

*Reducing the effect of motion
generated noise on
magnetometer performance in
shallow turbulent water.*

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Project Aims

- To determine if the signal to motion induced noise ratio can be increased by averaging the output from each of two caesium vapour magnetometers in a tandem array.
- To determine if the performance of these magnetometers in this configuration can be optimised further by adjusting the distance between the two instruments.
- To use this research to contribute to the search for the *Leusden* shipwreck.

The *Leusden* Project overview

- Slave ship of the Dutch West Indian Company.
- In 1738 the vessel hit a sandbank and broke up in the mouth of the Maroni River.
- Of the 680 African slaves on board 664 died.

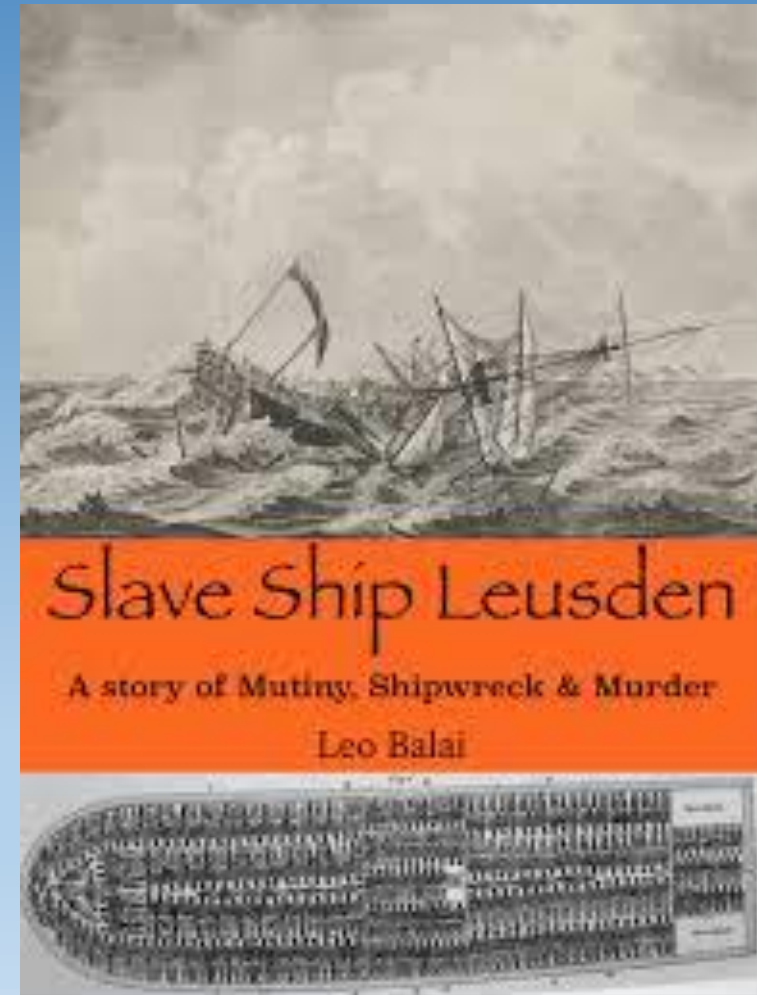


Fig. 1 L. Balai 2014

Search area

Challenging environment:

- Intensity of the Earth's magnetic field.
- Very shallow water.
- Turbulent.
- Shipping.

