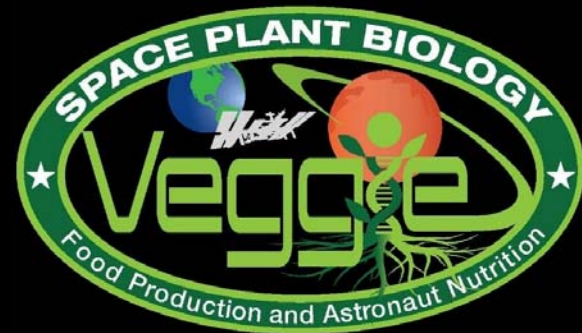




# Veggie at the Forefront of NASA Food Production



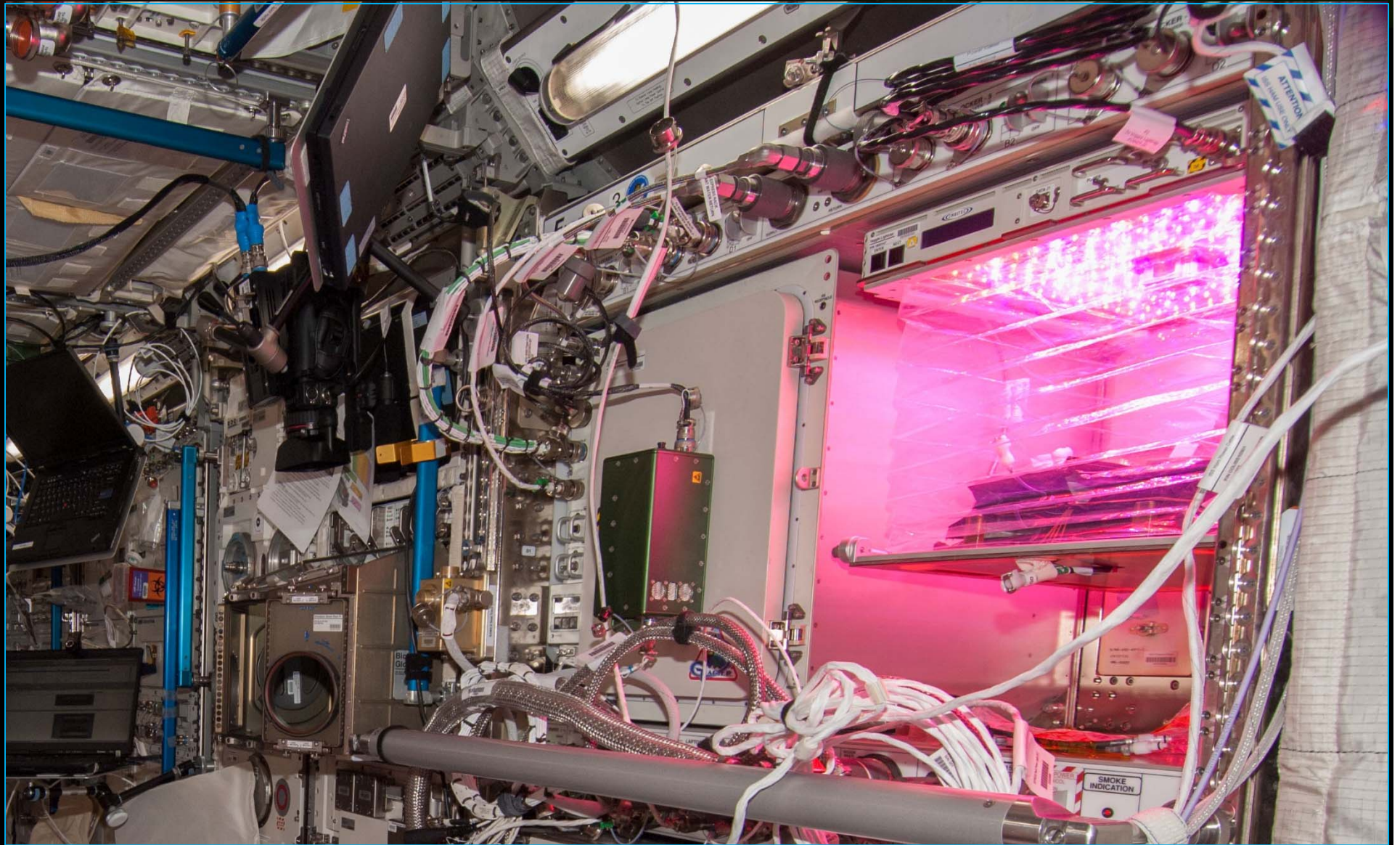
**Exploration Research and  
Technology Programs**



Gioia Massa, Ye Zhang, Nicole Dufour  
NASA, Kennedy Space Center



# Veggie on ISS







# Crop Selection for VEG-01

- Reliable germination
- Rapid growth
- Attractiveness
- Low native microbial levels
- Palatability / acceptability
- Antioxidants

