The background of the slide is a light blue color with a large, faint NASA logo watermark. The logo consists of a circular emblem containing a stylized spacecraft in orbit around a planet, with the word "NASA" written across the center. The text "ADVANCES IN SPACE-BASED PLANT RESEARCH TECHNOLOGIES" is centered at the top in a bold, black, sans-serif font.

# **ADVANCES IN SPACE-BASED PLANT RESEARCH TECHNOLOGIES**

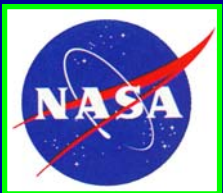
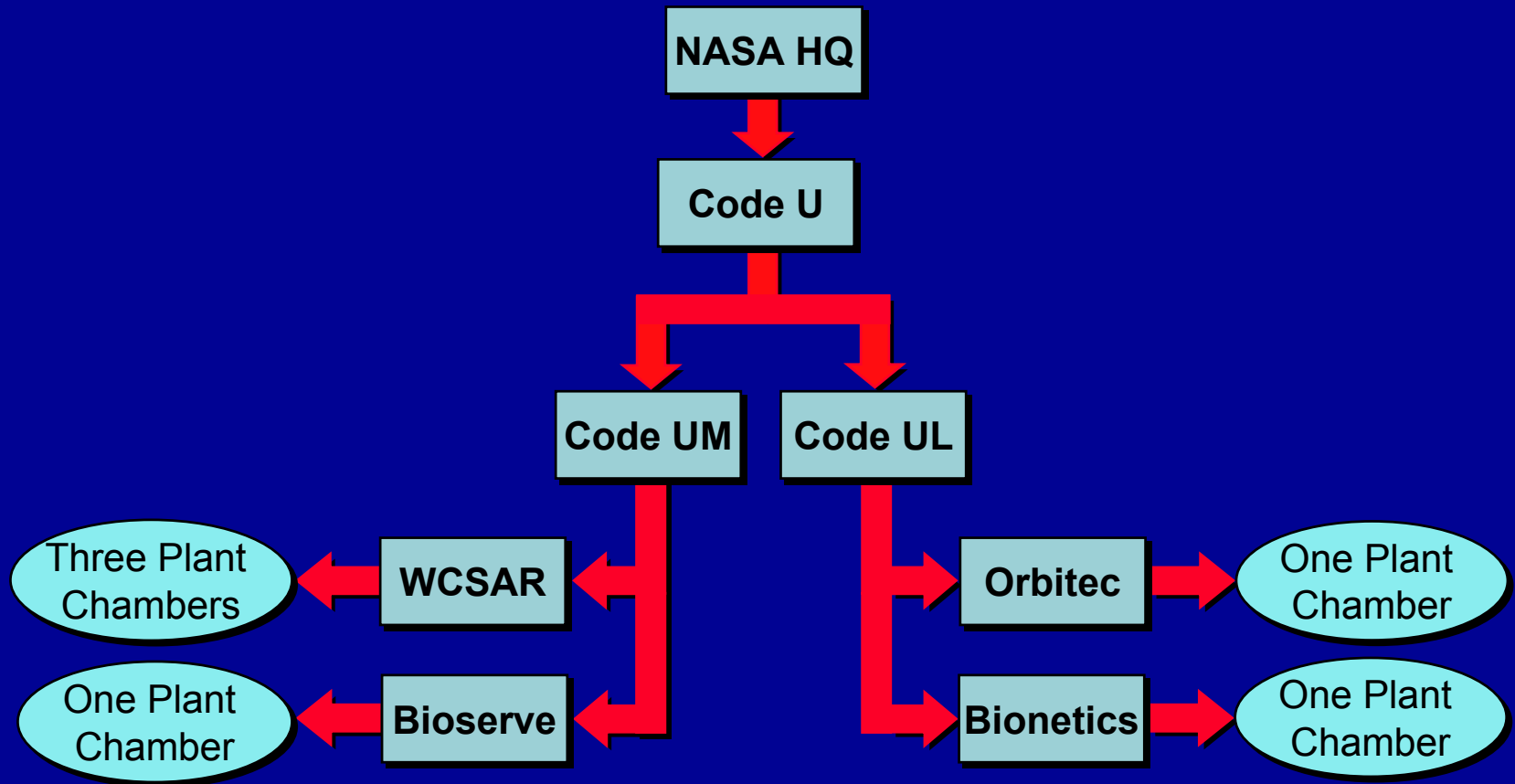
**By**

