USBL System Optimisation

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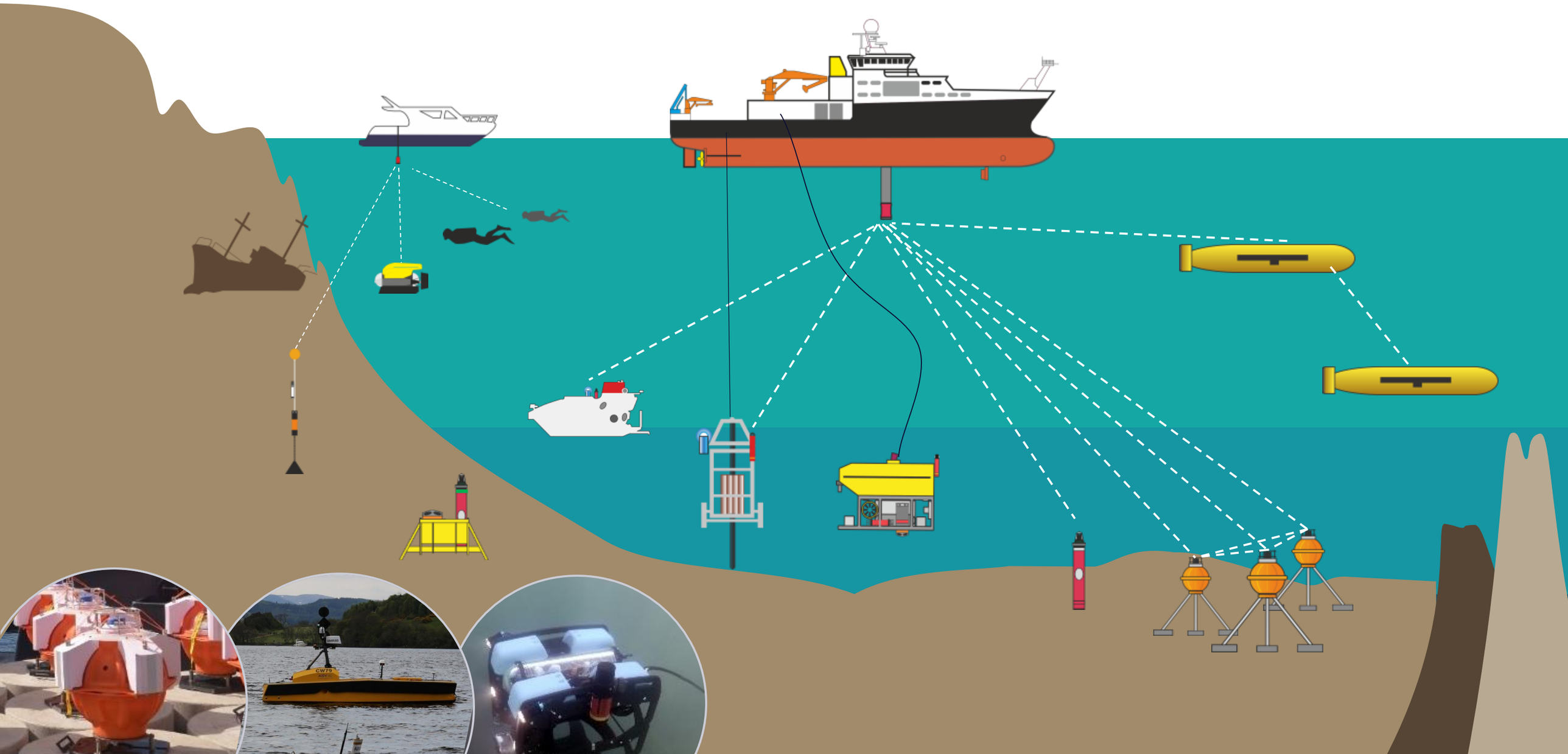
RVTEC 2025 – San Diego – November 2025

What is USBL?

Sonardyne



How does it work?

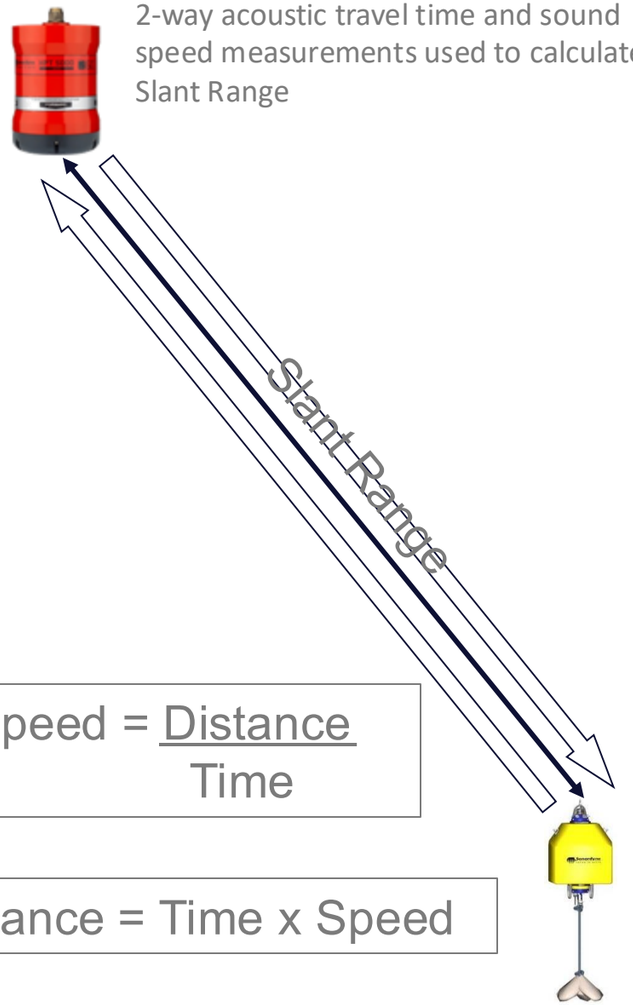
Transceiver face comprises two acoustic element types, which are recessed into high grade plastic and encapsulated in polyurethane:

- 1 x transmit
- A number of receivers

How does it work?

SLANT RANGE

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

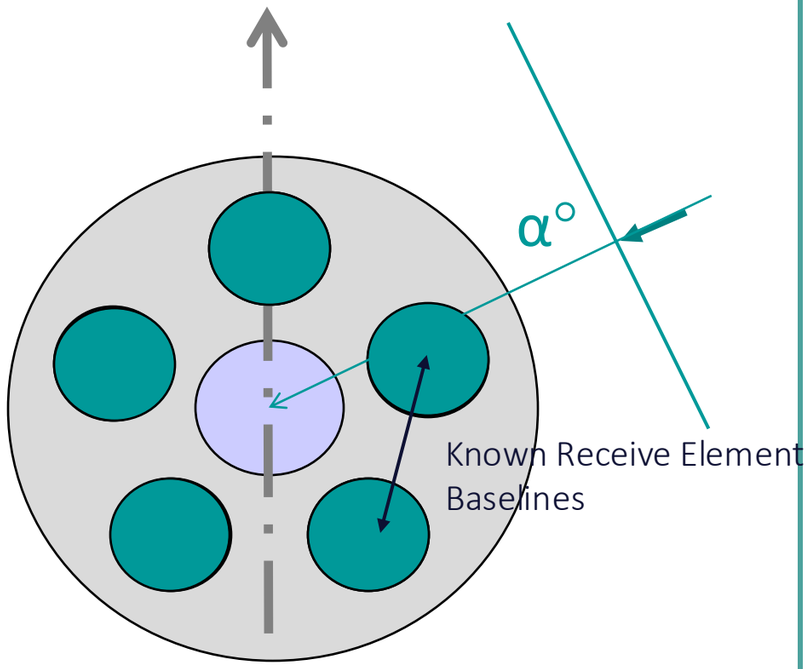


Speed = Distance / Time

Distance = Time x Speed

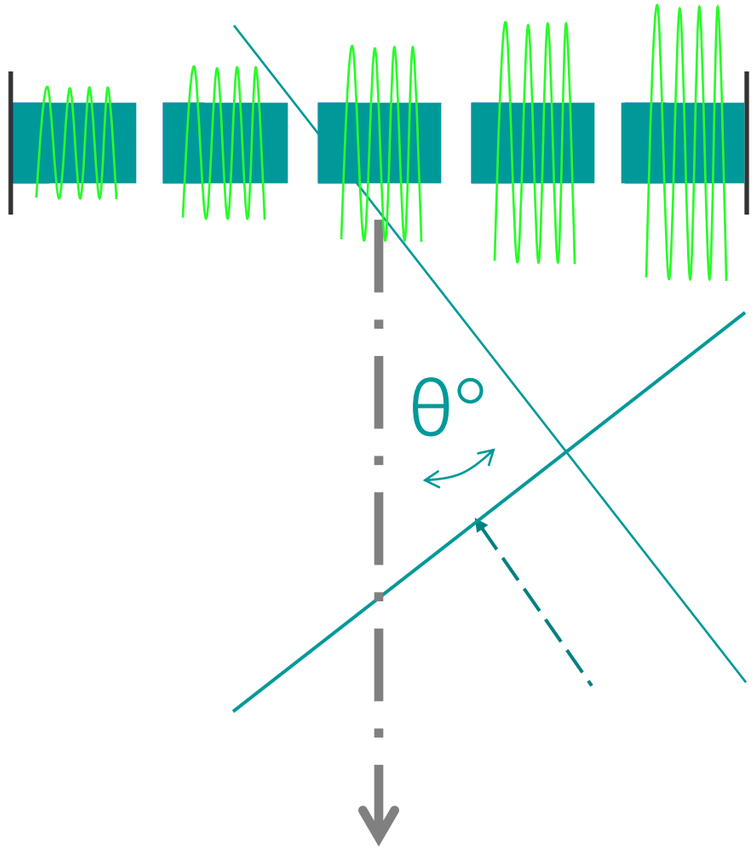
AZIMUTH

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)

