

# Centre for Nuclear Engineering Newsletter

Welcome to this edition of the Centre for Nuclear Engineering Newsletter.

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This is an occasional letter to bring you up to date on recent developments in the CNE.



Issue | 6

## News and Awards

by Emma J. Warriss, Andrew G. Buchan and Edoardo Giorgi

### Prof Laurence G Williams appointed to Chair EU Expert Panel

The European Commission has invited Prof Laurence G Williams FREng from the CNE to chair the high level panel of experts appointed to deal with the ex-post evaluation of the 7th Euratom Framework Programme.

The programme, first implemented in 2007, now looks to assess the current programme's rationale, implementation and achievements.

### Andrew G Buchan awarded EPSRC fellowship

Andrew Buchan working with Chris Pain in the Earth Science & Engineering Dept. has been awarded a highly prestigious EPSRC fellowship in nuclear modelling.

Computer models have for decades played a central role in assessing the behaviour of nuclear power facilities, they have ensured nuclear operations remain safe to both the public and the environment. This project will develop a new and highly advanced nuclear modelling capability that is accurate, robust and validated. A new multi-physics, predictive modelling framework will be formed for simulating neutron transport, fluid flows and structural interaction problems. It aims to combine novel and world leading technologies in numerical methods

and high performance computing to form a simulation tool for geometrically complex, nuclear engineering problems. This will surpass current computational capabilities, by providing modelling accuracy to the levels required through the use of efficient adaptive resolution, and will tackle grand challenge problems such as full core reactor modelling. This model will be developed within a predictive framework that combines modelling with uncertainty and experimental data. This is a vital component as inherent uncertainties in data, geometry, parameterisations and measurement will place uncertainties in the modelled predictions. These uncertainties will be integrated within the calculation in order to quantify the uncertainty they place on the final result.

The combination of all these technologies will result in the first modelling framework of its kind, offering unprecedented detail through optimised resolution with combined uncertainty quantification and data assimilation. It will provide substantially improved analysis of nuclear facilities; it will improve operational efficiency and, ultimately, help ensure its safety. The project will work closely with

world leading academics and industry, both within the UK and overseas. This collaboration will result in the technologies being used to analyse future reactor designs, as well as those reactors due to be built in the UK over the coming years.

### Dr Chris Cooling awarded Two Prizes



The Unwin Postgraduate Prize is awarded each year at Imperial to the best graduating PhD student in the Mechanical Engineering Dept. Dr Chris Cooling (pictured) was awarded this year's Unwin Prize for his outstanding thesis on the subject of a novel nuclear reactor design for the production of medical isotopes.

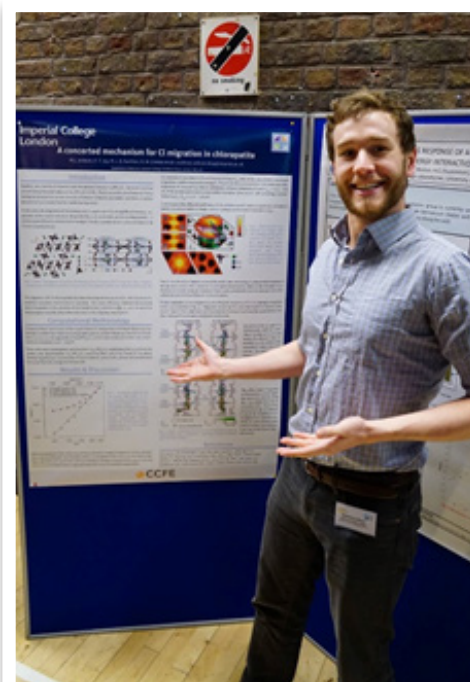
Dr Cooling did his EngD degree with Dr Matthew D Eaton modelling a novel fissile liquid medical isotope production system (MIPS). He is currently a Rolls-Royce PDRA. His thesis was also awarded a European ENEN PhD/EngD prize. The ENEN prize is given to the best three presentations and accompanying papers on the topic of the competitor's PhD thesis. It is a Europe-wide competition run by the European Nuclear Education Network, this year's 9th event was held in Nice. It is the first time a UK student has been awarded this prize.