**Weijia Zhou, Director**

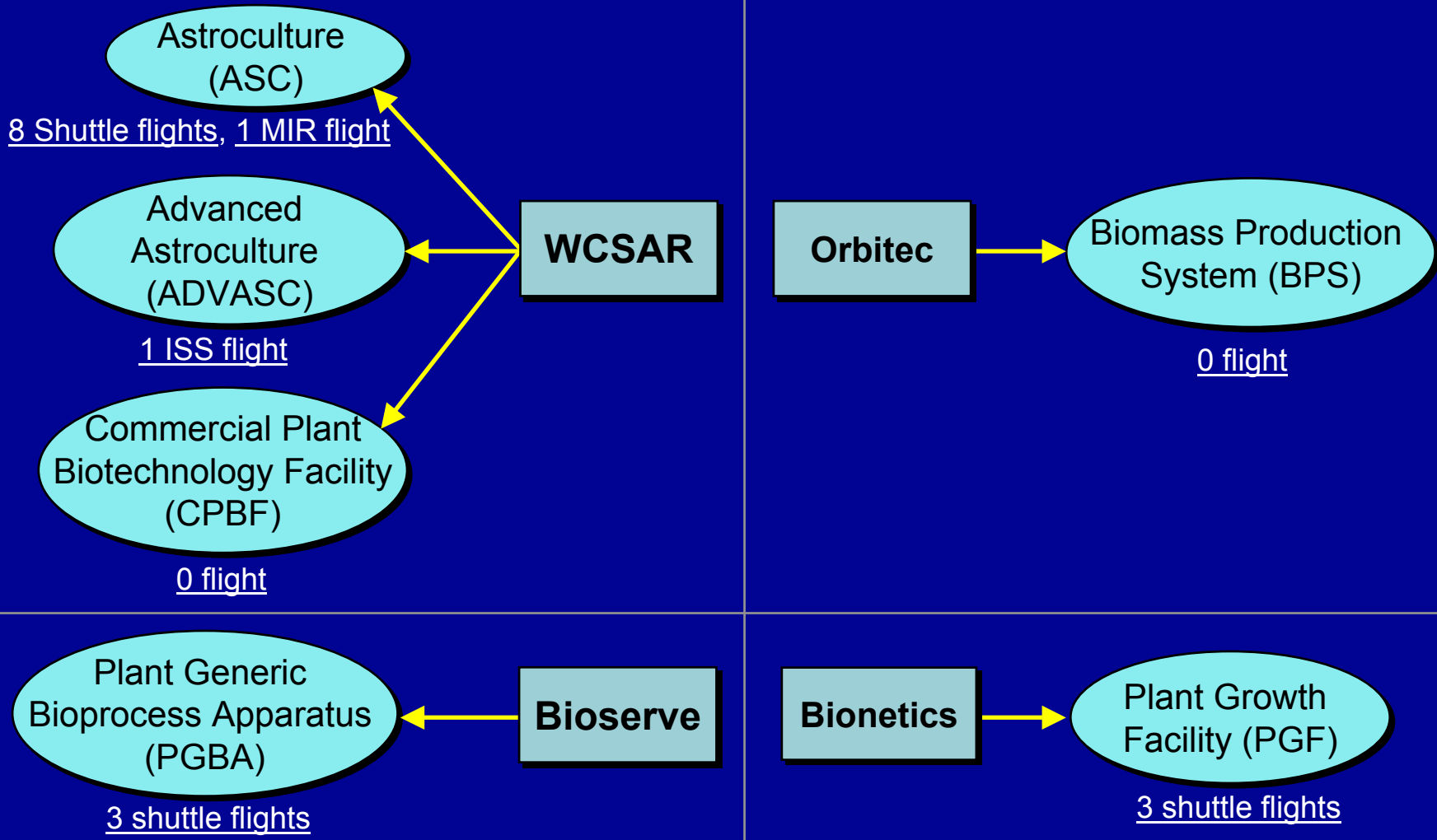
**608-262-5526**

**Wisconsin Center for Space Automation and Robotics**  
College of Engineering, University of Wisconsin-Madison  
<http://wcsar.engr.wisc.edu>

# NASA's SPACE-BASED PLANT GROWTH CHAMBERS



# SPACE PLANT GROWTH CHAMBERS



# ASTROCULTURE



- Growing Volume

Single Chamber,	Volume:	4,071 cm <sup>3</sup>
	Shoot height:	23 cm
	Root height:	4 cm
Dual Chamber (each),	Volume:	1925 cm <sup>3</sup>
	Shoot height:	14 cm
	Root height:	4 cm

- Chamber Conditions

Temperature:	19 - 45 °C ± 0.5 °C
Humidity:	55 - 95 %RH ± 3 %RH
Light Intensity:	0 - 450 μmol/m <sup>2</sup> /s (LED Red)
	0 - 50 μmol/m <sup>2</sup> /s (LED Blue)
CO <sub>2</sub> :	300 - 2000 ppm
Ethylene:	< 50 ppb
Transpiration recovery rate:	Max. 0.5 l/day



