



## Delivering operational savings with the latest acoustic inertial technology

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Marksman / Ranger 2: Position, Monitor, Control

A glimpse of our capabilities



## Marksman / Ranger 2: Position, Monitor, Control



### Over 20 years of innovation

- **1993: Sonardyne's first DP reference USBL system - Dimona**
- 1996: Master/Slave Dual USBL introduced for critical positioning
- 1997: 'Big Head' transceiver developed for ultra-deep water/noisy operations
- **2000: 300th vessel installed with USBL**
- **2005: The first USBL system to use Wideband digital acoustics launched**
- **2010: Ranger 2 introduced as part of Sonardyne's 6G technology platform**
- 2011: 1,000th USBL system sold, 40% stand alone independent systems
- 2011: New calibration free transceiver saves vessel time and money
- **2011: Sonardyne installs first USBL-aided INS system on DP rig**
- **2012: World record for DP drilling - 7,740 metres "Chikyu"**
- 2013: Ranger 2 DP-INS system accuracy equivalent to GPS
- 2015: Transponder options save deployment and calibration time



## Marksman / Ranger 2: Position, Monitor, Control



### More recent highlights

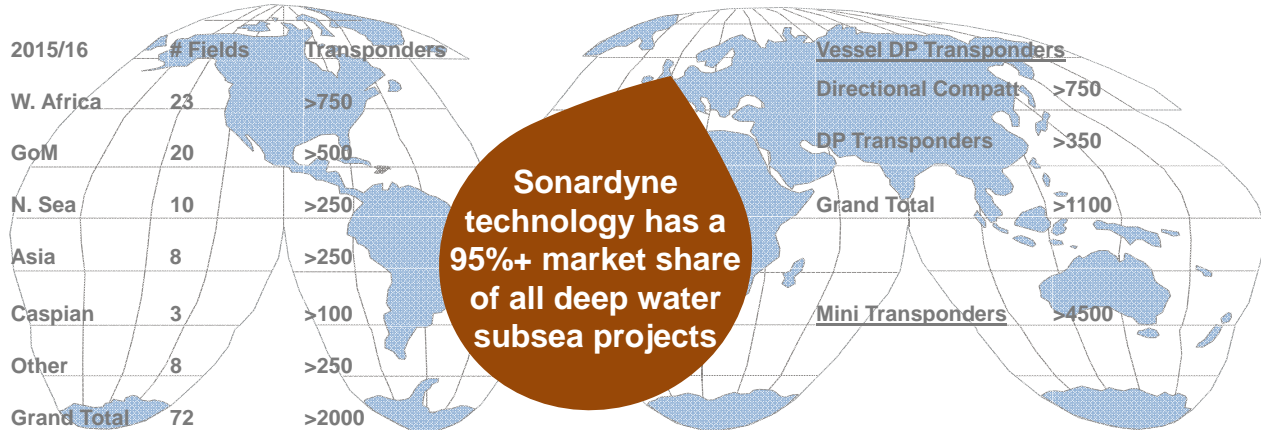
- Over 1,200 USBL systems sold (fixed and portable)
- Over 300 vessel HPR systems delivered with Deployment Machines, including:
- Over 50 HPR systems to drilling vessel market
- Over 150 HPR systems to Construction and Support vessel market
- Sonardyne positioning and communications technology is used in over 95% of all deep water subsea projects

#### Recent achievements:

- 100% of Vantage and approximately 50% of Transocean fleets
- Oceaneering, Bourbon, Island Offshore, Brandon, Maersk and McDermott vessels



Sonardyne Transponders worldwide



Source : Field database : using or planning to use Sonardyne tranponders, 2015 / 16

