MarONet for support of PACE Vicarious Calibration

UNIVERSITY OF MIAMI

10/8/21, PI: Kenneth Voss, Physics Dept., Univ of Miami
Co-I's: Carol Johnson (NIST), Mark Yarbrough (MLML), Art Gleason (UM), M. Feinholz (MLML), D. Antoine (Curtin)

Implementation of MarONet for support of PACE Vicarious Calibration

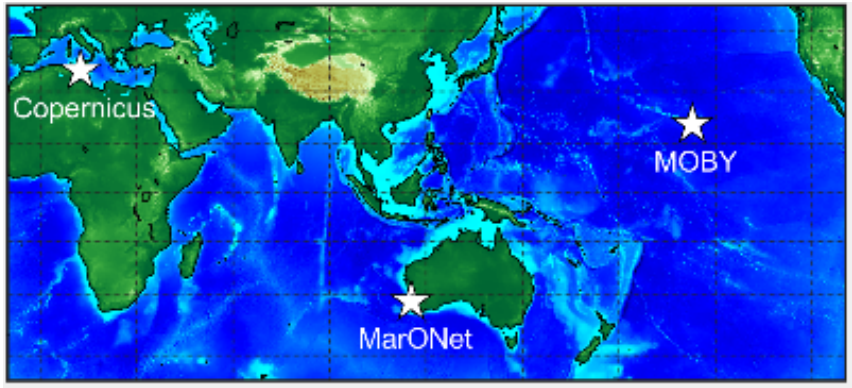
PI: Kenneth Voss, University of Miami

Objective

Our goals are to prove the suitability and applicability of the MarONet system for use as the primary OCI/PACE Vicarious Calibration data source.

Develop an ocean color vicarious calibration site in Perth, Australia.

Provide Vicarious Calibration data to the PACE science team, upon the launch of PACE to quickly and accurately calibrate the OCI instrument on the PACE platform.



This proposal will develop the MarONet site, which can be combined with the MOBY site in Hawaii, and possibly the Copernicus site in the Mediterranean to form a network of three complimentary vicarious calibration sites.

Approach

We will build up two MarONet optical buoys and do a complete characterization/calibration of the optical systems.

Deploy these buoys in Hawaii for a 6 month testing period.

Develop an additional field site off of Perth Australia

Field these MarONet optical buoys at this field site, and provide operational vicarious calibration data to the PACE mission.

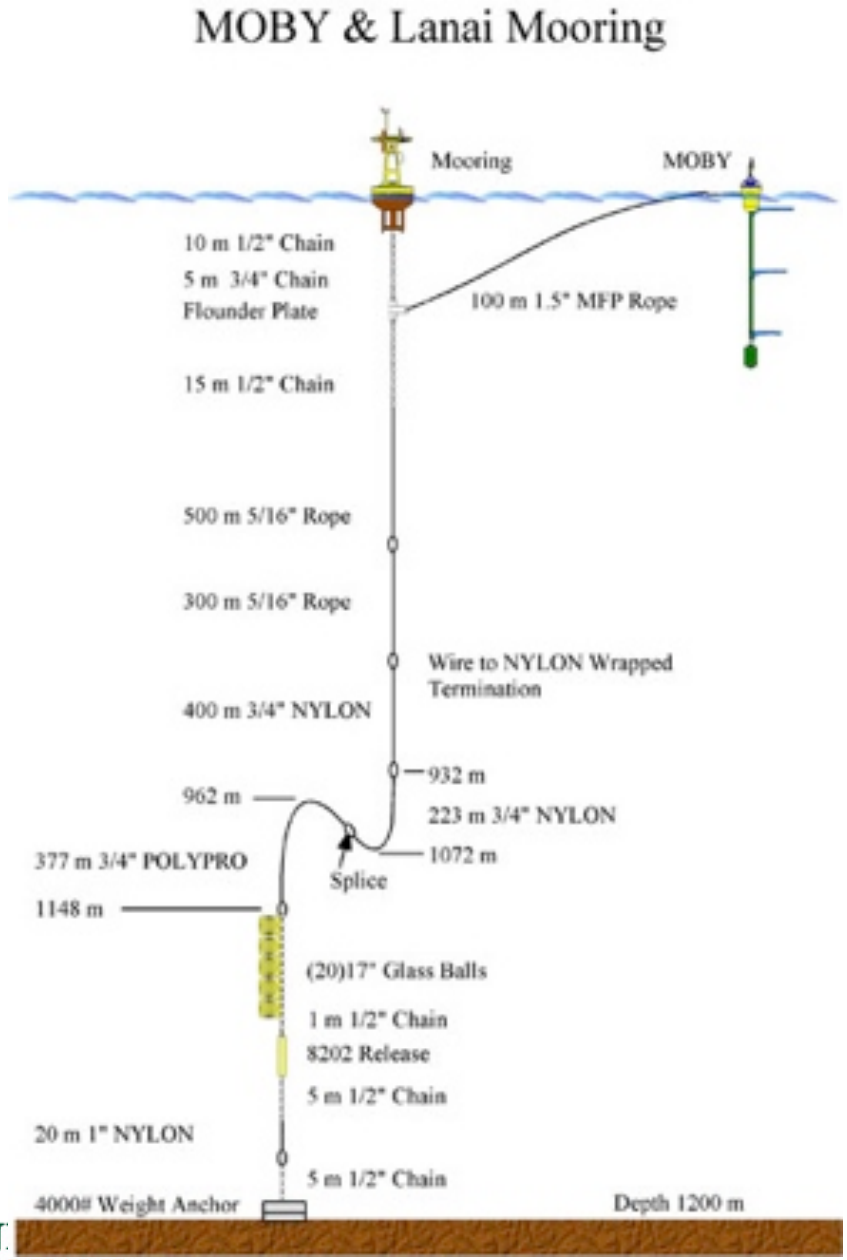
Co-Is/Partners: B. C. Johnson, M. Yarbrough, A. Gleason, M. Feinholz, D. Antoine

