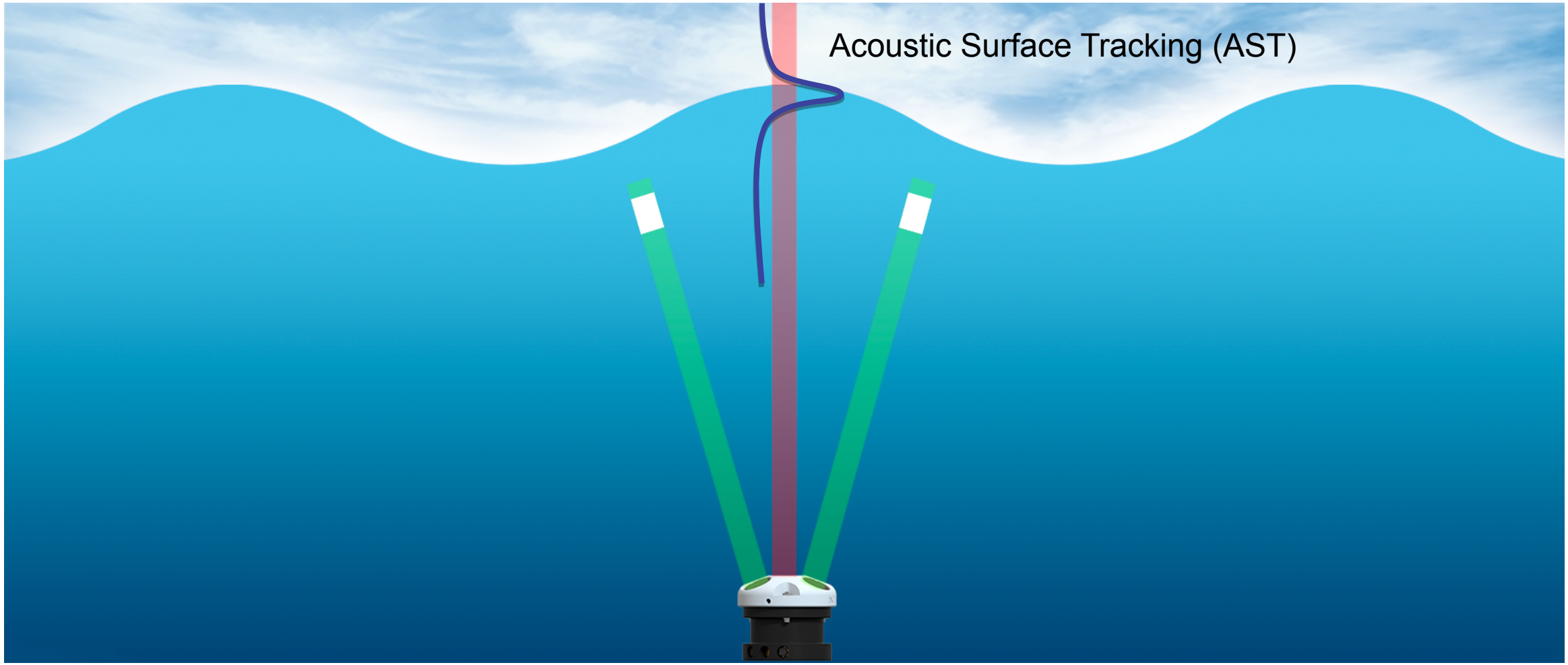
Coastal Engineering Measurements with the AWAC and Scour Monitor

Torstein Pedersen, Nortek

- High Energy and High Frequency Wave Measurements
- Ice Measurements
- Scour Measurements

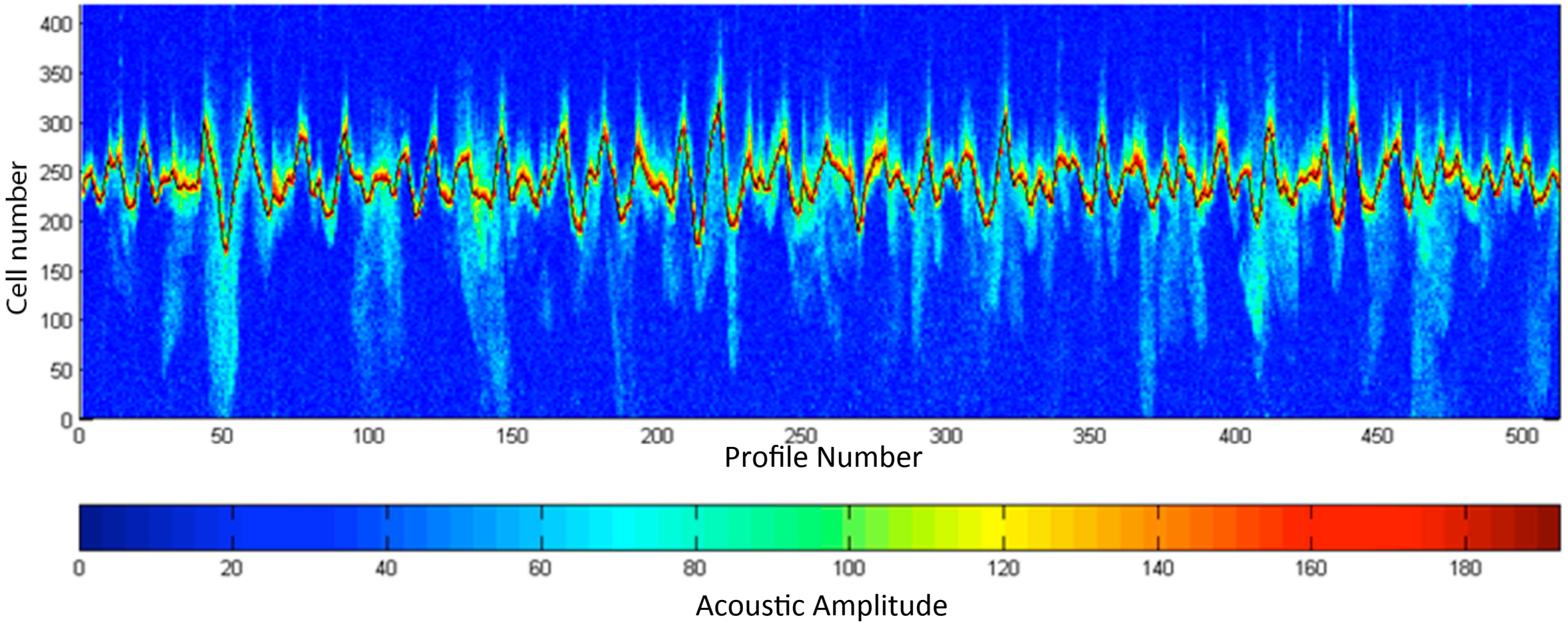
Common thread: Acoustic Surface Tracking

AWAC: Acoustic Surface Tracking Concept



AST: A tool for water column and boundary characterization

TRUE INNOVATION MAKES A DIFFERENCE



AWAC – System overview

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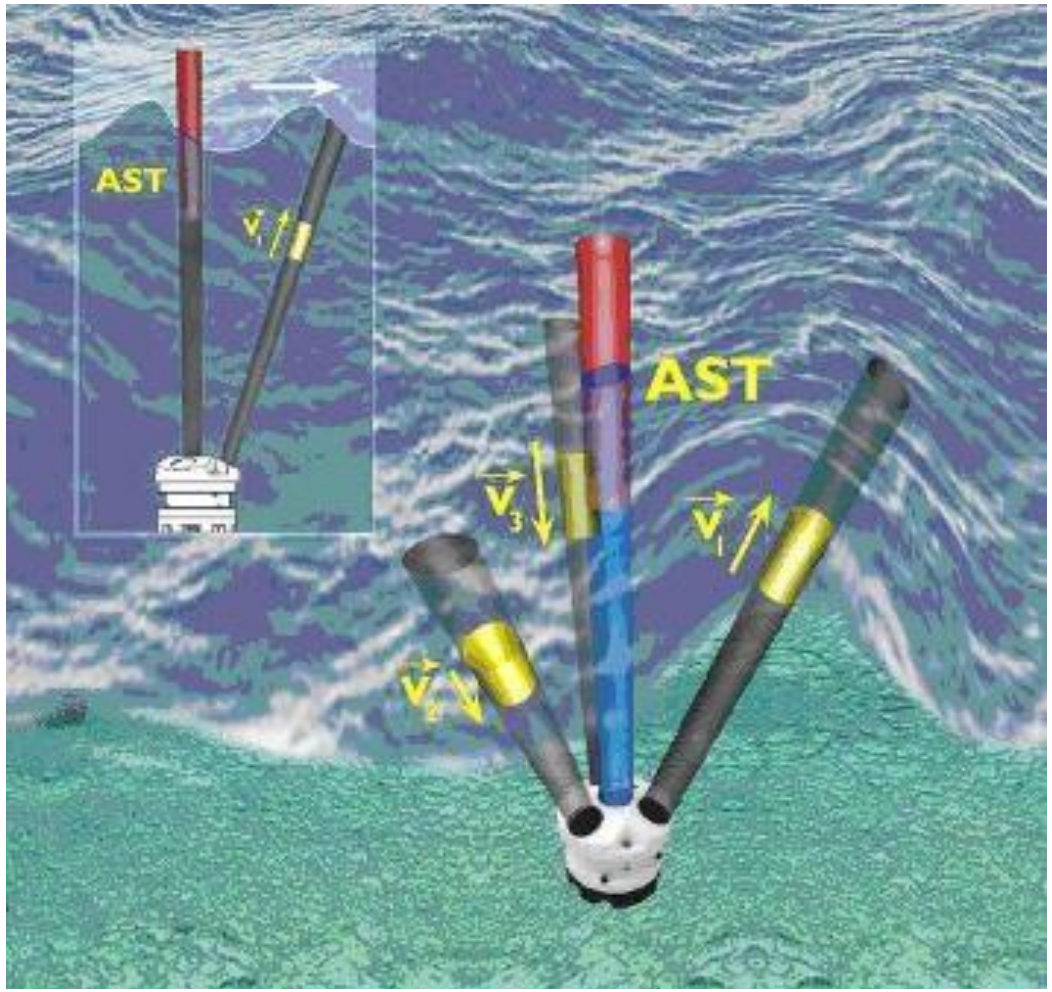
Composed of the basic collection of sensors…

- Transducers/beams for current profiling & Directional waves
- AST beam
- Suite of sensors



AWAC – How does it all work?

