$e4\nu$ analysis topics

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Data sets available

- CLAS6 (data well analyzed understood, thoroughly data mined)
  - E2a
    - 1.1, 2.2 and 4.4 GeV beams
    - 3He, 4He, 12C, 56Fe
  - Eg2
    - 5.0 GeV
    - D, C, Al, Fe, Sn, Pb
- CLAS6 (well analyzed and understood)
  - E2b
    - 1.1 and 4.4 GeV
    - Mostly 3He and Fe
  - E1
    - Various energies
    - H, D
  - E6
    - 5.7 GeV
    - D

- CLAS12 (Oct-Dec 2021)
  - 1 GeV
    - H, C, Ar
  - 2 GeV
    - H, C, Ar
  - 4 GeV
    - H, D, 4He, C, Ar, 40Ca, 48Ca, Sn
- Smaller angles
- Better neutron detection
- More hermetic hadron detection for $40 < \theta < 120°$
- Require ~ 12 months to calibrate and "cook"

Goals

- Overall goal: Reduce systematic uncertainties in neutrino analysis due to discrepancies between the event generators and reality
- Choose analysis topics to best challenge, constrain, and optimize event generators
  - Overall topics
    - energy reconstruction
  - Detailed topics
    - reaction mechanisms
    - Hadron production
    - Transverse variables

Analysis topics

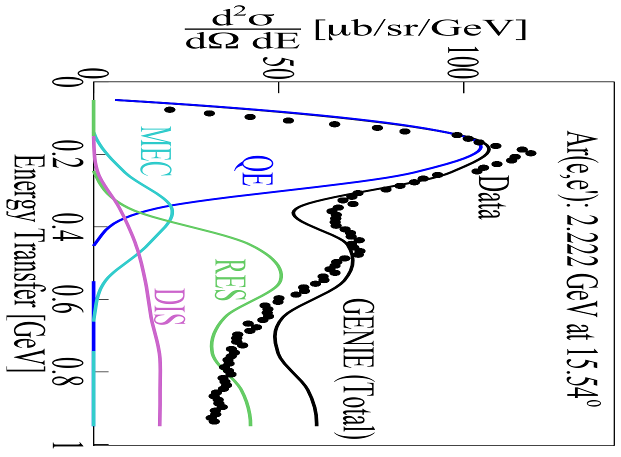
In progress

1. 1p0pi channel (see Afro's talk)
   1. Energy reconstruction
   2. Single transverse variables (STV)
2. 1p1pi channel (Stuart Fegan, Alicia Mand)
   1. E rec
   2. STV

New ideas (your name here) (details on next slides)

1. Final state hadrons for different reaction mechanisms (RES, MEC, DIS)
2. NN final states
3. Pion transparency
4. $(e, e'\pi)$ final states
5. FSI models
6. Resonance production in H and D

Final state hadrons



- Goal – understand the hadronization for different GENIE reaction mechanisms (MEC, RES, DIS)
- Technique: choose beam energy and (e,e') kinematics (Q^2, ω) to emphasize different reaction mechanisms
- Compare distribution of final state hadrons to GENIE predictions for different reaction mech
  - Multiplicities
  - Angular and momentum distributions
  - E and A dependence
- Difficulty level: straightforward
  - Hard to isolate MEC

NN final states

- Goal: understand NN reaction mechanisms
  - QE + FSI
  - MEC
    - Neutrino CC MEC -> pp final states
    - Electron NC MEC -> pn final states
  - RES
- Technique: Isolate pn and pp final states.
  - Study Q^2, ω dependence
  - Study A/density dependence (3He, 4He, C especially)
- Compare to GENIE
- Difficulty: hard
  - Neutron identification
  - Isolation of NN final states (removing contributions from high multiplicities)

Pion transparency

- Goal: understand how pions propagate and rescatter as they travel through the remaining nucleus
- Technique: choose beam energy and (e,e') kinematics (Q^2, ω) to emphasize RES events.
  - Compare (e,e'p) and (e,e'p pi) yields.
  - Study A dependence
    - E2a: 4He, C, Fe at 1, 2, and 4 GeV
    - Eg2: d, C, Fe, Pb at 5 GeV
- Compare to GENIE FSI models
- Difficulty: medium
  - Isolating events where we expect pions

$(e, e'\pi)$ final states

- Goal: understand pion production
- Technique: choose beam energy and (e,e’) kinematics (Q^2, ω) to select RES events. Look at pion distributions in energy, angle etc
- Compare to GENIE. Work with pion transparency analysis
- Difficulty: straightforward

FSI models

- Goal: constrain hadron rescattering models
- Technique: choose different event topologies. Look at how STV (single transverse variables) distributions depend on A, E, Q^2, ω
- Compare to GENIE.
- Difficulty: straightforward

resonance production

- Goal: constrain resonance production models
- Technique: look at resonance production using (e,e’p pi) and other topologies in H, D, 3He, 4He, …
- Compare to GENIE.
- Difficulty: straightforward