



Sensors II

Using Doppler Logs for Safer DP Drilling

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Alstom Power Conversion



APC Power Conversion

Using Doppler logs for safer
DP in drilling

Richard Stephens

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Customised Technology for Customer Success

- DP and PMEs
- Doppler log (speed log)
- Achieving independence
- Simulation results
- Full scale trial data

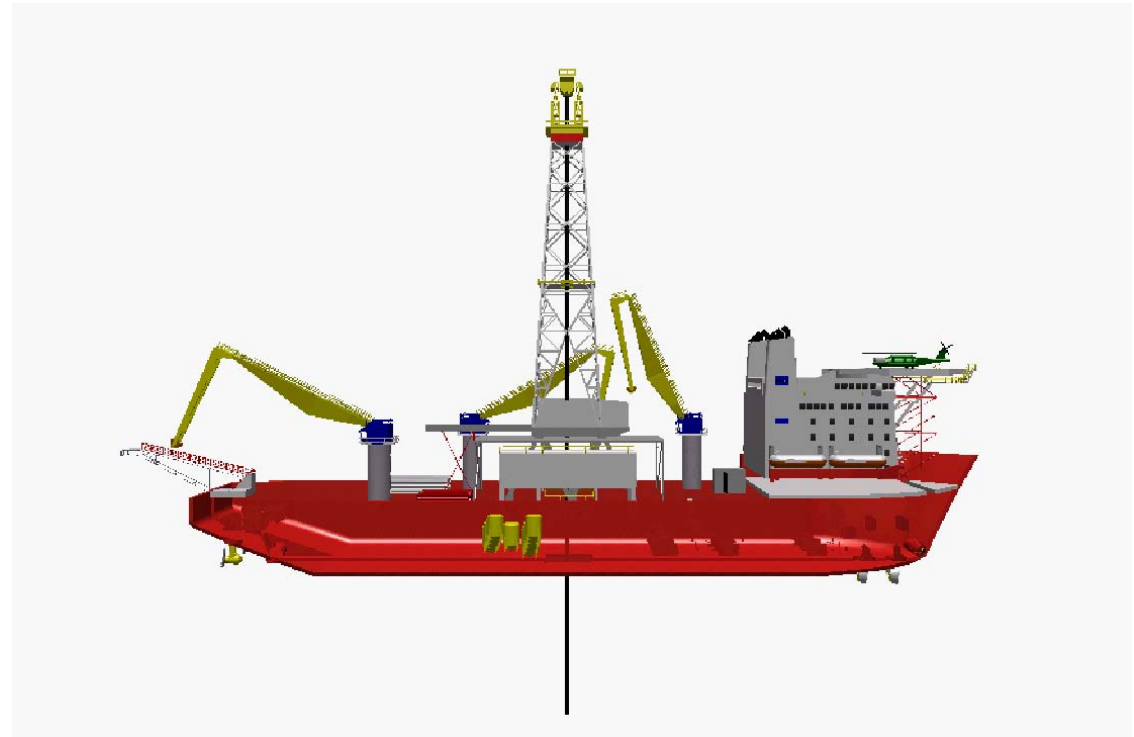


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Summary

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- The problem
 - lack of independent PME's
- Loss of PME's leads to:
 - down time
 - delay
 - incidents
- The solution
 - use Doppler log as back up

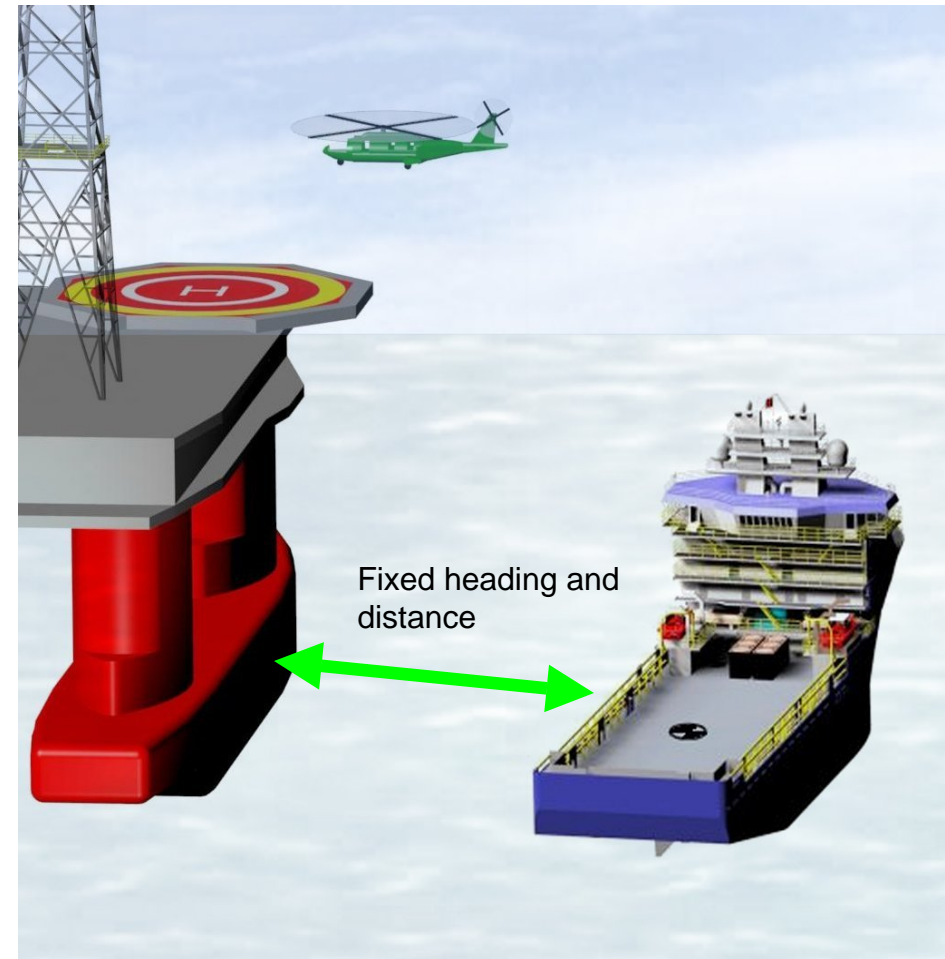


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Dynamic positioning

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- Maintains vessel in fixed position relative to a fixed reference point
- Fixed heading
- Position controlled by PME
- Heading controlled by gyro-compass
- Position and heading can be changed whilst in DP Mode

