Dynamic Positioning Committee

Marine Technology Society

SENSORS

HAIN
An Integrated Acoustic Positioning and Inertial Navigation System

Hans Petter Jacobsen and Jan Erik Faugstadmo

Kongsberg Simrad

Session Chair – Steve Browne, Thales Geo Solutions

September 16-17, 2003
Houston, Texas

HAIN

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Hydroacoustic **A**ided **I**nertial **N**avigation

HAIN

Integrated acoustic positioning and inertial navigations system

Jan Erik Faugstadmo

Hans Petter Jacobsen

Kongsberg Simrad AS

Dynamic Positioning Conference, Houston, September 16-17 2003

arranged by

Dynamic Positioning Committee
Marine Technology Society

HAIN

Benefits

Survey:

- Increase accuracy
- Increase update rate

Dynamic Positioning:

- Extend both SSBL and LBL operation limits
- Use slow acoustic update rate -> Save batteries
- Position update during acoustic drop-out

HAIN

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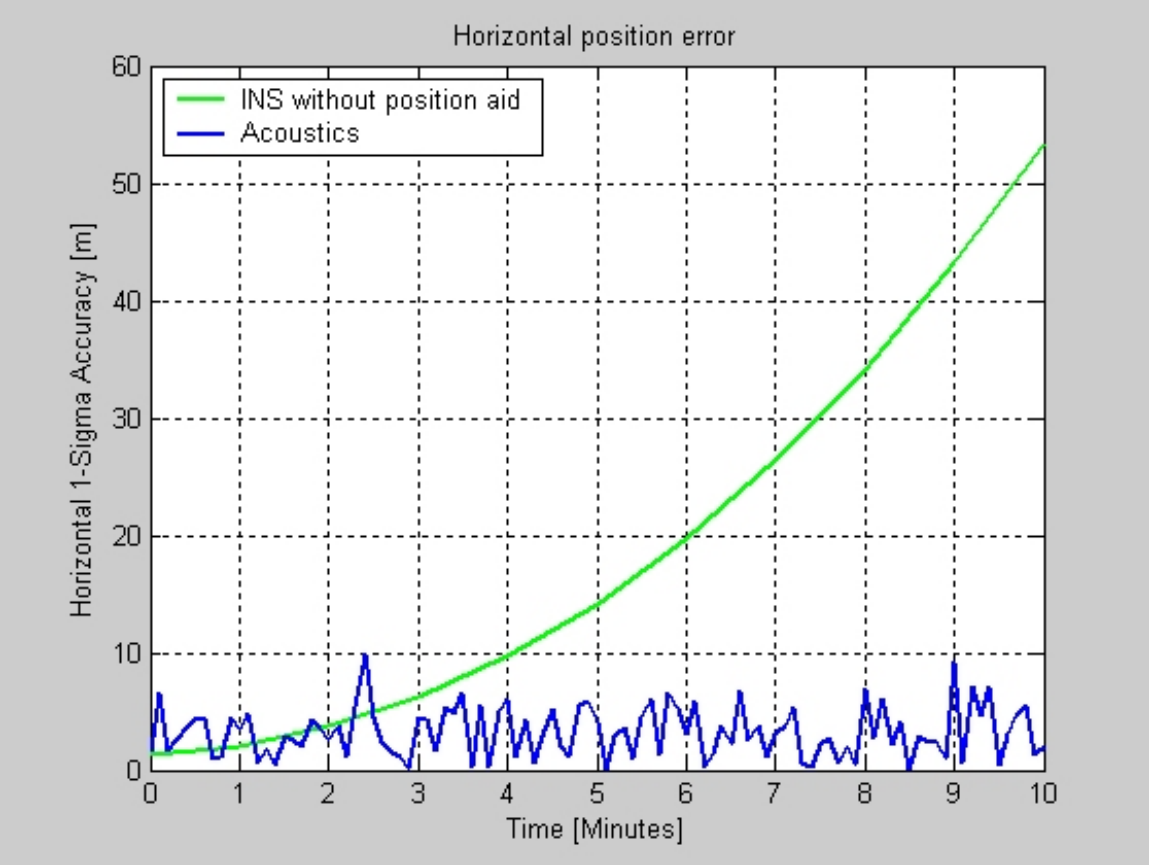

Acoustic positioning: Relativ high and evenly distributed noise No position drift

Inertial positioning: Very low short term noise. Relativ large position drift

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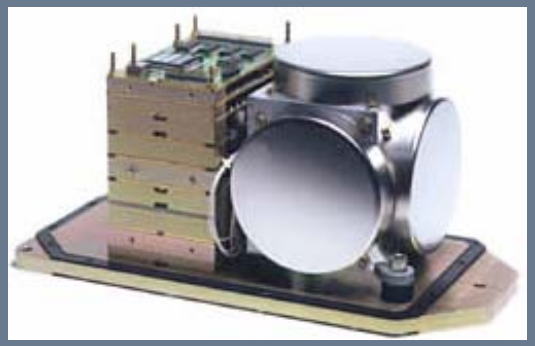
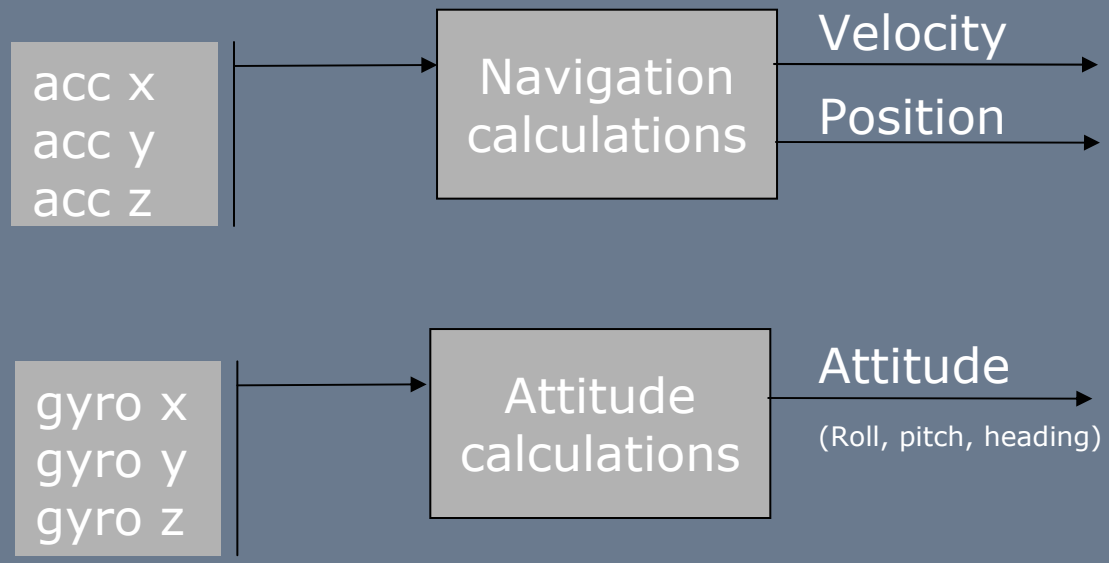
HAIN – Inertial Navigation





The IMU measurements are relative to inertial space.

Integrate accelerometers 1x gives velocity, 2x gives position

Integrate gyros 1x gives attitude

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HAIN – INS classes

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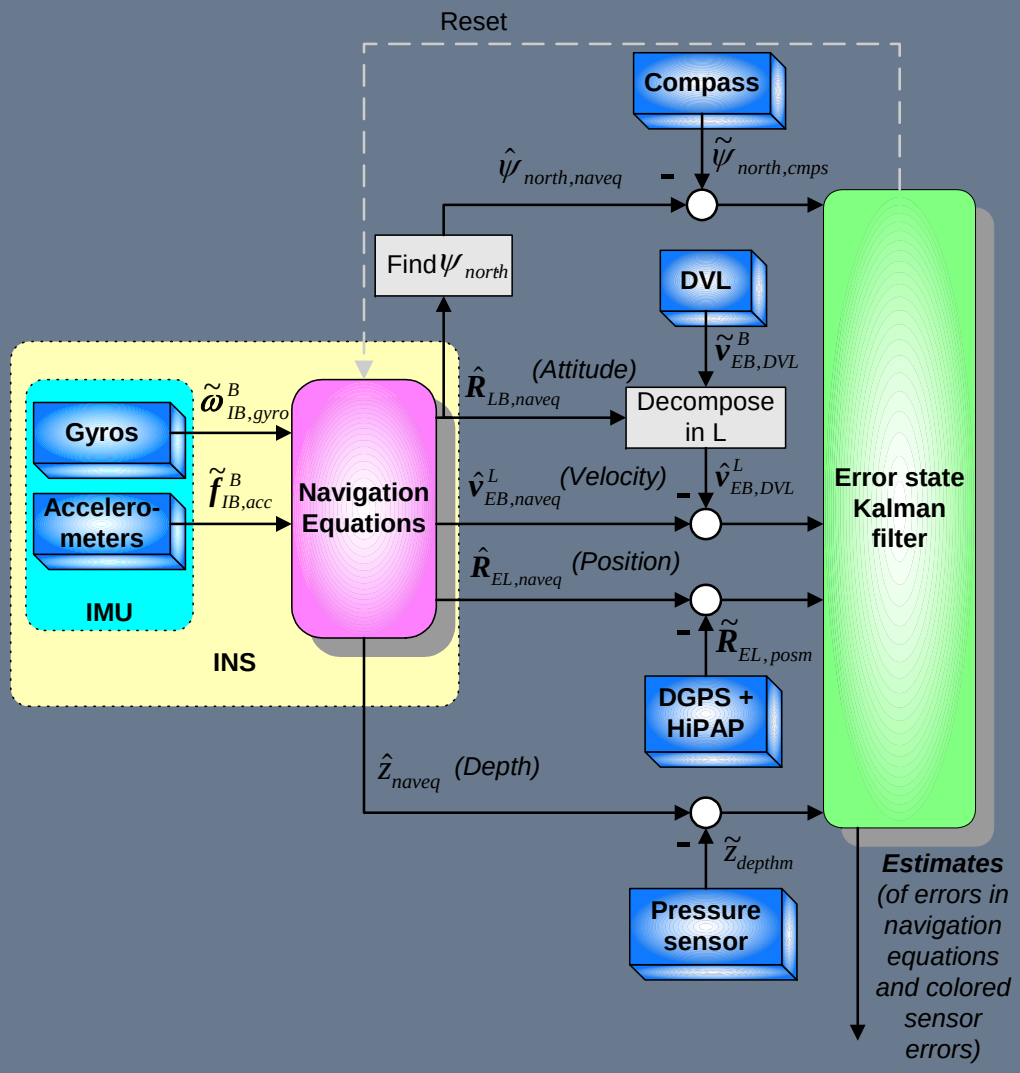
INS systems are usually classified by the standard deviation of the position error growth of their free unaided performance

