THE QUARTERLY NEWSLETTER OF THE BRITISH CRYOGENICS COUNCIL (BCC)

WINTER 2019

British Cryogenics Council

LOW TEMPERATURE NEWS

COVER STORY: UK SCHOOL CRYOGENICS LAB OPENED

ICEC27–ICMC2018: HOW DID IT GO?

IoP PRIZE FOR TESLA ENGINEERING

Inside this Issue

Editorial

Dear Readers,

2018 saw the successful ICEC27-ICMC2018 and the opening of the first cryogenic lab in a school in the UK – see inside for more details!

This year we can look forward to a particular one-day gathering on **Friday May 24 at Rutherford Appleton Laboratory, for a Helium-Themed Cluster Day**, comprising talks, posters, exhibition and a visit to the Helium Recovery Facility at the ISIS Neutron Source. This occasion is being arranged in recognition of price escalation and recurring supply concerns in the helium market, causing concern for a significant segment of the cryogenic community - and to both raise the profile and lend support to initiatives for exploration for (yes) indigenous supplies of helium. The Pickavance Lecture Theatre is reserved for the occasion, as is the New Visitor Centre at RAL which will enable a more spacious exhibition and lunch. Potential exhibitors should contact John Vandore.

This year's Helium-Themed event has displaced plans for a Scottish Cryogenics Day this year - however the new Higgs Building at the Astronomy Technology Centre at the Royal Observatory on Blackford Hill in Edinburgh has been booked for Thursday May 21 2020. Again, let us know if you would like to take part.

Happy Reading from the Editorial Team!

BCC Safety Manual Fifth Edition - **Free download for Members, see website for details**	-	£10
Cryogenic Fluids Databook	Compiled by P.Cook and B.Hands	£25
Energy Dissipation in Superconducting Materials	Kovachev	£20
Cryopumping - Theory and Practice	Haefer	£20
re Refrigerators for Cryogenic Sensors and Cold Electronics	Walker	£20
History and Origins of Cryogenics	Scurlock	£25
Cryogenic Liquids [The Application of Cryogenic Fluid Dynamics]	Scurlock	£55

More detail on these high-quality publications is available on the BCC website at www.bcryo.org.uk. To order copies, please e-mail, phone or write to the Editor (contact details below). Payment can be made by cheque, or by credit card through the BCC PayPal account, on request. Subject to quantity and destination, it may be necessary to add a charge for postage. Publications can also be ordered from The Institute of Refrigeration at Kelvin House, 76 Mill Lane, Carshalton, Surrey SM5 2JR, England. Tel: +44 (0)20 8647 7033 or e-mail: ior@ior.org.uk or by going to their website at www.ior.org.uk and selecting the list of 'all publications' at their on-line shop page.

Readers' Contributions
Readers' contributions are most welcome. If you have an article or a point of view to put forward, supportive or controversial, contact the Editorial Team via admin@bcryo.org.uk.

Disclaimer
Low Temperature News is edited and produced on behalf of the British Cryogenics Council (BCC). Views expressed in the newsletter are not necessarily those of the BCC. More information about the BCC can be found on the website at www.bcryo.org.uk.

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Welcome to New Members

We are delighted to feature three more new corporate members this quarter:

CSC Integrity Management is a global services team, pioneering the acoustic emission-based inspection and testing regime applicable to the cryo installations and high pressure gas cylinders within universities, research facilities and laboratories. CSC IM is part of **Chesterfield Special Cylinders** https://bcryo.org.uk/users/chesterfield-special-cylinders

SK Wiring is one of the worlds leading thermocouple ,RTD and specialist cable manufacturers we offer a broad range of insulation types while our in house wire production and calibration facility enables us to offer thermocouple cables measuring temperatures from -196 deg c up to + 1000 deg c.

https://bcryo.org.uk/users/sk-wiring-products-limited

Cryogen Energy Group for innovative cryogenic technology delivering clean efficient energy solutions. Liquified gas (LN2, LO2, LAir) production by energy saving cryogenic process.
Applications across multiple sectors. energy storage, clean fuels for generation, LNG re-cycling, liquid gas fuels, waste energy utilisation.
Low carbon footprint, clean, no particulate emissions.

https://bcryo.org.uk/users/cryogen-energy-group-ltd

In Memoriam: John A. Smith

In the Spring/Summer 2017 edition we noted the resignation of John Smith, a long time contributor to the CryoDiary page of Low Temperature News - and extended the considerable thanks of the British Cryogenics Council to John for his support over many years, starting in the 1960s. At that time, John had worked for BOC, and rapid development taking place in superconductivity had caught John's attention and interest. John was a trooper for the BCC, taking the time to visit the British Library on a regular basis, researching meetings and events around the world of potential interest to other BCC Members. It is with deep regret that we learned on September 23rd 2018 from his sister Jenny Clifford, that John passed away earlier last year. Jenny had known John to be involved in many things, but not the extent to which he had been a part of the BCC publication of Low Temperature News, and she was pleased to learn how fondly we regarded him for his diligent support to the BCC. John will be sadly missed. All at the British Cryogenics Council wish to extend their deepest sympathies.

ICEC27-ICMC 2018 Report

Thank you Oxford ! We had 491 delegates at the Conference in September, it was deemed by all to be a success - people just enjoyed being in Oxford (and the weather was kind too)!

Oxford was a candidate for ICEC 17 in 1998, but rejected, partly on account of the venues. And indeed, much to outsiders' surprise, the venues in Oxford are limited. There is no brand new purpose-built conference centre, and while many of the colleges have first-class facilities, they are necessarily at college scale rather than town or university. So you have to work round what there is - and the combination of the Sheldonian Theatre, the Examination Schools and the Town Hall did us proud.

Profs Ian Shipsey, (above), Steve Blundell and Marcel ter Brake (below)

The Opening Ceremony took place in the Sheldonian Theatre, appropriately the University's official ceremonial hall. The Conference was welcomed by Professors Ian Shipsey, Head of Physics at the University & Neil Geddes, now Head of STFC National Laboratories. Prior to presentation of the Mendelssohn Prize to Professor Fons de Waele by ICEC Chairman Marcel ter Brake, Professor Stephen Blundell from the Clarendon Laboratory spoke on Mendelssohn and his time in Oxford.

