Dynamic Positioning Committee
Marine Technology Society

Sensors

Hydroacoustic Aided Inertial Navigation – HAIN
A New Reference for DP

Arnt Helge Olsen
Kongsberg Maritme

October 9-10, 2007

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DP Conference 2007

Hydroacoustic Aided Inertial Navigation - HAIN
A new reference for DP

presented by
Arnt Helge Olsen

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We maximize marine performance by providing

THE FULL PICTURE

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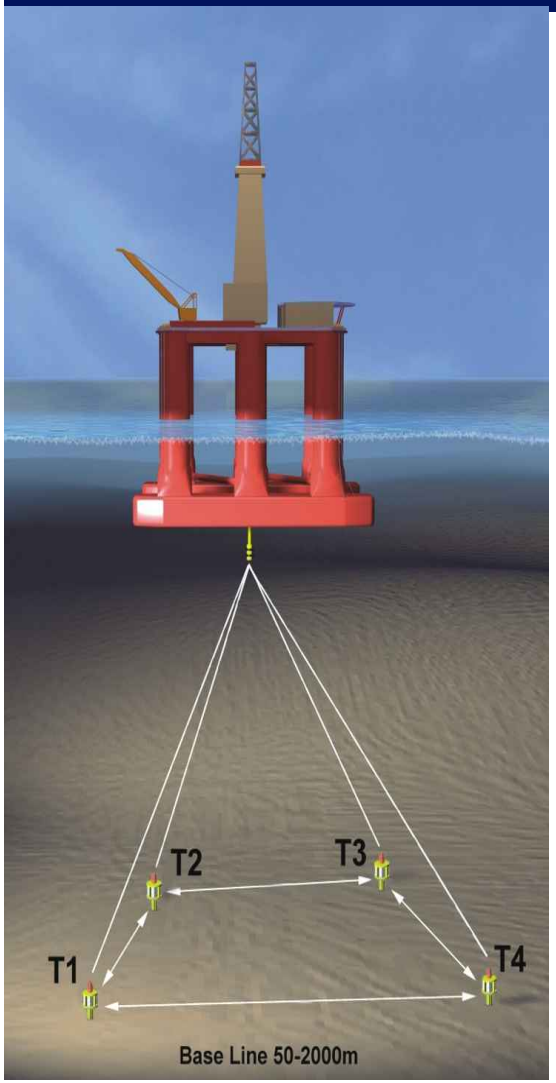
Global Positioning System GPS



Any reference system with accuracy (standard deviation) less than 1 meter and with an update rate of minimum 1 second is allocated equal weighting in the DP system.

The GPS is of such nature.

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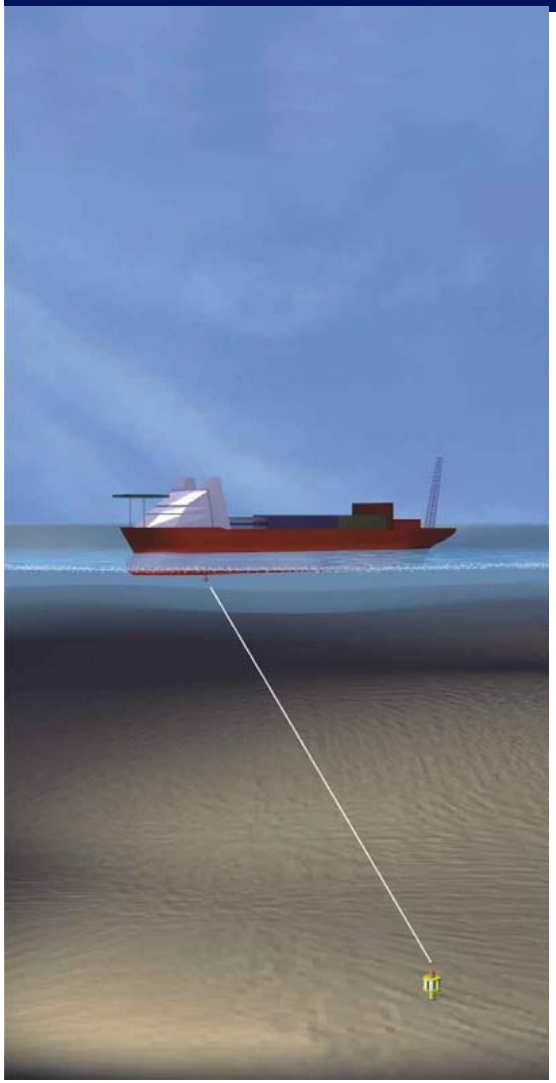
SSBL as reference to Dynamic Positioning



The Super Short Base Line (SSBL) principle:

(Some say Ultra Short Base Line or USBL)

Positioning based on distance and angle measurements from one vessel-mounted transducer to one seabed transponder.

- System accuracy (standard deviation) is approximately 0,2% of slant range or **+/- 1 m at 500 m depth.**
- Update time is 1 second in water depths down to approximately 700 m, and from then increasing with 1 second for every 700 m extra depth. I. e. update rate is **from 1 to 6 seconds** dependant on water depth.

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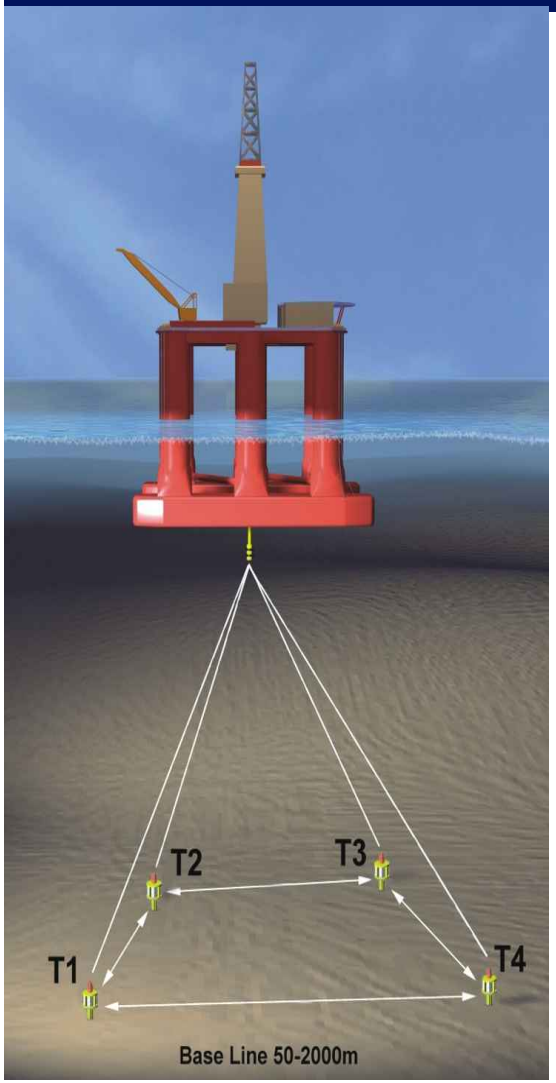
LBL as reference to Dynamic Positioning



The Long Base Line (LBL) principle:

Positioning based on distance measurements from one vessel-mounted transducer to one seabed transponder-array with known geometry.

