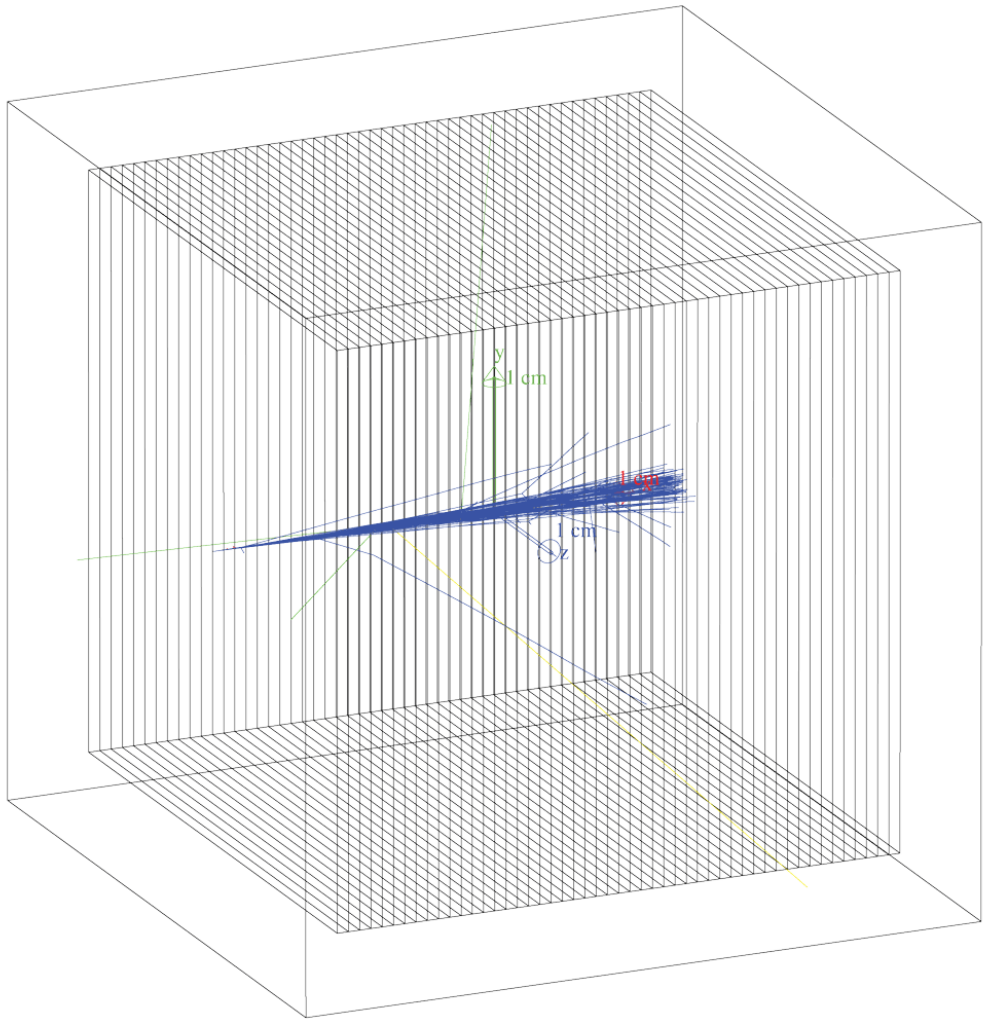
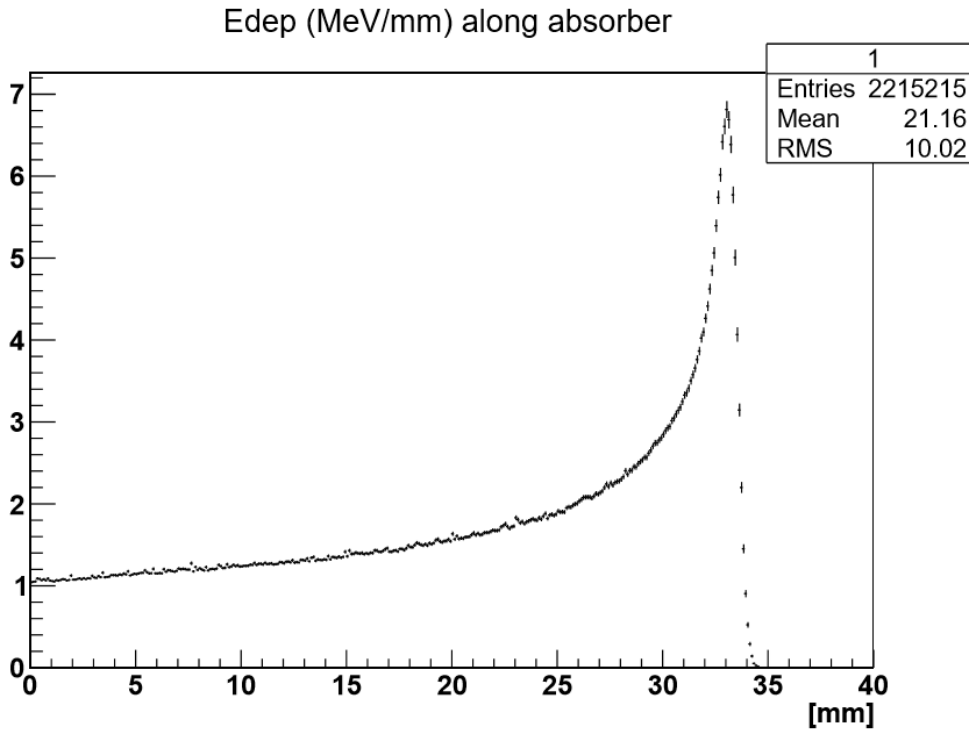
Mono-energetic Proton Pencil Beam Tutorial

