

Tel Aviv University



Application to CLAS12

Igor Korover

Adi Ashkenazi

Tel Aviv University at glance

Initial seeds for the university established out during 1930s

Institute of Natural Sciences, 1931

School of Law and Economics, 1935

On November 3rd, 1963, TAU became independent fully functional University.



TAU today: Israel's largest institution of higher education,
with over 30K students across 9 faculties.

School of Physics & Astronomy: Particle Physics, Condensed Matter and Astrophysics

~ 50 faculty members

~ 200 MSc/PhD students

~ 30 Postdocs



TAU group at CLAS12

Adi Ashkenazi

- Senior lecturer since 2021
- Main work, ERC funded, electrons for neutrinos using CLAS data



Research group:

- Lab manager, 2 postdocs, 5 Graduate student, 3 BSc students
- Out of which: postdoc, 2 Graduate students and 1 BSc student working on CLAS data

Igor Korover

- Joining as to Tel Aviv University on July 2024
- 1 BSc student, 1 Mechanical Engineer, 1 Electrical Engineer
- Active member of CLAS12 collaboration (postdoc at MIT)



Currently hiring:

- Graduate students
- Postdocs

Physics Plans

Short Range Correlation: RGB/RGM

NN interaction at short distances

In medium modification

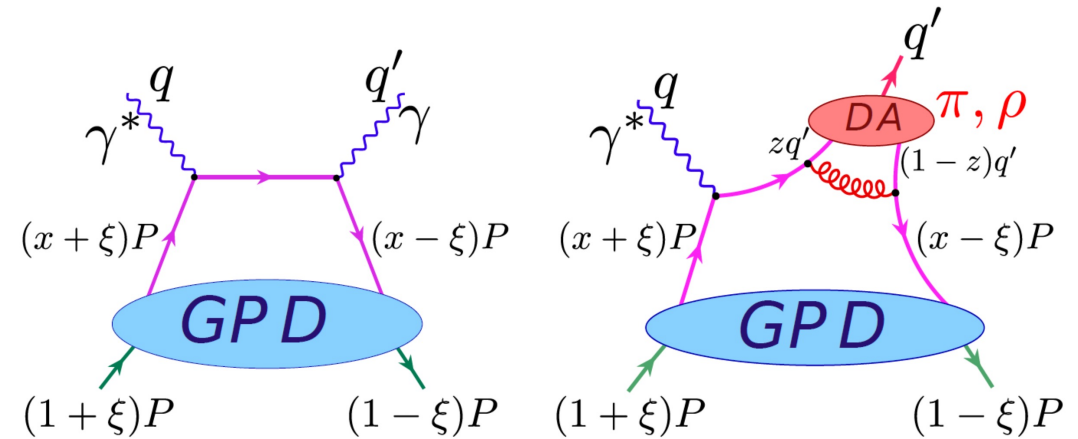
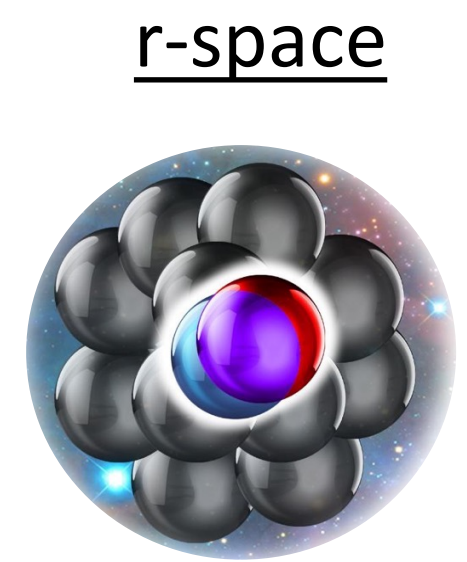
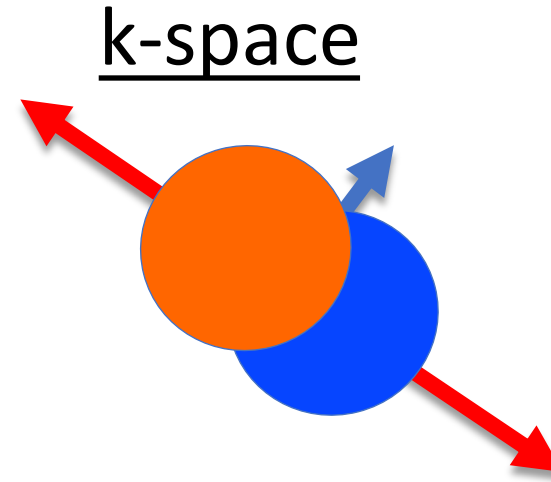
3N-SRC correlation study

Deeply virtual exclusive processes: RGA

Nucleon structure

Dynamical properties of the nucleon

Spin/Mass



DVCS (left) and DVMP Feynman Handbag diagrams

[V. Kubarovsky Nuc Phys B 2011]

