

Do subsea heading sensors meet
their specifications?



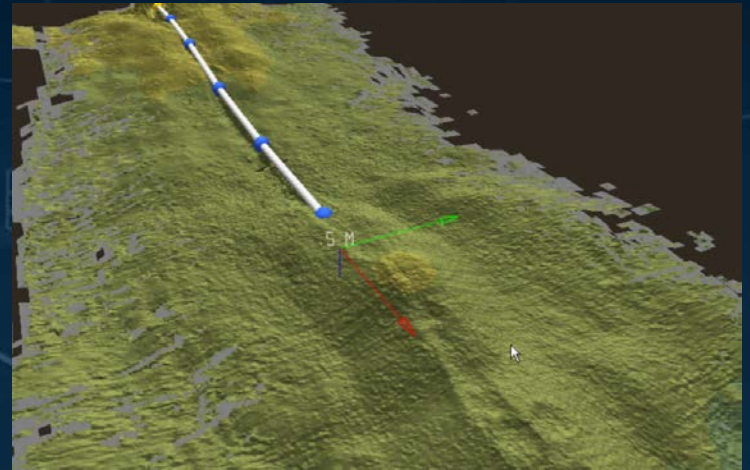
Julian Bell

DOF Subsea Norway

OSP, Stavanger, October 2013

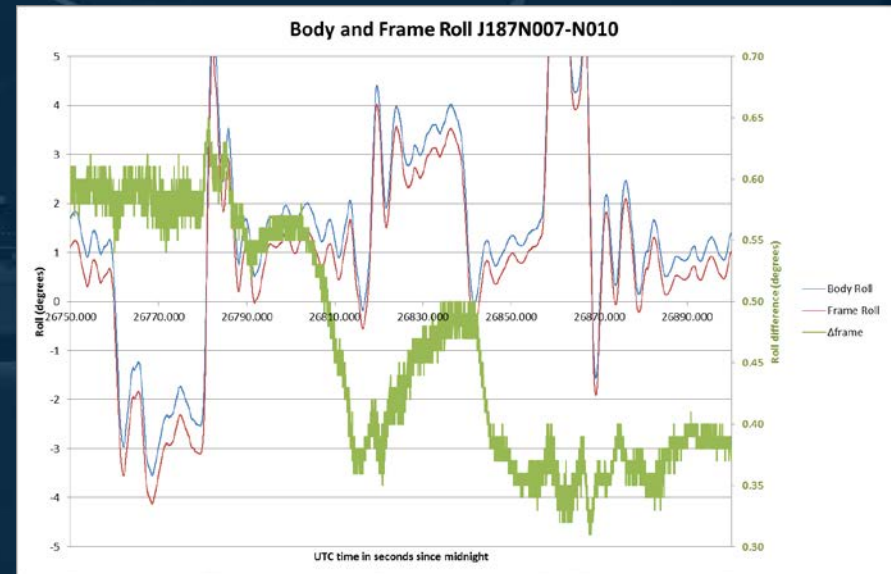
The 2012 Statoil Season

- High spec sensors
- Calibration
- Continuous monitoring
- WTF?!
- Work-arounds
- The solution
- The way forward



The 2013 Statoil Season

- Manufacturer's improvements
 - Accelerometer bias
 - Recalibration
- Product considered complete
 - No further investigation / development
- The new way forward
 - Alternative solutions



High spec sensors

- Why do we need high spec sensors?
 - Contract specifications
 - Best results

TSS Orion Heading accuracy specification:

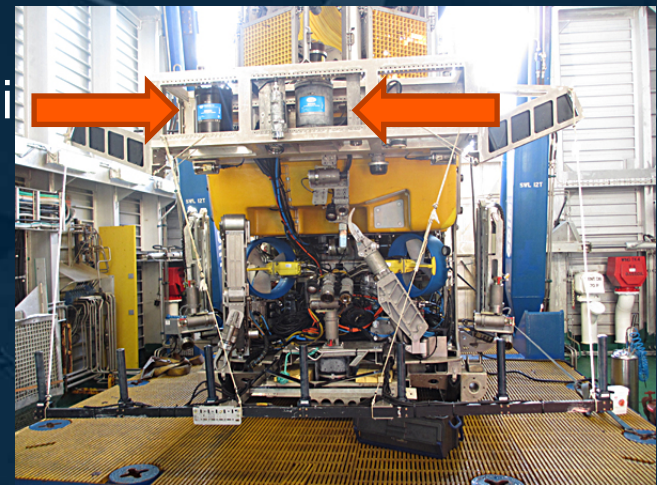
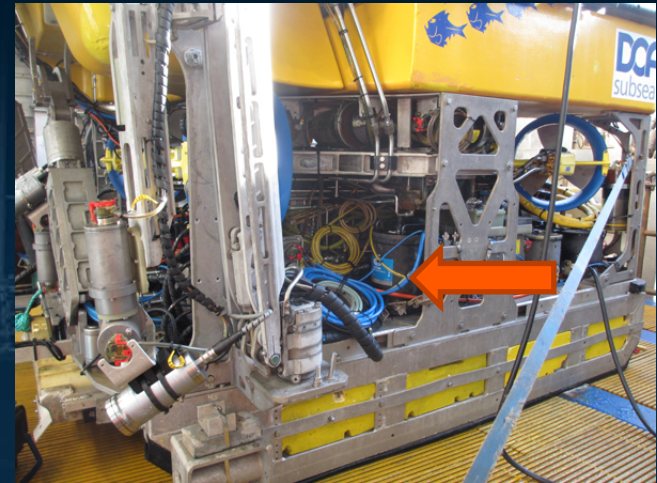
GPS Aided : $0.1^\circ \times \sec(\text{Lat})$ RMS

Manual Aided: $0.15^\circ \times \sec(\text{Lat})$ RMS

Attitude: 0.01° (dynamic)

WTF (Will TSS Function?)

