

# ASV C-Worker 6

## Unmanned Support Vessel for Offshore Survey Operations

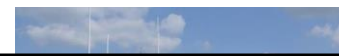
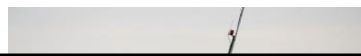


AUT 2105, Perth  
Brian Anderson, ASV  
Cory Brooks, Western Advance

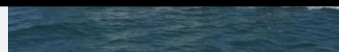
# Outline

- ASV Overview, Historic Products and Designs
- Design Architecture
- C-Worker 6
- Payloads and Data Examples
- New Designs with Scalable Technology
- Conclusions
- Questions & Answers

## Other ASVs...



- Successfully delivered over 75 systems from 4' to 40' in length, and from 3 to 65 knot top speeds.
- ASV owns all of its own software and hardware IP so can be trusted to deliver the 'whole package'.





# AREAS OF DEVELOPMENT





## C-Worker 6

- 6m Vessel
- Industrial Grade
- 20 Day Endurance
- 4 Knot Cruise
- Dual Redundancy
- Radar, AIS, Cameras
- 1.5x1x1.5m Payload
- LOS or OTH Supervised
- Ship by Air, Sea, Road
- Robust LARS

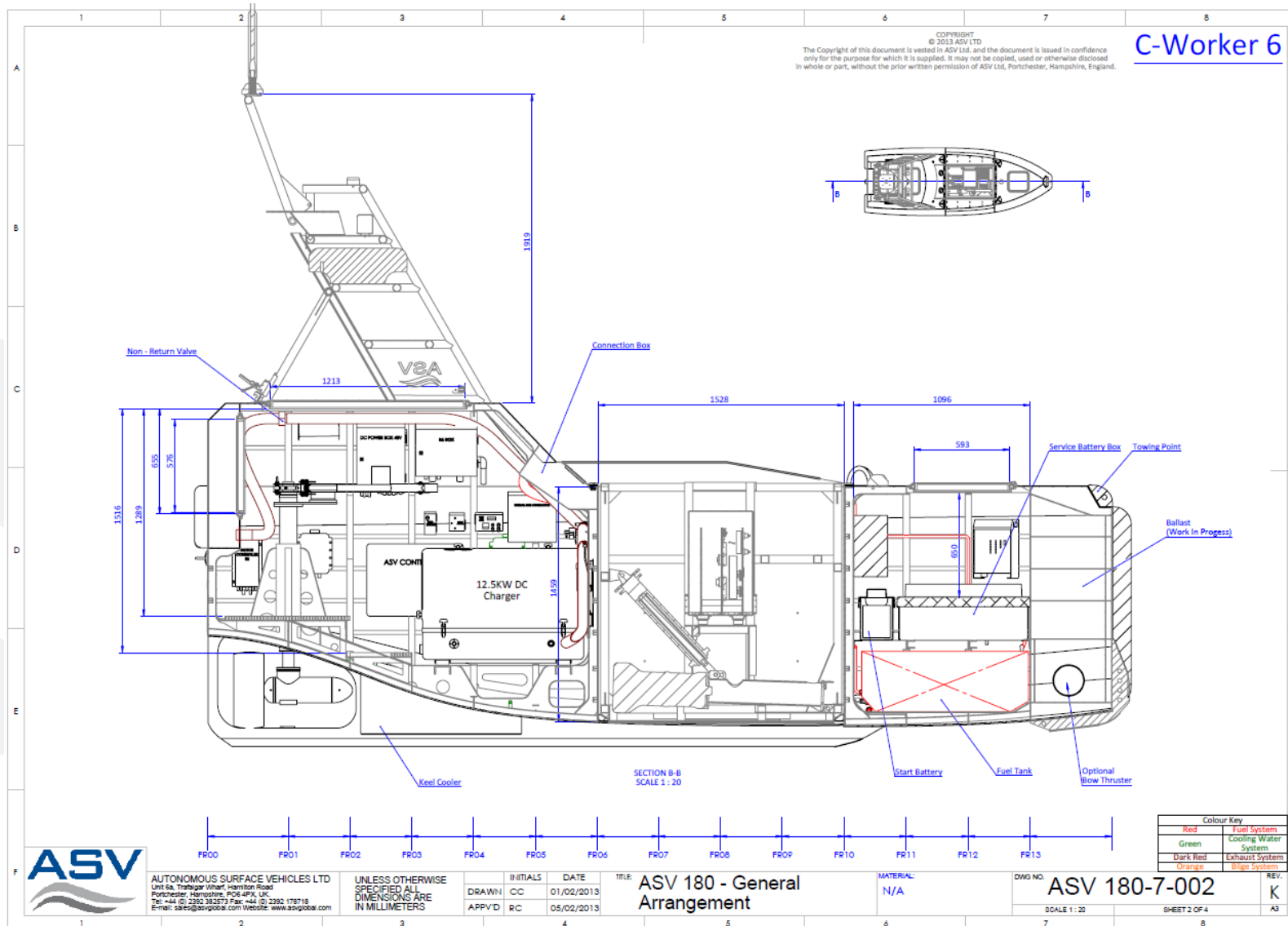
## C-Worker video

**ASV** unmanned  
marine systems



# C-Worker 6 Design Overview – Vessel Design

## General Arrangement



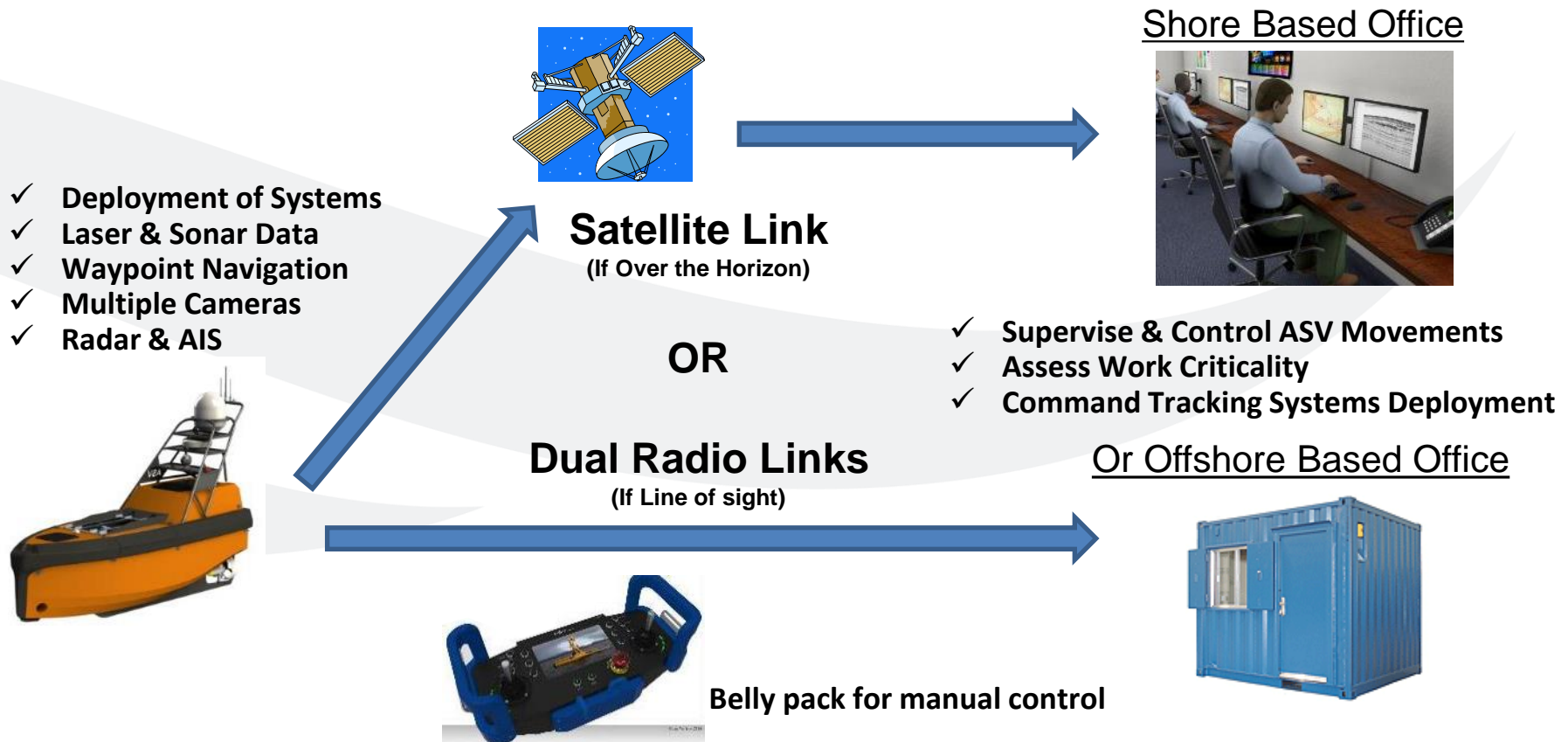






# Supervised Autonomy

- ASV Operations Supervised from:
  - Mothership via 30km Radio Link or
  - Shore via VSAT Satellite Link