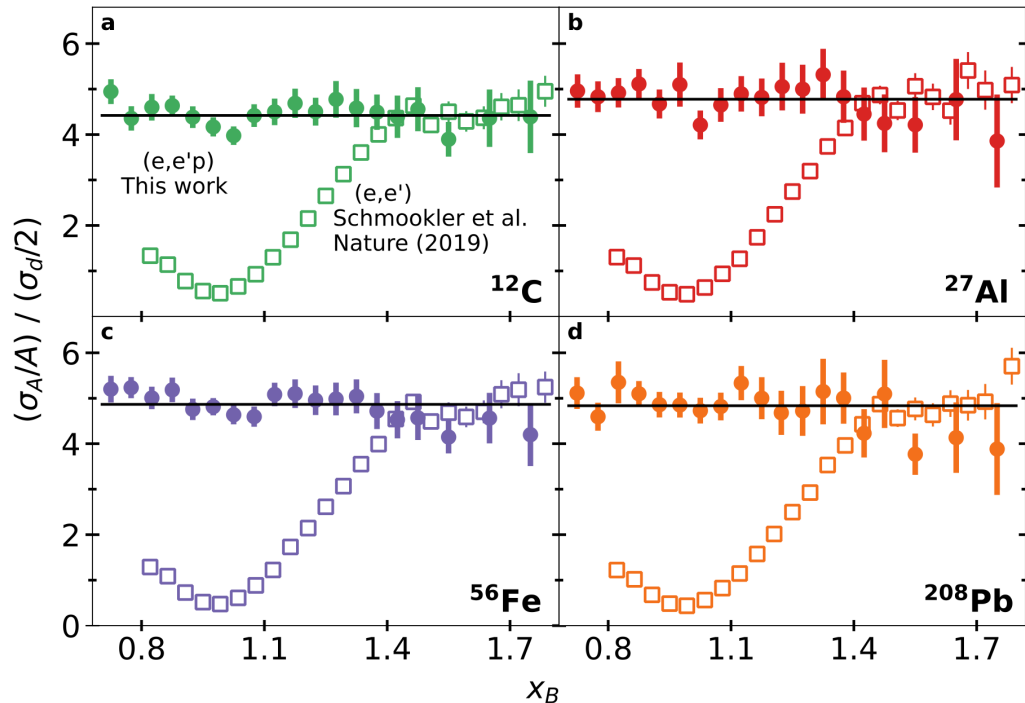
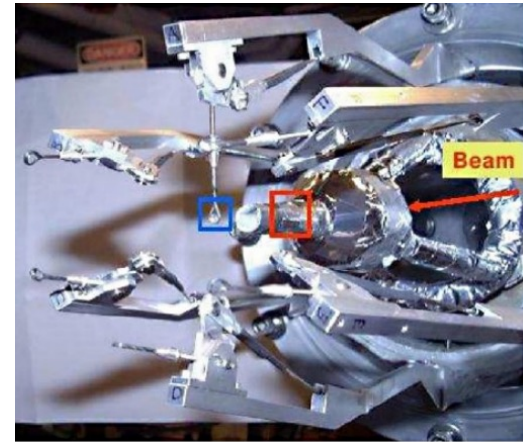
Recent Results

CLAS 6 – Short Range Correlation

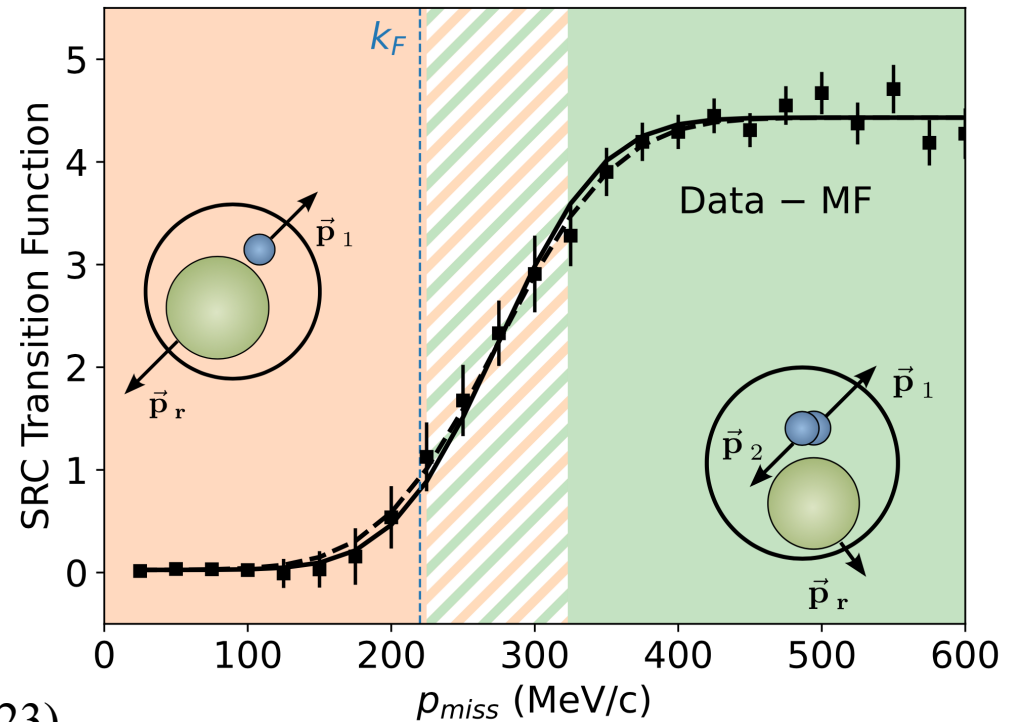
Semi-inclusive $A(e,e'p)X$ scattering

Data Mining project on eg2a run period

Observation of 2N-SRC pairs over wide kinematical range



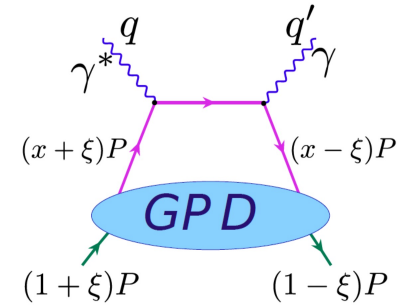
MF to SRC transition



Recent Results

DVCS

$$ep \rightarrow e' p' \gamma$$



$$\frac{d\sigma}{dx_B dQ^2 d|t| d\phi} = \Gamma \times |\mathcal{T}_{BH} + \mathcal{T}_{DVCS}|^2$$

$$= \Gamma \times (|\mathcal{T}_{BH}|^2 + |\mathcal{T}_{DVCS}|^2 + \mathcal{I})$$

