Pion-LT Meeting

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HEEP Study

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

HEEP Study

- 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 < hsypfp< 0.045

SHMS Cuts (Protons)
-10 < ssdelta< 20
-0.06 < ssxpfp< 0.06
-0.04 < ssypfp< 0.04

HEEP Study

- **Global In-Plane Offset from Garth:**

Global In-Plane Offsets – Momentum and Energy offsets in 0.1% unit, Angle offset in mrad unit									
dthe	1.2000	**dpe**	-0.1000	**dthp**	1.7000	**dpp**	-0.2000		
BE	5984.8	6394.7s1	6394.7s2	6394.7s3	7937.6	8478.6	9171.3	9876.9	10546.8
dE	-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

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

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

- 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 ¾ 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 data/simc ratios.
- Looking into SHMS ¾ Hodo Efficiency.
- Will work on Proton absorption correction.

HEEP Study

Beam Energy (GeV)	Year	Run Numbers	Data/SIMC Ratio	Issues
5.986	2021	13058 – 13062, 13128	1.054 +/- 0.005	
6.395 (s1)	2022	16277 – 16279	1.083 +/- 0.004	EM_little broad
6.395 (s2)	2022	16280 – 16282	0.941 +/- 0.004	EM_little broad
6.395 (s3)	2022	16512 - 16517	1.094 +/- 0.011	Dummy run issue EM_little broad
7.937	2021	14589 - 14600	1.114 +/- 0.009	
8.479	2022	16162 – 16165	1.136 +/- 0.007	EM_little broad
9.177	2021	11846 - 11879	1.258 +/- 0.014	
9.876	2021	13164 - 13169	1.146 +/- 0.013	
10.549	2022	14986 - 14993	1.220 +/- 0.011	EM distribution is broad

HEEP Study

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	Doing Raster Check	

Raster Check

- Raster Check:
- Flipped sign of gfrya_adcpercm and gfryb_adcpercm variables.

Existing Parameters

```
; Raster constants for pionlt June 2 2022
gfr_cal_mom  = 7.950
gfrxa_adc_zero_offset = 54300
gfrxb_adc_zero_offset = 54300
gfrya_adc_zero_offset = 54630
gfryb_adc_zero_offset = 54800
;
gfrxa_adcpercm = (63427-44954)/.2
gfrxb_adcpercm = (63841-44824)/.2
gfrya_adcpercm = -(65450-44885)/.2
gfryb_adcpercm = -(64417-45240)/.2
```