Source : Vessels database : Transponders types used for DP

Marksman

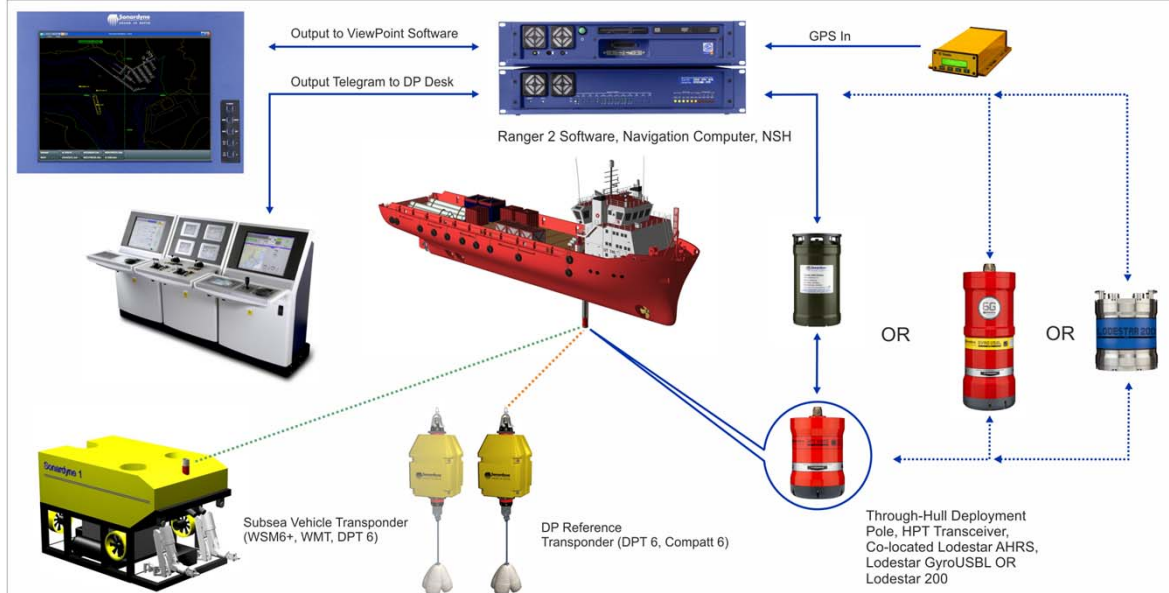
- Position reference for DP vessels with simultaneous tracking of ROVs
- Fully compatible with all DP systems INCLUDING Kongsberg.
- DP-INS for added reliability and operational savings
- Dual and triple independent configurations
- Time saving using multi-user transponders .
- Long life transponders with up to 2 years continuous operational use
- Acoustic BOP control
- Riser Angle Monitoring
- Riser profiling (including SMART VIV)



## Marksman / Ranger 2: Position, Monitor, Control





### System Overview



## Marksman / Ranger 2: Position, Monitor, Control



### Takes standard USBL into deeper water

	Sonardyne HPT 5000	Sonardyne HPT 7000	Sonardyne Summary
Note: All data taken from online datasheets			
Operating Range	Up to 7000m	Up to 7000m	Greater range
Position Repeatability (single transceiver, 1DRMS, 63.2%)	Up to 0.1% slant range	Up to 0.07% slant range	More accurate
Position Repeatability (two transceivers, 1DRMS, 63.2%)	Up to 0.07% slant range	Up to 0.05% slant range	
Minimum Gate Valve	350mm	350mm	Smaller gate valve
Transceiver unit	Combined with transducer	Combined with transducer	Easier to install, less space needed, less wiring

