Pulsed Laser System

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Need for a pulsed LED light monitoring system

What is does well:

- **Live monitoring**
- **Longevity test**
- **Time walk correction (if important)**
- **Verify the relative gain matching**

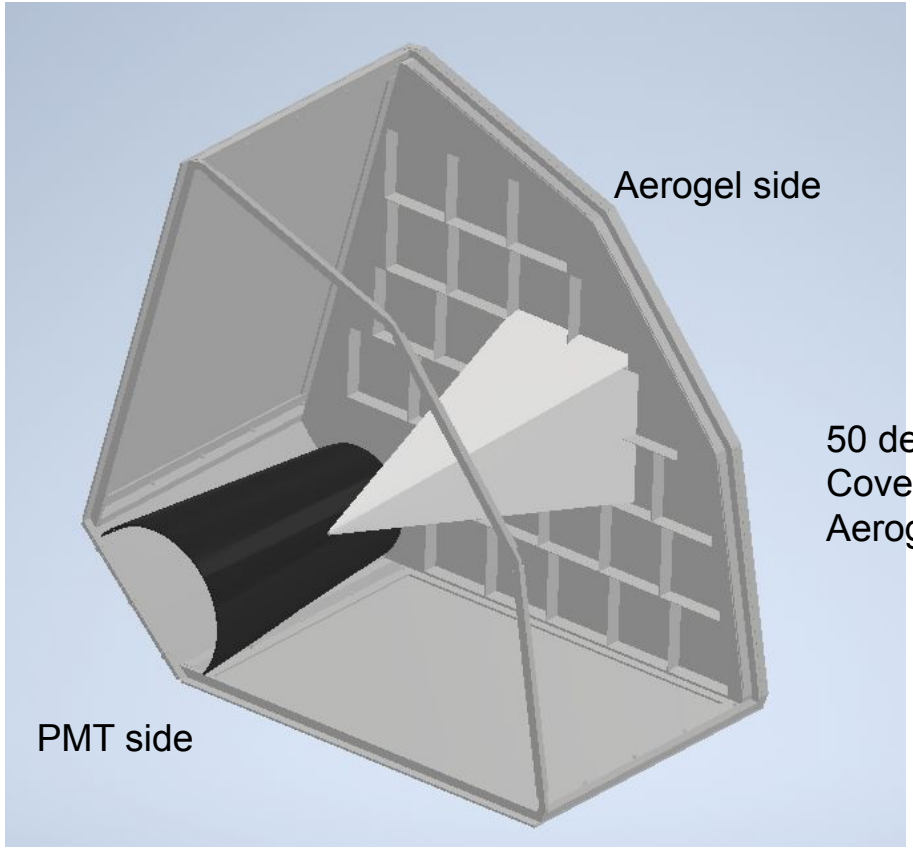
What it doesn’t not do well:

- **Single photon gain calibration**
- **Detector (absolute) characterization (must come from standalone test stand)**

Communication with Fernando (JLab)

- **Fernando is onboard with the similar system as GlueX DIRC**
  - **Easier to build such system at JLab**
  - **Will be in time for the July 2024 beam test**
  - **Need requirements now.**

Rough sketch



50 degree square pattern
Covers almost exactly 4
Aerogel slots

What is our requirement ?

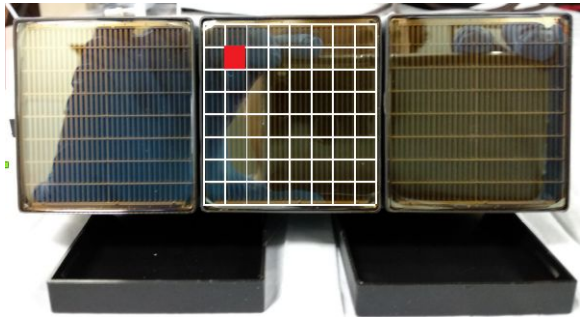
Waiting on his response:

I am assuming the following:

- Pulse frequency range.
- Pulse wavelength range.
- Pulse height. (This probably comes standard)
- Wavelength
- Diffuser angle
- How you need the DAQ or slow control system information at all?
- How many splits?
- Fiber length

