NORWEGIAN FORUM FOR OFFSHORE SURVEY AND POSITIONING

FUGRO

Dynamic Calibration of Navigation Sensors with GNSS Technology

John Vint, Fugro Survey AS, Stavanger, 5th November 2015

Scope of Presentation

Benefits of Dynamic Calibration.

Methodology.

Data Logging Requirements.

Processing Software and Results.

Quality Considerations

Conclusions

Normally undertaken in port using land survey techniques.

Dynamic Calibrations

Gyro Calibration

MRU Calibration

DGPS Verification

Dynamic Calibration Benefits

- Anywhere
  - In production offshore.
  - In transit.
  - In port.
- Any time
  - Instant calibration when required.
- Environmentally friendly
  - No need for external surveyor.
- Cost efficient
  - No need for additional time in port.

- Three GNSS receivers in known vessel positions.
- Simultaneous vessel data logging for minimum four hours.
- GNSS Data converted to RINEX.
- Logging at 1 Hz.

Navigation Sensor Data logging

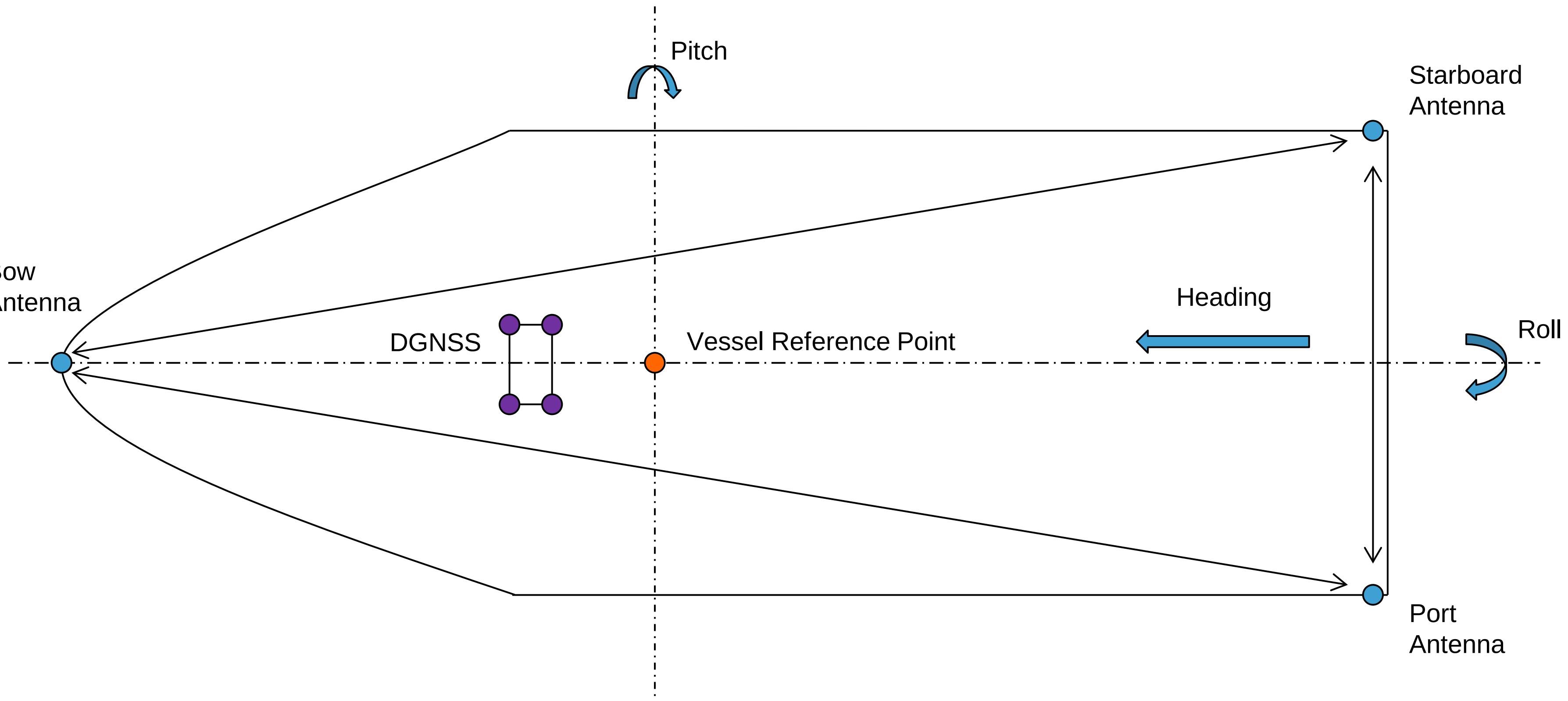
- Logged simultaneously with GNSS Data.
- Logging interval 1 Hz.
- All time tagging of data to UTC.
- Heading Sensor – time and uncorrected heading readings.
- Motion Sensor – time and uncorrected pitch and roll readings.
- DGNSS Systems – geographical co-ordinates reference to WGS84 or a derivative.
- Vessel Metadata.

Vessel Metadata

- All data from the vessel is sent to Fugro for processing.
- Vessel Metadata is very important.
- Metadata includes:
  - Vessel Name, Date, Location and Timings.
  - Precise offsets for GNSS Logging unit antennae in vessel reference frame.
  - Precise offsets for vessel DGNSS System antennae.
  - Start and stop times for logging.
  - List of system name, manufacturer, serial number and logging filenames.

