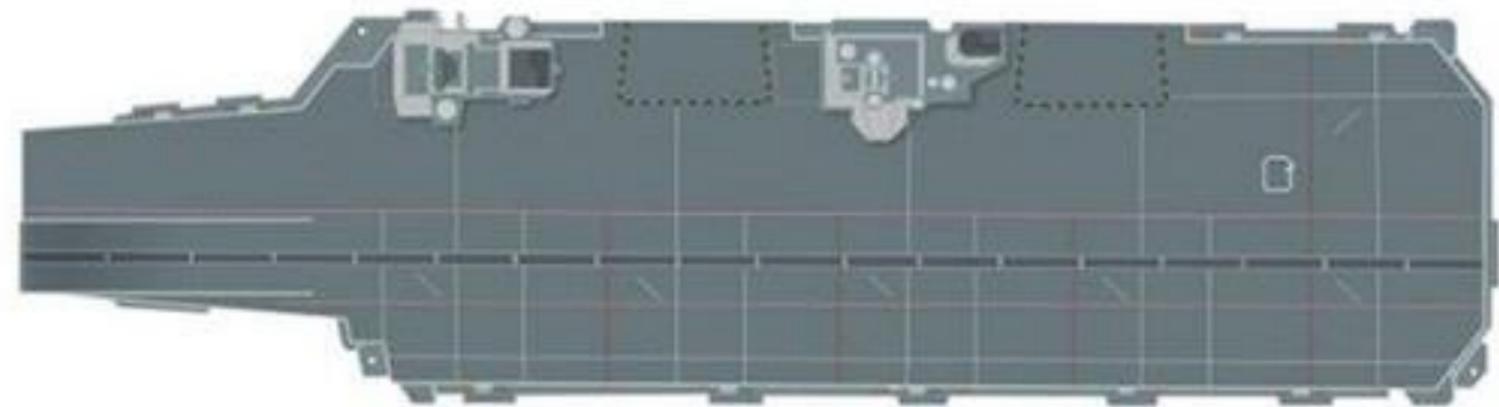
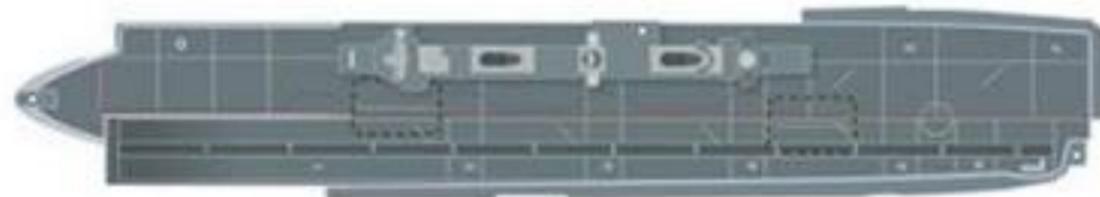


Marine Case Study Portsmouth Harbour, UK.

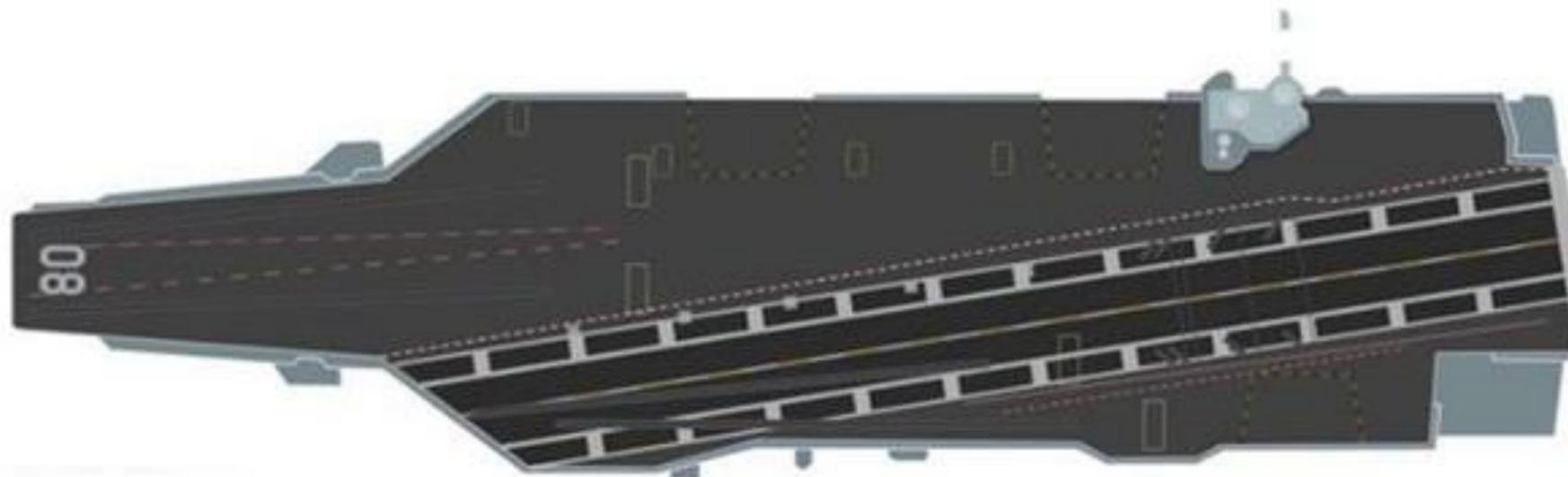




Queen Elizabeth Class
284 metres
70,600 tonnes
1,600 crew
40 Aircraft



Invincible Class
209 metres
22,000 tonnes
1,000 crew
22 Aircraft



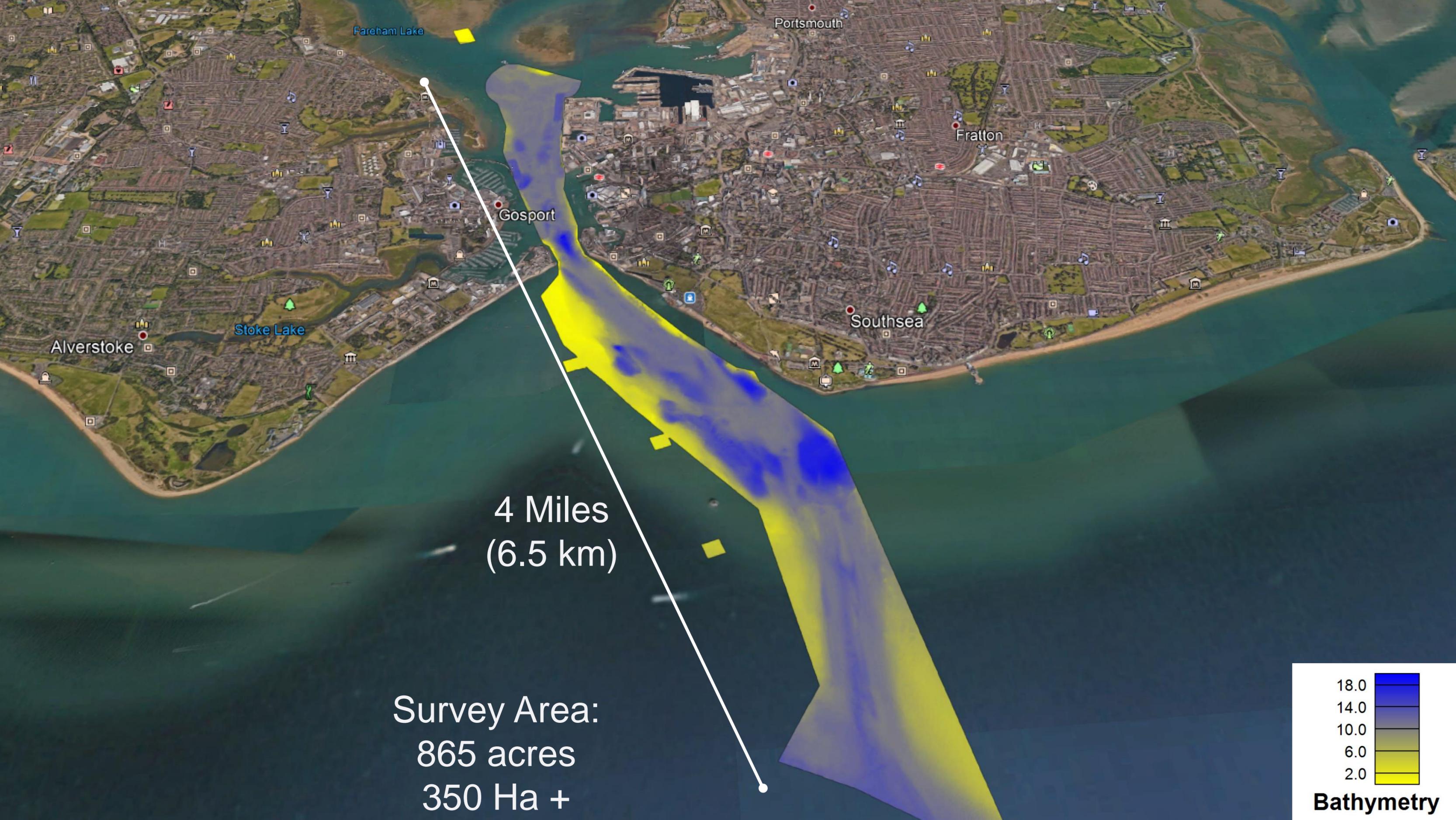
Gerald R Ford Class
337 metres
112,000 tonnes
4,297 crew
70+ Aircraft

largest
warship
ever built
for the
Royal
Navy.

**Portsmouth
Harbour
location map**

Portsmouth
Harbour





Fareham Lake

Portsmouth

Fratton

Gosport

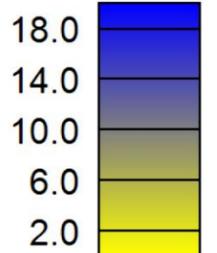
Southsea

Stoke Lake

Alverstoke

4 Miles
(6.5 km)

Survey Area:
865 acres
350 Ha +



Bathymetry

Portsmouth Harbour abbreviated history

1194 Construction of dockyard

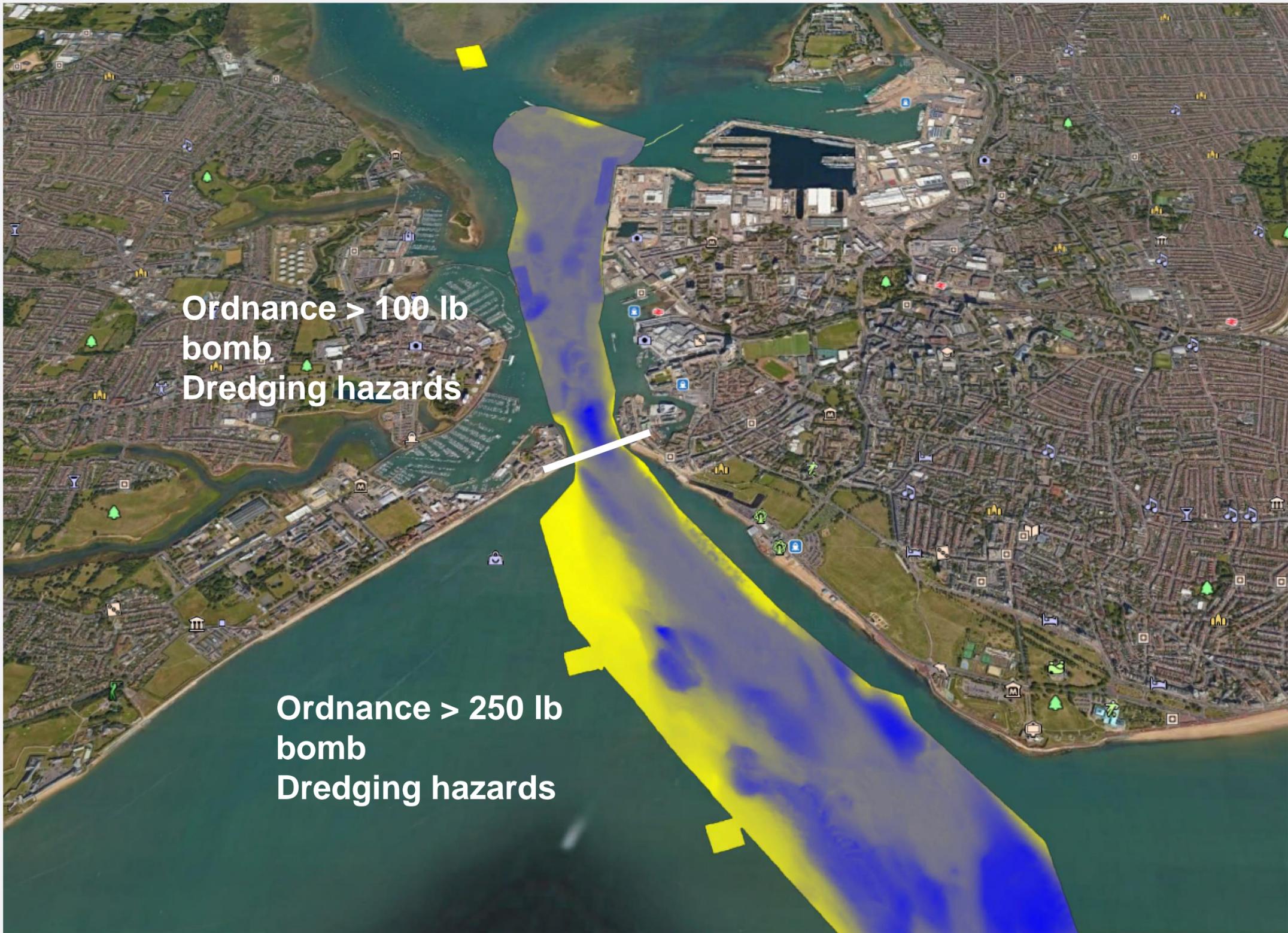
1914 during world war I 1,658
-18 ships are docked for
refit or repair

