

The Year in Space



Liz Warren, Ph.D.
ISS Program Science Office

2015: THE YEAR AHEAD

TIME

SCOTT KELLY
WILL SPEND ONE YEAR IN SPACE

HIS IDENTICAL TWIN WILL STAY ON EARTH WHILE NASA STUDIES THEM BOTH
P32



- PLUS**
BUSH VS. CLINTON REDUX
P62
- WHAT TO FEAR NOW
P47
- THE PROBLEM WITH POT CANDY
P72
- AMY SCHUMER'S WORLD
P94
- JOEL STEIN'S PREDICTIONS
P114

International Space Station

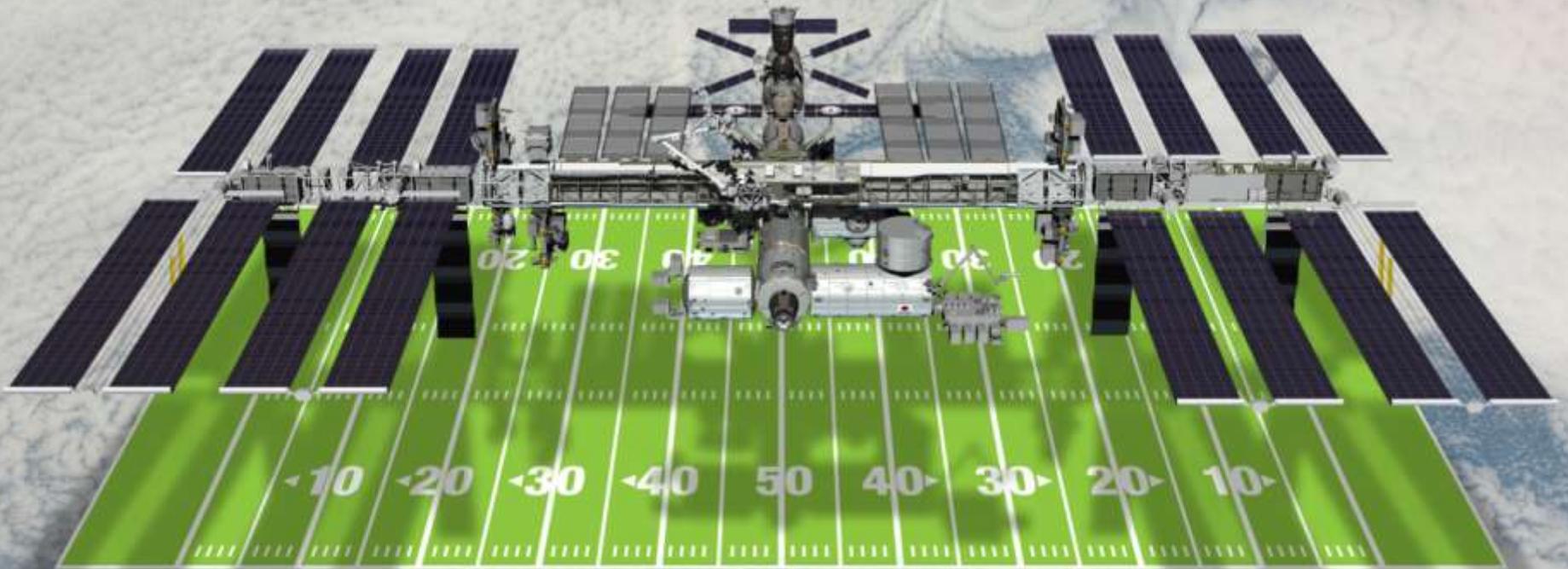
See it over your town!

<http://spotthestation.nasa.gov/>



International Space Station

By the Numbers



Spacecraft Mass: 924,739 lb

Spacecraft Pressurized Volume: 32,333 ft³

Velocity: 17,500 mph

**Science Capability: Laboratories from four international space agencies
US, Europe, Japan, and Russia**

NASA's goals onboard the Station

Advance benefits to humanity
through research

Enable a commercial demand driven
market in LEO

Enable long duration human
spaceflight beyond LEO

Basis for international HSF
exploration partnerships

International Space Station

Off the Earth, for the Earth



- About 2000 science experiments have been conducted by researchers in 95 countries and areas.
- During this expedition, about 250 experiments are occurring on-board.
- Categories of space station research include: biology and biotechnology, Earth and space science, human research, physical sciences, education and technology demonstration.

Why microgravity?



Astronauts experience a spectrum of adaptations to spaceflight

- Neurovestibular
- Vision
- Cardiovascular
- Bone
- Muscle
- Immunology
- Nutrition
- Behavior
- Radiation



Cardiovascular deconditioning
Immune dysfunction
Muscle atrophy
Bone loss
Vision impairment



FEMALE ASTRONAUT



Women suffer less from hearing loss with advancing age, and do not display a bias towards loss of hearing in the left ear



Women demonstrate a slight bias towards accuracy versus speed in response to an alertness test



Women mount more potent immune responses



Struvite kidney stones more common in women



Female astronauts, (to date) do not exhibit clinically significant visual impairment



Female astronauts are more susceptible to orthostatic intolerance



Urinary tract infections are more common in female astronauts



Large individual variability to muscle and bone loss in women



Health effect observed on Earth

MALE ASTRONAUT



Men suffer more from hearing loss with advancing age, and display a bias towards loss of hearing in the left ear



Men demonstrate a slight bias towards speed versus accuracy in response to an alertness test



