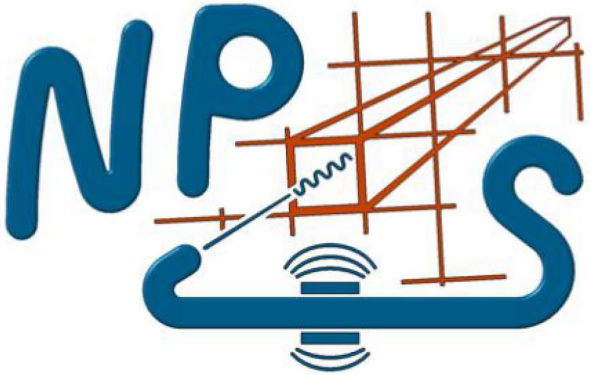
The Neutral Particle Spectrometer Science Program in Hall C



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A. ALIKHANYAN National Laboratory

THE CATHOLIC UNIVERSITY OF AMERICA

University of Colorado Boulder

JLab Irène Joliot-Curie Laboratoire de Physique des 2 Infinis

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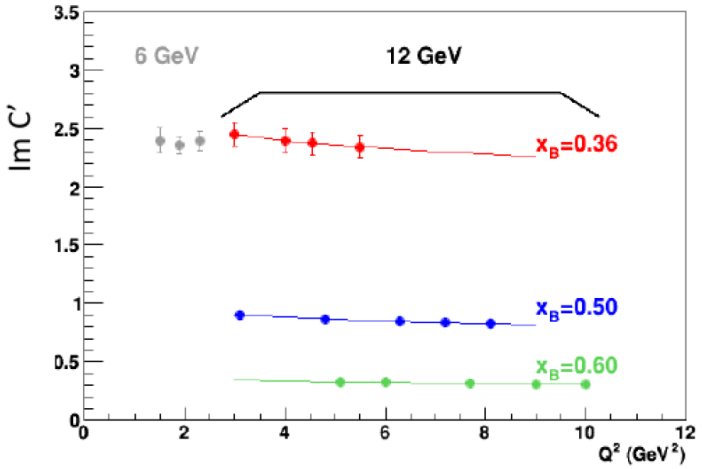
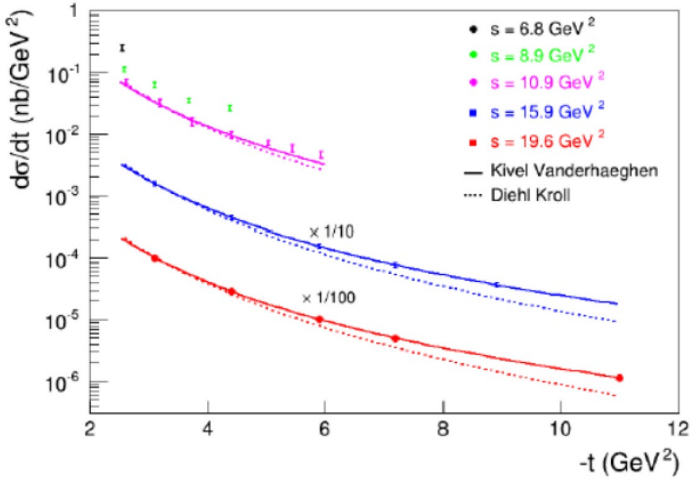
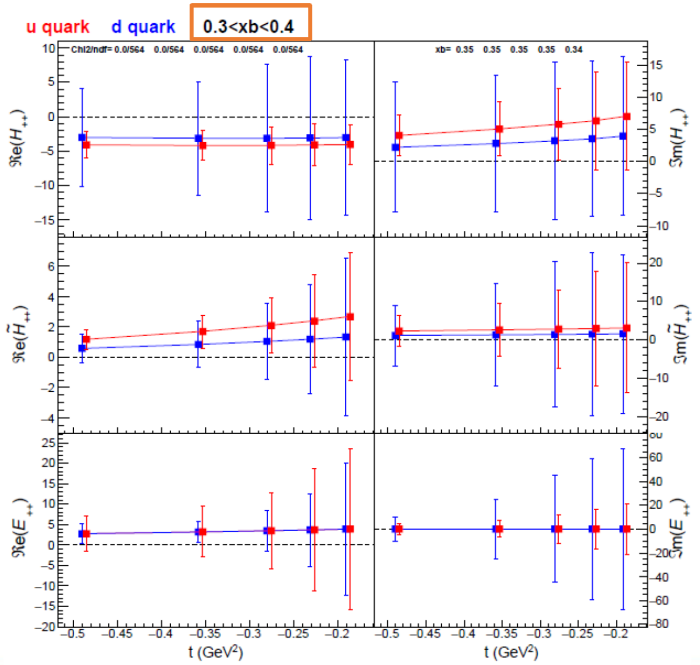
Neutral Particle Spectrometer Science – Planned

