Characterization of Integrating Spheres for Ultraviolet Radiometry

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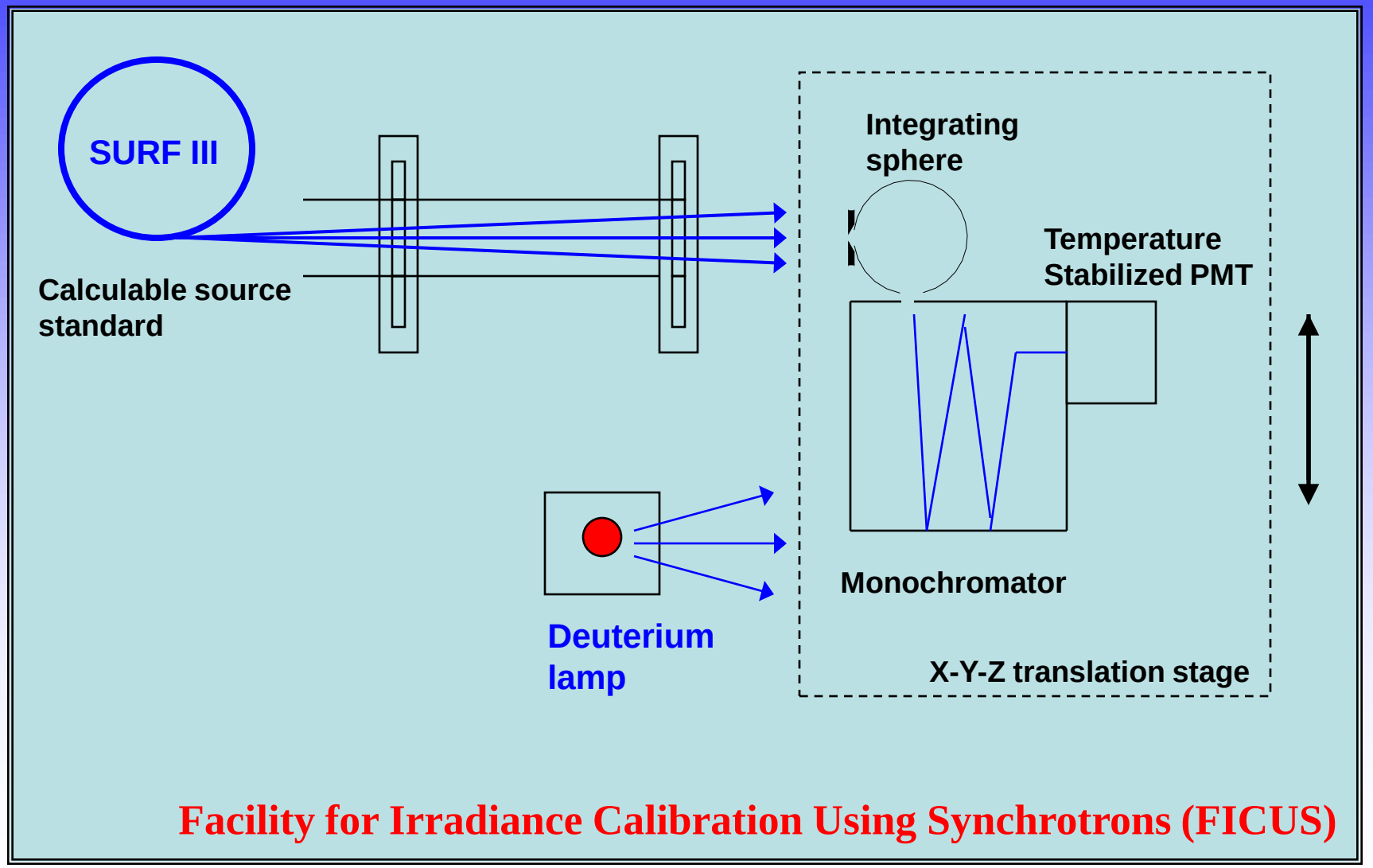
NIST

Integrating Sphere for UV Application

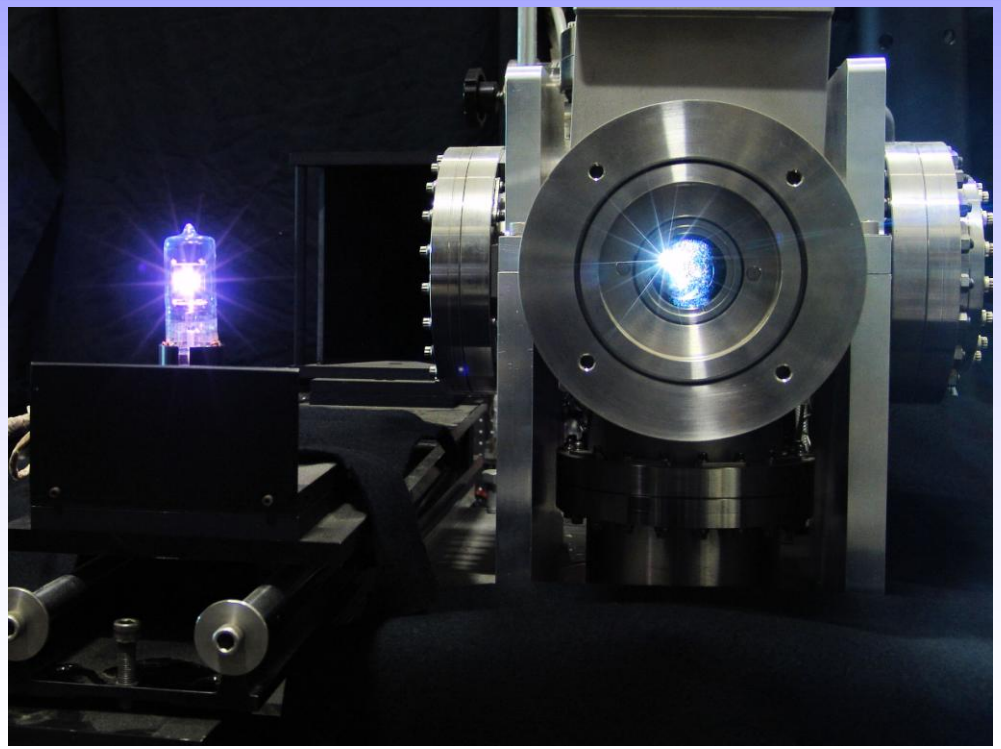
- irradiance calibration of deuterium lamps using synchrotron radiation at NIST



