NPS Collaboration Meeting
5-6 May 2025

NPS refurbishment and preparation for next run group

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NPS Run Group 2?

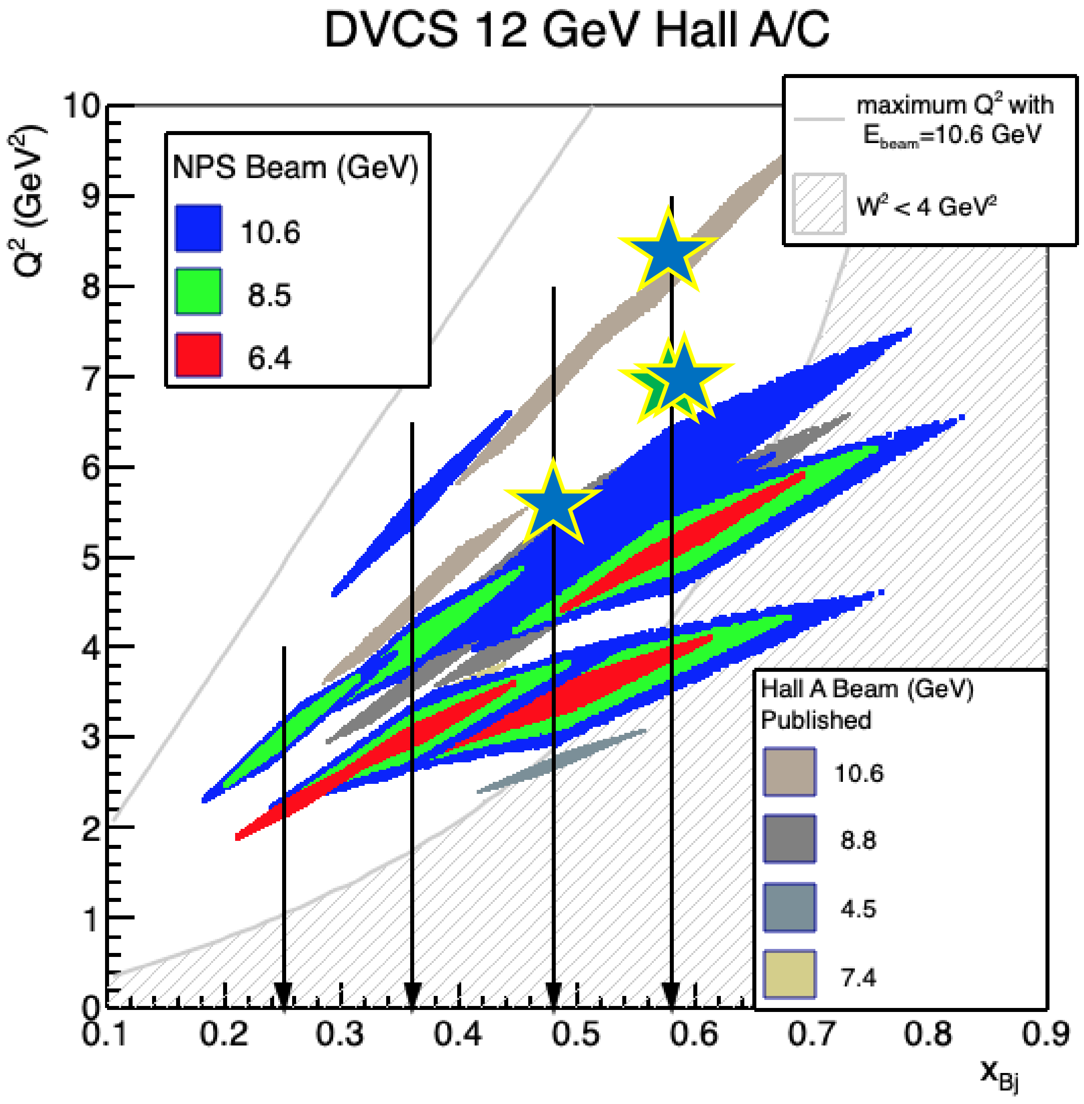
- E12-06-114 proton DVCS Jeopardy update 2019: 35 PAC days
- Wide-Angle Exclusive Photoproduction (*i.e. s, t, u* all large)
  - Run group, 42 PAC days:
    - E12-14-003: Wide Angle Compton Scattering, (B.W., D.H., S.Sirca)
    - E12-14-005: Wide Angle Exclusive pi0 (D.Dutta *et alia*)
  - Unpolarized
  - ~5% Cu radiator attached to target ladder
  - NPS sweep magnet at full current to separate radiated elastic $(e', e'_{Calo} p_{HMS})$ from Bremsstrahlung $(\gamma, \gamma_{Calo} p_{HMS})$

DVCS Jeopardy Proposal (proton only)

- "Fill in the gap",
- x_B = 0.60: Two beam energies at two high Q^2 points.

