A Low-Cost Sensor for Marine Monitoring

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3. Field Deployments
4. Field Results
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   - Data Treatment
   - Temperature Correction
   - Turbidity Events
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Need for (Continuous) Monitoring

- Legislation - WFD and other Directives
- Human and animal health

} Discrete Monitoring

- Climate change and weather events
- Anthropogenic activities and their effects
- Inform modelling and predictions of aquatic systems
- Real-item information for decision makers

Needs of the Monitoring Community

- Robust and reliable sensors
- Sensor webs - lower cost
- Sensors capable of longer deployments without maintenance
- Trust in the data being outputted by the sensor and in the results derived from the data
- Real-time data handling systems

Optical Colourimetric Sensor - Aims

- An optical sensor to be designed, built and tested in-house
- Capable of monitoring changes in bulk water properties (opacity, colour, etc.)
- End use as a pollution alert system
- Robust, low-cost and simple
- Ability to log and transmit data effectively
- Making use of advanced data analytics to detect events

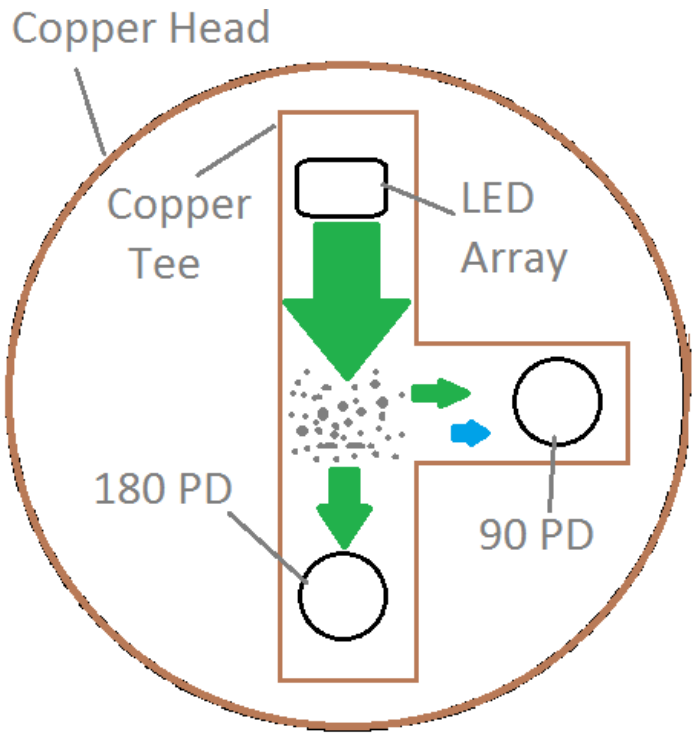
Construction of the Optical Sensor

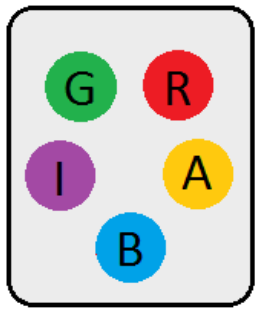
- The Optical Colourimetric Sensor (OCS) is a low-cost, flexible, robust, marine deployable system
- Body made of low cost, robust materials (PVC-U and stainless steel)
- Houses a foam filled flotation chamber, electronics compartment (IP 68 rated) and the detection head shrouded in copper plating

K. Murphy, *et. al.*, Talanta, IN PREP

Construction of the Sensor - Detection Head

- Five LEDs: Blue (λ_{max} =430nm), Green (λ_{max} =515nm), Amber (λ_{max} =583nm), Red (λ_{max} =627nm) and IR (λ_{max} =850nm)
- Two photodiodes (PDs) at 180° and 90° to the light path to measure transmitted and scattered light simultaneously

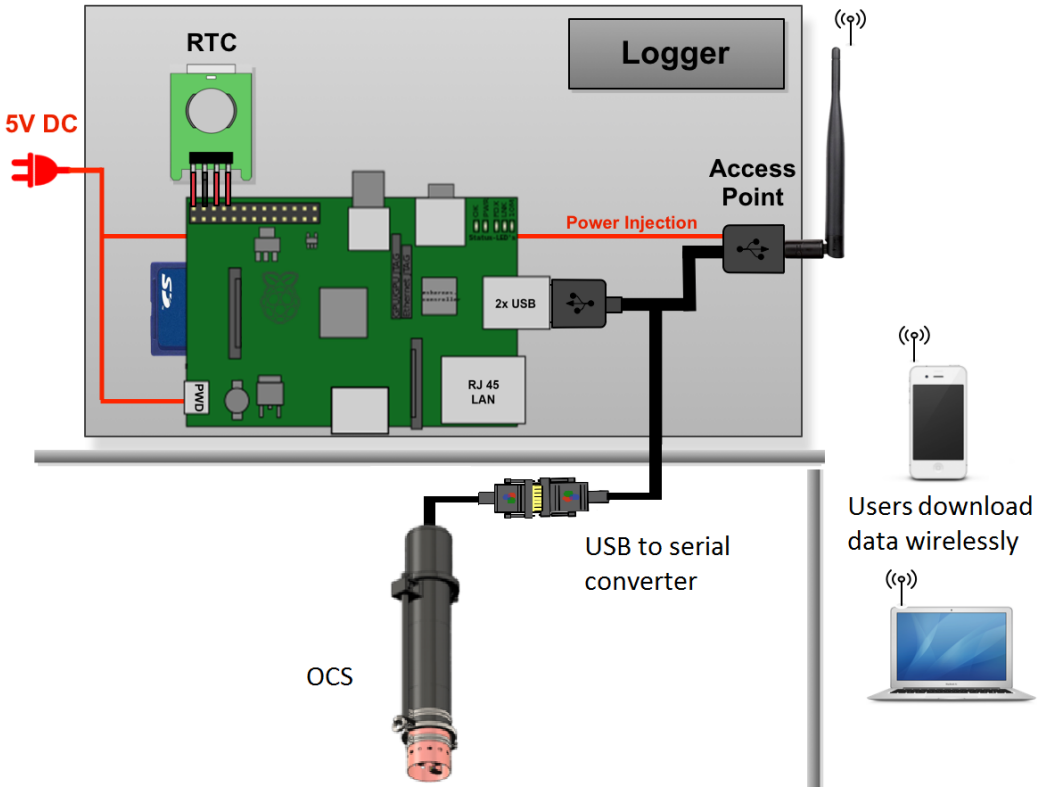




LED Array configuration

Construction of the Sensor

- System controlled through the use of a Wixel development board and is reprogrammable (frequency of measurements, the LED cycle, PDs communications, etc.)
- The data is communicated back to a logger, via RS232 (or USB)



Design Advantages of the Optical Sensor

Low-cost - sub €650 for single unit.

High temporal sampling resolution - down to one measurement per second.

Flexible - reprogrammable to suit application.

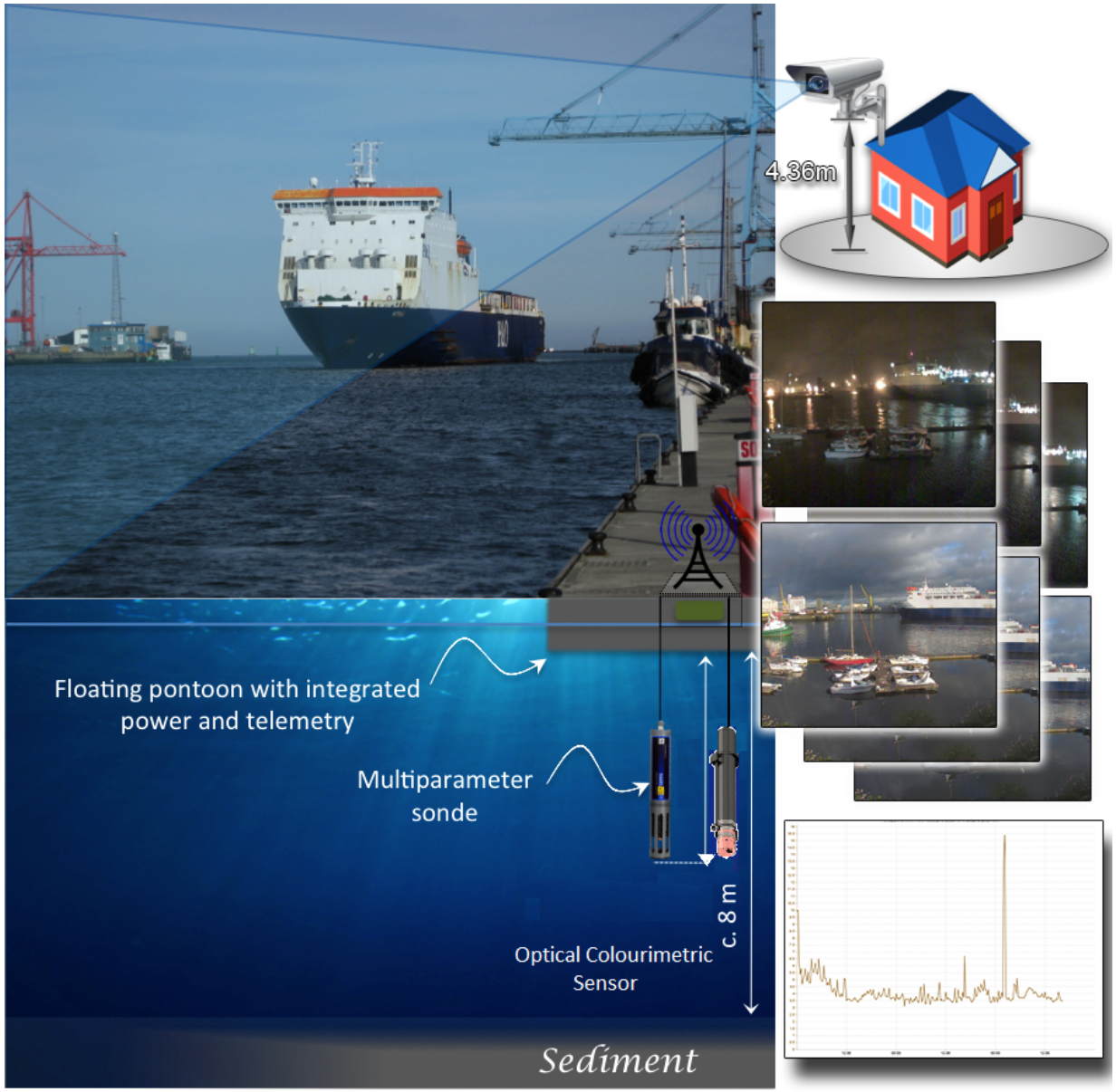
Simple - no moving parts.