- Motivation of NPS Experiments: Validation of Reaction mechanism for TMDs & GPDs through measurements such as deeply-virtual compton scattering off proton and deuteron targets, semi-inclusive deep-inelastic scattering with π^0, (polarized) wide-angle compton scattering (WACS), etc.
- 6 approved experiments to date: DVCS p+n & SIDIS (e,e'π^0), WACS(γ, π^0) & polarized WACS
- NPS provides a unique EM calorimeter to detect e^-, γ and π^0 enabling precision exclusive measurements at the luminosity frontier – *only* accessible at Jefferson Lab.
- NPS would also be used for experiments using positron beams, e.g., for a conditionally-approved DVCS exp
- NPS was constructed by an international collaboration and will see its first series of experimental runs in 2023 at Jefferson Lab to measure DVCS p+n & SIDIS (e.e'π^0).



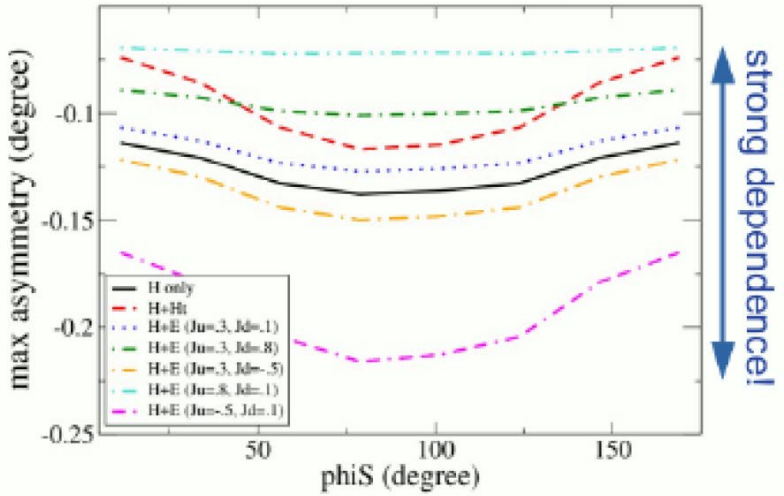


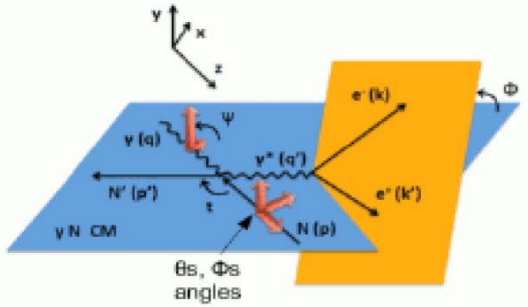


Neutral Particle Spectrometer Science – Future

- Because of the unique nature of this science program, many new physics ideas exist to access exclusive measurements at the luminosity frontier that will **benefit from NPS detector extensions**:
  - Time-like Compton Scattering (TCS) on a transverse polarized target – unique to constrain the Compton form factor E closely related to quark orbital angular momentum, Double DVCS, measurement of the strangeness form factor G_S at high Q^2, etc.
- Many of these exclusive measurements would reach higher Q^2 (or s) scales with a Jefferson Lab energy upgrade, and again **only** be possible at Jefferson Lab.

Sin(φ) moment of transverse spin asymmetry vs φ_S,
Dependence in GPD E and $J^{u,d}$ (VGG model)

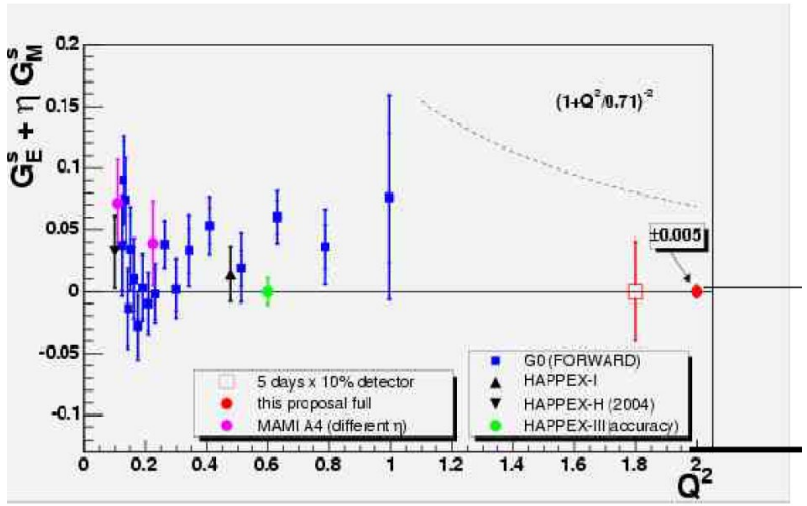




TSA as a function of φ and φ_S

- Sensitive to Im(interference), BH cancels
- Strong dependence in angular momenta,