1670 becomes Royal dockyard
As part of the establishment of the
Royal Navy

1939 during world war II
-45 harbour bombed &
mined multiple times

1805 Lord Nelson sails with
the British fleet to the
battle of Trafalgar

1982 fleet sails for the
Falkland Islands



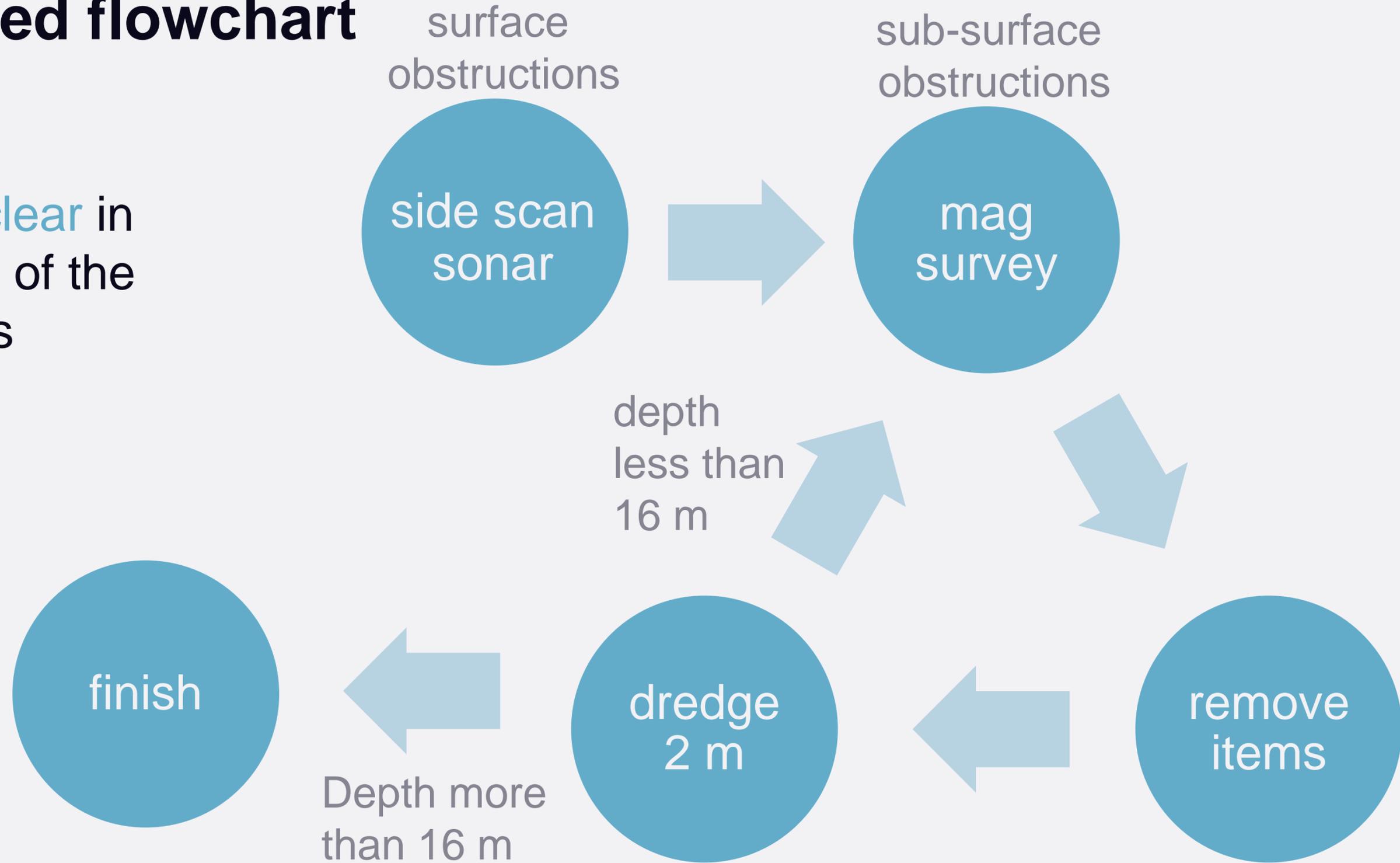
risk assessment

Inner Harbour
100 lb and larger
Dredging hazards

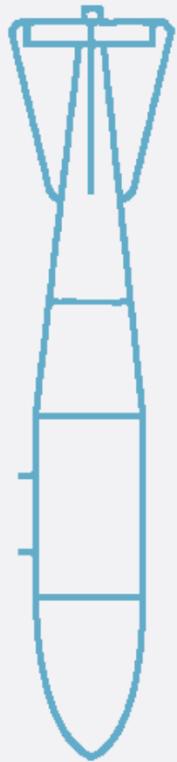
Outer Harbour
250 lb and larger
Dredging hazards

project execution simplified flowchart

> 10 m to clear in
some parts of the
outer banks



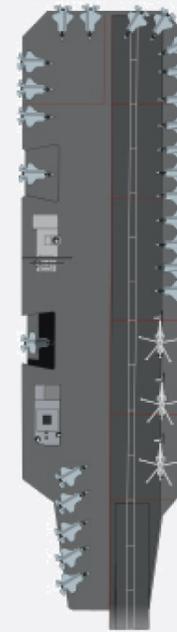
project timeline



survey work - commences

Side-Scan-Sonar

Magnetometer



1

aug 2015

dec 2016

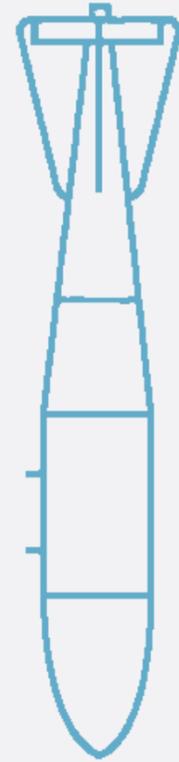
aug 2016

feb 2017

aug 2017

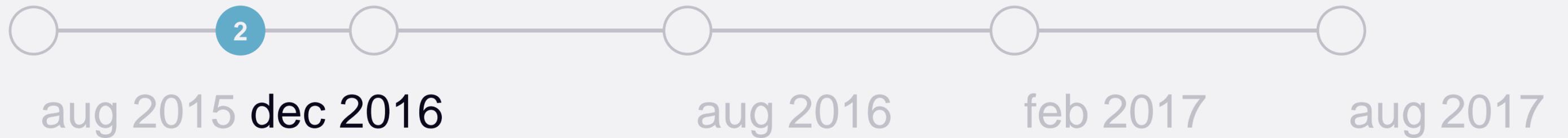
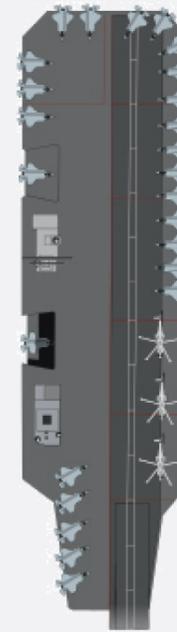


project timeline



first layer - completed

Survey and target
selection of first layer
completed

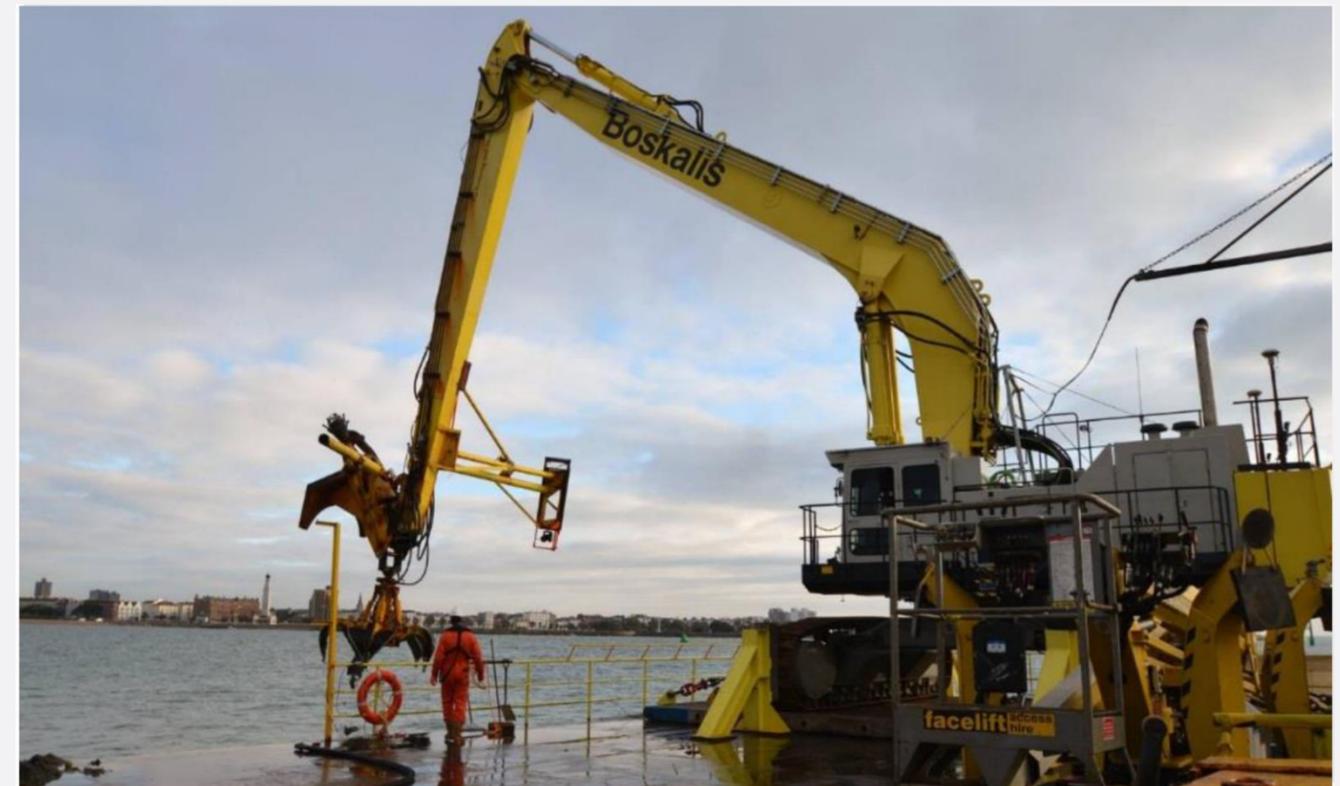


item recovery at best 20 per 24 hour shift

1,324 side scan sonar targets

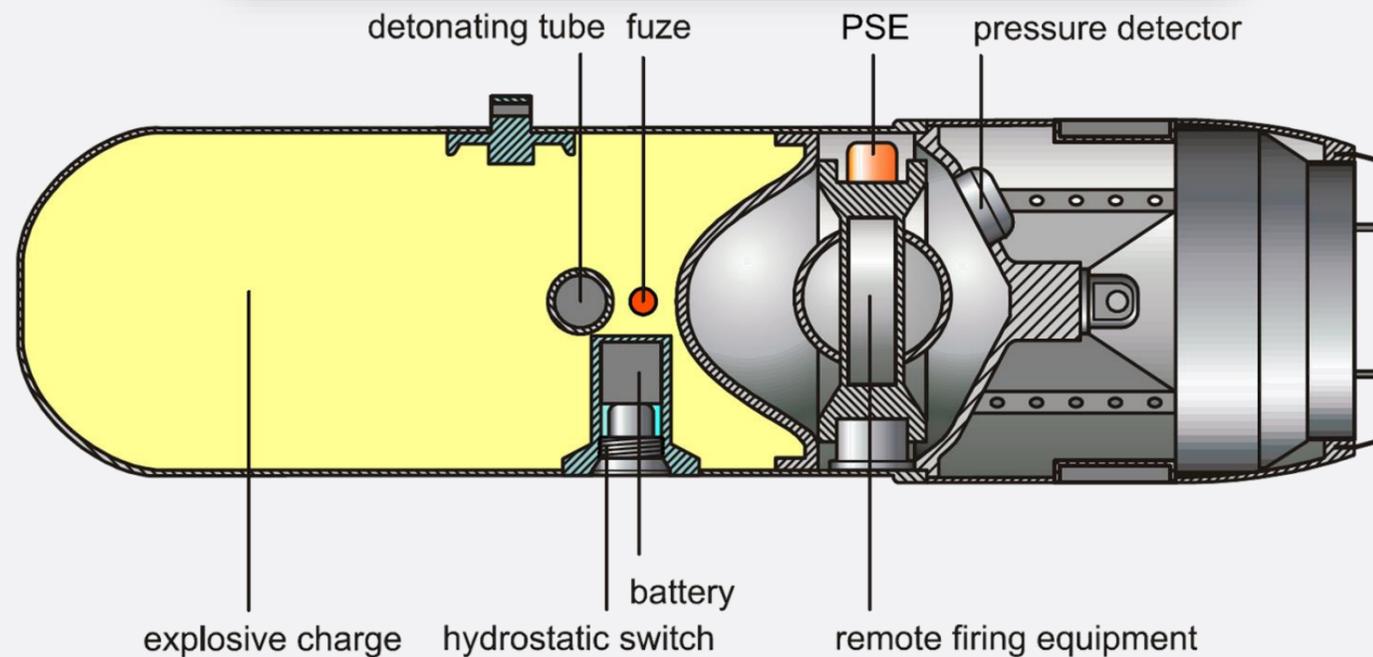
2,480 magnetometer targets
outside harbour

? magnetometer data
unusable inside harbour



december

non-ferrous mine recovered



during dredging and not by the SSS or magnetometer surveys

aluminium LMB ground-mine

- Undetectable by magnetometers & SSS
- Dropped by Luftwaffe along the approaches into the harbour

project timeline



design considerations for an EMI sensor

01

high resolution

For operation in the inner harbour.