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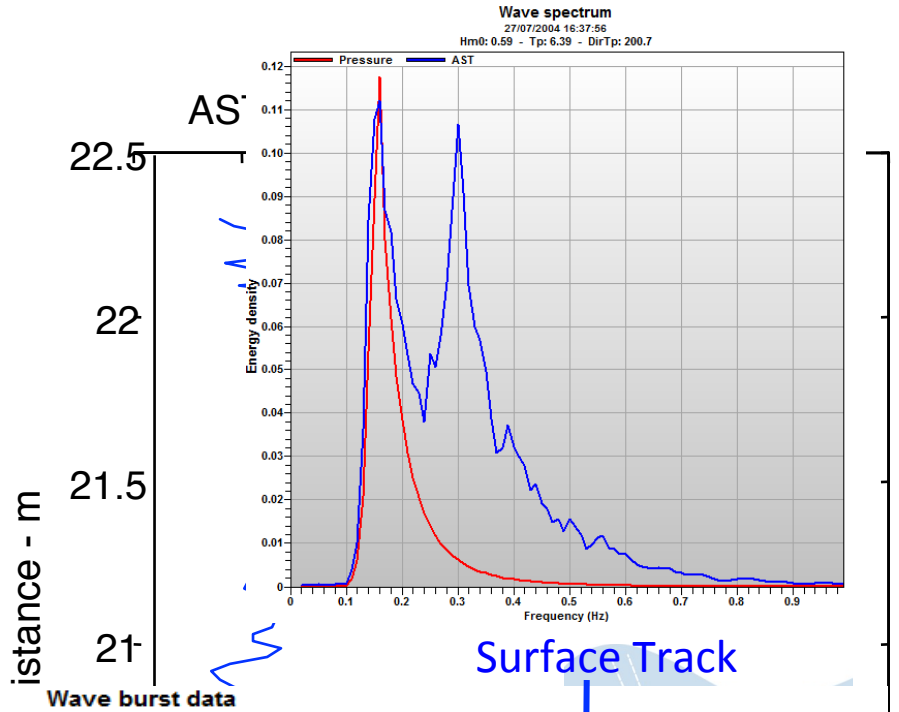
First we have to separate the wave problem into two types of estimation problems. (1) Energy (height & period), (2) Direction.

- AST overview
- Echo-sound to the surface
- Track the position of the surface
- Construct energy spectrum
- Wave parameters

- Specify a receive window
- Transmit short pulse
- Discretise receive
- Use quadratic interpolation to finely



AWAC – How does it all work?

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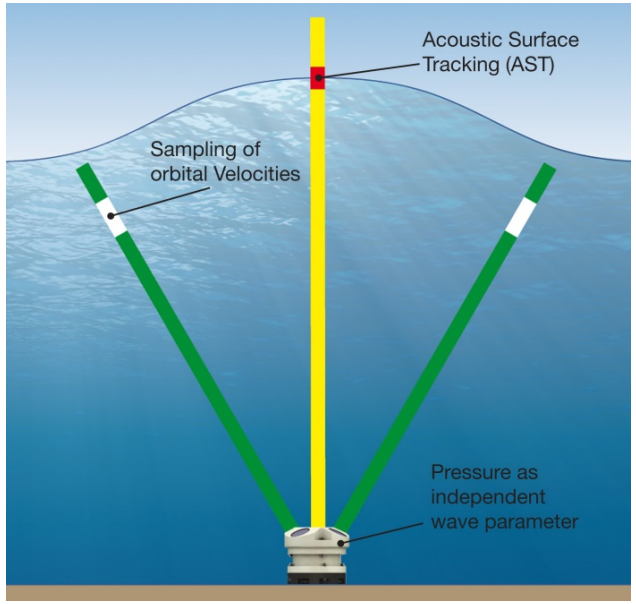
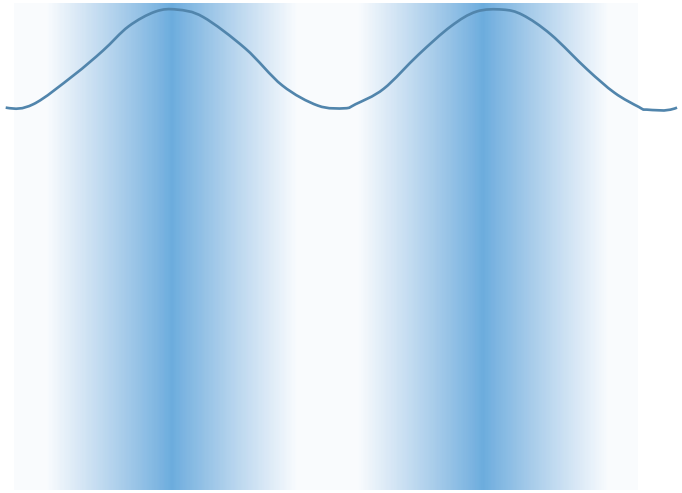
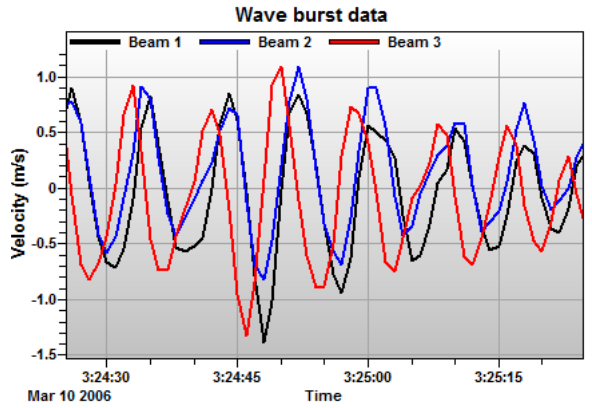
Directional Waves

- Directional Estimates
- Measure close to the surface
- Construct an array
- Direction estimated from the phase relationship between array elements
- If any of this is unclear, then see the webinar on wave measurements







Quality Assurance – Every burst is optimized

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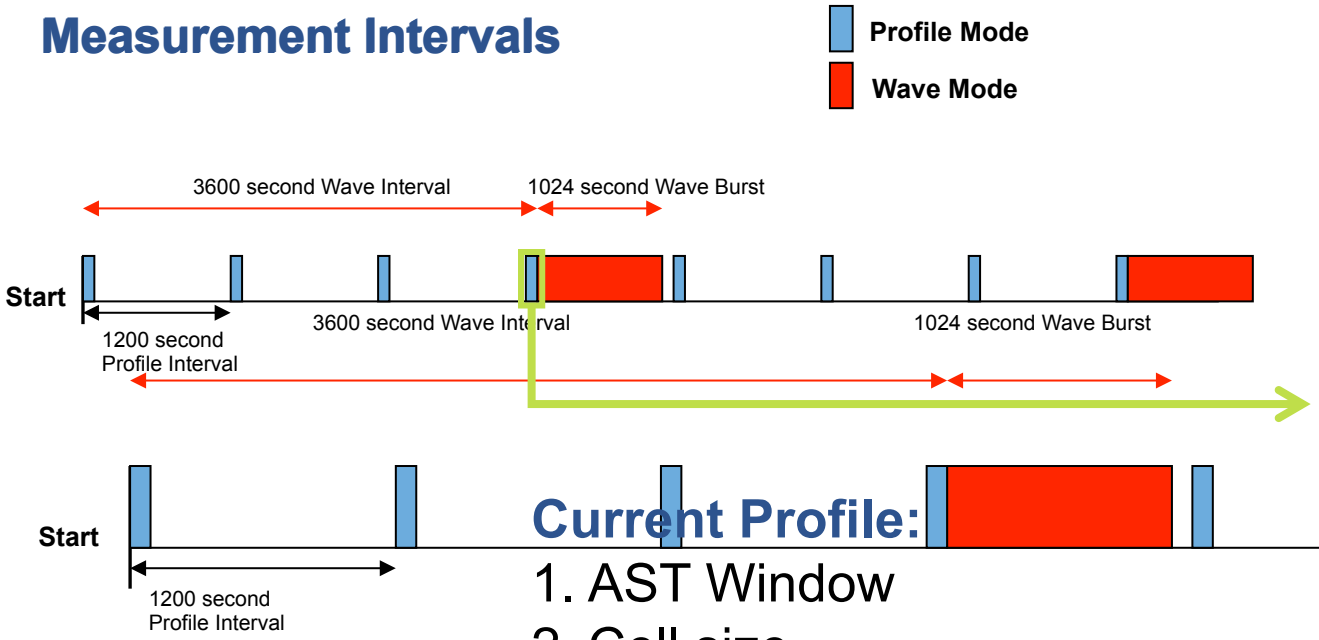
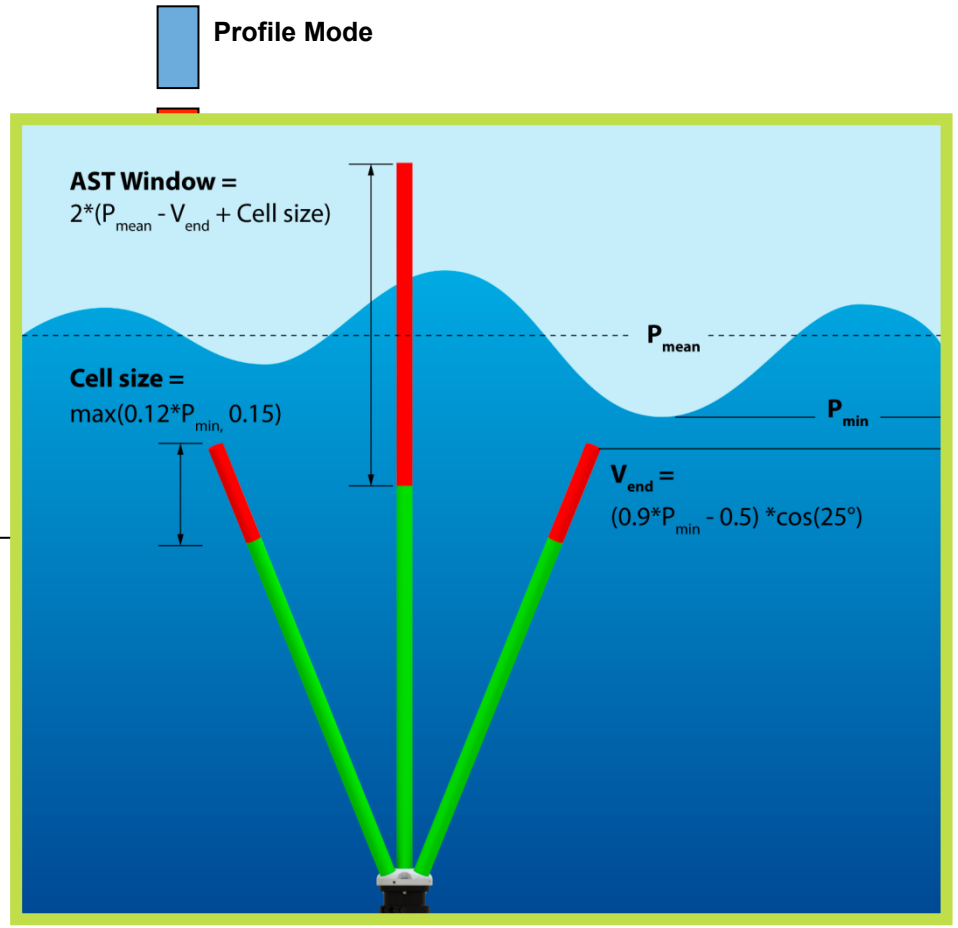
Measurement Intervals



