FOOT reconstruction & Global Tracking

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Foot general meeting

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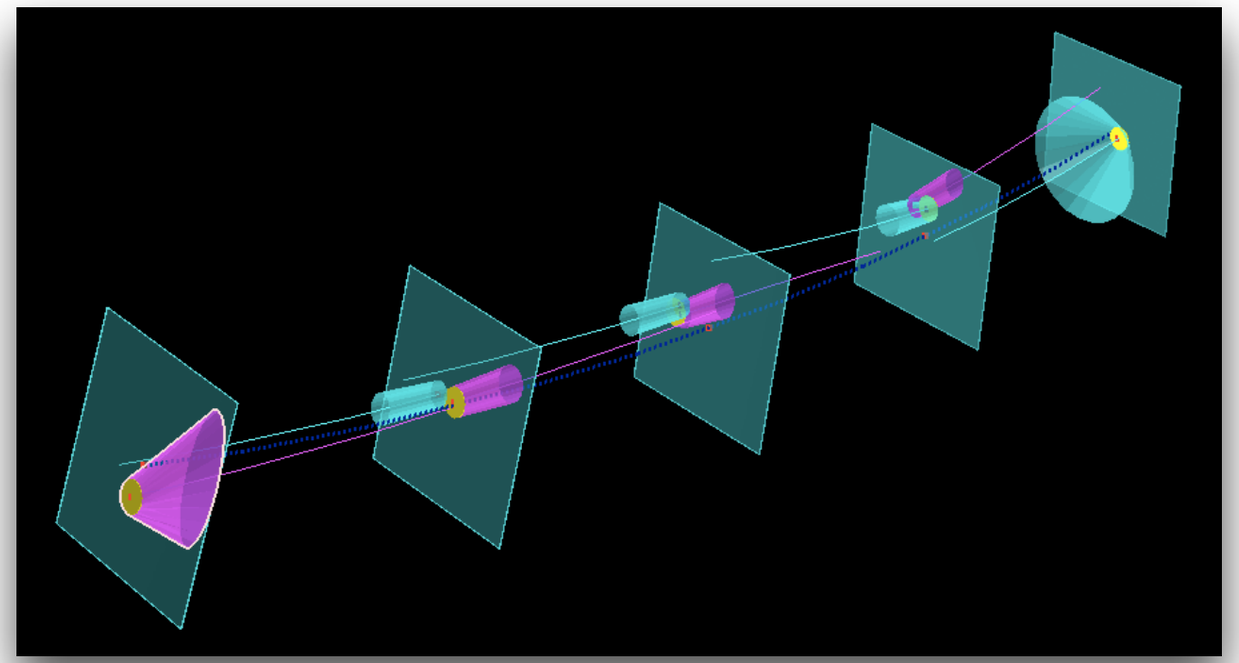
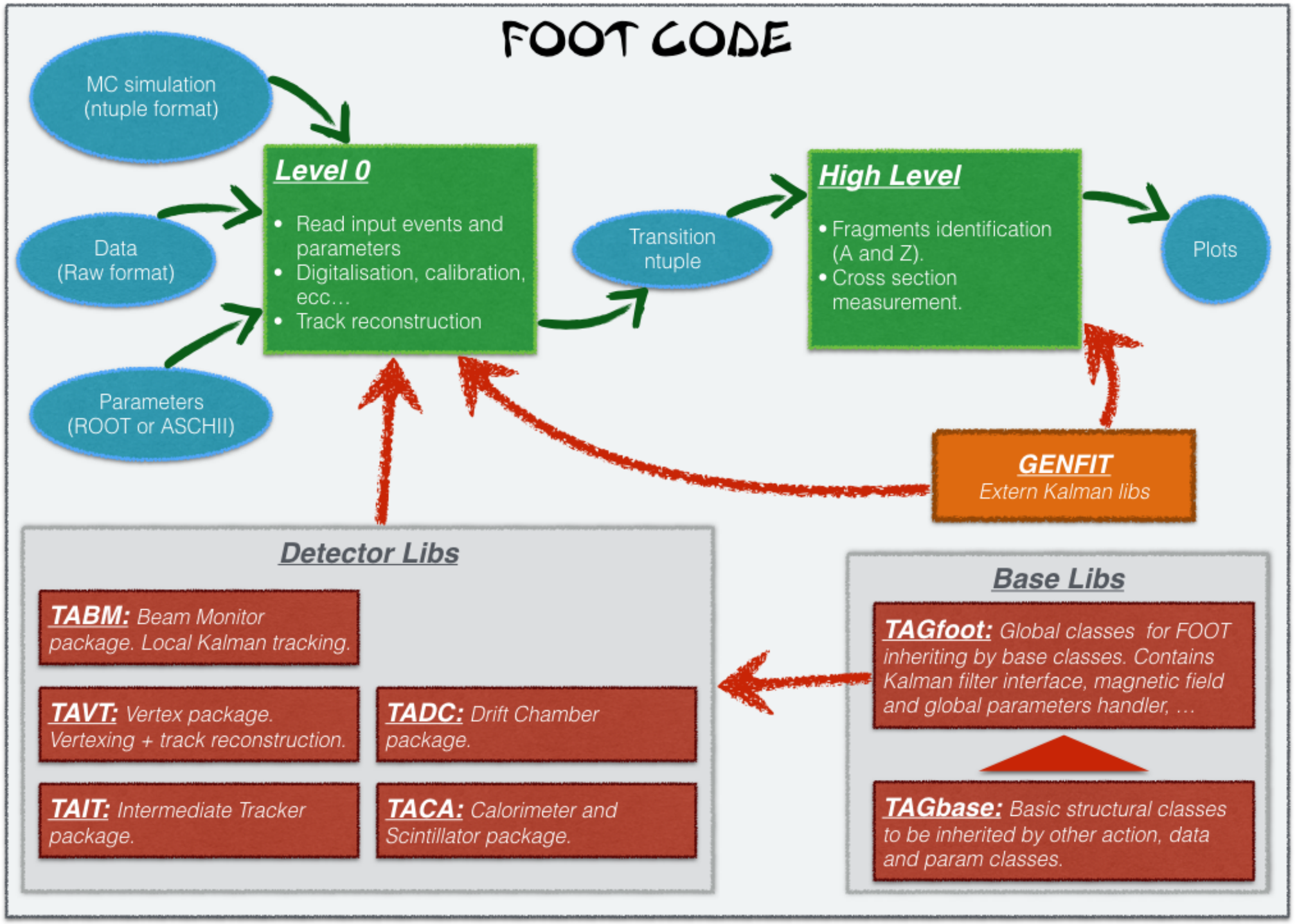
Code Intro

- **ROOT-based Software** from the FIRST experiment.
  - Code **stability** and **know-how** granted from past expertise;
  - **Already used by many FOOT collaboration members** to produce the first Mc based results for different part of the detector (Beam Monitor, Tracking Systems, Calorimeter and Scintillator).

- Tracking reconstruction based on **Kalman Filter** implemented in the **GenFit** software (already used by other collaborations like Panda, Belle-II, …).
  - Different tracking mode available;
  - Possibile **event-display** integrated.



Code schema


FOOT CODE
MC simulation (ntuple format)
Data (Raw format)
Parameters (ROOT or ASCHII)
Level 0
• Read input events and parameters
• Digitalisation, calibration, ecc…
• Track reconstruction
Transition ntuple
High Level
• Fragments identification (A and Z).
• Cross section measurement.
Plots
GENFIT
Extern Kalman libs
Detector Libs
TABM: Beam Monitor package. Local Kalman tracking.
TAVT: Vertex package. Vertexing + track reconstruction.
TADC: Drift Chamber package.
TAIT: Intermediate Tracker package.
TACA: Calorimeter and Scintillator package.
Base Libs
TAGfoot: Global classes for FOOT inheriting by base classes. Contains Kalman filter interface, magnetic field and global parameters handler, …
TAGbase: Basic structural classes to be inherited by other action, data and param classes.

