MOBY Project Overview

12 March 2009

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MOBY Project Funded by NOAA Grant to SJSU-RF, NOAA Award #NA08NES4400014

MOBY TEAM

- Yarbrough, Feinholz, Houlihan -- HI, Operations
- Flora, Peters -- CA, Data processing
- Feinholz -- Optical Calibrations
- Johnson -- SI traceability and Research

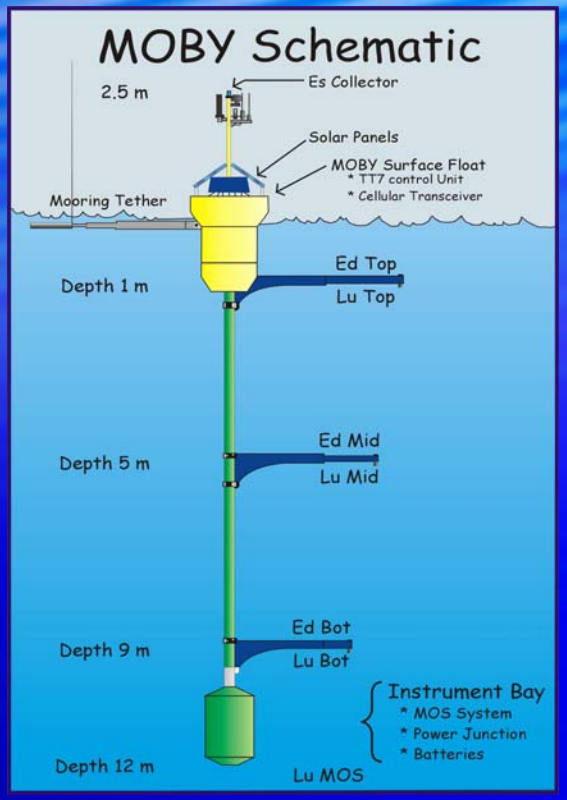
MOBY Operations

- Hawaii Operations Site
- Lanai Study Area
- MOBY System
- MOS Optics
- Field Operations
- MOBY-C

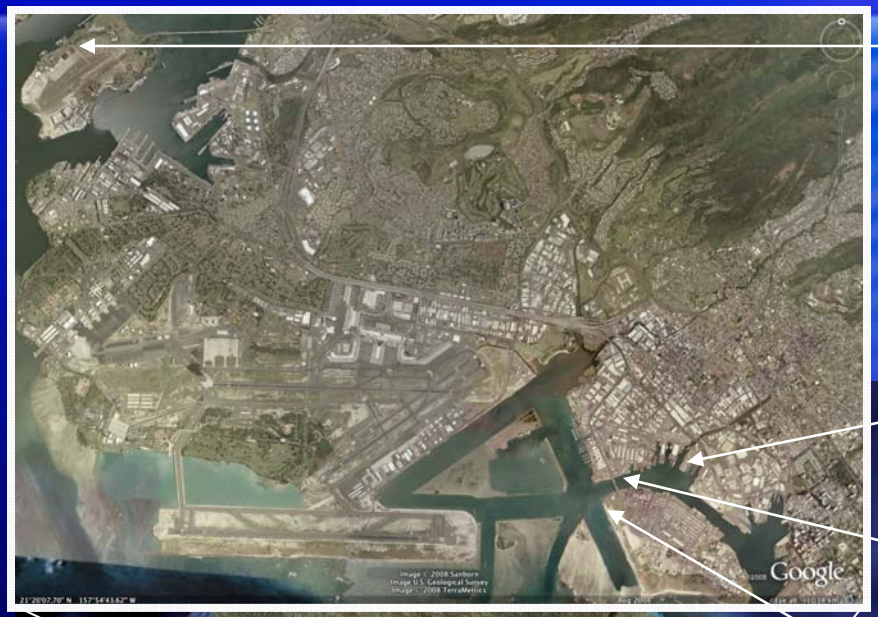
MOBY Calibration & Measurement Validation

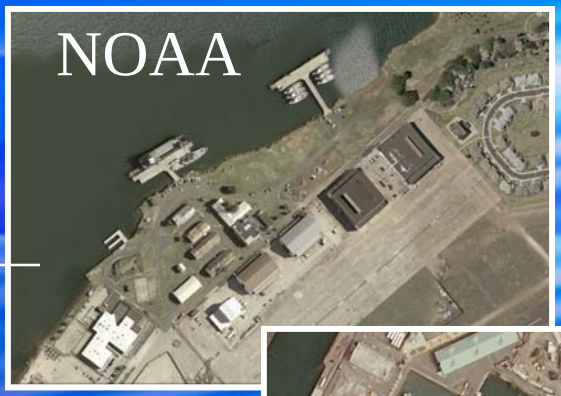
- MOS sensor level characterization
- MOBY system level characterization
- Uncertainty budget

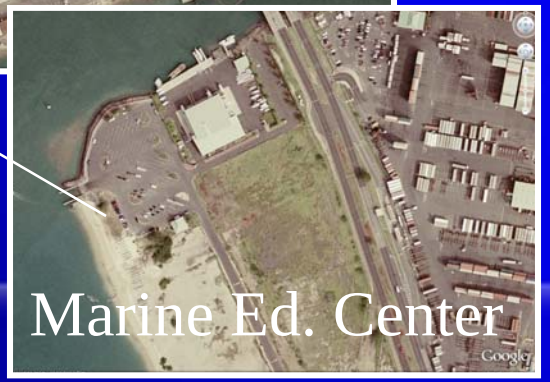
Marine Optical BouY

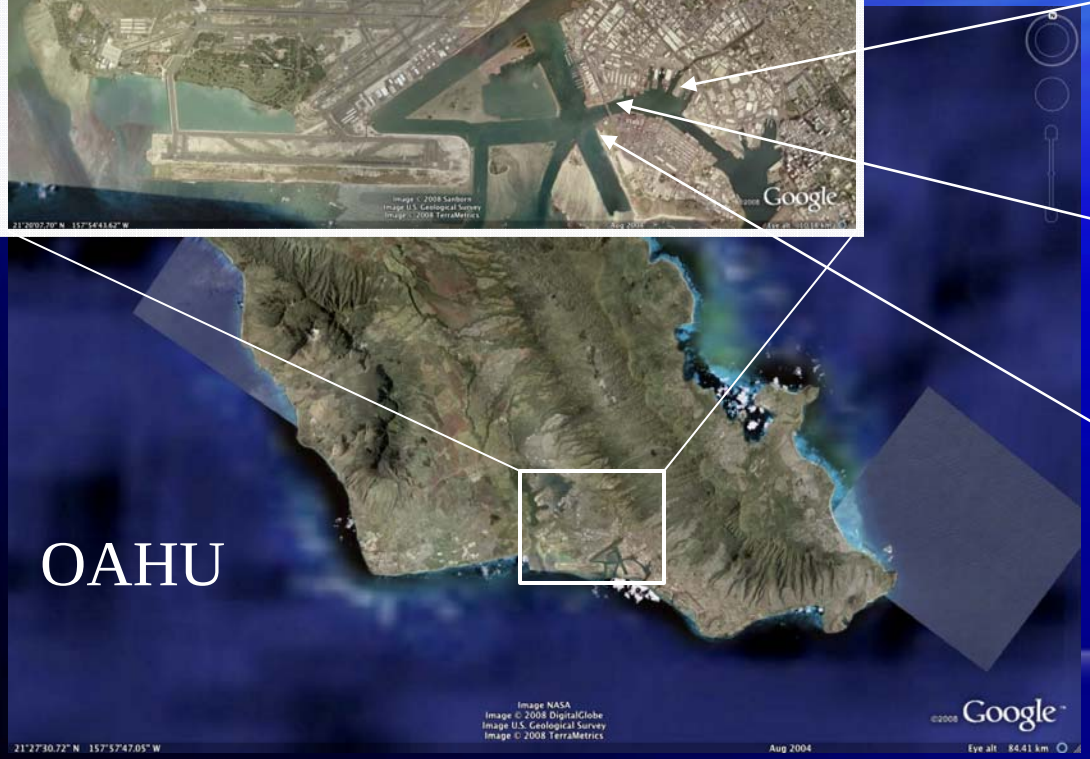


Hawaii Facilities









MOBY Operations Site - Univ. Hawaii

MOBY Operations Site - Tent

Pier Side - 30,000 sq. ft

16 Portable vans/tent

offices, shops, storage, labs (calibration, optics assembly, filtration)