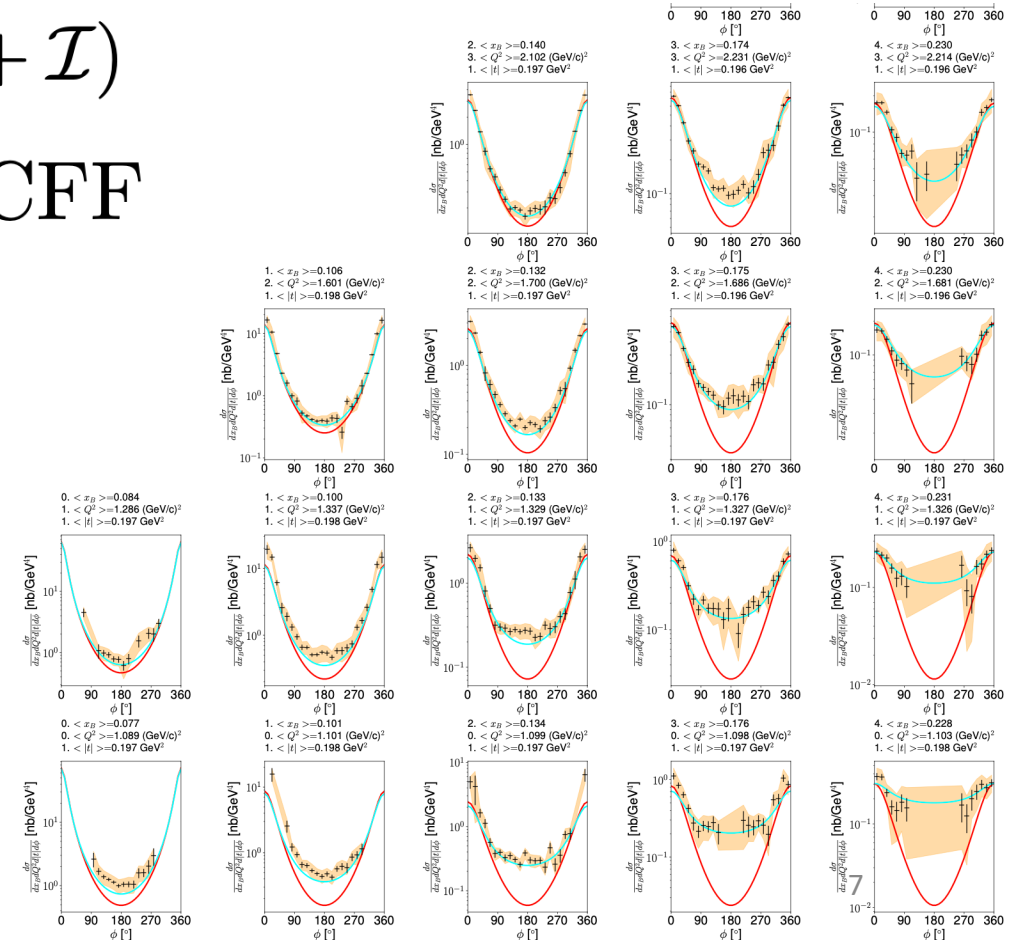
$$\mathcal{T}_{BH} \propto FF, \quad \mathcal{T}_{DVCS} \propto CFF$$

Compton Form Factors to GPDs

$$H(\xi, |t|) = \int_0^1 dx \left[\frac{1}{x - \xi + i\epsilon} - \frac{1}{x + \xi - i\epsilon} \right] H(x, \xi, |t|)$$

CLAS 12 provide wide kinematic coverage for multibin analysis

Analysis note in final review stages

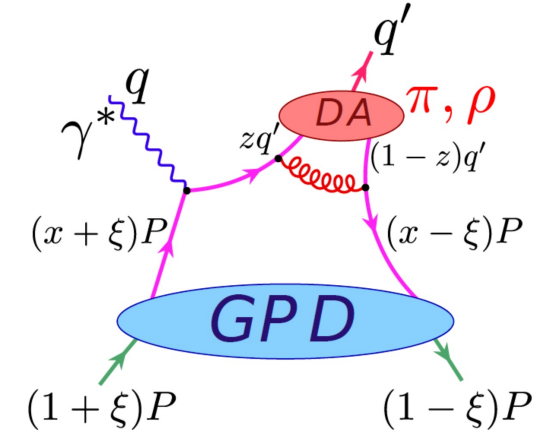


Recent Results

DV π^0

$ep \rightarrow e' p' \pi^0 \rightarrow e' p' \gamma_1 \gamma_2$

$$\frac{d^4\sigma}{dQ^2 dx_B dt d\phi} \propto \left(\frac{d\sigma_T}{dt} + \epsilon \frac{d\sigma_L}{dt} \right) + \epsilon \cos(2\phi) \frac{d\sigma_{TT}}{dt} + \sqrt{2\epsilon(1+\epsilon)} \cos(\phi) \frac{d\sigma_{LT}}{dt}$$

