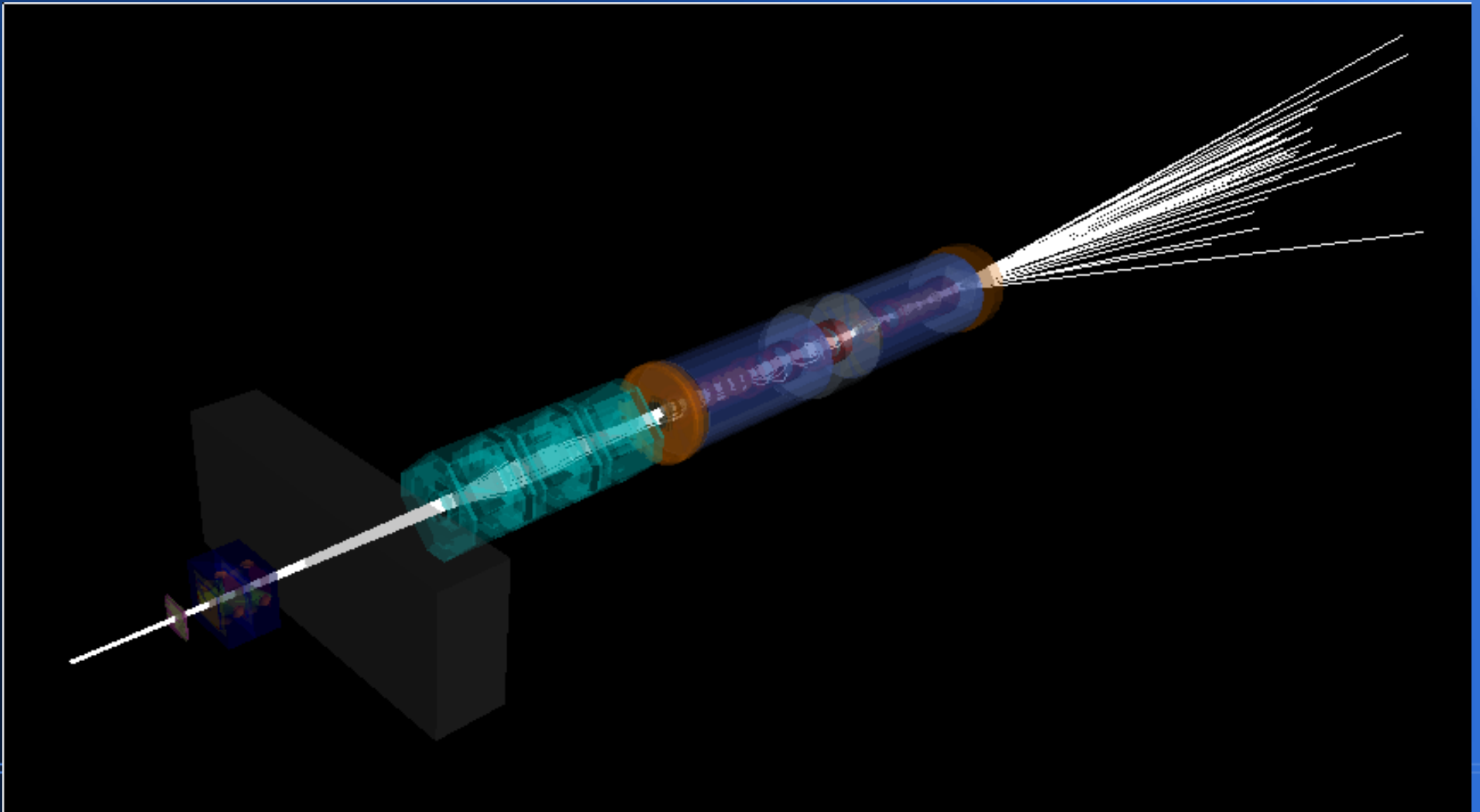


Global Reconstruction of Step 4

Peter Lane
Illinois Institute of Technology

Step 4 Simulation



Beam Configuration

```
beam = {"particle_generator":"binomial", "binomial_n":500, "binomial_p":1,
  "random_seed":2,
  "definitions":[
    ##### MUONS #####
    {
      "reference":simulation_reference_particle,
      "random_seed_algorithm":"incrementing_random", "weight":100.,
      "transverse":{"
        "transverse_mode":"twiss",
        "beta_x":1000., "alpha_x":0.0, "emittance_x":0.1,
        "beta_y":1000., "alpha_y":0.0, "emittance_y":0.1
      },
      "longitudinal":{"longitudinal_mode":"uniform_time",
        "momentum_variable":"p",
        "sigma_p":25., "t_start":-1.e6, "t_end":+1.e6},
      "coupling":{"coupling_mode":"none"}
    }
  ]
}
```

Reconstruction Input Notes

- Trigger time is unknown. Times relative to beam creation time.
- Tracker times are not synched with TOF times, so they are treated as unknowns (set to 0).
- Tracker energy/momenta are smeared MC since helical reconstruction is not available yet.
- Energy in TOF are unknown, so they are treated as unknowns (set to ref. particle E)

Momentum Smearing

```
ThreeVector momentum;
const SciFiClusterPArray clusters = (*scifi_space_point)->get_channels();
for (SciFiClusterPArray::const_iterator cluster = clusters.begin();
     cluster != clusters.end();
     ++cluster) {
    ThreeVector true_momentum = (*cluster)->get_true_momentum();
    momentum += true_momentum;
}
if (clusters.size() > 0) {
    momentum /= clusters.size();
}
momentum.setX(momentum.x() + ::CLHEP::RandGauss::shoot(0., 3.));
momentum.setY(momentum.y() + ::CLHEP::RandGauss::shoot(0., 3.));
momentum.setZ(momentum.z() + ::CLHEP::RandGauss::shoot(0., 20.));
...
const GlobalDS::PID particle_id = GlobalDS::PID(reference_pgparticle.pid);
const double beta = Beta(particle_id, momentum.mag());
const double energy = momentum.mag() / beta;
```

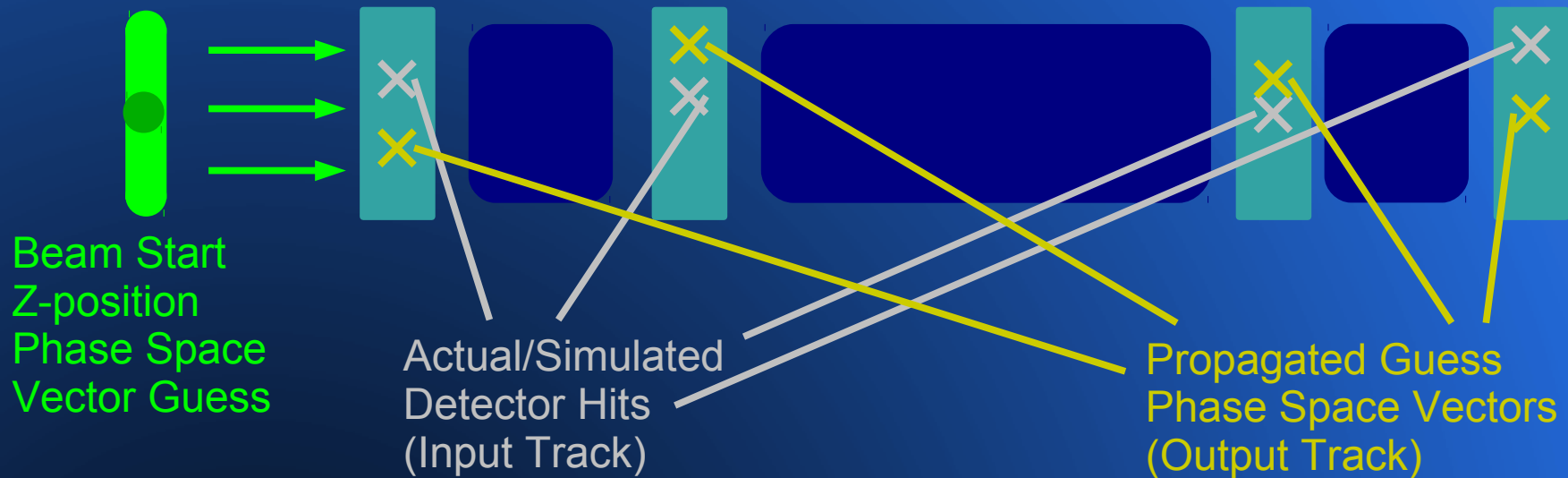
Raw Track Residuals (Description)

- Simulation is run.
- Detectors yield individually reconstructed space points (detector hits).
- Raw tracks are created using the space points provided by the detectors.
- Track points are 6-D phase space vectors.
- These raw tracks are used as input to global reconstruction.
- Residuals are created between raw track components and MC truth.

Reconstructed Track Residuals (Description)

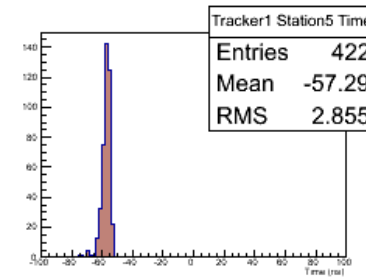
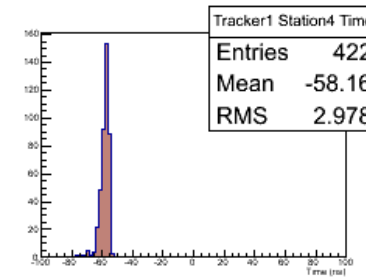
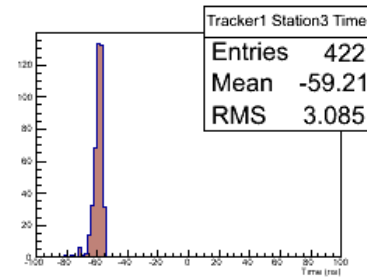
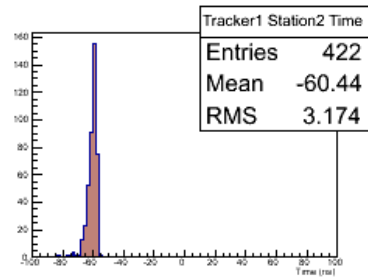
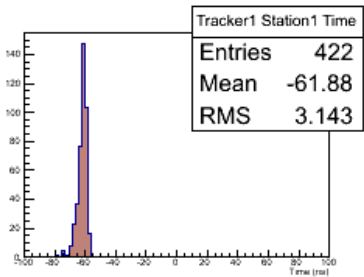
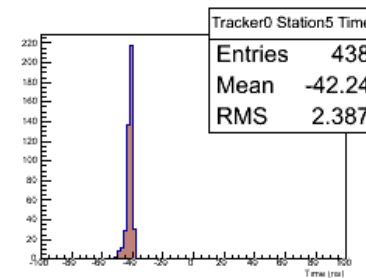
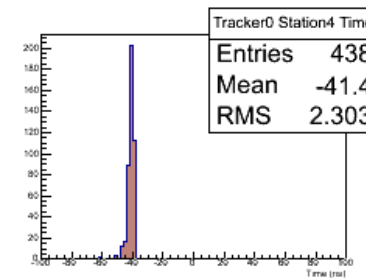
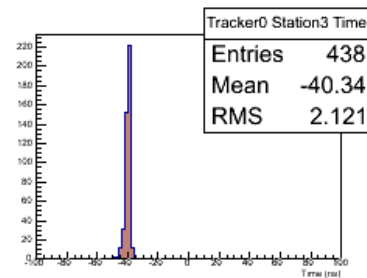
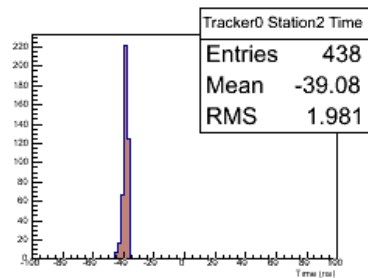
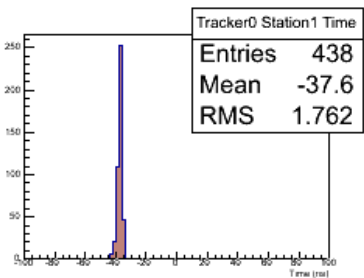
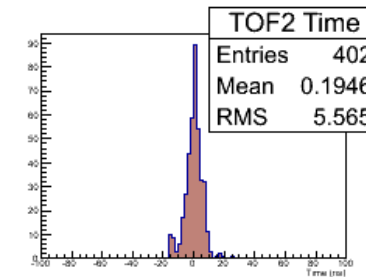
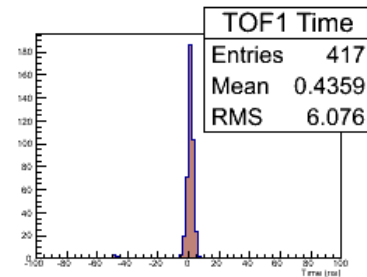
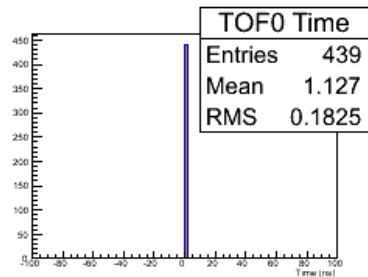
- Global reconstruction takes raw tracks as input.
- Transfer maps created by performing polynomial fits to test particle hits.
- Track fitting is done on each raw track (see next slide for details).
- Outputs are tracks composed also of 6-D phase space vectors.
- Residuals are created between reconstruction output tracks and MC truth.

