1. Project Information

Proposal reference number[1]	871153
Project Acronym (ID)[2]	S1100-HTHSal
Title of the project[3]	ANB Sensors S Series: High temperature and high salinity
Host Research Infrastructure[4]	**POSEIDON** Calibration Lab (PCL) and FerryBox (PFB)
Starting date - End date[5]	01/10/2021 – 01/10/23
Name of Principal Investigator[6] **Home Laboratory** **Address** **E-mail address** **Telephone**	Dr. Nathan Lawrence ANB Sensors 6 Old Farm Business Centre, Toft, CB23 2RF, UK nlawrence@anbsensors.com 01223 263545

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

The aim here being to test the S1100 performance as the conditions transcend the season when biofouling is and isn't prevalent. In addition to the long term and bio-fouling evaluation, testing of the sensor in waters that have a higher salinity and higher temperature are extremely valuable, and the lessons learnt from these tests will be incorporated into ANB Sensors next revision. Most importantly the impact of temperature and salinity on the sensitivity of the response will be key to ensuring the sensor can work accross the entire oceanographic range.

The principle objectives for the project are:

1. Deploy the S1100 on a costal observing multiplatform system in elevated temperatures and salinities.
2. Deploy a second sensor on one of a field profiler or a surface vehicle equipped with a FerryBox system to understand the impact of lateral flow accross the sensor surface and the impact of temperature sensitivity on the sensors response.

[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.

3. Provide feedback on the sensors ease of use, ease of deployment and data retieval features.
4. Validate the sensors response against independent measurements in real time deployment.
5. Allow ANB Sensors to understand the issues associated with oceanography and sensor deployment for other analytes – providing scope for future collaborations.

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

One of the main achievements was proving the performance of the S1100 in a lab, as well as the verification from the end user that the sensor was indeed easy-to-use. Maintenance of the transducer was carried out successfully both in the lab and on deployment onboard the ferry, realising the goal of this sensor being the preferable option for long term deployments as it doesn't need to be recovered for maintenance. The tests at the lab were conducted in higher saline waters and showed the sensor responded well in these conditions with no detrimental impact on the sensors transducer.

There were two main difficulties the first was with access to the facilities due to hardware malfunctions which were rectified by HCMR and the second was with longterm data collection on the sensor. The sensor in deployment failed to save data after some time of monitoring due to issues with the internal memory. This is discussed below.

4. Dissemination of the results[9]

Utilizing the data and results gathered throughout this Jerico S3 project, in conjunction with our *in-situ* lab-based research, an academic peer-reviewed article detailing the measurement technique and the performance of the sensor in HTHP. In addition, the data will be communicated through conference/meeting presentations in order to demonstrate the validity of our system, and for the public, through social media.

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

The experimentation for this project was conducted at the PCL (Poseidon calibration) laboratory in HCMR and on the PFB (Poseidon ferry box) mounting.