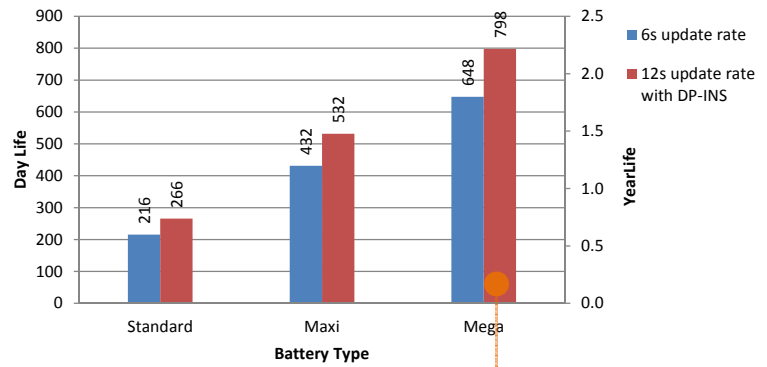


Low maintenance seabed transponders

Standard

Maxi

Mega



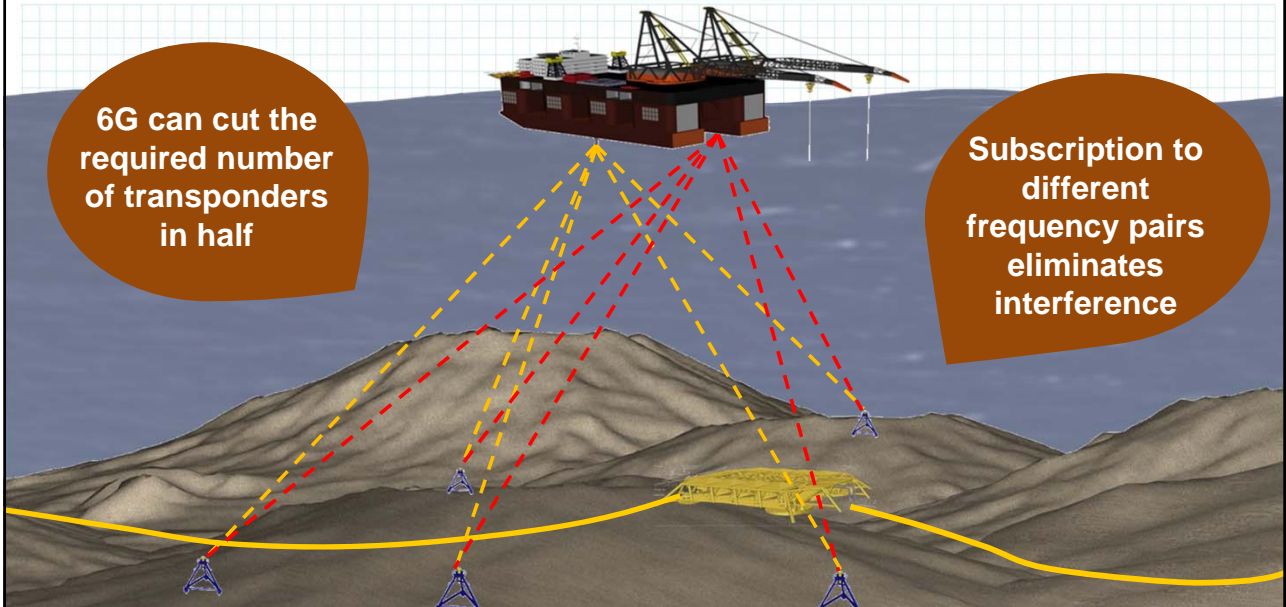
ROV can carry more transponders (Ultra is 50% lighter as float and clump weight not needed)

Up to 2 years continuous operational use

Shared 6G Arrays

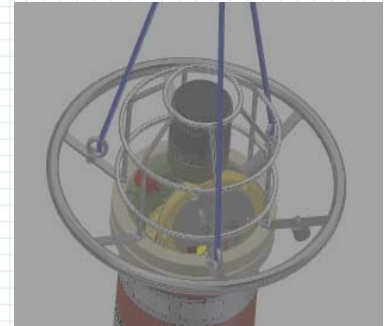
6G can cut the required number of transponders in half

Subscription to different frequency pairs eliminates interference



## Example Rig using a shared array

Acoustic Reference System	Original	Updated
Set-up	Dual Independent	Dual Independent
Generation	5G	6G
Transponder type	Standard	Mega
Acoustic Update rate	6	6
<b>Deployment and calibration</b>		
Number of transponders	10	5
ROV payload (tpdrs)	4	5
ROV trips*	3	1
Average array set-up time (hours)	18	9
Number of wells per year	5	5
Annual deployment and calibration time (hours)	90	45
Time saved (hours)**		45



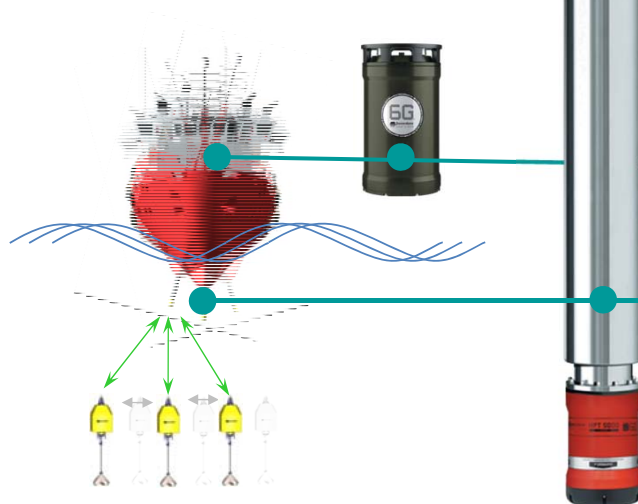
**Save nearly 2 days rig time per year**

