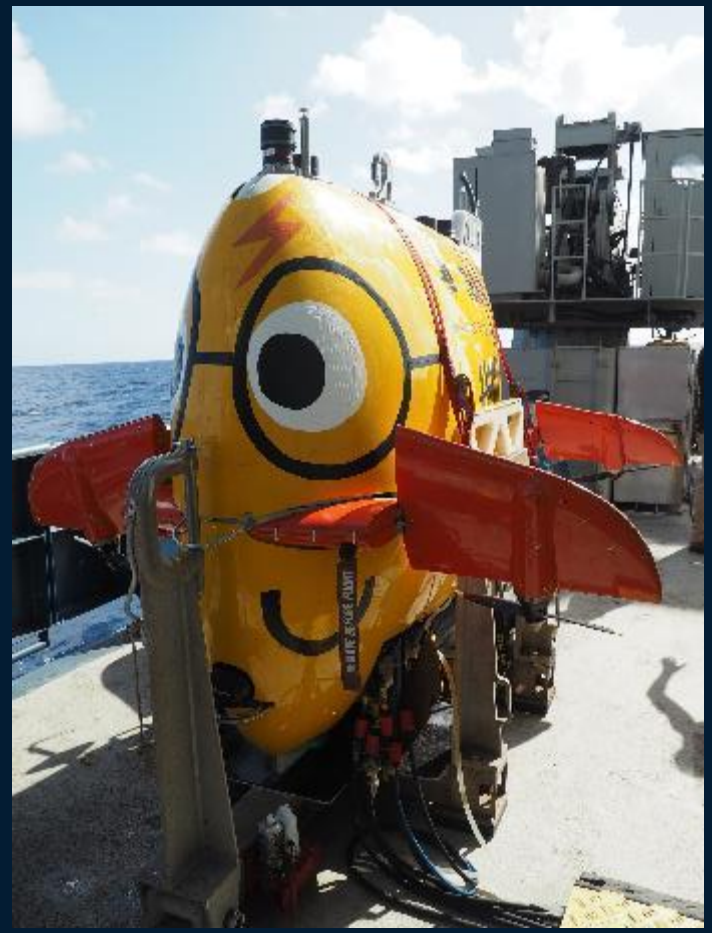
Why USBL Calibration

Implications for AUV Operations

Ian Vaughn (ivaughn@whoi.edu)
AUV Sentry Operations Group

AUV Sentry operates with both Sonardyne Ranger 2 USBL and Phins+DVL dead-reckoning

- Fly-away Ranger 2
- USBL “installs of opportunity”
- R/V Atlantis / HOV Alvin
  - Ranger 2 NSH
  - Ranger 1 USBL Head
  - Head to be upgraded during midlife refit



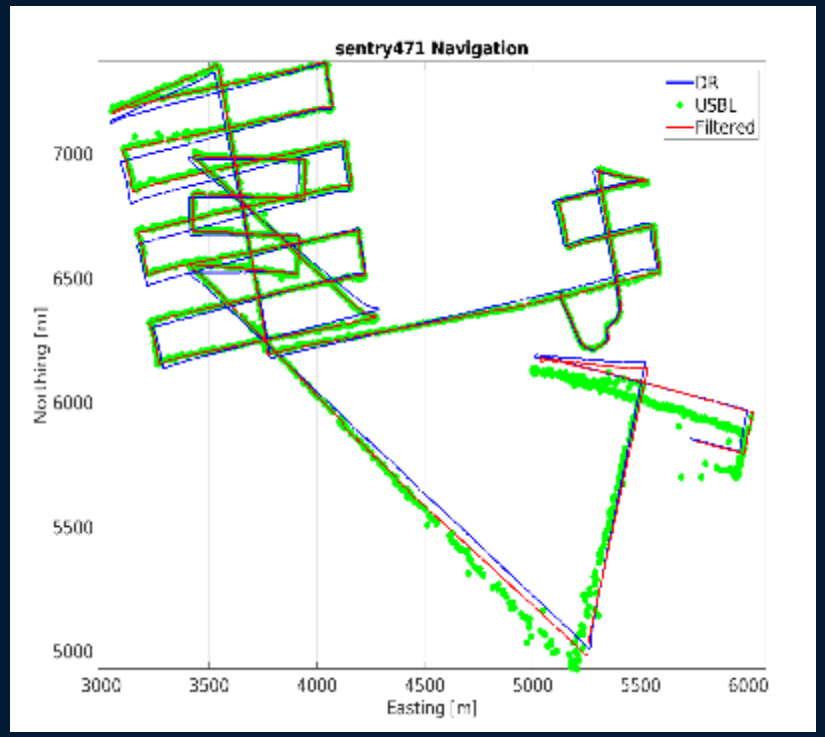
Fly-away install,
R/V Atlantic Explorer

Images: Manyu Belani

The 2018 Alvin/Sentry engineering presented a unique opportunity to evaluate the effect of USBL calibration procedures