Men mount less potent immune responses



Calcium oxalate kidney stones more common in men



Some male astronauts exhibit clinically significant visual impairment



Male astronauts less susceptible to orthostatic intolerance



Urinary tract infections less common in male astronauts



Large individual variability to muscle and bone loss in men



Health effect observed in space

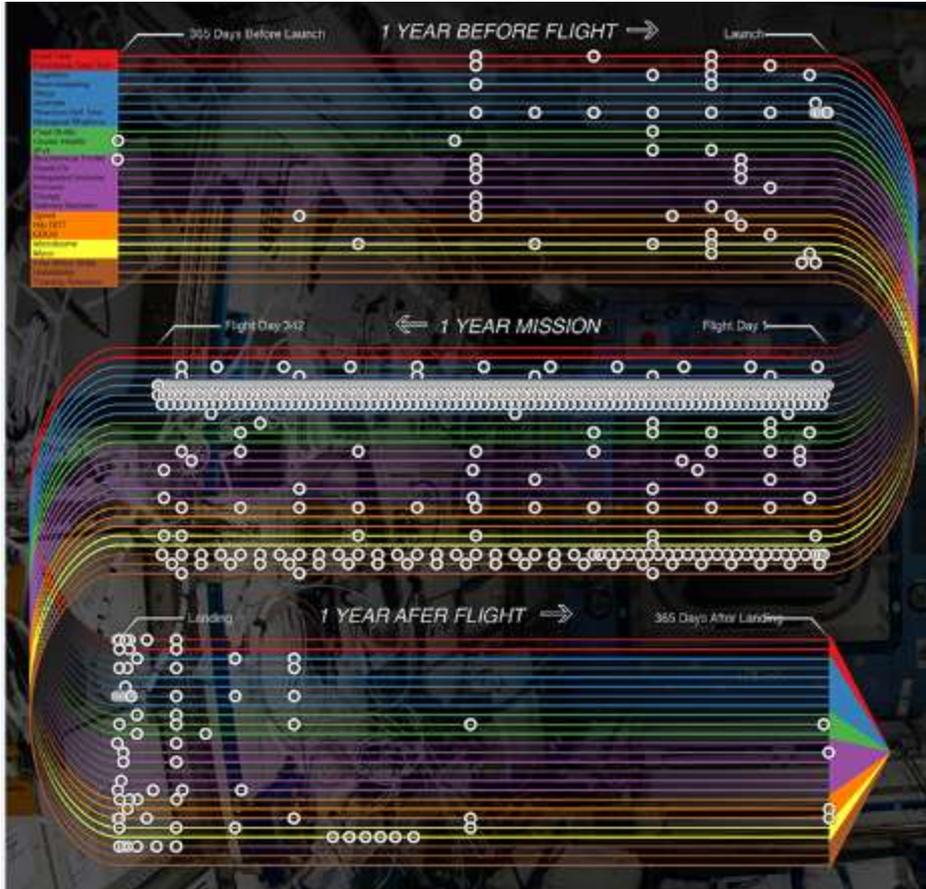


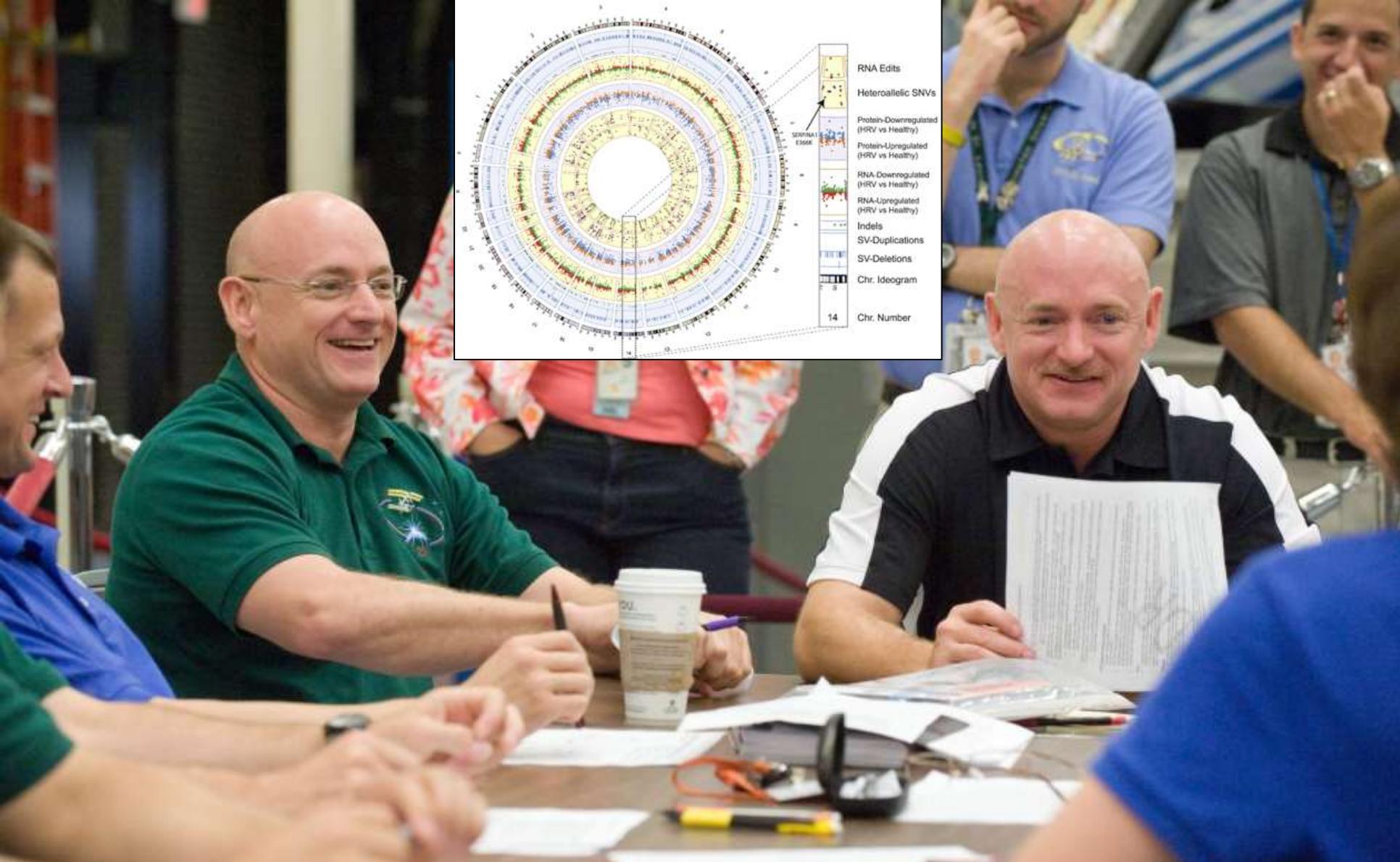


One Year Mission

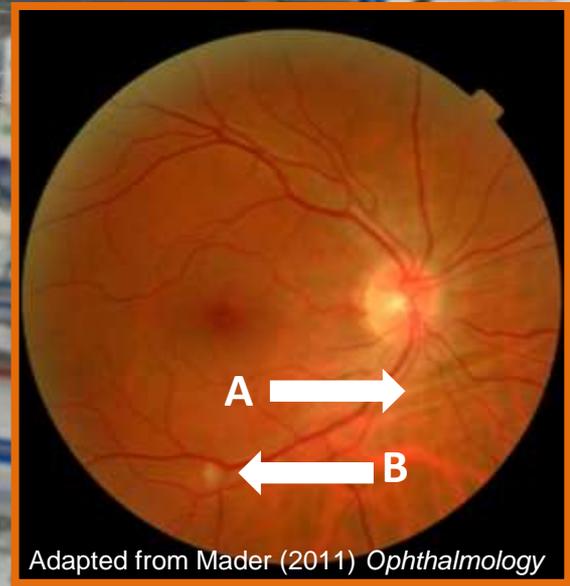
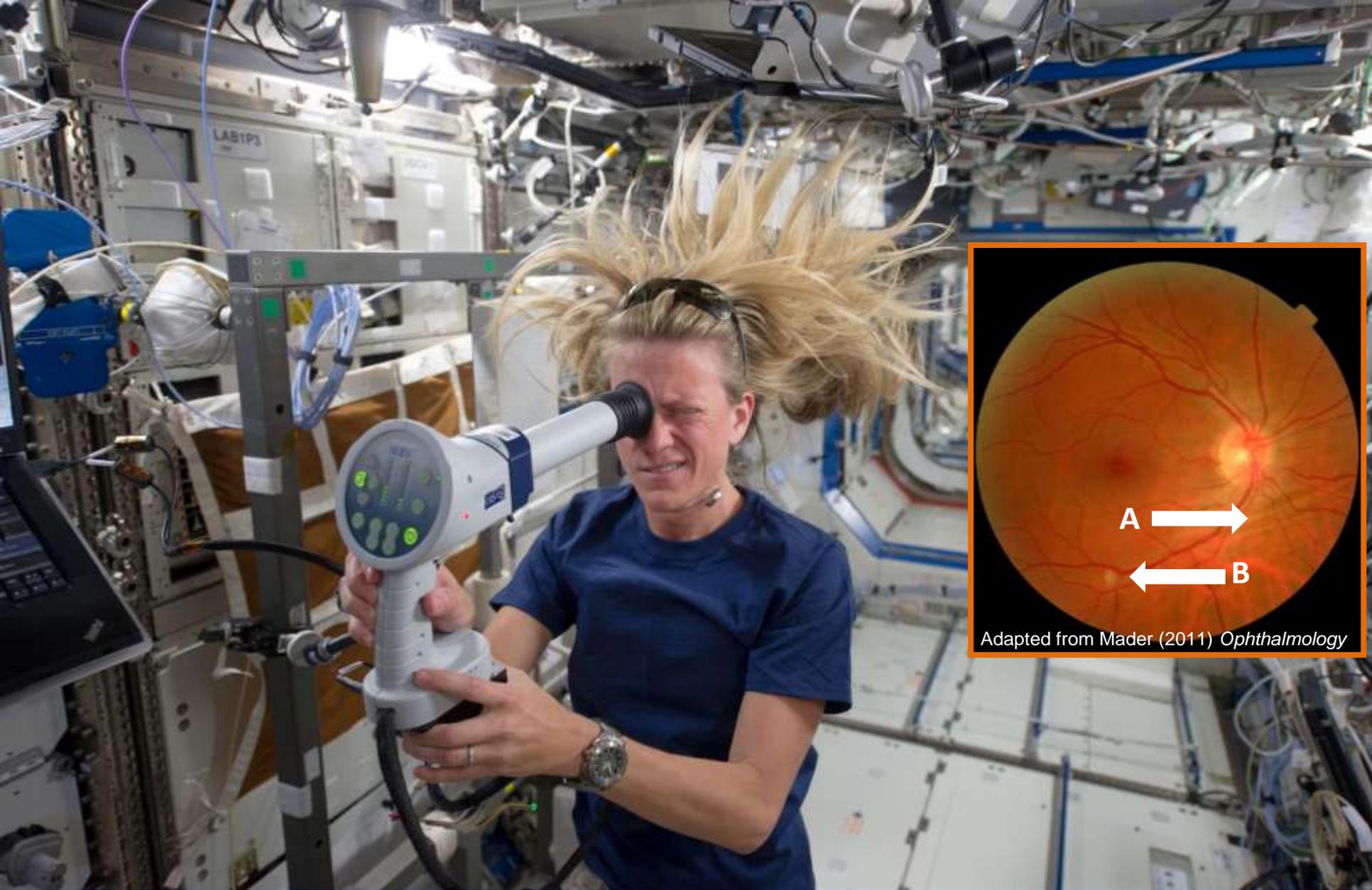


