# User requirements identified by Industry

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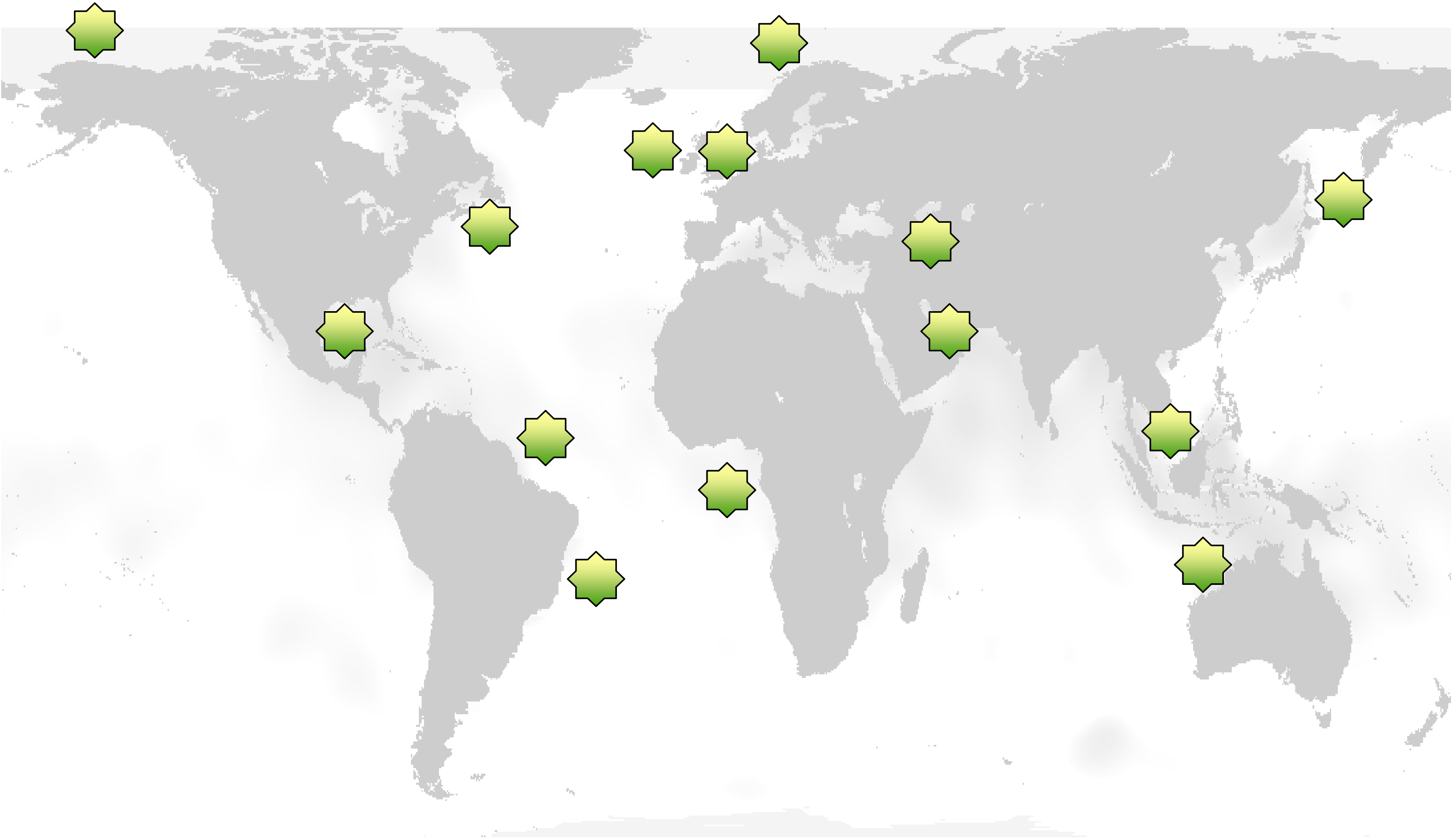
JCOMM, New York 2nd October 2008

# Overview

- General Requirements
  - Regional coverage
  - Business needs
- Data Requirements
  - Sources of data
  - Parameters
- Research Interests
  - Near-shore/shallow-water
  - Extreme crests

