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# Joint PRIMaRE and UK&CHN|CORE Summer School Programme: Hydrodynamic modelling and well-being in engineering

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*Joint PRIMaRE and UK&CHN | CORE Summer School*

University of Plymouth (COAST Lab)  
University of Exeter (Penryn Campus)

*10-14<sup>th</sup> September 2018*

# Hydrodynamic Modelling and Well-being in Engineering

## Programme



[www.primare.org](http://www.primare.org)

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**EXETER**

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**BRISTOL**

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**BATH**

**CARDIFF**  
UNIVERSITY  
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**CAERDYDD**

 UNIVERSITY OF  
**PLYMOUTH**

 THE MARINE BIOLOGICAL  
ASSOCIATION  
Est. 1884  
Incorporated by  
Royal Charter 2013

**PML** | Plymouth Marine  
Laboratory

## Introduction

Dear Summer School Participants,

A warm welcome to this Joint PRIMaRE and UK&CHN|CORE Summer School on Hydrodynamic Modelling and Wellbeing in Engineering, hosted in collaboration between the Universities of Plymouth and Exeter. The Hydrodynamic Modelling module will take place at the University of Plymouth's COAST Lab while the Well-being in Engineering module will take place at the University of Exeter (Penryn Campus).

A variety of lectures and practical sessions have been designed to help you maximise your learning at this summer school and at the same time enjoy your stay in both cities. This represents a unique opportunity to learn from recognised experts in the sector and access some of PRIMaRE's state-of-the-art facilities and engage in UK-China ORE research activities. The hydrodynamic modelling module presents a unique opportunity to get an insight into physical modelling directly from one of the world-leading facilities, while the well-being in engineering module will tackle the conflict between work , day pressures and life balance. In addition, two evening lectures from internationally recognised experts in hydrodynamic modelling will take place on Monday and Tuesday.

I would like to take this opportunity to give a warm greeting to Professor Deborah Greaves, who was recently awarded an OBE for her enormous contribution to research in offshore renewable energy. Deborah, has been a fundamental actor behind PRIMaRE and is currently leading the new Offshore Renewable Energy SuperGen Hub, which will act as an essential catalyst to support and build on the existing academic capacity within these three internationally leading research areas (offshore wind, wave and tidal technology), whilst also enabling shared learning on common research challenges.

I hope this joint Summer School between PRIMaRE and the UK & China Centre for Offshore Renewable Energy sets the grounds for future international collaborations, and wider engagements between academia and industry.

I hope you have an enjoyable time in Plymouth and Falmouth. I would also like to thank everyone who has made this event possible, including the participants, sponsors and all those who have helped with the organisation.