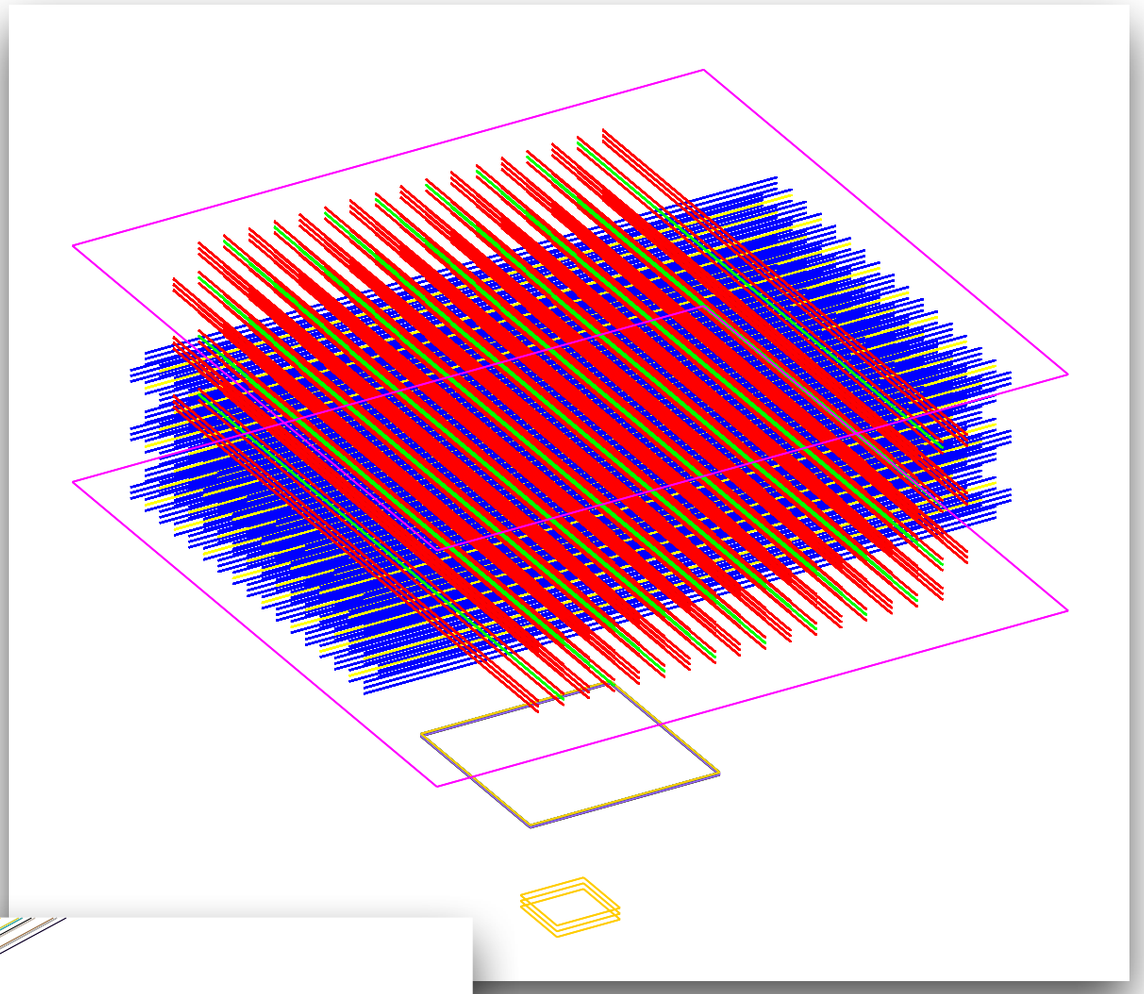
Code status

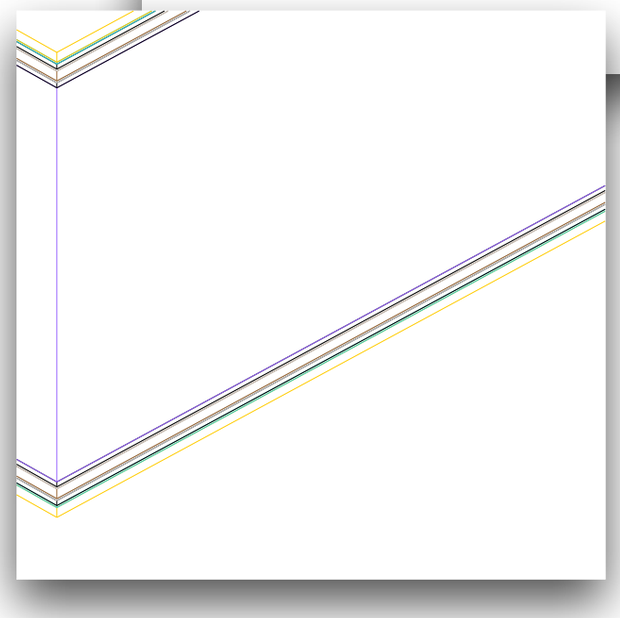
- Already implemented and **working**:
  - MC event reading,
  - Beam Monitor dedicated Kalman tracking,
  - Global Kalman tracking with multi-detector info.

- Geometry of 4 tracking sub-detectors implemented (Beam Monitor, Vertex, Intermediate Tracker, Outer Drift Chamber),

- Close to real material simulation for a pixel Intermediate tracker.

- Global Kalman filter tracking.





pixel IT material in section

Code future

- Everything serious must have a name!

proposal

Software for

Hadrontherapy

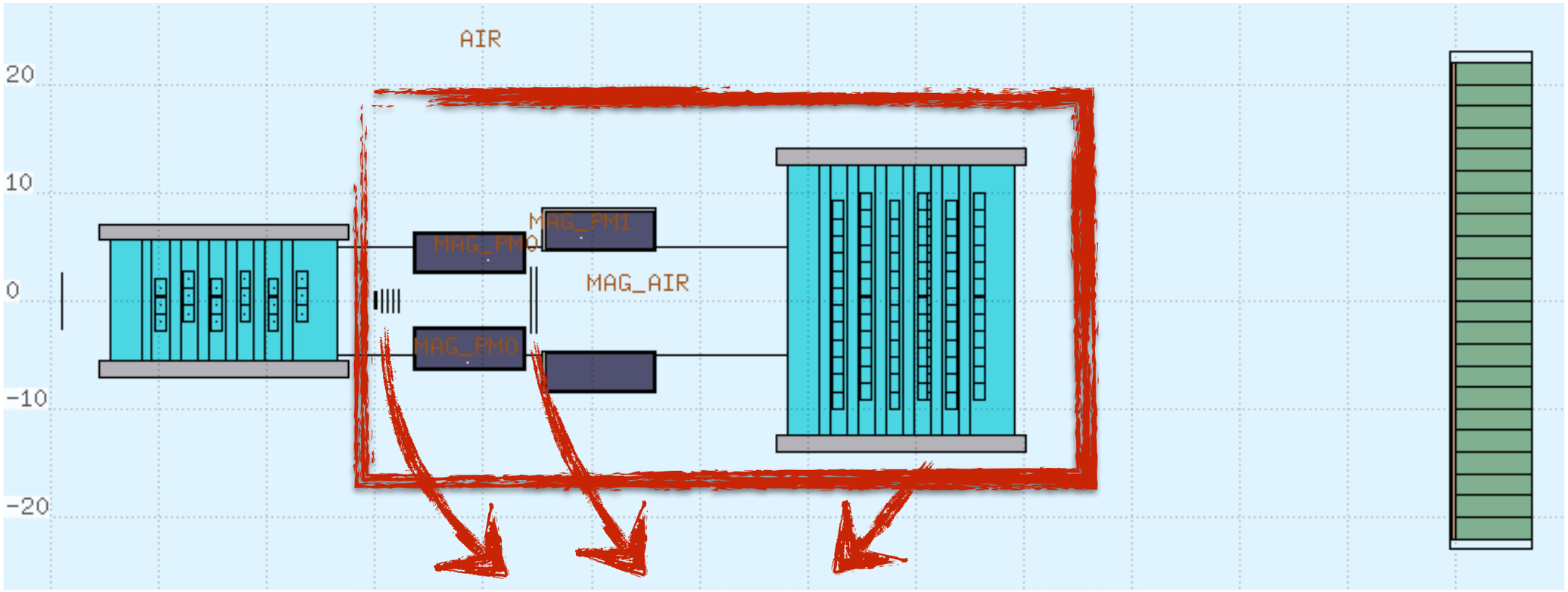
Optimisation

Experiment

- After the CDR rush we should start filling each detector parts;
- put together the independent analysis codes;
- built up the second level (reco level);
- **Mandatory to be modular with crystal-clear coding.**
- **Use Git branches!**