Track Fitting Algorithm

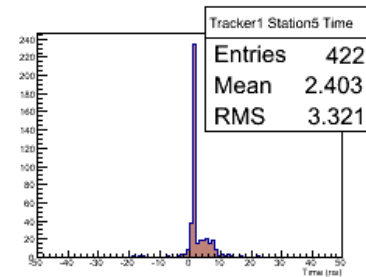
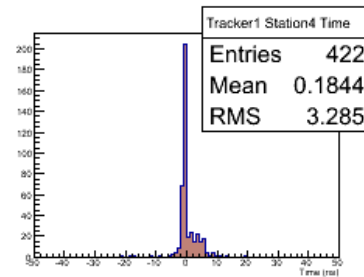
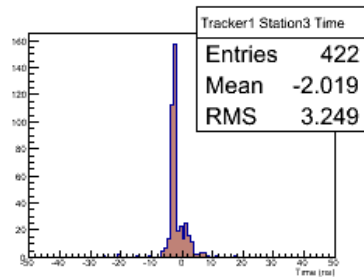
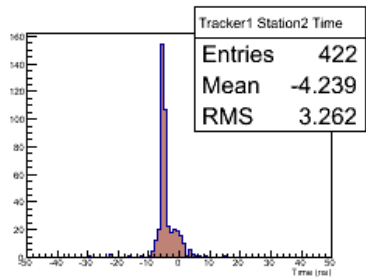
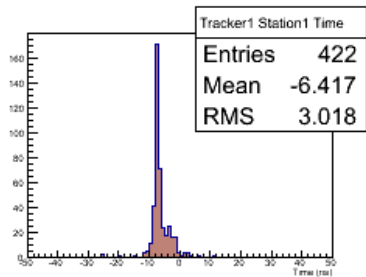
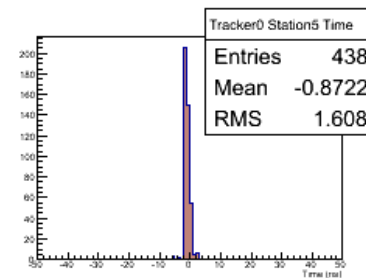
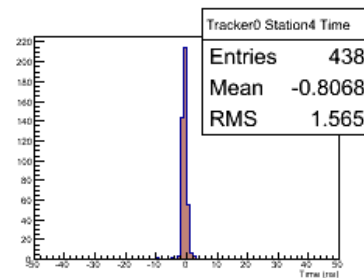
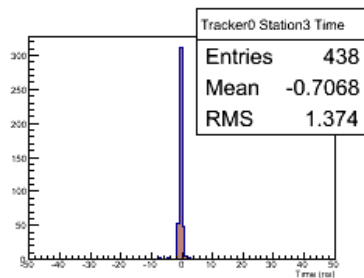
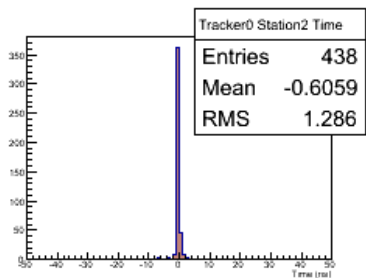
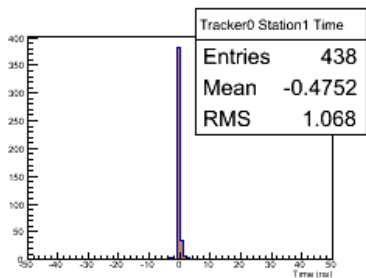
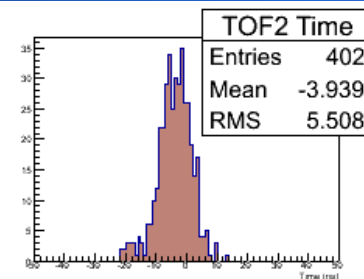
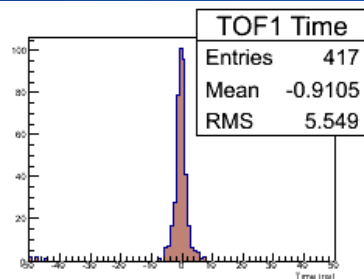
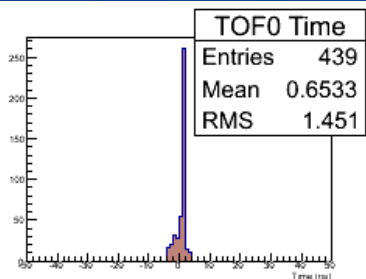


- Find **initial phase space vector** that minimizes χ^2 -- the sum of the squares of the differences between the **propagated guesses (potential outputs)** and the detector hits (raw track point inputs).
 - weighted by the detectors' measurement uncertainties

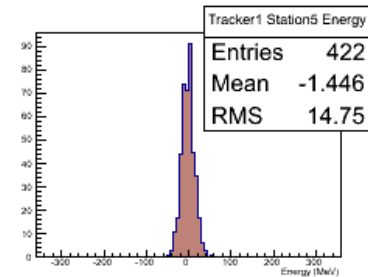
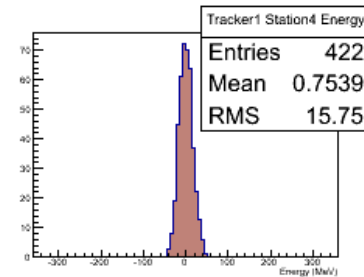
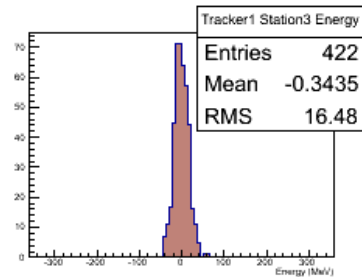
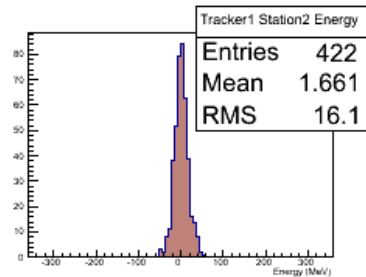
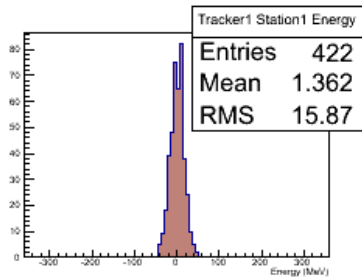
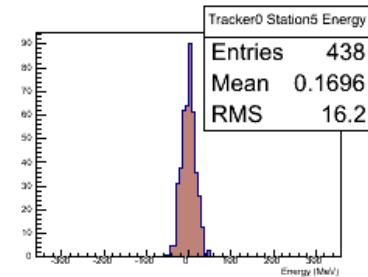
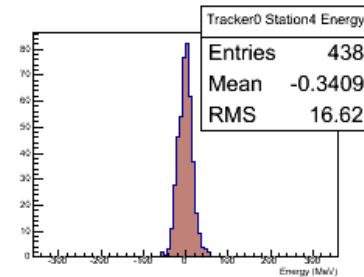
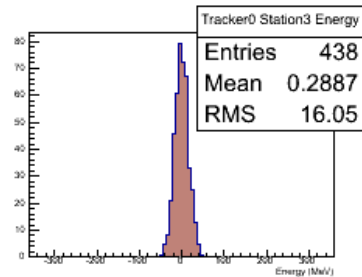
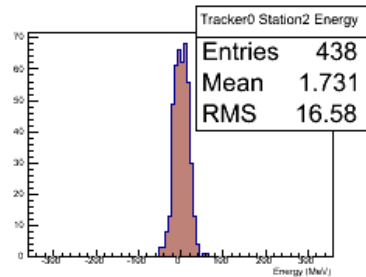
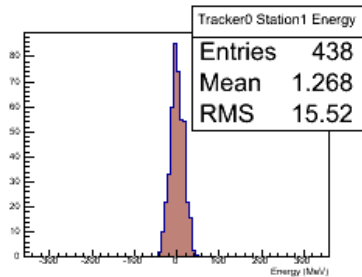
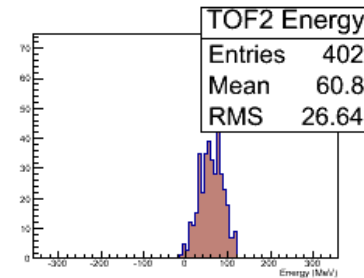
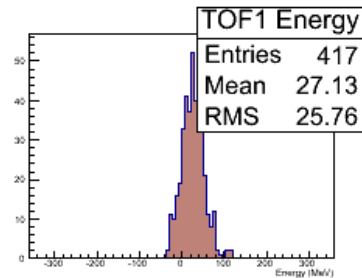
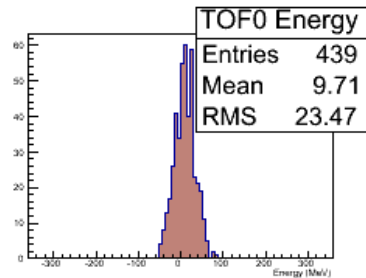
Raw Track Residuals (t)



