Study of the Short-Range Nucleon-Nucleon Potentials via Electro-disintegration of the Deuteron at High Four Momentum Transfers Q^2

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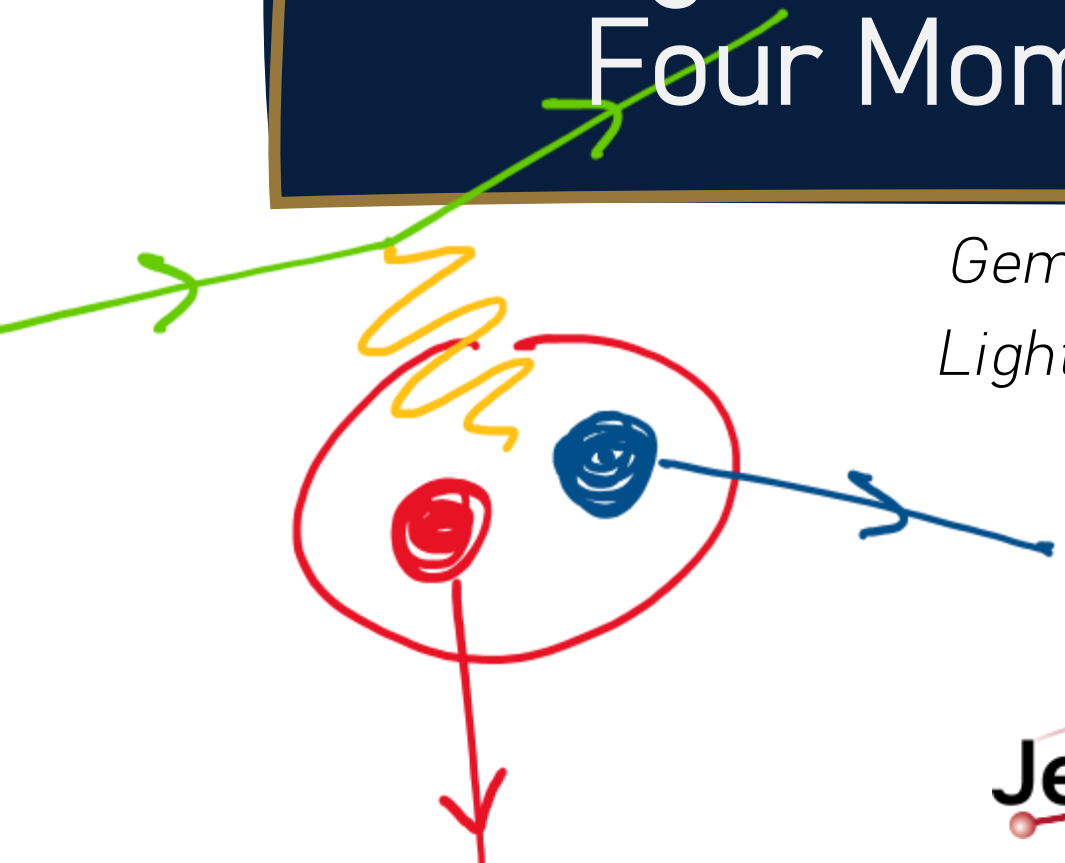
Light-Ion Summer School