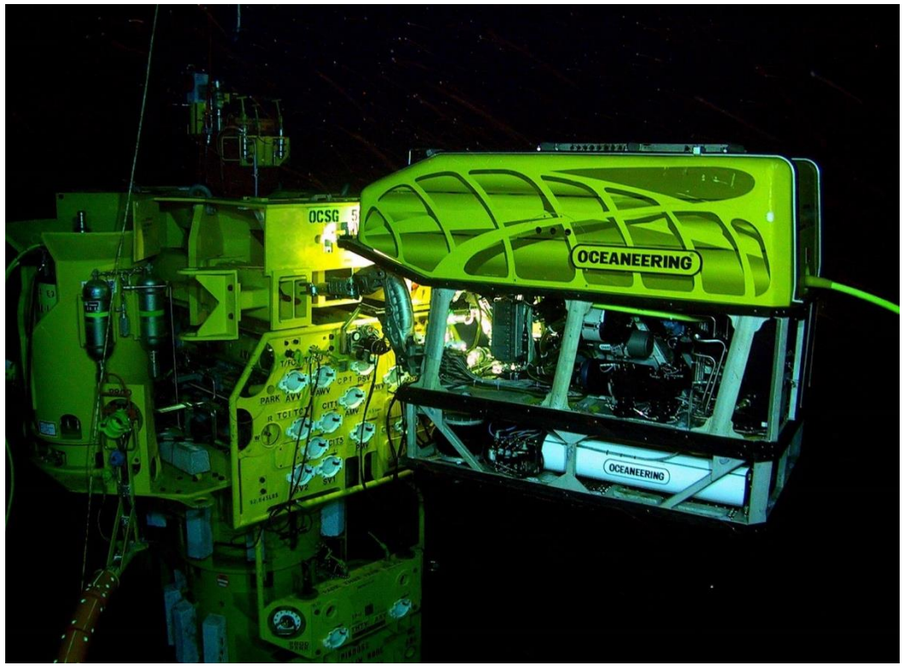
ELEVATION



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

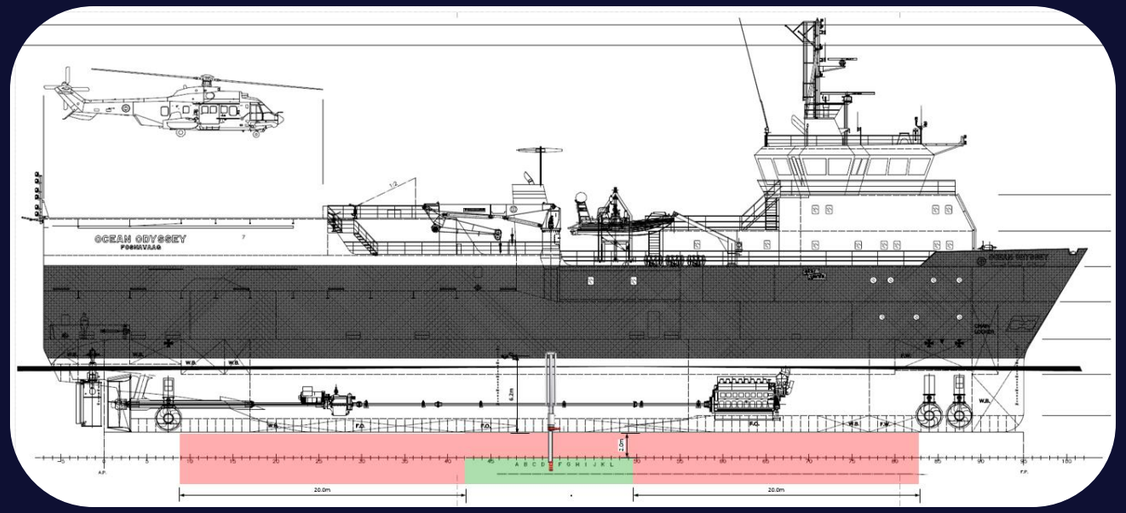
Part 1 – Considerations

Q1: What will the system be used for?



Q2: How and where will the system be deployed?

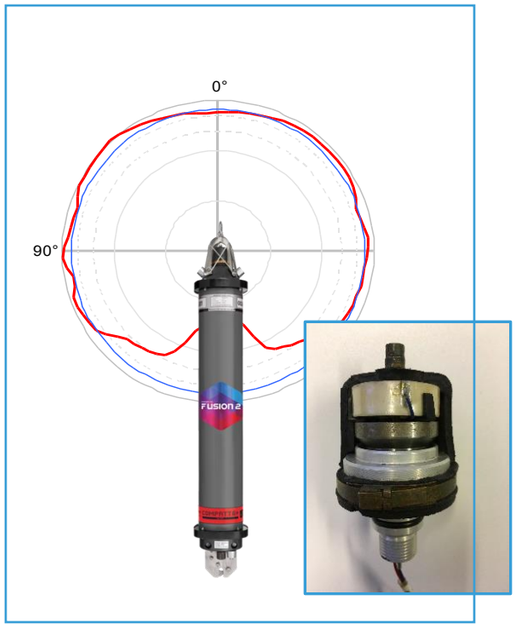
- Reduce received noise
- Clear aerated water
- Repeatable position when deployed
- Vibration resistant