Class	Traditional application	Gyro technology	Gyro bias	Accelerometer bias
1nmi/h	Marine, air and land navigation	RLG, FOG	≈0.01°/h	≈50µg
>10nmi/h	Tactical systems	RLG, FOG	≈1°/h	≈1mg

HAIN – Kalman Filter Structure



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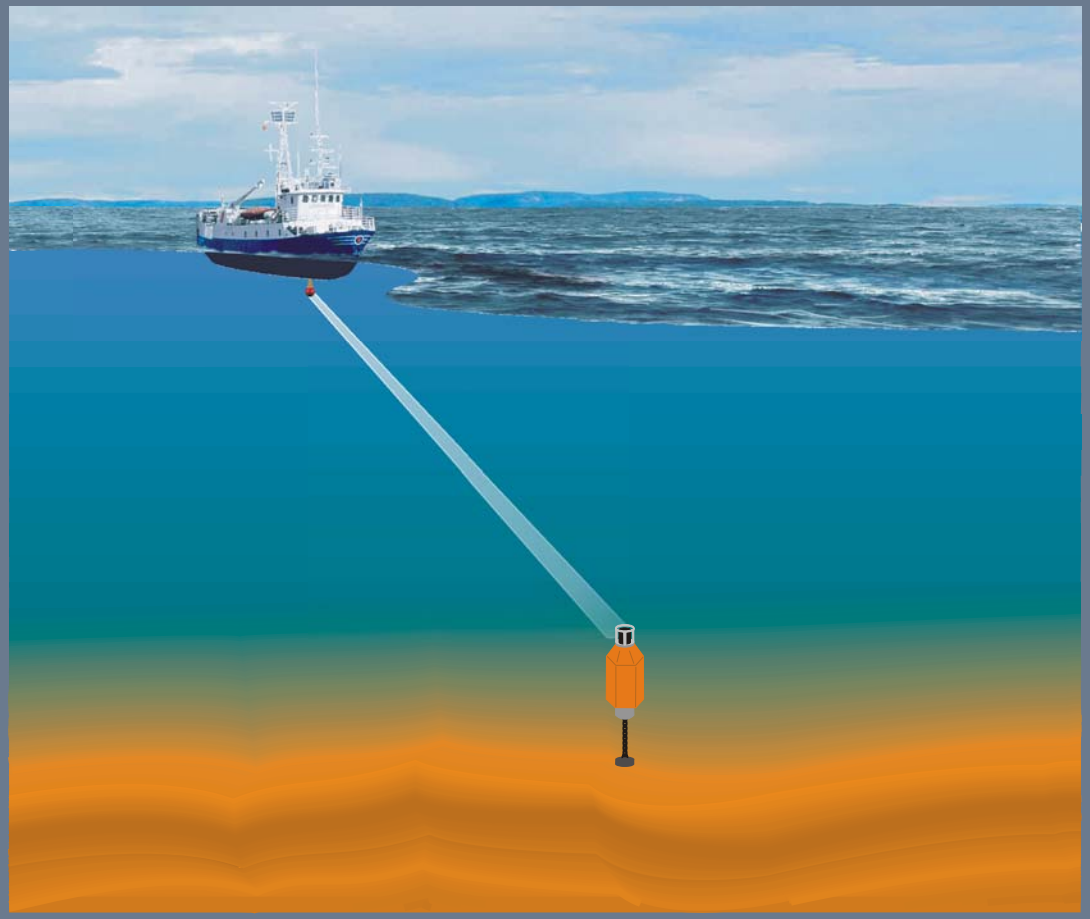
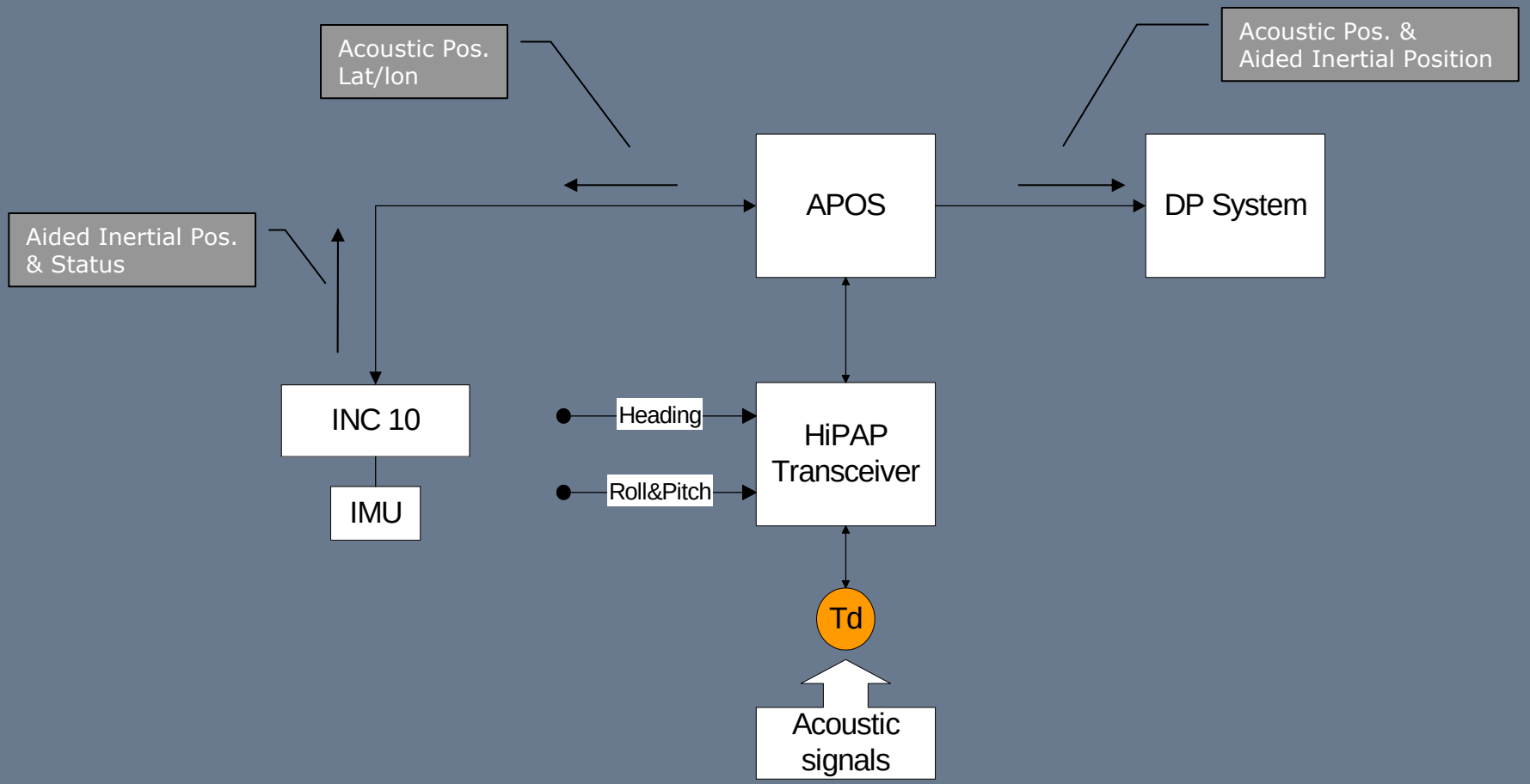
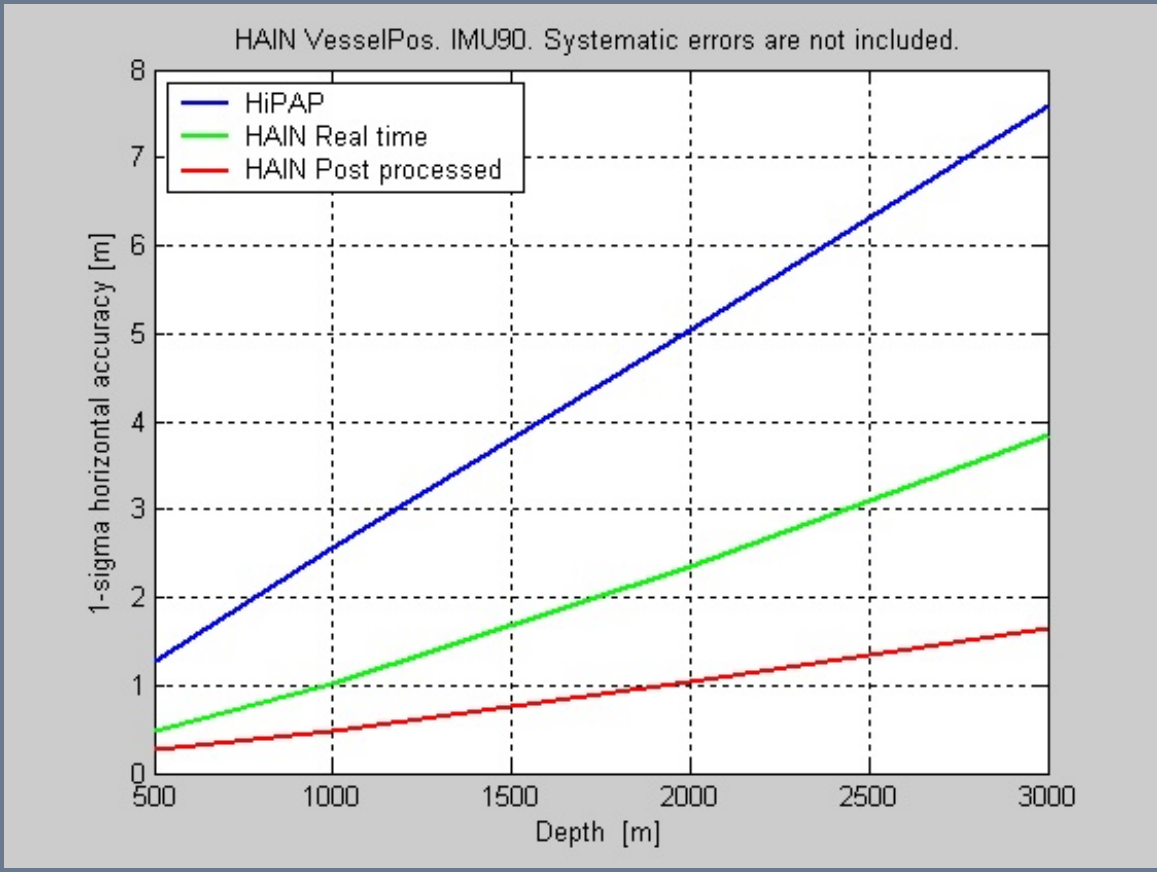
VesselPos