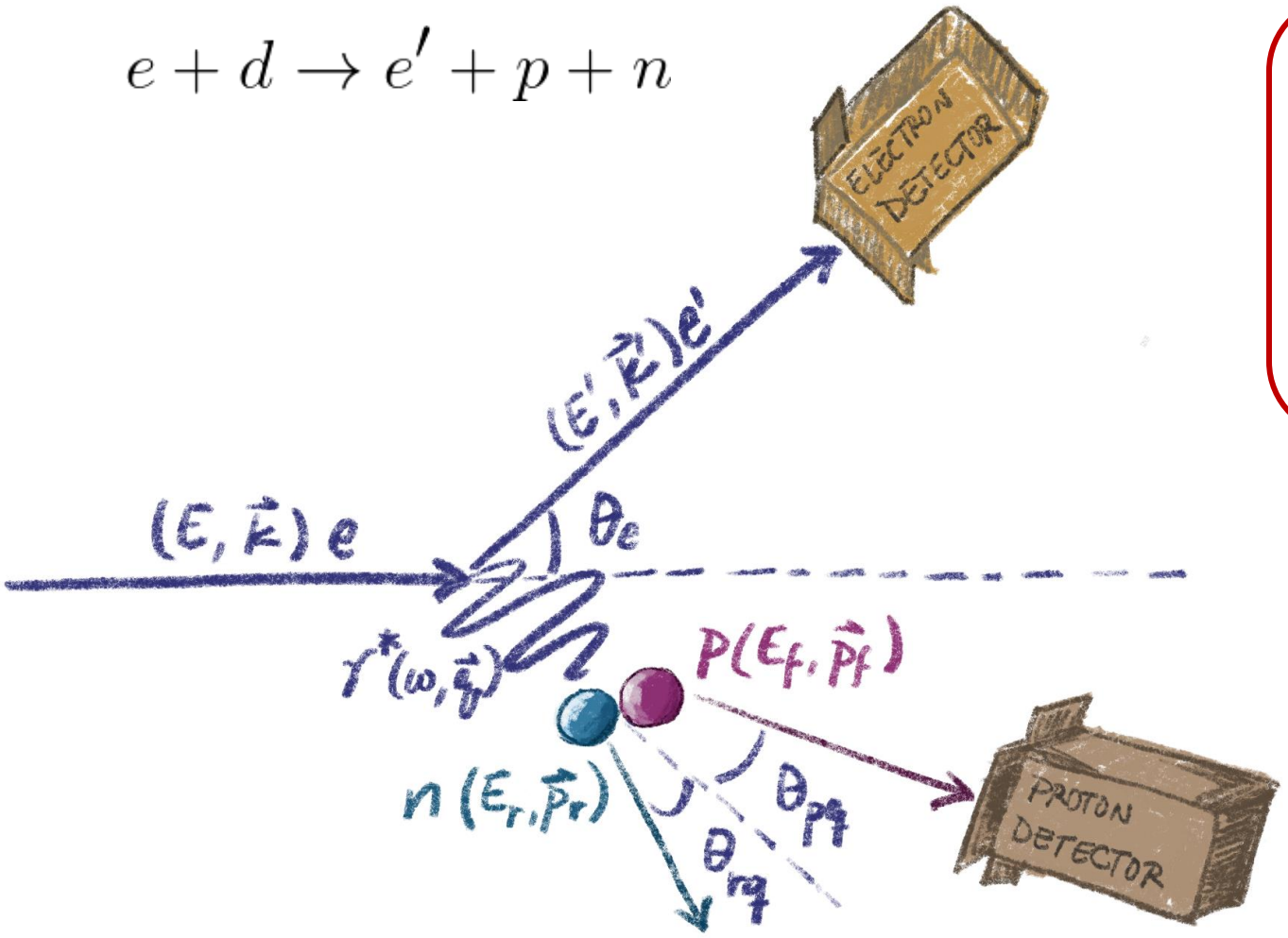
25 June 2025

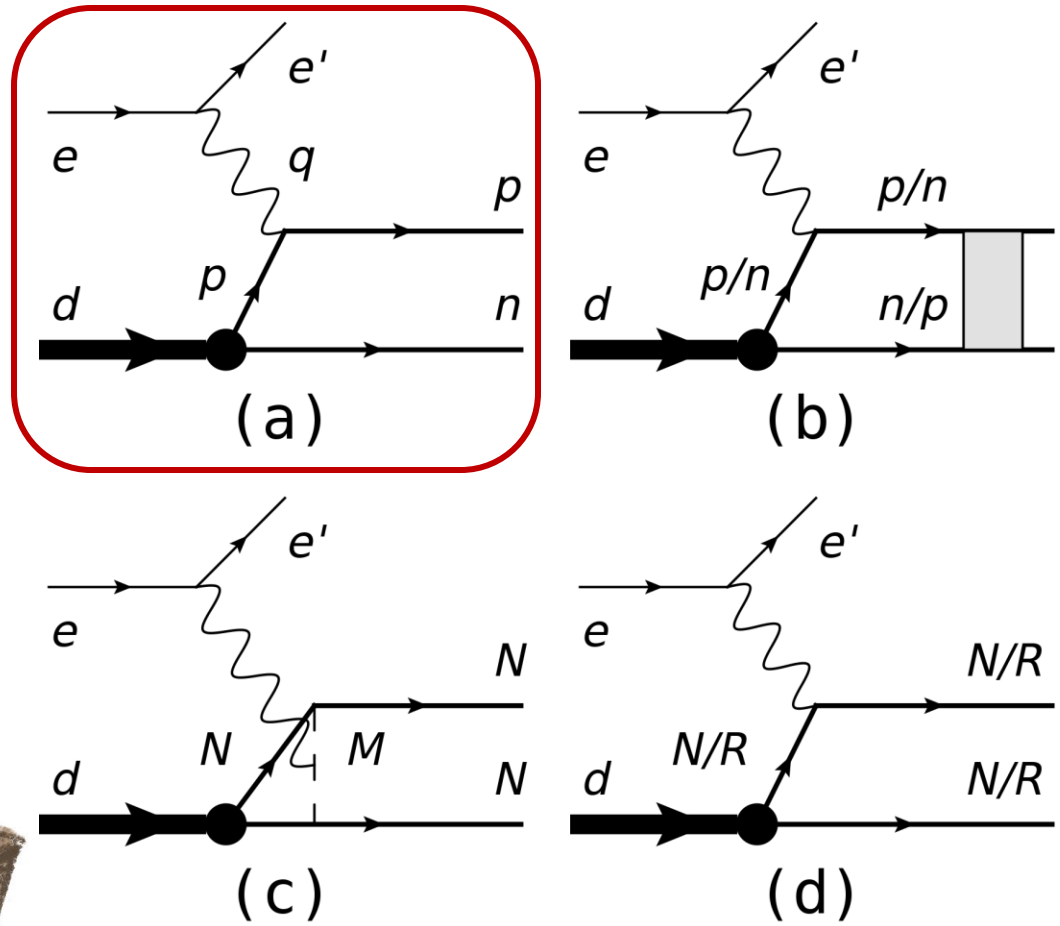


Jefferson Lab Hall C FIU

Brief Overview of Deuteron Break-Up

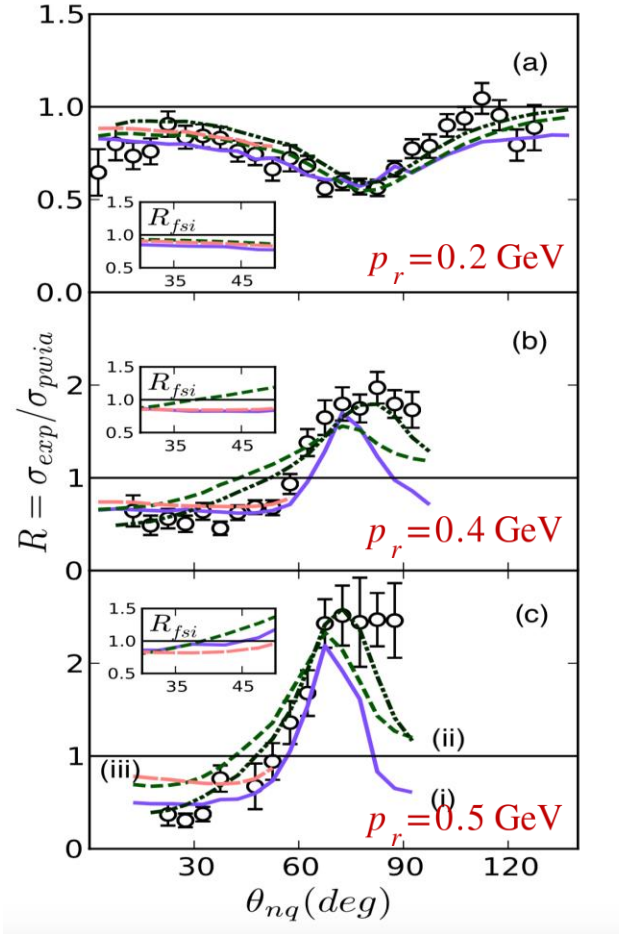
$$e + d \rightarrow e' + p + n$$





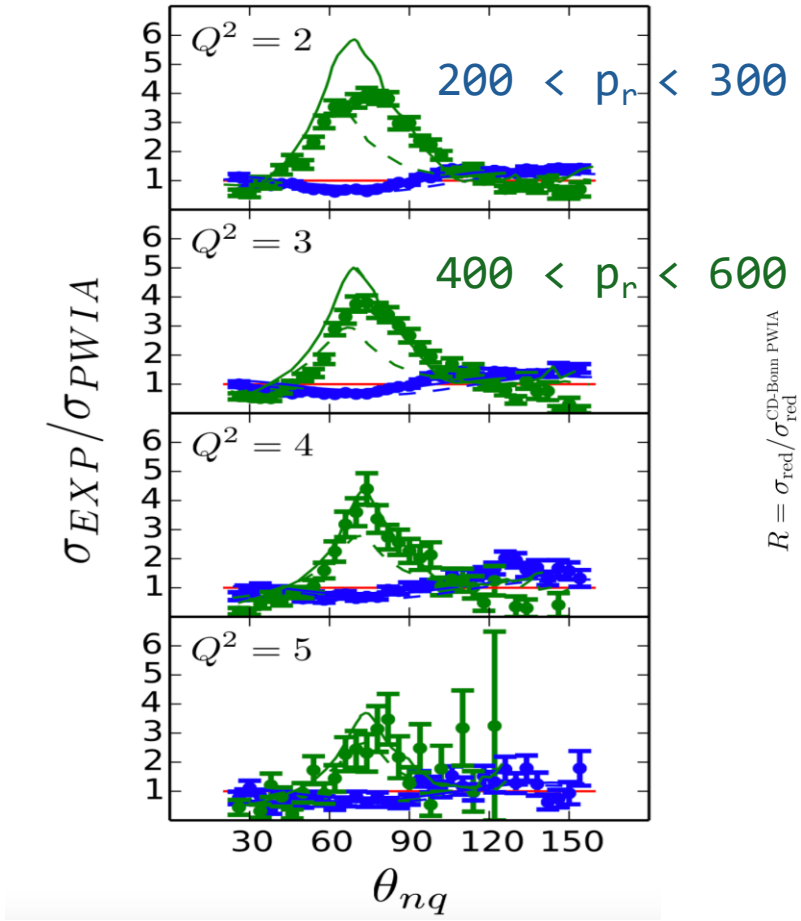
(b), (c), and (d) are suppressed in the kinematic window used

