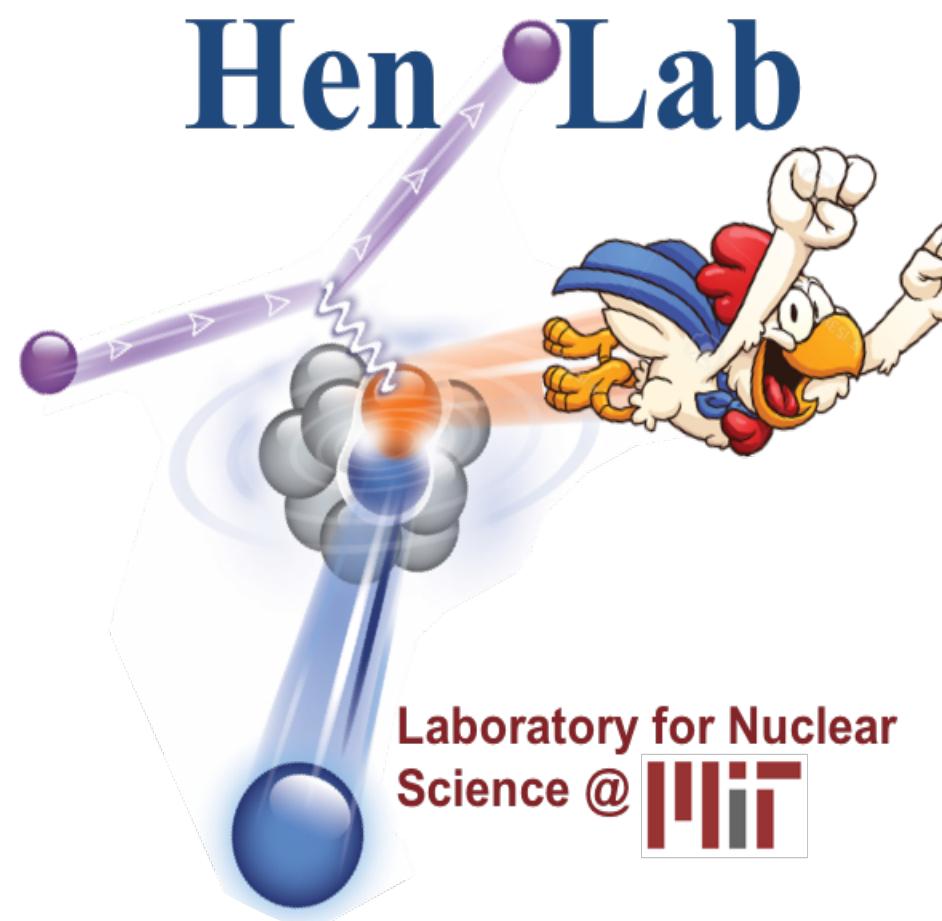


Applications of the Generalized Contact Formalism

Jackson Pybus
SRC/EMC Workshop
23 March 2021

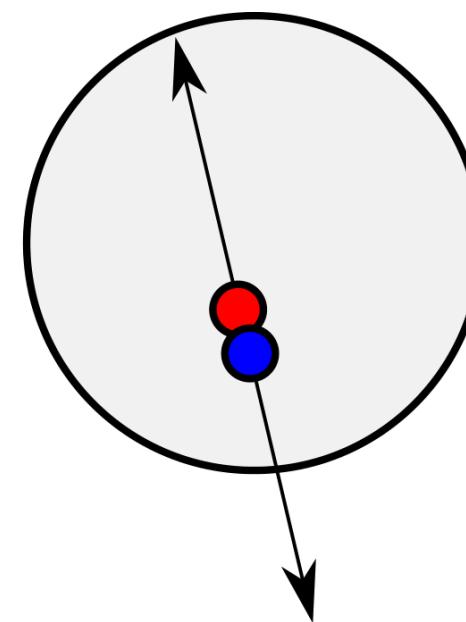


The Generalized Contact Formalism

- Until recently SRC data analysis has been limited in ability to connect to theory – largely phenomenological
- GCF provides an opportunity to perform **quantitative** data-theory comparisons
- Allows direct cross section measurement, extraction of SRC properties
- Provides detailed theoretical predictions for high-precision experiments and new reactions

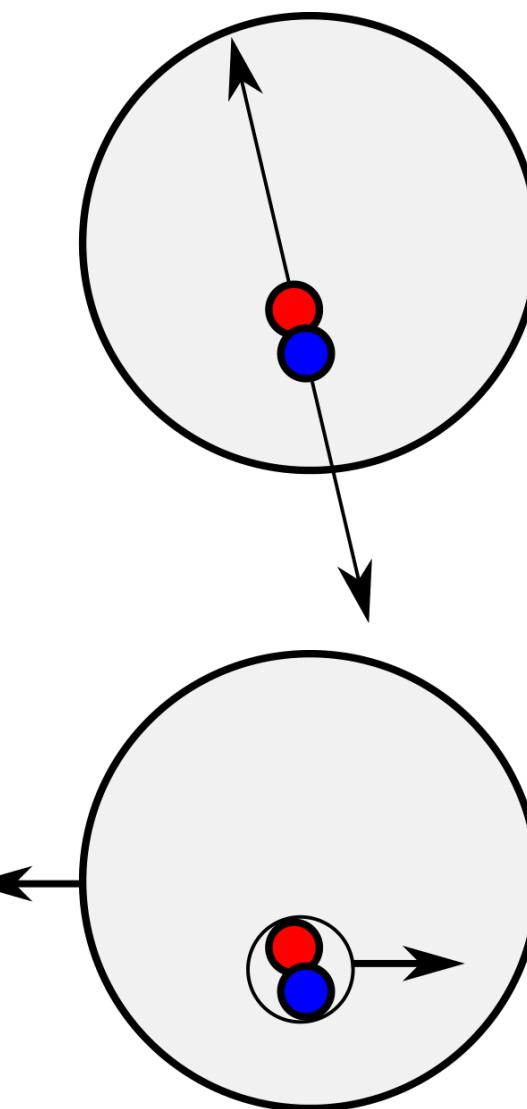
GCF provides a factorized model of SRC behavior

Pair Interaction

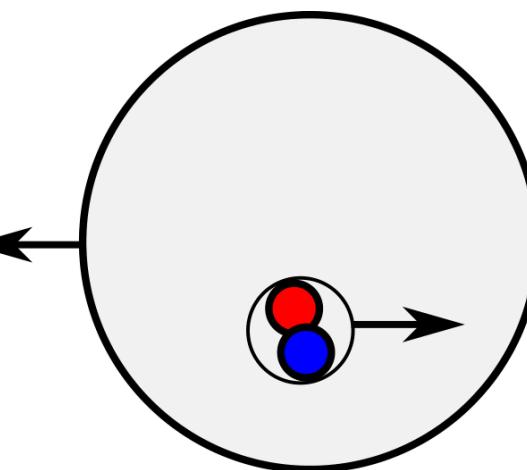


GCF provides a factorized model of SRC behavior

Pair Interaction

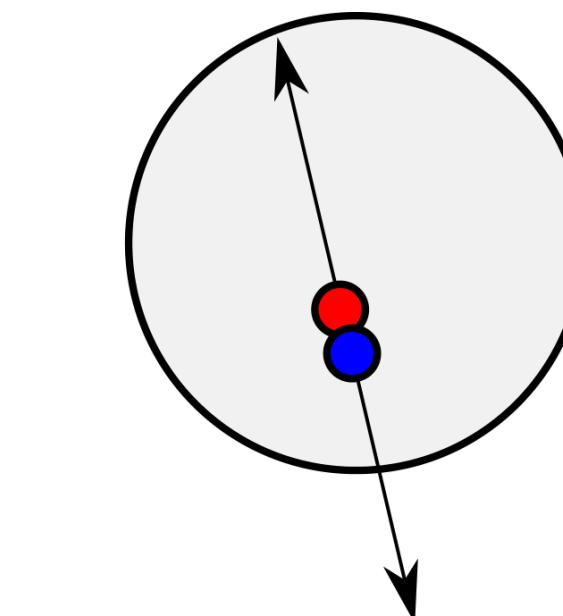


Center-of-Mass

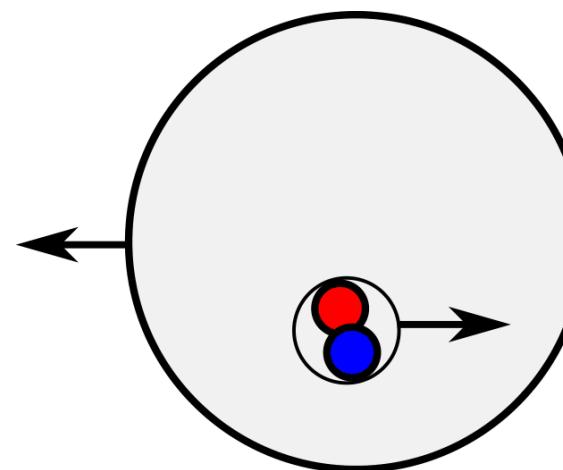


GCF provides a factorized model of SRC behavior

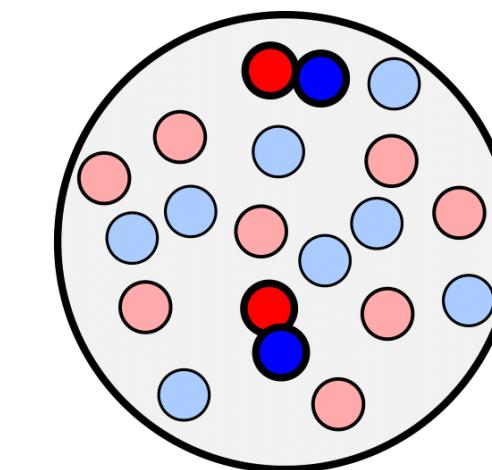
Pair Interaction



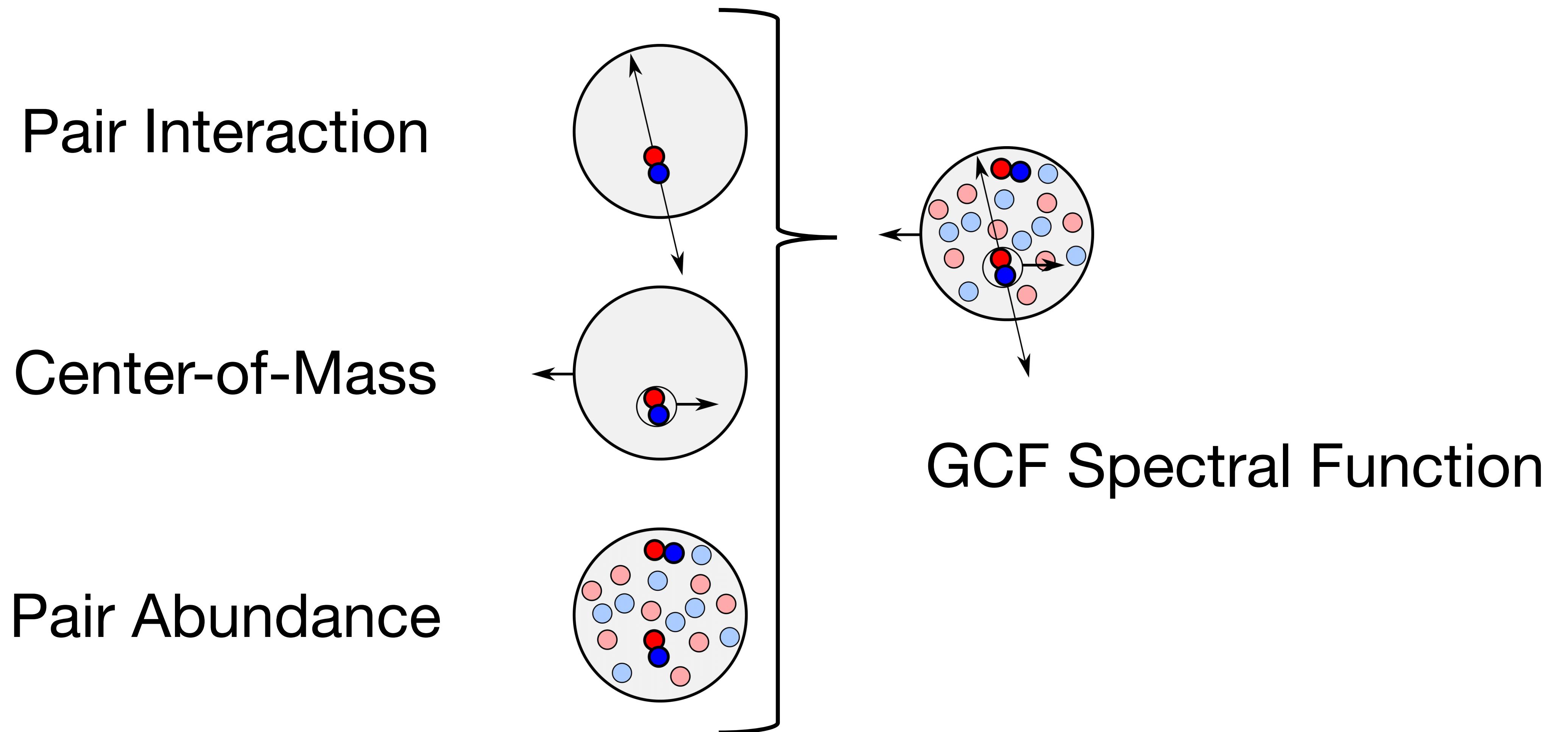
Center-of-Mass



Pair Abundance

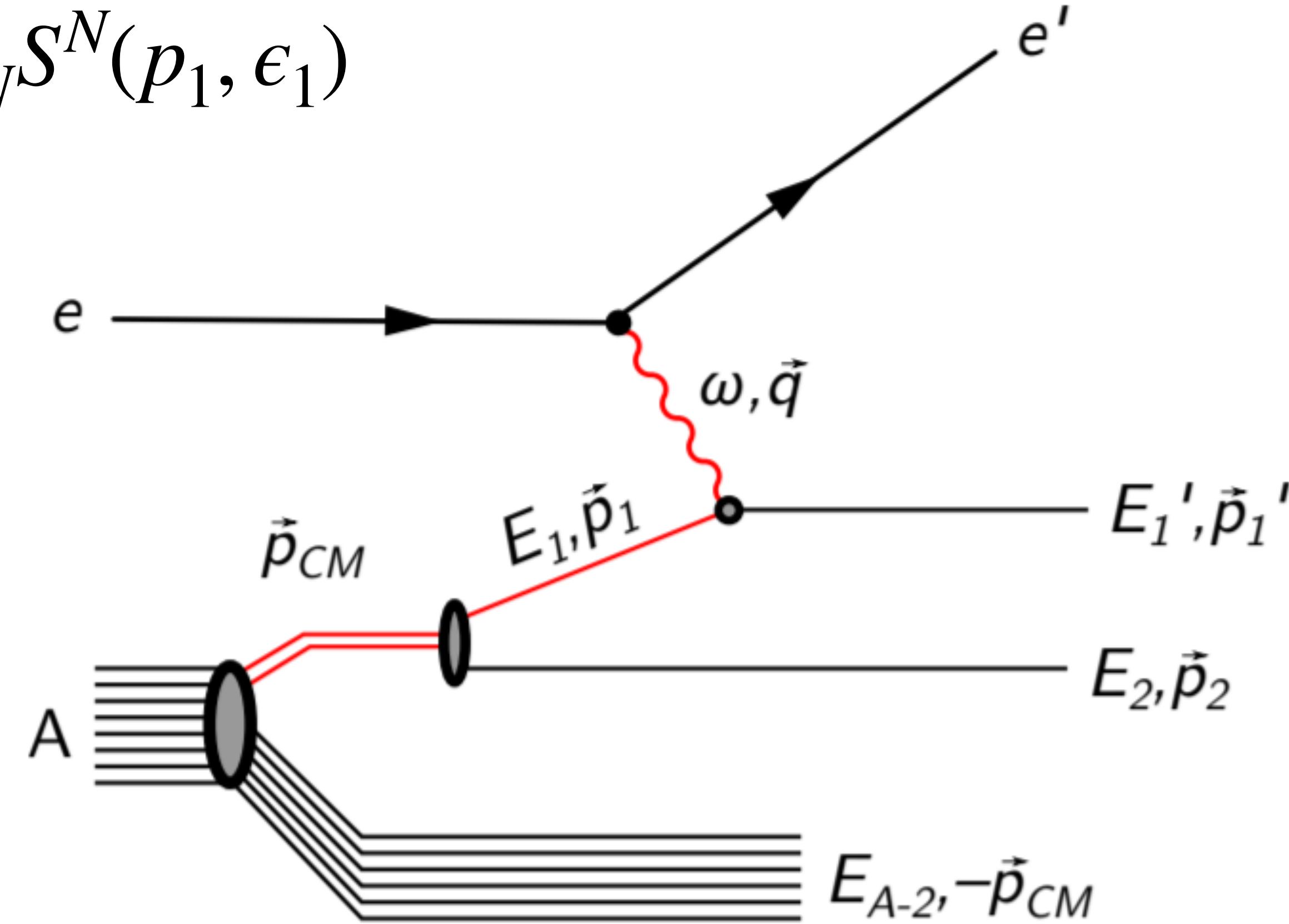


GCF provides a factorized model of SRC behavior



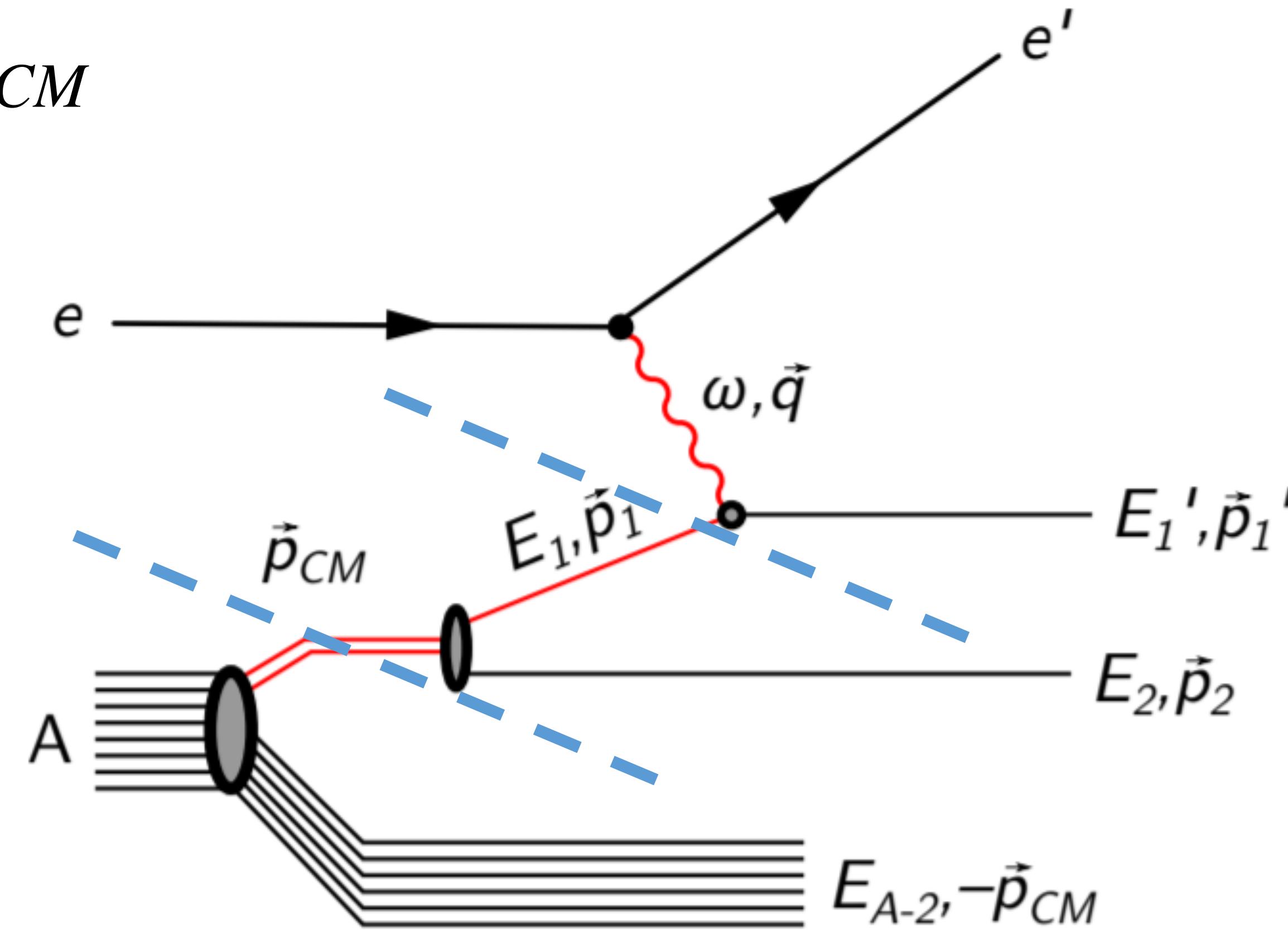
PWIA GCF Cross Section Models

$$\frac{d^6\sigma}{d\Omega_k dE_k d^3p'_1} = \mathcal{J}\sigma_{eN} S^N(p_1, \epsilon_1)$$



