2008 International Meeting on Controlled Environment Agriculture
Session A: New Approaches for Control and Monitoring Environmental Conditions

Changing the way light is delivered to plants in controlled environments: Novel practices with LED lighting

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The Problem

Redesigning how light is applied

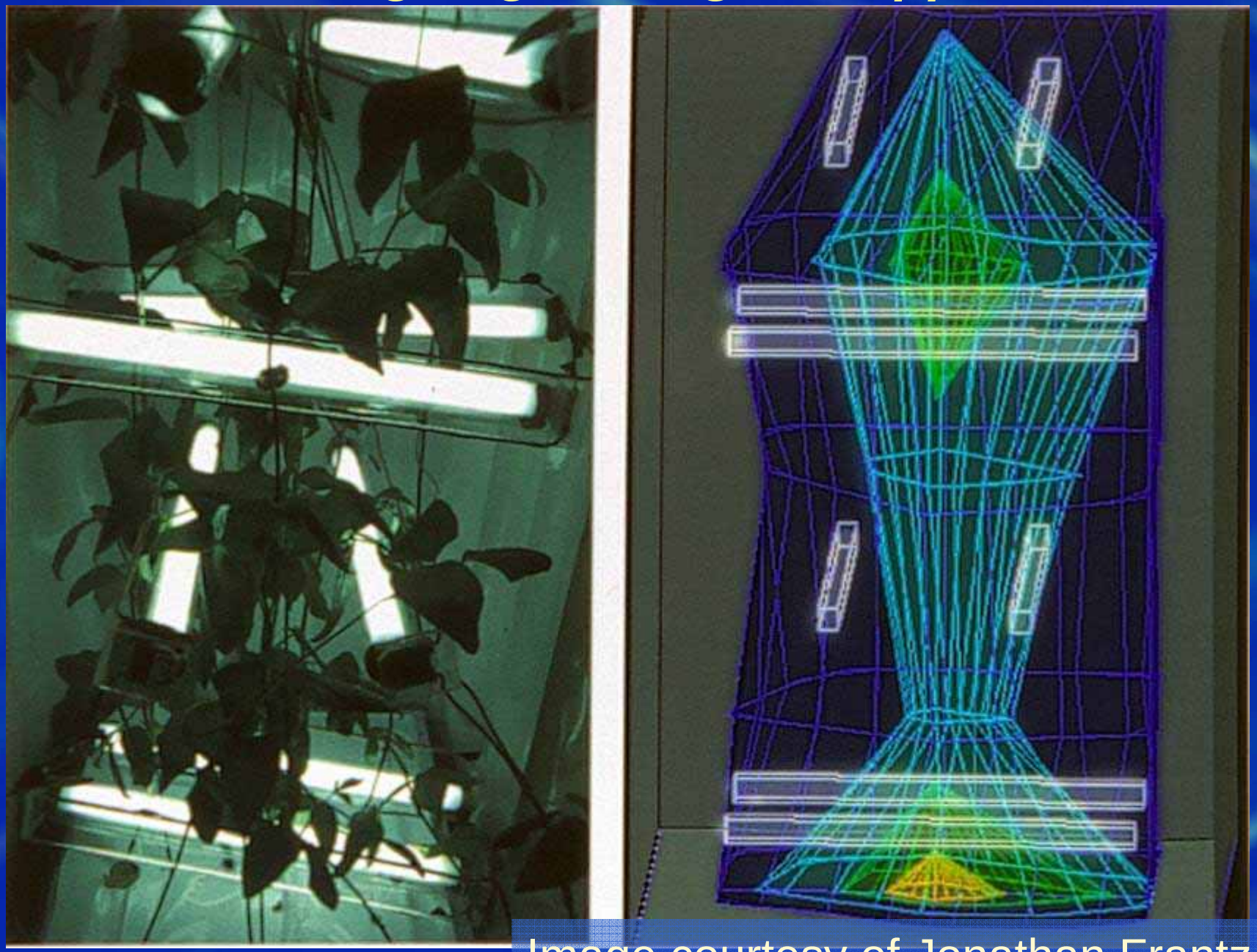
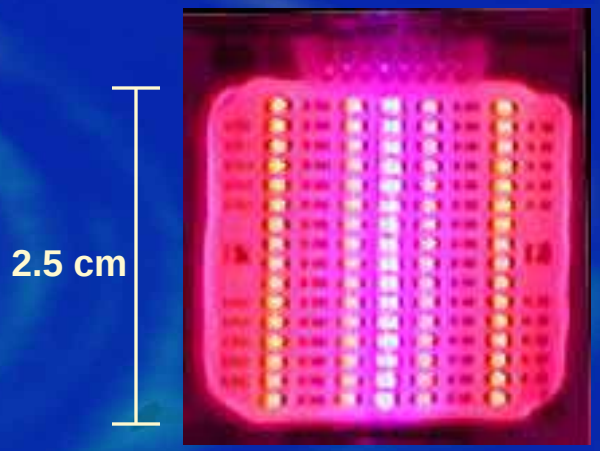


Image courtesy of Jonathan Frantz

Why LEDs?