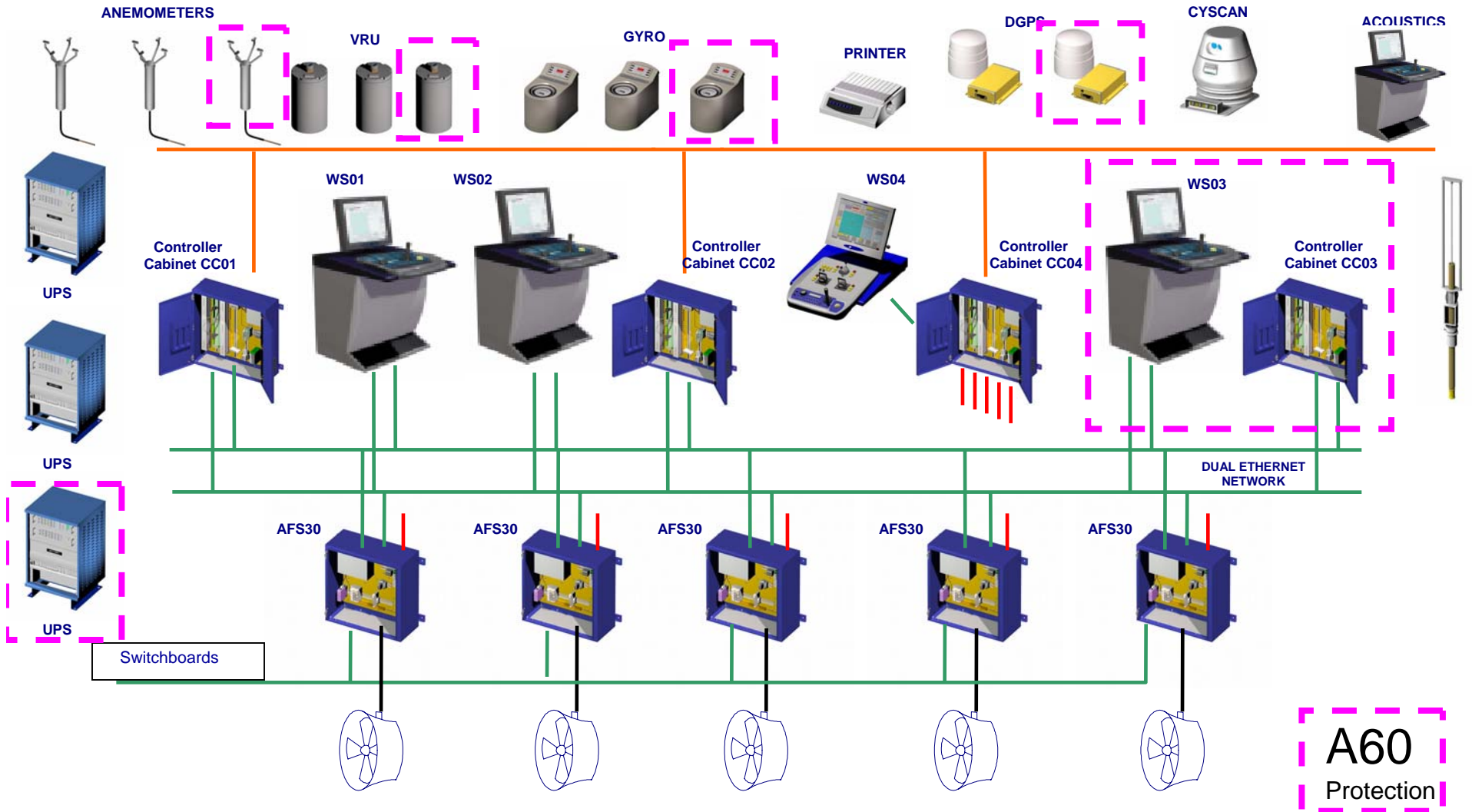


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- For DP a reliable, continuous and accurate position measurement equipment (PME) is required.
- For Class II and III operation, 3 PMEs are required with 2 measuring techniques.
 - OSV's typically have two absolute and one relative position reference systems
 - Drilling Rigs typically have two DGPS/Glonass and two dual acoustics (USBL/LBL)

Class II/III triple voting system

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- Independent PMEs must not have a common mode of failure.
 - multiple (D)GPS systems are not really independent
- Better safety could be achieved with a wider range of available independent PMEs

- Common PME's used for DP include:-
 - Acoustics
 - DGPS
 - Taut wire
 - Laser systems:
 - CyScan
 - Fanbeam
 - Radar systems
- Other options include:-
 - Darps/Artemis
 - Inertial navigation system (INS)

