

Heapcheck scripts with Energy loss calculations

**By Abishek Karki
Mississippi State University
11/21/2017**

Scripts to calculate the heap checking variables

- $W^2 = \text{sqrt}(M_p * M_p + 2 * M_p * (E - E_p) - Q^2);$
- $E_m = E + M_p - (E_p + E_{pp});$
- $P_{m_par} = q_z - p_{pz};$
- $P_{m_per} = q_x - p_{px};$

$Q^2 = 4$ - momentum transfer square;

E = beam energy;

E_p = scattered electron energy;

M_p = mass of proton;

E_m = missing energy;

z - axis = along the q - vector;

q_x = comp of q along x ;

P_{m_per} = missing momentum perpendicular to
the q - vector;

P_{m_par} = missing momentum parallel to q vector;

Energy Loss Formula

- **Energy loss suffered by incident electrons and scattered electrons**

$$\text{loss} = (0.0001536 * Z_{\text{mat}}) / (A_{\text{Mat}} * \text{thick} * (19.26 + \log(\text{thick}/\text{dens})))$$

here,

Z_{mat} , A_{mat} , thick , dens = Z , A , thickness (cm),
density (g/cc) of the material in the electron's path.

- **Energy loss suffered by scattered proton:**

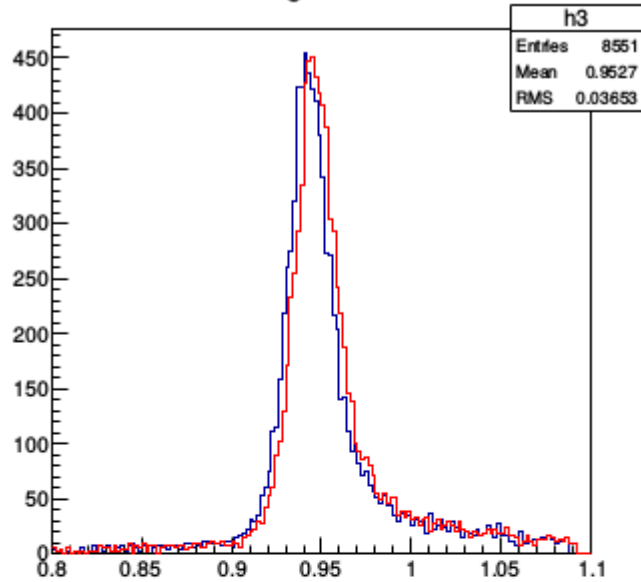
$$\text{loss} = \log(46880.64 * \beta^2 / (1 - \beta^2)) - \beta^2$$

$$\text{loss}_{\text{net}} = (0.0003072 * (Z_{\text{mat}}/A_{\text{mat}}) * \text{thick} / \beta^2) * \text{loss}$$

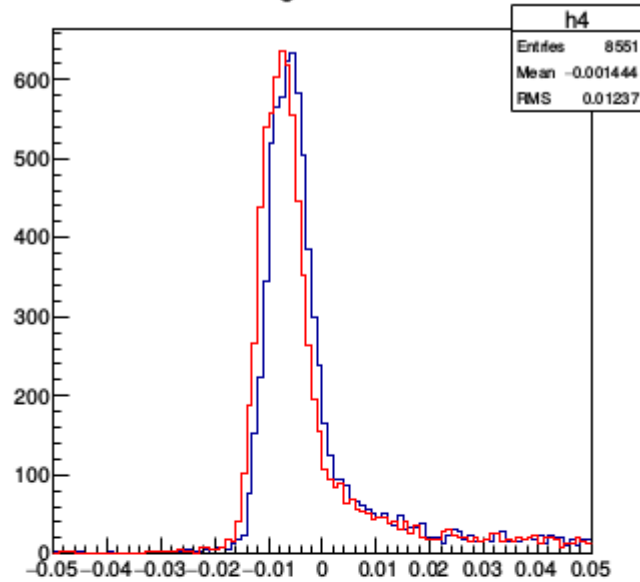
$\beta = p_p/E_p$ is the velocity of the scattered proton

