So what is the big deal with AST?

A direct surface measurement without loss of short wave information:

Can measure wave from greater depths than when using inferred measurements

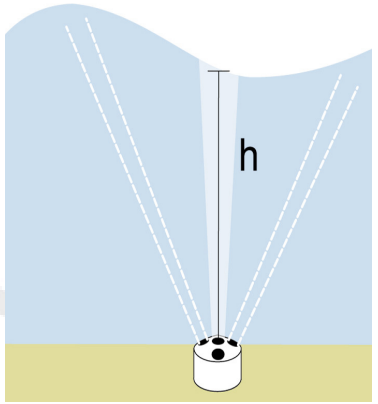
Data compares directly with buoys for long term consistency in measurements

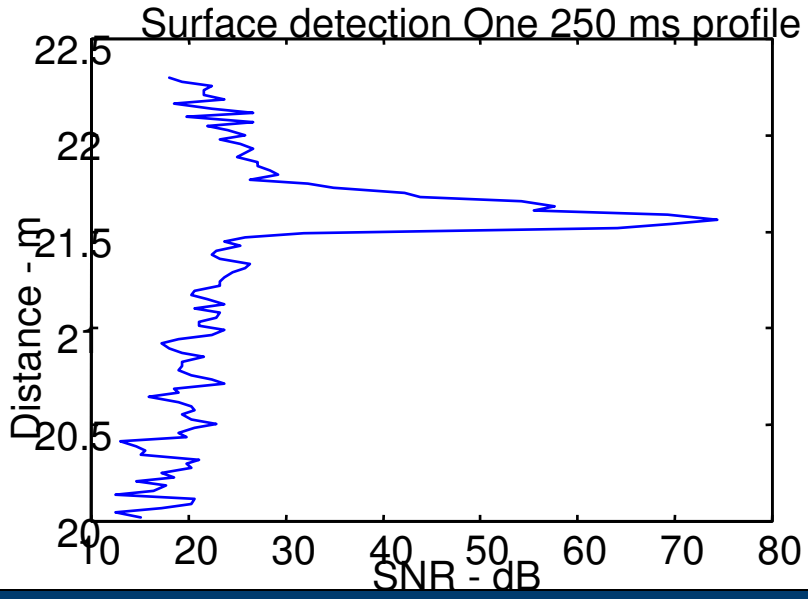
Can calculate time series statistics such as H1/10, Hmax, etc.

Transient waves

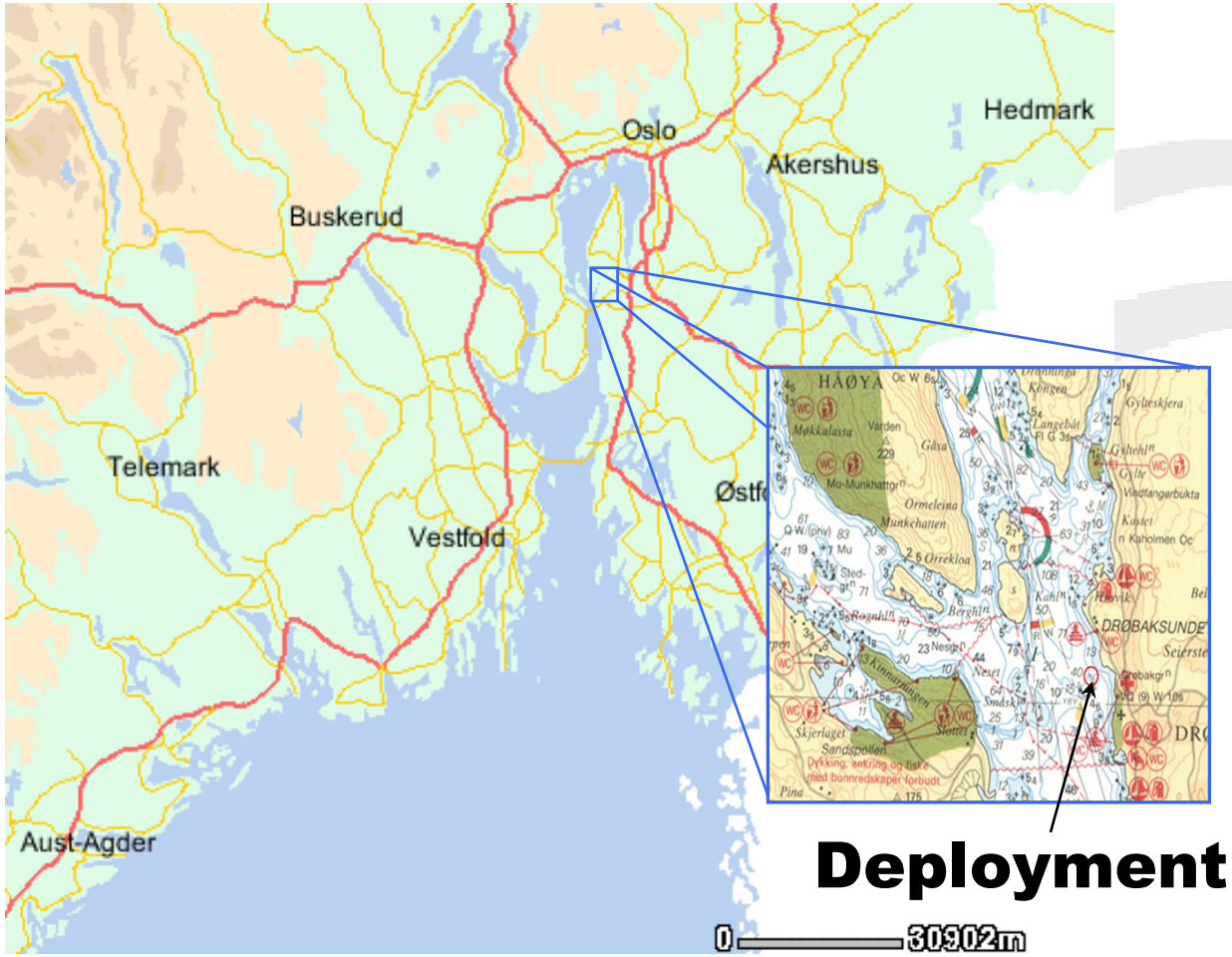
Steps in AST processing

- Transmit short pulse
- Specify a receive window
- Discretise receive window into multiple cells (2.3 cm)
- Find largest return in record
- Use quadratic interpolation to finely resolve surface position