- RTK (Real Time Kinematic) Processing
  - Used to derive the vectors for calibration of heading, pitch and roll sensors.
  - Moving base technique - vectors derived while a vessel is in motion.
- PPP (Precise Point Positioning) Processing
  - Used to derive the vessel DGNSS antenna positions for DGNSS Verification.
  - Uses raw GNSS data (code and carrier) combined with precise satellite orbits and clock corrections.
  - Software with “State-of-the-Art” error modelling.

Processing Sequence



Results and Deliverables

- The results of the GNSS processing and the logged vessel sensor data are combined in Fugro software to produce the deliverables.
- Nominally within 2 days:
  - Heading Sensor Corrections.
  - Motion Sensor Corrections.
  - DGNSS System Verifications.
- Nominally within 4 days:
  - Full calibration report.
  - Description of methodology.
  - Data QC information.

Quality Considerations 1

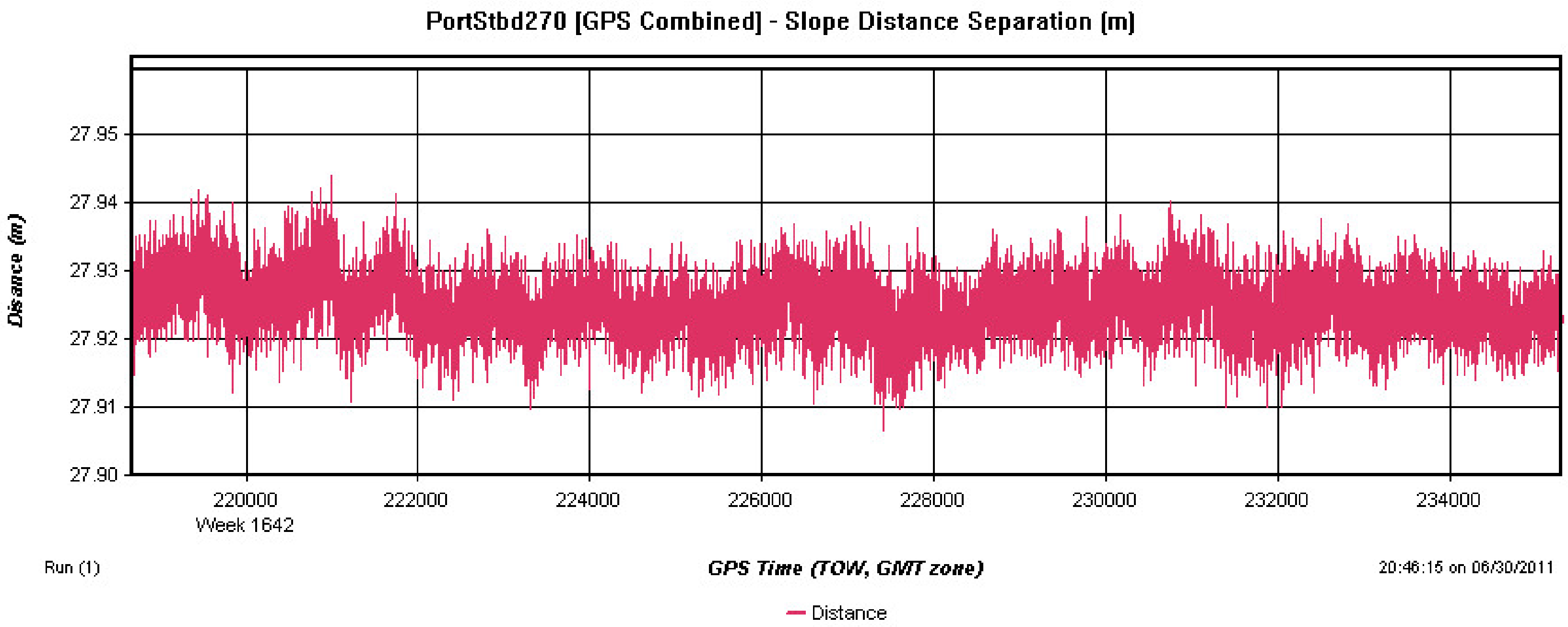
- A clear view of the satellites, down to a satellite elevation angle of 10 degrees.
- It is very important to minimise the location's surrounding obstructions.
- Precise offsets for the antennae in the vessel's local co-ordinate system (X, Y, Z).
- This is obtained through an accurate offset survey of the three antennae.
- Longest possible baselines to optimise the accuracy of the RTK processing.

Quality Considerations 2

- Firm and horizontal antennae mountings.
- Designated and well defined antennae locations.
- Well defined vessel Metadata.
- “State-of-the-Art” processing software.

Dynamic GNSS Vector Quality

Example of 4 hours of dynamic horizontal vector separations from Port to Starboard SD = 0.005m