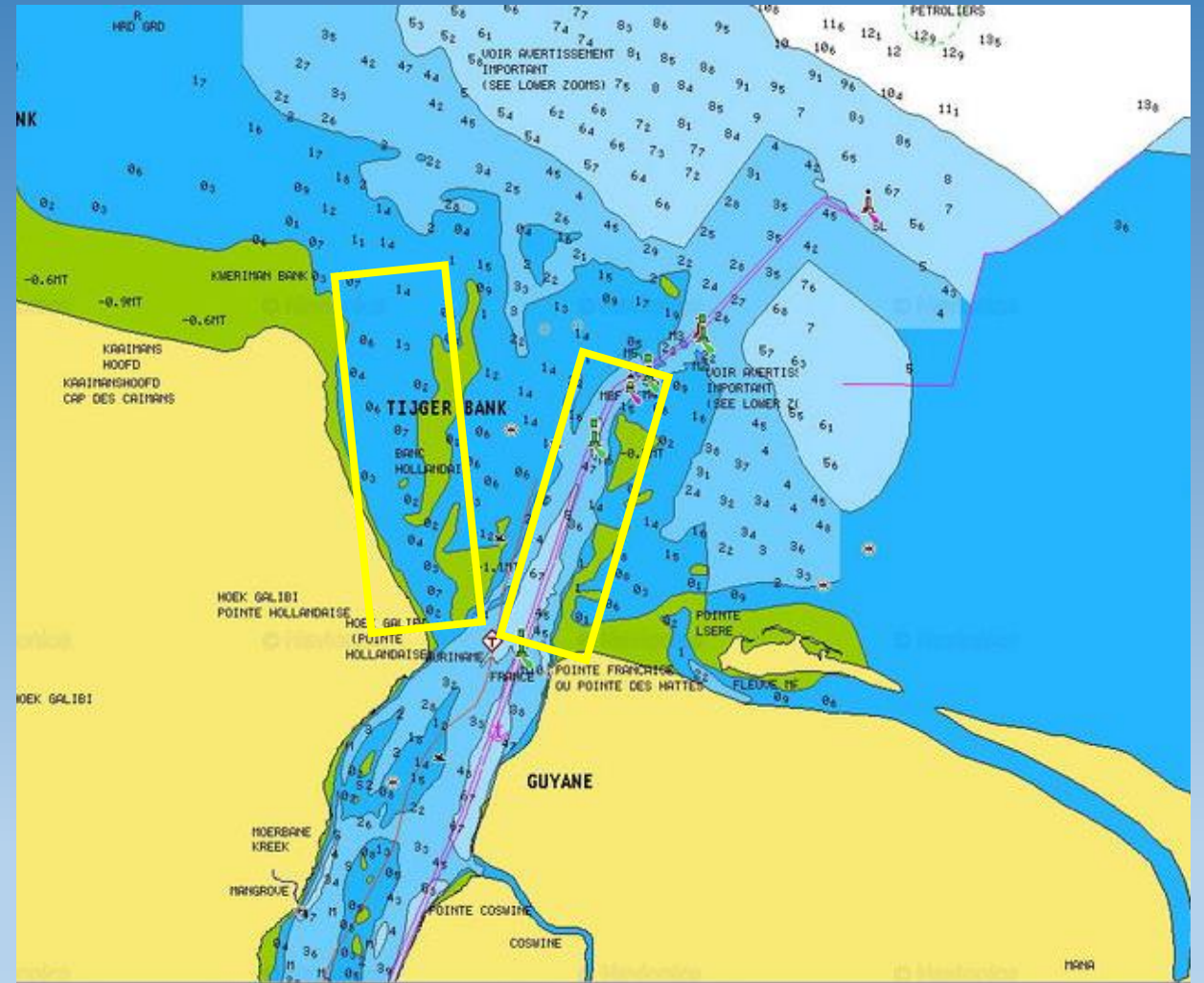
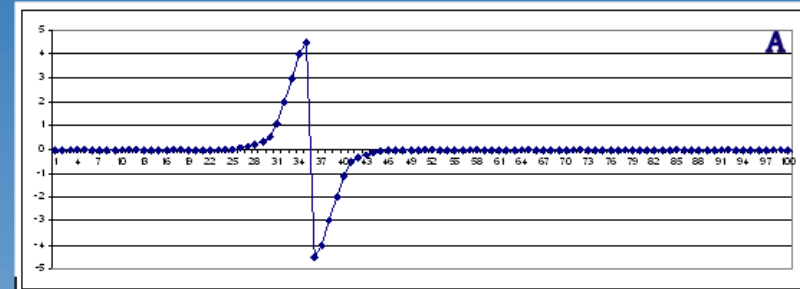


