# CaFe H(e, e'p) Elastics Kinematics @ beam energies: 10.3 GeV and 10.6 GeV

July 14, 2022

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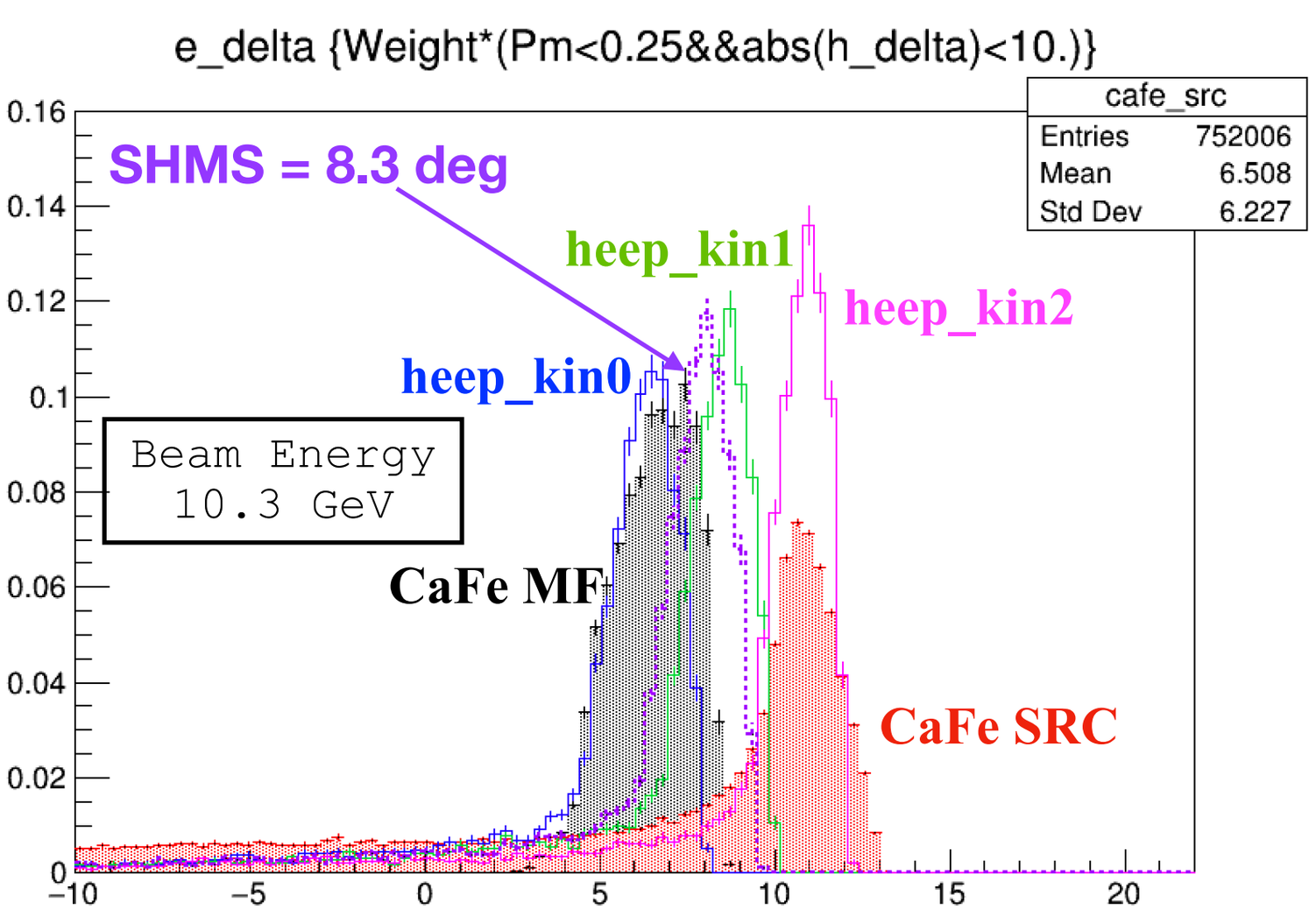
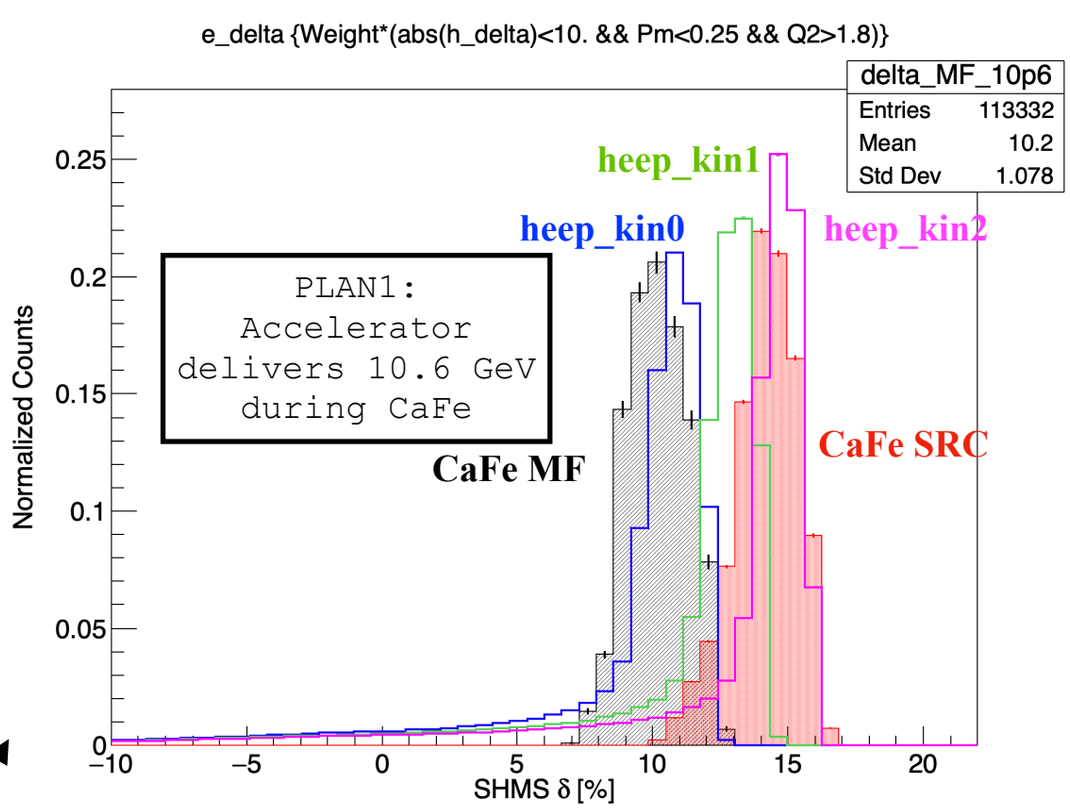
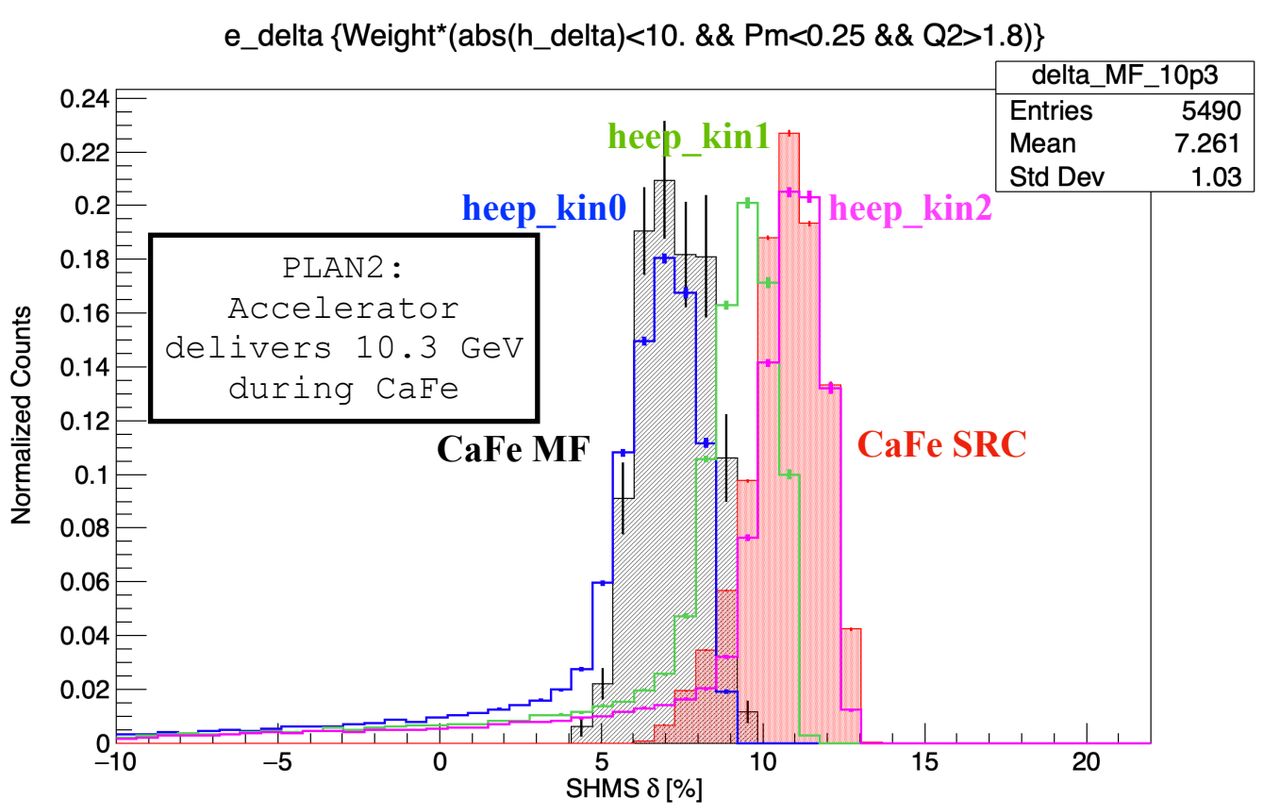



