Australian ITER Forum Website News Update 6/18

B.J.Green (15/6/18)

1. [Power](#) - [Nuclear Power](#)

Faster nuclear fusion work

22nd May 2018

https://www.engineerlive.com/content/faster-nuclear-fusion-work

Case study showing how advanced technology is speeding up MRO at the world's largest nuclear fusion facility

As the world's largest nuclear fusion power experiment, the JET (Joint European Torus) nuclear fusion tokamak is designed to harness energy with the intention of furthering the development of fusion power generation. Fusion is based on the same principle that powers our sun and stars and is a key stepping stone towards a carbon-free world in energy production.

Operated by the UK Atomic Energy Authority's (UKAEA) RACE (Remote Applications in Challenging Environments) department at Culham Science Centre near Oxford for the EuroFusion consortium of European fusion scientists, the project started in 1983 and is at the cutting edge of scientific development.

Third Dimension supports quality control and maintenance, repair and overhaul (MRO) of JET with its profile measurement systems. When the company originally started working with UKAEA, a third generation GapGun was installed onsite and used for inspection, in and out of the fusion rig, for many years. However, the GapGun, designed for handheld measurements, was upgraded in 2017 to the recently launched Vectro system.

Vectro is not only based on the fifth generation GapGun Pro technology, but was also designed to be installed as an integrated robotic inspection tool. Already, it has proven to deliver improvements to the speed and productivity of maintenance procedures for UKAEA. This has been achieved with the authority's MASCOT robot.

During operation, the reactor runs for 30 seconds every half hour, with scientists from around the world eagerly awaiting their data and test results. The tokamak has a heating capacity of around 40MW. To achieve power generation through nuclear fusion, plasma temperatures of over 100 million °C are required. This makes the reactor the hottest temperature in the solar system, hotter than the sun.

Inside the reactor specially designed tiles are densely packed to cover the inner area of the tokamak core and protect it from the extreme temperatures and hostile environment generated by the process. These castellated, beryllium-coated Inconel tiles are made in the USA at a cost of over US$700 per 100g.

Tiles are around 1cm square and are slightly offset at an angle to encourage
the hot gas – known as plasma – in the core to circulate in a controlled manner. This presents a challenge to ensure that the tiles are within a strictly controlled tolerance band.

Any excessive amount of step or gap between tiles increases the danger that plasma could cause tiles to detach or get damaged. This would then mean expensive replacements and so inspection and the correct positioning carried out on these tiles is critical to the project.

However, inevitably tiles do get damaged occasionally – often by plasma escaping from JET's powerful magnetic fields. Therefore, as part of regularly scheduled maintenance procedures, the JET facility is closed for six months every two years for an overhaul, and this is when the Vectro comes into play.

Due to the hostile environment of the reactor, it is left to cool for a couple of months before the MRO begins; though even then it is still unsafe for humans to enter the tokamak safely without the use of protective suits. However, Vectro thrives and is effective under these conditions and so is operated remotely with a robotic device called MASCOT.

MASCOT is mounted onto an in-vessel transporter system to enable Vectro to check for damage to the surface of every single tile lining the reactor. Each tile is inspected to see if it needs to be replaced and if so, to ensure that the replacements are re-positioned in exactly the right place and orientation.

MASCOT is a highly dextrous haptic force-feedback master-slave telemanipulator, with each kinematically similar master or slave unit consisting of two seven-degrees-of-freedom arms. The MASCOT master station is driven by experienced remote handling operators and can be positioned around the vessel by a transporter system; a 12m-long articulated robot.

James Kent, remote handling development engineer at RACE, says: “Every tile we replace, we check with the Vectro system. This speeds up our overhaul time, which means JET can be up and running again sooner, delivering the results that will help to make fusion a dependable source of energy in the future. GapGun and Vectro are very precise. We couldn’t position or check the tiles as accurately or efficiently without them.”

During a regularly scheduled shutdown, around 600 tiles are removed and replaced during the six-month period including many sample divertor tiles for chemical and physical examination.

The divertor is a device within the JET tokamak that allows removal of waste material from the plasma while the reactor is operating. This allows control over the build-up of fusion products in the fuel and removes impurities in the plasma that have entered from the vessel lining. A diverter is made up of the following components costing between £60,000 – £100,000:

* 48 Gasbox Inner Carrier (tiles)
* 48 Gasbox Outer Carrier (tiles)
* 48 Bulk Tungsten LBSRP (tiles)
* 48 Base Carriers (tiles)

Vectro is used to check any tile that is replaced and to quality check new tiles before they are installed into the JET wall. During the 2010-2011 shutdown, every single tile was replaced, which was in the region of 4-5,000 tiles.

The GapGun technology is the only way to check that the tiles are in the right position, within 10 microns, which ensures minimal damage when the reactor is operational. It is impossible for the human eye to detect to such accuracy.

Before GapGun and Vectro, operators had to check quality by eye, using a standard gap flush test, compare against a checklist and manually input all data into a spreadsheet. This was slow and prone to error. GapGun, and now Vectro, deliver the results immediately and electronically, so operators have a record of what has been done. Saving the project time and money, they deliver repeatable results time and time again.

Using this inspection method means that not only is it possible to reduce the number of tiles that fail during experiments (allowing for a higher chance of successful tests), but that in the future it could also be possible to meet even tighter tolerances.

Looking ahead to the next phase of fusion power development, the ITER reactor in the south of France is currently being built and is due for completion in 2035. JET is carrying out technical preparations for ITER to ensure it is a success – playing a powerful role in the development of fusion energy.

UKAEA's RACE is now developing the next phase of the robot, MASCOT 6, to be launched in 2018. Robert Howell, Mechatronics Engineer at RACE, explains: "MASCOT 6 addresses the obsolescence issues present in the older MASCOT 4.5 system but also introduces performance improvements and new features. This includes: new actuator designs for both the master and slave units; a modern control system; and improvements to the system software and the operator's GUI."

2. UK industry welcomes clarity on Euratom R&D

23 May 2018

http://www.world-nuclear-news.org/NP-UK-industry-welcomes-clarity-on-Euratom-RD-23051801.html

The UK's Nuclear Industry Association (NIA) has welcomed confirmation of the government's intention to seek associate status to Euratom R&D programmes. NIA chief executive Tom Greatrex stressed however that this is just one part of the current Euratom framework, and progress in replicating other vital areas is still needed before the UK leaves the treaty, as part of its exit from the European Union, in March 2019.

One such programme is Horizon 2020 - the biggest EU research and innovation funding project - and the government last year made a commitment to underwrite UK funding of the Joint European Torus (JET) fusion project at Culham Laboratory, in Oxfordshire, until the end of 2020.

In a speech on 21 May on Science and the Modern Industrial Strategy, Prime Minister Theresa May said she wants the UK to have a "deep science partnership" with the EU. May, who was speaking at the Jodrell Bank Observatory - part of the Jodrell Bank Centre for Astrophysics at the University of Manchester - said she wanted to "spell out that commitment even more clearly".

