Reconstruction of K_s from generated $K_L + p \rightarrow K_s(\pi^- \pi^+) + p$ reactions in the K_L-beam momentum interval (0,12) GeV/c.

The algorithm from S. Dobbs

1. **Generation** of $K_L + p \rightarrow K_s(\pi^- \pi^+) + p$.

   $HALLD_MY/bin/KLGenerator_hddm_V3 -M400000 -Fgenerated_Kl+p.root -Ekaon:histo:1.0:4.0 -Rkl2

2. **Reconstruction** of generated reactions via Geant (geometry?).

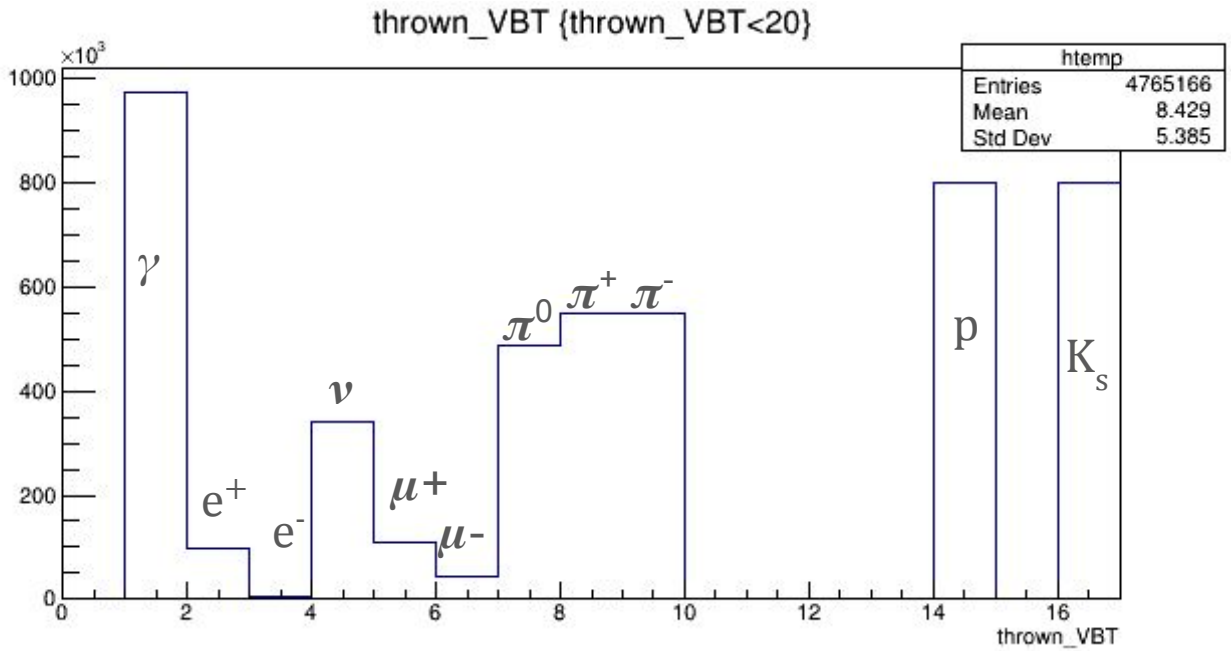
3. **Smearing** of reconstructed events.

4. **Generation of a "tree"** which includes particle momenta, **effective masses** of two pions, and **missing masses** of two pions for **several $\pi^+\pi^-$ combinations.**

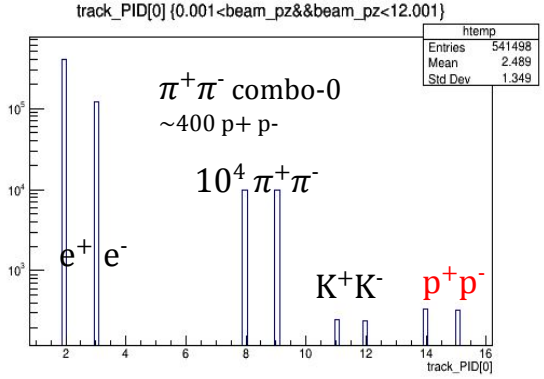
   hd_root --nthreads=8 --sodir=$HALLD_MY/Linux_CentOS7.7-x86_64-gcc4.8.5/plugins -PPRINT_PLUGIN_PATHS=1
   -PPLUGINS=EVENTRFBUNCH:USE_TAG=KLong -PVERTEX:USEWEIGHTEDAVERAGE=1
   -PPLUGINS=monitoring_hists
   -PPLUGINS=fcal_tree
   hdgeant4_output_smeared.hddm >& deleteme.out

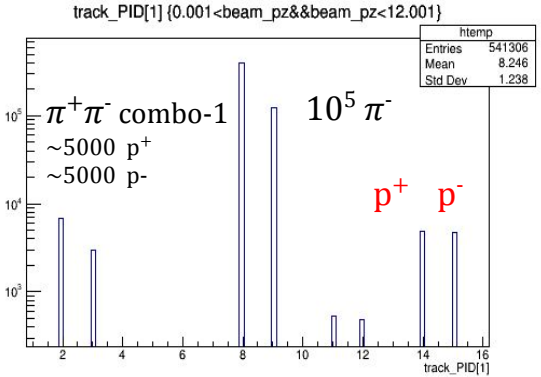
5. **Root analysis** of K_s reconstruction via $\pi^- \pi^+$ effective mass (doubled statistics?).