VEG-01 consisted of two sets of 'Outredgeous' lettuce and one set of 'Profusion' zinnia pillows



'Outredgeous'  
red romaine lettuce



'Profusion'  
Zinnia

# VEG-01A Wick Opening (3 DAI)

Veg-01 on-orbit wick opening assisted seedling growth (3 days after initiation)





# VEG-01A Plant Thinning (7 DAI)

Veg-01 on-orbit plant thinning operation eliminated competition for resources





# VEG-01A Water Stress





# VEG-01A Water Stress

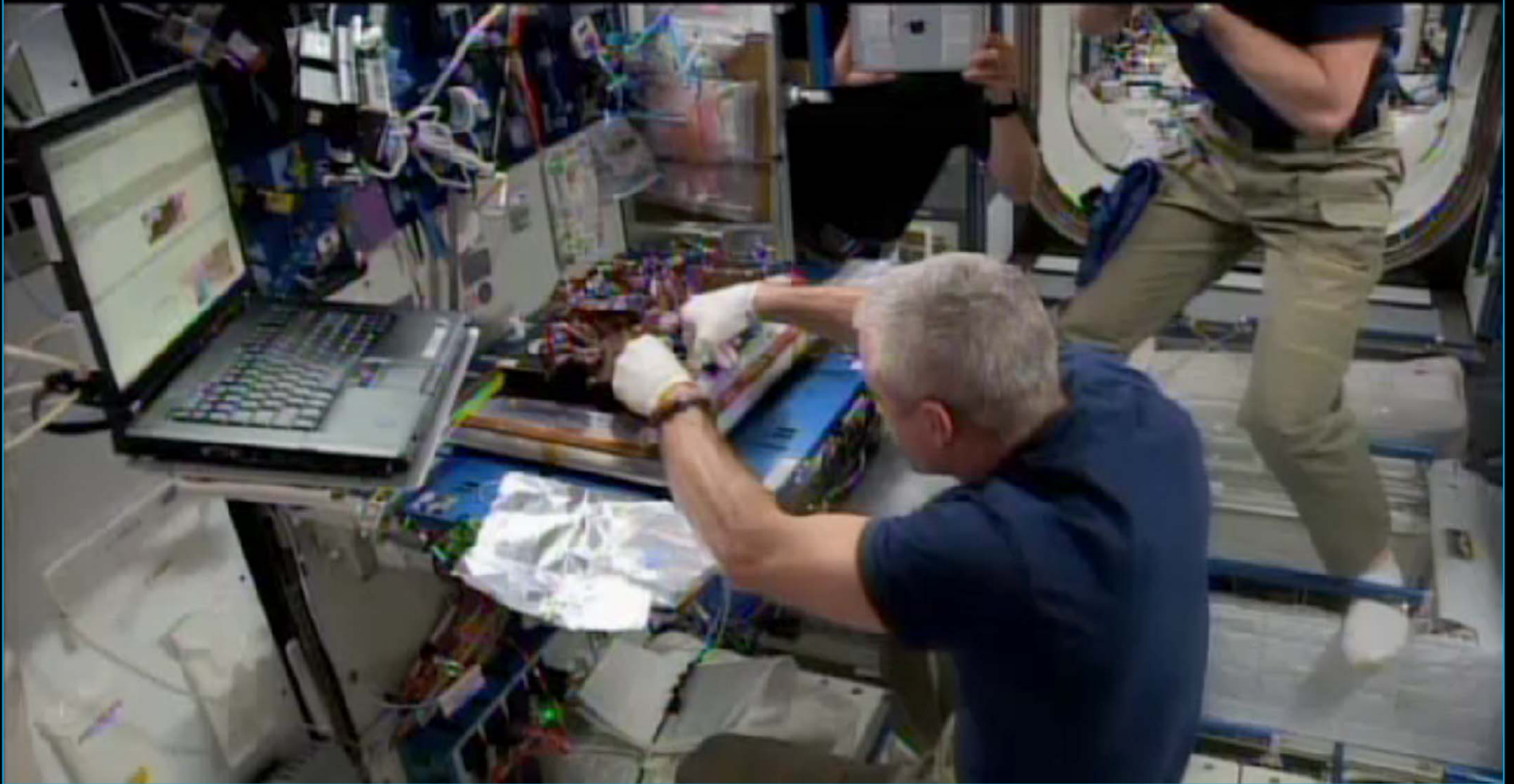
Plants in pillows A and C grew well

Plants in pillows D, E, and F exhibited stunting /water stress; D recovered and E and F died





