Experiences with compact tightly coupled GNSS/INS multibeam echosounders

Second Mexican Hydrography CONVENTION

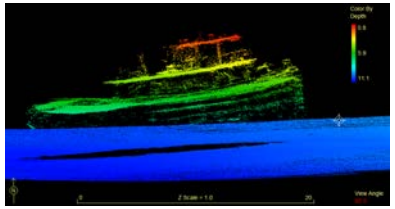
Manzanillo, Colima - Mexico

December 8, 2014

Table Of Content

1:

NORBIT Group



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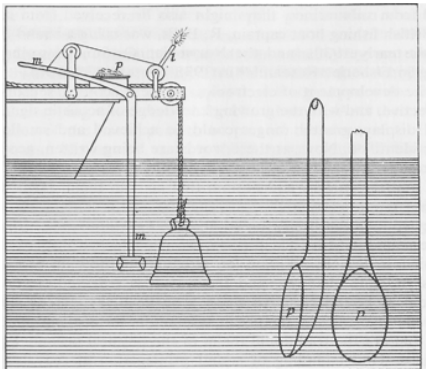
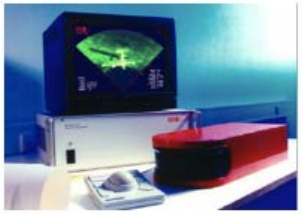


Mechanical



Analog

Digital

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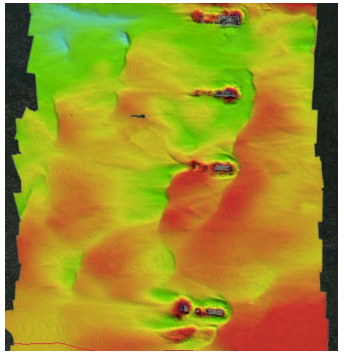

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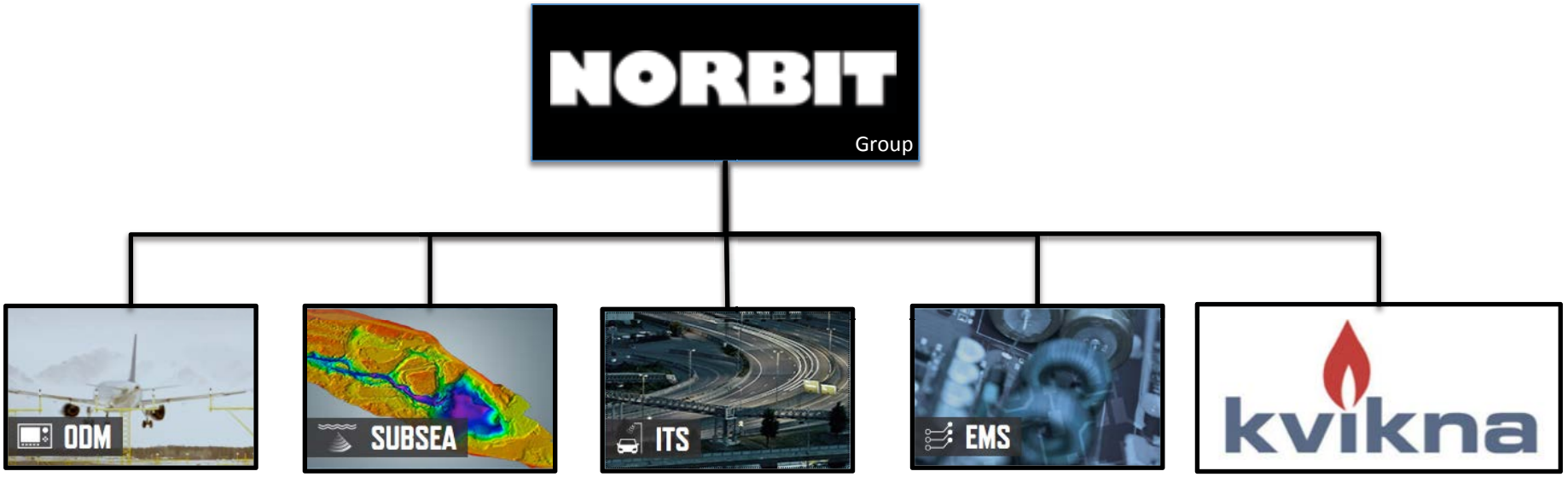

- Established 1995
- Revenue > $75M (2013)
- > 150 Employees

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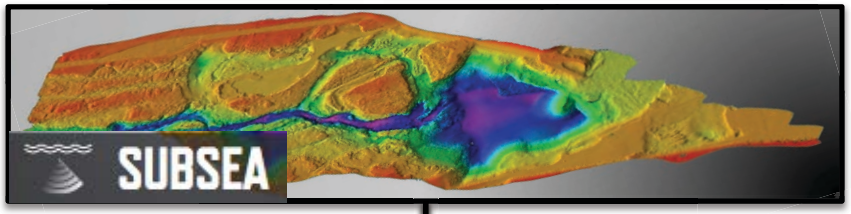
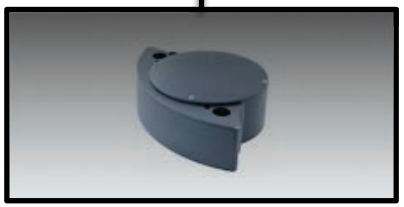
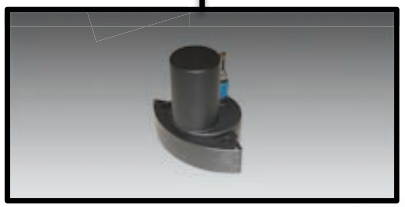


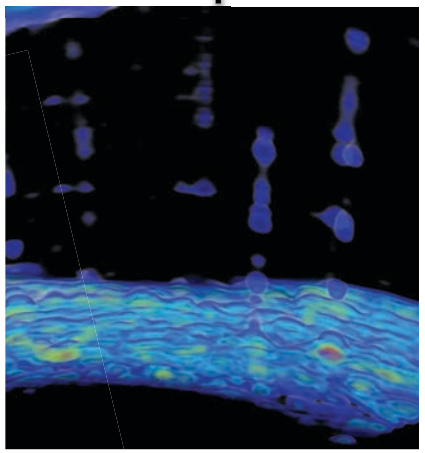


FORWARD LOOKING SONARS

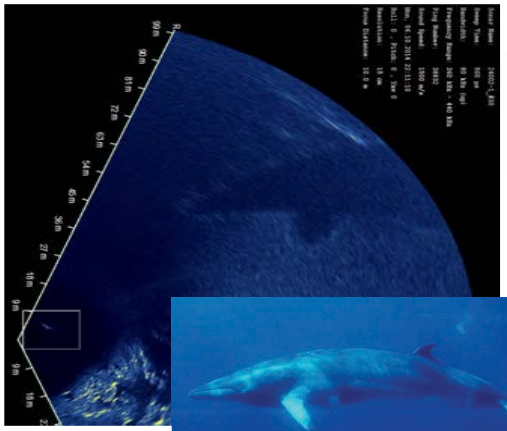


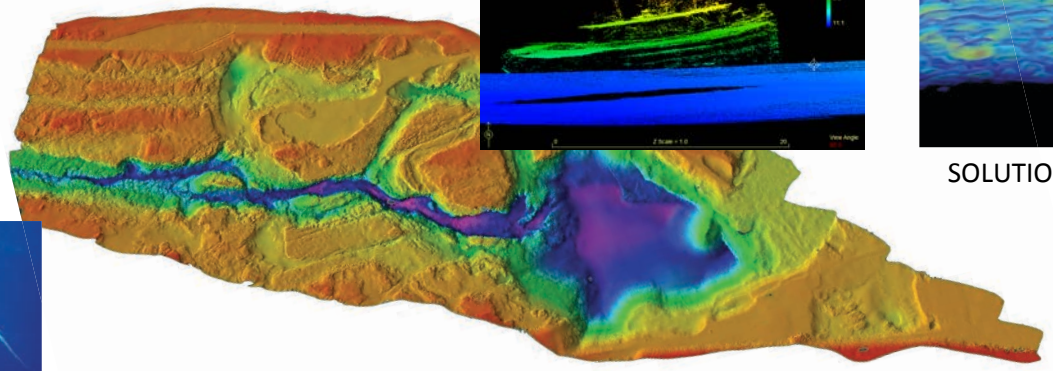
BATHYMETRY SONARS

INTEGRATED SYSTEMS



SOLUTIONS





Subsea Products

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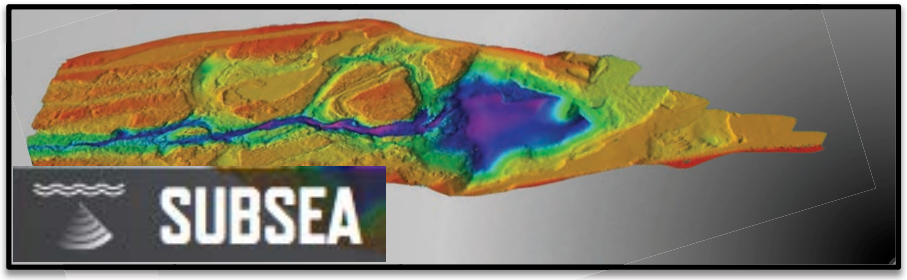
Selected References



