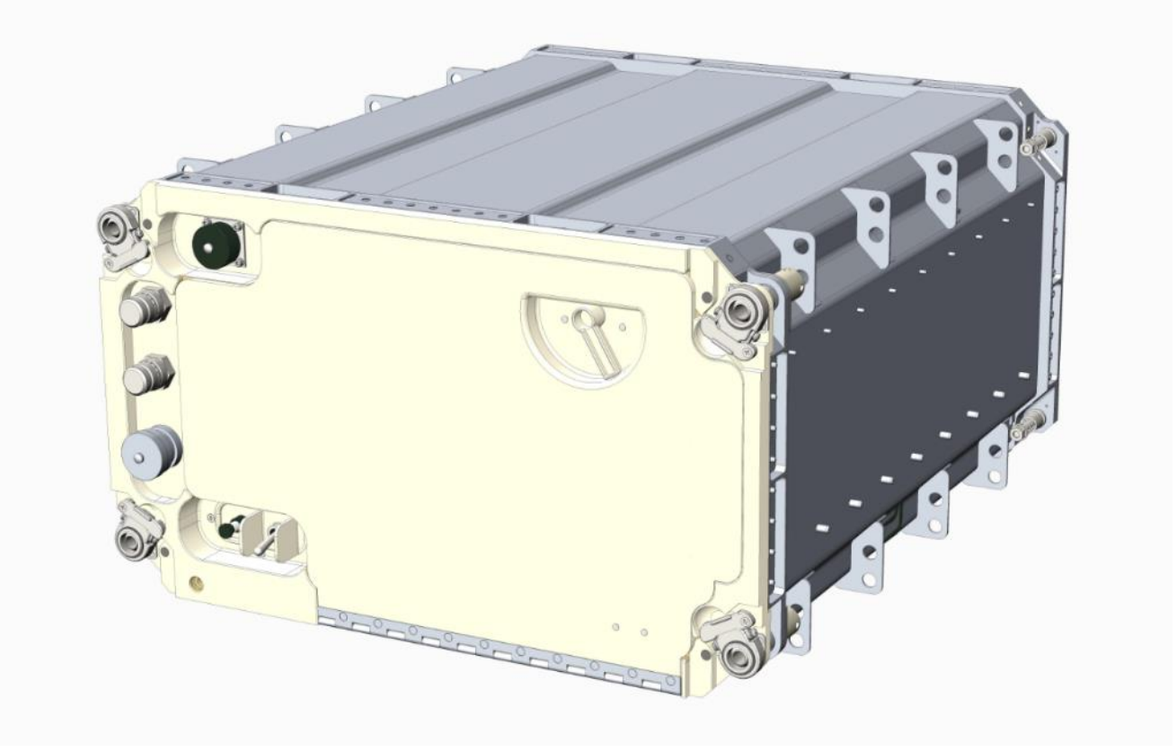
Engineering Services Contract

PAYLOAD INTEGRATION & ENGINEERING

Multi-Spectral Fluorescence Imager (MSFI)



