



## SHOCK WAVES AND EXTREME CONDITIONS

Studying the fascinating world of the behaviour of materials outside of the everyday.

### Welcome

Welcome to the second newsletter for the Shock Wave and Extreme Conditions (SWEC) Group. SWEC brings together parties from both industry and academia with a common interest in novel aspects of high strain-rate and pressure phenomena. This interest encompasses a wide range of disciplines from energetic material behaviour through biomaterials to phenomena such as crashworthiness of structures. Areas of interest include both the fundamental principles behind, and experimental techniques involved in accessing:

- Static high pressures, shock waves, blast and energetic materials
- Materials characterization across a range of strain rates
- High pressure or high-rate Materials Synthesis
- Development of equations of state and constitutive models
- The effects of high energy and high-rate energy deposition
- High-speed transient phenomena
- Complex diagnostics and sensing systems
- Pressure, energy, temperature and very high strain-rate response materials ranging from biological, soft systems to dislocation behaviour in single crystals.

SWEC seeks to facilitate research and discussion in these fields, aiming to initiate and develop links between physicists and other researchers in this multi-disciplinary area. We actively welcome all expressions of interest in collaborations with other interested parties.

*Gareth Appleby-Thomas (Chair)*

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### Help Needed from Members!

1. **Recruit new members** – spread the word and get your colleagues to join the IOP and SWEC.
2. **Get involved.**
3. **Tell us about your research interests** – we want to hear from you at [swec@physics.org](mailto:swec@physics.org)

## The SWEC Group Committee

The current SWEC Committee members are:

Gareth Appleby-Thomas	Cranfield University	<i>Chair</i>
Glenn Whiteman	AWE	<i>Secretary</i>
Ian Cullis	QinetiQ	<i>Treasurer</i>
James Perry	University of Cambridge	<i>Early Careers</i>
Chris Braithwaite	University of Cambridge	
Kate Brown	University of Cambridge	<i>Equality Diversity and Inclusion</i>
Mark Collinson	AWE	<i>Database management</i>
Daniel Eakins	University of Oxford	
Simon Finnegan	AWE	<i>Awards and Prizes</i>
Michael Goff	AWE	
Craig Hoing	MOD	
Bill Proud	Imperial College	<i>NMH 2020</i>
Steve Rothman	AWE	

## Meet the Committee

The committee has expanded since our last newsletter and we welcome Dan, Mike, Simon and Steve. Their scientific interests are:

Dan is an Associate Professor in Impact Engineering at the University of Oxford, working at the interface of "extreme" materials science, shock physics and dynamic measurement science. He leads a group conducting research on the ultrafast behaviour of materials under extreme loading conditions, using a combination of gas-guns and advanced laser/X-ray diagnostics to study key physical processes from their lattice-level origins to the bulk scale.

Mike studies the dynamic response of materials to shock loading, with a focus on explosive target 'run to detonation' experiments. These experiments use gas guns to produce loadings ranging from simple 1-D shocks to complex ramps. He uses a range of electrical and optical diagnostics, specialising in the use and ongoing development of the embedded particle velocity gauge technique. (UK Ministry of Defence © Crown Owned Copyright 2020/AWE)

Simon is primarily interested in the shock response of explosives and the shock to detonation transition across a wide range of loading conditions. Most of his research is completed using embedded particle velocity gauges and Heterodyne velocimetry on gas-gun based experiments. (UK Ministry of Defence © Crown Owned Copyright 2020/AWE)

Steve is interested in experimental measurements of high-pressure Equation of State (EoS), using high-power lasers, and concentrating on the analysis of shockless compression, and low-pressure shocks, to extract EoS and strength information. (UK Ministry of Defence © Crown Owned Copyright 2020/AWE)

*If you are interested in working with the committee or becoming a future member, please let Glenn know by emailing [swec@physics.org](mailto:swec@physics.org).*

## Studentships

### OXFORD

There are two studentships available within Dan's research group at the University of Oxford:

[The role of defects on the dynamic fragmentation behaviour of additively manufactured materials](https://eng.ox.ac.uk/study/research-studentships/research-studentship-in-impact-engineering/)  
<https://eng.ox.ac.uk/study/research-studentships/research-studentship-in-impact-engineering/>

[On the shock compression response of single crystal tin](https://eng.ox.ac.uk/study/research-studentships/research-studentship-in-impact-engineering-daniel-eakins/)  
<https://eng.ox.ac.uk/study/research-studentships/research-studentship-in-impact-engineering-daniel-eakins/>

If you are interested contact Dan ( [daniel.eakins@eng.ox.ac.uk](mailto:daniel.eakins@eng.ox.ac.uk) ) quoting Studentships in the subject line.

