Optimising Ultra-Short BaseLine (USBL) Positioning from Research Vessels

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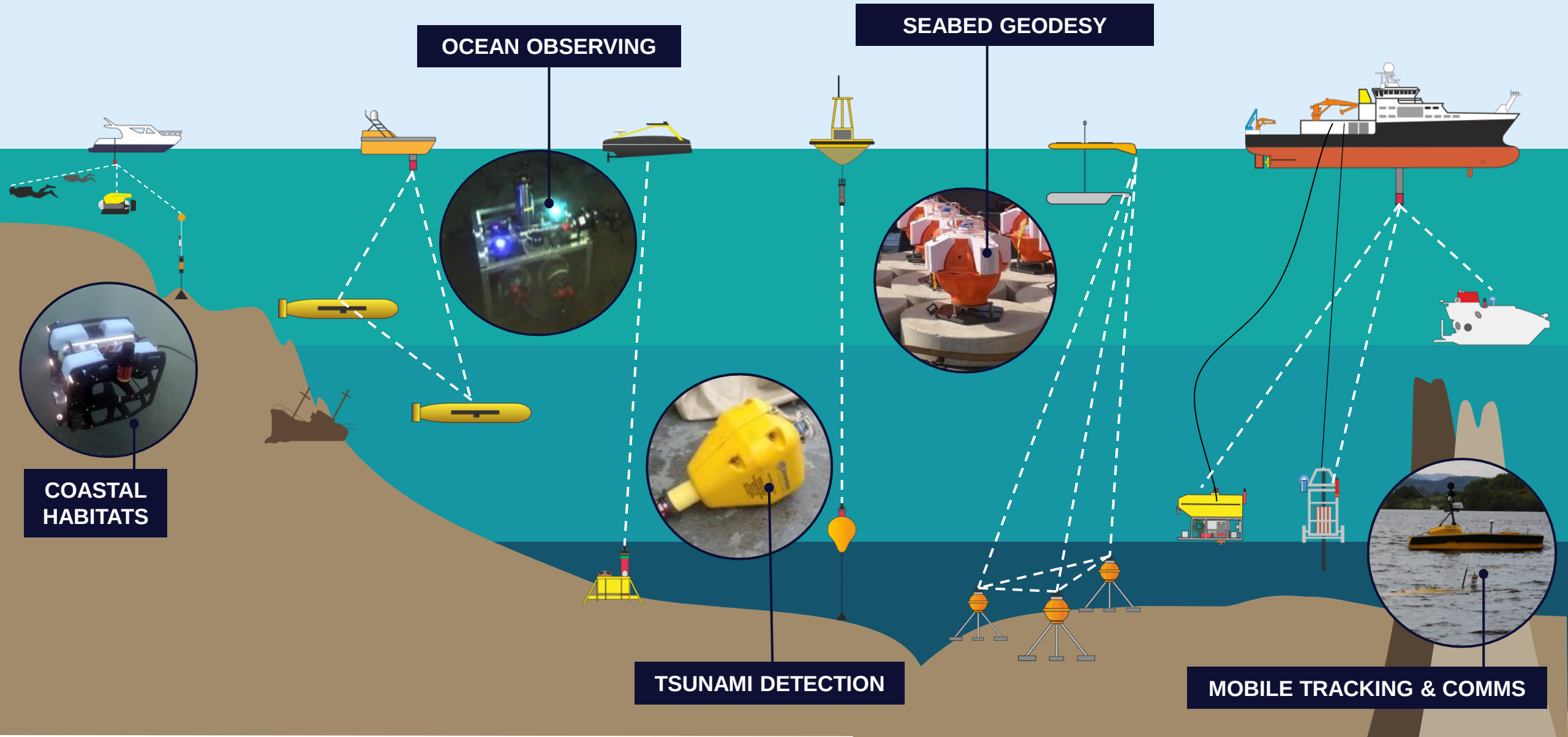
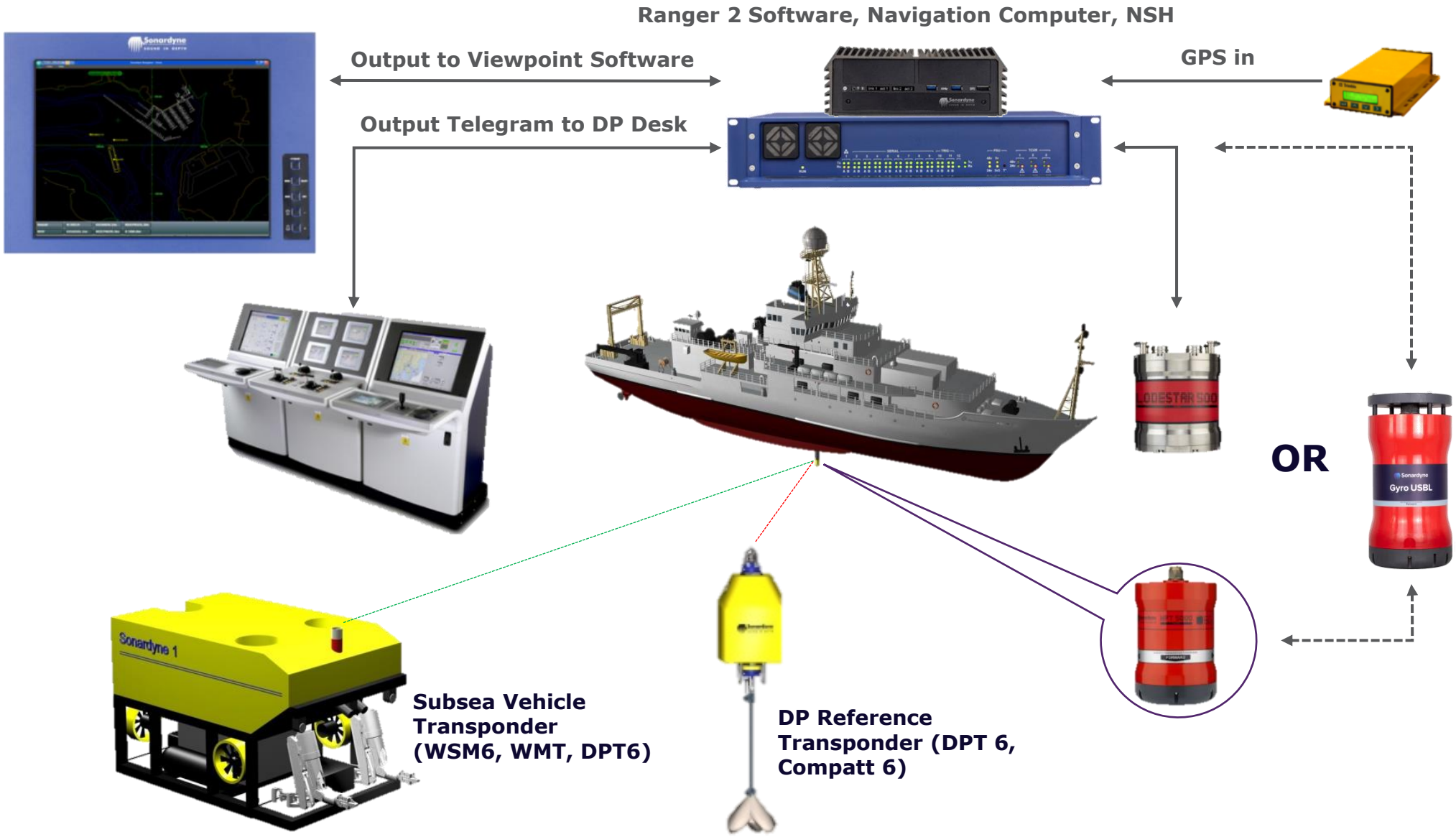
Ocean Science – Your data where you need it; when you need it

