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# Pion-LT Meeting

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# HEEP Study

PionLT Experiment

Beam Energy (GeV)	Setting (HeePCoin - 9)	Run Numbers
5.986	HMS_p = -3.271, HMS_theta = 29.170, SHMS_p = 3.493, SHMS_theta = 27.495	13058 – 13062, 13128
6.395 (s1)	HMS_p = -4.752, HMS_theta = 18.595, SHMS_p = 2.412, SHMS_theta = 37.970	16277 – 16279
6.395 (s2)	HMS_p = -4.391, HMS_theta = 21.095, SHMS_p = 2.792, SHMS_theta = 34.470	16280 – 16282
6.395 (s3)	HMS_p = -3.014, HMS_theta = 33.350, SHMS_p = 4.220, SHMS_theta = 23.115	16512 - 16517
7.937	HMS_p = -3.280, HMS_theta = 33.645, SHMS_p = 5.512, SHMS_theta = 19.265	14589 - 14600
8.479	HMS_p = -5.587, HMS_theta = 19.560, SHMS_p = 3.731, SHMS_theta = 30.020	16162 – 16165
9.177	HMS_p = -3.738, HMS_theta = 31.645, SHMS_p = 6.265, SHMS_theta = 18.125	11846 - 11879
9.876	HMS_p = -5.366, HMS_theta = 23.050, SHMS_p = 5.422, SHMS_theta = 23.050	13164 - 13169
10.549	HMS_p = -5.878, HMS_theta = 21.670, SHMS_p = 5.539, SHMS_theta = 23.110	14986 - 14993

- Cuts for HeeP data.

### HMS Cuts (Electrons)

$$-8 < H\_gtr\_dp < 8$$

$$-0.08 < H\_gtr\_th < 0.08$$

$$-0.045 < H\_gtr\_ph < 0.045$$

$$HMS\_Cal\_etottracknorm > 0.7$$

$$H\_Cer\_npeSum > 1.5$$

### SHMS Cuts (Protons)

$$-10 < P\_gtr\_dp < 20$$

$$-0.06 < P\_gtr\_th < 0.06$$

$$-0.04 < P\_gtr\_ph < 0.04$$

Ctime\_epCoinTime\_ROC1 – Prompt Peak

- Cuts for HeeP SIMC.

### HMS Cuts (Electrons)

$$-8 < hsdelta < 8$$

$$-0.08 < hsxpfp < 0.08$$

$$-0.045 < hsyfp < 0.045$$

### SHMS Cuts (Protons)

$$-10 < ssdelta < 20$$

$$-0.06 < ssxpfp < 0.06$$

$$-0.04 < ssypfp < 0.04$$

- Global In-Plane Offset from Garth:

### Global In-Plane Offsets – Momentum and Energy offsets in 0.1% unit, Angle offset in mrad unit

<b>dthe</b>	1.2000	<b>dpe</b>	-0.1000	<b>dthp</b>	1.7000	<b>dpp</b>	-0.2000		
<b>BE</b>	5984.8	6394.7s1	6394.7s2	6394.7s3	7937.6	8478.6	9171.3	9876.9	10546.8
<b>dE</b>	-0.6000	-0.6000	-0.6000	-0.6000	-0.5000	-0.5000	-0.6000	-0.7000	-0.0000

- Implemented energy, momentum and angle offset with positive sign on both DATA and SIMC.
- Implemented Out-of-plane offsets to DATA (**HMS = +0.0019rad** and **SHMS = -0.00005rad**).

# HEEP Study

PionLT Experiment

Beam Energy (GeV)	Run Numbers	Data/SIMC Ratio	Issues
5.986	13058 – 13062, 13128	1.054 +/- 0.085	
6.395 (s1)	16277 – 16279	1.083 +/- 0.078	
6.395 (s2)	16280 – 16282	0.941 +/- 0.074	
6.395 (s3)	16512 - 16517	1.094 +/- 0.011	Dummy run issue
7.937	14589 - 14600	1.116 +/- 0.330	
8.479	16162 – 16165	1.144 +/- 0.100	
9.177	11846 - 11879	1.259 +/- 0.348	
9.876	13164 - 13169	1.153 +/- 0.136	
10.549	14986 - 14993	1.228 +/- 0.179	