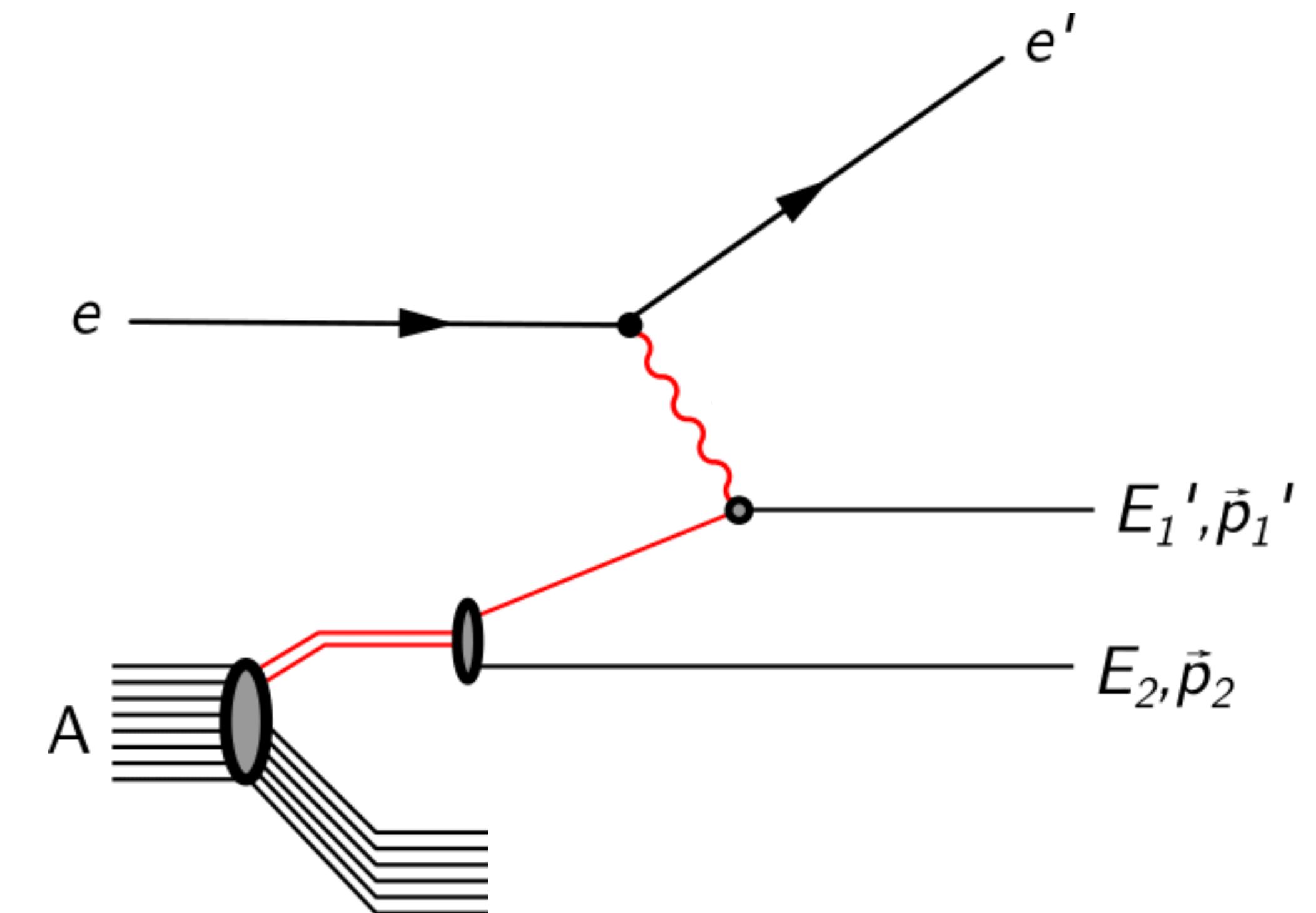
PWIA GCF Cross Section Models

$$q \gg p_{rel} \gg p_{CM}$$



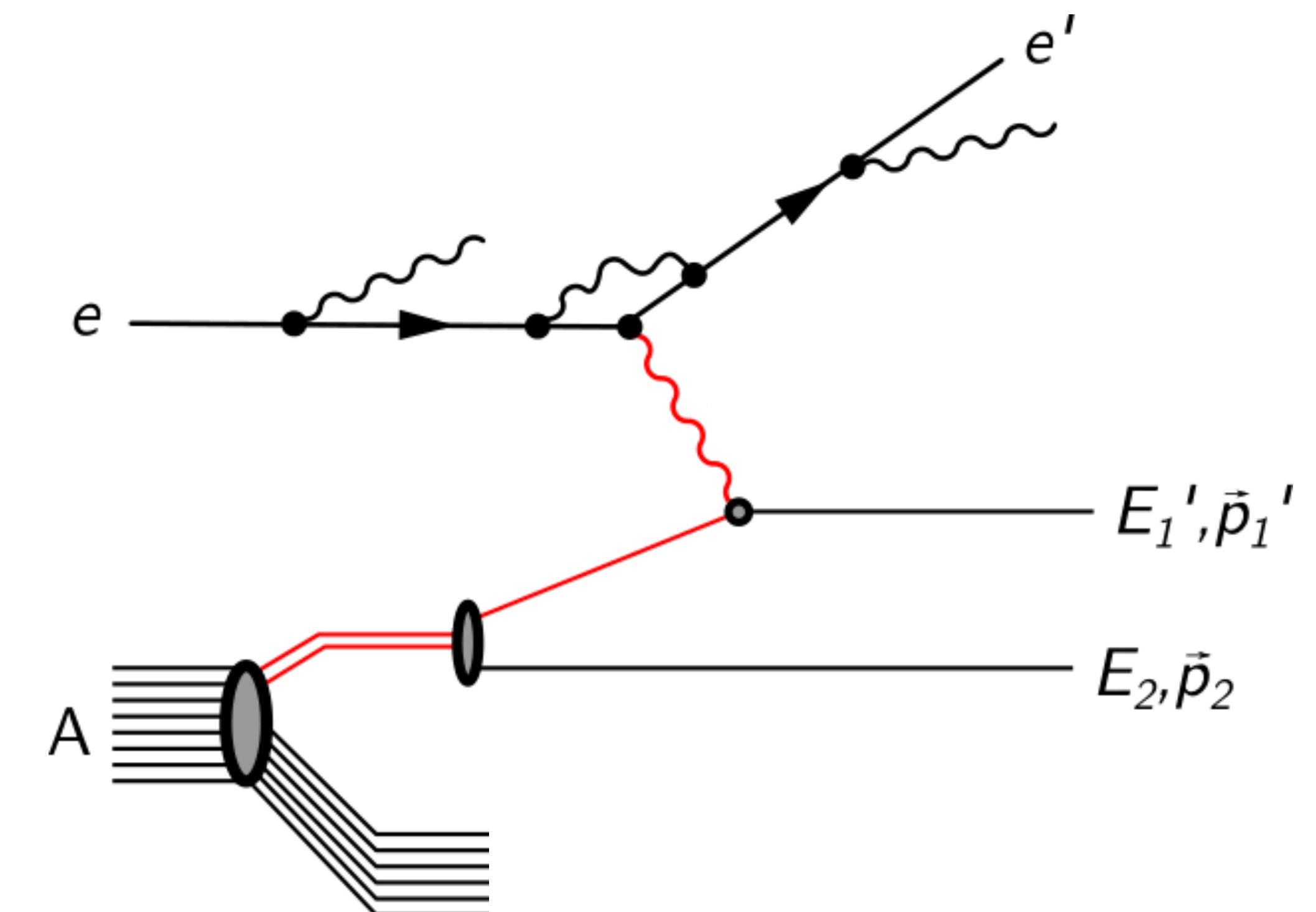
Data-Model Comparisons

1. Generate plane-wave events



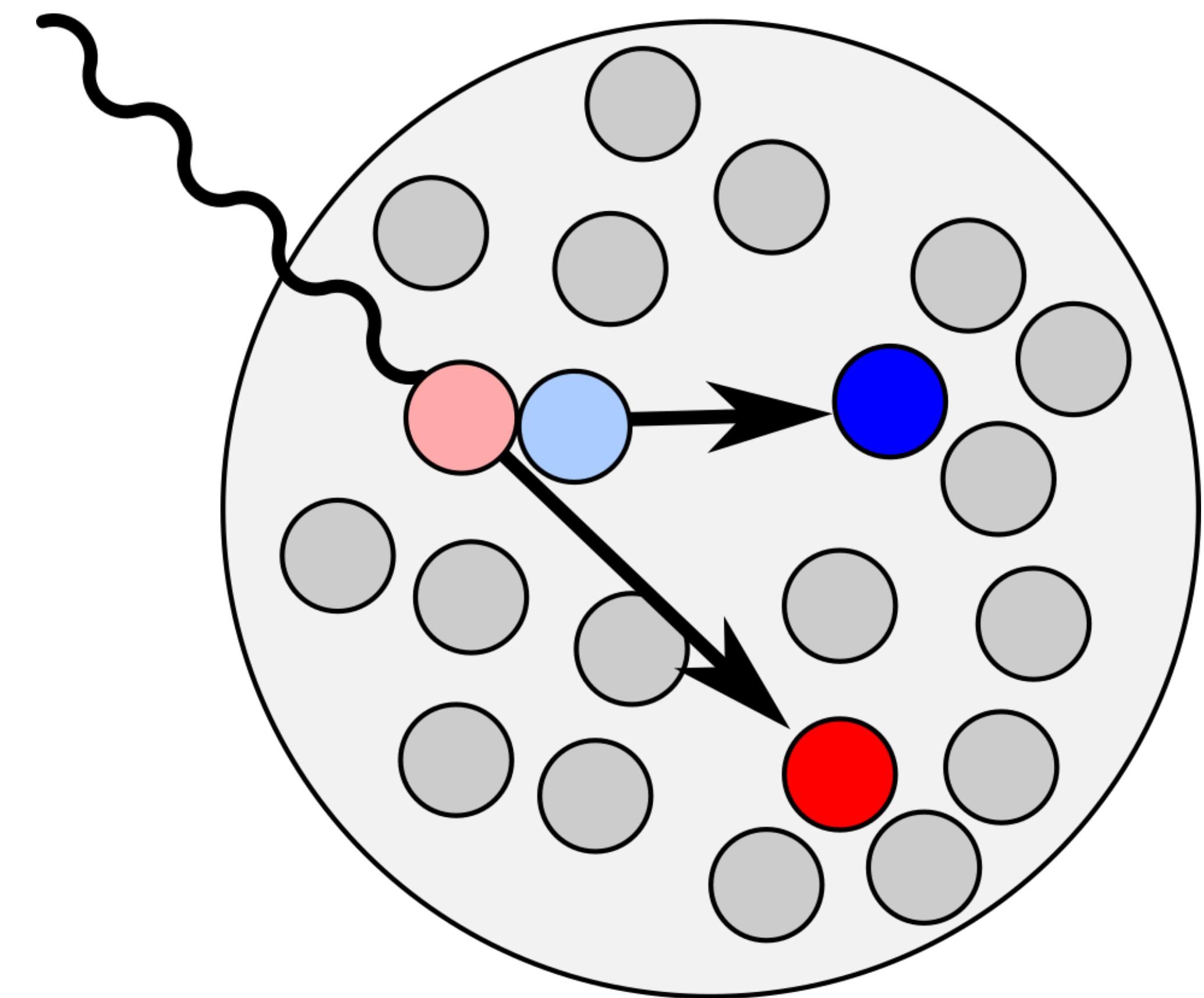
Data-Model Comparisons

1. Generate plane-wave events
2. Radiative Effects



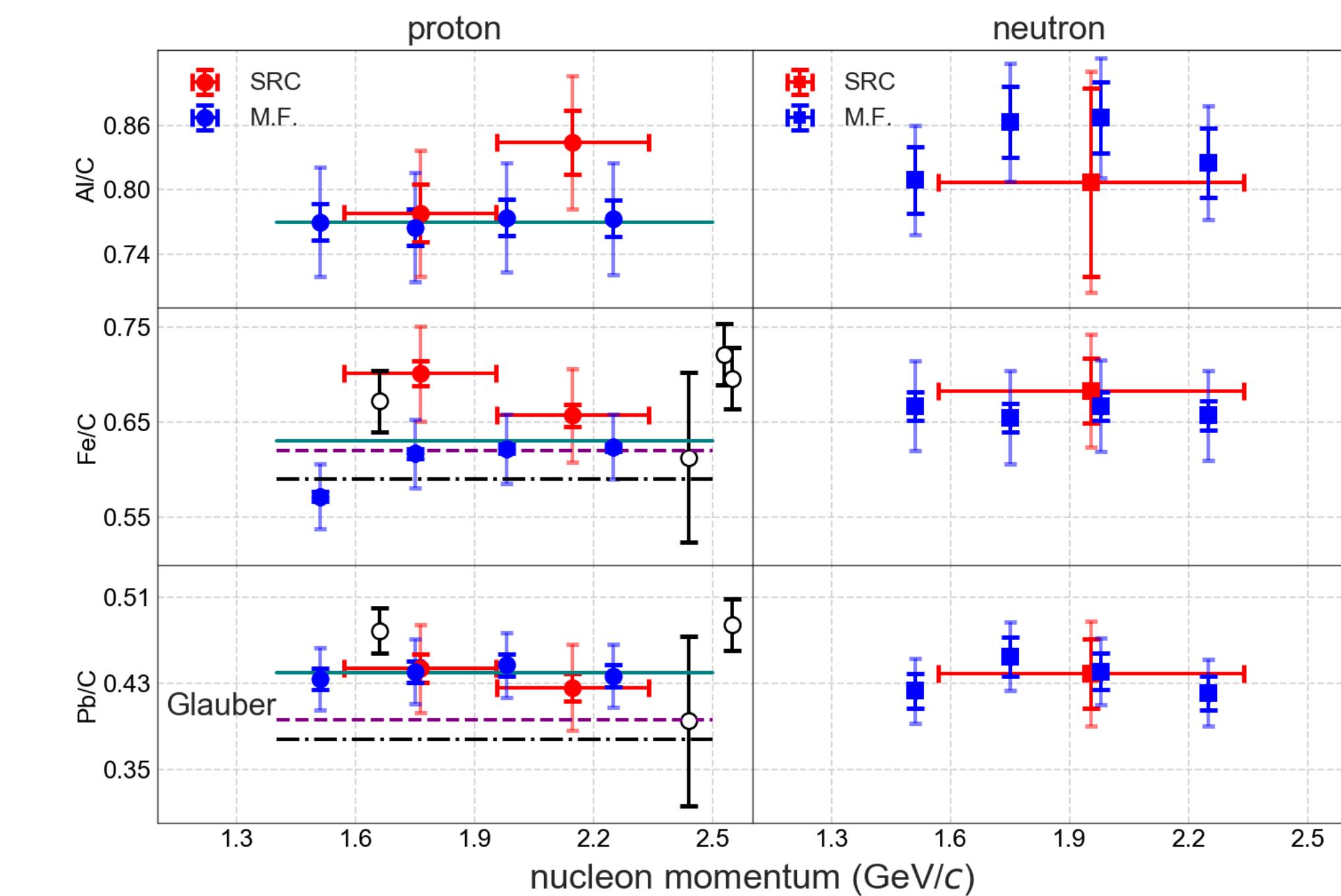
Data-Model Comparisons

1. Generate plane-wave events
2. Radiative Effects
3. Transparency + SCX from Glauber calculations



Data-Model Comparisons

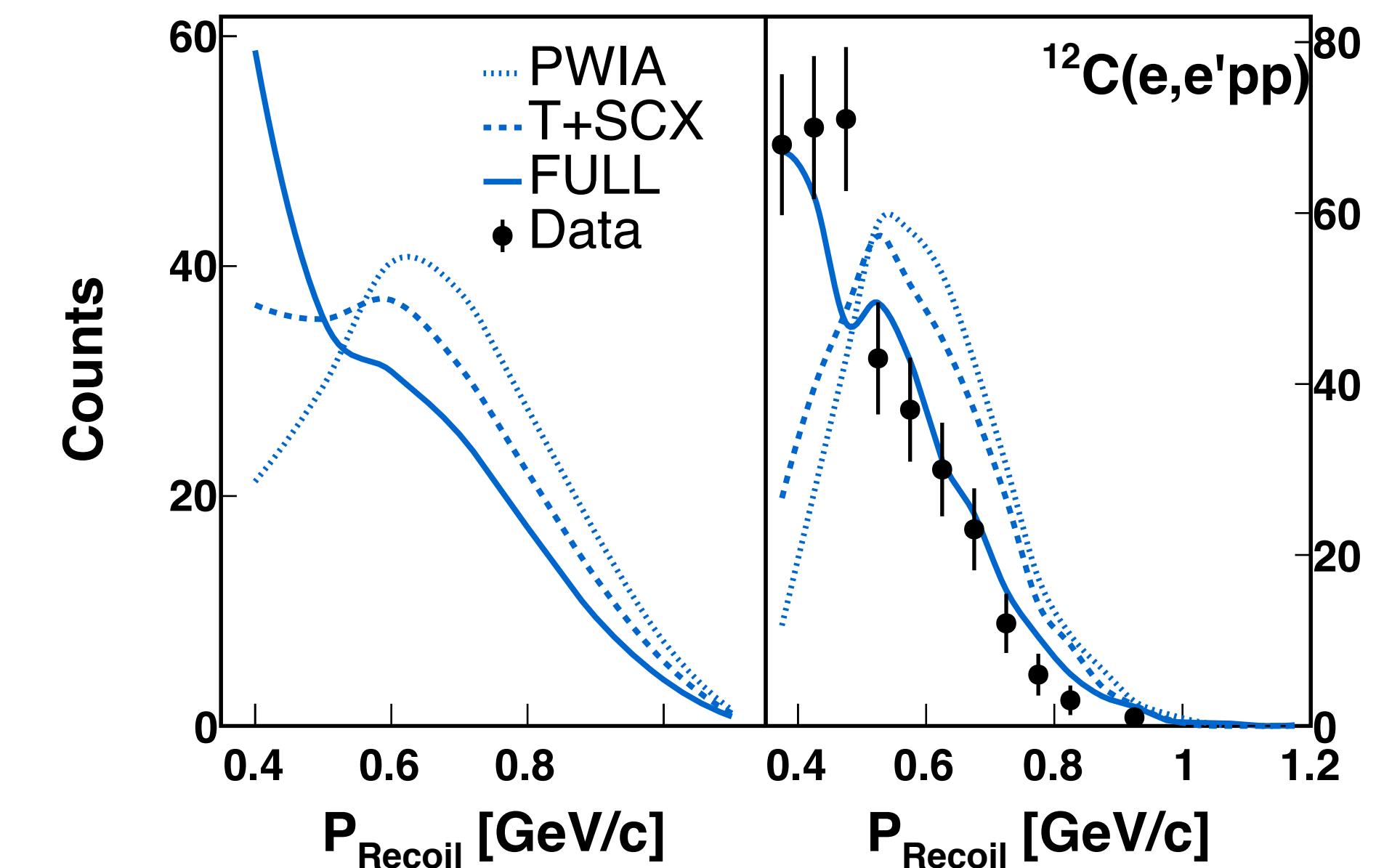
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Data-Model Comparisons