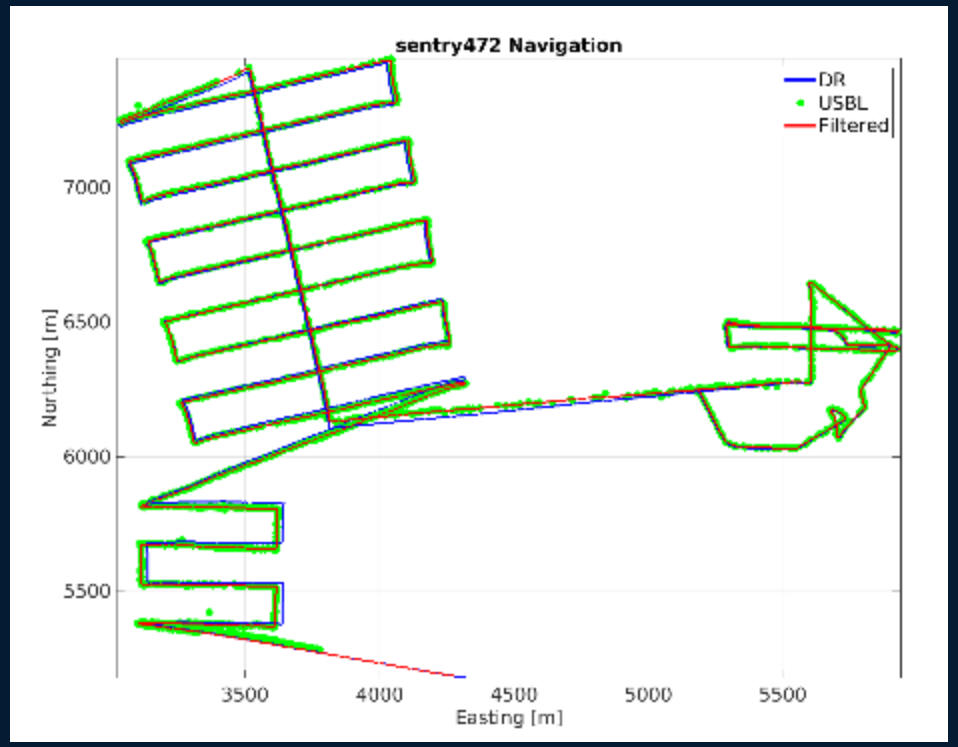
Sentry 471:

Before [/during] calibration



Sentry 472:

After calibration, same location



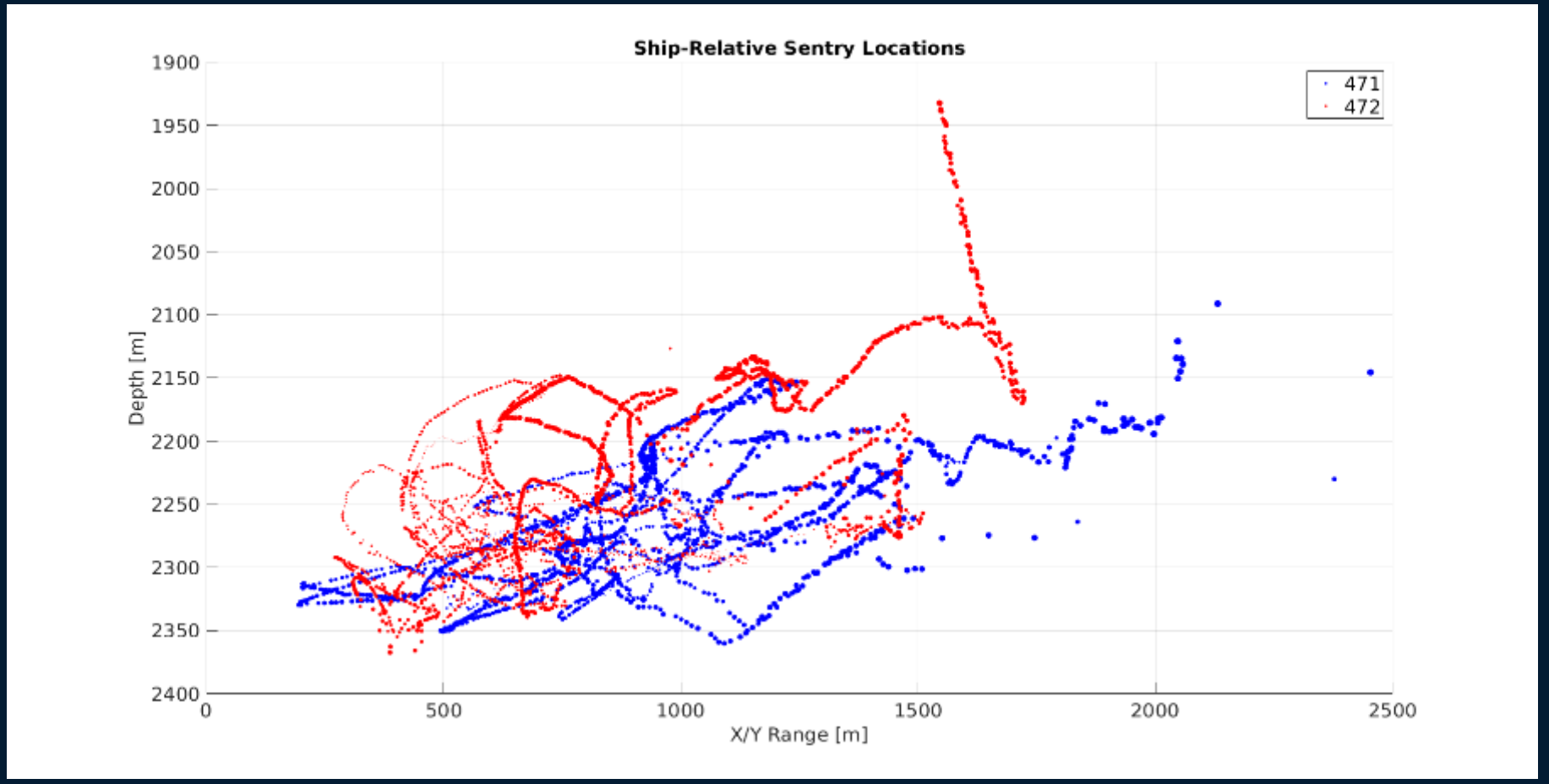
The *R/V Atlantis* USBL head was calibrated during Sentry471 using Sonardyne's CASIUS tool

Parameter	Before	After
Pitch Correction	0°	-0.05°
Roll Correction	0°	0.04°
Heading Correction	0°	1.97°
2-sigma accuracy	19.9 m	6.6 m

2,051 position fixes were taken using the "for DP vessels" calibration pattern in the CASIUS manual while simultaneously tracking Sentry