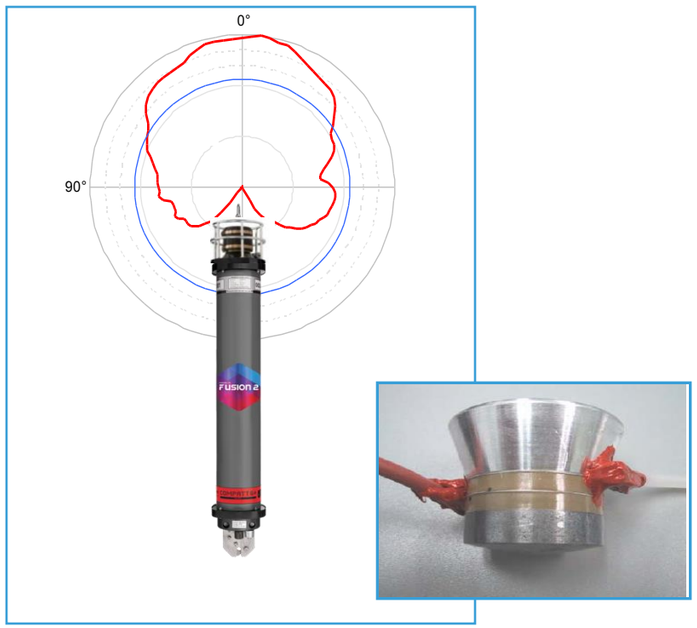


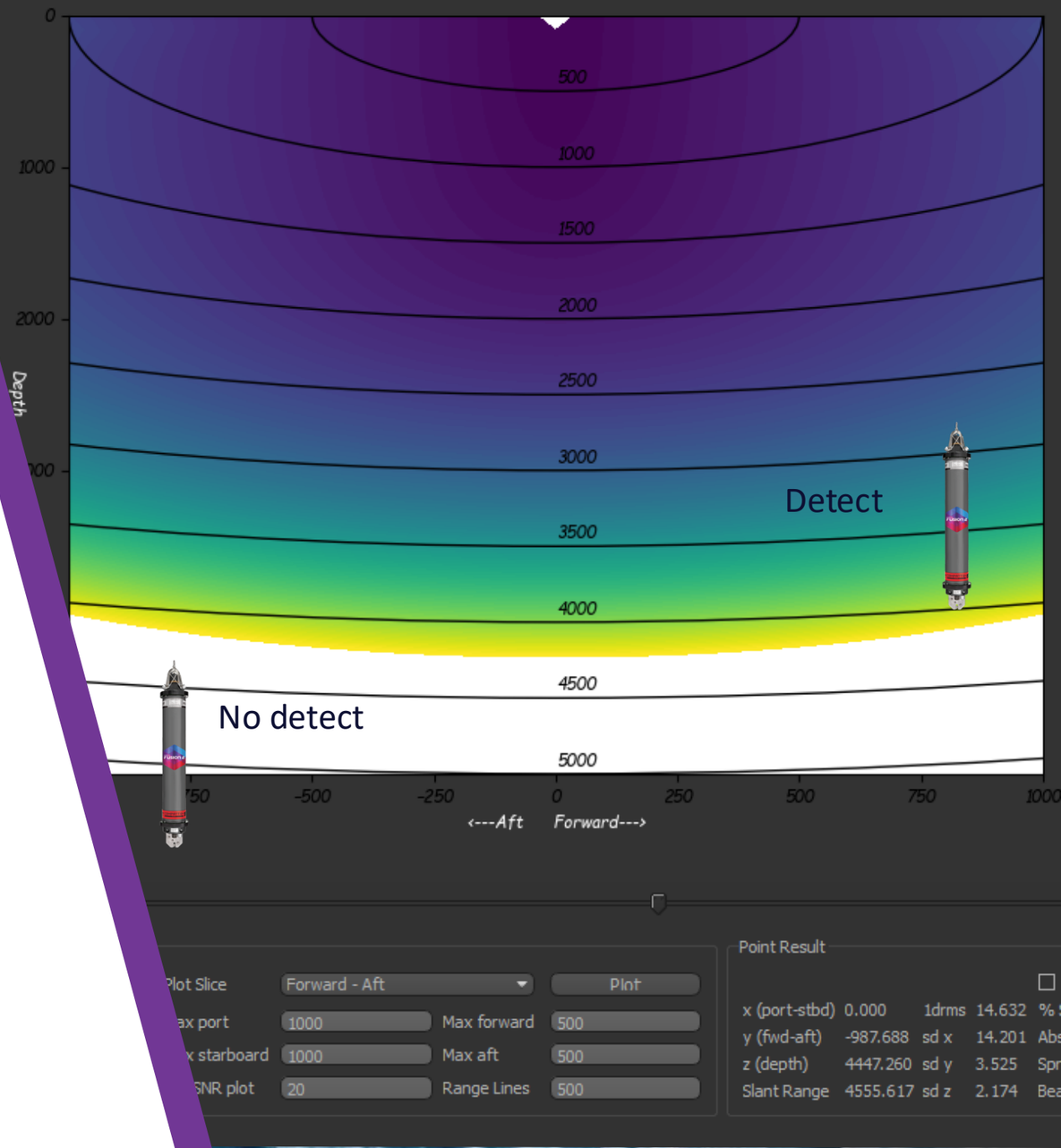
Noise modelling

Modelling system performance helps eliminate issues before they occur

- Will my beacons have enough sound energy?
- What range should I expect from the system?
- What affect does moving the deployment system have?
- Is there any benefit in tilting the transceiver?







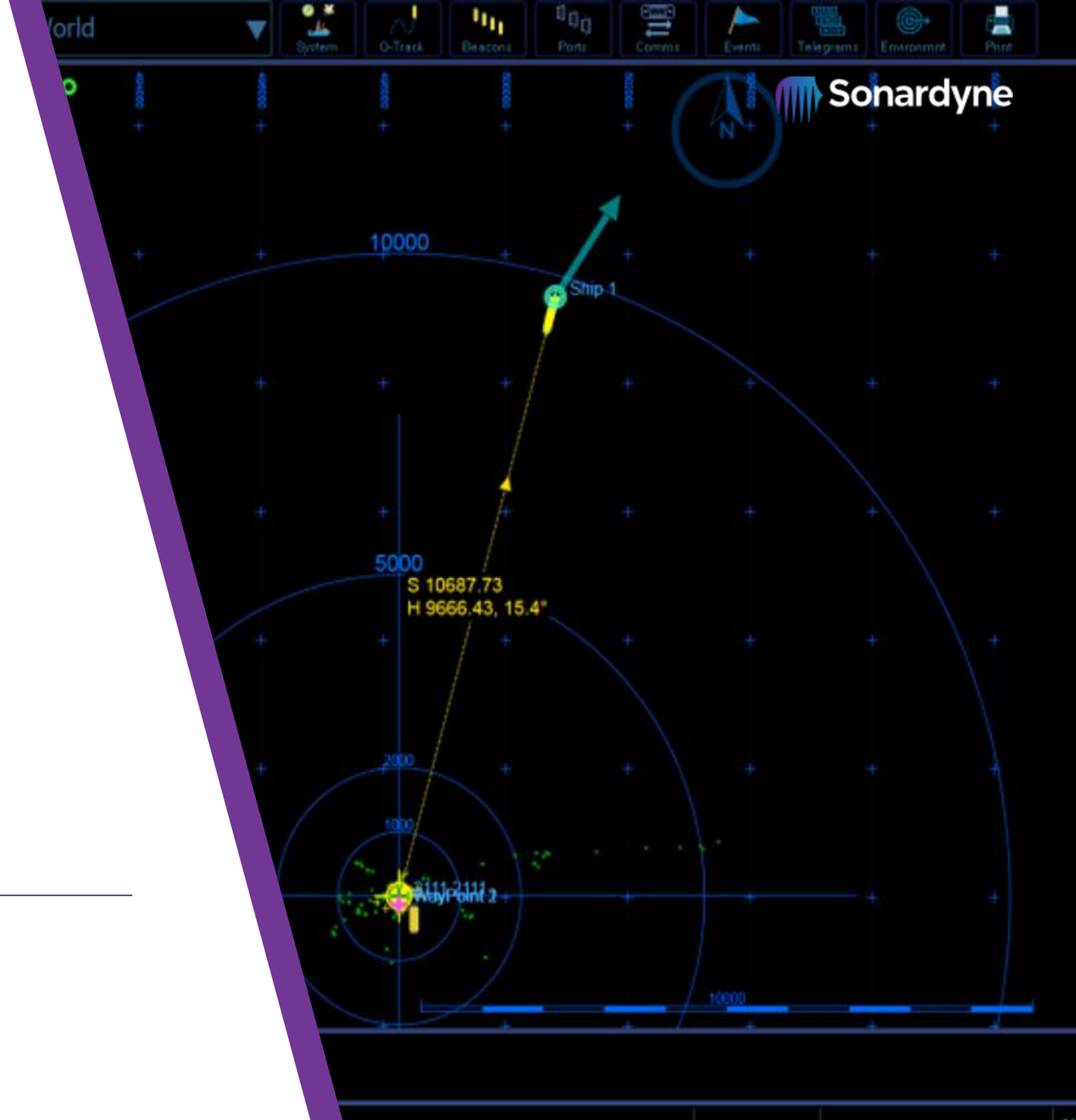
Additional options

Long-range – determined by frequency

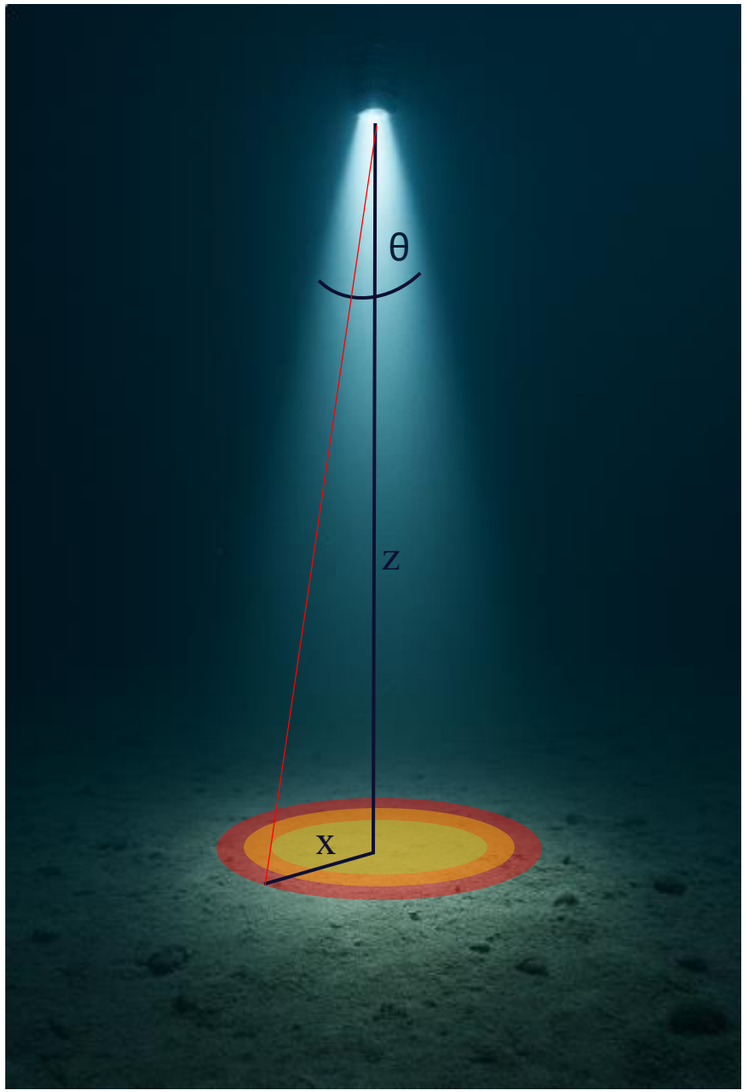
Inertial navigation – Improved precision, fast update rate, reduced acoustic traffic, improved battery life

