APPENDIX 3

TA PROJECT REPORT (TEMPLATE)

(see following pages)

TA PROJECT REPORT PACKAGE

- The completed and signed forms included in this package should be sent by email to jerico.ta@marine.ie and **jerico**-s3**@ifremer.fr** within **one month after the completion of the TA project** by the User Group Leader.
- **Refunding of the TA reimbursement to the user group will be processed as soon as these forms will be submitted**.
- The TA project report will be published in the JERICO-S3 website. The report, as well as other information collected with the attached forms, will be used to report to the European Commission.
- **Please note that any publication 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.**

1. Project Information

Proposal reference number[1]	21/1001599
Project Acronym (ID)[2]	FRONTIERS
Title of the project[3]	Fault detection, isolation and Recovery fOr uNderwaTer gIIdERS
Host Research Infrastructure[4]	SOCIB, ES
Starting date - End date[5]	02/07/2021 - 19/07/2021
Name of Principal Investigator[6] **Home Laboratory** **Address** **E-mail address** **Telephone**	Enrico Anderlini, Marine Research Group, Department of Mechanical Engineering, University College London Roberts Engineering Building, London, WC1E 7JE, UK E.Anderlini@ucl.ac.uk +44 7450272675

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

The updated aim of the project is to validate methods for the smart anomaly detection and fault diagnostics for underwater gliders. The project outcomes will help increase the reliability of these platforms and help over-the-horizon pilots to monitor the conditions of these systems.
The project aim will be achieved through the following updated objectives:
O1 Introduction of data-driven methods for the anomaly detection and fault diagnostics of MAS (as part of project ALADDIN funded by the Assuring Autonomy International Programme, a partnership of Lloyds' Register Foundation and the University of York);
O2 Validation of the tools with the actual field test of an underwater glider for the following case studies:

- suddenly wing loss;

[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.

- incorrect ballasting and trimming.

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

The project has successfully validated the introduced anomaly detection and fault diagnostics methods. The glider has been deployed, recovered and redeployed multiple times to simulate the loss of either wing, incorrect ballasting (through the addition or removal of weight pills) and incorrect trimming (through the addition or removal of the weight pills along the length of the vehicle as well as different settings of the internal battery position). Furthermore, the glider had additional intrinsic anomalies: slow leak in the thermal valve of the variable buoyancy device, a small offset in the CTD sensor readings and high energy consumption levels.

The simulated faults were correctly detected and identified, whilst the intrinsic smaller faults will provide additional training data to expand the system in the future. Validation of the diagnostics of these anomalies could be not completed as the training data available before the test from many other glider deployments did not present the same failures.

The main difficulties encountered concerned the global pandemic, which prevented the UCL team to travel to Mallorca due to the constantly changing travel rules. However, this problem was solved thanks to the professionalism of the SOCIB team, their user-friendly data exchange portal and regular email exchanges or calls. Bad weather before the project start meant that the project actually began a few days later than expected.

4. Dissemination of the results[9]

The project has been advertised on LinkedIn with two posts with 1,749 total views on 23/07/2021 and to the AAIP.
Further planned dissemination activities involve:

- Open-access publication of the collected data on the SOCIB data portal,
- Publication of one collaborative journal article in the Journal of Field Robotics or IEEE Journal of Oceanic Engineering,
- Use of the results in up to three additional journal article publications as part of project ALADDAIN,

[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.**

- Inclusion of the project outcomes within the AAIP's Body of Knowledge entries 2.2.4.1 – Verification of sensing requirements, 2.2.4.2 – Verification of understanding requirements,
- Further advertisement on LinkedIn once the results are postprocessed.

