# IOP | Institute of Physics
## Nuclear Industry Group

NEWSLETTER

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# Contents



## Notes from the Chair

Once again it is my pleasure as the Chair to introduce this, our 9th Newsletter, to all members of the Nuclear Industry Group (NIG). This newsletter is one of our main vehicles of communication with you and so once again we must again thank Alfie O'Neill for his hard work in producing it. My thanks also go to all those who have contributed articles and given up their free time to support the group. It has been a pleasure to work with our committee without whom the group would not be so successful and smooth running.

Later this year we will have some committee positions opening and we expect to be holding elections in the coming months so keep an eye on your inbox for the election call. Speaking from experience, I have found that being involved on an IOP Group committee opens the door to a range of

interesting activities and networking. It is also great CPD! It also provides the opportunity to help influence issues that affect our industry at a national level via engagement in IOP and input to IOP submissions to government consultations.

Over the past year we have held a number of events and have a programme of events for the remainder of 2019. In May we held an evening lecture given by Tony Judd entitled Reflections on Fast Reactors. This was an engaging lecture delivered by a world recognised Fast Reactor expert whose career spanned over 40 years in the industry. In June we co-hosted a full day event on the Lifecycle of Radionuclides in Medicine at IOPs new headquarters in London. This event was well attended and included a couple of lively panel sessions debating the potential implications of the UK's exit from the EU on the supply of radionuclides for medicine. I certainly learned a lot at this, including being introduced to the nomenclature norms used in radiochemistry – you can find an article on this later in this newsletter. We held two events in October. The first, jointly hosted by the Energy Group was part of IOP's Spotlight on Physics Event and focusses on the UK Nuclear Innovation Programme and providing an overview of some of the interesting physics related projects that are being carried out by the nuclear industry. We are planning on holding a longer seminar in 2020 which will include more detailed technical presentations around these topics. The second meeting the following week was at the University of Bristol and included four speakers from UKAEA focussing on Technologies for Fusion Energy, looking at such challenges as design materials to tritium technologies to robotics and remote handling. We have an ambitious programme of events in the planning stages for 2020 and hope to meet you at one of them.

Earlier this year, those of you who are chartered with IOP will have received some communication about maintaining and providing evidence for your CPD. Later in this newsletter you can find an article providing some nuclear industry specific examples and suggestions for CPD.

I hope that you find this newsletter interesting, as always, we value the comments and suggestions of you, our members, and any suggestions of event topics that you would find interesting or would like to participate or see us explore further would be welcomed so do please get in touch. Don't forget to look for us on Facebook and LinkedIn. On that note wishing you all a successful year.

**Heather Beaumont**
**Chair - IOP Nuclear Industry Group**

## Join the NIG Committee

IOP groups are at the forefront of advancing physics. Help drive your discipline forward by joining the Nuclear Industry Group committee. The group is now seeking new committee members and invites nominations for the positions of Ordinary Member. Please look out for a formal call notice that will sent out by IOP in the next few months.

The Nuclear Industry Group (NIG) was formed in 2010 as a group for physicists involved with, or interested in, the nuclear industry. The NIG is concerned with all aspects of the industry, including both the civil and defence-related sectors and reflects the diverse roles that physicists have within it. It normally meets once a year, with additional short teleconferences held as necessary. We hold relevant speaker meetings throughout the year, tours to facilities and actively promote the Nuclear Industry in the UK.

Meetings are held in a variety of UK locations to reflect the geographical spread of our members and at times which are sensitive to regular working hours. We particularly support professional development and networking opportunities. We encourage members to achieve formal status as physicists, such as achieving Chartered or Fellow status with the IOP and to continue to develop themselves throughout their career. The networking opportunities offered by the group help support this development, as well as providing opportunities to make contact with physicists with a wide range of backgrounds.

# Nuclear Industry Group Prize 2019

**Article by: Alfie O'Neill**

This year the Nuclear Industry Group was pleased to award both an Early Career Prize and a Career Contribution Prize. The prizes were presented at our June evening seminar by the group chair, Heather Beaumont.

The Early Career Prize is for physicists in the early stages of a career in the Nuclear Industry and is awarded to the nominee who the judging panel feel has displayed outstanding levels of innovative thinking, enthusiasm and determination in addressing a project or problem in their working environment.

This year the prize was awarded to **Jacob Home** for his work at the International Youth Nuclear Congress. On top of a day job at Horizon Nuclear Power, Jacob is the UK representative to the International Youth

Nuclear Congress and as part of this role was asked to chair the Opportunity Fund committee. This committee is intended to use the IYNC budget to support nuclear innovation and education initiatives worldwide through grants of up to $20,000 from a budget of $230,000. These include supporting the establishment of young nuclear professional networks in developing countries, supporting attendance to international conferences and science education programmes worldwide.

Jacob gathered an international team from over five continents to develop the process for assessing proposals for funding. His analytical approach to this challenge demonstrated his business skills at the same time as interpersonal and communication skills while coordinating such a geographically diverse team.

The Career Contribution Prize is for a physicist who has spent a substantial portion of their career in the nuclear industry. It is to be awarded to the nominee who the judging panel feel has most fully displayed outstanding levels of innovation and contributed to the progress of the industry over a sustained period. The nominee must have displayed outstanding commitment to the promotion of the nuclear industry throughout their career.

