

Oil Spill Detection (OSD)

by using

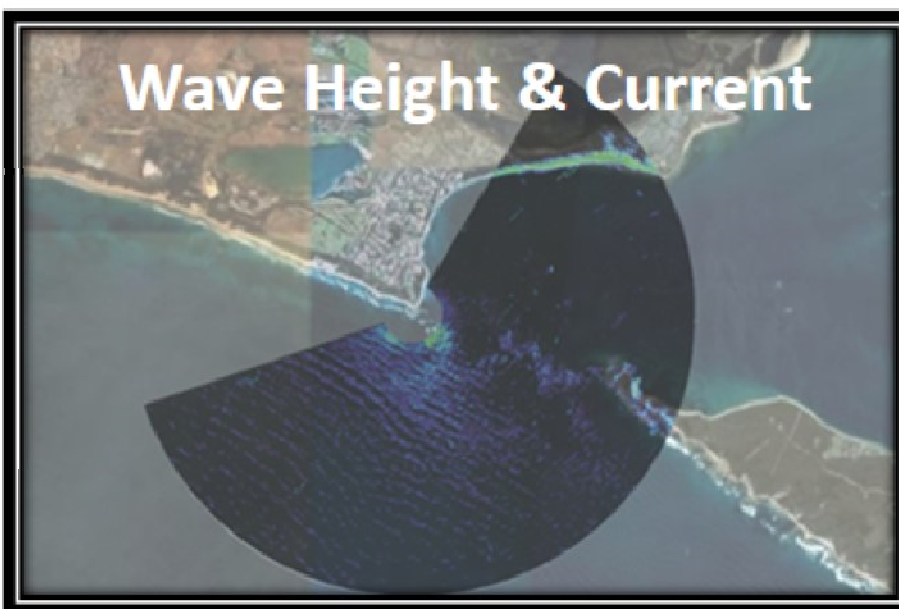
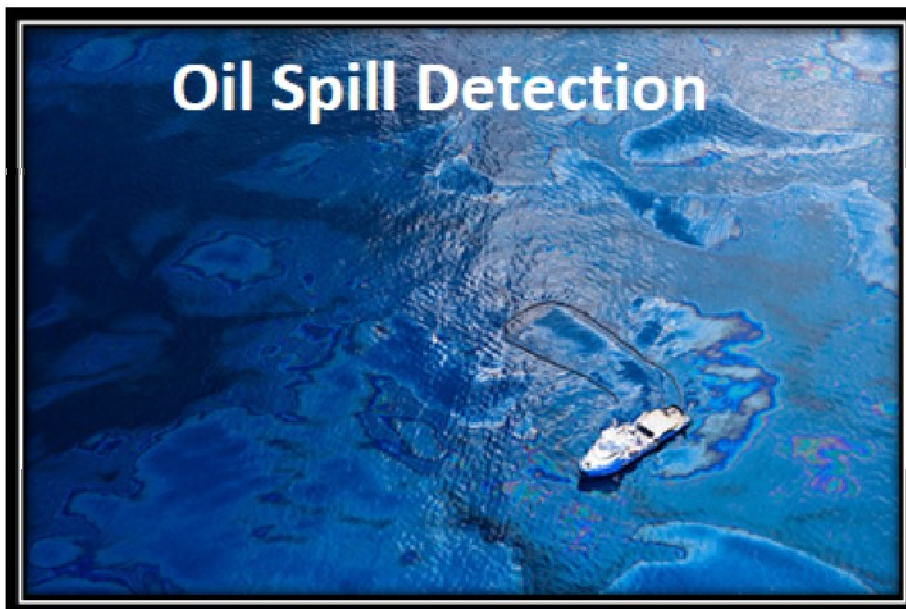
X-band radar

Ina Adegeest, Rutter Inc./ OceanWaveS GmbH, Germany



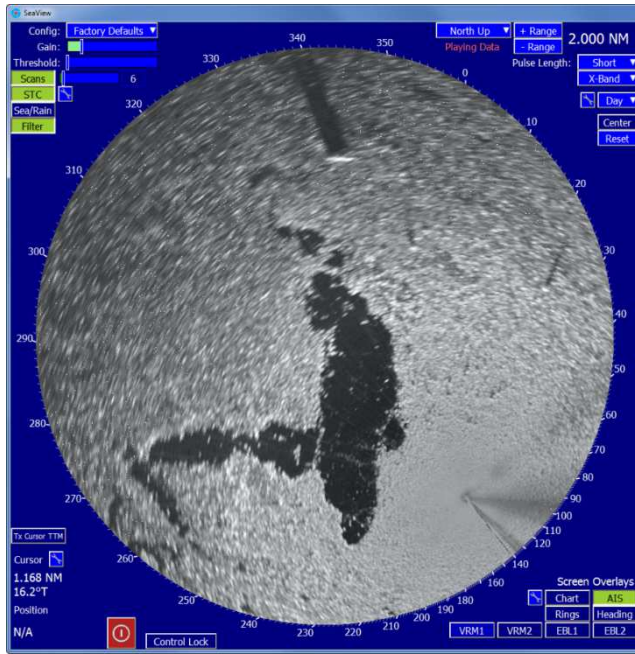
- Canadian company
- Head Office in St. John's, NL, Canada
- Incorporated in 1998
- Since October 2012 Sales office in Germany
- Company specialized in oil spill, ice and small target detection – sigma S6
- Company specialized in real time wave and current monitoring - WaMoS II
- By using navigational radar
- Offering enhanced Radar systems to the
 - Oil & Gas,
 - Maritime Shipping,
 - Seismic,
 - Security sectors