Hall A Experiment (E01-020)



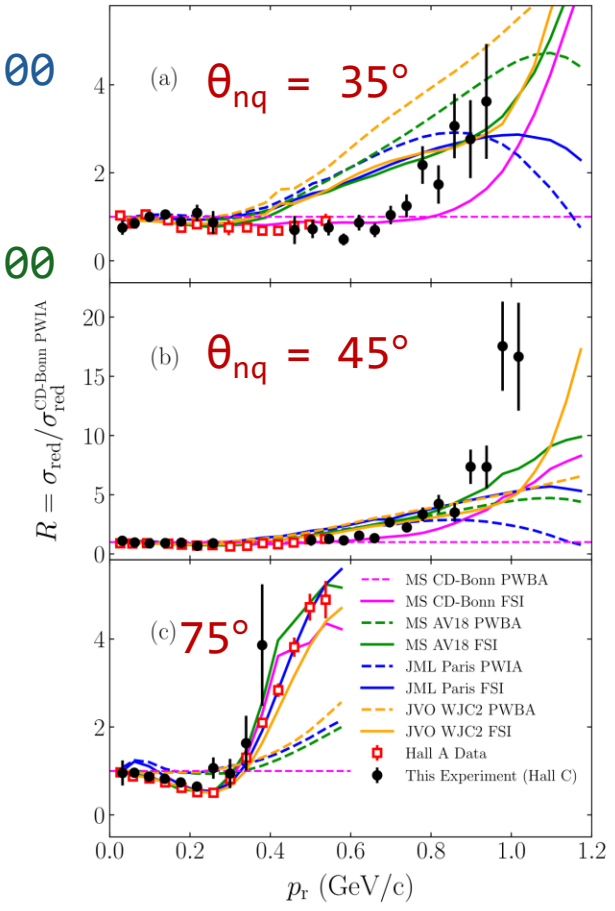
W. U. Boeglin et al. (2011)
10.1103/PhysRevLett.107.262501

Hall B Experiment (CLAS)



K. S. Egiyan et al. (2007)
10.1103/PhysRevLett.98.262502

Hall C Experiment (E12-10-003)



