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Acoustic Positioning in Deep Waters

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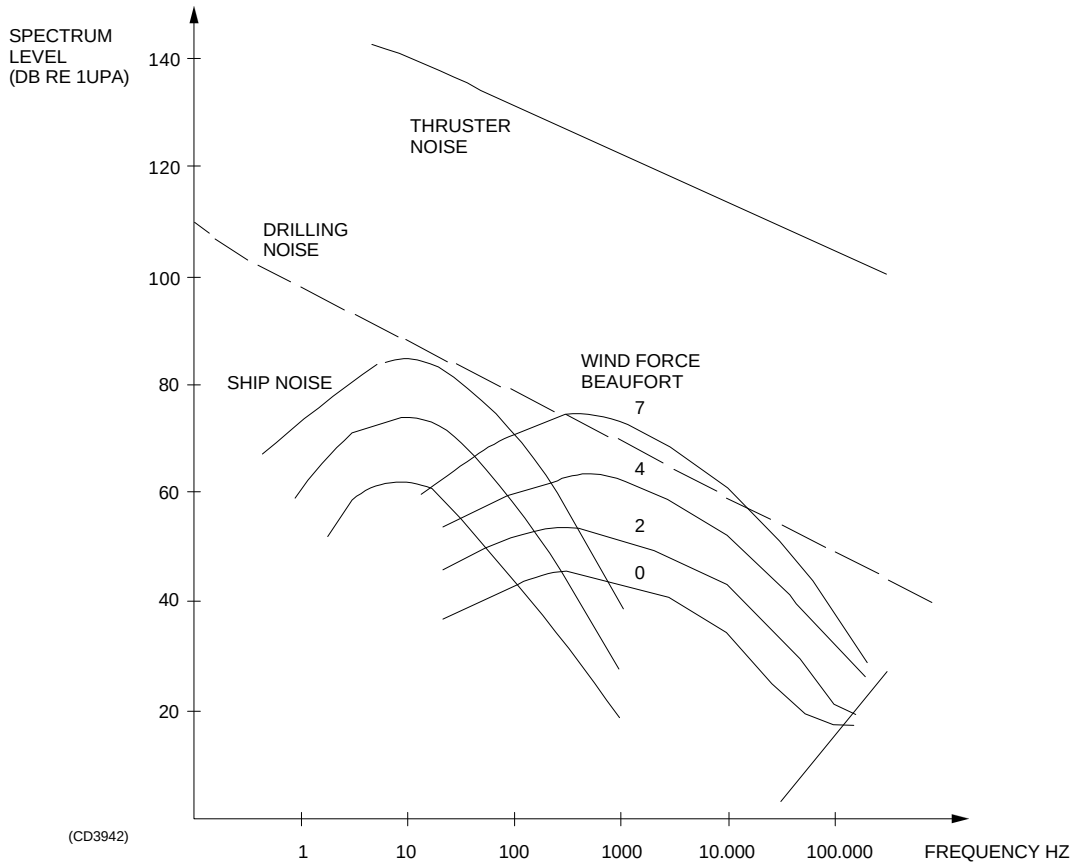

ENVIRONMENTAL ACOUSTIC NOISE LEVEL

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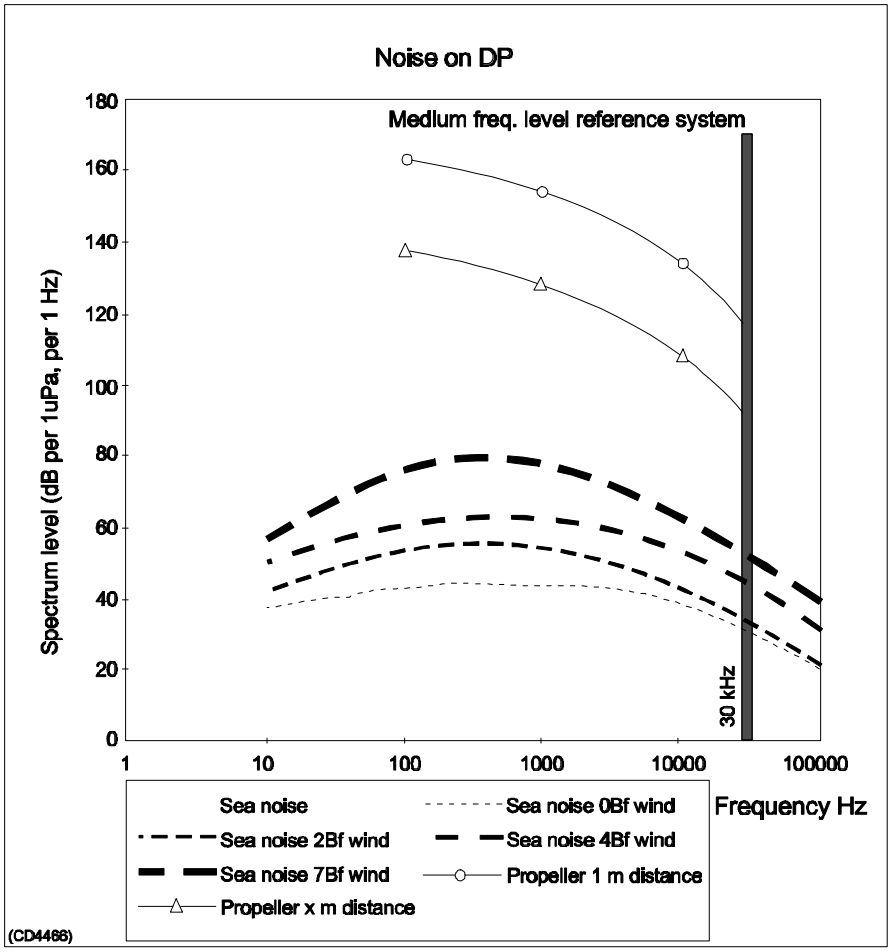