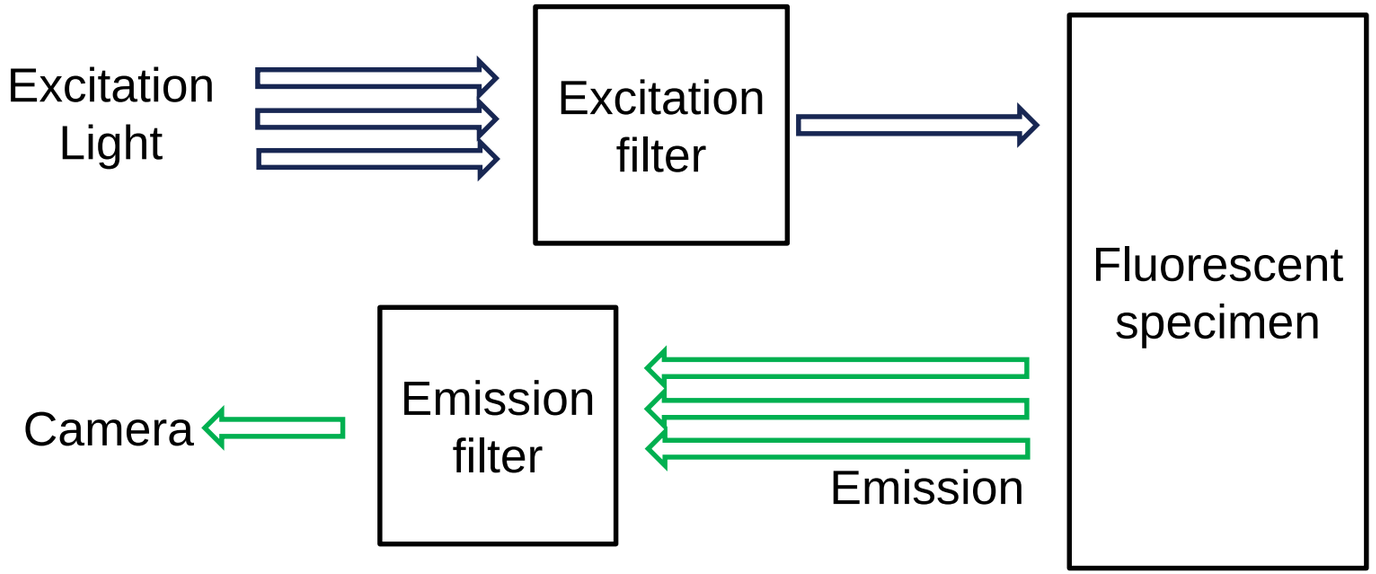
Prepared for ISS R&D Conference

July 14, 2016

VENCORE

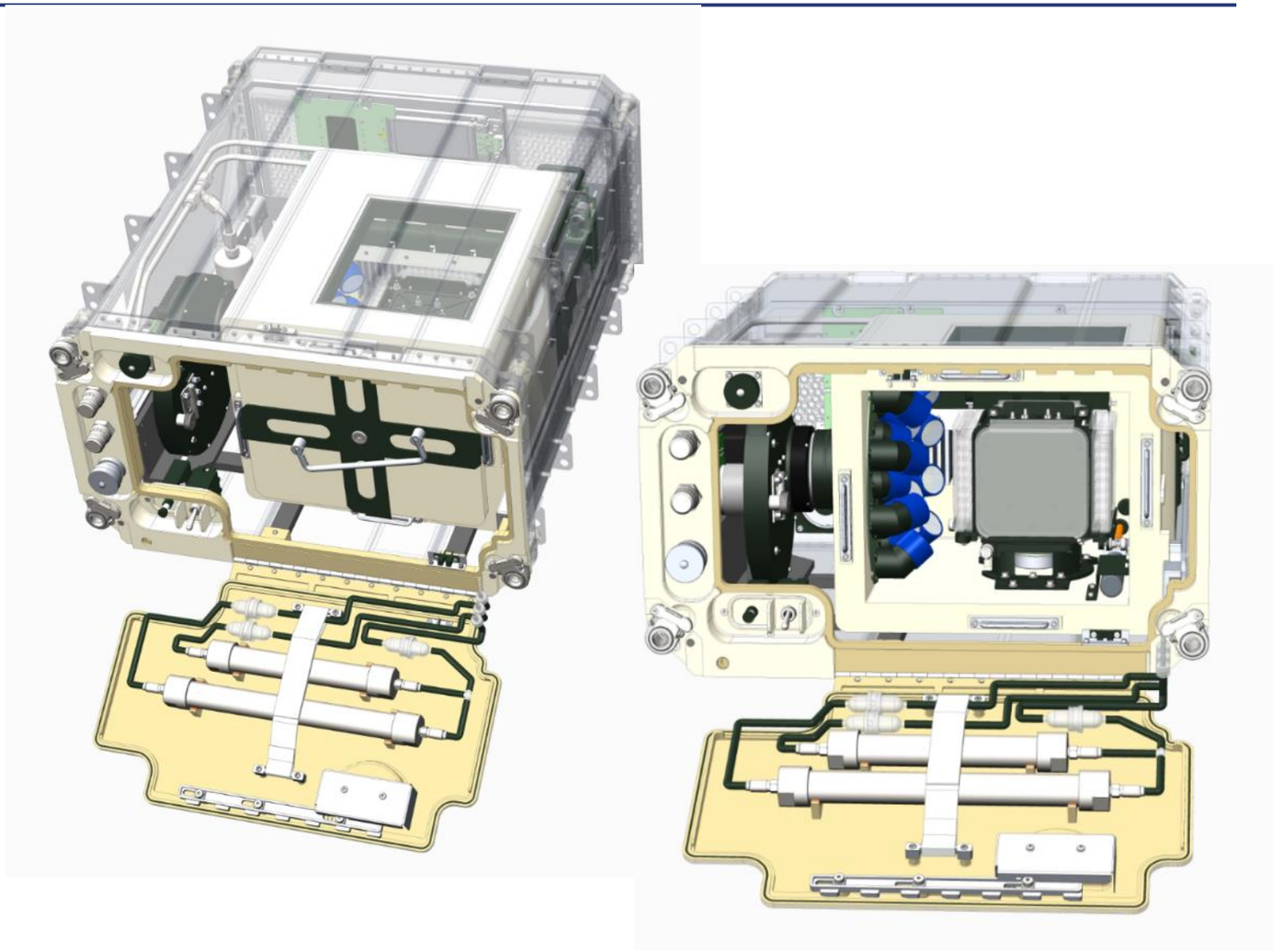
MSFI OBJECTIVE:

Provide in vivo high resolution fluorescence images of biological reporter genes (i.e. GFP) within a programmable controlled environment



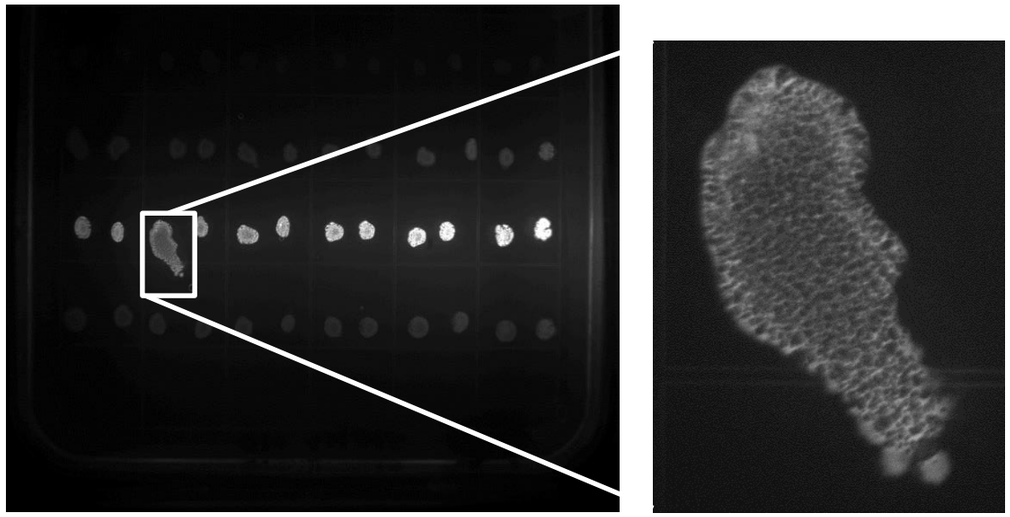
Outline

- **Science Possibilities**
- **Hardware**
  - Imaging
  - Environmental Control
- **Operations**
  - Process to Flight
- **Schedule**
  - Hardware fabrication and testing
  - Space X-15 Flight