# Regions



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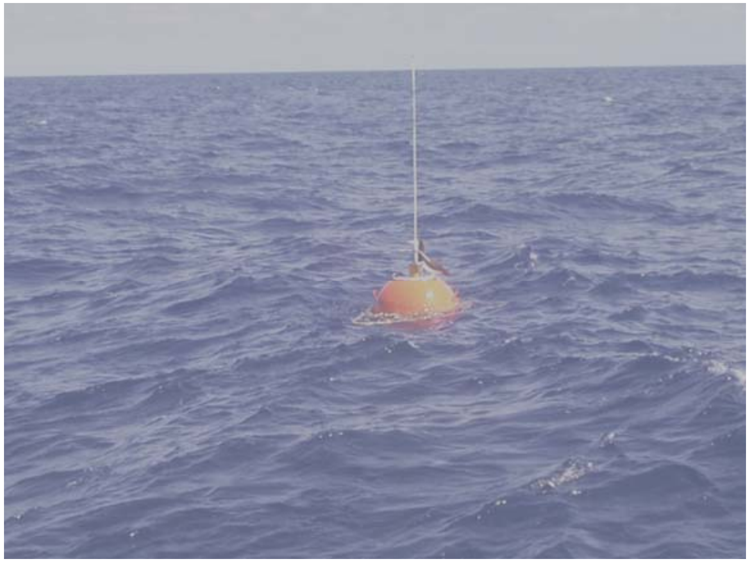
# Business Needs

- Operations
  - Optimise operations
  - Safety
  - Decision support
  - Improved forecasts
  - Performance monitoring
- Planning
  - Seismic Surveys
  - Tow outs
  - Installation of facilities
  - Operation of facilities

- Design
  - Jacket strengths
  - Air gap
  - FPSO moorings
  - Fatigue

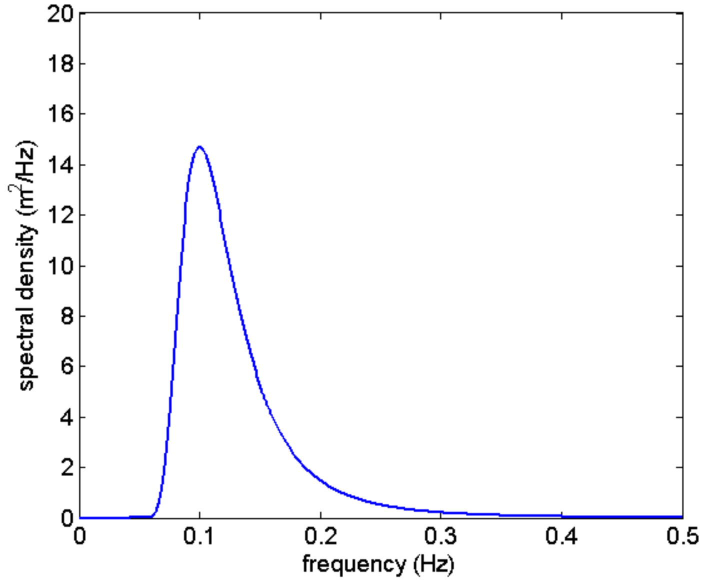
# Data Sources

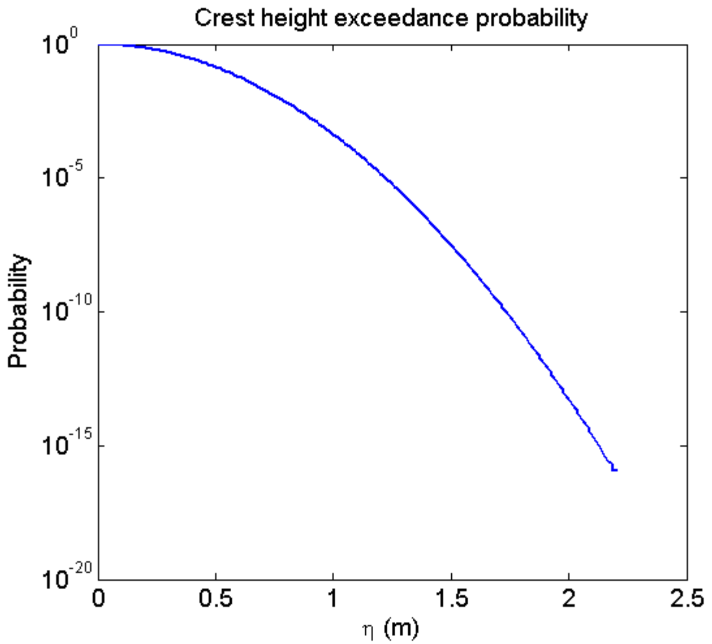
- Hindcast data are the usual sources (long length)
  - Important to have events responsible for extremes at location
  - Important to have long continuous (>10 years) for planning statistics
- Measured data
  - Site (project) specific
    - validation of hindcast data
  - More precise quantities
  - Establish associated parameters
    - Hs, Tp, T02, …
    - Current, wind, for response-based statistics
  - Spectral shape
  - Directionality