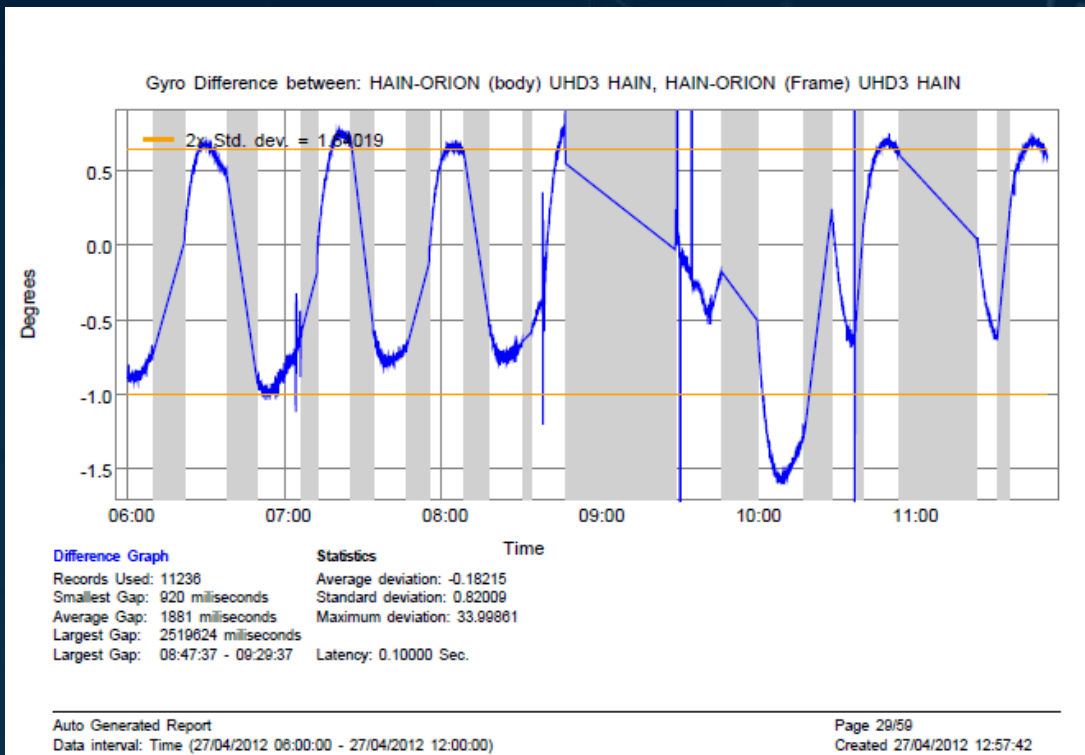
- Subsea & Surface
 - ROV mounted
 - Surface vessel mounted
 - Four Orions at once!
- Heading Drift
 - Indications Sept 2009
 - Spring 2012
 - Improved in 2013 but still need to ai
- Documentation
 - Description
 - Proof
- Attitude issues



- Subsea & Surface (2012)
 - ROV mounted units

Initially both units "Manually aided" i.e. Latitude and speed entered manually. Little change since upgrade.

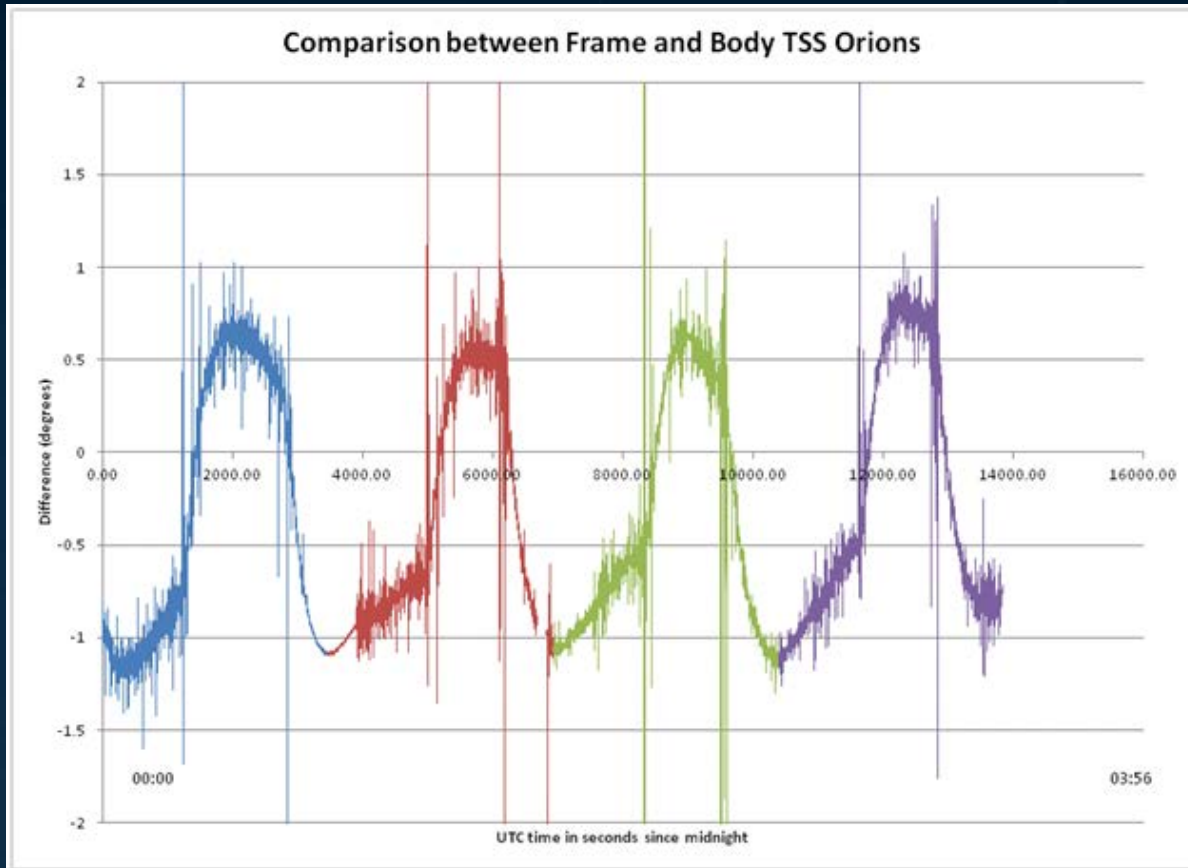
ROV MBE Survey:
Effect was a 0.5m position shift in DTM on outer beams – as expected for an error of this size



Plot from EIVA QC showing heading difference between two ROV mounted units. A grid survey was being run with short lines in opposite directions