Current Profile:

1. AST Window
2. Cell size
3. Cell position
4. SNR test

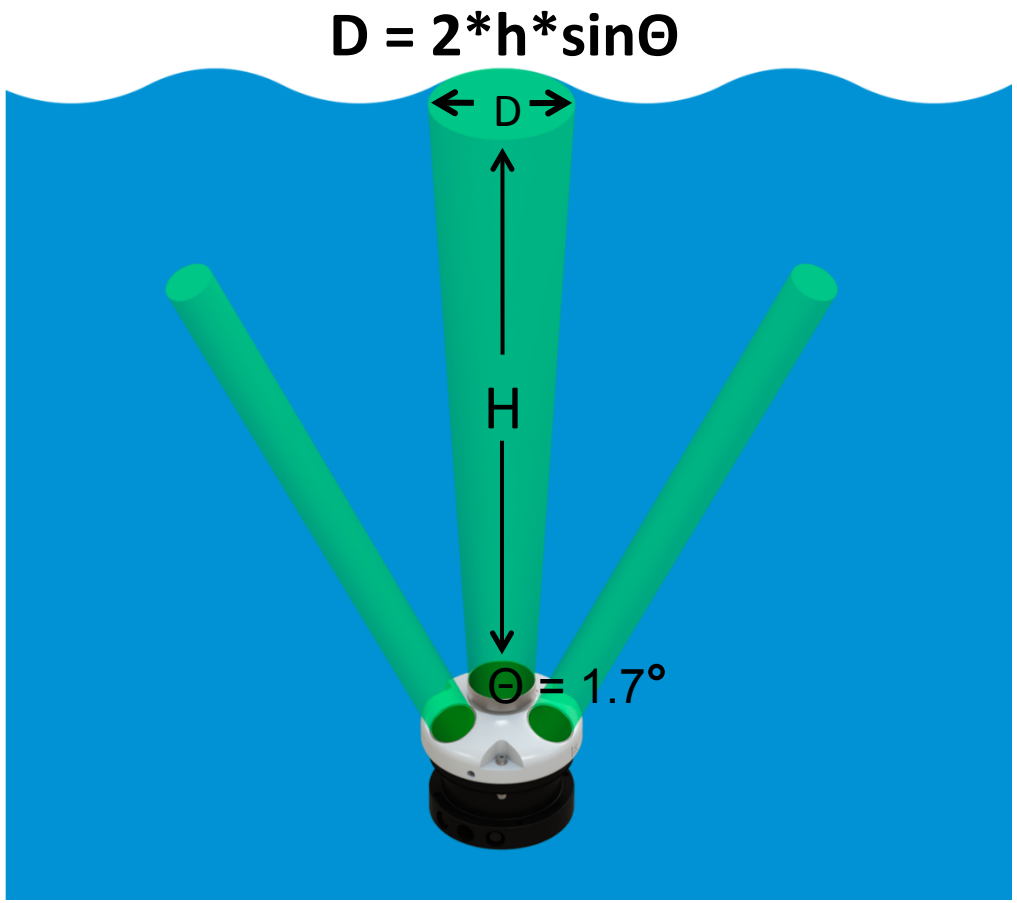


High Resolution AST

Community first introduced to AST by Nortek in 2001 – Designed for high resolution of the surface when first conceived.

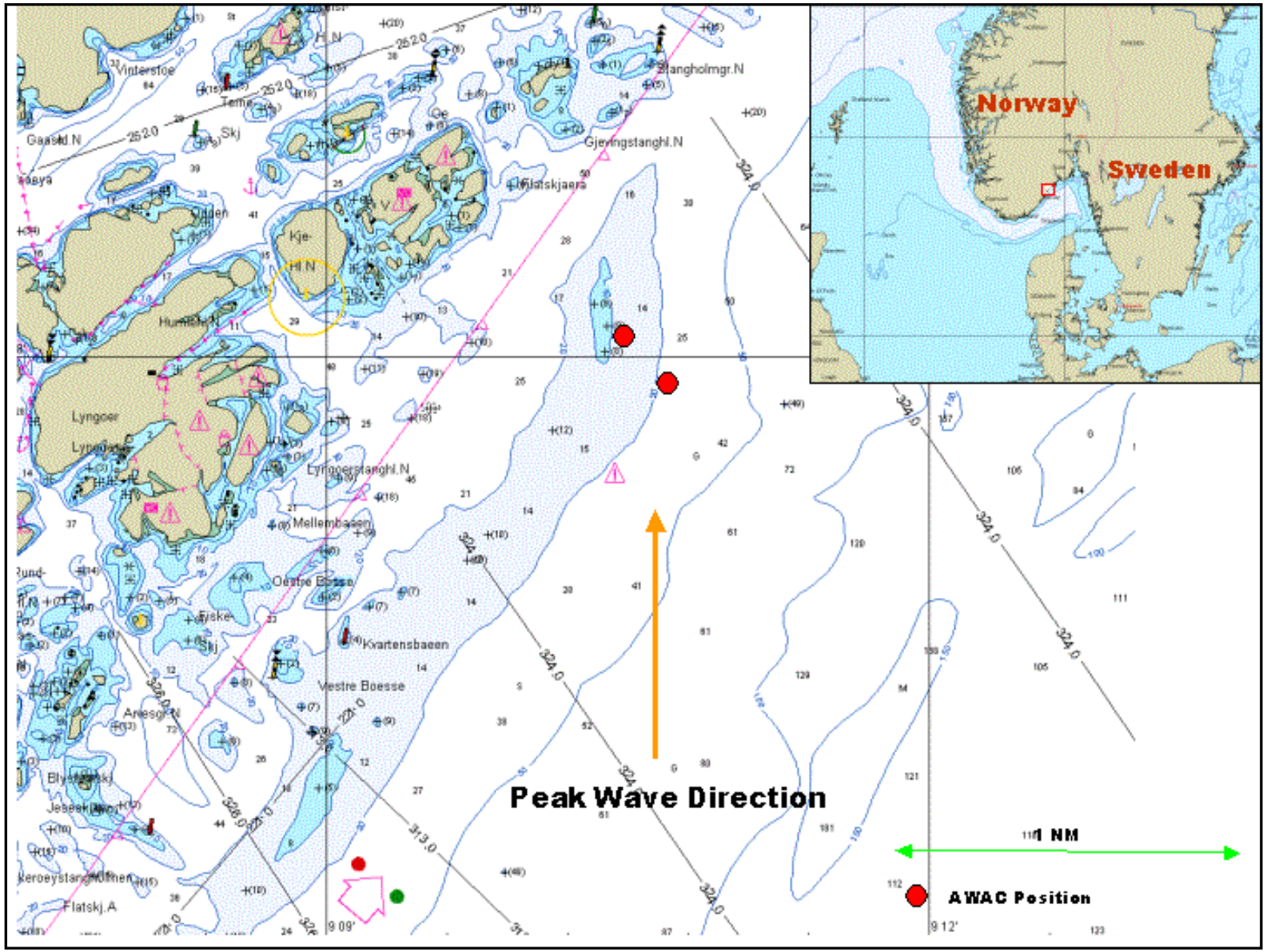
- 2 or 4 Hz sampling – Greater time resolution
- Large Transducers – Greater spatial resolution

Depth (m)	Footprint (m)	Period Limit (s)
20	0.6	.9
40	1.2	1.2
60	1.8	1.5
80	2.3	1.7
100	2.9	1.9