- System accuracy (standard deviation) is **within 1 meter** regardless of depth.
- Update time is **from 2,5 seconds to 6 seconds** dependant on water depth

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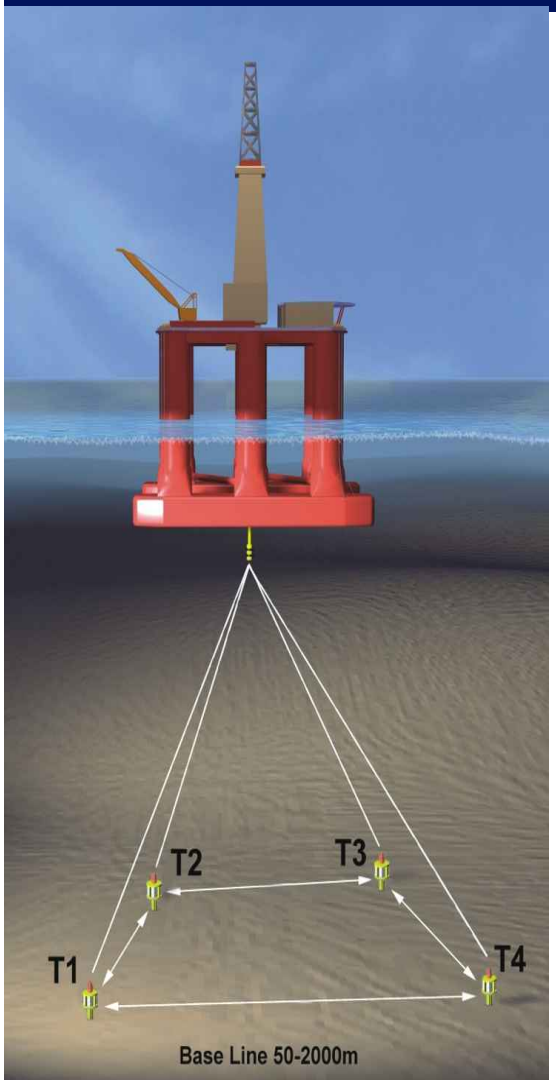
DP weights its Reference Systems



If you have more GPS systems in the solution then the HPR is even less weighted. And if the LBL have less than 1m accuracy for short periods, that weight it even less.

The Implication of this is that the DP system is vulnerable agains GPS failures, which tend to be common between the GPS system.

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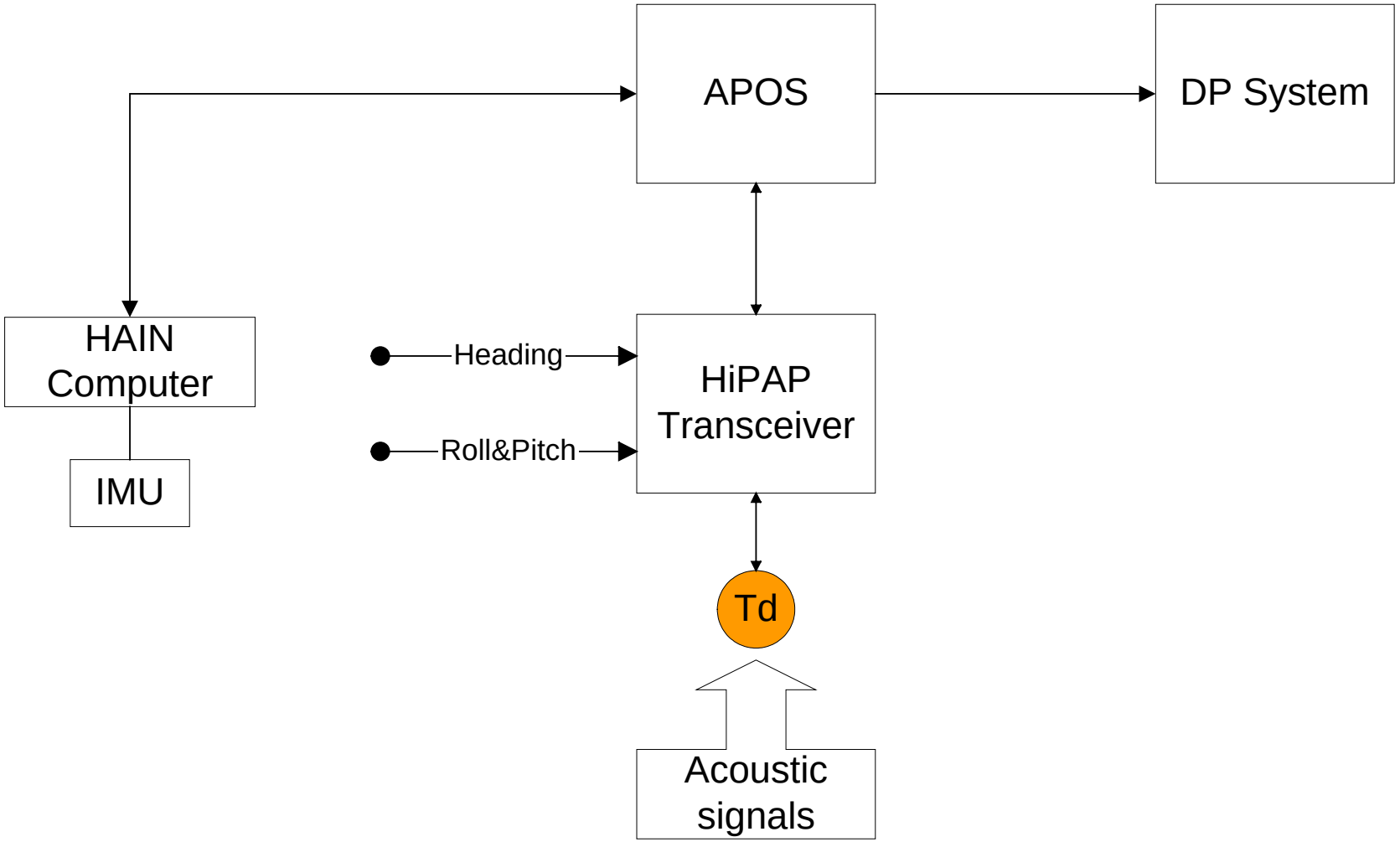
HAIN Positioning Reference overview