| Kinematic | SHMS P [GeV/c] | SHMS Angle [deg] | HMS P [GeV/c] | HMS Angle [deg] | Beam E [GeV] |
|---|---|---|---|---|---|
| **CaFe MF** | -8.55 | 8.3 | 1.88 | 46.2 | 10.3 |
| **CaFe SRC** | -8.55 | 8.3 | 1.325 | 65.8 | 10.3 |
| **heep_kin0** | -8.55 | 8.9 | 1.924 | 47 | 10.3 |
| **heep_kin1** | -8.55 | 8.1 | 1.715 | 49.7 | 10.3 |
| **heep_kin2** | -8.55 | 7.2 | 1.488 | 53 | 10.3 |
| **shms_8p3** | -8.55 | 8.3 | 1.767 | 49 | 10.3 |

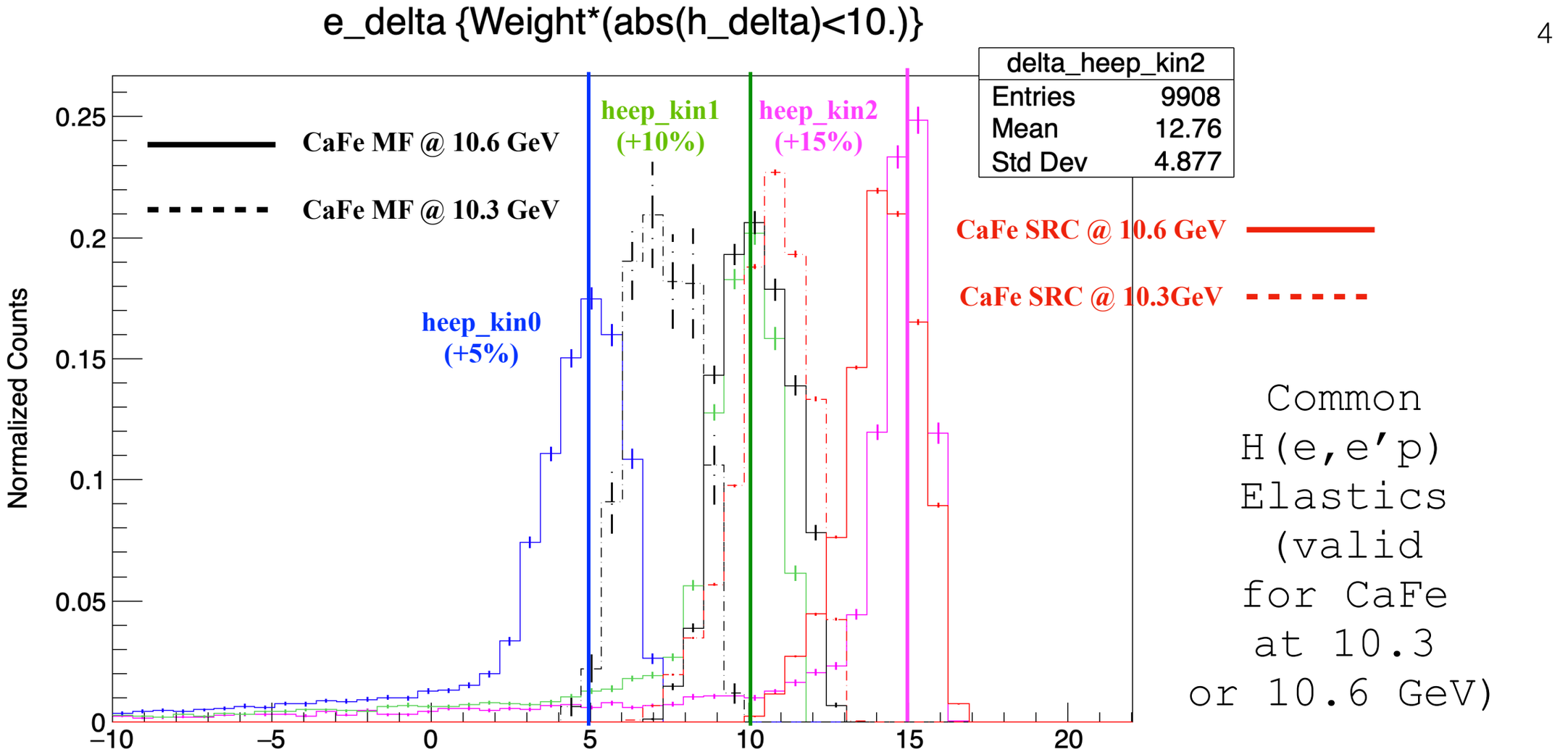
- At beam energy 10.3 GeV, cafe heep_kin2 setting restricted by the large beam pipe (min. 7.5 deg)
  - Still need to take hydrogen elastic singles during pionLT, with the smaller beam pipe installed to achieve angles smaller than 7.5 deg




- Too many H(e, e'p) elastic kinematics. It is best to select 3 elastic points that span over entire CaFe range regardless of whether 10.6 or 10.3 GeV beam is delivered (see next slide)

| Kinematic | SHMS P [GeV/c] | SHMS Angle [deg] | HMS P [GeV/c] | HMS Angle [deg] | Beam E [GeV] |
|---|---|---|---|---|---|
| **CaFe MF** | -8.55 | 8.3 | 1.82 | 48.3 | 10.6 |
| **CaFe SRC** | -8.55 | 8.3 | 1.325 | 66.4 | 10.6 |