US Army Corps of Engineers ®
Portland District

Boskalis

Chevron

bp

DEME
Dredging, Environmen & Marine Engineering

APEX-NAV
SOLUTIONS DE POSITIONNEMENT POUR OPÉRATIONS TERRESTRES

Royal Netherlands Navy

SEAVISION
UNDERWATER SOLUTIONS

ExxonMobil

OGP
International Association of Oil & Gas Producers

Statoil

TOTAL

eni

ConocoPhillips

BSEE
Bureau of Safety and Environmental Enforcement

Olex

SEABED

BR

NCOC
NORTH CASPIAN OPERATING COMPANY

GAZPROM NEFT

SRI International

PETROBRAS

UNIVERSITY of WASHINGTON

UAF
UNIVERSITY OF ALASKA FAIRBANKS

PRINCE WILLIAM SOUND SCIENCE CENTER

Polar Ocean Services

MPC

NATIONAL MAPPING AND RESOURCE INFORMATION AUTHORITY
1987

WOODS HOLE OCEANOGRAPHIC INSTITUTION
1930

PrimeGPS
Global Navigation Satellite Systems

EIC Laboratories

INLAND-GULF IGM MARITIME LLC

US Army Corps of Engineers ®
Cold Regions Research and Engineering Laboratory

Oil Spill Recovery Institute
Cordova, Alaska

Thew Associates
LAND SURVEYORS

Subsea References

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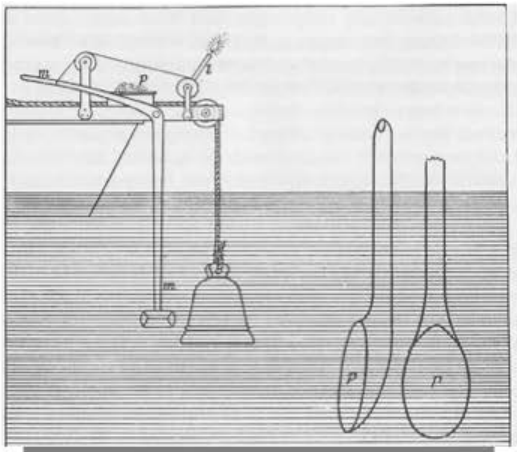
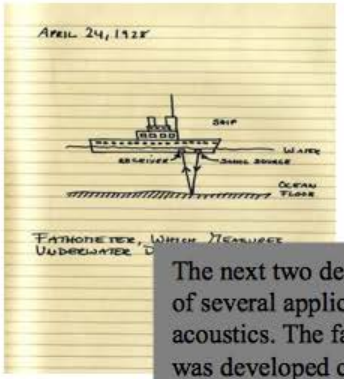
SONAR Early History





Daniel Colladon, a Swiss physicist, and Charles Sturm, a French mathematician. In 1827, on Lake Geneva, they measured the elapsed time between a flash of light and the sound of a submerged ship's bell heard using an underwater listening horn.

The next two decades saw the development of several applications of underwater acoustics. The fathometer, or depth sounder, was developed commercially during the 1920es. By the 1930es, sonar systems incorporating piezoelectric transducers made from synthetics were being used for passive listening systems and for active echo-ranging systems. These systems were used with good effect against German U-boats during World War II.

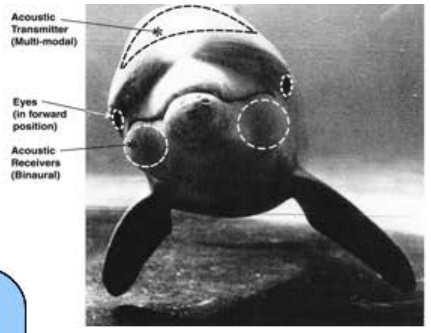
In 1490 Leonardo da Vinci wrote "If you cause your ship to stop and place the head of a long tube in the water and place the outer extremity to your ear, you will hear ships at a great distance from you."

The sinking of the Titanic and the start of World War I provided the impetus for the next wave of progress in underwater acoustics. Between 1912 and 1914, a number of echolocation patents were granted in Europe and the US, culminating in Reginald A. Fessenden's echo-ranger in 1914.

Echo sounders originated in the late 1950es, developed by the US Navy and General Instruments in the 1970es to map large swaths of the ocean floor to assist with underwater navigation of its submarine force. Companies such as General Instruments, Krupp Atlas , L3-Elac, and Kongsberg developed systems that could be mounted to the hull of small boats starting in the 1970es and rapidly improving technology through the 1980es and 1990es

1500 1830 1914 1940 1990

SONAR Resent History



Complexity
(Closely linked to Price)

Mechanical

Analog

Digital

FPGA
Focussed
Chirp
100+ Ch's

FUTURE
Everything **BUT**
Simpler and
integrated!!

1980 1990 2000 2010

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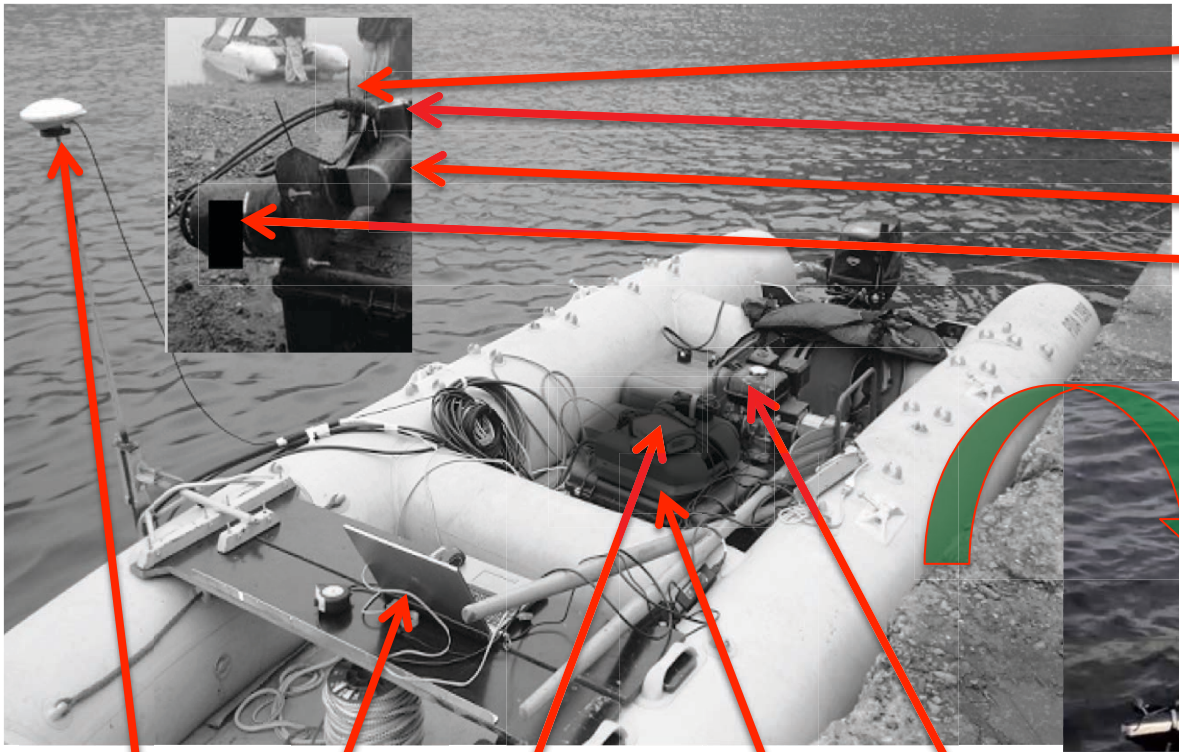
Integration : EXAMPLE of simplification (Competitors typical install)



Sound Velocity

Receiver

Transmitter

MRU

Antenna

Laptop

GPS

Processor (With Fans)