Sonardyne



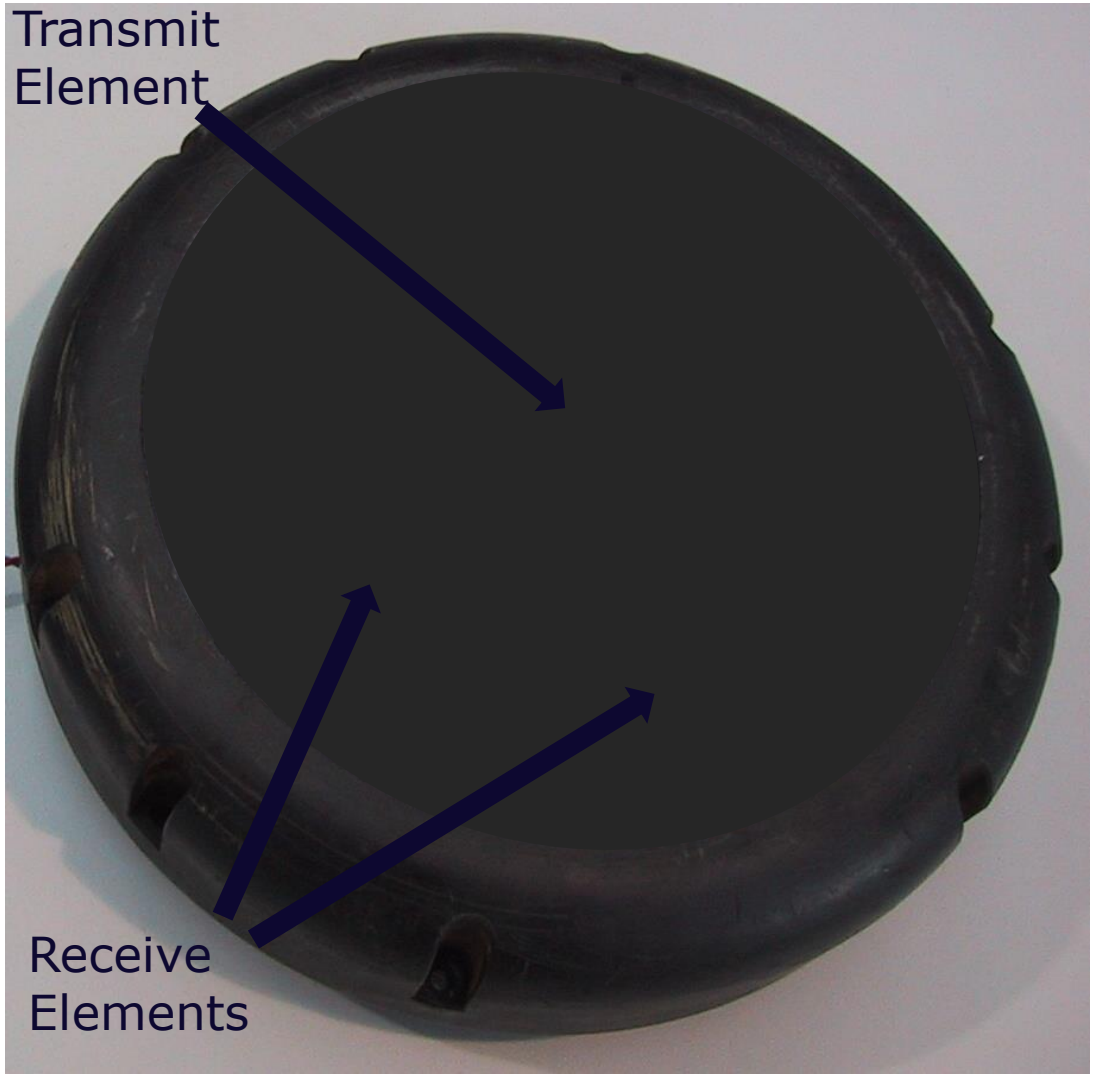
USBL Principles

USBL Principles – System Overview



Transceiver face comprises two acoustic element types, which are recessed into high grade plastic and encapsulated in polyurethane:

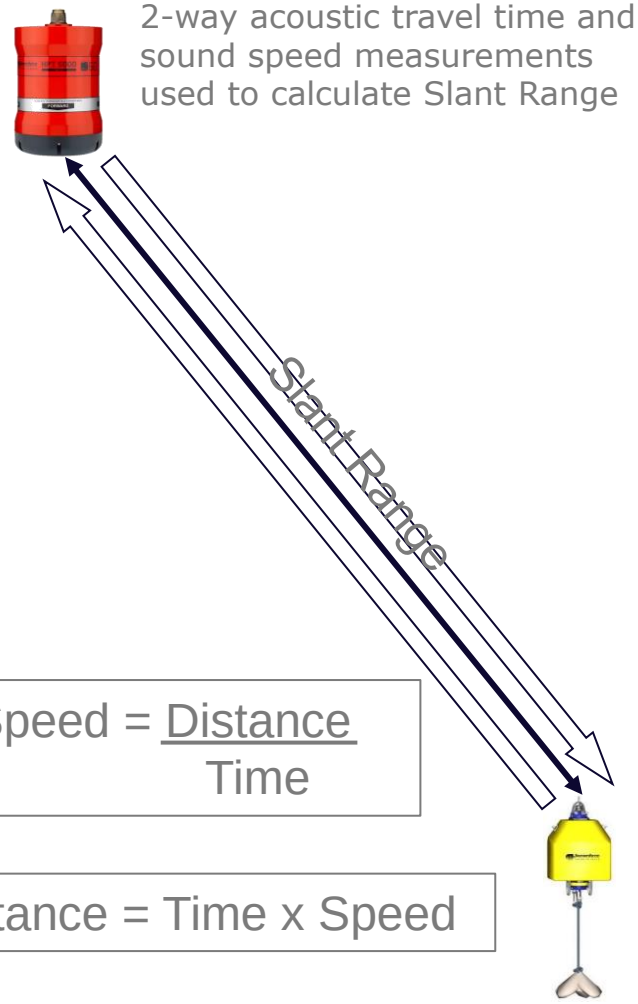
- 1 x transmit
- A number of receive



USBL Principles – Range & Direction

SLANT RANGE

2-way acoustic travel time and sound speed measurements used to calculate Slant Range

