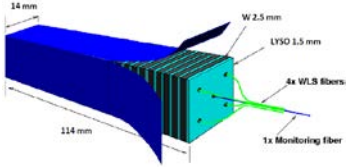


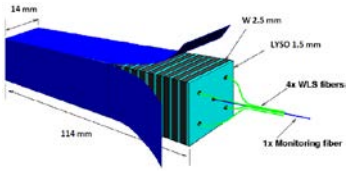
Monitoring LYSO Crystal Based Shashlik Matrix for Fermilab BT

Ren-Yuan Zhu

California Institute of Technology

July 16, 2014

A Tunable Laser Based Monitoring System



Used in April Shashlik beam test

18"x36" breadboard

Laser Safety Box

Shutter Attenuators

Opolette 355II+UV
(210–355, 410–2200 nm)
(20 Hz)

FC

Log. Variable

PIN

30 m

FC Feedthrough on Back Plane

5'6"

4x4 Matrix

3'

Reference

In beam enclosure

Integrating sphere
1x18 Fan–out

Readout with the same photo-detector, electronics and neutral density attenuators of 30 dB

Oplette Power Supply

Digital Delay

Shutter Control

Digital Scope

Ext. Trigger

Q–switch signal

USB

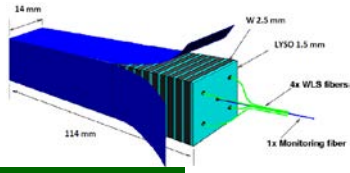
Slow Monitoring (USB)

Labview on Windows

In laser barracks/room

Caltech Jan. 24, 2014

Revised System with 3 Improvements



(1) 355 and 425 nm; (2) Home-made ½ inch IS; and (3) air-gap couplers

18"x36" breadboard

1

Laser Safety Box

Shutter

Sampler

Fiber couplling

Opolette 355II+UV

(20 Hz)

355 nm

425 nm

PIN

PIN

Log. Variable Attenuators

3

30 m

FC Feedthrough on Back Plane

5'6"

4x4 Matrix

3'

Reference

2

In beam enclosure

Integrating sphere

1x18 Fan–out

Readout with the same photo-detector, electronics and neutral density attenuator of 30 dB

Oplette Power Supply

Digital Delay

Shutter Control

Shutter Control

Digital Scope

Ext. Trigger

Q–switch signal

USB

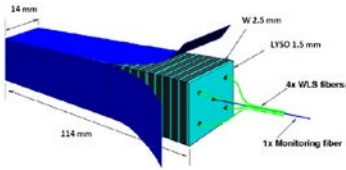
Slow Monitoring (USB)