- **Formula and constants from PDG.**

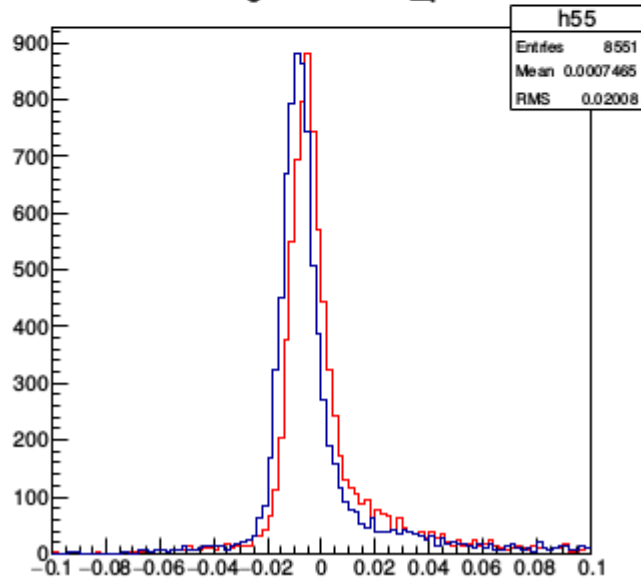
Histogram of W



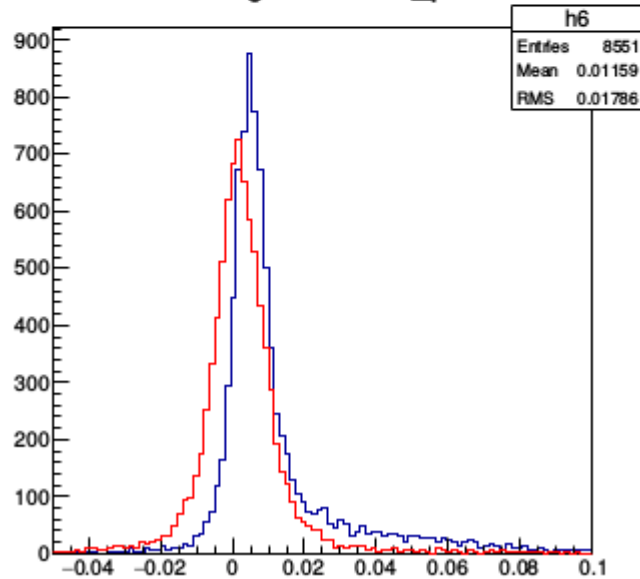
Histogram of Em



Histogram of Pm_par



Histogram of Pm_per



Kinematics

$E_{\text{beam}} = 3.060 \text{ GeV}$
 $p_e = 2.520 \text{ GeV}$
 $\theta_e = 24.80 \text{ deg}$
 $p_p = 1.300 \text{ GeV}$
 $\theta_p = 54.00 \text{ deg}$

- Red hist is from scripts
- Blue hist is from an E94139 ntuple (circa2000), $Q^2 = 3.03 \text{ GeV}^2$
- Eloss can be added or subtracted based on an input argument