C. Yero et al. (2020)
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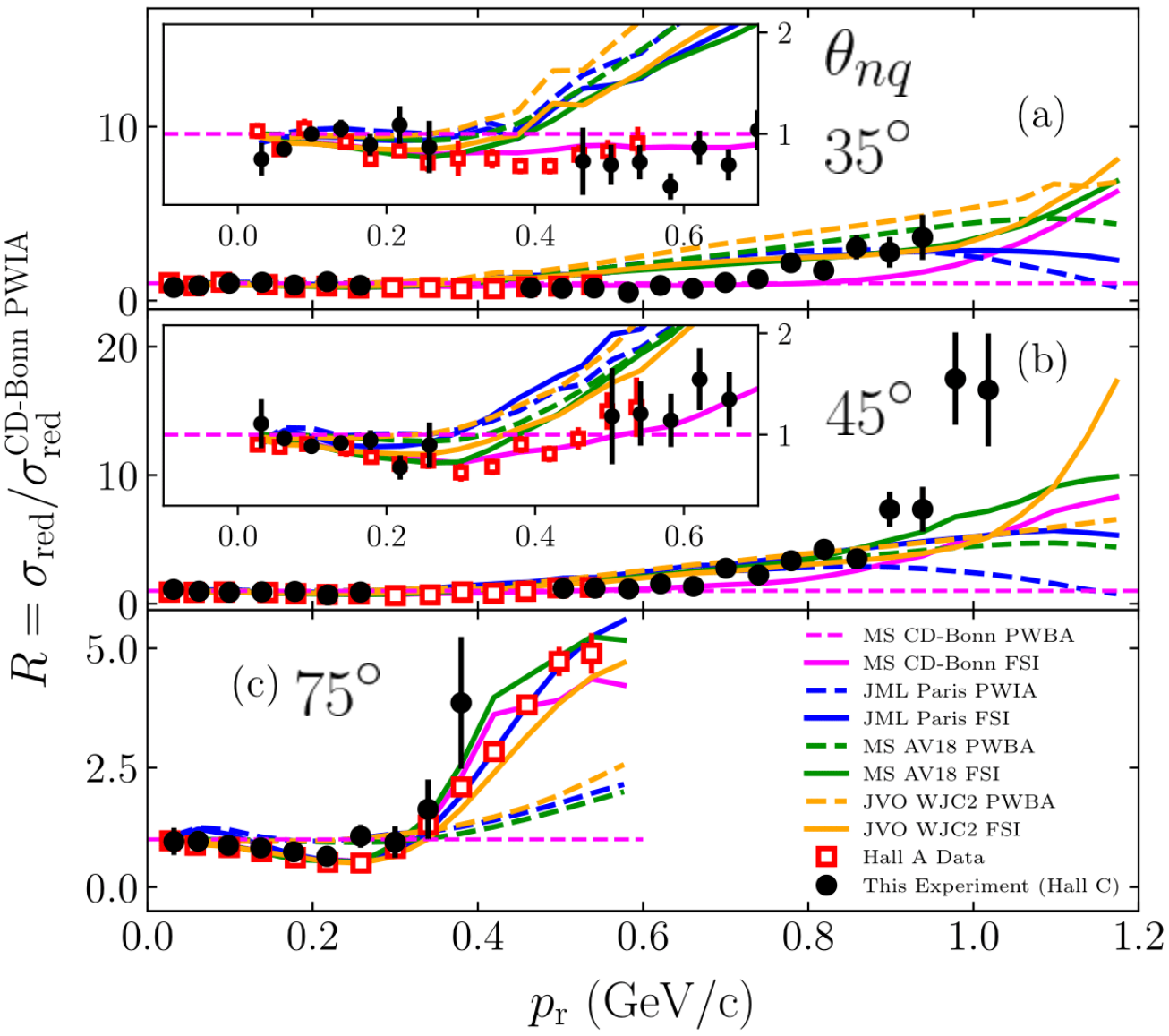


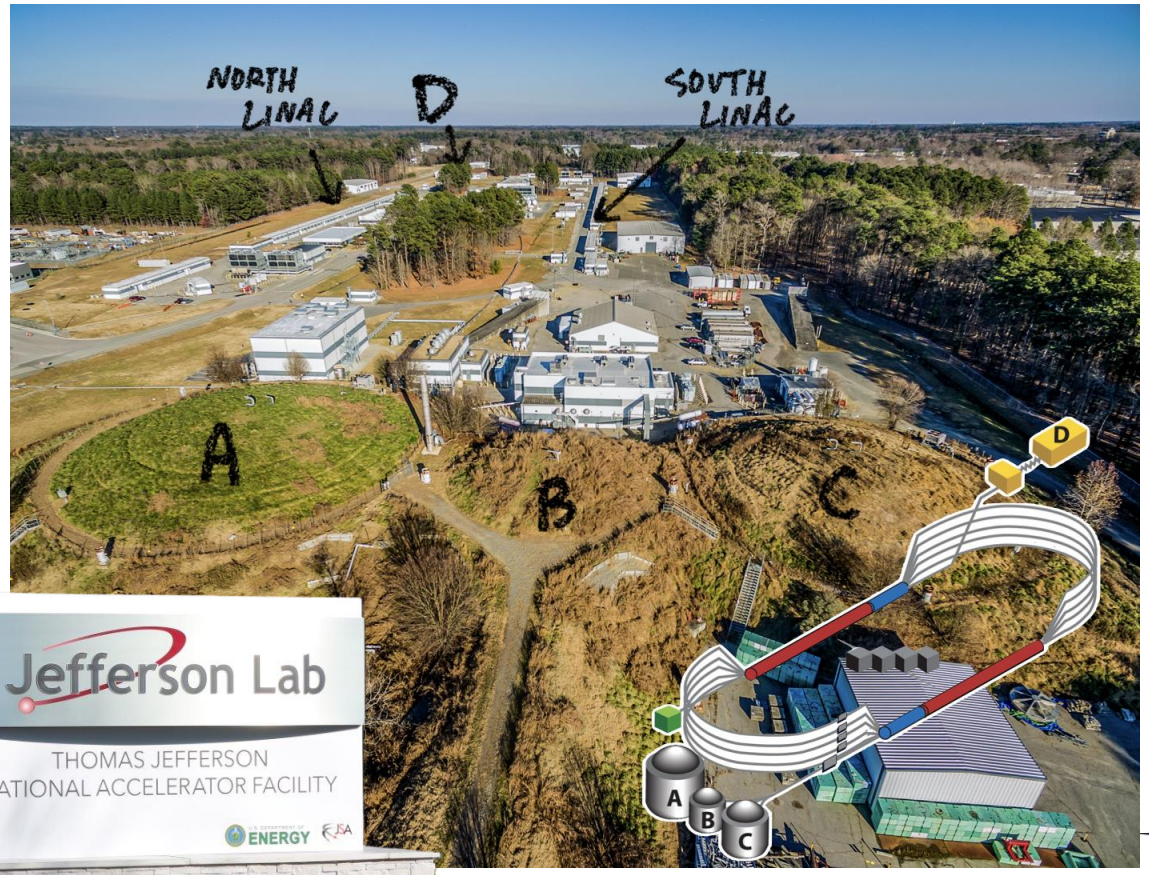
Theoretical Models:

(1) Charge-Dependent (CD) Bonn
(2) Paris
(3) AV18
(4) WJC2

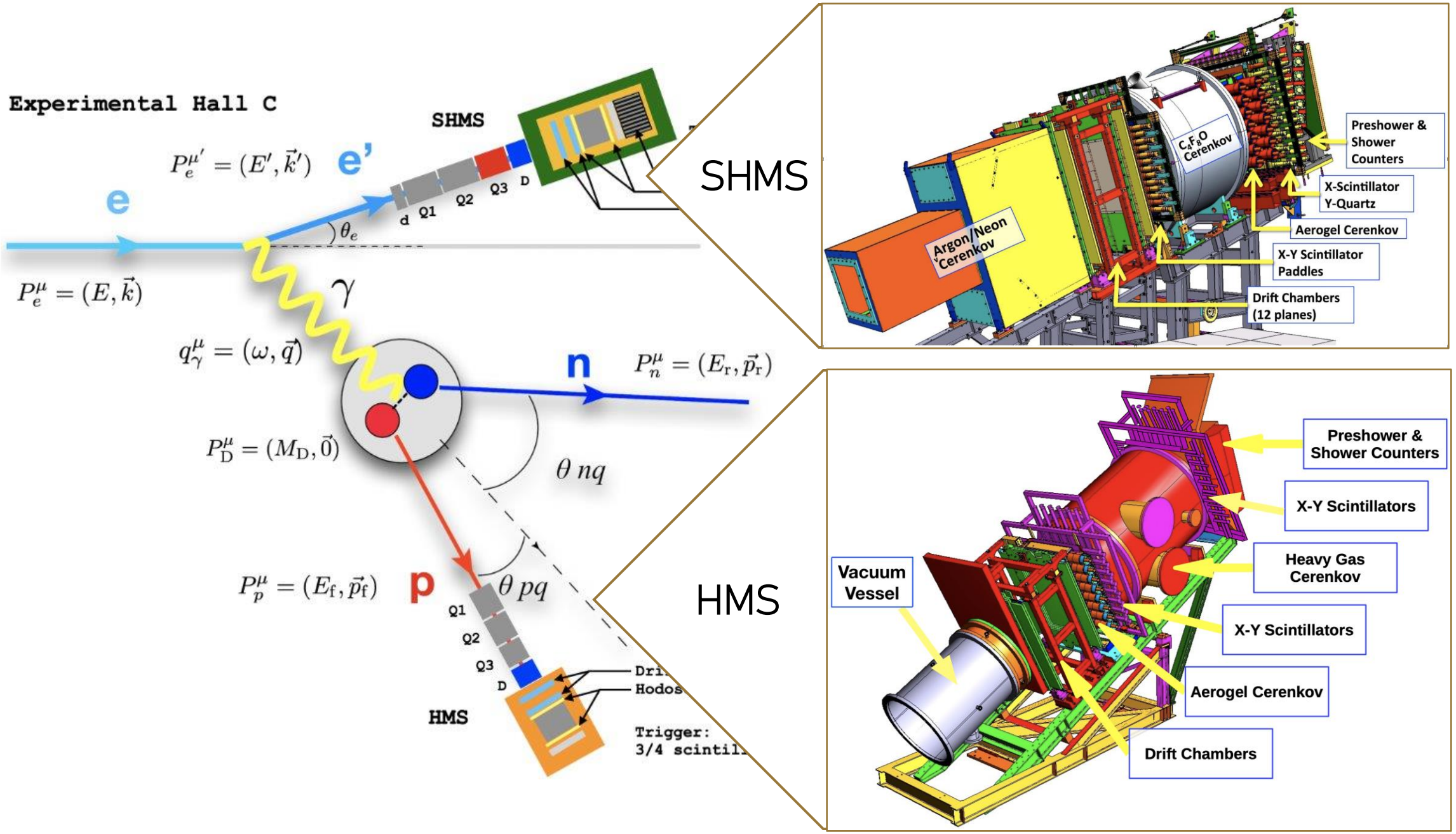
The models differ in the way they use empirical NN scattering data.

CD-Bonn and WJC2 models use an OBE potential approach, while AV18 and Paris are purely phenomenological.