Rugged - can survive long-term deployments.

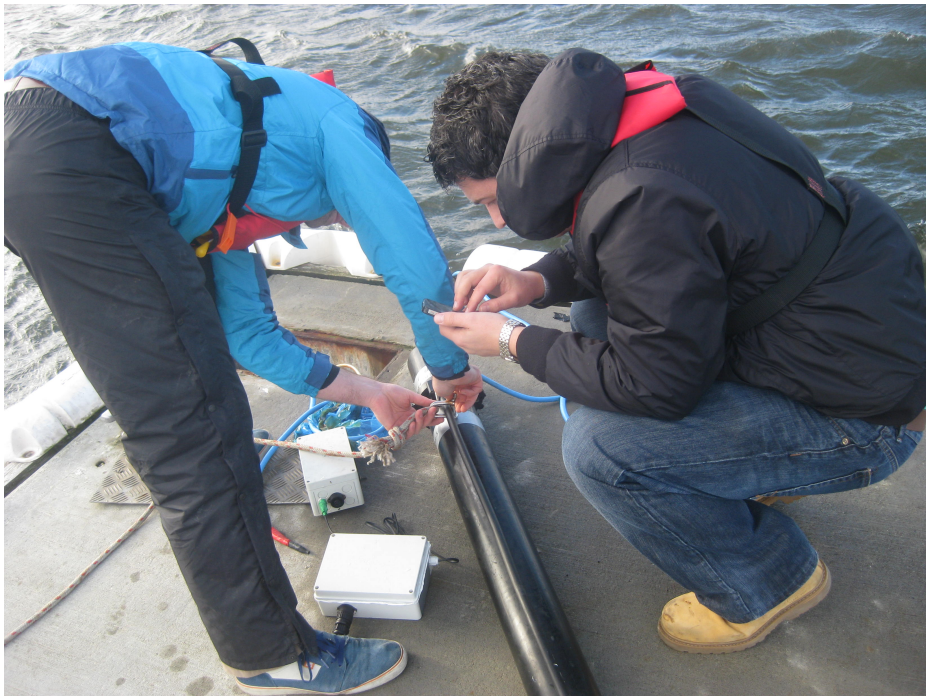
Field Deployments

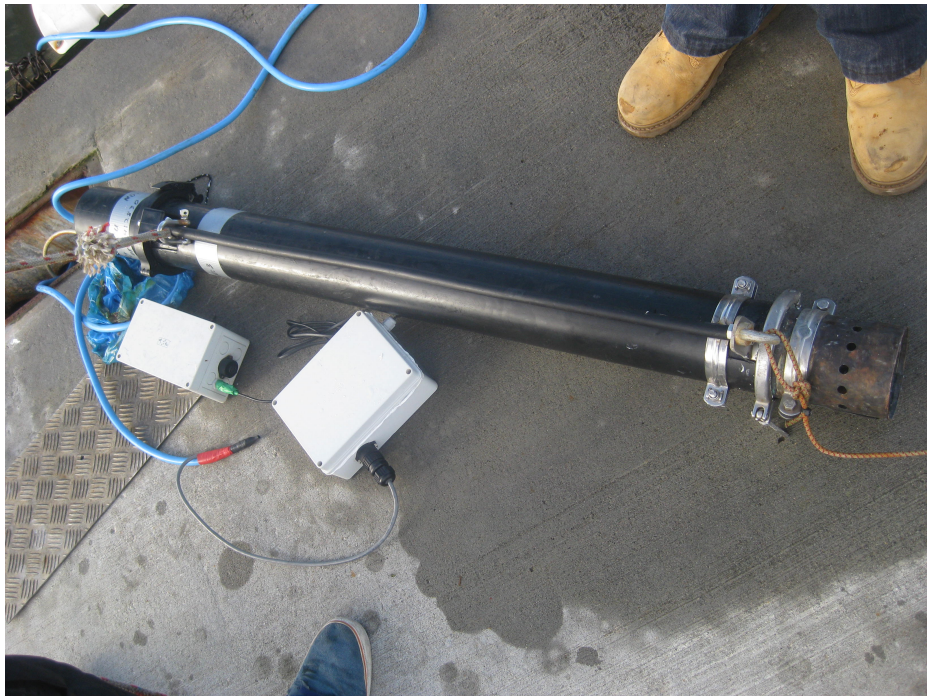
Regan, *et. al.*, SensorComm, 2013 and Briciu-Burghina, *et. al.*, Environ. Monit. Ass., 2014