Global Tracking

Global Tracking intro

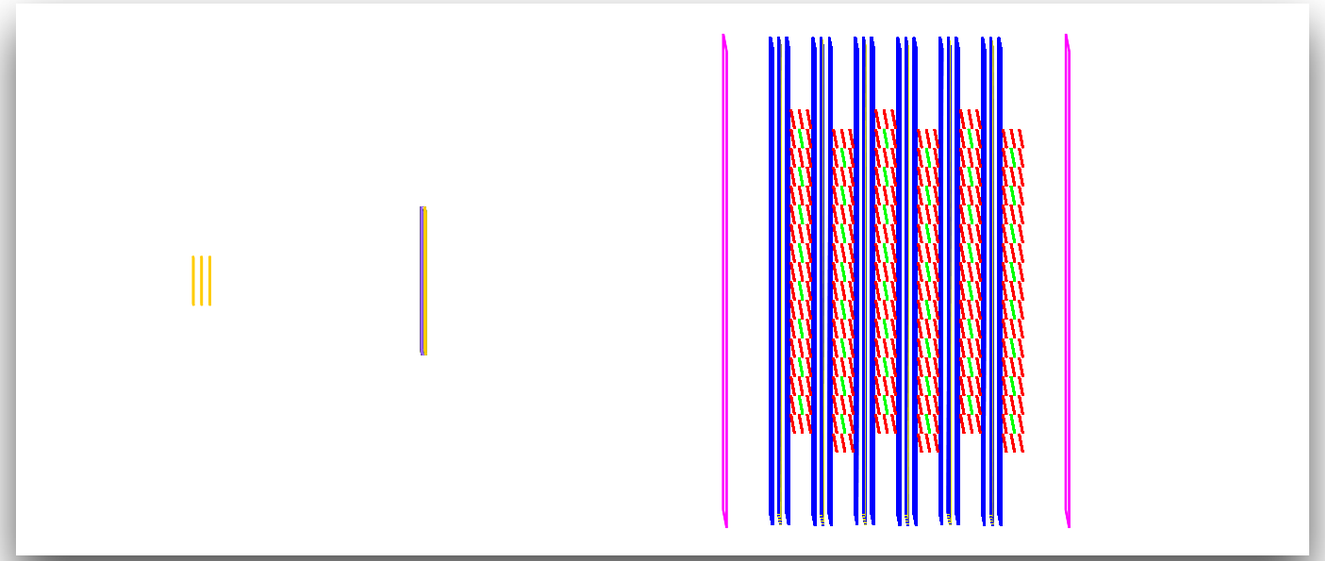


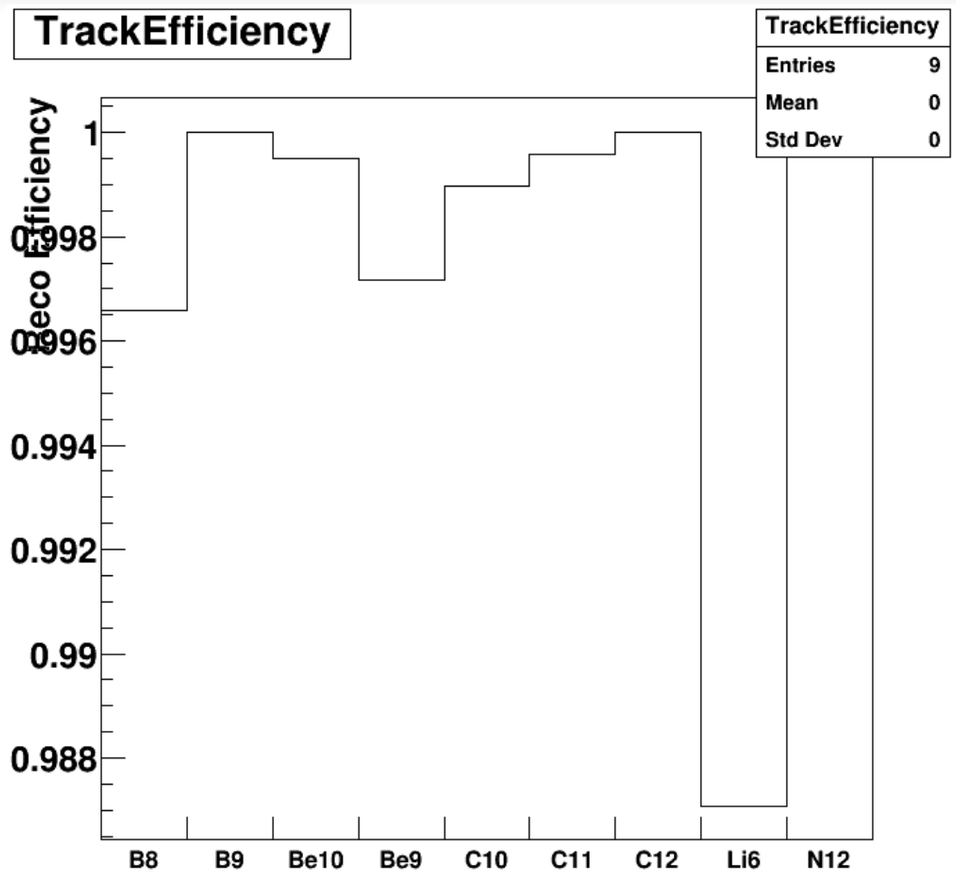
SHOE+GenFit

- **Goal:** track momentum resolution of 4% or less
- Test with the current simulation, with increasing level of complexity
- **Goal:** Full method and tracking apparatus comprehension!

First setup

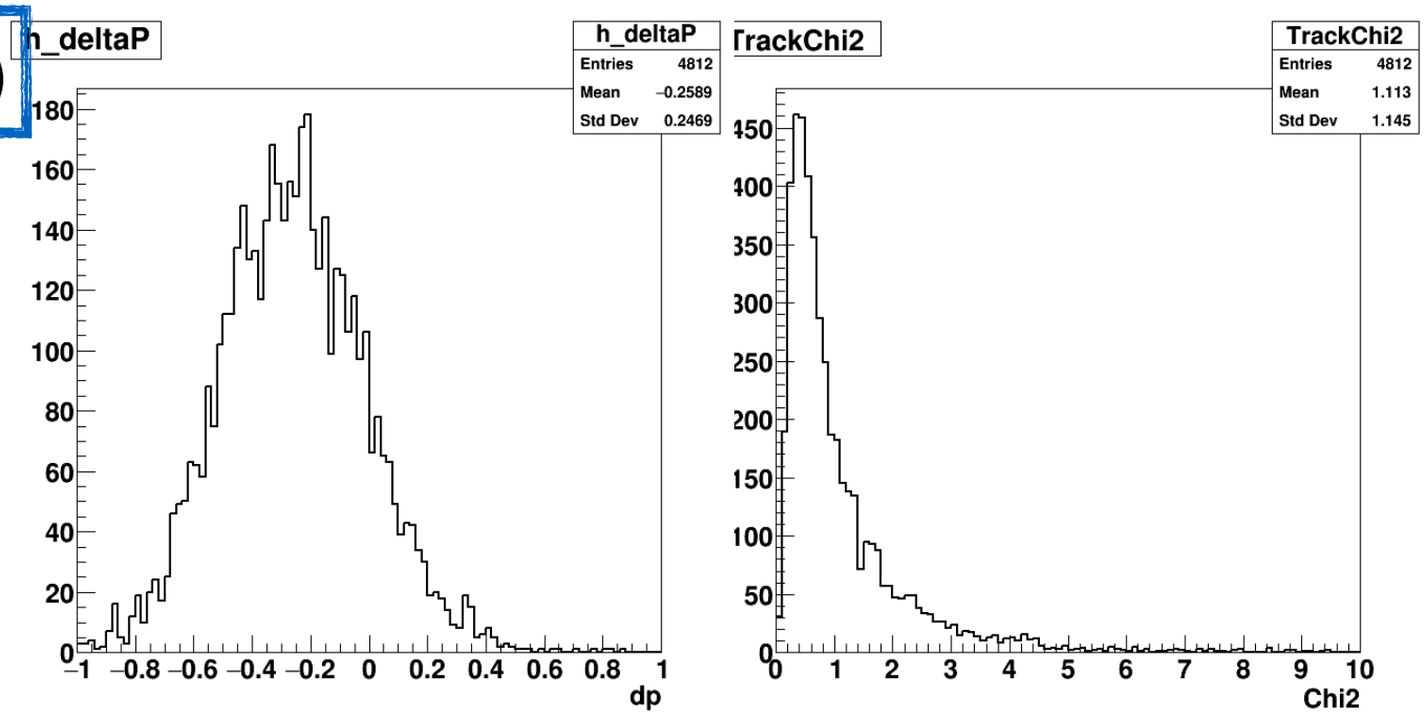
- **DC:** 6 layers, 8 cells x layer
- **IT:** pixel like, with supporting materials
- **VT:** 3 layers (only Silicon)
- *Constant magnetic field* (0.7 T)
- O16 bullet against C2H4 target
  - Tracking using hits from a **single fragment at a time**.
  - High Kalman reconstruction **efficiency** (when the fit converges over all processed)





C11

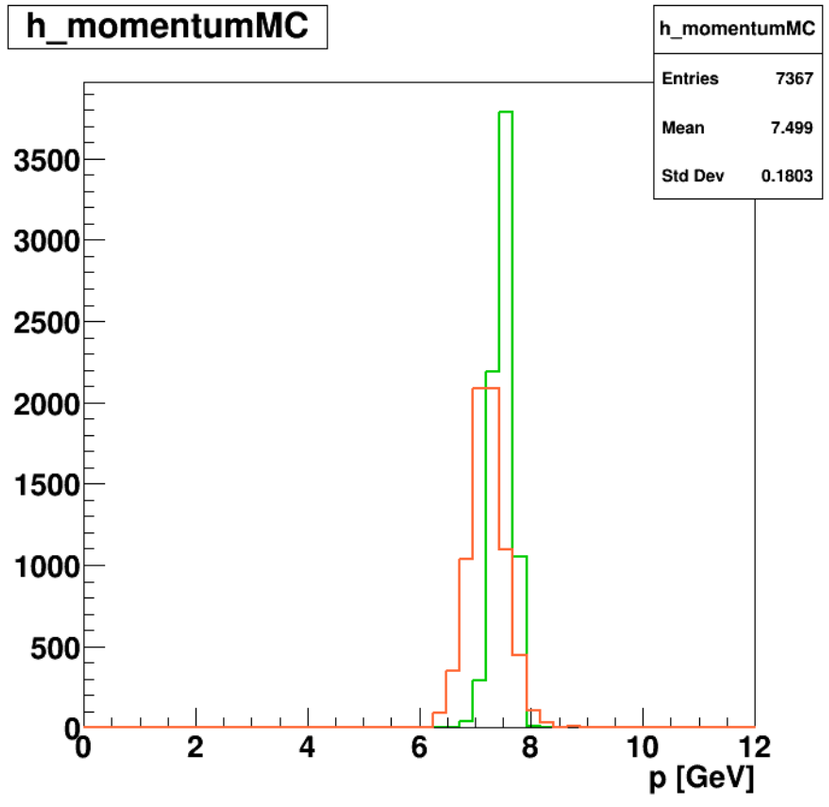
dp= p(reco)-p(true)



- momentum bias, reconstruct softer tracks.

