Update on Geant4 Simulation for the n-^{3}He Experiment

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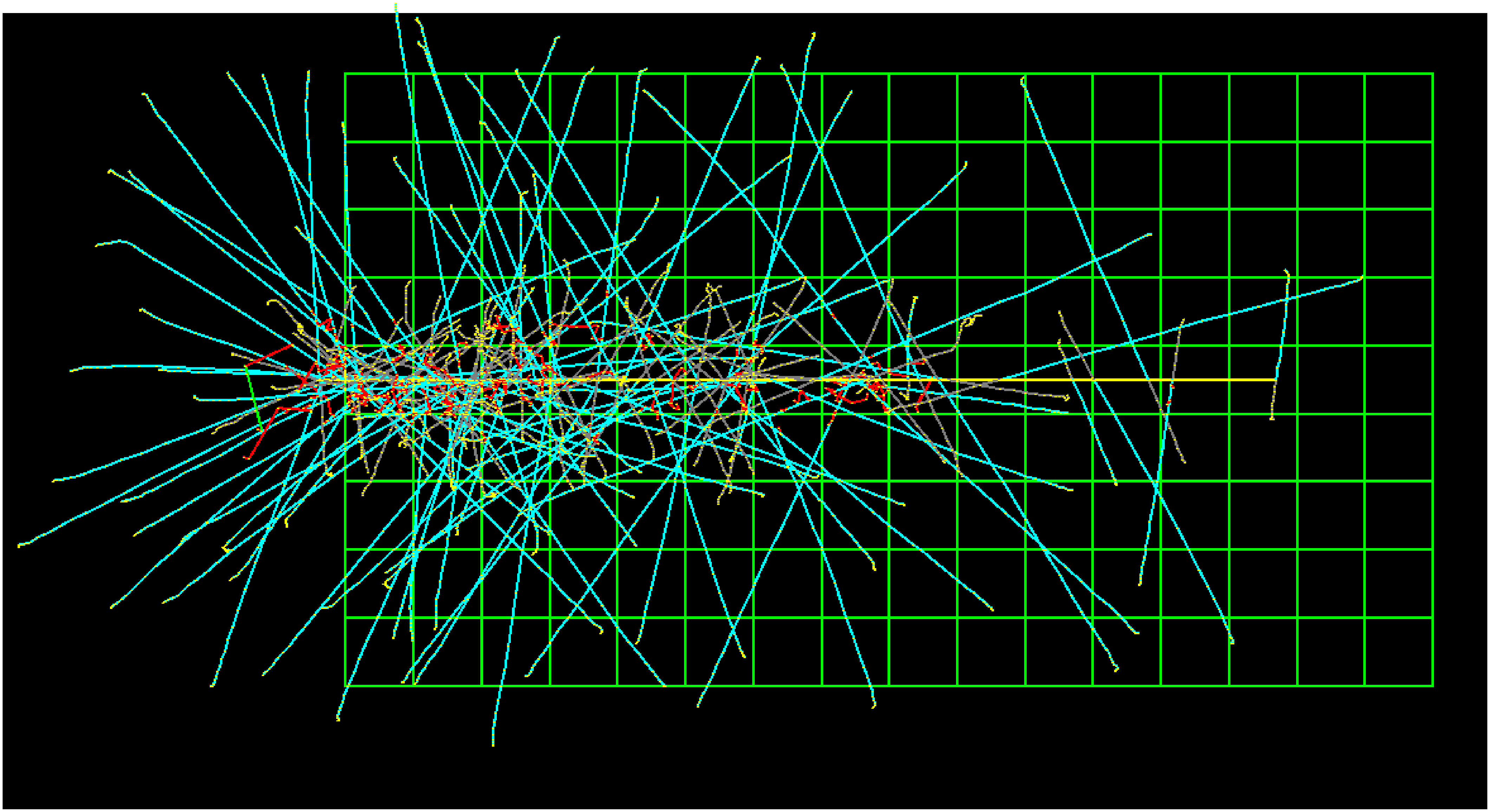
Dec 5th, 2016

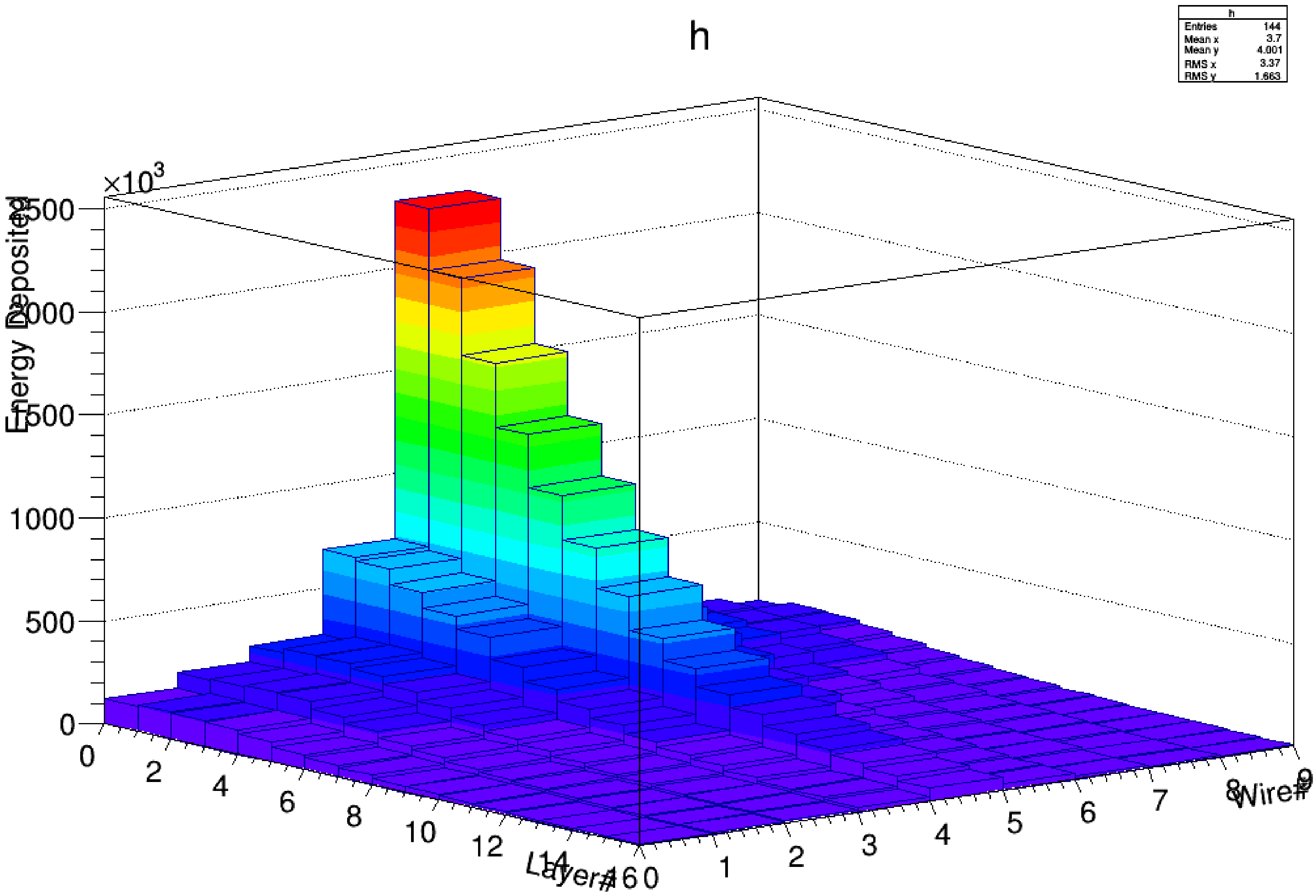
Correction to the geometry

- The boundary effect was resolved by replacing Air by Helium-3 outside the ion chamber.

