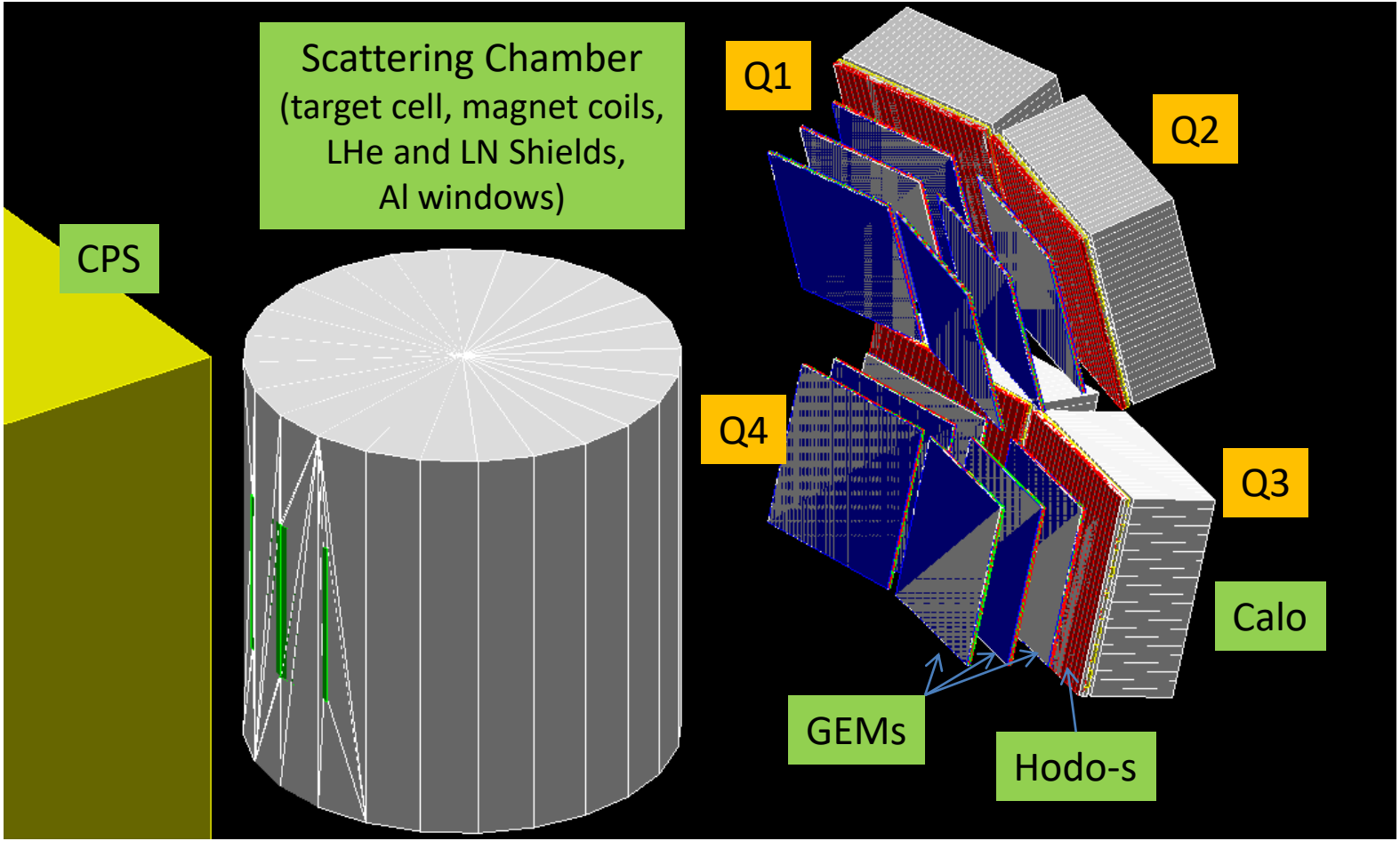
TCS vertex reconstruction
as of March of 2019

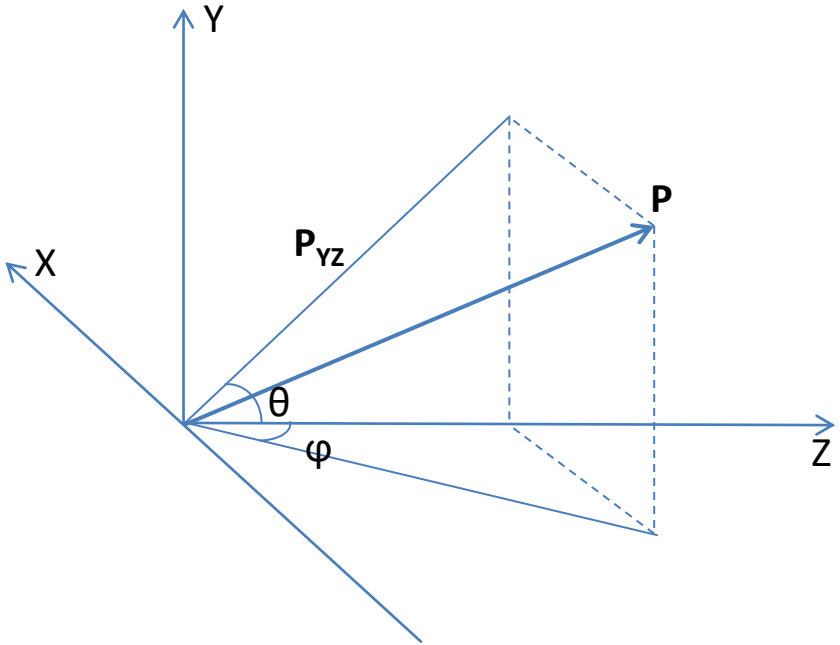
Vardan Tadevosyan

NPS meeting, 03/21/2019

Setup


Scattering Chamber
(target cell, magnet coils,
LHe and LN Shields,
Al windows)
CPS
Q1
Q2
Q3
Q4
Calo
GEMs
Hodo-s