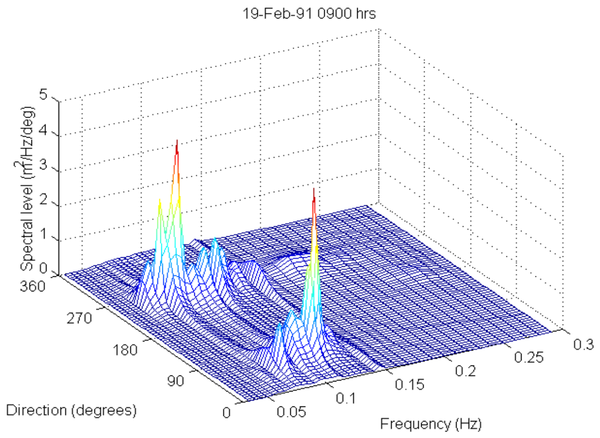
# Parameters

- Frequency spectrum
  - – Spectral shape – JONSWAP?
  - – Hs, Tp, T02, …
- Time domain
  - – Distributions for H, $\eta$
  - – Hmax, Tass, $\eta_{max}$



# Parameters




$$S(f,\theta)=G(f)H(f,\theta)$$

- Direction distribution

$$H(f,\theta)=\frac{1}{\pi}\left[\frac{1}{2}+\sum_{n=1}^{2}a_n(f)\cos(n\theta)+b_n(f)\sin(n\theta)\right]$$

$$\theta_1(f)=\arctan\left(\frac{b_1(f)}{a_1(f)}\right)$$

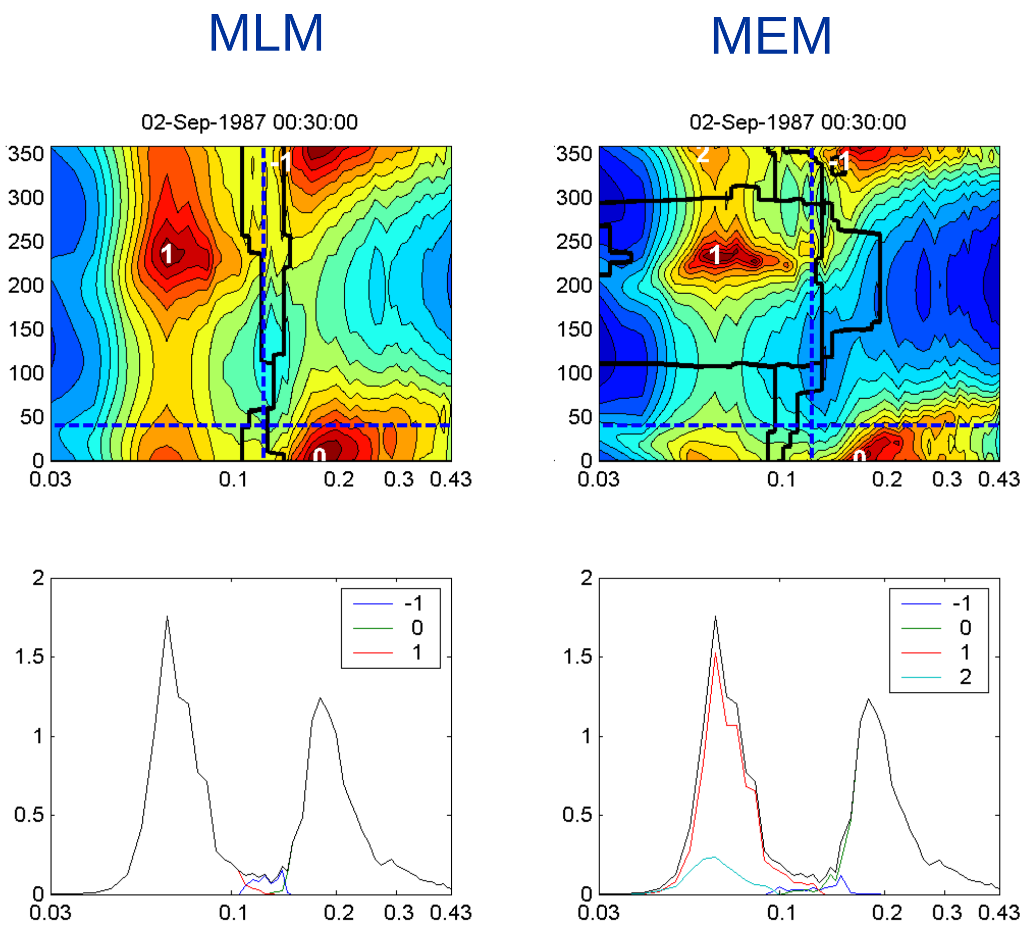
$$\theta_2(f)=\frac{1}{2}\arctan\left(\frac{b_2(f)}{a_2(f)}\right)$$