# VEG-01A Harvest (33 DAI)





# VEG-01A Harvest



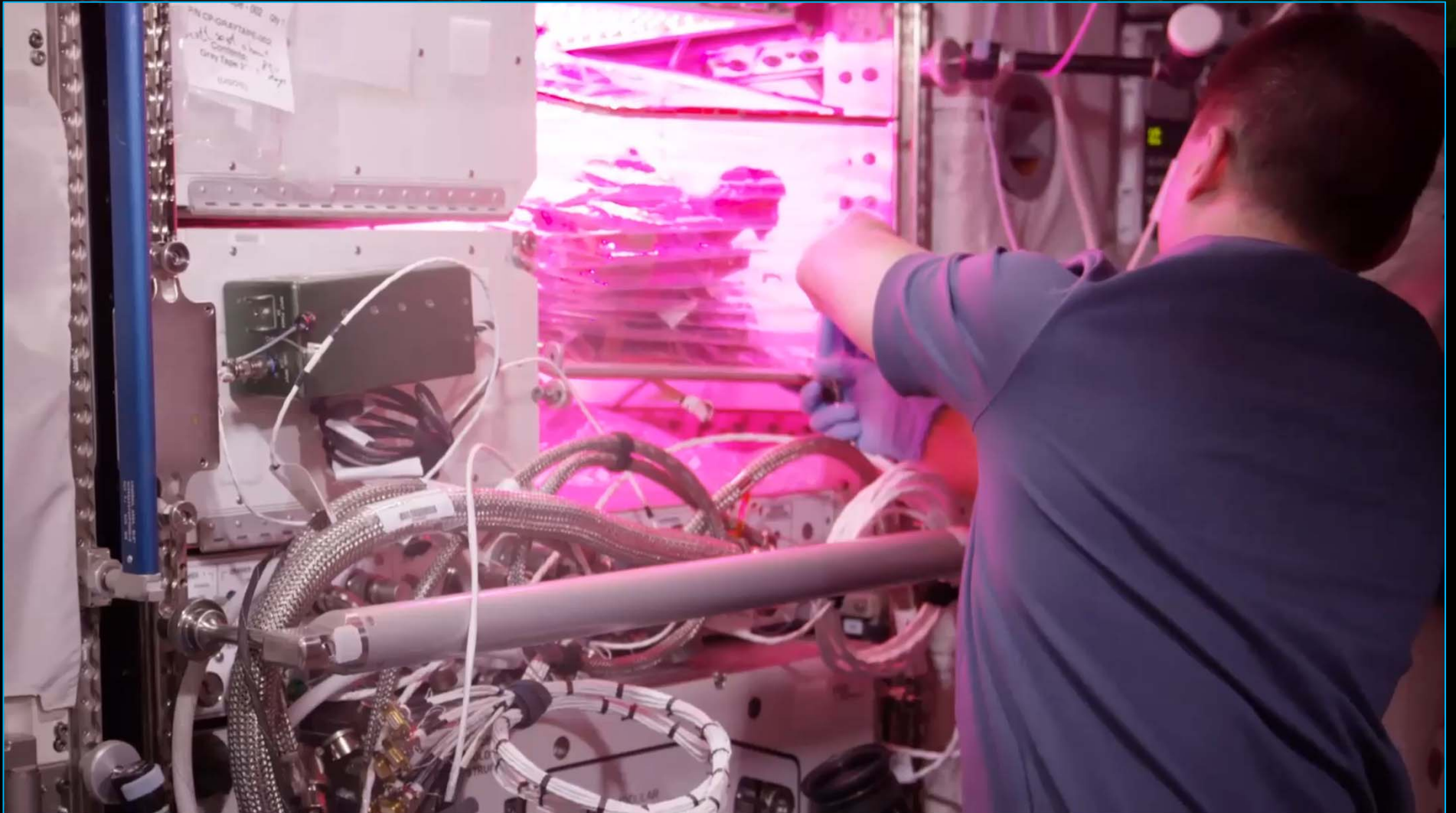


# VEG-01B - Second Crop - Lettuce

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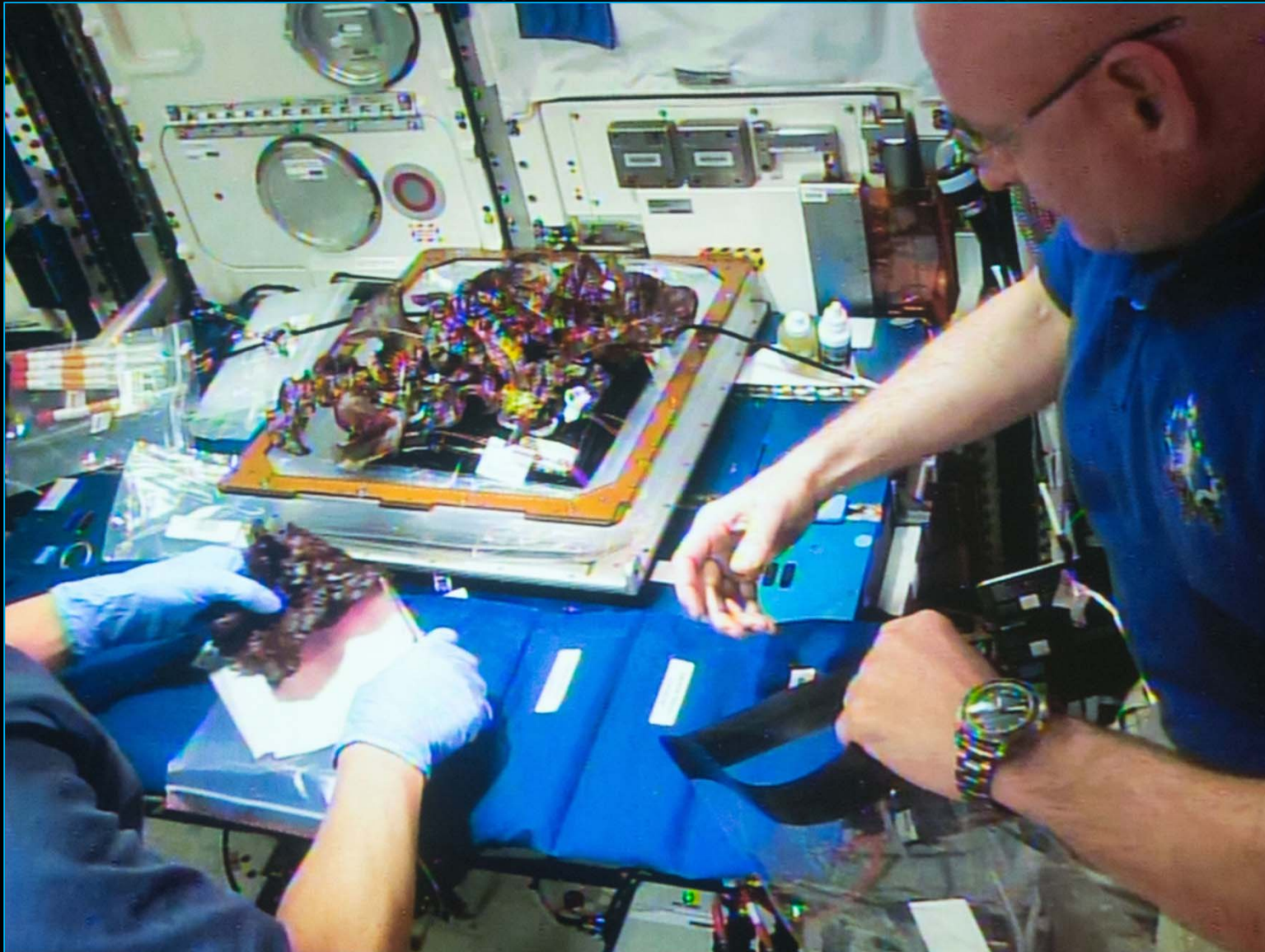
- Modified watering procedures, increased photo frequency
- Initiated by Scott Kelly on July 8, 2015 from seeds previously sent
- Grown by Scott Kelly and Kjell Lindgren
- Water stress observed but astronauts intervened and grew 5 plants
- ½ the produce for consumption, ½ for science
- Plants harvested Aug. 10, 2015, live on NASA TV
- Science samples frozen and returned May, 2016.

# VEG-01B Harvest





# VEG-01 B - Sanitizing Produce



# Astronaut Comments

- Scott Kelly
  - the logistical complexity of having people live and work in space for long periods
  - the supply chain that is required
  - For Mars, need a space craft that is more self-sustainable with regards to its food supply
- Kjell Lindgren
  - benefit of eating the fresh food
  - contribution that plants have to the ISS ecosystem
  - psychological benefit - it's really fun to see green growing things in the sterile environment of the ISS





# VEG-01C - Third Crop - Zinnia

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- Directly watered plants after initiation, decreased photos to reduce crew time demands
- Initiated on Nov. 16, 2015 from seeds previously sent
- Grown by Kjell Lindgren and Scott Kelly
- Plants received too much water; fungus developed
- Mitigation attempted but several plants were lost before flowering
- Autonomous gardening started in Dec.
- Plants harvested Feb. 14, 2016
- Samples frozen and returned May, 2016