Transponders – type, capability, depth rating

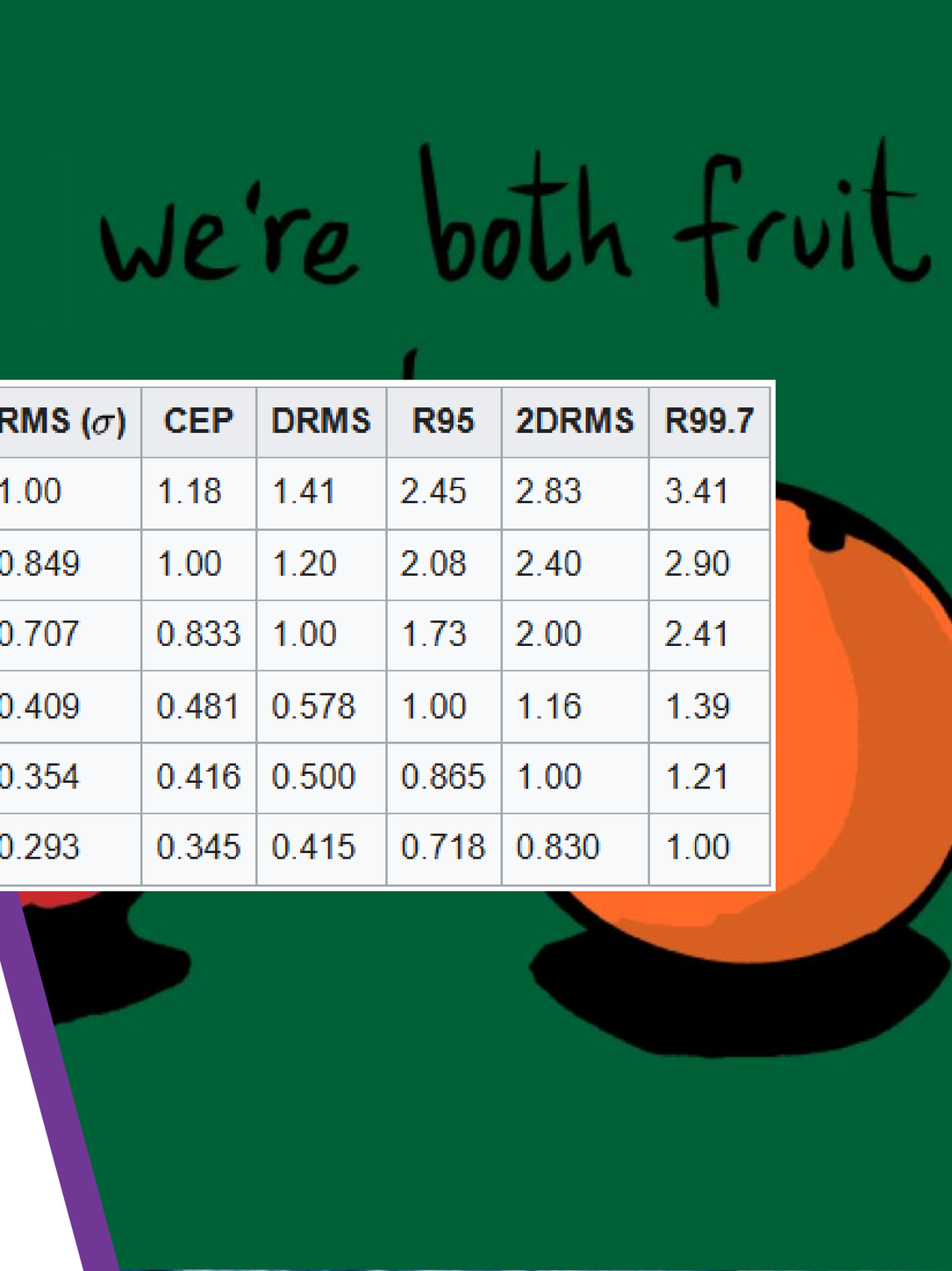
Acoustic release / Modem



Compare like-for-like



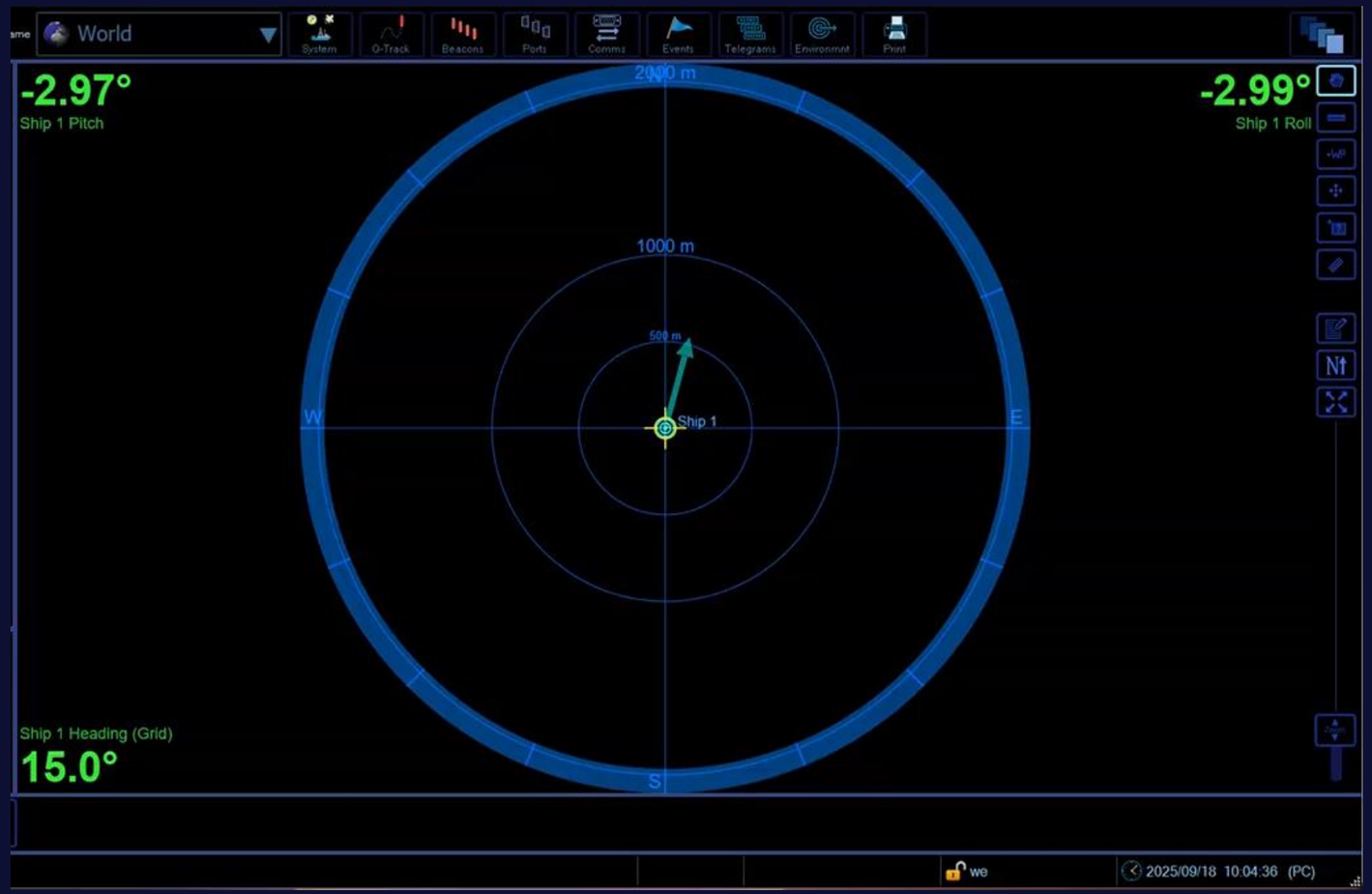
From $X \downarrow$ to $Y \rightarrow$	RMS (σ)	CEP	DRMS	R95	2DRMS	R99.7
RMS (σ)	1.00	1.18	1.41	2.45	2.83	3.41
CEP	0.849	1.00	1.20	2.08	2.40	2.90
DRMS	0.707	0.833	1.00	1.73	2.00	2.41
R95	0.409	0.481	0.578	1.00	1.16	1.39
2DRMS	0.354	0.416	0.500	0.865	1.00	1.21
R99.7	0.293	0.345	0.415	0.718	0.830	1.00