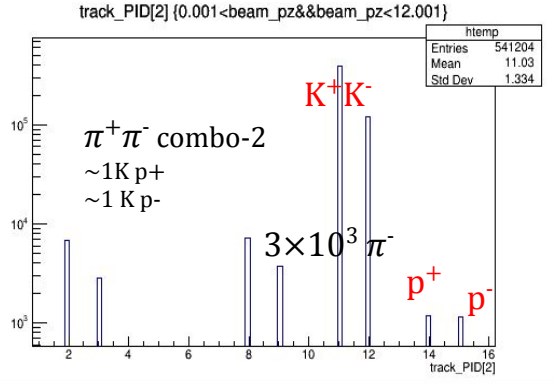
Secondary particles from generated $K_L + p \rightarrow K_s(\pi^- \pi^+) + p$ at K_L momentum (0,12) GeV/c

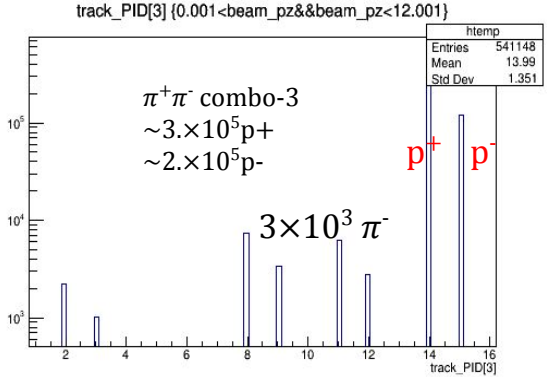


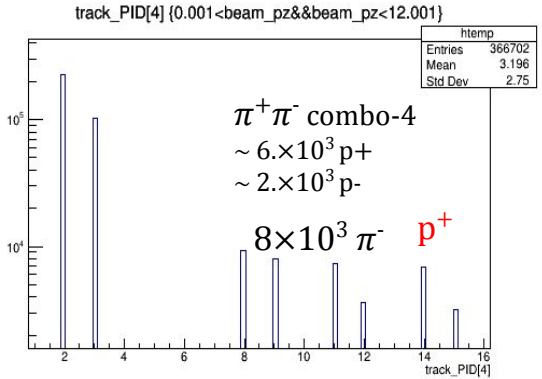
Track reconstruction from generated $K_L+p\rightarrow K_s(\pi^-\pi^+)+p$ at high K_L momentum <12 GeV/c

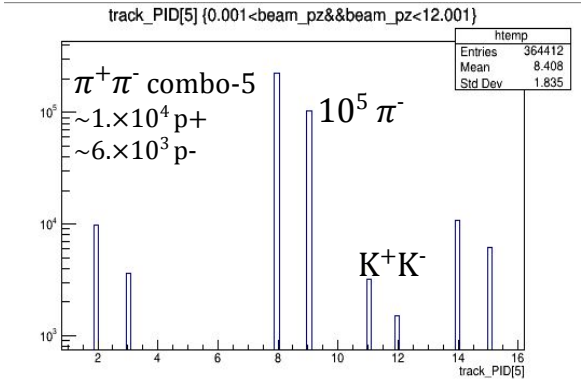




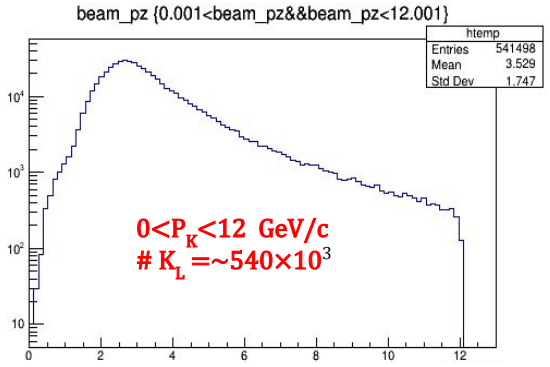




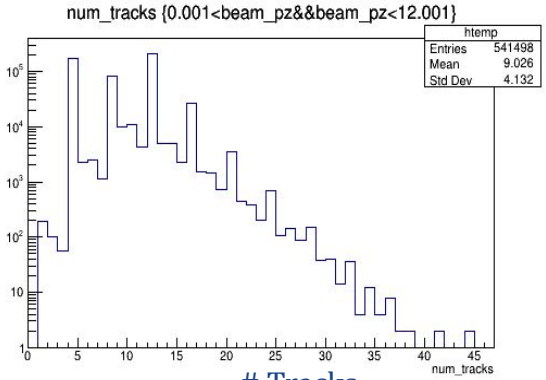




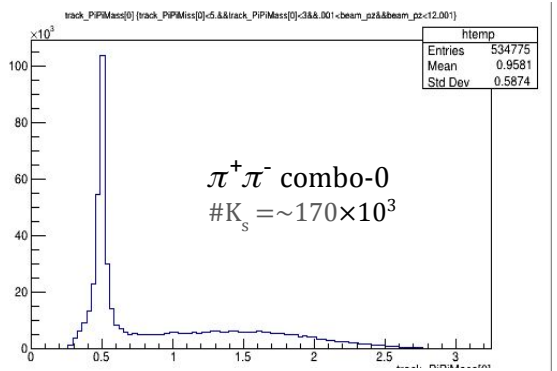
K_s reconstruction from generated $K_L + p \rightarrow K_s(\pi^- \pi^+) + p$ at $0 < K_L$ momentum < 12 GeV/c



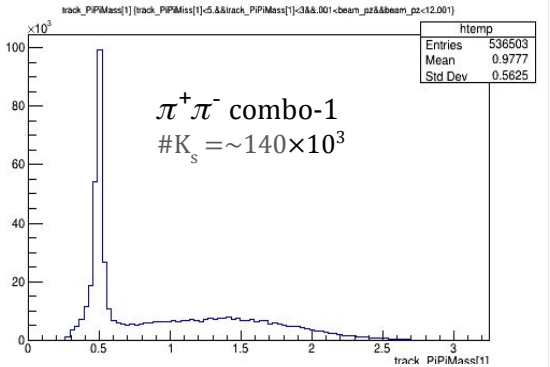
K_L momentum/GeV



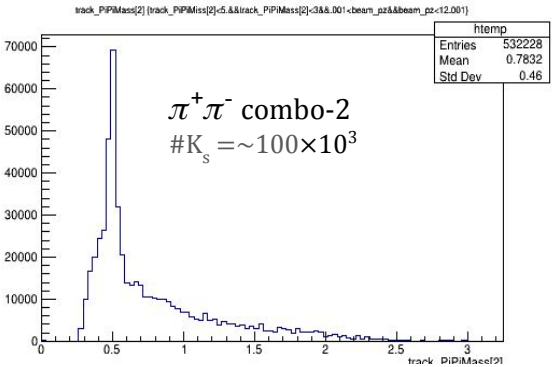
Tracks



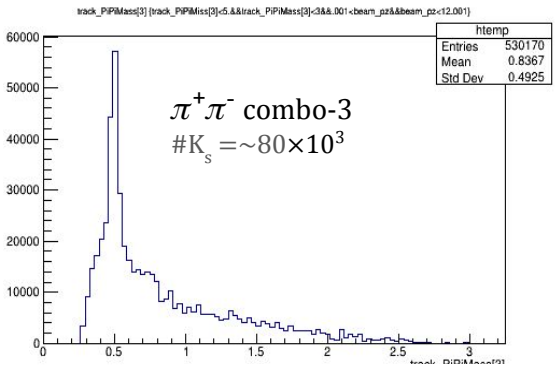
Effective Mass of $\pi^-\pi^+$ (GeV)