| **heep_kin0** | -8.55 | 8.3 | 1.82 | 48.3 | 10.6 |
| **heep_kin1** | -8.55 | 7.5 | 1.62 | 51.1 | 10.6 |
| **heep_kin2** | -8.55 | 6.8 | 1.44 | 53.8 | 10.6 |
| **CaFe MF** | -8.55 | 8.3 | 1.767 | 49 | 10.3 |
| **CaFe SRC** | -8.55 | 8.3 | 1.325 | 65.8 | 10.3 |
| **heep_kin0** | -8.55 | 9.6 | 2.196 | 44 | 10.6 |
| **heep_kin1** | -8.55 | 8.77 | 1.963 | 46.7 | 10.6 |
| **heep_kin2** | -8.55 | 8.23 | 1.815 | 48.5 | 10.6 |




Common H(e,e'p) Elastics (valid for CaFe at 10.3 or 10.6 GeV)

SHMS Momentum Acceptance [%]

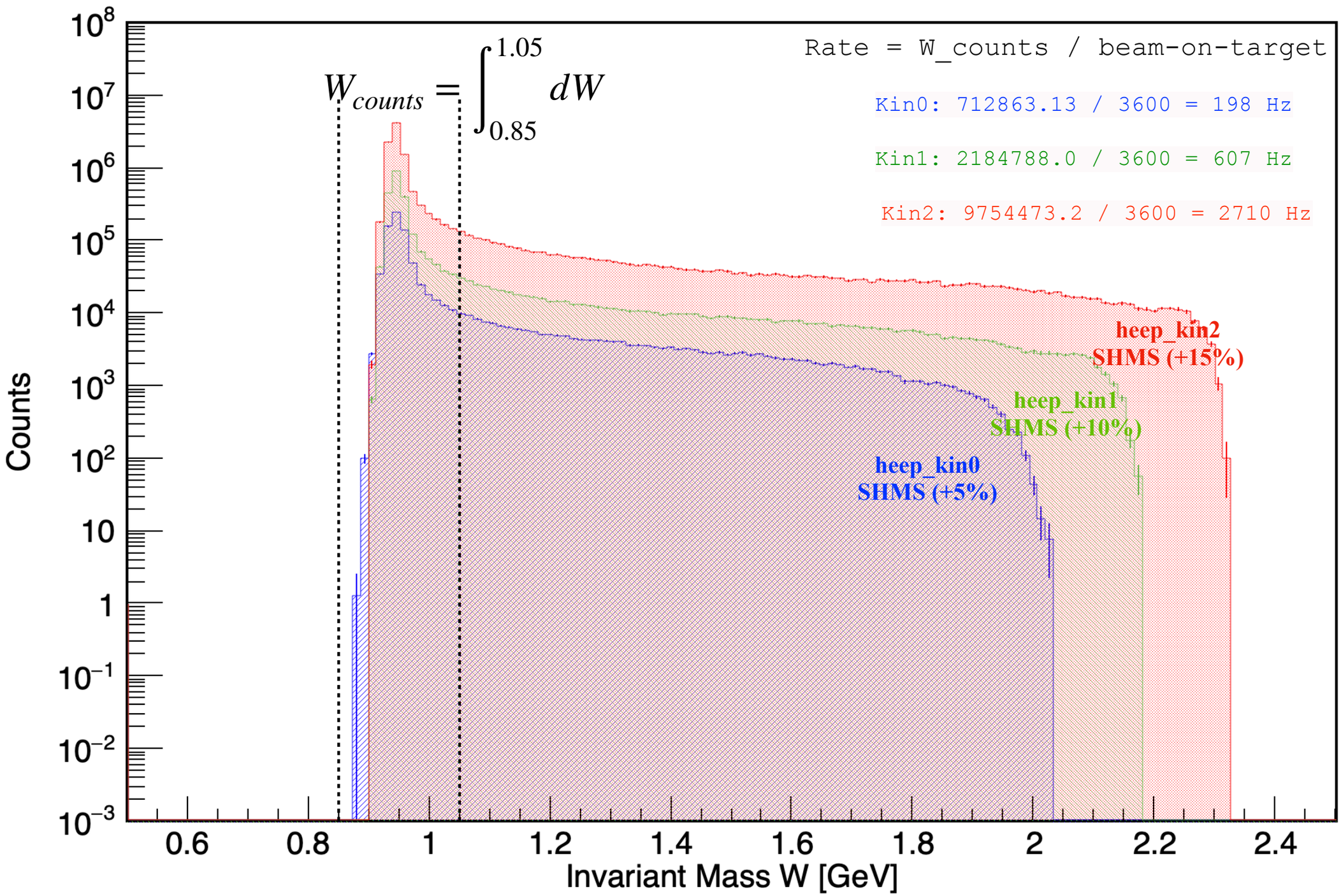
| Kinematic | SHMS P [GeV/c] | SHMS Angle [deg] | HMS P [GeV/c] | HMS Angle [deg] | Beam E [GeV] | Shms Delta |
|---|---|---|---|---|---|---|
| **CaFe MF (+ proton abs.)** | -8.55 | 8.3 | 1.82 | 48.3 | 10.6 | 10% |
| **CaFe SRC** | -8.55 | 8.3 | 1.325 | 66.4 | 10.6 | 14% |
| **CaFe MF (+ proton abs.)** | -8.55 | 8.3 | 1.767 | 49 | 10.3 | 7% |
| **CaFe SRC** | -8.55 | 8.3 | 1.325 | 65.8 | 10.3 | 11% |
| **heep_kin0 (+ optics)** | -8.55 | 10.26 | 2.382 | 42.17 | 10.6 | 5% |
| **heep_kin1** | -8.55 | 8.6 | 1.916 | 47.24 | 10.6 | 10% |
| **heep_kin2 (+ optics)** | -8.55 | 6.74 | 1.424 | 54.10 | 10.6 | 15% |

