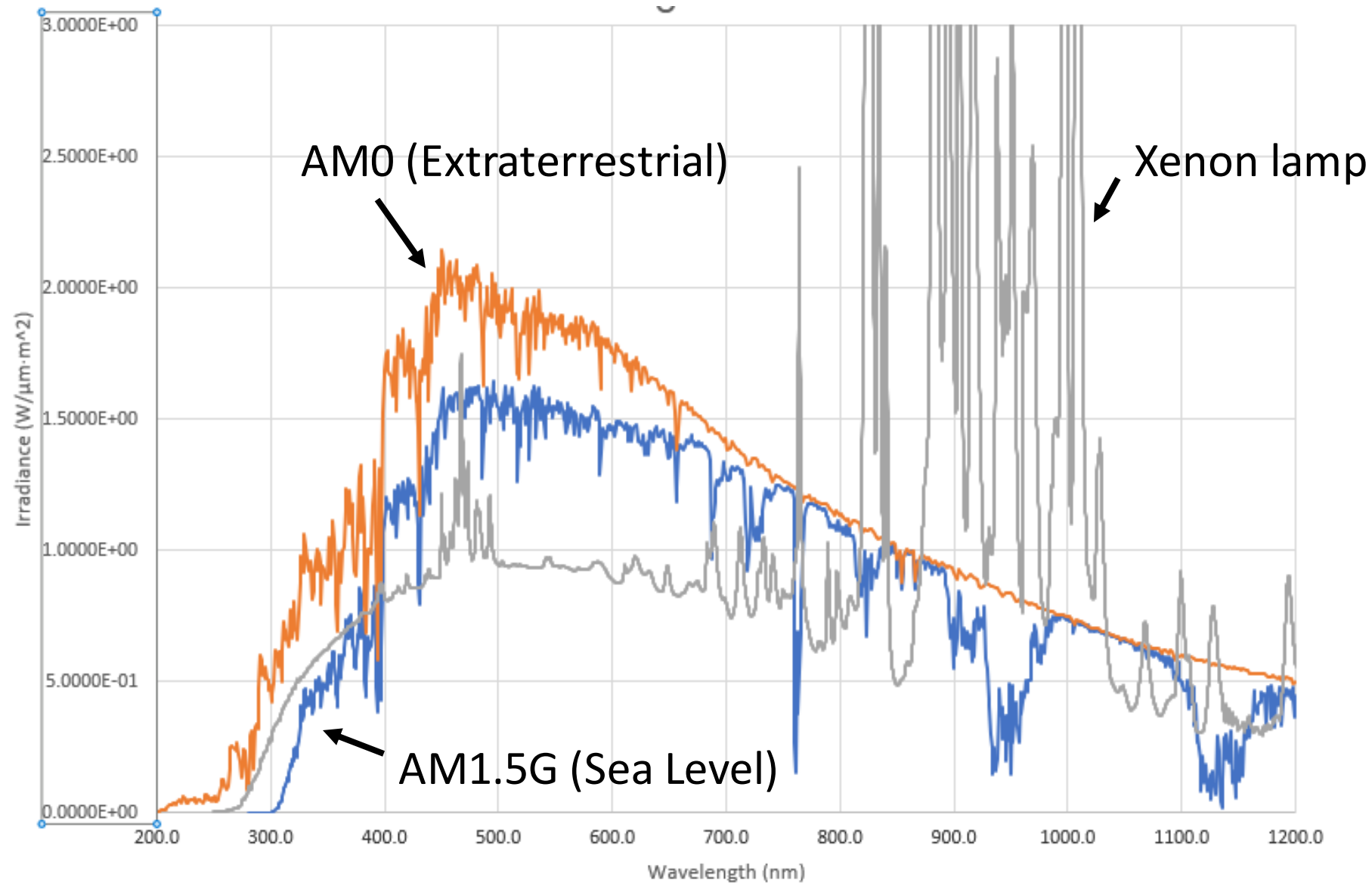# Importance of UV spectral distribution in Solar Simulators Applications

Andrew Brzezinski, PhD

Sciencetech Inc.