Conventions

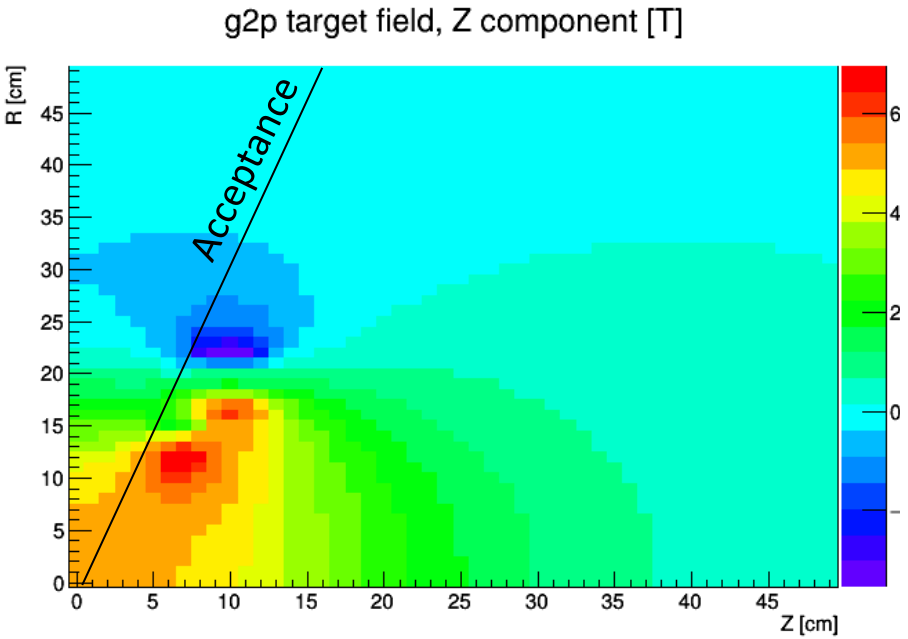


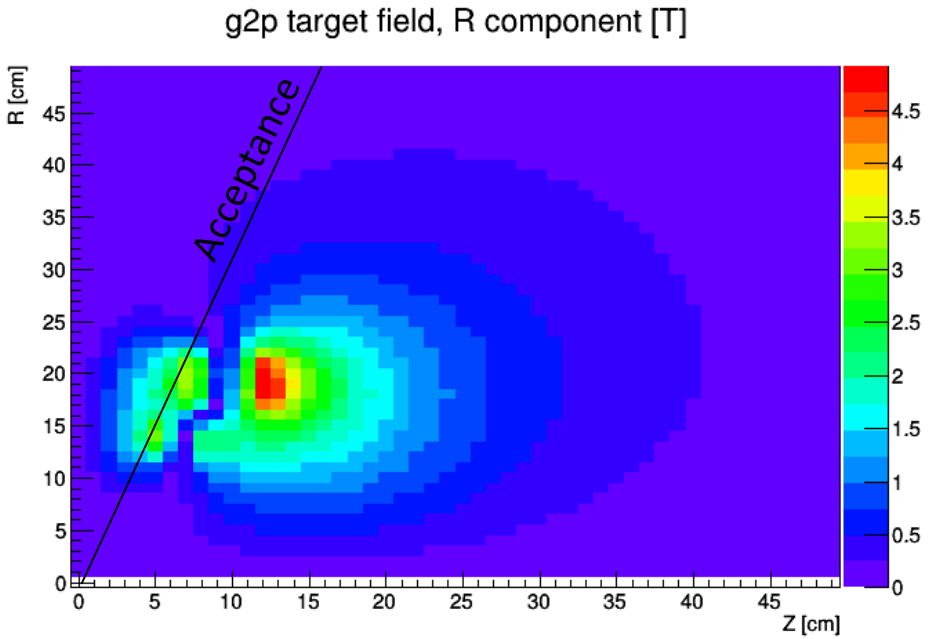
Beam direction

Θ – angle between P_Z and projection of **P** on YZ plane (P_{YZ}).

φ – angle between P_Z and projection of **P** on XZ plane (P_{XZ}).

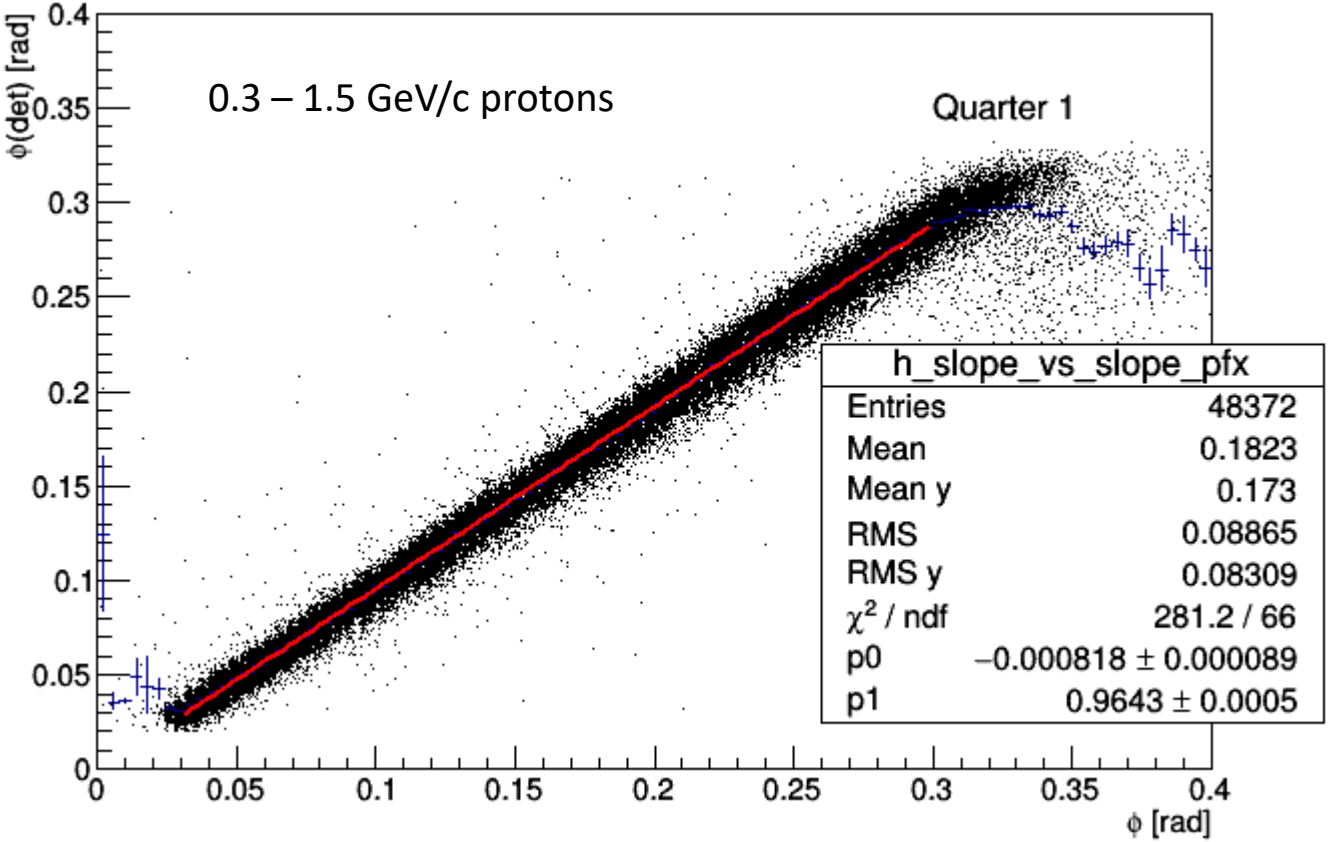
Target’s magnetic field components





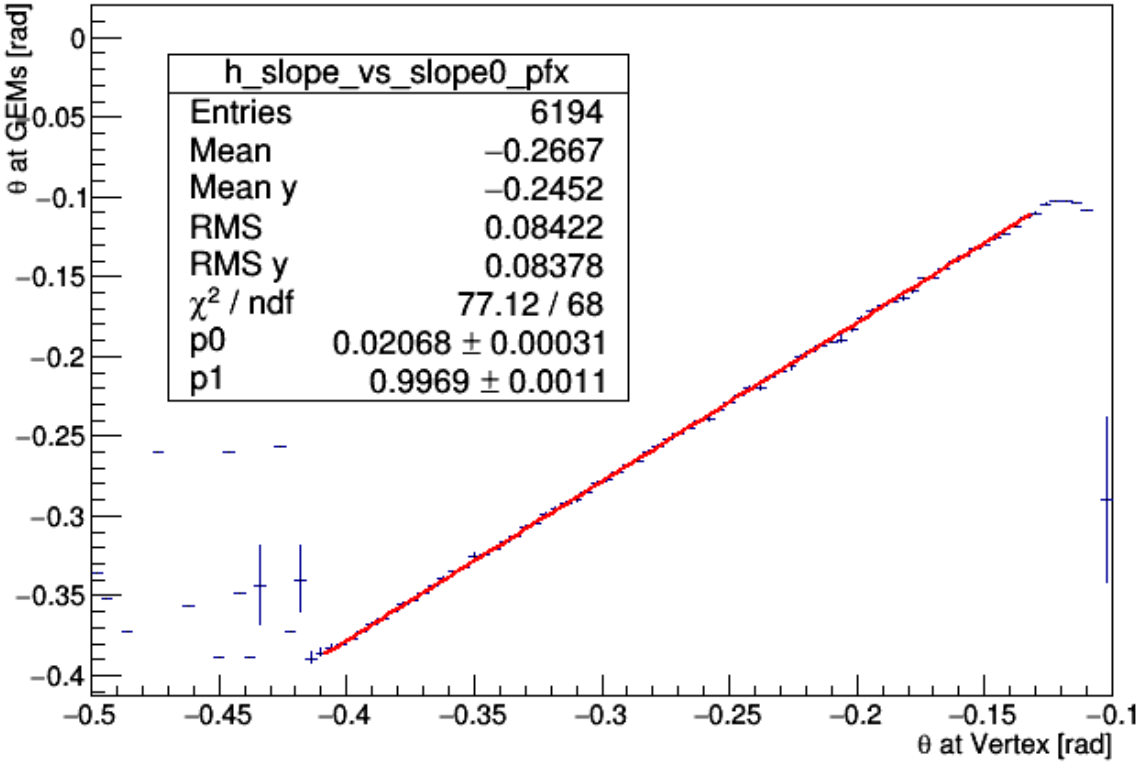
Magnetic field of 90^{o} rotated target is mostly transverse, along X axis.