# ADVANCED ASTROCULTURE



- Growing Volume

Volume: 18,217 cm<sup>3</sup>

Shoot height: 33 cm

Root height: 4 cm



- Chamber Conditions

Temperature: 17 - 45 °C ± 0.5 °C

Humidity: 45 - 95 %RH ± 3 %RH

Light Intensity: 0 - 550 μmol/m<sup>2</sup>/s (LED Red)

0 - 70 μmol/m<sup>2</sup>/s (LED Blue)

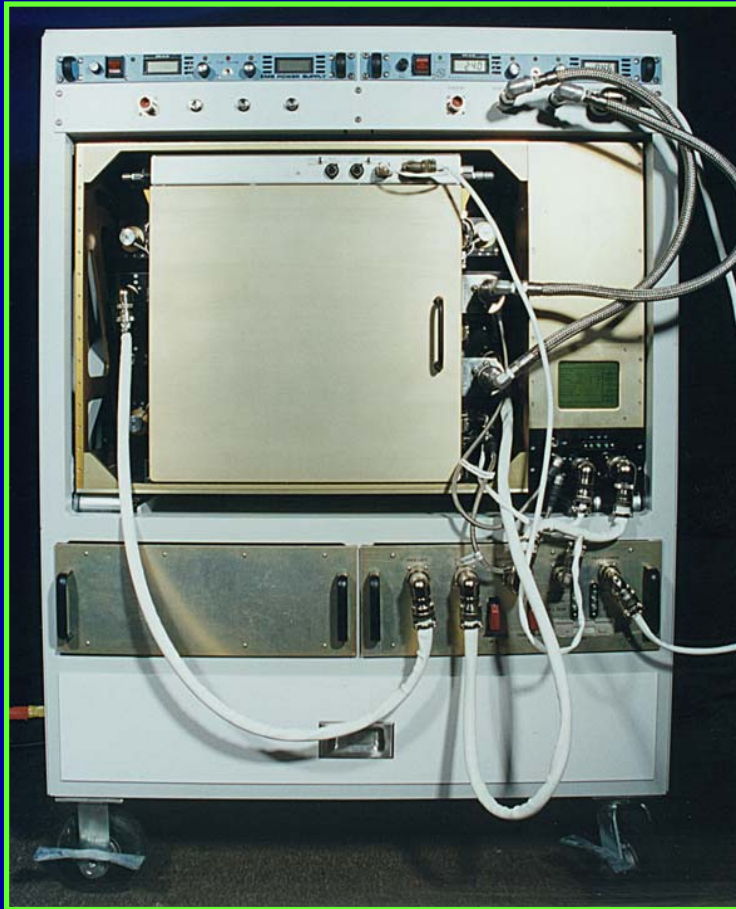
CO<sub>2</sub>: 400 - 2000 ppm

Ethylene: < 50 ppb

Transpiration recovery rate: Max. 1.1 l/day



# COMMERCIAL PLANT BIOTECHNOLOGY FACILITY (CPBF)

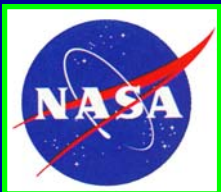


- Growing Volume

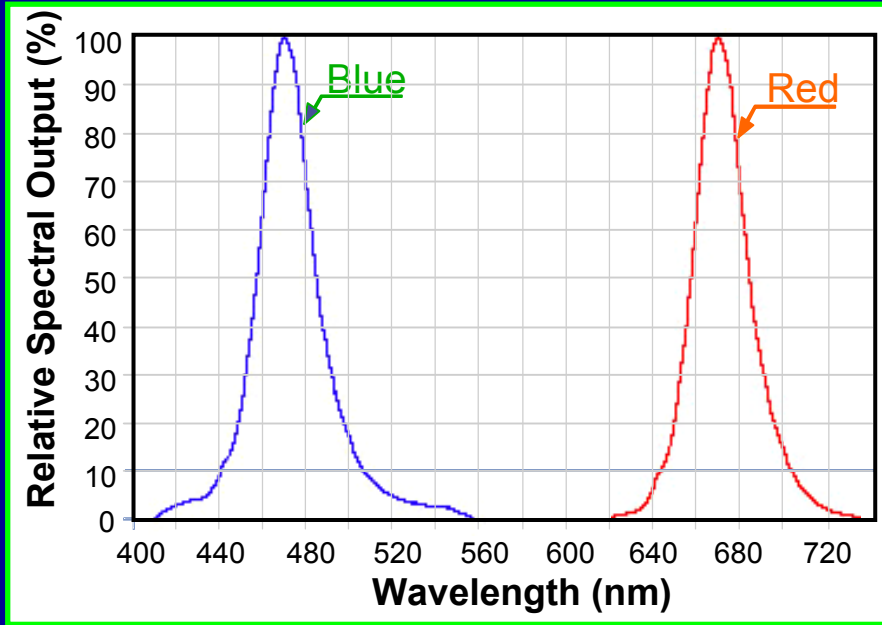
