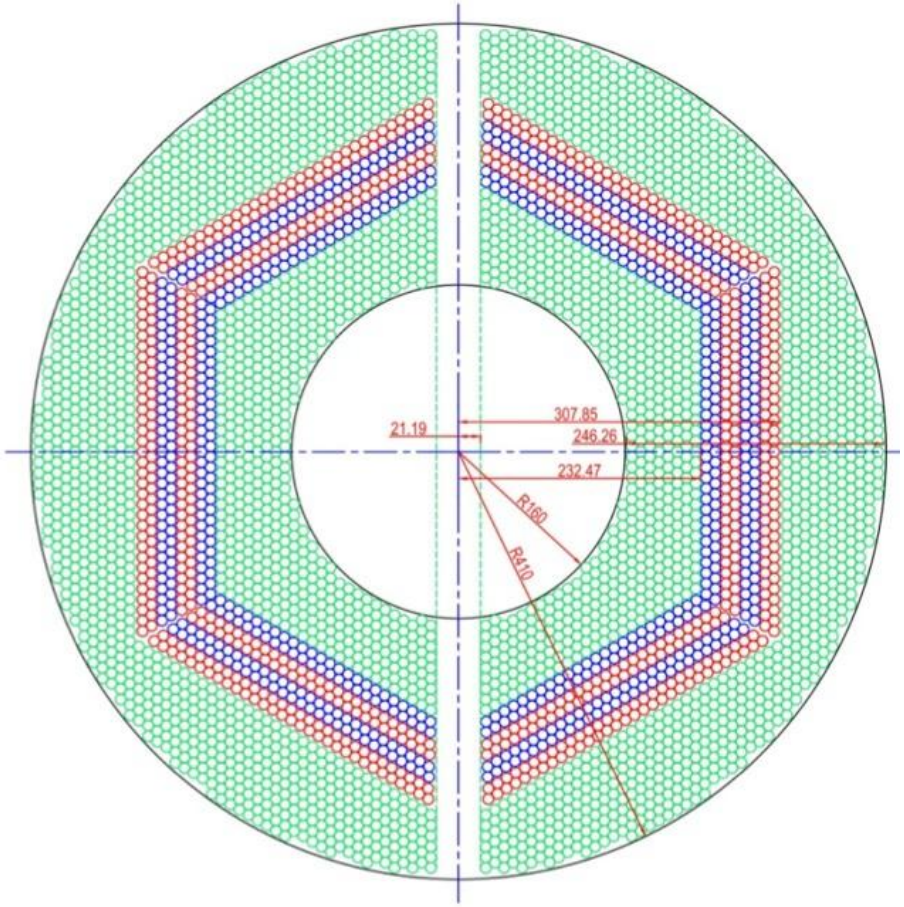
→ 4636 Straw tubes in 2 semi-barrels around beam/target cross-pipe

→ 23-27 planar layers in 6 hexagonal sectors

→ 15-19 axial layers (green) in beam direction

→ 4 stereo double-layers for 3D reconstruction, with $\pm 2.89^\circ$ skew angle (blue / red)

→ Gas: Ar/CO_2 at 2 bar



Simulation for π^- and e^-

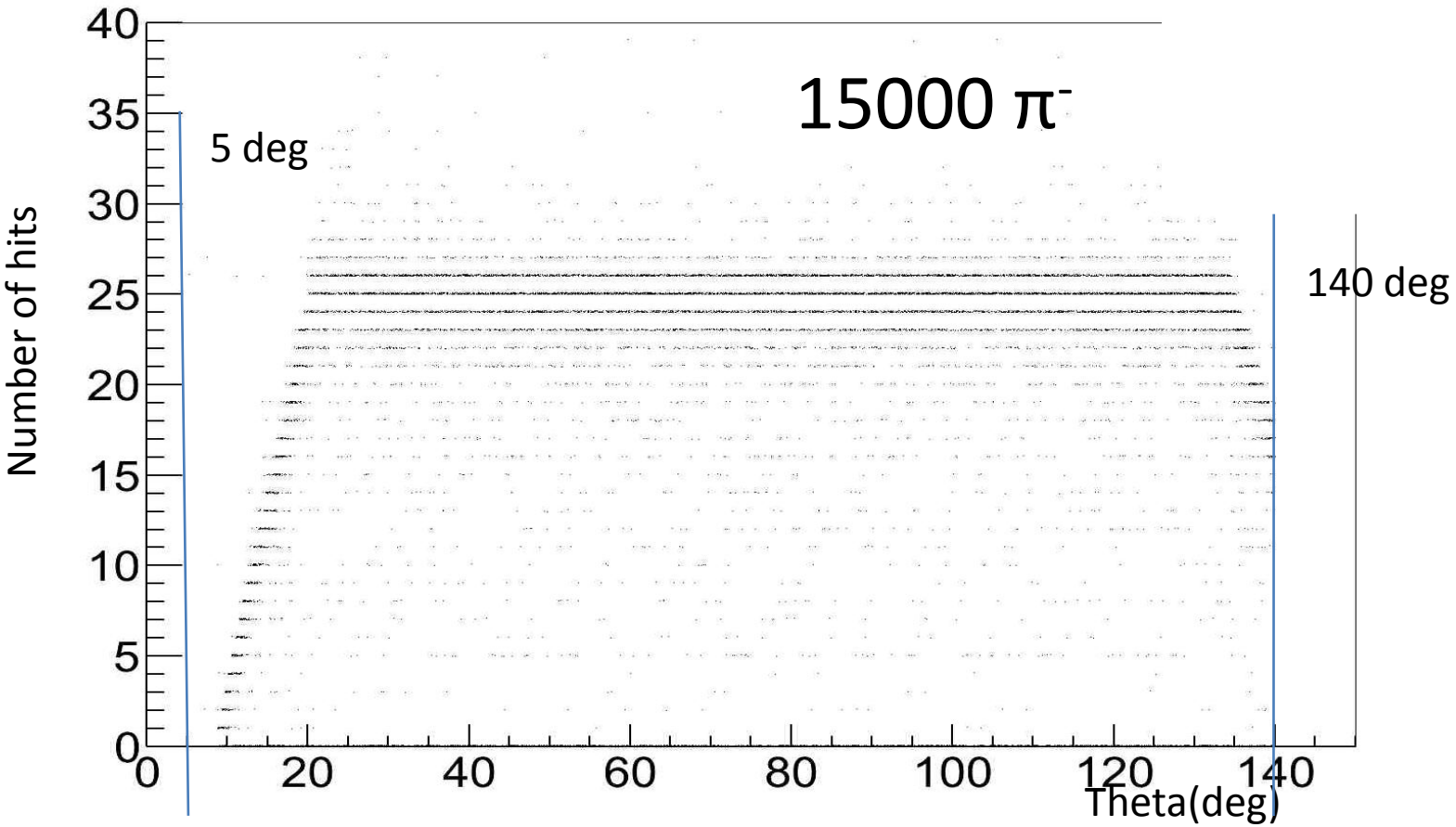
- 15000 events π^- and e^- with pgun mode (single particle events)
- Momentum: from 0.05 GeV/c to 5 GeV/c
- Theta : from 5° to 140°
- Phi: [0°,360°]
- preliminary studies of STT response to π^- and e^- :