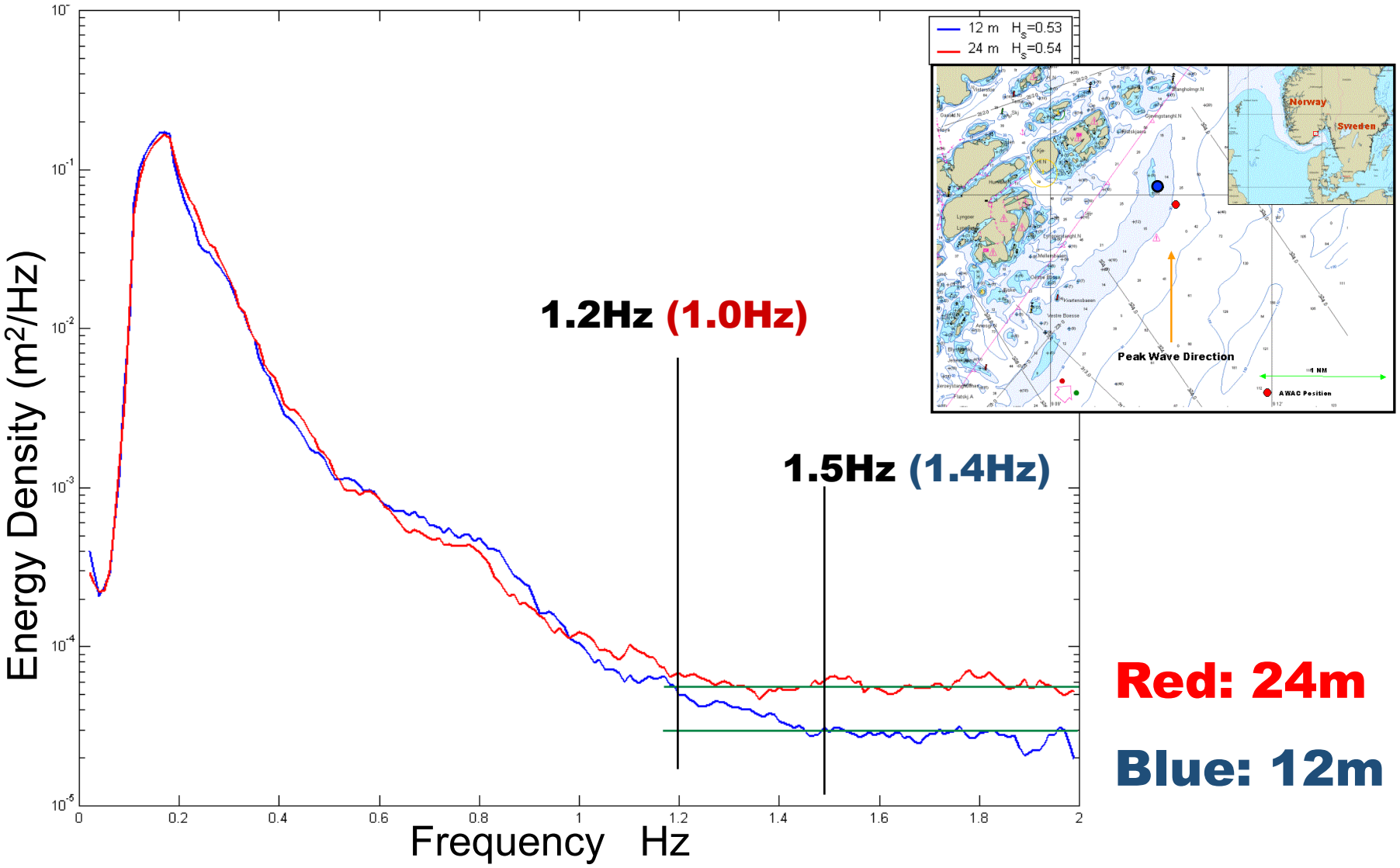


Resolve all waves and do not risk underestimating height

Resolving High Frequency Waves



Resolving High Frequency Waves



Long Waves in Relatively Shallow Water

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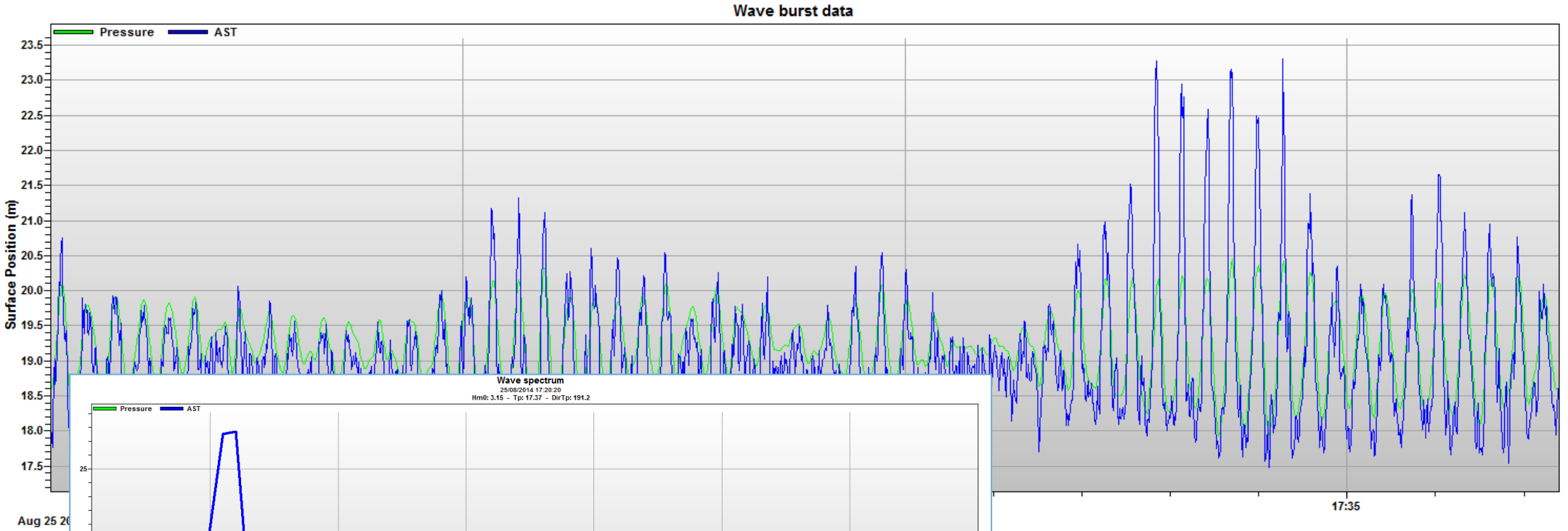
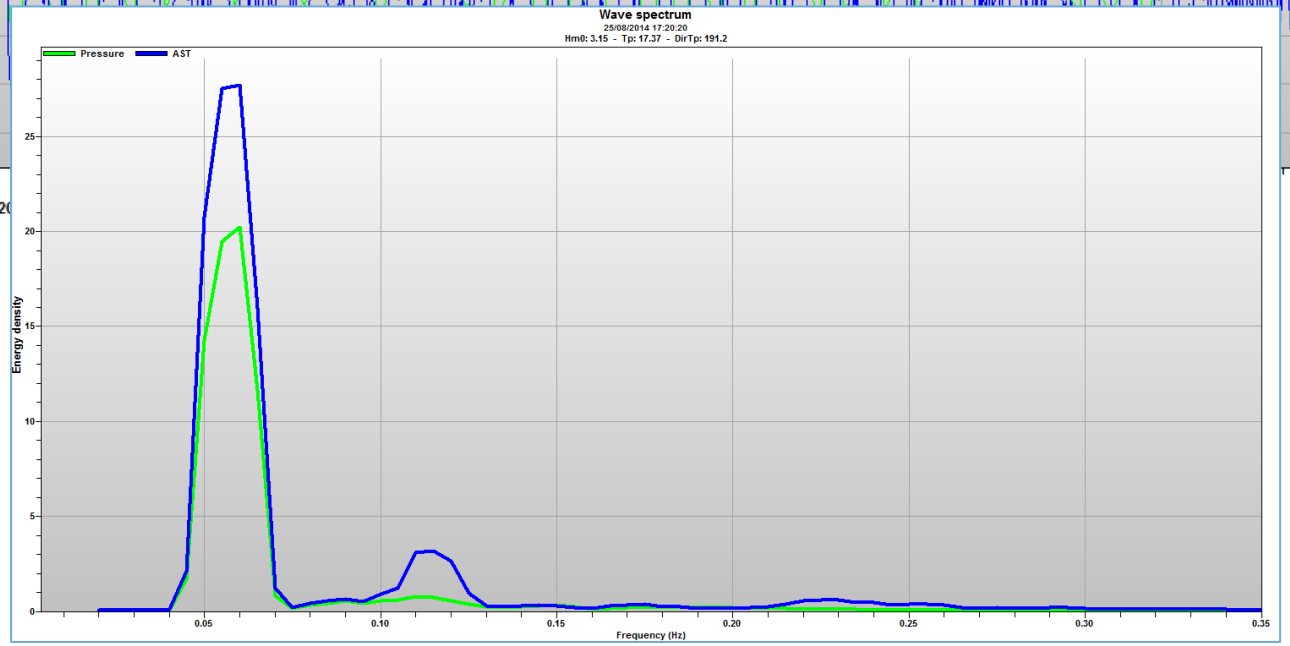
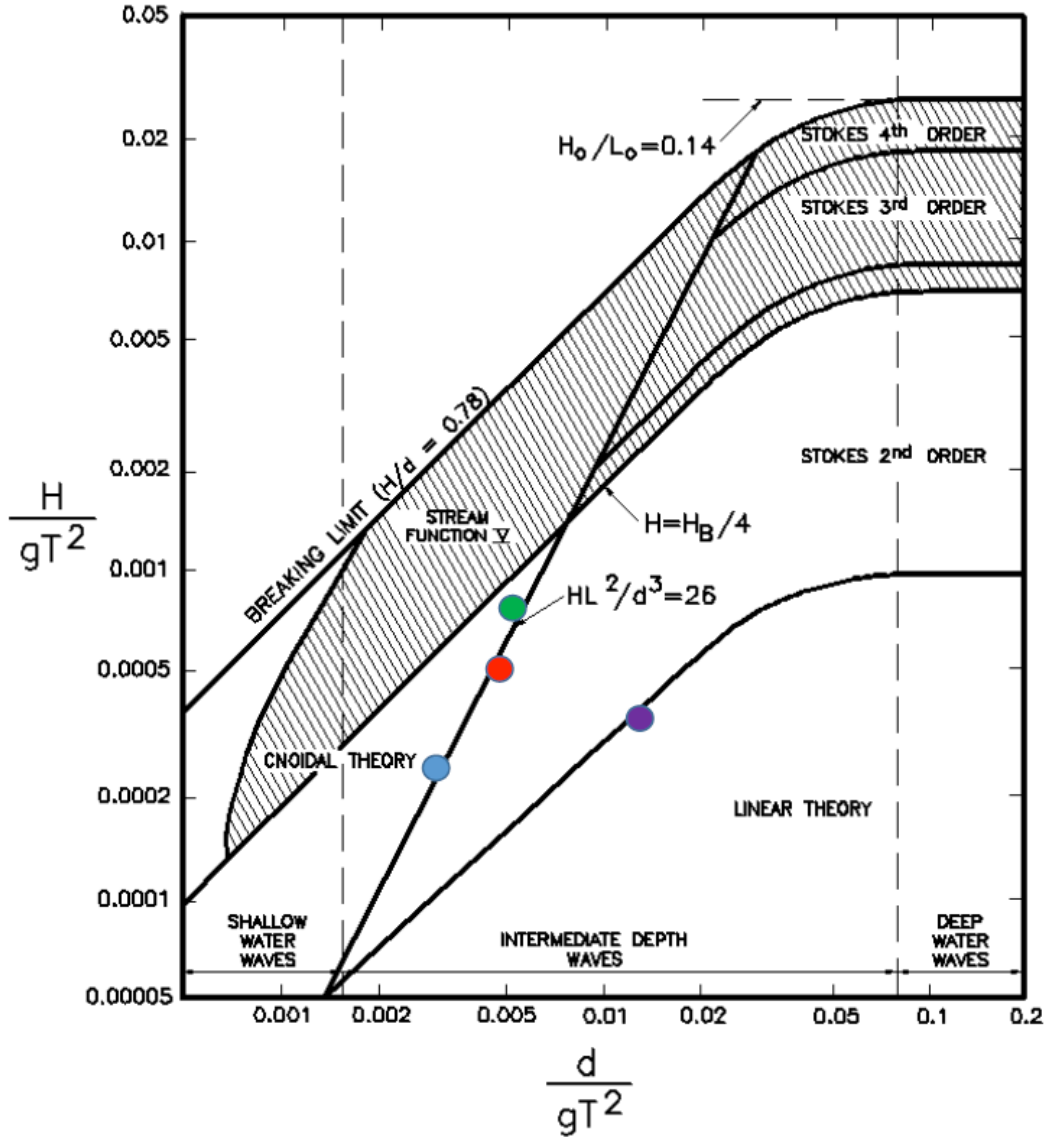