Field Deployments - Poolbeg

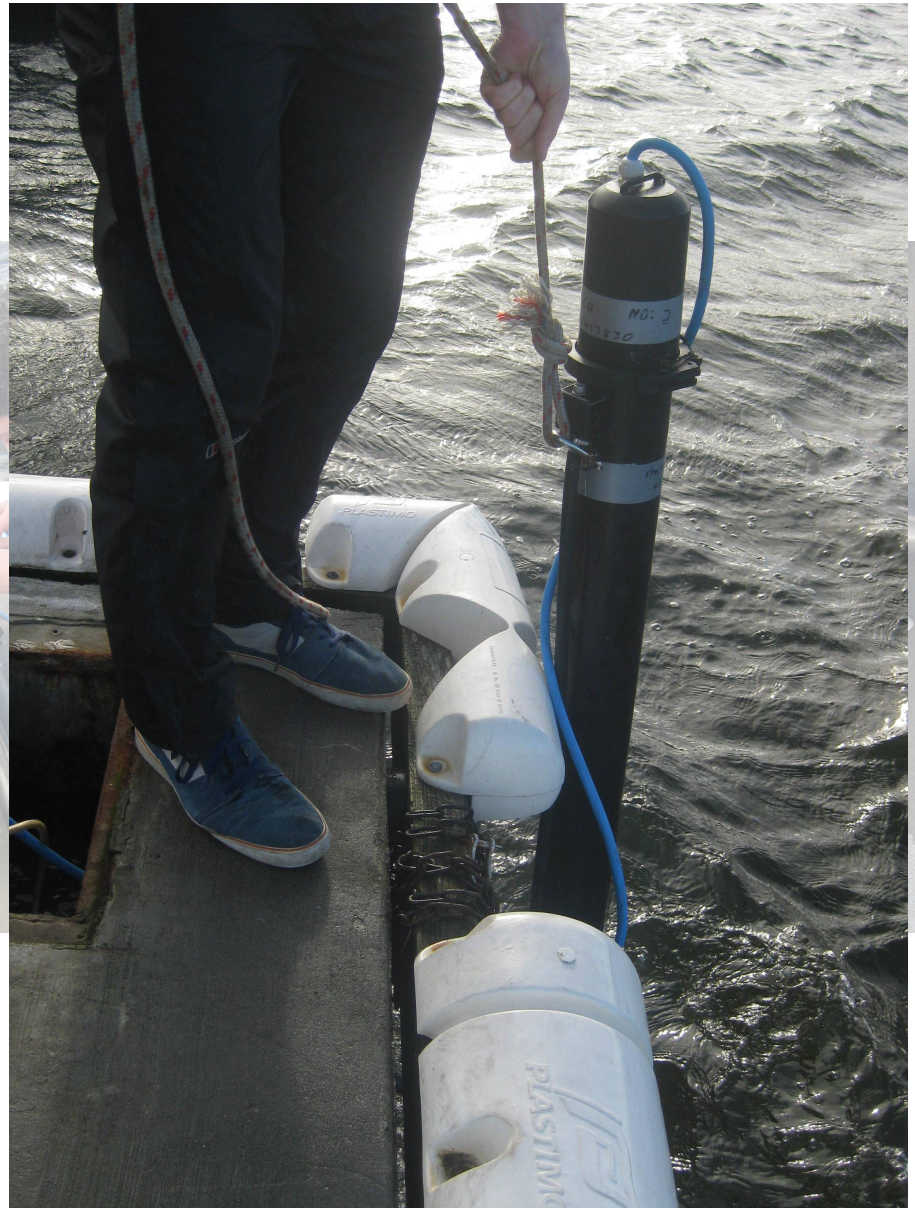


Field Deployments - Poolbeg

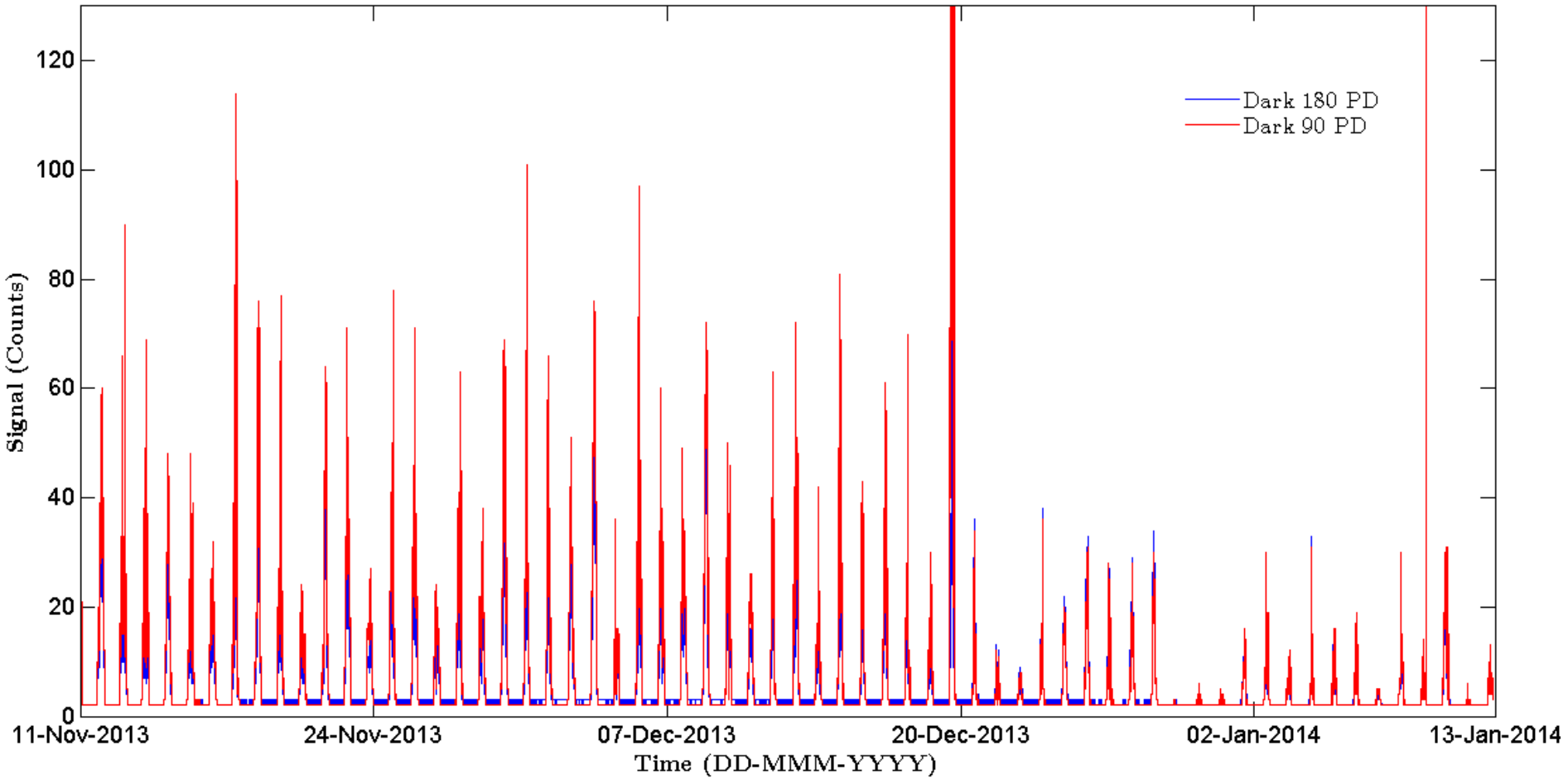




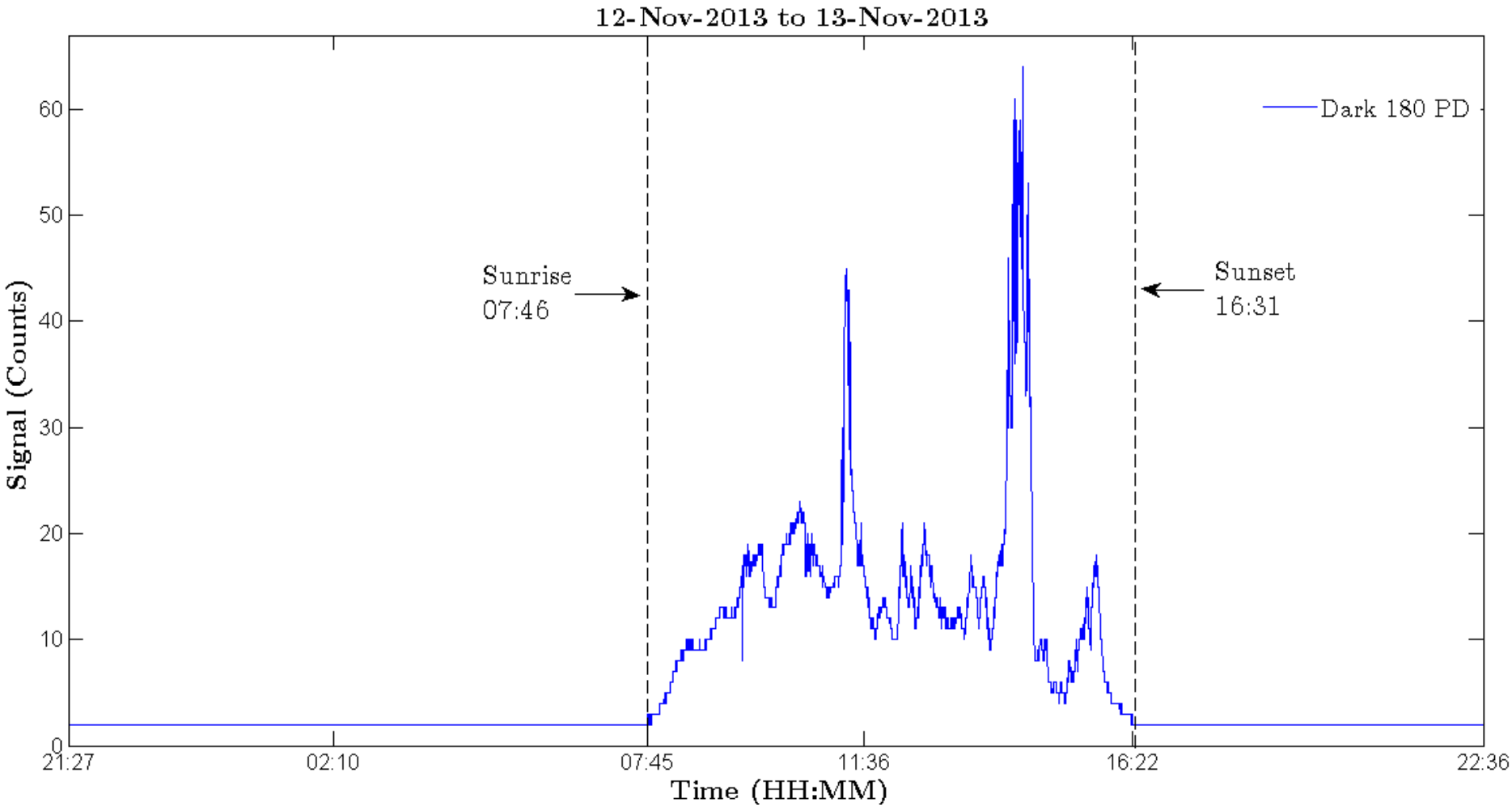