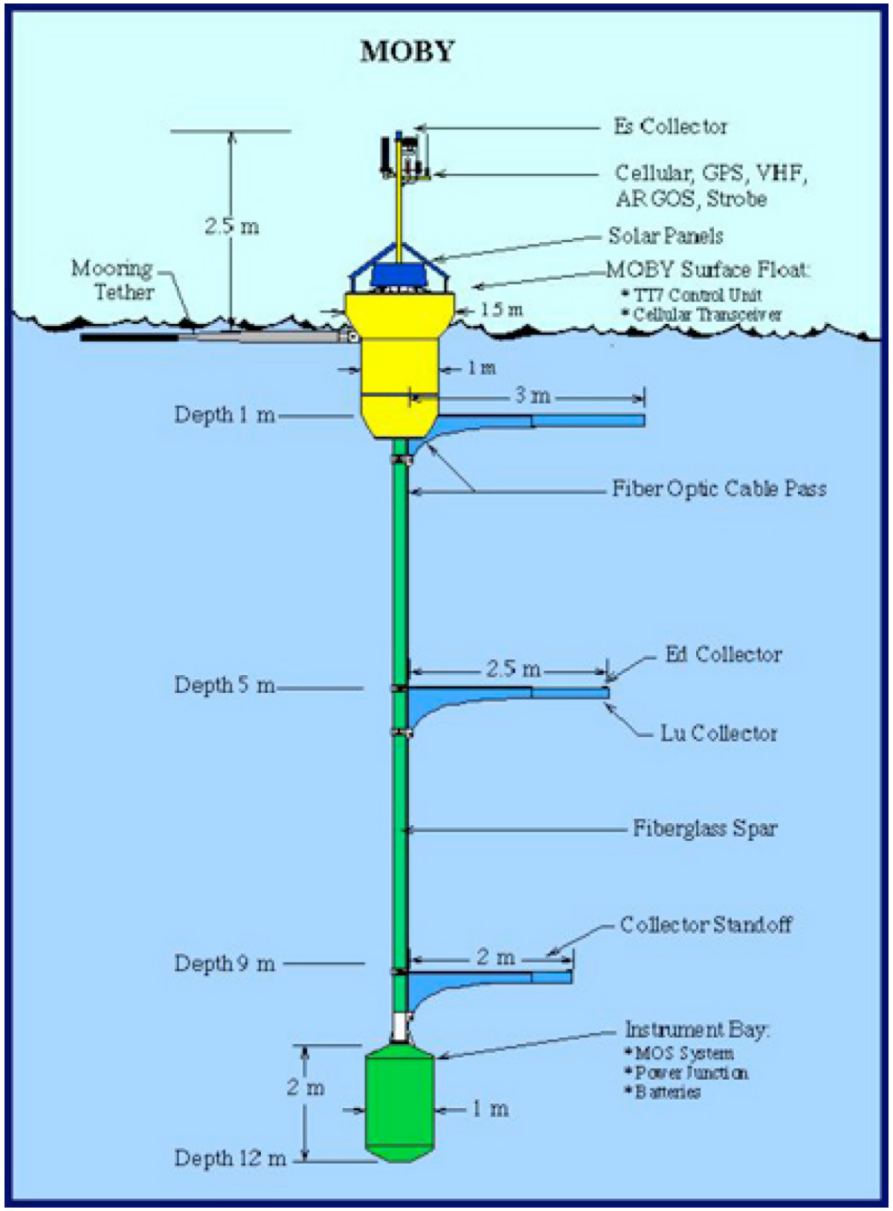
Key Milestones

- Start project 7/20
- Build MarONet instrument 1 and 2 7/21
- Complete testing of MarONet1 and MarONet2 12/21
- Develop Perth Vicarious Calibration site 1/22
- Deploy MarONet1 at Perth site 1/23
- Swap MarONet2 for MarONet1 at Perth site 7/23
- Continue operation with 6 month deployment schedule until end of project.

TRL_{in} = 5

Reminder of what MOBY-Heritage looks like





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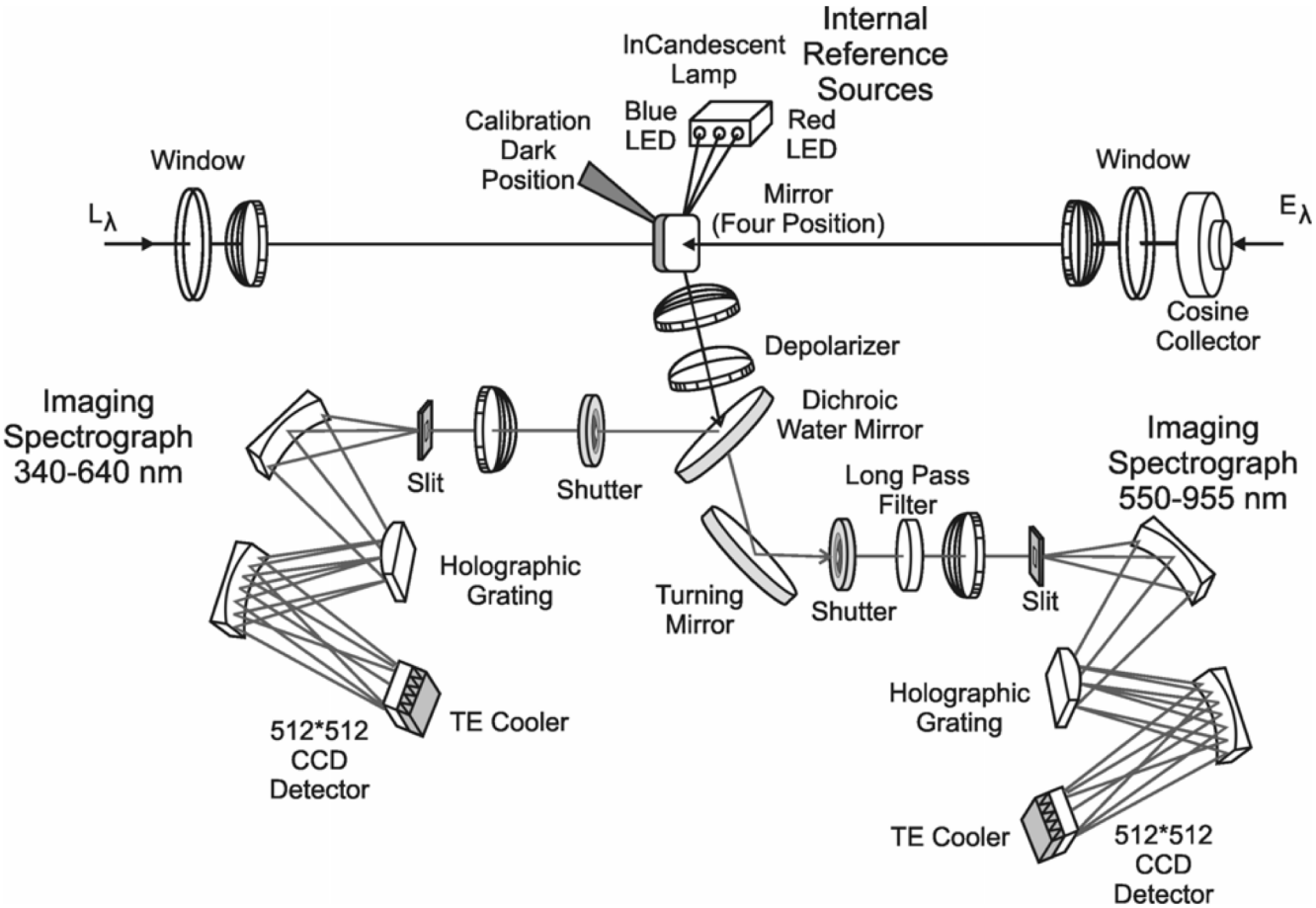
Schematic of MOBY Heritage