This year the prize was awarded to Professor **Jon Billows**, Head of the Nuclear Physics Group at the University of Manchester School of Physics and Astronomy. Following the publication of the “Nuclear Education in British Universities” report in 2002 and its statement that “if nuclear education were a patient it would be in intensive care”, the University of Manchester established the Dalton Nuclear Institute with Prof. Billowes appointed as Director of Education. Following the recommendations of the report Jon set about establishing a Master’s level programme in nuclear science and technology that would meet the needs of industry by providing nuclear university education for both students prior to entering the nuclear industry and the existing workforce. In the subsequent 14 years over 1200 students have taken at least one of the NTEC modules with 200 full-time students graduating with a MSc in Nuclear Science and Technology, of which over 80% are either employed by the nuclear industry or continue with further nuclear studies. This is not the only contribution he has made, as Head of the Nuclear Physics Group in Manchester he has directly supervised over thirty nuclear PhD projects to completion, published over 230 papers on nuclear research and established the Applied Physics

Research Group at The University of Manchester which works on neutron cross section measurements, fission yield measurements and nuclear codes to support the UK nuclear industry.


We're sure you'll join us in congratulating the two very worthy recipients.

The calling notice for the 2020 Nuclear Industry Group prizes will be released later this year where we will be looking for nominations for both an Early Career prize and a Career Contribution prize. So, if reading the above has reminded you of any of your colleagues or friends please get drafting those submissions!

# Event – Fast Reactors

**Article by: Alfie O'Neill**

In May this year Tony Judd gave an excellent talk on the UK's Fast Reactor programme. Tony has more than forty years' experience in the industry, including as Chief Technologist for Fast Reactors and was responsible for the entire UK national fast reactor R&D programme.

Starting with some physics and examining the neutron interaction cross sections, Tony explained how the neutron economy in fast reactors can be used to breed more fissile material than is being used. As neutrons being absorbed in fast reactors have energies in the 100 keV to 1 MeV range and don't require significant amounts of moderating material, the cores are typically smaller than their thermal counterparts, with around 10 times higher powder densities. As the neutrons in a fast reactor aren't thermalized, neutron poisoning is not an issue so there are less restrictions on the choice of materials used in the core. Long neutron mean free paths also mean fast reactors have well coupled cores and a positive void co-efficient means gives some inherent safety.

Examining the economic argument for Fast Reactors, Tony presented figures from the World Nuclear Association showing that fossil fuels hold reserves of around 70 ZJ of energy. Considering 'recoverable reserves' or

*The fastest reactor? – A "ЛУРА" (Alfa) class submarine (1969-81) was powered by a 155 MW fast reactor and could achieve a speed of 76 kph.*

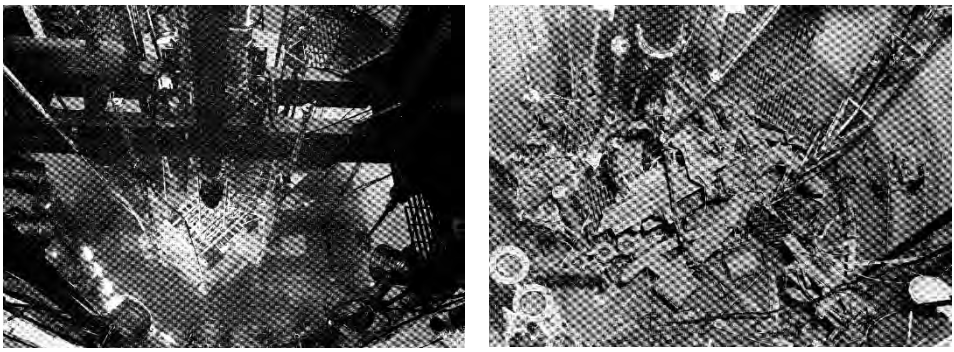
uranium at up to $130/kgU, thermal reactors could produce around 10 ZJ of energy, whereas fast reactors (assuming a breeding ratio of > 1) could produce almost 300 ZJ. The UK currently holds a stock of ~ 125,000 te of depleted and natural uranium, in fast reactors this could yield ~6 ZJ of energy, and currently we only use 0.01 ZJ/year.

The talk then examined the choice of coolant to be used in a Fast Reactor, ideally looking at a liquid or high-pressure gas to deal with the high power density, but with a high atomic mass to minimise moderation. Sodium has the advantage of being cheap, light and we have extensive experience using it, but it reacts with water and has a relatively low boiling point at ~900°C). A lead-bismuth eutectic coolant would be chemically inert and non-moderating, but is corrosive and expensive. Helium or carbon dioxide gas has a significant advantage in that it is transparent, but requires high pressures and pumping rates. Although we have operating experience with sodium coolant in fast reactors, there is always an unavoidable risk of a leak in the steam generators, meaning intermediate circuits are required to avoid venting the primary coolant in accident scenarios.

Tony then went on to consider national fast reactor development programs, detailing the achievements and results of several nations forays into the field. The UK Fast Reactor Project (1953-1993) invested around 40,000 professional person-years in the development of test reactors (ZEPHYR, ZEUS, ZEBRA) and power reactors (DFR, PFR) and achieved: closing the fuel cycle, 20% burnup in $MO_x$ fuel, commercial licensing and near trouble-free operation of the reactors. However, the UK programme at Dounreay was hampered by issues with the steam generation system which was prone to single point component failure and an unreliable design. Despite this the core itself ran well.

