

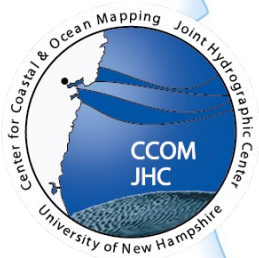


Multibeam Advisory Committee Improving Multibeam Data Quality Across the U.S. Academic Fleet

JONATHAN BEAUDOIN (CCOM-UNH)

PAUL JOHNSON (CCOM-UNH)

VICKI FERRINI (LDEO)



Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE



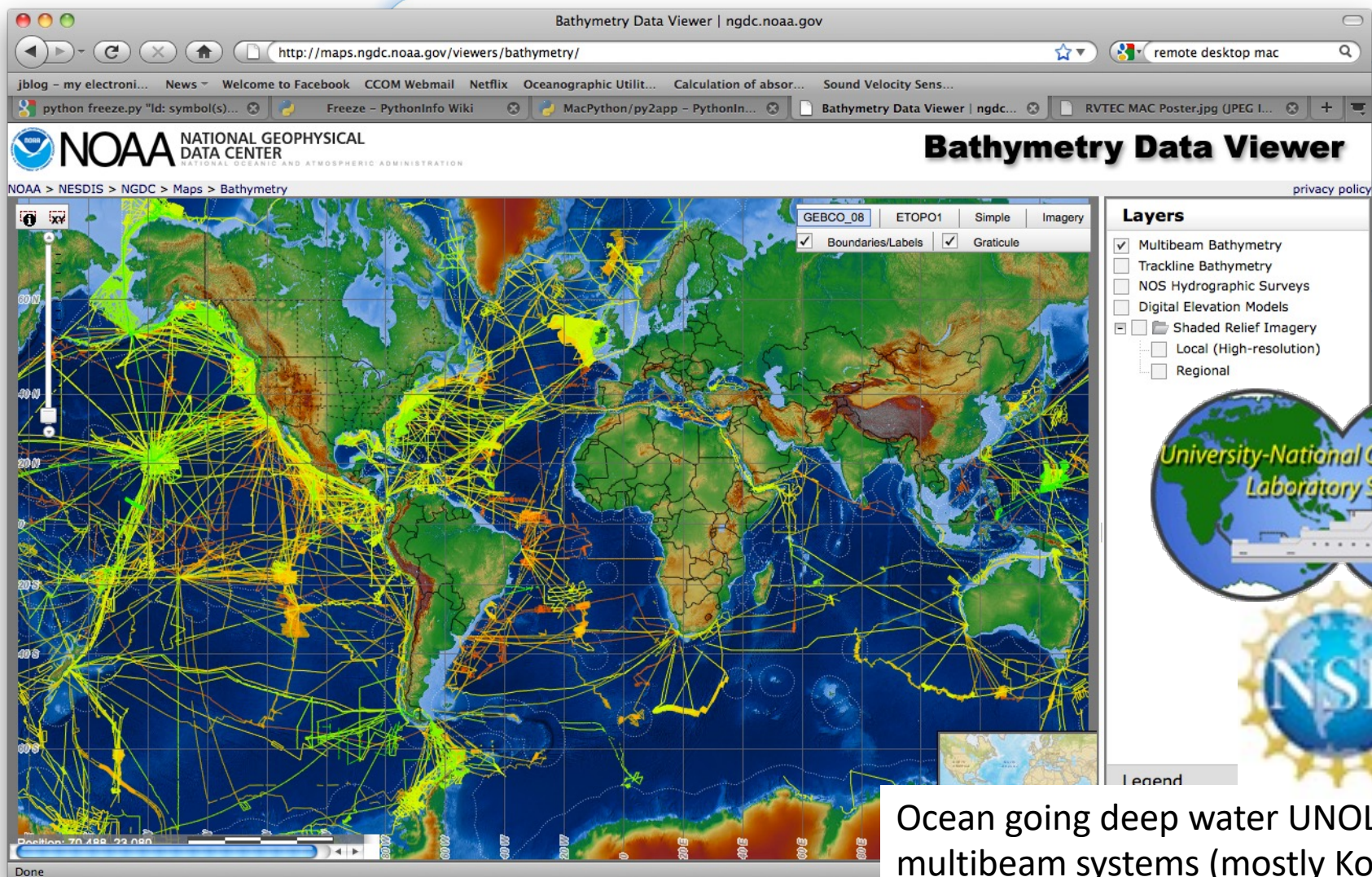
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FEMME 2013 Multibeam User Conference
April 16-19, 2013, Boston, USA



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Ocean going deep water UNOLS vessel multibeam systems (mostly Kongsberg EM122 12 kHz) are filling in the gaps with trackline mapping

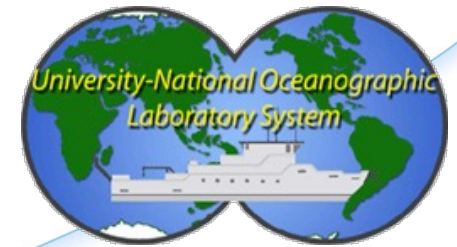


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U.S. Academic Fleet



 ATLANTIC EXPLORER Bermuda Institute of Ocean Sciences	 ATLANTIS Current Location Woods Hole Oceanographic Insti	 OCEANUS Current Location Woods Hole Oceanographic Institution	 PELICAN Louisiana Universities Marine Consortium
 BLUE HERON University of Minnesota - Duluth	 CAPE HATTERAS Duke University/UNC	 POINT SUR Moss Landing Marine Laboratories	 ROBERT GORDON SPROUL Current Location Scripps Institution of Oceanography
 CLIFFORD A. BARNES University of Washington	 ENDEAVOR Current Location University of Rhode Island	 ROGER REVELLE Current Location Scripps Institution of Oceanography	 RONALD H. BROWN NOAA
 HUGH R. SHARP University of Delaware	 KILO MOANA Current Location University of Hawaii	 SAVANNAH University System of Georgia	 F.G. WALTON SMITH University of Miami
 KNORR Current Location Woods Hole Oceanographic Institution	 MARCUS LANGSETH Lamont-Doherty Earth Observat	 THOMAS G. THOMPSON University of Washington	 WECOMA Oregon State University
 MELVILLE Current Location Scripps Institution of Oceanography	 NEW HORIZON Current Location Scripps Institution of Oceanography		

- NINE are equipped with multibeam echosounders
- THREE more are coming
- TEN of TWELVE are **KM**

<http://www.unols.org/images/ships/shipimages.html>



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Problems?

- UNOLS vessels serve many disciplines of science:
mapping is not always the priority
- Marine technicians must maintain all sensors and systems: ***multibeam often left unattended***
- Multibeam “know-how” is highly variable on many levels:
 - Technician to technician
 - Ship to ship
 - Institution to institution
- Know-how is not always transferred with crew rotation, personnel turnover:
Well understood system and procedures becomes poorly understood or forgotten very quickly

Net result....?



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DATA QUALITY VARIES DRAMATICALLY ACROSS THE FLEET



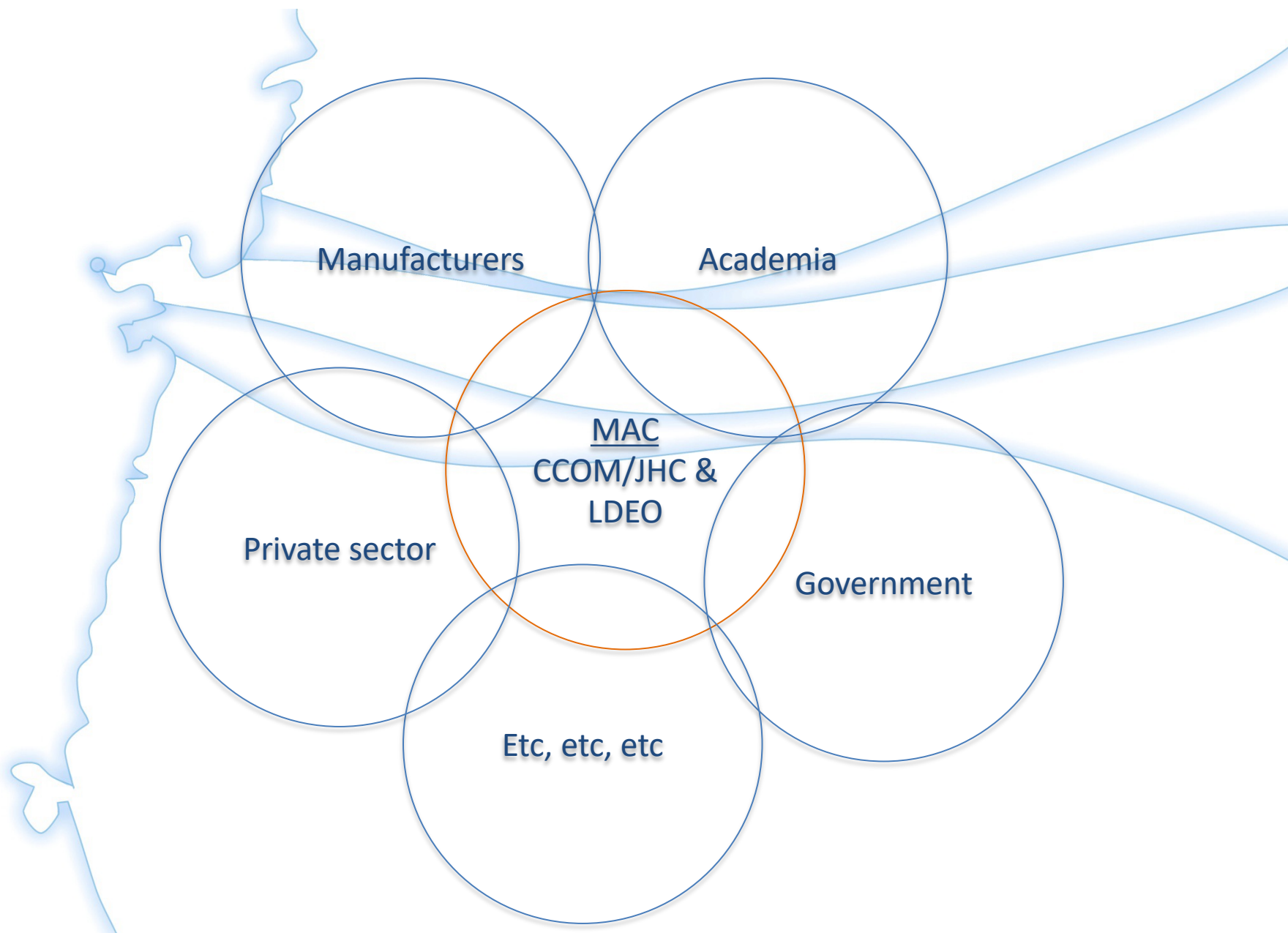
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Towards a Solution

