Characterisation of the Clatterbridge beamline simulation

11/01/2017 Matthieu Hentz

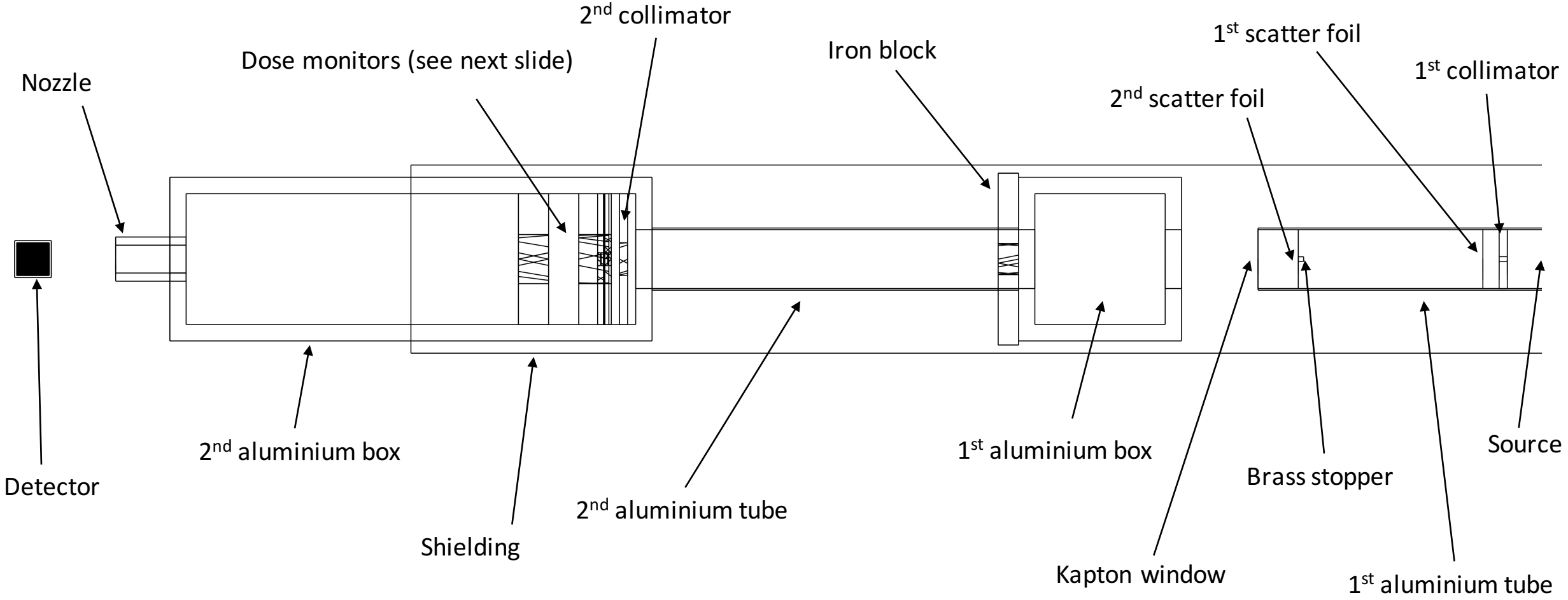
Updated the beamline construction:

- Moved the second dose monitor to check if it has an impact on the beam

Ran simulations to check flux and energy distribution after scattering components:

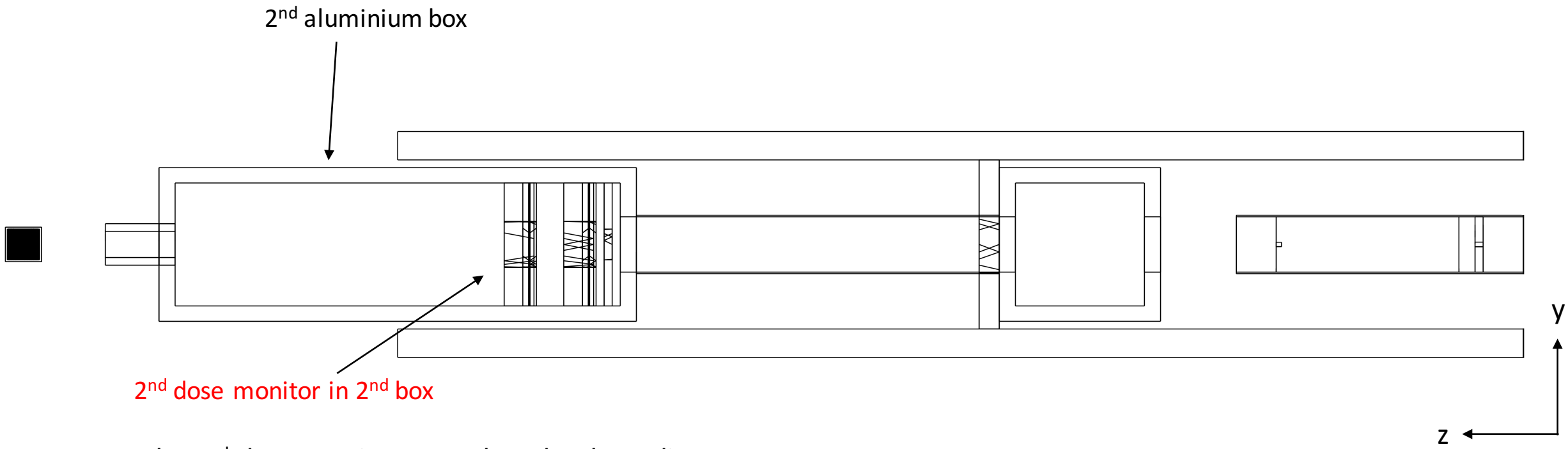
- Simulation now split into 100 simulations of 10,000 events. Takes about 30 minutes with narrow beam and about 5 minutes with wider beam (more protons lost more quickly).
- Lateral proton flux values as expected.
- Energy spectrum and spatial distribution at the nozzle look as expected.

Original beamline - DetectorConstruction.cc



Corrections to DetectorConstruction.cc

Top-down view.



The 2nd dose monitor was placed a short distance behind the 1st dose monitor to investigate the former's impact on the beam.

Flux scorers

The following graphs show the spatial distribution of protons in the beam after a selection of highly scattering components.

The simulations were carried out with a monoenergetic beam to check the spatial and energetic distributions at several locations. Using a narrow beam, fewer protons are lost at the first collimator allowing for better statistics since more protons are detected. Then simulations were carried out with a wider beam to investigate how much each component blocks the beam in more realistic circumstances.

