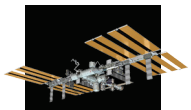


National Aeronautics and Space Administration

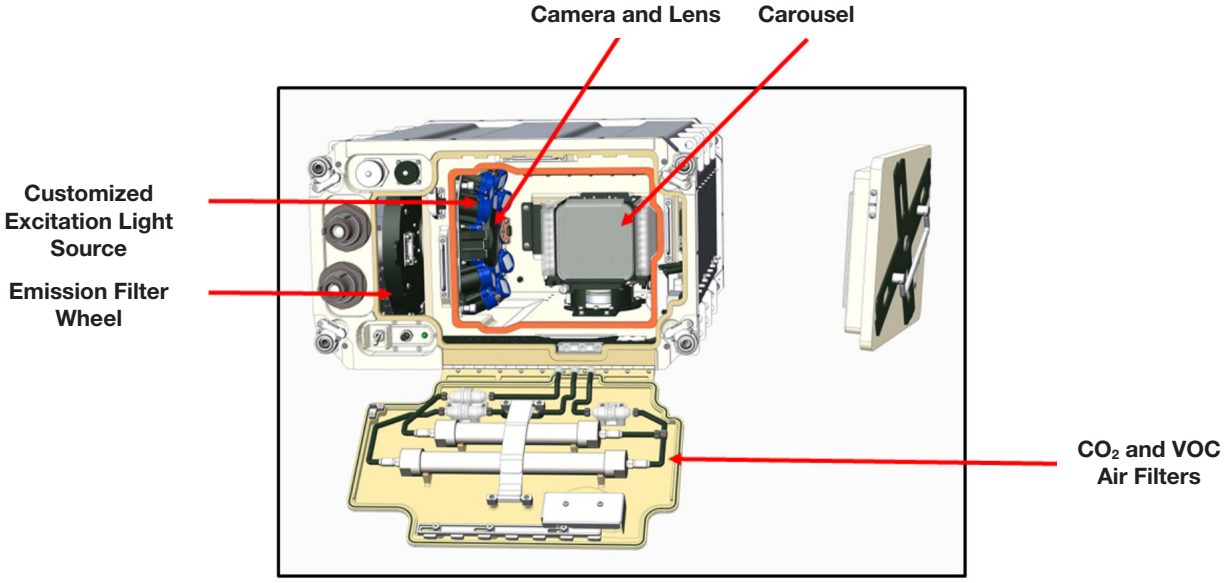
Spectrum

Spectrum*

*Currently under development

Spectrum is a multispectral fluorescence imager designed for capturing *in vivo* genetic expression in a variety of biological organisms, providing a capability that does not currently exist on the International Space Station (ISS). Researching organisms that have been transformed with *in vivo* reporter genes ligated with fluorescent proteins allows the scientific community to further understand the fundamental biological responses of these organisms when subjected to space environments. Model organisms that may utilize multispectral imaging on the ISS include unicellular organisms (e.g. *Saccharomyces cerevisiae*), plants (e.g. *Arabidopsis thaliana*), and invertebrates (e.g. *Caenorhabditis elegans*).

Spectrum will accommodate standard 10 cm x 10 cm Petri plates, various sized multi-well culture plates, and other custom containers within the growth chamber. Spectrum's enhanced capabilities include programmable temperature (18°C - 37°C), CO_2 control (ranging between 400 ppm up to ISS-ambient levels), photoperiods, and frequency of image capture, ethylene scrubbing (< 25 ppb), and directed airflow to prevent condensation that would interfere with imaging. Growth light intensity can be configured based on the research requirements and is provided through white, red, blue, and green LED lighting. Spectrum will allow on-orbit change out of filters and specimen plates requiring minimal crew time.



Schematics displaying front view of Spectrum assembled inside an Advanced Payload Modular Locker

Imaging System. Spectrum is capable of capturing high-resolution (~13µm per pixel, ~1950 ppi) and single field of view (macro) images from a fixed reference point, with magnification equivalent to a standard dissection microscope. Programmable time lapse images can be captured with minimum distortion varying by ≤10% per pixel. The filter wheel is designed to hold 10 emission filters (standard configuration is nine band pass filters and one clear filter for color imaging) with the rapid ability to switch between both excitation wavelengths and emission wavelengths. This capability allows researchers to image up to five fluorescent proteins in a single biological specimen providing the ability to collect multispectral emission for deconvolution for performing in depth multispectral analysis.

Points of Contact: Howard G. Levine, Ph.D. | Email: howard.g.levine@nasa.gov
A. David Flowers | Email: arthur.d.flowers-1@nasa.gov

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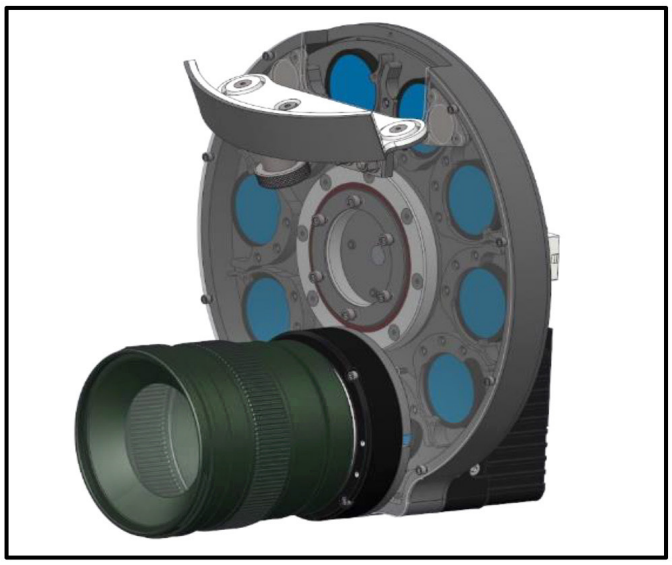
Spectrum



Enlarged filter wheel containing 9 emission filters and 1 clear filter for color imaging.

Enlarged carousel capable of holding 10mm² Petri plates or multi-well plates.

Environmental Control Chamber. Spectrum provides the option to adjust temperature and CO_2 set points, while utilizing the ambient ISS environment to provide relative humidity. The air filtration system has been customized to control CO_2 levels, remove excessive organic carbons and scrub ethylene ensuring a healthy growth environment for plants. The standard carousel configuration is capable of holding up to four 10 cm x 10 cm Petri plates and can be customized for any size or shape within a 10 x 12.7 cm footprint. The growth light cap has been placed 10 cm above the biological specimens achieving 80% lighting uniformity. The growth light cap is equipped with broad-spectrum white LED light (0-675 µmol $m^{-2}s^{-1}$, 400-750 nm), red LED light (0-850 µmol $m^{-2}s^{-1}$,630-660 nm), blue LED light (0-750 µmol $m^{-2}s^{-1}$, 400-500 nm), and green LED light (0-300 µmol $m^{-2}s^{-1}$, 520-530 nm) with the intensity and duration specified by the research requirements.

Data Commanding and Storage. Spectrum can be commanded either from the ground or by the crew on-orbit and internally collects and stores time stamped images with the option to downlink data retrieval for near-real time evaluation by the investigator team.