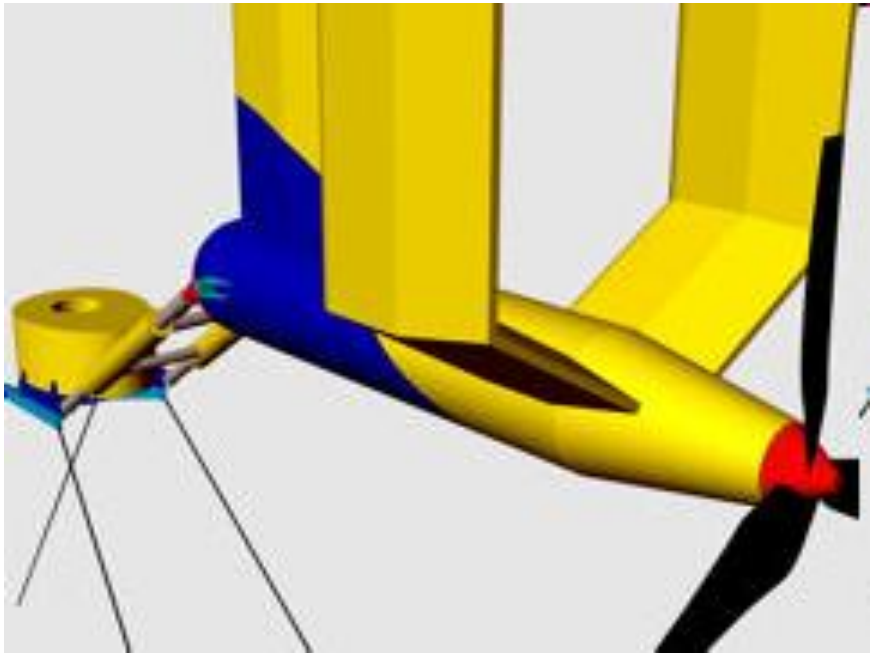
Moorings for Marine Renewable Energy Converters