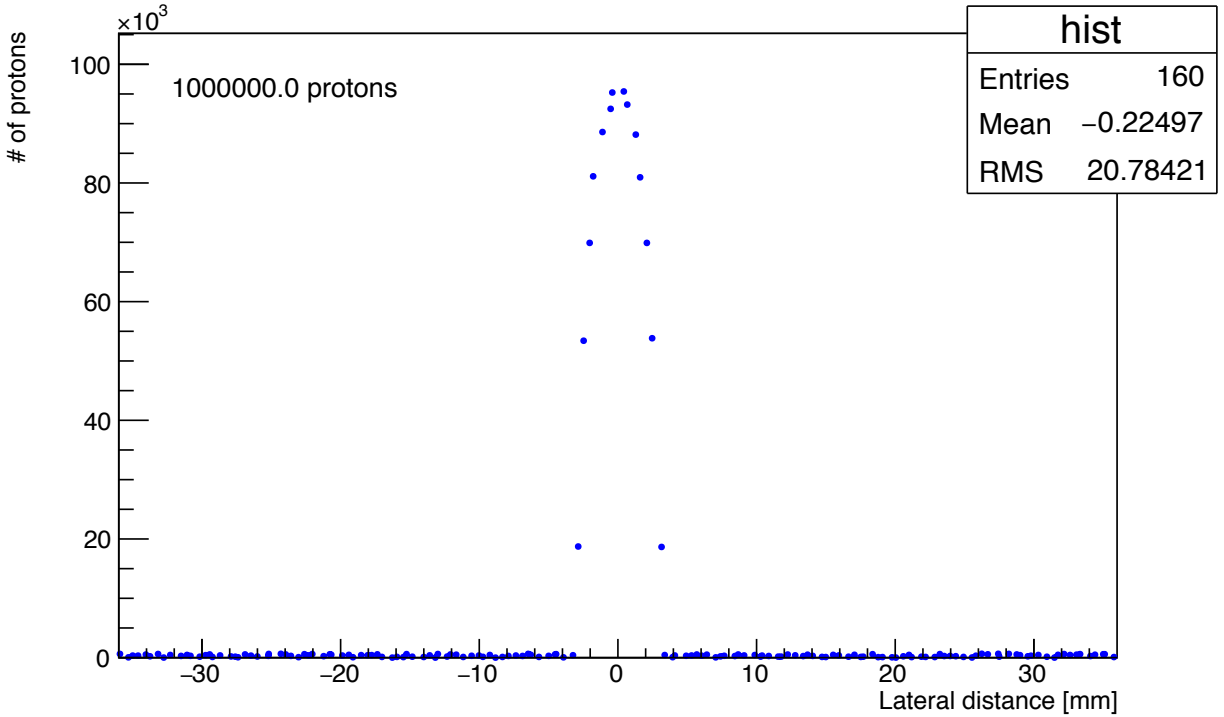
Narrow beam
Monoenergetic 62.5 MeV
Uniform radial distribution, Circle radius 3 mm, type plane

The beam is cut by almost 50% when it hits the brass stopper. By the time it reaches the nozzle only about 12.5% of the beam remains.

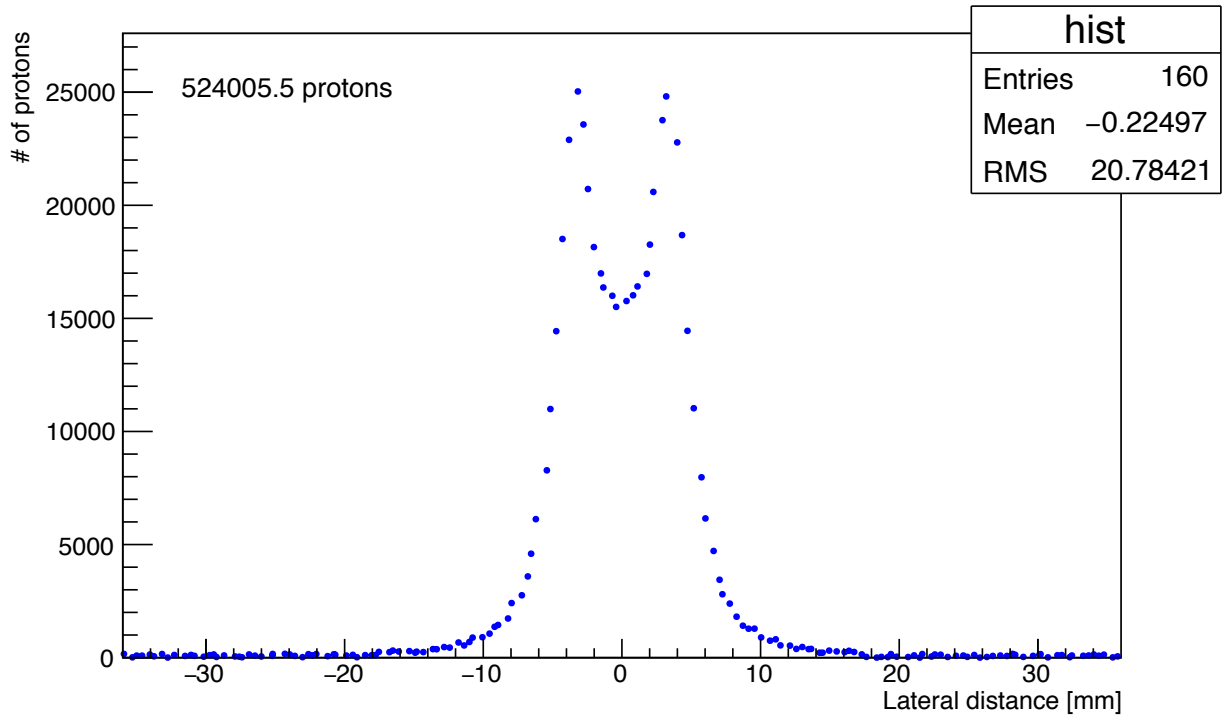
Wider beam
Gaussian distributed 62.5 MeV, sigma 0.082 MeV
Uniform radial distribution (?), Circle radius 3 mm, sigma x 0.0134 m, sigma y 0.00362 m, type beam
-> The above line needs checking.