ICMC Lifetime Achievement and Awards for Excellence were then presented by Professors David Evans and Cardwell. Member of Parliament Ed Vaizey rounded off this part of the proceedings with a Goodwill Message to the Conference, reflecting the local importance of Cryogenics.

Prof Ralph Scurlock presenting the Mendelssohn prize to Prof Fons de Waele and MP Ed Vaizey

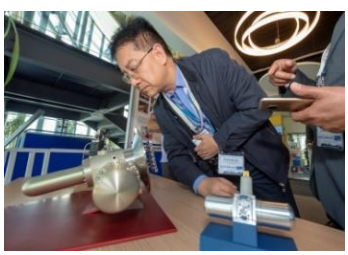
The Sheldonian Theatre

And so to the Examination Schools, the largest venue in the city centre, built in the 1880s to house the University's examinations, and our anchor location, accommodating the plenary talks, parallel conference tracks, exhibitors, poster sessions and catering. The plenary sessions were masterful. As Mendelssohn Prize Winner, Professor Fons de Waele gave a plenary talk titled "Challenges in Cryocooling." Barry Fuller's talk : "Stopping the Biological Clock" brought biology and cryogenics together in the field of Applied Cryobiology.
Oxford Alumnus Glyn Kirby opened his talk on Next Generation Materials for Future Magnet Development at CERN with a slide from memory lane featuring his favourite old Oxford haunts as a student. Neil Mitchell from ITER spoke on Lessons

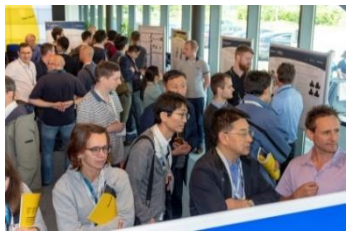
Learned from the ITER Magnets in Materials Development & Industrialisation. And Tiemo Winkler from the University of Twente spoke on the EcoSwing superconducting wind turbine project. We expect to include a report on the scientific content of the conference in the next edition of LTN, coinciding with publication of the Conference Proceedings.

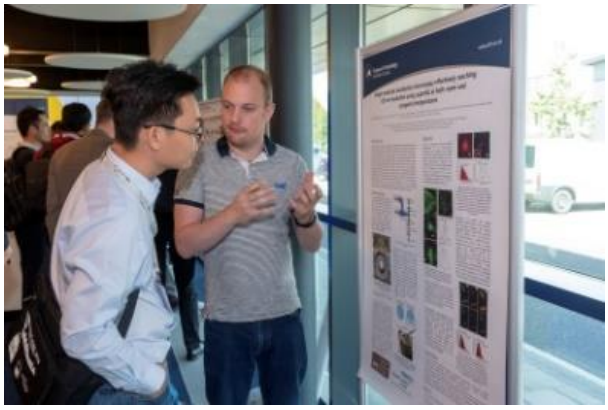
To accommodate all the components of the conference, a marquee was constructed outside in the Examination Schools quad, housing a number of exhibitors, poster sessions, and a superconducting levitation demonstration staged by the University of Cambridge. Other than for Oxford alumni with bad memories of student exams, the Examination Schools had great appeal for delegates - despite some perhaps inevitable shortcomings from age - there was some negative feedback on the restrooms (!) and disturbance from heavy footfall on the first floor to projectors suspended from the ceilings below! Nonetheless, the Examination Schools proved an enjoyable venue for the Exhibitor Reception held there on the Tuesday evening.

The conference included two other social occasions, held in the Town Hall, the scene of the BCC 50th Jubilee Birthday celebrations in May 2017. A welcome reception was held on the Monday preceding the conference and a farewell dinner on Thursday evening - once again requiring us to work around the constraints of Oxford venues. Capacity for a sit-down dinner was less than we would have liked, and despite the high cost, the dinner was sold out - and diners treated to entertainment in the form of "singing waiters" - opera singers disguised as staff who feigned an incident and broke into spontaneous song ! During the "free" evening on Wednesday, some of the sponsors found other venues to their liking for their own receptions, ranging from a very traditional English pub [Air Liquide in the Kings Arms] to a stylish boutique hotel [Linde in the converted Victorian prison which is now the Malmaison Hotel].

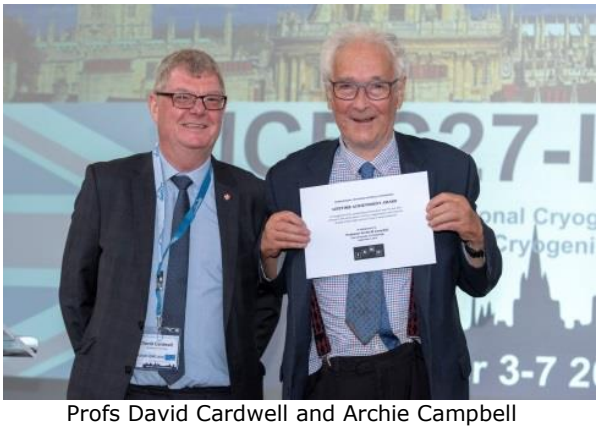


Four optional technical visits took place on the Friday, with one party leaving on foot for a visit to Oxford University, while three coaches set off in different directions - one to visit local industry in the form of Oxford Instruments and Polar Technology (occupying Oxford Instruments' former headquarters in Eynsham). Another went to visit "Science Vale," calling at the JET Fusion Reactor at Culham, and passing the Oxfordshire UTC (the world's first High School with its own Lab teaching Cryogenics) en route to Rutherford Appleton Laboratory on the Harwell Campus. The third coach went furthest - to Birmingham University, home to a Laboratory for the Dearman Engine, and a pilot Liquid Air Energy Storage Plant. Had the visits been the day before, it would have been disastrous, due to a local crash causing tailbacks up to 25 miles! As it was, delays affected the trip to Birmingham, which got back to Oxford in the nick of time! Not everyone could get on the trips they wanted, so we take this opportunity to apologise and invite anyone back for a visit another time.





