(SP)ectral (O)cean (C)olor Satellite

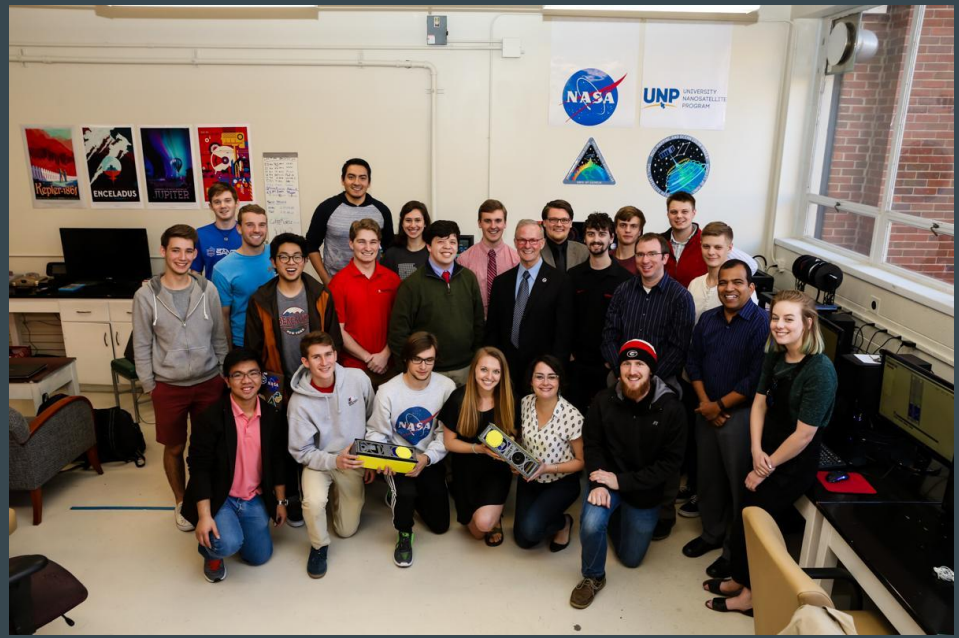
UNIVERSITY OF GEORGIA
Small Satellite Research Laboratory

Caleb Adams, David Cotten, Deepak Mishra, Nicholas Neel,
Graham Grable, Khoa Ngo

2017 Cubesat Developers Conference

SPOC – Spectral Ocean Color

- First Mission for UGA
- NASA USIP 2016
- CSLI 8, 2017
- Sparked founding of UGA SSRL
  - Undergraduate Founded
  - Undergraduate Run
  - Faculty Supported
  - Started with 4 undergraduates
  - Now has 54 undergraduates
- Past PDR
- CDR in May



UNIVERSITY OF GEORGIA
Small Satellite Research Laboratory

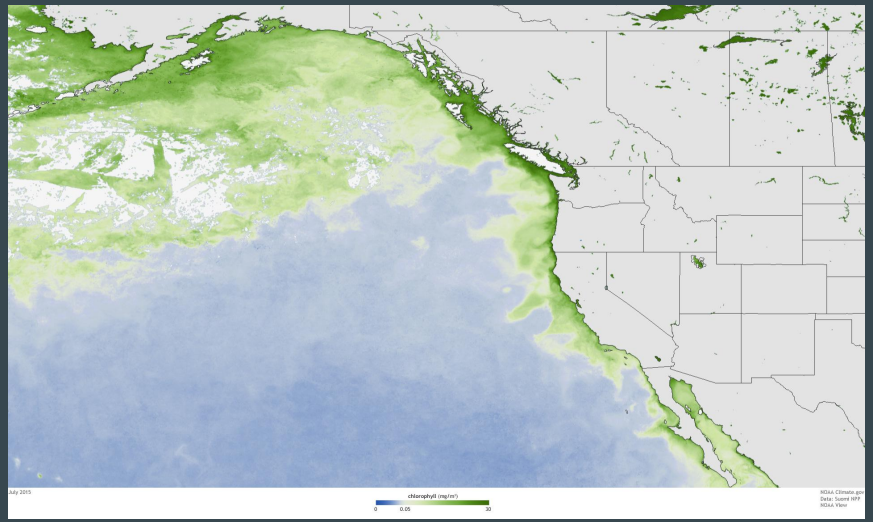
SPOC mission

- 3U Form Factor
- Schedule in CSLI 8, 2018-2020 launch
- Hyperspectral Sensor from 432 nm - 866 nm
- Coastal Analysis and Resources
- Data complements Sapelo Island LTER