VesselPos


Acoustic Pos.
Lat/lon
Acoustic Pos. &
Aided Inertial Position
APOS
DP System
Aided Inertial Pos.
& Status
INC 10
IMU
Heading
Roll&Pitch
HiPAP
Transceiver
Td
Acoustic
signals

HAIN - Simulations



Simulation parameters:

HiPAP SSBL angle accuracy:	0.1° in x and y
dGPS position white/coloured noise:	0.15m/0.1m North and East

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HAIN - Simulations

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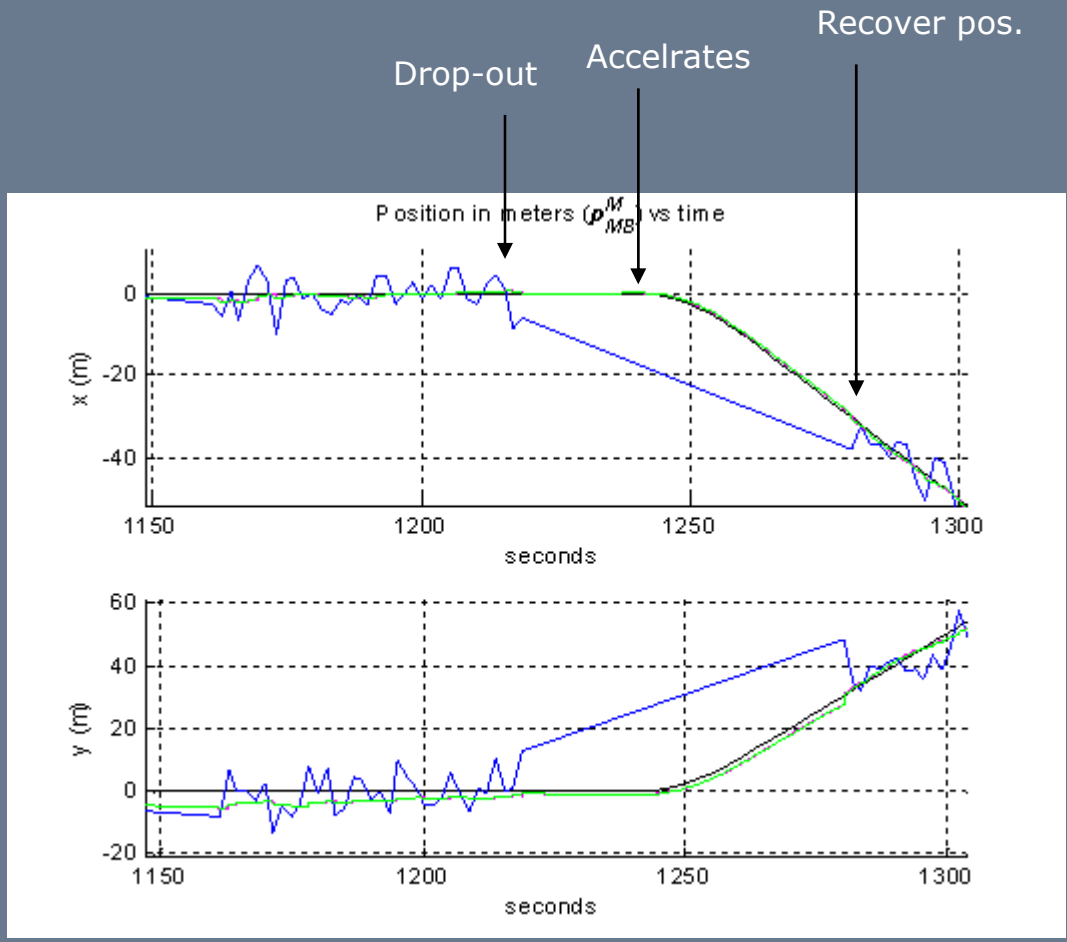
Drop-out during vessel move

IMU:1nmi/h

HiPAP SSBL 1000 m

Black : Correct position
Blue : HiPAP "
Green : HAIN "

Vessel accelerates during a HiPAP dropout between 1240s and 1250s



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HAIN - Simulations

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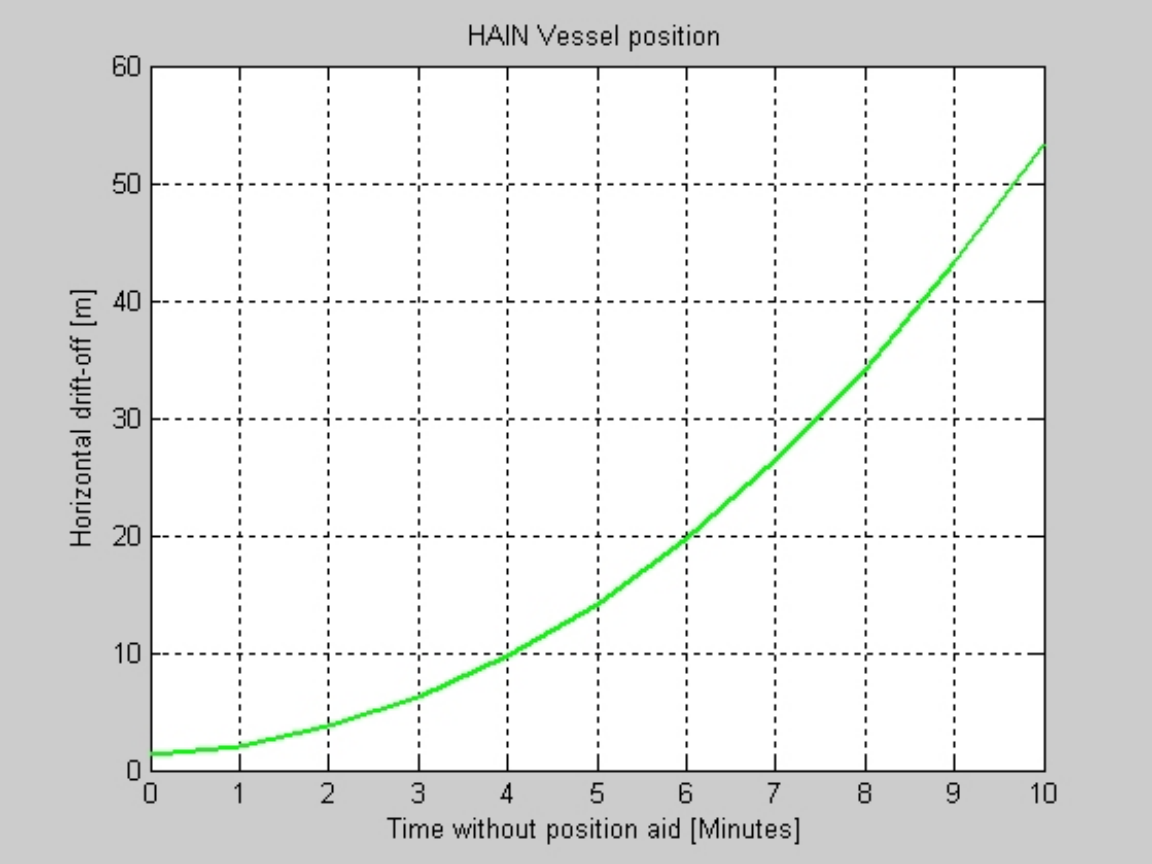
VesselPos accuracy during HiPAP dropout.
1nmi/h IMU