- Improving with chi2 cuts? worth the statistic leaking?

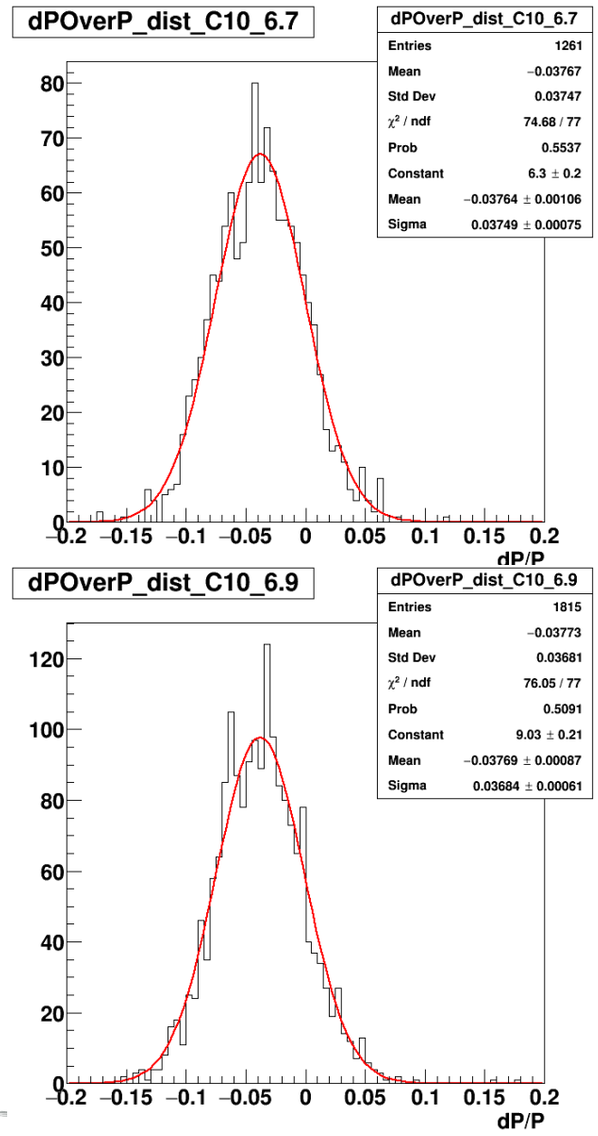
- Try surviving with that for a moment..

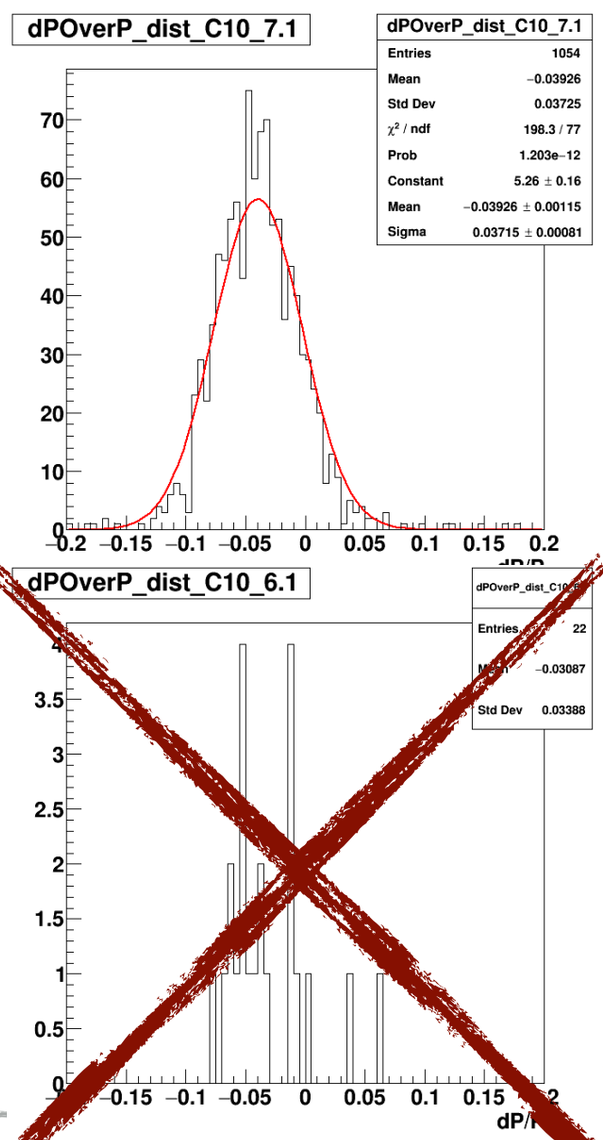


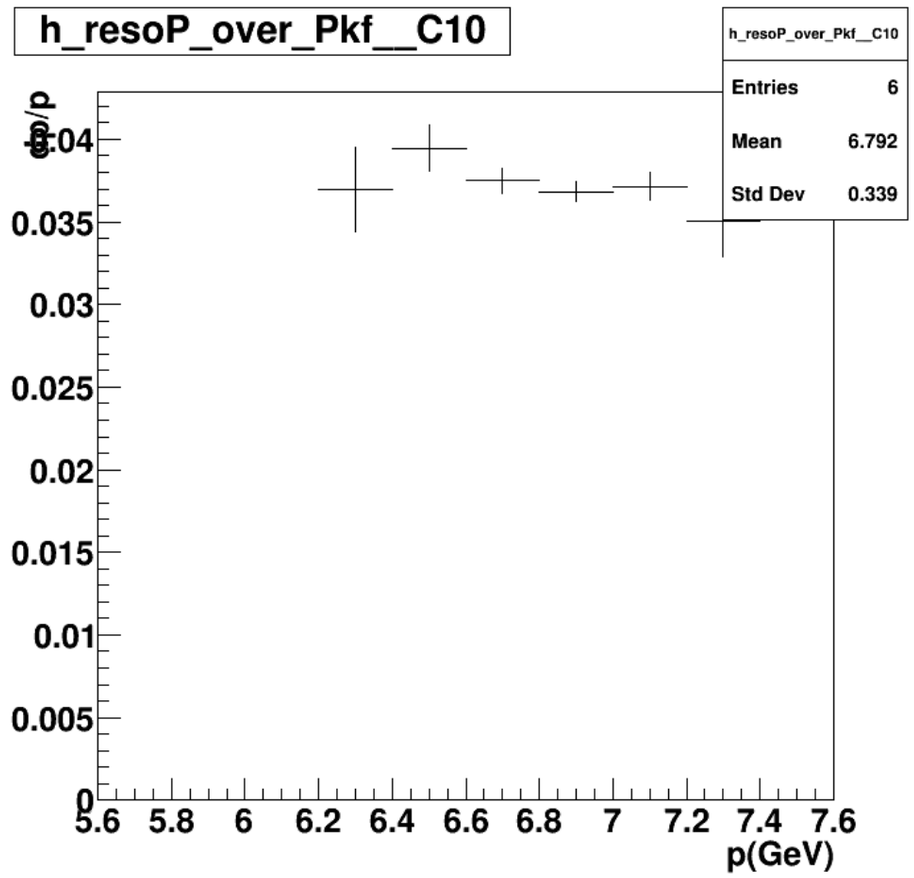
C11 - p resolution

- Divide the true momentum spectrum in bins (100-200 MeV each)
- Gaussian fit of the quantity dp/p(true) for each bin
- Take the gaussian sigma and mean (for bias check)

dp= p(reco)-p(true)