- Small
- Solid state
- Long lifetime ~ 100,000 hr
- Chose wavelengths for plant function
- Can operate at low power
- Emission surface relatively cool
  - Inverse square law $I \propto E / d^2$

Printed-Circuit LED “Light Engines”



ORBITEC Light Engine

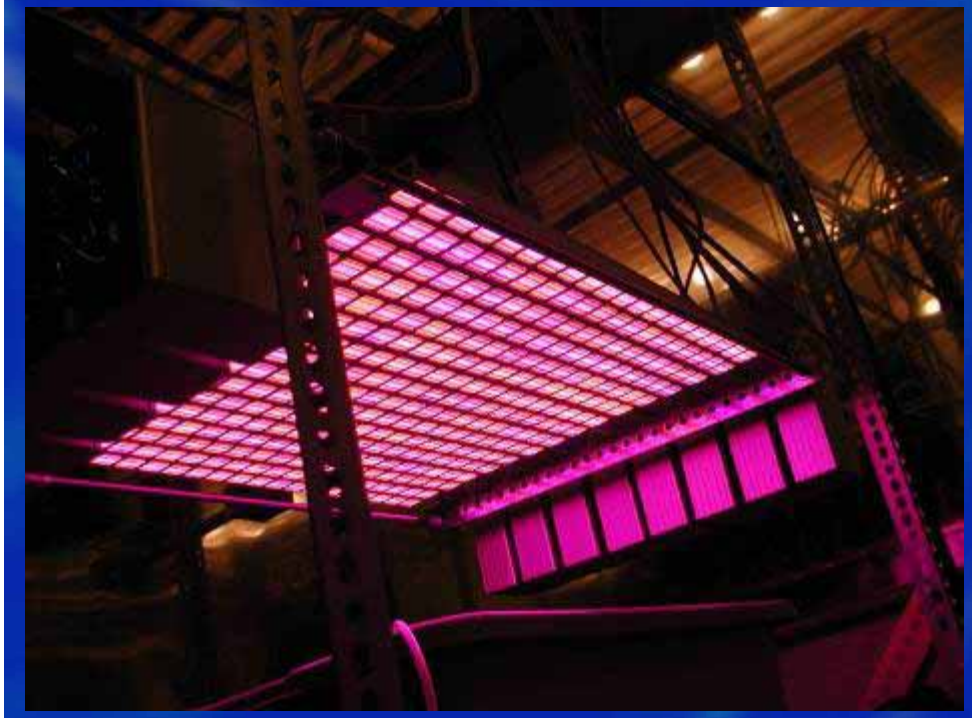
- 1 row of sixteen 440 nm blue
- 4 rows of sixteen 640 nm red
- 2 rows of ten 520 nm green
- 2 photodiodes