Flux scorers **narrow beam**

Source, z = 1 cm



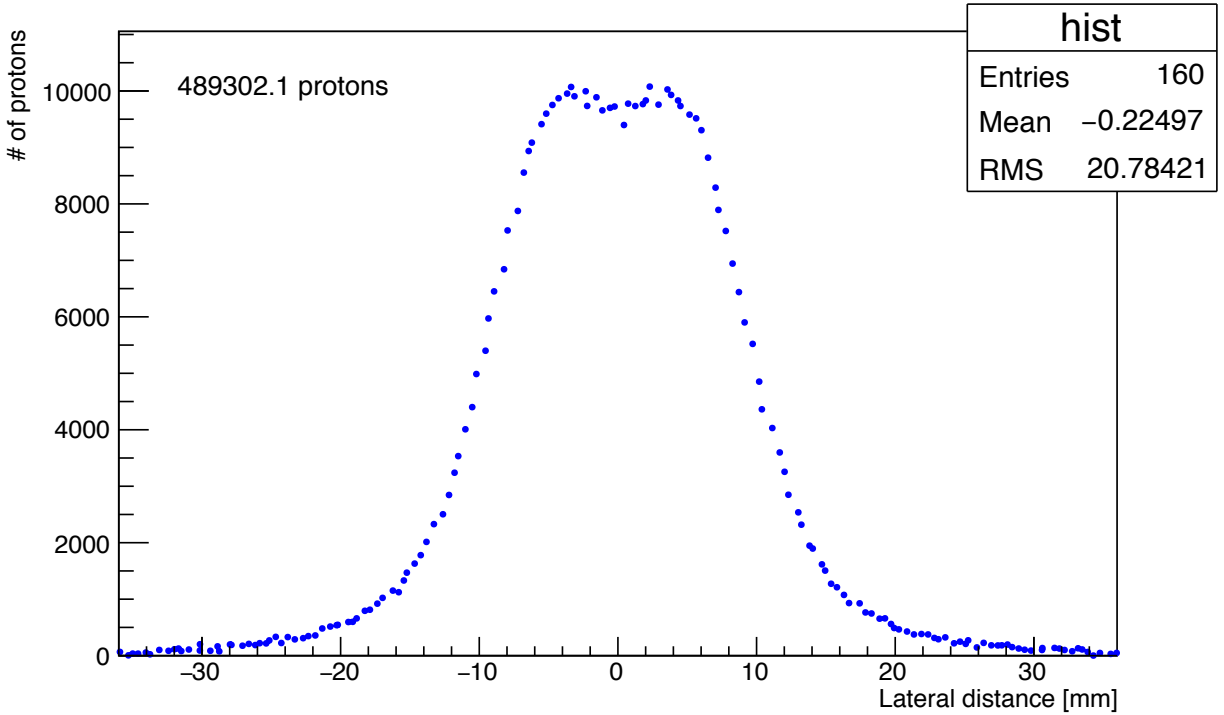
Kapton window, z = 35.654 cm



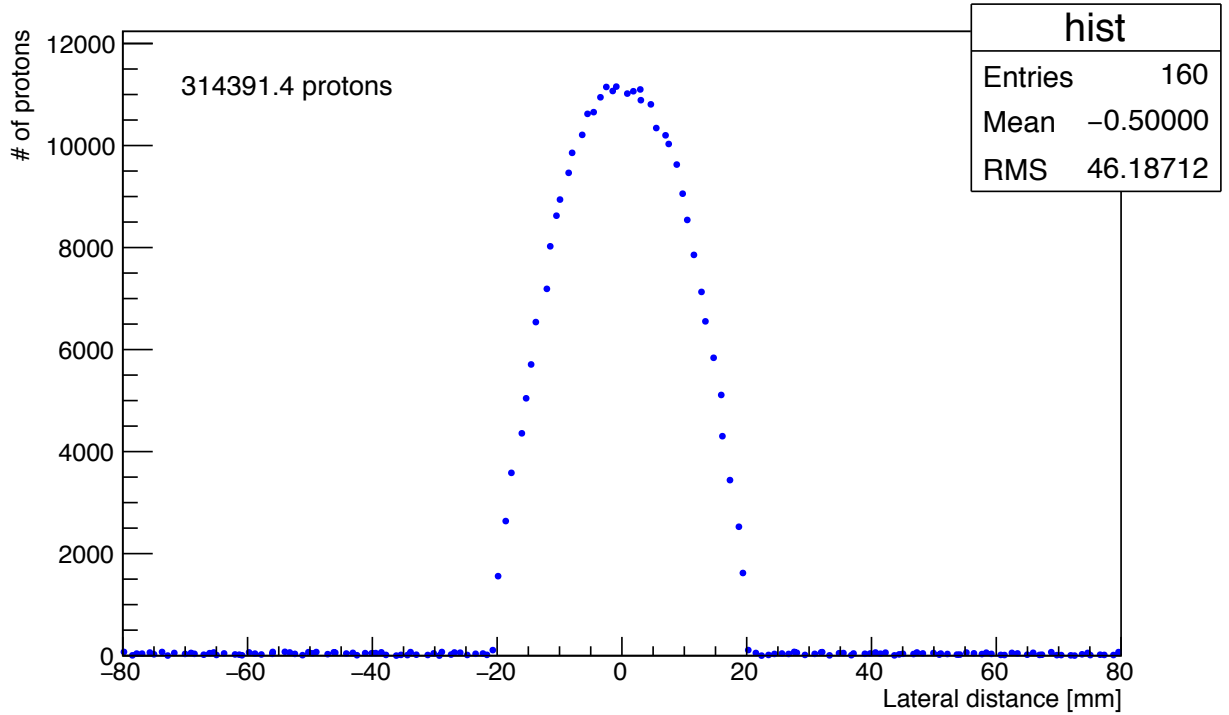
Not sure yet why the stats box is identical for both…