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

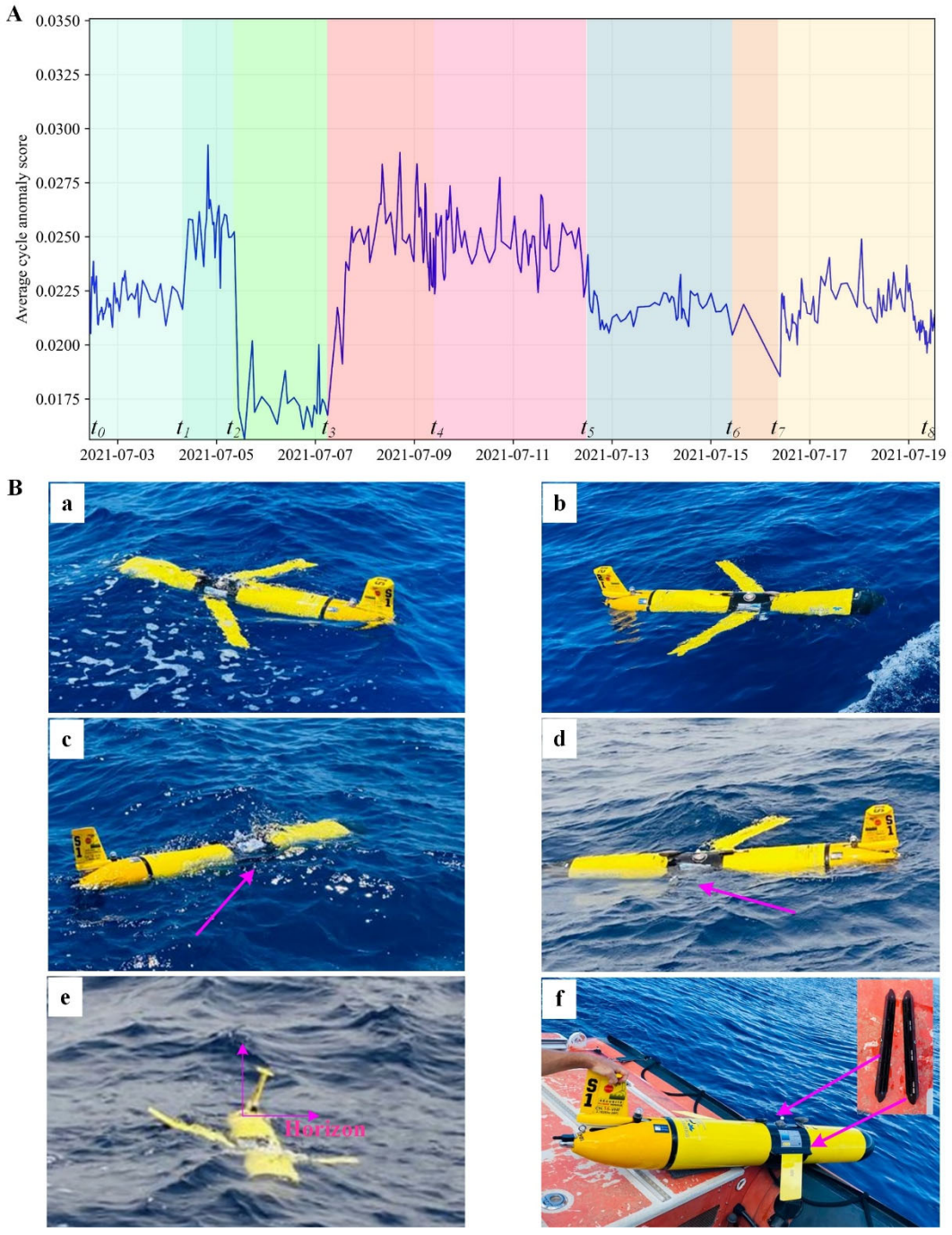

Figure 1. (A) anomaly scores over the test. (B) a: the glider at the beginning of the test, b: the glider before recovery at the end of the test, c: the glider with its left wing removed, d: the glider with its

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

right wing removed, e: incorrectly ballasted glider, f: the balancing weight setting for the simulated trimming fault.

