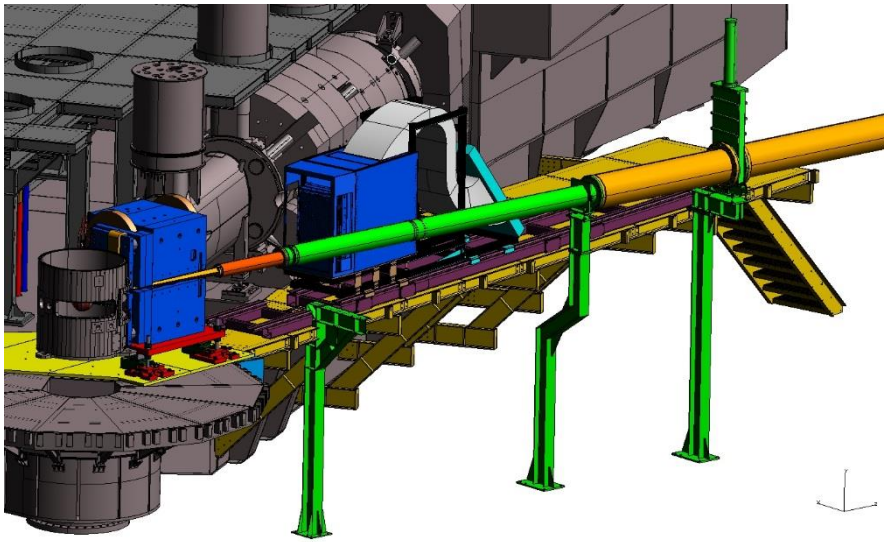
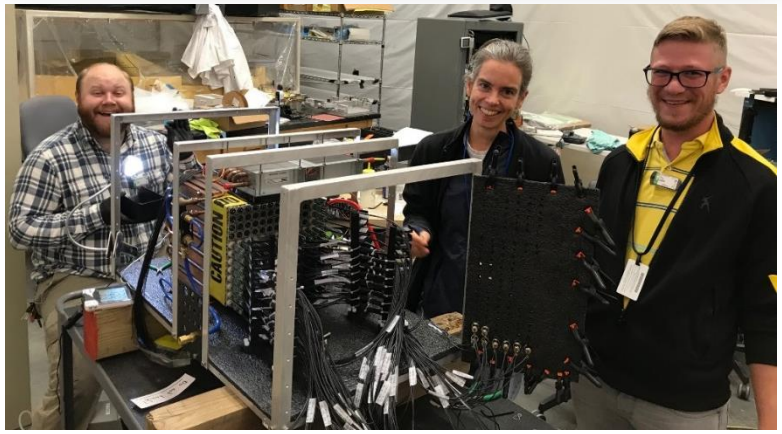
# Overview, General Requirements, Equipment, Manpower

