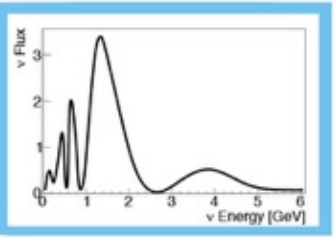
PHYSICS PROCESS

Neutrino comes in




Interacts with the nucleus

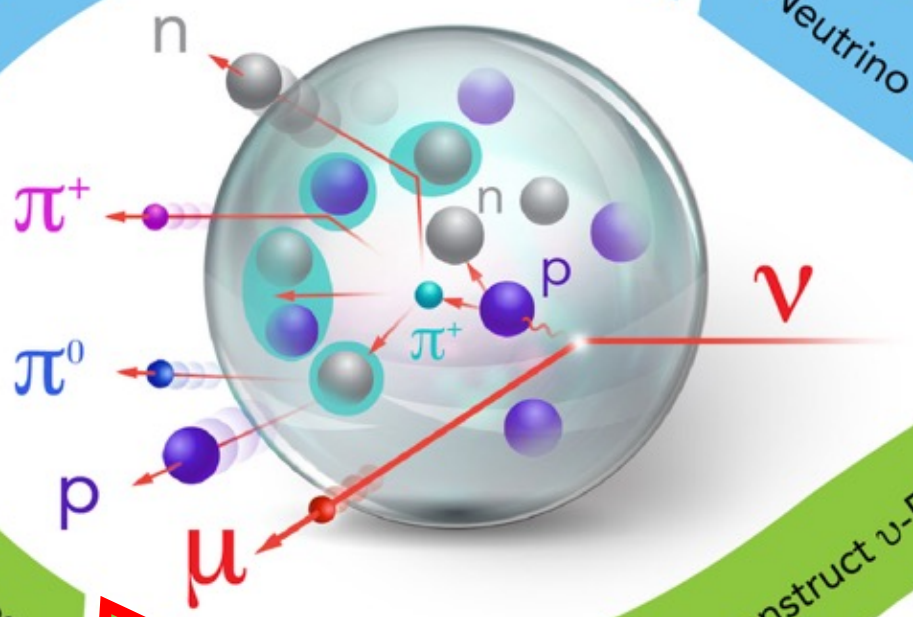
Particles shoot out

Measure Particles

Apply Interaction Model

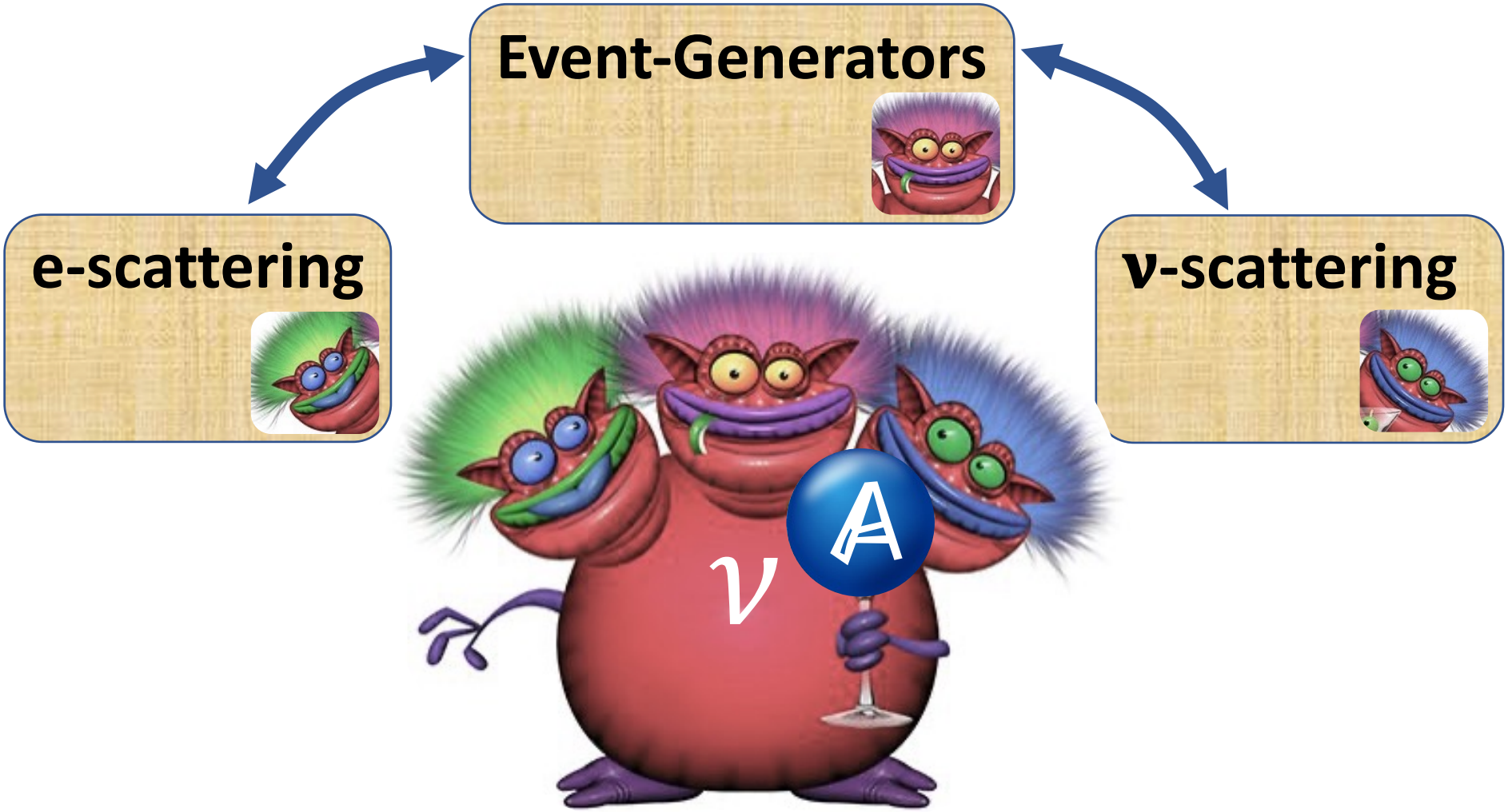
Reconstruct υ-Energy

