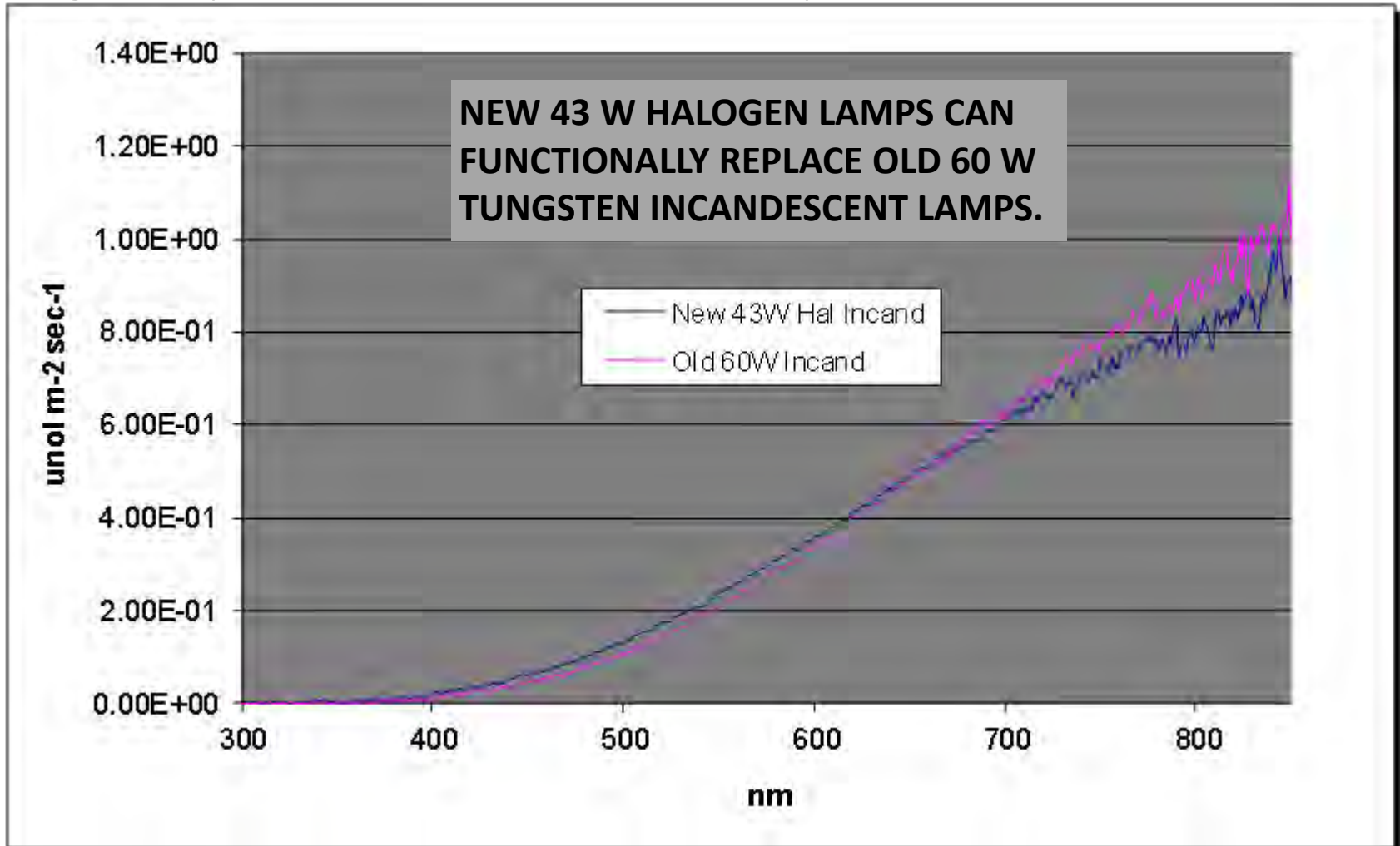




730_{NM} LED ALTERNATIVES TO INCANDESCENT LAMPS FOR SUPPLEMENTARY FAR RED RADIATION IN GROWTH CHAMBERS

Supplementary Lamps for Far Red

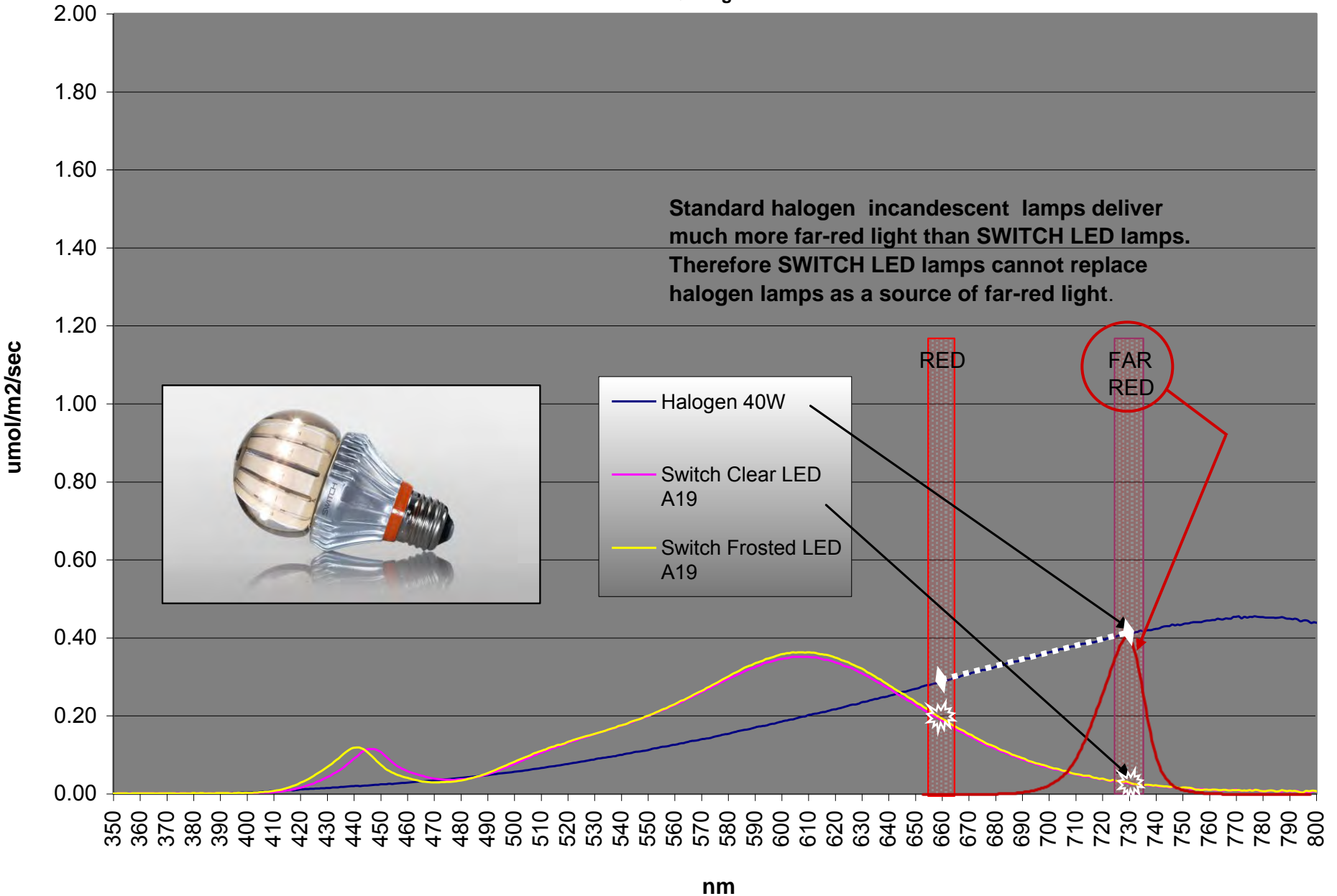
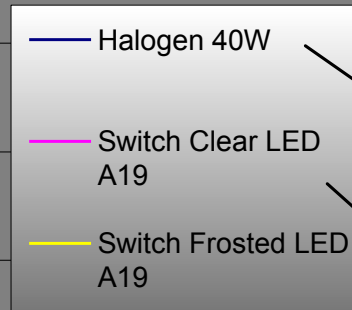
To add Far Red above 700 nm – Historically, Incandescent Tungsten and now Halogen lamps are the lowest initial cost compared to Far Red LEDs.



SWITCH Brand LED vs. Halogen Incandescent For Far Red Supplementation

R. Quiring March 26/13

Standard halogen incandescent lamps deliver much more far-red light than SWITCH LED lamps. Therefore SWITCH LED lamps cannot replace halogen lamps as a source of far-red light.



Fluorescent CFL “Incandescent Replacement” Lamps are NOT a source of Far Red Radiation.

- Changing out Incandescent lamps with CFLs will increase the delivered PAR somewhat but there is essentially NO Far Red contribution.