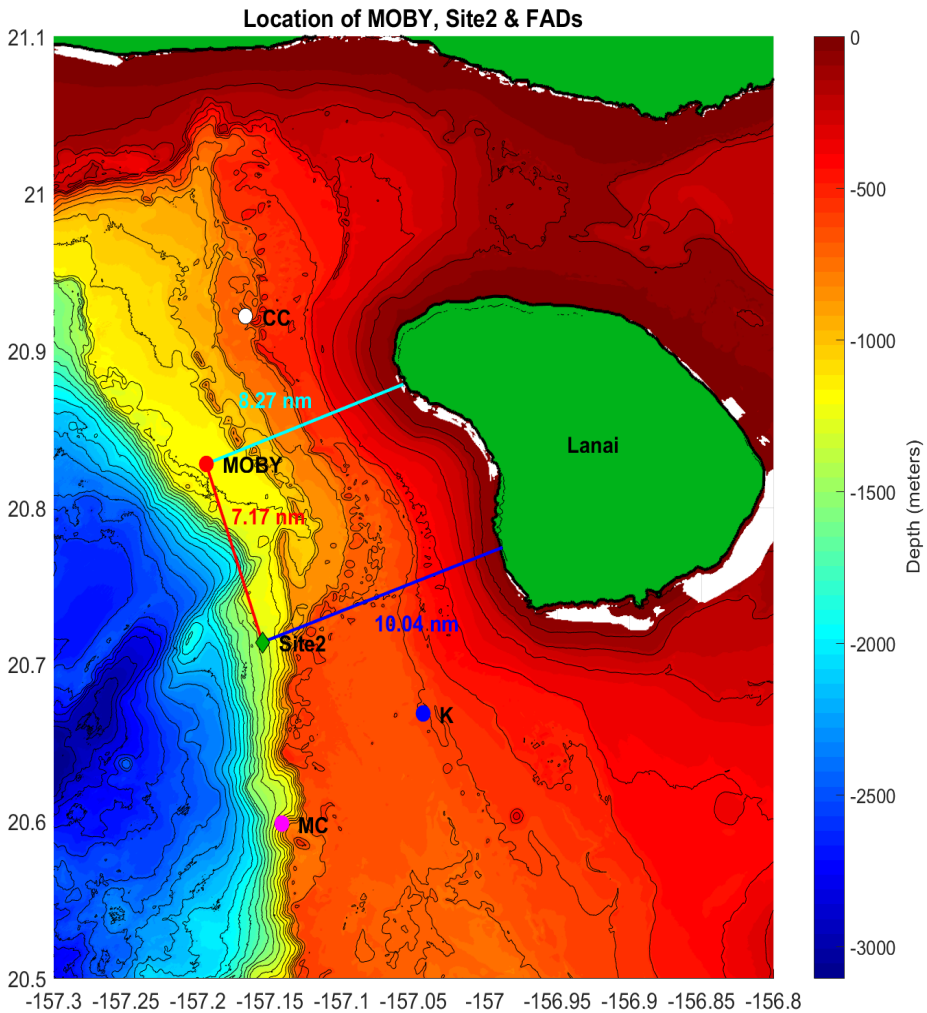
Hyperspectral,0.57 nm spacing in blue spectral region, 0.91 nm FWHM, and 1.2 nm FWHM in red.

Hyperspectral, with this much resolution, allows the same system (one site) to be used for multiple satellite sensor systems, including out-of-band response, to tie these systems together.

Differences between MOBY-Heritage and MarONet (Australia/NASA)/MOBY-Refresh(Hawaii/NOAA).

1) New optical system, red and blue spectrometers have 14 channels that can be measured simultaneously. Much better straylight characteristics.
2) Start at 350 nm rather than 400 nm.
3) Beam splitter moves from dichroic mirror (with associated fine scale spectral structure) to simpler polka dot beam splitter.
4) Carbon Fiber buoy structure for increased rigidity
5) Augmented auxiliary data, higher temporal resolution measurements of tilt/roll/compass heading of buoy along with advanced depth measurements of the upper arm.
6) For Australia: Stability source and monitor to allow transport of optical instrumentation back and forth from Perth to Honolulu for recalibration.

To facilitate testing of the new optical system, and to obtain a crossover between this new system and the old, we have installed an additional mooring near the MOBY time series site