Sensitivity to GPD E (also to H, Ht)

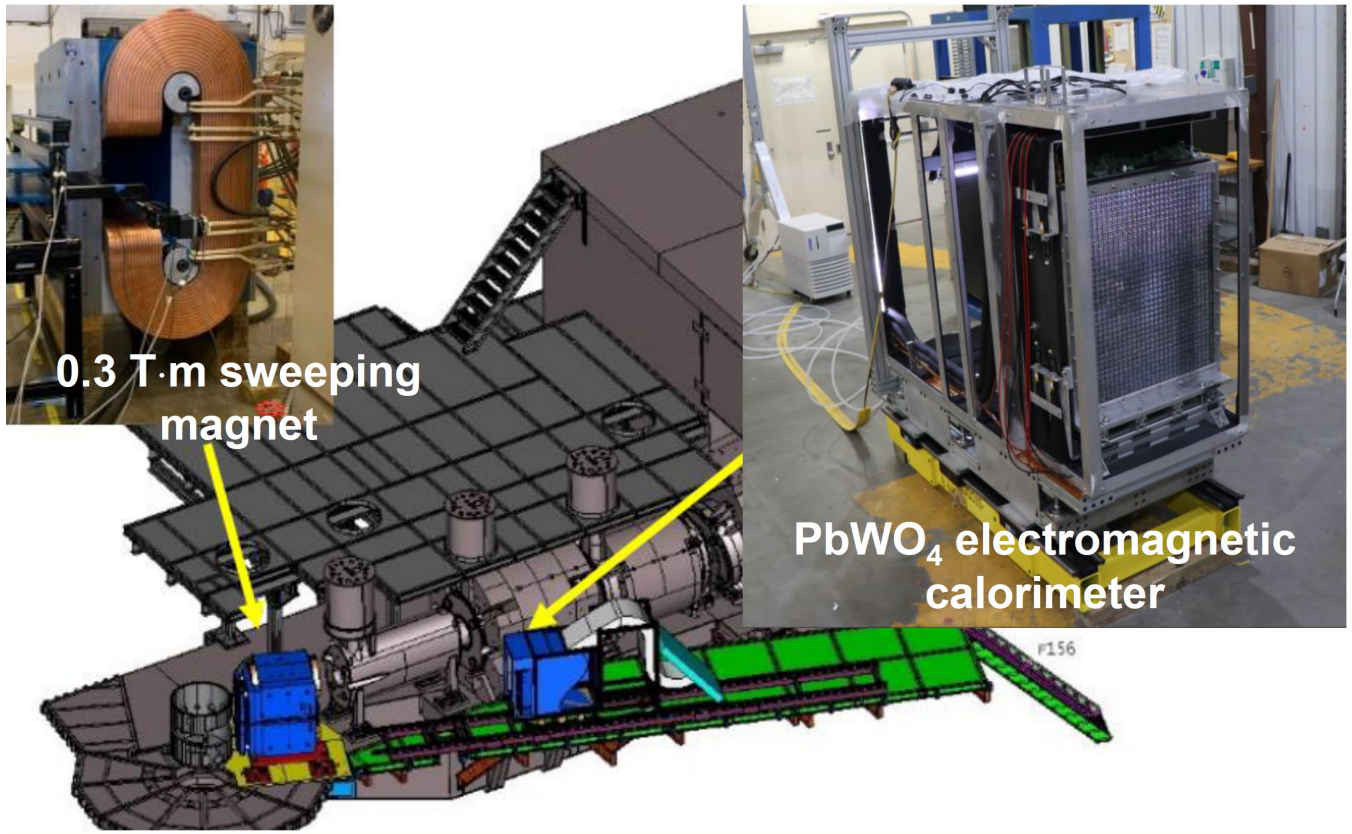


Neutral Particle Spectrometer – Construction Complete

NPS is a ~25 msr Neutral Particle detector which consists of :

- **1080 $PbWO_4$ crystals (30x36 matrix)** in a temperature controlled frame including gain monitoring and curing systems
- A vertical-bend sweep magnet for EM background suppression

The whole system sits on the SHMS frame in Hall C and can cover detection angles between 6° and 57°.



Opportunities for many early-career scientist contributions for radiator, design/construction, simulation, readout:

- PbWO4 crystal properties and performance tests

  NIM A 956 (2020) 163375

- Beam test program in Hall D with 12x12 NPS prototype

  Baseline tests completed in 2019

  Streaming readout tests in 2020