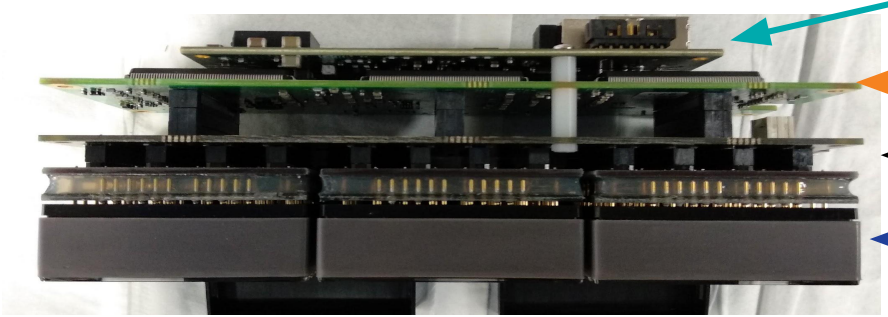
A successful story: GlueX DIRC laser system

R12700 PMT and Boards



ASIC board with 3 MORAC chips

- Hamamatsu R12700: 8 x 8 pixels



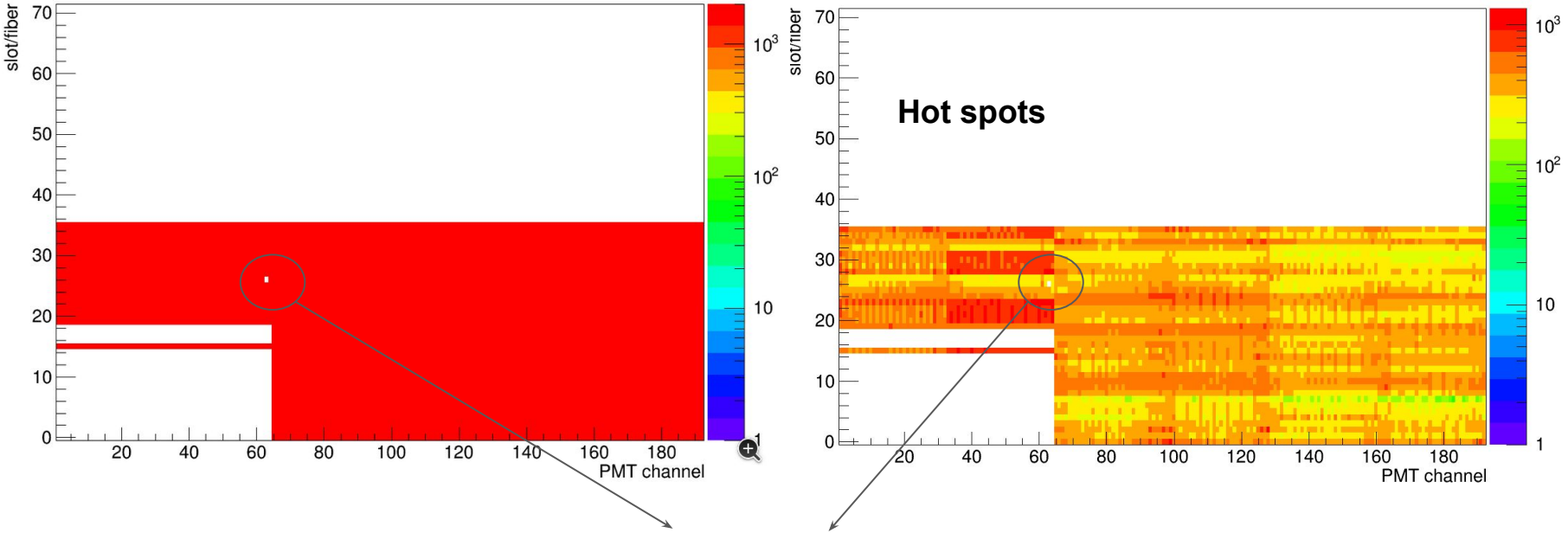
FPGA board: communication with DAQ, trigger for the laser pulse