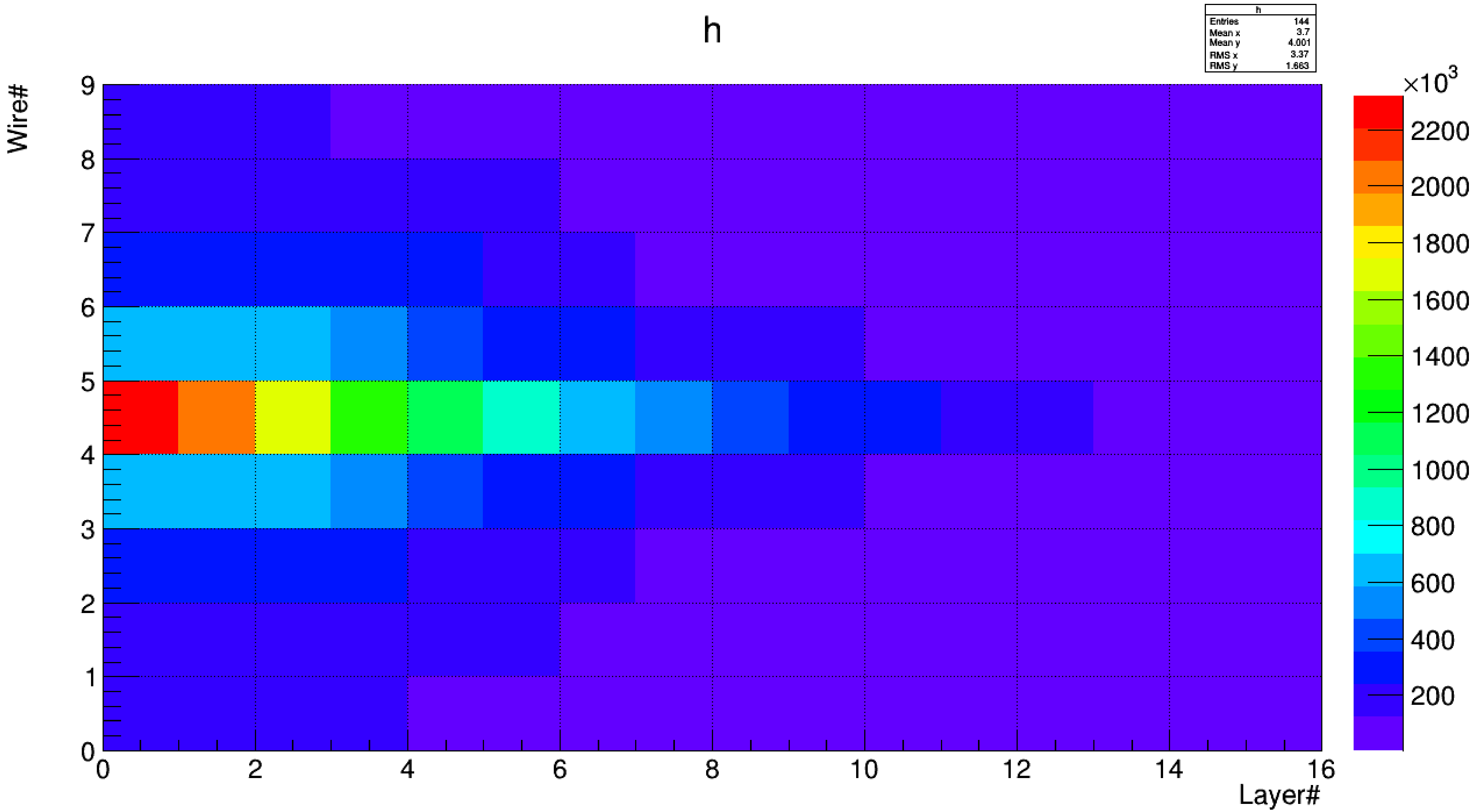
Capture events with boundary corrections



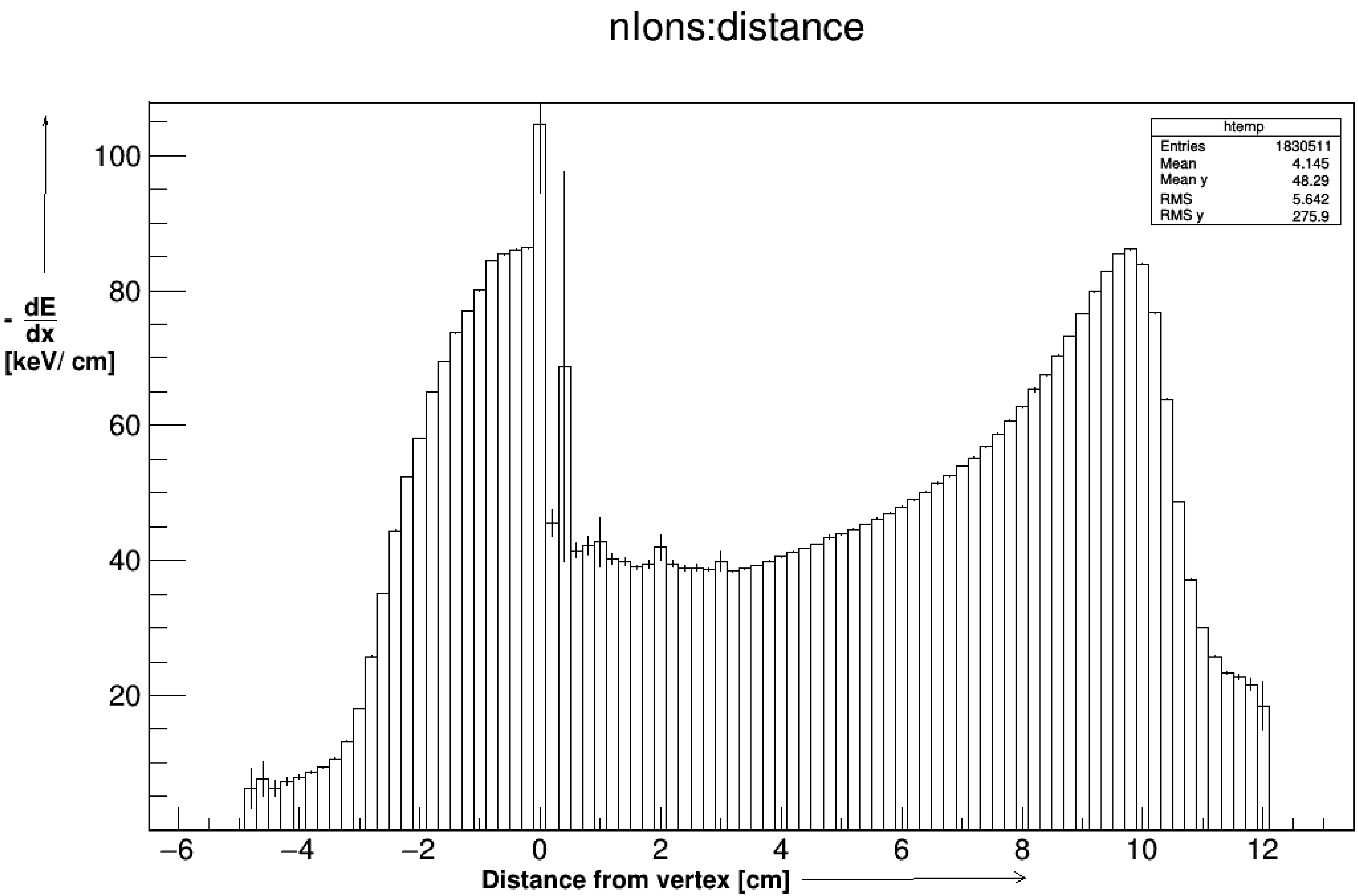
Yield distribution for all wires (Pencil beam)



