III FOOT Collaboration meeting

Bologna - 4-5 Dicembre 2017

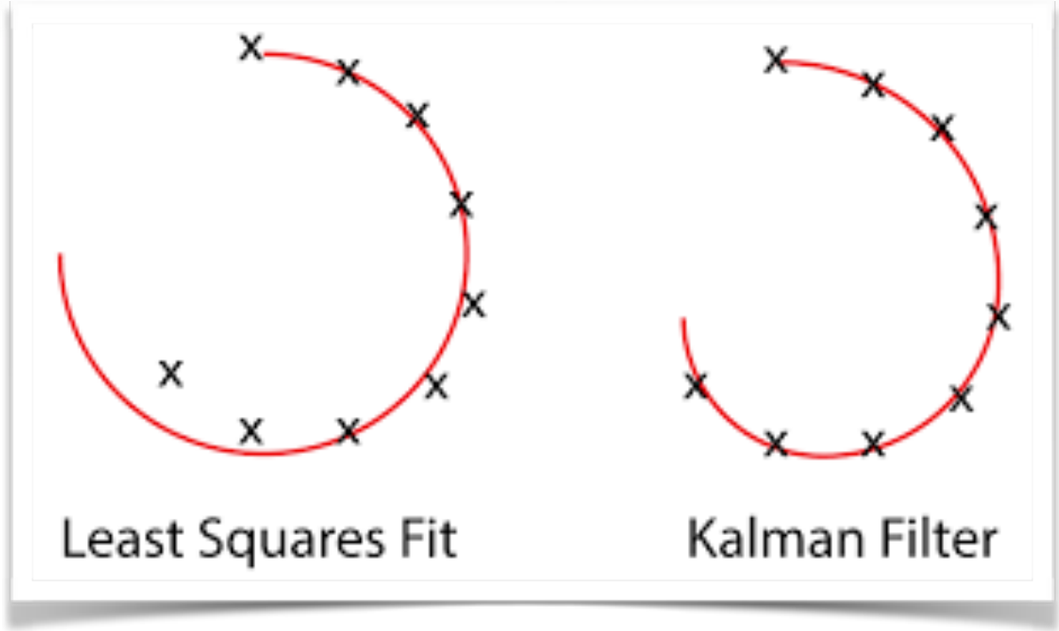
Global Track Reconstruction

Matteo Franchini

on behalf of Bologna group

Why global reco

- Track reconstruction combining info from all the 3 tracking detectors;



- Using Kalman Filter to have a momentum resolution of ~5% or smaller;

- Need to help reconstructing atomic mass A of the fragments;

TOF (β) – TRACKER (p)

$$A_1 = \frac{p}{U\,\beta\,\gamma}$$

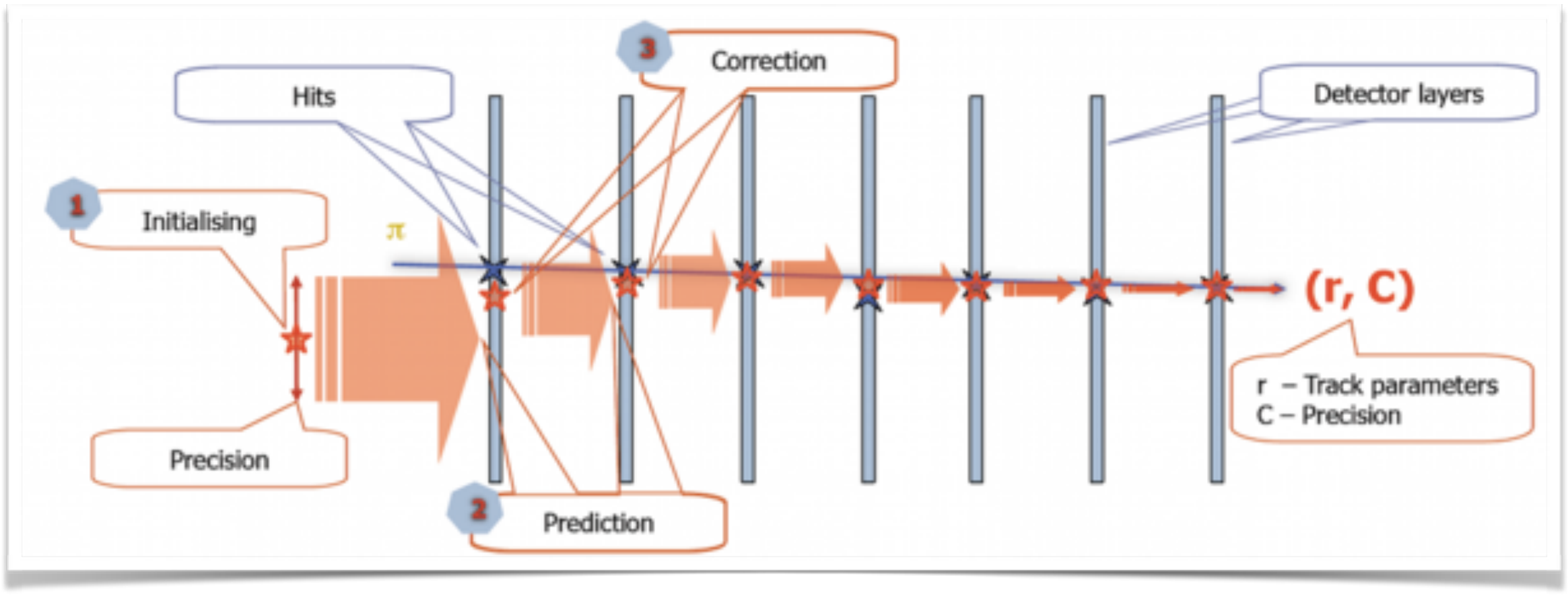
TRACKER (p) – CALO (T)

$$A_3 = \frac{p^2 - T^2}{2\,U\,T}$$

- Identify calorimeter deposits.

What's KF

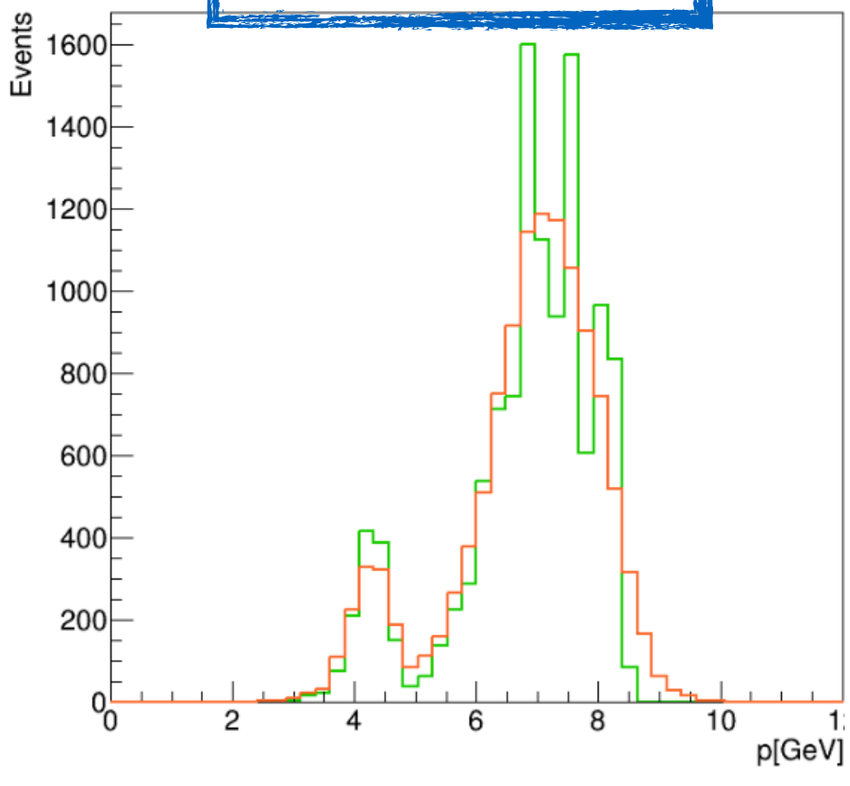
- Recursive algorithm that predicts the trajectory from detector layer to layer, also considering multiple scattering;
- Each layer **prediction** is corrected using the **observed hit;**
- **Track uncertainty** decreases layer by layer.