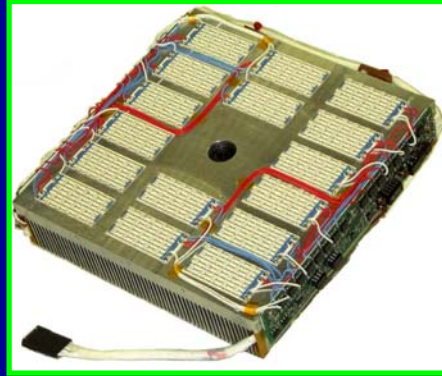
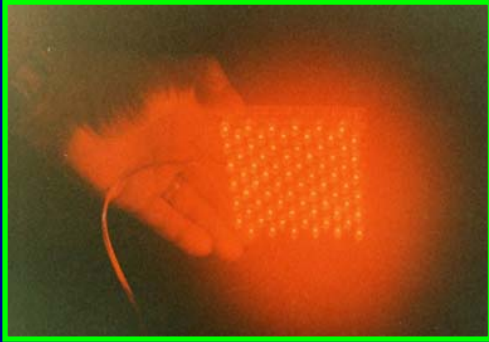
Volume:	109,935 cm <sup>3</sup>
Shoot height:	43 cm
Root height:	5 cm (changeable)

- Chamber Conditions

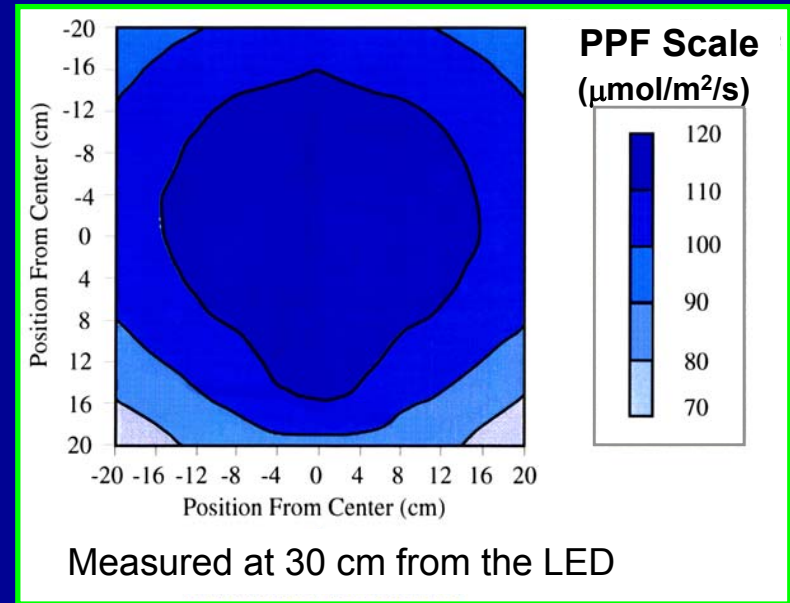
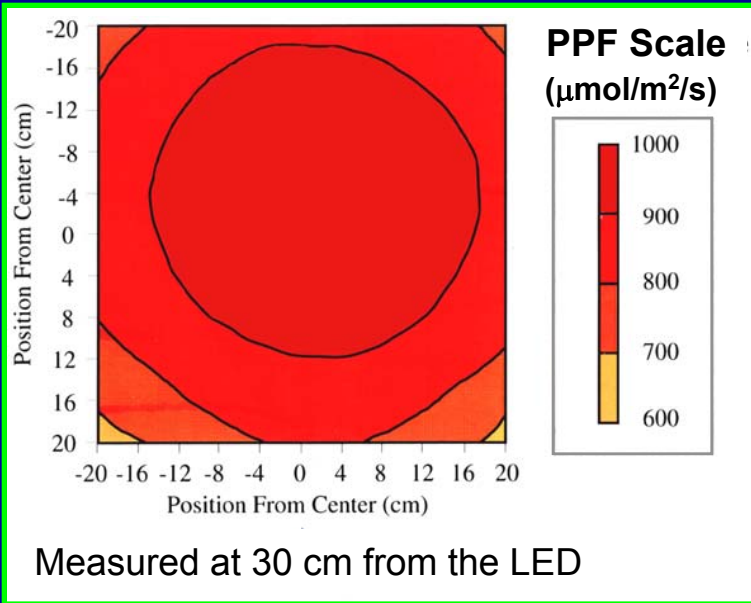
Temperature:	15 - 45 °C ± 0.5 °C
Humidity:	45 - 95 %RH ± 3 %RH
Light Intensity:	0 - 900 μmol/m <sup>2</sup> /s (LED Red)
	0 - 120 μmol/m <sup>2</sup> /s (LED Blue)
	0 - 470 μmol/m <sup>2</sup> /s (Fluorescent)
CO <sub>2</sub> :	300 - 2000 ppm
Ethylene:	≤ 50 ppb
Transpiration recovery rate:	Max. 2.0 l/day



