UK Nuclear Activity

October 2016 Issue 40

In this issue,

Newsletter archive: http://npg.dl.ac.uk/OutreachNewsletter/index.html

Nuclear Physics Public Engagement Website: www.stfc.ac.uk/NuclearPhysicsForYou

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1. Nuclear Physics Publications for October*

If you are publishing a paper that you think would be of media value please let Wendy Ellison wendy.ellison@stfc.ac.uk , STFC Press Officer, know. She can help with press releases and publicity. If you get in touch with her before publication she can also get material ready in advance for the day of publication.

EPJ Web of Conferences 123, 01007 (2016) http://dx.doi.org/10.1051/epjconf/201612301007
Proton emission – new results and future prospects
R. D. Page[a]
*Published 5 September 2016

Eur. Phys. J. A 52, 298 (2016) http://link.springer.com/article/10.1140/epja/i2016-16298-3
Differential cross section measurement of the $^{12}C(e,e'pp)^{10}Be_{g.s.}$ reaction
A1 Collaboration, M. Makek, P. Achenbach, C. Ayerbe Gayoso, C. Barbieri, J. C. Bernauer, R. Böhm, D. Bosnar, A. Denig, M. O. Distler, I. Friščić, C. Giusti, H. Merkel, U. Müller, L. Nungesser, J. Pochodzalla, S. Sanches Majos, B. S. Schlimme, M. Schwamb, Th. Walcher
*Published 27 September 2016

Nature 19345 (2016) http://www.nature.com/nature/journal/vaop/ncurrent/full/nature19345.html
Atom-at-a-time laser resonance ionization spectroscopy of nobelium
Mustapha Laatiaoui, Werner Lauth, Hartmut Backe, Michael Block, Dieter Ackermann, Bradley Cheal, Premaditya Chhetri, Christoph Emanuel Düllmann, Piet van Duppen, Julia Even, Rafael Ferrer, Francesca Giacoppo, Stefan Götz, Fritz Peter Heßberger, Mark Huyse,Oliver Kaleja, Jadambaa Khuyagbaatar, Peter Kunz, Felix Lautenschläger, Andrew Kishor Mistry, Sebastian Raeder, Enrique Minaya Ramirez, Thomas Walther, Calvin Wraith & Alexander Yakushev
*Published 28 September 2016

*Also including missed publications from previous months.

Eur. Phys. J. A 52, 304 (2016) http://link.springer.com/article/10.1140%2Fepja%2Fi2016-16304-x
Beta-delayed proton emission from ^{20}Mg
IDS Collaboration: M. V. Lund[1*], A. Andreyev[2], M. J. G. Borge[3,4], J. Cederkäll[5], H. De Witte[6], L. M. Fraile[7], H. O. U. Fynbo[1], P. T. Greenlees[8,9], L. J. Harkness-Brennan[10], A. M. Howard[1], M. Huyse[6], B. Jonson[11], D. S. Judson[10], O. S. Kirsebom[1], J. Konki[8,9], J. Kurcewicz[4], I. Lazarus[12], R. Lica[4,13], S. Lindberg[11], M. Madurga[4], N. Marginean[13], R. Marginean[13], I. Marroquin[3], C. Mihai[13], M. Munch[1], E. Nacher[3], A. Negret[13], T. Nilsson[11], R. D. Page[10], S. Pascu[13], A. Perea[3], V. Pucknell[12], P. Rahkila[8,9], E. Rapisarda[4], K. Riisager[1], F. Rotaru[13], C. Sotty[6,13], M. Stanoiu[13], O. Tengblad[3], A. Turturica[13], P. Van Duppen[6], V. Vedia[7], R. Wadsworth[2] and N. Warr[14]
Published 4 October 2016

