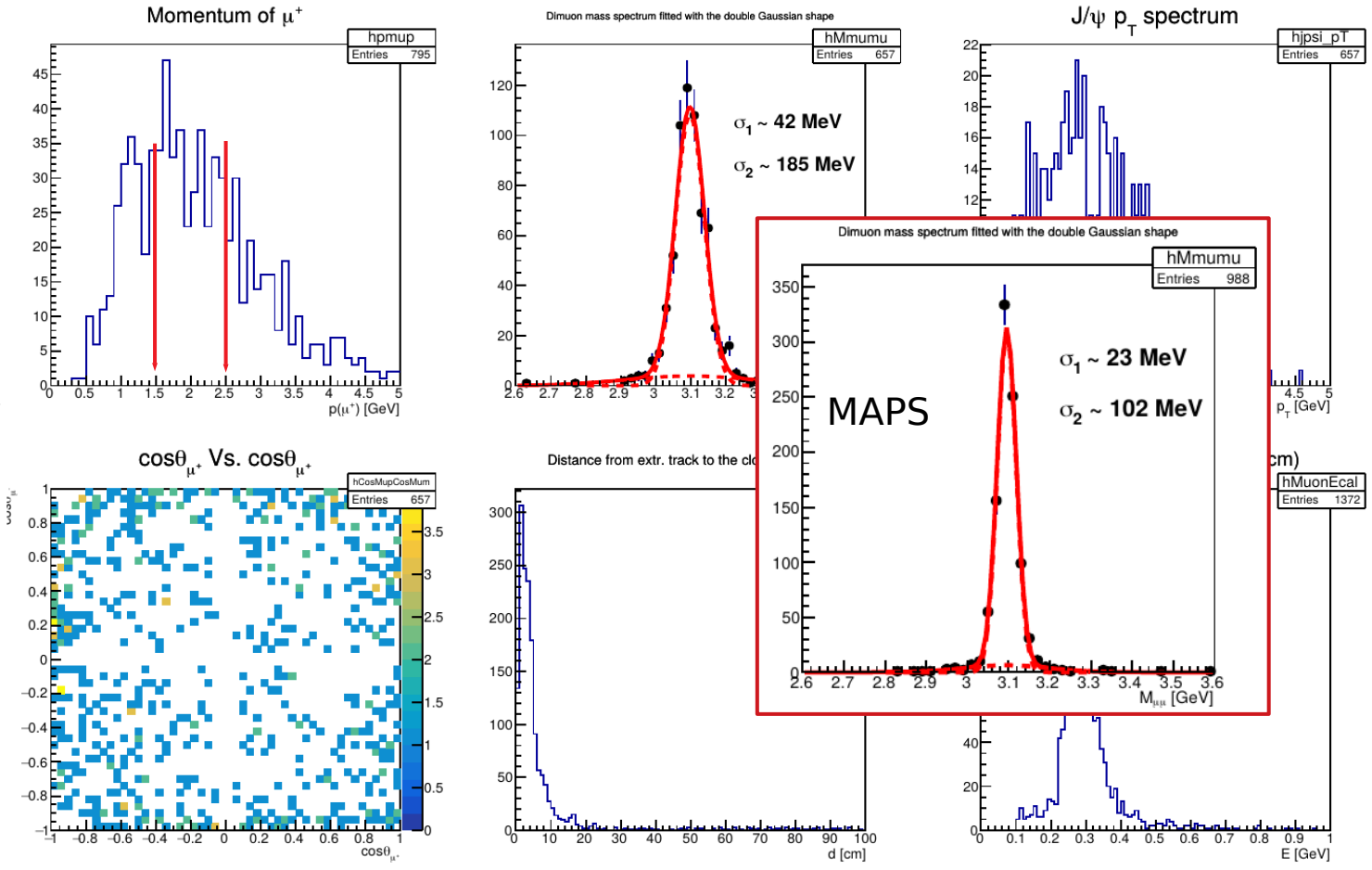
On muon/pion separation in RS

Igor Denisenko
iden@jinr.ru

SPD (Bi-)Weekly Meeting
01.03.2022

J/ψ → μ⁺μ⁻

- Example: jpsi-mumu
- Magnetic field: 1T
- Collision energy: 27 GeV
- 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

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

Hit:

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

MC:

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

Each track is fitted as a muon

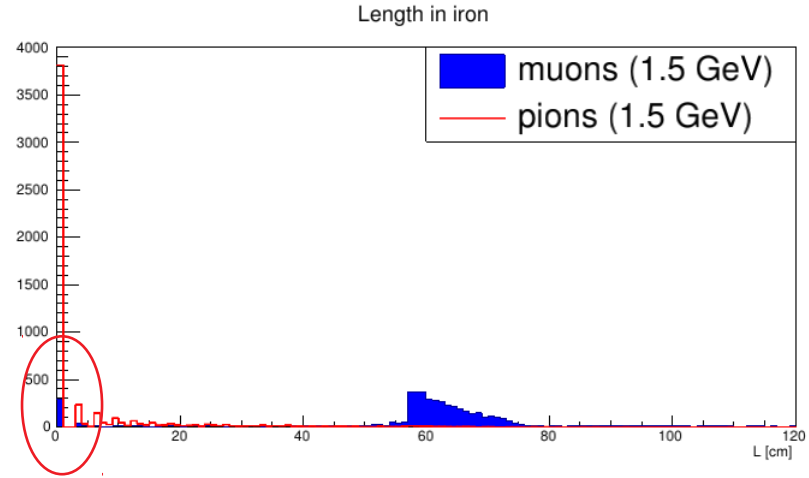
Used parameters

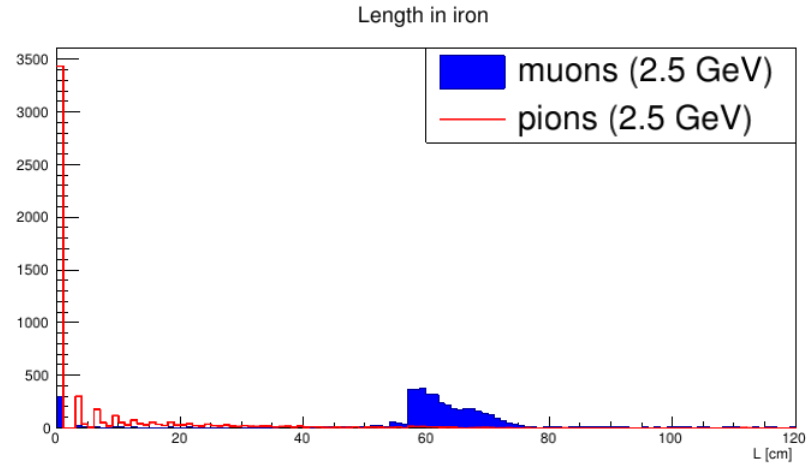
- points with $\chi^2<4$ are accepted, if $\chi^2<1.0$ extrapolation point is not added
- no more than **3 lost hits in a row**
- no more than **5 missing hits in total**
- among the track-candidates the one with the best track quality is selected
- Kalman tree size reduced to less than 100 candidates

MC:

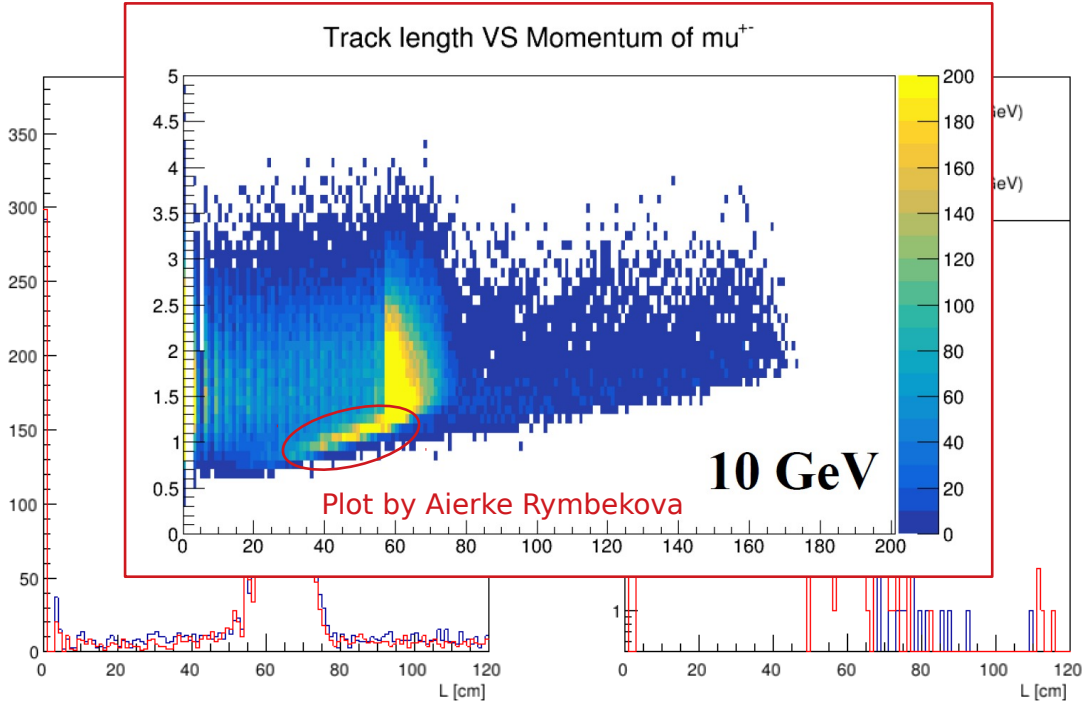
- Uniformly distributed muons and pions with **p = 1.5 GeV** , one track per event, samples of 10000 events generated.
- Two simulations with ECal and without ECal are performed.
- Only well-converged tracks considered.