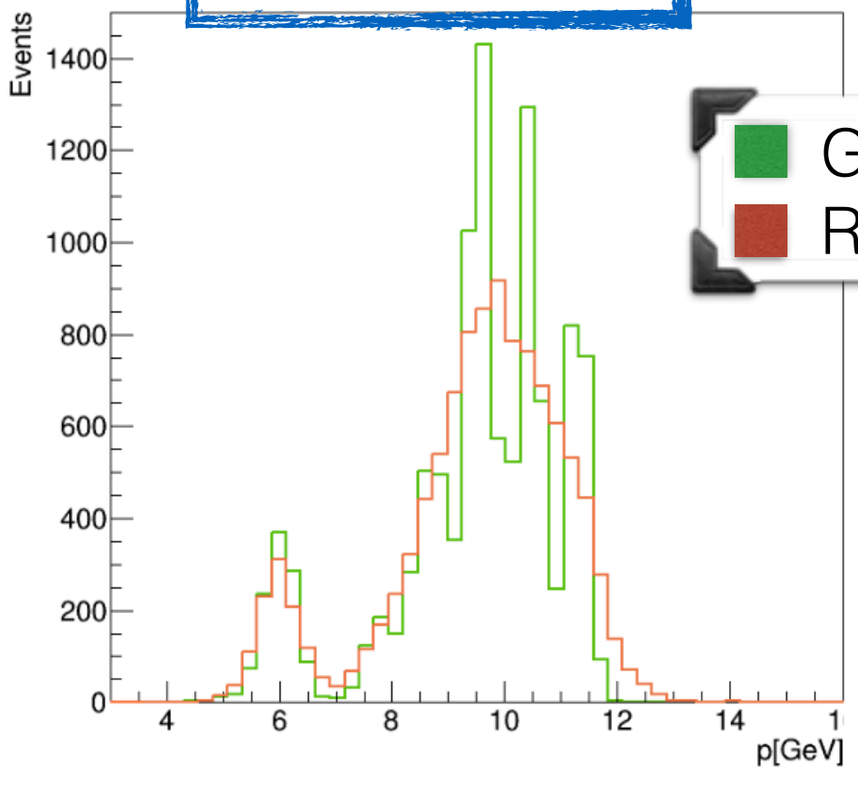
CDR status

- Global track fitting with simulation **version 12.4**
- Hits from VTX, IT, and Microstrip, simulating an x-y smearing
- ^{16}O projectile at different energies, all fragments;

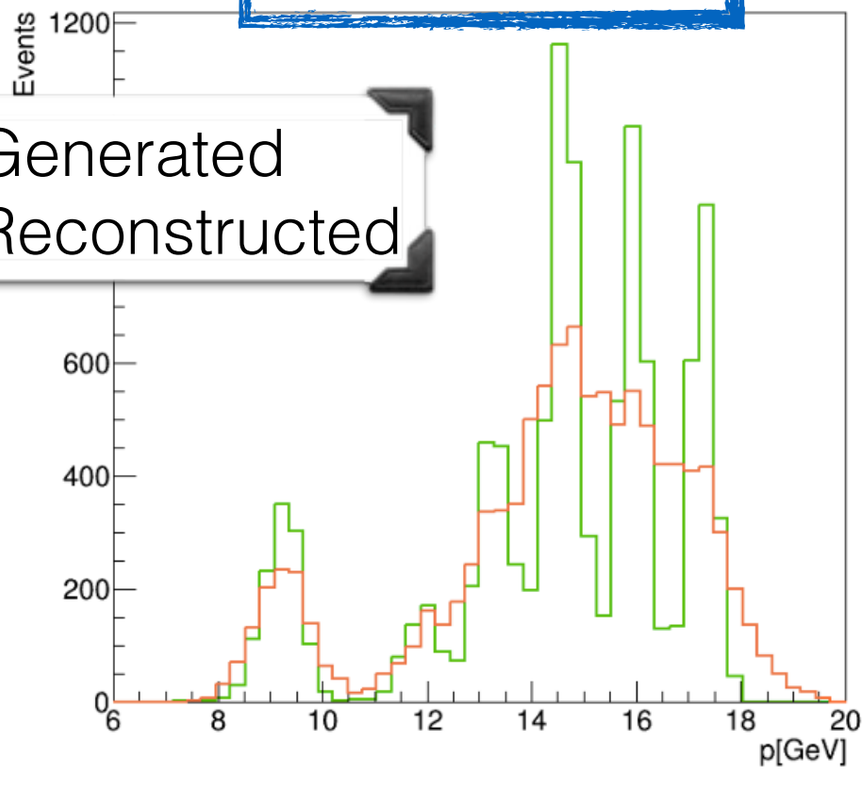
200 MeV/u



350 MeV/u

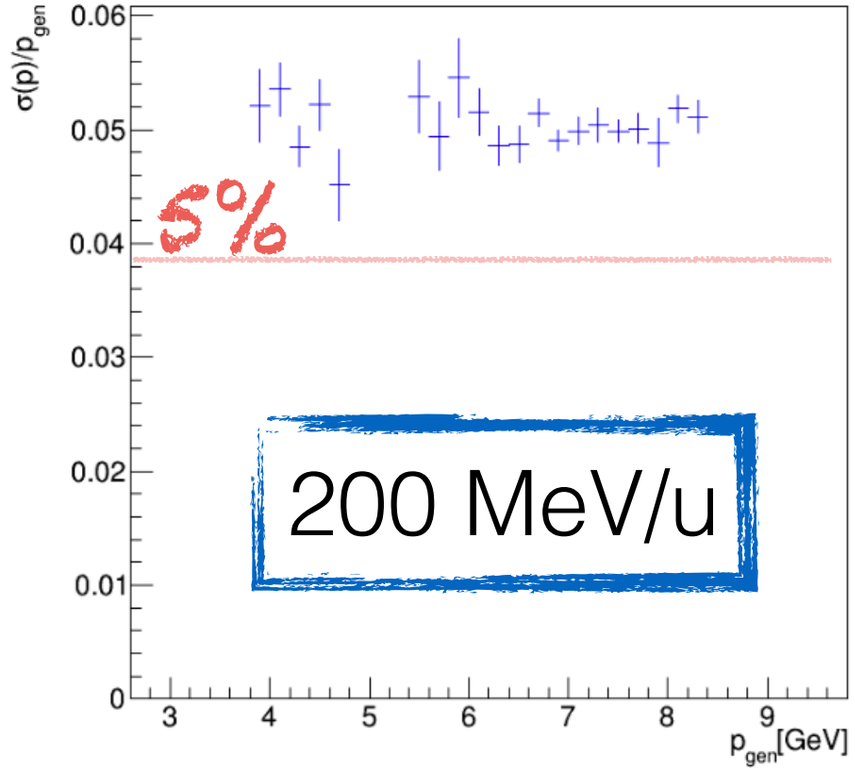


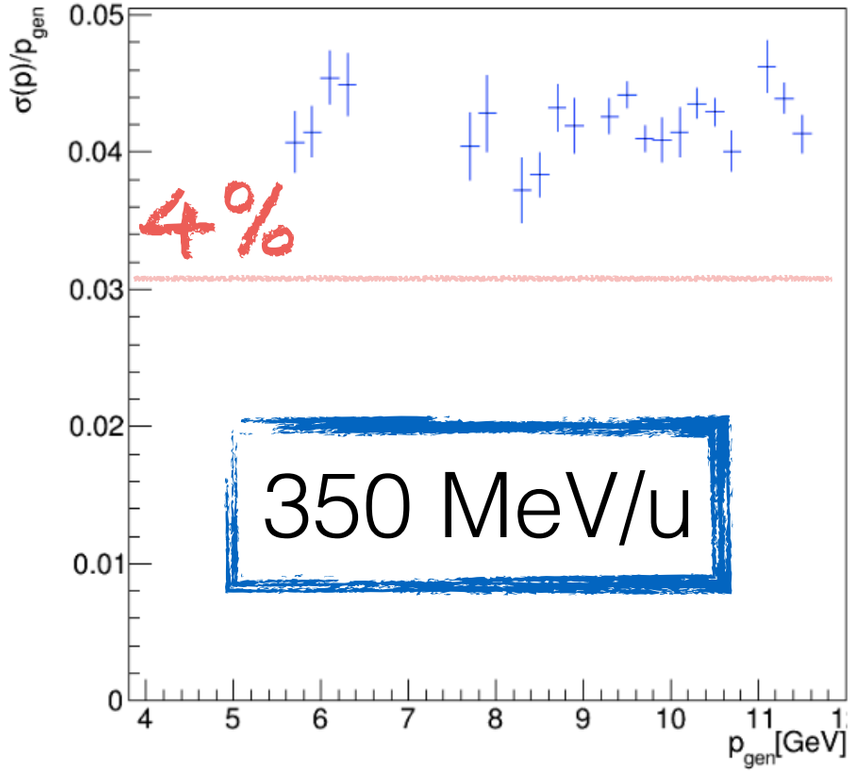
700 MeV/u

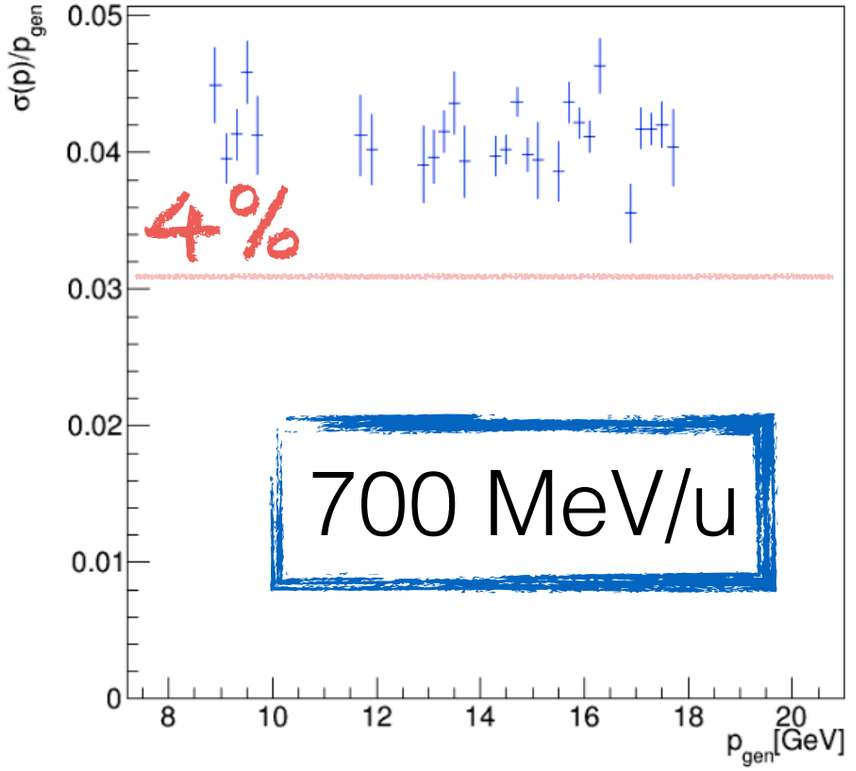


CDR status

- Measured a **momentum resolution** as a function of the generated momentum;
- Resolution ranges from ~5.5% to 4%
- All fragments considered.







