



MONITORING, DIGITAL TWIN AND CONTROL TECHNOLOGIES FOR MOORING SYSTEM INTEGRITY MANAGEMENT IN FLOATING OFFSHORE WIND

The MooringSense project aims at **reducing operational costs** and **increasing efficiency** through the development of an efficient risk-based integrity management strategy for mooring systems based on affordable and reliable on-line monitoring technologies.

Digital Twin technology that will be developed within the MooringSense project will integrate a detailed digital replica of the mooring system. The solution will be based on improved high fidelity coupled numerical models and advanced simulation tools that will be used to provide updated condition information, supported by real sensor measurements, and integrated within a risk-based integrity management plan. Some functionalities that will be achieved are:

- Real time virtual measurement of mooring line tensions.
- Accurate prediction of remaining useful time of the mooring system components.
- Continuous update of Ultimate Limit State and Accidental Limit States safety factors.
- More accurate modelling of typical degradation states and damages.
- Improved operation prediction.

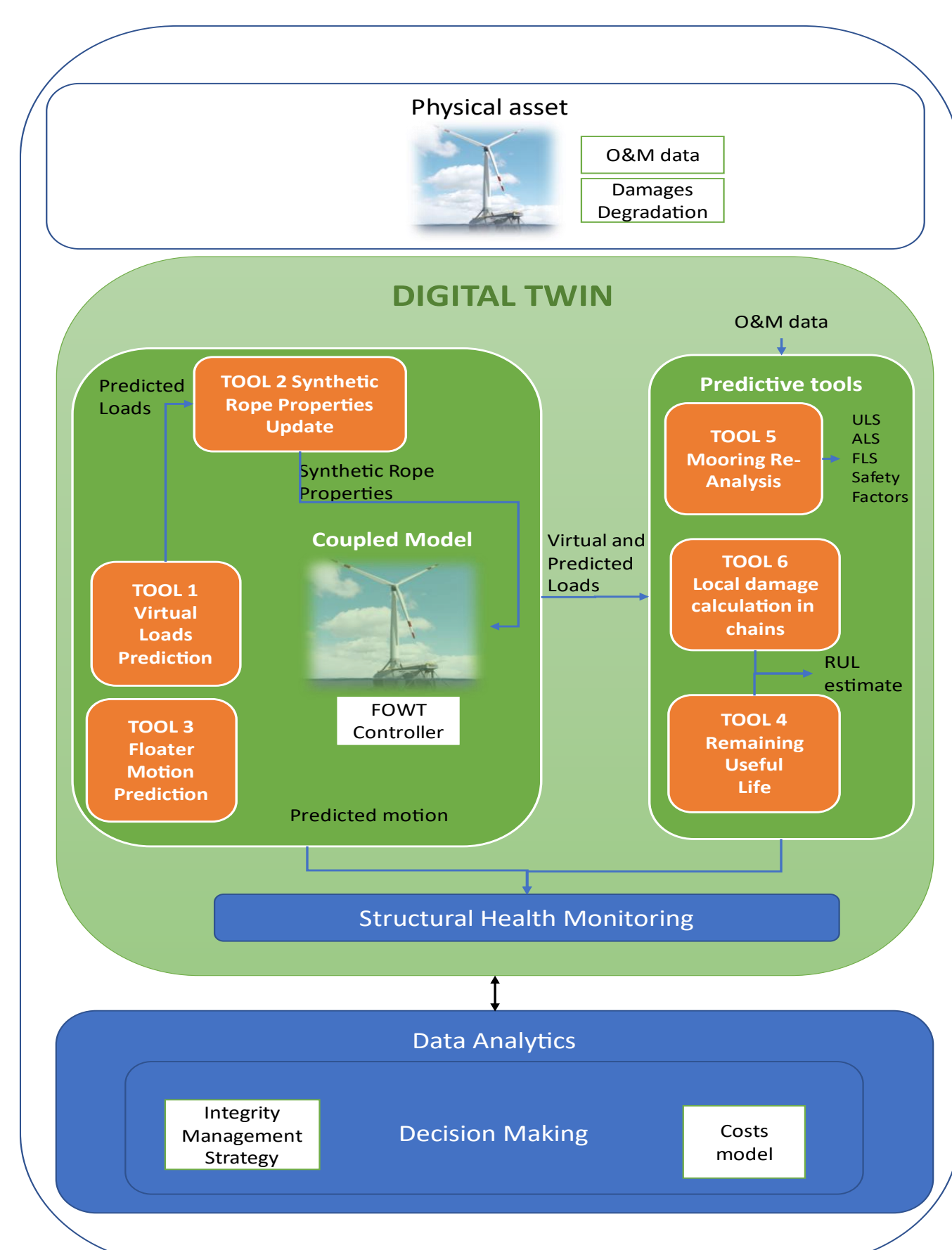
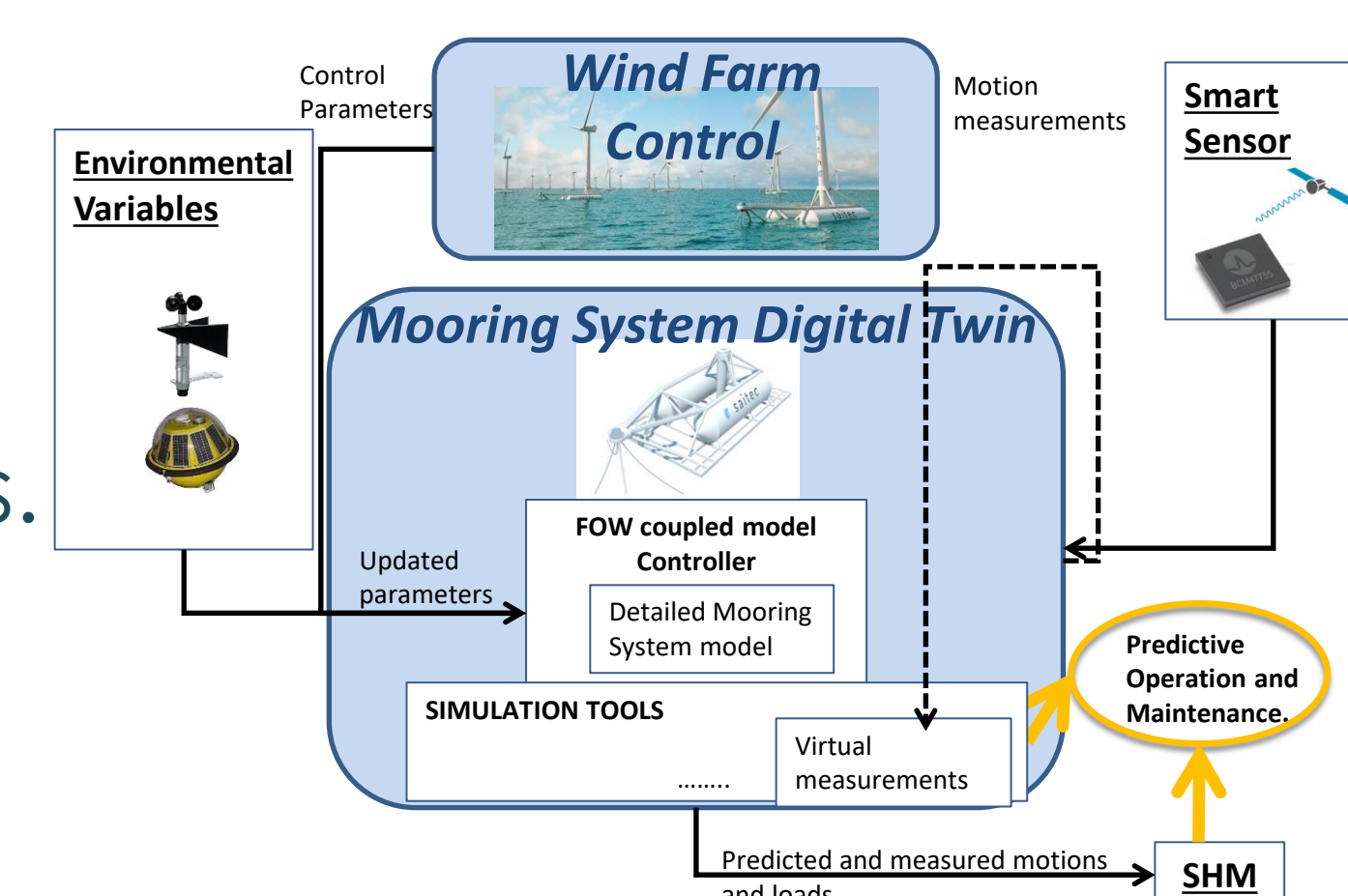


Figure 2 – MooringSense Project Structure

The **Smart Sensor** design is based on GNSS mass-market receiver technology. Design includes GNSS algorithms for precise attitude, position and velocity determination, followed with inertial measurement units (IMU) for the motion feature extraction. Modular design of the Smart Sensor is prepared for self-contained power harvesting and Wireless communication capabilities. Test result of the Smart sensor breadboard with integrated PPP algorithm operating in real-time is presented in Figure 3.

