

OPERATIONAL EXPERIENCES WITH THE KONGSBERG EM2040 ON AUV SENTRY



FEMME 2026 | GENOA



NATIONAL DEEP SUBMERGENCE FACILITY

A U.S. national facility funded
by NSF, ONR, NOAA.
Providing access to deep-sea
vehicles for the entire U.S.
research community



HOV
ALVIN



6500M

ROV
JASON



6500M

AUV
SENTRY



6000M

MISSION/VALUES

Enable Discovery

Advance Technology

Serve the Nation as a shared national resource

Foster Collaboration

Support transformative research

Ensure Reliability & Safety

AUV SENTRY

Workhorse for ocean science, consistently delivering high-quality data across a wide range of missions. Its robust design and adaptability have made it a cornerstone for seafloor exploration.

Integration of 3rd party equip.

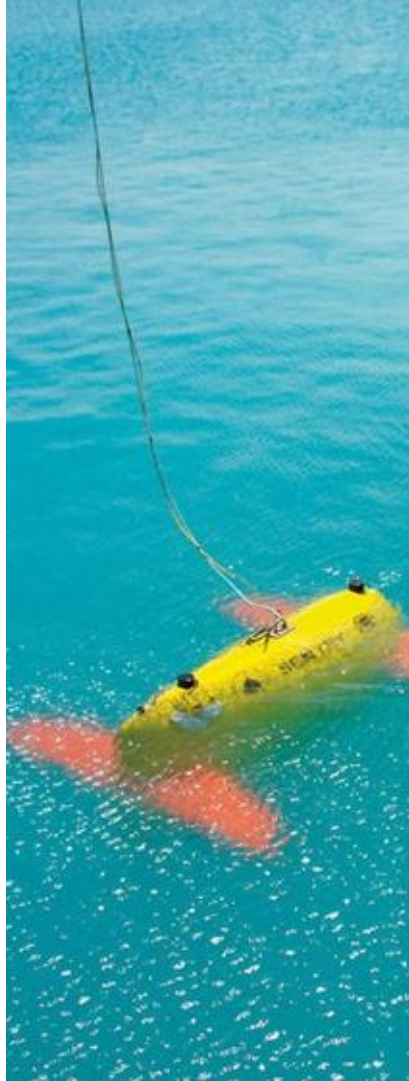
In house software/Hardware

Concurrent Operations w/ROV

2x Containers 20'

