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6G 2 Sonardyne Wideband®

Dynamic Positioning Inertial Navigation System
A Paradigm Shift

Mark Carter
Business Development Manager : Inertial

Petrobras P23

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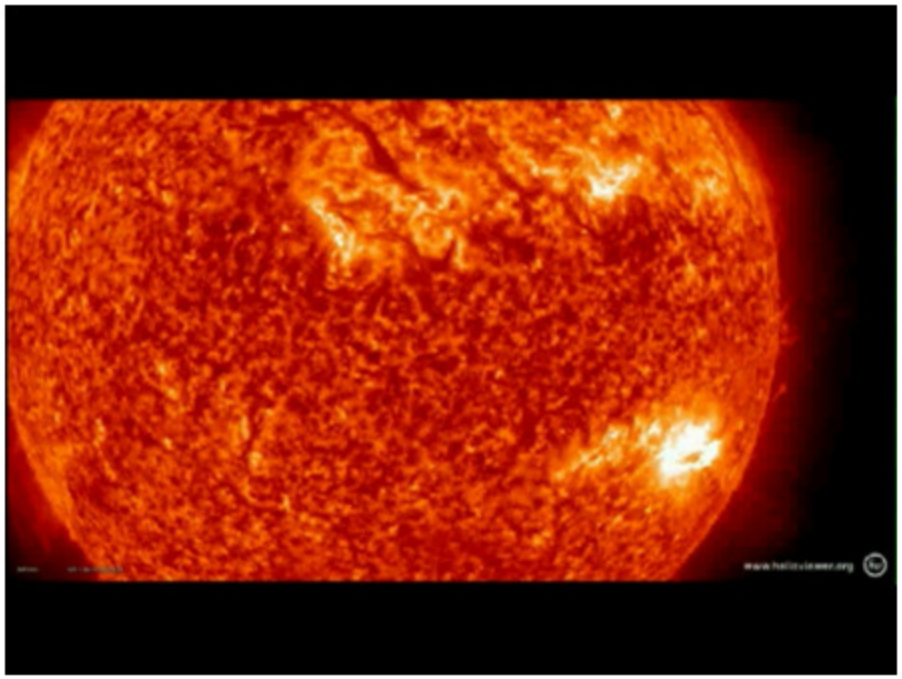
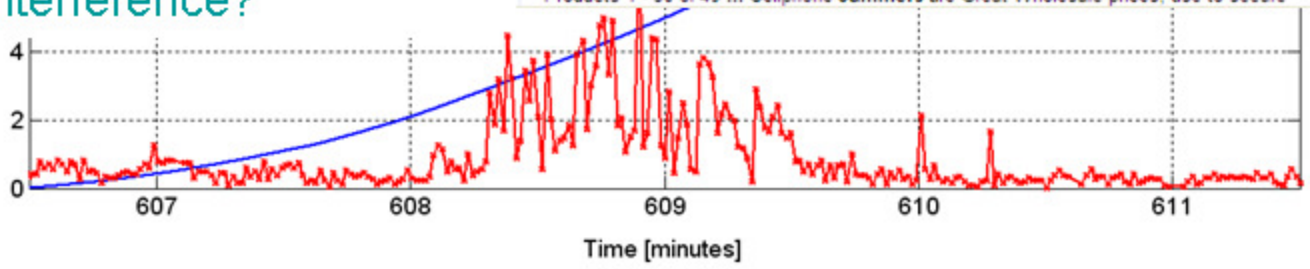
6G 2 Sonardyne Wideband



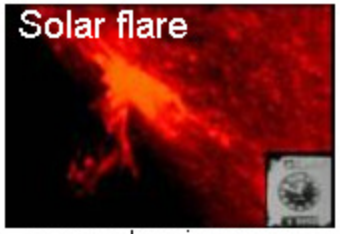
Are your DP operations resilient to positioning system interference?



Agenda

1. Positioning Challenges
2. DP INS : Principle of operation
3. Vessel Installation
4. Results – Brazil
5. Results – Gulf of Mexico
6. Summary

Positioning challenges
- Why look at INS for DP?



www.solarscience.com

DGPS

- Sunspot activity / scintillation
  - GPS can be lost for ***long periods of time***

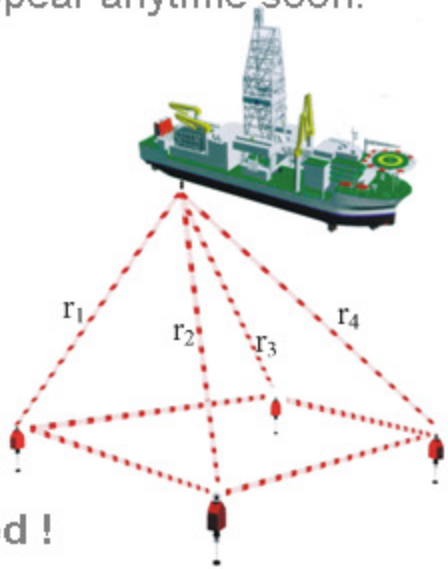
- Weak signals 10^{-16} watt/m2 ~ 40Watt light bulb @ 10.000 mile distance
  - A simple 1 watt jammer may destroy commercial GPS in a 100km radius
  - Unintentional jamming by faulty electronics has been seen.

- 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***.

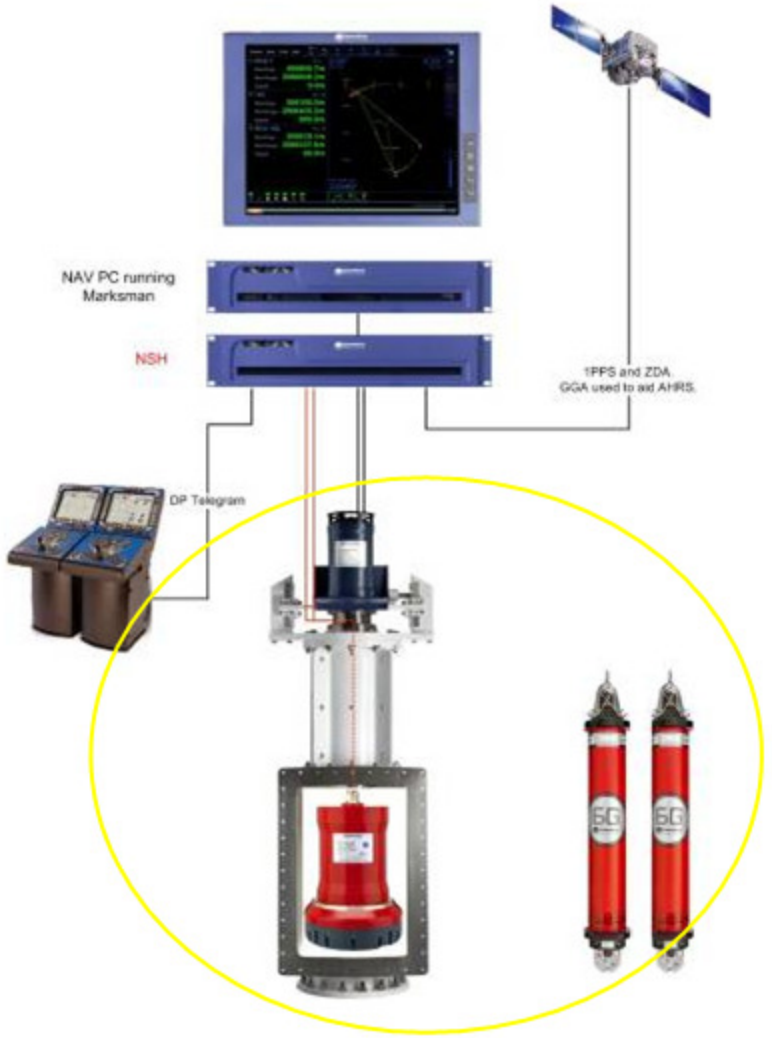
- LUSBL systems largely overcome these problems *through redundancy* but drop outs can still occur.



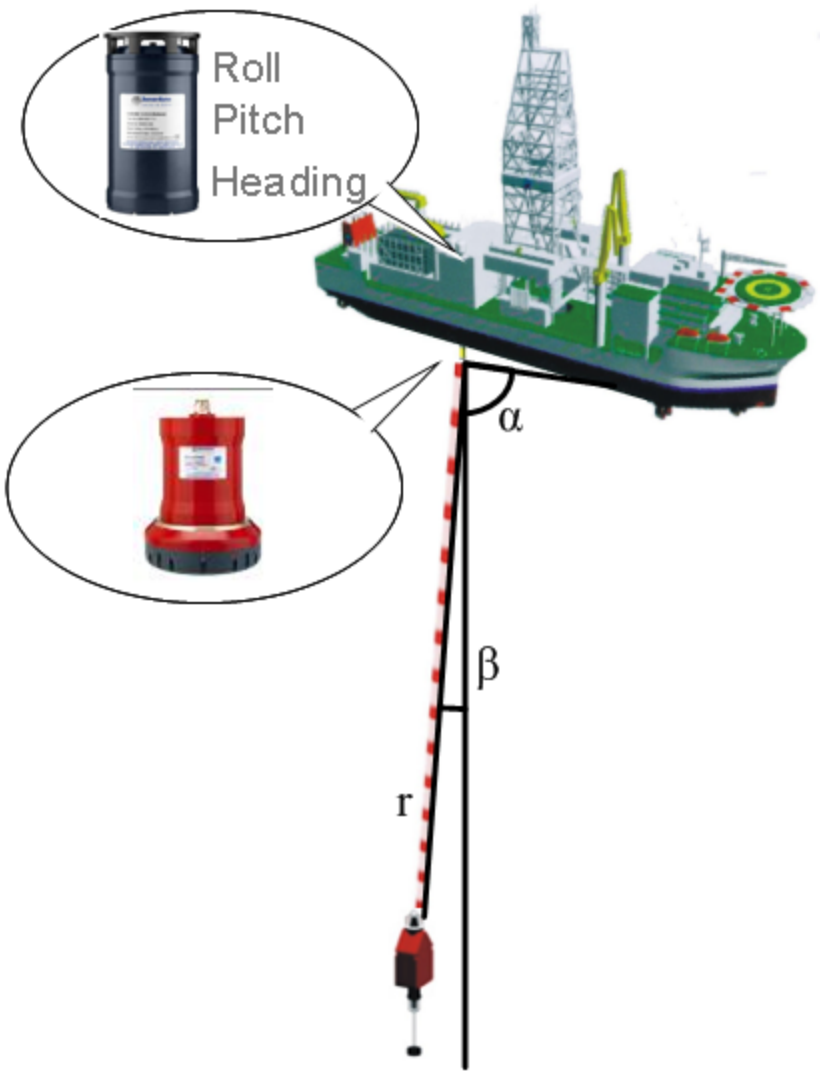
=> New reference type with "complimentary" characteristics needed !