Core disruptive accidents are a concern for fast reactor designs, given the prompt neutron lifetime of < 1 μs. In addition, a significant reactivity excess is available in the core as the design is not inherently in its most critical configuration. This leads to the question: can a fast reactor explode like a bomb? Doppler broadening provides a potential shutdown method in an accident scenario as the core's temperature increases. The Special Power Excursion Reactor Test (SPERT-1) in 1961 showed that whilst Doppler broadening did indeed shutdown the reaction, the thermal / pressure vapour

excursion caused an explosion! Extensive tests and appropriate pessimistic assessments are therefore required to demonstrate safety.



*The SPERT-1 test reactor before and after the experiment.*

Looking to the future, the ASTRID design used a plate fuel configuration to reduce the positive void coeffient in the centre of the core under loss of coolant and had fuel channels design to remove molten fuel to a sub-critical configuration in the event of a meltdown. Other designs for inherently sub-critical assemblies are also available.

The UK has recently re-joined the Generation IV International Forum looking at the development of future reactors, though this requires support from the government. In Russia there is an increasing deployment of fast reactors and in China extensive development is ongoing. India is working towards a thorium fuel cycle (potentially achieving this around 2040) and has the world's only $^{233}U$ fuelled reactor. Tony concluded by stating that if nuclear has a place in the future energy mix the fast reactors will be required as $^{235}U$ stocks are finite, and far from a technological dead end they have significant potential but require national and international programmes of work to unleash this.

# Event – The Lifetime of Radionuclides in Medicine

## Article by: Robert Shearman

On June 7th 2019 the Nuclear Industry Group were pleased to host a joint event with the IOP Medical physics group. The event entitled “The lifecycle of radionuclides in medicine” was held at the IOP HQ in King’s Cross and was aimed at synchronising the discussion and discourse of two different sectors when discussing radionuclides – a topic becoming more and more interesting to medical physics as the world begins to better manage and even look past the ubiquitous Tc-99m. The day was held across two sessions, where a panel discussion of all the speakers of the session drew each to a close. All of the sessions were of great value, and a few highlights are included below.

The first session was started by our chairperson Heather Beaumont (Wood) who outlined the role of radionuclides in medicine and created a basis in which all of the future discussions could take place within.

Jim Thurston of The Royal Marsden NHS Trust presented the first of his two talks of the day on a potted history of radionuclides within medical physics, uses, nuclides, and techniques were all covered.

Bev Ellis of Central Manchester University Hospitals NHS Foundation Trust then took the stage highlighting the security of current radionuclides in use, mainly Tc-99m. This radionuclide has a 6 hour half-life and as such is “milked” from the parent Mo-99, which has a more manageable 66 hour half-life. The production of Mo-99 occurs within a nuclear reactor – it is particularly well populated nuclide following fission. This current methodology is not favourable, as the HEU (highly Enriched Uranium) reactors will not continue to produce Mo forever. Bev highlighted such a problem and how in Europe observatories have been set up to monitor and better manage the supply chain of Mo, through better planning and communication between all of the supply chain; target production, irradiation, processing , generator production and finally to the end user. LEU reactors capable of Mo production and different technologies using (p,2n) reactions on Mo-100 were discussed and the associated problems with this discussed in meeting the world’s demand. Finally the changing legislature and possibilities in the future following any possible exit date from EURATOM and what that would mean for the U.K. was breached.

Tony Gee of King's College London presented on Radiochemistry and nuclear metrology at NPL for energy and environment, forensics, life sciences and health applications.

Peter Ivanov and Andrew Robinson of the National Physical Laboratory then delivered a presentation in two parts. One on the move to quantitative images. Whereby the image of a patient taken by a SPECT or PET camera can be linked back to the SI unit for radioactivity (the Becquerel) so that the patient's image can allow for patient specific treatment and diagnosis. Such a system from which greater understanding can be taken from the image, requires traceability from a primary radioactivity standard, through a secondary standard such as a ion chamber 9or hospital calibrator). Andrew elaborated on how NPL have made efforts to complete the circle of quantitative imaging through the use of a multi-modal imaging camera. Peter then discussed the radiochemical separation of emerging radionuclides, most noticeable the therapeutic Tb quartet, which can be used as thera(g)nostic radionuclides and imaging nuclides. Tb was made at CERN using the high energy proton beam and the steps taken to separate the nuclide from cerium oxide was presented as well as the efforts made at NPL to improve the nuclear data such as the half-life, and the gamma emission probabilities.

In this panel session the debate was quite lively to say the least! Talk focussed on the nomenclature of the industry, from whether; radio-isotope is ever correct, the difference between radionucleotide vs radionuclide and beyond, please see the links below for the correct vocabulary. Perhaps more interesting was the nature of the debate on the difference of the Becquerel vs the Hertz. Of course any question and answer session was in the current climate would not be complete without the B word, which was addressed in how the UK would be treated within observatories in any post Brexit landscape. Other notes were made discussing the different rates of use for different countries across the world.

- Consensus nomenclature rules for radiopharmaceutical chemistry — Setting the record straight: https://doi.org/10.1016/j.nucmedbio.2017.09.004
- Open letter to journal editors on: International Consensus Radiochemistry Nomenclature Guidelines: https://doi.org/10.1186/s41181-018-0047-y
- Status of the 'consensus nomenclature rules in radiopharmaceutical sciences' initiative: https://doi.org/10.1016/j.nucmedbio.2019.05.001

In the second session the talks away from the uses of radionuclides in medicine focussing on the before and after, primarily the use of accelerators in the production of nuclides, as well as the novel techniques that could be used in the future to harvest nuclides from the "waste" left in nuclear industry sites.