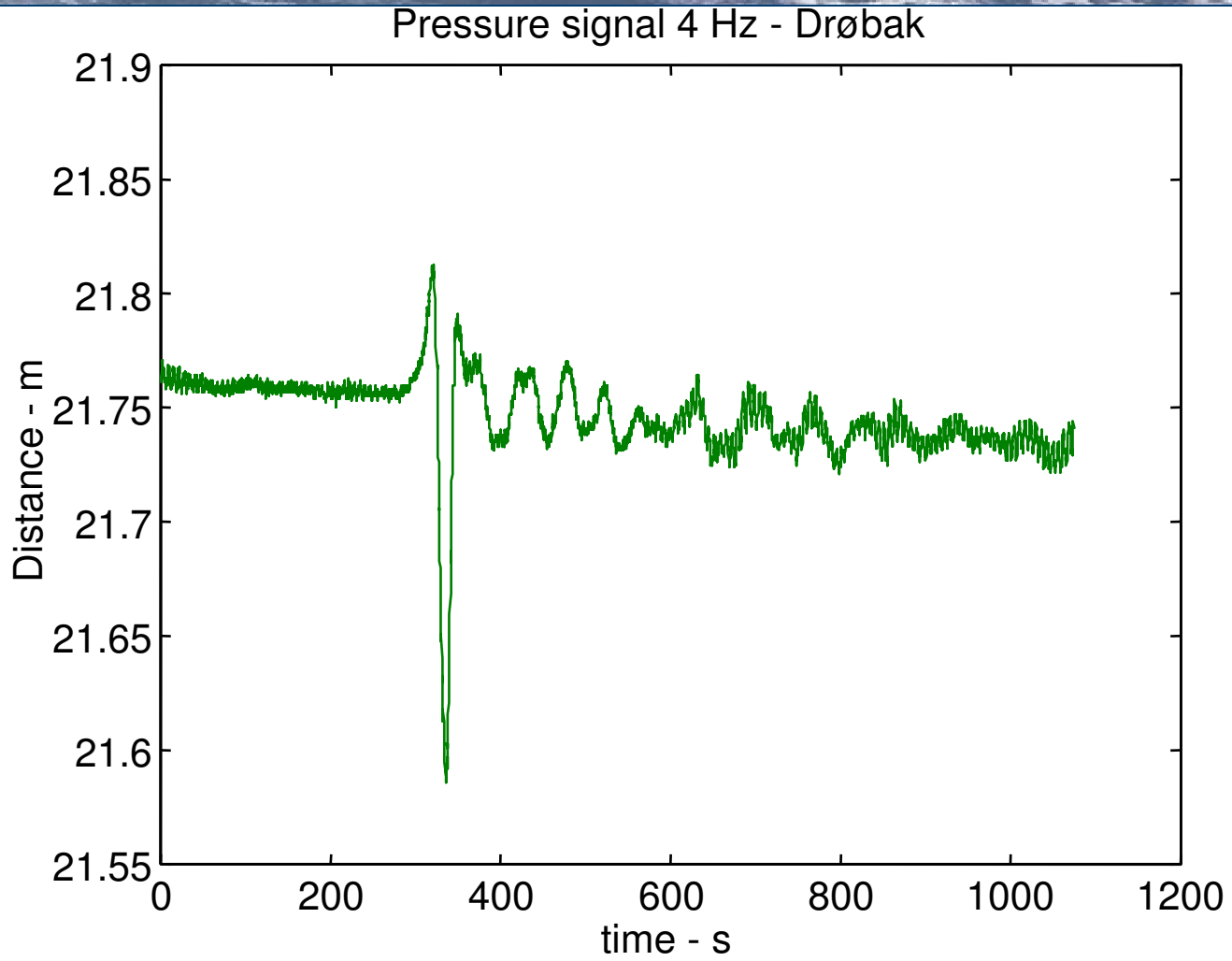
AST Proof of Principle



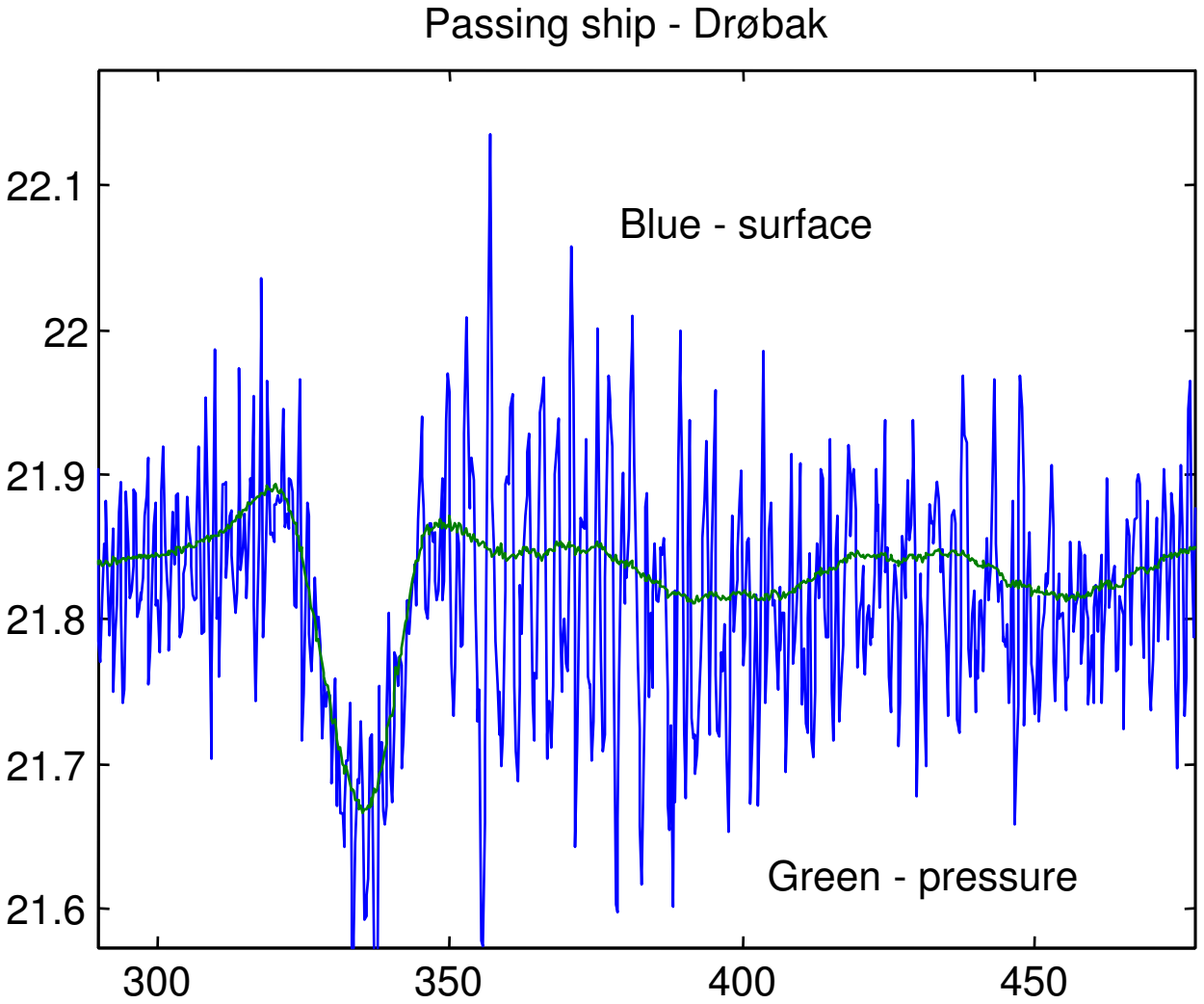
- AWAC online
- Depth 21 m
- Fjord sill
- Protected region
- Shipping Traffic
- 4Hz Sample Rate