$$\sigma_1(f)=\left\{2\left[1-\left(a_1^2(f)+b_1^2(f)\right)^{\frac{1}{2}}\right]\right\}^{\frac{1}{2}}$$

$$\sigma_2(f)=\left\{\frac{1}{2}\left[1+\left(a_2^2(f)+b_2^2(f)\right)^{\frac{1}{2}}\right]\right\}^{\frac{1}{2}}$$

# Parameters

- Frequency-direction
  - Spectral partitioning
  - Not unique
    - too few FCs

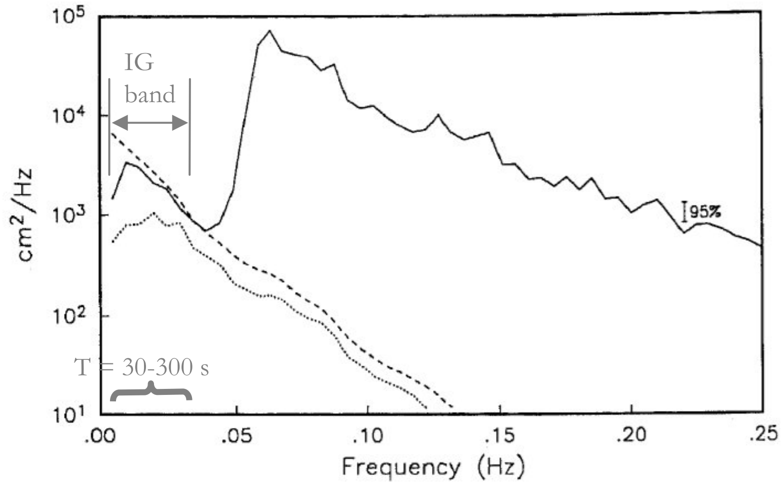


# Near-shore Interests

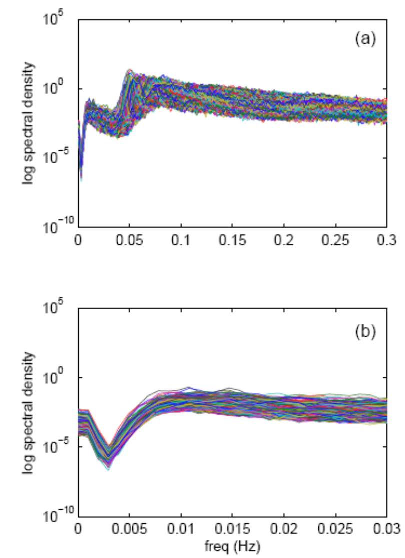
- Drivers
  - LNG offloading
  - Platforms
  - Pipeline stabilisation
- Phenomena
  - Wave height & crest elevation
    - Instrumentation – platform-based sensors
    - LoWish JIP (also kinematics)
  - IG waves
    - Instrumentation – GPS buoy, Doppler Profilers, Pressure Transducer
    - HAWAI and Safe Offload JIPs