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HAIN - Seatrials

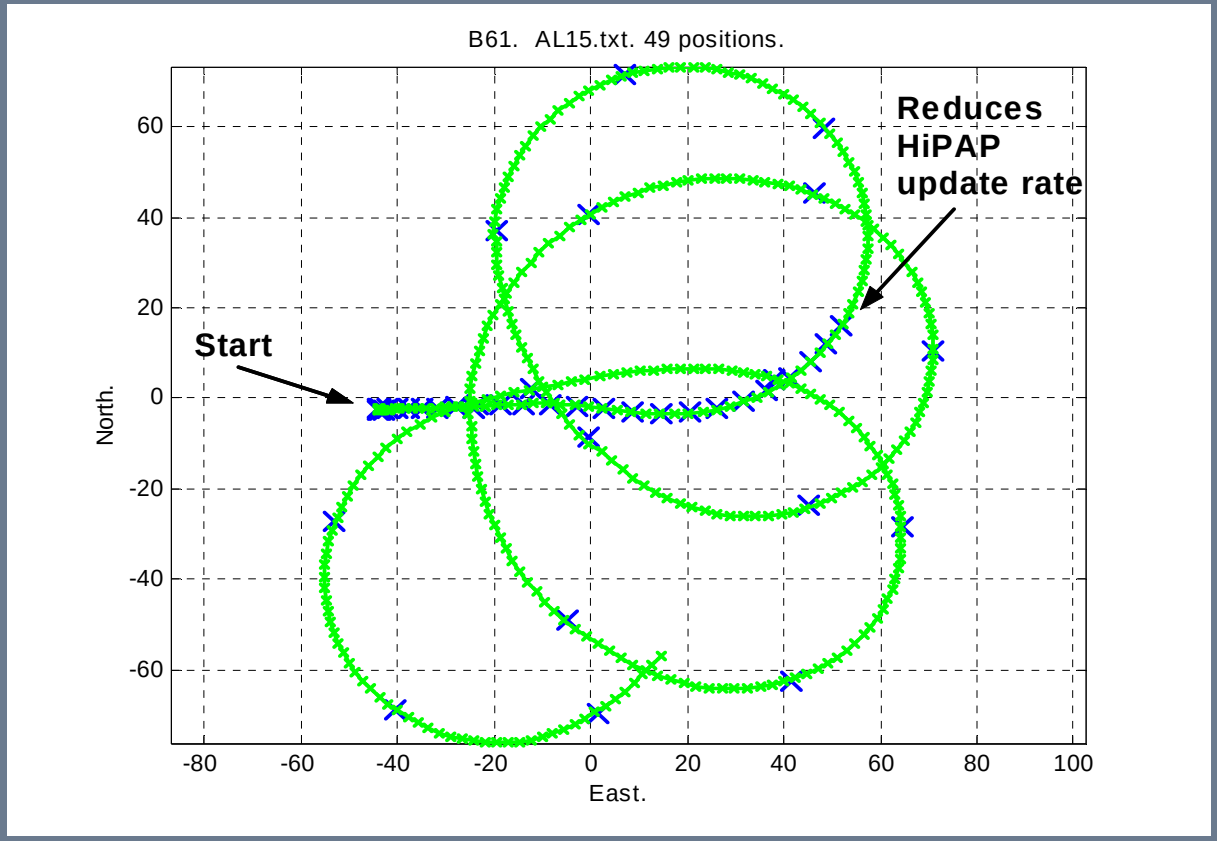
The measurements in the trials are:

HiPAP positions relative to a TP on the seabead with known lat long position. The waterdepth is 200m.

Known depth (The vessel is at the surface)

Readings with 100 Hz from the IMU 90.

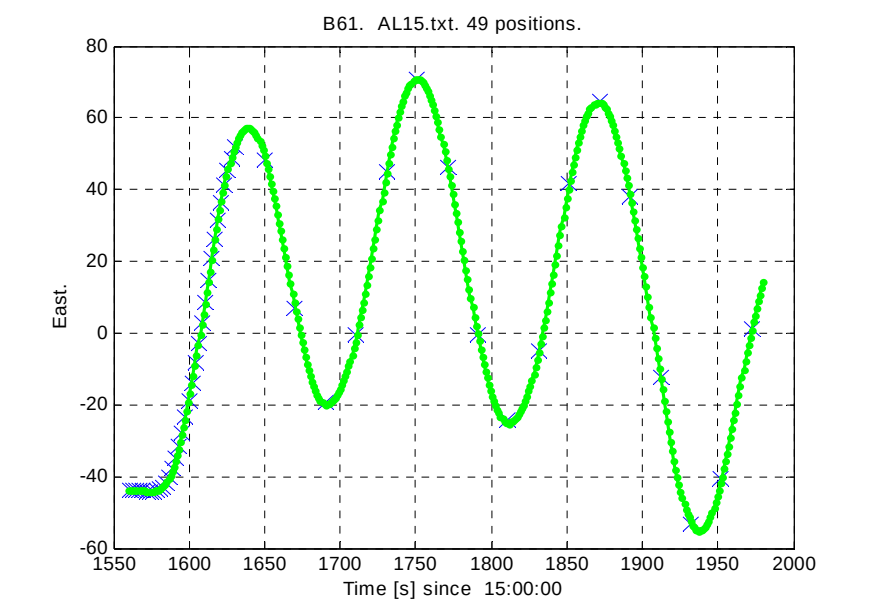
HAIN - Seatrials

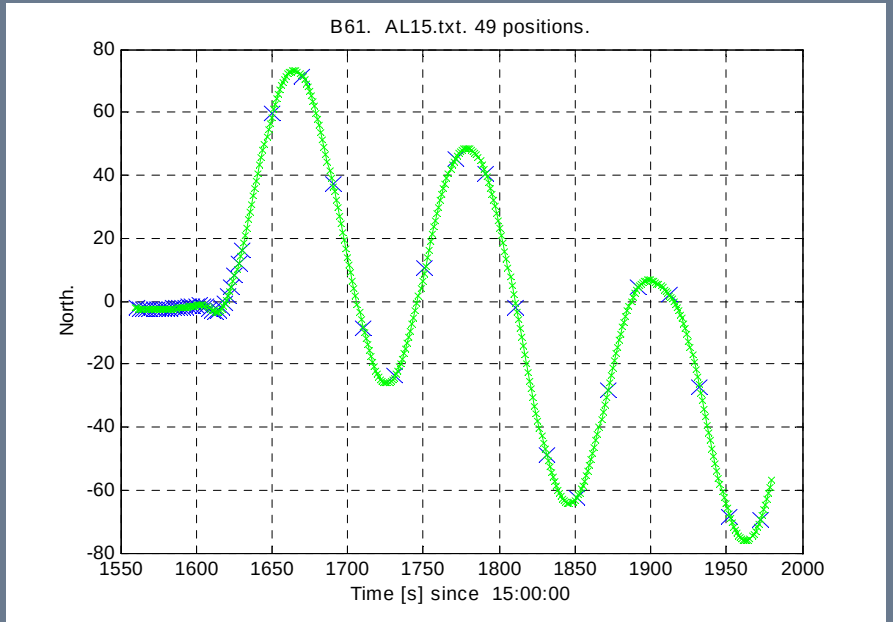


Blue crosses: Vessel position from HiPAP updates, 1.5 to 20 second.

Green crosses: Vessel positions from real time HAIN estimates every second

HAIN - Seatrials





The time plots show the same circles as the scatter plot on the previous slide.

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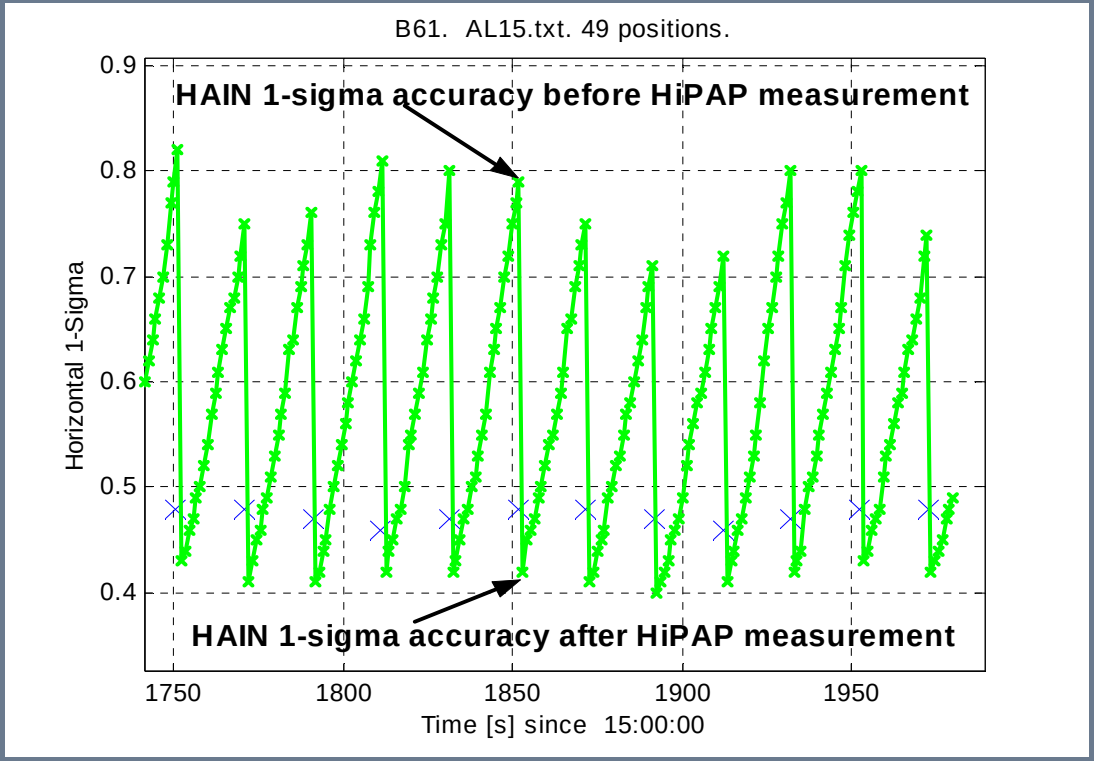
HAIN - Seatrials