6 Shipboard Vans

3 labs - (wet, optics, data acquisition) power, storage, & office

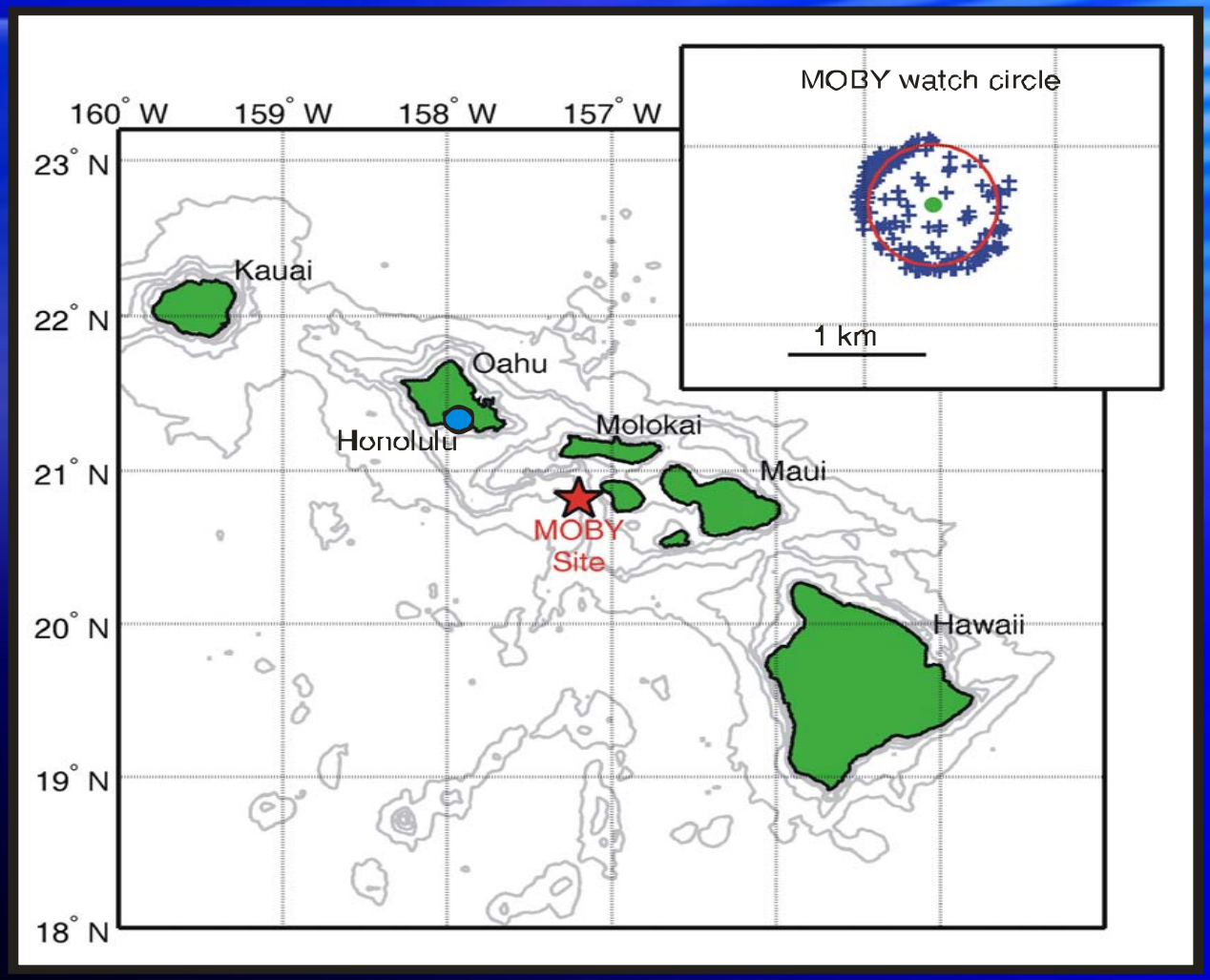
Pier side Support - cranes, machine shop.

