

**Issue no. 1**

Flamanville 3 – UK EPR Prototype – July 2010



Physics and the AP1000  
AP1000 Modular Design



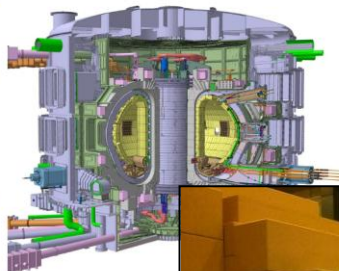
Power of tsunami



Office for Nuclear Regulation  
An agency of HSE

**Next Step: Build ITER**

- Aim – demonstrate/test integrated physics and engineering ( tritium generation, power conversion,...) in a burning plasma on the scale of a power station, with **energy out at least 1/2 GW = 10x energy in**
- Construction beginning
- Operation should start in 2019. Burning plasma ~ 2027



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## Notes from the Chair

Welcome to this – the first newsletter from the IoP’s Nuclear Industry Group. The Group came into existence on 10 March 2010. Since then, we have had several prestigious speakers – Dr Daryl Landeg, Sir Christopher Llewellyn Smith and Dr Mike Weightman to name just three – and we have organised a visit to the IC CONSORT Reactor at Silwood Park. We now have a properly constituted Committee, we held a meeting to discuss the future of research reactors in the UK, we have contributed to a new nuclear careers guide, have awarded a prize and we have contributed to numerous IOP policy documents and responses to consultation exercises.

Behind all this activity is a simple objective: to provide a mechanism for physicists working in the nuclear industry to develop themselves – as physicists! Plus to create a forum us to get to know and support each each other. We now have nearly 300 members – and the Nuclear Industry Group is said to be one of the fastest growing IoP groups of all time. To see more than 100 people at our first event – on the physics of the EPR and AP1000 – was hugely encouraging.

I should like to thank all the Committee for their hard work in making the Group happen – and especially Becca Holyhead and Michael Gifford who helped steer the Group in its very early stages when it was no more than an idea. Also, to Jenny Richards, IoP Vice President for Members and Qualifications, who has been a huge supporter of the Group.

**John Priestland**  
**Chairman**  
**IOP Nuclear Industry Group**

## Fukushima – Lessons Learnt

### A talk by Dr Mike Weightman, HM Chief Inspector of Nuclear Installations and Executive Head of the Office for Nuclear Regulation (ONR) on the lessons learnt from the Fukushima accident

**Julian Murgatroyd**

This July, the Nuclear Industry Group was very fortunate to welcome Dr Mike Weightman, HM Chief Inspector of Nuclear Installations and Executive Head of ONR to give a talk on lessons learnt from the severe accident that unfolded at the Fukushima Dai-ichi nuclear power plant following the earthquake and tsunami that hit the West Coast of Japan in March.



Dr Weightman started his presentation with an introduction to the ONR and an outline of its main activities. He went on to describe the sequence of events that took place on each of the six reactors at the Fukushima Dai-ichi plant following the earthquake. He related the ONR's initial response to the accident and their activities over the subsequent weeks. He explained that the ONR were requested by the Secretary of State to produce a report identifying lessons to be learnt by the UK nuclear industry following the accident. An interim report on lessons learnt was issued in May and is available on the ONR website.

Dr Weightman outlined the contents of the report and stated that it contained 10 conclusions and 26 recommendations. The conclusions and some of the most important recommendations were then presented. The recommendations are categorized under the headings of 'General', 'Relevant to the Regulator' and 'Relevant to the Nuclear Industry', the latter category having the largest

number of recommendations. One important conclusion for the nuclear industry is that it is considered safe for the UK fleet of nuclear reactors to continue operating. The 26 recommendations in the interim report cover a wide range of issues including the need for reviews of the layout of UK power plants, emergency response arrangements, dealing with prolonged loss of power supplies and the risks associated with flooding. The final report, to be published in September, will be an update to the interim report and will incorporate information from the International Atomic Energy Agency (IAEA), the Japanese report on the Fukushima accident and various other sources.

Following his discussion of the interim report on lessons learnt, Dr Weightman went on to relate some of the other activities in which the ONR had been involved following the accident. These included participation in the IAEA fact-finding mission to Japan and a week-long IAEA Ministerial Conference that took place in June. He also gave an idea of some of the ongoing activities, such as provision of the national report on stress tests on nuclear power stations and participation in European peer review of the stress test national reports.

