UDT 2019 Stockholm

Optimisation of platform electromagnetic signatures

Latest developments in data modelling and analysis

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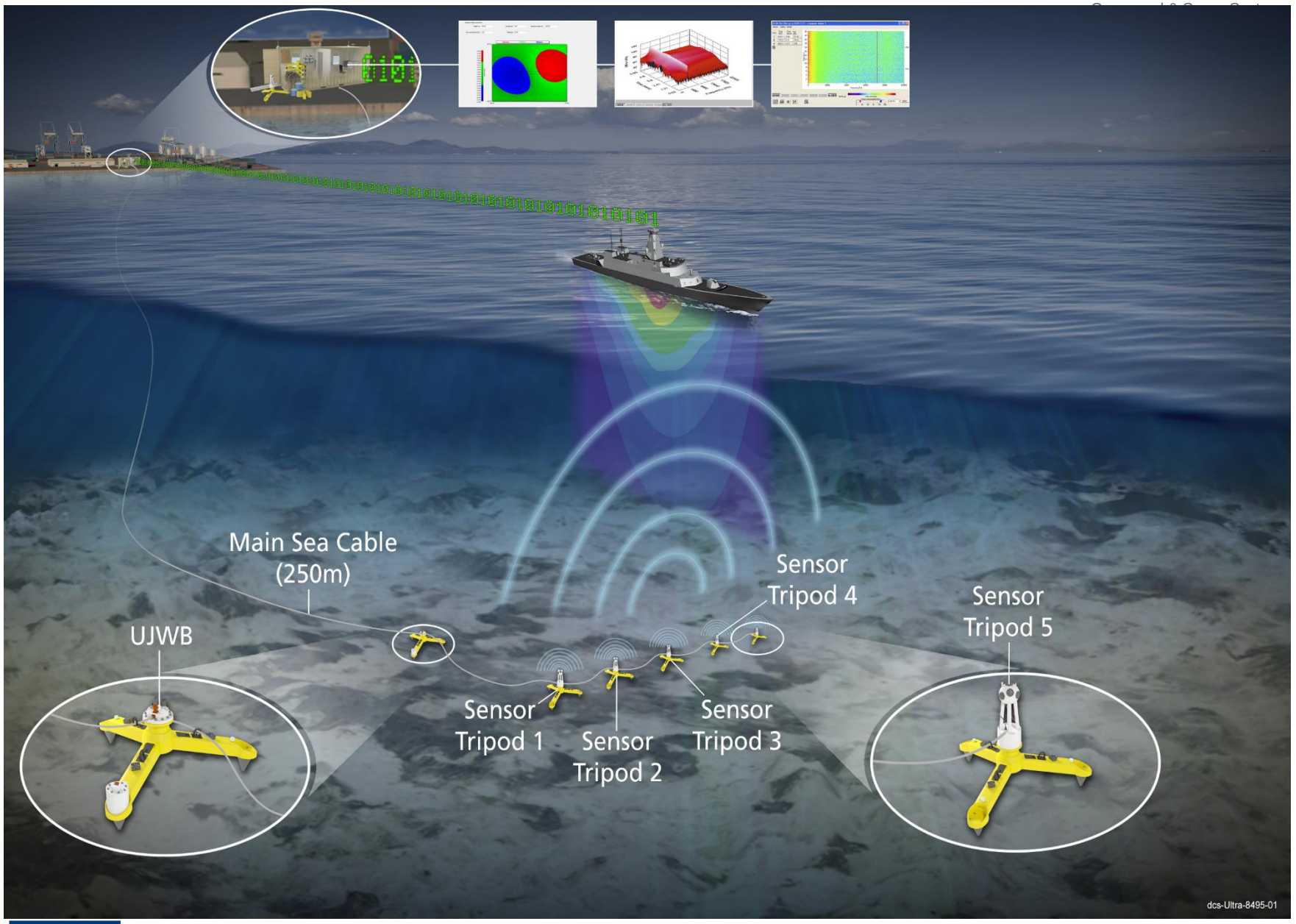
Optimisation of platform electromagnetic signatures