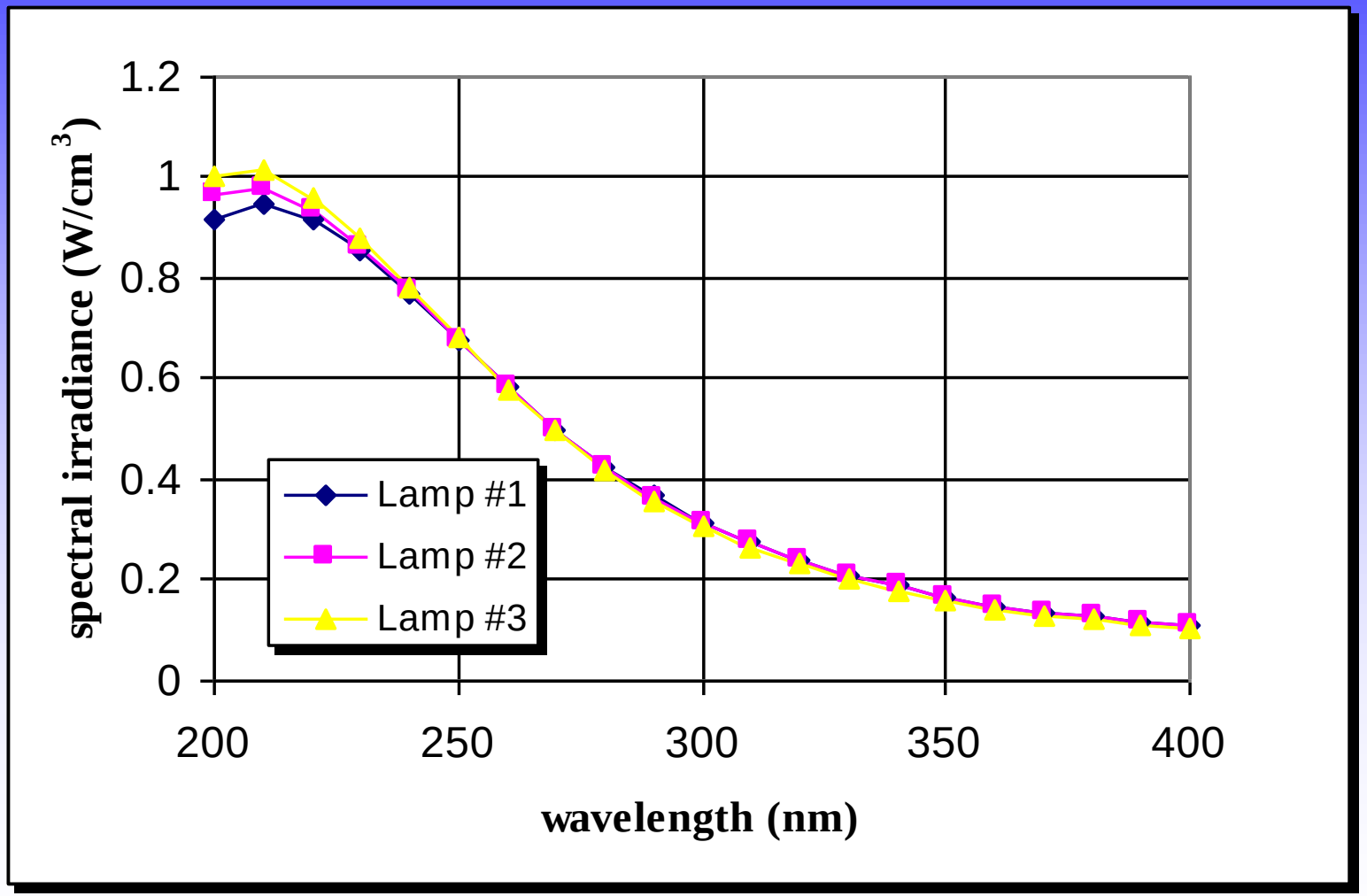
Facility for Irradiance Calibration Using Synchrotrons (FICUS)

Why integrating sphere?

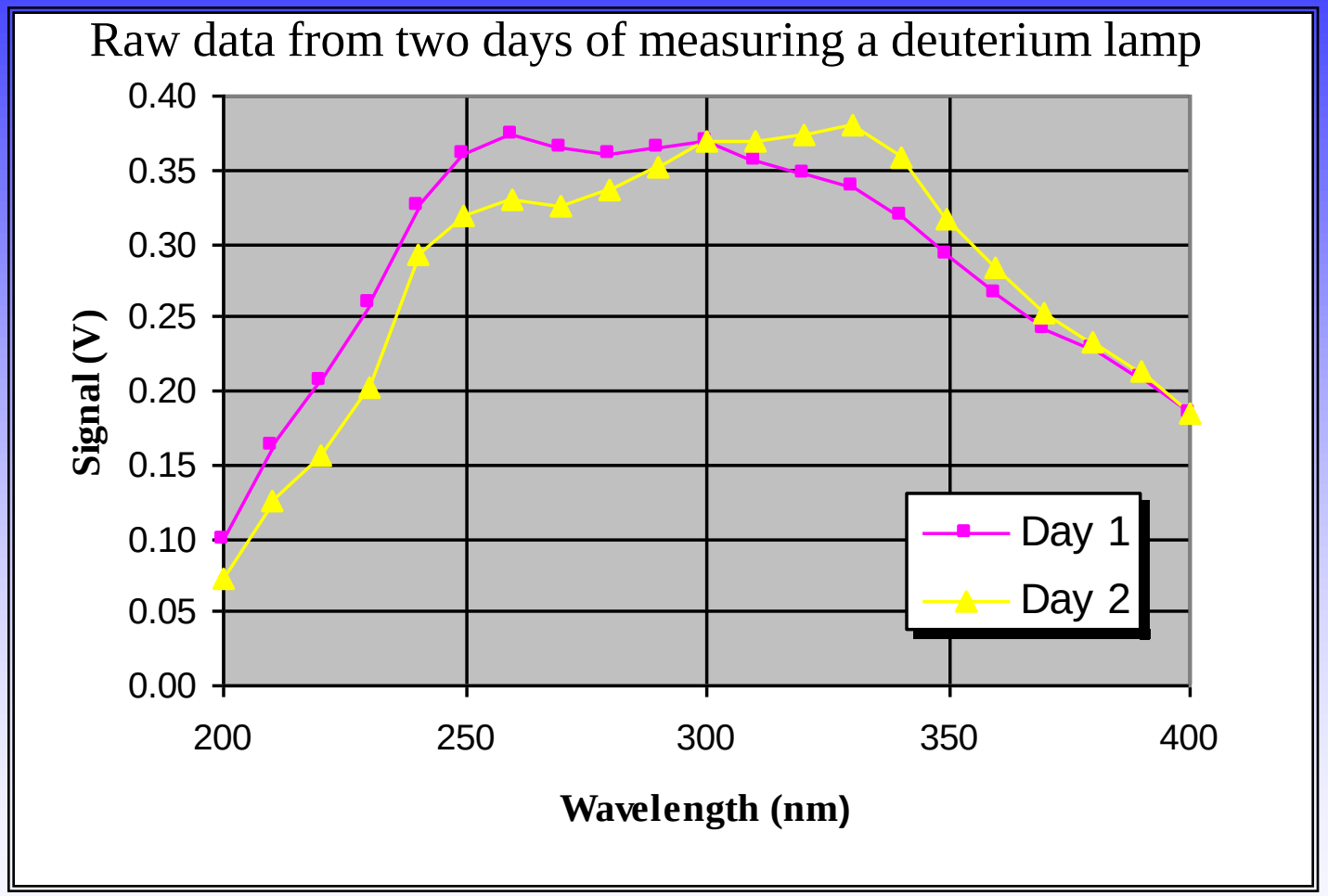
- Output light with near Lambertian distribution independent of input light distribution.
- Unpolarized output light.



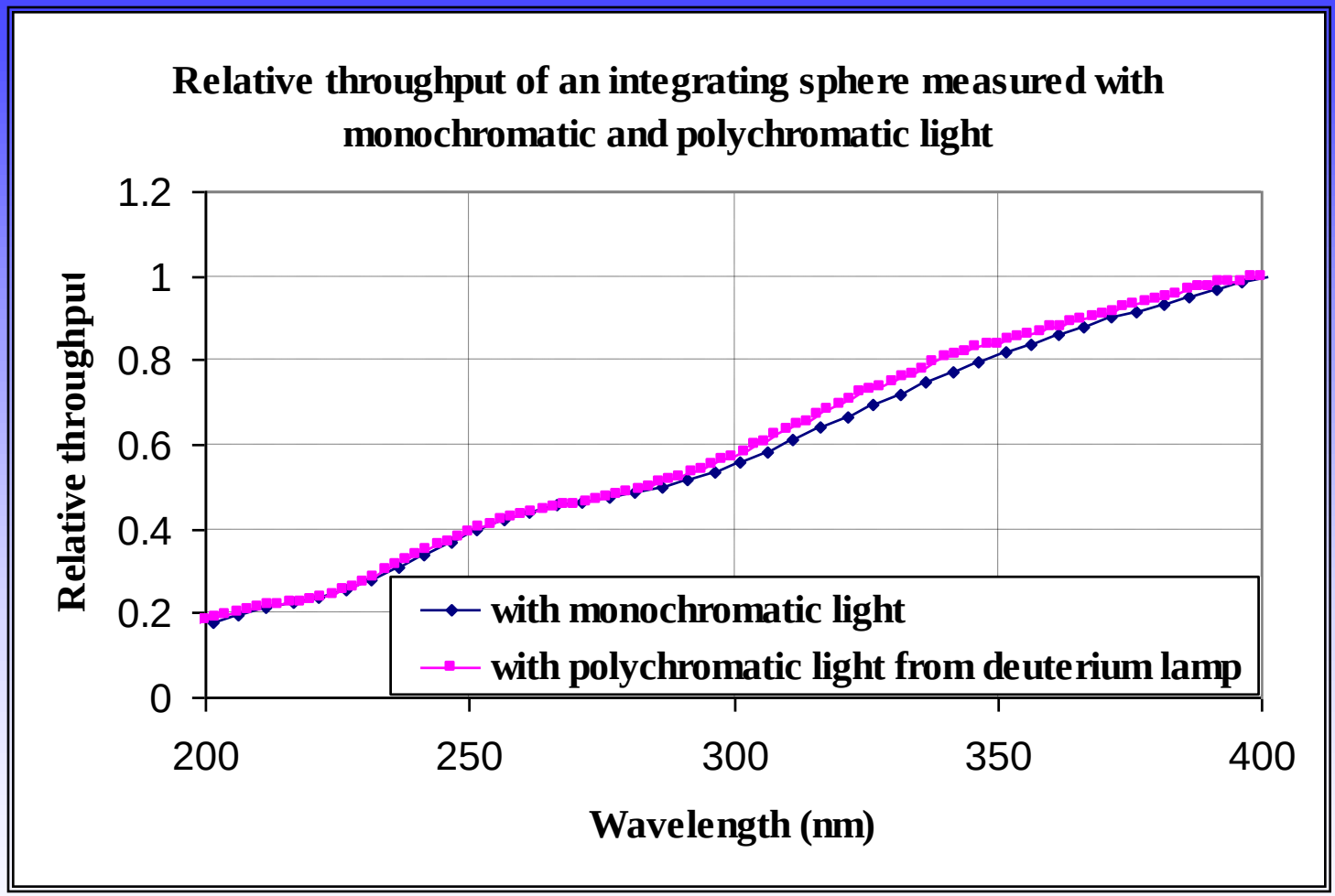
Measured irradiance of deuterium lamps at FICUS with combined uncertainty ~ 1.2% (k=2)