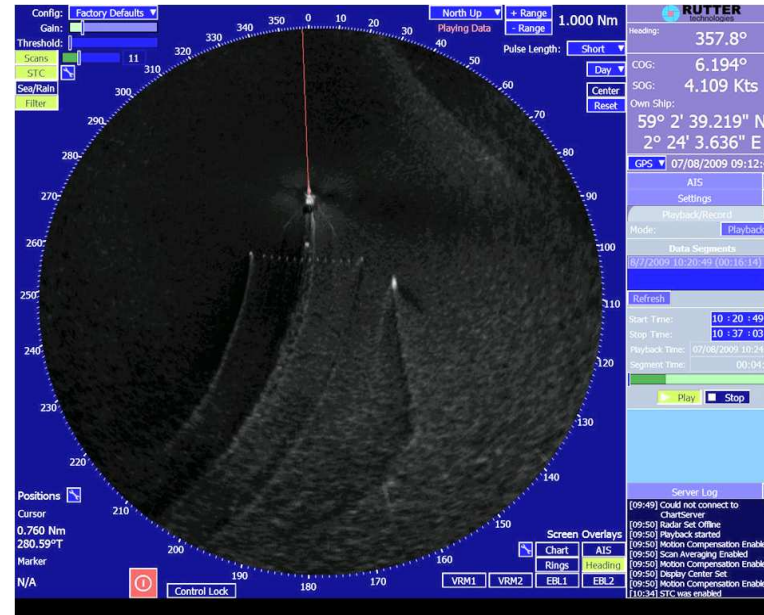


sigma S6 applications

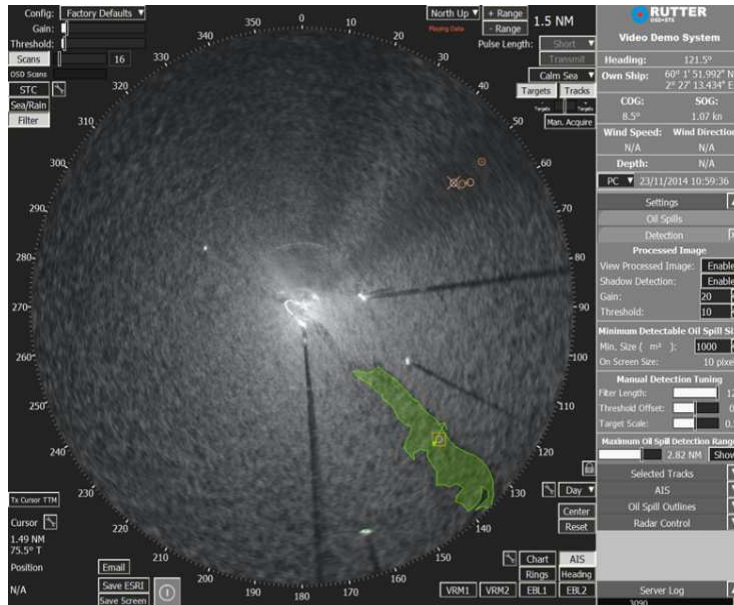
Ice



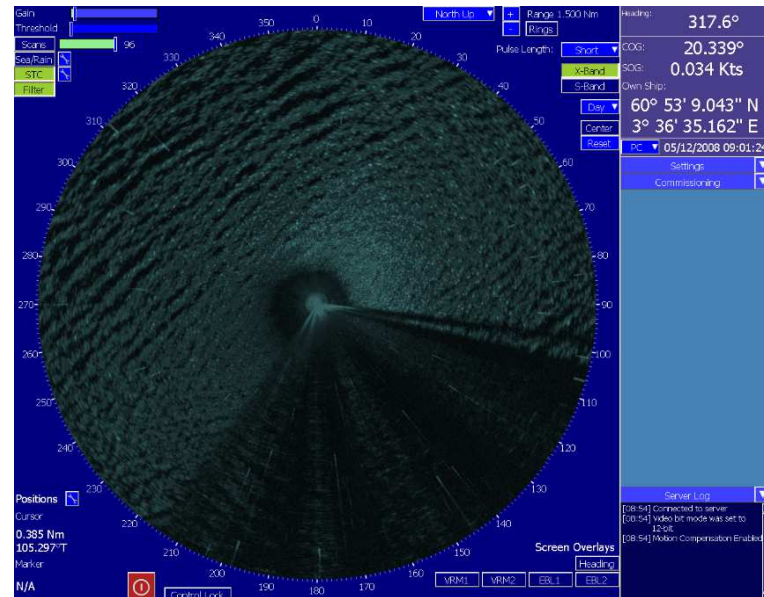
Target

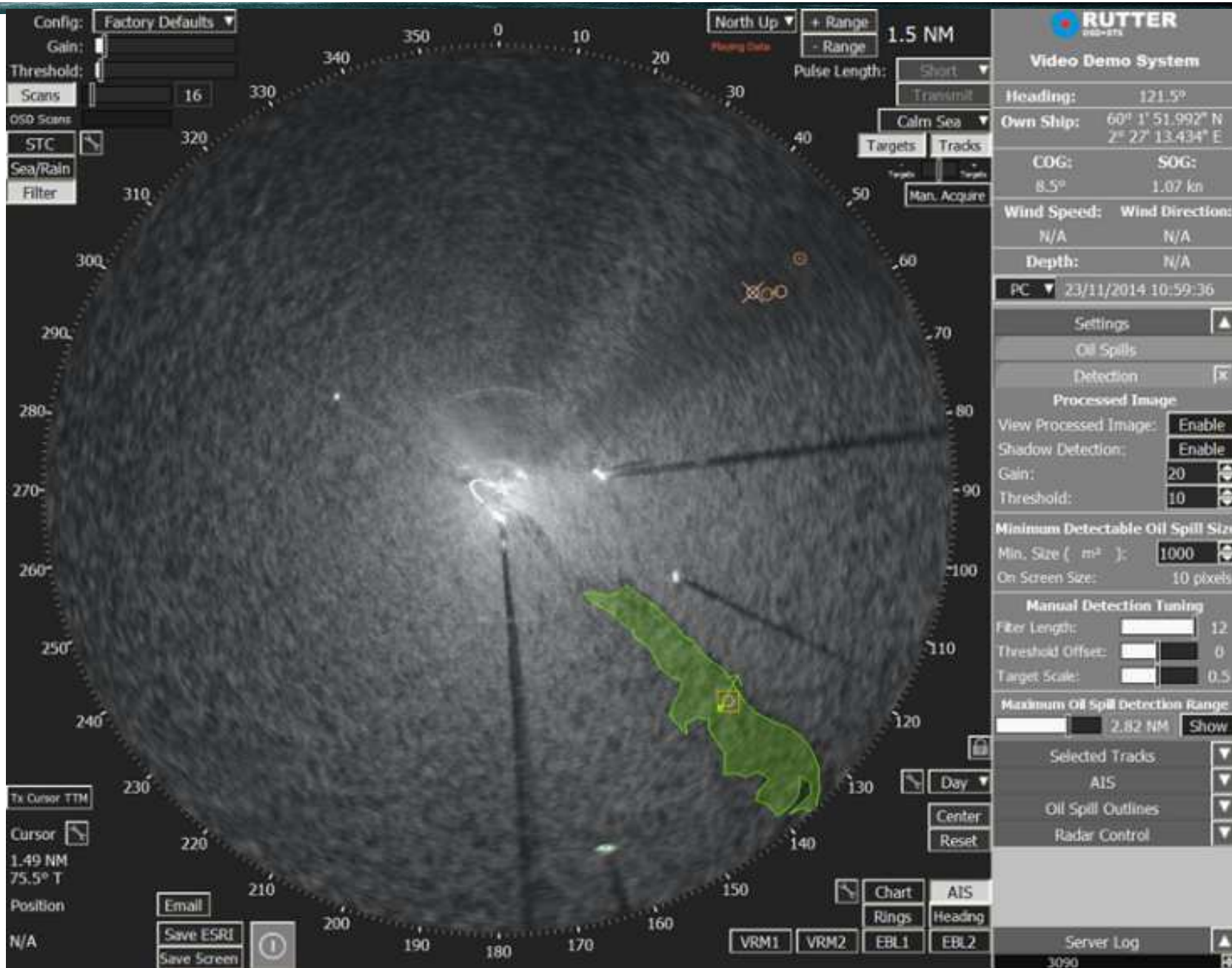


Oil



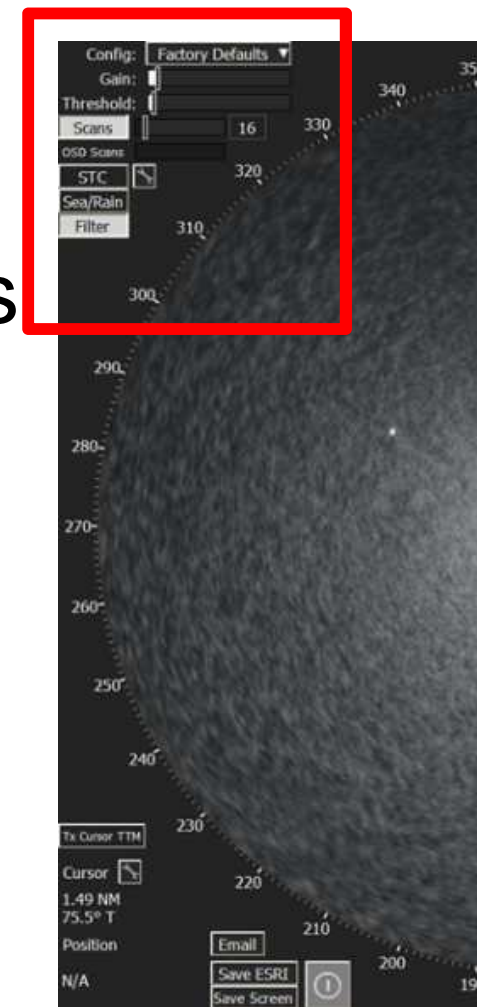
Waves





- High Definition processing & imaging capability
- Connectable to conventional X-Band radar systems
 - Either horizontally or vertically polarized
- Advanced clutter/ noise removal algorithms
- Motion compensation
- Enhanced display with control interface
- Stand alone or network capable
- Output standards/ data sharing for system data integration like command and control centres
- Data managed on Electronic Chart system

- Full signal A/D conversion and 12-bit processing
- Scan-to-Scan Averaging and range of filters for significant clutter reduction (Pulse filtering, Sea/Rain (CFAR), STC)
- Dynamic Thresholding
- Enhanced 256 level display with controls interface designed for rapid learning and usage
- Dual channel Plot Extractor with Tracker for simultaneous tracking of slow and fast moving targets



- Vessel, platform or shore-side installations
 - Vessels can operate at speed with OSD still operating with no degradation
- Vessel based system can move with slick
- Oil slick detection:
 - Detection is via signal processing, not image processing
 - Lowers false positives/ alarms
- Multiple slicks detection
- Appearance of the *sigma* S6 interface is similar to that of conventional marine radars -> easy to use

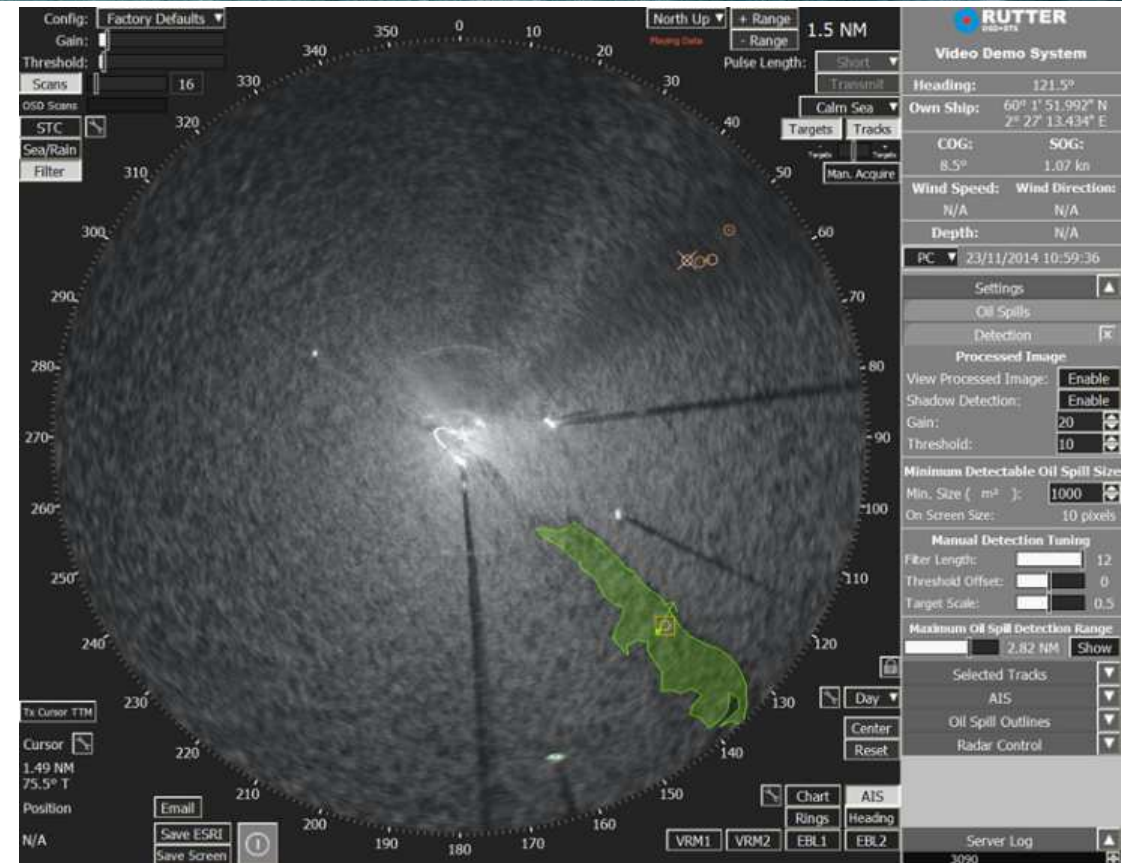
- Capable of detecting a light (0.00004 mm) to silver sheen (0.00007 mm)
- 4 nm range of detection and tracking
- Minimum detection volume is 5L from oil in water test
- Maximum detection volume is unknown, but measured 1000L was noted volume during NOFO oil in water exercise

Why Oil Spill Detection Radar

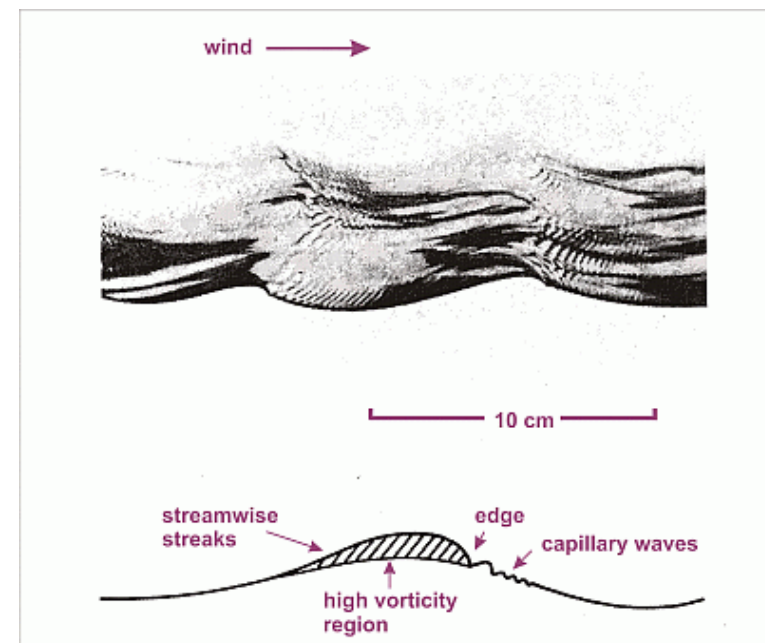
- Real-time detection and tracking of surface oil slicks
- Auto detection, tracking & outlining
- Tracking slick trajectories (Range, Bearing, Speed, Course)
- Auto alerts with alarm
- Area and user managed Volume estimation
- Day/night/ low visibility => 24/7
- Minimal user intervention
- ESRI outlines sharing for GIS systems
- Screen capturing
- IR camera integration
- Wave and current measurements capable of being integrated



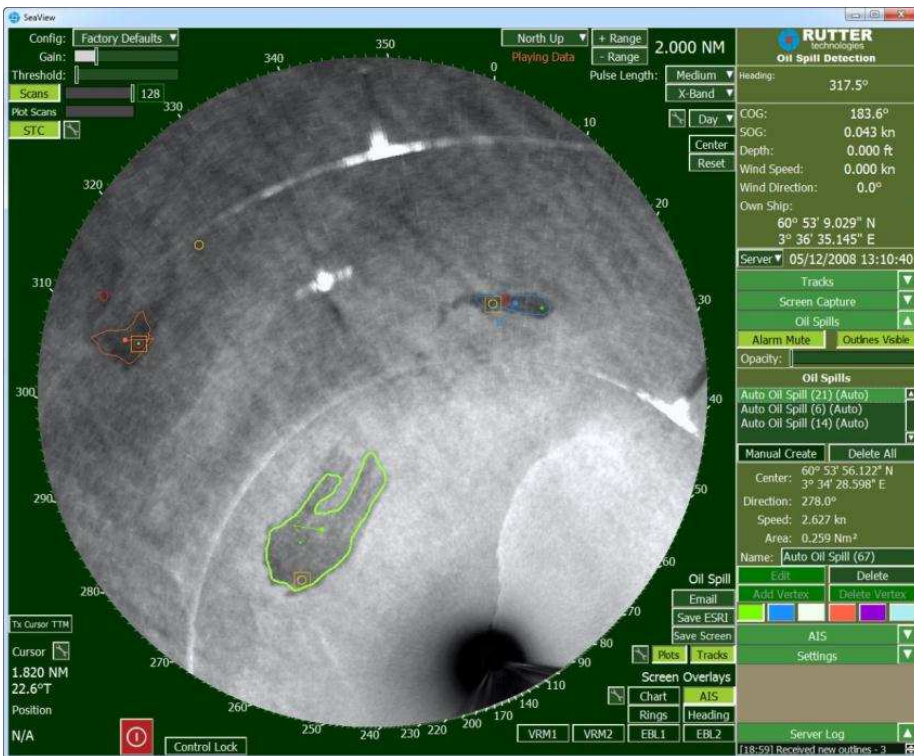
- Production Fluids
- Leaks during transfers
- Leaks from damaged or grounded vessels
- Bilge Dumping
- Leaks around trans-shipment or bunkering areas



- Small breeze moving over water surface creates capillary waves
- X-band radars detect capillary waves from backscatter
- Oil dampens capillary wave formation, dampens backscatter and lowers signal return: surface anomaly



Oil slick detection on-board Norwegian Coastal Patrol Vessel KV HARSTAD



Recommended Radar Configuration:

- X-Band, 25 kW, PRF ~ 3.000 Hz
- ~1° Beam Width (>8ft), ~ 40 RPM

Detection of Oil Spills with Marine Radars:

- oil is damping capillary waves
- this attenuates radar signal returns from sea clutter
- detection is possible
 - from wind speed > 2 - 3kt
 - out to > 4 NM / > 7 km
- signals must be motion compensated and averaged over many antenna revolutions
- oil spills are then presented as dark areas

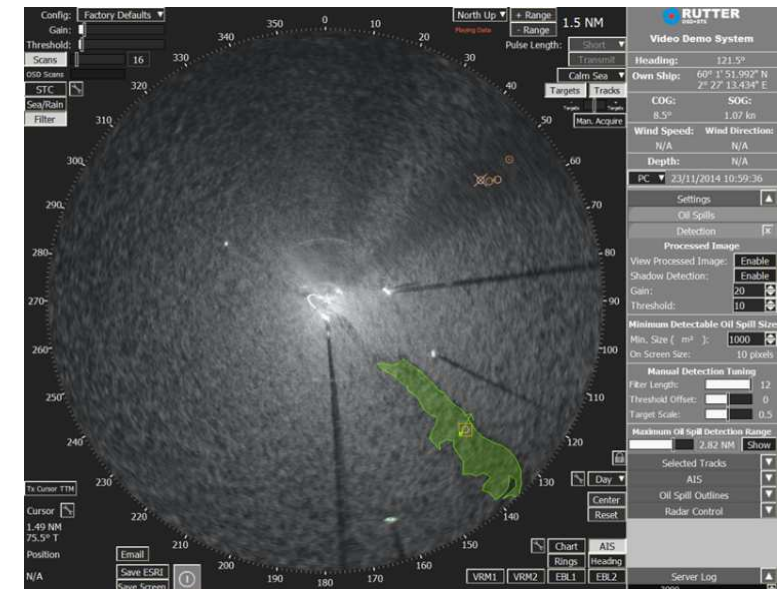
- Detect & track small and difficult to detect targets in sea clutter that standard IMO/Nav radars miss
- Use existing radar infrastructure where feasible: vessel, platform and shore
- Operational satisfactory for NOFO mode of operation (NOFO: Norwegian Clean Seas Association for Operating Companies)
- Combinable with
 - ICE Detection,
 - Small Target Surveillance Detection (STS),
 - and/or Wave/Surface Current Detection (WaMoS II)

Detects and tracks oil spills
across the widest range
of sea, weather
and light conditions.