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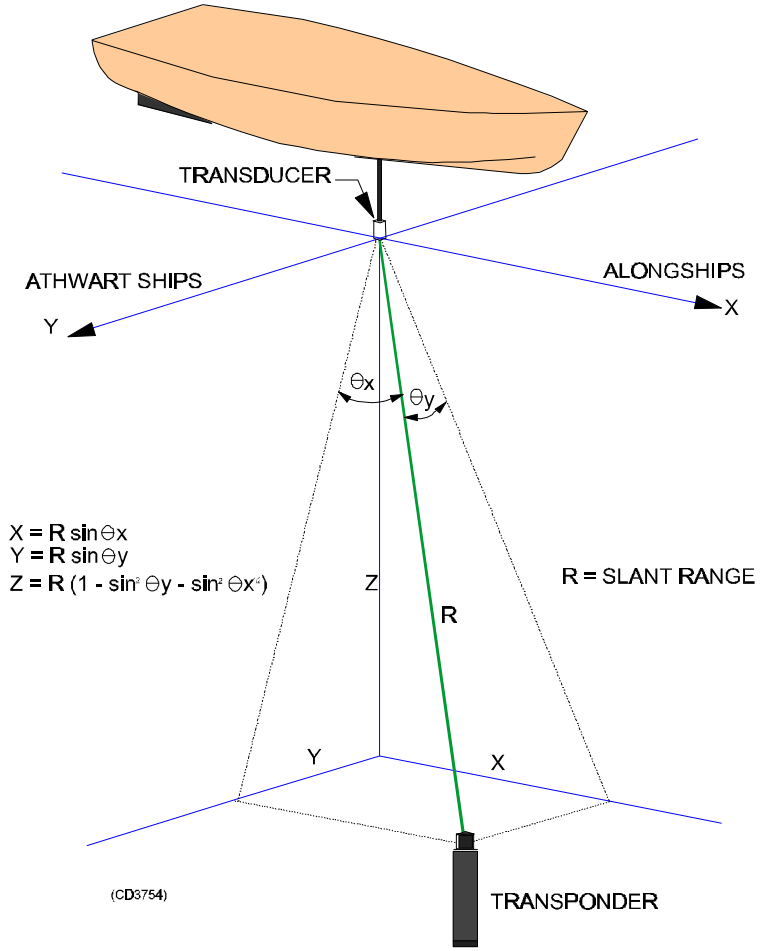

SSBL Principle: Measuring distance and phase of received signal

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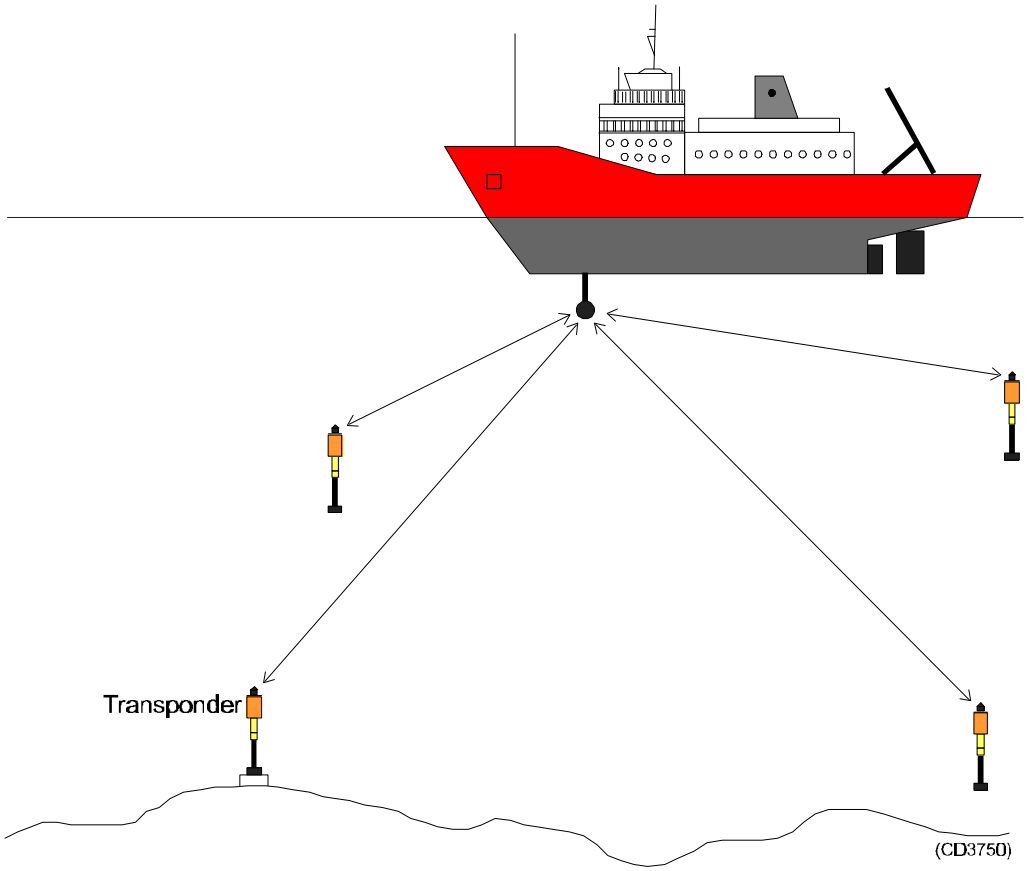

LBL Principle: Measuring distance to known co-ordinates

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Sonar equation:

$$TL = 20\log(r) + ar$$

where:

$TL = Transmission - Loss$

$r = range$

$a = absortion - factor$

Source level:

$$SL = 171 + 10\log(P) + E + DI$$

where:

$SL = Source - Level$

$P = Power(w)$

$E = 10\log(h)$

$h = transducer - efficiency$

$DI = Directivity - Index$

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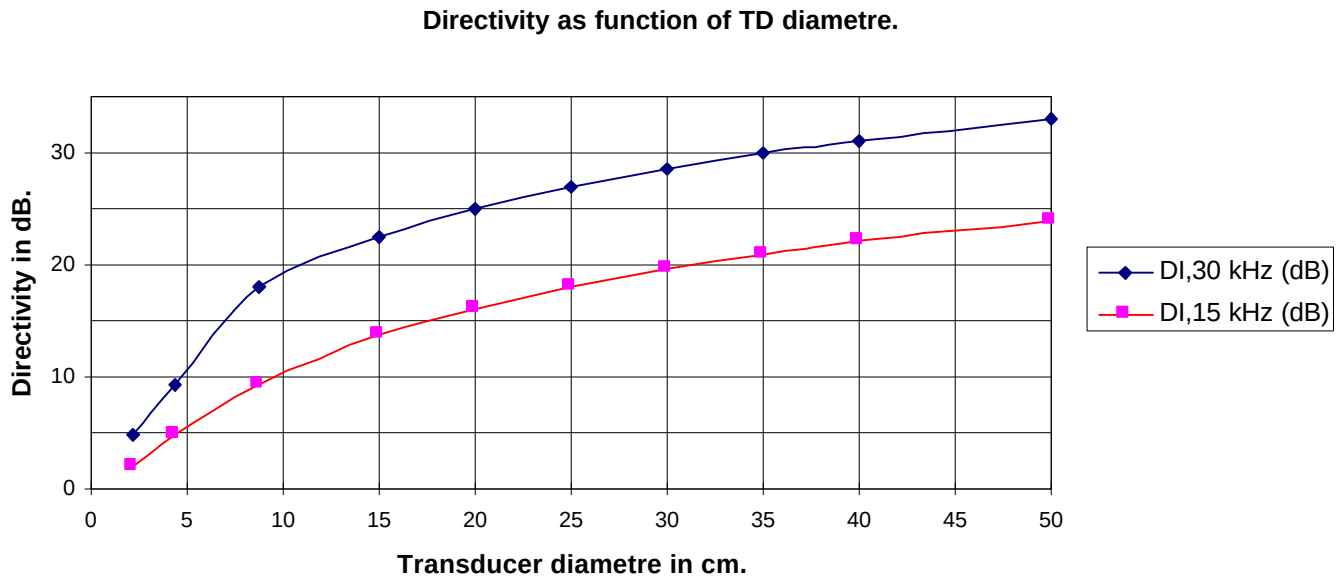