Phys. Lett. B 761, 412 (2016) http://www.sciencedirect.com/science/article/pii/S0370269316304890
Interaction cross section study of the two-neutron halo nucleus ^{22}C
Y. Togano[a,*], T. Nakamura[a], Y. Kondo[a], J.A. Tostevin[b], A.T. Saito[a], J. Gibelin[c], N.A. Orr[c], N.L. Achouri[c], T. Aumann[d], H. Baba[e], F. Delaunay[c], P. Doornenbal[e], N. Fukuda[e], J.W. Hwang[f], N. Inabe[e], T. Isobe[e], D. Kameda[e], D. Kanno[a], S. Kim[f], N. Kobayashi[a], T. Kobayashi[g], T. Kubo[e], S. Leblond[c], J. Lee[e], F.M. Marqués[c], R. Minakata[a], T. Motobayashi[e], D. Murai[h], T. Murakami[i], K. Muto[g], T. Nakashima[a], N. Nakatsuka[i], A. Navin[j], S. Nishi[a], S. Ogoshi[a], H. Otsu[e], H. Sato[e], Y. Satou[f], Y. Shimizu[e], H. Suzuki[e], K. Takahashi[g], H. Takeda[e], S. Takeuchi[e], R. Tanaka[a], A.G. Tuff[k], M. Vandebrouck[l], K. Yoneda[e]
Published 10 October 2016

Phys. Rev. Lett. 117, 162502 (2016) http://journals.aps.org/prl/abstract/10.1103/PhysRevLett.117.162502
Sensitivity of (d, p) Reactions to High n−p Momenta and the Consequences for Nuclear Spectroscopy Studies
G. W. Bailey, N. K. Timofeyuk, and J. A. Tostevin
Published 14 October 2016

Phys. Rev. C 94, 044315 (2016) http://journals.aps.org/prc/abstract/10.1103/PhysRevC.94.044315
Observation of the 2^+ isomer in ^{52}Co
S. E. A. Orrigo[1,*], B. Rubio[1], W. Gelletly[1,2], B. Blank[3], Y. Fujita[4,5], J. Giovinazzo[3], J. Agramunt[1], A. Algora[1,6], P. Ascher[3], B. Bilgier[7], L. Cáceres[8], R. B. Cakirli[7], G. de France[8], E. Ganioğlu[7], M. Gerbaux[3], S. Grévy[3], O. Kamalou[8], H. C. Kozer[7], L. Kucuk[7], T. Kurtukian-Nieto[3], F. Molina[1,9], L. Popescu[10], A. M. Rogers[11], G. Susoy[7], C. Stodel[8], T. Suzuki[5], A. Tamii[5], and J. C. Thomas[8]
Published 19 October 2016

Nature Physics 3916 (2016) http://www.nature.com/nphys/journal/vaop/ncurrent/full/nphys3916.html
A proton density bubble in the doubly magic ^{34}Si nucleus
A. Mutschler, A. Lemasson, O. Sorlin, D. Bazin, C. Borcea, R. Borcea, Z. Dombrádi, J.-P. Ebran, A. Gade, H. Iwasaki, E. Khan, A. Lepailleur, F. Recchia, T. Roger, F. Rotaru, D. Sohler, M. Stanoiu, S. R. Stroberg, J. A. Tostevin, M. Vandebrouck, D. Weisshaar & K. Wimmer
Published 24 October 2016

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2. News to Report

a. Report on NuPECC meeting: October 7-8 2016, Vienna.

Science Workshop

The first part of the meeting was a presentation of work in Austria. Topics included theoretical and experimental particle and hadron physics, studies with cold neutrons, nuclear data, precision environmental measurements using AMS and the physics programme associated with their hadron therapy facility.

Long Range Plan

The main business of the meeting was the presentation and discussion of the draft working party reports for next NuPECC long range plan. Final drafts of all reports to be available by end October. These will then be considered by the appointed convenors and the executive group to look at overlaps etc. There will be a NuPECC meeting before the Town Meeting which is 11-13 January 2017. This meeting will take place on the afternoon of 10th January 2017. Registration web pages for the Town meeting will be made available from Monday 10th October 2016. See the link:
http://indico.gsi.de/conferenceDisplay.py?confId=5177

Other Reports

Reports were presented concerning a range of other topics:

- A report on EIC presented the current status. Following a positive recommendation in the DOE long range plan a number of steps now have to happen. The earliest date for a site decision is 2019/20 (Brookhaven and JLab have proposals). Construction money would follow the completion of FRIB. The earliest date for this would be 2022/23. The funding for EIC relies on a 1.4% annual increase in the nuclear physics budget.
- IAEA presented a report on nuclear data evaluation. Currently there are 6 FTE evaluators in the US, with 3.4 FTE elsewhere in the world. IAEA think at least 12 FTE are required to keep pace with nuclear data evaluations especially when the new facilities start producing data on new nuclei. Europe is low in the number of evaluators. One suggestion is that each major facility should have funding for 1 FTE of evaluation effort associated with their work. IAEA can provide training and pump prime funding.
- The Hadron Physics Horizon application (EU funding) has been rejected. Despite previous funding the proposal seems to have been considered as coming from a starting, not an established community. The evaluation report was discussed. Next steps are being considered.
- ENSAR2 started on 1st March 2016 and is planned to last 4 years. The structure of the planned programme was described.
- The current ECT*scientific programme is operating well. There are three workshops remaining in 2016. There are budget problems for the future. The contribution from Foundation Bruno Kessler (FBK) is reducing. There is no funding from Hadron Physics Horizon. Some support staff positions will be lost. These were funded directly by the Trento province. One of the PDRA positions may have to be filled in a complementary field to reflect the priorities of FBK. Financial support for workshops in 2017 will be lower.
- Reports were presented from the Asian and Latin American equivalents of NuPECC.
- Nuclear Physics News recently requested new articles. These are still needed for future issues.
- The EPS Nuclear Physics Division board was held recently in Dubna. Nicola Bianchi was elected chair, with Paul Stevenson as secretary.

NuPECC items

The current status of the NuPECC budget was presented. About 30keuro are outstanding from the expected income of ~200keuro. These countries will be reminded. In the current financial year a small surplus is expected which can be carried over.
NuPECC would like to improve the look of its web page, at least the home page.
Next meetings: CERN March 10th, Lisbon June 16th, Saclay Oct 6th.
Contribution by Paul Nolan P.J.Nolan@liverpool.ac.uk (Liverpool) and Alex Murphy a.s.murphy@ed.ac.uk (Edinburgh)

b. Nuclear Physics for Cultural Heritage.

The European Physical Society has just published a major review paper describing the use of nuclear physics techniques to study, characterise and preserve cultural heritage artefacts. There has been enormous progress in this field in recent years and the current review aims to provide the public with a popular and accessible account of this work. The review explores applications ranging from neutron activation to accelerator mass spectrometry, and everything else in between. It is extensively illustrated with important discoveries and examples from archaeology, pre-history, history, geography, culture, religion and curation, which underline the breadth and importance of this field. The large number of groups and laboratories working in the study and preservation of cultural heritage across Europe indicate the enormous effort and importance attached by society to this activity.
This review was instigated in 2013 under the leadership of Douglas MacGregor, vice-chair and subsequently chair of the EPS Nuclear Physics Division. The production and editing were jointly led by Douglas and by Anna Mackova, head of the Tandetron Laboratory of the Nuclear Physics Institute of the Czech Academy of Sciences, Rez. To create a truly authoritative account, the Editors have invited contributions from leading experts in the field. The publication of the report represents the successful culmination of three years' work, which involved the creation of an ad-hoc collaboration of 39 experts in different

applied nuclear physics specialities from across Europe.
The document has been published on EDP Open at
http://www.edp-open.org/books-in-english#Nuclear-physics-for-cultural-heritage
It is also available on DOAB (the Directory on Open Access Books).
DOI: 10.1071/978-2-7598-2091-7
ISBN: 978-2-7598-2091-7
Contribution by Douglas MacGregor Douglas.MacGregor@glasgow.ac.uk (Glasgow)