WTF

- Subsea & Surface (2012)
 - ROV mounted units



Drifting does not seem to be random – behaviour is repeatable on same heading

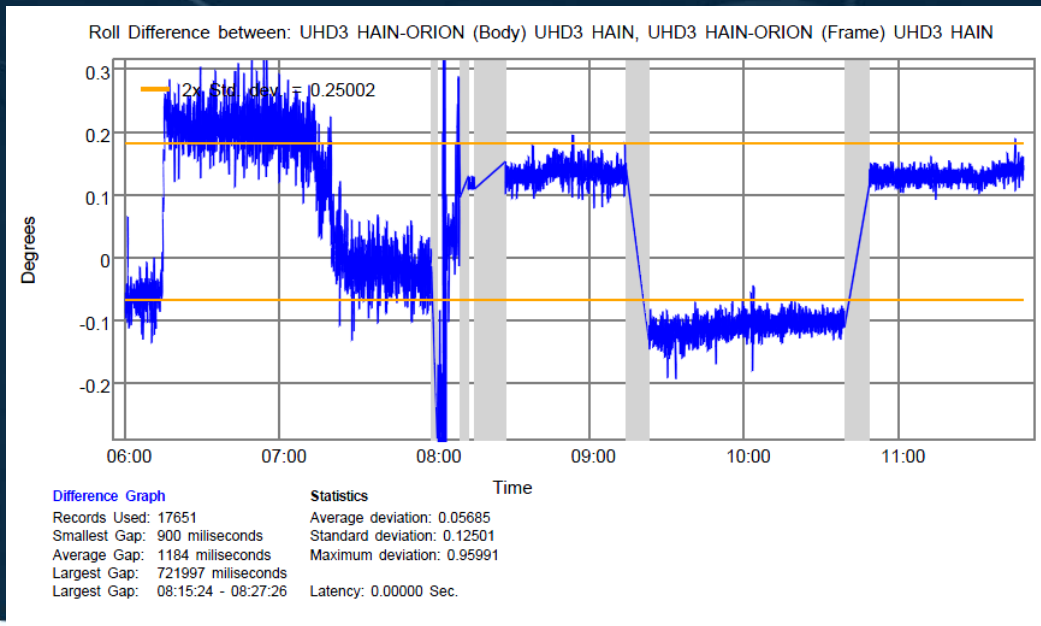
Drifting not as apparent on long lines

WTF – post aiding

- Attitude

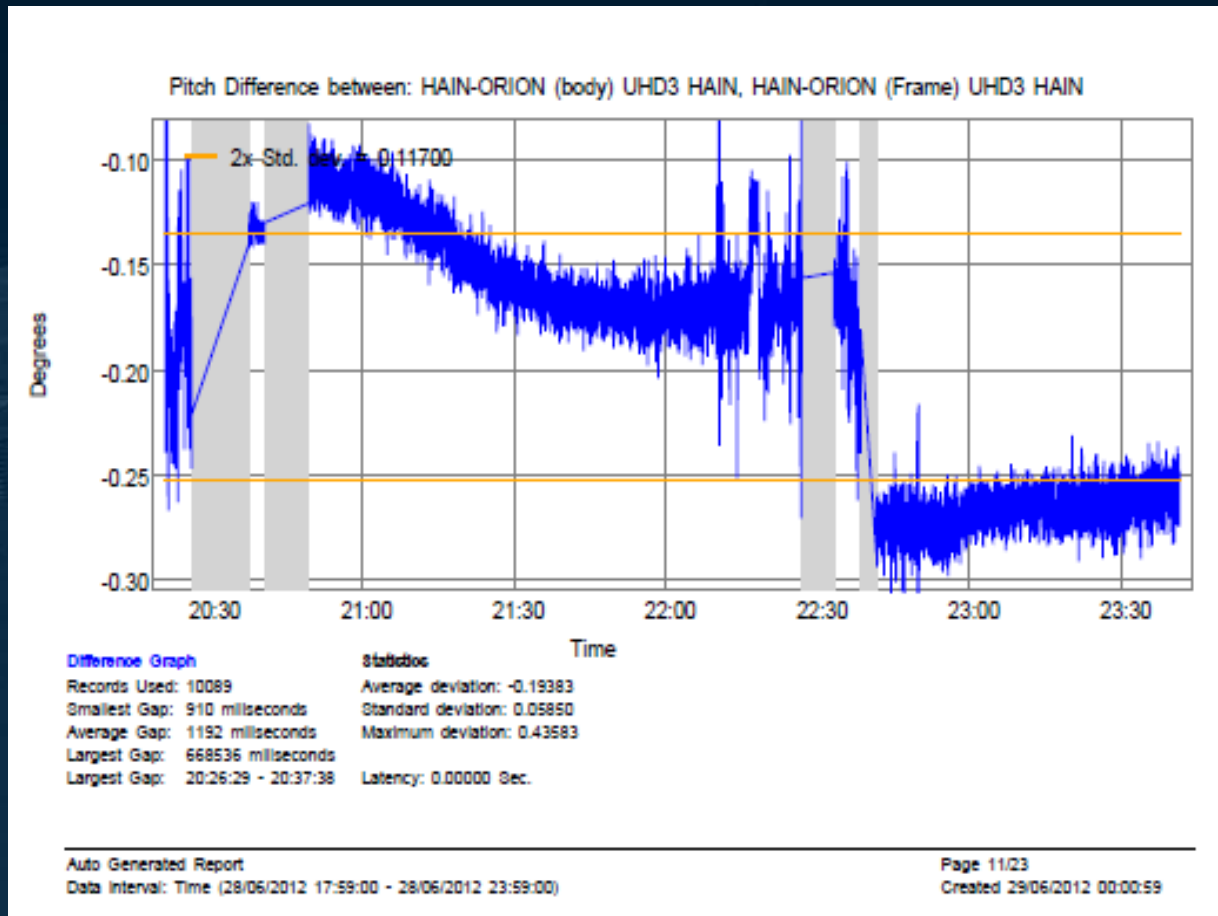
- After GGA & VTG aiding difference in attitude became apparent
- Surface mounted units also affected
- Do not want to aid subsea units this way for various reasons
- Still present after upgrade
- Differences can be large!

