HAVTRONIX
DEEPWATER TECHNOLOGY
MAKING WAVES WORLD WIDE
IMPROVED
ACOUSTIC POSITIONING
FOR
DP OPERATIONS
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International Product Manager,
Acoustics
N.E.M.O.

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INTRODUCTION

Acoustic signalling has changed little in 30 years.

Nautronix have developed a new broadband signalling technique, ADS² and applied it to acoustic positioning systems for DP reference.

ADS² systems provide a highly reliable DP input with resulting benefits for DP operations.

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The marine acoustic environment poses significant problems to achieving both range and accuracy in positioning.

Existing Acoustic Systems use ‘pulse’ Signals.

All manufacturers are ‘stretching’ the technology to meet increasing industry demands.

Pulse Technology is reaching the end of its Life Cycle.

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Nautronix have developed a solution to these limitations through **innovative signalling** technology.

The **technology** was originally developed over a **5 year period** for Defence Applications. A **subset** is now available for **commercial** use.

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THE TECHNOLOGY IS

ADS²

Acoustic Digital Spread Spectrum

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THE PROBLEM

- The laws of physics put considerable constraints on the acoustic system designer.
- A number of compromises need to be made in each design.

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DEEP WATER – THE PROBLEM

- How to maintain the necessary Signal to Noise Ratio (SNR)
- How to minimise the variance in the time of arrival of the signal.

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SNR AT RECEIVER

$$SNR_{REC} = 2\frac{E_S}{N_0}$$

E_S = the energy of the received signal in joules

N_0 = the noise spectral density in Watts / Hz at the Hydrophone

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VARIANCE OF TOA

$$\sigma_{TOA}^2 \geq \frac{1}{\overline{F}^2 \left(\frac{2E_s}{N_0} \right)}$$

Equation 1 : Variance of the TOA estimate

$\overline{F}^2$ = the mean square bandwidth of the signal

$\left(\frac{2E_s}{N_0} \right)$ = the SNR of the received signal

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BANDWIDTH

$$B = \frac{1}{T}$$

B = the bandwidth of the signal in Hz

T = the duration of the signal in seconds

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SONAR EQUATION

$$SNR = (SL\text{-}TL) - (NL\text{-}AG_H)$$

SNR = signal to noise ratio at the hydrophone in dB

SL = source level in dB

TL = the transmission loss in dB

NL = the noise level at the receiver

AG_H = the array gain of the hydrophone in dB

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TRANSMISSION LOSSES

- **Range Loss**
  - *Outwith Designers Control*
    - *71dB loss over 3500m*
- **Absorption Loss**
  - *Less at lower frequencies*
    - *Up to 14dB*
    - *Low frequency limits hydrophone baffling*

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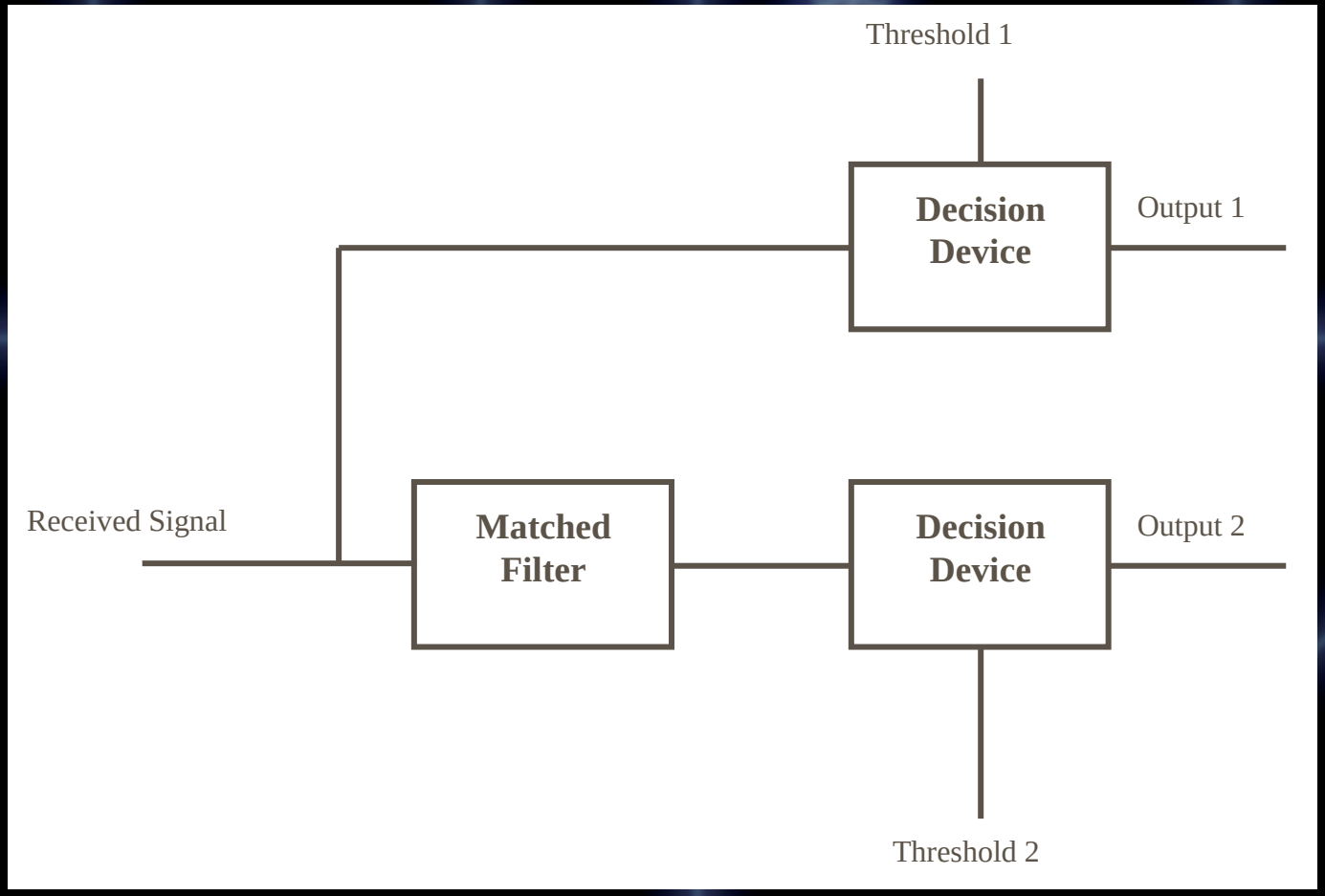
MATCHED FILTER DETECTOR



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MATCHED FILTER DETECTOR

- Responds “best” to desired signal – tends to attenuate others
- For pulse with duration T received at time t_0 the matched filter response is maximum at time $t_0 + T$

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ADS² v CONVENTIONAL SIGNALS

- Conventional acoustics are “narrowband”
- ADS² signals are broadband “Spread Spectrum”
- Spread Spectrum = “Pulse (Time) Compression”