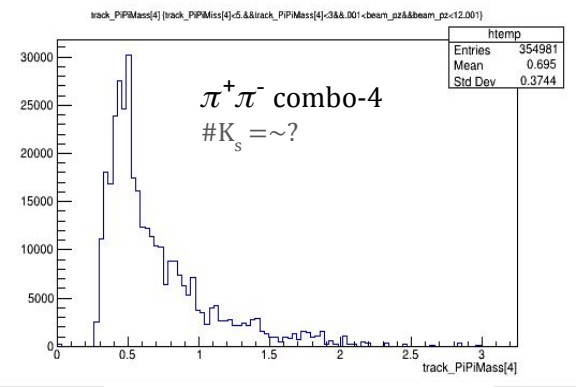
Effective Mass of $\pi^-\pi^+$ (GeV)



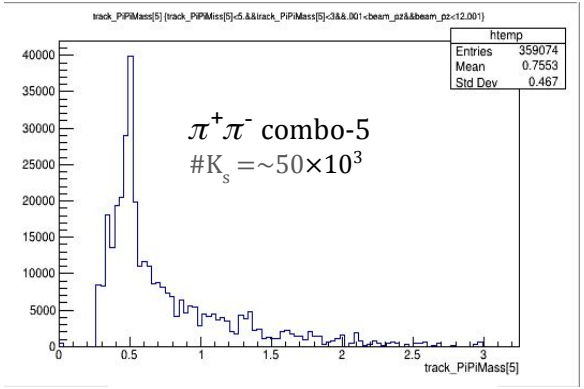
Effective Mass of $\pi^-\pi^+$ (GeV)



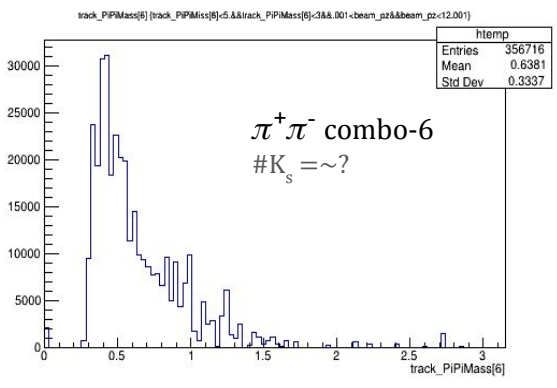
Effective Mass of $\pi^-\pi^+$ (GeV)



Effective Mass of $\pi^-\pi^+$ (GeV)



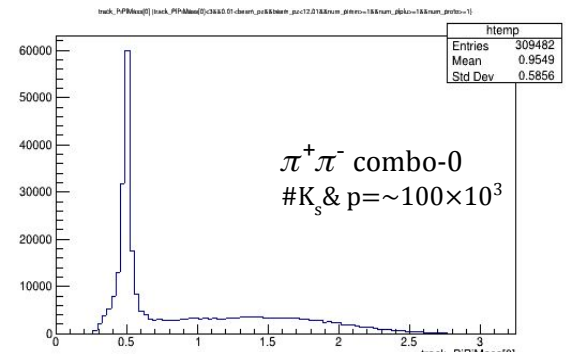
Effective Mass of $\pi^-\pi^+$ (GeV)



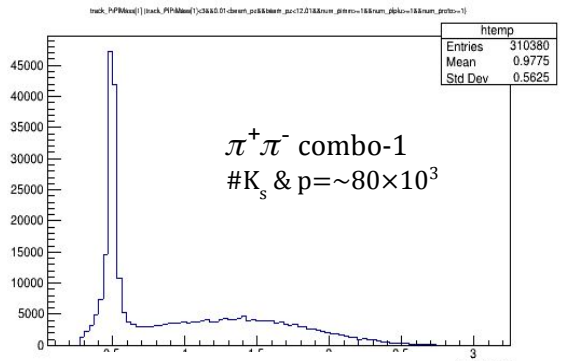
Effective Mass of $\pi^-\pi^+$ (GeV)

- Total (in all combos) #K$_s$ =~540×10^3 per beam #K$_L$ =~540×10^3
- **Reconstruction efficiency for K$_s$ = 540,000/540,000=~100%.**
- Can it be that high due to secondary K$_s$ which are not seen in final state as PID=16 ?

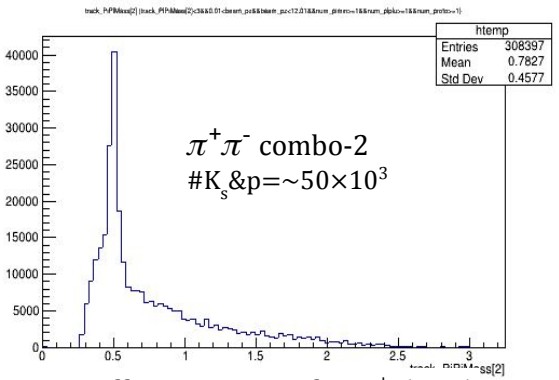
K_s reconstruction from $K_L+p \rightarrow K_s+p$ with identified proton track.



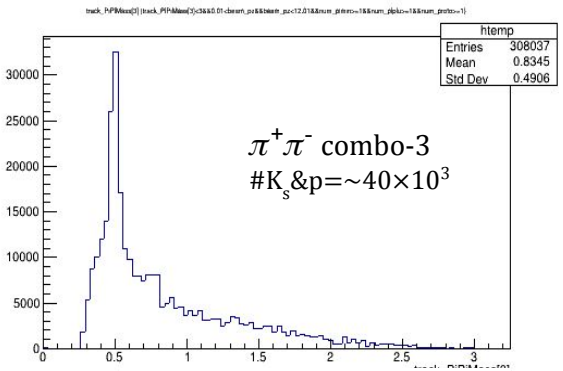
Effective Mass of $\pi^-\pi^+$ (GeV)