From October 2013



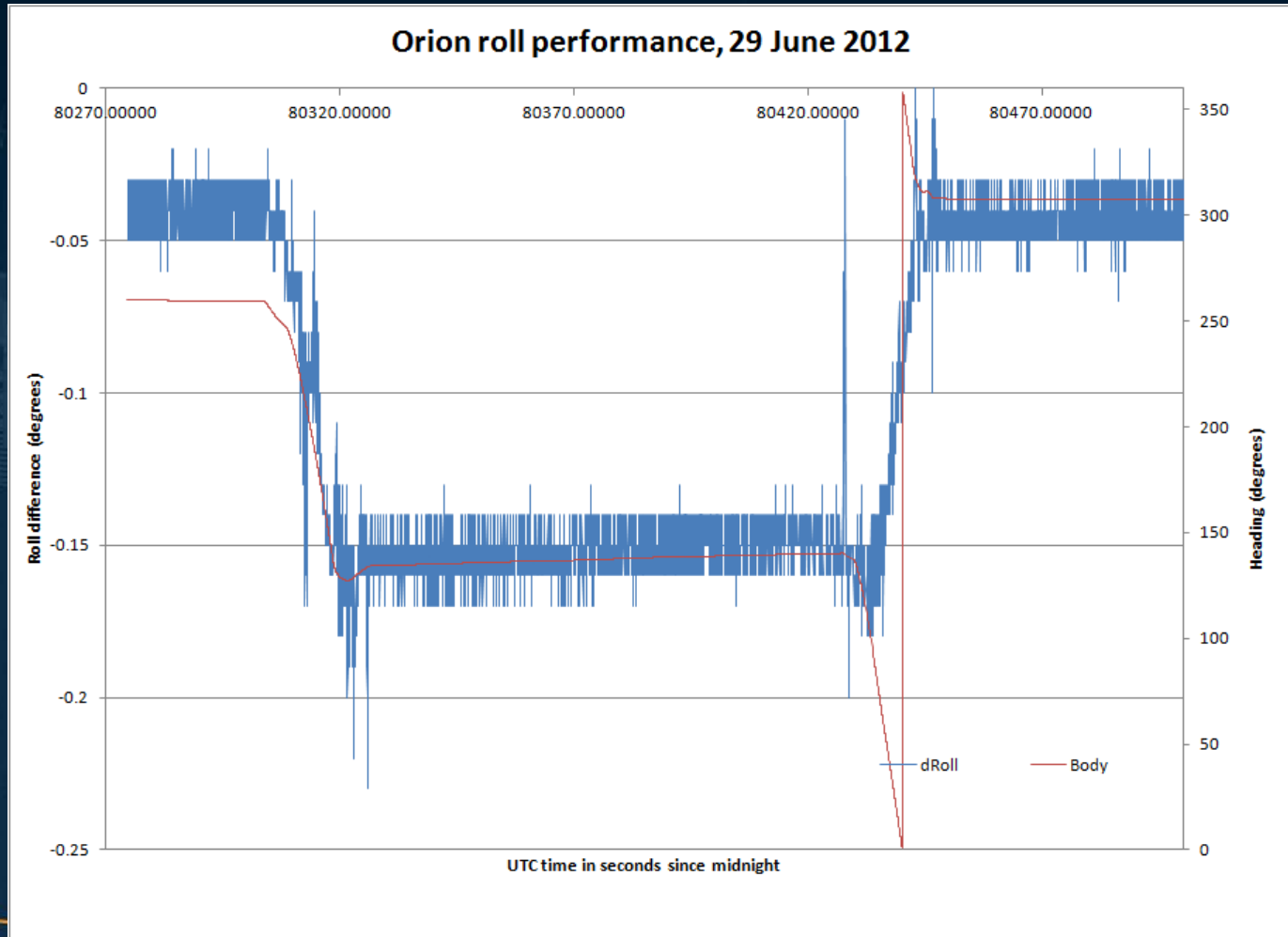
WTF – post aiding

- Attitude - pitch



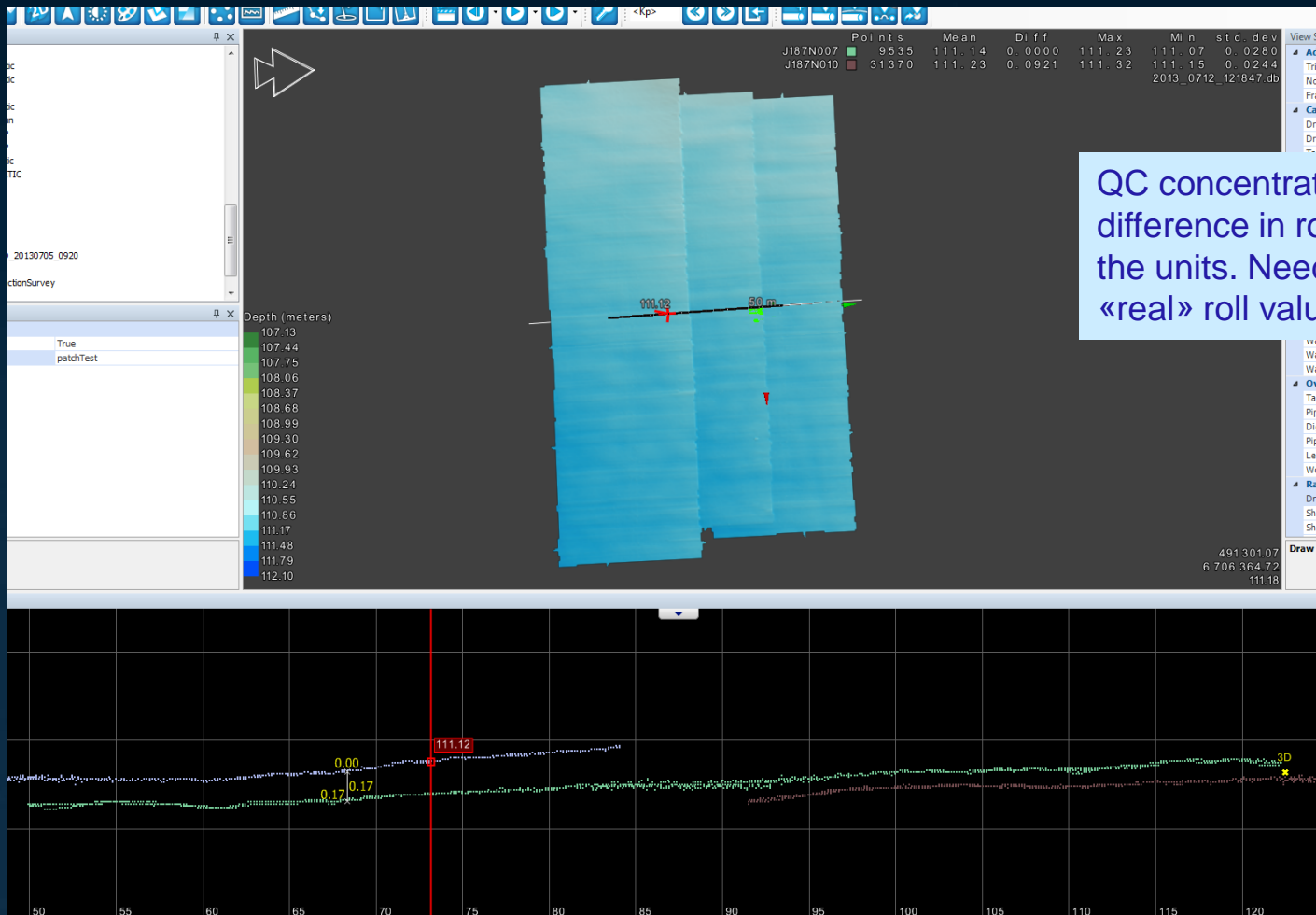
WTF – post aiding

- Attitude - roll



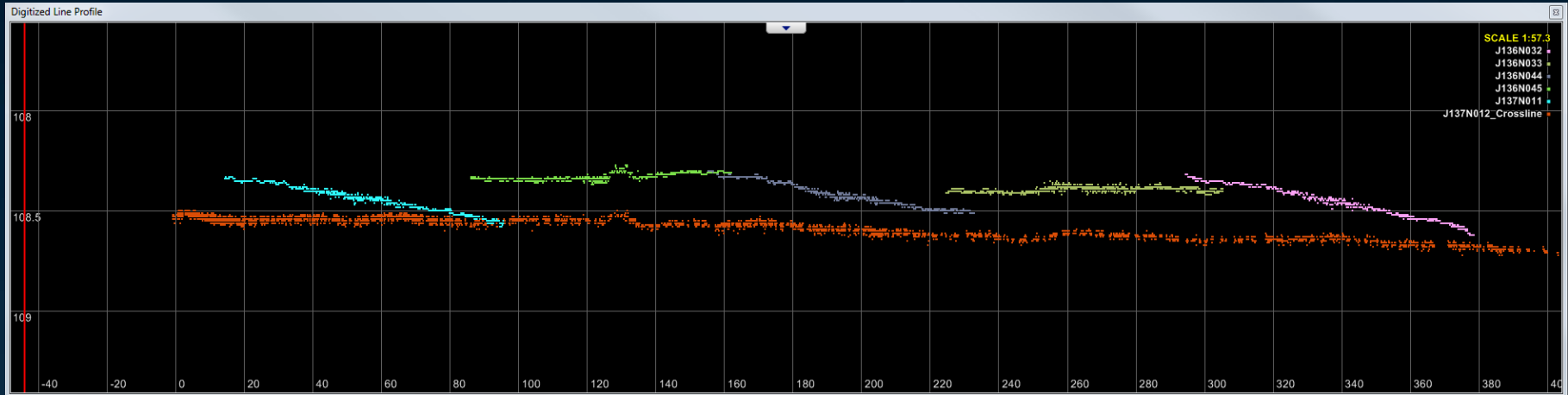
WTF – post aiding

- Attitude – roll (July 2013)



WTF – post aiding

- Attitude – roll (May 2013)



Indication of roll error in the order of $0.1 - 0.2^\circ$. Time consuming to investigate and (if necessary) correct for.