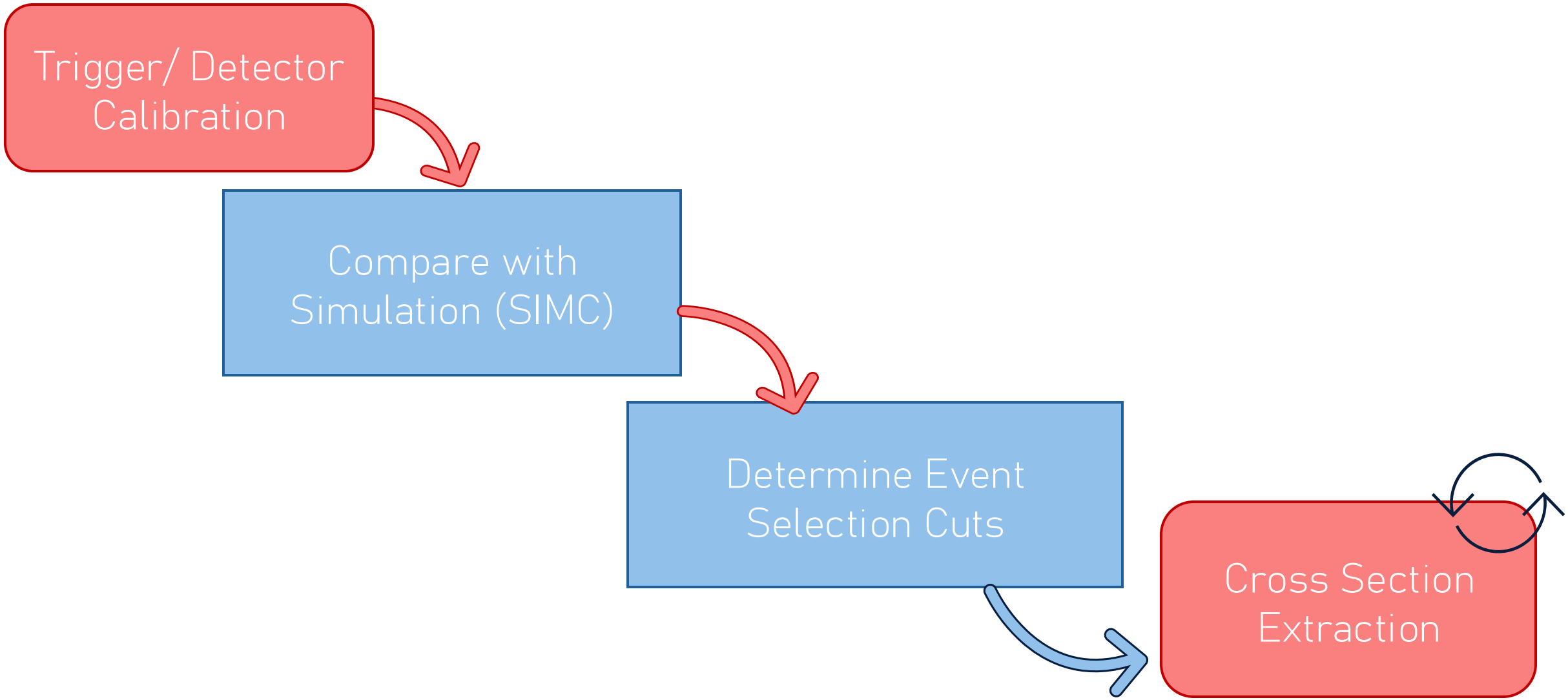
Jefferson Lab: Experimental Hall C



Hall C


Experimental Hall C
SHMS
$P_e^{\mu'} = (E', \vec{k}')$
e'
e
θ_e
Q1
Q2
Q3
D
$P_e^{\mu} = (E, \vec{k})$
γ
$q_\gamma^{\mu} = (\omega, \vec{q})$
n
$P_n^{\mu} = (E_r, \vec{p}_r)$
$P_D^{\mu} = (M_D, \vec{0})$
$\theta\, nq$
$P_p^{\mu} = (E_f, \vec{p}_f)$
p
$\theta\, pq$
Q1
Q2
Q3
D
HMS
Trigger:
SHMS
Preshower & Shower Counters
C_4F_8O Cerenkov
X-Scintillator Y-Quartz
Aerogel Cerenkov
X-Y Scintillator Paddles
Drift Chambers (12 planes)
Argon/Neon Cerenkov
HMS
Preshower & Shower Counters
X-Y Scintillators
Heavy Gas Cerenkov
X-Y Scintillators
Aerogel Cerenkov
Drift Chambers
Vacuum Vessel

Analysis Procedure

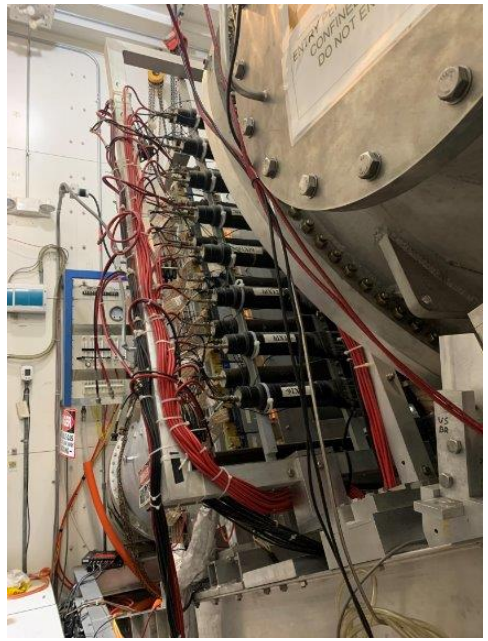


Analysis Procedure

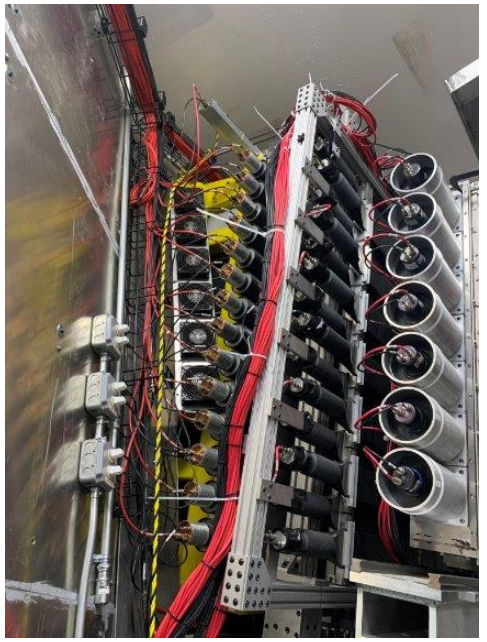
Trigger/ Detector Calibration

The most important detectors to calibrate are the hodoscopes and drift chambers.

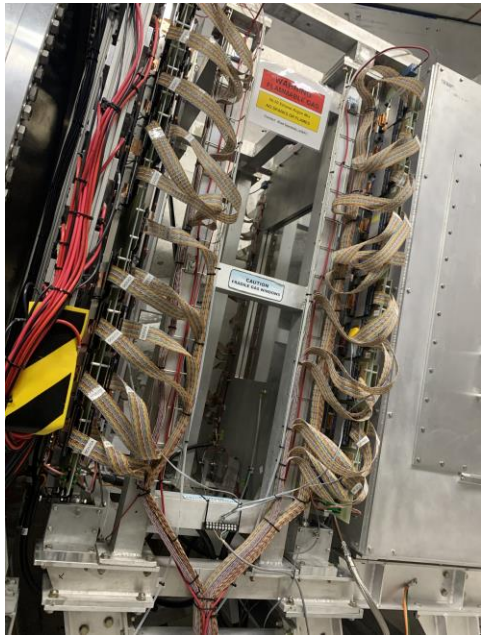
The hodoscopes form the main trigger, while the drift chambers record particle tracks which give particle's angle and momentum information.