Proton, φ reconstruction



Almost 1:1 correspondence between φ at vertex and φ at GEMs.

e-, θ linear regression

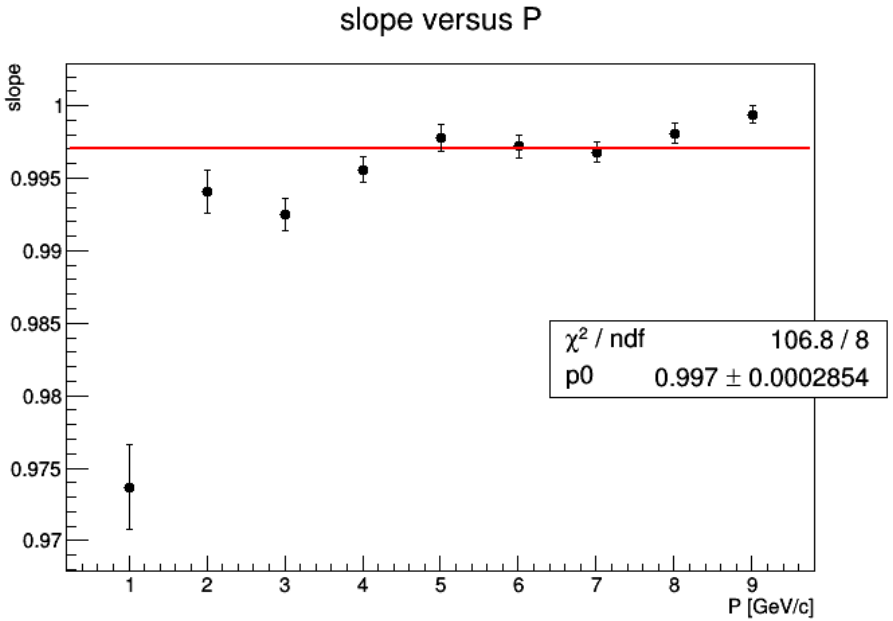


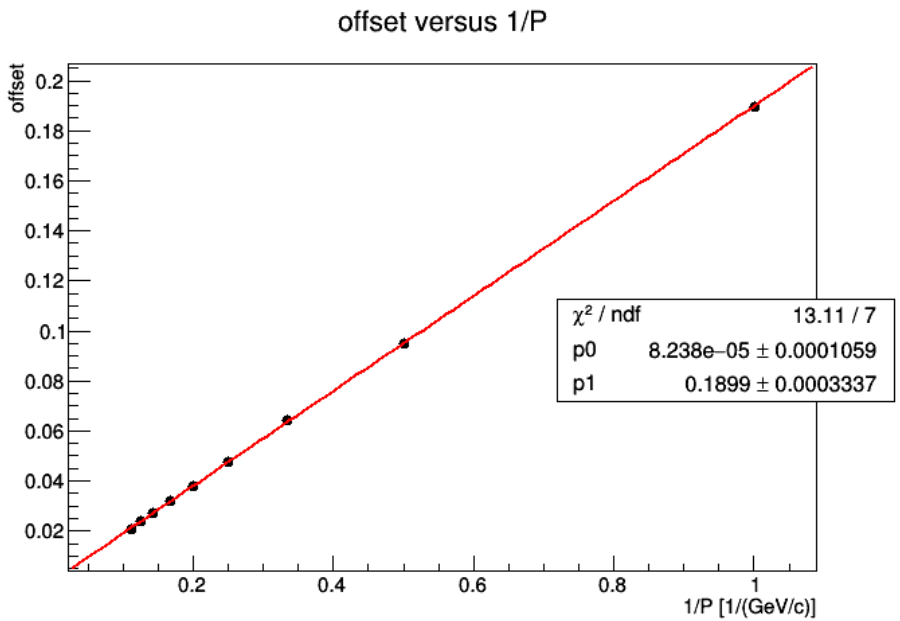
$\Theta = \Theta_0 + 0.3 \cdot \int Bdl/P$

Approximate
$\Theta \sim a \cdot \Theta_0 + b$;
expect
$a \sim 1$,
$b \sim 0.21/P$
for $\int Bdl \sim 0.7$ Tm.

For fixed P_{YZ}, there is linear relation between θ at vertex and θ from GEM trackers.

e-, θ linear regression



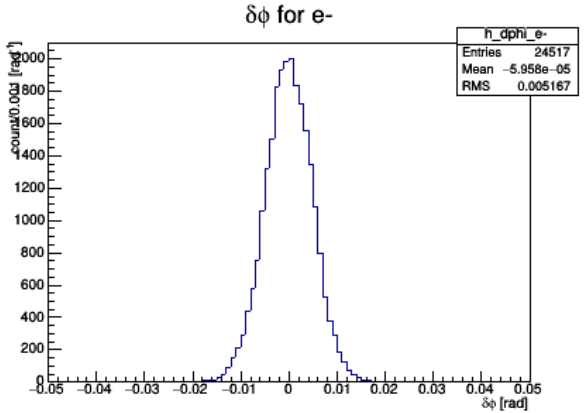


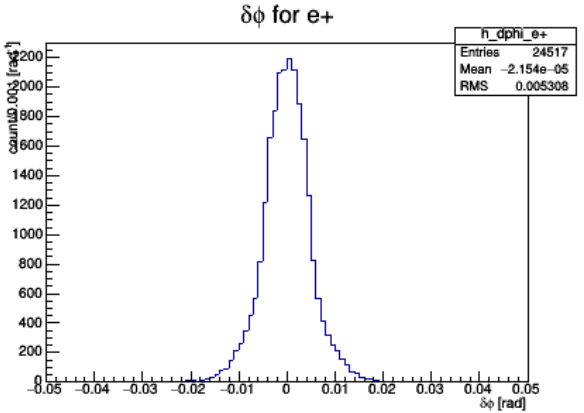
Slope and offset of the θ linear regression versus P_{YZ} and $1/P_{YZ}$ respectively.

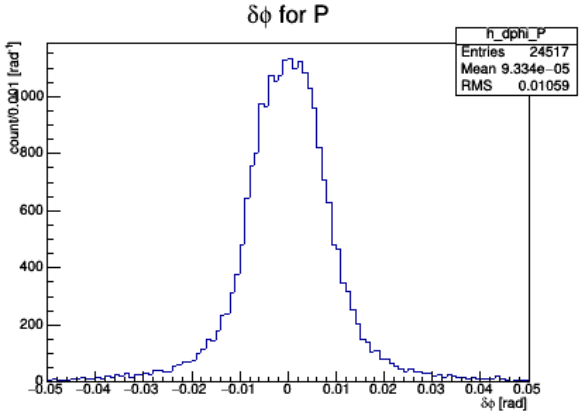
Vertex reconstruction, step by step

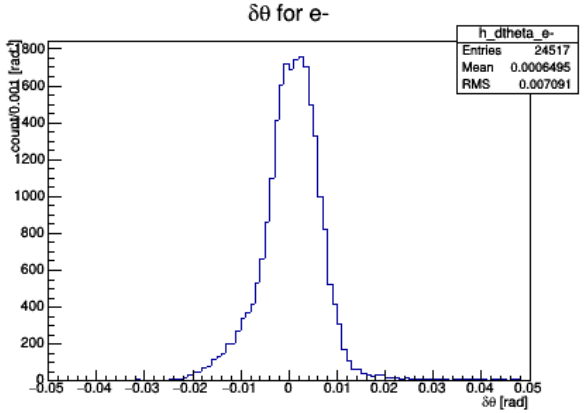
1) Use TCS events generated by DEEPGen (M.Boer)
2) Track TCS events through the TCS setup (target field + interaction with material)
3) Select events with e-, e+ and p tracks passing through GEMs (request hits in the 1-st layer, and in either or both of 2-nd and 3-rd layers)
4) Sample deposited in the calorimeters energies from e- and e+ tracks (assume HYCAL resolution)
5) Assign e- and e+ momenta equal to the energy depositions in the calorimeters
6) Determine detected track directions from GEM hits (straight line fit)
7) For e- and e+:
   a) Put φ at vertex equal φ measured at GEMs
   b) Derive θ at vertex from linear regression (for the measured in the calorimeters momenta)
8) Derive γ* 4-momentum equal to sum of lepton momenta
9) For the recoil proton:
   a) Derive φ at vertex from φ measured by GEMs, by linear regression
   b) Put P_X and P_Y at vertex equal to P_X and P_Y of γ* (*co-planarity*)
   c) Derive P_Z at vertex from P_X and φ at vertex
   d) Iterate [θ measured, P_{YZ} → θ at vertex → P_Z at vertex] one time