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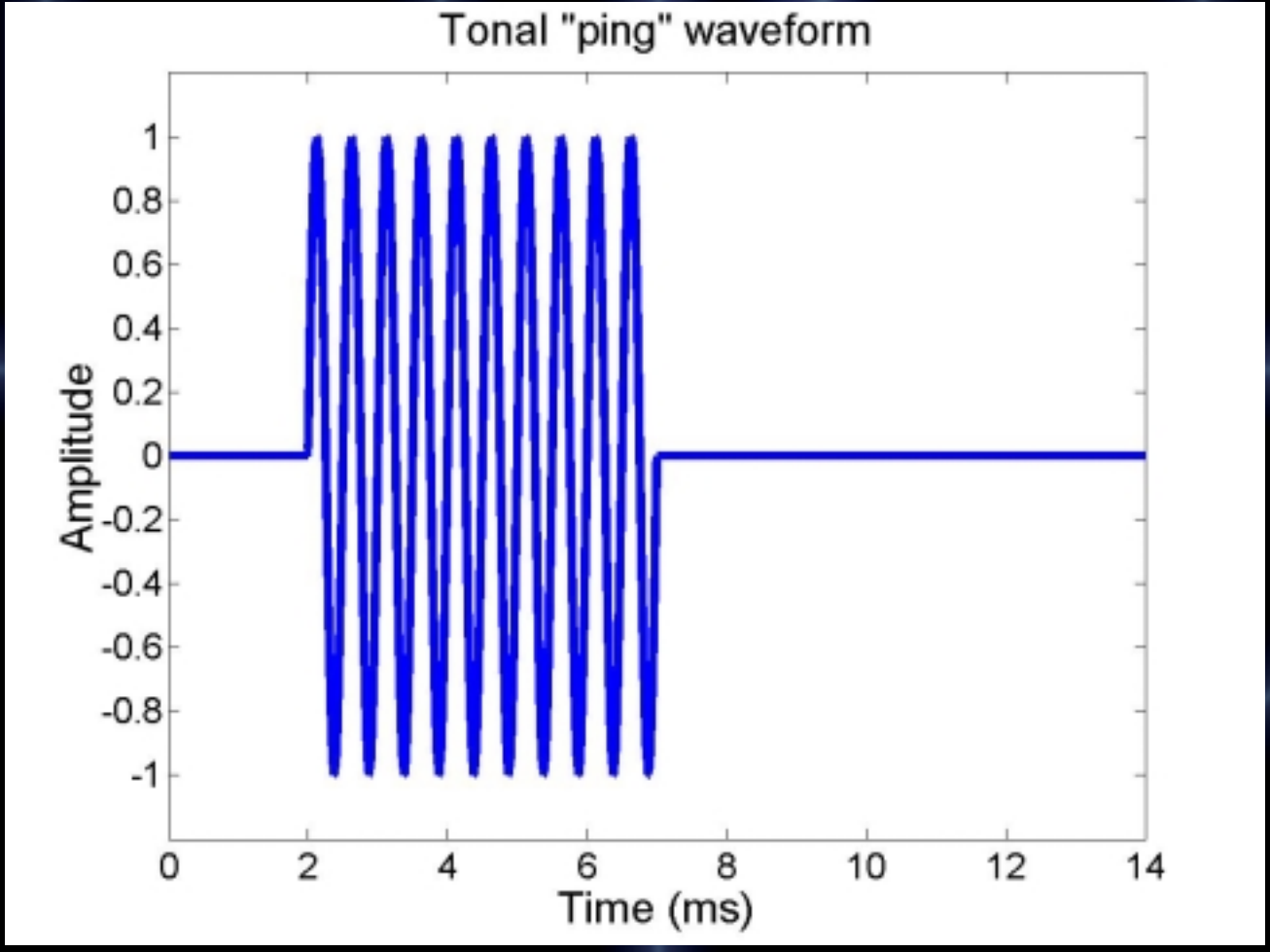
CONVENTIONAL SIGNALS



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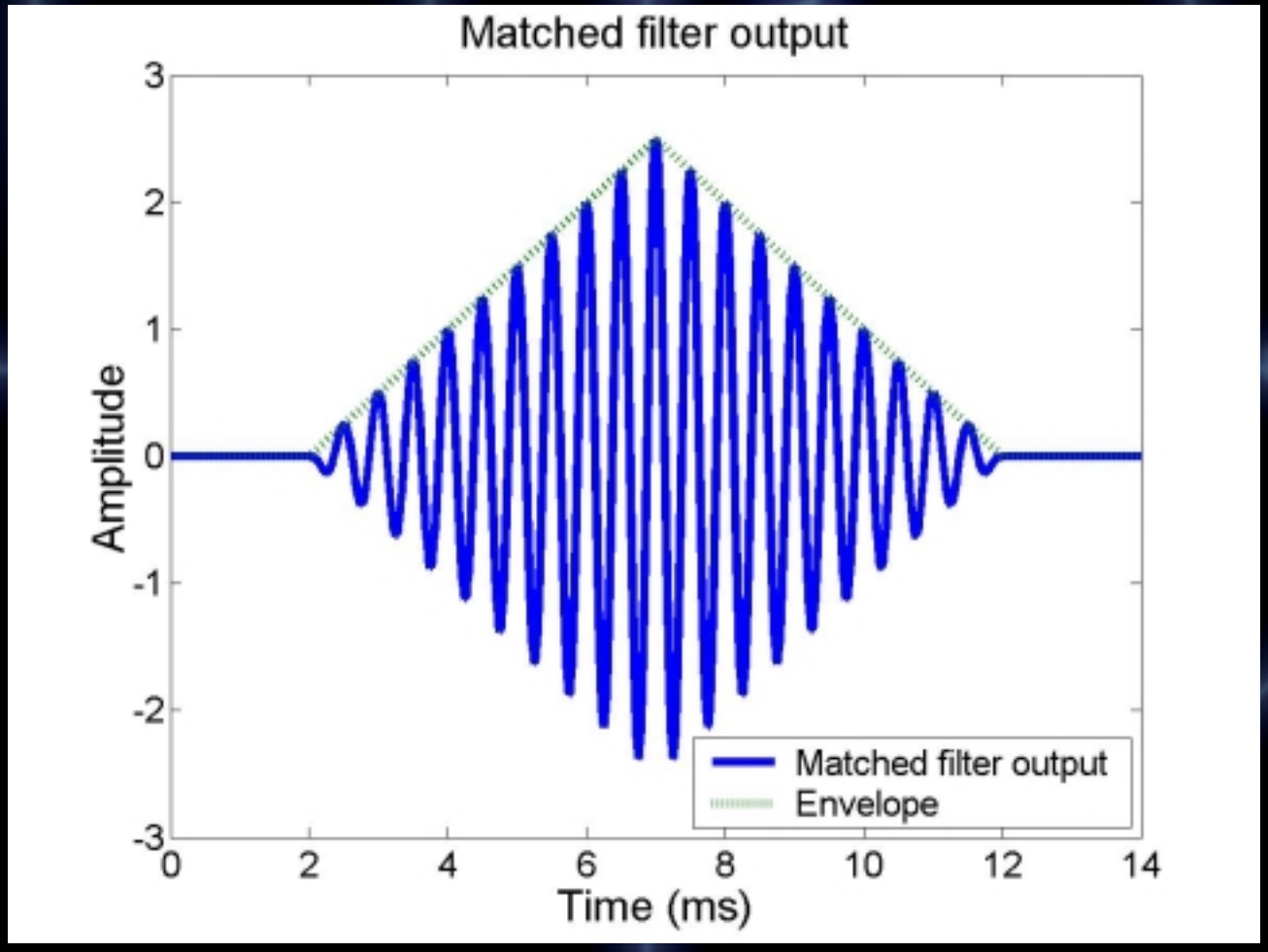
CONVENTIONAL SIGNALS