Generator

And Many Many cables

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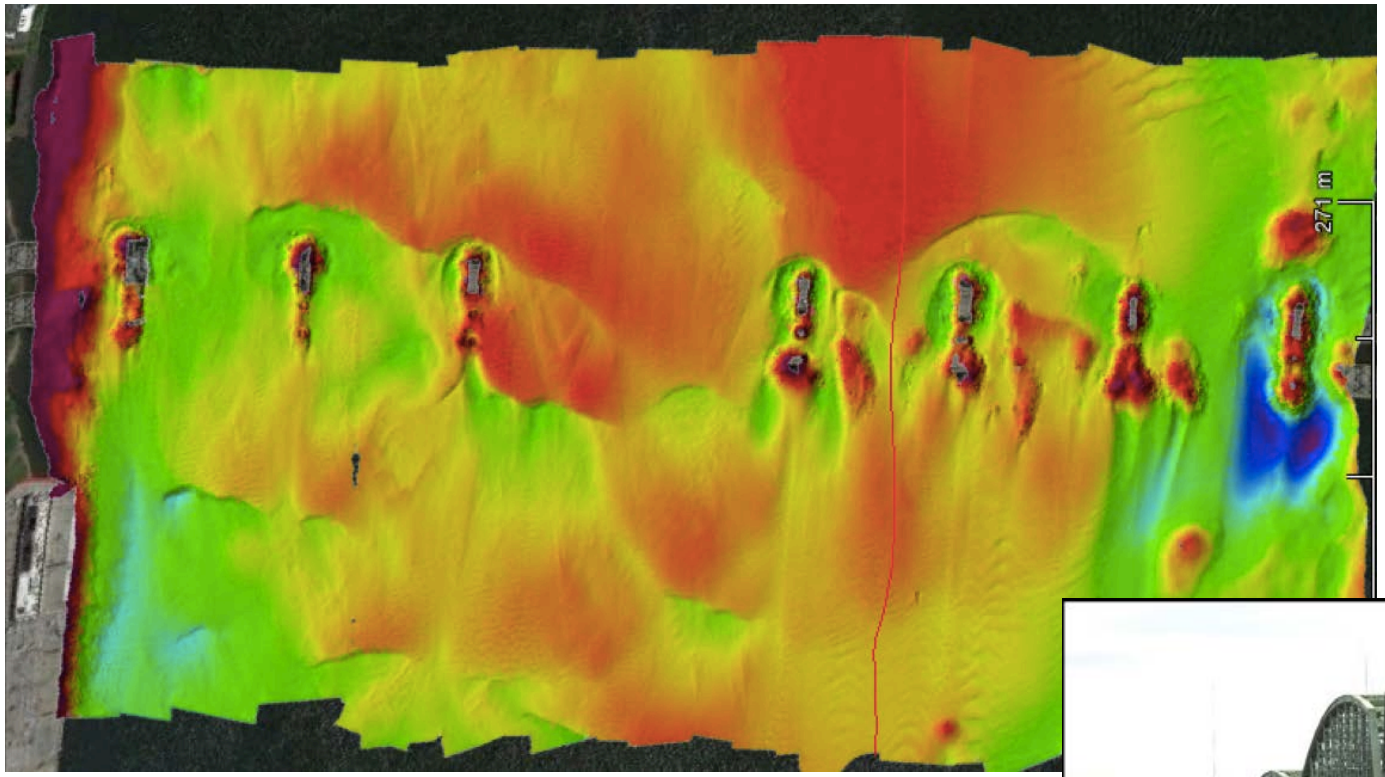
GNSS/INS Benefits



Robust positioning solution

- Keep positioning during GPS outages
- Improve dynamic performance
- Simpler installations
- Utilizes raw observables from GPS and INS