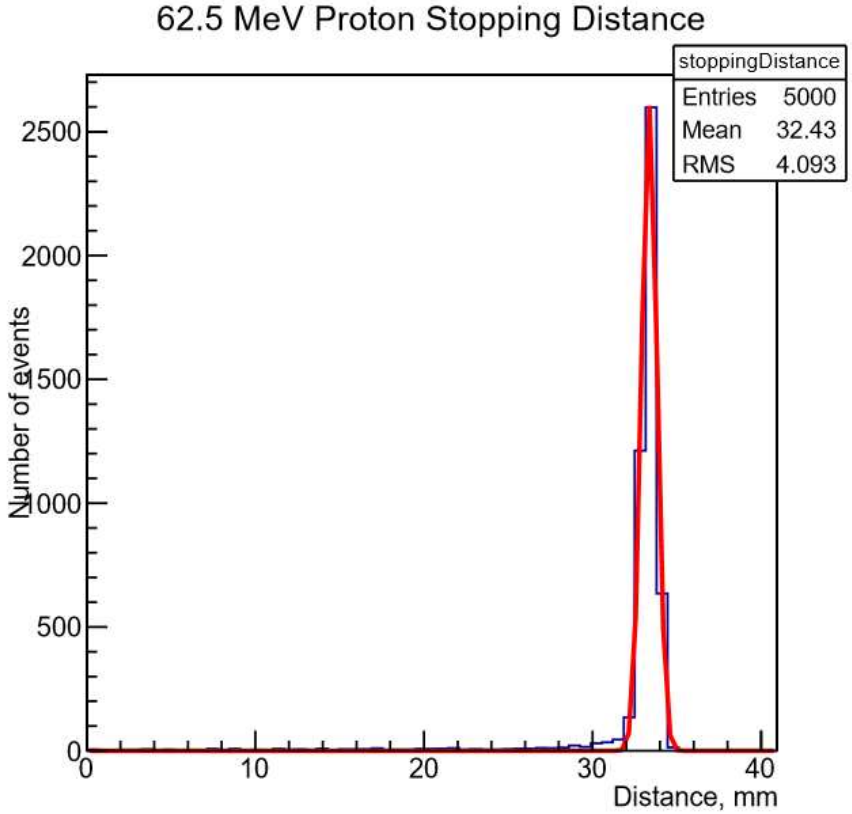
- Water volume divided into slices perpendicular to incident beam
- Deposited dose and energy computed at each slice
- Computed total energy at positions inside water volume, but did not track energy deposition of individual particles
- Adapted simulation removed replica volumes (water volume slices)



Comparison to original tutorial simulation

- Initial beam energy = 62.5 MeV
- Both versions of the simulation show the Bragg peak at 33 mm depth in the water box