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EXPENSIVE TO OSV AND RIG

SETUP TIME

TRAINING ON OSV AND RIG

DEDICATED

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MEDIUM TO HIGH COST

INITIAL SETUP TIME

MINIMAL TRAINING

DEDICATED

**OFFERS OTHER
INFORMATION ON
HEADING/PITCH/ROLL/
POSITION AIDED**

Limitations

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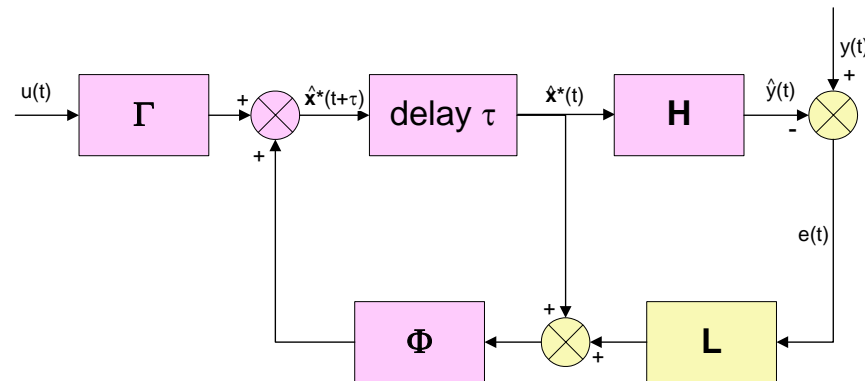
- Each PME type is subject to limitations
 - GPS: ionospheric interference
 - GPS: rig shadowing satellites
 - GPS: correction updates can be up to 60 seconds
- Deep water introduces problems:
 - acoustics noise and update rate
 - taut wire not available
- Laser Systems
 - short range
 - line of sight
 - weather (snow, fog)



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- Dual axis Doppler log
 - known/proven product used by mariners on larger vessels
 - velocity information for bottom and water track
 - surge and sway axes
 - independent of other PME's
 - back up for PME failure
 - 'fill-in' for slow acoustic update rates
 - used in Kalman filter to estimate vessel velocity and position
 - provides useful information to the operators for normal manual operations
- Why use this type of measurement?
 - Past history with cable layers using Doppler log with auto speed mode

- The KF structure allows Doppler measurements to be utilised in a straightforward manner to give optimal estimates of vessel state.
- Properties of the measurement system can be built into the model for improved accuracy.
- For water lock, estimation of current (velocity offset) is easily included.

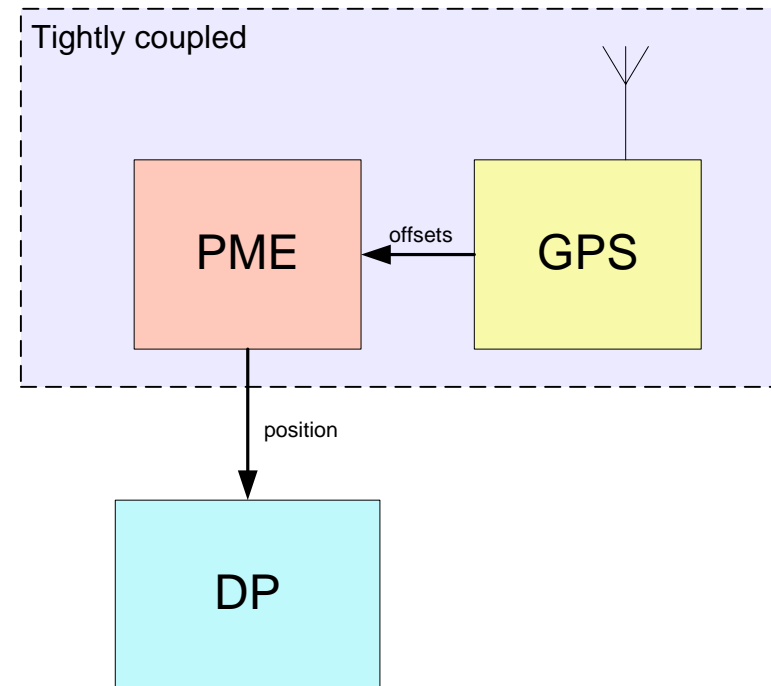


- Offsets identified in the DP system
- Not 'tightly coupled' to (D)GPS
- Fault detection is included in DP system
- Fault tolerant strategies are required to avoid corruption of velocity estimates

Dependent PME

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- PME directly communicates with GPS
 - PME system calculates offsets
 - Combined position sent to DP
 - Cannot be considered independent of GPS
-
- INS falls into this category

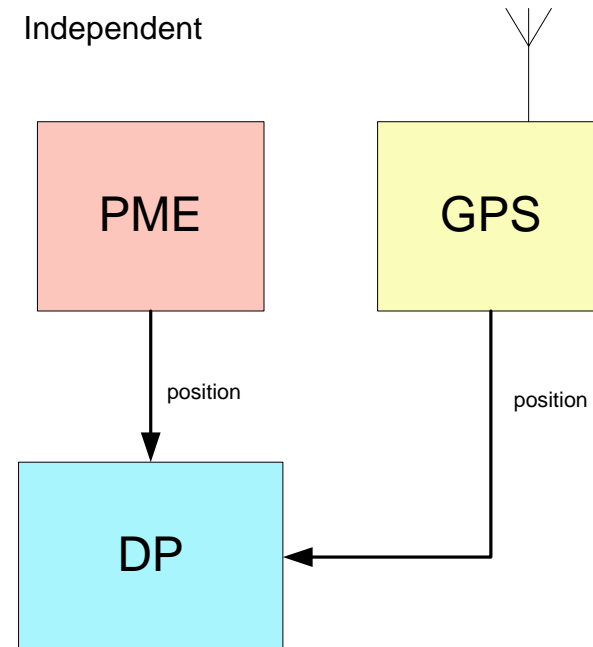


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Independent PME

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- No interconnection between PME and GPS
- DP system calculates offsets
- DP system performs fault detection
- DP system has the ability to reconfigure when a fault is detected