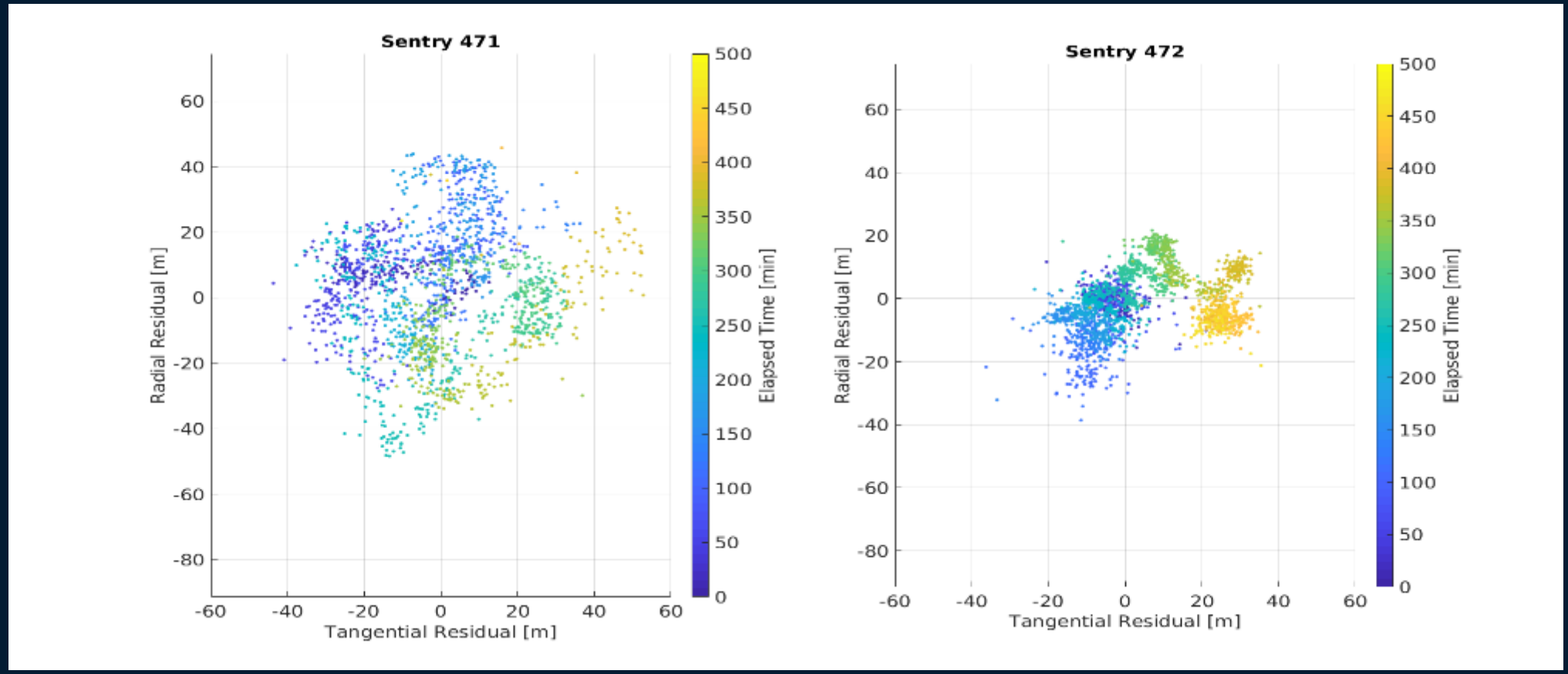
CASIUS data collected & processed by AUV Sentry team, notably Stefano Suman

Error from USBL head misalignment depends on Sentry's depth and horizontal distance from the ship (range). Sentry spent both dives in similar operating areas, although the ship was often further away conducting the USBL calibration procedure during the first dive.



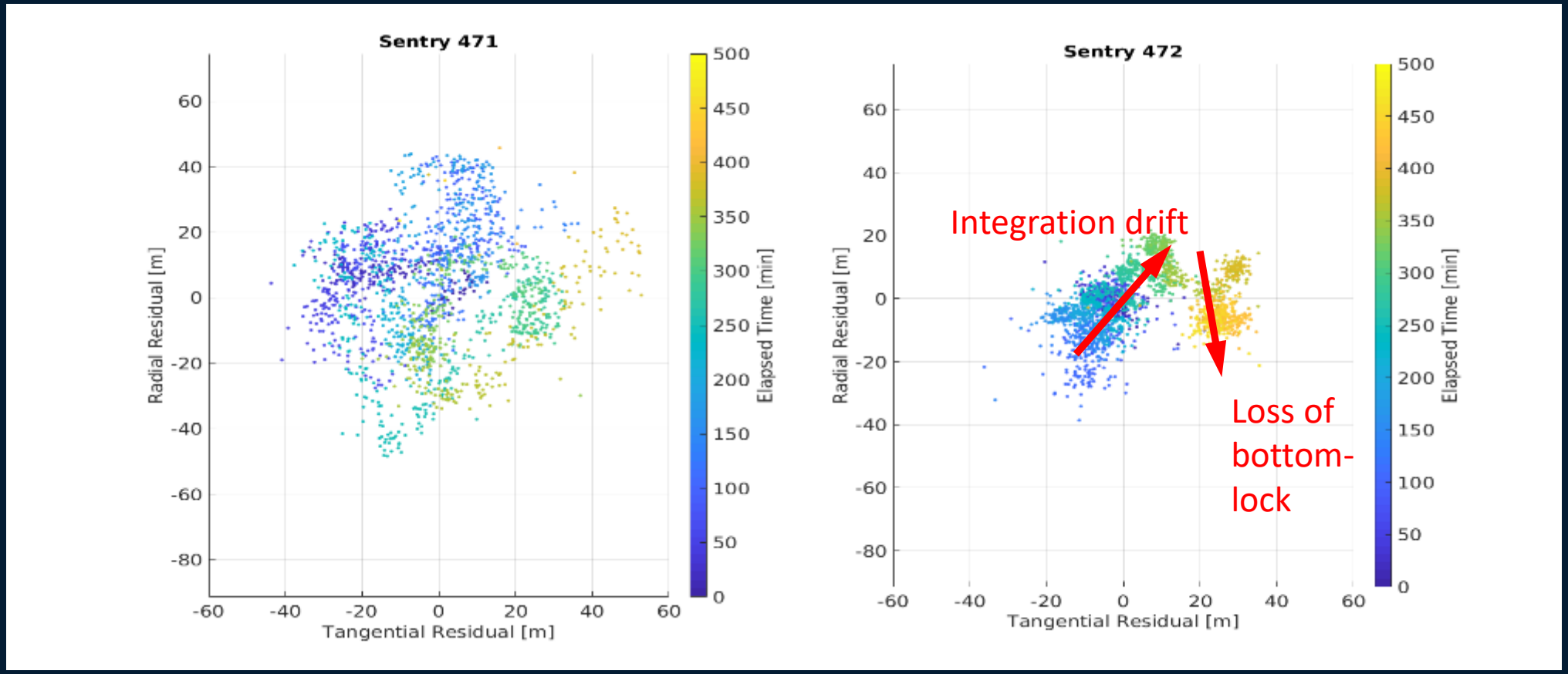
Marker size proportional to difference from dead-reckoning track