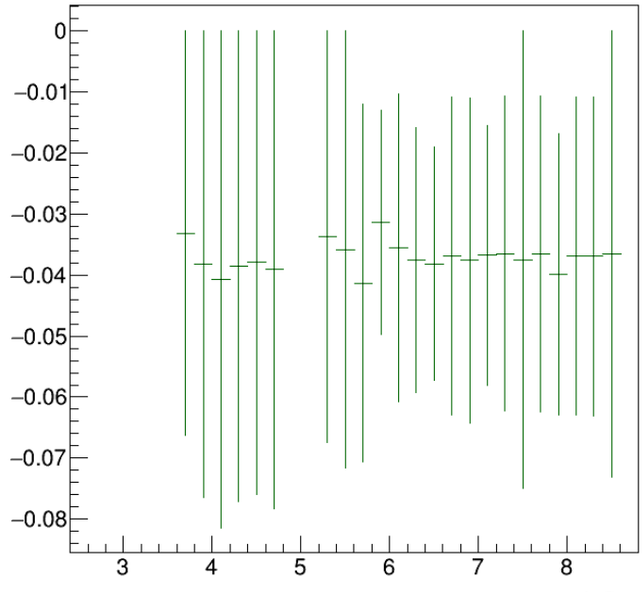


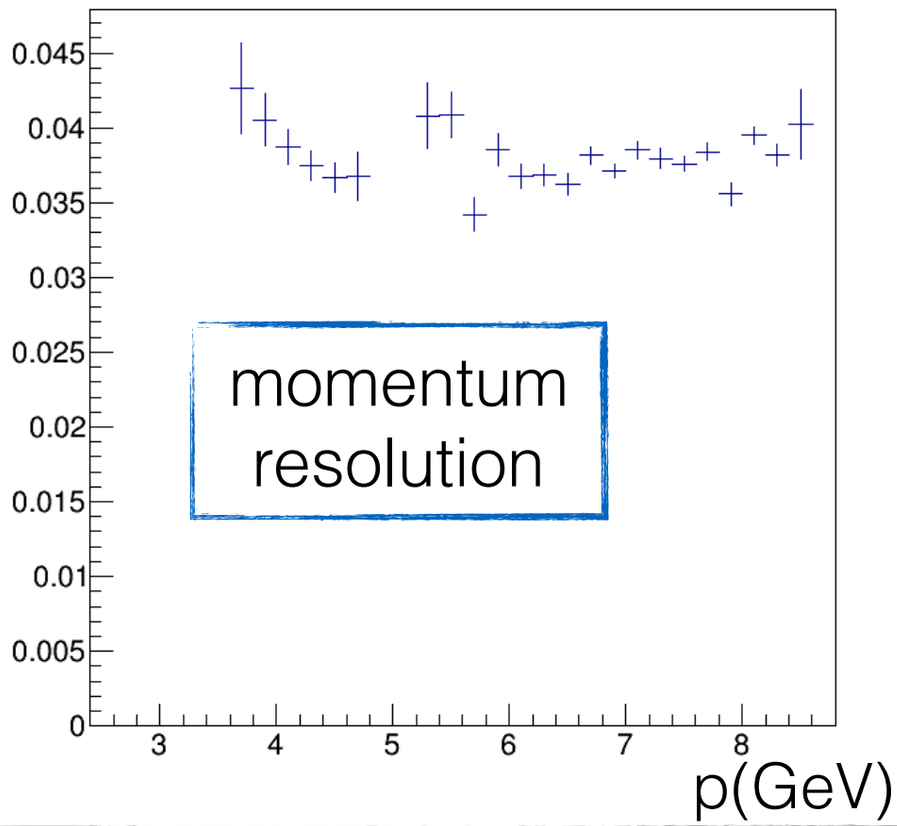


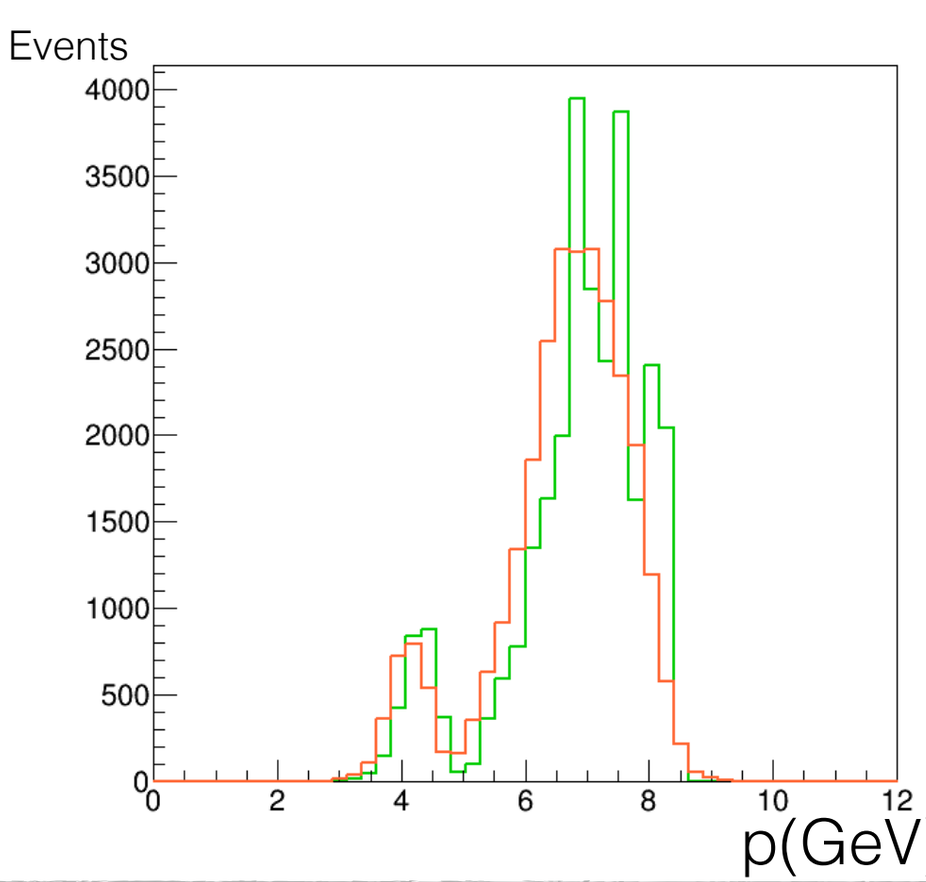
reject bad-fitting dist.

Combine all fragments

- All fragments together!
- Summing the momentum dist. , weighed average of mom. resolution if bins overlap.
- Constant bias, ***<u>average 4% resolution anyway!</u>***

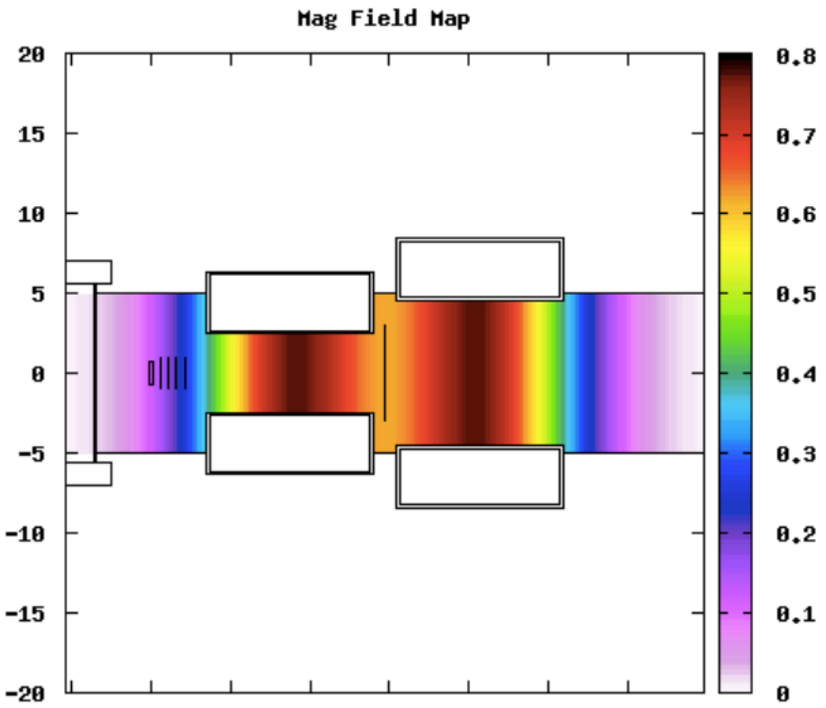




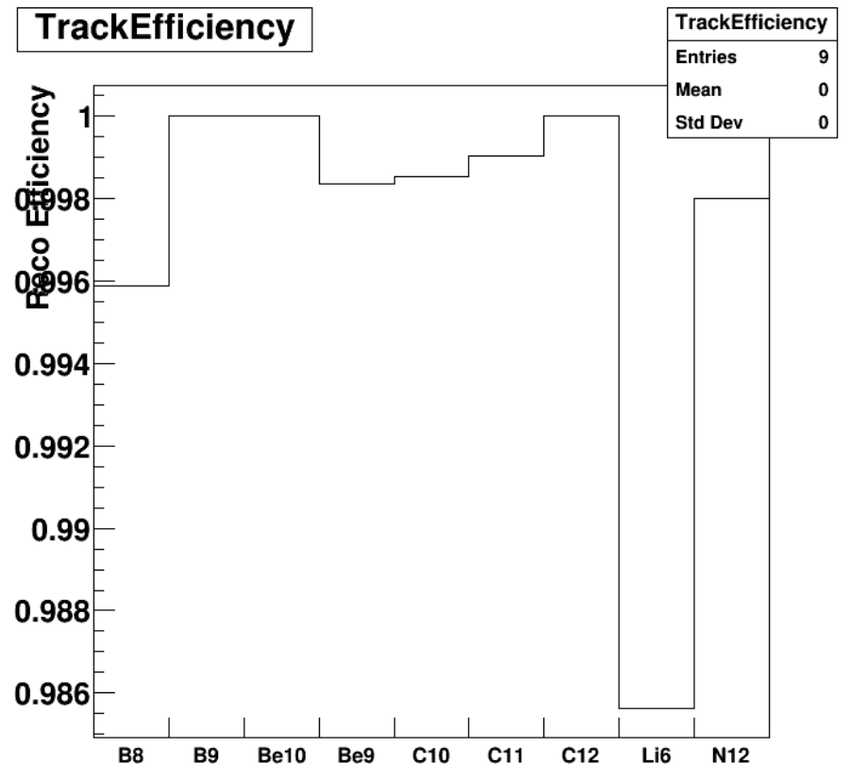


New setup - v10.2

- **DC:** 6 layers, 8 cells x layer
- **IT:** pixel like, with supporting materials
- **VT:** 3 layers (only Silicon)
- ***Variable magnetic field***

