# Software Updates + Global Reco

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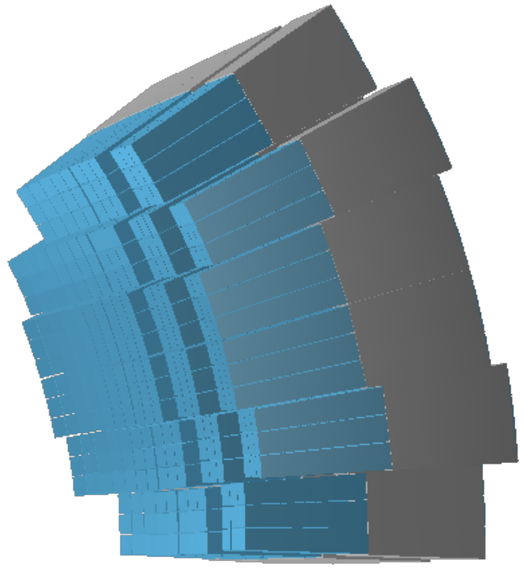
@ FOOT Collaboration Meeting – Rome

5-12-19

Istituto Nazionale di Fisica Nucleare

# SHOE - status

- Currently using branch newgeom_v1.0 (group preference have a single branch by now)
- Compatible both with GSI data configuration and a full step-up MC production.
- CALO geometry included SHOE
- Updated MC sample according with latest geometry in `/gpfs_data/local/foot/Simulation/newgeom_v1.0` with 10^7 primary events.
- Join our mailing list and our software meeting (every 2 months)



# SHOE - Local

- Level0 part (sub-detector reconstruction) is mostly in place. Weak points:
  - Improve scintillator digitisation (i.e. ghosts are not considered…)
  - Finish Calorimeter data chain (ongoing work - Lorenzo & Ernesto)
  - Digitiser and clustering strategy for MSD (input from detector experts are needed)
- Overall good status!
- Time to look at sub-detector integration —> Full Reconstruction level

# SHOE - Global

- Global track reconstruction (the most burdening one…)
  - ☆ *Momentum resolution, track preselection, efficiencies*
- Event building (Hits matching, quality criteria, …)
- Charge reconstruction
- Alignment (see https://agenda.infn.it/event/20972/ )
- Analysis chain

**Most efficient way to improve is let run the code by more people to spot errors**

# SHOE - How to install

- Clone and install
  - git clone <username>@baltig.infn.it:asarti/shoe.git
  - cd shoe; mkdir build; cd build
  - Setup ROOT 6.14.6 e cmake 3.14
  - cmake ..
  - make

- If everything went fine:
  - cd Reconstruction/level0
  - MACRO:
    - root
    - .L macro.cc++
    - MethodYou like
  - Executable:
    - ./DecodeMC –in input

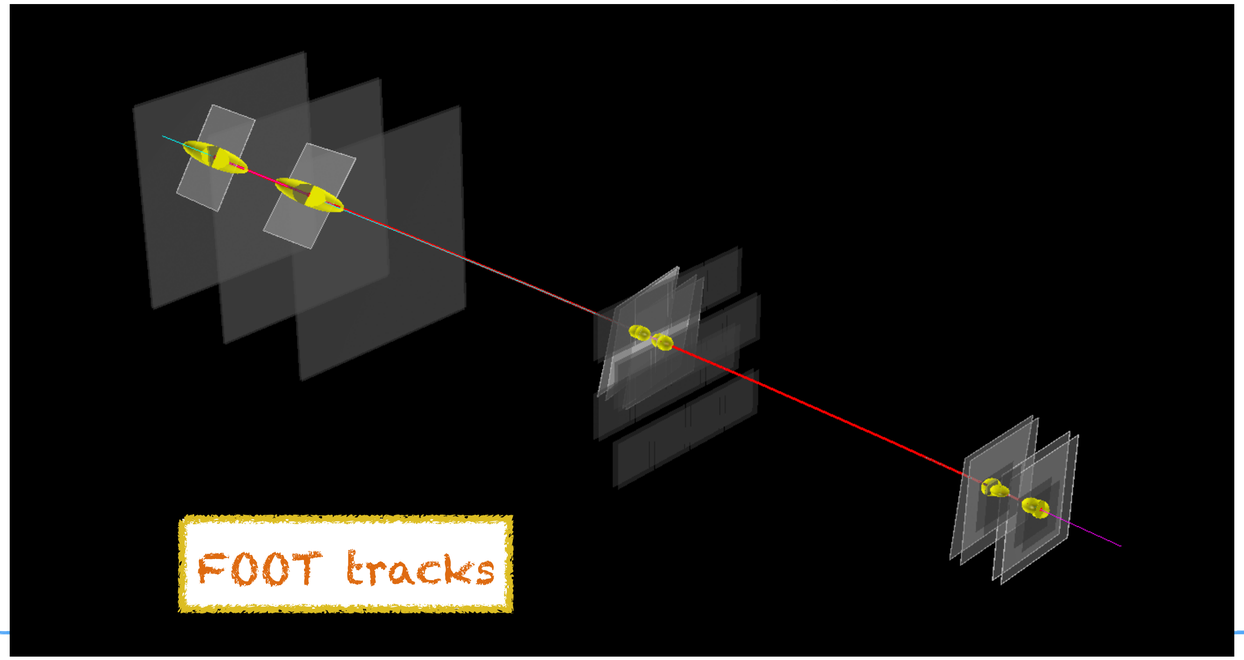
# SHOE - Overview

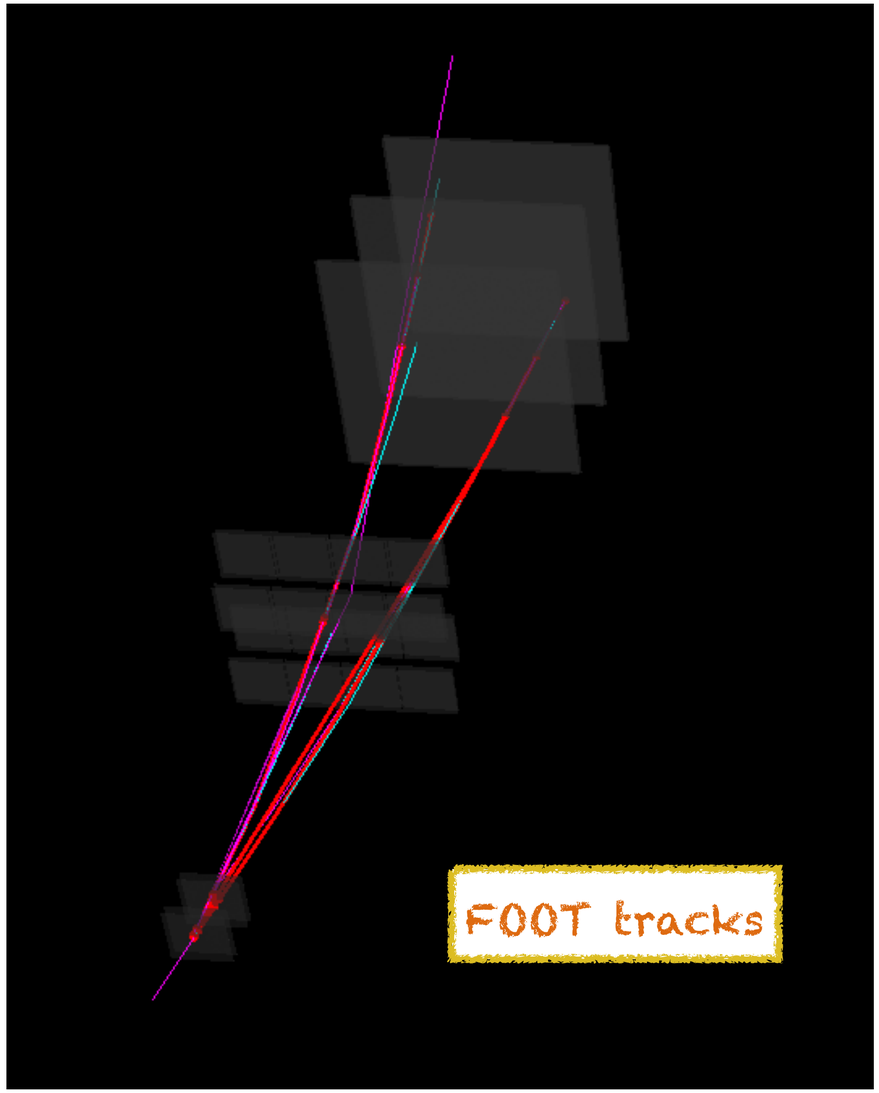
- All method are preinstalled in `BeforeEventLoop()` of `LocalRecoMC` and `BaseReco` (already called by Macro and executables).
  - ☆ *enable/disable using flags mainly in FootGlobal.par or command line.*
- At each event `Action()` is called from all `TA*act*` classes. This basically takes some input -> elaborate -> give output as `TA*ntu*` object