Directivity Index:

$$DI = 10\log\left(\frac{2.47}{\sin\left(\frac{b}{2}\right)^2}\right)$$

where ß=opening angle in degrees

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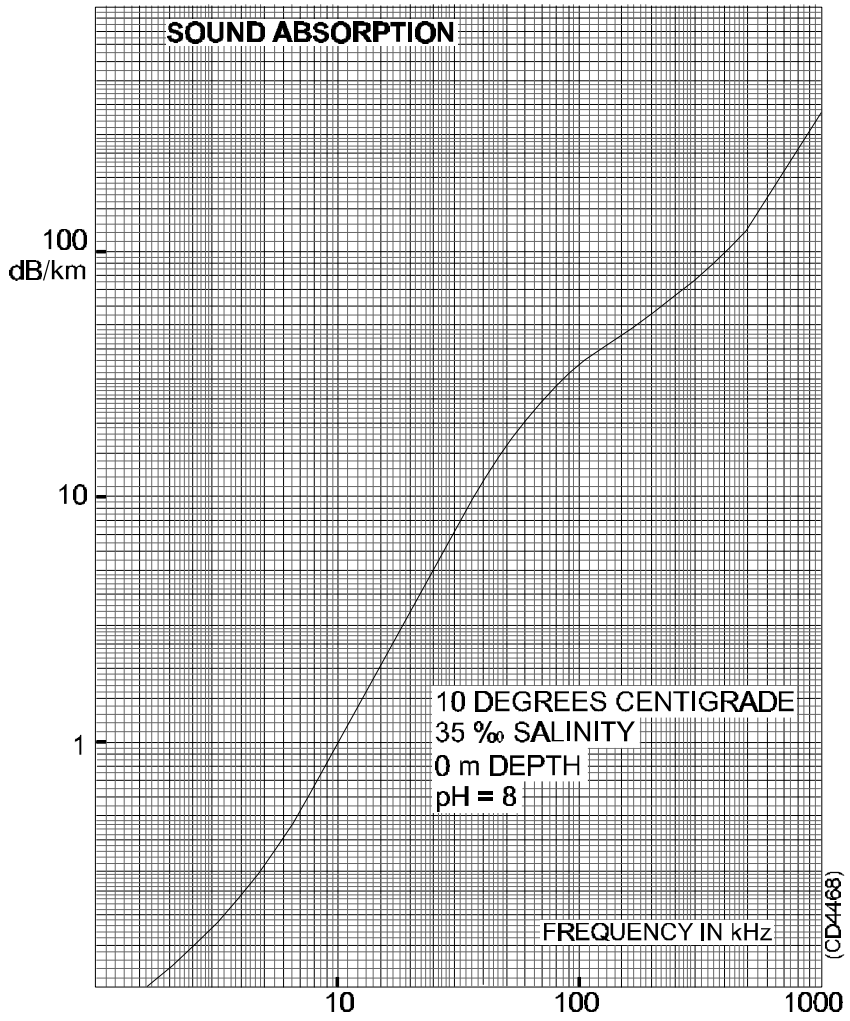

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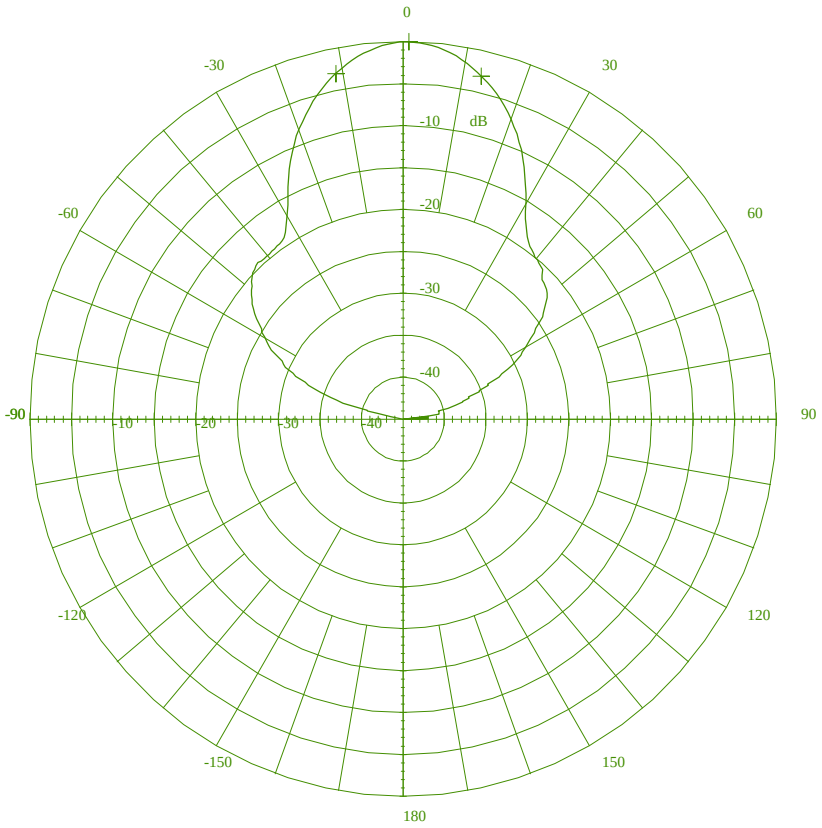
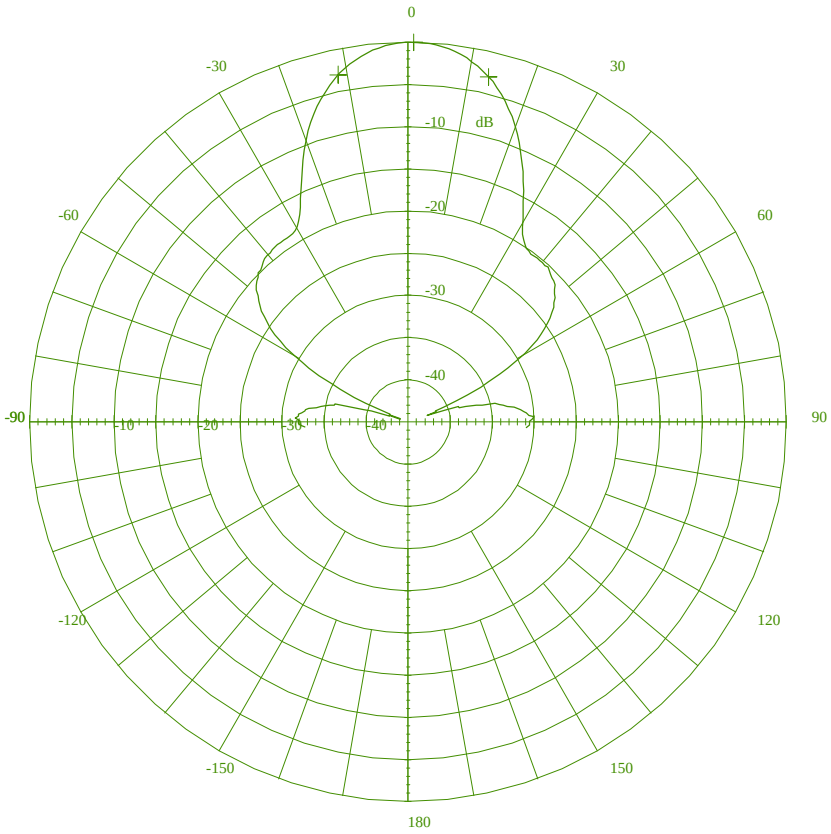