She said: "The United Kingdom would like the option to fully associate ourselves with the excellence-based European science and innovation programmes - including the successor to Horizon 2020 and Euratom R&T. It is in the mutual interest of the UK and the EU that we should do so.

"Of course, such an association would involve an appropriate UK financial contribution, which we would willingly make. In return, we would look to maintain a suitable level of influence in line with that contribution and the benefits we bring. The UK is ready to discuss these details with the Commission as soon as possible."

Culham Laboratory is the world's leading centre for magnetic fusion energy research and JET is the world's most powerful tokamak. In December, the UK Atomic Energy Authority welcomed the government's investment of GBP86 million (USD115 million) that will fund the building and operation of a National Fusion Technology Platform (NaFTeP) at Culham Science Centre, which is expected to open in 2020.

Greatrex said scientific innovation "lies at the heart" of the UK civil nuclear sector, noting the country has world-leading fusion research at Culham in Oxfordshire.

"There are thousands of highly skilled personnel working on the Euratom funded fusion R&D programme, many of whom have felt uncertain about the future of their jobs since the referendum. That is why the UK civil nuclear industry has long called for an association between the UK and Euratom, so this important collaborative scientific research can continue in the UK," he said.

"It is welcome that the UK government has acknowledged the benefits of the UK's participation in these Euratom programmes and is seeking an association agreement that will enable that to continue. That is a benefit to the UK, to the rest of the European Union and to the global scientific community, and I hope the European Commission respond positively," he added.

NIA represents more than 260 companies including nuclear power station operators, new build developers and vendors, those engaged in decommissioning, waste management, all aspects of the nuclear fuel cycle, supply chain and consultancy companies. The nuclear industry generates a fifth of all electricity used in the UK, directly employs around 64,000 professionals and has the support of 74% of the public. In 2016 its activities directly contributed GBP6.4 billion to UK GDP.

Written and researched
by World Nuclear News

3. Scientists improve ability to measure electrical properties of plasma

By
Raphael Rosen
May 29, 2018
https://www.pppl.gov/news/2018/05/scientists-improve-ability-measure-electrical-properties-plasma

Any solid surface immersed within a plasma, including those in satellite engines and fusion reactors, is surrounded by a layer of electrical charge that determines the interaction between the surface and the plasma. Understanding the nature of this contact, which can affect the performance of the devices, often hinges on understanding how electrical charge is distributed around the surface. Now, recent research by scientists at the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL) indicates a way to more accurately measure these electrical properties.

The recent discovery relates to the layer, the so-called plasma-wall sheath of electrical charge that surrounds objects, including diagnostic probes, inside the plasma, which is composed of charged electrons and ions. This layer protects probes by repelling other electrons in the plasma that affect the measurements of the instrument and sometimes even cause damage. "In effect, the object insulates itself from all these electrons in the plasma that carry energy and heat and could cause the probe to melt," said Brian Kraus, a graduate student in the Princeton Program in Plasma Physics who was lead author of the paper that published the findings in *Physics of Plasmas*.

Kraus and principal research physicist Yevgeny Raitses, co-author of the paper and research advisor for Kraus on his first-year graduate project, found that the layer's charge can sometimes be positive, contradicting what scientists have long thought — that the blanket always has a more negative charge than the surrounding plasma. The findings indicate that researchers must determine exactly what kind of charge surrounds the probe to be able to make corrections that will generate an accurate measurement of conditions inside the plasma.

Specifically, research conducted on the Raitses-led Hall Thruster Experiment (HTX) at PPPL, which is typically used to study plasma thrusters for spacecraft and related plasma devices, showed that a heat-emitting diagnostic that is not connected to a grounded wire can sometimes produce the positive charge. The HTX was able to provide a steady, stable plasma that let the scientists detect more precisely what kind of charge was building up next to the probe.

"The big new thing is that until now, scientists for at least a decade had been developing theoretical calculations and performing computational simulations showing that the positive layer, or inverse sheath, could occur, but no one had seen it in experiments involving probes," Kraus said. "In this paper, we say we think we are indeed seeing it in an experiment, as well as seeing the transition between negative and positive sheaths."

The research was the first to support these calculations concerning the effect of so-called highly emissive walls. Developing such calculations were Michael Campanell, Alexander Khrabrov, and Igor Kaganovich of PPPL, along with Dmytro Sydorenko at the University of Alberta. (Campanell is now at DOE's Lawrence Livermore National Laboratory.) The new experiments thus provide an excellent example of how theoretical predictions motivate experimental research that in turn validates theoretical predictions.

According to Raitses and Kraus, future research involving physical experiments will measure more carefully how well the highly emissive probe model matches observations. One such experiment would determine whether an emissive probe with a long wire would retain a positive charge more easily.

Support for this research was provided by the DOE Office of Science.

PPPL, on Princeton University's Forrestal Campus in Plainsboro, N.J., is devoted to creating new knowledge about the physics of plasmas — ultra-hot, charged gases — and to developing practical solutions for the creation of fusion energy. The Laboratory is managed by the University for the U.S. Department of Energy's Office of Science, which is the largest single supporter of basic research in the physical sciences in the United States, and is working to address some of the most pressing challenges of our time. For more information, please visit science.energy.gov

4. Amy Wendt envisions a bright renewable energy future for burning plasma

June 12, 2018

// ELECTRICAL & COMPUTER ENGINEERING

https://www.engr.wisc.edu/amy-wendt-envisions-bright-renewable-energy-future-burning-plasma/

magine an abundant energy source that could power the world without harming the environment.

Fusion energy—the same powerful reactions that keep stars burning—could provide a completely renewable alternative to fossil fuels while being much more reliable than solar or wind. What's more, fusion power plants will not emit greenhouse gasses nor produce long-lived radioactive waste.

"Fusion energy as a clean and viable energy source will have a huge impact on our society," says Amy Wendt, a professor of electrical and computer engineering at the University of Wisconsin-Madison.

Wendt is shaping the future of fusion energy research in the United States as one of 19 leaders of a National Academies of Science, Engineering and Medicine committee to develop a strategic plan for U.S. burning plasma research. Since 2017, the university researchers, government scientists and industry representatives have been attending meetings and gathering information for recommendations on U.S. strategy to realize fusion energy for electricity production by mid-century. UW-Madison is well-represented on the committee, as Wendt is joined by Cary Forest, a professor of physics.

To eventually achieve fusion energy, scientists have set their sights on burning plasmas, similar to the hot ionized gases found in stars. The most promising approach to harnessing burning plasmas is known as magnetic confinement fusion, where tremendously high temperatures combined with enormous amounts of compression causes atoms to start fusing, so that the energy released from those fusion reactions is enough to sustain the plasma without further external energy input.

The easiest path to fusion makes use of isotopic forms of hydrogen as the fuel, with helium formed as the fusion product. Magnetic fields produced by currents in the plasma and in exquisitely designed external magnet coils contain and compress the plasma until fusion begins.