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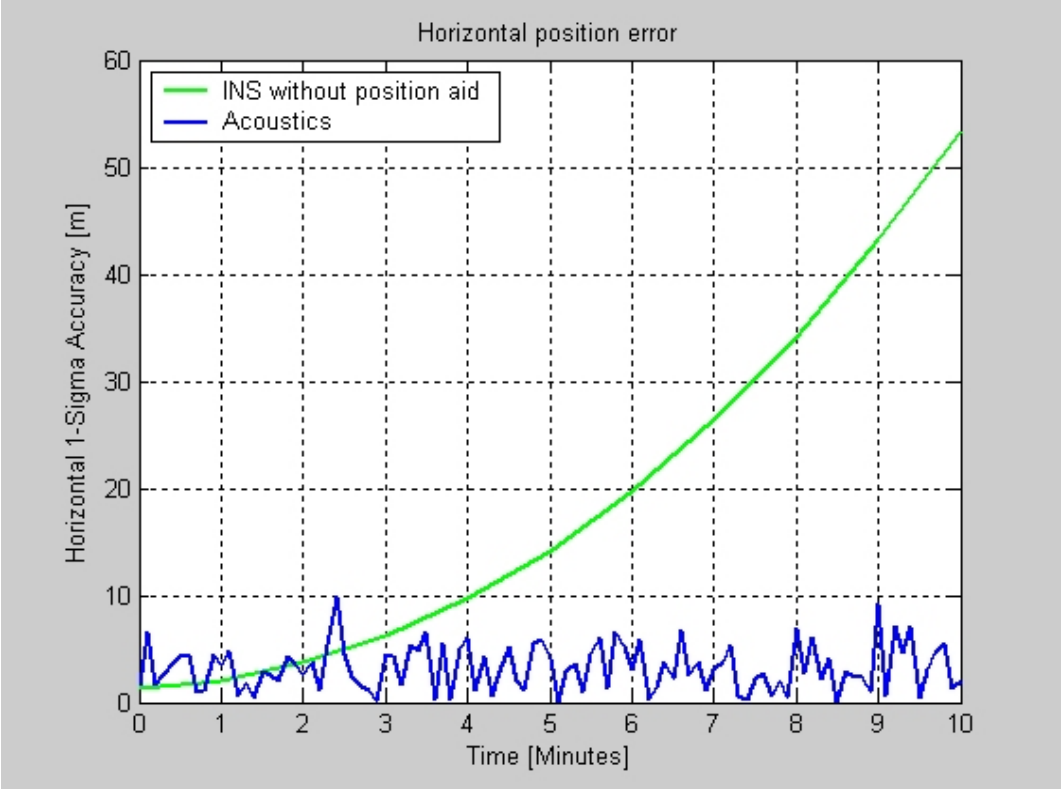
Nature of Acoustics and INS



Ideal combination

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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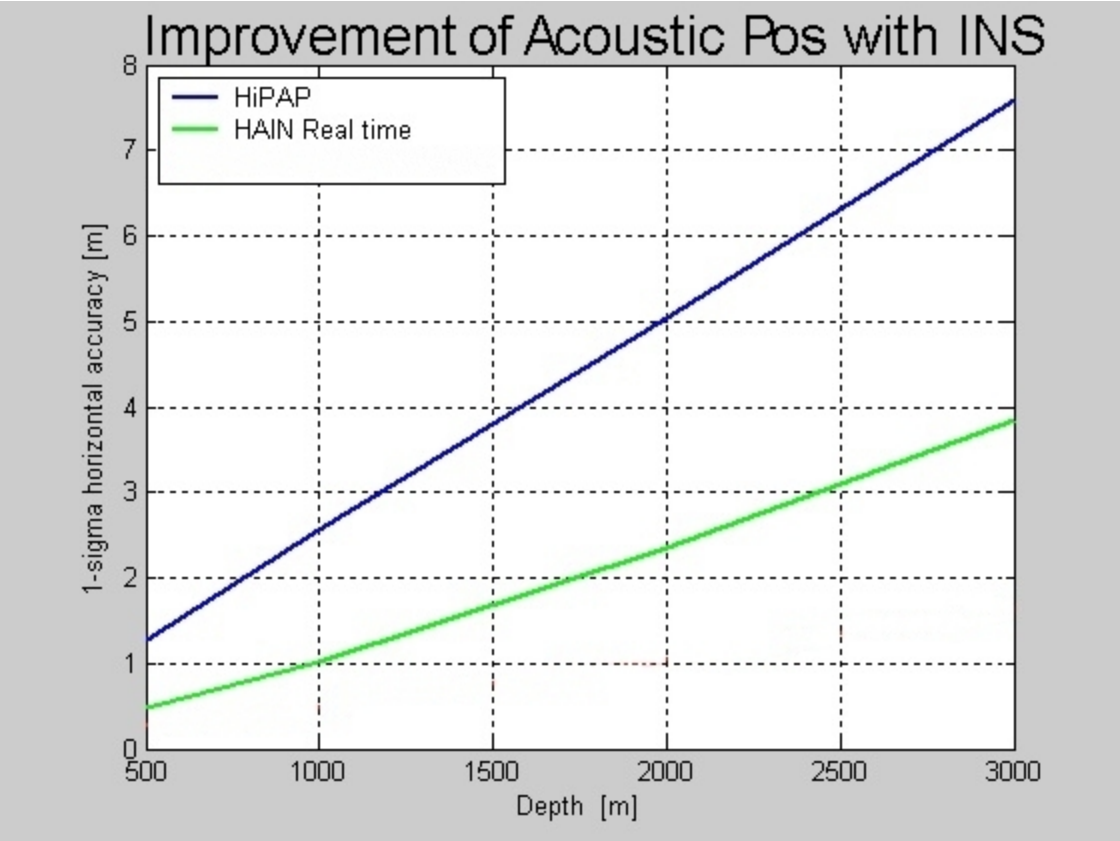
HAIN - Simulations



Simulation parameters:

HiPAP SSBL angle accuracy: 0.1° in x and y

dGPS position white/colored noise: 0.15m/0.1m North and East

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Easy to install HW and SW

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A HAIN computer interfaces:

- Inertial Measurement Unit (IMU)
- Acoustic Positioning system (HiPAP or HPR)

The HAIN computer outputs improved reference data to DP and improves thereby also the DP itself!