Fig. 2 Cultural Heritage Connections 2015

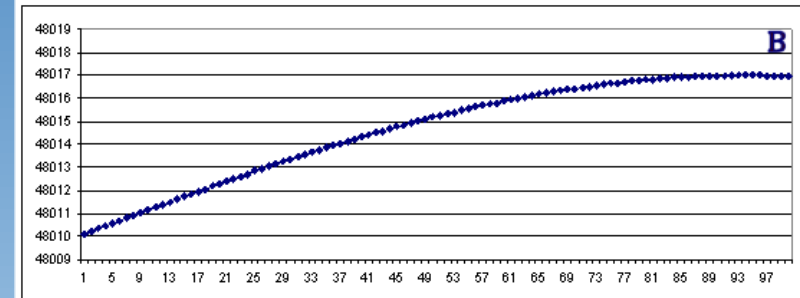
Signal Noise

Single anomaly without any noise

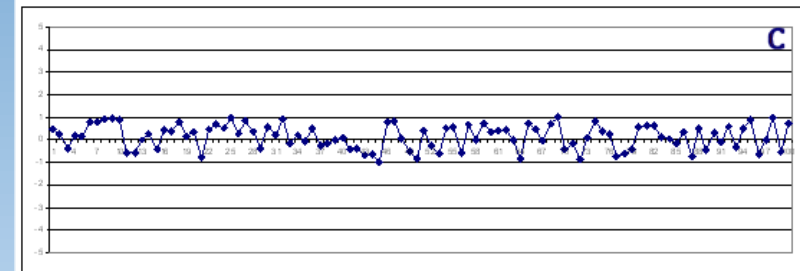


- Geological noise may be ignored depending on scale of survey site
- Diurnal noise caused by fluctuations in ionosphere can be accounted for using data from a magnetic observatory e.g. Hartland, North Devon.
- Internal noise (when instrument is static) cannot be eliminated.
- Noise is also generated in the instrument by movement.

Geological noise



Internal instrument noise



Combined signal

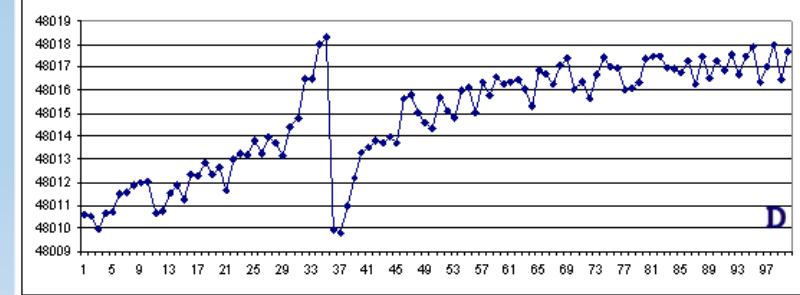
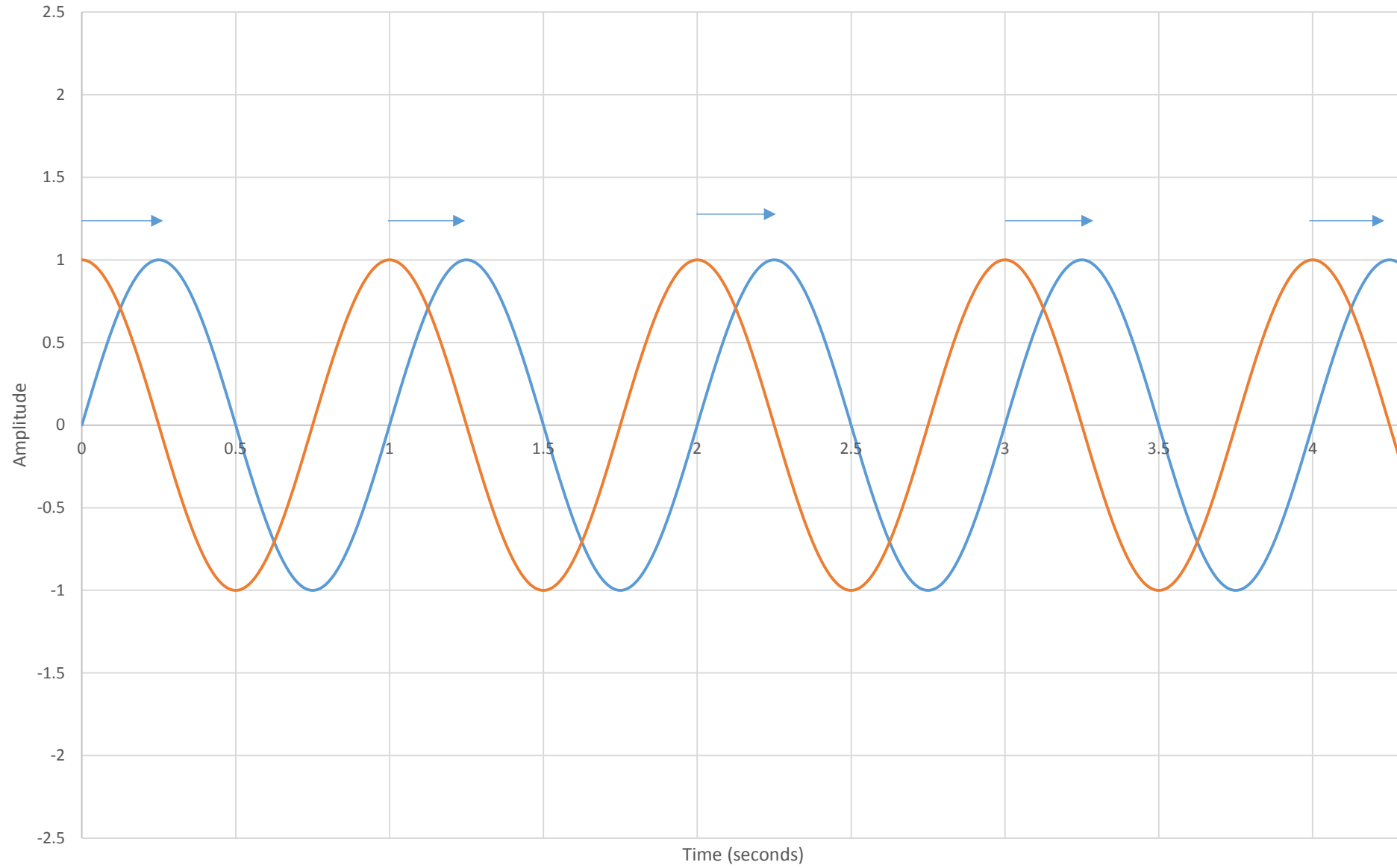