Labview on Windows

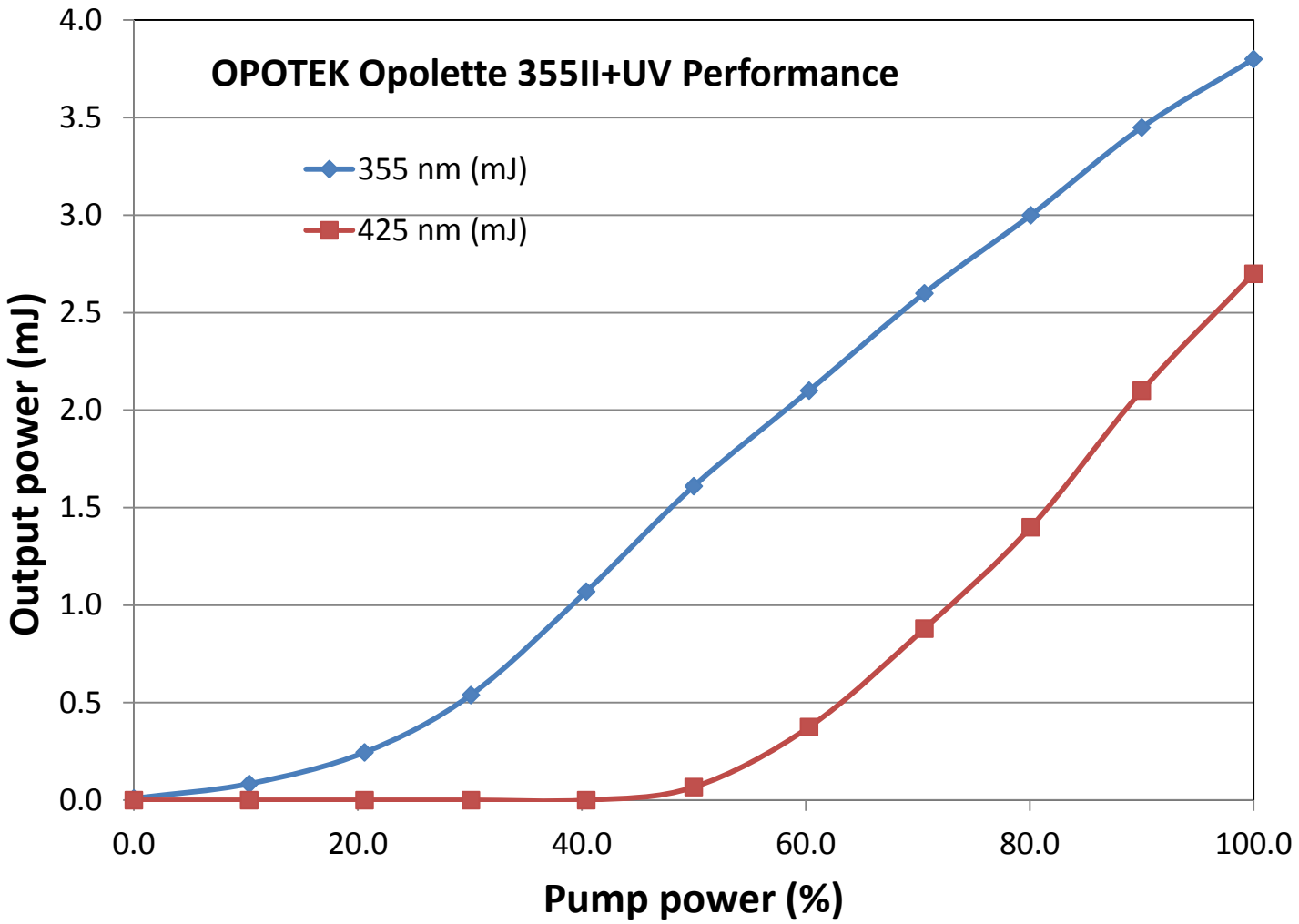
In laser room

Caltech July 10, 2014

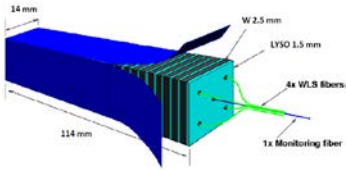
Opolette Laser Performance