One Year in Space, Three Years of Data



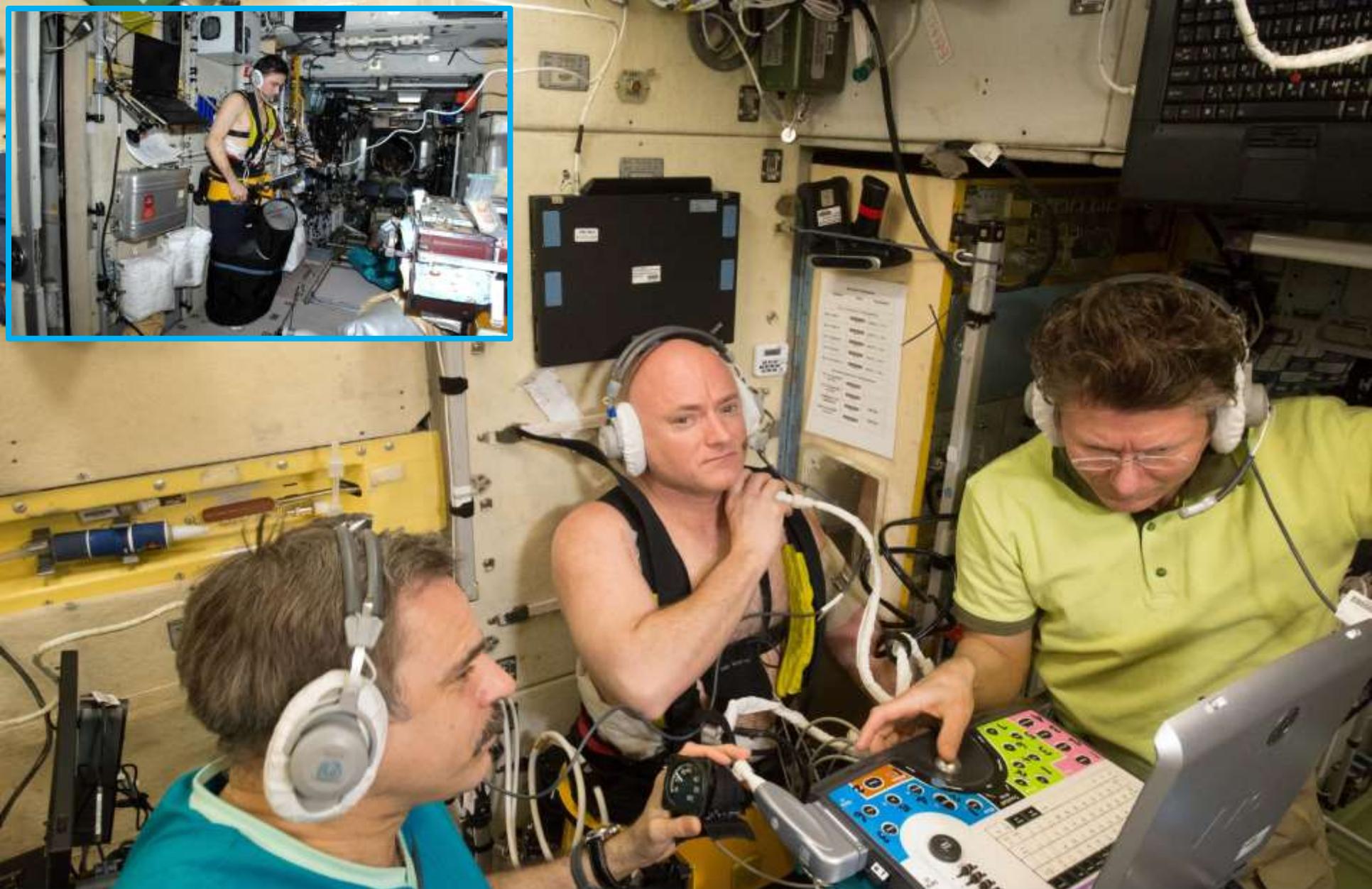


Twin Study – Using integrated human -omic analyses to better understand the biomolecular responses to the physical, physiological, and environmental stressors associated with spaceflight.

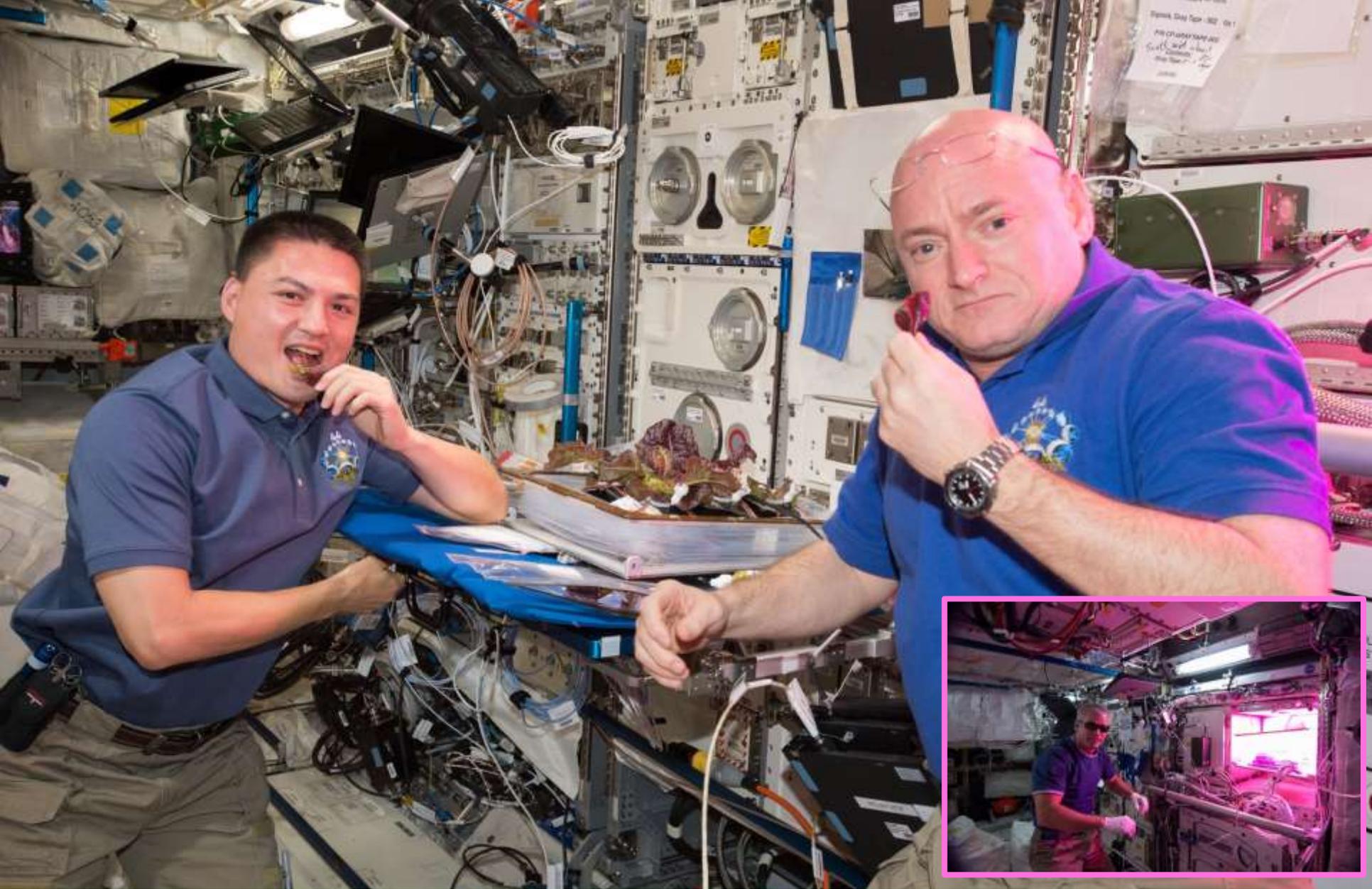


Adapted from Mader (2011) *Ophthalmology*

Vision Impairment - Some astronauts' vision deteriorates during spaceflight; this is an active area of research on the space station.



Fluid Shifts - Some astronauts' vision deteriorates during spaceflight; this is an active area of research on the space station.



