On muon identification in SPD RS

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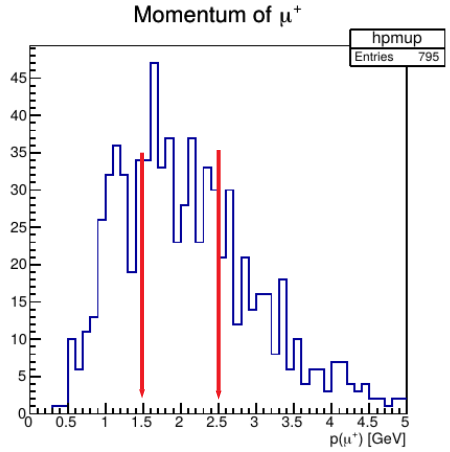
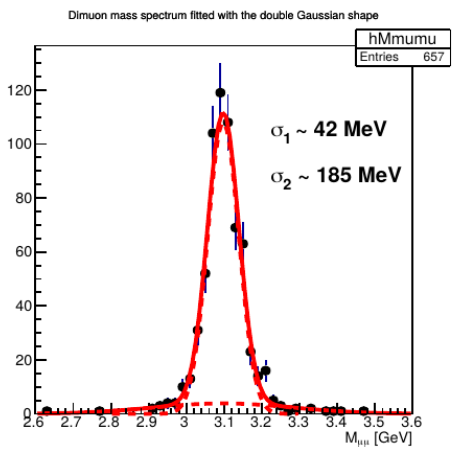
Motivation of this talk

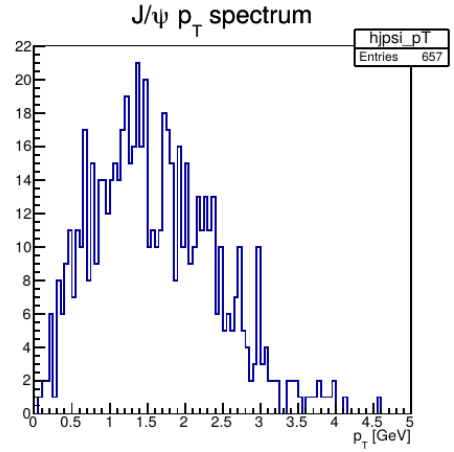
- What performance can we expect from RS for pion/muon separation?

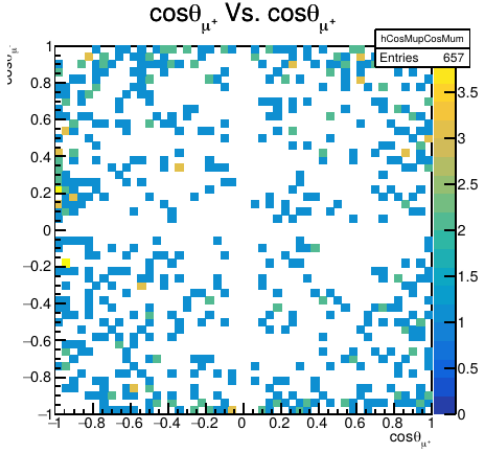
$J/\psi \rightarrow \mu^+\mu^-$

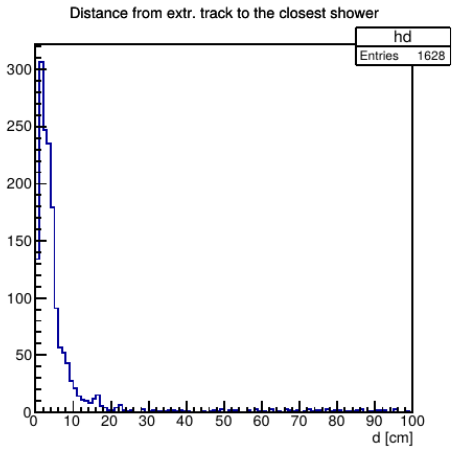
- Example: jpsi-mumu
- Magnetic field: 1T
- 1K event generated

