

Upgrading the Spectral Irradiance Scale at NRC

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CORM 2015 Annual Technical Conference

Photometry, Radiometry and Thermometry
Measurement Science and Standards

National Research Council, Ottawa, Ontario, Canada

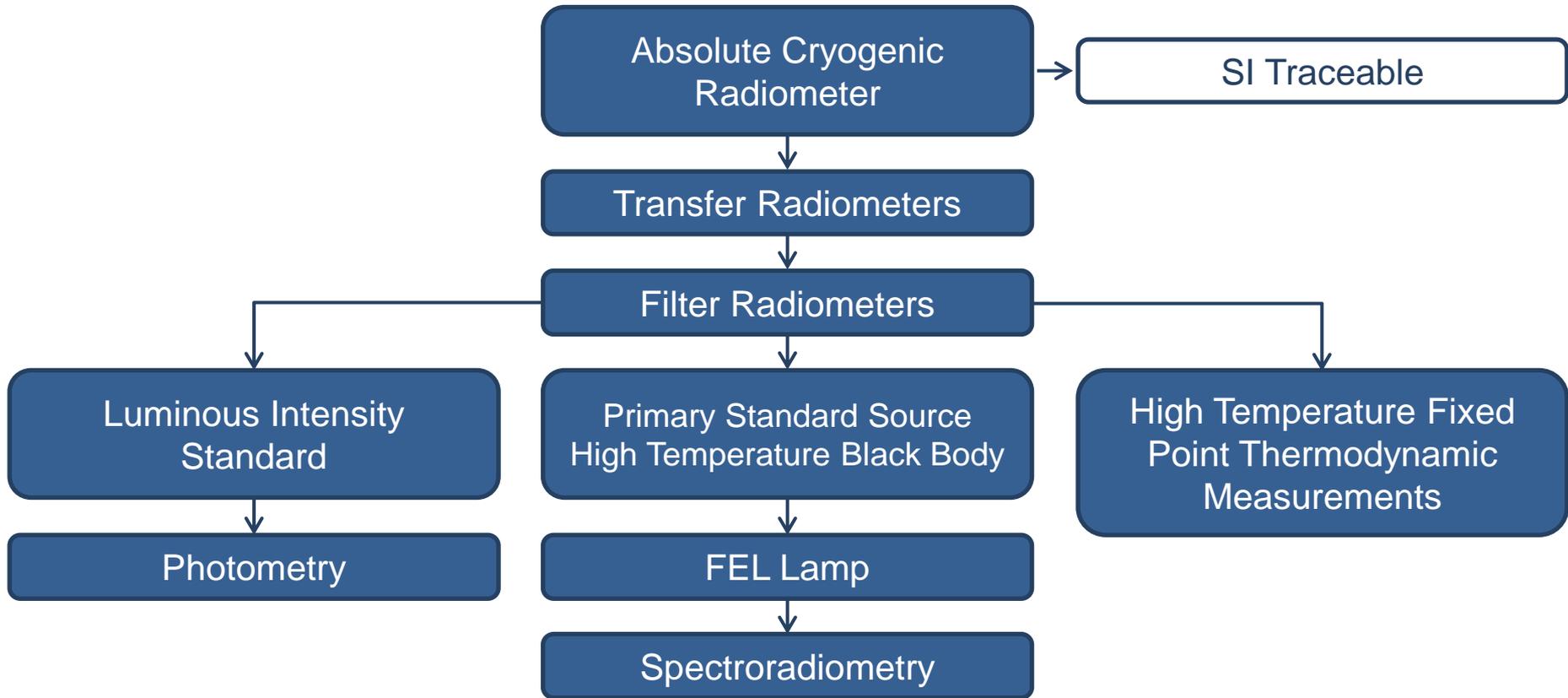


Outline

- Optical radiation calibration chain
- Spectroradiometric calibration chain
- Spectral irradiance facility

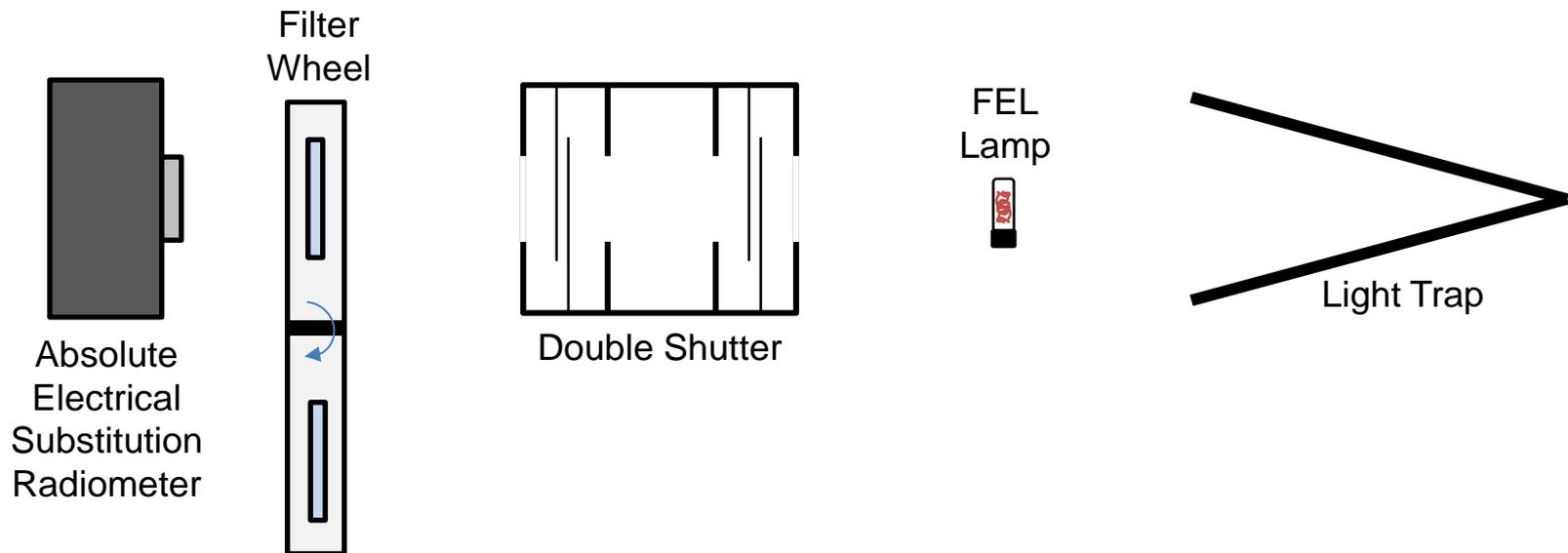
- NRC Solid State Lighting Lab
- OLED measurements