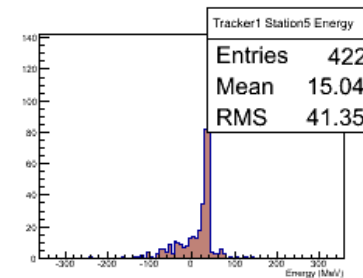
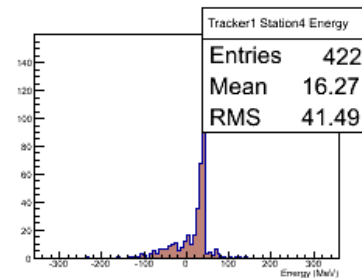
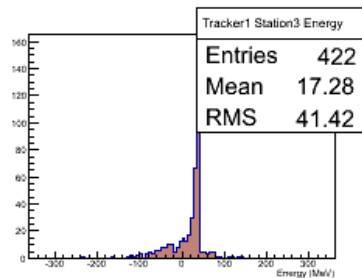
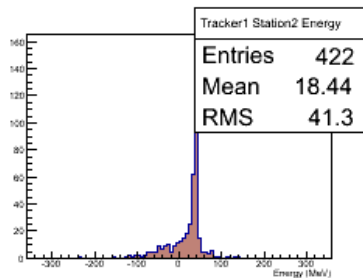
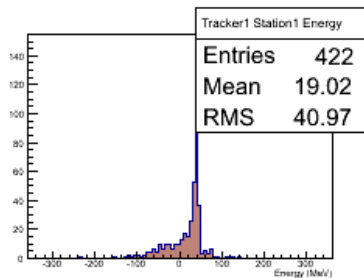
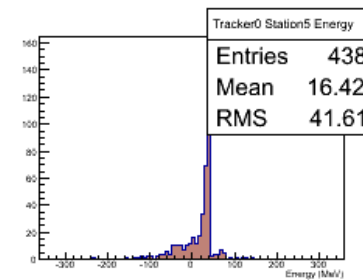
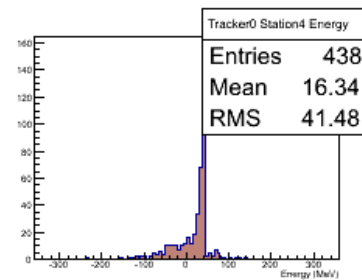
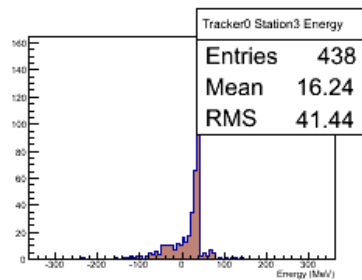
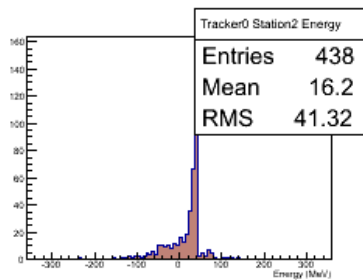
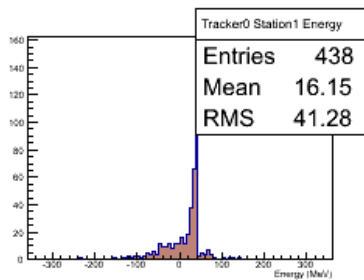
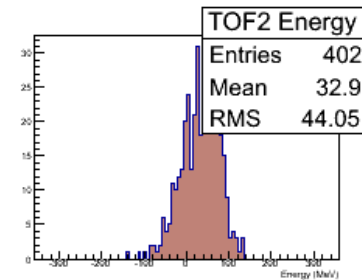
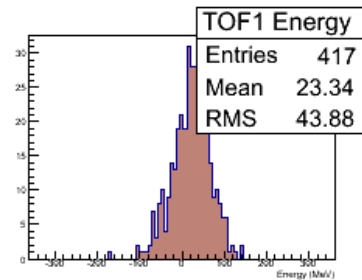
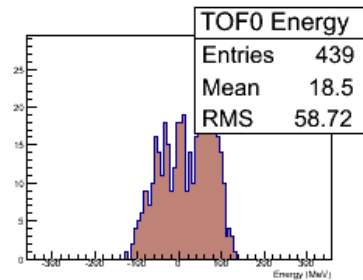
Reconstructed Track Residuals (t)



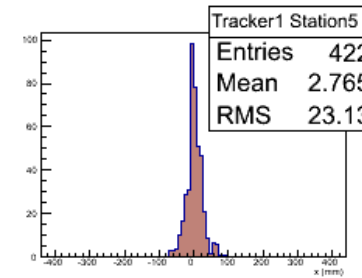
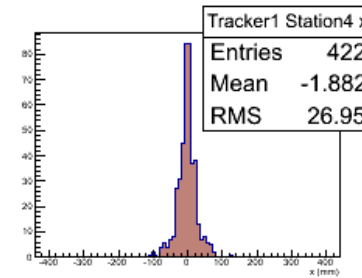
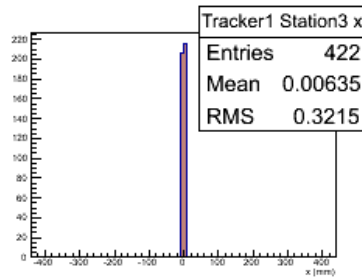
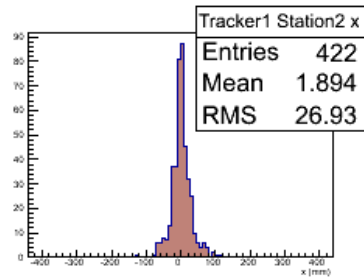
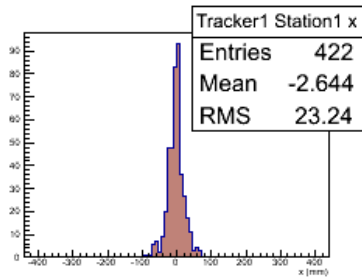
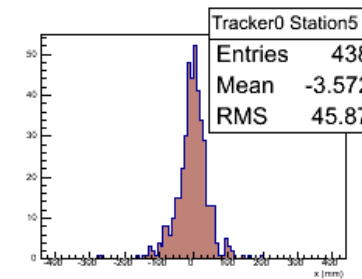
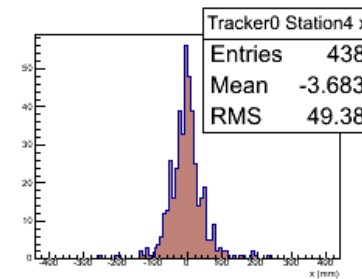
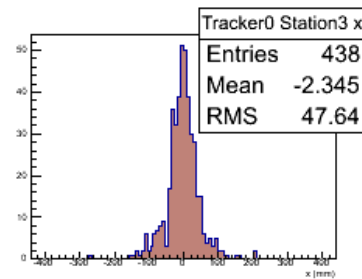
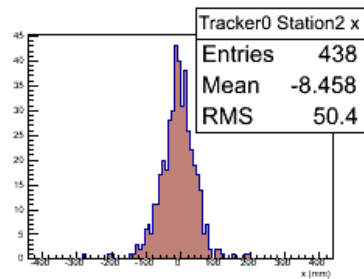
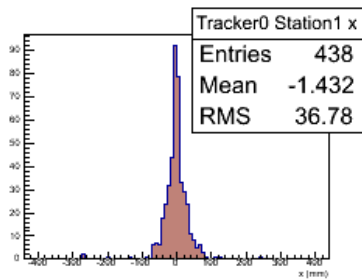
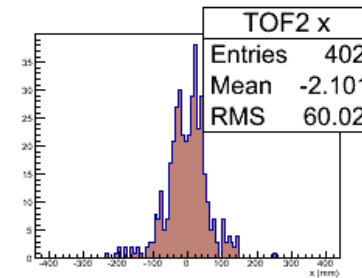
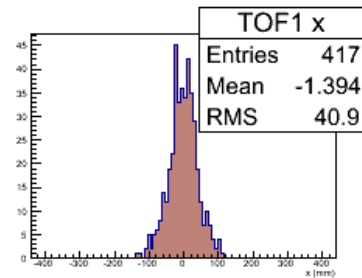
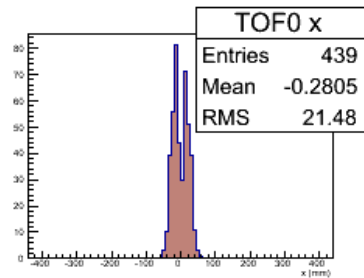
Raw Track Residuals (E)



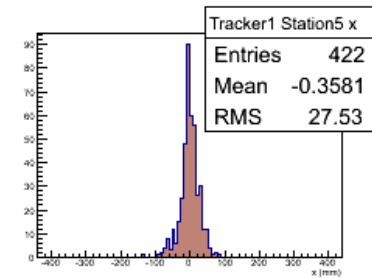
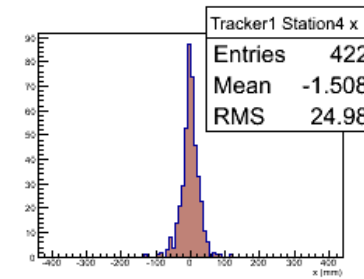
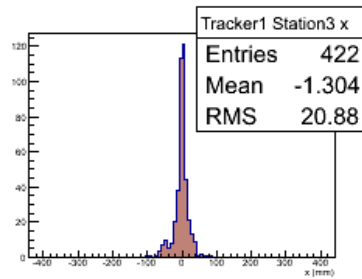
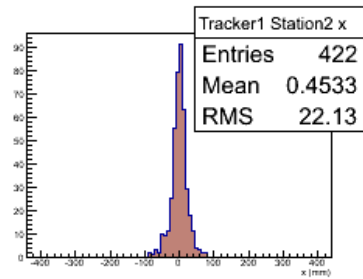
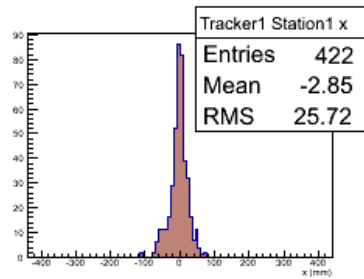
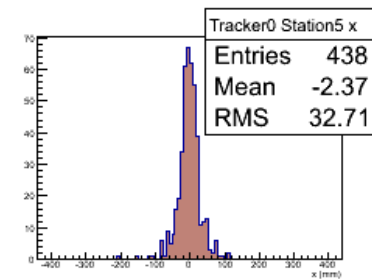
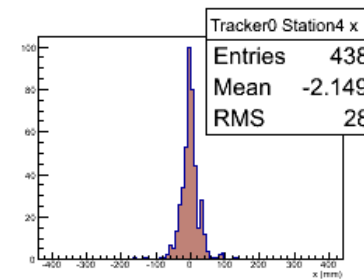
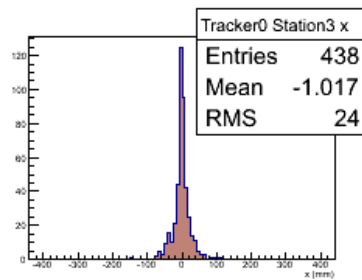
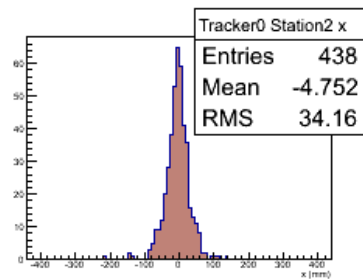
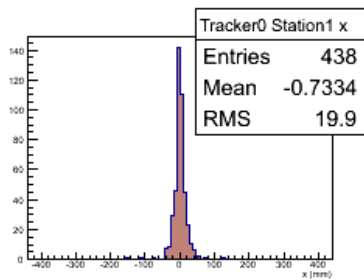
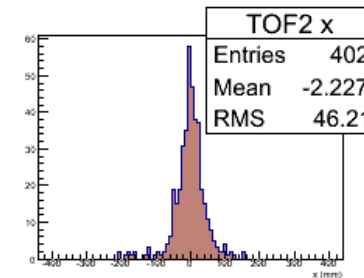
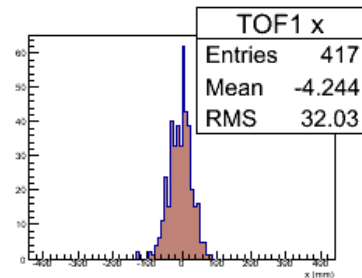
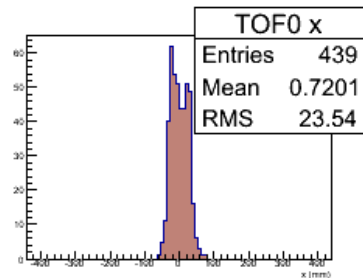
Reconstructed Track Residuals (E)