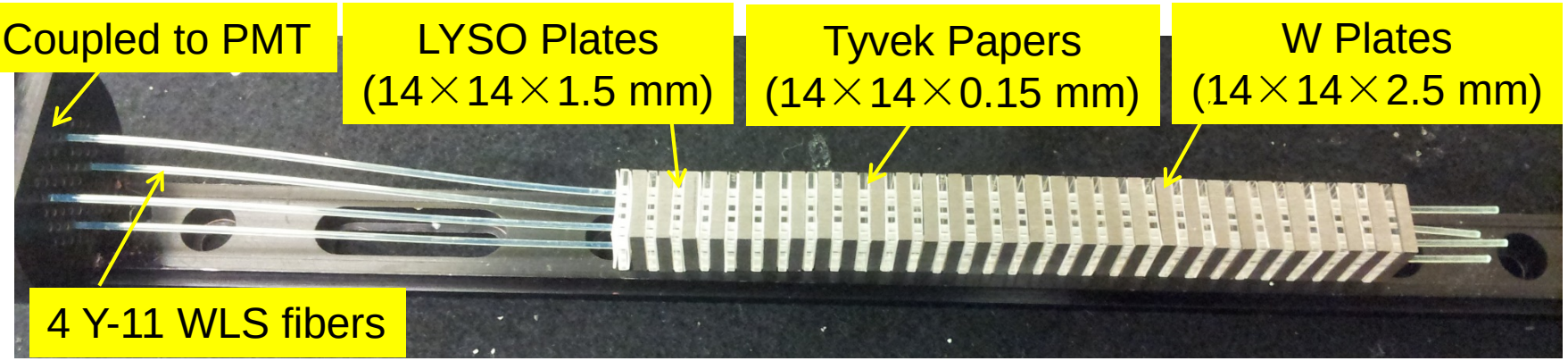


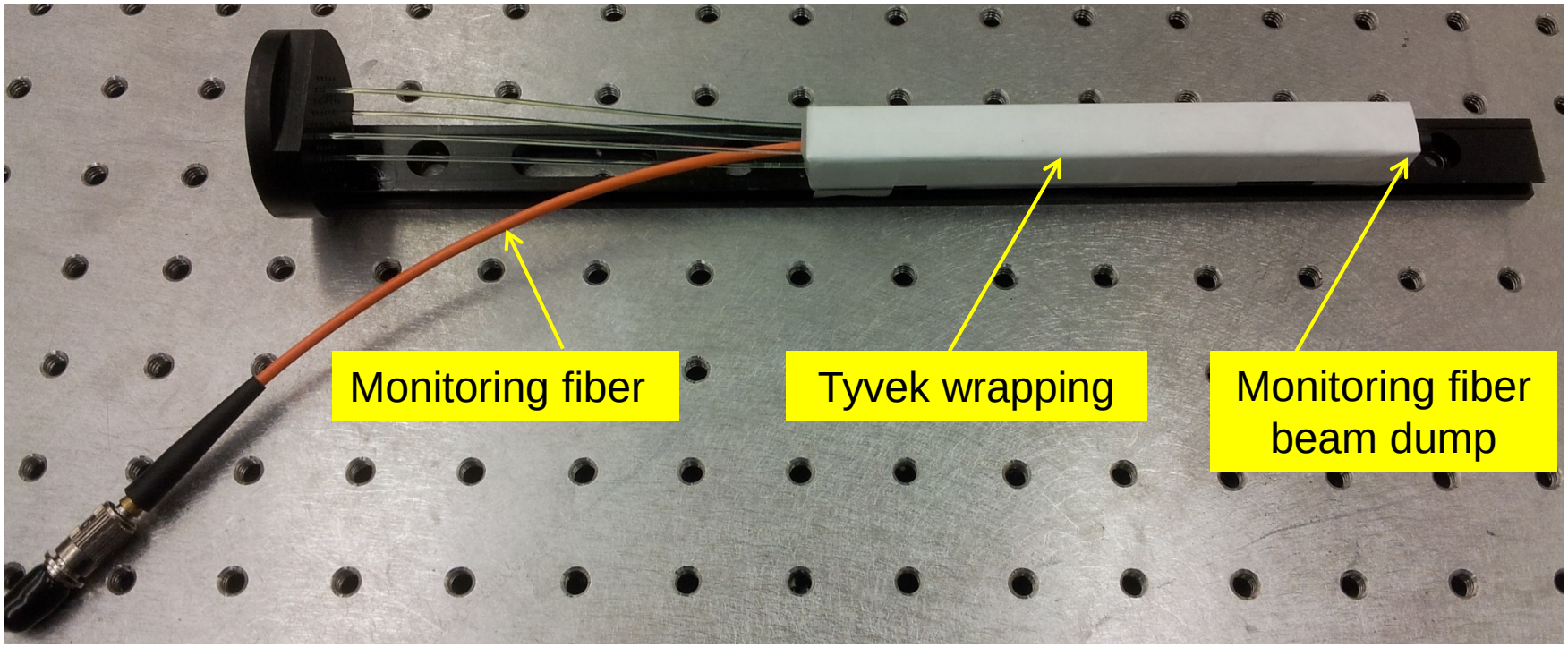
Both 355 nm/425 nm are available up to 3.8 mJ/2.7 mJ
Nominal settings for 355 nm/425 nm are 50%/70%