Solar simulators
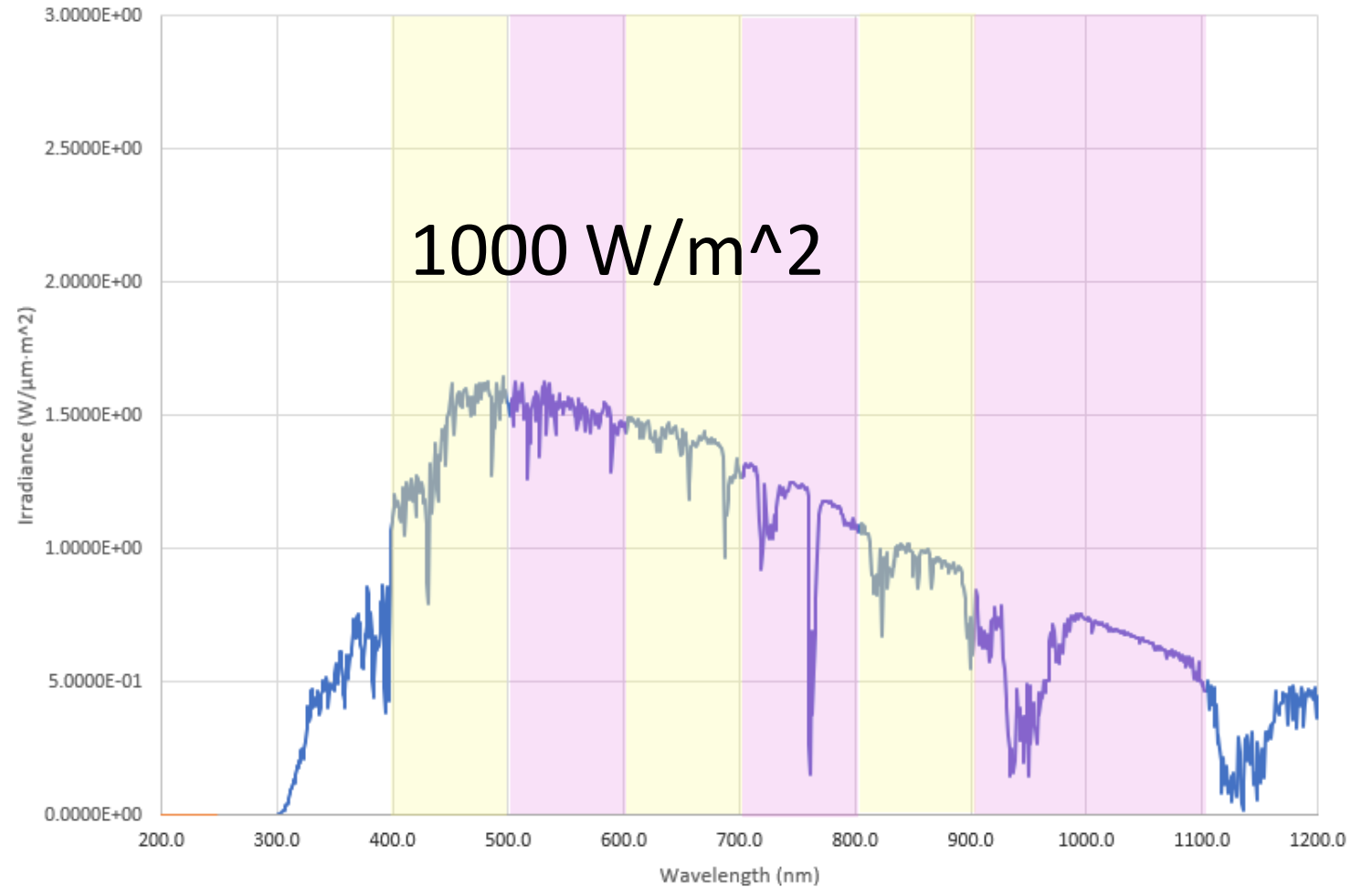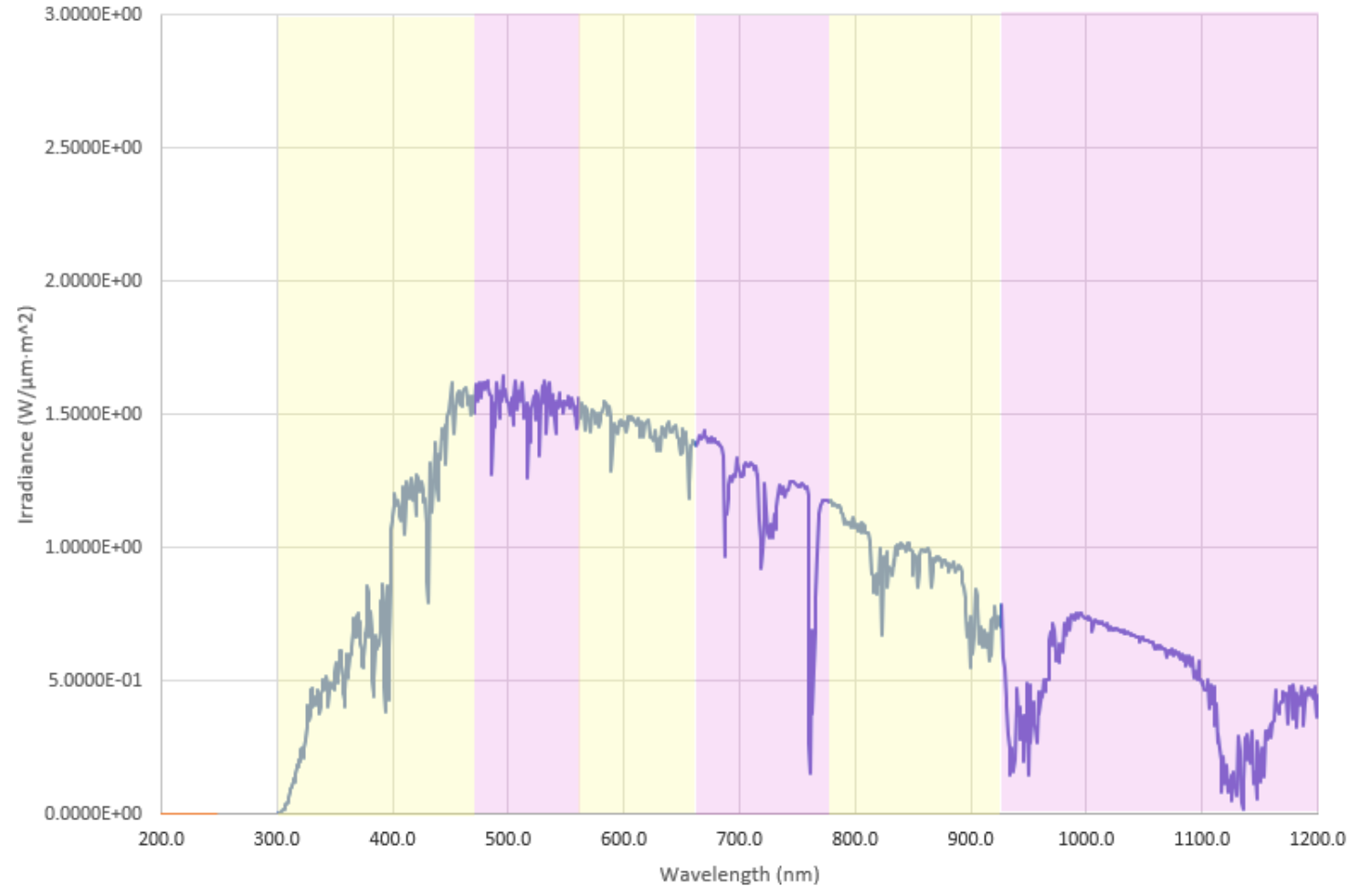
Spectral Band for Solar Simulator Standards