Overview

- Building a common **geometry** and **materials** definition between FLUKA and SHOE;
- Studying the introduction of hit preselection, i.e. using **Deterministic Annealing Filter** (**DAF**), to fight the noise and bkg hits;
- **Checking** the correct implementation of GENFIT, *"the most reasonable way is not always the right on"*, especially with codes;
- Is it possible to **improve the momentum resolution** found?

- Abrupt stop due to the flood, restarting last week…

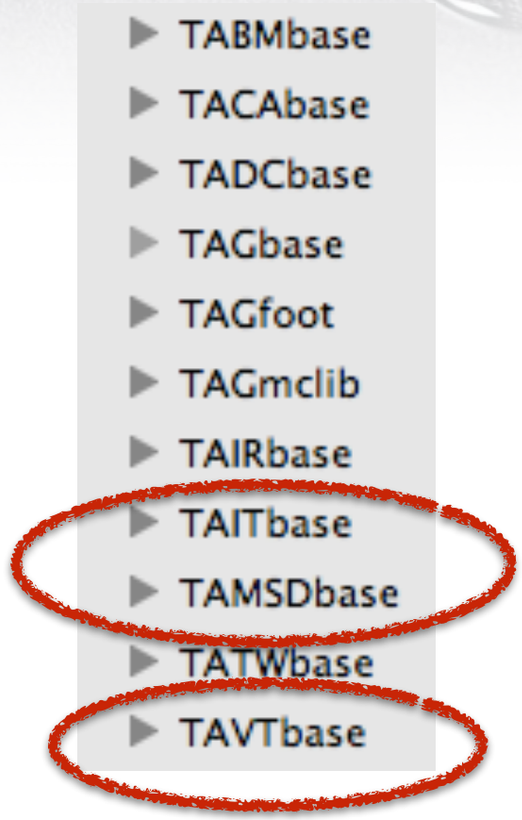
Geometry and Materials

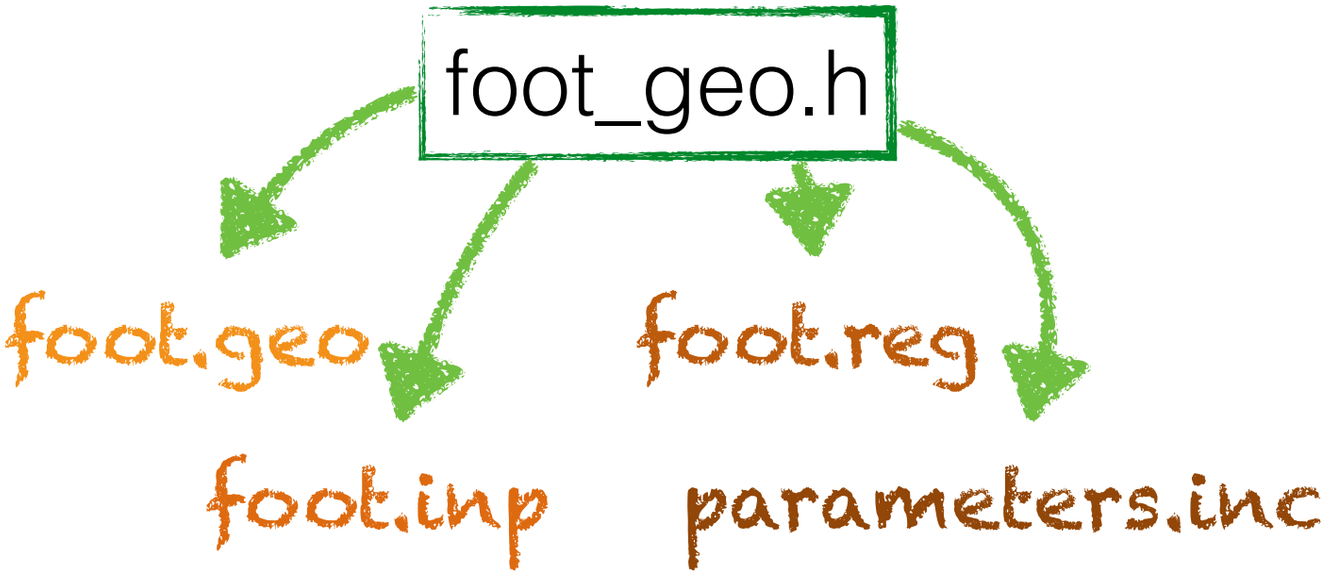
- FOOT geometry implemented in SHOE, in the geo classes for each detector/structure;

- SHOE produce the input files to generate FLUKA simulation
  —> <u>same geometry, same materials!</u>

- FLUKA input produced in *dedicated runs* —> fast!