Comparing Sentry's DVL (deadreckoned) and USBL positions is a standard way to evaluate navigation performance. Rotating into a ship-relative coordinate system can isolate the effect of calibration errors.



The ship is down here. Vertical is error towards/away from the ship, horizontal error is left/right.

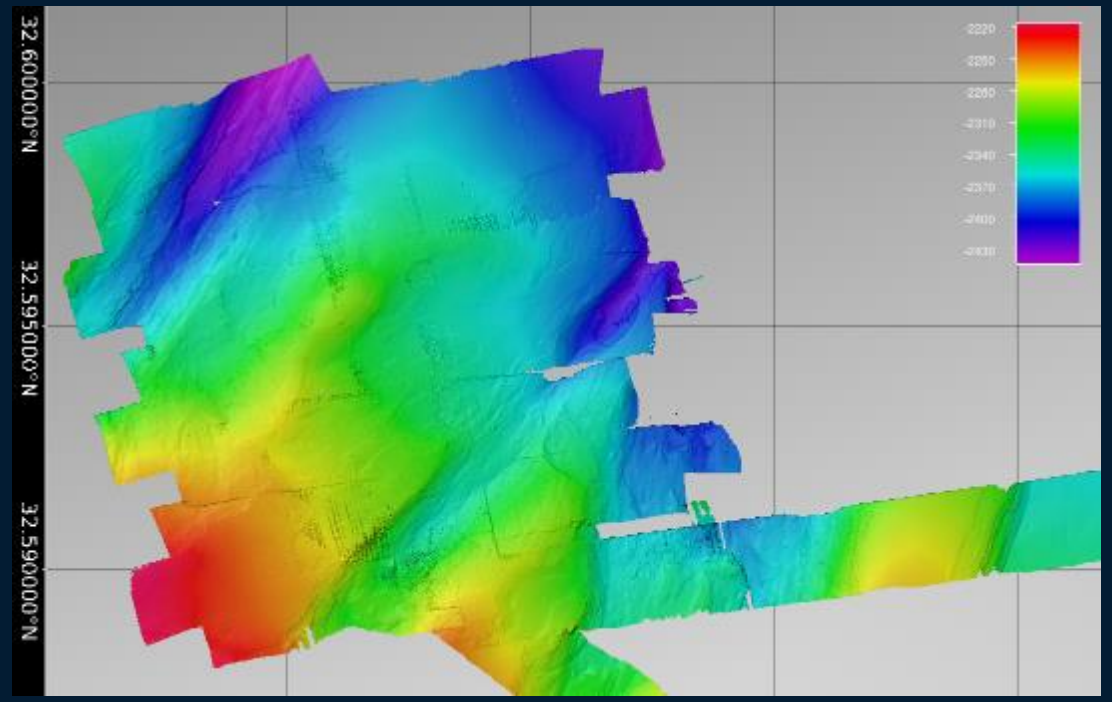
Comparing Sentry's DVL (deadreckoned) and USBL positions is a standard way to evaluate navigation performance. Rotating into a ship-relative coordinate system can isolate the effect of calibration errors.