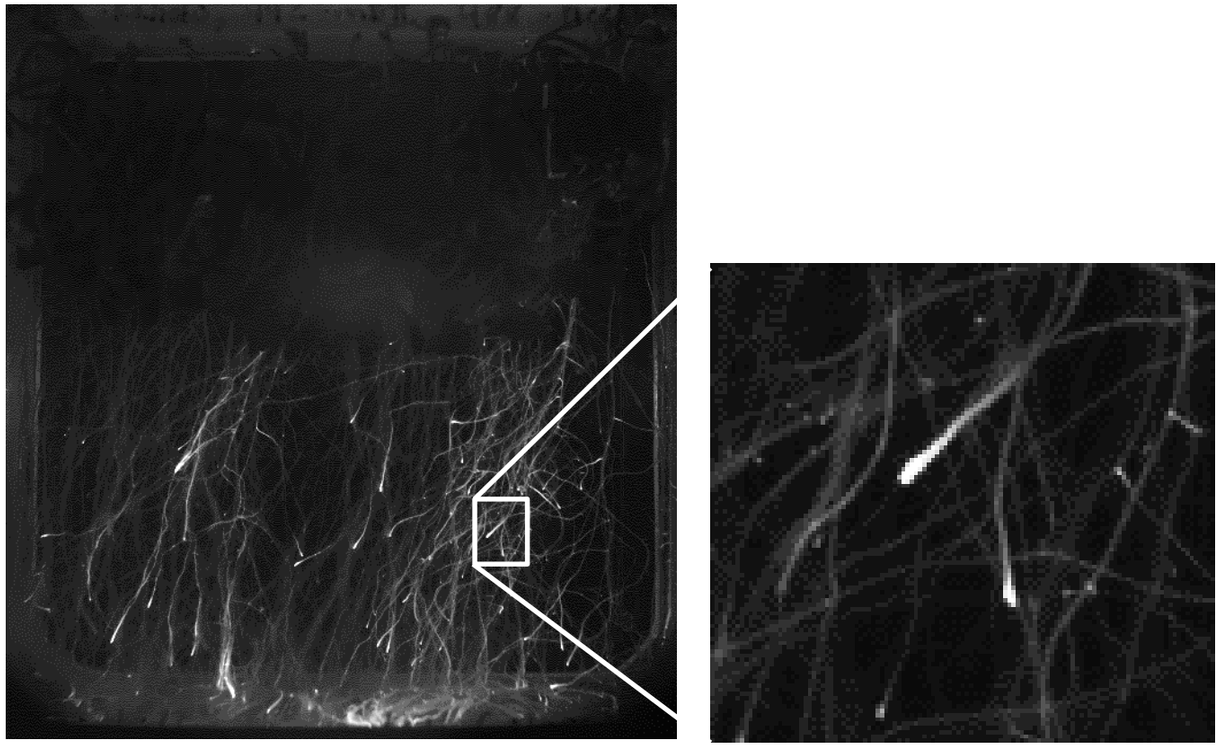


Science Possibilities

- **Genetic transformation with *in vivo* reporter genes for fluorescent proteins**
  - unicellular organisms
  - plants
  - invertebrates