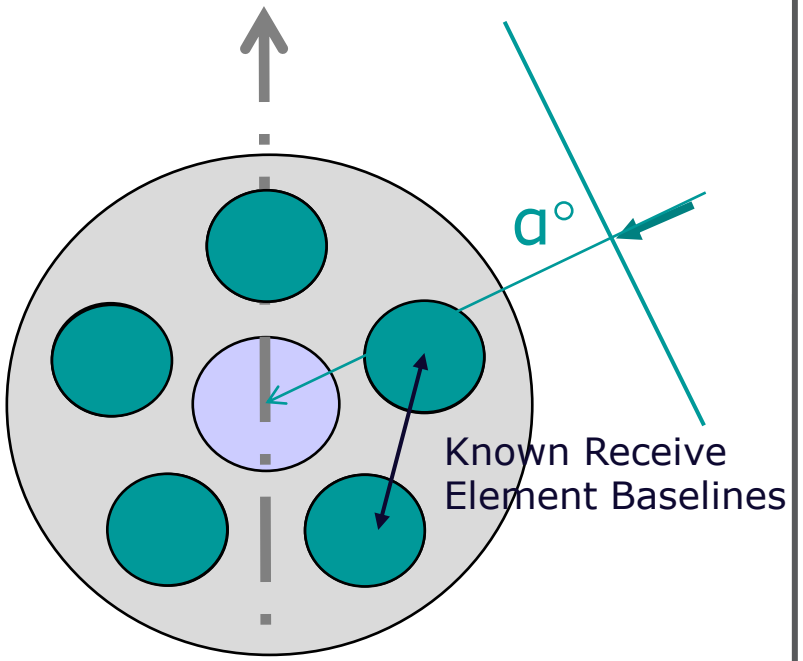


Speed = Distance / Time

Distance = Time x Speed

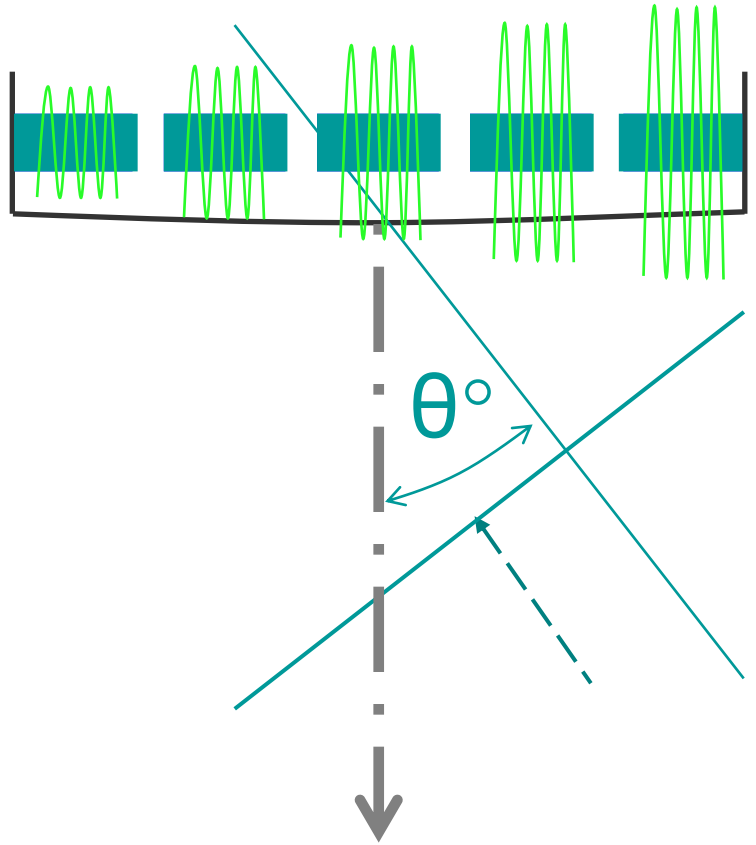
AZIMUTH

As the returning acoustic pulse passes over the transceiver, the time of arrival is measured for all elements.



The difference is used to calculate the angle from the forward mark (Ship's Head)