# H(e,e'p) Elastic Rate Estimates

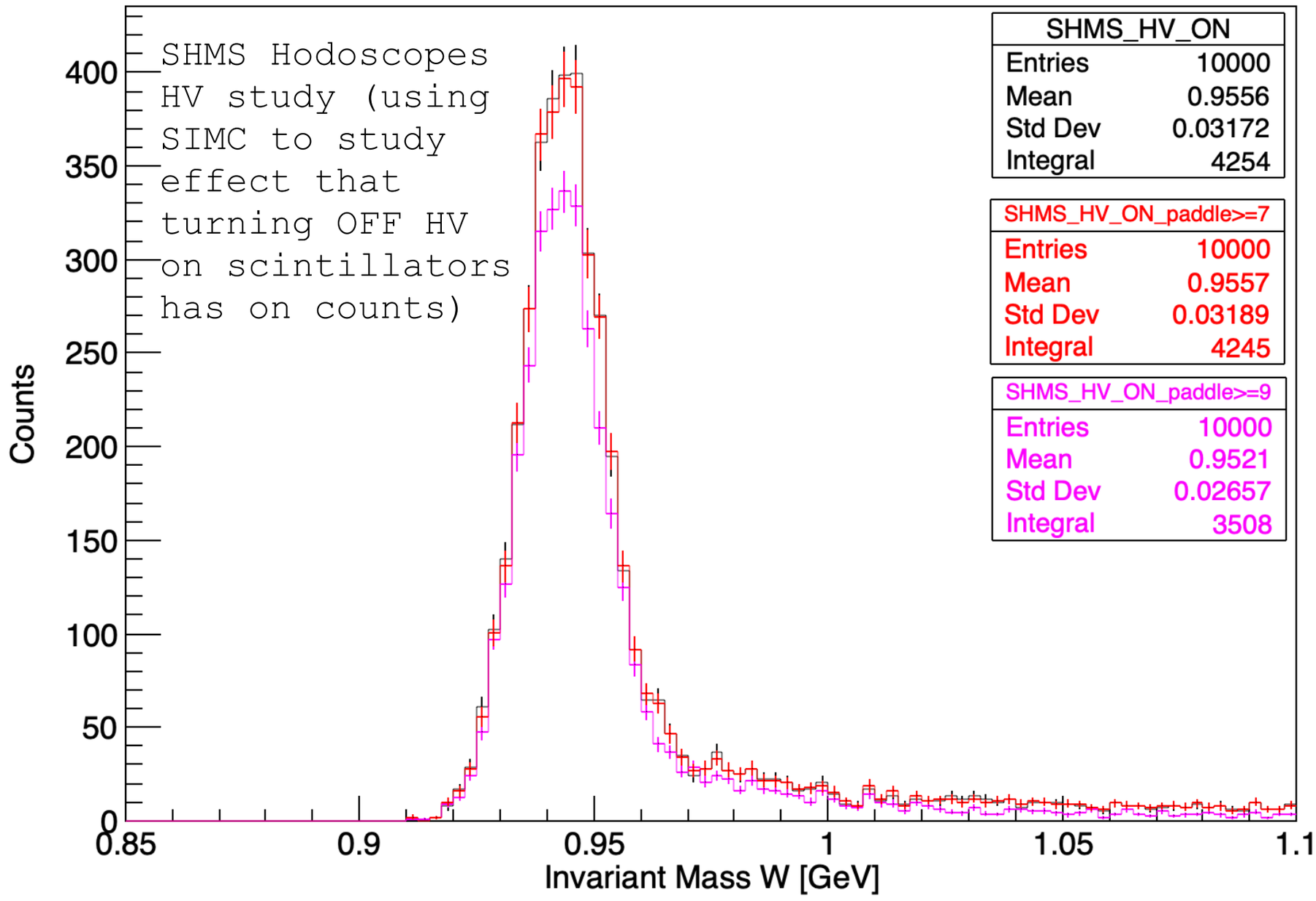
- beam-on-target time: 1 hr
- beam current: 60 uA

- analysis_cuts:
  - ✓ $|\delta_{HMS}| < 10\,\%$ , $-10\,\% < \delta_{SHMS} < 22\,\%$
  - ✓ HMS/SHMS Collimator Cuts