Extract Oscillations




EXPERIMENTAL ANALYSIS

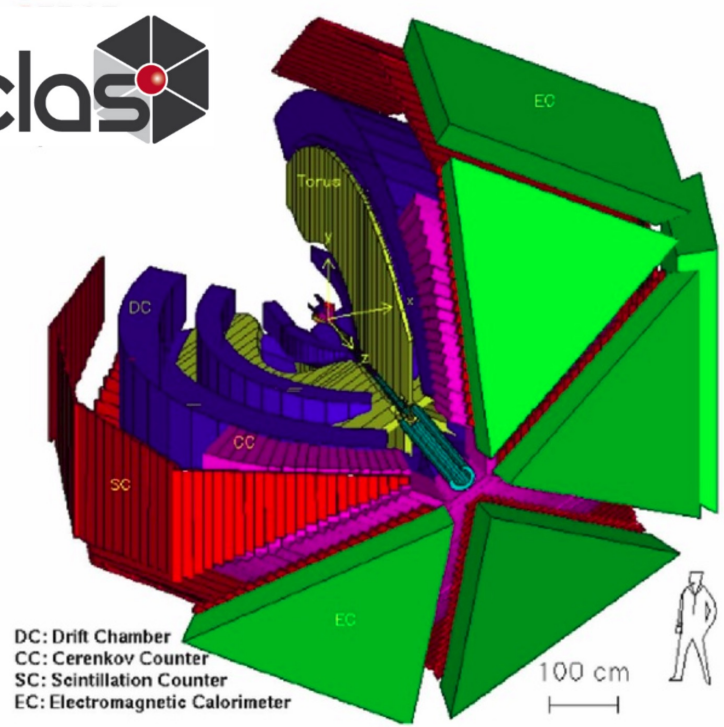
# Attacking the Monster From All Sides

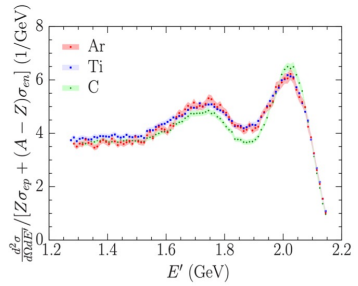


# Parallel Efforts

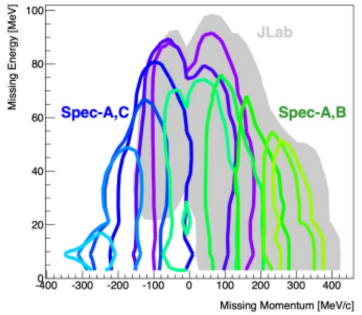
e4v @ Jefferson Lab
Thomas Jefferson National Accelerator Facility