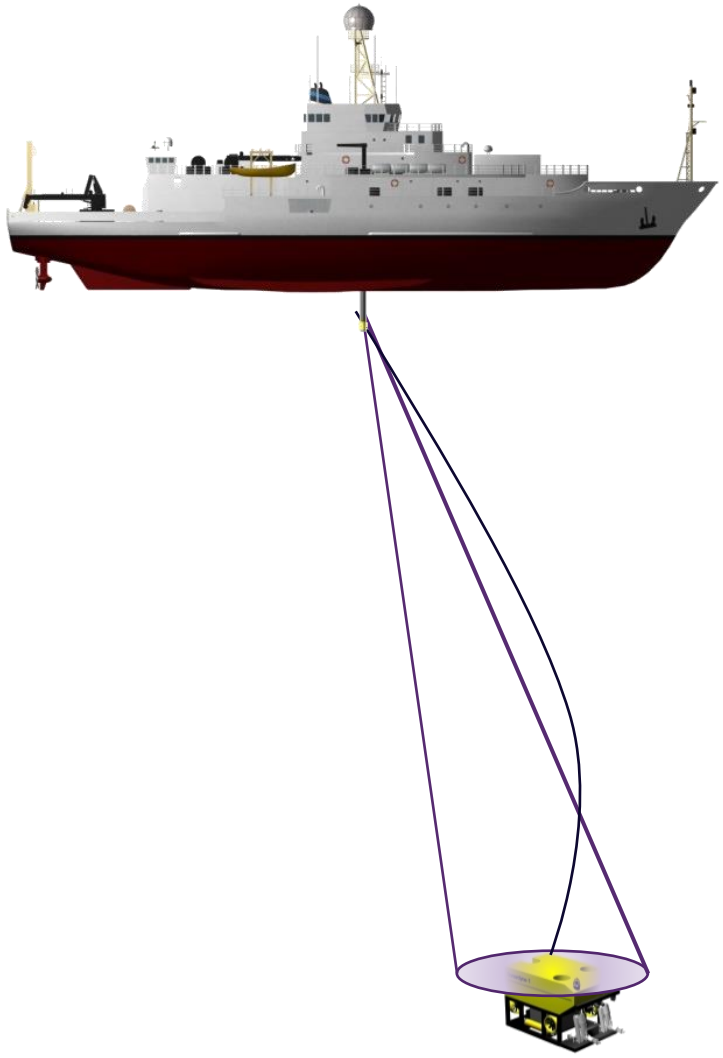
ELEVATION

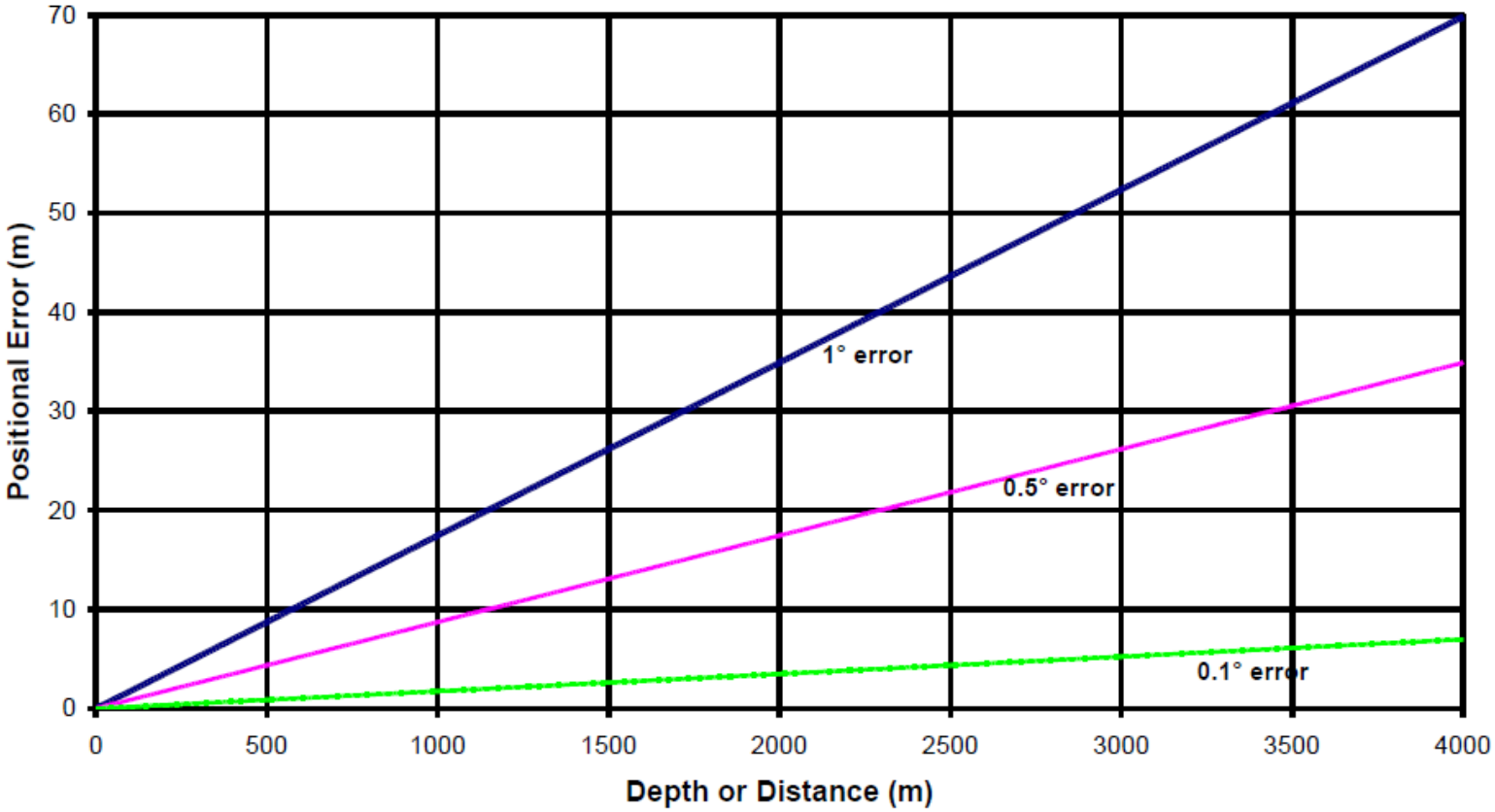


Time of arrival (phase) and signal amplitude are analysed to calculate the elevation angular offset

USBL Errors & Issues

USBL Errors & Issues – % Range Error



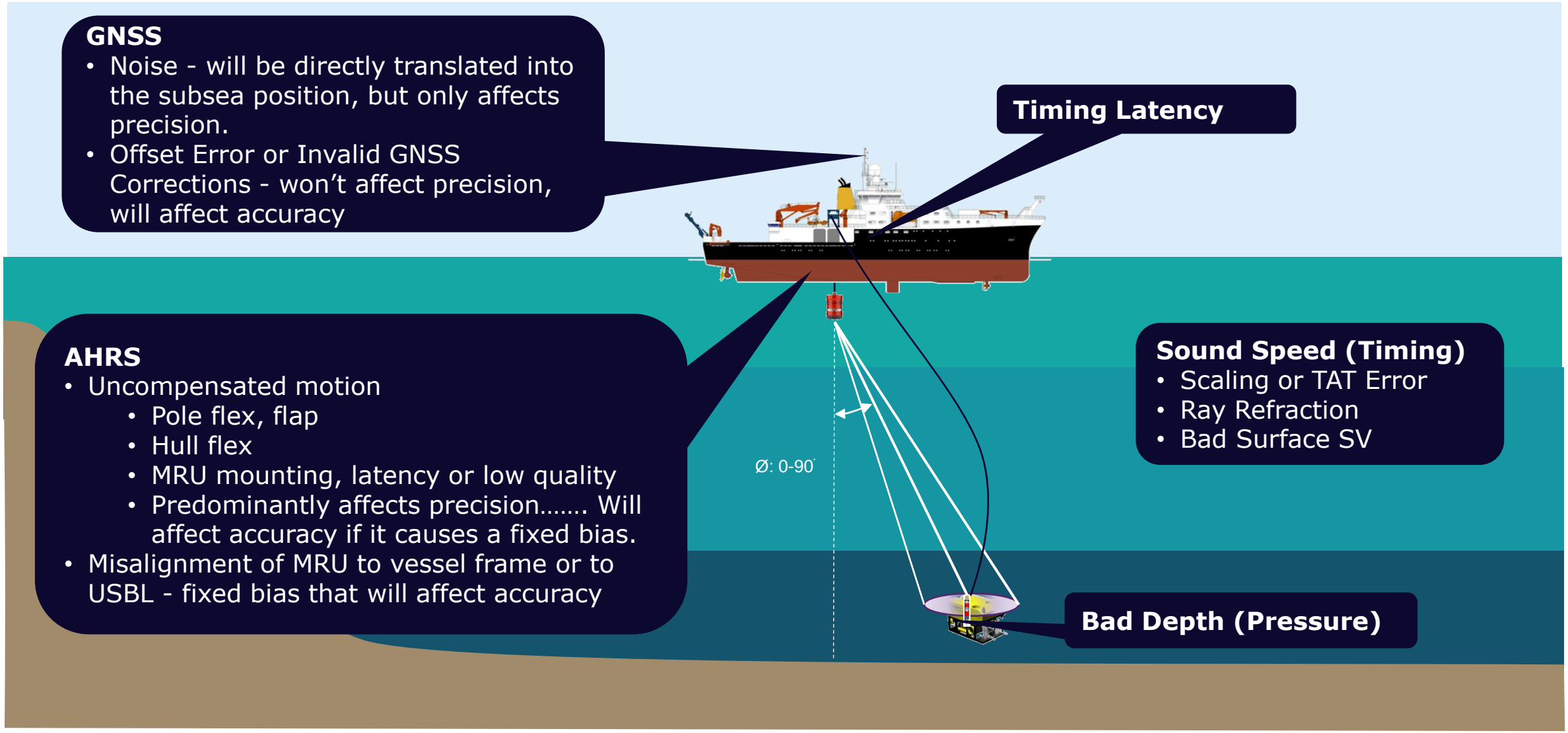


eg - a 0.5° error in transceiver pitch or roll would equate to 17.5 m positional error at a slant range of 2,000 m (0.88% of slant range)

USBL Errors & Issues – Error sources

GNSS
- Noise - will be directly translated into the subsea position, but only affects precision.
- Offset Error or Invalid GNSS Corrections - won't affect precision, will affect accuracy

Timing Latency

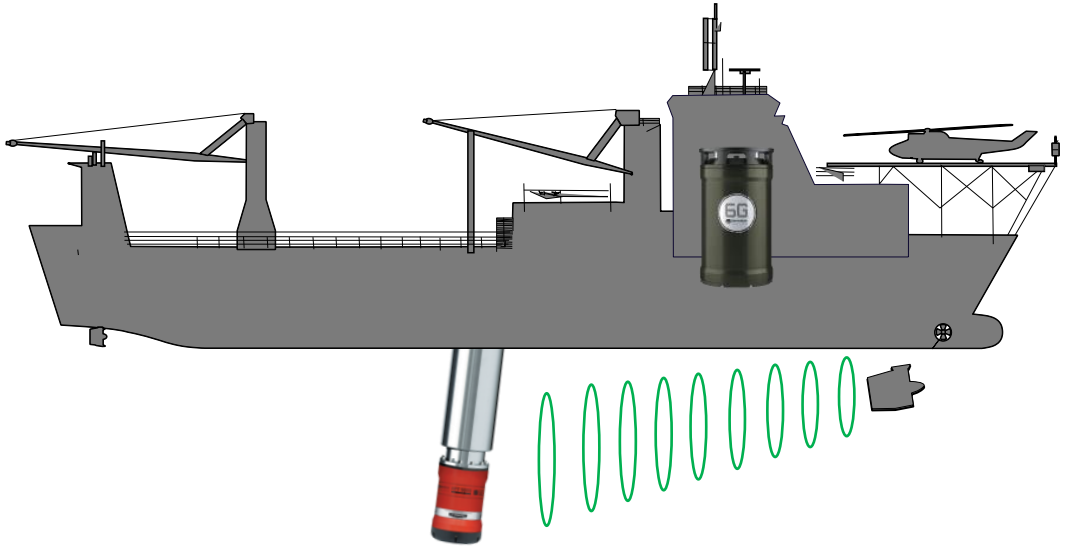


AHRS
- Uncompensated motion
  - Pole flex, flap
  - Hull flex
  - MRU mounting, latency or low quality
  - Predominantly affects precision……. Will affect accuracy if it causes a fixed bias.
- Misalignment of MRU to vessel frame or to USBL - fixed bias that will affect accuracy

