Update/Status for NPS HV, Electronics, DAQ

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NPS Collaboration Meeting

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DAQ Hardware for NPS (Overview)

- **NPS: 1080 $PbWO_4$ blocks**
  - → Readout consists of JLab F250 FADCs
    - » Full waveform for crystals of interest
    - » < 1ns timing res. is provided by F250s
  - → NPS trigger generated by JLab VTP modules in NPS F250 VXS crates
- **Hardware needed for NPS** **(All hardware in-hand!)**
  - → 68x FADCs
  - → 5x VXS crates
  - → 5x SD + TI + Linux SBC / ROC
  - → 5x VTP modules
  - → HV supplies (2x SY4527 crates + 64 HV modules: 1152 HV channels)
  - → Low Voltage supplies for amplifiers (New req. as of 2021; ordered and delivered; all in-hand)
- **Firmware development**
  - → VTP firmware
    - » provide required summing trigger, and 'sparsification mask' to F250s
  - → F250 FADC firmware updated to emit waveform data based on channel mask from VTP
  - → TI/TM firmware must support full complement of 5 NPS crates + 3 HMS crates
- **LED System Driver boards**
  - → Each NPS block has a UV LED attached; can be run in two modes
    - » Bleaching (extended UV exposure used to 'heal' accumulated radiation damage)
    - » Pulse mode (used to test trigger and individual block responses)

VTP / F250 / TM Firmware / Trigger (Reminders)

- VTP (5+1 modules ordered May 2020)
  - → Cluster trigger based on 3x3 groups, with 1 row shared between crates
  - → Logic signals emitted by each VTP will be OR'd in NIM to form NPS trigger
    - » CODA trig: HMS .AND. (.OR. of NPS)
    - » Timing latency on VTP triggers deterministic to <12ns
  - → Define/update VTP data payload
    - » cluster charge, timing?
    - » cluster crystal list to be used to sparsify F250 waveform readout
- F250 FADC (51 modules from FE/PD pool)
  - → Hi-res timing required (< 1ns)
    - » Preserve multi-hit/ch output
  - → QDC data, Scaler data
  - → Full waveforms (25 samples)
    - » Compressed?
  - → VTP info used to sparsify F250 readout channels to those in a 5x5 cluster(s) centered on the 3x3 'trigger' cluster(s)
- TI/TM modifications (if needed?)
  - → must support 5 NPS crates + 3 HMS crates
  - → maintain six L1 trigger inputs on primary TM
- CODA / HMS trigger assumptions
  - → 'Standard HMS' NIM triggers will be available
    - » ¾, EL_{real}, EL_{clean}, ...
  - → NPS + HMS trigger made in NIM
    - » NPS + HMS {¾, EL_{foo}}
    - » NPS VTP latency is NOT a problem
- NPS detector assembly and full DAQ chain readout tests to be done in EEL space Spring/Summer 2022

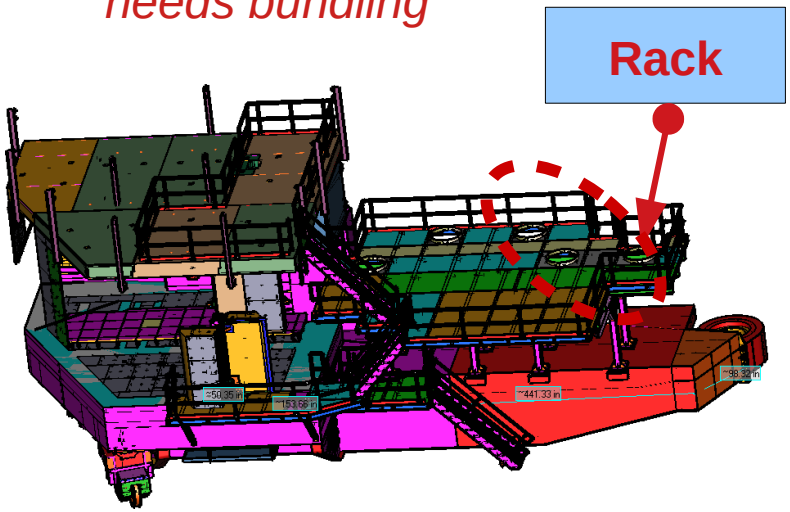
FE/DAQ group reports 'first draft' of needed firmware complete

NPS DAQ Challenges (Reminders)