Optical Radiation Calibration Chain



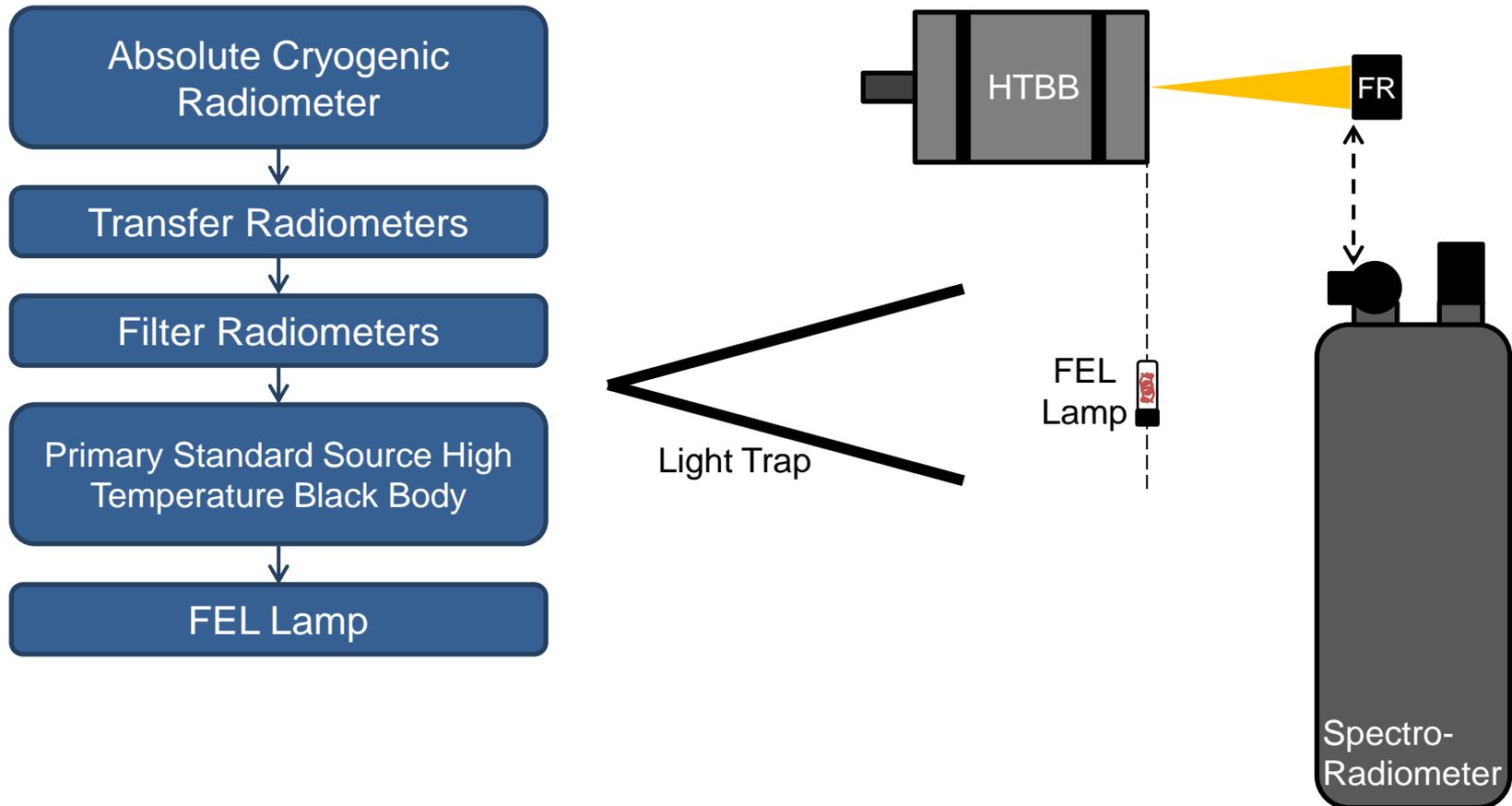
Spectroradiometric Calibration Chain

Detector Based Scale



Spectroradiometric Calibration Chain

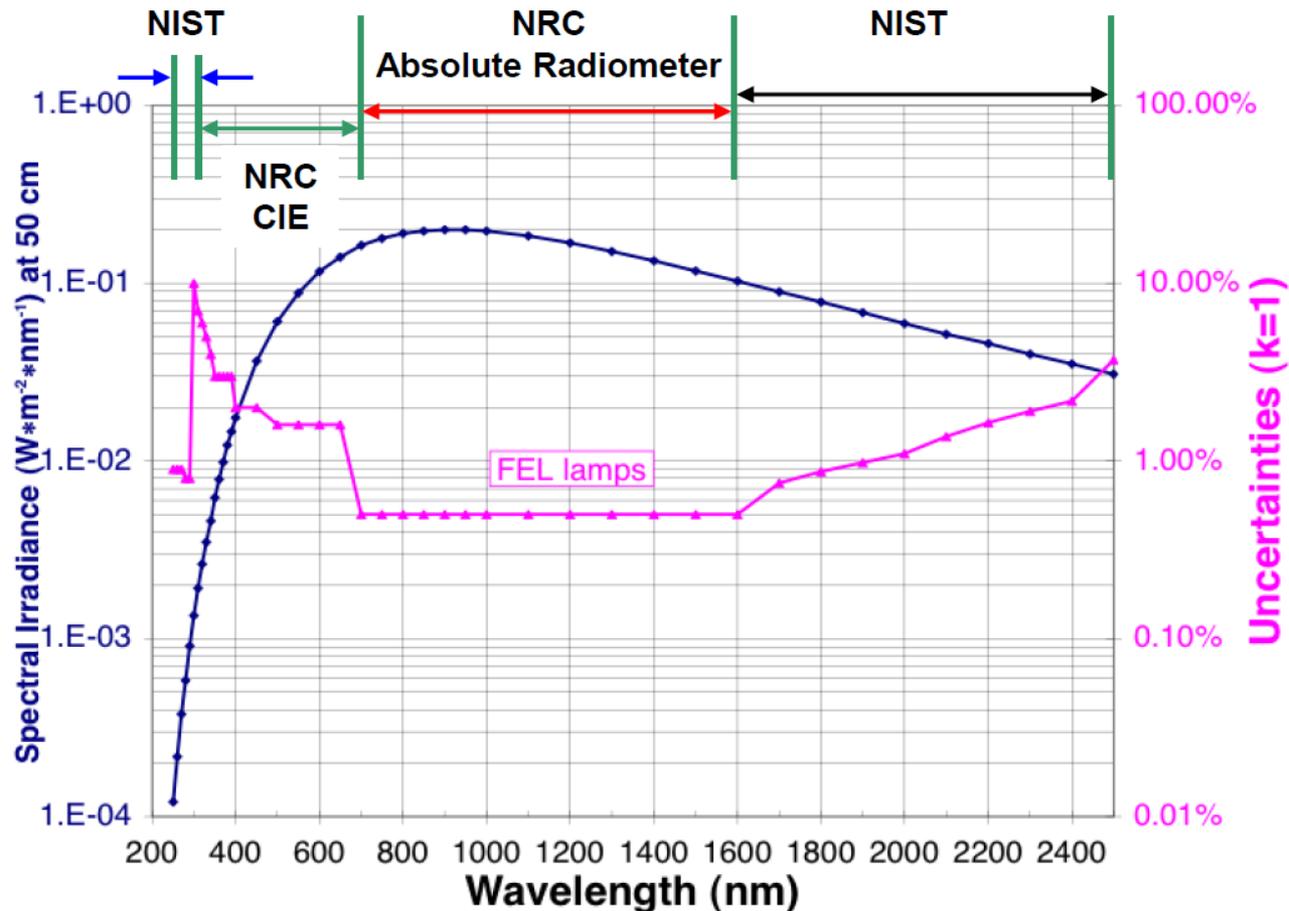
Source and Detector Based Scale



Spectroradiometry – Spectral Irradiance

Present NRC Spectral Irradiance Scale

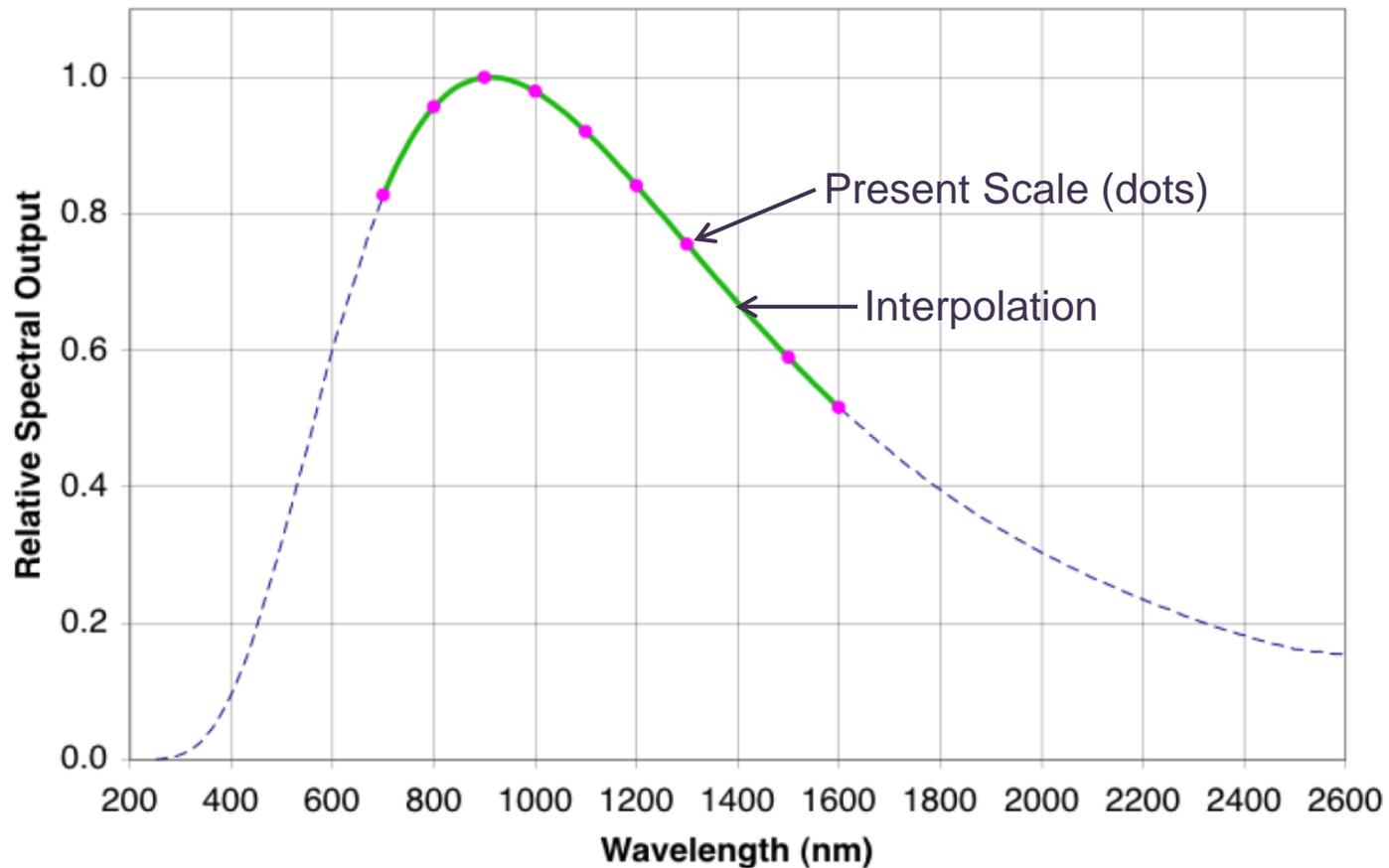
- Detector based → 700 – 1600 nm



Spectroradiometry – Spectral Irradiance

Upgrade to the NRC Spectral Irradiance Scale

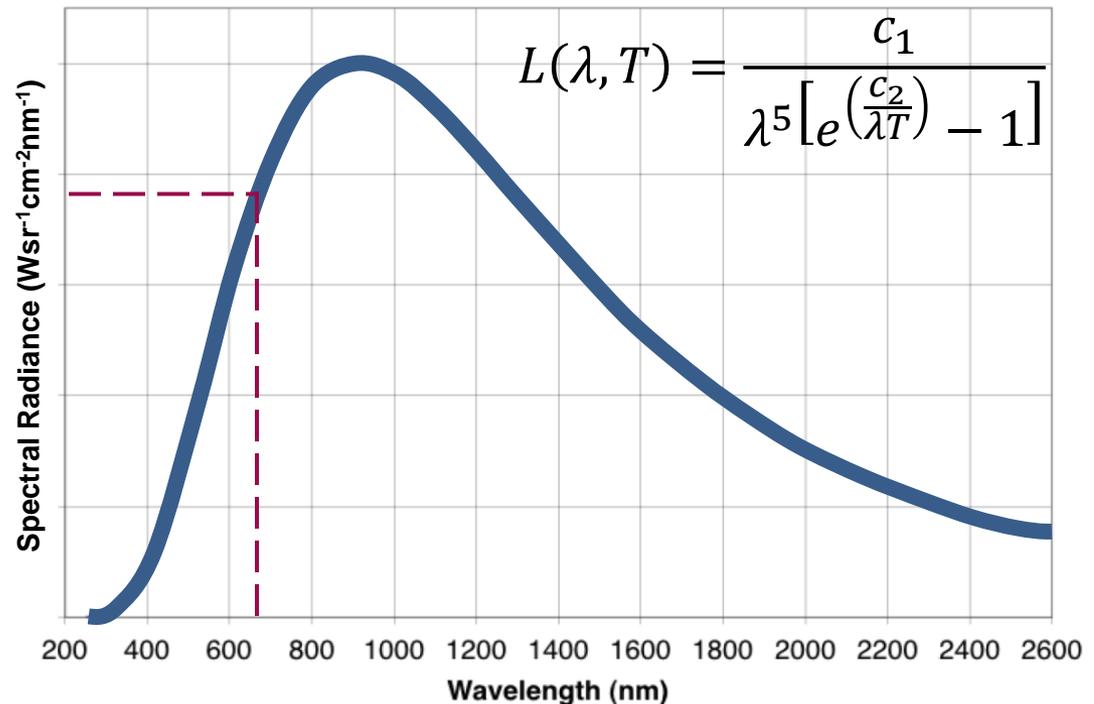