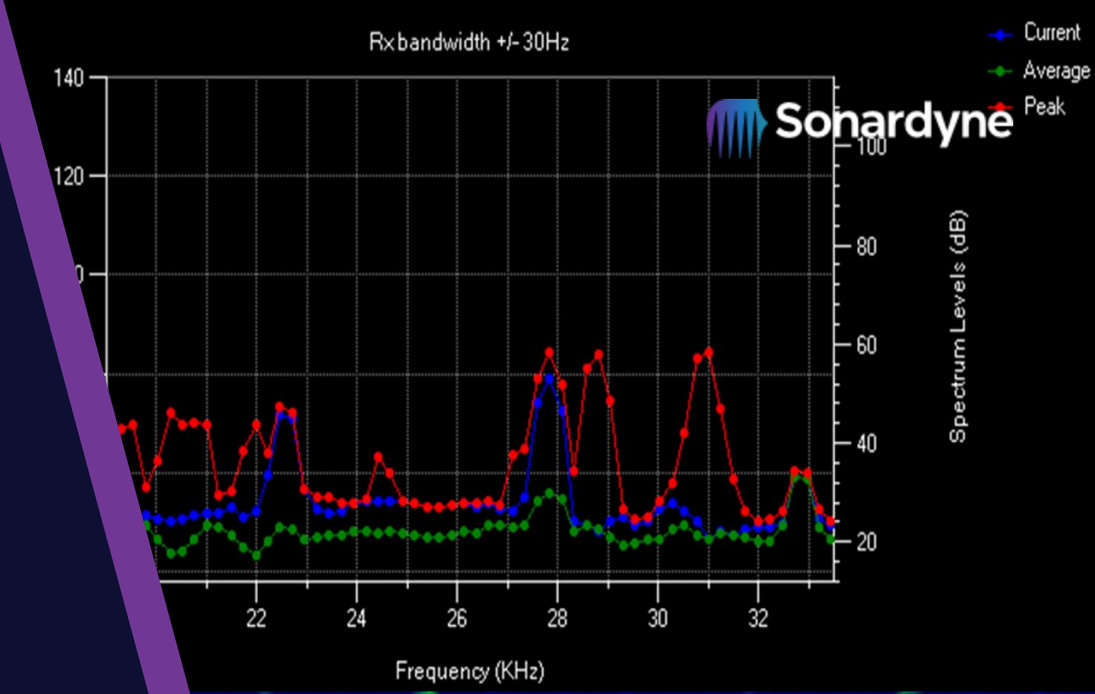


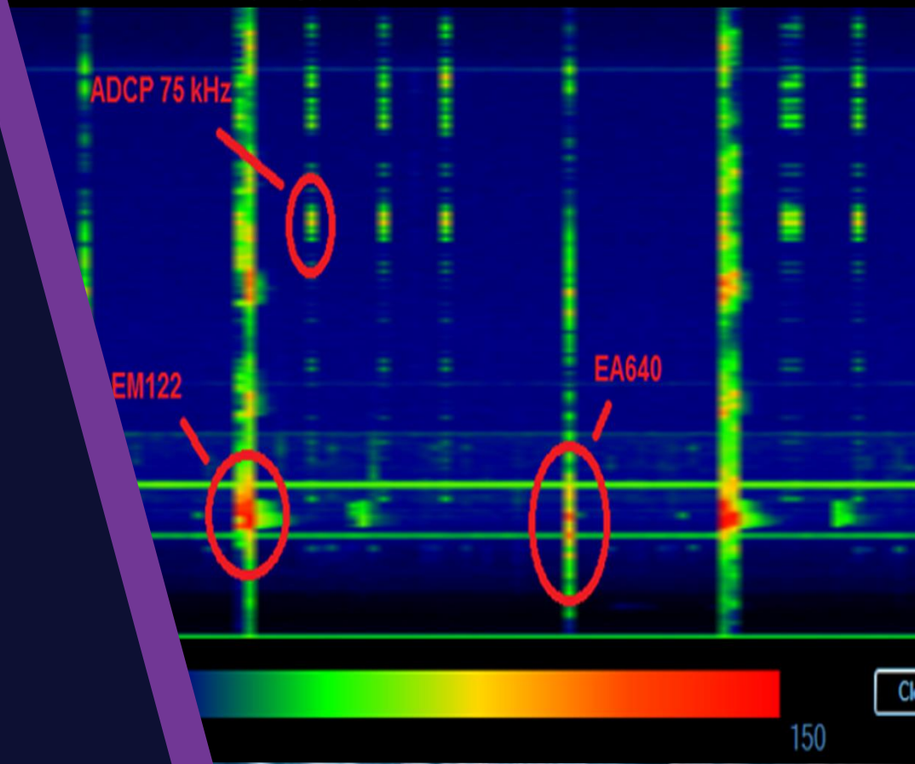
Part 2 – System Optimisation

Noise

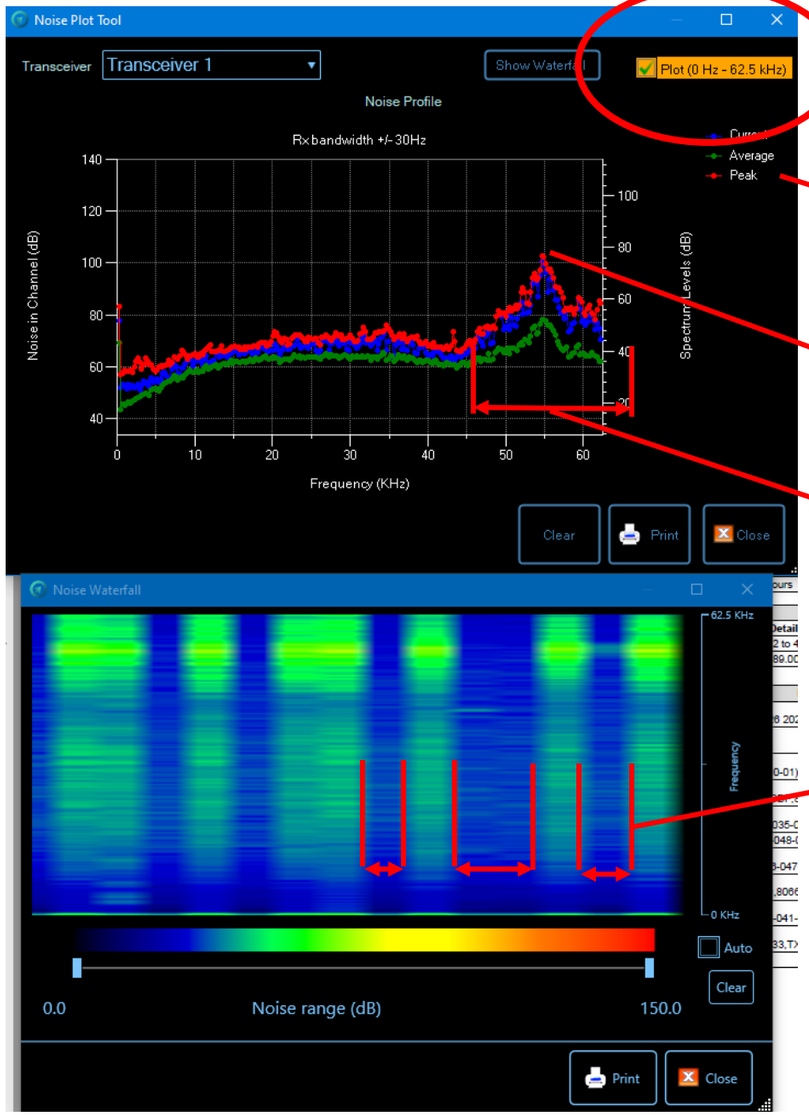
- Frequency management
- Monitor for noise sources that impact USBL