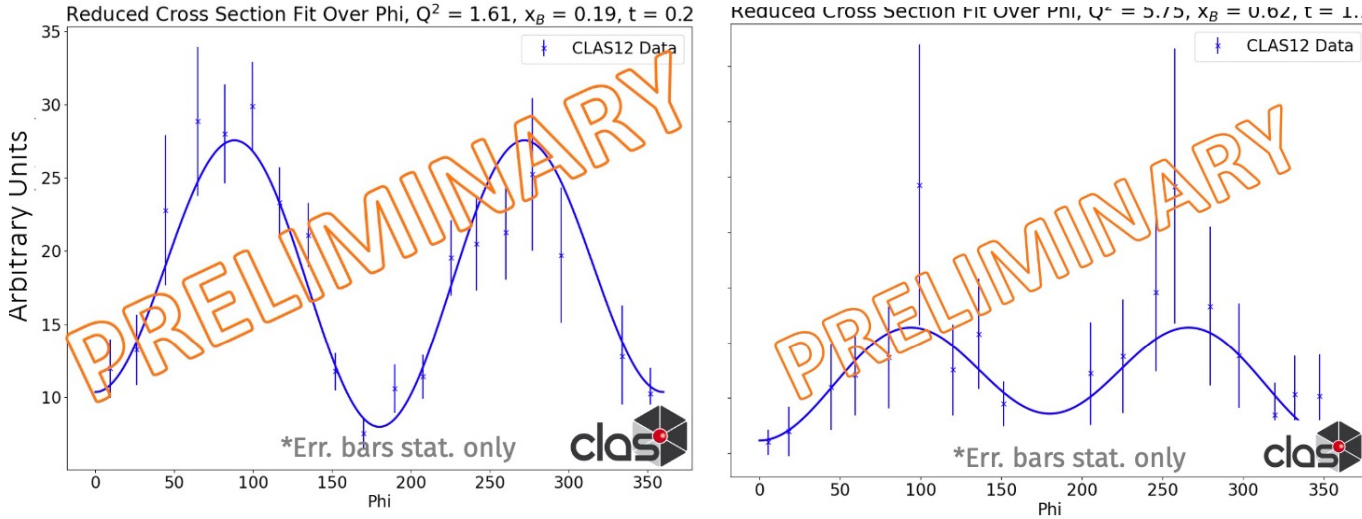


Sensitive to chiral odd GPDs, distinguishing it from DVCS as a GPD probe

$$\begin{aligned} \frac{d\sigma_L}{dt} &= \frac{4\pi\alpha}{kQ^2} \left\{ (1-\xi^2) |\langle \tilde{H} \rangle|^2 - 2\xi^2 \Re \left[\langle \tilde{H} \rangle^* \langle \tilde{E} \rangle \right] - \frac{t'}{4m^2} \xi^2 |\langle \tilde{E} \rangle|^2 \right\} \\ \frac{d\sigma_T}{dt} &= \frac{2\pi\alpha\mu_\pi^2}{kQ^4} \left\{ (1-\xi^2) |\langle H_T \rangle|^2 - \frac{t'}{8m^2} |\langle \bar{E}_T \rangle|^2 \right\} \\ \frac{d\sigma_{LT}}{dt} &= \frac{4\pi\alpha\mu_\pi}{\sqrt{2}kQ^3} \xi \sqrt{1-\xi^2} \frac{\sqrt{-t'}}{2m} \Re \left\{ \langle H_T \rangle^* \langle \tilde{E} \rangle \right\} \\ \frac{d\sigma_{TT}}{dt} &= \frac{4\pi\alpha\mu_\pi^2}{kQ^4} \frac{-t'}{16m^2} \langle \bar{E}_T \rangle^2 \end{aligned}$$