With Oxford being an expensive place to visit, student accommodation was made available from a number of colleges within walking distance of the venues. One example was in "New College" [new in 1379 !]. Delegates who chose to stay there had the pleasure of eating breakfast in a Dining Hall reminiscent of Harry Potter's Hogwarts. Thank you again Oxford, the weather - and everyone who took part in making this special occasion.



Profs David Cardwell and Archie Campbell

UTC Oxfordshire opens Cryogenics Laboratory

Press release: 19 OCTOBER 2018

UTC Oxfordshire were excited to officially open their state-of-the-art Cryogenics Laboratory today; a first for a UK school.

In planning since April 2015, and brainchild of John Vandore (Trustee of the British Cryogenics Council), the cryogenics laboratory will be used by students to enhance their employer led projects and science curriculum. Ahead of their first project in November students will visit facilities at STFC to find out more about the benefits of, and uses for, cryogenics.

Building on relationships with businesses and organisations the UTC was able to create this unique opportunity - in planning from early on in the school build. Annette Jonathan, science technician led the project, with the support of Quantum Cryogenics, DY Assist, LTI Metaltech, STFC, University of Southampton, British Cryogenics Council, Proactive Gas Safety, Goetze, and AirProducts who all worked to ensure the safe and effective provision of the innovative school cryogenics laboratory.

Although the laboratory was built into the school plans it has taken 3.5 years planning, procurement and testing to ensure the success of this ambitious project.

Ed Vaizey (MP) *"Once again the UTC is proving a trailblazer for secondary schools in the UK. I am thrilled that they are opening a first school cryogenics laboratory in the country. This fabulous facility will provide its students with a unique chance to study this important field of science"*

Nigel Tipple (CEO OxLEP) – *"It is vitally important that education providers and businesses work closely together. The opening of UTC Oxfordshire's cryogenics laboratory will inspire young people to consider and investigate a career the cryogenics industry – an industry with global impact at the heart of Oxfordshire"*

Stirling Cryogenics BOG Management System

Press Release from Member DH Industries

14th September 2018

Stirling Cryogenics BOG management system for the bunkerbarge "Clean Jacksonville" tested successfully!

DH Industries BV (the Netherlands) is proud to announce that the BOG management system for the "Clean Jacksonville" bunkerbarge has been tested successfully.

Six StirLNG-4 Cryogenerators are installed on board of this 2,200 m3 LNG bunker barge, built by Conrad Industries and owned by Tote Maritime Puerto Rico, to re-liquefy the Boil Off Gas. During the final gas trials all units have performed perfectly and as expected. During the tests, the units maintained the operational pressure within the GTT membrane tanks below the given setpoints.
The **StirLNG-4** is a micro scale, stand alone, plug and play (re-)liquefier with a small footprint and specifically designed to manage (e.g. produce, peakshave or condition) boil off gas, both on- and offshore. Either by direct (re)-liquefaction or subcooling.

DH Industries has obtained ABS type approval for the StirLNG-4, addressing marine and offshore applications. For another maritime BOG management project with three **StirLNG-4** units, the type approval, by bureau Veritas, is expected in October 2018.

The **StirLNG-4 cryogenerators** on the Clean Jacksonville, operated by Tote services, operate in parallel and have a total re-liquefaction capacity of 6 metric Tons per day. Each cryogenerator has single operation functionality. This solution provides customers with high flexibility, efficiency and reliability.

For over sixty years DH Industries is designing and manufacturing cryogenic gas liquefaction solutions.

For more information about this solution and also other onshore and maritime projects, contact Peter Lamberts at p.lamberts@dh-industries.com.

dh industries cool to excel.

UK delivers super-cool kit to USA for Next-Generation Dark Matter Experiment

17 July 2018

A worker inspects the titanium cryostat for the LUX-ZEPLIN experiment in a clean room at the Sanford Underground Research Facility in South Dakota. (Credit: SURF)

A huge UK built titanium chamber designed to keep its contents at a cool -100C and weighing as much as an SUV has been shipped to the United States, where it will soon become part of a next-generation dark matter detector to hunt for the long-theorised elusive dark matter particle called a WIMP (Weakly Interacting Massive Particle).

This hunt is important because the nature of dark matter, which physicists describe as the invisible component or 'missing mass' in the universe, has eluded scientists since its existence was deduced by Swiss astronomer Fritz Zwicky in 1933. The quest to find out what dark matter is made of, or whether it can be explained by tweaking the known laws of physics, is considered one of the most pressing questions in particle physics, on a par with the previous hunt for the Higgs boson.

The cryostat chamber was built by a team of engineers at the UK's Science and Technology Facilities Council's Rutherford Appleton Laboratory in Oxfordshire, and journeyed around the world to the LUX-Zeplin (LZ) experiment, located 1400m underground at the Sanford Underground Research Facility (SURF) in South Dakota.

After being delivered to the surface facility at SURF the Outer Cryostat Vessel (OCV) of the cryostat chamber spent five weeks being fully assembled and leak checked in the SURF Assembly Lab (SAL) clean room. It has now been disassembled and packaged for transportation from the surface to the underground location at SURF. Meanwhile the Inner Cryostat Vessel is now in the SAL clean room getting prepared for the leak tests.

STFC's Dr Pawel Majewski, technical lead for the cryostat, said: "The cryostat was a feat of engineering with some very stringent and challenging requirements to meet. Because of the huge mass of the cryostat – 2,000kgs – we had to make sure it was made of ultra radio-pure titanium. It took nearly two years to find a pure enough sample to work with. Eventually we got it from one of the world's leading titanium suppliers in the US where Electron Beam Cold Heart technology was used to melt the titanium.

"This type of ultra-pure titanium is used, for example, in the healthcare industry to fabricate a pacemaker encapsulation. In our case it is used to hold the heart of the experiment."