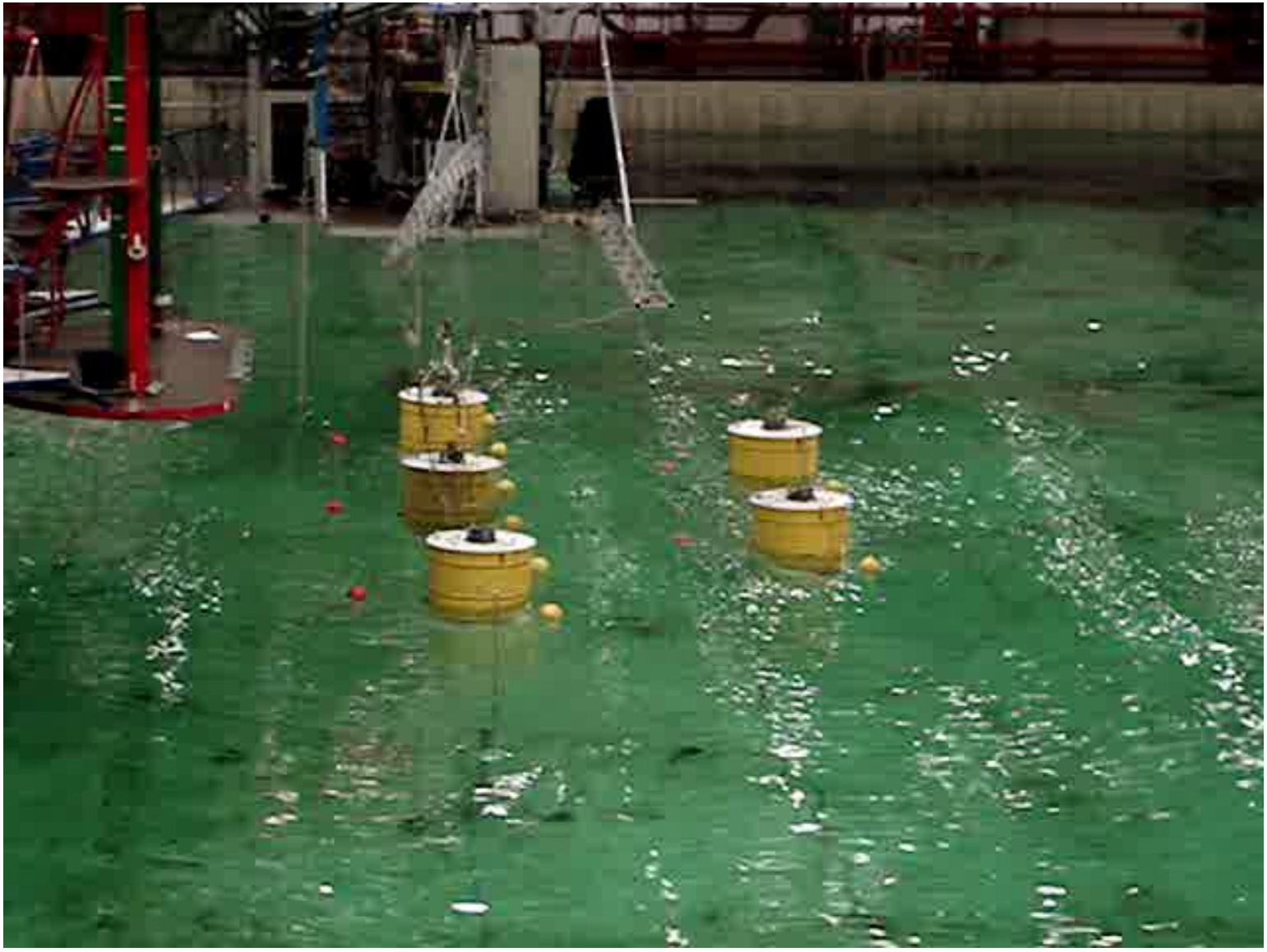
Testing in the Lab and at Sea

Moorings and Positioning

- Laboratory tests on WECs (Trondheim, Heriot-Watt)
- Simulation modelling (Matlab, OrcaFlex)
- Optimisation: power take off, mooring loads
- Environmental effects: damage to sea bed, sediment erosion
- EIA, Indirect effects of suspended sediments.
- Tests on WECs and TECs (Strangford Lough)
- SWMTF (Exeter university) and EVOPOD (OceanFlowEnergy)