UNIVERSITY OF GEORGIA
Small Satellite Research Laboratory

Scientific Objectives

- Monitor coastal wetlands status
- Monitor estuarine water quality including
  - Wetland biophysical characteristics
  - Phytoplankton dynamics
- Monitor near-coastal ocean productivity
  - SPOC shall use hyperspectral remote sensing techniques to quantify vegetation health
    - primary productivity
    - ocean productivity
    - suspended sediments
    - organic matter in coastal regions.



NOAA record setting toxic algal blooms

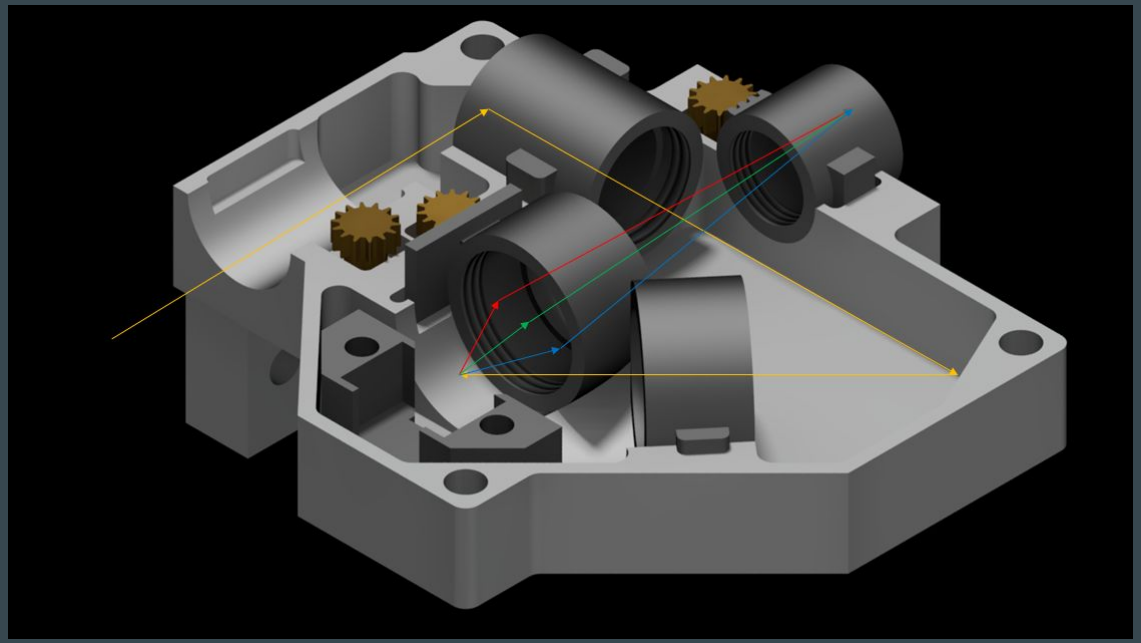
Science Data

- Sapelo Island ~50x50 km area
  - Takes 385 frames to cover the island
  - 506 frames needed due to ADCS pointing inaccuracies
- 4.12 nm (Hyperspectral) Scheme yields 228 MB of data
  - Pro: High Spectral Resolution
  - Con: Low SNR
- 20 nm (Multispectral) Binned Scheme yields 18.22 MB of data
  - Pro: Wide Area Data Acquisition
  - Con: Low Spectral Resolution