It took two-and-a-half years to design the specialist equipment, and another two years to build in Italy by a company specialising in vessels and pipes fabrication only from titanium.

The cryostat is a vital part of LZ, as it keeps the detector at freezing temperatures. This is crucial because the detector uses xenon – which at room temperature is a gas. But for the experiment to work, the xenon, which itself has low background radiation, must be kept in a liquid state, which is only achievable at around -100C.

LZ is the latest experiment to hunt for the long-theorised elusive dark matter particle called a WIMP (Weakly Interacting Massive Particle). Many scientists believe finding WIMPs will provide the answer to one of the most pressing questions in physics – what is dark matter? WIMPS are thought to make up the most of dark matter – the as-yet-unknown substance which makes up about 85% of the universe. But because WIMPs are thought not to interact with normal matter, they are practically invisible using traditional detection methods.

Liquid xenon emits a flash of light when struck by a particle, and this light can be detected by very sensitive photon detectors called photomultiplier tubes. If a WIMP collides with a xenon nucleus we expect it to produce a burst of light.

The inner cryostat vessel is off-loaded from a truck at the Sanford Underground Research Facility in South Dakota. (Credit: STFC)

Before delivery to SURF the cryostat underwent several weeks of rigorous testing and a month-long thorough clean from an expert cleaning company in California. Five years after the design efforts started, the cryostat arrived safely at SURF and the LZ team then carefully unwrapped it and put it into place.

"It's a great experience to see all of the planning for LZ paying off with the arrival of components," said Murdock "Gil" Gilchriese, LZ project director and a Berkeley Lab physicist. "We look forward to seeing these components fully assembled and installed underground in preparation for the start of LZ science."

UK PI for LZ is Professor Henrique Araujo from Imperial College London and he said: "It is incredibly gratifying to see LZ beginning to take shape. Seeing the cryostat arrive is a milestone moment as it has been years in the making.

"Now we have to wait for the other constituent elements to arrive before we can start to see some exciting science taking place at this ground-breaking facility."

LZ will be at least 100 times more sensitive to finding signals from dark matter particles than its predecessor, the Large Underground Xenon experiment (LUX). The new experiment will use 10 metric tons of ultra-purified liquid xenon, to tease out possible dark matter signals. Xenon, in its gas form, is one of the rarest elements in Earth's atmosphere

Although this is a major milestone for the experiment, there are still many components yet to be assembled and tested. Upgrades of the underground Davis cavern at SURF, where LZ will be installed, are in progress and will be completed by August and large acrylic tanks that will help to validate LZ measurements are expected to arrive at SURF by September. It is currently expected that the experiment will start taking data in 2020.

The LZ collaboration now has over 200 participating scientists and engineers who represent 38 institutions around the globe – with UK scientists, supported by the STFC, representing about a quarter of the collaboration. The cryostat is not the only contribution the UK is making to LZ – although it is the largest. In fact, STFC on behalf of the UK is providing £4.5million worth of funding to the project over 5 years, also including calibration delivery, photomultiplier tubes and internal monitoring sensors.

More information about dark matter.

More information about the LZ and the LZ collaboration.

More information about SURF.

Media contact

Jake Gilmore

STFC Media Manager

Business Success at the ESS for a British Company

GRE Ltd, a thermal engineering specialist based in Devon have won a contract to supply an ultra-pure water cooling system, including design, manufacture, testing, installation, commissioning, on-site training and handover for the European Spallation Source (ESS) in Lund, Sweden worth ~£250,000.

The GRE equipment will provide cooling to the linear accelerator that begins the flow of protons that is then accelerated to approximately 96% of the speed of light, before hitting a tungsten target, which then releases neutrons that are distributed to ESS' experimental stations and used for studying samples. The ESS is set to be the most powerful pulsed neutron source in the world and will initiate the user programme for researchers in 2023.

Deionised water is typically used to cool equipment where high voltages are present as it eliminates the risk of electrical danger. The GRE system delivers deionised water to the linear accelerator within the specified parameters including temperature of the fluid, pressure, conductivity, oxygen content and flow rate. The user has the option to control the

flow rate based on either constant outlet pressure or constant flow rate.

Delivering this contract has required a very high level of skill and also allowed GRE to develop new expertise as some of the required parameters are new for the company.

"It has been really interesting working with ESS on their specific requirements for their application and it is extremely rewarding having met their high standards, ultimately delivering a machine the customer is happy with. I look forward to working with them on the next part of the project," said Natalie Martin, Design Engineer from GRE Ltd.

(Credit: GRE Ltd)

GRE have been working with the STFC national laboratories for a number of years and through contacts at the laboratories they were made aware of the opportunities for UK companies at the large international science facilities. They registered with the STFC Business Opportunities database to be alerted to tender opportunities from the international facilities that STFC fund. In late 2015, after receiving an alert from the STFC Business Opportunities team, GRE responded to a Request for Information (RFI) from the ESS for Deionized Water Cooling Skids. GRE worked with the ESS on the RFI and in 2017 they successfully bid for the contract.

Richard Booth, Managing Director, from GRE Ltd said: "Without the STFC team GRE would never have known about, let alone bid for a tender of such a scale and with the facility of this size. We made a cryogenic system for STFC in 2013 and through this we got to know John Vandore and the cryogenic cluster people, which really allowed GRE to get our foot in the door to open up opportunities to us the science sector. We then started to look for similar work, using the same contacts we had made and as a result we're now regularly winning contracts for STFC's national laboratories."

The ESS contract has increased GRE's awareness of the big science market sector and vast array of opportunities available. They are now engaging with other large science facilities and have attended a number of industry events, such as the 3rd CERN HiLumi Industry day, UK@CERN trade mission and the first Big Science Business Forum, to help build relationships with the facilities.

GRE estimate that one-third of their business is currently from the science sector and it's an area of their business that is continually growing. The work in this sector is also of great interest to the employees of the company, which GRE value.