Similar to DVCS – wide kinematic coverage

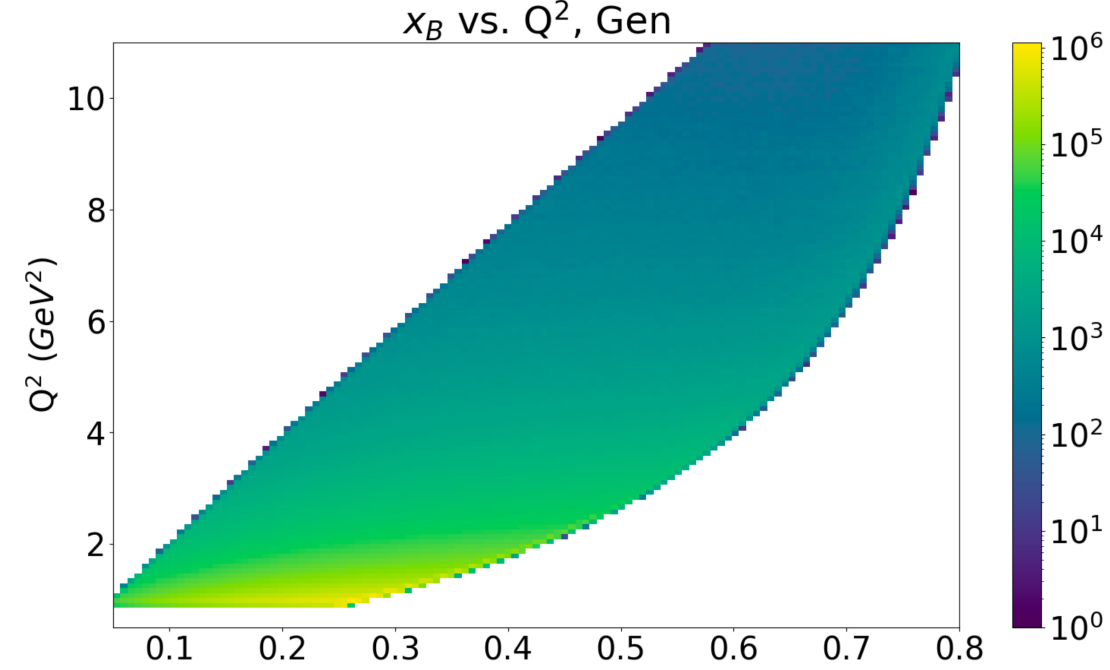
Analysis performed on Pass 1



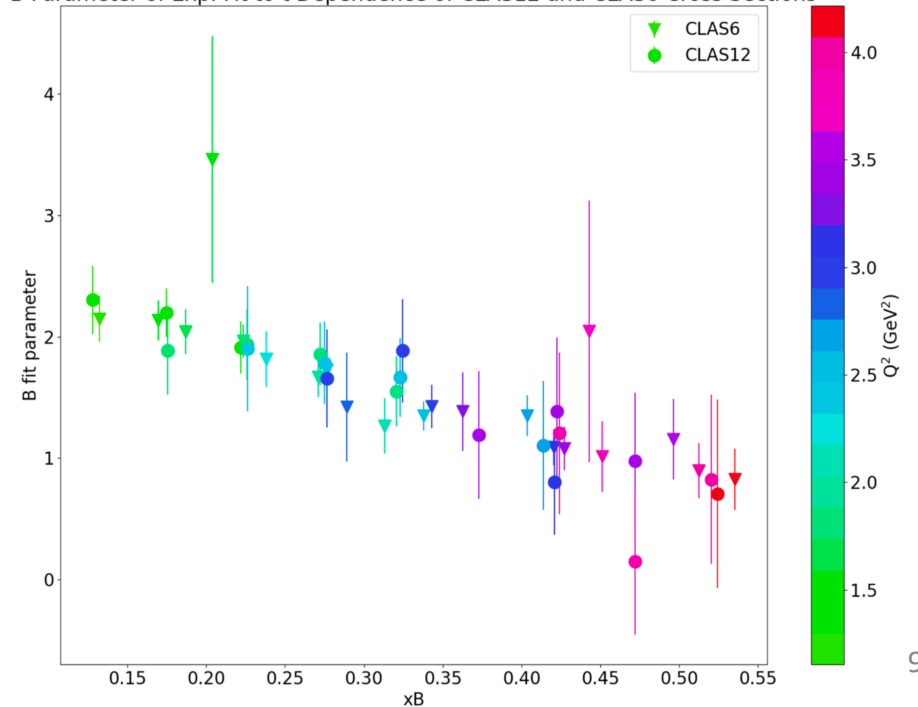
Extraction of impact parameter and t dependence

$$\frac{d\sigma_U}{dt} = \int \frac{d^2\sigma}{dt d\phi} d\phi.$$

Cross Section fit with: $\propto A e^{-bt}$



B Parameter of Exp. Fit to t Dependence of CLAS12 and CLAS6 Cross Sections



Future plans

Short-Range correlation physics: Analysis of the recent RGM data set.

Study of 2N-SRC at high missing momentum.

Reaction factorization study over wide Q^2 range.

Search for 3N-SRC – identification and characterization

Initial candidate ^4He target

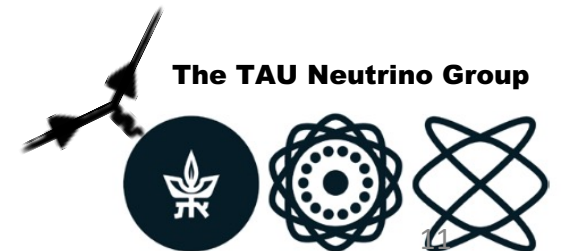
Deeply virtual scattering processes:

RGA/RGK analysis of DV π^0 reaction

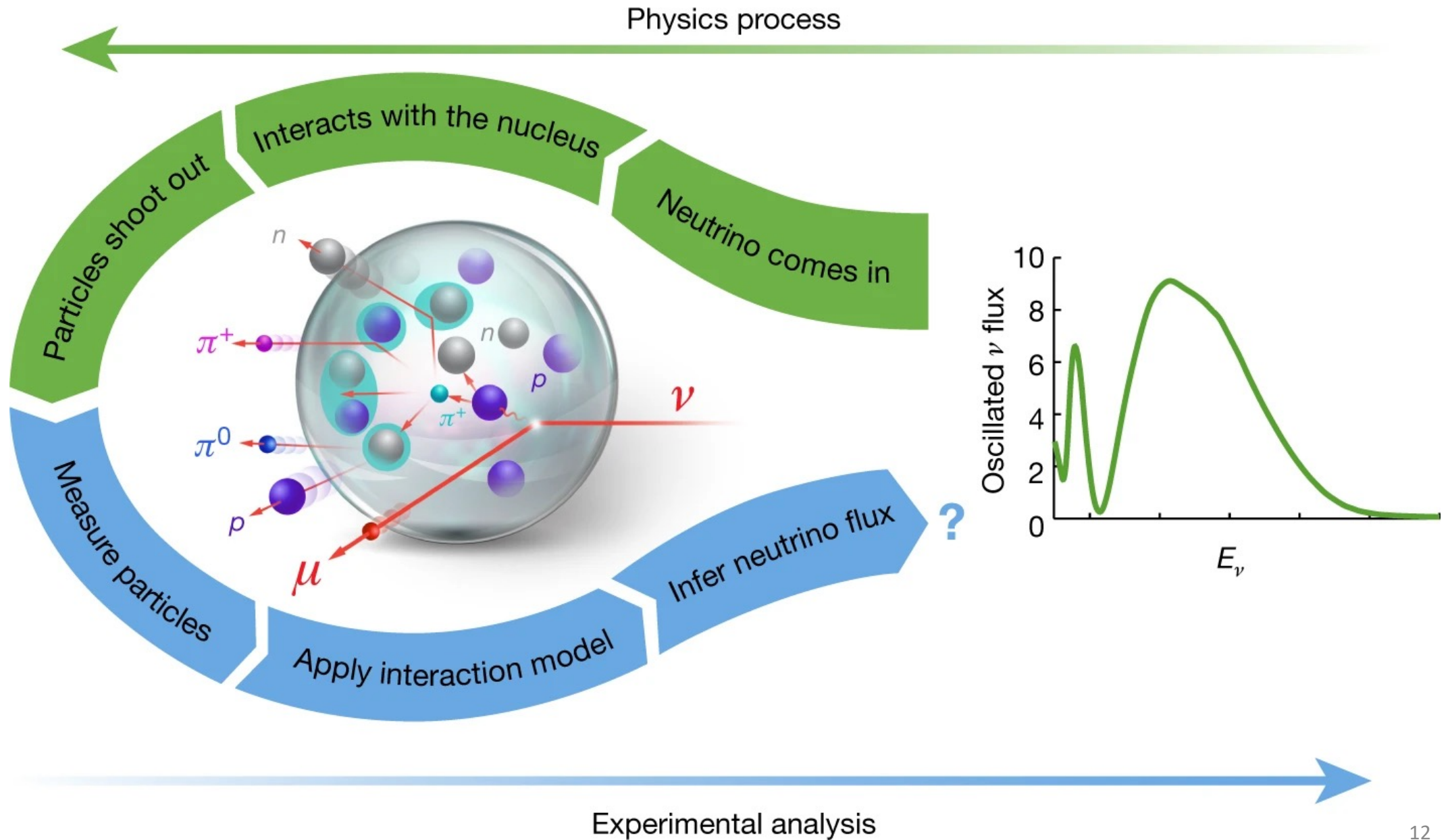
Explore additional exclusive meson production channels