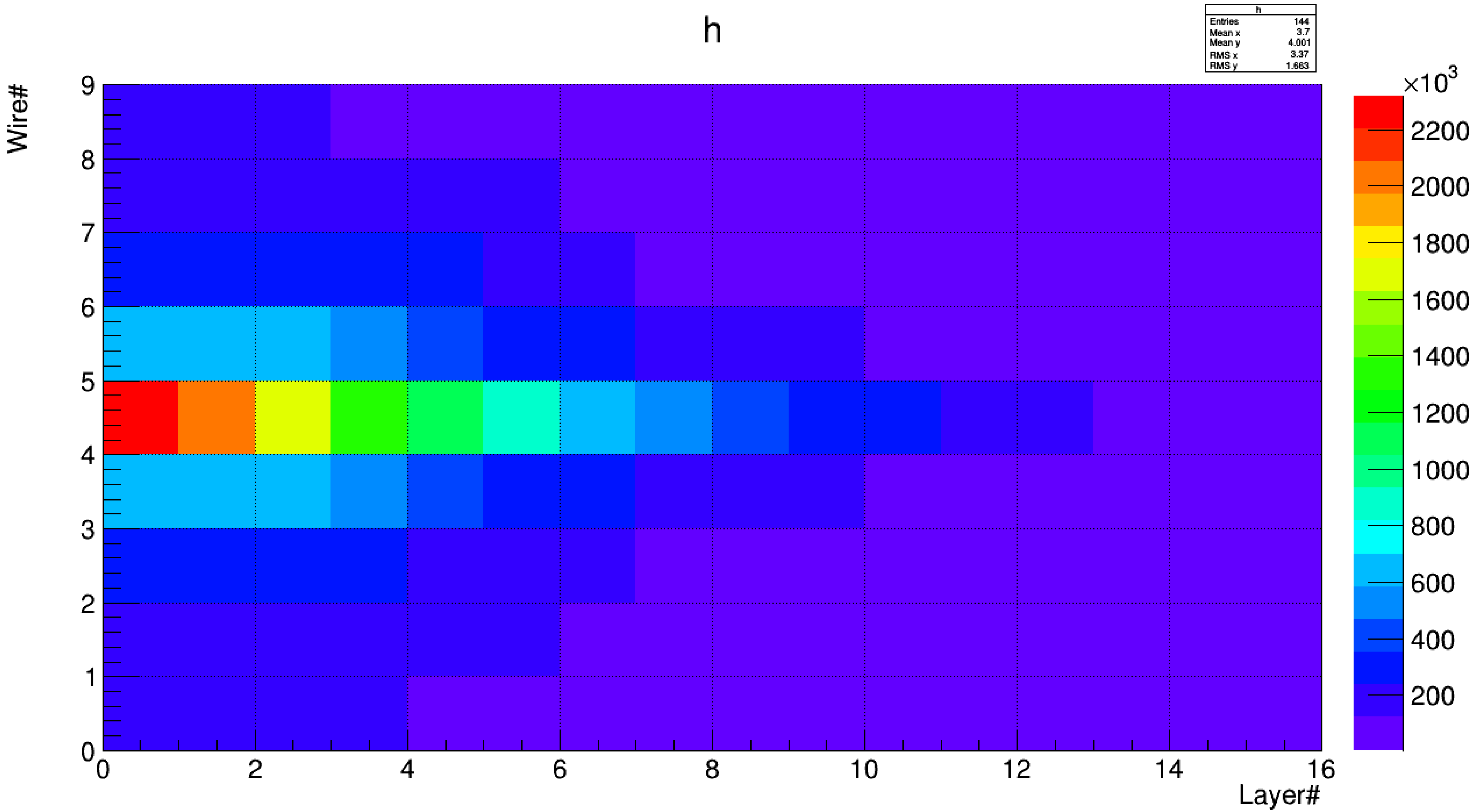
Yield distribution for all wires (Pencil beam)