Vessel speed 12 knots

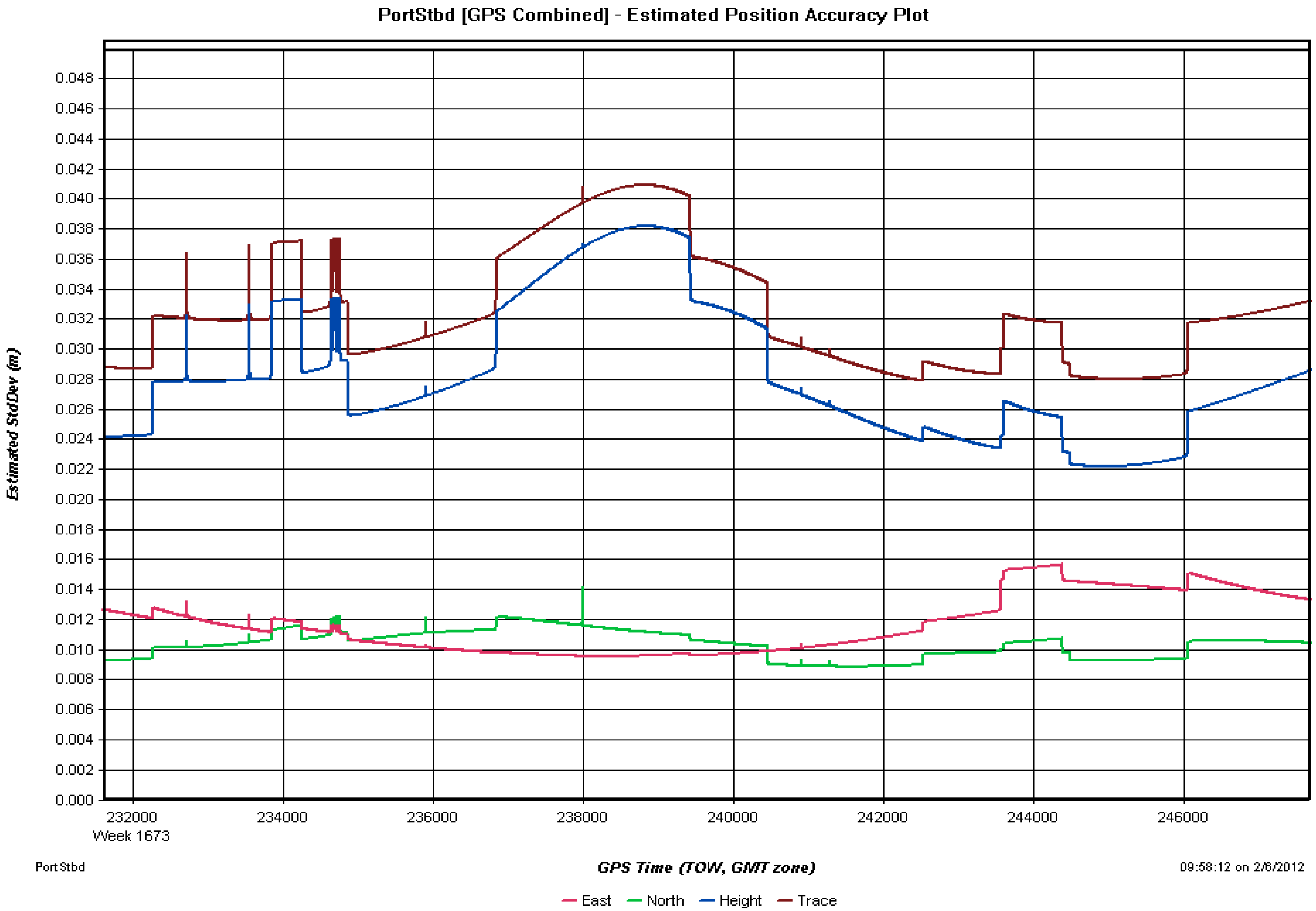
Case Study #1

- In a period of three months in 2010 one vessel carried out three dynamic calibrations and one traditional calibration.