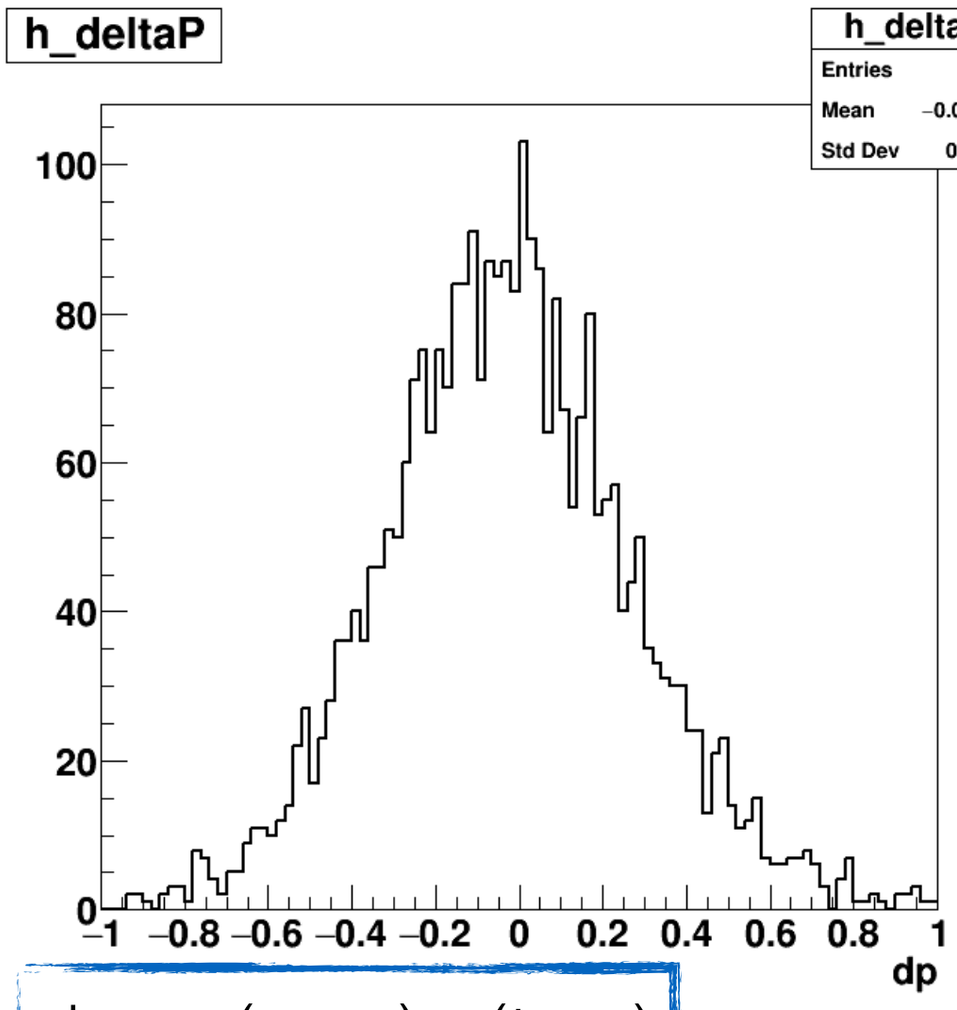


- O16 bullet against C2H4 target
  - Tracking using hits from a **single fragment at a time**.
  - High Kalman reconstruction efficiency (when the fit converges over all processed)