## Invariant Mass, W



# SHMS Hodoscope HV Study

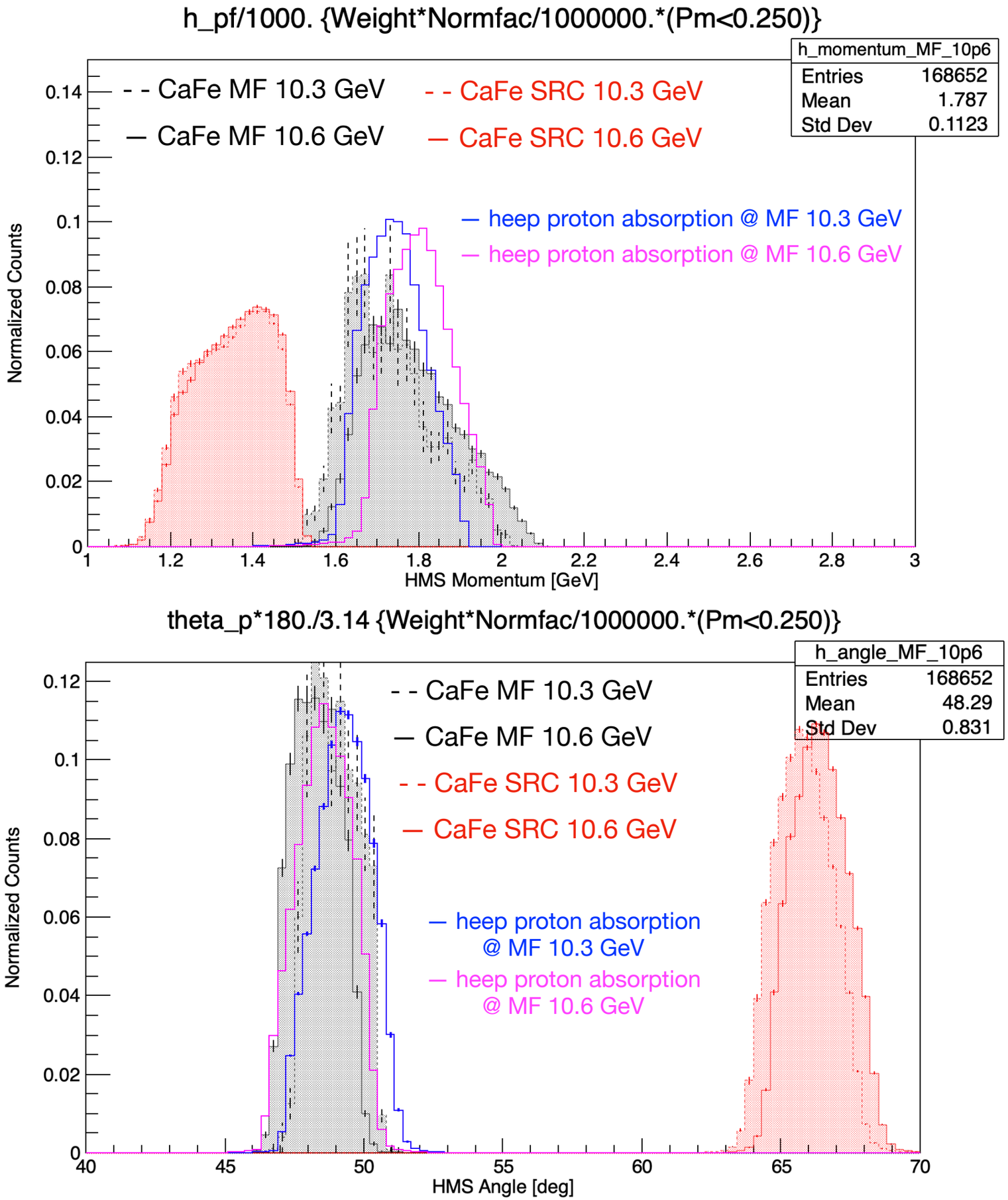



- SHMS S1X+S2X paddles PMT HV turned OFF corresponding to unused part of momentum acceptance (~ < 0 %)

  - SHMS Hodoscopes ALL paddles HV ON,
  - paddles >=7 HV ON produces similar (e, e'p) elastic counts as ALL paddles HV ON -> safe to turn OFF paddles <7 for S1X+S2X
  - as a test, Turning OFF paddles < 9 already shows a decrease in counts

# Proton Absorption Measurements






- **Proton absorption:** probability proton gets absorbed as it traverses thru spectrometer (HMS) before it makes a trigger
- **(Top, bottom plots):** Kinematic coverage for proton absorption in HMS acceptance @ MF kinematics for both possible beam energies, 10.3, 10.6 GeV
- The proton absorption measurement will be done at the same kinematics as the CaFe mean-field
- **Questions/Comments:**