# Global Tracking

# SHOE Global Tracking

- GenFit package is included into SHOE.
- Very versatile, allows fwd/bwd Kalman Filter, extrapolation, vertexing. Taking into account scattering and energy loss via ROOT geometry.
  - *Implements the use on multiple types of hits (points, planes, wires, … ).*
  - *Event display ROOT based.*
- Developed and used by other experiments, we already have a quite good expertise in it.
  - *Produced baseline momentum resolution one year ago.*



# SHOE Global Tracking

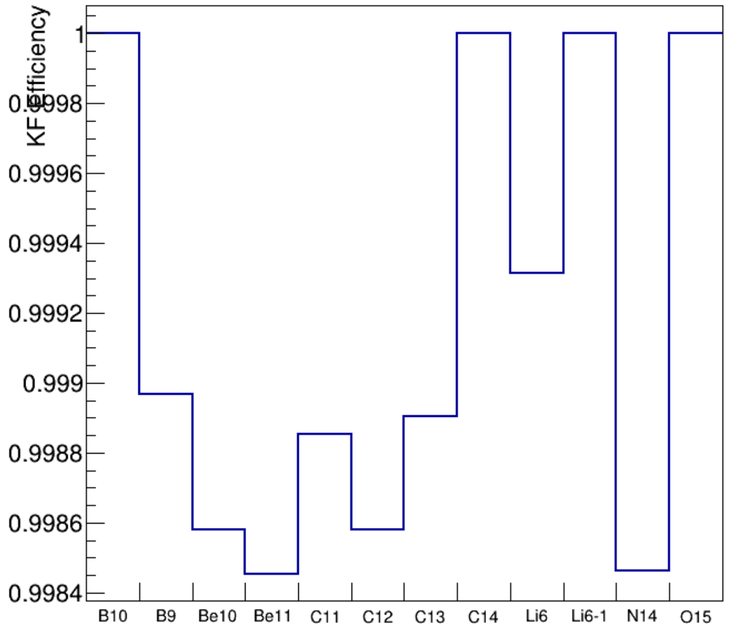
- Many things changed in software during GSI beam test. We reproduced the past configuration results.

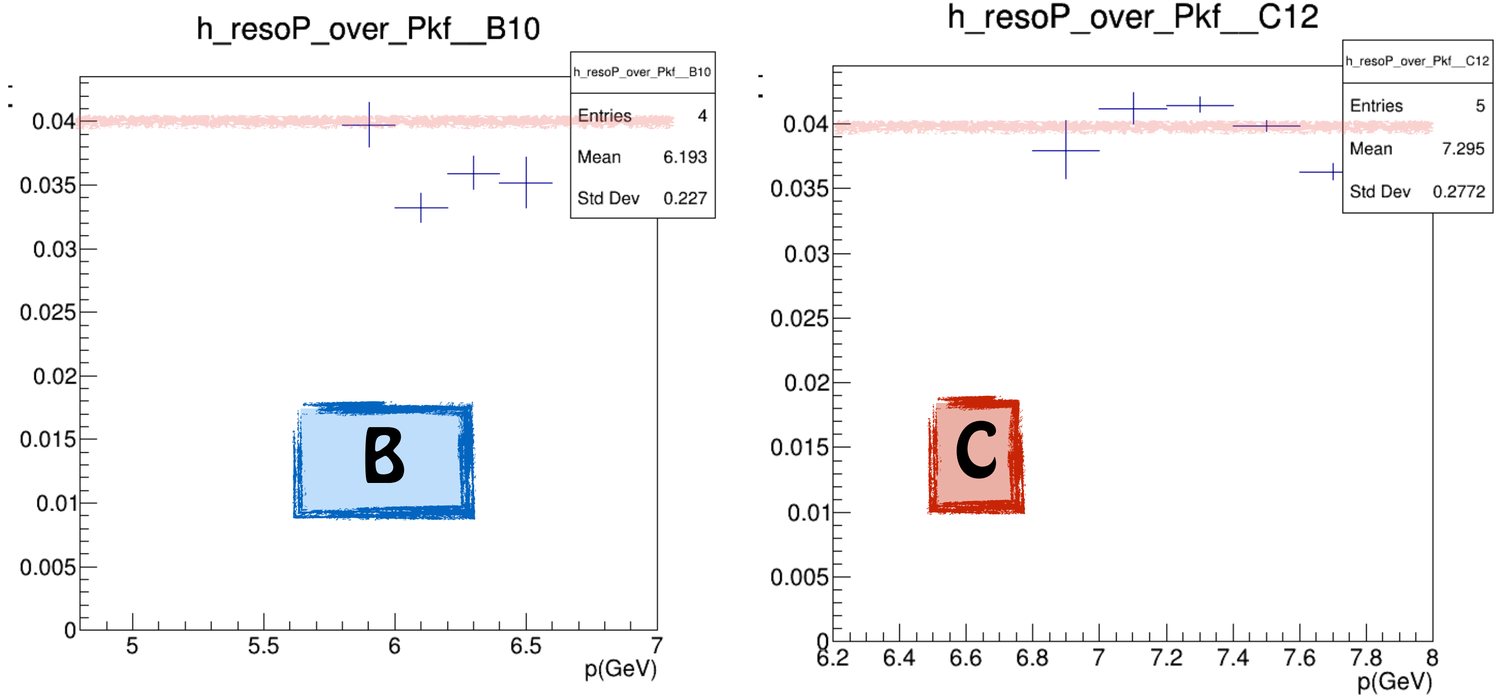
- First goal is to test the system -> run on MC samples using RECO positions:
  - *Taking VTX and IT clusters + MSD strips;*
  - *Group and fit together if coming from the same MC_particle;*
  - *After fit, check with TRUTH position and momentum;*

# Results - baseline

## Exactly one hit per layer

- High fit efficiency with "almost perfect" hit preselection
  - ☆ *Clusters from same MC particle*
- Momentum resolution comparable with the 2018 one.