02

deep detection

To minimise the number of layers

03

operate in sea-water

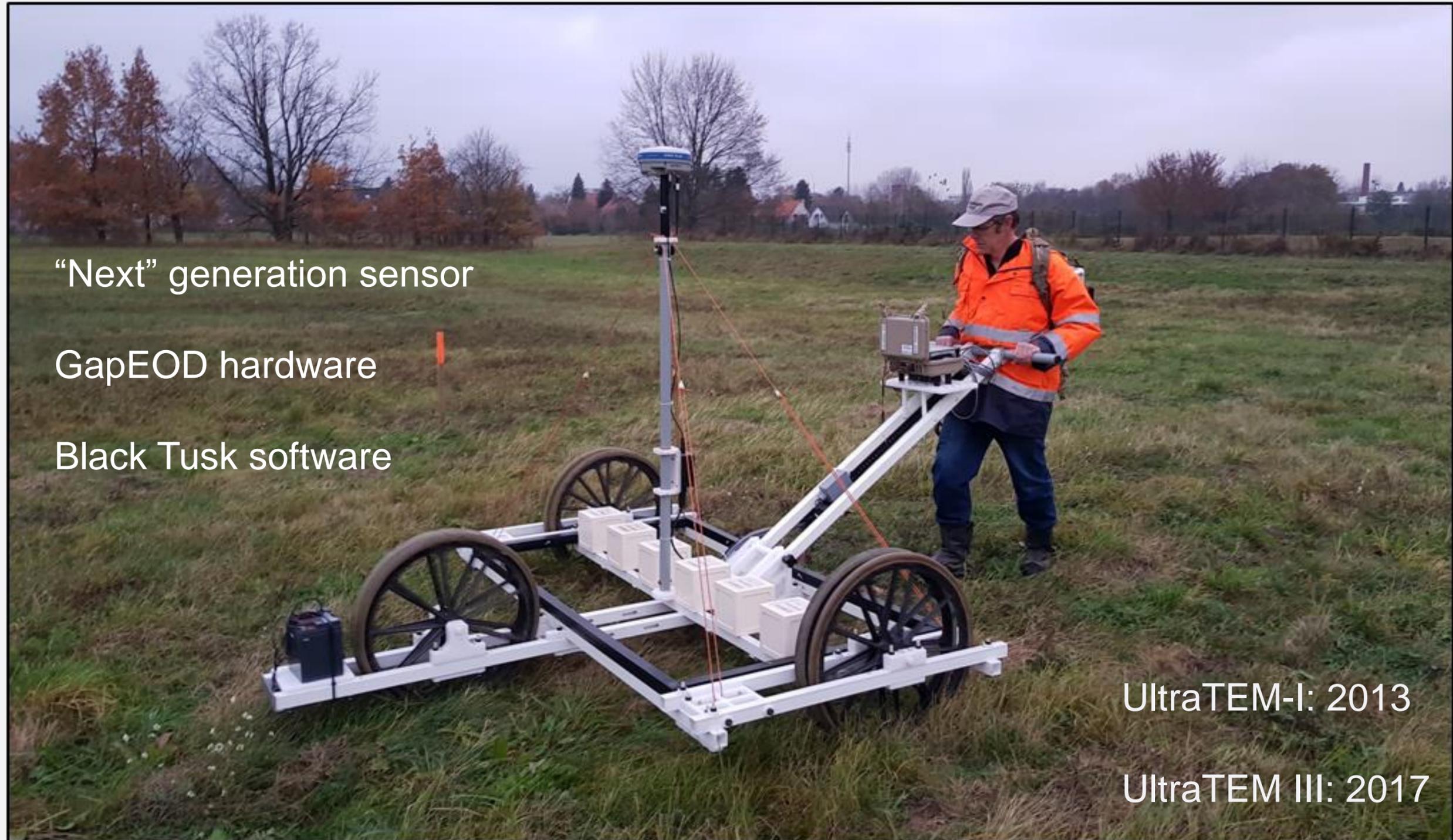
introduces some challenges to an active EMI system

04

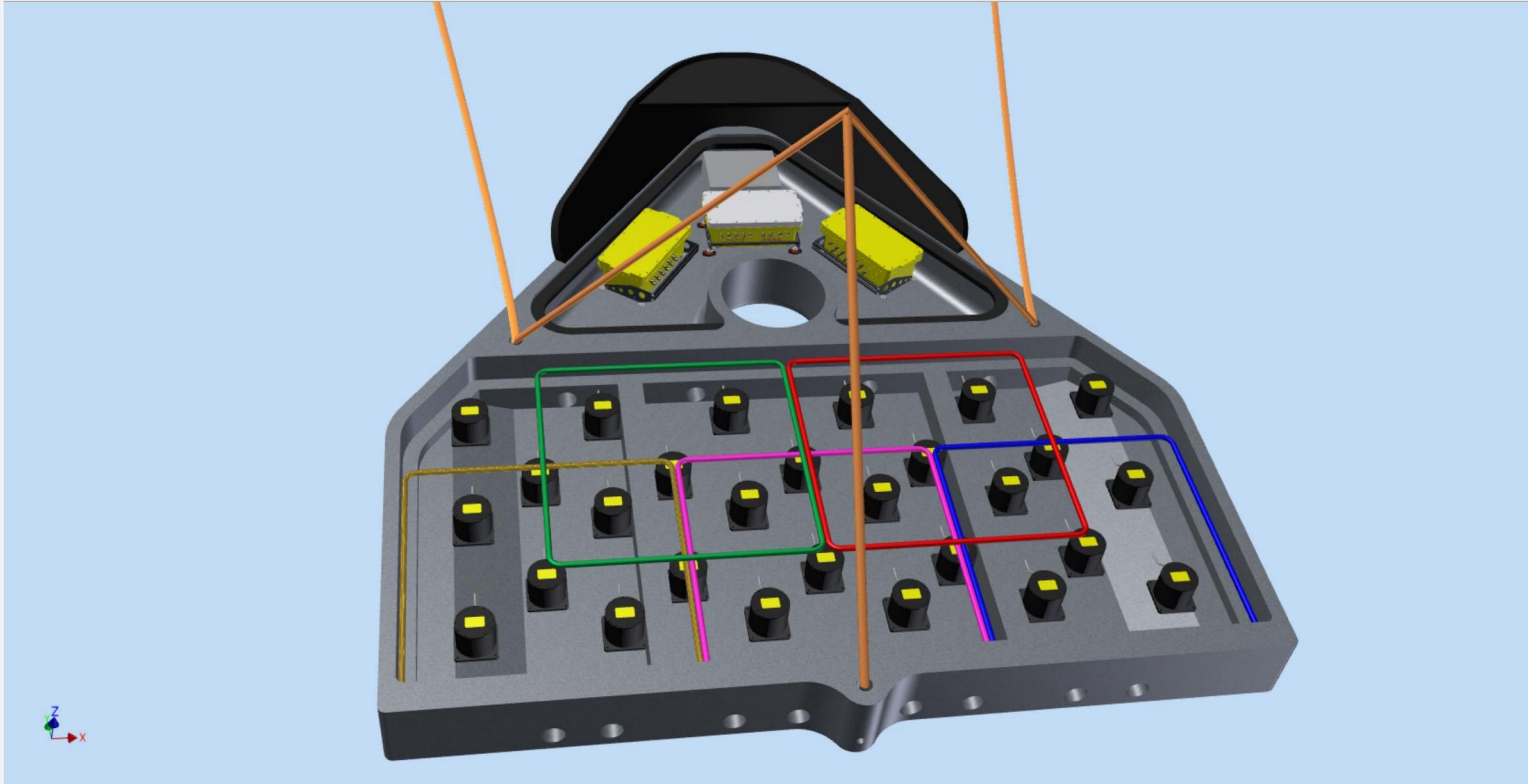
multiple looks

For effective excitation of all axes of an object

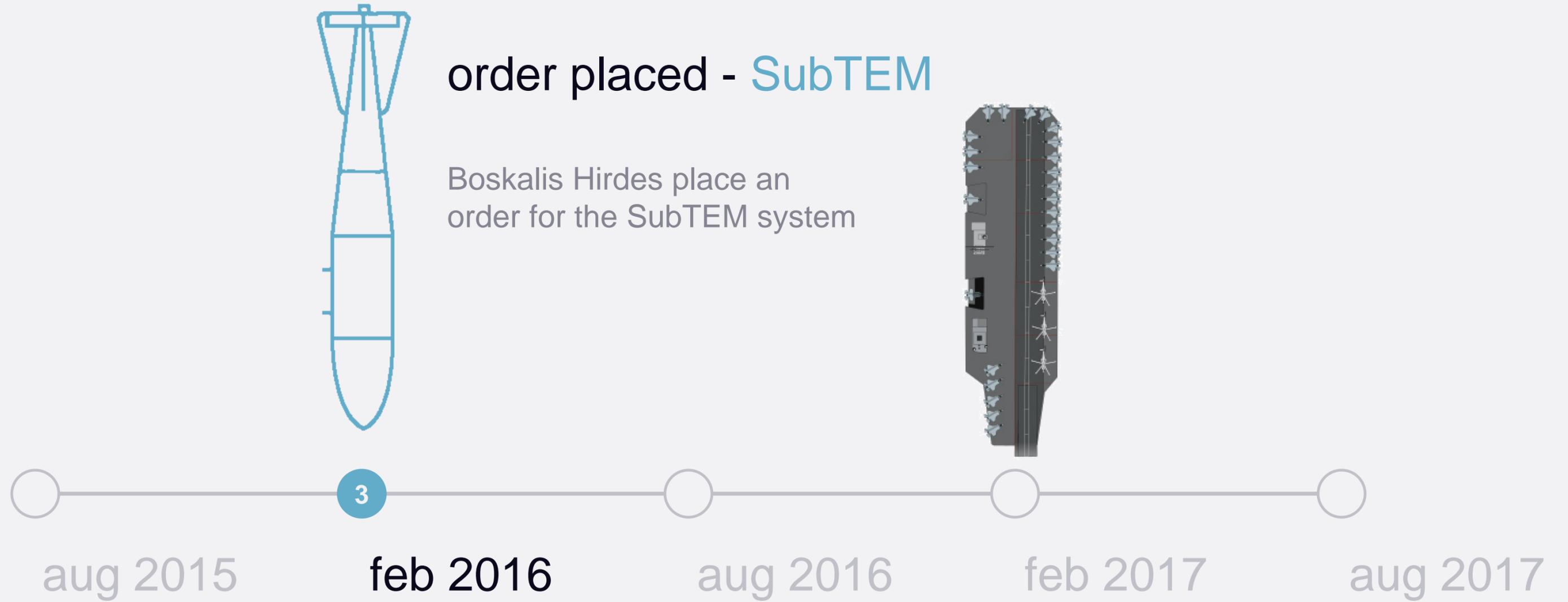
01 high resolution UltraTEM system



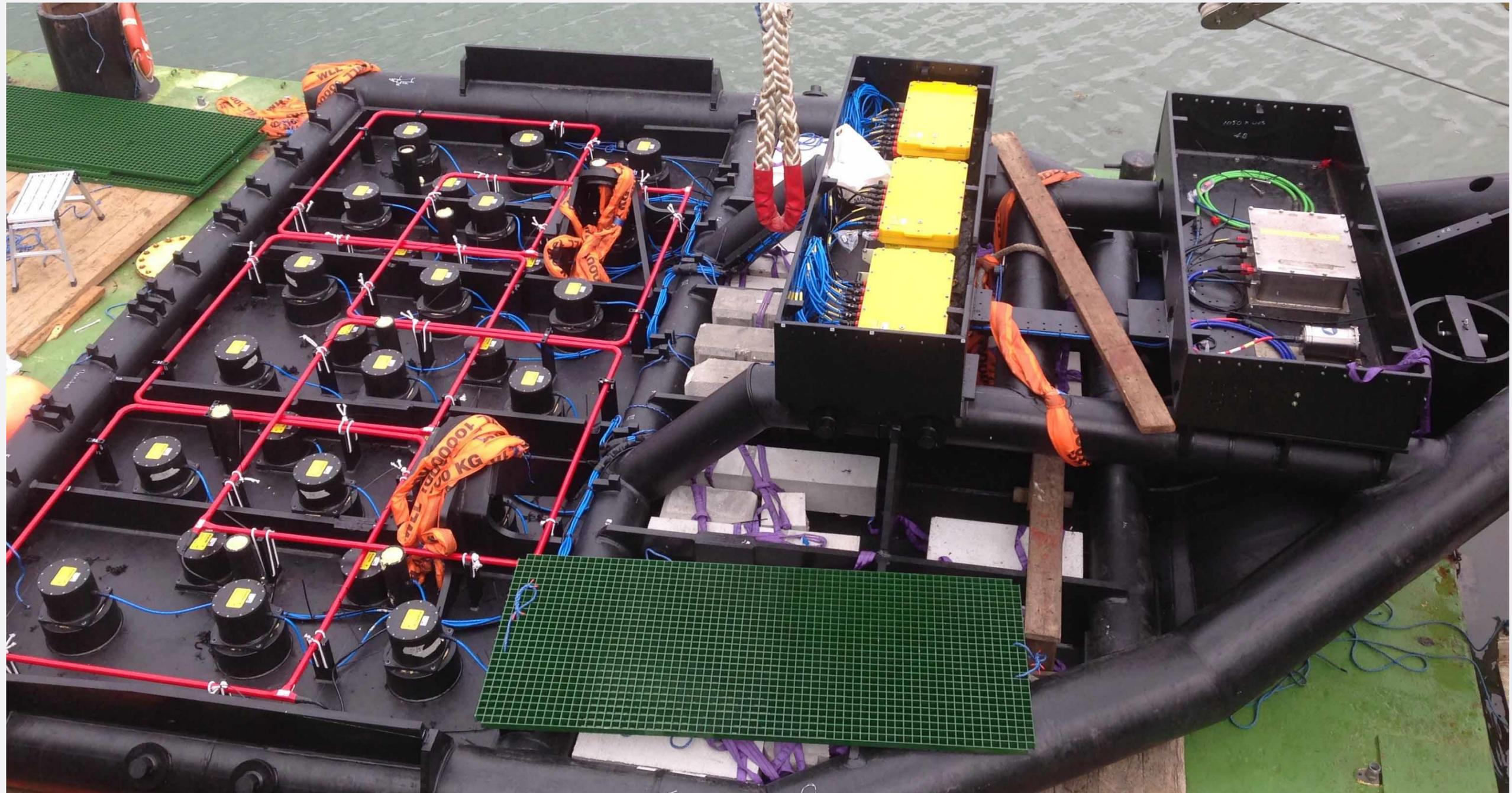
04 multiple looks design for large array