Individual units seem to behave differently? Or behaviour changes?

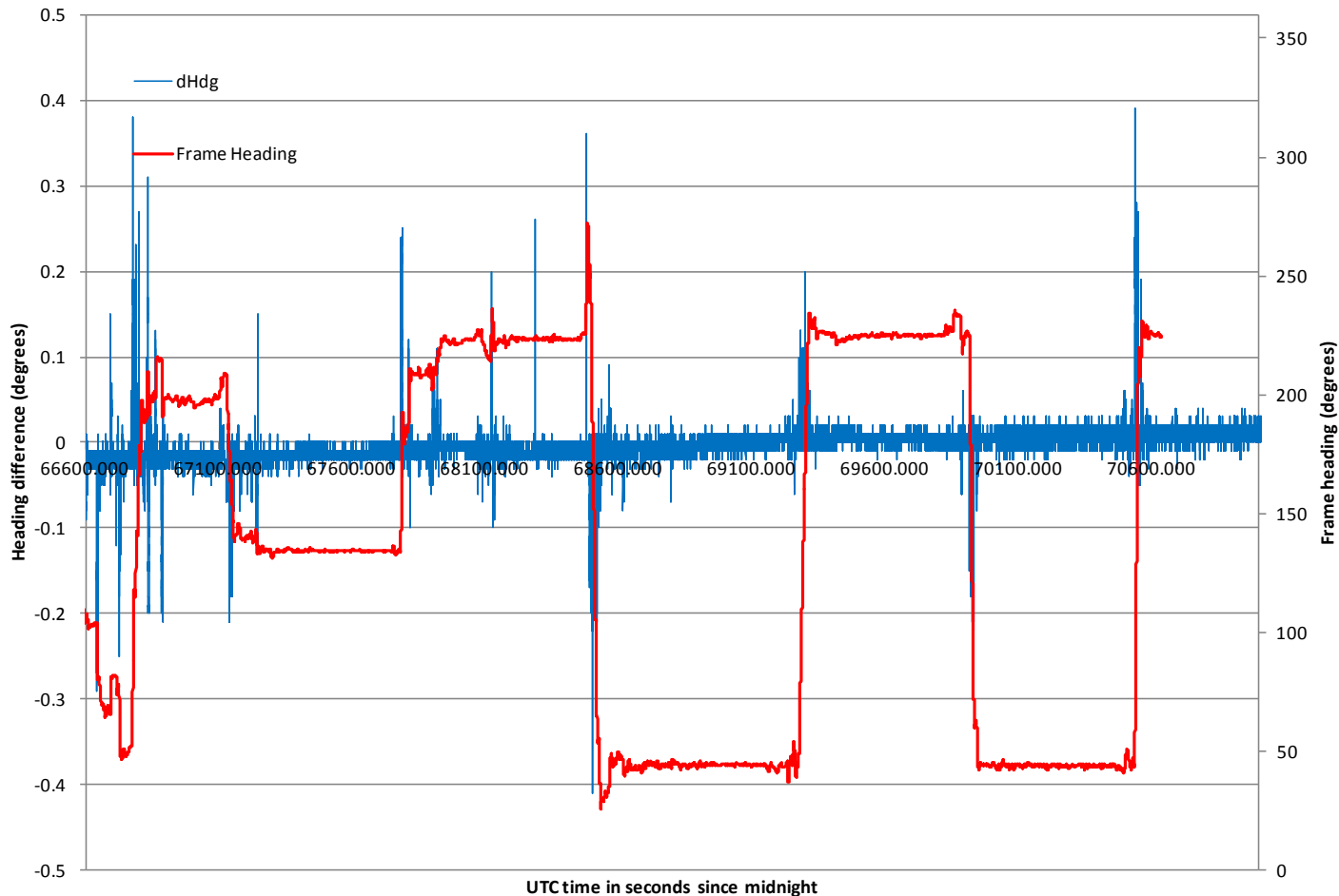
Work- arounds

- Longer run-ins
 - Help but inefficient
- Aiding with vessel's GGA & VTG
 - Still necessary in 2013
 - Big Improvement
 - Less drifting on heading
 - Quicker response after turns
 - Some disadvantages
 - Impractical to use ROV position
 - This was tried and worked but was limited
- Post-processing
 - NavLAB