c. Physicists help unravel the atomic and nuclear structure of nobelium

Research published in Nature describes how laser spectroscopy has been successfully applied to reveal the atomic structure of a transfermium element, Nobelium, for the first time.
Nobelium atoms were produced at the GSI Helmholtzzentrum in Darmstadt, Germany using fusion evaporation reactions.
In a break-through experiment, researchers used a high energy 217 MeV beam of ^{48}Ca ions to impact on thin isotopically-enriched lead foil targets. They then velocity-filtered the Nobelium products inflight, decelerated and delivered them into a buffer gas cell.
Here, a set of five tuneable lasers were used in an exhaustive search of a theoretically probable, but wide frequency range for an optical resonance.
Neutral atoms were repeatedly pulse-heated off a catcher filament, interrogated using a two-step resonance ionisation process, and the Nobelium ions identified via their characteristic alpha decay fingerprint.
Rates as low as 1 atom per second were sufficient for success, allowing location of an excited atomic state in such a heavy element. Having no primordial isotopes meant that unlike conventional optical spectroscopy for nuclear structure studies, the atomic physics was completely unknown, and could only be studied "live" at an accelerator facility, with beam time at a premium.
Bradley Cheal, from the University's Department of Physics, said: "Scanning the first laser beam in high resolution now opens up exciting ways for physicists to study a number of fundamental properties, including the hyperfine structure, unveiling isotopic changes in nuclear charge radius, shape, magnetic moment and spin. Scanning the second (ionising) step permits an extraction of the ionisation potential via the converging Rydberg series."
The experiments were conducted by an international collaboration of scientists from GSI, the Helmholtz Institute Mainz, Johannes Gutenberg University Mainz, Technical University Darmstadt (Germany), KU Leuven (Belgium), and TRIUMF (Vancouver, Canada). Researchers from the Department of Physics (Dr Cheal and PhD student Calvin Wraith) participated in the experiments and Calvin visited GSI for several months for the vital preparatory work ahead of the accelerator beam time.
Further information can be found here.
Contribution by Bradley Cheal Bradley.Cheal@liverpool.ac.uk and Calvin Wraith (Liverpool)

d. Workshop on the Physics and Engineering Opportunities at the Electron-Ion Collider Loch Lomond, 13-14 Oct 2016

The first UK workshop on the US-based Electron-Ion Collider (EIC), focussing on the physics and engineering opportunities which the facility presents to the wider scientific community, was successfully held at Ross Priory on Loch Lomond, organised by Daria Sokhan from Glasgow University and co-sponsored by the STFC and IoP. Talks were spread over two days with a wide range of presentations by those leading the EIC effort across multiple fronts: on the accelerator design, the theoretical motivations and experimental opportunities and the detector R&D. There was much animated discussion both after the talks and in the evening, facilitated by the excellent catering of the Ross Priory, the beautiful scenery and a whisky tasting. Some participants joined remotely and a number of areas of interest and opportunities for UK involvement became clear in the discussions, which also focussed on the mutual benefits of a greater European involvement in the project. The new ideas are being pursued after the workshop and will hopefully lead to new collaborations. The success of this pilot, and its much-applauded venue, lays the ground for a larger scale workshop in the future.
The physics motivations for the EIC, which will be the world's first polarised electron-ion collider, are very broad and address crucial questions, such as the nature of confinement, the composition of nucleon spin and the

dynamical generation of hadron mass. The EIC programme will study aspects of nucleon structure across the widest range of scales, from the most "active" and valence quarks to the quark-gluon sea, and investigate the behaviour of quarks and gluons in the full range of nuclear densities. The physics case was presented by Prof. Deshpande of Stony Brook University, Dr Yoshida and Dr Aschenauer who are leading the EIC programme at JLab and BNL respectively, and a number of European and US collaborators, who also gave the perspectives of the French and Italian teams working on the project. The facility will allow the study of the quark-gluon sea in hadrons, aimed at answering such questions as "what is the role of gluons in nucleon spin?", "does gluon density saturate at some point and what can this tell us about the generation of hadron mass?". It will enable extensive measurements of hadronisation, observing the passage of a colour charge through nuclear matter, which can shed light on the processes of confinement and hadron-formation. New opportunities with the EIC have been identified in the very high-precision measurements of parton distribution functions (PDFs) for quarks carrying the highest momentum fractions of the nucleon. There was an extensive account of the two versions of the collider under consideration — JLEIC, to be based at Jefferson Lab (JLab), Virginia, where an electron accelerator already exists, and eRHIC, which would make use of the existing ion beam-line at Brookhaven National Lab (BNL), New York — given by Dr Fulvia Pilat, the deputy associate director of the accelerator division at JLab, and Dr Ferdinand Willeke, the director of the accelerator division in the photon sciences at BNL. A number of talks focussed on detector R&D and Dr Laura Gonella presented the Birmingham group's work on silicon tracking and vertexing for the EIC, which has recently been awarded funding.

The programme and all talks are available through the main workshop website: https://ukeicworkshop2016.wordpress.com

Contribution by Daria Sokhan Daria.Sokhan@glasgow.ac.uk (Glasgow)

e. Report on the 72nd Board Meeting of the EPS Nuclear Physics Division

Venue: The 72nd Board Meeting of the EPS Nuclear Physics Division was held at Dubna, Russia on 27th and 28th September 2016. The meeting consisted of a series of presentations highlighting nuclear physics work in Russia, and a tour of experimental facilities, as well as the formal board meeting.