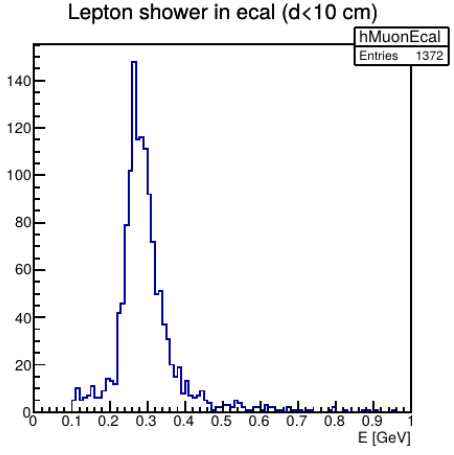












A simple GF-based algorithm to search for muon tracks

GenFit2:

- track fitting and extrapolation
- accounts for material effects (dE/dx, multiple scattering, and Bremsstrahlung for e^+ and e^-)

Idea: starting from the last track state in the tracker, prolong track adding points one by one based on χ^2 value.

Advantages: reconstructs track in 3D, allows extrapolation from barrel to endcaps, accounts for physics.

Disadvantage: speed,…

Algorithm

Recursively

- find a layer where the track can be extrapolated to;
- check hits in the layer: for “good” points update the track state and repeat the procedure;
- if there are no good points, add extrapolated point and repeat

Stop when **track can not be extrapolated, there to many missing hits or the last layer is reached**.

Currently, I fit two “measurements”: point representing the last track state and a new measurement.

Hit:

- defined by the ends of MDT wire and distance
- for the moment distance is set to zero with the error of pitch/sqrt(12)

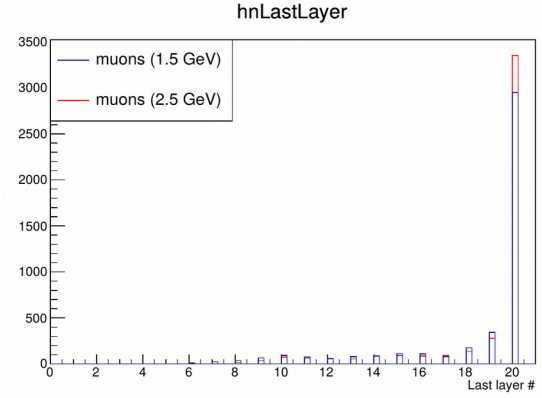
A simple GF-based algorithm to search for muon tracks

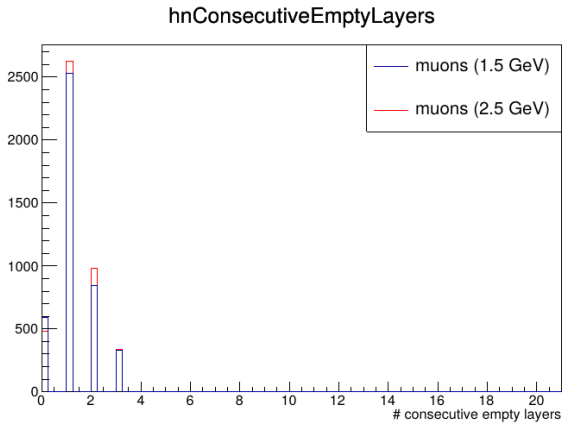
Used parameters

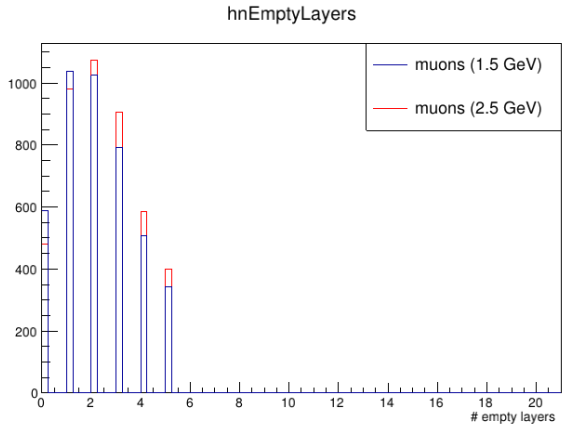
- points with $\chi^2<4$ are accepted, if $\chi^2<1.5$ extrapolation point is not added
- no more than **3 lost hits in a row**
- no more than **5 missing hits in total**
- among the track-candidates
  - the ones which cross the maximum amount of layers are selected,
  - the one with the largest probability is selected (layers detection efficiency **p=0.97** is used).