Hywel Owen from the University of Manchester opened the proceedings discussing the nature and benefits of different accelerators used in the production of nuclides, and how these might be used in the future, specifically in the UK.

David Parker of the University of Birmingham, then presented a very detailed and informative case study of how the university delivers a GMP accredited radioisotope using its MC40 accelerator as well as how the accelerator is more broadly utilised, as well as covering the previous accelerators used in institutes across the UK. The specific radionuclide produced by Birmingham is the gas 81mKr which of particular importance for lung ventilation imaging to diagnose possible pulmonary embolisms. The direct reaction is the (p,2n) reaction on 82Kr gas for the parent nuclide 81Rb which decays in 4.4 hours to 81Kr. Perhaps most of interest to the audience was the nuances and intricacies of the regulated procedure of how clinical radionuclides are produced, furthermore the sheer scale at which one accelerator is used to produce a radionuclide, 5 days/week 50 weeks/year with around 96 % success rate.

Tim Tinsley from the National Nuclear Laboratory (NNL) addressed the audience on recovering useful radioisotopes from nuclear industry waste. Tim highlighted known cases, such as Pb-212 being used as a targeted alpha therapy nuclide, Sr-90 a beta emitter associated with the well-produced Sr-90 present on many waste streams and the possibility. Tim

highlighted the case of Am-241 from NNL stock used in the development of space power for the European Space Agency (ESA). Throughout the talk, in keeping with the spirit of the overall event the benefit of cross field collaboration, suggesting it is not always clear to the owner of radionuclide matrices the possible benefits of them, “where there is muck there is brass!”

Jim Thurston was the final speaker of the event, bringing it to close by presenting the final fate of radionuclides in the medical sector. Jim, in his position as a health physicist guided the group through the necessary procedures required to properly dispose of all the various waste streams that could be envisaged whilst a patient in a hospital is being treated. From the good accountancy of record keeping, the assessments of all different waste vectors, good practice for when handling with a third party. Jim also presented the necessary contingency plans and risk assessments needed while storing radioactive waste, from fire hazards to flood possibilities!

The final panel session echoed Tim’s talk calling for greater community across the sectors and better understanding how one could help the other.

# Event – Technologies for Fusion Energy

## Article by: Jamie Townes

Public Seminar, University of Bristol, 29th October 2019

The Institute of Physics Nuclear Industry Group brought the UKAEA together with the South West Nuclear Hub for an evening exploring some of the new technologies that will be needed to realise the fusion power station of the future. With the UK at the forefront of nuclear fusion research, experts from the UKAEA talked about where the challenges and opportunities lie.

The event was organised to reach out to an audience beyond the fusion field, including companies, experts and institutions that might be able to bring new engineering solutions from outside the sector. Following an overview of the global fusion landscape by Alexandra Davies, the event covered:

**Designing Materials that Withstand Fusion by Jason Hess, UKAEA** – the materials that a fusion power plant will be composed of have very interesting requirements. For example, the components that face the 150 million degree plasma must endure its heat and hitherto unknown radiation loads. Jason explored why designing these 'plasma facing components' is so challenging.

**Maintaining the Reactor: Robotics and Remote Handling by Iain Farquhar, UKAEA** – after an operational history of over twenty years carrying out remote maintenance of JET, the UKAEA is facing a series of challenges to maintain its current capabilities, as well as multiple opportunities to share its unrivalled expertise with both domestic and international partners. Iain described some of these challenges and how they are informing upcoming upgrade and maintenance campaigns, and the development of new remote handling technologies.

**Technologies for Tritium by Alexandra Davies standing in for Zoltán Köllő, UKAEA** - Tritium handling in a fusion power plant poses significant challenges. Large amounts of tritium and tritiated materials have to be transferred and processed continuously and efficiently. Technologies from breeding tritium, through separating tritiated gases, to gaining back

tritium from tritiated water have to be advanced. These involve significant amount of research on properties of materials in contact with tritium, changing known processes and developing new ones. Alexandra described how the interaction of tritium with components will influence the design of most reactor elements.

The audience showed a keen interest in the topics covered, with the Q&A producing novel questions in a session that could have run late into the night. The event formed part of the South West Nuclear Hub's programme to raise awareness of advanced nuclear technologies and the opportunities they offer to the region and the country.


UK Atomic Energy Authority

SOUTH WEST NUCLEAR HUB

# Event - Physics Aspects of the UK Nuclear Innovation Programme

**Article by: Heather Beaumont**

The Nuclear Industry Group (NIG) together with the IOP Energy Group (EG) hosted an afternoon speaker event as part of IOP's first Physics in the Spotlight week. This was the first of a new type of IOP forum – four days of discussion, debate and knowledge sharing at the IOP's flagship King's Cross building. Members of IOP special interest groups, including leading thinkers in the physics community in the UK and Ireland, hosted discussions, talks, meetings and panels to foster debate and exploration of a range of key topics in physics. The NIG and EG had the honour of opening the Spotlight week with this event. The event was well attended by over 60 delegates from a range of nuclear industry companies and academia.