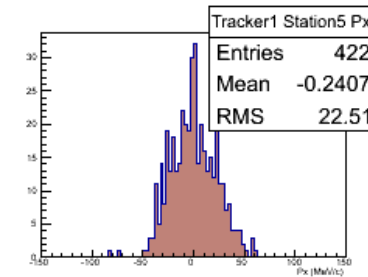
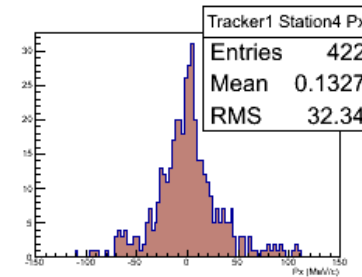
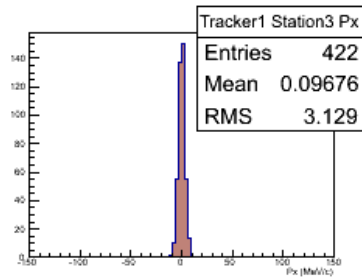
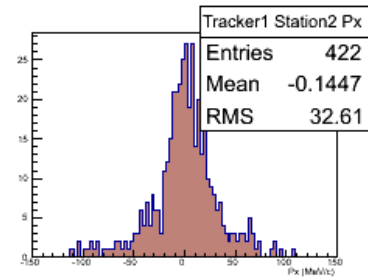
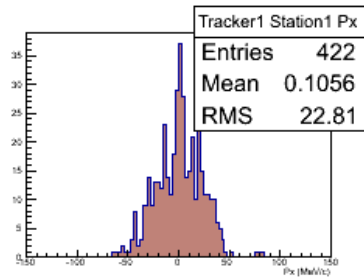
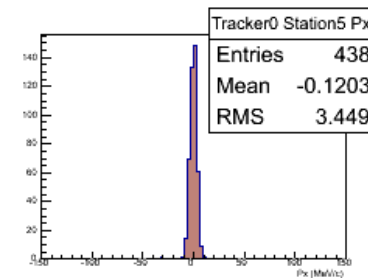
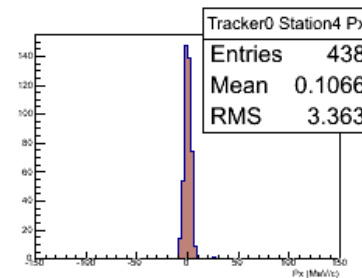
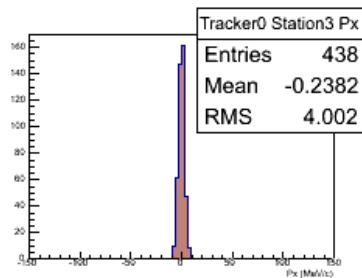
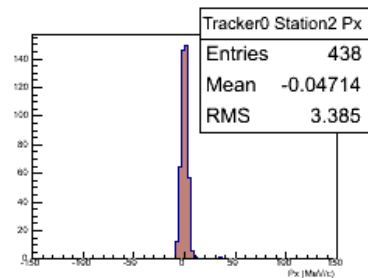
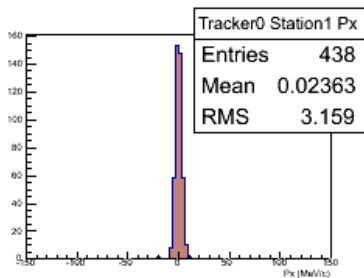
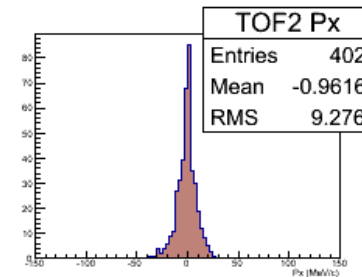
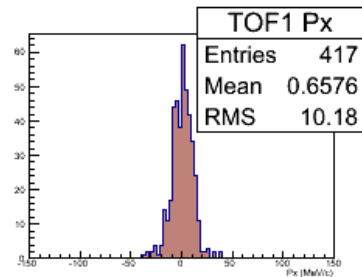
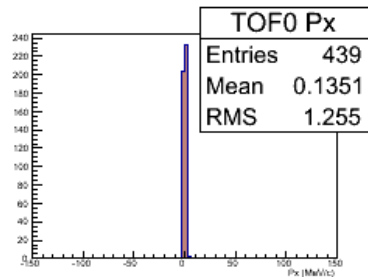
Raw Track Residuals (x)



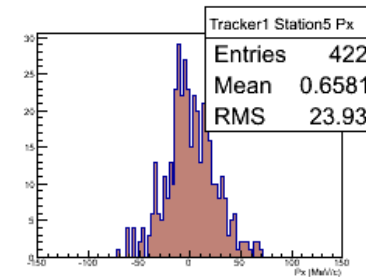
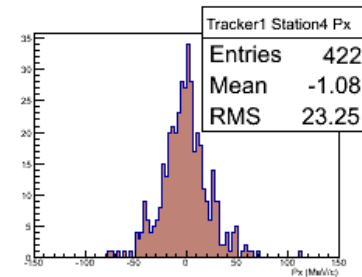
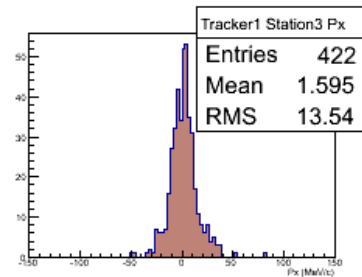
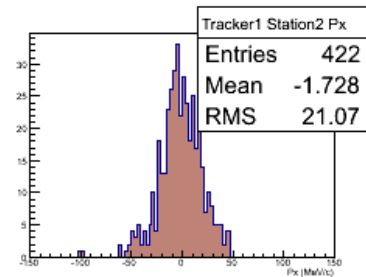
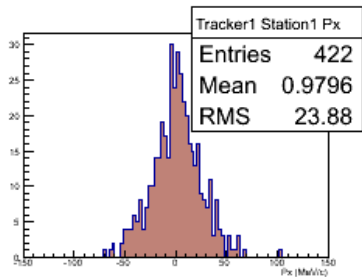
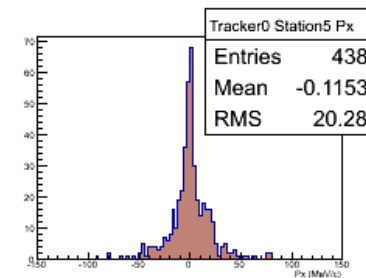
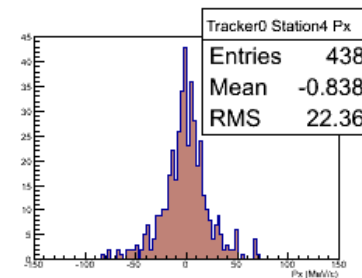
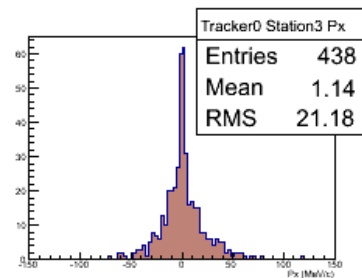
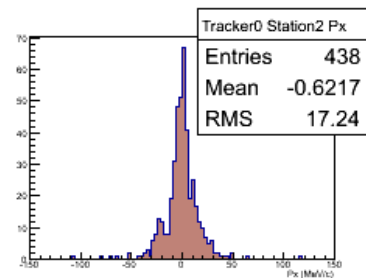
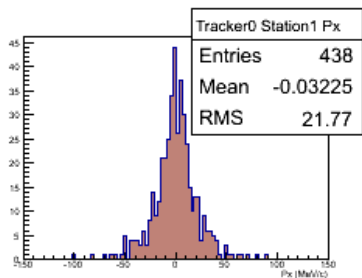
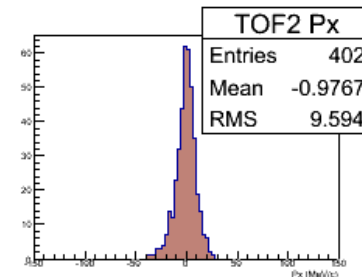
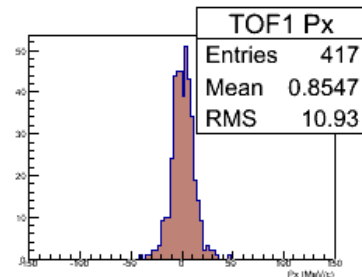
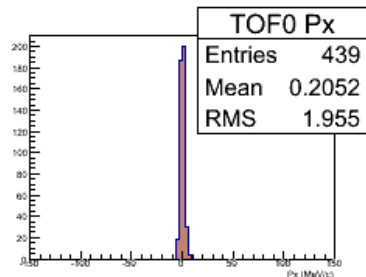
Reconstructed Track Residuals (x)



Raw Track Residuals (Px)



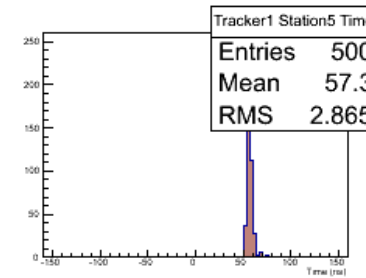
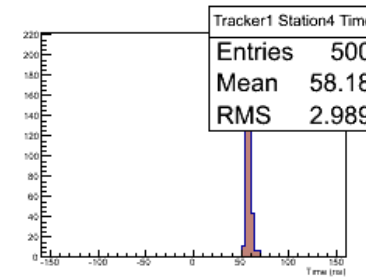
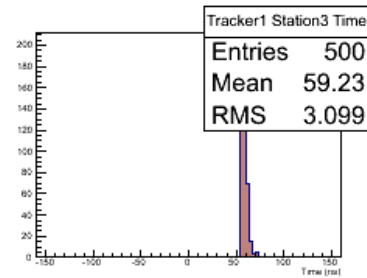
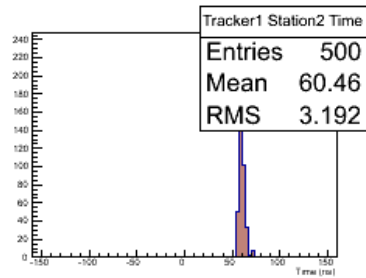
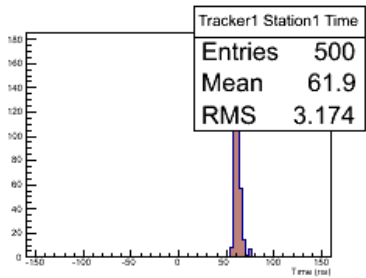
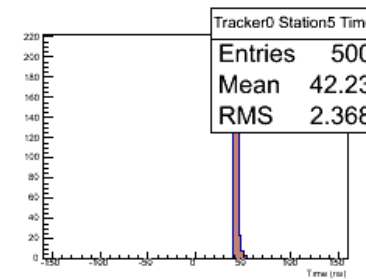
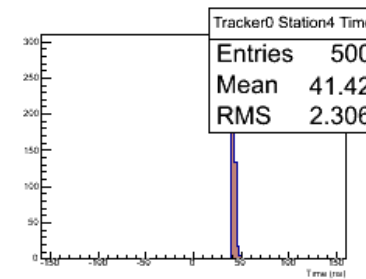
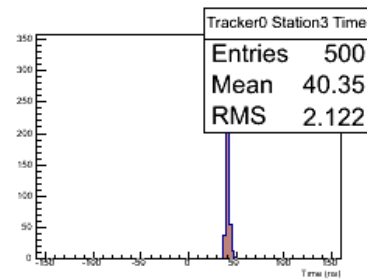
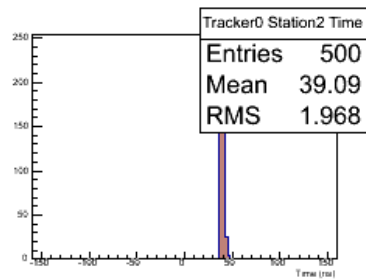
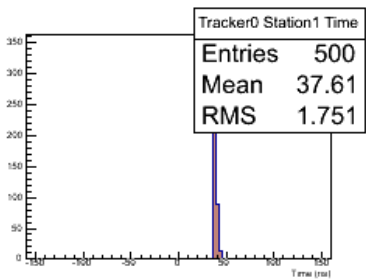
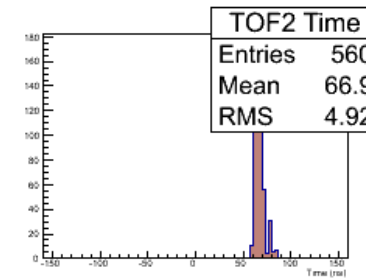
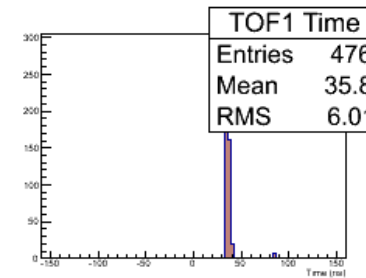
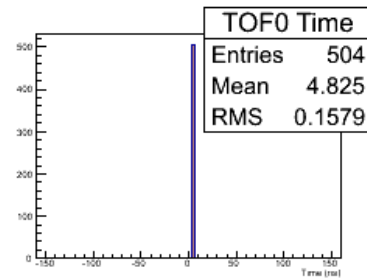
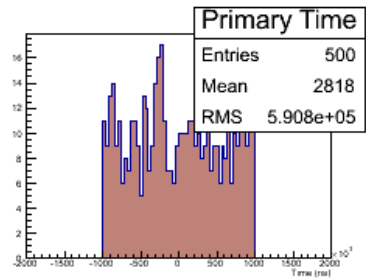
Reconstructed Track Residuals (Px)