Track extrapolation length in iron





- Only well-fitted tracks are considered
- length in iron **excluding first 6 cm** layer is shown
- using L Vs. p correlation is not possible



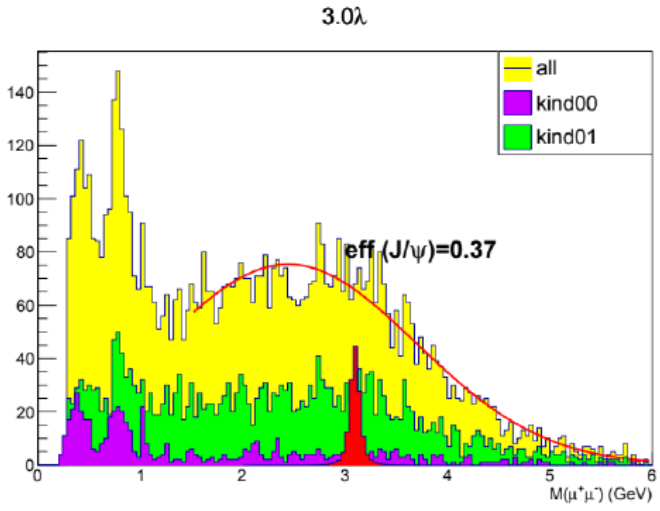
Efficiency/misidentification rate and effect of ECal

Muon selection efficiency		Pion misidentification rate	
With Ecal	Without ECal	With ECal	Without Ecal
85% (87%)	88%	0.44% (2.6%)	0.61%

- Removal of ECal on average increases fraction of pions identified muons by 40%.
- Aierke Rymbekova is working on simulations with concrete absorber in the barrel part.

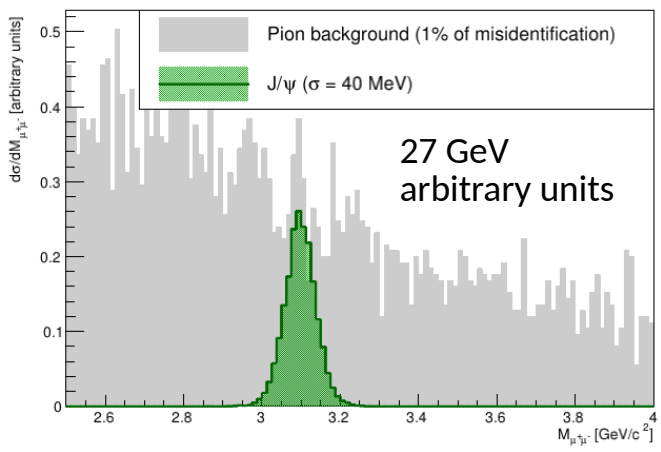
Signal to background ratio

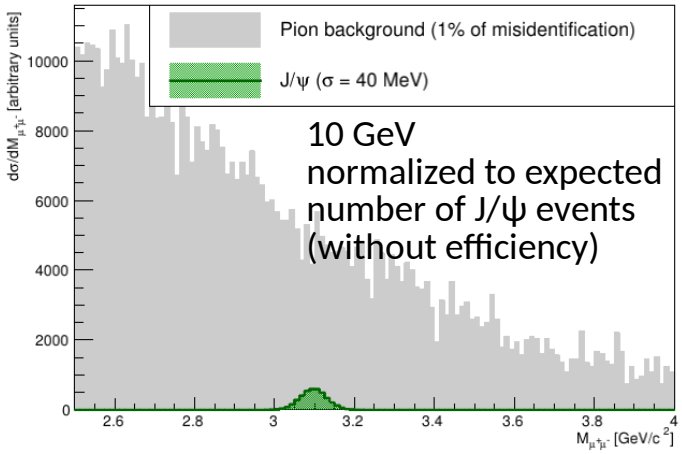
CDR



case 1

$|\cos\theta_\mu|<0.9$





Gen-level events:

- only **pions** considered
- for pions misidentification of 1% is assumed
- only pions with $|\cos\theta|<0.9$ are selected

The target value for pion survival ratio should be ~ 1%.

Summary

- MC simulation indicates that pion suppression rate of 1% is achievable, studies with RS prototype are crucial. Mixed particle identification methods (Kalman + ML) could be promising.

- In the absence of ECal pion misidentification rate increases by 40%. Studies with absorber are ongoing.