



Determining Reflectivity Test Station's Capabilities for UV Wavelengths

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Components – Measurement Device and Light Source

Measurement Device

- Thorlabs compact CCD spectrometer (CCS)
 - Part number CCS200
- Measures power across full spectrum of input light



| Specification | Value |
|---------------------------|---|
| Wavelength Range | 200 - 1000 nm |
| Spectral Accuracy | <2 nm FWHM @ 633 nm |
| Grating | 600 Lines/mm, 800 nm Blaze |
| Detector Range (CCD Chip) | 200 - 1100 nm |
| CCD Pixel Size | 8 μm x 200 μm (8 μm pitch) |
| Resolution | 4 px/nm |
| Integration Time | 10 μs - 60 s |
| S/N Ratio | $\leq 2000 : 1$ |
| Interface | USB 2.0 |
| Dimensions (L x W x H) | 122 mm x 79 mm x 29.5 mm |

Light Source

- Thorlabs stabilized Quartz-Tungsten Halogen (QTH) broadband source
 - Part number SLS201L
- Has built-in output stabilization circuit to keep changes in output power to < 0.05%

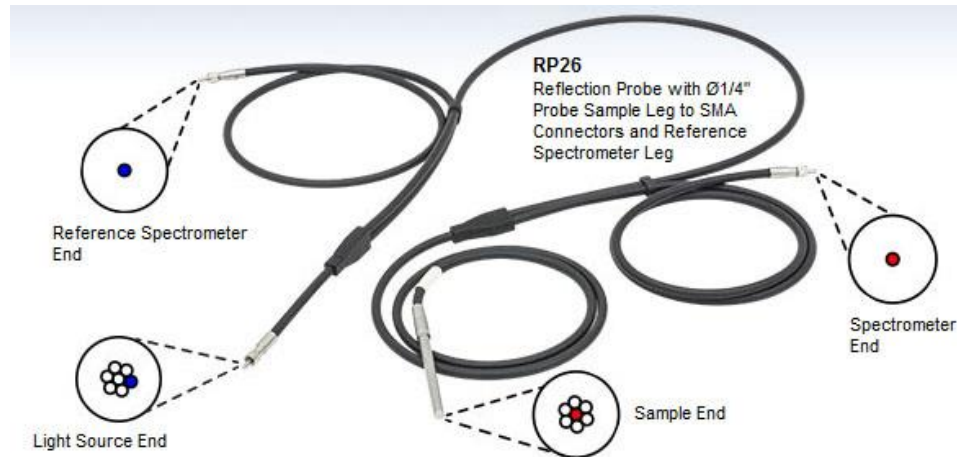


| Specification | Value |
|------------------------|------------------------------------|
| Wavelength Range | 360 - 2600 nm |
| Peak Wavelength | 1000 nm |
| Bulb Electrical Power | 9 W |
| Output Coupling | Fiber Coupled (SMA) and Free Space |
| Output Power Stability | <0.05% |
| Dimensions (L x W x H) | 8.52" x 2.17" x 2.26" |

Components – Fiber Optic Probe

Fiber Optic Probe

- Thorlabs reflection probe with reference leg
 - Part number RP26
- Fiber optic bundle for routing test light to sample and devices