- Blue crosses: Estimated HiPAP 1-sigma accuracy, based on Signal to Noise level, distance and geometry
- Green line: HAIN 1-sigma estimated accuracy.
- Based on these values we should expect 0.90m difference between HiPAP measurement and HAIN estimate.

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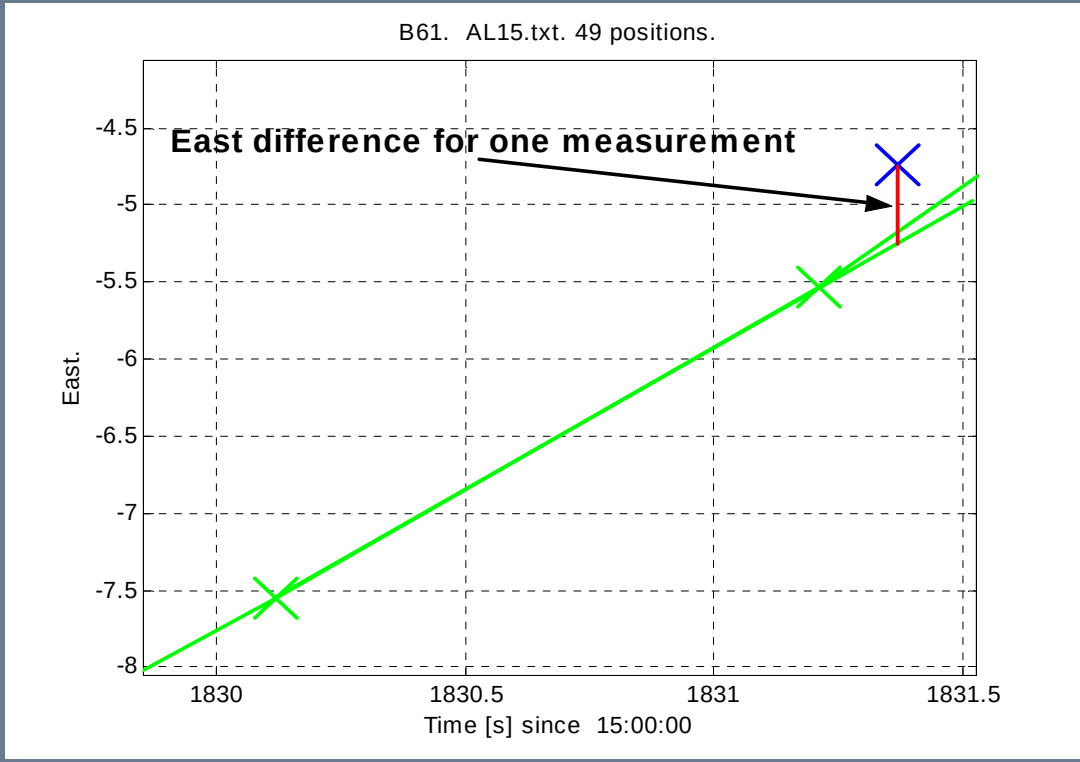
HAIN - Seatrials



The average of the difference in the horizontal plane is 0.64m.

It is not possible to distinguish between HiPAP error and HAIN error.

The average difference 0.64 m in the horizontal plane corresponds to a HiPAP angle error of 0.13º in X and Y.

The difference is less than expected, which is 0.9m.

HAIN – Seatrials with offshore DP vessel

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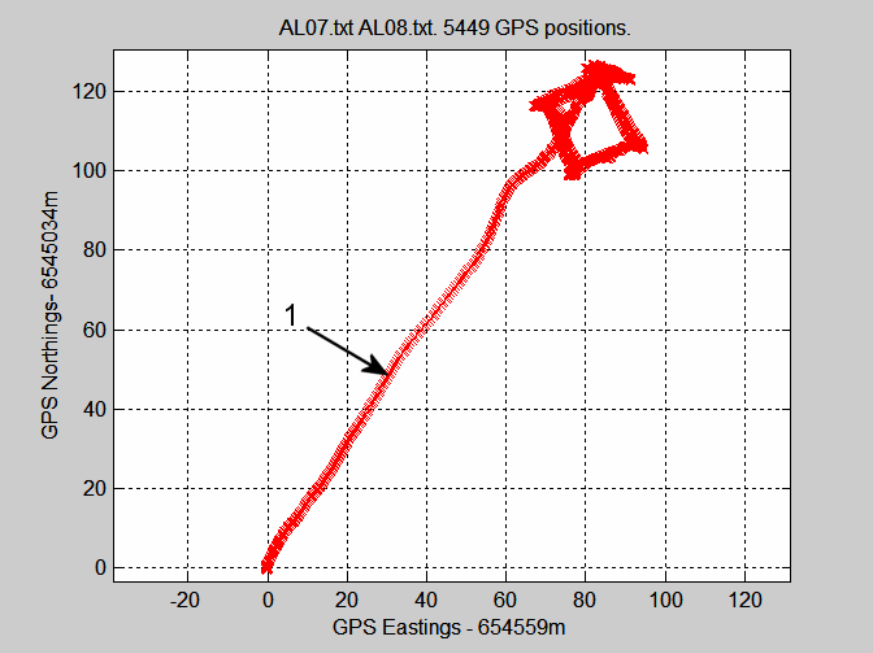
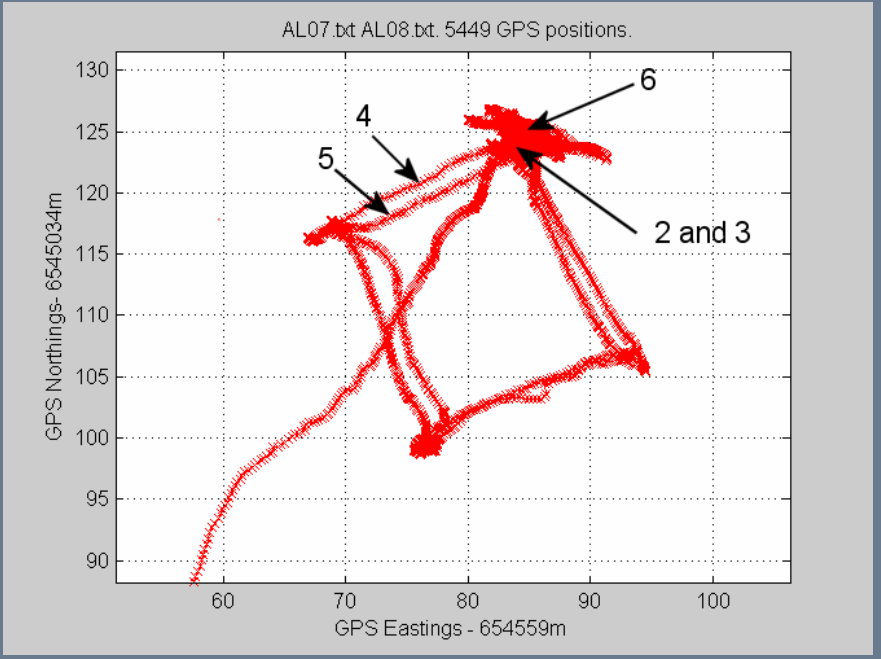
Vessel position during the test as logged with dGPS





DP used HAIN as the position reference during the test

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HAIN – Seatrials with offshore DP vessel