Membership: The meeting was chaired by Faiçal Azaiez, now at iThemba Labs. During the meeting, Nicola Bianchi was elected as the next chair of the Division. He will take the role of chair–elect for 2017; chair for 2018–2019; past–chair for 2020. Paul Stevenson was elected as secretary for 2017–2018.

Nuclear Physics in Russia: A half–day mini–workshop of presentations started with an historical and organisational overview of JINR, which celebrates its 60th anniversary this year. There were further presentations on low–energy heavy–ion physics, the Gatchina spallation neutron source, nuclear physics at the NRC Kurchatov Institute, the NICA project, nuclear theory at JINR, neutron induced reaction physics, reactor neutrino physics, and applied nuclear physics.

EPS news: The chair reported that the EPS wishes to be more involved in influencing policy makers and has appointed a liaison officer in Brussels to act in such a role. The next overall president of the EPS will be elected on 14th October 2016 (note added after meeting; Rüdiger Voss was elected)

Prizes: The Lise Meitner Prize, awarded earlier the year to Ulf Meißner, was announced via the e–EPS bulletin. A workshop has been organised in Jülich for 7–9 Nov in honour of the award. Douglas MacGregor (past–president of the Division) will present the award at the meeting. The next Lise Meitner prize will be awarded in 2018. The next IBA prize for applied nuclear physics will be awarded in 2017. The call for nominations is up on the EPS website and the deadline is 15th January 2017. The next PhD thesis prize will be awarded in 2018. Theses submitted in 2015, 2016 and 2017 will be eligible.

Cultural Heritage Paper: The topical review on Nuclear Physics for Cultural Heritage,

which has been under preparation by the Division has now been completed and will shortly be assigned a doi (see news item b). Some paper copies will be made available, but it will be freely available online (note added after meeting; it can be found on the website http://www.edp-open.org/books/).
Divisional Conferences: An update was addressed to the meeting about the Eurisol DF (=Distributed Facility) 2016 meeting taking place in Leuven in October 2016. The next EuNPC meeting will be in Bologna in 2018. The dates have now been fixed as 2–7 September 2018. A holding website has been put up at http://www.eunpc2018.infn.it/ and will start being populated from January 2017. The next Nuclear Physics in Astrophysics (NPA) conference, NPA9 will be held in 2019. Nominations for its venue are open. The possibility of the Division supporting a conference to coincide with the opening of the NICA facility at Dubna (http://nica.jinr.ru/) was discussed.
Next Meeting: The next meeting will be held in Prague in spring 2017, followed by Bucharest in autumn 2017.
Contribution by Paul Stevenson
p.stevenson@surrey.ac.uk *(Surrey)*

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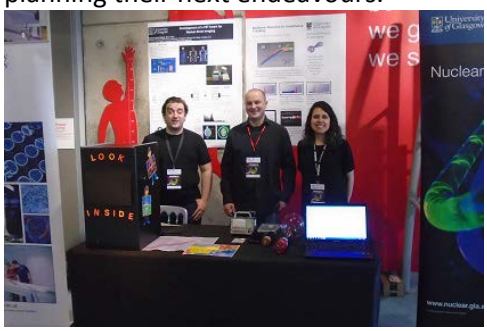
3. Outreach Activity

European Researchers Night in Glasgow
The European Researchers Night on the 30th September 2016 was celebrated across Scotland as the Explorathon with the University of Glasgow leading the local activities across the city. The nuclear physics group at the University of Glasgow was strongly engaged in a variety of events. While Dr Bjoern Seitz took the day to local secondary school enthusing higher and advanced higher physics classes about the beauty and challenges of the strong interaction, a group of Glasgow's nuclear physics PhD students (R. Gray, F. Thomson, N. Campos-Rivera, A. Powell) braved the public at the sold out "Explorathon Extravaganza" at Glasgow's Science Centre from early evening till the early hours. They won a place for a stall entitled "Nuclear Physics: Fantastic particles and how we detect them" in a very competitive process and hence hosted a nuclear physics research station to demonstrate our work on detector development for medical imaging and the monitoring of environmental radioactivity. This included a PET scanner simulation and live radionuclide identification. The team clearly caught the outreach bug and are now planning their next endeavours.