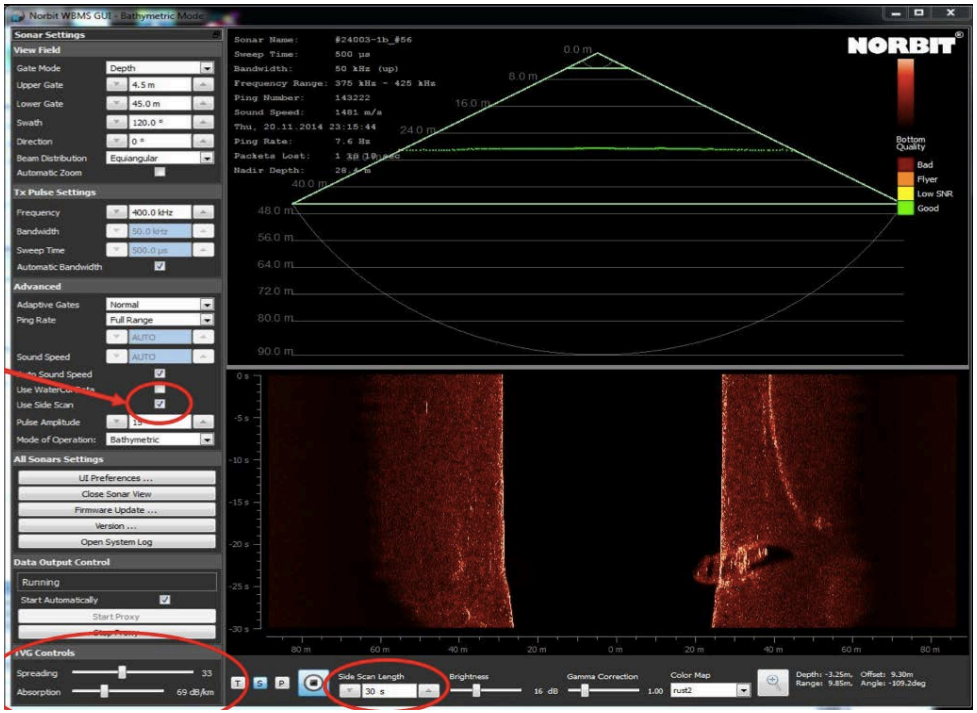
Ease of use

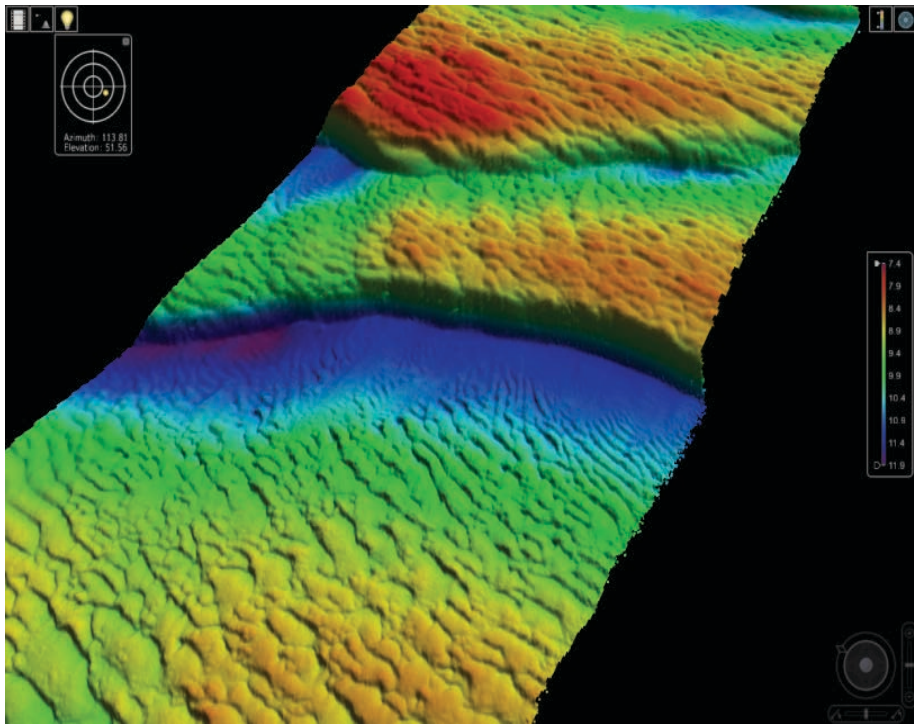
Simple installation

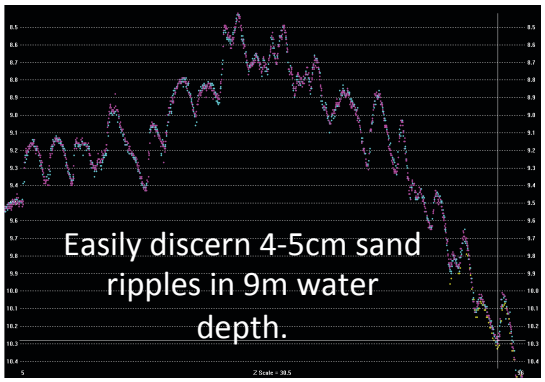
User interface simplification

- Automatic gain
- Automatic Power
- Adaptive range

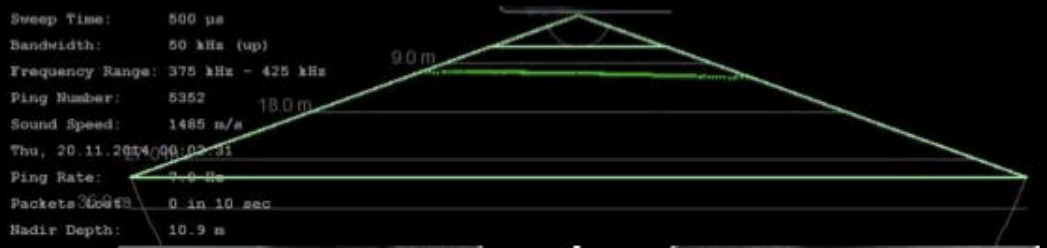
ON/OFF

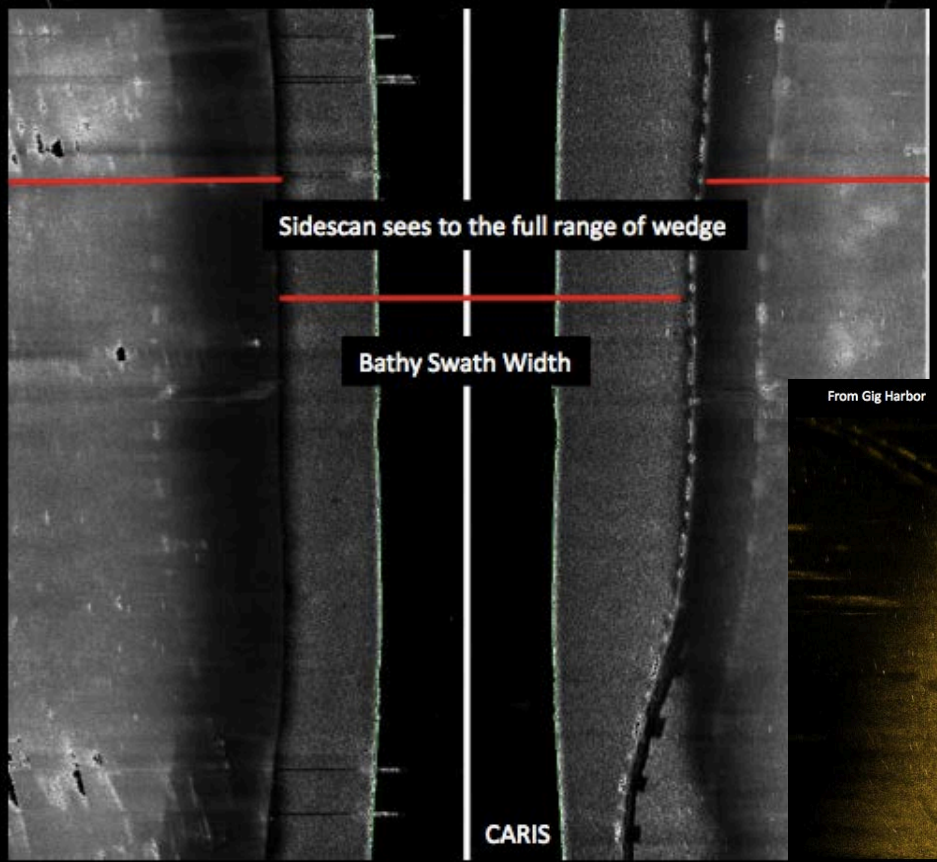






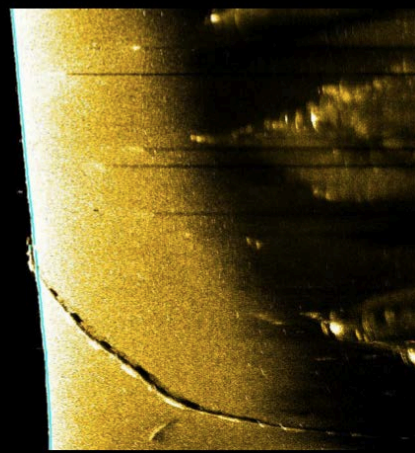
Sidescan Analysis





The ability of the WBSM to see beyond the edge of the swath can be a very handy feature to be used for scouting/Recon work.

From Gig Harbor



Hypack


3:
GEMINI
VALLEY
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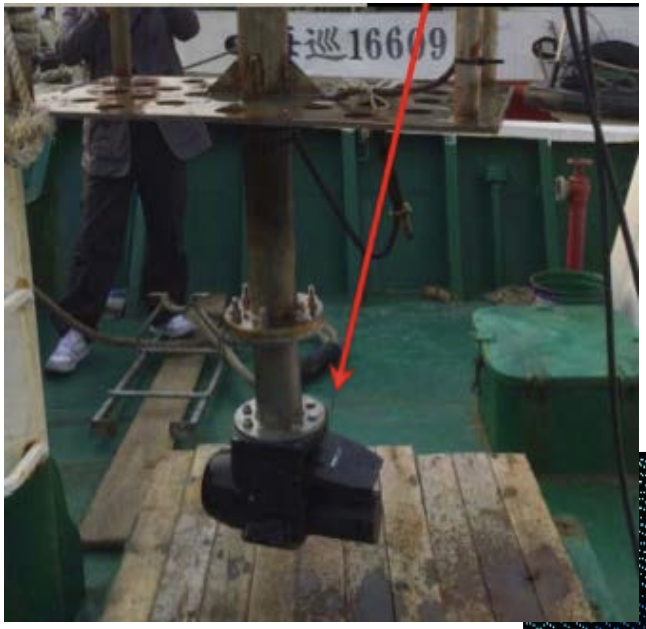
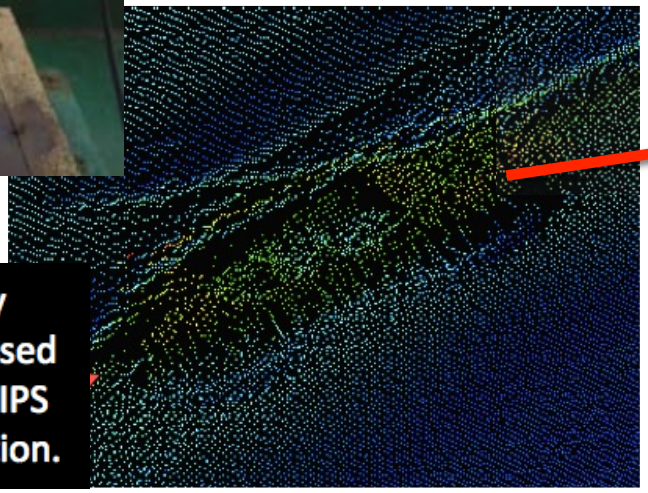
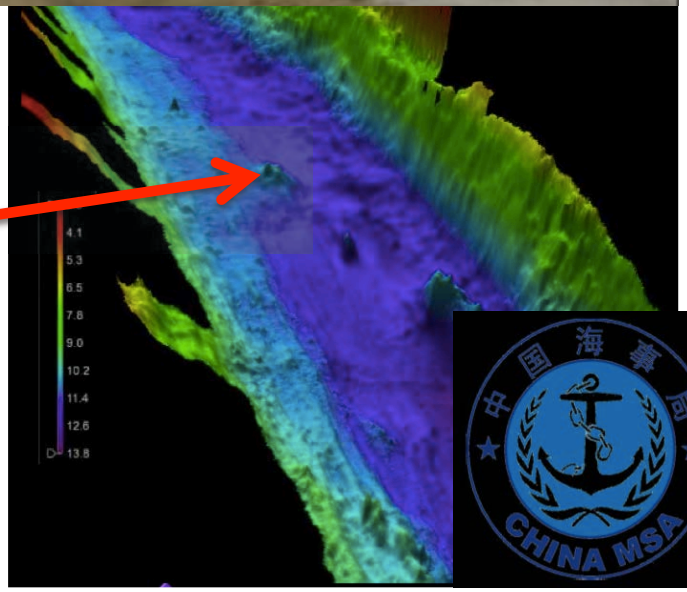
Moonpool Installation Example

Sonar (iWBMS) in
FWD Moonpool







Data from China MSA survey vessel "Hai Heng Yi". Processed by China MSA using CARIS HIPS with large vertical exaggeration.