Sound Speed (Timing)
- Scaling or TAT Error
- Ray Refraction
- Bad Surface SV

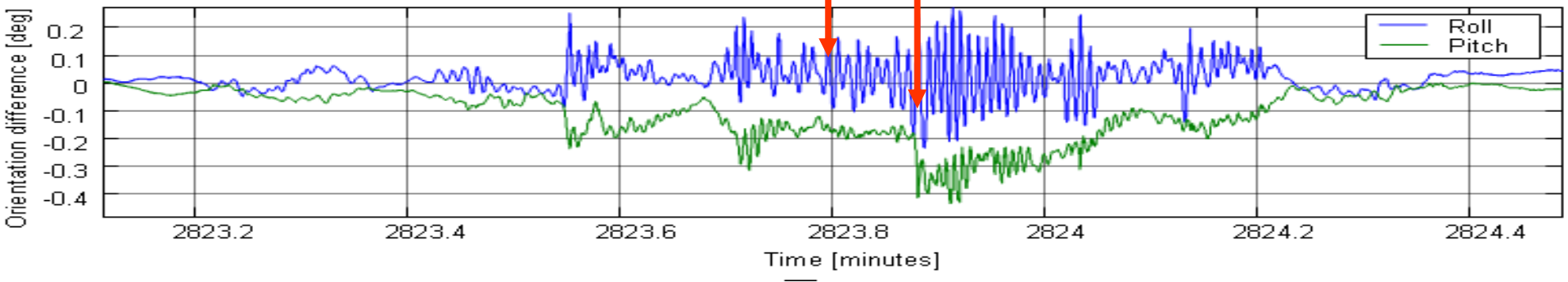
Bad Depth (Pressure)

USBL Errors & Issues – Pole Flap

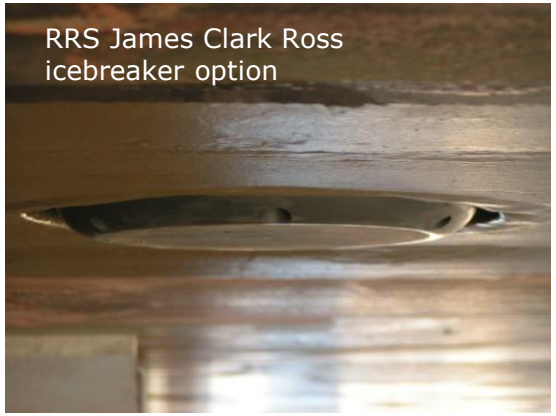


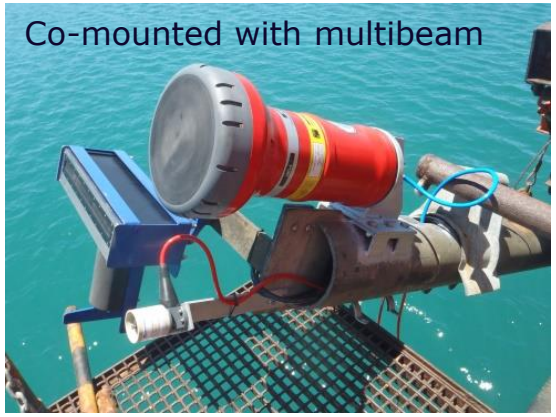
Pole resonates at 2Hz approx

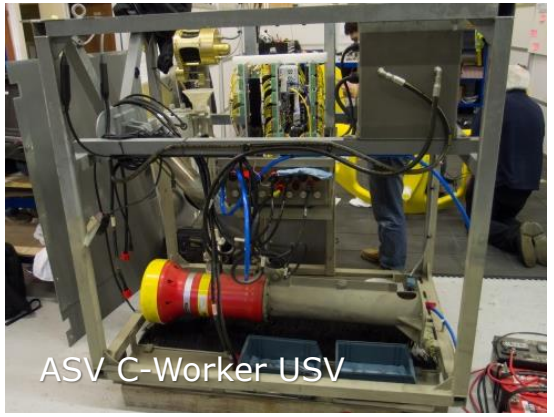
<0.3° pitch bias directly affects position accuracy



USBL Errors & Issues – Deployment machines







USBL Errors & Issues – GyroUSBL

- GyroUSBL is a combined USBL and attitude sensor
- Out of the box “Calibration free”
- ~0.3% slant range precision improving to up to 0.1% slant range after the first and only calibration
- GyroUSBL can be moved from vessel to vessel without a need to re-calibrate with only a quick spin test to verify alignment required

USBL Errors & Issues – % Range Error

- Random:
  - Range ‘jitter’ due to acoustic noise
  - Transponder timing
  - AHRS/Gyro sensor drift
  - Angle measurement error
- Systematic
  - Sound speed error
  - Incorrect offsets
  - Uncalibrated on incorrect calibration
  - Sensor latency
- Mistakes
  - Incorrect TAT
  - Multipath
  - Reference beacon movement
  - Tracking the wrong beacon