- June 2010: MB workshop at NSF in response to fleet-wide issues with multibeam performance
- Goals:
 - Discuss operation of the sonars
 - Identify common threads in documented problems
 - Get advice from domain experts and other MB users
- Outcomes:
 - Identified several specific operational and technical issues, some poorly understood, impacting multibeam data quality
 - Identified *a strong need to coordinate operational and technical efforts across the fleet*





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Multibeam Advisory Committee (MAC)

- NSF funded project: UNH and LDEO
- Fleet-wide Approach
- Facilitate Communication
- Community of Stakeholders
- Technical Resources
- Seek out Best Practices
- Technical Teams
 - Shipboard Acceptance
 - Acoustic Noise
 - Quality Assurance

Boots on the Ground



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Overview of Technical Teams



ANT and SAT

help optimize ship and system performance

(Tim Gates, John Hughes Clarke)

QAT

help optimize the way data is acquired

(Jonathan Beaudoin, Paul Johnson, Vicki Ferrini)



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MAC:

Acoustic Noise Team

- **Goal:** Perform acoustic noise tests to assess and potentially improve sensor efficiency (coverage) and data quality
- Establish baseline noise levels
- Help populate an archive of historical data on noise properties of each vessel to aid in monitoring over sensor lifetime
- Several ships already assessed prior to formation of MAC



Benefits of Acoustic Testing

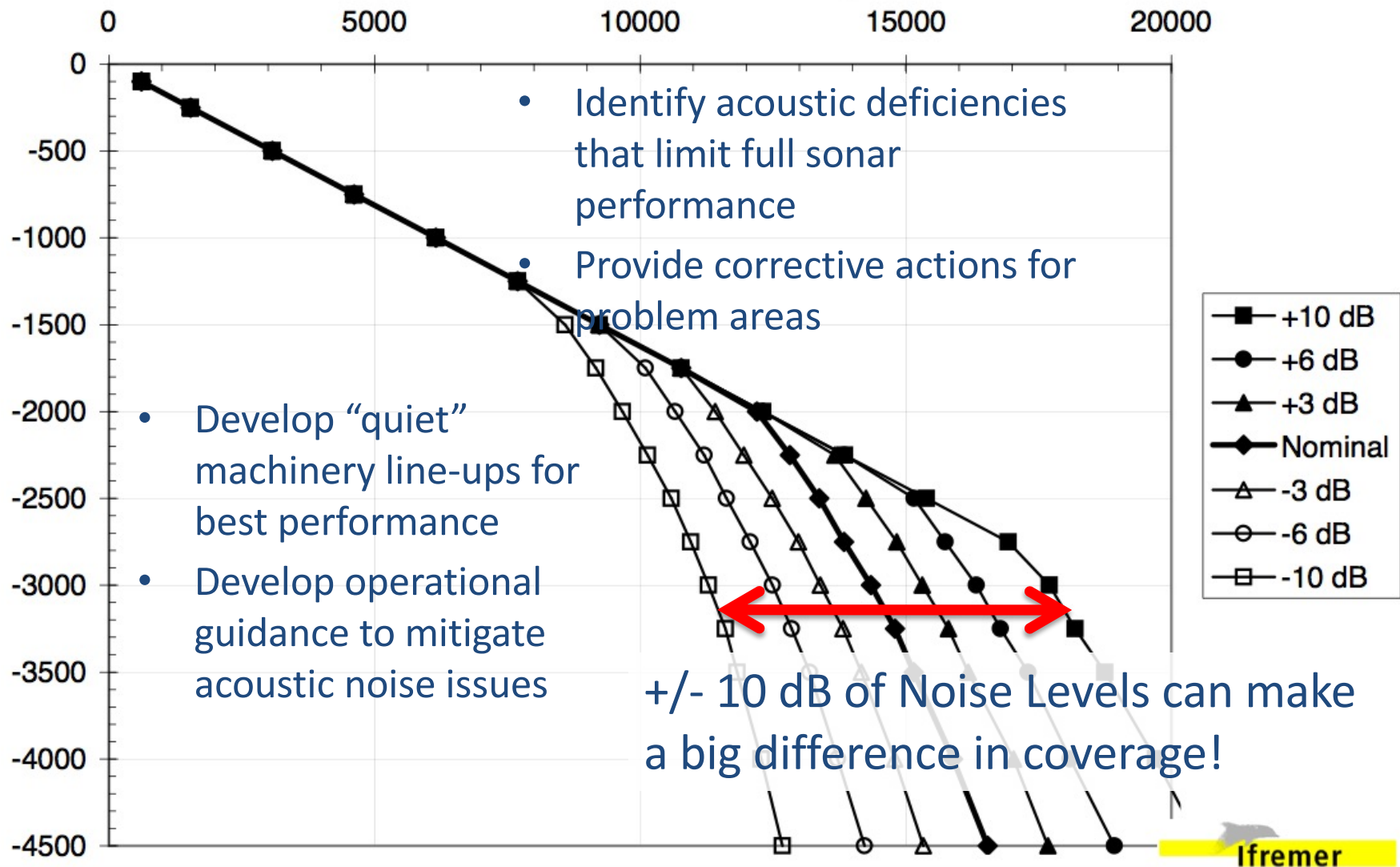


Figure prepared by X. Lurton



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Examples of Recent Acoustic Findings

- ATLANTIS – has a cavitating gondola
- LANGSETH – quieter at 9 knots than 0 to 8 knots due to controllable pitch propellers
- KILO MOANA –performance is impacted by diesel engines above 9 kts
- MELVILLE – anti-roll system increases noise levels and limits sonar performance during roll events
- REVELLE – bubble sweepdown transients limit sonar performance in higher sea states





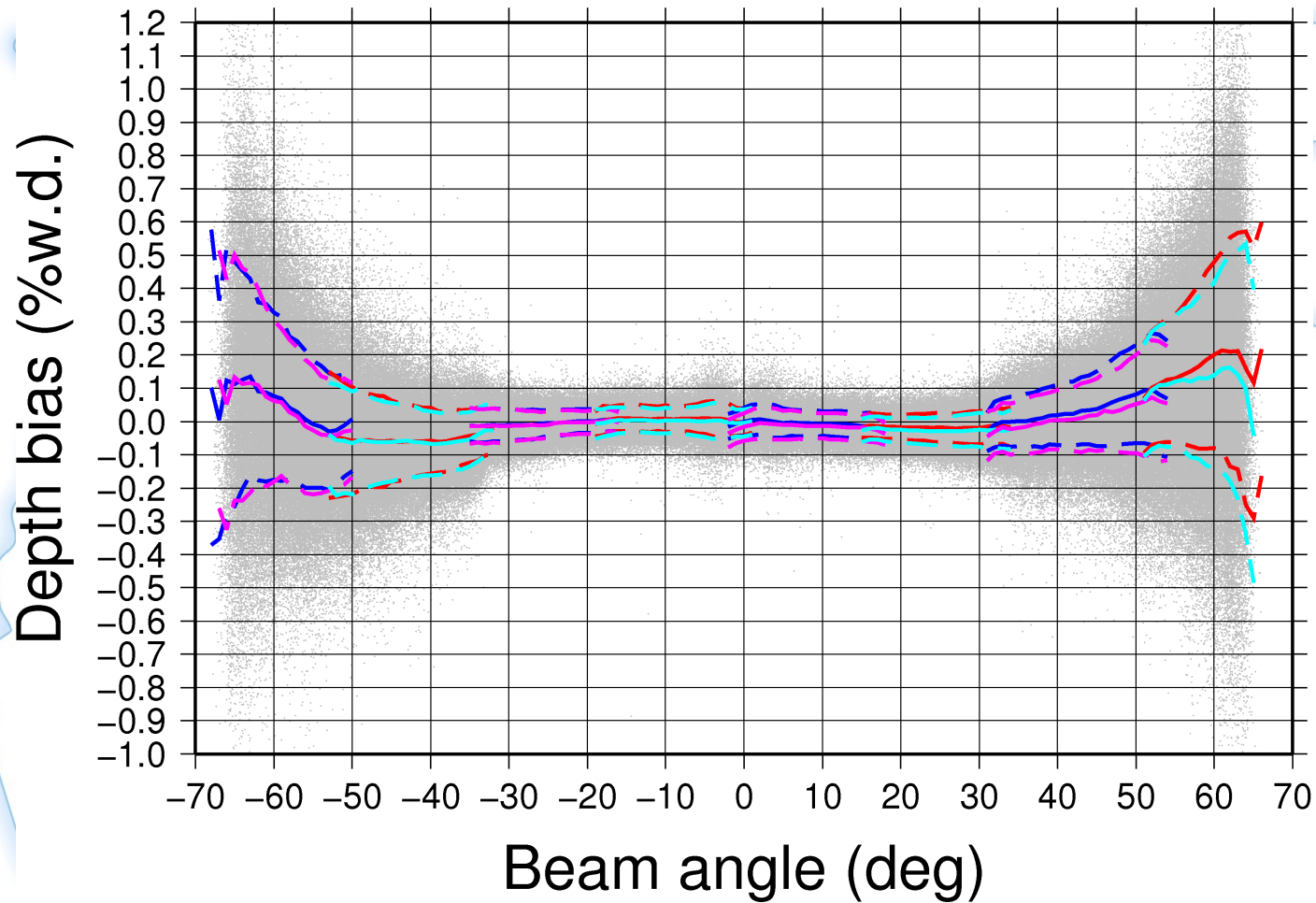
MAC:

Shipboard Acceptance Team

- **Goal:** Ensure all hull-mounted multibeam systems are installed, calibrated, and configured properly and consistently
- Participate in Sea Acceptance Trials for new and/or poorly understood existing installations
- Helping operators (and ultimately science users) understand how their system performs:
 - Bathymetric accuracy
 - Backscatter artifacts
 - Achievable coverage



SAT Evaluations: System Accuracy





MAC:

Quality Assurance Team

- **Goal:** Ensure multibeam sonar systems are operated in a consistent manner that maximizes data accuracy, precision, and scientific utility
- Help operators however we can, e.g.
 - Verify vessel survey and sensor configuration
 - Develop and disseminate best practice documentation (COOKBOOKS!)
 - Develop and deploy tools and procedures to optimize data quality during acquisition
- Ship Visits: funding for 4-6 ship visits per year (2-3 visits if travelling as a team)



QAT: Cookbooks

Documenting Multibeam System Parameters in SIS

Multibeam Advisory Committee
2012-03-21

Multibeam Advisory Com

SIS Software Uninstall Instructions Cookbook

Multibeam Advisory Committee
March 21, 2012
SIS 3.8.3

1

SIS Software Install Instructions Cookbook

Multibeam Advisory Committee
March 21, 2012

Multibeam Advisory

SIS Start Up and Run-Time Configuration

Multibeam Advisory Committee
July 14, 2012
SIS 3.8.3

Multibeam Advisory Committee – July 14, 2012

1



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SIS

File View Tools

Default

FK003_EM710_003_TestSurvey Rescan EM710_225 WCL Not Logging Pinging Line cnt. 0000 FK003_EM710_003_TestSurvey

Beam intensity

Intensity Quality

Depth (Z)

Cross track

Waterfall

Time series

Active Heave Active Pitch Roll

Runtime parameters

Sounder Main Sound Speed Filter and Gains Data Cleaning GPS and Delayed Heave Simulator Survey Information

Turn "Pitch stabilization" on.

Turn "Yaw stabilization" on with "REL. MEAN HEADING" Mode.

If you are synchronizing the sounder with other acoustic instrumentation, be sure to click the "External Trigger" checkbox. Otherwise, make sure it is unchecked since the sounder will not ping until it receives an external transmit trigger.

Runtime parameters

Transmit Control

☒ Pitch stabilization

Along Direction (deg.): 0

Yaw Stabilization

Mode: REL. MEAN HEADING

Heading: 0.0

Heading filter: MEDIUM

Max. Ping Freq. (Hz): 10

☐ External Trigger

Ready.

Mode: RA DEEP Depth: 1108.22 Across: 1836.99 Soundspeed: 1449.40

12:32 PM 7/14/2012

Numerical display	
N 61.68415	North DD.
W 50.77295	East DD.D
2012 7 14	ZDA Date
12:32:19	ZDA Time
12:32:18	PU Time
46	PU - POS
0	PU - ZDA
On	PPS
9.19	Speed kn
4.73	Speed m/
290.29	Heading
1108.22	Depth
1836	Across
46/43	Coverage
1040/796	Port/Stb.
HIDENS EQDIST	Beam sp.
0.00	Depth Ser
Off	Dual swat
EXTRA DEEP	Mode
0.25	Ping Hz
55378	Pingno.
1449.40	SV Profile
1454.3	SV sensor
1454.20	SV Used
4.73	Speed m/
-15.00	TVG OB
-14.00	TVG NIB
1079.00	TVG RN
0.00	TX pow.
2.0	TX pulse (
FM	TX pulse f
327/400	Beams
4.75	AttVel for
Off	Dual swat
55378	Pingno.
☐ Satellites	



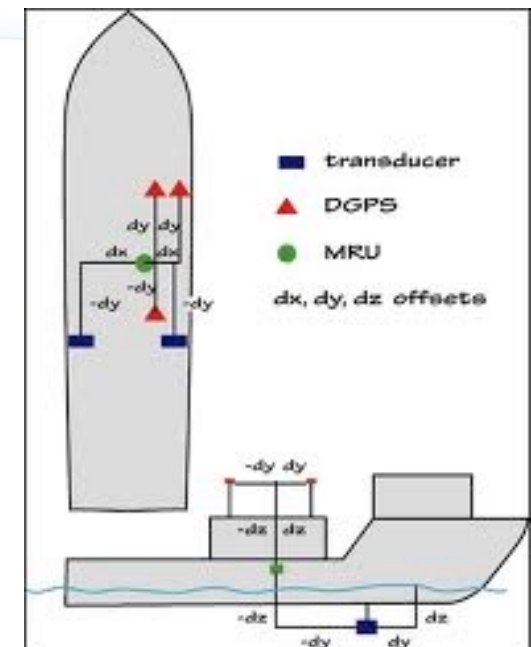
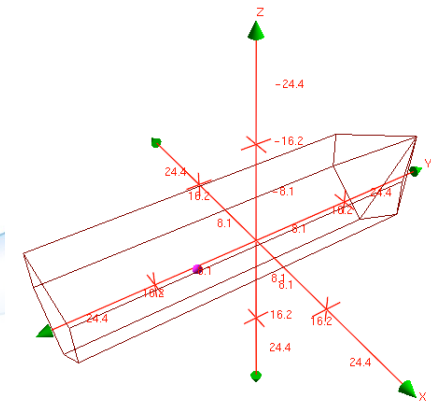
EM710: 3000 m is a safe default
EM302: 9000 m is a safe default
EM122: 30000 m is a safe default

Setting the “Angular Coverage Mode” to AUTO will allow the sounder to adjust the angular sector in response to what it can reasonably track, e.g. it will reduce the sector if it finds that it cannot track at large angles, this allows for an increased ping rate.

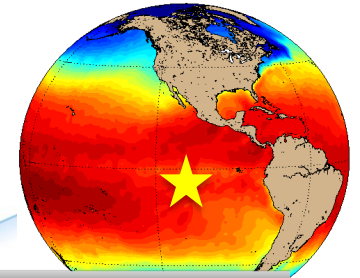
You can force the sounder to attempt to track over a larger sector by setting this into MANUAL mode. Your ping rate will drop and you will not gain additional data if the system cannot detect the bottom at the outer edge of the swath.

QAT: R/V Kilo Moana Ship Geometry Verification

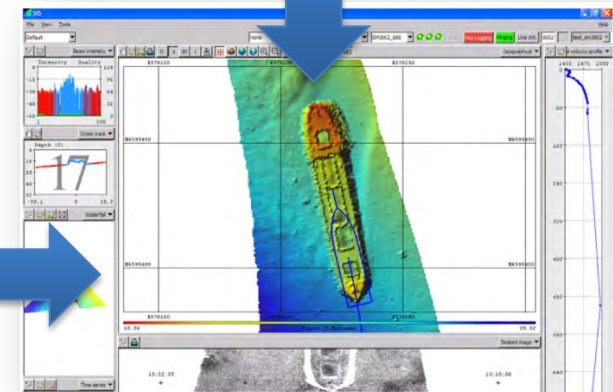
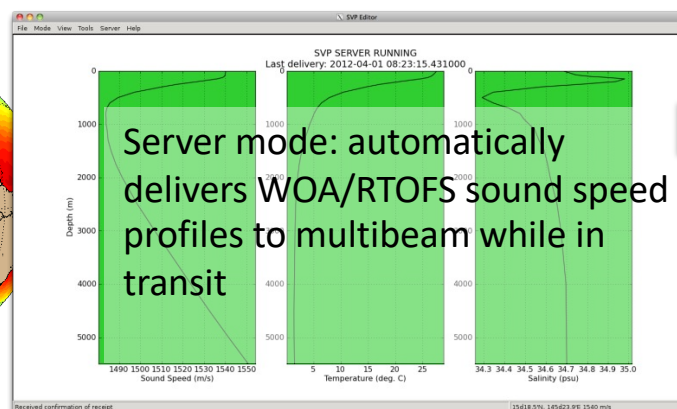
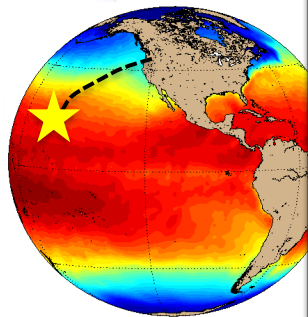
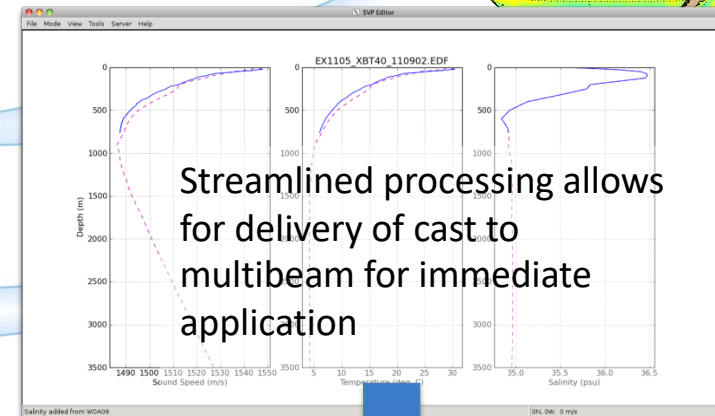
- Verification of current system geometry by establishing “chain of custody” by reviewing:
 - Ship drawings
 - Blom survey (2005): initial survey of mapping system offsets
 - Applanix site visit reports (2006 & 2008)
 - IMTEC survey (2012): survey of new EM710 installation
- Independently established linear and angular offsets from above documentation and verbal reports of configuration changes
- Found and corrected errors in current configuration:
 - Primary GPS location in POS/MV configuration
 - Pitch offset in EM710 configuration