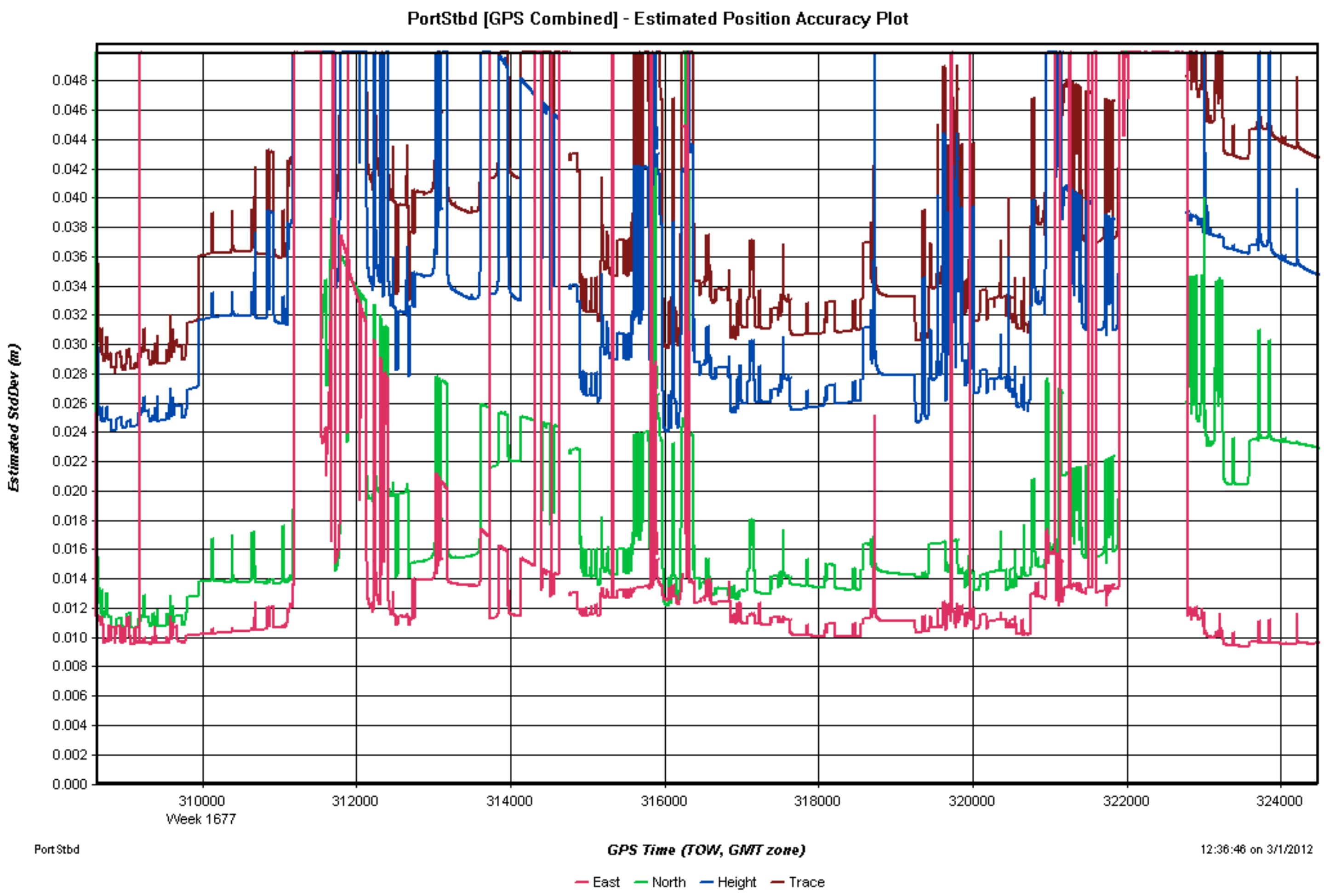
Technique	Location	Heading	Pitch	Roll
Traditional	Romania	-0.13°	-0.02°	+0.28°
In Transit	Indonesia	-0.13°	-0.03°	+0.28°
In Transit	Romania	-0.11°	-0.04°	+0.26°
In Port	Australia	-0.14°	-0.05°	+0.25°