Long Waves in Relatively Shallow Water

Tp	Hm0	d/gT^2	H/gT^2
24	1.25	0.0034	0.00022
20	2	0.0048	0.00051
19	3	0.0054	0.00085
12	5	0.013	0.0035

d = 19 meters



Ice Measurements

Ice Measurement with Doppler Instruments

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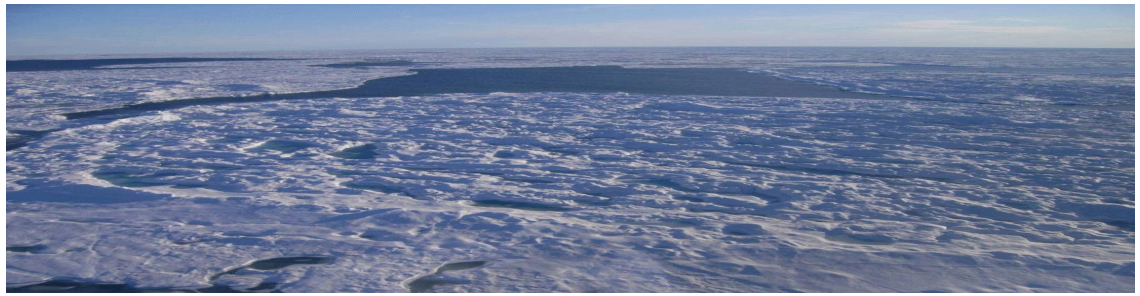


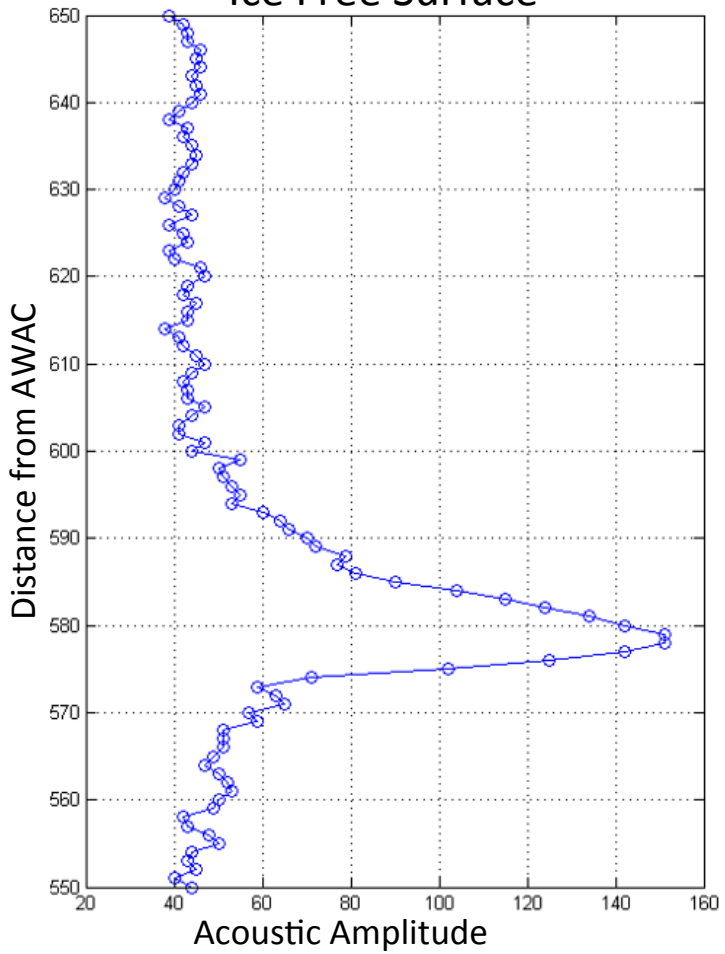
- Upwards-looking sonars
  - Mounted on seabed or subsurface buoys
  - Mounted on autonomous underwater vehicles (AUV)

- Capabilities:
  - Ice presence
  - Ice thickness
  - Current profile
  - Ice tracking