# Infragravity Waves

- Shallow-water infragravity waves
  - – Statistics
    - Operational
    - Design
  - – HAWAI
    - Overview of coastal wave models
    - Effect of IG waves on LNG carriers
  - – Safe Offload
    - Method to develop data base for operational and design statistics
    - Evaluation of IDSB model with measured data
      - – Pressure transducers, AWAC, GPS-buoy (to 100s)




after Okhiro et al. (1992)



# Air Gap Interests

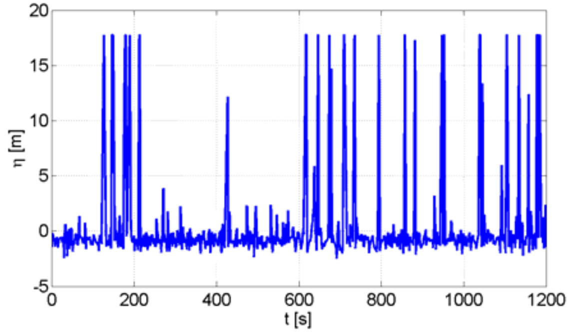
- Crest elevations
  - Design practice – $2^{nd}$ Order only
  - Damage to platforms
  - Measurements
    - Good accurate profile data
    - Problems with platform-based sensors
    - Buoys provide sea state information but not absolute elevation
  - CresT JIP
    - Develop models for realistic extreme waves
    - Develop design methodology for loading and response of floating platforms

# CresT – wave data

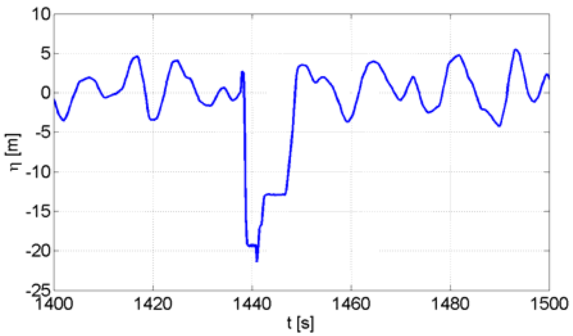
- CresT
  - Laboratory measurements
    - Probability distributions
      - Long-crested, short-crested, crossing-seas, waves on currents
    - Assessment of buoy performance in extreme waves
  - Analysis of field measurements
    - Identify extreme crest events
    - What are the sea state characteristics
      - Spectral characteristics (bimodal?, narrow-band?, directionality?)
    - Platform-based sensors (radars & lasers)
    - Wave buoys (or hindcasts) for directionality