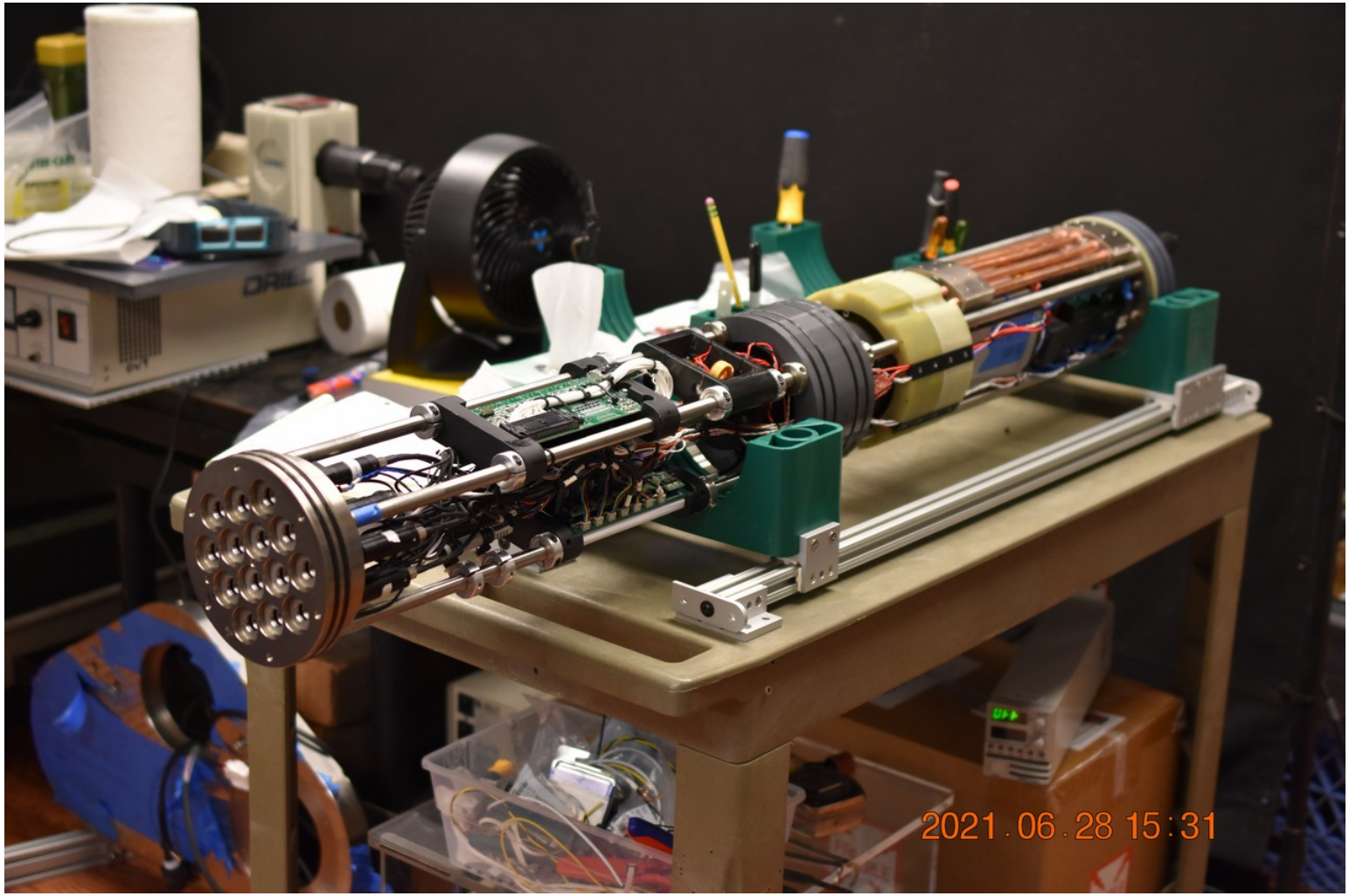
We will be installing first the two MarONet instruments here, followed by the MOBY-Refresh instruments. Goal is a 1 year time series of crossover data between old and new instrumentation.

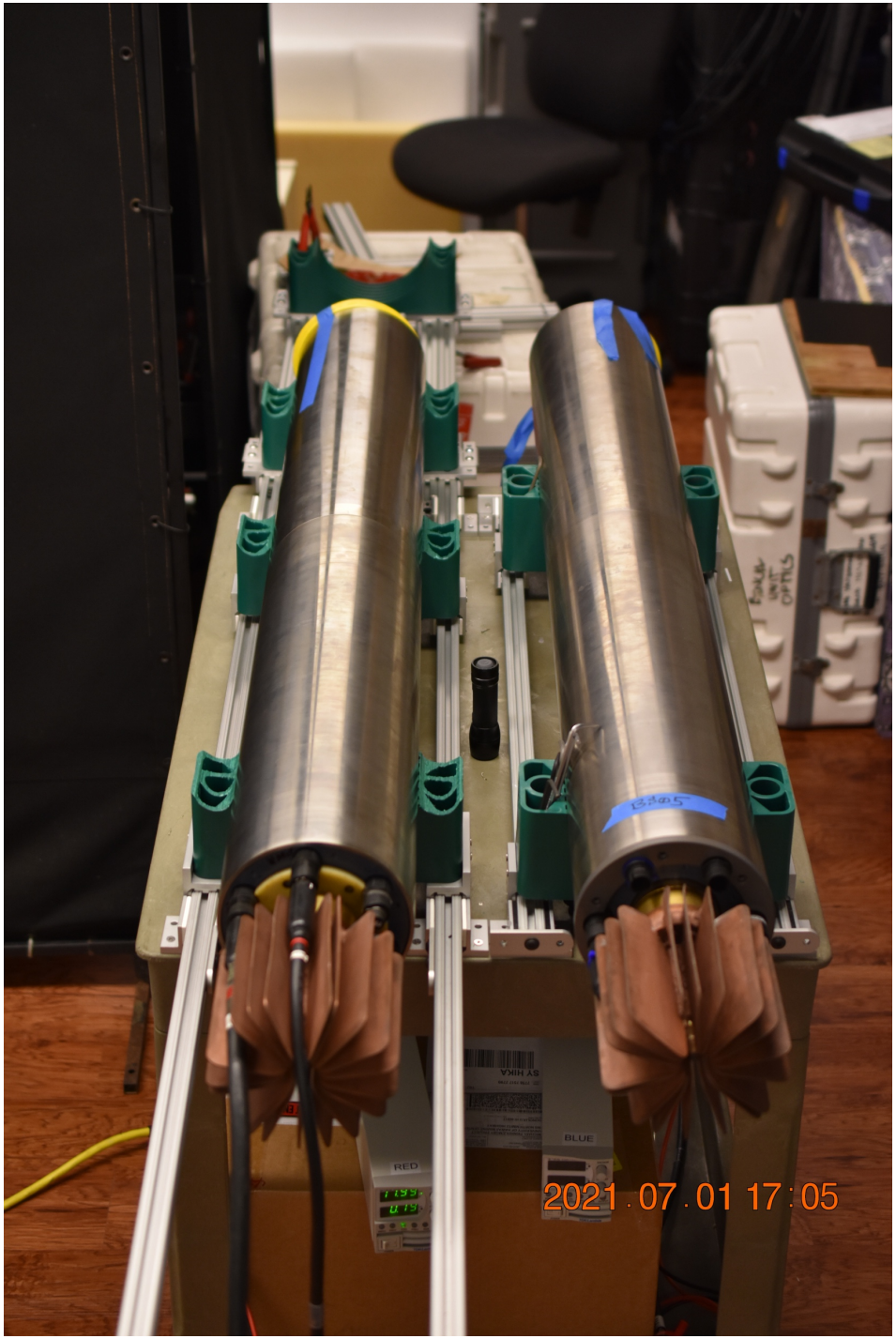
When MarONet has been fully tested here, it will be moved to Perth, Australia to be installed there.

