

Large High-Output LED Array for Plant Growth

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ORBITEC LED Plant Growth Room



Physical Characteristics

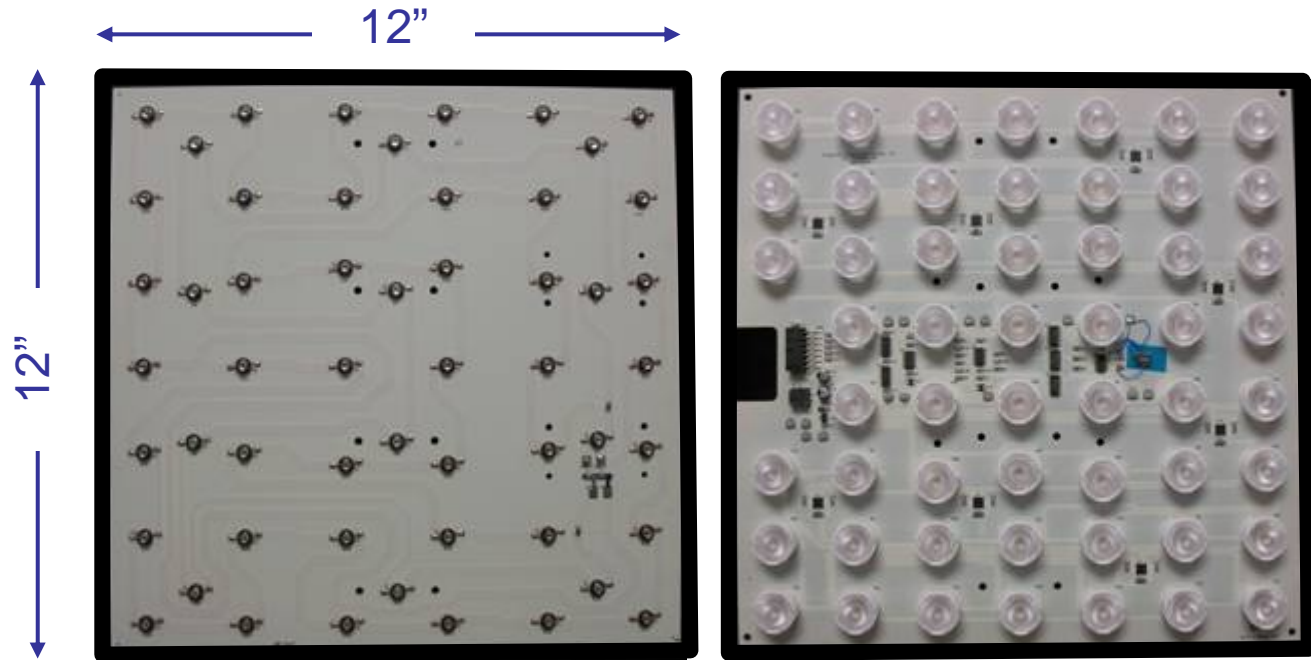


Four arrays per room



Three rows of 5 panels, each row has independent control of red and blue light levels

Second generation LED panel



LED Panel v.1

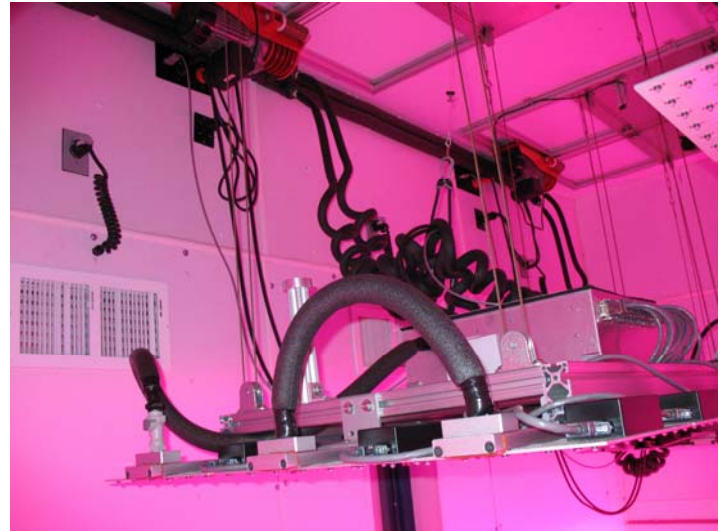
42 red (640)/12 blue (460)