The system incidentally is amazing. Picked up a slick in 5 to 8 foot seas with 35 knot winds and was 50 meters wide and a kilometer long. In the anchorages picks up bilge slicks at a distance of 6 to 8 miles which are invisible to the eye. Amazing.

*Thanks, Captain,
OSRV vessel in Brasil, October 2011*

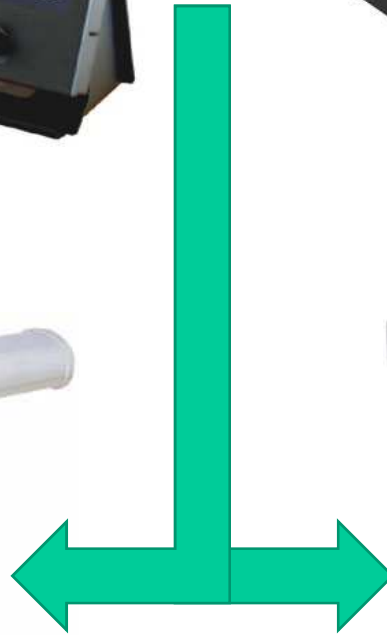


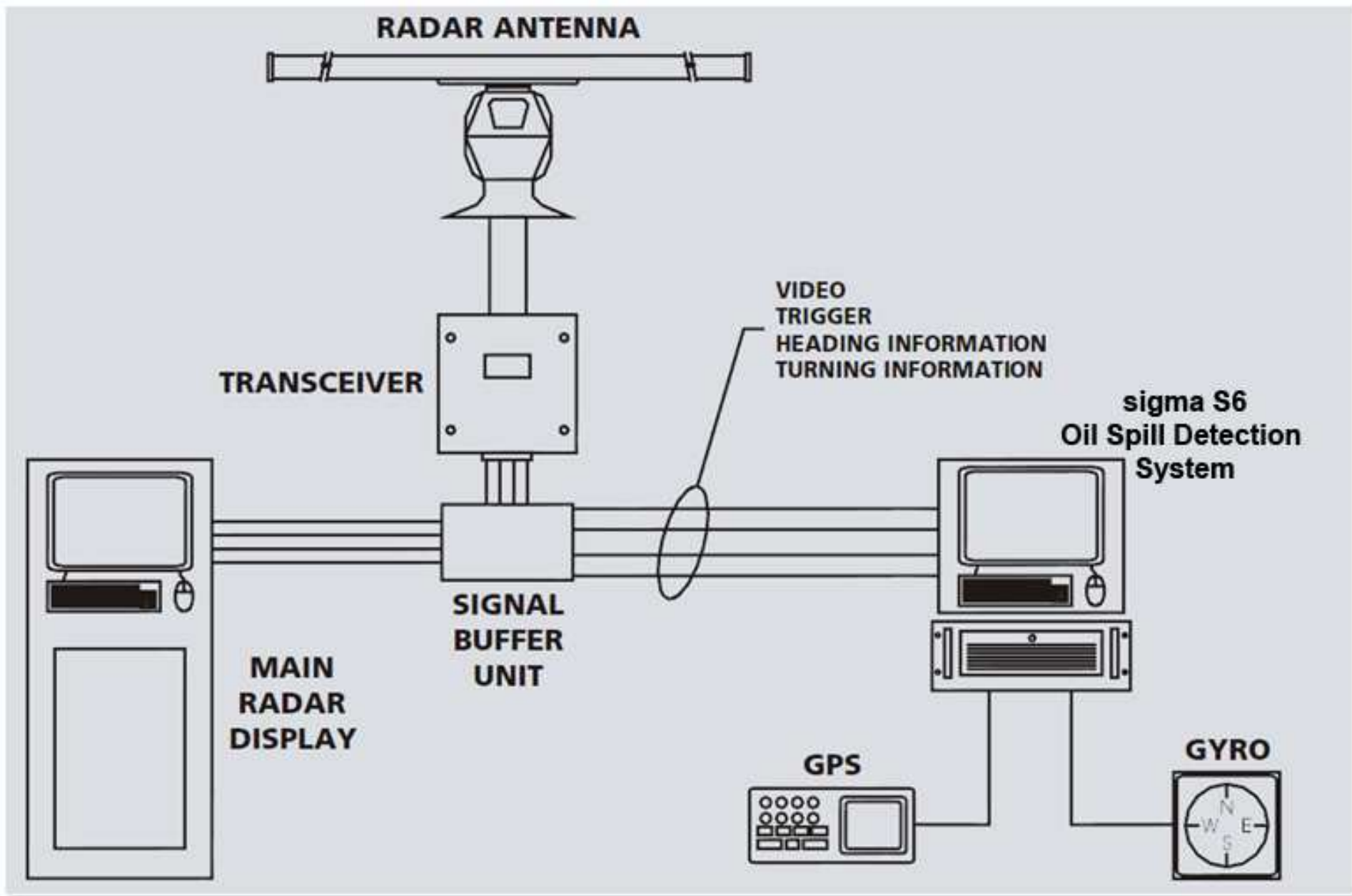


Existing radar



sigma S6 Dedicated Radar





- X-band radars are required due to wavelength characteristics
- Short pulse mode is required
- Platform 360-degree coverage
- Horizontal and Vertical Polarized Antenna



- Integrate an IR camera into the *sigma* S6 for verification

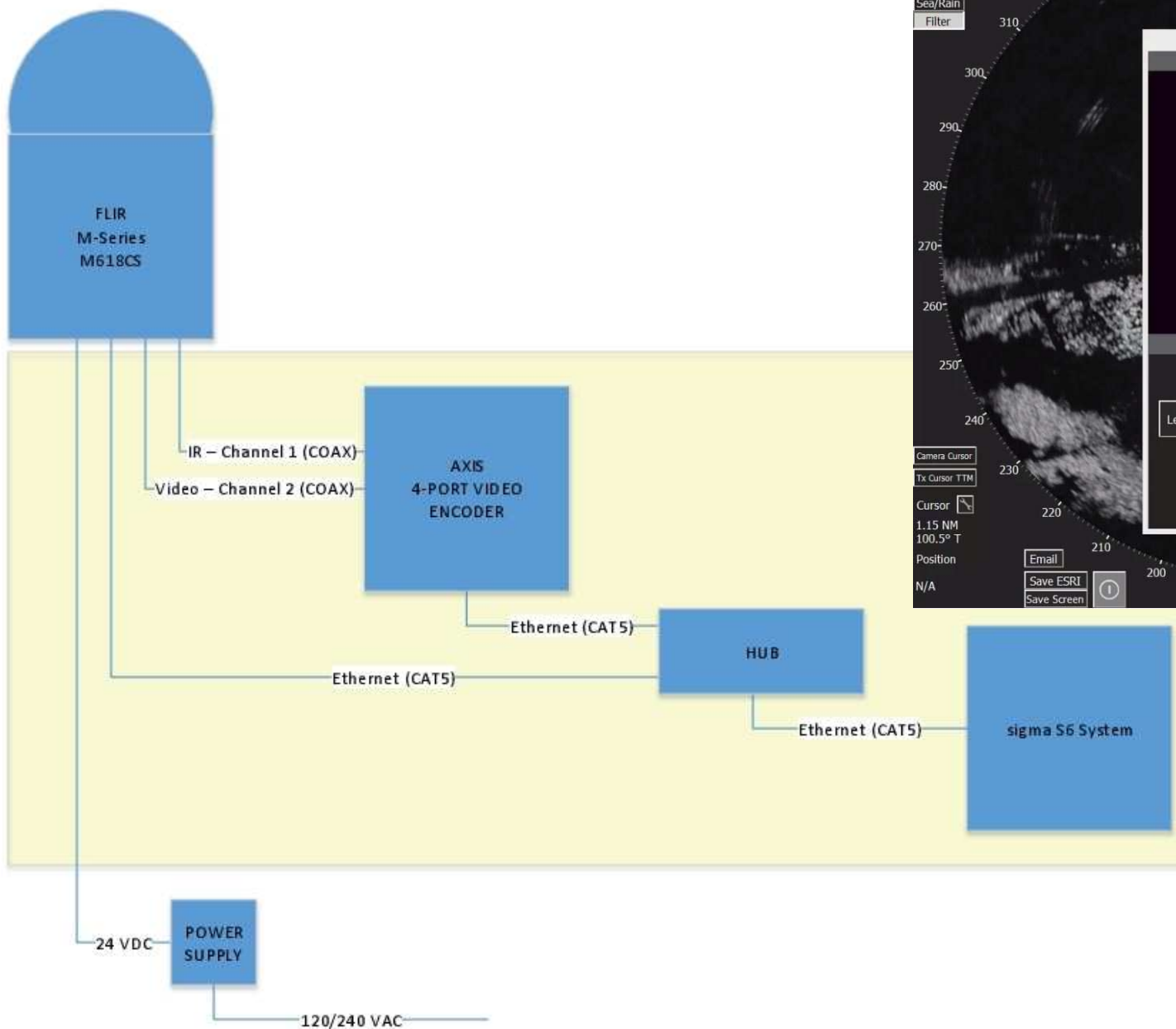
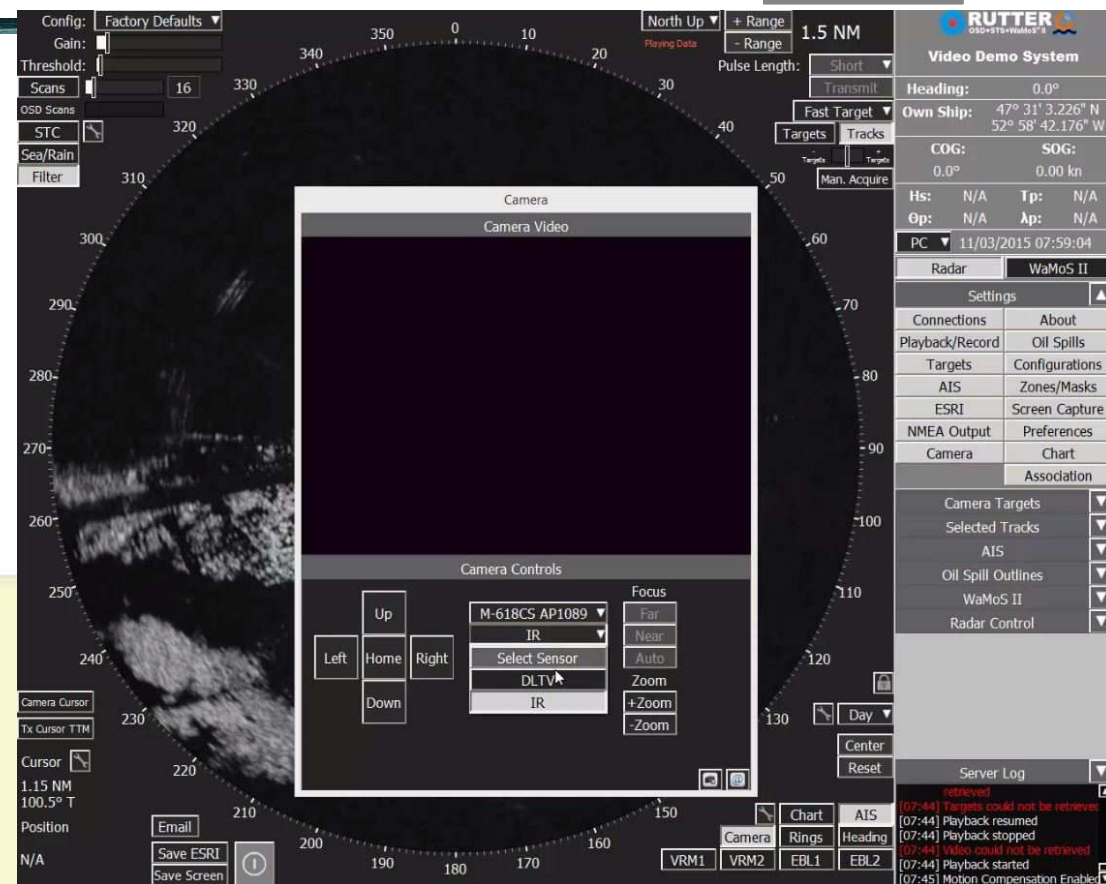
Either:

- Target info passed from *sigma* S6 Radar to IR camera, point camera
- Works with most any IR camera

Or: State of the Art / FLIR IR (Voyager III or M-Series)

- Full integration of camera control in *sigma* S6 radar system
- Integrated video window
- Camera control in radar display
- Automatic target acquisition
- Click target to manually slew camera
- Slew to detected spill
- Point to detected spill



The screenshot displays the Rutter WaMoS II radar interface. The main display is a circular radar plot with a range of 1.5 NM. A camera video overlay is visible in the center, showing a dark, grainy image. The interface includes various control panels and data readouts.