# Water Issues / Consequences



Guttation and Leaf Curling



Fungal Development  
& Abnormal Growth

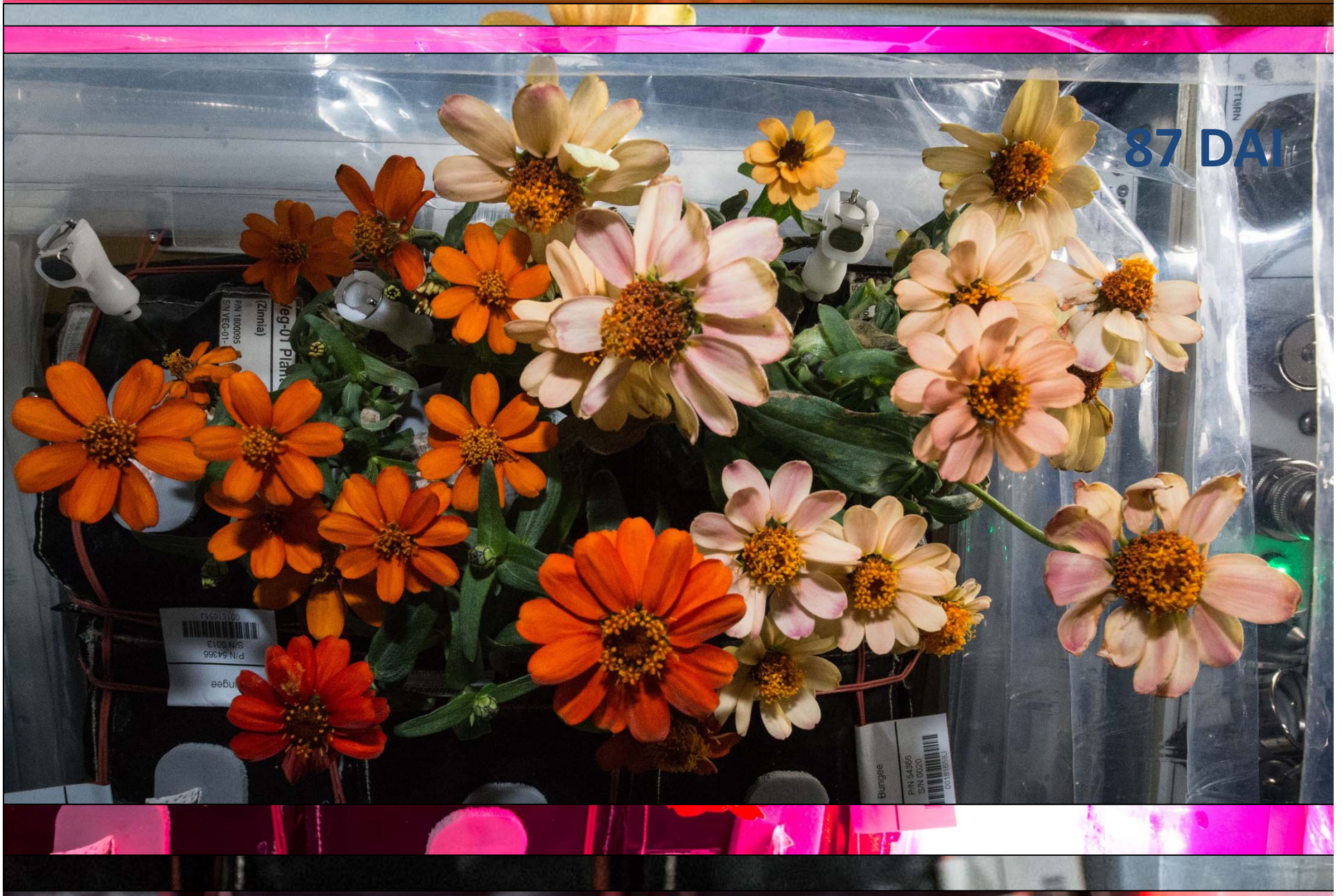


# Zinnia Action Shots





And they bloomed, and bloomed...