E.coli RFP



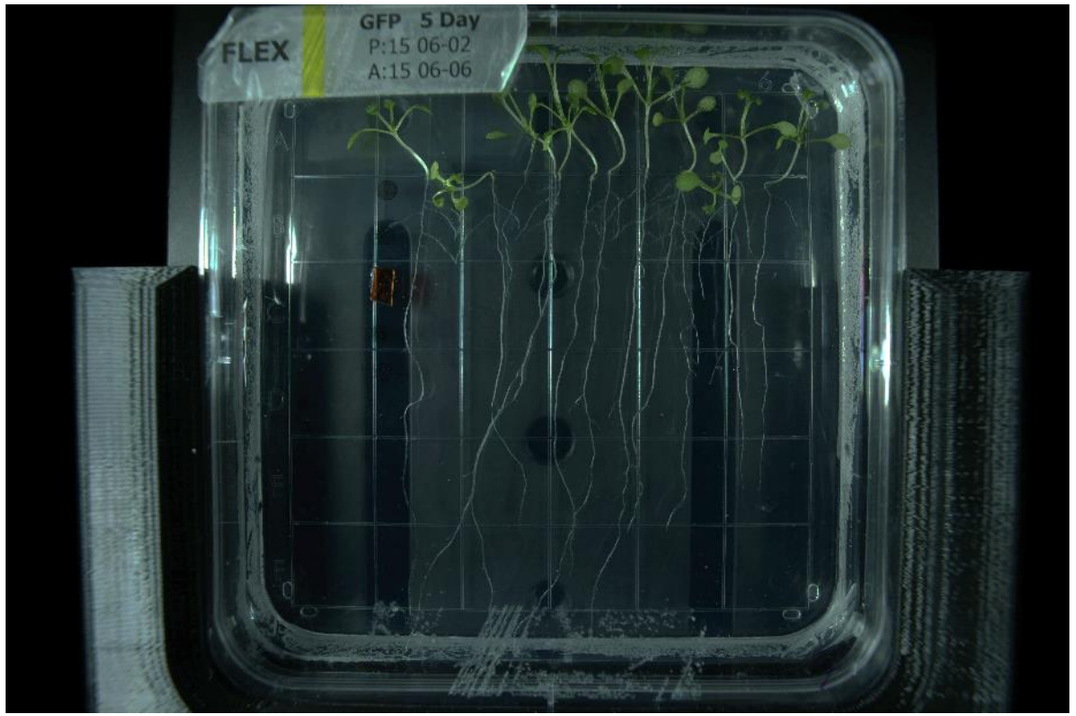
Arabidopsis GFP

Science

- **Multi-spectral capable allows for more than one reporter gene to be studied at a time**
- **Specimens can be contained in:**
  - 10cm x 10cm Petri plates
  - various sized multiwell plates
  - various sized round Petri dishes
  - custom culture containers
- **Capable of receiving near real time imagery and telemetry for PI review at KSC ground station**

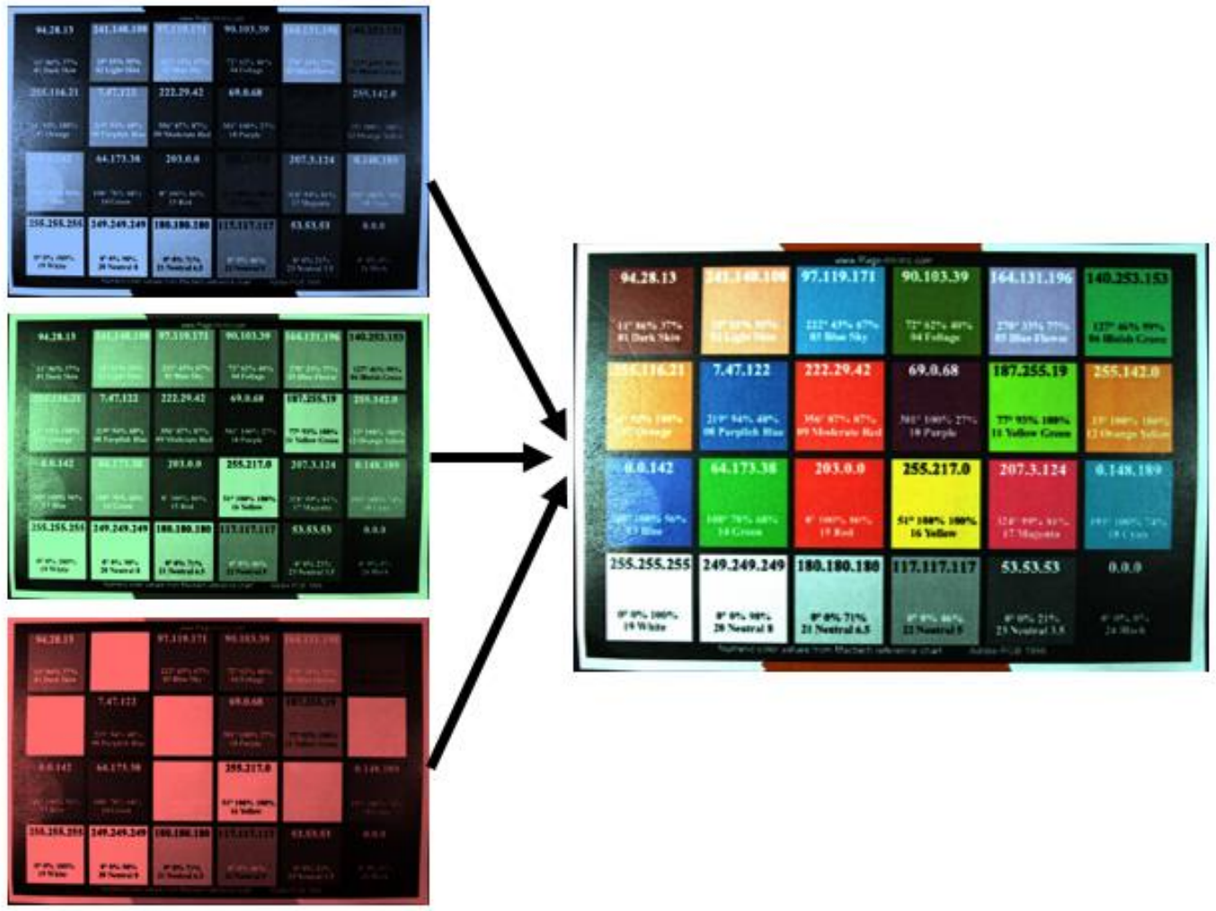
Imaging System Capabilities

- **Green, yellow, orange, red, cyan, blue fluorescence proteins**
  - Excitation light and emission filters are modular and can be replaced on-orbit for specific PI needs
- **Chlorophyll fluorescence**
- **Monochrome high resolution camera with better than 25µm resolution with minimized distortion**
- **Single field of view over entire petri plate**



