Multi-vertex fiTQun for pion scattering measurements in WCTE

Adding constraints

Institut de Física d'Altes Energies

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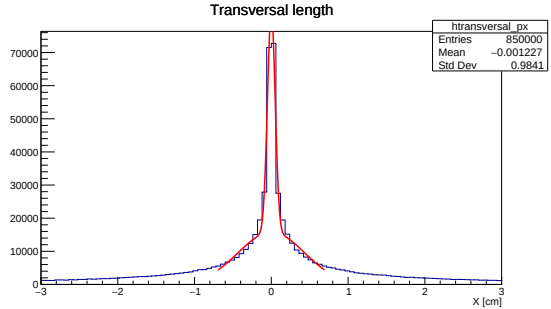
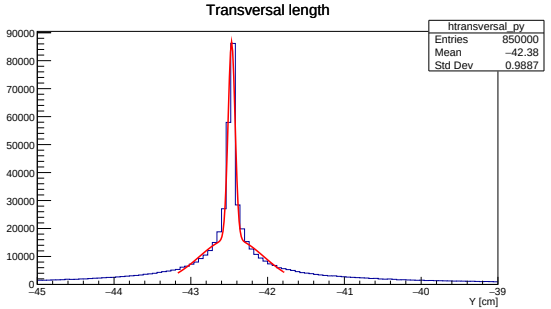
Adding constraints

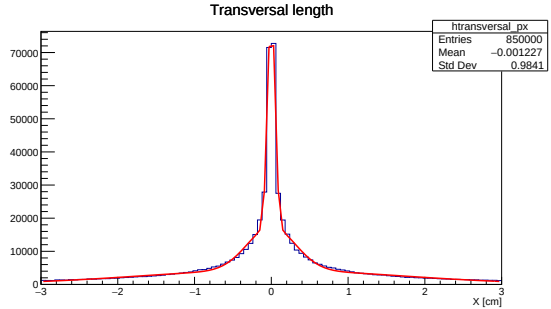
- 2+ rings working as intended,
- 1 ring was not properly constrained, position was changed after fit $\rightarrow$ solved, production in process for tuning,
- Updated WCSim to version 1.12.21,
- fiTQun constraints:
  - First vertex, fix z at beam pipe, x and y in a 2.5 cm radius,
  - Second vertex, x and y in a 2.5 cm radius, and z from beam pipe to wall.
- New proposition to constrain the position in transversal plane of the beam for 1^{st} and 2^{nd} vertex using a PDF based on the first interaction point of pions.

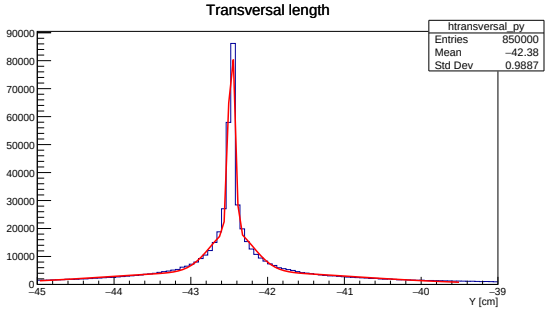
First pion interaction point with a two Gaussian fit



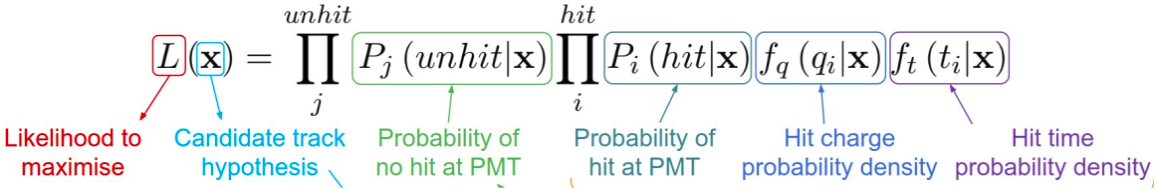


First pion interaction point with a three Gaussian fit



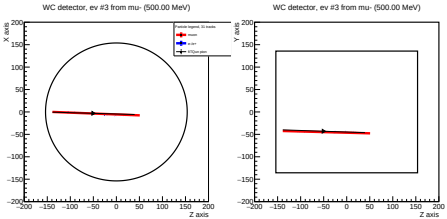


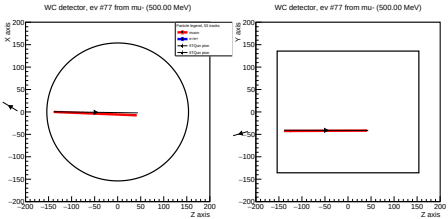
Adding to the negative log likelihood

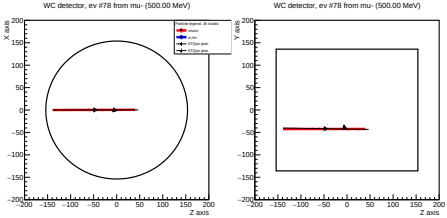


- In practice, fiTQun is adding each component as negative log,
- Adding : Constant $\times -\log \sum_{i=1}^{2or3} \frac{A_i}{\sum_{j=1}^{2or3} A_j} G(x; \mu, \sigma_i)$
- The constant is there to control how much influence this restraint on the position should have.