Assembled buoy structure (weighted appropriately to simulate instruments/battery) was tested at sea for movement characteristics.

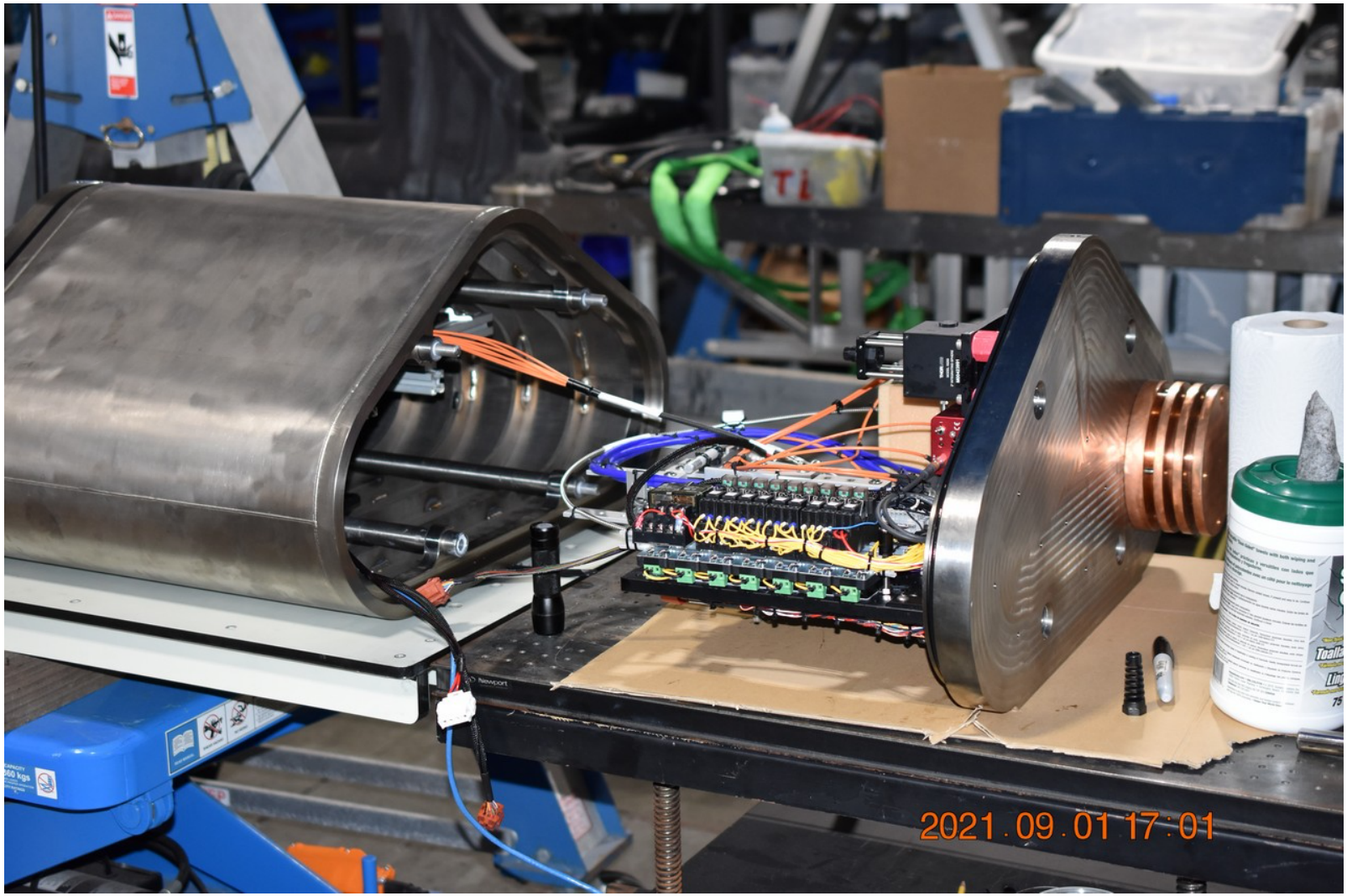
Have videos from top arm and mast of buoy, but very large files so dealing with them here. Structure behaved properly in the sea states they had, and while being towed at 4-5 knts.

Here is the assembled Blue spectrometer. On the right side is the spectrometer, on the left shows the shutter plate, the collimator for each fiber, and the spectrometer pigtails all hooked up to the collimators.