  Is proton absorption at SRC kinematics needed? **NO**

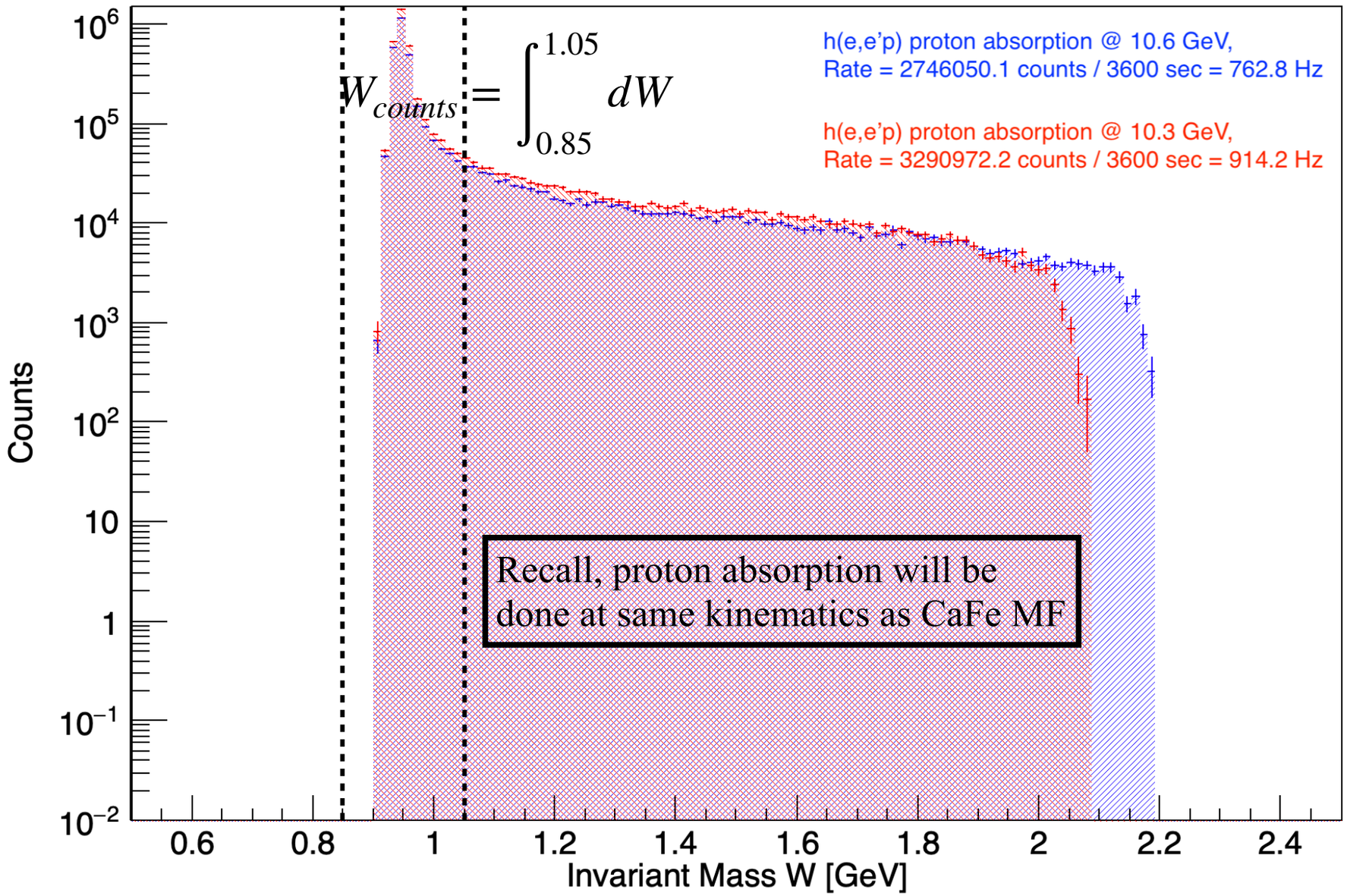
How does a SRC: ~1.3 GeV (66 deg) proton and a MF: ~1.7 GeV (48 deg) proton compare as they traverse thru HMS? Maybe cross sections at these energies are not significantly different? And thus proton absorption results at only MF are sufficient? **Previous measurements (Ruonan Li thesis, Carlos Yero thesis) show absorption is ~0.95 % for momentum range ~0.8 - 2.92 GeV . Also, pp-total cross sections are ~ momentum-independent in this range. Single proton absorption measurement at MF kinematics is sufficient**

Even if proton absorption at SRC kinematics would be needed, that would require SHMS angles <7.5 deg, and thus CANNOT be done during CaFe (larger beam pipe installed)

# Proton Absorption Studies Rate Estimates of Good Elastic (e, e'p) events

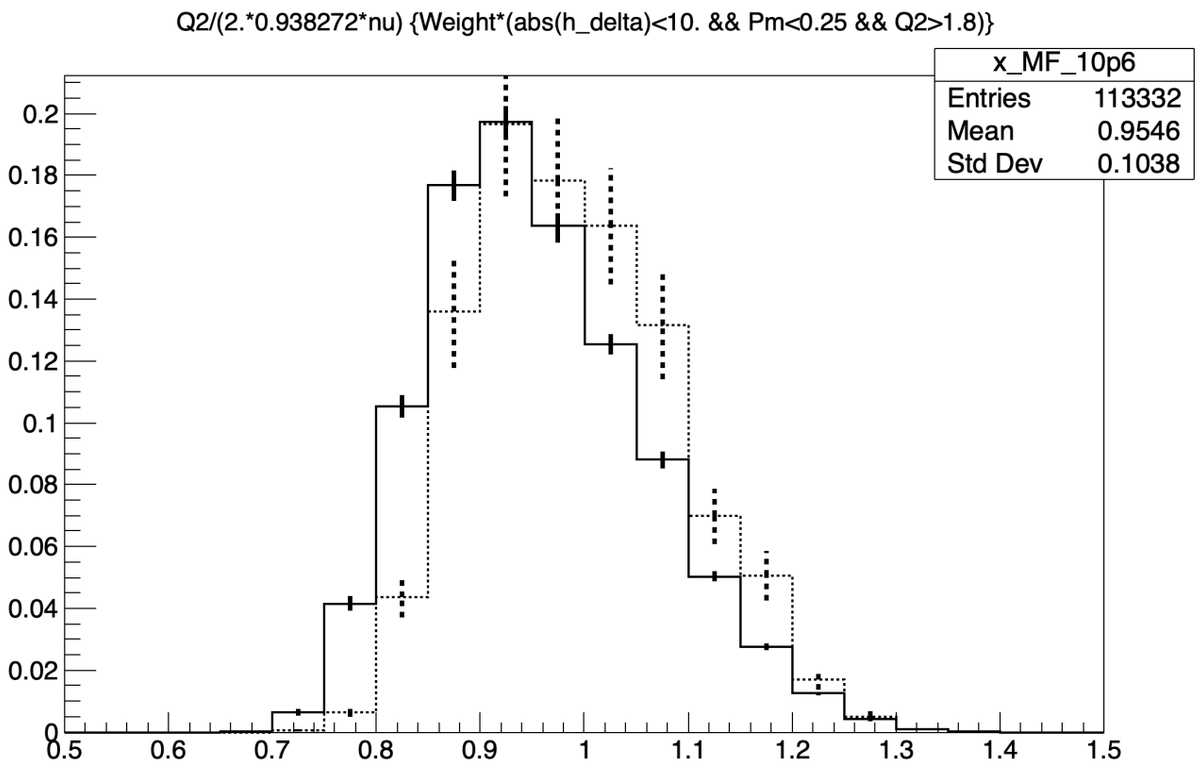
- beam-on-target time: 1 hr
- beam current: 60 uA