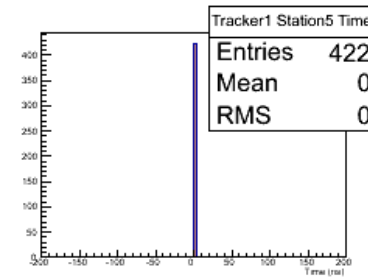
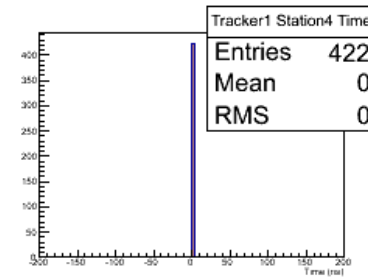
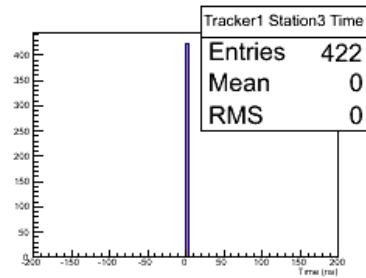
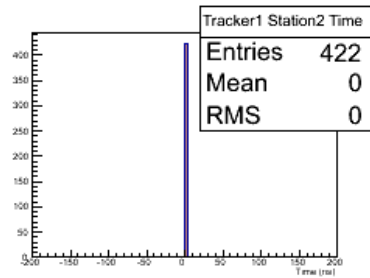
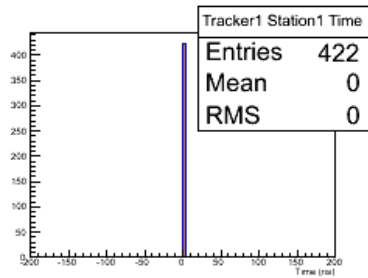
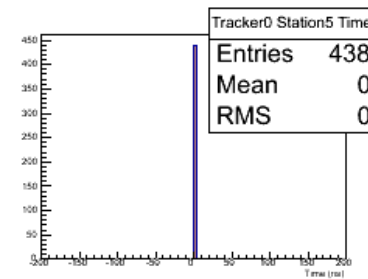
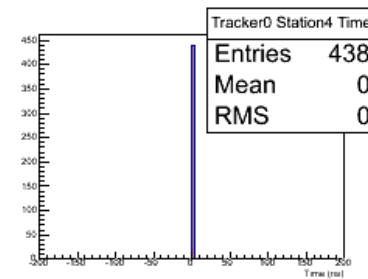
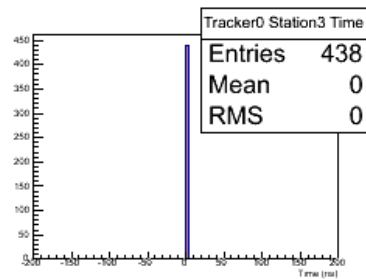
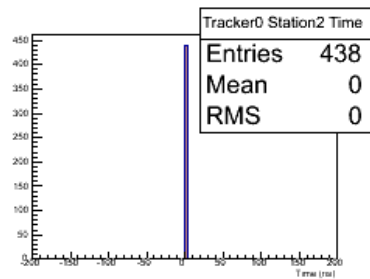
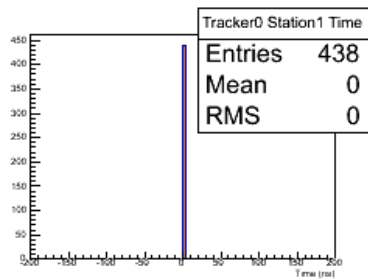
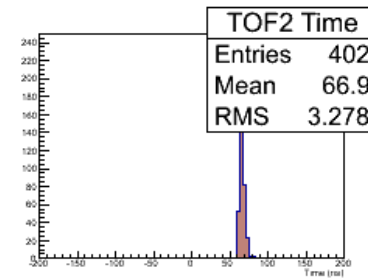
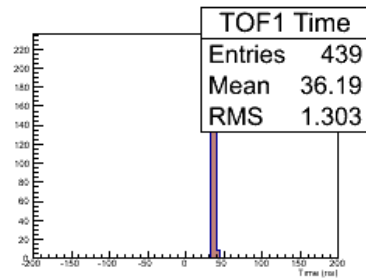
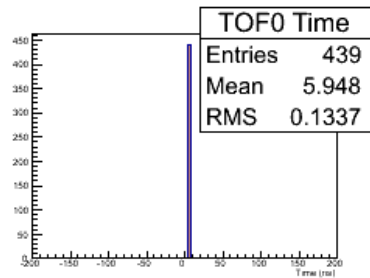
Extra Slides

- MC Histograms
- Raw Track Histograms
- Reconstructed Track Histograms

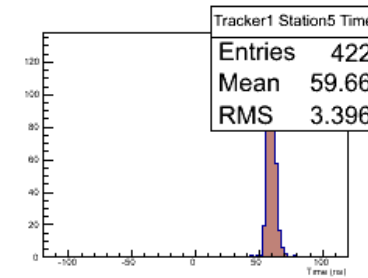
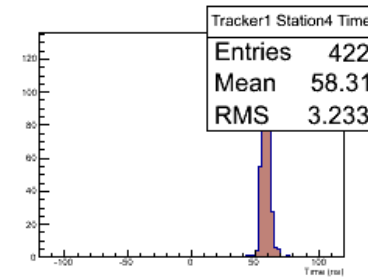
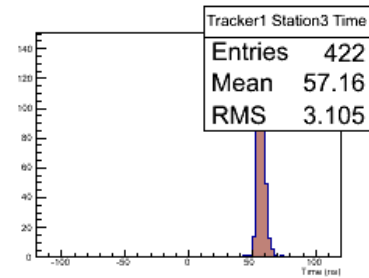
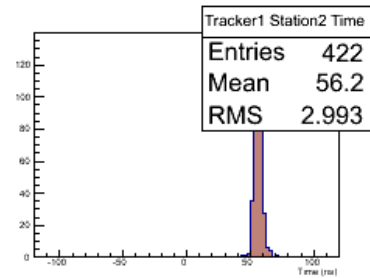
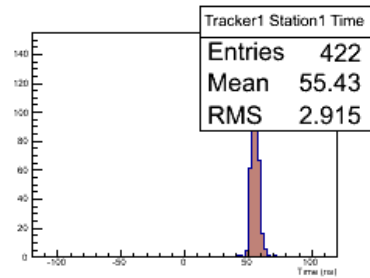
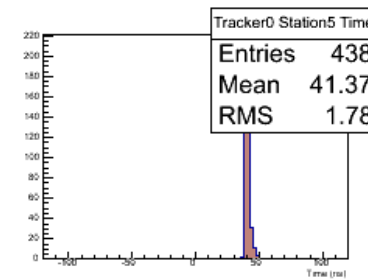
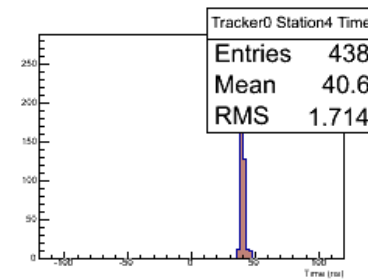
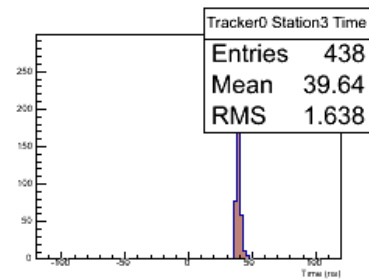
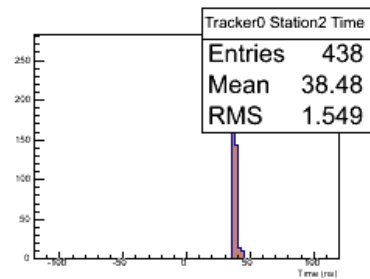
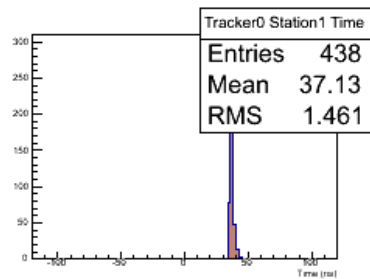
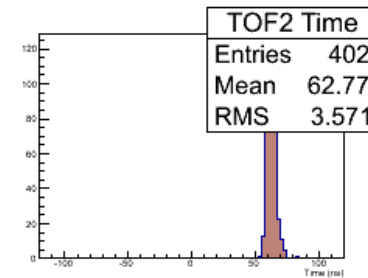
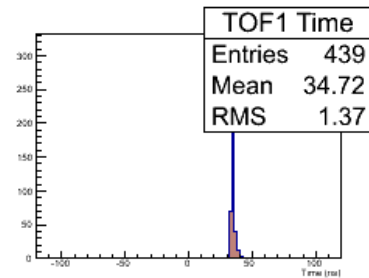
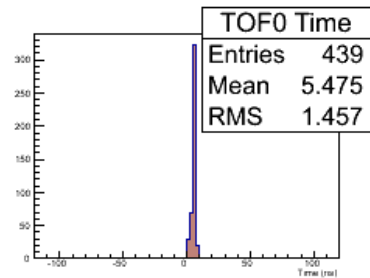
Monte Carlo Data (t)