Technique	Location	Easting	Northing
Traditional	Romania	+0.01 m	+0.09 m
In Transit	Indonesia	-0.06 m	+0.01 m
In Transit	Romania	-0.01 m	-0.06 m
In Port	Australia	-0.04 m	+0.03 m

Case Study #2 – Installation

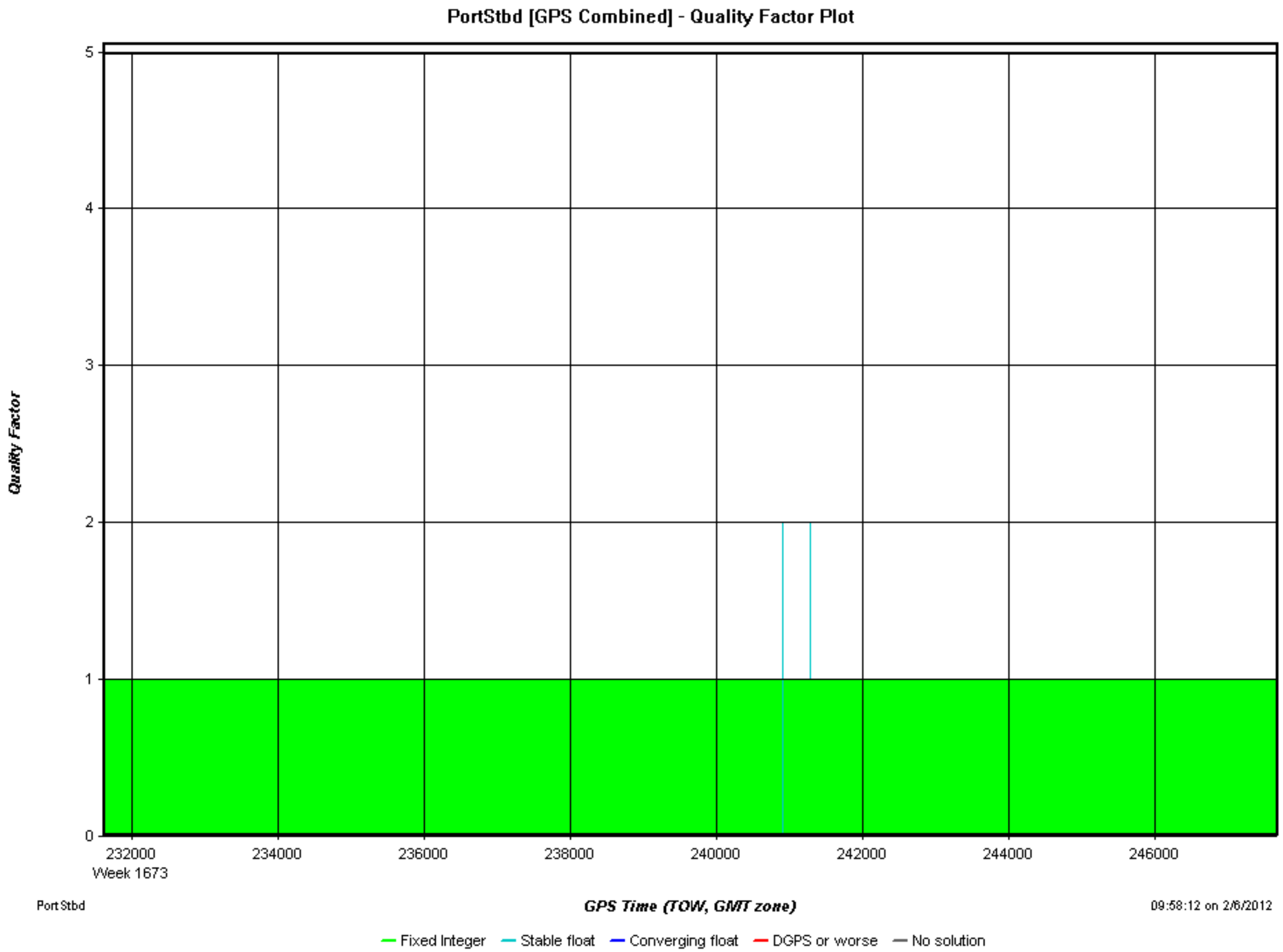


Estimated Position Accuracy - Baseline Port / Starboard



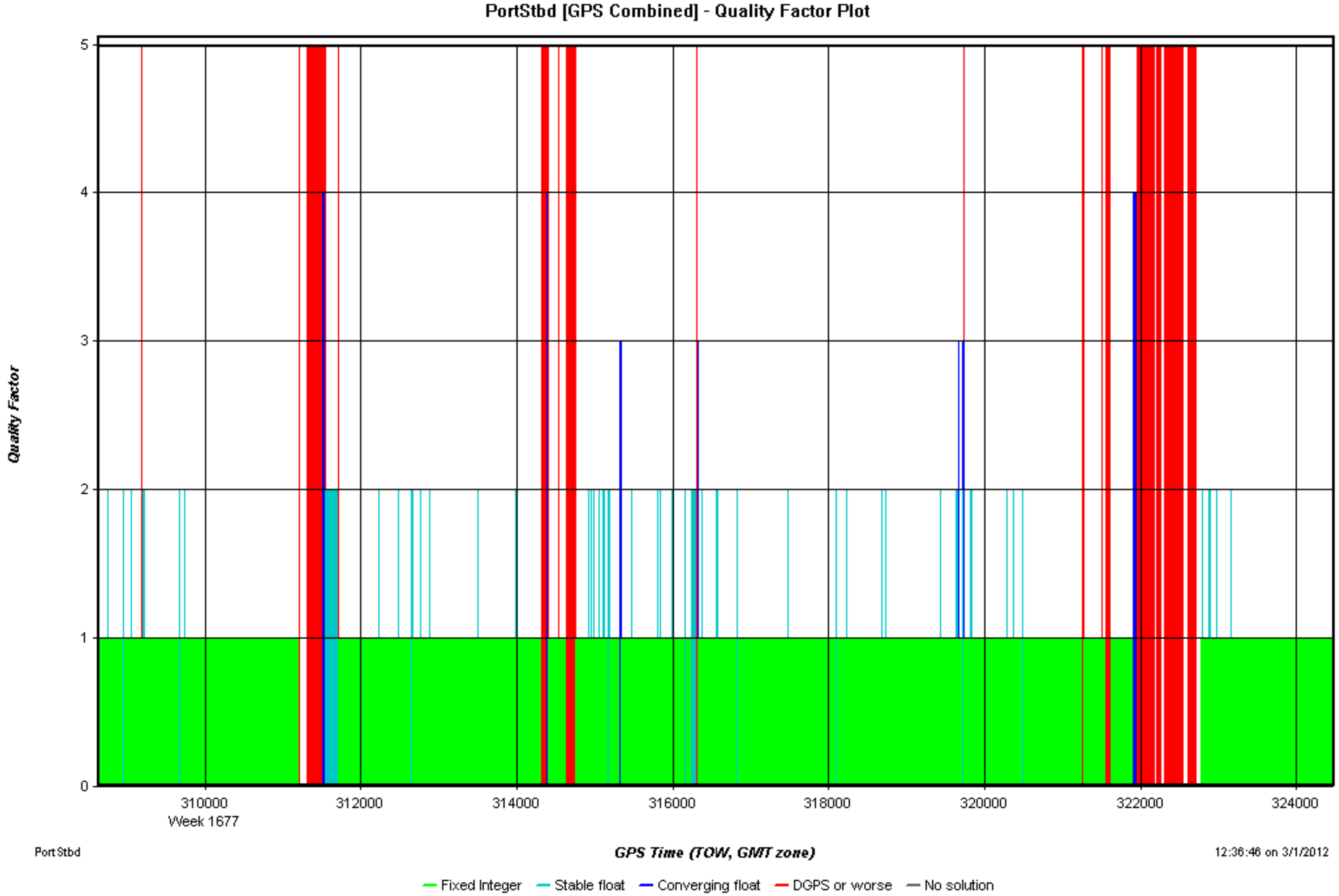
Estimated Position Accuracy - Baseline Port / Starboard