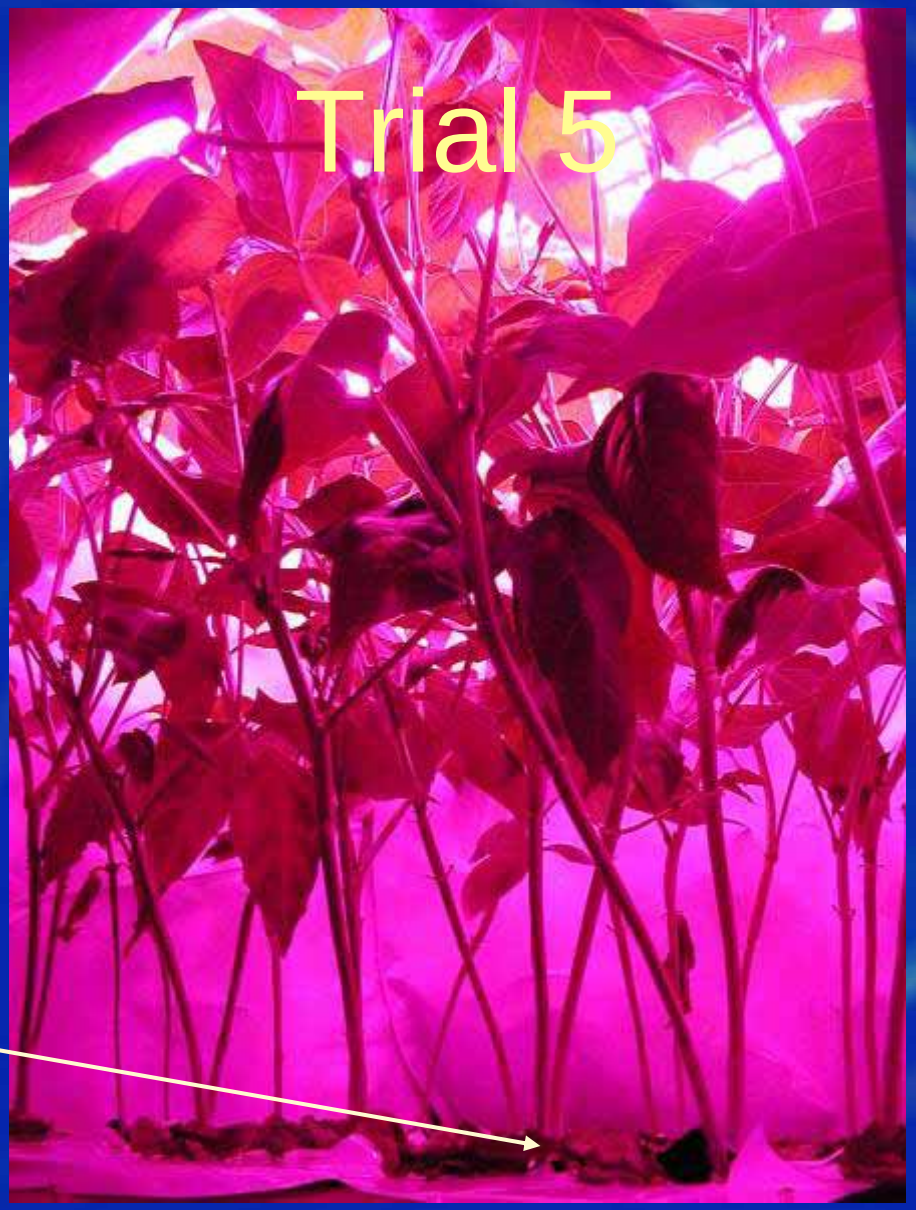
Trials and Modifications

Results

	Trial 1	Trial 2	Trial 3	Trial 4
Total gDW	6.8	5.5	62.4	96.4
Average gDW/plant	0.6	0.4	4.5	3.7
gDW/kW-h	0.2	0.2	0.9	1.0
gDW/m^2	30.9	23.8	271.1	415.4
gDW/m^2/day	1.2	1.3	8.5	13.0
gDW/m^3	60.9	88.2	580.9	718.8