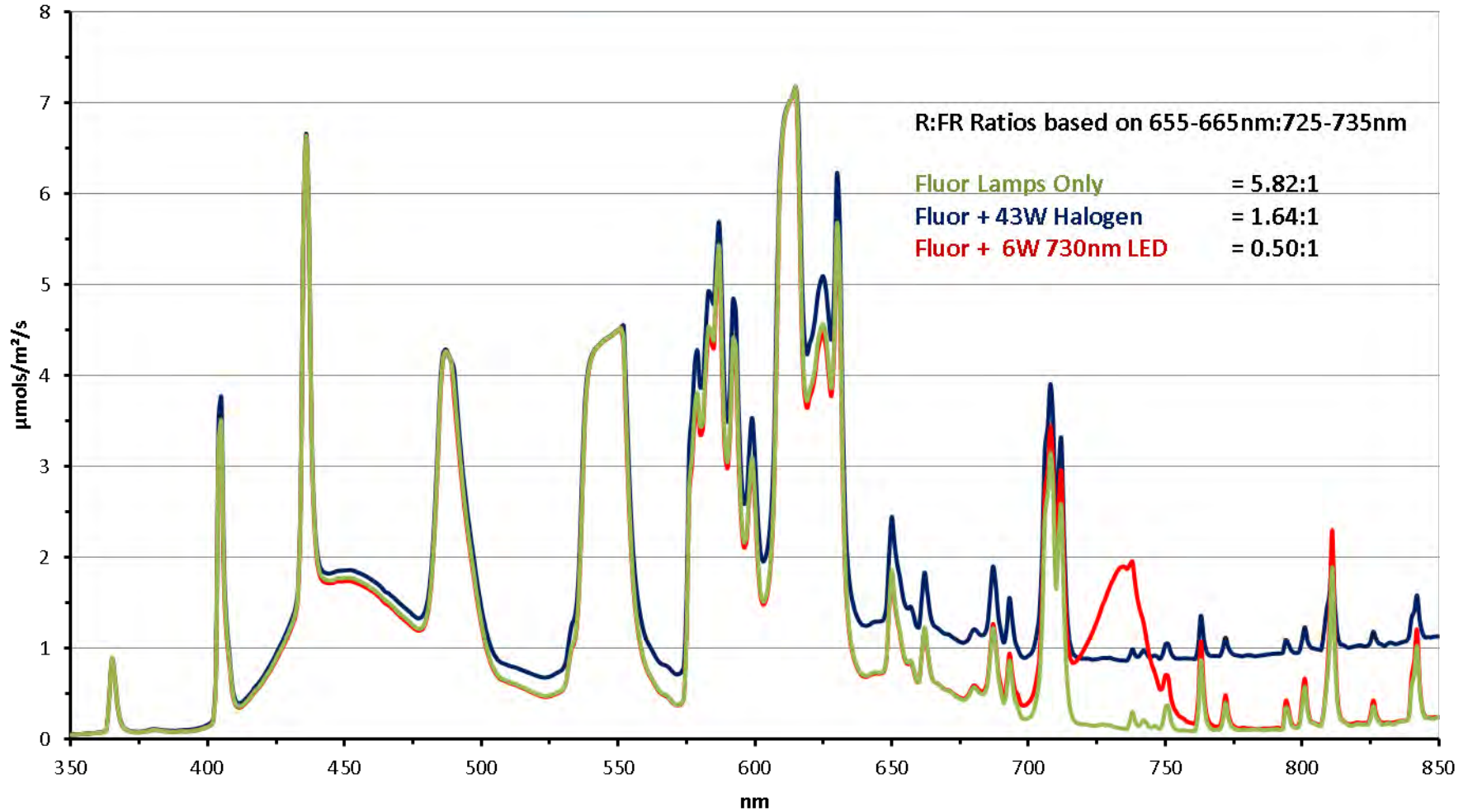
Supplementary Lamps for Far Red – Existing Chambers

- Historically Incandescent Tungsten, and now slightly more efficient Halogen lamps
- Traditional filament lamps are becoming obsolete and hard to find.
- Many complaints about short incandescent life span and sensitivity to vibration.
- Moving to 730nm LEDs as supplementary light source for independent Far Red
- **NOTE!** Unlike old filament lamps, ALL Electronic driven lamps MUST be CSA/UL/CE certified. Many have temperature limitations lower than maximum chamber ranges.



