# MOCI

Multiview Onboard Computational Imager

# The University of Georgia Small Satellite Research Laboratory

~/ UGA SSRL /

# SPOC

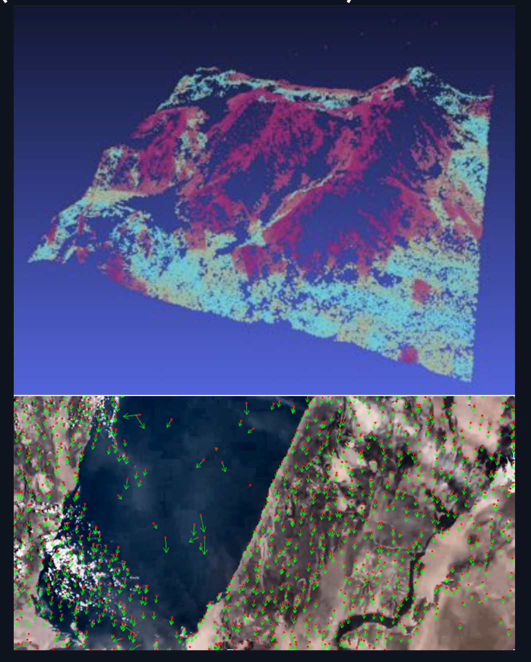
Spectral Ocean Color Imager

## Mission Overview

The MOCI mission will perform complex computations, using AI on a modified Graphics Processor Unit (GPU)/System on a Chip (SoC), to passively reconstruct the surface of earth, track desired targets, and identify anomalies semi-autonomously in near real-time using custom algorithms and off the shelf, high performance computational units (the Nvidia TX2i).

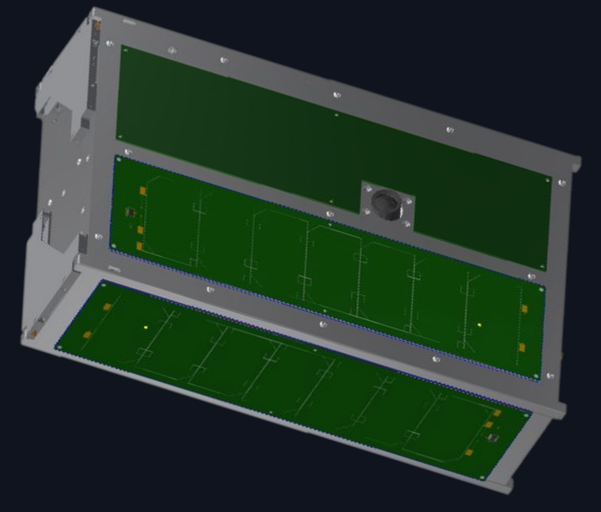
Goals/Objectives:

- Feature detection
- Structure from Motion
- Generation of 3D models
- Object identification and tracking
- Transition autonomous robotics tech to space
- Miniaturization of state of the art terrain mapping systems
- Develop methods for autonomy
- Test on orbit DNN/CNN training capabilities
- CV testbed



(top) A simulated/generated 3D model from MOCI's algorithms. (bottom) Example tracking with Optical Flow