But containing and compressing those hot ionized gases is anything but easy.

“It’s like taking a lump of Jello and trying to compress it with your hands—it wants to squirt out between your fingers,” says Wendt.

And that lump of Jello is at a temperature roughly 10 times hotter than the core of the sun.

Burning plasmas have not yet been sustained long enough to be a viable power source here on Earth. Even though plasma scientists have identified clear pathways to achieve that goal, a cost-effective power plant requires better understanding of how burning plasmas behave, as well as further development and testing of new technologies needed to fuel the sustained plasma and to collect the excess energy it produces.

Efforts are currently underway to build a burning plasma facility in the south of France, under the auspices of an international collaboration called the ITER organization. When completed, the ITER machine will weigh more than 23,000 tons, and the donut-shaped burning plasma confinement chamber will be more than six stories tall.

“It’s hard to convey the enormity of this construction project. It’s fantastically huge and complex and there’s a lot of new technology,” says Wendt. “When you’re standing in the room where the plasma chamber will be located, it’s like you’re in a Roman coliseum.”

The United states contributes machine components and financial support to the endeavor, and UW-Madison faculty, including engineering physics professors Ray Fonck, Paul Wilson and Oliver Schmitz, among others, have devoted their expertise to ITER over the decades.

Wilson, for example, was instrumental in developing software tools to measure radiation levels in the facility and Schmitz performed sophisticated modeling experiments to predict how the burning plasma will behave once ITER turns on.

ITER marked a major milestone in 2017 when it reached the halfway point for its construction. The facility should be up and running by 2025.

The National Academies committee issued a preliminary report in December 2017 that identified burning plasma experiments as necessary steps toward fusion power. Wendt, along with the other committee members, visited the ITER construction site in February 2018 as part of their evaluation of whether the United States should continue participating in the international collaboration or consider launching an independent burning plasma research effort.

The committee's preliminary report emphasized the potential benefits to the U.S. of combining scientific and engineering expertise through international collaboration if it remains a full partner. For example, supporting burning plasma experiments can help boost our country's overall industrial capabilities by advancing research in materials science, superconducting magnets, cryogenic cooling systems, ultra-precise construction, and robotic manufacturing.

The committee will make detailed recommendations a final report to be released in September 2018.

Even after the ITER burning plasma facility switches on in 2025, advances in many disciplines will be necessary to build a full-fledged fusion power plant. which is another reason why Wendt and the committee were invited to make recommendations on a long-term strategic plan for the United States.

"Fusion power on the electric grid is something that I will not see in my lifetime, but the potential benefit to humanity is incalculable. I think there's a human drive to create these things that are bigger than ourselves, and in this case it is to meet a societal need," says Wendt.

While visiting the ITER construction site, Wendt took a side trip to Paris where she marveled at the beauty and history of the Notre Dame Cathedral. Although French Gothic architecture shares few construction materials in common with burning plasma confinement chambers, Wendt was struck by connections between the labor of medieval artisans and that of present-day fusion researchers.

"The cathedrals were conceived by people with a vision powerful enough to sustain the construction over the lifetimes of many generations of contributors," says Wendt.

Author: Sam Million-Weaver

5. 2 June 2018

SPIDER is switched on and produces its first plasma!

http://fusionforenergy.europa.eu/mediacorner/newsview.aspx?content=1245

"Pulse on!" said the chief operator from the SPIDER Control Room and instantly the 350 guests in vast hall of the ITER Neutral Beam Test Facility (NBTF) started the countdown. Only few seconds were left for the Director General of ITER Organization to press the button so as to trigger off the first plasma of SPIDER—the world's most powerful negative ion beam source. A decade of research and manufacturing carried out by Consorzio RFX, F4E, European companies, laboratories, ITER India and ITER Organization were reaching a crescendo. All eyes were on stage. The tension started to build up as representatives from the SPIDER Parties together with political authorities were getting ready to make history. The cameras placed in the vacuum vessel of the beam source were now transmitting live from the core of the machine. The audience started to count 5-4-3-2-1…plasma! A spark illuminated the big screen on stage. The first SPIDER plasma was now paving the way for the one that will follow in MITICA, the real-scale ITER neutral beam injector prototype, which will be operational in a couple of years, assembled a few metres away. And MITICA, in turn, would pass the torch to ITER.

The room was charged with emotion and excitement. A big round of applause, almost like a wave of energy, spread in the hall. The feeling was contagious, euphoric and uplifting. The spark they had witnessed represented years of collaboration which turned into a celebration. A dancer dressed in white moved gracefully through the audience, holding a ball on which beams of light were thrown upon and were deflected in the entire hall. A quartet playing Vivaldi's "Gloria" filled the hall with music as the beams of light caressed the big concrete door, known as the bioshield, protecting the beam source. Slowly the door opened and revealed SPIDER almost like a hidden treasure coming to light. It was epic. Art and science, two of Europe's finest hallmarks, fused in perfect harmony to set the tone of the inauguration ceremony.

Keynote speakers praised the role of science and Italy's role as a Host of the ITER NBTF. Francesco Gnesotto, President of Consorzio RFX, paid tribute to the members of staff, all contributors and the founding father of the facility—Giorgio Rostagni. The mayor of Padua, Sergio Giordani, welcomed the establishment of this "centre of scientific excellence" in the city where Galileo held a chair at the University of Padua. Salvatore La Rosa, representing Italy's Ministry of Universities and Education, stressed the importance of R&D and the commitment of the new government to maintain this as a priority. Carles Dedeu, representing the European Commission, and Flavio Zanonato, Member of European Parliament, used this opportunity to remind audiences of the EU's commitment to ITER and its potential in changing the energy mix. Bernard Bigot described this day as "an important achievement" for ITER and the fusion community. Johannes Schwemmer, Director of F4E, argued that SPIDER built a bridge between business and science. And last, but not least, Chandramouli Rotti, representing ITER India, highlighted the need of sharing technical knowhow which is essential for progress.

During a round table discussion, companies highlighted the industrial benefits stemming from fusion and explained how SPIDER helped them grow, learn, expand their supply chain and become familiar with the fusion community. Charles-Antoine Goffin

(Thales) described the importance to be involved in research projects in order to remain competitive. Giuseppe Taddia (OCEM) listed reputation, staff motivation and market expansion as some of the direct benefits. Fabien Siroti (ATT) mentioned how SPIDER enabled smaller companies to work with bigger ones and create partnerships. Christian Eckardt (PVA Tepla) talked about the way SPIDER offered a new level playing field in line with Big Science business opportunities. Michele Tamagnone (Delta Ti Impianti) described how SPIDER has proven to be a good school to sharpen project management skills and apply new standards.