ASTM AM0 2019

Band Start	350	400	500	600	700	800	900	1100
Band End	400	500	600	700	800	900	1100	1400
Percent Power	4.67	16.8	16.68	14.28	11.31	8.98	13.5	12.56

ASTM AM1.5G

Band Start	400	500	600	700	800	900
Band End	500	600	700	800	900	1100
Percent Power	18.21	19.73	18.2	14.79	12.39	15.89

IEC 60904-9 ed2

Band Start	400	500	600	700	800	900
Band End	500	600	700	800	900	1100
Percent Power	18.4	19.9	18.4	14.9	12.5	15.9

IEC 60904-9 ed3

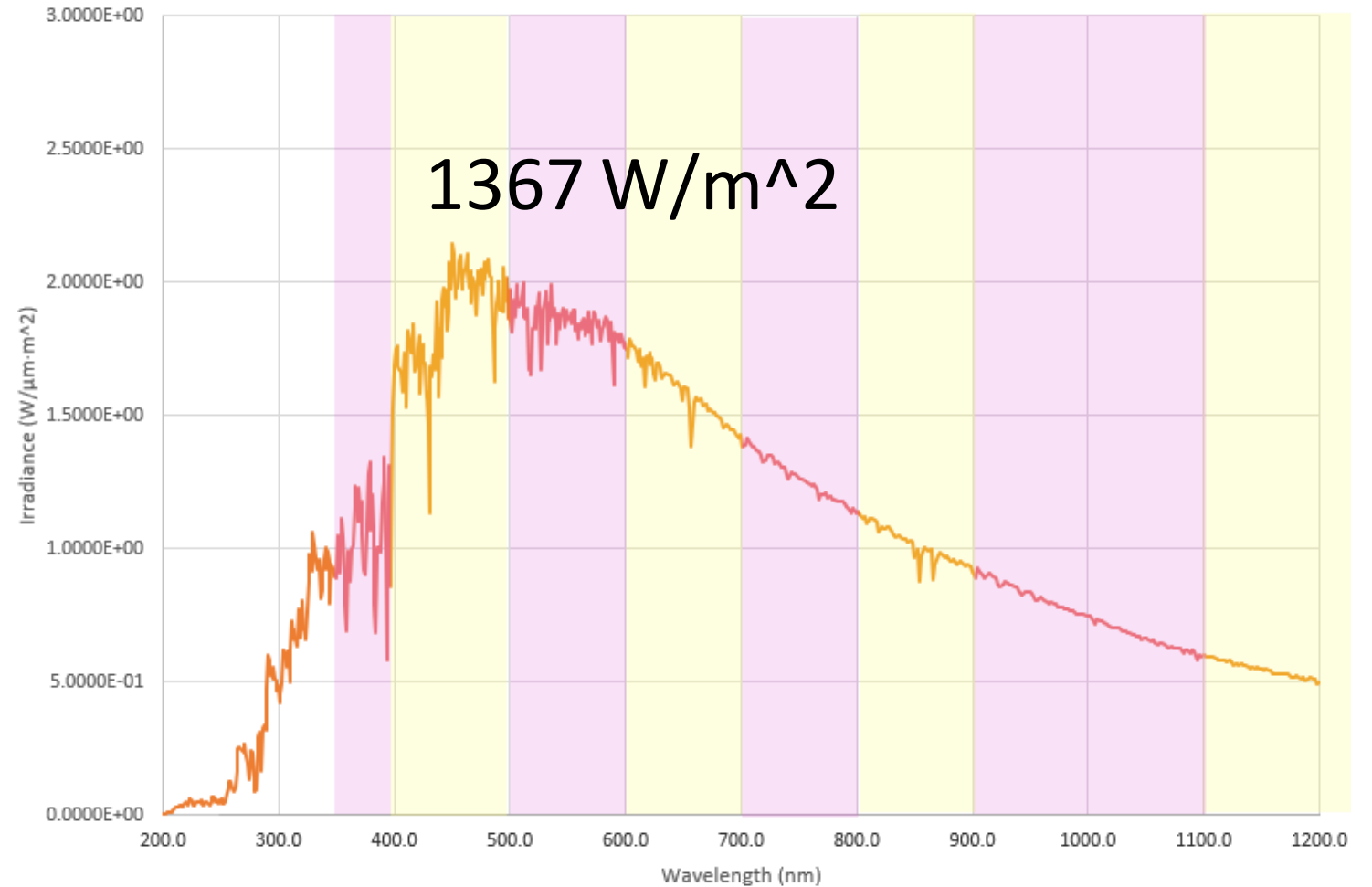|						
Band Start	300	470	561	657	772	919
Band End	470	561	657	772	919	1200
Percent Power	16.61	16.74	16.67	16.63	16.66	16.69

AM1.5G Spectral Bands (ASTM & IEC)