Online AWAC Drøbak

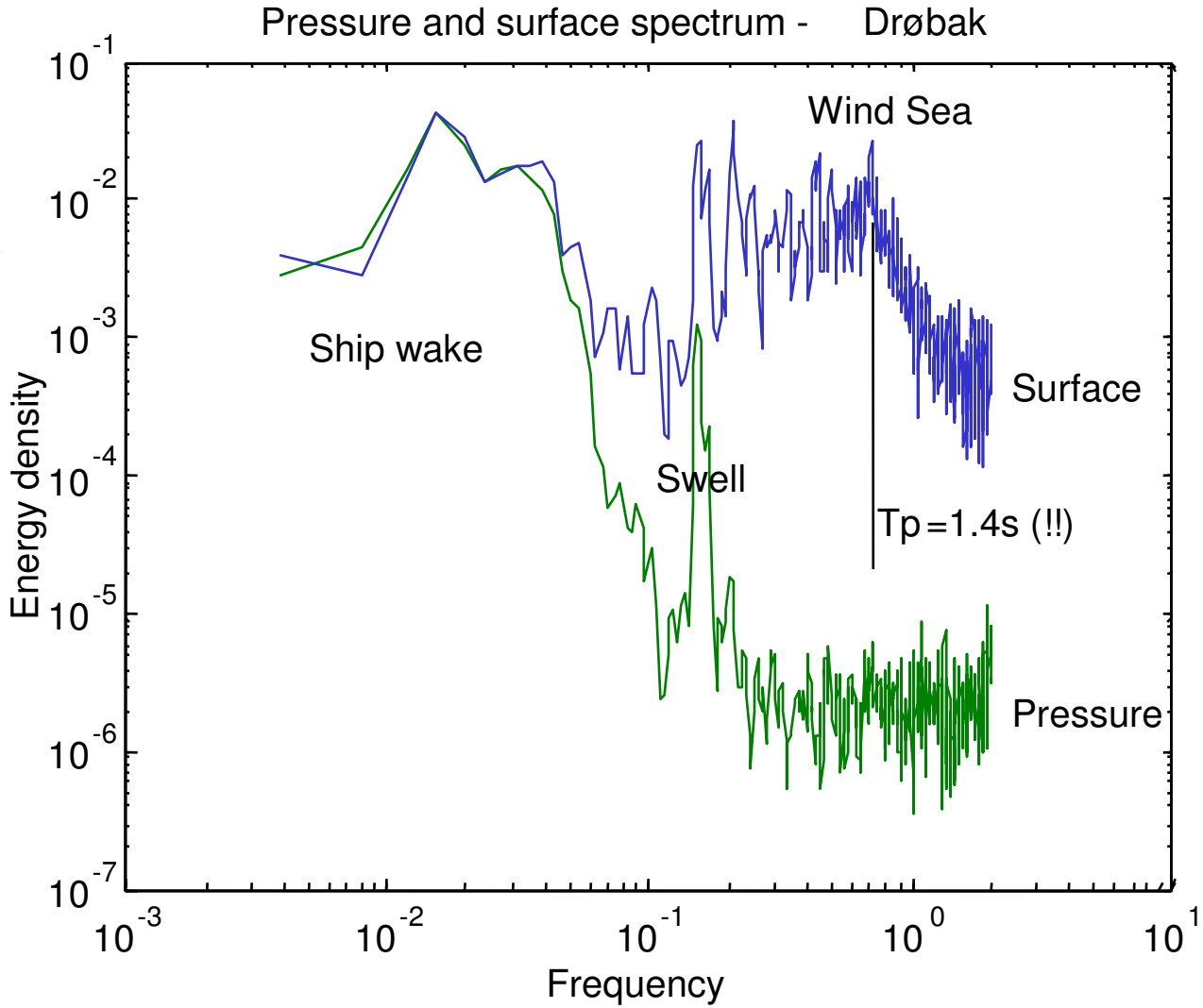
A passing ship wake



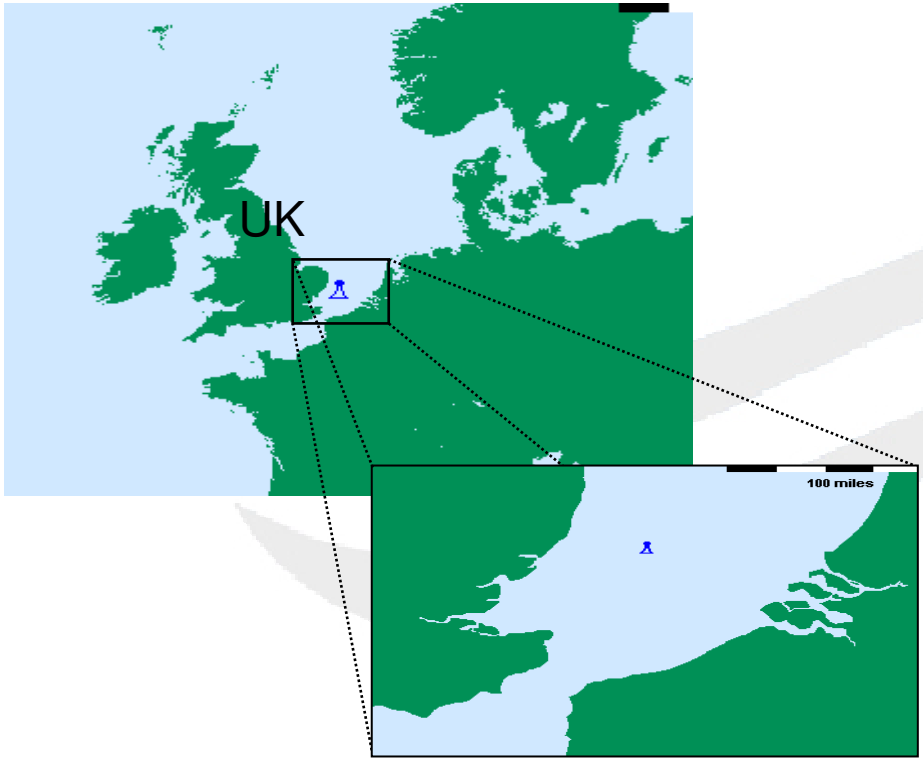
With AST overlaid



Comparing the two spectra



A final validation: Gabbard



http://www.cefas.co.uk

Gabbard:

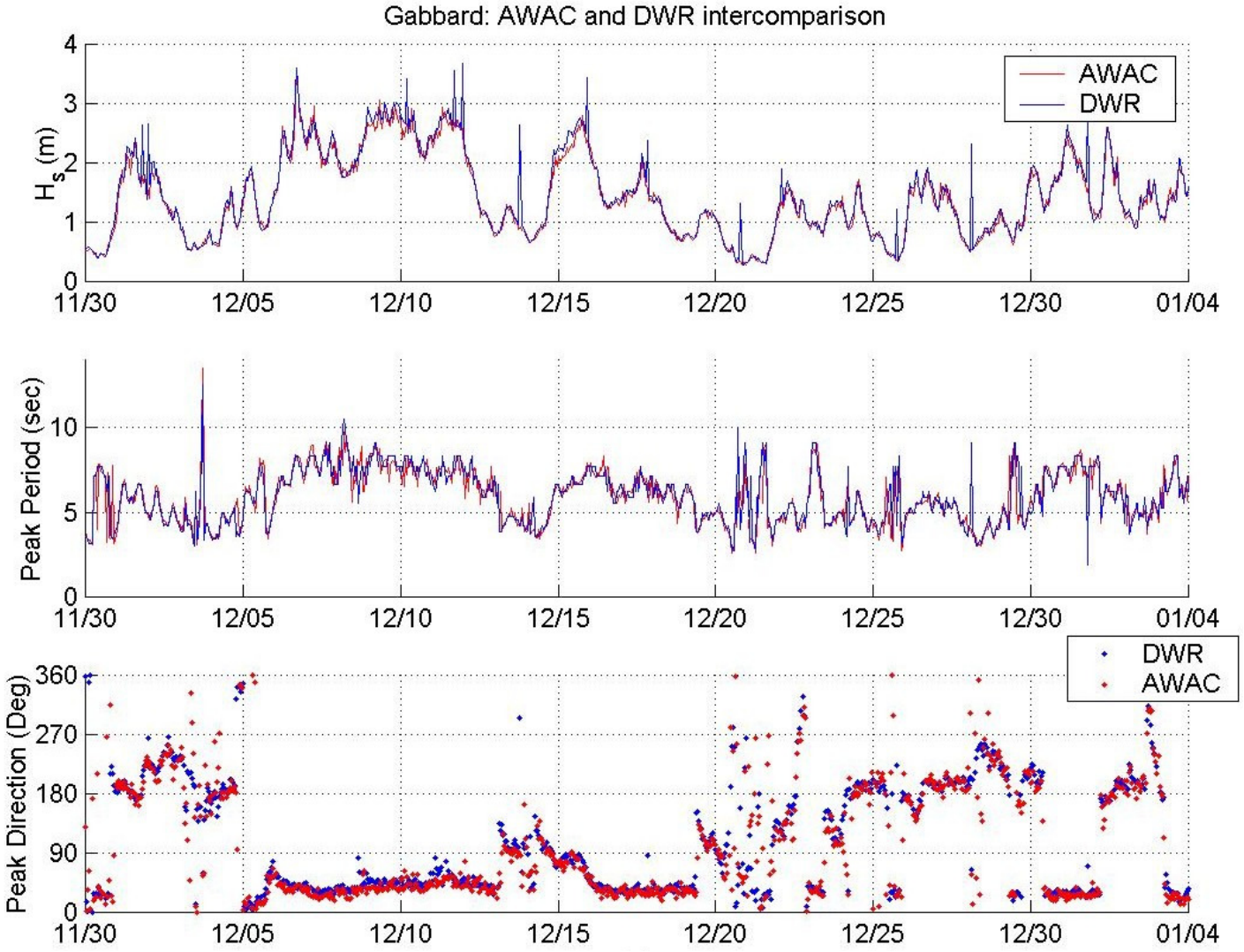
Depth 32 meters

AST sampling 2 Hz
2048 points ~17 min

Burst every hour.
Profile every 10 min

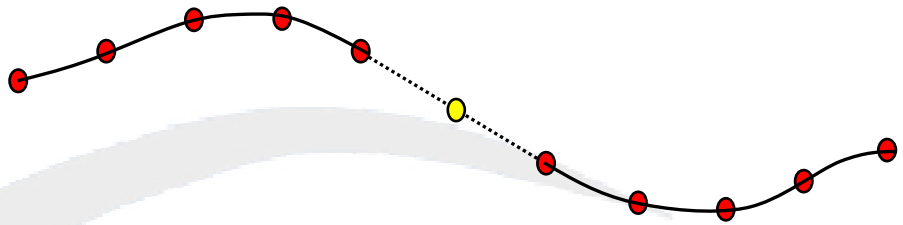
1215 burst
16 w/AST Error

Waverider comparison



Handling lost data

- Interpolate missing points.
- Occurance is independent of location on waveform (ie crest, trough).
- False Detect & No Detect Define maximum number of tolerable missing data (10%).



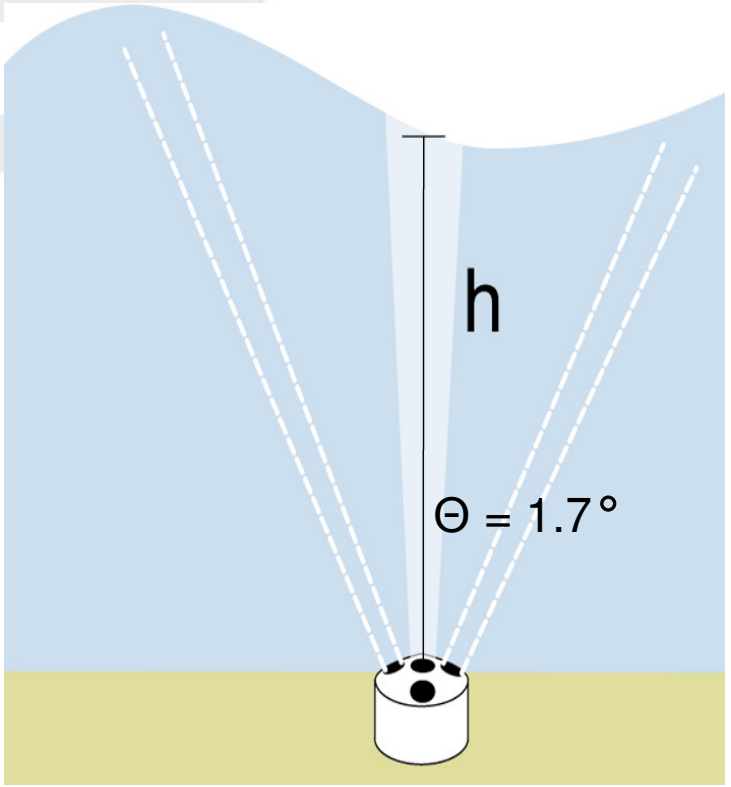
Simulation of Error for H_s (%) given wave period and data loss in time series

	% of Data Loss				
Period (s)	*2*	*5*	*10*	*20*	*30*
3	0.3	1	2	4.1	5.6
5	0.3	1	1.6	3.3	3.8
10	0.1	0.2	0.8	1	2.3
15	0.1	0.1	0.2	0.7	1.1

Footprint limitations

- As depth increases so does the footprint.
- Resolvable waves limited by twice the footprint diameter (Nyquist).
- Surface resolution (noise level)
- Acoustic foot print on the surface (”smearing effects”)

2*h*sinΘ



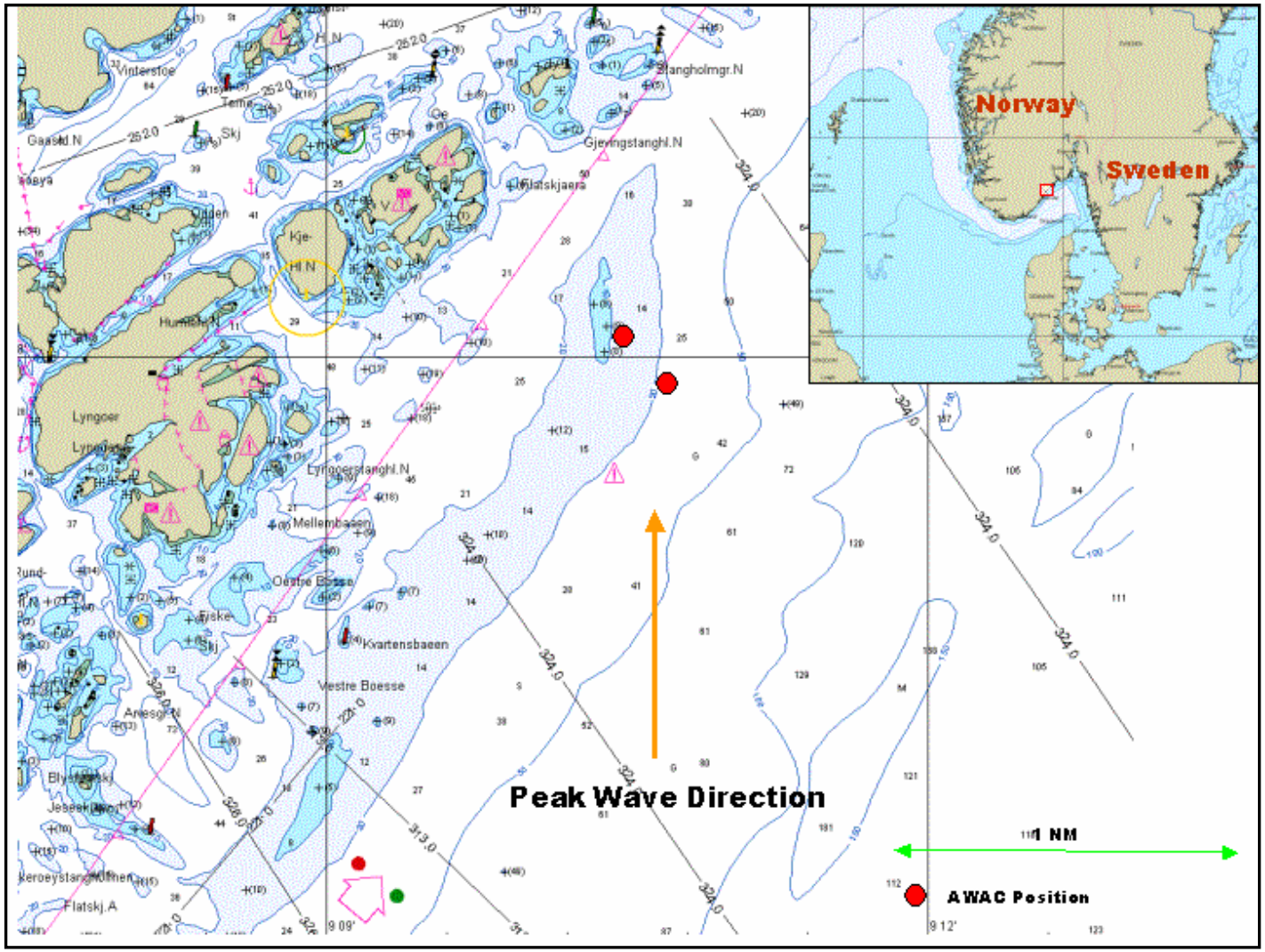
Depth vs. Footprint

Depth (m)	Footprint Diameter (m)	Nyquist Ltd Period (s)
10	0.3	0.6
20	0.6	0.9
30	0.9	1.1
40	1.2	1.2