\* DP Mega Transponders can be used (lighter and smaller compared to compact, float and clump weight)

\*\* Assumes dedicated rig time is needed for array deployment, a percentage of this is more likely

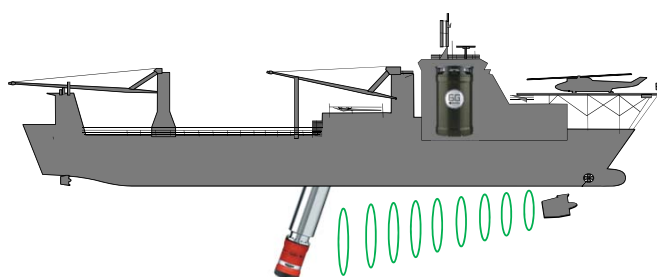
## HPT – Deployment Options

**“Transceiver pole mechanics are a key to providing optimum positioning”**



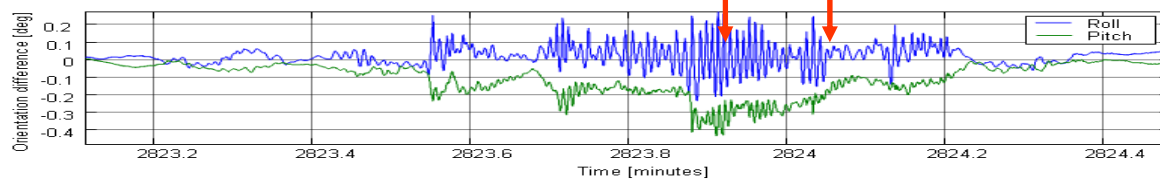
## KEY POINT

- Improvements in acoustic signals, signal processing and transceiver hardware means that mechanical deployment stability of transceivers and motion sensors has become a dominant contributor to system level error

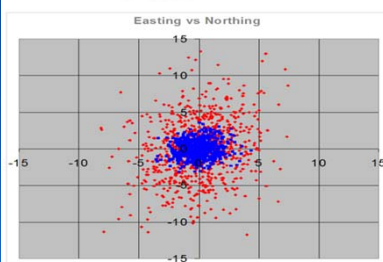


Pole resonates at 2Hz approx

Up to 0.3 degree pitch bias directly affects position accuracy



Accurate and Calibration free



## KEY POINTS

- GyroUSBL is calibration free - saving vessel time
- Combining the acoustic transceiver and AHRS improves accuracy
- USBL is extended into deep water

HPT - Through hull deployment machine

- The optimum deployment system for permanent vessel installations
- Remote operation for the deployment and recovery of Pole
- Sea chest with inspection hatch for access to transceiver above gate valve
- Gate valve and pole safety interlock
- Hydraulic operation of pole
- Transceiver can be deployed up to 3.0 metres below hull
- Custom lengths available
- Kongsberg poles can also be used





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HPT - Stem tube and over the side deployment options are also available



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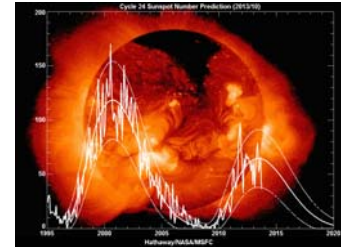
Increasing performance and reliability

**“Inertial and  
acoustic  
positioning...a  
marriage made in  
Heaven”**

Increasing performance and reliability

## DGPS

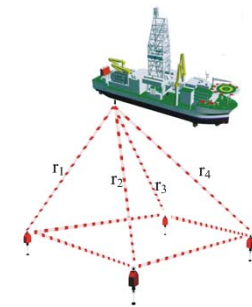
- GPS can be lost for critical periods of time
- Weak signals 10–16 watt/m<sup>2</sup> ~ 40Watt light bulb @ 10.000 mile distance
- A simple 1 watt jammer may destroy commercial GPS in a 100km radius
- Unintentional jamming by faulty electronics has been seen
- Improvements are pursued but issues are unlikely to entirely disappear anytime soon