# 90 DAI: Harvest on February 14, 2016



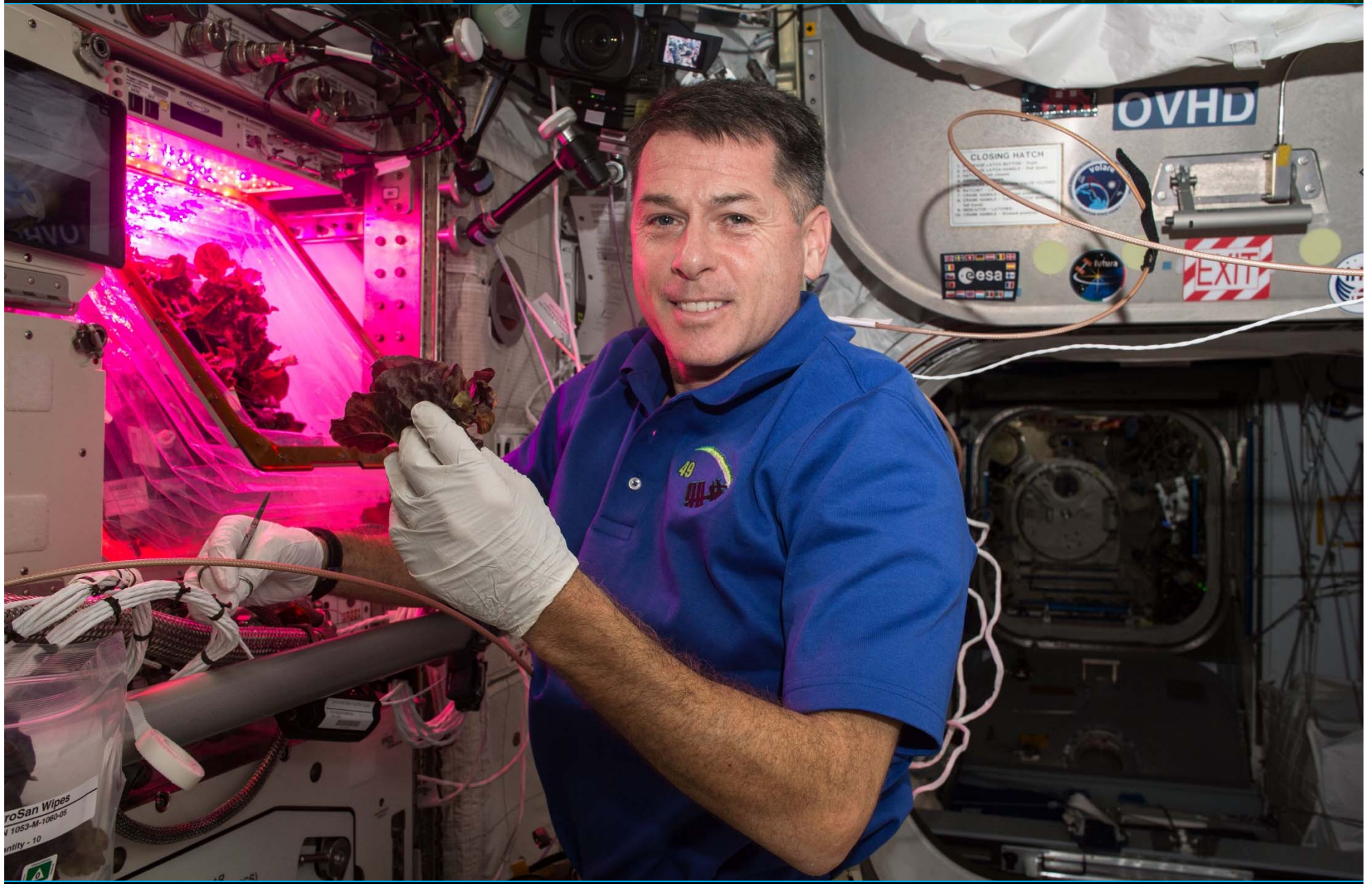
# Valentine's Day Bouquet on the ISS

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# VEG-03A Cut-and-Come-Again





# VEG-03C Cut-and-Come-Again





# VEG-03C Cut-and-Come-Again





# Happy Crew



Thomas Pesquet  
@Thom\_astro

#TGIF! On Fri  
best food item  
lettuce with lol  
-chef @AstroP



RETWEETS 199  
LIKES 725


11:18 AM - 16 Dec 2016

Thomas Pesquet ✓

#TGIF! Comme tou  
vendredi soirs on s  
retrouve tous pour  
nos meilleurs plats  
menu ici: salade sp  
par @AstroPeggy