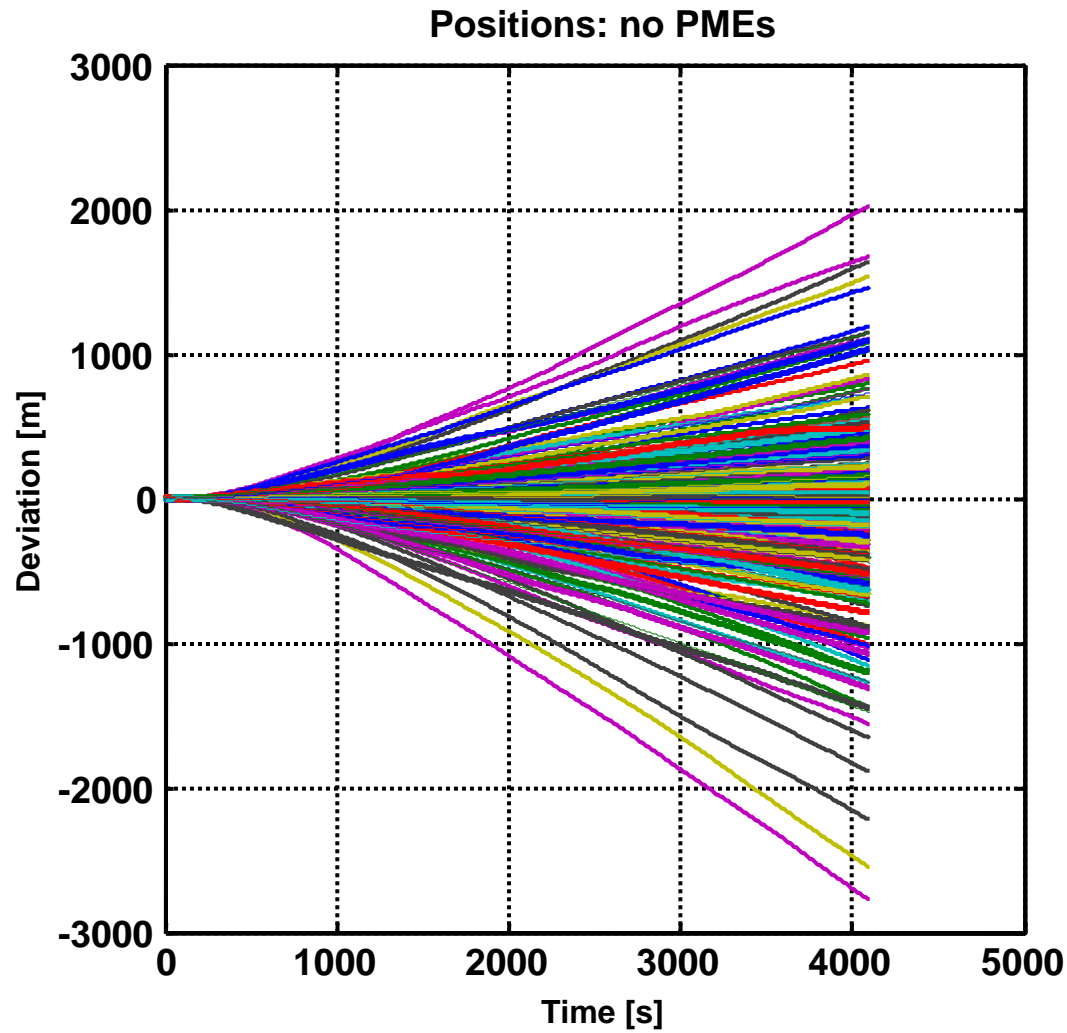


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- Simulation results
 - Monte Carlo multiple runs
 - randomly generated starting conditions
 - DGPS fails after 100 s

No PME

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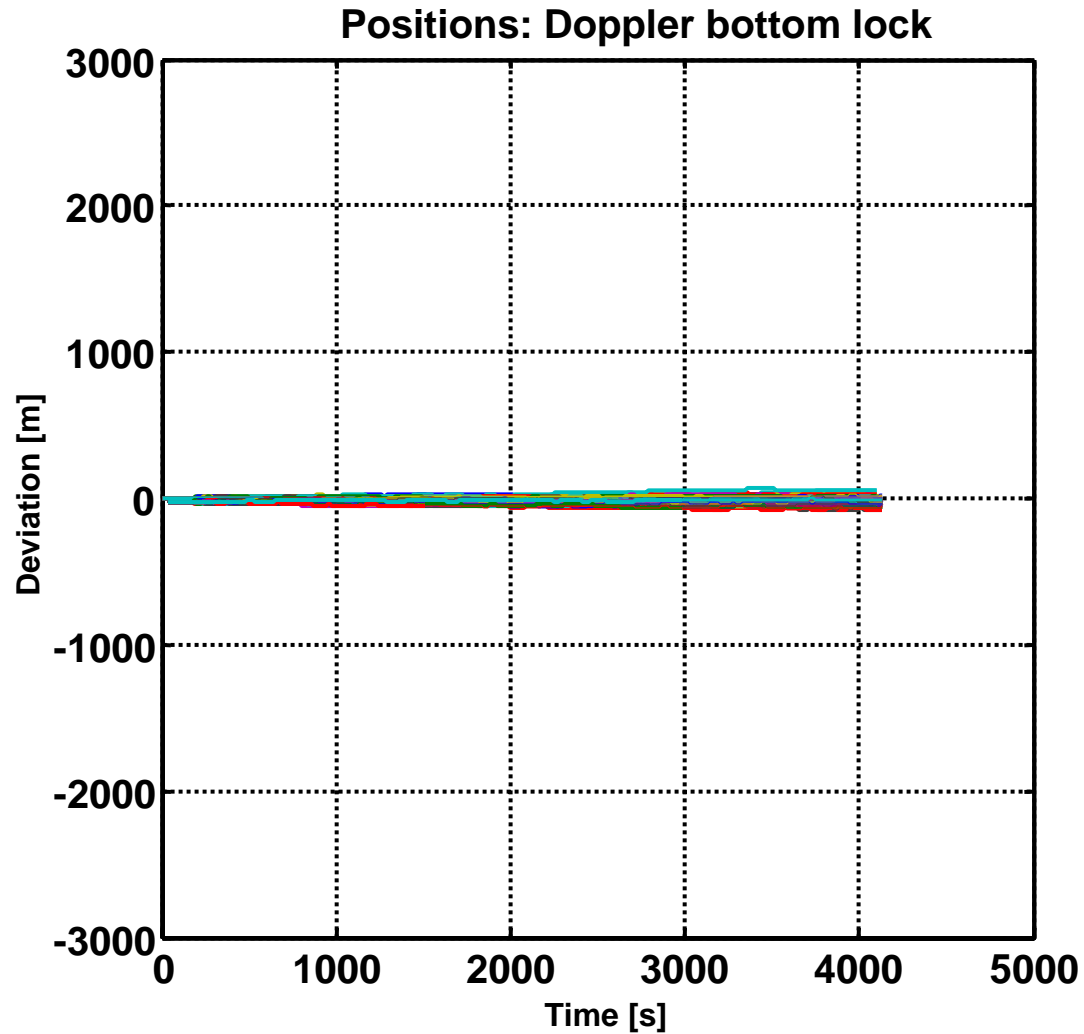