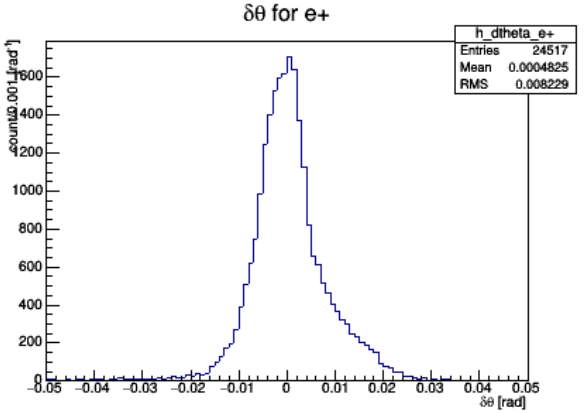
Angle reconstruction of TCS events

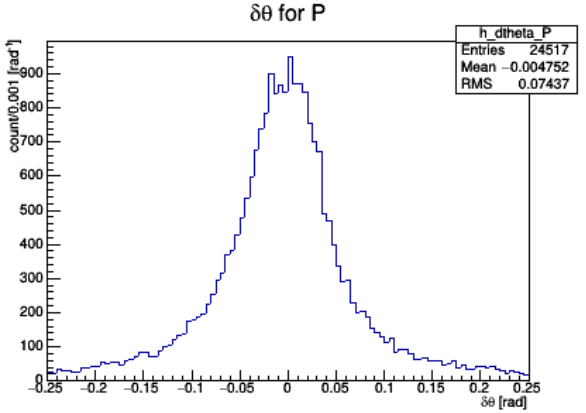




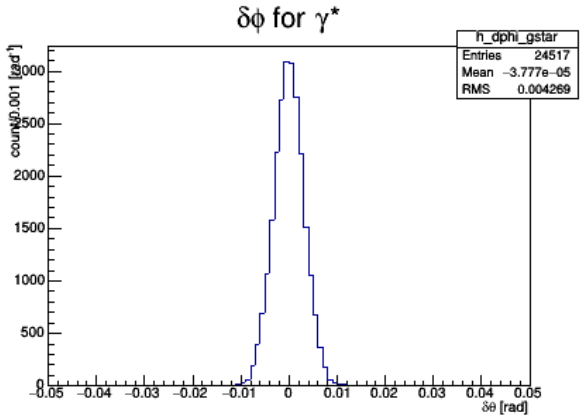


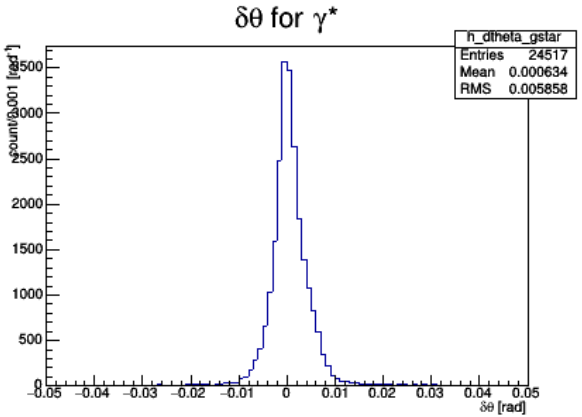


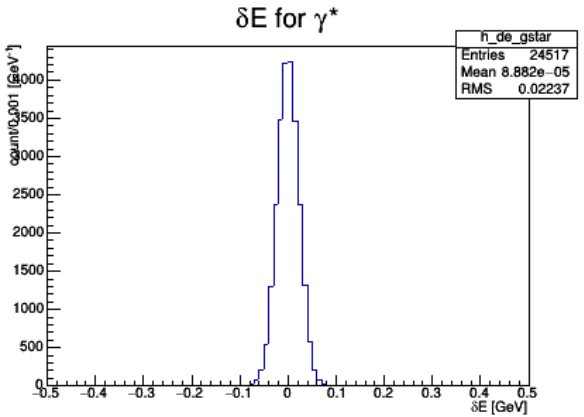




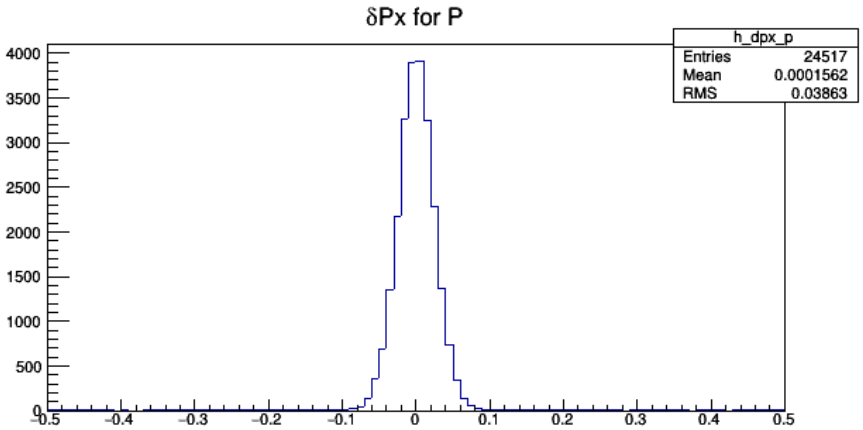
γ* reconstruction

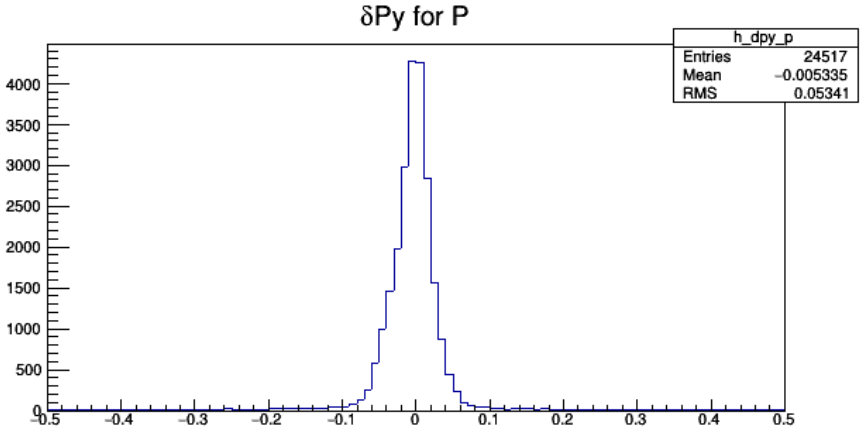


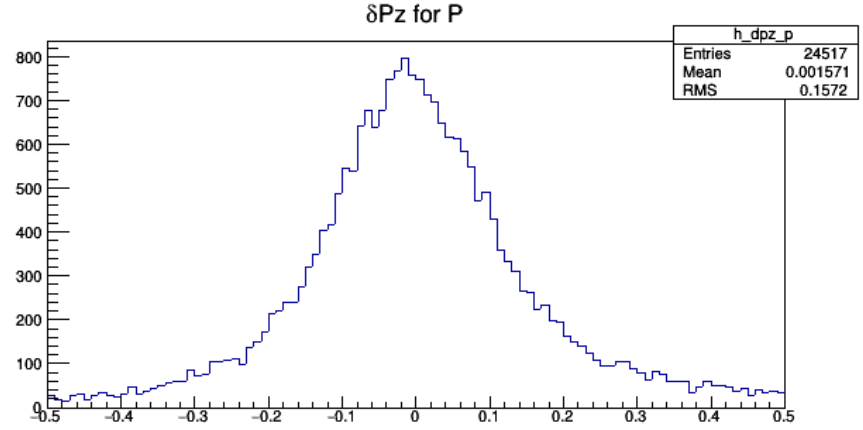