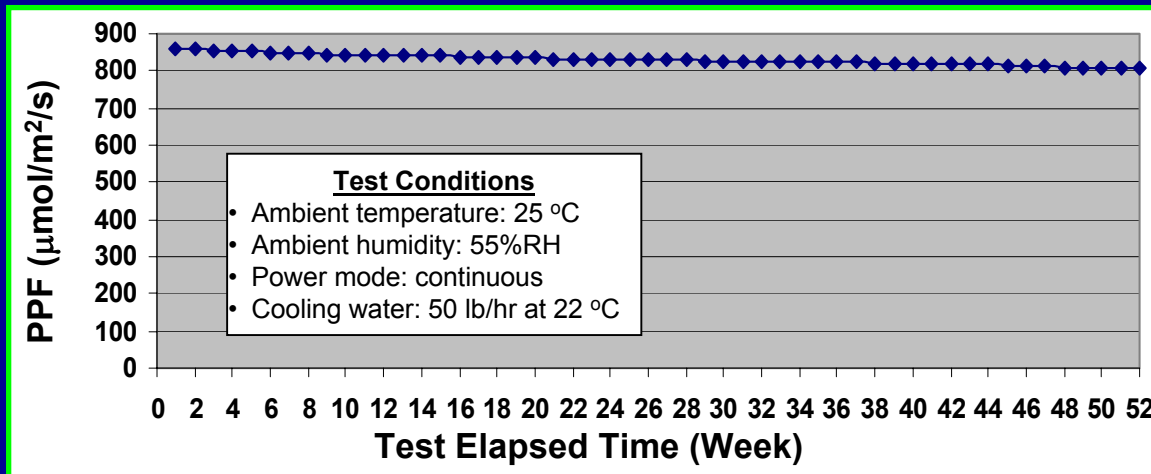
# PLANT LIGHTING TECHNOLOGY - LED UNIT



# LED LIGHT PERFORMANCE

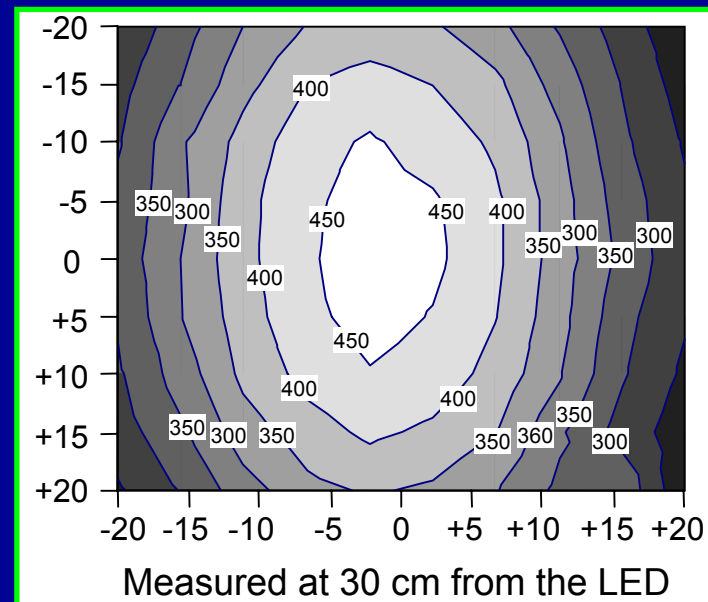


## LED Burning Test

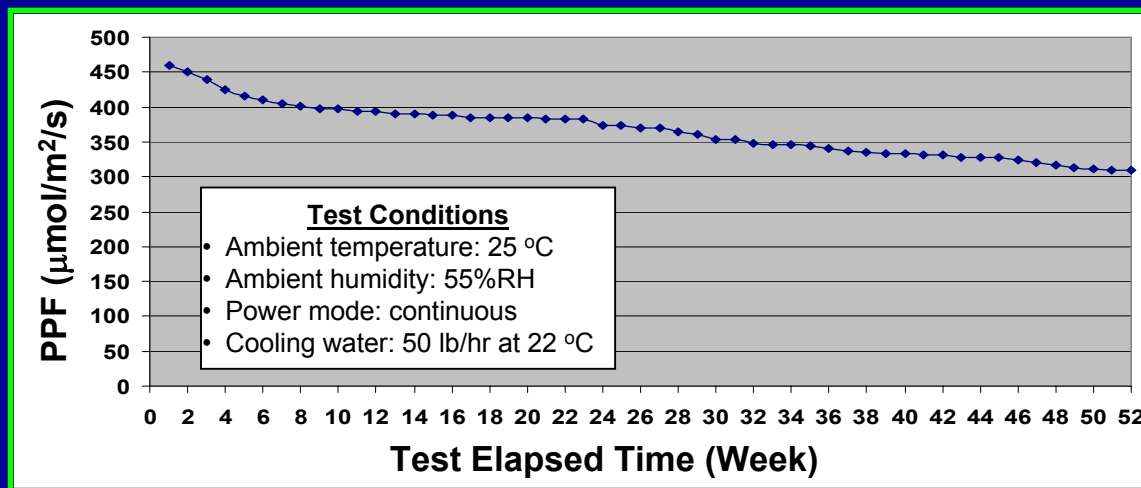




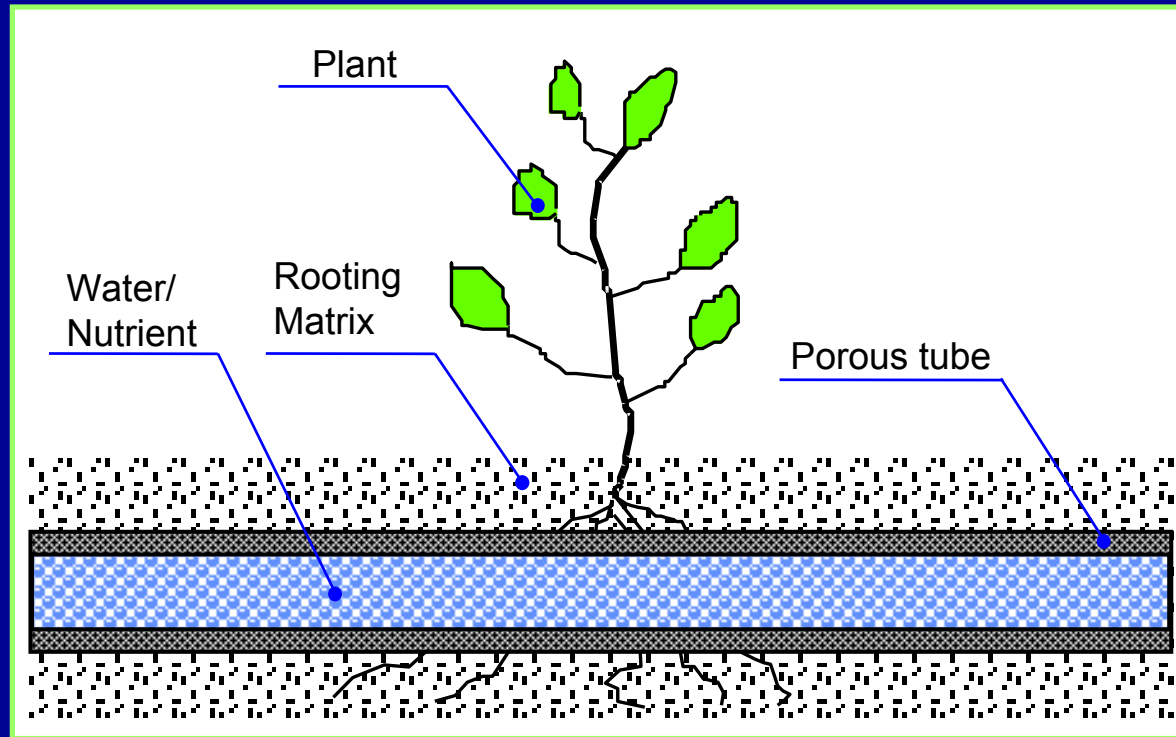
# PLANT LIGHTING – FLUORESCENT UNIT



FLU  