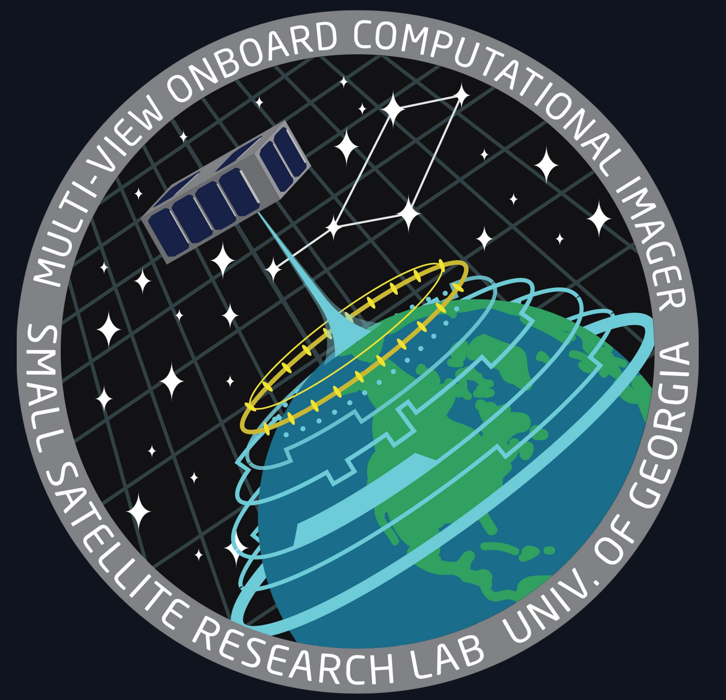
MOCI's optics will have a ~6m GSD



The final design of the 6U MOCI Satellite

## Success Criteria

1. Generate a Digital Surface Model (DSM) within 80% accuracy of existing DSMs;
2. Identify and track an object on the Earth's surface with 90% predictive accuracy.;
3. Acquire 15 images, at least three days apart, of one coastal target or the Sapelo Island test area over the lifetime of the mission;
4. Directly involve at least 50 students in satellite development and integration.




MOCI was selected as one of the winners of the UNP-9 competition and is expected to launch in 2020.

## Mission Statement

Our mission is to place UGA among the top spacefaring universities in the world, giving the university a permanent presence in outer space. We aim to develop cutting edge intelligent remote sensing payloads and high performance computational units for space based applications. We are using our facilities and expertise to teach and train undergraduate students how to design, build, and operate spacecraft, additionally we involve local K-12 students, and expose them to space-based research through internships and outreach events.

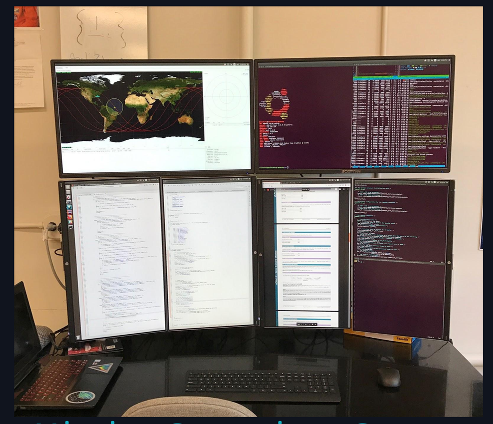
Some of the SSRL team, spring 2019

## Facilities

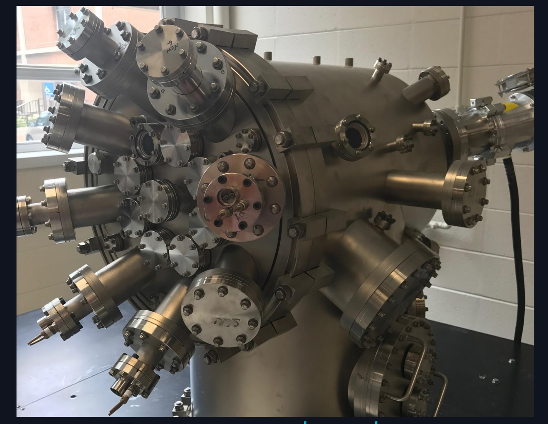
The SSRL has developed the necessary facilities and equipment to accomplish its mission, including:

- Temperature - Vacuum Chamber
  - $10^{-6}$ torr
  - -40 C° to 100 C°
- Clean Room operating at ISO 7
- 150 sq ft of ESD workspace
- Ground station
  - S-Band/UHF/VHF
  - Athens, Georgia, USA (33.9519° N, 83.3576° W)