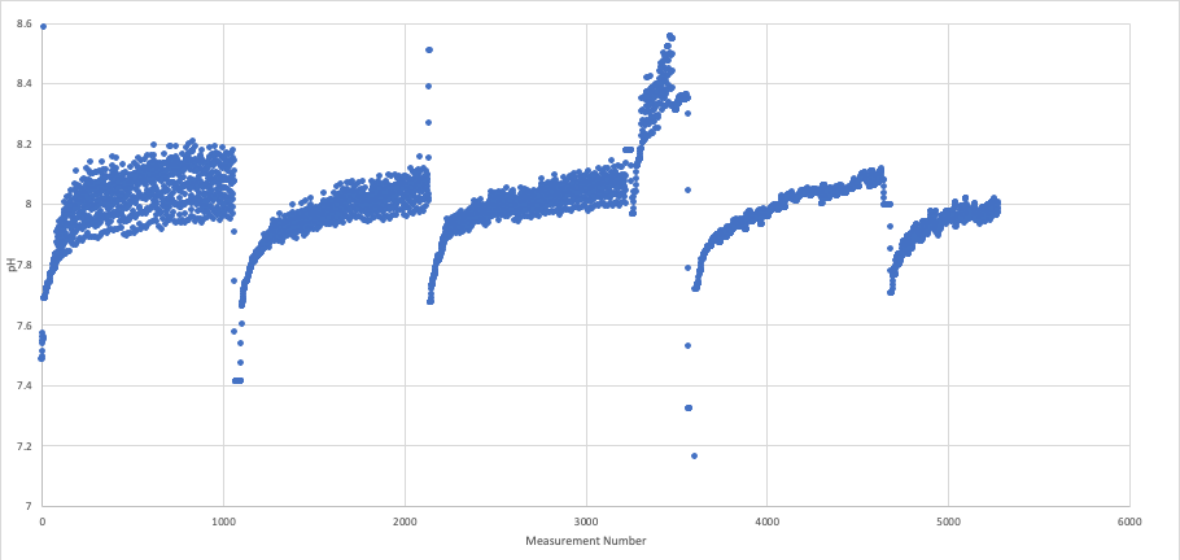
[8] Describe briefly the main achievements obtained and possible impacts, as well as possible difficulties encountered during the execution of the project. Use no more than 250 words.

[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.**

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

The sensors were first tested in the lab at HCMR to ensure a good performance before deployment. The tests were performed in a high salinity seawater solution and were powered simulating the Ferry Box connection. The sensors were run over a period of hours and data was retrieved from each showing consistency of pH measurements between the two. At this point we asked for operational feedback of the sensor, the USP's of easy to use, and set-up were confirmed. However, on discussions it was thought the size of the sensor maybe an issue for AUV monitoring.

Due to technical issues with the Ferrybox there was a delay in getting the sensor onboard the vehicle. Once operational a bespoke flow chamber was constructed by the team at HCMR which was capable of being attached to the main FB flow circuit. In operation solution was passed by the sensor and the sensor monitored the pH of the solution continuously. The sensor was powered using the FB power channels and the data logged in the FB windows PC through terminal software. The first device was installed at 22/07/23 and operation started to operate on the 25/07/23. However, there was an issue found with the sensor, it was stalling and no data was obtained. This sensor was operational in the previous laboratory trials. This sensor was then replaced with the second device on the 15/08/23 in accordance with ship maintenance schedule. The second sensor collected data for a period of time however, failures were then seen with the health number of the transducer rising and the data showing error messages. The collected data is shown in the figure below:



It can be clearly seen that there is periodic trend in the data, which is not from the solution it is immersed and it appears to be the sensor repowering after a power cycle and restabilising after this power cycle. Analysis of the average of the all the data provides a pH of 7.952 and a standard deviation of 0.23. Removing the data associated with the stabilisation data pH <7.8 provides an average pH of 7.99 and a standard deviation of 0.11. the normalized (25deg C) pH values in the Cretan sea annual variation is 7.99-8.05 based on a full year sensor deployment in one of the HCMR buoys in 2020-21

The work and data obtained has been extremely useful in improving the operational performance of the sensor. The data and understanding from these trials has been fed into the development of our next generation sensor range, the most notable impacts are:

Smaller size: the new range is 10 times smaller per unit volume than the S Series

Improved sealing: issues around transducer sealing from solution contact to the internals of the sensor were seen to be an issue and has been completely redesigned to ensure pressure integrity. Measures are now in place to pressure test all sensors.

Improved transducer performance – Due to the sealing issues failures of the transducers occurred quicker than expected. New manufacturing methods have been implemented to improve the structural rigidity of the sensing elements and thus significantly improve mean time to failure.

Improved data saving – Data saving was an issue observed in these trials, the firmware around the data saving has been re written with a significant reduction in failures.

ANB Sensors, 05/01/2024 N Lawrence

Location and date

Signature of principal investigator