Field Deployments - Poolbeg



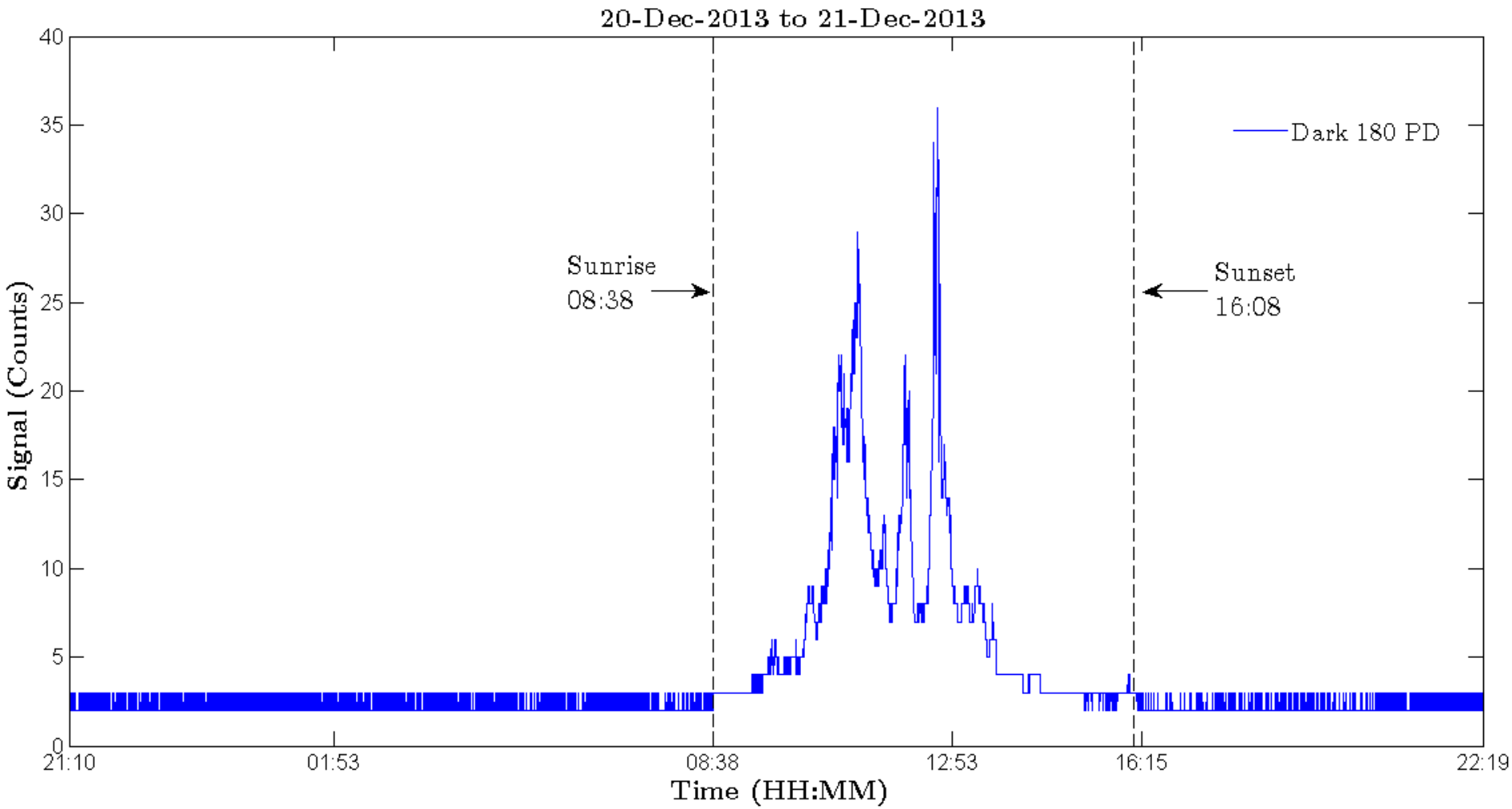
Poolbeg Results - Background



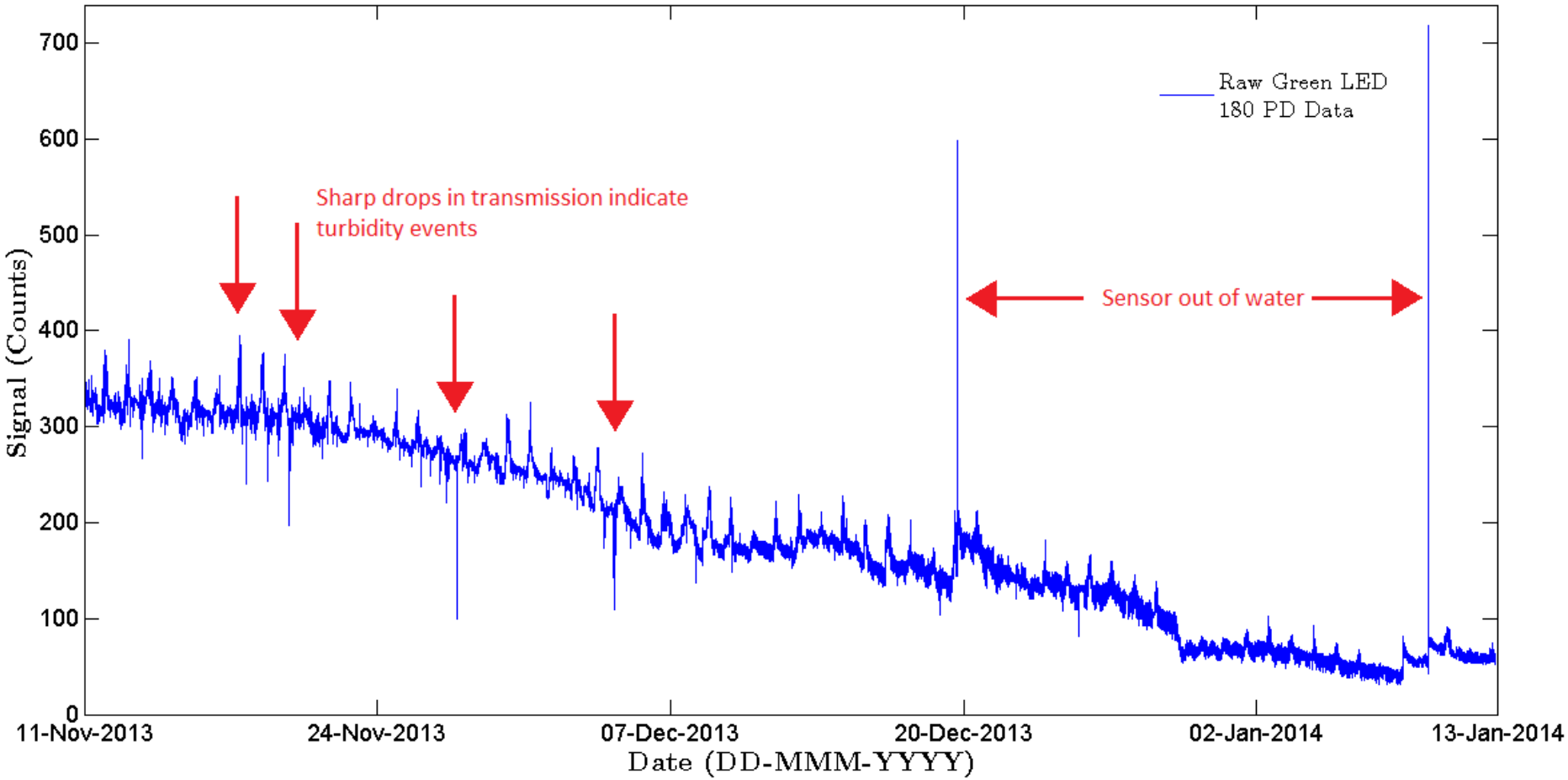
Poolbeg Results - Day Length



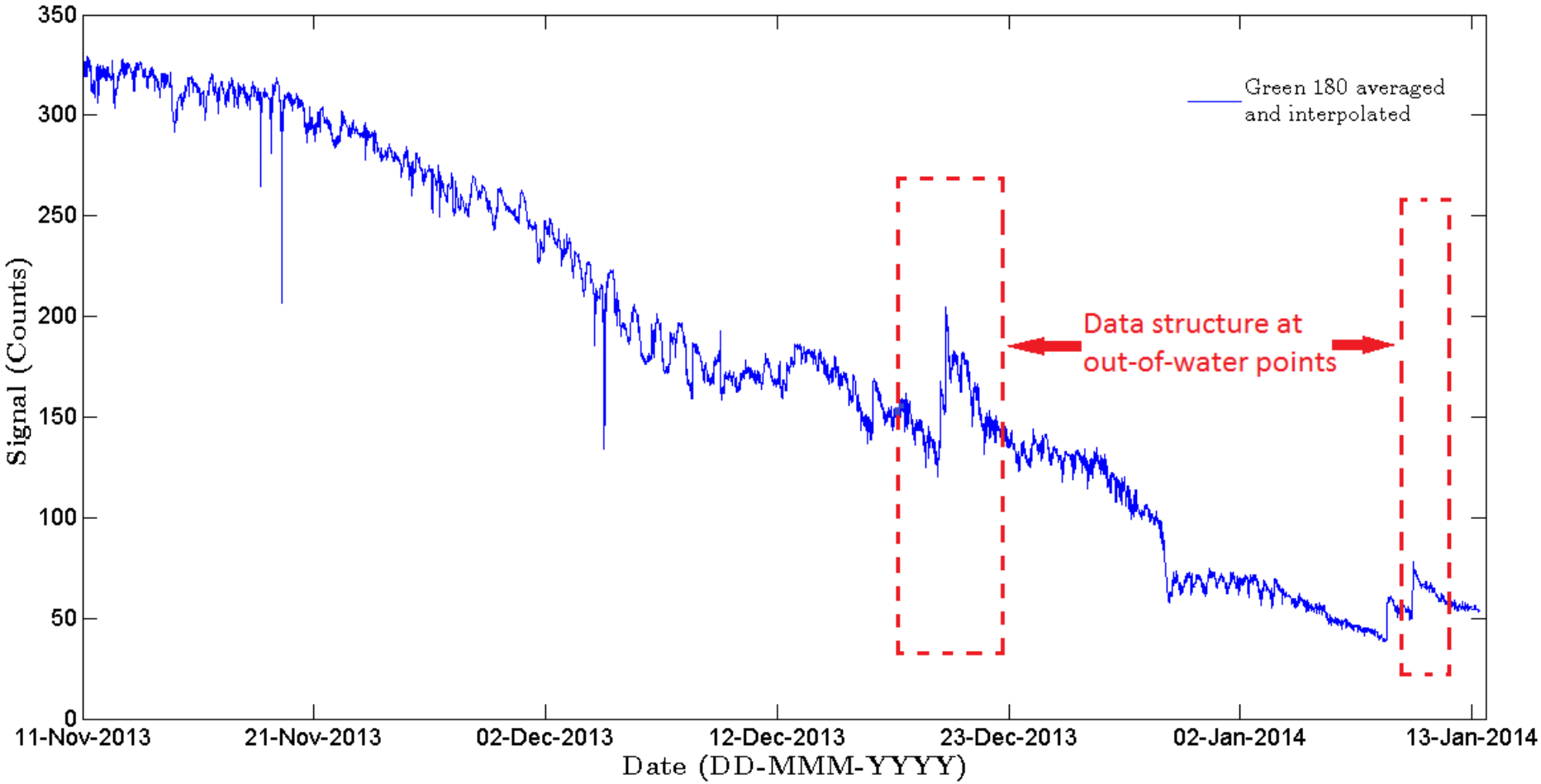