Dr Weightman finished his talk by summarizing some of the key messages. He emphasised the importance of getting the design basis of nuclear power plants right but also being prepared for severe accidents. In addition he mentioned the need for clarity of the roles and responsibilities of Government, the independent regulator and the nuclear operators. Lastly, he highlighted the necessity for transparency and openness in the nuclear industry and the challenge of continuous improvement. There followed a long series of questions and answers, which served to further illuminate this fascinating subject. The talk generated a lot of interest and was very well attended.

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Julian Murgatroyd is a reactor physicist at AMEC and sits on the committee of the Nuclear Industry Group.

## The Nuclear Industry Group Annual General Meeting

### A report from the Nuclear Industry Group AGM held on 16<sup>th</sup> February

**Julian Murgatroyd**

The first Annual General Meeting of the Nuclear Industry Group was held at IOP headquarters in London on the 16<sup>th</sup> February 2011. Proceedings began with the Chairman's report, in which the Chairman, John Priestland, explained the need for the formation of the Nuclear Industry Group, its objectives, its scope, and some of its intended activities.

Activities will include encouraging professional development through the IOP, arranging speaker meetings across the country, producing a newsletter, commenting on and contributing to the development of IOP policy and responding to external consultations. He also stated that the group intends to liaise closely with other bodies (including the Nuclear Institute and the IOP Nuclear Physics Group).

The Chairman's report was followed by the Honorary Secretary's report. The Honorary Secretary, Rebecca Holyhead, said a few words and then presented the results of the election of members onto the first Nuclear Industry Group committee. The election would have taken place at the AGM were it not for the fact that all of the places on the committee were uncontested. For a brief introduction to the members of the new committee see the next article.

Next on the agenda was the award of the Nuclear Industry Group's first prize - the Early Career Prize, which will be presented annually to a physicist in the early stages of their career in any of the nuclear industries. The prize is intended to recognize outstanding levels of innovative thinking, enthusiasm and determination in addressing a project or problem in the recipient's working environment.

This year the prize was awarded to Lindsay Cox of AWE for her work on remote detection of nuclear material using cosmic muons. Michael Gifford, Treasurer of the Nuclear Industry Group, announced the award. He described Lindsay's work and listed some of the impressive achievements that had led to Lindsay being selected for the award. Lindsay was then presented with a certificate and her prize.



**Lindsay Cox of AWE receiving her Early Career Prize from John Priestland**

The final item on the agenda, prior to the ensuing speaker event, was the launch of the IOP's new nuclear industry careers guide, entitled "The Nuclear Industry – Opportunities for Physicists". Vishanti Fox, Careers Manager for the IOP, introduced the guide, saying a few words about what it contains and how it came to fruition. The guide can be downloaded from the IOP website and hard copies are also available free of charge.



**John Priestland and Vishanti Fox with the IOP's new nuclear industry careers guide**

## Meet the Committee

### A brief introduction to the newly elected committee of the Nuclear Industry Group



**Chairman: Mr John Priestland CPhys FInstP**

John Priestland is Group Commercial Director at Hyder Consulting and a Fellow of IOP. He has worked on projects for AWE, British Energy, DECC and new build consortia. He is a former Energy civil servant and has a MBA from London Business School. He was a founder member of the Nuclear Industry Group and has been Chairman since its inception.



**Secretary: Miss Rebecca Holyhead MInstP**

Rebecca is a Senior Consultant in the nuclear team at PWC, having previously been a project manager at the World Nuclear Association, NUKEM and Atkins. She has an MSc in Radiation and Environmental Protection from the University of Surrey.



**Treasurer: Dr Michael Gifford CPhys MInstP**

Michael has worked in a number of sectors within the large engineering consultancy that is Atkins. Previously he spent longer than is usual studying and researching the physical mechanisms taking place in energetic materials under high strain rates (playing with explosives). In addition to work Michael is a keen sailor during the summer months and enjoys skiing in the winter.



**Ms Heather Beaumont CPhys MInstP**

Heather is Head of Profession for Physics and Team Leader for Physics and Licensing in AMEC's Existing Nuclear Business based in Knutsford, Cheshire. Heather has been in the nuclear industry with AMEC and its predecessor organisation NNC for 20 years. Her technical background is in reactor physics and she has worked on many physics based projects for a number of reactor types. She now leads a team working on AMEC's portfolio of UK and international nuclear projects covering a range of physics based technical disciplines.