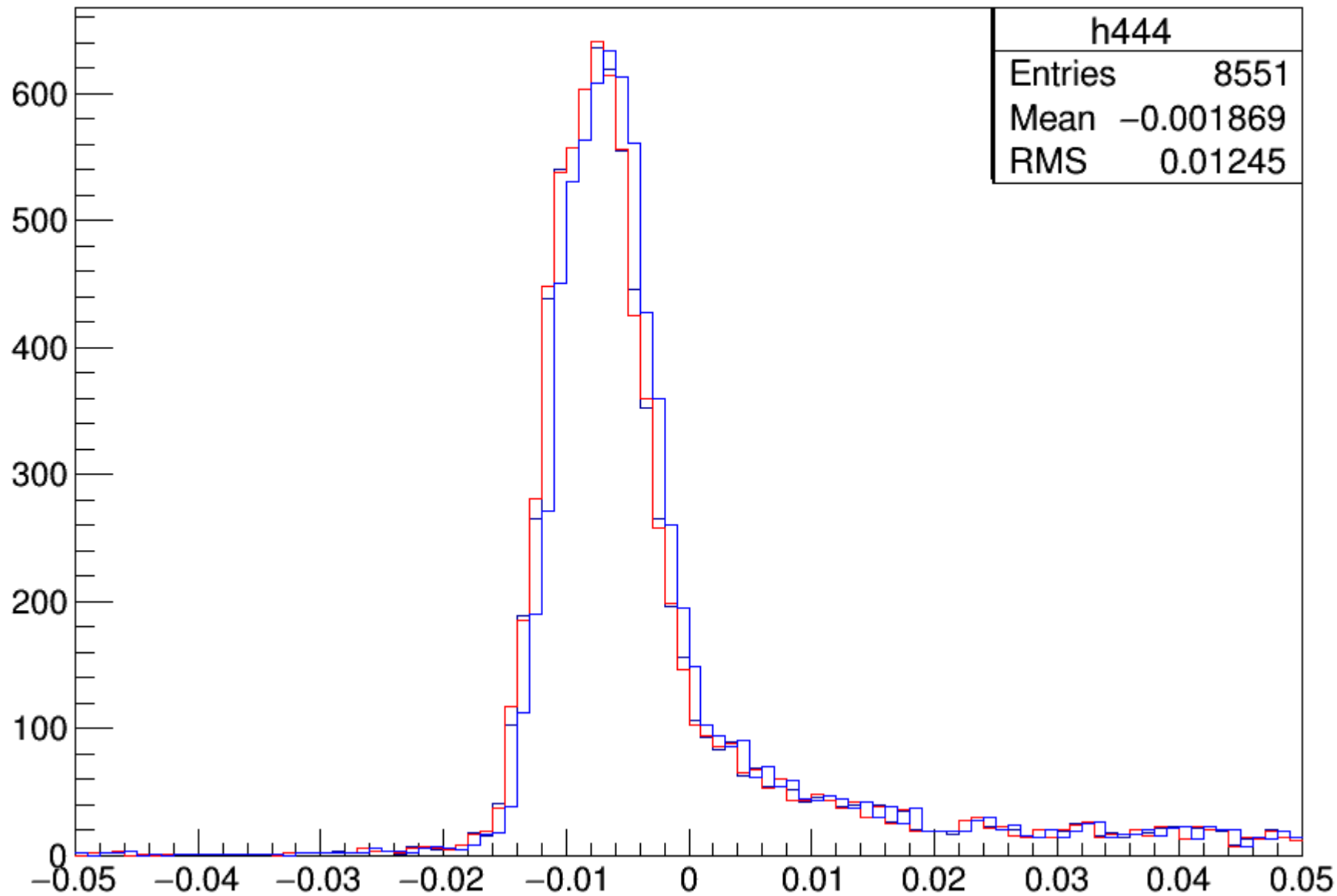
Histogram after Energy loss has been added.

Energy loss in 3 different target size

Target size:

- 10cm, 2.65" diameter
- 10 cm, 1.6" diameter
- 4 cm, 1.6" diameter

Histogram of Em



Script will be loaded to the git repository:

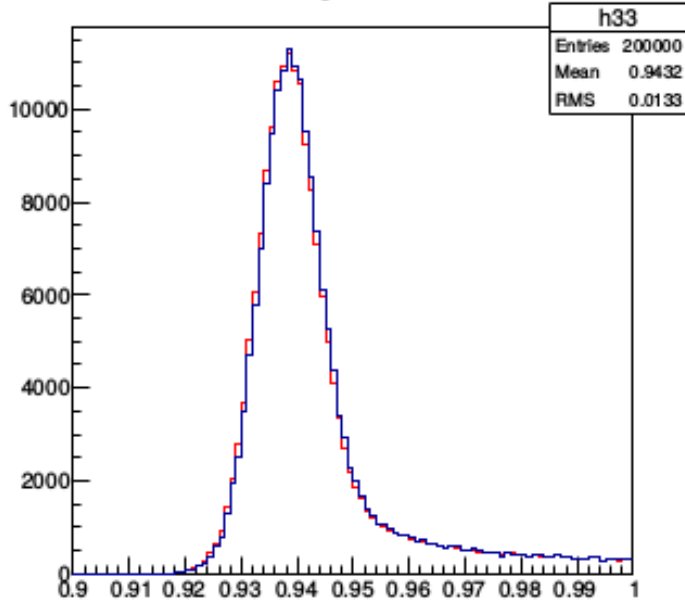
<https://github.com/MarkKJones/fall2017-plans/blob/master/heapcheck/scripts>

Currently adding comments and making the script more user friendly.