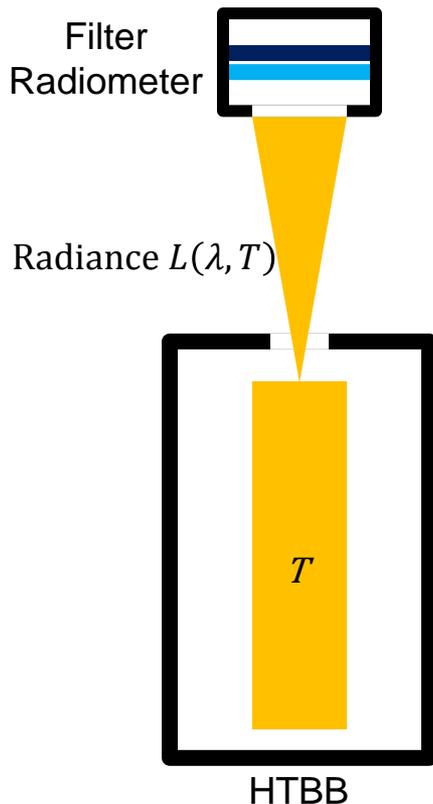
- Detector and source based → 200 – 2500 nm



Spectroradiometry – Spectral Irradiance

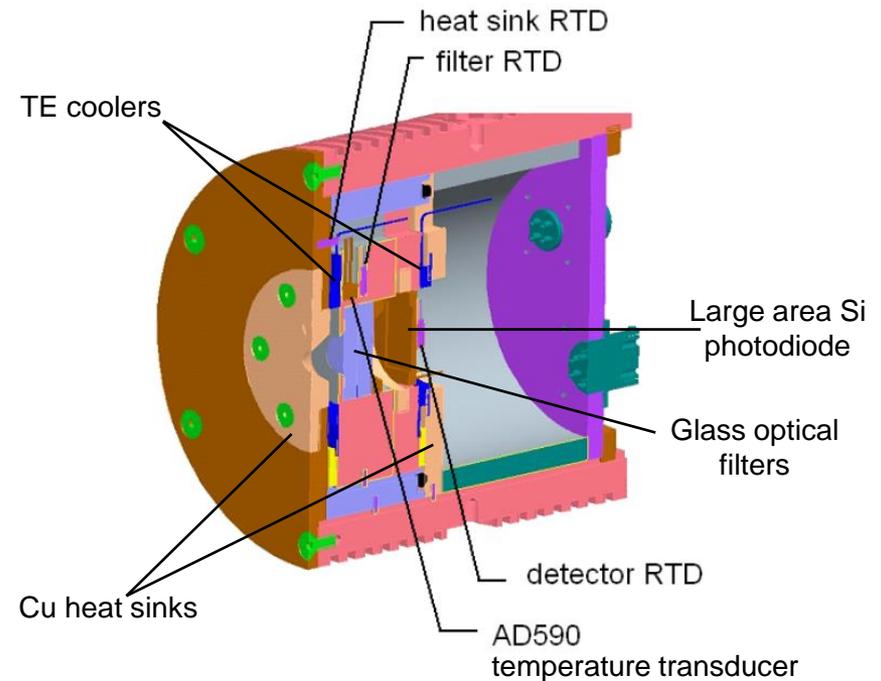
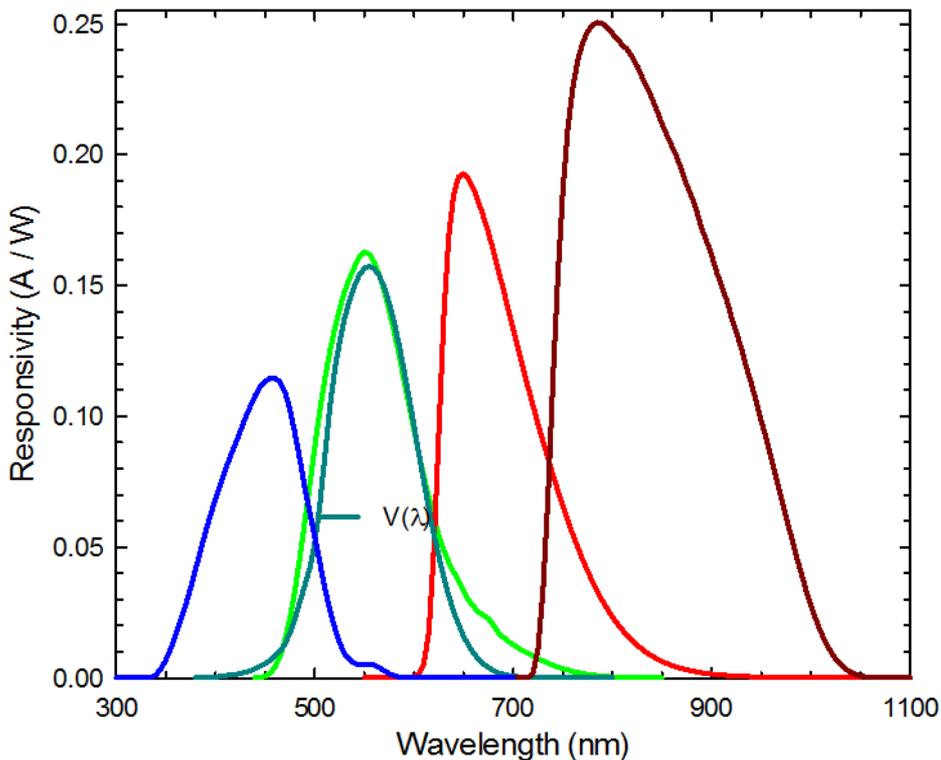
Filter Radiometers for Spectroradiometry

- To determine thermodynamic temperature of HTBB source
- Measure HTBB radiance at one wavelength



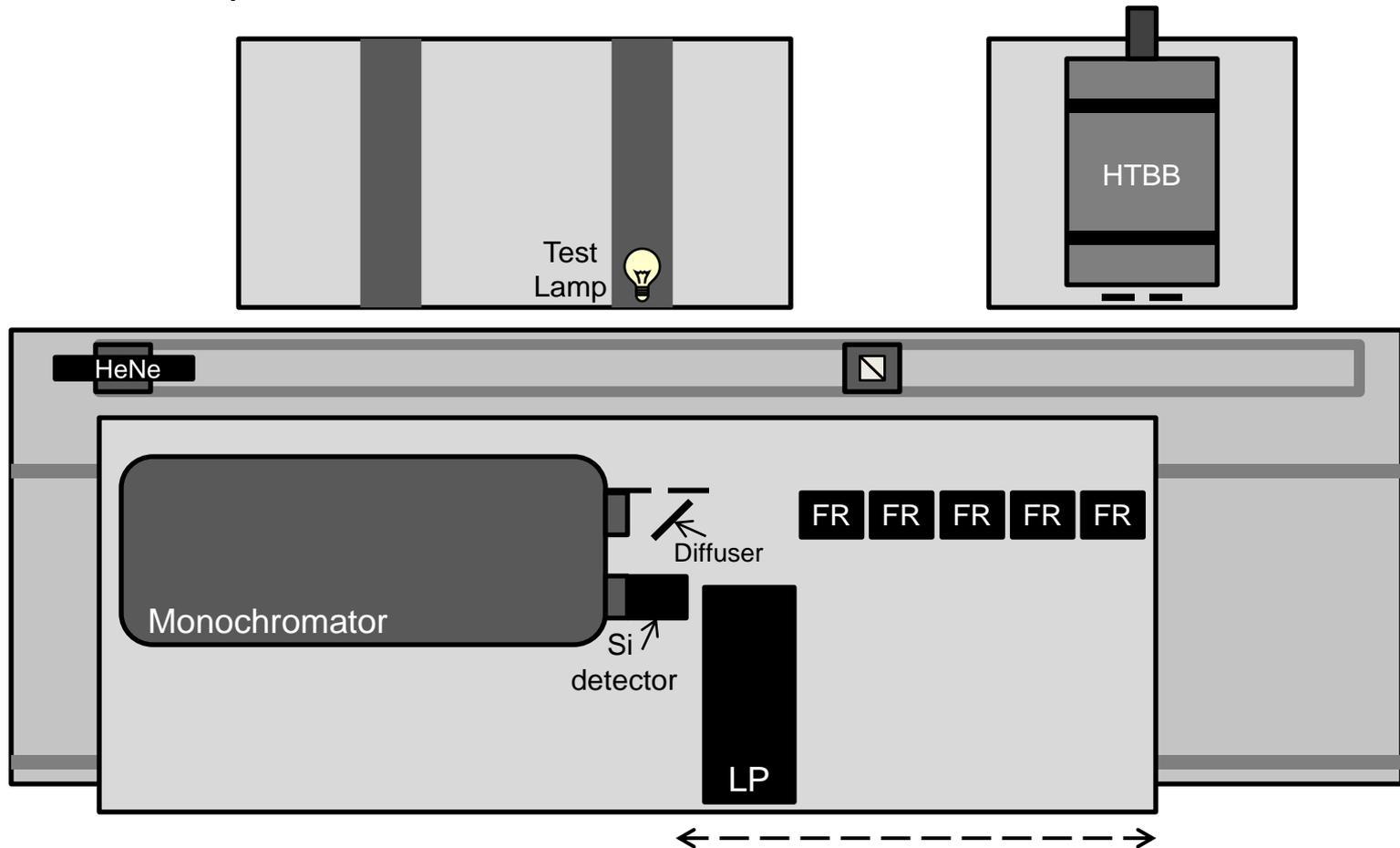
NRC Filter Radiometers

- Five radiometers for HTBB temperature determination (L.P. Boivin)
- Calibrated using transfer radiometers and monochromator based apparatus