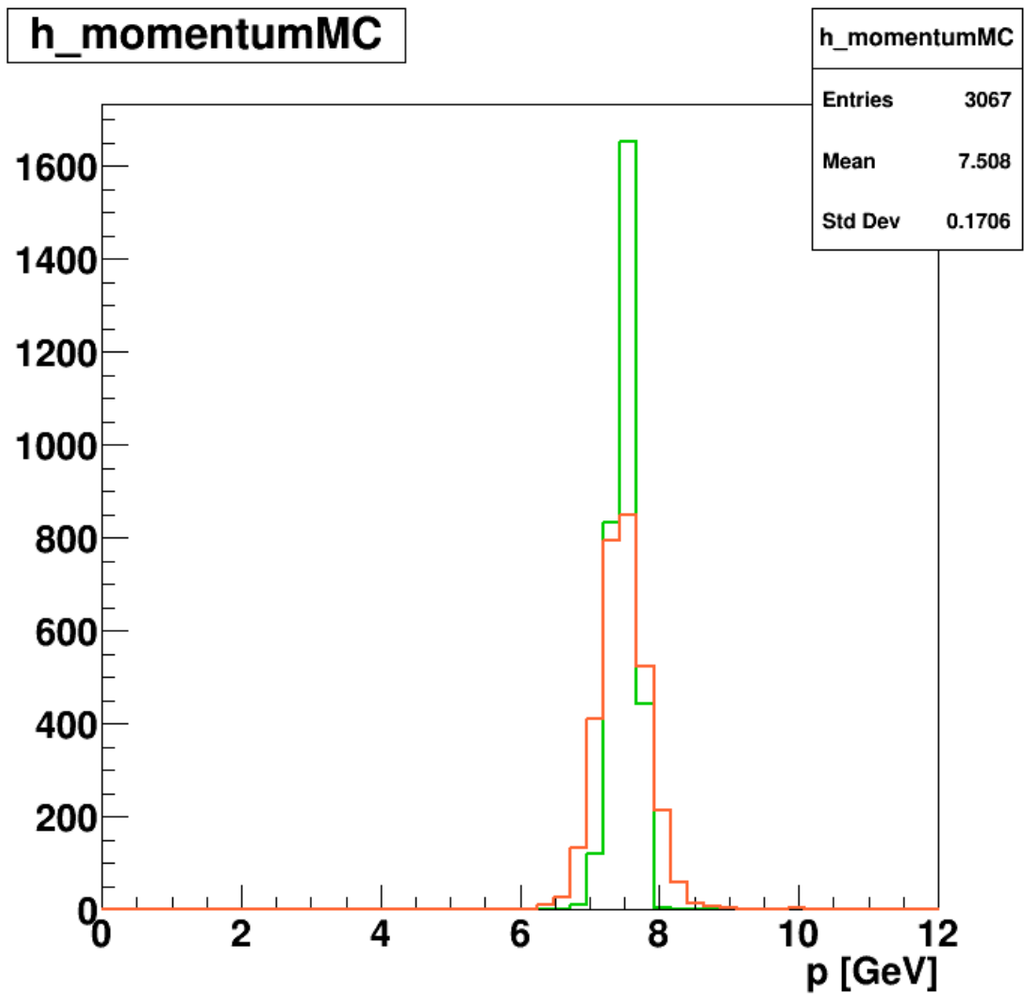


C11

- Bias recovered.
- Still too migrations between reco/true bins

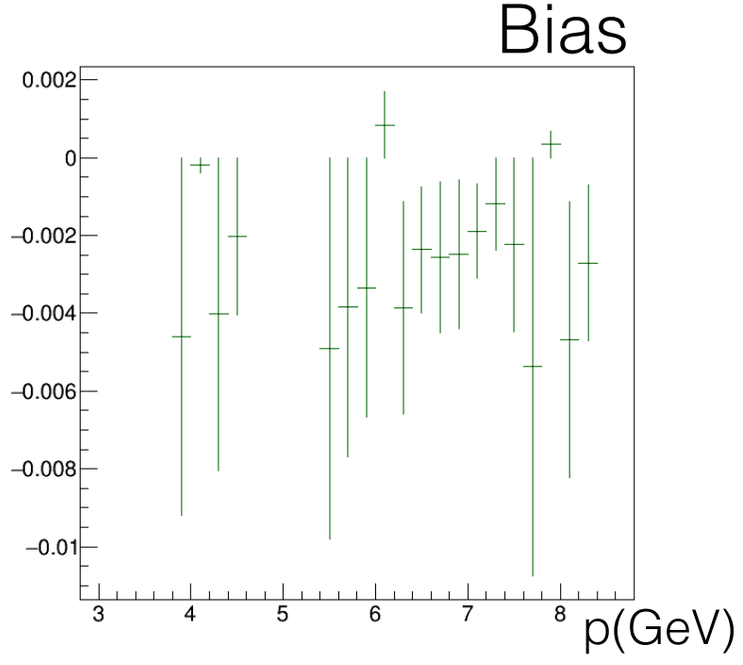


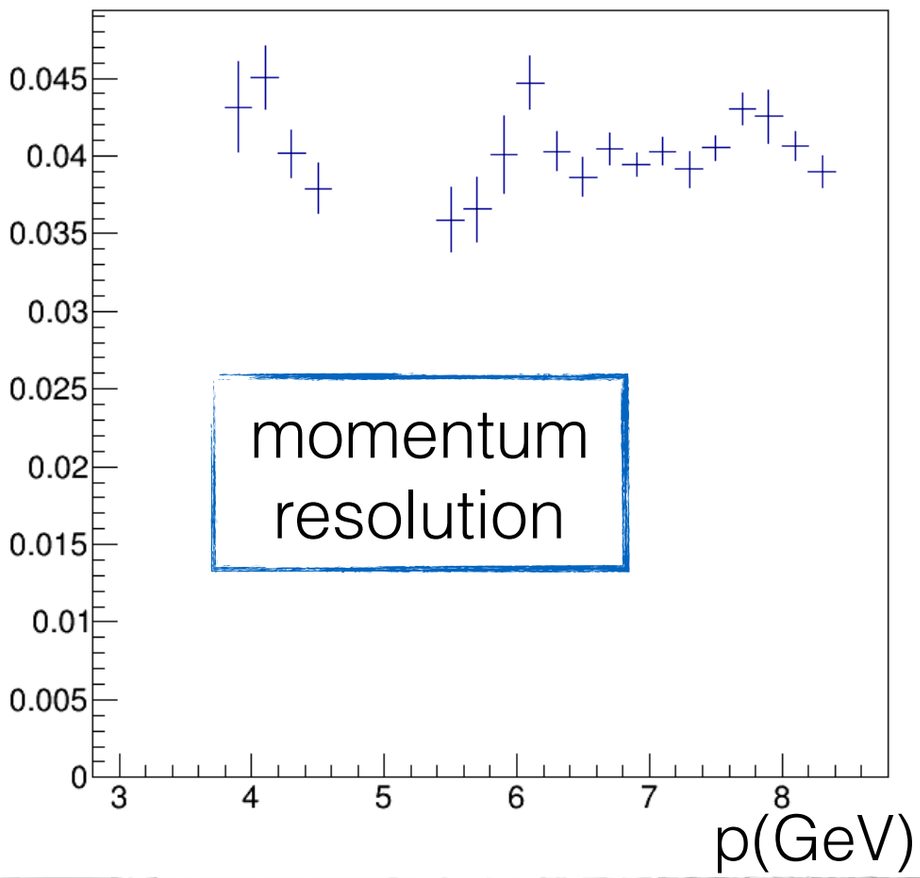
dp= p(reco)-p(true)

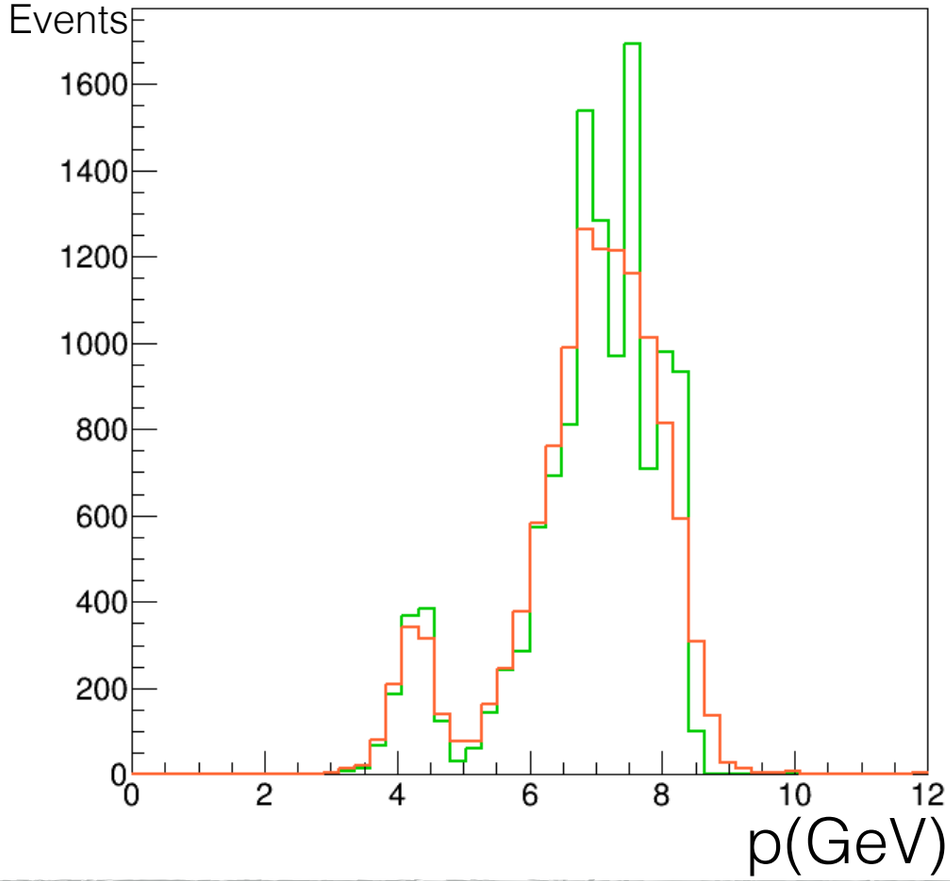


Combination

- No bias big in the combined plots, tendency to reconstruct softer p;
- Momentum resolution is slightly higher but ~4% on average (0.5% higher).
- Now we'll try to improve resolution!!!







Next

- Now that we have a stable and quite reasonable results, it's time for finer tuning!!
  Deep understanding and optimisation starts now!

- Main Goal: improve the momentum resolution estimation. Optimise binning? Fit dp distribution first? Search for bugs?

- Fully understanding of the tracking propagation, especially material behaviour.

- Introduce strategies for "background" hits rejection. Cone rejection? Deterministic Annealing Filter (DAF) that should be more robust for high hit multiplicity?

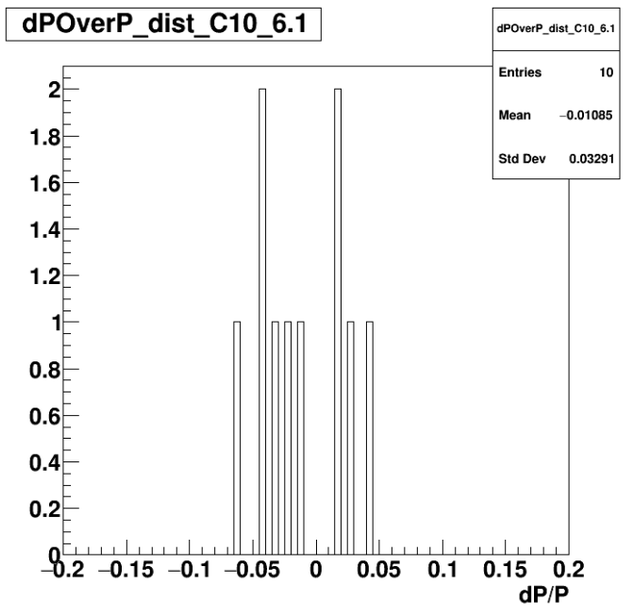
- Try different:

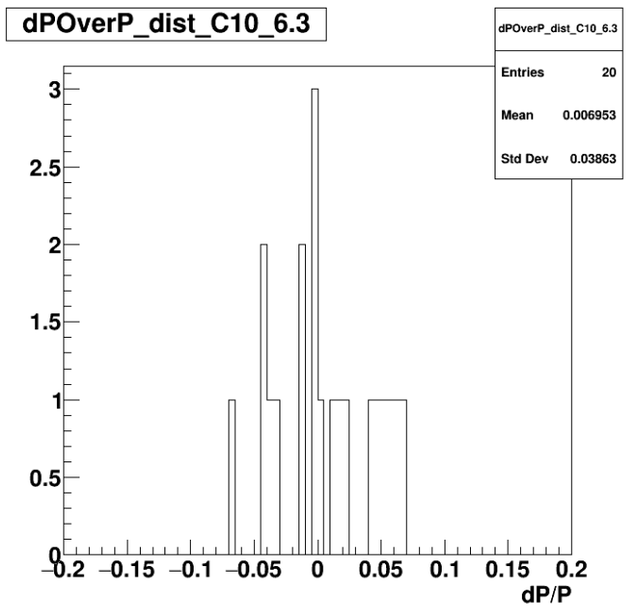
  - geometries: Moving forward the DC, adding a vertex layer, …