# C-Worker 6 Design Overview – Control System

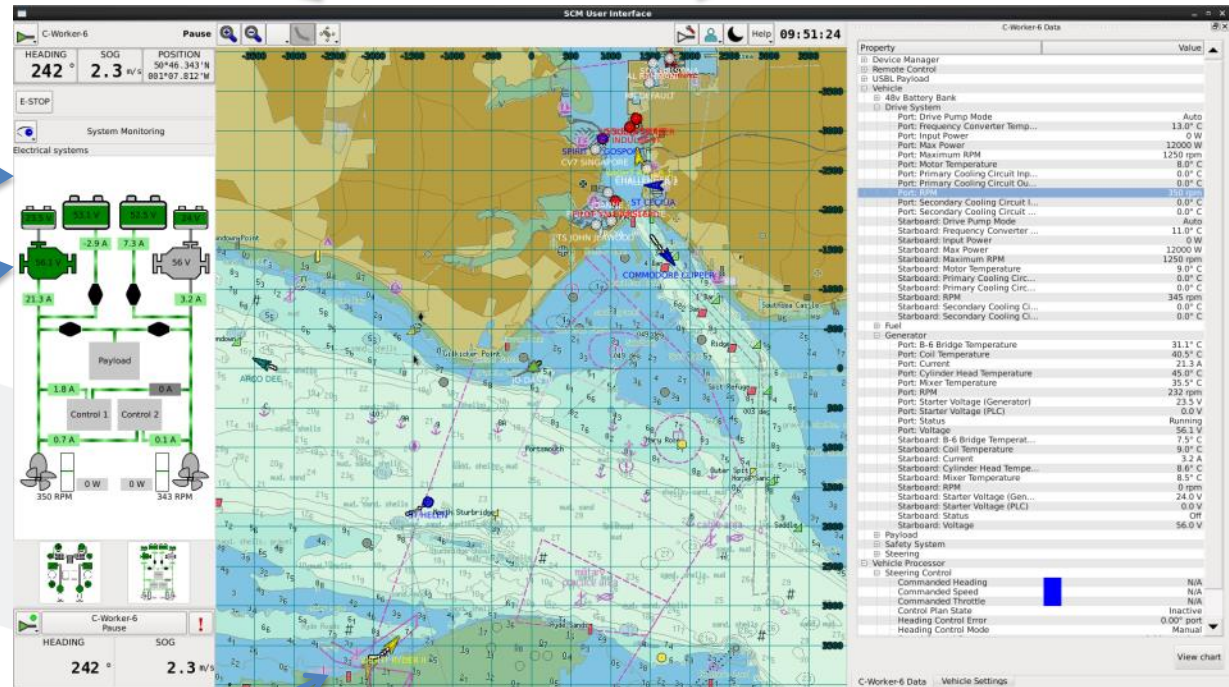
## User Interface

View controls

Setup controls

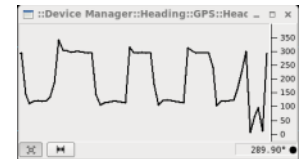
Key Data

Selectable Tabs



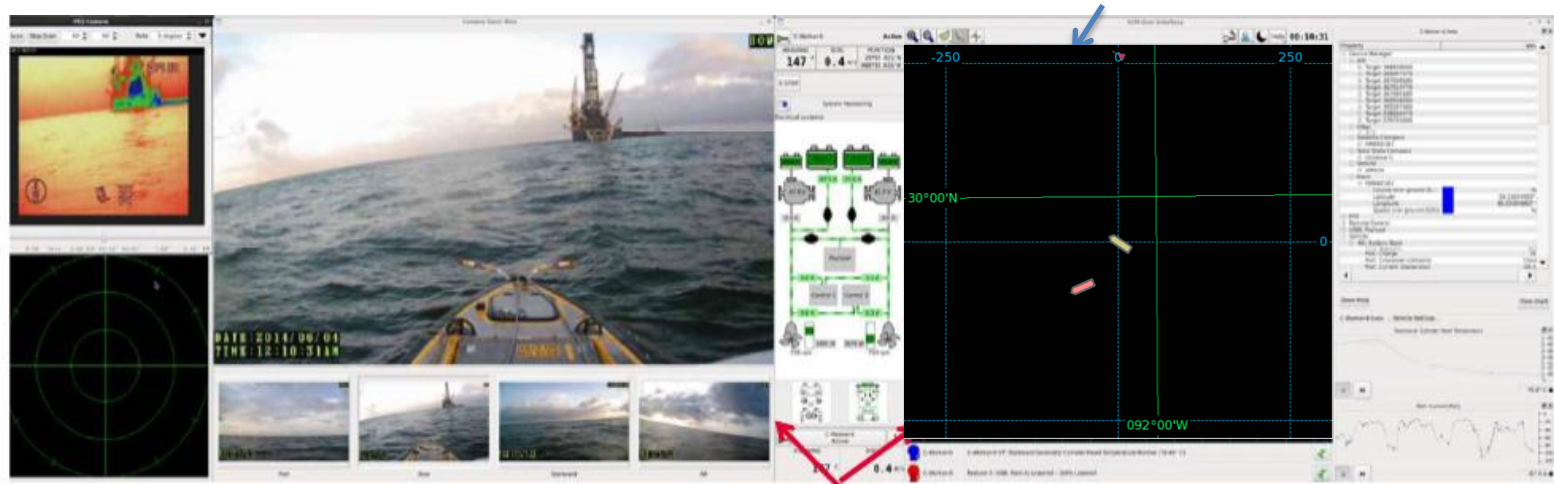
Top down displaying;  
Full S57 ENC's  
AIS targets from receiver on USV  
Vessel track  
Vessel mission plans

Data window  
displays all vehicle  
telemetry data. All  
data can be  
viewed in a trend  
plot

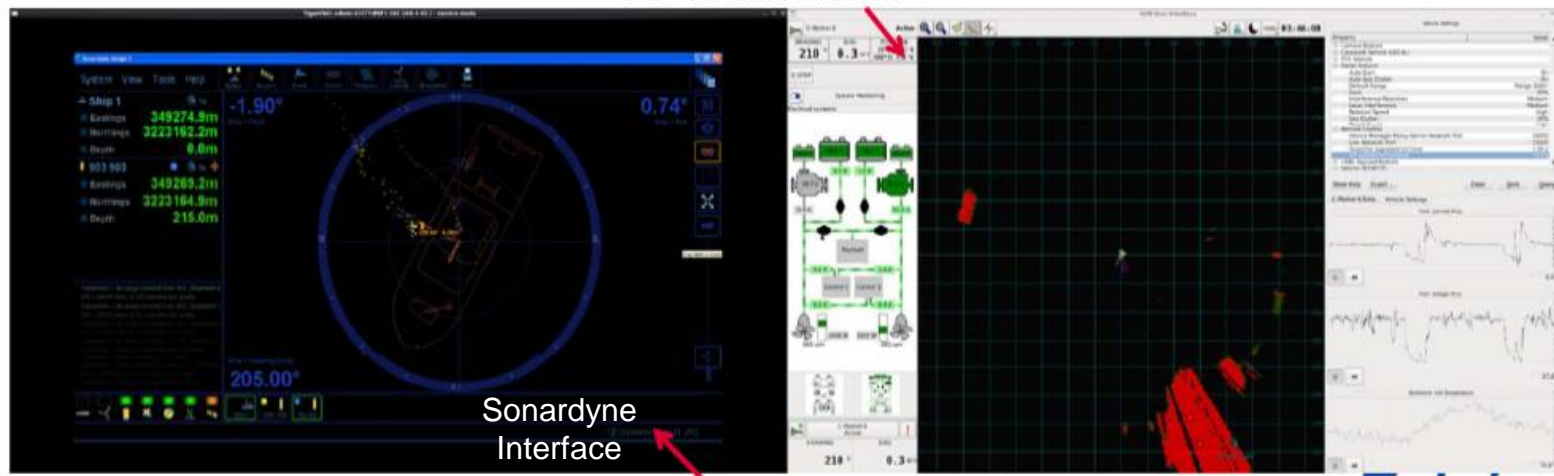


# C-Worker 6 Design Overview – Control System

## User Interface



ASVttd interface



Sonardyne Interface



# Payloads Operated to Date

- Single Beam Echo Sounder (Odom CV100; Odom SMBB200-3)
- Multi-beam Echo Sounder (Kongsberg 2040, R2sonic, Teledyne MB1, Edgetech 6205)
- Ultra Short Baseline Positioning System (Sonardyne 6G Lodestar GyroUSBL)
- Sidescan (Edgetech 4200, Edgetech 4125, Tritech Starfish)
- Acoustic Doppler Current Profiler (Teledyne RDI and Nortek)
- Passive Acoustic Monitor arrays (various)
- Conductivity, Temperature, & Depth (various)
- Acoustic Fish Tracking (Vemco)
- Wetlabs Triplet Puck (Chlorophyll, Dissolved Oxygen, Fluorometer)
- Inspection ROV (Saab Seaeye Falcon)
- Acoustic Modem (various)
- Helikite w/ Camera
- Meteorological (wind speed, pressure, temperature, humidity)
- Laser (Renishaw Dynascan, Velodyne)

## Working on...

- Small Seismic Compressor & Airguns
- Oil Spill Dispersant Application
- Oil Boom Towing
- Hull Mounted & Towed Subbottom Profiler
- Magnetometer & Gradiometer Surveys
- UAV Deployment & Recharge
- Remote Tide Modelling
- AUV Deployment / Comms / Positioning
- Drifter Buoy Deployment
- XBT Deployment
- Sonardyne Blue-comm LED Modem
- Fire Suppression Foam Application

# Sediment plume monitoring and Heli-kite/Camera Integration

- For dredge plume monitoring
- Acoustic communication integration
- Demonstrated quick and simple sensor integration
- Potential for future work associated with dredging projects

- Marine mammal spotting
- Sea bird spotting
- Potential for application in environmental impact assessments for infrastructure projects
- Application proven in scientific studies

