# **HCal Status Update**

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Jefferson Lab

# General DAQ/Software Status

# Completed:

- All DAQ electronics tested and working.
  - Except summing modules require testing.
- Operational decoder and readout lists (CODA  $2 \rightarrow$  CODA 3).
- Full database implemented.
- Available Triggers:
  - Cosmic trigger.
  - LED pulser trigger.
- Flags file to configure ROCs (switch between triggers, set windows, prescales, etc).
  - Standardize across subsystems? GUI?
- Event display available.
- Simple cluster finding algorithm implemented (max energy module).
  - More advanced algorithm under development. (e.g. associates regions of BB with regions of HCal.)

# To-do:

- PMT QE calibration requires more LED data (test lab).
- Calibrate NPE to ADC signal (test lab).
- Calibrate HV to ADC signal (test lab).
- Test summing module trigger (test lab).
- Implement online monitoring software (maybe mimic Hall C).
  - fADC250 scaler mode. GUI exists (ask Steve Wood?).
- Determine alarm handler information.
  - HV alarms etc.
- Setup HCal in the hall.
  - Reestablish DAQ.
  - Synchronize timings.

#### Coda 3 Upgrade

- In the process of upgrading DAQ to CODA 3. (Thanks, Bryan!)
  - New CODA configuration written.
  - DAQ readout lists almost updated.
  - About to install final VXS crate. (Thanks, Alex!)
- Need to test CODA 3 on cosmic data as final test.

	ROCcandy	EBbles nail	<b>J</b> FILE		
ROC:					
Name ROCcandy Priority 1,210	Master Roc		Type ID	ROC 0	
ROL1 /home/daq/rol/vme_lis	tso		User Str	ing userstring	
ROL2 //home/daq/rol/event_l	ist.so		User Str	ing userstring	
User Config undefined					(optional)
Description (optional)					
Process		Run	Data	⊮ tsCheck	
Open New	•	🗌 Spa	rsify	2 tsSlo	Р
		Ok App	ly to All	Clear	Cancel

# Completed:

• All front-end electronics, cables, patch panels etc. installed and operational.

# To-do:

- Need to finish greasing PMTs.
  - Calibrations can't be finalized until this is completed.
  - Requires test lab access.
  - Unless we have a volunteer who can access the test lab, Scott will do this when authorized to enter.
  - Hopefully granted access when JLab enters SAD.
- Assemble 4 remaining pulser boxes (CMU).
- Fabricate remaining 3 shims that go between the 4 subassemblies. Other 20 installed already (JLab).
- Move to Hall A and revive the DAQ system.
- Install dry air supply for PMTs in the hall.

#### **LED** Calibration Procedure

- 1. Illuminate PMTs with internal LED fiber optics and take a data run at a nominal voltage setting.
  - Calculate the number of photoelectrons (NPE) observed by PMTs.

$$NPE = \left(\frac{\langle ADC \rangle}{\sqrt{RMS^2 - RMS_{pedestal}^2}}\right)^2 \tag{1}$$

• Calibrates NPE to ADC value.



- 2. Take a cosmic run at the same voltage as the LED run.
  - Use NPE to ADC calibration to estimate the NPE observed from cosmic rays.
  - Note: Not an absolute calibration. Cosmics don't perfectly obey Poisson statistics.
  - Compare results with estimates from simulation.
    - G4SBS predicts  ${\approx}5.5$  PE per MeV deposited.
    - G4SBS predicts 13-14 MeV for average cosmic event.
- 3. Use NPE to ADC calibration along with G4SBS simulations to predict ADC signals from hadrons.

#### LED Calibration Procedure Cont.

- 4. Use LEDs to perform voltage scans.
  - LEDs much quicker than cosmics.
  - Gives calibration of HV to ADC.
- 5. Use the NPE to ADC calibration along with the HV to ADC calibration to predict safe voltage setting ranges for the PMTs during experiments.
  - Benchmarked such that 99.5% of hadron signals do not saturate the DAQ. See https://hallaweb.jlab.org/wiki/images/4/4f/ HCal\_Energy\_Deposition.pdf for energy deposition study.
  - Energy deposition study based on G4SBS simulations of  $G_M^n$  and signal tracing through the electronics.
- June-July 2018 JLab cosmic tests (Vanessa Brio, Catania):
  - Cosmic tests with 4x4 block of PMT modules.
  - Two runs measured 56 and 70 PE detected.
  - Average G4SBS cosmic 72-77 PE.
  - PMTs not greased yet (can improve PE collection up to 30%).

### **Current Status Summary**

- DAQ operational and detector fully assembled.
- Cosmics/calibrations will resume when test lab access is restored.
- To do: https://docs.google.com/document/d/ 1S--OKOlQLOgP-EP-2nf8LSBLx6Y6d6TAFrWK1UkRxBE/
- Grease remaining PMTs.
- Calibrate relative PMT QEs.
- Calibrate PMTs with LED pulser/cosmics.
- Voltage scans.
- Simulation cosmics vs. real.
- Finish CODA 3 upgrade.

- Online monitoring.
- Analysis scripts.
- Assemble remaining pulser boxes.
- Fabricate shims.
- Move to Hall A.
- Install dry air supply.

- Personnel:
  - 2 postdocs: Scott Barcus and Juan Carlos Cornejo.
  - 1 student: Vanessa Brio.
  - Brian Quinn and Bogdan Wojtsekhowski.
  - New collaborators: Jim Napolitano, Donald Jones, and Kent Paschke.

### Acknowledgments

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- Thanks to the many students who have worked on HCal including Alexis Ortega, So Young Jeon, Jorge Peña, Carly Wever, and Dimitrii Nikolaev.
- Thanks to Alexandre Camsonne for helping us get the DAQ working and finding all the modules for us.
- Thanks to Chuck Long for all his help fixing and acquiring things.
- Thanks to Bryan Moffit for DAQ help.
- Thanks also to Brian Quinn and Bogdan Wojtsekhowski.
- Thanks to Vanessa Brio, Cattia Petta, and Vincenzo Bellini for their cosmic commissioning efforts.

# Questions?