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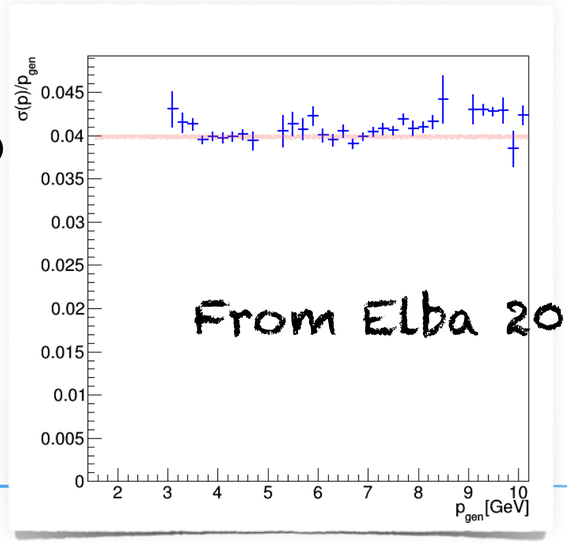
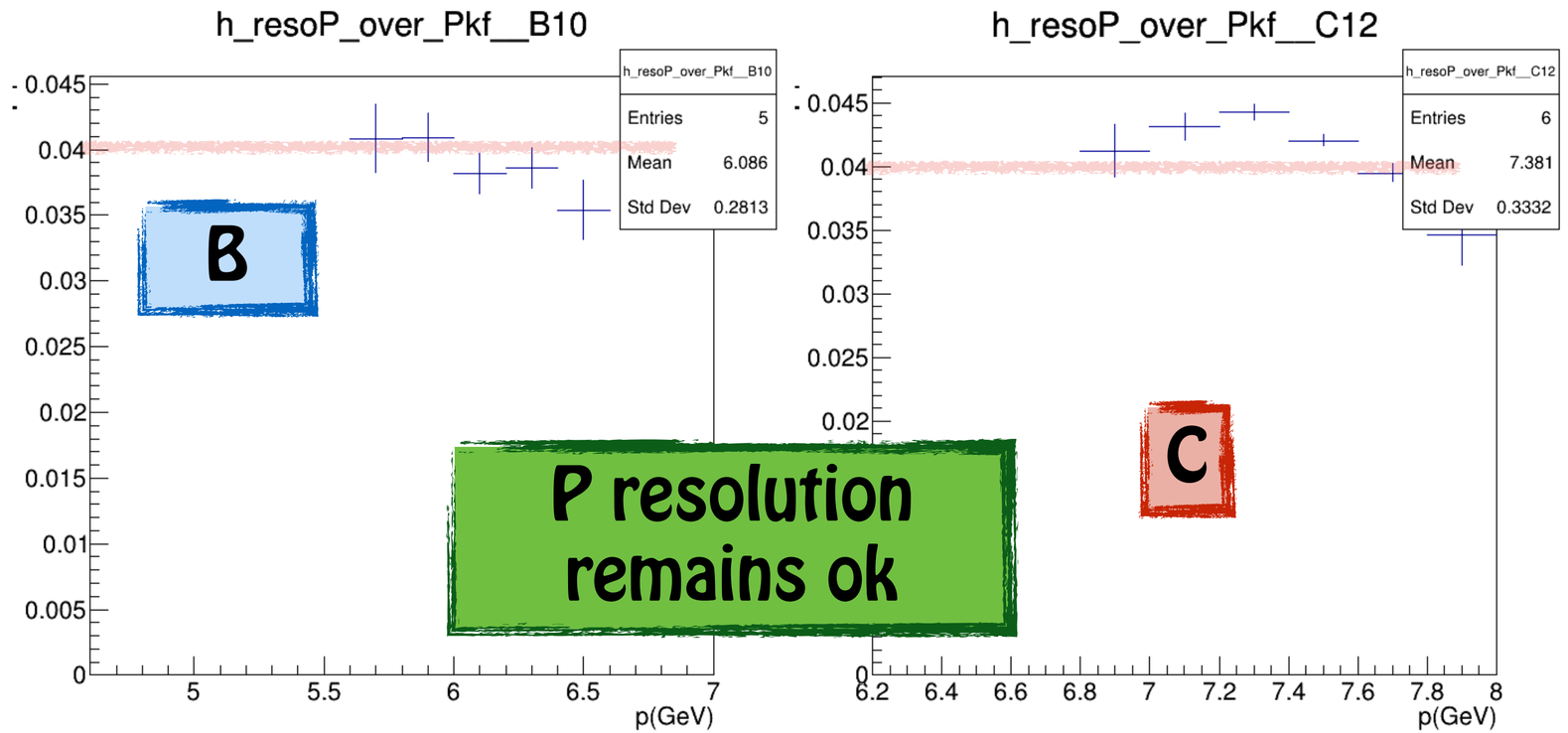
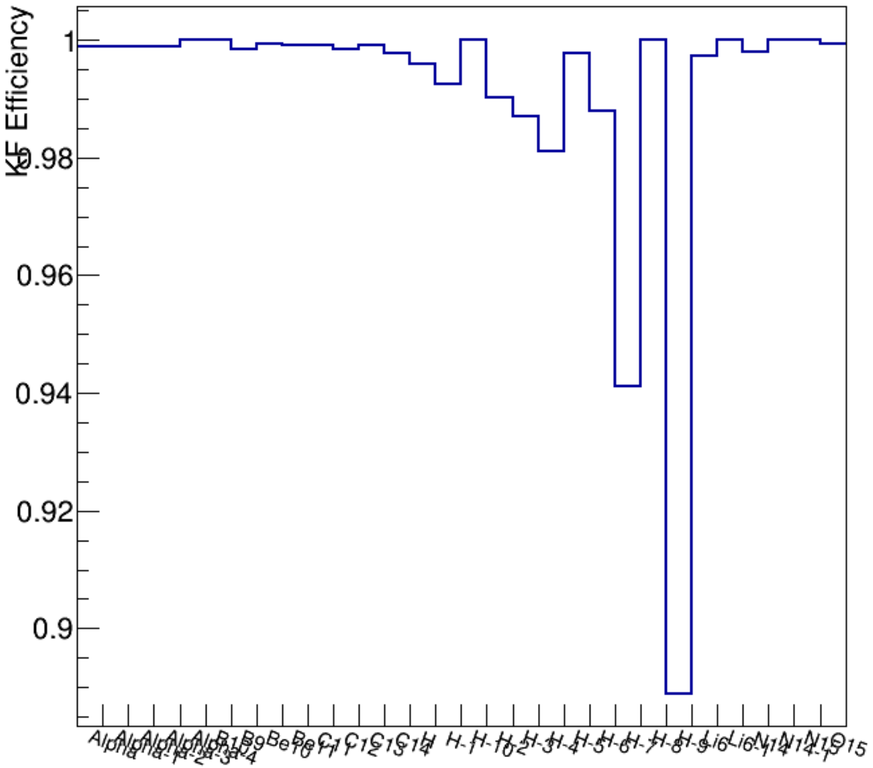


# Results - variation 1

VTX 3 or 4 hits
IT >= 2 hits
MSD 2 or 3 hits

- Consider:
  - ☆ hit loss in VTX and MSD
  - ☆ multilayer hits in IT (new staggered geometry)