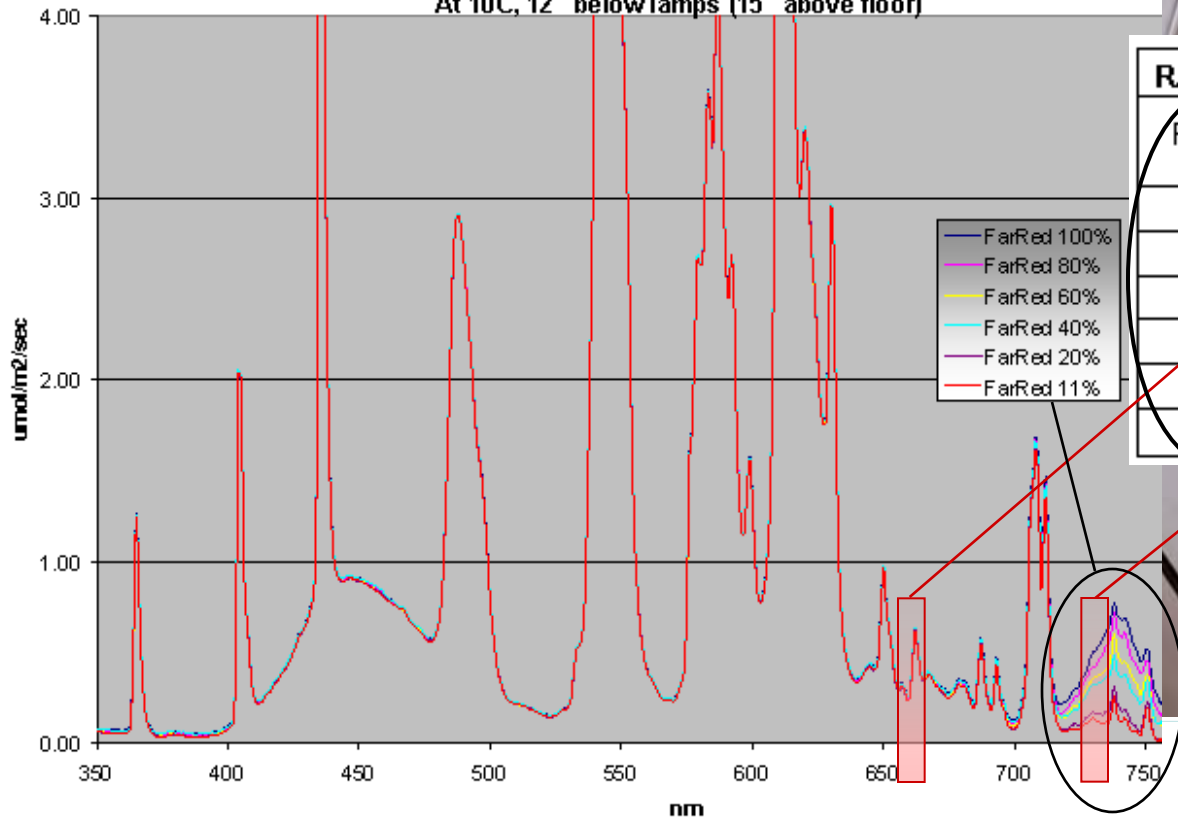
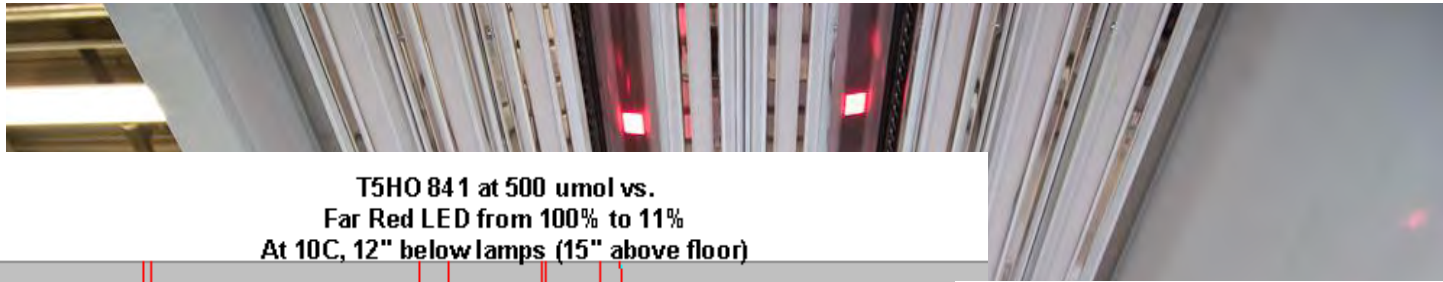
Comparison of T5/841 Fluorescent Lamps ONLY to Fluorescent + 12 x 6W Far Red LED Bulbs and Fluorescent + 12 x 43W Sylvania Halogen Bulbs

— $\mu\text{mols}/\text{m}^2/\text{s}$ (Fluor +Halogen.)
 — $\mu\text{mols}/\text{m}^2/\text{s}$ (Fluor+ Far Red LED)
 — $\mu\text{mols}/\text{m}^2/\text{s}$ (Fluor Only)



T5HO Fluorescent with Illumitex 730nm LED Bars

Independent dimming control of the primary T5HO lamps and the supplementary 730nm LED Far Red fixtures enables R:FR ratio of 1.1:1 specified by the researcher:



| R:FR, At 500 umol vs. Various FR Set Points | | | |
|---|------------------------|-------------------------|-------------|
| FR Set Point | Irradiance R 655-665nm | Irradiance FR 725-735nm | R:FR |
| 100% | 4.23 | 5.28 | 0.80 |
| 80% | 4.08 | 4.55 | 0.90 |
| 60% | 4.03 | 3.71 | 1.09 |
| 40% | 4.21 | 3.32 | 1.27 |
| 20% | 4.00 | 1.67 | 2.40 |
| 11% | 4.00 | 1.26 | 3.18 |

DIMMABLE 730nm LED BARS CAN PROVIDE ABUNDANT AND ADJUSTABLE FAR RED.

LED Wide Spectrum Primary Lighting plus Independent 730nm Far Red supplementary Lighting

- LED sources are a maturing form of producing light efficiently for plant growth, but evolution is rapid.
- LED Spectra available for Primary and Supplementary lighting applications
- Multiple suppliers of LEDs available for integration into chambers to meet spectral requirements
- Approx. 40%-50% energy saving possible over T5HO lamps
- Higher initial Cost for LED