### CRANFIELD

There is a scholarship available from Cranfield University within Gareth's department, focused on Mechatronics and Inertial Sensing:

<https://www.findaphd.com/phds/project/mechatronics-tracking-using-inertial-sensors/?p119594>

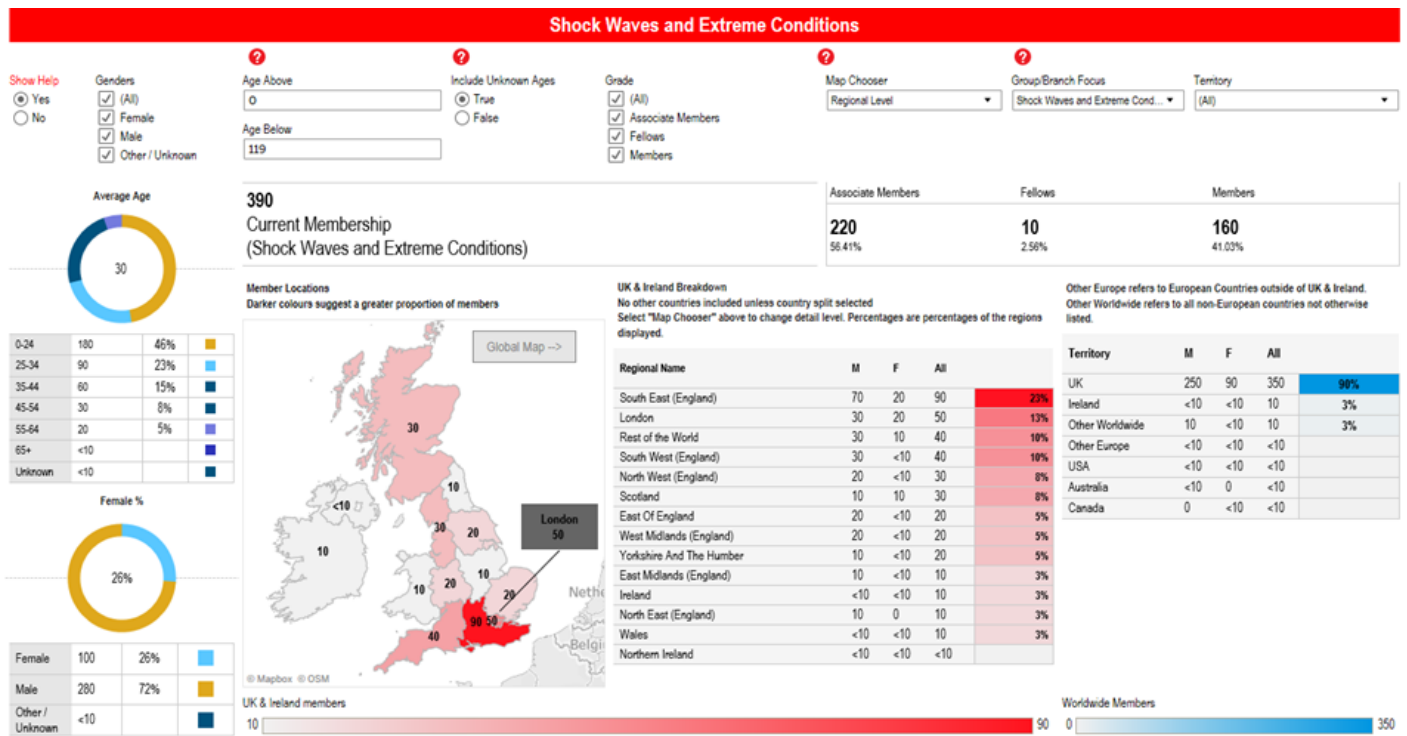
If you are interested contact Gareth ( [g.applebythomas@cranfield.ac.uk](mailto:g.applebythomas@cranfield.ac.uk) ) quoting Scholarship in the subject line and Gareth will arrange contact with the project supervisor.