Case Study #2 – Data Quality – RTK Processing



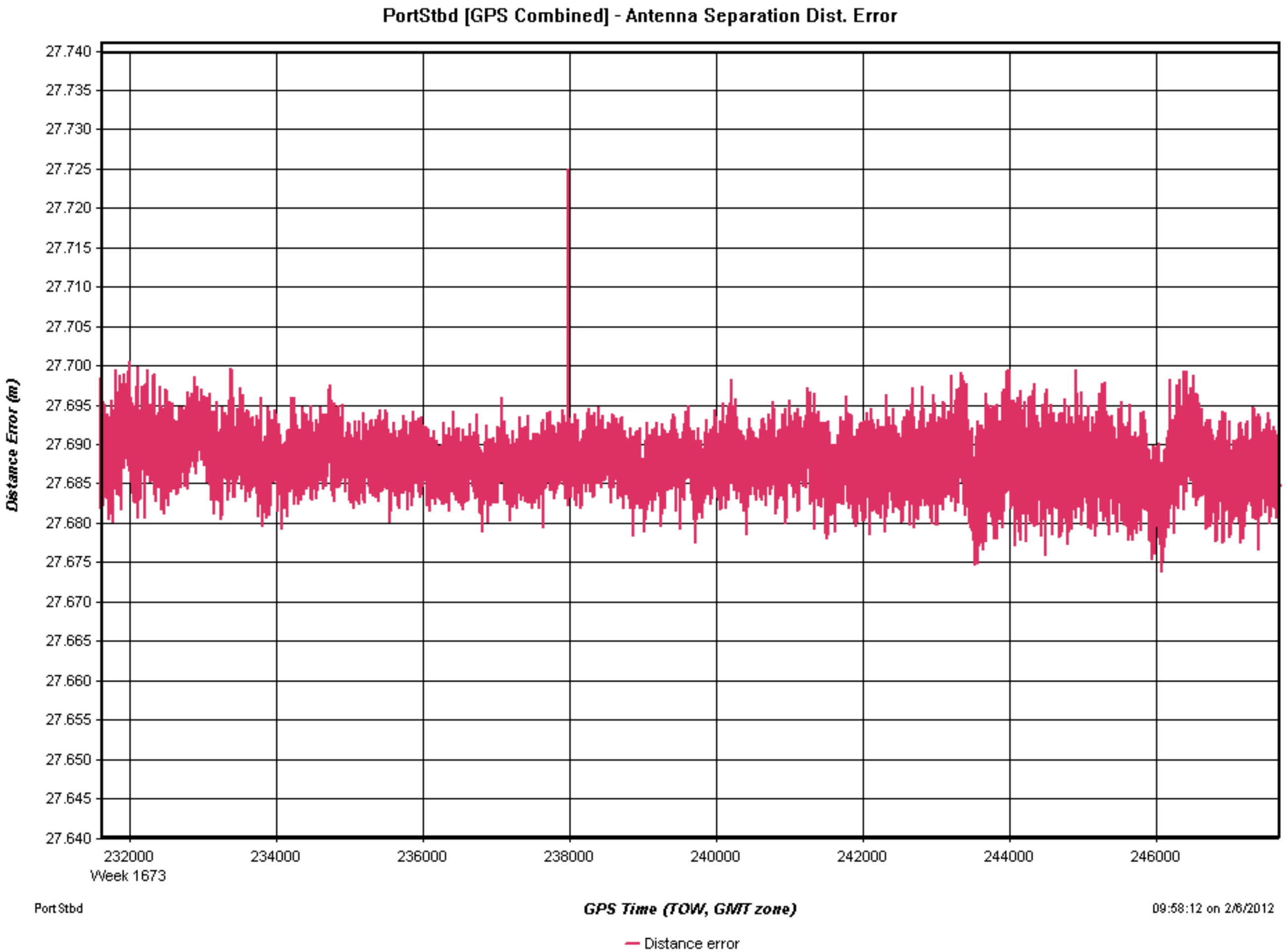
Quality Factor - Baseline Port / Starboard

Case Study #2 – Data Quality – RTK Processing



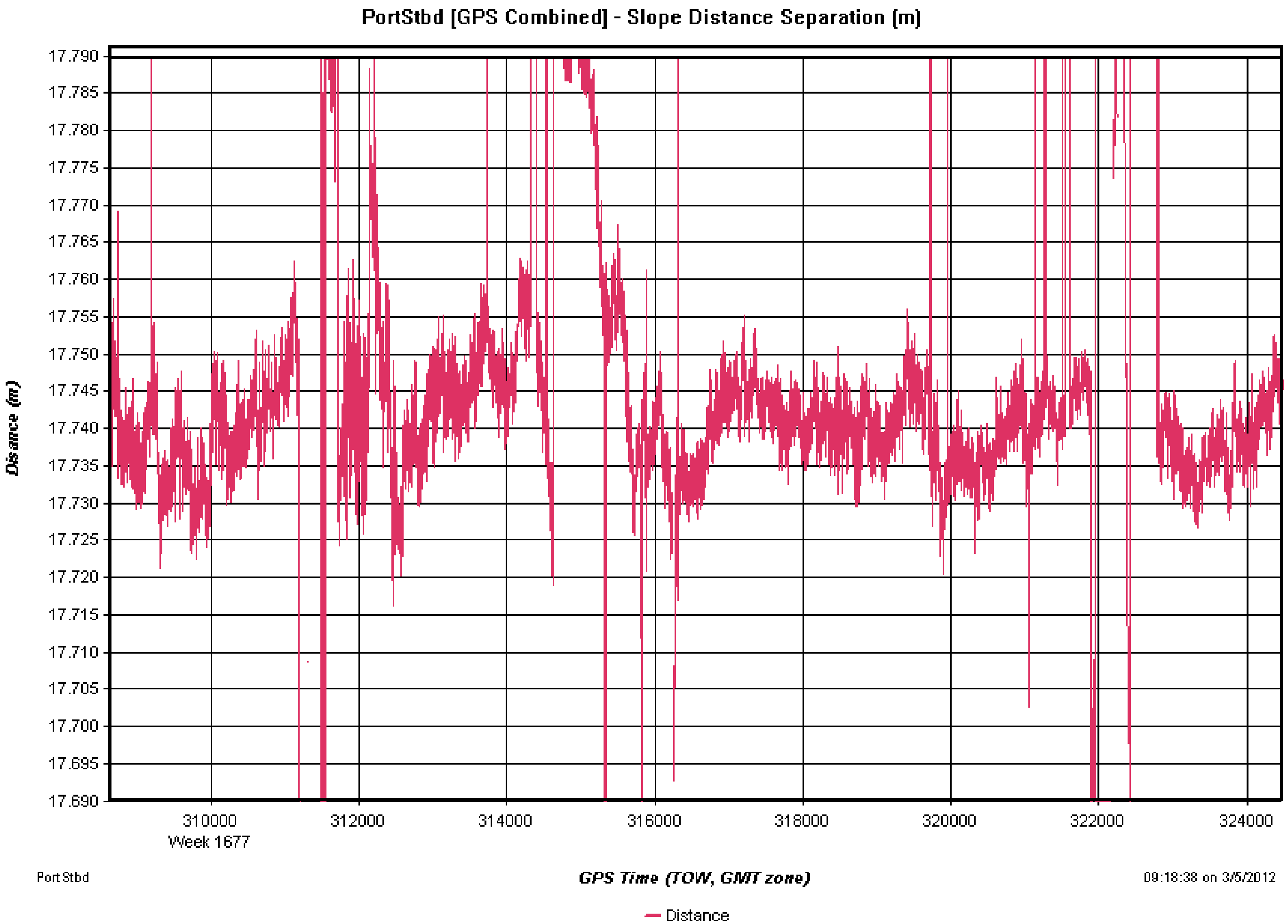
Quality Factor - Baseline Port / Starboard