Wide beam,27kHz



Wide beam,30kHz

HiPAP System

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Signal to noise ratio:

$S = SL_{TP} - 20\log(R) - \alpha(R)$

$N = N_O - (20\log(R_T) + DI + 10\log(B))$

Signal-to-noise ratio = S/ N.

where:

S	=	signal at receiver
SL_{TP}	=	source level of transponder
R	=	range to transponder
α	=	absorption factor
N	=	noise level at receiver
N_O	=	noise level at thruster
DI	=	directivity index
B	=	receiver bandwidth

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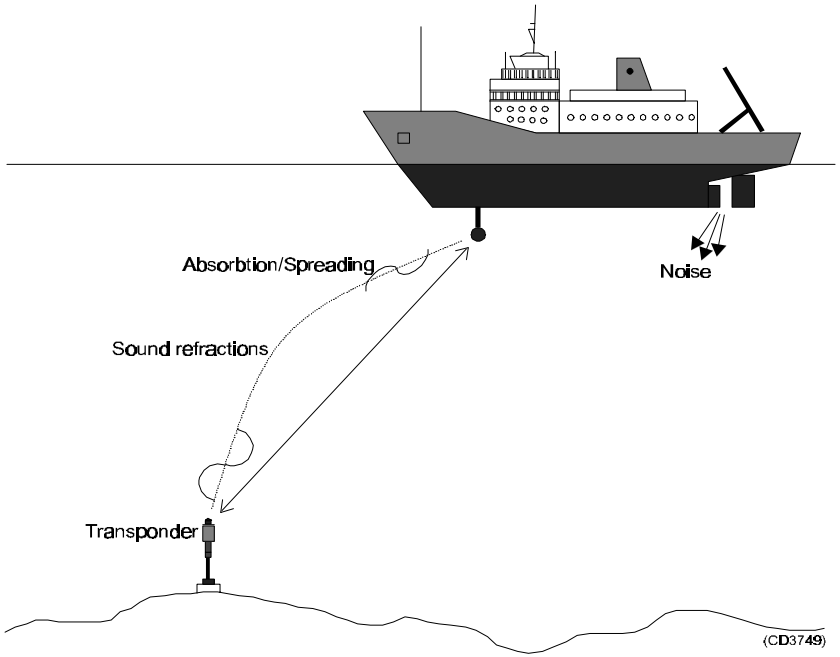
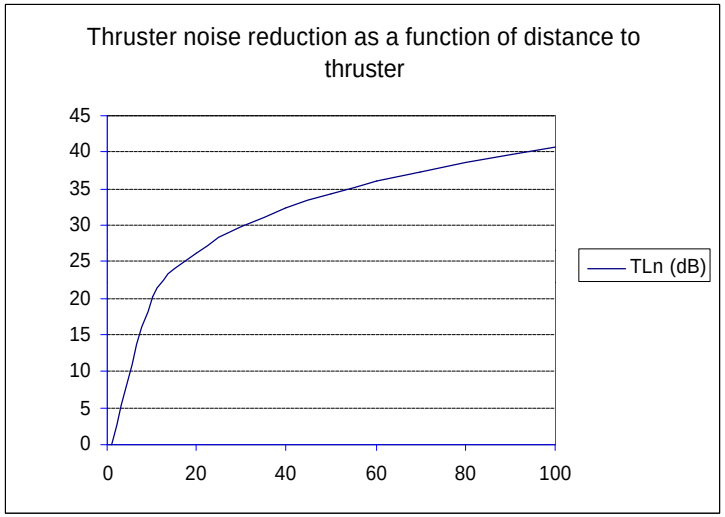
Reduction of noise from thruster (30kHz): TLn = 20logR + 0.007*R