Config: Factory Defaults

Gain: [Slider]

Threshold: [Slider]

Scans: 16

OSD Scans: [Slider]

STC: [Slider]

Sea/Rain: [Slider]

Filter: [Slider]

North Up [Dropdown]

+ Range [Slider]

- Range [Slider]

Pulse Length: Short [Dropdown]

Transmit: [Slider]

Fast Target [Dropdown]

Targets [List]

Tracks [List]

Man. Acquire [List]

Camera

Camera Video

Camera Controls

Up [Button]

Down [Button]

Left [Button]

Home [Button]

Right [Button]

M-618CS AP1089 [Dropdown]

IR [Dropdown]

Select Sensor [Button]

DLTV [Button]

IR [Button]

Focus

Far [Button]

Near [Button]

Auto [Button]

Zoom

+Zoom [Button]

-Zoom [Button]

Cursor

Tx Cursor TTM

Cursor

1.15 NM

100.5° T

Position

N/A

Email [Button]

Save ESRI [Button]

Save Screen [Button]

Chart [Button]

AIS [Button]

Heading [Button]

VRM1 [Button]

VRM2 [Button]

EBL1 [Button]

EBL2 [Button]

Server Log [Dropdown]

retrieved

[07:44] Playback could not be retrieved

[07:44] Playback resumed

[07:44] Playback stopped

[07:44] Video could not be retrieved

[07:44] Playback started

[07:45] Motion Compensation Enabled

Oil on Water Thickness	< 5 μm	5 – 50 μm	50 – 200 μm	> 200 μm
Concentration (m³ / km²)	< 5	5 - 50	50 – 200	> 200
Human Eye	Sheen / Rainbow	Metallic	Transitional Dark or True Colour	Dark or True Colour
Sigma S6 OSD w. X-Band Radar	- > Visible	Visible	Visible	Visible
SECurus IR Camera	Not visible	grey - black	black - white	white



Sheen/ rainbow (<5 μm)



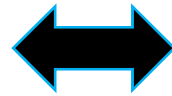
True Colours (>200 μm)

Interval (μm), litres per km²





Radar Sensor



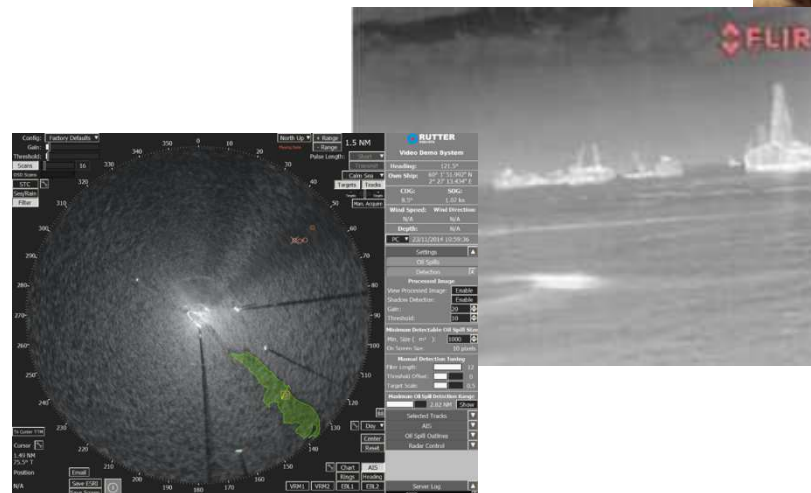
Signal & Image Processing



Infrared & LLTV Sensors

Effective Oil Spill Response requires

- 24 / 7 detection
- continued operation at night
- sharing of data and images
 - with other vessels
 - with a control center



sigma S6 Version 9.0 to be released June 2015 including system output of geospatial information

Includes the following through a web interface:

- Radar imaging via
 - o GeoTIFF
 - o JPEG
 - o PNG
- Targets/Plots, Tracks, Ice Outlines, Oil Spill Outlines, Wave & Current Information and User Annotations via
 - o GML
 - o KML
 - o DXF
 - o ESRI shape files

Playback Data, all functions are the same as for life operation



The screenshot shows the SeaView software interface. The main display is a circular radar plot with a range of 3.000 NM. The plot shows a bright return from the own ship at the center. The interface includes various control panels and data displays.

Top Left Panel:

- Config: Factory Defaults
- Gain: [Slider]
- Threshold: [Slider]
- Scans: 2
- Plot Scans: [Slider]
- STC: [Slider]

Top Right Panel:

- North Up (selected)
- + Range
- Range
- 3.000 NM
- Pulse Length: Medium
- X-Band
- Day
- Center
- Reset

Right Panel (Oil Spill Detection):

- Heading: 317.6°
- COG: 25.6°
- SOG: 0.080 kn
- Depth: 0.000 ft
- Wind Speed: 0.000 kn
- Wind Direction: 0.0°
- Own Ship: 60° 53' 9.056" N, 3° 36' 35.151" E
- Server: 05/12/2008 13:09:42
- Tracks
- Screen Capture
- Oil Spills
- AIS
- Settings
- Playback/Record

Bottom Right Panel (Playback/Record):

- Mode: Playback
- Data Segments
- 12/5/2008 13:09:24 (00:03:09)
- Refresh
- Start Time: 13 : 09 : 24
- Stop Time: 13 : 12 : 33
- Playback Time: 05/12/2008 13:09:42
- Segment Time: 00:00:18
- Pause
- Stop

Bottom Left Panel:

- Tx Cursor TTM
- Cursor: 2.823 NM, 131.6°T
- Position: N/A
- Control Lock

Bottom Right Panel (Screen Overlays):

- Chart
- Rings
- EBL1
- EBL2
- AIS
- Heading
- Server Log

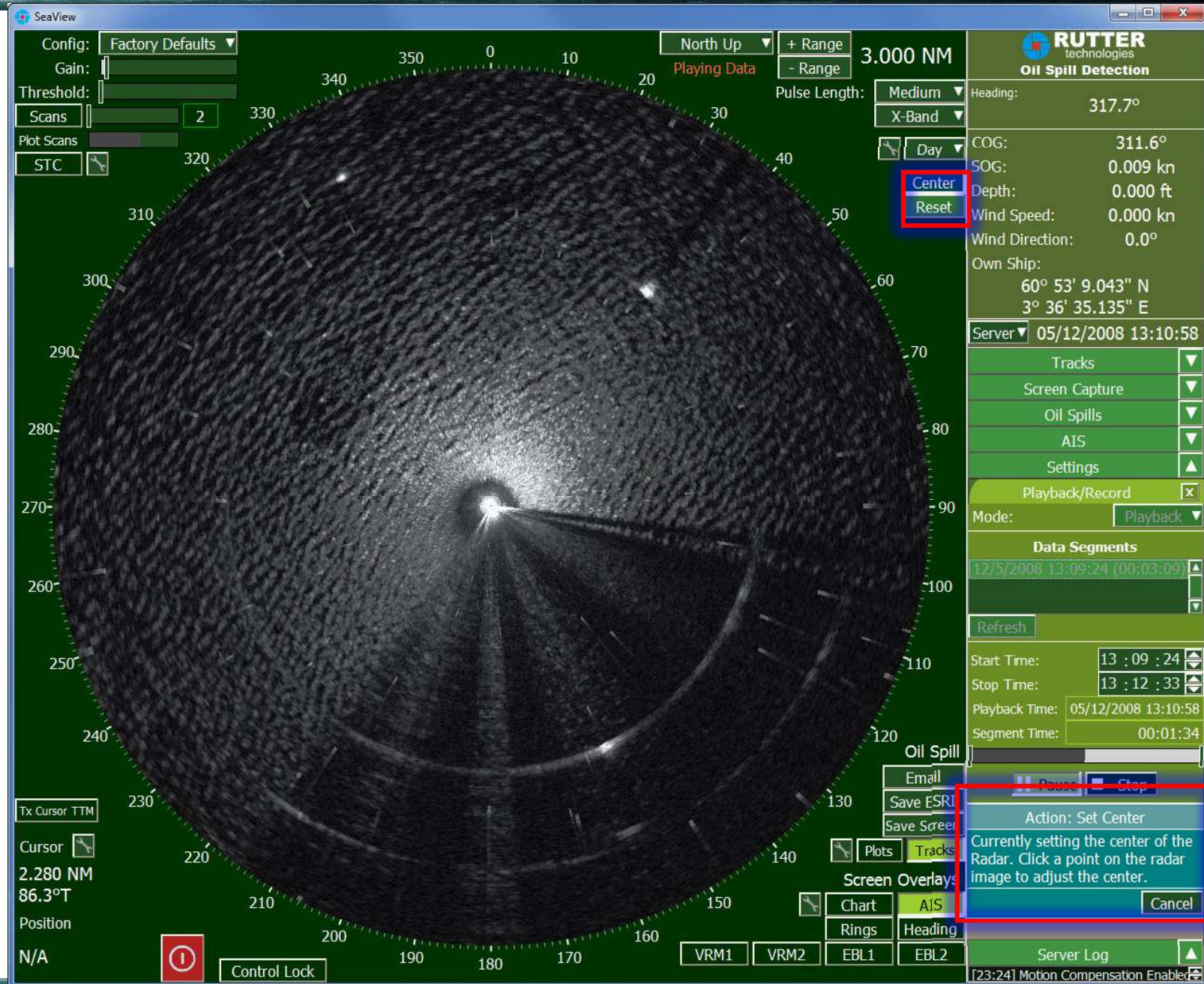
Bottom Center Panel:

- VRM1
- VRM2
- EBL1
- EBL2

Bottom Right Panel (Status):