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HAIN experience from DrillRig Eirik Raude

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Gulf of Mexico

~ 2650m depth

Period
2007-07-07
to
2007-08-09

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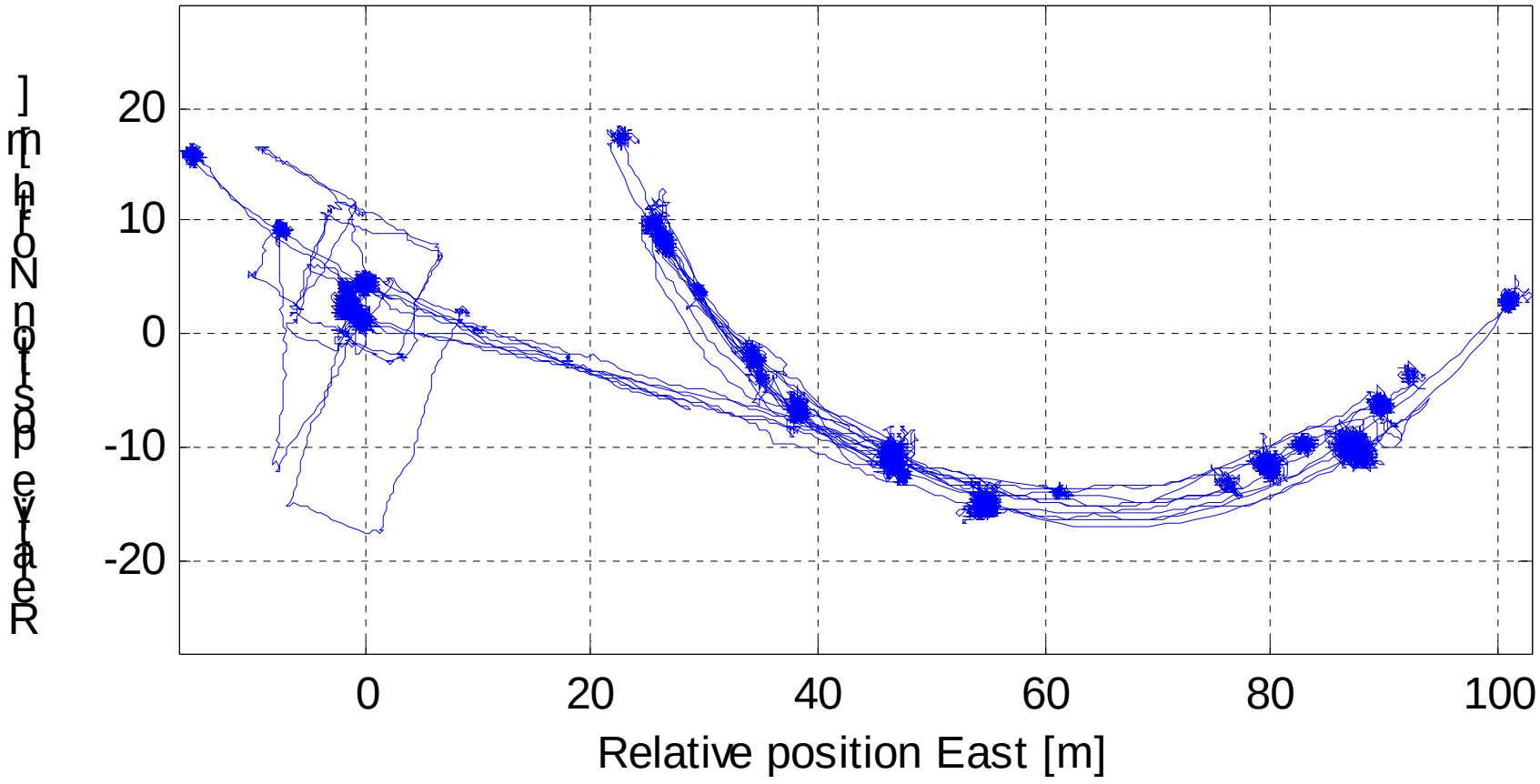
HAIN experience from Drill Rig Eirik Raude



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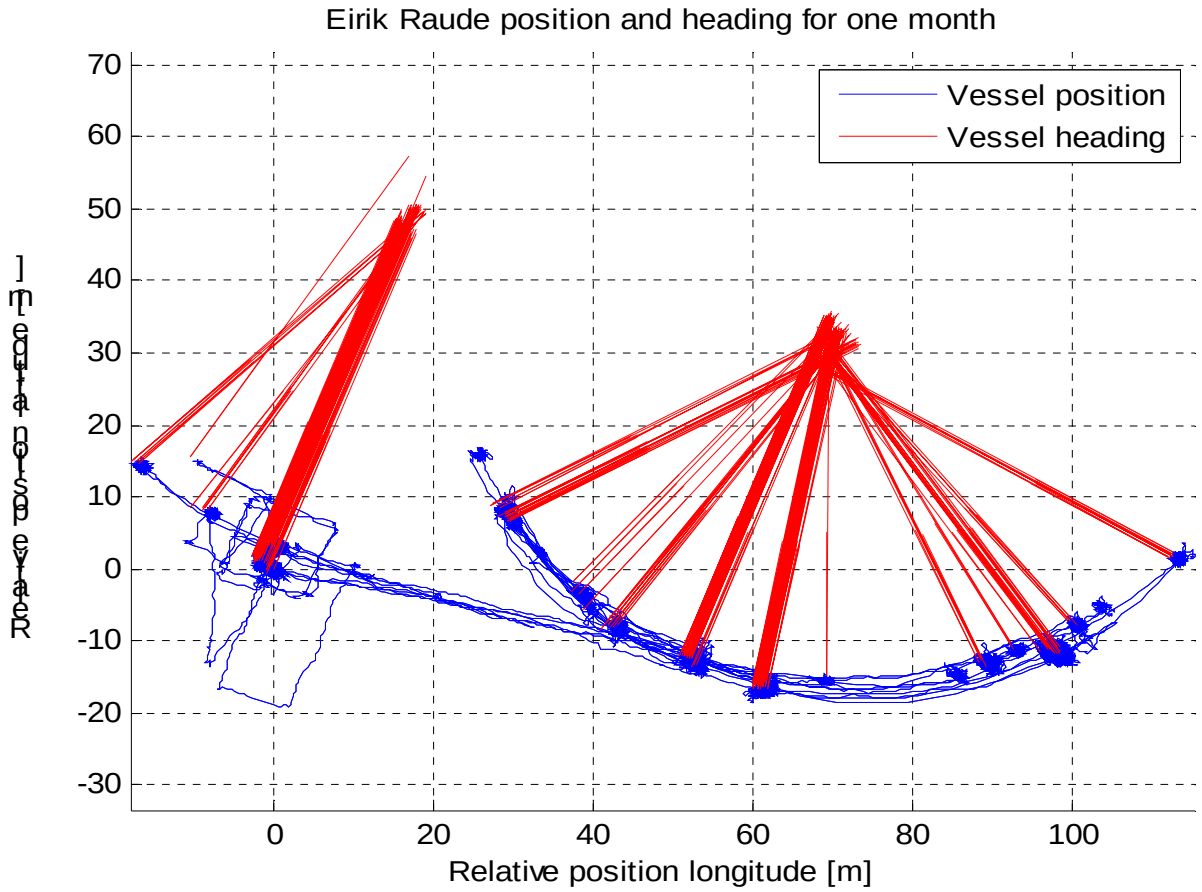
HAIN experience from DrillRig Eirik Raude



