DAQ Interfaces of the LED Flasher System

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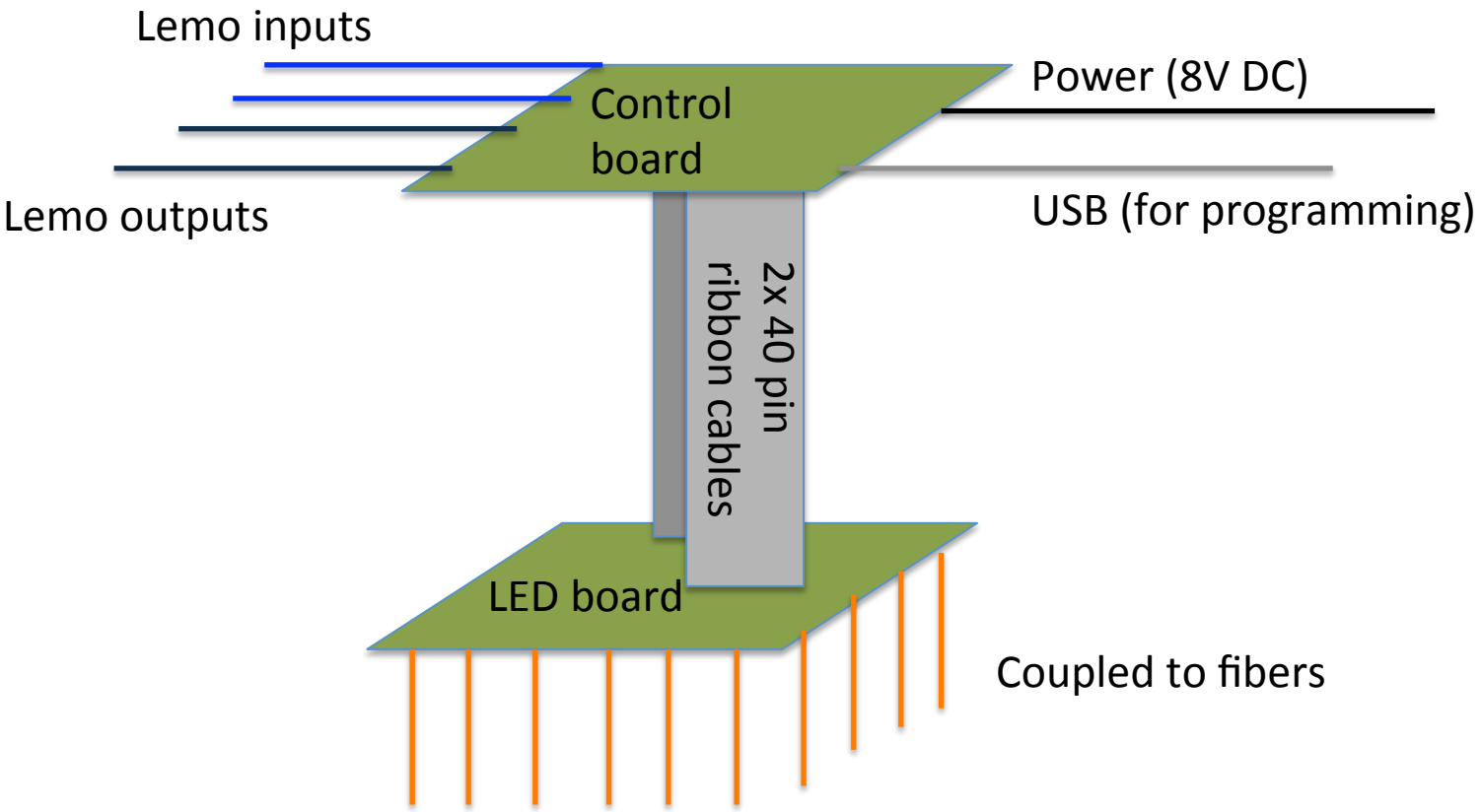
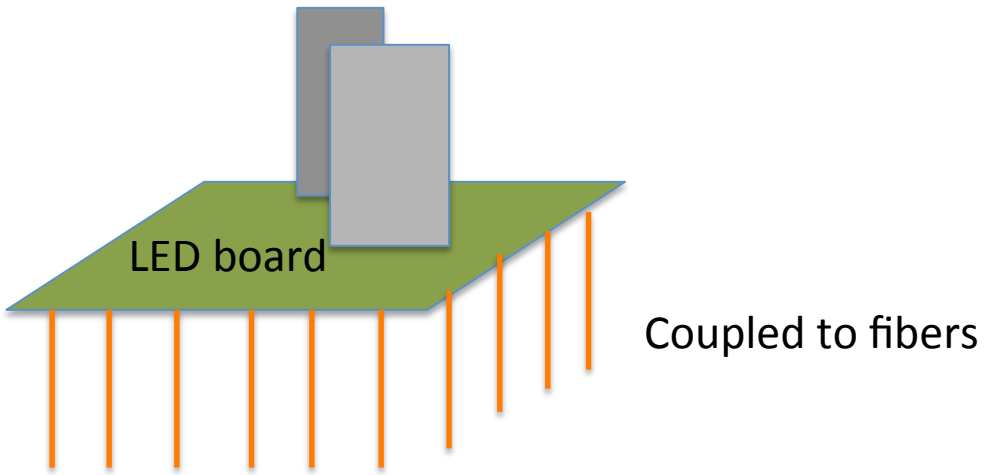
- We have two PCB boards which will be mounted on the cryostat feedthrough