The UK Government have indicated that nuclear energy could play a significant role in the UK's future energy mix. To support this Government is currently investing in a multi-year R&D programme to underpin and deliver this policy. In November 2016 BEIS (Department for Business, Energy and Industrial Strategy) launched its Nuclear Innovation Programme (NIP) across five major areas, building on the recommendations set out by a number of external expert bodies, including the Nuclear Innovation and Research Advisory Board (NIRAB) and the joint Government– Industry Nuclear Industry Council. An integrated £180m, 5-year programme funded by BEIS began in 2016 and runs until 2021.

Dan Wolff from NIRO [1](Nuclear Innovation Research Office) opened the event, discussing the key elements of the Governments Nuclear Industrial Strategy, key targets of the Nuclear Sector Deal which was published in June 2018 and how these support the Government's commitments to

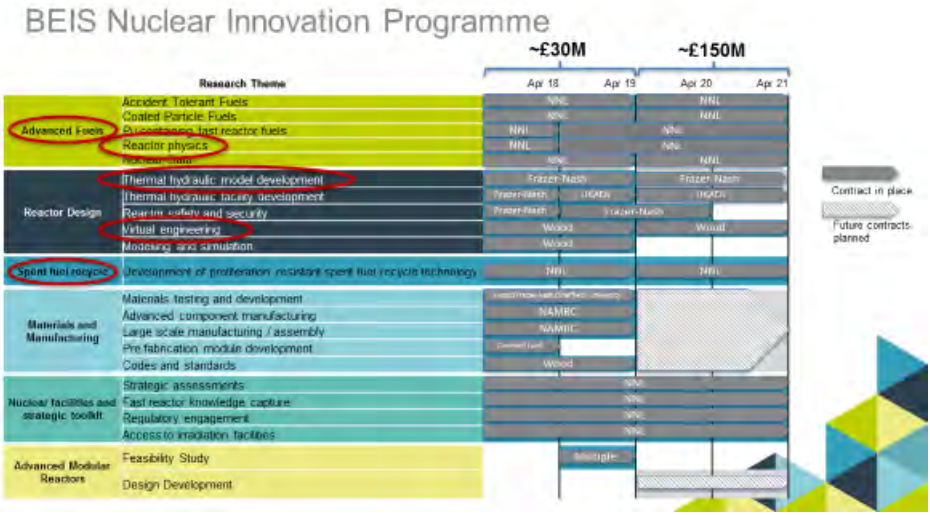
[1] NIRO is a full-time team which, in partnership with NIRAB, forms the nuclear research and innovation advisory framework. NIRO: one of their roles is to facilitate coordination of nuclear innovation and R&D activity and communications within and between Government and industry

reducing carbon emissions in a bid to combat climate change. Dan described BEIS's long term vision for R&D in the UK Nuclear Industry, from engagement in collaborative design projects underway now and into the next decade to re-positioning the UK industry as a significant partner in the global development of Generation III+, Generation IV and SMR (Small Modular Reactor) technologies by 2050.

The R&D programme is grouped into six key areas, addressing NIRAB's recommendations, which aim to develop the UK's current position and exploit future markets whilst securing and developing critical high value skills and jobs. These include:

1. Advanced Fuels – aimed at making more efficient, safe fuels for the future
2. 21st century nuclear manufacture – centred on advanced materials and manufacturing and modular build in nuclear factories of the future
3. Reactor Design – aimed at delivering the people, processes and tools to make the UK the partner choice as globally the unclear industry heads towards SMRs and Generation IV nuclear technologies
4. Recycling Fuel for Future Reactors – aimed at developing cost-effective technologies to deliver a secure and sustainable low carbon fuel supply.
5. UK Strategic Toolkit – to inform and underpin decisions on which emerging nuclear technologies can be brought to market and give the best economic return for the UK.
6. Advanced Modular Reactors

A number of the projects currently underway have a significant physics content and this event included speakers from four of these projects. Albrecht Kyrieleis from Wood talked about the Nuclear Virtual Engineering Capability (NVEC) Project. This project is currently beginning its second phase, the first phase having been completed in April 2019. Albrecht described the Phase 1 project which established a network of UK wide facilities for virtual engineering aimed at facilitating remote collaboration between researchers in industry, national laboratories and academia. He described the two proof of concept use-cases which had been used in Phase 1 to demonstrate the high-level-architecture (HLA) that had been




*Source: NIRO presentation, Dan Wolff.*

established within the project providing a structure for coupling analysis tools together. He went on to describe how the Phase 2 project will build upon the HLA developed in Phase 1 and broaden out to cover a wider range of use-cases relating to both Small Modular Reactors (SMRs) and Advanced Modular Reactors (AMRs). The overall aim of establishing an NVEC is to enhance and reduce the cost of nuclear design and development and to reduce calculational uncertainties. The latter has the potential benefit of reducing margins and allowing more efficient operation and hence potential cost savings.

Beth Slingsby from the National Nuclear Laboratory (NNL) described the Reactor Physics Project. The broad aim of this project is to provide the skillset and tools to be capable of modelling any future reactor system that might be deployed within the UK. Beth talked about why reactor physics modelling is important and the current status of UK modelling in the context of the development, design and licencing of reactor fuels for both near term and long-term deployment. The Reactor Physics project is currently in Phase 2. In the Phase 1 programme a requirements capture exercise was carried out, aimed at deriving a number of recommendations for developing and validating innovative techniques to model the physics and performance of new reactor fuel types. The Phase 2 project builds upon the outcome from Phase 1 and covers current LWR reactors, Generation IV reactors and

reactor fuels. Phase 2 is structured around six tasks focussing on defining and enhancing modelling and simulation capabilities for light water, high temperature reactors and liquid metal fast reactors. The work currently underway includes the development of high-resolution neutronics modelling techniques, thermal hydraulics methods development for High Temperature Reactors, coupling fuel performance and reactor physics codes.