1. Generate plane-wave events
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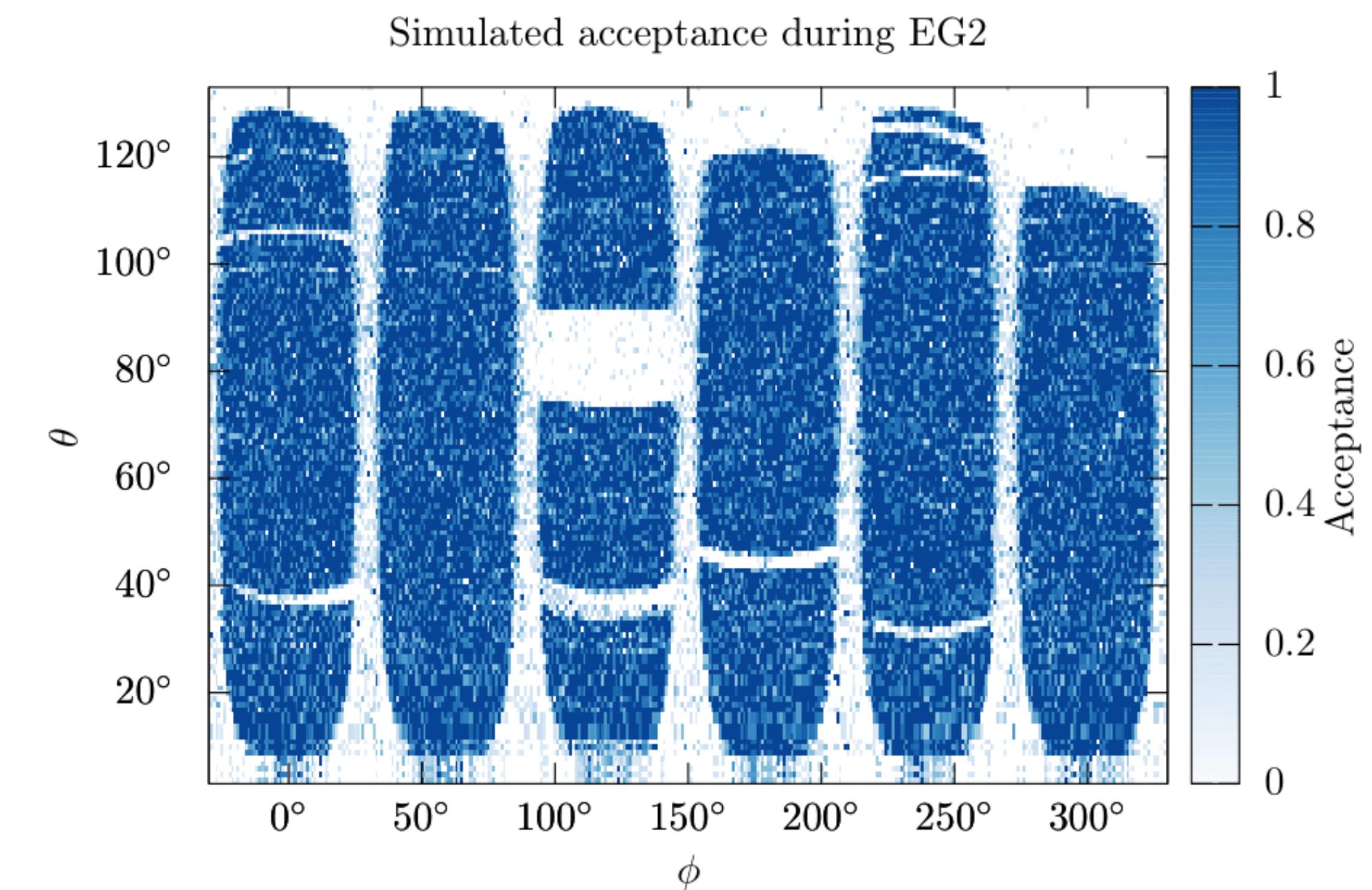
(More detailed FSI models being worked on)



Talk by Natalie
Thursday Afternoon

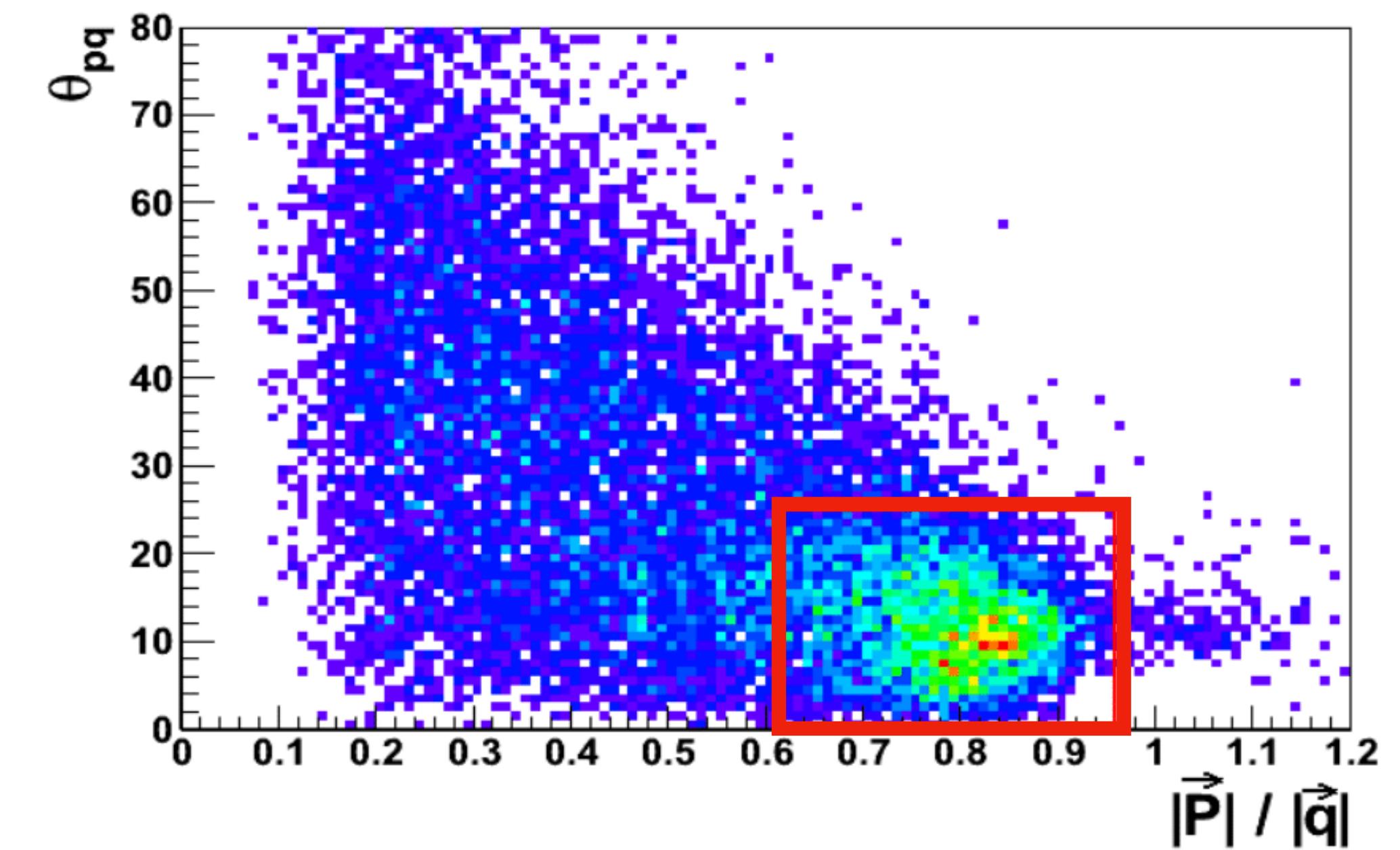
Data-Model Comparisons

1. Generate plane-wave events
2. Radiative Effects
3. Transparency + SCX from Glauber calculations
4. Detector Effects



Data-Model Comparisons

1. Generate plane-wave events
2. Radiative Effects
3. Transparency + SCX from Glauber calculations
4. Detector Effects
5. Event Selection



Systematic Uncertainty

Numerous input parameters with uncertainty

- Contacts
- σ_{CM}
- $A - 2$ excitation energy
- p_{rel} cutoff
- SCX probabilities
- Transparency
- Detector resolutions

Systematic Uncertainty

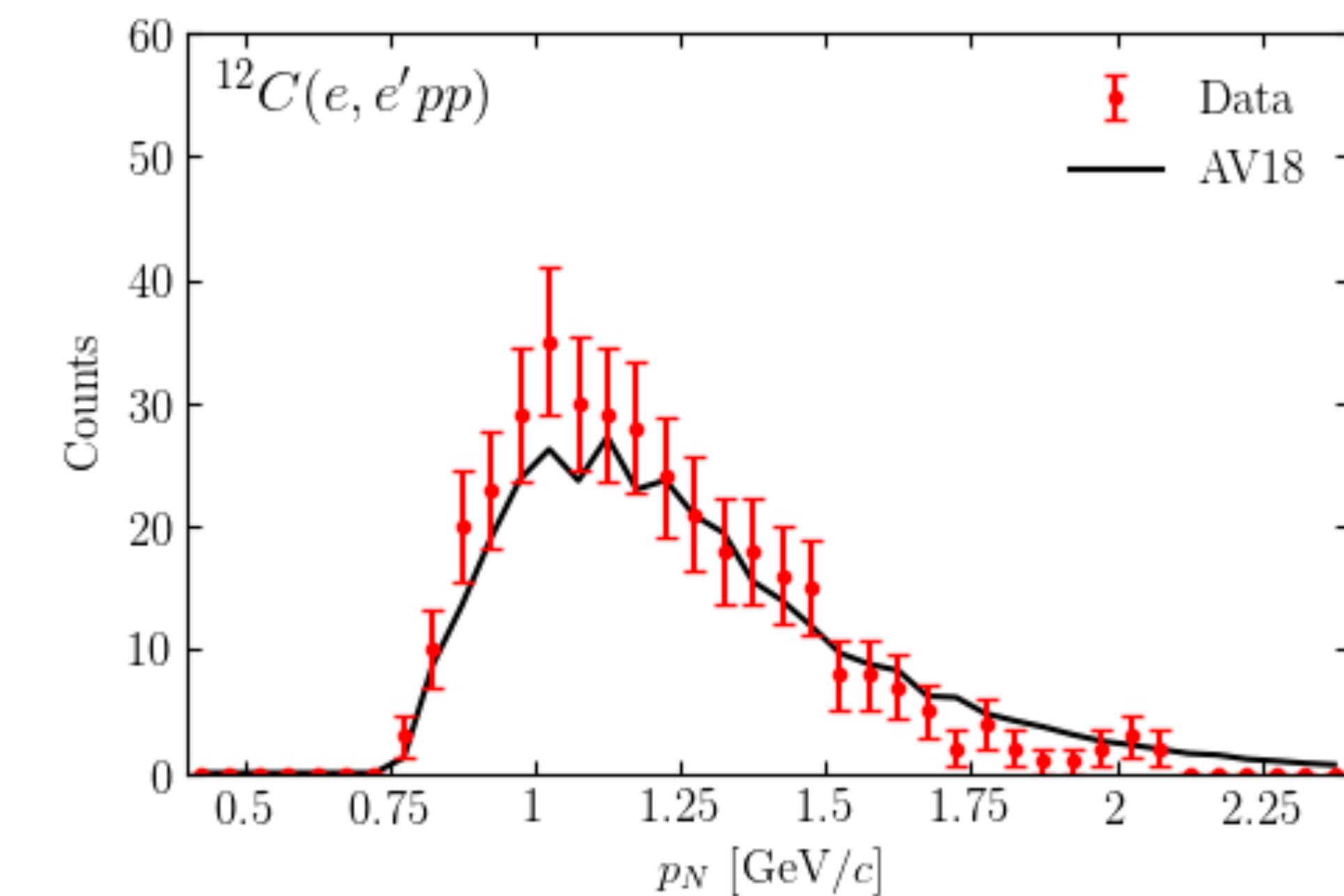
Numerous input parameters with uncertainty

1. Randomize model parameters by uncertainty
 - Contacts
 - σ_{CM}
 - $A - 2$ excitation energy
 - p_{rel} cutoff
 - SCX probabilities
 - Transparency
 - Detector resolutions

Systematic Uncertainty

Numerous input parameters with uncertainty

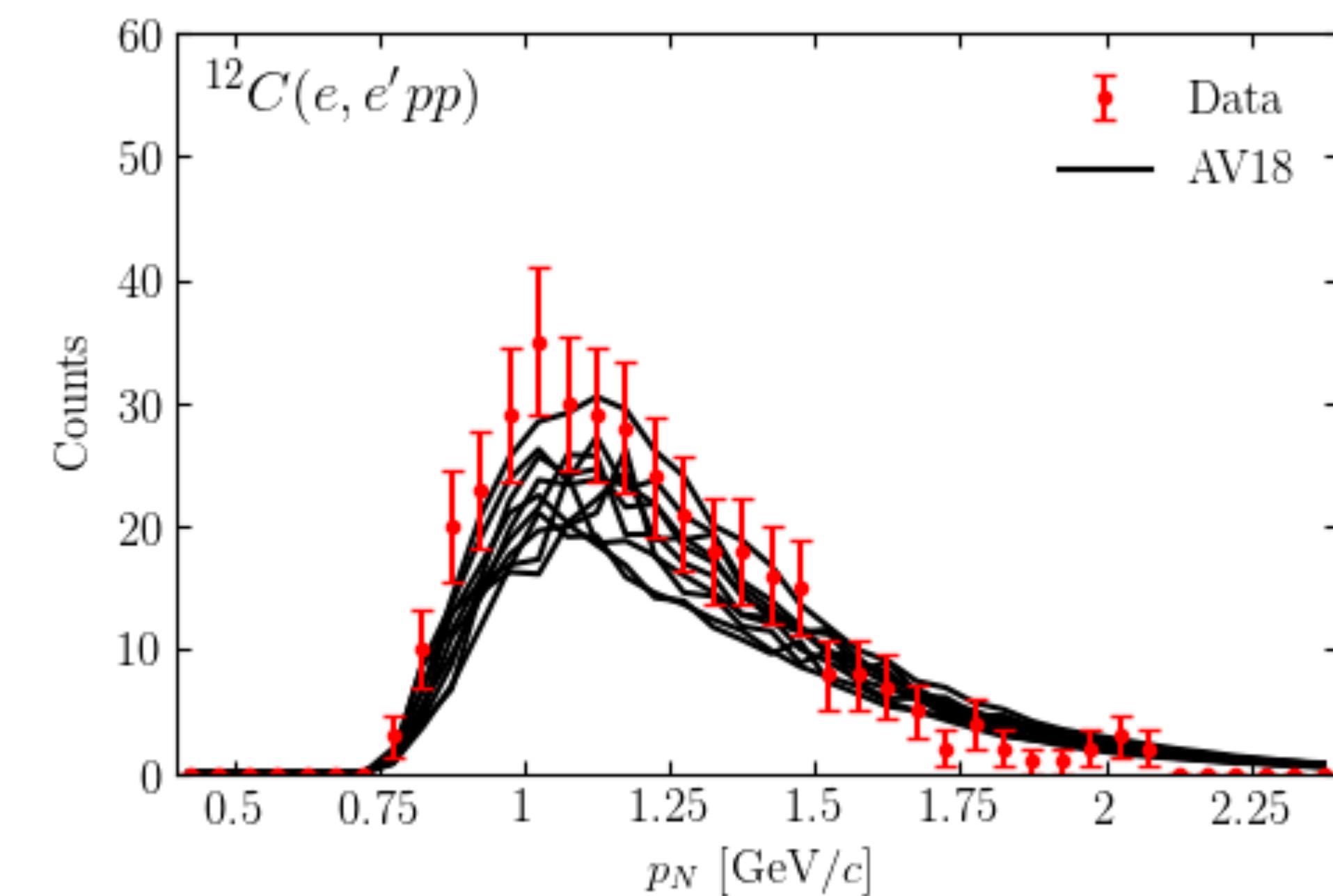
1. Randomize model parameters by uncertainty
2. Generate simulation with selected parameters



Systematic Uncertainty

Numerous input parameters with uncertainty

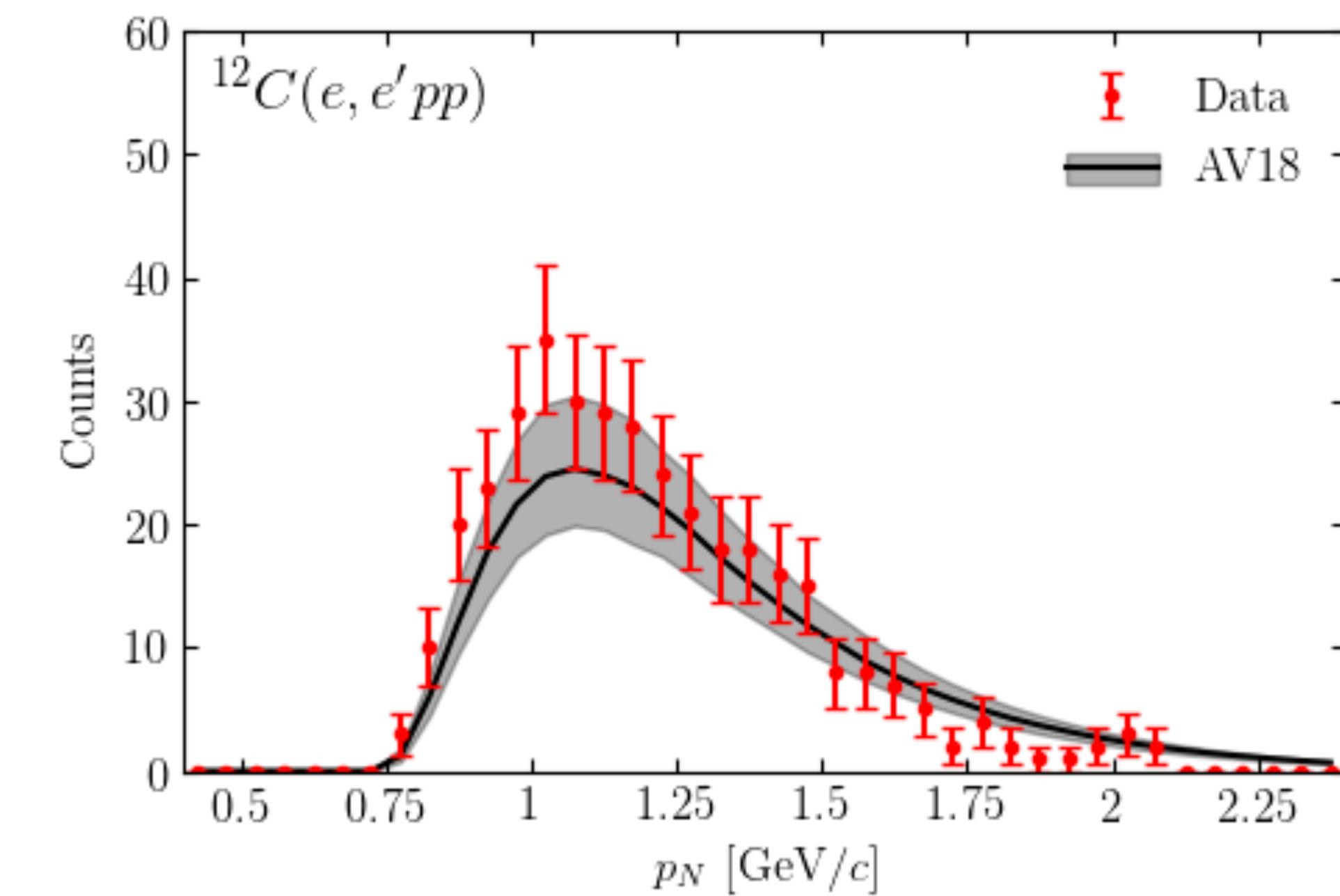
1. Randomize model parameters by uncertainty
2. Generate simulation with selected parameters
3. Repeat for numerous selections