Problem with integrating sphere - instability



Problem with integrating sphere - fluorescence



Questions:

What is the cause for the instability and fluorescence in UV? Are instability and fluorescence correlated?

Problem with integrating sphere – UV fluorescence

Spectral irradiance measurements: effect of uv-produced fluorescence in integrating spheres

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The spectral irradiance of a 30-W deuterium arc lamp was determined by comparing it with a tungsten quartz–halogen lamp calibrated for spectral irradiance in the 250–350-nm region. Because the deuterium lamp and the tungsten lamp subtend different solid angles, four independent measurements were carried out by using the following entrance optics to the spectrometer: (1) a $BaSO_4$ coated integrating sphere; (2) a Halon[1] coated integrating sphere; (3) no sphere, but a ground-Suprasil diffuser in front of the entrance slit; and (4) no sphere and no diffusing element. The last two same results

Table I. The Percentage Differences: (1) Between the D_2 Lamp Spectral Irradiance as Determined by use of a $BaSO_4$ Integrating Sphere and as Determined by use of a Ground-Suprasil Diffuser; (2) Between the D_2 Lamp Spectral Irradiance as Determined by use of a Halon Integrating Sphere and as Determined by use of the Ground-Suprasil Diffuser.

Wavelength (nm)	$BaSO_4$	Halon
350	3.1	14.7
340	3.2	17.3
330	2.5	16.4
320	2.4	12.7
310	1.9	9.1
300	1.9	7.2
290	1.8	6.5
280	1.4	4.3
270	0.8	0.9
260	0.3	0.3
250	0	0

"It has been suggested[2] that these differences could have been caused by the accumulation of tobacco smoke on the surface of the sphere."

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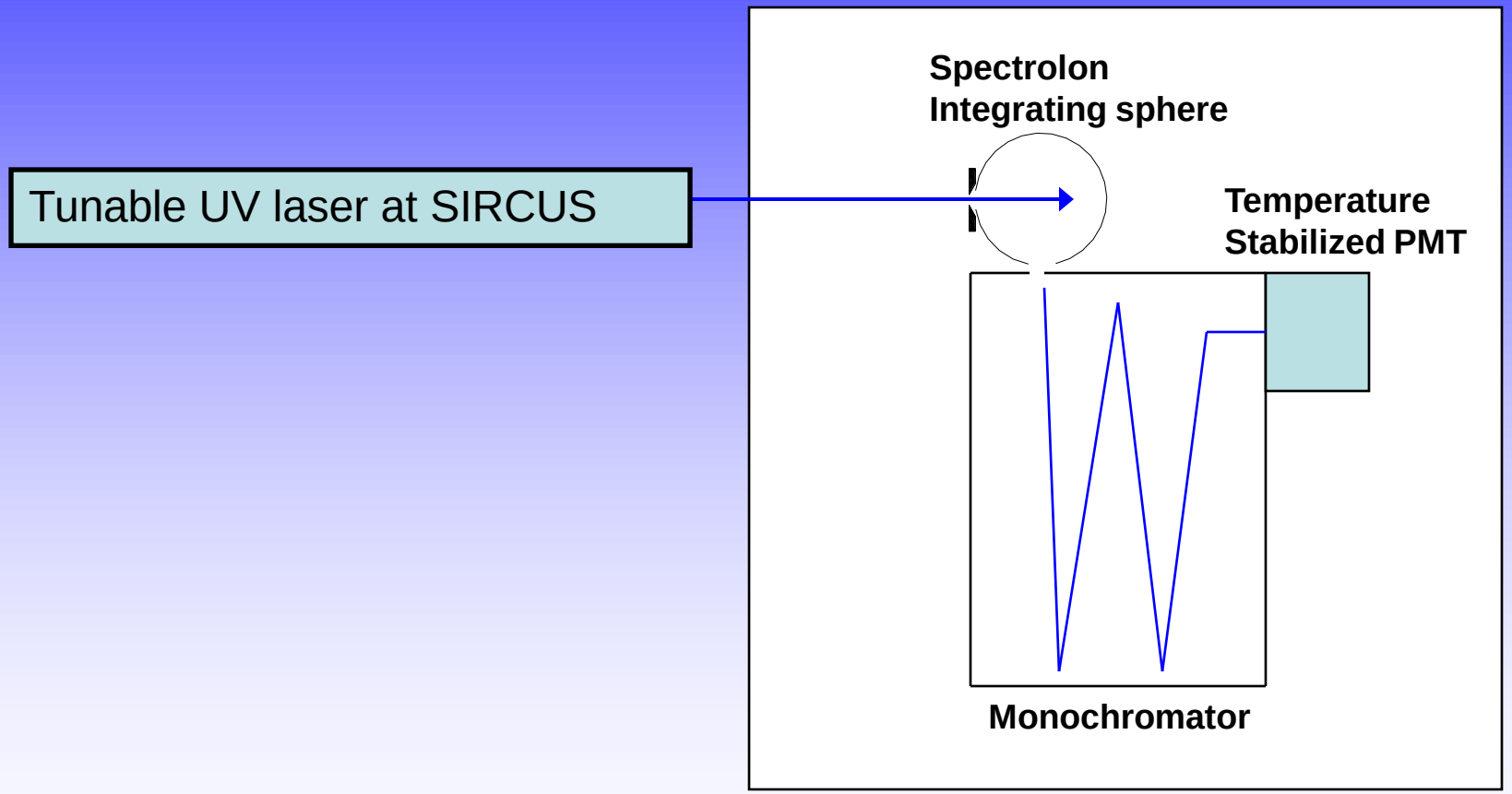
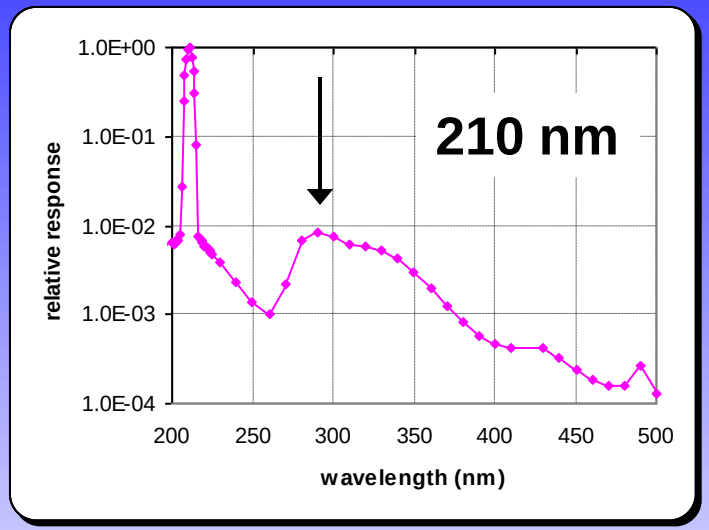
UV Characterization of integrating spheres