Further Information

STFC funds a number of large international science facilities besides the ESS. The STFC Business Opportunities team works to increase the return that the UK gets from tenders and contracts at these facilities by providing free assistance to UK companies and helping them to access tenders at these facilities.

The international laboratories include: CERN in Geneva, Switzerland; ESO in Garching, Germany; ESS in Lund, Sweden; SKA in the UK, South Africa and Australia; European X-FEL in Hamburg, Germany; the ESRF and the ILL in Grenoble, France; and FAIR in Darmstadt, Germany. We are not involved in contract opportunities for our national facilities.

If you would like to be alerted to upcoming tender opportunities or to hear about events to connect with the facilities please register with us.

MBA Engineering and Noblegen Partner to offer N2 Generation

Gaworld Press Release 19th October 2018

MBA Engineering, supplier of leading laser cutting and metal fabrication equipment, has exclusively partnered with Noblegen to offer market-leading nitrogen (N_2) generation systems, which could save laser users up to £1,000 per month on energy costs.

The new partnership will see MBA Engineering now providing complete, one-stop N2 generation solutions from Noblegen – alongside its renowned customer service and support – enabling manufacturers and engineers with day-to-day laser cutting needs to generate their own N2 to power their equipment.

By generating their own N2 on-site, manufacturers eliminate the need to purchase the N2 gas required

to run the equipment from an independent vendor. This provides them with the opportunity to significantly reduce gas purchasing costs, as well as the expense and carbon dioxide (CO2) emissions associated with daily, weekly or monthly truck deliveries.

Speaking about the new partnership, Bradley McBain, Managing Director at MBA Engineering, said, "With gas prices forever changing, manufacturers run the risk of seeing their energy bills spiral if efficient, economical practices aren't implemented."

"With gas prices forever changing, manufacturers run the risk of seeing their energy bills spiral..."
Bradley McBain, Managing Director at MBA Engineering

McBain continued, "Like all our solutions, we aim to provide valuable cost savings for our customers and these N2 generation systems can save customers thousands of pounds. Companies within the manufacturing industry are always looking for ways in which to reduce their overheads, and our new partnership with Noblegen delivers a long-term, affordable solution for customers, which puts them in control of their N2 generation."

"Combining the British-made N2 generation system with a laser cutting system creates a sustainable, cost-effective laser cutting solution. Costs per metre squared can be significantly reduced with N2 generation systems when compared to storing gas purchased from an independent vendor. The system also produces N2 at a pressure and flow rate required for a specific demand, generating low-cost N2 in the long run,"

An additional benefit of utilising a N2 generation system to run a laser cutting machine is that it can be set to run as required, so no gas is wasted. There's also no need to stop production completely to replace N2 gas cylinders, which again saves manufacturers valuable time and money.

As well as providing the equipment, MBA Engineering will manage the installation of the new N2 generation systems, in addition to providing complete servicing and support once the new equipment is in-situ.

Finance and leasing options are also available on the N2 generation systems, making on-site N2 generation attainable for a host of manufacturers.

MBA Engineering has exclusively partnered with Noblegen to offer market-leading nitrogen generation systems

Drs Begg & Ramage win 2018 IoP Award

Drs Michael Begg and James Ramage of Tesla Engineering Ltd won the 2018 the IoP Katharine Burr Blodgett Medal and Prize award for the transformation of Tesla Engineering Ltd from a manufacturer of conventional magnets for particle accelerators into a world leader of magnets for high-energy physics, MRI and oncology equipment. Originally this medal was known as the Business and Innovation Medal; from 2012 it was renamed the Swan Medal of the Institute of Physics in recognition of Sir Joseph Swan, and in 2016 it was renamed to the Katherine Burr Blodgett Medal and Prize to recognise her contributions to physics. Dr Graham John Batey (ex Siemens Magnet Technology) won this prize in 2011 whilst working for Oxford Instruments.


Dr Michael Begg Dr James Ramage

Drs Michael Begg and Jim Ramage have transformed Tesla Engineering Ltd, over more than 20 years, from a manufacturer of conventional magnets for high-energy physics, into a world

leader additionally supplying MRI and radiation oncology equipment. This involved extending in-house experience to encompass superconducting systems, an expansion involving not just full acquaintance with superconducting theory but also developing novel processes, engineering know-how and tooling, meeting the critical demands of this technology.

Applying multi-physics and new materials, coils have been developed that are smaller and lighter than those from all other suppliers, with optimised electro-mechanical properties from 4K to 200C. Such processes have led to a portfolio of 12 patents and one pending, generating many commercially important product firsts. Examples include:

- the first direct water-cooled gradient coil (1995), increasing gradient field, reducing coil space, enhancing image resolution and enlarging patient space
- the first rotatable cryostat for a compact 10T proton-therapy synchrocyclotron (2007), rotatable over ±95°, enabling the beam to be directed without additional gantry magnets, reducing costs and space

Tesla is now working with others to produce an advanced 7T MRI system occupying the same space as 3T systems, decreasing costs of high field MRI. Tesla's developments include:

- Restraining ≈ 250 MPa hoop stresses
- Conduction-cooled designs requiring only a few litres of circulating liquid helium
- Quench protection capable of non-destructively dissipating 69MJ in seconds

Accurate process monitoring and rigorous control are vital for these systems.

Innovative, physics-backed engineering has made Tesla a global leader for performance-critical electromagnets for medical equipment. It now annually produces more than 1000 gradient coils for MRI systems, supplying Philips, Hitachi, Toshiba, GE and smaller manufacturers – probably more than any other company.

Tesla supplies conventional and superconducting magnets to all the major manufacturers of Proton Beam Therapy systems, working closely with all major international accelerator laboratories in the UK, Europe, the US and Japan.

Tesla now has sales of about £50m, over 97% exported. It employs more than 450 people in the UK, the Netherlands and the US where, additional to Tesla's main market areas, the group supplies specialised coils for the US navy and the nuclear industry.