Systematic Uncertainty

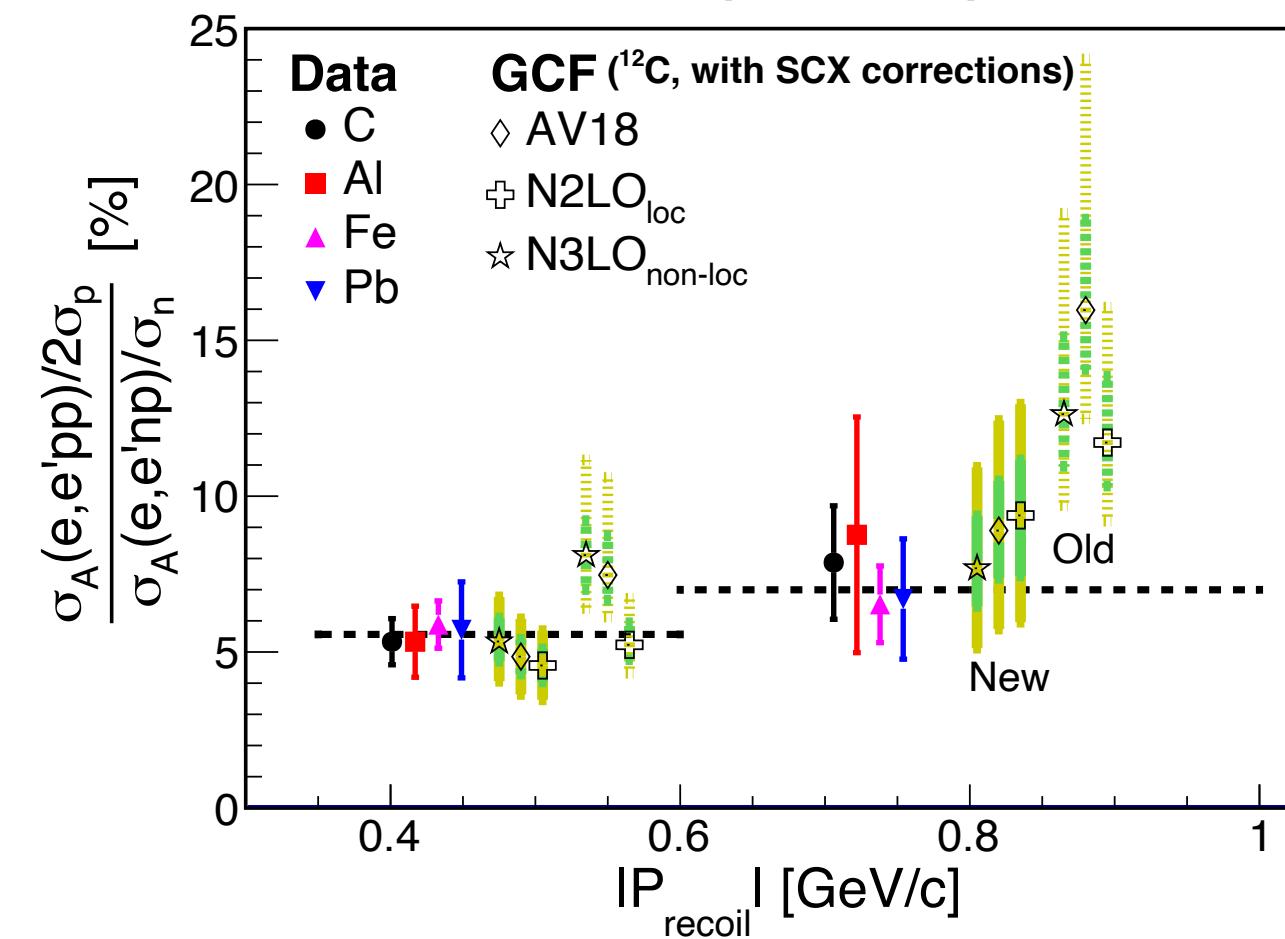
Numerous input parameters with uncertainty

1. Randomize model parameters by uncertainty
2. Generate simulation with selected parameters
3. Repeat for numerous selections
4. Combine simulations to create confidence intervals

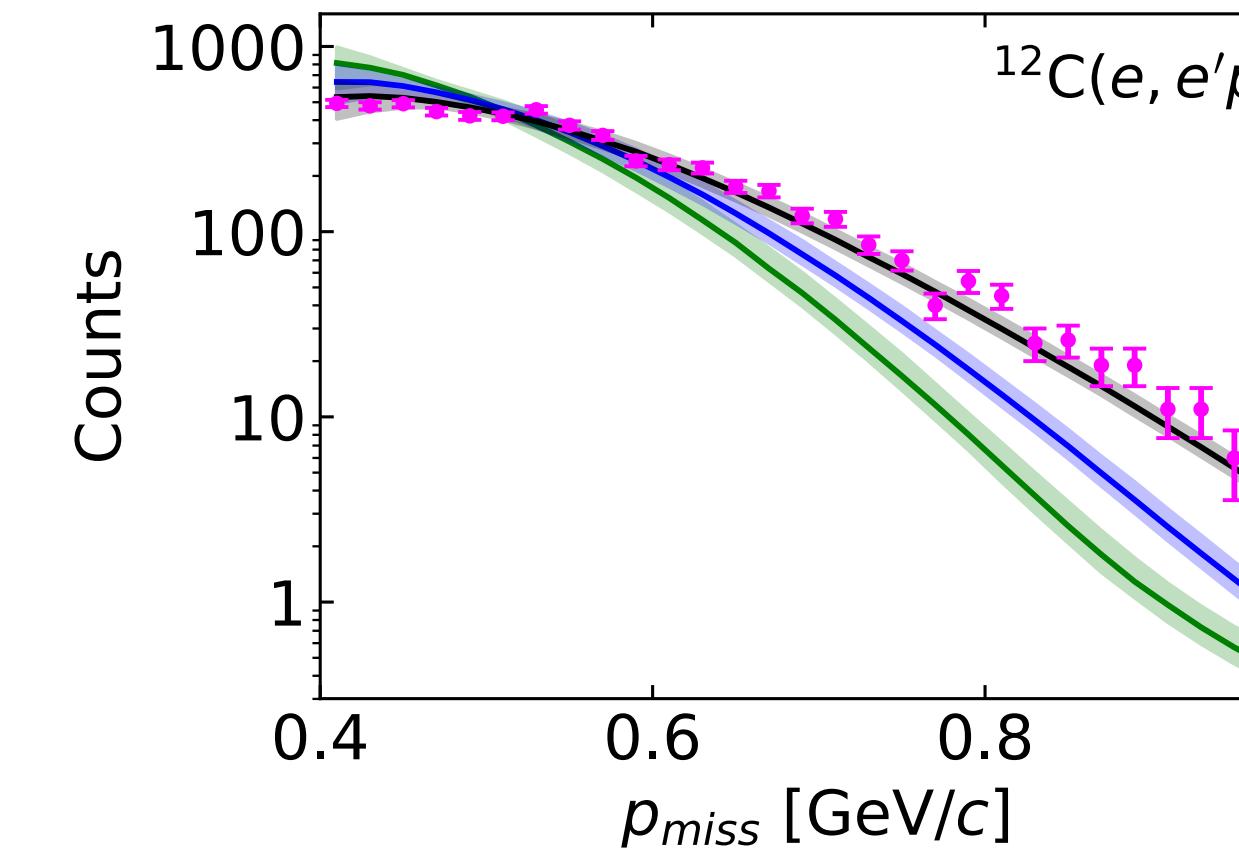


Useful in analyzing a wide variety of data

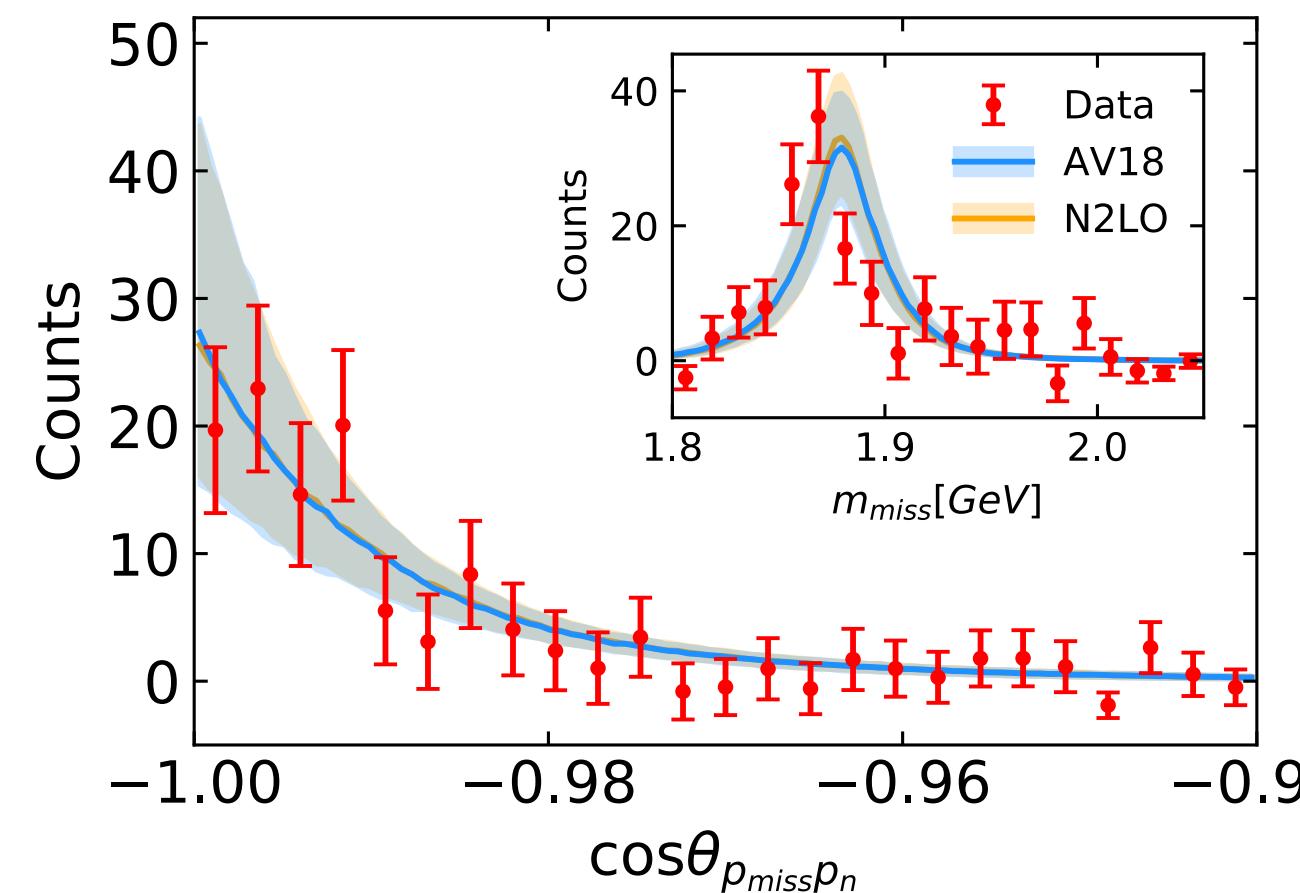
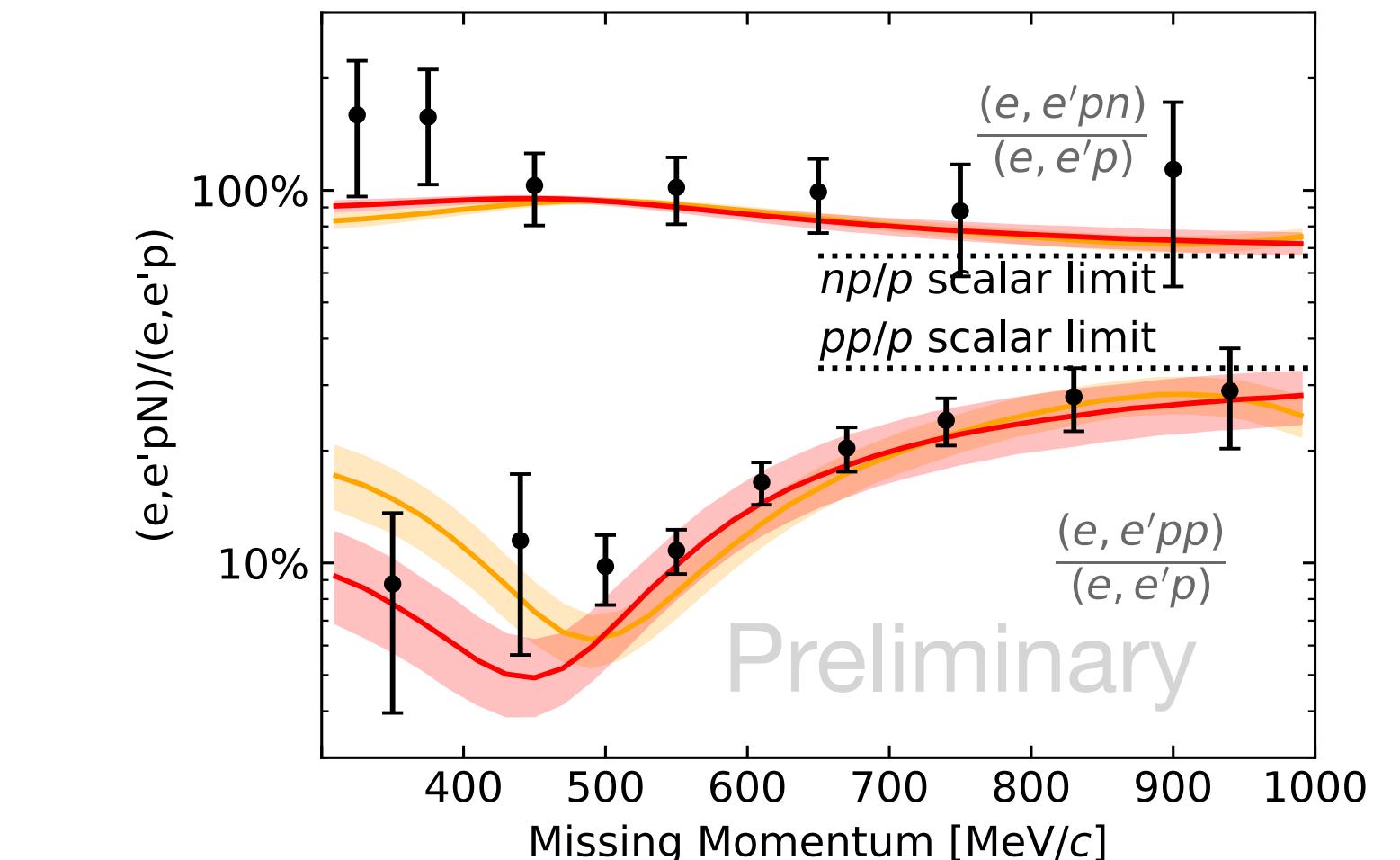
PRL (2019)



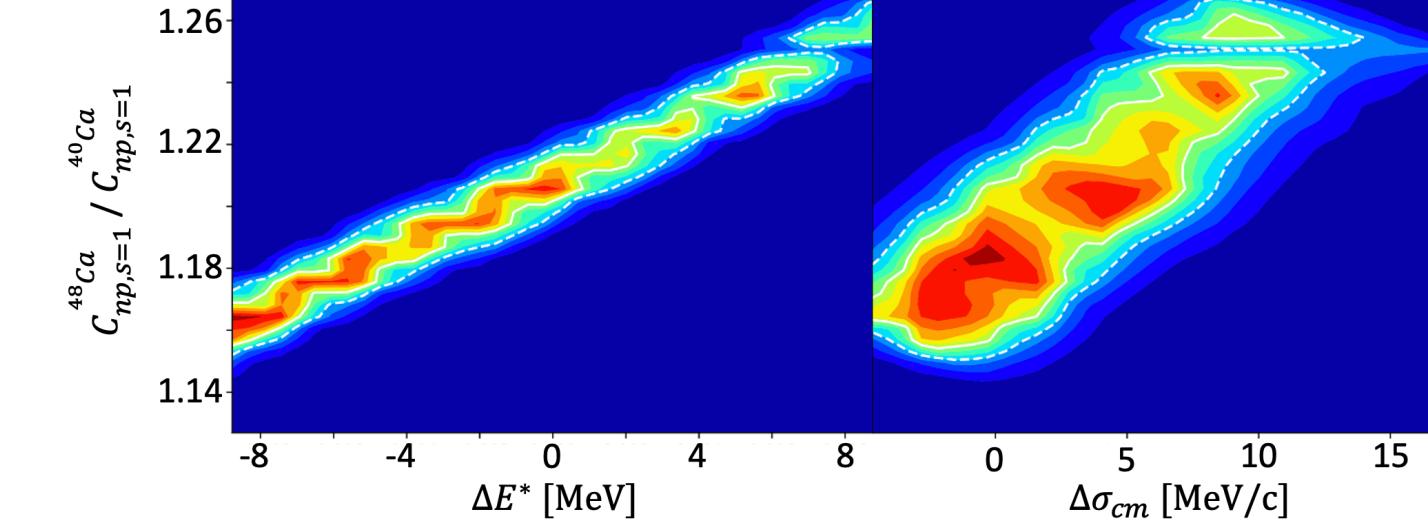
Nature (2020)



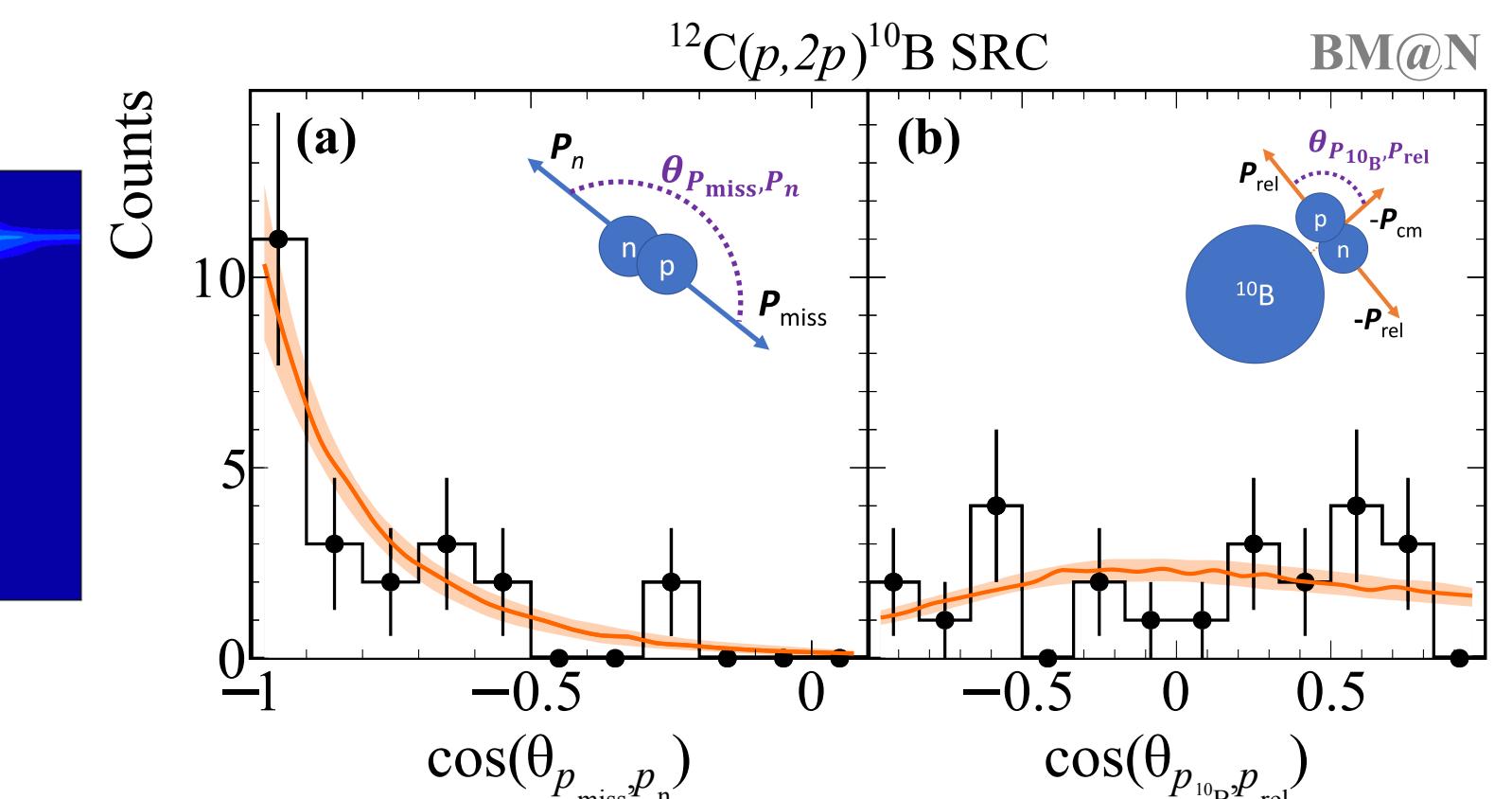
(Submitted 2020)



Phys. Lett. B (2020)