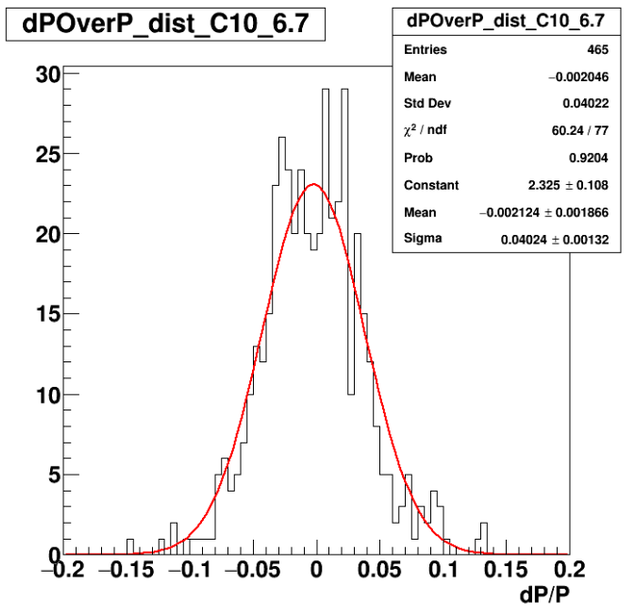
  - and materials: more realistic material, understand if and where we can

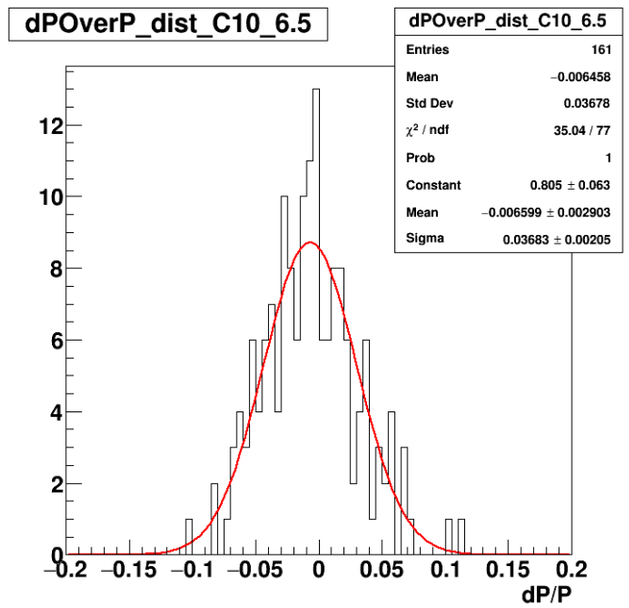
Thanks!!!

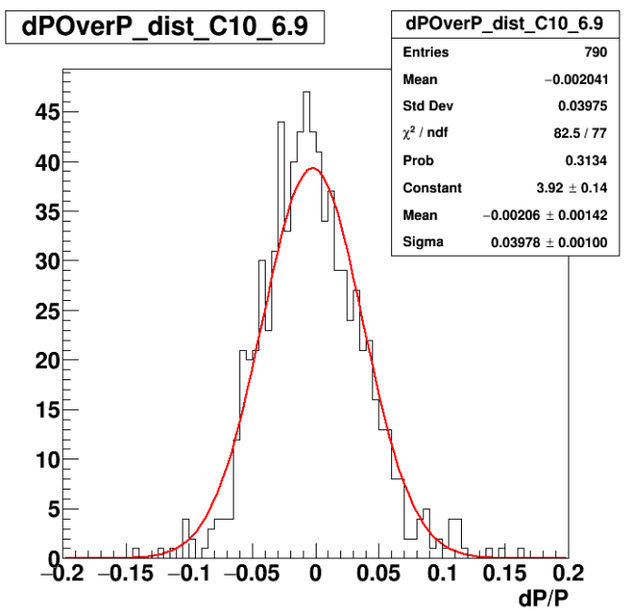

Back-up

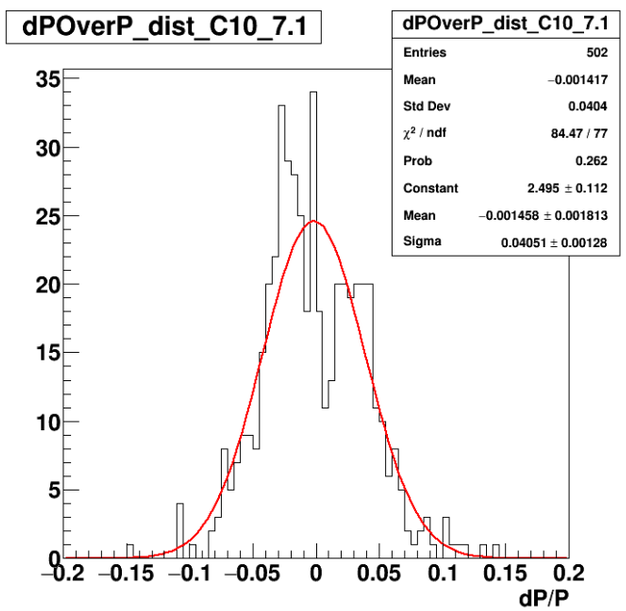

dPOverP_dist_C10_6.1
dPOverP_dist_C10_6.1
Entries 10
Mean −0.01085
Std Dev 0.03291
dP/P

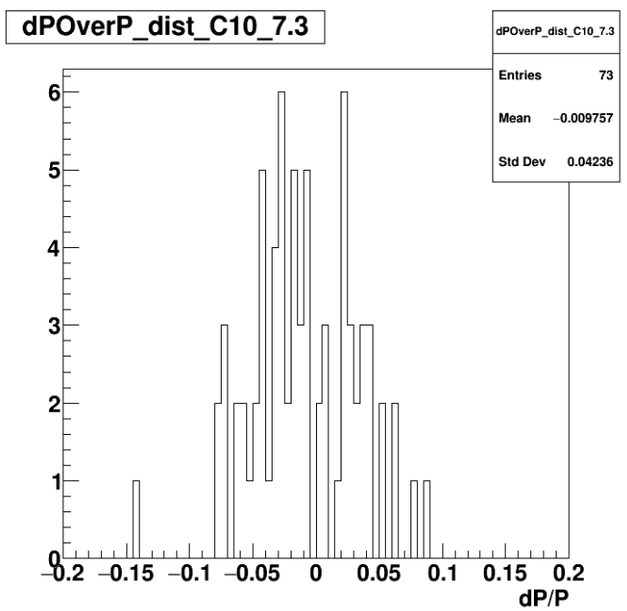

dPOverP_dist_C10_6.3
dPOverP_dist_C10_6.3
Entries 20
Mean 0.006953
Std Dev 0.03863
dP/P

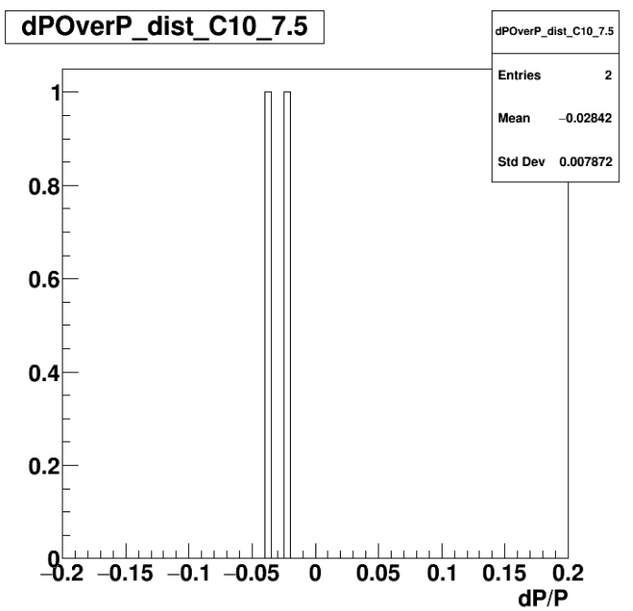

dPOverP_dist_C10_6.7
dPOverP_dist_C10_6.7
Entries 465
Mean −0.002046
Std Dev 0.04022
χ² / ndf 60.24 / 77
Prob 0.9204
Constant 2.325 ± 0.108
Mean −0.002124 ± 0.001866
Sigma 0.04024 ± 0.00132
dP/P


dPOverP_dist_C10_6.5
dPOverP_dist_C10_6.5
Entries 161
Mean −0.006458
Std Dev 0.03678
χ² / ndf 35.04 / 77
Prob 1
Constant 0.805 ± 0.063
Mean −0.006599 ± 0.002903
Sigma 0.03683 ± 0.00205
dP/P


dPOverP_dist_C10_6.9
dPOverP_dist_C10_6.9
Entries 790
Mean −0.002041
Std Dev 0.03975
χ² / ndf 82.5 / 77
Prob 0.3134
Constant 3.92 ± 0.14
Mean −0.00206 ± 0.00142
Sigma 0.03978 ± 0.00100
dP/P


dPOverP_dist_C10_7.1
dPOverP_dist_C10_7.1
Entries 502
Mean −0.001417
Std Dev 0.0404
χ² / ndf 84.47 / 77
Prob 0.262
Constant 2.495 ± 0.112
Mean −0.001458 ± 0.001813
Sigma 0.04051 ± 0.00128
dP/P


dPOverP_dist_C10_7.3
dPOverP_dist_C10_7.3
Entries 73
Mean −0.009757
Std Dev 0.04236
dP/P


dPOverP_dist_C10_7.5
dPOverP_dist_C10_7.5
Entries 2
Mean −0.02842
Std Dev 0.007872
dP/P