Fig. 3 Camidge etal, 2010

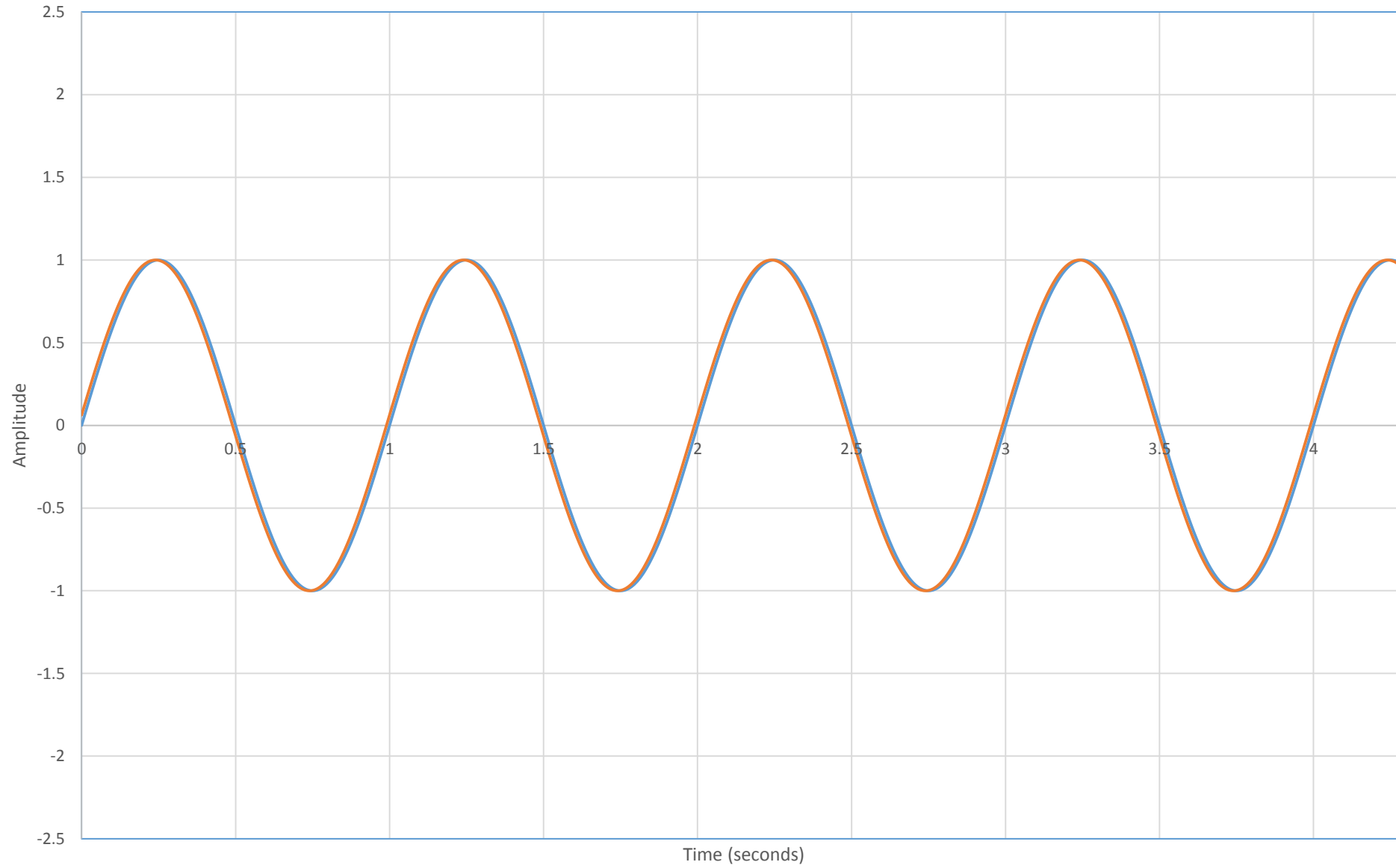
Remaining Noise

- Two remaining components within the signal must be:
 - Motion generated movement.
 - An anomaly.