Spectral Irradiance Facility - Spring 2015

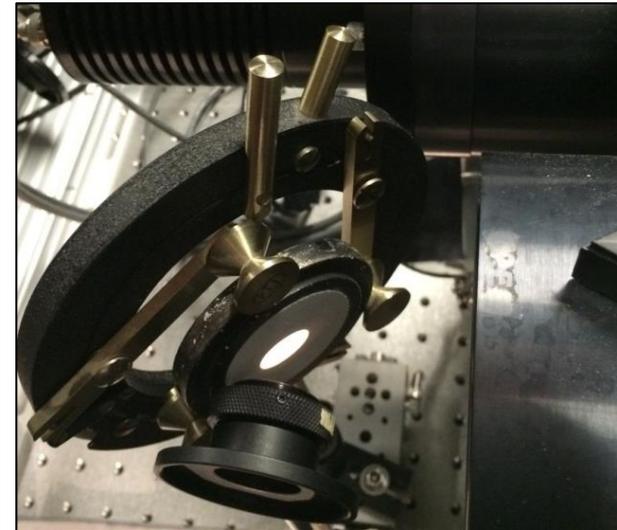
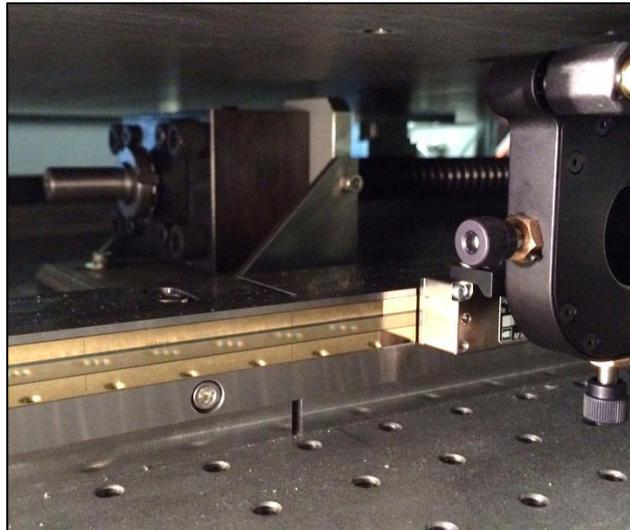
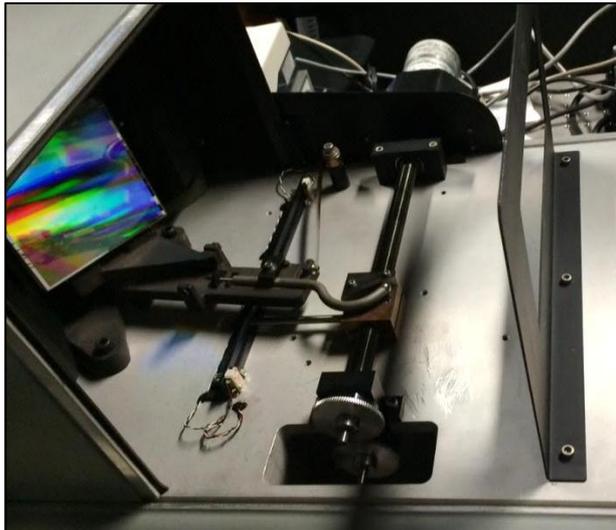
Initial Set-up



Spectral Irradiance Facility - Spring 2015

Apparatus

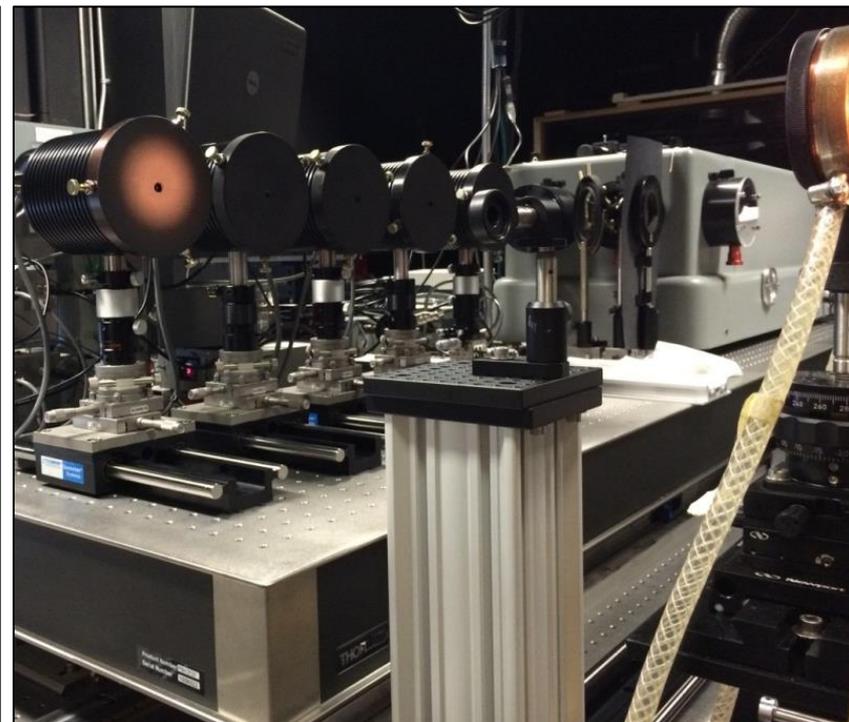
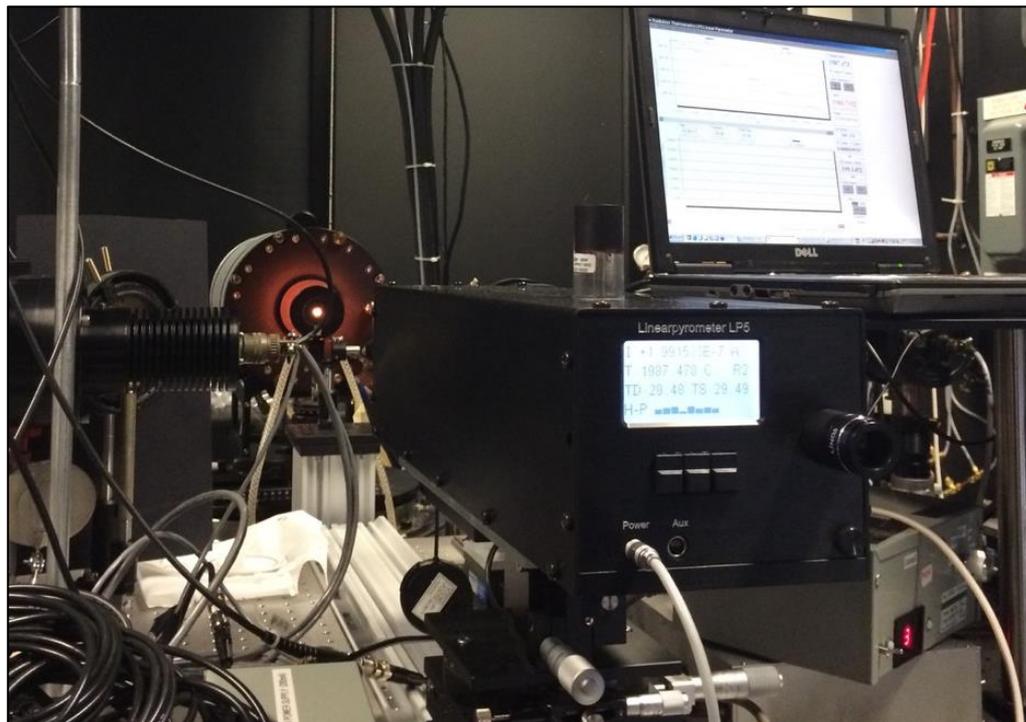
- 1 m Czerny–Turner monochromator (1200 g/mm)
 - λ repeatability 0.02 nm
- Linear encoder for optical table positioning ($\pm 5 \mu\text{m}$)
- Diffuser and aperture at monochromator input
 - To be replaced with pre-disperser and integrating sphere