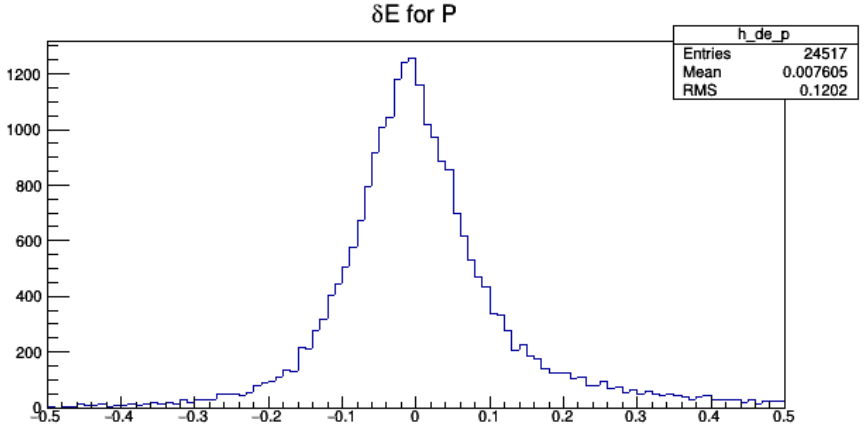


Recoil proton reconstruction

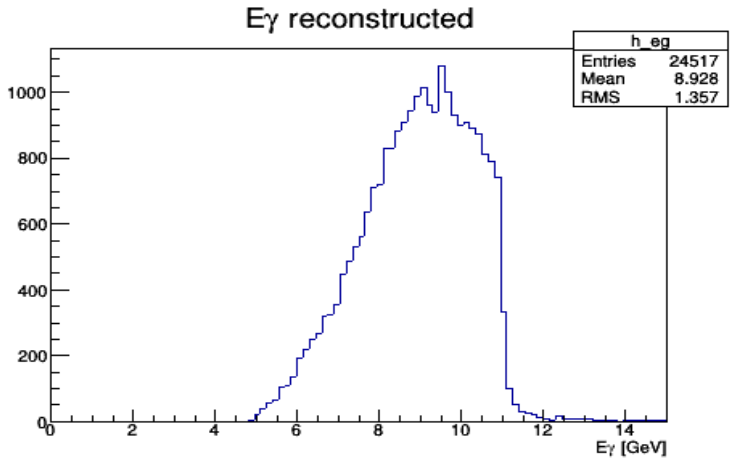


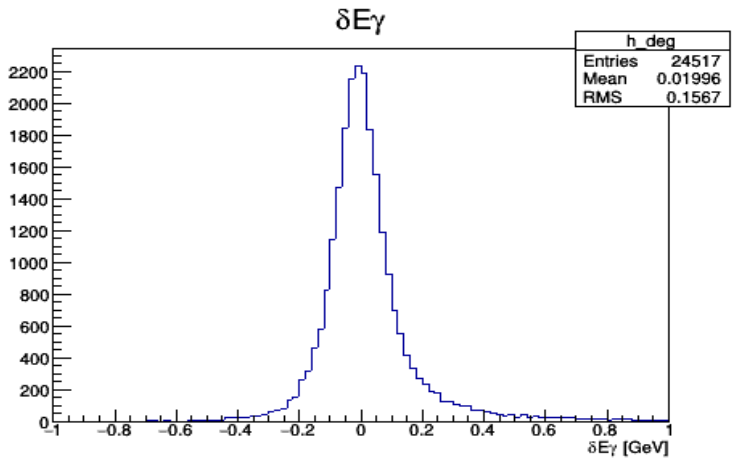


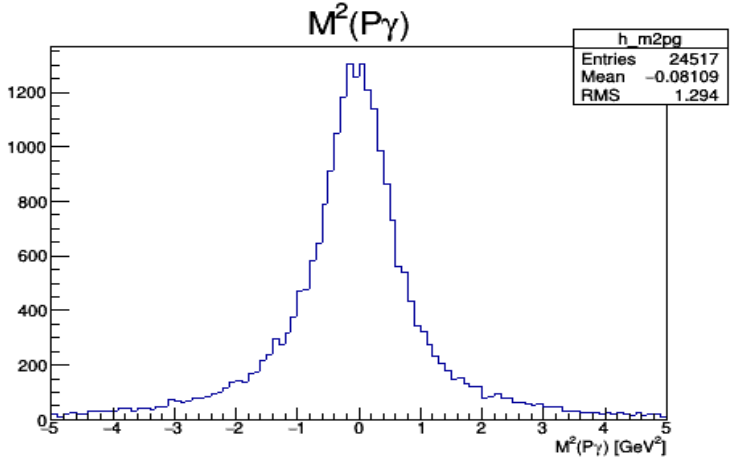


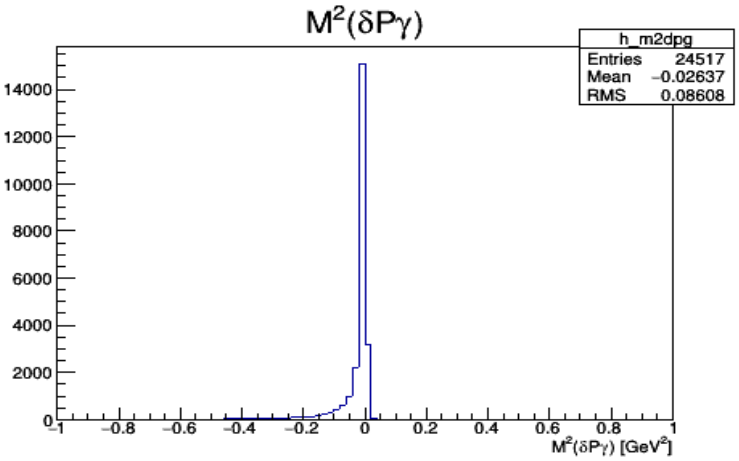


γ incident reconstruction

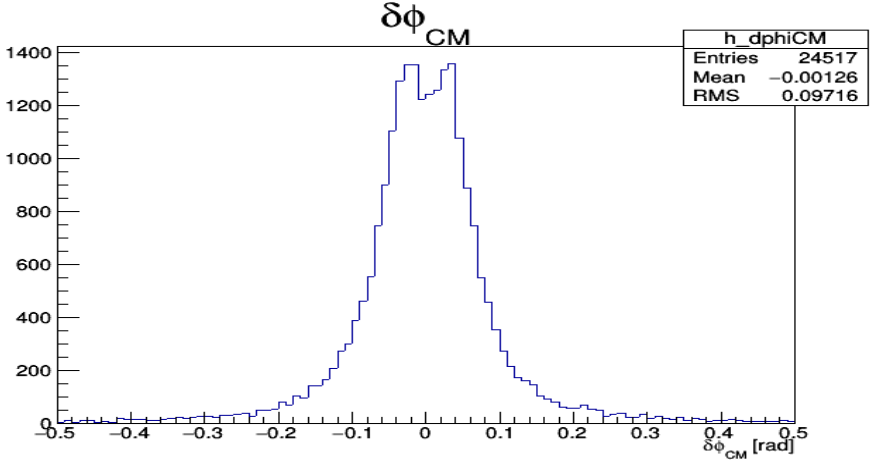


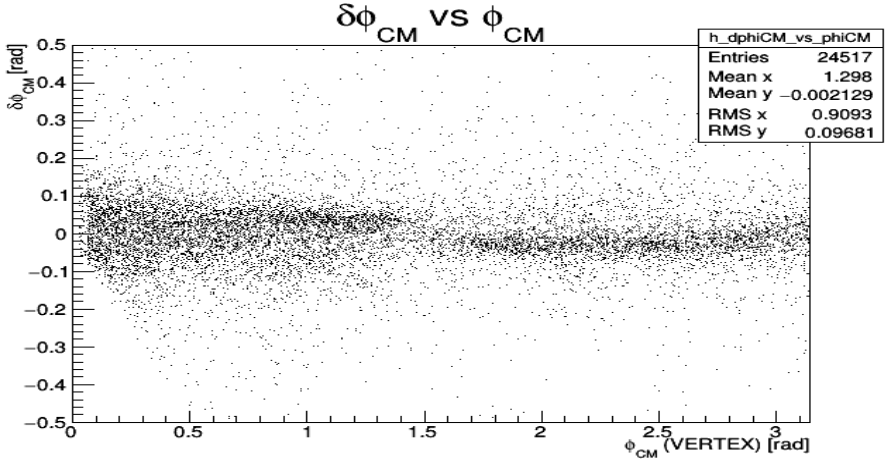