→ Acceptance considerations: select STT hits associate with π^- from MC track

→ secondary particles study

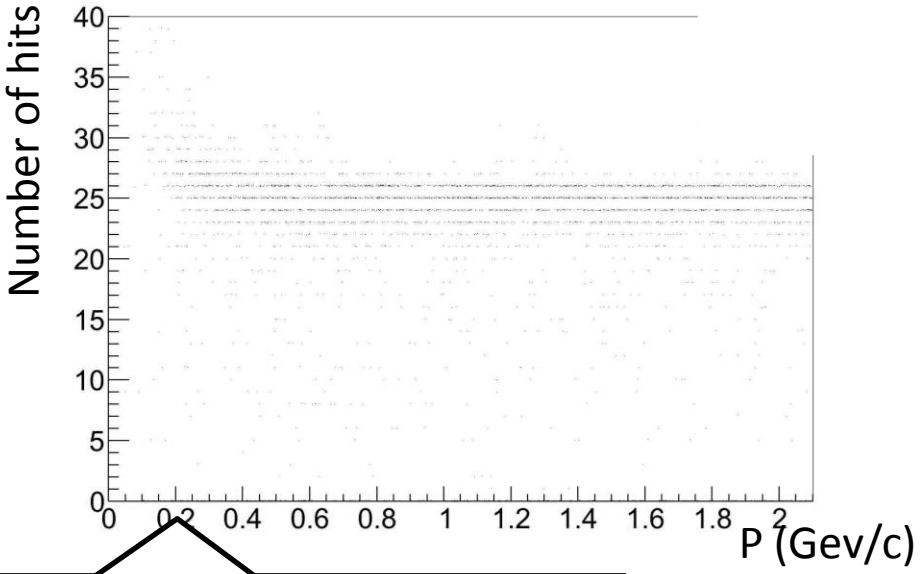
Numbers of STT hits for π^-

info from PndSttHit class(simulation level), only hits associated with the primary π^- are selected