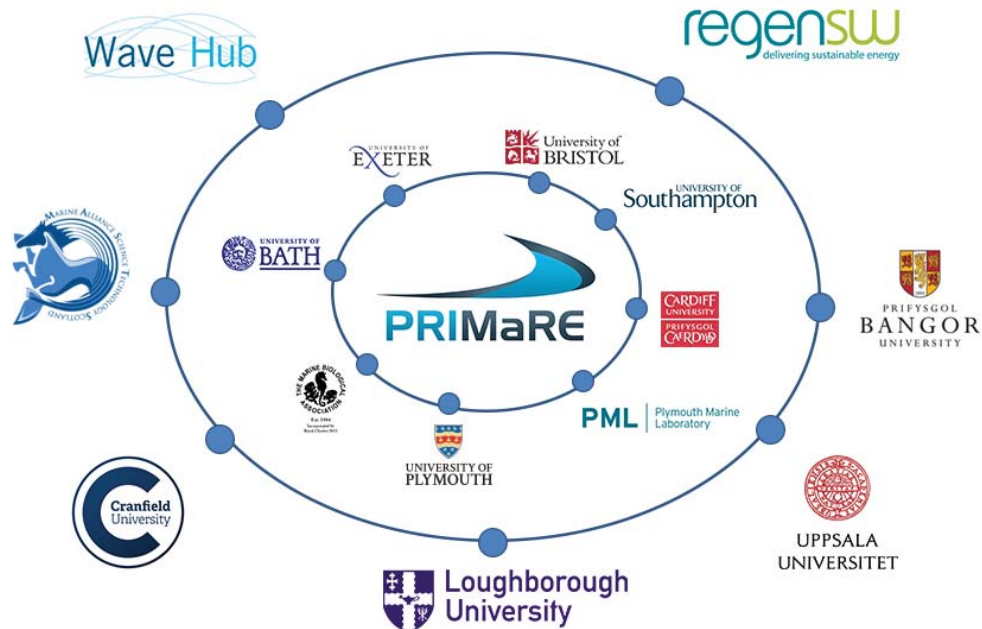
Kind regards,



**Carlos Perez-Collazo**  
**PRIMaRE Research Fellow**  
**University of Plymouth**

## PRIMaRE Overview

The Partnership for Research in Marine Renewable Energy (PRIMaRE) is a consortium of marine renewable energy experts across higher education, research and industry which have joined together to establish a network of excellence centred in the south of the UK. The work of PRIMaRE aims to address the research and development challenges facing the Marine Renewable Energy (MRE) sector, including wave, tidal stream, tidal range and offshore wind. The main Partner organisations are the Universities of Plymouth, Exeter, Southampton, Bristol, Bath and Cardiff, along with the Marine Biological Association of the UK and Plymouth Marine Laboratory. We also work closely with a number of Associate Partners, including Wave Hub, Regen and the Universities of Cranfield, Loughborough and Uppsala.



## UK&CHN | CORE Overview

Researchers from the UK and China will collaborate on five projects to develop the next generation of offshore renewable energy (ORE) technologies to enable the safe, secure, cheap and efficient provision of clean energy.

The collaborative, multidisciplinary three-year-long projects will use environmental science, technology and engineering to tackle key challenges affecting the development of ORE systems, such as offshore wind, wave and tide facilities, and maximise their environmental and socio-economic benefits. The projects will determine where the best energy resource is available and where would be best to implement ORE technologies, and inform the development of technology so that structures are resilient to extreme events such as typhoons and earthquakes.

## General Information

### University of Plymouth:

The University of Plymouth is renowned for high quality, internationally-leading education, research and innovation.

With a mission to Advance Knowledge and Transform Lives, Plymouth is a top 50 research university with clusters of world class research across a wide range of disciplines including marine science and engineering, medicine, robotics and psychology. A twice winner of the Queen's Anniversary Prize for Higher Education, the University of Plymouth continues to grow in stature and reputation.

It has a strong track record for teaching and learning excellence, and has one of the highest numbers of National Teaching Fellows of any UK university. With 21,000 students, and a further 17,000 studying for a Plymouth degree at partner institutions in the UK and around the world, and over 100,000 alumni pursuing their chosen careers globally, it has a growing global presence.

<http://www.plymouth.ac.uk>

### University of Exeter:

The University of Exeter is a Russell Group university and in the top one percent of institutions globally. It combines world-class research with very high levels of student satisfaction. Exeter has over 18,000 students and is ranked 8th in The Times and The Sunday Times Good University Guide league table, 10th in The Complete University Guide and 12th in the Guardian University Guide 2014. In the 2008 Research Assessment Exercise (RAE) 90% of the University's research was rated as being at internationally recognised levels and 16 of its 31 subjects are ranked in the top 10, with 27 subjects ranked in the top 20. Exeter was The Sunday Times University of the Year 2012-13

The University has four campuses. The Streatham and St Luke's campuses are in Exeter and there are two campuses in Cornwall, Penryn and Truro. In a pioneering arrangement in the UK, the Penryn Campus is owned and jointly managed with Falmouth University. At the campus, University of Exeter students can study programmes in the following areas: Renewable Energy, Animal Behaviour, Conservation Biology and Ecology, English, Environmental Science, Evolutionary Biology, Geography, Geology, History, Human Sciences, Mathematics and the Environment, Mining and Minerals Engineering, Politics and International Relations, and Zoology.

<http://www.exeter.ac.uk/>

### Summer School Sponsors:

The Summer School is sponsored by PRIMaRE and the UK-China ORE Research and Partnership Fund. Funding which has the economic support of the Engineering and Physical Sciences Research Council (EPSRC), the Natural Environment Research Council (NERC) and the Newton Fund.