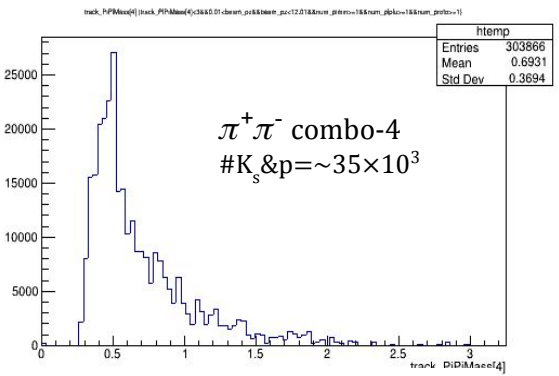
Effective Mass of $\pi^-\pi^+$ (GeV)



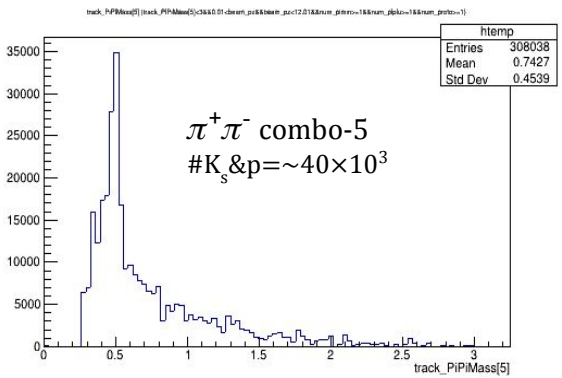
Effective Mass of $\pi^-\pi^+$ (GeV)



Effective Mass of $\pi^-\pi^+$ (GeV)

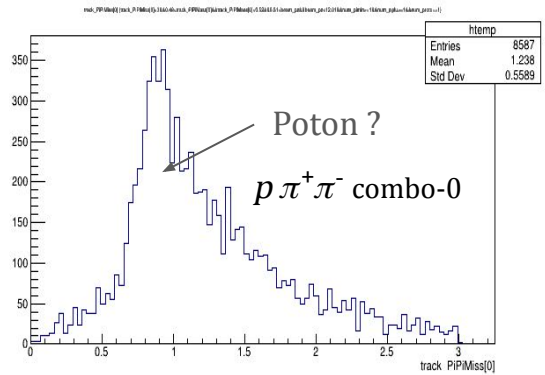


Effective Mass of $\pi^-\pi^+$ (GeV)

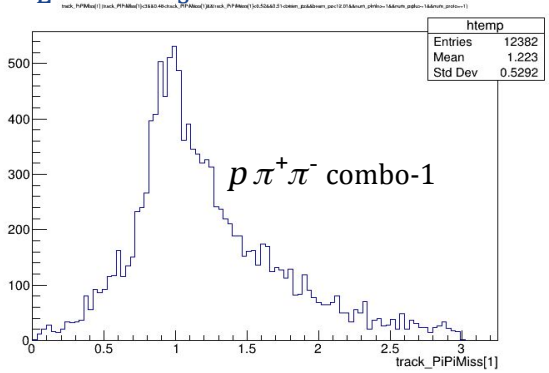


- **At beam momentum (0,12) GeV/c the 540 $\times10^3$ K_L interactions results in ~340×10^3 of final K_s& p identified tracks (*i. e.* ~50%).**

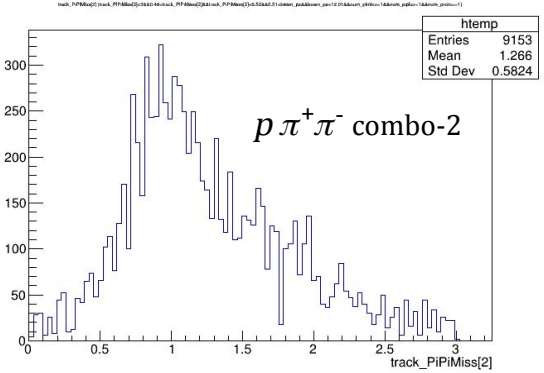
Proton reconstruction from $K_L + p \rightarrow K_s + p$ **with identified proton tracks**.



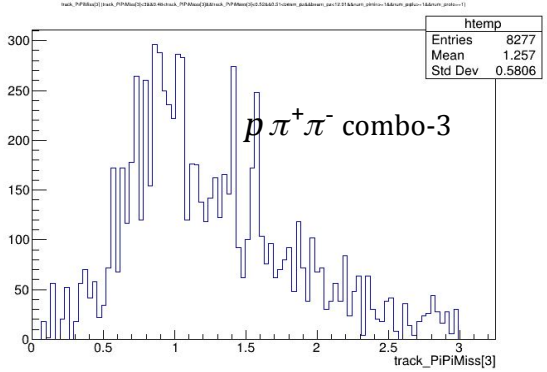
Missing Mass of $\pi^-\pi^+$ (GeV)



Missing Mass of $\pi^-\pi^+$ (GeV)



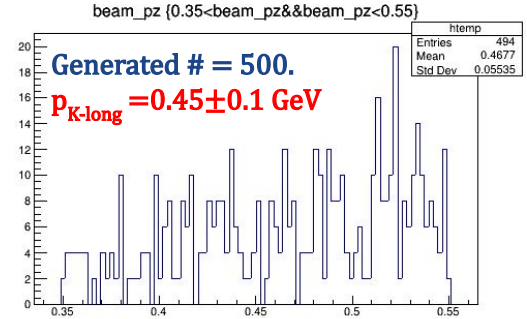
Missing Mass of $\pi^-\pi^+$ (GeV)



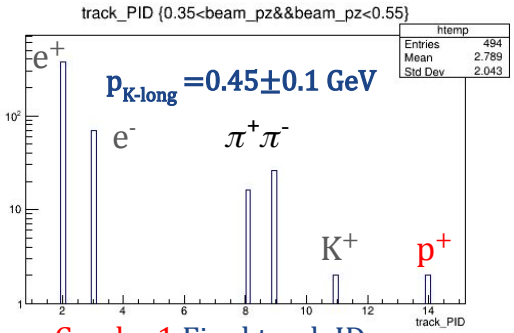
Missing Mass of $\pi^-\pi^+$ (GeV)

Momentum region of special interest.