LED Panel v.2

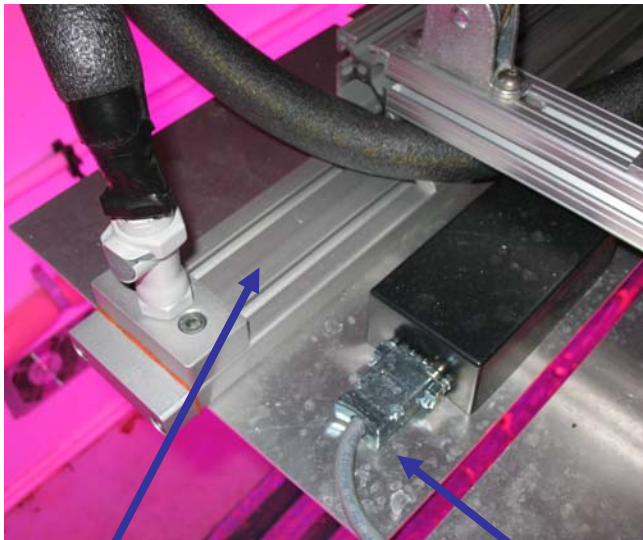
Physical Characteristics



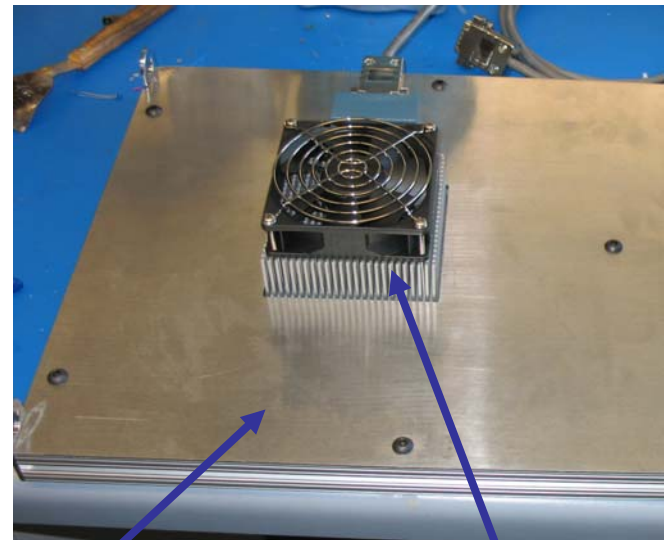
- Each 3' x 5' array suspended from ceiling with hoist to control vertical position
- Vertical travel range is from 1' to 10'



