TA PROJECT REPORT

1. Project Information

Proposal reference number[1]	JS3_CALL_1_REF_4036b_EuroFluoro
Project Acronym (ID)[2]	EuroFluoro II
Title of the project[3]	Field testing and validation of a new multiparameter sensor in European Coastal waters 2
Host Research Infrastructure[4]	Marine Institute
Starting date - End date[5]	26-08-2021 - 20-12-2021
Name of Principal Investigator[6] **Home Laboratory** **Address** **E-mail address** **Telephone**	Dr James Kirkbride Chelsea Technologies 55 Central Avenue West Molesey Surrey KT8 2QZ UK jkirkbride@chelsea.co.uk +44 (0)20 8481 9000

2. Project objectives[7] (250 words max.)

Chelsea Technologies Group has developed its new VLux miniature multi-parameter fluorometer configured to provide high quality in situ detection of either Algae, Aromatic Hydrocarbons or Tryptophan-like fluorescence. Fluorescence is automatically corrected for turbidity, absorbance and temperature to provide robust data collection over extended deployments. The instrument has

[1] Reference number assigned to the proposal by the TA-Office.

[2] User-project identifier used in the proposal.

[3] Title of the approved proposal. The length cannot exceed 255 characters

[4] Name of the installation/infrastructure accessed with this project. If more than one installations/infrastructures are used by the same project, please list them in the box.

[5] Specify starting and end date of the project (including eventual preparatory phase before the access).

[6] Fill in with the full contact of the Principal Investigator (user group leader).

[7] Write the short-term, medium and long-term objectives of the project. Use no more than 250 words.

several monitoring applications. EuroFluoro will test the usability of the VLux AlgaePro fluorometer, having 4 excitation bands and one emission band, in optically complex coastal waters.
The main objectives of project EuroFluoro were:

- Follow development of a spring bloom and demonstrate the added value of having several wavebands to identify different algal classes.
- Monitor the biofouling accumulation on the sensor, measuring the effectiveness of the antibiofouling inbuilt UV LED light in the sensor. - Compare against a VLux casing with no anti-biofouling LED.
- Compare readings with another commercially available algae sensor (ECO FLNTU).
- Compare environmentally corrected readings with ECO FLNTU which lacks the corrections.

3. Main achievements and difficulties encountered (250 words max.)[8]

The project encountered several problems. In the first place COVID restrictions and procurement issues delayed the build of the sensors, delaying the deployment until the end of the summer (August 2021) rather than spring as intended. Following on from this, travel restrictions, both government imposed and company policy concerning COVID prevented anyone from Chelsea Technologies from visiting the host at any stage in the process.
The second problem was only realised towards the end of the deployment. The sensor stopped responding at the end of November. The next available window to raise the subsea frame coincided with the end of the deployment so it was not possible to fix or replace the sensor. On raising the sensor and the control housing it became apparent that significant corrosion had occurred around the windows, raising severe doubts about the validity of the collected data. This will be more fully explored in section 5. When the sensor was dismantled, the electronics showed rust and residue showing that a leak had occurred.

4. Dissemination of the results[9]

Results will be used to inform further internal development work.

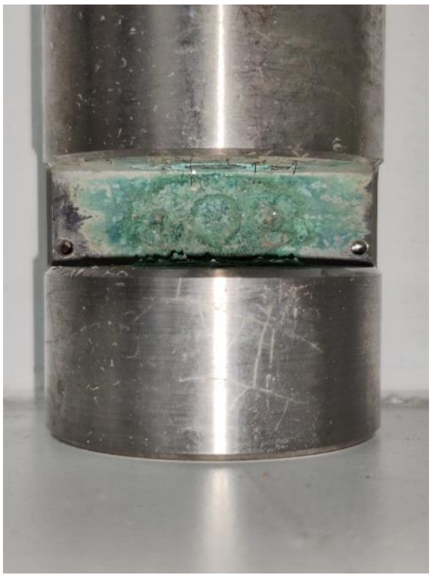
[8] Describe briefly the main achievements obtained and possible impacts, as well as possible difficulties encountered during the execution of the project. Use no more than 250 words.