Poolbeg Results - Day Length



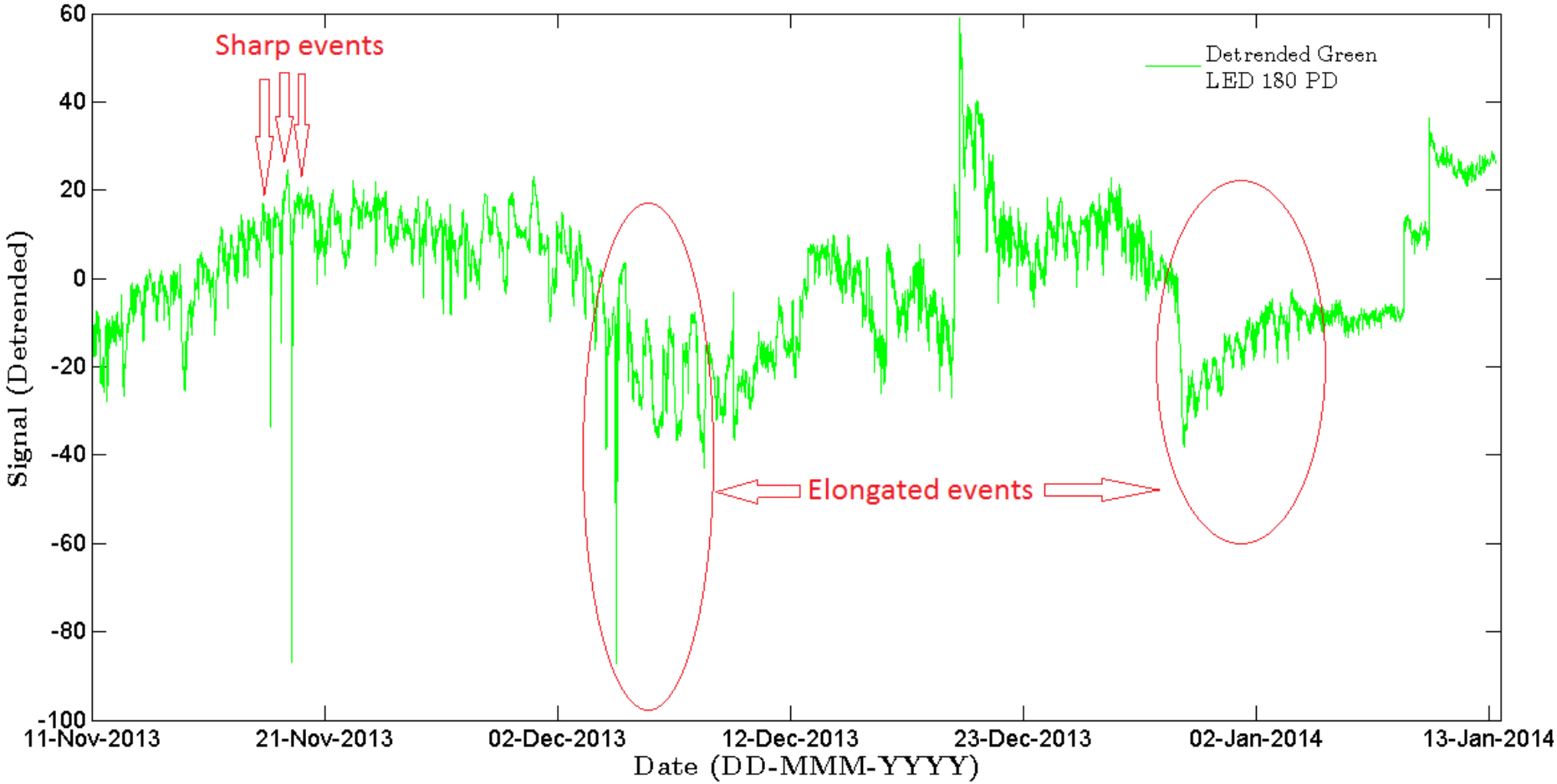
Poolbeg Results - Raw LED Data



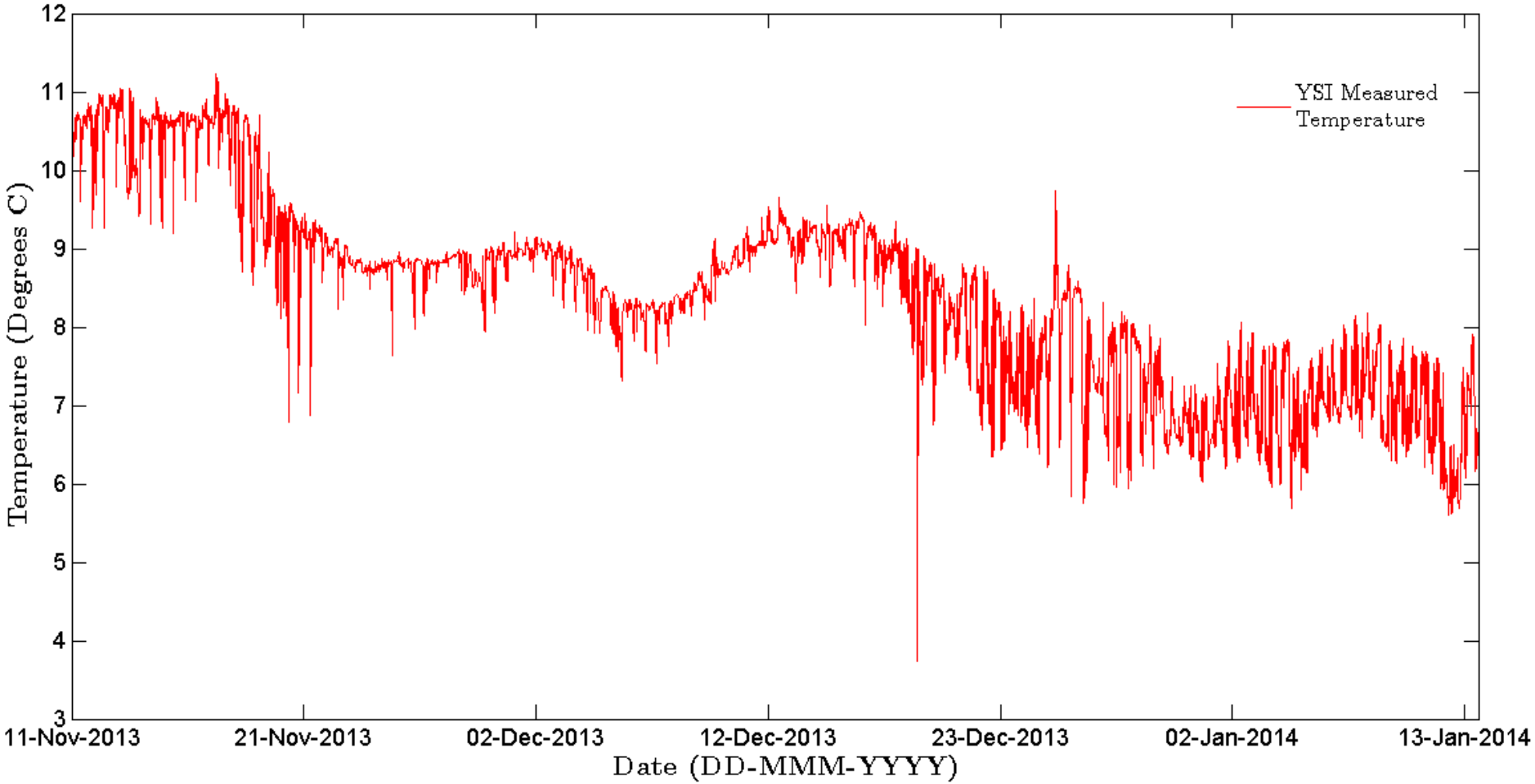
Poolbeg Results - Averaged and interpolated