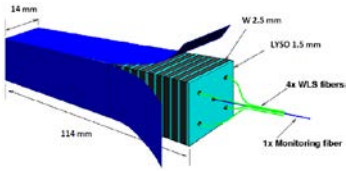
A Prototype Shashlik Cell



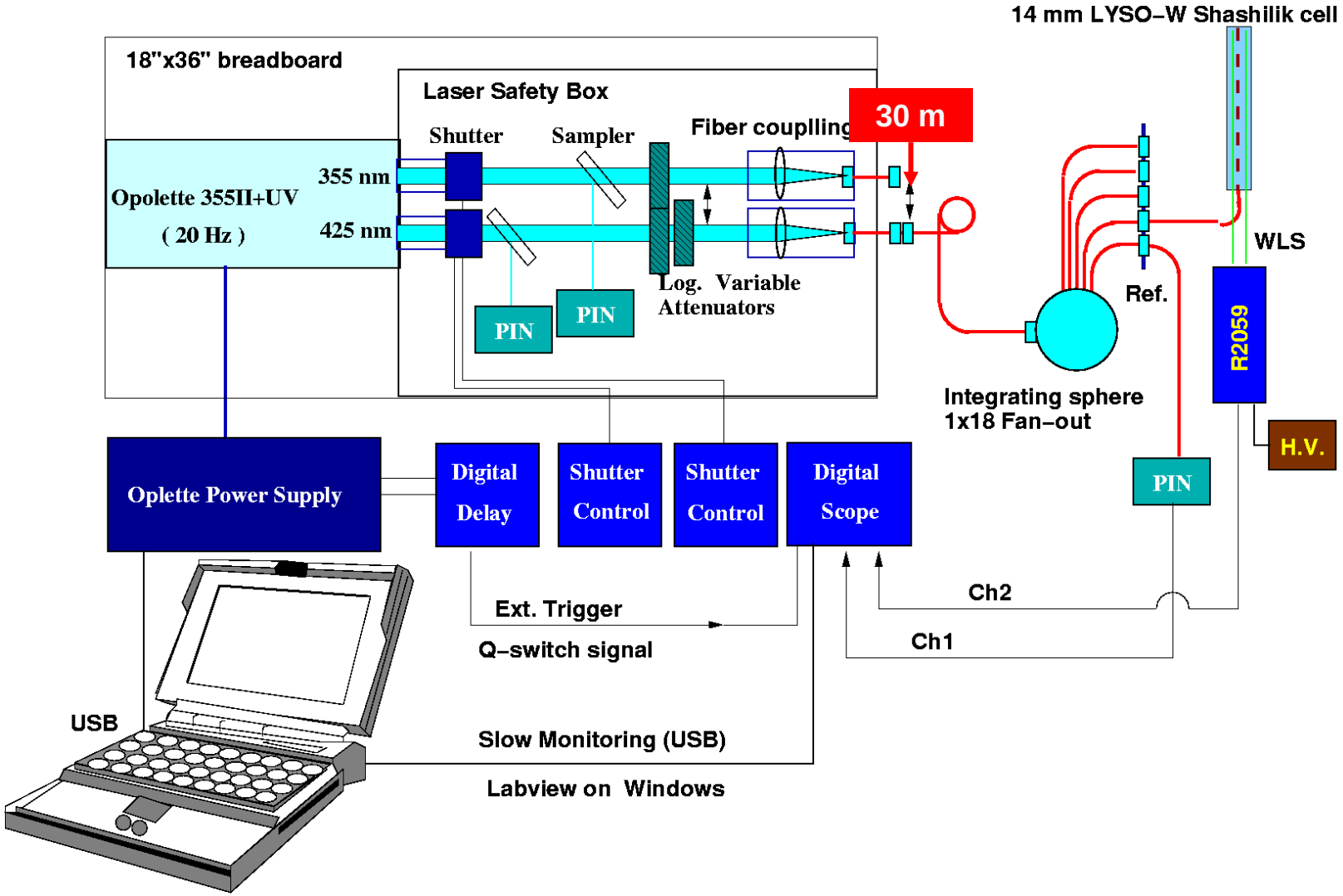




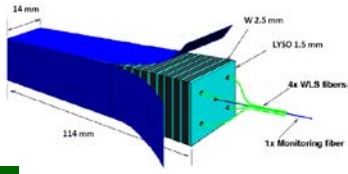
A Monitoring Test Setup



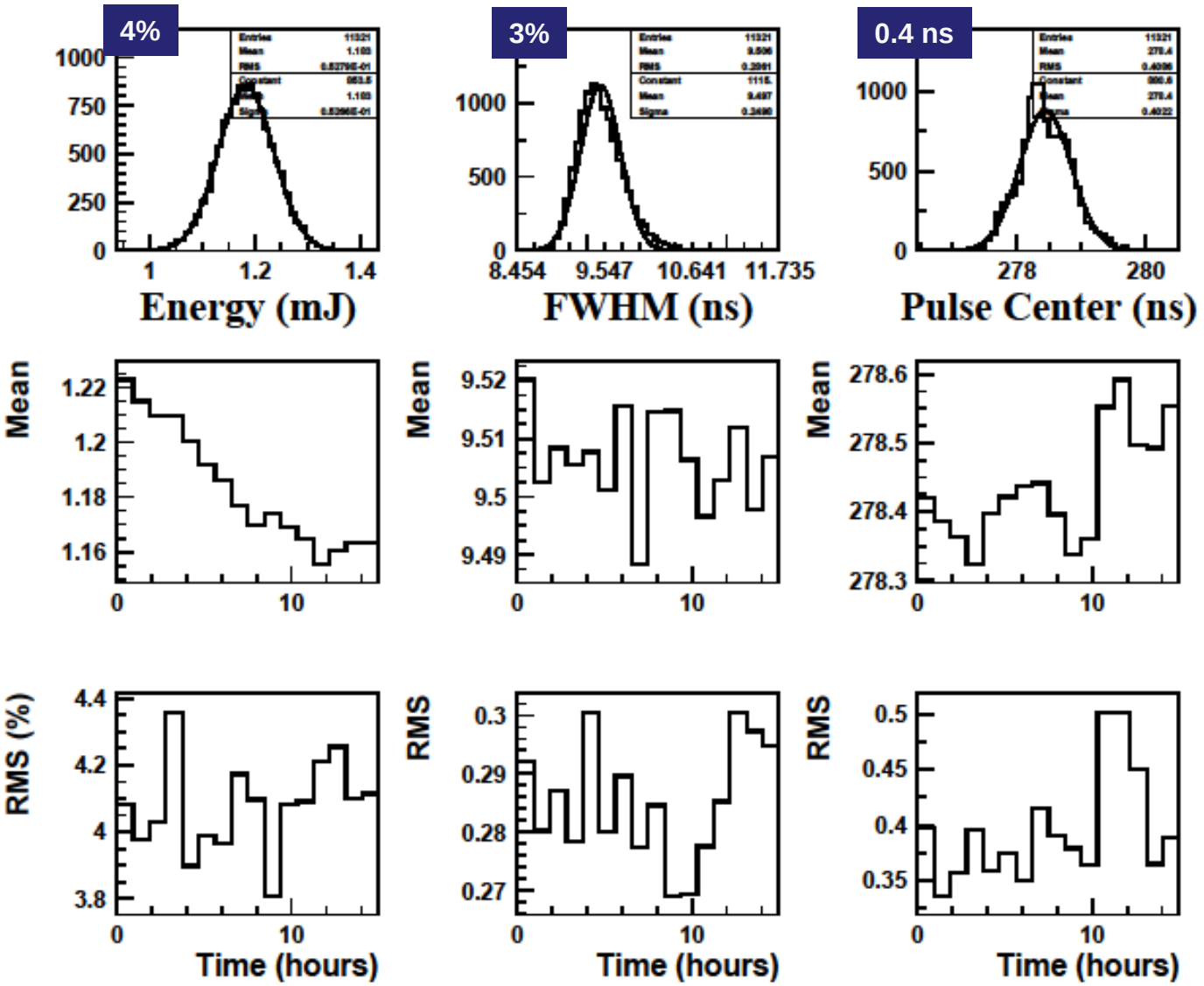
Two channels from the ½ inch integrating sphere were read out by a R2059 PMT through Shashlik and a PIN diode (Thorlabs DET10A) as a reference