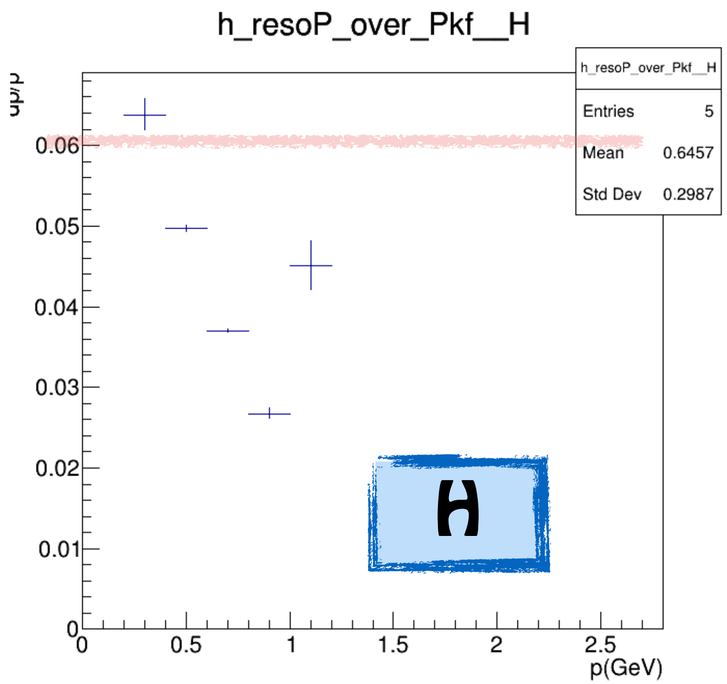


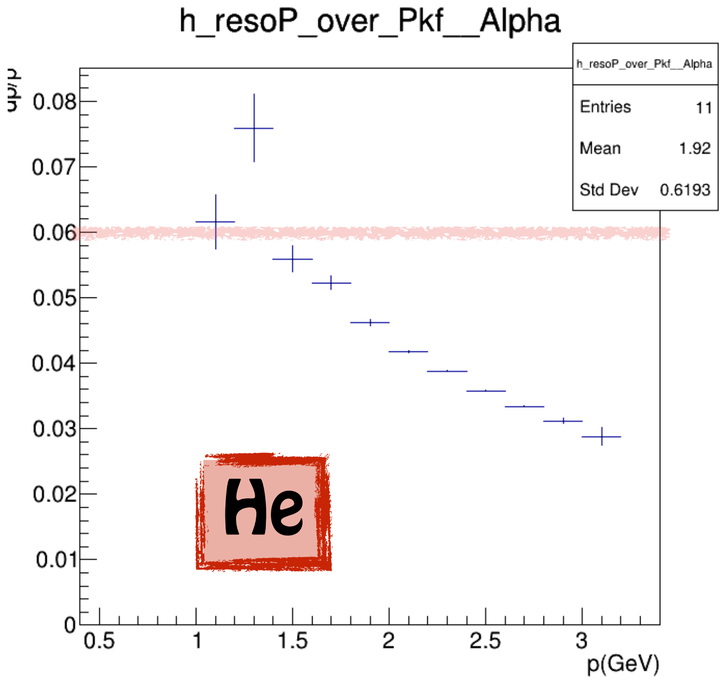




Test with H and He

# Results - H & He

- Having a look at lighter fragments
- Worse at low p, but not so much…




VTX 3 or 4 hits
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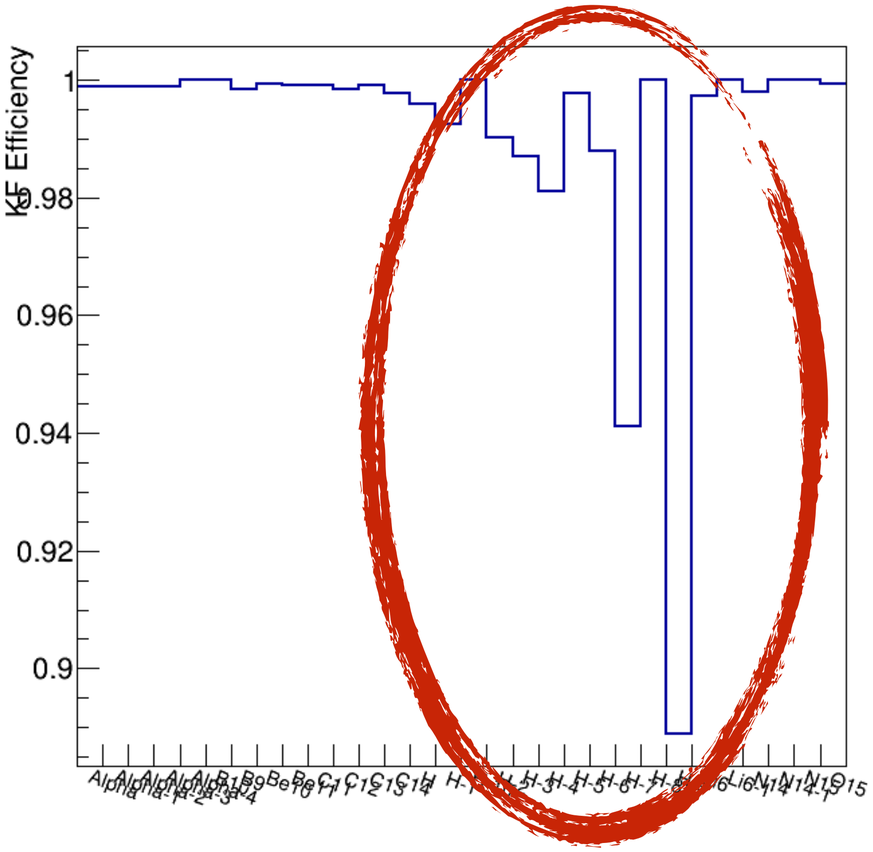
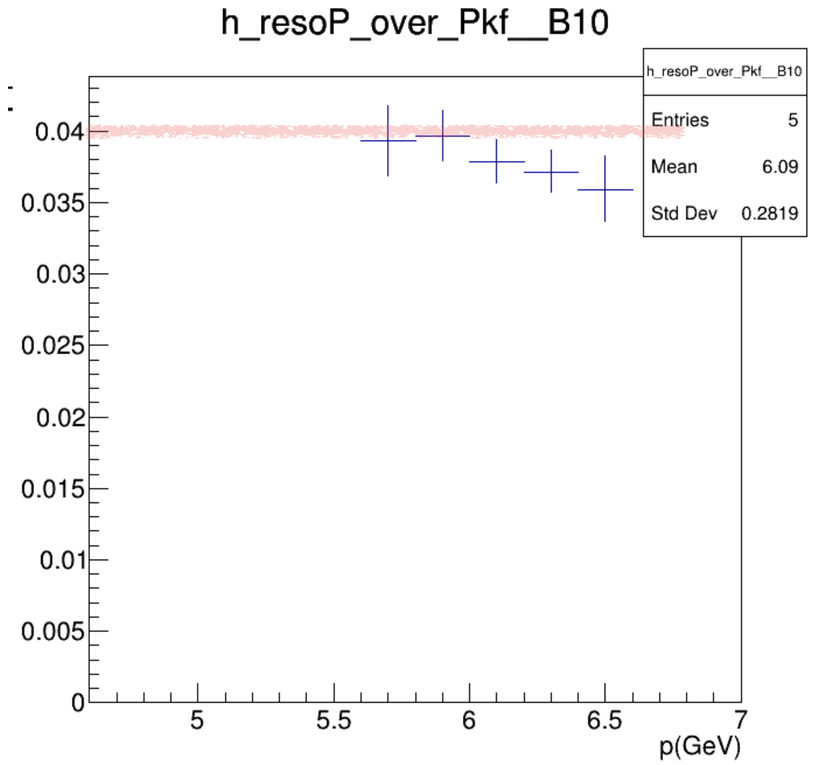