Raw AST Profile Examples

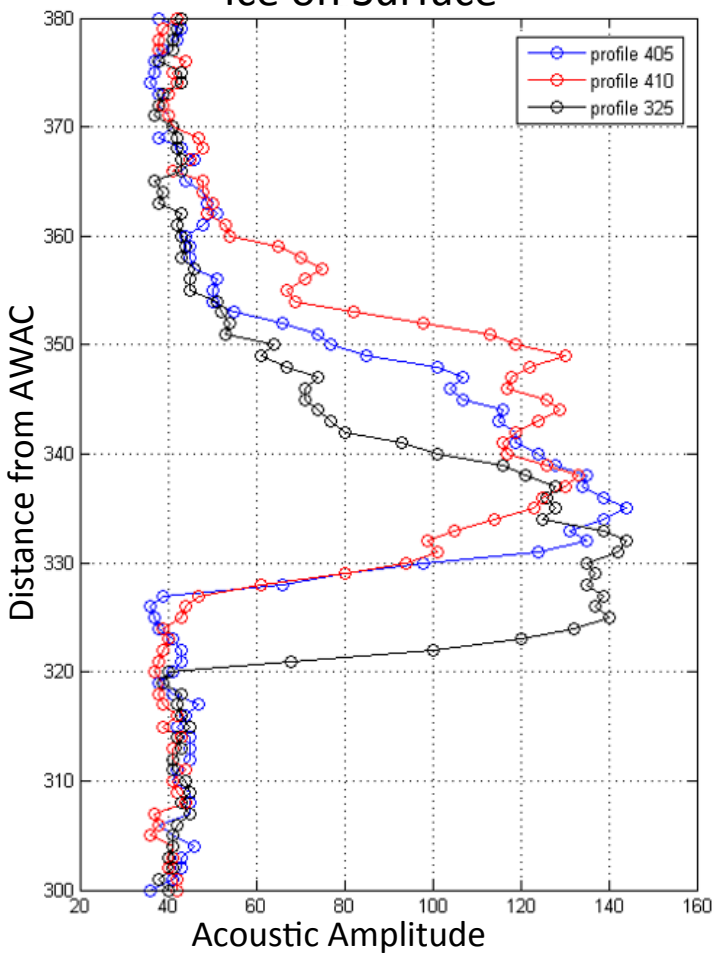
Raw AST Profile Examples

Ice Free Surface



Single Peak

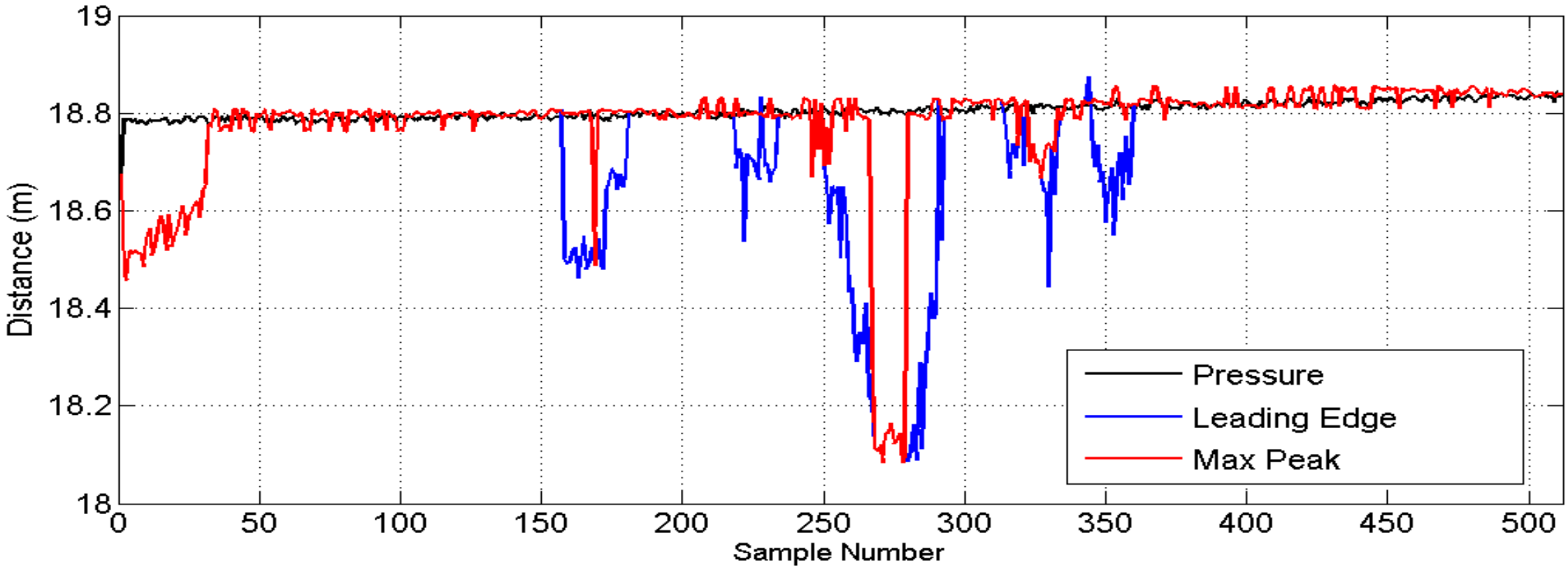
Ice on Surface



Multiple Peaks

Sharp Rise

Differences with Max Peak and Leading Edge Detectors



Ice Draft: Pressure – AST distance

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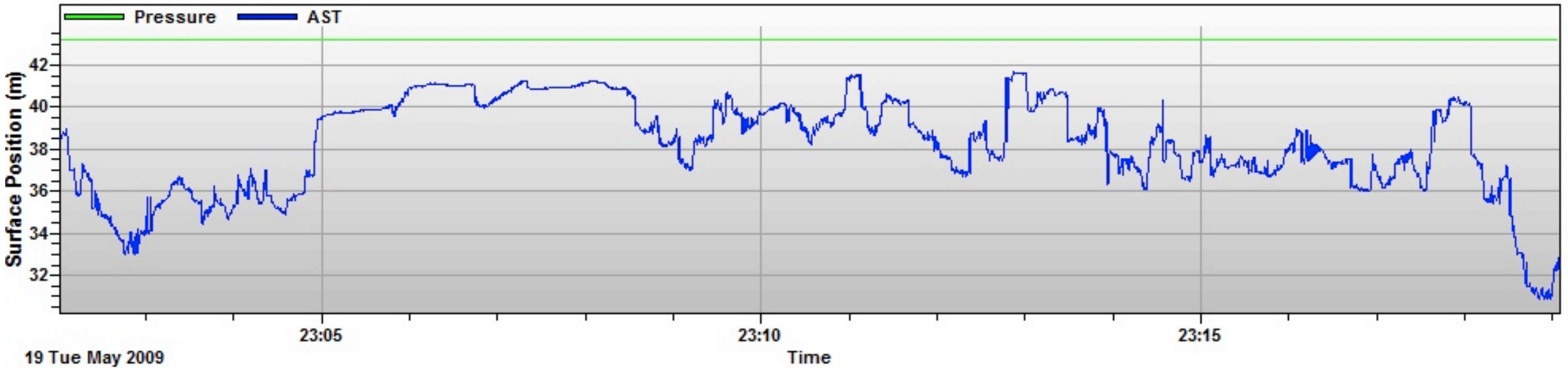
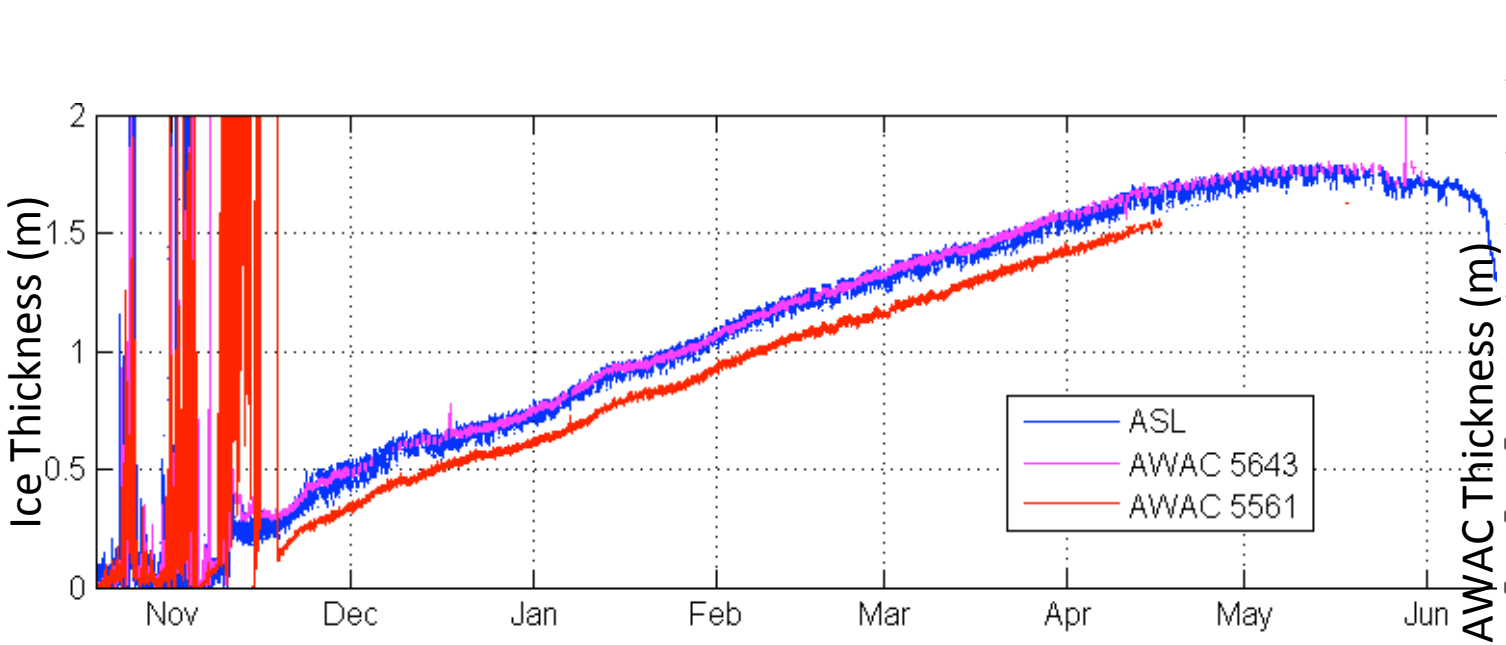
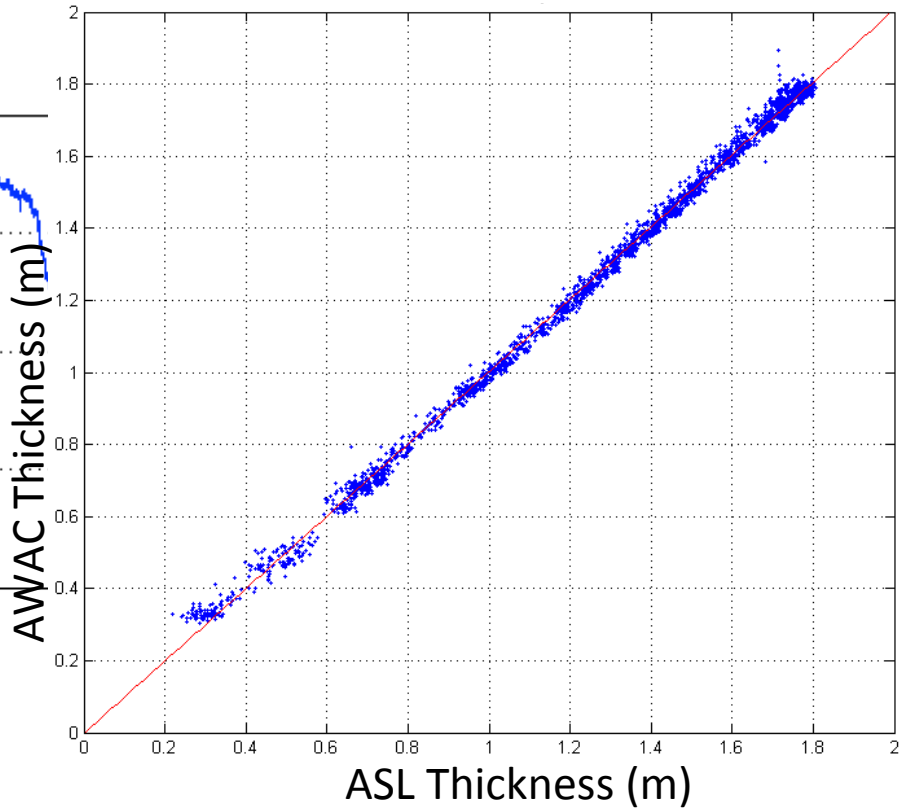
Distance and Pressure Estimates within a Wave Burst



- Requires temperature compensated pressure sensor
- 0.1% Full Scale

Ice Draft Comparitive Data





Signature Series for Ice Thickness and Ice Velocity

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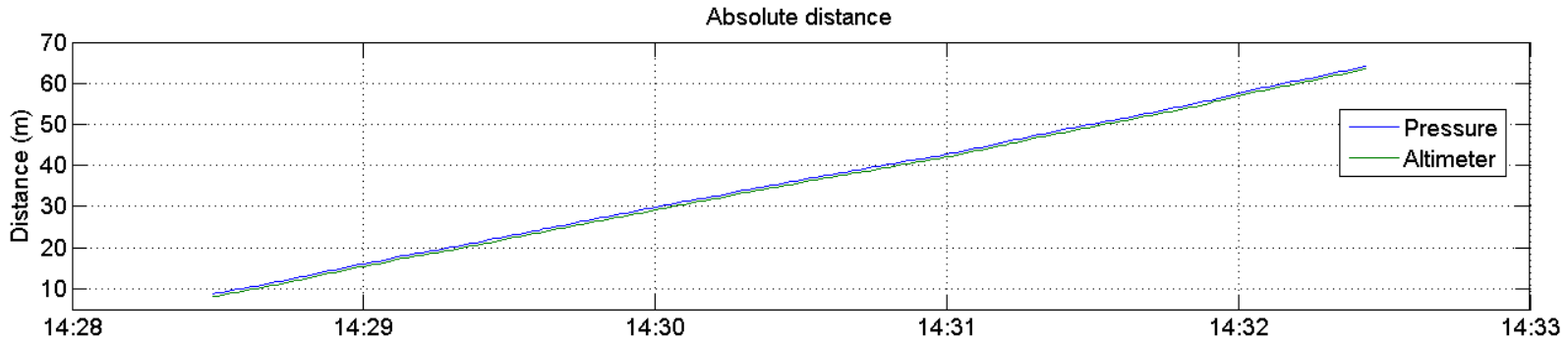
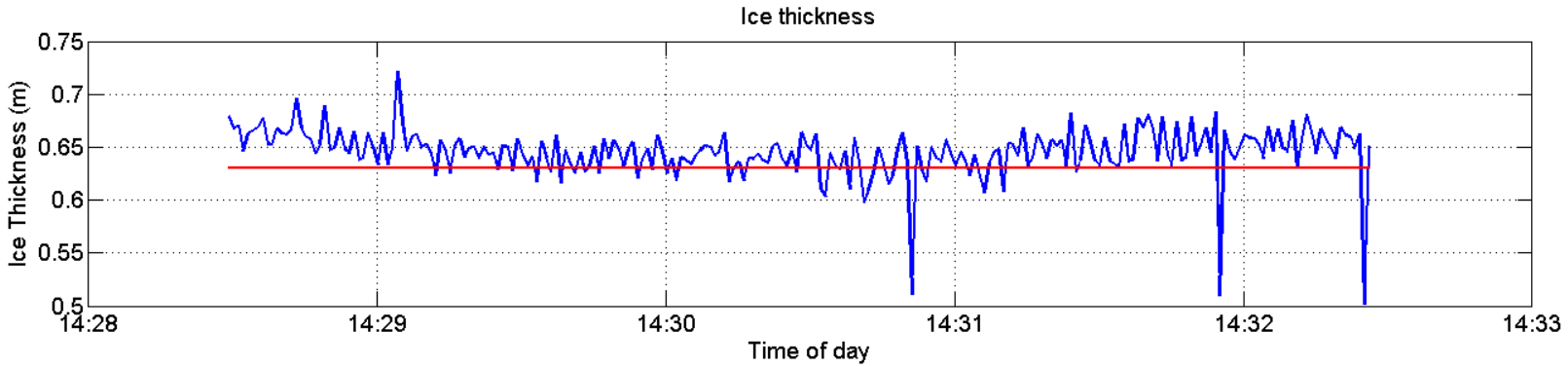
Signature Ice Thickness

- Altimeter and Pressure -> Thickness:
- Shows that for a controlled environment the sensors are working well.