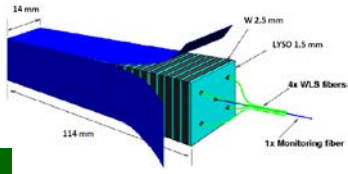
Response of 355 nm Reference in 15 h



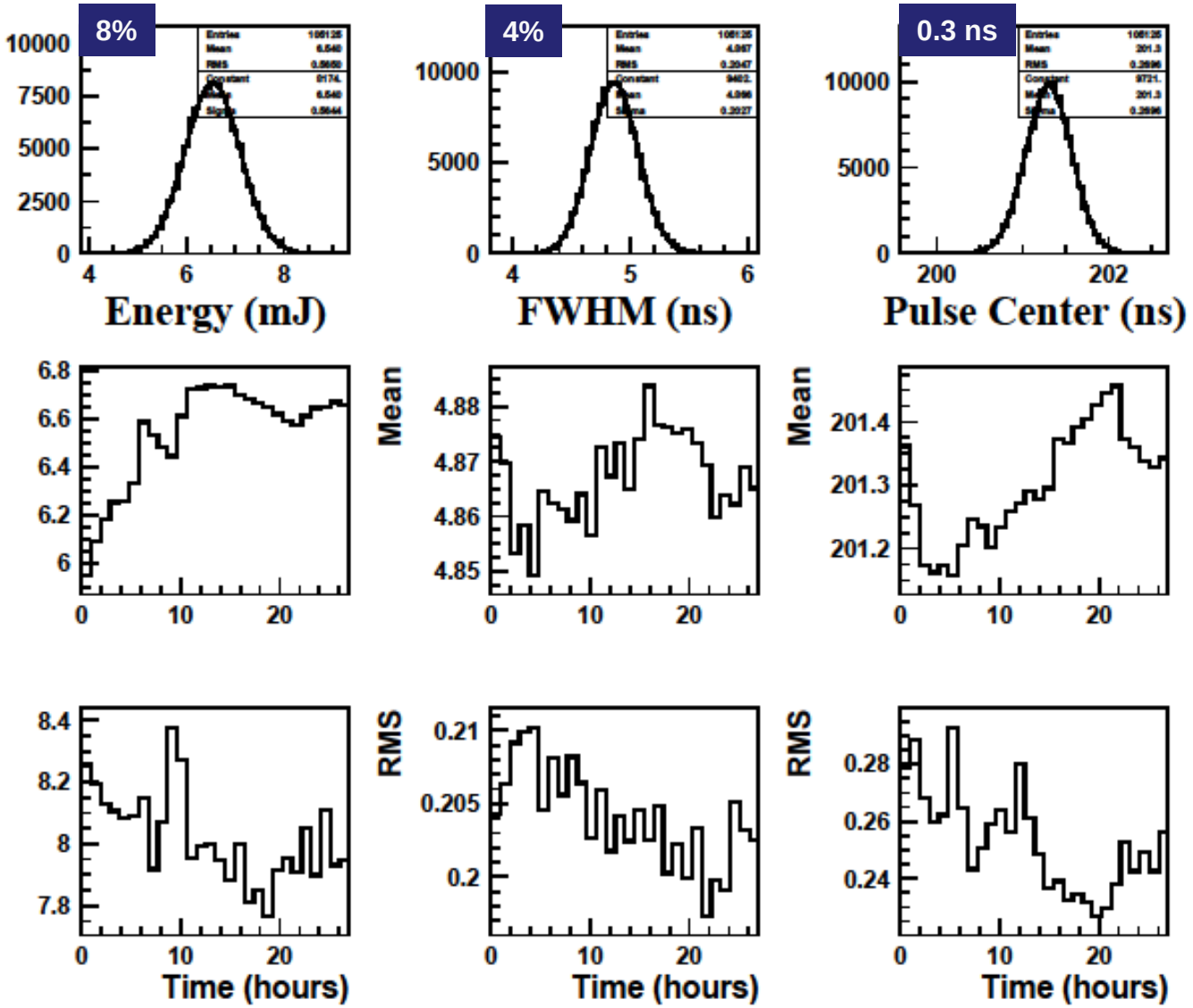
4%, 3% & 0.4 ns for pulse energy, FWHM width & jitter