QAT Tools: SVP Editor



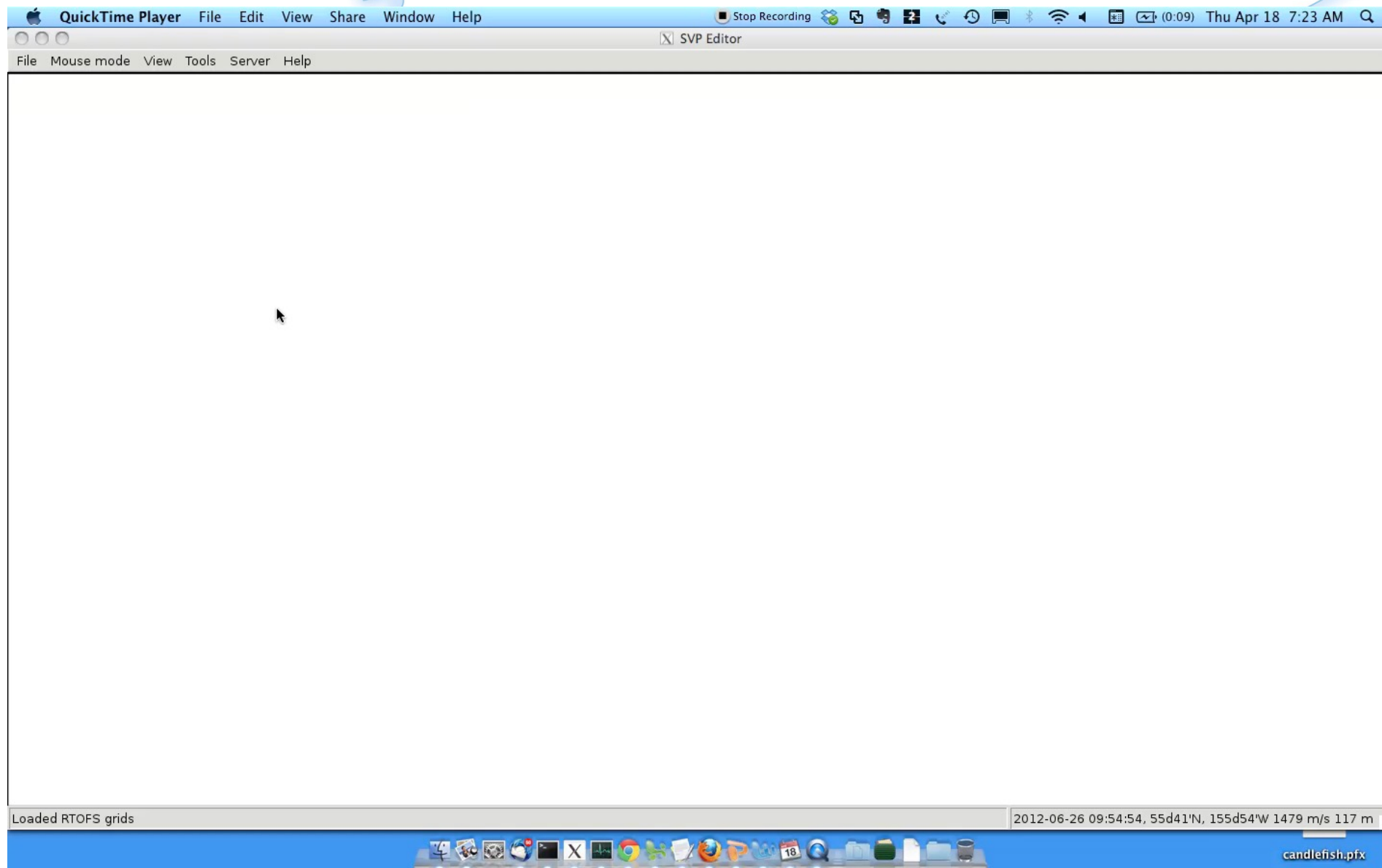
- Graphical display and editing of SVP/CTD/XBT/XSV/MVP data
- Make use of oceanographic (e.g. Levitus or real-time models)
- Integration with echosounder:
 - Take advantage of navigation/depth information
 - Automatic delivery of SVP cast after processing
- Implements processing best-practices
- Allows for refraction monitoring in real-time



Multibeam acquisition system



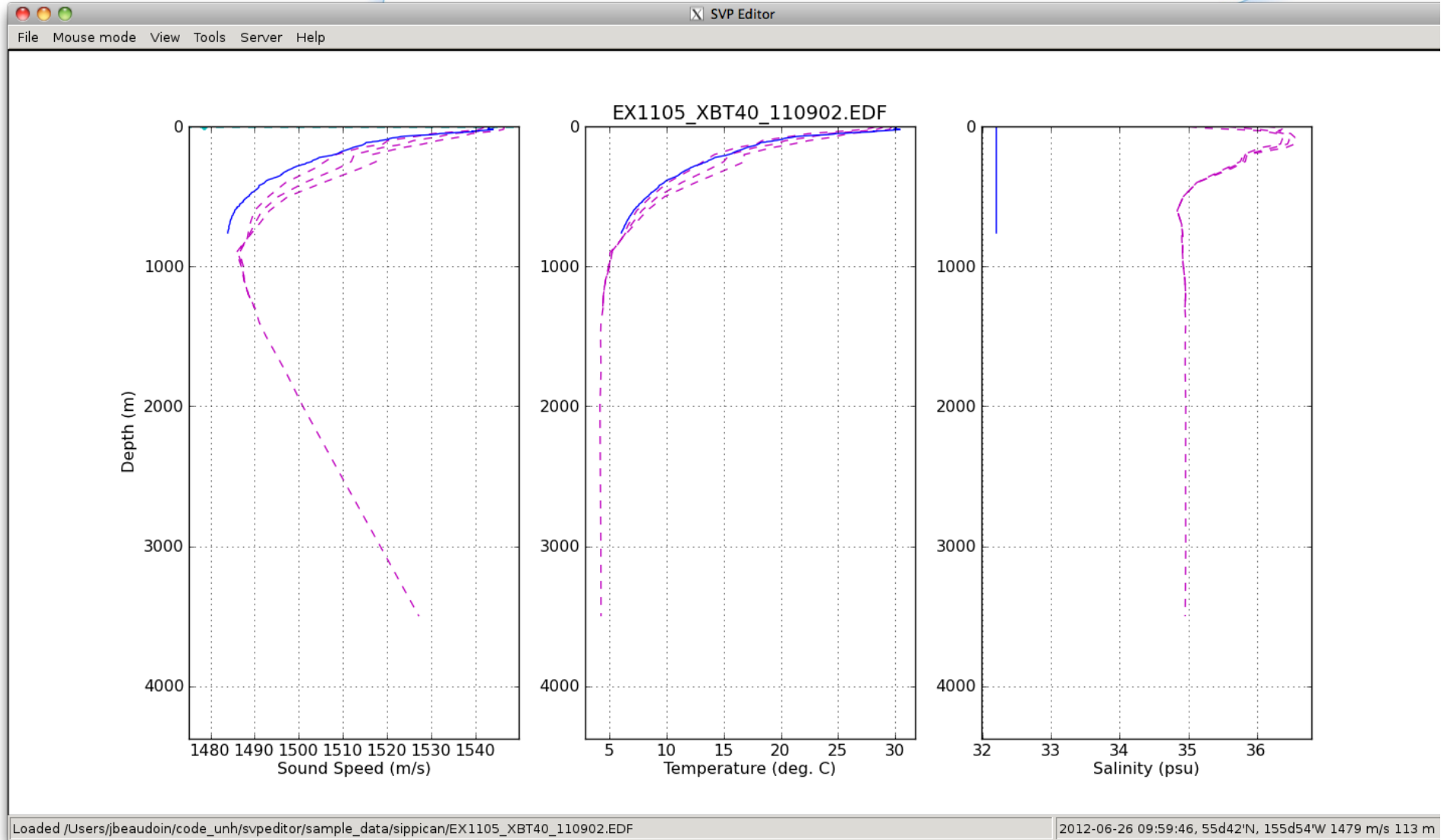
QAT Tools: SVP Editor



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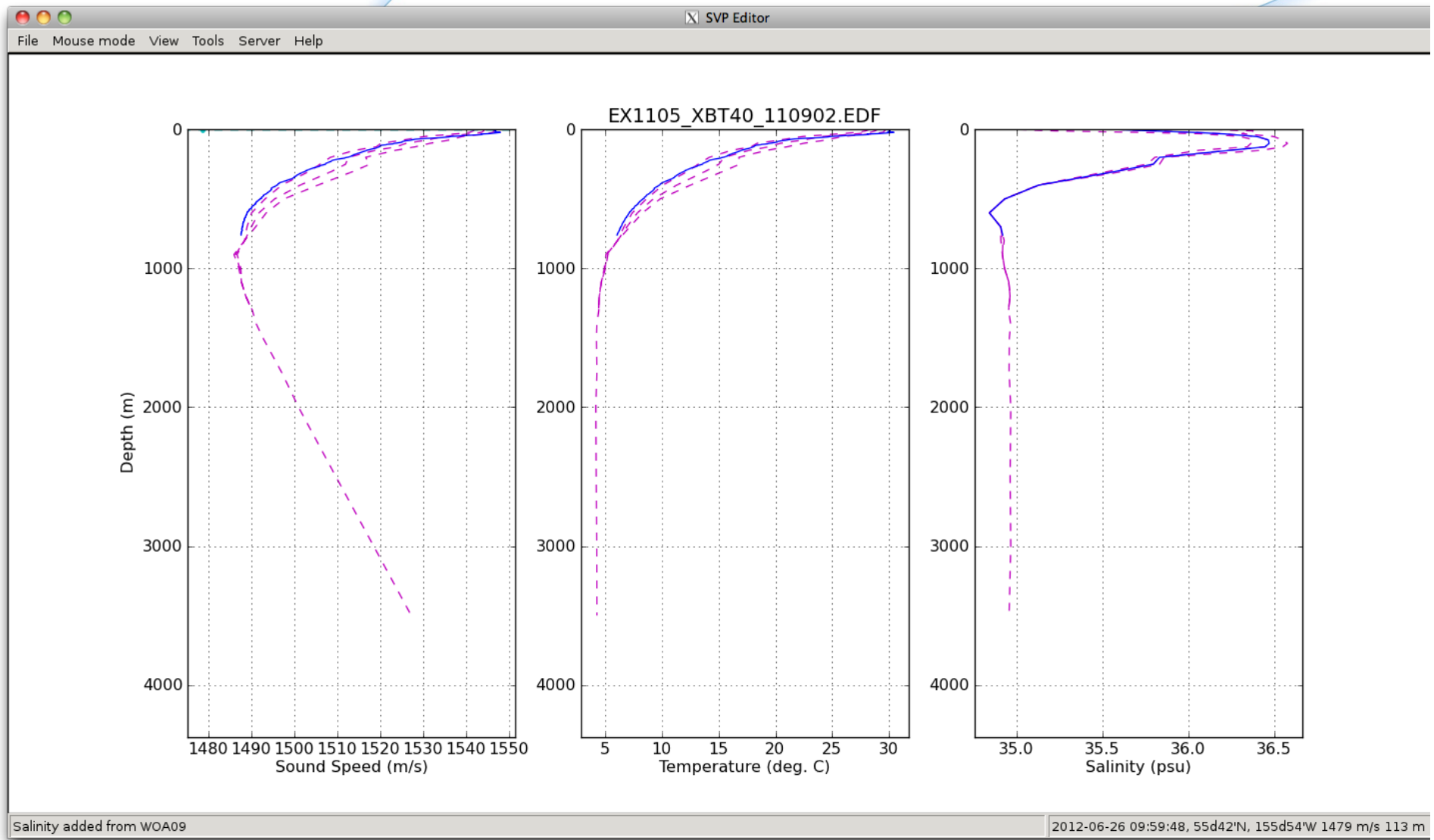
QAT Tools: SVP Editor