Use good equipment

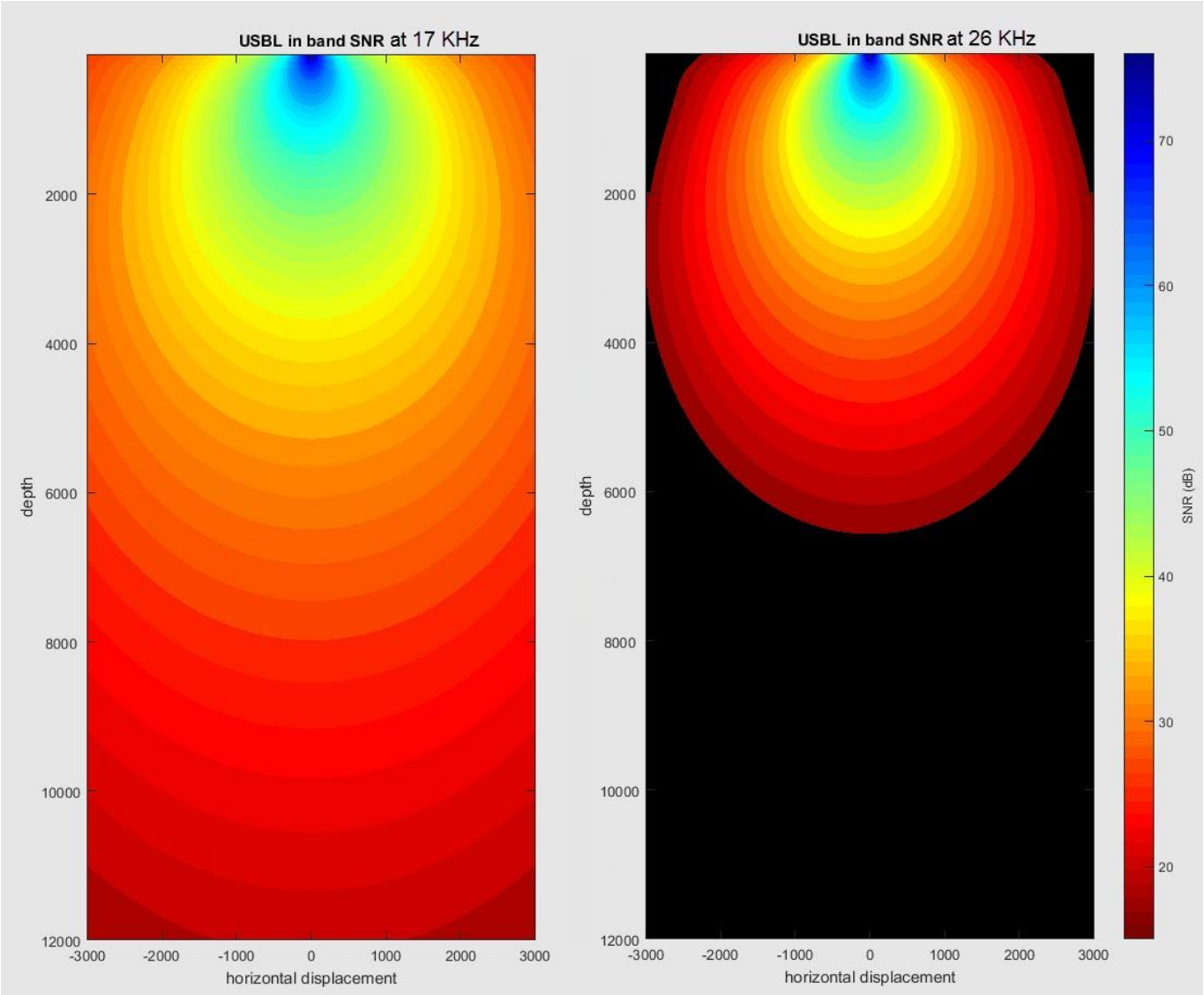
Calibrate the equipment and use it properly

Ensure your people are trained well

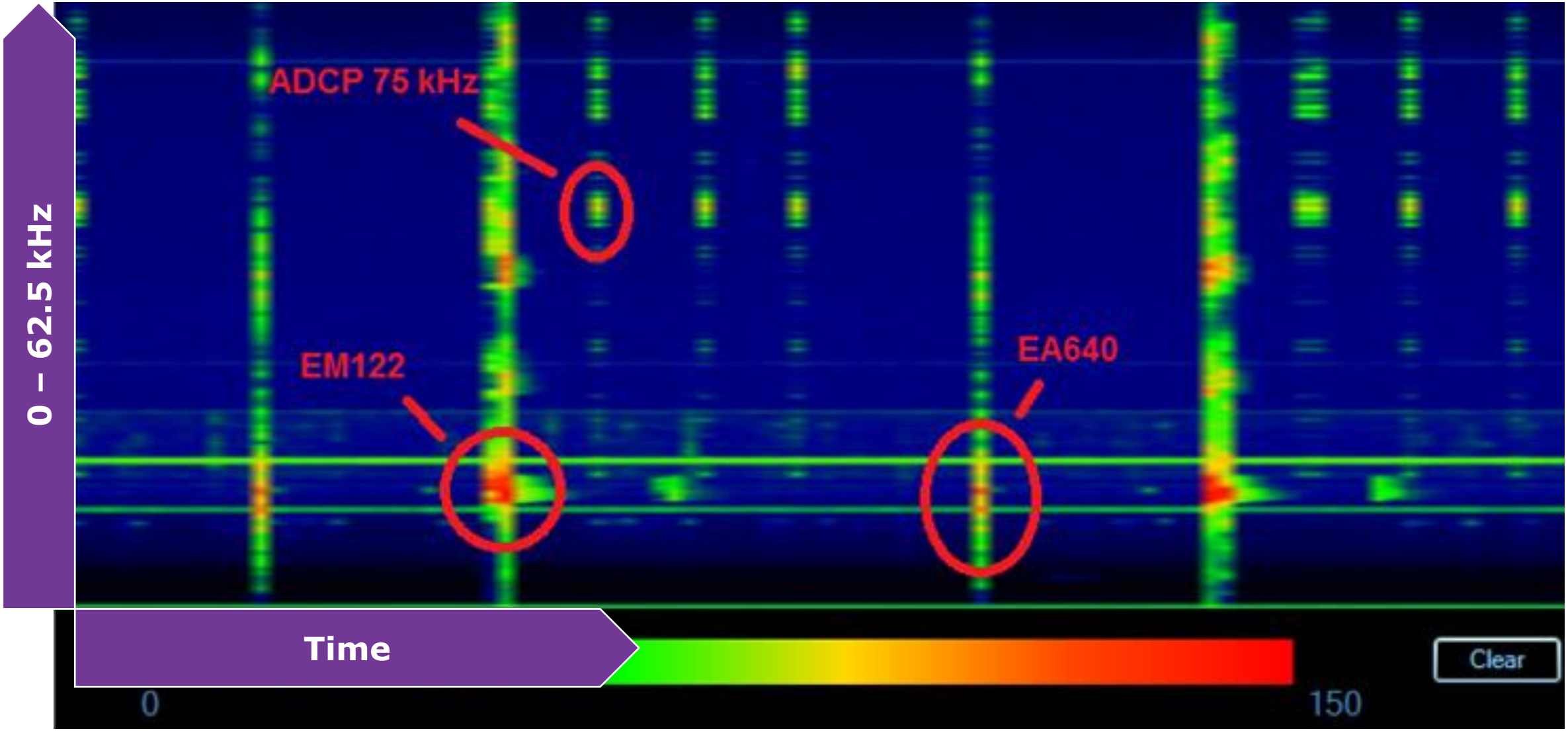
Noise

USBL Noise – Absorption & Frequency

Frequency (kHz)	Absorption (dB/km)	Δ from 14kHz (dB/km)
14	1.93	-
17	2.71	0.78
19	3.27	1.34
25	5.12	3.19
34	8.01	6.08