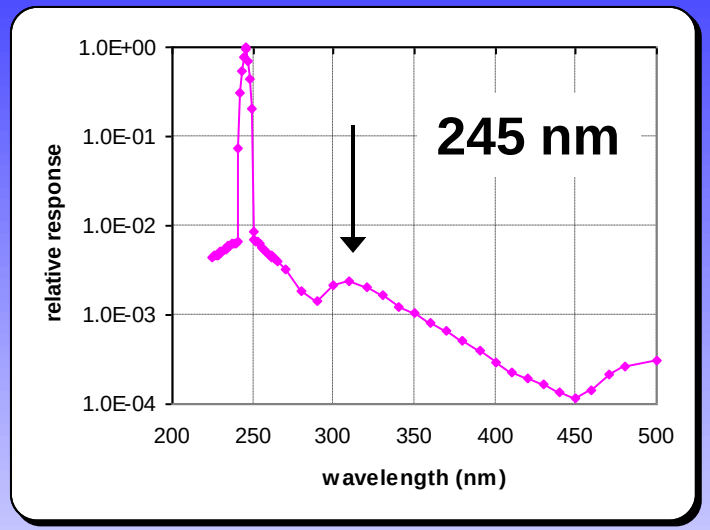
(1) Laser Induced Fluorescence (LIF)

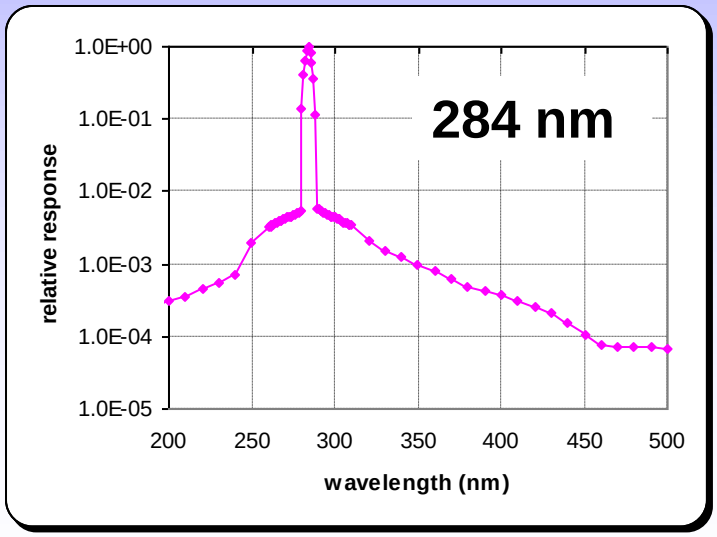


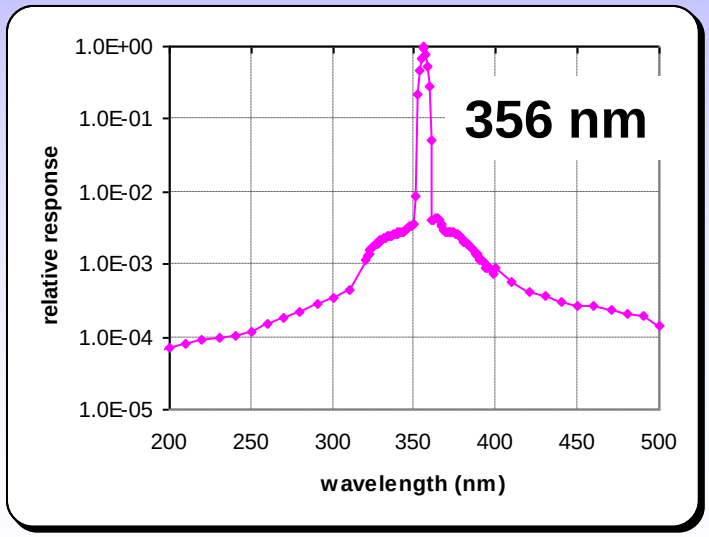
SIRCUS - Spectral Irradiance and Radiance Responsivity Calibrations Using Uniform Sources

Response of a sintered PTFE integrating sphere/monochromator system from incident laser beam