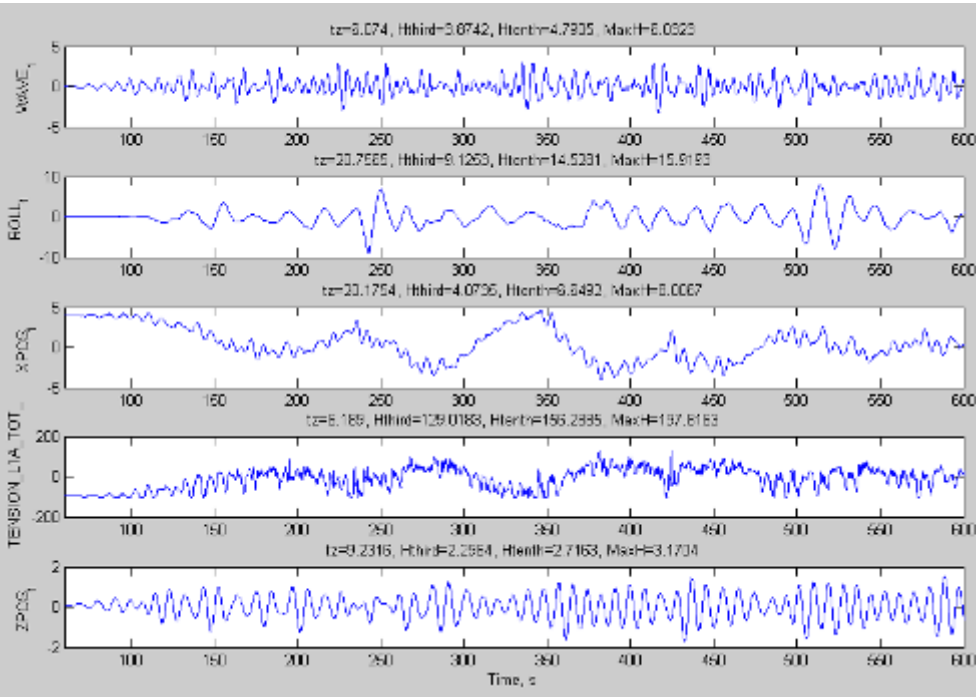


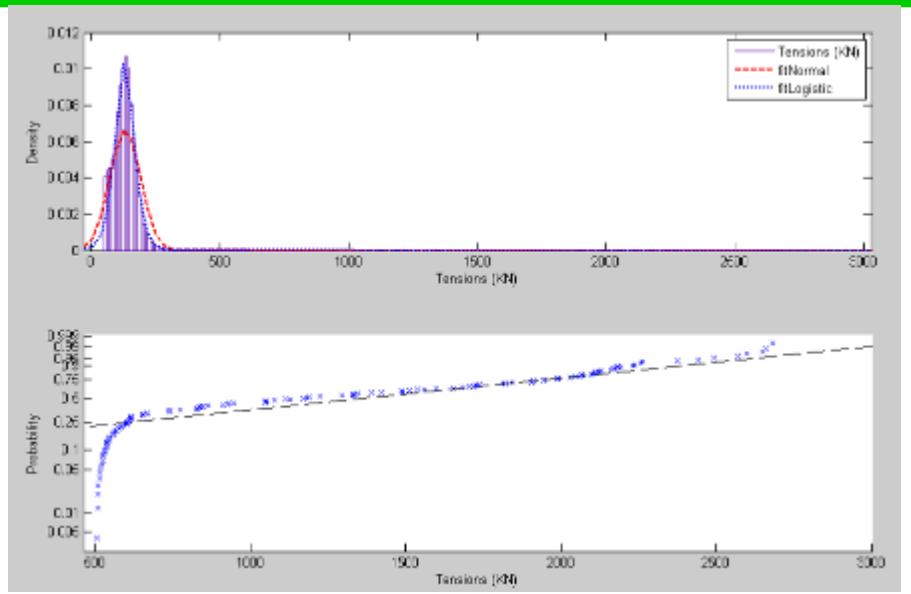
Tests at MARINTEK (Trondheim)

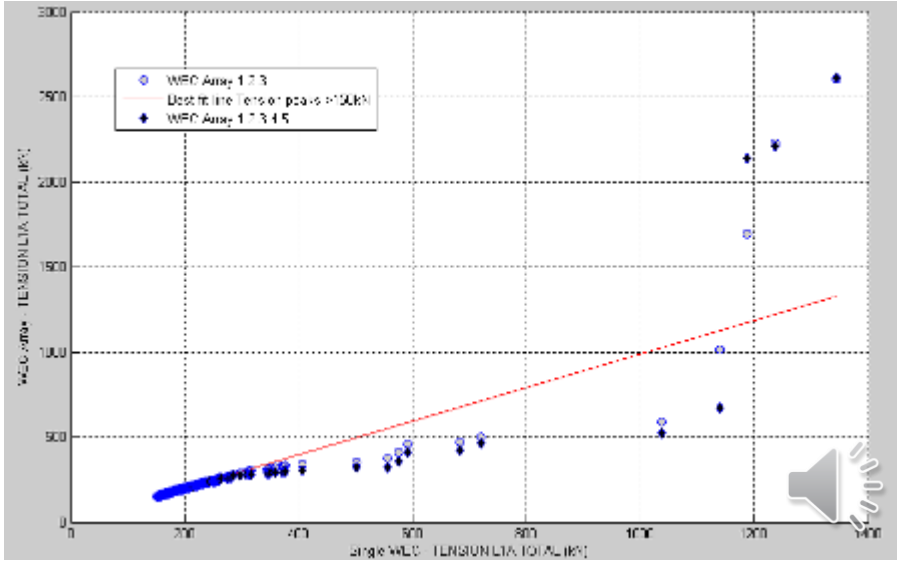


Testing in Irregular Waves

- Complex interplay between high and low frequency motions
- Bulk of loads conform to normal and logistic distribution, right tail to extreme value distribution
- In arrays, enhanced power take off, but also higher mooring loads and ecological impact