You may wonder why the ITER Neutral Beam Test Facility is a key step in the fusion roadmap. When ITER starts producing energy through the fusion of hydrogen atoms, it will rely on very powerful heating devices to achieve the necessary 150 million °C for the fusion reactions to occur. The power-horses of the ITER heating systems are two neutral beam injectors, with a third as an option during operation. Although neutral beam injection is routinely used for plasma heating in fusion devices, the size of ITER poses a set of challenges: particle beams have to be much thicker and individual particles have to be much faster to travel far into the core of the plasma. SPIDER (Source for the Production of Ions of Deuterium Extracted from a Radiofrequency plasma) will help developing this new technology.

The experiment is built on the premises of Consorzio RFX, located in Padua, Italy. SPIDER also represents a unique international collaboration. Italy and Consorzio RFX have provided the facility and a large contribution towards the personnel. The team of Consorzio RFX will also be responsible for the operation of SPIDER. F4E has procured, financed and supervised the fabrication of most of the components, building on the expertise of European industry and research organisations. ITER India, managing India’s contribution to ITER, has also provided important equipment. ITER Organization, has led the design and oversight, and when it operates

6. Magnum-PSI's time to shine

06/14/2018
https://www.euro-fusion.org/news/2018/june/magnum-psis-time-to-shine/

"We will gain the first detailed look into how ITER's wall materials will evolve during their lifetime in the reactor, something no other experiment is able to investigate," ~Thomas Morgan, head of DIFFER's research into plasma material interactions

The latest world record in fusion research comes from The Netherlands. Operating with superconducting magnets since 2017, Magnum-PSI at DIFFER (Dutch Institute for Fundamental Energy Research) has set a new record for the longest exposure of a material to the harsh plasma conditions in a fusion device.
Magnum-PSI exposed *tungsten* wall components to the equivalent of a full year of high power fusion operations in the future ITER reactor. So, why is it important to expose *tungsten* to harsh plasma conditions? Simply, because thse are the conditions expected in ITER's exhaust system, once ITER is operational, and experiments such as those conducted in Magnum PSI, will give insights about materials that can be used in ITER and future fusion reactors. The upcoming issue of Fusion In Europe will carry an article about the record-breaking experiment. And, you can also get all the details from the DIFFER News page.

7. New PPPL Director Steve Cowley is honored with knighthood by Queen Elizabeth II

By
Larry Bernard
June 12, 2018

https://www.pppl.gov/news/2018/06/new-pppl-director-steve-cowley-honored-knighthood-queen-elizabeth-ii

Steven Cowley, newly named director of the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL) effective July 1, has received a knighthood from Queen Elizabeth "for services to science and the development of nuclear fusion."

Now known formally as Sir Steven Cowley, he previously was chief executive of the United Kingdom Atomic Energy Authority (UKAEA) and director of the Culham Centre for Fusion Research, and most recently was president and professor of physics at Corpus Christi College at Oxford University.

"Princeton is truly delighted that Steve is coming to lead the Lab," said Dave McComas, Princeton University Vice President for PPPL. "His contributions earlier in his career in the U.S. and then more recently in Europe have been stellar and we are counting on him to lead PPPL to new heights."

The honor was announced on June 9 in The Queen's Birthday Honours, which recognizes the achievements of extraordinary individuals across the United Kingdom.

"I am personally delighted and humbled," Cowley said. "I have been privileged to work with many extraordinary people in fusion research. This honor reflects the huge importance of our collective work developing new, clean forms of energy production."

Rich Hawryluk, a physicist and currently interim director of PPPL, said: "This is a most deserved honor. Steve's role in advancing fusion energy and his stellar leadership in the field over the years are testimony to his knowledge, skill and acumen. We are thrilled he is bringing his expertise to PPPL and continuing to lead the world's quest for fusion energy from here."

The current chief executive of UKAEA, Ian Chapman, said: "I am so pleased for Steve receiving this award. It is fully deserved for all his hard work in fusion over the years – undertaking research, leading us for eight years so effectively and his unstinting efforts to publicize fusion at every opportunity."

Greg Hammett, a principal research physicist at PPPL who earned his doctorate from Princeton University the year after Cowley, said: "It's nice to see that the Queen is still knighting people for slaying fire-breathing dragons, of the plasma instability variety." One of Cowley's scientific contributions, Hammett said, has been on the understanding and controlling of plasma instabilities, types of weaknesses that can reduce or halt fusion reactions. "These are important steps toward making fusion energy more practical," Hammett said.

Fusion, the power that drives the sun and stars, is the fusing of light atomic elements in the form of plasma — the hot, charged state of matter composed of free electrons and atomic nuclei — that generates massive amounts of energy. Scientists are seeking to replicate fusion on Earth for a virtually inexhaustible supply of power to generate electricity in what might be called a "star in a jar."

A fusion theorist, Cowley will become the seventh director of PPPL, one of 10 national science laboratories funded by the DOE's Office of Science. Princeton has managed PPPL since its origin in 1951, when Professor Lyman Spitzer, a founder of the field of plasma physics, initiated the study of fusion at the University.

Cowley earned his Ph.D. in astrophysical sciences from Princeton in 1985, was a staff scientist at PPPL from 1987 to 1993, and also taught at the University. In his new role, Cowley will be appointed professor of astrophysical sciences at Princeton.

Culham operates the Joint European Torus (JET) and Mega Amp Spherical Tokamak (MAST) fusion facilities. During Cowley's tenure, he led the fusion research program and provided the vision and strategy for fusion in the United Kingdom. His role included overseeing more than 1,000 employees and contractors and having management authority for implementation and operations for the Culham Laboratory and the UKAEA.

In parallel, he expanded and strengthened relations with other fusion programs in Europe and around the world, and served in key advisory roles for the U.K., U.S. and European governments. Cowley is a fellow of the Royal Society and of the Royal Academy of Engineering. He holds a bachelor's degree in physics from Oxford.

PPPL, on Princeton University's Forrestal Campus in Plainsboro, N.J., is devoted to creating new knowledge about the physics of plasmas — ultra-hot, charged gases — and to developing practical solutions for the creation of fusion energy. The Laboratory is managed by the University for the U.S. Department of Energy's Office of Science, which is the largest single supporter of basic research in the physical sciences in the United States, and is working to address some of the most pressing challenges of our time. For more information, please visit science.energy.gov(link is external).

8. PPPL wins three awards for its environmental programs

By
Jeanne Jackson DeVoe
June 4, 2018

https://www.pppl.gov/news/2018/06/pppl-wins-three-awards-its-environmental-programs

The U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL) has won two awards from the U.S. Environmental Protection Agency (EPA) for its 97 percent recycling rate and for its composting program, and has won a third award from the Green Electronics Council for its green electronics purchasing program.

PPPL received a U.S. EPA 2017 Federal Green Challenge Regional Award and a U.S. EPA 2017 WasteWise Regional Award from the EPA Region 2, based in New York, for reducing waste and diverting waste from landfills in 2016 through its recycling and composting efforts. The high recycling rate was largely due to PPPL recycling 98 percent of concrete, metal, and other materials removed during a building improvements project. Leanna Sullivan, PPPL's acting environmental compliance officer, accepted the awards at a ceremony at the Region 2 headquarters in New York in April.