Spectral Irradiance Facility - Spring 2015

Preliminary Measurement

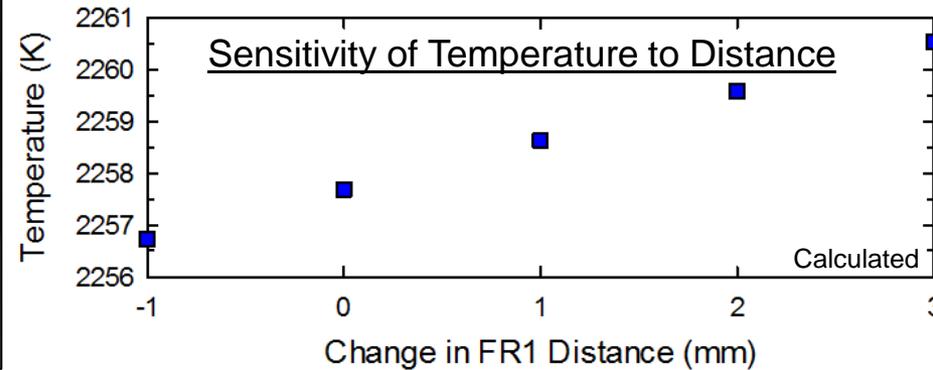
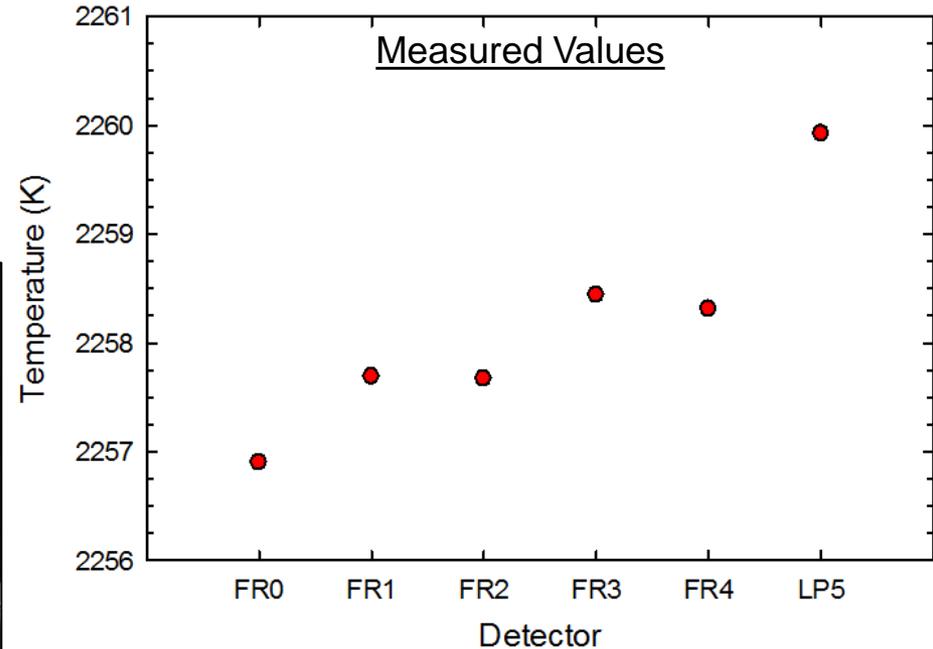
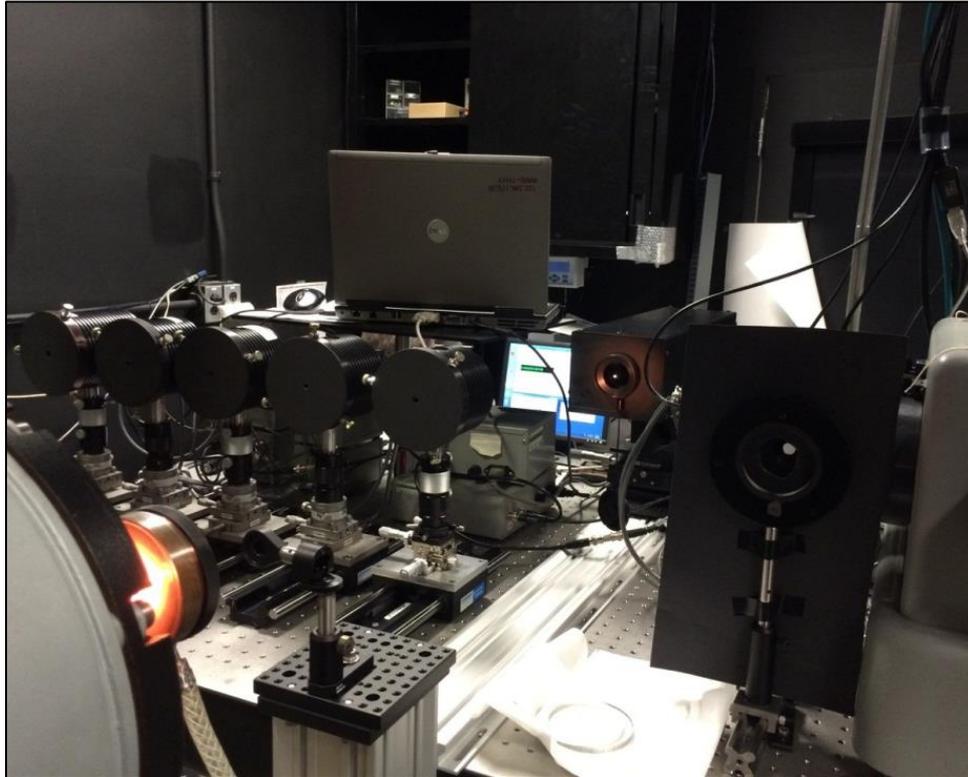
- LP5 Linearpyrometer used to monitor HTBB
- 52.5 cm from HTBB aperture to filter radiometer aperture



Spectral Irradiance Facility - Spring 2015

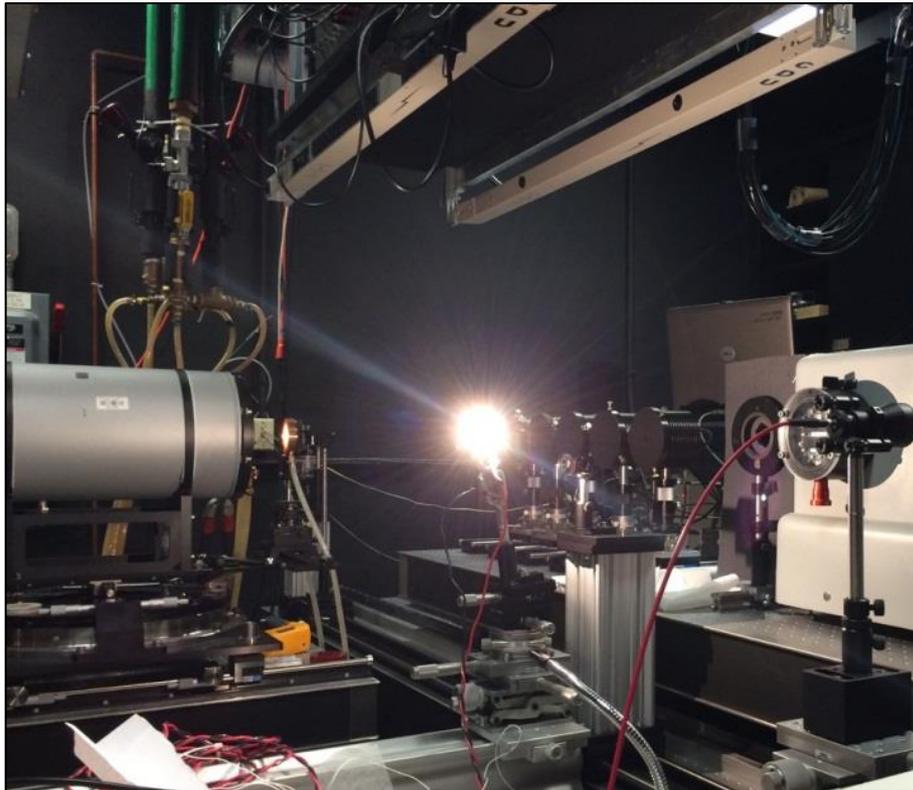
Preliminary Measurement

- FR temperatures agree within ~ 2 K
- Distance measurement to be improved

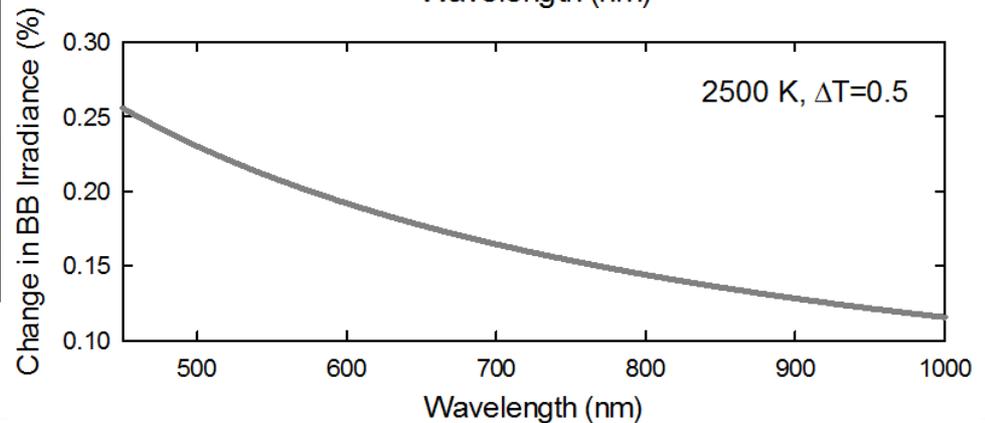
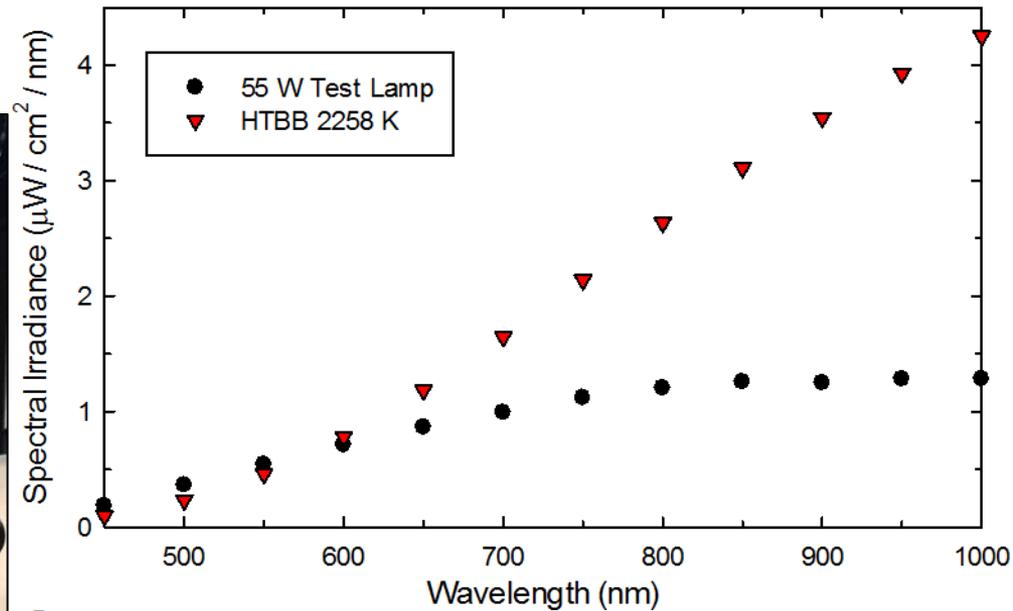