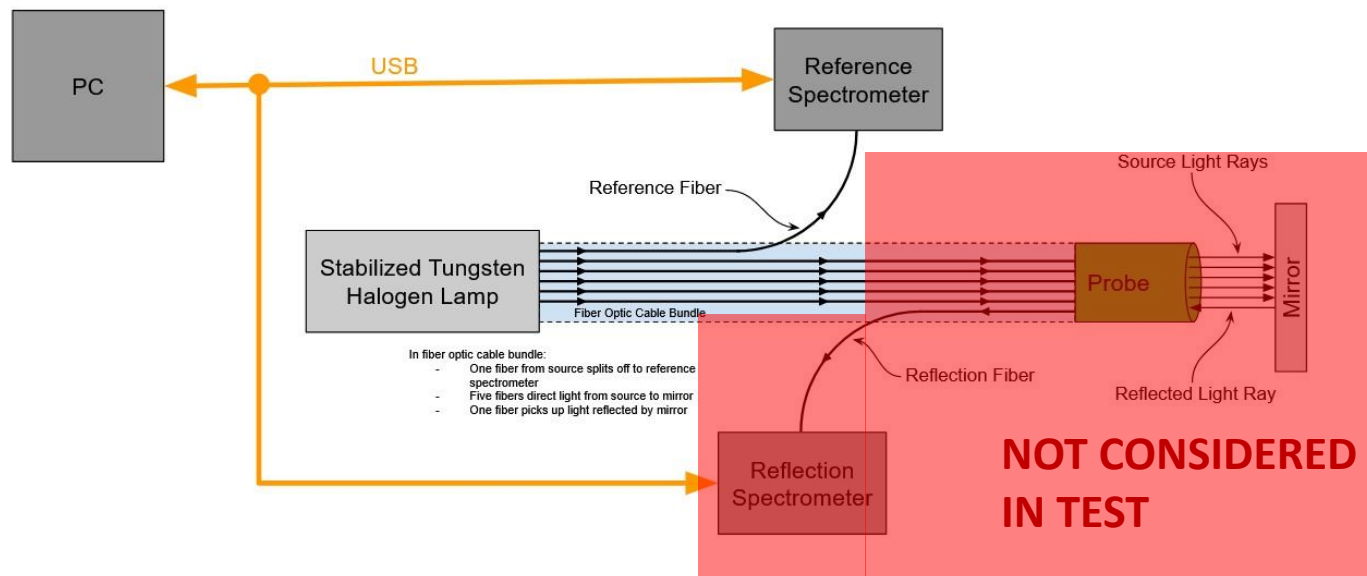
| Specification | Value |
|------------------------|--|
| Wavelength Range | 250 - 1200 nm |
| Overall Length | 2 m |
| Number of Legs | 4 (source, reference, sample, measurement) |
| Sample Leg Termination | 1/4-inch OD probe |

Components – Summary & Comments

- Only CCS is rated for wavelengths down to 200 nm
 - Lower limits:
 - CCS – 200 nm
 - Probe – 250 nm
 - Source – 360 nm
- Probe should not be used for long term measurements less than 250 nm
 - Okay to use briefly for one or two tests
 - Optical fibers in probe's cable may be damaged by UV, or become solarized, making the fibers more optically opaque over time
 - Can get custom probe with solarization-resistant optical fibers
 - Information requested from Thorlabs on lead time and cost of custom probe; waiting for reply

On-Hand Components Test

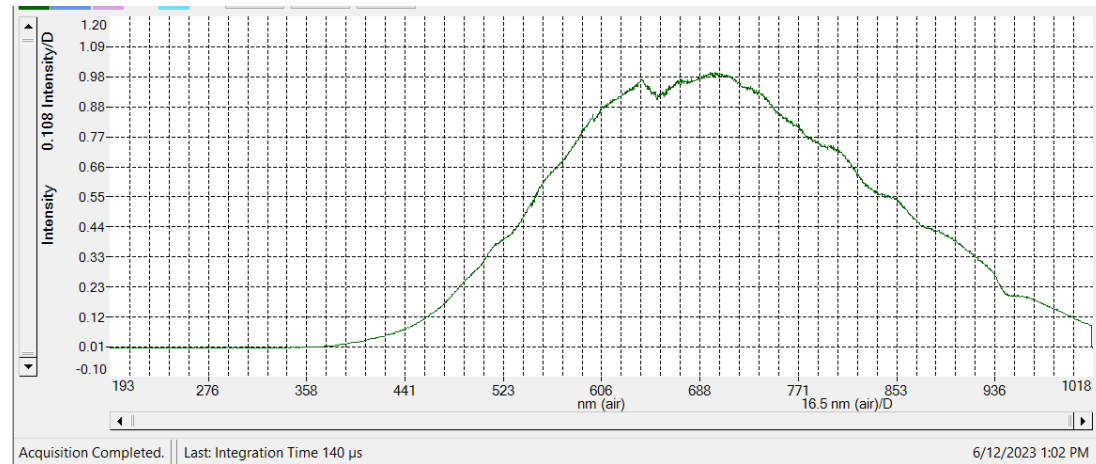
- Reference leg of set up tested to see its response for low-wavelength light



System diagram of test set up.
For test, only the reference leg of the fiber-optic cable and the reference spectrometer (CCS) was used.