Implementing the new Kelvin 2 - 3rd newsletter

Credit Ossi Hahtela, InK2 - Impact WP leader

The EMPIR project 'Implementing the new kelvin 2' (InK2) started in June 2016 and it is the continuation of the EMRP project 'Implementing the new kelvin' (InK). The aim of the InK projects is to lead the thermometry community to a successful redefinition of the kelvin. In 2018, the CIPM will introduce the most fundamental change to the SI system ever undertaken since its inception. The new SI will be based on defined values of fundamental constants. This momentous change needs to be supported with research and documentation to ensure a successful and effective redefinition takes place. The InK2 project will focus on delivering primary thermometry results needed to facilitate the redefinition of the kelvin in terms of the Boltzmann constant.

Below from Prof Graham Machin's newsletter:

Welcome to the 3rd Newsletter of InK2 project! This is the last InK2 newsletter before the historic and widely anticipated redefinition of the international system of units (the SI) takes place. On the 13–16 November 2018 the 26th meeting of the Conference on Weights and Measures (CGPM) will be held in the opulent surroundings of the Palace of Versailles. It is expected that at the close of the CGPM meeting there will be an affirmative vote on the resolution "On the revision of the International System of Units (SI)" ushering in the biggest change to the SI since its inception in 1960. From that point on the seven base units of the SI will be defined in terms of a set of fixed value fundamental (temperature, length, ampere, amount of substance, mass), atomic (time) and conventional (candela) constants. The redefined SI implementation phase will then begin and run until World Metrology Day on 20 May 2019. The research undertaken by the InK projects has made, and continues to make, substantial contributions to the redefinition of the kelvin and fittingly concludes the same time as the redefined SI implementation. Looking back the first InK project ended with a workshop at the UK's Royal Society, the modern world's first scientific institution. That workshop consisted of 16 presentations which were written up in a special edition of the Philosophical Transactions of the Royal Society. I am pleased to report that these papers are now freely available for download at the following link:

http://rsta.royalsocietypublishing.org/content/374/2064. The Royal Society are very pleased with the performance of the volume as it has already been cited more than 120 times and in their words "is one of our best performing issues in physics".

Looking forward as the end of the second InK project approaches we are anticipating a number of outstanding results in support of the kelvin redefinition. These will be contributions to the mise en pratique for the definition of the kelvin (MeP-K-19), both through documented primary thermometry methods and support for the technical annexes through new low uncertainty values for T–T90 and T–T2000. These will be reported and deliberated on at the important Tempmeko/Tempbeijing conference (10–14 June 2019). At that conference there will be a session dedicated to the InK2 project and a technical workshop focused on developing consensus values of T–T90 and T–T2000. In the ensuing months work will continue culminating in submissions to the Consultative Committee of Thermometry (CCT/29) which next meets in March 2020 at the International Bureau of Weights and Measures (BIPM) in Sevres, Paris. That meeting will be the first occasion for the international thermometry community to take stock of the operation of the redefined kelvin.

Finally looking to the future. The redefinition of the SI and more specifically the kelvin is the starting point of the larger realisation phase of the redefined unit. National Measurement Institutes around the world will be working to turn the redefinition into a reality. Within the Europe we have recently proposed a project to the EMPIR Programme entitled "Realising the redefined kelvin" which, if successful, will guide our first steps in this great endeavour.

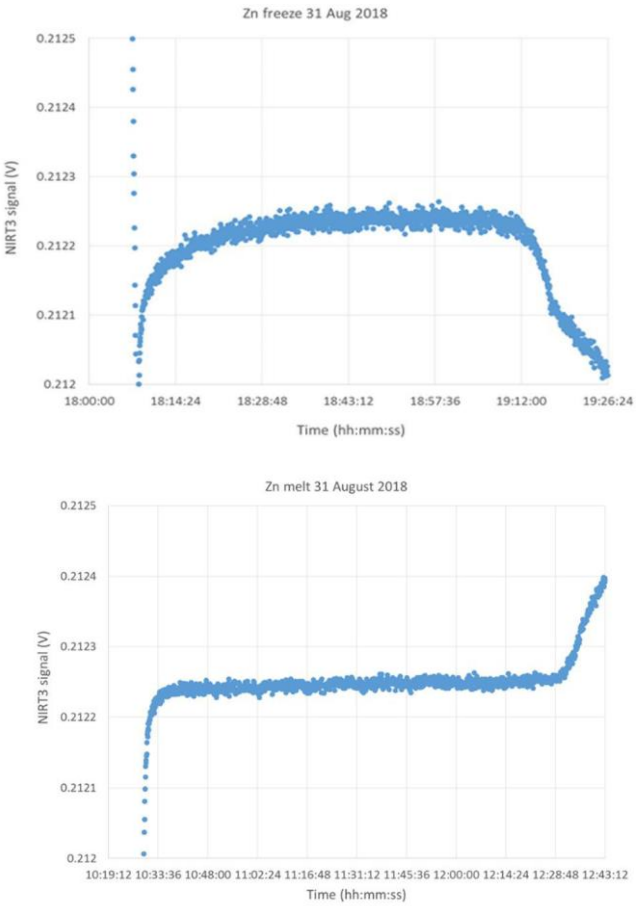
Research highlights

T–T90 by primary radiometry

To ensure linkage among the independent, radiometric T – T90 measurements being done by the various partners, a set of zinc (freezing point 692.68 K) and silver (freezing point 1234.93 K) fixedpoint blackbody cells was constructed by LNE-Cnam. The cells were designed to be of a size suitable for installation in the furnaces belonging to the different partners.

One of each type of cell has been circulated for measurement of T using the various absolute radiation thermometry facilities. Comparison of the measurements using the same cells will help to confirm consistency of the T measurements being made in each of the laboratories. Additionally an aluminium fixed-point blackbody cell (freezing temperature 933.47 K) has been circulated to provide some information in-between the zinc and silver freezing temperatures.

Graphs showing the melting and freezing of the Zn transfer cell, as measured by the NPL Near Infrared Radiation Thermometer (NIRT3).