OVERVIEW

- Signature Management is a key element of operational capability.
- The primary goal of signature management technology is to reduce the likelihood of detection and thereby to increase survivability in the operational field.
- There are three prime elements for electromagnetic vessel signature management:
  - Vessel design for stealthy signature vessel
  - Signature optimisation for stealth
  - Cathodic protection system health assessment



Ultra ELECTRONICS

making a difference

Optimisation of platform electromagnetic signatures

OVERVIEW

Latest developments in data modelling and analysis

- Scalability
  - Broad range of platforms
  - More detail
  - Increased accuracy
- Signature optimisation
  - Degaussing
  - Electric signature optimisation
  - CLDG set up
  - Deperming/treatment
- Analysis compatibility
  - Utilisation of measured data from other systems

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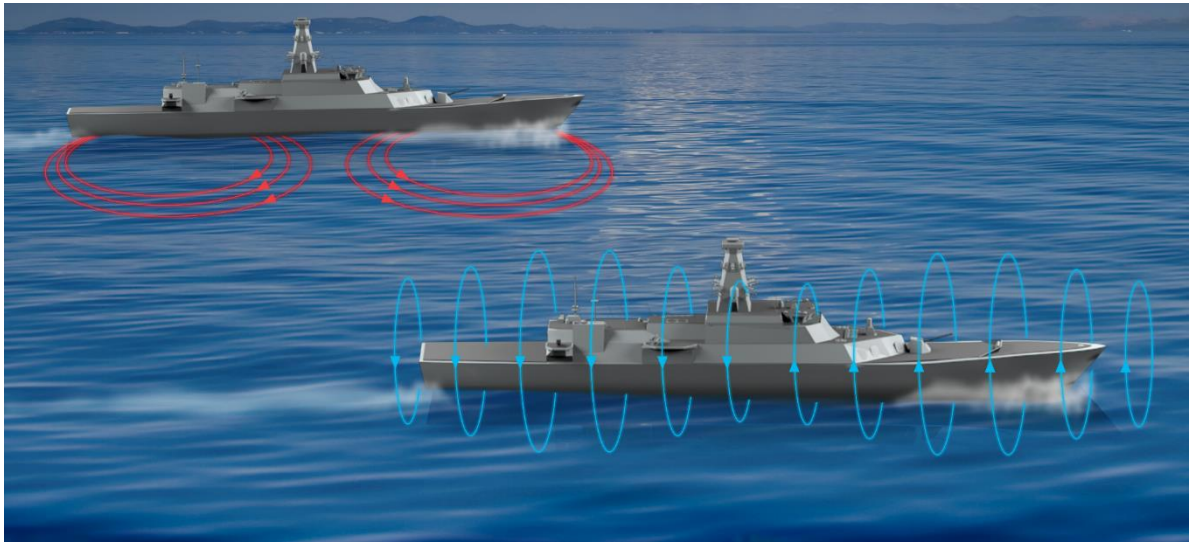
RANGE PURPOSE

Ranging comprises:

- Measurement
  - Static magnetic DC-10Hz
  - Static electric DC-10Hz
  - ELFE - Extra Low Frequency Electromagnetic DC-3kHz
  - Acoustic 1Hz - 100kHz
- Optimisation
  - Static magnetic
  - Static electric
- Data utilisation
  - Treatment
  - Analysis



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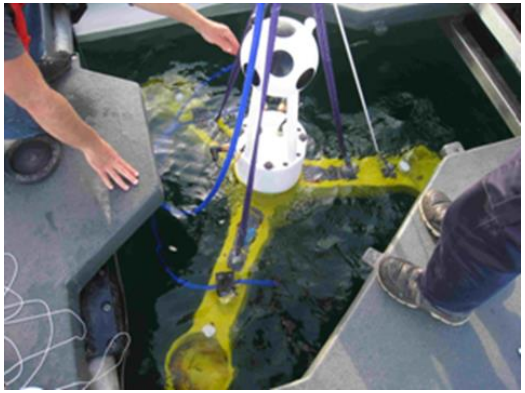
RANGE SYSTEM COMPONENTS