Ground Station System



Mission Operations Center



T-vac test chamber

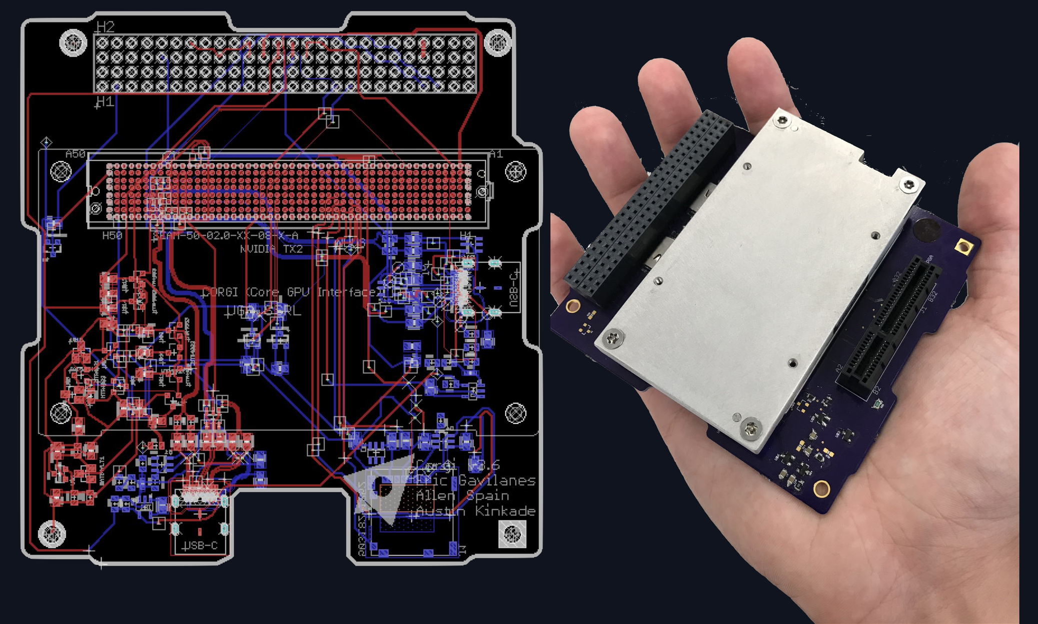
UGA SSRL's members integrating SPOC

## Research

The UGA SSRL specializes in Intelligent Remote Sensing.

SSRL is currently advancing capabilities for onboard processing of large datasets including:

- An interface board for a System on a Chip (SoC) containing a Central Processing Unit (CPU) and Graphics Processing Unit (GPU) to be used in the CubeSat form factor
- Integration of a traditional flight computer with existing miniaturized GPU/SoC systems.
- A minimized OS build meant to keep the file system in RAM, allowing less reliance on sensitive flash storage and Triple Modular Redundancy on the bootloader.
- Extraction of dense SIFT features with mid-resolution camera systems in LEO
- Onboard 3D surface reconstruction and mapping of planetary surfaces from images
- Neural network tailored to classify terrains and objects within the terrain



Some of the UGA SSRL's GPU/SoC Prototypes for Space-Based High Performance Computation

## Outreach Partnership

UGA SSRL has reached over 1600 K-12 students over the past 4 years and is now partnering with Let's Go to Space to further educate the community. Lets Go to Space focuses on:

- Hosting university seminars, K-12 classroom visits, after-school STEM programs, and virtual STEM day damps (https://letsgo2space.com/get-involved/)
- Developing amateur radio satellites, like MEMESat-1, for educational and public awareness