# SWEC – Who are we?

The IOP has developed a powerful database management tool to analyse the membership of the Institute to understand their interests and to help in targeting resources to best support and grow the study and application of physics. Mark, responsible for Database Management, has been using it to analyse the SWEC group membership and to provide information to assist the Committee in planning and securing funding for various activities to develop the group. Some of these data concerning group membership (as at 30<sup>th</sup> September 2019) are reproduced below.

## Membership Statistics (note that all numbers are rounded to the nearest 10):

### General Statistics (age, location etc.):



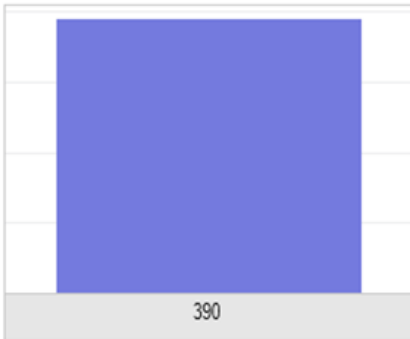
[Physics Insights] Source: Institute of Physics Member Data. Counts of members above 0 and less than 10 are shown as <10 and percentage figures aren't shown against them, though they are included in the total member counts. Other figures rounded to the nearest 10 and so percentages may not add up to 100%. Count of members is a count of distinct memberships where the member status is Active or Applied, and the relationship to the group, branch or institution selected is not out of date. Also Excludes Non-IOP members, who may sometimes serve on group committees.

Comparison against IOP as a whole (Yellow: SWEC, Blue: Overall IOP)

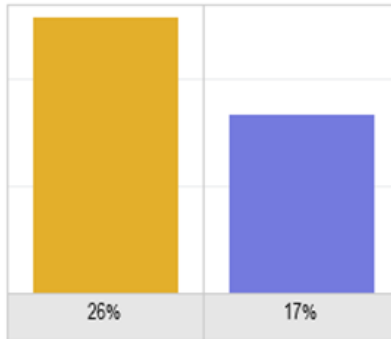
All	390
Other IOP members	20950



Number of Members

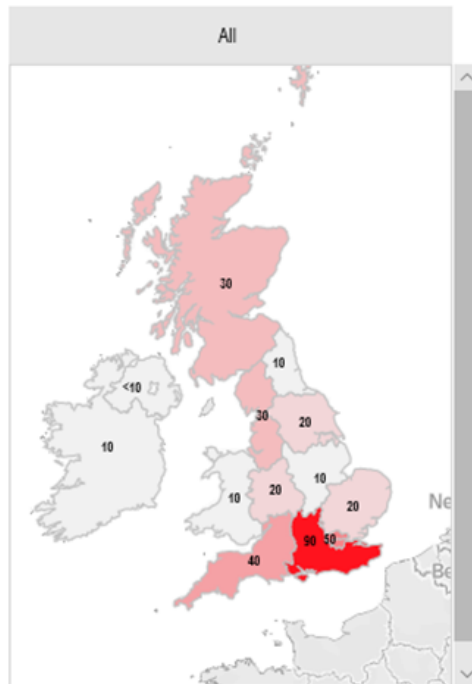


Female %

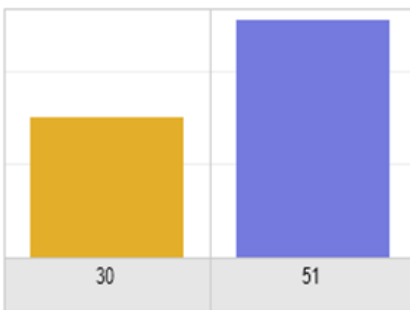


Member Locations

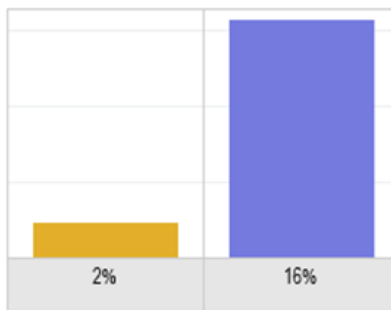
Darker colours suggest a greater proportion of members