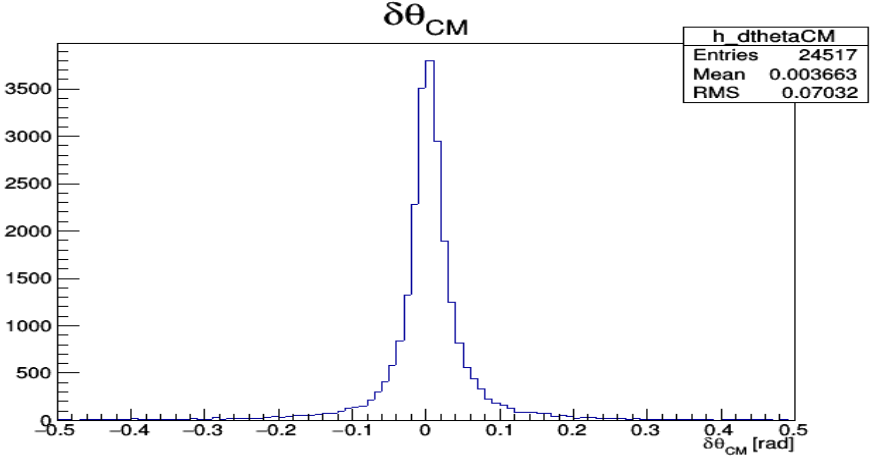


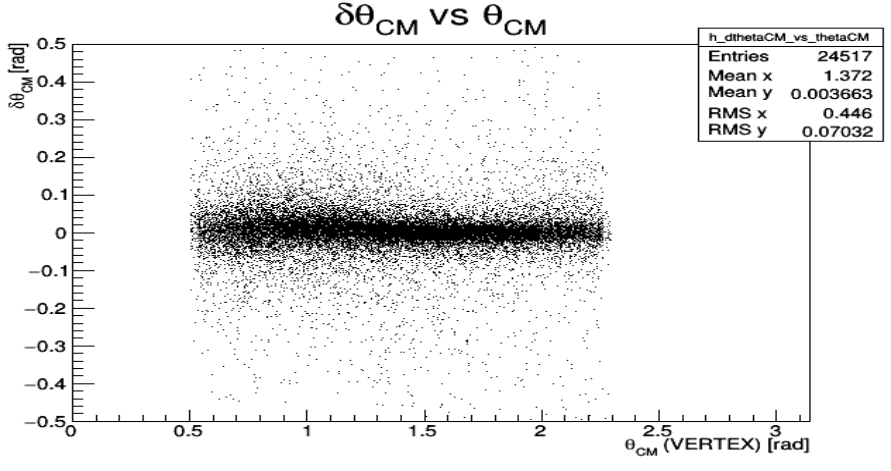


CM angle reconstruction of TCS events

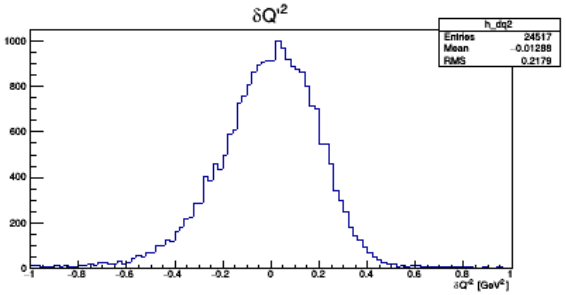


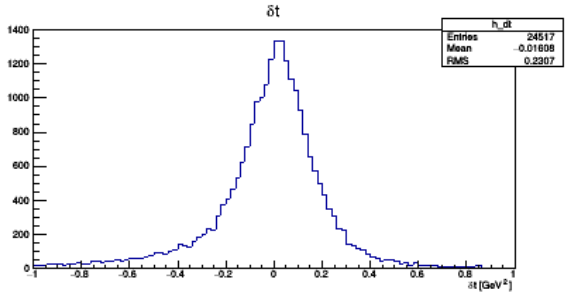


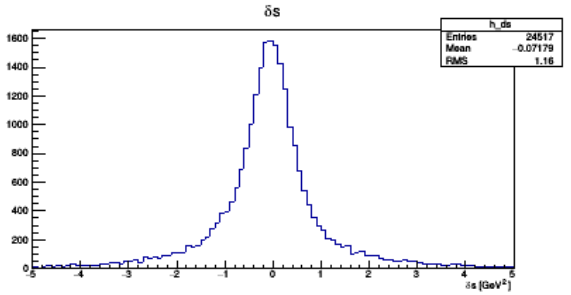


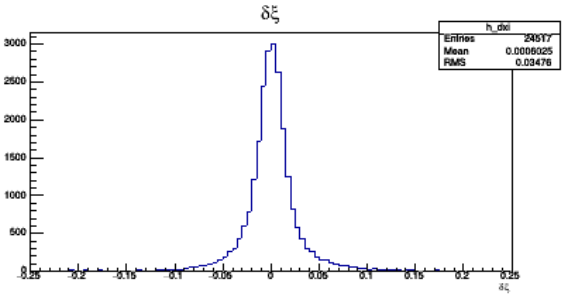


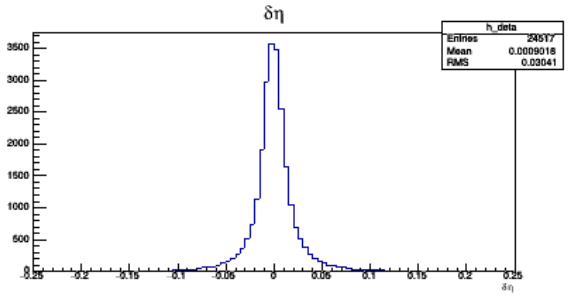
Accuracies of reconstruction of TCS quantities