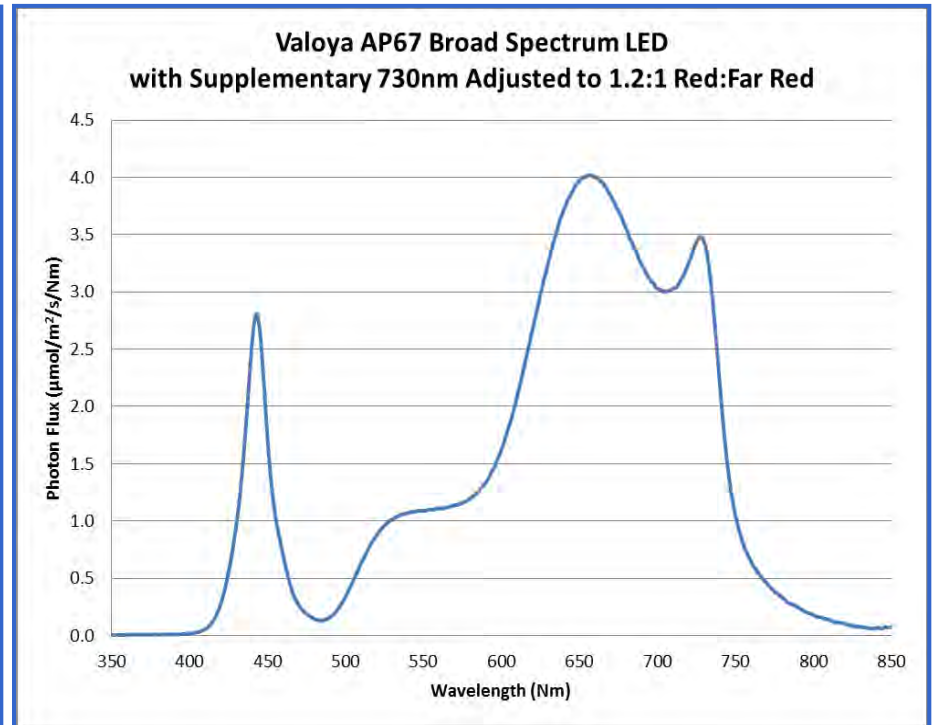
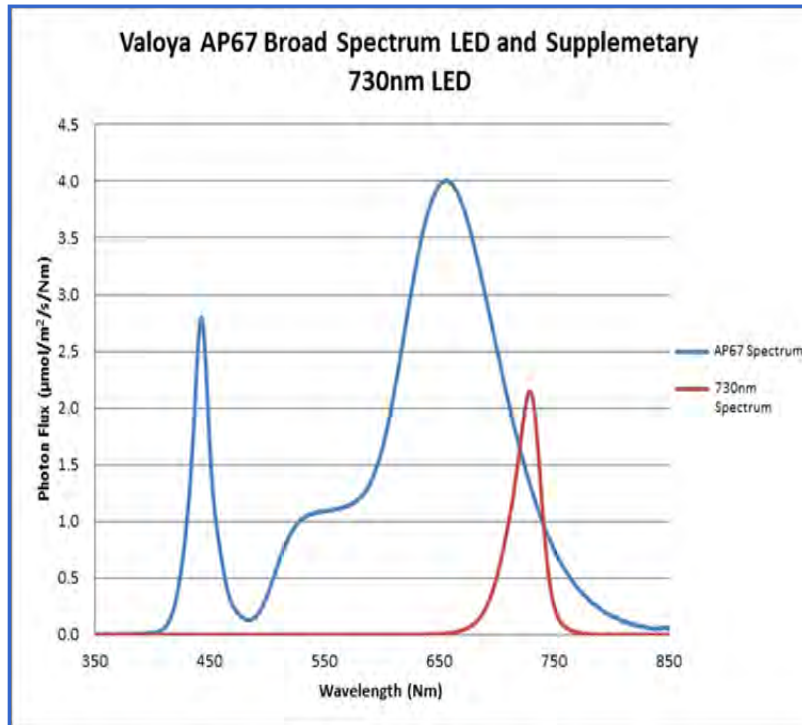


| Lighting – Large Chamber with Valoya AP67 Spectrum combined with Independent 730 nm Far Red Fixtures



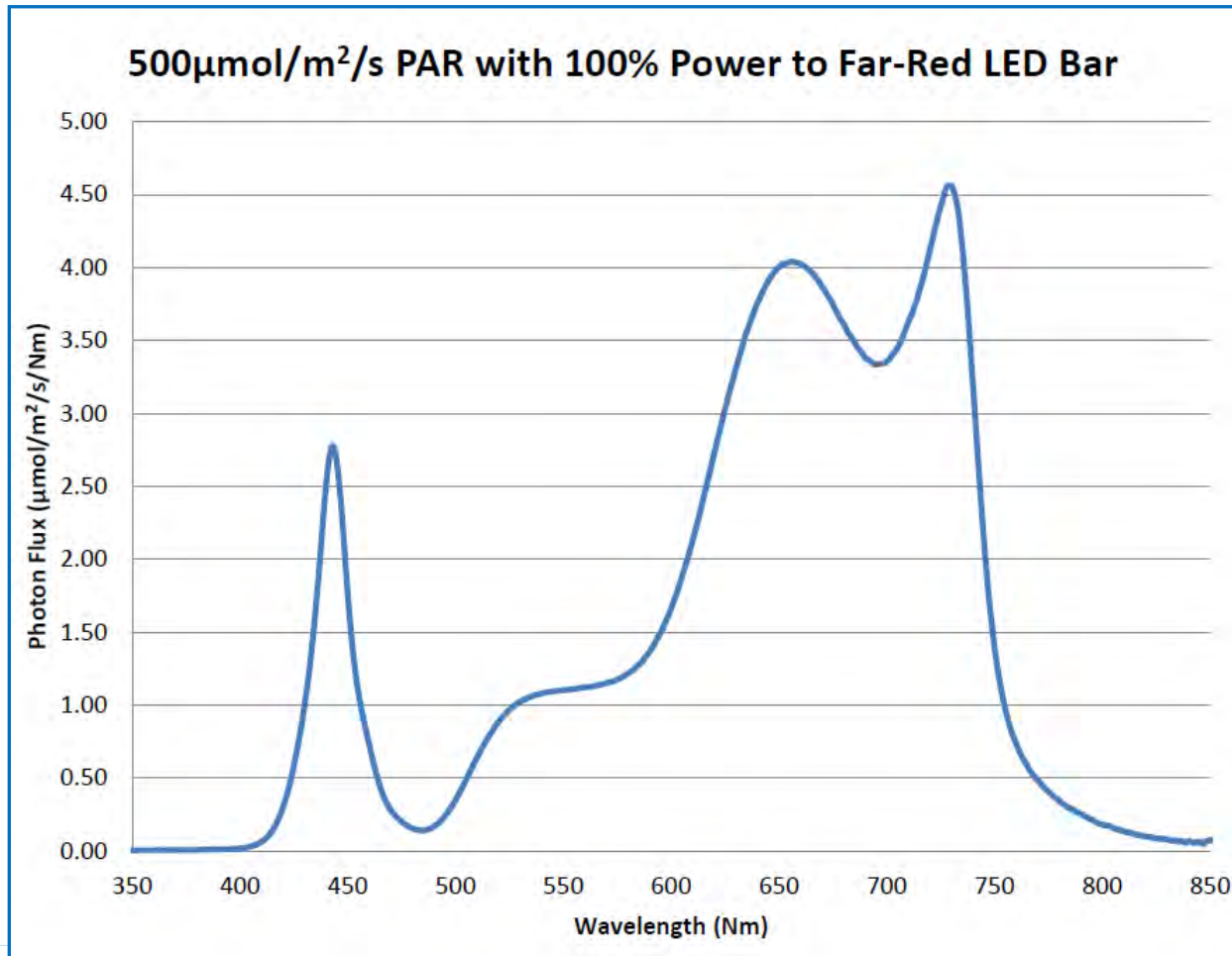
Lighting – Valoya Broad Spectrum Primary LED with Supplementary 730nm LED for near Solar Noon R:FR