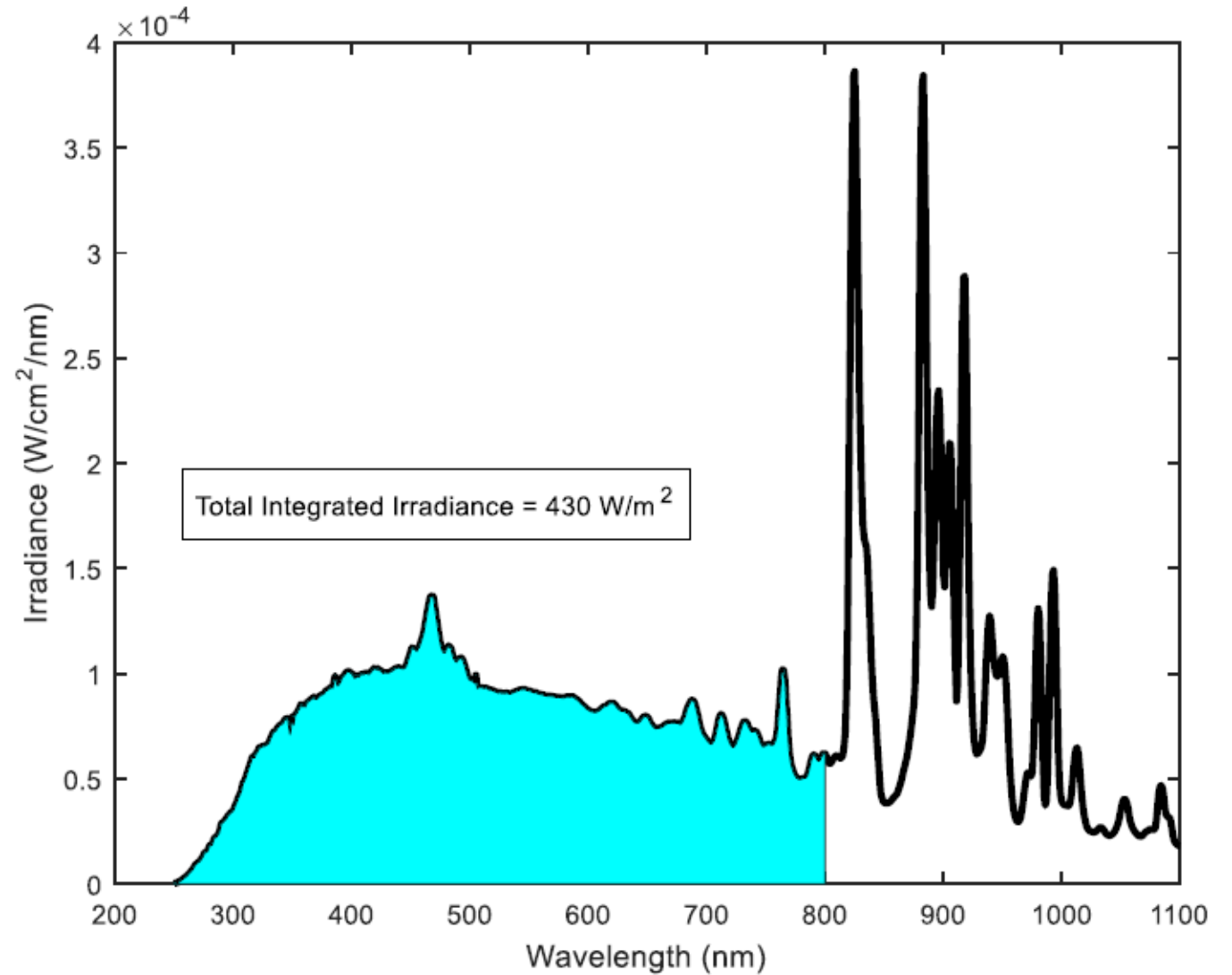# AM1.5G Spectral Bands (latest IEC)

AM0 Spectral Bands (ASTM)

1367 W/m^2

Mars Solar Simulator

- Simulate UV-Vis on Martian surface

- 430 W/m^2

- Spectral fit to AM0 (no Martian standard)

- Measuring UV shorter than 300 nm problematic due to stray light

CONUS Spectrum

- Simulator for upper atmospheric photochemistry experiments

- UV spectrum more tightly specified than VIS.

- Custom arrangement with many optical elements required custom filtering

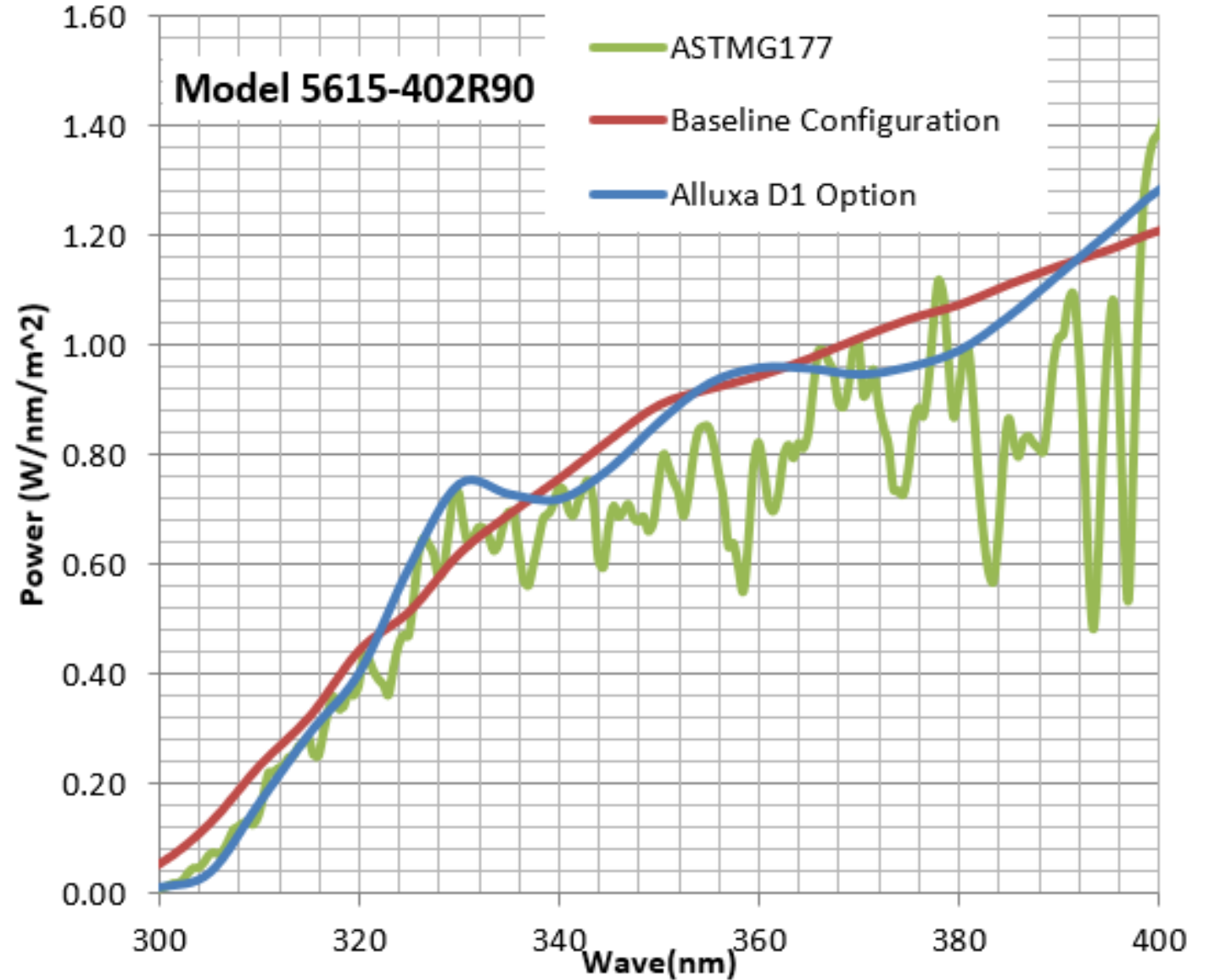| CONUS						
Band Start	280	315	400	500	600	700
Band End	315	400	500	600	700	800
Percent Power	0.5	5.9	22.6	26.3	24.8	20.3