Ford Island NOAA Facility

Ford Island Facilities

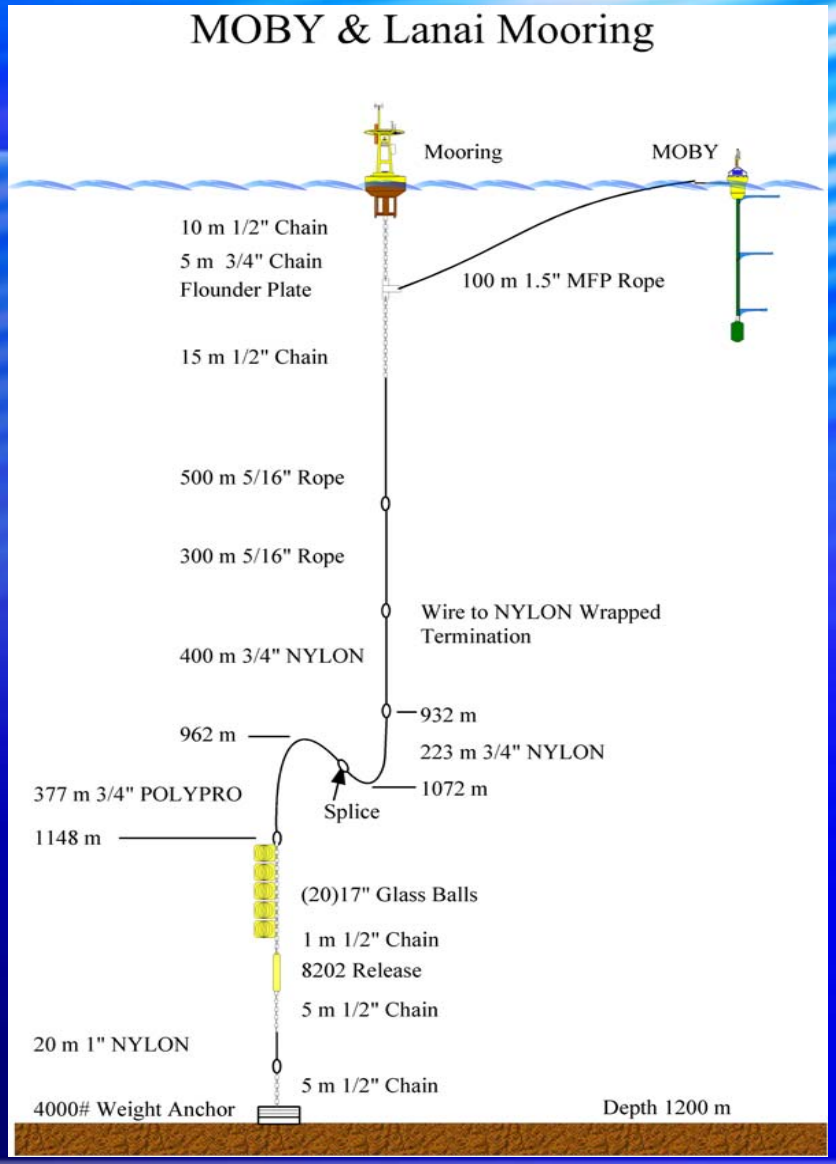
MOBY on Kilo Moana

MOBY Lanai Study Area

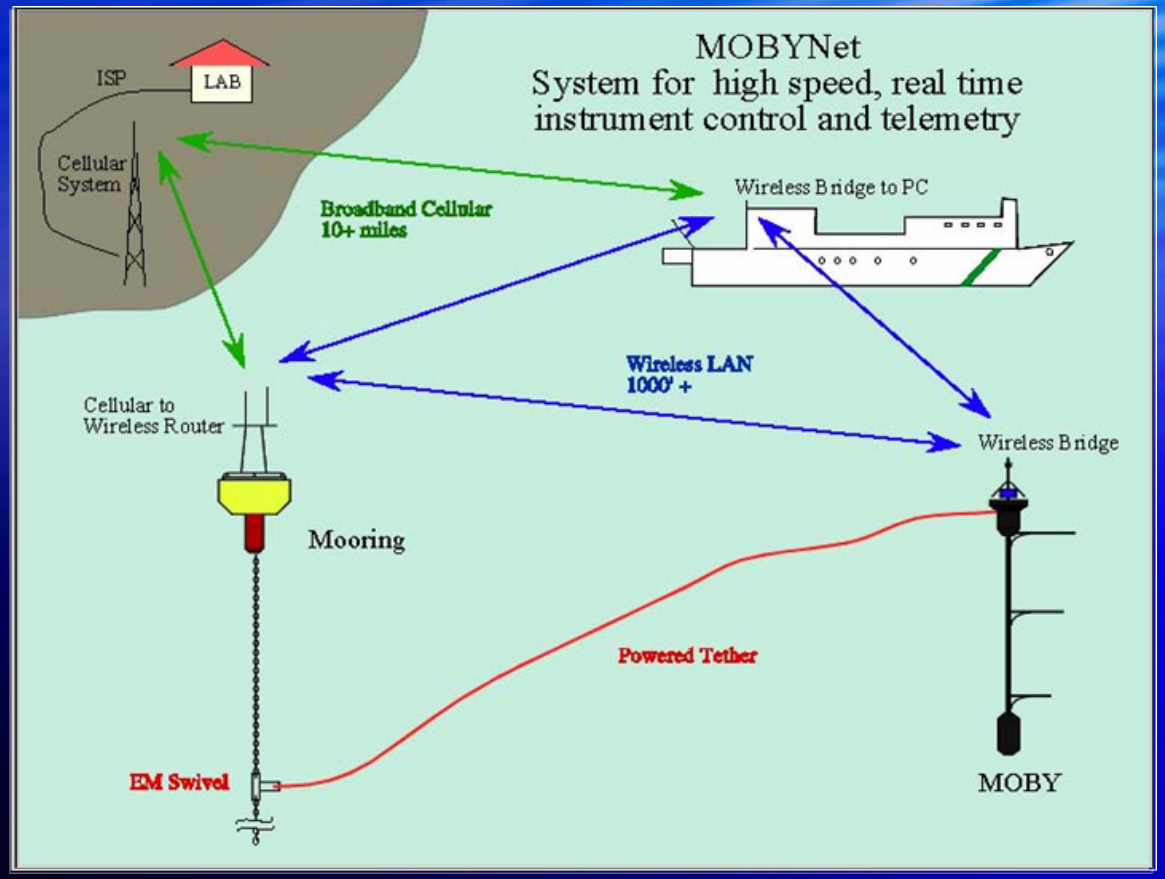


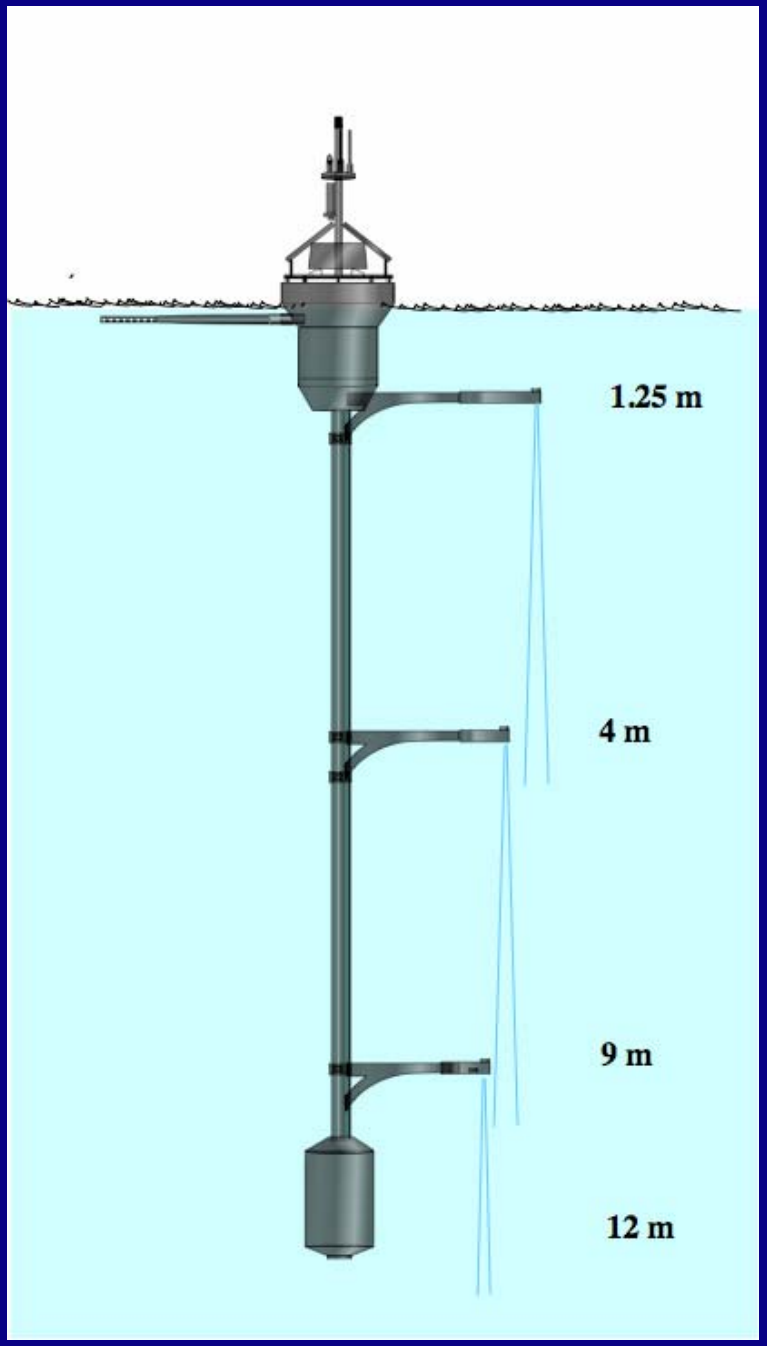
Mooring Buoy

MOBY Lanai Mooring



Communications System Design: MOBYNet



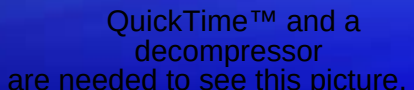


MOBY

Satellite Vicarious Calibration Instrument

- Primary product is, L_w
- Es
- Lu,Ed at 3 depths
- MOS radiometer
- Multiplexed fiber optic inputs
- Sequential Sampling

Typical MOBY Data Set




QuickTime™ and a
decompressor
are needed to see this picture.

Data uncertainty without MOBY

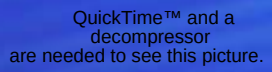
Median Percent Differences (MPD) with and without MOBY Calibration

QuickTime™ and a
decompressor
are needed to see this picture.

QuickTime™ and a
decompressor
are needed to see this picture.

From: Franz et al 2007

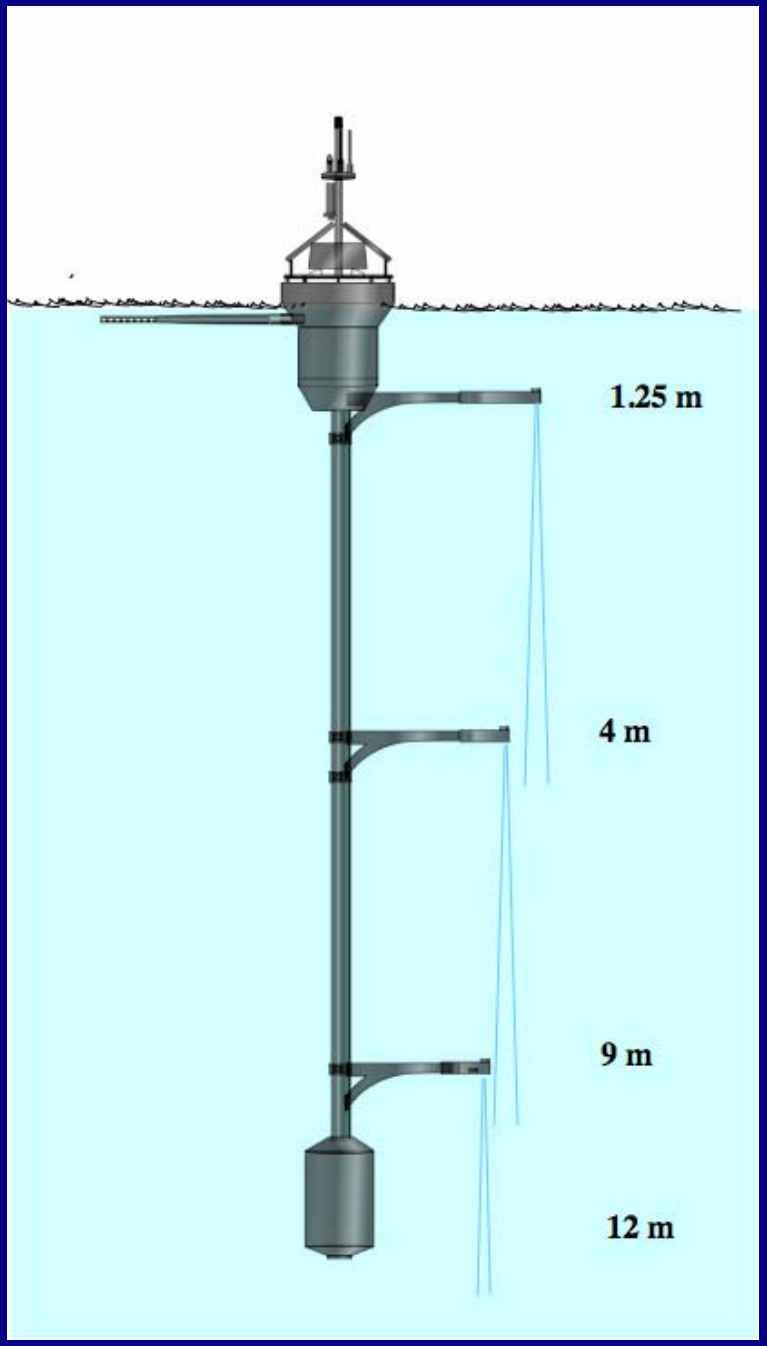
Uncertainty table



Continuing MOBY into the future

Technology Refresh Rationale

- Continue the only OC climate quality time series
- Existing hardware is approaching end-of-life
- MOBY failures are costly and not budgeted
- Improves measurements
- MOBY-C ensures support for VIIRS calibration
- Refresh addresses OC community recommendations
- Reduce operational costs
- Improve operational safety



MOBY

Satellite Vicarious Calibration Instrument

- Primary product is, L_w
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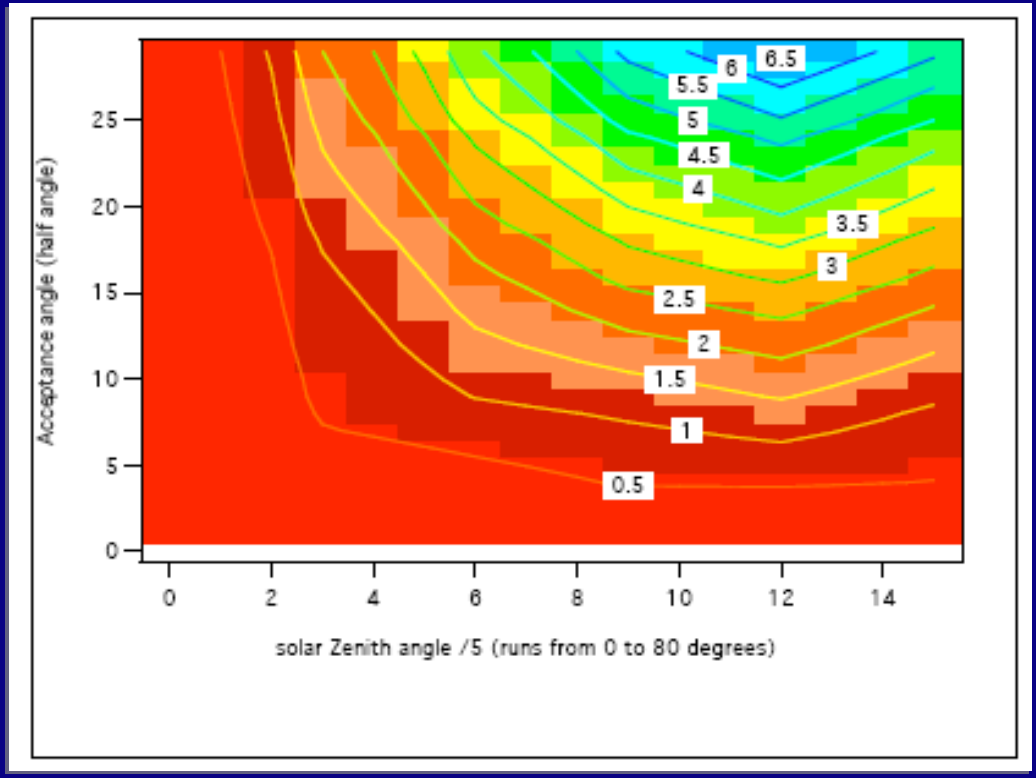
- Sequential Sampling