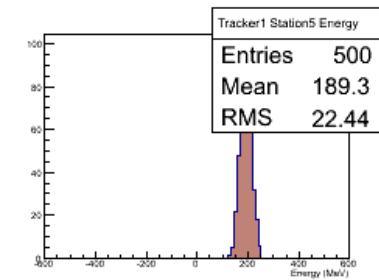
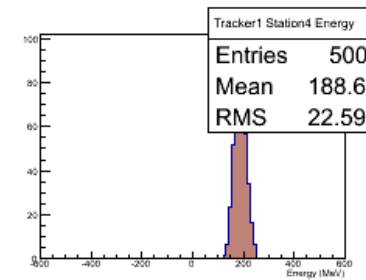
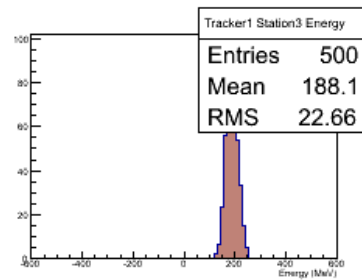
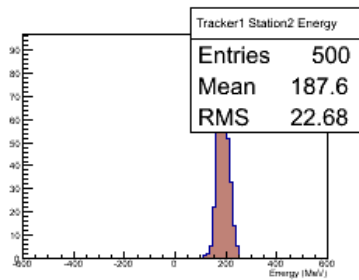
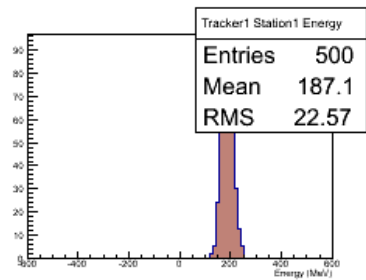
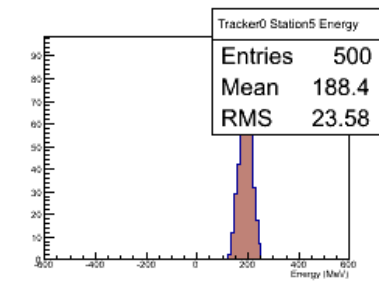
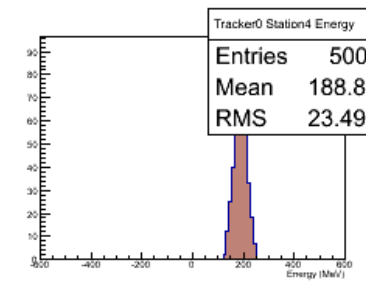
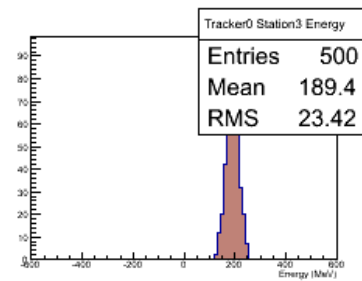
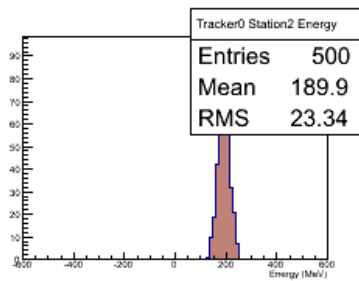
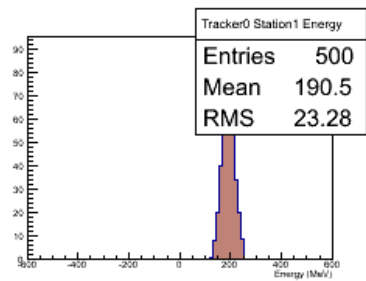
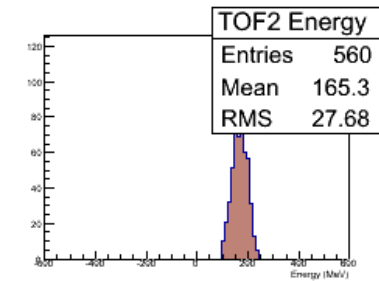
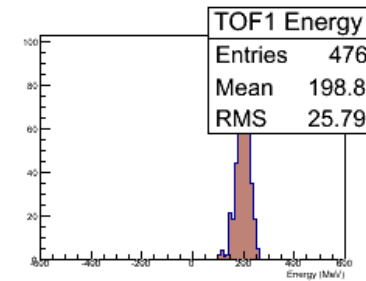
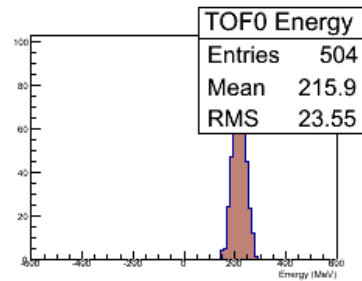
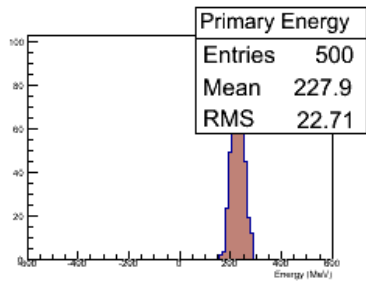
Raw Track Data (t)



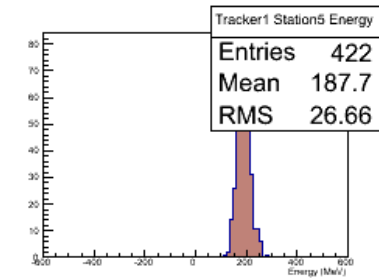
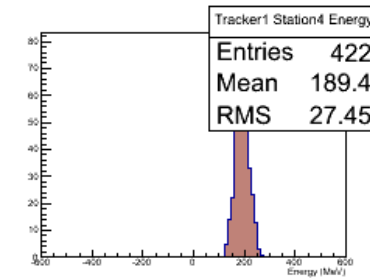
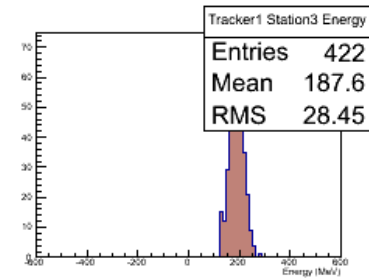
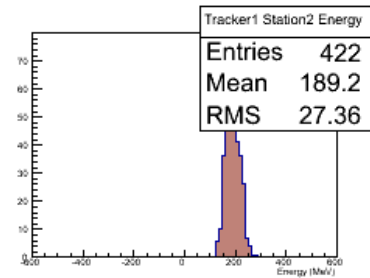
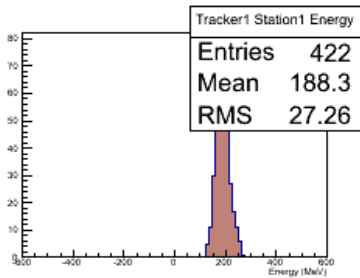
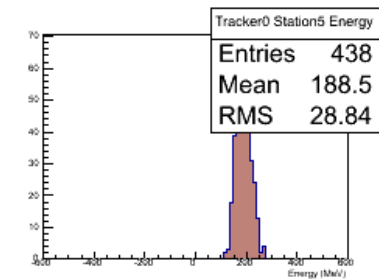
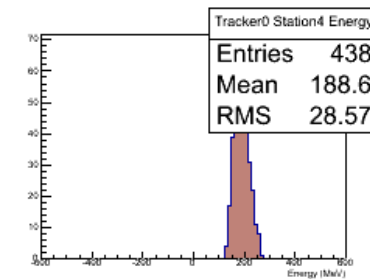
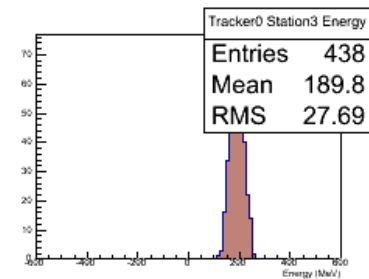
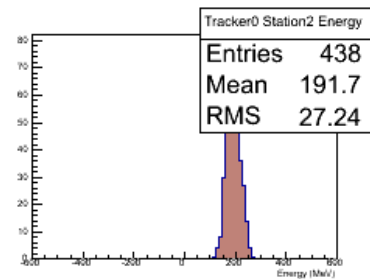
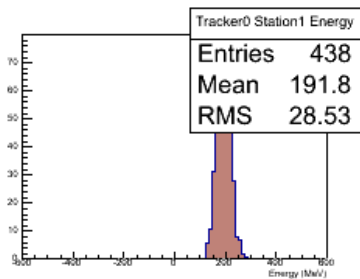
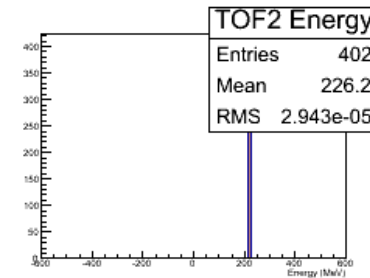
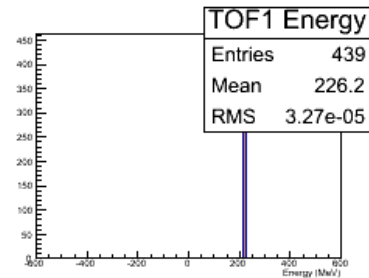
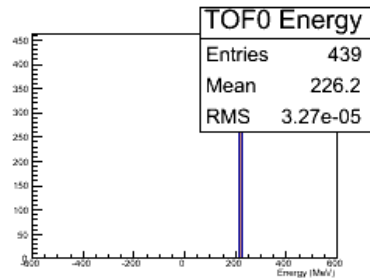
Reconstructed Track Data (t)



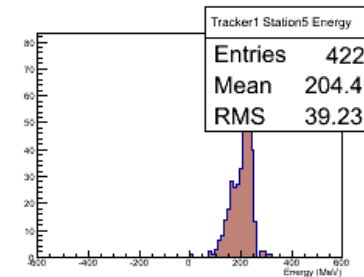
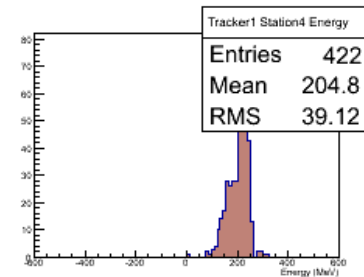
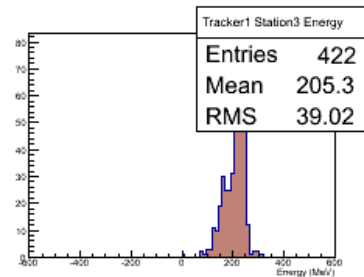
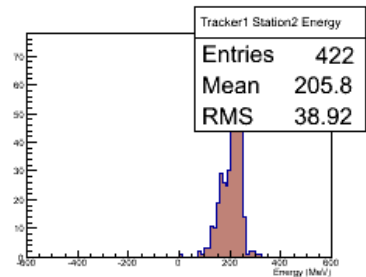
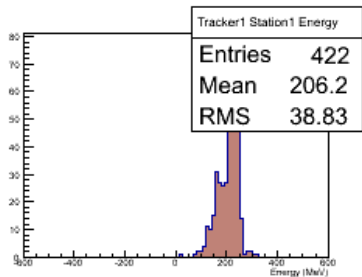
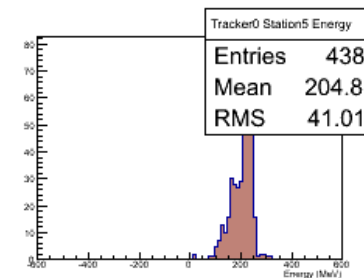
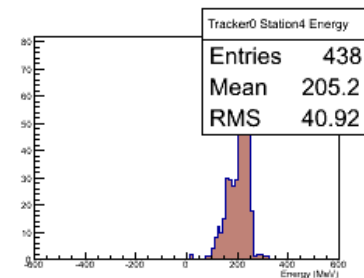
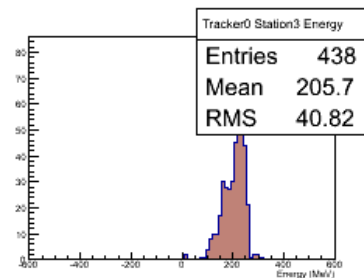
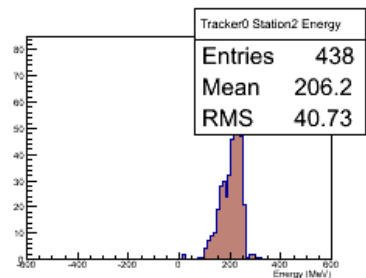
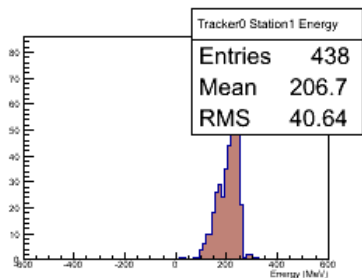
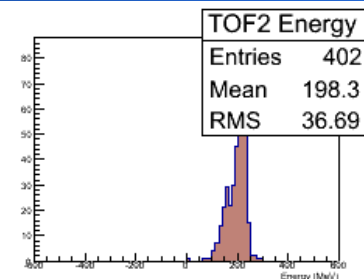
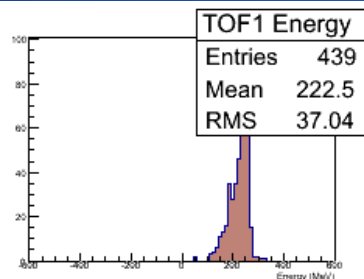
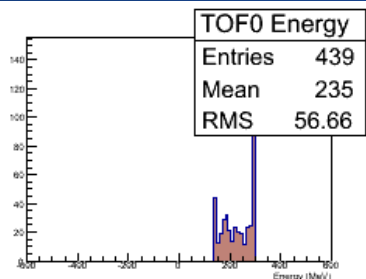
Monte Carlo Data (E)