- Most work driven by requirement to handle high-rate kinematics + waveform output
  - → 13 kHz HMS (DIS) triggers (+ background)
    - » need NPS trigger (→ VTP firmware)
    - » need 'Event-Blocking' enabled
  - → 'high' multiplicity in NPS (75+ crystals)
  - → waveform output for participating crystals is a 'Must' (~25 samples/ch)
- Pending issues
  - → VTP firmware development
    - » 3x3 crystal cluster triggers
    - » Emit logic-out for NIM trigger with HMS
    - » 'sparsify' F250 readout (only store waveforms from 5x5 clusters centered on 3x3 'trigger' cluster)
  - → Analyzer support for VTP payload
  - → Analyzer support for Event-Blocking mode
    - » 'Unblock' in secondary ROL?
      - – may be simplest? no analyzer changes needed [Moffit?]
    - » 'Unblock' at analyzer? [Bob M]
- Firmware questions *wrt* VTP/F250s
  - → Hall B firmware has compression, but removes features to achieve this
    - » need to ensure necessary timing, QDC, scaler(?) data still present
  - → May require upgrading HMS F250 firmware as well
    - » need to address knock-on changes to CRLs and analyzer assumptions for HMS
  - → *Or* lossless compression in 2nd stage ROL + libCoda mod?
    - » no F250 firmware change, no decoder changes
- Firmware / DAQ questions have been discussed with FE Group
  - → No “show-stoppers” but requires development resources be allocated to this project
- Updates to Hall C analyzer software
  - → Non-trivial work here!

Signal/HV/LED Cable Runs

- Plan is for a single 84” tall, 19” standard width rack to be placed near the pivot
  - → Planned to go on the upper, power supply deck
- Cable path, cable supports details near final (Paulo, Brad)
- Rack at pivot is BNC:BNC patch for 1080+20 RG-58 cables *only*
  - → *Cables in-hand and labeled; needs bundling*



- Other cables will follow the same path past the rack to the NPS, but with no patch panel:
  - → 30+2 multi-conductor HV
    - » Assem. and QA testing complete (DSG)
  - → 60+2 80-wire ribbon cables for LEDs
    - » Need to buy/assemble when LED board final (ie. spring 2022)
    - » Not expensive or long-lead, but on the ‘Follow-up’ list (Brad)
  - → Heavy-gauge grounding cable(s)
    - » Necessary to establish/ensure clean detector ground
    - » Isolation pads for NPS
      - – Plan in place with Paulo
    - » *Discussed with J. Segal who will do the ordering*
      - – *Not long-lead; on ‘Follow-up’ list (B)*

Cable Bundle Summary

- This covers cables run between SHMS detector hut to NPS detector
  - → Signal, HV, LED cables
  - → All cables follow same run
    - » Cables are ~150' long
    - » Patch panel rack for signal cables is intended to be roughly half way
- Cable bundle cross section and weight estimate (above cables)
  - → ~120 in^2 (cross section area)
  - → ~50 kg/m; ~33 lbs/ft
- *NOT* considered in this document (but not forgotten)
  - → Thermal monitoring readout & Temperature control systems
    - » Heat exchanger plumbing, control lines, etc
  - → Paulo, DSG, and Brad have a plan.
    - » Still to be detailed.