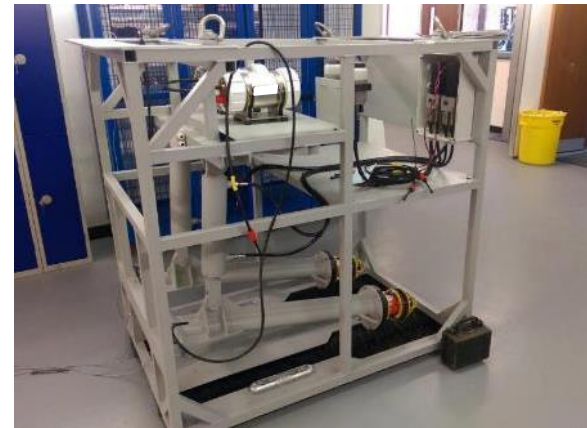
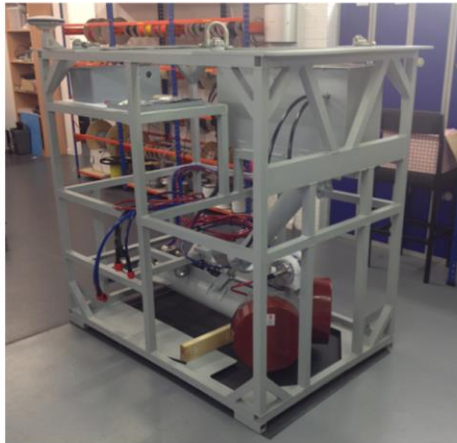


# CW6 Payload Developments

## Hydrographic surveying EM 2040C

The EM 2040C multibeam echosounder for high resolution mapping and inspection applications.

- High resolution
- Wide frequency range
- Short pulse lengths and large bandwidth
- Extended range due to Frequency Modulated (FM) chirp
- Complete roll and pitch stabilization
- Water column data (standard)
- Seabed image (standard)

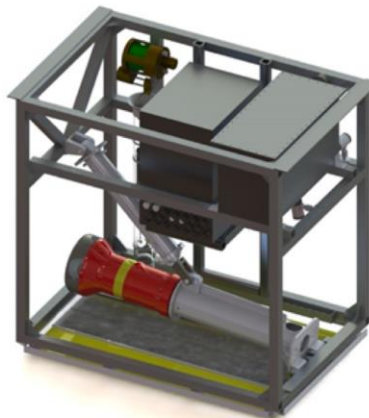


**Acoustic Modem Payload**

## Subsea Positioning USBL

Lodestar GyroUSBL combines a Sonardyne 6<sup>th</sup> (6G) generation high performance HPT USBL transceiver and a Lodestar Attitude and Heading Reference System (AHRS) / Inertial Navigation System (INS) in the same mechanical assembly.

With the AHRS / INS in fixed mechanical alignment to the USBL's acoustic array, the Lodestar GyroUSBL can be quickly deployed without need for a USBL calibration to determine the alignment of the ship's motion sensors to the acoustic transceiver.



**R2Sonic Multibeam Payload**

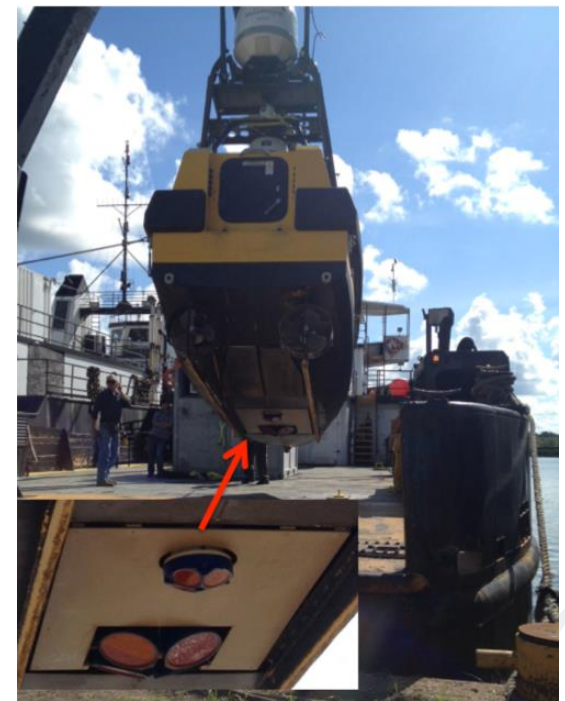


# CW6 Payload Developments

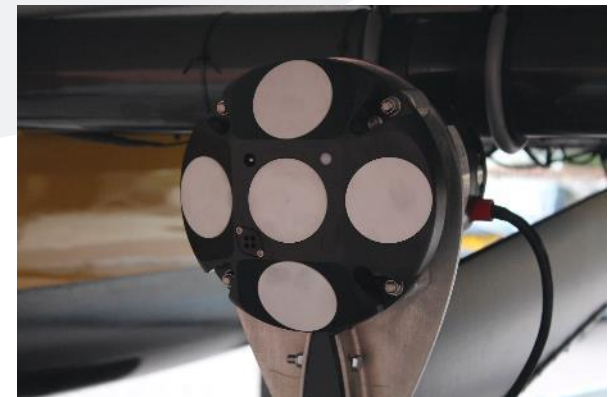


**EdgeTech 6205 Multiphase / Sidescan / Sub-bottom Profiler**

- SSS range: 230 – 1600 kHz
- SBP range: 1 – 24 kHz
- MBES range 230 – 540 kHz
- Operating depth ranges: 2.5m to 150m



