Centre for Nuclear Engineering

Newsletter

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Welcome to this edition of the Centre for Nuclear Engineering's (CNE) Newsletter.

The Newsletter contains the latest information on the Centre's activities and achievements.

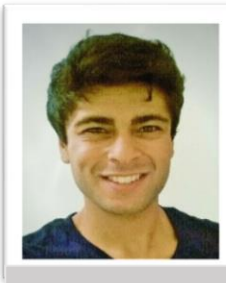
Updates

ed.: Jonathan Tate design: Edoardo Giorgi.

Well done, and good luck!

As one academic year closes and the next one starts, we say goodbye to 25 MSc in Nuclear Engineering students – 16 on the one-year programme, and 9 on the first year of our CDT in Nuclear Energy. Many congratulations to **Sophie Morrison**, who received the Rolls-Royce Award in recognition of her graduation results and contribution to the cohesion of the cohort, and **Jure Aleksejev** and **Alan Charles**, who received the 1st and 2nd William Penney (AWE) project prizes respectively.

We thank our External Examiner, Dr Tom Scott (Bristol), for his hard work and suggestions, and of course Raj and the Teaching Office team for their hard work and enthusiasm.



Above: Dhan-sham Rana (l) and Nathan Read (r), two new MRes students.

Below: 2014-5 MSc Nuclear Engineering cohort, with course director Dr Britton (foreground, fifth from the left).

Welcome, welcome

Moving into this next academic year, we welcome 10 new students to the MSc in Nuclear Engineering, as well as 10 students to the new MRes in Nuclear Energy, which leads into the CDT.

We also welcome Jonathan Tate, who joined the Centre on October 1st. Before joining us Jonathan (or Jon – he doesn't mind) studied in Sheffield and Aberdeen, culminating in a PhD in History at the latter institution. Having held previous roles in higher education teaching, public sector administration, sales and marketing, and retail and hospitality, Jonathan brings many different skills and experiences to the CNE, and will support students, staff and our external partners. He can be humoured with cups of tea and anything sports related.

Christmas Lecture

Prof Bill Lee, the Director of the CNE, will deliver the Centre's Christmas Lecture on Wednesday December 16th at 16:00 in Go6. Entitled 'Why Radionuclides are Good for You', the lecture will then be followed by a drinks reception. We encourage those connected to the centre to attend and celebrate the festive season. Any questions please contact j.tate@imperial.ac.uk.

Awards, funding, and esteem

by J. Tate and D. Horlait

International collaboration on EPSRC-funded project

Bill Lee and Dr Luc Vandeperre were awarded an EPSRC research grant for a project on 'Advanced Waste Management Strategies for High Dose Spent Adsorbents'. The aims are to create models for the wasteforms to predict temperature distributions due to radiolytic heat generation, as well to examine long-term changes to the wasteforms from sintering, crystallisation, or cracking.

'Advanced Waste Management …' is an international collaborative project that involves investigators from Imperial College, Sheffield University (UK), Kyushu University (Japan) and Tohoku University (Japan).

New PhD funding

Handled by Dr Mark Wenman, over the past several months funding has been secured for several EPSRC CDT Projects. A portion of the funding has been provided by some of the CNE's partners. The projects are:

- 'Atmospheric Stress Corrosion Cracking of 316L Spent Nuclear Fuel Containers' (£65K from EdF Energy);
- 'Fuel Performance Modelling using Mixed Finite Element and Peridynamics Methods for Pellet-cladding Interactions in Nuclear Fuel' (£55K from the NNL);
- 'Understanding Neutron Irradiation Embrittlement of Reactor Pressure Vessel Steels Manufactured by Novel Methods' (£68K from Rolls-Royce).

Prof Bommer to lead project for Spanish nuclear regulator (CSN)

From early 2016 Prof Julian Bommer, Senior Research Investigator from the Department of Civil and Environment Engineering, will lead the ground-motion characterisation project for nuclear power plants in Spain. Using probabilistic seismic hazard analyses (PSHA), it is the first time a regulator outside the US has specified explicitly that the Senior Seismic Hazard Analysis Committee (SSHAC) Level 3 procedures must be followed in such a study.