[9] Describe any plan you have to disseminate and publish the results resulting from work carried out under the Transnational Access activity in JERICO -S3: scientific articles, books - or part of them -, patents, as well as reports and communication to scientific conferences, meetings and workshops. Highlight peer-reviewed publications. **Note that any publications resulting from work carried out under the JERICO -S3 TA activity must acknowledge the support of the European Commission – H2020 Framework Programme, JERICO -S3 under grant agreement No. 871153.**

5. Technical and Scientific preliminary Outcomes (2 pages max.)[10]

The VLux was installed on the subsea observatory with the data being transmitted in the form of csv files sent by email once per hour. As this soon constituted several hundred file attachments, the emails were automatically placed into a separate folder from which an automated process downloaded the data to OneDrive. The VLux provides data with an interval of 1 second so a Python script was used to average the data over a 5-minute period to reduce the number of data points and smooth out measurement noise. Some periods of missed data occurred, though it is not apparent whether this was due to the sensor or to data transmission issues. The first data was collected on 26/08/2021 and the sensor failed on 25/11/2021, having run for three months. The sensor frame was raised at the next scheduled maintenance period prior to Christmas so in total the sensor and control housing were underwater for four months.

Upon raising the sensor, severe corrosion of the copper bezels surrounding the windows was observed. The sensor housing is made of titanium and the copper bezels surrounding the windows are incorporated for the anti-biofouling properties of copper. The experiment was intended to look at the effectiveness of the inclusion of a UV light source for anti-biofouling above that of the copper bezels alone. In actuality, the corrosion of the copper has resulted in the deposition of chemical contaminants on the windows. This occurred on both the complete sensor and on the control housing which contained no electronics.



Galvanic corrosion of dissimilar metals is of course a common problem. Nevertheless, the scale of the corrosion seen here in just four months was a surprise. VLuxs have been deployed in freshwater with no sign of any corrosion and while saltwater is obviously a much more corrosive environment than fresh, this was not expected to be an issue over the length of the deployment. A VLux has previously been deployed on a FerryBox system in the Baltic sea without showing this type of corrosion, although that system was not fully submerged and was subject to regular cleaning.

The anodic indices of titanium and copper differ by just 0.05 V, a value generally considered suitable even for harsh environments. Moreover, copper generally corrodes to form basic copper carbonate which forms a layer that protects the remaining copper underneath (as on copper roofs or the Statue of Liberty). The exact chemical makeup of this copper patina depends on the environment. In this instance the corrosion has not simply formed a protecting layer but spread to cover the sapphire windows and some of the titanium housing adjacent. This coating raises significant doubts over the validity of the acquired data.

[10] Describe in detail results and main findings of your experiment at the present stage.

The leak which caused the failure of the sensor appears to have been from the connector end of the instrument so is not thought to have been due to the corrosion of the window bezels. There is no evidence of a leak on the control housing, so it is suspected that this was due to a failure of the seal around the top of the instrument. Further investigation will be necessary to determine the exact cause. With seawater ingress, the optics are likely to have been damaged to some extent which raises further doubts over the validity of the data. There is no indication as to whether the leak was a sudden failure or a slow accumulation so it is difficult to say at what point the data may have been affected. Similarly, it is not known over what time scale the corrosion occurred, so it is difficult to say to what extent the data is affected at any time during the deployment.

As an example of the effect the chemical fouling has had on the data, below is shown the VLux turbidity response over the course of the deployment:

The turbidity rises sharply shortly after deployment then begins to fall. It eventually plateaus at a negative reading. This is because there is normally a small amount of scatter that is measured in zero turbidity water which produces an offset in the readings. With the windows clouded over, both the IR light emitted and the scattering is blocked and the offset applied to the calibration causes a negative value to be output. We cannot assume that the data preceding the negative values is valid since build-up of fouling must have occurred during this period and affected the data. It is possible that initial build-up may have caused an increase in scatter, but this is conjecture and would require specific investigation to understand.

Due to the problems of corrosion and leaking, we do not have confidence in the validity of the acquired data. For this reason, we are not able to comment on the efficacity of the UV illumination for biofouling prevention. We will further investigate the corrosion issue to try to better understand the problem and see whether there is a way the copper bezels can be used in marine environments.

UK, 08/02/2022

Location and date

Signature of principal investigator