CONUS Spectrum

- Simulator for upper atmospheric photochemistry experiments

- UV spectrum more tightly specified than VIS.

- Custom arrangement with many optical elements required custom filtering

MIL-STD-810H

- Testing materials degradation and heat effects

- UV distribution more tightly specified than VIS or IR

- Simulates standing in desert near equator (1120 W/m^2)

- Simulates diurnal cycle

| MIL-STD 810H							
Band Start	280	320	360	400	520	640	800
Band End	320	360	400	520	640	800	3000
Percent Power	0.5	2.4	3.2	17.9	16.6	17.3	42.1

MIL-STD-810H

- Testing materials degradation and heat effects

- UV distribution more tightly specified than VIS or IR

- Simulates standing in desert near equator (1120 W/m^2)

- Simulates diurnal cycle
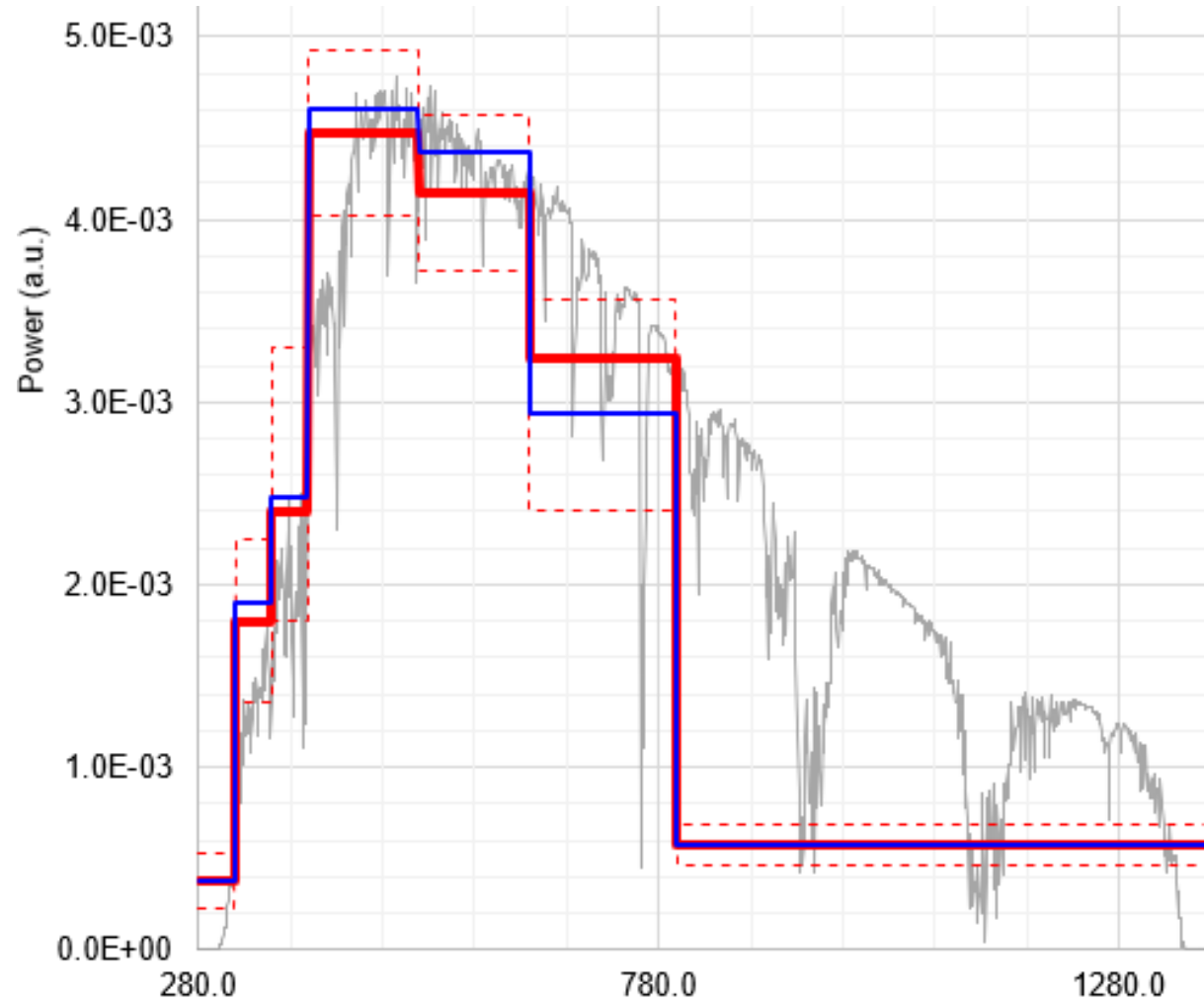
Sunscreen Testing