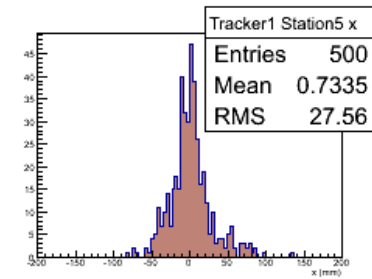
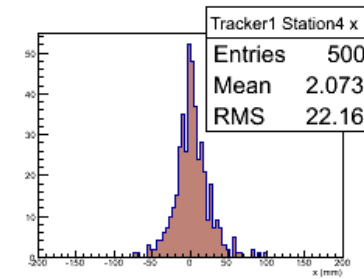
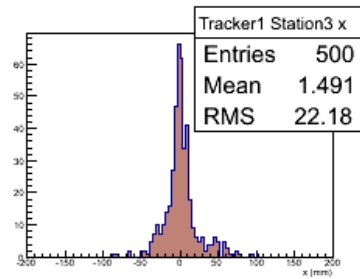
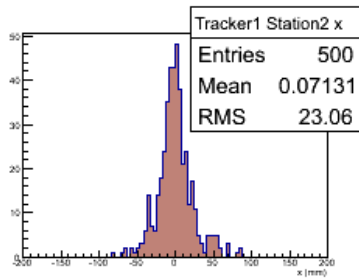
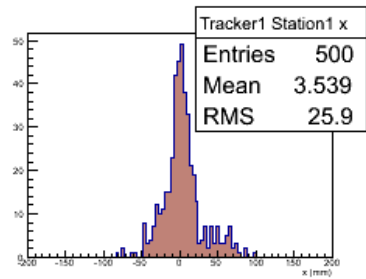
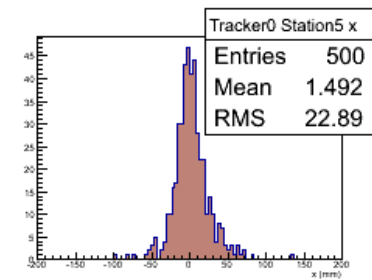
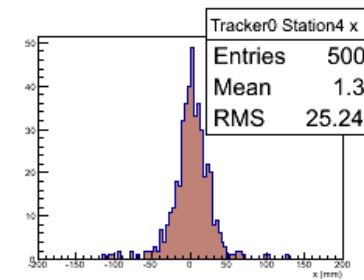
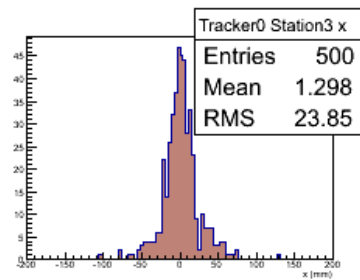
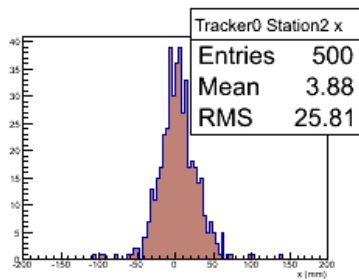
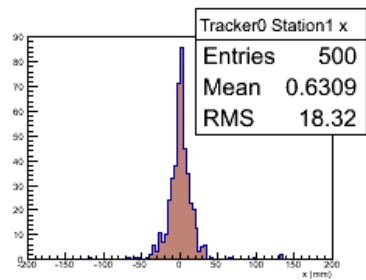
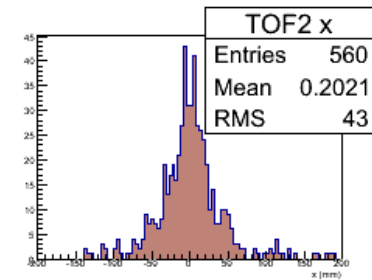
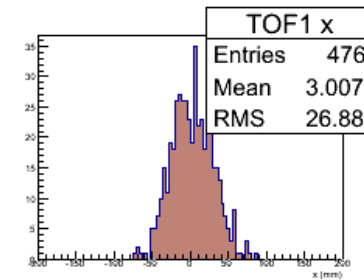
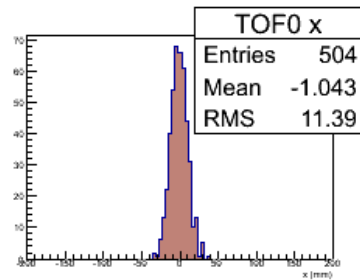
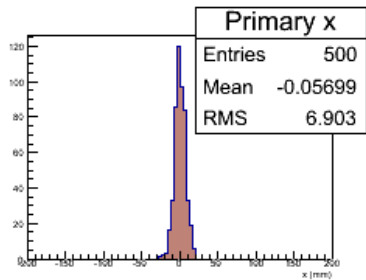
Raw Track Data (E)



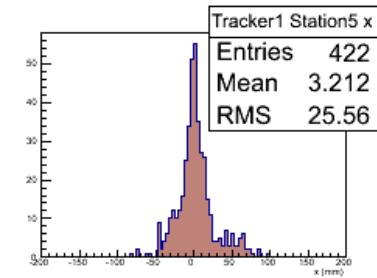
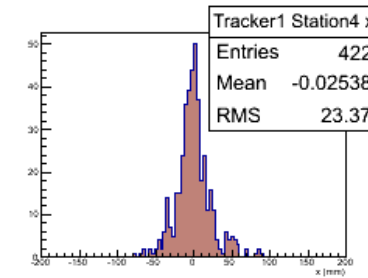
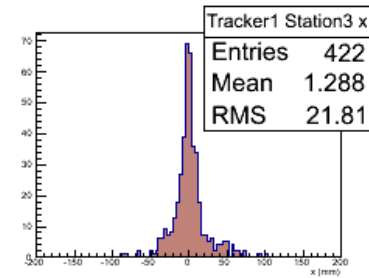
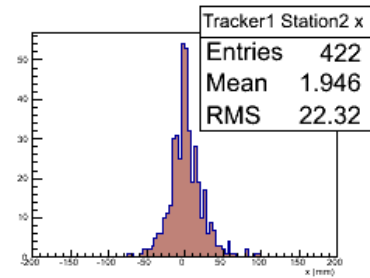
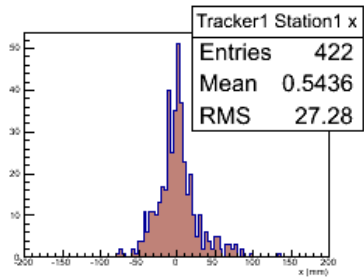
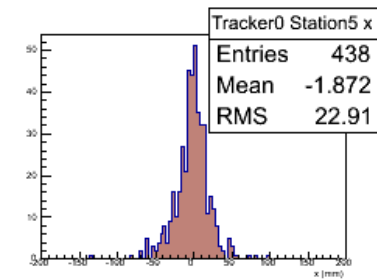
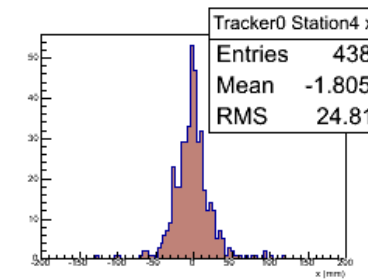
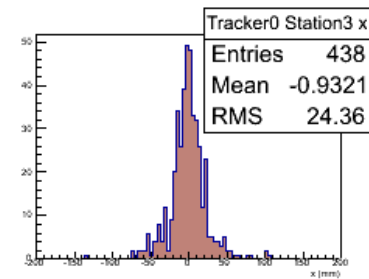
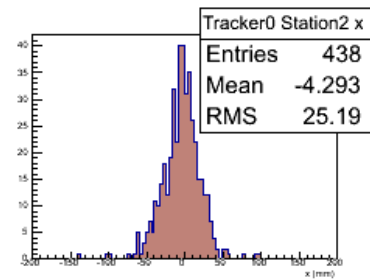
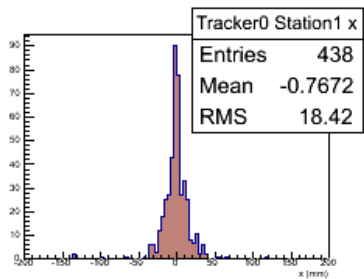
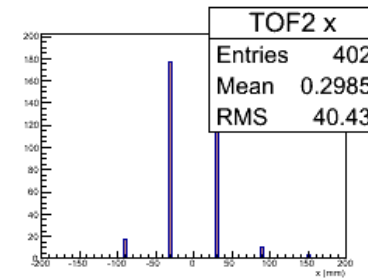
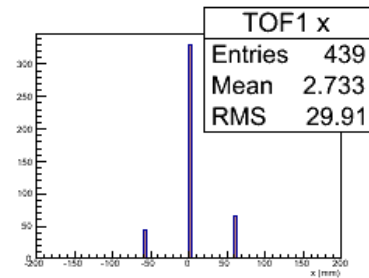
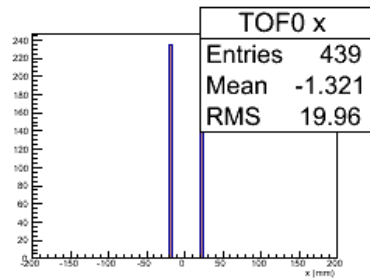
Reconstructed Track Data (E)