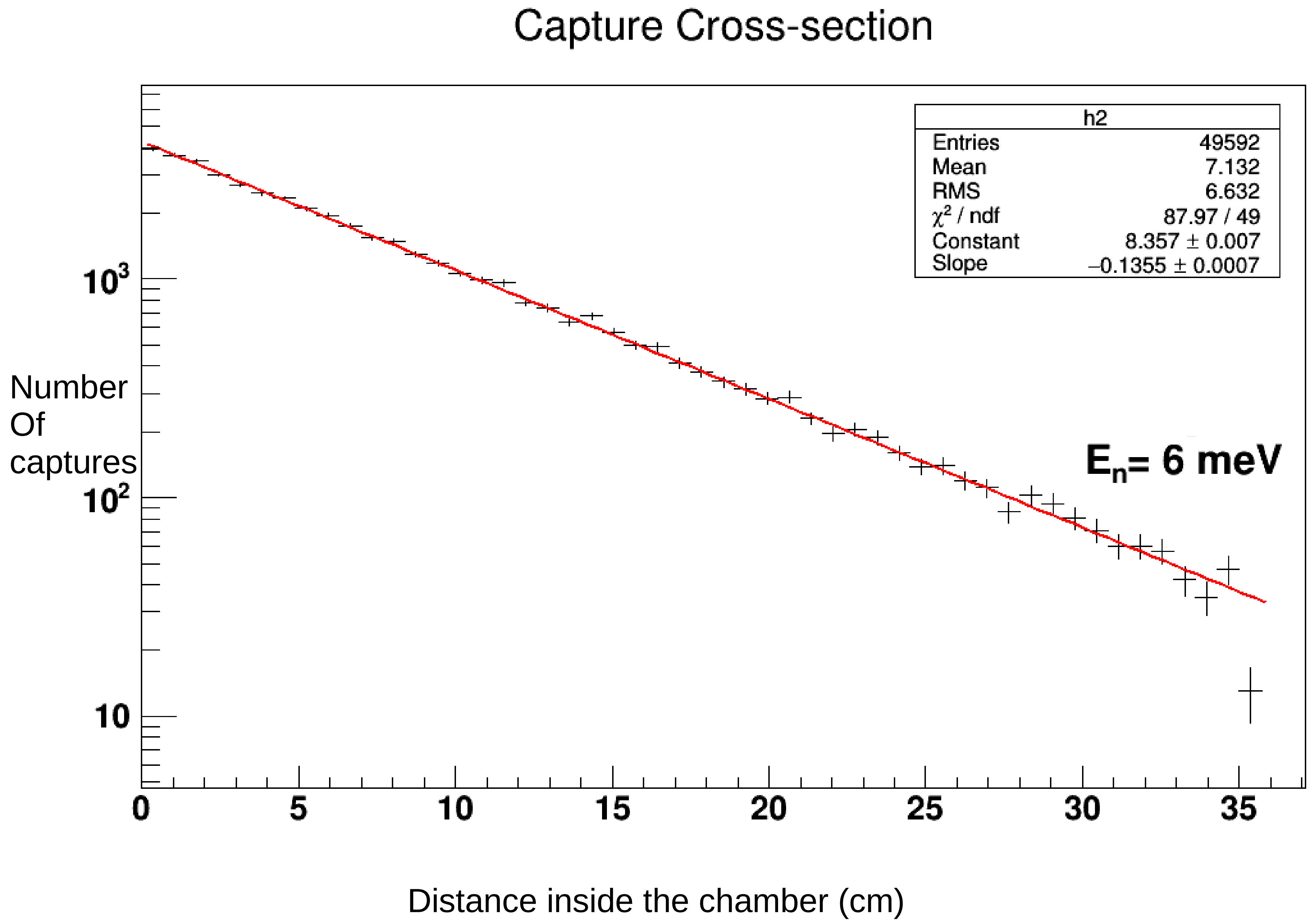
Ionization Curve



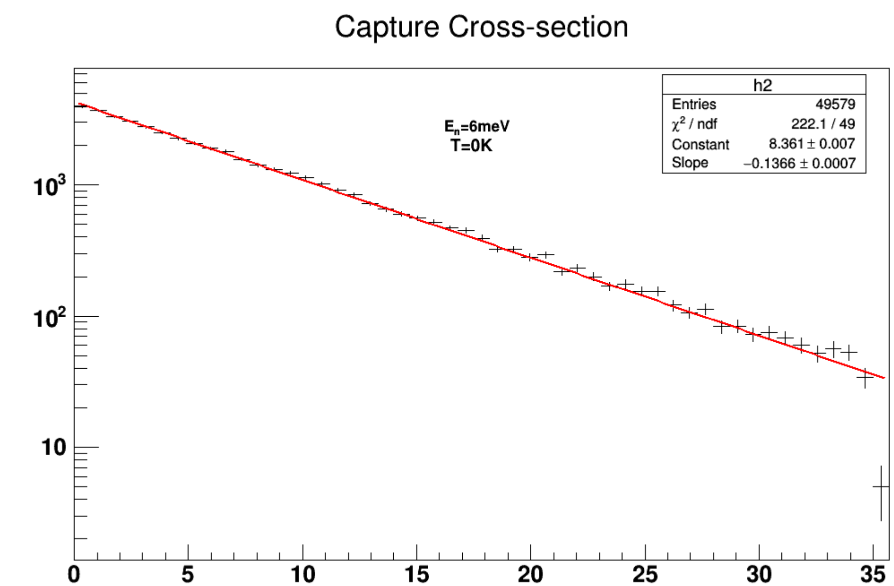
Yield distribution for all wires (Pencil beam)



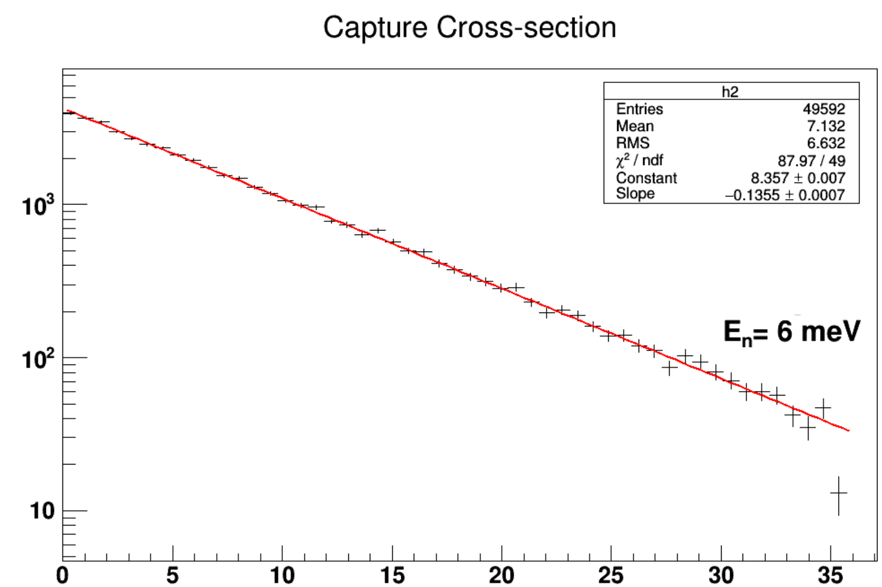
Capture Cross-Section (^{3}He at 293K, 0.5 atm)