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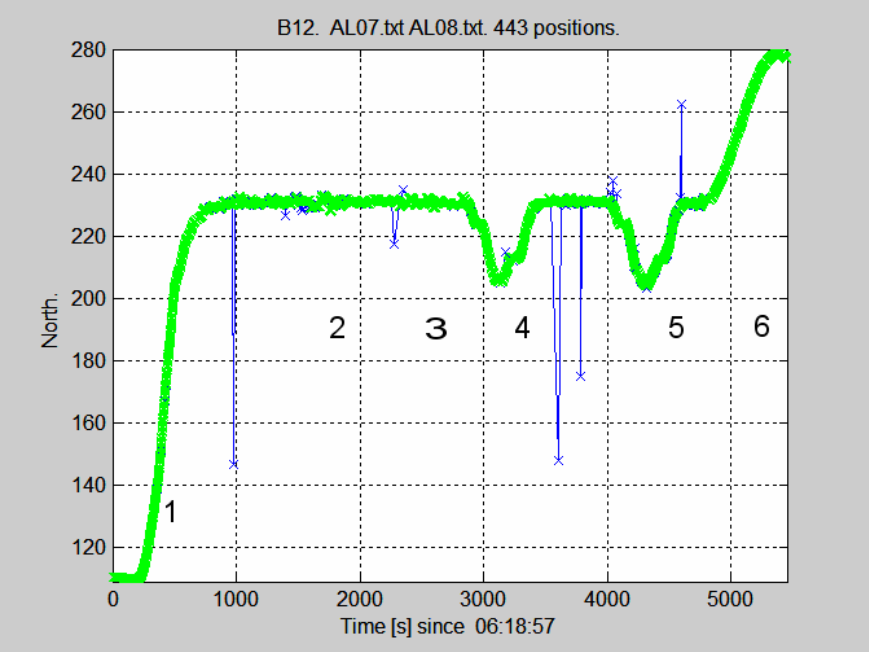
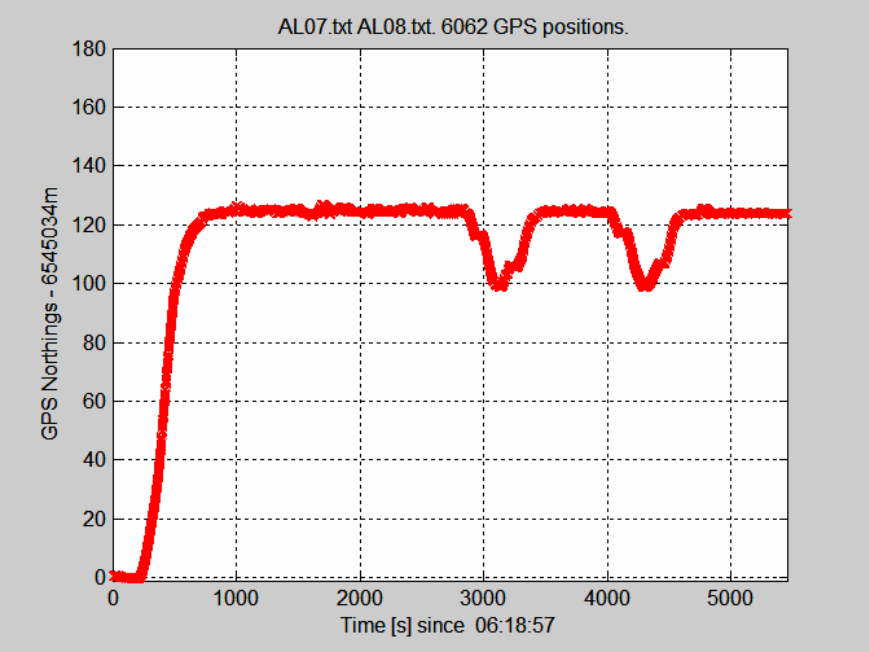
Timeplot North co-ordinate





HAIN green, HiPAP blue, dGPS red

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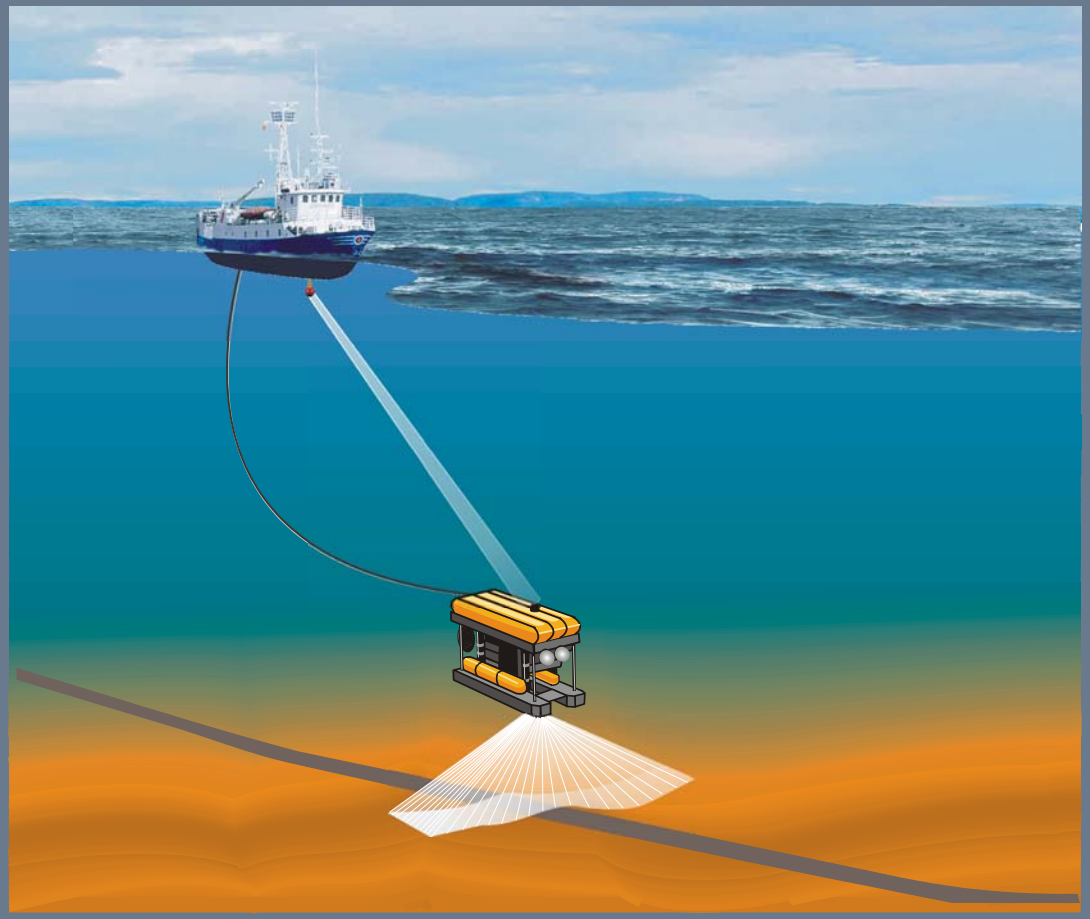
SubseaPos



HAIN

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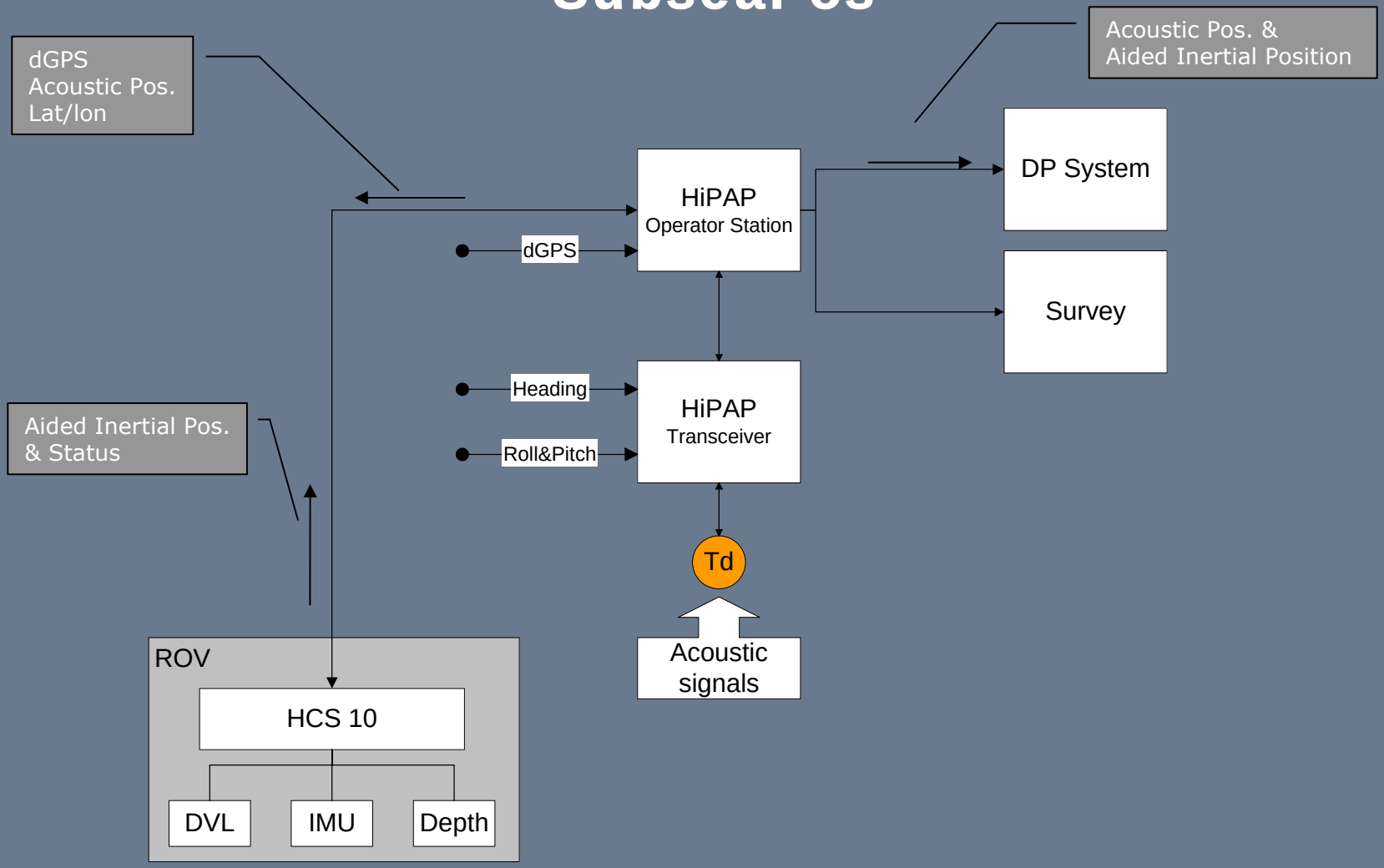
SubseaPos