- **Ready and tested for tracker detectors!**



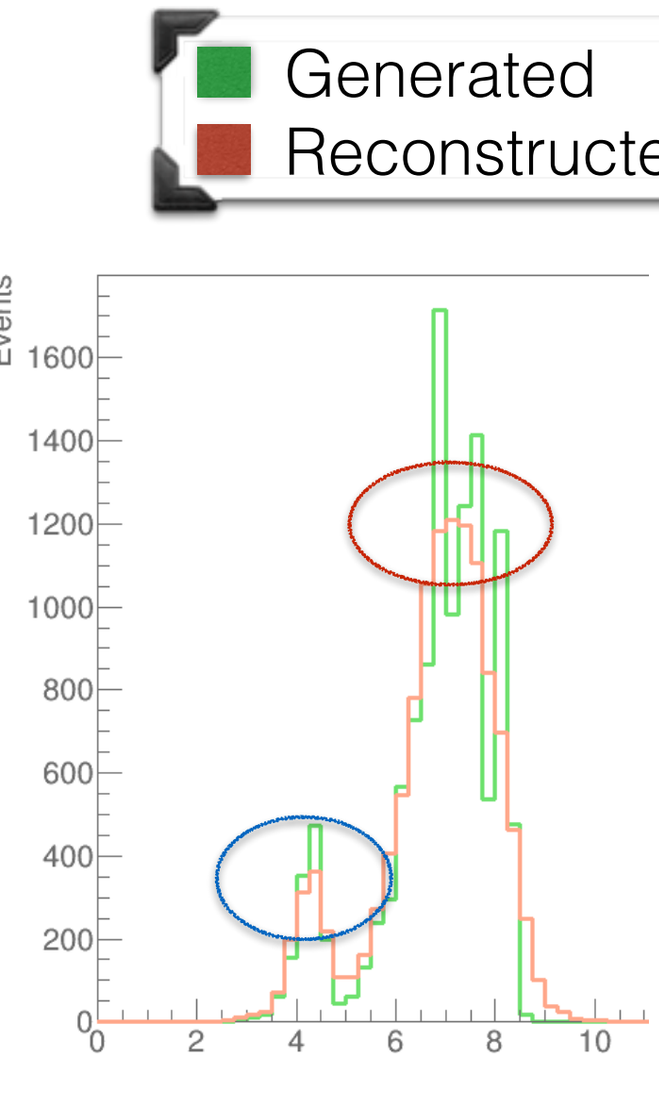


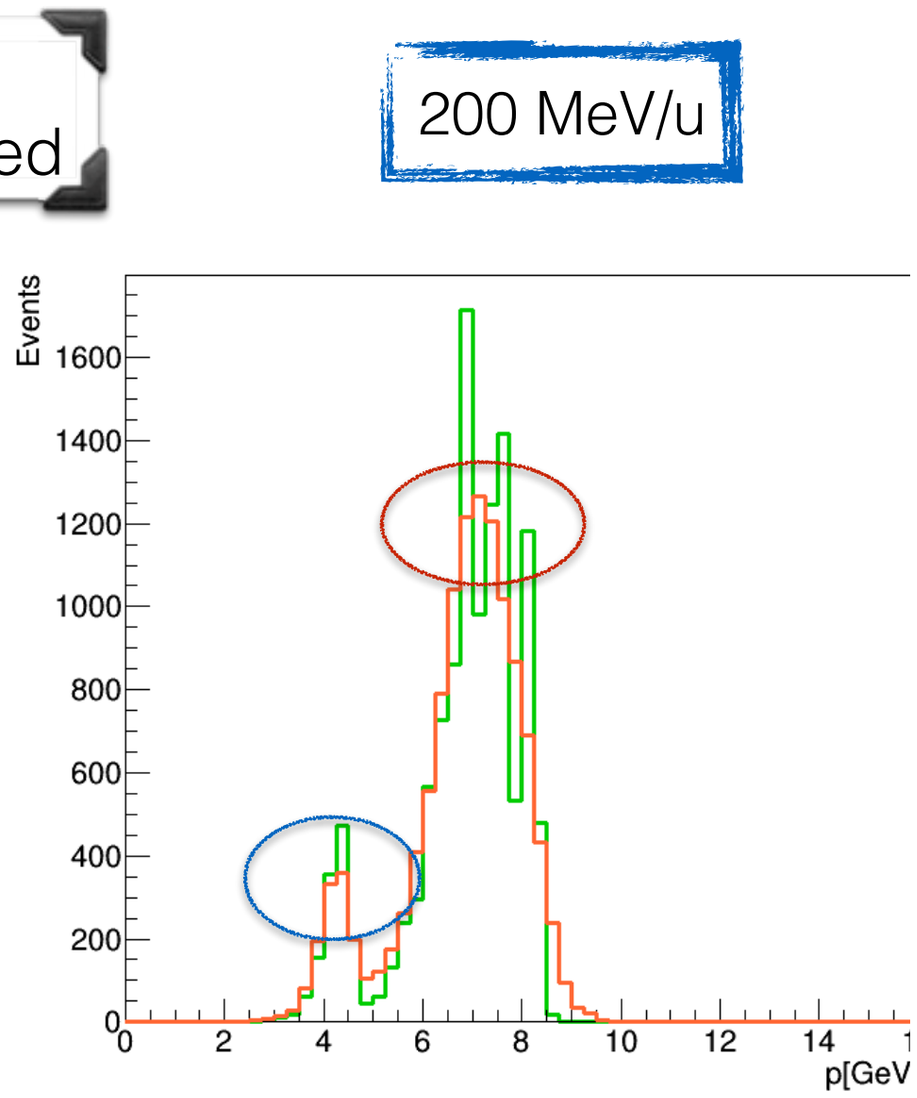
Geometry and Materials

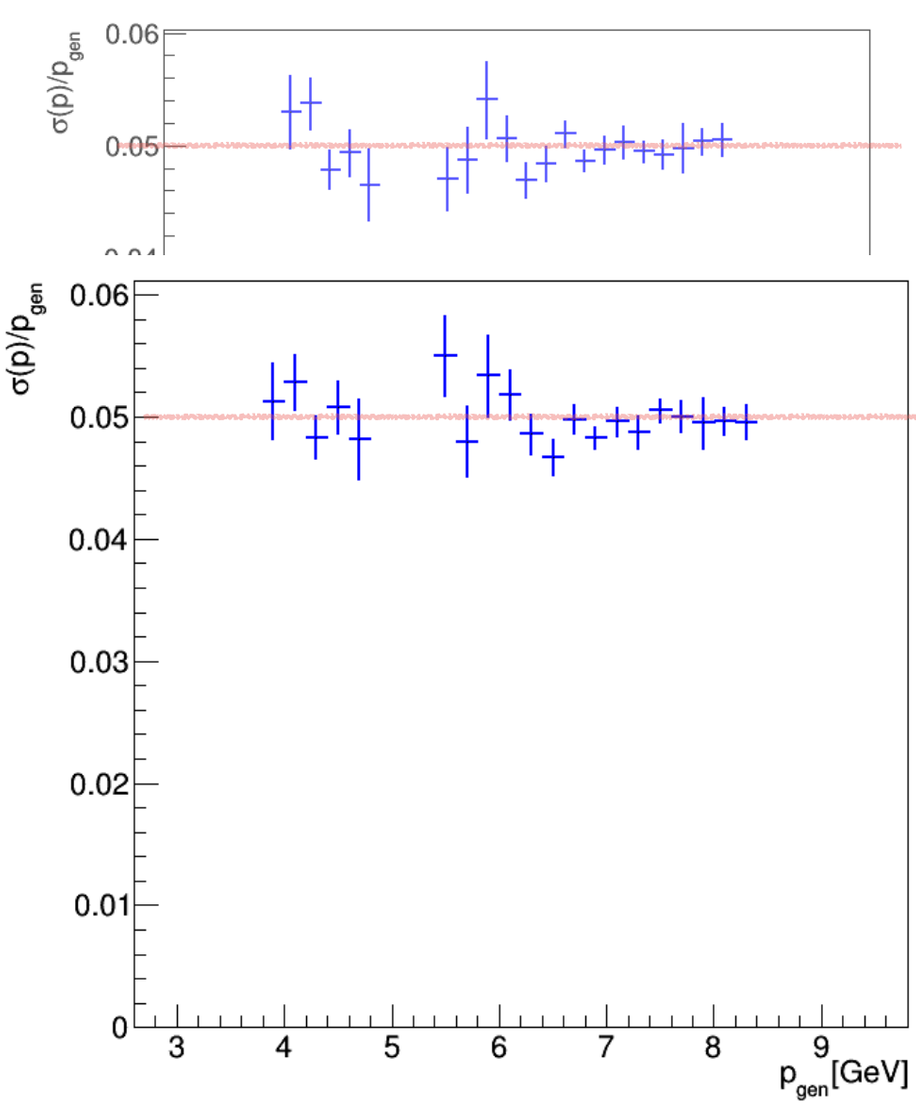
- Corrected some bugs (**material composition**) -> result changed;
- Changed not so much -> it was a **good approximation**.

Generated
Reconstructed

200 MeV/u





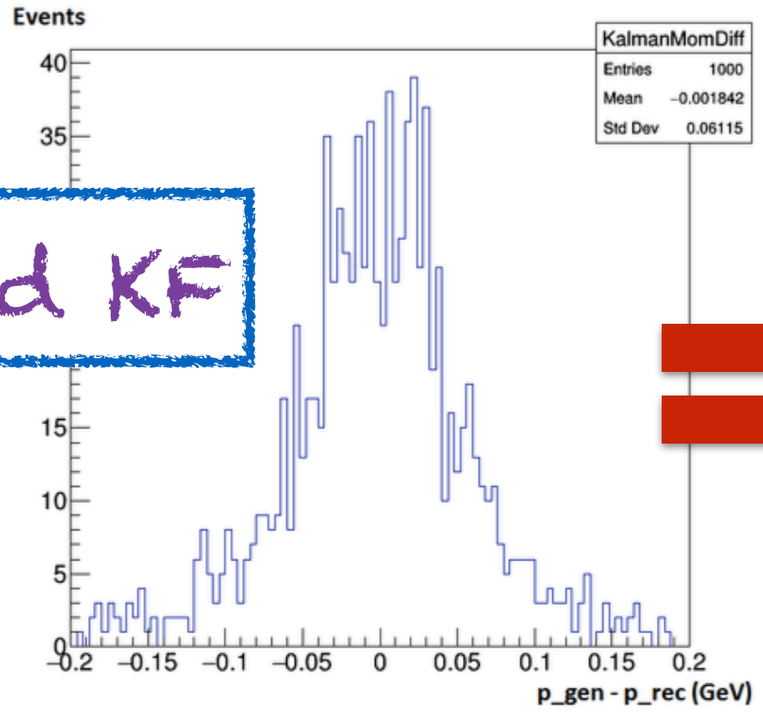


DAF

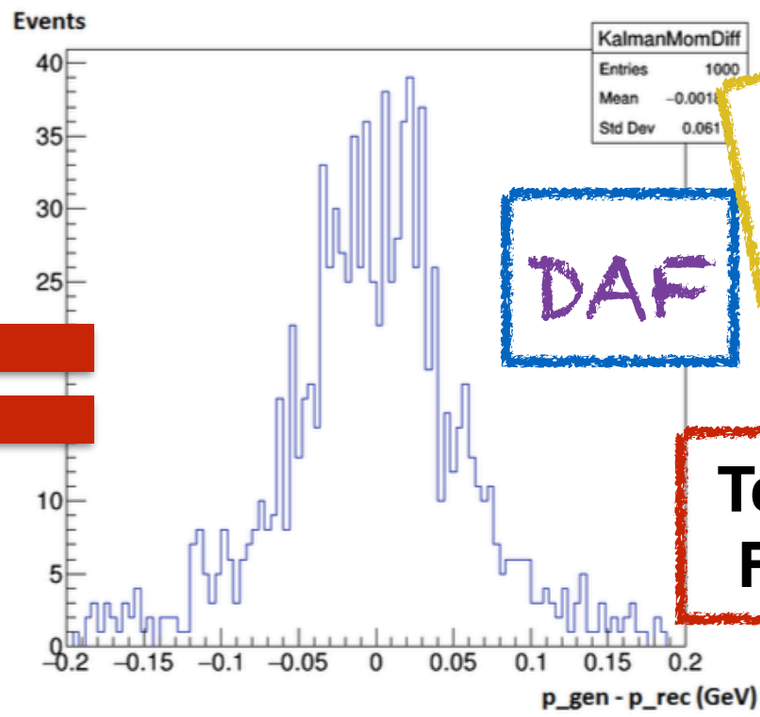
- In parallel we stared **preliminary test** to study the response of the Deterministic Annealing Filter;

- Should help discriminating **signal to noise hits**;

- Tested outside SHOE, starting from a GENFIT testing code. Compare wrt standard KF in a minimal environment. Results in perfect agreement.



Standard KF



DAF

Independant code!