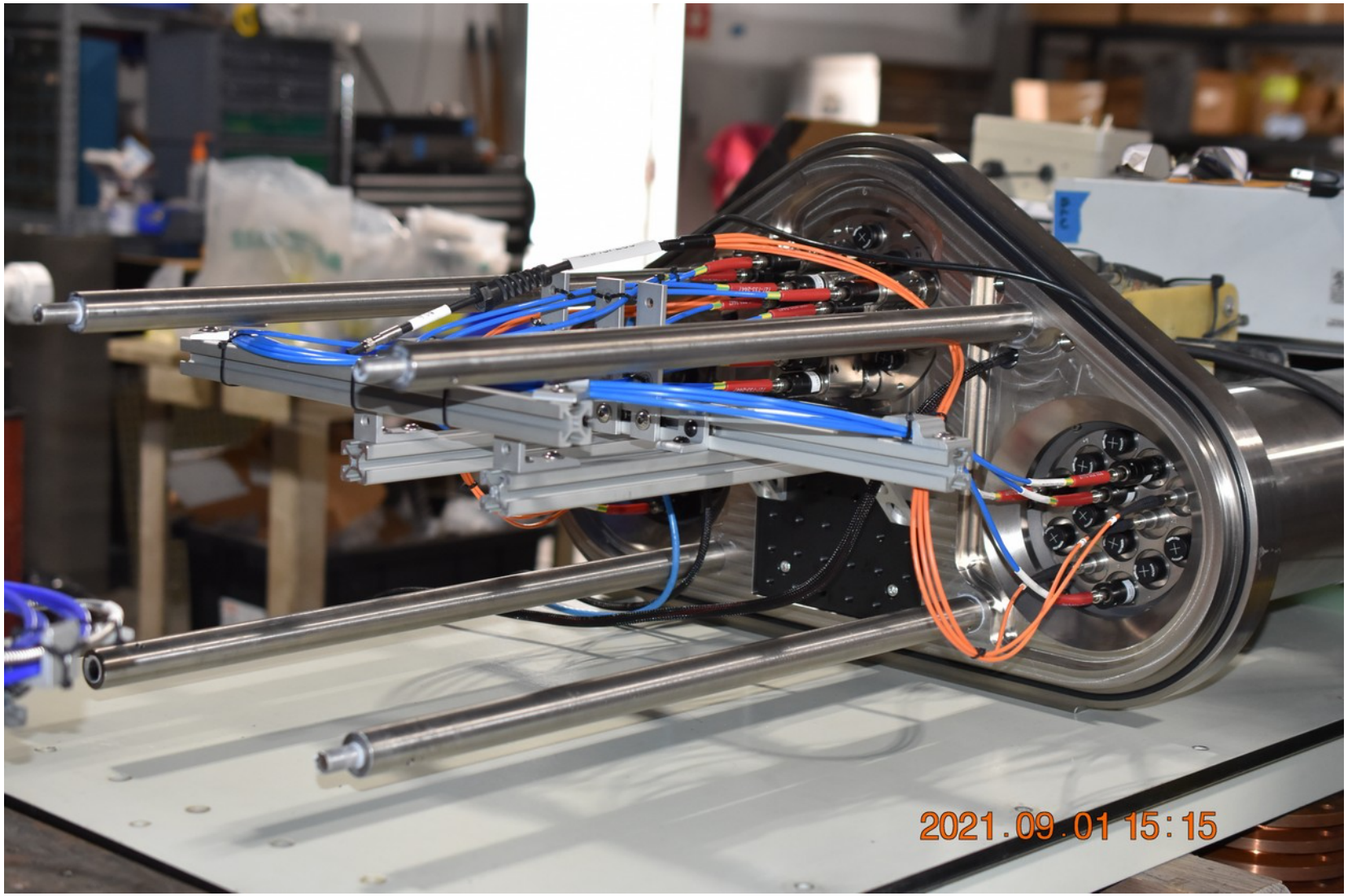




The Red and Blue spectrometers, side by side, with their copper heat fins installed



Inside one end of the splitter housing, this site holds the internal light sources used for monitoring partial system response during deployment

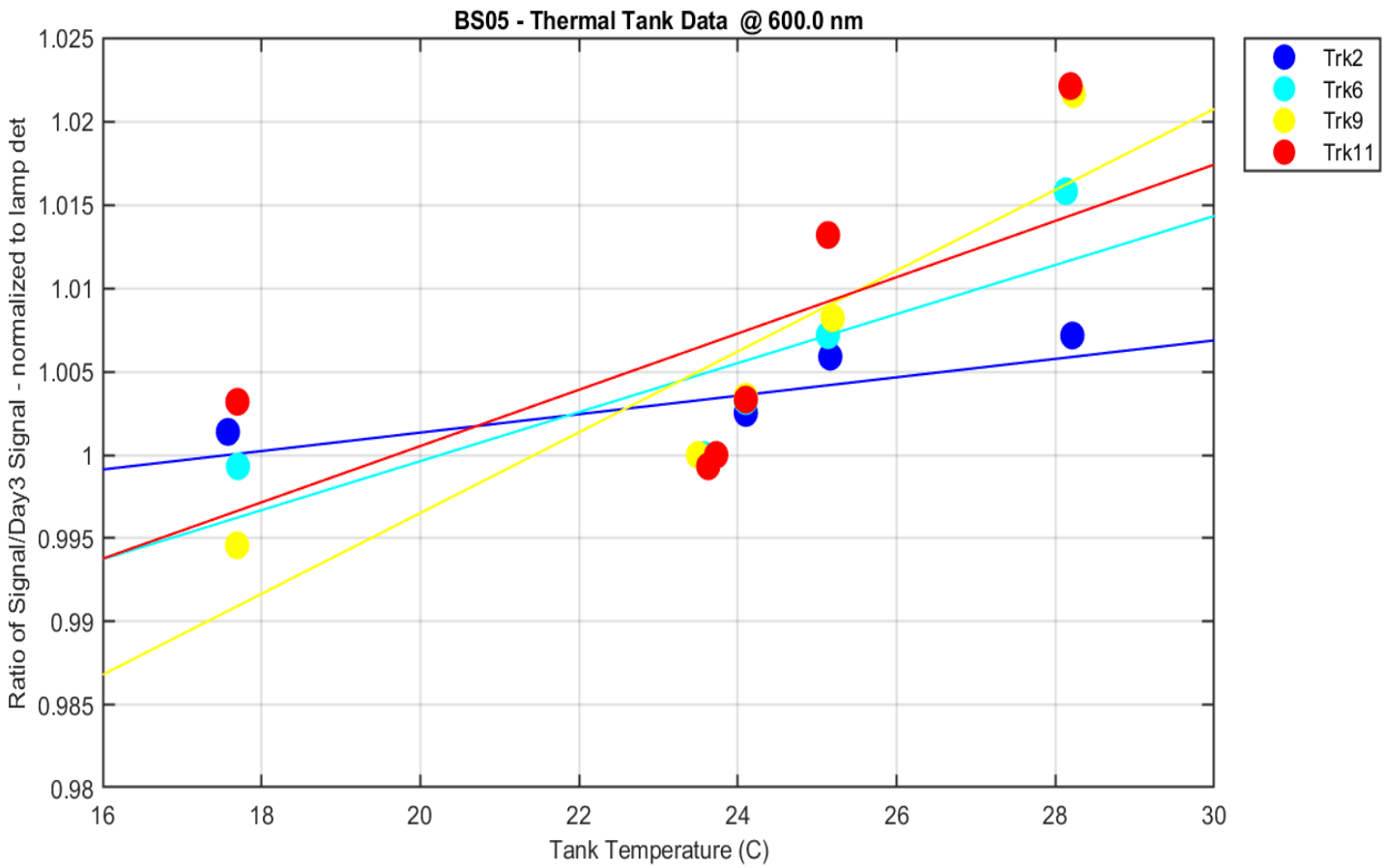


Other side of splitter, with incoming signal coming in on top (actual splitters are attached here), then fibers carrying signal to each spectrometer (round areas on the bottom).