GGA = Lat & Long
VTG = Track made good
and ground speed

Work- arounds – both units GPS aided

Heading difference between ROV mounted Orions, 12 June 2012



**Both units
aided**

Some jitter
remains during
turns but within
specification

Just over one
hour shown
here

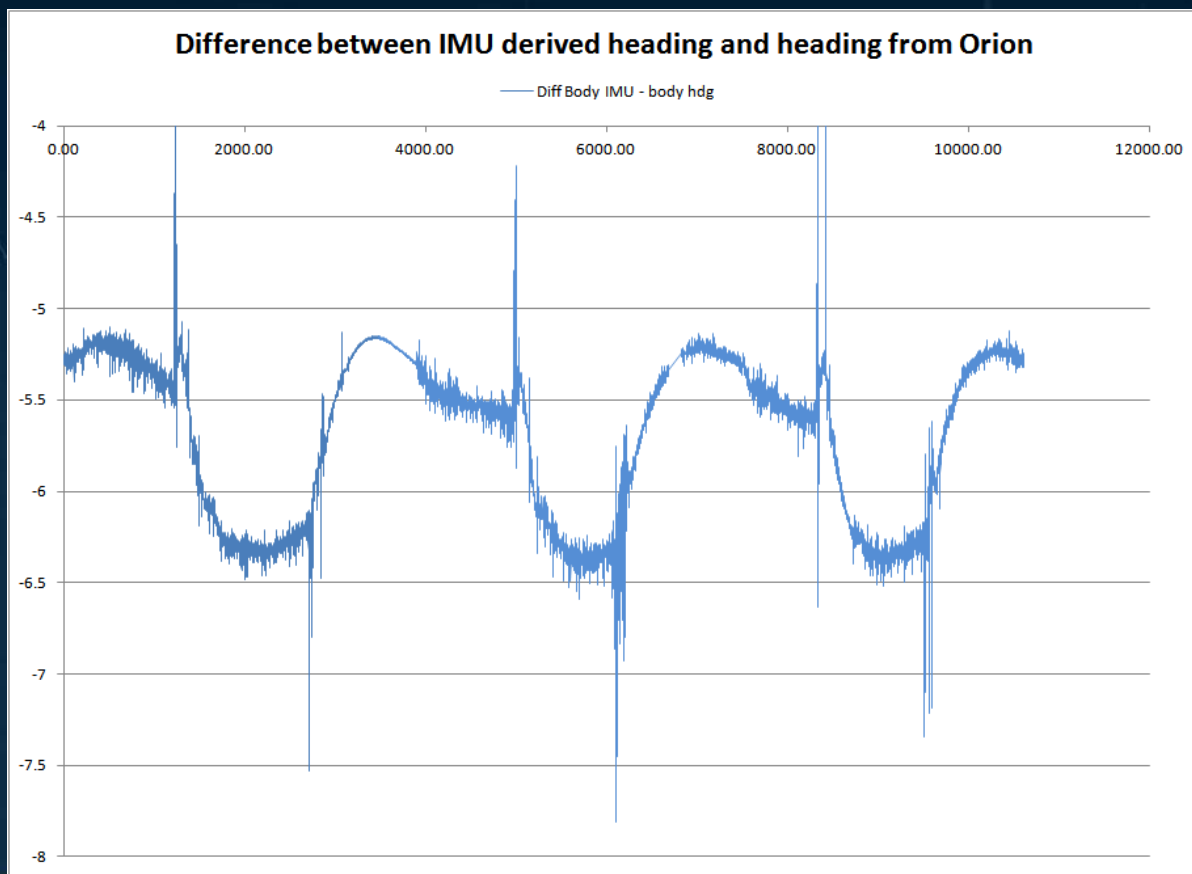
The solution

- TTSS
 - Nothing happening here
- Other ways to have found the problem / solution
 - NavLAB – some indications
 - HAIN?
 - Vectory
- Other sensors
 - How well do they meet their specs?
 - Other sensors being investigated

The solution

Alternative sources of info

- NavLAB – heading from post processed accelerometer data



Large difference is due to mounting angle.

Plot illustrates difference between heading derived in NavLAB from IMU data.

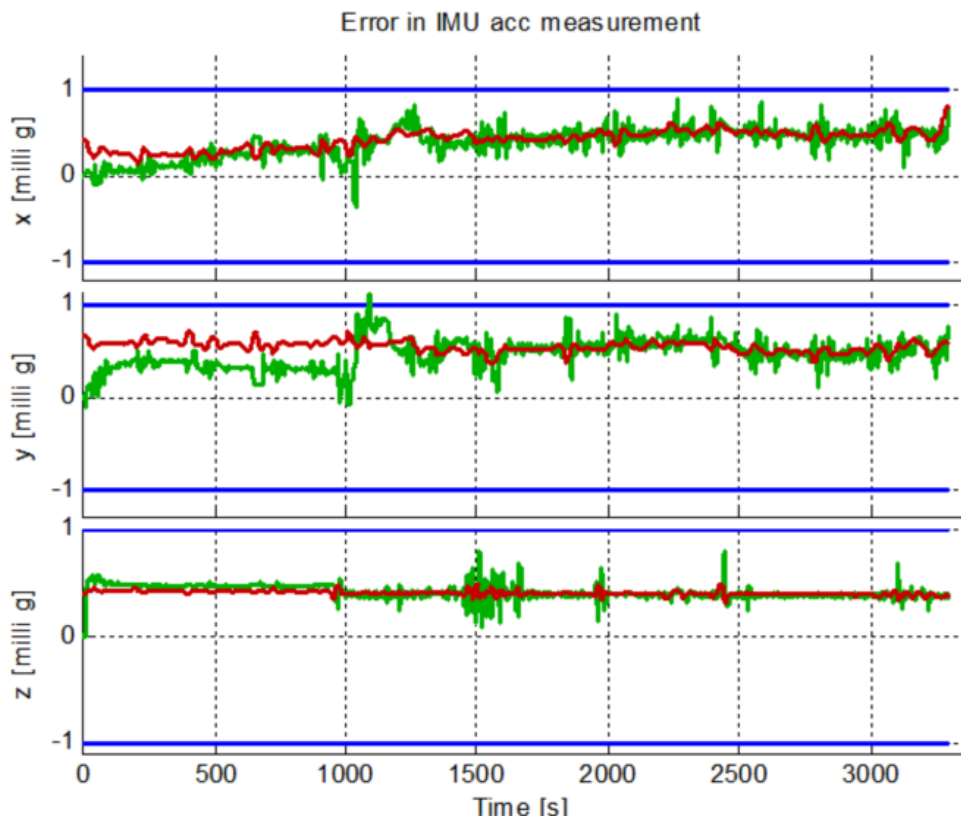
Similar pattern to differences between units

Indicates that nothing is wrong *per se* with the IMU data?