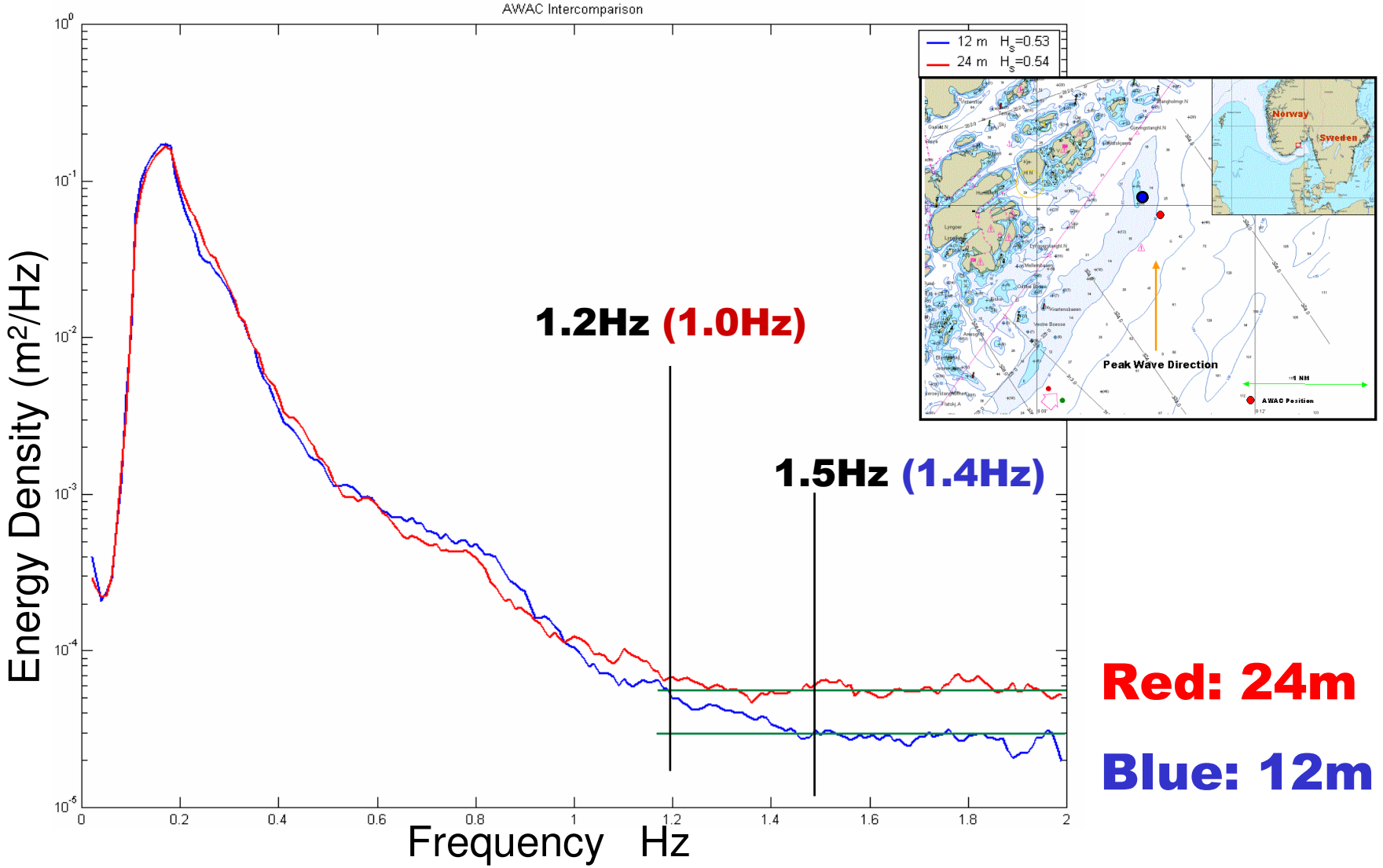
Acoustic footprint

Depth	Footprint	Min. Wavelength	Frequency	Period
6	0.2m	0.4m	2.0Hz	0.5s
12	0.4m	0.8m	1.4Hz	0.7s
24	0.7m	1.5m	1.0Hz	1.0s
36	1.1m	2.1m	0.9Hz	1.1s
48	1.4m	2.8m	0.8Hz	1.3s
60	1.8m	3.6m	0.7Hz	1.5s