Tesi Triennale di Francesca Neri

- Not so straight forward in SHOE, where a bias in momentum appeared in the first (and only) very preliminary test;

Momentum Reso Study

- **Next Goal:** improve momentum resolution;
- What is our **lower limit**?

$$\sigma\left(\frac{\Delta p}{p}\right) = \frac{p \cdot \Delta x}{0{,}3 \cdot B \cdot L^2} \cdot \sqrt{\frac{720}{N+4}} \sim 4{,}8\%$$

Close to our result!

p = 7 GeV
Δx = 20 μm

N = 9
L = 30 cm
B = 0,8T

What if decrease spatial resolution?
Δx = 10 μm **—>** ~ 2,4%

…but we have ms…

$$\left(\frac{\sigma_p}{p}\right)^2 = \left(\left(\frac{\sigma_{p_t}}{p_t}\right)^2 + \left(\frac{\sigma_\theta}{\sin\theta}\right)^2\right)$$

$$\left.\frac{\sigma(p_T)}{p_T}\right|_{MS} = \frac{0.2}{\beta B\sqrt{LX_0}\sin\theta}$$

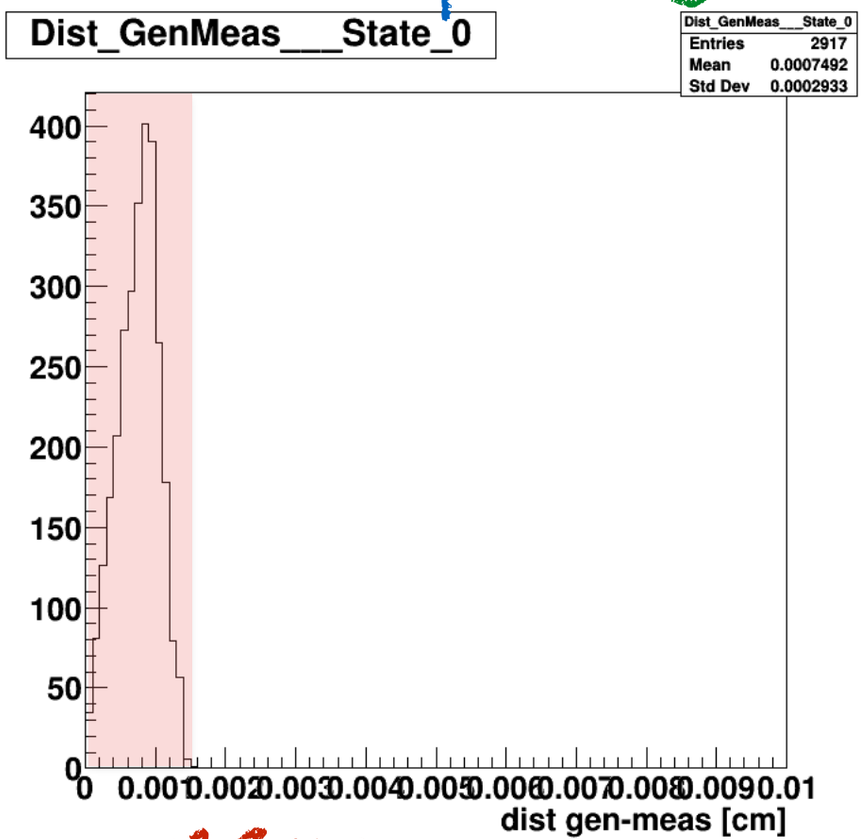
Difficult to be calculated so try it out…

Momentum Reso Study

- Feeds Kalman Filter with **generated-track coordinates** instead of **pixel positions**;
- Check the distance wrt **reconstructed point**;
- Change pixel detector uncertainty…

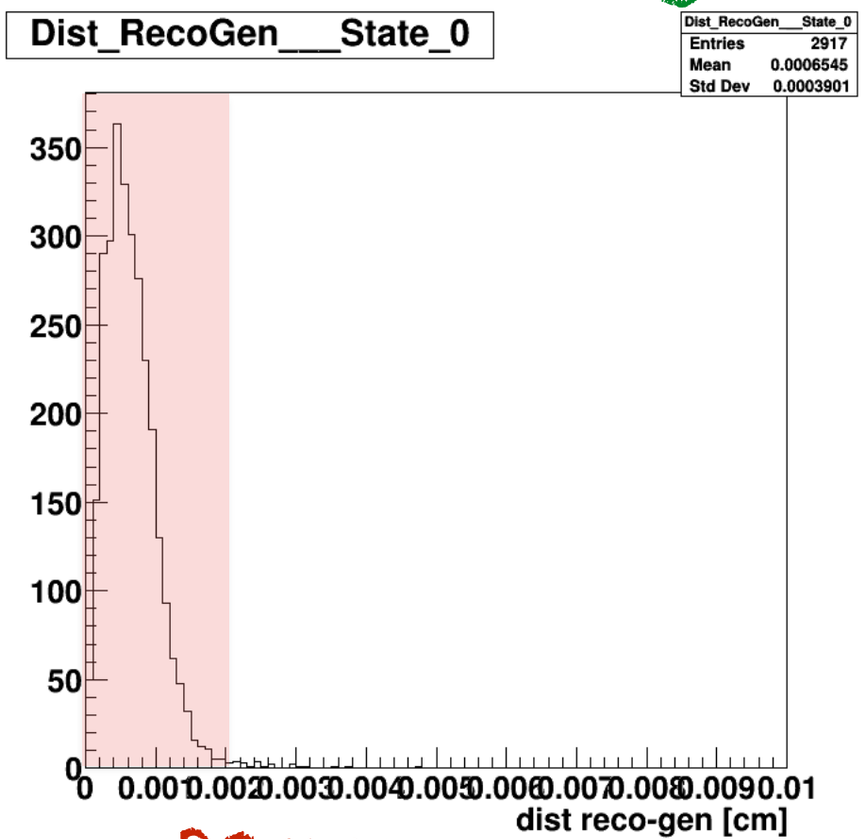
C11
VTX first layer

distance pixel/gen



<15 μm

distance reco/gen



<20 μm

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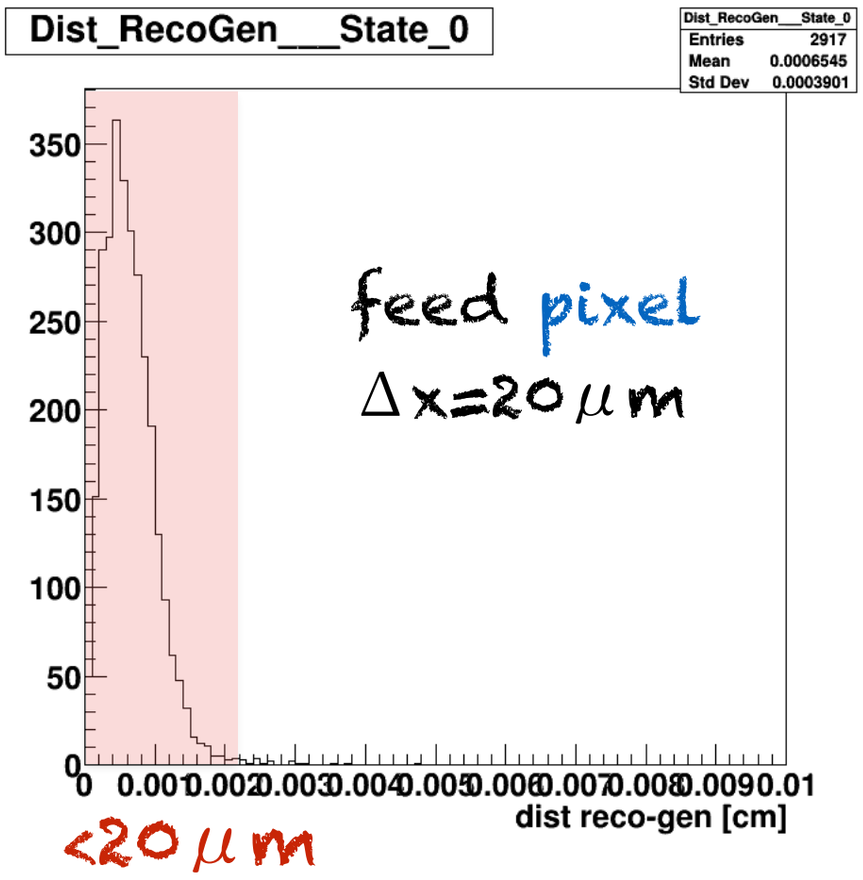