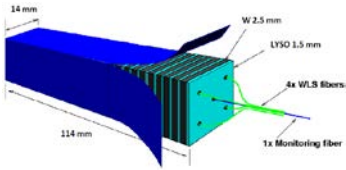
Response of 425 nm Reference in 27 h



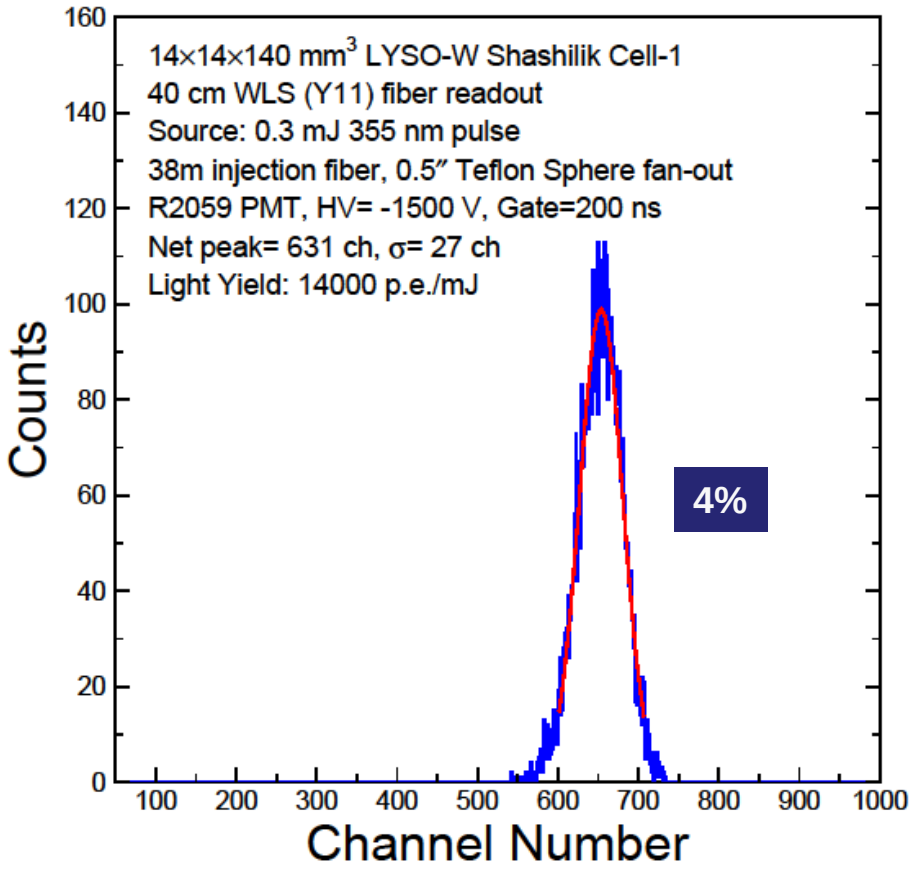
8%, 4% & 0.3 ns for pulse energy, FWHM width & jitter