LED Panel Cooling Systems



Chilled water conduit



Fan/heat sink combination

LED panel

Individual LED panels in both systems have over-temperature protection

Electrical Characteristics

Room #1

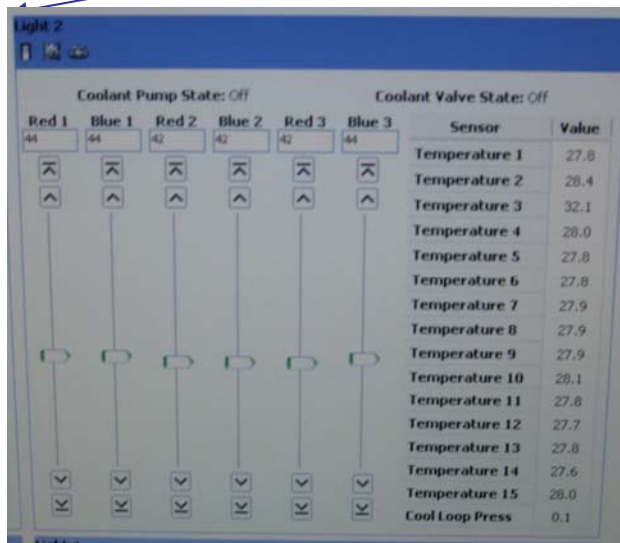
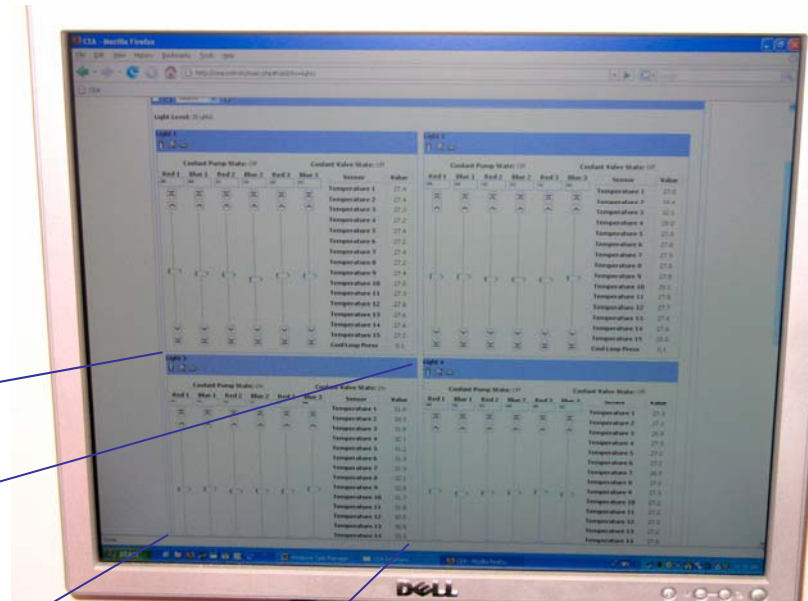
- Light levels in excess of $1200 \mu\text{mol m}^{-2} \text{s}^{-1}$.
- Runs on 48VDC and uses a high efficiency (~95%) switching converter
- Uses about 52 amps at 208VAC at full power:
 - 152 watts (3.17 amps @ 48VDC) per panel
 - 2280 watts (47.5 amps @ 48VDC) per array
 - 9120 watts (190 amps @ 48VDC) per room