**C-Worker 6 ADCP Payload (TRDI 75 & 300 kHz), C-Enduro Below (Nortek 600 kHz)**



# C-Worker 6 Payload Developments

## ROV & Innovatum Pipeline & Cable Survey Tool

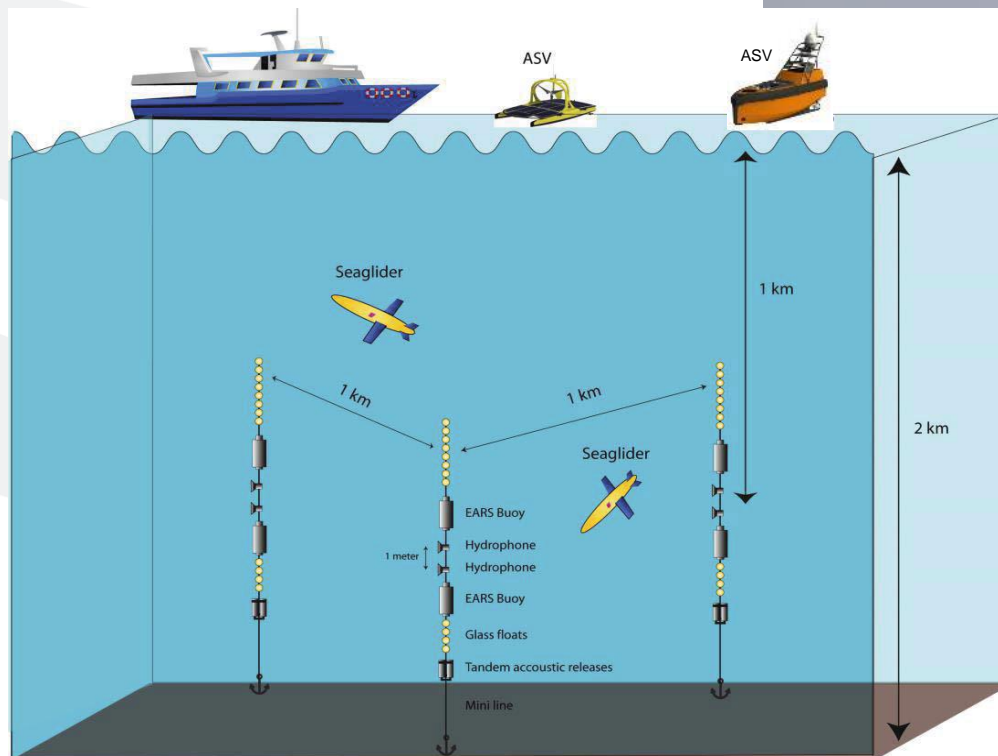


**Obs Class ROV to ~150m**

# C-Worker 6 Payload Developments

## Passive Acoustics –GoM Marine Mammal Monitoring

100m tow system on C-Worker 6,  
50m on C-Enduro



## Applications:

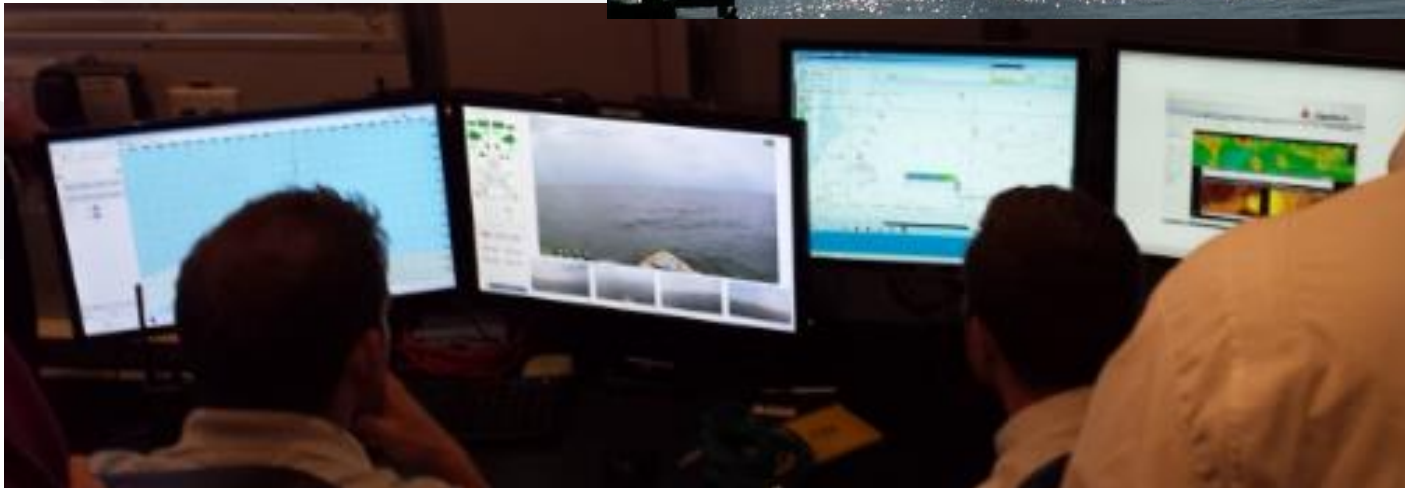
- Seismic Surveys
- Naval Exercises
- Pile Driving



## ***“Force Multiplier”* Examples**

# MBES Results – Mississippi Oyster Bed Test

- “Force Multiplier” program in parallel with DEA hydrographic survey vessel
- Excellent feedback from NOAA, US Army Corps of Engineers, others.
- EdgeTech 6205 MPE & Sidescan



# Narrow Beam Survey – Bering Sea

- “Force Multiplier” program in parallel with Terrasond hydrographic survey vessel
- SBBB200-3. 200kHz, 3 degrees. Used with an Odom CV100. “eChart” software was used to control the singlebeam and Hypack 2014 was used to collect all the data. Post-processed kinematic (PPK rather than RTK) GPS positioning with a Trimble system. Hemisphere V113 for heading, heave, pitch, and roll.



Image Courtesy of Terrasond



# Multi Beam & Sidescan Sonar Survey – GoM

- “Force Multiplier” program in parallel with C&C Technologies hydrographic survey vessel
- Kongsberg 2040 Multi Beam Bathymetry, EdgeTech 4125 Sidescan with Tow Fish & winch
- IXSEA Octans 3000 TI IMU