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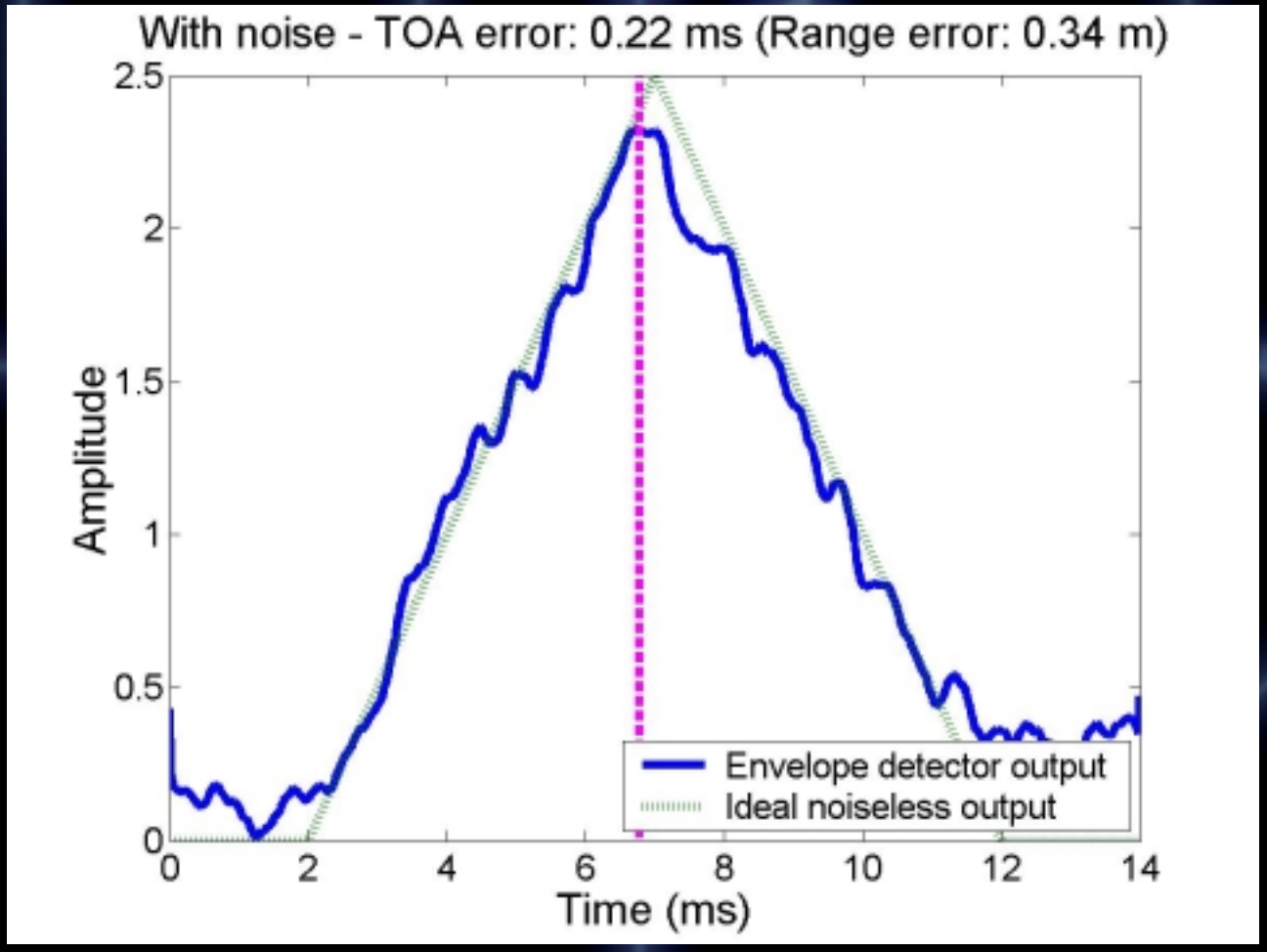
CONVENTIONAL SIGNALS



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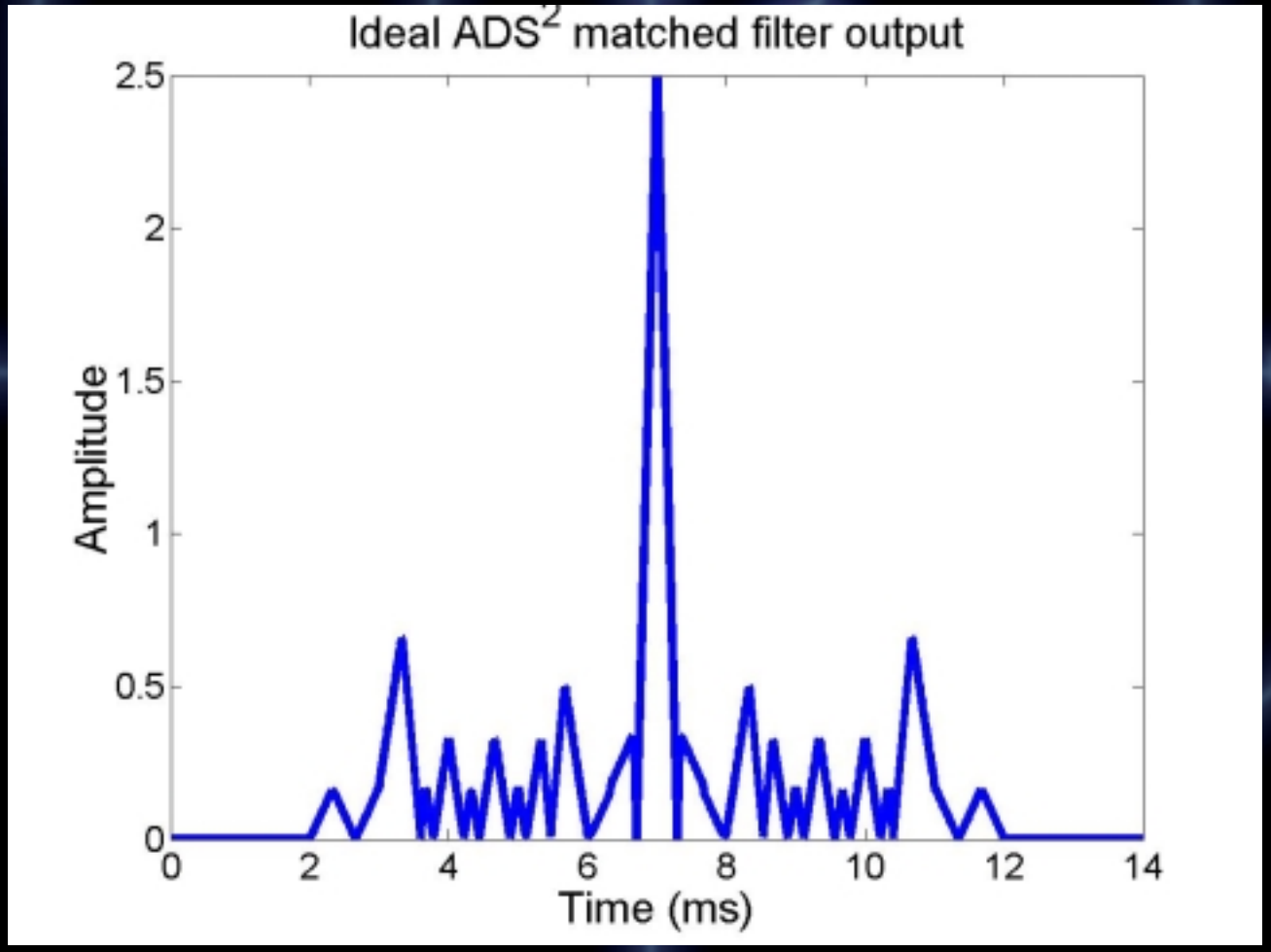
ADS² SIGNALS