The solution

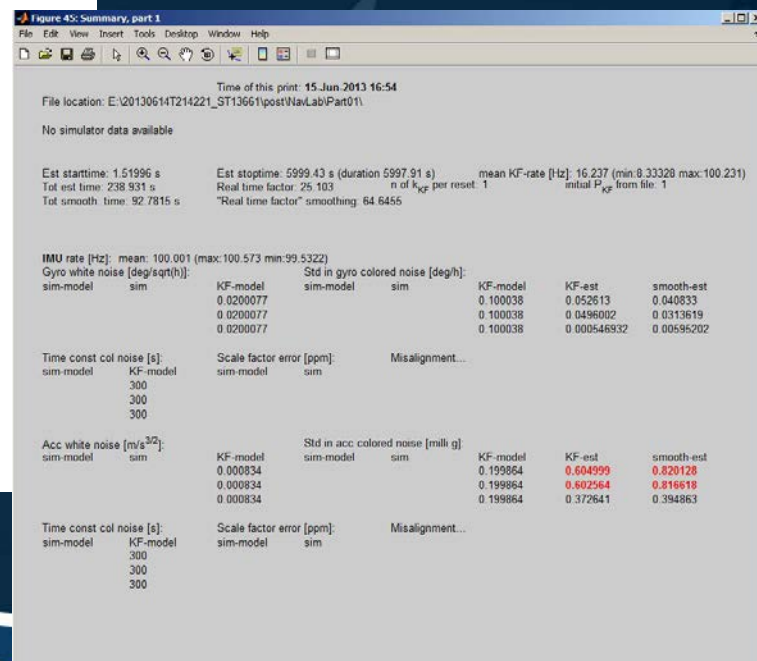
Alternative sources of info

- NavLAB – heading from post processed accelerometer data



This dataset may not have been optimal – but perhaps there is an indication here.

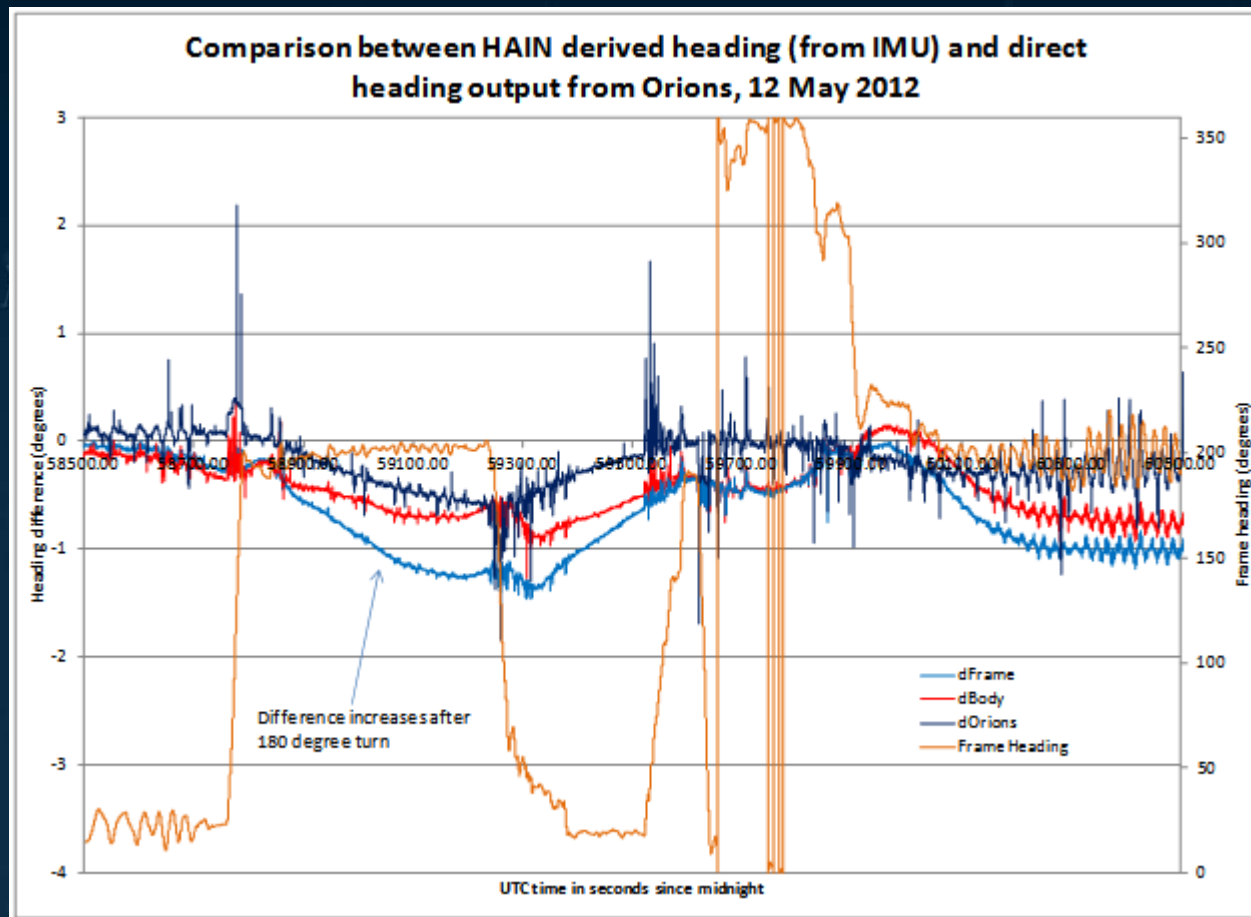
NavLAB has produced some useful pointers.



The solution

Alternative sources of info

- HAIN



This shows that both units heading output drifted away from the heading calculated by HAIN from IMU data from **one of the same units** in real-time –as well as drifting apart from each other.

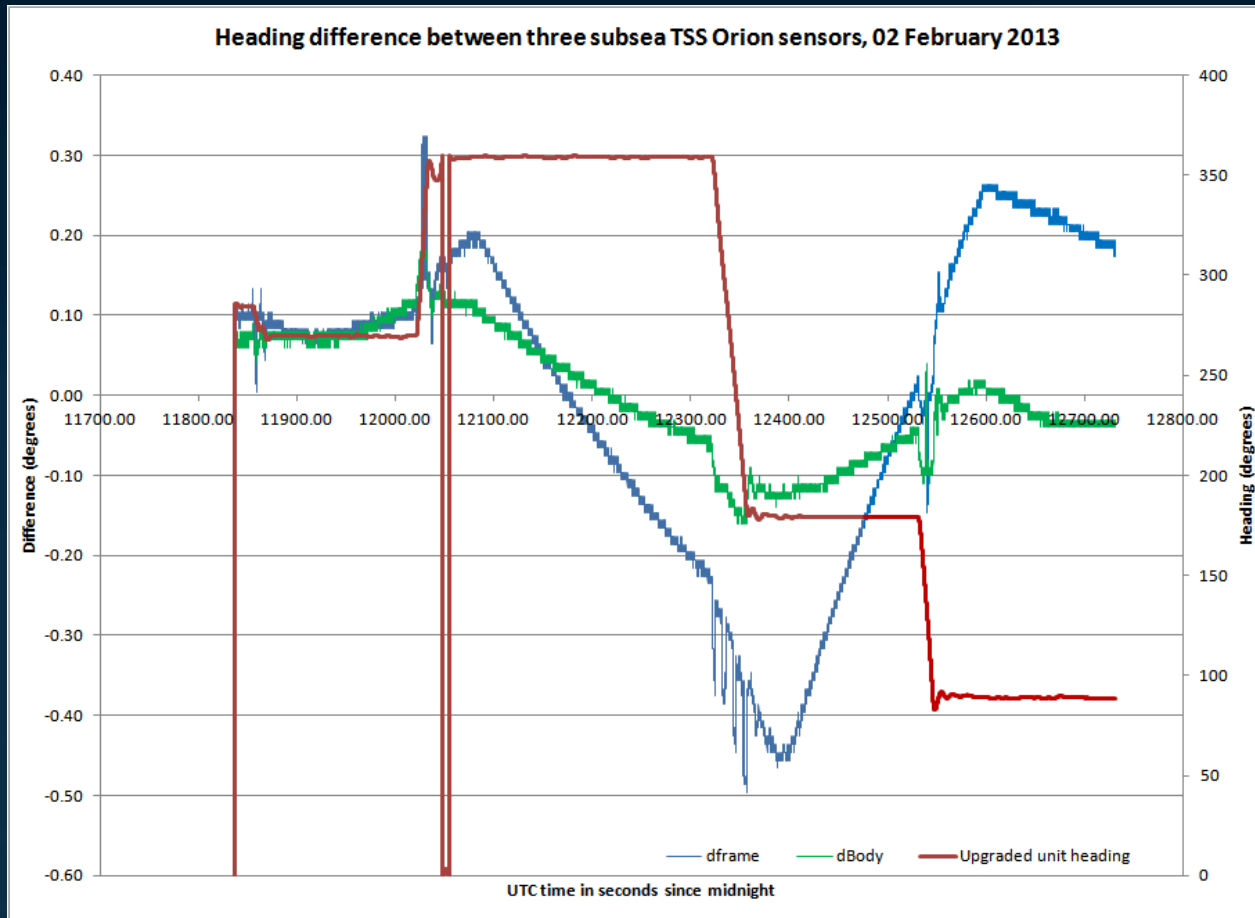
Indicates that nothing is wrong *per se* with the IMU data?