ASIC board: signal processing give leading and trailing time, ADC

Adapter board: host PMTs, HV

PMT

Dead pixels

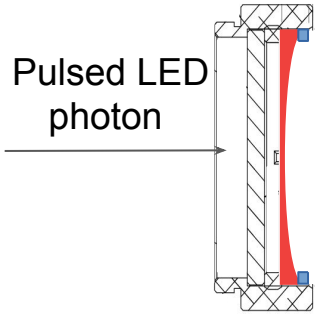


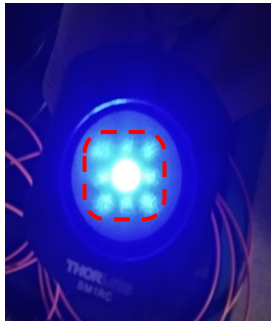
Dead FPGA pixels

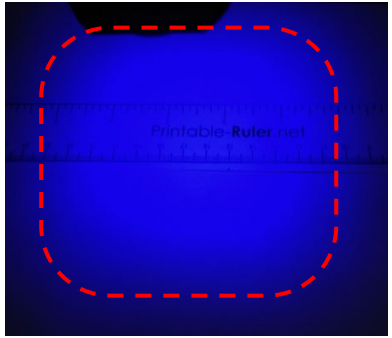
DIRC LED Diffuser

Each optical box: three LED fibers

- 50 Degree square diffuser
- Pulsed at 500 Hz during production
- 10ns delay for each fiber
- Live calibration, timing, monitoring

