## HI-2020-01, 2x LabSphere Si PDs via Ekspla-cfg10

File: \data\2020\HI-2020-01\doc\HI-2020-01\_2xSiPDs(20200206,MF).pptx 05-Feb-2020; By: MF/MLML; Rev: 06-Feb-2020

The HI-2020-01 experiment began to characterize the BS05-cfg101 and RS05-cfg101 spectrographs prior to and during build-up of a new pair of instruments for NASA's MarONet test deployment(s).

This document focuses on checking 2x LabSphere Si PhotoDiode monitors on the 12 in dia. Spectralon sphere coupled to the Ekspla NT242 tunable laser system. The Ekspla-cfg10 was repaired in Dec-2019 by replacing the 2x pump chambers for the pump laser. The Si PDs output to the pulsed laser input was measured via a Keithley Electrometer in charge integration mode.

#### Measurement time-line:

- 1.) Fri 17-Jan-2020 HST: 2x Si PD check #1: file = 20200117-01\_2pdCheck.txt
- 2.) Tue 28-Jan-2020 HST: setup BS05c101 & RS05c101 in cal van for new inst. build
- 3.) Wed 29-Jan-2020 HST: 2x Si PD chk#2 w/ BS05c101 & RS05c101 = Day01
- 4.) Thu 30-Jan-2020 HST: 2x Si PD chk#3 w/ Gentec Maestro power metre + UP19K detector
- 5.) Tue 04-Feb-2020 HST: 2x Si PD chk#4 w/ BS05c101 & RS05c101 = Day02

## Equipment List:

Ekspla-cfg10 NT242 tunable laser + 12 in dia. Spectralon integrating sphere MOBY 1mm single-mode FO# 2103 between Ekspla & Spectralon sphere (M246 EdMid, ~8m length) 2x Labsphere Si PhotoDiode monitors @ 2x sphere mon ports:

port #A = old Aug-2014 Si PD

... Electro-Optical Systems Inc. PD part# UVS-100-TE2, active area 10 x 10 mm

- ... was @ NIST SIRCUS & VisSCF in 2018, had no near-UV response!
- ... ( see: \NOAA\detectors\SphereOptics\_TO-8\_#1\2018\_NIST-cal\ )

port #B = new Sep-2019 PD = SN# 0918191365

... Electro-Optical Systems Inc. Si PD part# UVS-050-TE2, active area 5 mm dia.

Keithley 6517B Electrometer, SN# 4046127

Coulomb charge integrating mode

"The Model 6517B is equipped with four coulombs ranges to resolve charges

as low as 10fC (10^-14C) and measure as high as 2.1uC"

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new LabView crtl/acq = \NOAA\src\Keithley_6517B\
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MF\_6517A\_Many\_ReadWrite\_Coloumb\_1.vi (rev: 17Jan2020)

charge integration over 1 PLC (power line cycle)

Gentec laser power metre, Model = Maestro, SN# 234357, cal date 11-May-2016

detector = UP19K-15S-W5-DO, SN# 233370, cal date 07-Apr-2016

... 1mW Noise Level, 1.4sec rise time,

... Pmax=15W, Pmax(1min)=30W, Emax=200J, 190nm:10um, 17mm aperture,

... cal unc +/-2.5%, repeatability =/-0.5%,

Figure 1 shows the BS05 & RS05 setup at the 12 in dia. Spectralon integrating sphere







Figure 1, HI-2020-01 experimental setup photos

Figure 2 shows the setup of 2x monitor PhotoDiodes at the 12 in dia. Spectralon sphere



Figure 2, HI-2020-01 experimental setup photos

Figure 3 shows the setup of Gentec laser power metre at the fiber optic from the Ekspla laser



Figure 3, HI-2020-01 experimental setup photos

Figure 4 shows typical output energies expected from the Ekspla NT242 tunable laser. Note: the MLML Ekspla does not presently include the SH option.

Hand-notes at top-of-figure show the spectral-placement of the Short-Pass and Long-Pass filters, which were added to our SCU = spectral cleaning unit. The SP & LP filter-holder positioning was corrected during the Dec-2019 repairs.



Figure 4, Typical output energy from the Ekspla NT242 laser

Figure 5 plots approximate power from of the Ekspla-cfg10 output fibre optic, after Dec-2019 repairs. I hand-"digitized" the Red lines from page 2 plots in the Altos Service Report, which were measured at Port 1 (includes SCU) via the Altos engineer's Coherent FieldMax + PM10 power meter. Then a correction was applied from page 1 table for "Fiber Coupling", to convert Port 1 output power to fiber output power. The average ratio over N=3 wavelengths, Port1+SCU mW versus fibre couple mW was  $2.376 \pm 0.14$ .