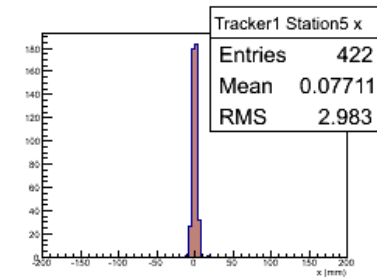
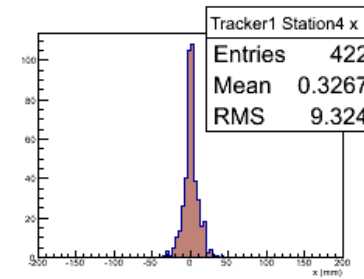
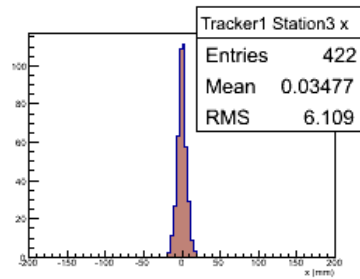
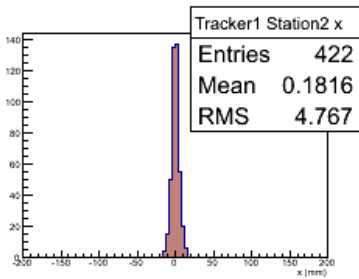
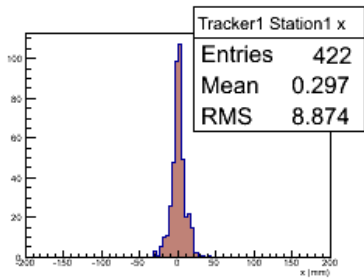
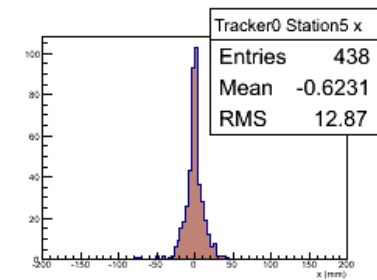
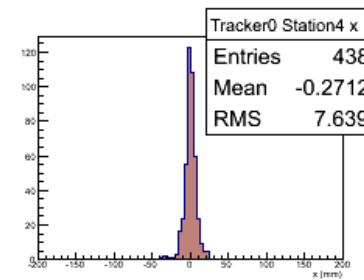
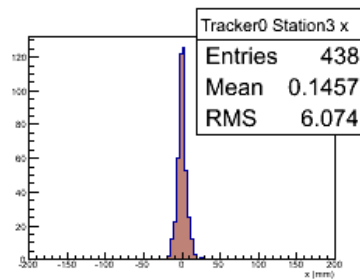
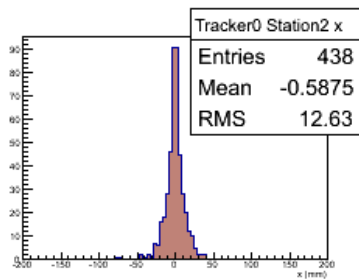
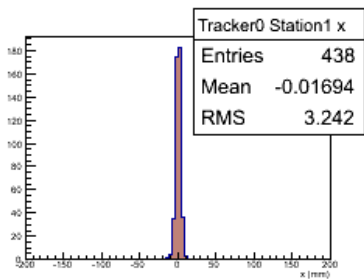
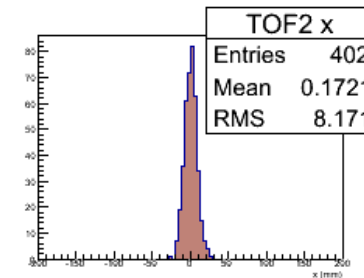
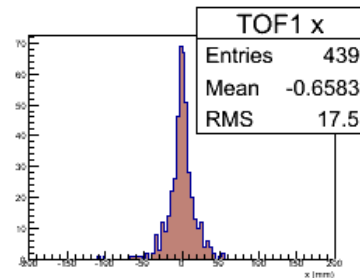
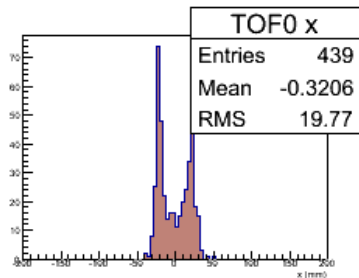
Monte Carlo Data (x)



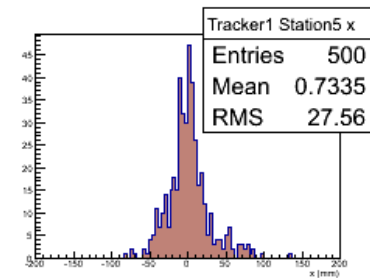
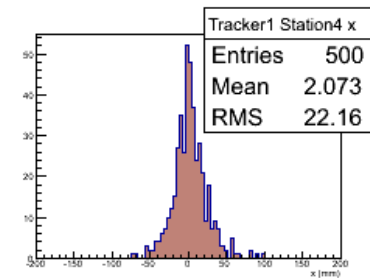
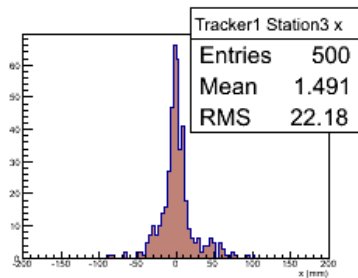
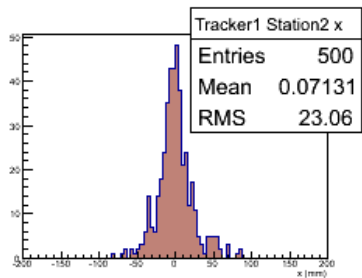
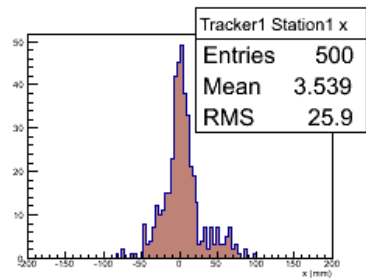
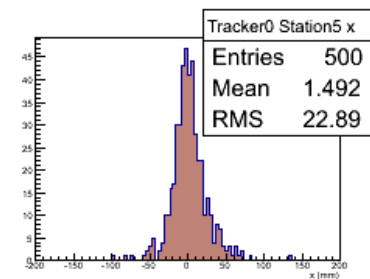
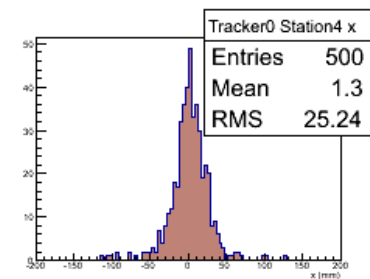
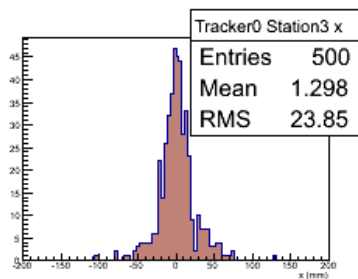
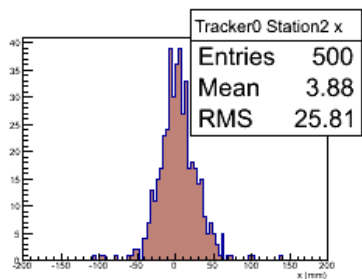
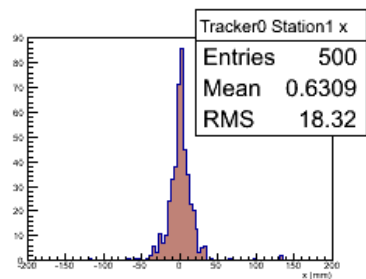
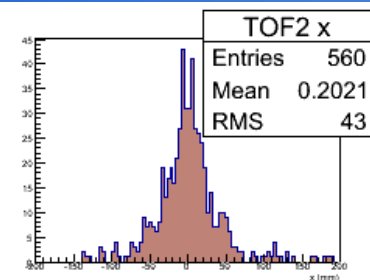
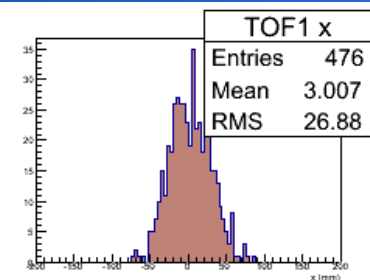
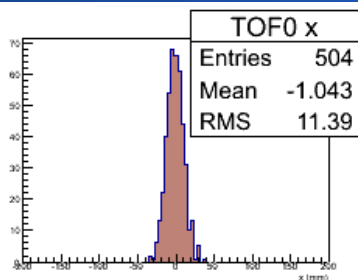
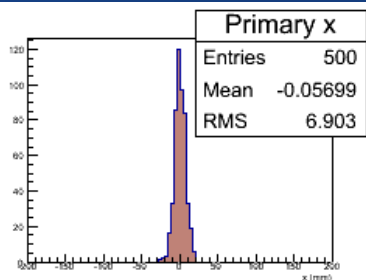
Raw Track Data (x)



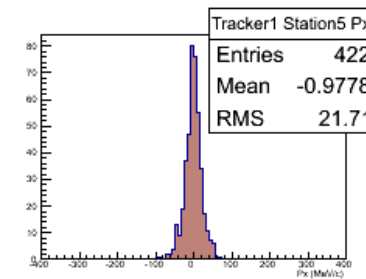
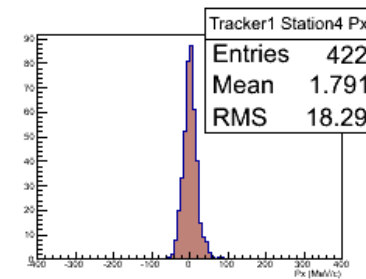
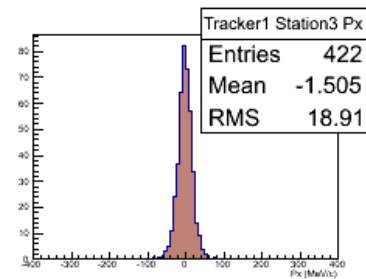
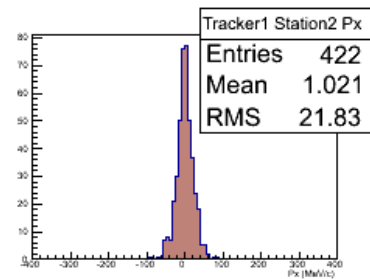
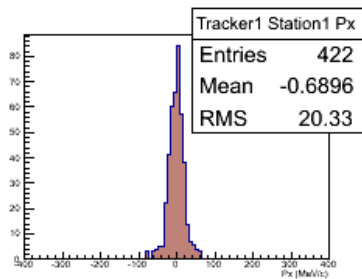
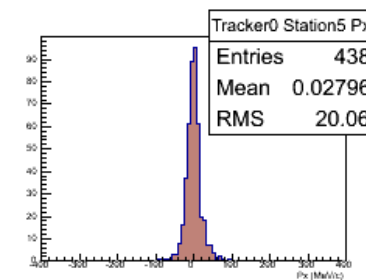
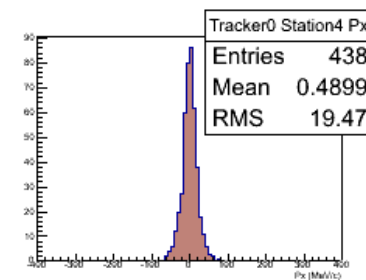
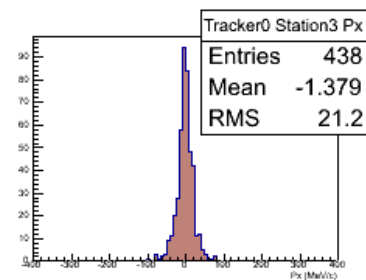
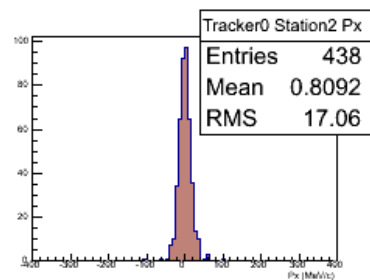
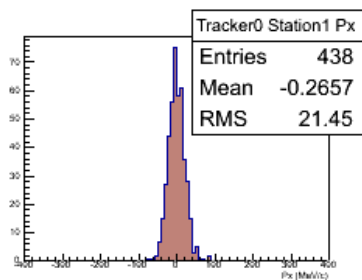
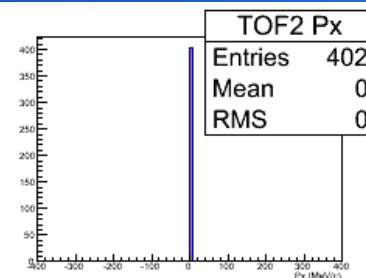
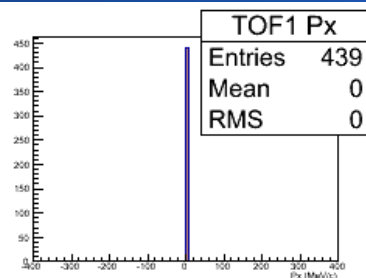
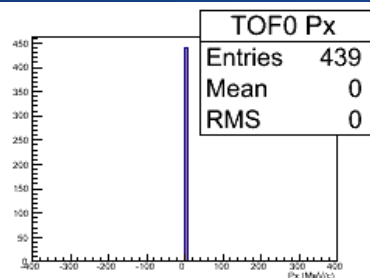
Reconstructed Track Data (x)



Monte Carlo Data (Px)



Raw Track Data (Px)



Reconstructed Track Data (Px)