# CNE at UNTF 2015

by Conor Galvin

On the 31st of March to the 2nd of April the Open University at Milton Keynes hosted the annual Universities Nuclear Technology Forum (UNTF). The UNTF meetings are aimed at students and postgraduate researchers from UK universities working on nuclear related projects. Imperial College was well represented by PhD & MSc students from the CNE, who gave talks and poster presentations on their research covering a variety of topics including

nuclear materials, atomic scale simulations, fusion energy, thermal hydraulics and detector analysis. The audience consisted of students, post-docs, lecturers and people from industry. The event was a success with doctoral candidates from different universities networking, discussing and presenting their work. It was a great experience for all involved and everyone is looking forward to next year's UNTF.



(Above) Matt Jackson (PhD at CNE) with his poster on display.

(Left) Imperial College students after a long day of presenting at UNTF.

# CNE Cumbria Lectures

by Sam Humphry-Baker

On the 10th of March, one of the CNE postdocs, Sam Humphry-Baker (pictured to the right), delivered a series of lectures in Cumbria, as part of Sellafield Ltd's public outreach programme.

In the morning Sam gave two talks about Materials Science to around 700 primary school children from the neighbouring communities. The caption shows one of his popular demonstrations: making Nylon fibres by drawing them from a beaker of two liquids. The biggest challenge however was after the talks, where he faced some fierce questioning from the young audience!

That afternoon there was an opportunity to visit James Walker in Cockermouth –

a world leading engineering company in sealing technology. Sam was amazed at the companies diverse range of challenges being addressed, involving everything from R&D to product application to materials processing.

Sam delivered his third and final lecture to the Materials Society of Cumbria. The society is an affiliate of IOM3, and is mainly formed of James Walker, Sellafield, and NNL employees. At the evening lecture he gave a short overview of the CNE, followed by a more detailed overview of his work on plasma-facing fusion reactor materials.





# Fukushima Daiichi Site Visit by the CNE

by Dimitri Pletser

On Monday 9th of March 2015 Prof. Bill Lee and CNE PhD student Dimitri Pletser visited the site at Fukushima Daiichi, just days before the 4 year anniversary of the 2011 Tohoku earthquake and subsequent tsunami, which caused the accident at Fukushima Daiichi.

The visit was organised by Hitachi Ltd. current sponsor of Dimitri Pletser and of the CDT in nuclear engineering at Imperial College, Cambridge University and Open University. The day started early at Iwaki, where we met up with the Hitachi delegation, from where a taxi was taken to J-Village. J-Village was the former headquarters of the Japanese national football team, its build being sponsored by TEPCO. This centre is being used as the staging point for all response efforts during the immediate aftermath of the tsunami and is now the departure point for all visits.

We were received by TEPCO and were given an in-depth briefing of the current situation, including the progress of current decommissioning and remediation efforts and had our itinerary explained. After a whole body

count, we were then shepherded onto a bus and driven through the abandoned exclusion zone towards the actual site. This 20 km zone is currently uninhabited and only accessible during day time, giving it a very surreal ghost town feel.

Upon arrival at the Fukushima site, we were taken to the seismic isolation building which houses the main control centre, where we got kitted up in multiple layers of PPE, including Tyvek suits, respirators and safety helmets. Once fully suited up we were driven around on-site to visit various parts of the facility. Our first stop was at the Hitachi run High Performance Advanced Liquid Processing System (High Performance ALPS), where we were shown the current set-up used

to treat effluent cooling water and the various other adsorbent systems.

The next stop was Unit 4; Unit 4 was one of the hardest hit units near the sea front. The removal of its fuel was completed very recently, on the 22nd of December 2014, and we were very fortunate to be allowed to visit inside the containment building. Once inside the structure the magnitude of the task became clear, as a cantilevered structure containing a colossal 100-tonne heavy-lifting crane was built against the side of the reactor building, ensuring that no weight leaned on the battered reactor building. This crane was then used to lift the heavy cask into the spent fuel pool, into which the fuel debris was transferred using the previously present smaller crane. Once the fuel debris was fully loaded into the cask, it was sealed and remotely removed using the cantilevered crane for processing. The complexity and magnitude of this operation was staggering and serves to illustrate just how much work has



(Above) Getting kitted up for the tour.