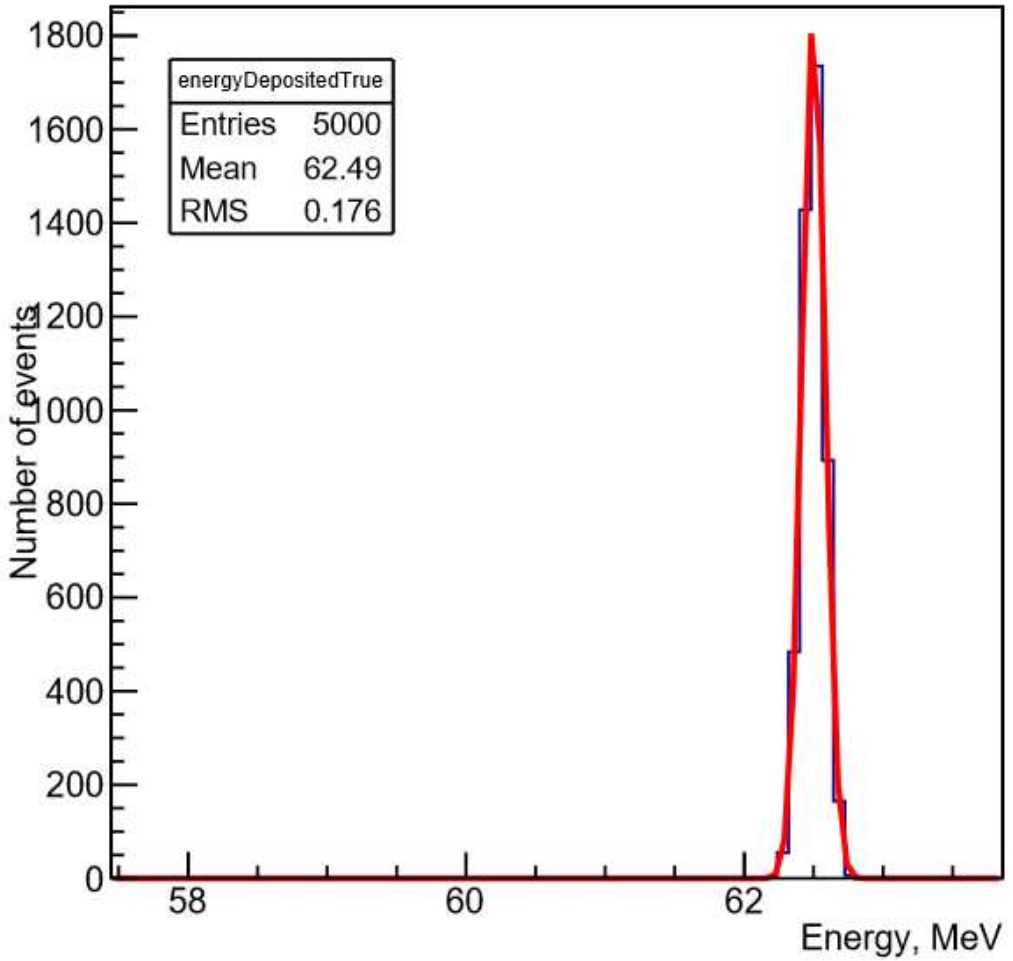


Initial beam

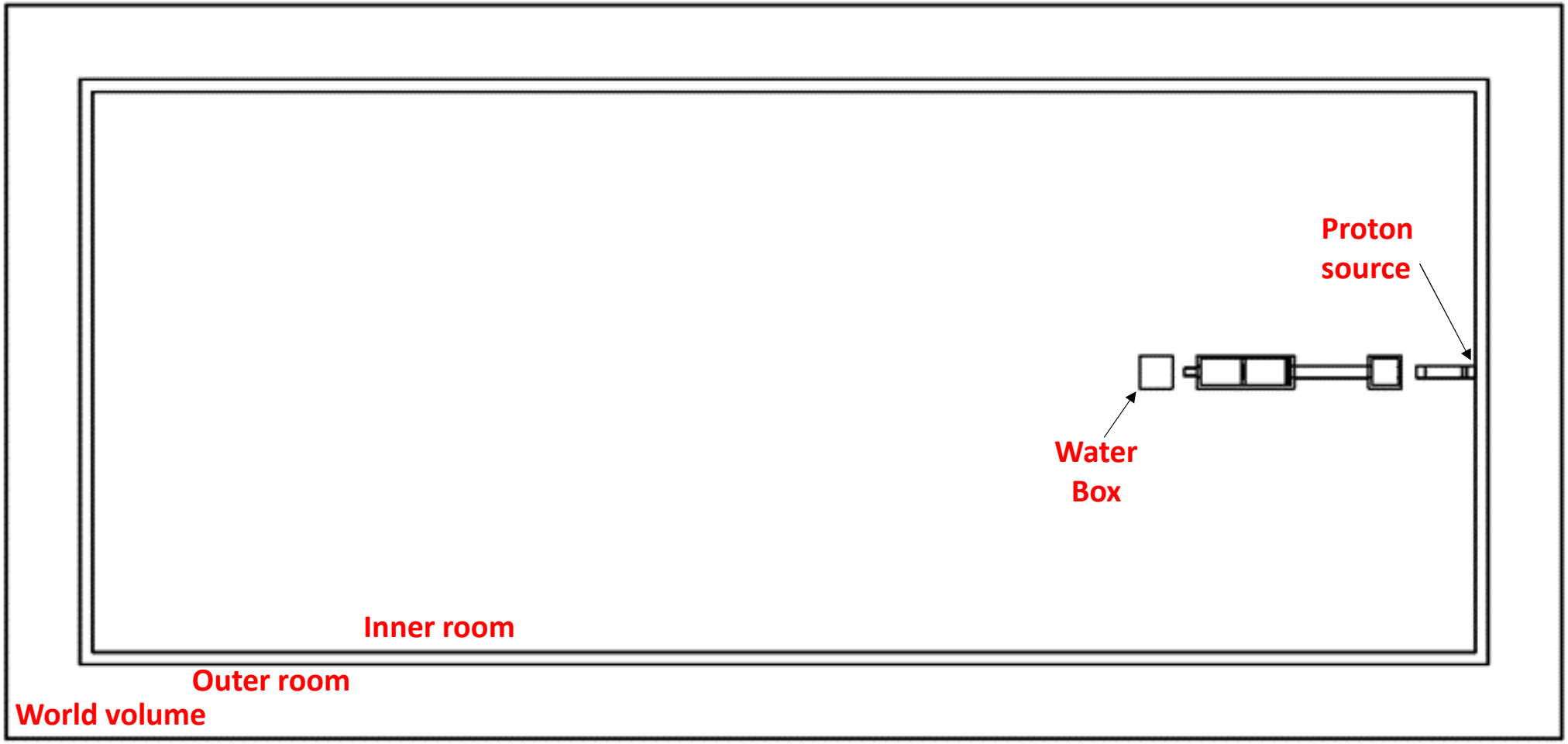
- Monoenergetic 62.5 MeV proton beam
- Gaussian distribution: sigma = 0.082 MeV
- Beam radius 3 mm
- Physics list: QGSP_BIC_HP