PPPL is converting the C-Site Motor Generator Building, which once housed giant motor generators that powered PPPL's experiments decades ago, into technical shops through the Infrastructure Operational Improvements (IOI) project. To do that, contractors removed tons of concrete and metal that reinforced the floors and walls of the building.

The IOI project recycled 3,453 tons of concrete and 201 tons of metal in fiscal year 2016, the year for which PPPL received the award. PPPL also recycled 69 percent of all solid waste that would otherwise end up in the landfill, including 28 tons of wood from tree removal, 19 tons of compost, and 41 tons of single stream recycling.

"PPPL takes its responsibility to the environment seriously and we are proud that we were able to recycle most of the concrete debris from our improvement project," said Rich Hawryluk, PPPL's interim director. "We also applaud our employees for continuing to recycle electronics, papers, bottles, and cans, as well as to compost food from our cafeteria. This recognition is a tribute to the entire staff."

The Laboratory also received a three-star 2018 EPEAT Purchaser Award from the Green Electronics Council in May for purchasing 150 green electronic products in fiscal year 2017, the fourth year in a row PPPL has received the award.

In addition to purchasing green electronics, PPPL also recycled 24 tons of electronics and 248 pounds of toner and ink cartridges last year. PPPL also collected more than two tons of home electronics from employees in 2017 for UNICOR's Federal Prisons Industries program.

"The fact that we have year over year been recognized for this type of environmentally preferable purchasing means we are doing the right thing," said Rob Sheneman, head of the Environmental Services Division. "It really does require a team effort among a bunch of different parts of the Laboratory to make it successful, and the criteria changes from year to year."

Sullivan, who oversees the program, echoed that point. "It's definitely a collective effort across the Laboratory and we hope to continue the effort."

PPPL was one of more than a dozen U.S. Department of Energy winners and among more than 50 winners nationwide to receive the award. The list includes cities like Portland, Oregon, and Santa Monica, California, other federal agencies such as the U.S. General Services Administration, and companies such as The World Bank Group. Together, they saved more than $83 million over the lifetime of the products purchased and reduced greenhouse gases equivalent to removing 94,000 passenger cars from the road for a year, according to the Green Electronics Council.

PPPL has received numerous awards for its environmental programs over the past several years, including a gold Green Buy Award from the DOE last year for its green buying program in fiscal year 2016. The Laboratory's main office building, the Lyman Spitzer Building, was U.S.-LEED Gold certified in 2011. PPPL received a DOE Federal Sustainability Award for reducing greenhouse gas emission and was named a U.S. Environmental Protection Agency Waste-Wise Federal Partner of the Year in 2012.

PPPL's sustainability efforts in 2016 had the following effects, according to PPPL's Environmental Services Division:

- More than 4,000 barrels of oil conserved
- More than 200,000 gallons of gas conserved
- Energy savings equivalent to 150 homes
- Gasoline savings equivalent to 500 passenger vehicles removed from the road

The Green Electronics Council estimates the green products PPPL purchased will have the following impact over their lifetime:

- Reduce the use of primary materials by 14 metric tons, the equivalent of the weight of three elephants.
- Avoid disposing 130 kilograms of hazardous waste, equal to the weight of a refrigerator.
- Eliminate 508 kilograms of solid waste, the equivalent of one household's solid waste for three month.
- Avoid 88 kilograms of water pollution emissions.

By purchasing electronic products that meet or exceed federal ENERGY STAR specifications, PPPL will use less energy to use the products over the products' lifetime, thereby saving $4,901. According to the Green Electronics Council, using less energy will also have the following environmental effects:

- Save more than 47,000-kilowatt hours of electricity – enough to power four U.S. households as a year.
- Reduce 8 metric tons of greenhouse gas emissions – the equivalent of taking six U.S. passengers cars off the road for a year.

PPPL, on Princeton University's Forrestal Campus in Plainsboro, N.J., is devoted to creating new knowledge about the physics of plasmas — ultra-hot, charged gases — and to developing practical solutions for the creation of fusion energy. The Laboratory is managed by the University for the U.S. Department of Energy's Office of Science, which is the largest single supporter of basic research in the physical sciences in the United States, and is working to address some of the most pressing challenges of our time. For more information, please visit science.energy.gov(link is external).

9. Scientists from around the world come to New Jersey to discuss how to control plasma-surface interactions for fusion

By
Larry Bernard
June 4, 2018

https://www.pppl.gov/news/2018/06/scientists-around-world-come-new-jersey-discuss-how-control-plasma-surface-interactions

PRINCETON, New Jersey (June 6, 2018) – The 23rd International Conference on Plasma Surface Interactions in Controlled Fusion Devices – the preeminent biennial research conference in this field – begins on June 17 and continues for six days.
More than 400 scientists from around the world will convene at Princeton University to discuss the state of research on how plasma-material interactions can be managed so fusion reactions – the same reactions that occur in the Sun and stars – can produce virtually unlimited energy on Earth in what could be called "a star in a jar." The conference web site is: https://psi2018.princeton.edu/(link is external)

Organized this year by the Princeton Plasma Physics Laboratory (PPPL), a collaborative national center for fusion and plasma research operated by Princeton University for the U.S. Department of Energy (DOE), the conference covers topics ranging from the dizzying complex conditions at the edge of fusion plasmas to the control of the intense heat flowing to the walls of fusion devices. Temperatures inside such devices are many times greater than the core of the sun. PPPL is the only one of 10 national laboratories in the DOE Office of Science dedicated to fusion research.

PPPL physicists Rajesh Maingi is overall Conference Chair and Charles Skinner is Chair of the Local Organizing Committee; Egemen Kolemen, Princeton University assistant professor of mechanical and aerospace engineering with an appointment at PPPL, is the Princeton Contact.

Fusion, the power that drives the sun and stars, is the fusing of light elements in a plasma — the hot, charged state of matter composed of free electrons and ions — to generate massive amounts of energy that can, it is hoped, be converted to electricity for the benefit of humankind. The hot plasma in the core of a fusion energy device must interact with its low-temperature material walls.

"Taming the plasma-material interface has long been recognized as a key quest in the development of fusion energy. The seventh conference in this 46-year series was also held in Princeton in 1986, and notable progress has been made since then," Skinner said. More than 400 research papers have been accepted for presentation at the 2018 conference, enough for all participants to find something of interest.

The conference begins Monday, June 18, with an introductory talk by Robert Socolow, Princeton University professor emeritus of mechanical and aerospace engineering, on a thought-stretching and provocative question: "In a low-carbon future, where does fusion fit in?(link is external)"

The conference includes tutorials led by worldwide experts on hot topics in the field, including how ITER (pronounced 'EAT-er'), the major international fusion device under construction in France, will manage the intense heat and particles flowing to its walls. PPPL is an appropriate organizer of this conference, as it manages the nation's spherical torus (ST) tokamak, or fusion energy device. Called the National Spherical Torus Experiment-Upgrade, the cored-apple-shaped device will be the most capable ST tokamak in the world. It has already yielded valuable research clues that help inform ITER and other next-generation fusion devices.