Variable \ Setting	Units	Kin48_J1	Kin60_J1	Kin60_J2	Kin60_J3
x_B		0.480	0.600		
Q^2	GeV^2	5.334	6.822		8.40
Beam Energy	GeV	10.617	8.517	10.617	8.517
HMS (e^-)	GeV/c	4.696	2.458	4.558	1.057
HMS (θ_e)	deg	−18.83	−33.17	−21.64	−57.77
NPS (γ-Calo)	deg	13.79	11.76	14.76	6.41
D(Calo)	m	3.0	3.0	3.0	4.0
Luminosity	$10^{37}/\text{cm}^2/\text{sec}$	7.5	7.5	7.5	13
Beam Current	μA	30	30	30	50
PAC Days	**Day**	**3**	**8**	**7**	**12**

Table 3: Jeopardy Kinematics for Hall C — NPS running. HMS and NPS values are the nominal central values. Negative angles are beam-left, positive angles are beam-right. The total beam-time required to run these settings is 30 days.



WACS: Two NPS Configurations

- Large reach in s and *t*
- NPS Calo & Sweep on beam-side of SHMS carriage
- NPS Calo & Sweep on wide-angle side of SHMS carriage
- 42 days total

Table 2: Kinematics variables for WACS in five settings with a 4-pass, 8.8 GeV electron beam (4A–4E) and five settings with a 5-pass, 11 GeV electron beam (5A–5E).

Kin	E_{in} [GeV]	θ_γ [°]	E_γ [GeV]	θ_{p} [°]	p_{p} [GeV/c]	θ^{cm} [°]	s [GeV^2]	$-t$ [GeV^2]	$-u$ [GeV^2]
4A	8	14.2	6.347	40.1	2.416	55.8	15.89	3.10	11.03
4B	8	17.9	5.663	33.7	3.138	67.6	15.89	4.39	9.75
4C	8	22.5	4.851	27.8	3.978	80.4	15.89	5.91	8.22
4D	8	26.9	4.161	23.7	4.684	90.9	15.89	7.20	6.93
4E	8	34.0	3.255	18.9	5.605	104.8	15.89	8.90	5.23
5A	10	11.0	8.362	41.7	2.399	48.9	19.65	3.07	14.81
5B	10	13.8	7.647	35.3	3.154	59.5	19.65	4.41	13.47
5C	10	16.9	6.848	30.0	3.981	70.1	19.65	5.91	11.97
5D	10	19.7	6.158	26.3	4.687	78.7	19.65	7.21	10.68
5E	10	29.9	4.135	17.8	6.739	103.2	19.65	11.01	6.88

NPS Refurbishment

- Mandatory (?)
  - Where is it all?
  - Check all crystals, PMTs, bases
  - Upgrade HV isolation on HV/Signal distribution boards
  - Redesign temperature sensor interface to avoid radiation damage (longer leads?)
- Potential upgrades?
  - Upgrade bases to 1 KV (currently 800 V?)
  - Reconfigure LEDs
  - Cable tray for longitudinal calo motion
  - Spare PMTs?
    - Test samples for lifetime

Who will do the work?

- JLab, ODU, Glasgow??, everyone welcome!!!
- Comments from Bogdan W.
  - 2-May-2025 email:
    - "Just tell that Bogdan will do NPS preparation in coordination with ODU."
  - 12-April-2025 email:
    - Yes, I hope to start work on NPS after completing the current SBS run (high Q2 GEp experiment). So, it will be in September 2025