project timeline



system assembled at Portsmouth Harbour



system on the Afon Lligwy sailing back into harbour

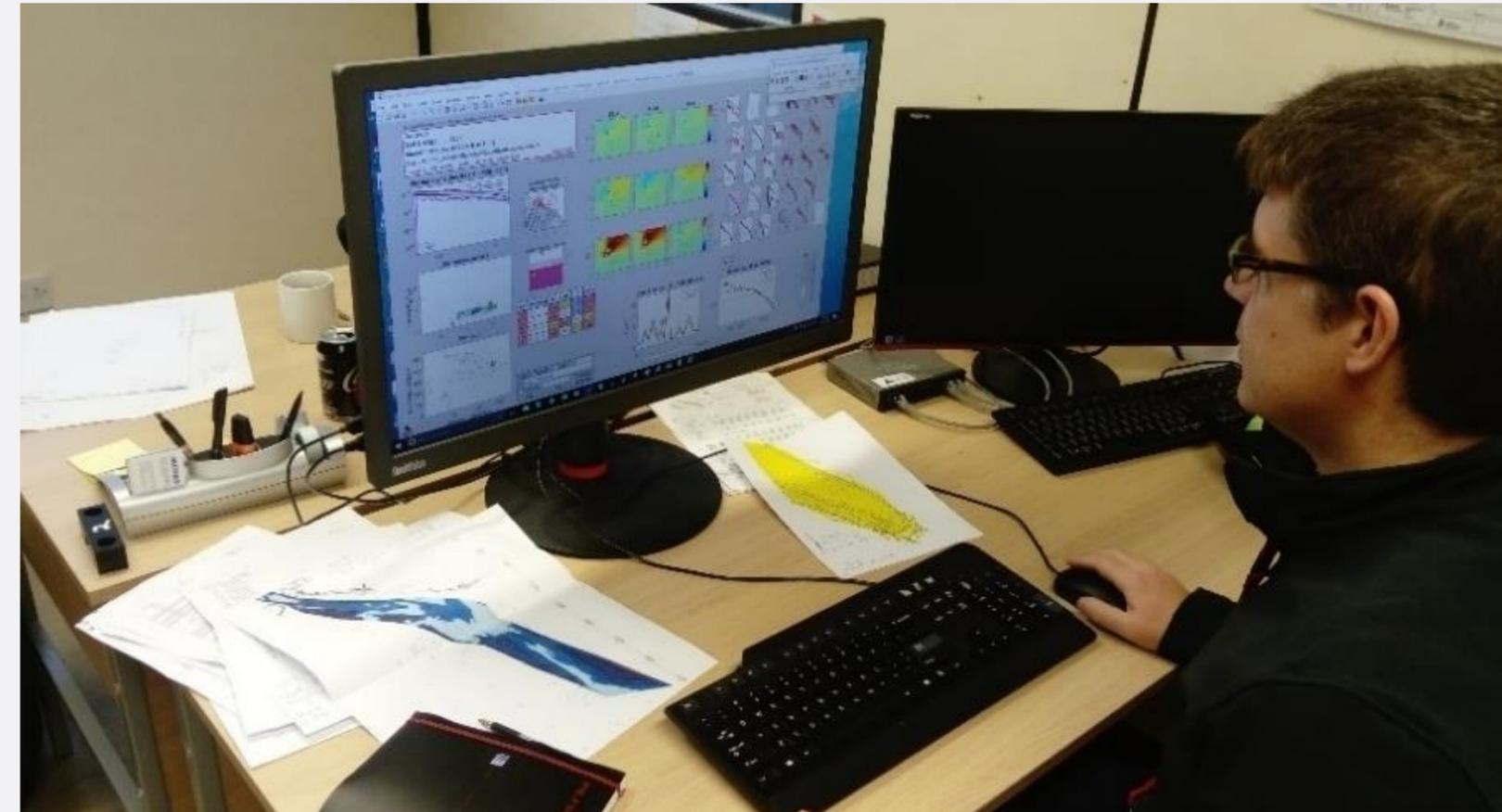


system software combination of two packages

BTField: Data acquisition



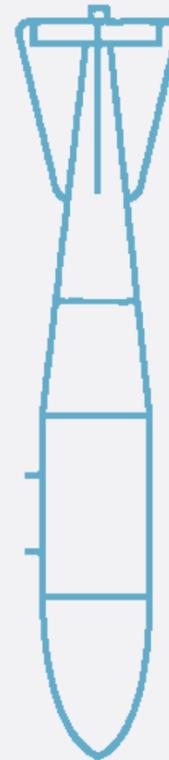
UXOLab: Data interpretation



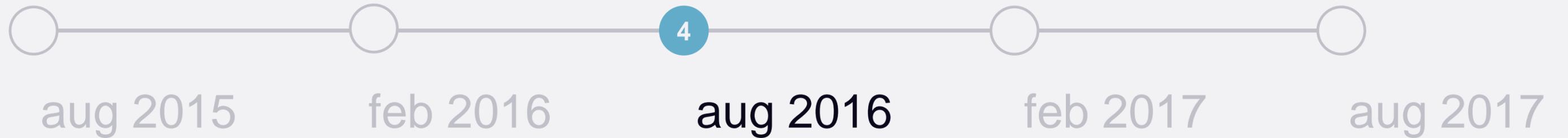
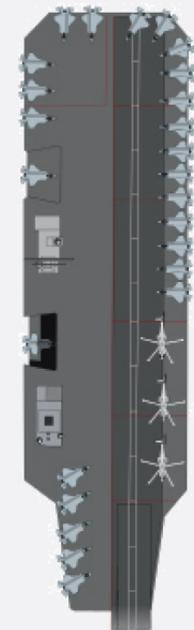
project timeline

SubTEM surveys commence

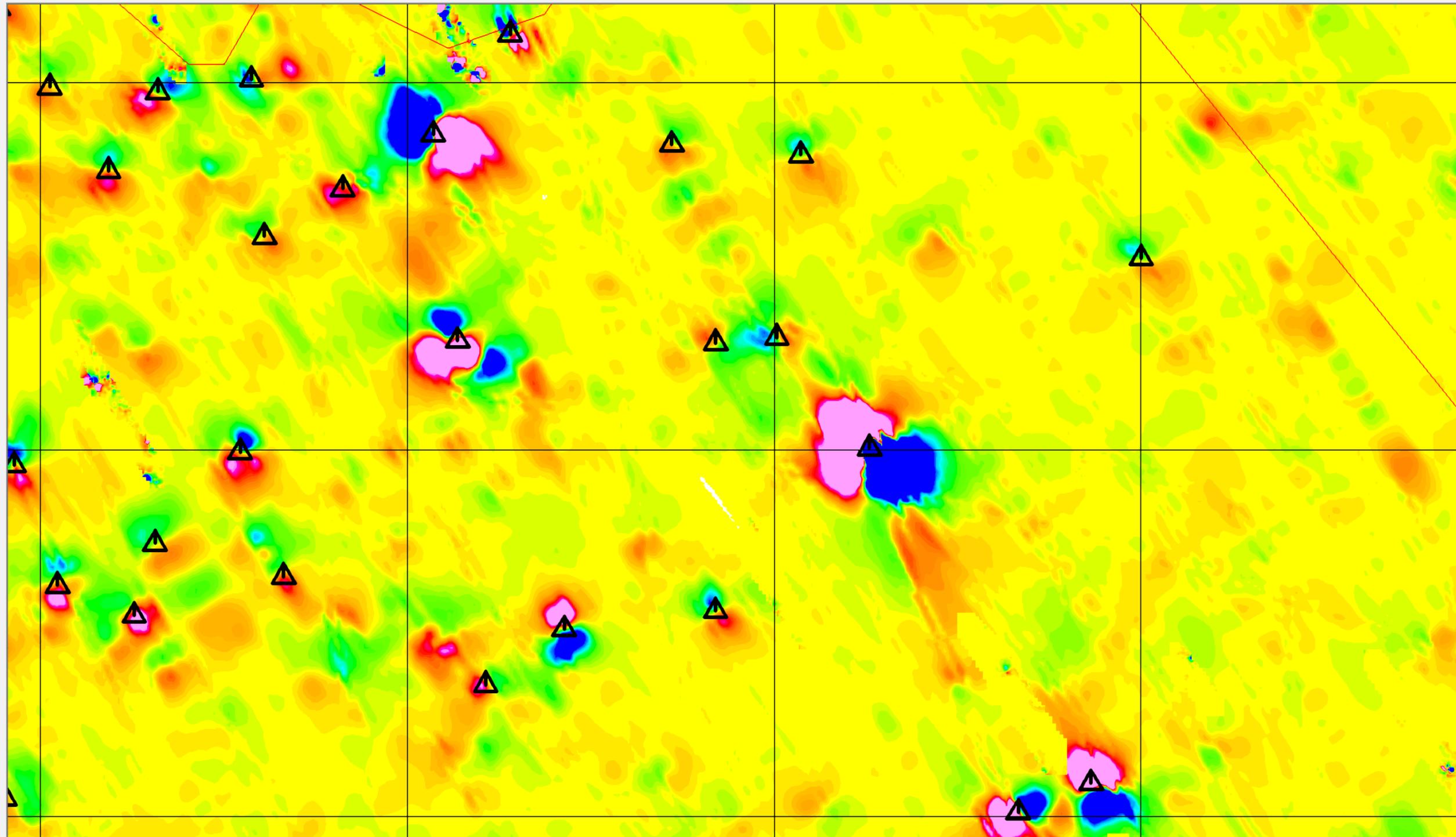
Initially in the outer harbour
as these areas require
multiple layers to be removed