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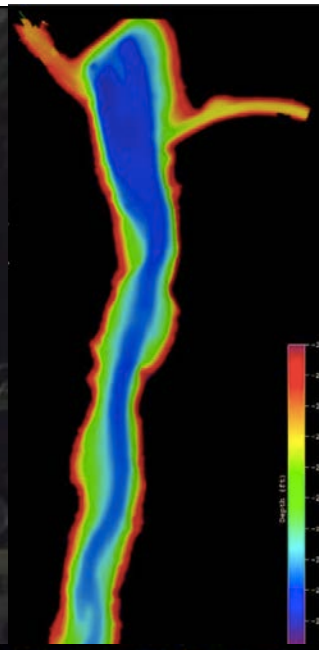
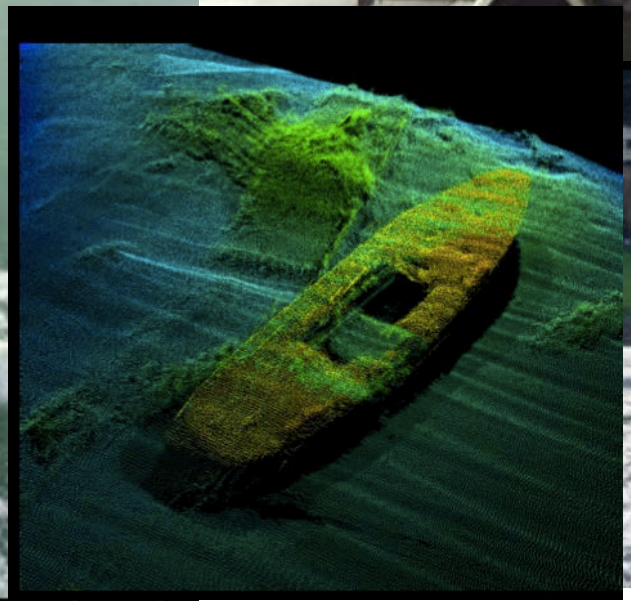
Over the side Installation Examples





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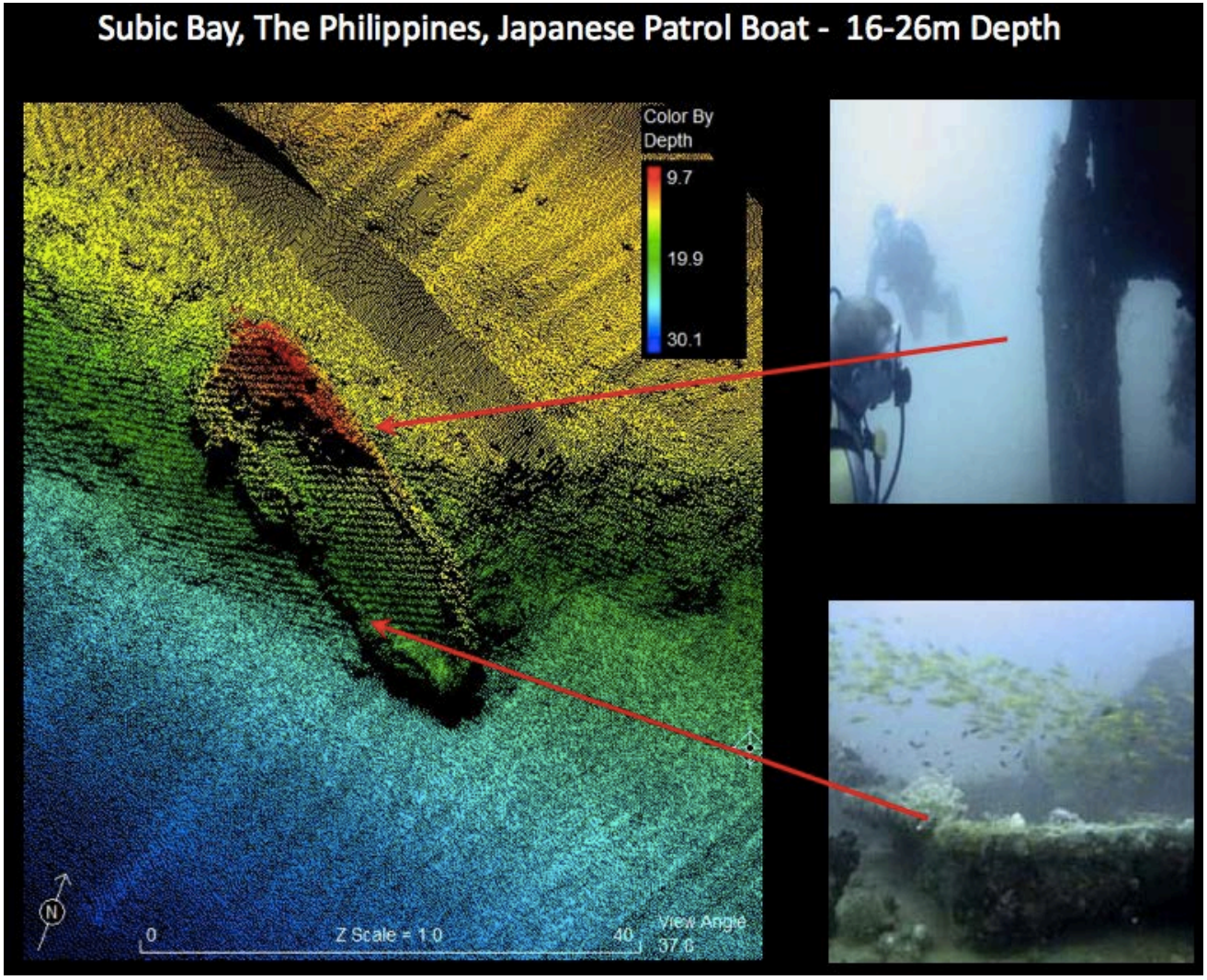
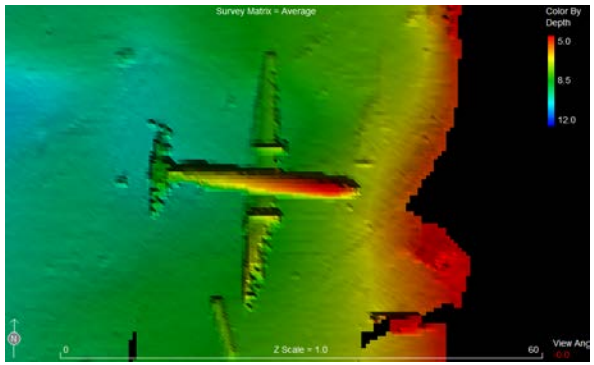
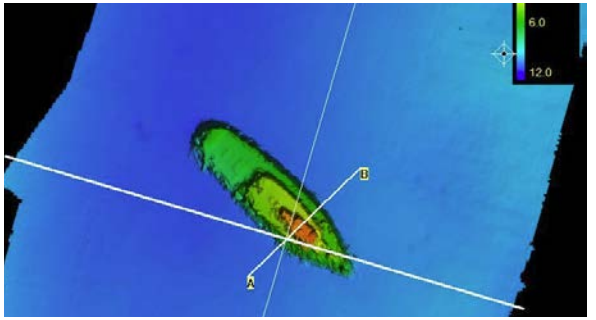
DATA Examples, Boat, Plane, Cars







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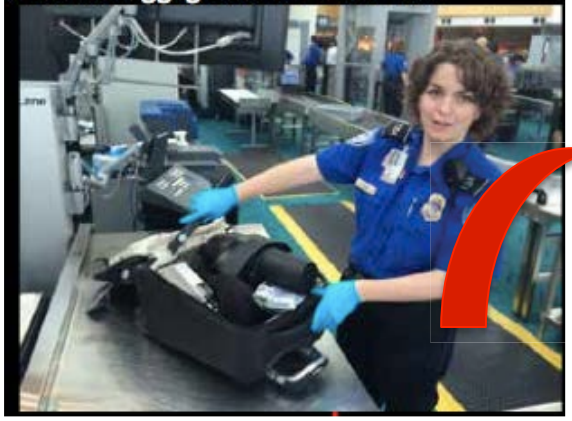
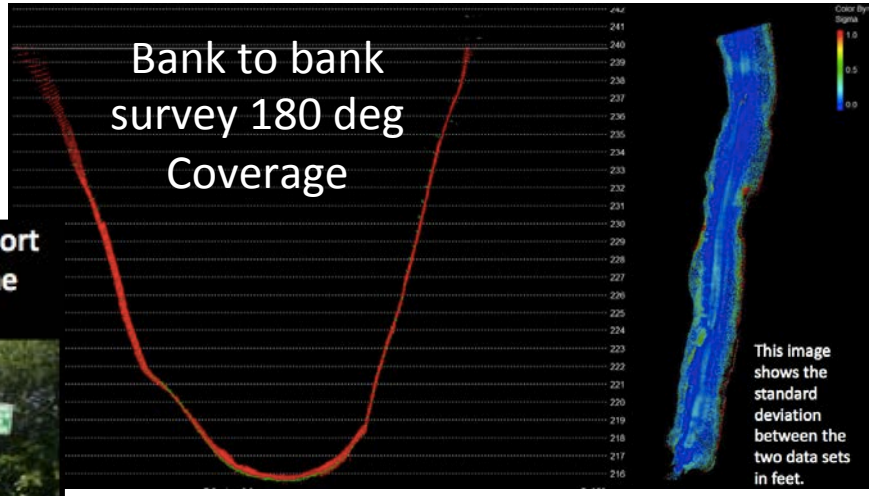
Rapid Installation Examples, Moonpool

Shipping to customer was easy. Expensive components hand-carried to reduce insurance risk. Rest went as standard checked luggage on Delta Airlines.