Full, built up system (Red and blue spectrometers) along with splitter all assembled and ready for testing (pressure, etc…all tests passed) and Sean.

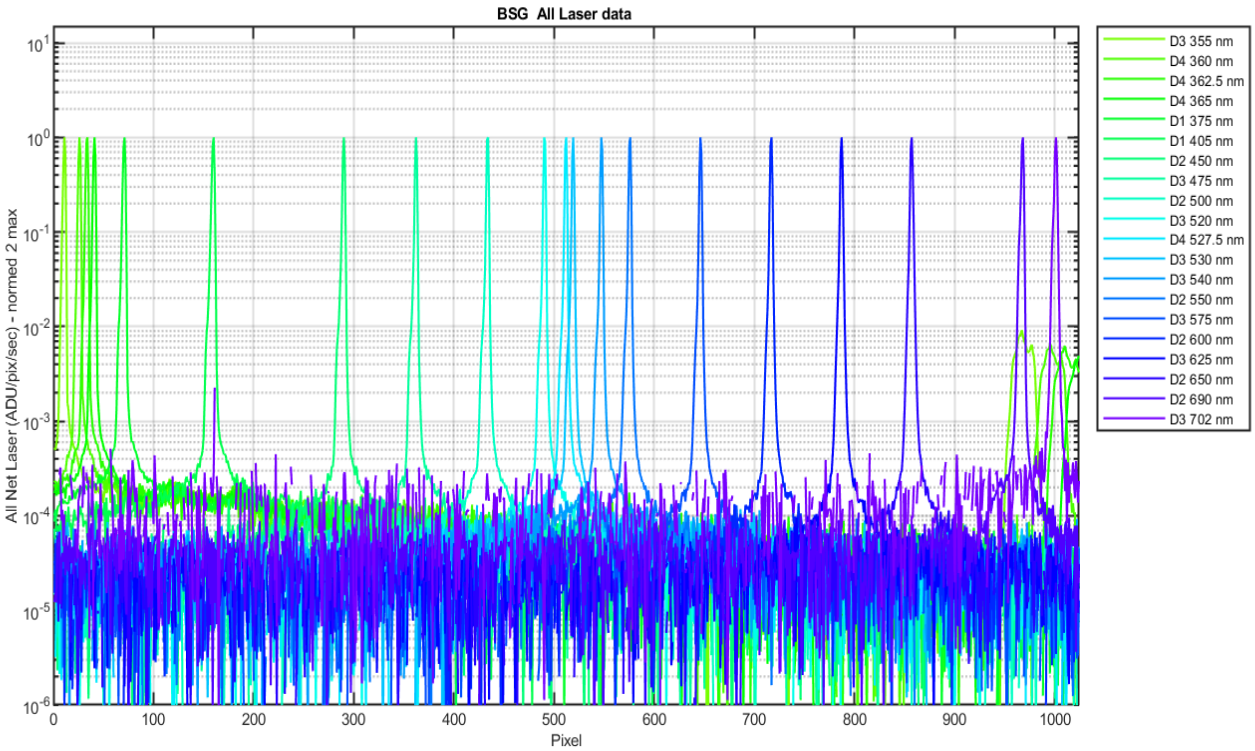
System, on it's back plane, ready to be lifted into water tank. Has to be done outside to get the height needed to lift into tank.

Example Thermal characterization Data



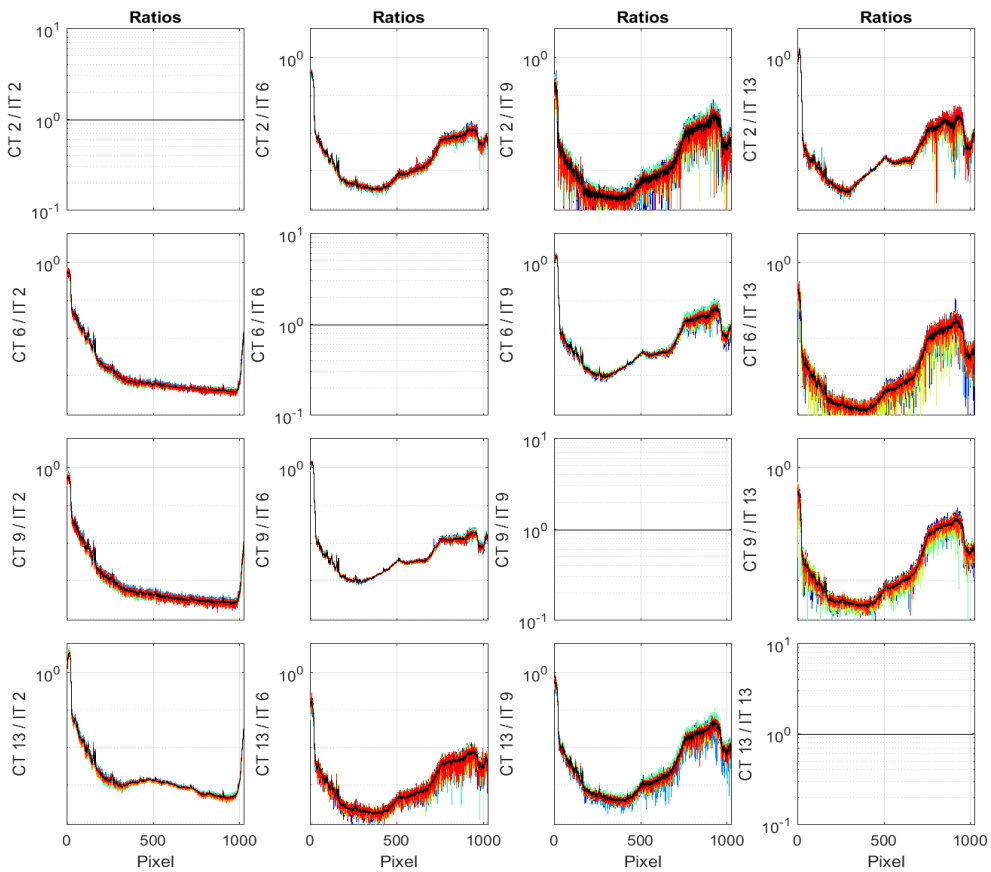
Displayed vs external tank temperature, there are many other internal temperature measurement positions, so we will be looking at these to see which give the best predictions.