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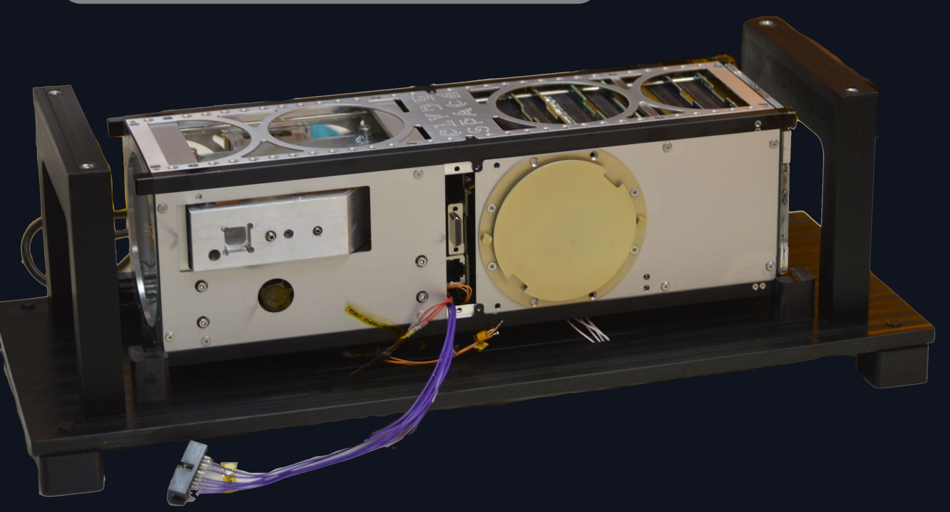
@UGASSRL

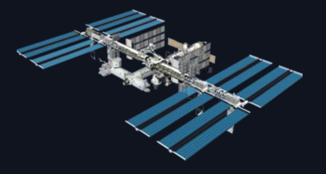
## Mission Overview

SPOC is an *adjustable multispectral 3U CubeSat*. Its payload has a spectral range from ~422-880 nm with a spectral resolution of ~1 nm and a spatial resolution of ~130 m. Its objective is to provide moderate resolution multispectral images to monitor wetland status, estuarine water quality, and near coastal water quality. It will augment environmental data from the Georgia Ecosystems Long Term Ecological Research Program.

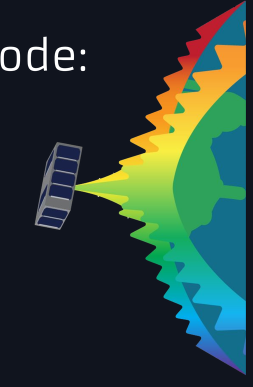
SPOC is funded by the NASA USIP and was selected for the eighth round of NASA's CSLI. SPOC will be integrated with the Nanoracks deployer in late July 2020 and is scheduled for launch in early September from Wallops, VA.

## Concept of Operations

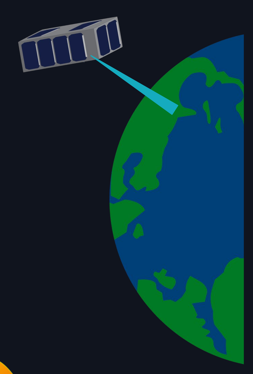





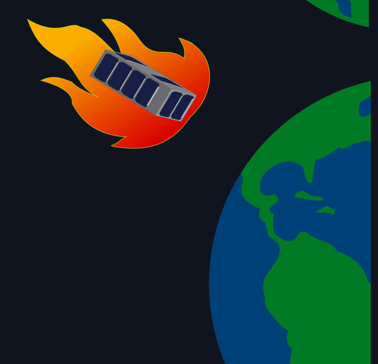
1. Launch to ISS
2. Deployment: Deployed from ISS, Health Checks, Beacon, Detumble
3. Cruise Mode: Power Generation, Health Checks, Basic (UHF) Comms
4. Scan Mode: Fine Pointing, Scans Target



6. Data Downlink Mode: Fine Pointing, S-Band Comms



7. Deorbit: Mission End



## Payload

SPOC's payload allows for 16 user defined bands that can be downlinked at one time therefore providing several advantages compared to traditional sensors:

1. Binned datasets result in a higher SNR;
2. Due to CubeSat downlink bottlenecks more locations can be imaged;
3. Adjustable bands create more opportunities for cross calibration with existing legacy sensors;
4. This sensor provides the freedom to choose bands after launch, therefore phenomenon outside the scope of the original mission can be observed.