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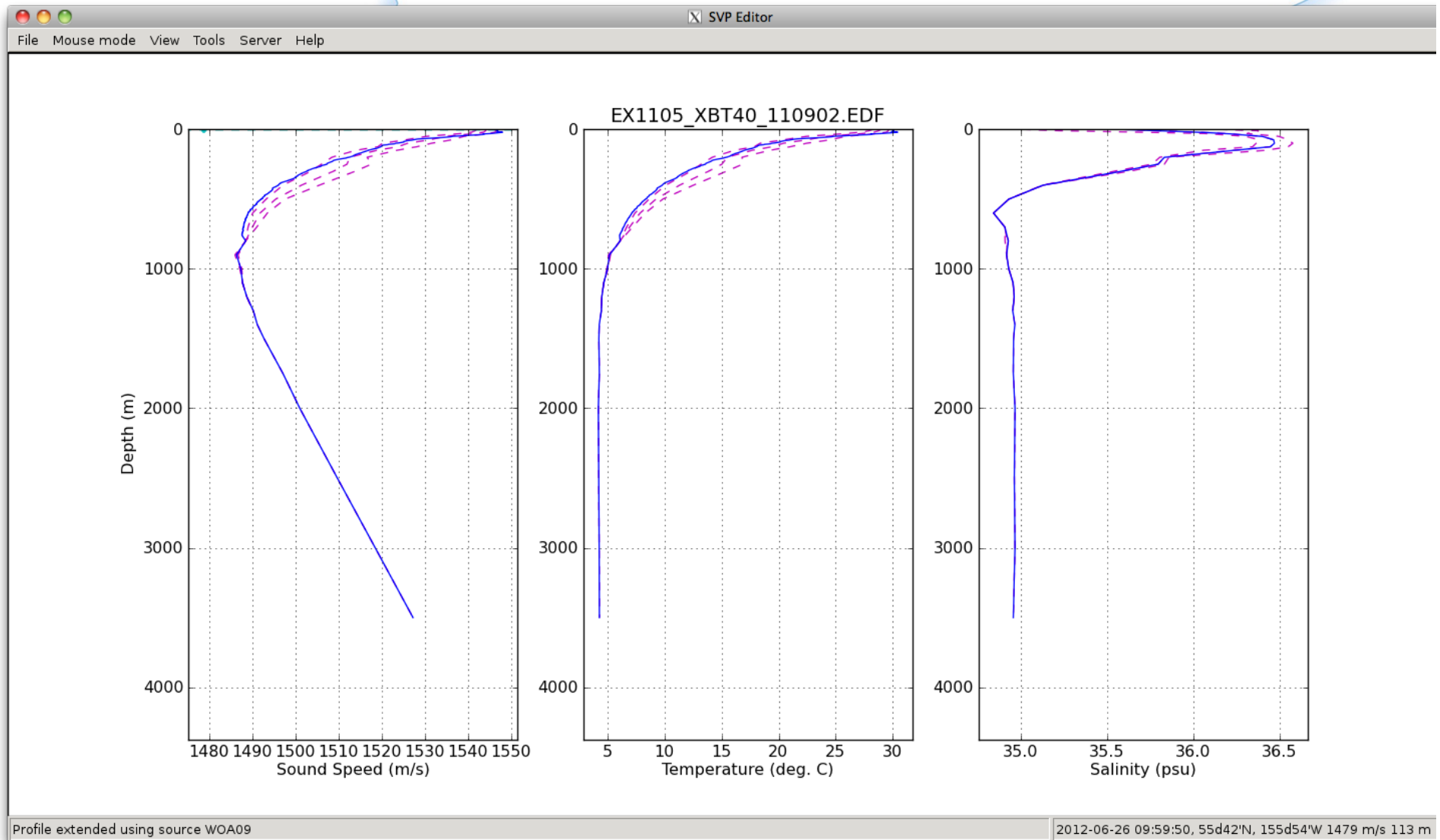
QAT Tools: SVP Editor



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QAT Tools: SVP Editor



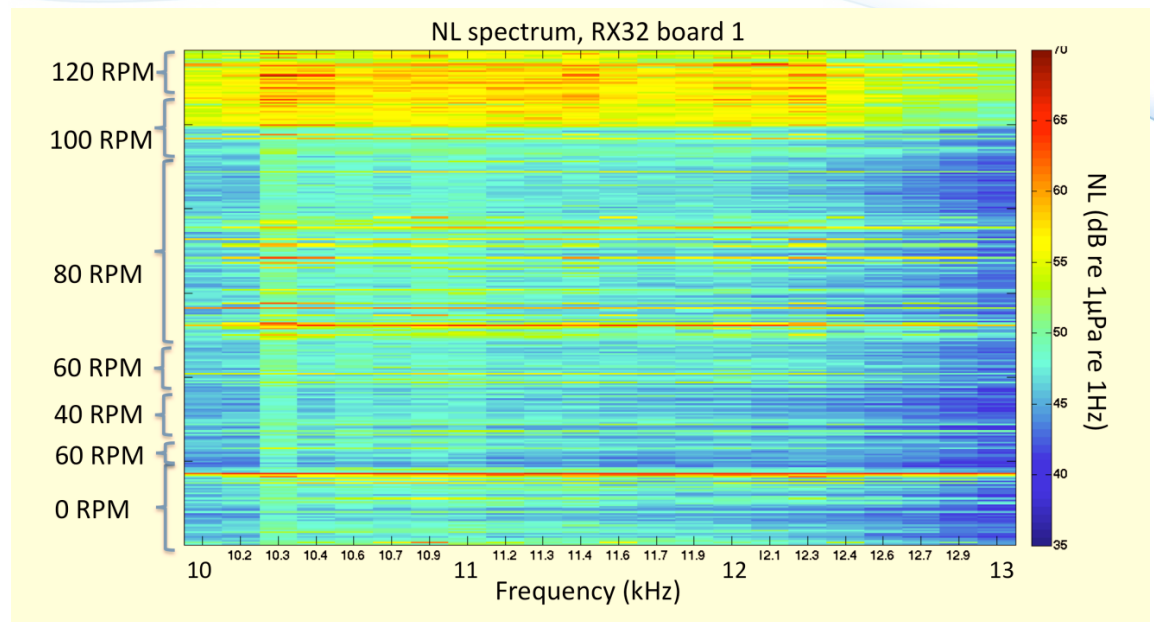
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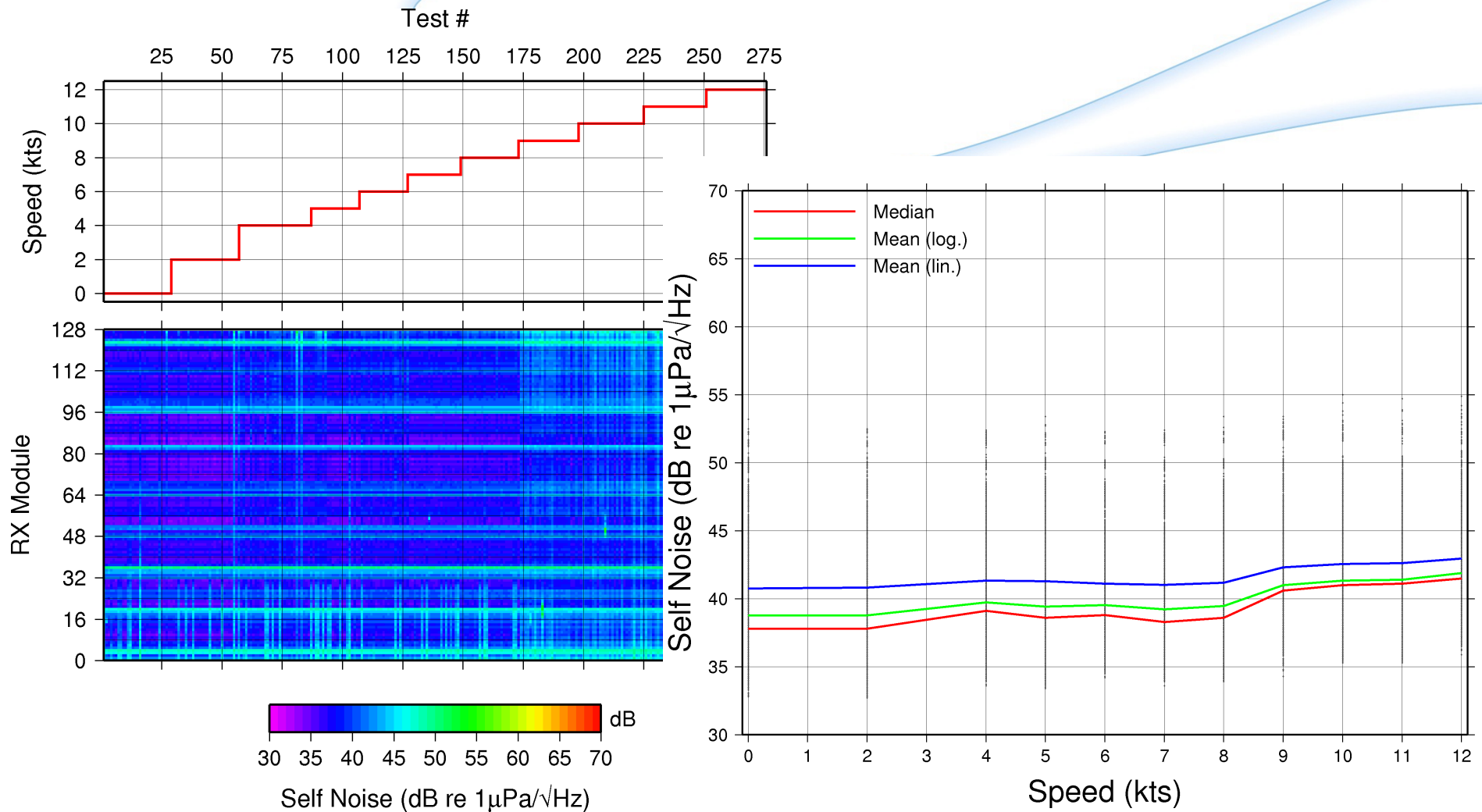
QAT Tools: BIST Logger