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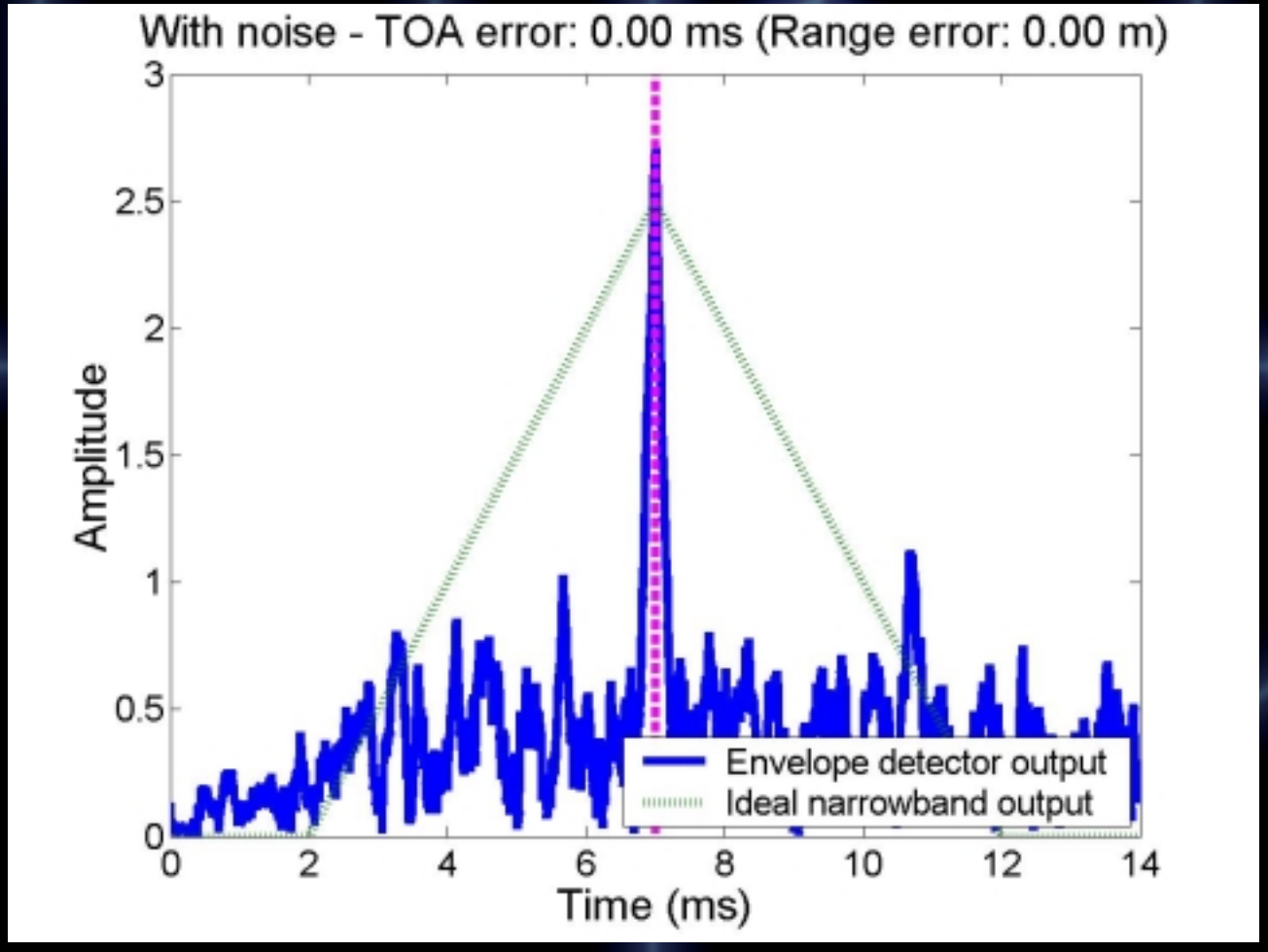
ADS² SIGNALS



