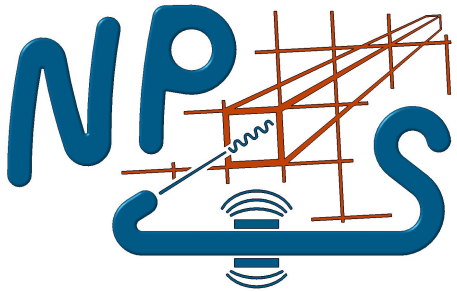


NPS Calorimeter Refurbishment

Discussion points, not recommendations

Charles Hyde

17 July 2024

NPS Collaboration Meeting

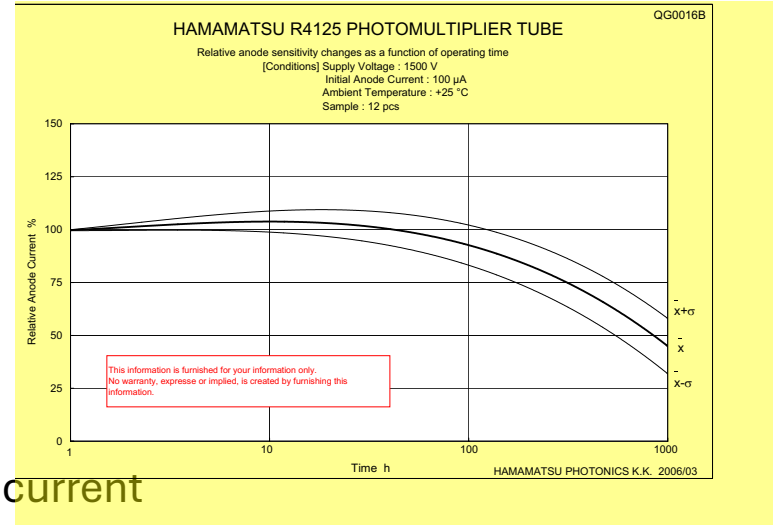
Calorimeter Status

- At end of experiment, Calorimeter was working very well!
  - No sign of PMT failure
  - Crystal darkening manageable
- Calorimeter “mothballed” in EFB
  - Calorimeter intact with all FEE
- Next NPS experiment (likely?)
  - WACS (unpolarized) +¿E12-14-118 DVCS?
  - Put the calorimeter back on the platform, recable, and take data
  - No refurbishment necessary?

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)

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

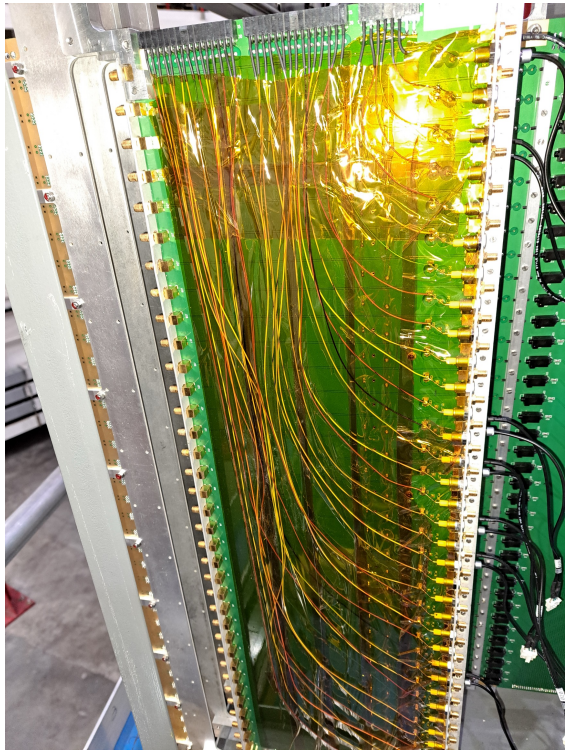
- Rebuild bases with improved low-voltage filtering
  - Or just leave alone, everything is fine with LV regulators removed

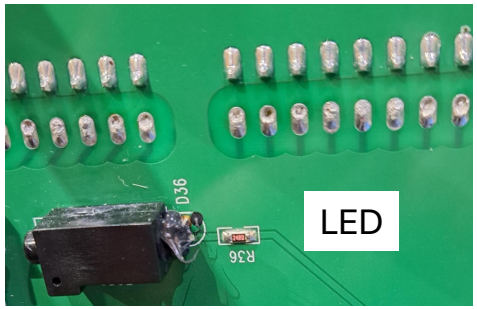
Temperature Sensors

- 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

Distribution Boards, Patch cables to PMTs

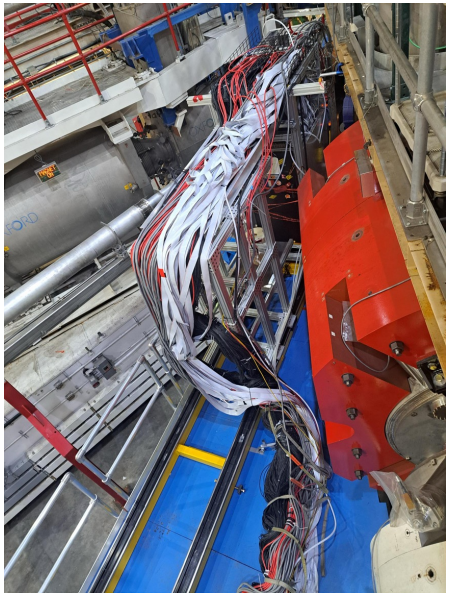
- HV Issues
  - HV connections shorted (Boards too thin…)
  - All HV connections bypassed
  - Many of isolation capacitors fell off, trapped in cover
- Patch cables had many failures (displacement of central pin on SMC connectors).
  - All is well after ~first month of operations
- LED/Fiber system
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





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

No Conclusions, Just Questions

- What is Truly Necessary?
- Who Will Do the Work?

My original list

1. Crystals
   a. Bleach with blue lights?
   b. Measure transparency?
2. PMTs
   a. Test ~10 at high anode current (e.g. 10 μA until death)
   b. Replace?
3. PMT Base Redesign?
   a. No LV regulators, replace with LC filter.
   b. Find certified rad-hard components for pre-amps
   c. Replace signal and HV connectors with pigtails?
   d. "True" DC monitoring?
   e. Heating system for Base when HV off, to stabilize calo temperature.
4. Calo-mounted distribution boards
   a. Redesign/replace for proper HV isolation
      i. Replace boards with guided cable bundles?
   b. Revise connections to PMT bases
   c. Any mechanical suggestions (expand lateral movement beyond size of Calo)
   d. Low Voltage distribution
   e. HV connectors?
5. Optical Fibers
   a. LED system / driver
   b. Coupling to crystals
   c. Put microLEDs directly on crystal
6. Cabling
   a. Build/buy a moving cable tray (stacked vertically) to allow easier motion on platform
7. Sweep Magnet
   a. Reconsider placement, rotation with respect to crystal axis
8. Calorimeter Mechanics
   a. Any way to simplify repairs?
      i. Expanded lateral movement of distribution boards
   b. Improve temperature sensor reliability, radiation hardness