*Tanja Horn*



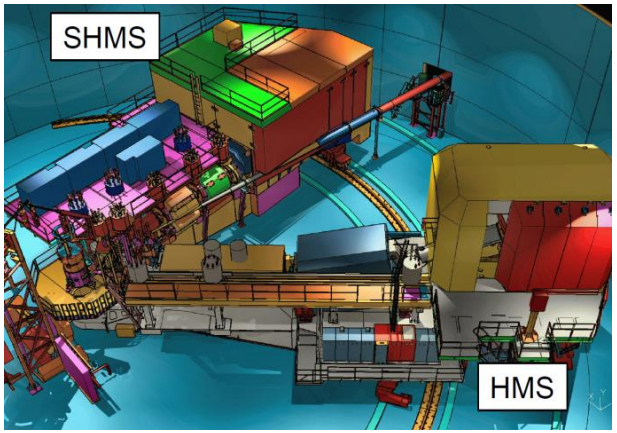


NPS Experimental Readiness Review

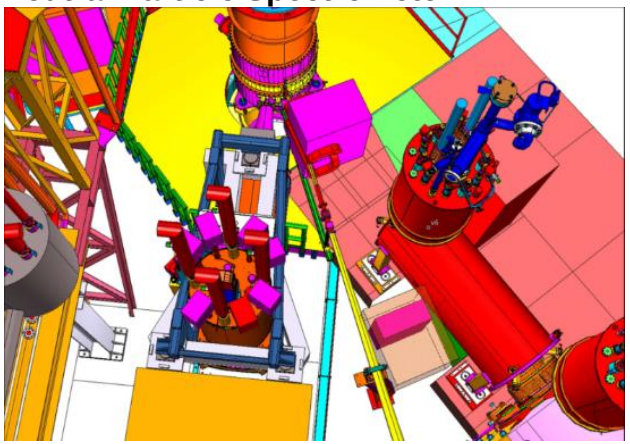
# Overview

- Neutral Particle Spectrometer replaces one of the Hall C focusing spectrometers in the experiments
  - Angle reach between 5.5 and 60 degrees
  - allows for precision (coincidence) cross section measurements of neutral particles ($\gamma$ and $\pi^0$).
- HMS (existing 6 GeV era)
  - Has been recommissioned for 12 GeV
- Beam line and beam line instrumentation
- Cryogenic liquid hydrogen and solid targets
- Data acquisition, counting house, computing

**Hall C focusing spectrometers**




**Neutral Particle Spectrometer**



# Overview Scientific Program

- Approved experiments to date

**NPS ERR 2019**

Run group 1

- E12-13-010 – Exclusive Deeply Virtual Compton and $\pi^0$ Cross Section Measurements in Hall C
- E12-13-007: Measurement of Semi-inclusive $\pi^0$ production as Validation of Factorization

Run group 2

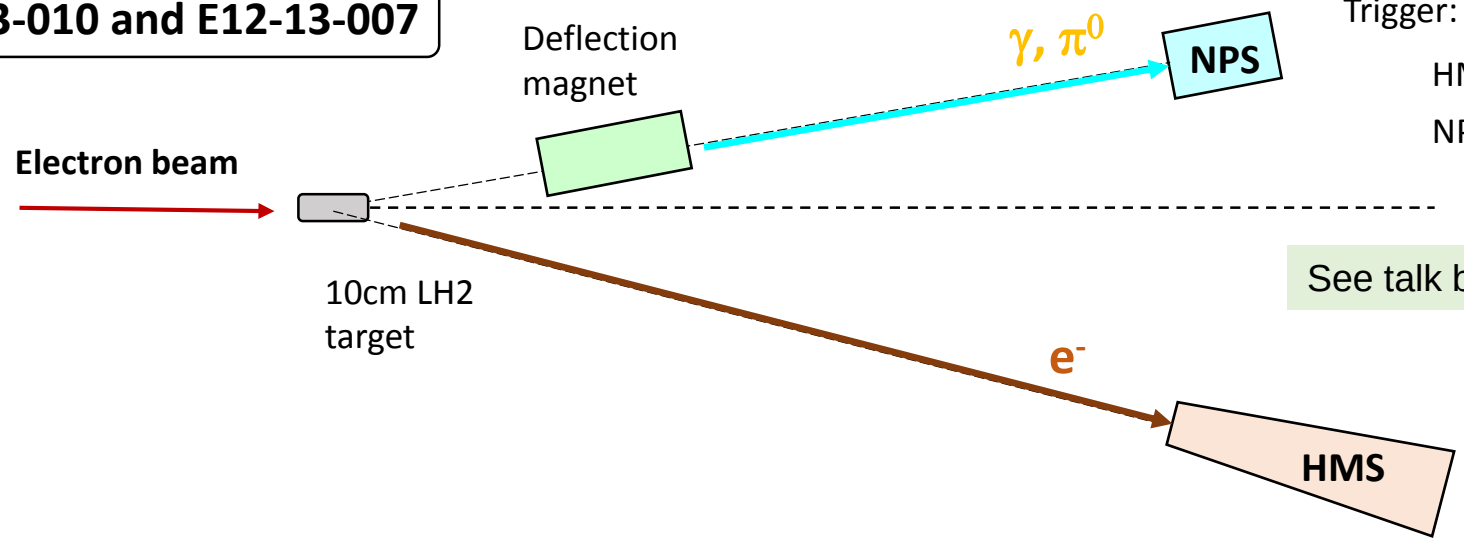
- E12-14-003 – Wide-angle Compton Scattering at 8 and 10 GeV Photon Energies
- E12-14-005 – Wide Angle Exclusive Photoproduction of $\pi^0$ Mesons