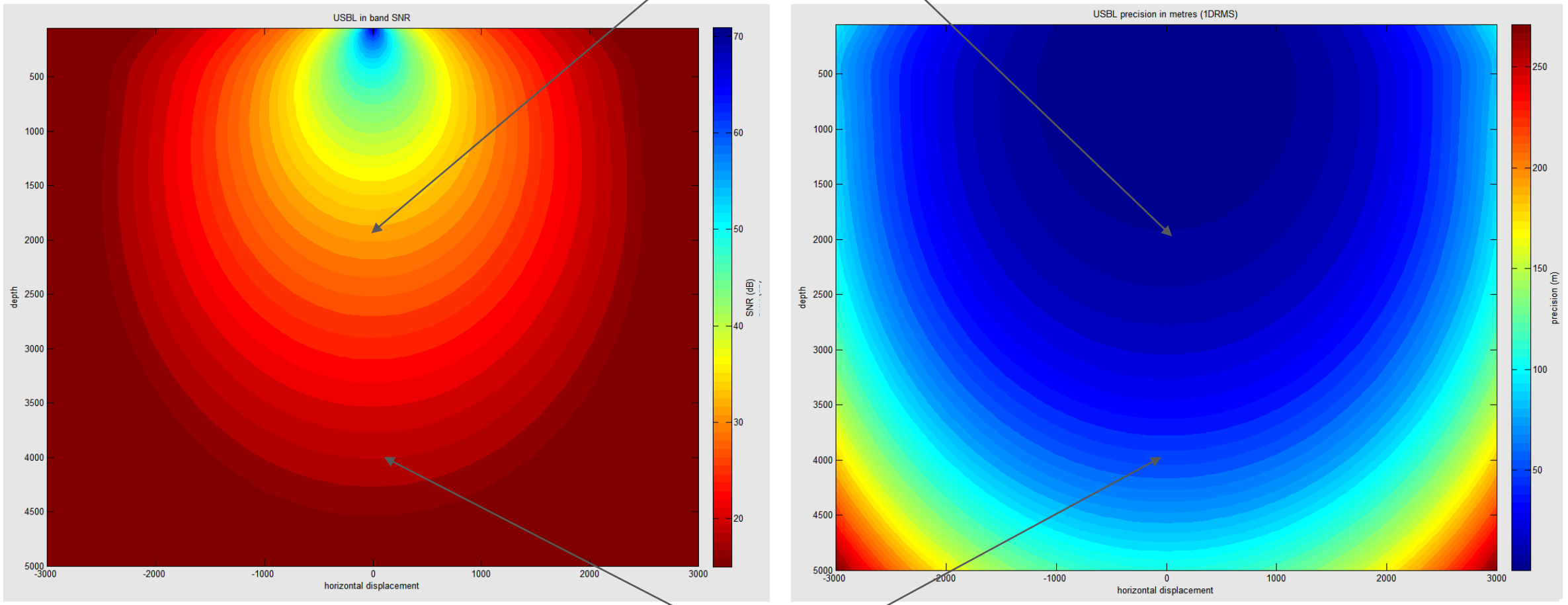
USBL Noise – Other acoustic sensors



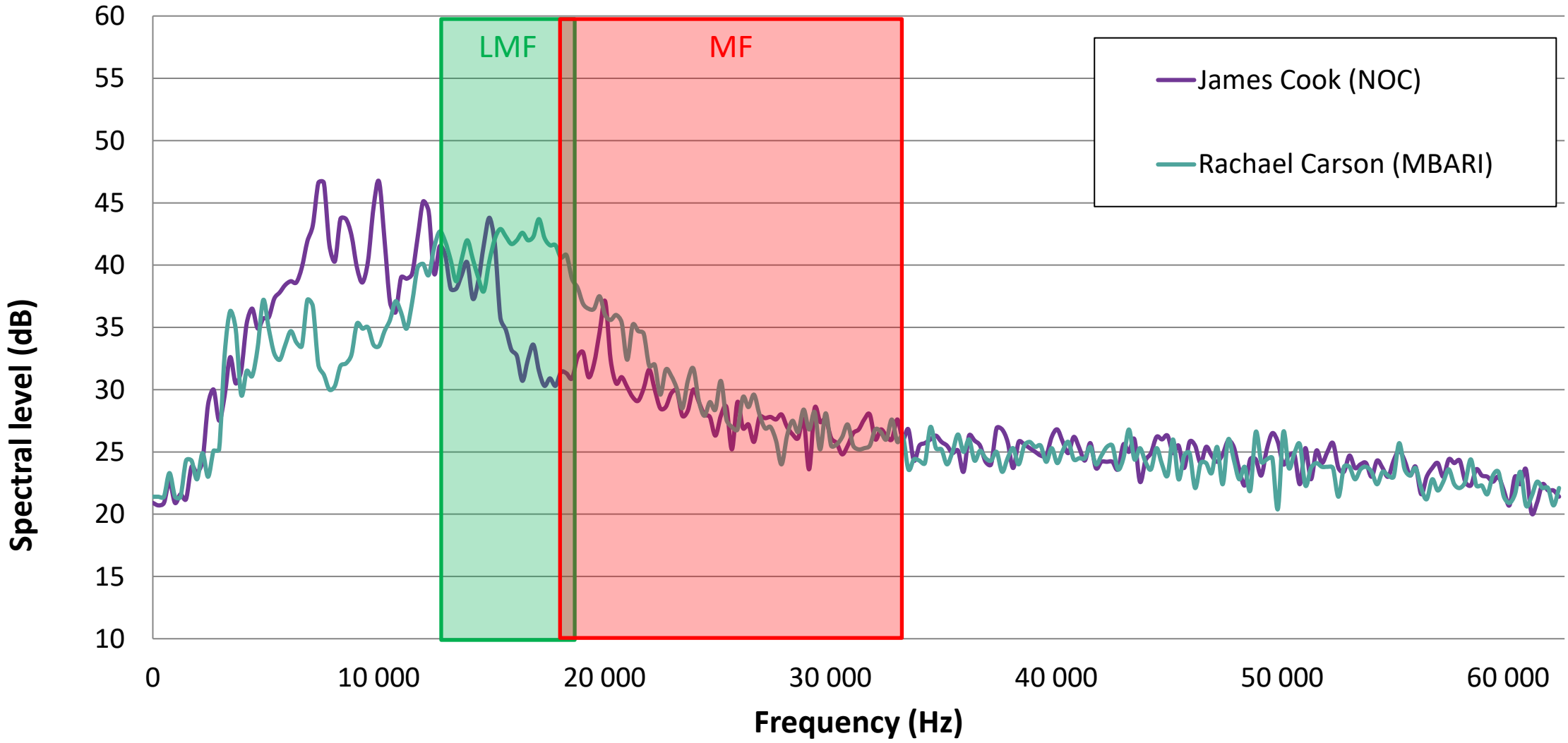
USBL Noise – SNR & Precision

In band SNR

Precision in metres (1DRMS)