Sapelo Island on the Georgia Coast

Payload Overview

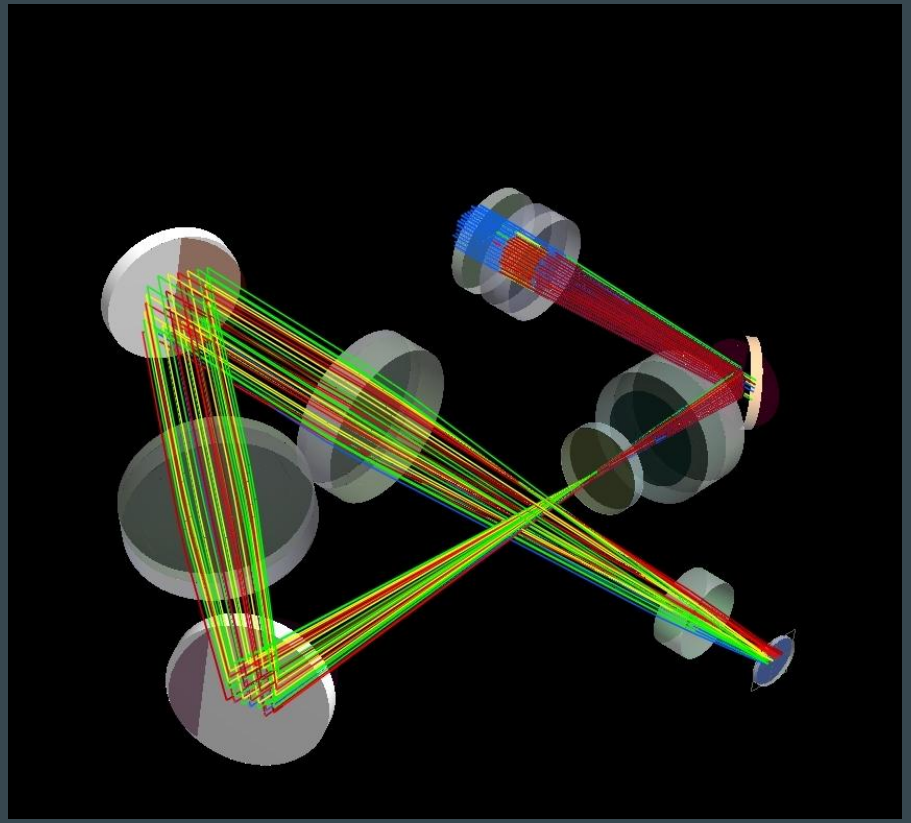
- Pushbroom Scanner
- Diffraction Grating
- Monochrome CMOS
- Data similar to ESA Sentinel 2 and NASA MODIS
- 120m Spatial Resolution
- 4.12nm Spectral Resolution
  - Can bin from 4 - 40nm



UGA SSRL design for the SPOC Satellite's internal optical payload

Payload Optics

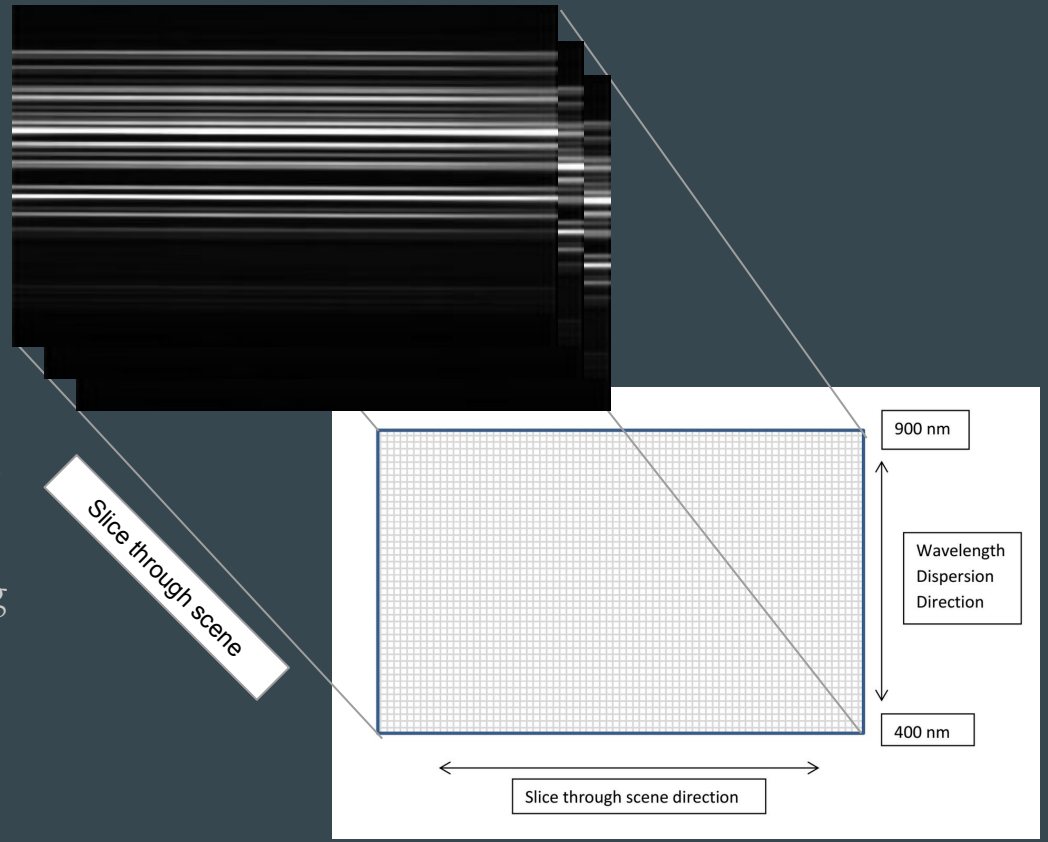
- Mirror System
- Single Slit
- Collimating Lense
- Grating spectrometer blazed for 500 nm and has 150 lines per mm
- Focusing Lenses
- 752 x 480 pixel Monochrome CMOS array
- Adjustable Lense System