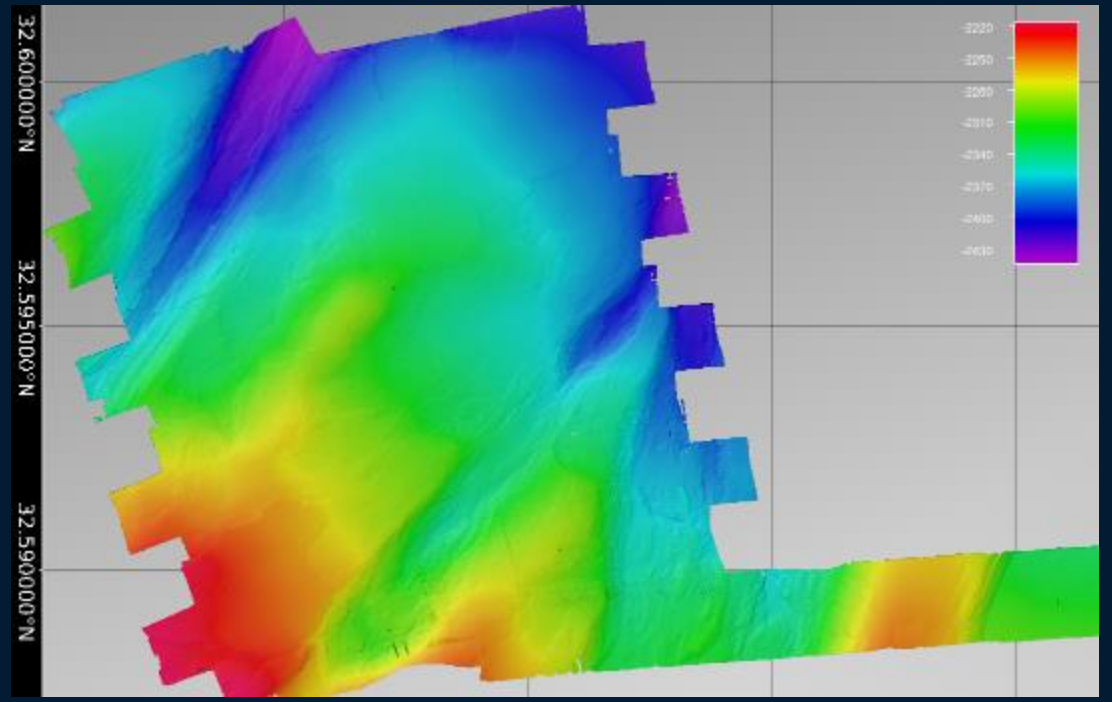
The ship is down here. Vertical is error towards/away from the ship, horizontal error is left/right.

The additional USBL error is not fully removed by Sentry's navigation post-processing routines and degrades the map

Sentry 471 (pre-calibration)