- python script to log BIST output over network via UDP
- Includes vessel position/speed and engine RPMs; reduces requirement to embed “metadata” in filenames, e.g.
`starboard_engine_200_rpm_5kts_045_heading_BIST.txt`
- Enables acquisition of rich acoustic noise data sets with minimal effort

Results from acquisition of 294 BIST noise spectrum measurements over 38 minute time span with gradual increases in ship speed. Achieved with one operator repeatedly launching the appropriate BIST test; all data and metadata were logged automatically. Plot generated with Matlab.



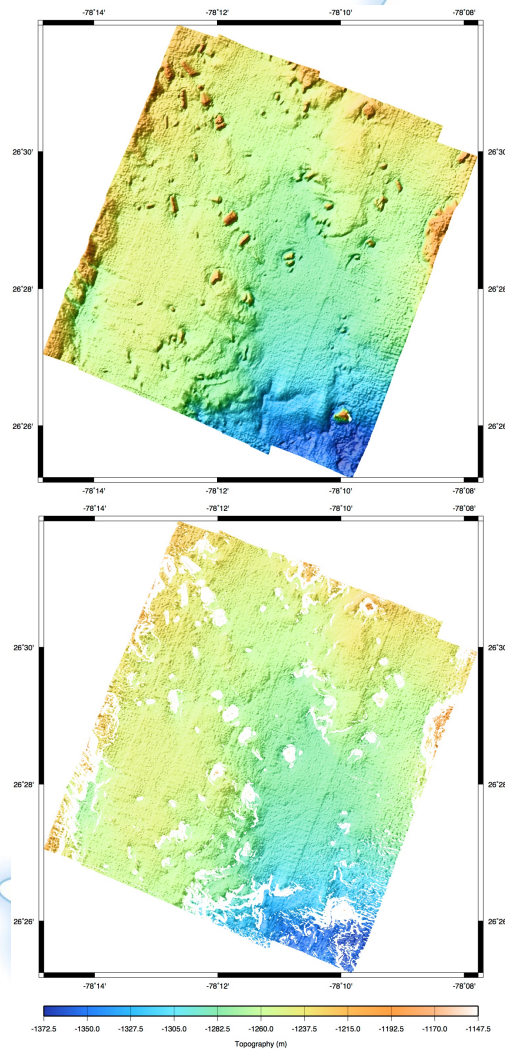
QAT Tools: BIST Logger



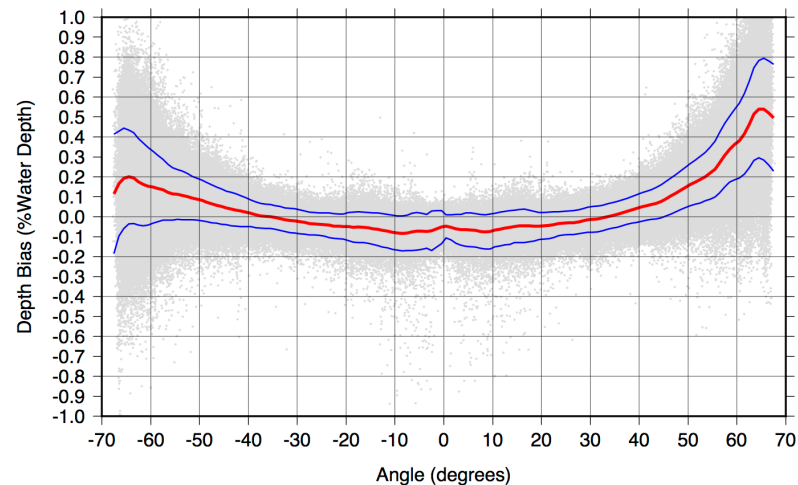
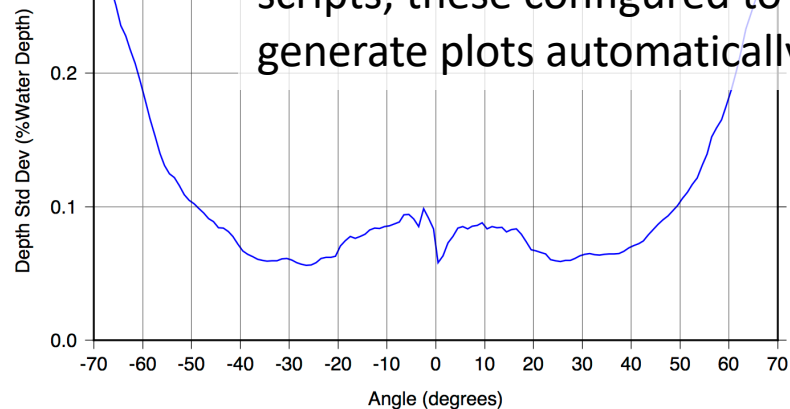
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QAT Tools: Automated Crossline Analysis



Ubuntu Virtual Machine configured with MB System and GMT and processing scripts; these configured to process and generate plots automatically.



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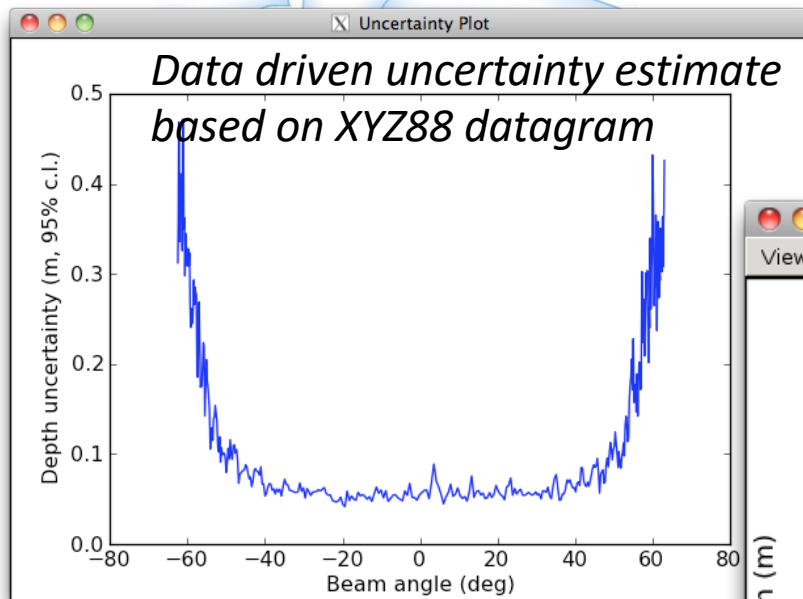
QAT Tools: Multibeam Wizard

The screenshot shows a window titled "Multibeam Wizard" with a menu bar (File, View, Help) and a "Start" button. The main area displays various configuration options with their current status and a "Stop" button. The status of each option is as follows:

Option	Status
Surface sound speed source	Sensor
Yaw stabilization	Vessel heading
Pitch stabilization	Enabled
Beam spacing	High density equi-distant
Along-track tilt angle	Acceptable
Depth mode	DEEP
Dual swath	Dynamic
Vessel geometry	Invalid



QAT Tools: Multibeam Wizard



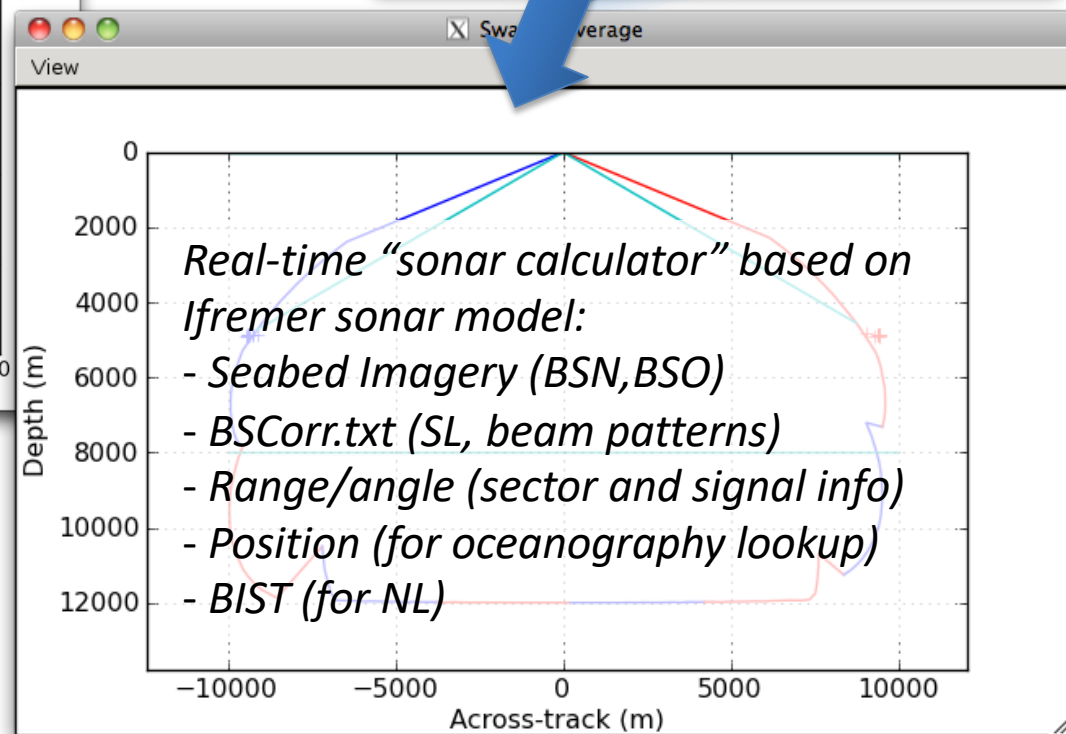
SIS provides majority of information required for calculations in real-time via network transmission