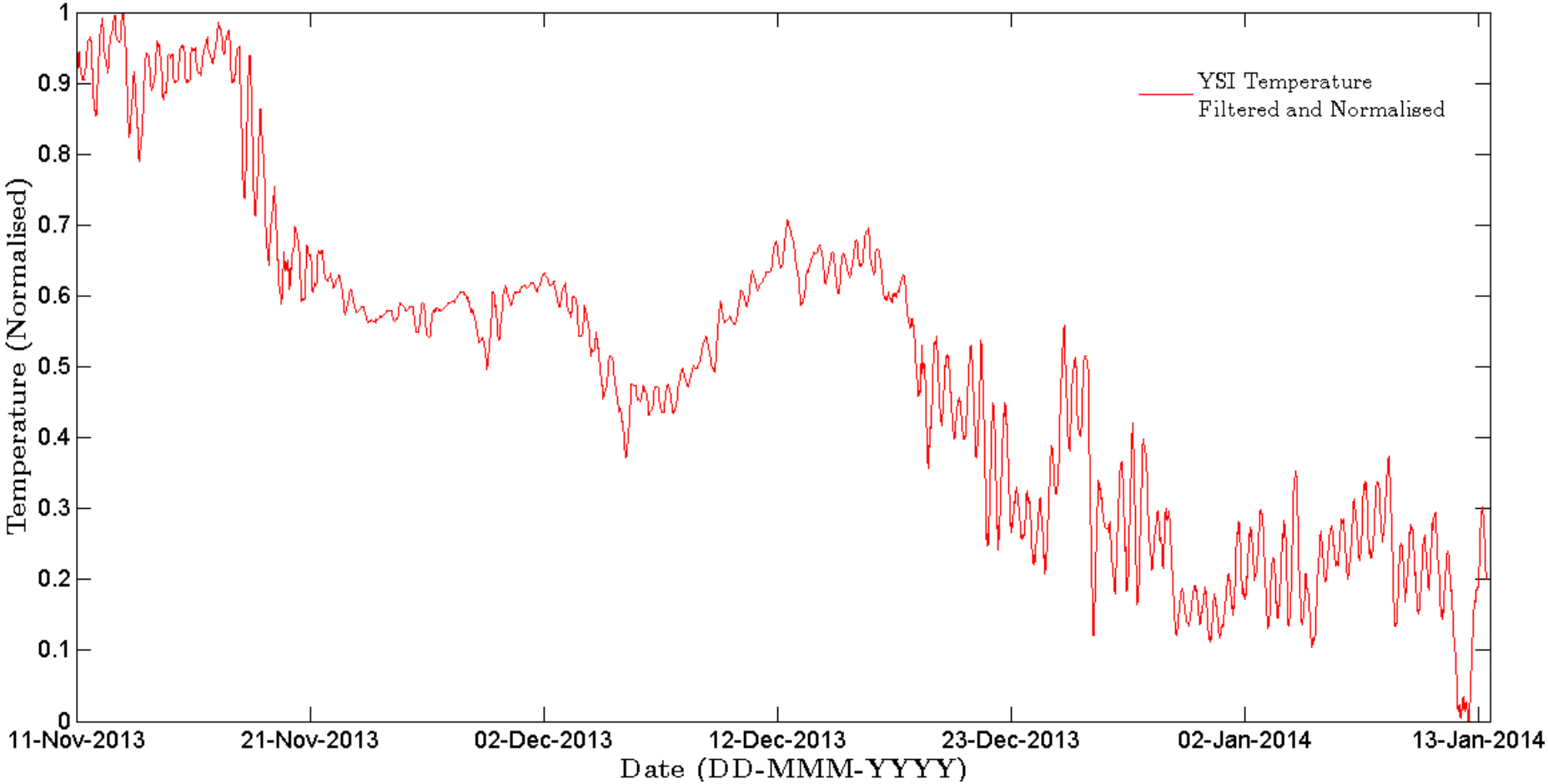
Poolbeg Results - Detrended optical signal