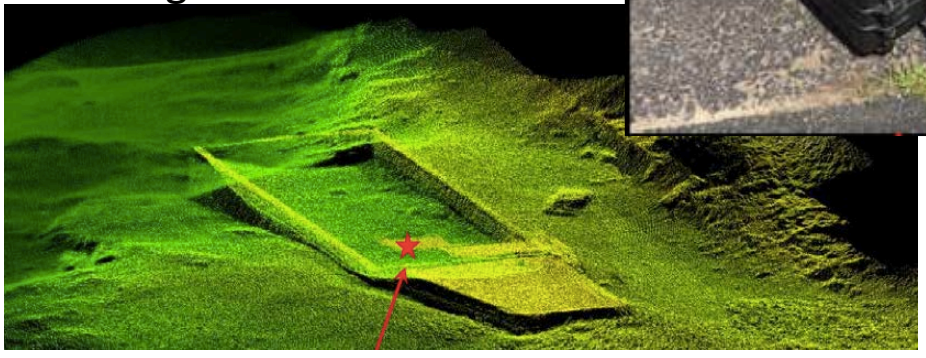
One person may easily transport entire kit nearly anywhere (the wheels on case help!)

Bank to bank survey 180 deg Coverage



Survey within 1-2 hours of arrival at vessel.

Submerged Foundation



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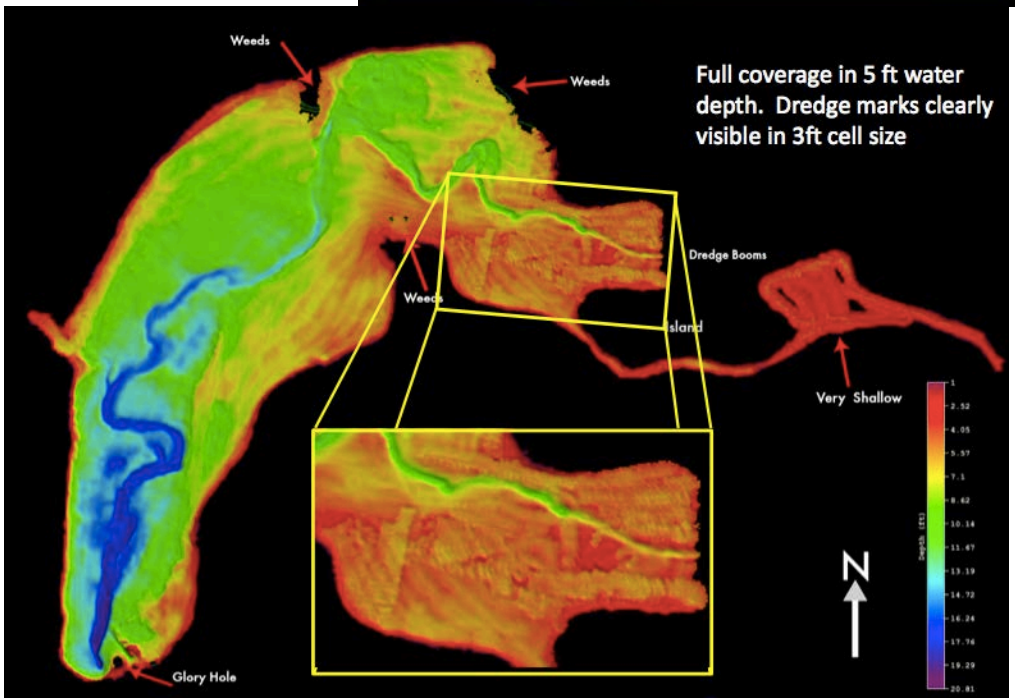
RAPID Installation Examples

Fishhawk Lake
Speed-Rail utilizing 2” aluminum pipe, mounted all sensors, fitted on site.
Battery operated

CHS
Canadian Hydrographic Service



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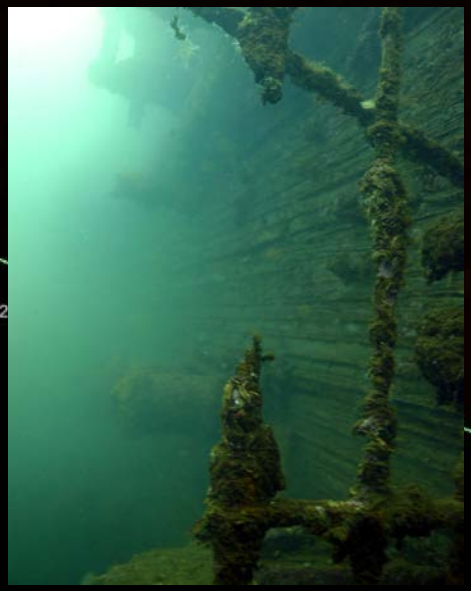
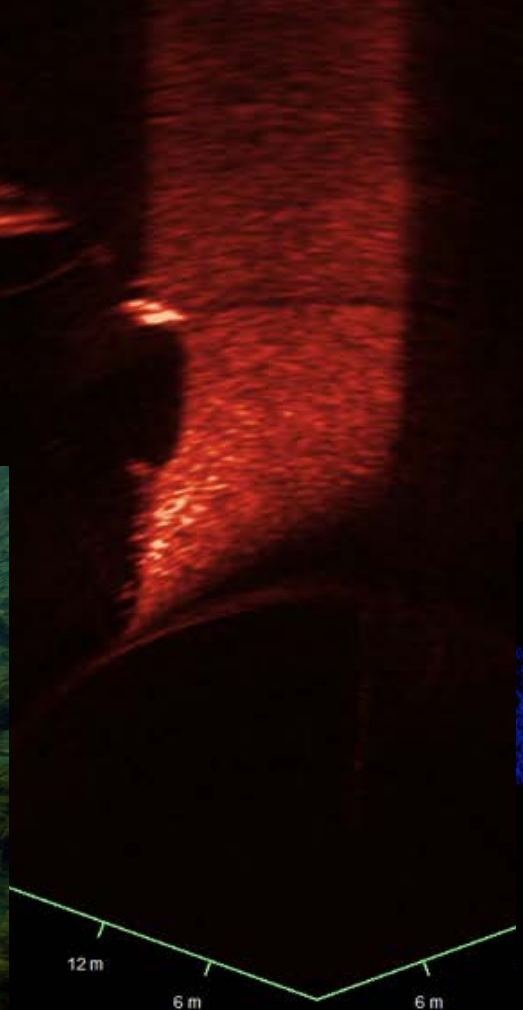
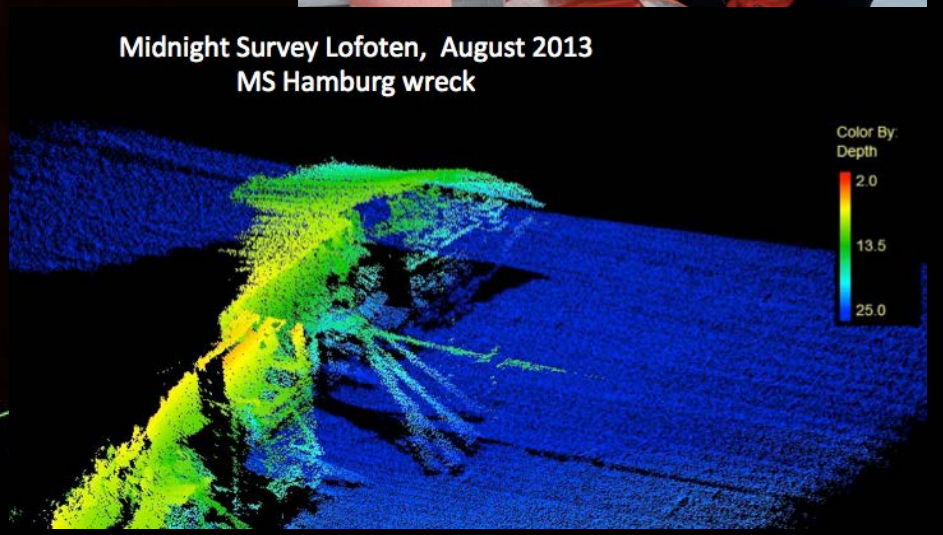
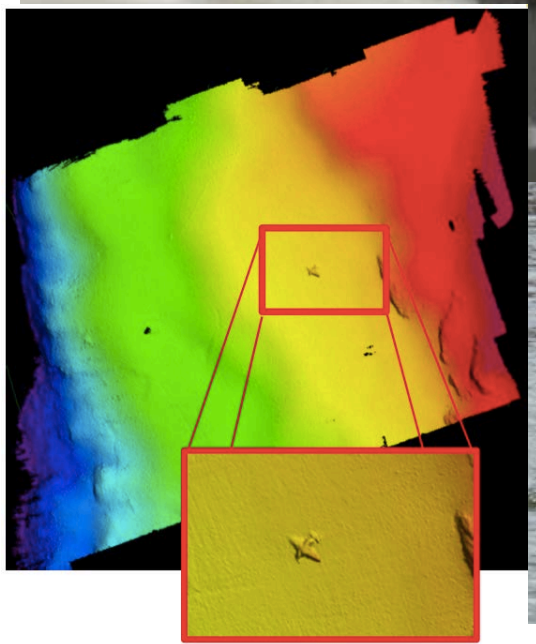
Midnight Kayak Survey