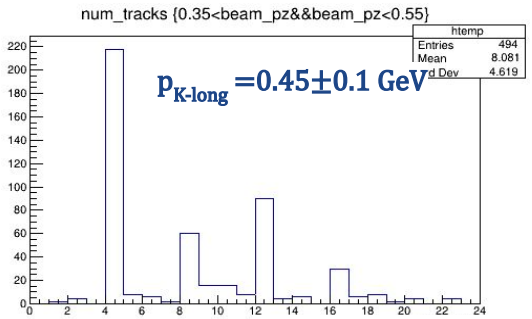
K_s -reconstruction from $K_L + p \rightarrow K_s(\pi^- \pi^+) + p$ at low K_L momenta in 5q region.



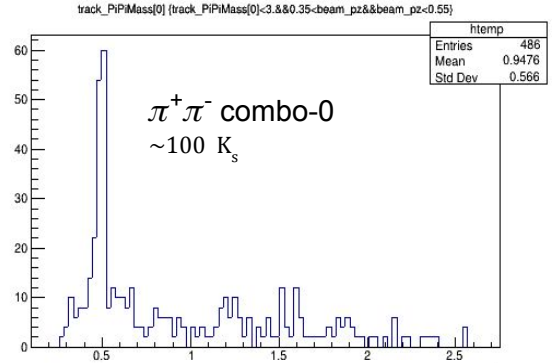
K_L momentum/GeV



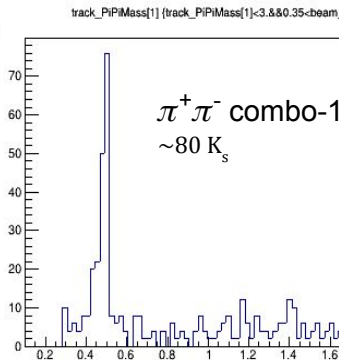
Combo 1 Final track ID



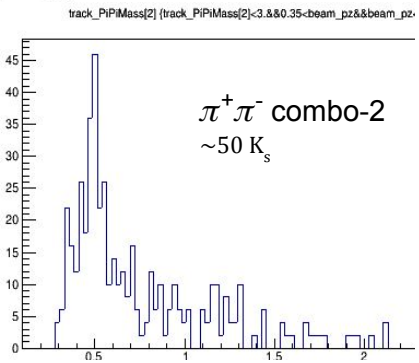
Number of tracks



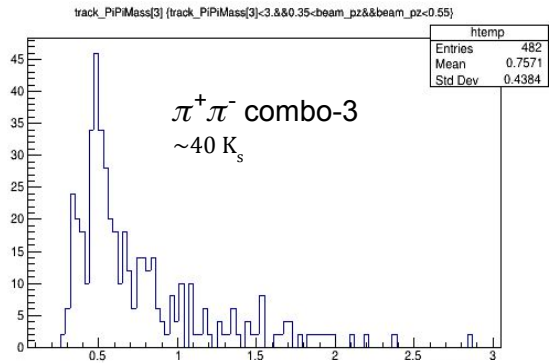
Effective Mass of $\pi^-\pi^+$ (GeV)



Effective Mass of $\pi^-\pi^+$ (GeV)



Effective Mass of $\pi^-\pi^+$ (GeV)



Effective Mass of $\pi^-\pi^+$ (GeV)

- In 5q-region the number of generated beam particles (K_L) =~500 K_L
- The corresponding **reconstruction efficiency of $K_s(\pi^- \pi^+)$ =~270 K_s / 500 K_L =~50%!**

K_s counting rate at low K_L momenta in 5q region.

- Number of generated beam particles N = 540,000 [K].
- Number of K_s(π- π+), per Δp =200 MeV of beam momentum, is **M = ~270 [K_s]**.
- Thus we write

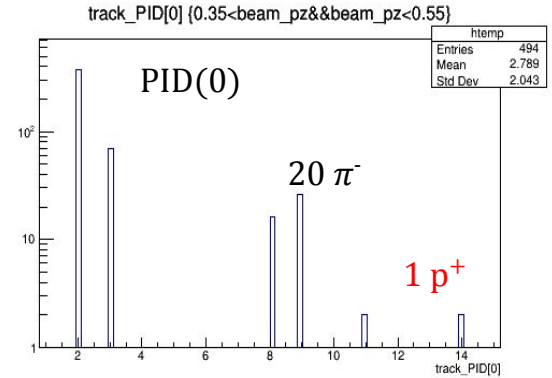
$$dM/dp/K = M/\Delta p/N = 2.5\ E\text{-}6\ [K_s/MeV/K]$$

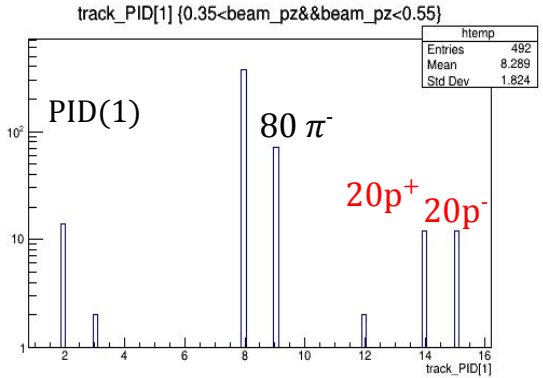
- The corresponding counting rate at beam intensity 1.E+4 [K/s] yields:

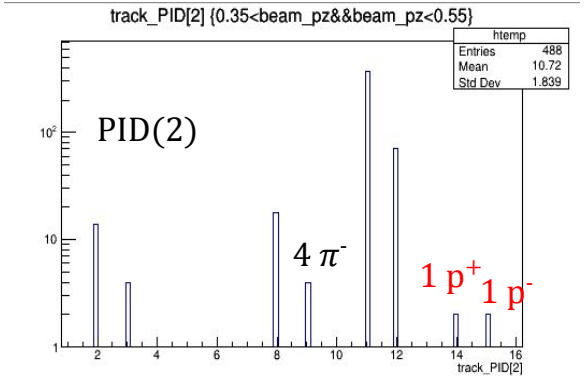
$$\mathbf{dM/dp/dt = \sim 0.025\ [K_s/MeV/s]}$$

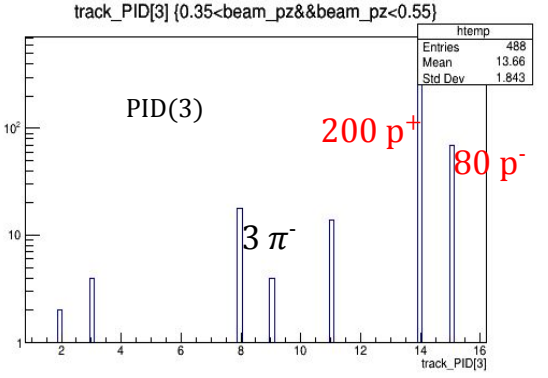
that is about ~10% of the expected rate from the 5q decay.