Case Study #2 – Data Quality – RTK Processing



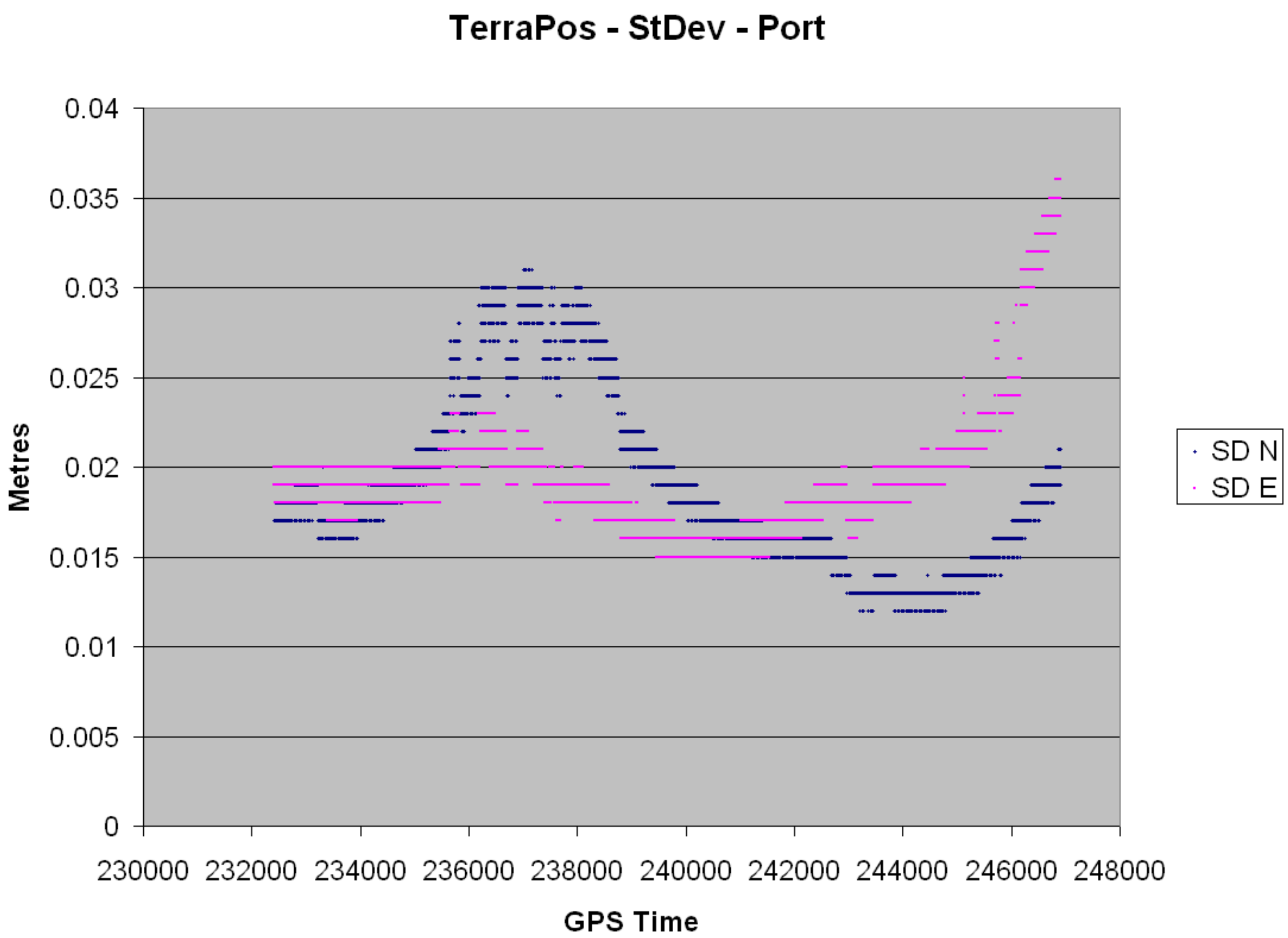
Baseline Distance - Baseline Port / Starboard