Flux scorers **narrow beam**

After first aluminium box, z = 67.6 cm

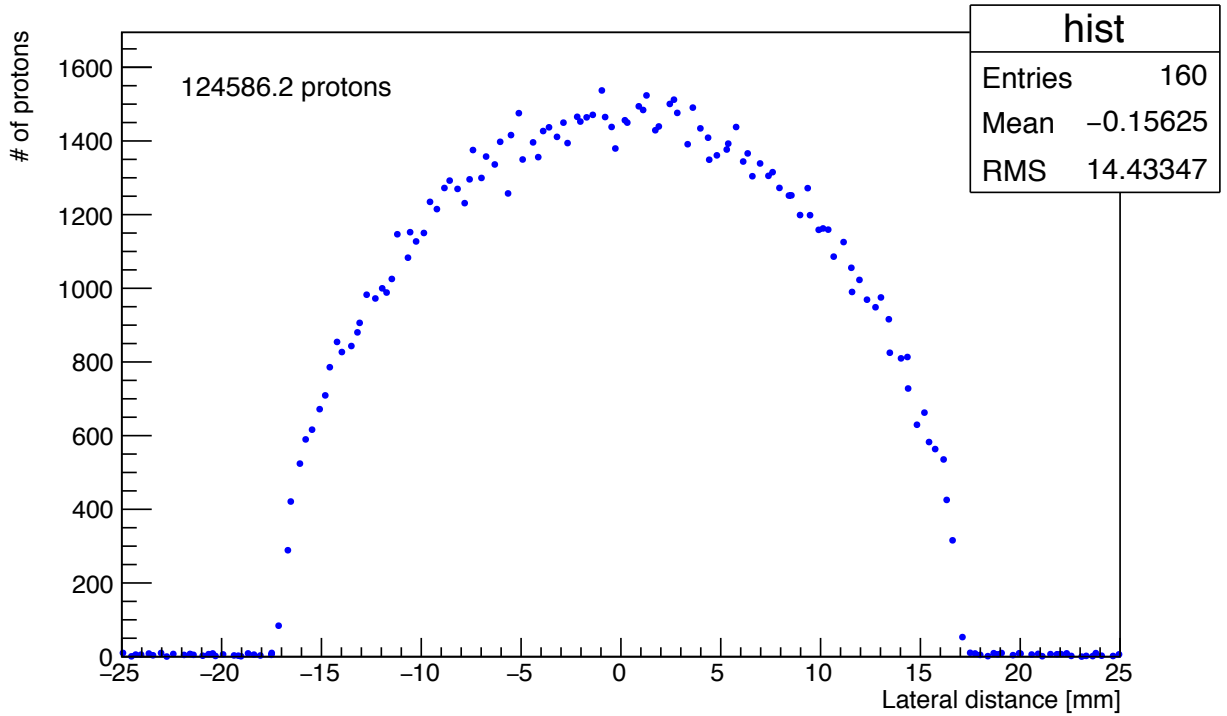


Collimator 2, z = 114.5 cm



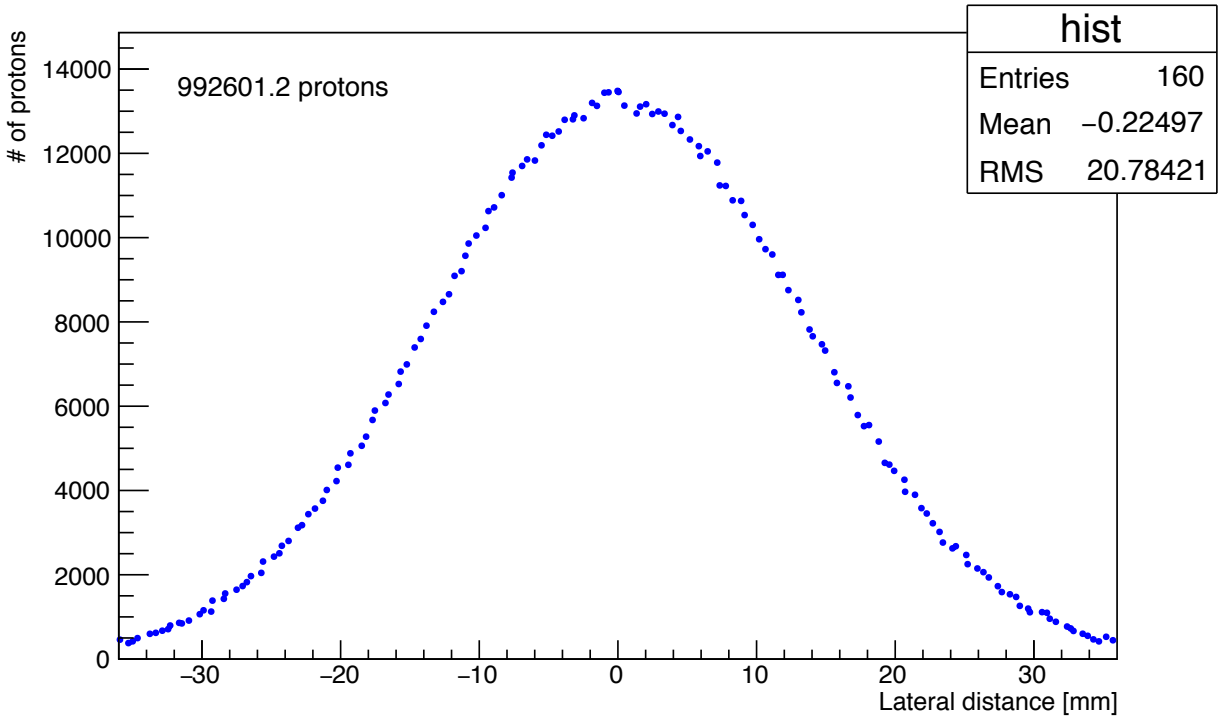
Flux scorers **narrow beam**

Nozzle, z = 175.9 cm

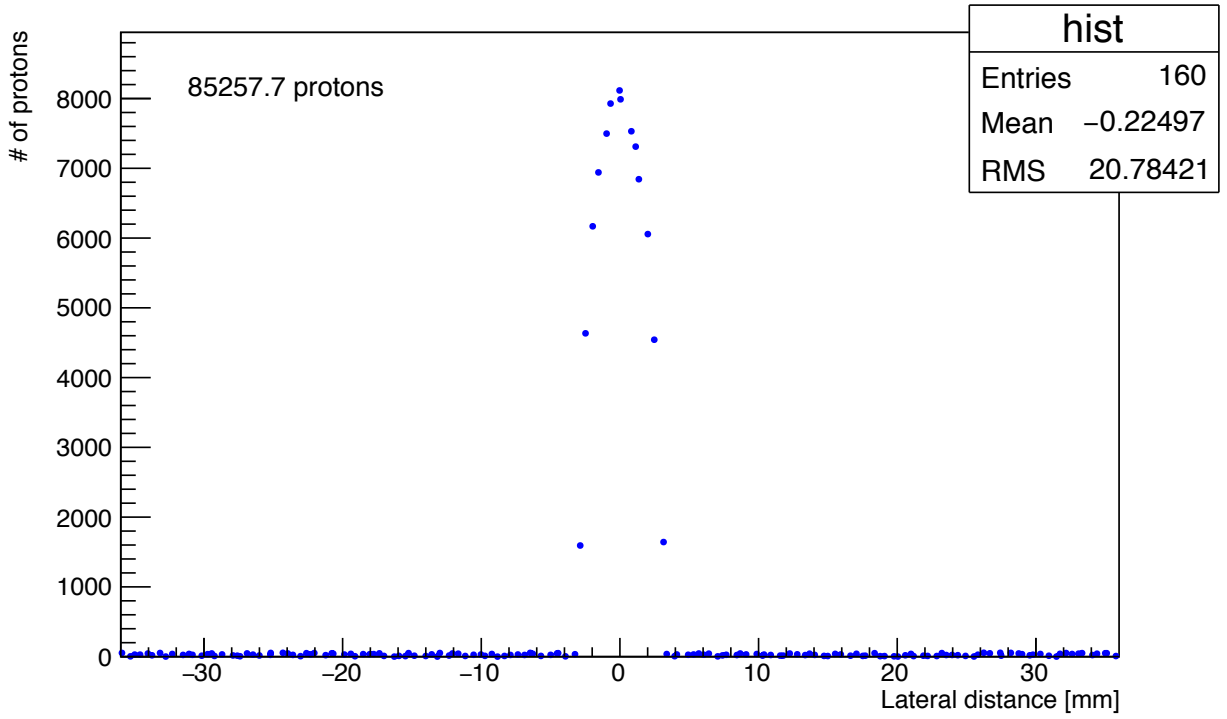


Flux scorers **wide beam**

Source, z = 1 cm



Collimator 1, z = 5 cm