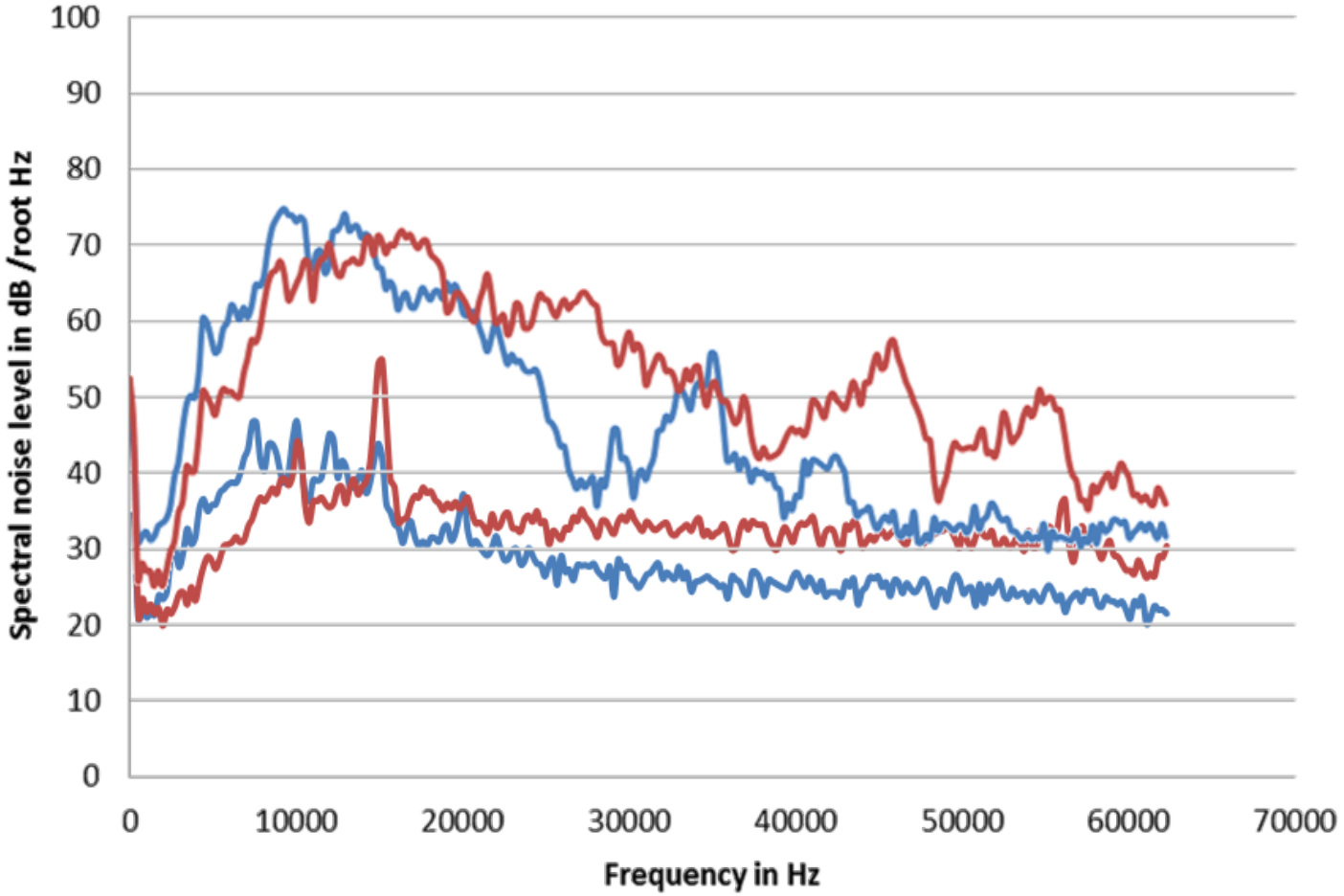


USBL Noise – SNR & Precision



USBL Noise – SNR & Precision

Band	kHz	Stationary	Underway	Station keeping
		dB	dB	dB
MF	20	36	36	65
	26	35	35	62
	30	34	34	58
LMF	12	40	40	70
	15	40	40	65
	18	32	32	60



Sonardyne Ranger 2 USBL

Sonardyne Ranger 2 USBL – Systems for all applications

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Micro Ranger 2

995 METRES MAX RANGE

3.5 - 5% SLANT RANGE PRECISION

10 MAX NO OF BEACONS TRACKED

Mini Ranger 2

<4,000 METRES MAX RANGE

1.3-0.2% SLANT RANGE PRECISION

10 MAX NO OF BEACONS TRACKED

Ranger 2

>11,000* METRES MAX RANGE

0.1% SLANT RANGE PRECISION

99 MAX NO OF BEACONS TRACKED

* LMF

Ocean Science – The integrated 6G ecosystem

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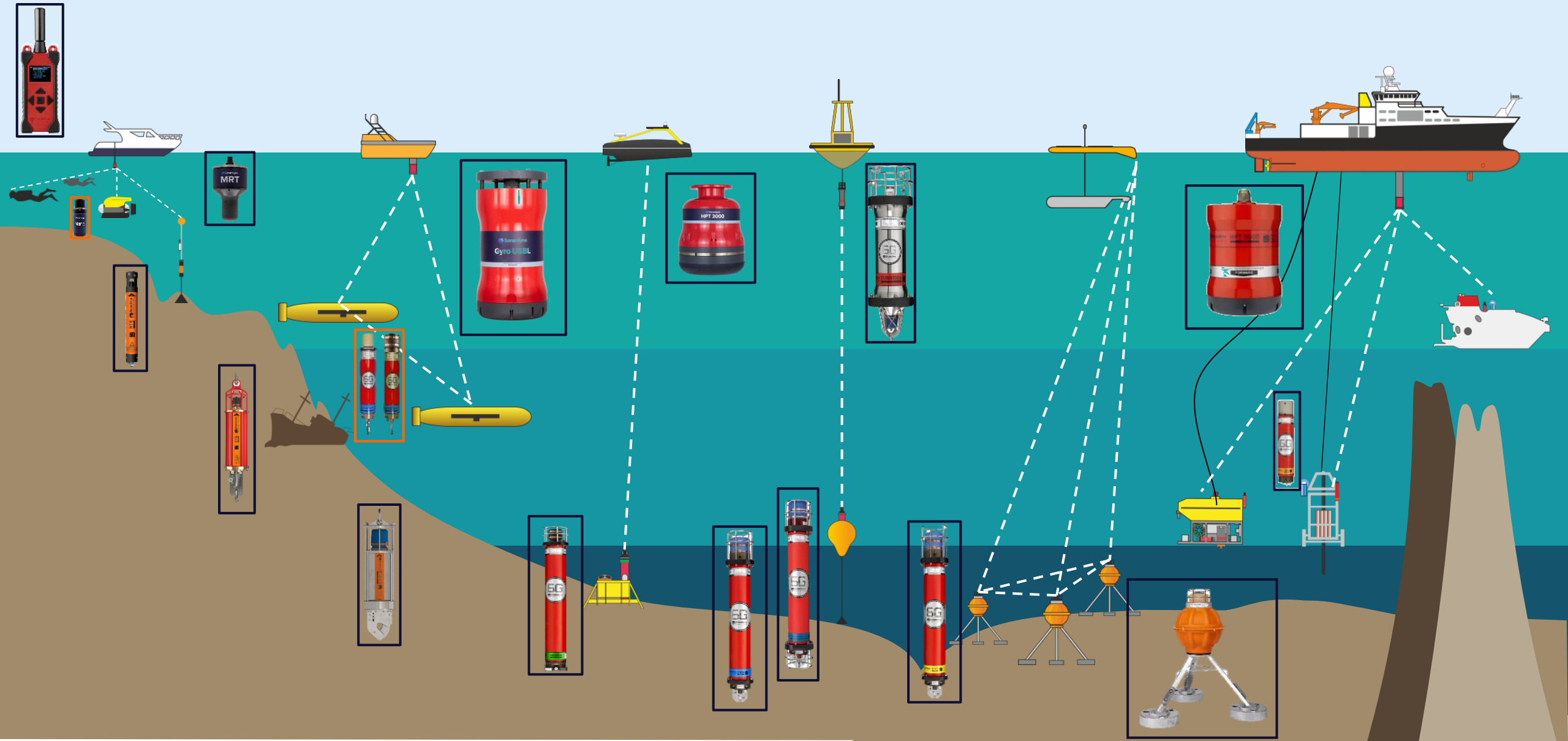

Sonardyne Ranger 2 USBL – Track Record

Sonardyne

- Ranger 2 USBL: https://www.sonardyne.com/products/ranger-2-subsea-positioning-usbl/
- Mini Ranger 2 USBL: https://www.sonardyne.com/products/underwater-positioning-mini-ranger/
- Micro Ranger 2 USBL: https://www.sonardyne.com/products/micro-ranger-2-shallow-water-usbl-system/
- Gyro USBL: https://www.sonardyne.com/products/gyrousbl-high-precision-acoustic-positioning/
- Which deployment machine? https://www.sonardyne.com/products-knowledge-base/which-usbl-deployment-machine-is-most-suitable-for-my-vessel/
- Healthy deployment machine: https://www.sonardyne.com/healthy-deployment-machine-healthy-usbl-results/
- CASIUS: https://www.sonardyne.com/products-knowledge-base/what-does-my-casiuis-results-tell-me-about-my-calibration/

Thank you for your time today

Any questions?

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