The Solution : Acoustically Aided Inertial Navigation System

- Independent : Mitigates GNSS interference risks
- High availability : Bridges acoustic outages
- Robust : high update rate increases DP system integrity
- Precise : Three times more precise than standard USBL
- Fast : Only 1 seabed reference needed



Principle of operation : USBL (6G acoustic aiding)



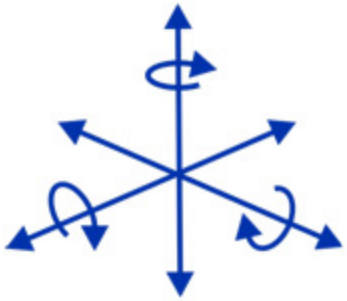
- Positioning is based on measuring range and bearing from an acoustic transceiver to a seabed transponder and combining with attitude/heading
- Improved USBL precision and robustness utilising Wideband 2 ranging and telemetry
- Enhanced USBL array designs for improved noisy vessel and deepwater performance
- Richer quality metrics for improved INS integration
- Acoustic update rate 3-4 sec in 2000m depth

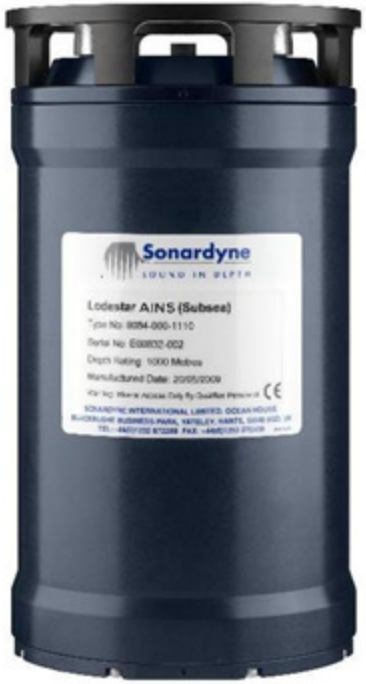
Principle of operation : Inertial navigation

Inertial navigation

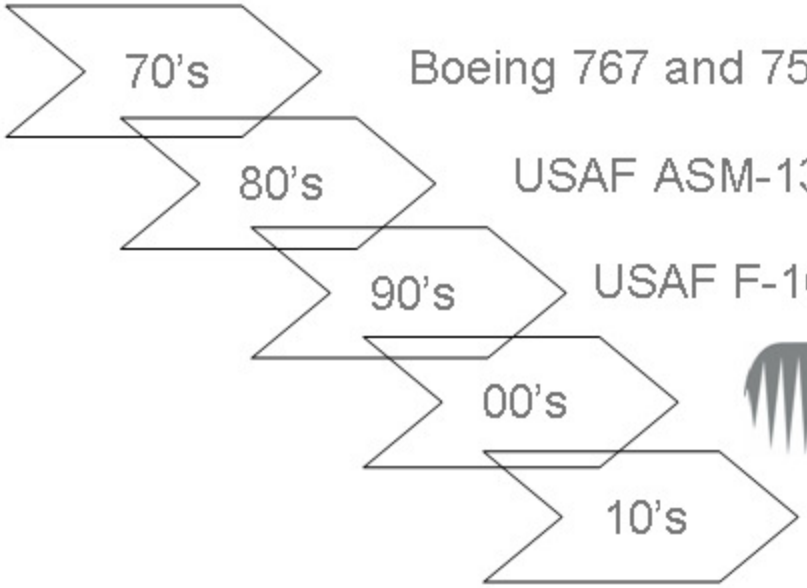
- Inertial Navigation involves determining a position through dead reckoning.
- An INS calculates position, velocity and attitude changes using gyros and accelerometers
- It is completely self contained and therefore ***inherently robust***
  - *Earth gravity and rotation is not easily disturbed!*
- Continuous output with ***very good short term accuracy***
- But drifts with time…

⇒ ***Complementary to acoustic positioning***





Principle of operation : Sonardyne Inertial



Boeing 767 and 757 aircraft

USAF ASM-135

USAF F-16 Fighting Falcon

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Navy F/A-18 fighter-bomber

- Exploit 40 years of Honeywell expertise developing gyros
- Most proven sensors available
- 400,000 hr MTBF
- Highest performing sensors that are easy to export (relatively)

Principle of operation : Sonardyne Inertial

Assembly

- Triad of gyros and accelerometers
- Power and Processing

Environmental ✓

- Temperature
- Vibration
- EMC

Performance ✓

- Bias calibration
- Scale factor calibration
- Heading repeatability
- Settling time

CERTIFICATE OF TYPE APPROVAL
(EC Certificate of Type Examination - Module B)
(Marine Equipment Directive - 96/98/EC, as amended*1)

NOTIFIED BODY No 0155

Applicant:-
Sonardyne International Ltd
Ocean House
Blackbush Business Park
Yateley, Hampshire
GU46 6GD United Kingdom

Manufacturer:-
Sonardyne International Ltd
Ocean House
Blackbush Business Park
Yateley, Hampshire
GU46 6GD United Kingdom

This is to certify that the applicant has submitted details of a:-

MARINE GYRO-COMPASS EQUIPMENT
(COMMISSION DIRECTIVE 2009/26/EC– ITEM A.1/4.3)

Of system type known and designated as:-

Lodestar - Type no 8084-000-xxxx

(Comprising component parts and having technical characteristics shown in schedules 1 & 2)

and that this has been tested and assessed, and is CERTIFIED as complying with:

ISO 8728:1997,	"Marine Gyro-Compasses"
IEC 60945:2002	"General Requirements for Marine Navigation Equipment"
IEC 62288:2008	"Presentation of navigation-related information on shipborne navigational displays

(being testing standards listed in column 5 of Annex A.1 of Directive 2009/26/EC for item 4.3)

Note: IEC 62288:2008 covers the presentation standard of all navigational equipment and appropriate assessm for this Gyro-compass has confirmed minimum standards required for IMO Resolution MSC.191 [79].

It is also RECOGNISED that the equipment conforms to performance standards not inferior to those adopted by the International Maritime Organisation, and which are contained in Resolution A424(XI), Resolution MSC.191(79) and Resolution A694(17).

SIGNED: P J Goddard — Authorised Signatory, for and on behalf of QinetiQ Ltd

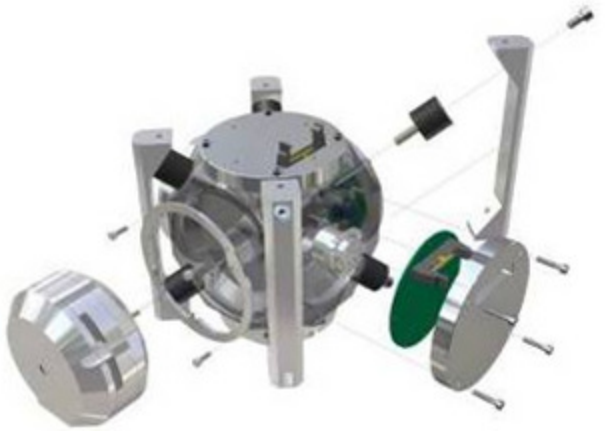
DATE of ISSUE: 20th August 2010
DATE of EXPIRY: 11th August 2013
Certificate Number: QQ-MED-15/08-02

EU/USCG Mutual Recognition Agreement Council Decision 2004/425/EC
USCG Approval Number: 165.103/EC0191/1508-02