- Sensors with IP address and Ethernet comms
- Underwater hub to connect strings of sensors
- Underwater Cables
- Tripods
- PC
- Modelling software



- Support equipment
  - Seabed calibration (electromagnetic)
  - Validation source (multi-influence)

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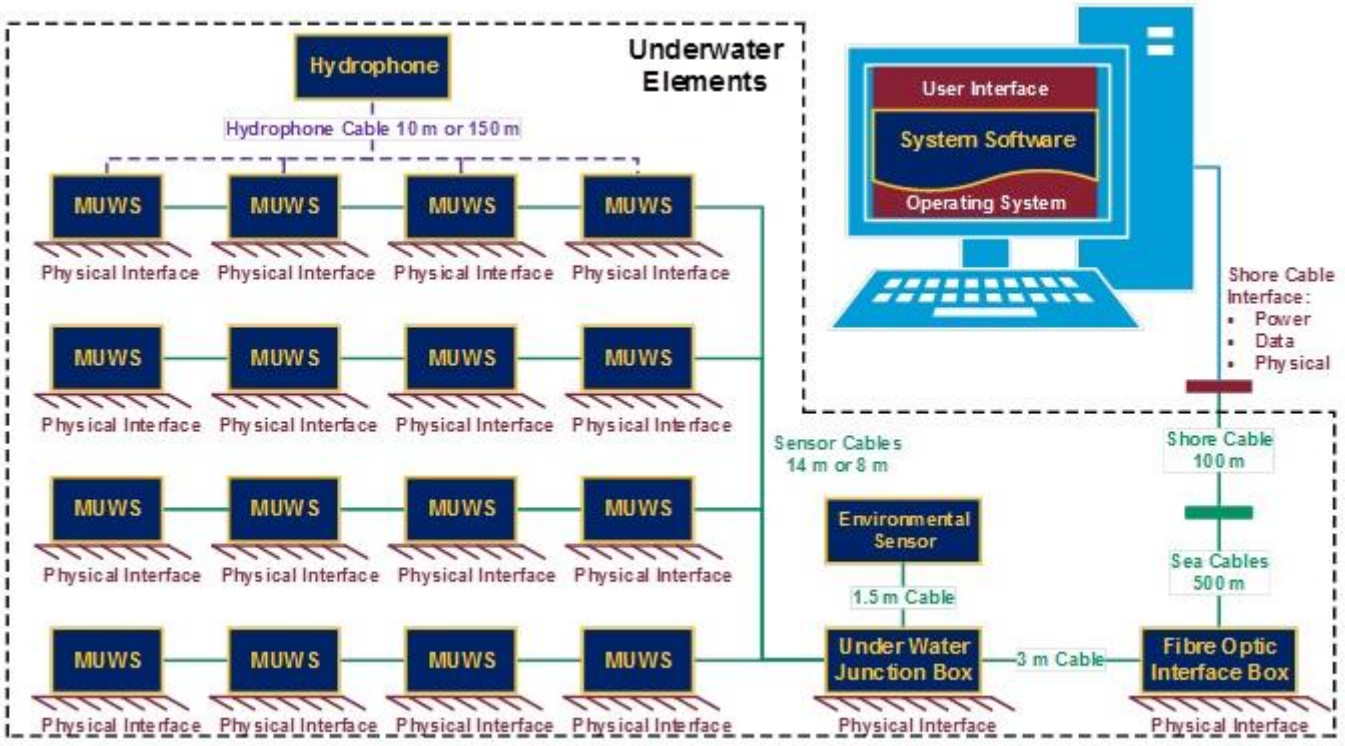
SCALEABILITY