UGA SSRL optical simulation with lens, grating, and slit system

Payload Sensor

- Monochrome CMOS
  - 752px by 480px active
  - 55.55 fps
  - 17.5 ms readout
- Results in 120 m spatial resolution
- Each pixel is 1.03 nm spectrally
- Onboard FPGA performs binning of 4 pixel to produce 4.12 nm spectrally
- 3 Dimensional Data Cube

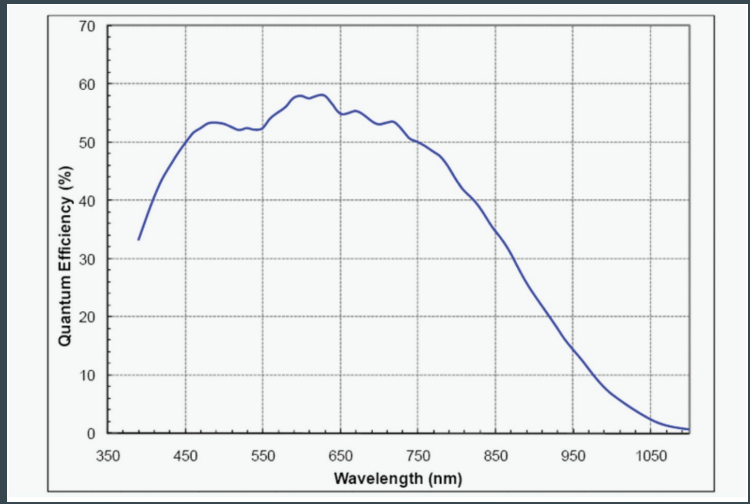


UGA SSRL pushbroom method for data acquisition with CMOS

Binning

- Optimization in progress
- Current Binning Scheme:

Wavelength (nm)	Bandwidth (nm)	QE	SNR (per pixel)
443	20	0.48	181
490	20	0.53	185
510	20	0.52	171
555	20	0.52	157
670	20	0.55	139
750.9	20	0.50	83
865	40	0.33	63