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Flux scorers **wide beam**

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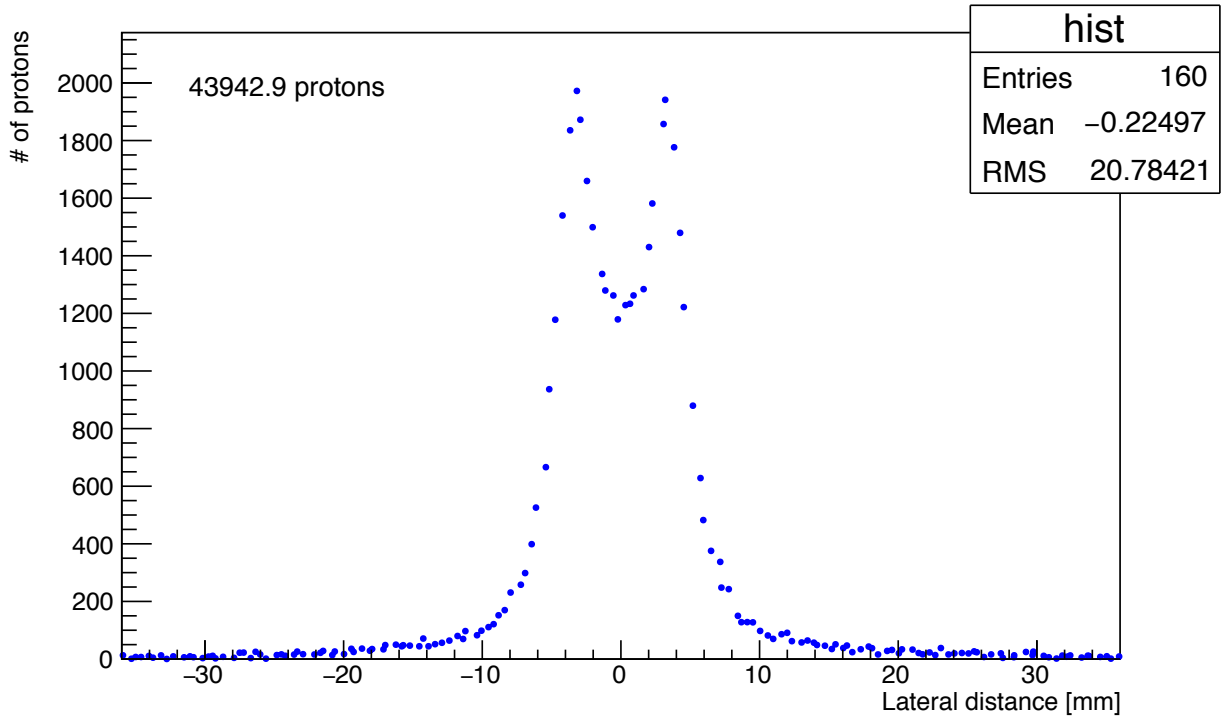

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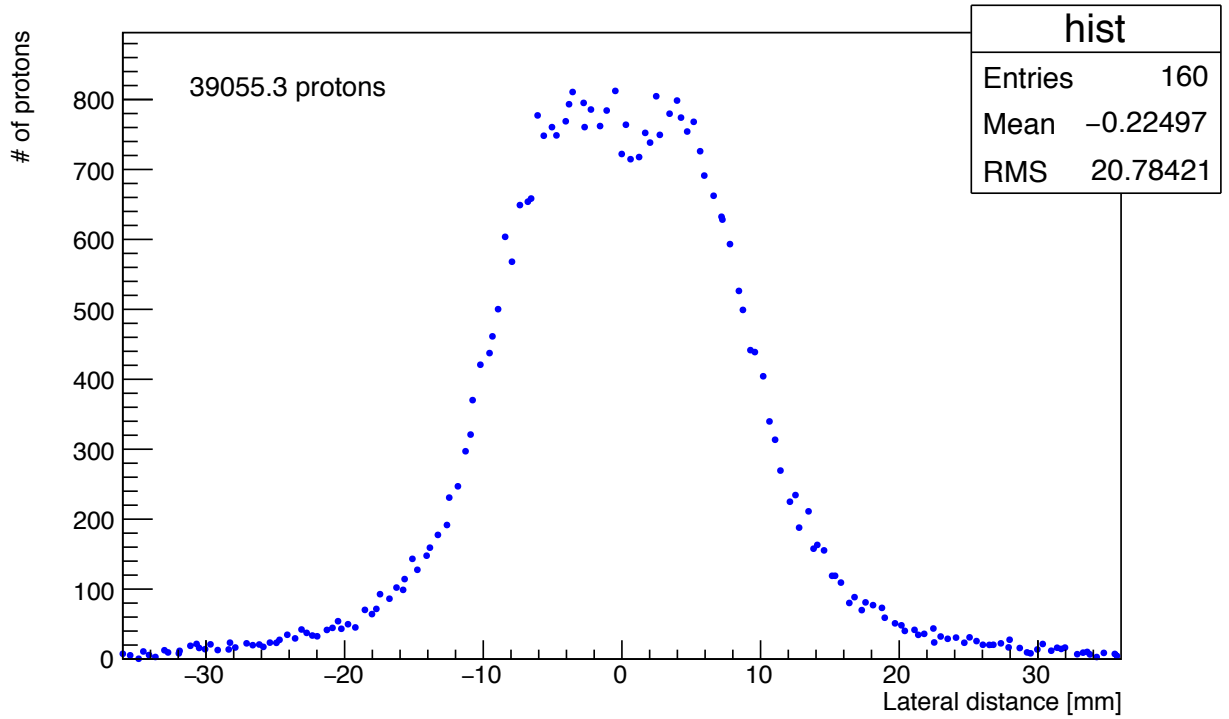

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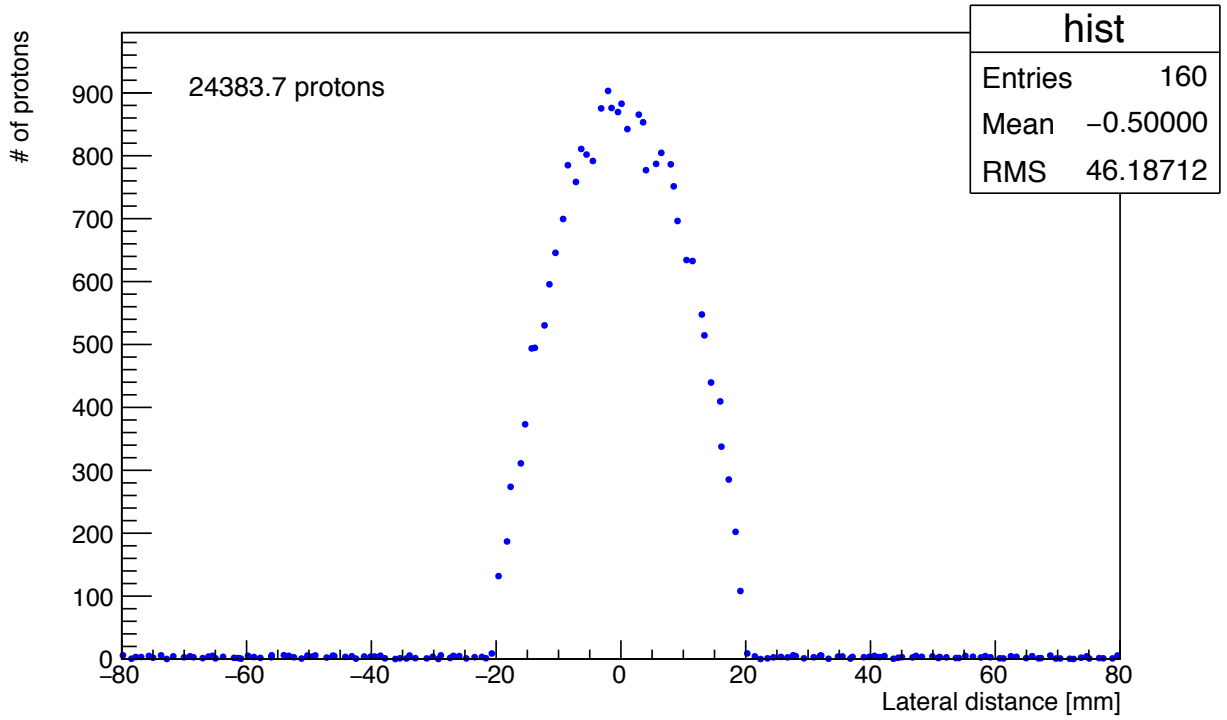