Tests at Heriot-Watt

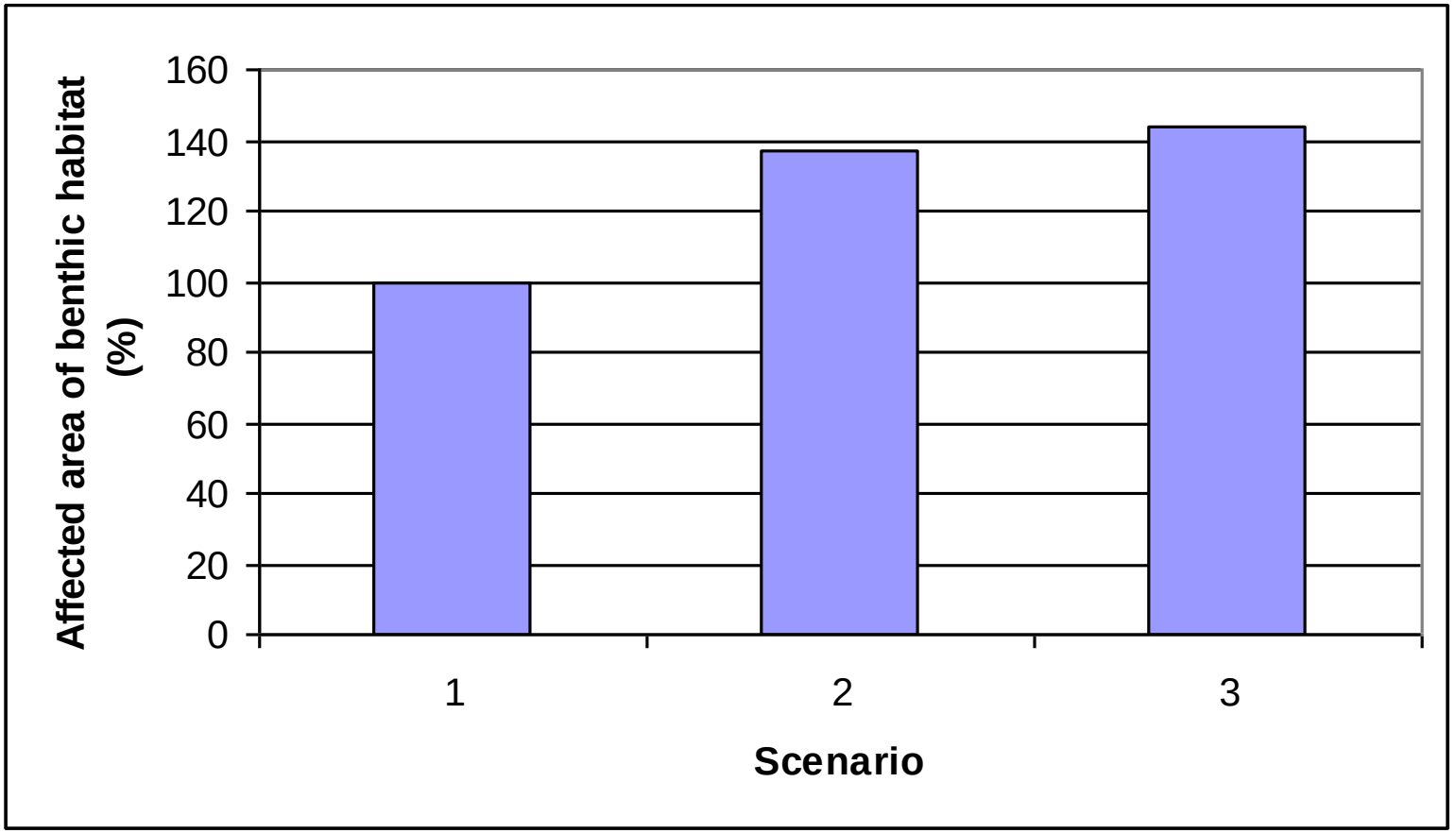
Further Tests at Heriot Watt : Trials of Different Buoys

- Tests in Long Crested Waves
- Hs of 2, 3 and 4 m
- Tp of 12, 10 and 8 s
- Larger Buoy provides softer moorings (e.g. B2 vs B1)

Simulation Modelling

- OrcaFlex model initially compiled to simulate tensions on mooring lines
- Qualitative agreement with the data
- The model was used to assess the scouring effect on bottom sediments and consequent disruption of benthic habitats
- Output from OrcaFlex is imported to Matlab
- The affected area is calculated using the time series of coordinates of touch down points