Tracks:

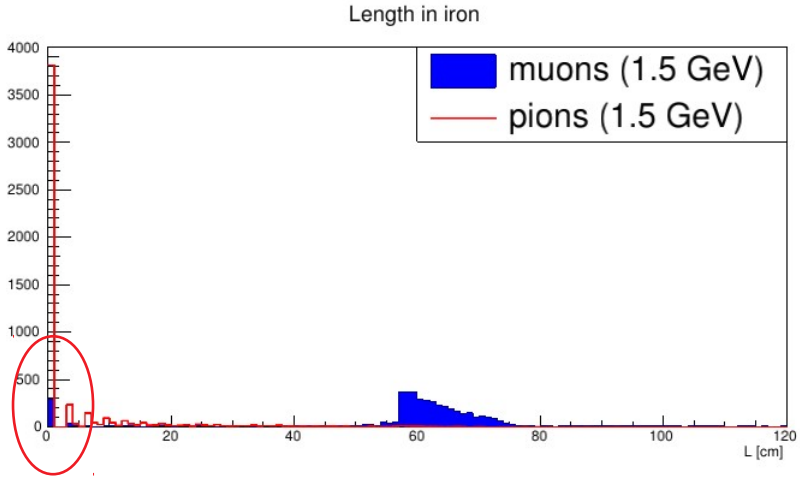
- Uniformly distributed muons and pions with **p = 1.5 GeV** and **p = 2.5 GeV**, one track per event, samples of 5000 events generated.