SHMS Hodoscopes



SHMS Drift Chamber



Analysis Procedure

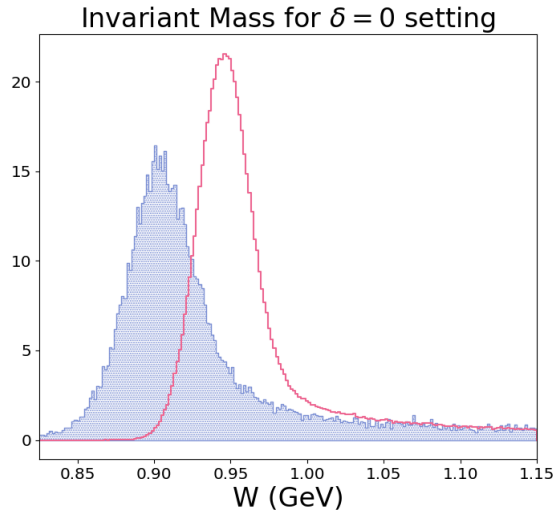
Compare with Simulation (SIMC)

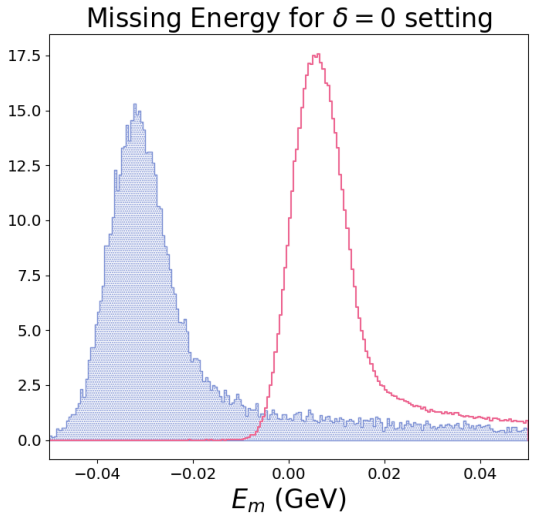
Variables that could be causing offsets in the kinematics:

$p_{e'}$, $\theta_{e'}$, p_p , θ_p

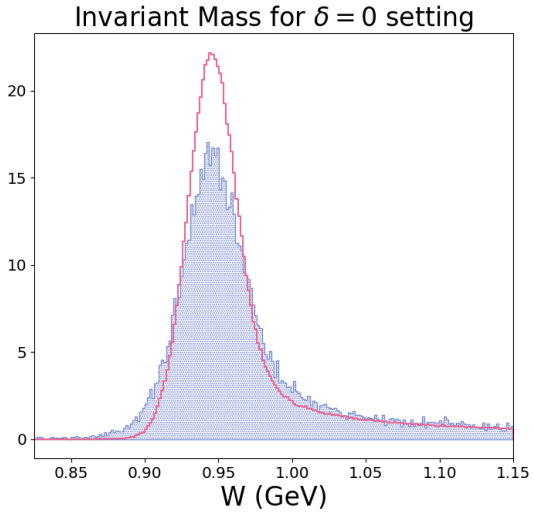
*Overdetermined system, the offset determination procedure relies on an initial choice of spectrometer (e or p side) as a starting point.

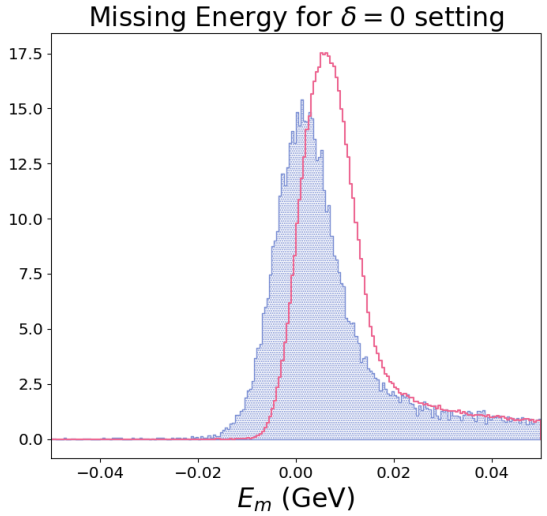
Before: no offsets





After $p_{e'}$ offset





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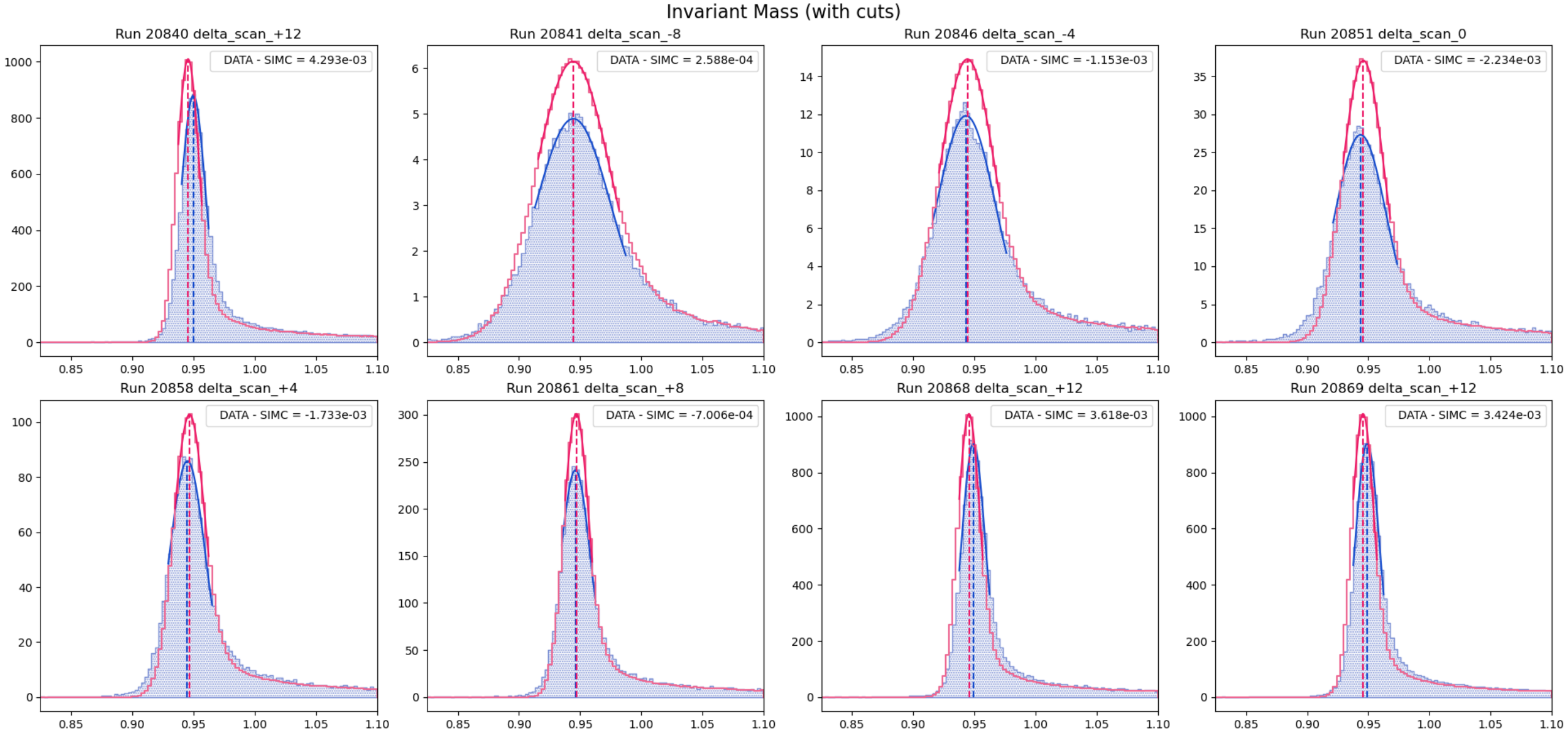