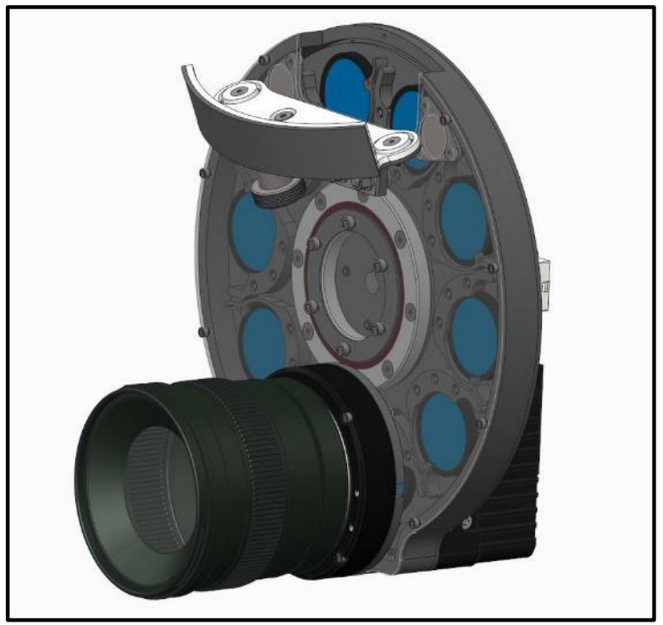
Imaging System Capabilities

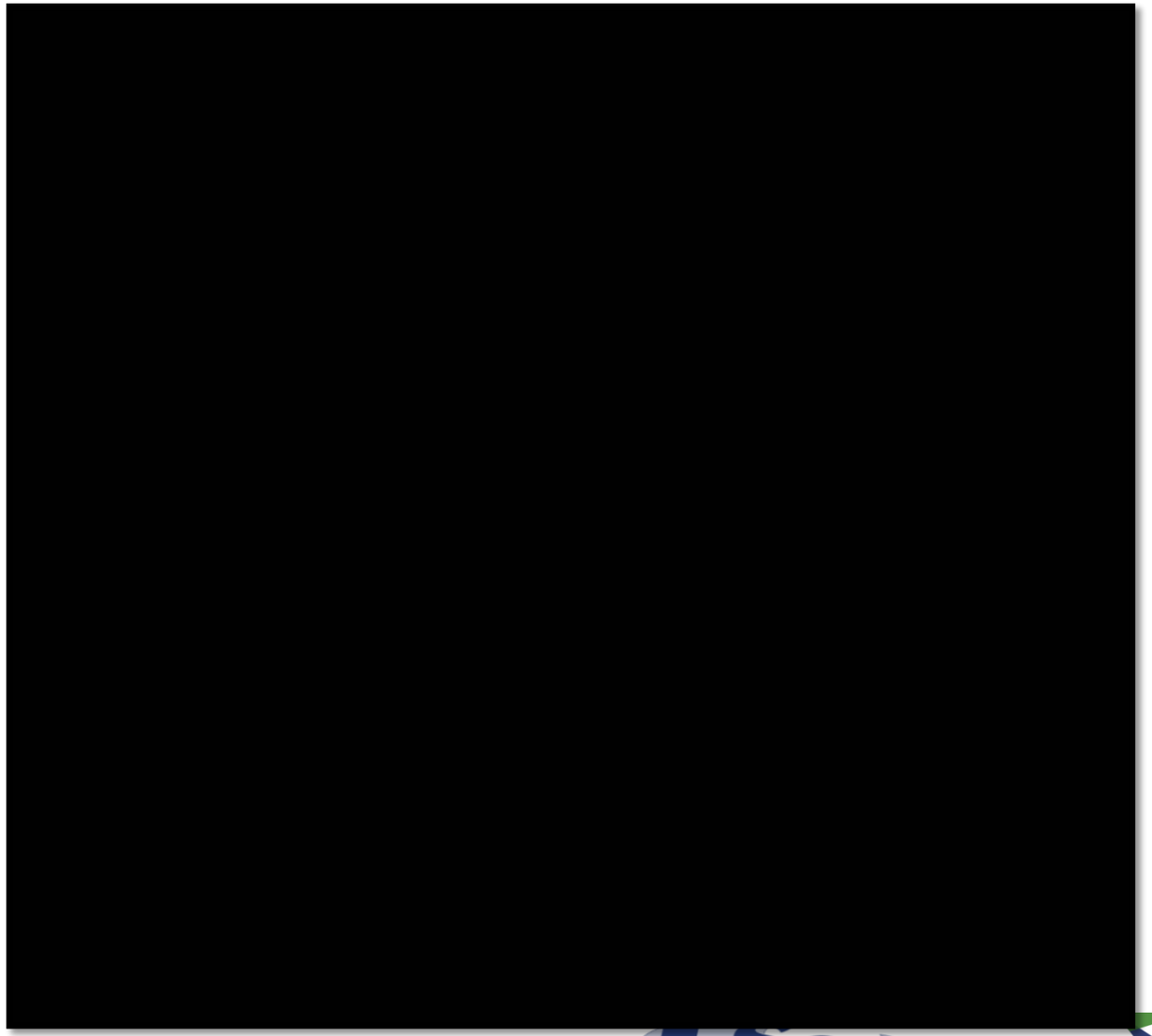
- **Focus from front to back of dish**
  - Stacked/over-laid images can be used to build 3D image or 1 single image in focus
- **Programmable autofocus routine**
- **Time lapse capable**
- **Programmable exposure**
- **False color images**