Bommer has plenty of experience in seismic hazard studies for nuclear sites: he has studied and reviewed sites in Abu Dhabi, Romania, and the US. He has also helped construct guidelines for the US Nuclear Regulatory Commission, and more recently he has led projects in South Africa and Brazil. Bommer also heads the Expert Panel on Seismic Hazard at the Office for Nuclear Regulation (ONR), and is a registered expert with the International Atomic Energy Agency (IAEA).

PDRA gives keynote talk

During the third week of June 2015, PhD student Claudia Gasparrini and PDRA Dr Denis Horlait travelled to Toledo, Spain, for the 14th European Ceramic Society Conference.

Claudia gave an oral presentation of her recent results concerning the high-temperature oxidation mechanisms of zirconium carbide, while Denis was invited to give a keynote talk; Denis then presented on the development of MAX Phases as protective materials of nuclear fuel cladding, in the context of a severe accident.

In addition to enjoying the warm weather and the beauty of Toledo [so not jealous – Ed.], CNE and Centre for Advanced Structural Ceramics delegates were pleased to meet and hear more about the research of numerous other ceramicist scientists from Europe and beyond: in total, around 500 oral and 300 poster presentations were given.

The next ECSC meeting will be in Istanbul in June 2017.

PDRA Work Exp. Placement

by N. Kuganathan

As part of the Materials Department's Work Experience Programme, Dr Navaratnarajah Kuganathan successfully offered placements to three Y12 students in his lab in G10, Royal School of Mines. Over the week of 20th July, students Piyush Seiram, Max Bennett and Sammuel Syed had a taste of what it is like to be a researcher in the field material chemistry, including materials that can generate nuclear energy.

The research of Dr Kuganathan uses computers to model nuclear materials. Under his supervision, Piyush, Max and Sammuel were able to visualise thorium oxide on computers before and after reactions, and ran some short simulations and analysed the basic results, which showed how chain reactions occur within the materials to generate electrical power.

During their placement, the students gained some knowledge on nuclear materials, how to load and visualise materials, how simulations can be initiated and ran on computers, and how the results are analysed and interpreted.

We congratulate Kuganathan and Piyush, Max and Sammuel on their accomplishments.

India trip

by C. Galvin and N. Kuganathan.

During the week June 15th research associate Dr Kuganathan and PhD student Conor Galvin visited the Bhabha Atomic Research Centre (BARC) in Mumbai, India.

They were given a tour of the site and saw the wide variety of research and work conducted at BARC, from medical isotope production to the nuclear energy sector. As thorium is a potentially valuable resource for India, considerable research has been done on the topic.

Dr Kuganathan and Conor discussed with Dr Ashok Arya and Mr Partha Sarathi Gosh computational simulations of thorium dioxide and possible future collaborative work.

While at BARC, Dr Kuganathan presented his work on 'Theoretical Simulations of Carbon Nano Materials, Cathode for Lithium Ion Batteries and Inorganic Electrides' in the Materials Science Division Seminar room. The talk was received extremely well, with around fifty researchers from various disciplines attending.

Overall, the trip was a great success and strengthened the existing bonds between CNE and BARC.

(Left to Right) Mr Conor Galvin, Dr Navaratnarajah Kuganathan, Dr Ashok Arya and Mr Partha Sarathi Ghosh.

Visit to Los Alamos National Lab

by C. Galvin

During August and September PhD student Conor Galvin visited Los Alamos National Laboratory (LANL). Established in 1943 and located in New Mexico, USA, the LANL is one of the largest science and technology institutions in the world, and conducts multidisciplinary research in fields such as space exploration, renewable energy, nanotechnology, and supercomputing.

Partly funded by himself and the LANL, during his stay there Conor participated in collaborative work using molecular dynamics simulations to investigate the influence of dislocations in UO_2 on helium diffusion. The findings are potentially important to studying nuclear waste management and storage.

Connor also took the opportunity to take in several very interesting talks from eminent figures such as one from Dr Sergei L Dudarev on 'Magnetic Molecular Dynamics and other Models for Fusion Reactor Materials', and one by Novel Laureate Prof Roy J Glauber on his recruitment to the Manhattan Project and his time at Los Alamos.

Japan Internship

by G. Scatigno

After successfully applying in November 2014, PhD student Giuseppe Scatigno undertook a paid internship with Hitatchi-GE Nuclear Energy Ltd between the 29th June and the 19th July. Based at the company's Kaigan Factory in Hitachi City, 2 hours' drive north of Tokyo and where components for turbine buildings are made, Giuseppe was part of a cohort that included students from Birmingham and Manchester Universities.