## Plymouth Venue:

COAST Laboratory  
Marine Building  
University of Plymouth  
Drake Circus  
Plymouth PL4 7QX



## Penryn Venue:

University of Exeter  
Penryn Campus  
Penryn  
Cornwall TR10 9FE



## Websites:

- <https://www.plymouth.ac.uk/your-university/visit/getting-here>
- <https://www.plymouth.ac.uk/your-university/visit>
- <https://www.visitplymouth.co.uk/>
- <https://www.exeter.ac.uk/visit/directions/cornwall/>
- <http://www.exeter.ac.uk/thesouthwest/cornwall/>
- <https://www.falmouth.co.uk/>

## Summer School Schedule

## Monday 10<sup>th</sup> September 2018

|   | START | END   | SESSION  | VENUE                      |
|---|-------|-------|--|----------------------------|
| Day 1 - Monday 10 <sup>th</sup> September | 08:30 | 09:15 | Arrival, registration and briefing<br>(Deborah Greaves)  | Room 200, Smeaton Building |
|   | 09:15 | 10:30 | Introduction to physical modelling (3 groups)<br><b>All groups:</b> Ocean Basin<br>(Deborah greaves)<br><b>Group A:</b> Coastal Basin<br>(Carlos Perez-Collazo)<br><b>Group B:</b> Flumes<br>(Martyn Hann)<br><b>Group C:</b> Lab induction<br>(Alastair Reynolds) | COAST Lab, Marine Building |
|   | 10:30 | 11:15 | Modelling: from concept to reality<br>(Carlos Perez-Collazo)   | Room 200, Smeaton Building |
|   | 11:15 | 11:30 | Tea and coffee break   | Room 200, Smeaton Building |
|   | 11:30 | 12:15 | Model construction for scientific experimentation<br>(Richard Pemberton)   | Room 200, Smeaton Building |
|   | 12:15 | 13:00 | Instrumentation, error & repeatability<br>(Alison Raby)  | Room 200, Smeaton Building |
|   | 13:00 | 14:00 | Lunch  | Campus Cafes               |
|   | 14:00 | 16:00 | Model calibration (3 Groups)<br><b>Group A:</b> Sensor Calibration (WF)<br>(Carlos Perez-Collazo)<br><b>Group B:</b> Pendulum test – IST buoy (MF)<br>(Richard Pemberton)<br><b>Group C:</b> Decay tests – IST buoy (OB)<br>(Nan Xie)                              | COAST Lab, Marine Building |
|   | 16:00 | 16:30 | Tea and coffee break   | Outside LT2 RLB            |
|   | 16:30 | 17:30 | <b>Key note speaker 1</b><br><b>Peter Stansby (University of Manchester)</b><br>Model testing (operational and extremes)   | Lecture Theatre 2, RLB     |
| 17:30                                     | -     | Close |  |                            |

## Summer School Schedule

## Tuesday 11<sup>th</sup> September 2018

|  | START  | END   | SESSION   | VENUE                      |
|--|--------|-------|---|----------------------------|
| Day 2 - Tuesday 11 <sup>th</sup> September | 09:00  | 09:10 | Day briefing (tea/coffee)<br>(Carlos Perez-Collazo)   | Room 200, Smeaton Building |
|  | 9:10   | 9:50  | Experimental planning I: Facilities & set-up<br>(Carlos Perez-Collazo)  | Room 200, Smeaton Building |
|  | 9:50   | 10:30 | Experimental planning II: Fixings & moorings<br>(Martyn Hann)   |                            |
|  | 10:30  | 10:45 | Tea and coffee break  | Room 200, Smeaton Building |
|  | 10:45: | 12:45 | Experimental issues (3 Groups)<br><b>Group A:</b> Effect of mooring lines (OB)<br>(Martyn Hann)<br><b>Group B:</b> Noise and accuracy (CB)<br>(Carlos Perez-Collazo)<br><b>Group C:</b> Inst. limits/reflection (WF)<br>(Scott Brown & James Allen) | COAST Lab, Marine Building |
|  | 12:45  | 13:30 | PTO: Turbine aerodynamics & control for OWCs<br>João Henriques (IST - Lisbon)   | Room 200, Smeaton Building |
|  | 13:30  | 14:30 | Lunch   | Campus Cafes               |
|  | 14:30  | 16:30 | Model test (3 Groups)<br><b>Group A:</b> Operational Conditions (CB)<br>(Carlos Perez-Collazo)<br><b>Group B:</b> Extremes & Survivability (OB)<br>(Martyn Hann)<br><b>Group C:</b> Currents & Turbulence (WF)<br>(Scott Brown & James Allen)       | COAST Lab, Marine Building |
|  | 16:30  | 17:00 | Tea and coffee break  | Outside LT2 RLB            |
|  | 17:00  | 18:00 | <b>Key note speaker 2</b><br><b>João Henriques (IST - Lisbon)</b><br>The development of spar-buoy OWC at IST  | Lecture Theatre 2, RLB     |
| 18:00                                      | -      | Close |   |                            |