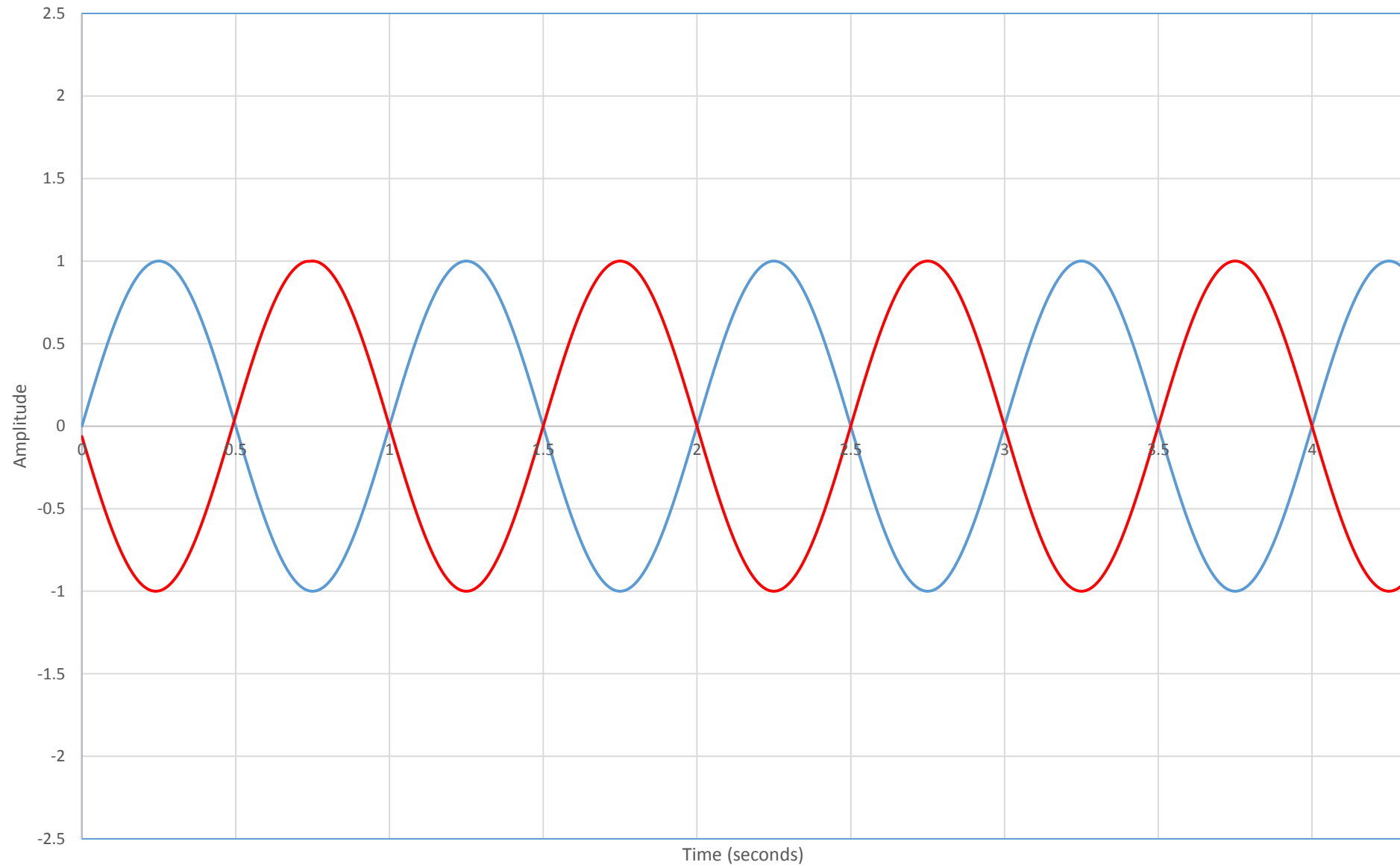
Two magnetometer signals



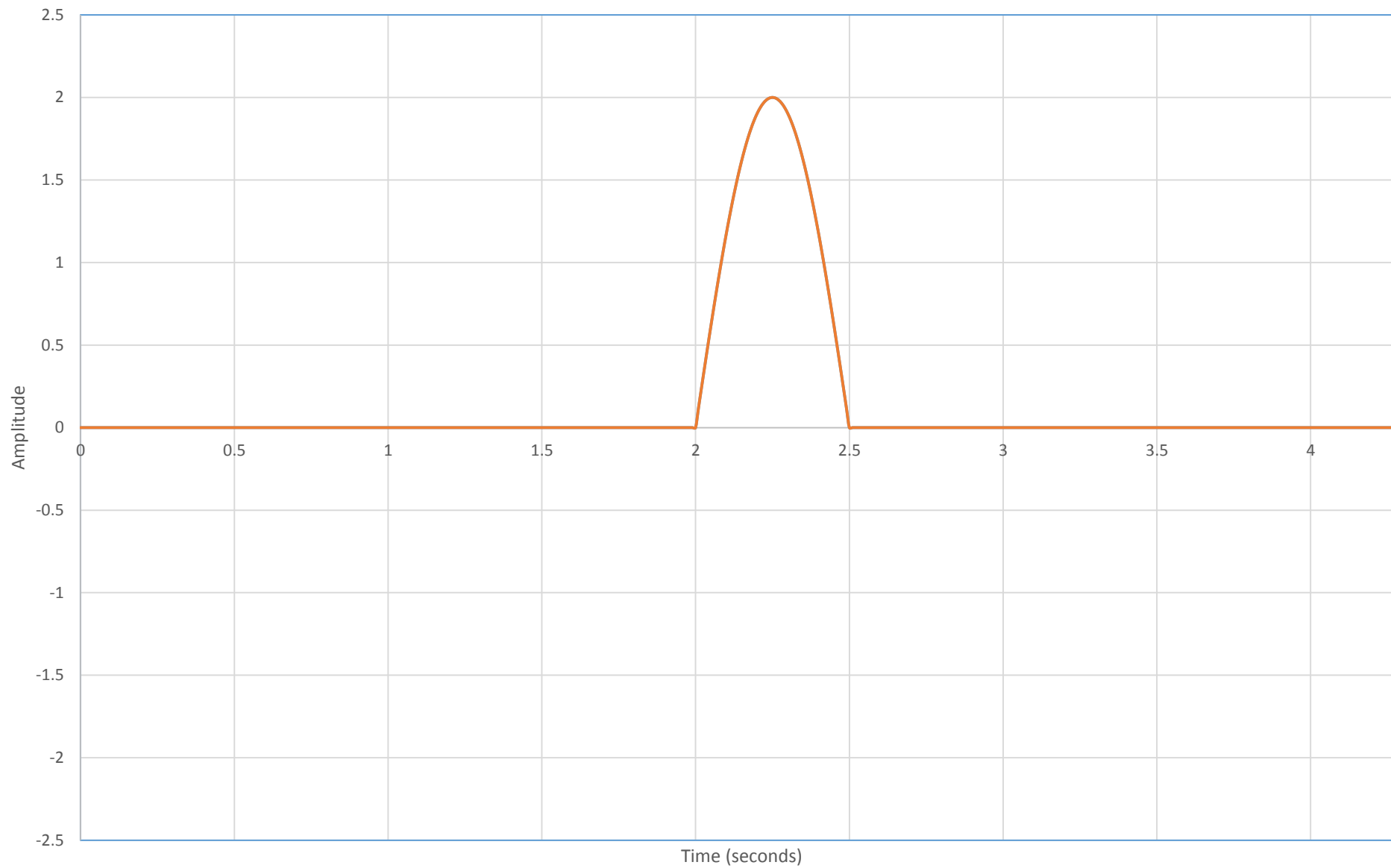
Two sine waves superimposed



180 Degrees out of phase



Anomaly spike



- It is assumed that a genuine anomaly will:
 - Be located at a discrete fixed point in space.