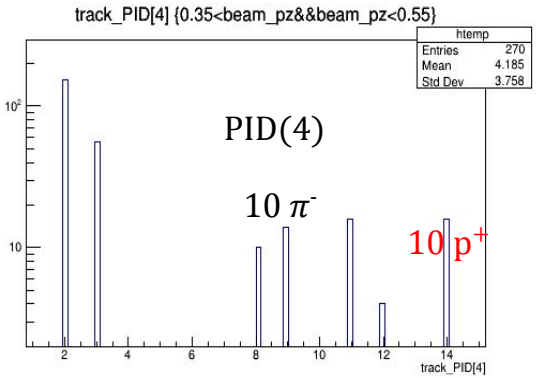
Track reconstruction of $K_L+p\rightarrow K_s(\pi^-\pi^+)+p$ at **low K_L momentum (5q region)**.

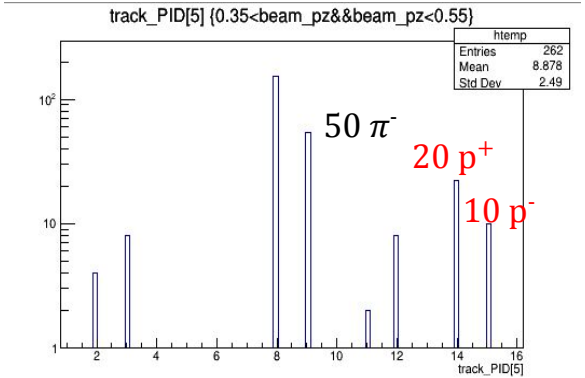




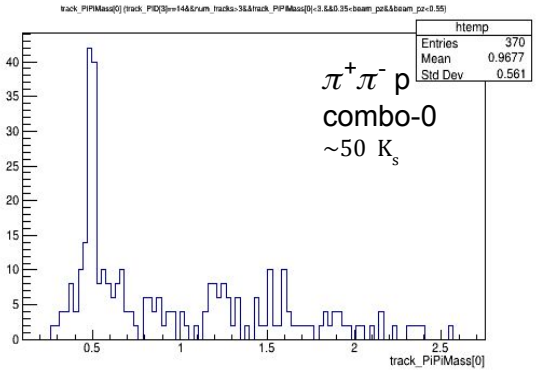


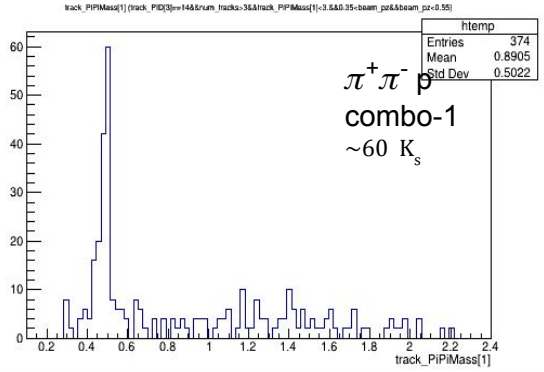


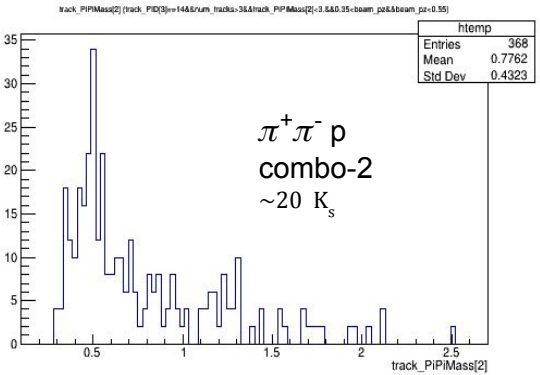


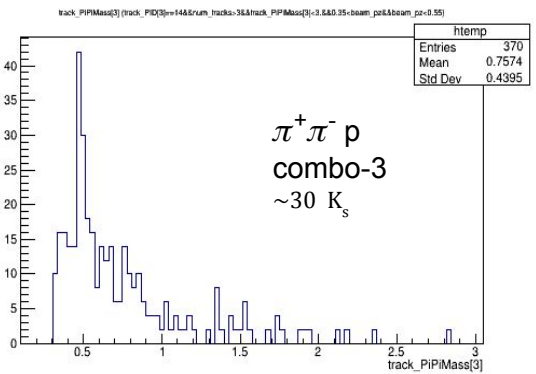


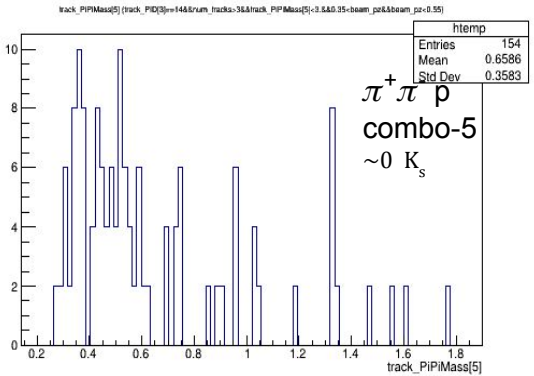
K_s reconstruction from $K_L + p \rightarrow K_s(\pi^- \pi^+) + p$ at **low momentum** with identified proton track.