As shown in Figure 1A, the test started at t_0 (Figure 1B-a) and ended at t_8 (Figure 1B-b). The BiGAN-based anomaly detection system has successfully output anomaly scores over the test. The pitch angles for t_0-t_1, t_1-t_2, and t_2-t_3 were set as 30°, 18°, and 26°, respectively. As the 30° and 18° pitch settings were not included in the training dataset, high anomaly scores have been provided. The glider's right wing was removed at t_3 (see Figure 1B-c). At t_4, the right wing was restored while the left wing was removed (see Figure 1B-d). Removing the right and left wings resulted in highly anomaly scores in similar magnitudes. At t_5, the left wing was restored while the balancing weight setting in the wing rails was adjusted from left-2 & right-5 to left-5 & right-2 (each pill is 15.5 g) (see the vehicle status in Figure 1B-e). At t_6, the wrong battery position was applied. At t_7, the battery position servo mode was set, and the balancing weight setting was changed to left-0 & right-3 (2 extra pills removed along the length of the vehicle in each wing rail, see Figure 1B-f). Relatively high anomaly scores can be observed from t_5 to t_8 for the incorrect ballasting and trimming. The glider was recovered at t_8. In conclusion, the simulated faults were correctly detected, validating the proposed anomaly detection solution.

Work is currently being undertaken to validate the fault diagnostics methods, too.

___London, 23/07/2021___

Location and date

Enrico Anderlini

____ _____

Signature of principal investigator

USER GROUP INFORMATION

Project Acronym[11] [insert acronym]	Researcher			Employing organisation/Home institution			Activity Domain (Discipline)
	Name	**Gender**	**Nationality**	**Name**	**Legal Status**	**Country**	
Project leader (Principal Investigator):	Enrico Anderlini	M	Italian, British	UCL	UNI[12]	United Kingdom	Engineering & Technology [13]
Project user 1:	Peng Wu	M	Chinese	UCL	UNI	United Kingdom	Engineering & Technology
Project user 2:	Davide Grande	M	Italian	UCL	UNI	United Kingdom	Engineering & Technology

___ London, 23/07/2021_____

Enrico Anderlini

____ _____

Location and date Signature of principal investigator

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

[12] UNI = University and other higher education organisations; RES = Public research organisation (including international research organisation as well as private research organisation controlled by a public authority); SME = Small or Medium Enterprise; PRV = Other Industrial and/or profit Private organization; OTH = Other organisation not fitting in one of the above categories.

[13] [Physics]; [Chemistry]; [Life Sciences & Biotech]; [Earth Sciences & Environment]; [Engineering & Technology]; [Mathematics]; [Information & Communication Technologies]; [Material Sciences]; [Energy]; [Social Sciences]; [Humanities

CONFIRMATION OF VISIT FOR TRANSNATIONAL ACCESS

ICTS SOCIB

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I, Albert Miralles, herewith confirm that the following project was carried out at our infrastructure SOCIB (GLIDER FACILITY) in the context of JERICO -S3 Transnational Access:

FRONTIERS.

The amount of access delivered to the project group (project users) is as follows:

<In person access> <Remote access>[14]

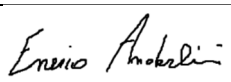
	Participant name	**Duration of stay (start – end date)**	**Amount of access**[15]
Principal investigator:	Joaquim Tintoré	[02/07/2021– 02/07/2021]	1
Project user 1:	Alber Miralles	[02/07/2021– 19/07/2021]	18
Project user 2:	Manuel Rubio	[02/07/2021– 19/07/2021]	18
Project user 3:	Nikolaus Wirth	[02/07/2021– 19/07/2021]	18
Project user …[16]			
Total amount of access delivered to project group[17]**:**			**55**

[14] Select the pertinent heading. In case of partially remote access, duplicate the table and fill in it for both the in person and remote access options.

[15] The amount of access is defined as the time, in days, spent by the user at the infrastructure for this project, including weekends and public holidays (e.g., a scientist who spent 4.5 days at the infrastructure must indicate '4.5').

[16] Please expand, if necessary.

[17] The total amount of access of the project group is the sum of days when users were hosted (if users 1 and 2 have stayed at the infrastructure the same period, for instance from 1 to 5 March 2020, the total amount of access is 5 days). Please use / round to half days where appropriate.

London, 16/08/2021		
Location and date		Signature of principal investigator[18]
Palma, 16/08/2021		
Location and date		Signature of access provider[19]

[18] The document must be 1) signed by the project leader; 2) signed by the access provider; 3) sent to the TA office by the access provider (please respect order).