Conference sponsors are the DOE, PPPL, Princeton University, MIT, the University of California-San Diego, and the University of Tennesee-Knoxville.

PPPL, on Princeton University's Forrestal Campus in Plainsboro, N.J., is devoted to creating new knowledge about the physics of plasmas — ultra-hot, charged gases — and to developing practical solutions for thecreation of fusion energy. The Laboratory is managed by the University for the U.S. Department of Energy's Office of Science, which is the largest single supporter of basic research in the physical sciences in theUnited States, and is working to address some of the most pressing challenges of our time. For more information, please visit science.energy.gov(link is external).

10. Fusion energy and hidden symmetries

IPP scientists get grant from the Simons Foundation for further development of stellarator optimization

June 14, 2018

For treating the topic, Hidden Symmetries and Fusion Energy, Max Planck Institute for Plasma Physics (IPP) at Greifswald in conjunction with nine universities in the USA, Switzerland, the United Kingdom and Australia has been awarded research funds from the renowned Simons Foundation. The foundation was established in New York City by Marilyn and Jim Simons – he a mathematician, hedge fund manager and billionaire – to promote research in mathematics and other fundamental sciences.

The Hidden Symmetries and Fusion Energy project, which the Simons Foundation will support with an annual two million US dollars for four years, is dedicated to the development of new sophisticated methods of computational optimization of fusion devices of the stellarator type. The objective of fusion research is a power plant that like the sun is to derive energy from fusion of atomic nuclei. As the fusion fire needs over 100 million degrees to ignite, the fuel, viz. a low-density hydrogen plasma, ought not to come into contact with cold vessel walls. It is confined by magnetic fields and is suspended inside a vacuum chamber with almost no wall contact.

Unlike the circularly symmetric magnetic field of the competing tokamak concept, which ensures good particle confinement, the magnetic field of a stellarator at first glance exhibits no symmetry whatsoever. Nevertheless, stellarator fields may have hidden symmetries that should likewise lead to good particle confinement. A "quasi-symmetric" structure forms the basis of, for example, the HSX stellarator at Madison, Wisconsin. The Wendelstein 7-X stellarator at Greifswald, whose first experimental results are highly promising, also shows that a tailored magnetic field can improve confinement.

The international team of plasma physicists, mathematicians and IT scientists, headed by a scientist from Princeton University, aims to find the optimum magnetic fields with hidden symmetries. Their objective is to produce a palette of novel, interconnected mathematical and numerical optimization tools, called the Simons Stellarator Optimizer. Professor Dr. Per Helander at IPP Greifswald is in charge of applying this optimiser to new stellarator designs: "The funding", states Per Helander, "will allow the participating institutes provision of eight additional scientist positions for the four years – a great boost for stellarator optimisation".

11. *DIII-D National Fusion Facility Begins Transformation to Prepare for Future Reactors*

New equipment will enable studies of burning plasma physics and sustainment

San Diego, May 18, 2018 – One of the most flexible and highly instrumented fusion research reactors in the world is undergoing major enhancements that will pave the way to future fusion power plants.

http://www.ga.com/diii-d-national-fusion-facility-begins-transformation-to-prepare-for-future-reactors

The DIII-D National Fusion Facility, operated by General Atomics for the Department of Energy, is the largest magnetic fusion experiment in the U.S. This week marks the start of a series of enhancements to DIII-D that will make it possible to commence new studies of the physics of future fusion reactors. That will help scientists understand how to achieve high fusion power in the ITER device now under construction in France, and how to sustain such regimes indefinitely in the fusion power plants that will follow ITER.

The planned year-long activity will enhance DIII-D systems by adding increased and redirected particle beams and radio frequency systems to drive current and sustain the plasma in a so-called “steady state.” The improvements will also expand capabilities with the installation of new microwave systems to explore burning-plasma-like conditions with high electron temperatures. This will allow researchers to explore how to achieve higher pressure and temperatures while increasing control of the plasma, conditions critical to sustained fusion operation.

“In our recent campaigns, DIII-D has pioneered many of the key techniques for ITER, controlling plasma instabilities and developing startup and quenching of fusion plasmas,” said Richard Buttery, DIII-D experimental science director. “These new capabilities will give us the flexibility to optimize performance for the reactor scale, and develop the basis for sustained fusion for commercial power.”

ITER is one of the most ambitious energy projects in the world, and will demonstrate the feasibility of fusion power at a reactor scale. The facility will create a self-heated burning plasma that produces ten times the energy required to heat it, and hold it for 400 seconds. Like DIII-D, it is a “tokamak” – a donut-shaped magnetic field that holds the hot plasma at over 100 million degrees, causing the atoms to fuse and release energy. The new capabilities at DIII-D will help the U.S. play a leading role in ITER and map the path to future fusion power plants to establish fusion as a viable and plentiful form of energy.

In this first extended opening of DIII-D in more than five years, technicians will open the vacuum chamber to install three major systems. An off-axis neutral particle beam will allow researchers to control the location and direction of high-energy atoms injected into the plasma. New microwave systems will significantly increase electron heating power. And a new ultra-high frequency “helicon” radio wave antenna will provide high-power tests of a promising reactor technology for efficient sustained current.

Together, these developments will deliver unprecedented flexibility to discover and explore solutions for future fusion reactors. The facility enhancements are expected to enable very high-pressure plasmas, in which the plasma current needed to sustain fusion performance becomes driven by the plasma itself – known as the “bootstrap” effect – which has the potential to help sustain the plasma indefinitely. DIII-D will resolve how to achieve such self-sustaining configurations.

“The knowledge gained during the next phase of operations will be critical for developing the next step for the U.S. fusion program, and for our international collaborators,” said David Hill, DIII-D director. “The path toward commercial fusion will require construction of a device that can take advantage of the sustained plasmas that we will be investigating at DIII-D.”

While the facility enhancements are being implemented, researchers at DIII-D – which draws hundreds of collaborators from more than 100 institutions worldwide – will be busy analyzing data from recent operations, looking for new breakthroughs that have applicability for ITER and other advanced fusion concepts.

About General Atomics: *General Atomics pioneers advanced technologies with world-changing potential. GA has been at the cutting edge of energy innovation since the dawn of the atomic age – for more than 60 years. With scientists and engineers continually advancing the frontier of scientific discovery, GA is serving our growing planet’s needs through safe, sustainable, and economical solutions across a comprehensive array of key energy technologies.*

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12. Tracking the Causes of Energy Loss in NIF Implosions

https://lasers.llnl.gov/news/papers-presentations

A variety of factors can affect the performance of inertial confinement fusion (ICF) experiments on NIF, and they all happen within a few billionths of a second of each other. They include the symmetry—or asymmetry—of the fusion fuel as it implodes; perturbations caused by “engineering features” like the tube used to fill the target capsule with fuel and the thin membrane, or “tent,” that suspends it inside the hohlraum; and the mixing of capsule material with the fuel as a result of hydrodynamic, or fluid, instabilities (See “How NIF Targets Work”).