120-150 Operational days/year

Funded largely by NSF/NOAA/ONR



UNIQUE FEATURES

FINS/SERVOS



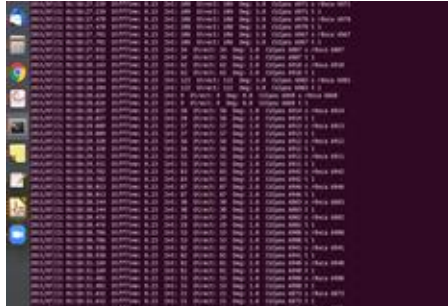
INNOVATIVE
PAYLOADS



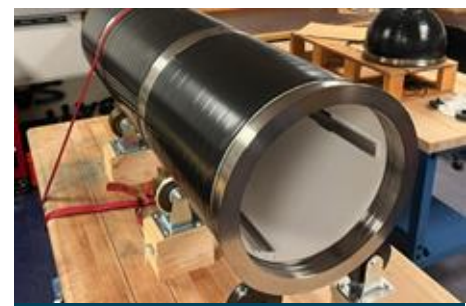
BATTERIES



2-20' CONTAINERS

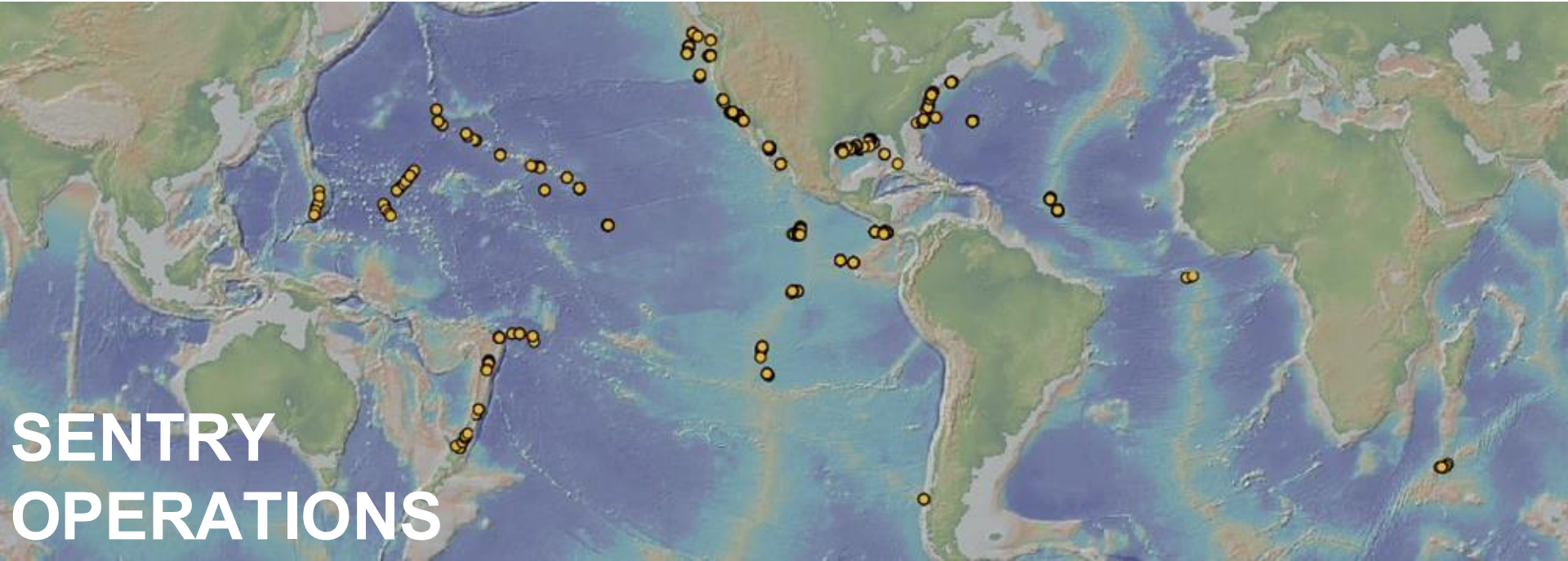


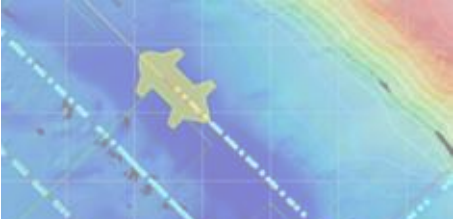
ROS SOFTWARE



CERAMIC HOUSING

SENTRY OPERATIONS

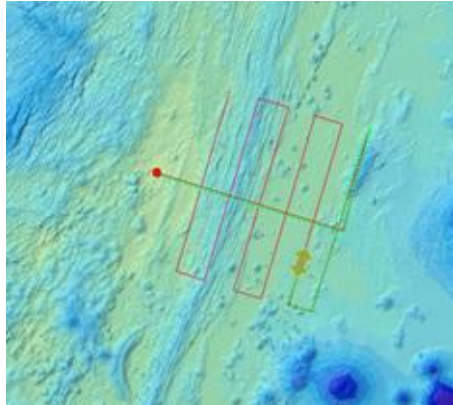




MODES OF OPERATION



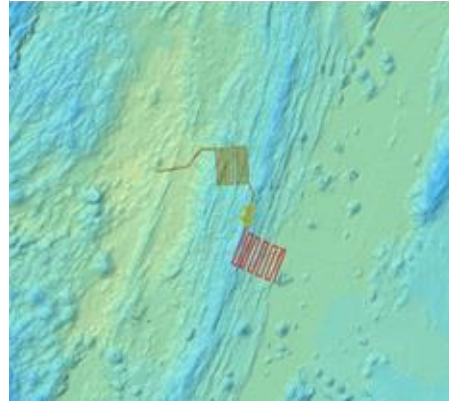
MULTIBEAM



Altitude: **65m**
Speed: **1m/s (2-knots)**
Line Spacing: **200m**
Range: **70km**
Duration: **24h**

**MB (400Khz)/Sidescan
(120Khz)**

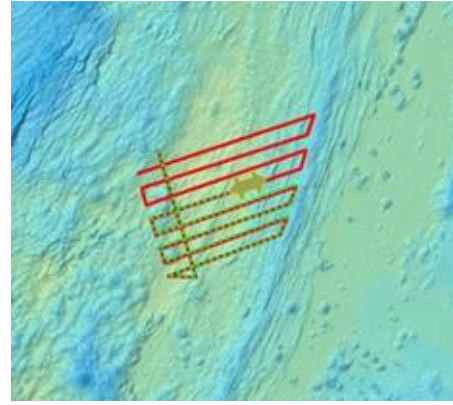
CAMERA



Altitude: **5m**
Speed: **1-knots**
Line Spacing: **5+**
Range: **~120km**
Duration: **35h**

Photos/HF SS(512Khz)

CUSTOM



Custom surveys from 5M
altitude to 100M, water
column,

Typical applications include
100m magnetic surveys,
embedded camera and
multibeam, etc.