- Simulates sunlight for in vivo sunscreen testing

- Very tight specification of UV, especially below 340 nm

- Spectral bands are cumulative

- Specification based on erythemal effectiveness
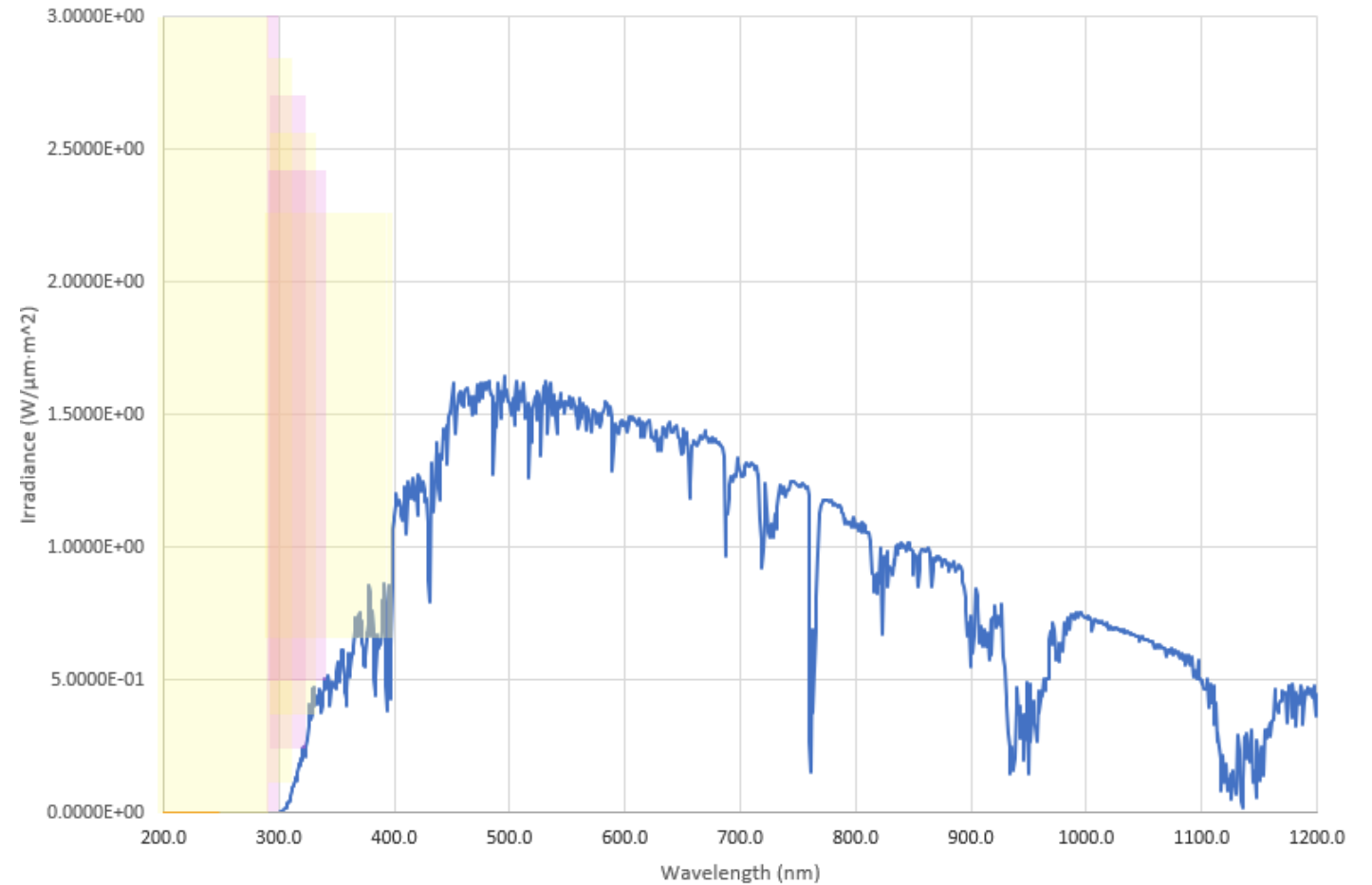
ISO 24444