Reconfiguration



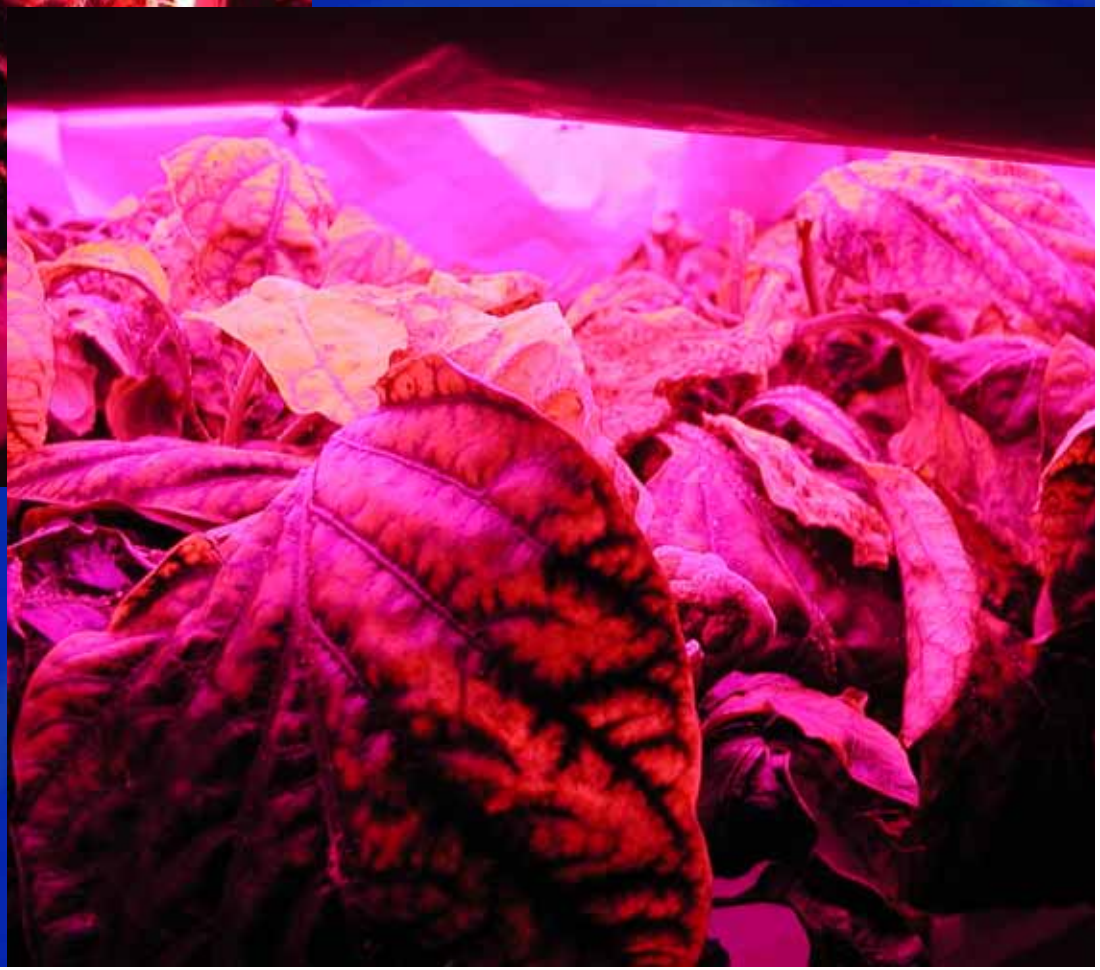


Results

	Trial 3	Trial 4	Trial 5
Total gDW	62.4	96.4	72.0 (81.1)
Average gDW/plant	4.5	3.7	2.8 (3.1)
gDW/kW-h	0.9	1.0	0.7 (0.8)
gDW/m^2	271.1	415.4	310.3 (349.4)
gDW/m^2/day	8.5	13.0	9.7 (10.9)
gDW/m^3	580.9	718.8	537.9 (605.6)