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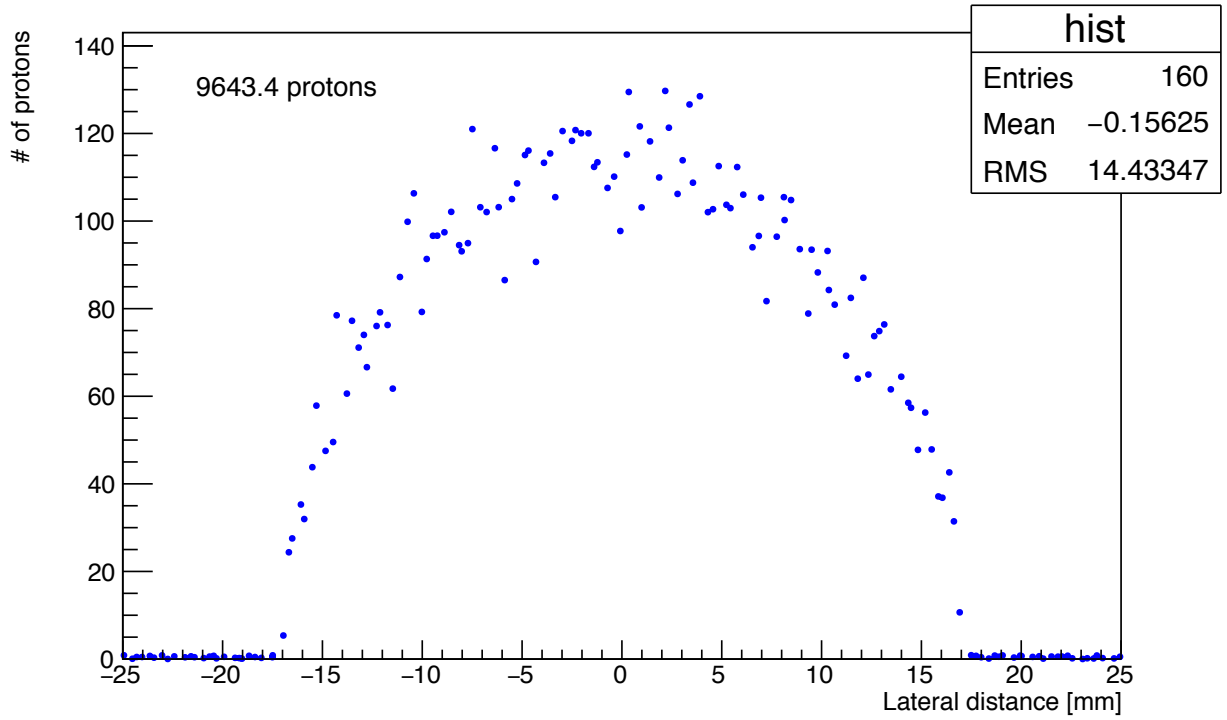
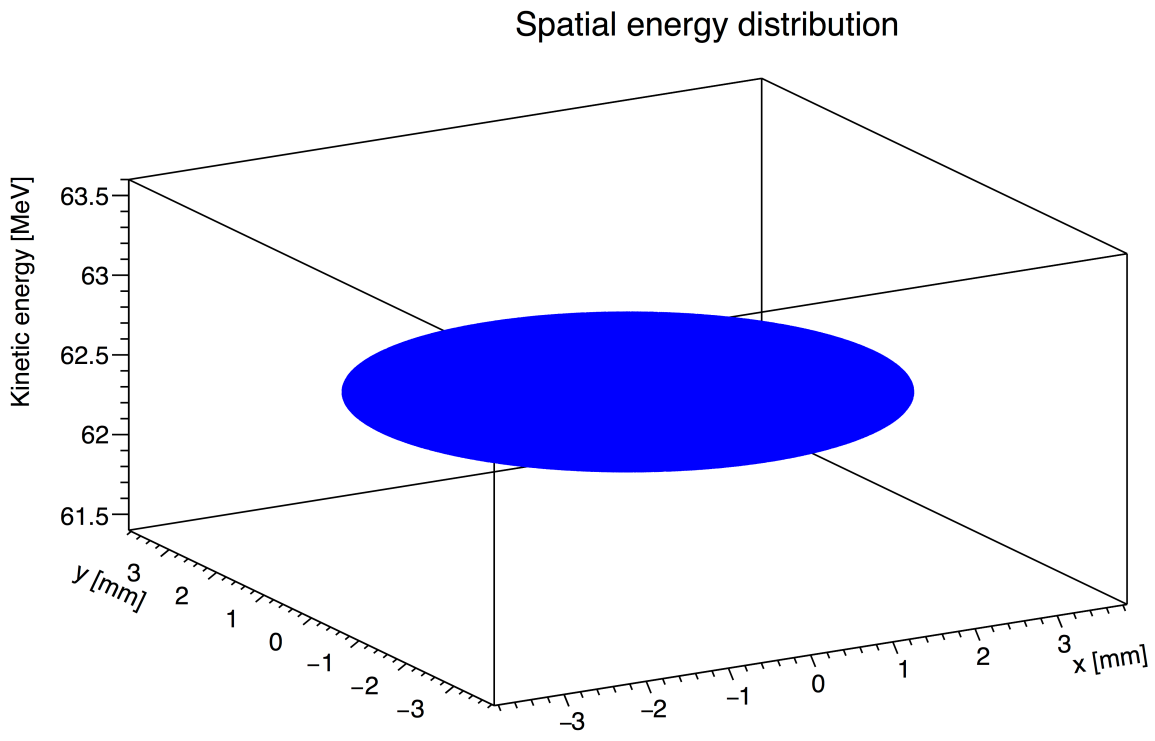
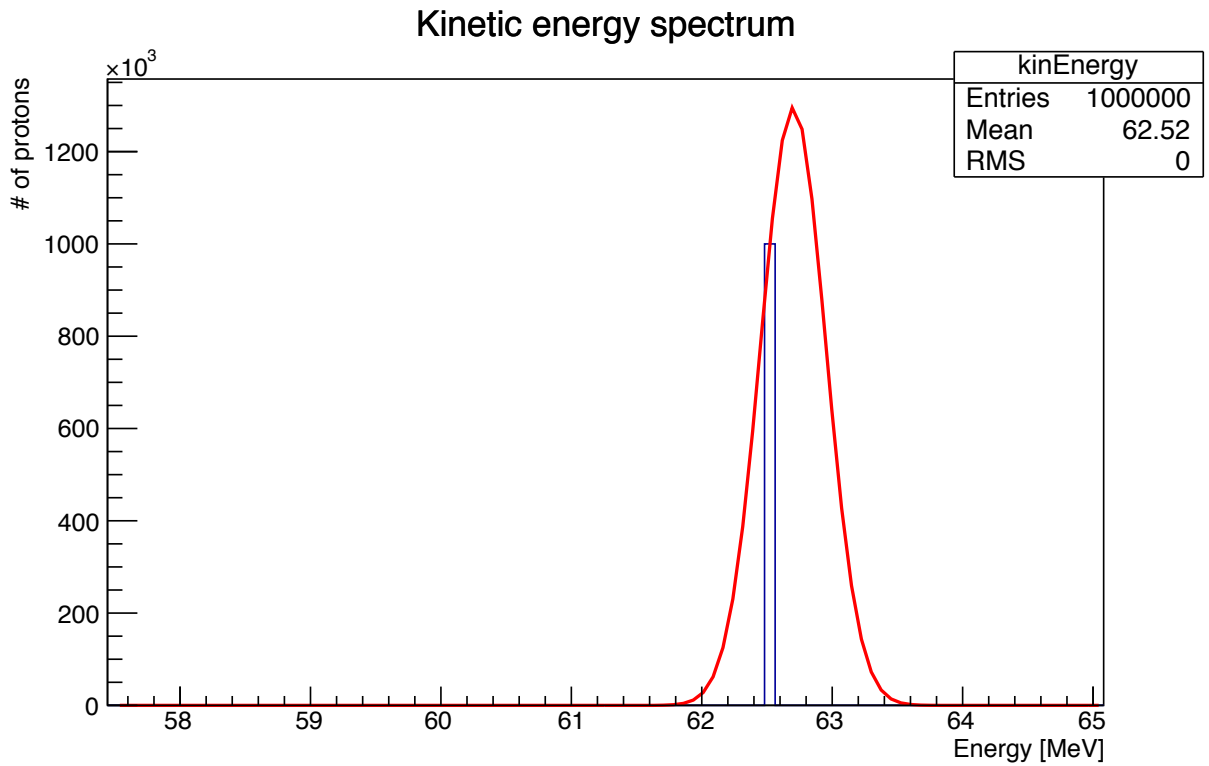