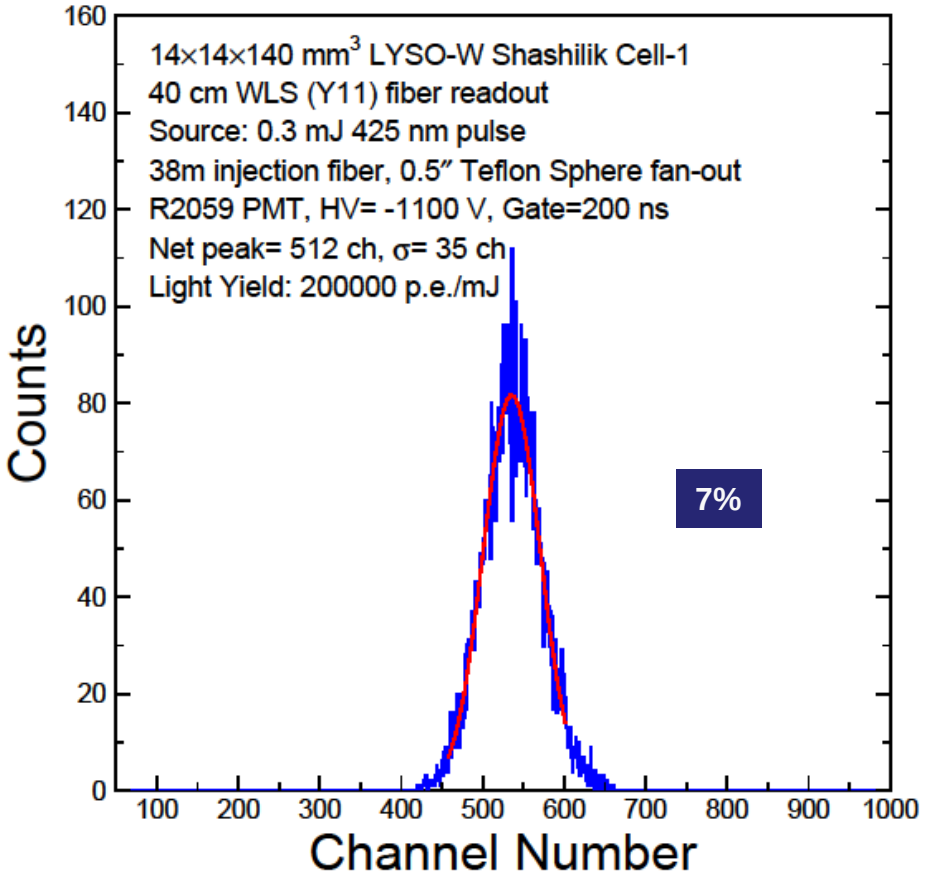


Dynamic Range



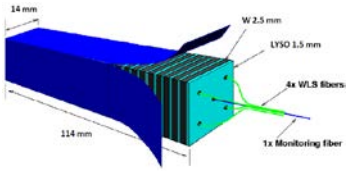
355 nm: 14,000 p.e./mJ, corresponding to 2.5 GeV/mJ
425 nm: 200,000 p.e./mJ, corresponding to 36.5 GeV/mJ





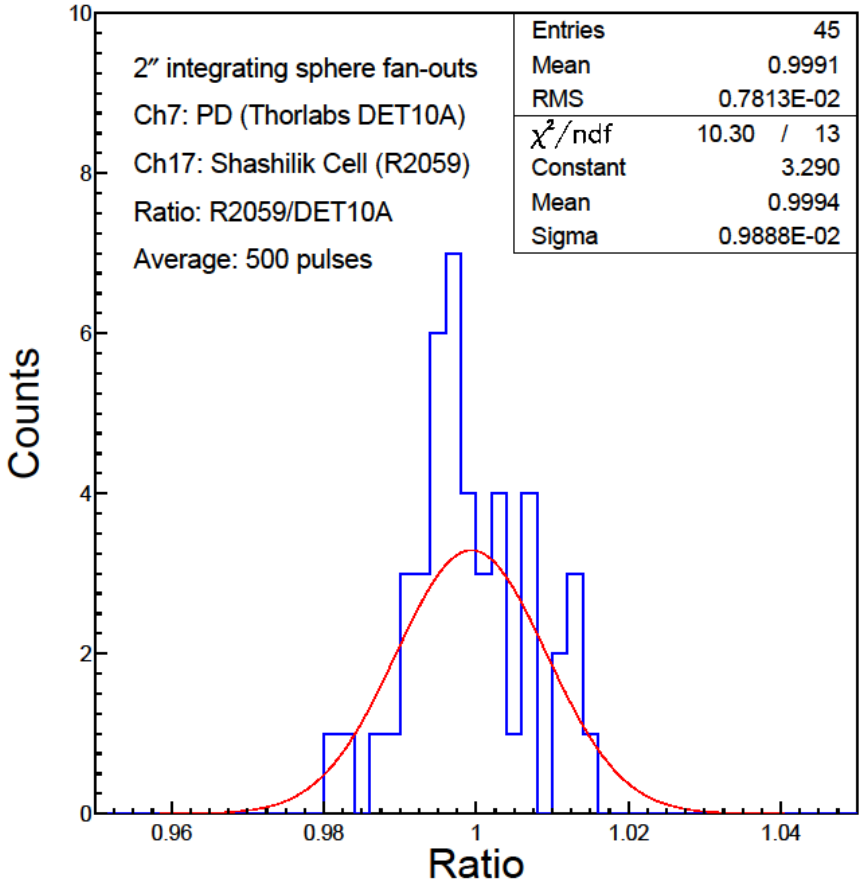
A factor of 15 lower dynamic range for 355 nm caused by excitation and attenuation