Imaging Capabilities – Filter Wheel

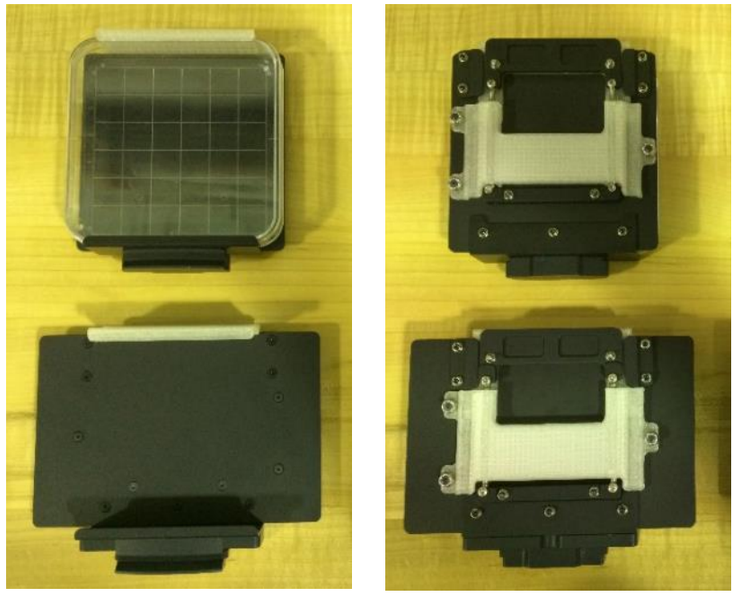
- **Rapid ability to switch between different fluorescence filters**
- **Replaceable filters on-orbit, if needed**
- **10 filter locations**



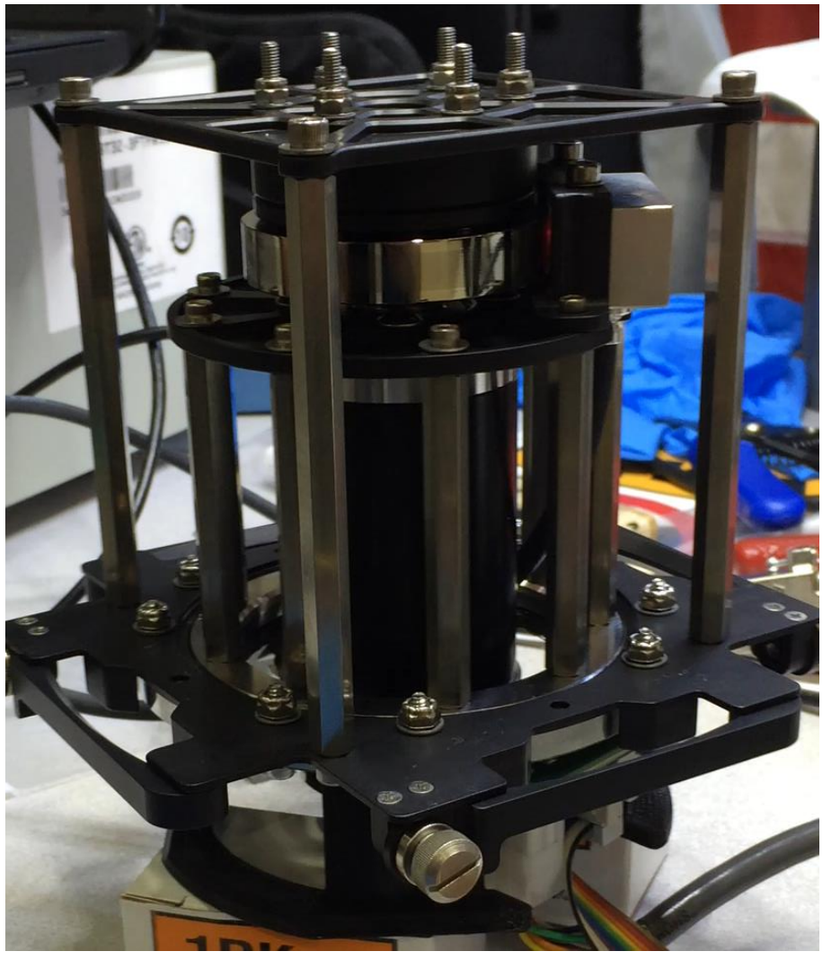


Imaging Capabilities - Carousel

- **Precision control at slow or fast speeds**
  - Max 30 rpm
- **Removable Petri Plate Holders**
  - Customizable for any dish size or shape within a 10 x 12.7 cm footprint
- **Repeatable positioning to <25µm**
  - Approx. 1 pixel