Noise - examples



Outside of regular USBL window, but may still cause interference

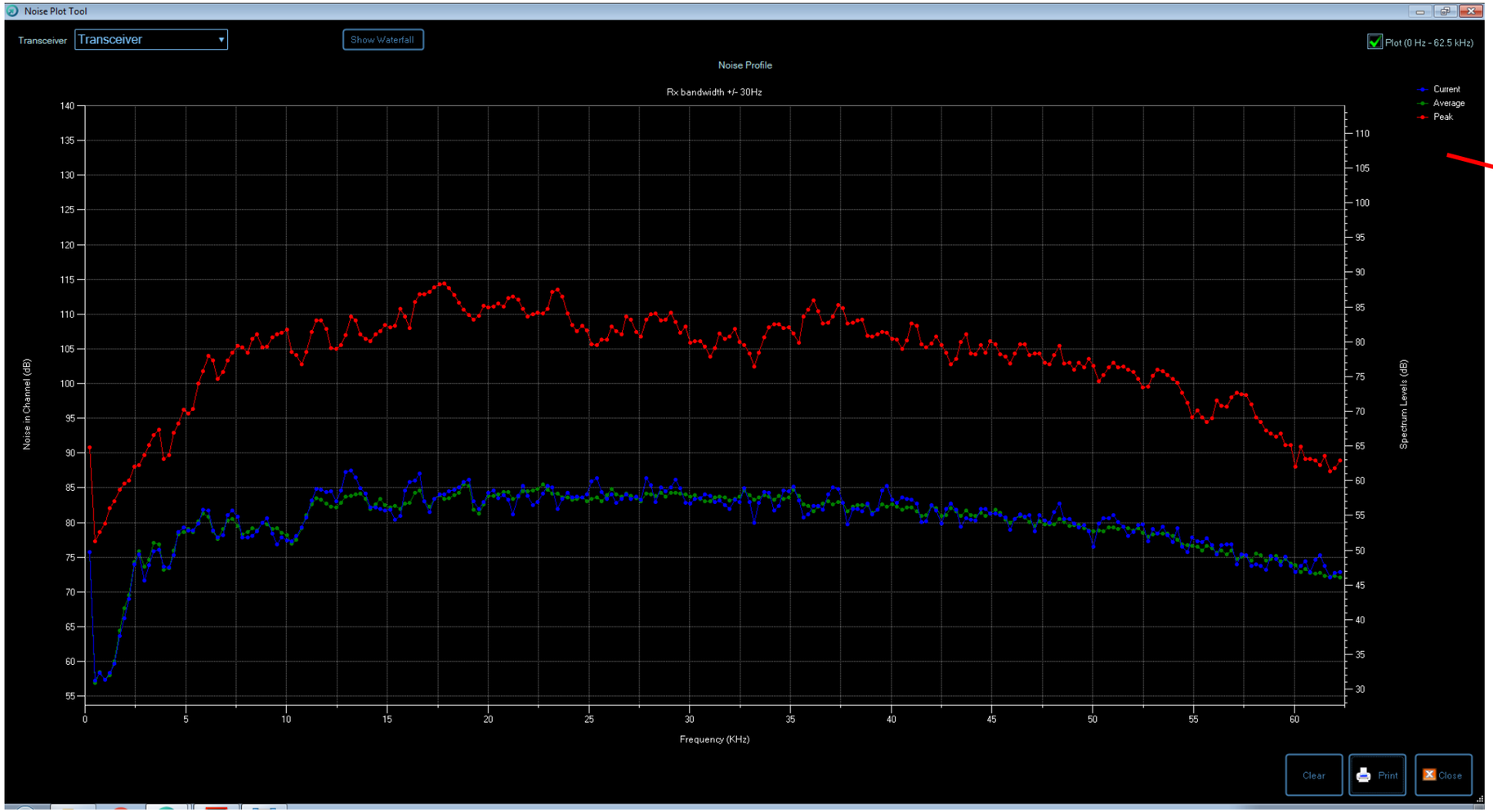
Current, average and peak all similar so a regular occurrence