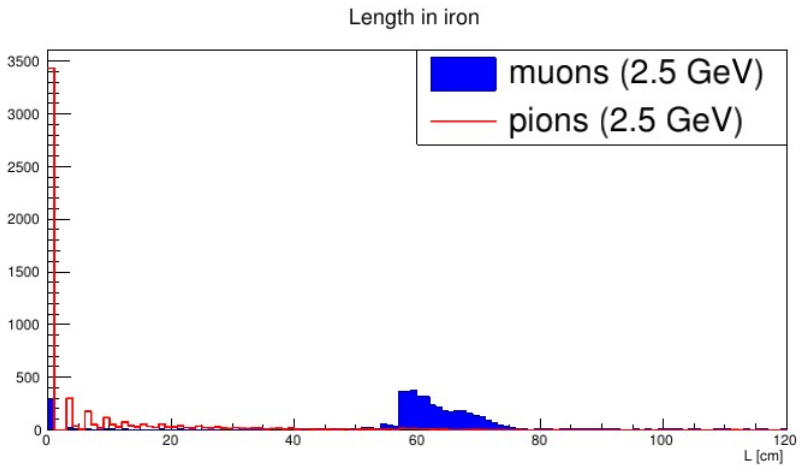




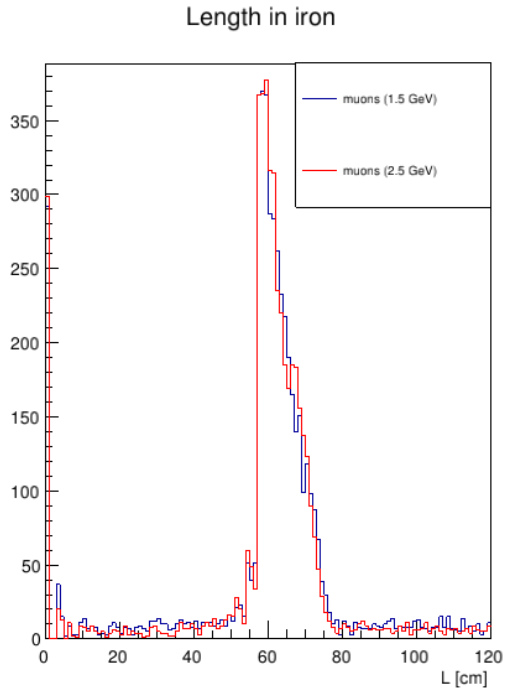


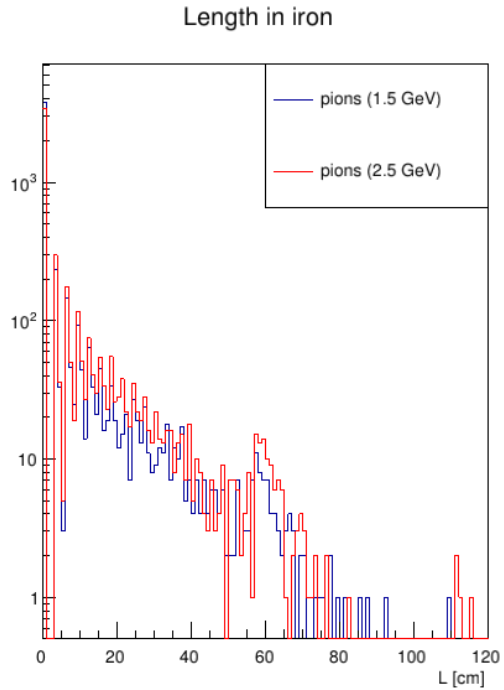
Track length in iron