clas



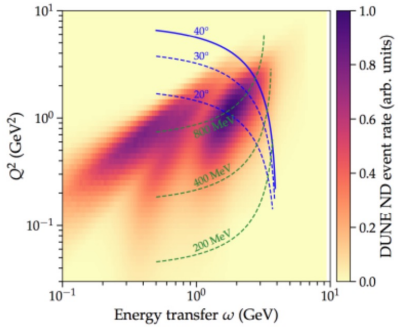




**ArTi (e,e') & (e,e'p)**
See talk
by L. Jiang




mami MAINZER MIKROTRON

See talk
by L. Doria




SLAC

See talk
by A. Ankowski

# ‘Focused’ + ‘Broadband’ Studies

- Broad:
  - e4$\nu$ (e,e’p) cross-sections.
  - Integrate wide phase-space.
  - Emulate neutrino experiments.
- Focused:
  - JLab ArTi cross-sections
  - Highly selective kinematics.
  - Constrain specific aspect of the interaction model.

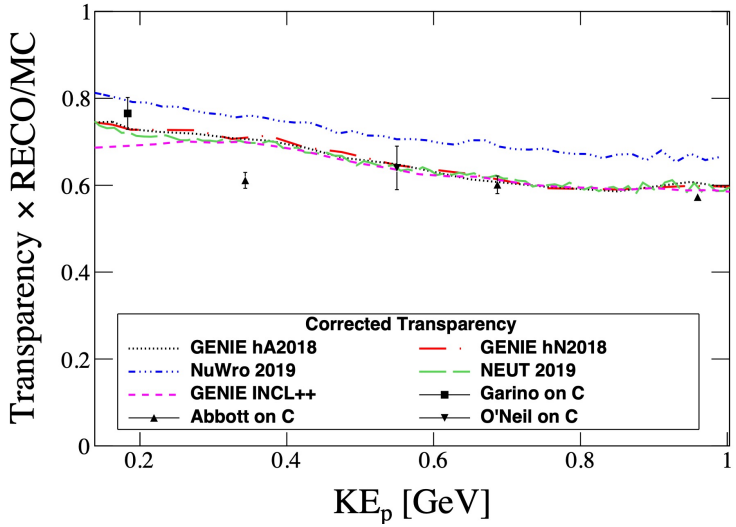
In both cases its CRUCIAL to use:

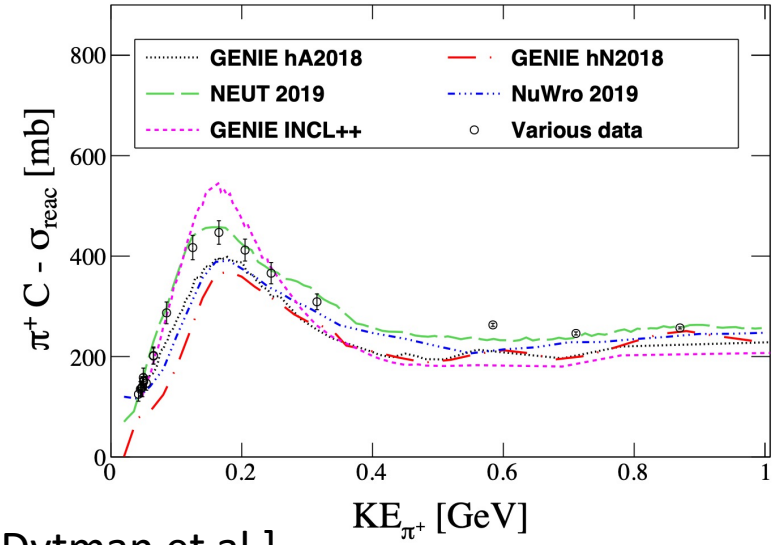
- Generators with consistent e & $\nu$ calculations.
- Generator models used by $\nu$-experiments.