- Example Block diagram16 sensors



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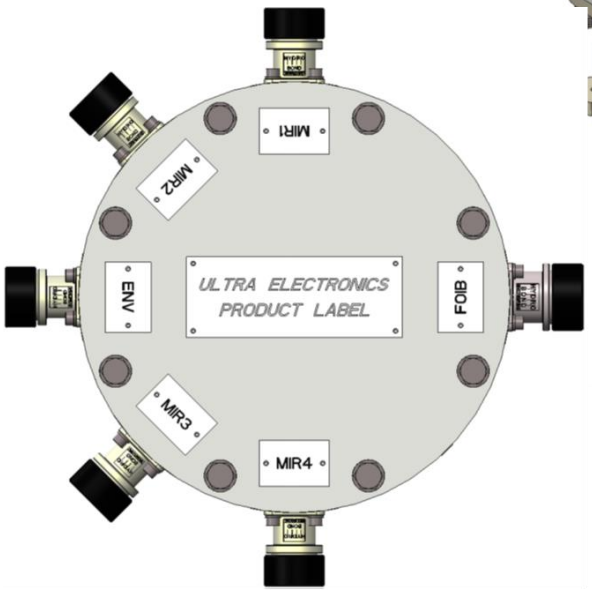
HARDWARE DEVELOPMENTS

- Chains of sensors enabled by underwater Ethernet hubs
  - Fibre optic cables
  - Maximum 9 km cable run
  - 4 chains of sensors
  - Number of sensors dependent on sensor spacing
  - Sensor spacing up to 80m
-



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RANGE SCALABILITY

What do we mean by ‘Scalability’?

- Extendable in blocks of up to 16 sensors
  - 16 sensors,32 sensors, 64 sensors etc…..
- Different sensor spacings one system
  - Enables different vessel classes with different beams on same site
  - Optimum spacing/array width for different vessel types
- Several ranges from one control office
  - Different depths
- Different shaped arrays

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SCALABILITY

- Variable spacing for ships with large and small beam on same system
- Carrier versus stealthy frigate versus submarine

Advantages:

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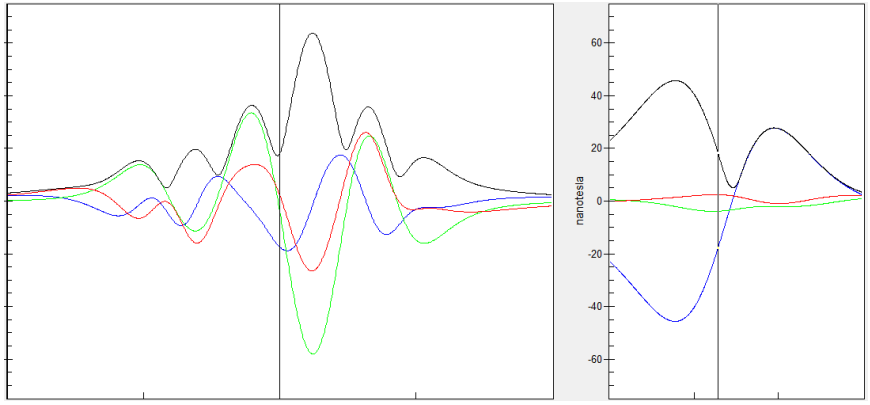
MODEL ACCURACY

- *Stealthy vessels*
  - *More sensors, more detail*
  - *Resistance to noise*
  - *Better environmental detail*
  - *More accurate predictions*
    - ⇨ *Better signature optimisation (reduction)*

  - Simulated variation: longitudinal athwartships



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IMPROVED ACCURACY OF SITE ENVIRONMENTAL CALIBRATION

- Particularly important for electric field, ELFE signature
- Affected by seawater conductivity and seabed resistivity
- Known signature generated by calibrated sources
  - More information, more robust fit to data
  - Resistance to noise
  - More accurate electric and ELFE signatures