Heading is plotted each 10 minutes. The IMU is located at the bridge at one side of the rig – approx. 50 m off centre. The length of the red heading indicator is 50 m

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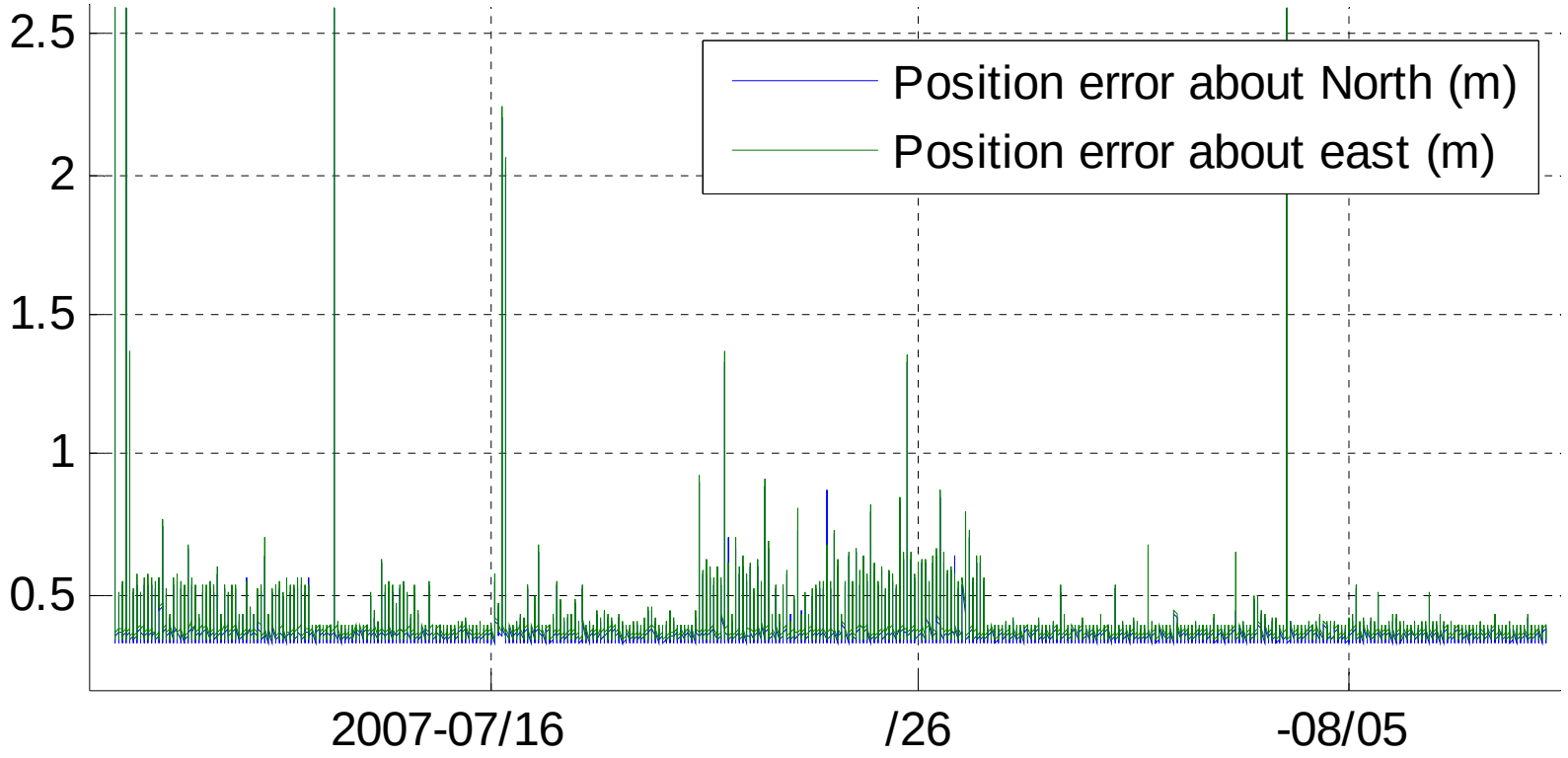
HAIN experience from DrillRig Eirik Raude



The standard deviation is on the scale of a meter for the entire period.
Except for incidents on 2007-07-12 and 2007-08-03.
There are periods where the reported accuracy is slightly poorer.

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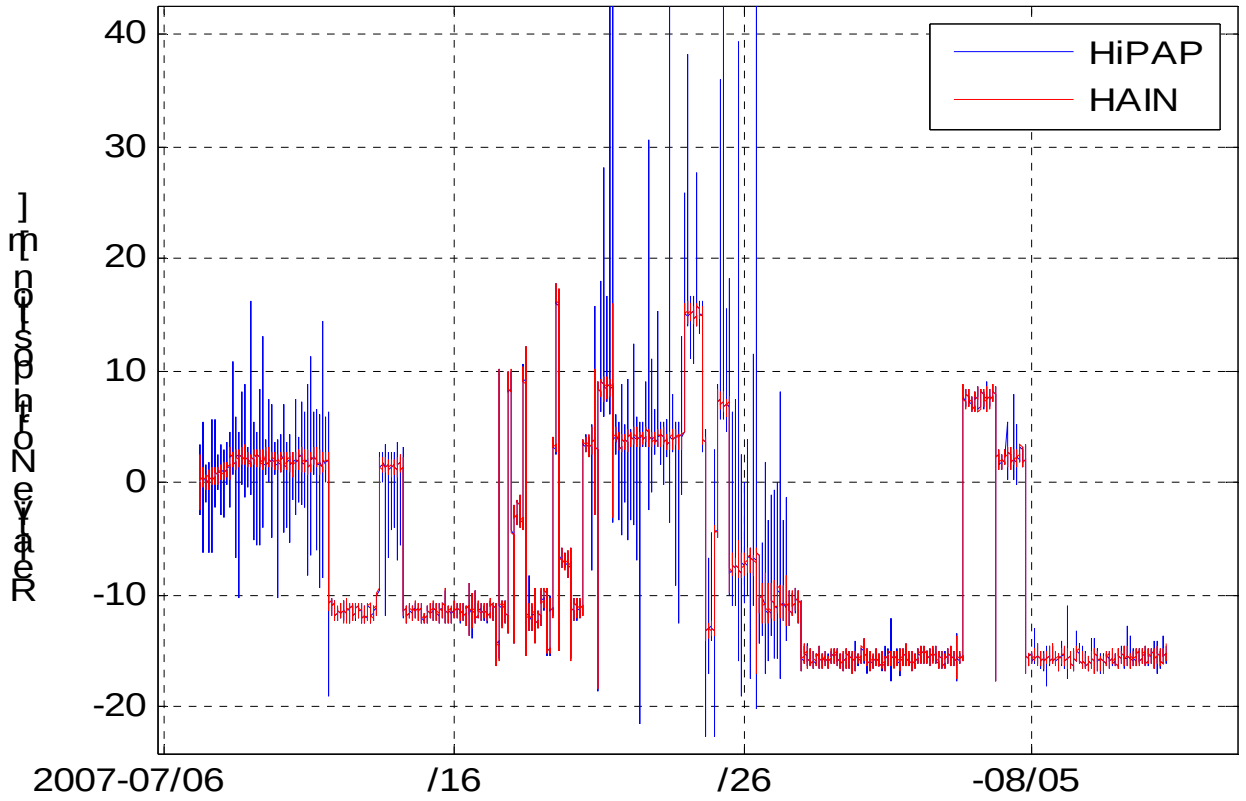
HAIN experience from DrillRig Eirik Raude