- [23:22] Motion Compensation Enabled

Off-Centering

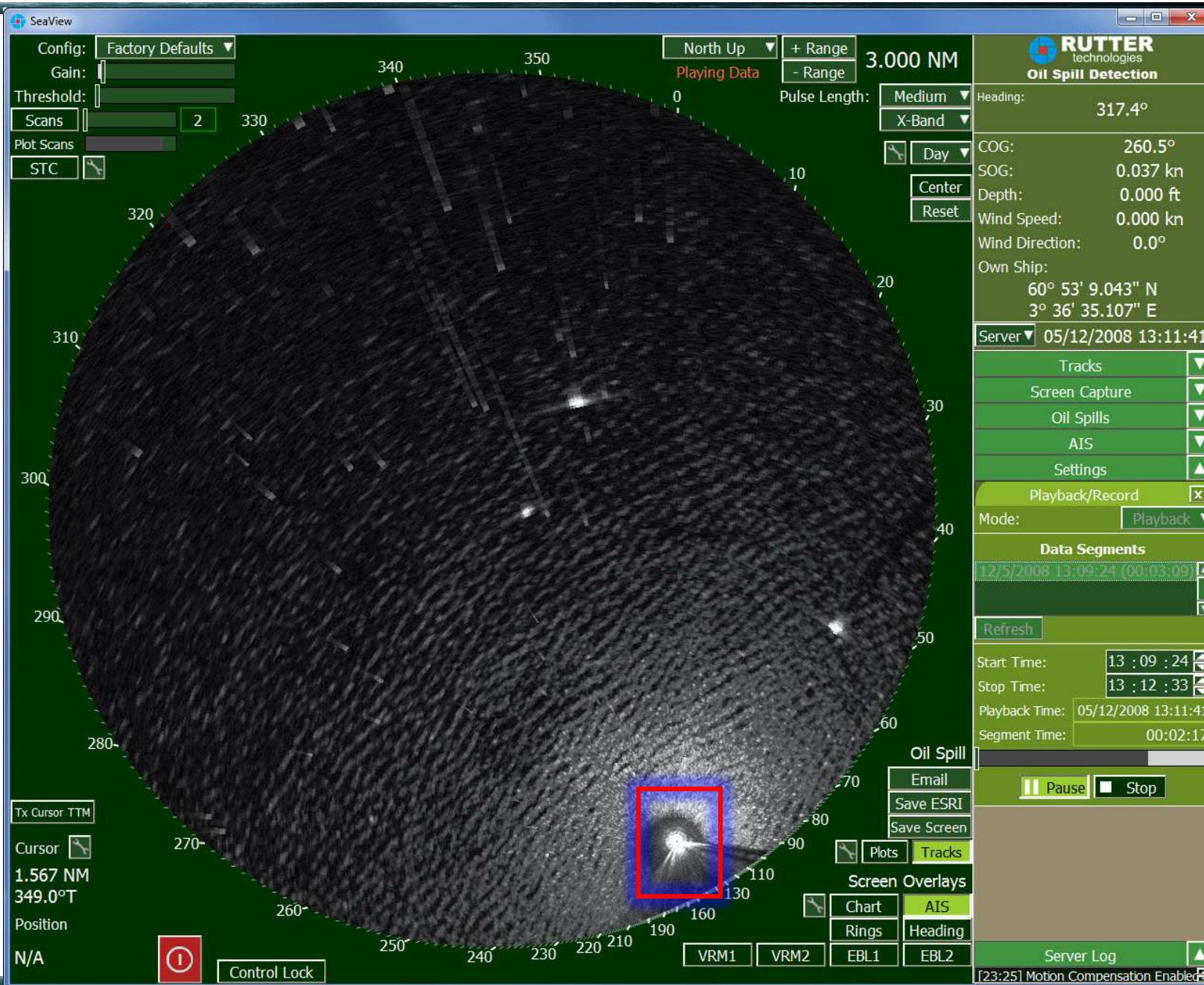


The screenshot shows the SeaView software interface. The main display is a circular radar plot with a range of 3.000 NM and a pulse length of Medium. The plot shows a bright return from the own ship at the center. The interface includes various control panels and data displays.

Key elements visible in the interface:

- Config Panel:** Factory Defaults, Gain, Threshold, Scans (2), Plot Scans, STC.
- Navigation Panel:** North Up, + Range, - Range, 3.000 NM, Pulse Length: Medium, X-Band, Day.
- Oil Spill Detection Panel:** Heading: 317.7°, COG: 311.6°, SOG: 0.009 kn, Depth: 0.000 ft, Wind Speed: 0.000 kn, Wind Direction: 0.0°.
- Own Ship Position:** 60° 53' 9.043" N, 3° 36' 35.135" E.
- Server:** 05/12/2008 13:10:58.
- Mode:** Playback.
- Data Segments:** 12/5/2008 13:09:24 (00:03:09).
- Start Time:** 13 : 09 : 24, **Stop Time:** 13 : 12 : 33.
- Playback Time:** 05/12/2008 13:10:58, **Segment Time:** 00:01:34.
- Oil Spill Panel:** Email, Save ESRI, Save Screen, Plots, Tracks, Screen Overlays (Chart, AIS, Rings, Heading), VRM1, VRM2, EBL1, EBL2.
- Position:** Tx Cursor TTM, Cursor, 2.280 NM, 86.3°T, Position N/A.
- Control Lock:** Control Lock.

A dialog box titled "Action: Set Center" is open, with a red box highlighting it. The dialog contains the text: "Currently setting the center of the Radar. Click a point on the radar image to adjust the center." and a "Cancel" button.



