



EIC DIRC Photodiode Testing and Readout Investigation

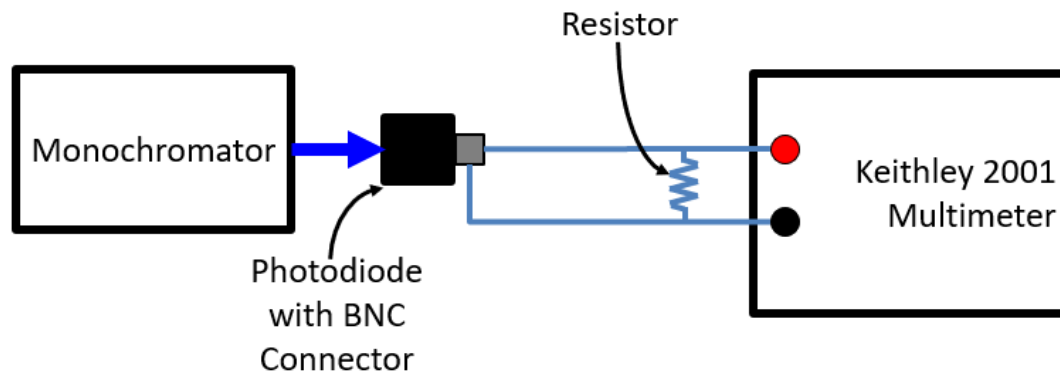
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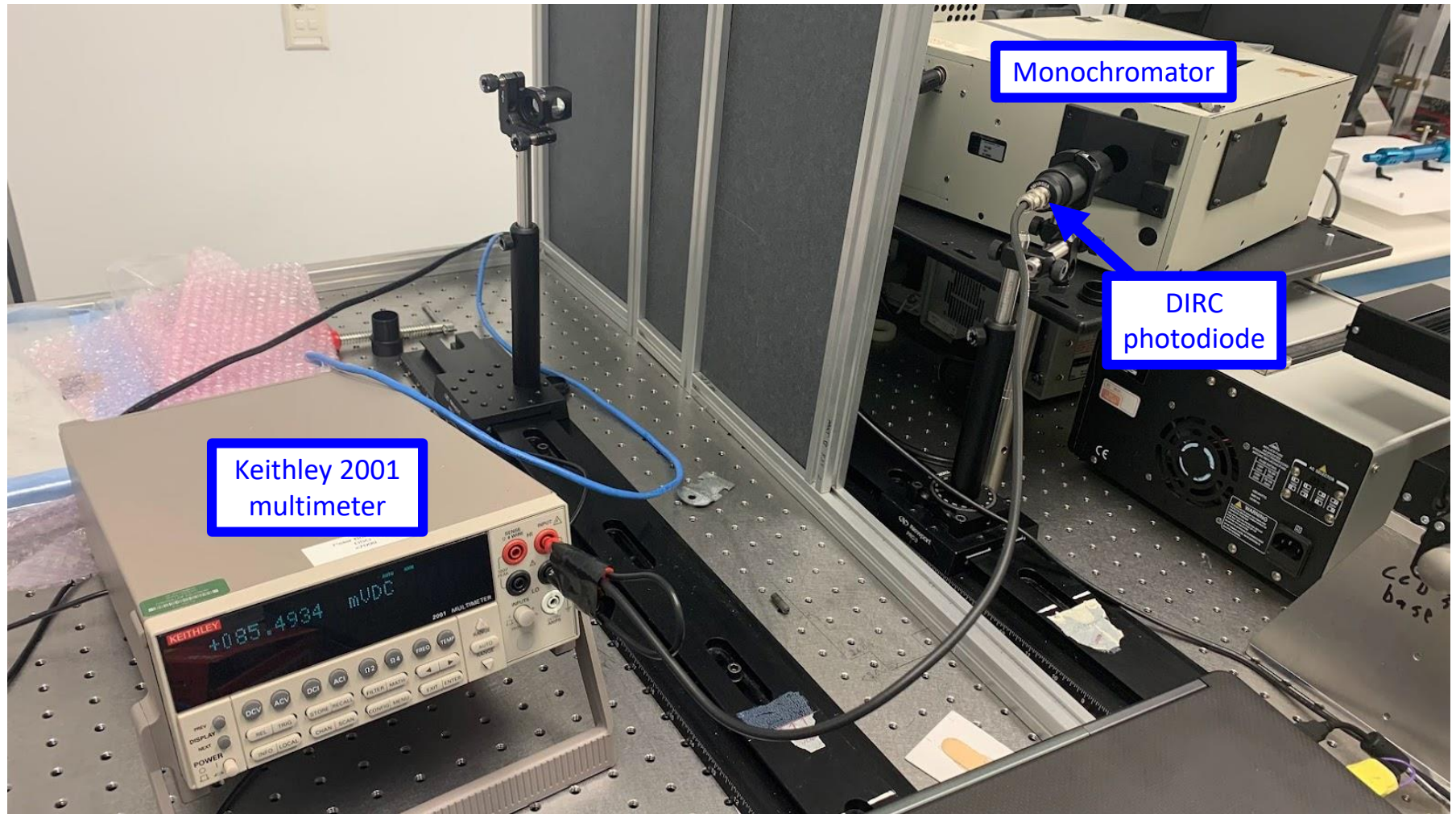
Test Setup

- Goal of test
 - Verify DIRC photodiode responsivity at 442-nm wavelength light
 - Laser for DIRC tests has a ~ 44 -mW, 442-nm wavelength output
 - Determine best way to read signal from DIRC photodiode
- Newport 260 Monochromator provides 442-nm wavelength light
 - Light is $< 100 \mu\text{W}$
 - System's output accuracy is $\pm 0.35 \text{ nm}$
- Used SM1-threaded lens tube to consistently position photodiodes near monochromator output port
- Two calibrated photodiodes with known responsivities used as a reference to determine power of light



System diagram of test setup for voltage measurements. When current was measured, resistor was removed.