Signature – Ice Velocity Tracking

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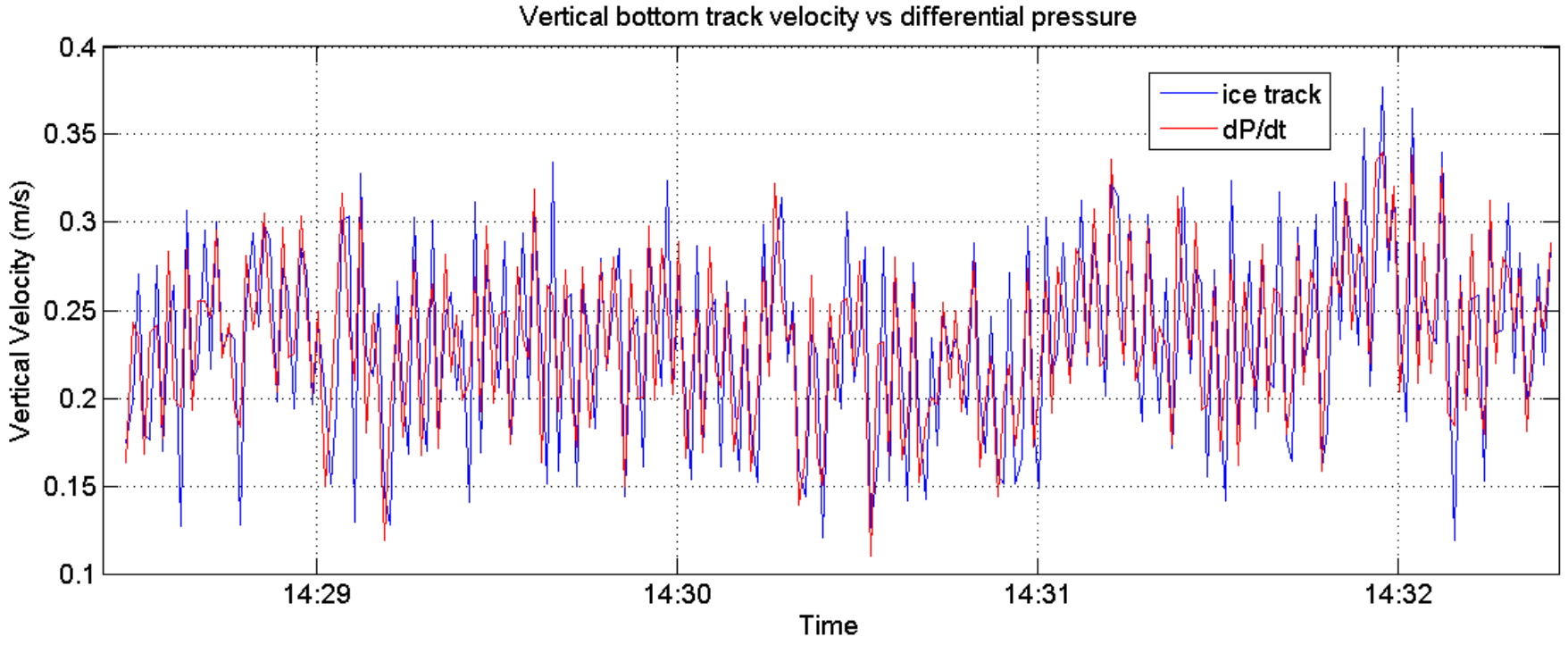
- Lowering Signature 500 from surface to bottom
- Vertical velocity during lowering
- Compare Ice track against differential

- Pressure: dP/dt = vertical velocity
- Mean Ice Track = 23.26 cm/s
- Mean dP/dt = 23.32 cm/s



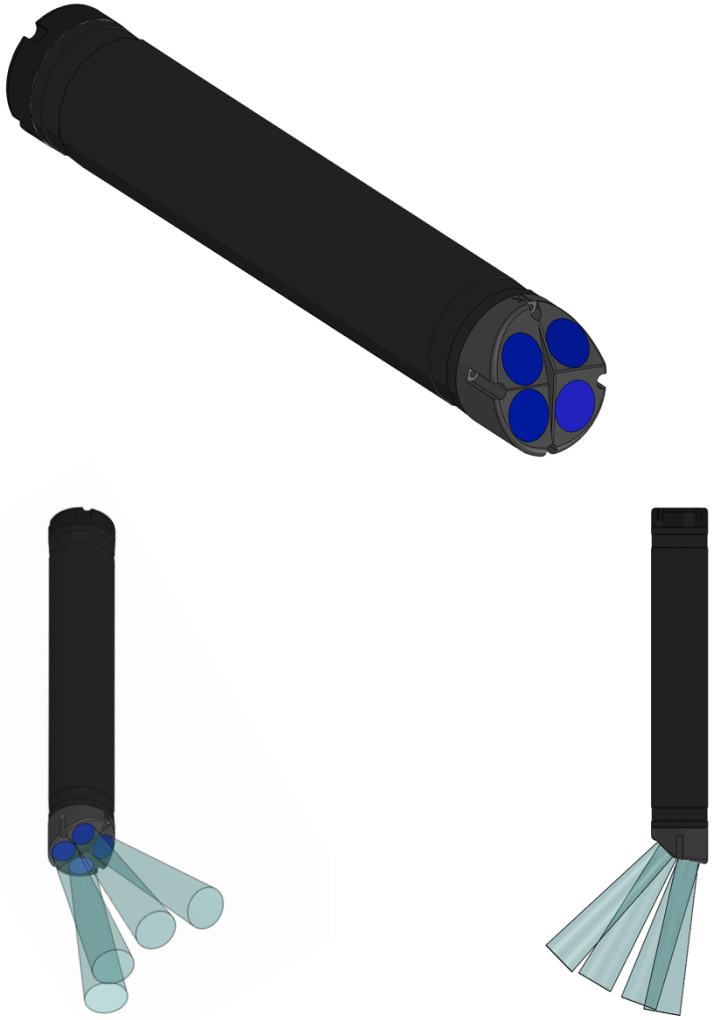
Scour Monitor

TRUE INNOVATION MAKES A DIFFERENCE

Scour Monitor

TRUE INNOVATION MAKES A DIFFERENCE

- 1 MHz Instrument
- Four acoustic beams at 10, 20, 30, 45 degrees
- All in one plane, like a fan
- Records amplitude profile for each beam



Scour Monitor – What does an installation look like

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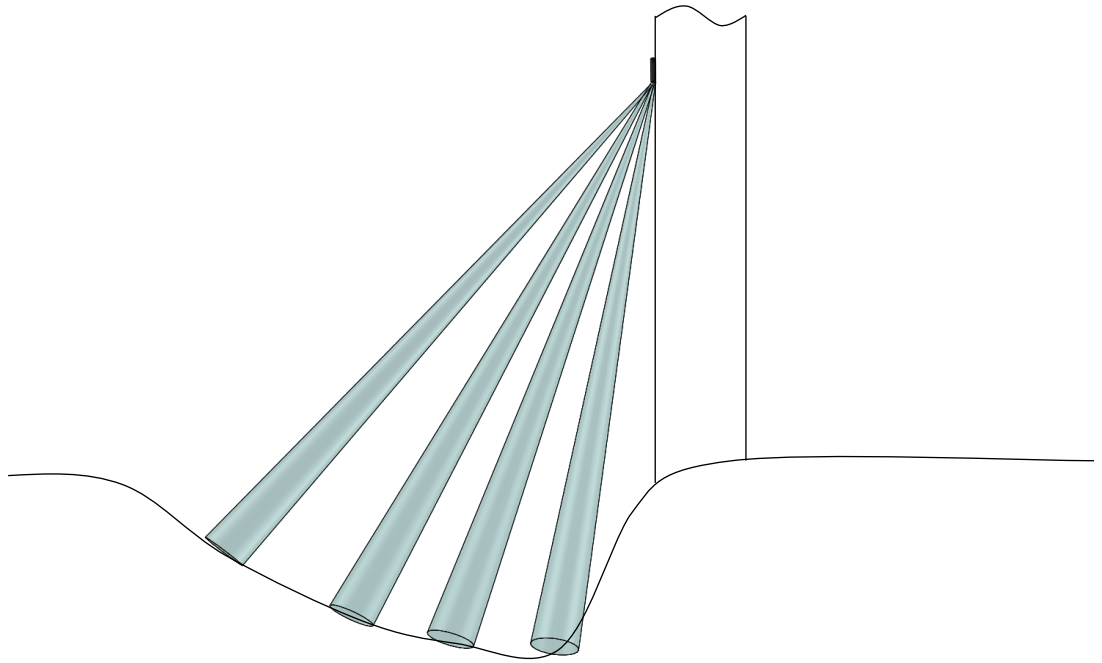
- Bullet 01
  bullet 01 soft shift line



Who is intrested in Scour Monitoring?

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Offshore Monopoles

TRUE INNOVATION MAKES A DIFFERENCE

- Offshore Wind
- Yes it happens
- Dumping rock at base, at a cost

Scour Monitor Data

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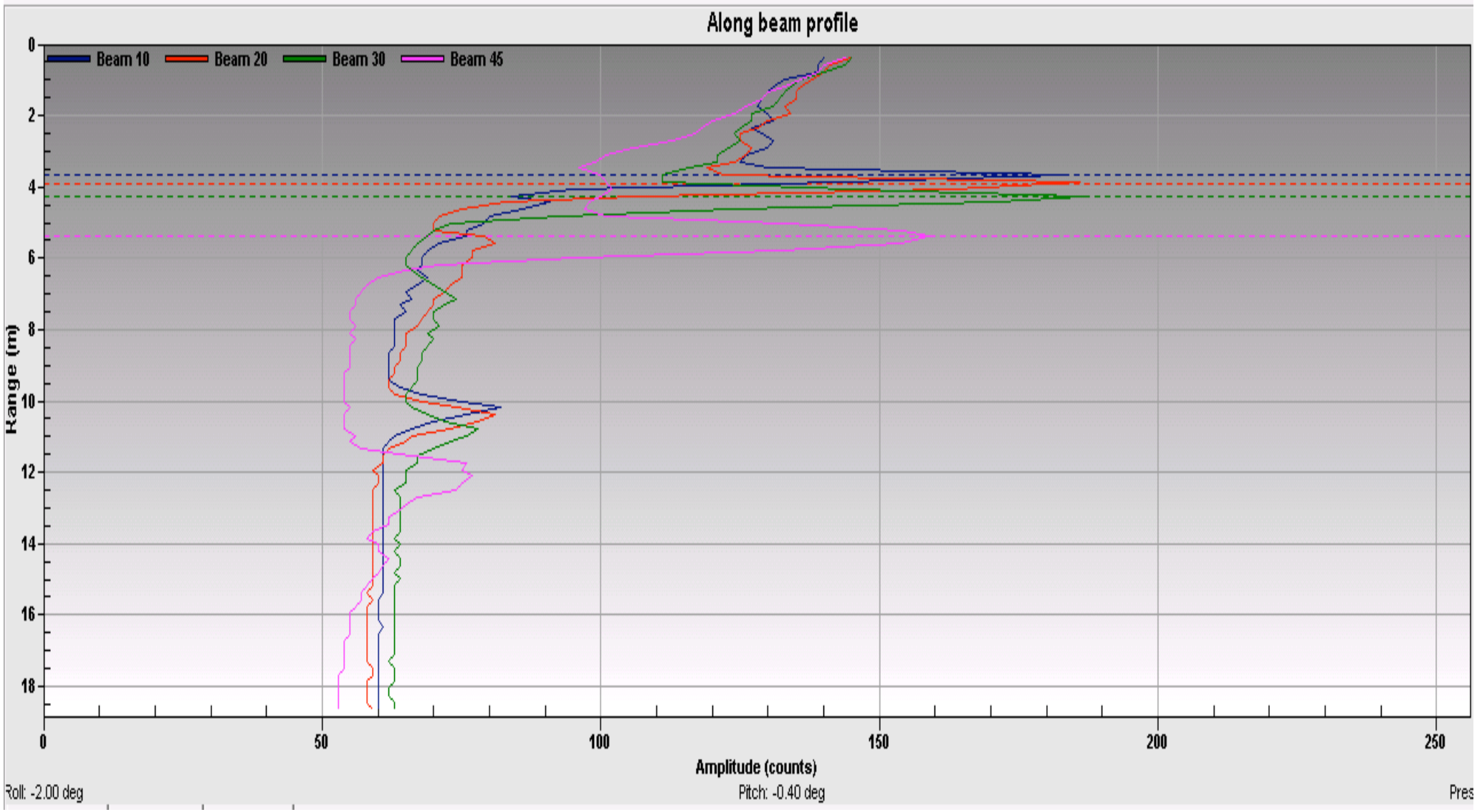