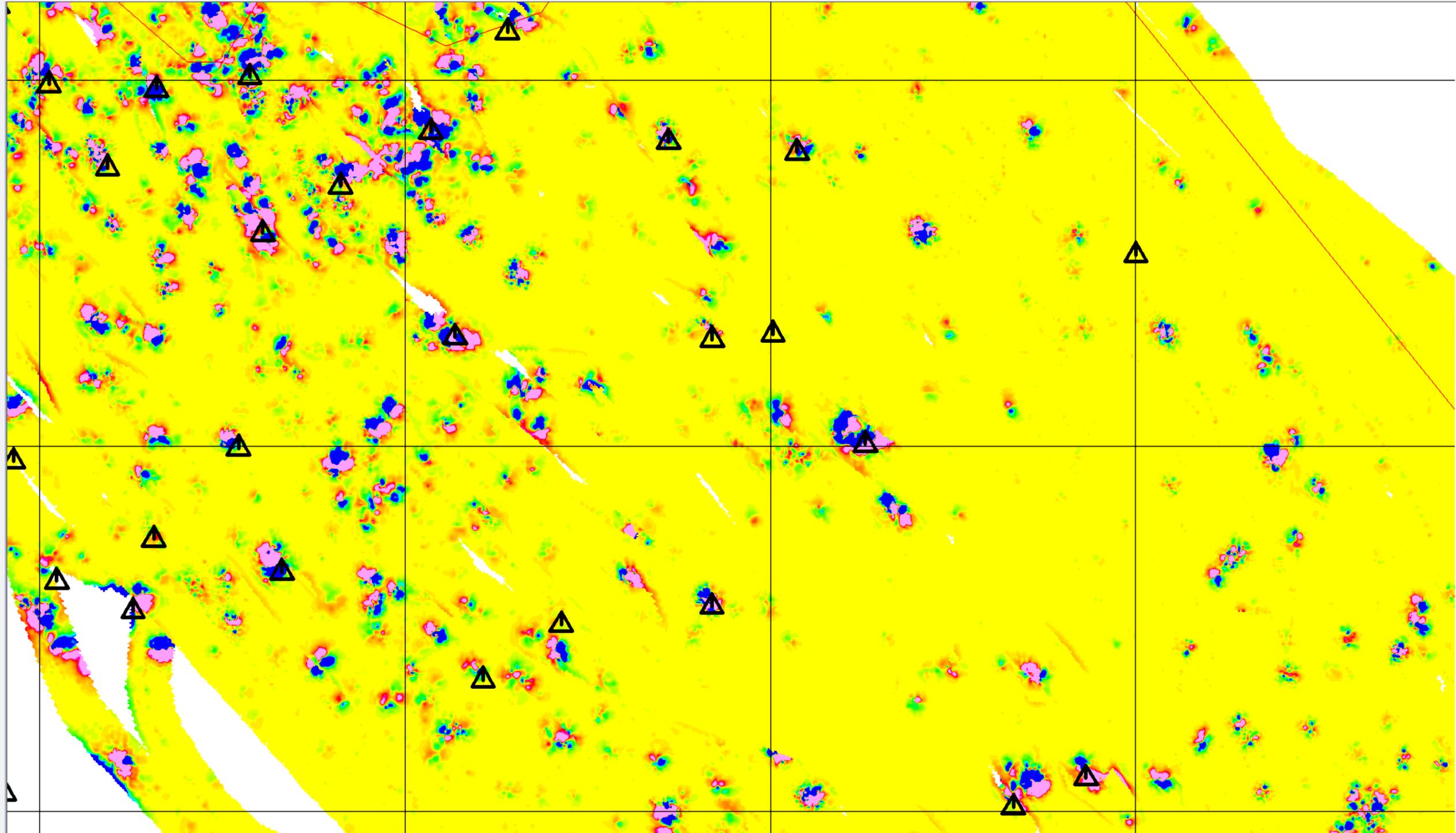
carrier arrival
delayed



magnetometer total-field

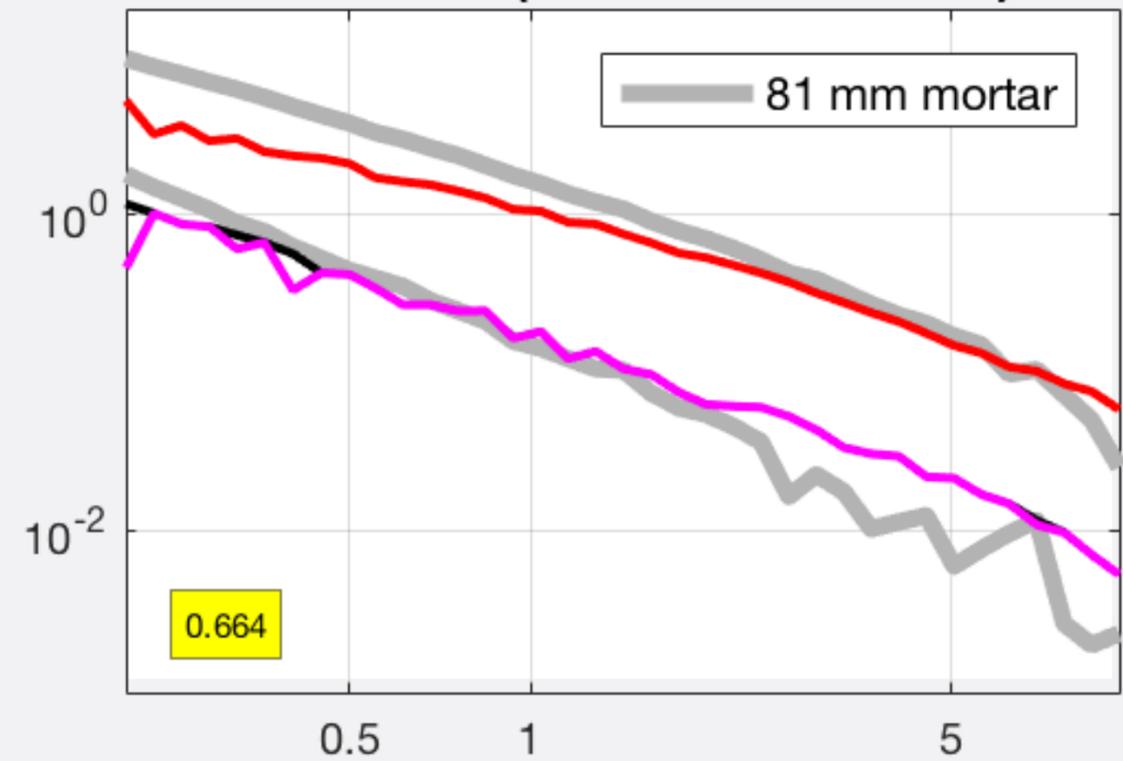
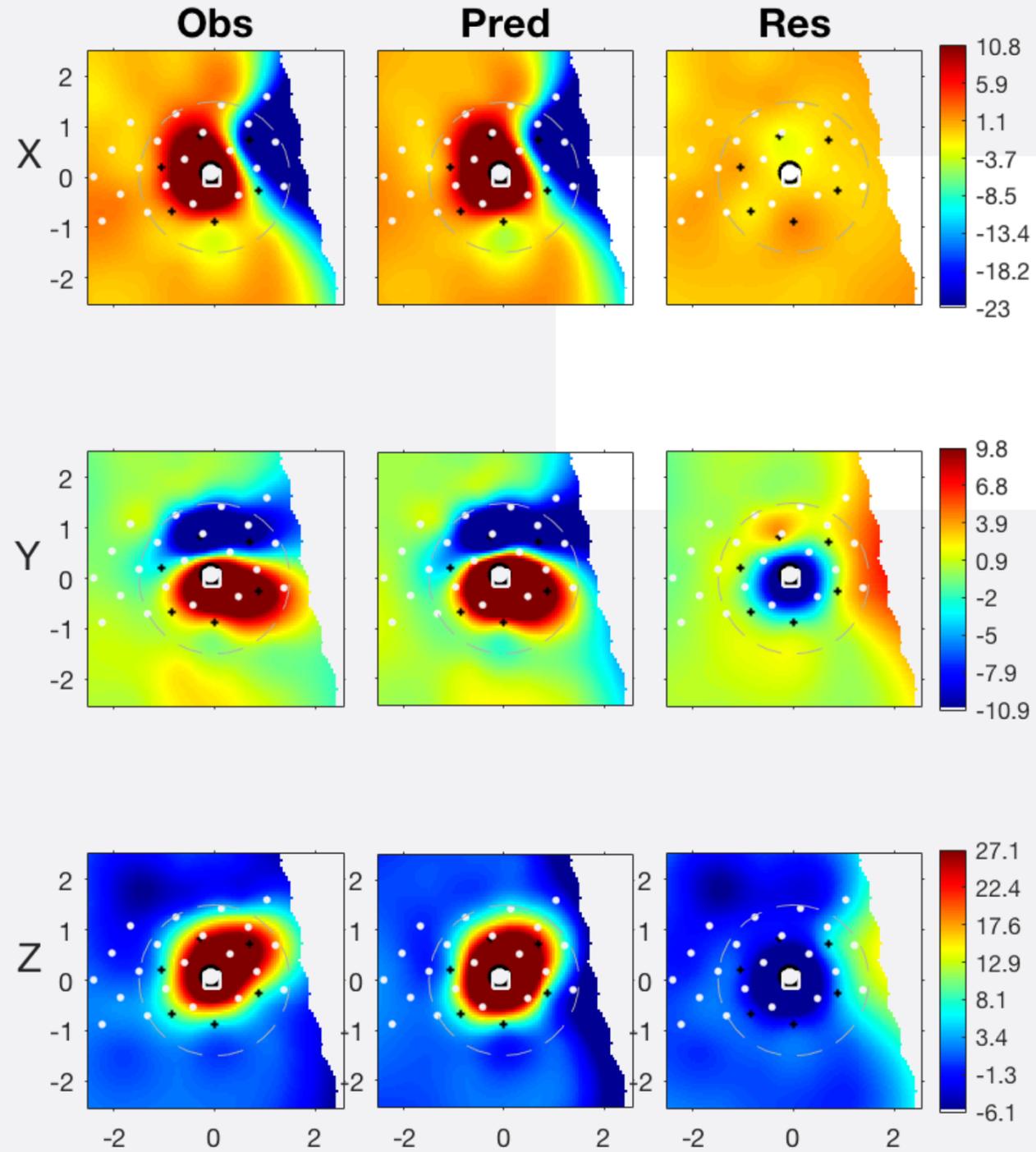


SubTEM y-component



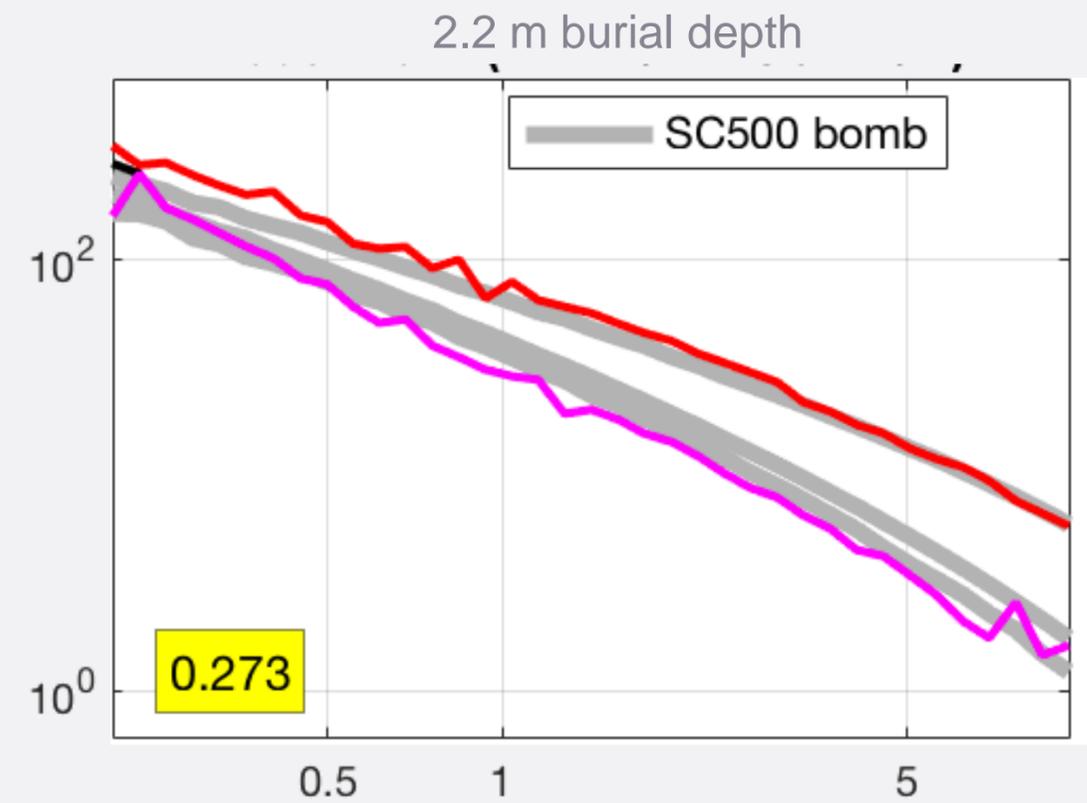
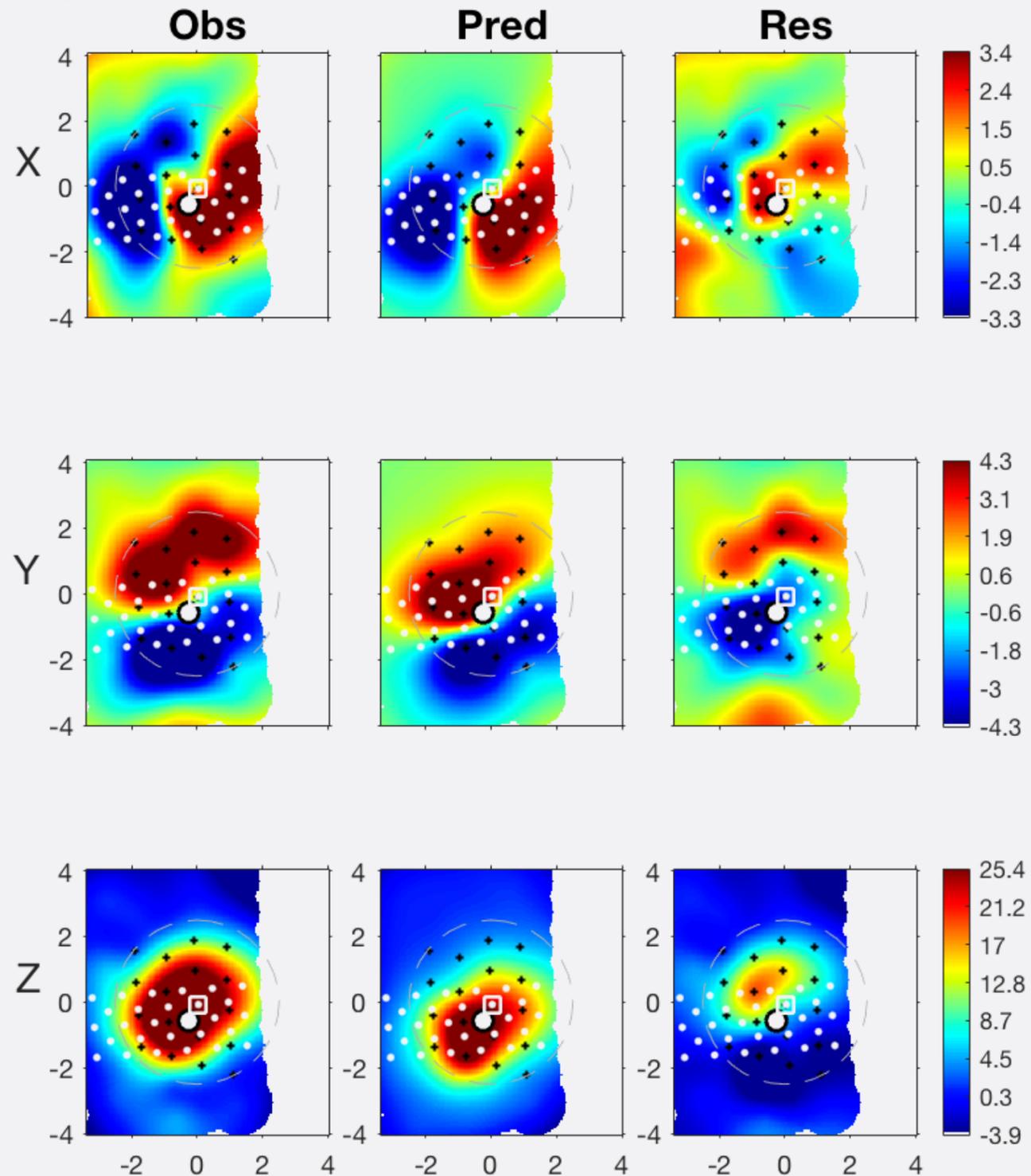
classification strategy