Operational Characteristics

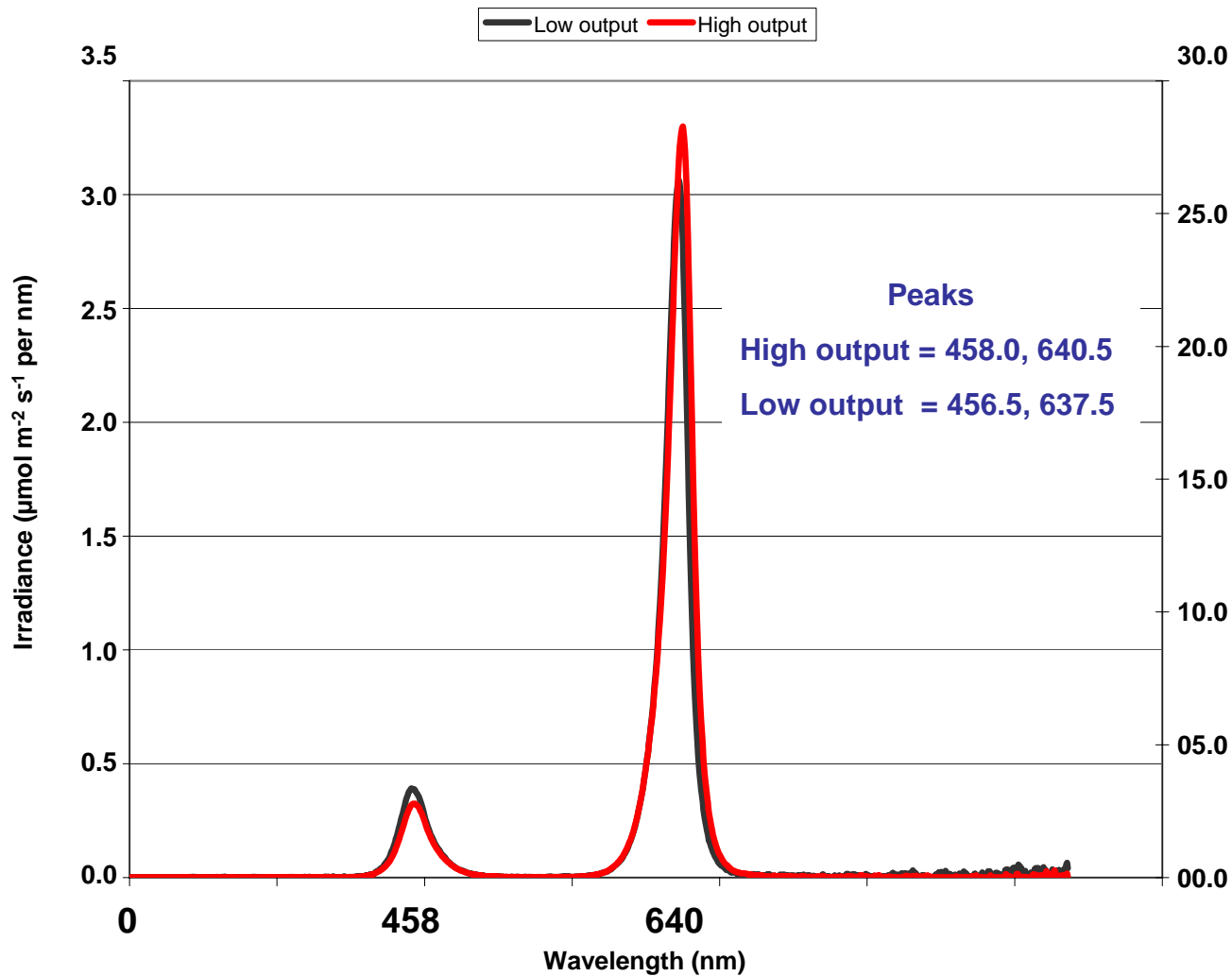
Each of four arrays controlled separately