Burning Test

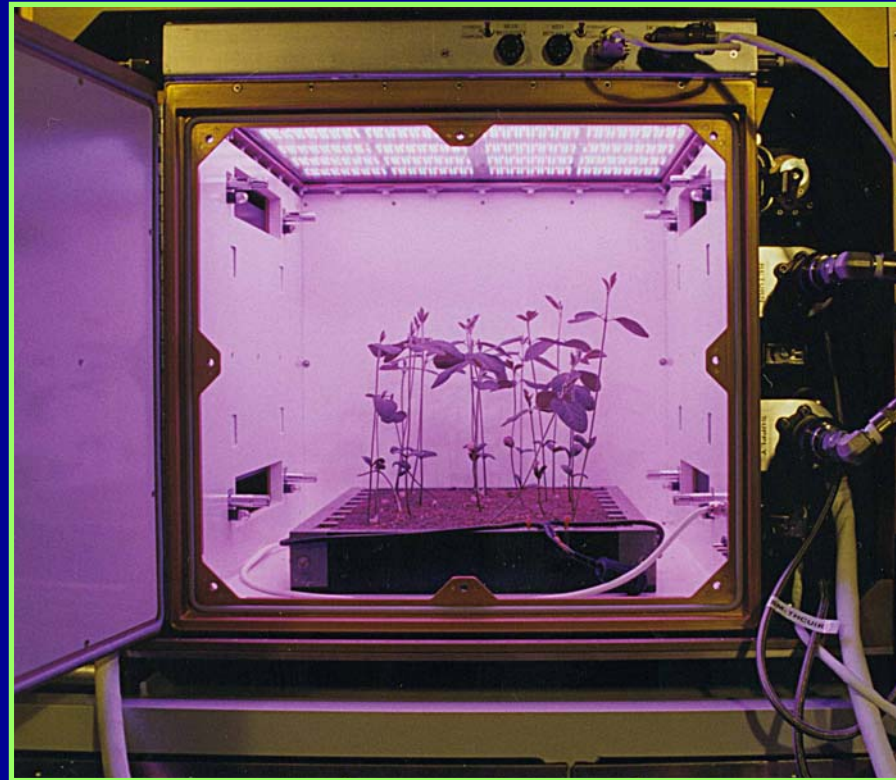


# FLUID NUTRIENT DELIVERY SYSTEM

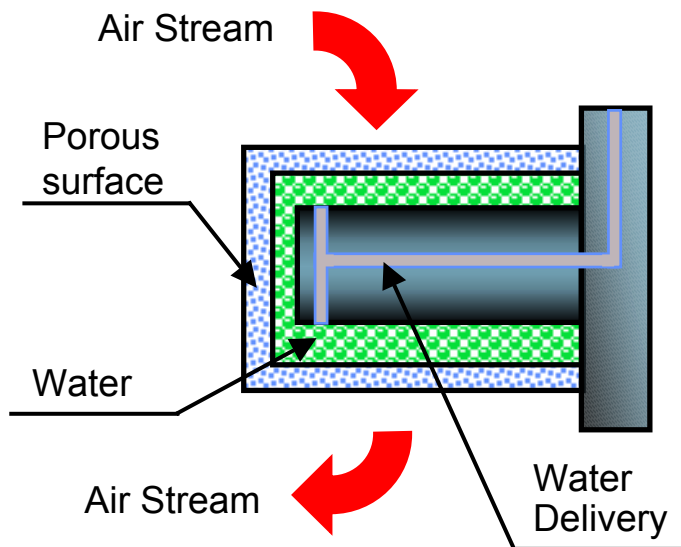


# FLUID NUTRIENT DELIVERY SYSTEM (Cont.)

Root Tray in use inside CPBF



# ASTROPORE™ HUMIDITY CONTROL

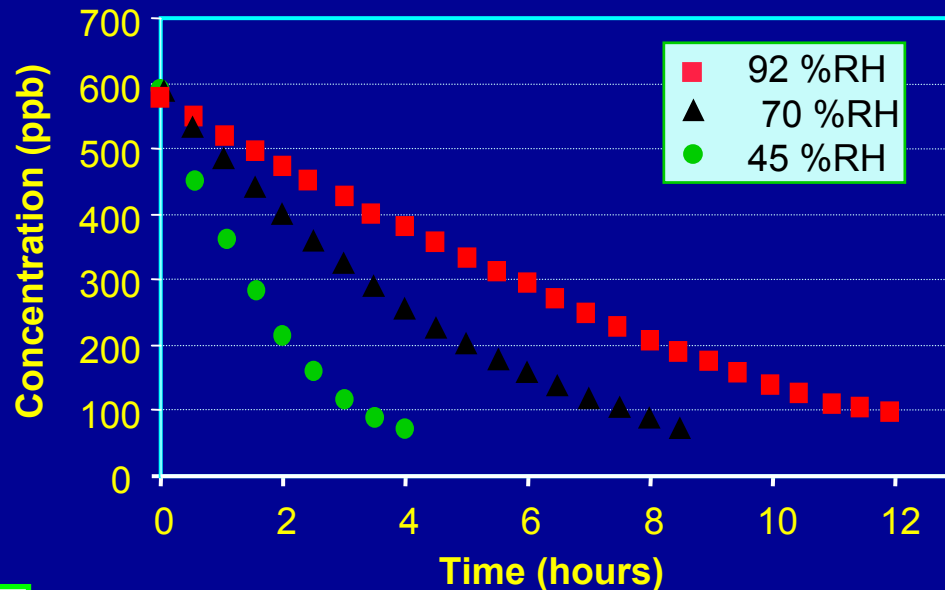