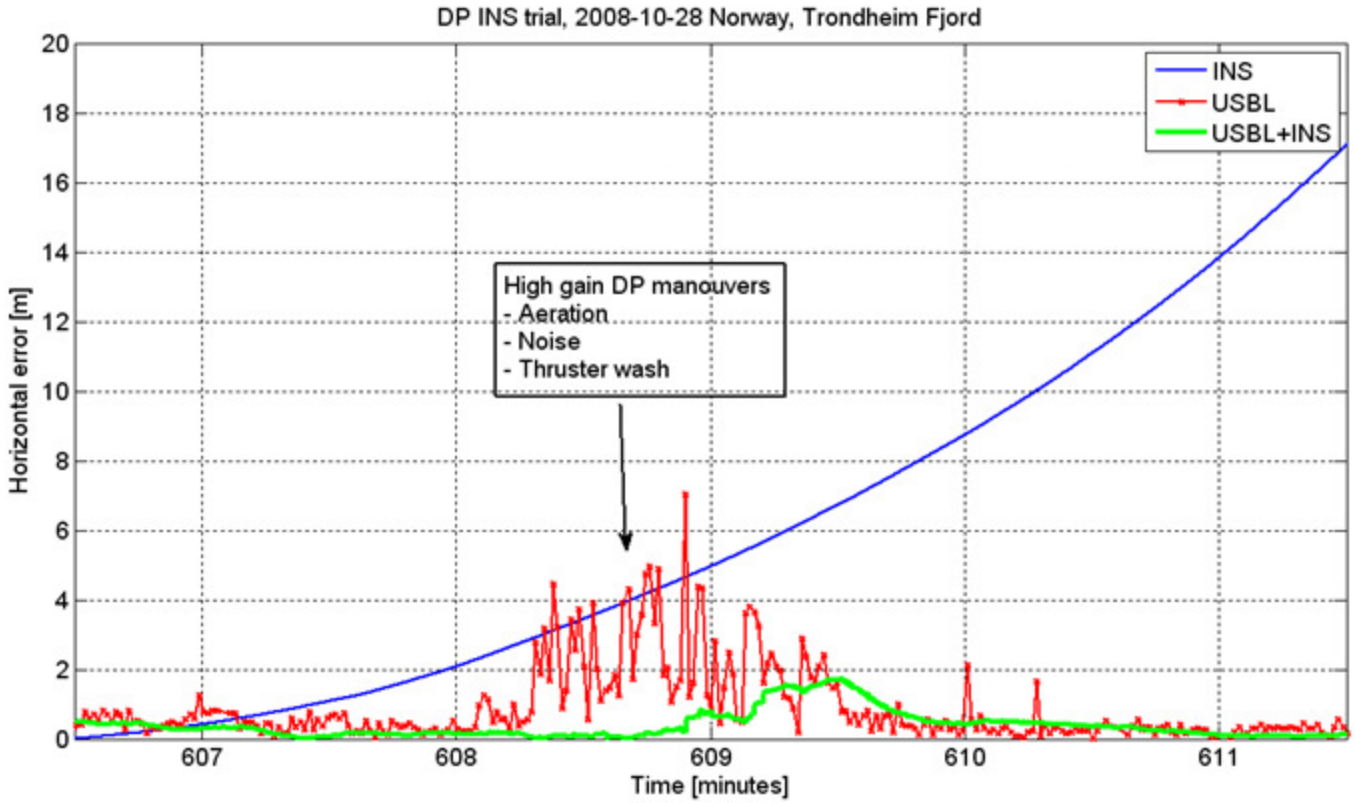
This Certificate is Valid until expiry date shown, subject to the standard conditions of issue printed on the attached schedule Sonardyne International Ltd are Module D registered with QinetiQ in accord with standard condition 3, ref Certificates DQAS-23/08-SO1001.

QinetiQ
Cody Technology Park
Ively Road, Farnborough
Hampshire, GU14 0LX

mca
Maritime and Coastguard Agency
This MCA is an Executive Agency of the Department for Transport



DP INS : Complementary characteristics



INS: Good short term accuracy but long term drift
Inherently self-contained and robust

Acoustics: Good long term accuracy, some risk of drop outs due to noise and the environment.

DP INS : Accuracy and robustness ++

Principle of operation : Sonardyne Inertial

Proven sensors → Flexible deployment → Reconfigurable systems

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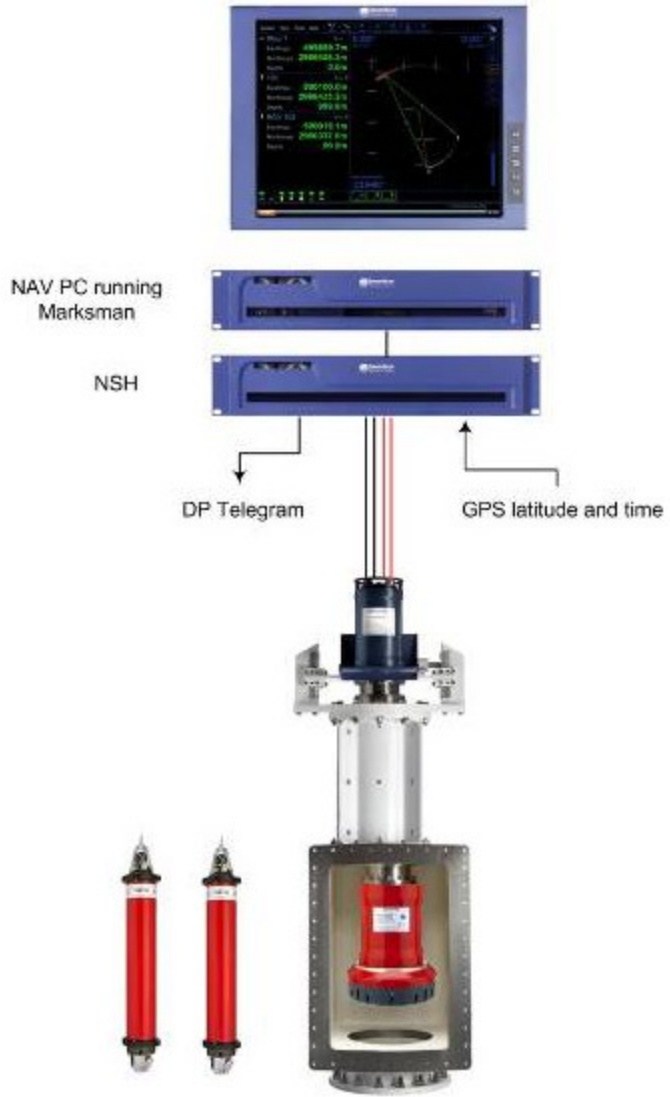
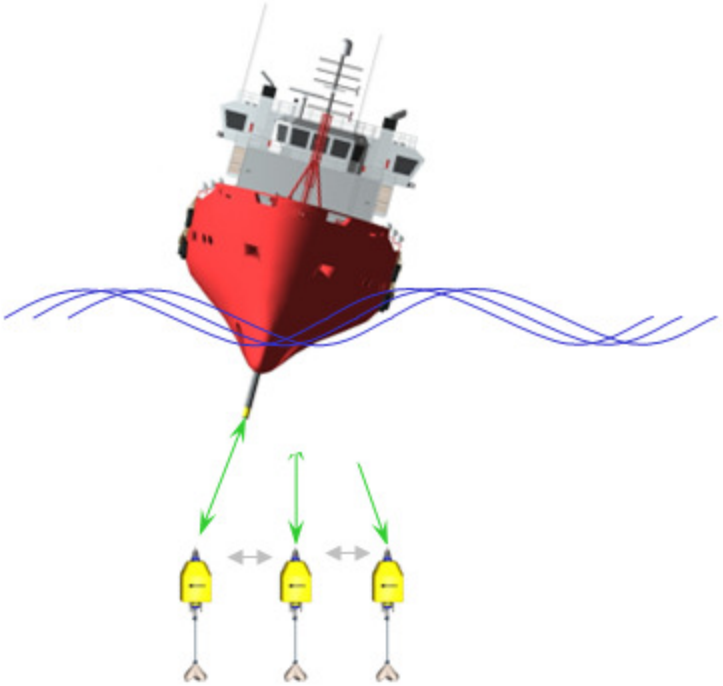
DP INS system configuration



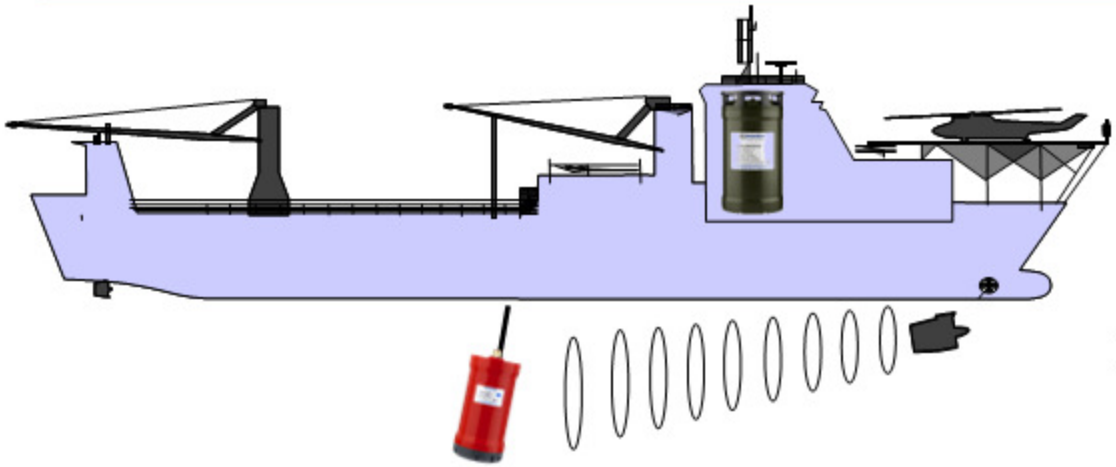
- Navigation sensor hub allows seamless integration with Marksman
- 1xCAT6 used for acoustic transceiver comms. Copper pair used to power Tcvr
- 1xCAT6 used for INS comms. Copper pair used to power Lodestar
- GPS for timing and latitude aiding only
- Output Telegram to Converteam, L3, MT, Kongsberg and other DP systems

INS installation

- Improvements in acoustic signals, signal processing and transceiver hardware means that mechanical stability is becoming a dominant contributor to system level error.