SENTRY EM2040 MKII

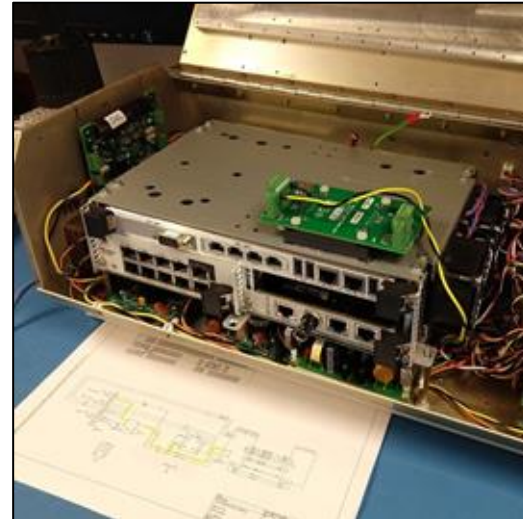
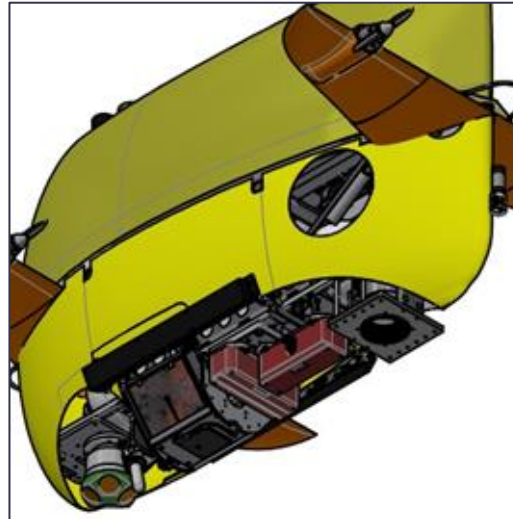
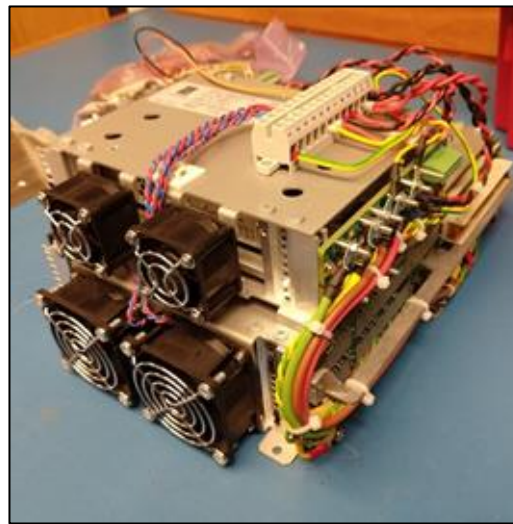
EM 2040-07 MKII

The system was purchased and received in 2019, installed mid-year after modifications and tested late 2019 on engineering cruise

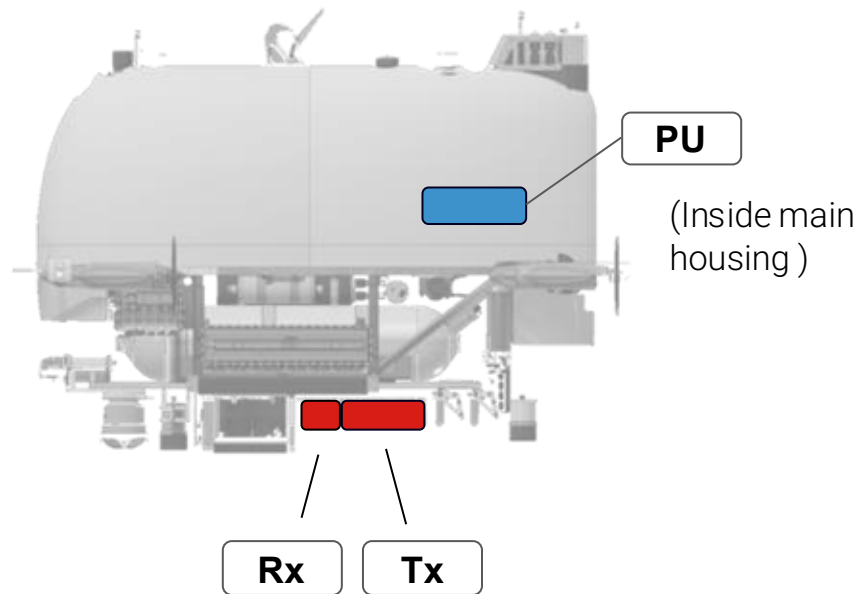
We own three units

INSTALLATION

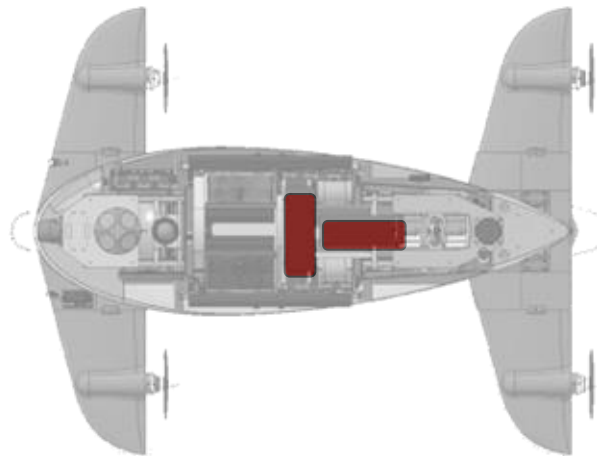
- PU installed in Sentry chassis
- PU needed significant mods to fit inside chassis
- Tx/Rx Mid AUV
- Tx/Rx through Eth BH connectors
- SW dev for integration including controller through kcntrl