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Doppler available

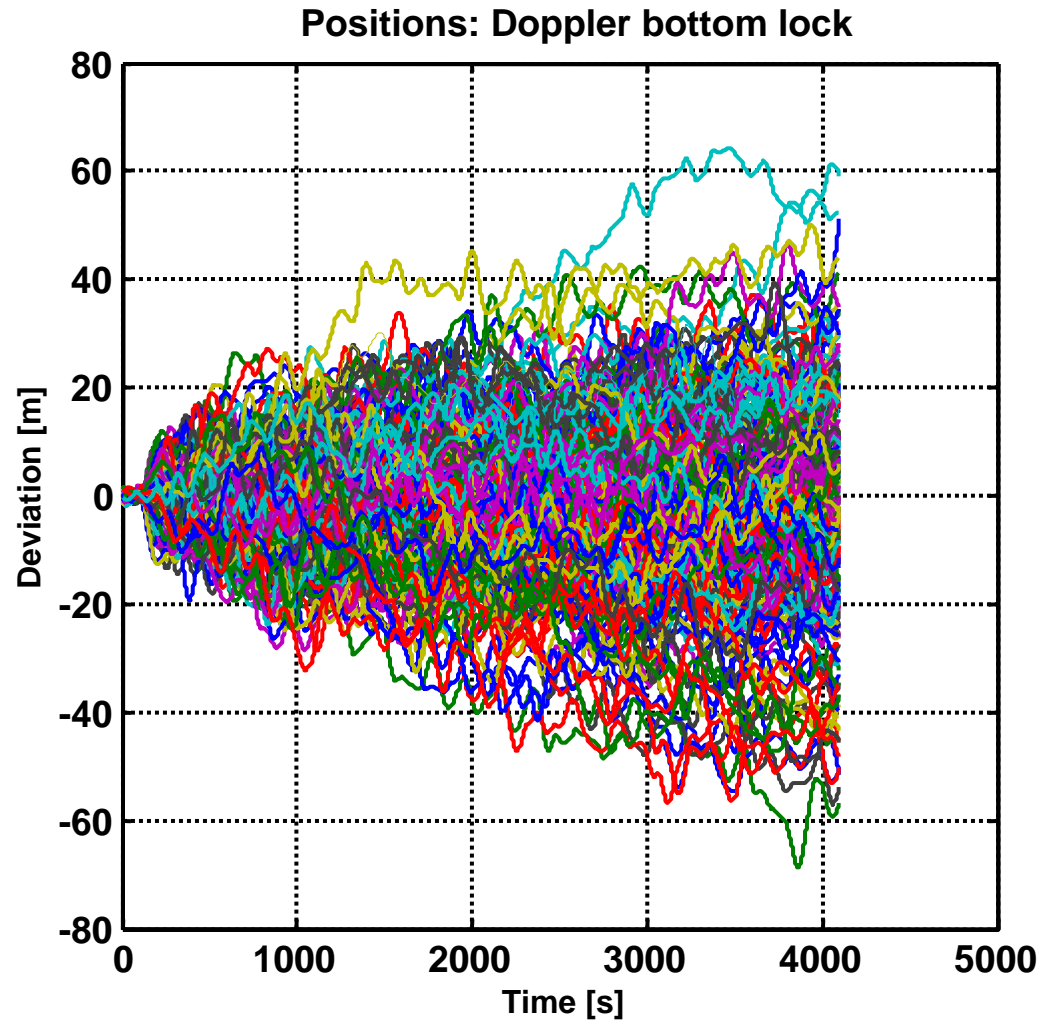
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Doppler available (expanded)