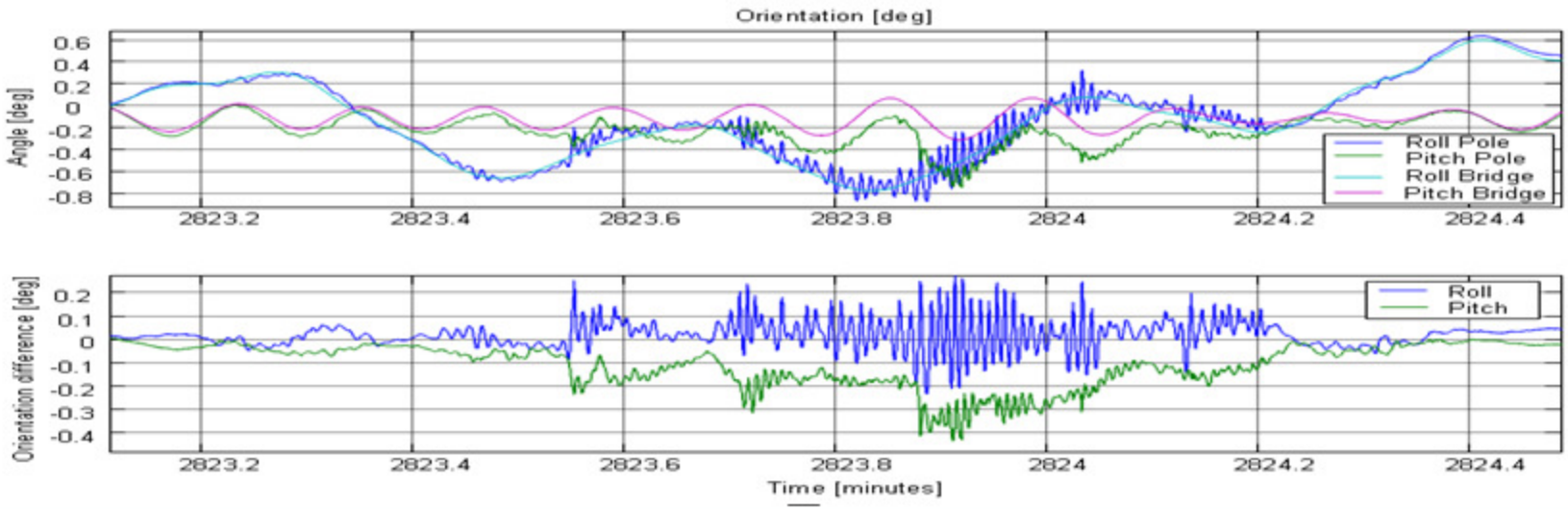


INS Installation

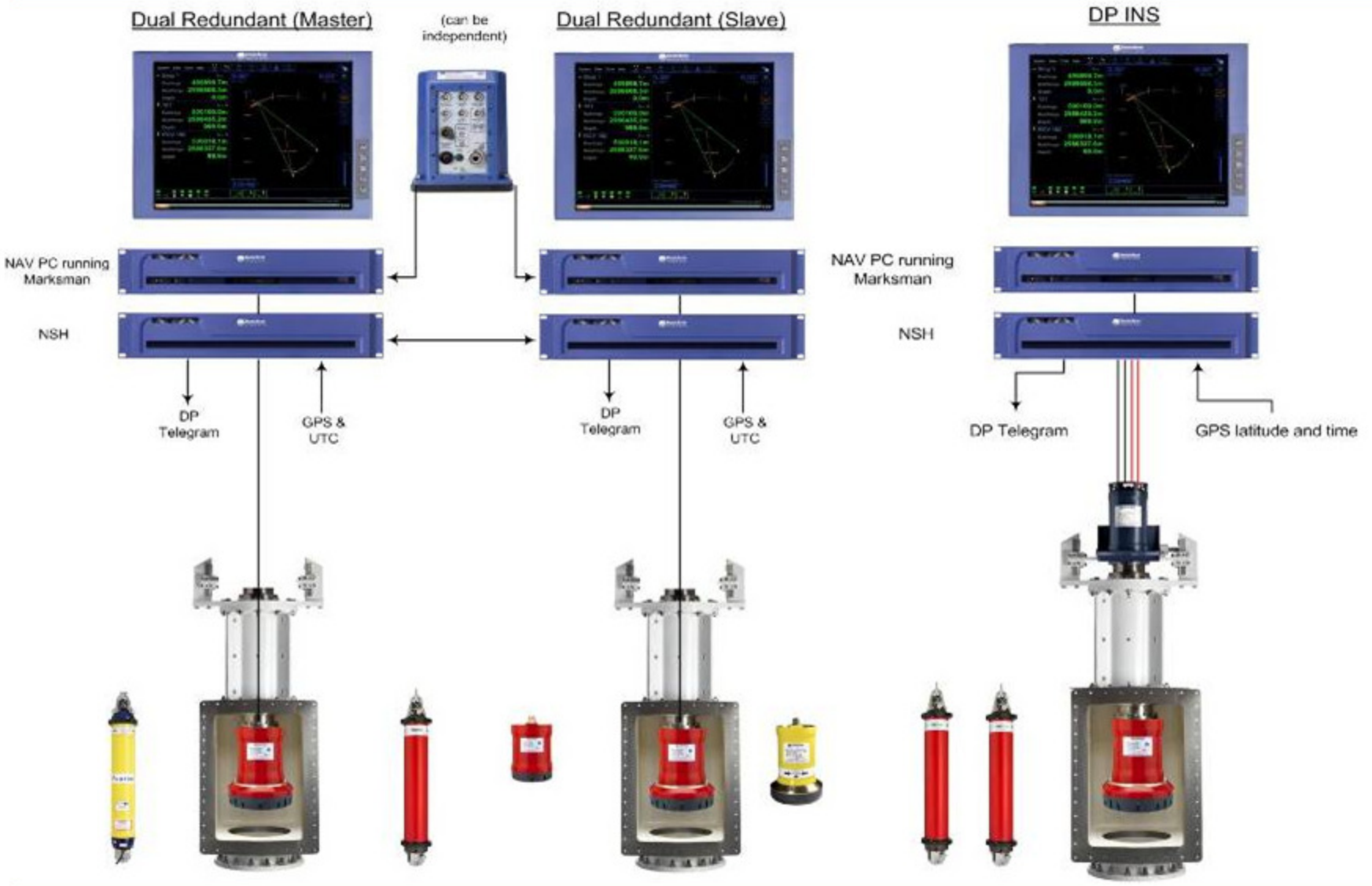


Pole resonates at 2Hz approx

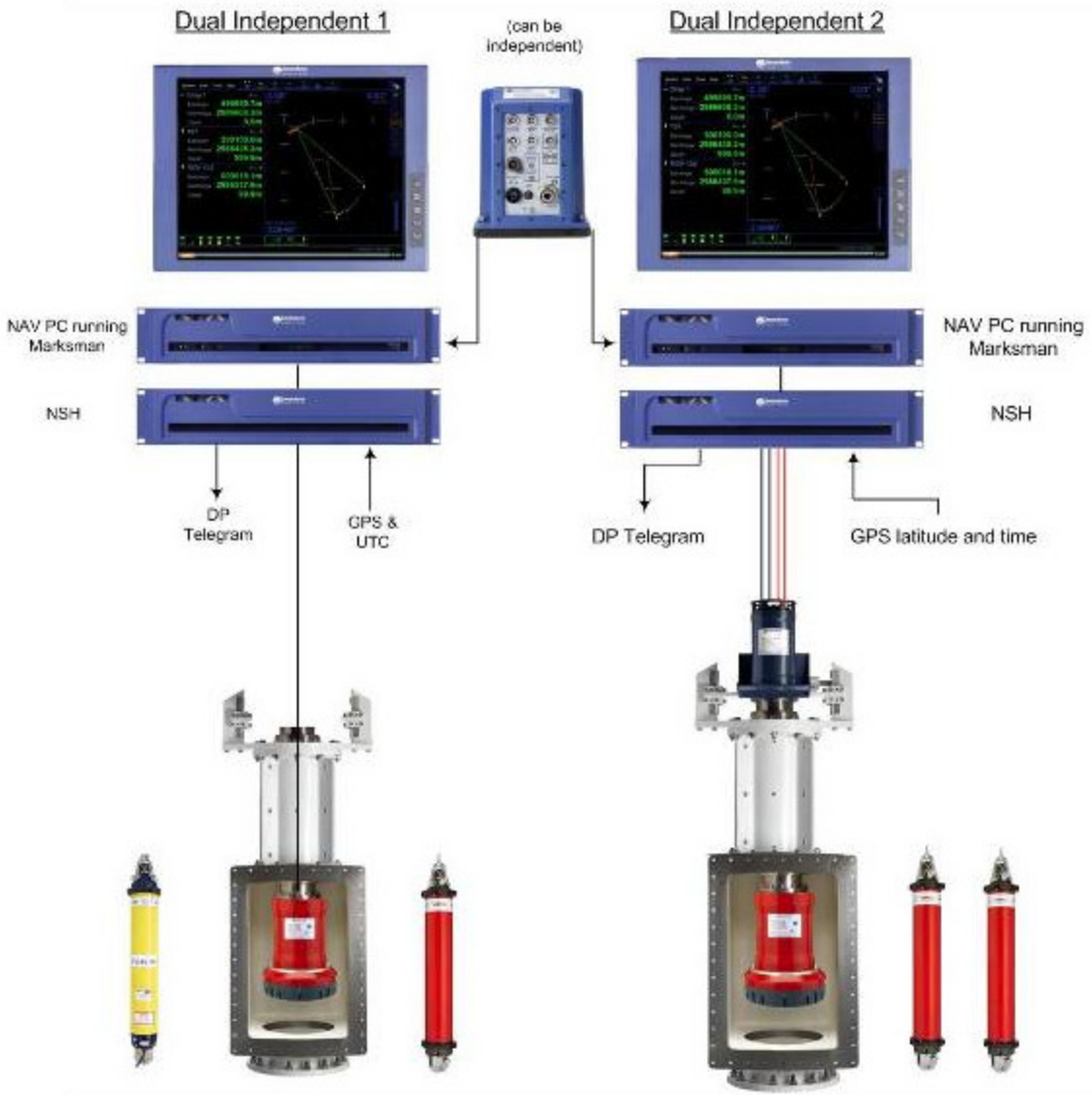
Up to 0.3 degree pitch bias directly affects position accuracy



