AVFF Proposal Overview

T. Averett, 9/14/2024
Inaugural AVFF Collaboration Meeting

GOALS:

1. Produce a winning proposal by PAC 53. Need to finish by end of May 2025

2. Satisfy comments on LOI response

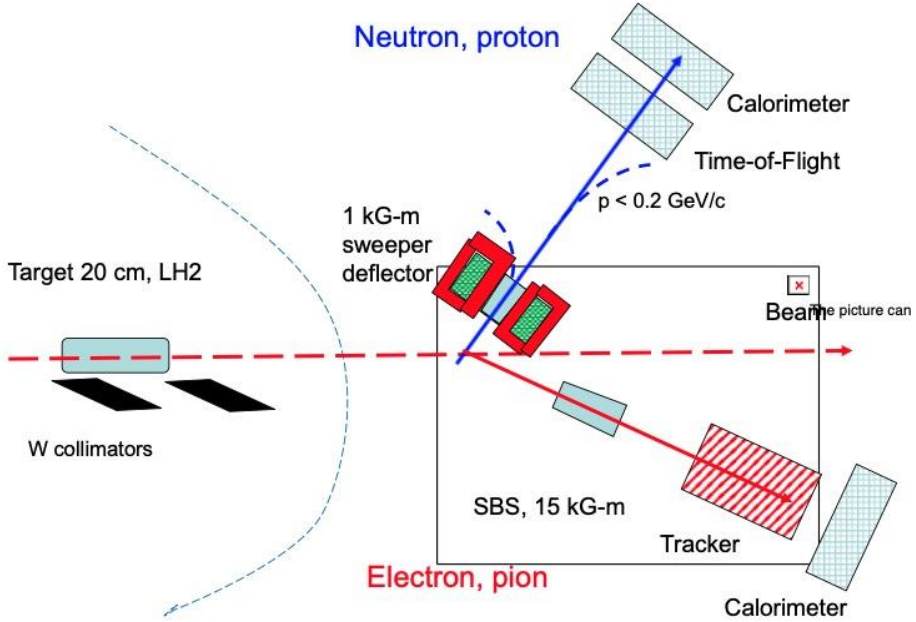
3. Identify areas that need someone to take responsibility
    1. Initially focus on proposal
    2. Hopefully follow up as long-term collaborator

4. Disclaimer: I know EM FFs and SBS, but I am new to V-A physics and this experiment
    1. Learning as I go

Rough Summary of Experimental Idea
– to motivate proposal work

- **Goal:** Measure the cross section for $\mathrm{p}(\vec{e},\mathrm{n})\nu_e$ at $Q^2 = 1\ \mathrm{GeV}^2$
- **Value of measurement:** AV FF – Q^2 dep , difference in M_A thus $\langle r_A \rangle$ between elastic and pion production methods, GPD constraint, robust LQCD predictions, kinematically constrained xsec is of value to neutrino community, perhaps some doorway to pseudoscalar FF-not likely but interesting.
- **Existing data:** Hasn't been measured on free proton since 1980s except recent MINERvA measurement. $\mathrm{p}(\overline{\nu}_\mu,\ \mu^+)\mathrm{n}$ Poorly constrained kinematics, low statistics.
- **Cross section is small:** $\frac{d\sigma}{d\Omega} \sim 10^{-39}$ cm^2/sr
- **Problem:** Can't detect neutrino so must rely on elastic kinematic constraint on neutron.
- **Challenge:** elastic $\mathrm{p}(\vec{e}, e'\mathrm{p})$ and pion photoproduction xsecs 10^7 – 10^8 larger

- **Technique:** Weak asymmetry is = 1. Measure rates for +/- beam helicity, subtract.
- **Asymmetry Correction:** $\mathrm{p}(\vec{e}, e'\mathrm{p})$ Asymmetry ~ 5 x 10^{-5}
- **Rates:** Expect 200 kHz rate on neutron detector from *e*p and pion events.
- **Neutron Arm:**
  - NDET/NCAL/LND: 2 m X 8 m W x H hadron calorimeter. 288 iron/scintillator modules. Based on SBS HCAL
  - TOF scintillators, each 6 cm x 6 cm x 200 cm. Stacked 140 tall, 7 layers deep
  - Sweeper magnet: deflect low energy junk, separate p/n events on NDET
- **Trigger:** High threshold event in NDET with proton hit in front 1-2 layers of TOF. 98% proton/charged particle rejection → 50 x rate reduction – 4 kHz DAQ rate
- **Veto Spectrometer:**
  - SBS magnet
  - 8 layers of GEMs
  - Use existing SBS HCAL (now VCAL) to detect recoil ep electrons and pions offline



- **Total rejection:** Expect total *e*p and pi-n online + offline rejection ~10k
  - Proton trajectory deflected in neutron arm – sweeper
  - Separation of νn events from πn using TOF. Need 100 ps resolution
  - Pion and electron veto in Veto Spectrometer
  - Some p-n conversion in TOF, reject using veto

- **Expected result:** 500 h @100 uA @ 10cm LH2
  - Asymmetry = 11 x 10^{-4} +/- 3 x 10^{-4}
  - Cross section 1.1 x +/- 0.3 x 10^{-39} cm^2/sr 30%
  - Form Factor 15%

Needed for Proposal

- MC of Neutron Arm - Shandong U + additional
- MC of background – JLab
- Physics formalism and motivation – Kroll, LQCD, Kordosky
- AV cross section calculation – Averett, Kroll
- Estimates of pion photoproduction rates
- Define trigger plans - Averett, BW
- Detector efficiencies, online and offline rejection
- Prototype TOF + DAQ < 100 ps – has begun, needs people
- Define calibration needs/plans
- Expected results, statistics, systematics – Averett, BW
- Cost Estimate > $10M?

We need significant help on all of these now to have a proposal ready for PAC 53
Please Join Us

Timeline for Experiment

- Full simulation of Neutron Arm: NDET, TOF Sweeper - Users
- Full simulation of Veto Spectrometer - Users
- Full simulation of background - JLab
- Prototype TOF - Users
- Prototype NDET -Users
- Prototype DAQ - JLab
- Specify and purchase Sweeper Magnet - JLab
- Design/Engineering of all components: new detectors, supports, platforms – JLab + Users
- Purchase and build DAQ + HV + Cables - JLab
- Build NDET - Users
- Build TOF - Users
- Modify Veto Spectrometer - JLab

Collaborators will be needed for everything above!
MRI(s) needed for NDET and TOF
Please join us

Nov 14, 1988 : This probably is impossible.
$\gamma + p \rightarrow \pi^+ + n$.

Measurement of the Nucleon Weak Axial Vector Form Factor

A CEBAF Letter of Intent

Oct 31, 1988

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Abstract

It may be possible to carry out direct measurements of the weak axial vector form factor $F_A(Q^2)$ at CEBAF by detecting the neutron in the reaction $p(e^-,n)\nu_e$ as a function of energy and angle. Such a direct measurement is not complicated by the usual assumptions and experimental uncertainties in neutrino reaction measurments. In addition, it may be possible to extend the present range of Q^2. However, the viability of the experiment depends crucially on background rates in the neutron detector. It appears that the beam microstructure of the accelerator, as well as the availability of longitudinally polarized beam, can be used to reduce the dependence on these background rates. We also discuss the possibility of using the data to search for right handed weak currents.

Jim Napolitano this morning: “The physics very is sexy! Let’s have some fun.”