HAIN and HiPAP are compared. Measurements are of North position.
HAIN positions are smoother than HiPAP positions (as expected).
HAIN and HiPAP correspond well in the measurements.

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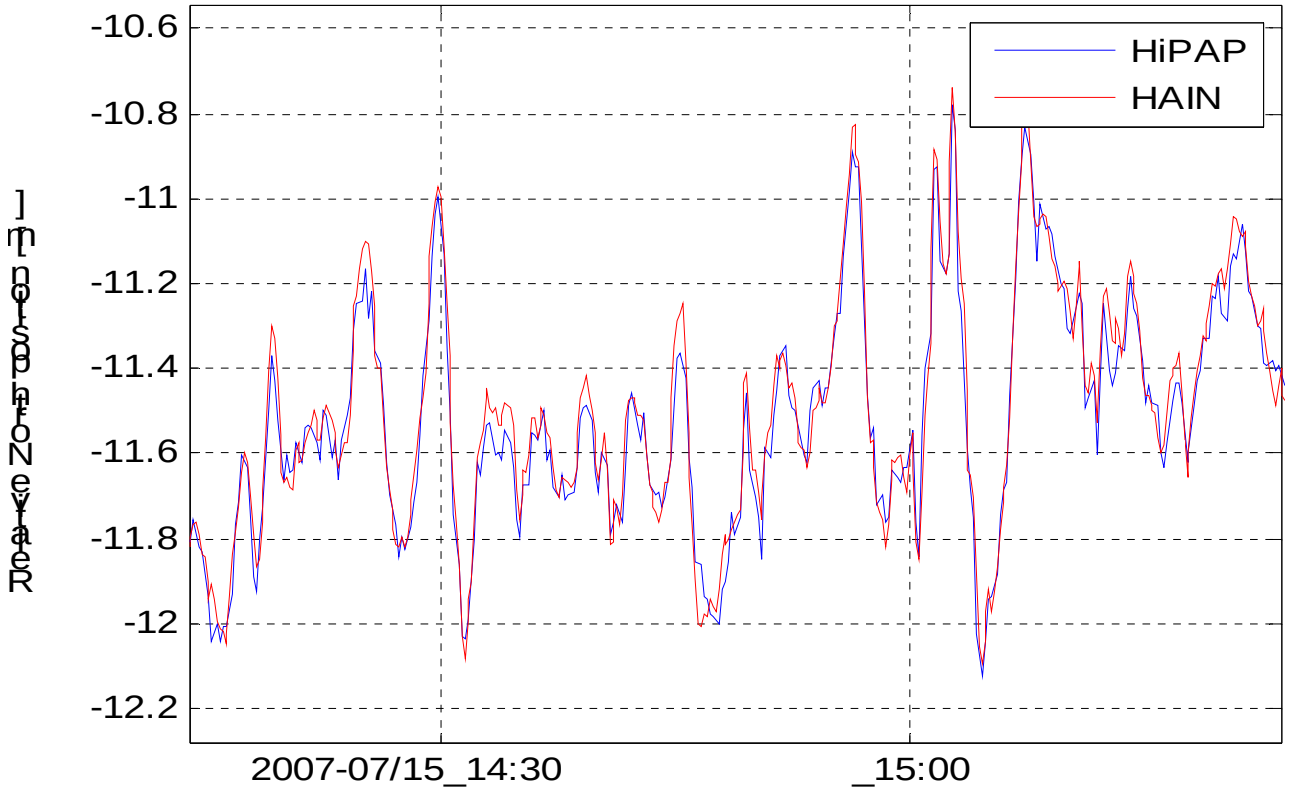
HAIN experience from DrillRig Eirik Raude



During a period of very good acoustics

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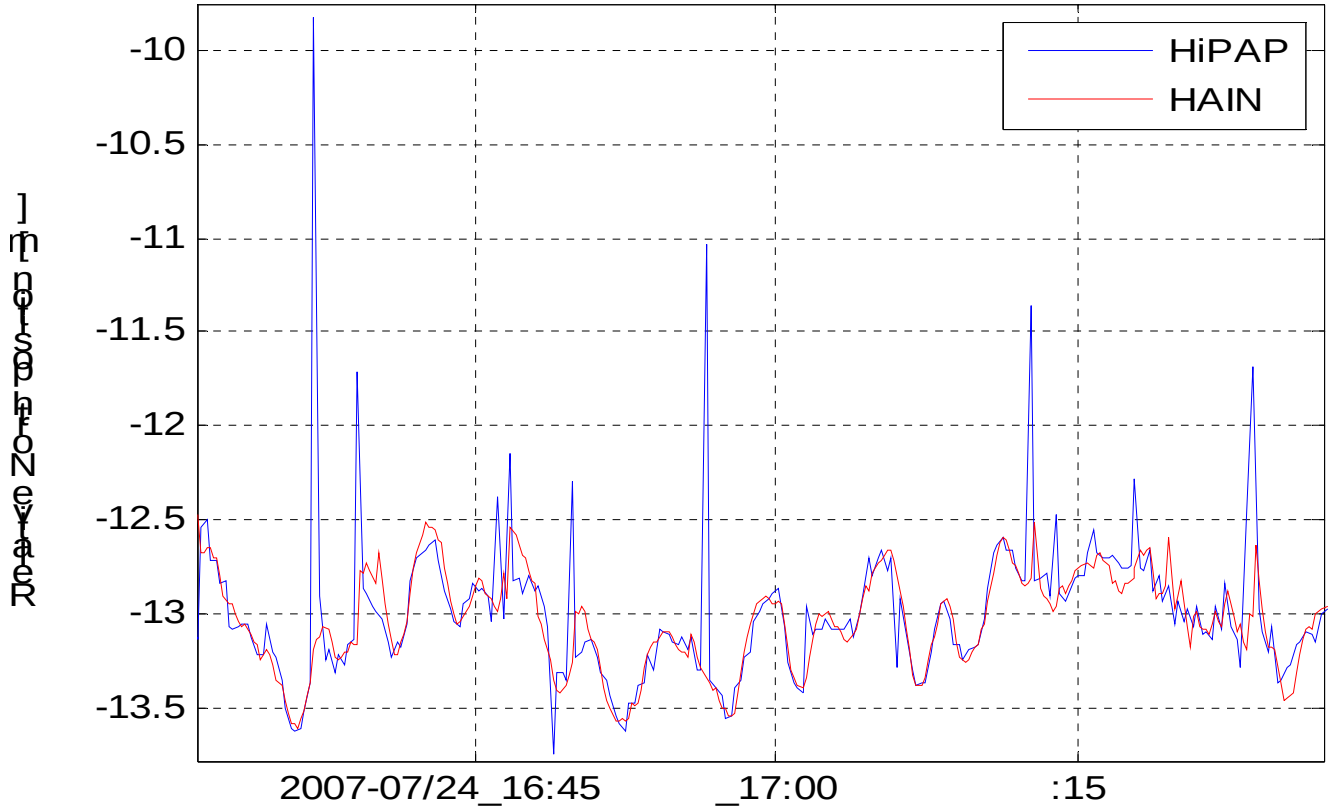
HAIN experience from DrillRig Eirik Raude