Sign flipped Parameters 2022

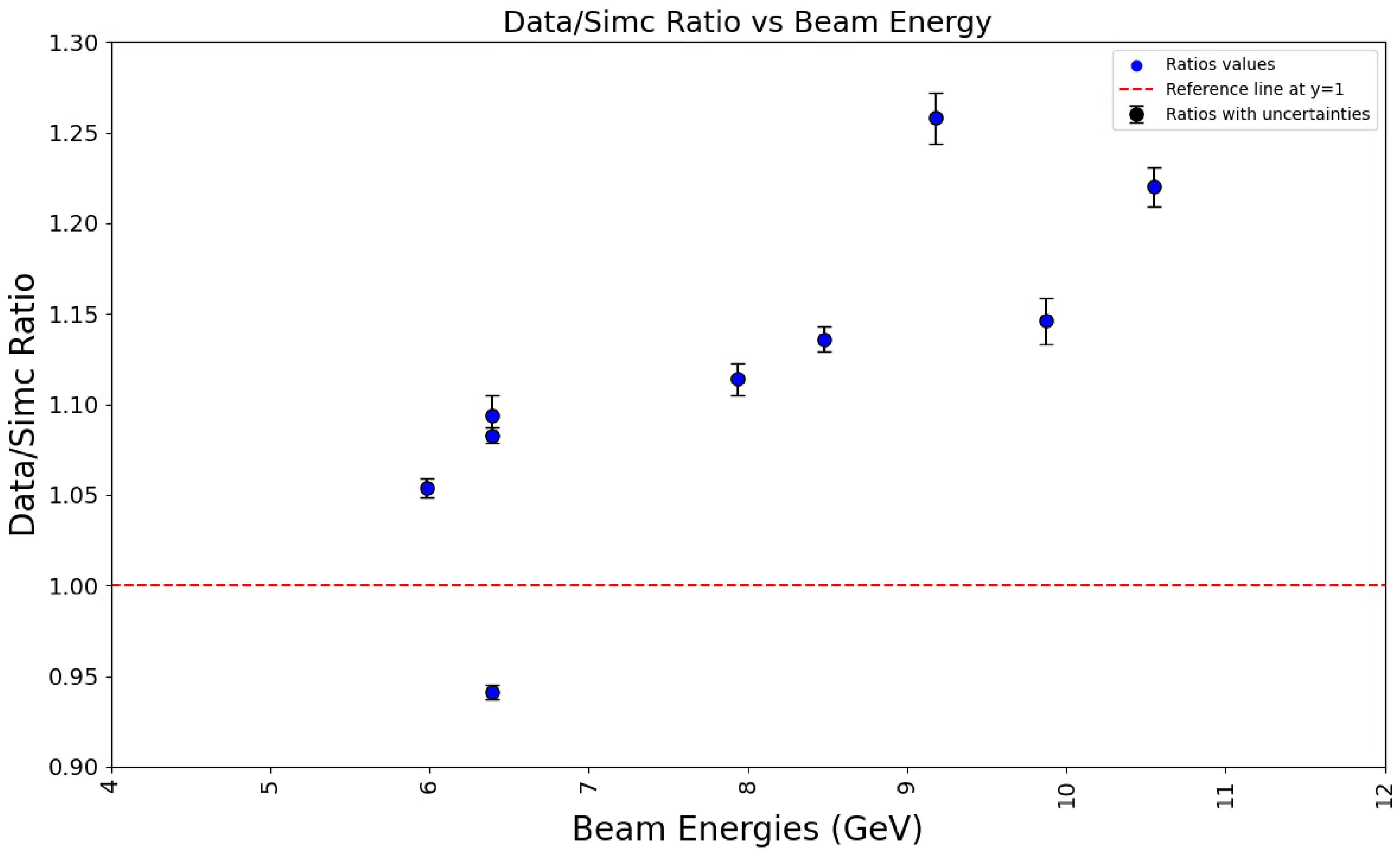
```
; Raster constants for pionlt June 2 2022
gfr_cal_mom  = 7.950
gfrxa_adc_zero_offset = 54300
gfrxb_adc_zero_offset = 54300
gfrya_adc_zero_offset = 54630
gfryb_adc_zero_offset = 54800
;
gfrxa_adcpercm = (63427-44954)/.2
gfrxb_adcpercm = (63841-44824)/.2
gfrya_adcpercm = (65450-44885)/.2
gfryb_adcpercm = (64417-45240)/.2
```

Sign flipped Parameters 2021

```
 Raster constants for pionlt Sept 5 2021
gfr_cal_mom  = 9.203
gfrxa_adc_zero_offset = 54290
gfrxb_adc_zero_offset = 54290
gfrya_adc_zero_offset = 54290
gfryb_adc_zero_offset = 54800

gfrxa_adcpercm = (66346-42290)/.2
gfrxb_adcpercm = (64590-43750)/.2
gfrya_adcpercm = (65450-43750)/.2
gfryb_adcpercm = (64750-44860)/.2
```

- Distributions improved after flipping signs.


Data/Simc Ratio vs Beam Energy
Ratios values
Reference line at y=1
Ratios with uncertainties
Data/Simc Ratio
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
4
5
6
7
8
9
10
11
12
Beam Energies (GeV)

HEEP Study

- 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);

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

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

- Total effective charge is calculated as;

$$Total\_effective\_charge = Effective\_charge\_run1 + Effective\_charge\_run2 + Effective\_charge\_run3 + \ldots\ldots\ldots\ldots..$$

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

- For dummy, also included thickness correction factor.

HEEP Study

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

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

$$Normalized\_data\_dummy\_sub = Normalized\_data - Normalized\_dummy$$

$$Normalized\_data = Data\_counts/Total\_data\_effective\_charge$$

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

$$Normalized\_dummy = Dummy\_counts/Total\_dummy\_effective\_charge$$

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

$$Normalized\_data\_dummy\_sub\_err = \sqrt{(Normalized\_data\_err)^2 + (Normalized\_dummy\_err)^2}$$

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

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

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