Slides from 2024 Meeting

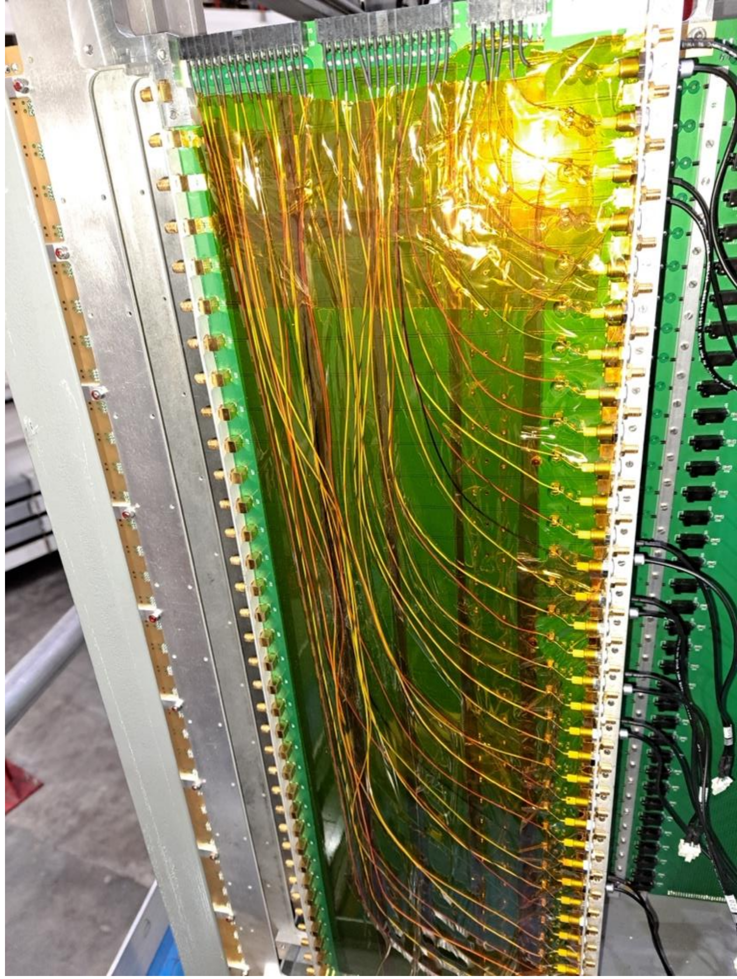
No updates

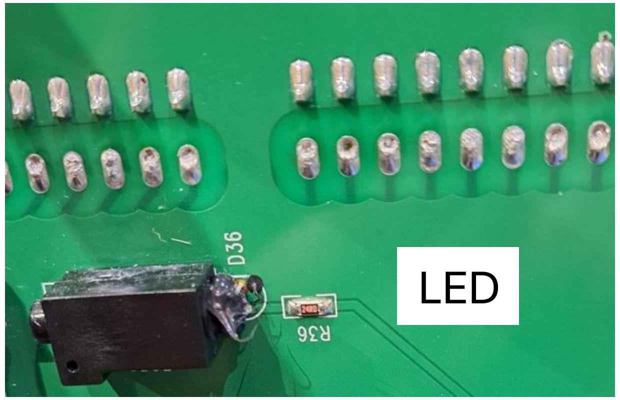
Some issues of concern

- PMT lifetime
- Temperature sensor interface
- HV distribution boards
- Mechanical access to Crystal assemblies
- Ease of longitudinal motion (on platform cable bundle)

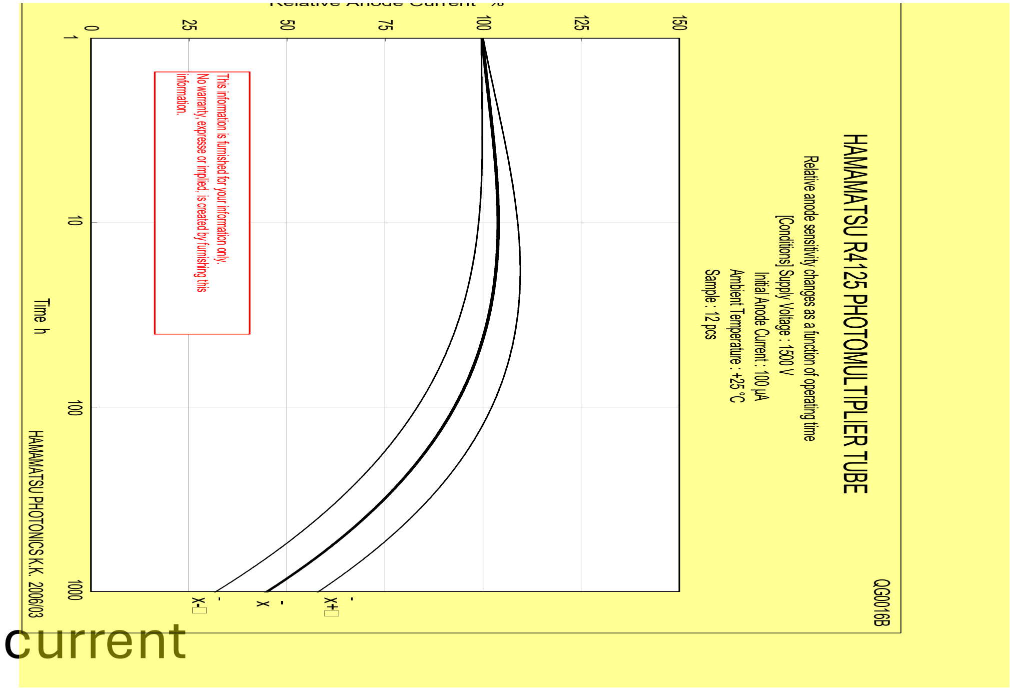
Distribution Boards, Patch cables to PMTs

- HV Issues
  - HV connections shorted (Boards too thin…)
  - All HV connections bypassed
  - Many of isolation capacitors fell off, trapped in cover
- Patch cables had many failures (displacement of central pin on SMC connectors).
  - All is well after ~first month of operations
- LED/Fiber system
  - Delicate, (only) 70% of connections operational
- Redesign/Rebuilt signal, HV, LV, LED connection and mechanics or leave well-enough alone?