don't dig: too small

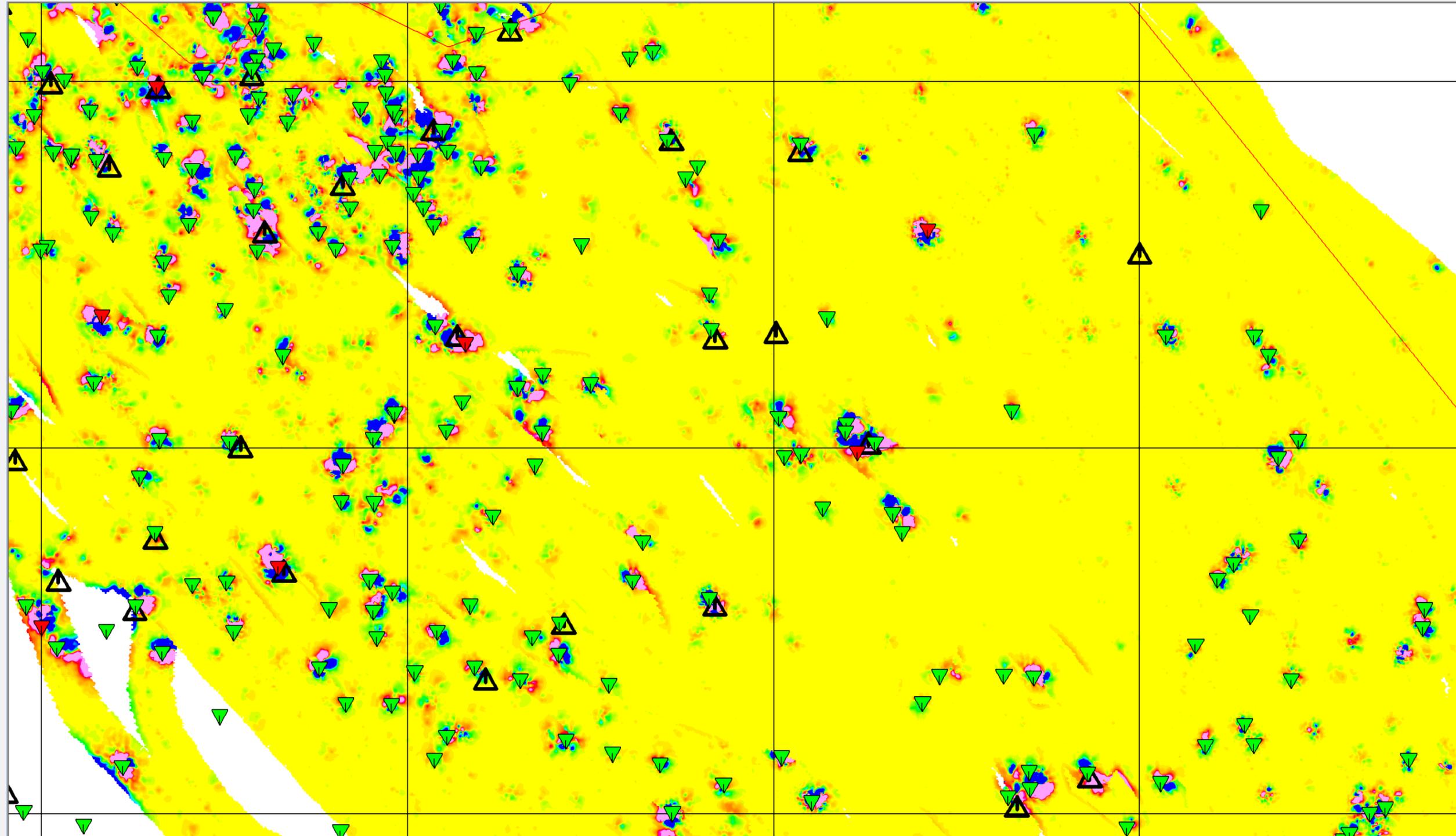


classification strategy

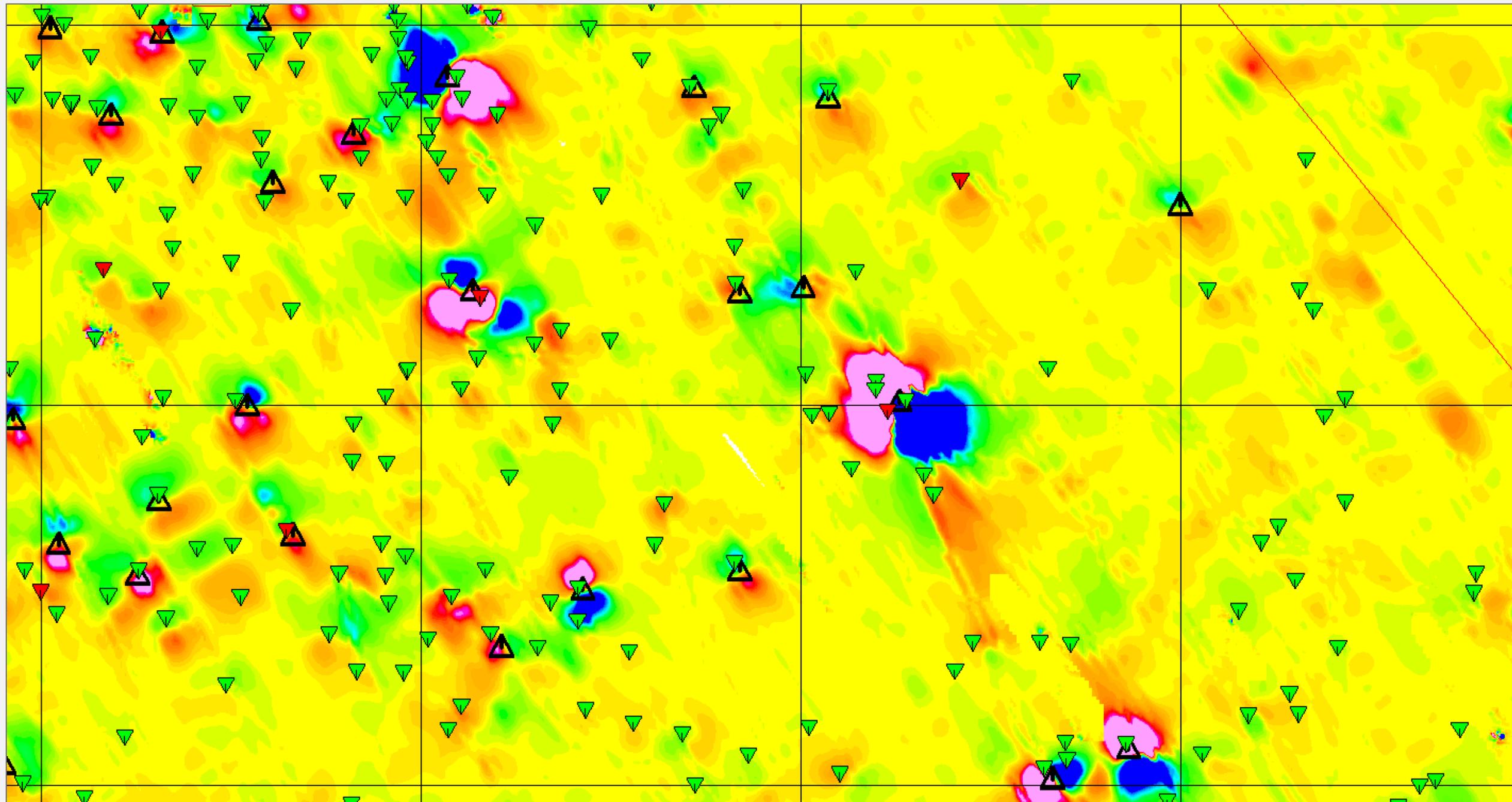
dig: large UXO and dredging hazards



SubTEM y-component

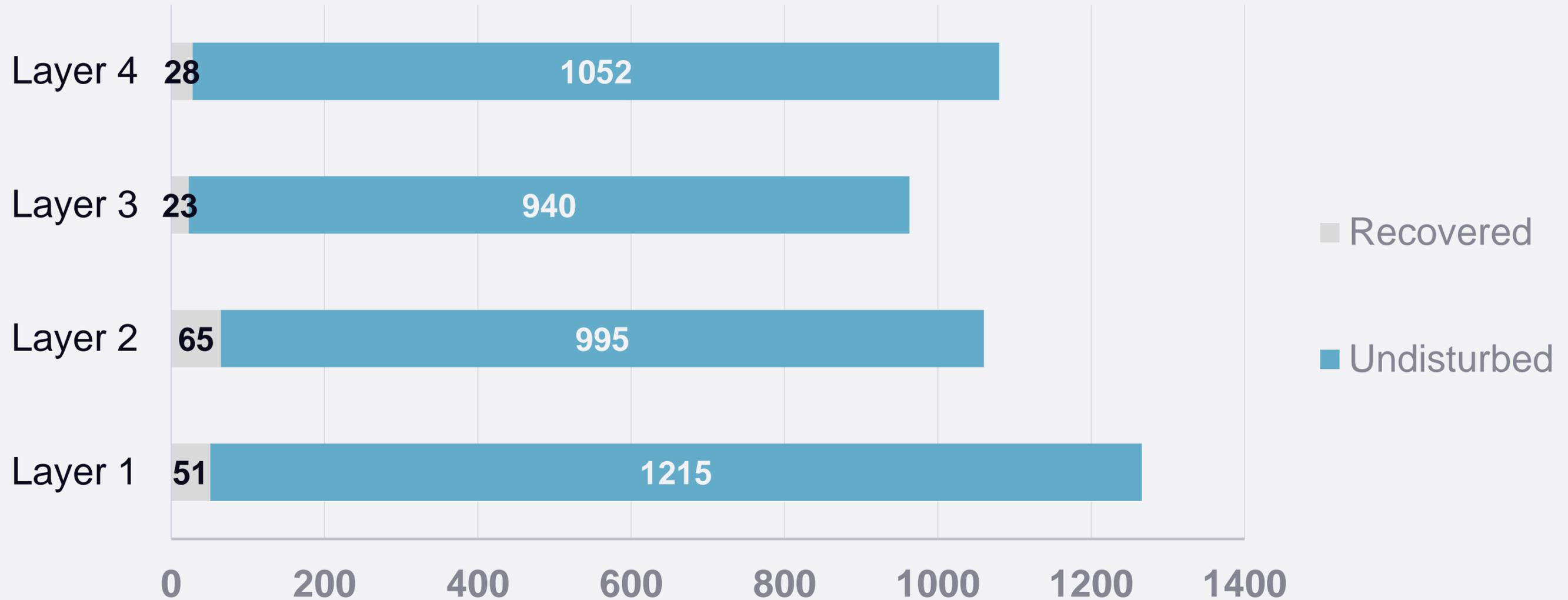


magnetometer total-field



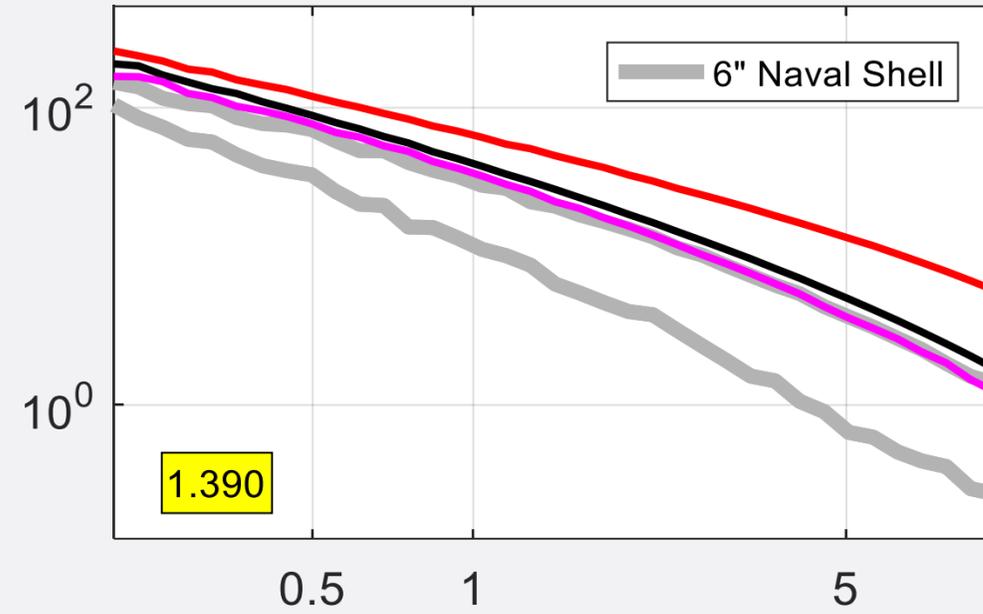
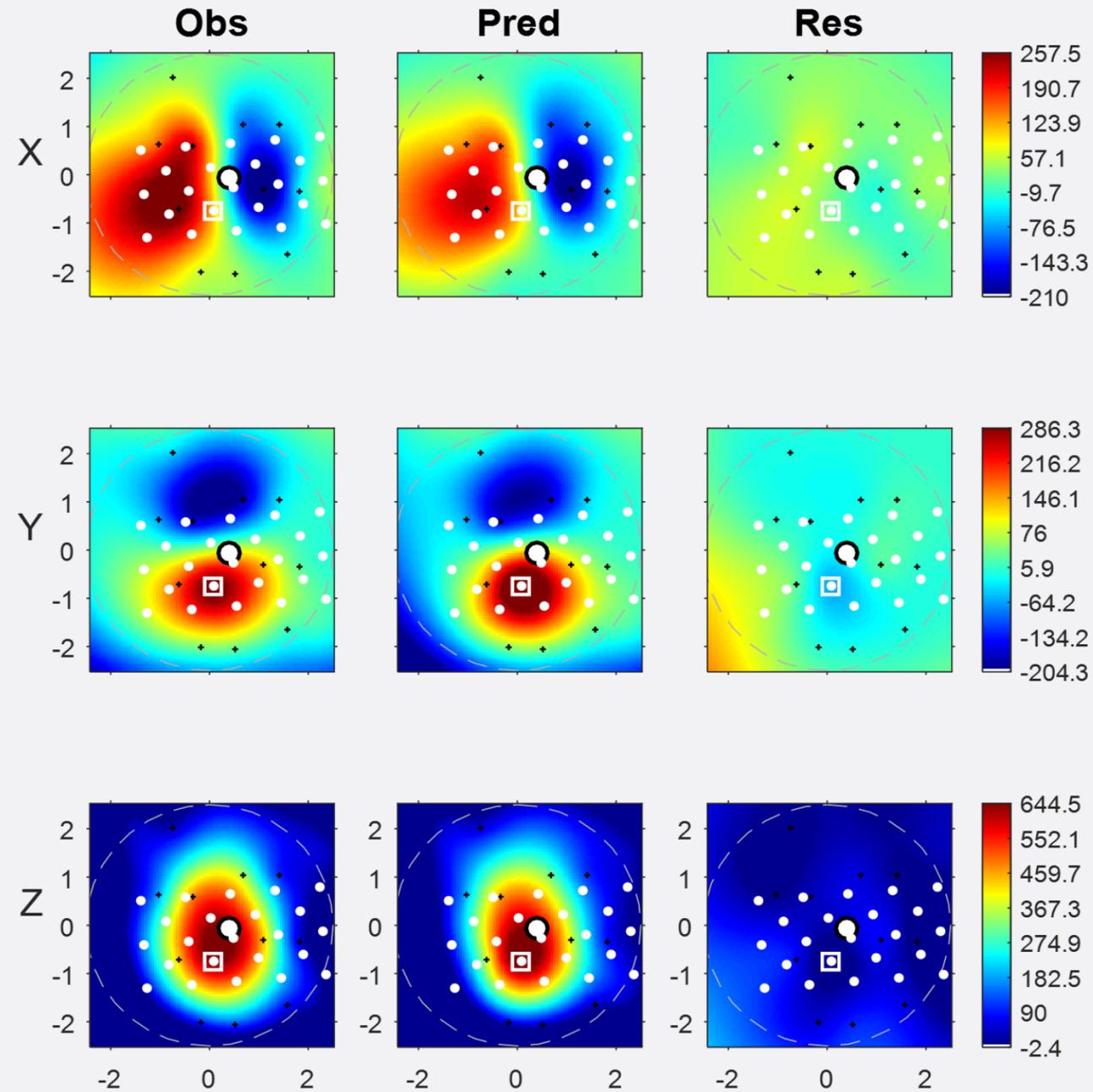
outer banks