PORT SIDE

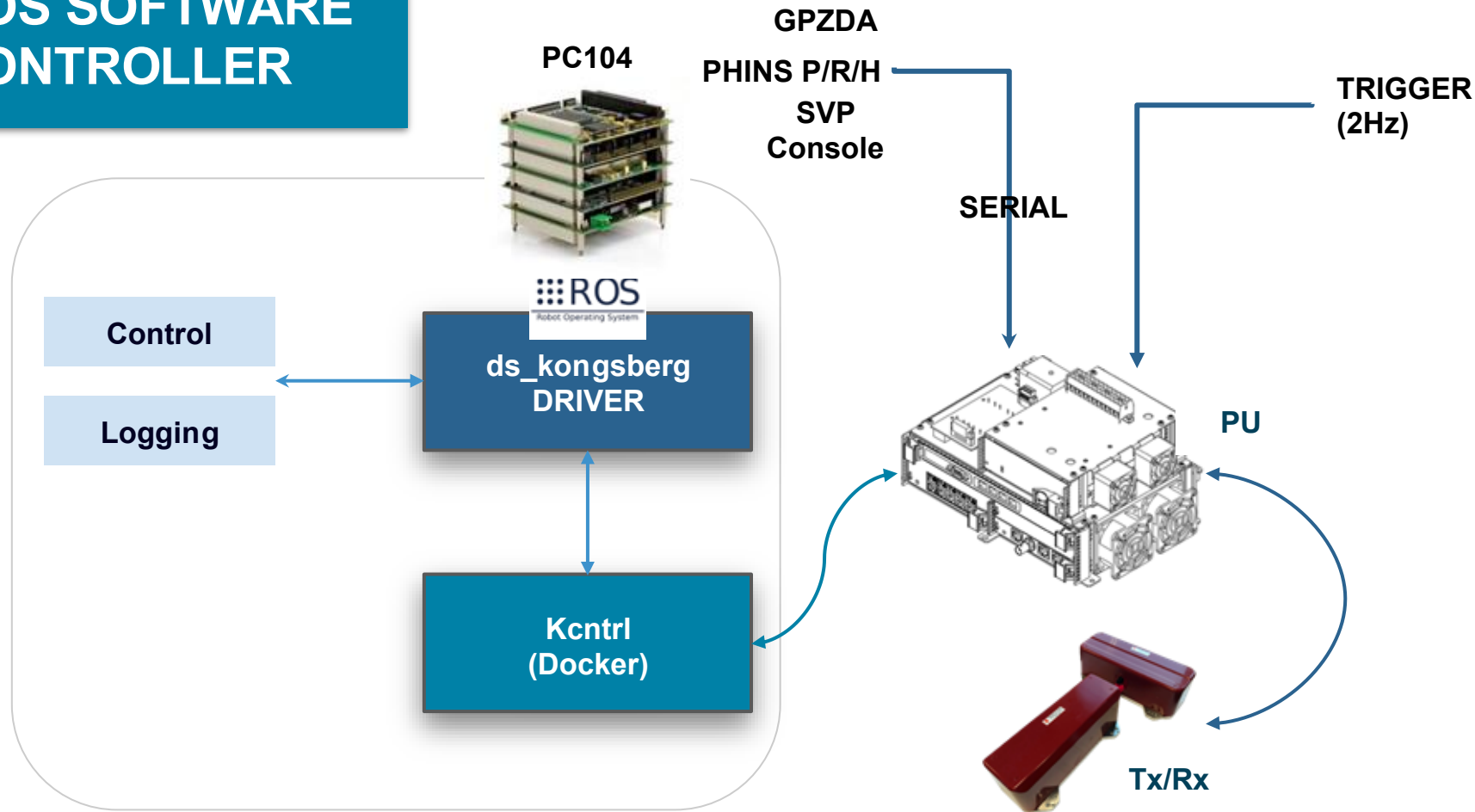


BOTTOM VIEW



EM2040 SENTRY INSTALLATION

ROS SOFTWARE CONTROLLER



REAL TIME STATUS

Acoustic comms are transmitted between vessel/AUV every 30 seconds. Several Acoustic Que's are used to send or receive data.

SDQ 45 : Kongsberg Status

S: KCTRL Sensors Block Flags. flags: 0 -> unkown, 1 -> bad, 2 -> good

- 1) position sensor
- 2) attitude sensor
- 3) sound velocity sensor
- 4) time sync
- 5) pps
- 6) depth sensor

P: **Ping Control. flag values:** (0/1/2)

- 7) ping flag
- 8) water column enabled
- 9) ping frequency (kHz)
- 10) ping rate (hz) recorded by PU

R: **Recording control**

- 11) recording flag 0 -> unknown, 1-> off 2 -> on
- 12) ping #
- 13) number of soundings
- 14) % good soundings
- 15) min depth (m) in swath
- 16) max depth (m) in swath
- 17) center beam depth (m)\
- 18) swath width (m)