Richard Underhill from Fraser Nash Consultancy discussed the Thermal Hydraulics Project. As with the previous projects presented, this project is currently in Phase 2 which started in 2019. Richard described the vision for the thermal hydraulics projects in terms of creating an enduring, co-ordinated and industry focussed nuclear thermal hydraulics capability in the UK. He described the Phase 1 project (2017 to 2019) which delivered three key objectives, namely, the specification of a new thermal hydraulics facility; the specification of thermal hydraulic model development; the initial innovative model development. The Phase 2 project which began this year and runs until 2021 will focus on industrial application and commercialisation including heat transfer and natural convection; predictive capability for passive safety arguments; upskill UK in modern digital methods; relevant to all SMR and AMR technologies. Phase 2 is focussing on the production of six technical volumes describing good practice for industry and regulators. In addition four case studies (for real SMR and AMR industrial applications) are being carried out to demonstrate the use of these technical volumes. The project will also aim to integrate with the NVEC project.

James Gath and Joel Lucas from NNL talked about the Advanced Fuels project. They delivered an informative talk covering the manufacture techniques for new and advanced fuels. They described the need to maintain a fuel manufacturing capability in the UK and went on to introduce the audience to Accident Tolerant Fuels and Advanced Technology Fuels (collectively ATF), which aim to provide safety improvements in severe accident scenarios (e.g. Fukushima) and economic improvements to help ensure that nuclear remains competitive as a source of low carbon energy. They described various ATF concepts, covering both fuel and claddings. These concepts included Uranium Silicide and Silicon Carbide cladding and coated particle fuels. They provided an overview about manufacturing techniques for these types of fuel and the R&D that is underway to develop these ATFs.

The day closed with a panel discussion which attracted wide ranging questions and discussion from the audience including broadening activities in NVEC to consider fusion reactors; the rationale for excluding thorium fuelled reactors from the NIP projects; leveraging international collaborations and closing the fuel cycle. The panel discussion closed with a debate instigated by the question “What is the biggest thing that would help in terms of developing and leveraging UK capability apart from money?” The suggestions included UK Government backing one reactor design; wider collaboration; resolving perceived barriers around code licences and commercial code licences; developing people to carry forward the vision to 2050.

Overall this event provided a high-level overview of a selection of the physics related projects underway with in the UK Nuclear Innovation Programme. A longer event is in the planning stages for 2020 which hopes to include a wider range of speakers from across industry and academia and more technical topics. We look forward to welcoming you to that meeting.

## Event – IOP Pub Quiz!

Branching out from our usual technical talks, we recently held our first IOP Pub Quiz social, orgainsed with the IOP Lancs and Cumbria Branch and UCLAN PhySoc. Several teams batteld it out through multiple rounds including Science Fact or Fiction and Fantasy Geography as Quizmaster Henry Preston (NNL) kept everyone entertained. In an extremely close finish, the Mitre Taverners just clinched it.

## HBO's Chernobyl

Many of you may have seen the recent HBO television series on the Chernobyl Accident in 1986 (https://www.hbo.com/chernobyl). The dramatisation certainly bought the event back into the spotlight, and there has been a flurry of reviews and opinion pieces on both the series and the event published in the media. Whilst the series was impressive and entertaining, in order to condense the event and response into a few hours of television some artistic license had to be applied. To separate the facts from fiction here's a couple of reviews from reputable sources:

Physics World – Chernobyl is magnificent despite its flaws:
https://physicsworld.com/a/chernobyl-is-magnificent-despite-its-flaws/

World Nuclear News - The drama and the facts about Chernobyl:
http://www.world-nuclear-news.org/Articles/The-drama-and-the-facts-about-Chernobyl

For further information on the event we recommend having a look on the IAEA website: https://www.iaea.org/newscenter/focus/chernobyl

*Jared Harris as Soviet physicist Valery Legasov in Chernobyl (Image from Physics World, courtesy of Sky).*

# Continued Professional Development

**Article by: Heather Beaumont**

Those of you who are Chartered with IOP will have recently received an email from IOP asking you to confirm that you are still professionally active and indicating that monitoring of CPD will be mandatory going forwards. It is thus a good time to reflect a little on what CPD actually is and why as professional physicists we need to maintain and grow our knowledge and skills via CPD, what counts as CPD and look at some good sources of free courses and material you can access to support your CPD. You can access IOP guidance on maintaining your CPD here: https://membership.iop.org/guidance-maintaining-your-cphys

## Why do we need to do CPD?

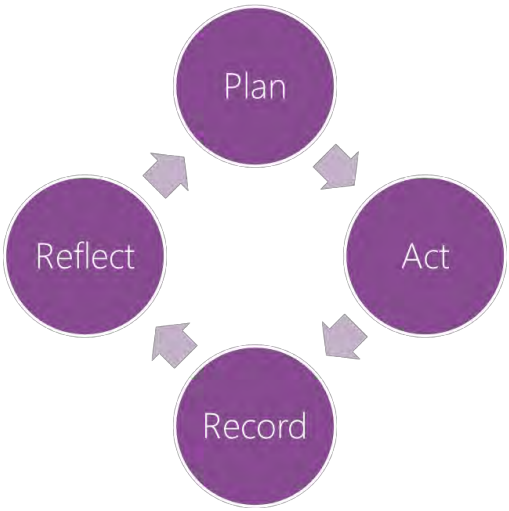
Obtaining and maintaining the professional recognition of CPhys/CEng indicates that as an individual you are working at the highest standards of professionalism, using up-to-date expertise, working to the highest quality and safety standards, you have the capacity to undertake independent practice and the capacity to exercise leadership. As well as competence, CPhys/CEng denotes a commitment to keep pace with advancing knowledge and with the increasing expectations and requirements for which any professional must take responsibility.