Here are SPD charts of the Valoya AP67 and 730nm fixtures shown separately and then combined to deliver the client's specification to have a 1.2:1 R:FR at 500 μmol PAR (1m below the lamps).



| Lighting – Valoya Broad Spectrum Primary LED with Supplementary 730nm LED for near Solar Noon R:FR

Here is the SPD chart of the Valoya AP67 and 730nm fixtures combined with the FR LEDs at full power.
The R:FR ratio achieved was 0.9:1. Measure PPE was 0.73.



Valoya LED Broad NS1 Spectrum Primary Lighting Fixtures with Integrated 730nm Far Red Supplementary LEDs Independent Dimming Control of Each Channel

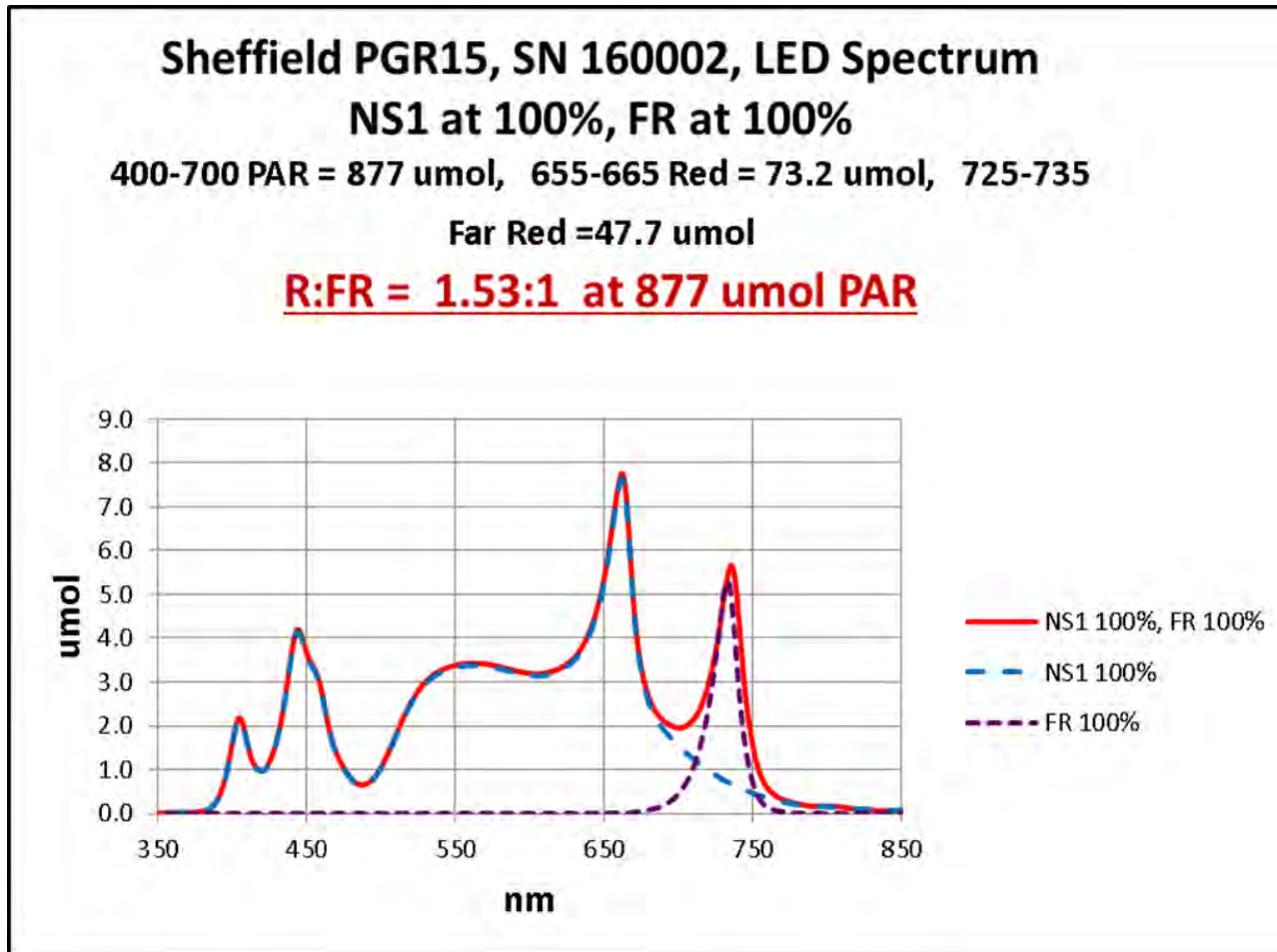
- This integrated Valoya solution enables significant Far Red radiation with the best possible uniformity of BOTH the Primary Broad Band PAR and the Supplementary Far Red light.
- This photo is looking up at the 5 fixture array in a 16 sq. ft. chamber. The Primary light channel is OFF shown how uniformly the 730 nm LEDs are distributed in the lamp canopy.