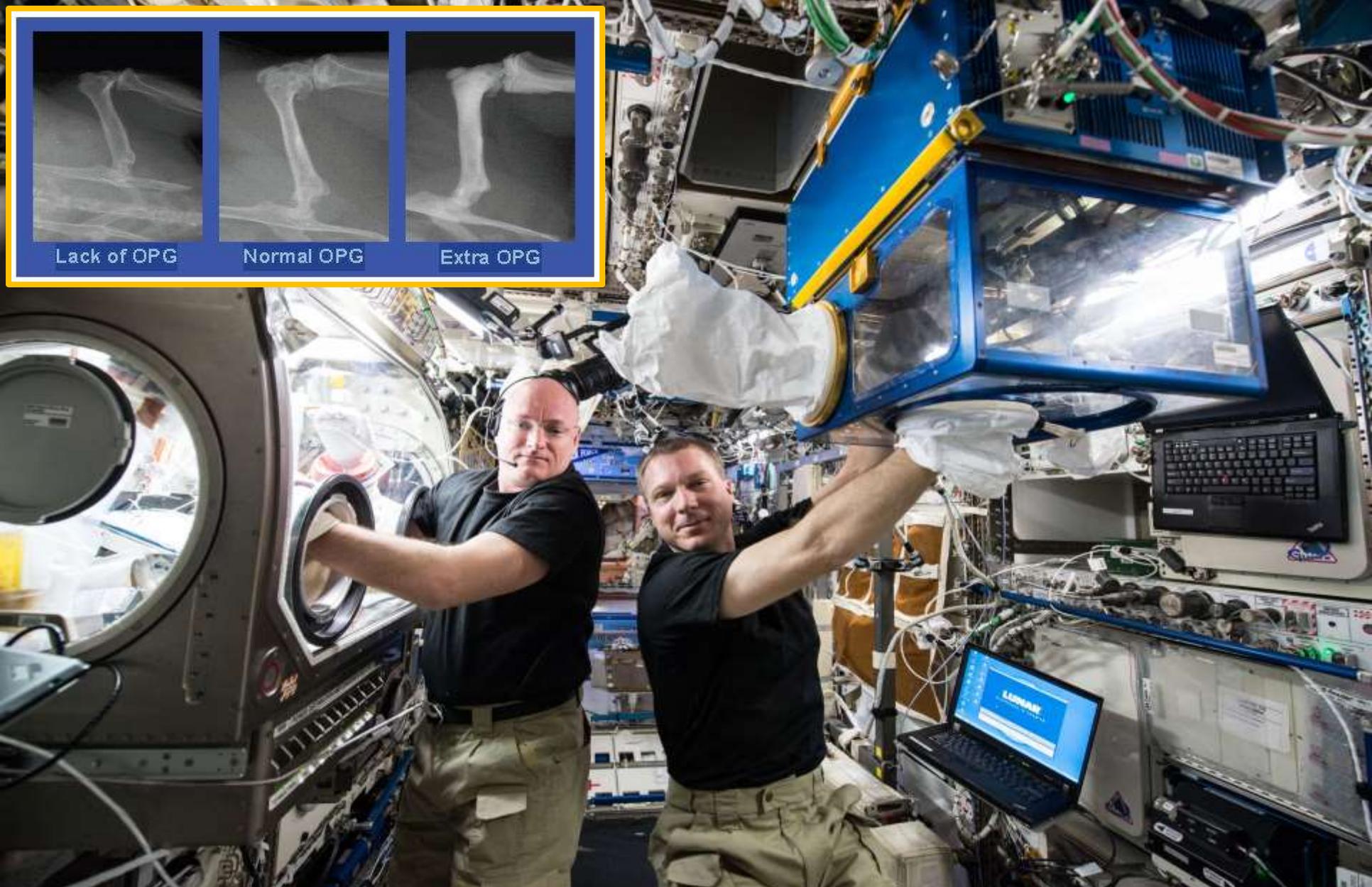
Growing Vegetables - Understanding the effects of gravity on plant life is essential in preparation for future exploration missions.



CubeSats – Cost-effective, independent means of getting commercial payloads in a variety of disciplines to orbit.



3D Printing – The ability to manufacture objects on-board a spacecraft is our first step in independence from Earth.

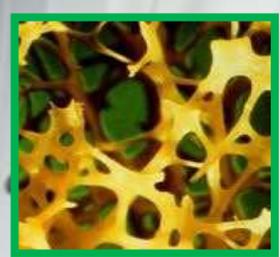


Lack of OPG

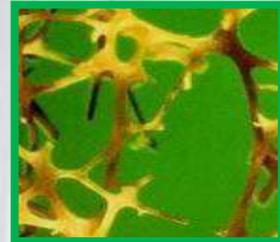
Normal OPG

Extra OPG

Rodent Research - Studies on model organisms are informing new pharmaceuticals for bone loss and other maladies.