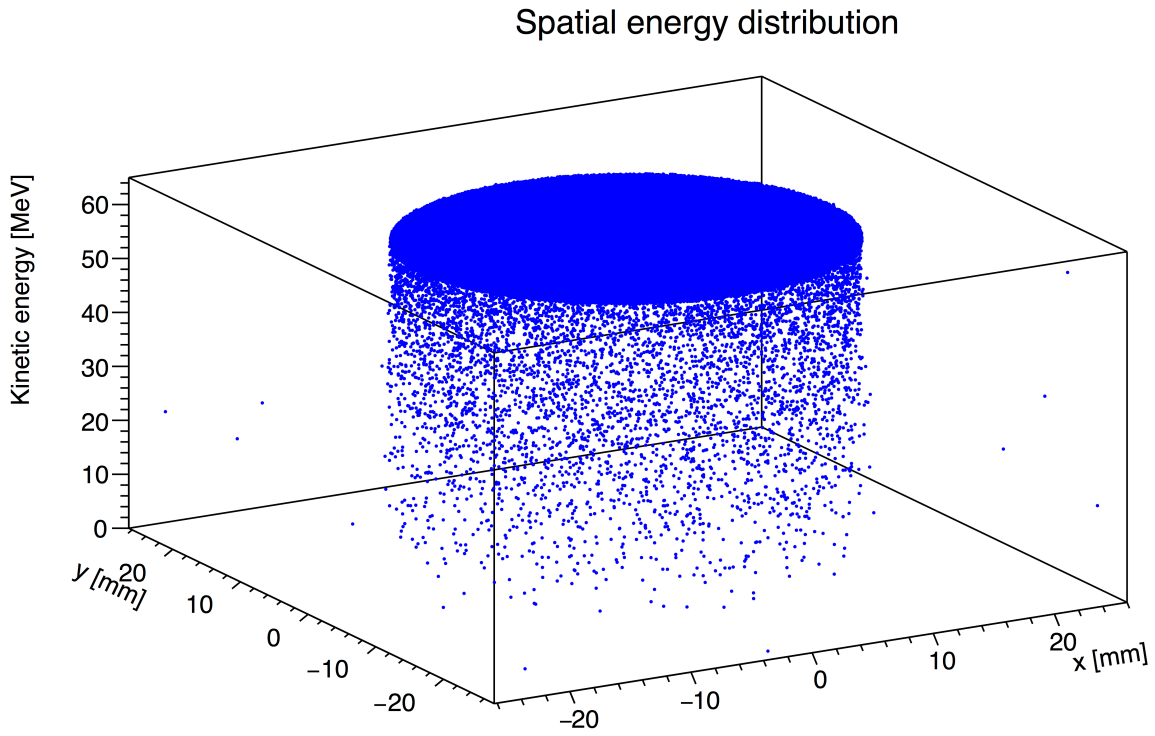
Energy distribution **narrow beam at source**