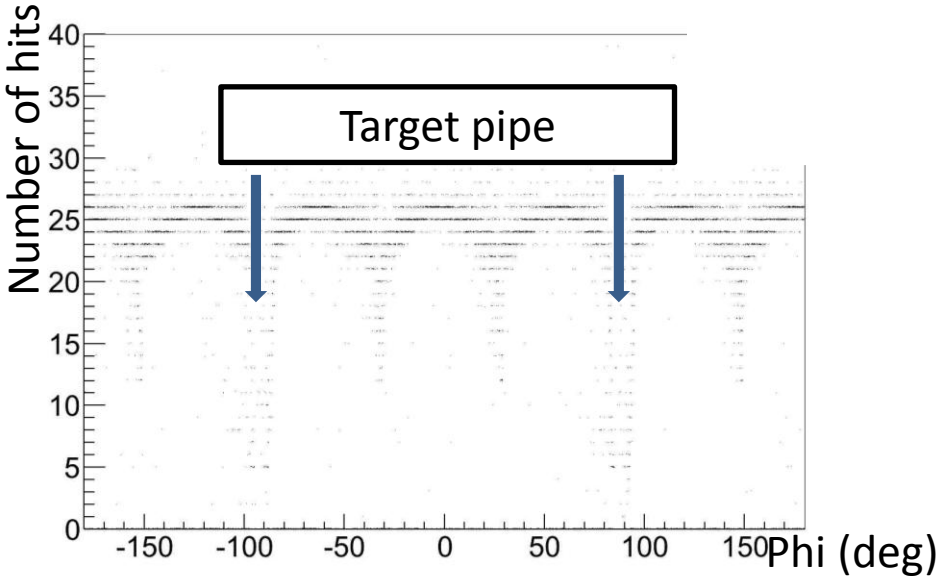


Dependence on momentum and ψ

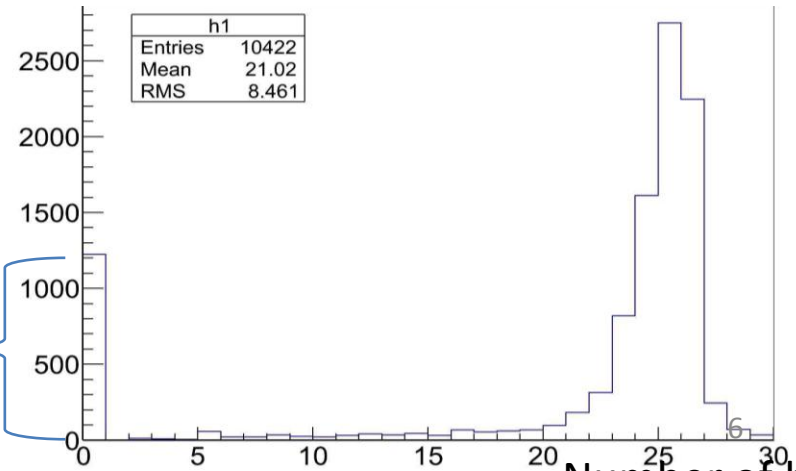
θ∈ [30, 120]



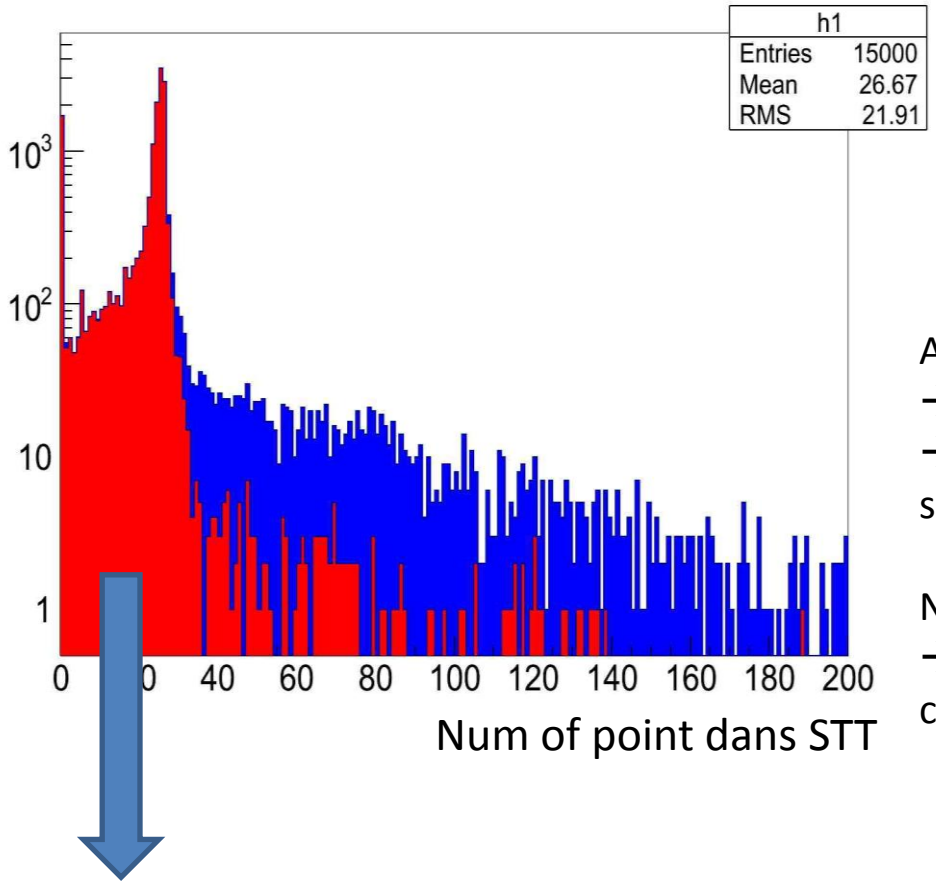
Low P region, more hits found (or less hits)



No hit events: 12%
Very low P particles
Particles drop in target pipe



Secondary particle(from π^-) study



Red: points associate with primary π^- MC track

At the level of MC simulation(PndSttHit class):
→29.1% of hits from STT associated with secondaries
→14.8% of events reaching STT with at least 1 secondary particle.

Nature of these secondary particles?
→ Investigation in PndPidCandidate class (at least 1 charged track reconstructed)

Numbers of π^- interacting before reaching STT

- $N=N_0 \exp(-\rho e N_A \sigma / A)$

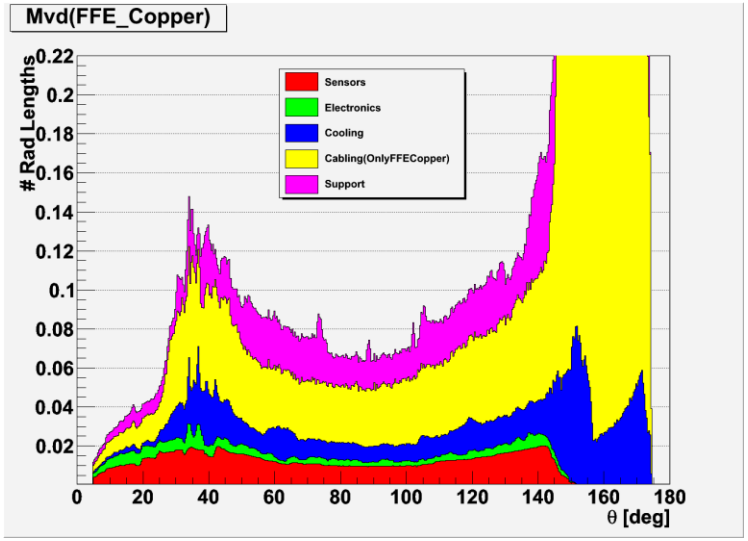
MVD total thickness at 90° : 0.67cm($0.07X_0$)