(Left) Visiting the Hitachi High Performance ALPS.



already been done and how much still remains.

We were then driven across the site to witness various parts of the site and its clean-up. These sites included the ever-increasing amounts of water storage units, in all their variations, the ground water bypass system, used to avoid ground water ingress into the basements, the intended site of the frozen soil walls, and finally the restored Shallow Draft Quay, which ensures vital access by sea and many other parts of the site. We were then driven back to the seismic isolation building where we changed out of our PPE. Once changed we met with Site Superintendent Akira Ono and were shown around the central control centre. Professor Lee addressed the workers in the control centre, thanking them for their dedication and hard work and expressing his hope for future UK-Japan collaborations to aid in the remediation of the site.

It is difficult to truly appreciate the scale of the operation without being able to witness the site first-hand, since images and news reports do not do it justice. Currently more than 7000 people work on-site every day, often

(Above) Treated water storage area. Various generations of the tanks can be seen in this picture.

(Below) Meeting Site Superintendent Akira Ono.

in difficult or hazardous conditions, making their achievements all the more impressive. Being able to see first-hand the devastation that the tsunami and the accident had wrought on the site aided in putting things into perspective. Despite media coverage suggesting otherwise, an astonishing amount of work has already been done under very

difficult circumstances, but the task ahead for all parties involved is of epic proportions. This visit proved to be a humbling experience, one that is sure to inspire for years to come.



# Publications

## Accommodation of tin in tetragonal $\text{ZrO}_2$

B.D.C. Bell, S.T. Murphy, P.A. Burr, R.W. Grimes and M.R. Wenman

Journal of Applied Physics 117, 084901 (2015).

## Preliminary Surface Study of Short Term Dissolution of UK High Level Waste Glass

N.E. Ahmad, S. Fearn, J.R. Jones and W.E. Lee

Procedia Materials Science 7, 230–236 (2014)

## In situ micropillar deformation of hydrides in Zircaloy-4

H.E. Weekes, V.A. Vorontsov, I.P. Dolbnya,

J.D. Plummer, F. Guiliani, T.B. Britton and D. Dye

Acta Materialia 92, 81–96 (2015)

## Thermal conductivity and energetic recoils in $\text{UO}_2$ using a many-body potential model

M.J. Qin, M.W.D. Cooper, E.Y. Kuo, M.J.D. Rushton,

R.W. Grimes, G.R. Lumpkin and S.C. Middleburgh

Journal of Physics 26, 495401 (2014)

## Thermophysical properties and oxygen transport in the $(\text{U}_x\text{Pu}_{1-x})\text{O}_2$ lattice

M.W.D. Cooper, S.T. Murphy, M.J.D. Rushton and

R.W. Grimes

Journal of Nuclear Materials 461, 206–214 (2015)

## Mechanism and Kinetics of Oxidation of ZrN Ceramics

R.W. Harrison, W.E. Lee

Journal of the American Ceramic Society, In press (2015)

## Crystal structure, thermodynamics, magnetism and disorder properties of Be–Fe–Al intermetallics

P.A. Burr, S.C. Middleburgh and R.W. Grimes

Journal of Alloys and Compounds 639, 111–122 (2015)

## Structural stability and fission product behaviour in $\text{U}_3\text{Si}$

S.C. Middleburgh, P.A. Burr, D.J.M. King, L. Edwards,

G.R. Lumpkin, R.W. Grimes

Journal of Nuclear Materials, in press (2015)

## Experimental and numerical creep–fatigue study of Type 316 stainless steel failure under high temperature LCF loading condition with different hold time

R. Hormozi, F. Biglari, K. Nikbin

Engineering Fracture Mechanics 141, 19–43 (2015)

## Experimental study of type 316 stainless steel failure under LCF/TMF loading conditions

R. Hormozi, F. Biglari, K. Nikbin

International Journal of Fatigue 75, 153–169 (2015)

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