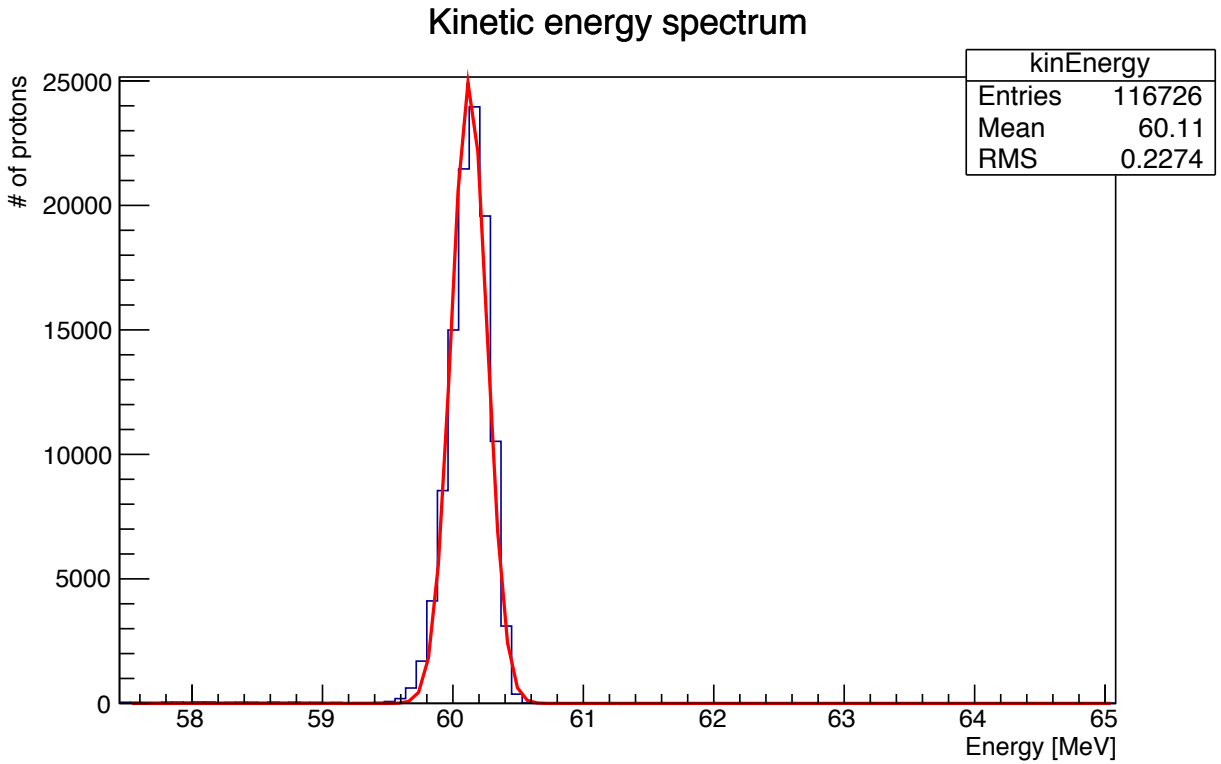




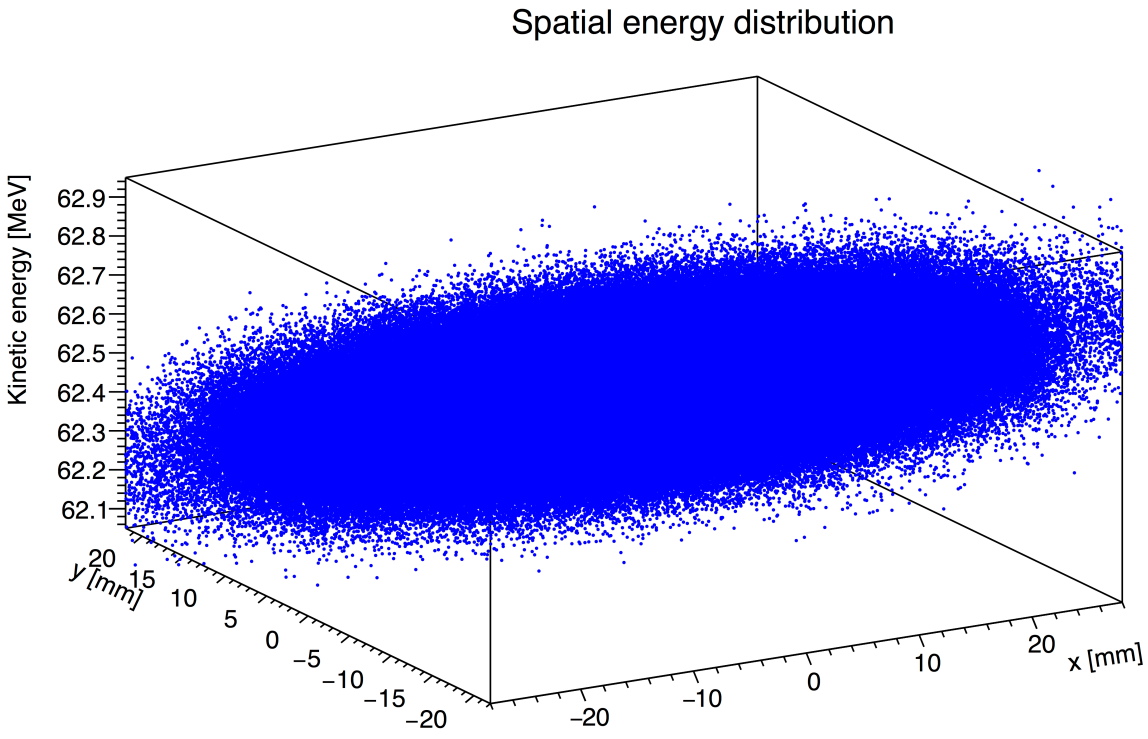
Energy distribution **narrow beam at nozzle**

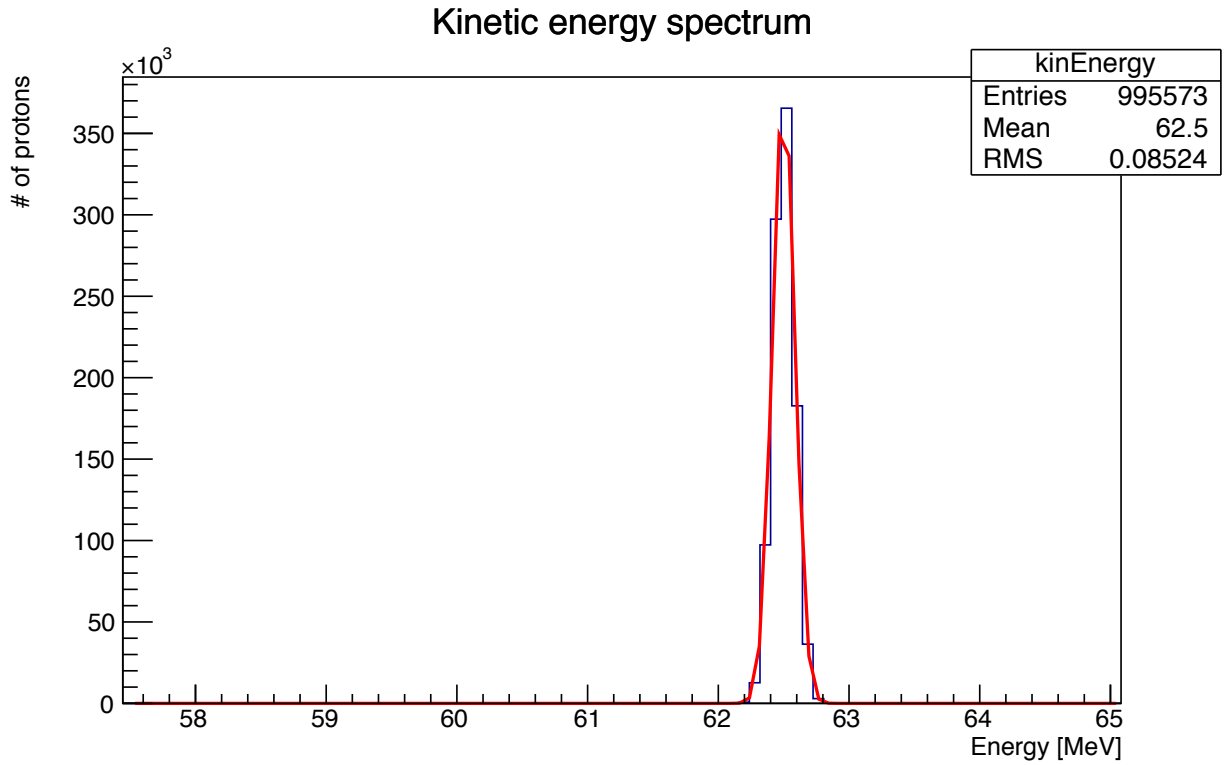
60 MeV mean energy as expected at the nozzle





Energy distribution **wide beam at source**





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