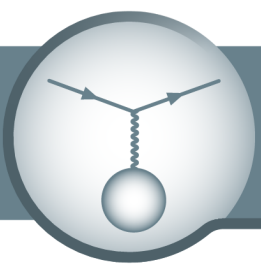


Electrons for neutrinos



The TAU Neutrino Group



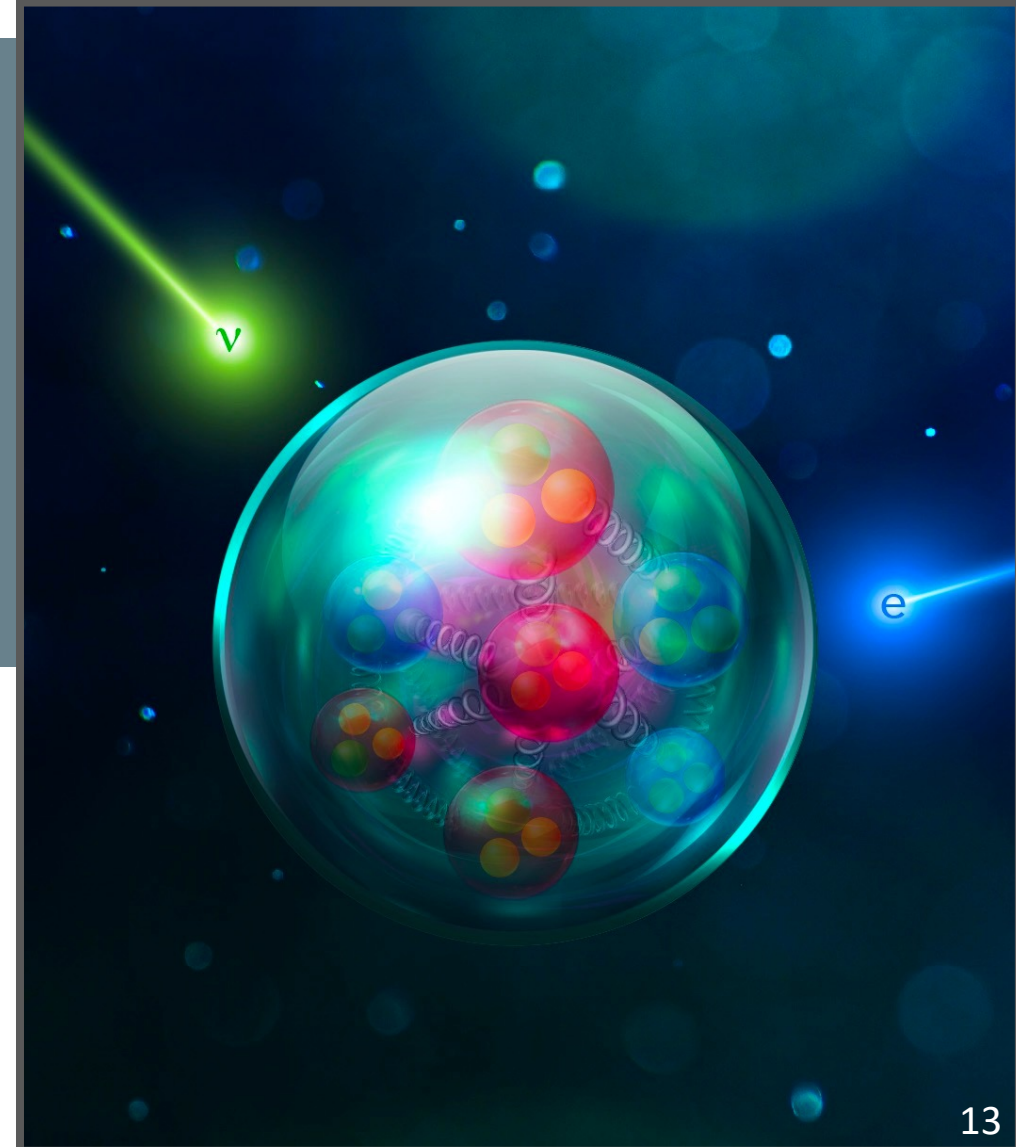


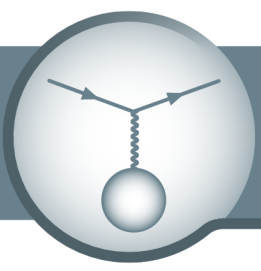
Improving Modelling Input with electrons

Electrons and neutrino interactions have:

- Identical initial nuclear state
- Identical intra-nuclear cascade
- Similar interactions
vector vs. vector + axial vector