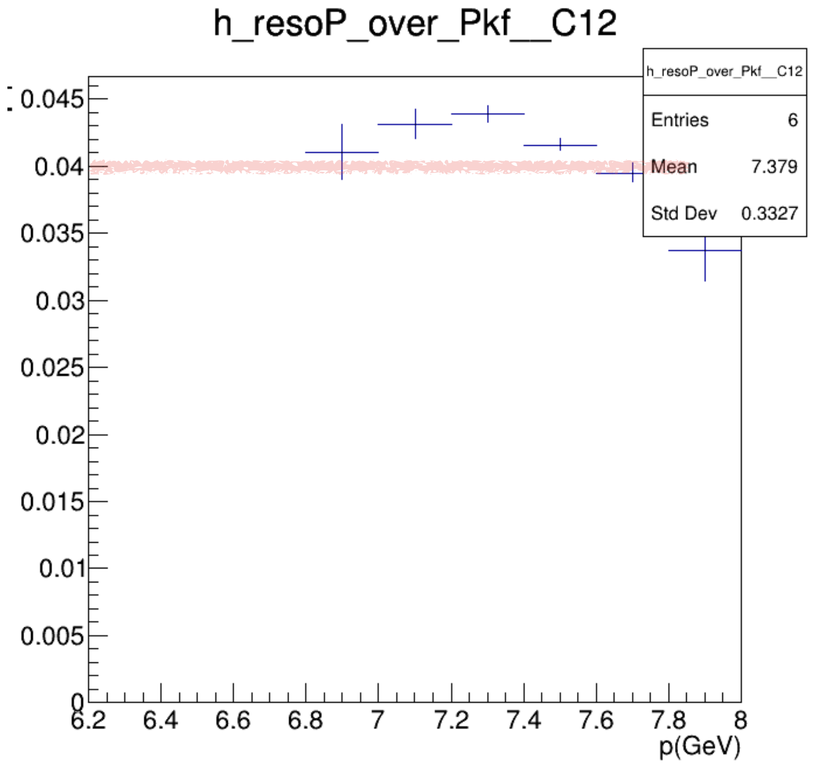

Test with H and He

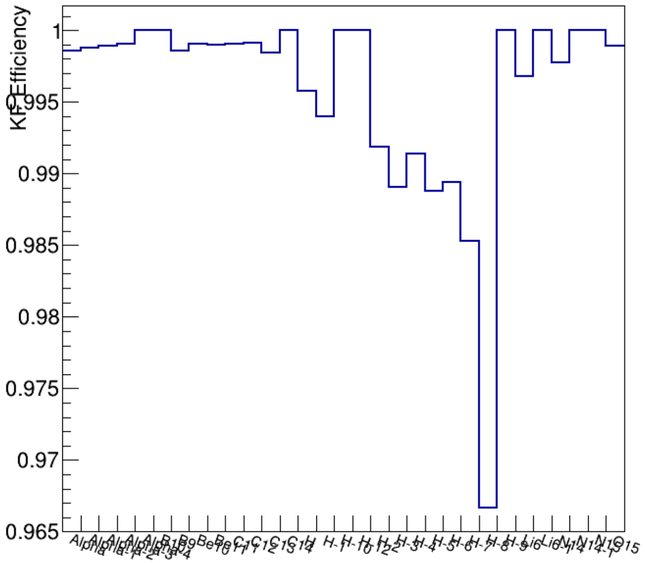
# Results - variation 2

**VTX 3 or 4 hits**
**IT >= 1 hits**
**MSD 2 or 3 hits**

- Test including events with only one hit in the IT



# Results

- This results gives a wonderful closure-test of the method —> implementing well!!!
- Gives us the best possible performance we can reach.
- Checks the geometry and magnetic-filed implementation
- Gives the p resolution as a function of the fragments type

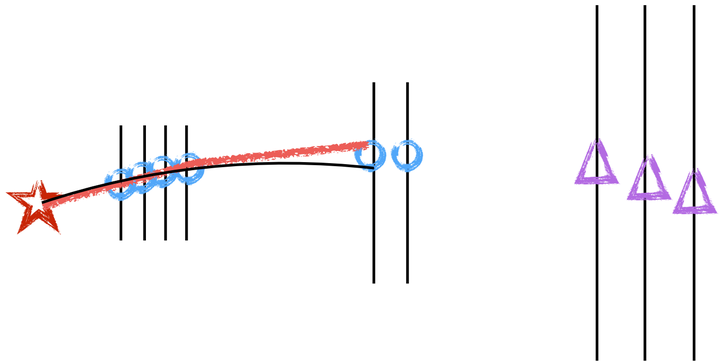
**MC validation successful!**
**Now moving to a data-like fit**

# DataLike fit

- Possible strategies divided in 2 big categories (both to be tested!):
  - Forward hit selection and Backward hit selection
- We decided to start from the Forward one.
  - *First implementation and test ongoing right now!*

# Global tracking - strategy

- Using the interaction point as a seed
- Starting using clusters from VTX simple straight tracks
- Extrapolate each one to the IT. Find the closer cluster in 2 possible ways:
  - Straight + average bending
  - Kalman prefit
- MSD kalman extrapolation
- Extrapolate to Scintillator retrive the charge -> use it for P evaluation
- Rerun with RECO change and mass



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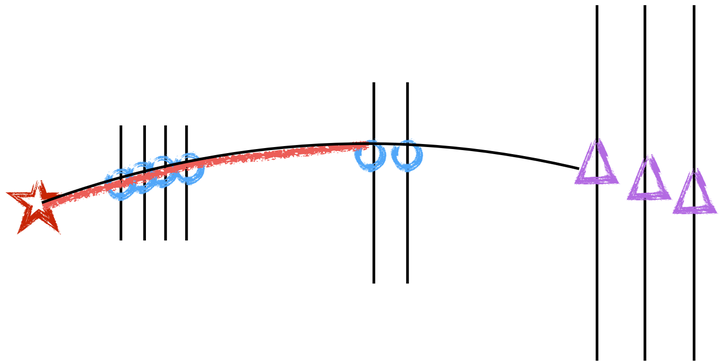