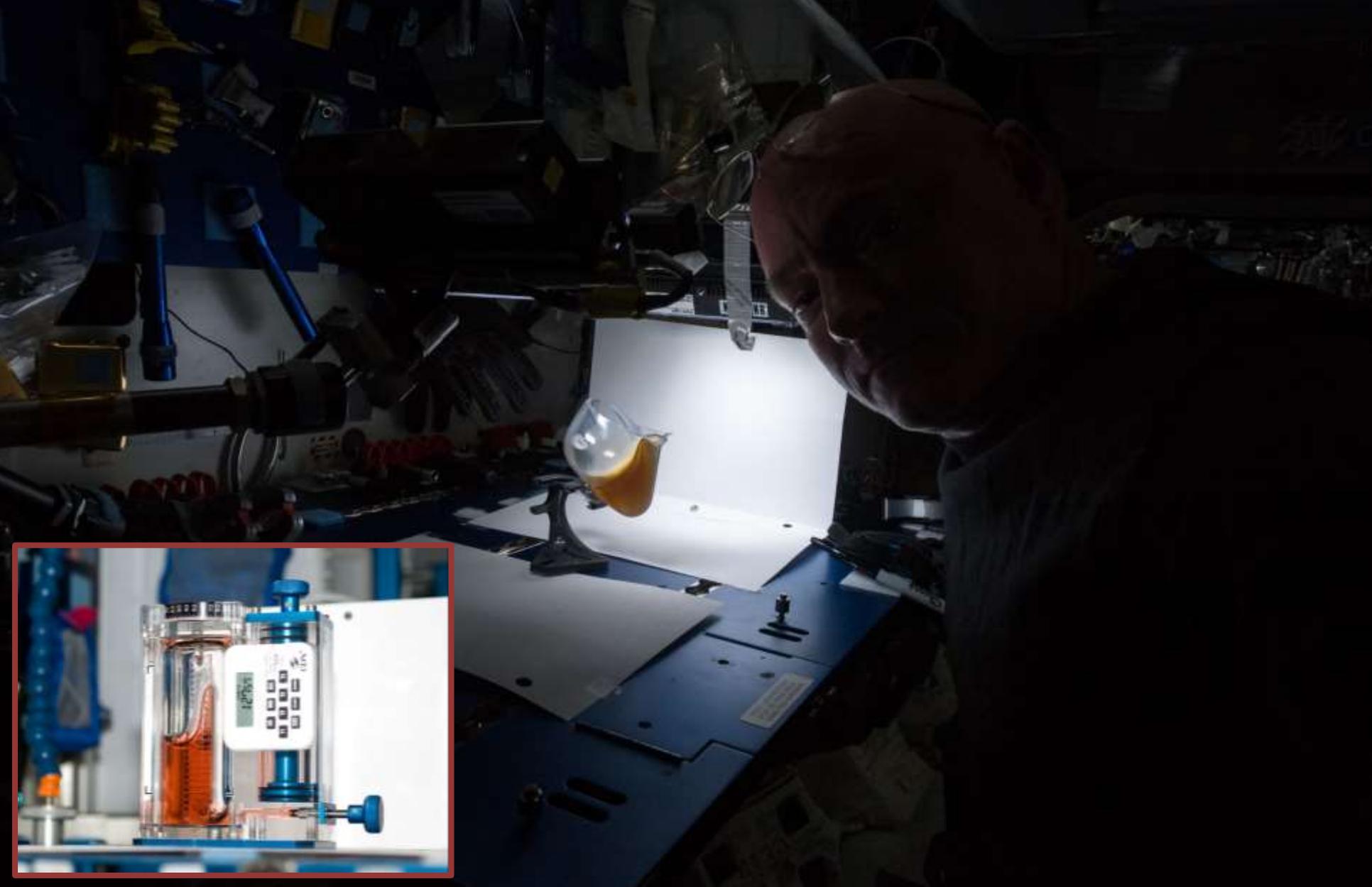
Normal Bone



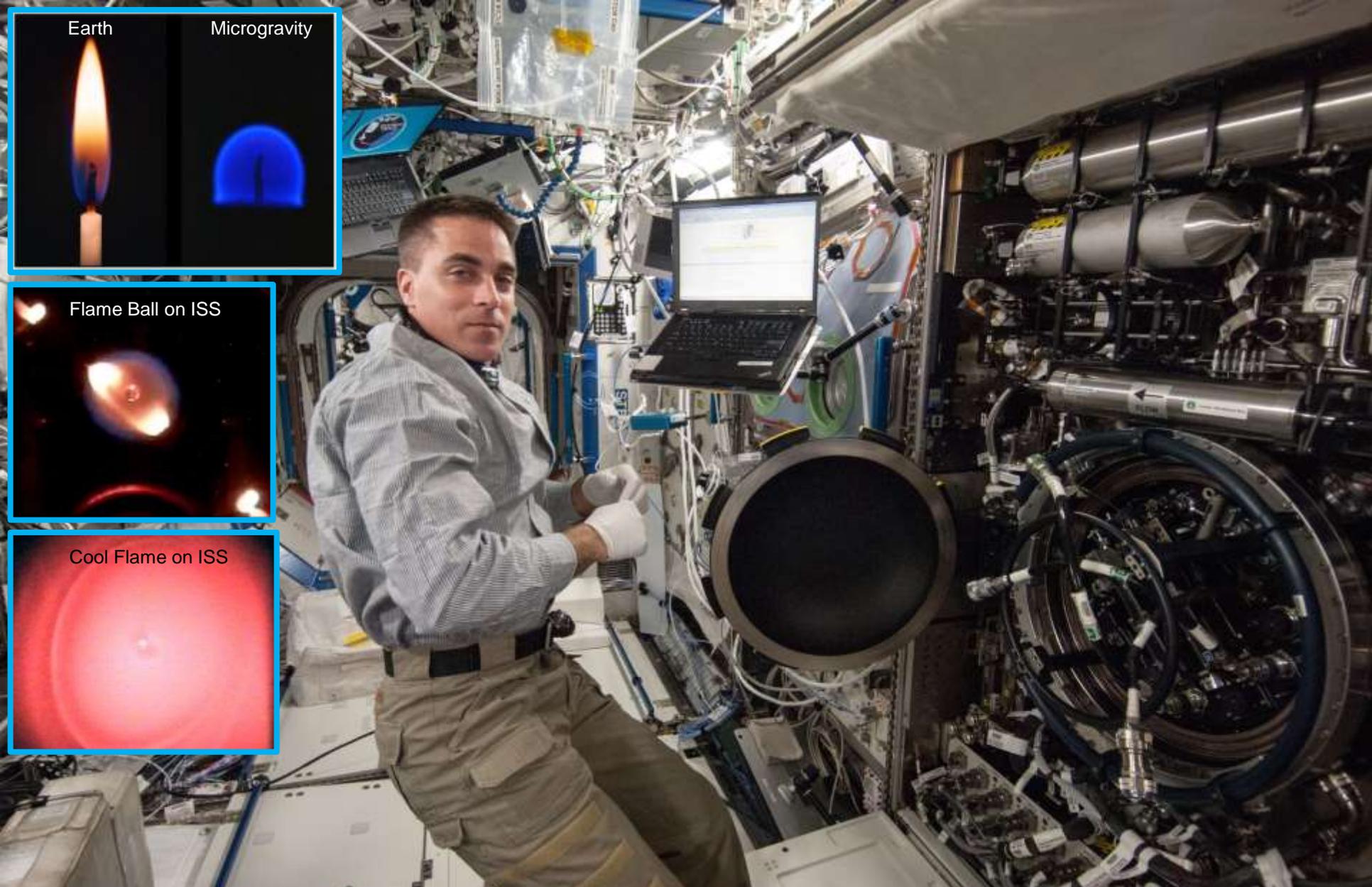
Osteoporotic Bone



Preventing Bone Loss - High intensity resistive exercise, along with adequate calorie intake and Vitamin D helps to prevent bone loss in space.



Fluid Behavior - Studies on liquid movement and surface tension are informing better spacecraft tanks and portable medical diagnostics on Earth.