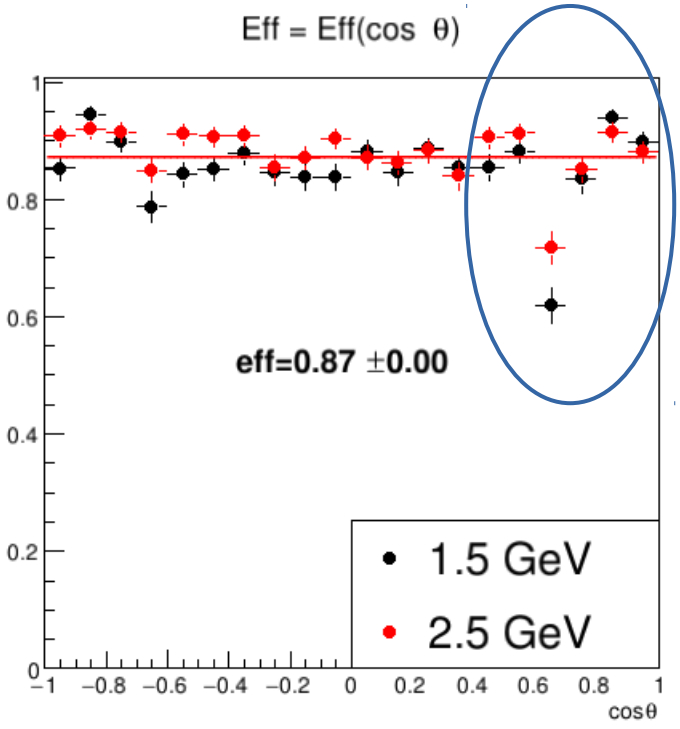


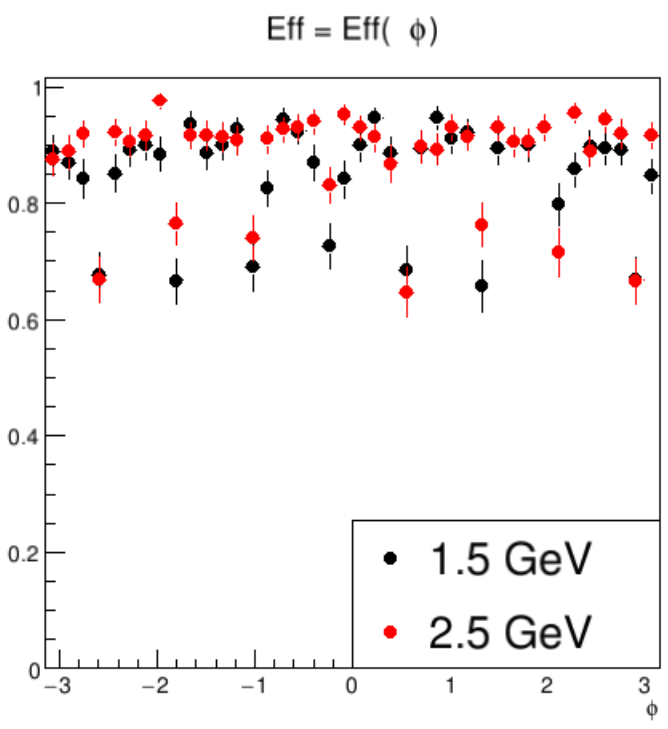
- length in iron **excluding first 6 cm** layer is shown
- using L Vs. p correlation is not possible