Acoustic Footprint Study



Acoustic Footprint - Response

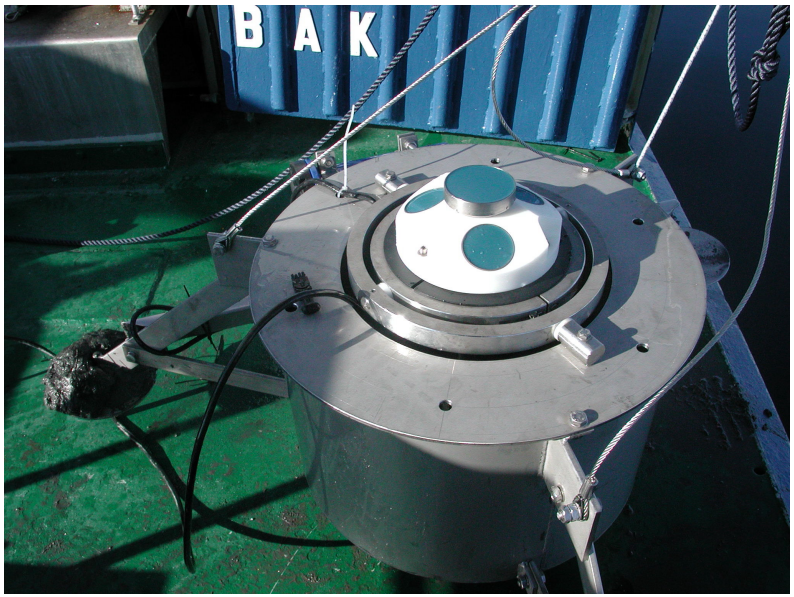


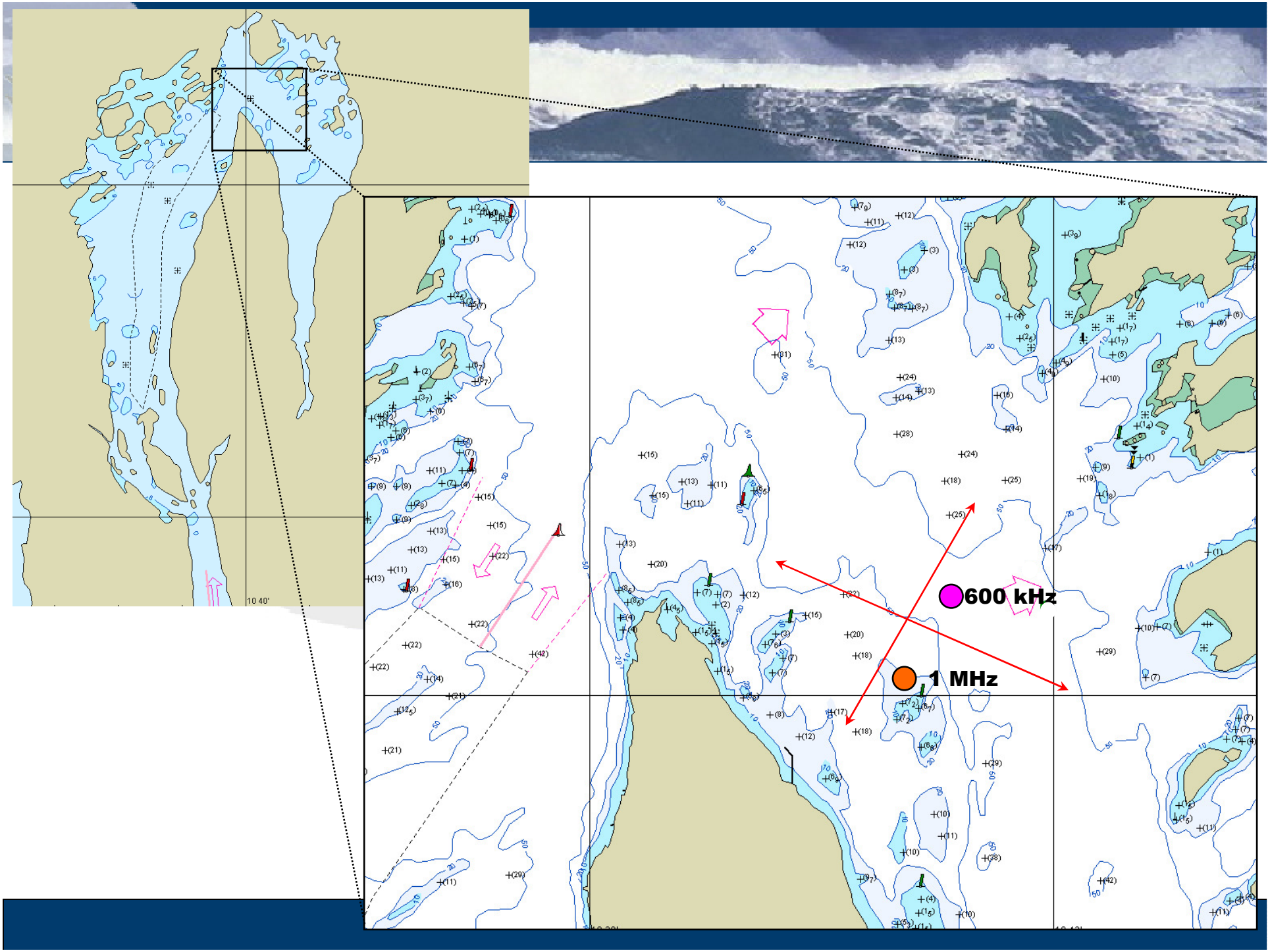
600 kHz AWAC Development

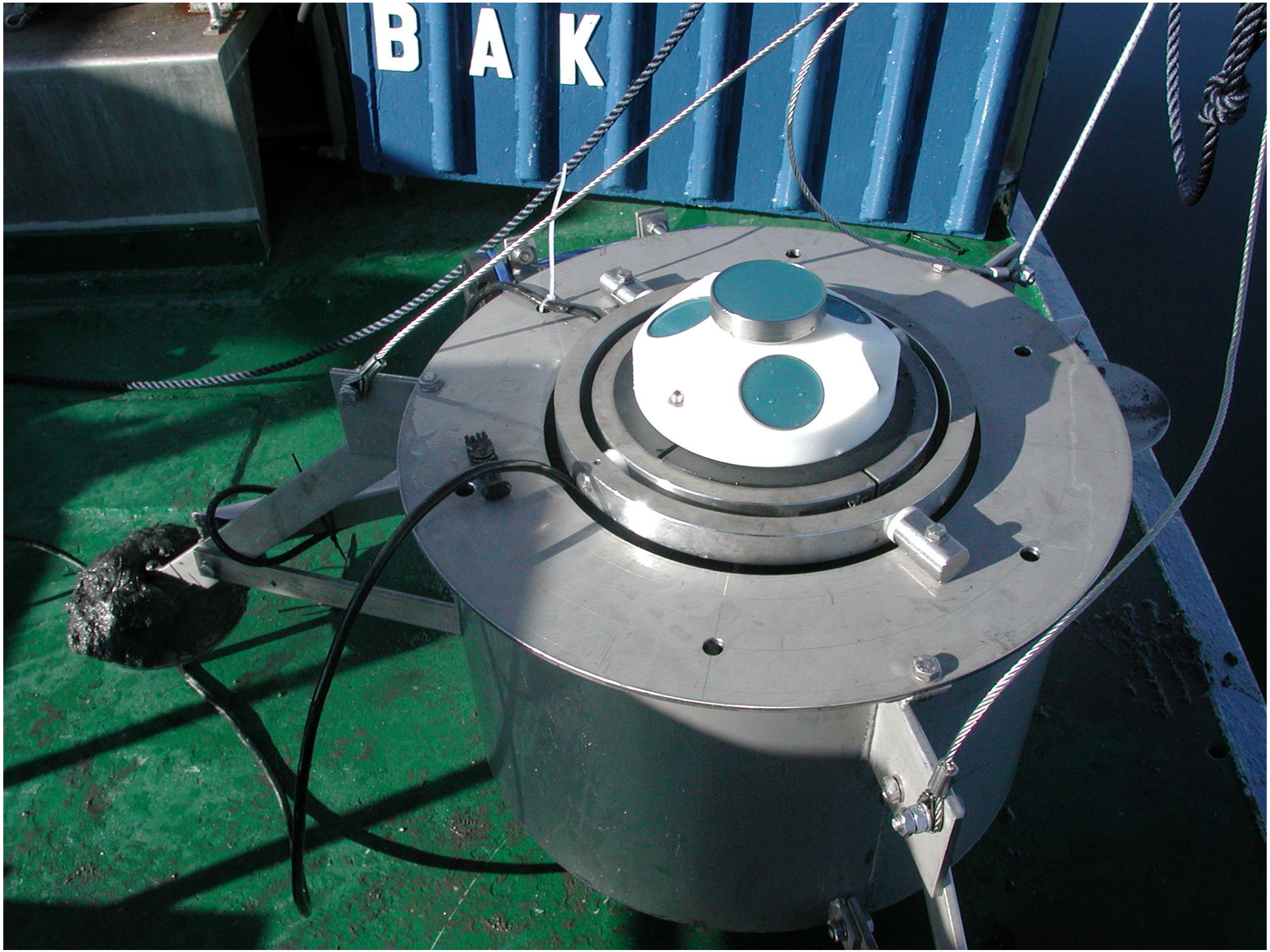
THE CHALLENGE: DEEPER WATER SMALLER WAVES!