Intumescence

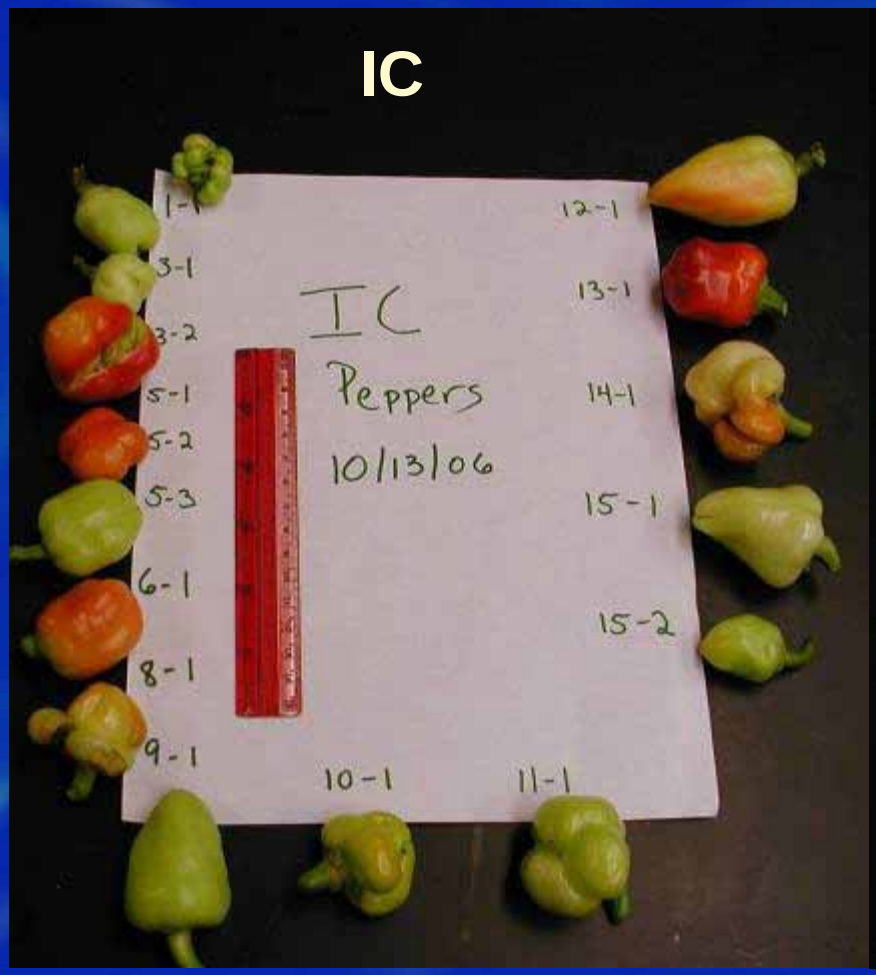
Side-By-Side Peppers

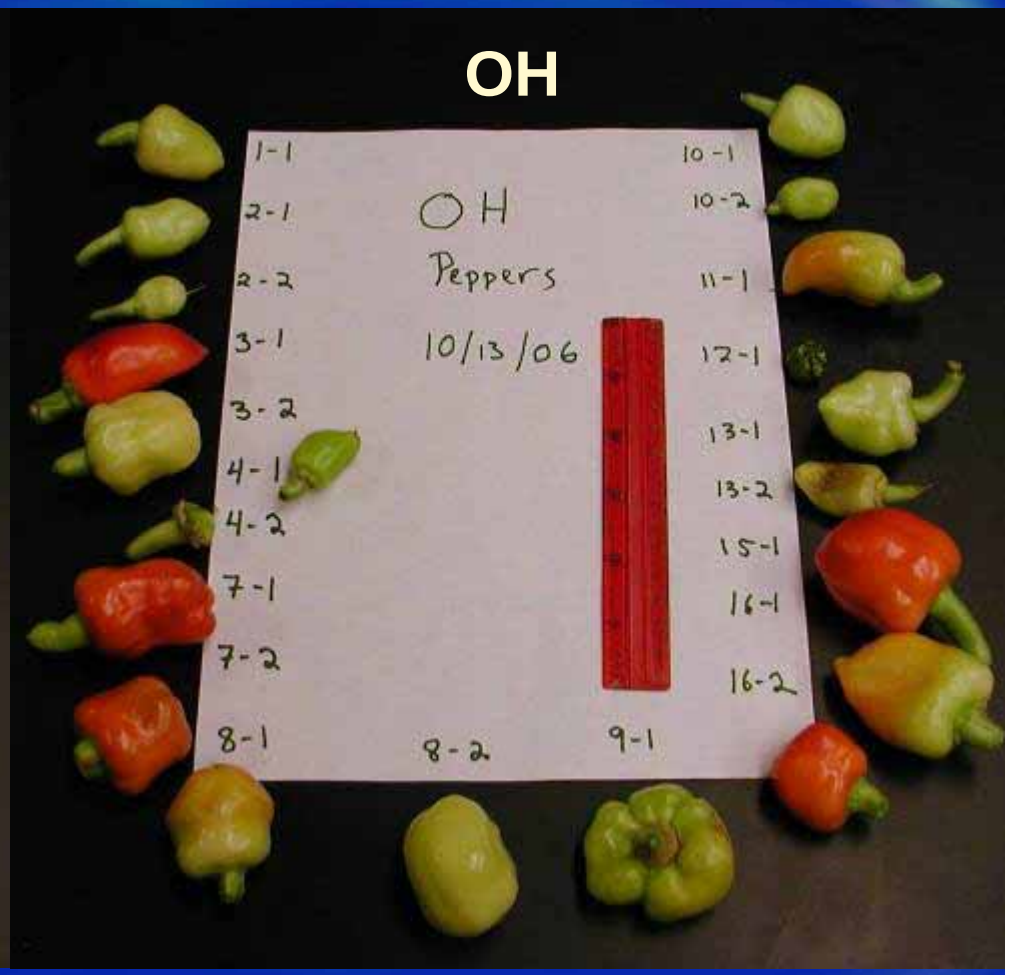


But under white light….