less than 3% of SubTEM targets required excavation



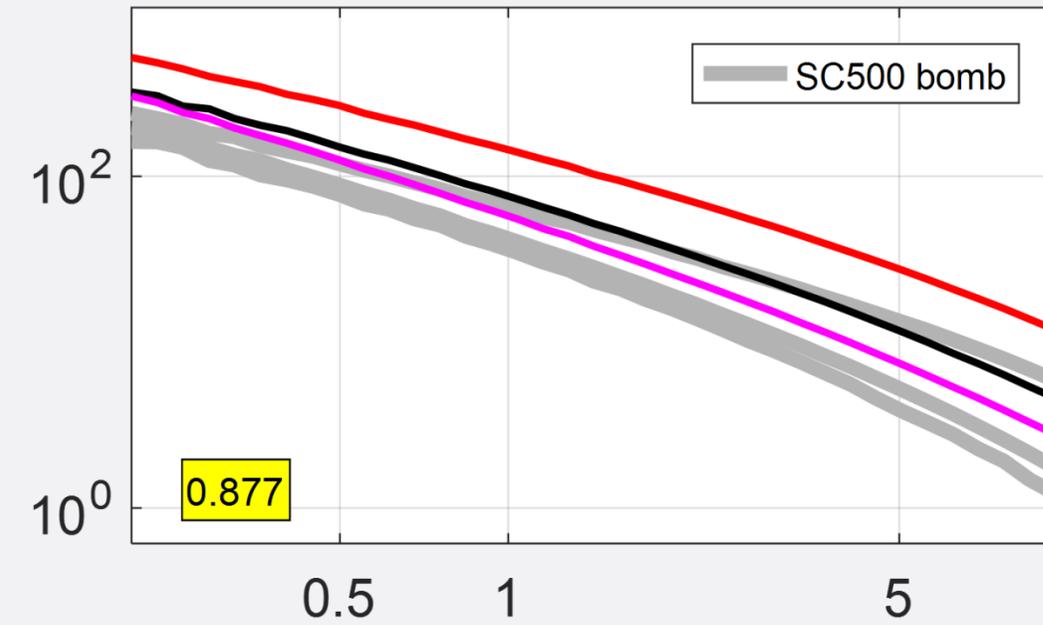
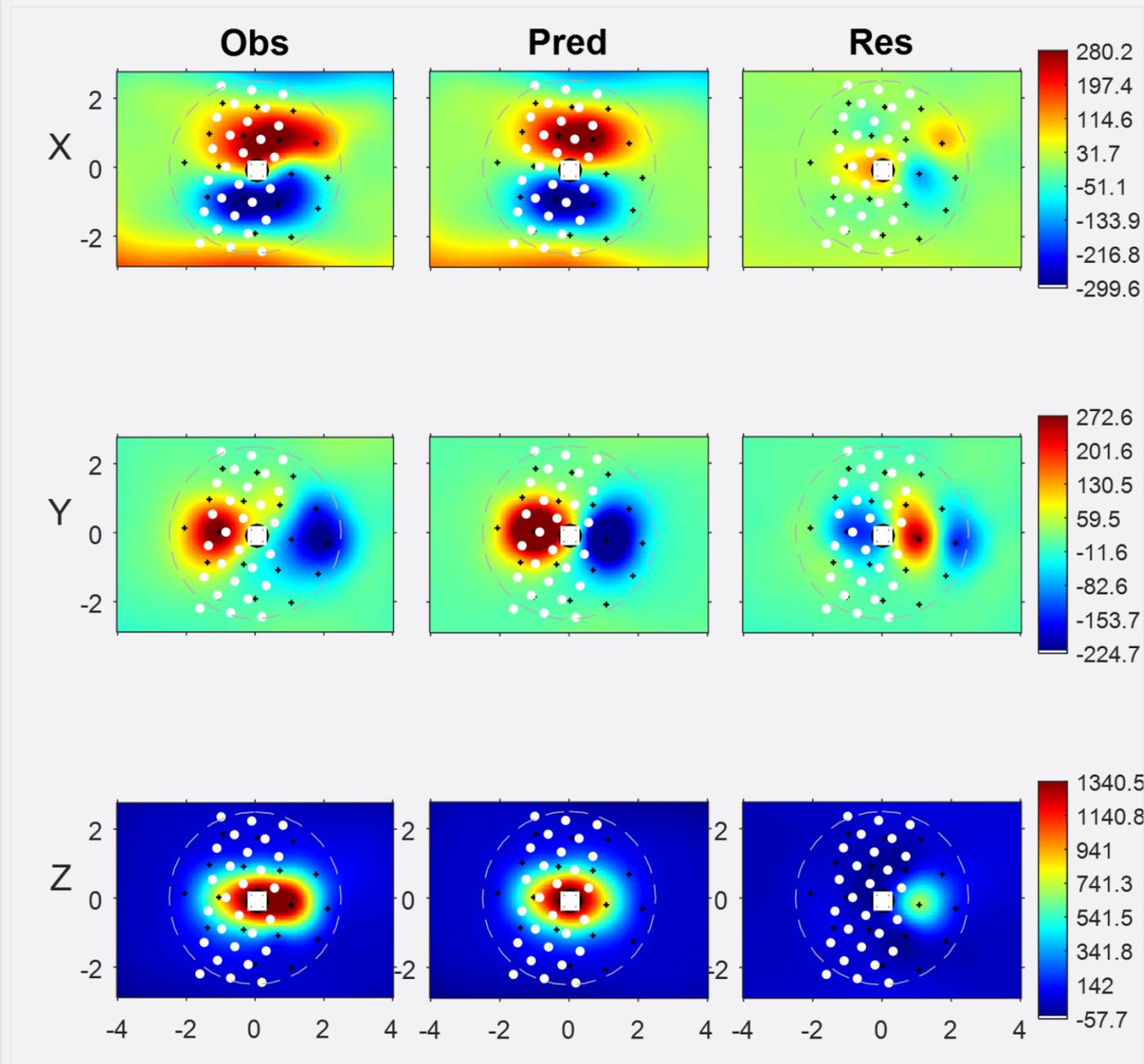
classification examples

SC-500 German bomb

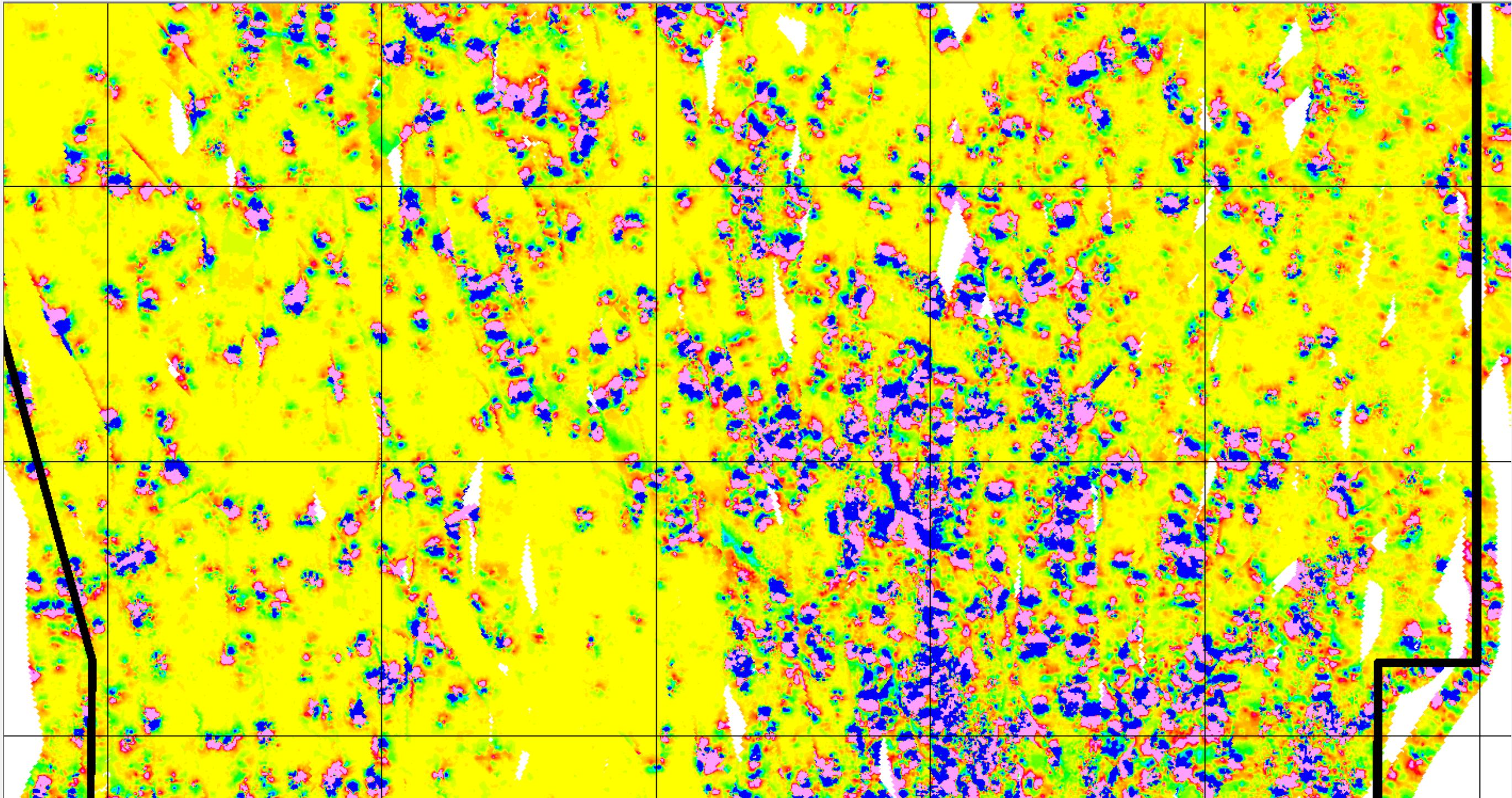


classification examples

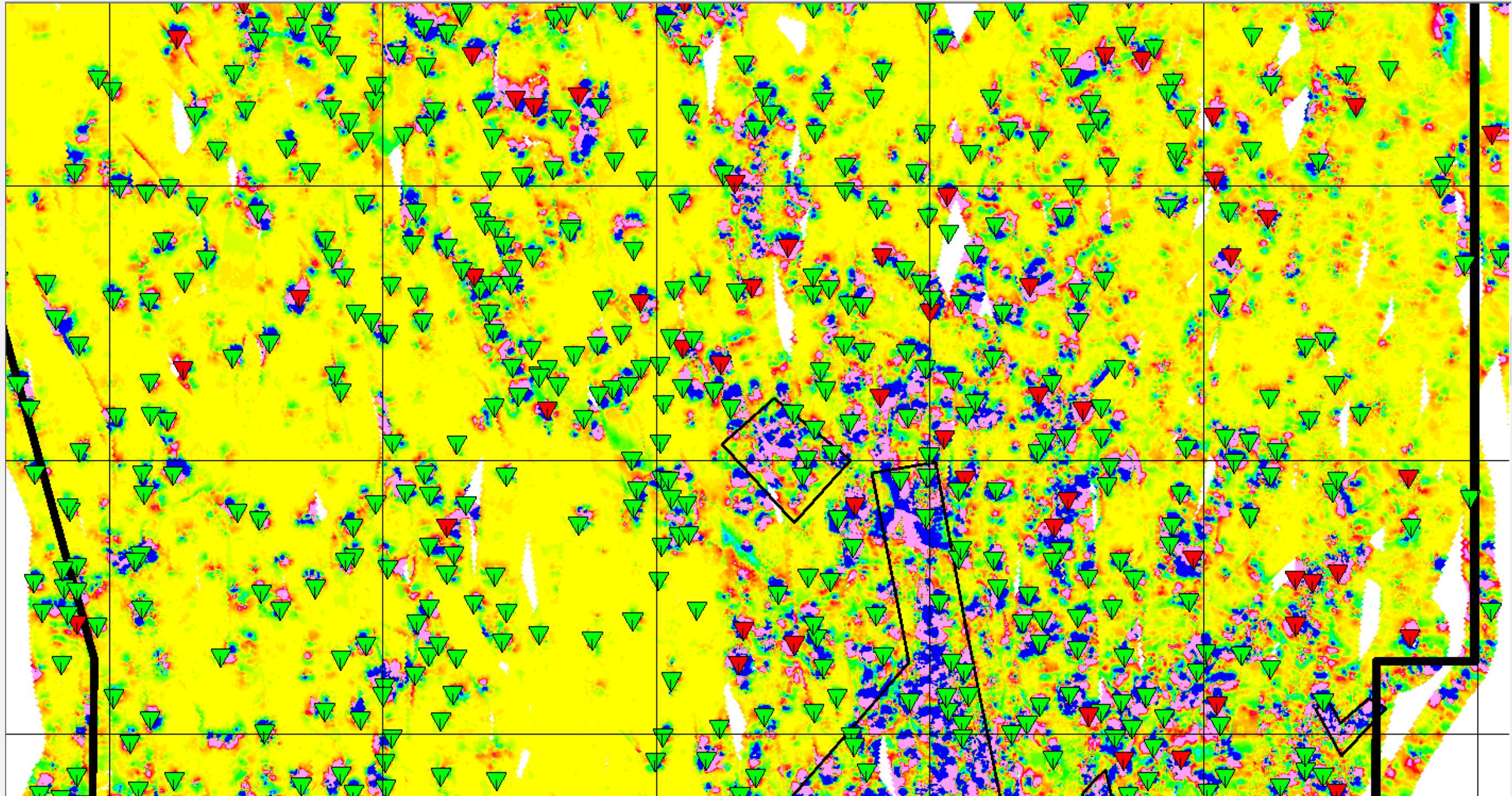
dredging hazard (large anchor)