Proton beam fired at water box in vacuum to verify it is monoenergetic at 62.5MeV

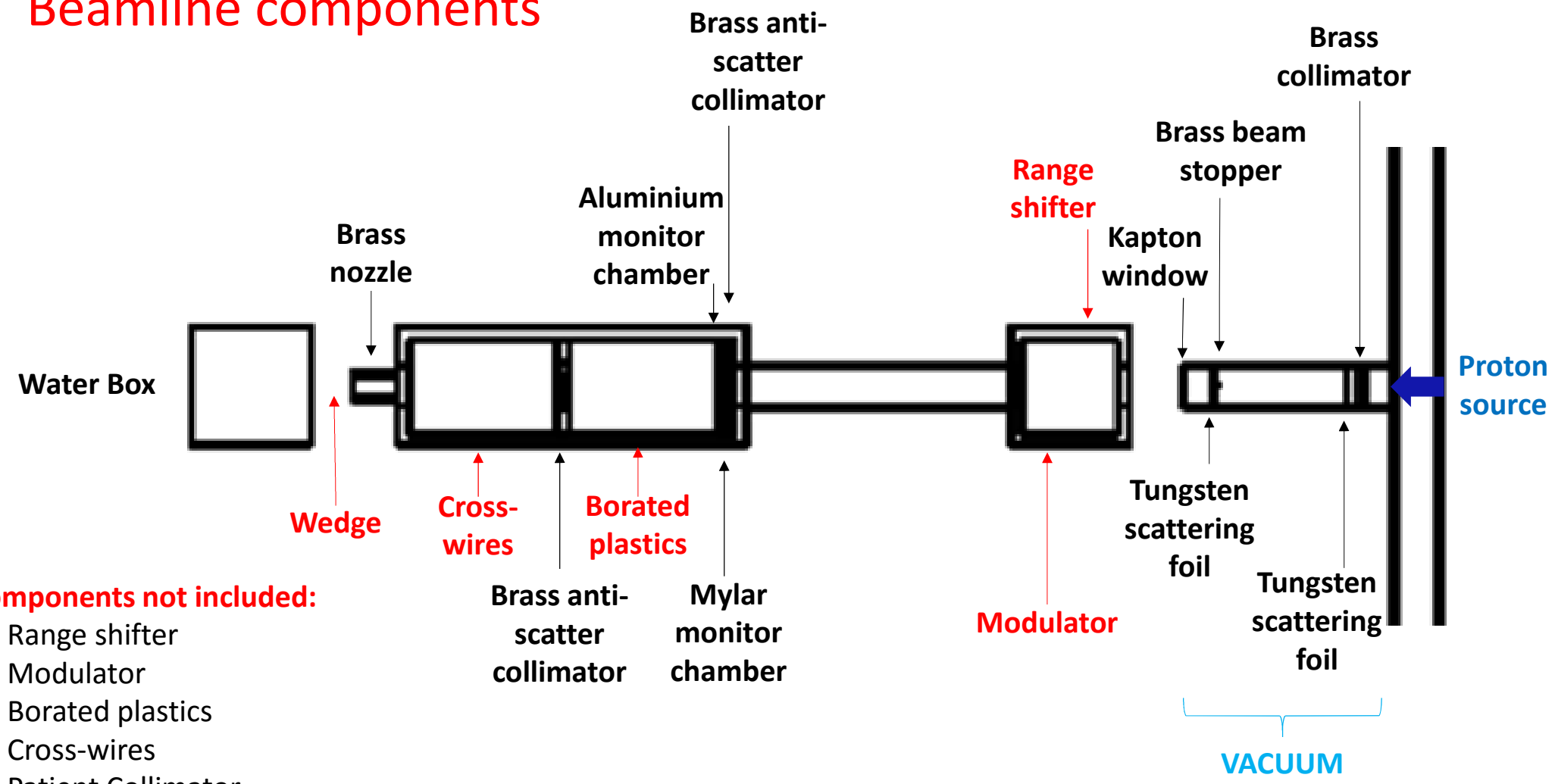
Monoenergetic proton beam (62.5 MeV) energy deposition in water