USV Installation Examples



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ROV Installation Example (Alternative Positioning)

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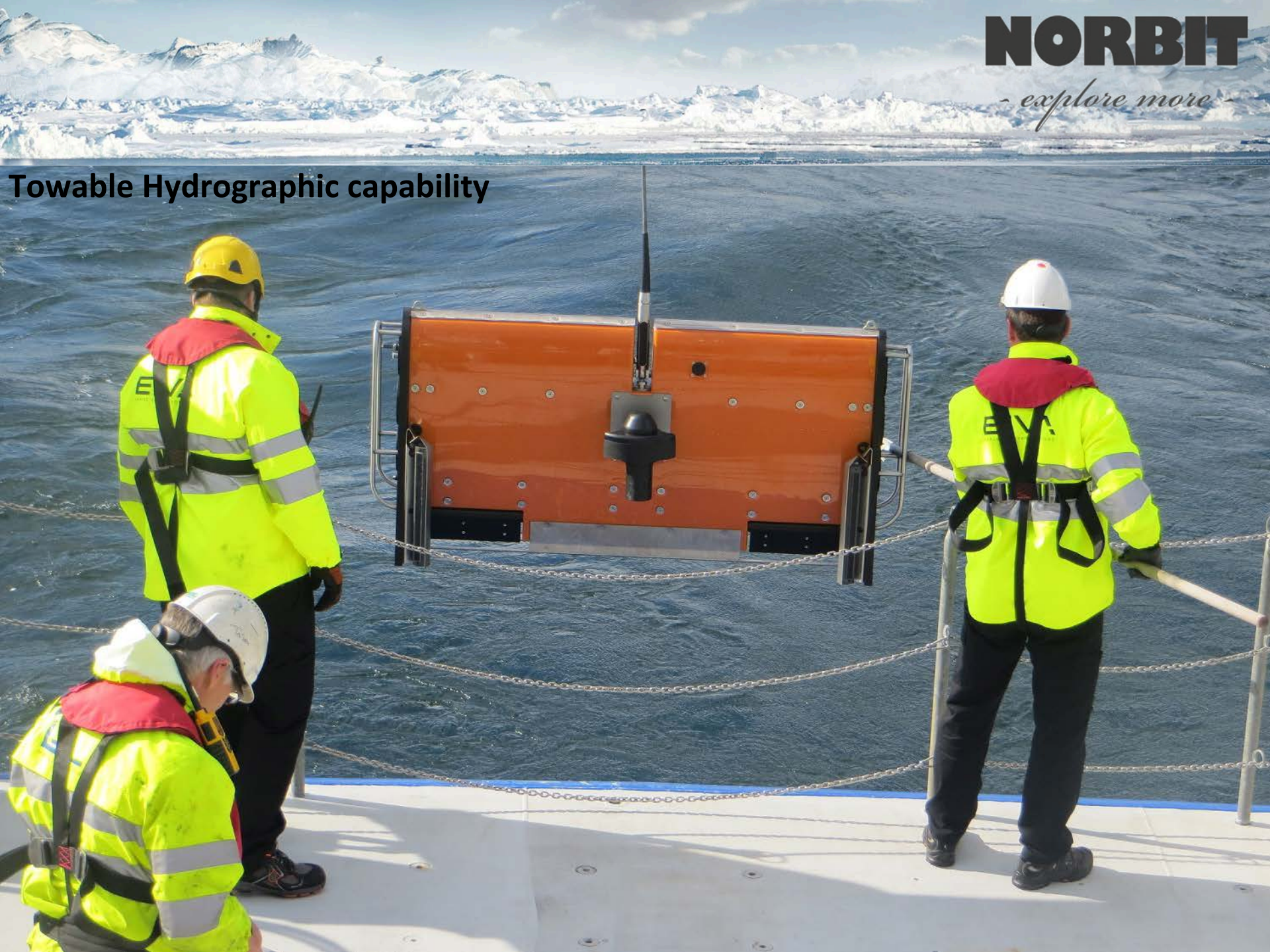
Towable Hydrographic capability



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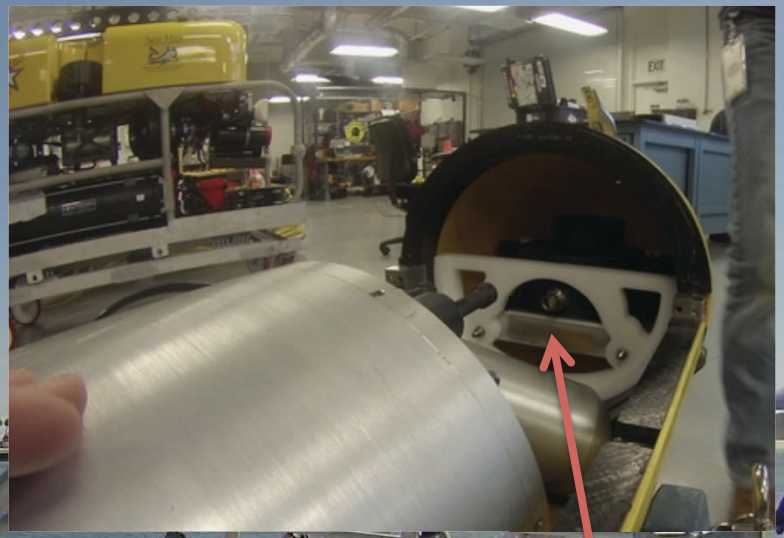
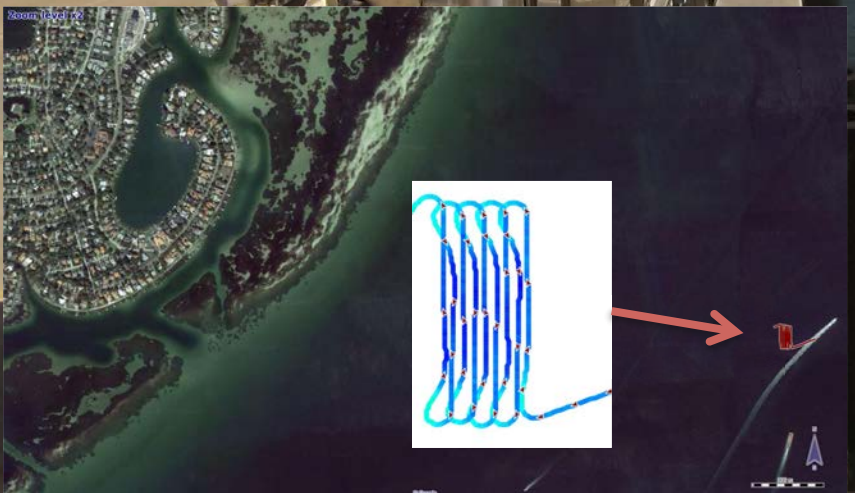
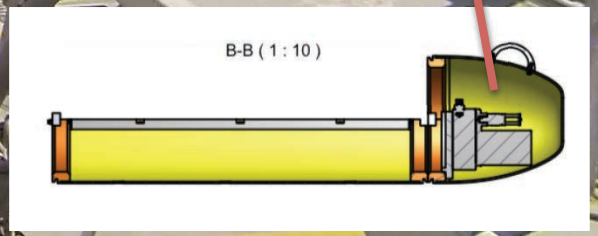
AUV Installation Example (Alternative Positioning)