Six sliders provided, one each for red and blue light levels for a given row



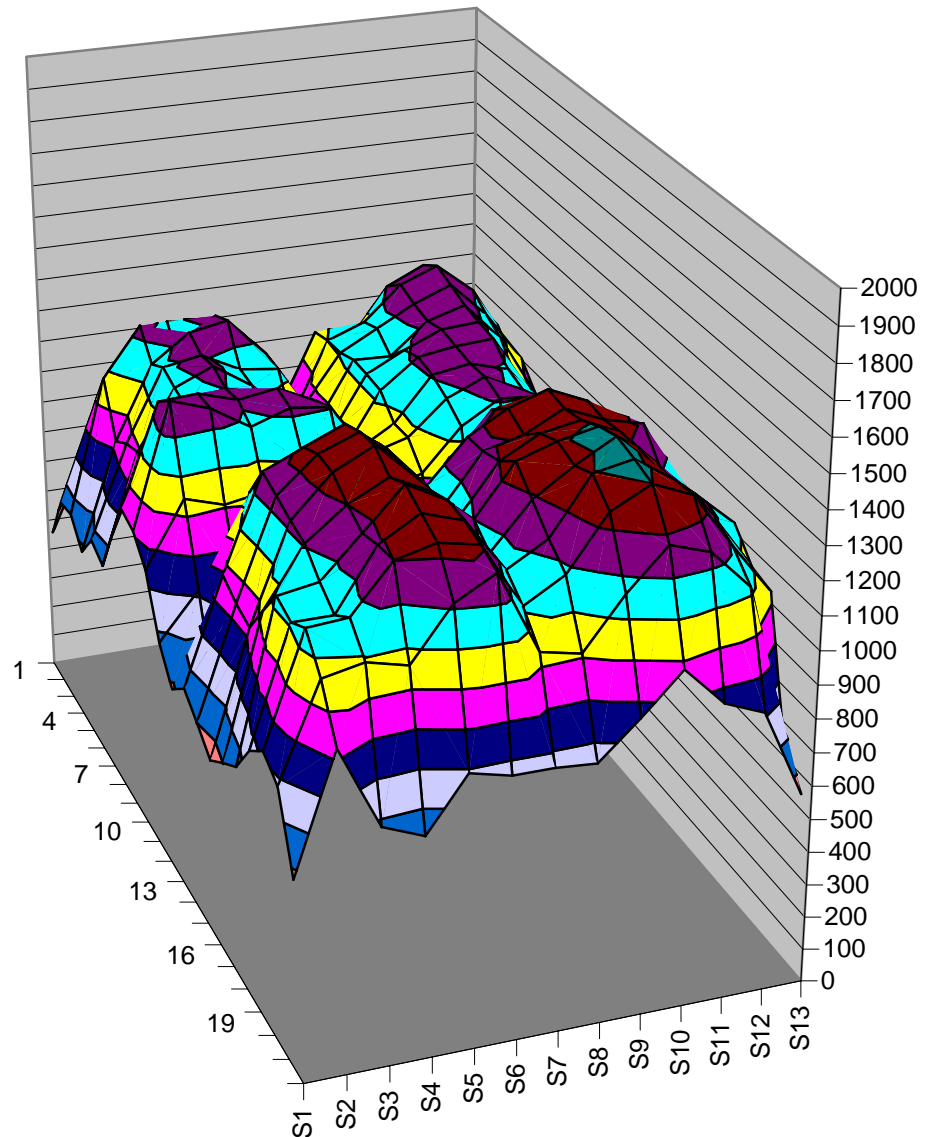
Temperature output provided for each 1 sq ft LED panel

LED Panel Spectral Composition



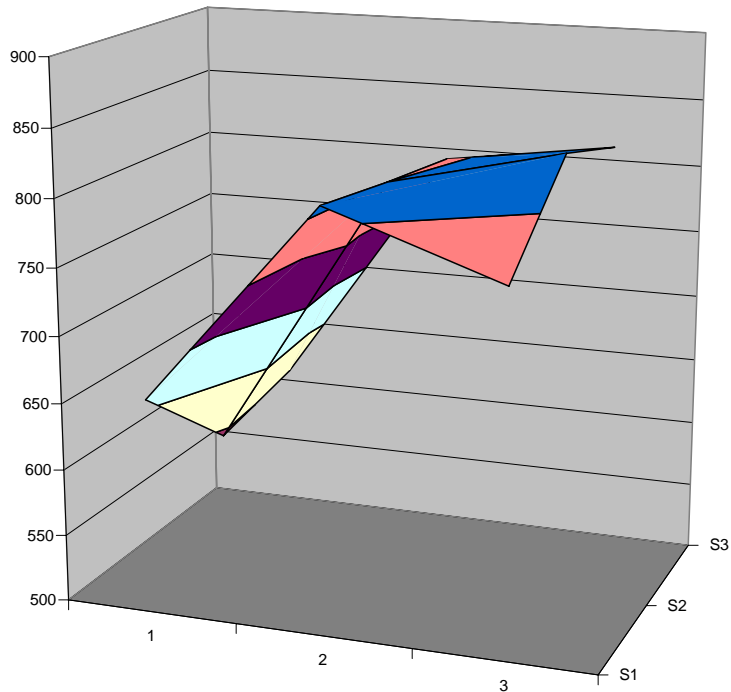
Uniformity

- 10 ft x 12 ft plant growth room
- Measurements at 20 cm from array
- Red and blue light levels set to max