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  - Straight + average bending
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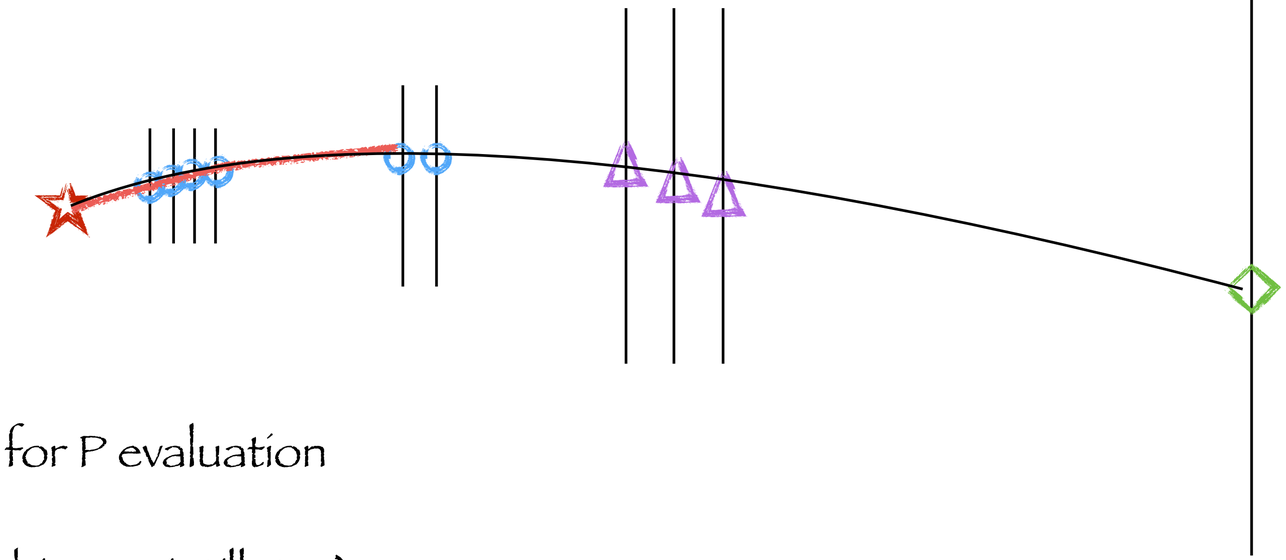
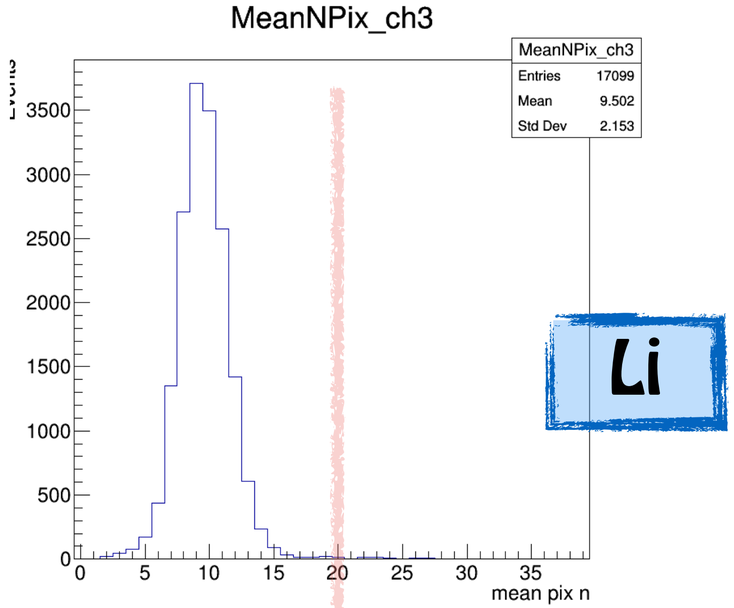
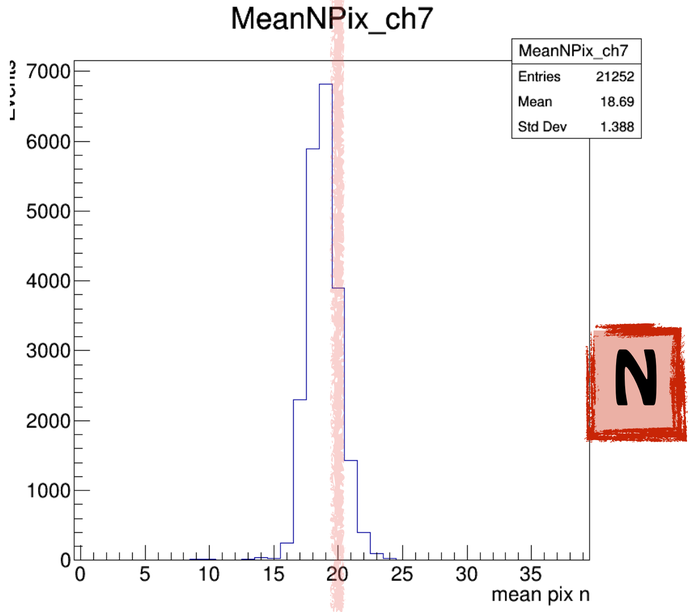
- Extrapolate to Scintillator retrive the charge -> use it for P evaluation
- Rerun with “correct” charge and mass (from TOF, tracking, scintillator)



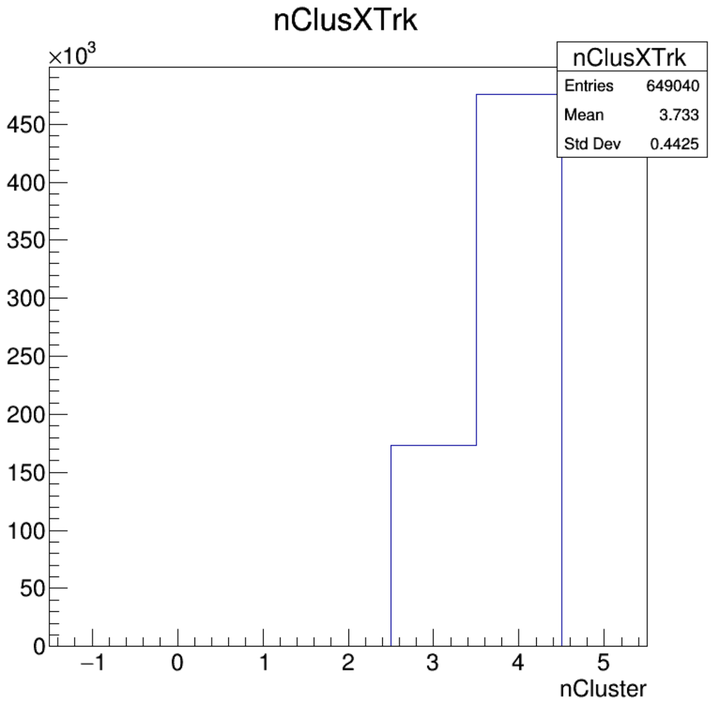
# Fit initial assumptions

- Charge and mass:
  - ☆ From cluster size (forward fit)
  - ☆ From scintillator (backward fit)
  - ☆ Fit using multiple Z/A hypothesis (2 or 3 depending on scintillator results) and use the best performing (both strategy).
- Probably no big issue for the first estimate since used for energy loss and multiple scattering.
- Always need to rerun with the proper values.