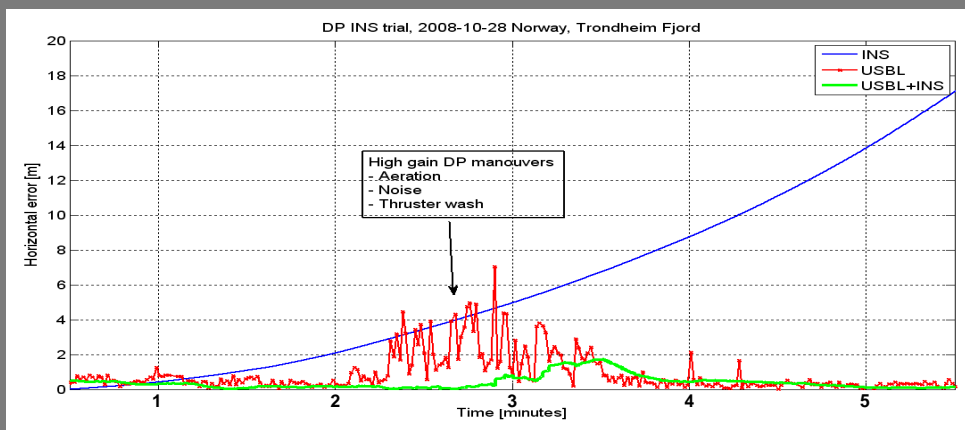
## Acoustic Positioning

- Aeration clouds, masking and increase in acoustic noise level
- Typically short term
- Latest systems largely overcome these problems but drop outs still occur

Complimentary reference needed to address these challenges



High integrity positioning



- INS: Good short term accuracy but long term drift. Inherently self-contained and robust
- Acoustics: Good long term accuracy, some drop outs due to noise and the environment
- DP INS : Accuracy and robustness ++

## Ranger 2: Reducing the operational cost of acoustic reference systems



### Unique “tightly coupled” integration gives market leading performance

#### Lodestar Acoustically Aided INS – AAINS

IMU:  
Inertial Measurement Unit



IMU Data  
100-200Hz  
 $\Delta v, \Delta \theta$

AAINS: Aided INS

INS: Inertial Navigation System

$\Delta v$  ••• Velocity ••• Position •••  
 $\Delta \theta$  ••• Orientation •••

Correction

Kalman Filter (error state)

Tight  
Integration



Acoustic Positioning System



Loose  
Integration



Acoustic INS Position

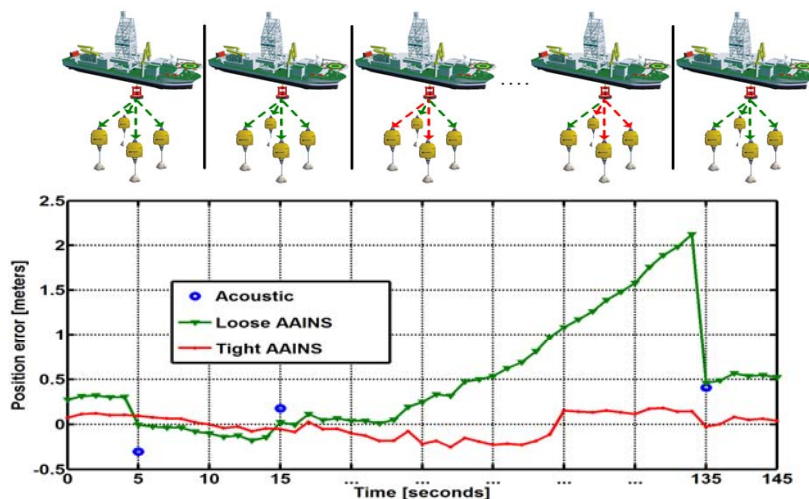


Acoustic Position

## Marksman / Ranger 2: Position, Monitor, Control



### Unique “tightly coupled” integration gives market leading performance



Red arrow in the top most illustrations indicates a failed acoustic measurement.