The workplace is always changing – we have to grow and develop in order to keep up (and move forward). If we never do any CPD our skills could stagnate and in real terms become less relevant in the workplace and, ultimately if we don't keep up, we will move backwards. This is particularly true in the nuclear industry where new reactors and reactor designs are being proposed for the UK, and new techniques are being developed to improve safety and to help manage waste and deal with decommissioning and clean-up. Advances in IT, greater computer power and topics like big data are all relevant and the ability to understand and apply these is advantageous in moving forwards.

## The CPD cycle

There are many models defining CPD and the CPD cycle online, the simplest of which is illustrated in Figure 1, each stage in this cycle is important.

Most of us who are in professional roles within the Nuclear Industry will undergo some form of annual development appraisal and this is a good way of helping to plan our CPD and reflect on our CPD from the previous year. Regardless of this having a personal development plan is also effective in career planning and identifying relevant CPD. The IOP Career development hub provides some good hints and tips to help with personal development planning. Some further information on accessing this is included later in this article.




The IOP on-line CPD recording tool asks the following questions which help to guide you through the CPD cycle and help you to reflect on your learning.

- What CPD activity did you undertake?
- Why did you choose this CPD activity?
- What were the outcomes?
- Who benefits from you carrying out the CPD activity?
- What are your next steps?

Whilst IOP don't mandate the use of their CPD recording tool knowing what expected can help you in planning, executing and recording your CPD in such a way that will be appropriate for presenting as evidence to maintain your chartership.

## What counts as CPD?

The IOP's CPD policy defines CPD as "the systematic maintenance, improvement and broadening of knowledge and skill, and the development of personal qualities necessary for the execution of professional and technical duties throughout working life. Put more simply, it is a life-long learning approach to planning, managing and benefiting from development activities."

CPD should be relevant to your role. It doesn't have to be formal training courses or lectures, in fact simply turning up and sitting in a lecture or training course is not in itself CPD. The key element is the outcome from participating, for example how have you benefitted from it and how it might help you in the future. The IoP take a broad view of what activities constitute CPD. These include formal training courses, on-the-job training and mentoring, attendance at evening talks (such as those organised by the NIG), to sitting on committees, panels or networking.

It is also recognised that many people participate in activities outside the workplace from which they can gain personal development that can help them in the workplace. For example, sitting on a school Governors board, leading scouts, brownies or guides, coaching children's sports teams, or actively participating in non-work-related committees (e.g. sports, social clubs or active involvement in church, mosque or temple committees or doing charity/voluntary work) are great ways of growing communication, interpersonal and organisational skills all of which are transferable into the workplace.

The key is that the activity needs to result in some kind of learning. Reflection on your learning is thus a significant part of your CPD. Above all CPD is your responsibility, not something that your employer or university does for you, it is your commitment to your career development.

It is worth looking back at the competencies we all had to demonstrate in order to demonstrate our suitability to be awarded Chartership. These fall into 5 categories and keeping up to date and enhancing our skills across these competencies is all helpful in our careers:

A. Application of general and specialist knowledge
B. Applying physics to the analysis and solution of problems
C. Technical and managerial skills
D. Communication and interpersonal skills
E. Professional conduct

Carrying out CPD which builds upon skills in any of these areas are all relevant and can be used in maintaining chartered status.

## The role of CPD in obtaining and maintaining Chartership status

CPD forms an important part of becoming Chartered. The IoP website provides a useful document with guidance on what you will need to submit

to reinstate your Chartered Physicist status (http://www.iop.org/membership/prof-des/policy/file_50377.pdf). Remember this submission is not something that can simply be prepared a few days before you need to send it off. One of the key aspects of any CPD is reflecting on what you have gained from your activities and to capture this close to the time of your activity and not months or even years after the event.

## How can IOP help?

IOP are committed to supporting us in our lifelong learning journey. There are numerous resources available on IOPs website which can help us. You can access the IOP Lifelong Learning pages via this link.

It is worth highlighting the IOP career development hub which provides you with a range of videos, tutorials and e-learning resources which can help in our development. These have been developed by IOP specifically for the physics community. As a member you can access this via IOPConnect. I have signed up to the career development hub newsletter and have worked through a number of the e-learning courses and found them excellent and great CPD! A vast array of topics are covered ranging from career planning, to mentoring, to business skills, to management skills to IT skills and everything in between.

## What about nuclear industry specific CPD?

There are a number of free on-line technical training courses from reputable organisations that you can access if you plan to grow your understanding into different areas of the industry. Below is a selection of these, this isn't an exhaustive list but gives a flavour of what you can find if you look around.