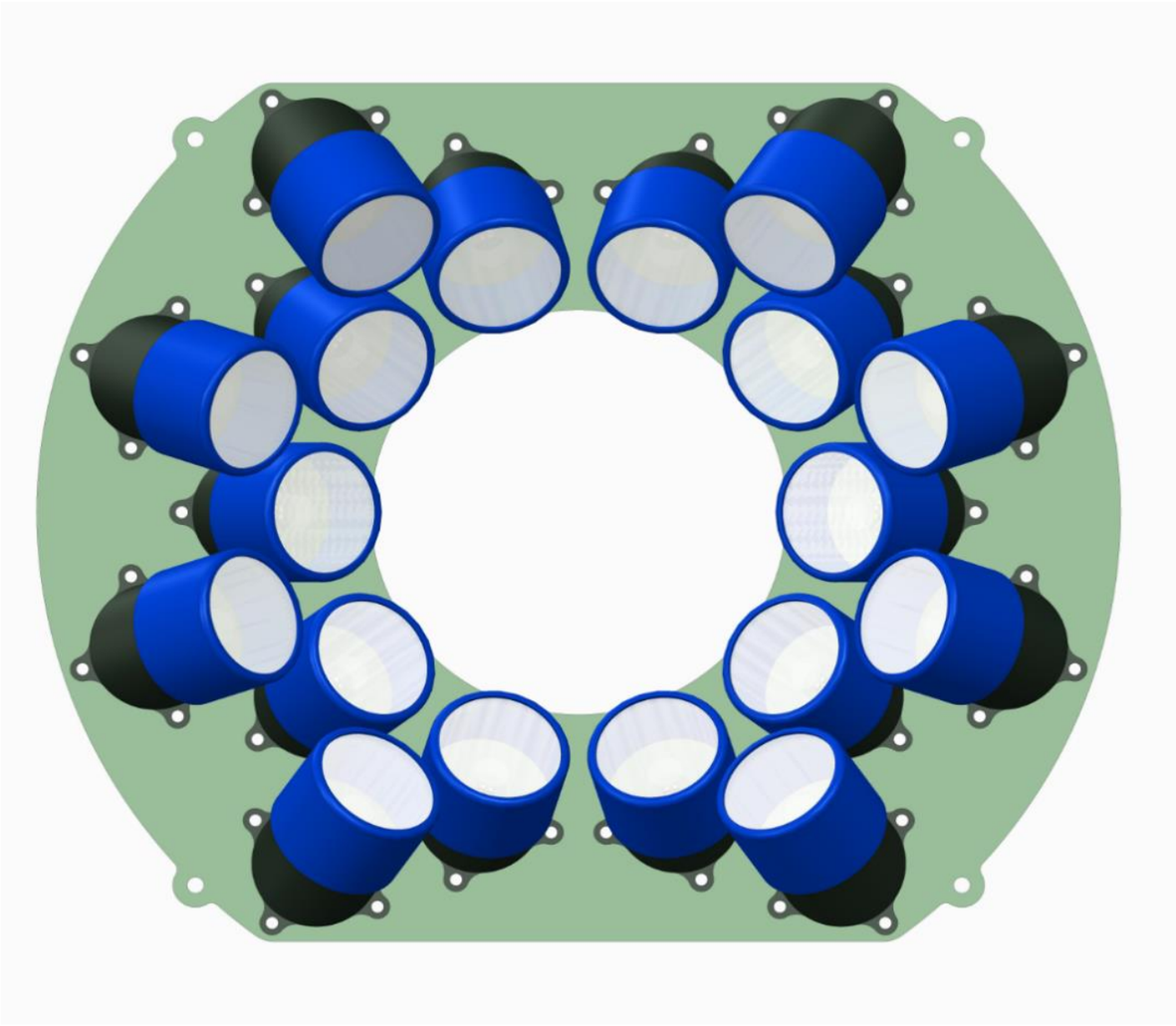


Petri Plate Holders



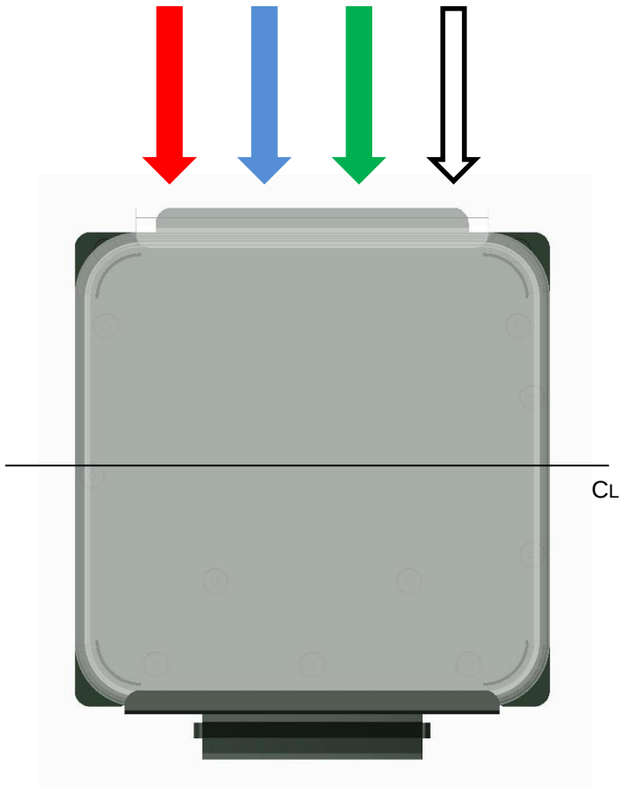
Imaging Capabilities – Excitation Light Source

- **Modular design that may be reconfigured on-orbit**
- **~70% light efficiency on target**
- **>80% light uniformity over area of 10cm x 10cm plate**
- **Control to <1 sec switching between excitation wavelength sources**