Giuseppe, third from the right, and other interns with the British Ambassador to Japan, third from left

As part of Gen-Pu-Setsu, the design group that includes Japanese and international engineers, Giuseppe worked on the UK-ABWR nuclear power plant design that Hitachi plans to build in the UK. Within this area, he worked on pipe design, where he helped design the piping line connecting the SLC tank (a safety feature) to the reactor using CompoCAD, a 3D in-house software programme. In his role, Giuseppe also contributed to the Generic Design Assessment (GDA) which will be examined by the Office for Nuclear Regulations (NCR), and where he met with

regulators, consultants and contractors.

During his internship Giuseppe, who is supervised by Dr Mark Wenman, reviewed material choices, contributed to operations, and compiled reports for compliance with the ONR. Working with the stress analysis group, Giuseppe learned how to use their in-house software, HISAP, by inputting pipe supports and calculating pipe stress. He also helped review a new (confidential) lug introduced by Hitachi, which requires extensive study and analysis to obtain regulatory approval.

Above: The Mutsu Obon Festival

Below: Interns have a mirthful dinner with Hitachi-GE staff, including the CEO

But it wasn't all work! Giuseppe also absorbed Japanese culture and travelled the country, visiting Tokyo, Nigata, Kyoto, Nikko, Yamagata Aomori and various small towns.

Professionally and personally, the internship was enormously enriching. Giuseppe learnt not only technical information and abilities, but also how a large organisation like Hitachi operates, and he met some very eminent and interesting people, like the British Ambassador to Japan, Mr Hitchens, and the President of Hitachi-GE Nuclear Energy Ltd, Mr Takehara.

Oak Ridge Talk

by M.J.D. Rushton

Dr Michael Rushton recently represented the CNE at the 'Radiation Effects in Advanced Nuclear Materials Workshop' held at Oak Ridge National Laboratory in Tennessee, USA. This four-day event, which was held between the 29th September and 2nd October, was co-organised by the UK Foreign and Commonwealth Office through the Science and Innovation Network, and encouraged collaboration between US national labs and universities and their counterparts in UK academia and industry.

Dr Rushton, in full flow, presenting at Oak Ridge

The UK was well represented, with delegates from ten universities, and bodies such as the National Nuclear Laboratory (NNL). A series of engaging presentations, ranging from discussion of ion bombardment studies, to the particular issues surrounding material design for fusion applications, through to computer simulations of radiation damage, were followed by equally lively discussions.

Overall, the workshop was a considerable success and showed that both nations have much to offer in nuclear materials research.

CNE Latest Research Outputs

Modelling Pellet-clad Mechanical Interaction during Extended Reduce Power Operation in Bonded Nuclear Fuel

Ball JA, Haynes TA, Shea JH, and Wenman MR
Journal of Nuclear Materials 465, 280-292 (2015)

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Finite Element Modelling of Pellet-clad Interaction during Operational Transients

Idem.
TopFuel 2015 Zurich

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A SSHAC Level 3 Probabilistic Seismic Hazard Analysis for a New-Build Nuclear Site in South Africa

Bommer JJ, et al
Earthquake Spectra 31, 2, 116-698 (2015)

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A POD Reduced Order Model for Resolving Angular Direction in Neutron/Photon Transport Problems

Buchan AG, Calloo AA, Dargaville S, Fang F, Goffin MG, Navon IM, and Pain CC
Journal of Computational Physics 296, 138-157 (2015)

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From Solid Solution to Cluster Formation of Fe and Cr in α-Zr

Burr PA, Edwards L, Gault B, Grimes RW, Ivermark M, Moody MP, Preuss M, Rushton MJD, and Wenman MR
Journal of Nuclear Materials (In Press)

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Modelling Explicit Fracture of Nuclear Fuel Pellets using Peridynamics

Mella R, and Wenman MR
Journal of Nuclear Materials 467, 55-67 (2015)

Contact Details

Prof Bill Lee
Director for CNE
020 7594 6733
w.e.lee@imperial.ac.uk

Dr T Ben Britton
Nuclear Teaching Champion
020 7594 2634
b.britton@imperial.ac.uk

Mr Jonathan Tate
Administrator – CNE
020 594 6802
j.tate@imperial.ac.uk

Miss Emma Warriss
Manager - CNE
020 7594 9916
e.warriss@imperial.ac.uk