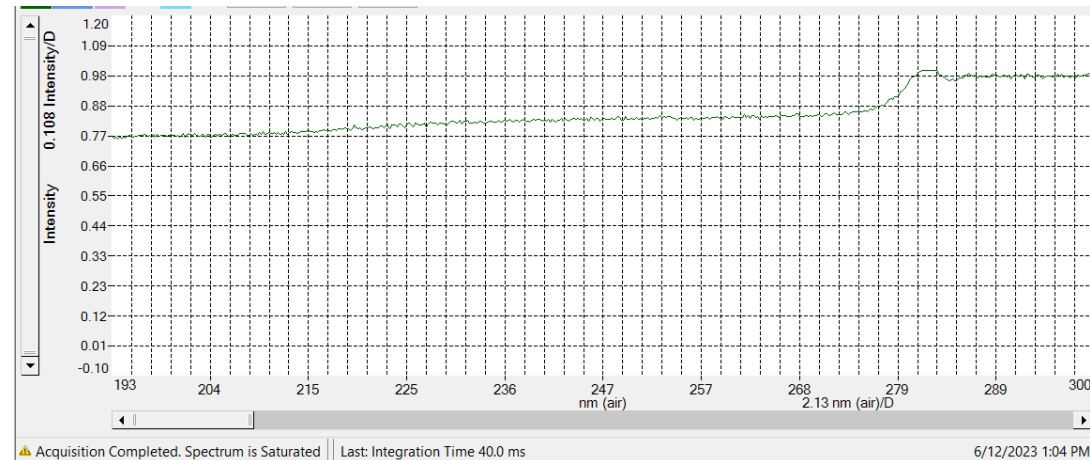
On-Hand Components Test Results

- CCS can read down to ~193 nm
- QTH lamp's output is mainly in visible spectrum
 - Need ~250 times longer CCS integration time to get equivalent measurement results for 200-nm wavelengths
- Do not recommend using QTH lamp for EIC RICH tests



Above: CCS measurement of QTH lamp full spectrum with 0.14-ms integration time.

Below: CCS measurement of QTH lamp, focusing on wavelengths ~190 – 300 nm with 40-ms integration time.

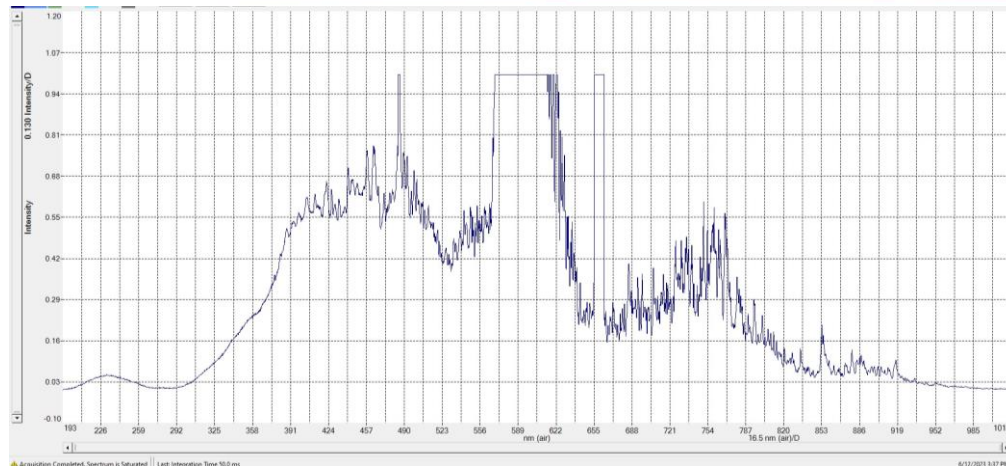


Deuterium Lamp Test

- From CLAS12 HTCC tests, we have a 30-W Deuterium lamp whose output is rated for 200 – 400 nm
- Fiber coupler and output cap used to create adapter for lamp to connect fiber optic cable