The Structural Health Monitoring (**SHM**) system aims at detecting changes in the movement of the platform that represent a deviation from its normal operating behaviour, indicating a failure in the development of the mooring system. It follows a data-driven approach using data provided by the Smart Sensors, FOWT control, DT and weather buoys.

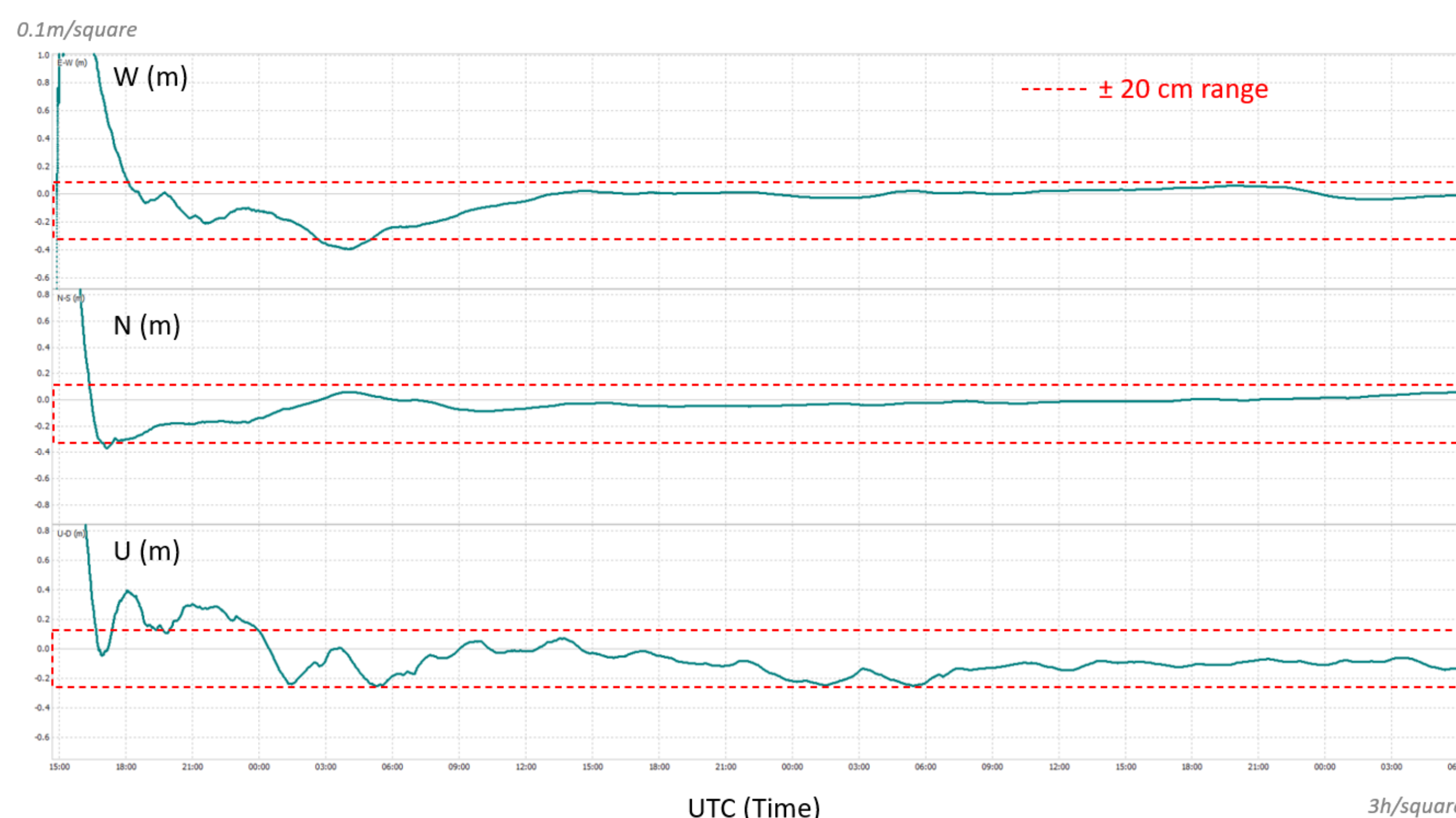


Figure 3 – Smart Sensor PPP real-time test preliminary result

Conclusion: After 18 months of the MooringSense project, the analytical demonstration for innovative concept which leads to a significant O&M cost reductions and increased efficiency have been achieved. Preliminary results from the Smart Sensor and the SHM system confirmed their potential as a reliable technical asset of the MooringSense concept.