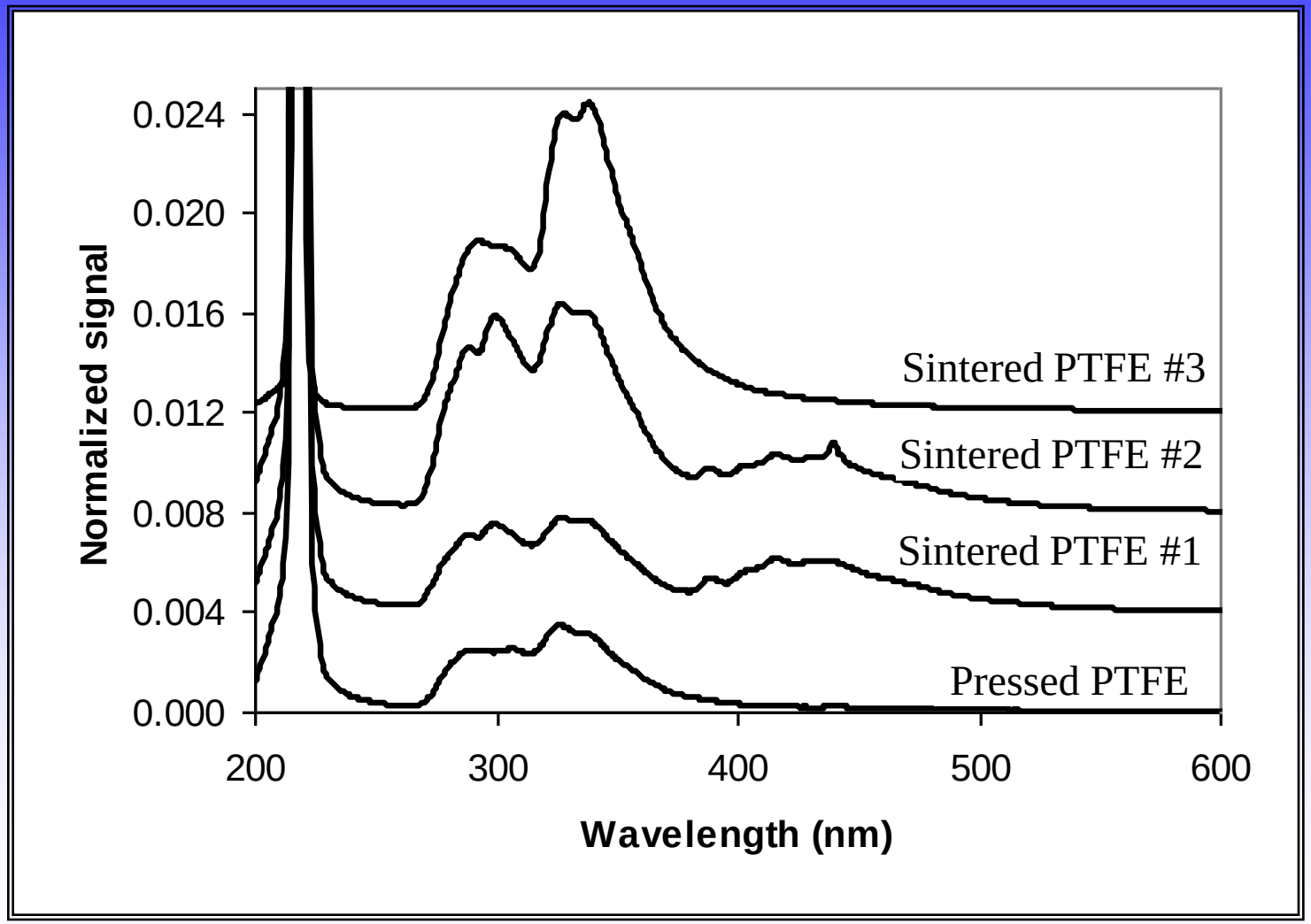






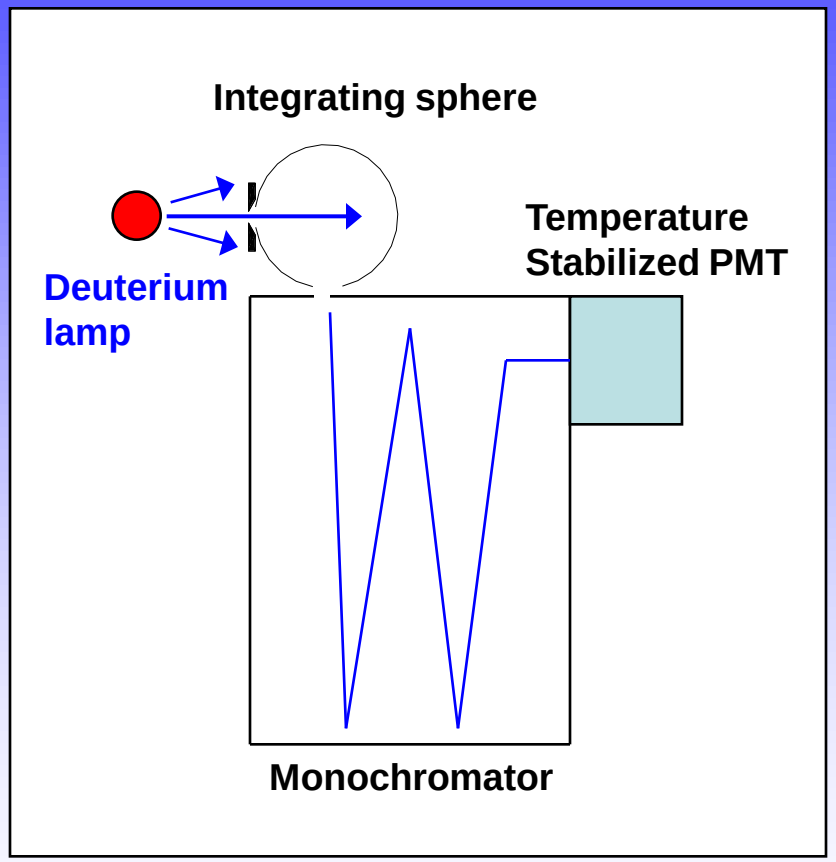


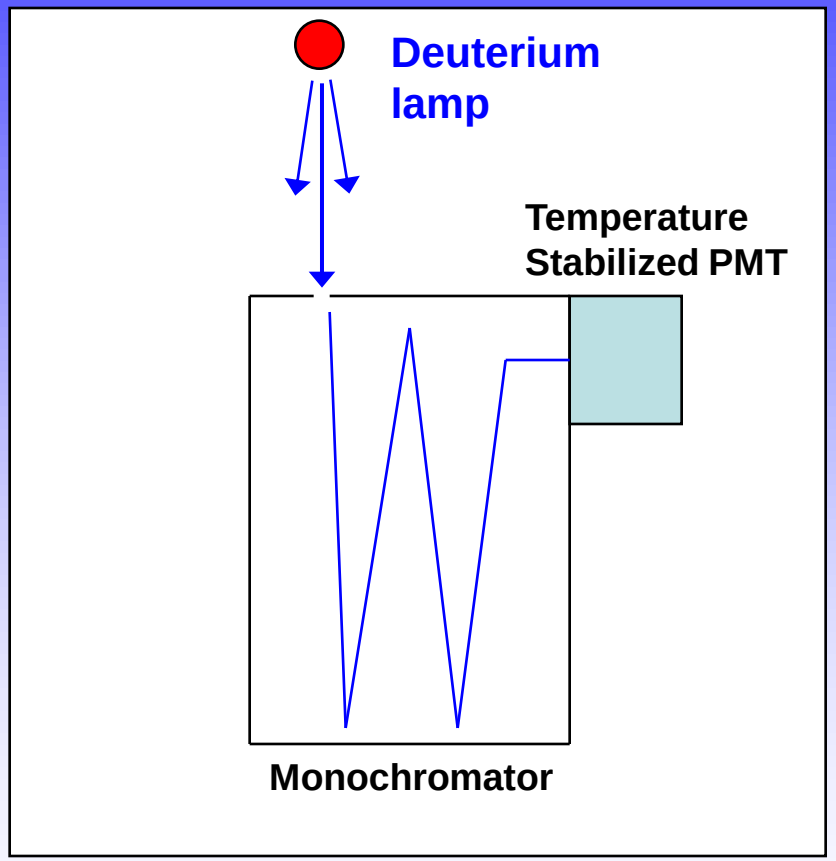
UV induced fluorescence from typical PTFE integrating spheres excited by 220 nm laser