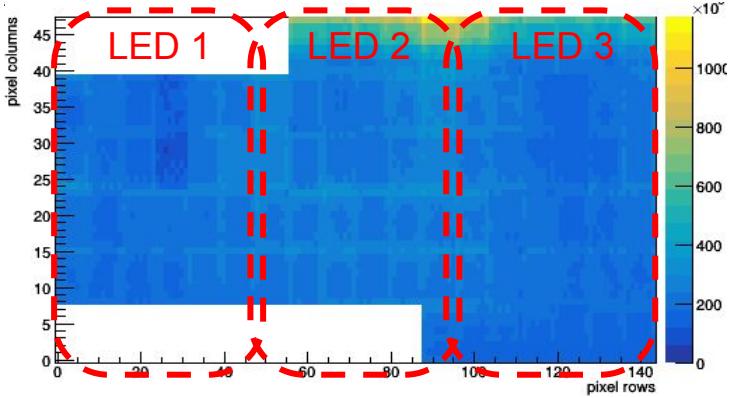


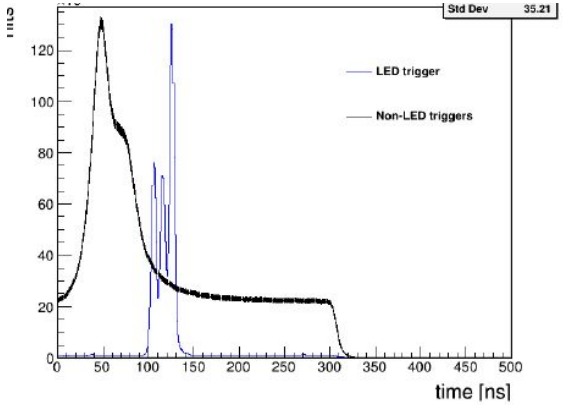




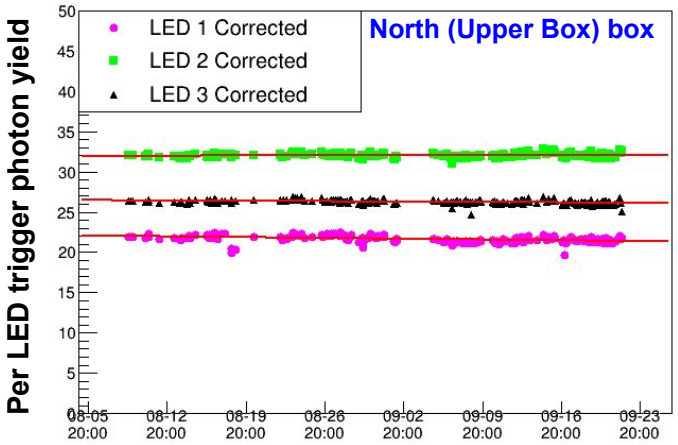
Square pattern

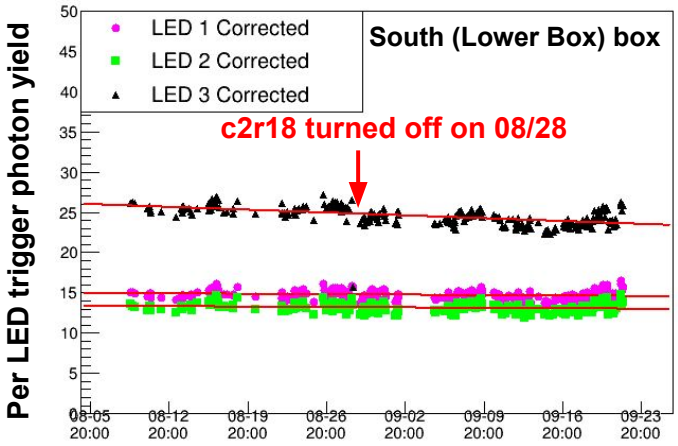
LED occupancy (three diffuser coverage)