- Similarly for determination of acoustic propagation

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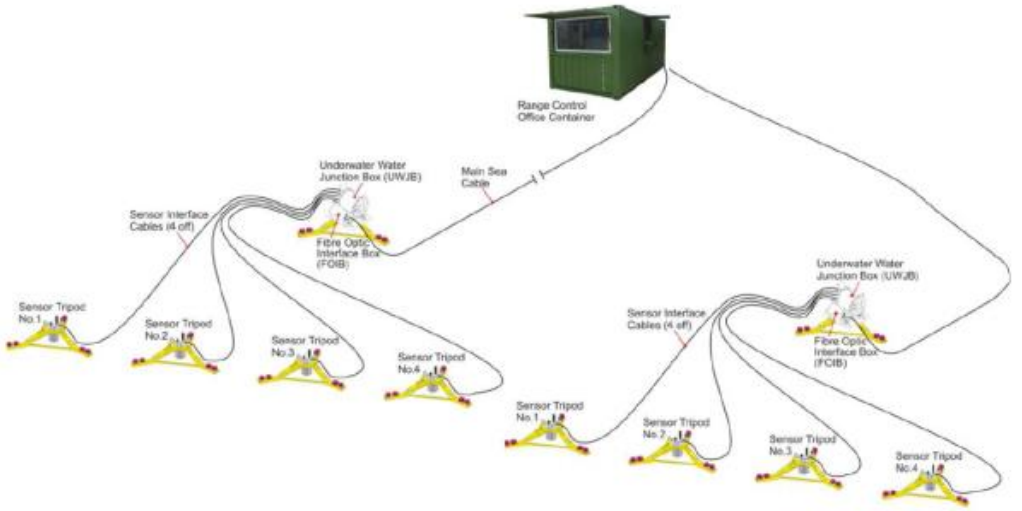
RANGE SCALABILITY

- Several ranges controlled from one control office
  - Different depths
  - Due to variation of dipole field strength with distance,
    - E proportional to $1/r^3$



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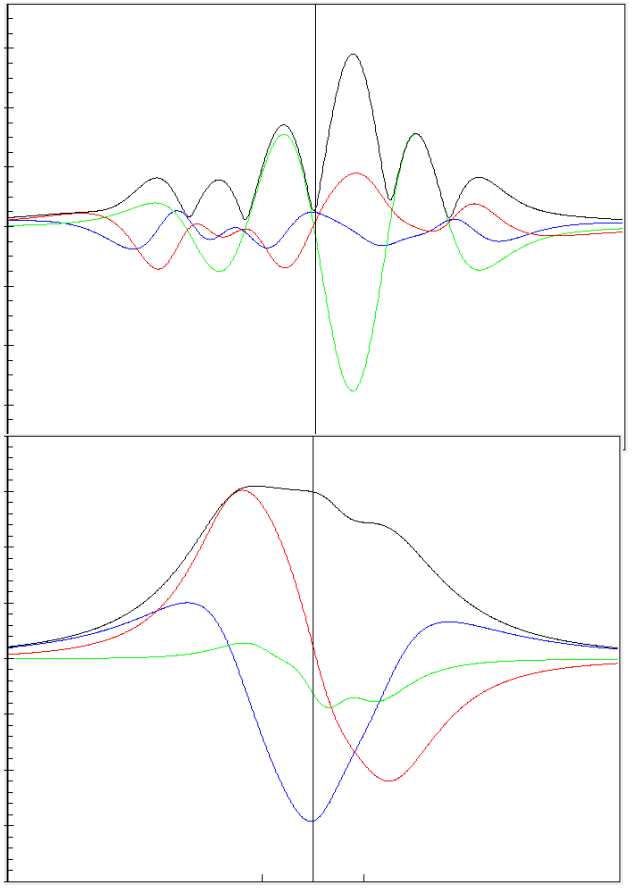
RANGE DEPTH

- Depth has significant effect on signature
  - Original depth
  - 3 x original depth