Sidescan towfish holder  
and winch



Up to 150 line kms production per day

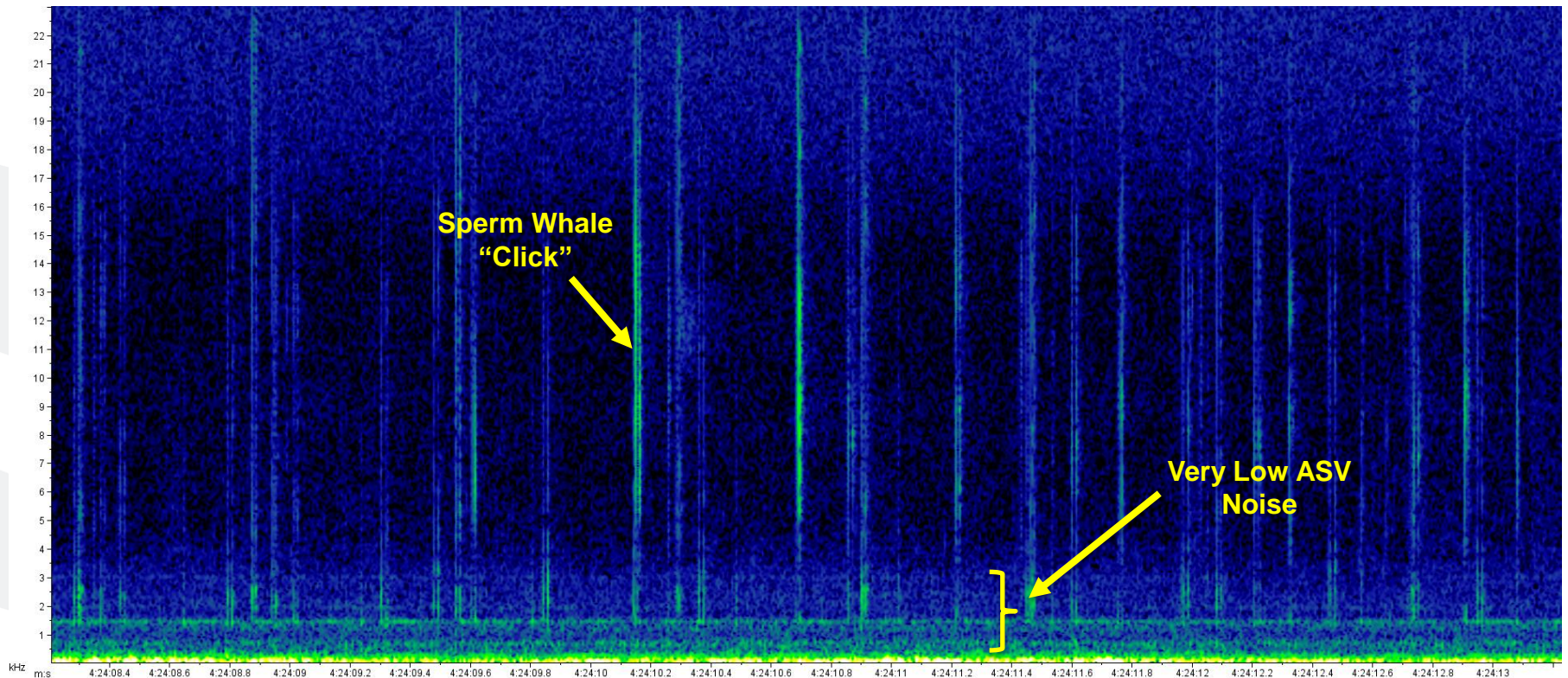
# Field Data Examples



# C-Worker 6 Payloads

## Passive Acoustics –GoM Marine Mammal Monitoring

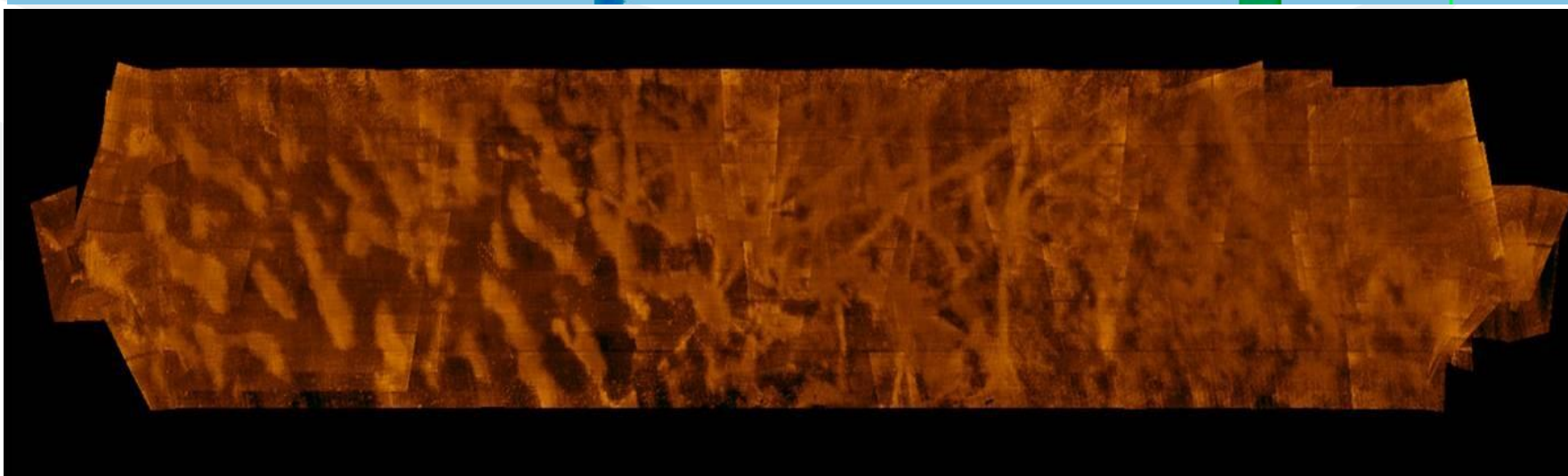
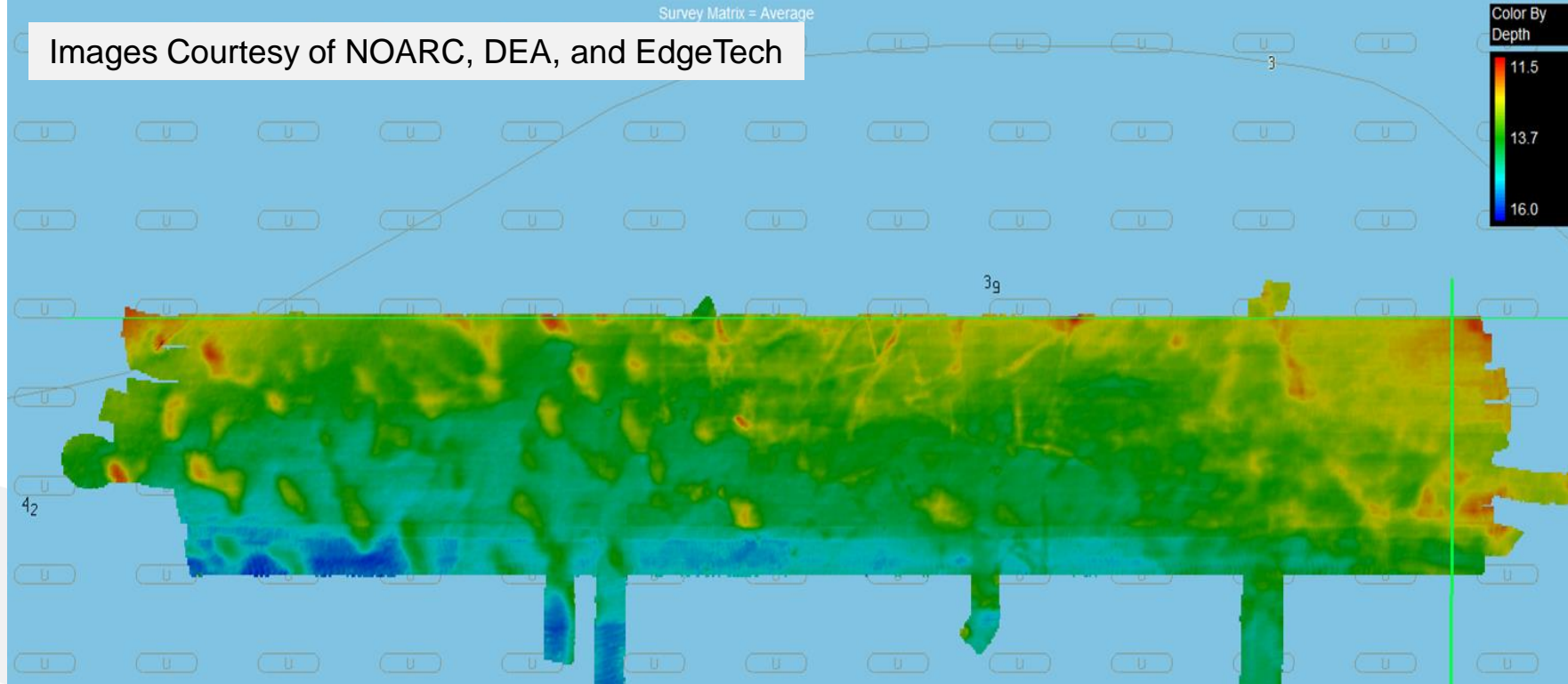
Single Hydrophone Channel, C-Worker 6  
Horizontal Scale = 5 minutes, Vertical Scale 0 to 24 kHz