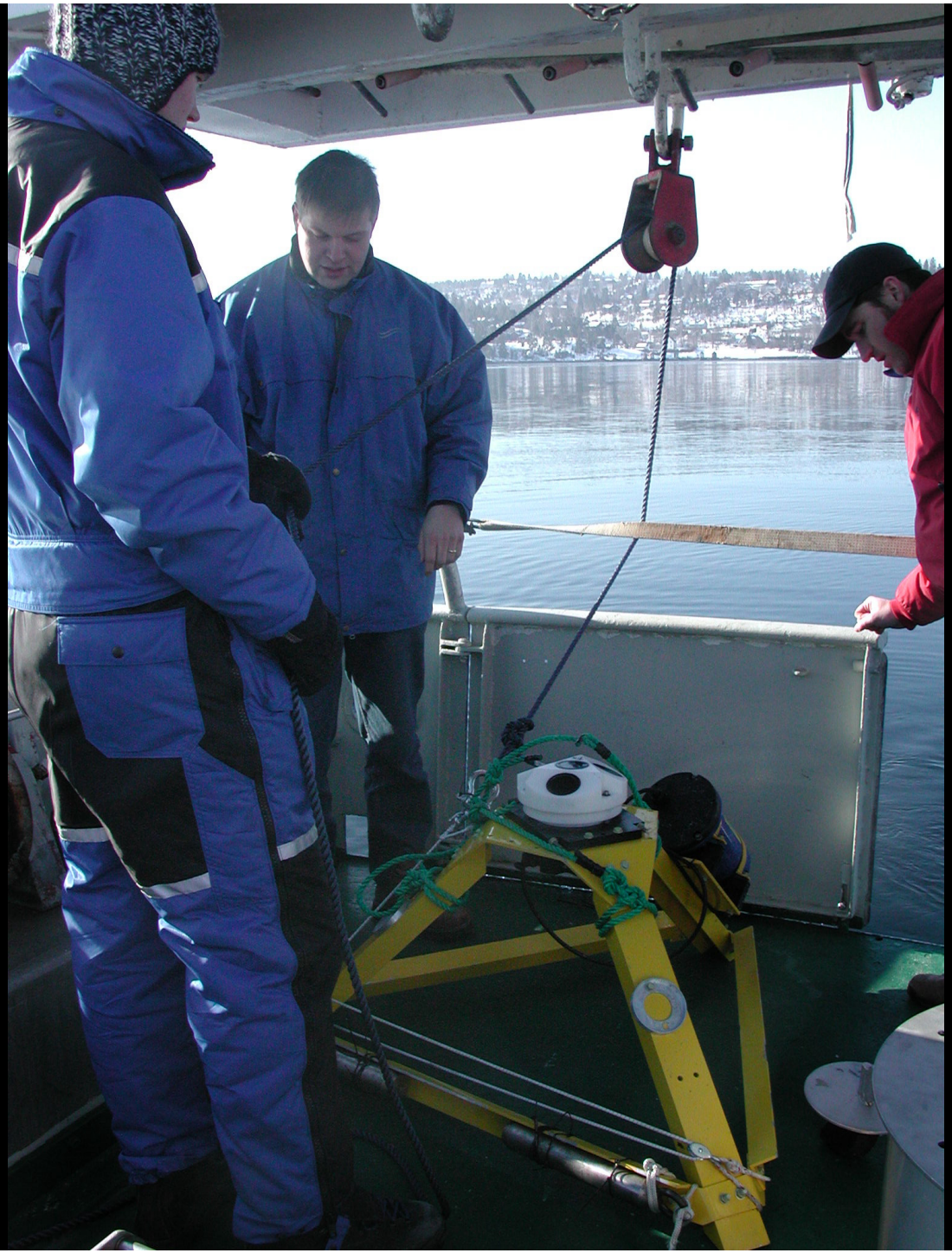
Key Features

- Larger center transducer
- Wave Sampling 2 Hz
- 50 m Profiling range
- 60 m AST range