Avg Age

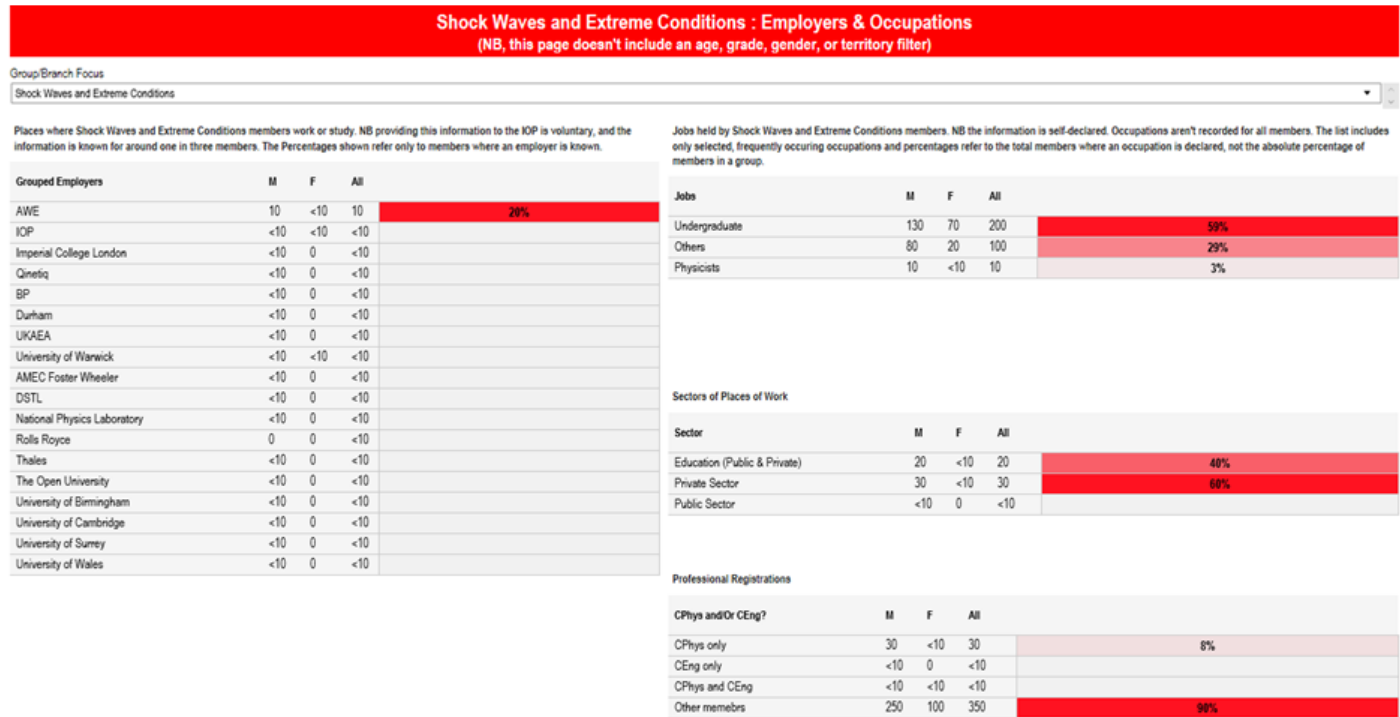


Fellow %



## Statistics on employer, student status etc. and professional registrations:

(Note that it isn't compulsory for people to declare this information, so it isn't necessarily complete/ add up to the full membership)



As you can see SWEC has 390 members with just over half (51%) being undergraduates, which is reflected in the average age of 30. In terms of gender 26% of our members are female, which is well ahead of the IOP average of 17%.

The membership is mainly located in the UK and Ireland, but we do have members (10%) in Europe, North America and Australia. The committee would really like to hear from the non-UK members and how we could help them. Whilst the UK membership is concentrated in the South East and London all regions are represented.

So drop us a line at [swec@physics.org](mailto:swec@physics.org) and tell us about your interests and what you think SWEC could be doing to promote the study of materials under extreme conditions.

## Group prizes

SWEC covers some fascinating science and we want to help people find out about it, so we are currently seeking approval to set up a science communication prize to open in the summer. We will be looking for clear, engaging videos or a series of photographs explaining some aspect of SWEC science to a non-scientific audience, though it will a great chance to share it with the community too. The aim is to have different prize categories so if you work in the field then please think about how you could demonstrate some aspect of what you do, but if you don't then specific knowledge is less important than creativity! There are some great examples on the internet if you are looking for inspiration so please start thinking and look out for the calling notice with the full details!