## Summer School Schedule Wednesday 12<sup>th</sup> September 2018

|  | START | END   | SESSION  | VENUE  |
|--|-------|-------|--|--|
| Day 3 - Wednesday 12 <sup>th</sup> September | 08:45 | 09:00 | Luggage drop   | Room 201, Smeaton Building                               |
|  | 09:00 | 09:10 | Day briefing (tea/coffee)<br>(Carlos Perez-Collazo)  | Room 200, Smeaton Building                               |
|  | 09:10 | 09:50 | Data analysis Theory<br>(Martyn Hann)  | Room 200, Smeaton Building                               |
|  | 09:50 | 11:20 | Data analysis practice<br>(Martyn Hann)  | Computer Lab, Room 100<br>Smeaton                        |
|  | 11:20 | 11:40 | Tea and coffee break   | Room 200, Smeaton Building                               |
|  | 11:40 | 12:20 | Measurement and modelling the environment<br>(Daniel Conley)   | Room 200, Smeaton Building                               |
|  | 12:20 | 13:00 | Practical applications/ CFD<br>(Deborah Greaves)   |  |
|  | 13:00 | 13:10 | Farewell<br>(Deborah Greaves)  |  |
|  | 13:10 | 13:30 | Lunch  | Room 201, Smeaton Building                               |
|  | 13:30 | 15:00 | Tea and coffee break   | Depart from James Street on<br>Campus                    |
|  | 15:30 | 16:00 | Welcome to Penryn Campus<br>Overview of Programme<br>(Tea & coffee provided)   | Penryn Campus<br>Peter Lanyon Building,<br>Seminar Room3 |
|  | 16:00 | 17:00 | Wellbeing through sleep:<br>"Go to bed and get some sleep: overcoming sleep<br>problems"   | Peter Lanyon Building,<br>Seminar Room3                  |
|  | 17:15 | 17:45 | Travel to accommodation<br>Penmere Manor Hotel, Falmouth, Mongleath Road,<br>Falmouth TR11 4PN;<br><a href="https://penmeremanorhotel.co.uk/">https://penmeremanorhotel.co.uk/</a> | Departure from Penryn<br>Campus Bus stop                 |

## Summer School Schedule

## Thursday 13<sup>th</sup> September 2018

|   | START  | END   | SESSION   | VENUE                  |
|---|--------|-------|---|------------------------|
| Day 4 - Thursday 13 <sup>th</sup> September | 8:00   | 09:00 | Rise & Shine – Starting the day with practice                           | Penmere Manor Hotel    |
|   | 09:00  | 10:30 | Breakfast   | Penmere Manor Hotel    |
|   | 10:45  | 11:15 | Transfer / Travel to Penryn Campus                                      |                        |
|   | 11:30: | 12:30 | Wellbeing Practice (mindfulness)  | PL, Seminar Room 3     |
|   | 12:30  | 13:30 | Lunch   | Stannary               |
|   | 13:30  | 14:30 | Equality and Diversity – Challenges and Actions for University Research | PL, Seminar Room 3     |
|   | 14:30  | 15:00 | Personal Diary – Thoughts and reflections of the day                    |                        |
|   | 15:00  | 15:30 | Coffee  |                        |
|   | 15:30  | 16:00 | Transfer / Travel to Falmouth   |                        |
|   | 16:00  | 18:00 | Activity - Coasteering  | Gyllyngvase Beach      |
|   | 19:00  | -     | <b>Workshop Dinner</b>  | Lecture Theatre 2, RLB |