DATA PRODUCTS & WORKFLOW

MYSYSTEMS

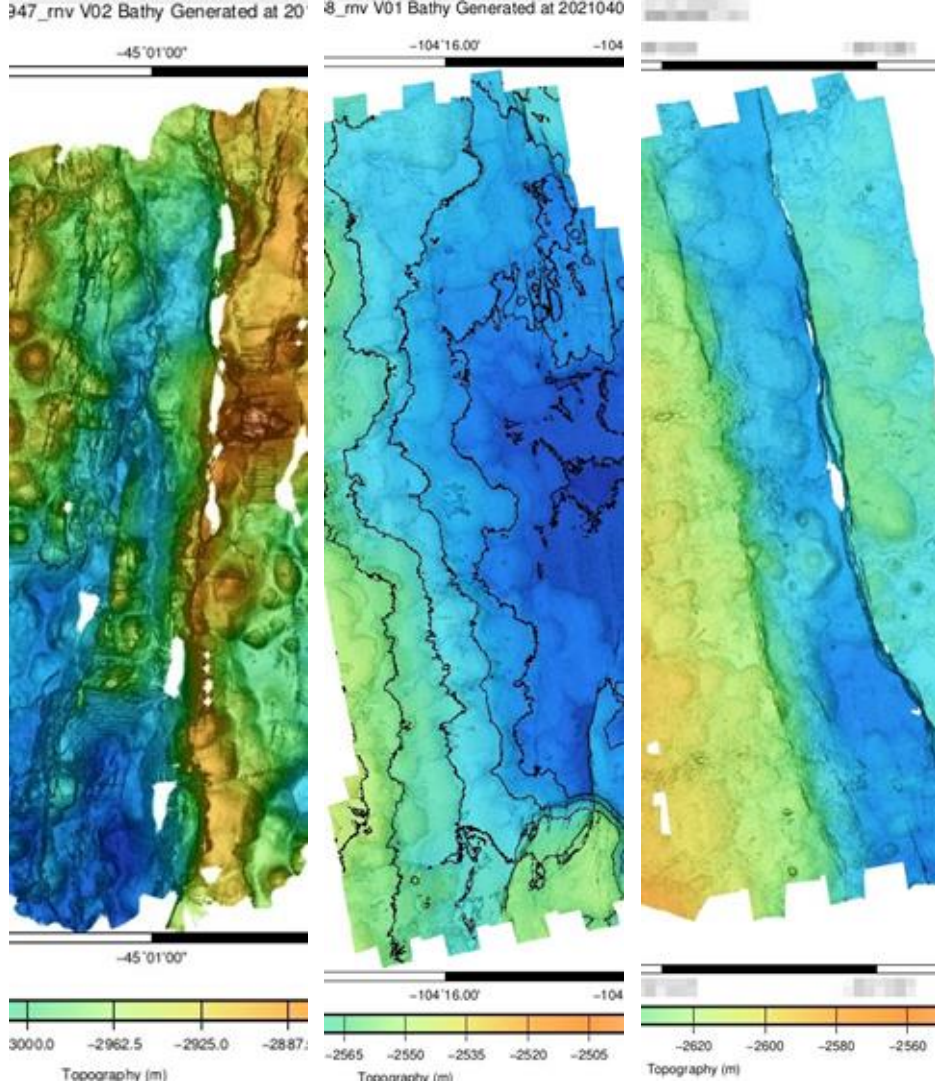
Mbsystems, a freeware multibeam processing software is used to process Kongsberg multibeam data for first draft data products.

DATAPRODUCTS

Kmall file format is considered the 'raw' data product, then various data products are produced from mbsystem, including .grd files, pdfs, etc.

WORKFLOW

Mbsystems is wrapped with a python script that commands various aspects of mbsystem in an automated pipeline for quick processing following each dive. First draft maps are created within an hour of on deck.



RMA's & CRM's

2019-2026

2019

— PURCHASED

2020

— CRM0043263 - TX PSU Repair (Warranty Repair)
CRM0043183 - TX PSU Repair (Warranty Repair)

2021

2022

2023

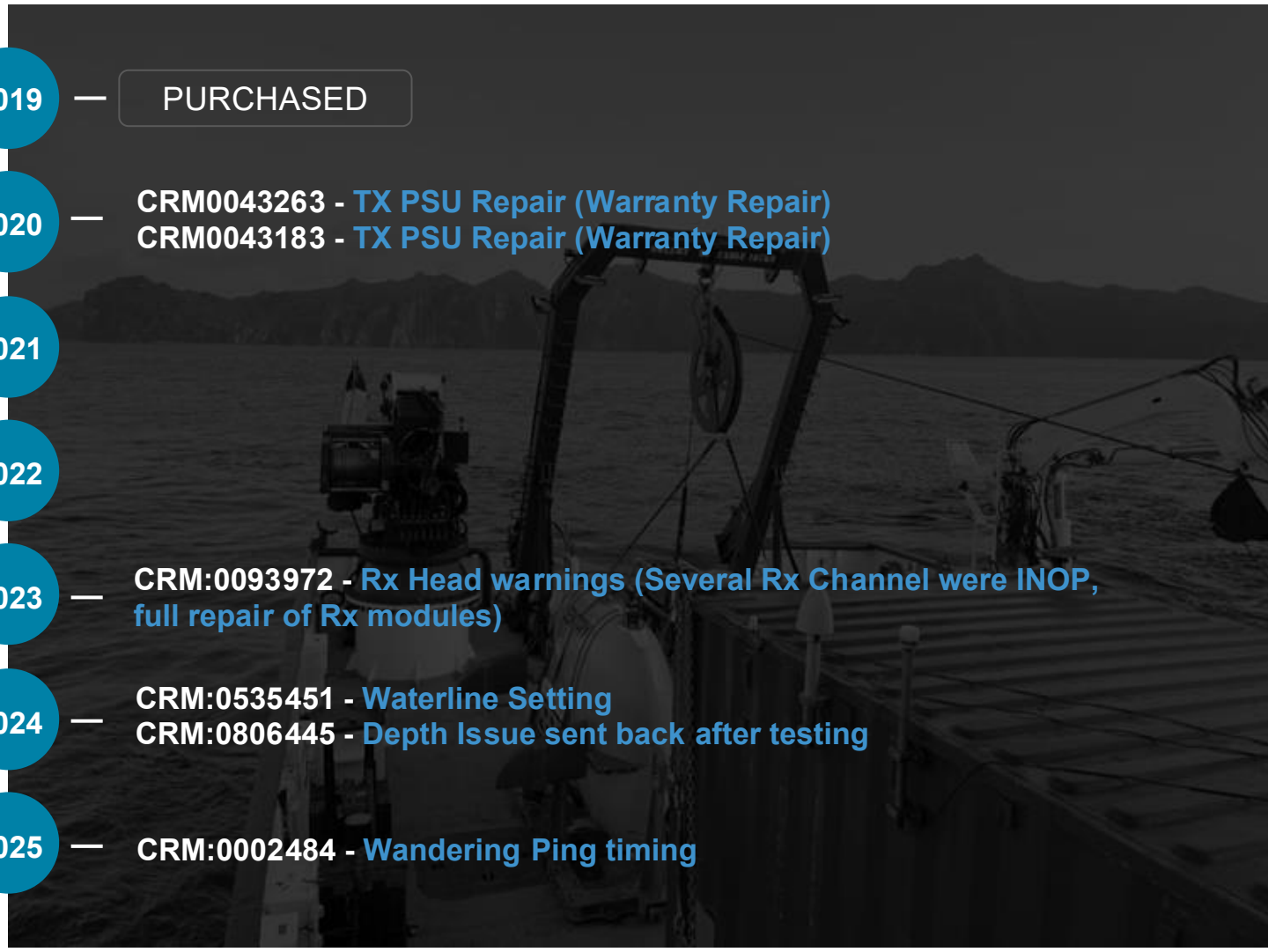
— CRM:0093972 - Rx Head warnings (Several Rx Channel were INOP, full repair of Rx modules)