Treatment Room



Beamline components

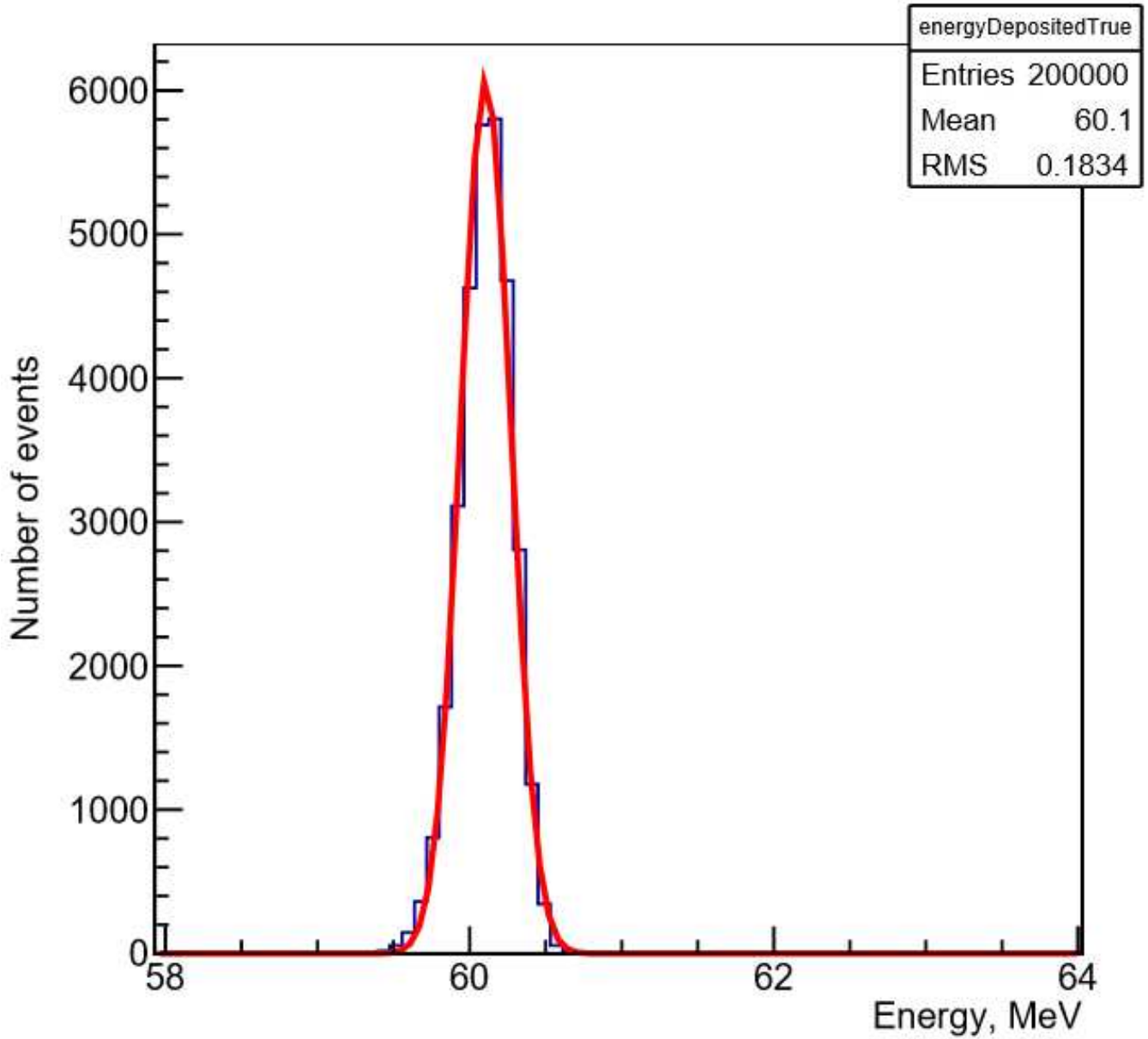


Components not included:

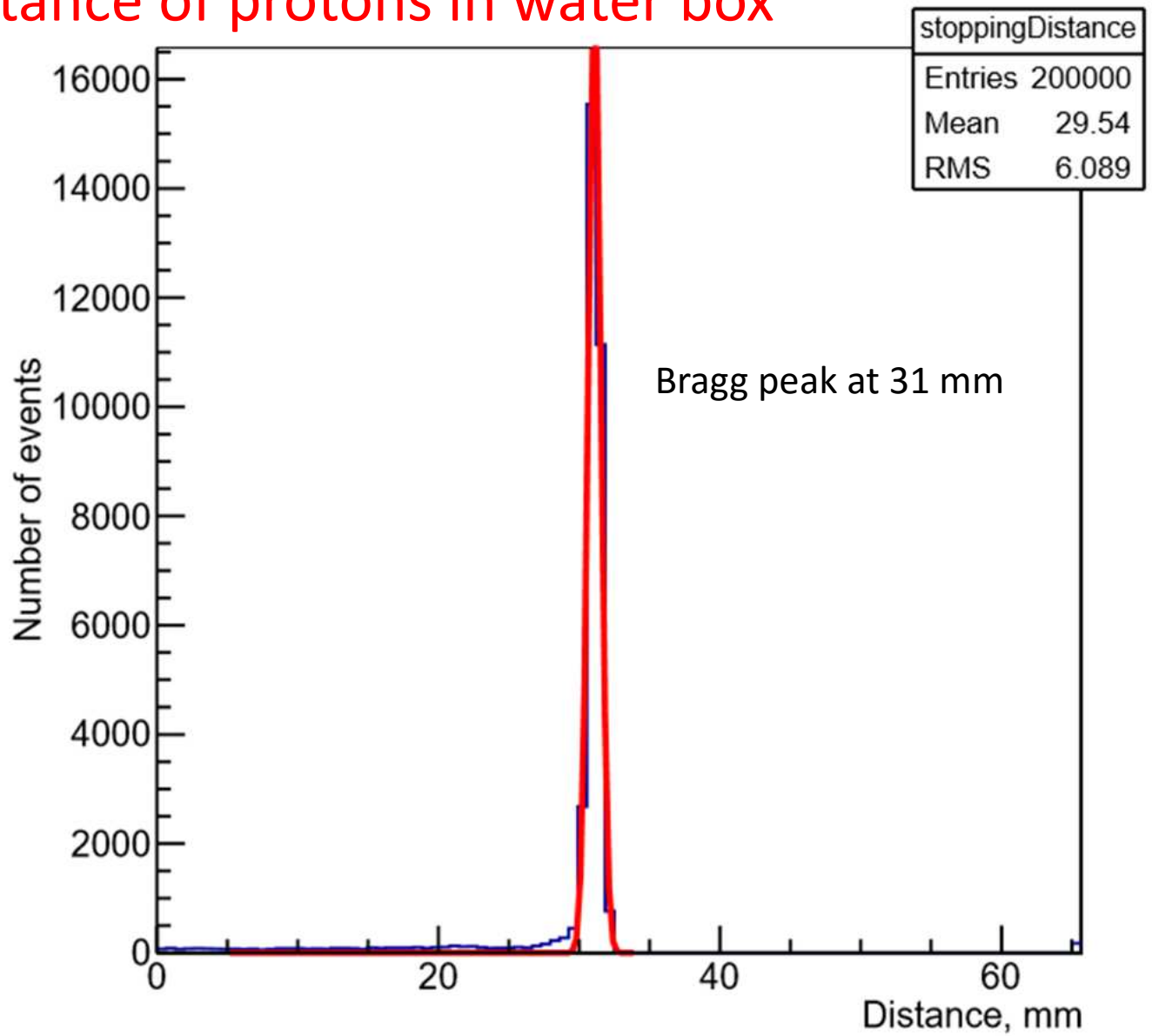
- Range shifter
- Modulator
- Borated plastics
- Cross-wires
- Patient Collimator
- Wedge

Energy deposition of protons in water box

- Peak in energy at 60.1 MeV
- Frequency at peak energy value is approx. 3% of number of initial events