Effects of Scouring



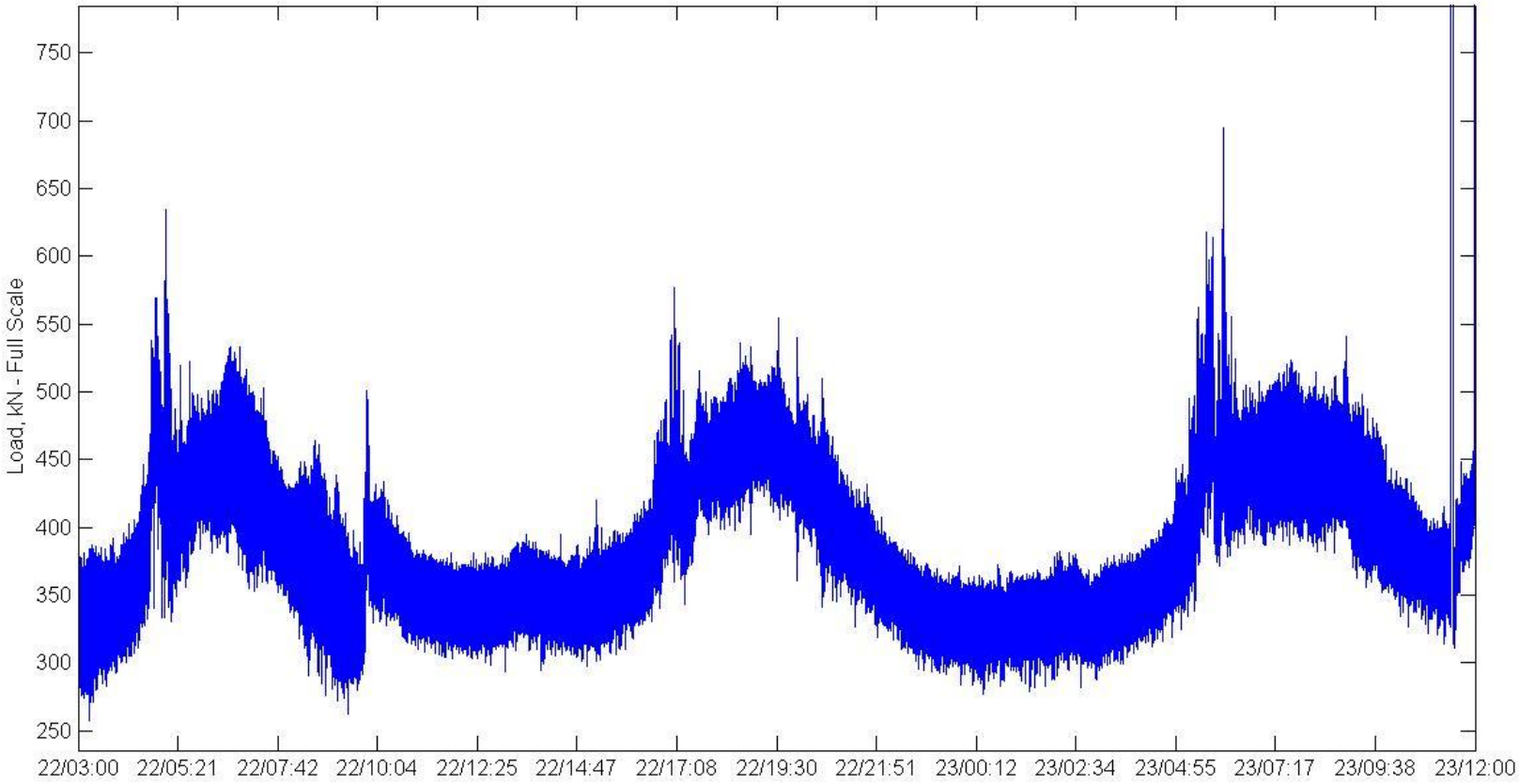
Area of benthic habitat adversely affected by the WEC's leading mooring line (values normalised to Scenario 1, which is taken as 100%). Scenario 1: Hs=4m; Scenario 2: Hs=6m; Scenario 3: Hs=8m;