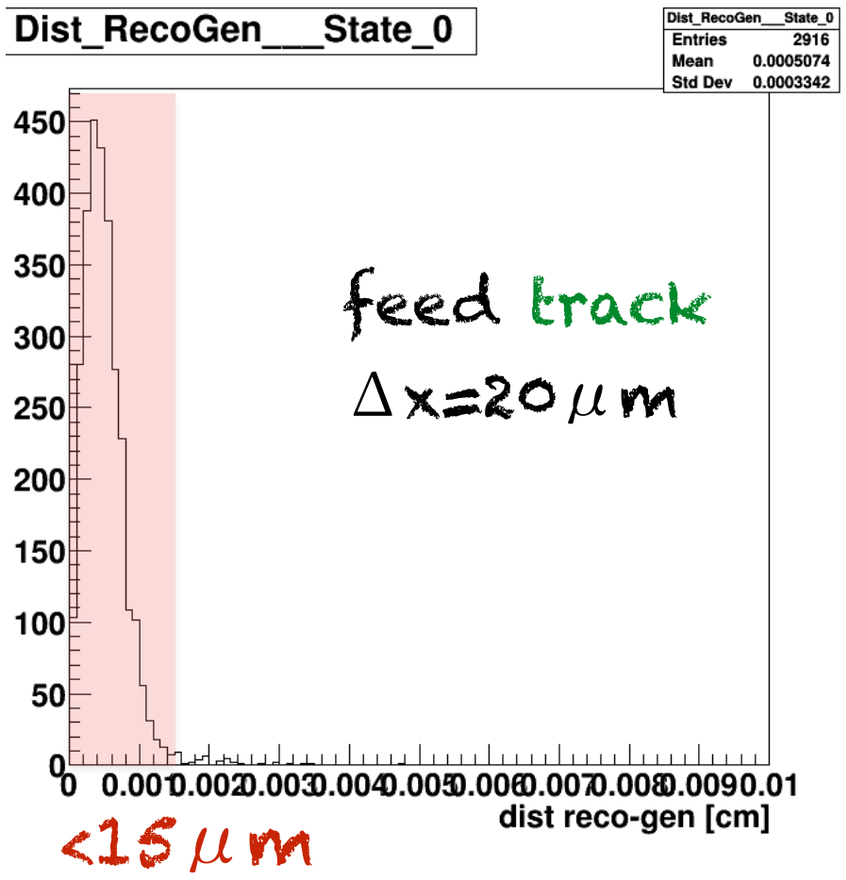

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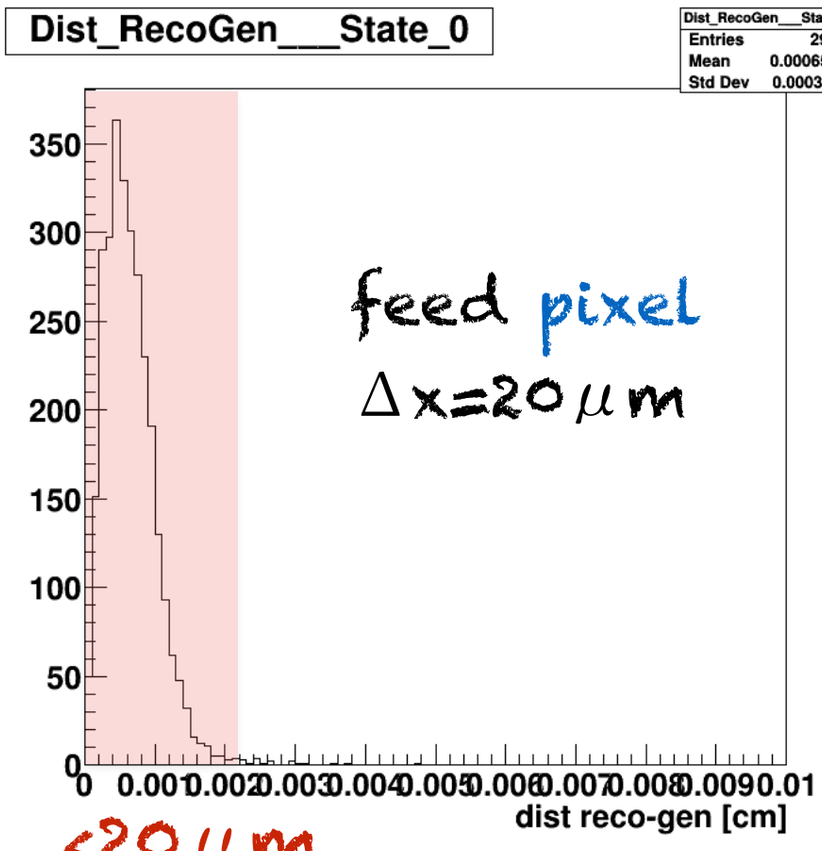

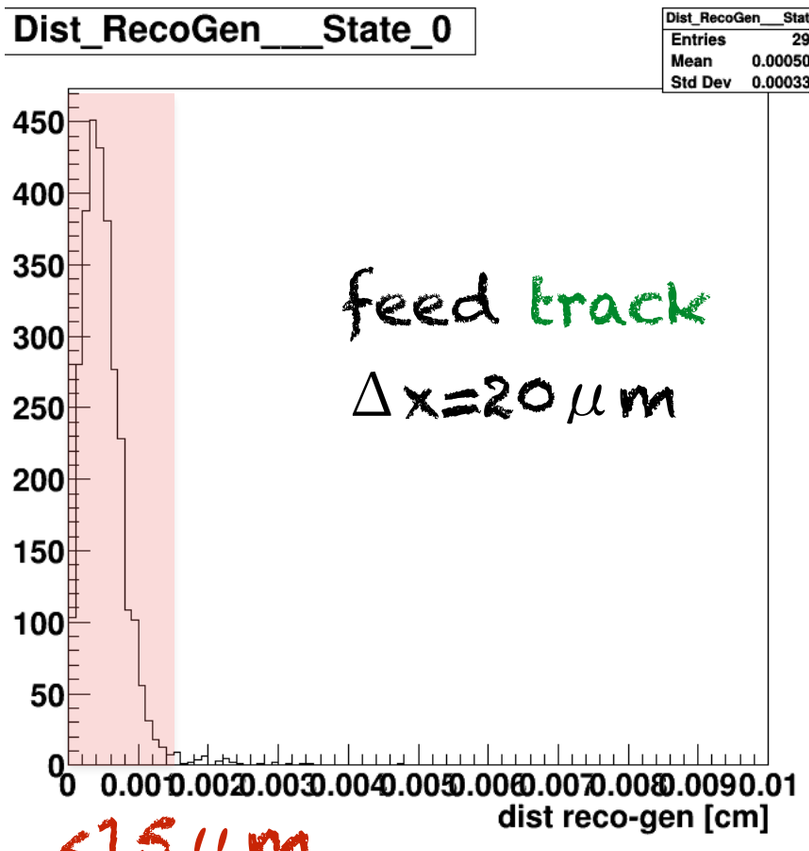

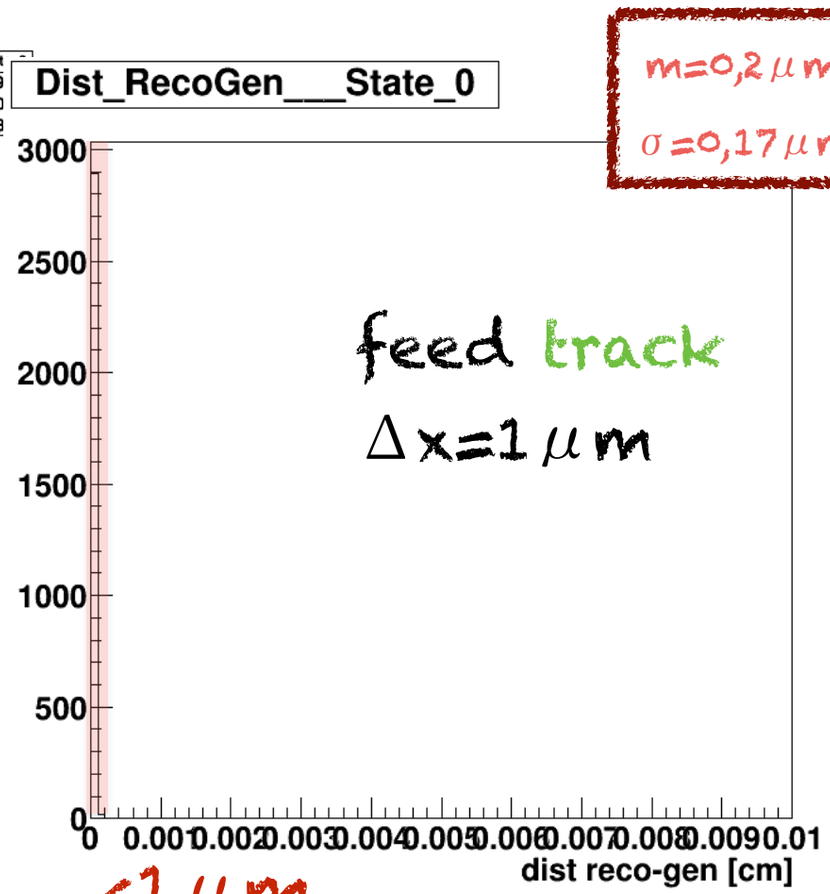

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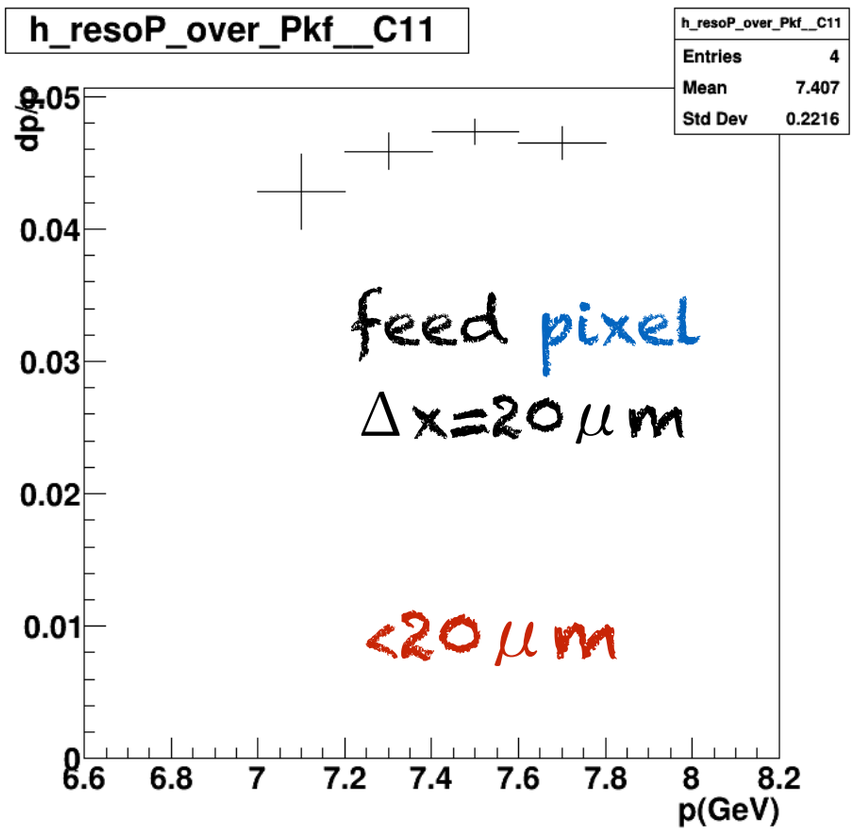
C11
VTX first layer