2024

— CRM:0535451 - Waterline Setting
CRM:0806445 - Depth Issue sent back after testing

2025

— CRM:0002484 - Wandering Ping timing



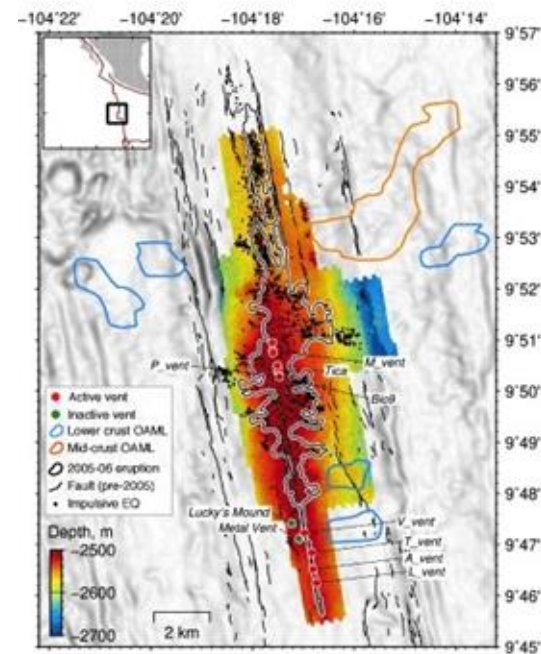
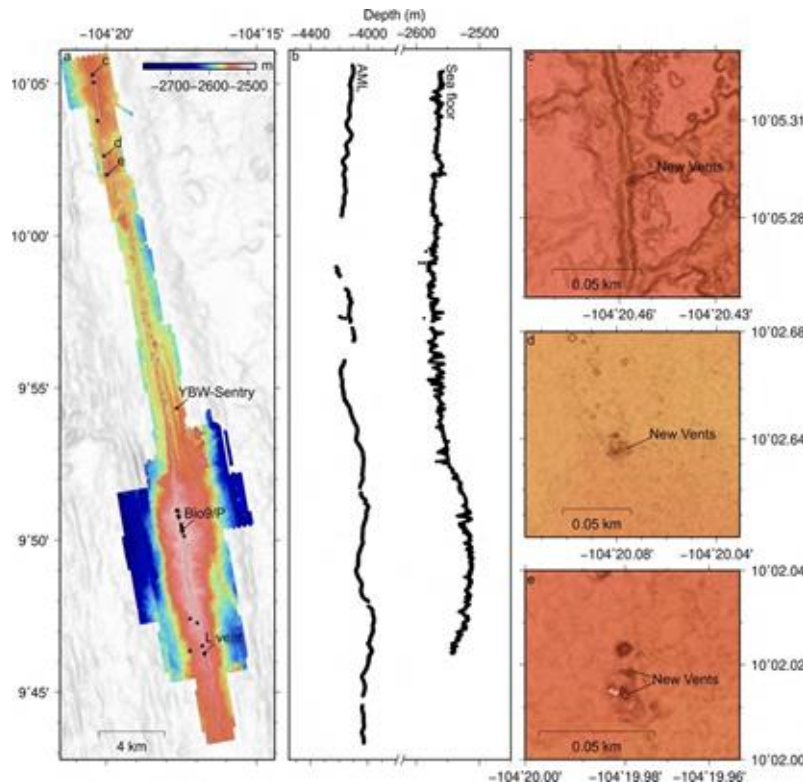
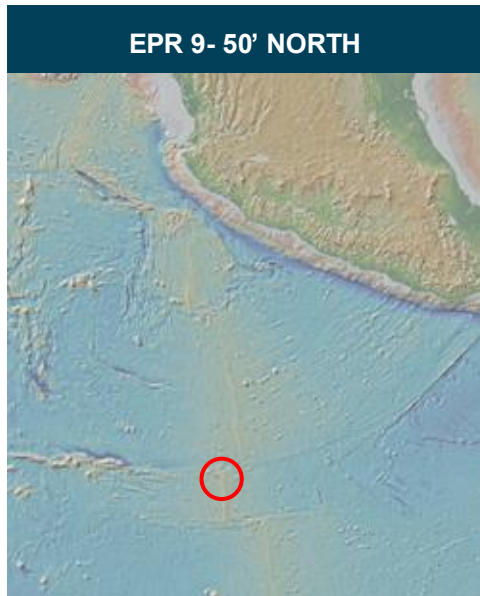
EPR MAPPING CAMPAIGN