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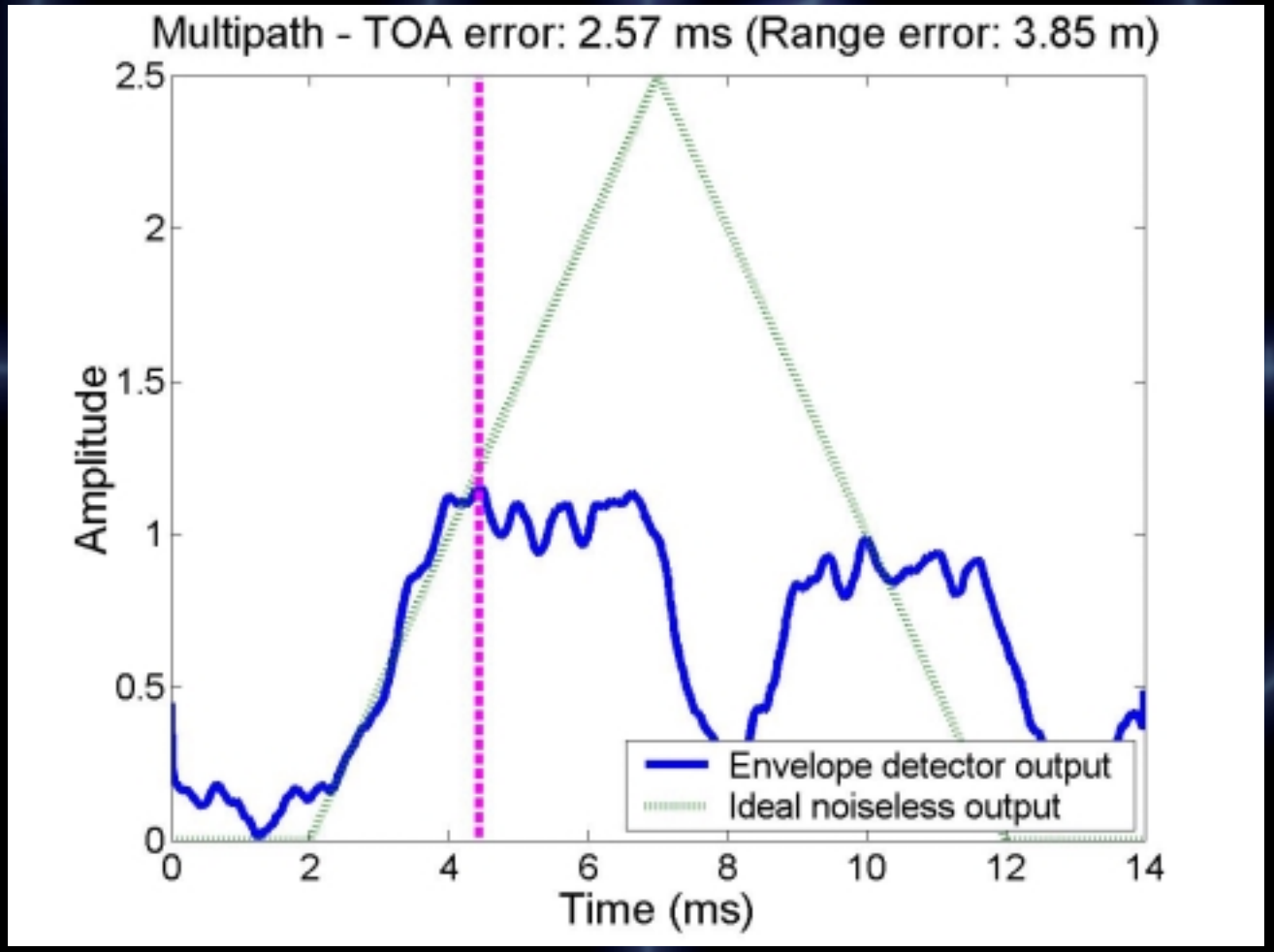
PULSE MULTIPATH RESPONSE



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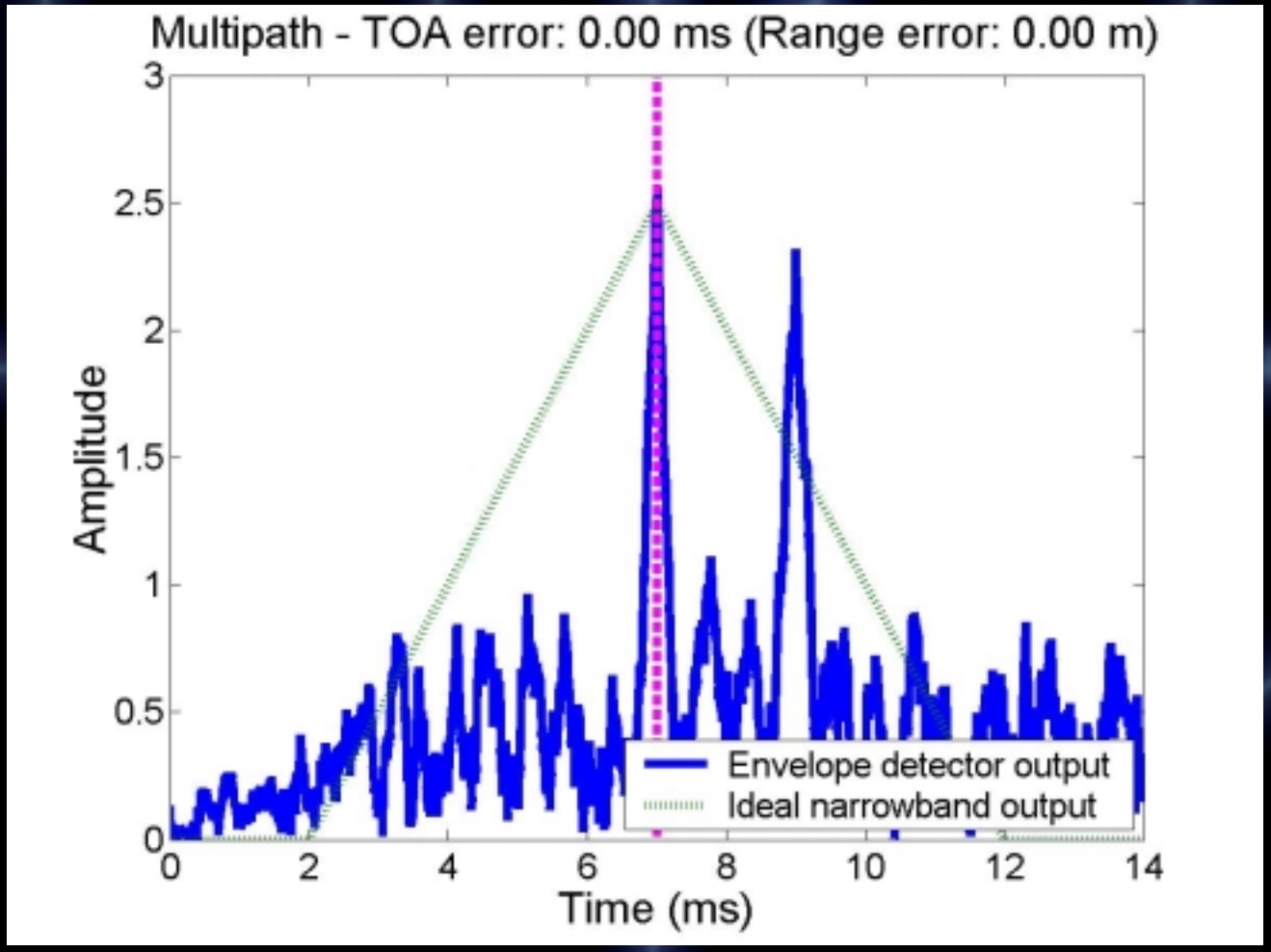
ADS² MULTIPATH RESPONSE



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ADS² BENEFITS

- ADS² allows much increased bandwidth
- ADS² allows the use of longer signals
- ADS² provides a significant Signal to Noise Benefit over pulse signals
- ADS² provides high signal Integrity

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ADS² MEANS

- Much improved SNR
- Greater ranges
- Higher accuracy
- Improved noise immunity
- Stacked signals (= fast updates)
- No or minimal interference with other systems
- Improved Shallow water performance

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SPREAD SPECTRUM COMMUNICATION

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BENEFITS FOR DP

- Increased positioning accuracy
- Better Deepwater performance
- Better Shallow water performance
- High integrity reference
- Fast update rates
- Reduce set-up time
- High noise tolerance
- One system for shallow and deep water