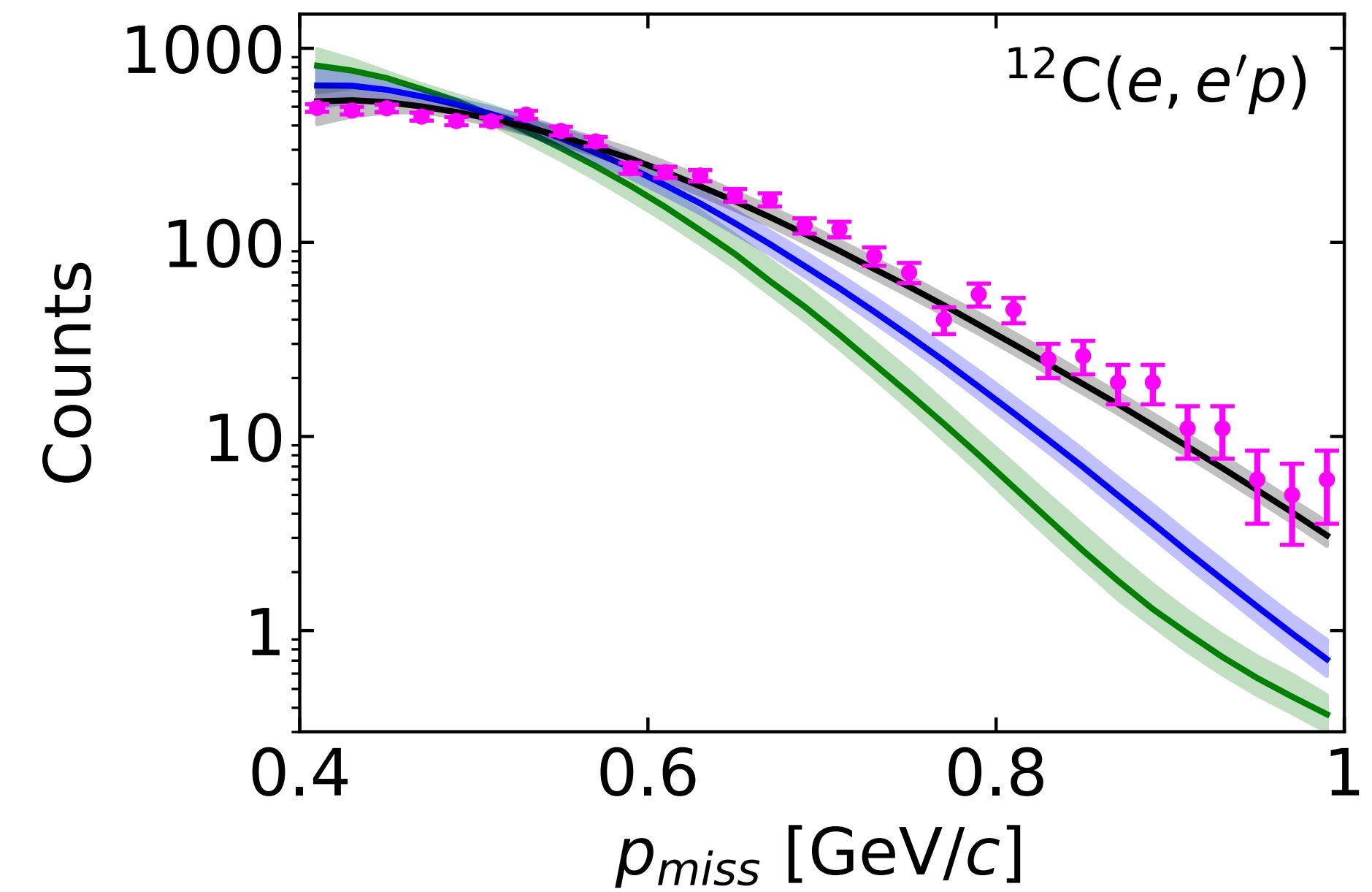
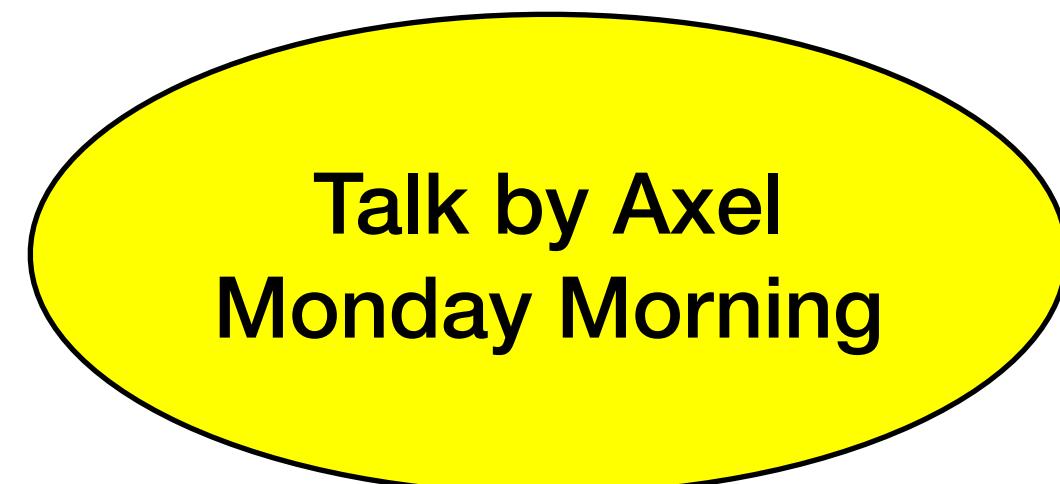
PRC Lett. (2021)



Nature Physics (2020)

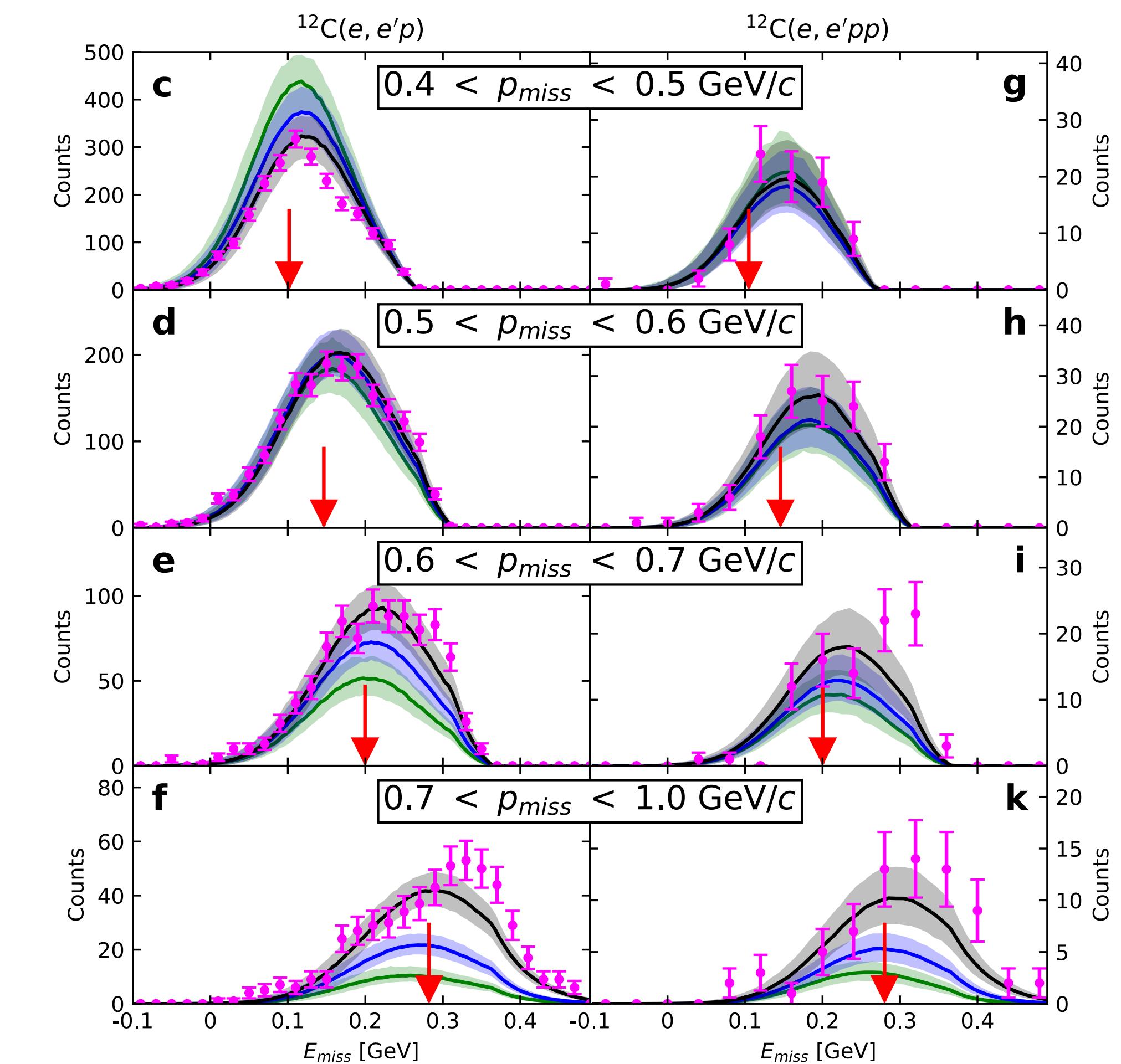
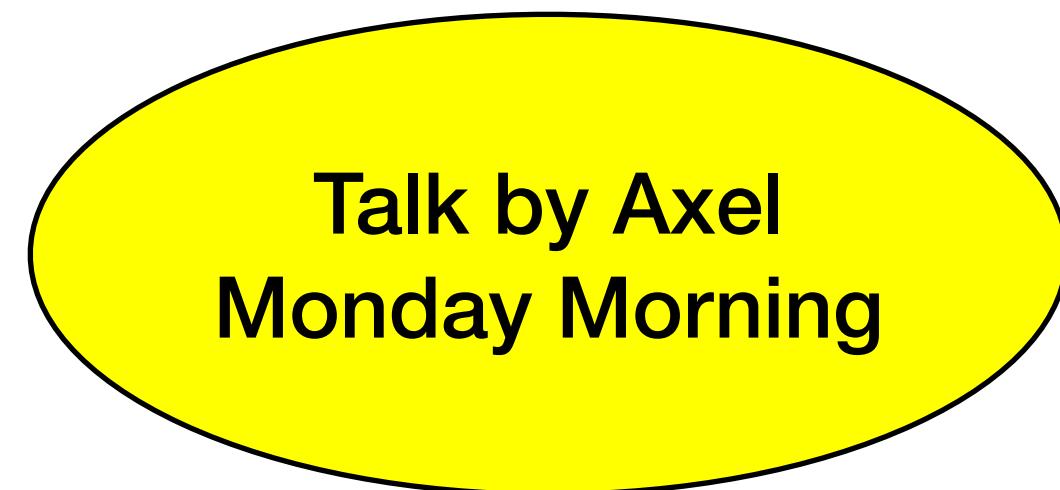
Useful in analyzing a wide variety of data

- CLAS6
- Large-acceptance ($e, e'p$),
 $(e, e'pp)$
- Used to compare models of the
NN interaction



Useful in analyzing a wide variety of data

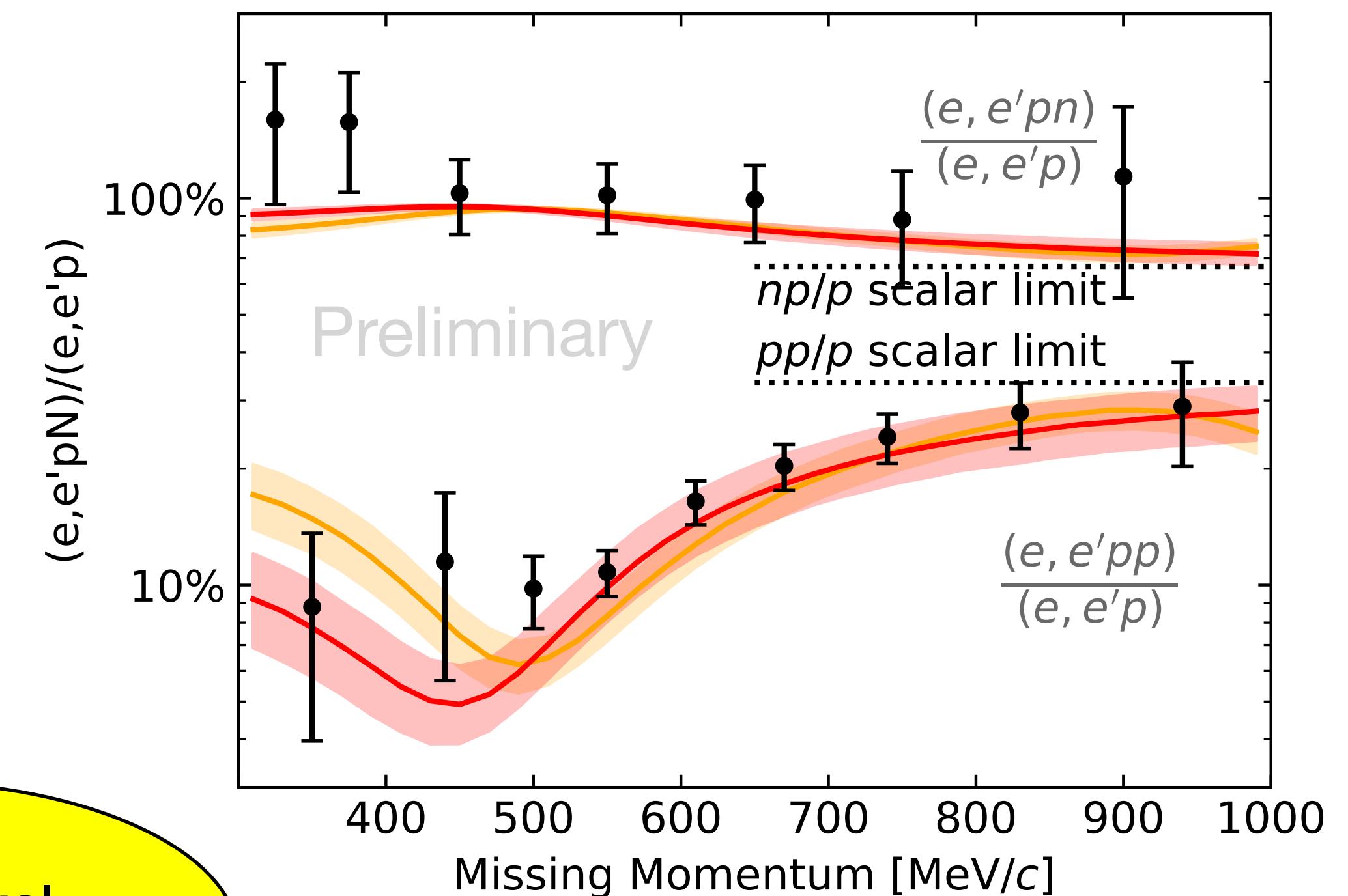
- CLAS6
- Large-acceptance ($e, e'p$), ($e, e'pp$)
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Useful in analyzing a wide variety of data

- CLAS6
- Large-acceptance $(e, e'p)$,
 $(e, e'pp)$, $(e, e'pn)$
- Allowed acceptance correction to demonstrate closure of SRCs in high-momentum region

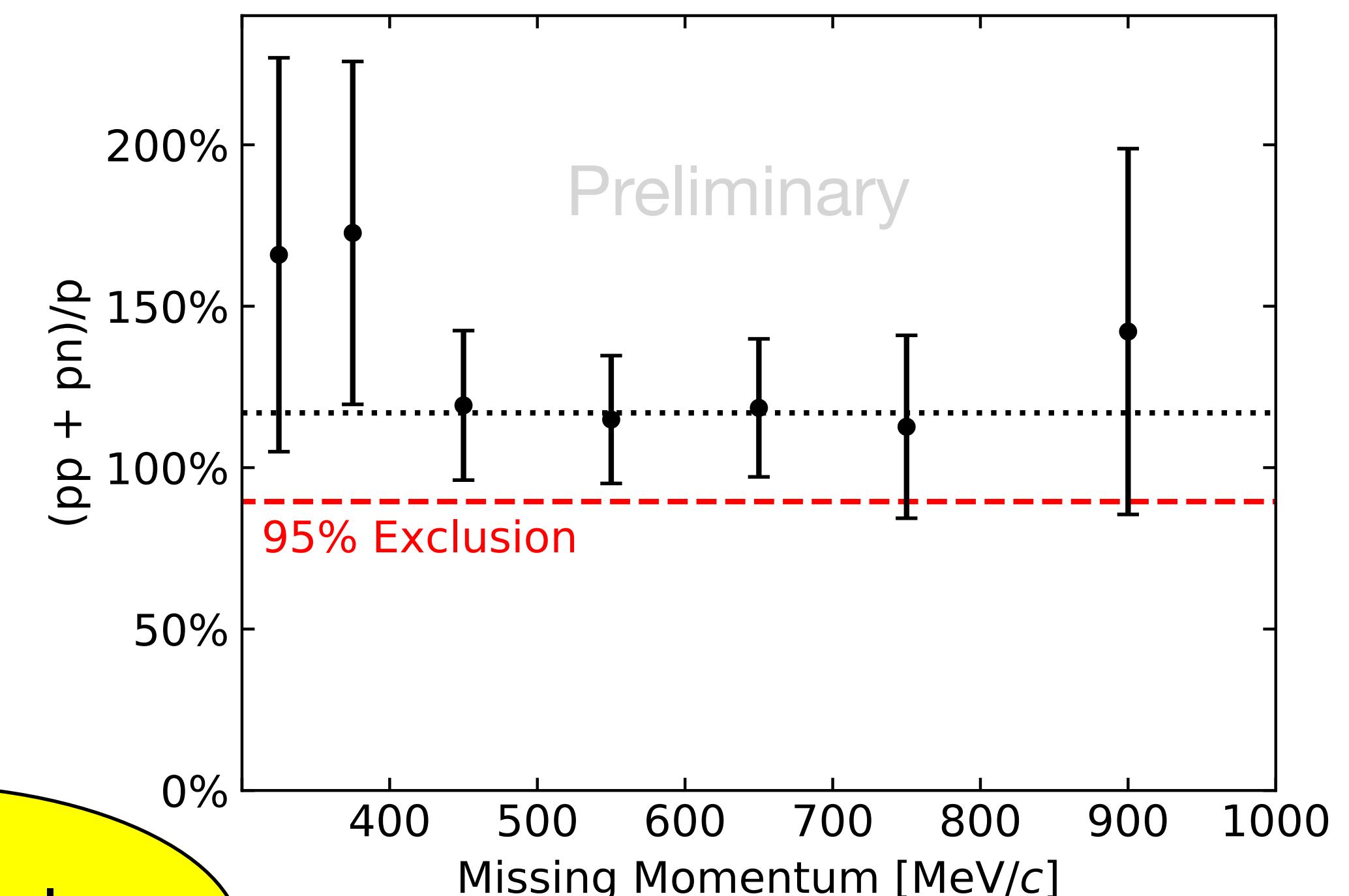
Talk by Axel
Monday Morning



Useful in analyzing a wide variety of data

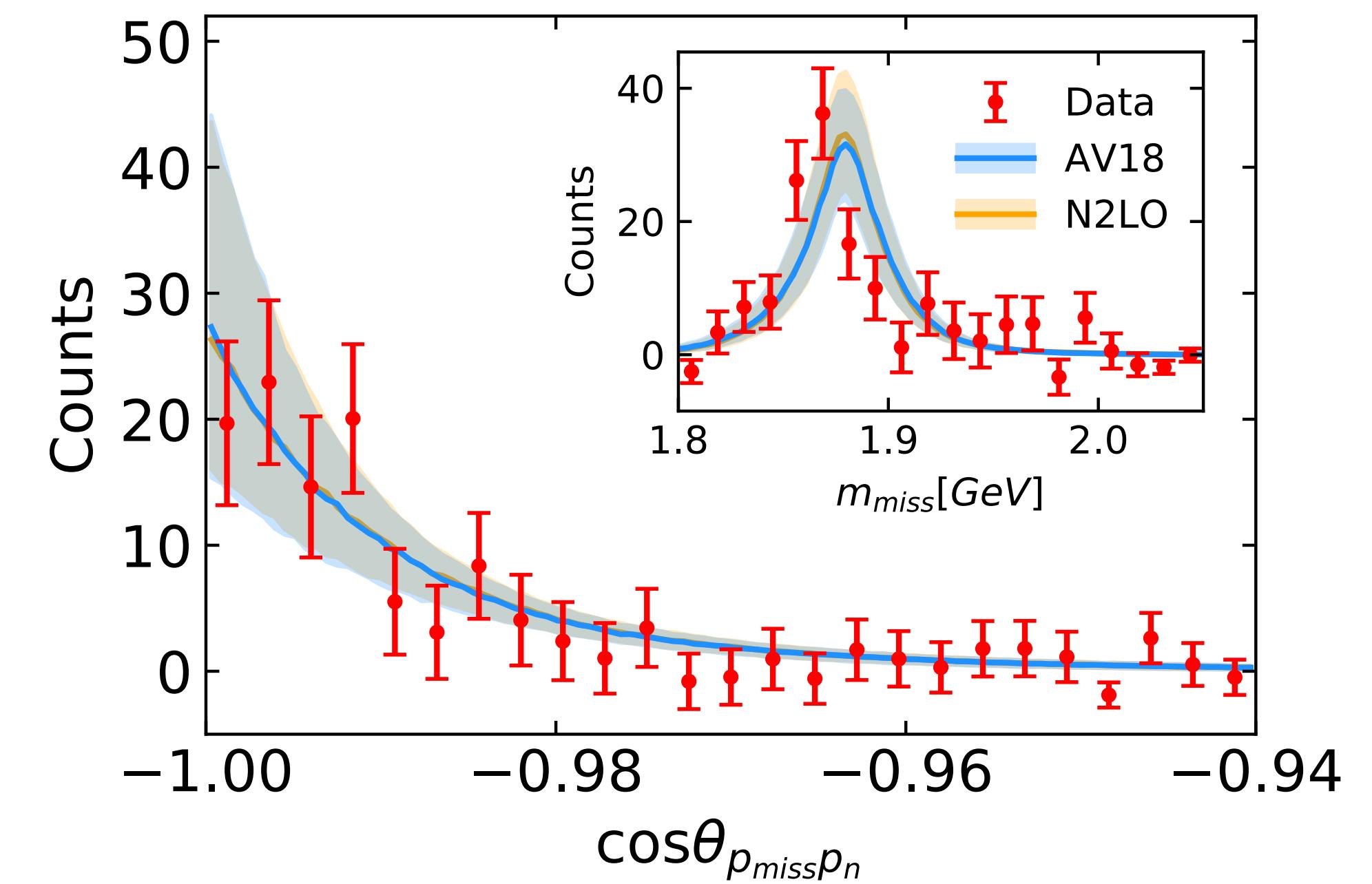
- CLAS6
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Talk by Axel
Monday Morning