# CresT – Sensor Problems

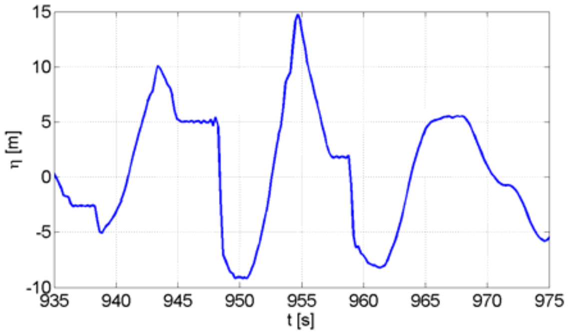
## spikes



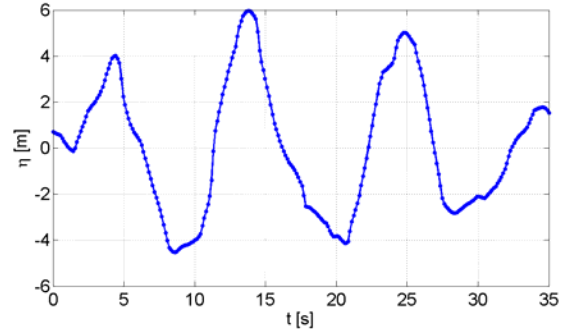

## drop-outs



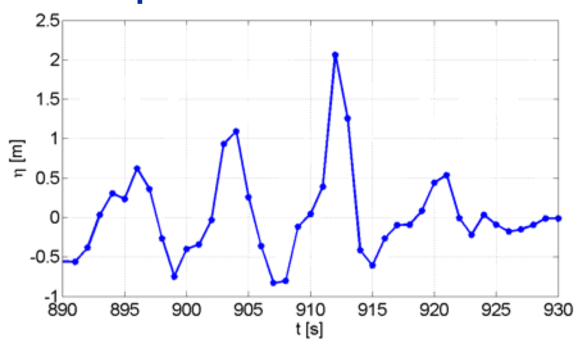

## lock-in




## sudden offsets



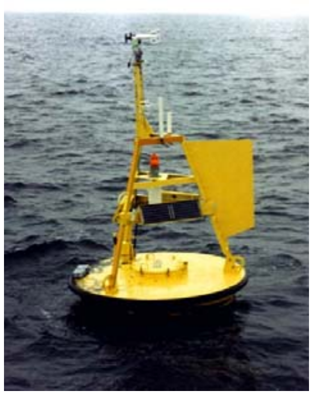

## poor resolution



# CresT – Buoy Performance

- Performance of wave buoys: Do they submerge and go around?
  - MARIN's Offshore Basin – model tests
  - Buoy & mooring details provided by NDBC, Datawell

10 m discus buoy

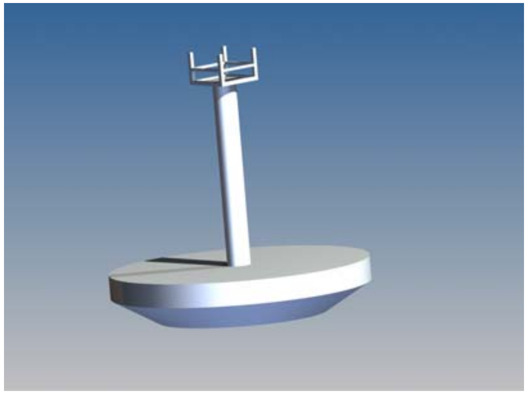


3 m discus buoy

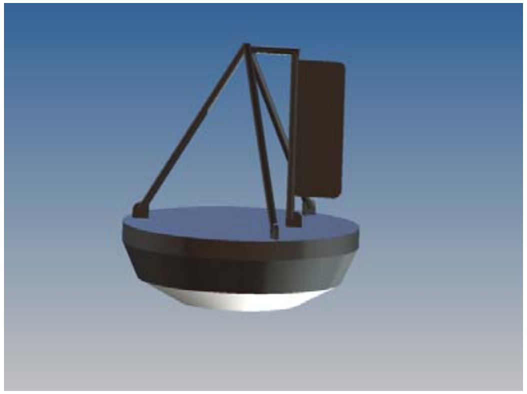
Waverider 0.9 m

# CresT – Buoy Performance

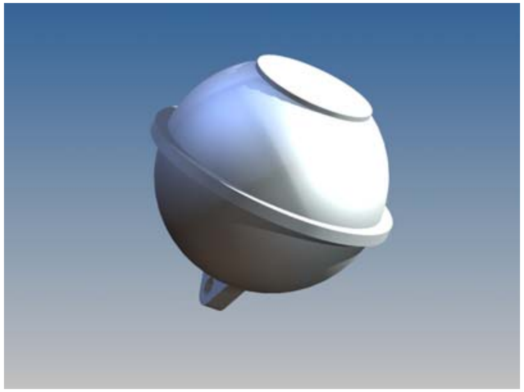
- Wave buoys at model scale 1:50
  - Weight distribution and mooring system as realistic as possible