- E12-17-008 – Polarization Observables in Wide-Angle Compton Scattering

- Conditionally approved experiments: TCS with transverse target

# Experimental Techniques

**E12-13-010 and E12-13-007**



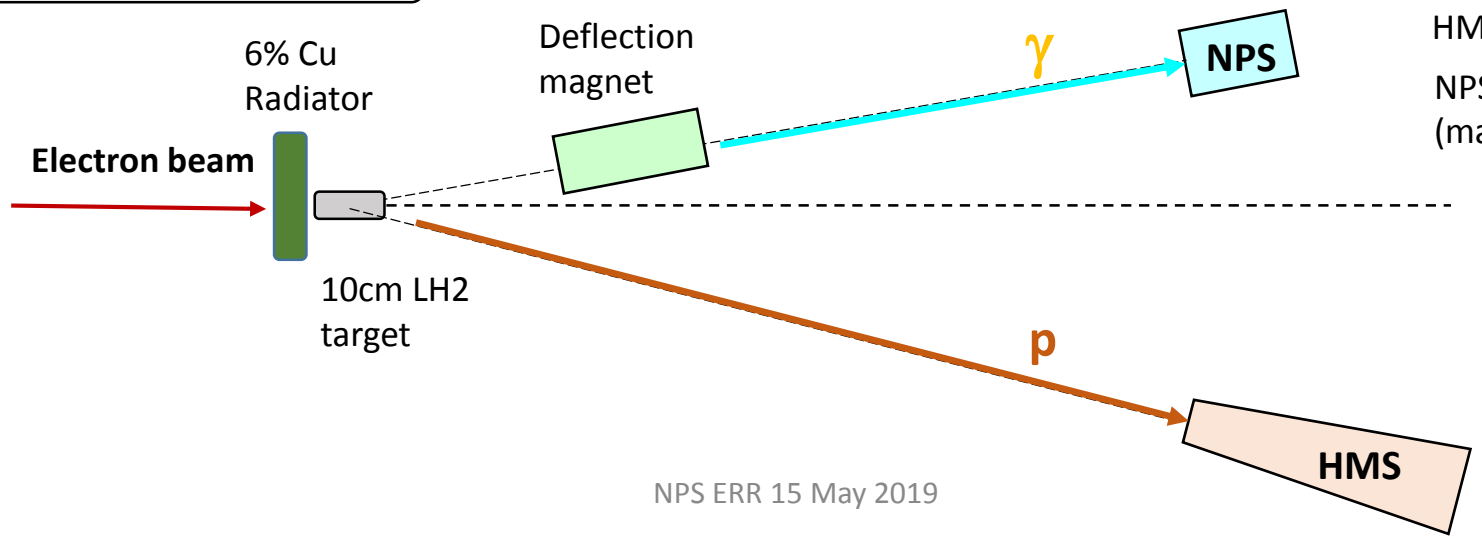

Trigger: HMS, HMS+NPS

HMS: 1 MHz (max)

NPS: 86 MHz (max)

See talk by B. Sawatzky

**E12-14-003 and E12-14-005**




Trigger: HMS

HMS: ~7 kHz (max)

NPS: 200kHz/uA (max)

# General requirements

$E_e$=6.6, 8.8, 11 GeV

| | E12-13-010 | E12-13-007 | E12-14-003 | E12-14-005 |
|---|---|---|---|---|
| Angular resolution(mrad) | 0.5-0.75 | 0.5-0.75 | 1-2 | 1-2 |
| Energy resolution (%) | (1-2)/√E | (1-2)/√E | 5/√E | 5/√E |
| Photon energies | 2.6-7.6 | 0.5-5.7 | 1.1-3.4 | 1.1-3.4 |
| Luminosity ($cm^{-2}$ $cm^{-1}$) | ~$10^{38}$ | ~$10^{38}$ | ~1.5x$10^{38}$ | ~1.5x$10^{38}$ |
| Acceptance | 60%/25msr | 10-60%/25msr | | |
| Beam current (uA) | 5-50 | 5-50 | ~40; +6% Cu radiator | ~40; +6% Cu radiator |
| Targets | 10cm LH2 | 10cm LH2 | 10cm LH2 | 10cm LH2 |

- ❑ Suppress and eliminate charged background – sweeping magnet
- ❑ Resolution for photon detection – good light yield, fine granularity
- ❑ Expected rates: up to 1MHz – fast response PMT, low gain, low anode current
- ❑ Radiation hardness – integrated doses 20-30kRad, monitoring and curing systems