Intumescence in Pepper

Third Harvest



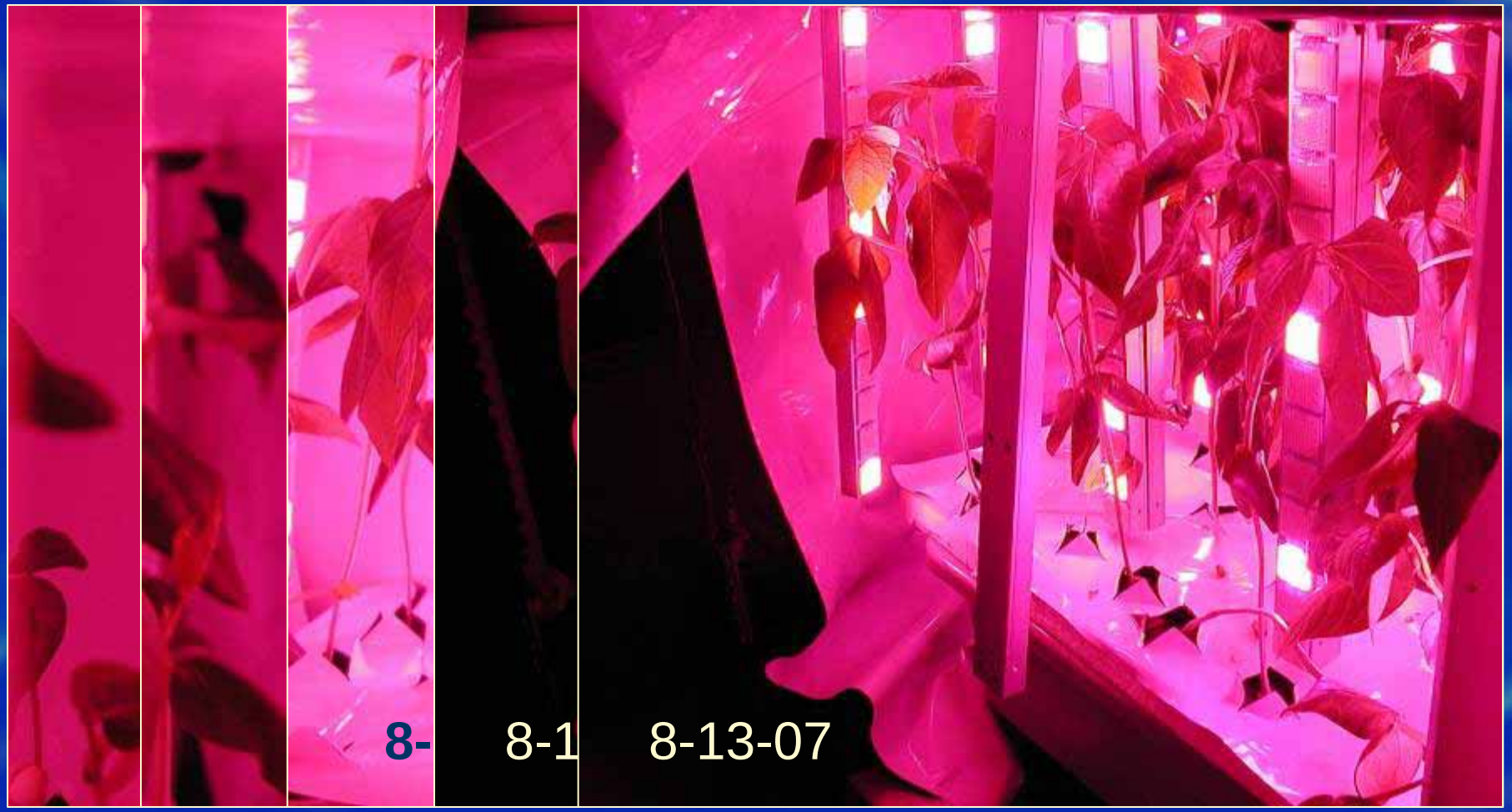


HELIAC

High Efficiency Lighting with Integrated Adaptive Control

- Phase I and II NASA SBIR grants awarded to ORBITEC
- Prototype plant position sensor was developed and constructed
- Light from 520 nm G LEDs is flashed/ detected by photodiodes
- R and B LEDs activated where leaves detected.
- Plant testing was performed at Purdue.
- Enables:
  - Automation of height sensing for IC
  - Detection of plant spread for CC array development

Cowpea Growth Study



Reconfiguration to Overhead

HELIAC Lettuce

Those who make it happen…

- Mercedes Mick
- Craig Schluttenhofer
- Ashley Hudson
- Yang Yang
- Dave Kotterman
- Ray Wheeler
- John Sager
- Jonathan Frantz
- Jeff Emmerich
- Tom Crabb