 - Present a consistent signal of similar amplitude on both magnetometers.

The average amplitude of this portion of the signal should be little different from its components.

- It is assumed that motion generated noise will:
 - Be entirely dependent on motion of the water.
 - The random nature of this noise will present a signal which will frequently differ between both magnetometers.

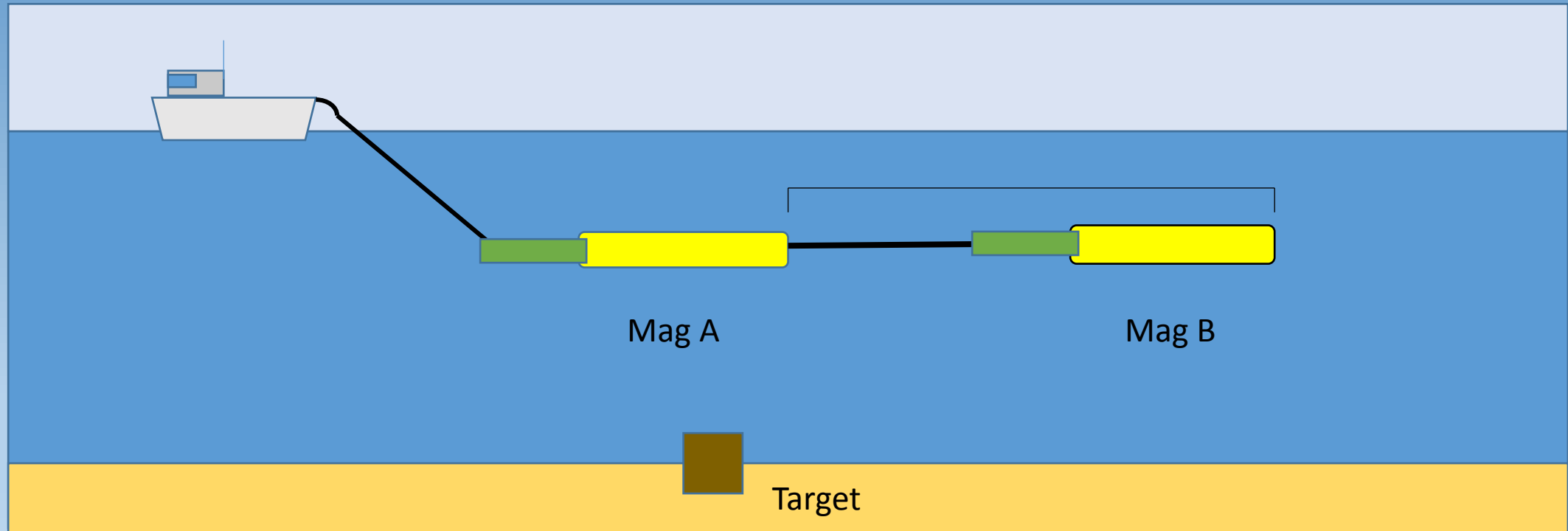
Where the amplitude from each magnetometer is similar then the average will also be similar...