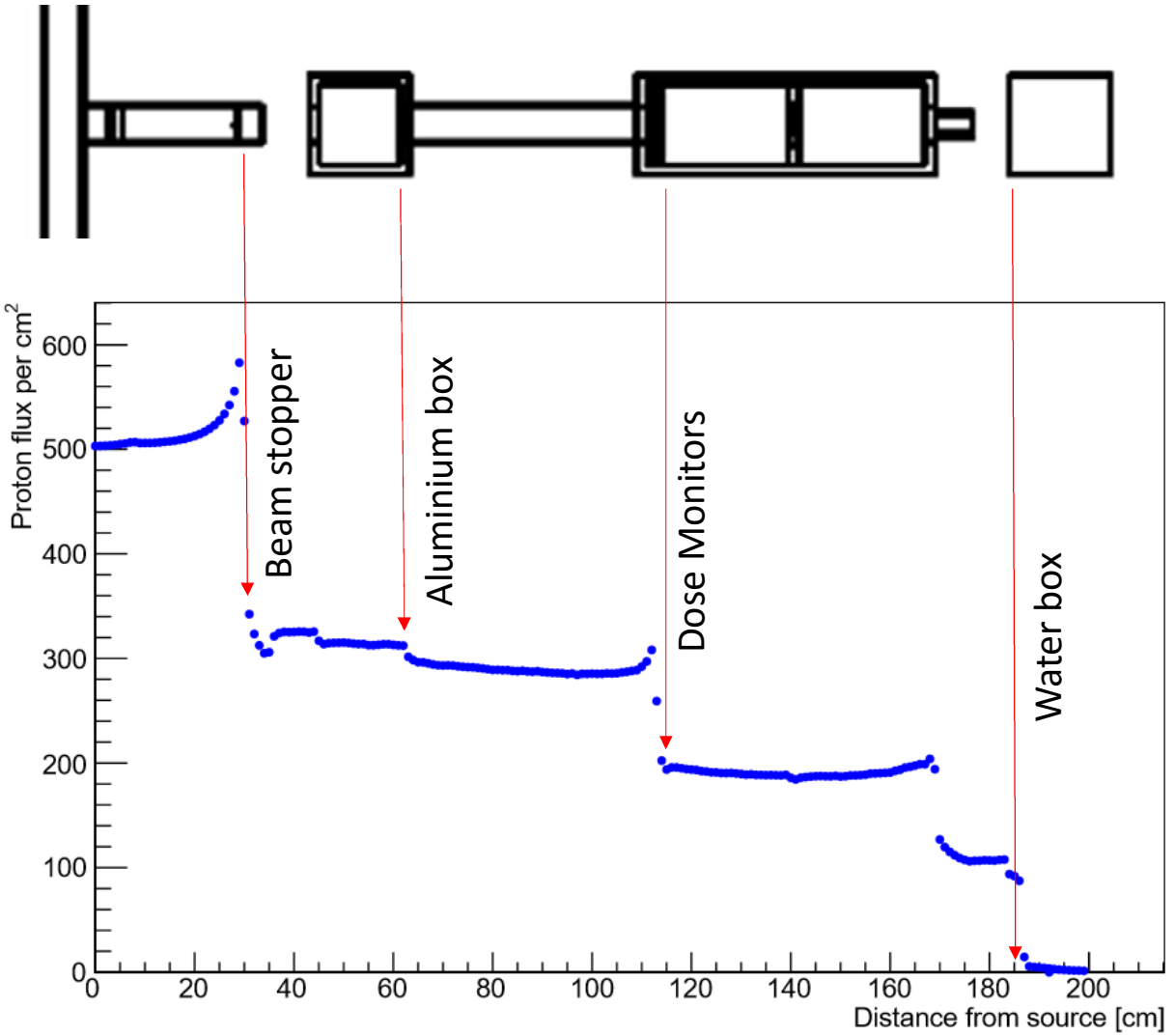


Stopping distance of protons in water box

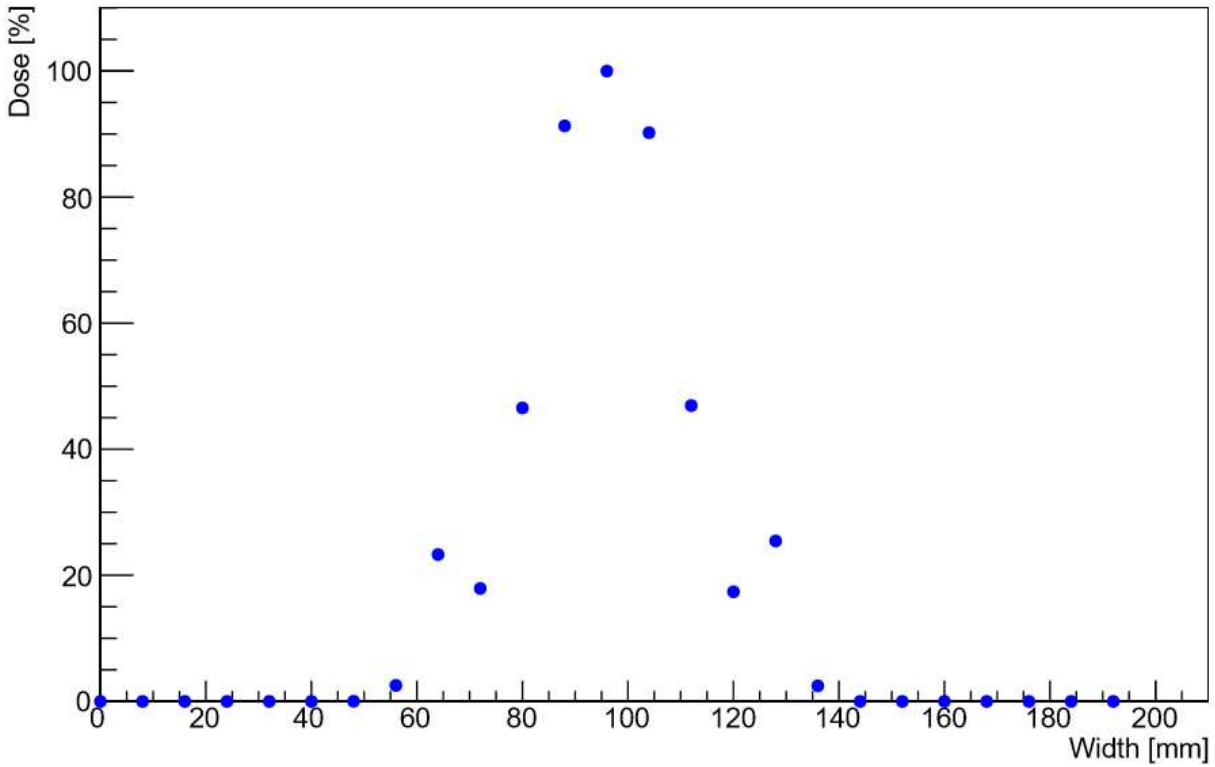


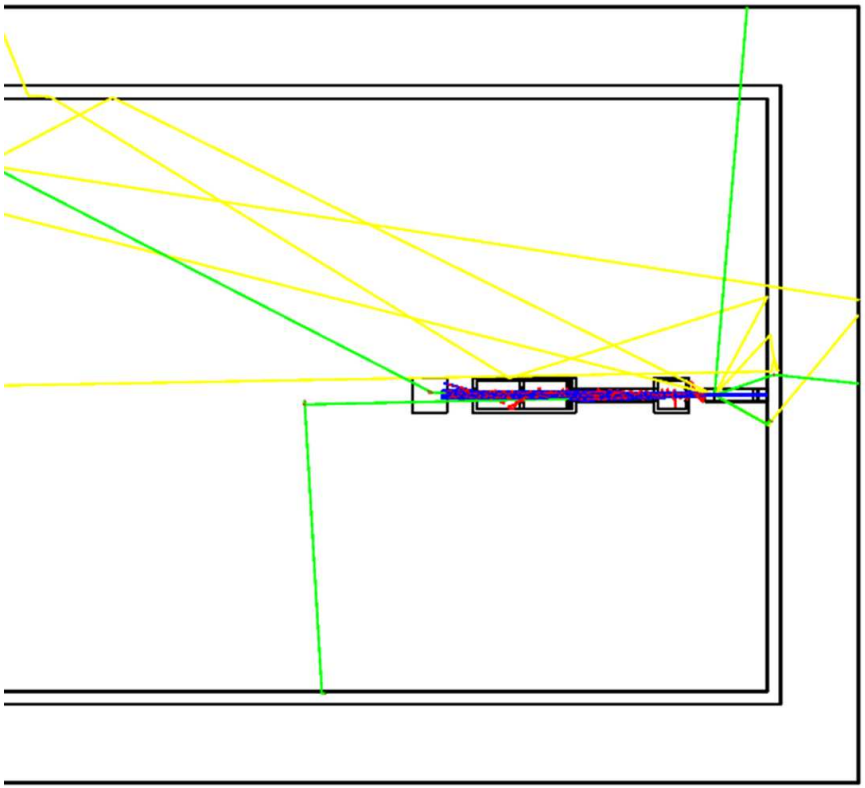
Proton flux along beamline

- Used longitudinal scoring mesh with a proton filter along the entire length of the beamline
- Number of particles increases as reach highly scattering beamline components



Lateral dose distribution at Bragg peak in water box





Visualisation

Proton
Gamma
Neutron

- Lateral scorer placed at location of Bragg peak (31 mm water box depth)
- Gaussian distribution of lateral dose at Bragg peak – from the visualisation the emerging beam is shown to have a significant width

Proton energy along beamline

- Separate runs of 2500 events, depositing beam energy into water box after each beamline component
- Slightly higher energy after the 2nd anti-scatter collimator – increasing number of initial events may remove this anomaly

Source:	**62.5 MeV**
1st Collimator:	**62.49 MeV**
1st Scattering foil:	**62.26 MeV**
Brass stopper:	**62.25 MeV**
2nd scattering foil:	**62 MeV**
Kapton window:	**62 MeV**
Aluminium box:	**61.59 MeV**
Aluminium tube:	**61.05 MeV**
Aluminium box:	**60.31 MeV**
Anti-scatter collimator:	**60.33 MeV**
Dose Monitor 1:	**60.29 MeV**
Dose Monitor 2:	**60.28 MeV**
Anti-scatter collimator:	**60.3 MeV**
Nozzle:	**60.11 MeV**