$\Delta p/p$ (reco/gen)



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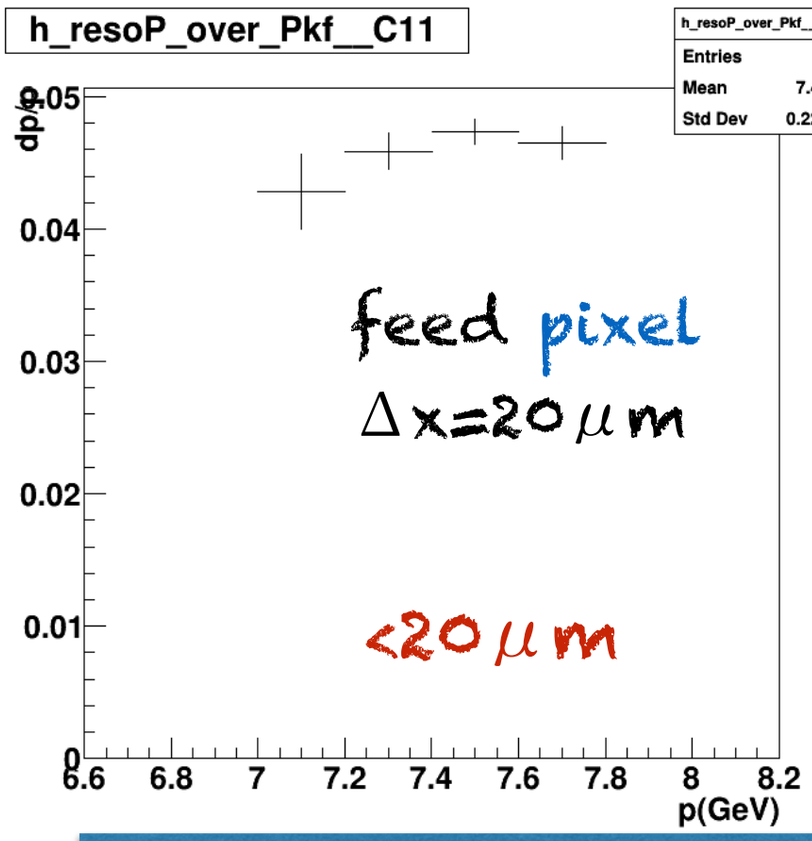

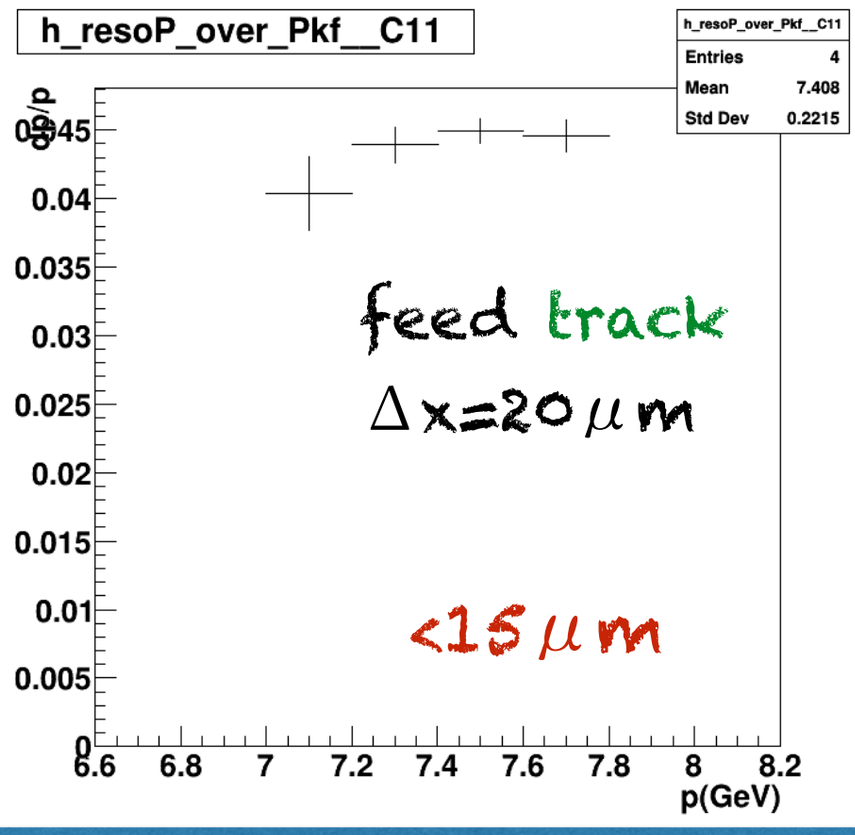

Δp/p Decreasing …. but ….

Momentum Reso Study

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VTX first layer

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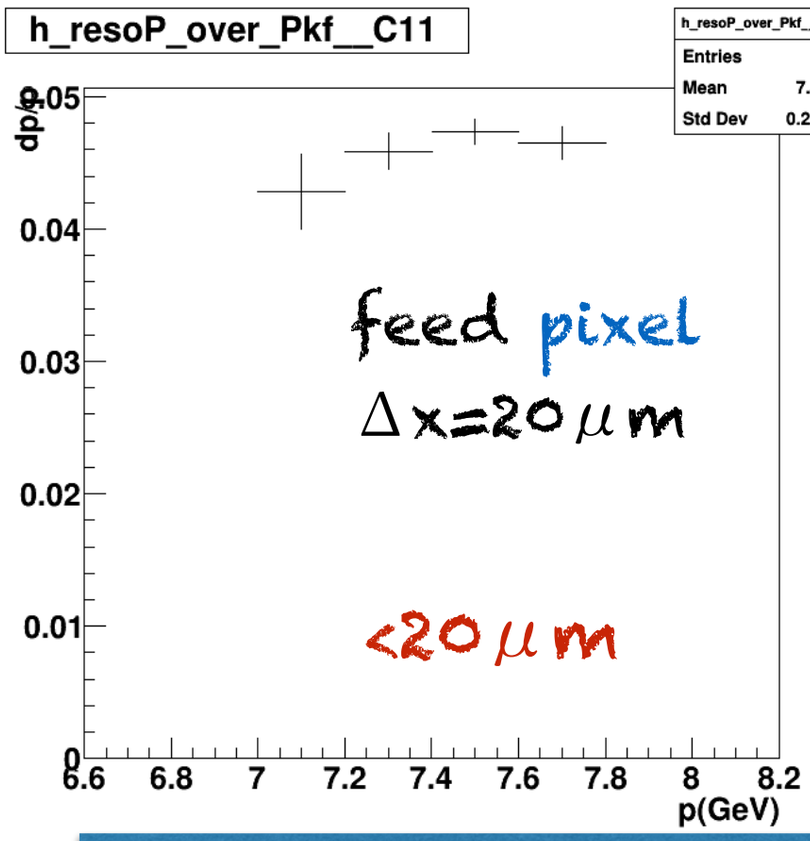
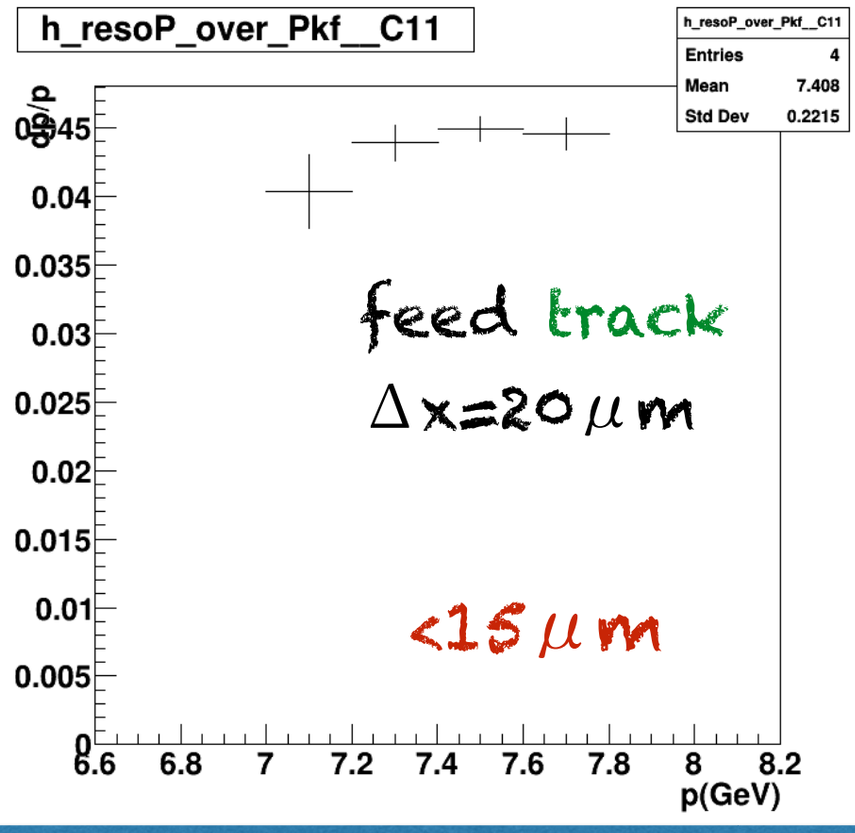
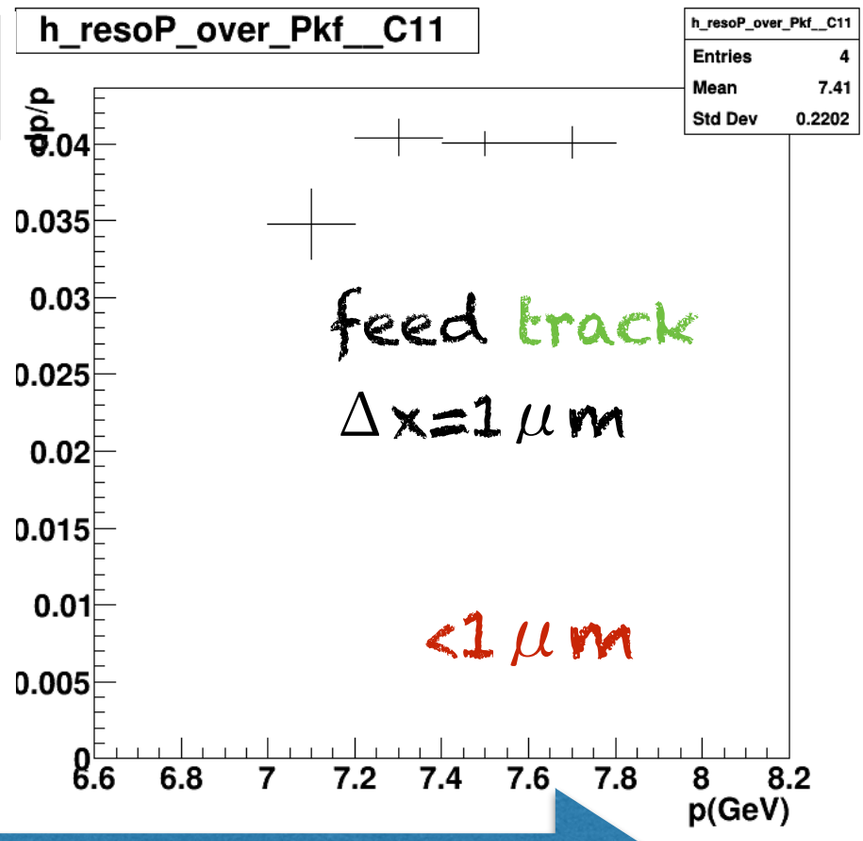