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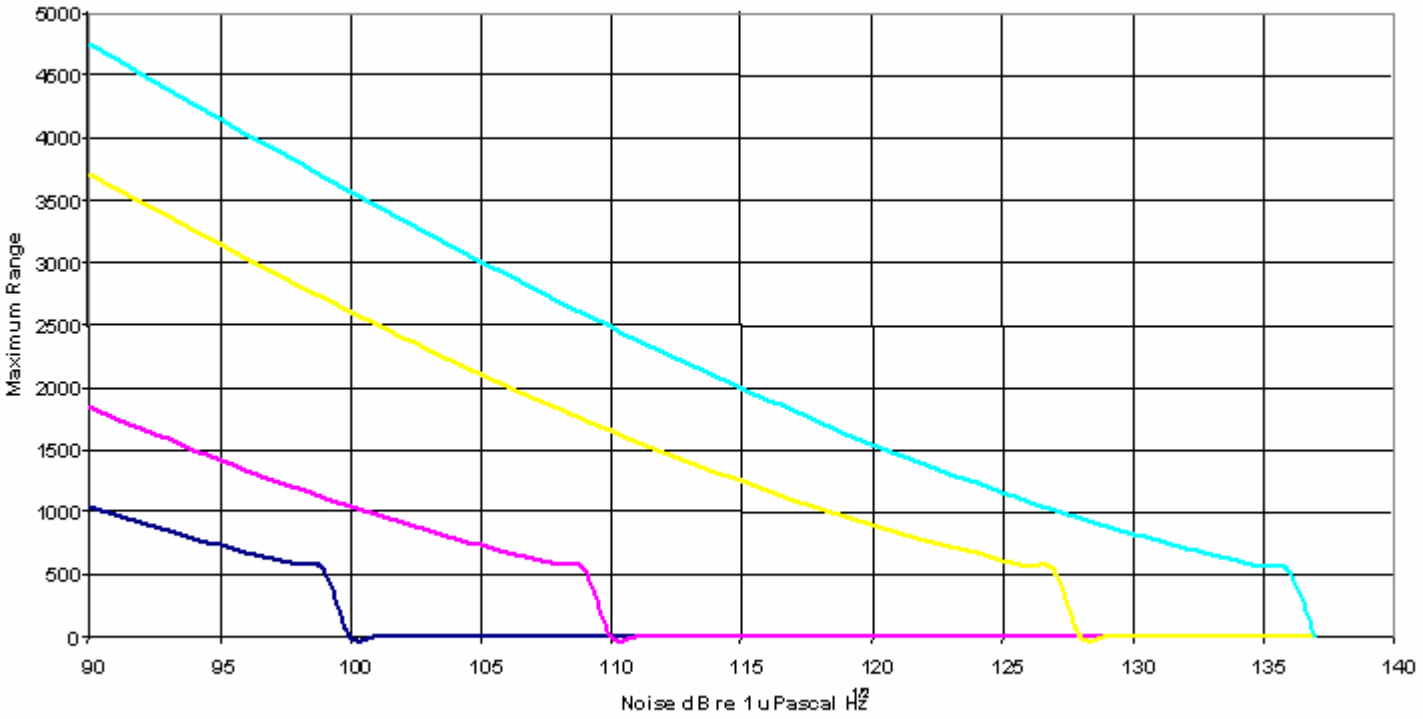
ADS² NOISE PERFORMANCE



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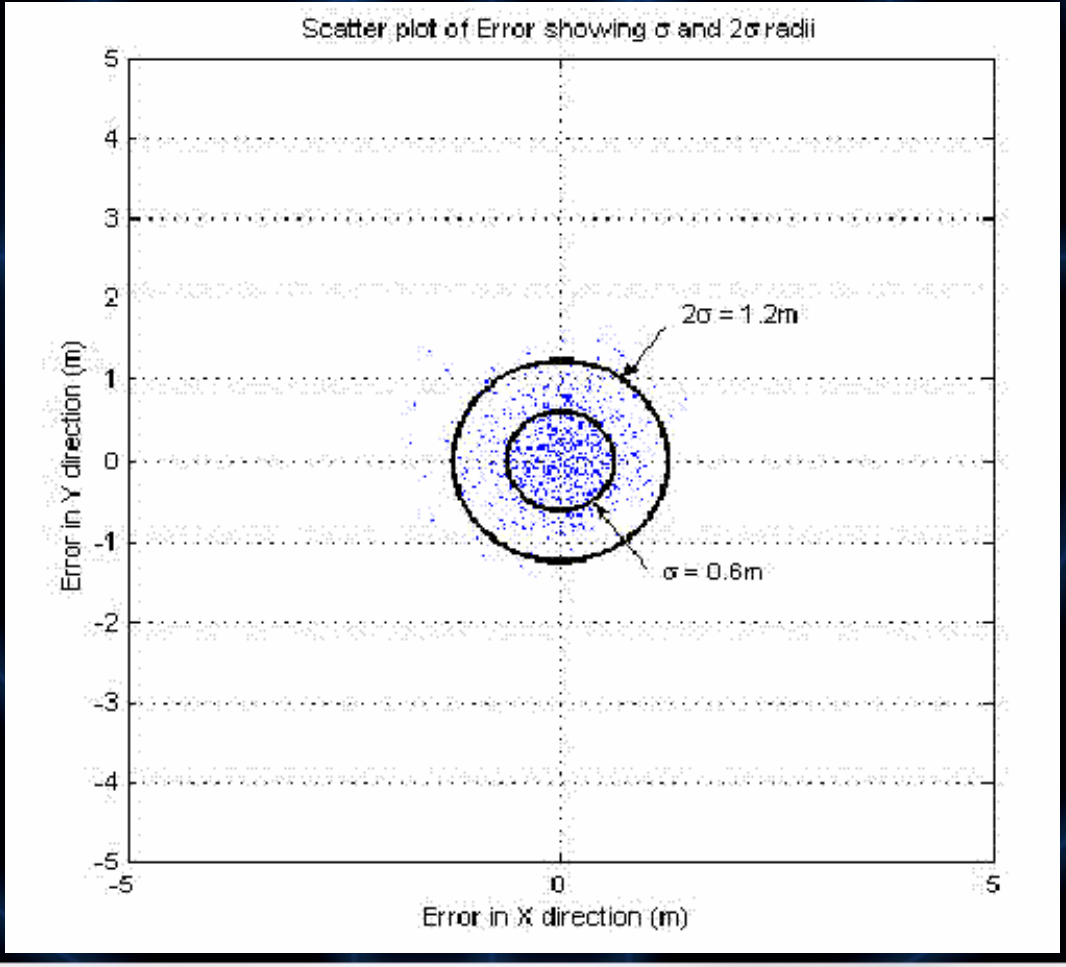
ADS² RESULTS
DEEPWATER EXPEDITION 580m 0.6m RMS