**Dr Elizabeth Duggan AMInstP**

Elizabeth Duggan studied physics at Leeds and worked on her doctorate at the University of Sheffield. She has worked in the Nuclear Industry for four years as a radiological safety assessor at Sellafield. She is an active member of her local regional IOP branch, and was an interim member of the Nuclear Industry Group during its formation.

**Dr Ian Holloway CPhys MInstP**

Ian is a graduate of Birmingham and Surrey Universities. His career began as an oil reservoir physicist for BP Exploration at Sunbury on Thames. Thereafter he relocated to Ipswich to work for University College Suffolk. Ian joined Royal Naval College Greenwich in 1997 as Principal Lecturer and now has the role of Nuclear Physics Group Manager in the Nuclear Department DCMT in Gosport. Ian has research interests in radiation detection, shielding and nuclear accident response.

**Dr Steven Judge CPhys FInstP**

Having spent much of my working life at the National Physical Laboratory, I'd describe myself as a radiation metrologist, leading research projects for radiation protection, environmental monitoring and radioactive waste measurement. I've also worked in the commercial world, supporting the manufacture of radiopharmaceuticals for imaging and cancer therapy, and marketing products for radiation measurement. I'm currently working for Magnox Ltd at Dungeness, where I've set up a new laboratory for waste clearance and site characterisation. In my spare time, when I'm not trying to repair an old yacht, I'm Managing Partner of Radiation Science Services (a technical writing and training company).

**Dr Julian Murgatroyd CPhys MInstP**

Julian started his career in experimental nuclear physics research but after six years as a postdoc he left academia to pursue a career in the nuclear industry. He joined NNC (now part of AMEC) as a reactor core physicist and has worked on a variety of projects in the reactor physics area, some concerned with the safety of operating reactors and others with the design of future reactors, including sodium-cooled and gas-cooled fast reactors, pebble bed and prismatic high temperature reactors and accelerator driven systems.

**Dr Simon Richards CPhys FInstP**

Simon Richards began his career in 1991 as a research student in nuclear fusion plasma physics at the Joint European Torus (JET). He then spent a number of years working in the defence industry (DRA/DERA/QinetiQ), becoming a QinetiQ Fellow in 2005. In 2008 he returned to the nuclear industry when he joined Serco at Winfrith, where he currently works on the development of Monte Carlo radiation transport models for nuclear criticality, reactor physics and radiation shielding applications.

**Dr John Roberts CPhys MInstP**

John is Nuclear Fellow at the Dalton Nuclear Institute at The University of Manchester. He has previously worked at the Universities of Sheffield and Leeds and the Rutherford Appleton Laboratory since obtaining his PhD in Nuclear Physics from the University of Liverpool. As well as being a member of the IOP he is a member of the Nuclear Institute and Secretary of the Nuclear Academic Industry Liaison Sub-Committee. He is very active in promoting and developing nuclear education and training initiatives through participating as a Technical Expert for the IAEA on Nuclear Knowledge Management Assist Missions and development of the Nuclear Liaison ([www.nuclearliaison.com](http://www.nuclearliaison.com)) and NLTV ([www.nltv.co.uk](http://www.nltv.co.uk)) websites.

**Dr David Tattam CPhys MInstP**

David is Head of Physics Group at GE Healthcare based on The Grove Centre site (at Amersham). He is also the Head of the Dosimetry Services and Qualified Expert for the UK sites. The Physics Group operates the Dosimetry services, environmental assessment services, the UKAS accredited calibration laboratory, Solid Waste assessment and Radiation Protection Instrumentation services.

**Mr Geoffrey Vaughan CPhys MInstP**

HM Superintending Inspector (Nuclear Installations), ONR. In my 37 years in the nuclear sector I've worked on safety research in UKAEA and as Fast Reactor Safety Section Head in NNC. I joined NII in 1988 and have done a variety of jobs and now head the ONR/UK work on international nuclear safety standards. I'm pleased that the NIG has been established as it is a recognition that not all physicists in the nuclear world are nuclear physicists. As NII has recently become the ONR, it seems every organisation I work for disappears! I am determined to do my bit to ensure the longevity of the NIG

***Nuclear Physics Group representative: Dr David Ireland CPhys MInstP***

David Ireland chairs the IoP Nuclear Physics Group, and is in the nuclear physics research group at the University of Glasgow.