Integrity – 3 system vessel



Integrity – 2 system vessel



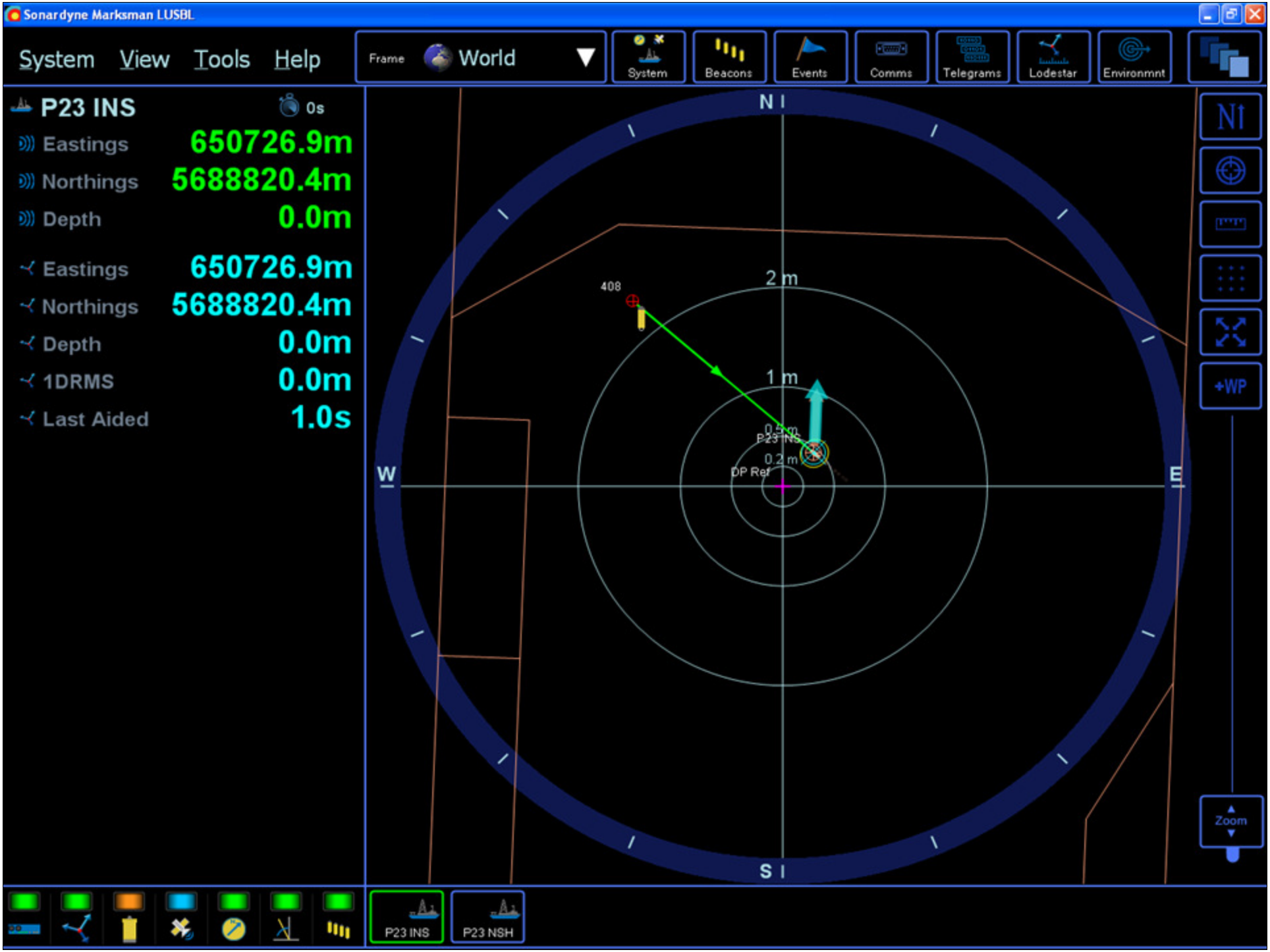
- Low risk configuration
- DP INS system computes INS and L/USBL solutions
- Reverts back to L/USBL if inertial data fails integrity checks.
- Single DP telegram

Integrity : Integration into DP desk

	Position only (flexible)	INS message (recommended)
Header	✓	✓
HHMMSS.ss,	✓	✓
Target ID.		✓
Status:		✓
Quality Indicator	✓	✓
Position	✓	✓
Position error	✓	✓
Depth	✓	✓
Speed		✓
Speed error		✓
Pitch	✓	✓
Roll	✓	✓
Heading	✓	✓
Heading Accuracy		✓
Aiding		✓

Flags degraded data / full accuracy data based on inertial QC

USBL / LUSBL / GPS / Unaided


Sonardyne Marksman LUSBL
System View Tools Help
Frame World
System
Beacons
Events
Comms
Telegrams
Lodestar
Environmnt
P23 INS
0s
Eastings 650726.9m
Northings 5688820.4m
Depth 0.0m
Eastings 650726.9m
Northings 5688820.4m
Depth 0.0m
1DRMS 0.0m
Last Aided 1.0s
N
2 m
1 m
0.5 m
0.2 m
W
E
S
408
P23 INS
DP Ref
+WP
Zoom
P23 INS
P23 NSH

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DP INS – Proven in Brazil

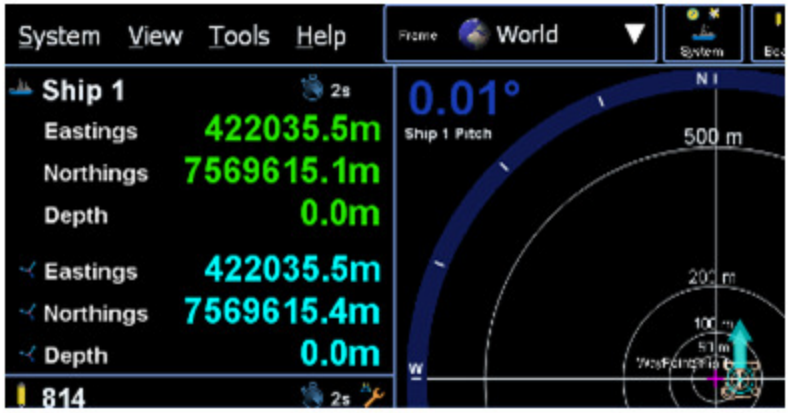
Petrobras P23, Roncador field, Feb 2010

Setup:

- Dual independent Wideband LUSBL
- Sonardyne deployment machine
- One system upgraded to DP INS
- DP from 1 or 2 Life of Field transponders (single reference transponder + wet spare)

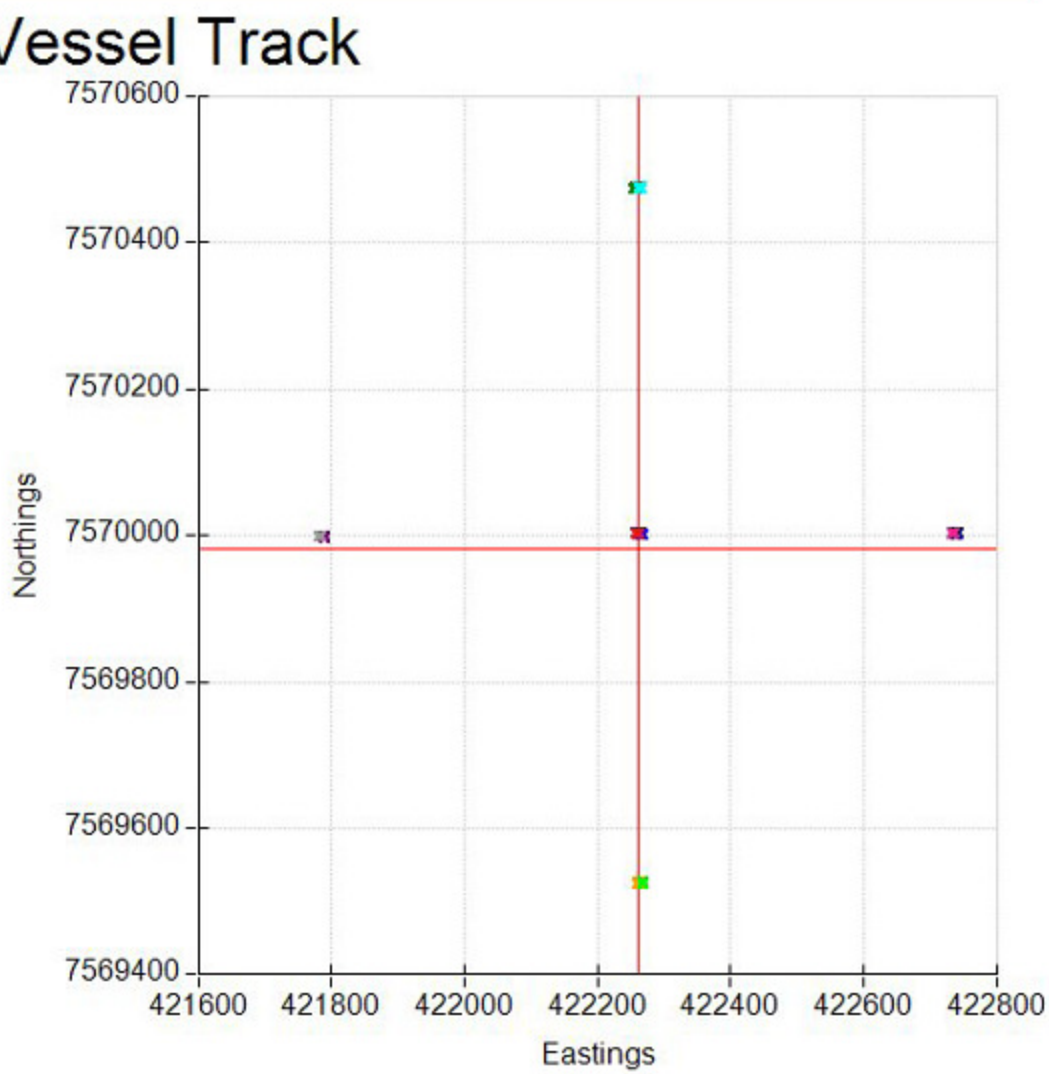
Customer Benefit:

- Scintillation risk mitigated
- Bridged acoustic outages
- 1 – 5 Hz update, high integrity input to DP
- Reduced number of seabed references
- System accepted as independent PME

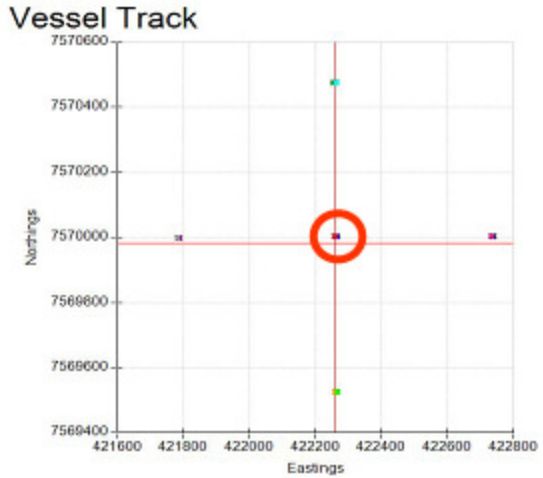


DP INS – Used during drilling operations

Petrobras P23, Roncador field, Feb 2010

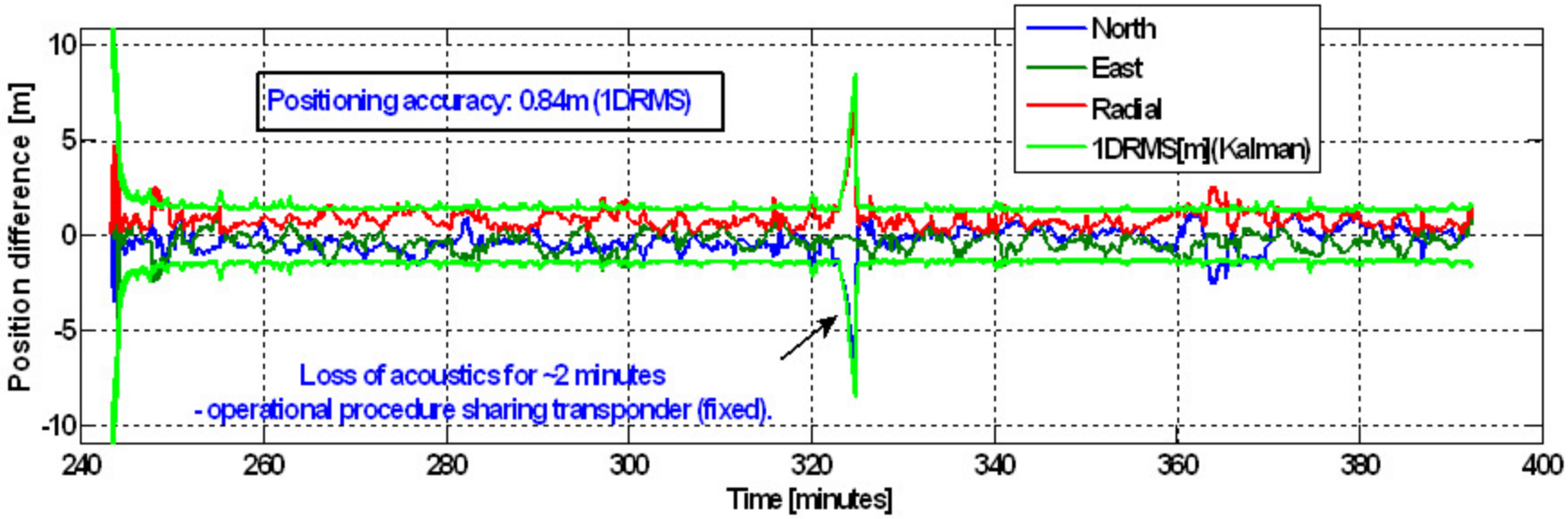


DP INS – Independent from GPS

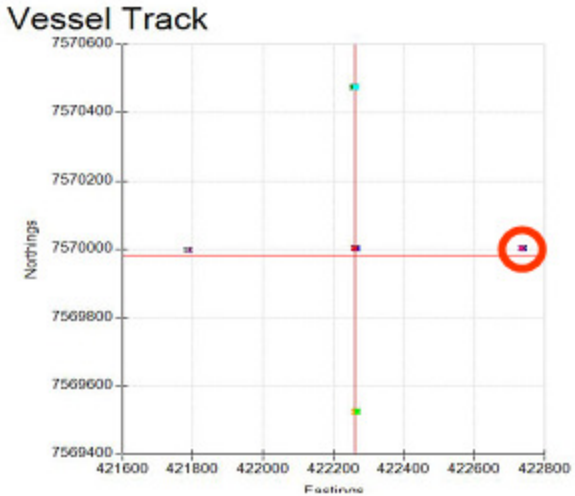


Test 1 Performance:

- 0.84m 1DRMS wrt a decimetric DGPS system
- Equates to 0.05% water depth (1800m)
- Single seabed transponder