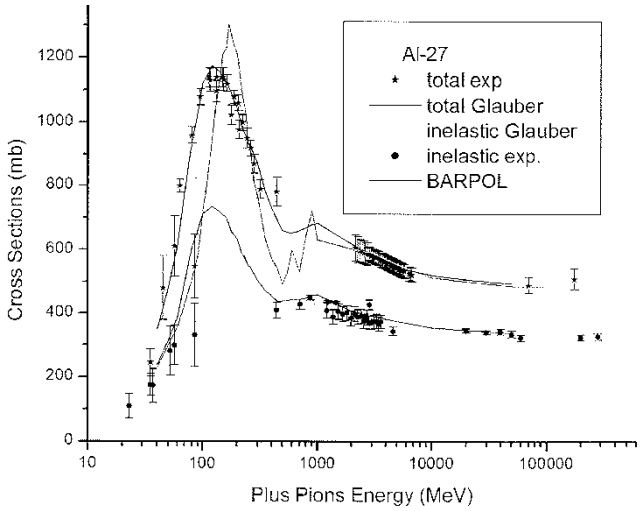
at 32° : 1.34cm($0.14X_0$)

cross section for π- reaction: 0.7 barn

N/N_0 (90°) ∽ exp(-0.0235)=97.6%

N/N_0 (32°) ∽ exp(-0.0887)=91.5%



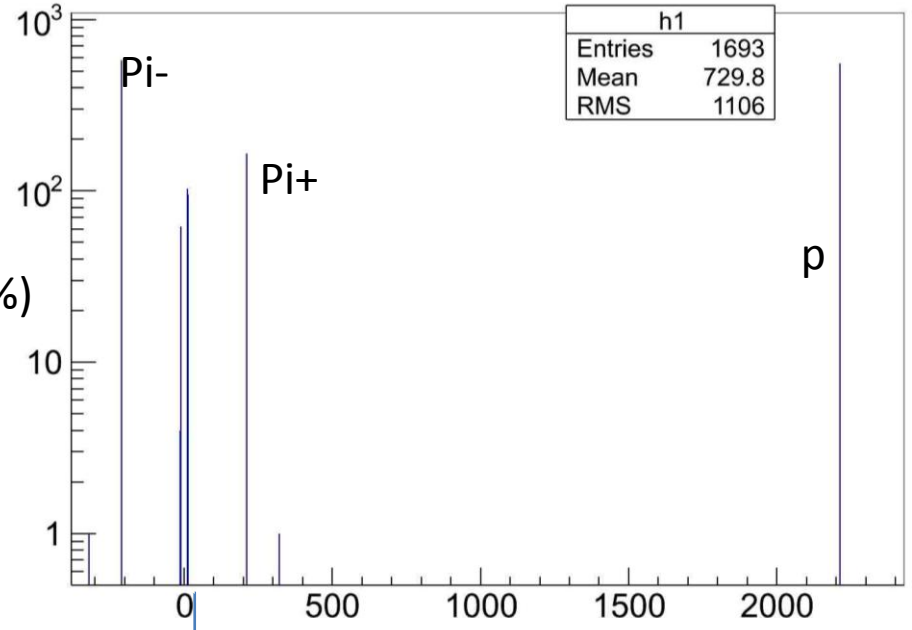


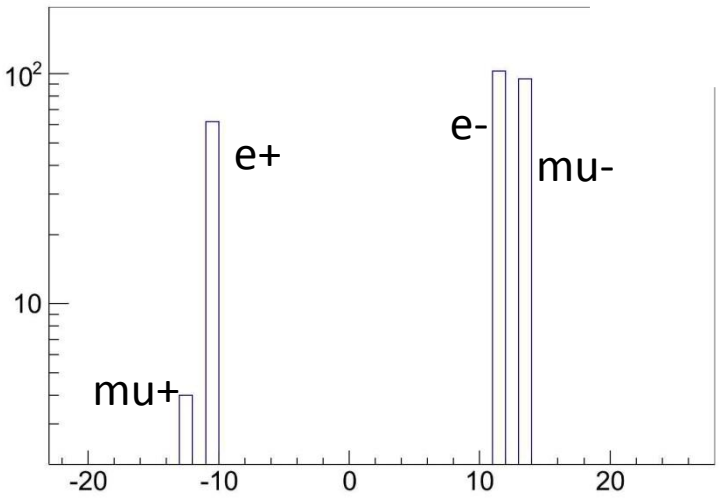
The secondary particles

Study from the PndPidCanditate class

Total numbers of track found: 14803

Numbers of primary π^- : 13110 (88.6%)