REPEAT SURVEYS AT EPR 9-50' NORTH PRE ERUPTION

Multibeam, sidescan, and photo surveys at EPR 9-50 deg north. High resolution mapping combined with 120Khz sidescan to characterize the geology over time, particularly before the next eruption

Dan Fornari - WHOI
Jill McDermott - Lehigh
Ross Parnell-Turner - UCSD/SIO
Thibaut Barreyre - UIB

EPR 9- 50' NORTH

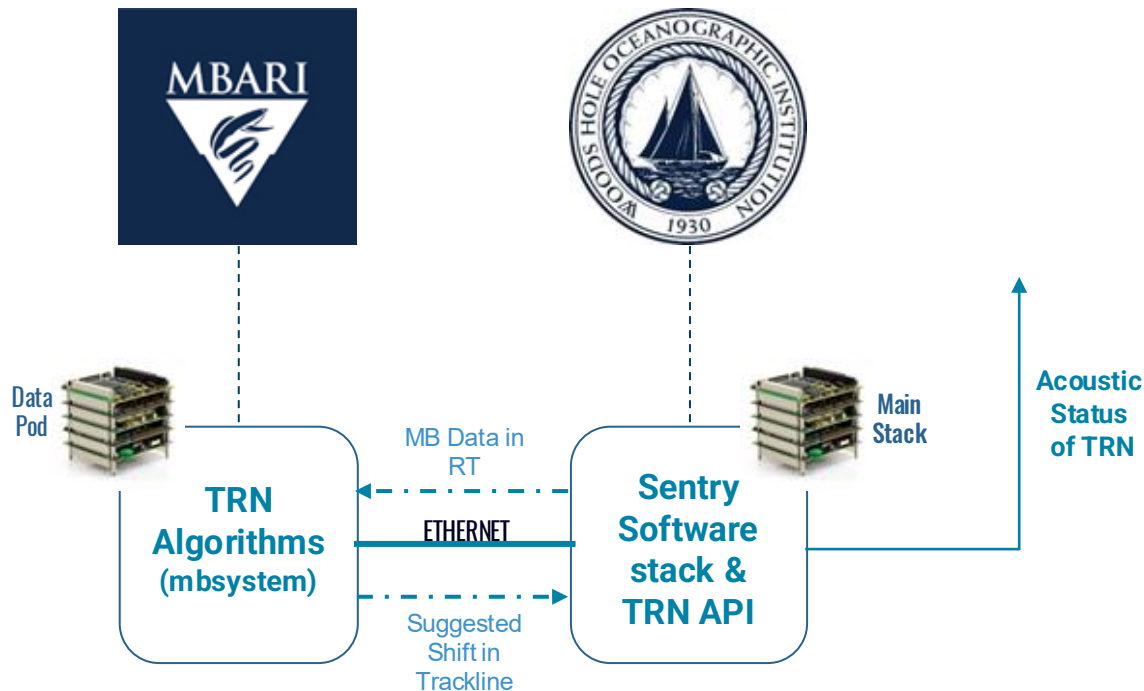
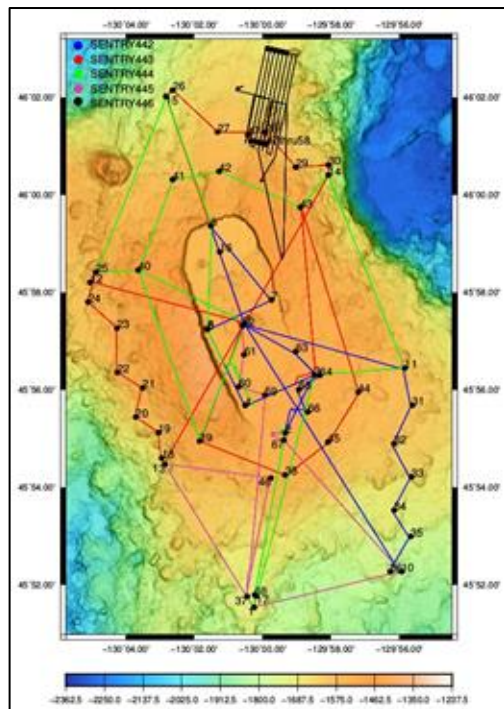


TERRAIN RELATIVE NAVIGATION

SEAFLOOR DEFORMATION SURVEYS AT AXIAL CALDERA

Repeat AUV multibeam surveys are performed every two years at Axial Seamount (Juan de Fuca Ridge, Northeast Pacific) to measure vertical seafloor deformation at this active volcano. Terrain Relative Navigation (TRN) software from MBARI enables precisely repeating the survey lines.