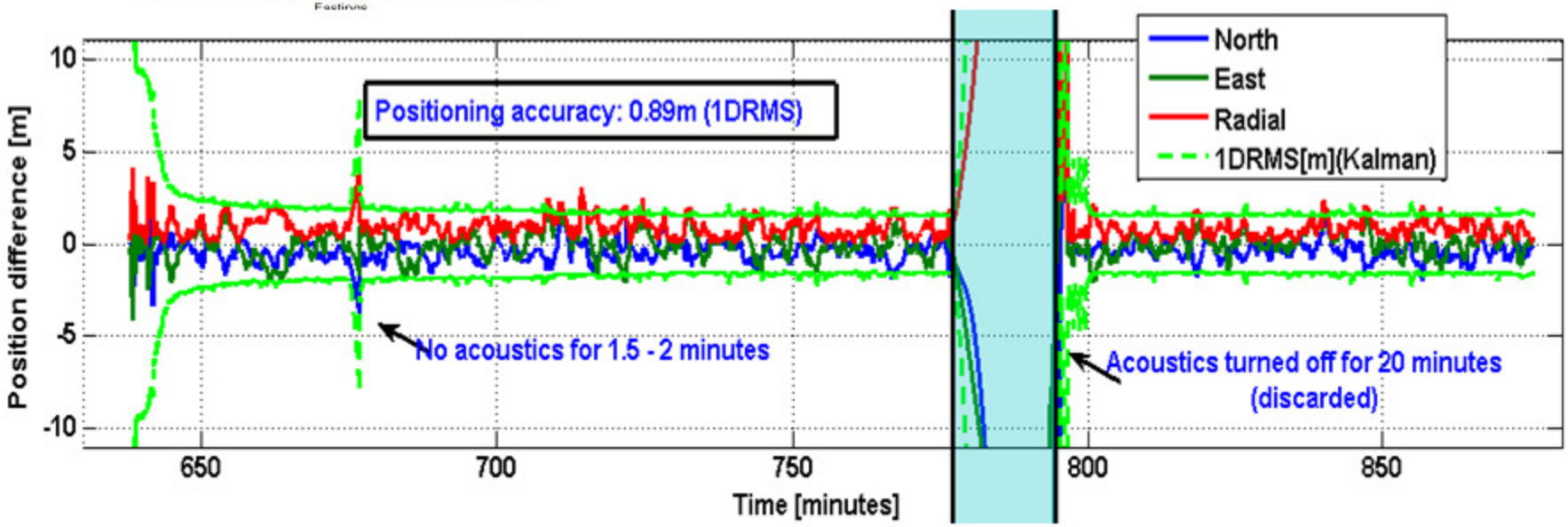


DP INS – Bridges acoustic outages

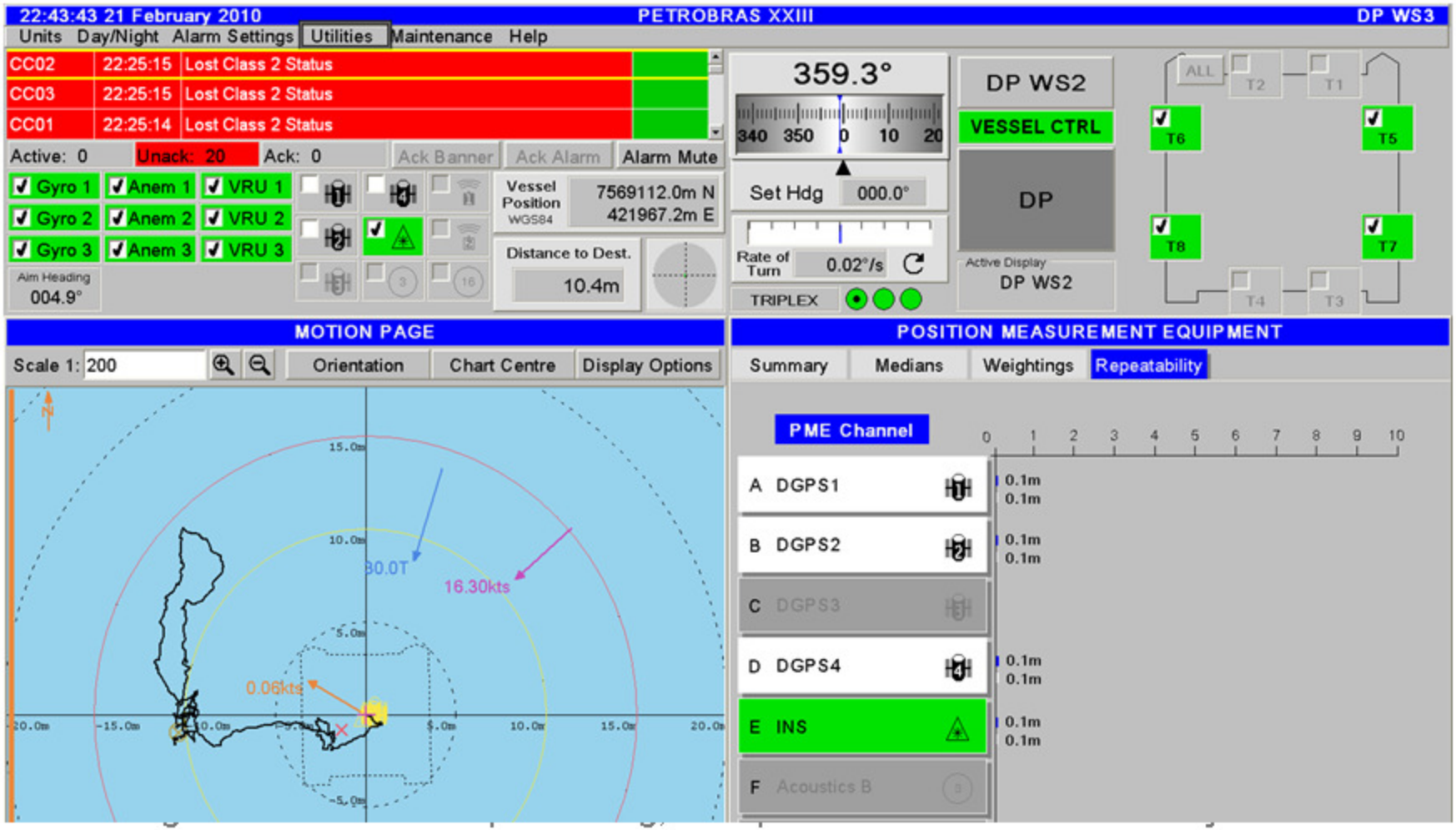


Test 2 Performance:

- 0.89m 1DRMS wrt a decimetric DGPS system
- Equates to 0.05% water depth (1800m)
- Single seabed transponder



DP INS – Improves DP integrity



- 10m fwd/aft and stbd/port position change with good control using standalone DP INS.
- Accuracy and repeatability is comparable to DGPS and same weighting can be used.

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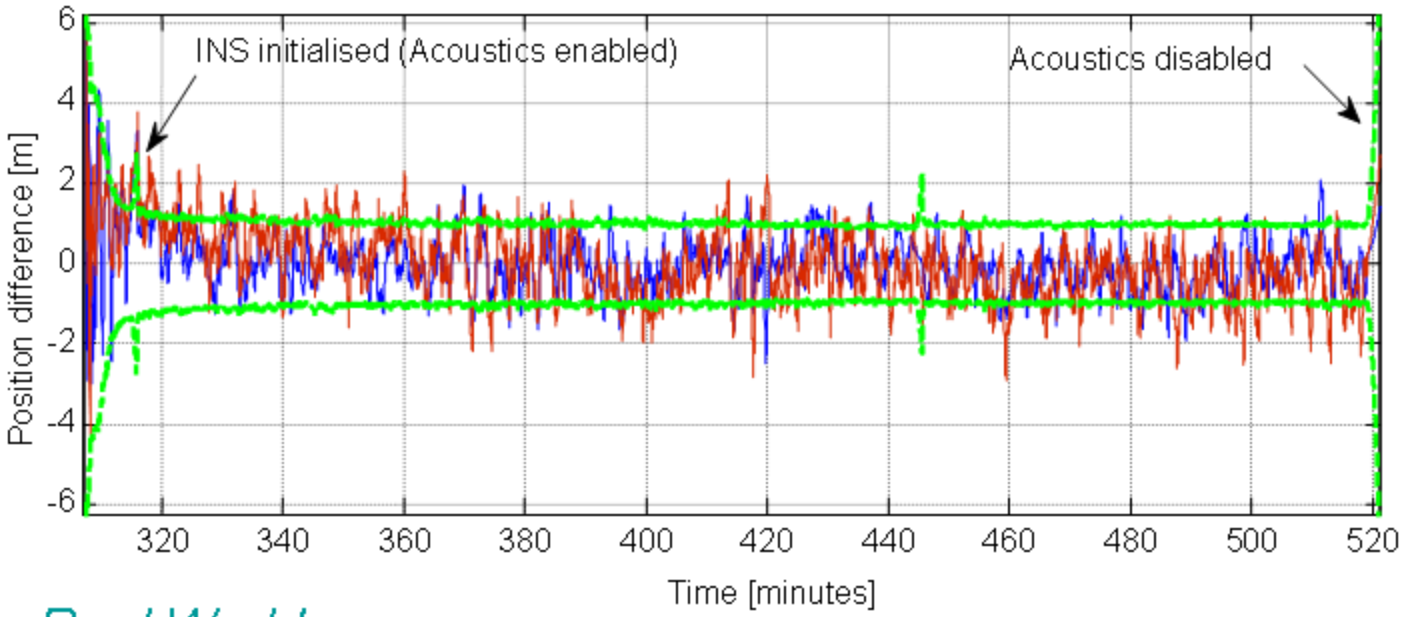
DP INS – Proven in Gulf of Mexico – 1650m



North
East
1DRMS

1DRMS = 0.93m
(Relative Veripos ULTRA DGPS)

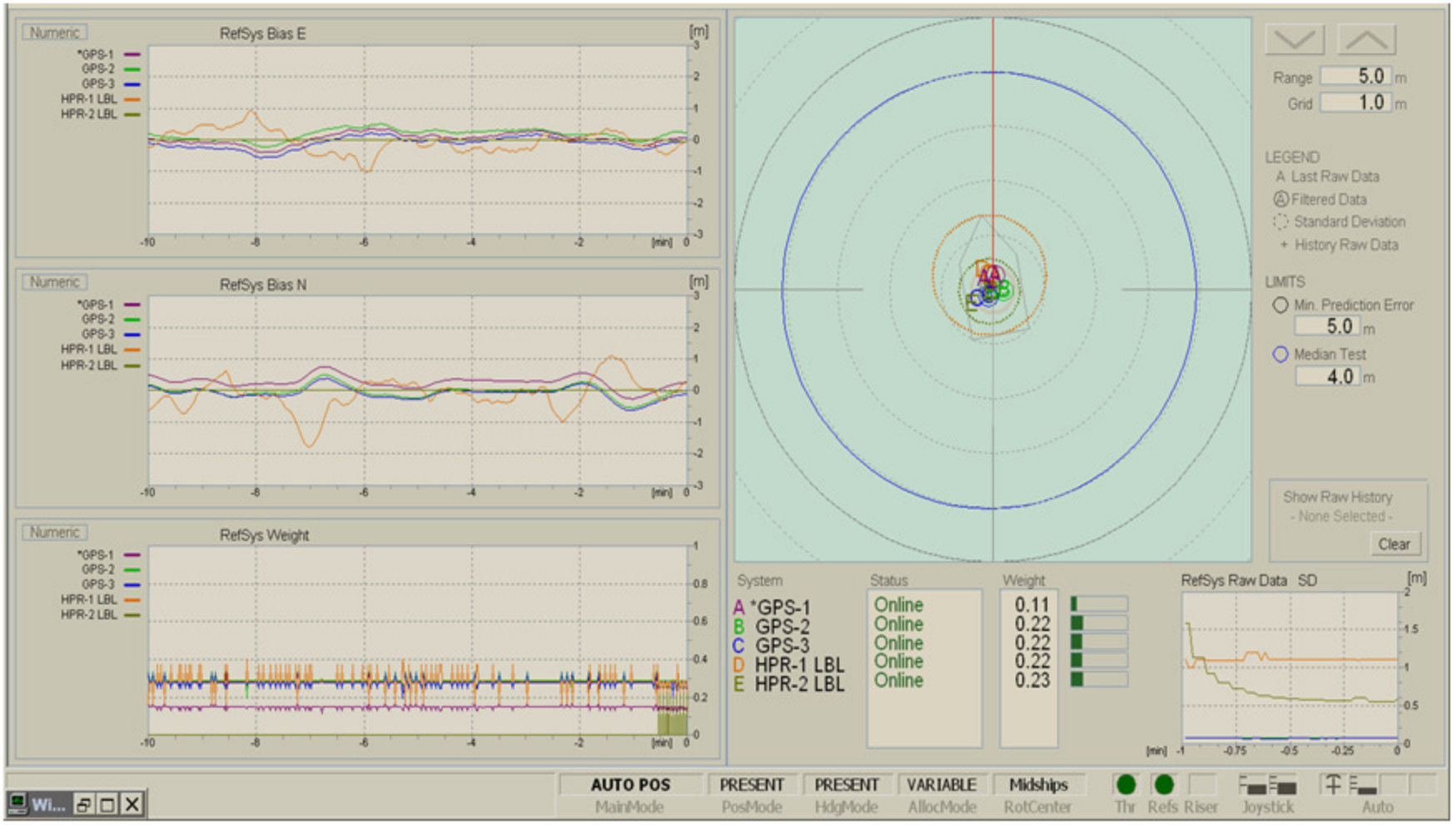
Real World Performance.....