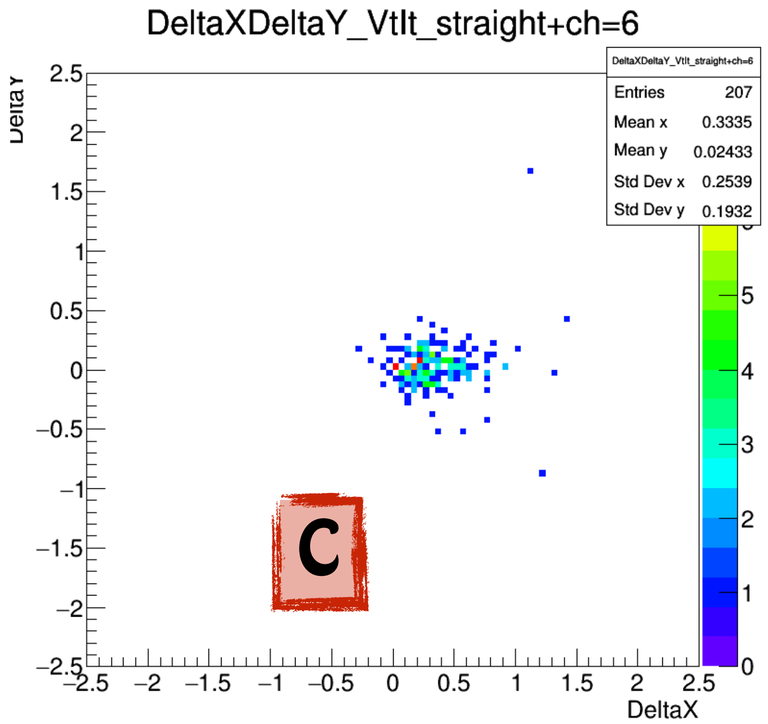



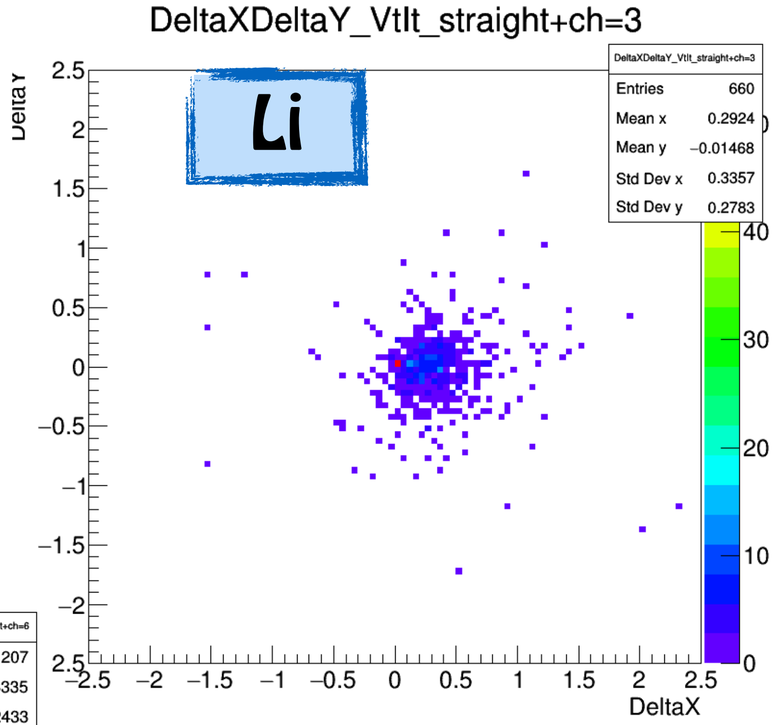
# Preliminary VTX track studies




3 or 4 clusters deposit

- Look at clusters made by the same particles



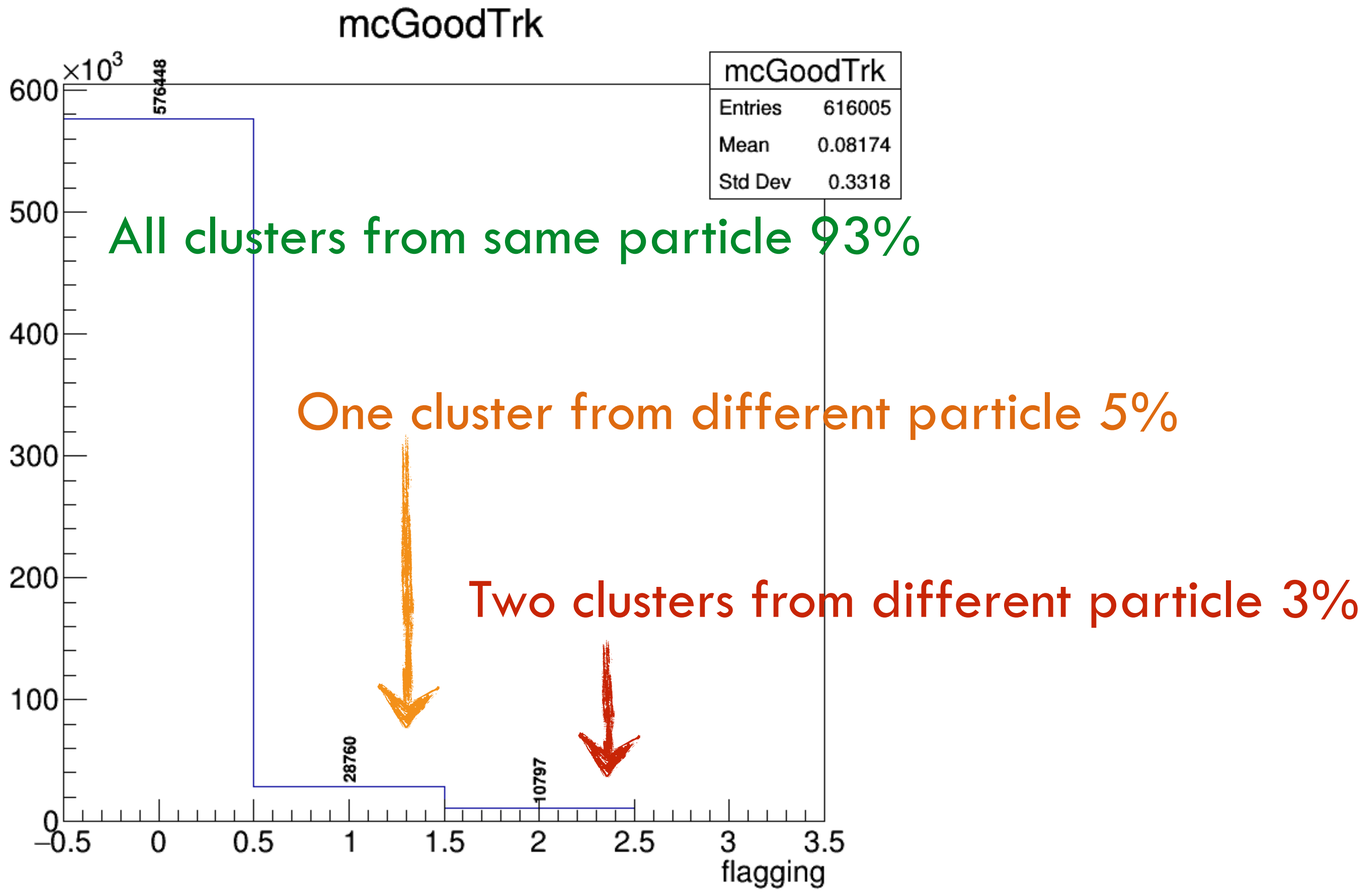

Average shift wrt straight tracks on IT

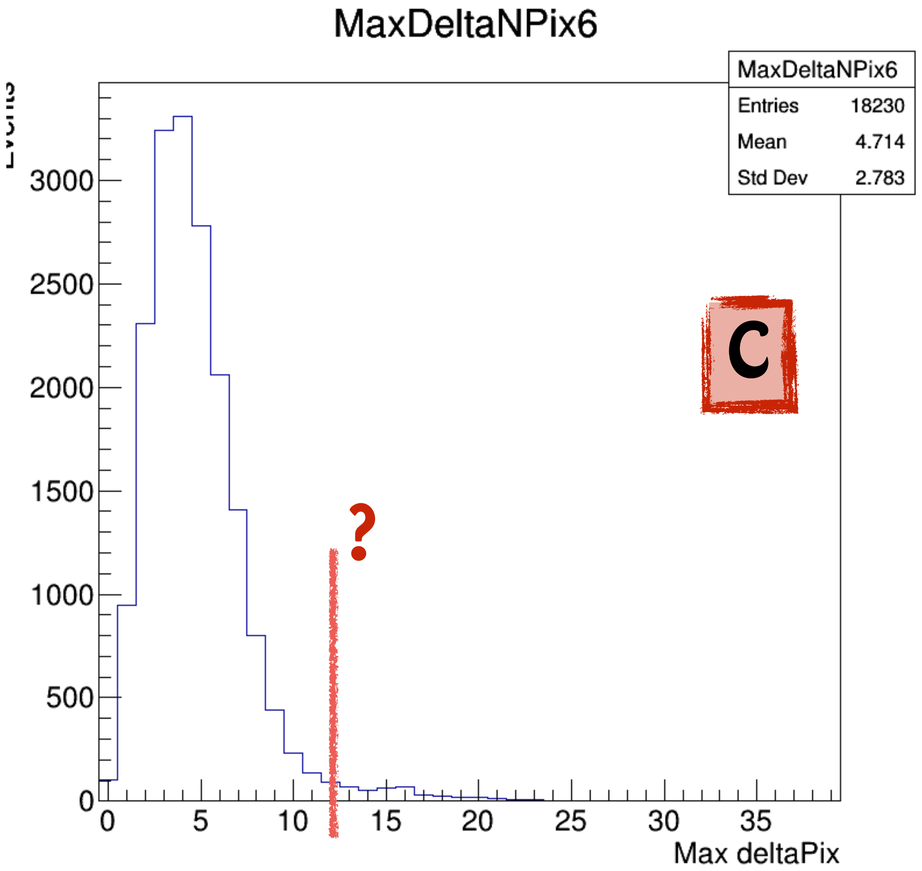
**y = 0 cm**

**x = 0.3 cm**

# Preliminary VTX track studies

- VTX Track quality studies




**Possible to discriminate good tracks from nPixel difference?**

# Conclusion

- Time to focus on Global Reconstruction! Everyone is invited to run it and look into it in a critical way.

- Thursday evening -> software round-table, join us!!!

  - Decide where to focus efforts and identifying weak points

  - Hits for discussion:

    - Calo full data-chain
    - Including Z evaluation (already done in private codes)