Ecological Modelling and Further Implications

- Increases to Hs from 4 to 6 and 8 m, resulted in the increase of the disrupted benthic habitats of, respectively, 37% and 44%
- Sediment erosion by mooring lines will effect a whole range of ecosystem processes, e.g. due to changes in biogeochemical cycling and light penetration
- These issues should be given a due consideration in practical applications of any moored objects
- Results presented at ECEM11

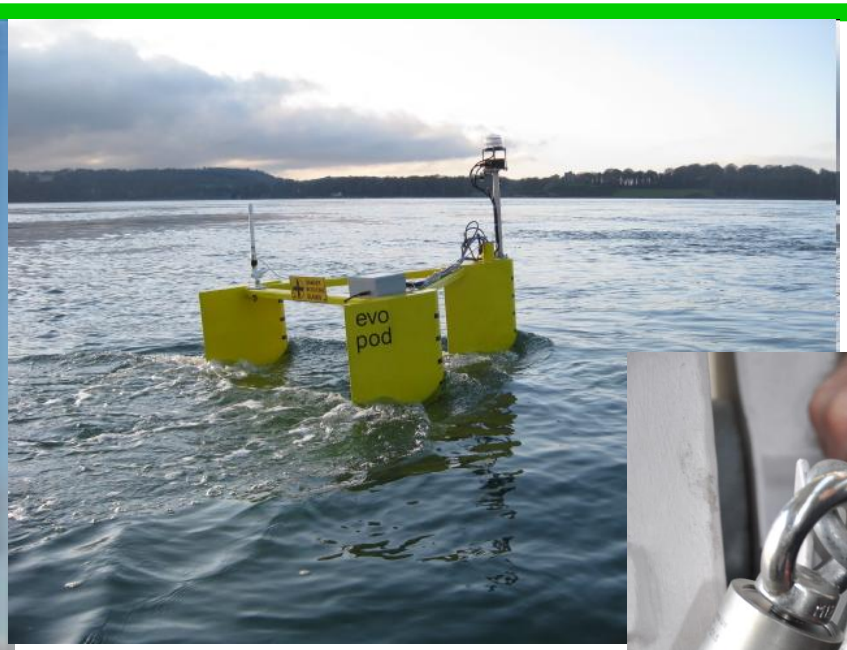
Test sites around Strangford Lough

Example Results from Strangford Lough



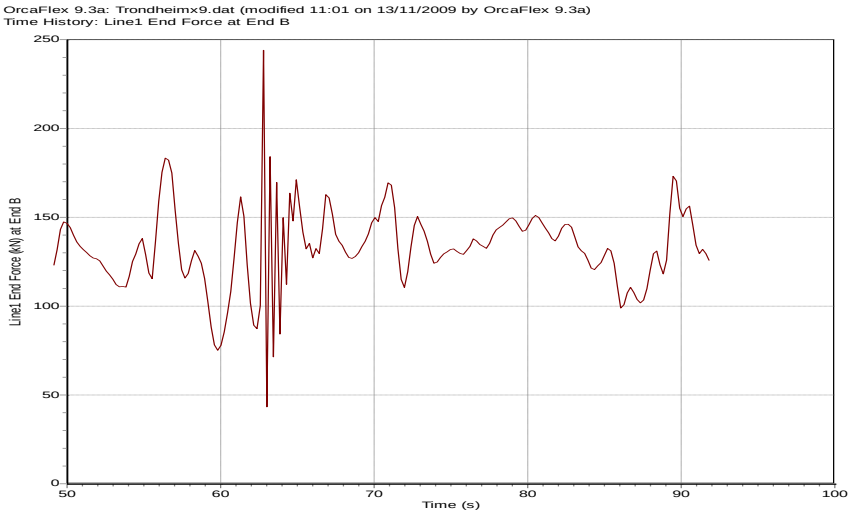
WEC IN A GALE

SWMTF and EVOPOD



Thanks for your attention!