But...

Where there is difference the average of the two signals will result in the motion generated noise being reduced.

Array

- Tandem array of two caesium vapour magnetometers towed in line.



Data Collection

- Test data
 - Plymouth Sound
 - Known conspicuous anomalies
- Trial data
 - Mouth of the River Yealm
 - Challenging environment.

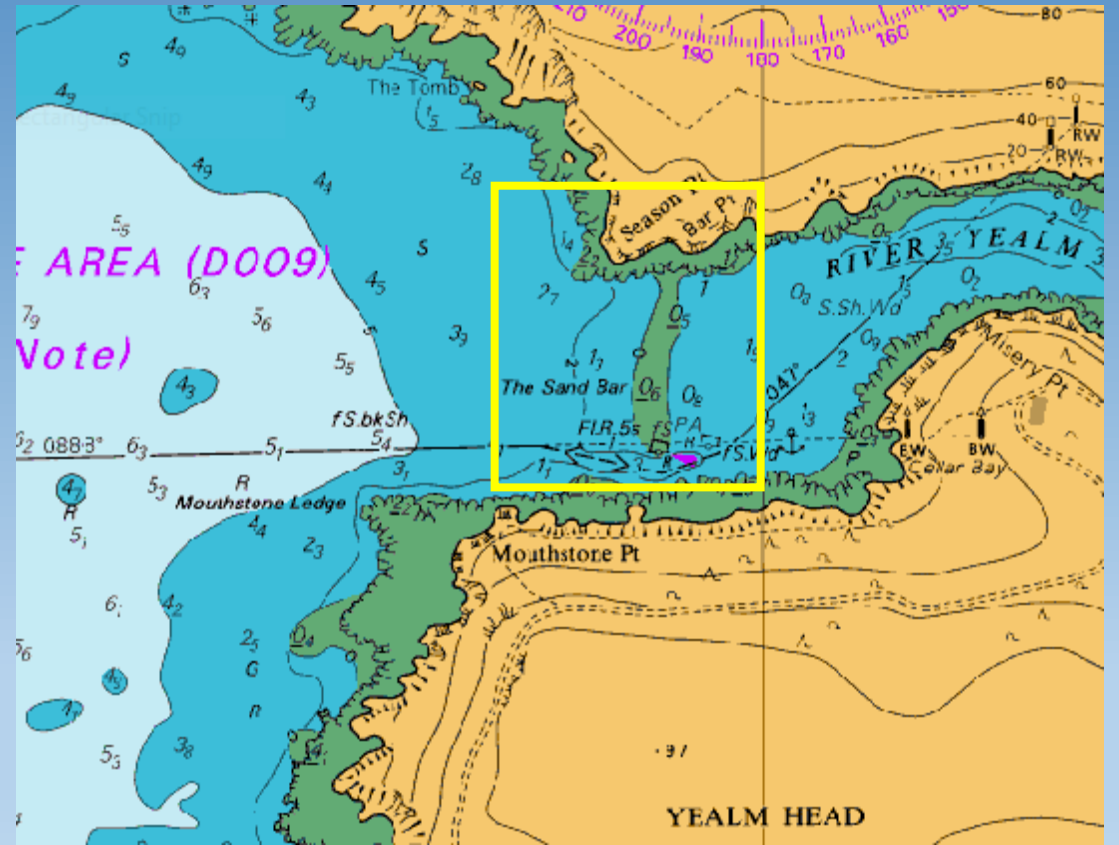


Fig. 4 HydroView Charts, Scale 1:20000, Tiles: 0030-0_W, 2015, DINA Marine Digimap Service

Application

- Reduce weather downtime by reducing noise will allow use of magnetometers in more turbulent conditions.
- Resolve targets with smaller mass due to increased visibility of anomalies within signal.

Any questions?