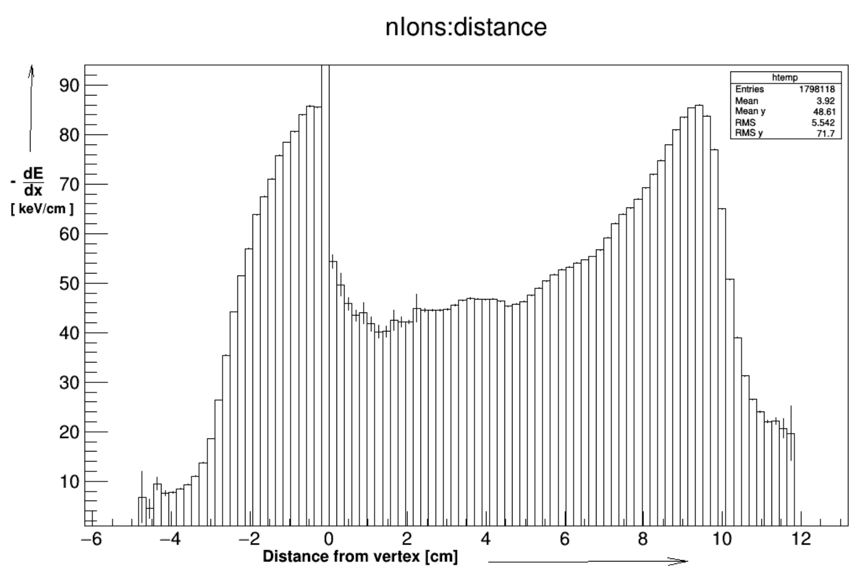
Helium-3 at 293K vs at 0K

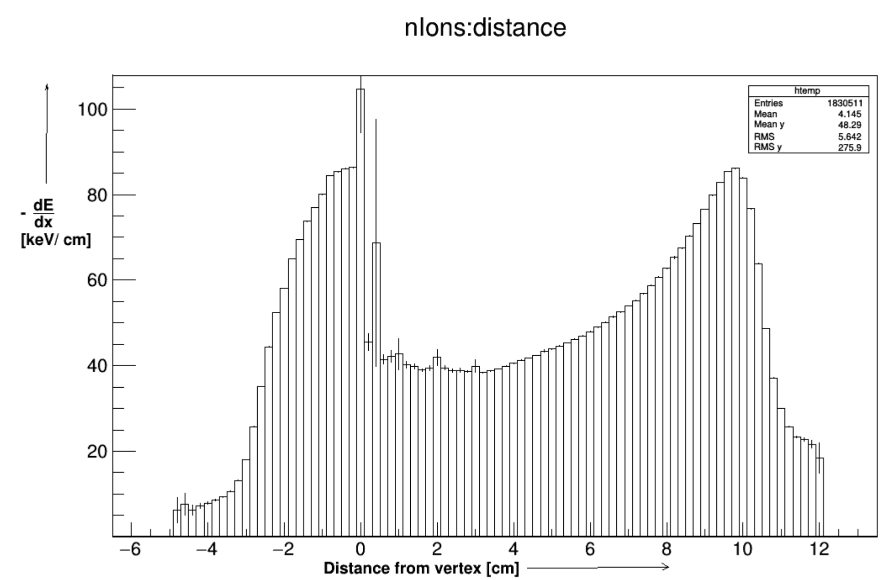


At 0K



At 293K





At 0K

At 293K

Calculating the geometry factors

$$Y_h^\kappa = \langle E^\kappa (1 + h\alpha \cos\theta) \rangle,$$

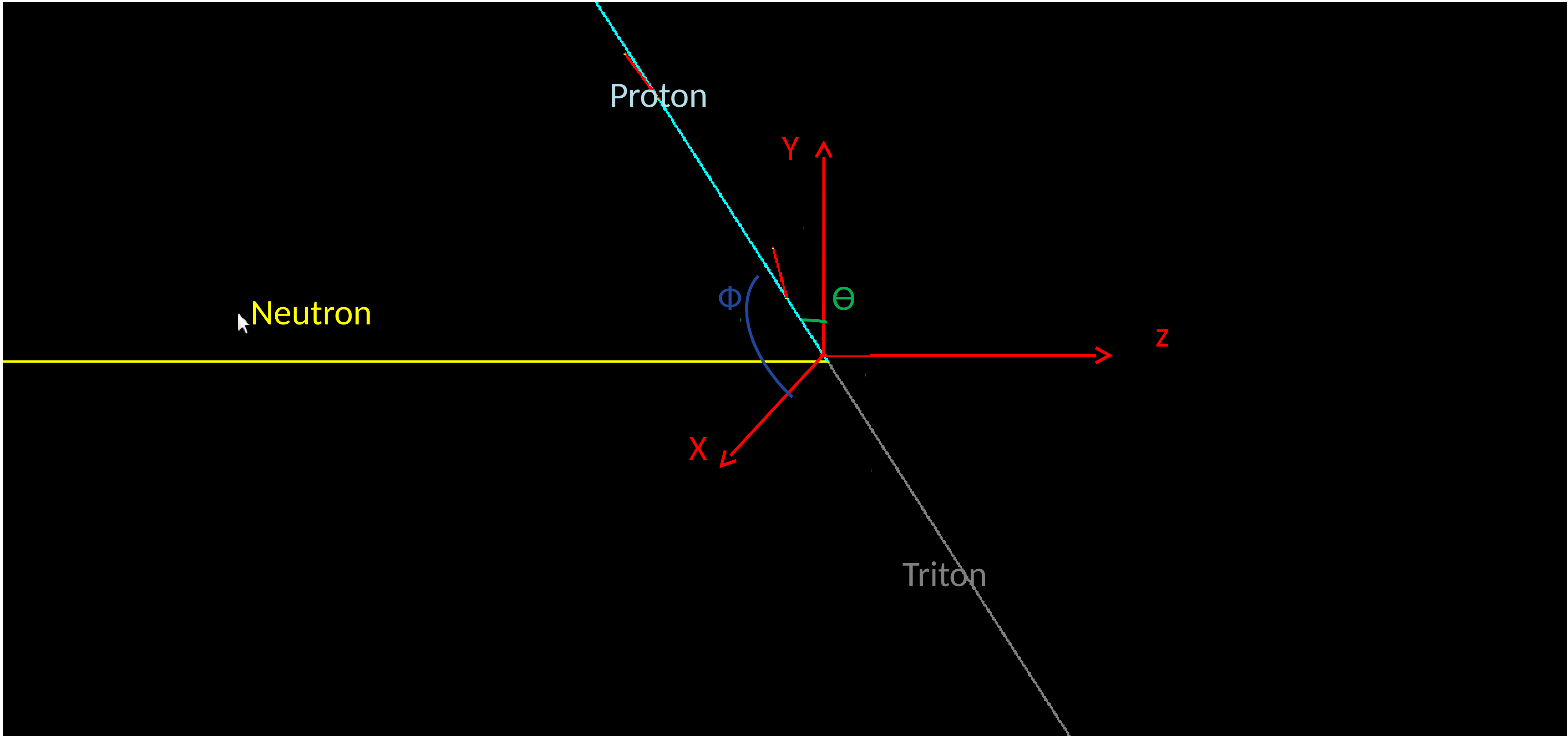
$$\frac{Y_+^\kappa - Y_-^\kappa}{Y_+^\kappa + Y_-^\kappa} = \alpha_\kappa \frac{\langle E^\kappa \cos\theta \rangle}{\langle E^\kappa \rangle}$$

$$G_\kappa = \frac{\langle E^\kappa \cos\theta \rangle}{\langle E^\kappa \rangle} = \frac{\sum_{i=1}^{N_{mc}} Q_i^\kappa \cos\theta_i}{\sum_{i=1}^{N_{mc}} Q_i^\kappa}$$

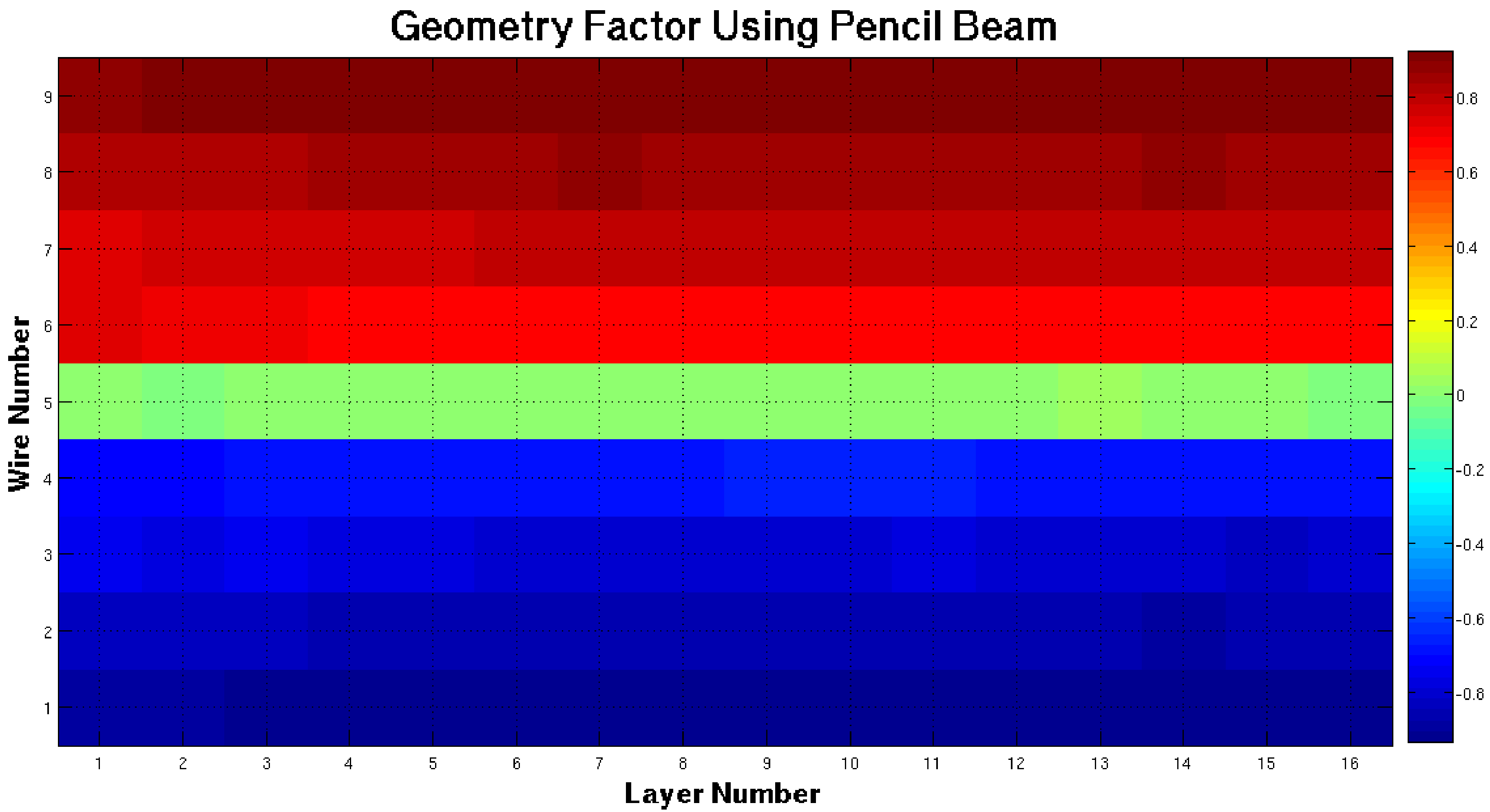
Proton and triton tracks are completely straight line and opposite to each other.