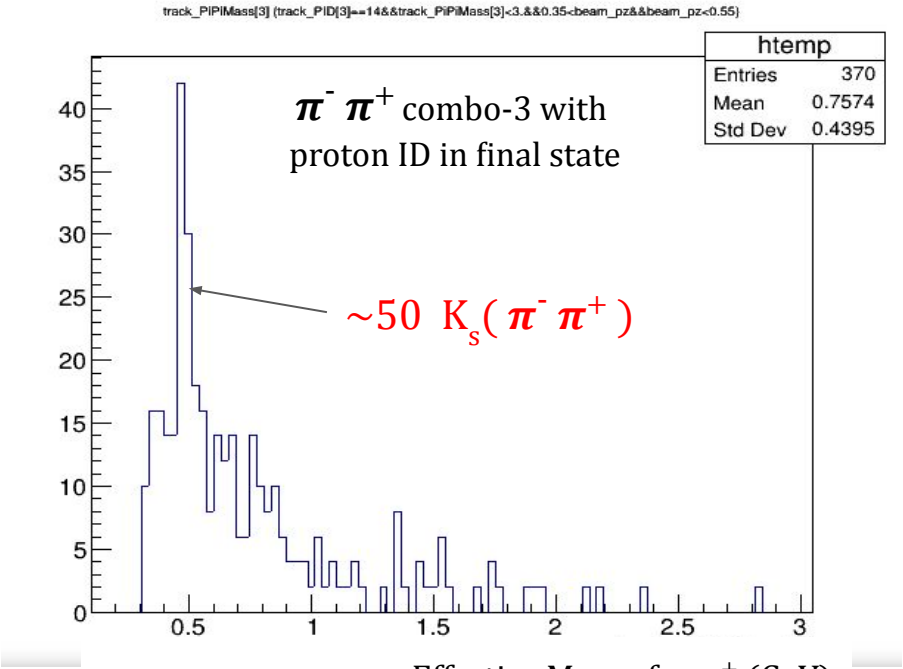


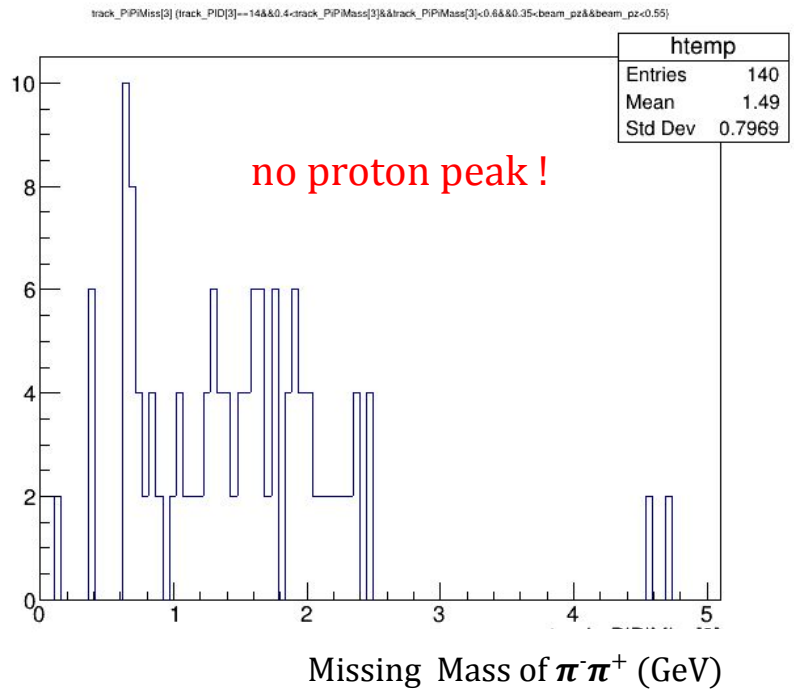




- Reconstruction efficiency of $K_s(\pi^- \pi^+)$ **with identified proton track** = ~ 150 K_s / 500 K_L =~30% !
- Do we see proton peak in the Missing Mass Specra?

K_s reconstruction from $K_L + p \rightarrow K_s(\pi^-\pi^+) + p$ at **low momentum** with identified proton track.

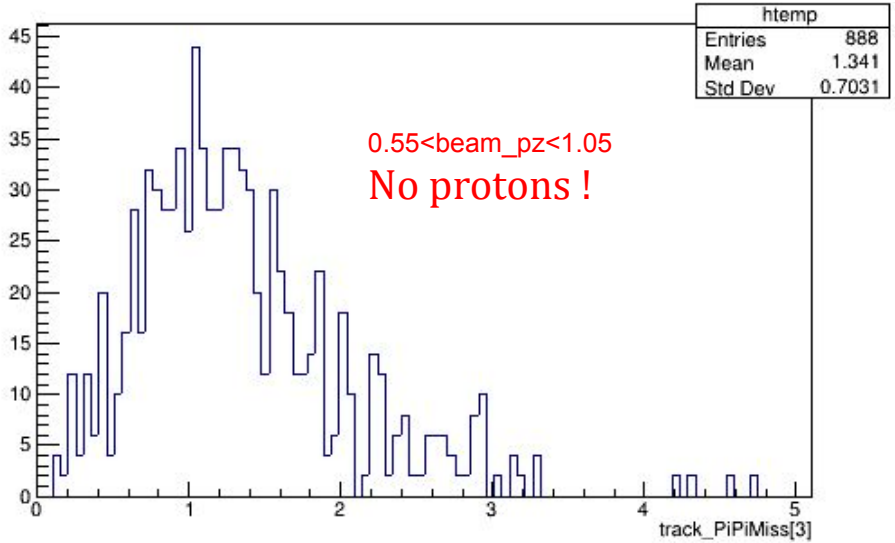




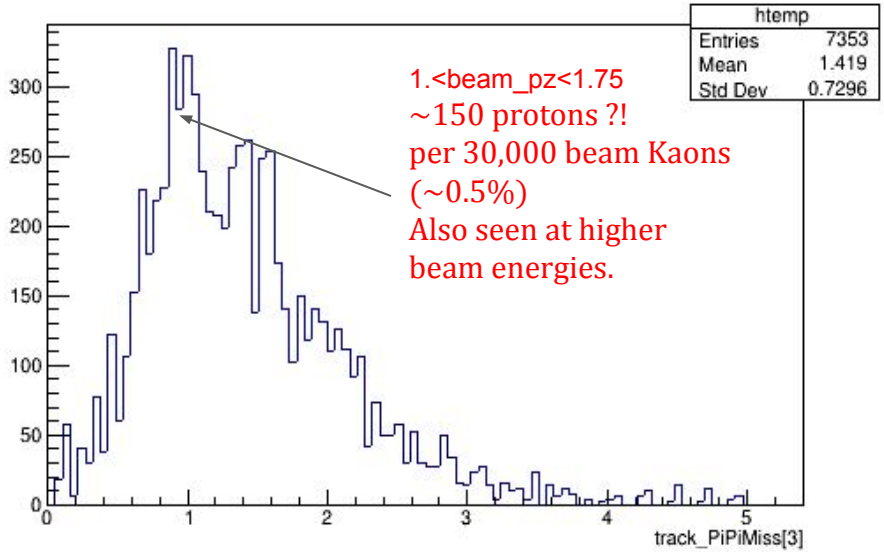
- Reconstruction efficiency of $K_s(\pi^-\pi^+)$ in 5q momentum region = ~250 K_s / 500 K_L =~50% !
- Reconstruction efficiency of $K_s(\pi^-\pi^+)$ **with identified proton track** = ~ 150 K_s / 500 K_L =~30% !