Case Study #2 – Data Quality – RTK Processing



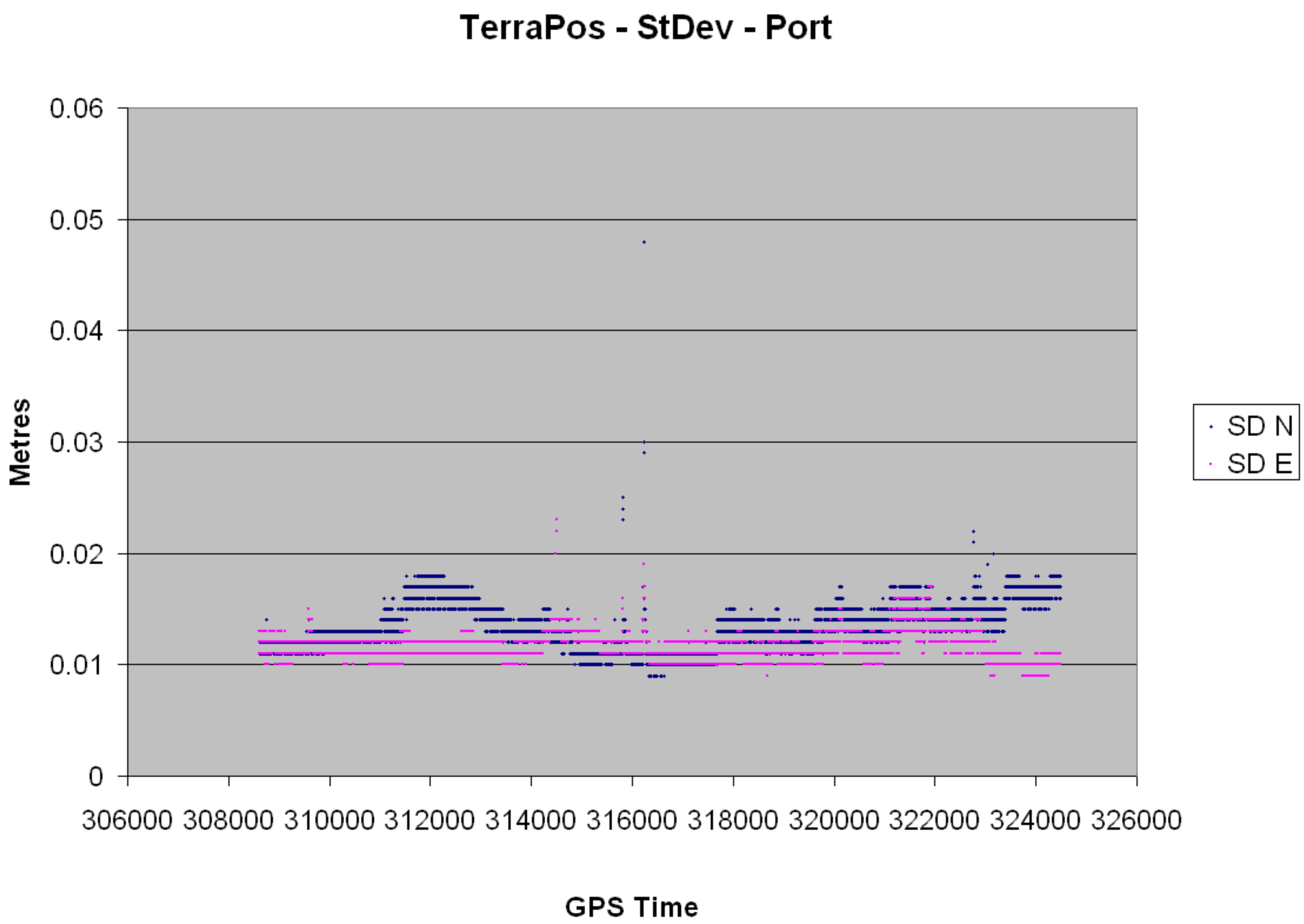
Baseline Distance - Baseline Port / Starboard

Case Study #2 – Data Quality – PPP Processing



Position SD Port Antenna

Case Study #2 – Data Quality – PPP Processing



Position SD Port Antenna

Case Study #2 - Results

Heading	Seapath	Octans
Traditional	-30.25°	+1.13°
Dynamic	-30.23°	+0.96°

Motion	System	Pitch	Roll
Traditional	Seapath	-0.29°	+0.01°
Dynamic	Seapath	-0.30°	+0.03°
Traditional	Octans	-0.24°	+0.10°
Dynamic	Octans	-0.26°	+0.13°

DGNSS	System	Diff E	Diff N
Traditional	Starfix.G2/StarPack	-0.01 m	-0.04 m
Dynamic	Starfix.G2/StarPack	+0.01 m	-0.01 m
Traditional	Starfix.G2/MultiFix	+0.03 m	-0.04 m
Dynamic	Starfix.G2/MultiFix	0.00 m	-0.04 m

Conclusions

The accuracy of navigation sensor calibration dynamically has been proven to equal that obtained by traditional methods.

The technique is flexible – the constraints imposed by traditional methodology are removed.

There is a continuing interest amongst clients to use this technique.

The technique has gained Oil Company approval.

Comments on Dynamic Calibration from Statoil (2013)

Statoil have no objections to the use of Dynamic Calibration techniques for their projects.

Statoil would like to see the first Dynamic Calibration done in parallel with a traditional quayside calibration to verify the results on a vessel to vessel basis.

Statoil would expect each vessel to keep a calibration log showing comparison of calibration values over time (both traditional and dynamic).

Statoil

Track Record

Fugro Survey AS has provided Dynamic Calibration Services to the clients:

Polarcus Limited (2011)

Electromagnetic Geoservices AS (2012)

CGG (2013)

Several Others (2014 – 2015)

Track Record – Oil Companies

BG GROUP

Eni

MÆRSK

REPSOL

FUGRO

wintershall

woodside

TOTAL

TGS

Statoil

Questions ?

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