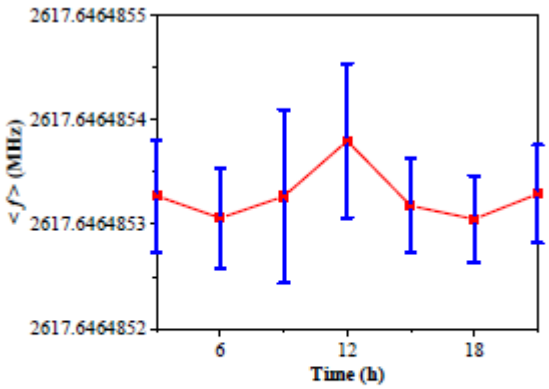
Single Pressure Refractive Index Gas Thermometry (SPRIGT)

TIPC-CAS has almost completed the three key technologies used in the single pressure refractive index gas thermometry (SPRIGT) with the help from LNE-Cnam, namely high stable of temperature regulation, pressure control and high-accuracy microwave frequency measurement, with results much better than the design goals.

The cryostat cooled using a two-stage pulse-tube has realized ultra-high temperature stability at temperature range of 5–25 K with the smallest instability about 0.021 mK with an integration time of 0.8 s. The gas pressure has been measured by an absolute-pressure piston gauge and maintained constant by a servo-loop at room temperature T = 298 K. High pressure stability of 0.0021 Pa at 30 kPa and 0.0032 Pa at 90 kPa, corresponding relative uncertainty of 0.11 ppm (10^{-6}) and 0.023 ppm, have been realized with an integration time of

1.4 s by maintaining the piston at a constant height.

The core element a quasi-spherical resonator has been machined and closed successfully at room temperature. It has been housed in the cryostat and evacuated to determine the mi-crowave resonance frequencies at tempera-ture from 5 K to 25 K. High stability (0.01 ppb) and low uncertainty (0.03 ppb) of resonant frequency of TM11 mode has been realized at 8 K with an integration time of 3 hours (see figure below).



High stability in the microwave frequency of the TM11 mode was realized by the quasi-spherical resonator in the SPRIGT.

Doppler Broadening Thermometry (DBT)

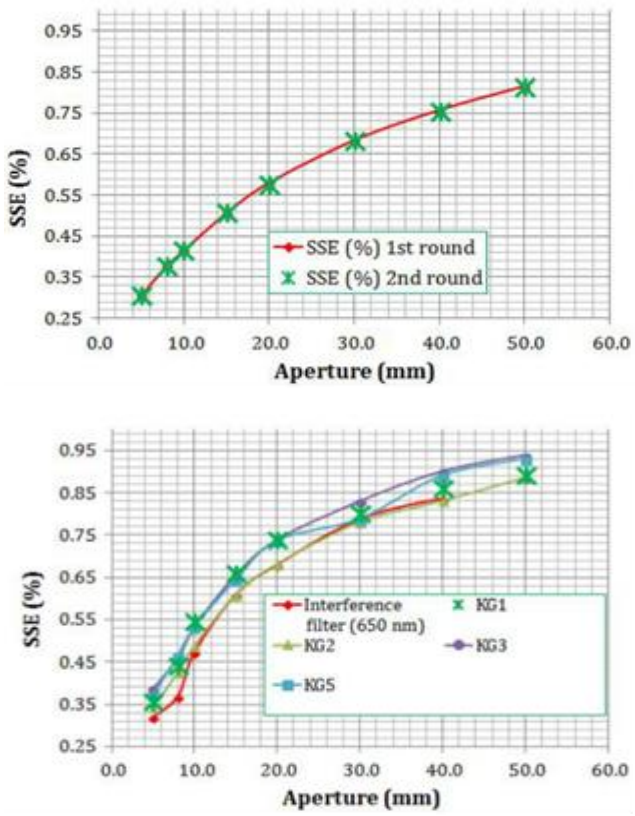
New determinations of thermodynamic tem-peratures have been performed by using Doppler Broadening Thermometry, thus testing the third generation spectrometer developed at University of Campania Luigi Vanvitelli. The apparatus is based on a pair phase locked ex-tended-cavity diode lasers in the near infrared spectral region, one of them being locked to a self-referenced optical frequency comb synthesizer. An important element of novelty, as compared to the previous spectrometers, is the use of a line doublet rather than an isolated spectral line.

The probe laser frequency was continuously tuned over an interval of 6 GHz so that an acetylene doublet could be observed, the two components being vibration-rotation transitions belonging to C2H2 combination bands. Highly reproducible absorption spectra were recorded at the tempera-tures of the triple point of water and at the gallium melting point. The isothermal cell was a home-made multiple-reflection cell of the spherical Herriott type. The line doublet was selected with a particular care in order to avoid the occurrence of collisional line-mixing effects. The clear advantage of retrieving the gas temperature from a line doublet is related to the possibility to implement a strong physical constraint in the spectral analysis procedure, the two lines sharing the same Doppler width. This allows one to reduce significantly statistical correlation issues as well as the uncertainty associated to the lineshape model

The 3rd generation DBT spectrometer

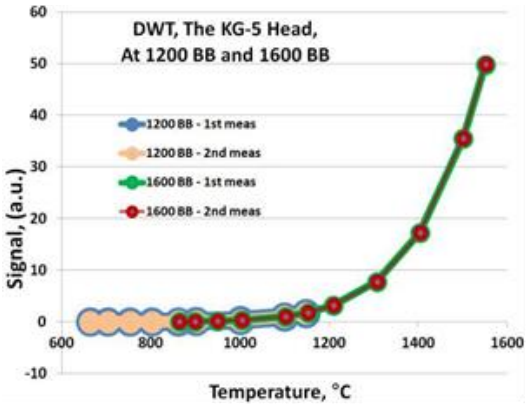
Double-wavelength radiation thermometer (DWT)

TUBITAK UME is developing a new double-wavelength radiation thermometer (DWT) specifically for the radiometric temperature measurements traceable to synchrotron radiation. Currently a design of optical and electronic parts of the DWT has been finished and the activities related to mechanical design and manufacturing of the mechanical parts are still in progress. The DWT comprises of two radiometric channels with two identical Si photodetectors, where one of the detectors is conjugated with a broadband filter and the other with an interference filter (650 nm ± 10nm). As a broadband filter a series of Schott glasses (from KG1 to KG5) were prepared and studied comparatively. As an example, the curves below depict a comparative study of Size-of Source Effect (SSE) of a transfer standard pyrometer (TSP-2) with these filters. Based on the results of these investigations, it was decided to build the DWT on the base of KG5 glass and of the interference filter.