ISS Research  
@ISS\_Research

"Better than any  
on the ground."   
space farming is



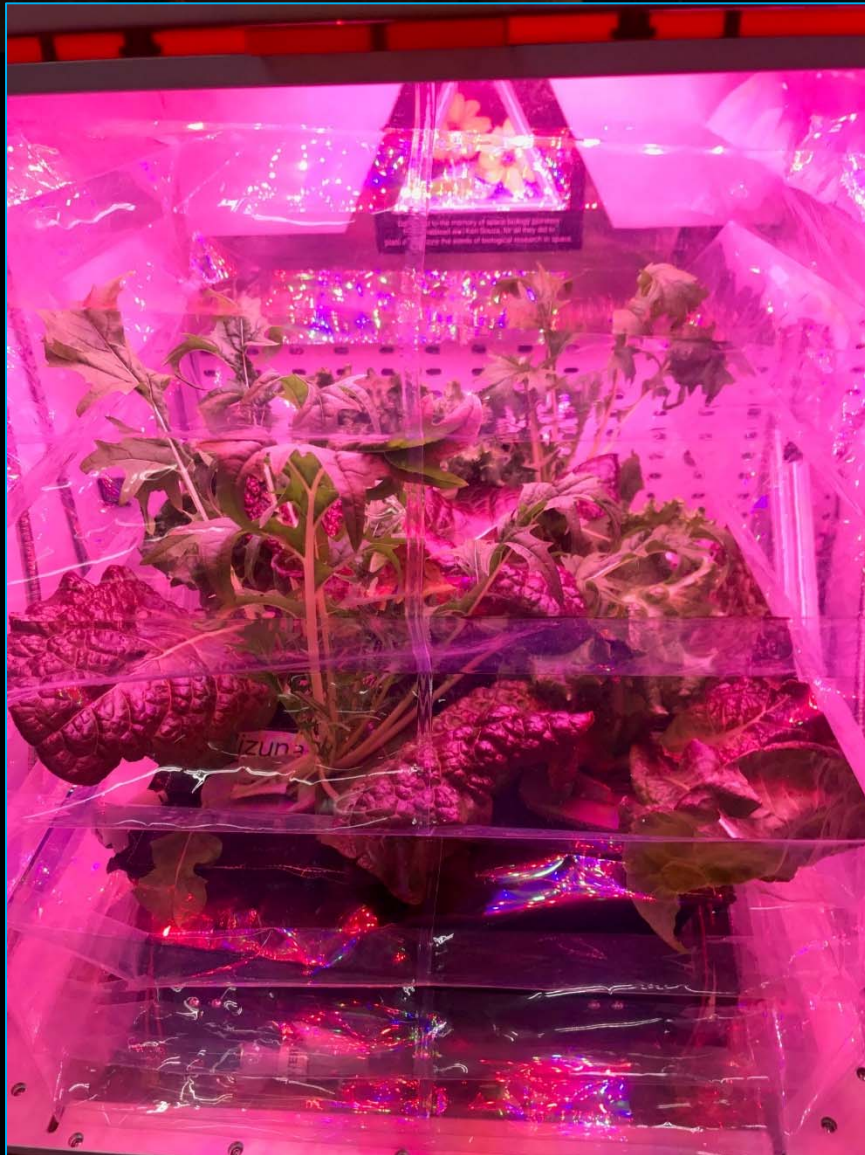
Peggy Whitson ✓  
@AstroPeggy

I am growing cabbage on  
station. I love gardening on  
Earth, and it is just as fun in  
space... I just need more room  
to plant more!





# VEG-03D - Mixed Crop Tests-Ground





# VEG-03D - Flight

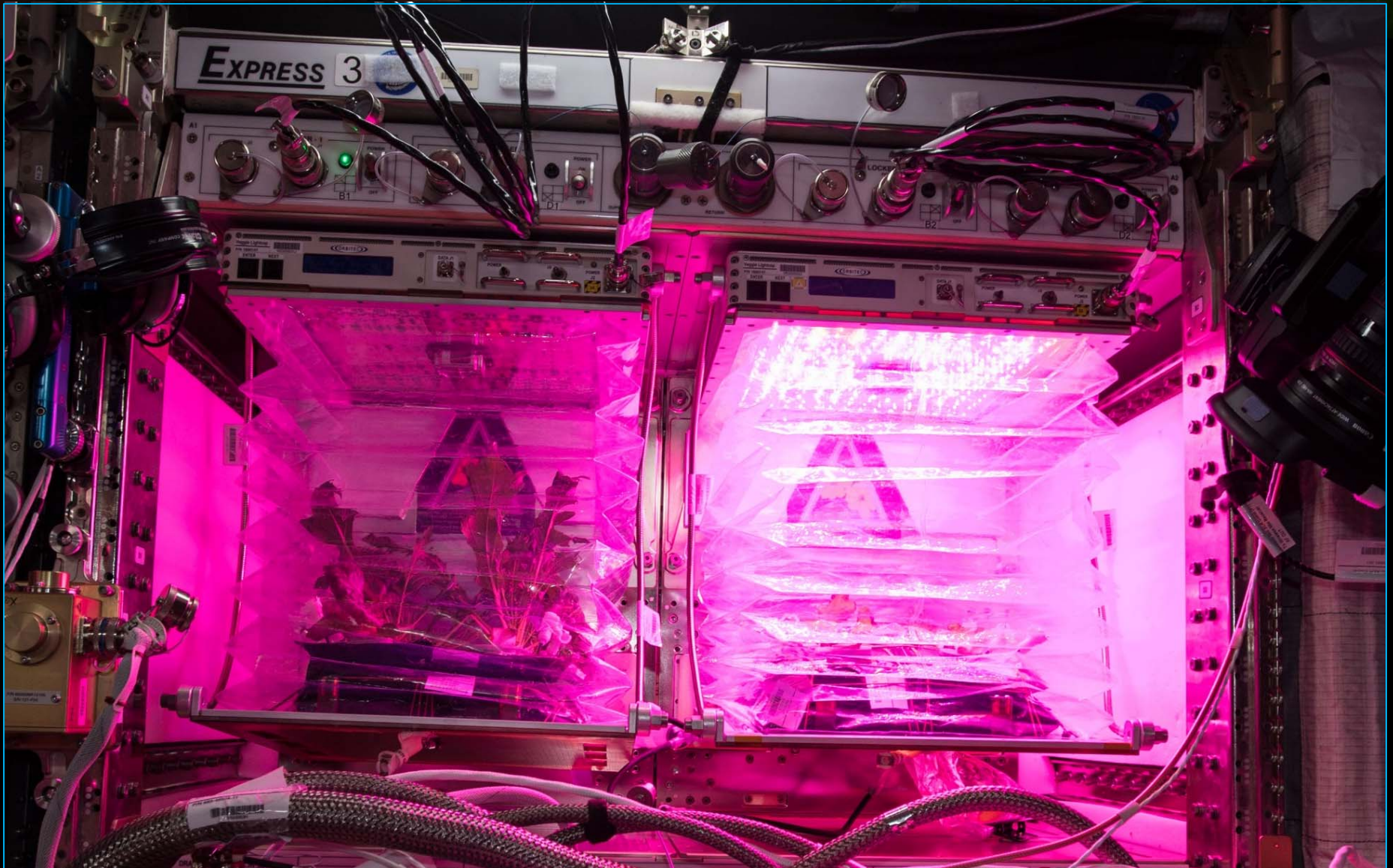
10/27/2017





# VEG-03E & F: A Tale of Two Veggies

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# Next Up – New Veggie Watering System and New Crops!