During period of very good acoustics

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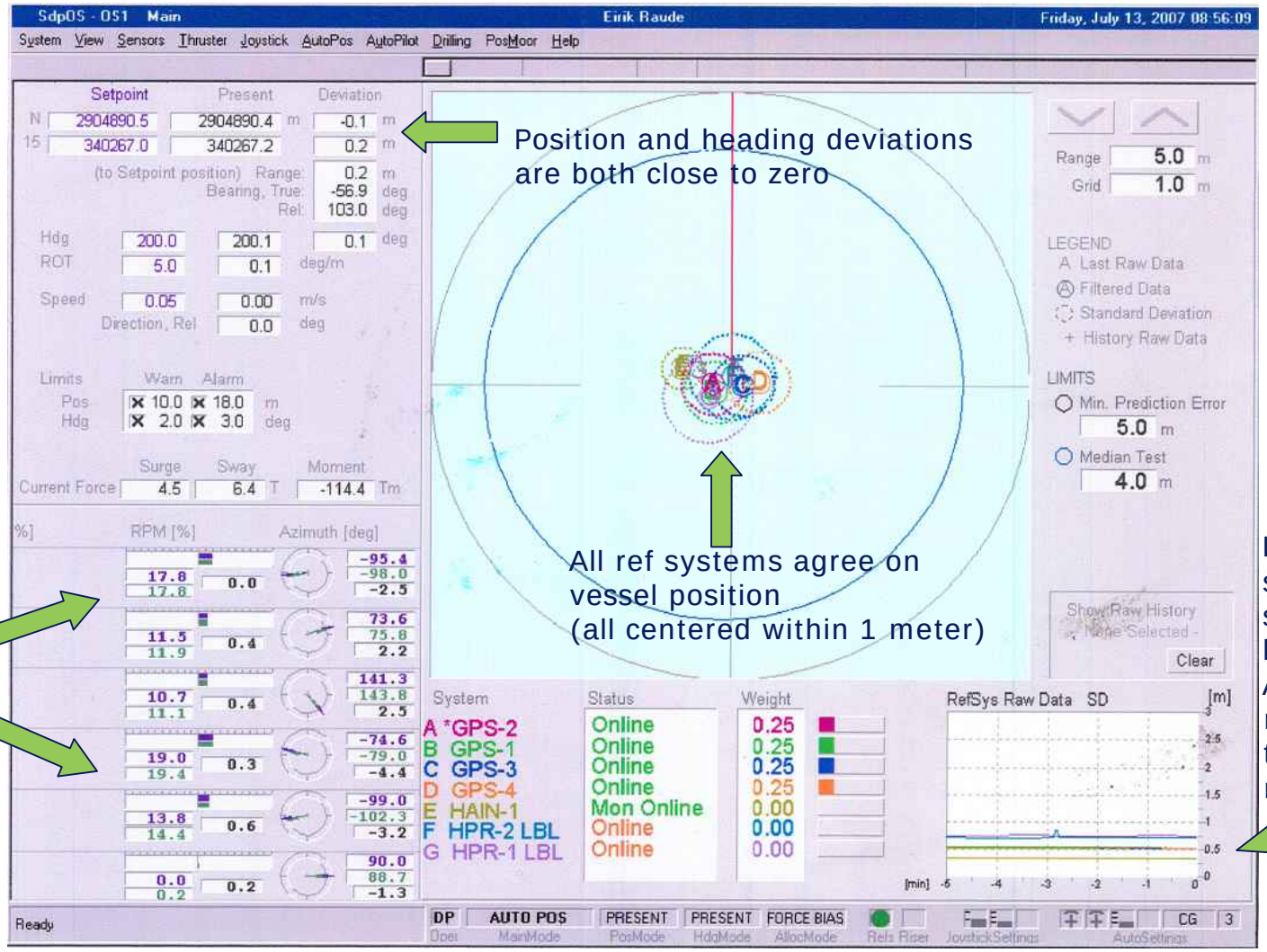
Snapshot of the DP screen - Eirik Raude



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Snapshot of the DP screen - Eirik Raude

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Last 5 minutes show all 7 ref. systems have low std dev. All less than 1 meter, HAIN the best at 0.4 meter