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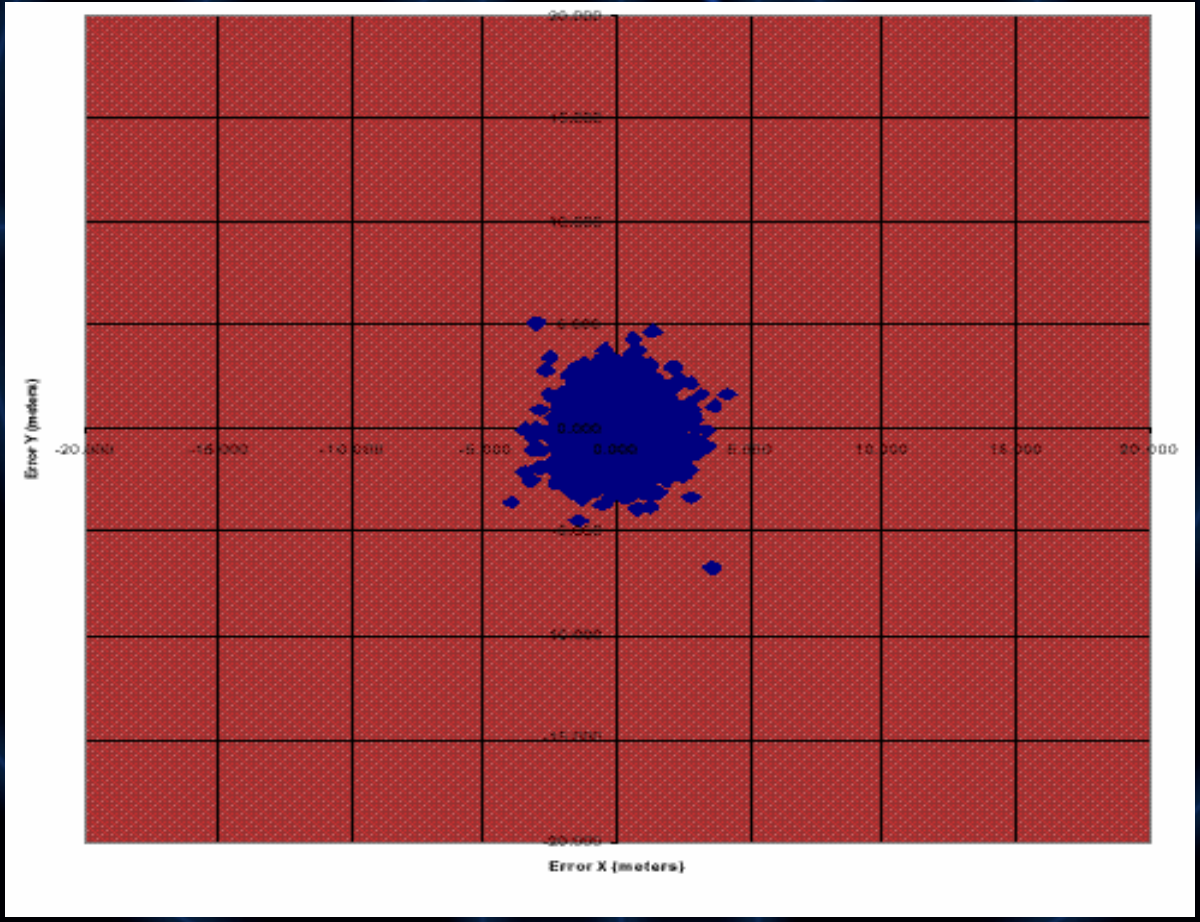
ADS² RESULTS
DEEPWATER EXPEDITION 2870m 1.7m RMS



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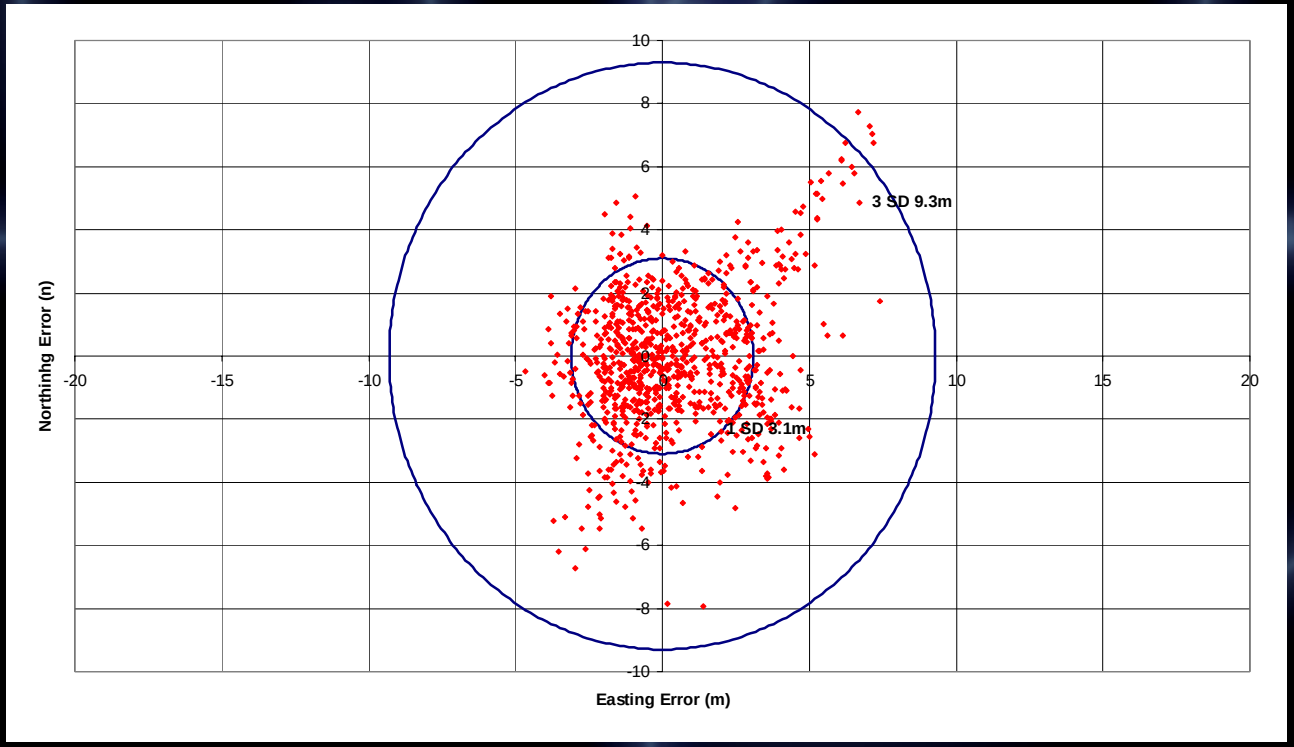
ADS² RESULTS
B/C TENEO 1000m 3.1 RMS