Test Setup – Physical Layout

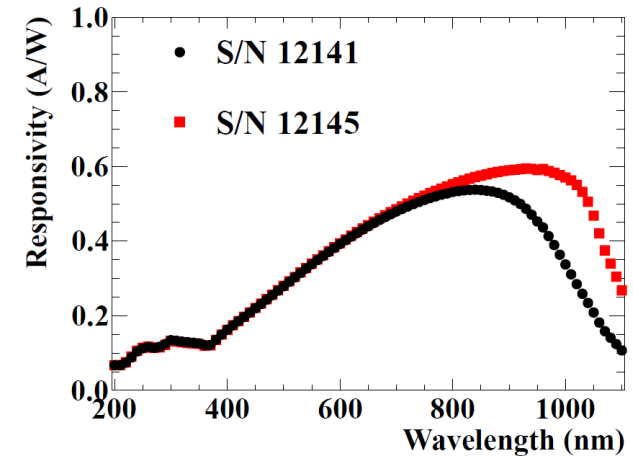


Photodiode Response Measurement

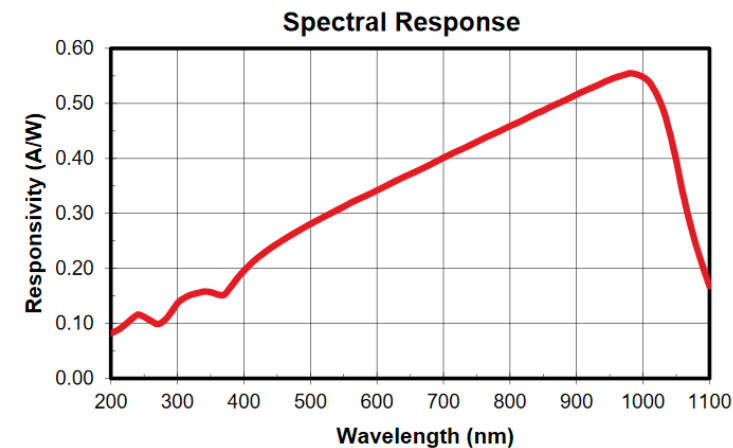
- For each photodiode, three measurements were taken
 - Voltage across 1-k Ω resistor in series
 - Voltage across 10-k Ω resistor in series
 - Direct current measurement
- Voltage, current, and resistor values measured with Keithley 2001 multimeter
 - Meter internally configured to average over 100 samples for each measurement

Photodiode Specifications

- Reference photodiodes
 - Newport 818-UV-L
 - Photodiode A serial number: 12141
 - Photodiode B serial number: 12145
 - Responsivity: 0.209 A/W
 - Responsivity provided by manufacturer as a calibration curve
- DIRC photodiode
 - Thorlabs SM1PD2A
 - In manual, responsivity specified to be ~ 0.241 A/W, but states “responsivity is a function of the wavelength of the incident light, applied reverse bias, and temperature conditions”
- For both photodiode types, responsivity curve exists only as a graph in image format
 - Newport contacted for reference photodiode calibration curve; waiting for reply
- Used online graph extrapolator to determine responsivity at 442 nm



Reference photodiode responsivity calibration curve



DIRC photodiode responsivity calibration curve

Test Results

Voltage Measurement with 1,002.047-Ω Resistor

Photodiode	Responsivity [A/W]	Voltage [mV]	Current [μA]	Power [μW]
Reference A	0.209	11.31	11.29	54.02
Reference B	0.209	10.34	10.31	49.35
Reference Average	0.209	10.83 ± 0.69	10.80 ± 0.69	51.69 ± 3.30
DIRC	?	8.67	8.65	—

Calculated DIRC Photodiode Responsivity [A/W]
0.167 ± 0.011

Voltage Measurement with 10,012.49-Ω Resistor

Photodiode	Responsivity [A/W]	Voltage [mV]	Current [μA]	Power [μW]
Reference A	0.209	112.88	11.27	53.94
Reference B	0.209	112.37	11.22	53.70
Reference Average	0.209	112.62 ± 0.35	11.25 ± 0.04	53.82 ± 0.17
DIRC	?	86.06	8.59	—

Calculated DIRC Photodiode Responsivity [A/W]
0.160 ± 0.001

Current Measurement

Photodiode	Responsivity [A/W]	Current [μA]	Power [μW]
Reference A	0.209	10.49	50.17
Reference B	0.209	10.39	49.72
Reference Average	0.209	10.44 ± 0.07	46.95 ± 0.32
DIRC	?	8.43	—

Calculated DIRC Photodiode Responsivity [A/W]
0.169 ± 0.001

- Comments
 - In each test, quantity that was measured is noted by the grey-shaded cells
 - Calculated DIRC photodiode responsivity used the averaged data from the two reference photodiodes

Conclusions

- Test served as a proof-of-concept that photodiode current response can be converted to a voltage by using a resistor in series with the photodiode
- DIRC photodiode current response was consistent across all three tests
- Calculated DIRC photodiode responsivity was $\sim 30\%$ lower than expected from its specifications
- Before any tests are done with the DIRC bars, all DIRC photodiodes should be characterized with the laser to determine their responsivity during test conditions