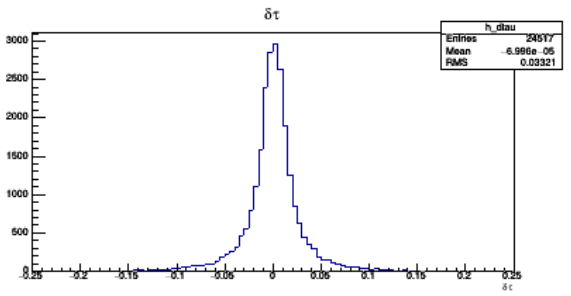


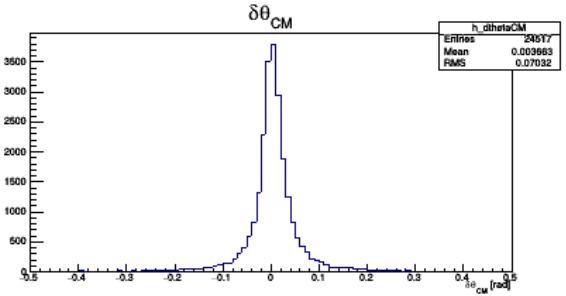


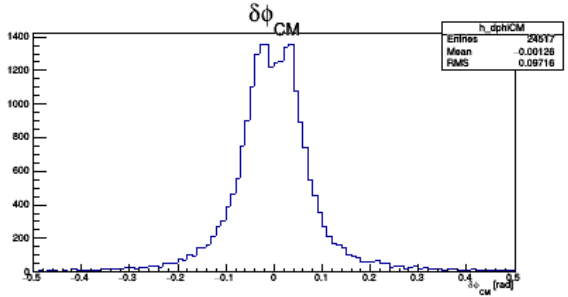


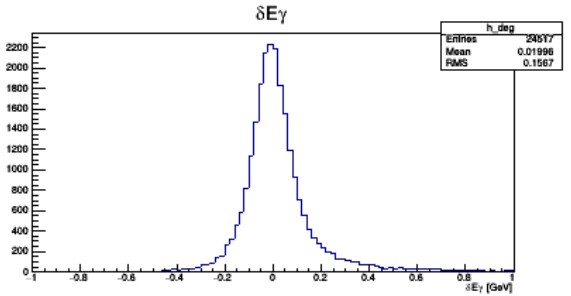






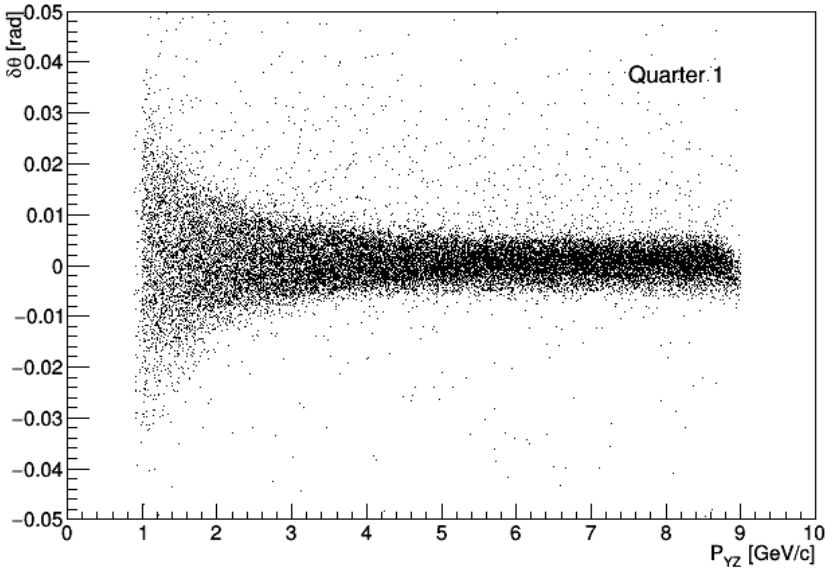


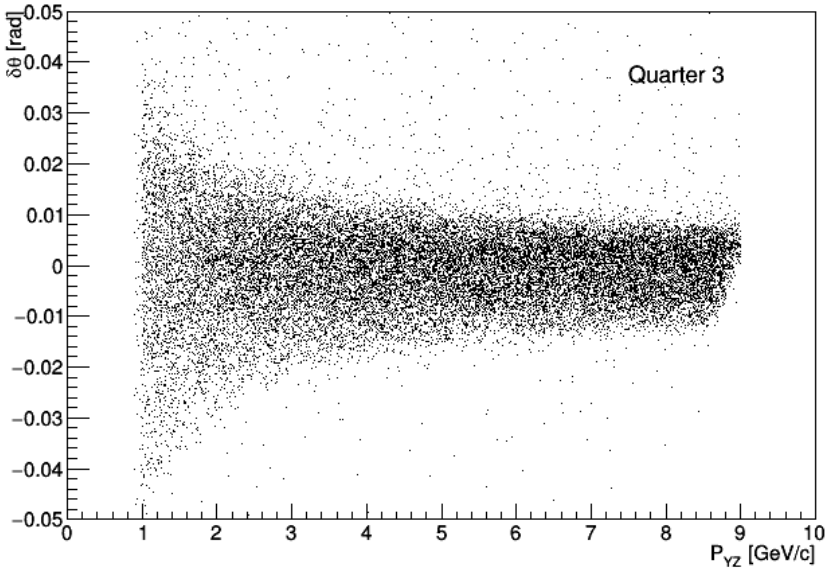




Back up

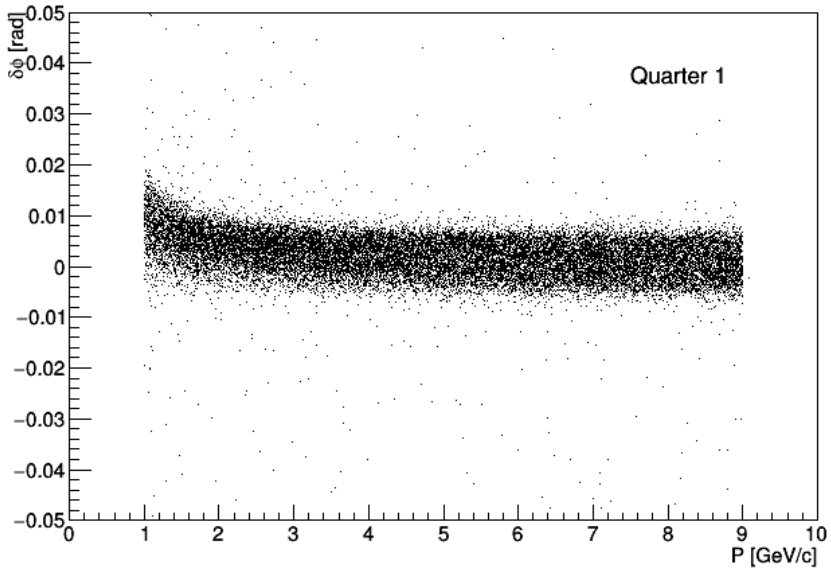
e-, Θ accuracy versus P

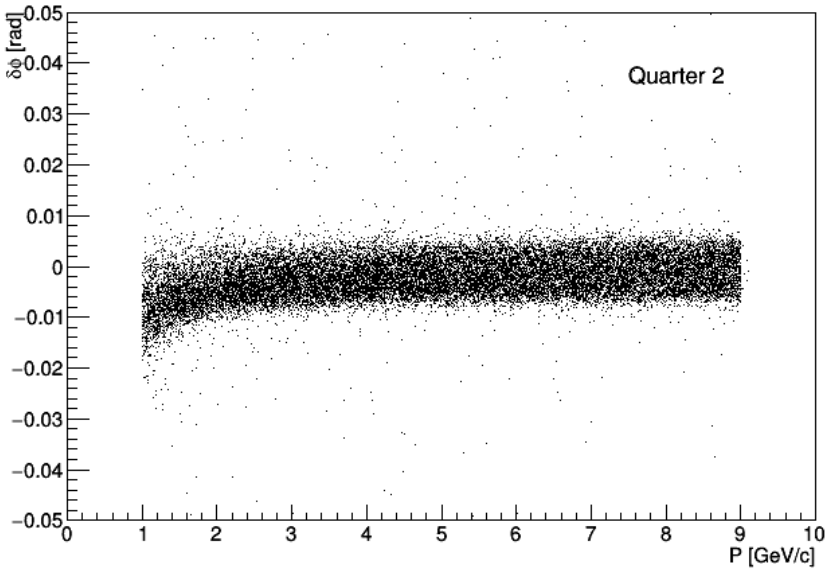




Spread of the reconstructed θ residuals for e- tracks in quarters 1 (above beam) and 3 (below beam).