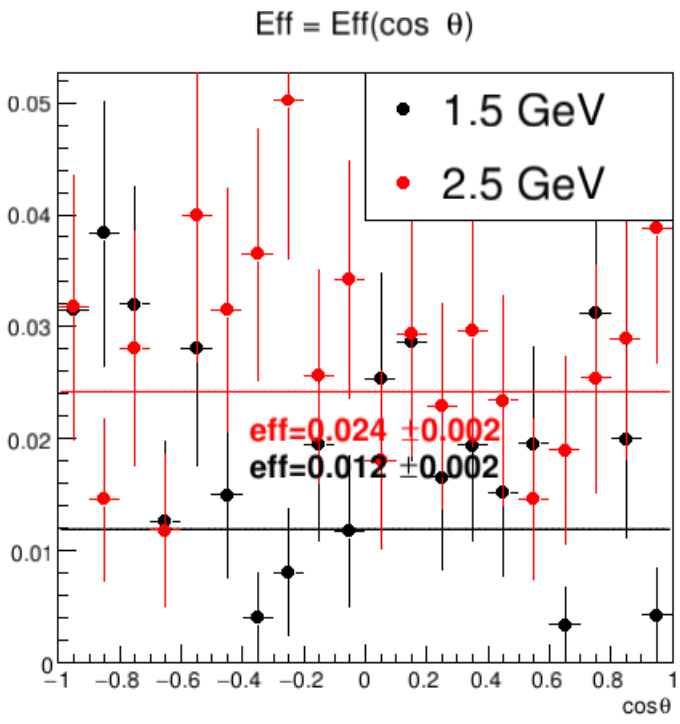
Muon selection efficiency

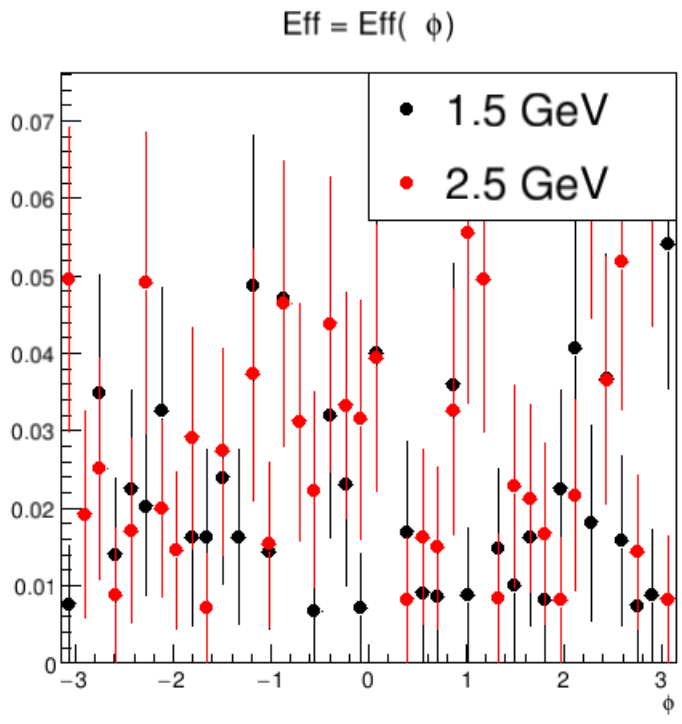




- L > 50 cm
- 5000 events generated

Pion survival ratio

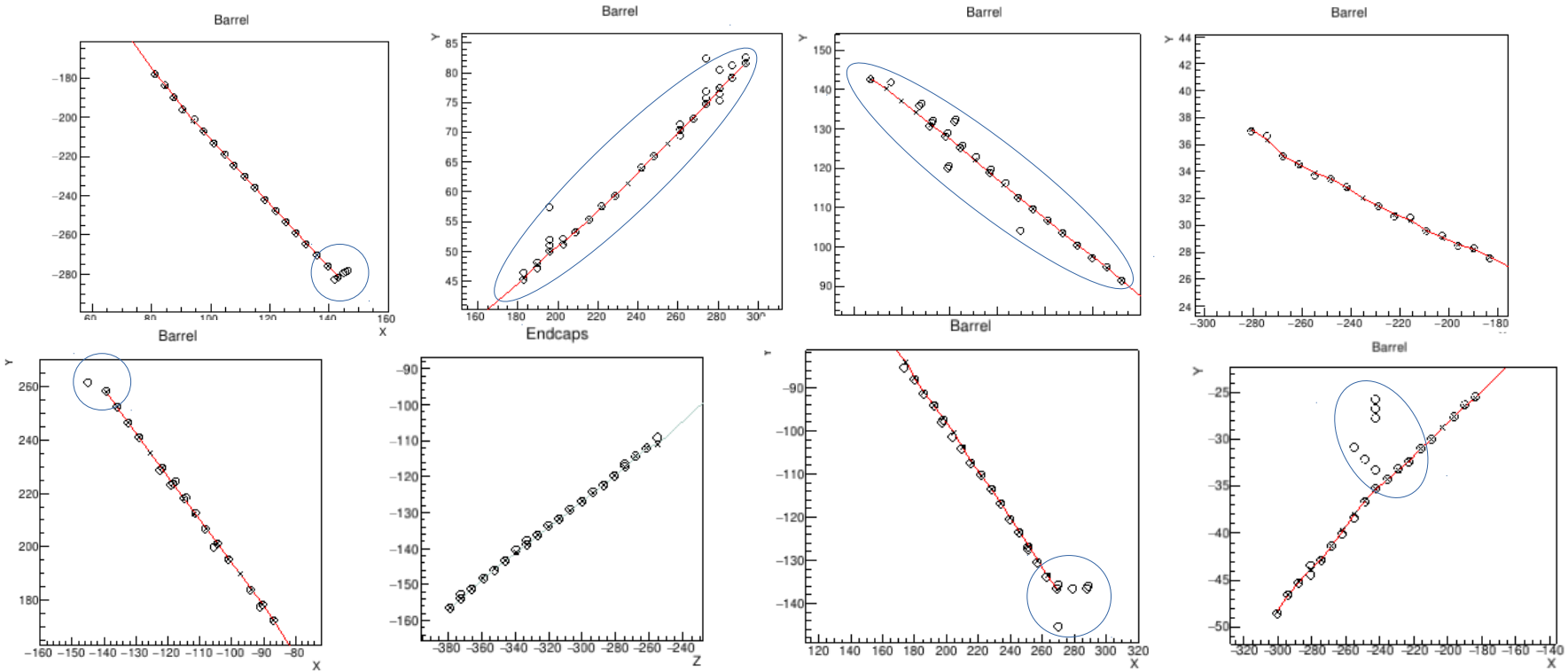




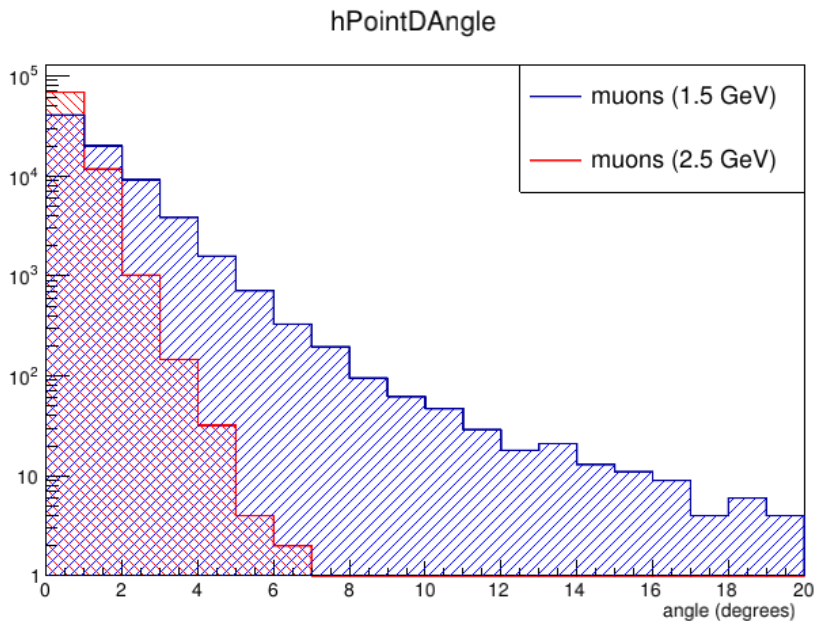
- L > 50 cm
- 5000 events generated

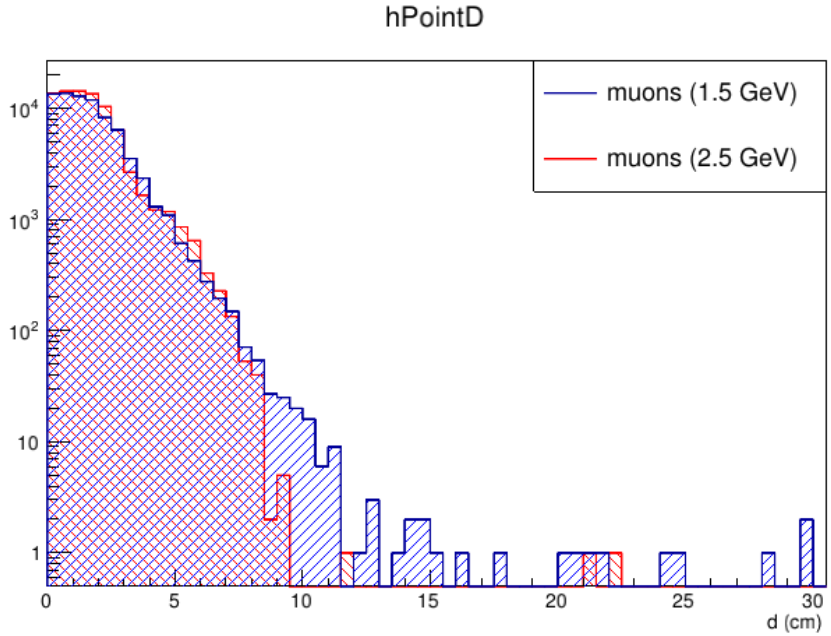
Pion survival ratio can be improved

- 8 consecutive pion events (p = 2.5 GeV) passing L>50 cm cut
- Further improvement is possible!



On simplified reconstruction





In the absence if magnetic field simple track selection algorithms should work well.

Comments, summary and plans

- Assuming that simulation is correct, pion suppression rate of at least 97% can be expected for the muon selection efficiency of 90%. Pion survival can be further suppressed.
- Magnetic in RS field is missing!
- Our Geant4 physics list validation is important for muons with low momenta in RS.
- Currently, the track reconstruction in RS takes very significant time. To be improved with more simple methods.
- Integration of XGBoost is the next on the TODO list. CNN may be another powerful tool discriminate pions.