The IAEA provide a number of free on-line training modules covering topics on Nuclear Technology and Applications; Nuclear Safety and Security; and Safeguards and Verification. Their on-line learning can be accessed here: https://elearning.iaea.org/m2/ .

The Open University have a free Future Lean course on the The Science of Nuclear Energy. You can access this here: https://www.futurelearn.com/courses/the-science-of-nuclear-energy.

The Nuclear Training Network provides access to a range of free courses and training material. These courses are wide ranging covering nuclear industry awareness, a number of aspects of waste management, nuclear security, information security and knowledge management and many more topics. You can access the full list of courses here: https://www.nucleartrainingnetwork.com/course/index.php

The Generation IV international forum are running a series of Webinars around numerous aspects of Generation IV reactors. You can sign up for new webinars and access the recordings from past webinars here: https://www.gen-4.org/gif/jcms/c_84279/webinars

The European Fusion Education Network has a free course on Understanding Nuclear Energy, covering the basics of nuclear science and nuclear energy, to the operating principle of nuclear reactors, the nuclear fuel cycle and the differences between current and future reactors. You can access this here: https://www.fusenet.eu/node/1128

If you're interested in fusion, the European Fusion Education Network also has free courses in plasma physics and the application of plasma physics to fusion reactors. You can access them here: https://www.fusenet.eu/node/1182

## Summary

CPD should be relevant to your role, you should record it and reflect upon it regularly. It is outcome driven, the key is that the activity needs to result in some kind of learning. Above all CPD is your responsibility, not something that your employer or university does for you, it is your commitment to your career development.

## Acknowledgements

Much of the material in this article has been drawn from the IoP website and other IoP material and has been reproduced here with the permission of the IoP.

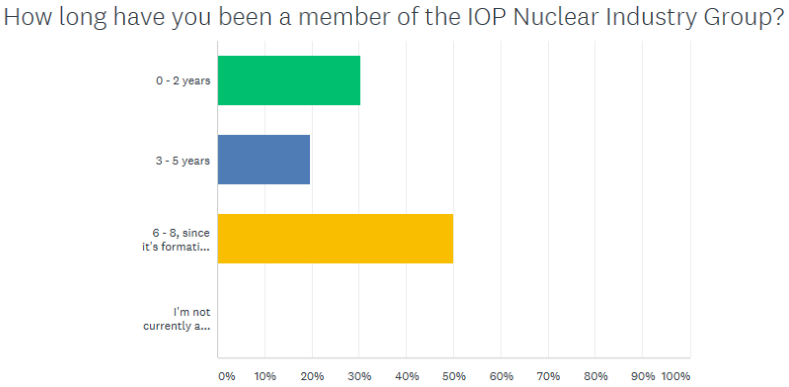
# NIG Members Survey

**Article by: Alfie O'Neill**

Last year we ran an online survey to gauge how well we're meeting the expectations of the group's membership, and how we can improve the range or type or activities we undertake. Thanks to all who took the time to complete the questionnaire, it provided some really useful feedback which as a committee we'll aim to take on board. Some of the key feedback was:

- Most of our responders have been members for a few years, and work in the Nuclear Industry.
- A significant proportion haven't been able to attend any recent events, though this is not because the events organised do not appeal to them or because the level of technical content isn't right.
- People would like more events in Cumbria and London / South of England.
- People generally feel we organise the right amount of events (66% vs 33% want more)
- Evening seminars remain the most popular (50%), but lunchtime seminars and full day events come in joint second.
- People would like more regular communication – with a more regular newsletter and more presence on social media.
- People would like presentations to be available online to those who can't attend.

Hopefully you'll see some changes and improvements in these areas as we take the feedback on board, but as ever please feel free to get in contact with the group with any suggestions or ideas via groups@iop.org.



# Upcoming Events

We've lots of exciting events in the pipeline for 2019 and beyond, so please keep an eye on our website and social media accounts for updates. The following events have been confirmed so far:

## Geological Disposal Facilities – Evening Seminar and Webinar

Spring 2020 – University of Oxford and online.

In a joint event with the Nuclear Institute, we'll be hosting speakers from Radioactive Waste Management on the selection process for a UK Geological Disposal Facility. This evening seminar will also be broadcast live online for those who can't attend in person.

## Women in Nuclear – Day Event

Following the success of the 2018 Women in Nuclear event, a joint event with the Women in Physics Group, a similar repeat event is to be held in the Manchester area in the second half of 2020.

## PHYSOR 2020

The NIG will be supporting PHYSOR 2020 around Easter 2020, with an event to be held in Cambridge.

## Space Batteries – Evening Seminar

An evening seminar with speakers from NNL and the Diamond Battery facility on the use of radioisotopes in Space Batteries. This is due to take place in 2020 with a date to be confirmed.

## Nuclear Industry Group on Social Media

We've recently improved our online presence, you can now follow the group's activities in the following locations:

www.nig.iop.org

@IOPNuclearIndustryGroup

IOP Nuclear Industry Group

## Letters to the Group

The NIG welcomes letters from its members, so please get in touch with us if you attended one of our events and it sparked an idea, you have been involved in a particularly interesting project or have any other thoughts which might be of interest to the rest of the group!

Please submit any articles and accompanying photographs or pictures to alfie.oneill@physics.org.

## Items for the next 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. We plan to publish the next Newsletter in autumn 2019.

## 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. In addition, the views and opinions stated in this Newsletter do not represent those of the organisations employing the article authors.

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