Photon Per LED Trigger Monitoring

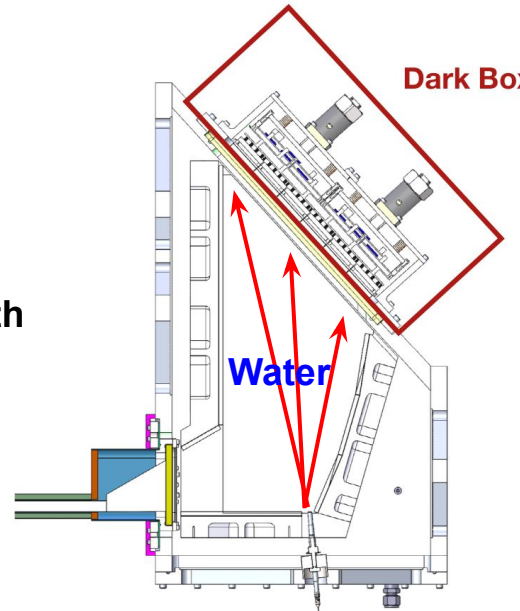




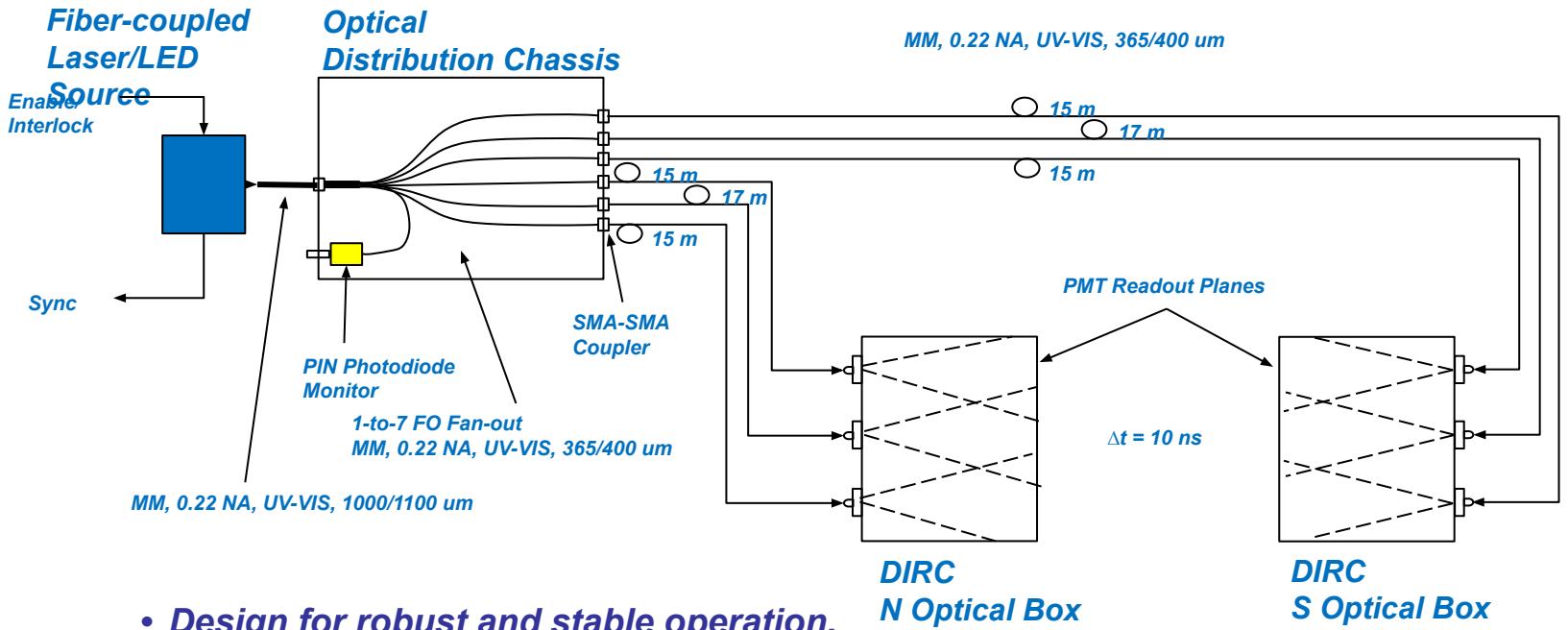
Per LED trigger Monitoring:

- **Configuration**: LED → Water→ Quartz → RTV→ PMT
- Flatness in Sep-Aug monitoring suggests stable PMT+ water quality
- **Evidence points to the mirror reflectivity degradation**

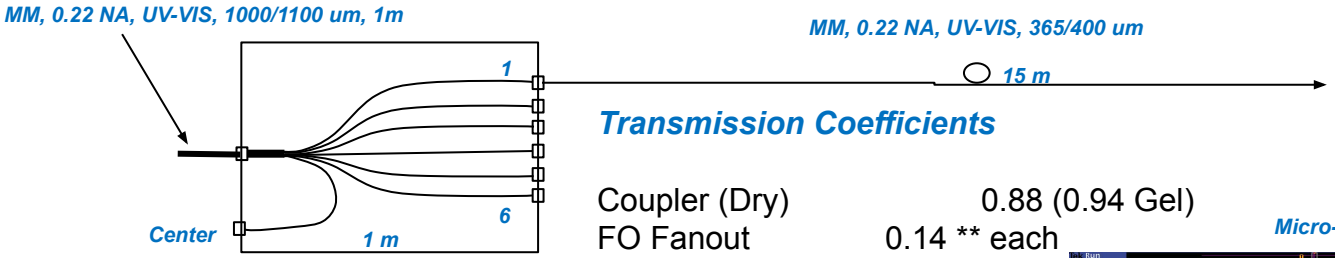
South box operated with one less PMT module during Sep 2020



DIRC Calibration System

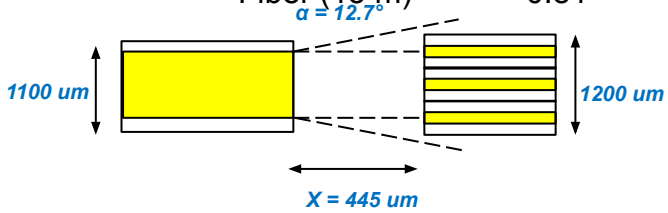


- Design for robust and stable operation.
- All fiber cables are custom made.
- Timing requirements: tr < 2 ns, Jitter < 50 ps.
- Laser or LED decision to be finalized by Spring 2018.
- Custom Optical Distribution Chassis to be developed during the Fall 2017.