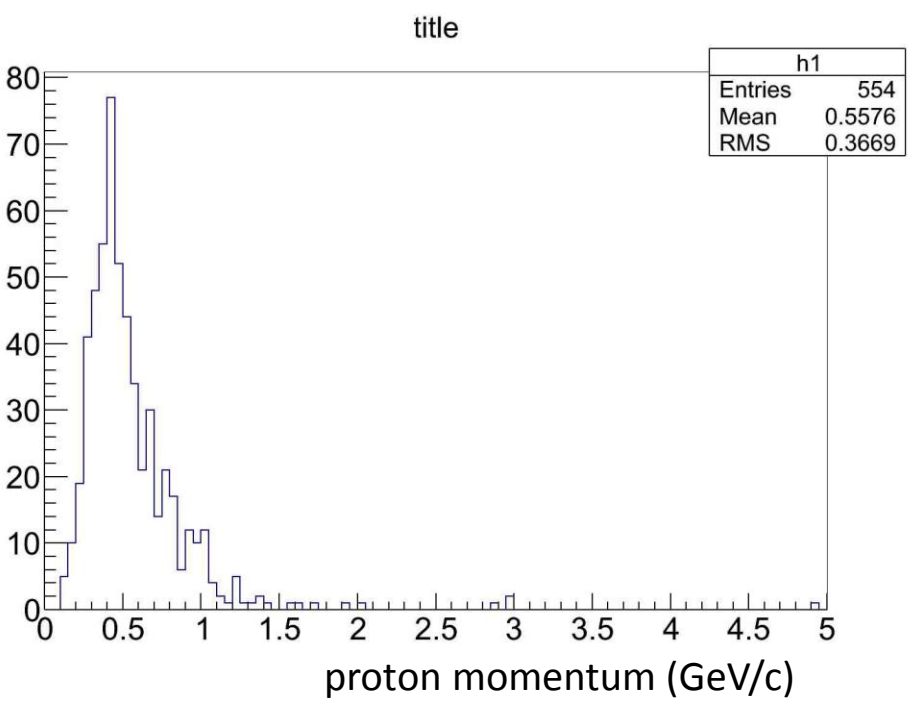


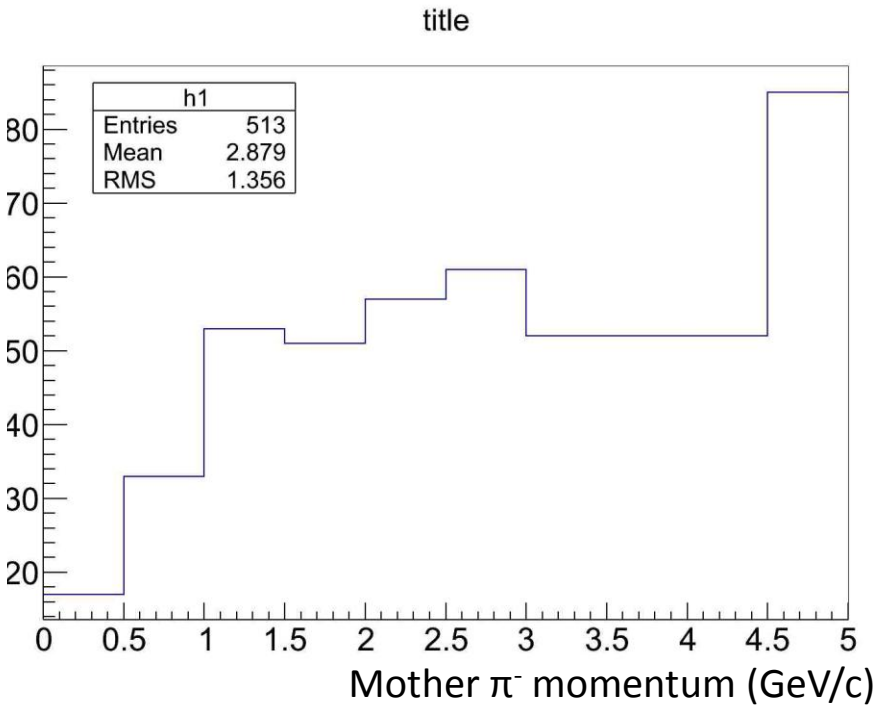
P : 554 (3.7%)
Pi-: 578 (3.9%)
Pi+: 165(1.1%)
Mu-: 95(0.6%)
…….

Origins of secondary particle

- Possible reactions producing secondary particle
- → $\pi^- \rightarrow \mu^- \nu_\mu bar$ (decay)($c\tau$= 780cm)
- → $\pi^- A \rightarrow k(\pi) +$…… (multi pion product)($\sigma \backsim$ 1 barn)
- $\pi^0 \rightarrow \gamma\gamma \rightarrow e^+e^-\gamma$ (conversion)(P = 2%~10%)
- $\pi^+ \rightarrow \mu^+\nu_\mu$ (decay)
- → $\pi^- A \rightarrow np +$ …… (absorption)(σ~500mb)
- → $\pi^- A \rightarrow \pi^- A$ (elastic scatting)(σ~200mb)