    - More precise digitisation and discrimination for scintillator (ghosts, bar reactions, ...)
    - Strategy for MSD digitisation and clustering
    - ...

# Backup

Take a breath after Beam Test

Wake up!

**September 2019**
- MSD software structure ready
- CALO geometry
- CALO basic software structure ready
- Revive MC Global tracking

Software meeting

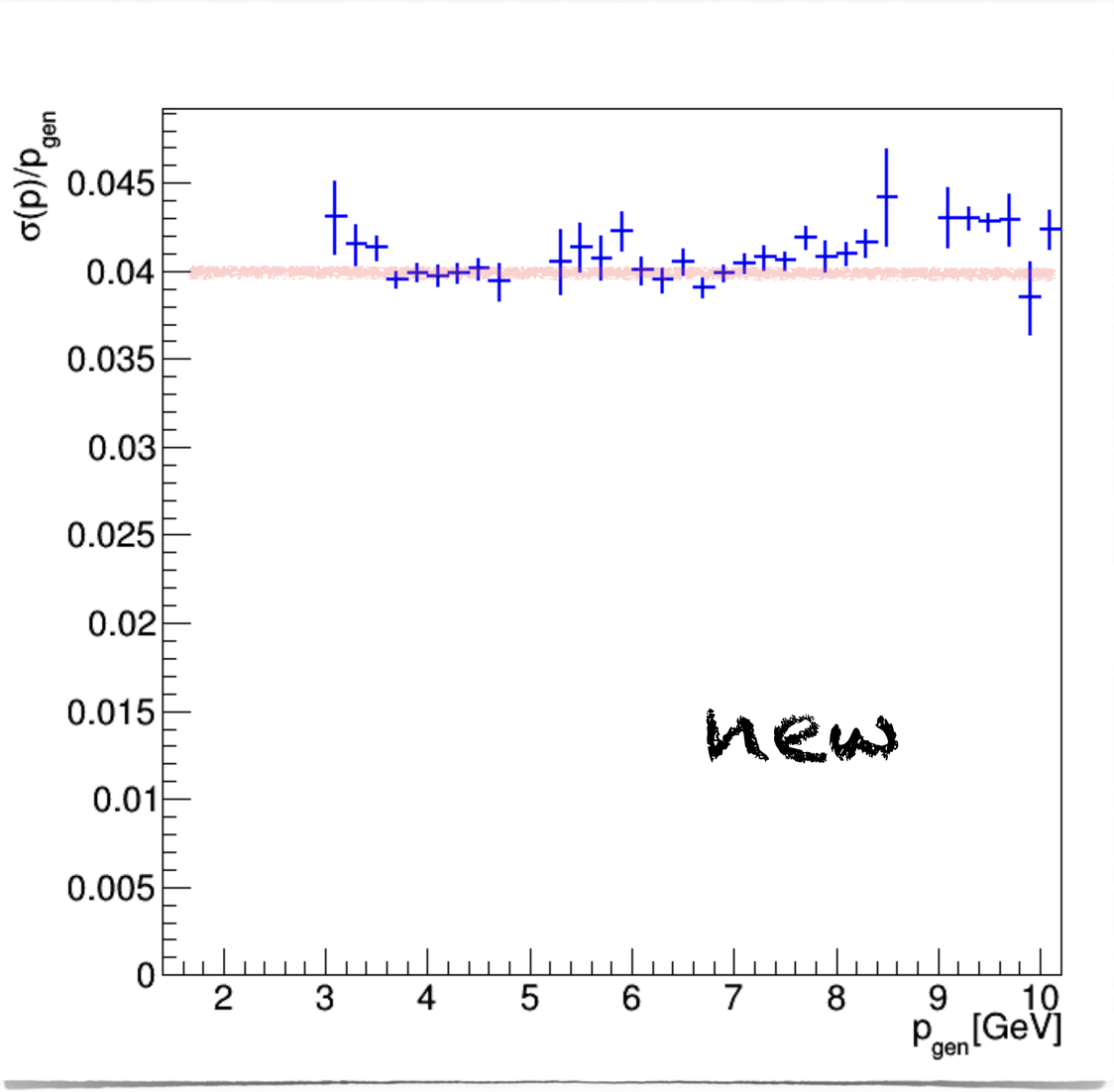
December

April — Data Building and understanding — 2019

July (end?)
Software meeting

**End of 2019**
- IT, MSD, CALO complete software
- FullRec ready
- Global Tracking completed
- Analysis code in SHOE
- **Full FOOT setup complete!**

**2020 goal**
**prepare and optimise code for data acquisition**




- **VT** xy Reso: 0.0006cm
  z Reso: 0.005cm
- **IT** xy Reso: 0.0006cm
  **z Reso : 0.05cm**
- **MSD** xy Reso: 0.003cm
  z Reso : 0.01cm