NPS Detector Slow Controls

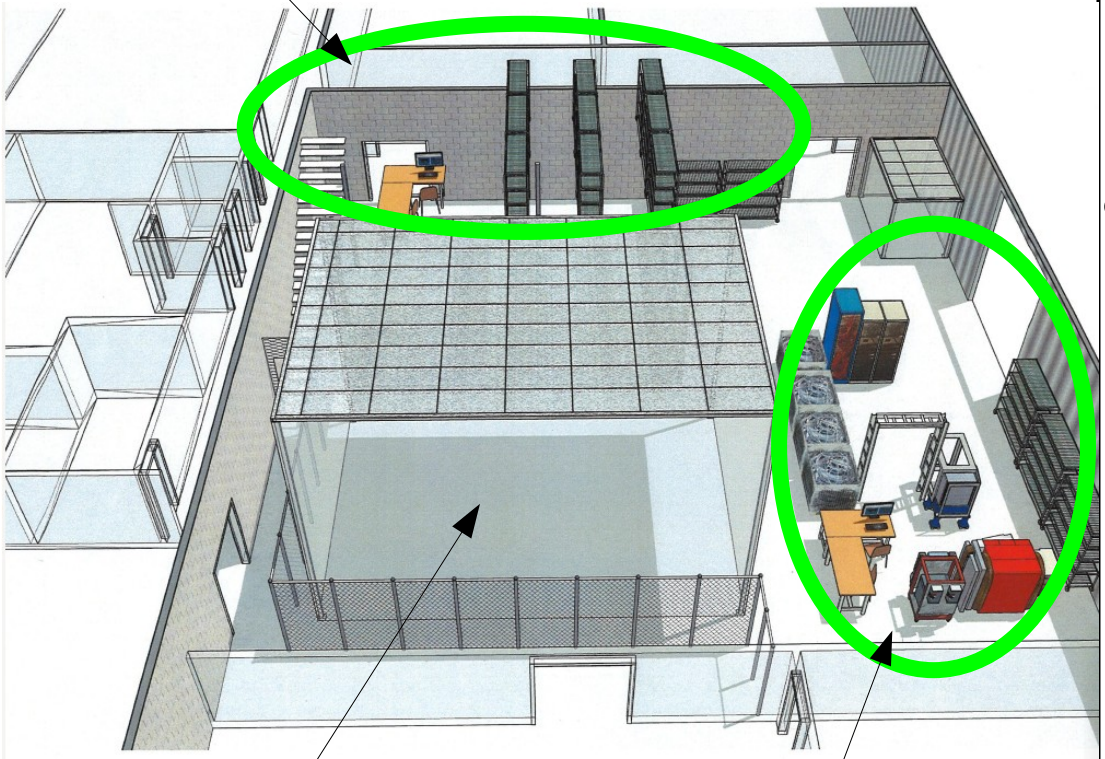
- NPS detector will need additional instrumentation for **Thermal Monitoring/Control** and **LED system**

- Thermal Monitoring/Control
  - → Model after Primex/HyCal/ComCal
  - → Only local control needed
    - » Remote monitoring is straight forward
  - → Brad will be JLab point of contact for integration / EPICS
    - » DSG support in place
    - » Good progress on all items
- Existing EPICS Archiver and Alarm Handler software used for automatic signal logging/ monitoring

- Thermal Monitoring/Control Notes
  - → Rough Channel/Function List:
    - » Readbacks for chiller/air-handler at minimum
      - – Status, in/outflow temps, etc
  - → Internal air temp readback(s)
  - → Multiple detector temp readbacks (few dozen ch)
    - » Several locations in crystal mount / HV divider region

- LED controls (JLab FE Group)
  - → Controller/driver design complete
    - » Design finalized (William Gu)
  - → Some issues with prototypes in 2021
    - » Revised boards arrived recently and are looking good

NPS Detector Layout in EEL Building



- Space will become ready for occupancy in late-Apr
- "To do" list
  - → Need to design/build cable bridge
  - → Unbox and bundle signal cables
  - → NPS detector assembly timeline / personnel
  - → Stage/Test DAQ

DAQ/HV/Cable Status Summary

- Support hardware staging (Brad)
  - → Patch panel, NPS→DAQ cabling
    - » *2200 signal cables in-hand but need bundling*
    - » *Patch panel rack needs assembly*
      - – *Parts in-hand.*
  - → HV Crates (Brad + DSG)
    - » Procurement complete; QA issues with CAEN (2021) have been resolved. Ready to go.
- Slow Controls
  - → LED Control (*DSG + FE Group*)
    - » Driver board design complete; fabrication near complete
    - » Control GUI is *TBD*
    - » Need 60x new ribbon cables
  - → "Integrated" NPS slow controls display is making good progress (*DSG*)
- DAQ HW Procurement (Brad)
  - → Completed (all in-hand)
- DAQ Firmware/SW Devel. (FE Group)
  - → VTP, F250 modifications
  - → 3.5 person-months
    - » Initial drafts of firmware complete; will test and iterate in Spring/ Summer
- Analyzer (Hall C) (***Do we have a Plan?***)
  - → *Integrate DVCS software into hcana*
  - → *Decoder updates for VTP, F250 mods*
  - → *Solve, Implement, and Test "Data Unblocking" feature*
  - → *Merge multi-threaded podd with hcana*
    - » *Unsure of status/practicality?*
  - → *Do we still have a lead on this?*
- Full DAQ integration and Testing (Brad)
  - → *Planned to start in ~May 2022*

Done