Secondary proton study

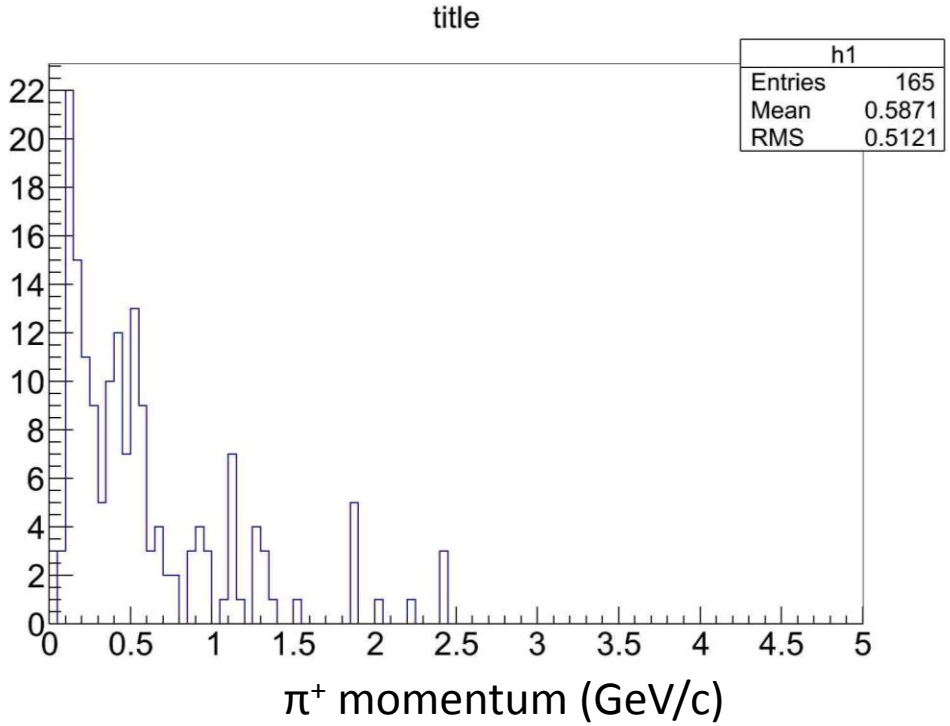


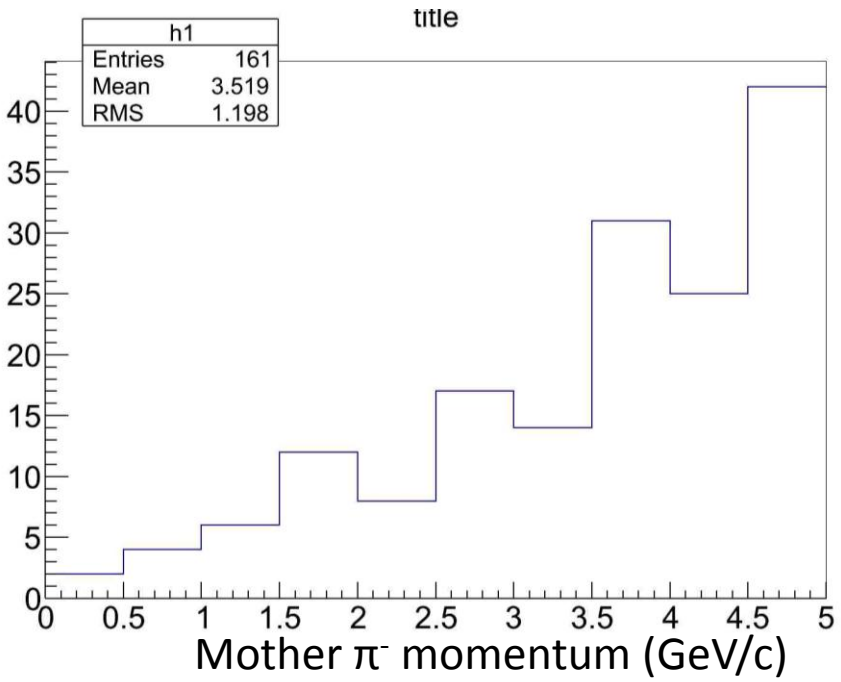


Low energy protons: <Tp> = 90 MeV

Contribution important for pions above 700 MeV/c

Secondary π^+ study

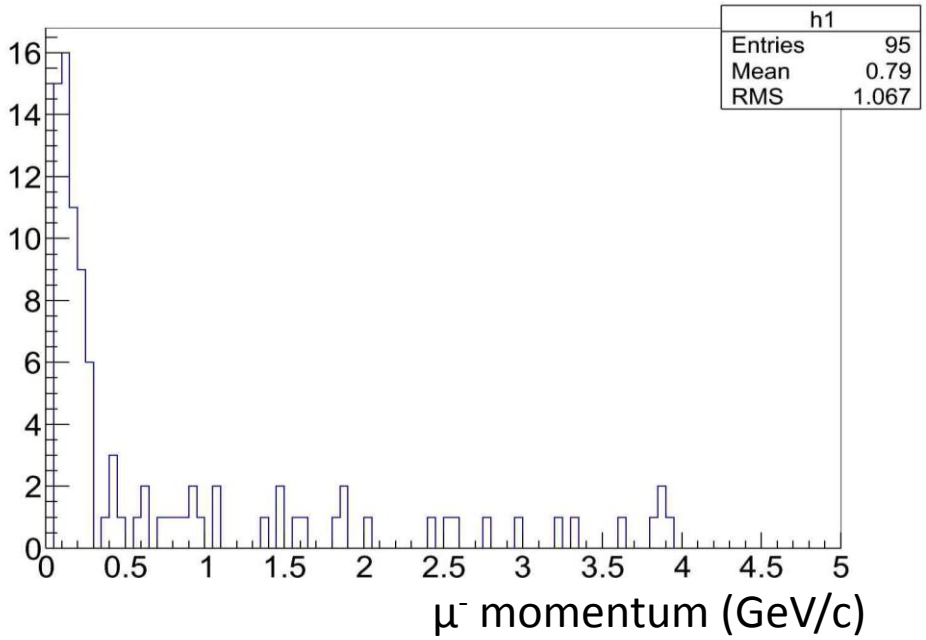


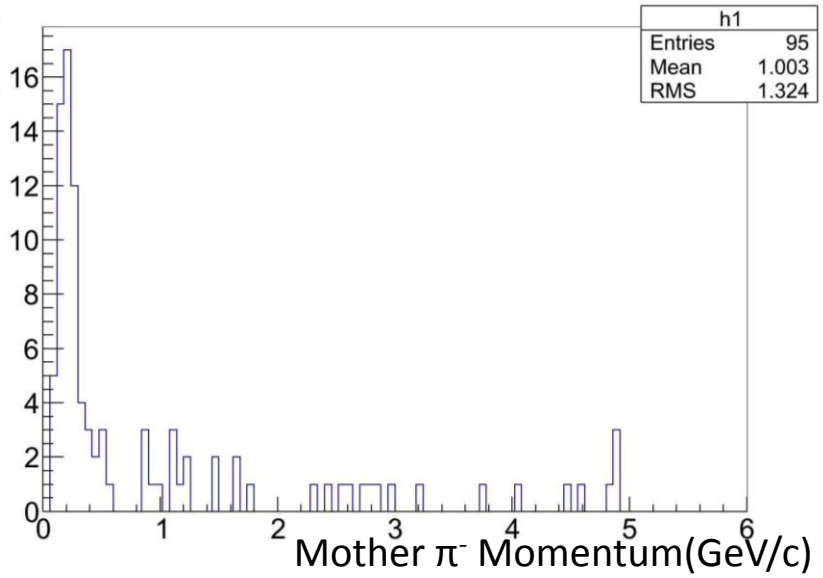


Low energy π^+ from multi-pion production

Rapid increase with P_{π^-}

Secondary μ^- study



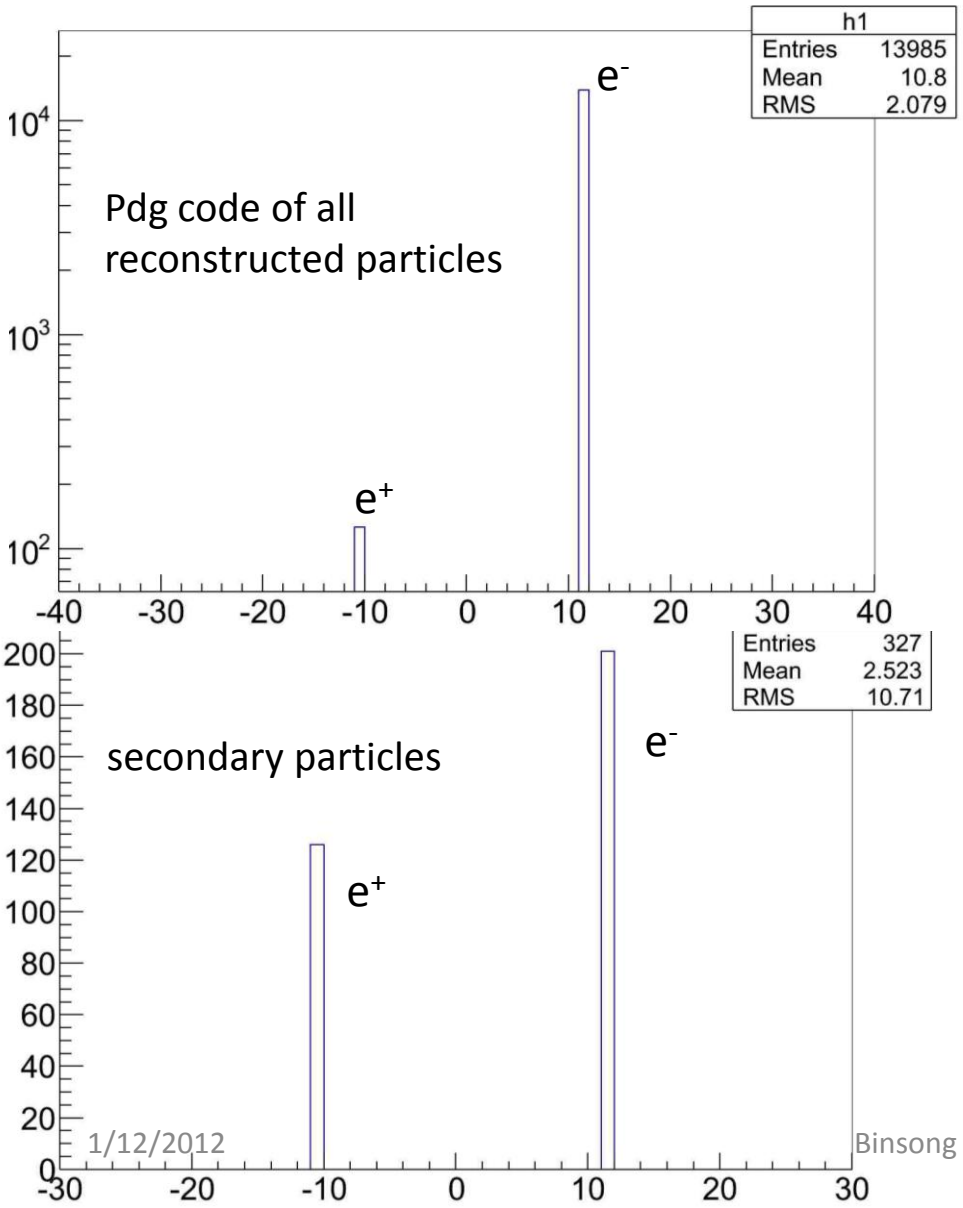