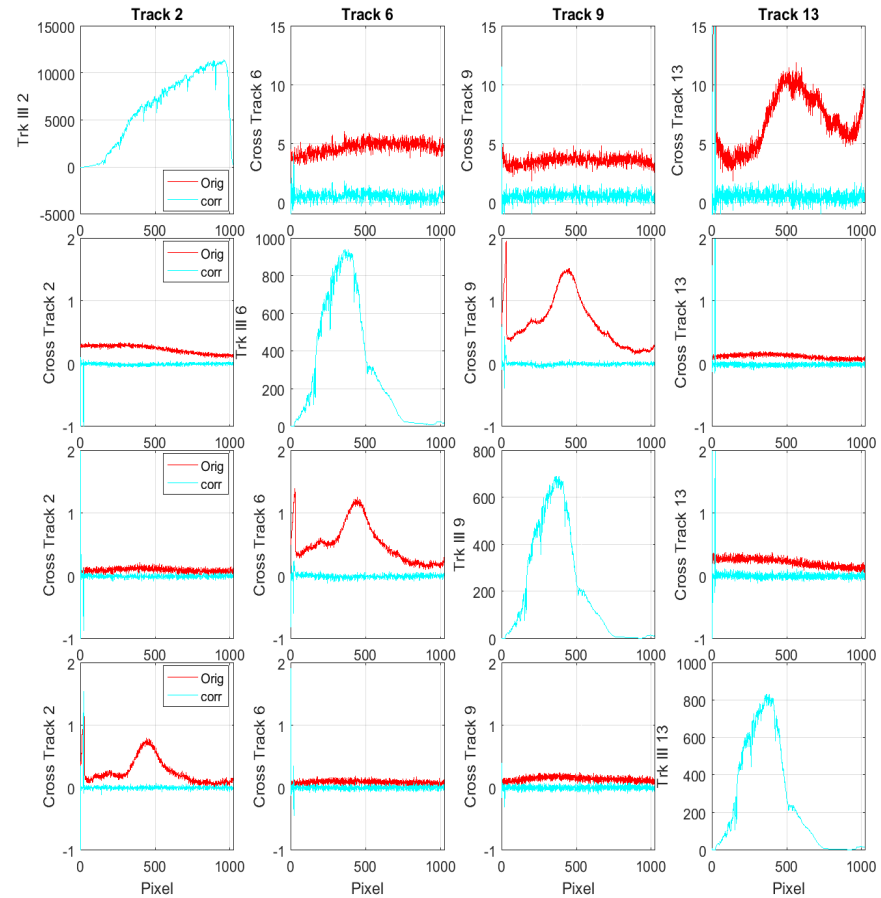
As the systems have been constructed, we have been taking stray light data (individual laser lines) along the whole time of system construction. Below shows an example of the latest stray light laser lines for the blue system. Note that second order is showing up on the far right (340 showing up at about 680..not exactly the same place that first order would be for 680 nm, but second order does not follow the same spectral calibration as first order).



Remember? D sin(θ) = m λ…so θ_2= 2 θ_2 D is distance between slits, m is ”order”

Spatial Straylight (or cross talk) characterization is best done at sea by individually turning on one track, and seeing the effect on the others. This replicates the spectra of the relevant light field





Example showing matrix to invert for cross track straylight on tracks 2, 6, 9, and 13.

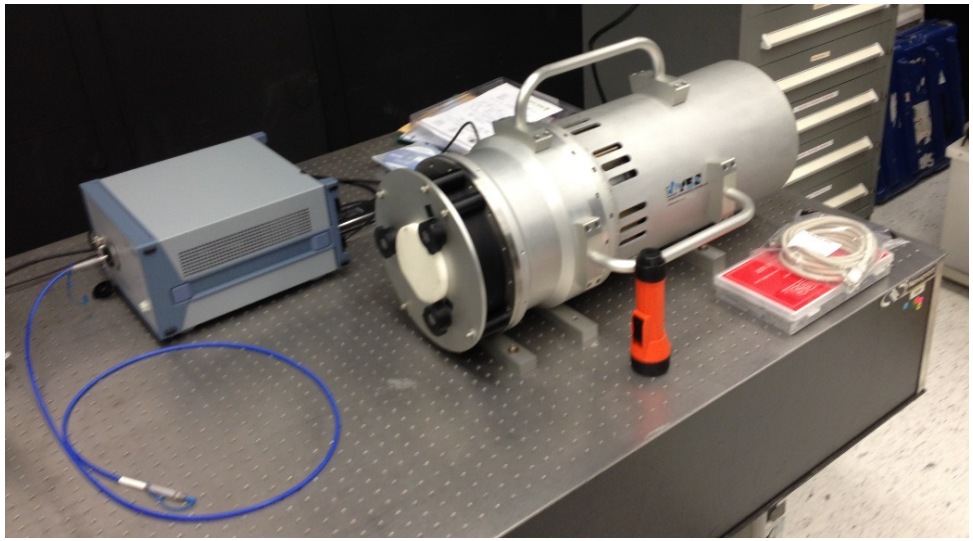
Showing data corrected with matrix, off diagonal elements should be zero, and have been corrected to be zero by using the matrix on the left.

Stability source and monitor

We have been working with two devices to use as a stability source, the Satellite quality monitor (SQM-5002, Yankee Scientific), and a hyperspectral, fiber-coupled radiometer (CAS140, Konica-Minolta) as the stability monitor.

Several tests and modifications have been made to these instruments, along with data collection software to log system performance.

The CAS is on the left, the SQM is on the right.



Scheme envisioned

- Support additional site off of Perth, Australia.
- Two MarONet hull structures on site. Allows more efficient use of ship time..one cruise to deploy and retrieve system.
- While the optics for one instrument is in field, the other is being sent back for calibration (with traveling source/monitor)…the Netflix part.
- Data forwarded to central location for common processing with MOBY/Hawaii.
- Central/common calibration and characterization site.

Last two items are requirements of the INSITU-OCR IOCCG White paper

Near term plan:
MarONet1 to be deployed this month

MarONet2 built up to be deployed 2-3 months later

Begin getting infrastructure set up in Australia in 2022

Carbon Fiber buoys shipped to Australia, once recovered

Complete characterization of optical systems, and ship them to Australia

Deploy in Australia (goal Jan 2023…depends on PACE schedule)