Frequency spikes at 55kHz

Bandwidth 45kHz – 65kHz

1 Hz update rate

Noise - examples



Current, average similar but peak much higher

Bandwidth across all channels

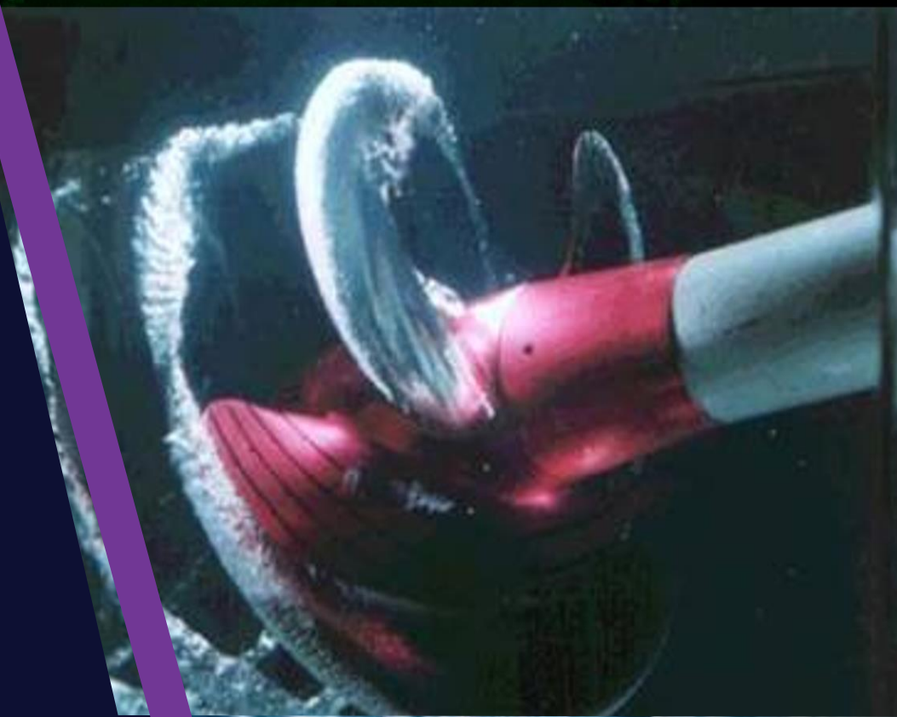
Maintenance

Competency

Part 3 – Fine tuning

Signal diagnostics – surface

- Improve system performance
- Monitor in real time signal quality

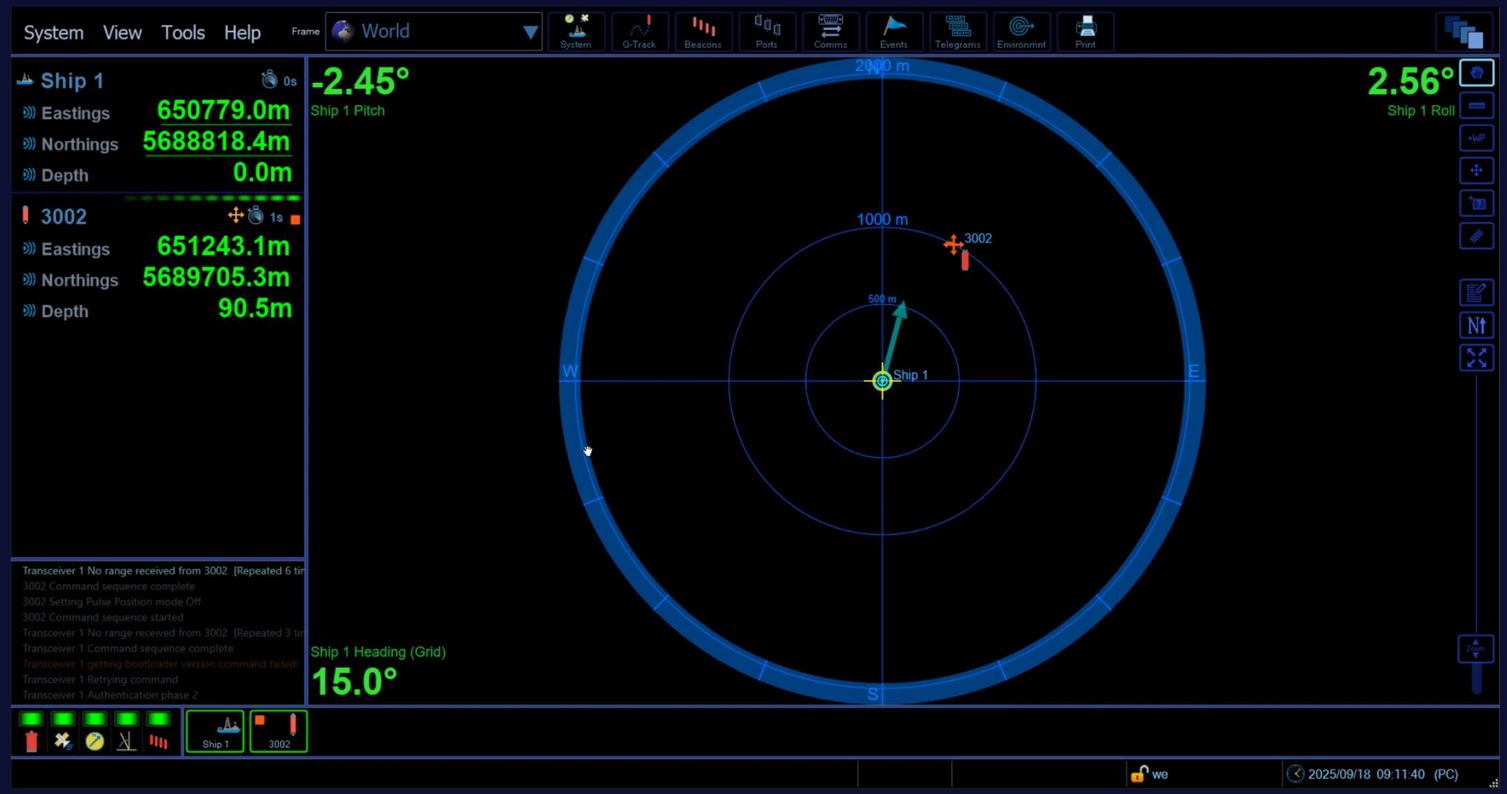


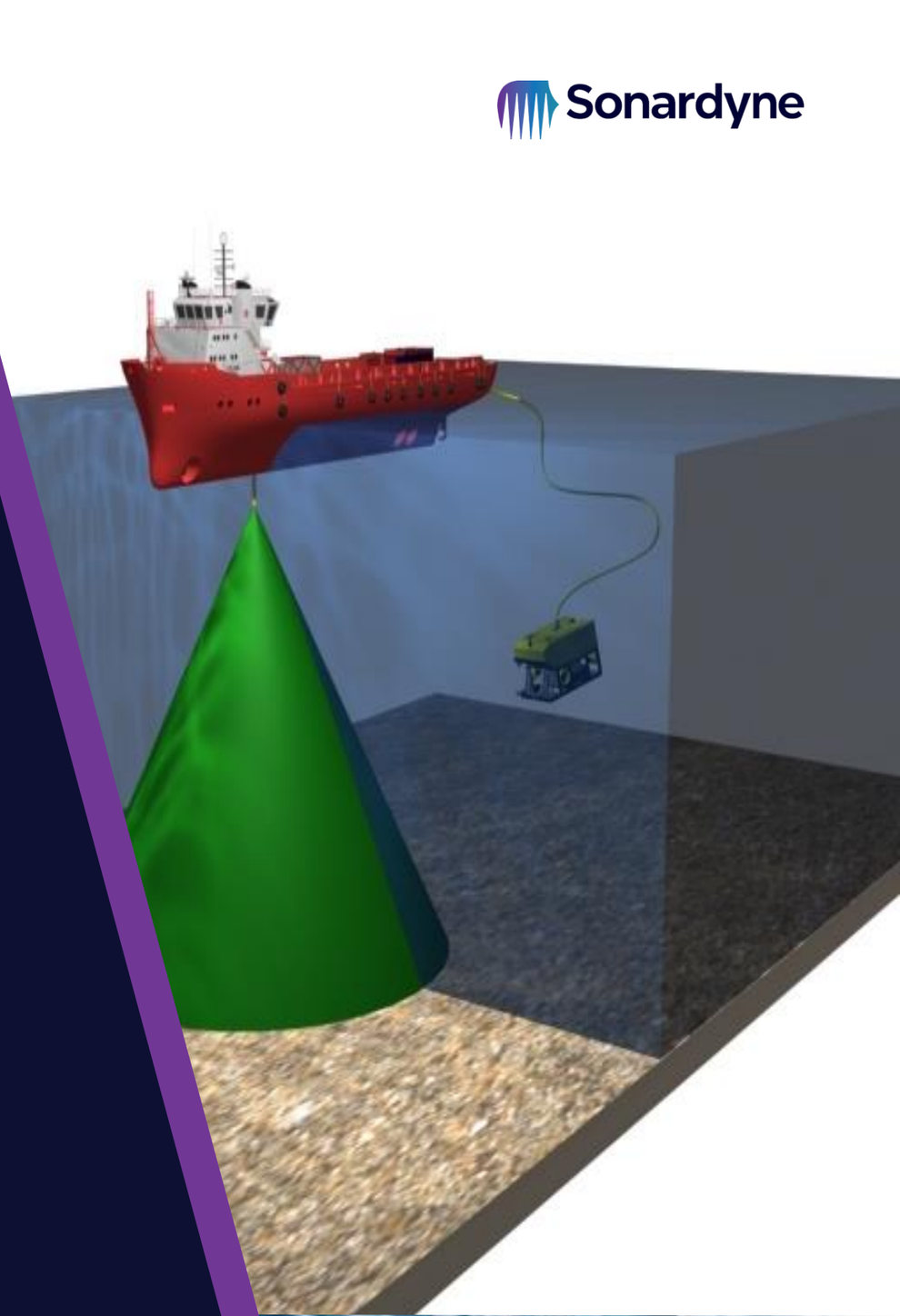
Signal diagnostics – subsea

- Use acoustic comms link to measure subsea environment
- Remotely change settings to improve performance
- Monitor for changes

High-elevation tracking

- Susceptible to interference from surface noise (waves, vessel etc)
- Thermoclines have maximum impact at surface
- Use beacon or 3rd party depth sensor





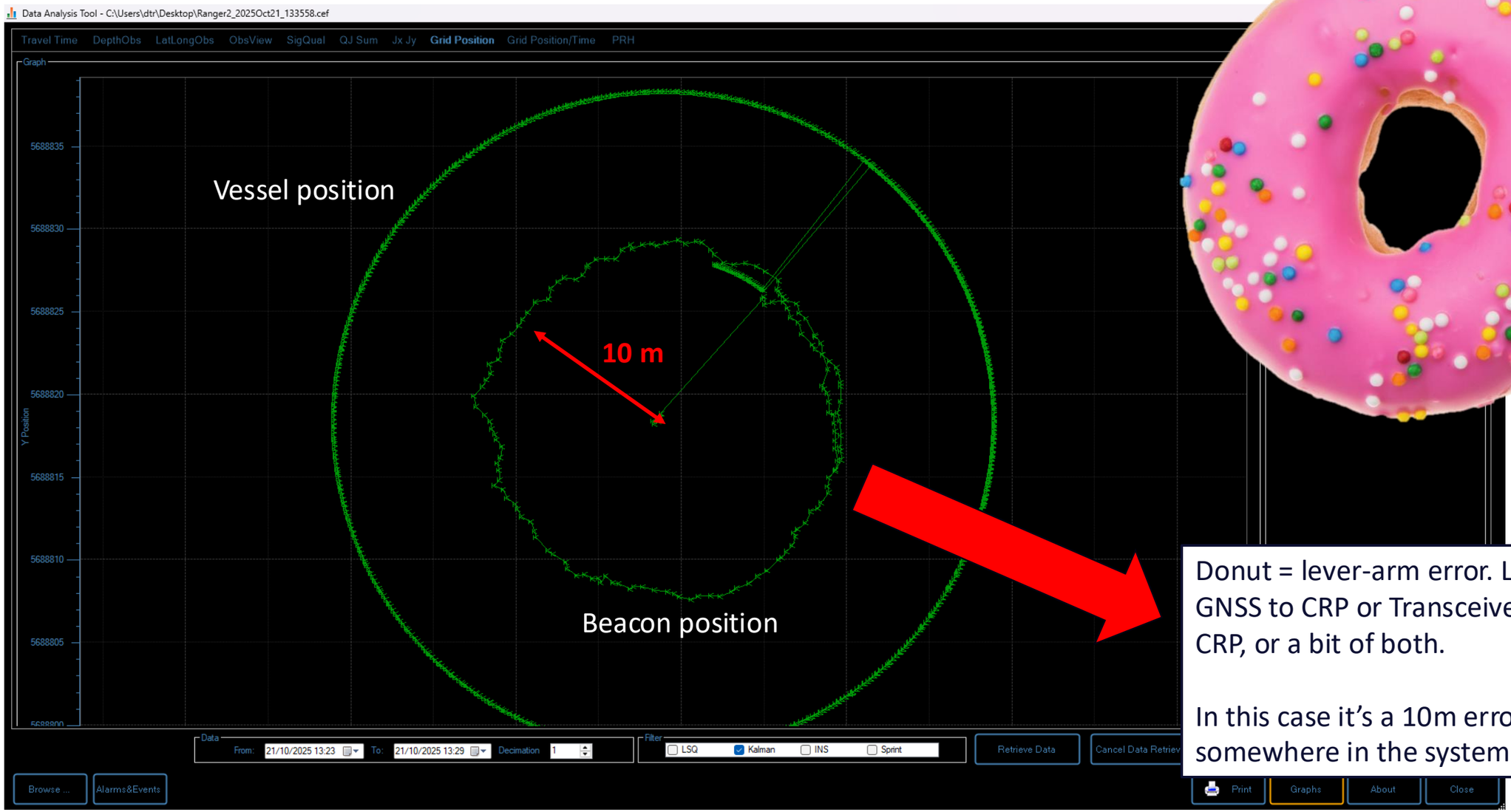
Part 3 – Data Analysis Tool (DAT)