# General requirements (cont.)

- Photon angles and distances of calorimeter from target cover a range

### E12-13-010 and E12-13-007

| Set | NPS angle | HMS angle | $D_{magnet}$ | $D_{calorimeter}$ | Magnet Angle (from Calo) |
|---|---|---|---|---|---|
| 3/B | 16.2 | 11.7 | 1.6 | 3.0 | 5.5 |
| 5/C | 12.4 | 15.3 | 1.6 | 3.0 | 5.5 |
| 7 | 21.7 | 11.7 | 1.6 | 3.0 | 5.5 |
| D | 7.9 | 24.2 | 1.6 | 3.0 | 5.5 |
| 8/E | 16.6 | 15.6 | 1.6 | 3.0 | 5.5 |
| 13 | 6.3 | 27.9 | 1.6 | 6.0 | 4.0 |
| 16 | 6.3 | 17.3 | 1.6 | 6.0 | 4.0 |
| F | 17.2 | 17.8 | 1.6 | 6.0 | 4.0 |

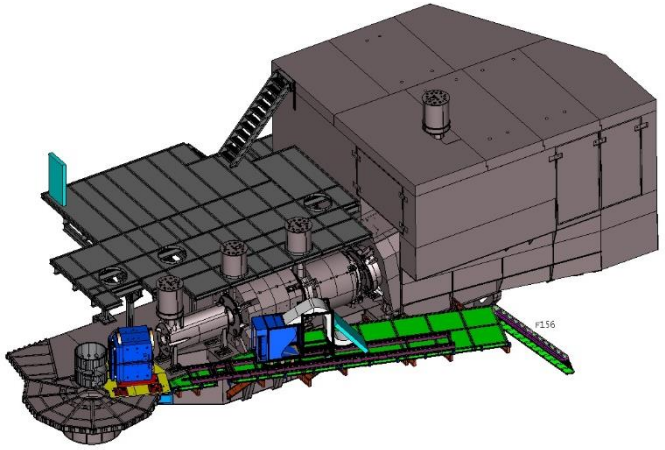
### E12-14-003 and E12-14-005

| Set | NPS angle | HMS angle | $D_{magnet}$ | $D_{calorimeter}$ | Magnet Angle (from Calo) |
|---|---|---|---|---|---|
| 4A | 14.2 | 40.1 | 1.85 | 9.0 | 5.5 |
| 4B | 17.9 | 33.7 | 1.85 | 7.0 | 5.5 |
| 4C | 22.5 | 27.8 | 1.85 | 5.0 | 5.5 |
| 4D | 26.9 | 23.7 | 1.40 | 3.5 | 5.5 |
| 4E | 34.0 | 18.9 | 1.40 | 3.0 | 5.5 |
| 5A | 11.0 | 41.7 | 1.85 | 11.0 | 5.5 |
| 5B | 13.8 | 35.3 | 1.85 | 9.0 | 5.5 |
| 5C | 16.9 | 30.0 | 1.85 | 7.5 | 5.5 |
| 5D | 19.7 | 26.3 | 1.85 | 6.0 | 5.5 |
| 5E | 29.9 | 17.8 | 1.40 | 3.3 | 5.5 |

- Two configurations are needed for angles <=23° (SHMS right) and angles >23° (SHMS left)

# Equipment to achieve science goals

- ~25 msr neutral particle detector consisting of ~1080 **$PbWO_4$ crystals** in a temperature-controlled frame including gain monitoring and curing systems – outer layers of 30x36 crystal matrix only to catch showers
- HV distribution bases with built-in amplifiers for operation in a high-rate environment
- Essentially deadtime-less digitizing electronics to independently sample the entire pulse form for each crystal – JLab-developed Flash ADCs
- 0.3Tm sweeping magnet allowing for small-angle and large angle operation at 0.6 Tm. The magnet is compatible with existing JLab power supplies.
- Cantelevered platforms off the SHMS carriage to allow for remote rotation (in the small angle range), and platforms to be on the SHMS carriage (in the large angle range)
- A beam pipe with as large critical angle as possible to reduce beamline-associated backgrounds – only a small section needs modification