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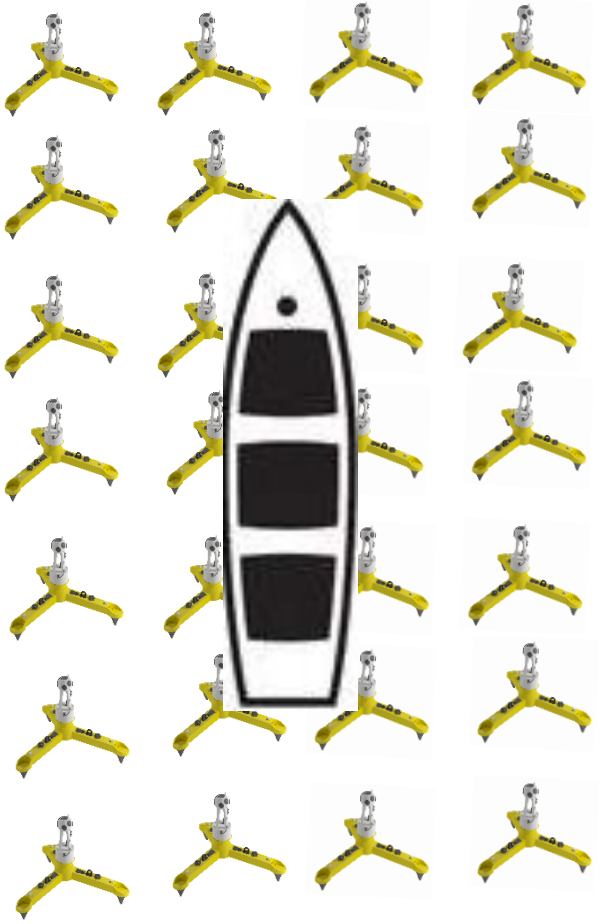
SCALABILITY

- Different shaped arrays
  - Rectangular garden arrays
    - Roll and stray field ranges
  - Cruciform “cross-shaped” arrays
    - Deperm/treatment facilities



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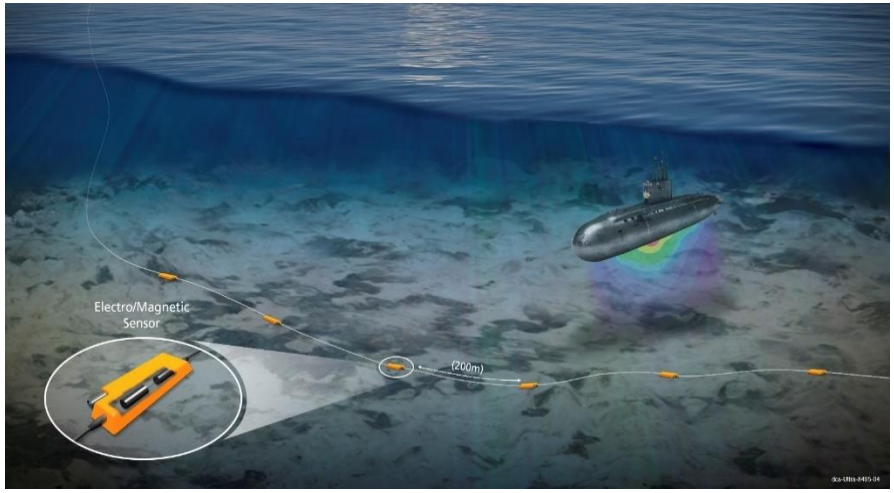
RECONFIGURABLE FOR OTHER APPLICATIONS

- Applications
  - Treatment / deperming range
  - Roll and stray field range
  - Induced magnetisation (EF simulator)
  - UXV ranges
  - Harbour entrance barrier



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SOFTWARE DEVELOPMENTS

- Importing of many different range data
- Electromagnetic optimisation

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DATA FORMATS

- Range types
  - Other single and multi-influence ranges
  - Treatment / deperming range
  - Roll and stray field range
  - Induced magnetisation (EF simulator)
  - UXV ranges
  - Harbour entrance barrier