Scour Monitor Evaluation – Jenette's Pier, North Carolina

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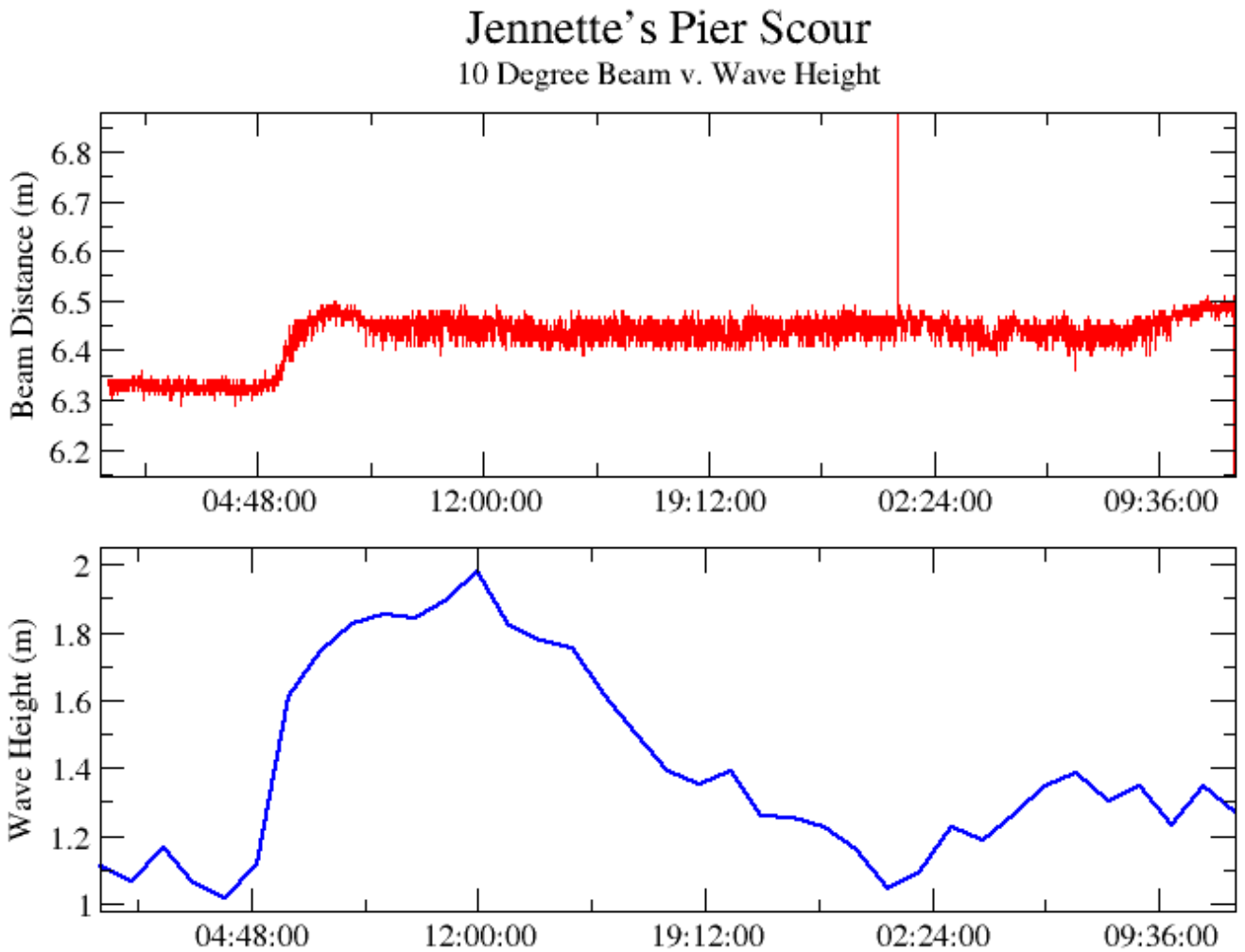
Scour Monitor Data: Jenette's Pier, NC



Scour Monitor Data: Jenette's Pier, NC

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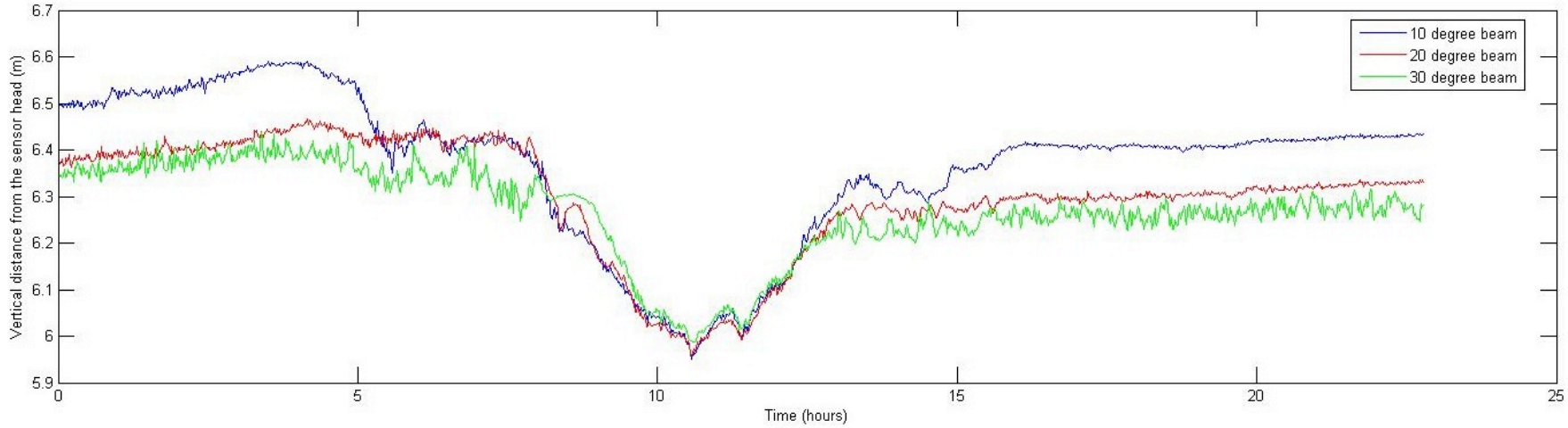

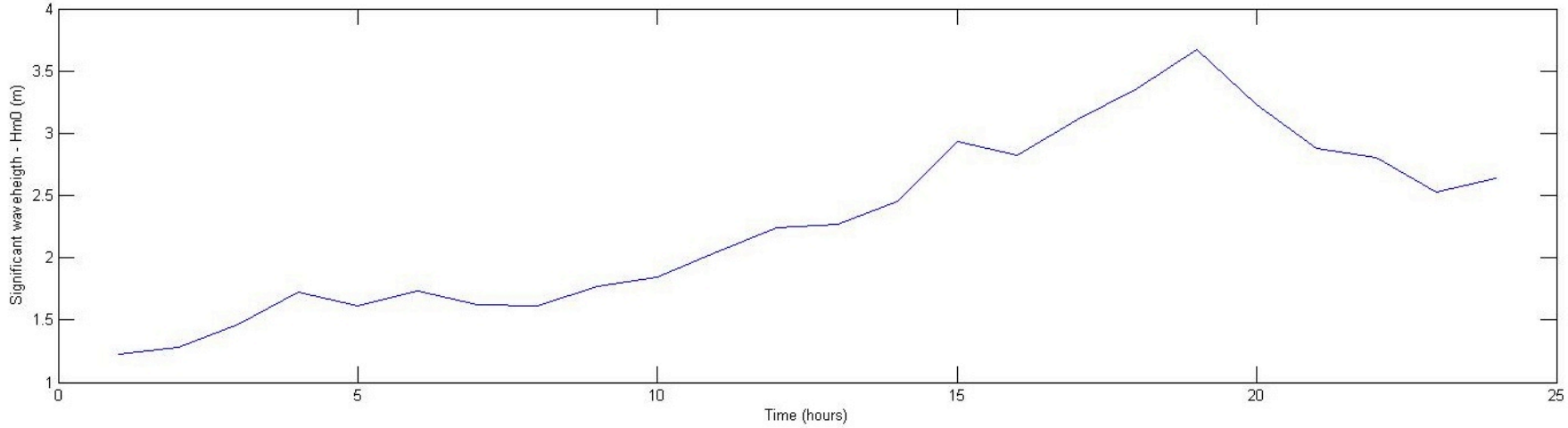

Scour Monitor Summary

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- The Nortek scour monitor provides distance to bottom measurements along four beams with 10, 20, 30 and 45 degrees inclination with respect to vertical
- The results are presented graphically, directly on the web
- An inexpensive solution that provides vital information, day and night, and irrespective of weather conditions
- Easy installation, and easy to use
- A robust sensor that requires a minimum of maintenance
- Can be installed as far away from the bottom as 20-30 metres
- Cost-effective alternative to rock dumping without prior knowledge?
- Accuracy: better than 20 cm at 30 meters range