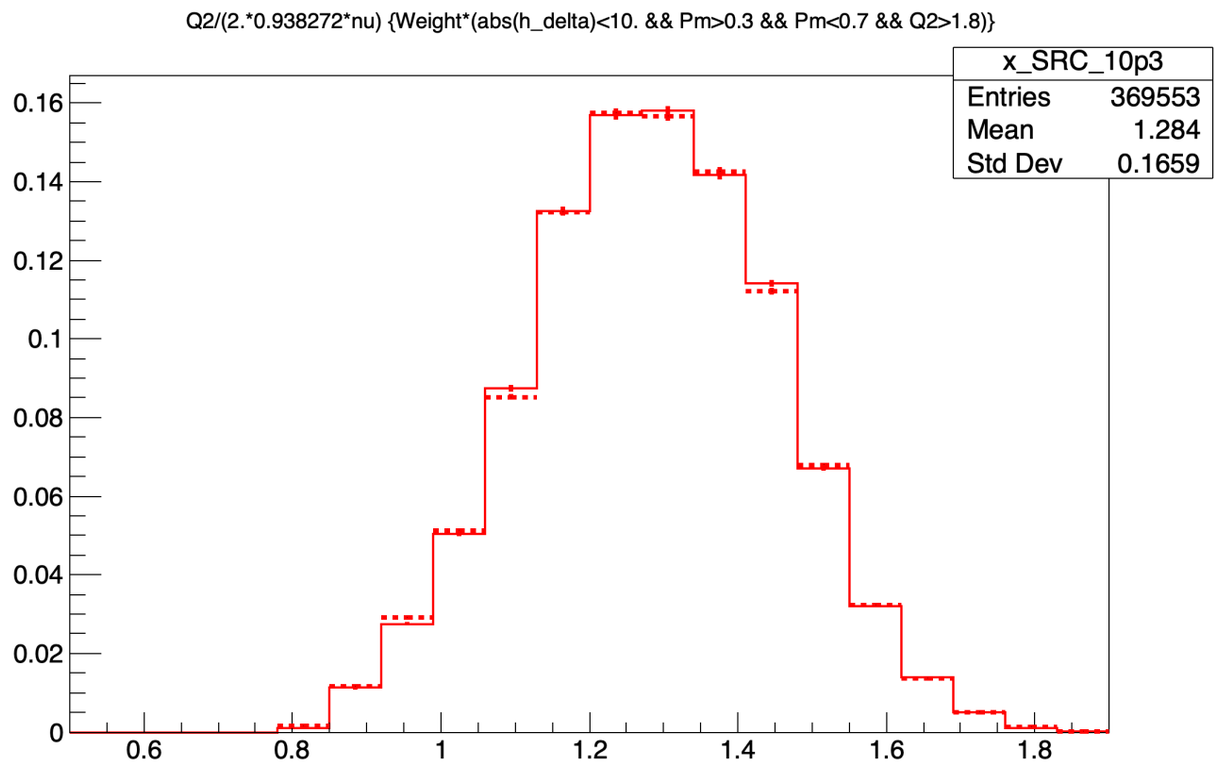
- analysis_cuts:
  - ✓ $|\delta_{HMS}| < 10\,\%$ , $-10\,\% < \delta_{SHMS} < 22\,\%$
  - ✓ HMS/SHMS Collimator Cuts




| Kinematic | SHMS P [GeV/c] | SHMS Angle [deg] | HMS P [GeV/c] | HMS Angle [deg] | Beam E [GeV] | Shms Delta |
|---|---|---|---|---|---|---|
| **CaFe MF (+ proton abs.)** | -8.55 | 8.3 | 1.82 | 48.3 | 10.6 | 10% |
| **CaFe MF (+ proton abs.)** | -8.55 | 8.3 | 1.767 | 49 | 10.3 | 7% |

# BACK-UP SLIDES




**CaFe MF: 10.6 GeV**

**CaFe MF: 10.3 GeV**

**CaFe SRC: 10.6 GeV**

**CaFe SRC: 10.3 GeV**

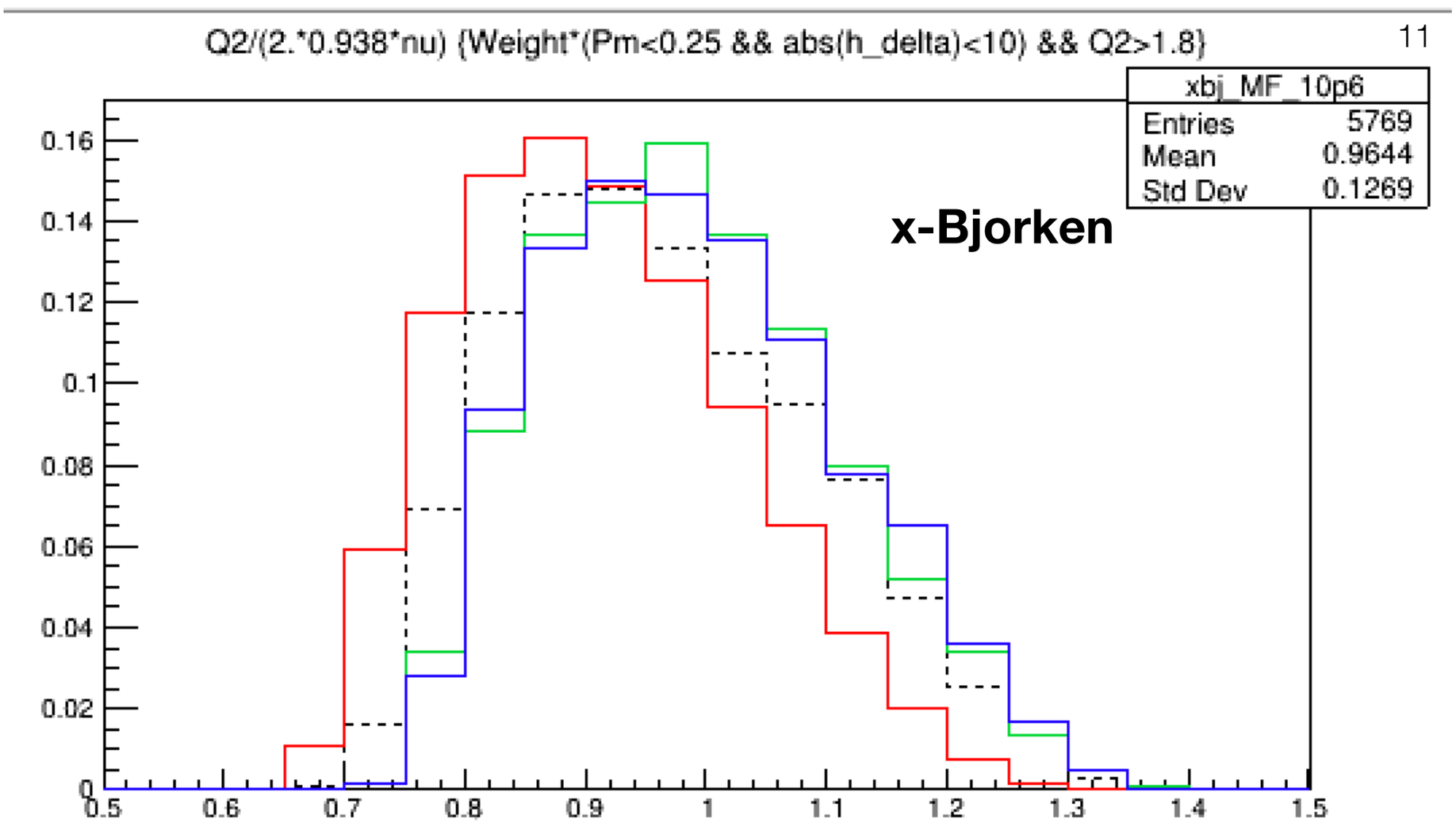
**x-Bjorken for CaFe MF and SRC kinematics at either 10.6 or 10.3 GeV beam**