Veggie POND&EG-04 Mizuna LightTestRobin Tomato in POND&S





# Thank you!

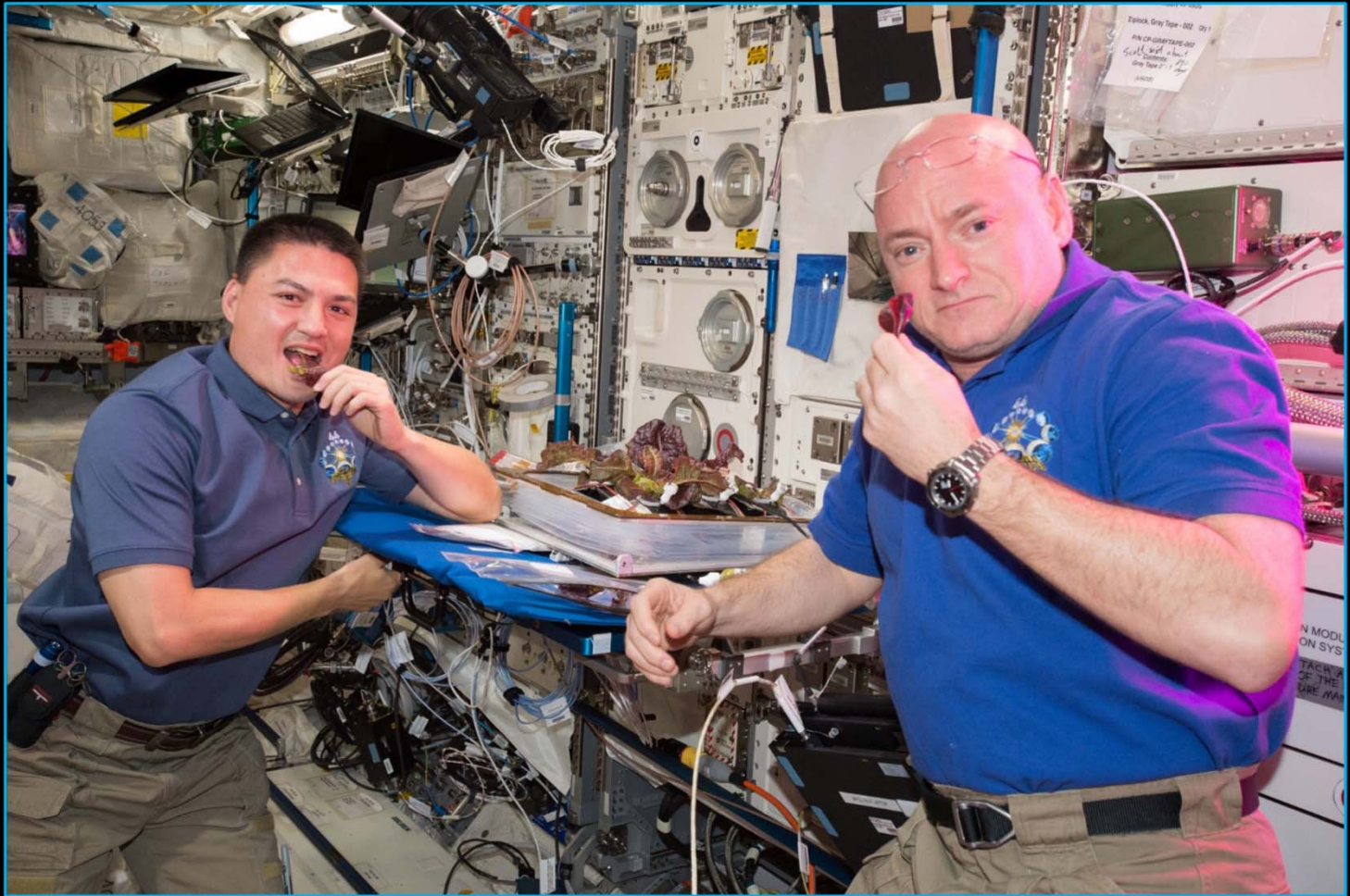
- Veggie and VEG teams at KSC and ORBITEC
- Astronauts Steve Swanson, Rick Mastracchio, Scott Kelly, Kjell Lindgren, Shane Kimbrough, Peggy Whitson, Jack Fischer, Joe Acaba, Scott Tingle
- Payload Operations and Integration Center
- NASA's Space Life and Physical Sciences, ISS Program, Human Research Program



Growing now on an ISS near you:  
NASA's Advanced Plant Habitat!



# Questions?



**VEGGIE**  
Vegetable Production System