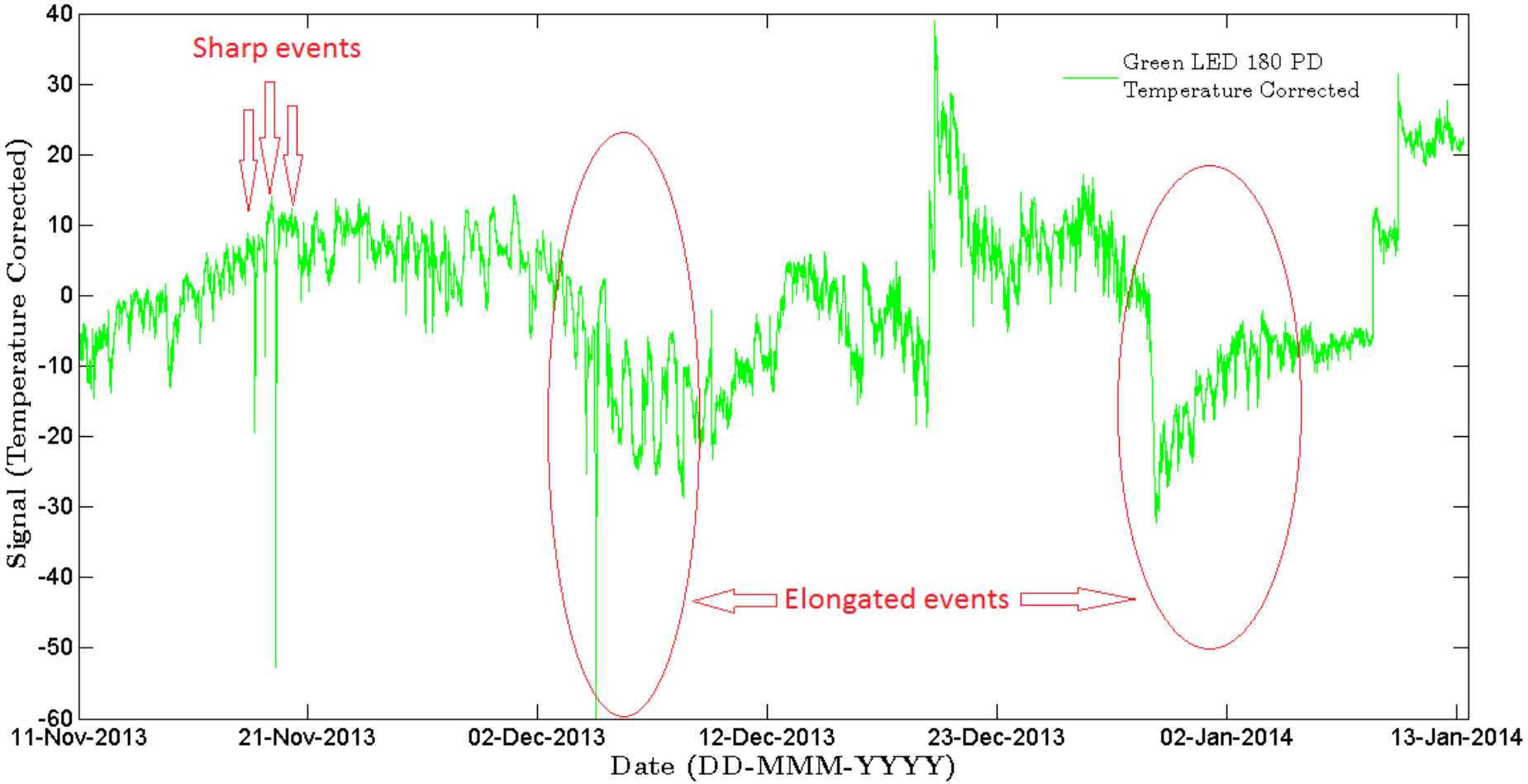
Poolbeg Results - Temperature



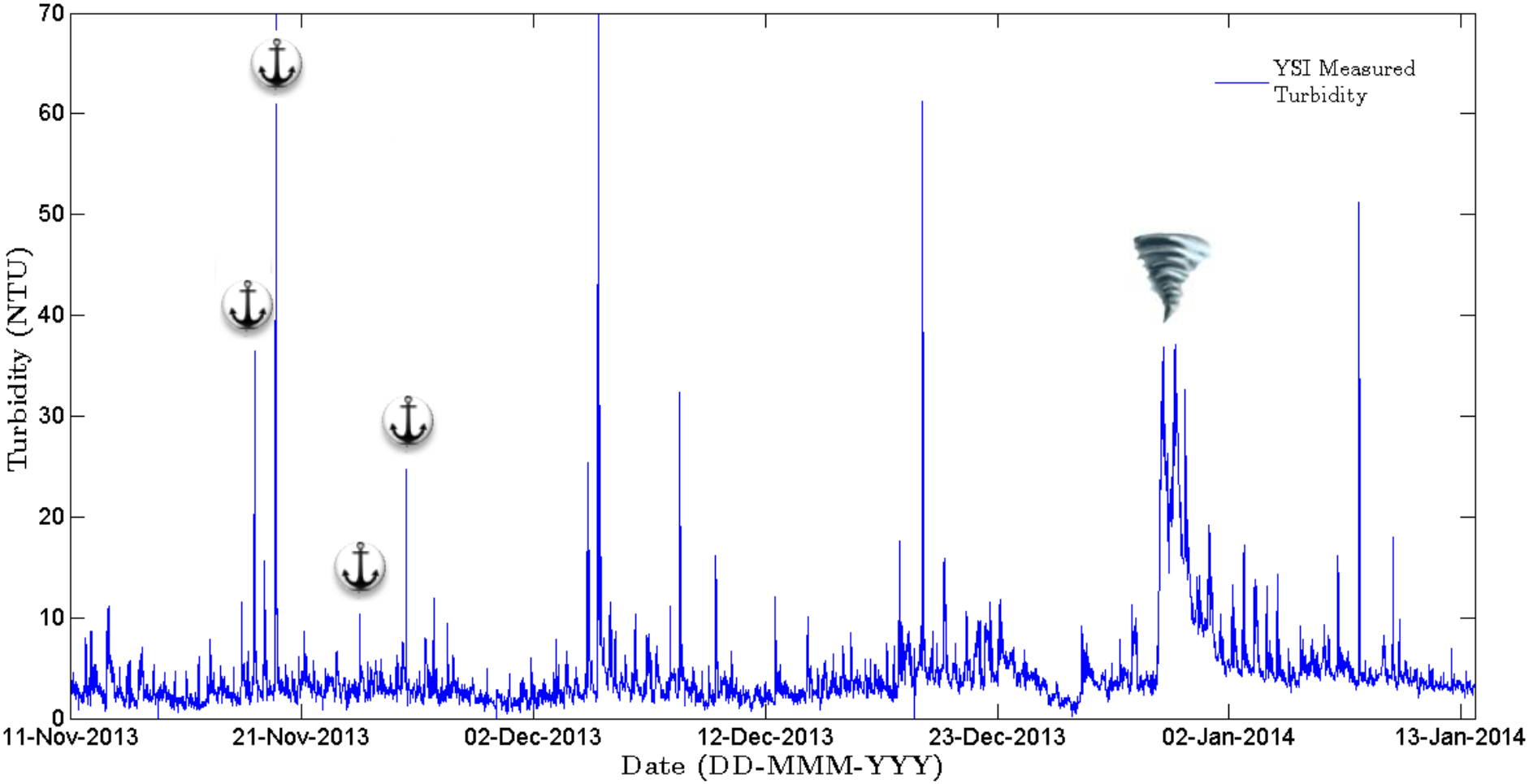
Poolbeg Results - Temp Filtered and normalised