Spectral Irradiance Facility - Spring 2015

- Lamp distance: 52.5 cm

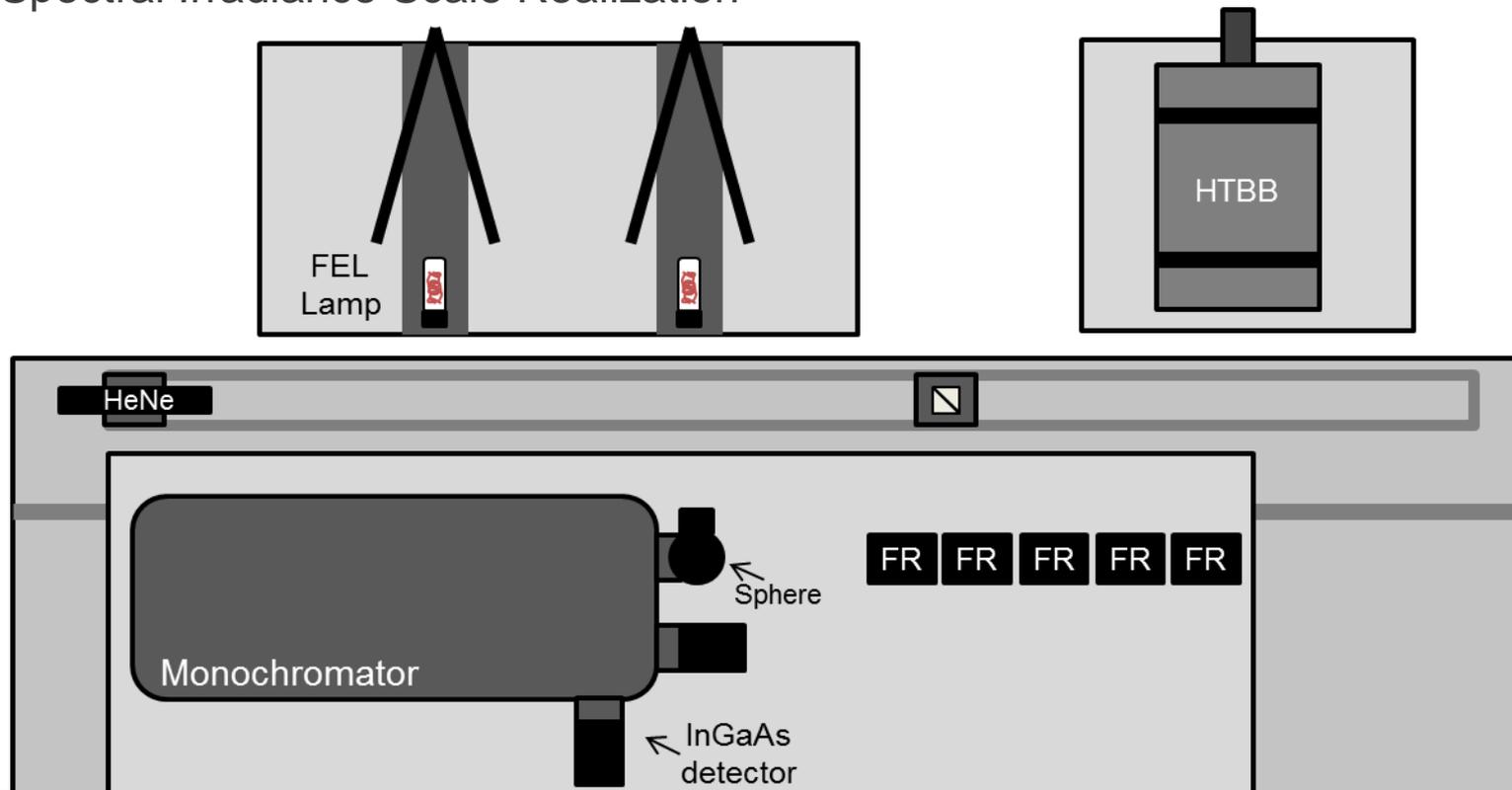


Preliminary Spectral Irradiance Measurement



Future Work

- Install FEL lamps, *etc.*
- Photodetectors to span 200 - 2500 nm range
- Uncertainty budget
- Spectral Irradiance Scale Realization



NRC Solid State Lighting Lab and OLED Measurements

William S. Neil and Arnold A. Gaertner

Photometry, Radiometry and Thermometry
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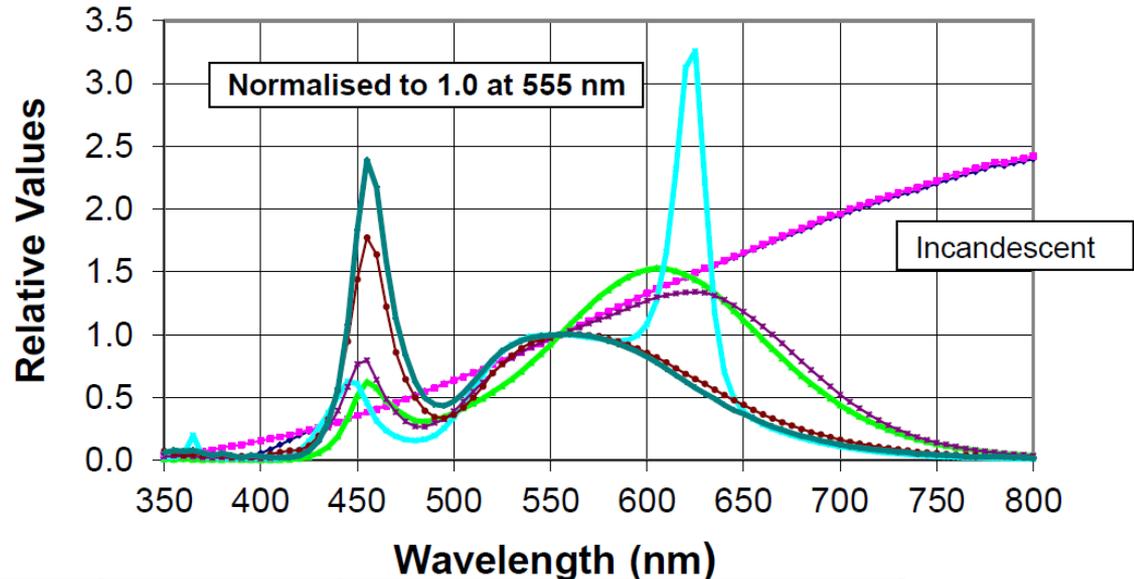


Solid State Lighting at NRC

- NRC measurements for IEA 4E SSL Interlaboratory comparison of LED products (2013)