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## Nuclear Warhead Science in the CTBT Era

### A report on the talk given by Dr Daryl Landeg, AWE Chief Scientist, following the AGM

#### **Julian Murgatroyd**

On the 16<sup>th</sup> February, after concluding the Annual General Meeting, the Nuclear Industry Group was pleased to welcome Dr Daryl Landeg, Chief Scientist at AWE, who gave a fascinating talk on nuclear warhead science in the era of the Comprehensive Test Ban Treaty (CTBT). Dr Landeg started by giving a historical overview of the development and early testing of the UK's nuclear deterrent. He explained that testing began with atmospheric tests in the 1950s and moved to underground tests in the 1960s but the last underground test by the UK was in 1991. The CTBT, which bans nuclear explosions of any kind, was signed by the UK in 1996 and ratified in 1998.

Dr Landeg then went on to describe the early foundations of nuclear warhead science in the

CTBT era, which essentially relies on the simulation and measurement of conditions in a nuclear explosion without actually performing such an explosion. He indicated that the main experimental tool was X-ray radiography of simulated explosions. Explosions can be simulated using full-scale mockups with conventional explosives or by compression and heating of small samples using high power lasers, the latter technique also being used for inertial confinement fusion research. A list of pulsed power radiography facilities that have been used over the years was presented, including AWE's HELEN laser facility. HELEN operated for 30 years, finally closing in 2009 to be replaced by a substantially more advanced facility named ORION.



**Dr Daryl Landeg presenting his talk on nuclear warhead science in the CTBT era**

Dr Landeg went on to describe the fundamentals of early and modern weapon design and the key physics involved. He then described some of the tools and approaches used by AWE in their research. This included analysis of existing underground test data, use of multiphysics hydrocodes, plasma physics, hydrodynamics and high performance computing. He also stressed the importance of multidisciplinary teamwork.

A description of the new laser facility at AWE, ORION, was presented. ORION represents a

significant advance on HELEN and is a unique facility in Europe. It can heat a sample in its target chamber to millions of degrees in less than a nanosecond and the heat and compression can be controlled with unprecedented precision. Dr Landeg said that a portion of the ORION beam time will be made available to the academic community, which will be the first time that access to an AWE facility has been granted to academic researchers.

In addition to using their own facilities, Dr Landeg explained that scientists at AWE also collaborate with scientists at the National Ignition Facility in the US, which is the largest laser facility in the World. In addition, a collaborative agreement has recently been reached with France. Dr Landeg finished his presentation by summarizing the recent technological progress at AWE and an assessment of the current status and future outlook. The talk was very well received and there were several questions from the floor, after which the Group Chairman thanked the speaker and the Group Secretary presented him with a token of the Group's appreciation.

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## CONSORT: The UK's Remaining Civil Research Reactor and the Proposed 'Energy Amplifier'

**Steven Judge**

The Imperial College London Reactor Centre was the setting for the Nuclear Industry Group's inaugural event. In October 2010 some twenty members of the group travelled from across the UK to meet the Reactor Centre staff and to hear about the history of the reactor and its applications.

The centre was set up as part of Imperial College to support the expanding nuclear industry in the 1960s (for more details, see [www3.imperial.ac.uk/reactorcentre/aboutthecentre/history](http://www3.imperial.ac.uk/reactorcentre/aboutthecentre/history)). The 100 kW CONSORT reactor went critical in 1965, only two years after the funding was agreed. Since then, the centre has helped train many of the UK's nuclear engineers and physicists. Its role has expanded to include research in environmental monitoring, radiopharmaceuticals, materials

science, reactor instrument calibration and forensics.

The reactor is reaching the end of its operating period and preparations are in hand for decommissioning. But before it closes, there is an intriguing proposal to contribute to the design of the next generation of reactors. The suggestion is to modify the reactor to act as a test bed for an accelerator-driven sub-critical reactor (the 'energy amplifier' advocated by Carlo Rubbia of CERN).

Our thanks to Trevor Chambers, Heather Phillips, David Bond, Sami Kafala and Nassar Mirzai-Baghini for hosting a fascinating visit.