+ work closely with ‘tunning’ experts!

# Example: e-data for FSI studies

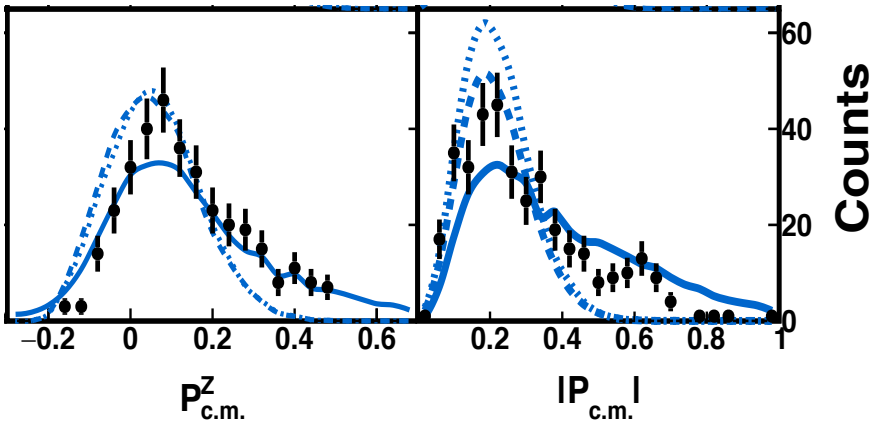
Single Particle Knockout

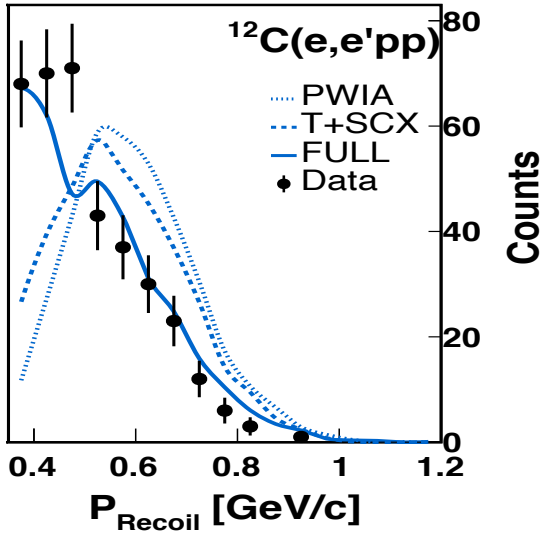



[S. Dytman et al.]

Two-proton Knockout




[N. Wright and A. Papadopoulou et al.]

# Complementarity of existing facilities (JLab & MAINZ)

| Characteristic | JLab (CLAS-12) | MAINZ |
|---|---|---|
| Beam Energy | 1, 2, 4, 6 GeV | Tunable up to ~1 GeV |
| Target | Liquid & solid | windowless oxygen + Liquid & solid |
| Detectors | Full acceptance spectrometer (high-multiplicity, gamma, neutrons…) | Small acceptance Spectrometers (inclusive electron / electron + proton) |
| Exclusivity | Can measure $0\pi$ etc. | Will be challenging |
| Detection threshold | $5^o$ – $145^o$<br>~150 MeV/c pion<br>~300 MeV/c proton | Spectrometers can scan wide angular range + Si detectors used in the past to measure low-momentum recoil protons! |
| Beamtime | Existing Data + Fall ‘21 | Coming soon (months / next year) |

CLAS excellent for ‘Broadband’ studies + focused complex reactions.

Spectrometers excellent for ‘focused’ studies.

Community will benefit from both! Especially if groups collaborate

# Join forces?

e4$\nu$ collaboration established \w ~15 institutions.
Dominated by neutrino physicists (exp + theory).

<u>Four active working groups:</u>

- Data analysis
- Generator development
- Model tuning
- Oscillation implications

- A LOT of generator development work was already done (especially for GENIE-v3, e.g. arXiv: 2009.07228).
  ➔ Can be put to good use for MAINZ/SLAC data.
- Tuning can be done jointly.
- Absolute cross-sections extraction machinery developed.
- Lots of knowledge can be shared!

➔ WE SHOULD COLLABORATE! ☺