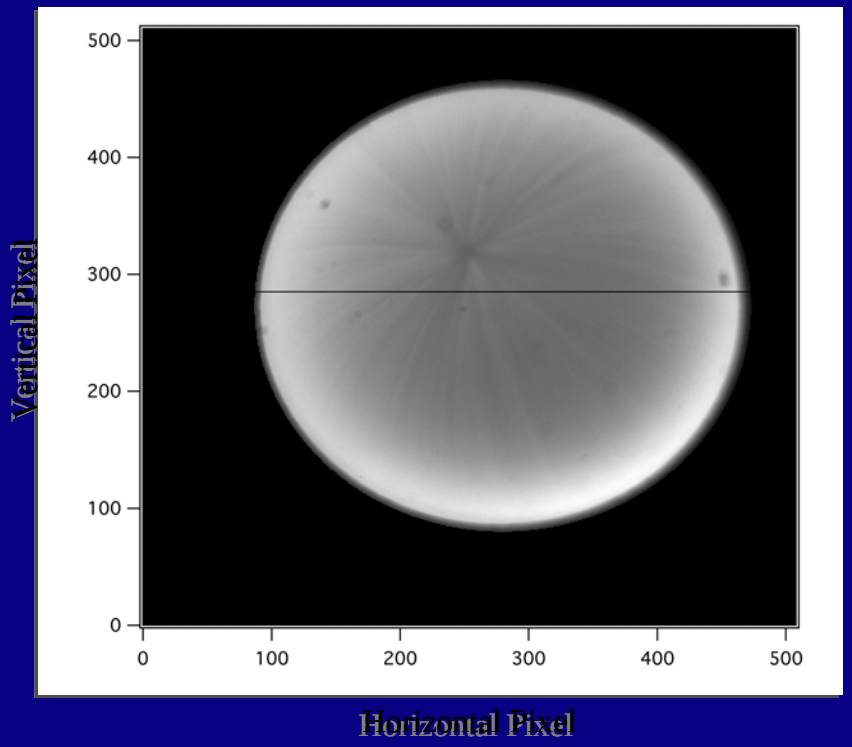
Modeled percent non-uniformity

The light field is within 1 % of the exact up-welling nadir value

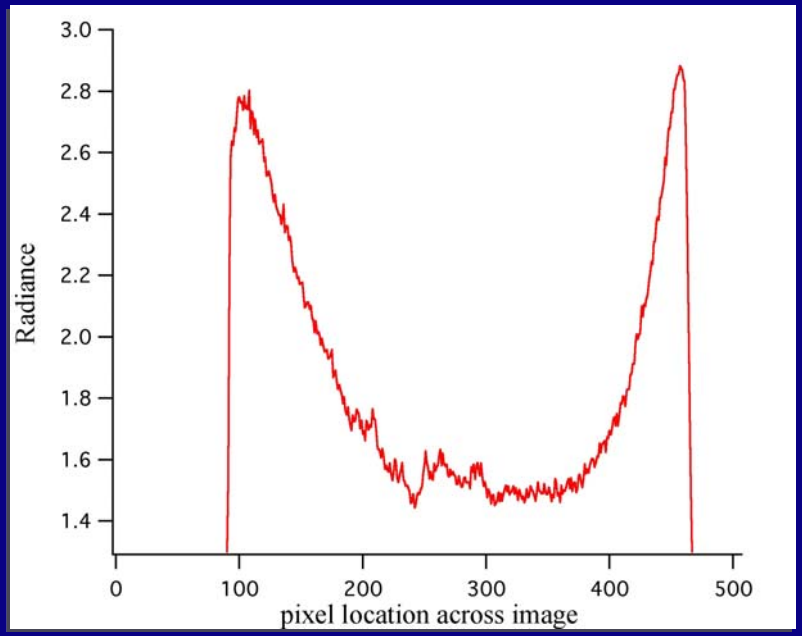


Upwelling radiance distribution in Case 1 water at 412 nm (NuRAD)

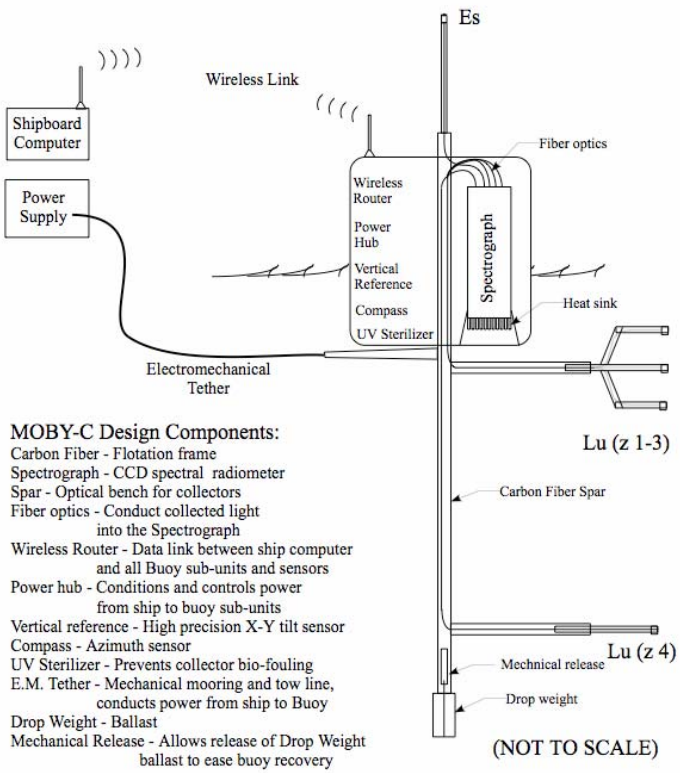
- A fisheye projection
- Center of the circle is the nadir
- Edge of the image represents radiance at 90˚ nadir angle



Variations in the light field ~10 %

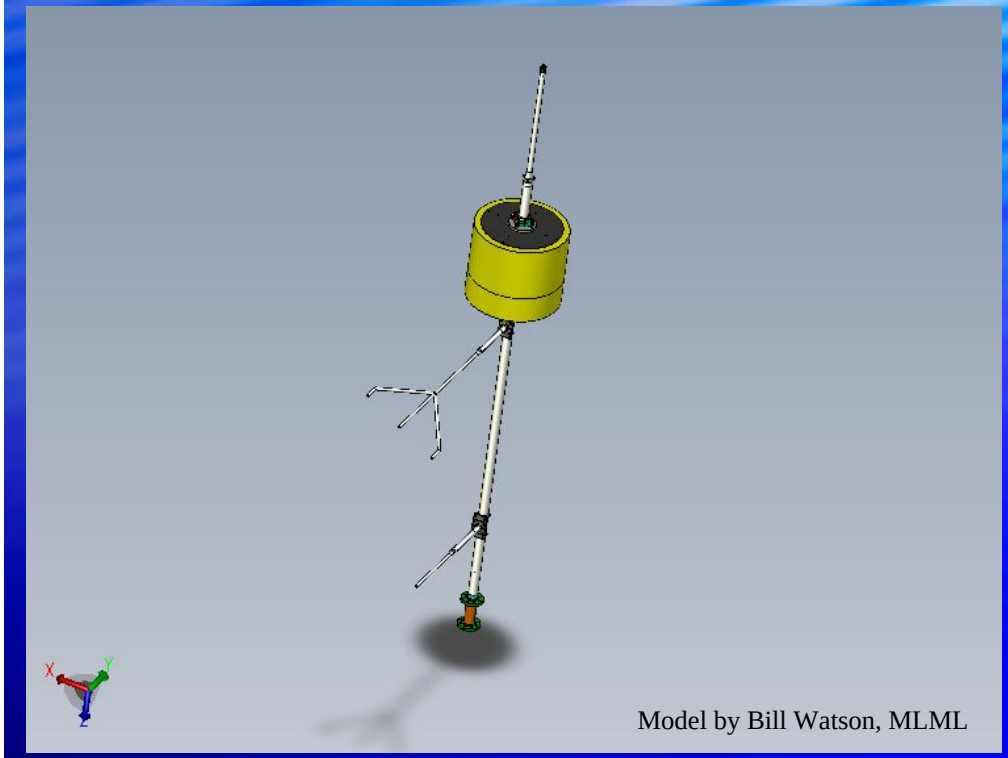


MOBY-C schematic



MOBY-C Design Components:

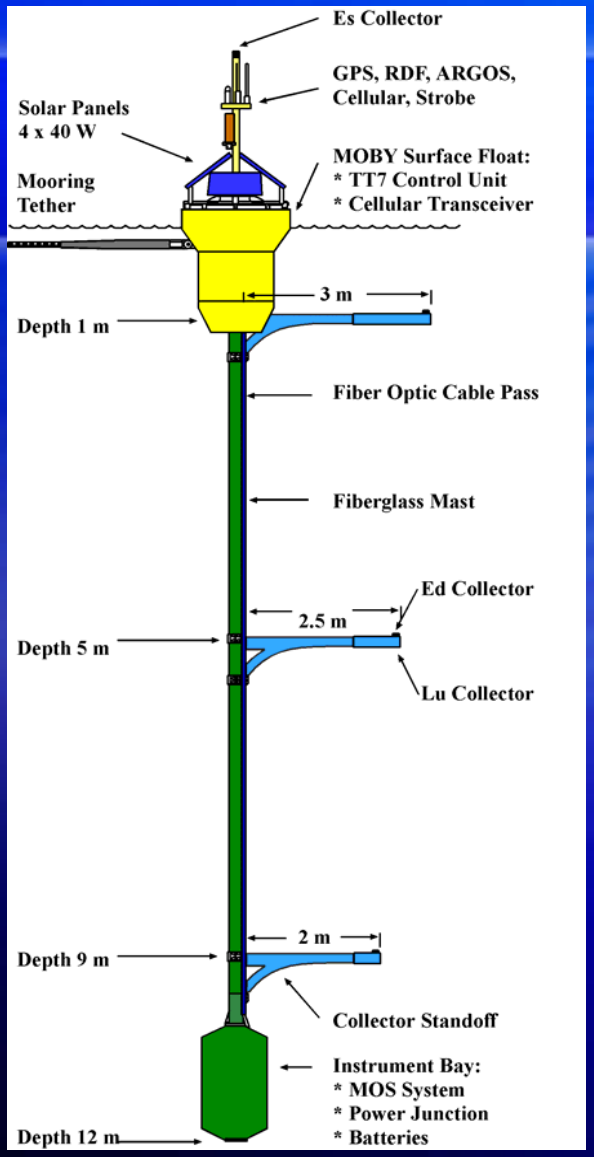
Carbon Fiber - Flotation frame
Spectrograph - CCD spectral radiometer
Spar - Optical bench for collectors
Fiber optics - Conduct collected light into the Spectrograph
Wireless Router - Data link between ship computer and all Buoy sub-units and sensors
Power hub - Conditions and controls power from ship to buoy sub-units
Vertical reference - High precision X-Y tilt sensor
Compass - Azimuth sensor
UV Sterilizer - Prevents collector bio-fouling
E.M. Tether - Mechanical mooring and tow line, conducts power from ship to Buoy
Drop Weight - Ballast
Mechanical Release - Allows release of Drop Weight ballast to ease buoy recovery

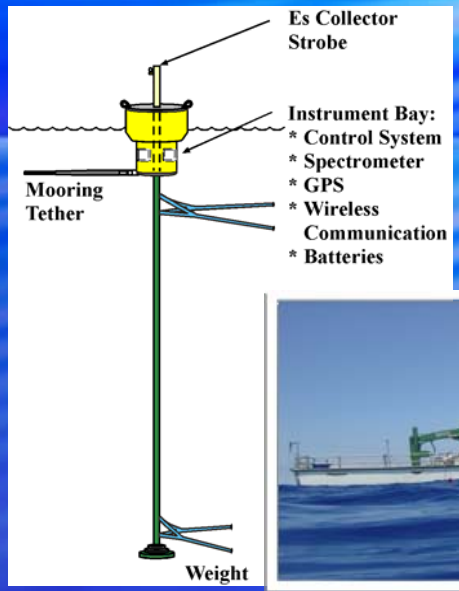


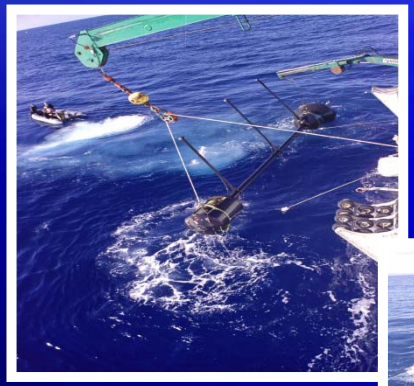
Model by Bill Watson, MLML

Unique Benefits of MOBY-C

- Supports ViCal of multiple satellites
- High data rate provides less data exclusion
- Geometry minimizes self shading errors
- Methodology for optimum Lw measurements
- Configurable for a range of OC applications
- One instrument provides up to 16 inputs


Es Collector
GPS, RDF, ARGOS,
Cellular, Strobe
Solar Panels
4 x 40 W
MOBY Surface Float:
* TT7 Control Unit
* Cellular Transceiver
Mooring
Tether
3 m
Depth 1 m
Fiber Optic Cable Pass
Fiberglass Mast
Ed Collector
2.5 m
Depth 5 m
Lu Collector
2 m
Depth 9 m
Collector Standoff
Instrument Bay:
* MOS System
* Power Junction
* Batteries
Depth 12 m


Es Collector
Strobe
Instrument Bay:
* Control System
* Spectrometer
* GPS
* Wireless
Communication
* Batteries
Mooring
Tether
Weight



MOBY-C Prototype

MOBY-C Prototype

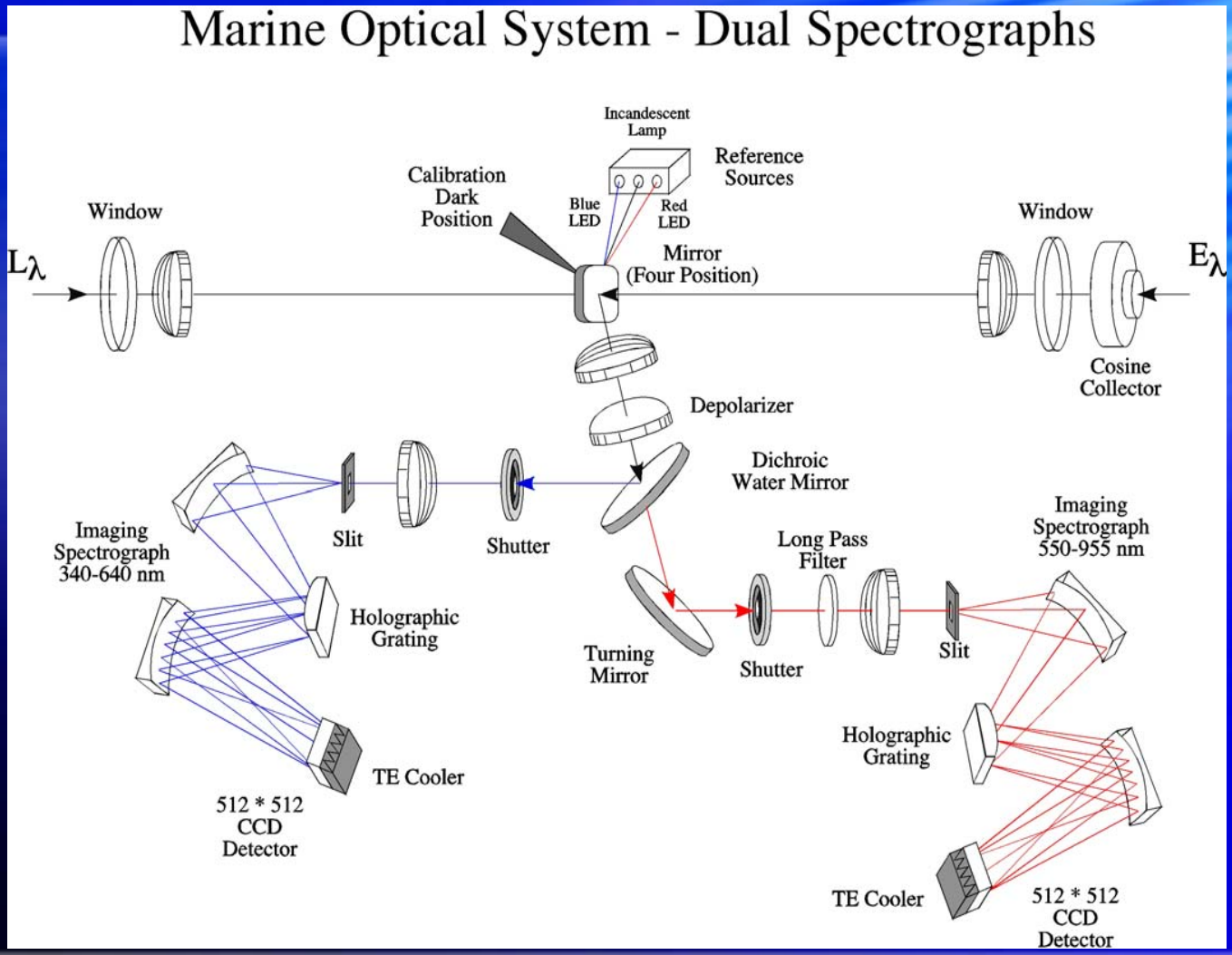
MOBY-C Prototype

MOBY-C Prototype

MOBY-C Lanai Buoy Prototype Testing

MOBY-C Optical Re-design

MOS Optical System



MOBY-C Optical Concept

Field Validation

Schematic diagram of the prototype buoy system

- Fiber-optic inputs located a different depths
- Fibers were located on small arms
- Arms were rotated approximately 45 deg
- Weight at the bottom to keep buoy vertical
- Optical fibers run from ship to the buoy