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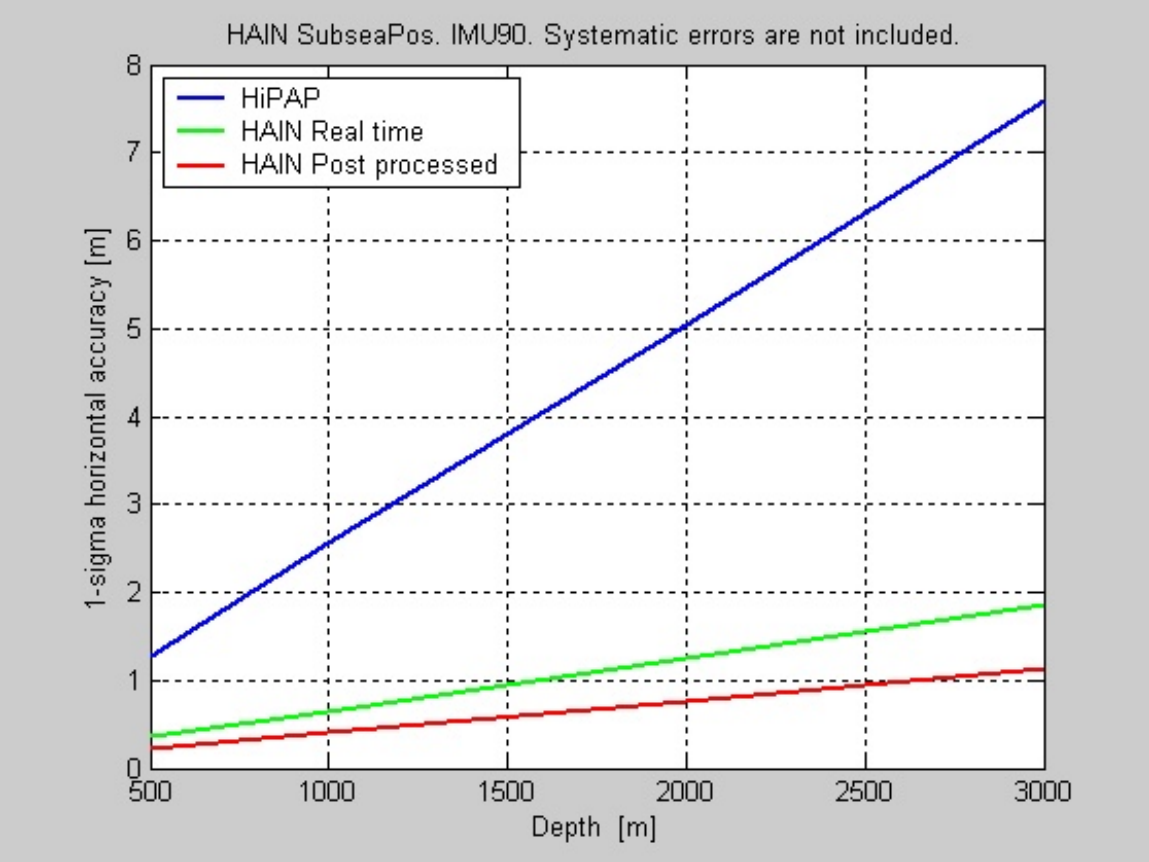
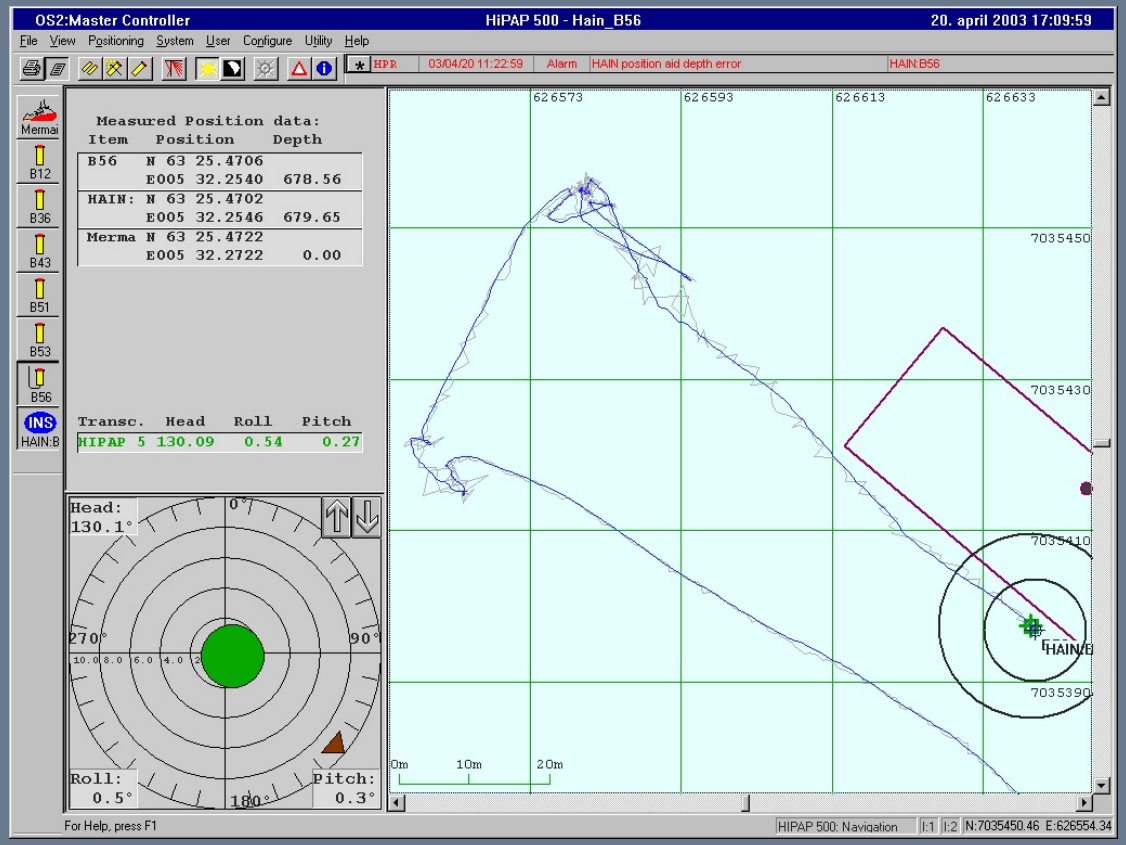
HAIN - Simulations



Simulation parameters:

HiPAP angle accuracy	0.1° in x and y
dGPS position white/coloured noise:	0.15m/0.1m North and East
DVL speed white/coloured noise:	0.02m/s / 0.015m/s

HAIN Pipeline route survey - Depth 650m



Sceen dump, real-time data
HiPAP SSBL – grey line, HAIN – blue line

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HAIN Pipeline route survey - Depth 650m

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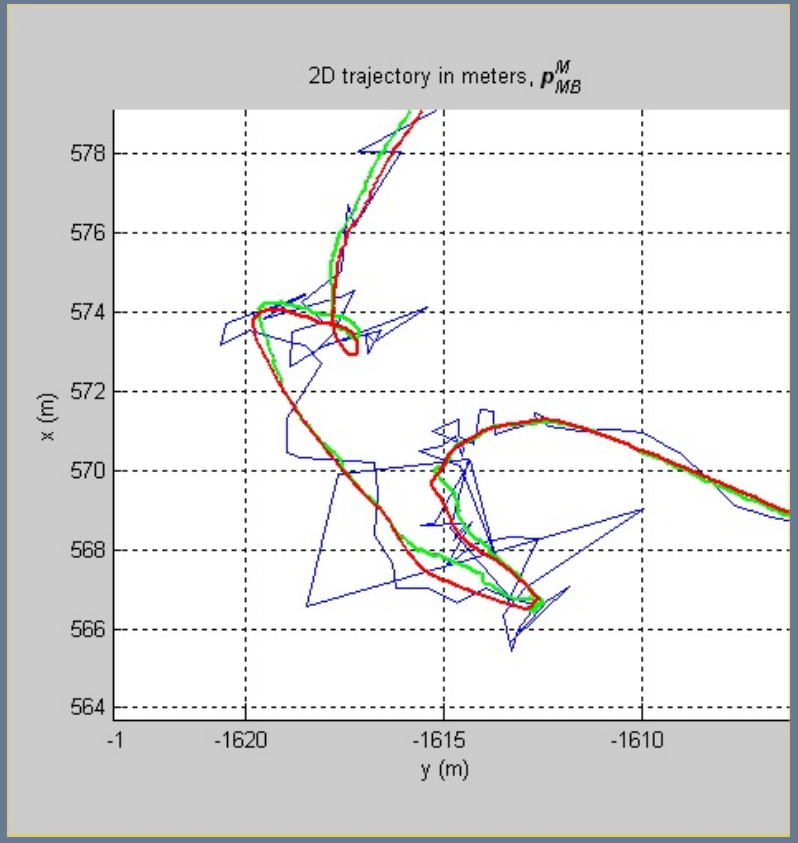