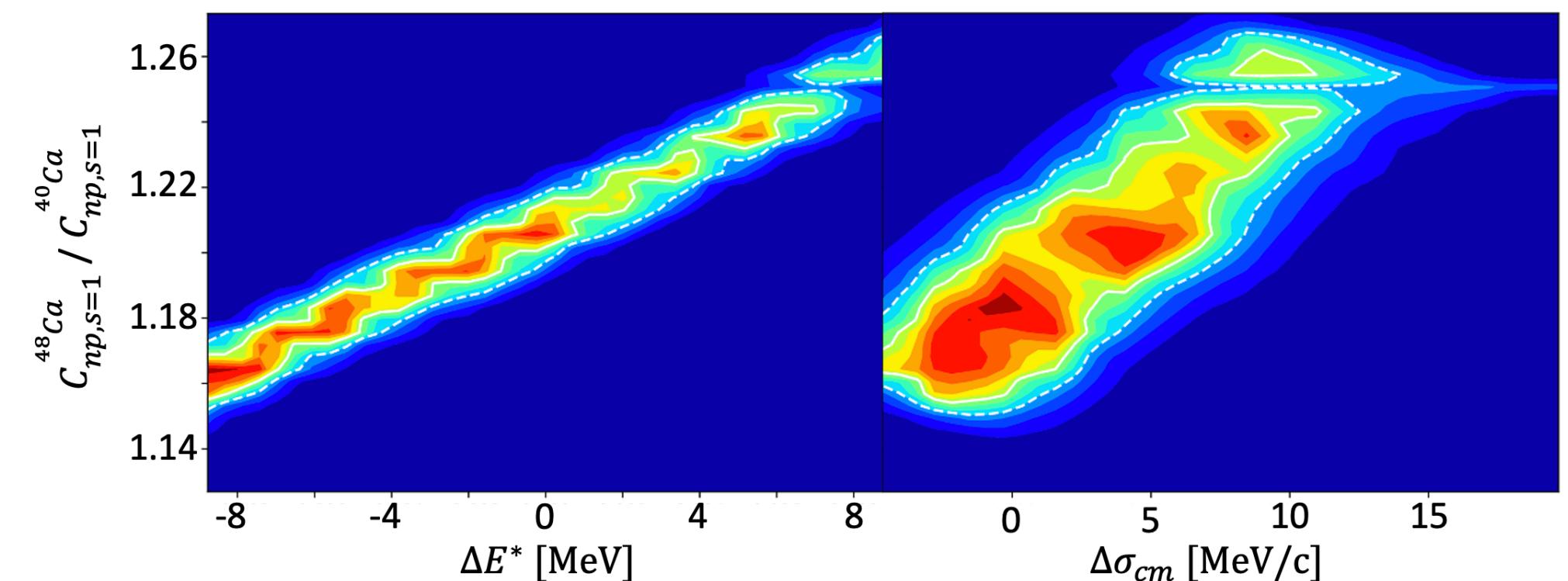
Useful in analyzing a wide variety of data

- Hall A
- Spectrometer ($e, e' p N$)
- Used for reanalysis of previous measurement — details later



Useful in analyzing a wide variety of data

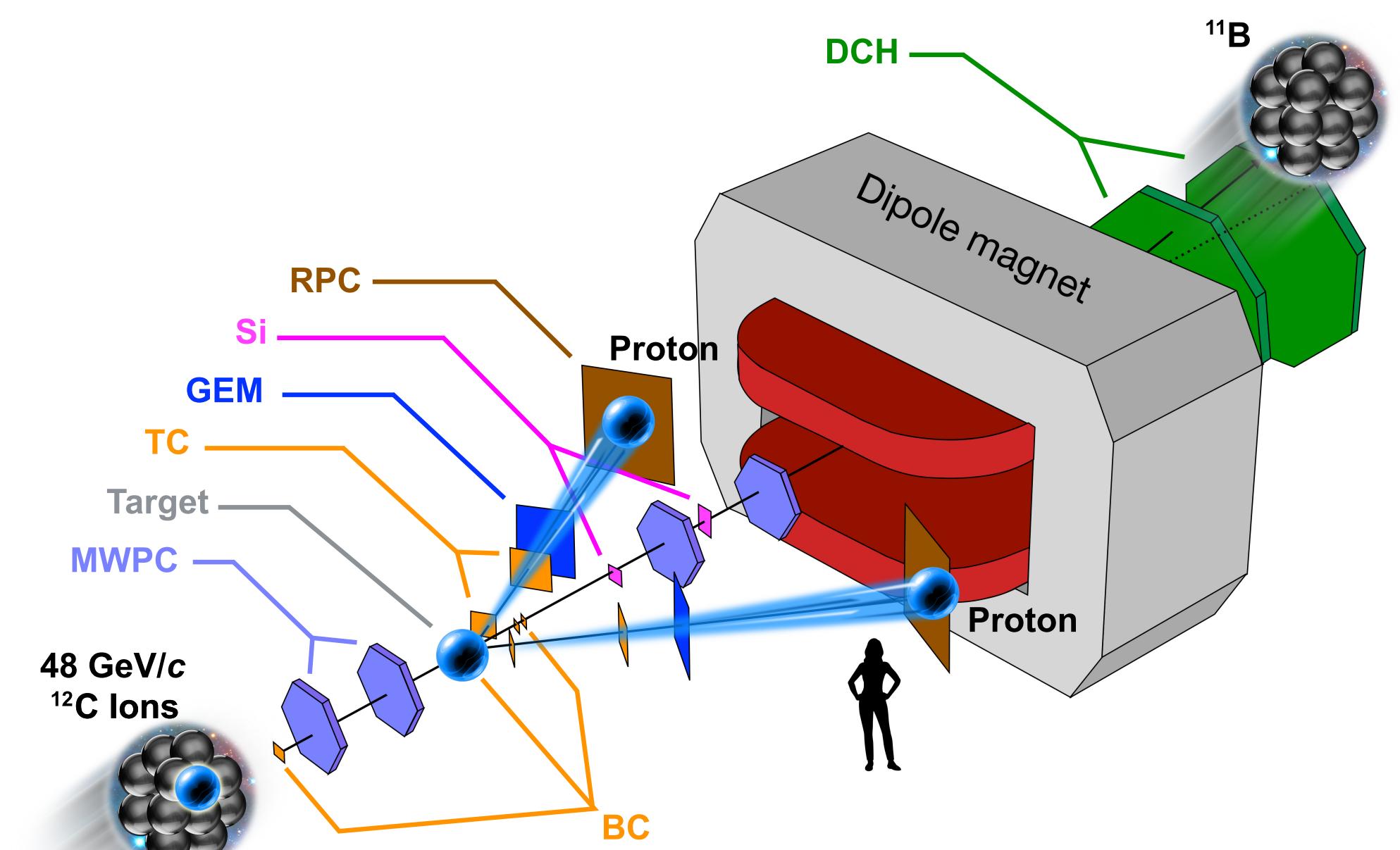
- CLAS6, Hall C
- Inclusive (e, e')
- Used to perform parameter inference on SRC parameters



Talk by Andrew
Next Up

Useful in analyzing a wide variety of data

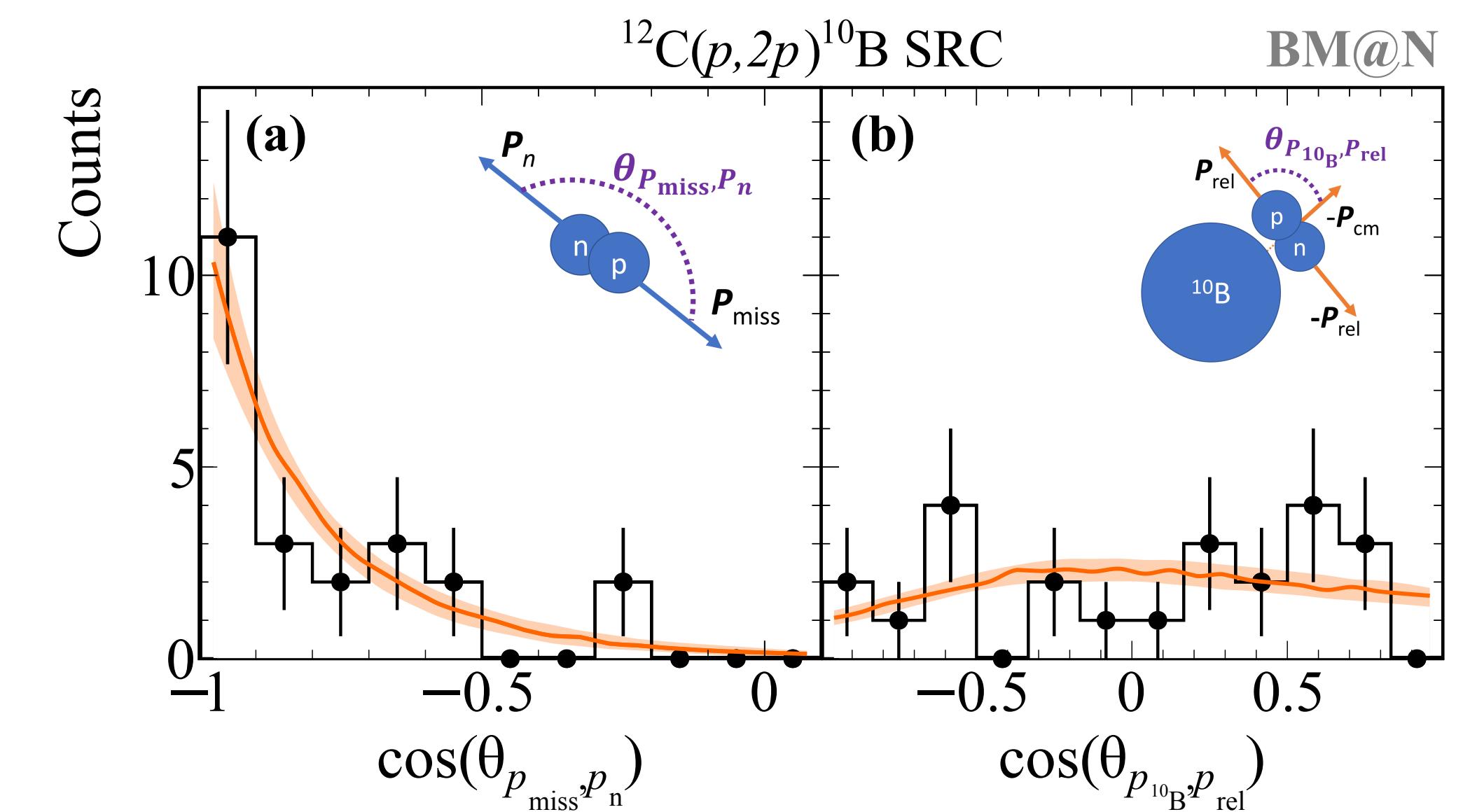
- JINR
- Inverse-kinematics ($p, 2p$)
- Helped to guide and refine cuts in this novel analysis



Talk by Maria
Monday Afternoon

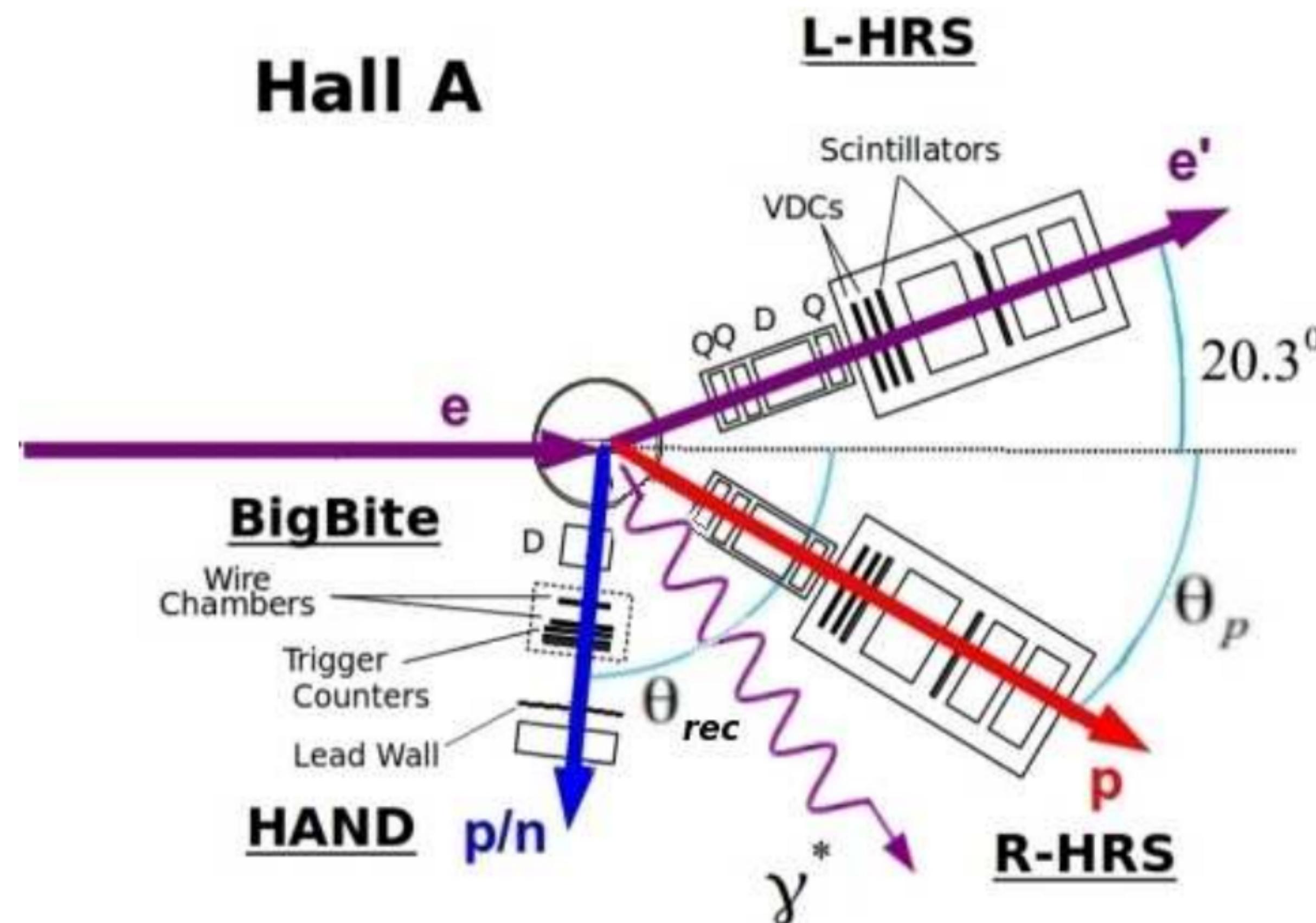
Useful in analyzing a wide variety of data

- JINR
- Inverse-kinematics ($p, 2p$)
- Helped to guide and refine cuts in this novel analysis