UV Characterization of integrating spheres

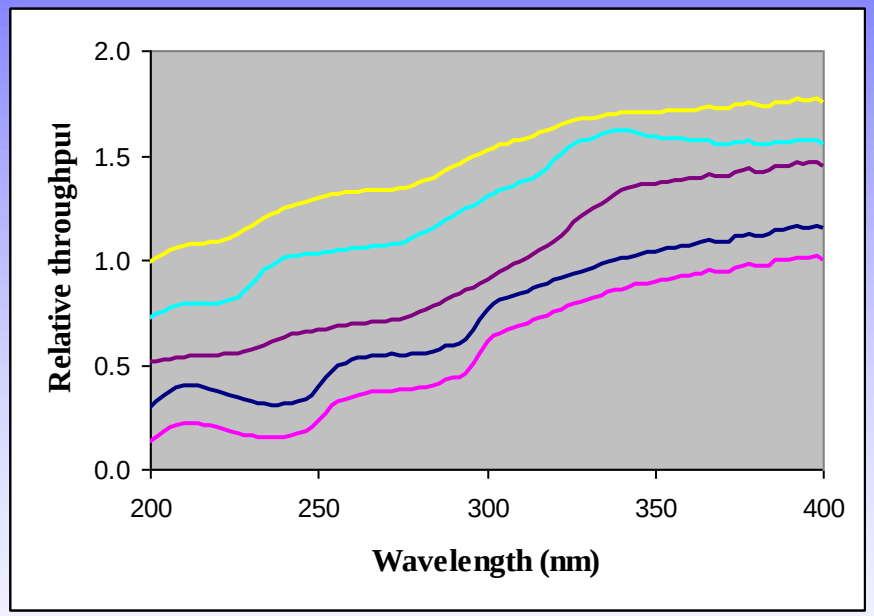
(2) Throughput measurement



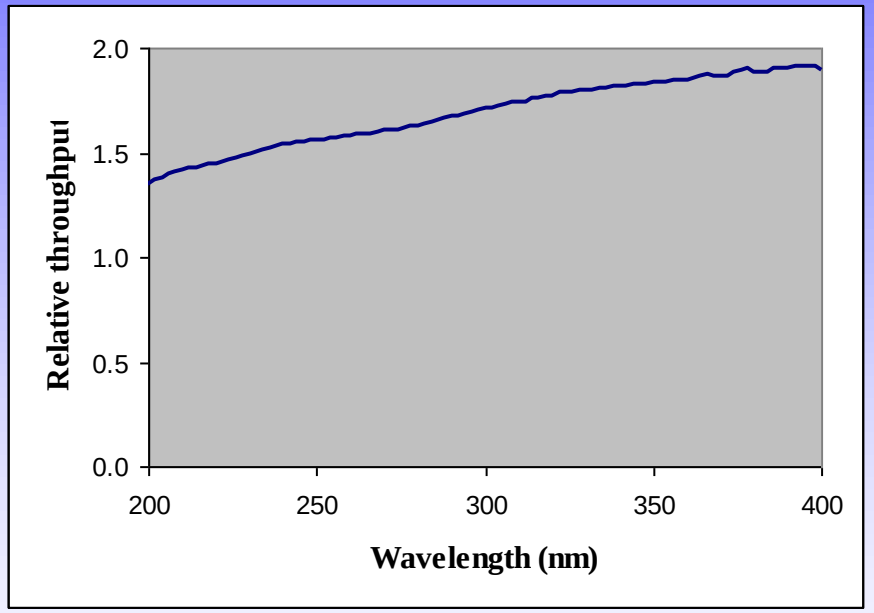


Throughput measurements using a deuterium lamp

Recently brought commercial sintered PTFE integrating spheres

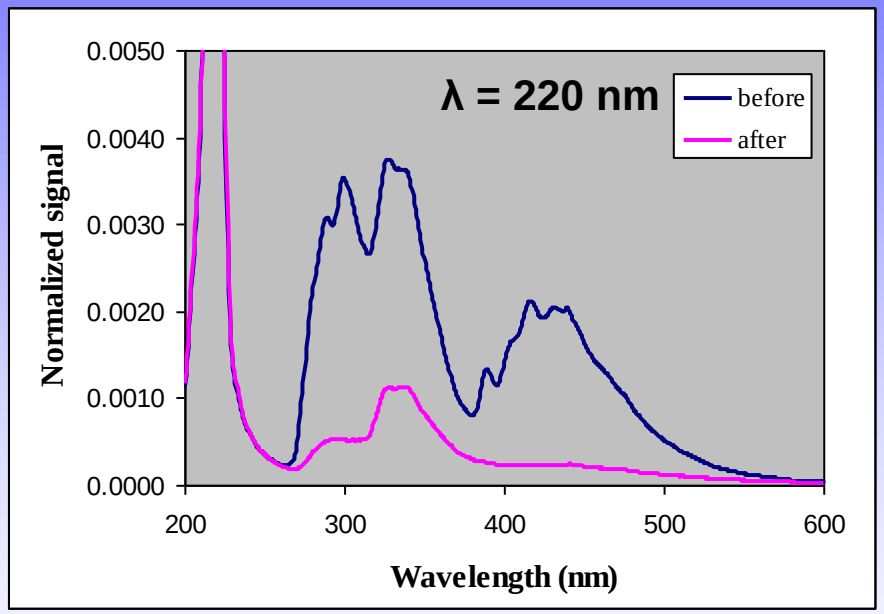


NIST pressed PTFE integrating spheres

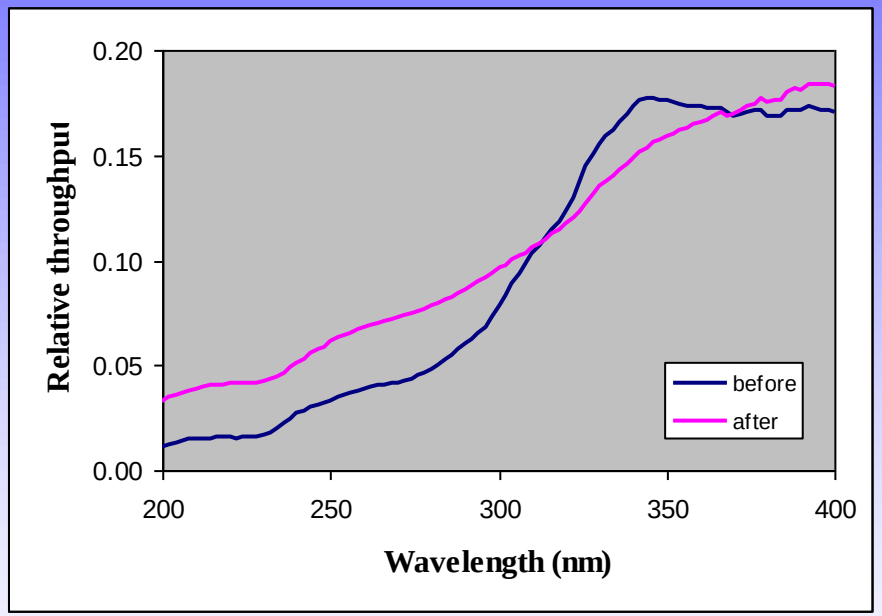


Effect of baking a sintered integrating spheres in vacuum at 90°C for 2 days

Laser induced fluorescence

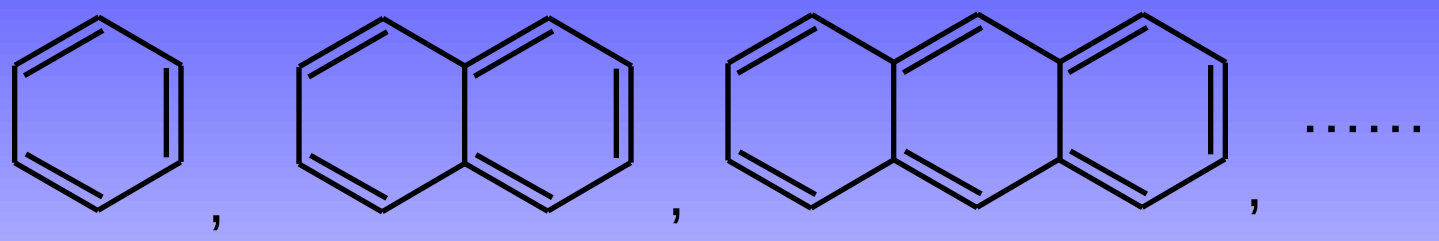


Throughput



Polycyclic Aromatic Hydrocarbons?

Typical structures of Polycyclic Aromatic Hydrocarbon (PAH)



1-ring
(Benzene)

2-ring
(Naphthalene)

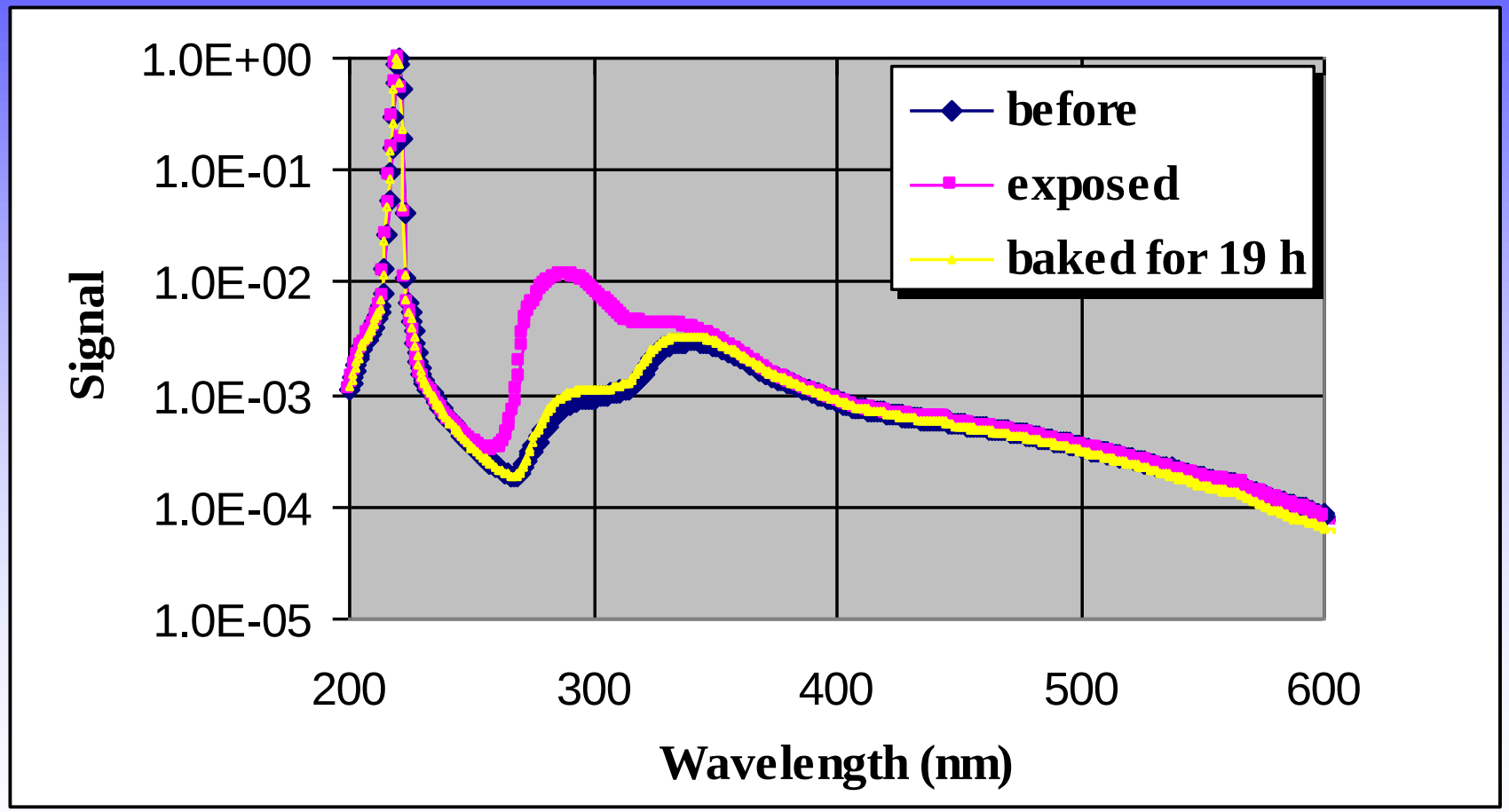
3-ring
(Anthracene)

A common source for PAHs is the gasoline and diesel fuel.