Optimised for long drilling campaigns

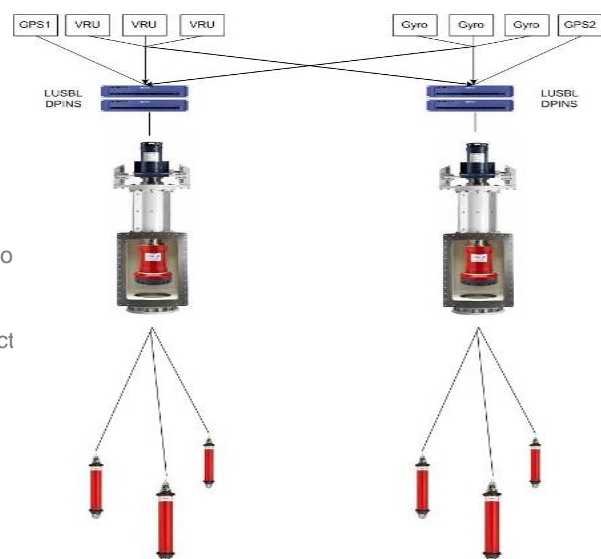


- Dual independent System with DP-INS
- 2 Wideband transceivers (6G)
- 6 seabed transponders (3 per system)

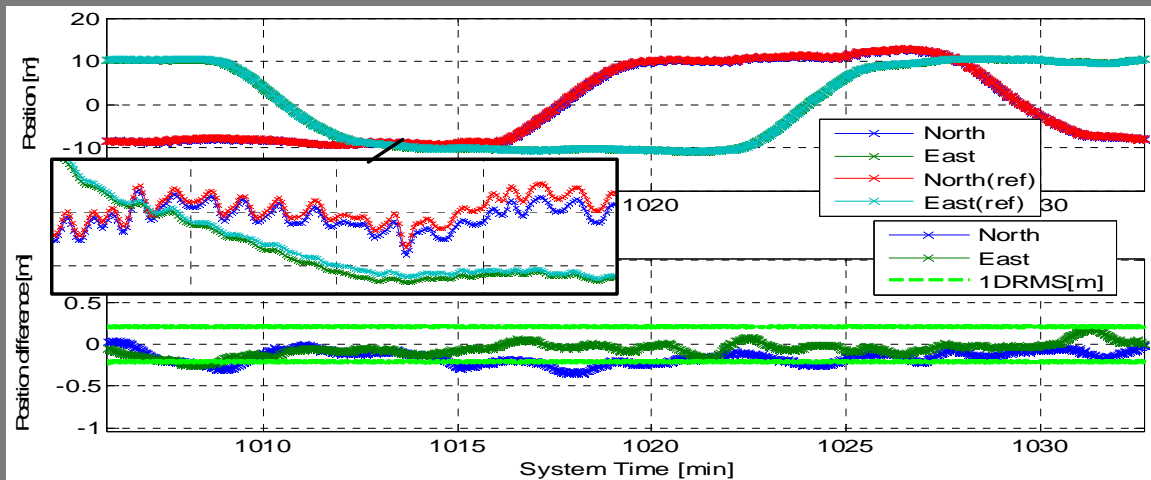
- Acoustic update rate: 12 seconds or 6 month battery life
- Maximum operational efficiency

Vantage Tungsten Explorer

- Operationally efficient due to fewer seabed references
- Robust, independent through water signals
- Accuracy and repeatability equal to GNSS
- Bridges acoustic outages
- 2 independent, 1Hz inputs to the DP
- Dual Tightly coupled INS integration (both poles) is the most robust configuration available
- Shared or separate arrays for flexibility in meeting contract requirements