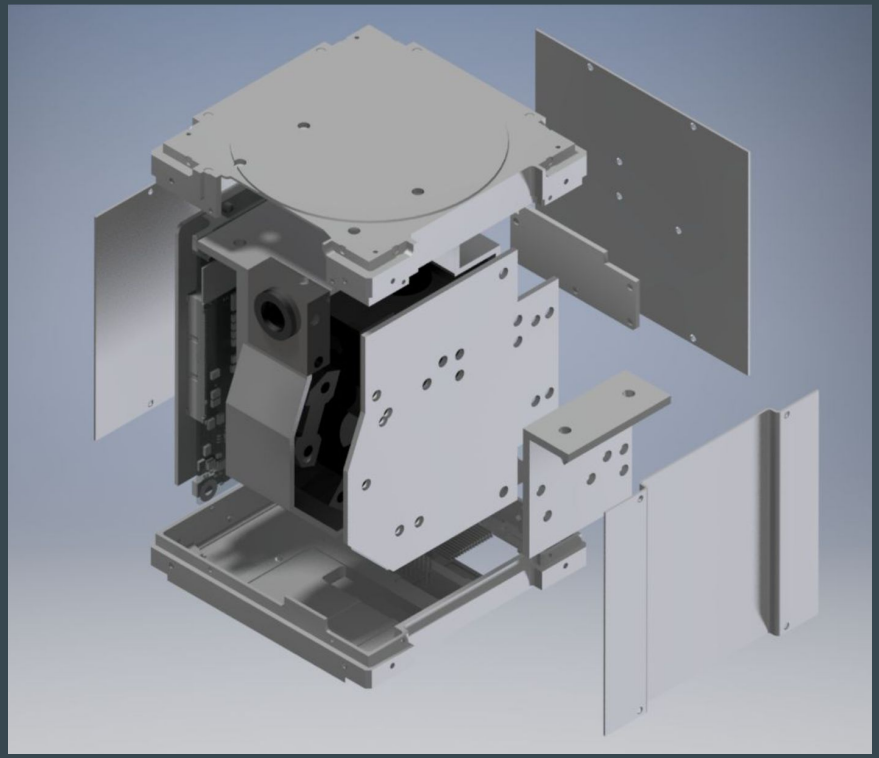


QE of the SPOC CMOS sensor

Payload Mechanics

- 2 piece housing
  - Lens housing
  - Electronics housing and payload structure
- PC104+ Compliant
- Total mass ~0.9 kg
- Designed for a low CTE

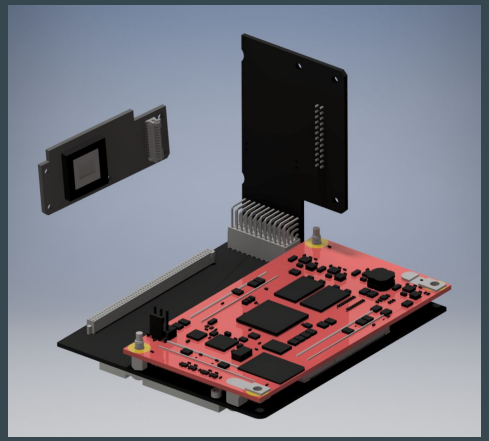
Material Name	Purpose	CTE
Aluminum 6061 t6	SpocEye Housing	2.36E-05
Aluminum 7075	SpocEye Housing	1.31E-05
Stainless Steel 304	Hardware	6.60E-05
Ultem 9085	Lens Holder	3.67E-05

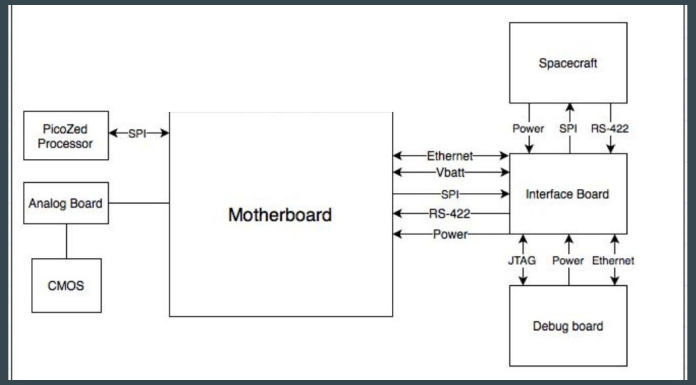


UGA SSRL mechanical housing for the SPOC payload

Payload Electronics

- PicoZed Board
- Cloudland Instruments Motherboard
- Cloudland CMOS board
- Cloudland Interface Board
- 17 Watt Total power draw