**- - - - MF @ 10.6 GeV**

**Original MF @ 10.3 GeV**

**Larry's suggestion (step 2)**

**Larry's suggestion (step 2, but using SHMS angle 8.3 deg)**




**We'll use this MF kinematic @ 10.3 GeV (then I will match the Heep elastic to this kinematic, similar to what we did @ 10.6 GeV)**

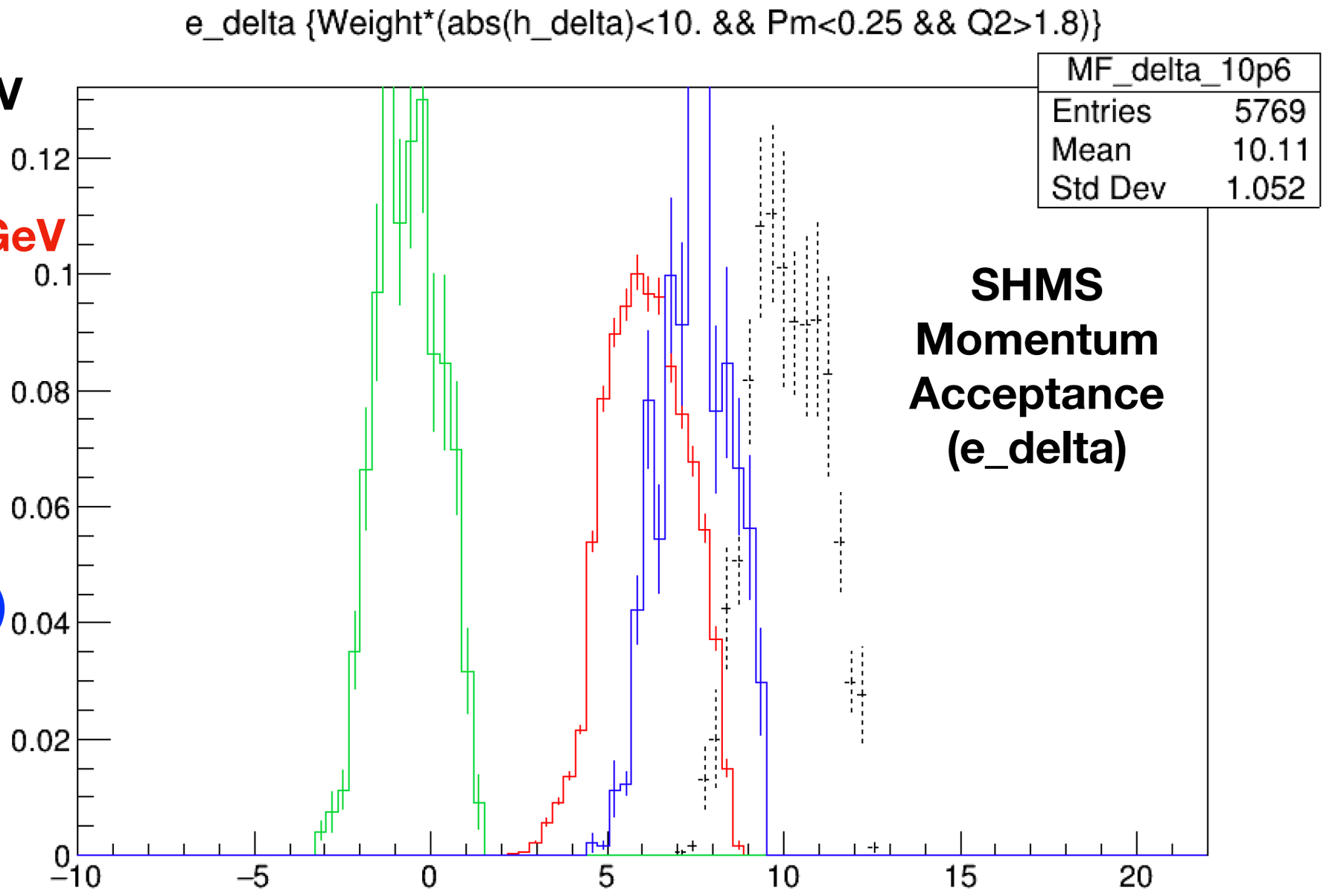
| Kinematic | SHMS P [GeV/c] | SHMS Angle [deg] | HMS P [GeV/c] | HMS Angle [deg] | Beam E [GeV] |
|---|---|---|---|---|---|
| **CaFe MF** | -8.55 | 8.3 | 1.82 | 48.3 | 10.6 |
| **CaFe MF** | -8.55 | 8.3 | 1.88 | 46.2 | 10.3 |
| **CaFe MF** | -8.55 | 9.238 | 1.767 | 49.7 | 10.3 |
| **CaFe MF** | -8.55 | 8.3 | 1.767 | 49.0 | 10.3 |

**- - - - MF @ 10.6 GeV**

**Original MF @ 10.3 GeV**

**Larry's suggestion (step 2)**

**Larry's suggestion (step 2, but using SHMS angle 8.3 deg)**




| Kinematic | SHMS P [GeV/c] | SHMS Angle [deg] | HMS P [GeV/c] | HMS Angle [deg] | Beam E [GeV] |
|---|---|---|---|---|---|
| **CaFe MF** | -8.55 | 8.3 | 1.82 | 48.3 | 10.6 |
| **CaFe MF** | -8.55 | 8.3 | 1.88 | 46.2 | 10.3 |
| **CaFe MF** | -8.55 | 9.238 | 1.767 | 49.7 | 10.3 |
| **CaFe MF** | -8.55 | 8.3 | 1.767 | 49.0 | 10.3 |