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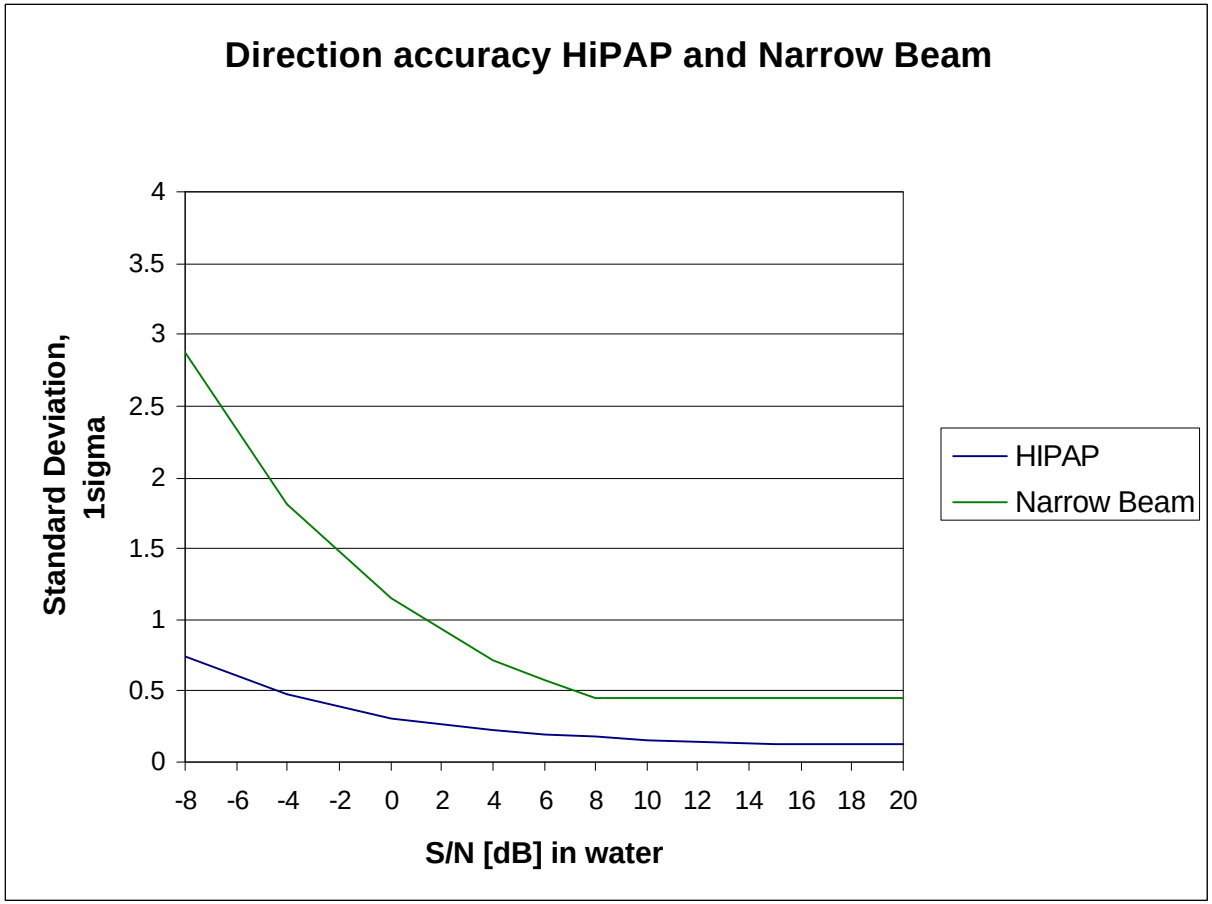

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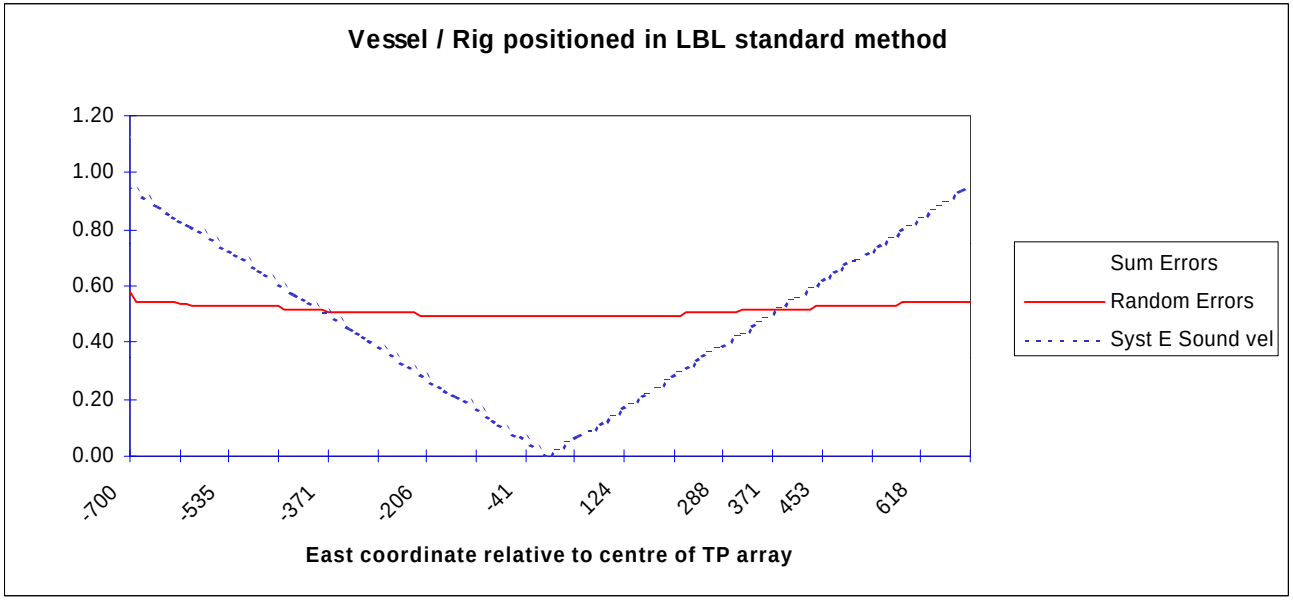

Horizontal position error in LBL positioning - 4 transponders

- Water depth: 1200m
- Array radius: 636m
- S/N: 20dB
- Sound velocity error: 1m/s