Dave Caress - **MBARI**
Bill Chadwick - **OSU**
Scott Nooner - **UNCW**

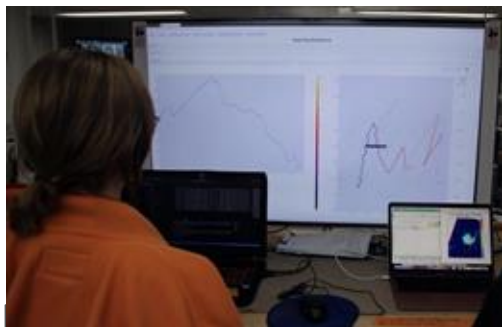
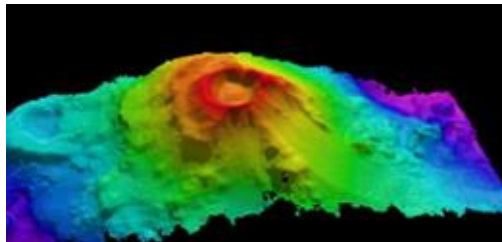


AUTONOMOUS PLUME MAPPING

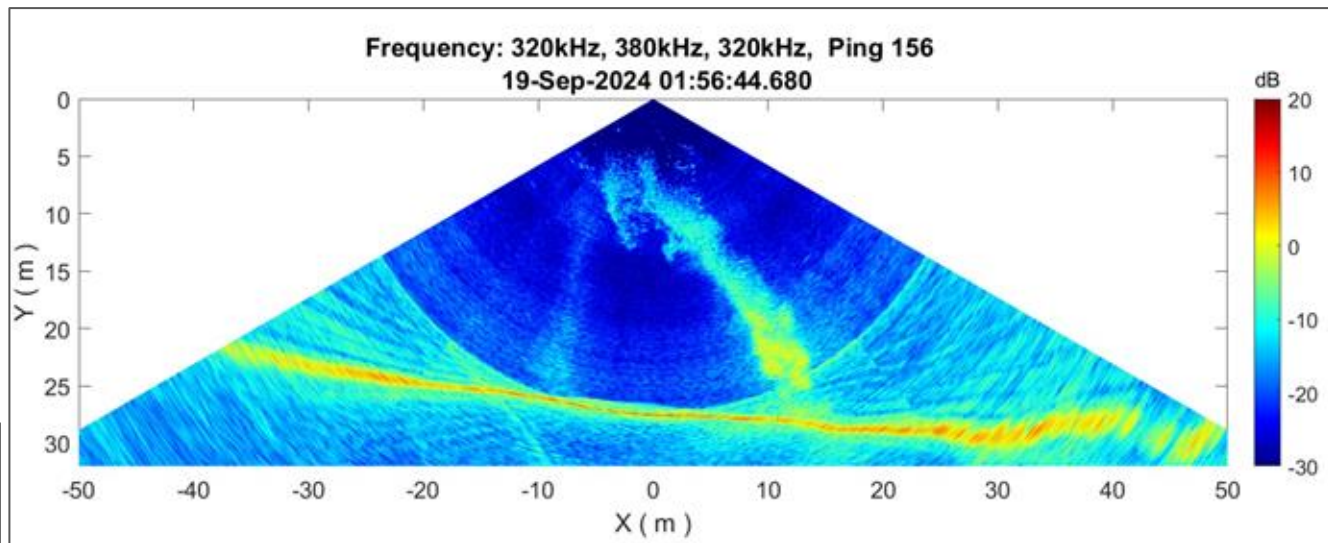
REAL TIME DATA FOR PLUME HUNTING

Using Water Column data to track and determine location of plume. Methane sensor installed for real time tracking, acoustically sent to surface

Chris German - **WHOI**
Guangyu Xu - **UW**
Andrew Branch - **JPL**
Victoria Preston - **Olin**
M. Burkitt-Gray - **WHOI**

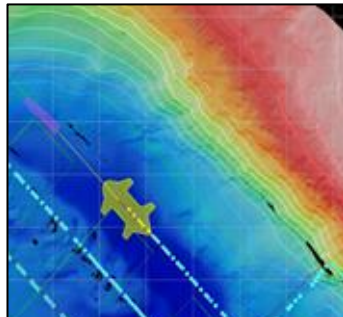


**METHANE
SENSOR**



FUTURE DEVELOPMENT

MISSION CONTROLLER

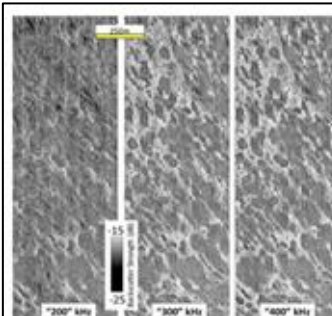


Adaptable Missions

API for Science users

Enable a more intelligent vehicle

EM2040 MULTIFREQUENCY MODE



Enable EM2040 Multifreq. Mode. Other users experiences welcome

FORWARD SONAR WITH 1171



Replace Forward looking sonar used for obstacle avoidance with Kongsberg 1171

Integrate with in house obstacle avoidance software

THANK YOU

SKELLEY@WHOI.EDU



FEMME 2026 | GENOA