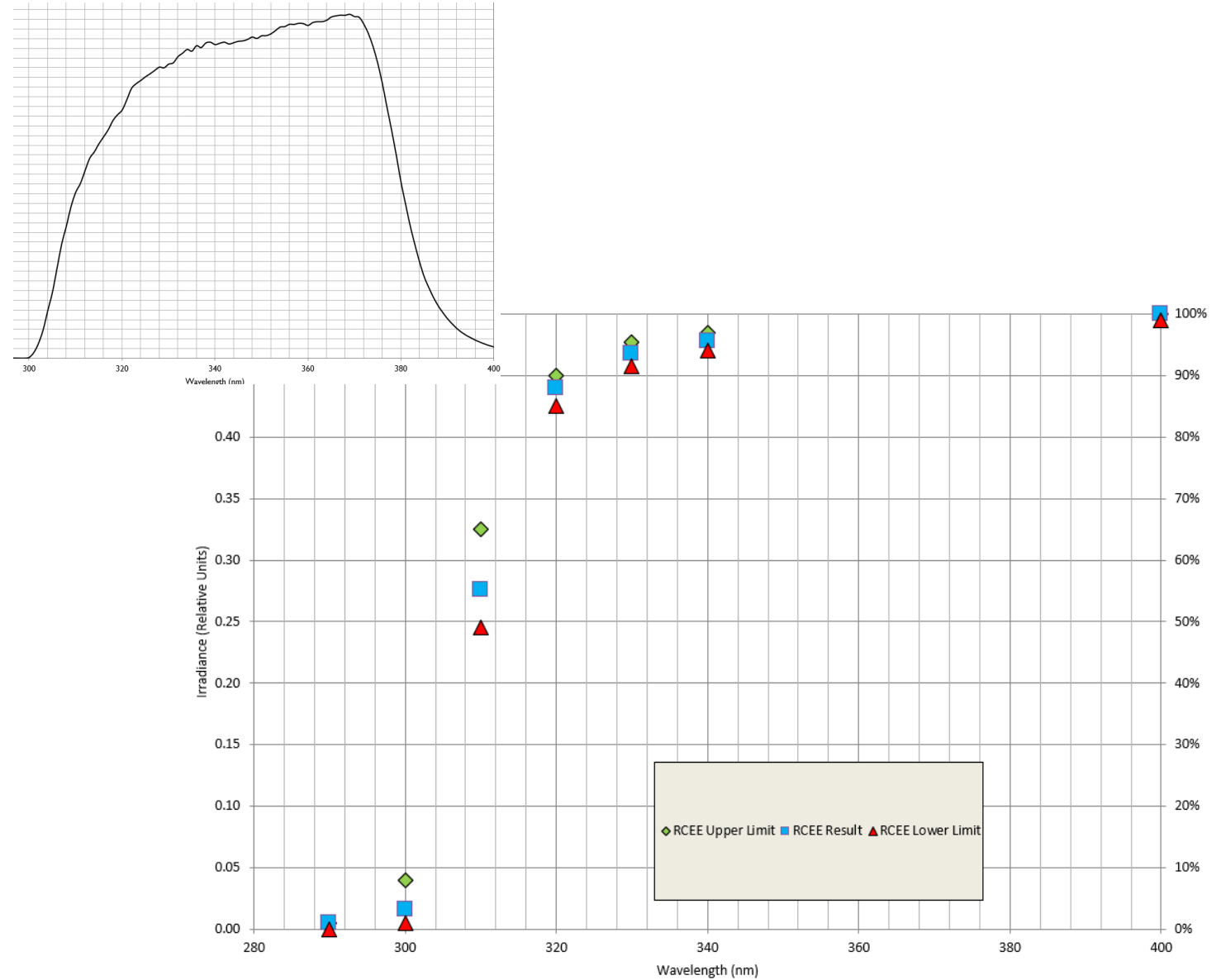|						
Band Start	0	290	290	290	290	290	290
Band End	290	300	310	320	330	340	400
Lower RCEE	0	1	49	85	91.5	94	99.9
Upper RCEE	0.1	8	65	90	95.5	97	100

Sunscreen Testing

- Simulates sunlight for in vivo sunscreen testing

- Very tight specification of UV, especially below 340 nm

- Spectral bands are cumulative

- Specification based on erythemal effectiveness
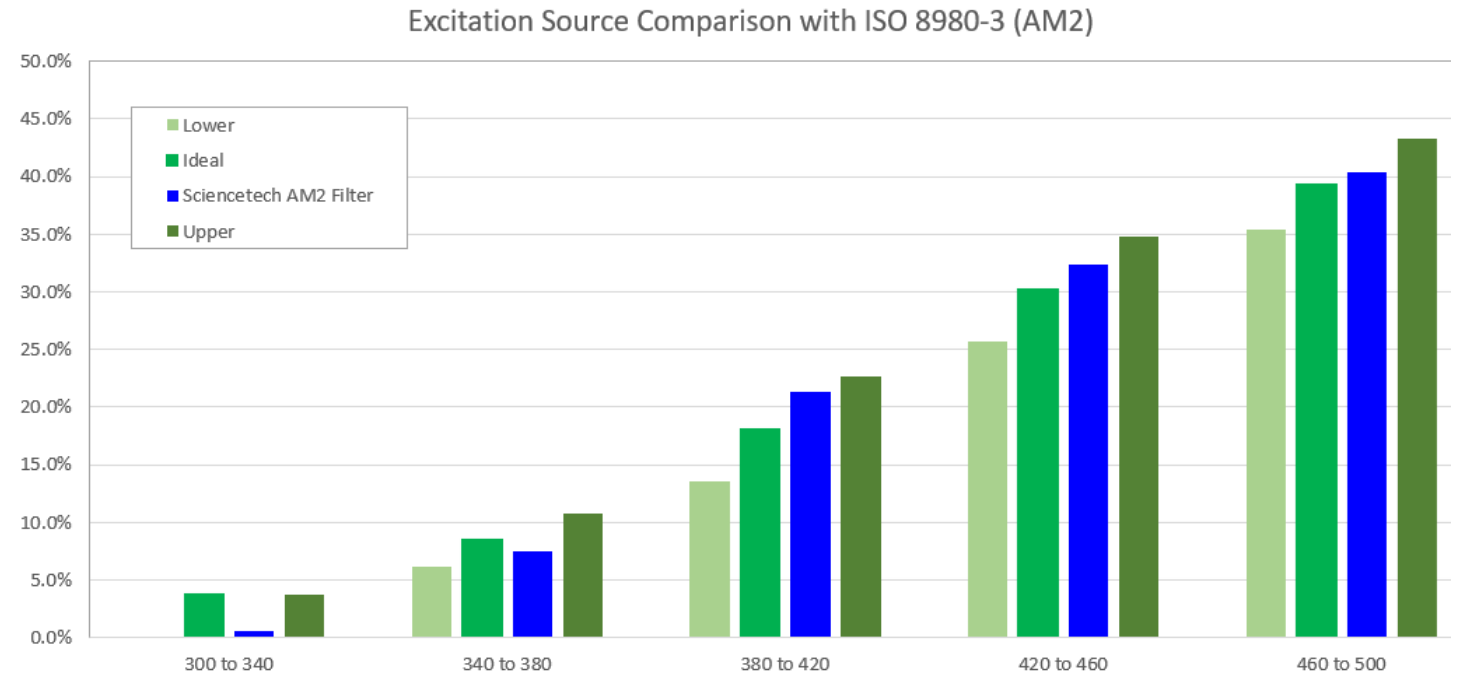
Photochromic Coating