<http://ssl.iea-4e.org/task-2-ssl-testing/2013-ic-final-report>

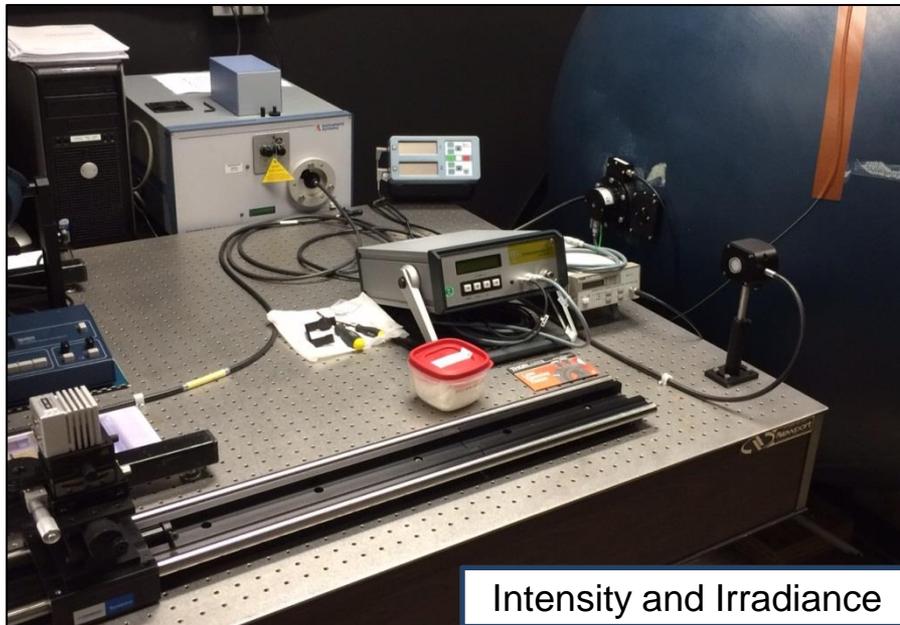
Total Spectral Flux of LED lamps



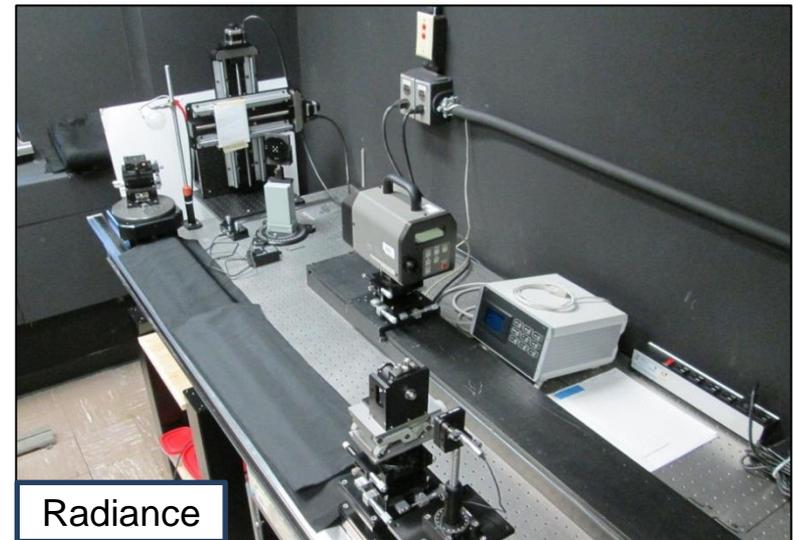
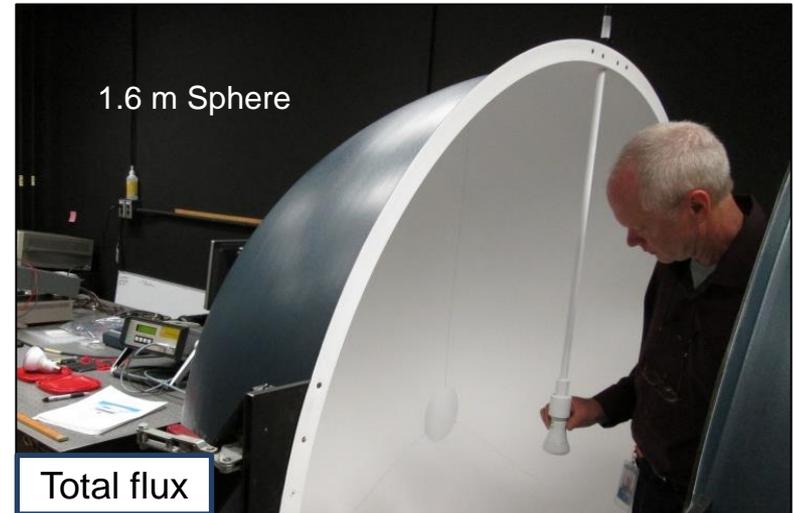
Lamp Type	Nominal CCT	Rated Power	Measurement Quantities
Incandescent	2900 K	150 W	1) Total luminous flux (lm) 2) RMS Voltage (V) and Current (A) 3) Electrical active power (W) 4) Power factor 5) Luminous efficacy (lm/W) 6) Chromaticity coordinates x, y 7) Correlated Colour Temperature (K)
Incandescent	2900 K	60 W	
Omnidirectional LED	2700 K	12.0 W	
Directional LED	2700 K	10.5 W	
Directional LED	2800 K	8.5 W	
Low power-factor LED	3000 K	6.0 W	
High CCT LED	6500 K	3.0 W	

NRC Solid State Lighting Facility

Fiber coupled scanning spectroradiometer
190 - 1700 nm



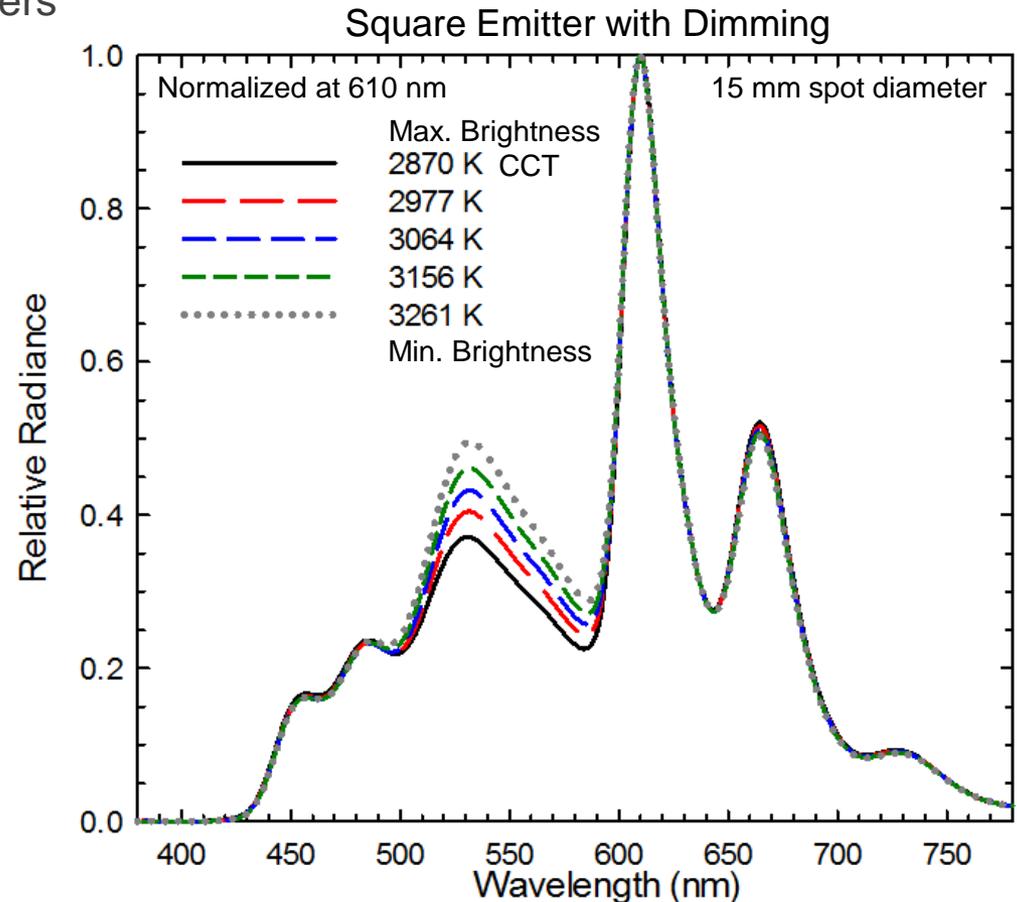
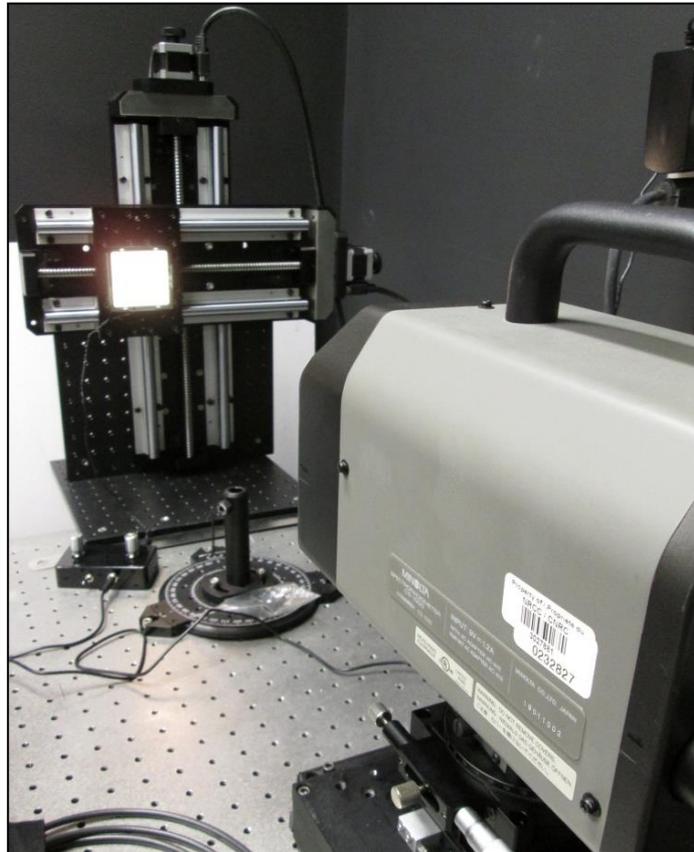
→ SI traceability using lamps



Preliminary Spectral Measurements of OLED Samples

Commercial OLEDs

- Square emitter (62 mm), round emitter (d = 71 mm)
- On/Off switch and dimming adjusters