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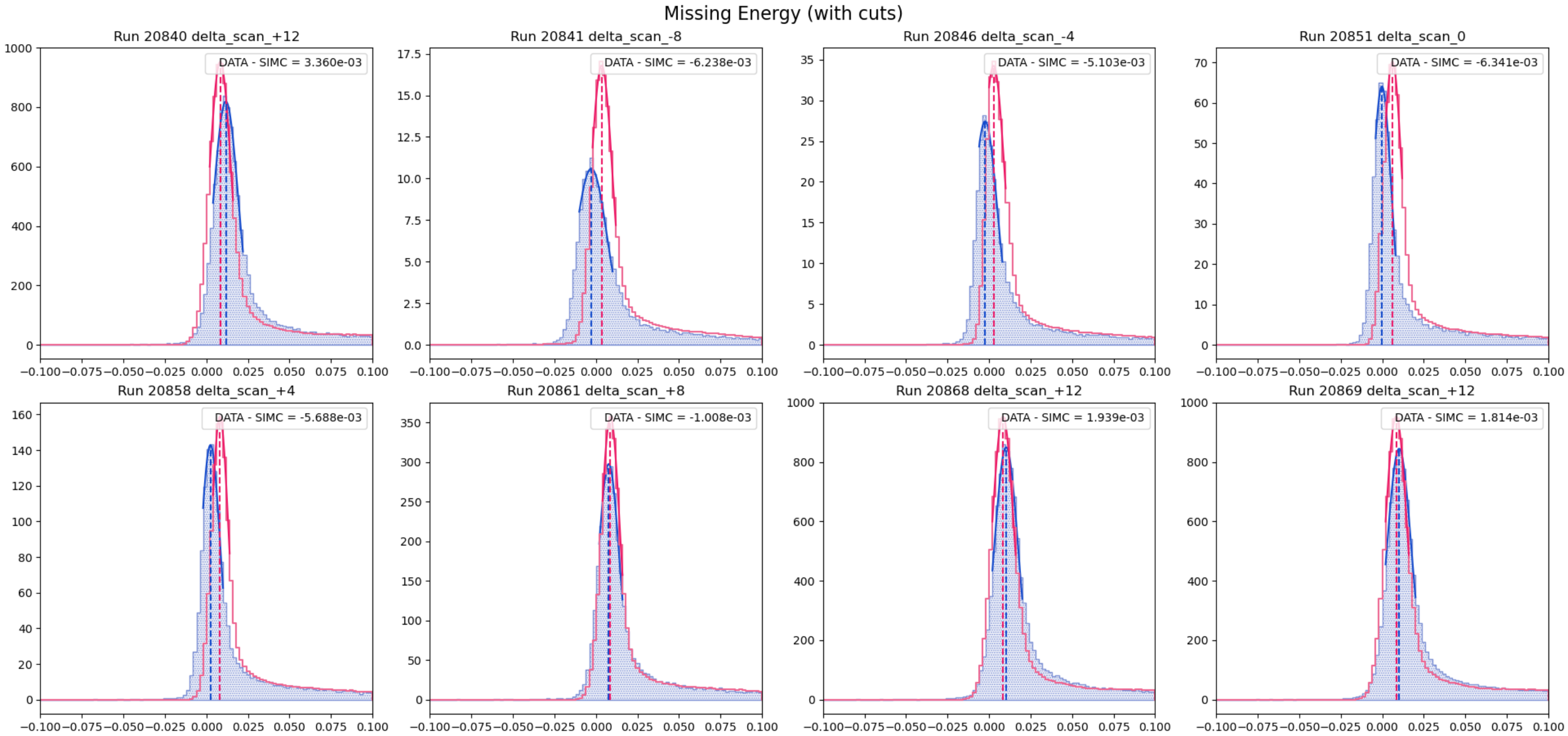
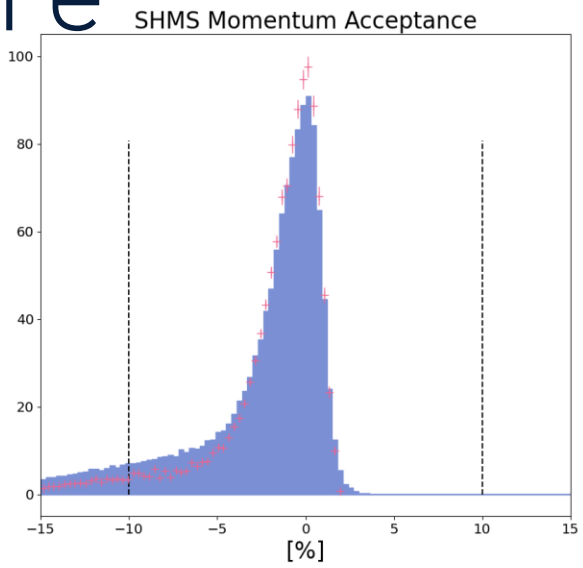


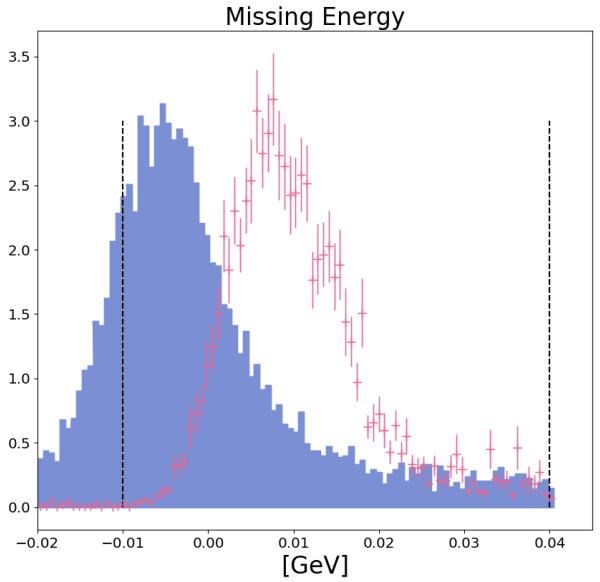
Analysis Procedure

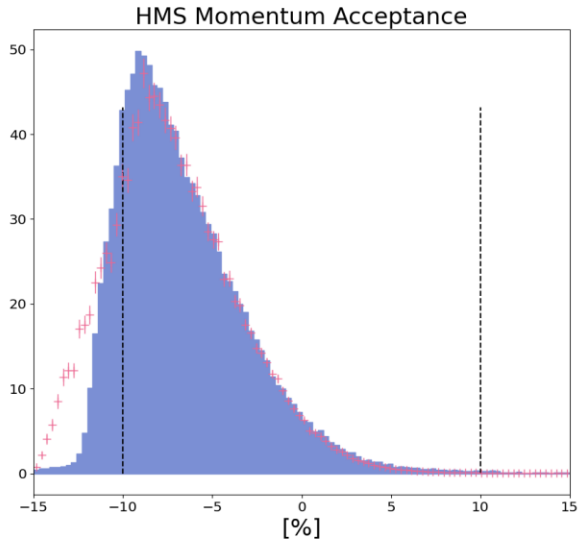
Determine Event Selection Cuts

Cross Section Extraction

- Missing energy
- Momentum Acceptance
- Collimator Cut
- Z – Target
- Calorimeter PID
- Coincidence Time
- Four Momentum Transfer (Q2)