- Testing darkening of photochromic coating in sunlight (i.e. "Transitions lenses")

- Spectral match in narrower 40 nm bands

- Photochromic response due to wavelengths ~400 nm and shorter

- Issues measuring lens transmission in UV due to probe beam causing photochromic response
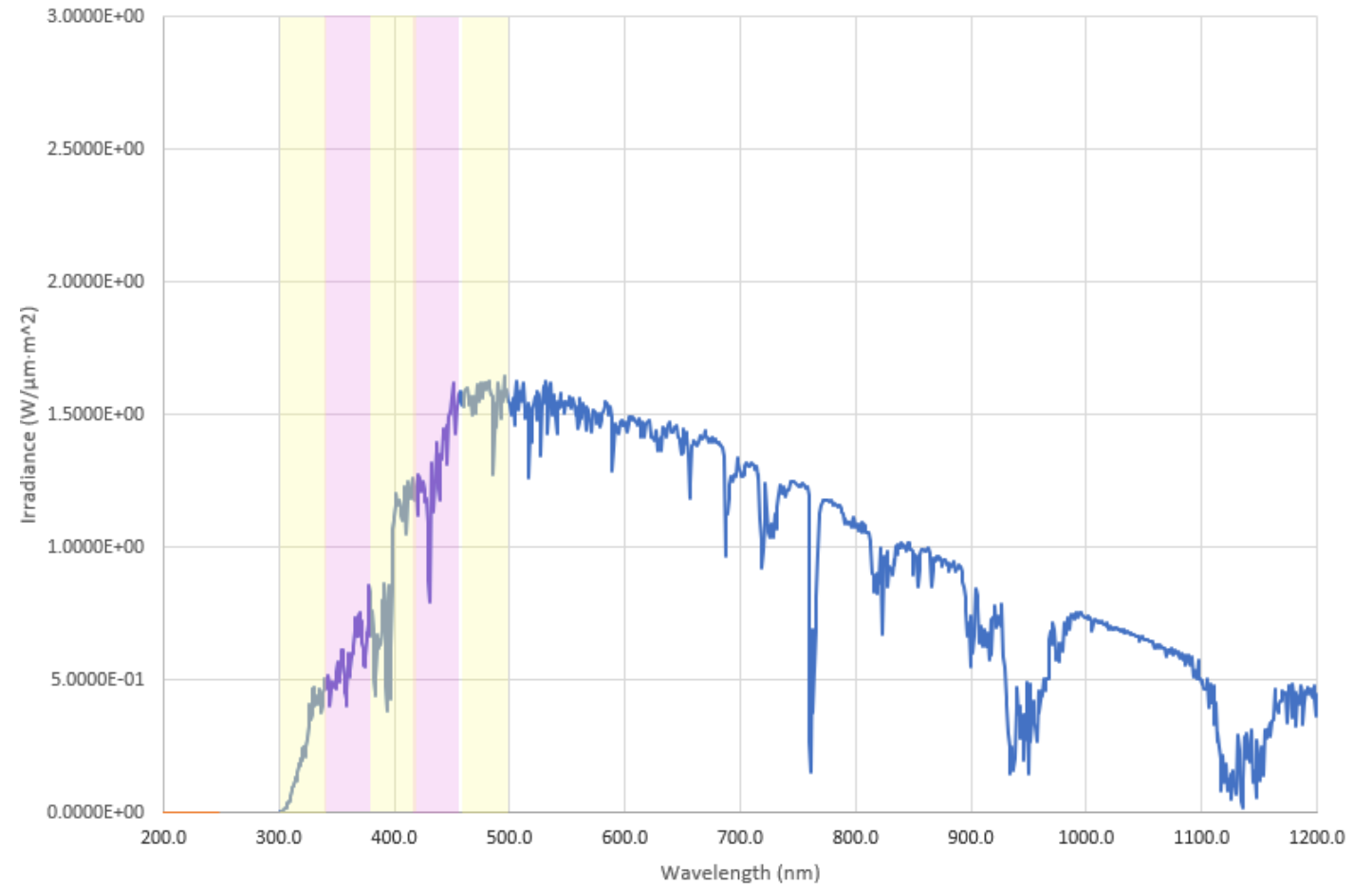
ISO 8980					
Band Start	300	340	380	420	460
Band End	340	380	420	460	500
W/m^2	2.5	5.6	12	20	26
Percent Power	3.78	8.47	18.15	30.26	39.33

Photochromic Coating

- Testing darkening of photochromic coating in sunlight (i.e. "Transitions lenses")

- Spectral match in narrower 40 nm bands

- Photochromic response due to wavelengths ~400 nm and shorter

- Issues measuring lens transmission in UV due to probe beam causing photochromic response

Excitation Source Comparison with ISO 8980-3 (AM2)

Legend: Lower, Ideal, Sciencetech AM2 Filter, Upper

x-axis categories: 300 to 340, 340 to 380, 380 to 420, 420 to 460, 460 to 500

Conclusion

- Many solar simulator standards exist and are evolving towards tighter specifications

- Many fields specify their own specialized standards for illumination

- The UV portion of the spectrum has the greatest attention and it is the most difficult to properly measure