HAMAMATSU R4125 PMT Lifetime



- Fermilab study:
    - https://lss.fnal.gov/archive/1997/pub/Pub-97-092.pdf, or NIM A v406 (1998) 103—116
    - 12 PMTs tested, illumination level: 100 μA anode current
    - Gain stable up to anode charge of 100 Coulomb.
    - Gain decrease to 50% after anode charge of 1000 Coulomb.
- NPS, Crystals closest to Calorimeter (very rough estimate)
    - (8 months) ⊗ (60%) ⊗ (10 μA) ≈ 115 Coul
        - Get exact recorded anode charge.
- Probably could run another 100 PAC days without catastrophic failure
    - Ran 3 generations of DVCS experiments in Hall A and only replaced 16 (out of 200) PMTs

PMT options

1) Test ~10 NPS PMTs to > 100 Coul
2) Buy ~100 spare PMTs (3 columns)
3) Do nothing.

Other PMT issues/options

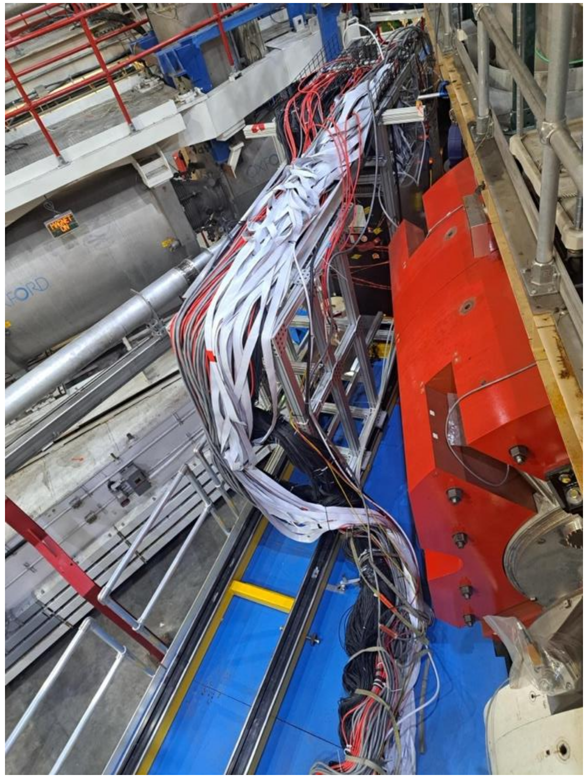
- Rebuild bases with improved low-voltage filtering
    - Or just leave alone, everything is fine with LV regulators removed

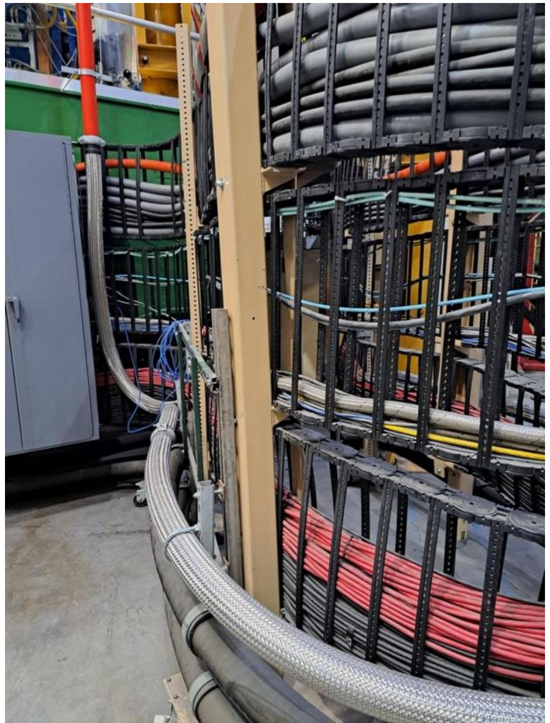
Temperature Sensors

- Crystal temperature stability monitoring
  - Gain variation –2% / °C
- ~most of front face sensors failed
  - Sensors are fine, interface-card between sensors and Keysight has active electronics—NOT rad hard. Solutions:
    - Long lead wires to move interface to more shielded location:
      Noise? Calibration Drift?
    - Find a Rad-Hard interface (CERN?)
    - Buy lots of spares

Mechanics

- Distribution boards, PMT+Crystal repair/replacement
- Cable bundle
  - Required crane to move Calo forward/back. Scheduling challenges.
- Build a vertical axis cable tray?





Hall C Pivot

Other?