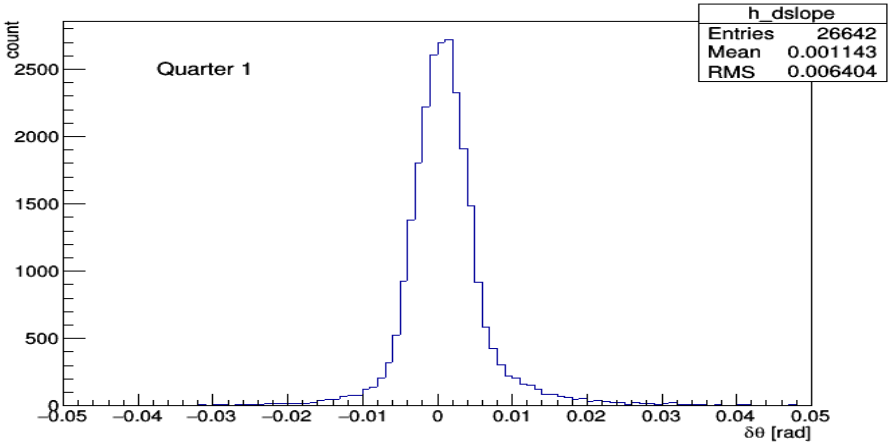
e-, φ accuracy versus P

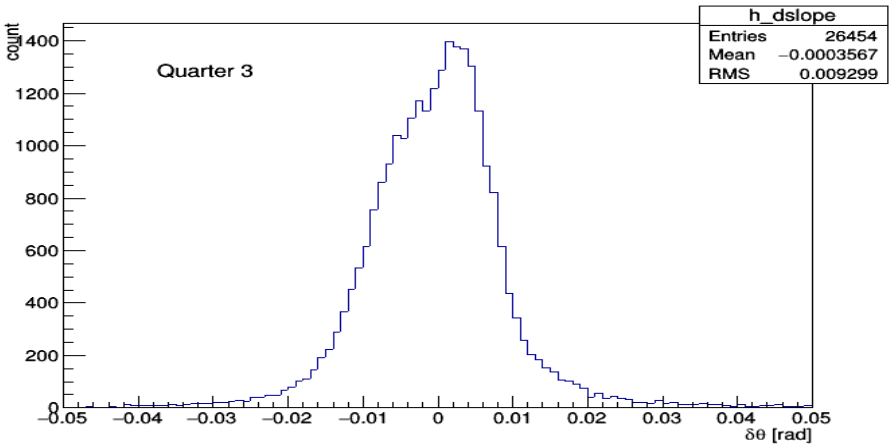


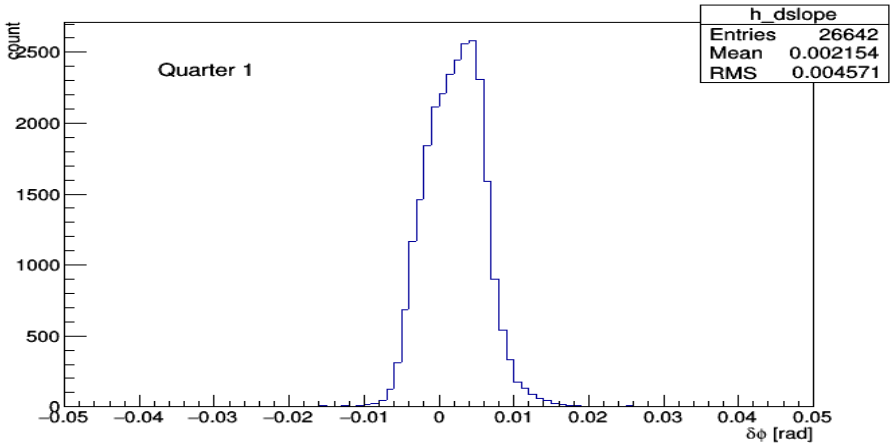


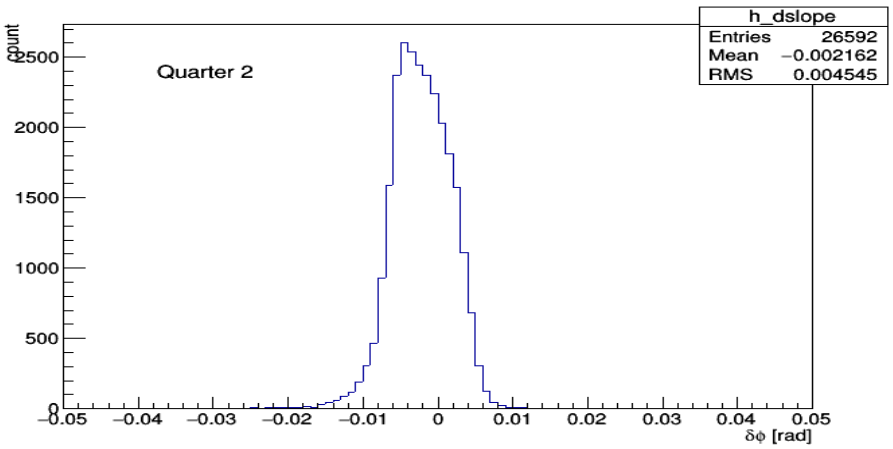
Spread of reconstructed φ residuals for e- tracks in quarters 1 (left of beam) and 2 (right of beam).

e-, reconstruction of θ and φ

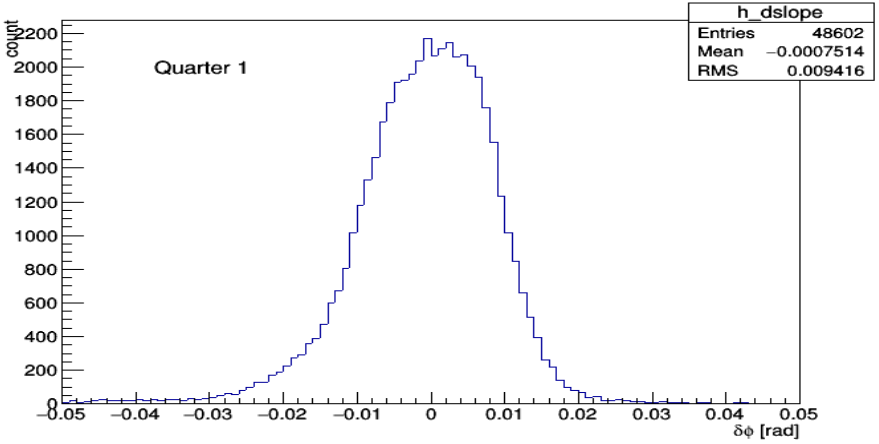


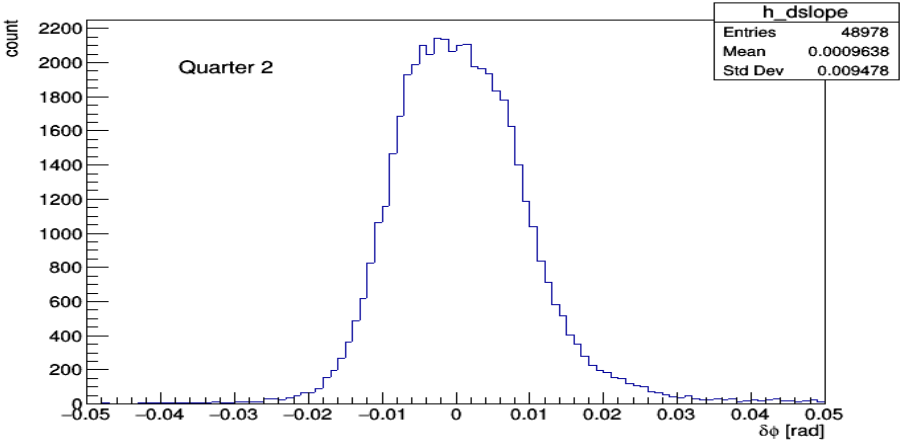


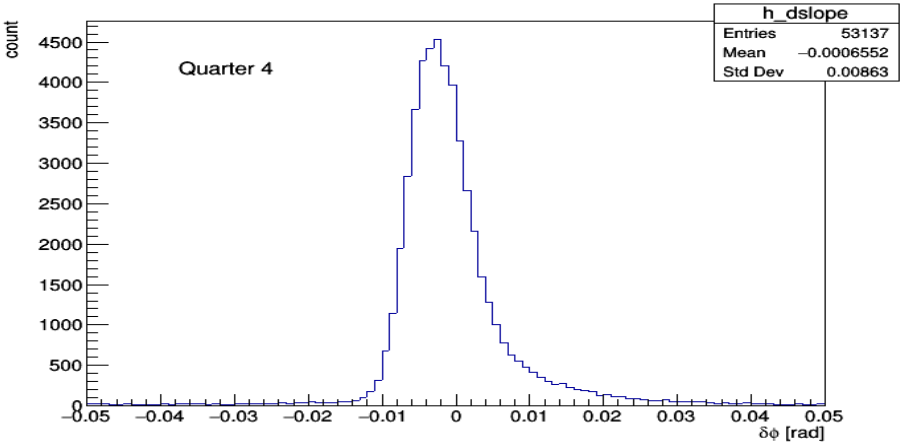


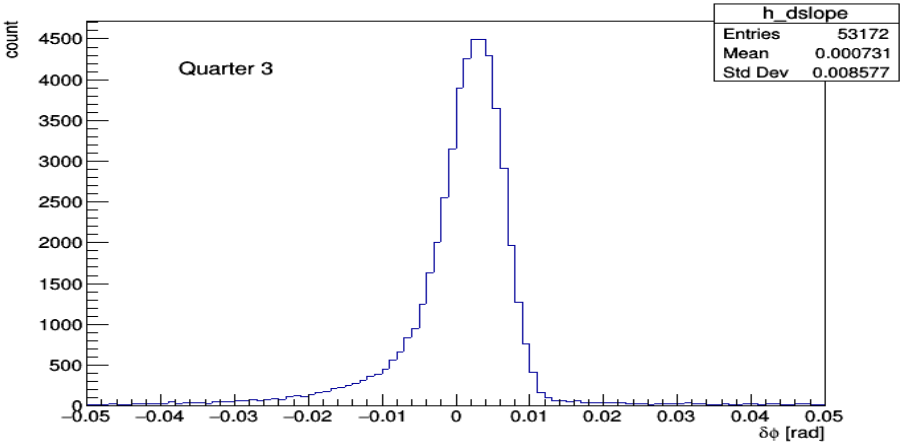


proton, reconstruction of φ









proton, φ accuracy versus P