***“The low acoustic noise level of the C-Worker 6 makes it an excellent platform for subsea acoustics” – Seiche Measurements***



Images Courtesy of NOARC, DEA, and EdgeTech

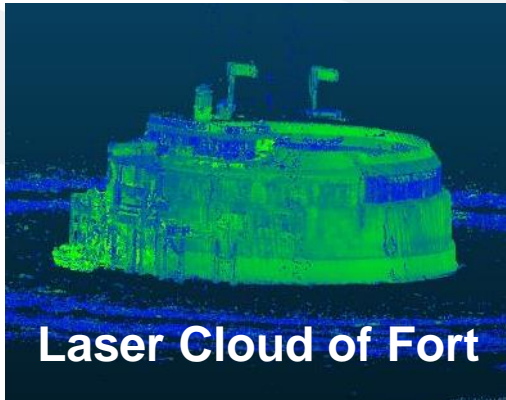
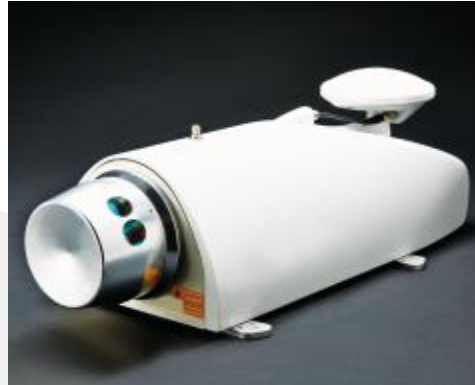


# Data Examples: Lidar & Meteorological Data

- Renishaw Dynascan M250 system
- Enables ability to provide above and below the waterline surveys simultaneously
- Evaluated range and resolution
- Potential future use for collision avoidance
- System provided excellent range (~250m)

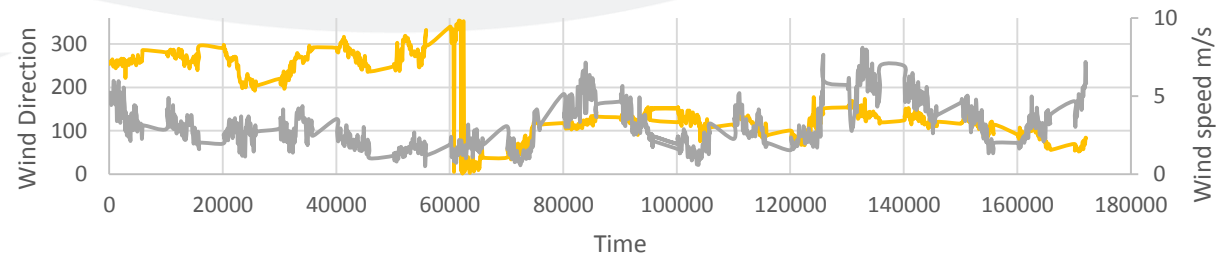


**Photo of Fort**



**Laser Cloud of Fort**

**Wind direction and Wind Speed**



# Operational Video – Heavy Weather

[Casius Report](#)



Deepwater GoM Compatt Calibration - 30 April 2014

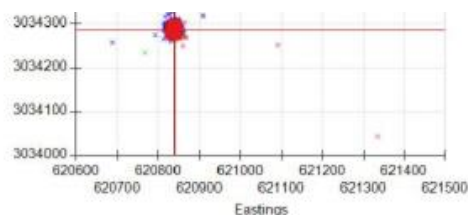




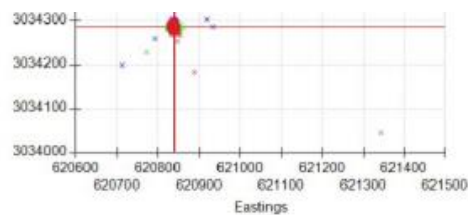
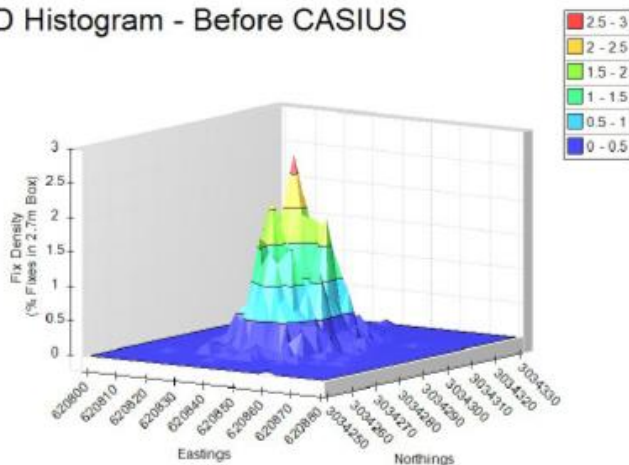
# Casius Report Results