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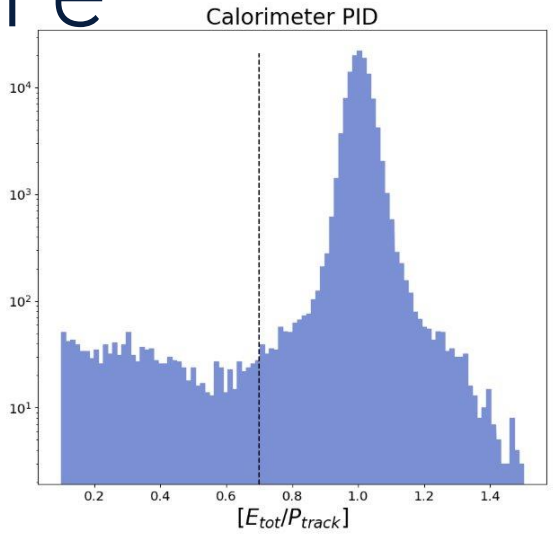
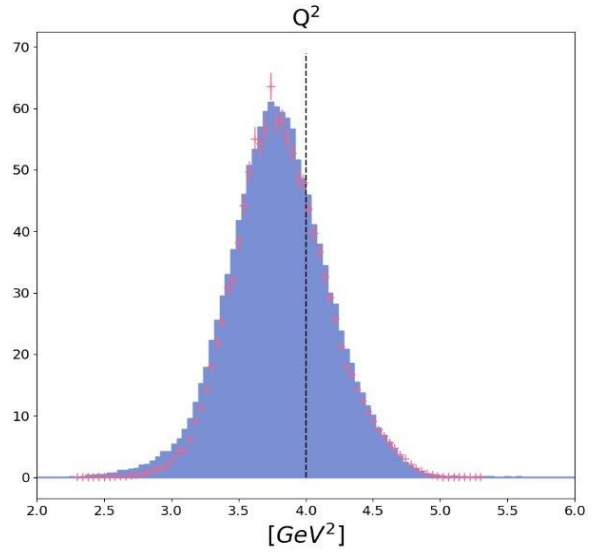
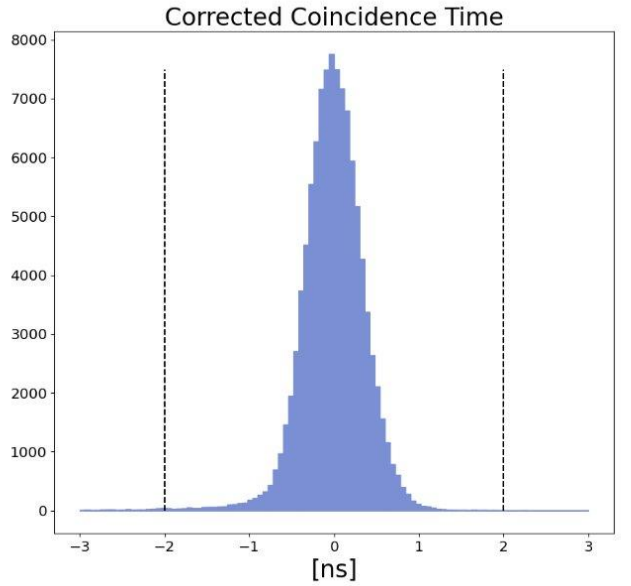




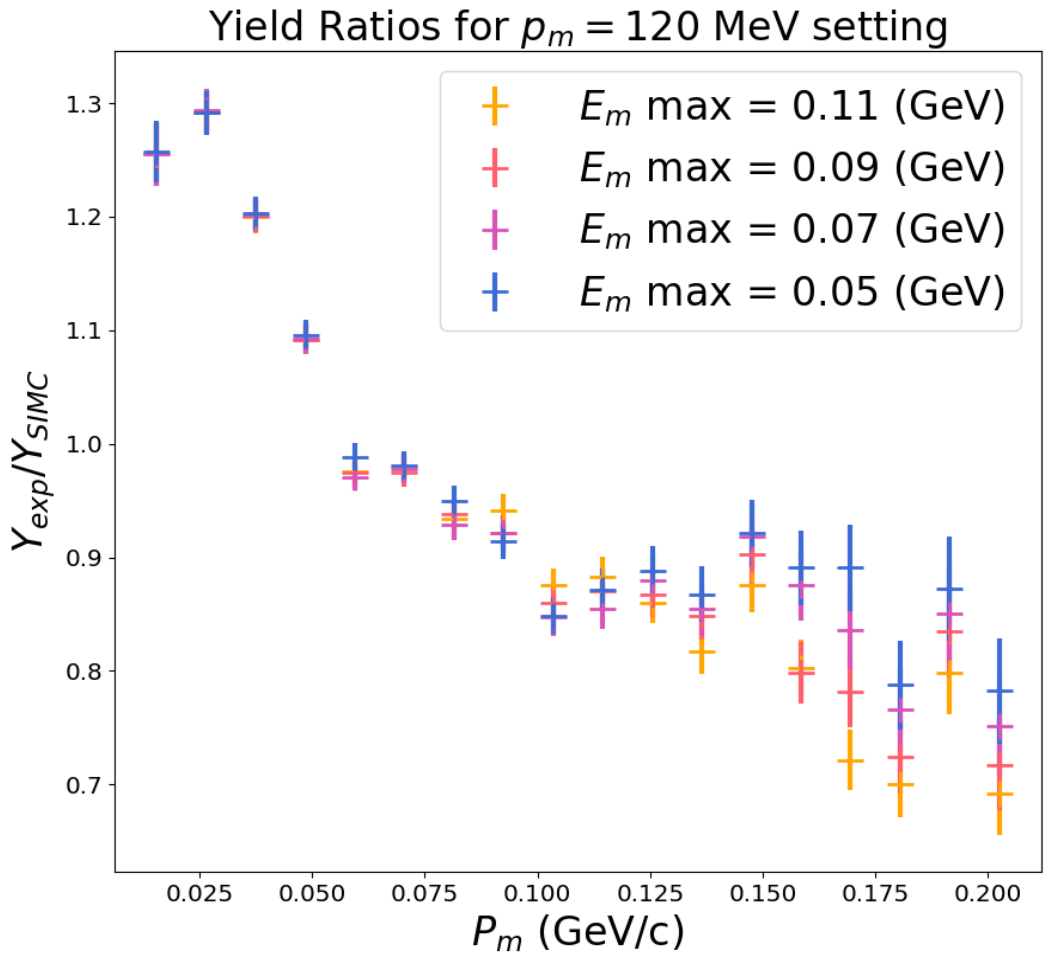


Analysis Procedure

Cross Section Extraction

$$Y_{corr} = \frac{Y_{uncorr}}{Q_{tot} \cdot \epsilon_{\mathtt{tLT}} \cdot \epsilon_{\mathtt{HMS}} \cdot \epsilon_{\mathtt{SHMS}}}$$

*Missing radiative, target boiling, and proton absorption corrections



Thank you!

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Hall C

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