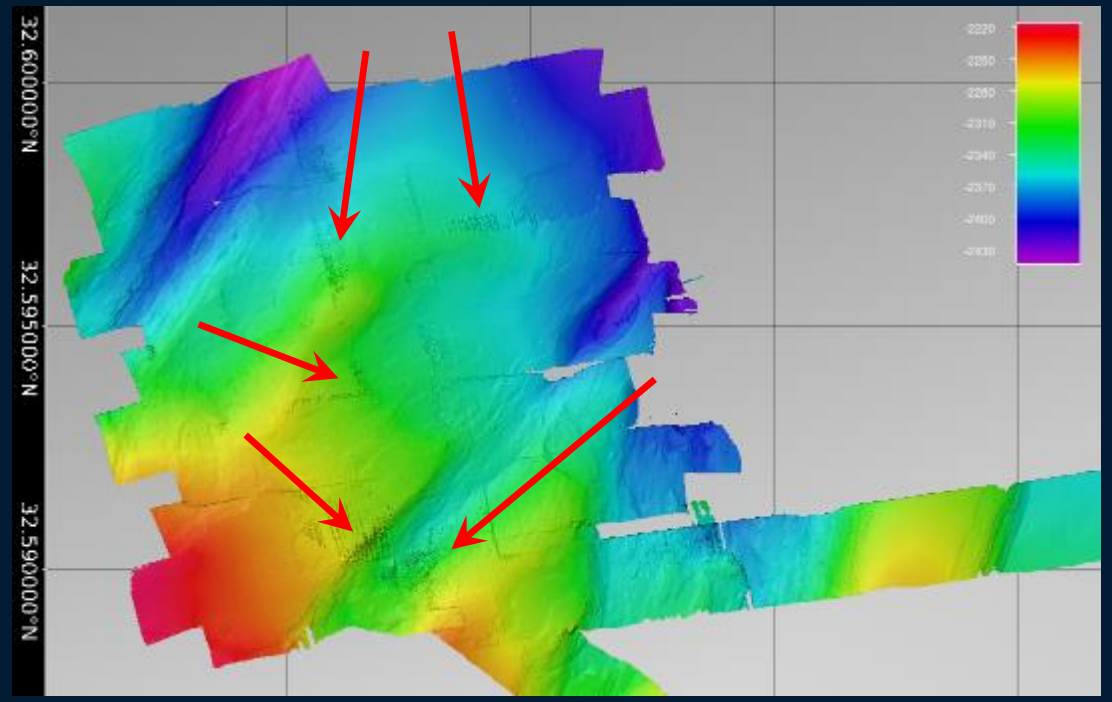


Sentry 472 (post-calibration)

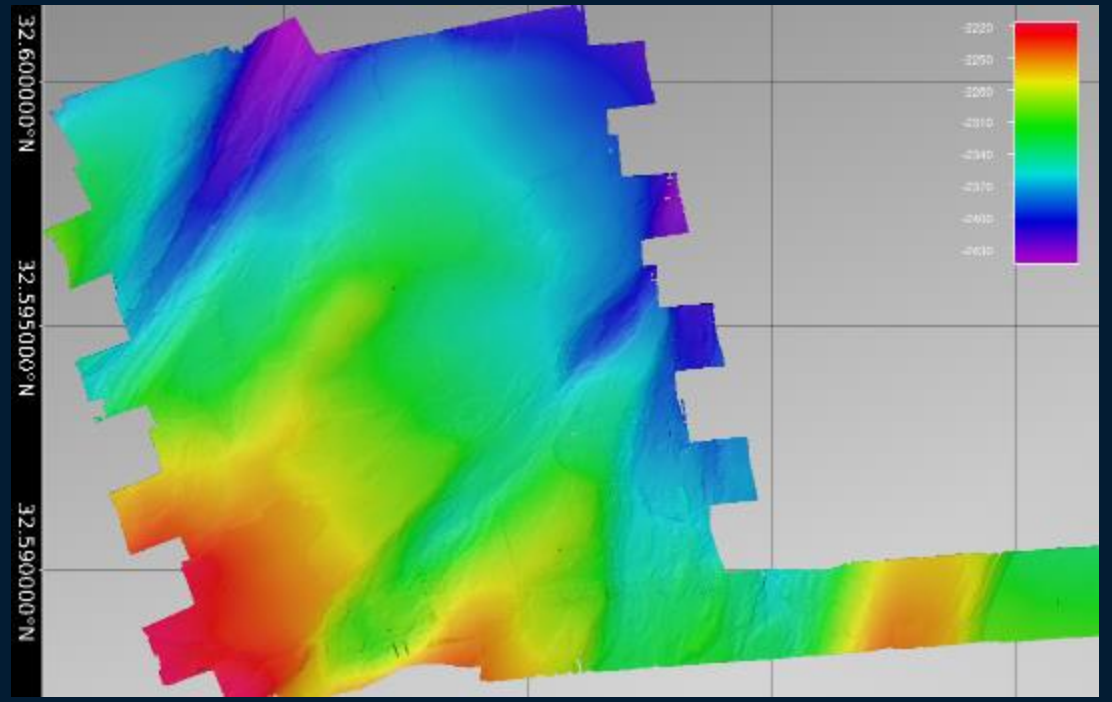


The additional USBL error is not fully removed by Sentry's navigation post-processing routines and degrades the map