## Statistics:

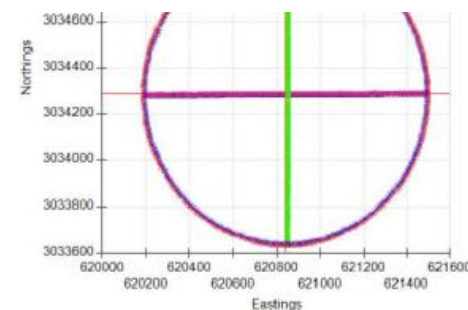
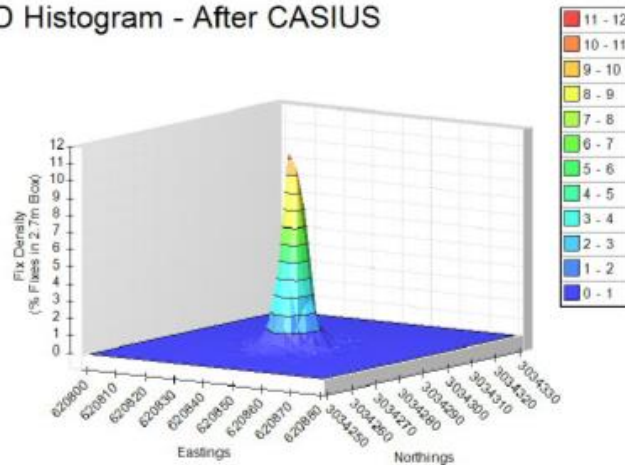
	Before CASIUS (distance)	After CASIUS (distance)	Before CASIUS (% depth)	After CASIUS (% depth)
<b>39.4% Beacon Positions (1 sigma)</b>	8.4m	2.8m	0.65	0.21
<b>50.0% Beacon Positions (CEP)</b>	9.3m	3.5m	0.71	0.27
<b>63.2% Beacon Positions (1 Drms)</b>	10.7m	4.5m	0.82	0.34
<b>86.5% Beacon Positions (2 sigma)</b>	14.9m	7.4m	1.14	0.57
<b>98.2% Beacon Positions (2 Drms)</b>	22.9m	14.0m	1.76	1.07



3D Histogram - Before CASIUS



3D Histogram - After CASIUS



# On Deck Storage

Technip G 1200

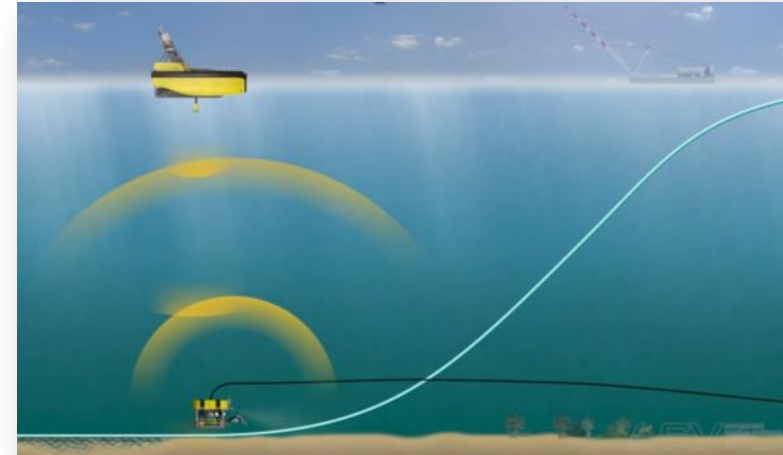




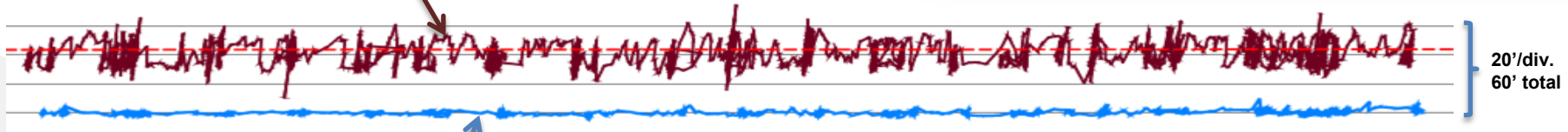
# C-Worker 6 USBL Data

## USBL Field Data Comparison – CW6 vs. Stinger Mounted Gyro USBL Data

- Intentional offset of data for display purposes
- C-Worker 6 data is quiet, indicates ROV stoppages at pipe joints
- Over 100m Horizontal and vertical offsets of stinger USBL from GPS antenna; less than 2m offsets for C-Worker 6.
- Data recorded during pipe lay operations in the GoM, 2014.
- A dramatic increase in signal to noise ratio with the C-Worker 6 USBL



Stinger Mounted USBL Data



C-Worker 6 Mounted USBL Data



Water Depth = 1,300' (~400m)



# C-Worker 6 Certification – Technip

**Technip**

*take it further.*

The following references are for recent technical presentations by Technip, co-authored by ASV, documenting the design, certification and acceptance process for the ASV C-Worker for use in offshore operations:

Title	<b>Unmanned Surface Vessel for Support of Marine Construction Operations</b>
Forum	Deep Offshore Technology International, Aberdeen, 14-16 October 2014
Speaker	Emilie Lachaud, Technip France
Co-Authors	Iain Miller, Technip France Richard Daltry, ASV Ltd UK Brian Anderson, ASV LLC, USA

Title	<b>Unmanned Surface Vessel for Support of Marine Construction Operations</b>
Forum	International Marine Construction Association (IMCA) Annual Seminar, London 19-20 November 2014
Speaker	Didier Renard, Technip USA
Co-Authors	Emilie Lachaud, Technip France Iain Miller, Technip France Richard Daltry, ASV Ltd UK Brian Anderson, ASV LLC, USA

**Technip's Jacques Franquelin Innovation Award, 2015**

# C-Worker Class ASV - Summary

## Benefits

- Easily mobilized by sea or air
- Decreases man hours on the water, improves HSE risks
- Robust design, very heavy duty
- Flexible payload for multiple parallel applications
- No dedicated LARS gear – only a deck crane is required
- Significant cost savings over surface ship operations

## Currently available & build plan

- Two units, one in GoM, one in Europe
- Six total in fleet by mid 2016
- “Scalable Technology”
  - CW5-H
  - CW12

## Acknowledgements

- Technip
- Western Advance





# Thank You



[www.asvglobal.com](http://www.asvglobal.com)

*Garry Armstrong*