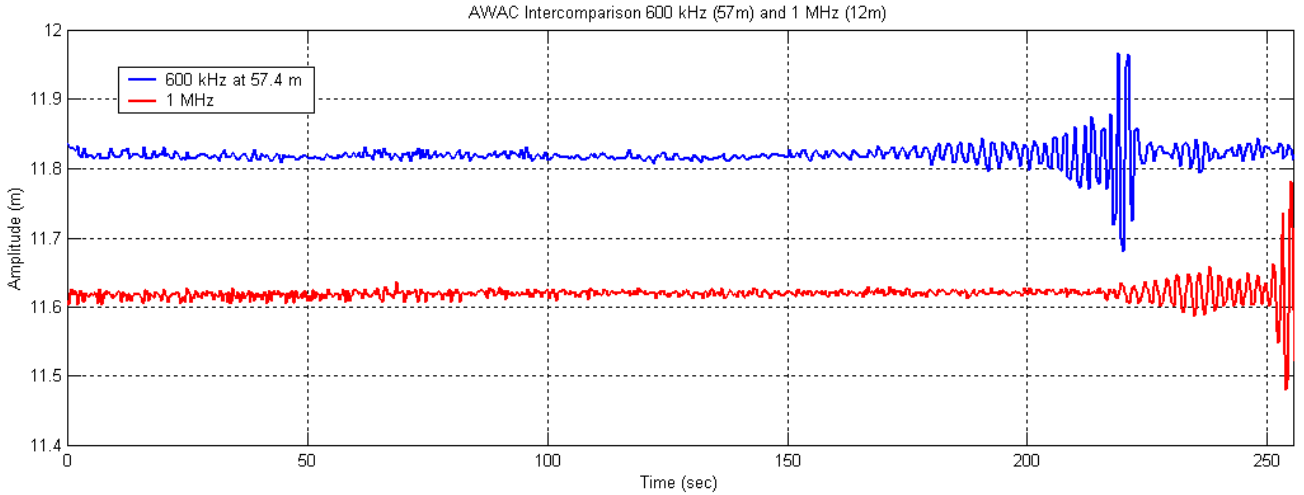

600 kHz
1 MHz

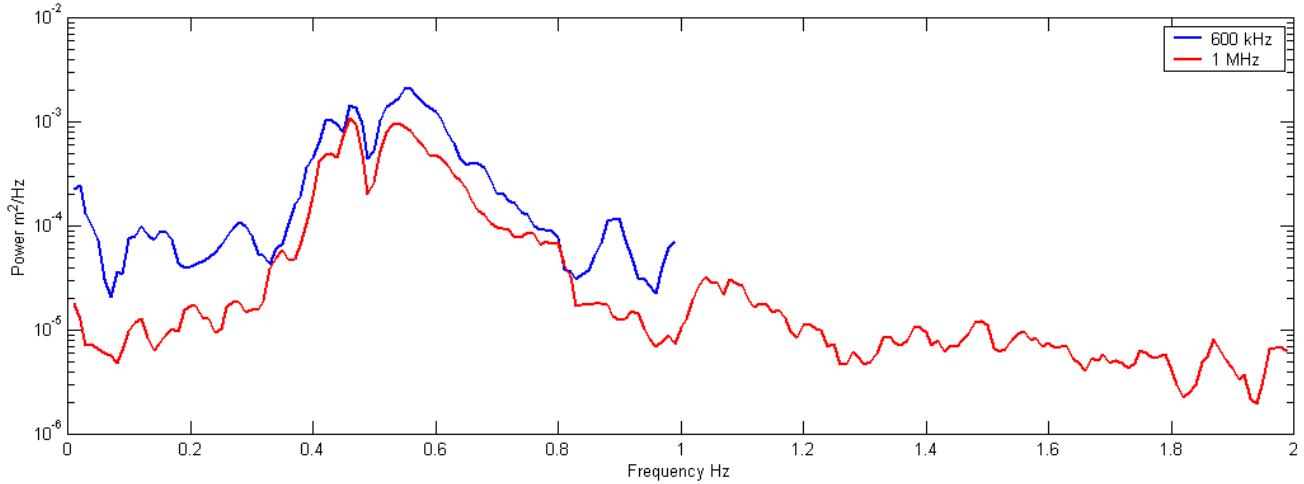

BAK



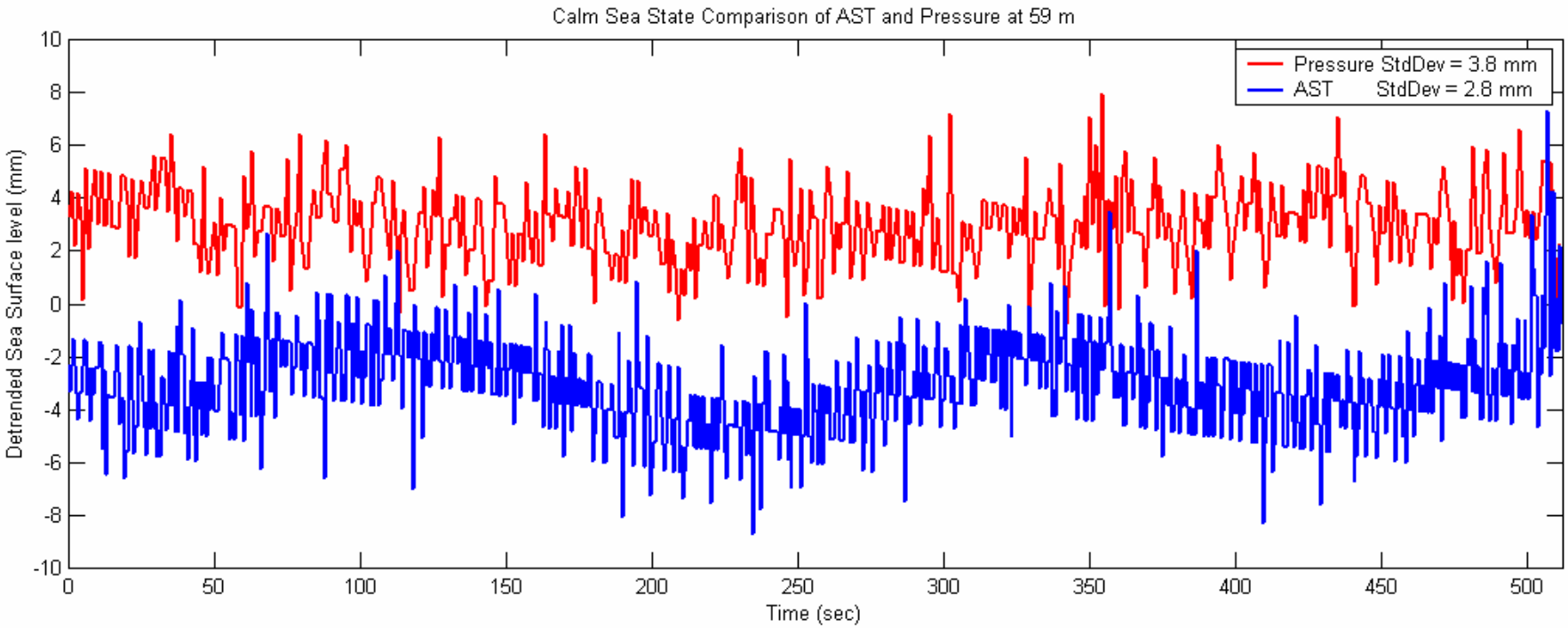

BJØRN FØYN
TMP 300K

Greater Depths with 600 kHz

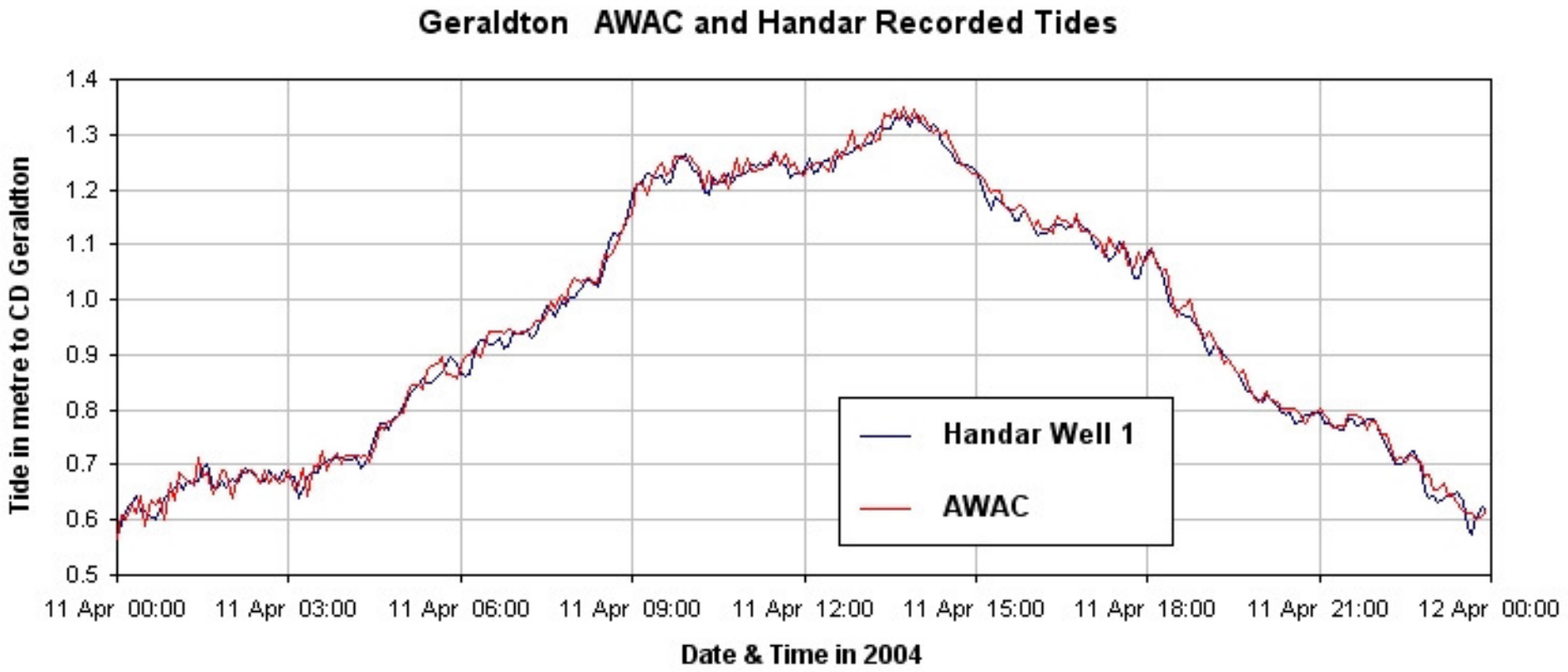




Surface resolution - 600 kHz AWAC



AST for Surface Level Detection



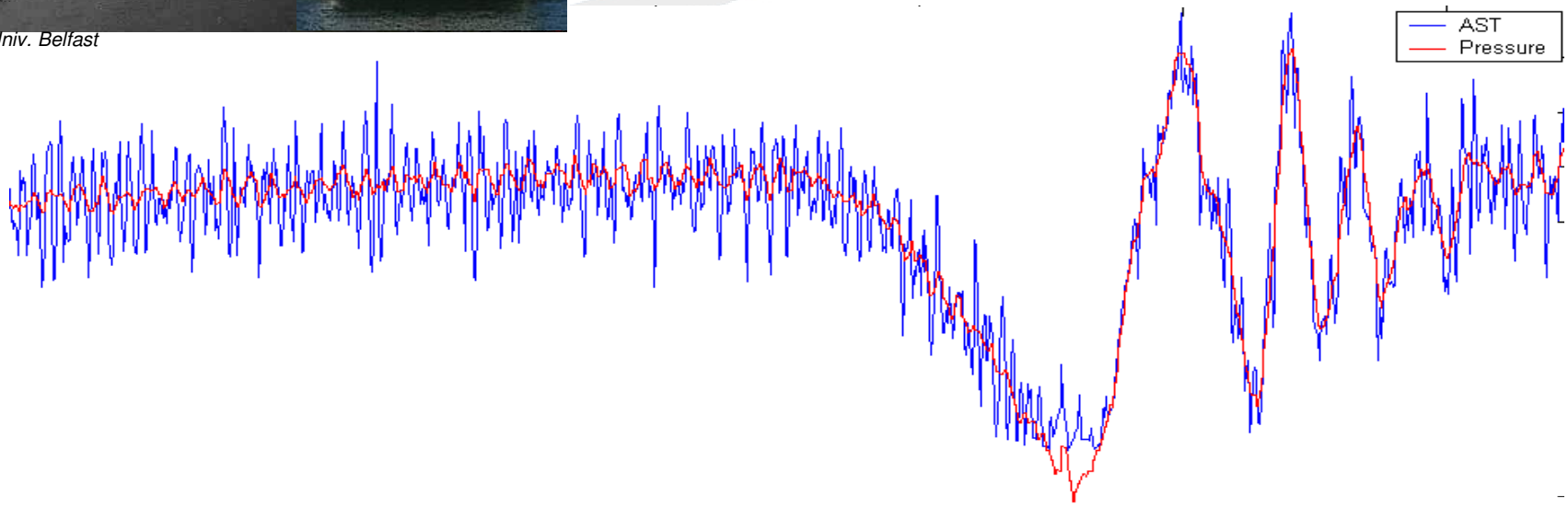
- **18 meters**
- **1 km separation**
- **Well Mixed / No substantial gradients**

Online Monitoring of Ship Wake

Queens Univ. Belfast

Time Series available for wake studies

Nonlinear only available with AST



AST Conclusions

AST development adds significant capability to this new class of wave systems

Direct surface measurements are valuable in many contexts (short waves, transients, extreme value statistics, etc)

Measurement resolution is not an issue

Footprint limitations are less significants than they first may seem