Multibeam Wizard

File View Help

Start Ping: 29676 Stop

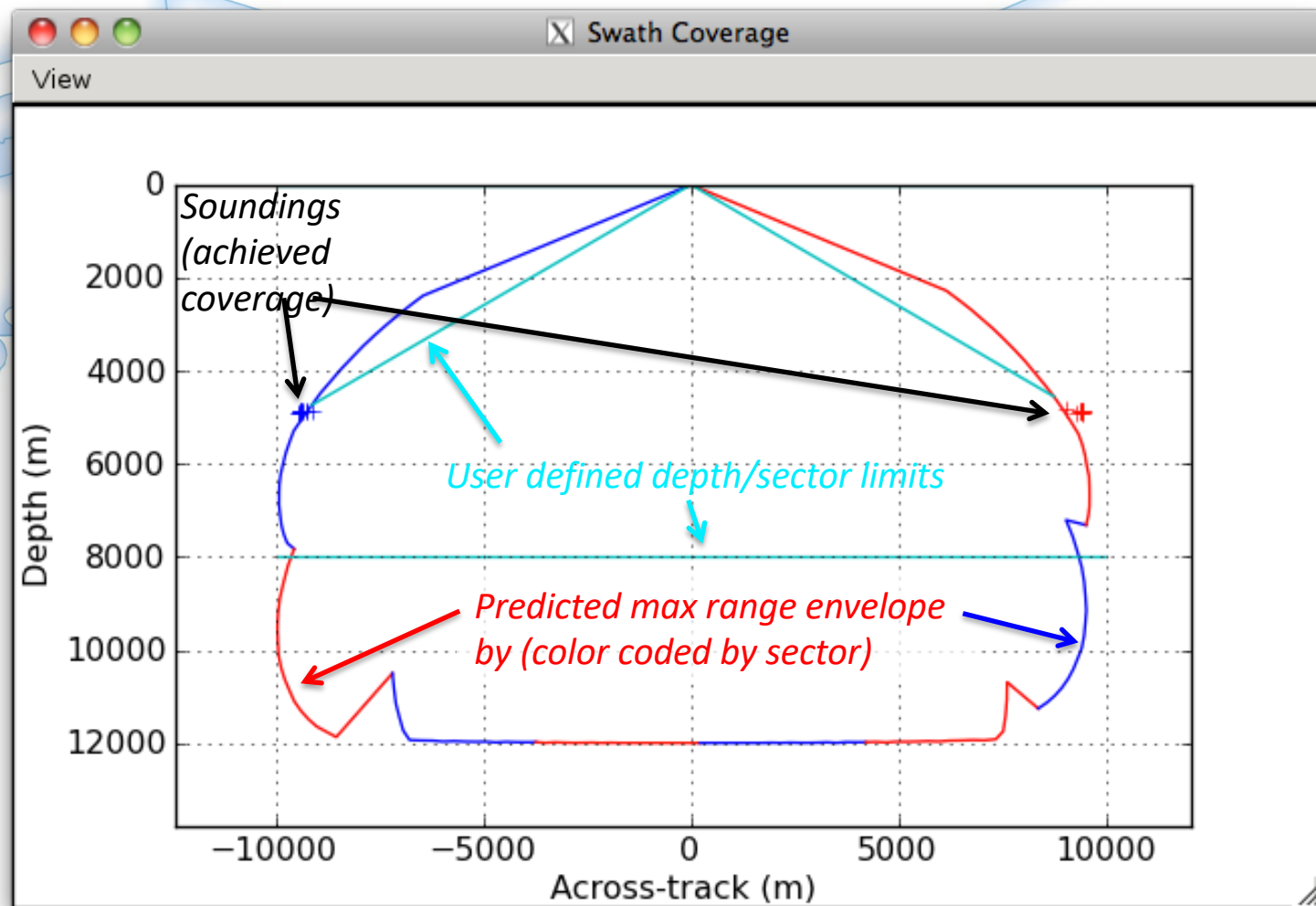
Surface sound speed source	Sensor	?
Yaw stabilization	Vessel heading	?
Pitch stabilization	Enabled	?
Beam spacing	High density equi-distant	?
Along-track tilt angle	Acceptable	?
Depth mode	DEEP	?
Dual swath	Dynamic	?
Vessel geometry	Invalid	?



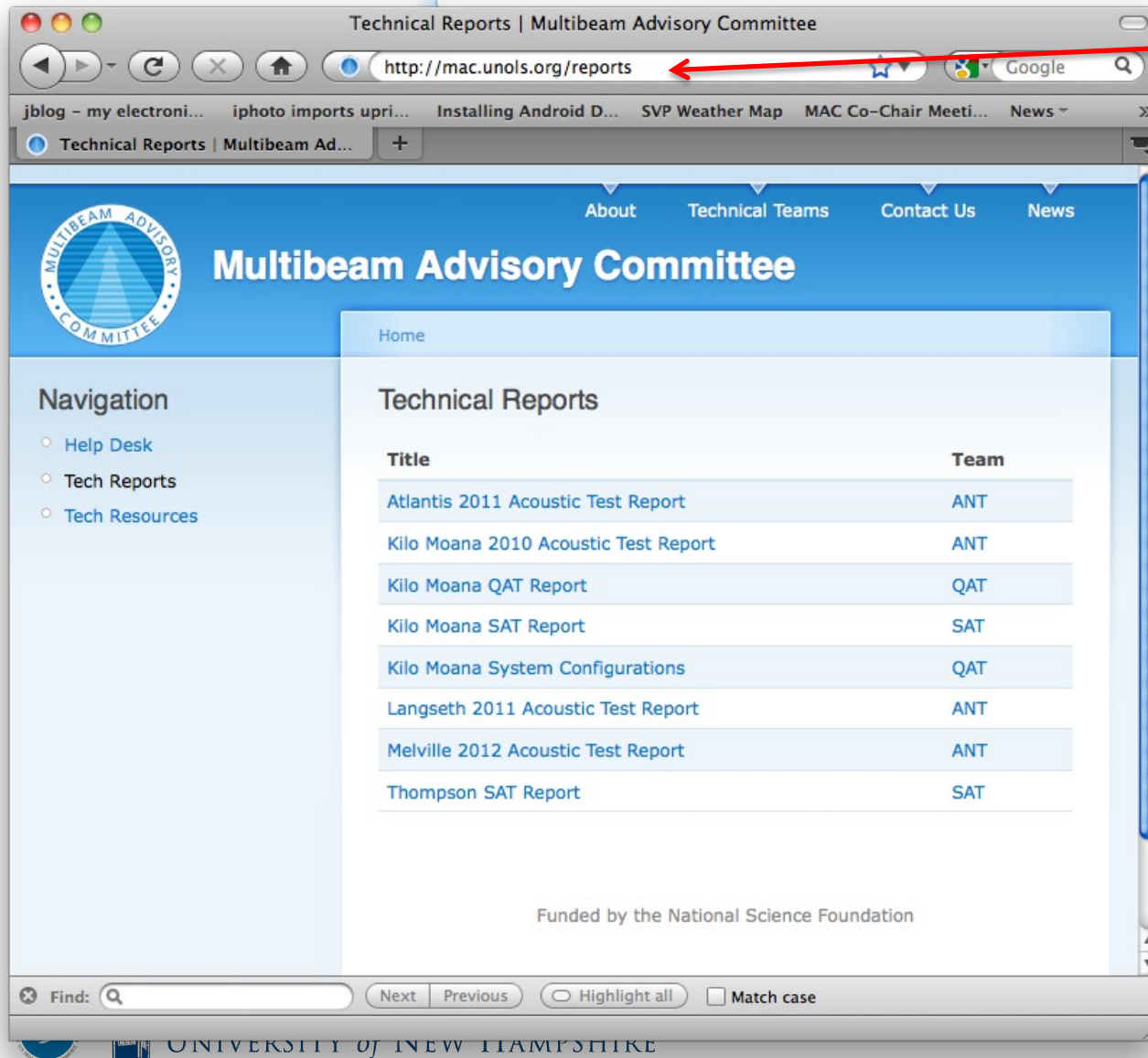
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QAT Tools: Coverage Monitor



Sharing with the Community: Central Repository of Technical Team Reports



The screenshot shows a web browser window with the URL <http://mac.unols.org/reports> in the address bar. The page title is "Technical Reports | Multibeam Advisory Committee". The website has a blue header with the Multibeam Advisory Committee logo and navigation links: "About", "Technical Teams", "Contact Us", and "News". A left sidebar contains a "Navigation" menu with links to "Help Desk", "Tech Reports", and "Tech Resources". The main content area, titled "Home", displays a "Technical Reports" table with two columns: "Title" and "Team".