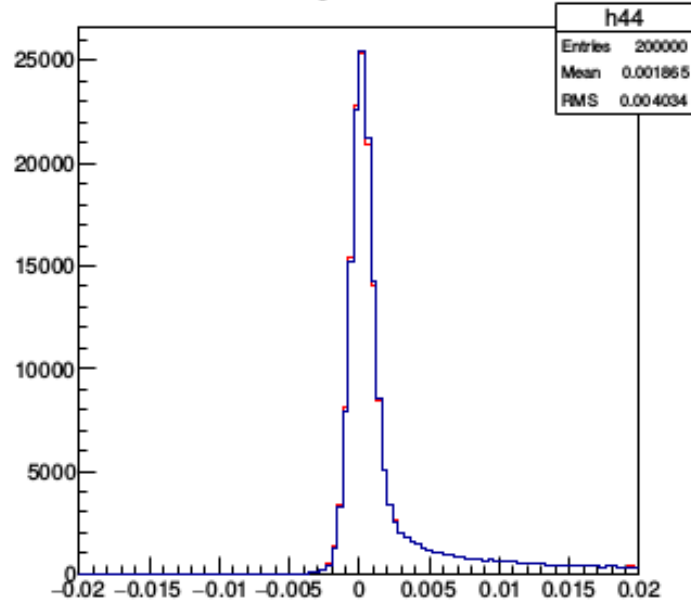
Will include script where electron is in SHMS and proton in HMS.

SCRIPT compare to SIMC results.

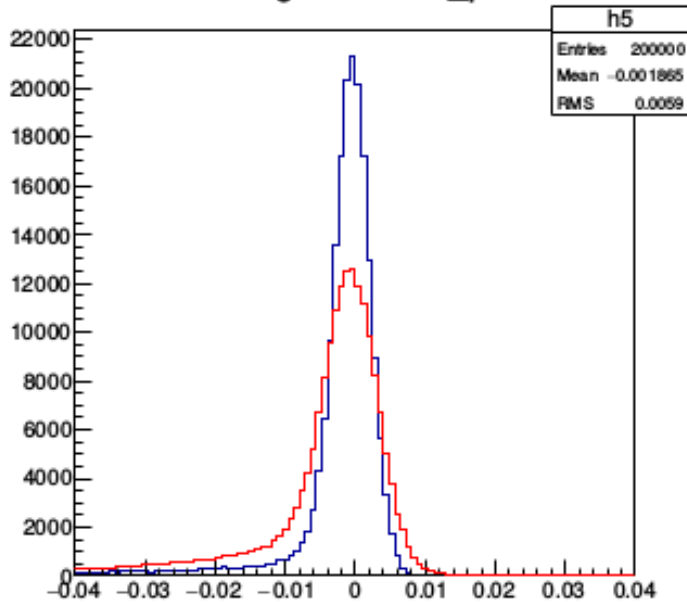
Histogram of W



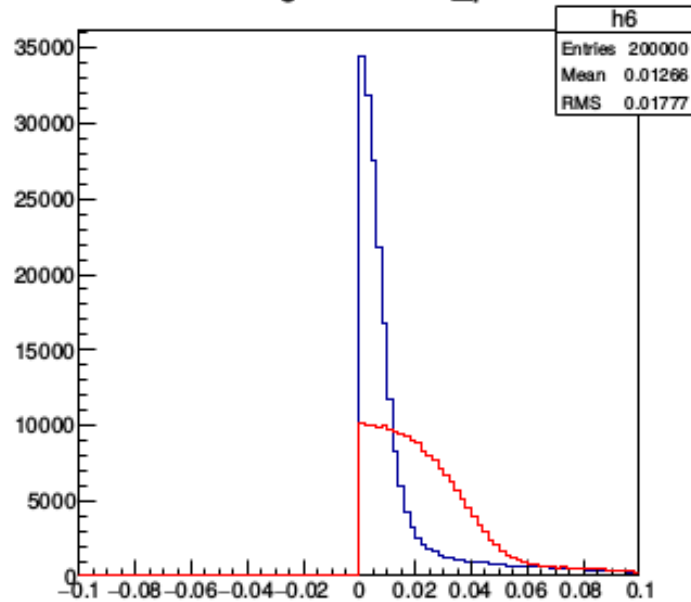
Histogram of Em



Histogram of Pm_par



Histogram of Pm_per



Kinematics

$E_{\text{beam}} = 2.2 \text{ GeV}$
 $\theta_e = 65.2 \text{ deg}$
 $\theta_p = 25.1 \text{ deEg}$
 $p_e = 0.9381 \text{ GeV}$
 $p_p = 1.9971 \text{ GeV}$

→ In SIMC Pm_z is long the beam direction (not along q-vector).