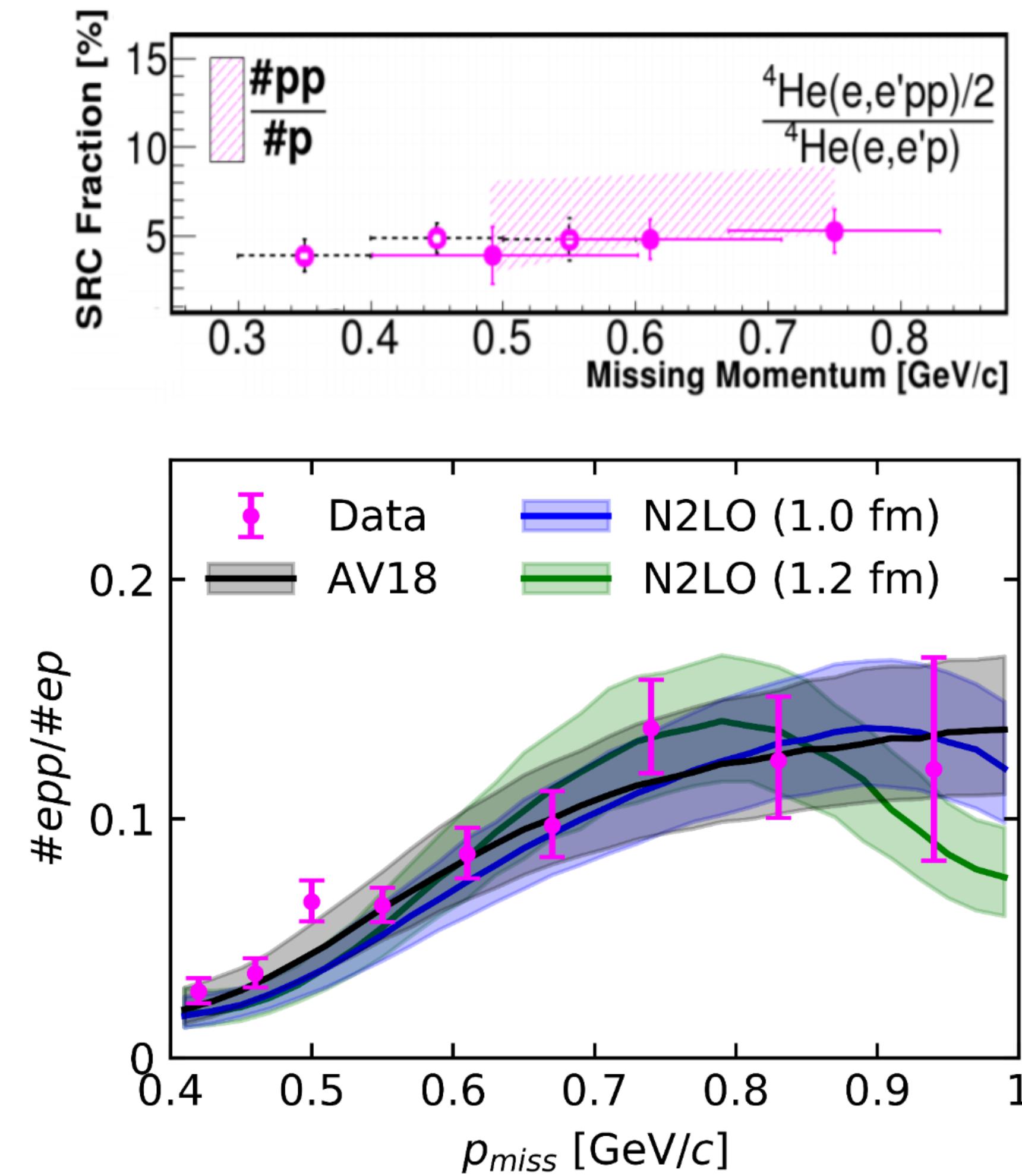
Talk by Maria
Monday Afternoon

Jefferson Lab Hall A

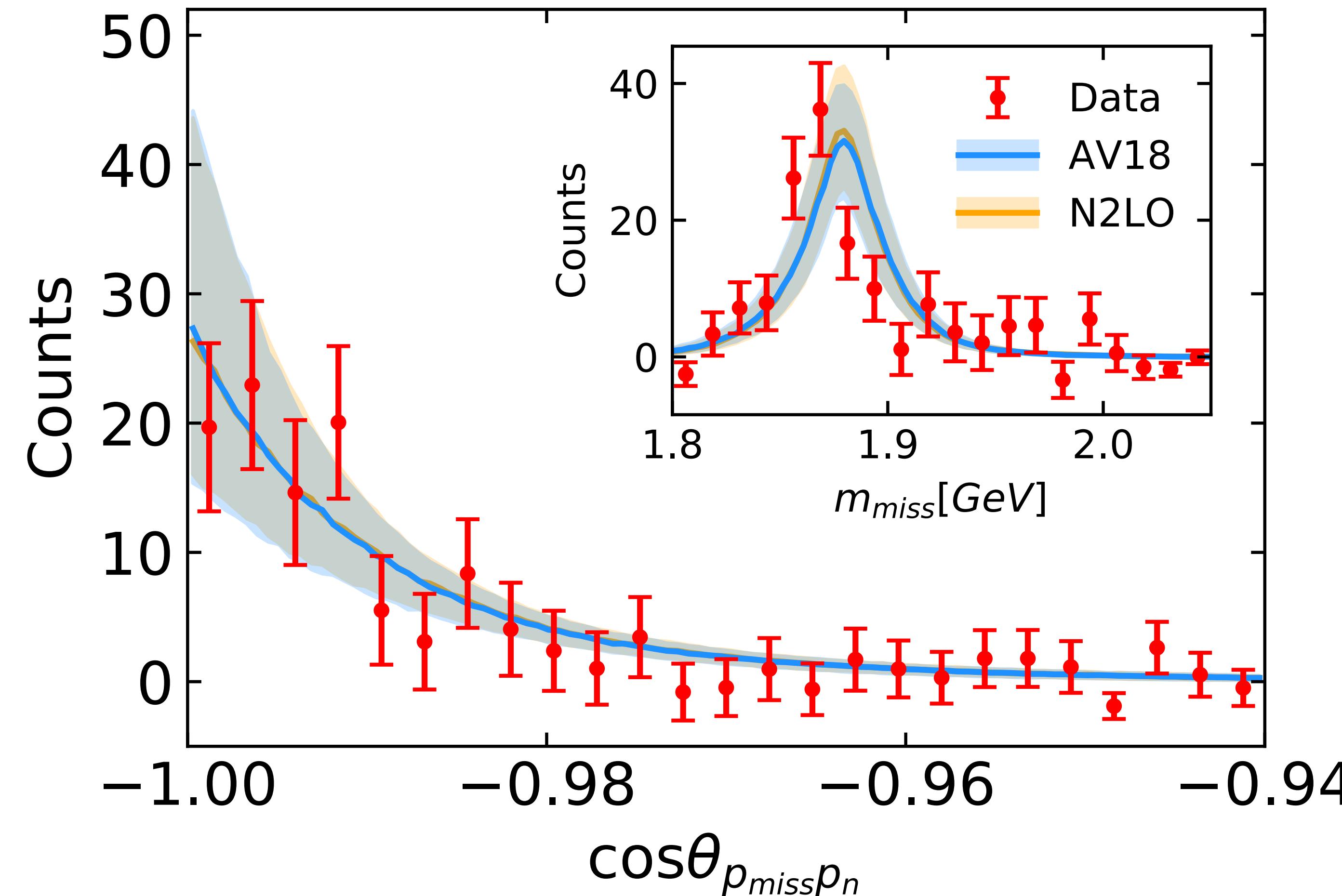


Jefferson Lab Hall A

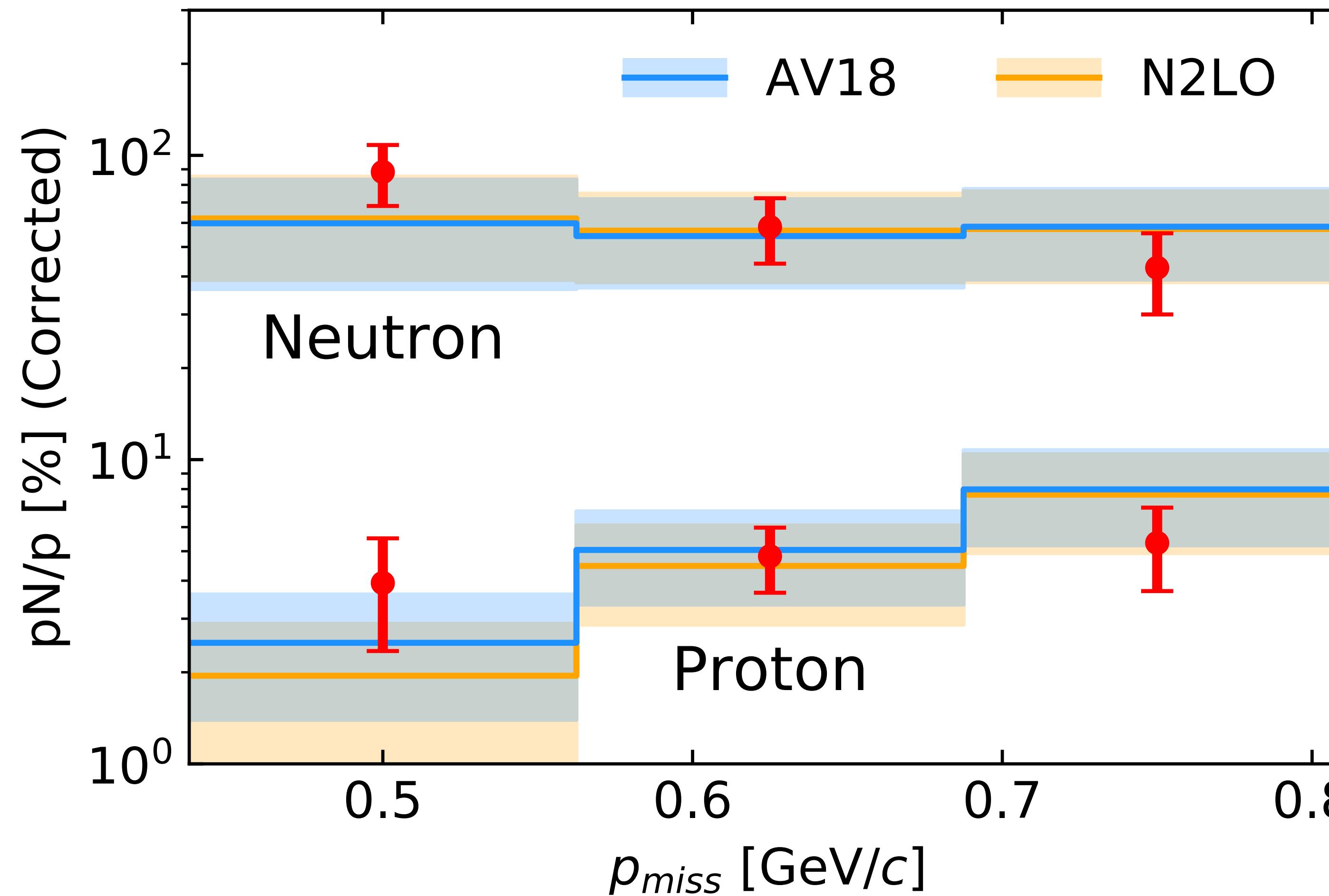
- Electron scattering spectrometer experiment
- Appeared to show flat pp/p fraction
- Tensor-to-scalar transition predicts a rising pp fraction!



Good Kinematic Agreement with GCF Model



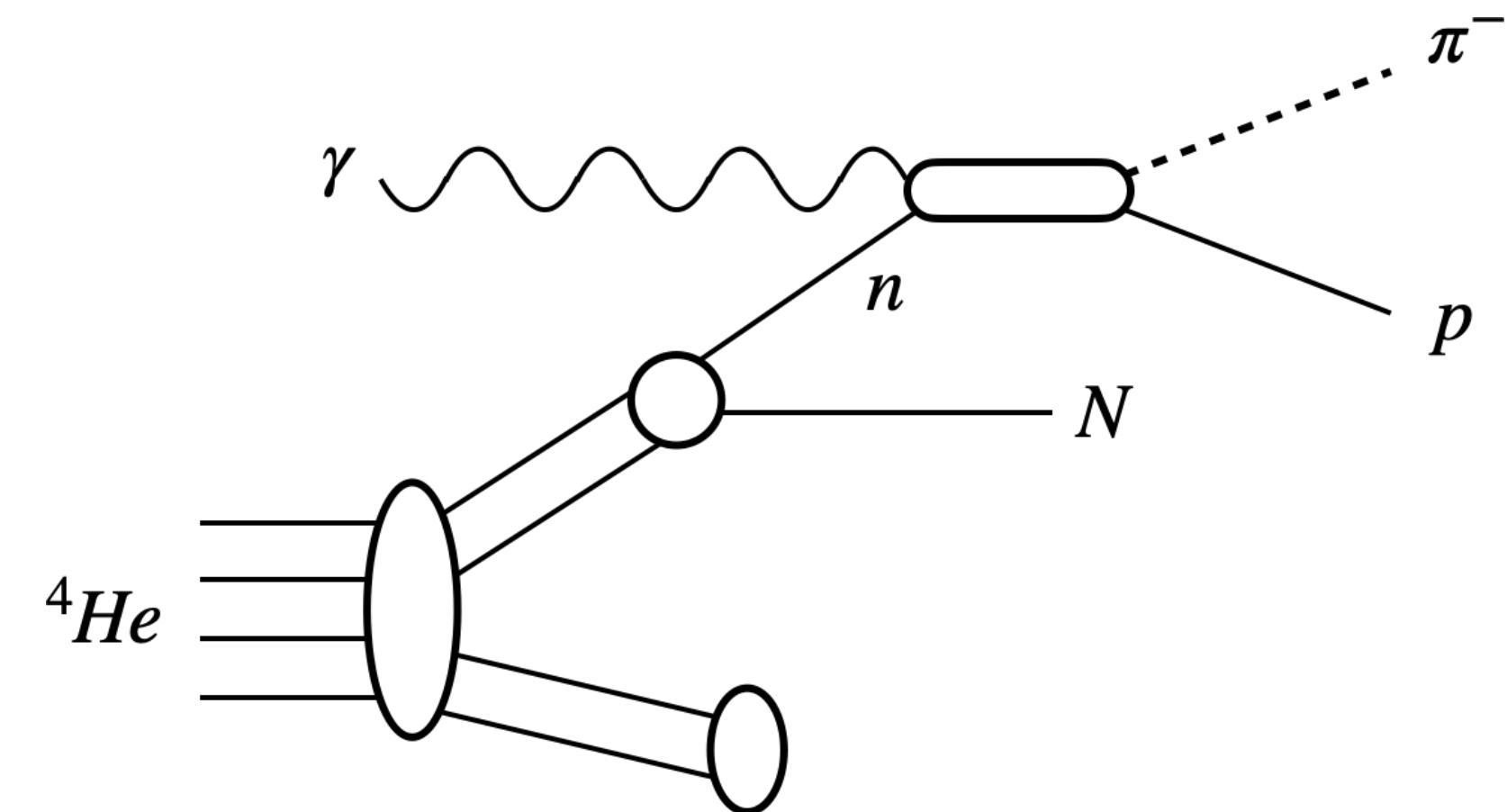
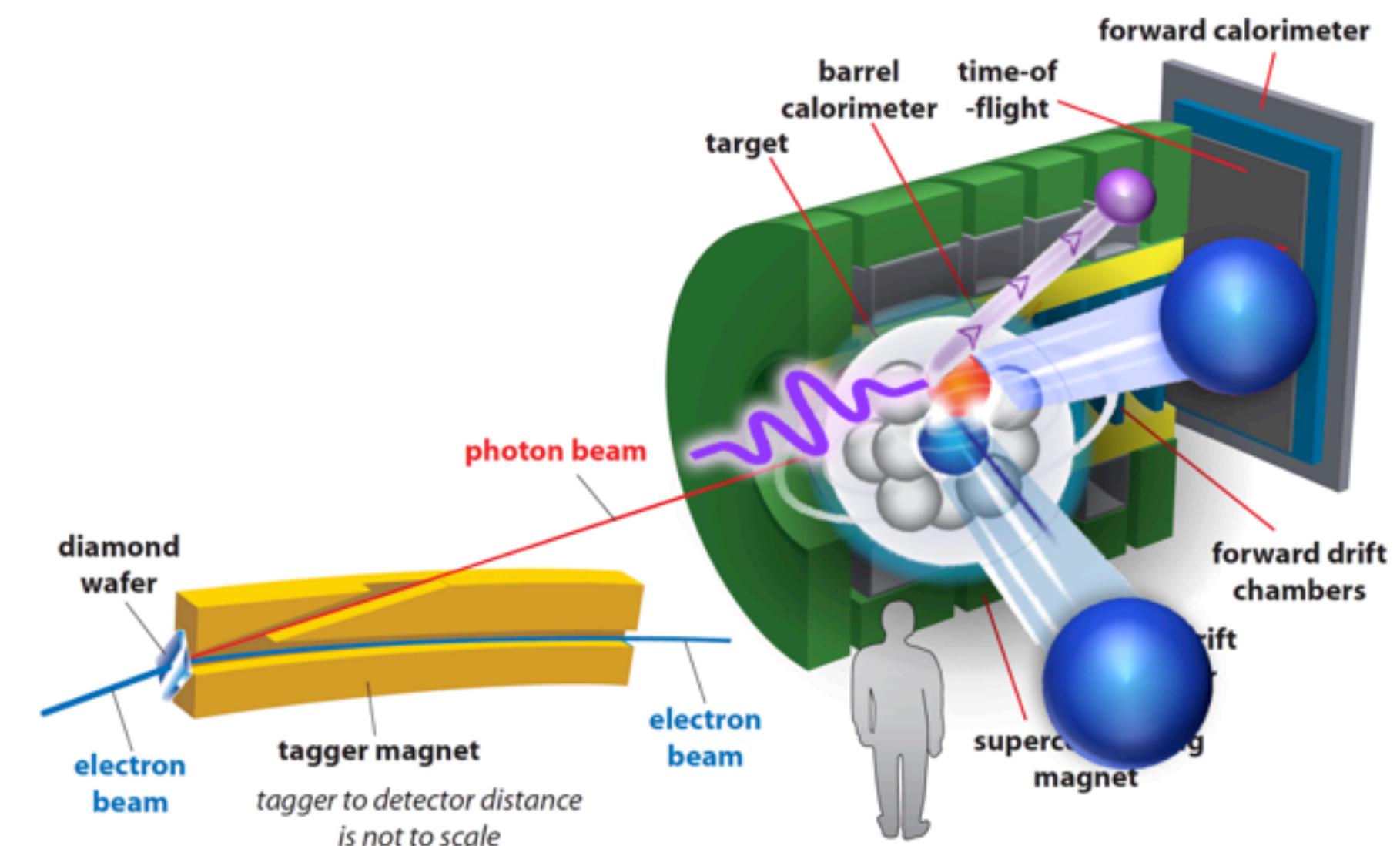
Data are consistent with GCF model



Upcoming Experiment: SRC@GlueX

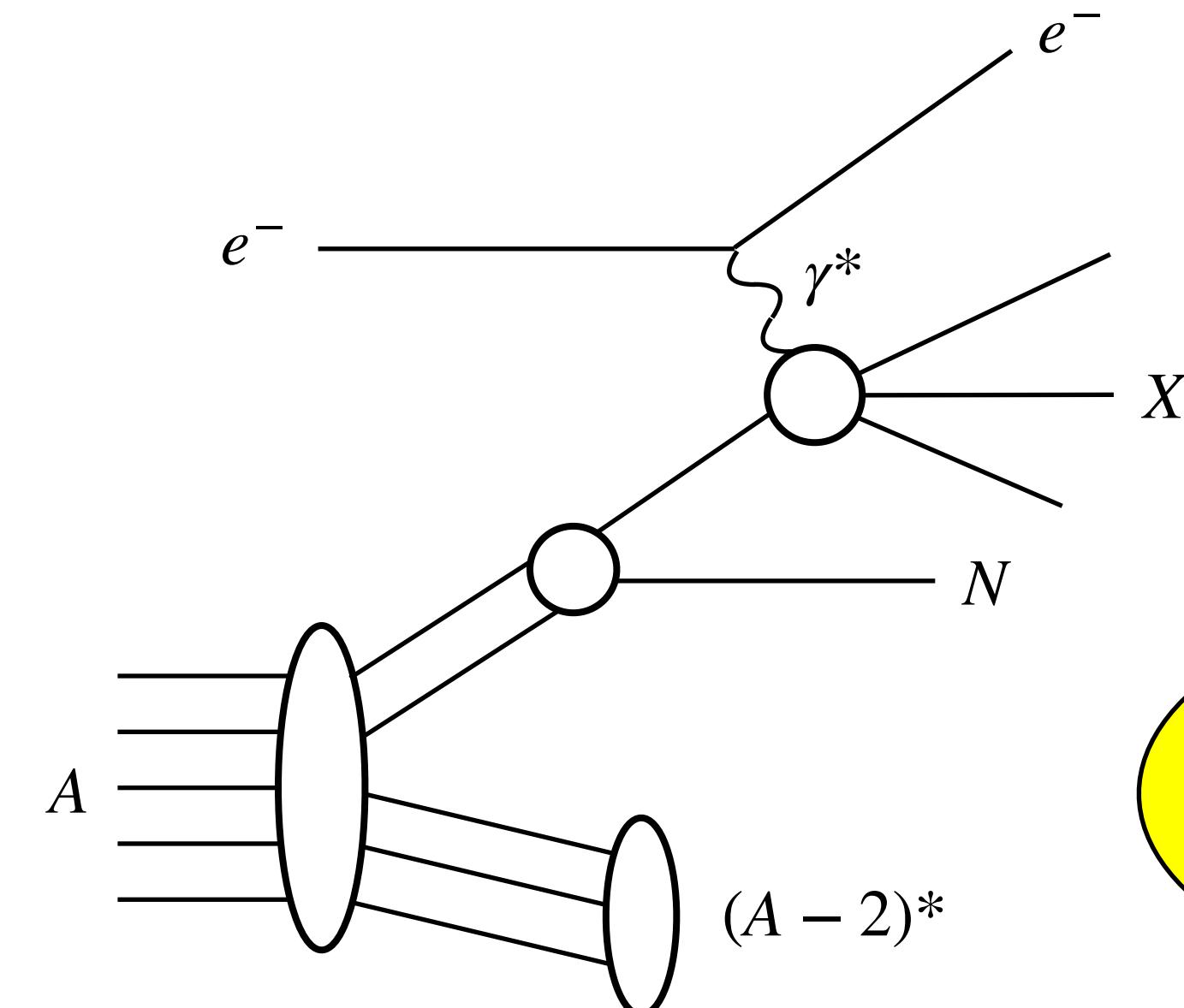
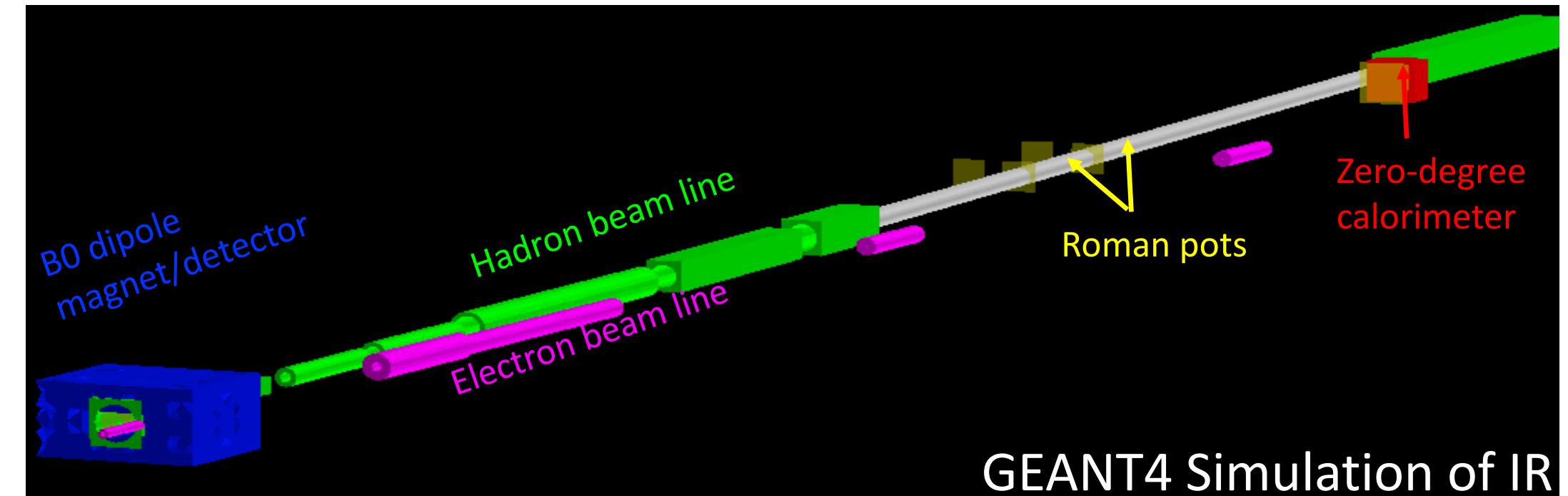
- Hall D
- Large-acceptance meson photoproduction
- Used to estimate event rates and asses PID capabilities for reactions of interest