LED Board

- Each pair of pins on a ribbon cable carries a DC offset voltage, which charges a capacitor on the LED board
- A transient 1ns pulse riding on that baseline causes the capacitor to discharge through the LED over a few (5?) ns.
- The LED flashes with intensity proportional to the DC baseline.
- The intensity of each LED can be controlled independently by setting different DC voltages on each pin-pair.



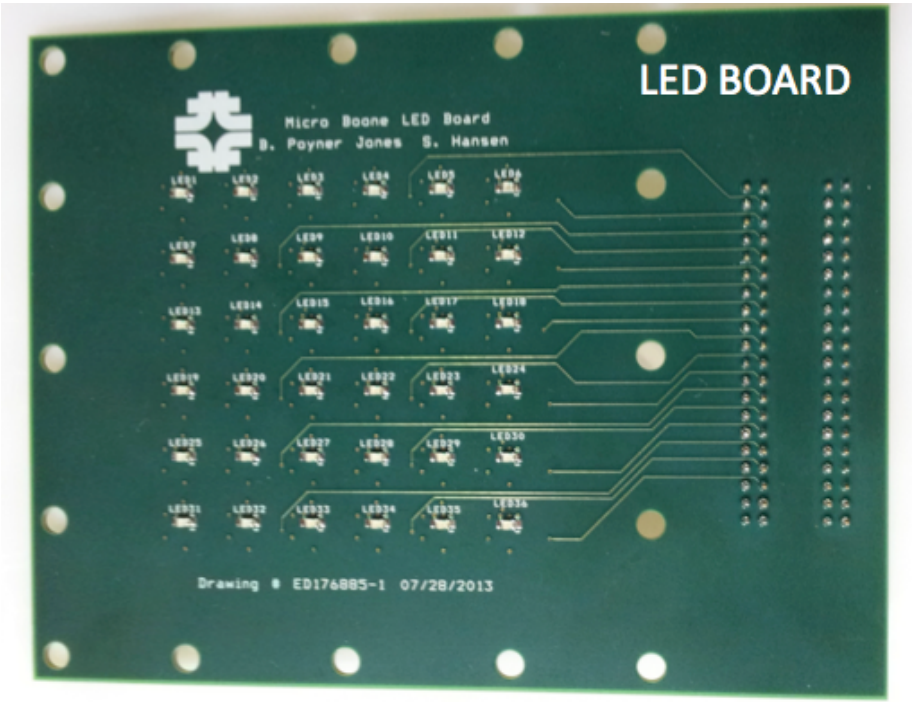
LED Board

- This board is assembled and tested two ways:

  1) using very high rate pulses for every channel, tested by eye

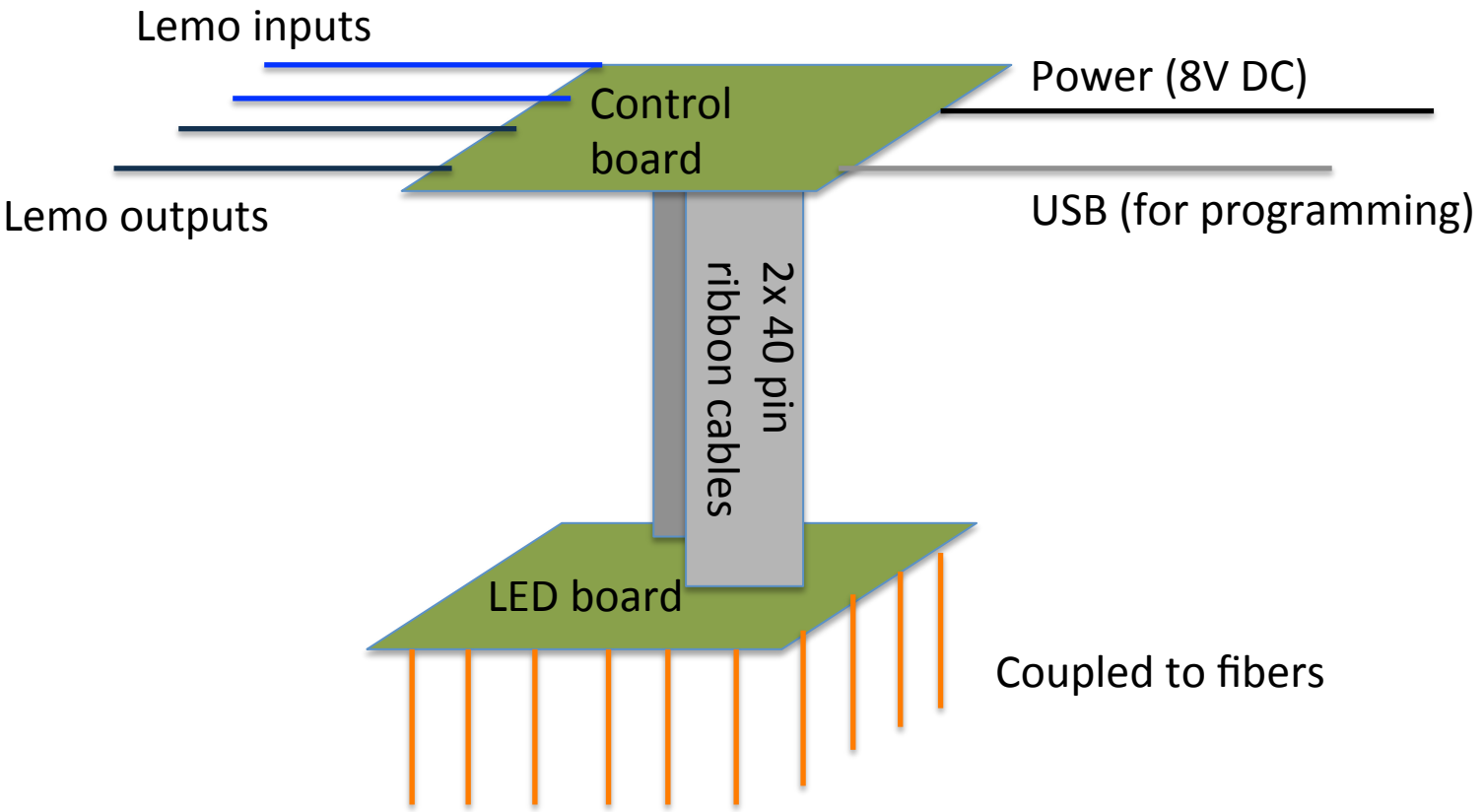
  2) using pulses closer to operating conditions with PMT readout in the cryostat

We have an adaptor which allows us to use this board with the Bo LED control board, with the channel to pulse specified by a jumper