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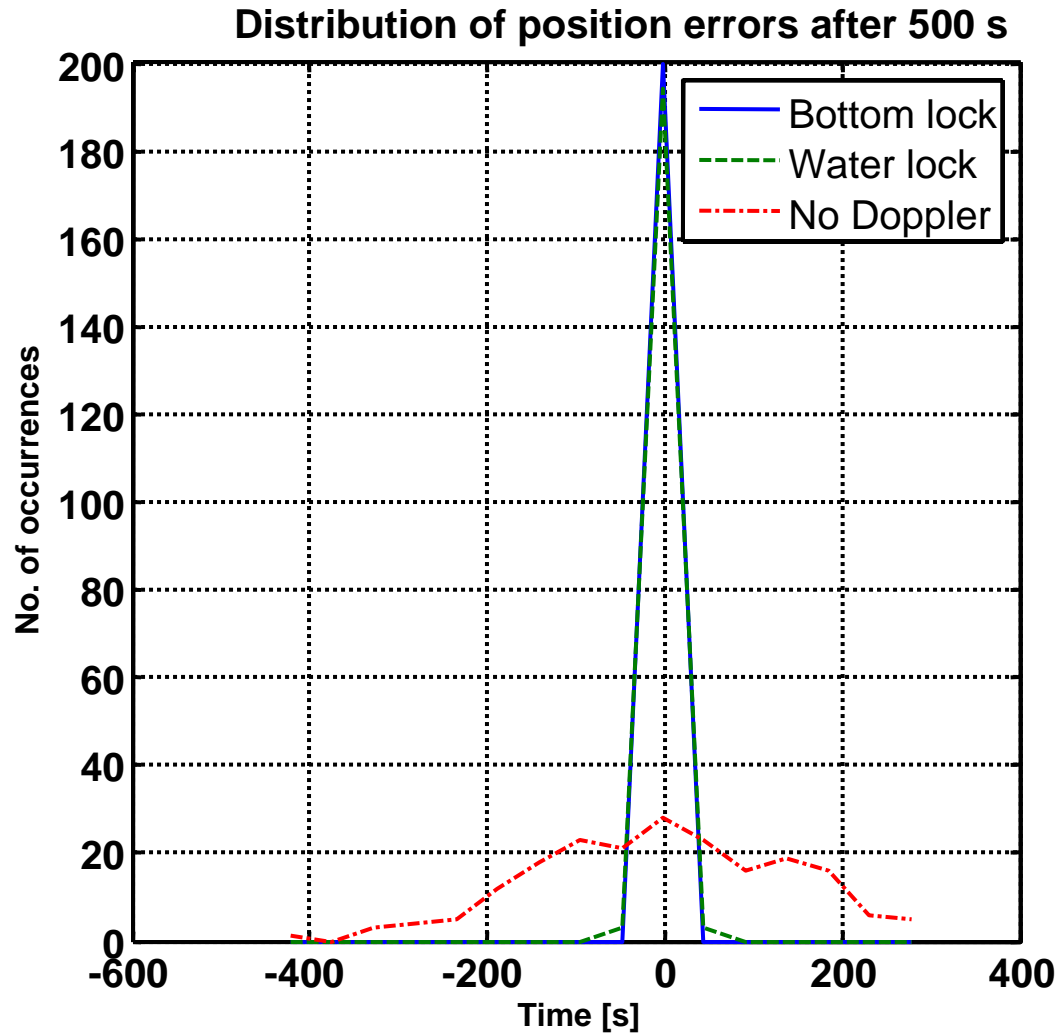


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Distribution of errors

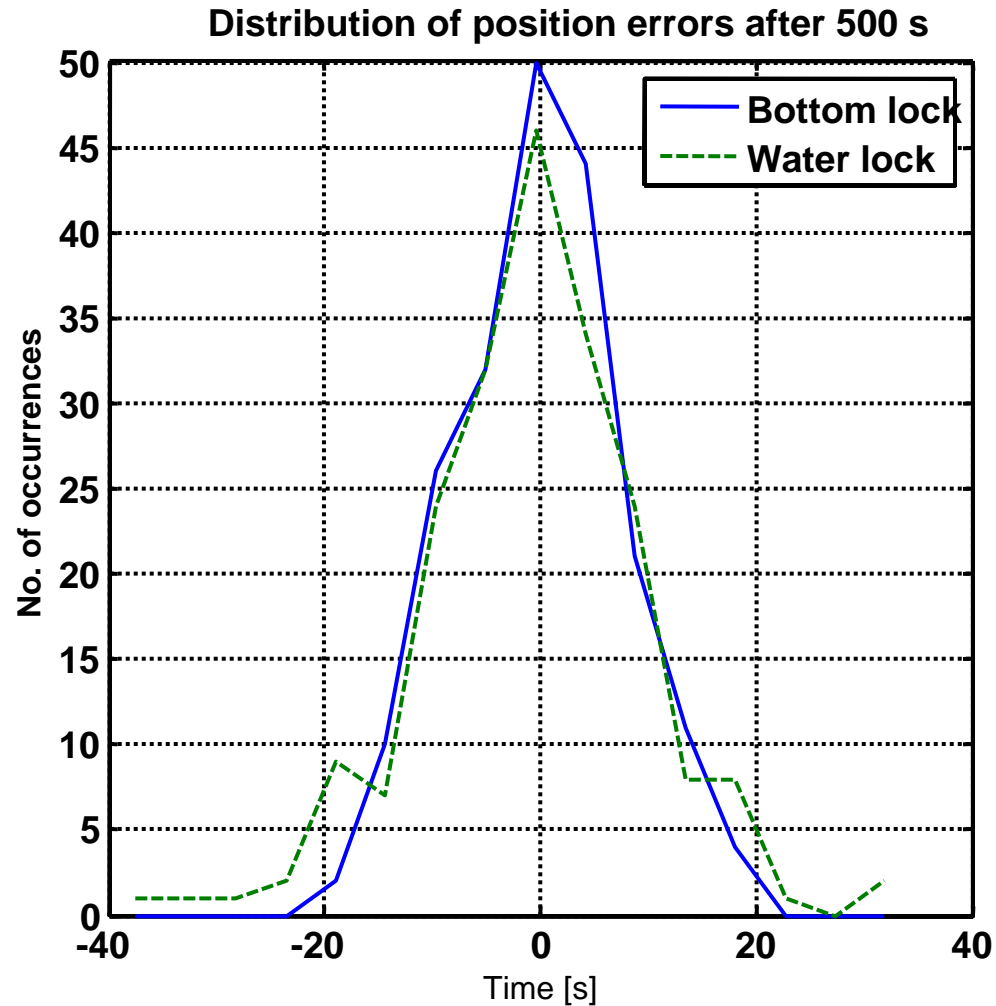
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Distribution of errors