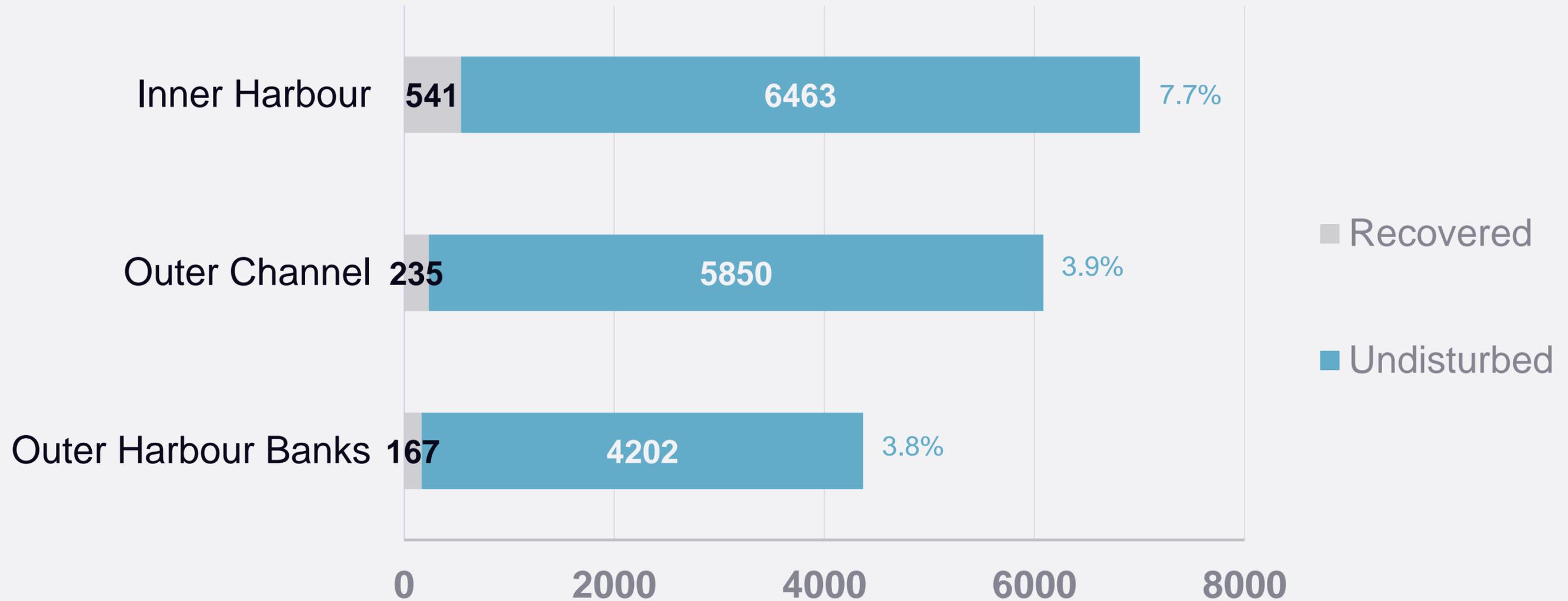
SubTEM y-component



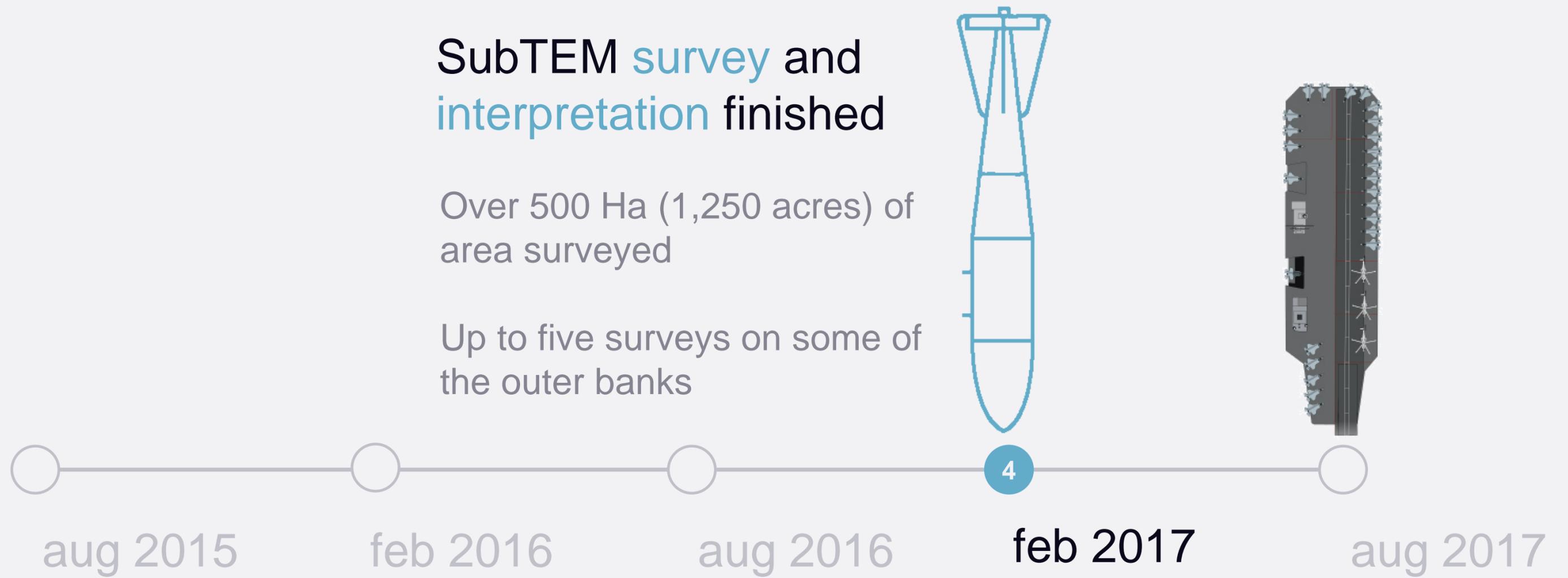
SubTEM y-component



inner harbour less than 8% of SubTEM targets required excavation



project timeline



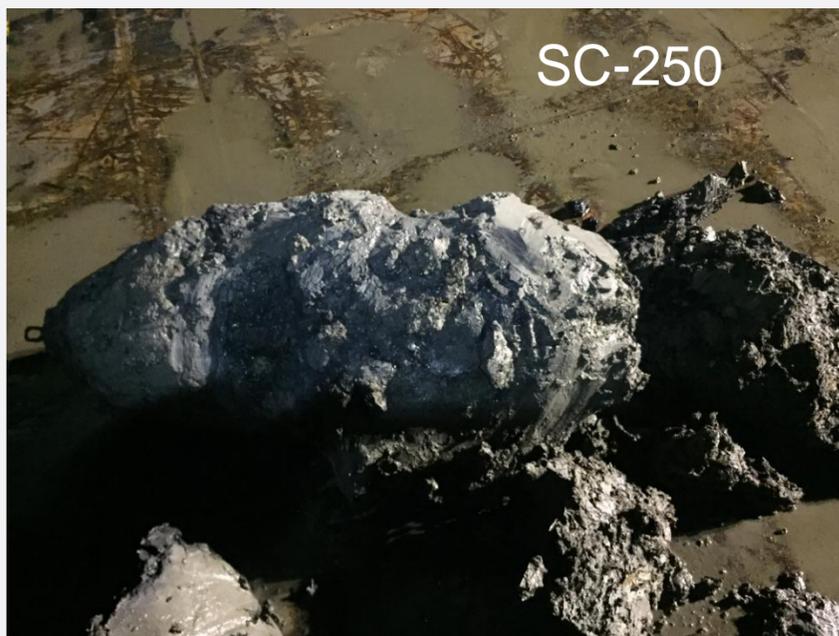
clutter items removed anchors and steel wire very common



A dozen cannons were recovered



SC-250



British Ground mine



21,000
items

3.2 million cubic meters
dredged

1.4 tonne of debris

110 pieces of UXO

1 British Ground Mine

4 bombs > 250 kg

1 torpedo

1 Dornier bomber (war
grave)

Portsmouth Harbour closed after unexploded TORPEDO found in the water

Train and ferry services were stopped after police closed off a 500-metre area around the harbour when the wartime device was found at around 5am this morning

Portsmouth

WWII bomb found in Portsmouth exploded by Royal Navy squadron

German bomb, the third explosive found since September, is towed out to area east of Isle of Wight for controlled detonation

WW2 bomb blown up off Portsmouth is damp squib

The 500kg German device was discovered during dredging works to deepen the harbour for a new aircraft carrier.

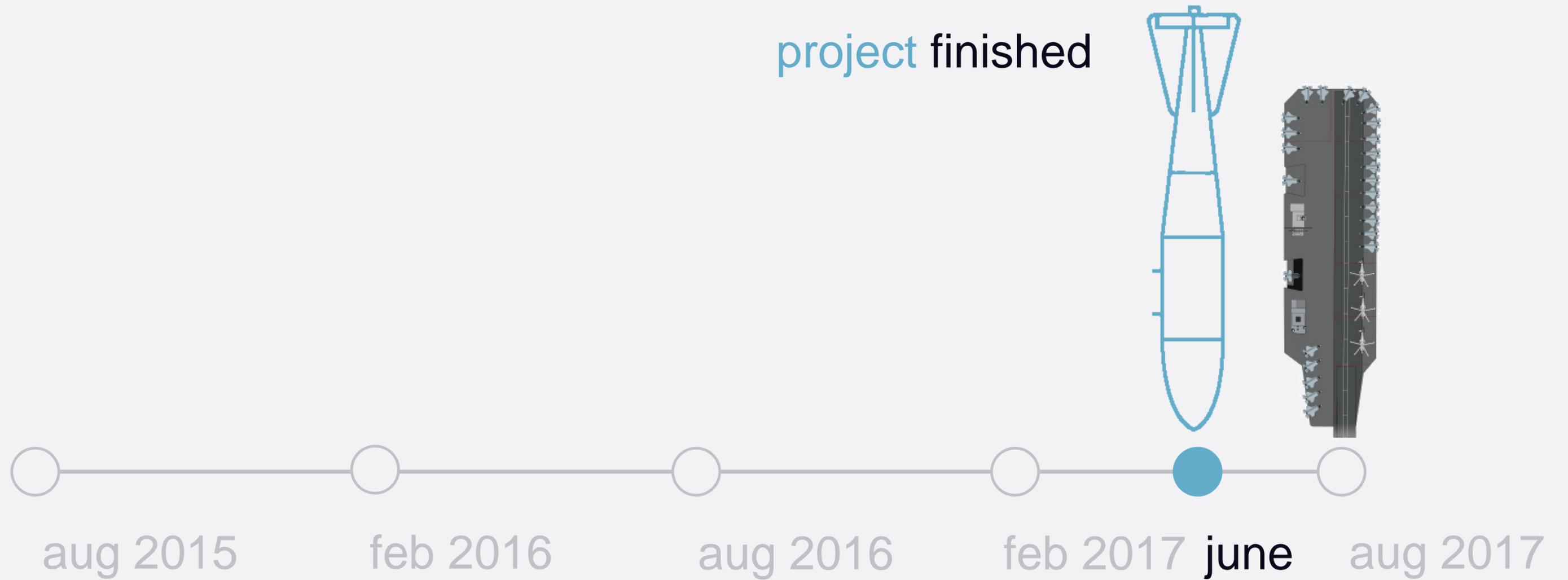
15:39, UK,
Friday 30 September 2016



news
items

4 items were towed from
the harbour and destroyed

project timeline





august
2017

Queen Elizabeth sails into
Portsmouth Harbour

credits

key contributors



Boskalis

project execution

Marine Engineering

UXO expertise

Item recovery

Dredging



Black Tusk

software

System design

Software

Data analysts



GapEOD

hardware

UltraTEM design

Electronics

Fabrication

future system

SubTEM on work-class ROV