Environmental Control – Growth Lighting

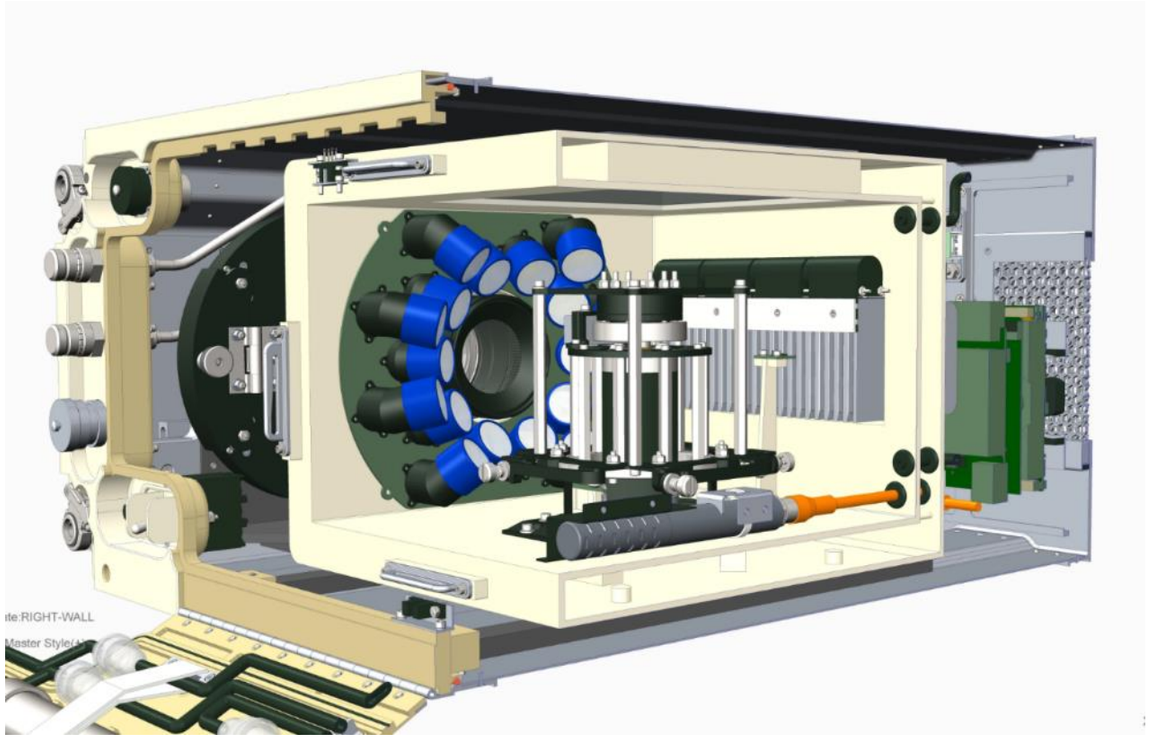
	Intensity (µmol/m²/s)	Wavelength (nm)
Red	0-100	630-660
Blue	0-50	400-500
Green	0-30	520-530
White	0-100	400-700



- **Independent wavelength and intensity control**
- **Selectable light levels at 10 µmol/m²/s**
- **80% uniform @ centerline of petri dish**
- **Light tight @ <1 µmol/m²/s**

Environmental Control - Temperature

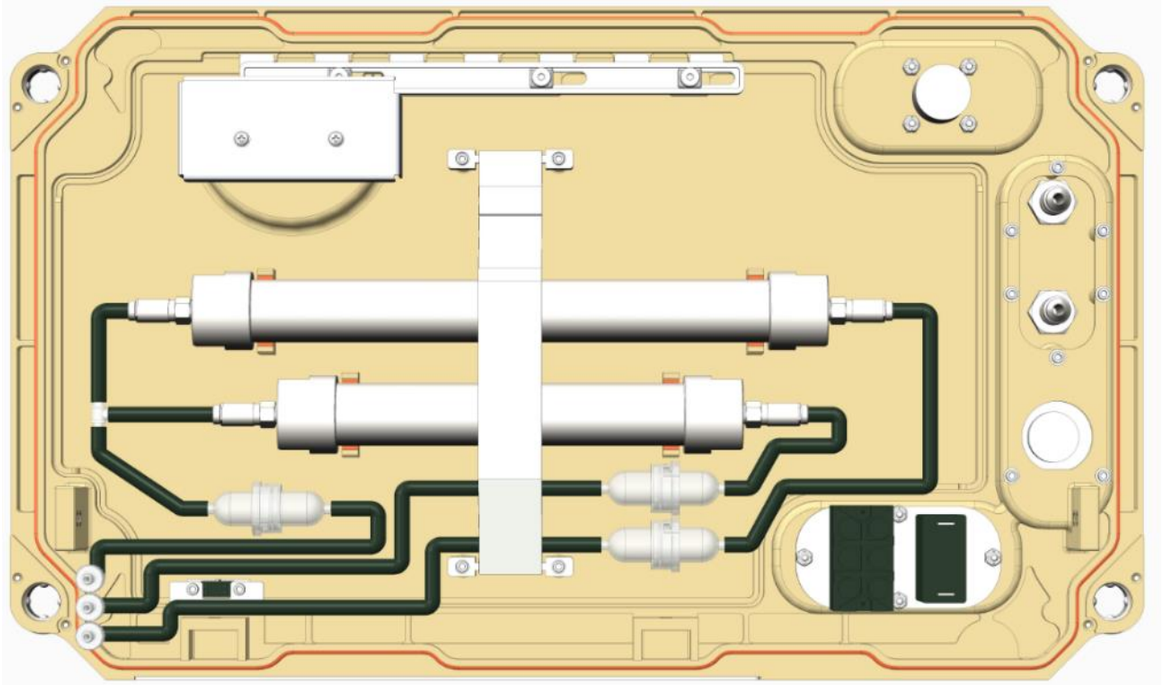
- **Temperature control from 18°C to 37°C in selectable 0.5°C increments**
- **Uniform temperature around petri dish to ≤1°C**
- **1min programmable temperature intervals**
- **Capable of rapid temperature changes at 1°C/min**



Environmental Control - Atmosphere

Air Filter Cartridges:

- **CO_2 control between 400ppm and ISS ambient levels**
  - Selectable in 100ppm increments
  - Monitoring both chamber and ISS ambient levels
- **Ethylene scrubbing below 25ppb**



Air Filter Cartridges located on Locker Door Rear Side

Hardware Availability

- **Currently in Critical Design Phase**
  - Finalizing design
  - Fabricating Engineering Development Unit used for certification
  - Testing sub-elements independently
  - Critical Design Review in April 2017

- **Targeting SpaceX-15 in April 2018**

- **NASA seeking first flight**