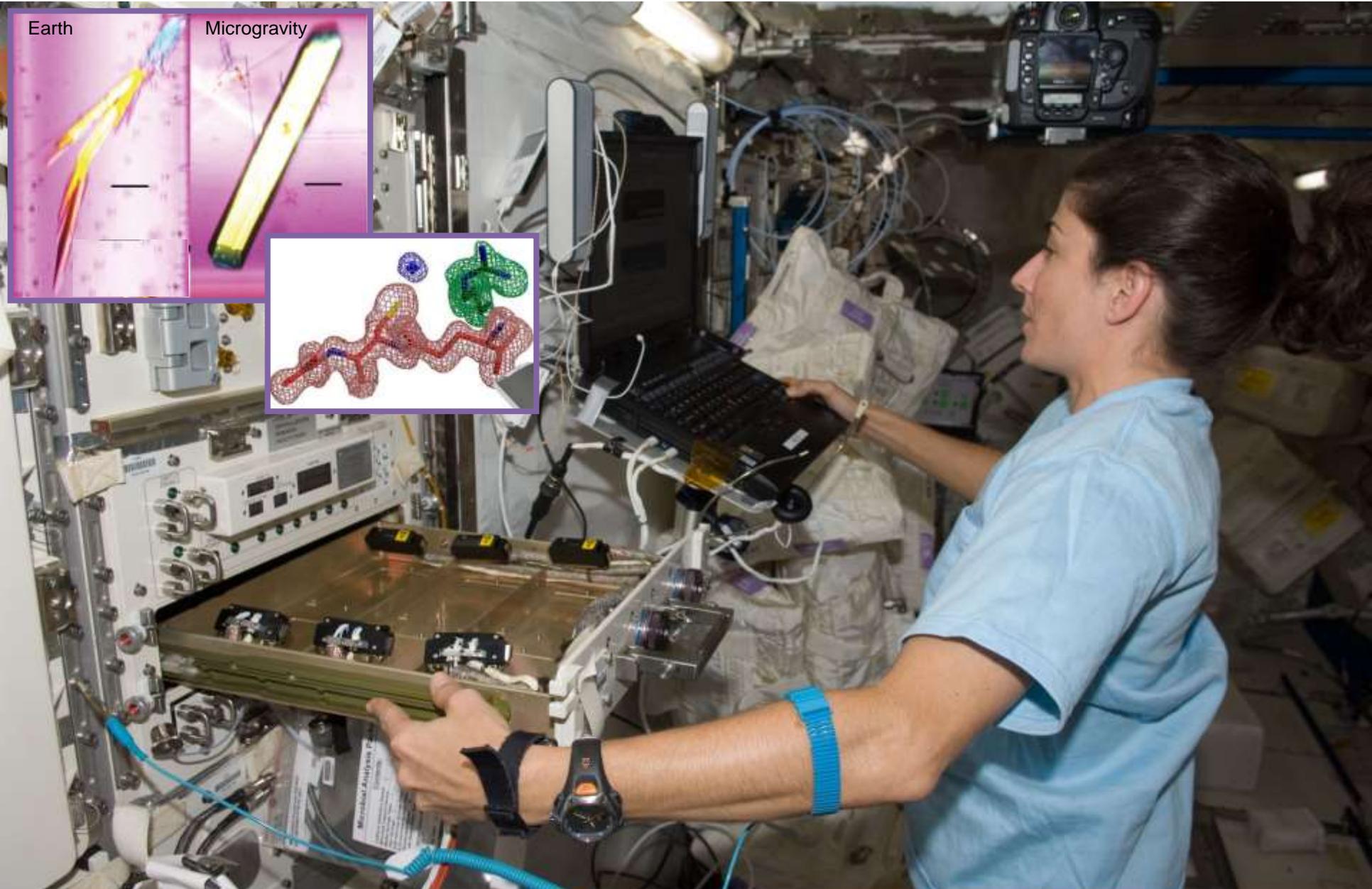
Earth

Microgravity

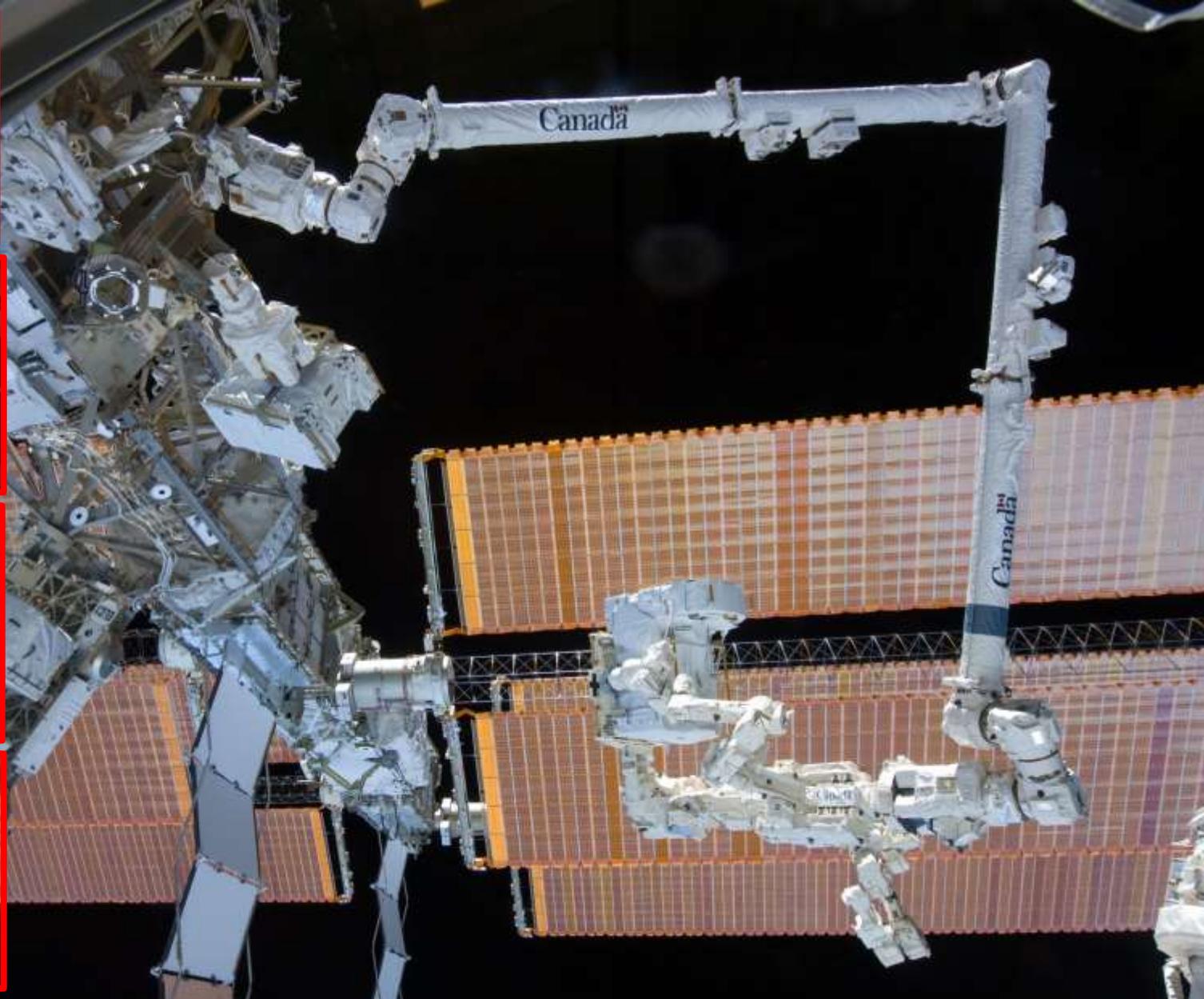
Flame Ball on ISS

Cool Flame on ISS

Combustion - Studies on flame behavior and fuel mixtures on the space station may lead to improved fuel efficiency and reduced pollution on Earth.



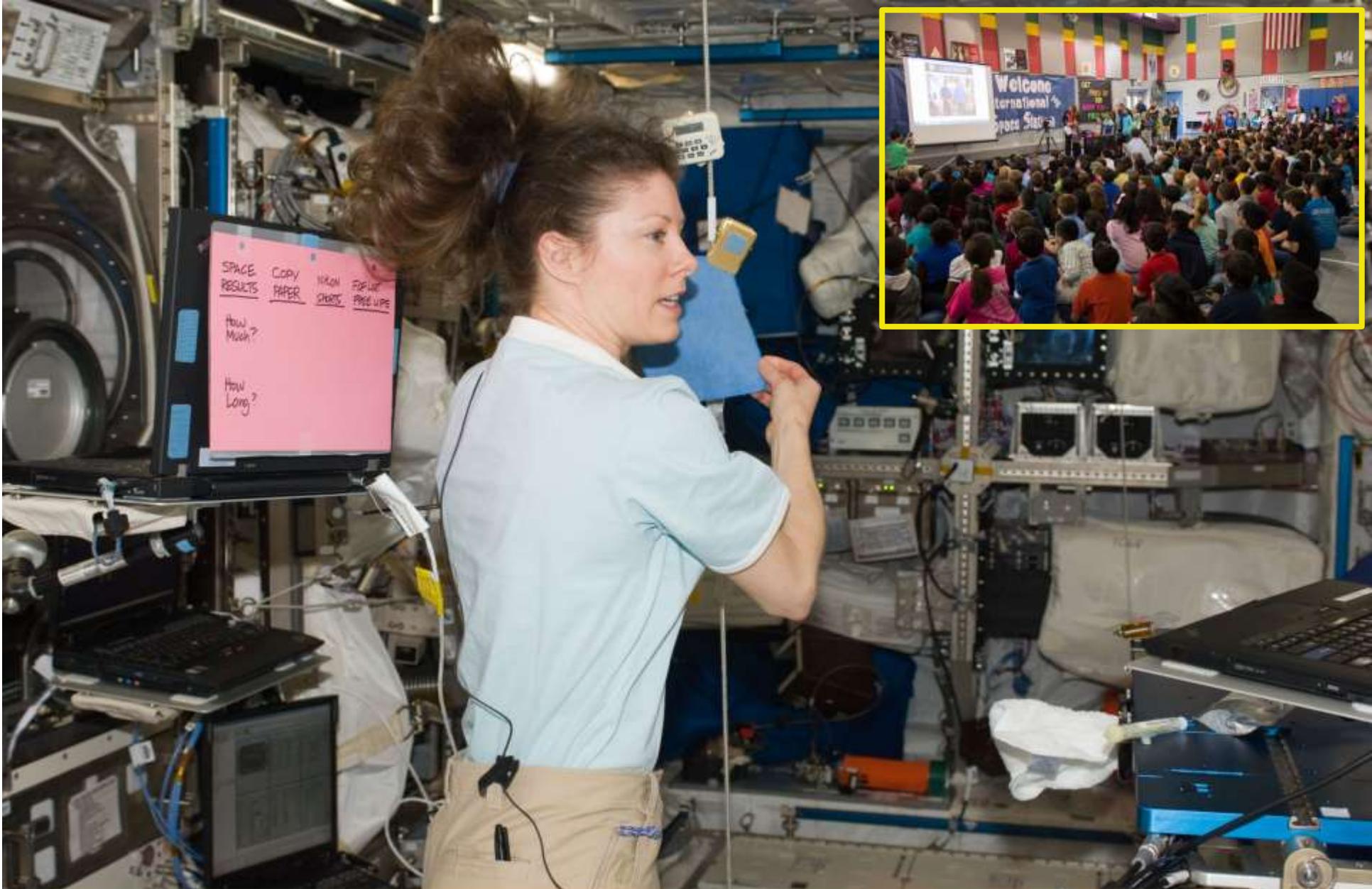
Protein Crystal Growth - Improved structure of biological proteins grown in microgravity can lead to better pharmaceuticals on Earth.



Robotic Surgery - The development of robotic arms for space missions has led to computer-assisted devices specifically designed for neurosurgery.



Disaster Response Networks - The space station is a unique vantage point for observing the Earth with both hands-on and automated equipment.



Education - 42 million students and 25,000 schools in 44 countries involved in space station education activities.



Plant Growth - Technology developed for a space station greenhouse led to a new tool for eliminating airborne pathogens (like Anthrax) on Earth.

Benefits for Humanity Videos

- Robotic Surgery
 - <https://youtu.be/LIWSyyT3w98>
- Protein Crystal Growth
 - https://youtu.be/1jEx4Q_nBW8
- Remote Medicine
 - <https://youtu.be/GhHe3oiLCo4>
- Clean Drinking Water
 - <https://youtu.be/DayWXWbVW4g>
- Education
 - <https://youtu.be/yzN9jSDKR8c>
- Ship Tracking
 - <https://youtu.be/TrsKZma-LTk>
- Cooperation with EPA
 - <https://youtu.be/w6XumQvbKag>



<http://www.nasa.gov/iss-science/>



@ISS_Research and @Space_Station

Email List

<https://lists.nasa.gov/mailman/listinfo/iss-program-science-group>



ISS Research Blog "A Lab Aloft"

http://blogs.nasa.gov/ISS_Science_Blog/



<https://www.facebook.com/ISS>



Instagram/ISS