Save A Tree
Remove A Bush

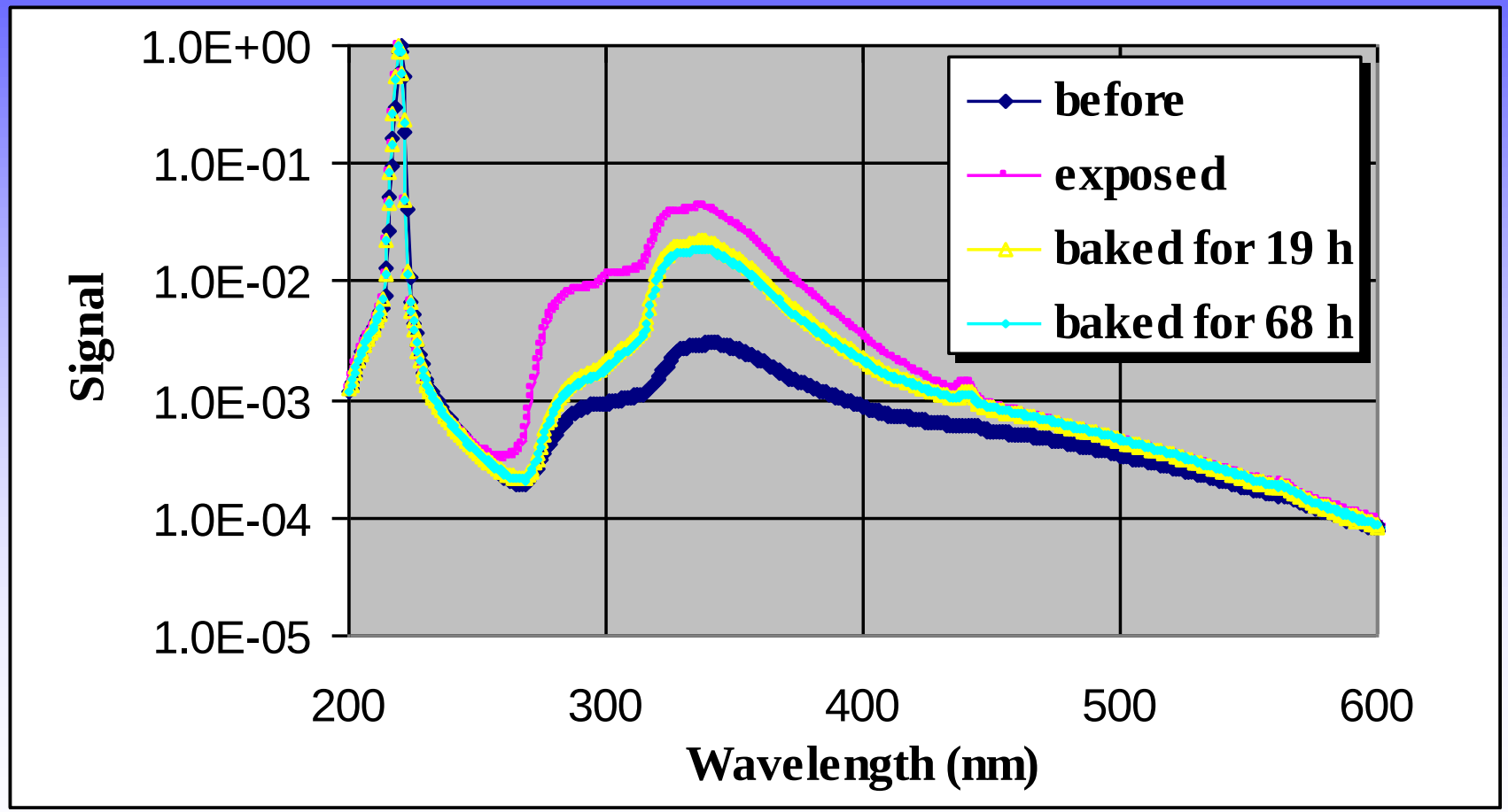
Sintered PTFE integrating spheres exposed to gas exhaust