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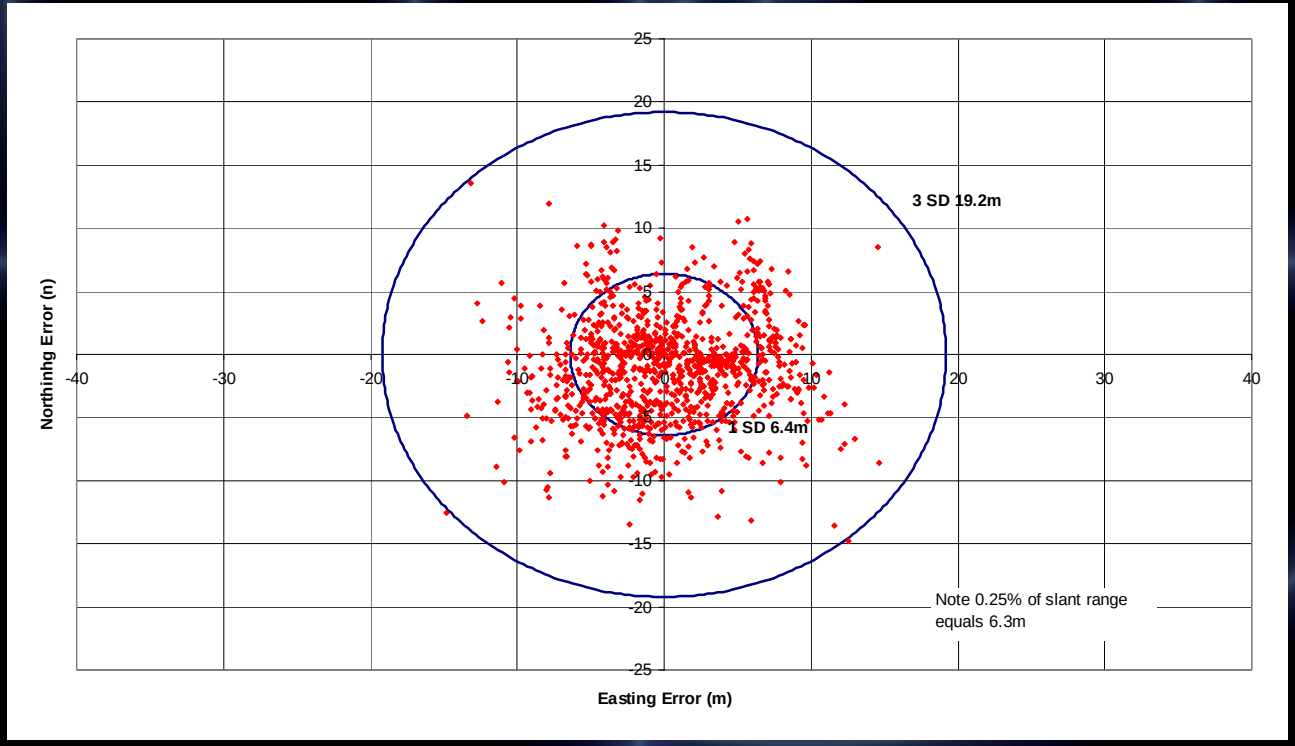
ADS² RESULTS
B/C TENEO 2500m 6.4 RMS



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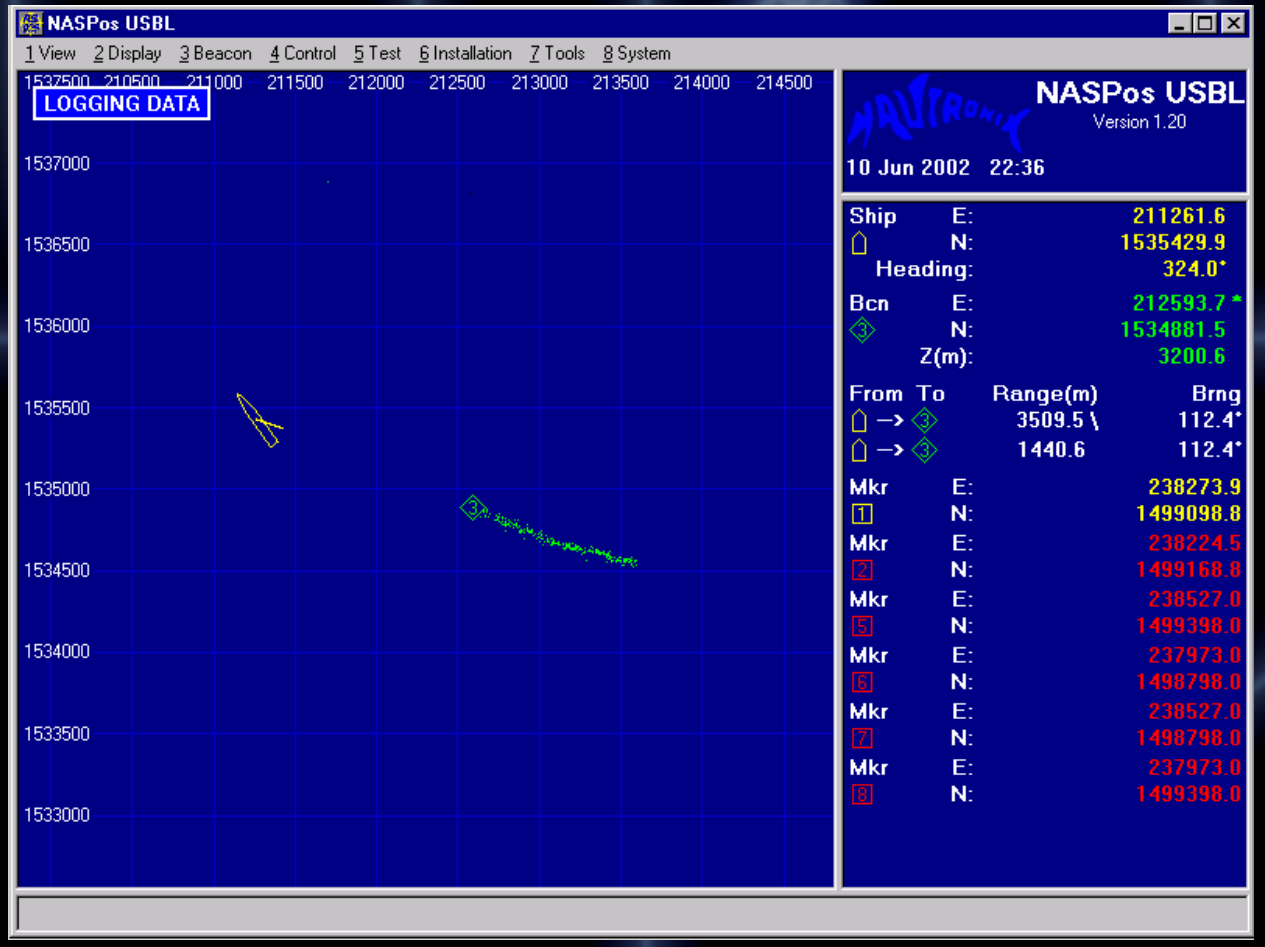
ADS² RESULTS
TOW FISH TRACKING AT 3,510m



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ADS² BENEFITS SUMMARY

- **Increased** Range
- **Increased** Accuracy
- **Increased** Noise Immunity
- **Increased** Update Rates
- **Reduced** Interference

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IMPLICATIONS FOR DP

- Higher accuracy reference
- High stability
- One reference for deep and shallow water
- Fast update rate
- Reduced set up time
- Faster settling and reaction from DP

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SUMMARY

Acoustic signalling has changed little in 30 years.

Nautronix have developed a new broadband signalling technique, ADS² and applied it to acoustic positioning systems for DP reference.

ADS² systems have been shown to provide a high integrity DP reference with resultant benefits for DP operations.

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