1 muon ring

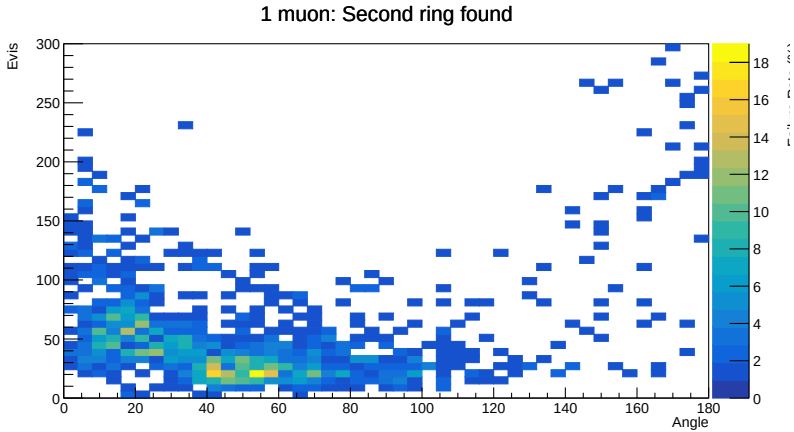




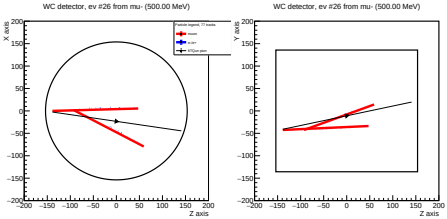


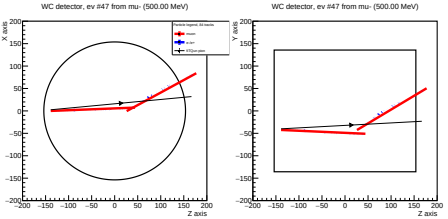
- Applied MR tuning, with 88.4% separation of 1/2 rings,
- When finding 1 ring: good
- Can sometimes find second ring outside (now added z constraints),
- Other times find a small ring.

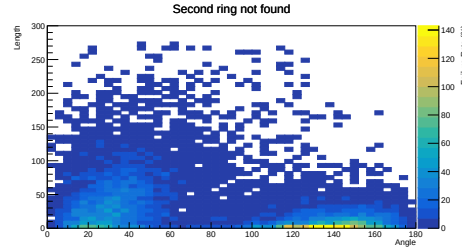
Visible energy of second ring and fiTQun angle between both rings

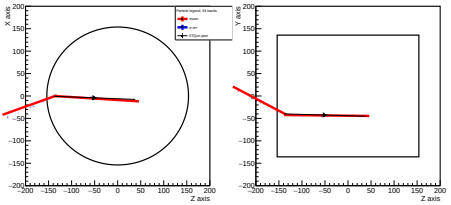


2 muon rings, rec. as one

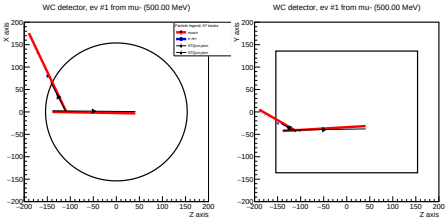


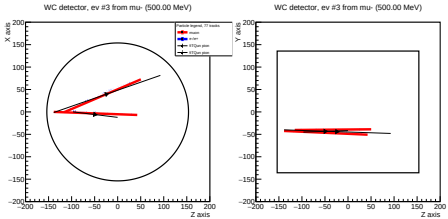


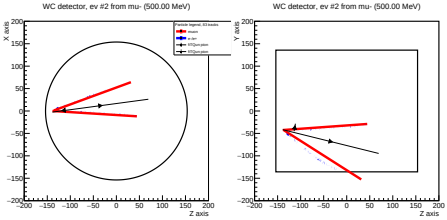


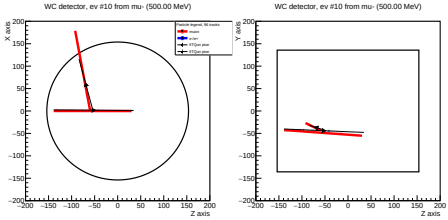


2 muon rings, rec. as two

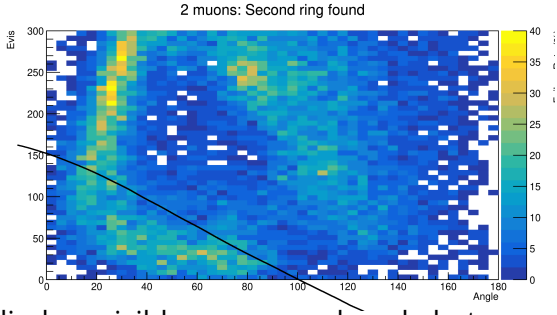








Visible energy of second ring and fiTQun angle between both rings for 2 muons



If cut applied on visible energy and angle between rings:

- 1 ring sample is improved (need to study statistics),
- 2 rings sample in the concerned region seems to be badly reconstructed, seeing the angular resolution.

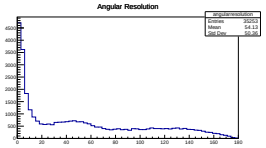


Figure: Above the line

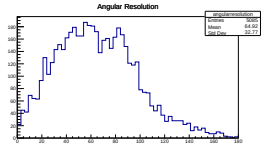


Figure: Below the line

Conclusion

- Solved the 1 ring constraints, now started with both vertices constrained,
- New idea to apply a PDF of the position to help the fit to focus on the desired region without having to block the fit range,
- Still need to consider the constant and how to tune that?
- Need to think of some cuts in order to improve the quality of the selection.