With 220nm excitation laser

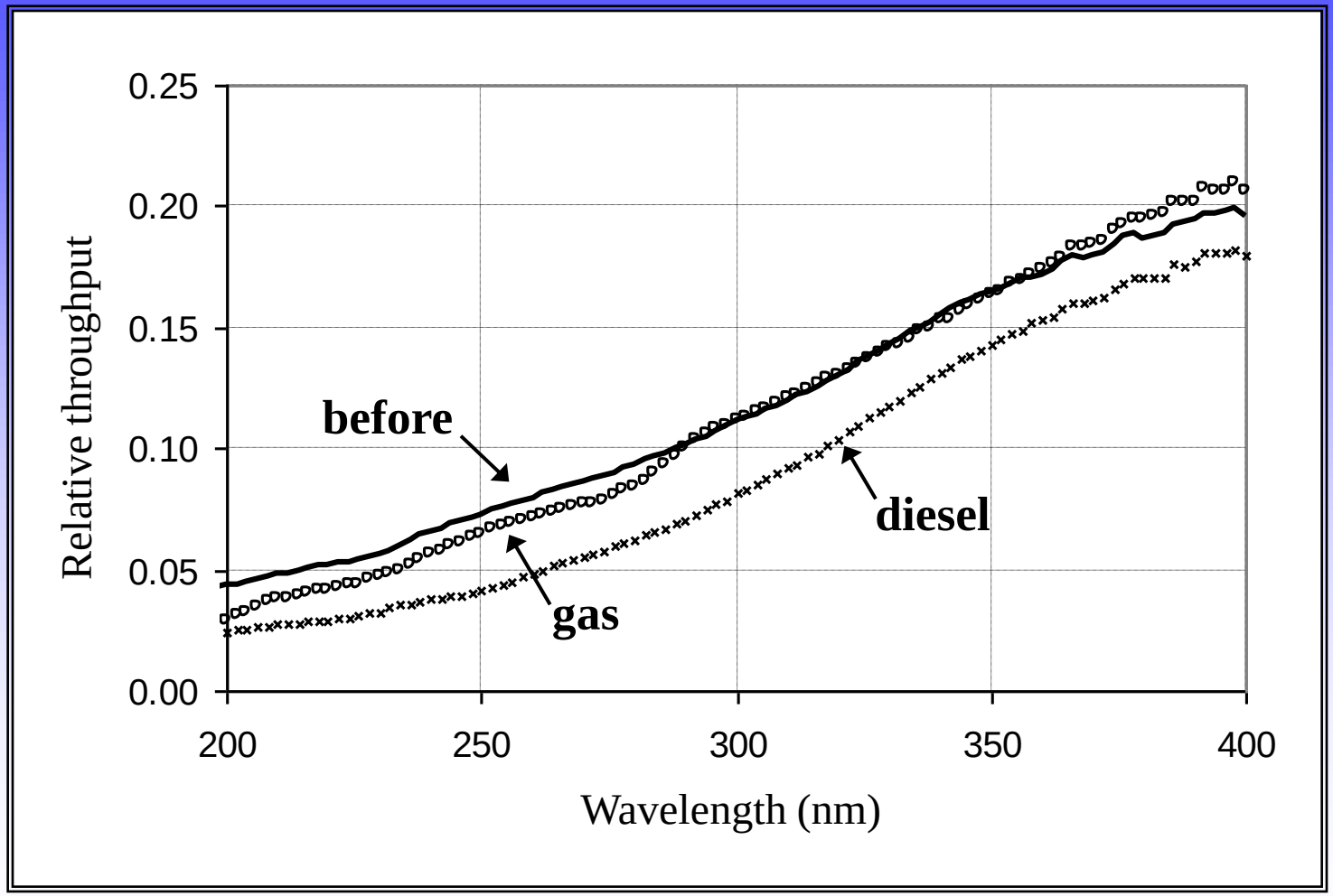


Sintered PTFE integrating spheres exposed to diesel gas exhaust

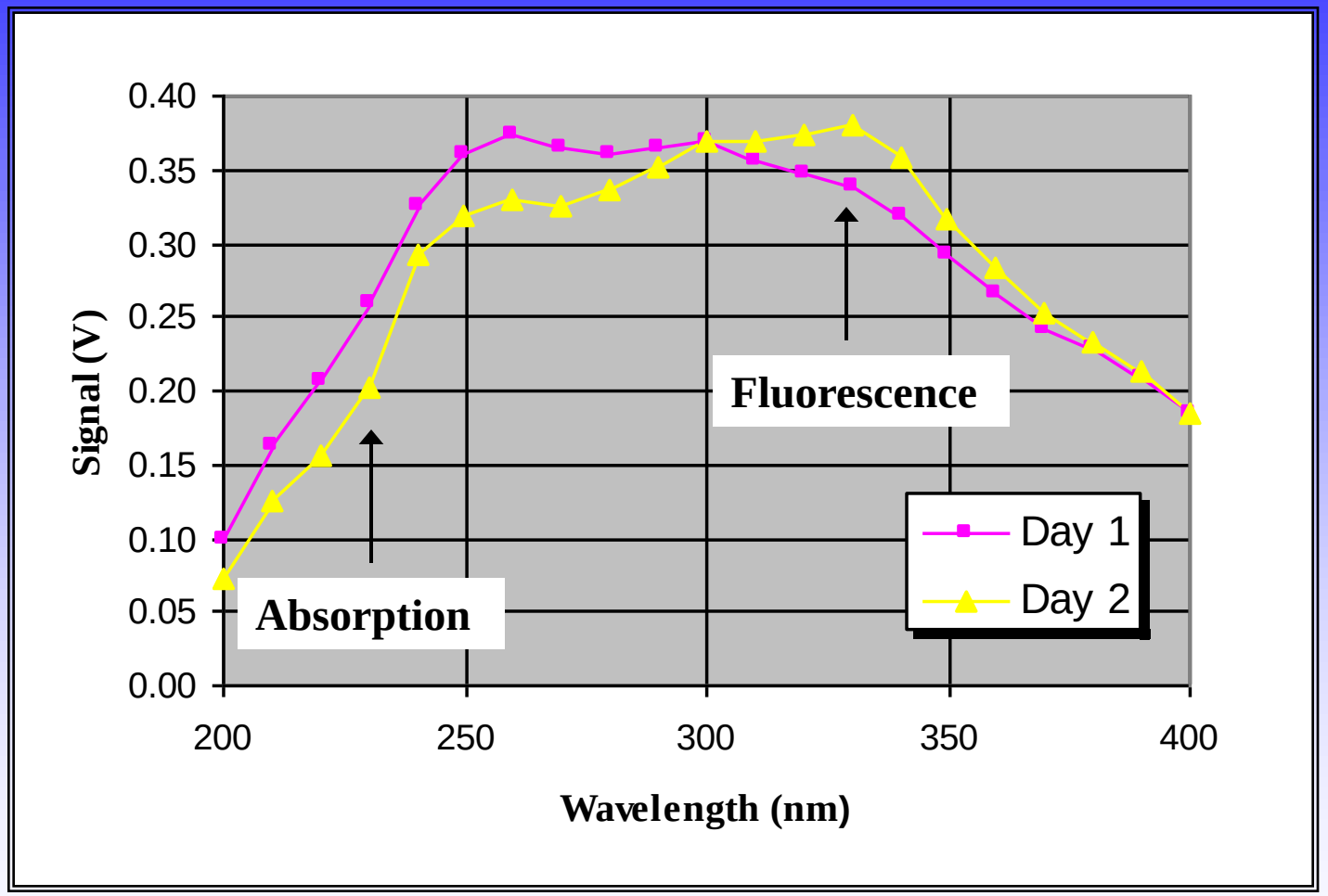
With 220nm excitation laser



Throughput of a Sintered PTFE integrating spheres exposed to gas and diesel exhaust

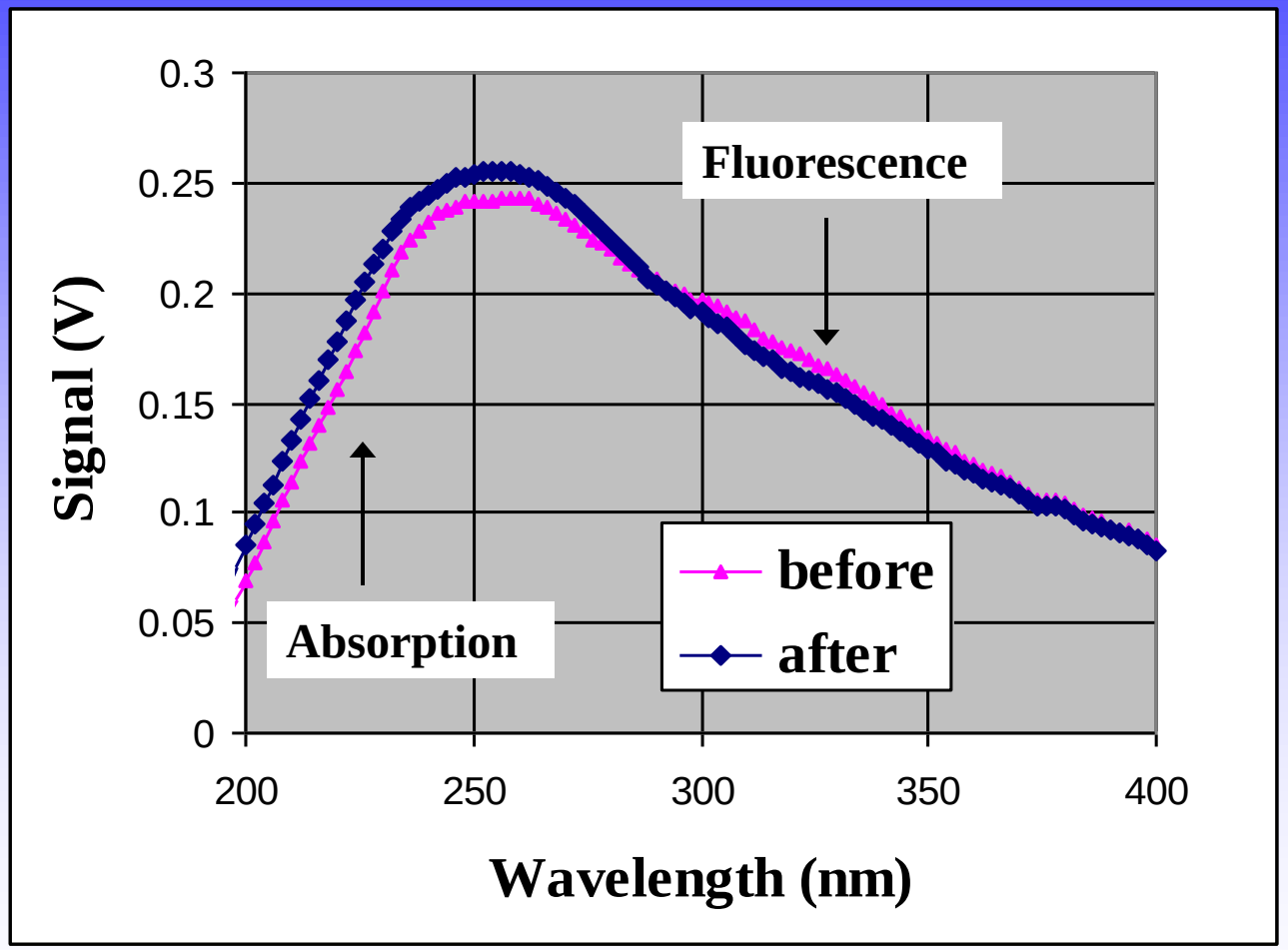


Raw data from two days of measuring a deuterium lamp



Effect of baking integrating spheres in vacuum at 95°C for 2 days

NIST pressed PTFE integrating sphere



Conclusion

- Fluorescence from laser excitation and measurement of the UV throughput of an integrating sphere are very useful in characterizing the condition of an integrating sphere.
- Fluorescence and instability in the UV are mainly caused by contamination of the wall coating.
- Baking in vacuum can remove some but not all contaminants.
- PTFE integrating sphere can be contaminated from environment by air pollution such as PAHs.