Useful to constrain model uncertainties





Improving Modelling Input with Electrons

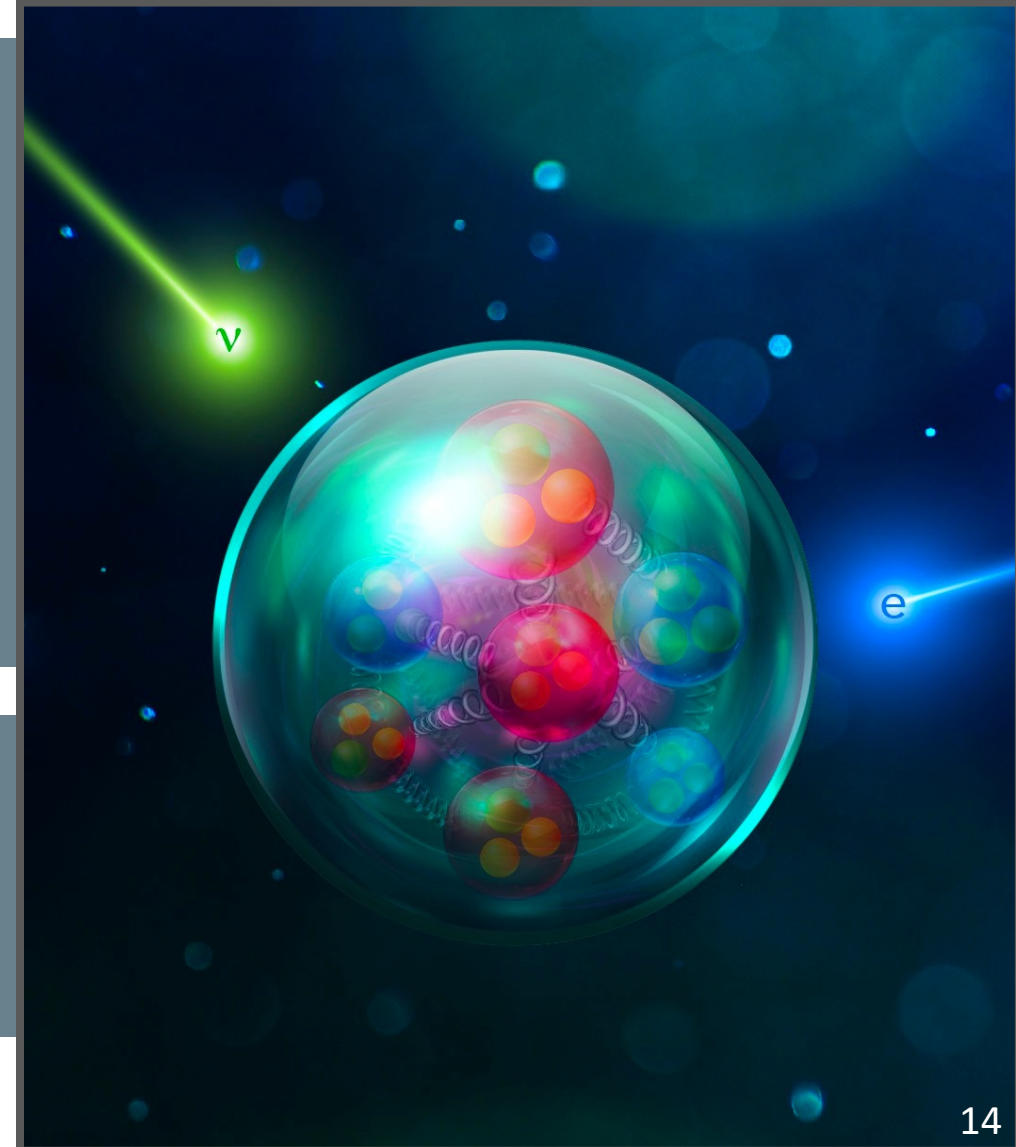
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Useful to constrain model uncertainties

Electron beams have known energies

**Useful to test incoming energy
reconstruction methods**



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Previous work

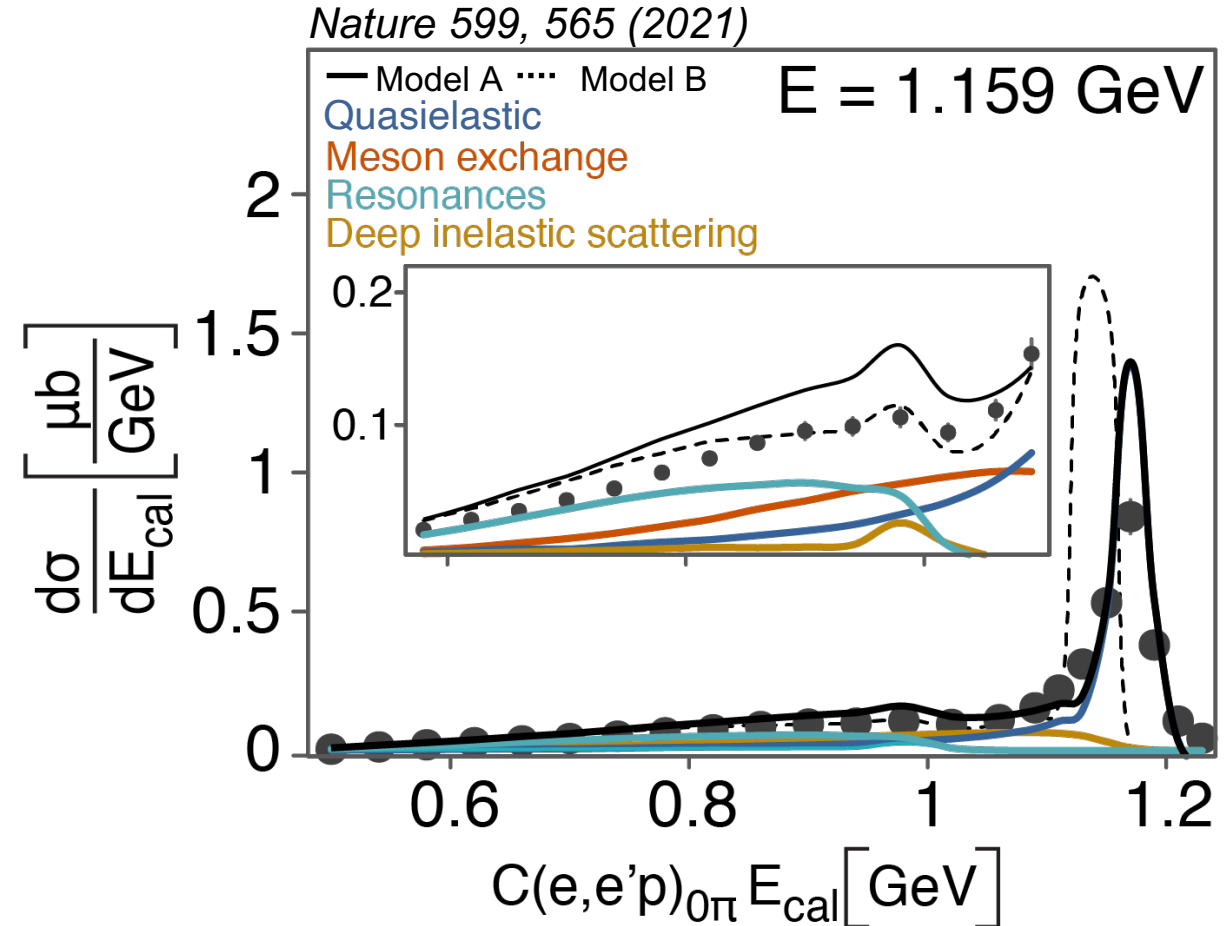
Preliminary results:

Showing data to MC disagreement
in simplest Quasielastic interaction



Impact

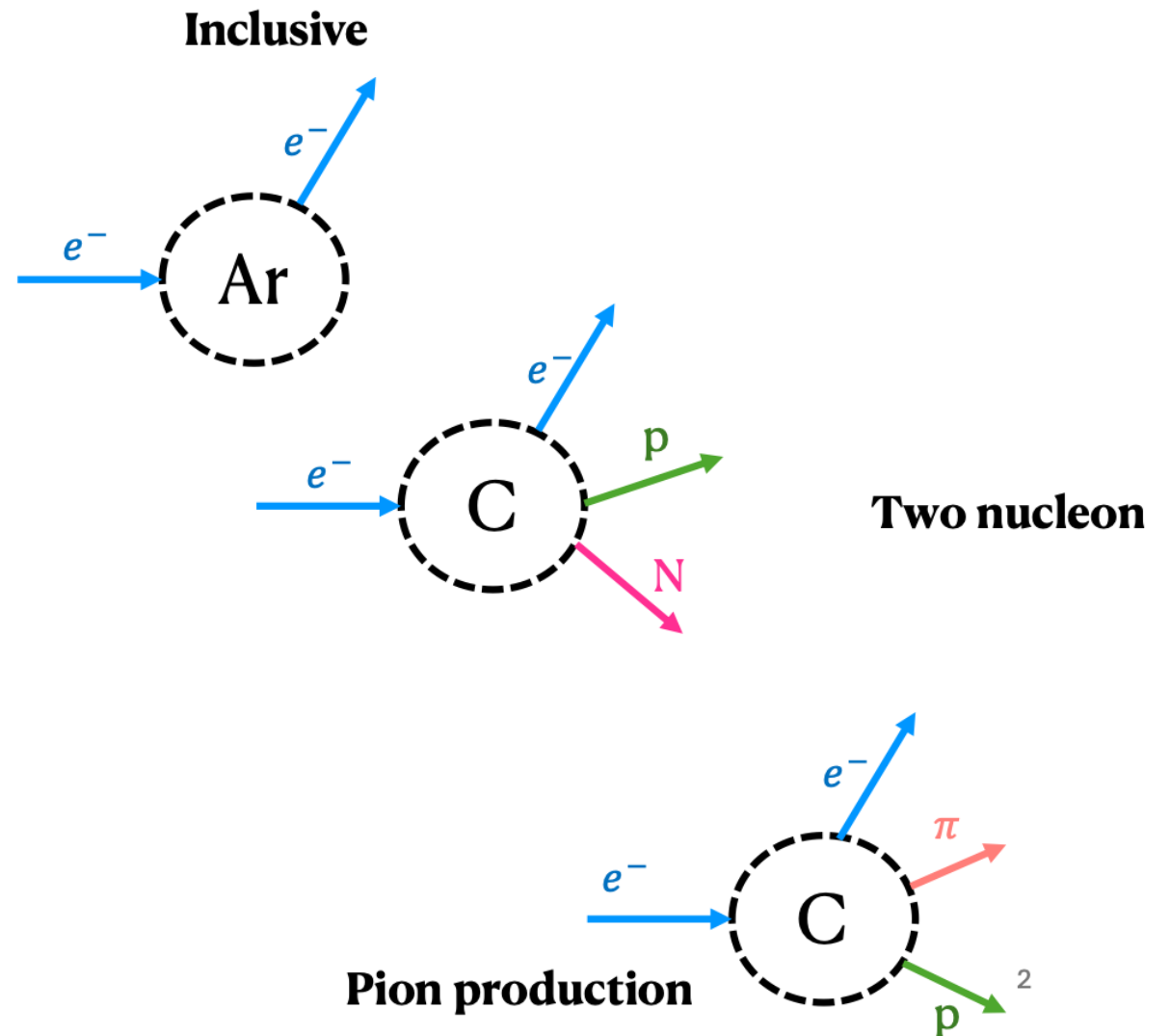
- A powerful tool to constrain model
- New event generators already comparing their results to new data set

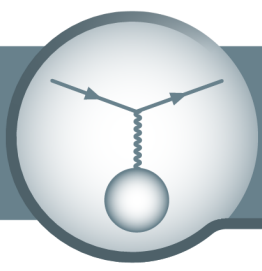


Huge increase in data base
for **hadron**
electroproduction

1-6 GeV electrons for many
targets (e.g. carbon, **argon**)

New $e_4\nu$ measurements
unveiled in this talk





e4ν unveils lepton-nucleus interactions

- Huge increase in data base for electron hadronproduction
- CLAS can measure many particle final states
- 1-6 GeV electrons forr many large targets
- Most relevant for main neutrino experiments
- Very high statistics and known energy beam

Significant impact on neutrino physics

Best constraints on nuclear model and FSI models

Event generator benefit greatly from CLAS data

We are excited to take advantage of this opportunity and contribute to the success of the CLAS12 physics program!

Contribution to CLAS12 collaboration services

Open to new excited opportunities

analysis reviews, software contributions, interest in future

hardware upgrade projects

Thank you!