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Stephen Judge currently works for Magnox Ltd at Dungeness, where he's set up a new laboratory for waste clearance and site characterisation.



## The Physics of the EPR and AP1000

### A report on the first speaker event held by the Nuclear Industry Group

**John Priestland**

In November 2010 the IOP Nuclear Industry Group was fortunate to have, for its first speaker meeting, talks from Keith Ardron (UK Licensing Manager at Areva UK) and Simon Marshall (GDA Project Director at Westinghouse UK). We had a great turnout with more than 100 people in the lecture theatre at the Centre, Birchwood (Warrington).



**Keith Ardron presenting the physics of the EPR at the Nuclear Industry Group's first speaker event**

Keith Ardron explained that the EPR is a Generation 3+ PWR design – effectively an evolutionary development of the most recent French and German PWRs (N4 and Konvoi designs). However the EPR has a higher net electrical output, thermal power, efficiency and design life than these earlier designs. He said that 40 EPR units could supply 100% of the UK's electricity demand. EDF plans to construct 4 EPR units in the UK with a total output of 4x1650 MW(e). The first unit is targeted for operation in 2018. This will be a twin unit plant at Hinkley Point in Somerset.

Keith described Areva's design philosophy to be the "practical elimination" of risk. He spelt out a number of dedicated features that have been included in the design to address severe accident challenges. These include: dedicated valves for rapid depressurization of the RCS at high temperatures; autocatalytic hydrogen recombiners to minimize the risk of hydrogen detonation and electrical and I&C systems dedicated and qualified to support severe accident mitigation features.

He concluded by summarising progress to date on the Generic Design Assessment and how important the GDA timetable is for the development of new nuclear build going forward.

Simon Marshall discussed the passive safety features on the AP1000. Following a physics theme, he explained the benefits of passive systems, including passive core cooling systems and passive containment. The impact of passive systems can hugely reduce the amount of equipment required, for example: 50% fewer safety grade valves, 35% fewer pumps and 45% less seismic building volume.

He set out a programme of four new reactors under development in China and six in the US. Simon added that the AP1000 is a modular design and how modular construction is hugely reducing the time it is taking to construct AP1000s in China with a five times reduction in the number of hours required on site. Whereas Sizewell B required 520 m<sup>2</sup> of concrete, an AP100 requires less than 100 m<sup>2</sup>. It is credible to imagine that the design life of the AP1000 could be extended to 100 years or beyond.

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John Priestland is the Group Commercial and Major Bids Director of Hyder Consulting and is Chair of the Nuclear Industry Group

## Funding crisis in nuclear physics research

**David Ireland**

The Comprehensive Spending Review settlement last autumn brought little cheer to most people, but there was a barely audible sigh of relief from the scientific research community. We learned that there would be a “flat cash” settlement for the funding councils. This was widely regarded as the least worst outcome, and was the result of effective lobbying from a number of sources, including the “Science is Vital” campaign and the research councils themselves. Allowing for a ring-fenced budget for the Medical Research Council that takes inflation into account, the other research councils now have to deal with a small decrease in funds and take a hit with inflation, as well as a reduction of 40% in capital expenditure. This is intended to be the long-term funding model, not just a temporary belt-tightening exercise. And the good news? Well, within the Science and Technology Facilities Council (STFC), the amounts intended for grants prior to the last general election will remain as had been planned before the CSR.

Having said that, the future for nuclear physics research still looks grim. STFC looks after research in the “fundamental” research areas: Particle Physics, Astronomy and Nuclear Physics. A prioritisation exercise in late 2009 delivered a savage cut to several nuclear physics projects that had previously been approved and funded by STFC, and has subsequently left the nuclear research community pondering whether it really does have “critical mass”.

Here are some facts and figures, if you are not already aware of them. The number of permanently appointed academics in the UK in nuclear physics is about 60. Compare this figure to that of our major EU competitors: Germany (330), France (350), Italy (350). At M€ 11.7 per annum the amount of research funding in the UK is also low compared to competitors: Germany (M€ 200), France (M€ 87.5), Italy (M€ 64.8). The net result is an amount of financial research support that places the UK behind

countries such as Poland and Romania in a European league table<sup>1</sup>.