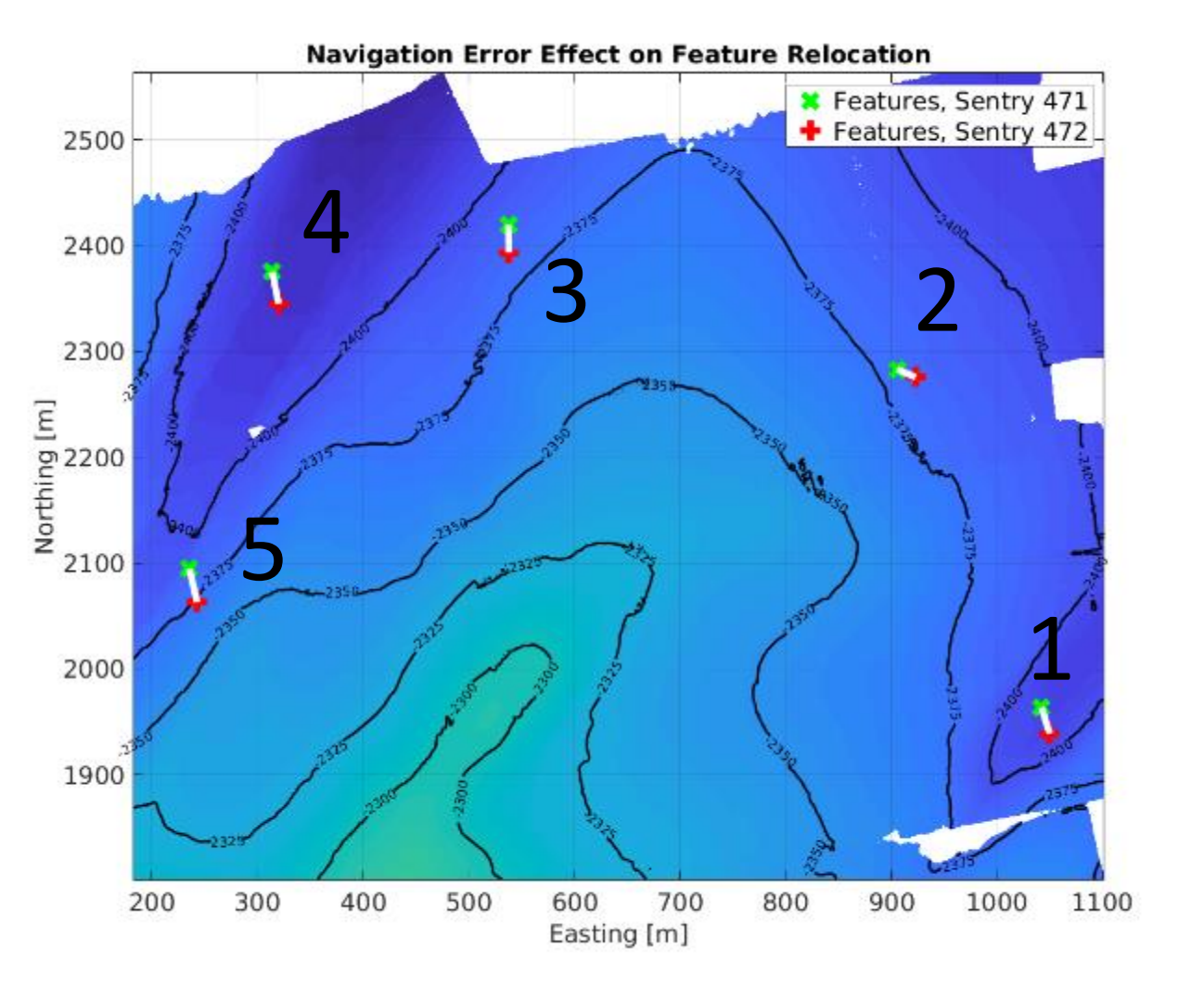
Sentry 471 (pre-calibration)



Sentry 472 (post-calibration)



A critical goal of Sentry navigation is enabling relocation of interesting features with Alvin or Jason. Comparing the location of 5 identifiable features on the two maps gives a measure of expected relocation error.



Shift from dive 471 to dive 472

Feature	Distance	Bearing
1	25.7 m	162°
2	19.1 m	113°
3	26.4 m	179°
4	30.8 m	168°
5	32.3m	166°

Sentry's mapping pipeline uses non-causal post-processing methods that Alvin and Jason can't use in real-time. Their performance may be worse. Especially if the ship changes heading.

Key take-aways:

- Sonardyne's USBL calibration can produce dramatic performance improvements
- Performance improvements appear consistent with CASIUS reports (based on 1 data point…)
- Better positioning gives better data products (maps)
- Impact of improving relocation performance is application-dependent