Kongsberg algorithms doing a better job of handling the IMU data?

The drifting stopped after GGA & VTG aiding was enabled

The solution

Upgraded unit – initial results



Manual aided upgraded unit compared to manual aided original unit and GGA & VTG aided original unit.

Obvious drift on manual aided original unit.

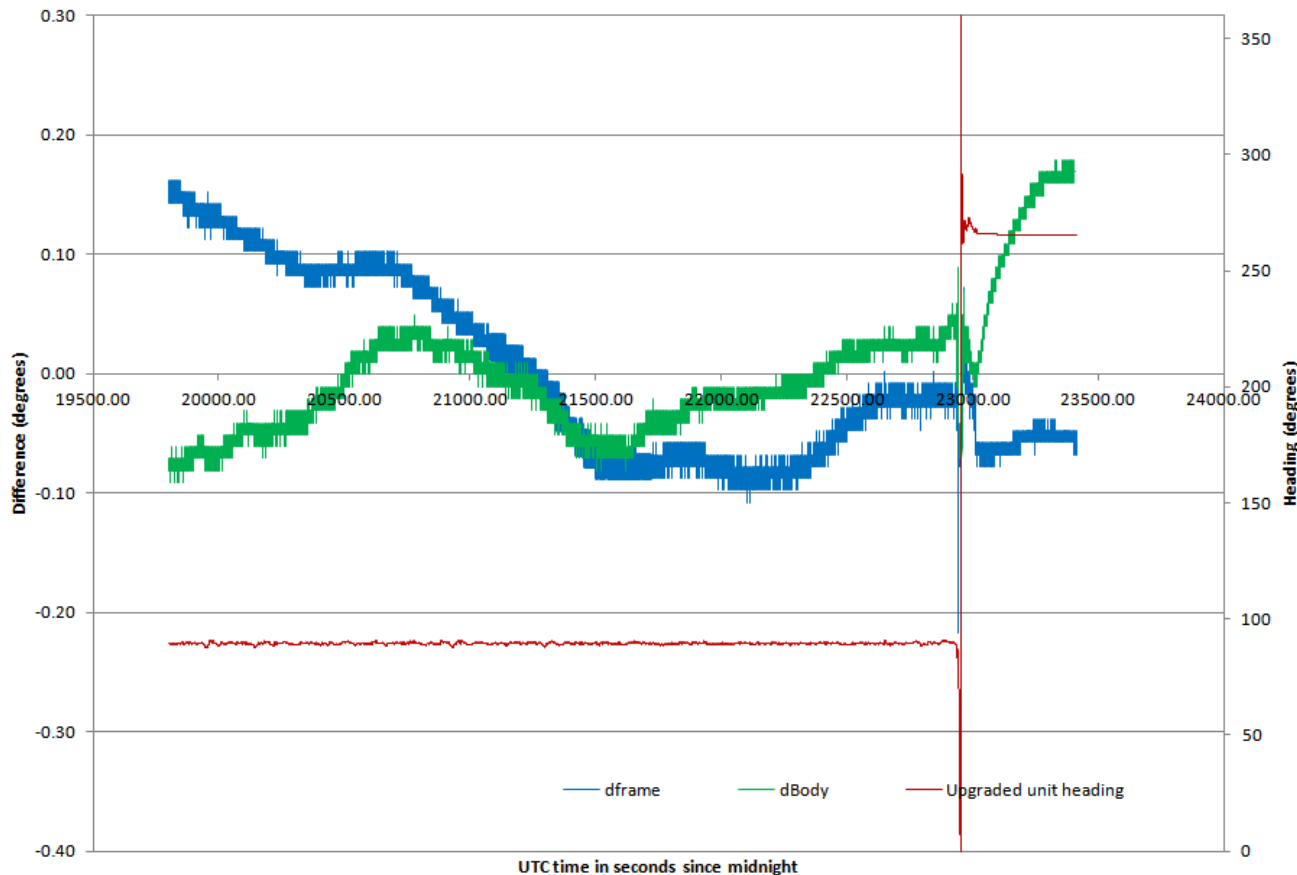
Upgraded unit agrees well with GGA & VTG aided original unit.

Further testing still required but optimistic.

The solution

Upgraded unit – initial results

Heading difference between three subsea TSS Orion sensors, 03 February 2013



An hour of data.

More drift between manual aided upgraded and original units.

Upgraded unit generally agrees well with GGA & VTG aided original unit.

180° turn and 5 minutes stationary at the end.

Differences are mostly with specifications.

The way forward

- Calibrations
 - Improve confidence in technique and quality
 - Two directions (whichever method is used)
- Aiding
 - GGA & VTG strings
 - How? ROV position often unsuitable, vessel not “correct”
- QC
 - More?!! (Longer term & preventative)
 - Improvements
 - Still requires time, motivation and resources
- Redundancy, redundancy, redundancy
- High price to pay for introducing new gear....

Wake up, it's over

Boring is good.....



delivering solutions at any depth