Valoya LED Broad NS1 Spectrum Primary Lighting Fixtures with Integrated 730nm Far Red Supplementary LEDs

Independent Dimming Control of Each Channel

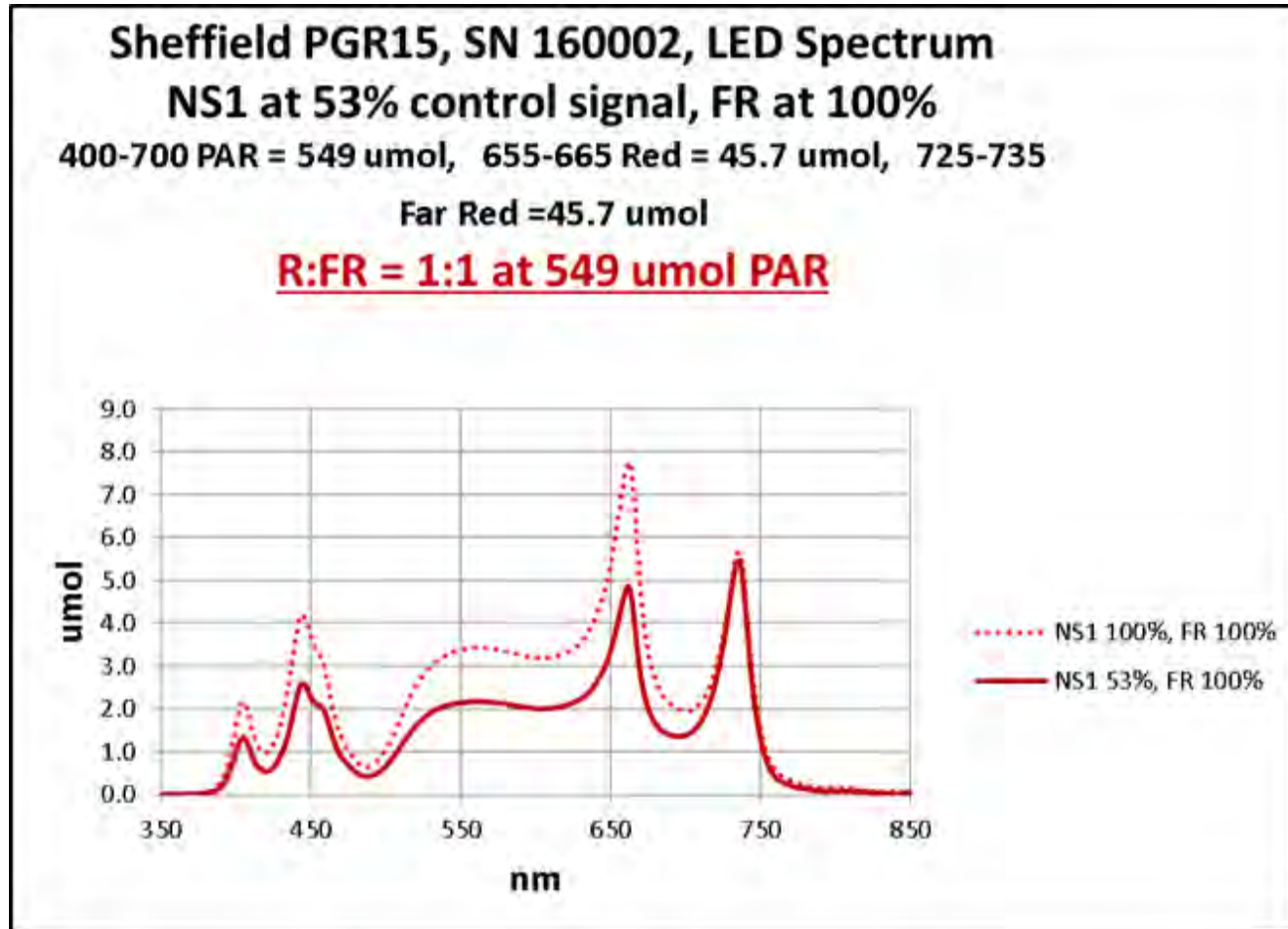
- With both the Primary and Supplementary LED channels at 100% at 12" (300mm) below the lights, the system achieved an average **877 umol PAR** with a **1.53:1 R:FR ratio**.