So, $\cos(\theta_p) = -\cos(\theta_t)$

Calculating the geometry factors



Geometry Factors Using Pencil beam

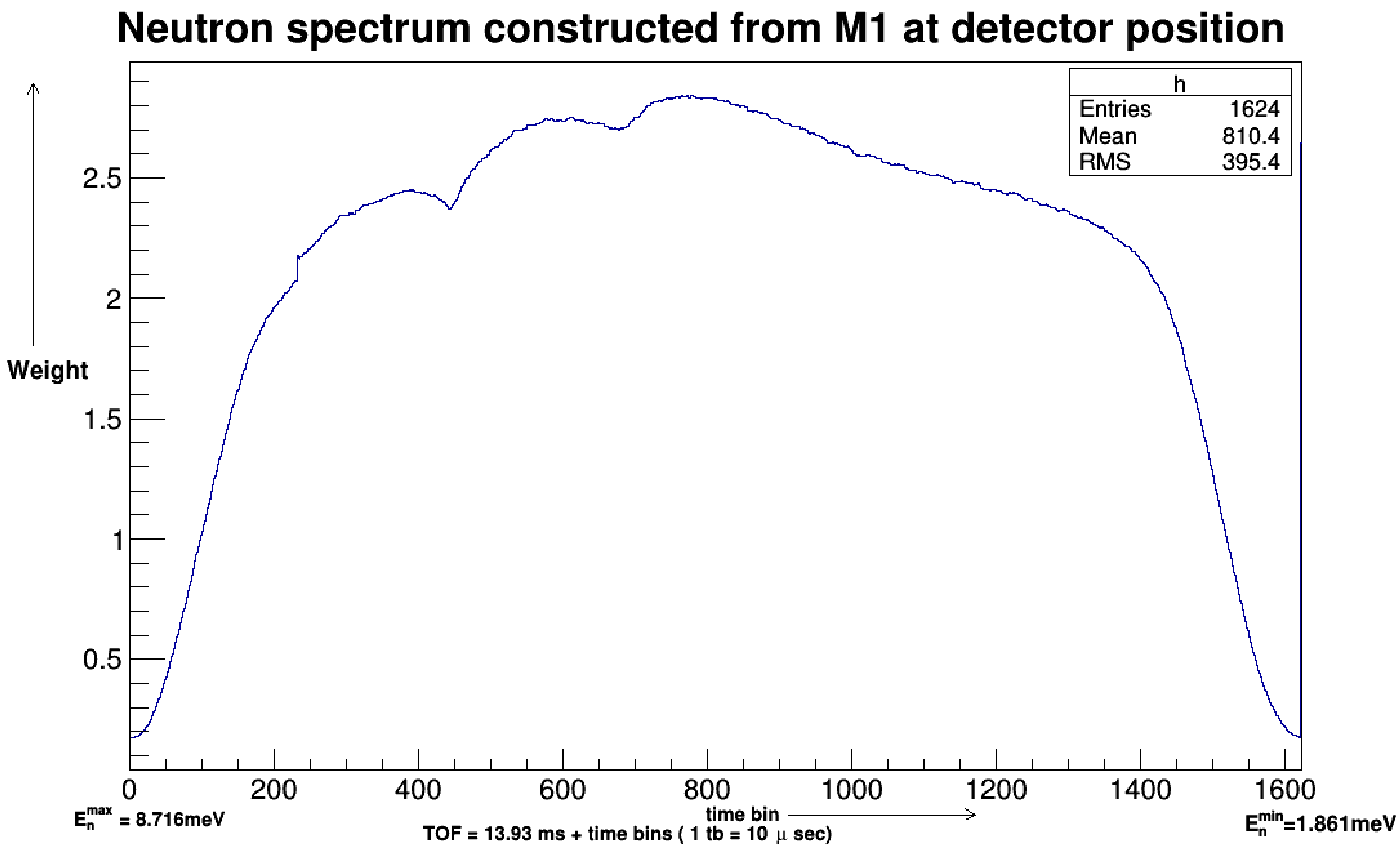


Towards more realistic n-^{3}He neutron source

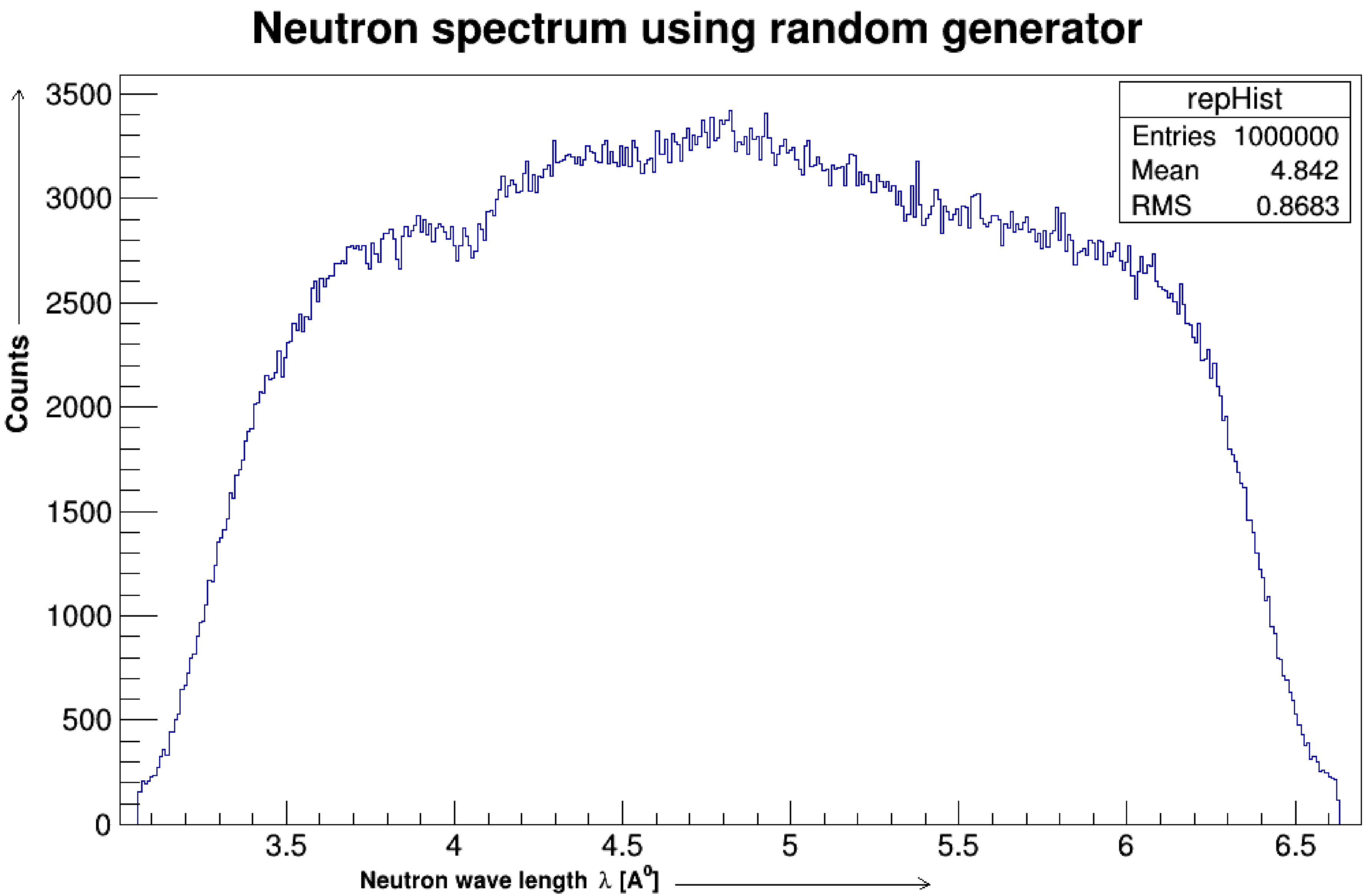
Towards more realistic n-^{3}He neutron source

- Use M1 signal to construct neutron energy spectrum at detector position.
- Use Up stream beam scan data to generate neutron’s position on XY plane.