Δp/p Decreasing …. but ….

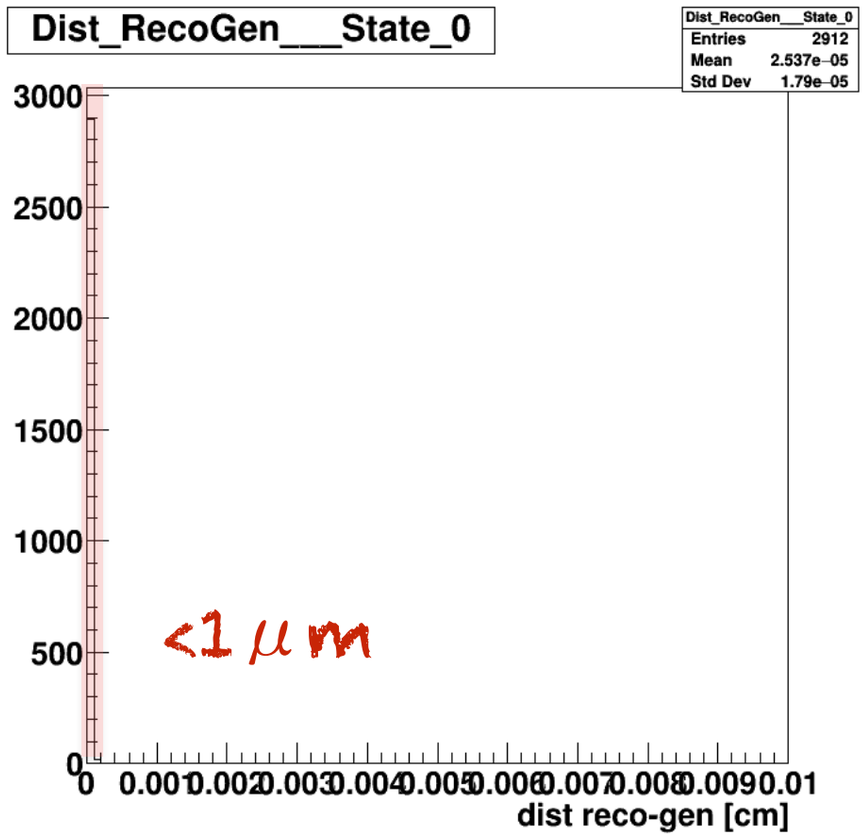
Momentum Reso Study

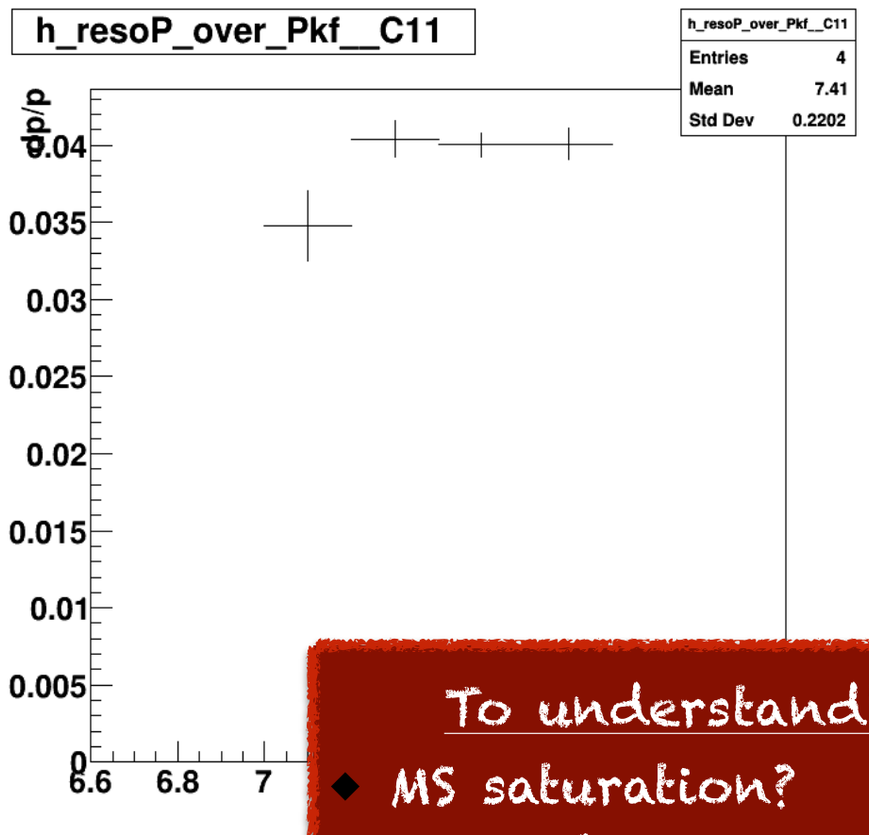
- Very good determination of the position

- Not corresponding good momentum resolution

feed track

$\Delta x = 1\,\mu m$





To understand!!!

- MS saturation?
- Sort of mismodelling?

expected from theory $\sigma\left(\frac{\Delta p}{p}\right) = \frac{p \cdot \Delta x}{0{,}3 \cdot B \cdot L^2} \cdot \sqrt{\frac{720}{N+4}}$ <1%

Conclusion

- Confident to well simulate geometry & materials (but don't lower the guard).

How to improve than?

- Enough basics know-how to start interacting with **GENFIT people**.

- Of course, we must keep a **low detector uncertainty**;

- Search for **discriminating variables**;

- Take advantage of the reconstructed **interaction vertex** and of **hits on the Calorimeter/Scintillator**?
  This would increase the lever arm.

Next Steps

Global Track Reconstruction

- Contact GENFIT people; check we're doing the right implementation;
- Built-up a strong and clear monitoring system for the future; need to modify GENFIT to extract more info?
- Double check with Serena that will join GTR effort.
- **Goal:** "finish" this by August, including preliminary noise study + clustering (depending on Chris).
- Update the simulation 13 quicker

Software Tutorial

- Collect information on who is interest to join and what he needs, useful to calibrate the tutorial; (call by mail in these days)
- When? Beginning 2018, send around a doodle before Xmas.
- Where? depending on the participants.


Thanks

- The dinner will be held in “Trattoria Osteria Buca Manzoni” Via Manzoni, 6/G, at 20:00