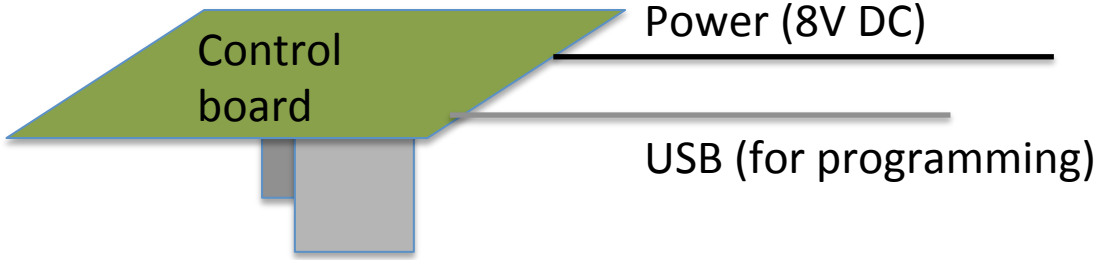
Control Board

- Responsible for controlling the administration of the offsets and transients to the LED board. Presently being laid out.
- We already know how it will work / interface with DAQ



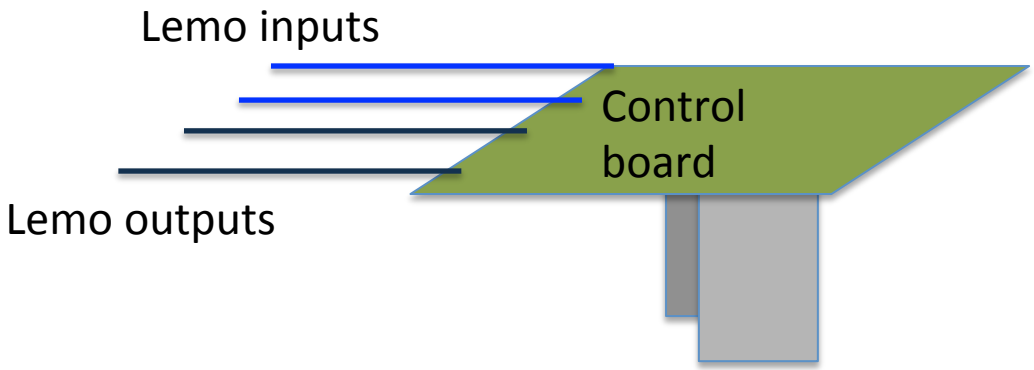
Control Board

- Power will be 8V DC. This approved by Linda, and an appropriate supply is nearby.
- USB connection will be made via a USB ranger to one of the DAQ machines (exact machine tbd).
- We can ssh into that machine to configure the board manually when necessary
- For steady-state calibration between data runs it will be integrated into the DAQ calibration machinery (more shortly).



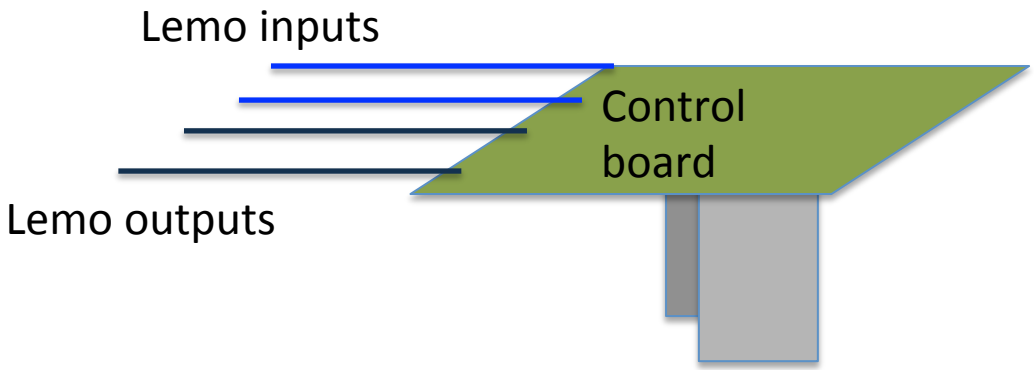
Control Board

- DC offset voltages are held on ribbon pins in steady state, and these are set via the USB connection. Flash only happens in response to transient.
- The board has no internal clock for flashing, and only flashes in response to NIM pulses on the LEMO inputs
- The exact behavior to be followed when an input pulse is received is configurable. We have asked the EED guys to pre-load it with two sequences:
  - LEMO input 1: Pulse every LED simultaneously
  - LEMO input 2: Pulse each LED at 100ns intervals, one at a time
- No current proposal to use the LEMO outputs.
- We can get cleverer later if we want to.