From left to right: F. Thomson, R. Gray, N. Campos-Rivera, A. Powell is taking the picture.

Contribution by Bjorn Seitz
Bjoern.Seitz@glasgow.ac.uk (Glasgow)

Physics Review 25th Anniversary, paper submission and more Binding Blocks news.
On the 19th of October, Binding Blocks exhibited for the Physics Review 25th Anniversary at the University of York, as well as sending a bit of the chart to Canada and submitting a paper for publication.
The purpose of the Binding Blocks chart is to explain nuclear phenomena to the general public and schools, for all age ranges and anyone with an enthusiasm for LEGO. On the chart, black blocks represent stable nuclei, yellow alpha decay, red beta+ decay, orange proton decay, light blue beta- decay and dark blue neutron decay. The height represents the available energy per kg material (in units of 25TJ/kg). This project revolves around building a full 8m, ~27000 brick chart of the nuclides, and two smaller portions can be built up to Yttrium (our Iron+ chart) and up to Neon (our Neon chart), depending on the event.
80 A-Level students visited the University of York for the 25th Anniversary of the Physics Review magazine, run by the University's Physics, Electronics and Education departments. The full Binding Blocks chart made its appearance for the

students and Physics Review members to see. We have also sent off another Neon chart, this time to our new collaborators at Guelph University in Ontario, Canada.
The Binding Blocks team have submitted a paper on the project, viewable here: https://arxiv.org/abs/1610.02296. It has also been submitted to the Focus on Nuclear and Particle Physics Journal. http://iopscience.iop.org/journal/0031-9120/page/Focus-on-Nuclear-and-Particle-Physics. The paper details everything about the project, from the chart itself and the physics behind it to building instructions, implementation, usage and much more.
We are in the process of organising several large events around the Yorkshire region, including a GCSE multi-school event and an A-Level multi-school event after the Christmas holidays. The chart will be on display as part of the Tim Peake event at the University of York on the 6th November. Furthermore, a training event is being held on the 9th November in collaboration with the University of Hull to train both undergraduates and postgraduates who would like to work on the project, and a teachers event is being held at the NSLC on the 12th November.
The project has its own website: http://www.york.ac.uk/physics/public-and-schools/schools/secondary/binding-blocks/ as well as our own YouTube channel: https://www.youtube.com/channel/UCvIXlFgJyGh4Jle_4_KE2aA, Twitter account: https://twitter.com/BindingBlocks and Facebook page: https://www.facebook.com/bindingblocks/
Contribution by Thomas Sanders tjs529@york.ac.uk, Alex Wright aw1139@york.ac.uk, Suzy Beanland srb534@york.ac.uk and George Duffett gd681@york.ac.uk (York)

Outreach Funding
The 2016 round of the Public Engagement Large Awards Scheme is now open for applications to Stage 1. Applications can be accepted up to 4.00pm on Thursday 3rd November 2016.
The Large Awards Scheme provides funds for projects which are expected to have a significant regional or national impact. We offer awards from £10,000 up to £100,000. Almost anyone can apply but project teams must have strong links with STFC's scientific research community. We also encourage partnerships that may positively impact on the success of the project e.g. universities with science centres.
Projects must be relevant to publicising engagement or teaching about the STFC science and technology areas, namely:

- particle physics
- nuclear physics
- space, solar and planetary science
- astronomy
- astrophysics
- cosmology
- studying materials with muon and neutron sources
- studying materials with synchrotron light sources
- research using laser facilities

Applicants are advised to consult the STFC Public Engagement Strategy in advance of submitting a proposal. Applicants are also encouraged (if applicable) to consider working with under-represented audiences such as girls and young women in engineering and physics, groups in areas geographically remote from STEM activity and underperforming schools.
Please see the LA: notes for guidance for further information.
All applications must be submitted through the RCUK Joint electronic submission (Je-S) system. E-mailed or hard copy applications will not be accepted. Please be aware that it may take up to four weeks for organisations to fully register for the first time on the Je-S system. However, for the small awards applicants may use the Je-S self-registration facility and then fully register if their application is successful.
For further information and advice please contact the STFC Public Engagement Team or Tel: 01793 442098.

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4. Media Interactions

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