Unique “tightly coupled” integration gives market leading performance

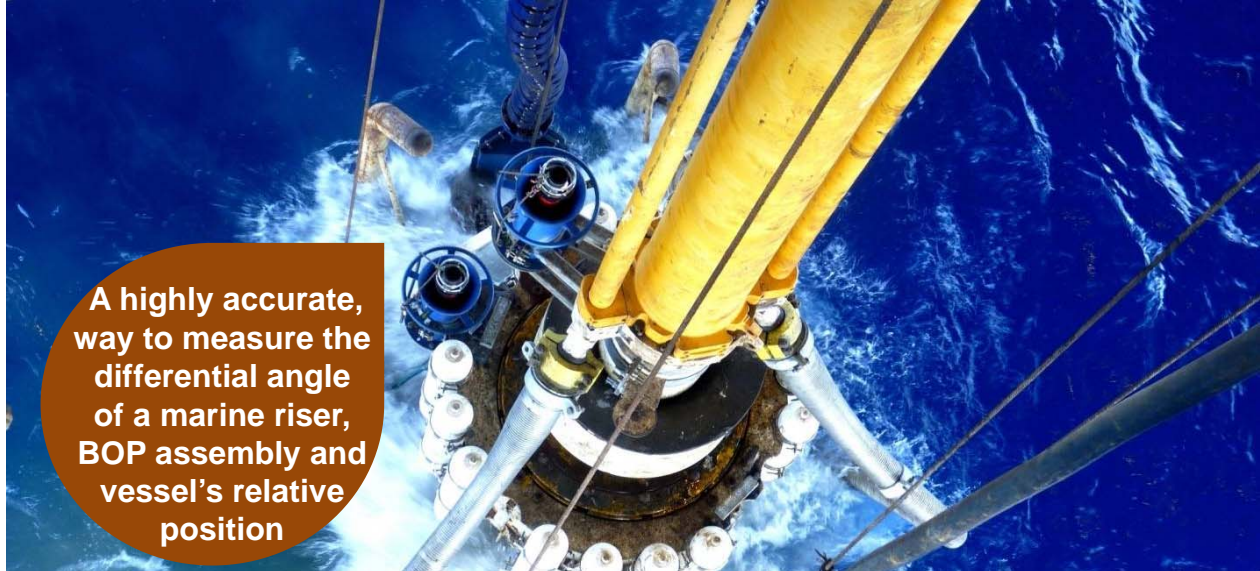


DP-INS offers GNSS levels of performance from 3 transponders in any water depth

Riser monitoring

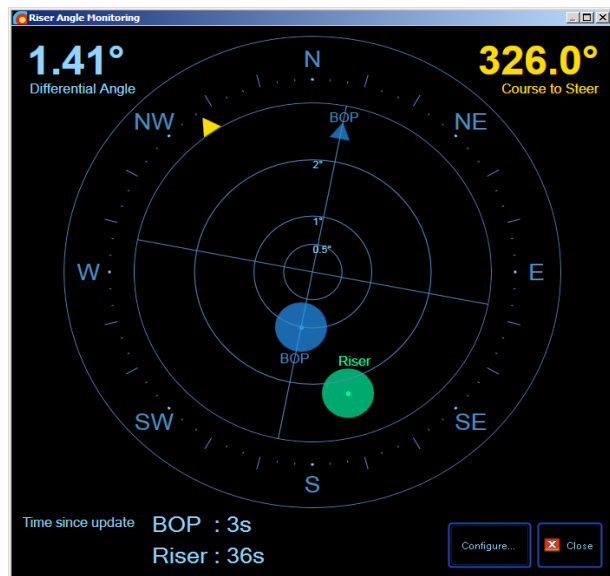
“Seamless integration  
of dynamic positioning  
and riser monitoring”