## IOP Joint group meetings

The Committee is actively developing our links with the various groups in the IOP, with some of our initial plans described in the previous Newsletter. However, we would like to invite ideas for cross-correlation of meetings, events etc, from those of you who are also members of other groups. If you want to organise something that just needs a home and backing for it then please get in touch as we may be able to help.

*We are aiming to organise between 1 and 3 events each year. Watch out for our calling notices!*

## Group sponsored events

The committee are always interested in sponsoring meetings related to the SWEC area. If you are interested in organising a workshop or training activity, then please contact a member of the Committee.

*Watch out for future events on the IOP and SWEC calendars.*

## SWEC Speakers

Many institutions maintain a list of potential speakers and topics, which is disseminated to groups who may wish to invite a guest speaker. We would like to create a SWEC relevant list which could be provided to local IOP branches.

*If you would like to offer a talk for our list, then please get in touch with a member of the committee or email [swec@physics.org](mailto:swec@physics.org) with 'Speaker' in the subject line.*

Gareth has recently founded a regular seminar series focused on materials and engineering at Cranfield University. If you are interested in either attending or being a speaker please contact him directly at [g.applebythomas@cranfield.ac.uk](mailto:g.applebythomas@cranfield.ac.uk) . The first three seminars are to be held on:

- Friday the 20th of March: 1230-1400 hrs: "Unusual aspects of shock physics", Gareth Appleby-Thomas.
- Friday the 23rd of April: 1230-1400 hrs: To be confirmed.
- Friday 22nd of May: 1230-1400 hrs: To be confirmed.

## Early Careers (EC)

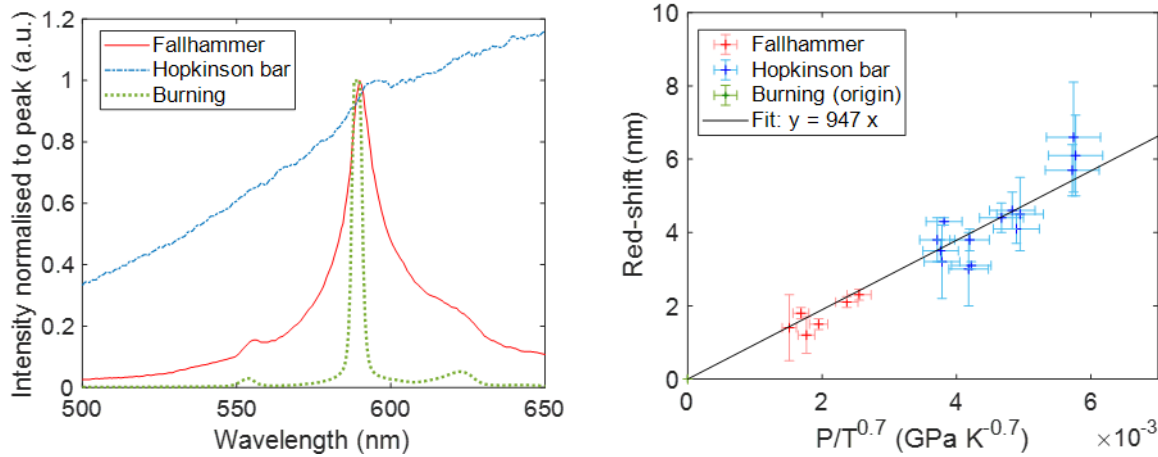
The analysis of our membership by Mark has naturally identified a direction for some of our Early Careers activities and I would very much like to hear from our undergraduate members about their needs and ideas. In addition, James is exploring ways in which SWEC can support the broader IOP Early Careers initiative. Please email James at [jip24@cam.ac.uk](mailto:jip24@cam.ac.uk) (with "SWEC EC" in the subject line) and confirm that you would like to be included in discussions of SWEC-specific early-career events.