- Common format for importing of many different data types

e.g. treatment induced magnetisation signatures

⇨ Optimisation of electromagnetic signatures

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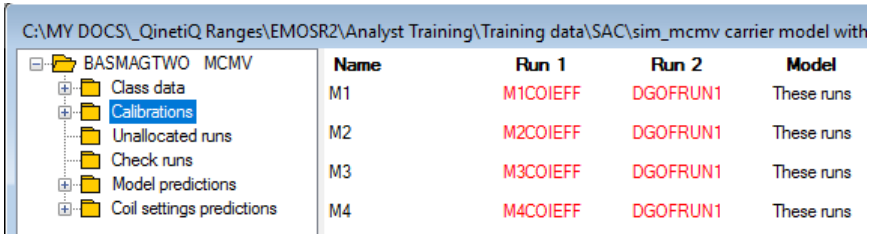
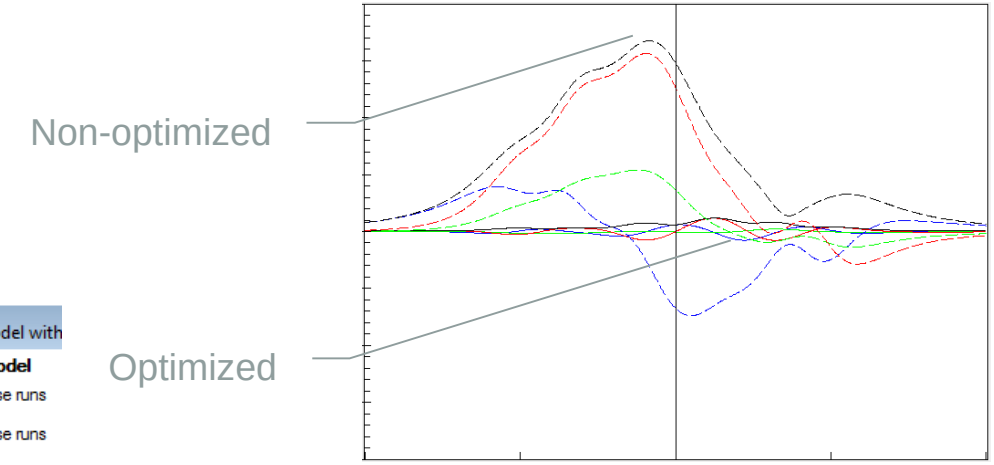
ELECTRIC SIGNATURE ON A RANGE

- Electric field optimisation uses an analogous process
- Degaussing (magnetic) signature reduction has a proven history
- Magnetic coil effects
  - Signature
  - Current in coil
- Minimise magnetic signature





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OPTIMISATION ON A RANGE

- The interaction of a vessel hull with its environment
  - the sea water gives rise to corrosion where metallic areas of the hull are exposed.
- The corrosion of a vessel can be minimised by the suitable application and maintenance of coatings.
- Coatings cannot be applied or maintained perfectly
  - an impressed cathodic corrosion protection system, ICCP, is used in order to impress current on to the hull such that the relative potential of hull relative to the seawater is such that corrosion is rendered energetically impossible.

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OPTIMISATION ON A RANGE

- Enables the control or optimisation of the electric field or Corrosion Related Magnetic (CRM),
- Requires detailed knowledge of the relative hull to seawater electrical potential or corrosion hull state.

- Knowledge of the vessel's corrosion hull state is necessary for the control of the signature
  - The hull state ultimately determines the vessel's electric signature
  - the systems placed on a vessel to control the signature will also impact on the hull state and thus affect its corrosion protection.
  - The majority of electric signature control systems employed are the same type of systems that are used to prevent corrosion of the vessel.

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OPTIMISATION ON A RANGE

- The corrosion hull state of vessel continually changes with time due to both the physical state of the hull and its interaction with the environment, the seawater.
- Thus in order to control the electric signature of a vessel it is necessary to routinely characterise the corrosion hull state of a vessel.
- On a range the signature of a vessel can be optimised in conjunction with the provision of an assessment of the health of cathodic protection systems.