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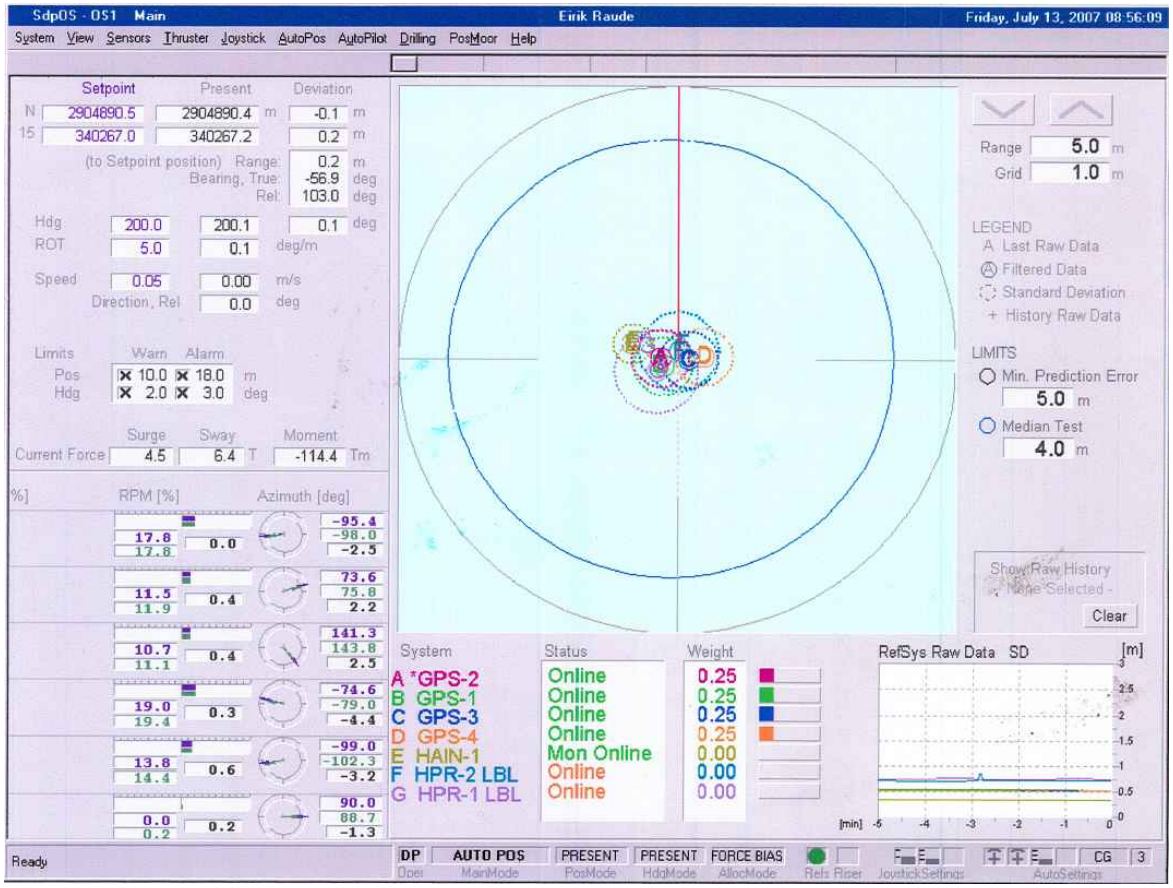
Snapshot of the DP screen - Eirik Raude



At the **instant** the snapshot was taken, both HIPAP LBL systems have zero weight (due to update rate).
HAIN has zero weight because of being in monitoring mode.
All four GPS's have the same weight because all have std. dev. less than 1 meter.

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SSBL, LBL and GPS as DP References

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Typical figures when operating in 1000 meter water depth.

	HiPAP SSBL	HiPAP LBL	GPS
Standard deviation	+/- 2 meters [1)]	+/- 0,5 meter	+/- 0,5 meter
Update rate	1,5 seconds [2)]	2,5 seconds	1 second

The above shows that neither SSBL nor LBL will be able to achieve as high weighting as GPS in the DP.

1)Accuracy of 0,2 % of depth
2)Travel time of 1,3s plus computation time

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HAIN benefits in Dynamic Positioning

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By introduction of HAIN, the following will be the result in 1000m depth.

	HAIN SSBL	HAIN LBL	GPS
Standard deviation	+/- 1 meter	+/- 0,5 meter	+/- 0,5 meter
Update rate	1 second	1 second	1 second

The above shows that the HAIN SSBL principle could be used with **high DP weight** in 1000 m depth compared to only 500 m without HAIN.

The above shows that the HAIN LBL principle also obtain the **high DP weight** as the update rate to DP will be 1 second – same as the GPS gives.

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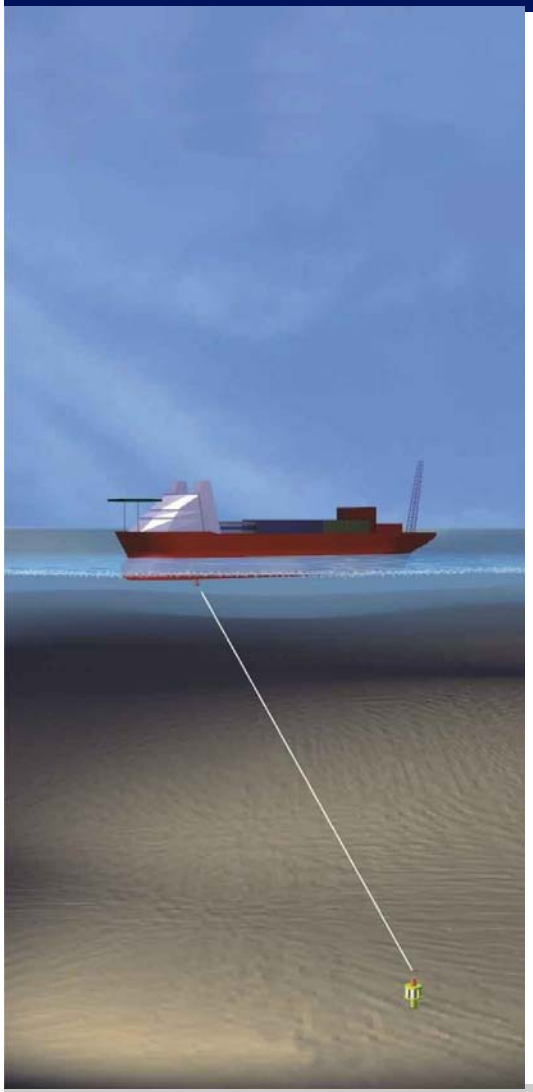
HAIN benefits in Dynamic Positioning



Extends both SSBL and LBL operational depths

Enables use of slow acoustic ping rate (thereby saving batteries)

Position update continues in case of acoustic drop-out

Reliable and independent reference to DP if drop out of GPS

The IMU in HAIN provides also Roll, Pitch and Heading data

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HAIN conclusions from DrillRig Eirik Raude

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The HAIN system onboard Eirik Raude was running while the vessel was in operation in the Gulf of Mexico 2007-07-07 to 2007-08-09.

Except for two distinct incidents, (one operator shut down and one power failure) which caused the HAIN not to function for 10-20 minutes, the analyzing report concludes that;

- HAIN was far superior to the HiPAP alone in performance
- HAIN was functioning well for the entire period
- A Hain system weighted similar to the GPS would add security to the DP (1m accuracy and 1 sec update rate)
- Allow more individual reference systems to be weighted equally.

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