## Summer School Schedule

## Friday 14<sup>th</sup> September 2018

|   | START  | END   | SESSION  | VENUE               |
|---|--------|-------|--|---------------------|
| Day 5 - Friday 14 <sup>th</sup> September | 8:00   | 09:00 | Rise & Shine – Starting the day with practice        | Penmere Manor Hotel |
|   | 09:00  | 10:30 | Breakfast  | Penmere Manor Hotel |
|   | 10:45  | 11:15 | Transfer / Travel to Penryn Campus                   |                     |
|   | 11:30: | 12:30 | Inclusivity – Teamwork & Decision making             | PL, Seminar Room 3  |
|   | 12:30  | 13:30 | Lunch  | Stannary            |
|   | 13:30  | 14:30 | Teampay – Know your type                             | PL, Seminar Room 3  |
|   | 14:30  | 15:00 | Personal Diary – Thoughts and reflections of the day |                     |
|   | 15:00  | 15:30 | Coffee   |                     |
|   | 15:30  | 16:00 | Discussion & close                                   | PL, Seminar Room 3  |
|   | 16:00  | -     | Departure  |                     |

### Legend:

Details about the Hydrodynamic modelling module (Plymouth) PRIMaRE Summer School:

- OB:** Ocean Basin
- CB:** Coastal Basin
- WF:** Wave Flume
- MF:** Mezzanine Floor

Details about the Well-being in Engineering (Falmouth), UK&CHN Summer School:

- PL:** Peter Lanyon Building, Penryn Campus
- Accommodation:** Penmere Manor Hote, Mongleath Road, Falmouth TR11 4PN,  
<https://penmeremanorhotel.co.uk/>

**P.S.:** Please do bring swimwear - you will be close to the beach and we will have an activity in the water

## Keynote Speakers

### Model testing (operational and extremes)

*Professor Peter Stansby, University of Manchester*



Peter graduated with a BA in Engineering from Cambridge University in 1971, and a PhD in aerodynamics three years later. His working life began in industry with the Atkins Group. In 1980 he joined the University of Manchester where he was awarded a DSc. He has been a Fellow of the Royal Academy of Engineering since 2001. His research interests have focused on offshore structures, coastal engineering, marine energy (wave and tidal), and Computational Fluid Dynamics (CFD) including Smoothed Particle Hydrodynamics (SPH). He has supervised over 60 grants/contracts mainly as PI and published 140 papers in Q1 journals, with a Scopus h-index of 33, making several seminal contributions. He is now the Osborne Reynolds Professor of Fluid Mechanics at Manchester.

The lecture focuses on physical model testing for wave energy converters (WEC) covering operational and extreme conditions for power generation and survivability respectively. Froude and Reynolds are introduced followed by experience with the M4 WEC. Investigations on extreme loading and pressures including breaking waves are described for single point absorbers and fixed columns as well as M4. The importance of coupling physical and numerical modelling and basic analysis for design is emphasised. The benefits, limitations and uncertainties in physical modelling are discussed.

### Development of the spar-buoy OWC at IST

*Dr João Henriques, IST - University of Lisbon*



João Henriques is an Assistant Professor of Mechanical Engineering at IST, University of Lisbon. His PhD was in numerical modelling of turbomachinery. Most of his research has been dedicated to the development of oscillating water column wave energy converters, covering a broad range of topics such: as numerical modelling and optimisation, experimental testing, aerodynamic design of air turbines, and power take-off control. He participated in ten European projects in the area of wave energy. He also holds five patents, four in the field of wave energy and another in wind power.

The lecture aims to present the development of the spar-buoy OWC from its inception to the current status. Closely linked to the design of the spar-buoy is the development of a new self-rectifying air turbine by the IST group, the so-called biradial turbine. The presentation covers the original idea behind the spar-buoy, the preliminary design stages, the numerical modelling and optimisation of the hull shape, and the experimental tests in several wave facilities (NAREC, COAST Lab and IST). The path that led to the invention of the biradial turbine is also described, as well as the one-year real sea test campaign of the turbine performed at the Mutriku wave power plant (Basque Country, Northern Spain). Besides, the talk addresses how the intellectual property affected the development process.

## List of Speakers

Speakers at the Hydrodynamic modelling module (Plymouth) PRIMaRE Summer School:

**Prof Deborah Greaves:** Professor in Ocean Engineering

**Prof Alison Raby:** Professor in coastal Engineering

**Dr Daniel Conley:** Associate Professor in Coastal Dynamics Modelling

**Dr Richard Pemberton:** Lecturer in Mechanical and Marine Engineering Design

**Dr Martyn Hann:** Lecturer in Coastal Engineering

**Dr CarlosPerez-Collazo:** PRIMaRE Research Fellow

**Dr Nan Xie:** Reseaech Fellow

**Dr Scott Brown:** Research Fellow

**Mr James Allen:** Research Fellow

**Mr Alastair M. Reynolds:** Lab Technician

## Participants

| Name              | Affiliation  | Email  | Group |
|-------------------|--|--|-------|
| Anna Feichtner    | University of Exeter                                   | <a href="mailto:af506@exeter.ac.uk">af506@exeter.ac.uk</a>                       | A     |
| Chenyu Zhao       | University of Plymouth/<br>Ocean University of China   | <a href="mailto:chenyu.zhao@plymouth.ac.uk">chenyu.zhao@plymouth.ac.uk</a>       | A     |
| Jack Huges        | Swansea University                                     | <a href="mailto:708774@swansea.ac.uk">708774@swansea.ac.uk</a>                   | A     |
| James Doddrell    | ARC Marine   | <a href="mailto:james@arcmarine.co.uk">james@arcmarine.co.uk</a>                 | A     |
| Oscar de la Torre | University of Plymouth                                 | <a href="mailto:dela.oscar@gmail.com">dela.oscar@gmail.com</a>                   | A     |
| Panpan He         | Dalian University of Technology                        | <a href="mailto:hpl0806@mail.dlut.edu.cn">hpl0806@mail.dlut.edu.cn</a>           | A     |
| Sixdelys Lan      | Marine Renewable Energy                                | <a href="mailto:sixdelys.lan@gmail.com">sixdelys.lan@gmail.com</a>               | A     |
| Yu Zhou           | Dalian University of Technology                        | <a href="mailto:yuzhouzhouyu@mail.dlut.edu.cn">yuzhouzhouyu@mail.dlut.edu.cn</a> | A     |
| Binzhen Zhou      | Harbin Engineering University/<br>University of Oxford | <a href="mailto:binzhen.zhou@eng.ox.ac.uk">binzhen.zhou@eng.ox.ac.uk</a>         | B     |
| Emilio Faraggiana | Swansea University                                     | <a href="mailto:951180@swansea.ac.uk">951180@swansea.ac.uk</a>                   | B     |
| Guangmao Chen     | Shanghai Jiao Tong University                          | <a href="mailto:chengm@sjtu.edu.cn">chengm@sjtu.edu.cn</a>                       | B     |
| Philippa Davies   | University of York                                     | <a href="mailto:psb519@york.ac.uk">psb519@york.ac.uk</a>                         | B     |

## Participants (Continuation)

| Name                     | Affiliation   | Email  | Group |
|--------------------------|---|--|-------|
| Siming Zheng             | University of Plymouth                              | <a href="mailto:siming.zheng@plymouth.ac.uk">siming.zheng@plymouth.ac.uk</a>                           | B     |
| Simon Waldman            | Heriot-Watt University /<br>Marine Scotland Science | <a href="mailto:s.waldman@hw.ac.uk">s.waldman@hw.ac.uk</a>   | B     |
| Tom Birbeck              | ARC Marine  | <a href="mailto:tom@arcmarine.co.uk">tom@arcmarine.co.uk</a>   | B     |
| Darshana Dassanayake     | University of Plymouth                              | <a href="mailto:dassa.dassanayake@plymouth.ac.uk">dassa.dassanayake@plymouth.ac.uk</a>                 | C     |
| Efrain Carpintero Moreno | The University of Manchester                        | <a href="mailto:efrain.carpinteromoreno@manchester.ac.uk">efrain.carpinteromoreno@manchester.ac.uk</a> | C     |
| Lin Yang                 | Harbin Engineering University                       | <a href="mailto:yanglin@hrbeu.edu.cn">yanglin@hrbeu.edu.cn</a>   | C     |
| Luis Recalde-Camacho     | University of Strathclyde                           | <a href="mailto:luis.recalde-camacho@strath.ac.uk">luis.recalde-camacho@strath.ac.uk</a>               | C     |
| Mohammed Al Moghayer     | Heriot-Watt University                              | <a href="mailto:ma211@hw.ac.uk">ma211@hw.ac.uk</a>   | C     |
| Ross Gwenter             | Swansea University                                  | <a href="mailto:881656@swansea.ac.uk">881656@swansea.ac.uk</a>   | C     |
| Wentao Xu                | Shanghai Jiaotong University                        | <a href="mailto:wentao.xu@sjtu.edu.cn">wentao.xu@sjtu.edu.cn</a>                                       | C     |

## Notes



**EPSRC**

Engineering and Physical Sciences  
Research Council

**NERC**

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