**ERR Talks**

Magnet – C. Hyde

Detector – C. Munoz-Camacho

Electronics, DAQ – B. Sawatzky

Mechanical structures, installation – S. Lassiter

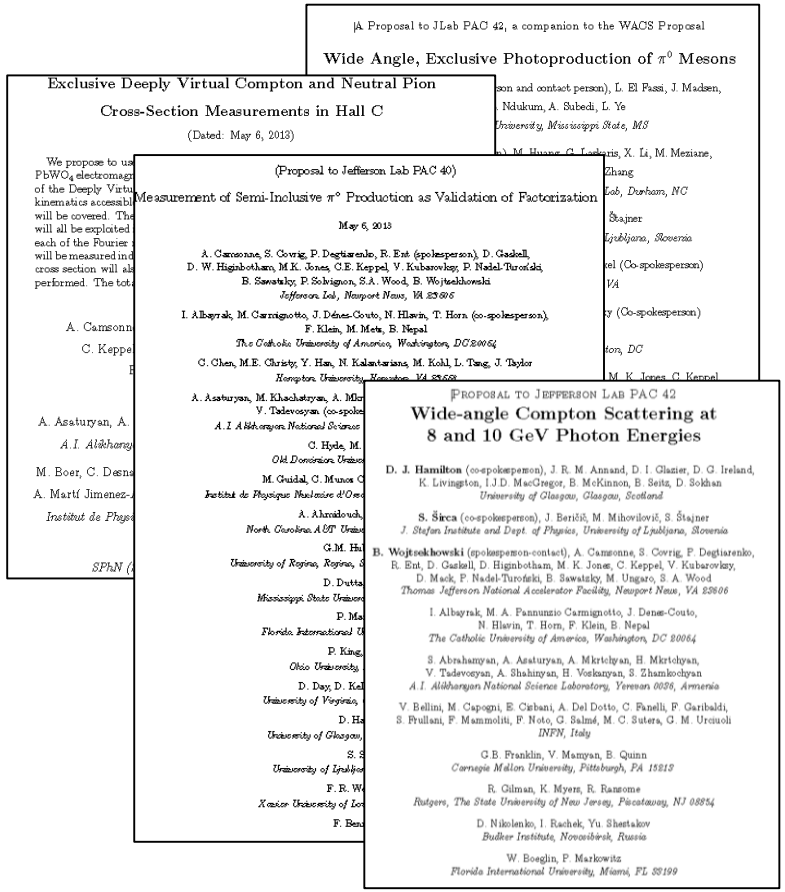
Beam pipe – J. Benesch

Software, analysis – G. Niculescu

# NPS collaboration

- Consists of members involved in NPS construction plus additional collaborators on the four experiments

1. Ibrahim Albayrak (Akdeniz Univ/Turkey)
2. Salina Ali (CUA)
3. Moskov Amaryan (ODU)
4. Vladimir Berdnikov (CUA)
5. William J. Briscoe (GWU)
6. John R.M. Annand (U Glasgow)
7. Arshak Asaturyan (AANL, YerPhI)
8. Vincenzo Bellini (INFN-Catania)
9. Kai Brinkmann (Giessen U.)
10. Marie Boer (CUA)
11. Alex Camsonne (JLab)
12. Marco Carmignotto (JLab)
13. Donal Day (UVa)
14. Dipangkar Dutta (MSU)
15. Stefan Diehl (Giessen U.)
16. Rolf Ent (JLab)
17. Michel Guidal (IPN-Orsay)
18. David J. Hamilton (U Glasgow)
19. Tanja Horn (CUA)
20. Charles Hyde (Old Dominion University)
21. Dustin Keller (UVa)
22. Cynthia Keppel (JLab)
23. Mitchell Kerver (ODU)
24. Edward Kinney (U. of Colorado)
25. Greg Kalicy (CUA)
26. Ho-San Ko (IPN-Orsay)
27. Mireille Muhoza (CUA)
28. Arthur Mkrtchyan (AANL, YerPhI)
29. Hamlet Mkrtchyan (AANL, YerPhI)
30. Carlos Munoz-Camacho (INP-Orsay)
31. Pawel Nadel-Turonski (Stonybrook)
32. Gabriel Niculescu (James Madison U.)
33. Rainer Novotny (Giessen U.)
34. Rafayel Paremuzyan (NH)
35. Ian Pegg (CUA)
36. Hashir Rashad (Old Dominion University)
37. Julie Roche (Ohio University)
38. Oscar Rondon (UVa)
39. Simon Sirca (U Ljubljana)
40. Alex Somov (JLab)
41. Igor Strakovsky (GWU)
42. Vardan Tadevosyan (AANL, YerPhI)
43. Richard Trotta (CUA)
44. Hakob Voskanyan (AANL, YerPhI)
45. Rong Wang (IPN-Orsay)
46. Bogdan Wojtsekhowski (JLab)
47. Steve Wood (JLab)
48. Simon Zhamkochyan (AANL, YerPhI)
49. Carl Zorn (JLab)
50. Jixie Zhang (UVa)




**ERR Talk**

Track record – G. Niculescu