Preliminary Monitoring Result

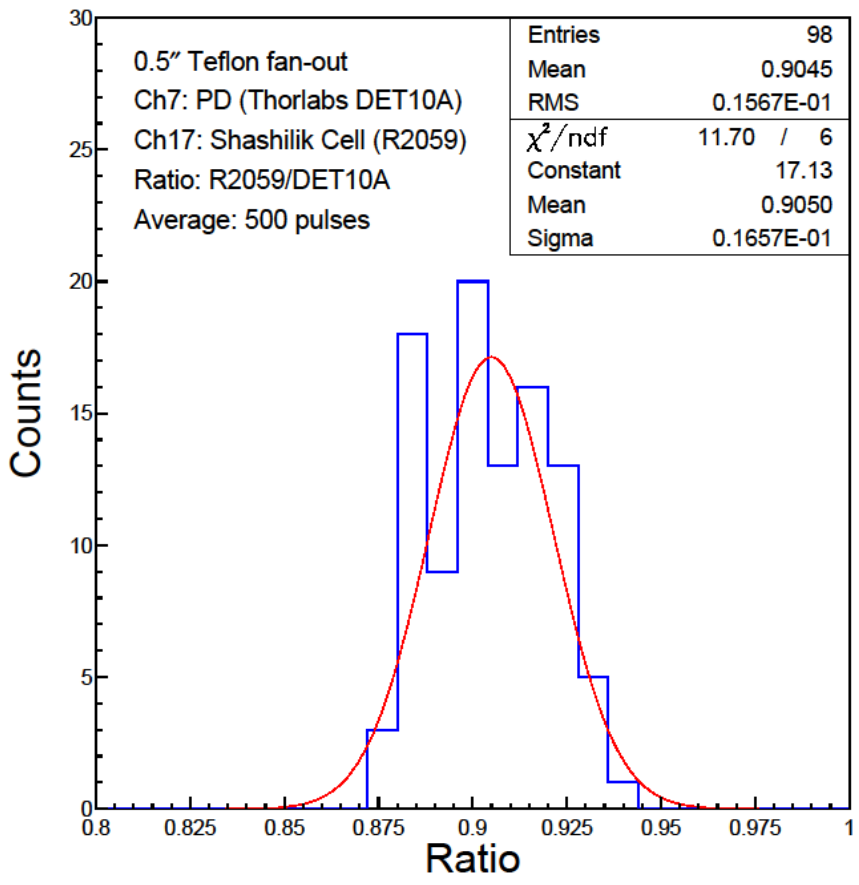


10% decrease observed in 425 nm monitoring response from the Shashlik cell after 100 Mrad ɣ-ray irradiation

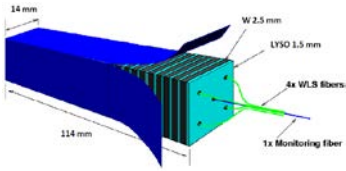
Before irradiation



After 100 Mrad



Summary



After the Shashlik test beam in Spring three modifications were made to the Opolette tunable laser based monitoring system. (1) Residual 355 nm was extracted. (2) The commercial 2" integrating sphere was replaced by a home-made 0.5" one. (3) The fiber coupler to the laser beam was replaced by a new one with air gap between fiber and connector to avoid laser power degradation caused by burning epoxy filling.

Initial tests at 355 nm and 425 nm for 15 and 27 h show laser pulse stability of 4%/3%/0.4 ns and 8%/4%/0.3 ns respectively for laser pulse energy/width/timing.

The laser system may provide up to 3.8 mJ/2.7 mJ @ 355 nm/425 nm with corresponding dynamic range of 9.5 GeV/99 GeV in Shashlik cell. The low dynamic range of 355 nm is caused by additional Ex-Em conversion in LYSO and attenuation in fiber transport.

A preliminary test shows about 10% degradation in monitoring response with 425 nm light for a Shashlik cell after 100 Mrad irradiation with Co-60 ɣ-rays at JPL.

Liyuan and I plan to be at Fermilab to commission the Opolette laser system on July 23 with a safety inspection scheduled in the afternoon. Liyuan will provide operation training for laser users on July 24.