System	Precision (1DRMS)	Update rate
USBL	0.13 - 0.27% depth	1 per 5 / 6 seconds
DP-INS (acoustically aided)*	0.05 - 0.1% depth	1 to 5Hz
DGPS	0.1m – 0.5m	1Hz

* Single transponder used

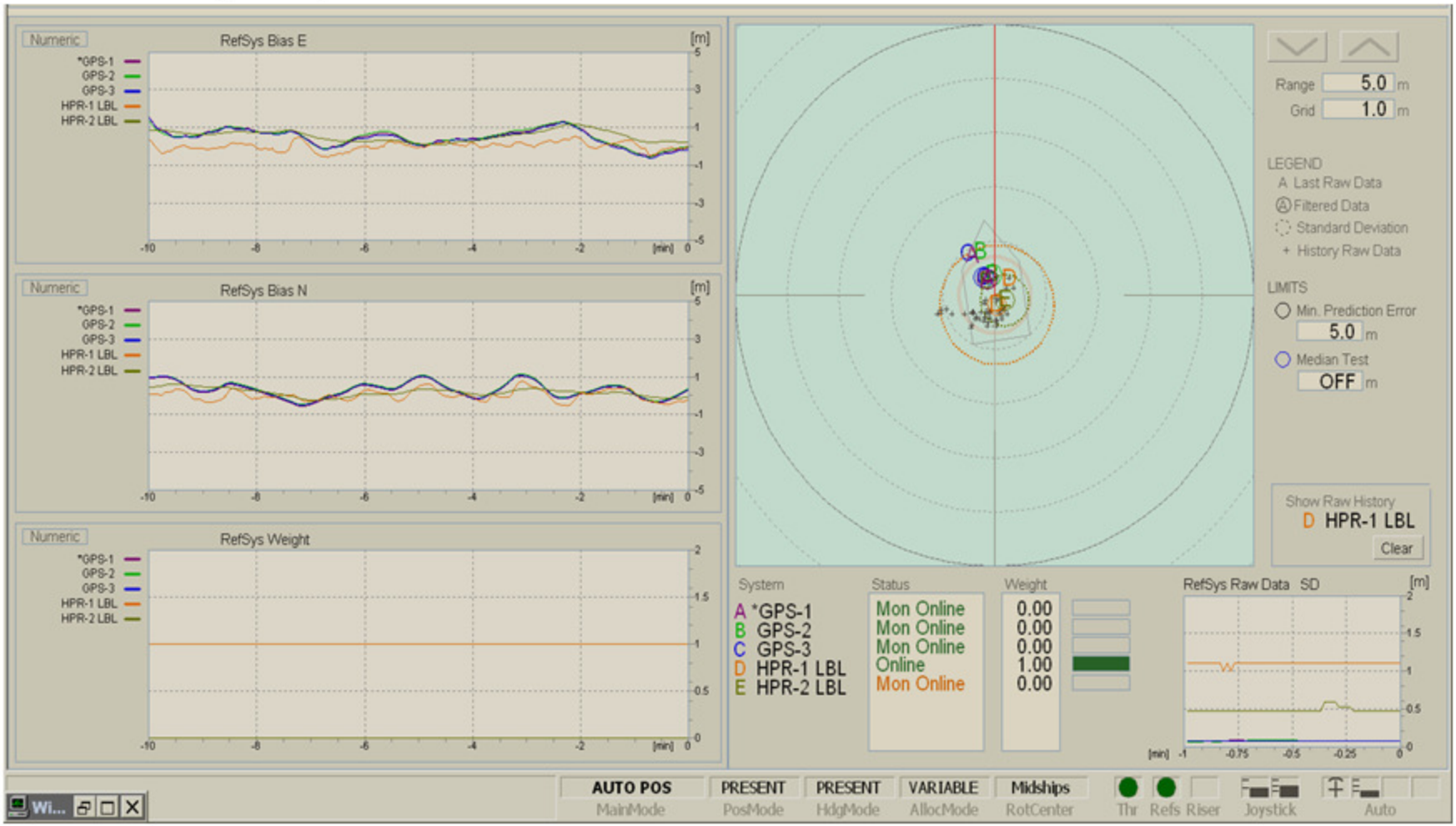
DP INS – Improves DP integrity

DP-INS (HPR-1 LBL) given equal weighting in DP desk to GPS.

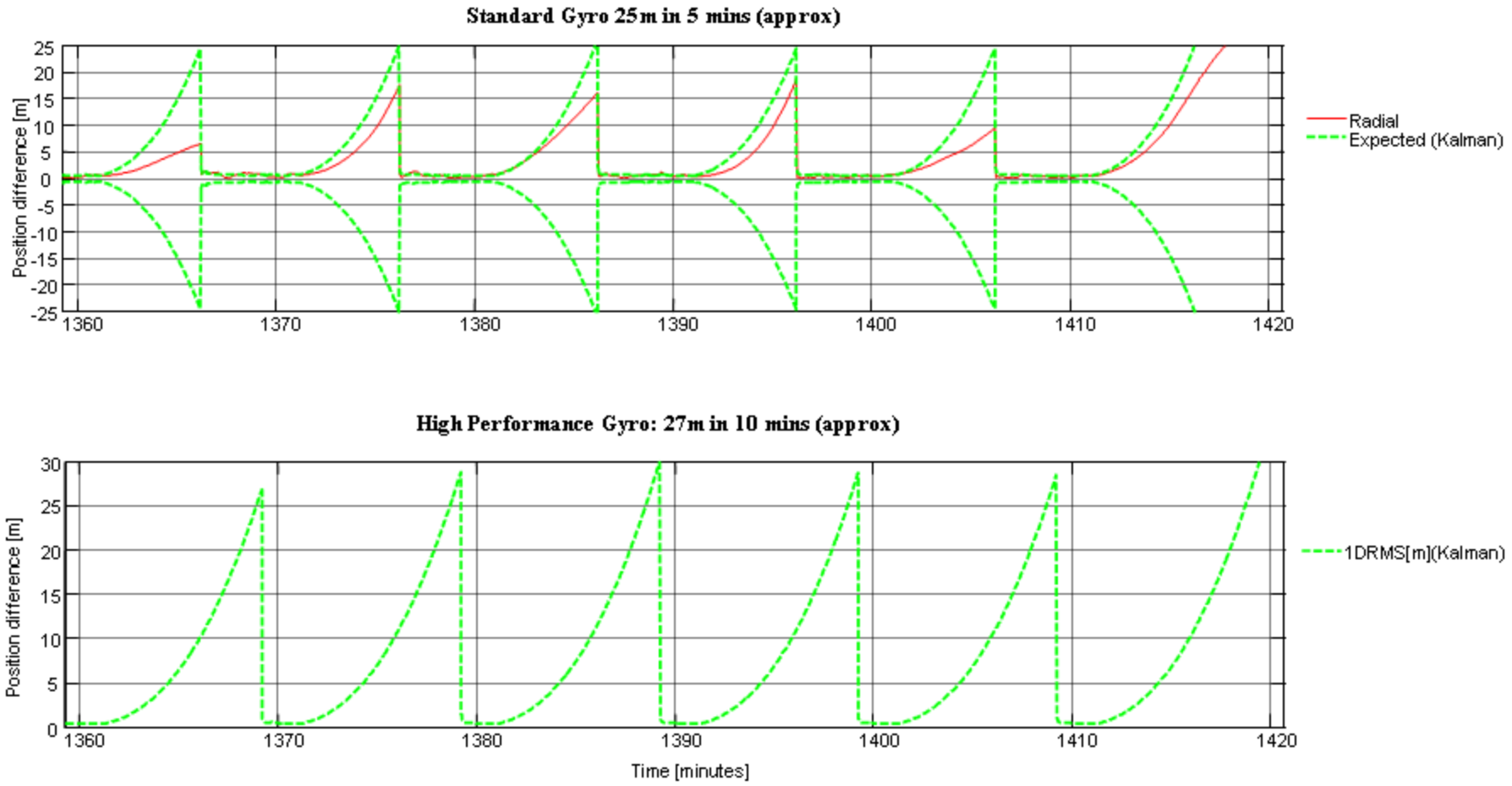


DP INS – Independent from GPS

2 Independent PMEs station keeping during simulated GPS outage : DP INS (HPR1) and LUSBL (HPR2)



Typical free inertial performance after complete loss of aiding



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Conclusion

- Independent : Mitigates GNSS interference risks
- High availability : Bridges acoustic outages
- Robust : high update rate increases DP system integrity
- Precise : Three times more precise than standard USBL
- Fast : Only 1 seabed reference needed

Are your DP operations resilient to positioning system interference?

Yes, with DP-INS

Sonardyne
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For more information please visit

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