Poolbeg Results - Temp corrected signal



Poolbeg Results - Turbidity

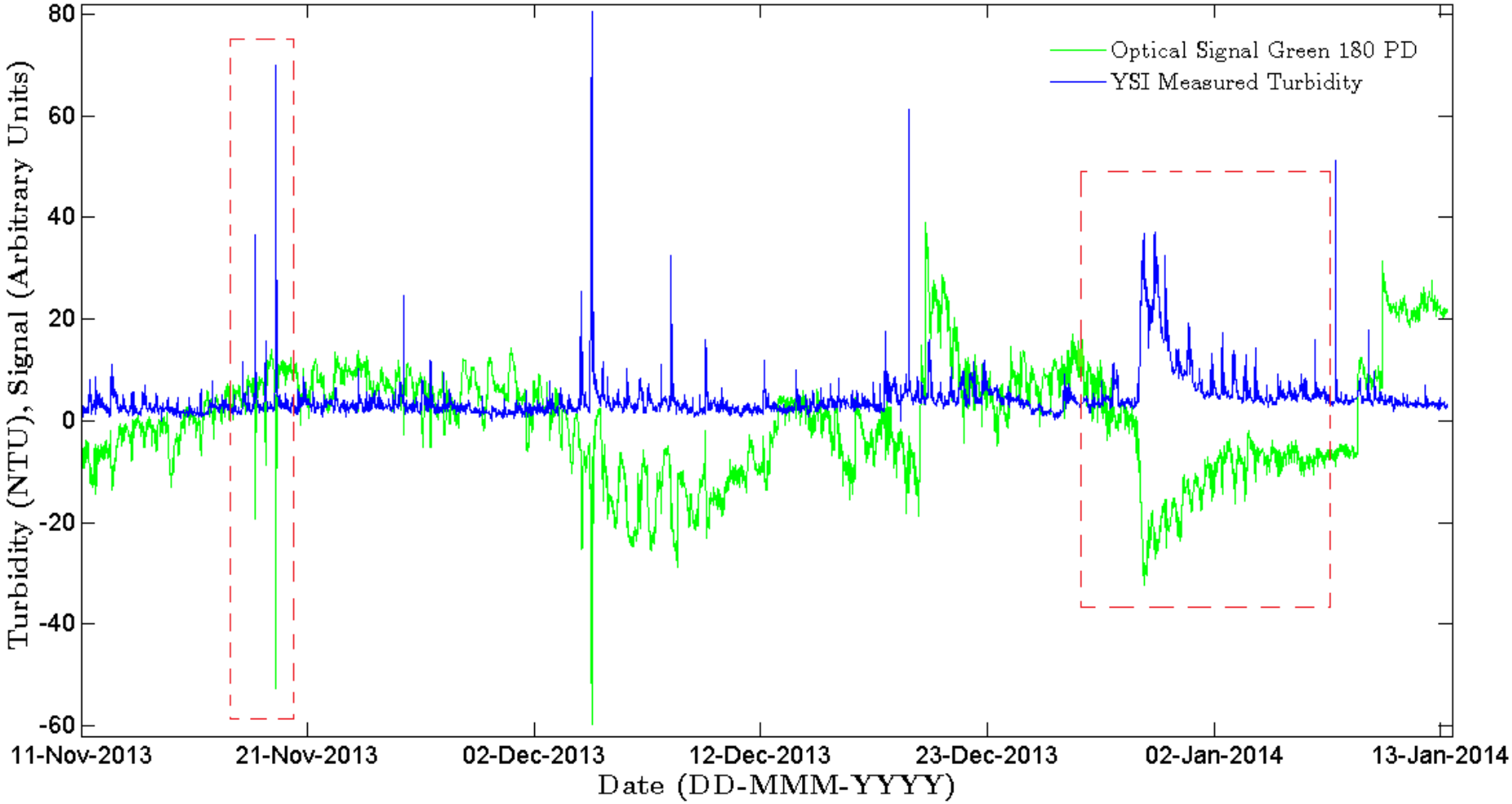


D. Zhang, *et. al.*, ACM, MAED 2013

Poolbeg Results - Turbidity

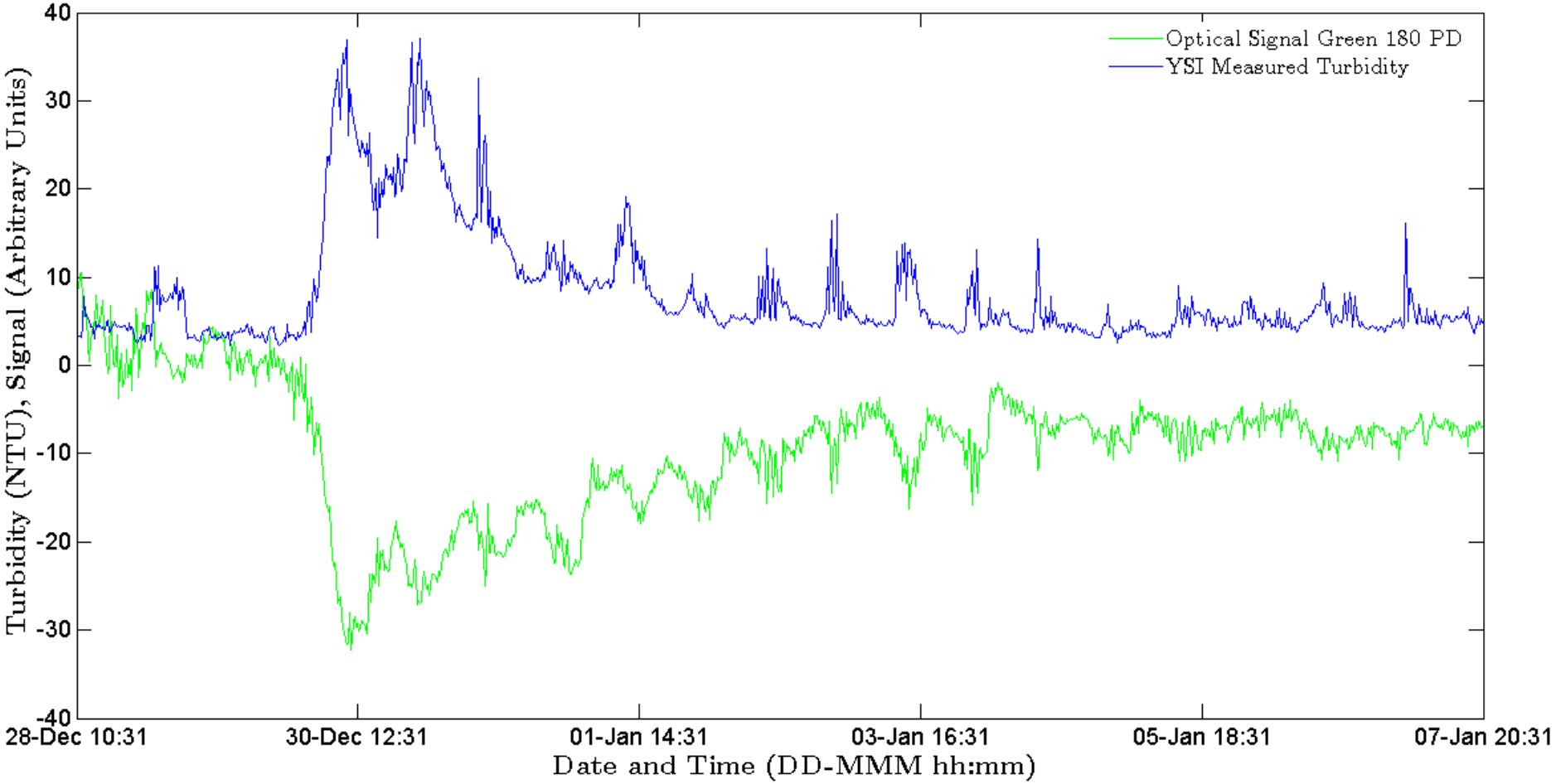
D. Zhang, *et. al.*, ACM, MAED 2013

Poolbeg Results - Turbidity and Optical Signal



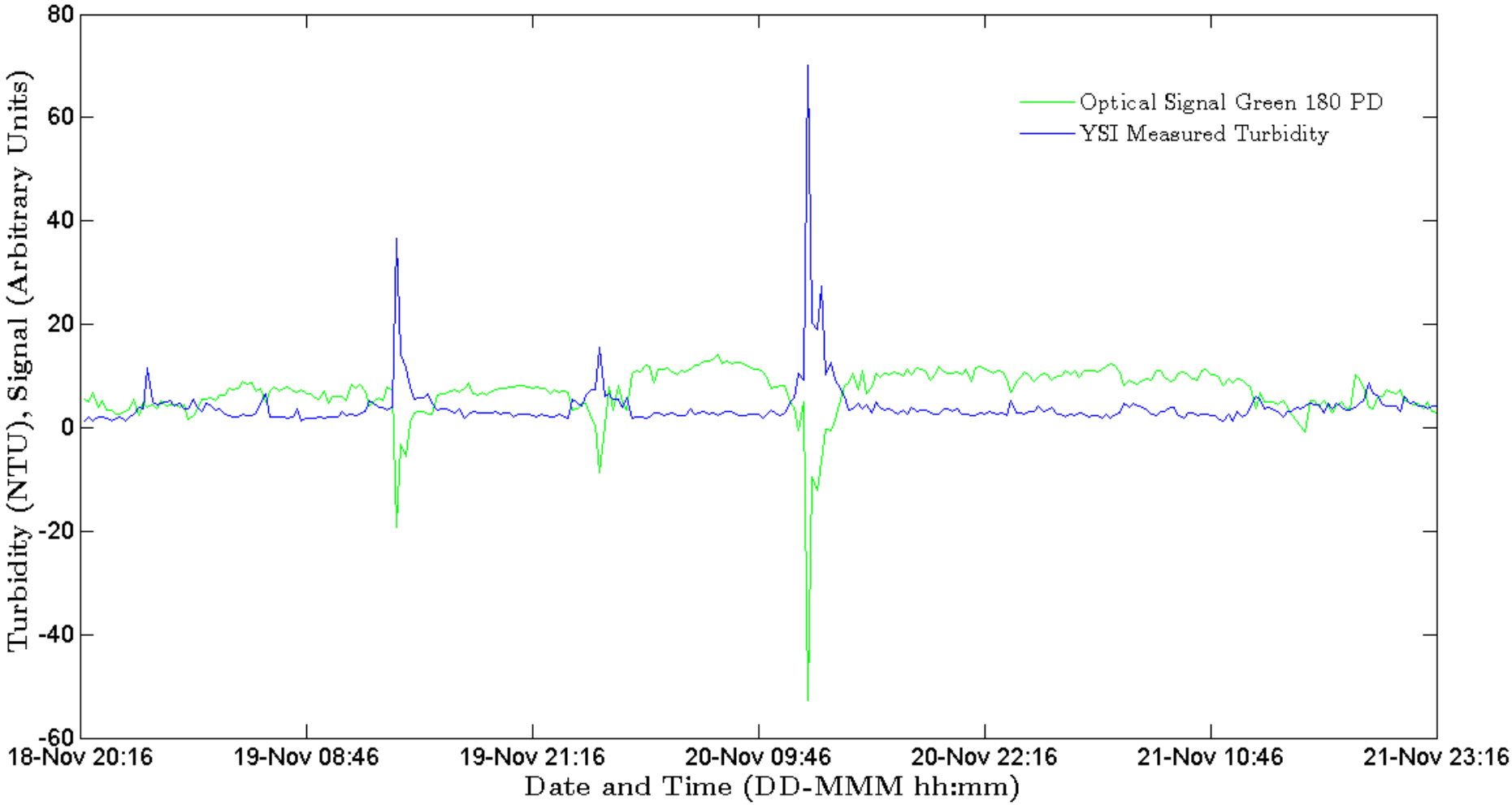
Poolbeg Results - Storm Event Correlation

- Pearson correlation Turbidity (YSI) and Green 180 PD signal = -0.803



Poolbeg Results - Ship Event Correlation

- Pearson correlation Turbidity (YSI) and Green 180 PD signal = -0.858



Conclusions

Low-cost easy-to-maintain optical sensor to monitor opacity and colour changes in the marine has been constructed, tested and verified

Survived long deployment ($\approx$ 3 months) in difficult conditions

OCS has undergone field characterisation for deployability and data usability

Data analysis shows sensor value for monitoring the marine environment

Potential use in spatially large monitoring network to detect event-driven spikes in bulk water parameters and aid decision making.

Future Work

Further analysis to identify strengths and weakness of the sensor and inform a new generation

Further reduce maintenance and develop a robust calibration/correction routine for field use

To fully characterise in the laboratory and the field the signal temperature dependence

Continue to deploy and test the sensor various locations (Brazil, Ireland, freshwater, marine, etc.)

Acknowledgements

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Questions?