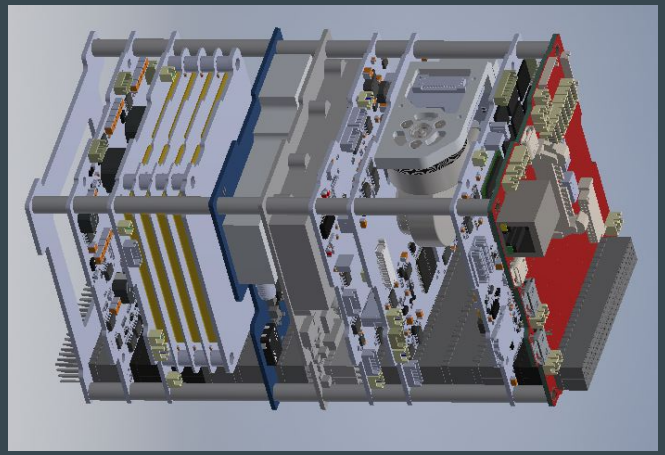




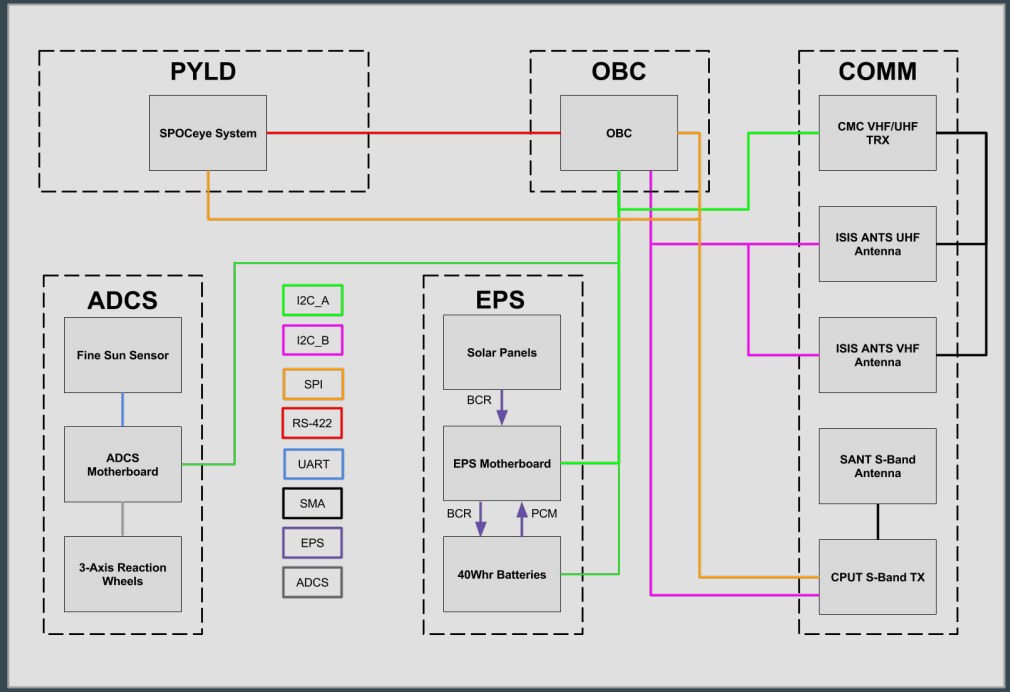
UGA SSRL internal board layout with serial communications diagram

Satellite Bus Integration

- CubeSat PC104+
- Clyde Space Core Avionic Stack with Custom interface boards



SPOC Clyde core avionic stack with SSRL boards and BUS diagram



UNIVERSITY OF GEORGIA
Small Satellite Research Laboratory

SPOC, MODIS, Sentinel 2 & 3

Comparing 400 - 866 nm

	SPOC	(Terra) MODIS	Sentinel 2	Sentinel 3
Sensor Type	Pushbroom	Cross Track	Pushbroom	Pushbroom
Bands	20 - 120	13	8	16
SNR	63 - 185	128 - 1087	72 - 172	232 - 2188
Spectral Resolution	4.12 - 20 nm	10 - 50 nm	15 - 115nm	2.5 - 20nm
Spatial Resolution	120m	250 - 1000m	10 - 60m	300 - 1200m

Questions?

SPECTRAL OCEAN COLOR
SMALL SAT RESEARCH LAB
UNIV OF GEORGIA - SPOC