HiPAP SSBL blue , HAIN real-time green, post processed red

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HAIN Seabed Survey – Depth 4000m

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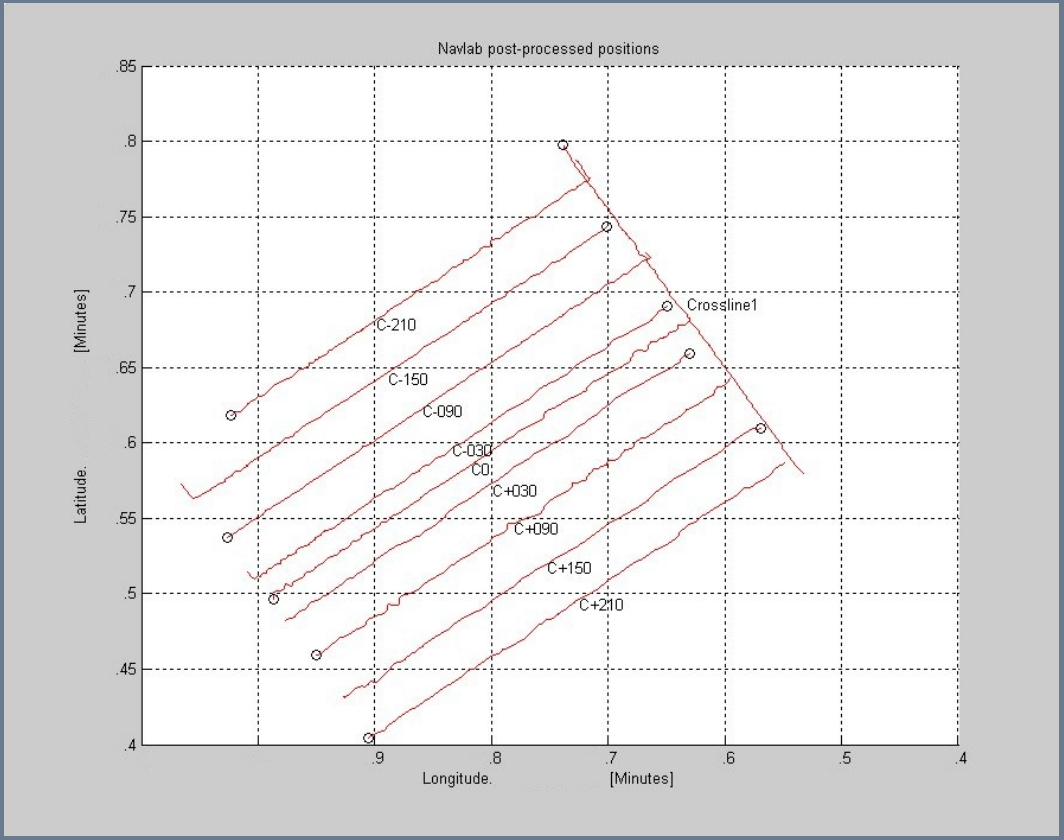

Survey lines – post processed

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HAIN Seabed Survey – Depth 4000m

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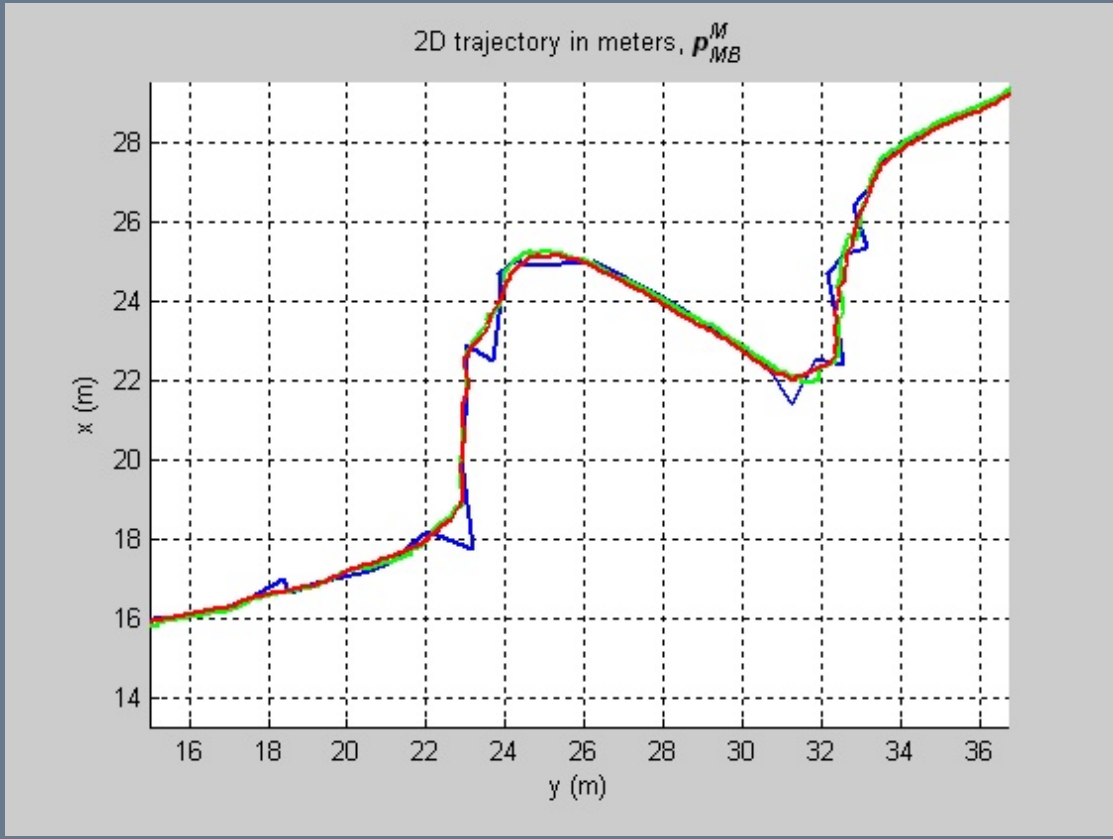

LBL blue , HAIN real-time green, post processed red

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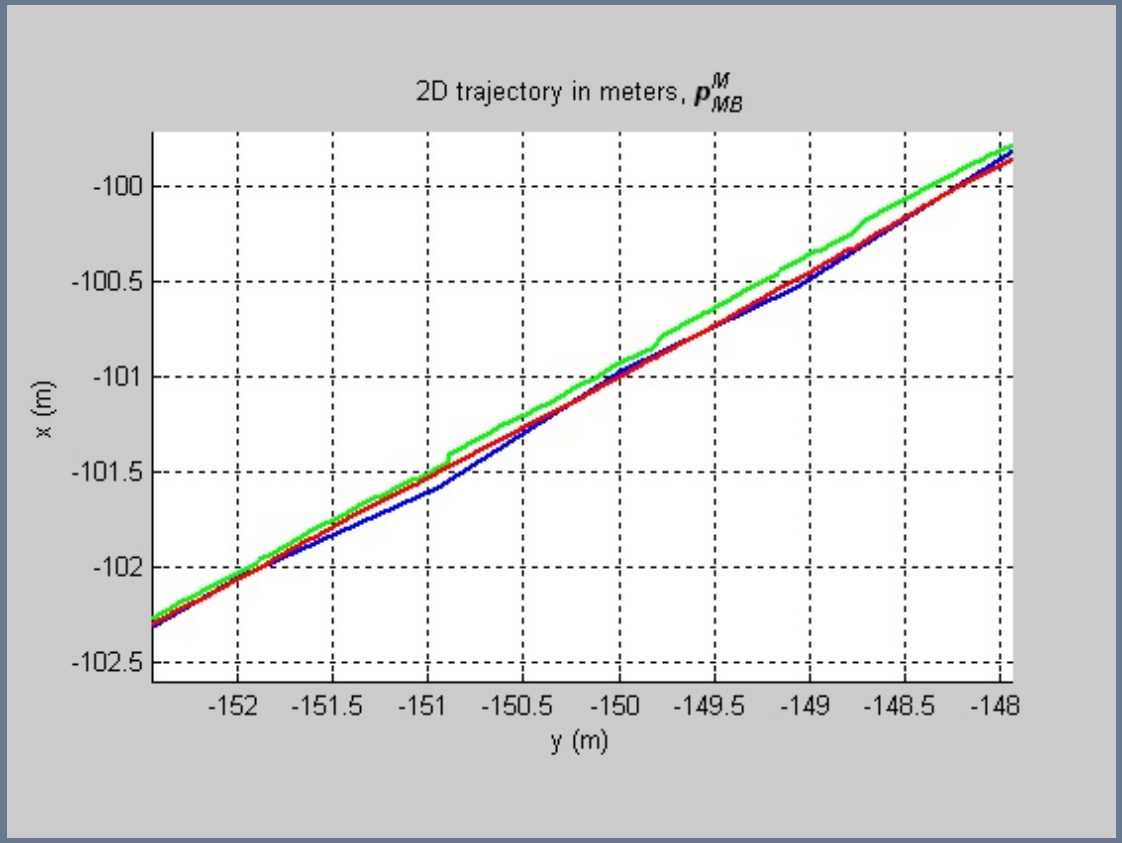
HAIN Seabed Survey – Depth 4000m

KONGSBERG



LBL blue , HAIN real-time green, post processed red

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