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Deviations after 500 s

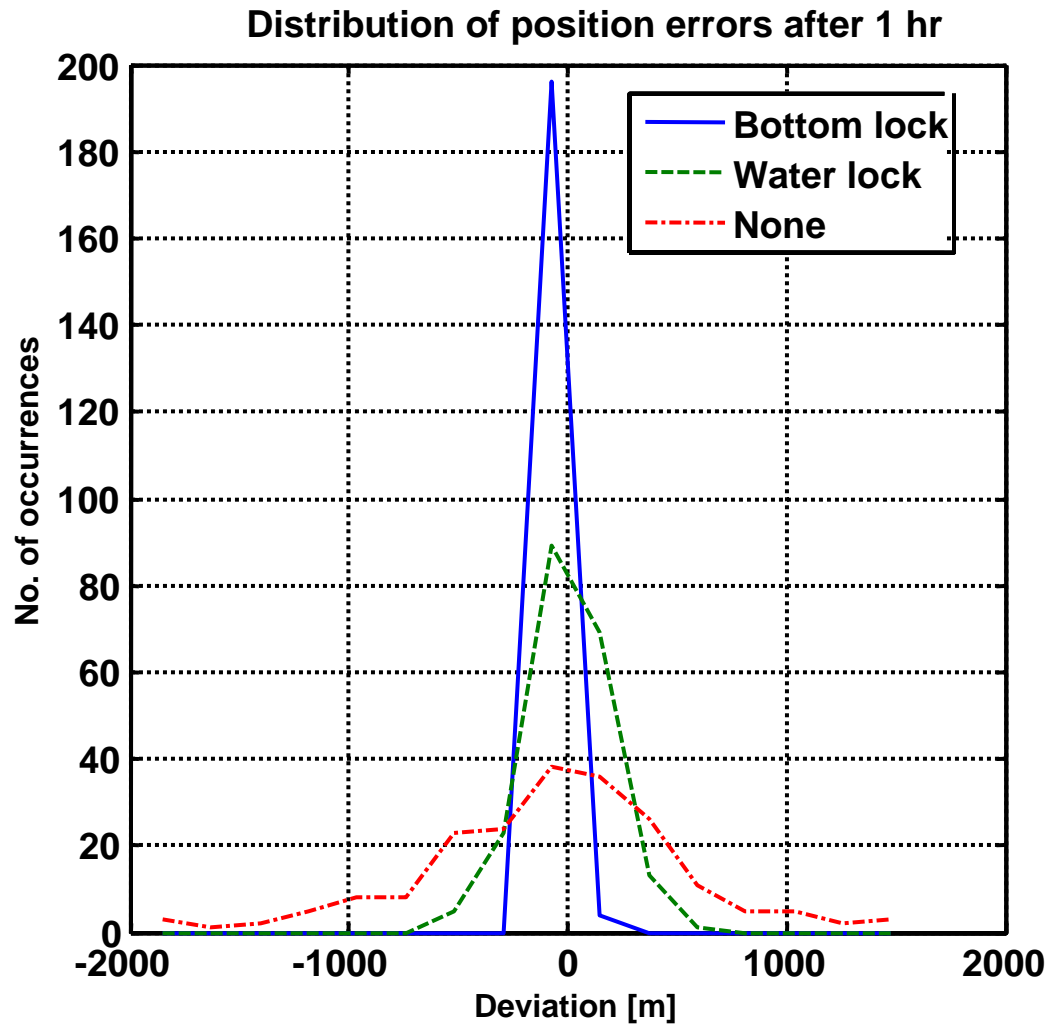
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Measurement type	Position error std. dev. (m)
DGPS	1.2
Bottom lock	7.7
Water lock	10.3
None	138.8

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Errors after 1 hour

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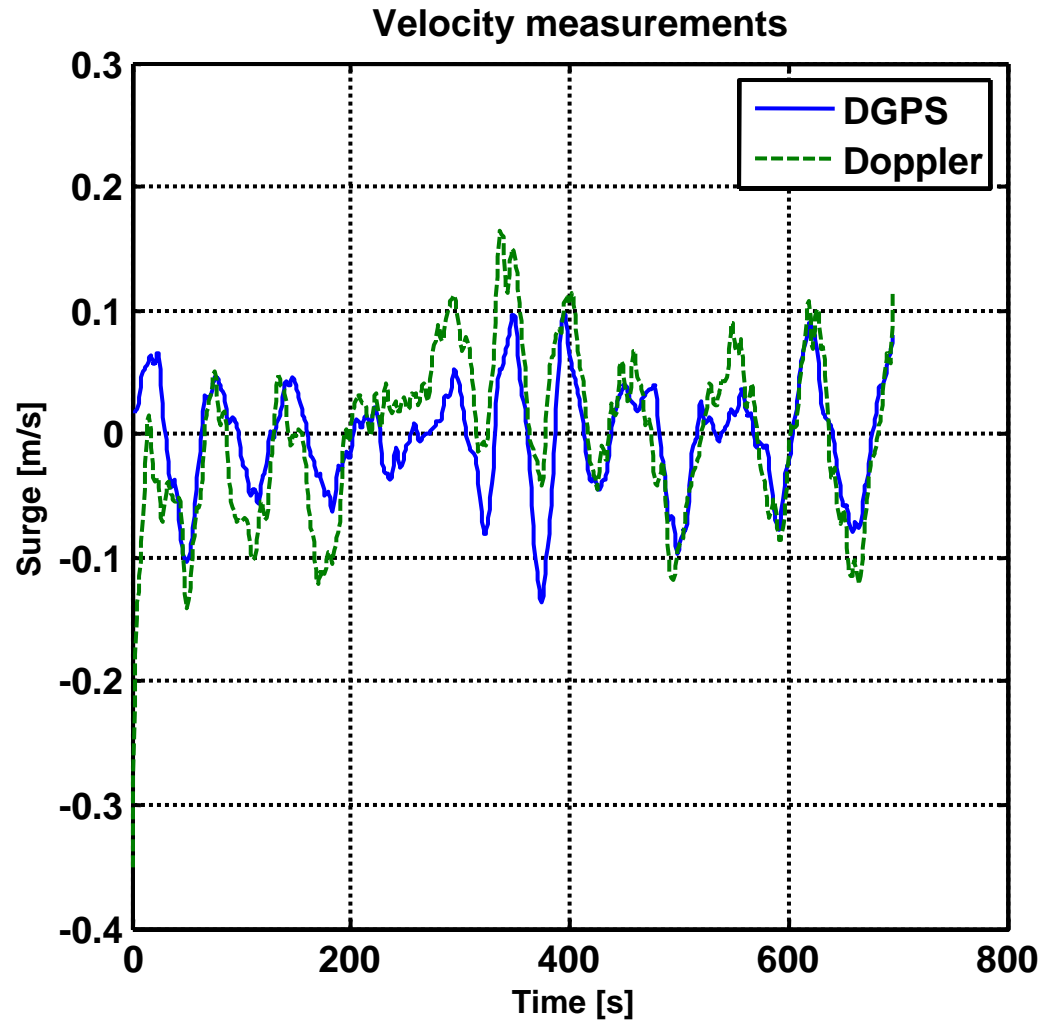