OrcaFlex Simulation: Hs 3.5 Tp = 8s



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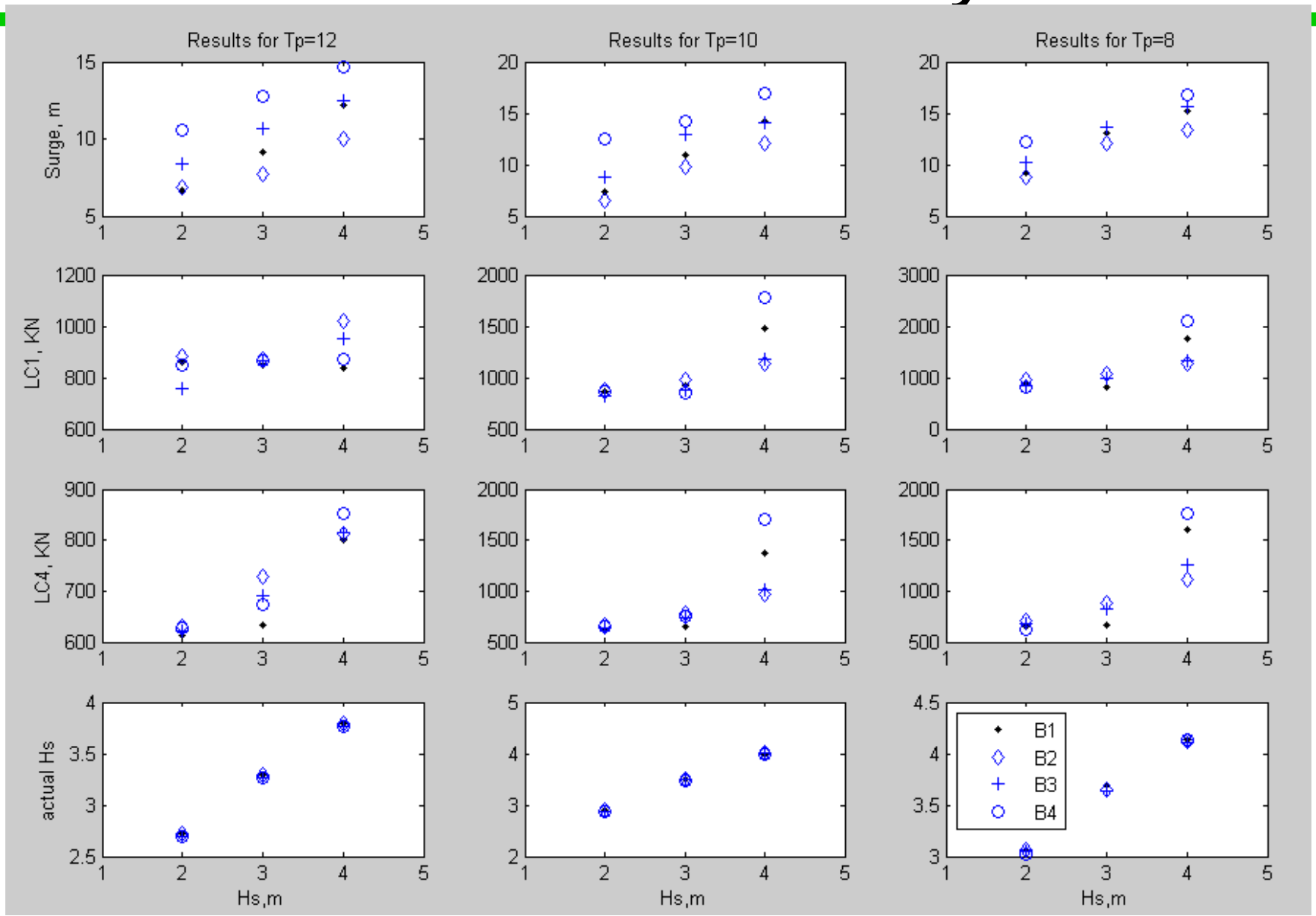
- Staff and Students at QUB, Heriot-Watt, Edinburgh and Exeter Universities

- Crews and Captains of Research Vessels Cuan Shore and Cuan CAT

Further Tests at Heriot Watt : Trials of Different Buoys



Summary and Conclusions

- In arrays: enhanced power take off, but also higher mooring loads and ecological impact
- Buoy size and shape appear to be important for the mooring loads; softer moorings alleviate the peak loads
- Orcaflex model has been successfully applied in an ecomodelling case study
- The area of benthic habitats affected by the leading mooring line increases with the increase in Hs
- Tests at Strangford Lough are currently underway