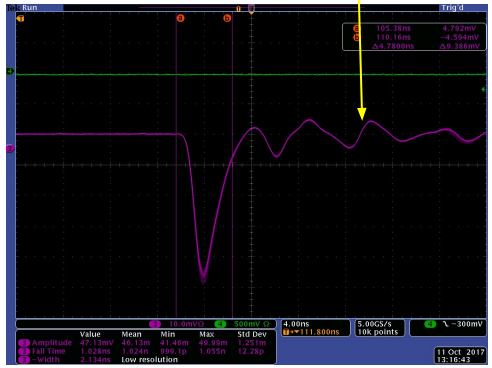


Transmission Coefficients

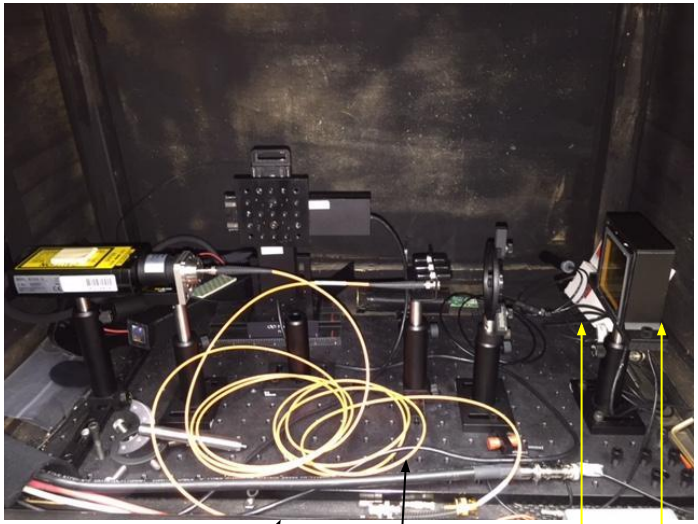
Coupler (Dry)	0.88 (0.94 Gel)
FO Fanout	0.14 ** each
FO Fill factor	0.70
Fiber (15 m)	0.81



Micro-channel electron recoil effects



- Power coupling equalization not guaranteed by manufacturer.
- 5 outer fibers within 1.4%; one at +19%
- Output beam is not collimated – Gaussian so higher power from center fiber
- Delay for 2 m fiber = 10.08 ns
- Dispersion causes Tr to increase 555 ps for 15 m
- Timing characteristics: Tr = 1 ns, Tw = 2 ns (FWHM)
- ~~Additional work~~ to improve distribution (fiber collimator?) and ~~PIN diode monitor~~
- Additional work leading to source selection.



Laser Head
λ = 405 nm

SMA
coupler

Fiber
MM, 365/400 um
UV-VIS

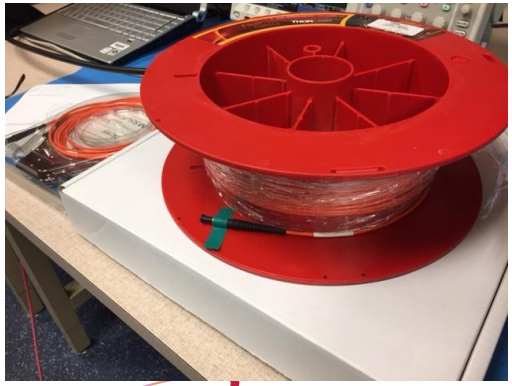
SMA
Holder

Diffuser

85001
MCP-PMT

1-to-7 Fanout [MM, 0.22 NA, 365/400 um, UV-VIS]

15 m reel [MM, 0.22 NA, 365/400 um, UV-VIS]



End Thoughts and Recommendation

- **Is a pulsed laser system needed?**
  - **Absolutely!**
  - **Reason 1:** it will tell us the if the **detector pixel+readout channel is okay or not** at any given time
  - **Reason 2:** it will tell us the gain matching is configured correctly.
  - **Reason 3:** it will tell us the detector + Cherenkov light system degradation.

- **A Yale responsibility item.**
  - Since Prakhar (Yale) is handling detector calibration.
  - Fernando Barbosa (Jefferson Lab) design contact person: barbosa@jlab.org