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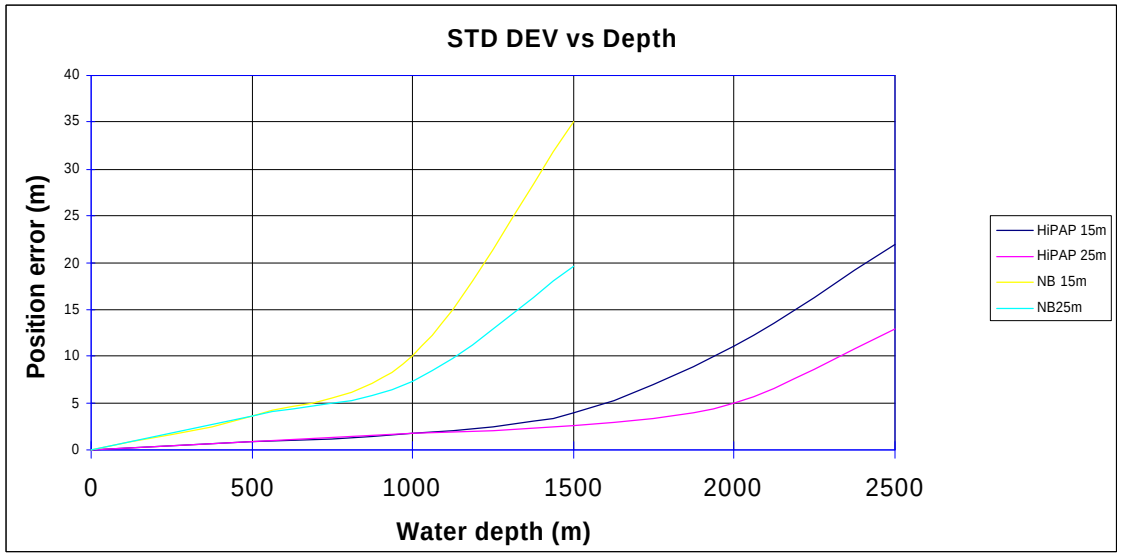

EXAMPLE:

Position error when distance from transducer to thruster is 15m and 25m.

System:	HiPAP and HPR 410 Narrow beam
Transponder source level:	202dB rel 1µPa at 1m
Thruster noise level:	125dB rel 1µPa/sqHz at 1m

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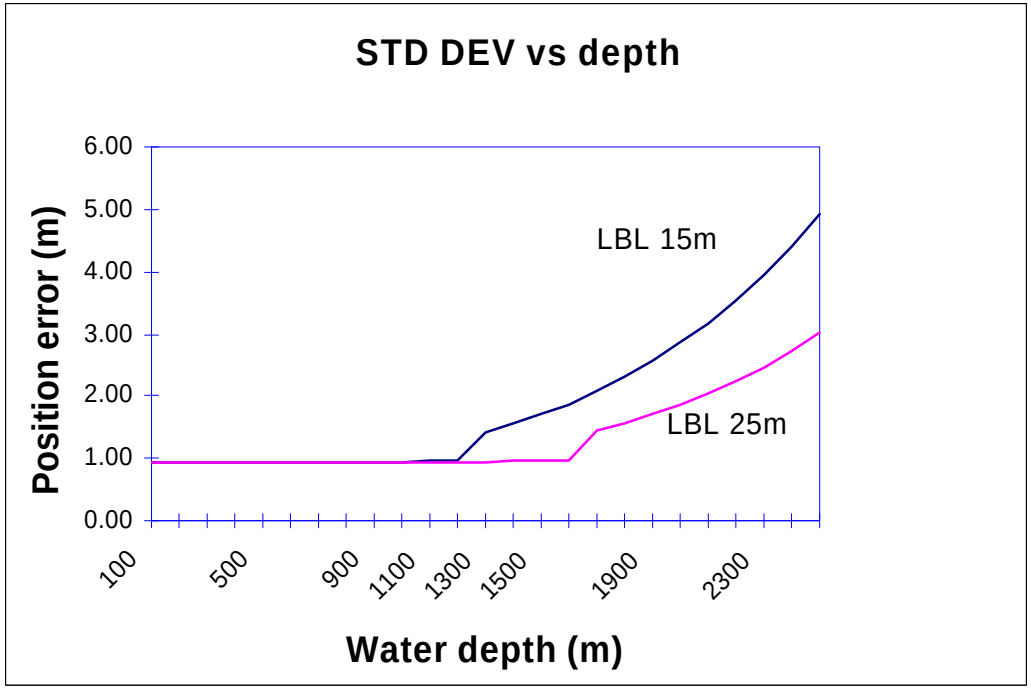

EXAMPLE:

Position error when distance from transducer to thruster is 15m and 25m.

System:	HPR 418 Narrow beam
Transponder source level:	202dB rel 1µPa at 1m
Thruster noise level:	125dB rel 1µPa/sqHz at 1m
Array:	4 Tp's within 14 degrees from vertical

Note: The measurement errors are magnified by the bad geometry.
This narrow array is only relevant for deep water application.

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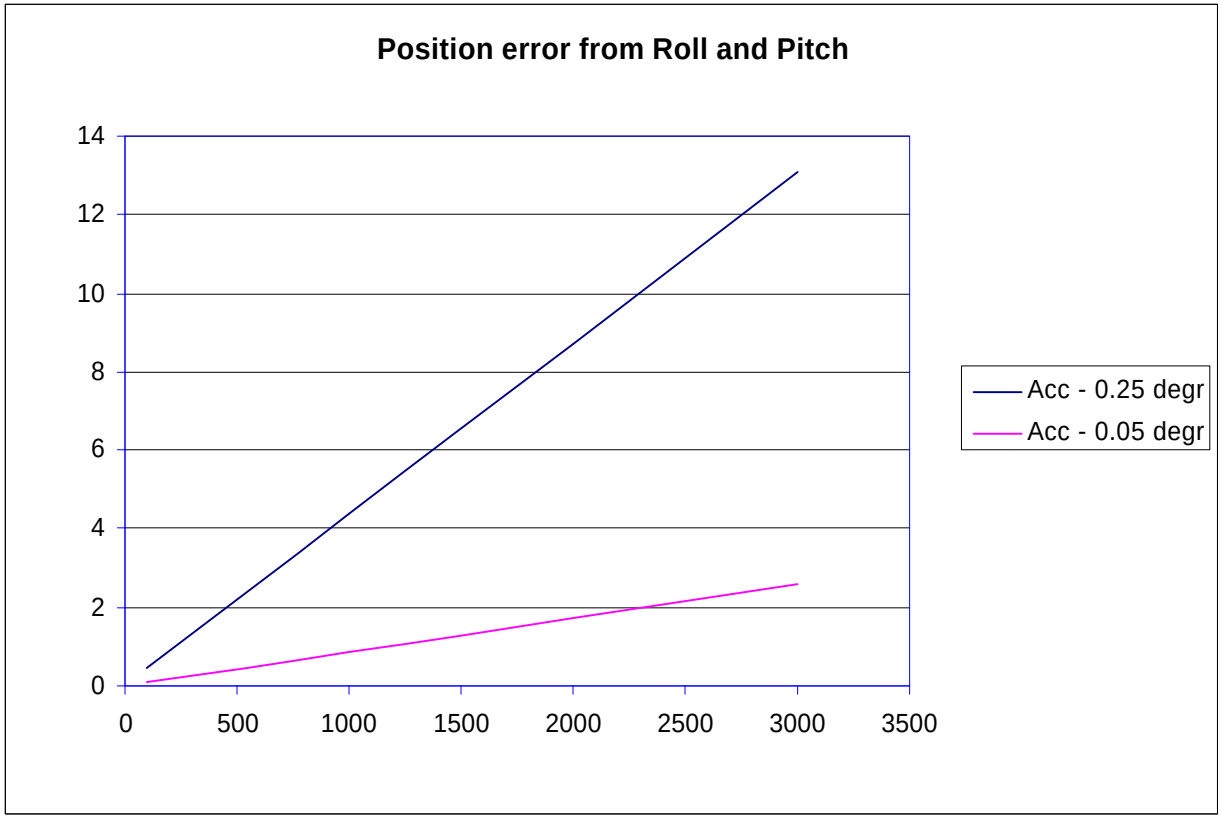