Now LLNL researchers and their colleagues have developed a technique for estimating the relative extent to which each of those factors can interfere with the successful outcome of a NIF ICF experiment. The new “enhanced self-emission” technique, coupled with a high-resolution x-ray microscope, has produced the clearest picture yet of how much energy is lost due to each individual factor. The results were reported in a *Physics of Plasmas* paper published online on May 3.

The self-emission technique provides images of asymmetries and perturbations around the time of an implosion’s peak compression by using x rays emitted by the capsule’s inner shell, as opposed to x rays produced by an external source such as a backlighter. The new technique complements the argon self-backlighting radiographic technique previously used to study implosion instabilities (see ““Measuring Instabilities in NIF Implosions at Peak Velocity”).

To produce the x rays, the researchers placed a layer of high-density carbon (HDC) "doped" with a small amount of tungsten on the inner layer of an HDC target capsule. When the capsule imploded, the tungsten-doped layer emitted bright x-rays that revealed the unique signatures of the engineering features and asymmetries.

"The combination of the enhanced x-ray signature from the shell and the neutron signature from the deuterium gas inside the capsule is very powerful," said LLNL physicist Louisa Pickworth, the paper's lead author. "We were able to link the amount of x-ray radiation that we observed coming out of the hot spot with the degradation in the (neutron) yield. It was a really nice measurement, and it was fun to pick apart all those different signatures. It took a little bit of detective work to separate everything out, but I think it came together very nicely.

"One of the nice things about these experiments," she added, "was that we used our high-resolution diagnostic, the Kirkpatrick-Baez Optic (KBO) microscope (see "Promising New X-ray Microscope Poses Logistics Challenges"). This was the first experimental application of that diagnostic. The images from the KBO are resolved in time, so it's taking snapshots as the implosion's progressing, and we can see a lot of different features due to the better spatial resolution and the enhanced self-emission technique."

Along with linking the individual factors to neutron yield degradation, the experiment revealed that the implosion's extremely high non-radial fuel velocity resulted in uneven heating in the capsule. "This particular implosion is moving very quickly in one direction," Pickworth said, "and we showed that the x-ray emission is skewed to that velocity, so that the hot spot, the hot deuterium inside, is pushing up against the shell. That portion of the shell is getting preferential heating, and the portion of the shell away from the region that the hot spot's moving in is not being heated as strongly." That finding could have relevance for future efforts to achieve ignition on NIF, which depend on the ability of the fusion reactions in the hot spot to spread heat into the colder outer layers of fuel and ignite additional fusion reactions.

The researchers said the experiments showed that the enhanced self-emission radiation losses of about 400 joules from the hot spot resulted in a roughly 50 percent reduction in neutron yield. They added that in a subsequent experiment "with a significantly increased level of short-mode initial perturbations, shown through the enhanced imaging technique to be highly organized radially," the neutron yield dropped an additional 50 percent.

Joining Pickworth on the paper were LLNL colleagues Bruce Hammel, Vladimir Smalyuk, Harry Robey, Robin Benedetti, Laura Berzak Hopkins, Dave Bradley, John Field, Steve Haan, Robert Hatarik, Ed Hartouni, Nobuhiko Izumi, Steve Johnson, Shahab Khan, Nino Landen, Sebastien Le Pape, Andrew MacPhee, Nathan Meezan, Jose Milovich, Sabrina Nagel, Abbas Nikroo, Art Pak, Bruce Remington, Paul Springer, Michael Stadermann, Klaus Widmann, and Warren Hsing, along with Brandon Lahmann and Rich Petrasso from MIT and Neil Rice from General Atomics.

13. Cooperation strengthens mining radiation protection

12 June 2018

The International Atomic Energy Agency (IAEA) and the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) are to work together to enhance radiation protection of workers in the uranium mining and processing industries under a new cooperation agreement.
http://www.world-nuclear-news.org/RS-Cooperation-strengthens-mining-radiation-protection-1206188.html

The agreement between the two organisations outlines plans to address potential harm that could be caused by the higher concentrations of naturally occurring radioactive materials - or NORM - that can result from the processing and handling of raw materials.
The activity concentrations of the radionuclides in rocks and soil found in nature are generally low, but some minerals, including commercially exploited ones, may contain radionuclides of uranium, thorium or potassium at elevated concentrations. Human activities such as mining and ore processing can significantly increase the concentration of NORM radionuclides, which may require radiation control and regulation.
ARPANSA CEO Carl-Magnus Larsson and IAEA Head of Radiation Safety and Monitoring Miroslav Pinak on 24 May signed practical arrangements building on an earlier agreement under which work was conducted to create a publication on occupational radiation protection approaches in uranium mining and processing stages and techniques, as a part of the IAEA Safety Report Series. That report was developed during meetings in Australia, Canada and South Africa involving regulatory body and industry representatives.
Cooperation under the new three-year agreement is expected to provide practical tools for regulators, mine operators and workers through a training package that supports the use of the report's recommendations. The agreement will also see ARPANSA help the IAEA strengthen its global survey of information on occupational radiation protection in uranium mining (UMEX), which aims to improve protection and safety through sharing of good practices and other information.
Researched and written
by World Nuclear News

14. Ontario Power Generation starts rebuilding Darlington 2

12 June 2018

Work has begun to reassemble Darlington unit 2, Ontario Power Generation announced yesterday. The 878 MWe Candu unit is the first of Darlington's four reactors to undergo refurbishment to enable it to operate for a further 30 years.

http://www.world-nuclear-news.org/C-Ontario-Power-Generation-starts-rebuilding-Darlington-2-1206177.html

Refurbishment of Darlington 2 began in 2016 when the reactor was shut down and isolated from the operating station, after which it was defuelled. The reactor was then completely disassembled, with the last of the unit's 480 calandria tubes removed on 3 May.

Reassembly began with inspections of the calandria vessel - the tank which holds the reactor's core of nuclear fuel as well as the heavy water moderator - using a remotely controlled camera to allow viewing of key areas such as high stress welds, reactivity mechanisms and moderator nozzles to assess their integrity. These features of the calandria vessel can only be inspected when the fuel channels and other components have been removed.

Rebuilding of the reactor will begin with the installation of calandria tubes, fuel channel assemblies and lower feeders. In total, 58 connected systems will need to rebuilt in sequence, in a precision operation which will take about a year to complete.

The refurbishment project also includes the rehabilitation of steam generators, turbine generators and fuel handing equipment, as well as system improvements and plant upgrades to meet current regulatory requirements.