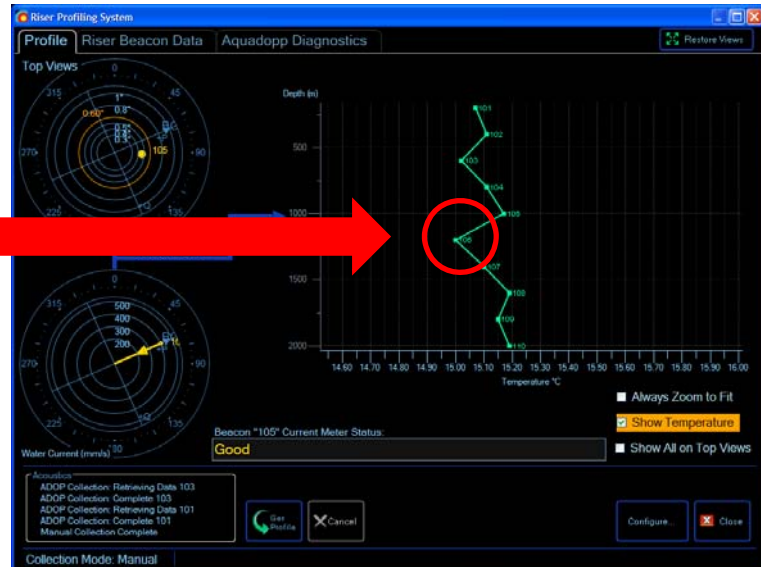
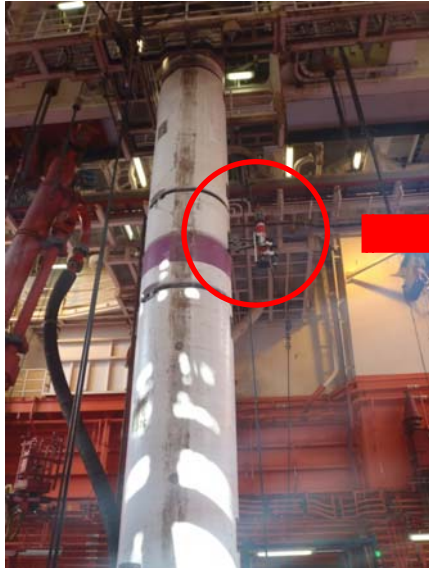




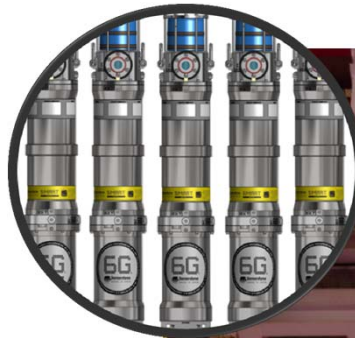
### Key Technology Features

- Provided as standard in Marksman software
- Monitoring and display of the relative attitude of the riser and BOP during drilling operations
- Requires a pair of Inclinator transponders attached to Riser and BOP
- Data collection by pulse position or wideband telemetry, typically slow up date ie 15-30min
- Recommends course to steer to reduce differential angle
- Warnings and alarms are raised when thresholds are crossed.
- Simple to set-up calibrate and operate





- Real-time displays of riser profile
- Inclination, current speed and direction and temperature
- Inclinator transponders, some with current meters, attached along length of riser
- Measurement taken either on demand or automatically at predefined intervals
- Data displayed in topside software
- Supports third party sensor options such as strain gauges and accelerometers
- New "SMART" versions can measure vortex induced vibration



# “Sonardyne: the only acoustics to be proven in a well control incident”



“Sonardyne Compatts in float collars connected by cable to the stab panel”

## Overview

- Telemetry of critical pressure data from the BOP stack to ROV and then back to shore
- 15 critical pressure sensors interfaced
- Analogue to digital conversion of sensor signals conducted in Compatt

## Results

- Delivered very rapidly to allow potential autonomous logging during hurricane
- Acoustic telemetry performed excellently despite being so close to the extreme vent
- First known measurements made under these conditions

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Well containment BOP stack on standby in the Gulf Mexico



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Key Technology Features



**4000<sub>M</sub>**  
DEPTH  
RATING

**API**  
REGULATION  
COMPLIANT

**12**  
CONTROL  
FUNCTIONS

- Emergency back-up system to actuate the closing of hydraulic rams on the BOP Stack
- Dual redundant architecture (batteries and electronics)
- Lithium batteries with 1 year battery life under normal use
- 4000m water depth and manufactured from Duplex Stainless steel.
- Hull-Mounted option using L/USBL transceivers that is fully integrated with Marksman
- Portable option with a Diving Transceiver





Training



Keeping you operational all the time



“Every client has access to unlimited 24/7 support, 365 days a year...”





- **Cost Savings** by reducing transponder deployment, calibration and maintenance time
- Improves positioning **Performance** with GyroUSBL
- **Reliability** with tightly coupled DPINS
- **Flexibility** to tailor vessel configurations to YOUR operational needs
- Global **24/7 Support** and expert advice