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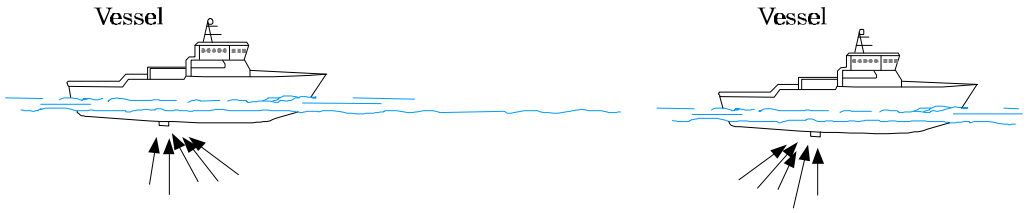
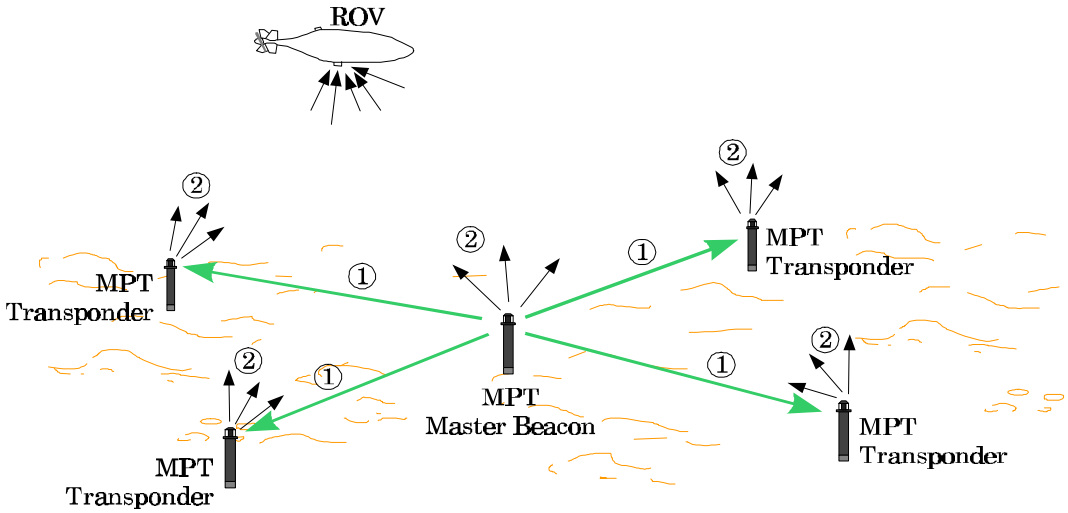
Multiuser LBL





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Multiuser LBL

- Common transponder array for several users
- Available to vessel and ROV LBL positioning
- Transponders in array available for SSBL positioning, beacon mode
- Update rate independent of water depth
- LBL accuracy: < 1.0m at 1500m depth
- High update rate: < 2.0sec.

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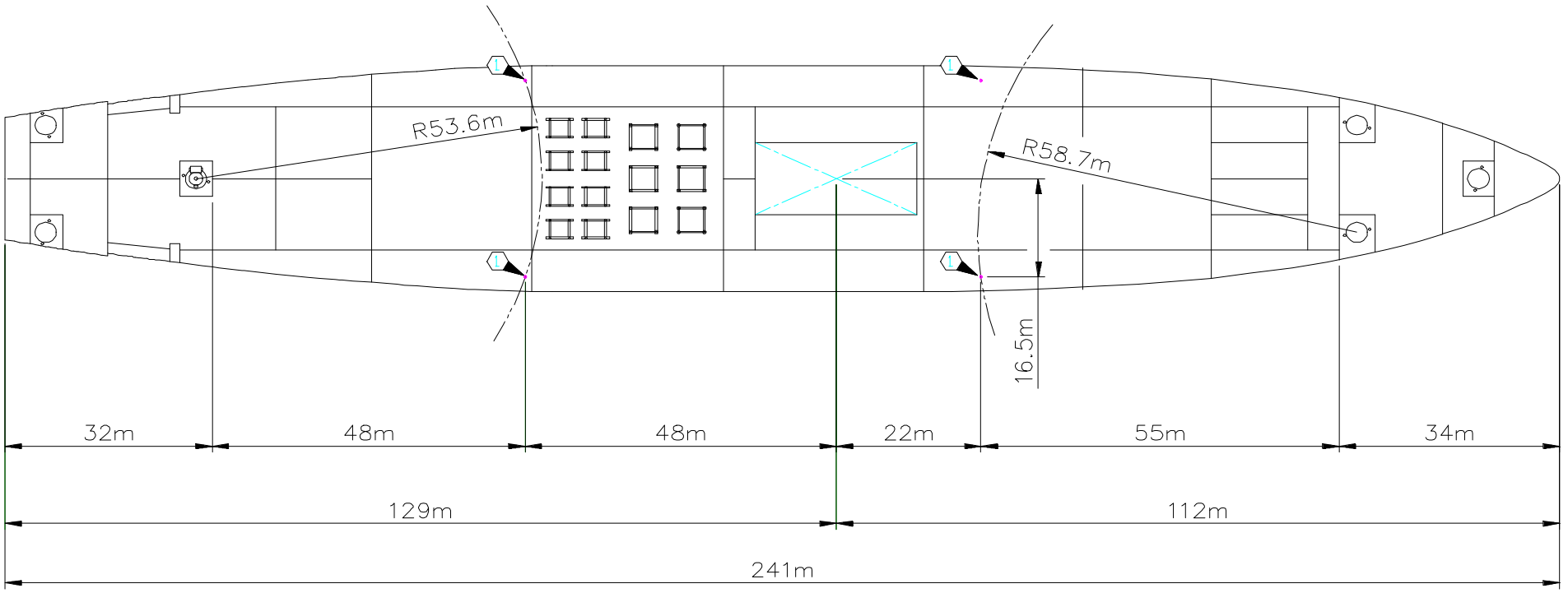