The CAD12.8 billion (USD9 billion) project to refurbish Darlington's reactors is scheduled for completion in 2026. Refurbishment of unit 3 is scheduled to begin after completion of work on unit 2 to allow the implementation of lessons learned.

Researched and written
by World Nuclear News

15. IAEA launches challenge on materials for fusion

11 June 2018

The International Atomic Energy Agency (IAEA) has launched a competition to find "innovative ways to visualise, analyse and explore" simulations of different materials that can be used to build fusion reactors. Such materials would subject to extremely high temperatures and energetic particles.

The IAEA said the results of the challenge will be useful for the development of a demonstration fusion power plant. Such a plant would show that controlled nuclear fusion can generate net electrical power and mark the final step before the construction of a commercial fusion power plant. This would represent the next stage after ITER, the world's largest fusion experiment under way, which is expected to demonstrate by the late 2030s that fusion can be used to generate net energy. It is not part of ITER's mission to convert this energy into electricity.

"Harnessing commercially-viable fusion power involves serious technological challenges that are expected to take many years to solve, including protecting the wall and other components of the reactor vessel from extremely high temperatures and energetic particles," the agency said.

Christian Hill, head of the IAEA's atomic and molecular data unit, noted that obtaining a very high temperature in a reactor is one of the required conditions for fusion to take place.

"At such high temperatures - ten times higher than at the core of our Sun - matter exists only as plasma, which must be confined by a magnetic field to keep it from damaging the reactor walls," he said.

Candidate materials for use in fusion reactors include tungsten, steel and beryllium, the IAEA said.

"Since experiments on physical samples are difficult and expensive to carry out, scientists have turned to computational models to simulate the behaviour of a material," it said. "Different metals or compositions, impact energies and temperatures can be explored [using molecular dynamics] and can help with the search for an effective first wall material."

The IAEA is inviting "experts and self-taught enthusiasts" to analyse simulations of the damage that can be caused to the reactor wall by the energetic neutrons released by the fusion reaction.

Participants are requested to submit ideas that take one or more of the following into consideration: novel software for visualising the material damage represented by the simulation data files in a way that aids qualitative and quantative assessment; new software tools to rapidly and reliably identify, classify and quantify new patterns and structures of particular kinds in the data sets; or, efficient algorithms to depict and summarise the statistical distribution of atom displacements and to analyse the effect of impact energy on this distribution.

Hill said, "By participating in this challenge, both specialists and non-specialists will be helping scientists to better understand how a material responds to high-energy events and will assist the development of a future fusion reactor."

The deadline for submitting ideas is 14 July.

The winner, who will be announced on 15 August, will receive EUR5000 (USD5894) and be invited to the IAEA's headquarters in Vienna to present their ideas.

Researched and written
by World Nuclear News

16. Steam generators in place at Hongyanhe 5

12 June 2018

The third and final steam generator has been put in place at unit 5 of the Hongyanhe nuclear power plant in China's Liaoning province. The ACPR-1000 reactor is scheduled to begin operating in late 2019.

http://www.world-nuclear-news.org/NN-Steam-generators-in-place-at-Hongyanhe-5-1206184.html

Steam generators are used in pressurised water reactors to transfer heat from the reactor coolant into water in a secondary circuit, producing the steam used to power the electricity-generating turbines. Each steam generator contains thousands of kilometres of tubes through which hot water flows.

The final steam generator - almost 21 meters in height and weighing more than 300 tonnes - was hoisted into place on its vertical support within the reactor building of Hongyanhe 5 on 10 June, China Nuclear Industry 23 Construction Company Limited (CNI23) has announced.

The first two steam generators were installed on 3 May and 24 May, respectively. CNI23 said installation of the steam generators has "laid a solid foundation for the subsequent start of the main pipeline welding work".

Installation of the steam generators followed that of the reactor pressure vessel on 30 March.

Construction of Phase I of the plant, comprising four CPR-1000 pressurised water reactors, began in August 2009. Units 1 and 2 have been in commercial operation since June 2013 and May 2014, respectively, while unit 3 entered commercial operation in August 2015 and unit 4 in September 2016.

Unit 5 is the first of two 1080 MWe China General Nuclear (CGN) designed ACPR-1000 reactors that will form Phase II of the Hongyanhe plant.

Construction of unit 5 began in March 2015 and that of unit 6 starting in July the same year. The second phase of the Hongyanhe plant is planned to be completed in 2021.

It is owned and operated by Liaoning Hongyanhe Nuclear Power Co, a joint venture between CGN and State Power Investment Corporation, each holding a 45% stake, with the Dalian Municipal Construction Investment Co holding the remaining 10%.

Researched and written
by World Nuclear News

17. First yellowcake from seawater for US team

14 June 2018

Researchers have successfully used acrylic fibres to extract uranium from seawater in a trial conducted at Pacific Northwest National Laboratory (PNNL). The team say the technology, which uses inexpensive material, could be competitive with the costs of land-based uranium mining.

The material was developed by Idaho-based clean energy company LCW Supercritical Technologies with early support from PNNL through the US Department of Energy's Office of Nuclear Energy. Uranium in seawater is adsorbed onto a molecule that is chemically bound to the surface of the polymer fibre. The adsorbent properties are reversible, meaning that the uranium can be easily released and processed into yellowcake, and the polymer is durable and reusable.

Three separate month-long tests were carried out using seawater from Sequim Bay, next to PNNL's Marine Sciences Laboratory. Seawater was pumped through about a kilogram of fibre in conditions mimicking the open ocean. The uranium was then extracted, producing in total about five grams of uranium.

PNNL researcher Gary Gill described the achievement as a significant milestone, showing that the approach could eventually provide a commercially attractive option. "It might not sound like much, but it can really add up," he said.

Chien Wai, president of LCW, said the adsorbent material was inexpensive and could even be produced using waste yarn. The fibres also have the potential to be used in environmental clean-up and to extract other metals from seawater, such as vanadium.

LCW is now applying for further funding for a uranium extraction field demonstration, to be led by PNNL, in the Gulf of Mexico. The material performs much better in warmer water and extraction rates in the Gulf are expected to be three to five times higher, which would improve the economics further.

Seawater contains naturally occurring uranium at a concentration of about 0.003 parts per million. Although this concentration is very low - the average abundance of uranium in the Earth's crust is about 2.7 parts per million and ore grades are many times greater than that - the oceans are estimated to contain some 4 billion tonnes of the metal. The total uranium resources in land-based ores recoverable at costs of up to USD130 per kilogram stands at around 3.7 million tonnes, so the oceans could be an important resource of uranium if it can be recovered economically.

Research groups in China and Japan are also actively studying methods to extract uranium from seawater. China National Nuclear Corporation's Beijing Research Institute of Chemical Engineering and Metallurgy in 2017 signed an agreement with Saudi Arabia's King Abdulaziz City for Science and Technology to collaborate in research on extracting uranium from seawater, with Saudi and Chinese researchers to conduct a two-year investigation.

Researched and written
by World Nuclear News