Optimisation on range utilises:

- Anode effects
- Reference cells measurements
- Electric field signatures

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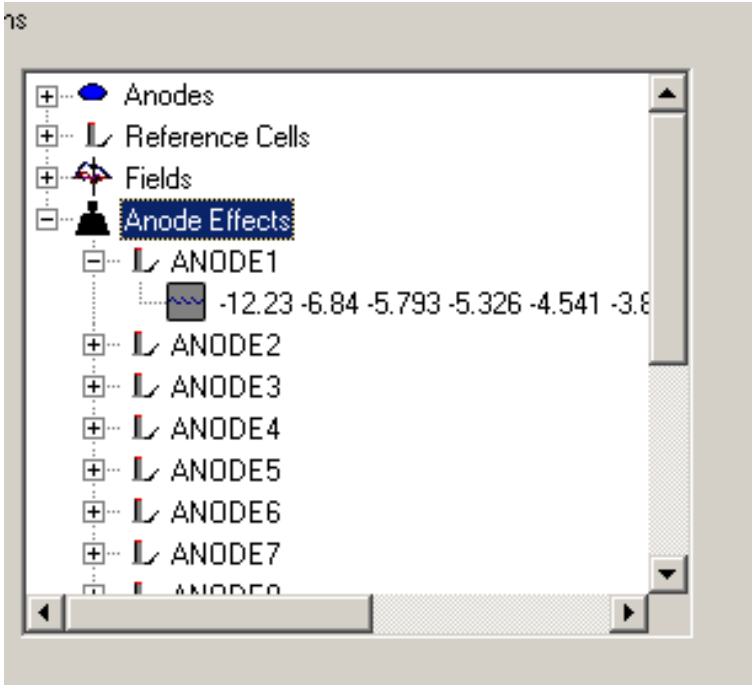
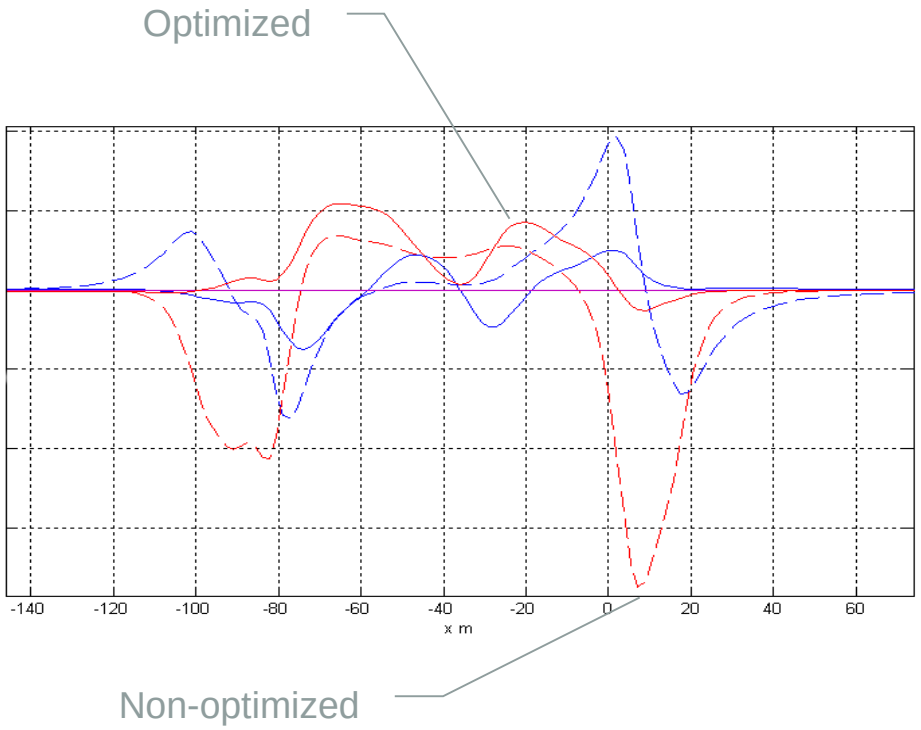
SOFTWARE INTERFACE

- Software facilitates
  - Anode effects
  - Reference cell data storage





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SUMMARY

Latest developments in data modelling and analysis for treatment systems and ranges

Electromagnetic signature optimisation

- More data and detail from extendable, reconfigurable and scalable system
  - Range data quality using enhanced electromagnetic magnetic data
  - Threat prediction quality increased
- Achievable in transportable systems
  - Transportable Scaleable Range
  - Transportable Validation Sources
- Use of modelling software on ranges
  - Optimisation of electric signatures

Questions?