Scan Averaging Activated

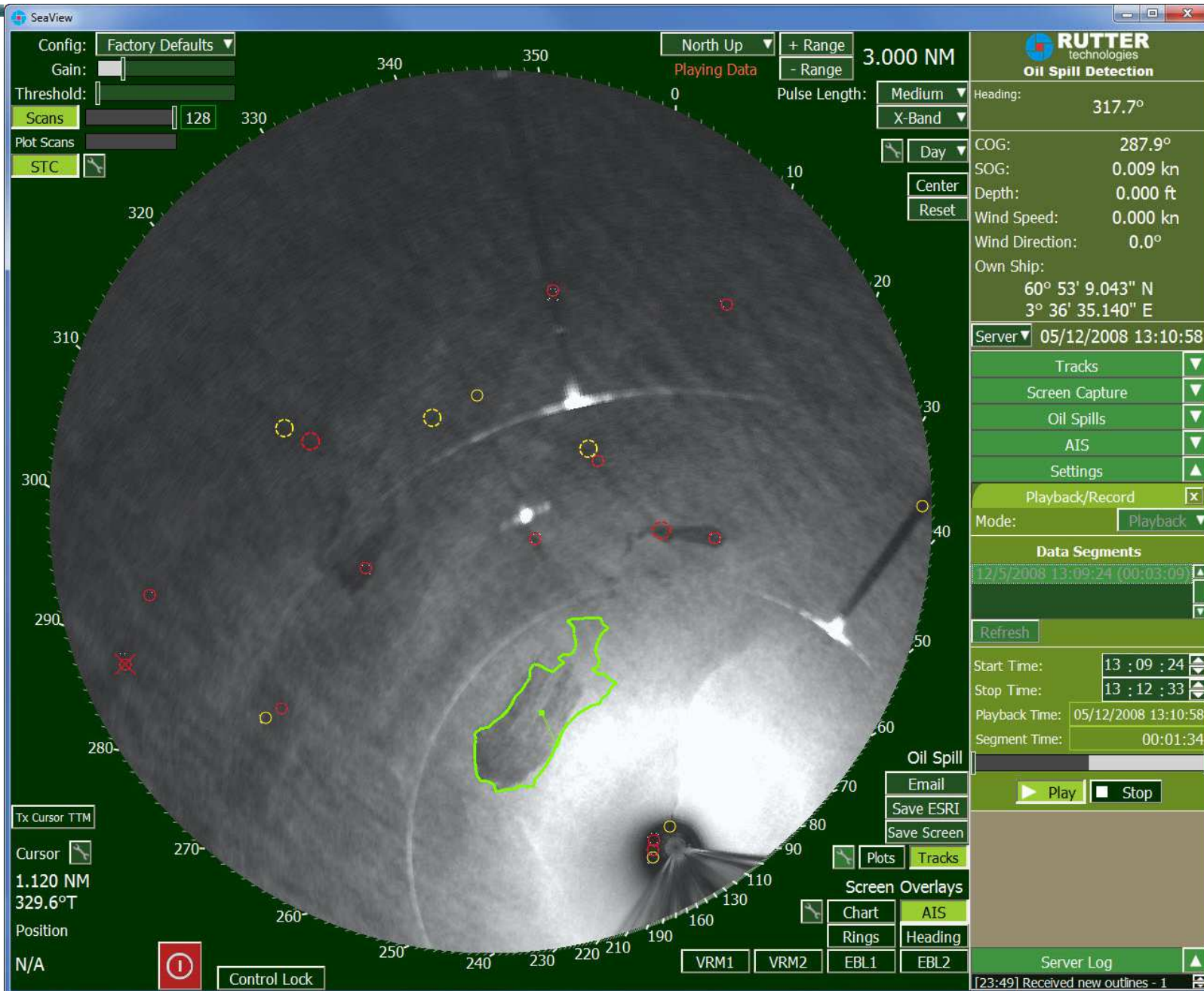


Potential oil spill targets displayed

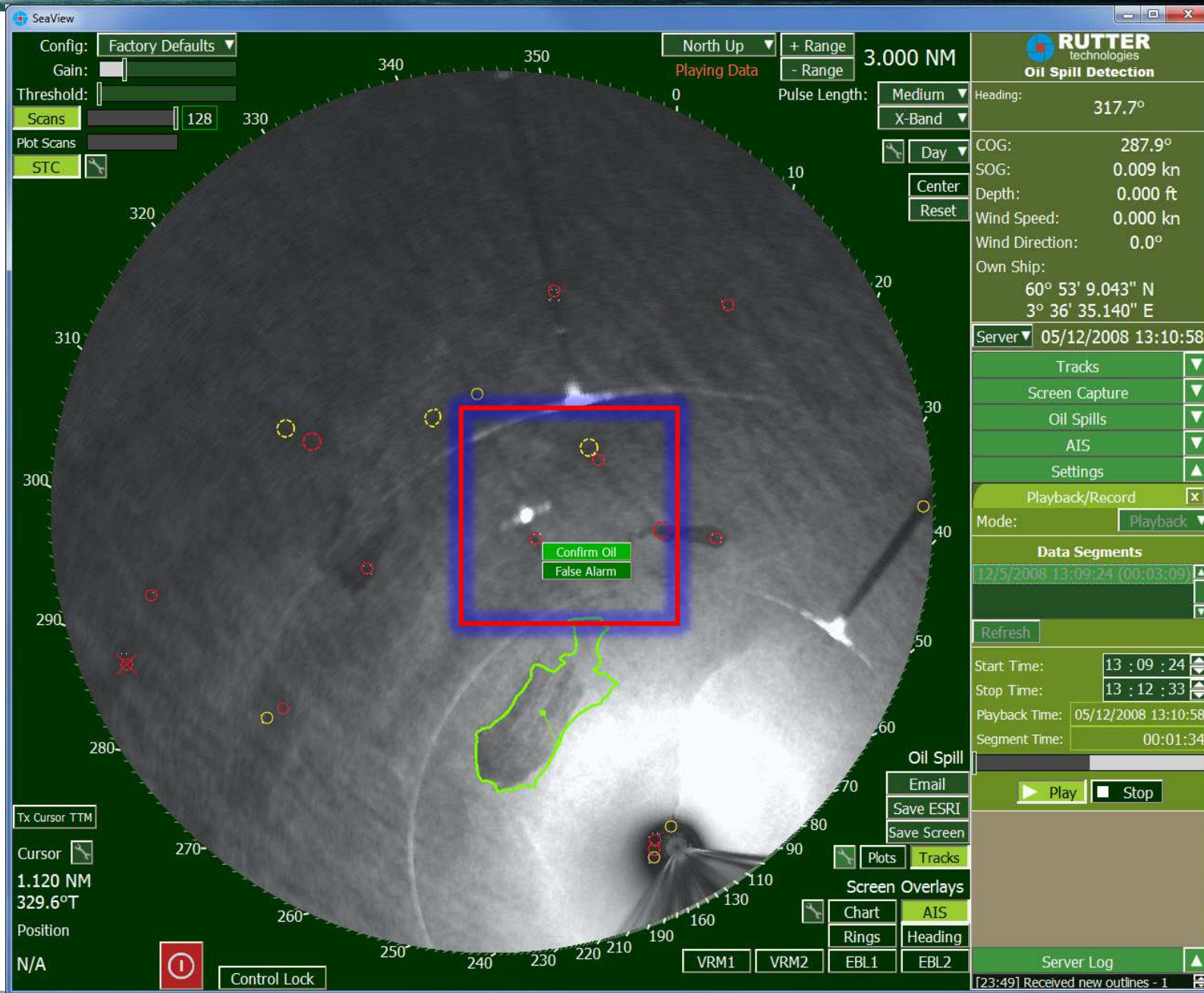


Oil Spill Target confirmed

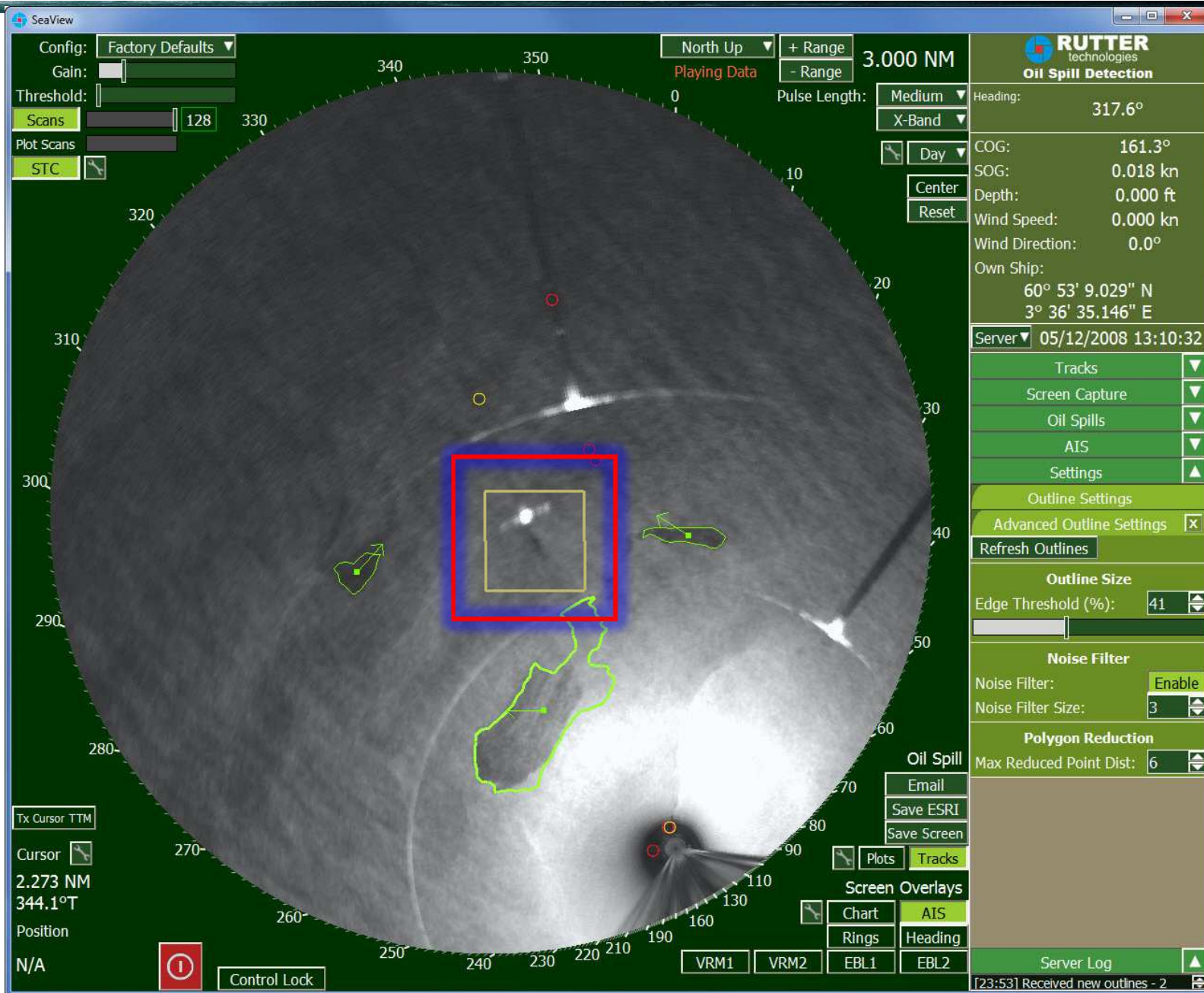


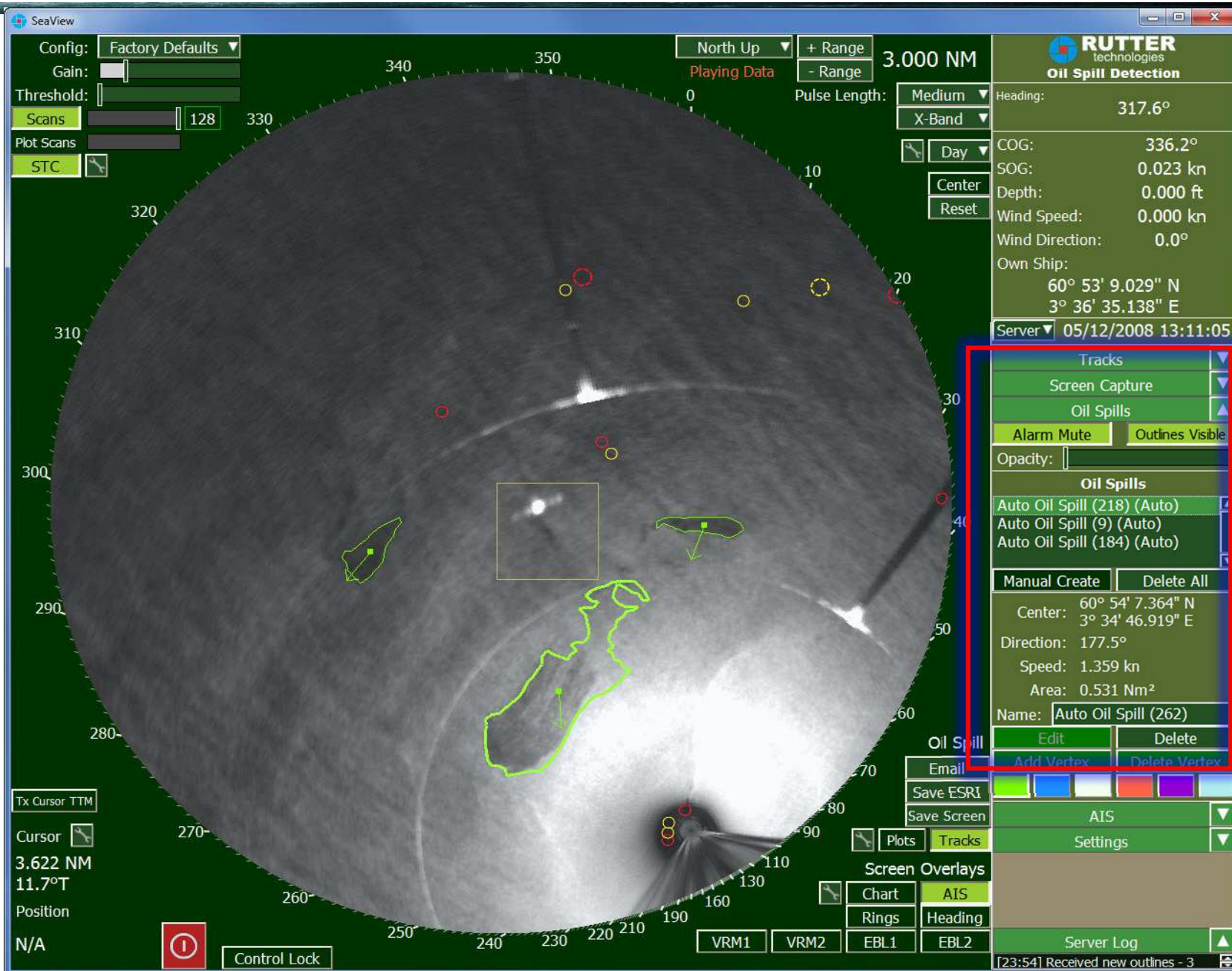


Exclude areas of observation

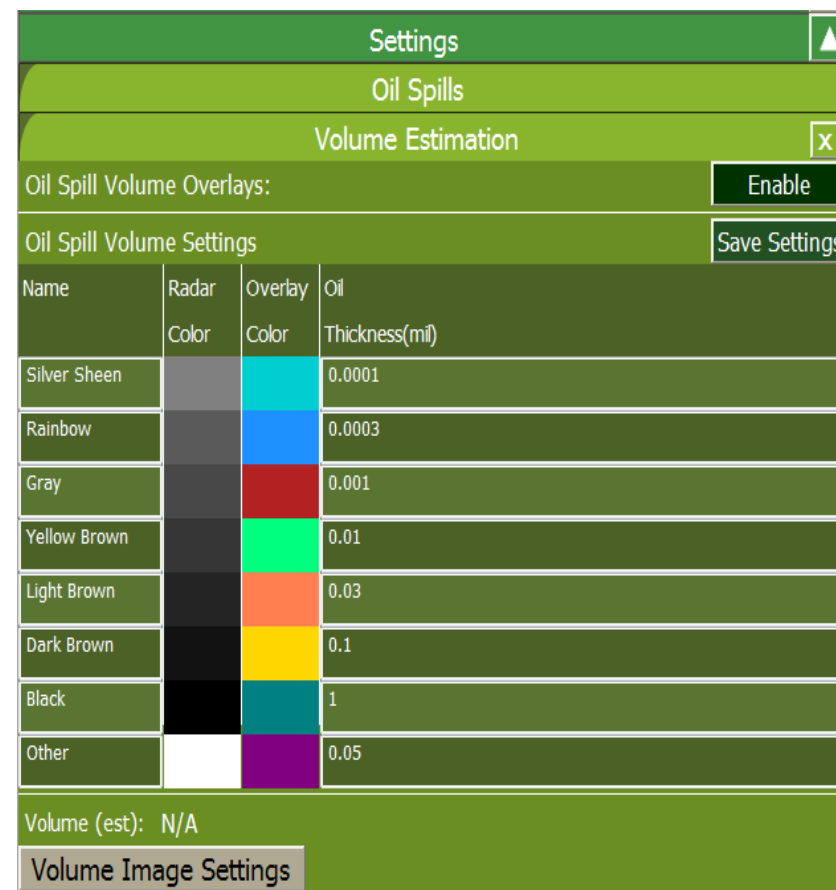


False Alarm Zone generated





- *sigma* S6 calculates area of slick
- Detects 8 levels of variation in slick thickness
- Thickness values with Area gives estimated Volume



Name	Radar Color	Overlay Color	Oil Thickness(mil)
Silver Sheen	Gray	Cyan	0.0001
Rainbow	Gray	Blue	0.0003
Gray	Gray	Red	0.001
Yellow Brown	Gray	Green	0.01
Light Brown	Gray	Orange	0.03
Dark Brown	Black	Yellow	0.1
Black	Black	Teal	1
Other	White	Purple	0.05

Volume (est): N/A

Volume Image Settings

When oil spill volume estimation is enabled, the area inside each oil spill outline is analyzed and colored according to the parameters set in the *Volume Estimation* settings window shown.

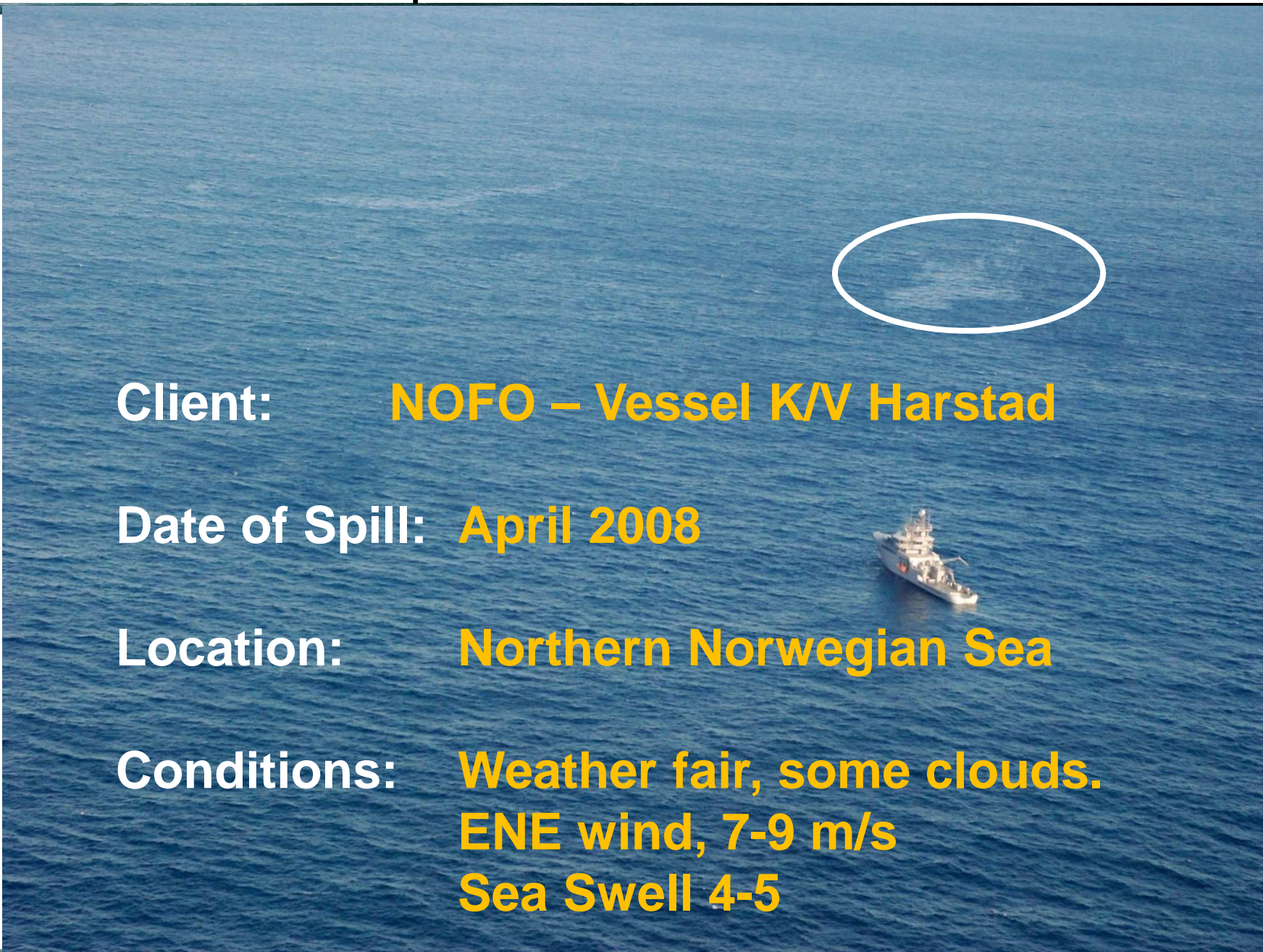




Sigma S6 Enhanced Radar Processor
Oil Spill Detection Trials in Norway

3 Trials 2008, with Norwegian Clean Seas Association for Operating Companies (NOFO) and Statoil

NOFO states that our OSD system (between others) has been found operational satisfactory and is compliant for NOFO mode of operation.