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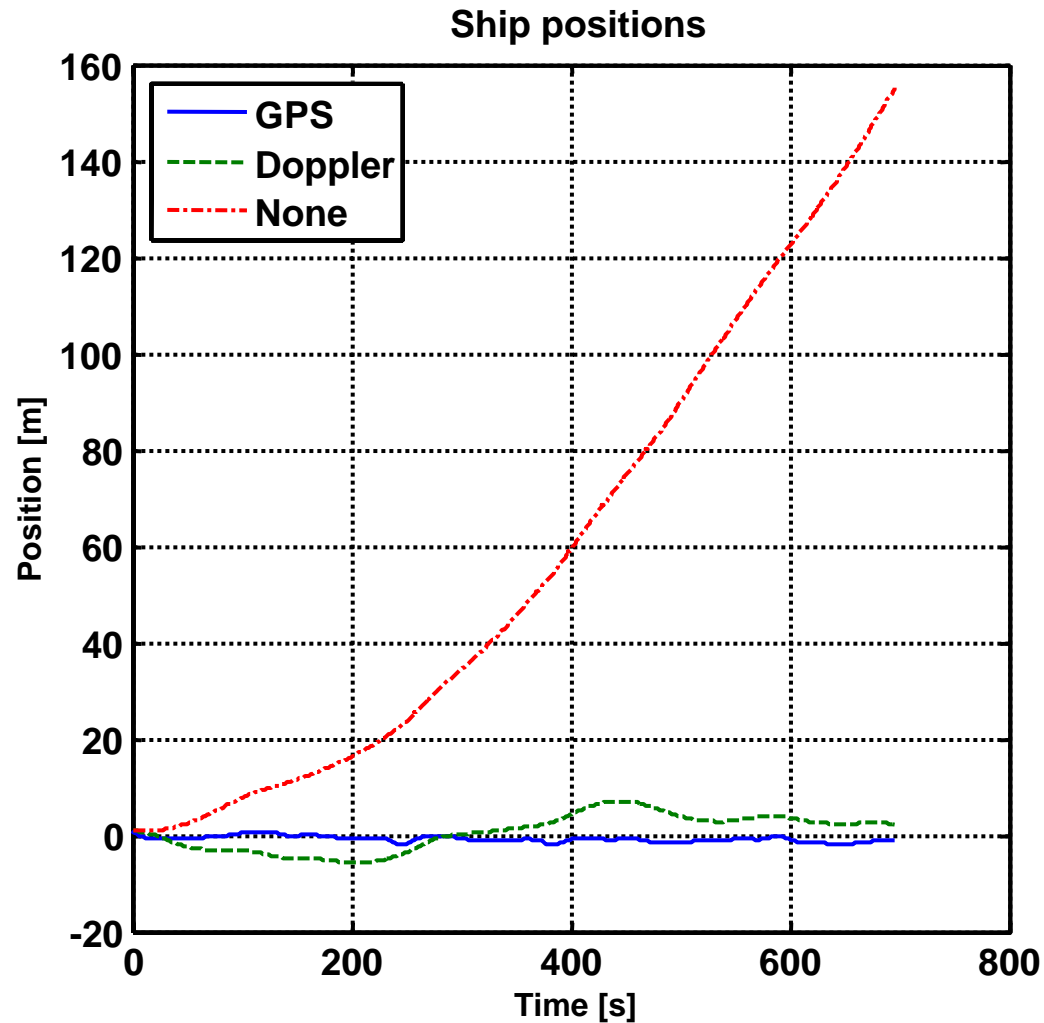
- Measurements acquired from real ship.
- GPS and Doppler measurements available.
- Measurements from both taken during DP.
- Simulation runs performed using each measurement compared to no PME.

Velocity measurements

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Customised Technology for Customer Success

- The more PME's the better (position and velocity)
- PME's must be independent
- The best place to combine measurements is the DP system itself
- Doppler logs can provide useful backup for PME failure
 - for over an hour on bottom lock (actual figures to be confirmed)
 - for minutes on water lock (actual figures to be confirmed)
- Dopplers logs give the operator an indication of fore/aft and port/stbd velocity (another visual aid) for automatic and manual manoeuvring
- Full scale trials are under way
- Follow up talks with INS manufacturers