About the same time as the cuts to nuclear physics projects were being announced (the week before Christmas 2009!), a panel chaired by Dame Dr Sue Ion had just published its report of a review of nuclear physics and nuclear engineering in the UK<sup>2</sup>. This review had been carried out by both STFC and EPSRC (Engineering and Physical Sciences Research Council). Among several thoughtful comments, the panel noted that “countries with large-scale nuclear power industries such as France and the US also have relatively large pure nuclear physics research programmes.” Whilst the panel could not prove a causal connection between the two, it recommended to STFC that it examine “whether operating support for nuclear physics research at a level significantly below international OECD norms is strategically justified”. STFC considered this, and rejected it!

Another fairly strong recommendation from the review was the recognition of the need for a vibrant research base and a pool of trained UK nationals when considering the UK’s future energy security. The panel recommended that “the Research Councils work in concert to optimise the links between nuclear engineering, nuclear physics and industry”. That has not yet happened, partly excused by the intervening change of government and spending review. However, I do not hold out a great deal of hope that anything will happen soon.

So where does that get us? With the remaining modest STFC funding, nuclear physics research will almost certainly stagger on, making the most of the crumbs of support that it does get, because it continues to attract small

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<sup>1</sup> These figures come from the NuPNET Report 2010, published by a committee of representatives from European research councils ([http://www.nupnet-eu.org/wps/portal/documents-pub/Nupnet\\_Web\\_05012011.pdf](http://www.nupnet-eu.org/wps/portal/documents-pub/Nupnet_Web_05012011.pdf))

<sup>2</sup> EPSRC/STFC Review of Nuclear Physics and Nuclear Engineering (<http://www.stfc.ac.uk/Resources/PDF/ReviewNPNE.pdf>)

numbers of bright and resourceful young scientists. There is no doubt in my mind that development of research-industry partnerships is most likely to be achieved from the ground up. The Ion Review also commented that the nuclear physics and nuclear engineering communities should “seek better research links in areas with potential for future economic impact”. In that respect, the research community needs to build on the links it already has, to make the most of the skill sets and expertise that it does have, and encourage industrial partners to create collaborations for the development of new applications of nuclear science.

For the research community, it is therefore timely that the Nuclear Industry Group has been established. The group has already provided letters of support in the campaigns to highlight the lack of research funding, and I look forward to a fruitful working relationship with the Nuclear *Physics* Group. I am delighted to have been asked to write this piece in the inaugural Nuclear Industry Group newsletter, I wish the group every success and I hope to continue my association with it.

David Ireland chairs the IoP Nuclear Physics Group, and is in the nuclear physics research group at the University of Glasgow.

## Notices

### Forthcoming Events

#### ***The Physics of Diagnostic Nuclear Medicine***

Dr Brian McParland

7:00pm, 19 Oct 2011, Institute of Physics, 76 Portland Place

Dr McParland is the Head of Medical Physics at GE Healthcare Medical Diagnostic (formerly Amersham plc). His talk will focus on the role that physics plays in diagnostic nuclear medicine.

**To register for this event, please go to:**

<http://www.iop.org/events/scientific/conferences/y/11/nuclear-med/index.html>

### Prizes

The Early Career Prize for 2010 was presented to Lindsay Cox of

AWE at the inaugural AGM as discussed in an earlier article. A call for nominations for prizes for 2011 will be issued later in the year.

### CPD

Further information relating to CPD will be circulated in our the next issue of the news letter.

### Notable Member Achievements

Chris Holland, of AMEC, has been awarded second place in the prestigious ‘Graduate Employee of the Year’ category of the annual National Graduate Recruitment Awards in London. The competition came from all business sectors across the UK and Chris was one of only 10

graduates short listed in this individual category.

Do you have any news you would like to share in future issues of the newsletter? For example, winning a prize or becoming a full member of the IOP, or perhaps even a fellow. If so please send the details to one of the committee members.

### Items for the newsletter

Submit an article – we’d like to hear what you’re doing, what you think of the Nuclear Industry Group, any ideas you may have for networking opportunities or anything else you think would be of interest to the rest of the group.

This newsletter is also available on the web and in larger print sizes

The contents of this newsletter do not necessarily represent the views or policies of the Institute of Physics, except where explicitly stated.

The Institute of Physics, 76 Portland Place, W1B 1NT, UK.

Tel: 020 7470 4800

Fax: 020 7470 4848