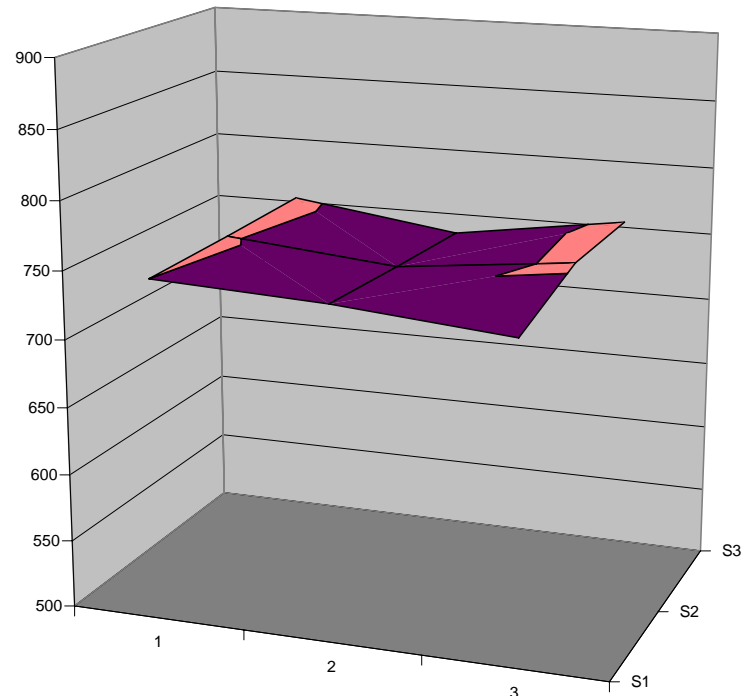


Uniformity Control

- Based on grid of nine measured points giving an average of about $740 \mu\text{mol m}^{-2}\text{s}^{-1}$
- Both graphs same scale



All six zones set at "50" on control system



Zones set at "70,70,45,45,55,55" on control system

Leaf Temperature

Room air temperature-28°C

LED panel temperature set to maintain at about 34°C

Distance between plants and LED array	Plants under LEDs		Plants in same room not under light array	
	Light Level ($\mu\text{mol m}^{-2}\text{s}^{-1}$)	Leaf Temperature (°C)	Light Level ($\mu\text{mol m}^{-2}\text{s}^{-1}$)	Leaf Temperature (°C)
1 cm	1680	29.4	12	26.8
10 cm	1450	28.7	40	27.2
20 cm	1204	27.8	45	26.9
30 cm	1061	28.4	40	27.4

Potential Power Savings

Walk-in chambers providing $1000 \mu\text{mol m}^{-2} \text{s}^{-1}$ PAR at canopy surface

Case Study	Lamp Type	“In situ” efficiency
ORBITEC plant production room	Red/Blue LEDs	$1.231 \mu\text{mol/m}^2\text{sec per W/m}^2$
High light growth chamber	HPS/MH mix	$0.285 \mu\text{mol/m}^2\text{sec per W/m}^2$
Kennedy Space Center Biomass Production Chamber	HPS	$0.417 \mu\text{mol/m}^2\text{sec per W/m}^2$

Plant Appearance



Photos of the same tobacco plant grown under (L>R) cool white fluorescent lamp, red/blue LED panel, and sunlight. (no flash used)



Observation

LED breakthrough into larger scale horticulture applications will require:

- Improvements in LED “chemistry”
 - More wavelengths
 - Higher output devices
 - More electrically efficient devices
- Improvements in LED mounting & packaging
 - Effective heat sinking
 - Reflectors
 - Lenses
- Mass production
 - Individual LED mounts
 - LED arrays