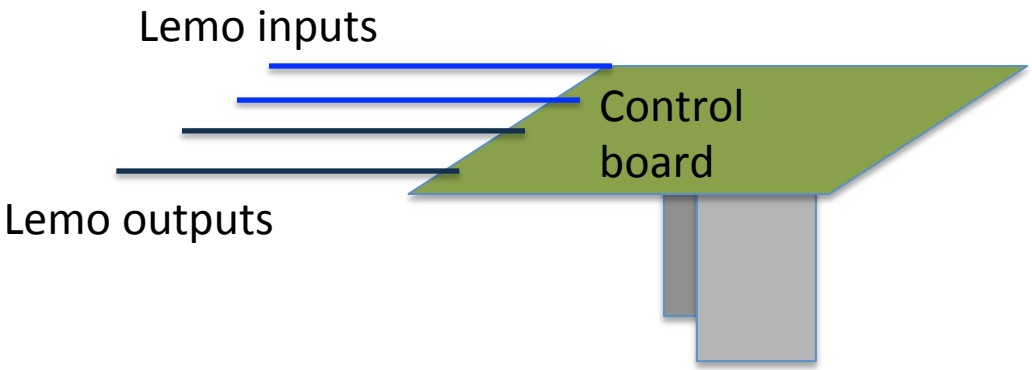
Manual commissioning tests:

- Using a function generator we will perform commissioning studies by sending NIM pulses to the control board “by hand” to flash the LEDs
- We will use this to find the required LED voltages to achieve single PE or multi-PE pulses on each channel
- Commissioning measurements of gain and timing on each channel will be made in this way both at DAB and LArTF.



Steady-state Calibration

- We plan to interleave PMT calibration with real data taking, just like TPC charge injection calibrations
- The control of this system and the ASIC calibration system will be ~identical.
- During a calibration run, an entry is found in a run configuration database, and appropriate devices are configured appropriately (including our control board)
- After configuration, NIM pulses are dispatched and fanned out to all systems (both the ASICs and to us), telling them to “GO”.
- During a PMT calibration run, the ASICs will have been switched off / instructed not to respond to the charge injection signal
- During an ASIC calibration run, all the voltages on the LEDs will have been set to zero. We receive input pulses but nothing happens.



Ongoing work

- In the coming weeks I will work with Eric on how to have the DAQ send voltage configuration instructions via USB to our control board (presently we use PuTTy - shouldn't be too hard to automate)

- Sten Hansen on WH13 is hoping to get our board layout done in the next 2 weeks

- EDRs are getting started for both the LED and control boards

- We will be making a test using the LED board only, pulsed "by hand" for all 40 PMTs in next 2 weeks.

PMT System Commissioning Tests

- PMTs were pre-commissioned by energizing and testing them one-by-one with stray light and an LED flasher board

- Each proposed commissioning test will read out all PMTs with the LED flasher system in coincidence with the TPC
  - Test 1: Before installing TPB-coated materials (~2 days)
    - Baseline test, which verifies proper functioning of full system
  - Test 2: After TPC is inserted before end cap is welded (~2 days)
    - Tests that nothing was damaged during TPC insertion
  - Test 3: After end cap is welded (~2 days)
    - Tests light isolation of cryostat and provides baseline for test 4
  - Test 4: After Cryostat is moved to LArTF (~2 days)
    - Tests that nothing was damaged during cryostat transportation

- Requires coordination between many groups/subsystems

What is the full test?

- Nominal HV applied to all PMTs at once
- PMT gain measurements for each PMT one at a time using full electronics chain, performed
  - At 2 different rates (~100 Hz, ~20 kHz)
  - At 2 different LED settings (multi-PE and single PE)
- Relative timing measurement for each PMT

Planned Course of Action

- All items needed for these tests expected to be ready 1st week of October (except LED flasher control board)

- Prior to LED flasher control board completion
  - We will first test PMTs one by one at 100 Hz, then
  - We will use an external function generator to test all PMTs simultaneously at 100 Hz and 20kHz

- After to LED flasher control board completion
  - We can perform the full suite of tests