Title	Team
Atlantis 2011 Acoustic Test Report	ANT
Kilo Moana 2010 Acoustic Test Report	ANT
Kilo Moana QAT Report	QAT
Kilo Moana SAT Report	SAT
Kilo Moana System Configurations	QAT
Langseth 2011 Acoustic Test Report	ANT
Melville 2012 Acoustic Test Report	ANT
Thompson SAT Report	SAT

At the bottom of the page, it states "Funded by the National Science Foundation". The browser's search bar at the bottom contains the text "Find:" and has buttons for "Next", "Previous", "Highlight all", and "Match case".

<http://mac.unols.org/reports>

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Documentation is Hosted Online

Documentation,
SOPs, Cookbooks

External source
documentation

Software Tools

The screenshot shows a web browser window with the URL <http://mac.unh.edu/resources>. The page title is "Technical Resources | Multibeam Advisory Committee". The navigation menu includes "About", "Technical Teams", "Contact Us", and "News". The main content area is titled "Multibeam Advisory Committee" and features a "Technical Resources" section. This section contains a table with columns for "Title", "Team", and "Post date". The table lists various resources, including cookbooks for MB Processing, SIS Configuration Backup, SIS Software Install, SIS Software Uninstall, and SIS Startup, as well as a MAC Help Desk, NOAA Patch Test Documentation, and two Sound Velocity Profile (SVP) related tools. The footer of the browser window shows a search bar and navigation controls.

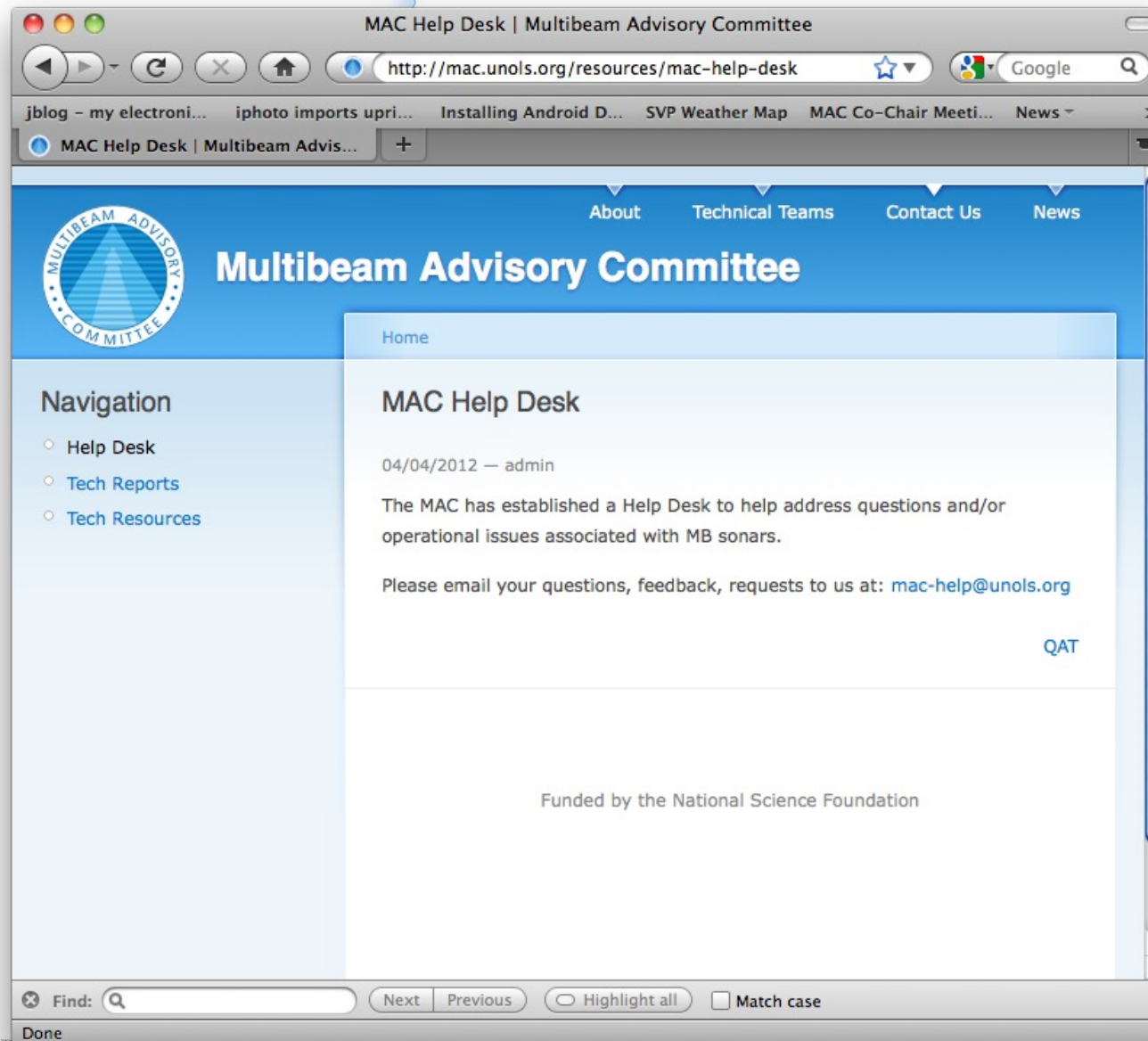
Title	Team	Post date
Cookbook: MB Processing with Caris	QAT	03-2012
Cookbook: SIS Configuration Backup	QAT	05-2012
Cookbook: SIS Software Install	QAT	05-2012
Cookbook: SIS Software Uninstall	QAT	05-2012
Cookbook: SIS Startup	QAT	07-2012
MAC Help Desk	QAT	04-2012
NOAA Patch Test Documentation	QAT	06-2012
Tool: Sound Velocity Profile (SVP) Editor	QAT	05-2012
Tool: Sound Velocity Profile (SVP) Mission Planning Toolkit [Preliminary]	QAT	06-2012



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MAC Help Desk



MAC Help Desk uses Request Tracker system. Requests are assigned ticket numbers and are claimed by a responder and can be marked as resolved.





Summary



- MAC seeks to raise quality of multibeam data quality in U.S. academic fleet:
 - Gather experts
 - Provide easy access to experts
 - Do “house call” check-up visits to ships
 - Share findings
- Hoping to reach out to others in the seabed mapping community to share and learn



We value your input!

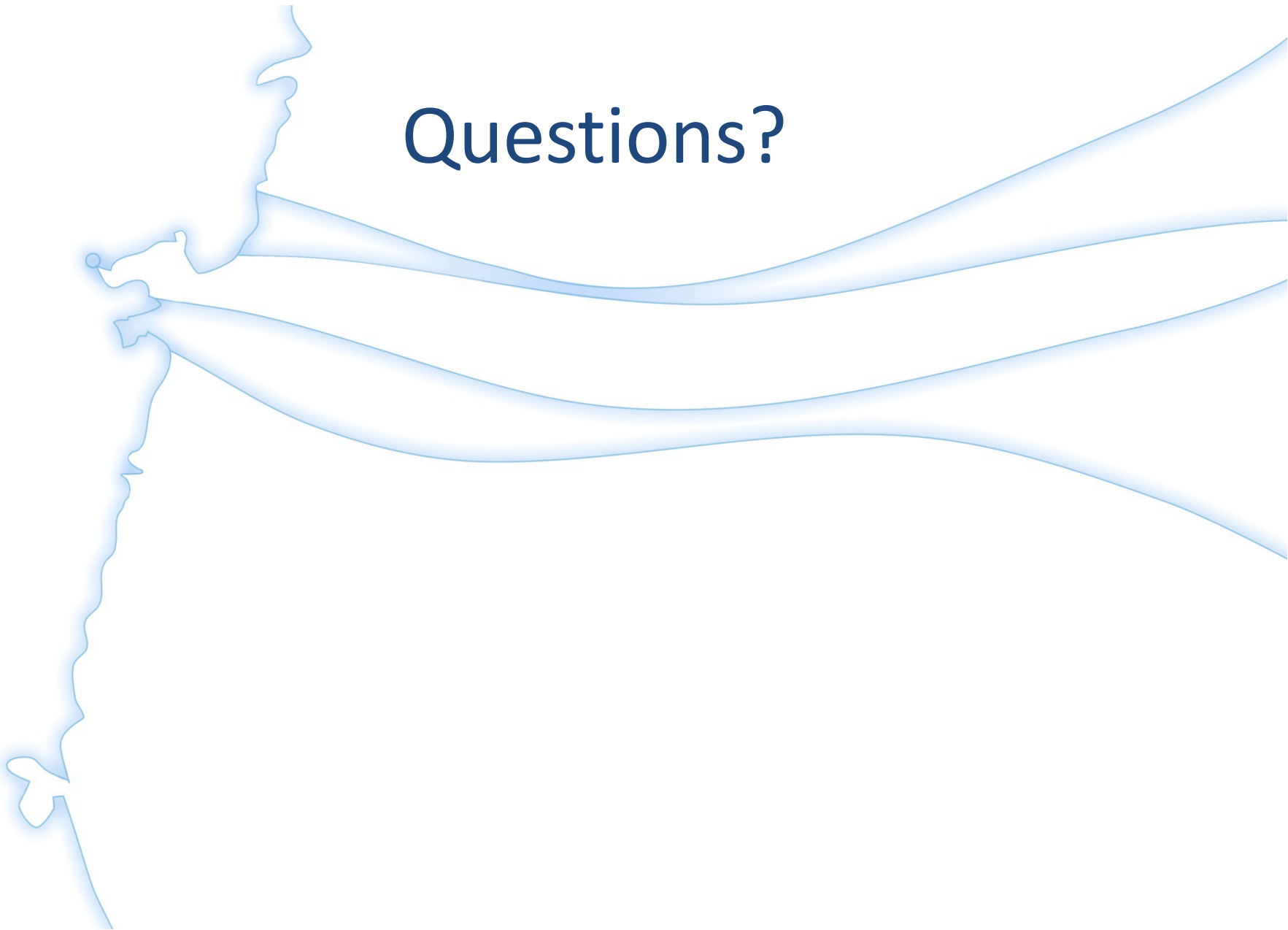
- You can benefit: Reports and tools are available publicly online
- You can contribute also:
 - Best practice documentation
 - Ideas
 - Multibeam Horror/Success stories

<http://mac.unols.org>



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Questions?



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