Talk by Or
Friday Morning



Upcoming Experiment: EIC

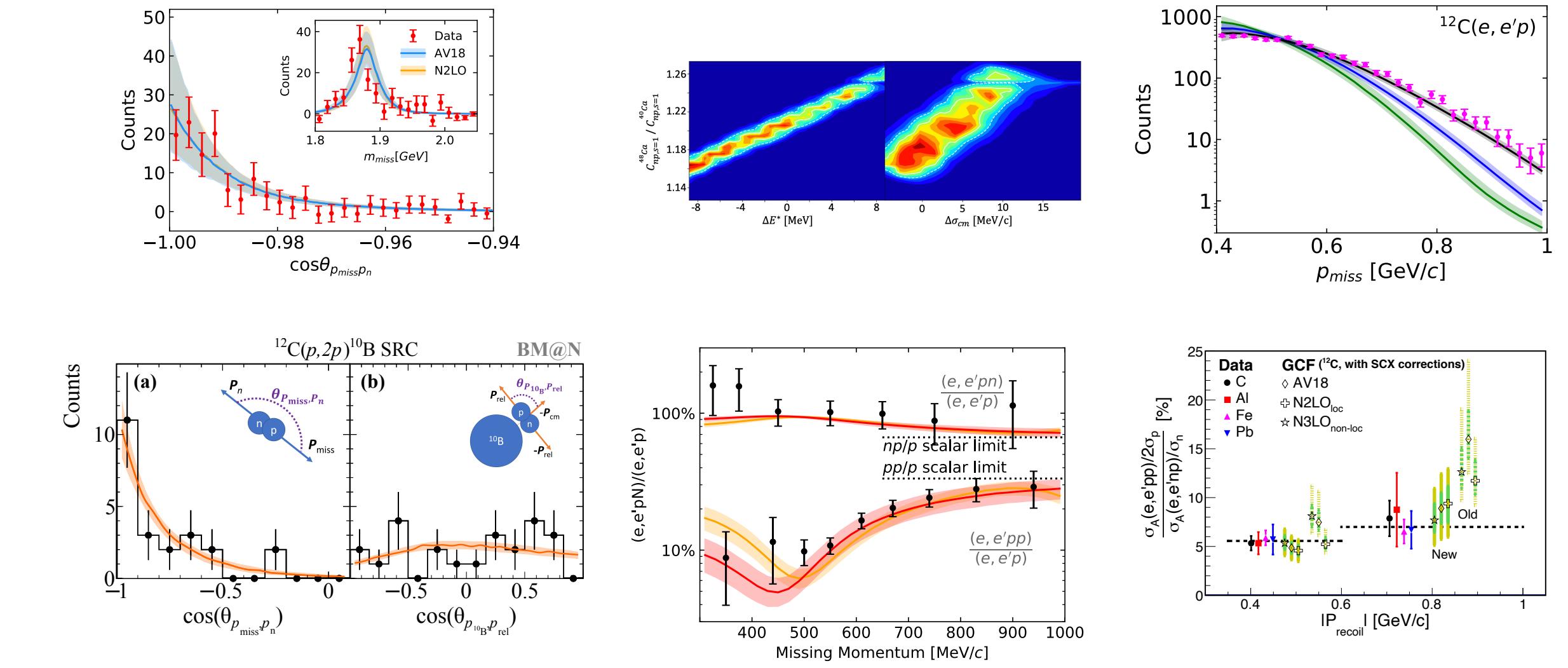
- EIC (Nuclear Structure)
- Accelerator ($e, e'NN$), DIS, VMP...
- Used to study EIC far-forward detection capabilities for SRC breakup reactions



Talk by Florian
Friday Afternoon

Conclusions

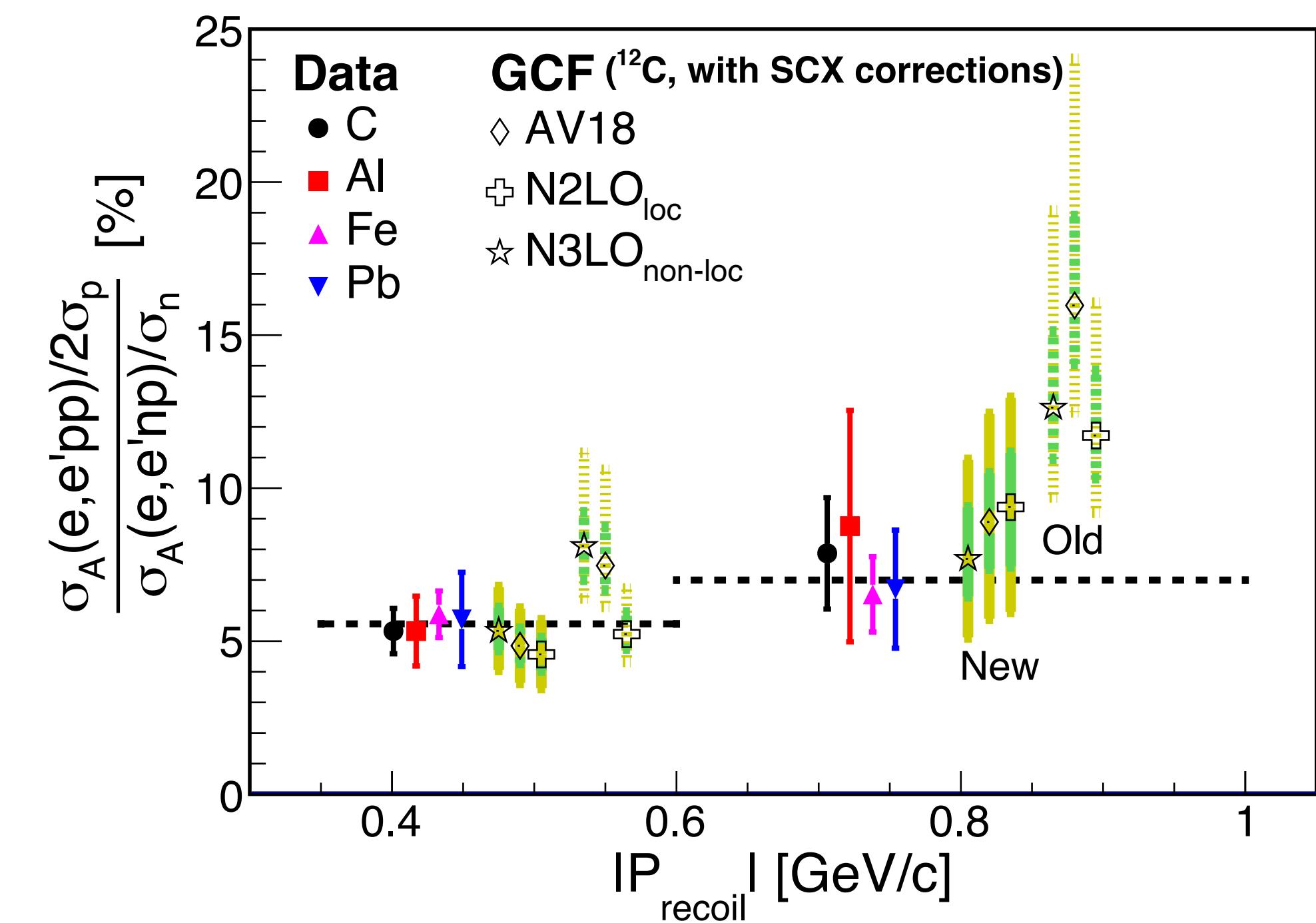
- GCF shows good agreement with data over a wide variety of experiments
- Powerful tool for guiding data analysis
- Also useful in preparing for future experiments



- PRL (2018)
- Nature (2020)
- PLB (2020)
- PRC Lett. (2021)
- Nature Physics (2021)
- More to come!

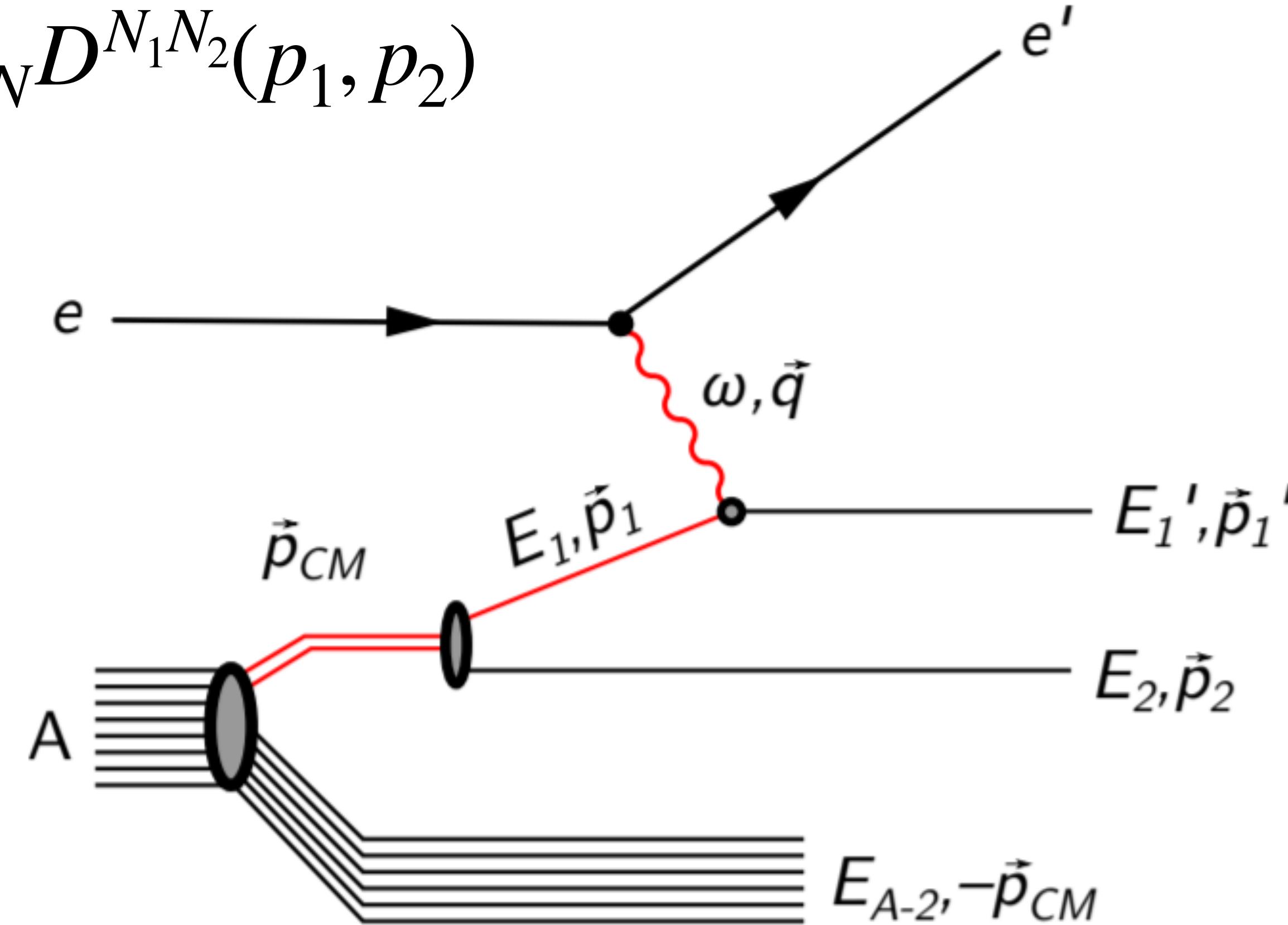
Useful in analyzing a wide variety of data

- CLAS6
- Large-acceptance ($e, e' Np$)
- Used to extract nuclear contacts from data

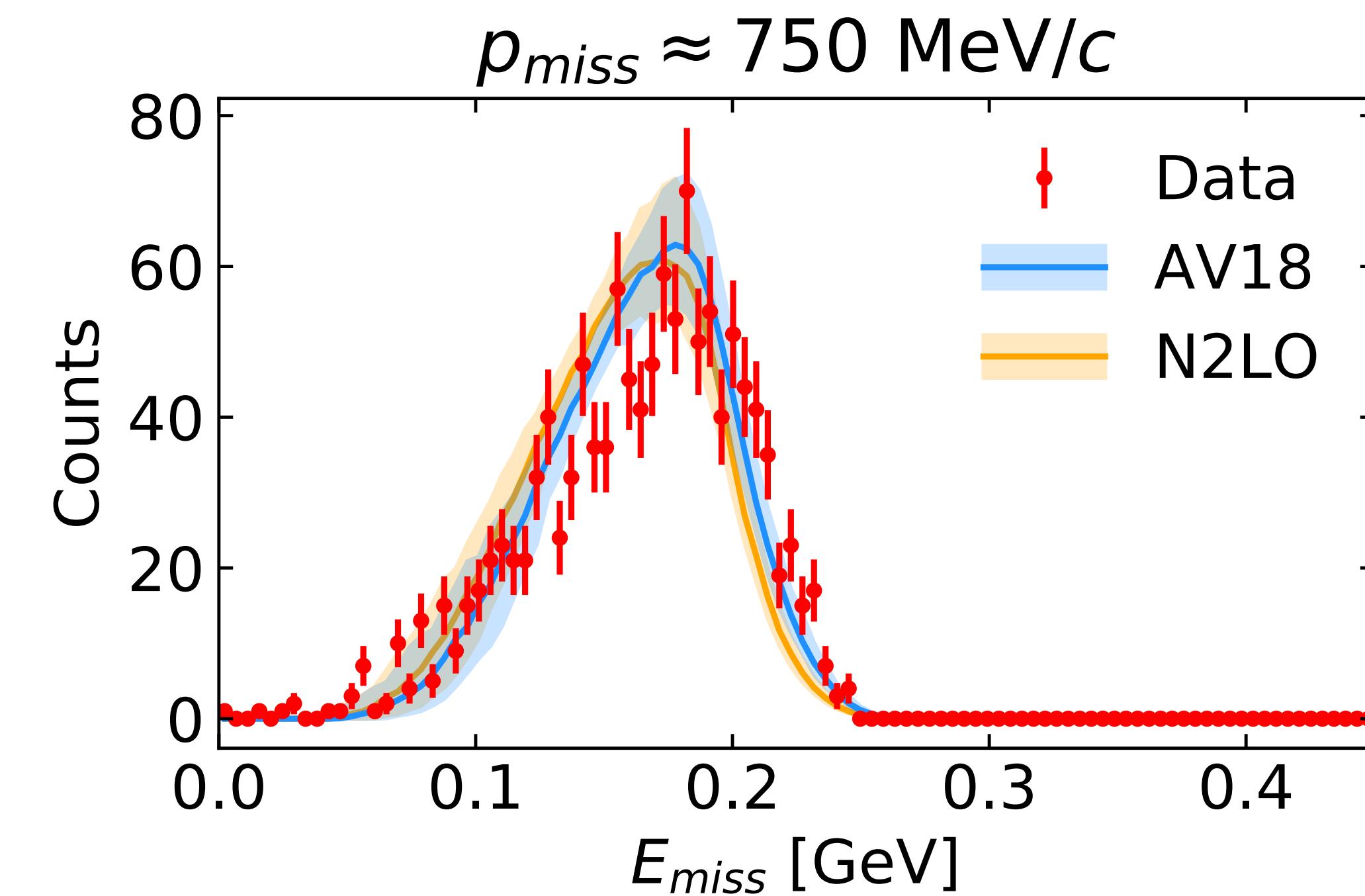
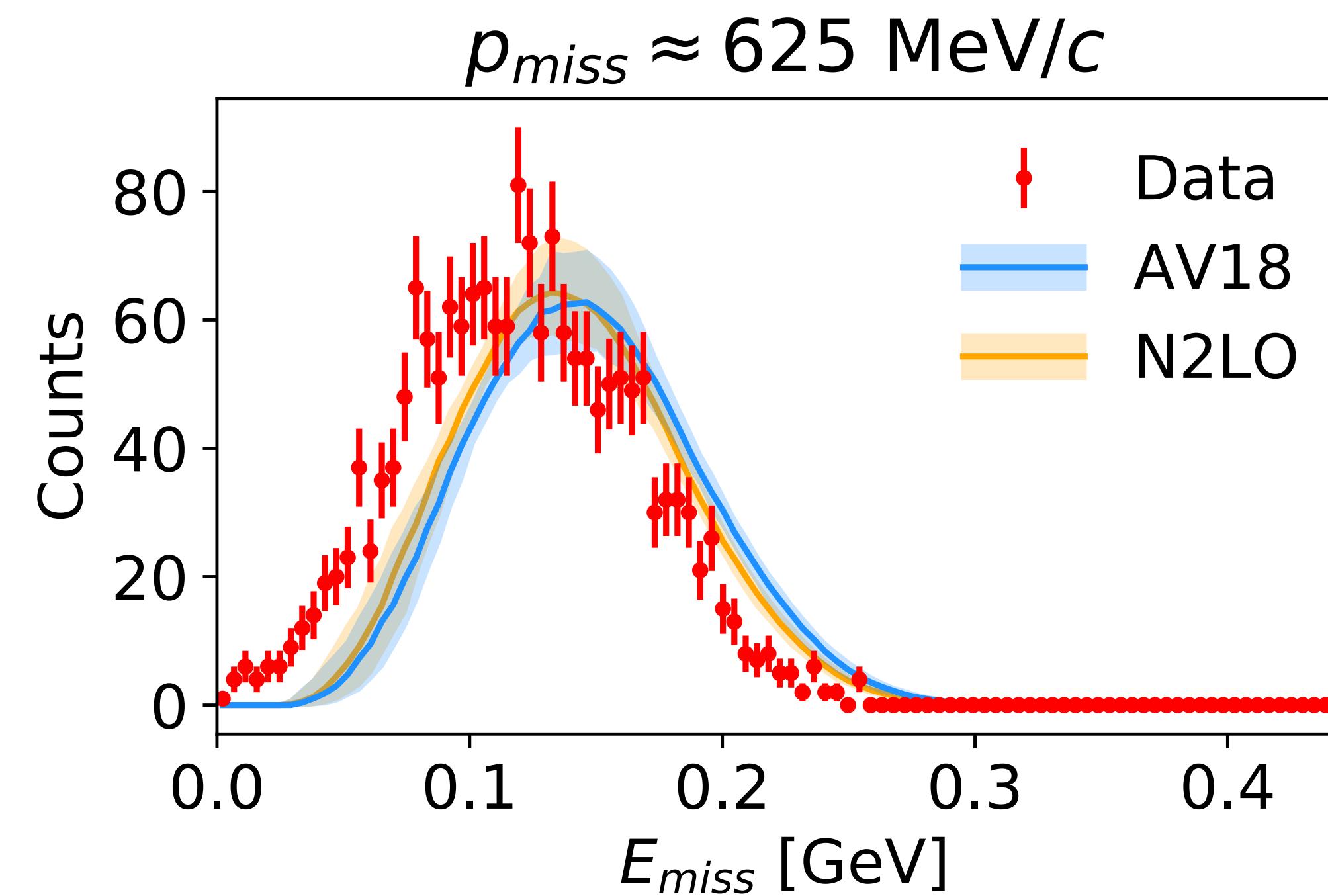


PWIA GCF Cross Section Models

$$\frac{d^8\sigma}{d\Omega_k d^3p'_1 d^3p_2} = \mathcal{J}' \sigma_{eN} D^{N_1 N_2}(p_1, p_2)$$



Good Kinematic Agreement with GCF Model



Useful in analyzing a wide variety of data