Prototype buoy deployment

Buoy being deployed
from the R/V Klaus Wyrtki

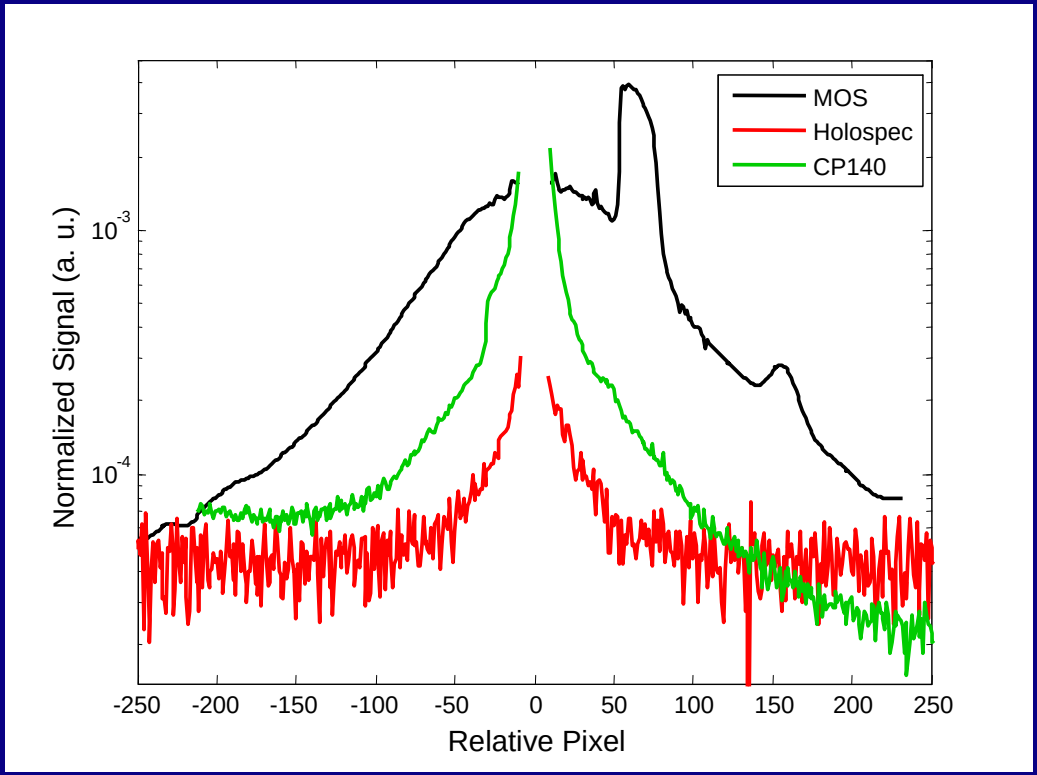
In the water at a typical
distance from the ship

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

MOBY-C Optics Test System

Normalized response to monochromatic laser radiation

Both multiple input systems have superior scattering characteristics when compared with MOS



Instrument	Integrated stray light signal
MOS	0.31
CP140	0.11
Holospec	0.033

Data were normalized to the peak response and the central pixels have been removed from each data set for clarity

Buoy test deployment

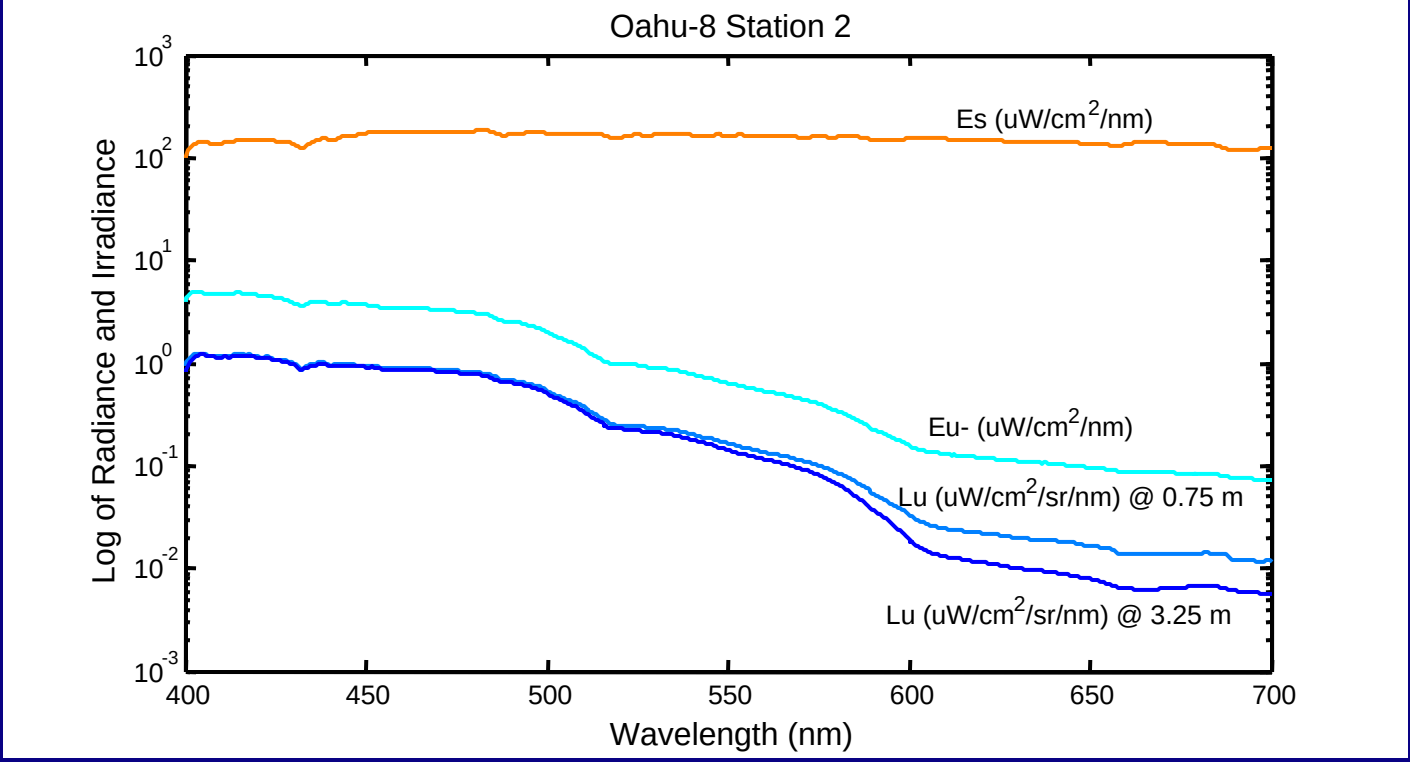
QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

- Buoy is a wave follower
- Small surface disk
- Buoy has Low shadowing profile
- Small surface umbilical
- Surface issues

In-water data set from the CP140 system

- Data were acquired simultaneously for intervals of time greater than 15 min

- Optically clear waters off of Oahu, Hawaii



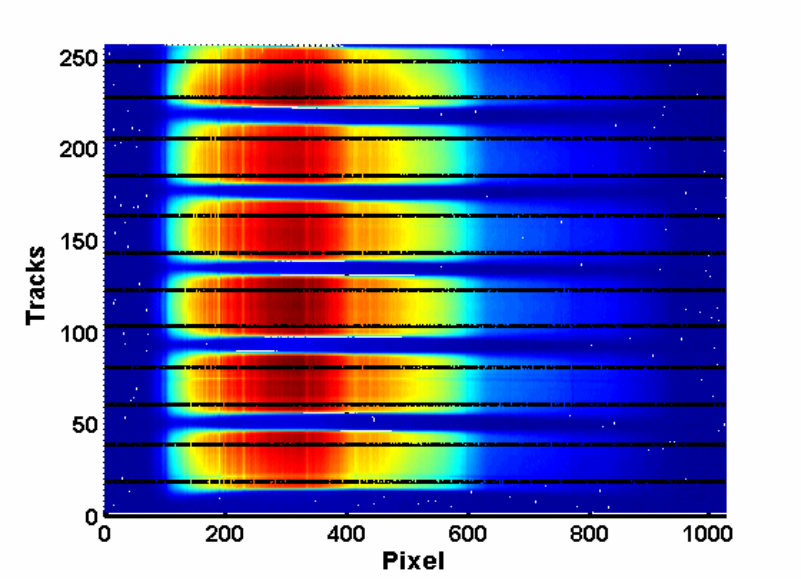
Multi-track image from the Holospec and CP140 system.