Valoya LED Broad NS1 Spectrum Primary Lighting Fixtures with Integrated 730nm Far Red Supplementary LEDs

Independent Dimming Control of Each Channel

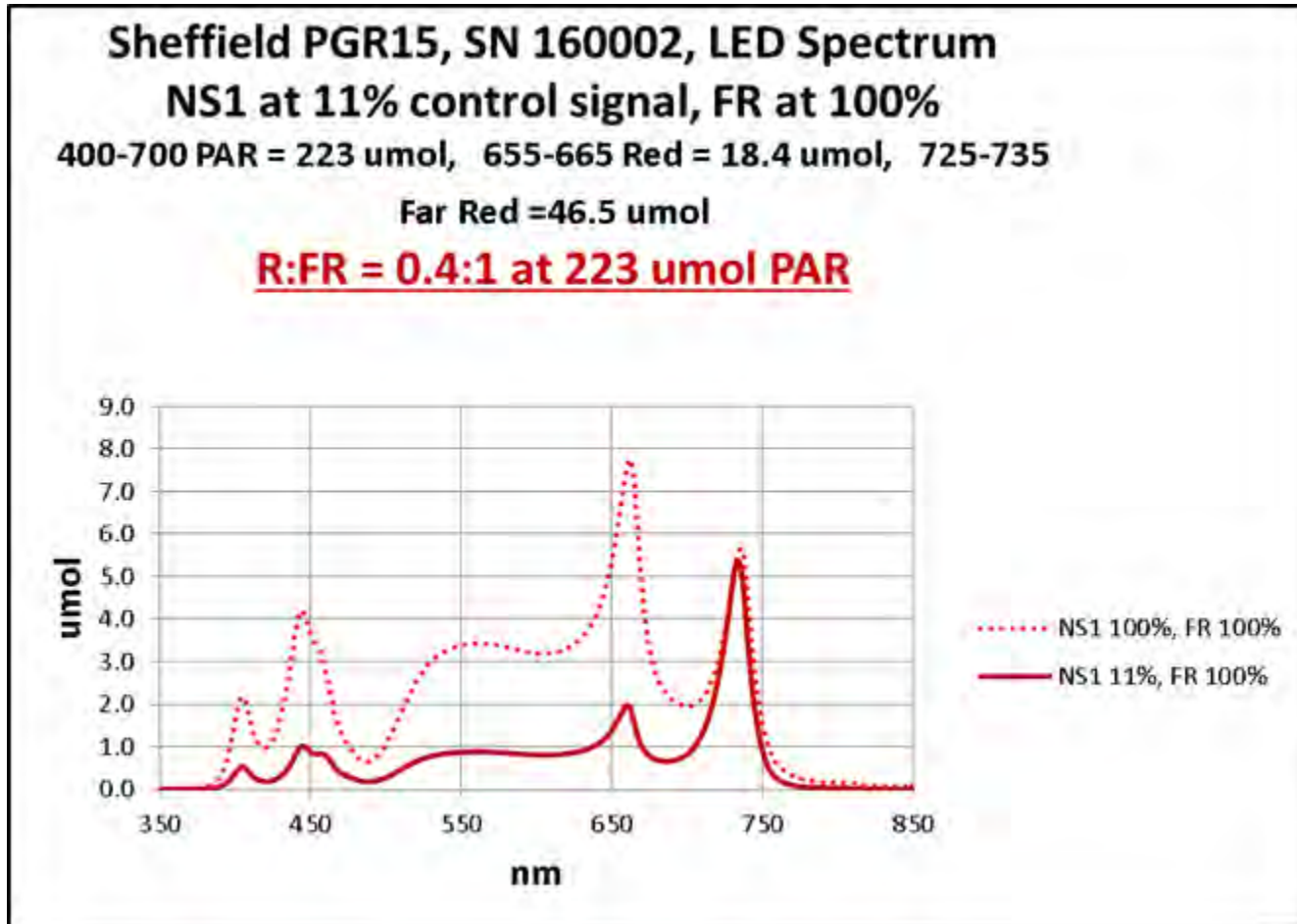
- With the Primary dimmed down and Supplementary LED channel at 100%, at 12" (300mm) below the lights, the system achieved an average **549 μmol PAR with a 1:1 R:FR ratio.**



Valoya LED Broad NS1 Spectrum Primary Lighting Fixtures with Integrated 730nm Far Red Supplementary LEDs

Independent Dimming Control of Each Channel

- With the Primary dimmed to minimum and Supplementary LED channel at 100%, at 12" (300mm) below the lights, the system achieved an average **223 μmol PAR with a 0.4:1 R:FR ratio.**





END

Thank you for your interest and participation