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HiPAP System

System modules:

- Color monitor
- Keyboard
- System controller
- Transceiver
- Hull Unit with Transducer
- Hoisting arrangement
- Calibration microphone

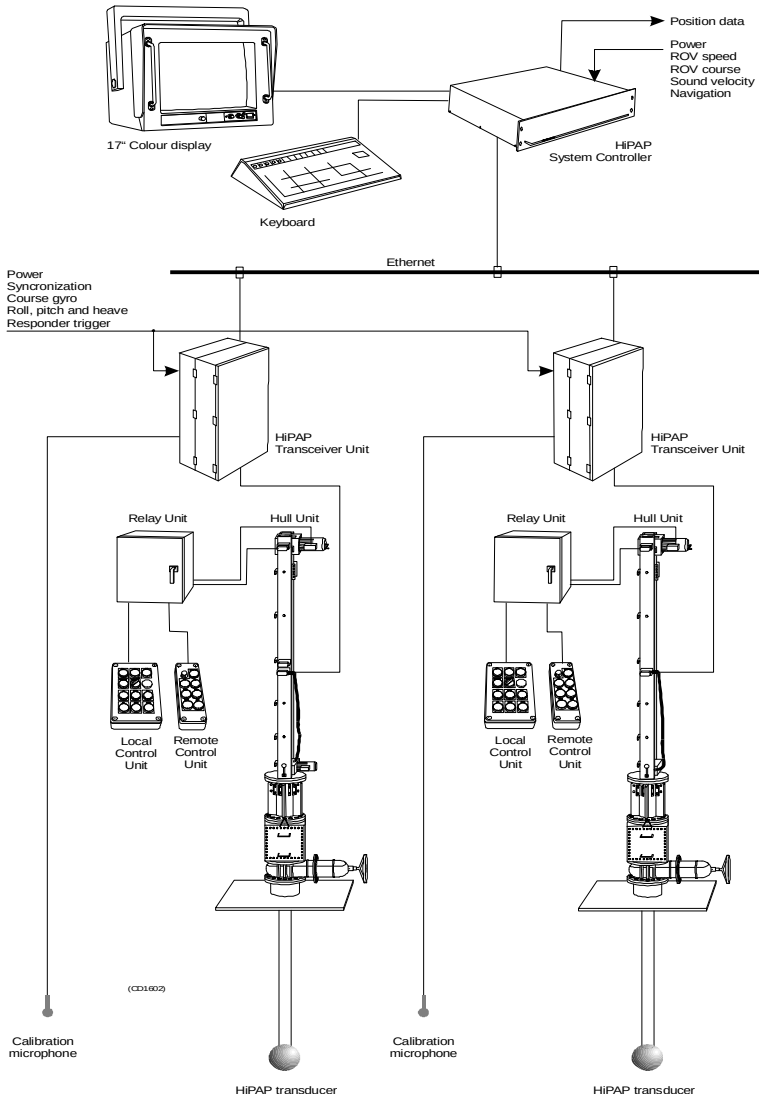
System interfaces:

Attitude:

- Seatex Seapath 400
- Seatex MRU 5
- TSS DSM

Sound velocity:

- ASCII file, depth and velocity



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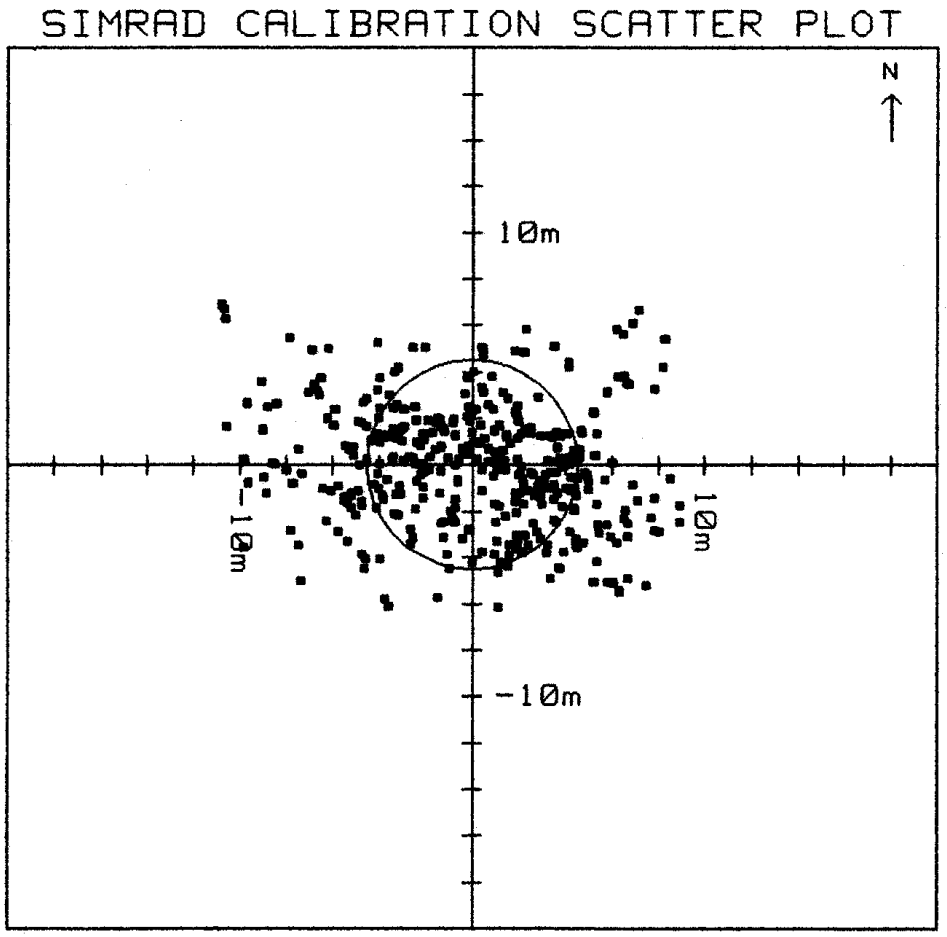
HiPAP System - Water depth 1430m, Std.:4.5m



Conditions:
Wind 30-45knots
Waves 3-5m