10 m discus buoy



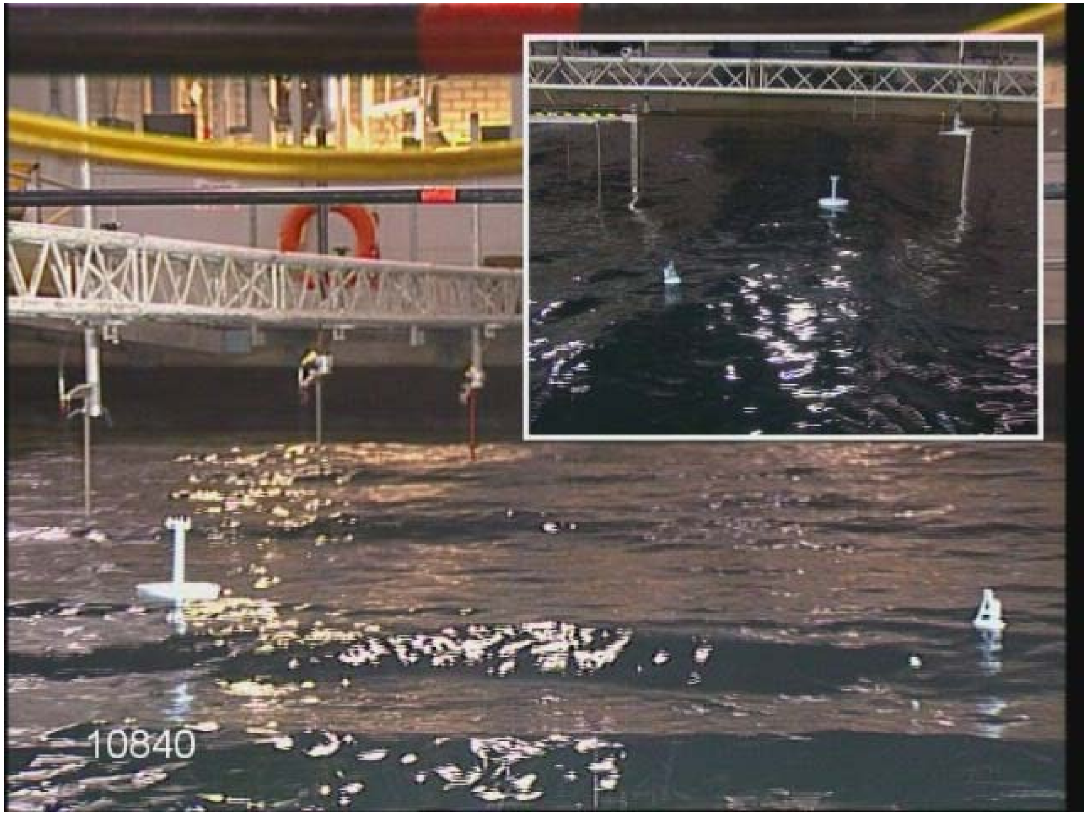
3 m discus buoy
(~6 cm and ~14 g)



Waverider 0.9 m
(~2 cm and ~2 g)

# CresT – Buoy Performance

- Long-crested, Hs = 12m, Tp = 12s, crest 8.2 - 8.4m



# CresT – Buoy Performance

- Long-crested, Hs = 12m, Tp = 12s , crest 14 → 9.7m

# CresT – Buoy Performance

- Short-crested, Hs = 12m, Tp = 9s – 3m discus & Waverider

# CresT – Buoy Performance

- Short-crested, Hs = 12m, Tp = 9s –Waverider

# CresT – Buoy Performance

- All three buoys move horizontally with larger waves, mainly in parallel with local direction of wave propagation
- Some evidence of buoys surfing on top of large wave crests (implications for profile)
- 10m buoy submerges mainly in breaking waves
- Little evidence of smaller buoys submerging
- No evidence for buoys skirting around large waves
- Discus 10 m buoy tends to capsize in larger waves
- Evidence that pitch-roll buoys not following slope
- Not easy to keep track of waverider during tests
- Further examination of all video material to be done

# Final Points

- Buoys generally provide what’s required, but …
  - – Questionable performance in extreme sea states
  - – Not suitable for extreme crest measurements
  - – Platform-based sensors – radar, laser not reliable enough
- Directionality is very important
  - – Buoy resolution sufficient for direction parameters
  - – Buoy resolution not sufficient for all applications
- Maintenance costs
  - – Vessels needed to service buoys
- Reliability needed

Questions?