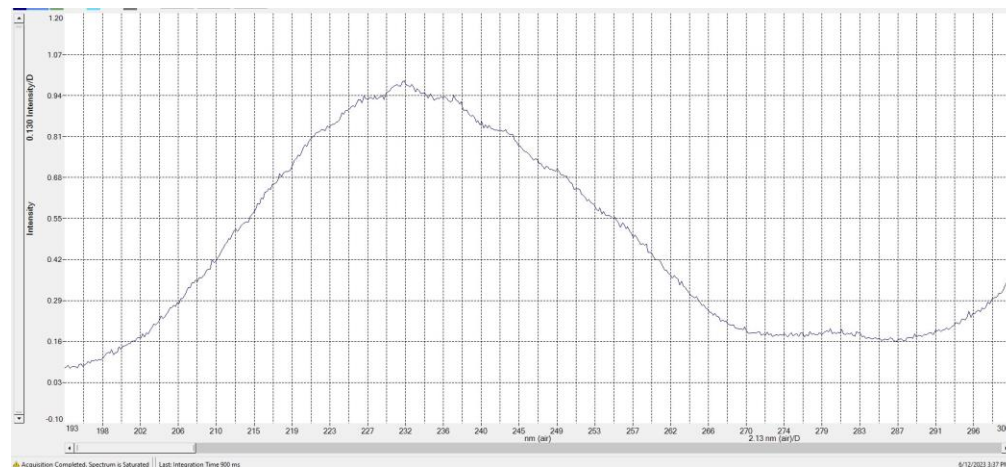
Deuterium Lamp Test Results

- Results show a better defined spectrum for lower wavelengths
- Requires much longer integration times
 - 900 ms for Deuterium lamp vs 40 ms for QTH lamp
- Results are better for ~190 nm – 300 nm wavelengths
 - Spectral curve present as opposed to a flatter curve



Above: CCS measurement of Deuterium lamp full spectrum with 50-ms integration time.

Below: CCS measurement of Deuterium lamp, focusing on wavelengths ~190 – 300 nm with 900-ms integration time.



Recommendations

- If CCS measurement spectrum with the Deuterium lamp is okay:
 - Recommend procurement of a custom fiber bundle that is solarization-resistant
- If CCS measurement spectrum with Deuterium lamp is not okay:
 - Recommend investigating a monochromator-photodiode set up
 - Monochromator lets a specific output wavelength to be set
 - Light induces a current response in the photodiode that proportional to the light's power
 - Photodiode current read by an ADC (multimeter, benchtop meter, peripheral device, etc.)
- Recommendations, regardless of set up:
 - New, more stable, UV light source
 - Power of on-hand UV source is known to vary over time and alignment can be tricky
 - Investigate optical fiber switcher so reference and measurement beams can be read by same CCS
 - Helps remove effects from any CCS calibration differences
 - Develop a full automation of alignment and DAQ

Conclusion

- ~200-nm is the lowest rated wavelength for measurement equipment we have on hand
 - CCSs do not provide data for wavelengths under ~193 nm
- CCSs could be used with a UV source, but the lower wavelengths introduce risk of solarizing fiber optic bundle
 - Risk could be mitigated with custom, solarization-resistant fiber bundle
- If better responsivity is needed with wavelengths around 200 nm, recommend using a monochromator-photodiode set up

Thank You

Backup – Monochromator-Photodiode Set Up

- Newport CS260 monochromator
 - DSG has one on hand
 - Newport has focusing optics to allow output of monochromator to be directed through an optical fiber
 - Could output the lower ~ 200 nm wavelengths, but a better source lamp is recommended
- Photodiodes
 - DSG has two Newport 818-UV-L photodiodes on hand
 - Each has calibration data down to 200-nm
 - Would need a photodiode readout device or circuit
 - Expect photodiode responsivity at 200-nm to be ~ 60 mA/W