*Any thoughts and suggestions for activities would also be very welcome, and if you're keen to get involved in organising things then please let me know!*

## Case study – Spectral red-shift in deflagration

A current area of research at the University of Cambridge, Cavendish Laboratory, features optical spectroscopy of a range of energetic reactions (with PhD student Olivia Morley and her supervisor David Williamson). The optical emission of HMX deflagration has been studied, in which the sodium D-lines are present (and red-shifted under pressure) as highly emissive impurities. Deflagration was initiated using both a conventional fallhammer and – for the first time - a Hopkinson bar apparatus, allowing a wider range of deflagration conditions to be observed. Measurements were taken of the sodium peak position, the temperature (T), and the reaction pressure (P). This allowed the red-shift of sodium under deflagration conditions to be calibrated<sup>1</sup> at  $(950 \pm 30)$  PT -0.7 nm, being in good agreement with collisional theory estimates, and allowing an optical measurement of pressure which can be exploited in a range of experiments.





Left: Sodium peak as seen in the emission spectrum of HMX burning, and in fallhammer and Hopkinson bar deflagration. Right: Position of peak centre against functional form given by collisional theory.

1. Morley O. J., Williamson D. M. (2020). Pressure and temperature induced red-shift of the sodium D-line during HMX deflagration. *Comms. Chem.* 3, 13.

***If you have a case study you would like to publish in future newsletters, then please let us know at [swec@physics.org](mailto:swec@physics.org).***

***Please note we now also have a twitter account: [@ShockGroup](https://twitter.com/ShockGroup)***

## Events diary

Some of the relevant forthcoming conferences and meetings that are pertinent to the interests of SWEC members.

Dates	Event	Location	Website	Notes
1-3 April 2020	NTREMS (New Trends in Research of Energetic Materials)	Pardubice Czech Republic	<a href="https://www.ntrems.com">https://www.ntrems.com</a>	
31 May – 5 June 2020	Gordon Conference: Energetic Materials	Newry, Maine, USA	<a href="https://www.grc.org/energetic-materials-conference/2020/">https://www.grc.org/energetic-materials-conference/2020/</a>	
23-26 June 2020	ICILSM	Trondheim, Norway	<a href="https://www.ntnu.edu/icilsm2020">https://www.ntnu.edu/icilsm2020</a>	Early Reg. Deadline - 01/04/20
30 June – 2 July	International Explosives Conference 2020	London, UK	<a href="http://www.iec-2020.com/?action=main">http://www.iec-2020.com/?action=main</a> <a href="http://www.coeem.org">www.coeem.org</a>	
6-7 July 2020	Auxdefense: 2 <sup>nd</sup> World Conference on Advanced Materials for Defense	Porto, Portugal	<a href="mailto:secretariat@auxdefense.pt">secretariat@auxdefense.pt</a>	
7-9 July 2020	DyCoMax: 3rd workshop on Studies of Dynamically Compressed Matter with X-rays	Grenoble, France	<a href="https://www.esrf.eu/dycomax-workshop">https://www.esrf.eu/dycomax-workshop</a>	Submission of abstracts for talk or poster: 07/06/2020
19-24 July 2020	Gordon Conference: High Pressure Physics	Holderness, New Hampshire, USA	<a href="https://www.grc.org/research-at-high-pressure-conference/2020/">https://www.grc.org/research-at-high-pressure-conference/2020/</a>	
21 – 30 August 2020	International Union of Crystallography	Prague, Czech Republic	<a href="https://iucr2020.auletris.com/sessions/">https://iucr2020.auletris.com/sessions/</a>	
6 – 11 September 2020	58 <sup>th</sup> European High-Pressure Research Group (EHPRG) International Conference	Tenerife, Spain	<a href="http://eventos.ull.es/36039/detail/58th-european-high-pressure-research-group-international-conference.html">http://eventos.ull.es/36039/detail/58th-european-high-pressure-research-group-international-conference.html</a>	

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9-11 September 2020	DYMAT: Microstructure – Dynamic properties relations in metals	Ghent, Belgium	<a href="https://dymat2020.org">https://dymat2020.org</a> .	
14-15 October 2020	DYMAT: Lightweight Armour Group (LWAG) 2020	Berlin, Germany	<a href="http://www.emi.fraunhofer.de/en/news/events/lwag-2020.html">www.emi.fraunhofer.de/en/news /events/lwag-2020.html</a>	
Late 2020	NMH 2020	Montenegro	TBC	

*If you have any additional events to add to the diary, then please let us know at [swec@physics.org](mailto:swec@physics.org).*