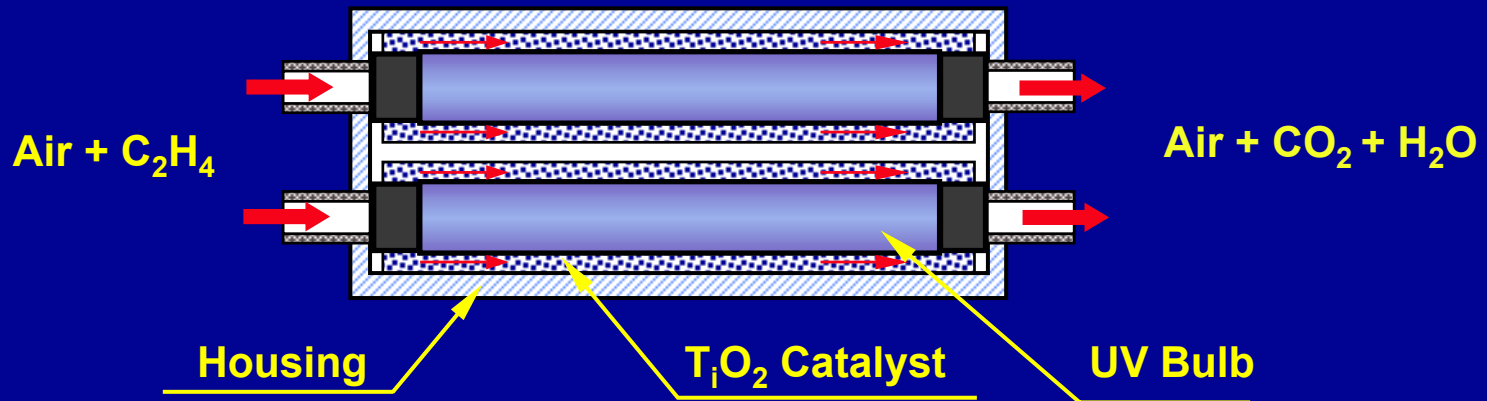


## FEATURES

- Humidification
- Dehumidification
- Condensation Recovery



# ETHYLENE SCRUBBER



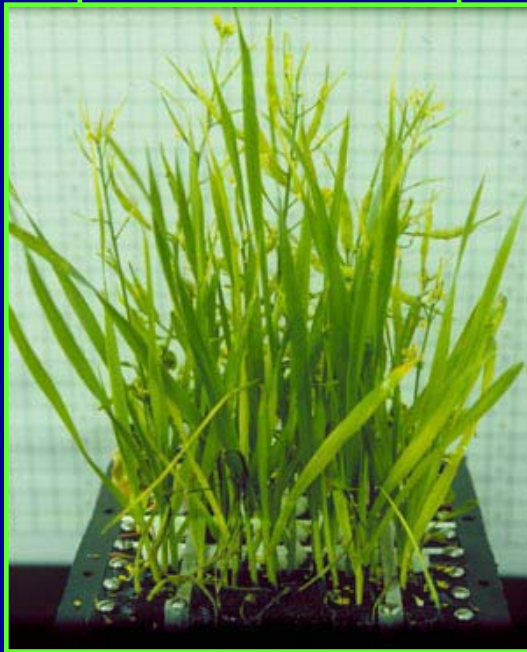
## Test Conditions:

Volume of treated air = 50 L  
 Catalyst Mass = 0.36 g,  
 Humidity = 45 %RH, 70, 92 %RH  
 Temperature = 25 °C



# FLIGHT EXPERIMENT

Wheat experiment  
(STS-63)



Potato experiment  
(STS-73)



# FLIGHT EXPERIMENT (STS-95)

Rose, before the flight  
(STS-95)



Rose, after the flight  
(STS-95)



# FLIGHT EXPERIMENT (6A-7A)

Arabidopsis experiment  
(6A - 7A)



Before the flight



After the flight