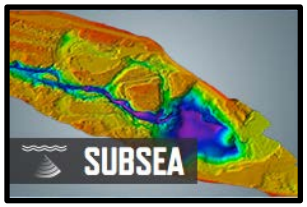


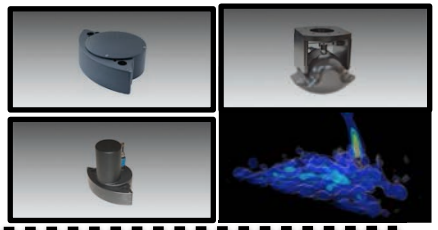
Conclusion

1:

NORBIT Group

- Established 1995
- Revenue > $75M (2013)
- > 150 Employees





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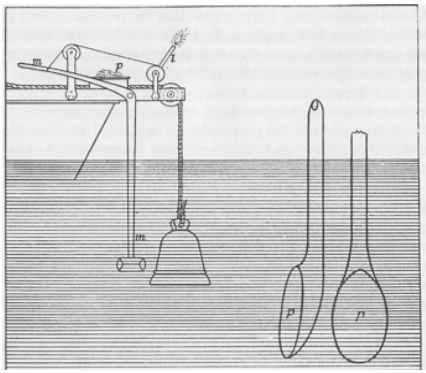
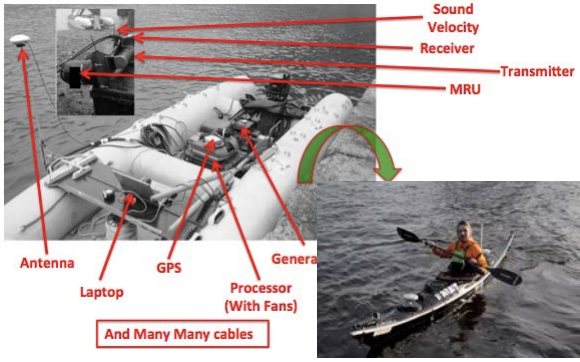
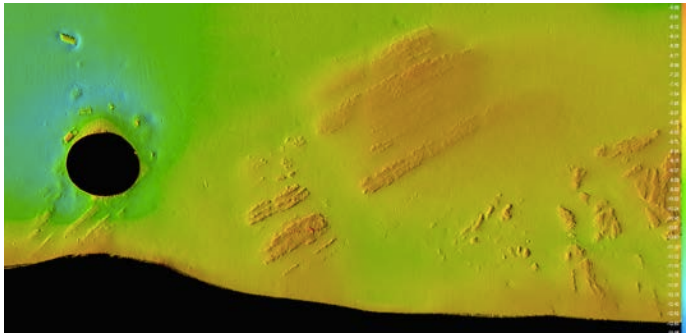




3:

- Hull Mounted
- Over the side
- Vessels of opportunity
- USV
- Towfish, ROV, AUV

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VALLEY
NORBIT
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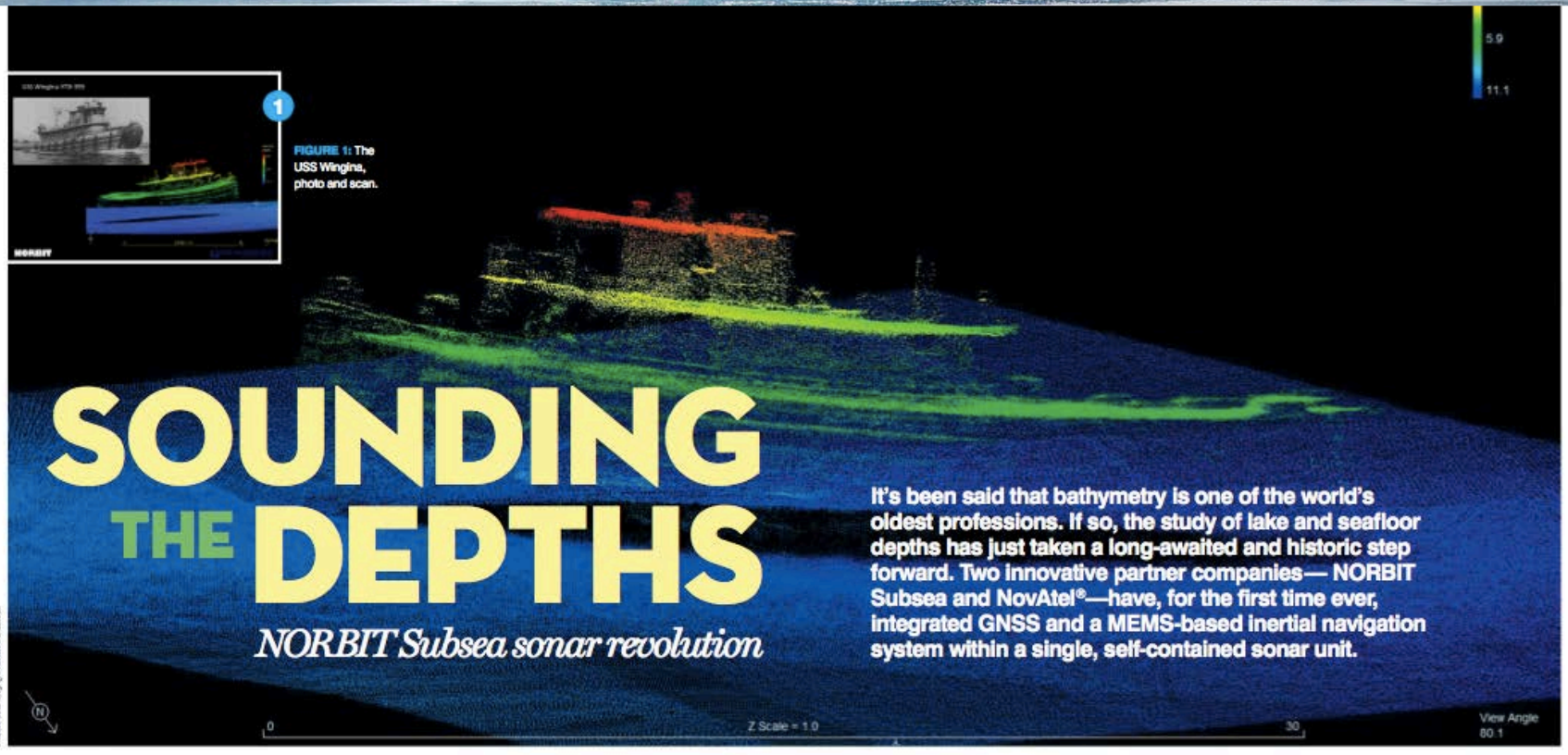

FIGURE 1: The USS Wingina, photo and scan.

Photos courtesy of NORBIT Subsea

SOUNDING THE DEPTHS

NORBIT Subsea sonar revolution

It's been said that bathymetry is one of the world's oldest professions. If so, the study of lake and seafloor depths has just taken a long-awaited and historic step forward. Two innovative partner companies— NORBIT Subsea and NovAtel®—have, for the first time ever, integrated GNSS and a MEMS-based inertial navigation system within a single, self-contained sonar unit.

KNOWING HOW DEEP THE WATER IS under one's vessel has been a must for safe navigation for thousands of years. With the rise of maritime trade and naval warfare, highly valuable and strategic charts derived from seafloor mapping became closely guarded secrets. Today, governments, militaries, telecommunications and petroleum companies, academic institutions and many more continue to chart the seafloor for a variety of reasons.

The stage thus set, enter NORBIT'S new iWBMSc mulitbeam sonar, featuring NovAtel's Synchronized Position Attitude Navigation (SPAN) system.

"There are really three major components here," explains NovAtel's Ryan Dixon. "The Inertial Measurement Unit (IMU) is manufactured by Sensonor. NovAtel manufactures the GNSS and interface cards, and the real technology element that NovAtel provides is the SPAN system, an Inertial Navigation Solution (INS) using both GNSS and the Sensonor IMU. NORBIT then makes the multibeam sensors, which incorporate all of these components."

The IMU Dixon is referring to is Sensonor's STIM300, a Micro Electromechanical Systems (MEMS) device for weight and size constrained environments, replacing previous bulky and cumbersome systems.

"The finished product is vastly simpler for an end customer to install," says Dixon. "Instead of having a totally separate INS system to plug in alongside the existing items like the computers and multibeam, all of the navigation equipment is directly and invisibly embedded into the multibeam equipment. It's like going from an aftermarket GPS glued to the dashboard to a built-in unit."

BATHYMETRY 101

Bathymetry is the marine equivalent of topography and it generally involves the use of a sonar transducer that transmits a sound pulse from the surface and records the returning signal as it bounces back from the bottom.

Bathymetric surveys need to be completed within a reasonably short period of time in order

FIGURE 2: The NORBIT WBMS.

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