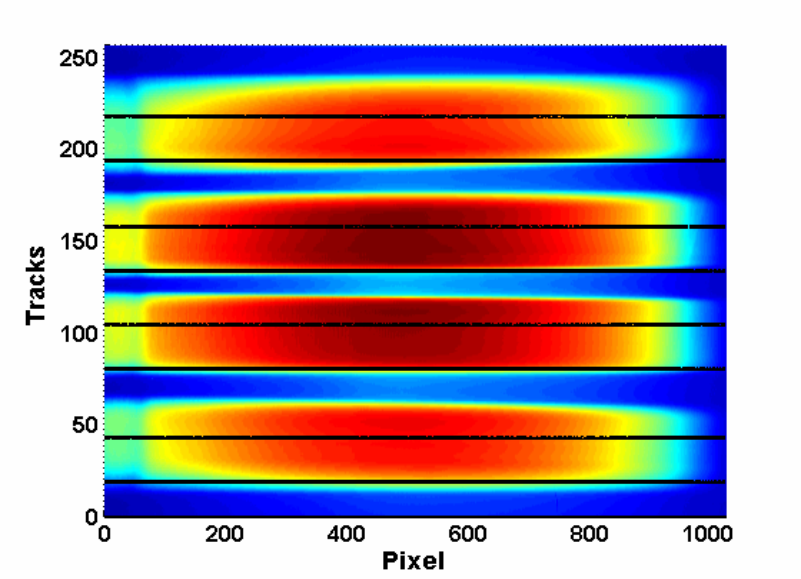
Holospec – 6 tracks

Tracks are images of 800 um m fibers separated by approximately 500 um

CP140 – 4 tracks

Tracks are images of 1000 um fibers separated by approximately 500 um

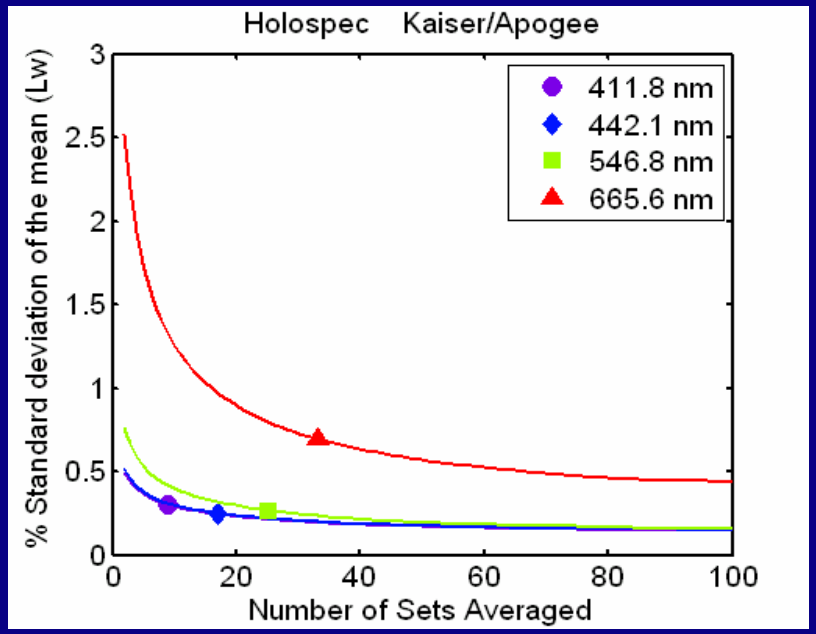


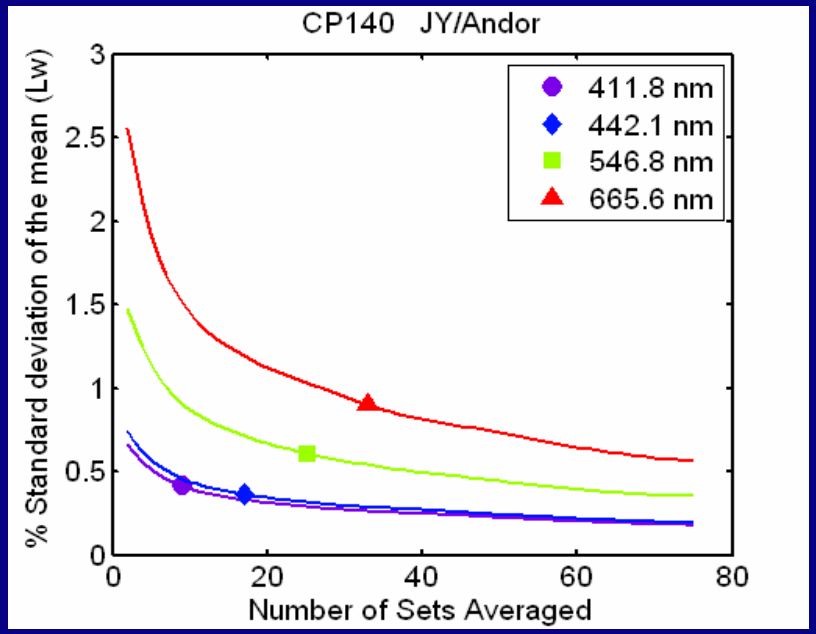


The solid black lines in the figure illustrate the fractions of the images averaged to create track spectra

Calculated percent standard deviation

•Acquiring multiple data sets simultaneously most of the variance can be averaged out

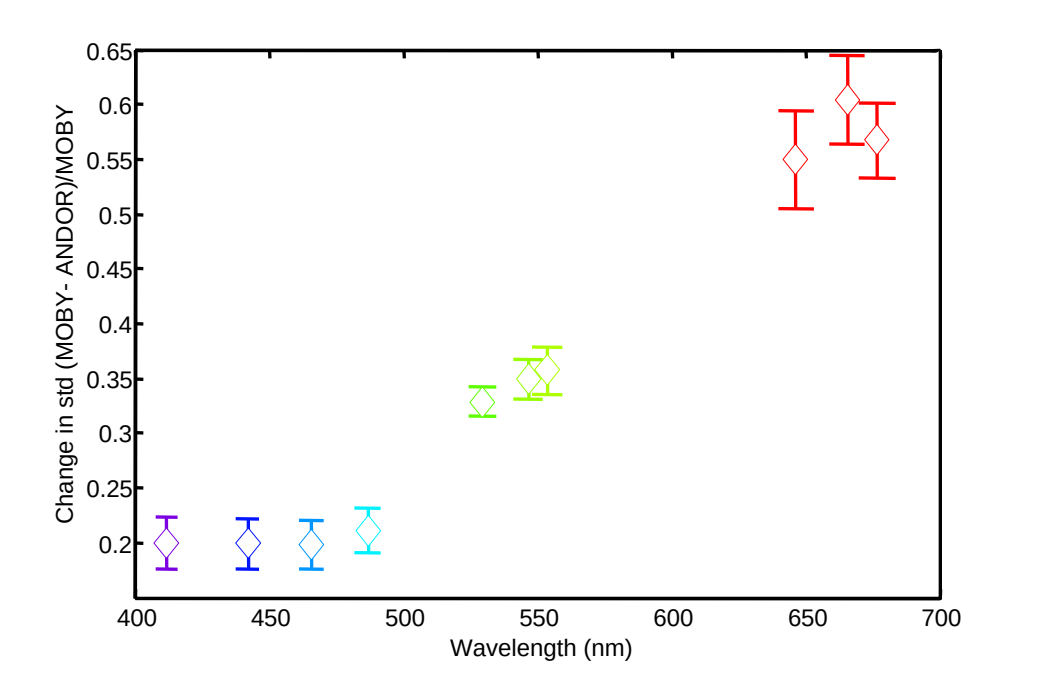




Holospec **CP140**

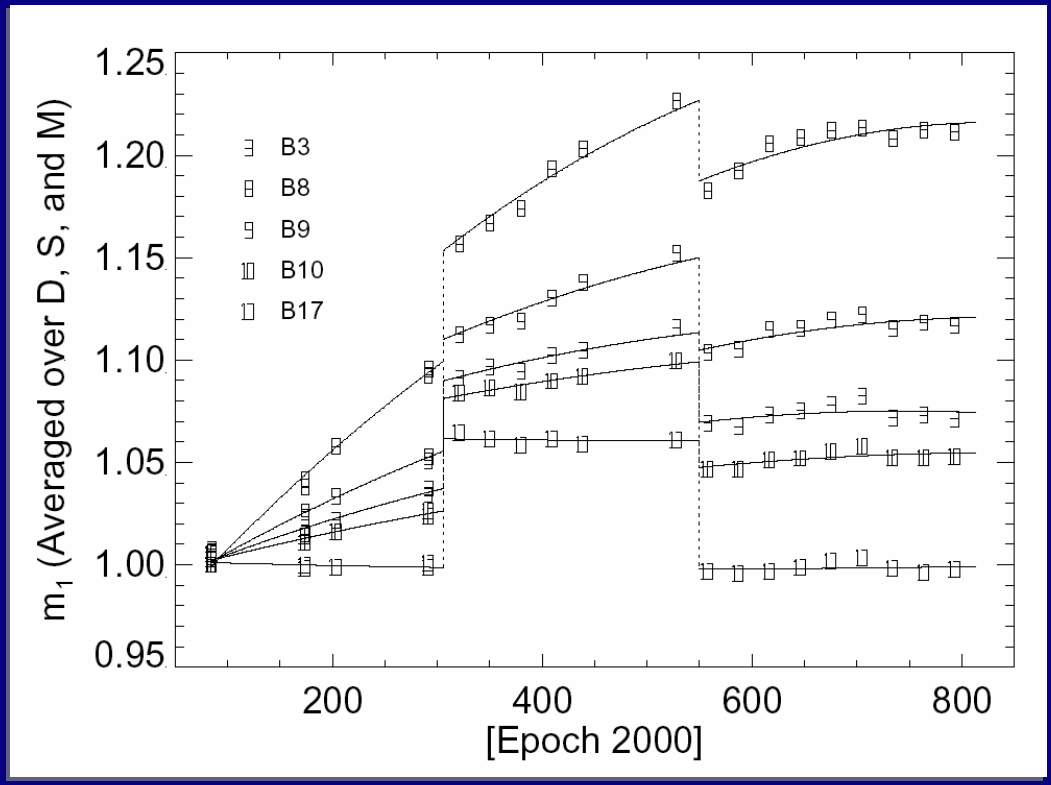
Improvement in standard deviations using simultaneous measurements

- Reduction in uncertainty - simultaneous vs sequential
- Simultaneous was a factor of 5 less than the sequential at 440 nm and 490 nm and a factor of 3 less at 550 nm
- Improvement is less at 665 nm due to greatly reduced signal at depth and increased scattering