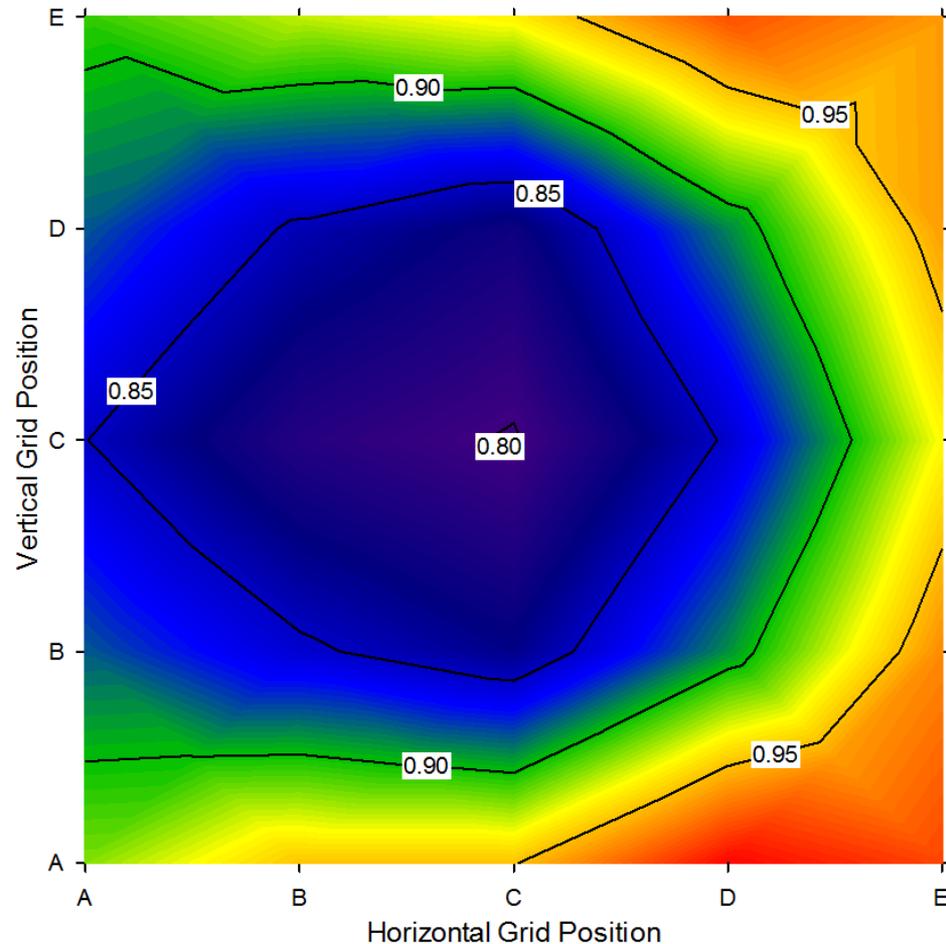


Preliminary Measurements of OLED Samples

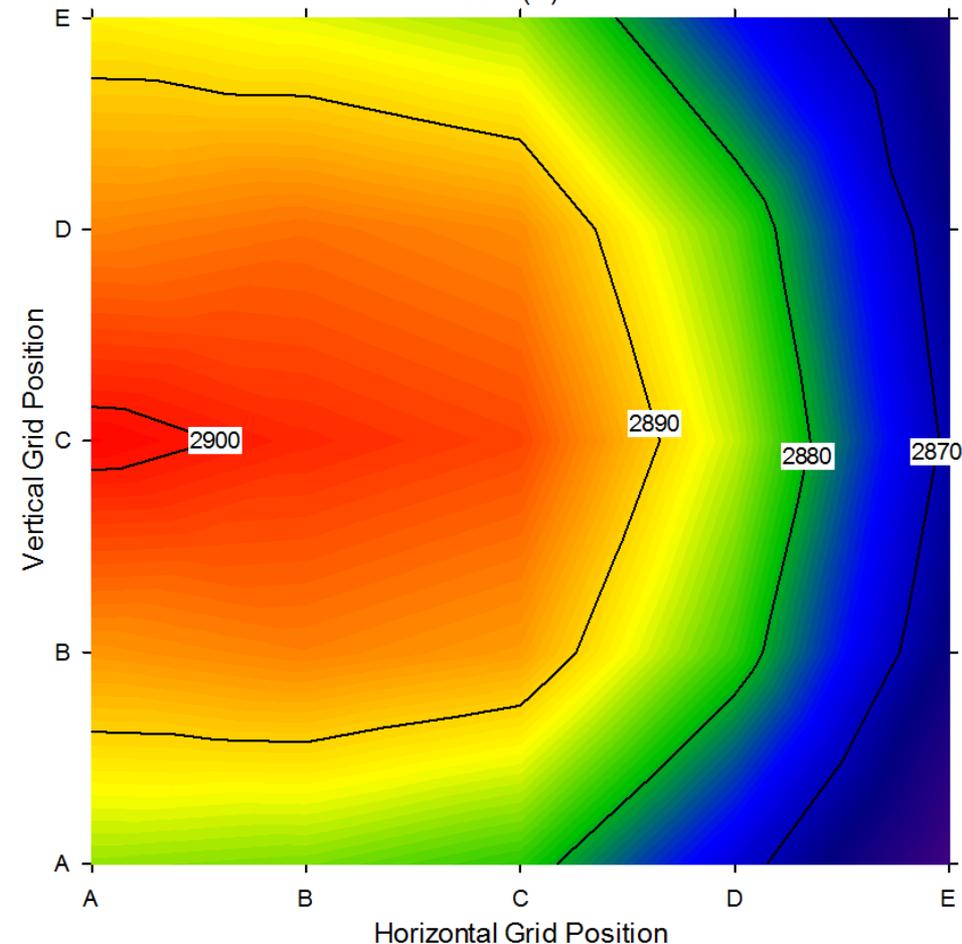
- Position dependent measurements, 80% maximum output power



Relative Radiance at 610 nm

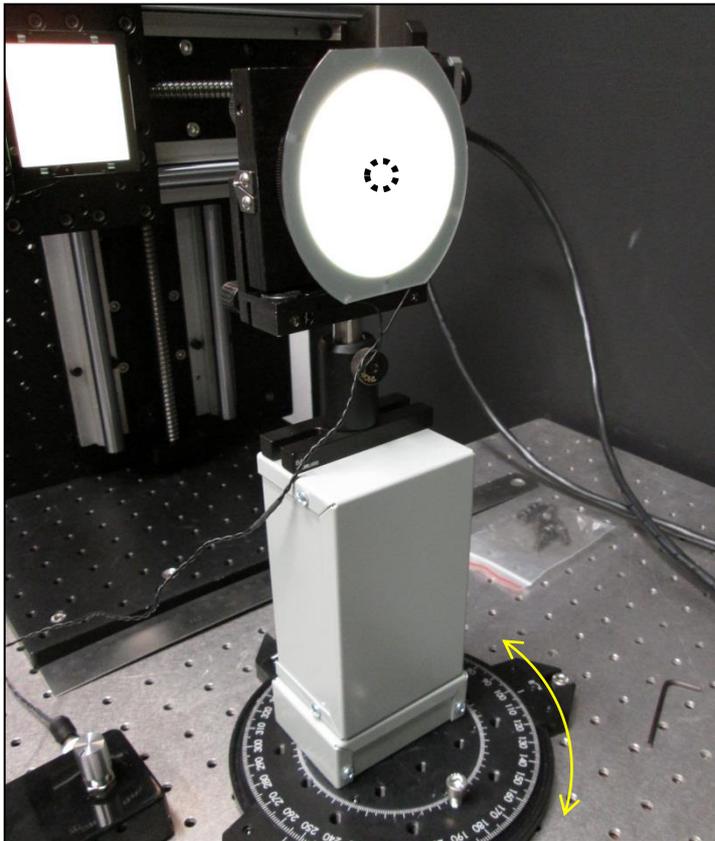


CCT (K)

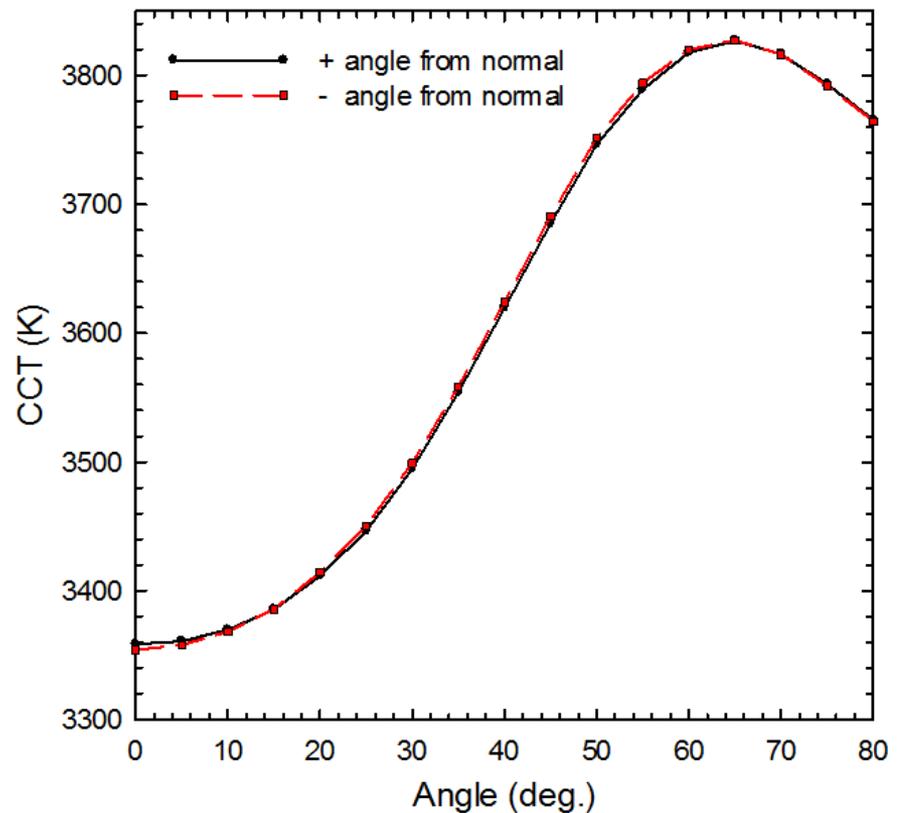


Spectral Measurements of OLED Samples

- Angle dependent spectral power distribution → 10 mm spot diameter (0 deg.)
- 0 deg. CCT: round emitter ≈ 3356 K, square emitter ≈ 2923 K



CCT calculated from spectral power distribution



Acknowledgments

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