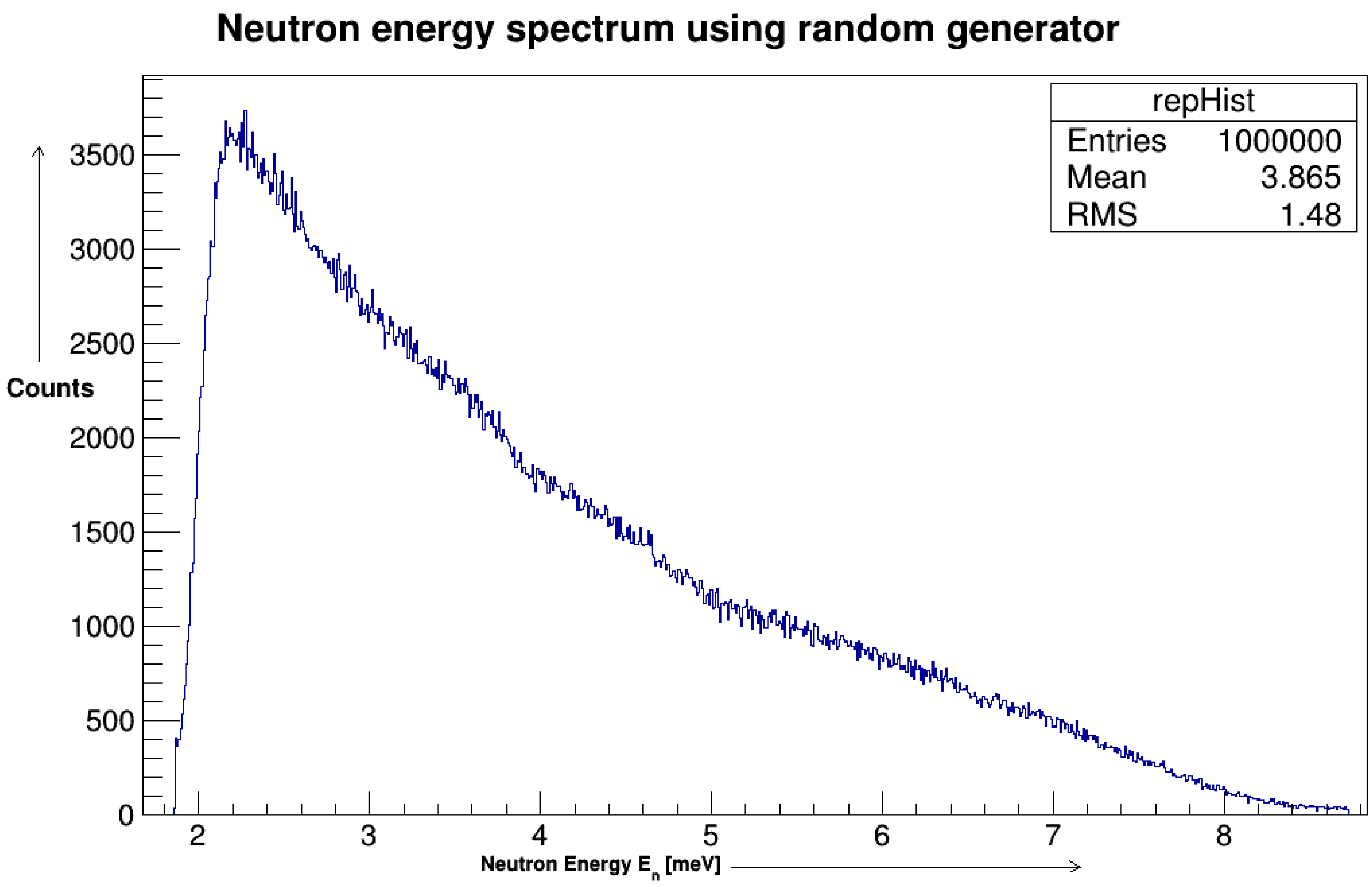
Producing neutron energy spectrum



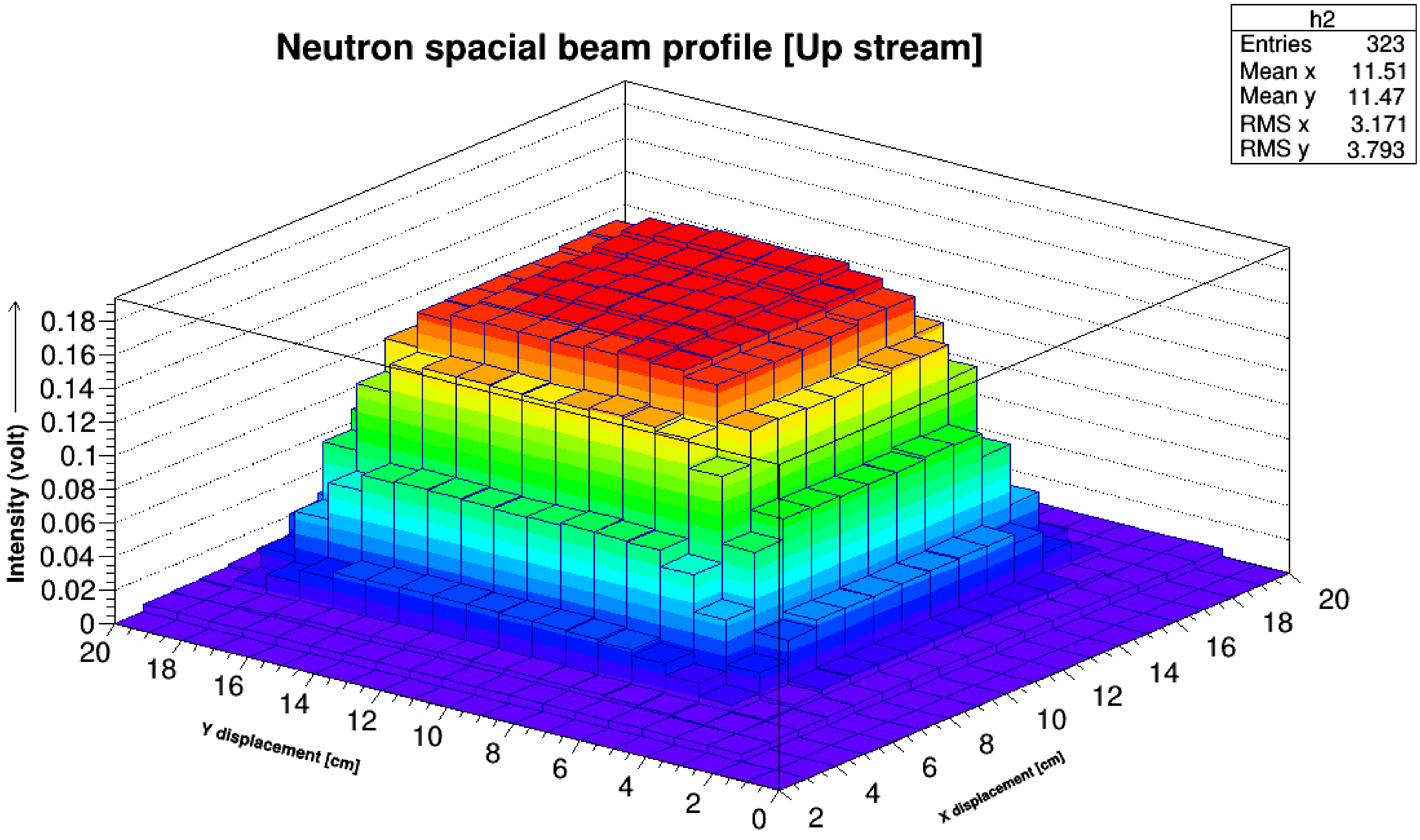
Neutron wave length form M1 signal



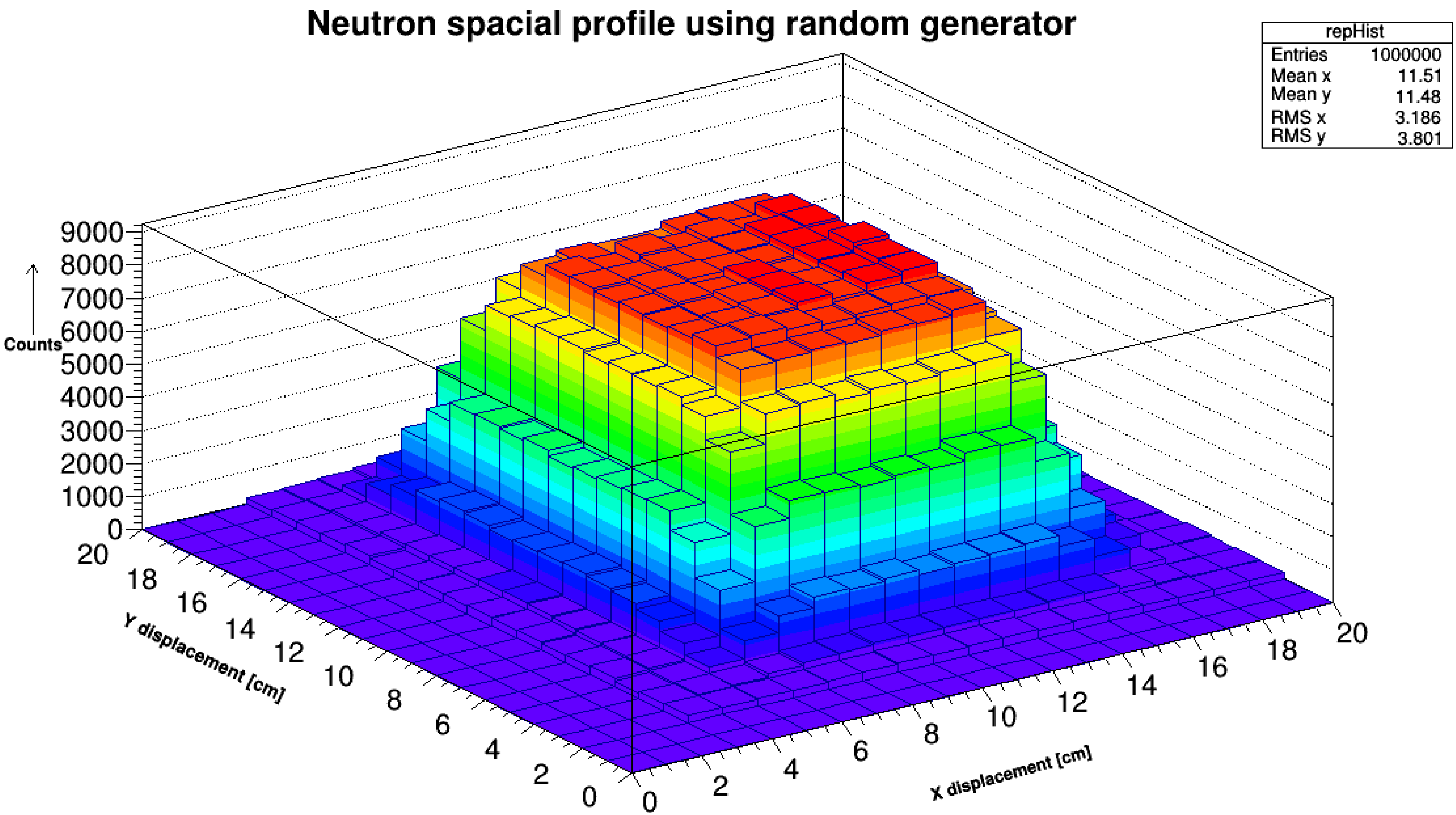
Neutron energy spectrum using random generator based on M1 signal



Neutron spacial profile from beam scan



Neutron spacial profile using random generator based on beam scan plot



To be included :

- The M1 signal at M1 position will spread out by the time it arrives detector position.

  This is because the neutrons in a pulse are squeezed at the moderator position and keep spreading out as it travels.

- The signal strength of M1 monitor has neutron wave length dependence. It is higher at long wave length and smaller for small wave length. So basically the M1 intensity that we see is proportional to the TOF or wave length. To get the correct intensity we need to attenuate the intensity proportional to TOF. As a result the energy spectrum will become more plat.

- The M1 signal that we see is a convoluted signal of many pulses. However the detector see individual pulses(neutron of specific energy). So actually we should use image (Perfect 1 Hz pulse) pulse for M1 signal.

- The beam has a small divergence. The beam profile should take this into account unless the effect it negligible.

- The neutron spacial beam profile should be chopped out to take into account the collimation imposed.