Client: NOFO – Vessel K/V Harstad

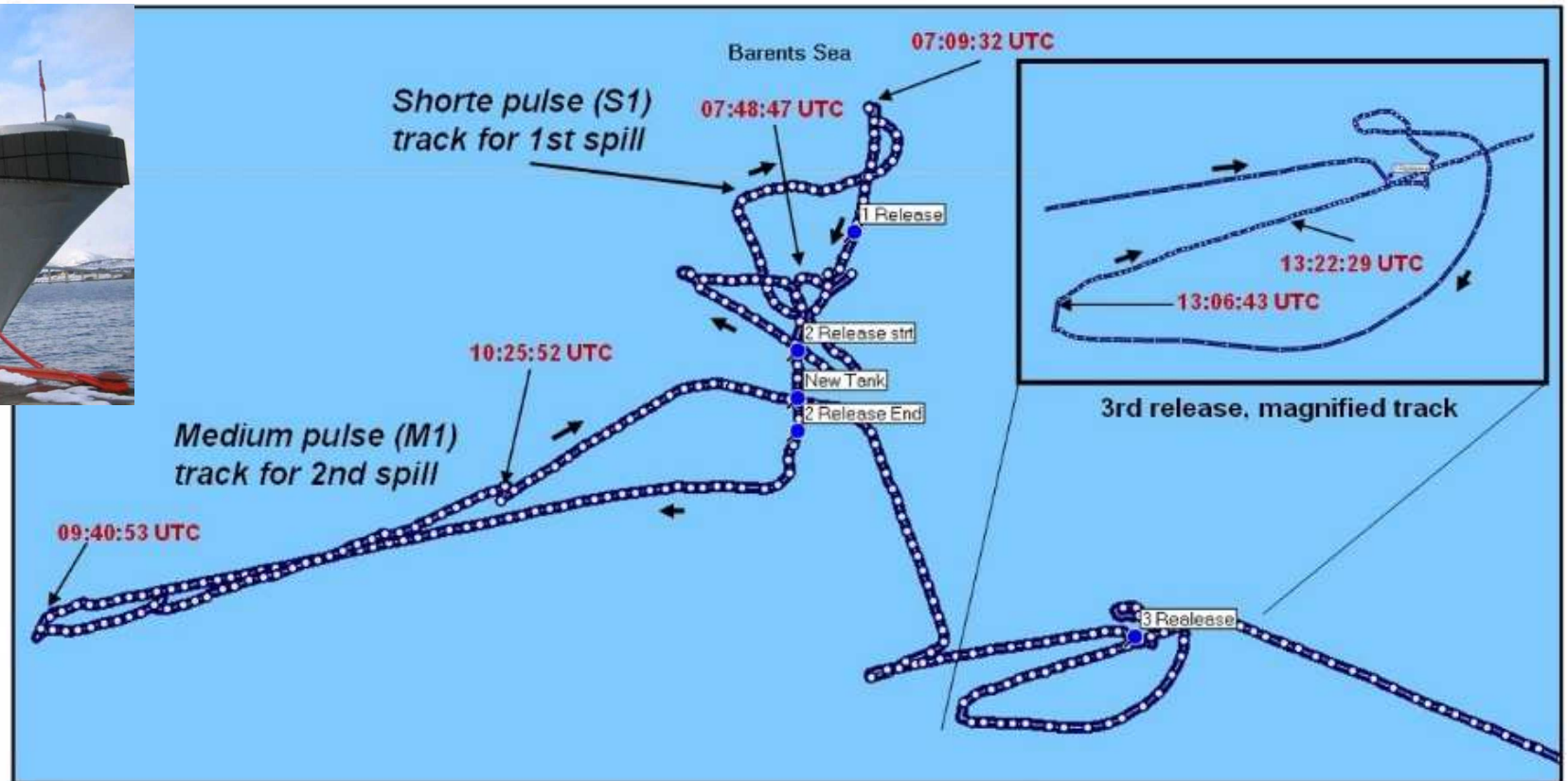
Date of Spill: April 2008

Location: Northern Norwegian Sea

Conditions: Weather fair, some clouds.
ENE wind, 7-9 m/s
Sea Swell 4-5



*NOFO - GPS track, spill 1, 2 & 3
KV Harstad, April 4, 2008*



1. Release,	3APRIL08, 07:33 UTC, POS N69 59,75 E015 14,73
2. Release start	3APRIL08, 08:56 UTC, POS N69 59,27 E015 14,05
2. New tank	3APRIL08, 09:03 UTC, POS N69 59,07 E015 14,06
2. Release end	3APRIL08, 09:09 UTC, POS N69 58,93 E015 14,06
3. Release	3APRIL08, 11:55 UTC, POS N69 58,09 E015 18,08



Gain

Threshold

Scans

Sea/Rain

STC

Filter

North Up Range 0.750 Nm

Playing Data Rings

Pulse Length:

Heading: **74°**

COG: **80.012°**

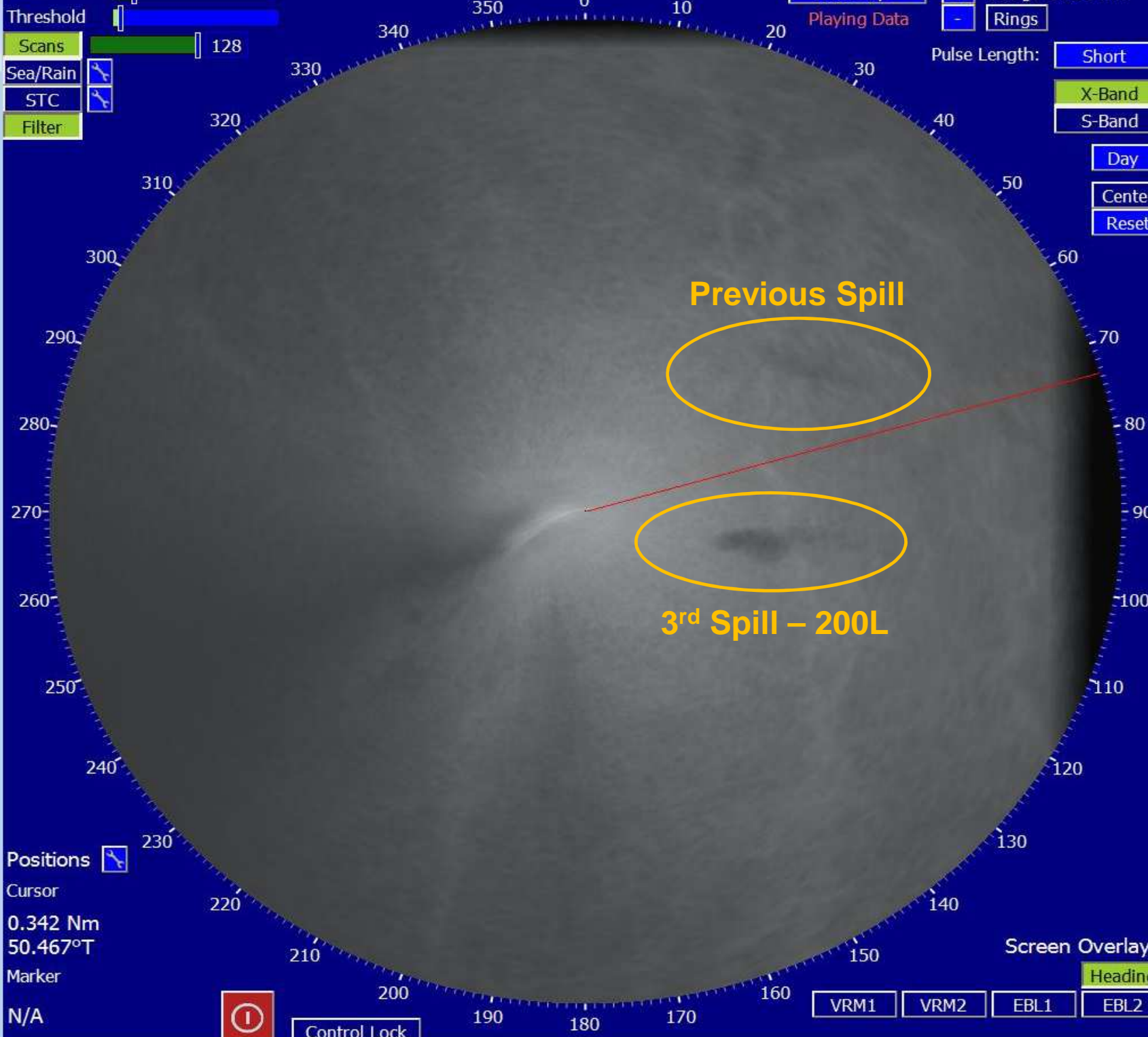
SOG: **1.450 Kts**

Own Ship:

69° 57' 53.740" N

15° 16' 23.239" E

Server 03/04/2008 13:12:42



Playback/Record

Mode:

Data Segments

4/3/2008 13:07:13 (00:22:06)

Start Time:

Stop Time:

Playback Time: 03/04/2008 13:12:42

Server Log

Function Failed

[15:28] Server Error: Radar Online Function Failed

[15:28] Radar NOT Set Online

[15:28] Server Error: Radar Online Function Failed

[15:28] Could not set radar Online

[15:28] Radar Set Offline

[15:28] Playback started

[15:28] Motion Compensation Enabled

Positions

Cursor

0.342 Nm

50.467°T

Marker

N/A

Screen Overlays

An aerial photograph of the North Sea showing a large, irregularly shaped oil spill. The spill is a lighter, greyish-brown color, contrasting with the darker greenish-blue water. Several containment vessels are visible, connected by long orange booms that form a perimeter around the spill. The sky is a pale, hazy blue, suggesting an overcast day.

sigma S6 Enhanced Radar Processor Oil Spill Detection Trial #2

Client: **NOFO – Vessel K/V Harstad**

Date of Spill: **June 2008**

Location: **North Sea**

Gain

Threshold

Scans

Sea/Rain

STC

Filter

North Up Range 3.000 Nm

Rings

Pulse Length:

Heading: **354.7°**

COG: **351.709°**

SOG: **12.298 Kts**


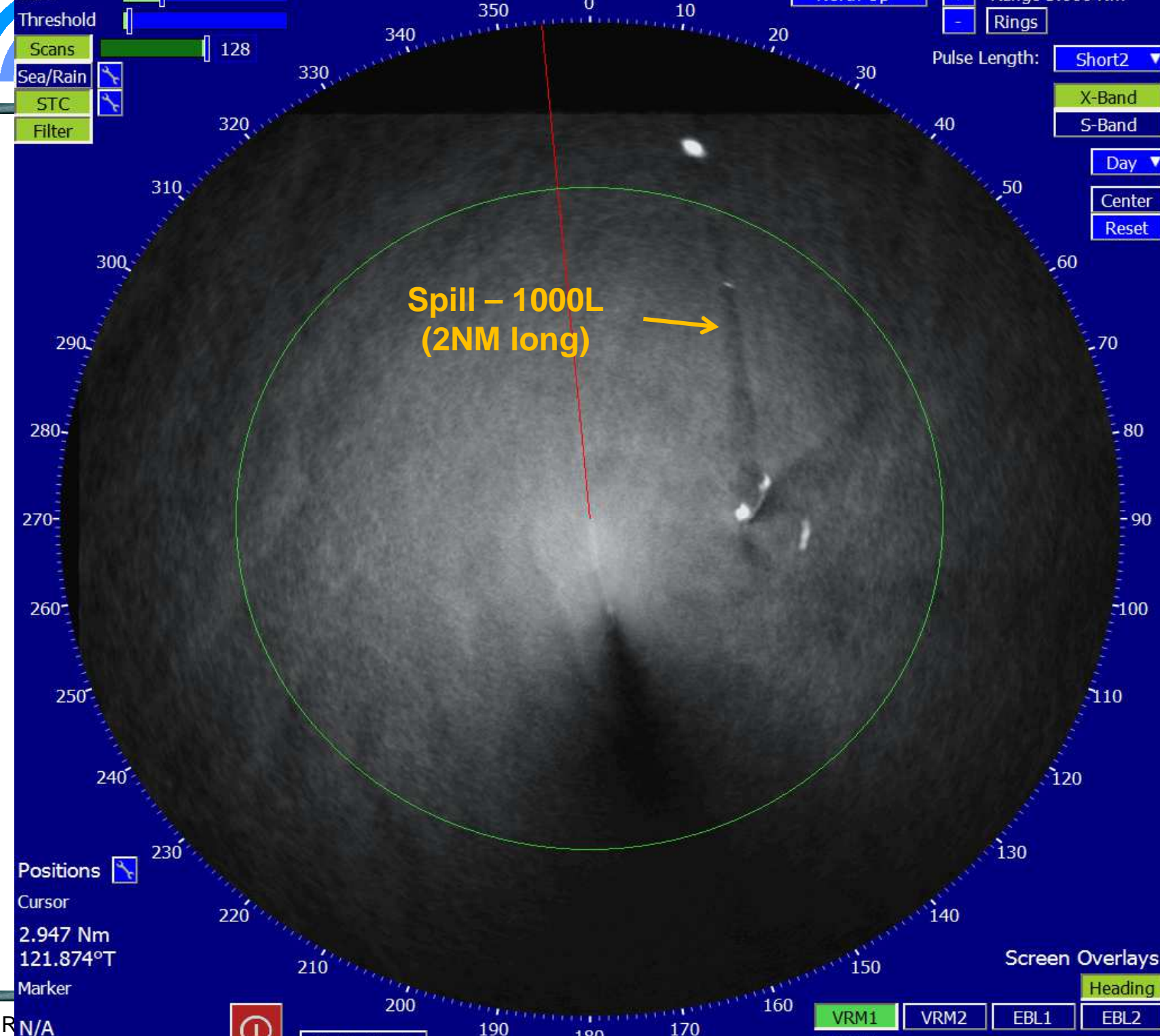
Own Ship:

60° 5' 20.691" N

2° 21' 53.964" E

GPS

**Spill – 1000L
(2NM long)**

Positions

Cursor

2.947 Nm

121.874°T

Marker

R N/A

Screen Overlays

2.000 Nm

Playback/Record

Mode:

Data Segments

Start Time:

Stop Time:

Playback Time:

Server Log

[16:44] Radar Set Online

[16:44] Radar Set Online

[16:44] Video could not be retrieved

[16:45] Radar Set Offline

[16:45] Playback started

[16:47] Radar Set Online

[16:48] Video could not be retrieved

[16:48] Radar Set Offline

[16:48] Playback started

[16:53] Radar Set Online

sigma S6 Enhanced Radar Processor Oil Spill Detection Trial #3



Client: **Statoil – Troll C GBS Platform**

Date of Spill: **December 2008**

Location: **North Sea**

3.000 NM

Config: Factory Defaults
Gain:
Threshold:
Scans:
Plot Scans:
STC:

North Up + Range
Playing Data - Range
Pulse Length: Medium
X-Band
Day
Center
Reset

Heading: 317.4°
COG: 280.3°
SOG: 0.032 kn
Depth: 0.000 ft
Wind Speed: 0.000 kn
Wind Direction: 0.0°
Own Ship:
60° 53' 9.043" N
3° 36' 35.105" E

Server 05/12/2008 13:11:43

Tracks:

NAME	ID	RGE	BRG	SPD	CRS	STAT	ALRM	AIS	TTM
	214	2,829 NM	311.7°	1.602 kn	207.7°	Tracking	None	N/A	Send
	175	2,157 NM	357.6°	0.606 kn	88.5°	Tracking	None	N/A	Send
	168	1,200 NM	297.1°	11.772 kn	76.1°	Tracking	None	N/A	Send

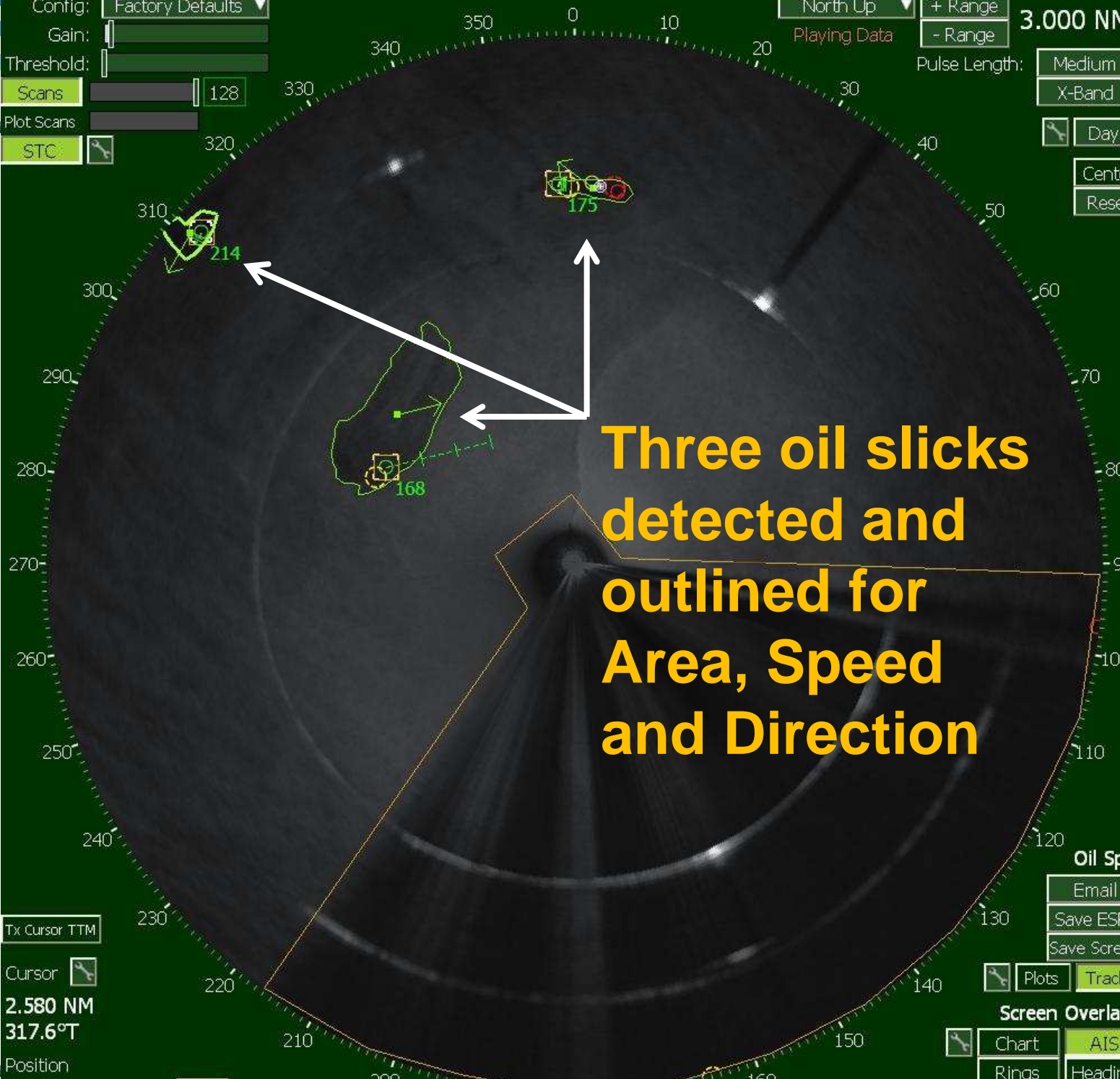
- [168] Tracking
- [214] Tracking
- [175] Tracking

Drop Selected Track Drop All

- Screen Capture
- Oil Spills
- AIS
- Settings

- Oil Spill
- Email
 - Save ESRI
 - Save Screen
- Screen Overlays
- Plots
 - Tracks
 - Chart
 - Rings
 - EBL1
 - EBL2
 - AIS
 - Heading

Server Log
[15:50] Received new outlines - 3



**Three oil slicks
detected and
outlined for
Area, Speed
and Direction**

Tx Cursor TTM
Cursor
2.580 NM
317.6°T
Position
2.145 NM
3.9°T

Control Lock

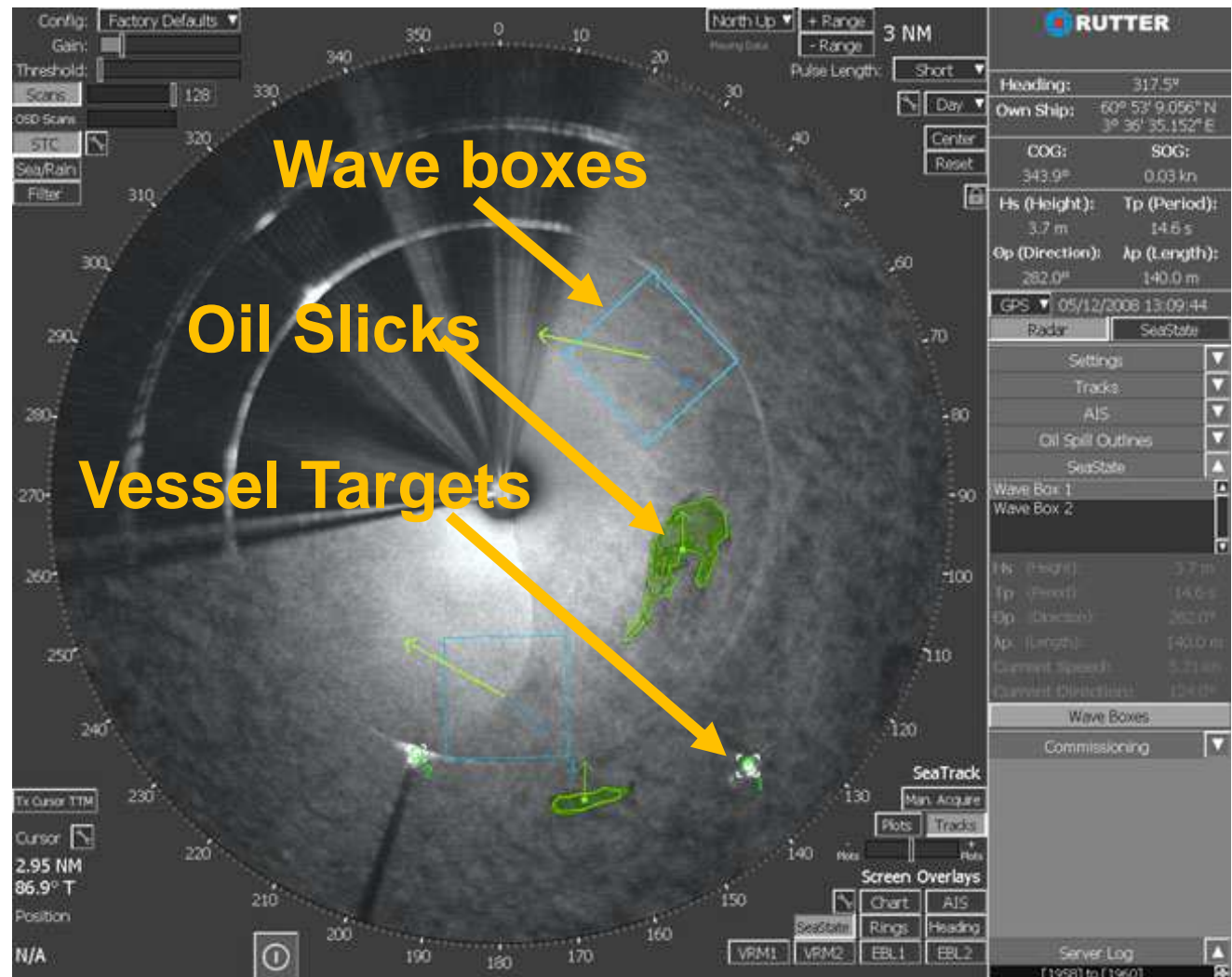
VRM1 VRM2 EBL1 EBL2

Integration of four systems on one platform

- Vessel,
- Offshore Platforms,
- Ports,
- At coastlines

Applications across all marine markets:

- OSD
- ICE
- STS
- Waves & currents



- Real time oil spill detection system
- 24/7
- Data is integrable to other system technologies
- Evidence giving by screen capturing

=> a system of systems



- Norwegian Clean Seas Association for Operating Companies certification: Oil Spill Detection radar
- Brazil / Petrobras has procured 30+ OSD systems
- Marine Spill Response Corporation (USA) has deployed 25 *sigma* S6 OSD systems
- USA, the Bureau of Ocean Energy Management, Regulation and Enforcement using NOFO standard for OSD radar
- 80+ *sigma* S6 Oil Spill Detection systems sold throughout USA, Brazil, Egypt, Turkey, Norway, Azerbaijan, China, etc.
- ExxonMobil and Rosneft select the combination *sigma* S6 Ice Navigator and Oil Spill Detection system as input to their Ice Defence System for the Kara Sea (Russia) drilling exploration program in 2014/15. Eighteen *sigma* S6 Ice Navigator systems deployed.
- ExxonMobil selects the combination *sigma* S6 Ice Navigator and Oil Spill Detection system, including SeaFusion, for the Hebron Gravity Base Platform for offshore Newfoundland.



Thank you very much
for your attention!

OceanWaveS GmbH

Ina Adegeest

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