Proton peak in $\pi^-\pi^+$ Missing Mass spectra $K_L+p\rightarrow K_s(\pi^-\pi^+)+p$ at higher **beam momentum**.

Draw("track_PiPiMiss[3]",
"track_PiPiMiss[3]<5.&&track_PID[3]==14&&0.4<track_PiPiMass[3]&&track_PiPiMass[3]<0.6&& 0.55<beam_pz&&beam_pz<1.05"
,"", 800000, 0);



Draw("track_PiPiMiss[3]",
"track_PiPiMiss[3]<5.&&track_PID[3]==14&&0.4<track_PiPiMass[3]&&track_PiPiMass[3]<0.6&& 1.<beam_pz&&beam_pz<1.75"
,"", 800000, 0);



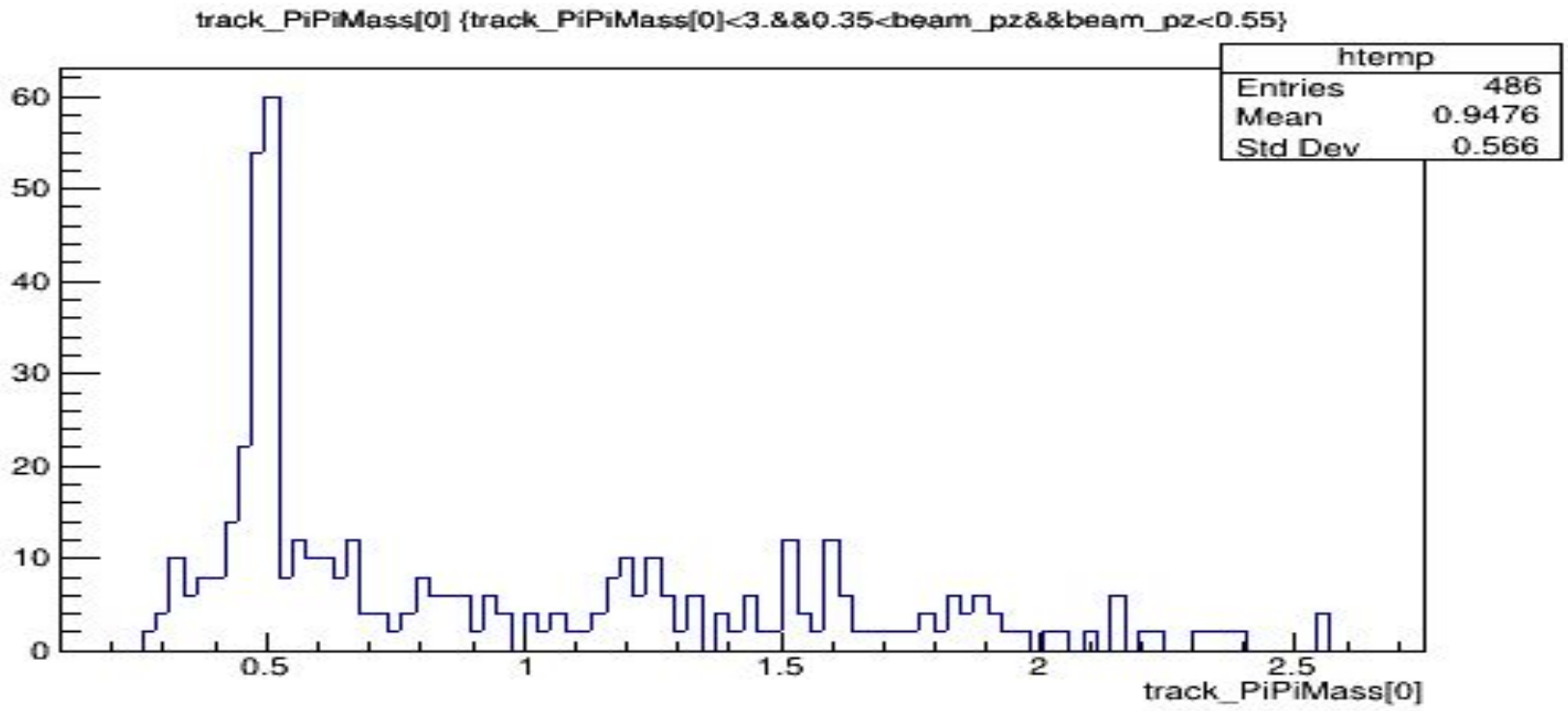
- We do not see a proton peak in $\pi^-\pi^+$ Missing Mass spectra at **beam momenta** in 5q region.

Conclusive remarks

- **Reconstruction efficiency of K_s** via $\pi^+\pi^-$ effective mass in the 5q region **is ~50%.** That is sufficient for the "**yield vs beam momentum**" measurements in this region.
- **Reconstruction efficiency of K_s and Proton pairs** in 5q region i**s ~30%** that is also sufficient for their "yield vs beam momentum" measurements.
- Unfortunately **I do not observe a narrow proton peak** in the $\pi^+\pi^-$ missing mass spectra (??).
- **Reconstruction efficiency of K-shorts** in the beam **momentum interval (0.5,12) GeV/c is close to 100%.**

Questions

- **What needs to be done for the review** in addition to **K^++n reconstruction**?
- Isn't it reasonable to generate uniform distribution of beam particle?
- Technical: Each generated event is **recorded twice** to the output tree. Seems it was doubled during generation? Or may be a corresponding "plugin" is called twice?
- Technical: Only **¾ of generated** beam momenta have **reasonable values** between 0 and 800 GeV/c.


track_PiPiMass[0] {track_PiPiMass[0]<3.&&0.35<beam_pz&&beam_pz<0.55}
htemp
Entries 486
Mean 0.9476
Std Dev 0.566
60
50
40
30
20
10
0
0.5
1
1.5
2
2.5
track_PiPiMass[0]