Prob(π^- decay): $p = 1 - \exp(- D/(\sqrt{(\gamma^2-1)}*c\tau))$

P(MeV/c)	At STT entry	At STT exit
50	4%	20%
>= 1000	1%	5%

→ 0.6 % survive the reconstruction

Simulation for electrons

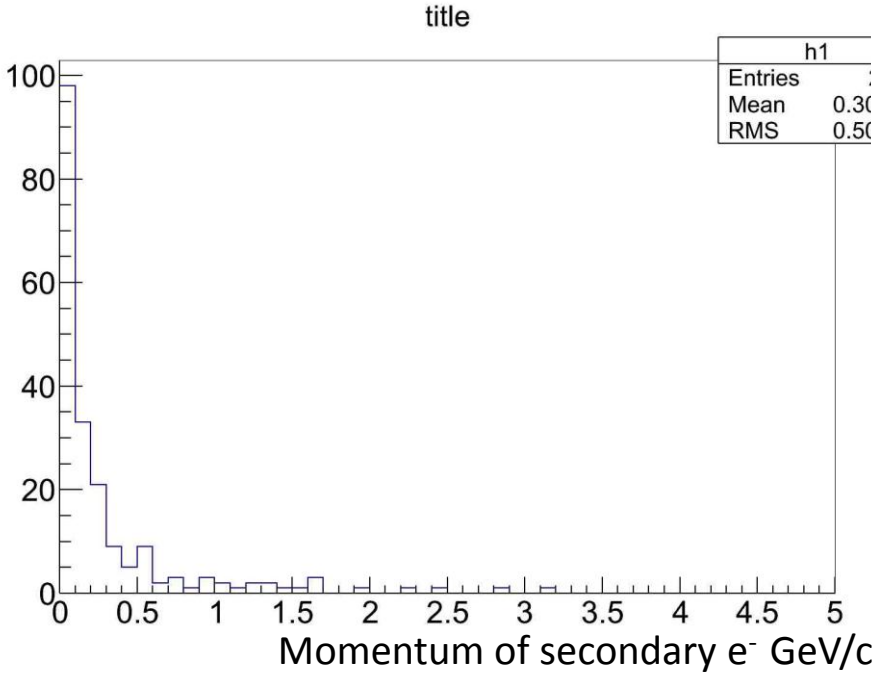


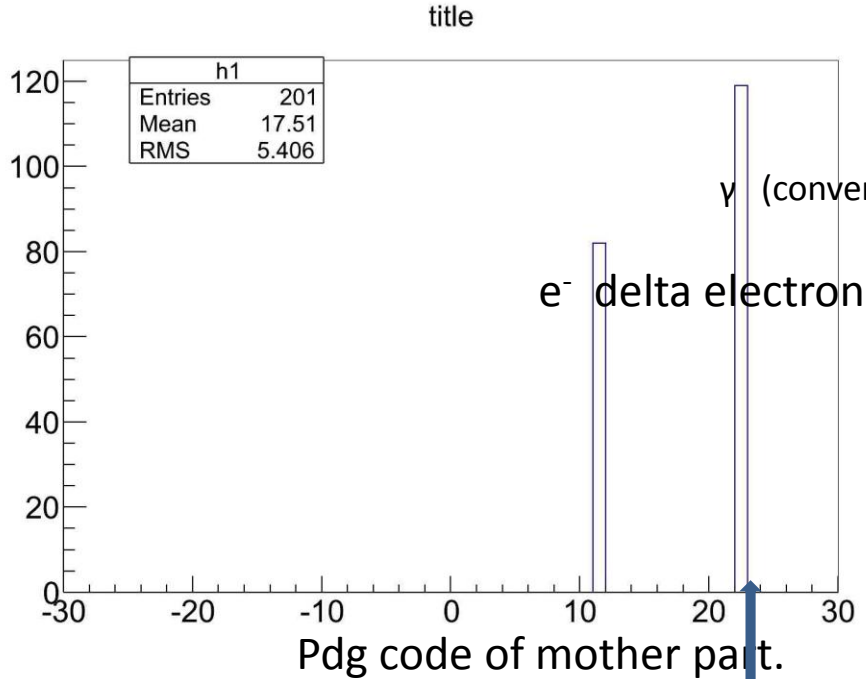
Based on reconstructed primary electrons

Reconstructed primary electron: 13658

Possible natures of secondary particles:
e^- A-> e^- A γ
γ -> e^-e^+ (conversion)
δ electrons

Secondary particles study





Very low energy secondary electrons

The same numbers of e^+

Conclusion and future work

- Simulation of π^- and e^- [50MeV/c, 5GeV/c]
- Production of secondary particles in MVD not negligible, 29.1% of STT points due to secondary particles (π^-)
- Global understanding of the origin of secondaries
- After reconstruction ~11.4% of secondaries for π^-

  ~2.4% of secondaries for e-

  dominated by low energy particle.
- Future work: momentum resolution

  dE/dx with STT