Figure 5, Approximate fiber output power from Ekspla-cfg10

Figure 6 plots the 17-Jan check #1 of charge integration from the 2x Si PDs – blue = old PD#A w/ 10 mm^2 active area, green = new PD #B w/ 5 mm dia area.

<u>Note:</u> the near-UV signal was low, but above the "dark" charge level at -3e-12 to -9e-12 Coul. Measured charge at 1250 & 1300 nm was equal to dark level. The horizontal red line is maximum charge integration level via the Electrometer, at 2.1e-6 Coul.

The overall spectral shape of charge integration mostly follows that of Ekspla power in Fig. 5.



Figure 6, Charge integration check #1

#### Fig. 6 Notes:

The BNC output from the photodiodes was directly connected to the Keithley Electrometer.

This was a first-pass at Keithley Electrometer control via LabView VI: \NOAA\src\Keithley\_6517B\MF\_6517A\_Many\_ReadWrite\_Coloumb\_1.vi (rev:16Jan2020)

Where, coulomb charge was integrated over 1x power line cycles, PLC, zero ON between readings.

10x loops of 10x samples were measured and saved to ASCII file, in the string format read from the Keithley, ex.

-0000.005E-09COUL,05:08:41.00,18-Jan-2020,+38702RDNG# -0000.005E-09COUL,05:08:42.00,18-Jan-2020,+38703RDNG# -0000.006E-09COUL,05:08:43.00,18-Jan-2020,+38705RDNG# -0000.006E-09COUL,05:08:43.00,18-Jan-2020,+38706RDNG# -0000.006E-09COUL,05:08:45.00,18-Jan-2020,+38707RDNG# -0000.006E-09COUL,05:08:45.00,18-Jan-2020,+38708RDNG# -0000.006E-09COUL,05:08:45.00,18-Jan-2020,+38708RDNG# -0000.006E-09COUL,05:08:46.00,18-Jan-2020,+38709RDNG# -0000.006E-09COUL,05:08:47.00,18-Jan-2020,+38710RDNG# -0000.007E-09COUL,05:08:48.00,18-Jan-2020,+38711RDNG#

My first-pass file ingestion via MATLAB was \wrk\readKeithley\_1.m (rev: 31Jan2020).

Figure 7 plots the 29-Jan check #2 of charge integration from the 2x Si PDs. Here, I wanted to get a high-resolution scan over the near-UV region. Scans were also collected during this run via the BS5 and RS5 spectrographs at 300, 320, 350, 375, 405 nm.



Figure 7, Charge integration check #2

Figure 8 over- plots the first and second checks of charge integration. During both runs the Ekspla was at maximum output power level. Perhaps this shows the variability of power to be expected from the laser...



Figure 8, Charge integration check #1 & #2

Figure 9 plots the 30-Jan check #3 of charge integration from the 2x Si PDs. No BS/RS scans were made, but at each wavelength the output of the fibre from the Ekspla was measured via the Gentec laser power meter (see Fig. 10). <u>Note:</u> attention was paid to measure near the expected MOBY FO absorption lines near 725, 878, and 945 nm, and the deep atmospheric H2O abs near 934 nm. The PD#A charges were saturated at 1 PLC integration near the 500 and 1000 nm laser power peaks.



Figure 9, Charge integration check #3

Figure 10 over-plots the approximate Ekspla fibre power from Fig. 5 (blue green red symbols), with Gentec power measurements from 30-Jan check #3, black stars. These were suprisingly close, with the exception of near the absorption lines at 934 & 945 nm.



Figure 10, Compare approx Ekspla power vs measured Gentec power





Figure 11, Approximate PhotoDiode response "curves"



For reference, Figure 12 is Stephanie's plot of the 2018 NIST calibrated response of the old Labsphere PD.

Figure 12, 2018 NIST calibrated response of the old PD #A

For reference, Figure 13 plots typical responses for Electro-Optical Systems Inc. UVS and S-series PhotoDiodes, typical response at 22 °C. <u>Note:</u> the S-series response peaks near 950 nm, and the UVS-series peak is near 750 nm.



Figure 13, Typical UVS and S-series photodiode responses

# **Confusions:**

I think both of our LabSphere photodiodes are S-series, and not UV-enhanced UVS-series...