Data Analysis Tool

Data Analysis Tool

Travel Time	DepthObs	LatLongObs	ObsView	SIgQual	QJSum	Jx Jy	Grid Position	Grid Position/ Time	PRH
Time for signal to travel from the vessel to the beacon and back again (remember TAT)	Vessel depth (hopefully always 0m)	Vessel Latitude and Longitude vs Time	Error checks for any interfaces into the system	Signal quality	The lower the better – how well the signal matches a stored version of the signal	Acoustic signal detection on the Transceiver	Beacon and vessel position and depth	Beacon and position vs time and depth	Pitch, roll and heading

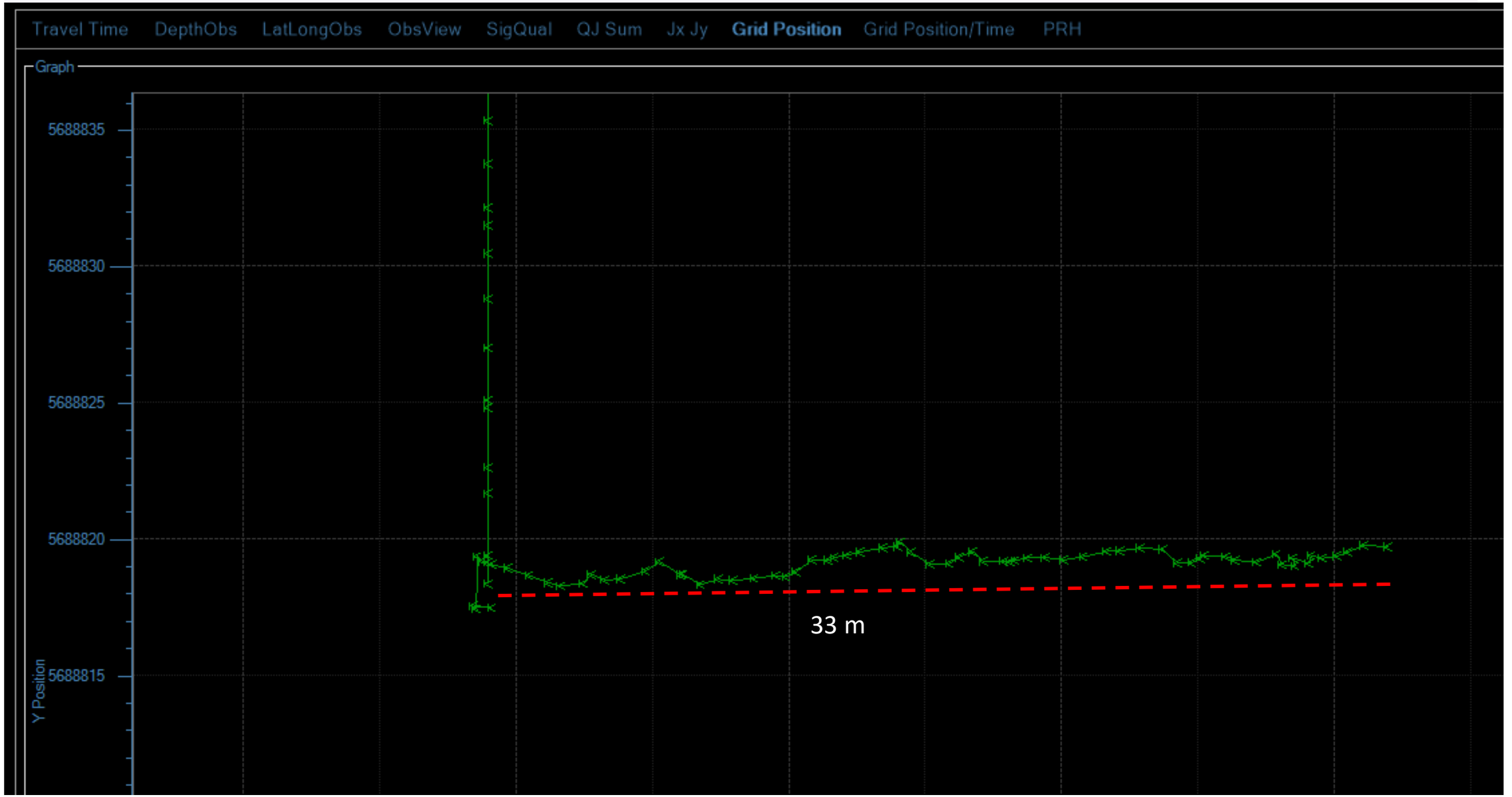
Data Analysis Tool - Spin Test



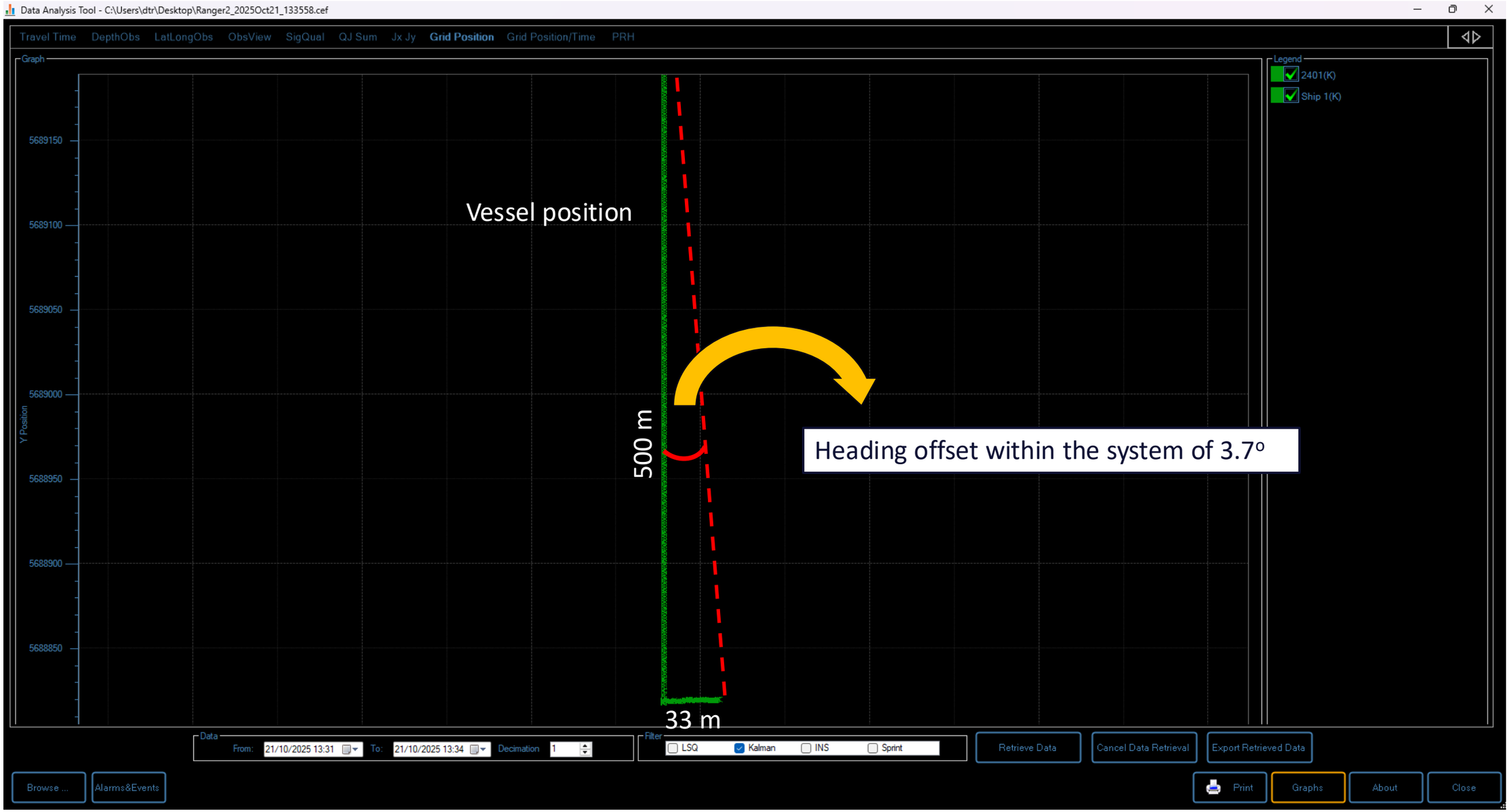
Donut = lever-arm error. Likely GNSS to CRP or Transceiver to CRP, or a bit of both.

In this case it's a 10m error somewhere in the system

Data Analysis Tool – Sail Away Test



Data Analysis Tool – Sail Away Test



Conclusion

- Use the right system for the job
- Correct installation
- Train and maintain
- Fine tune using inbuilt system tools
- DAT for offline processing

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Thank You

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