MODIS/Terra change to the calibration coefficients

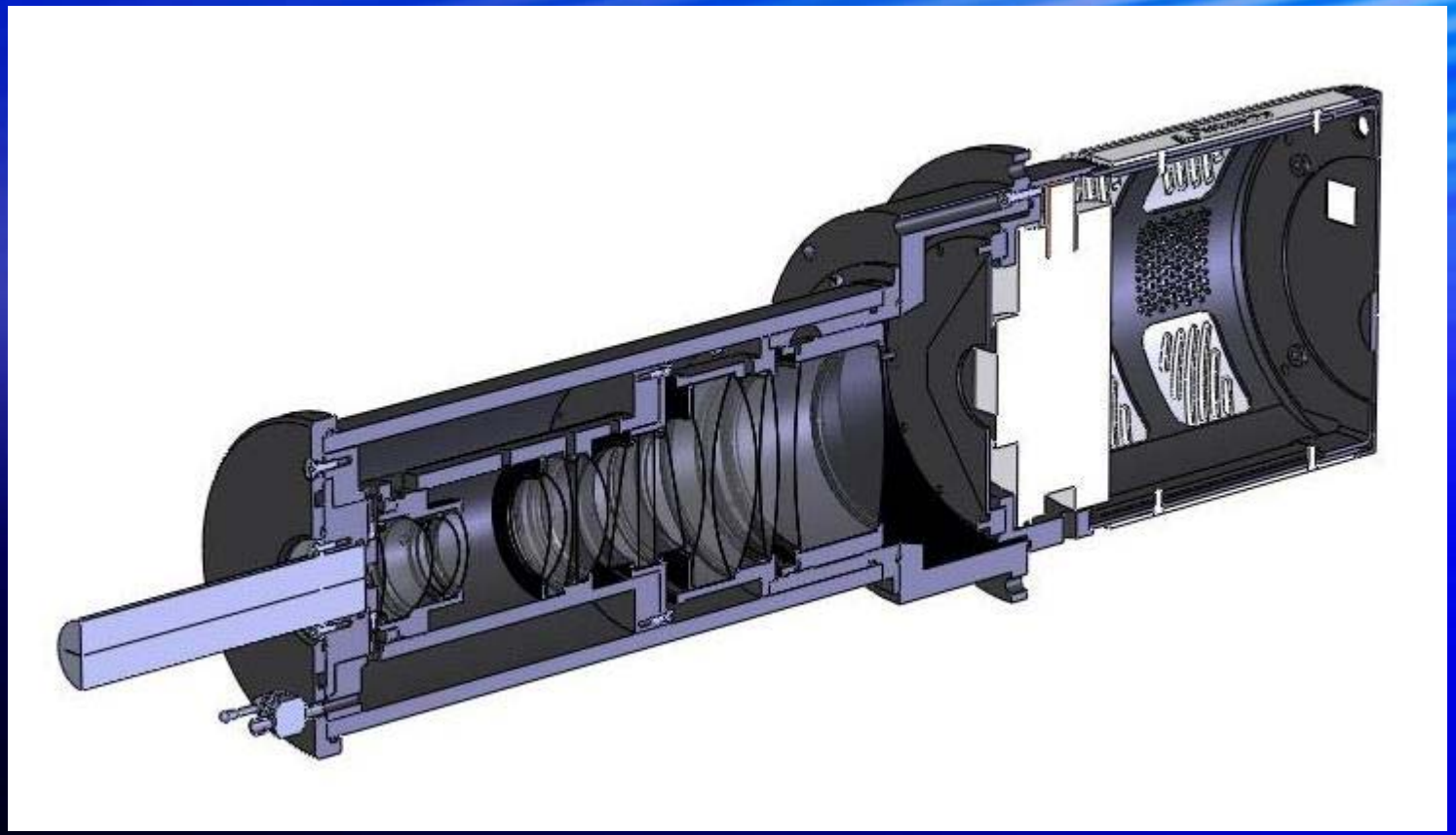
- "A-side" or "B-side" change to the calibration coefficients for the ocean color bands
- Increased precision benefit this program.
- Type A environmental uncertainties need to be reduced, to well below the 0.5 % level



MOBY-C Radiometer Status

- Validated multi-track spectrograph concept
  - Field studies
- Validated improved performance of VPH grating
  - Initial laser tests
- Spectrograph selected based on form factor
  - Must be compact design
  - In-line unit from Resonon
- Awaiting delivery of first Red and Blue versions

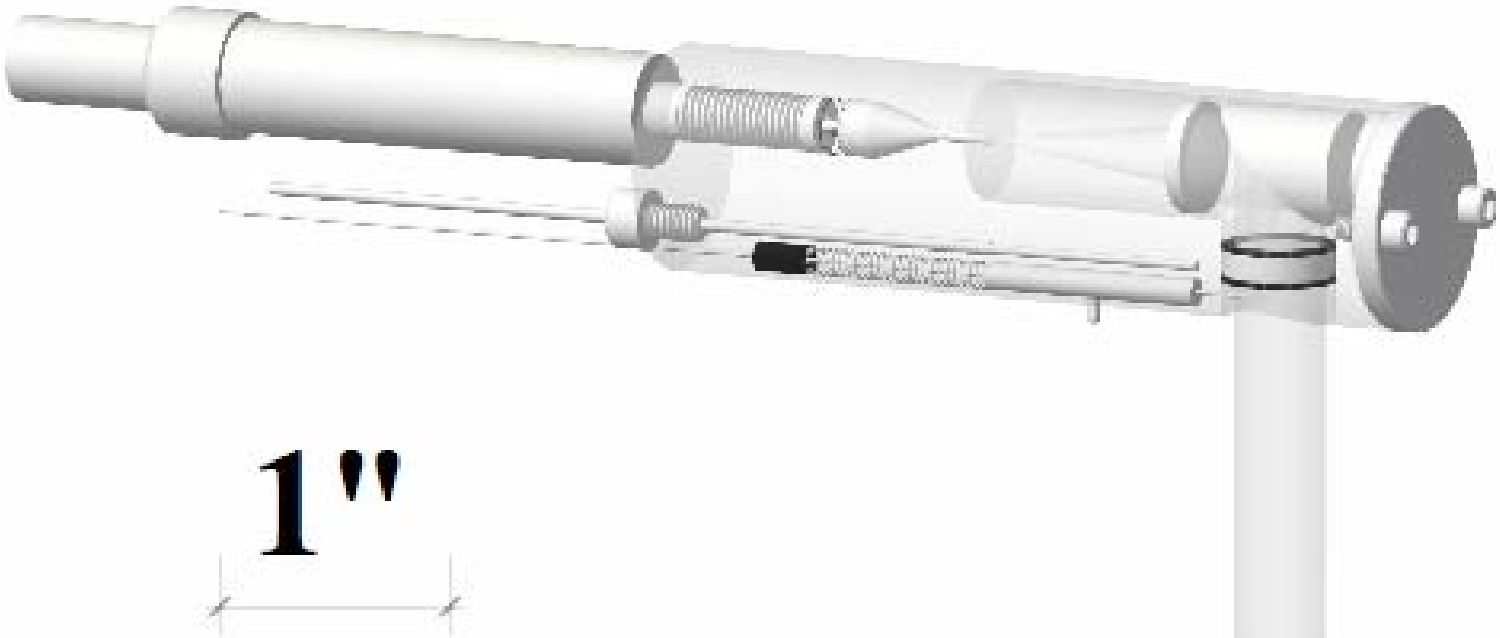
Resonon VPH Spec/PI CCD



MOBY-C Radiometer

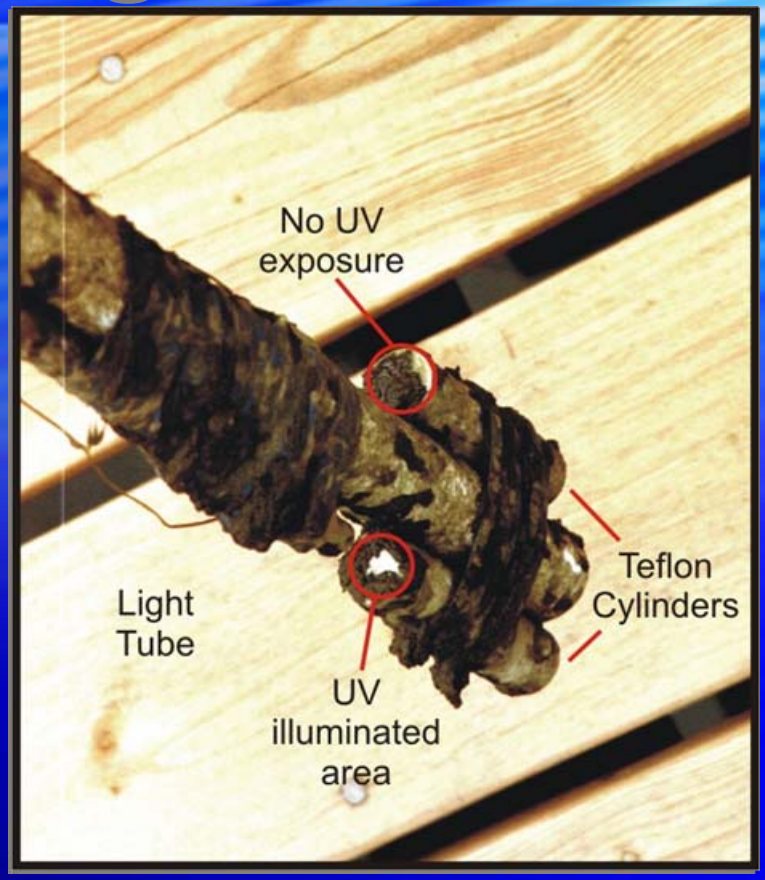
8 Fiber optic inputs
Independent shutters
In-line design
1024 X 1024 CCD
TE Cooled
Internal Reference
12 volt power
Ethernet interface

Fiber Optic Radiance Collector



Bio-fouling

10 Jan 1999
Top Arm
Dirty



ALOHA

Backup

MOBY-C Optical Concept