- Uncertainties Calculations (Absolute):
- Used raw histograms (after cuts) for error calculation.
- Took integral and error using ROOT (IntegralAndError())
- Effective charge is calculated as (calculated run-by-run);

$$Effective\_charge\_run\_i = Charge \times Tracking\ Eff \times Detector\ Eff \times Hodo\ \frac{3}{4}Eff \times EDTM\ Live\ Time \times Boiling\ Corr$$

$$Effective\_charge\_run\_i\_err$$

$$= Effective\_charge\_run\_i \times \sqrt{\left(\frac{charge\_error}{charge}\right)^2 + \left(\frac{Tracking\_Eff\_error}{Tracking\_Eff}\right)^2 + \left(\frac{Detector\_Eff\_error}{Detector\ Eff}\right)^2 + \dots}$$

- Total effective charge is calculated as;

$$Total\_effective\_charge = Effective\_charge\_run1 + Effective\_charge\_run2 + Effective\_charge\_run3 + \dots$$

$$Total\_effective\_charge\_err = \sqrt{(Effective\_charge\_run1\_err)^2 + (Effective\_charge\_run2\_err)^2 + \dots}$$

$$Total\_effective\_charge\_err = Total\_effective\_charge \times \sqrt{\left(\frac{Effective\_charge\_run1\_err}{Effective\_charge\_run1}\right)^2 + \left(\frac{Effective\_charge\_run2\_err}{Effective\_charge\_run2}\right)^2 + \dots}$$

- For dummy, also included thickness correction factor.

- Data/SIMC Ratio is calculated as (calculated run-by-run);

$$\mathbf{DataSimc\_Ratio} = \frac{\mathbf{Normalized\_data} - \mathbf{Normalized\_dummy}}{\mathbf{Normalized\_simc}}$$

$$\mathbf{Normalized\_data} = \mathbf{Data\_counts/Total\_data\_effective\_charge}$$

$$\mathbf{Normalized\_data\_err} = \mathbf{Normalized\_data} \times \sqrt{\left(\frac{\mathbf{Data\_count\_error}}{\mathbf{Data\_counts}}\right)^2 + \left(\frac{\mathbf{Total\_data\_effective\_charge\_error}}{\mathbf{Total\_data\_effective\_charge}}\right)^2}$$

$$\mathbf{Normalized\_dummy} = \mathbf{Dummy\_counts/Total\_dummy\_effective\_charge}$$

$$\mathbf{Normalized\_dummy\_err} = \mathbf{Normalized\_dummy} \times \sqrt{\left(\frac{\mathbf{Dummy\_count\_error}}{\mathbf{Dummy\_counts}}\right)^2 + \left(\frac{\mathbf{Total\_dummy\_effective\_charge\_error}}{\mathbf{Total\_dummy\_effective\_charge}}\right)^2}$$

$$\mathbf{Normalized\_simc} = \mathbf{simc\_counts/(simc\_nevents/simc\_normfactor)}$$

$$\mathbf{Normalized\_simc\_err} = \mathbf{Normalized\_simc} \times \left(\frac{\mathbf{simc\_count\_error}}{\mathbf{simc\_counts}}\right)$$

$$\mathbf{DataSimc\_Ratio\_error} = \mathbf{DataSimc\_Ratio} \times \sqrt{\left(\frac{\mathbf{Normalized\_data\_err}}{\mathbf{Normalized\_data}}\right)^2 + \left(\frac{\mathbf{Normalized\_dummy\_err}}{\mathbf{Normalized\_dummy}}\right)^2 + \left(\frac{\mathbf{Normalized\_simc\_err}}{\mathbf{Normalized\_simc}}\right)^2}$$

- Made HeePCoin comparison plots and calculated Data/SIMC Ratio.
- Calculated errors in ratios properly.
- SIMC and Data is normalized.

$$\textit{Effective charge} = \textit{Charge} \times \textit{Tracking Eff} \times \textit{Detector Eff} \times \textit{Hodo}^{\frac{3}{4}} \textit{Eff} \times \textit{EDTM Live Time} \times \textit{Boiling Corr}$$

- In data normalization, Following quantities are included:
  - **Charge (run-by-run)**
  - **Tracking Efficiencies (HMS and SHMS run-by-run)**
  - **Detector Efficiencies (HMS Cer and HMS Cal run-by-run)**
  - **Hodo <sup>3</sup>/<sub>4</sub> Efficiencies (HMS and SHMS run-by-run)**
  - **EDTM Live Time (run-by-run)**
  - **Dummy Target Thickness Correction Applied – (3.527 +/- 0.227 - PionLT)**
  - **Richard's Boiling Correction Applied (-0.0007899) - From Richard**

### In progress:

- Working on error calculations.
- Checking Em distributions (plotting it vs other variables.)
- Will do SIMC Model testing with Nacer. (10.6 GeV).
- Working on Proton absorption correction.