The SSE measurements of the TSP-2 without filter (left) and the SSE measurements of the TSP-2 with filters (right)

At UME, an experimental campaign for the rela-tive temperature measurements by means of a DWT has started, where the transfer standard ra-diation thermometer (TSP-2 pyrometer by VNIOFI) with interchangeable detector heads is adopted to DWT. One of the detectors is conju-gated with a KG-5 (Schott) broadband filter and the other one with an interference filter (900 nm). Measurements have been performed from 600 °C to 1550 °C by using two different blackbodies (see the figure below).

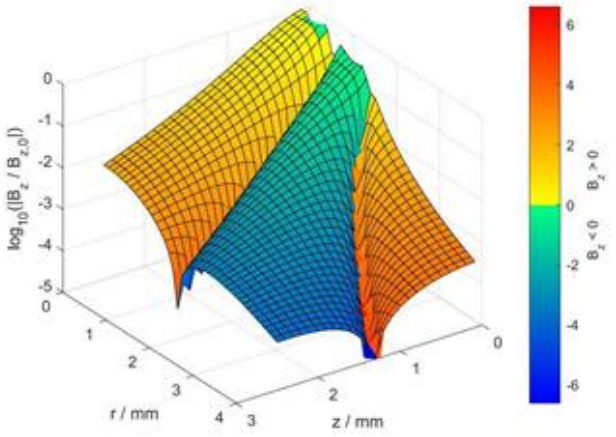


An example of the of temperature measurement results by means of DWT's broadband channel (the KG-5 filter and Si photodetector).

The analysis of these results and the preparation of one journal and three con-ference papers (will be presented in the TEMP-MEKO 2019) are in progress.

Primary magnetic field fluctuation thermometer

The uncertainty for the direct determination of thermodynamic temperatures has been considera-bly reduced by a factor of >2 in the range from 1 mK to 1 K. The primary magnetic field fluctuation thermometer (pMFFT) developed at PTB uses planar detection and calibration coils allocated on two silicon chips residing opposed to each other. The design of these circular, concentric coils has been refined in several aspects. The resulting key improvement is the almost complete reduction of the so far dominating uncertainty component related to the uncertainty of the distance of both chips (or coils respectively). Now, for a given distance *d* between both coils, the mutual inductance *M* has a local maximum, thereby making *M* insensitive to *d*. Nonetheless, both coils have quickly diminish-ing field profiles as before due to their design as radial gradiometers.



Normalized field profile B(z,r) of the detection coil (ra-dial first-order gradiometer in the plane z = 0). The calibration coil will be in the plane z » 2 mm.

Additional information and earlier Newsletters can be found from the project website: https://www.vtt.fi/sites/InK2

World's first totally British Cryotherapy Chamber

Quantum Cryotherapy Directors Adela Thornton-Wood and David Thornton-Wood. Photo by Tim Pestridge.

Press Release 7 January 2019

A UK business has launched the world's first entirely British designed, manufactured and installed 'indirect' whole body cryotherapy chamber. Marketing globally to sports clubs, health clubs and spas, the company says it is setting a new standard for safety and luxury in cryotherapy.

Quantum Cryotherapy is a new venture from Devon-based Quantum Cryogenics, a firm that has provided some of the UK's leading hospitals, universities and businesses with leading-edge cryogenic control and safety systems for more than 40 years. After supporting growing numbers of customers with the installation and maintenance of safety systems for whole body cryotherapy chambers, the company has created its own: CryoQube.

Whole body cryotherapy plunges the user into temperatures of around -130 degrees Celsius for up to three minutes. Subjecting the whole human body to these temperatures, cools the skin to around fifteen degrees Celsius, setting off a range of responses in the body, including releasing endorphins, reducing inflammation and numbing pain. This is known to deliver a range of health and wellbeing benefits, as well as enhancing sports performance and improving recovery from muscle injury.

Whole body cryotherapy is becoming more popular worldwide and among its alleged advocates are Mo Farah, Jessica Ennis and Cristiano Ronaldo, as well as celebrities such as Hugh Jackman, Jennifer Aniston and Daniel Craig. A number of premiere league football clubs now also have their own whole body cryotherapy chambers.

Because many cryotherapy chambers involve the user being directly exposed to freezing nitrogen vapour, concerns have been raised about its safety. CryoQube delivers ultra-cold temperatures but uses pure super-cooled air that has been pre-chilled using liquid nitrogen. Nitrogen gas is then safely ducted away. Known as 'indirect' cryotherapy, it allows the whole body to be immersed in the chamber, unlike direct cooled systems where the head has to be outside of the unit.

Co-founder of Quantum Cryotherapy Adela Thornton-Wood said: "We are proud to be launching the first fully British-designed and manufactured indirect whole body cryotherapy chamber, which is also installed by our own in house team of cryogenically trained site engineers. Developing CryoQube was a natural next step for us as a company and builds on our 40-year heritage of providing high-tech, high quality cryogenic control systems. This is an exciting new venture for us and we are delighted to be manufacturing our cryotherapy chambers for the sports, health club and spas markets."

Quantum Cryotherapy has created different versions of CryoQube, to provide a range of spaces. This covers every requirement, from single individuals to an increasingly popular more sociable cryotherapy experience for two or more users. As well as creating what they describe as a "high end, premium" product, the team believes its focus on supporting customers through the entire process will be a selling point for CryoQube. The company will conduct a full survey of each potential customer's premises, to check it is suitable for cryotherapy, as well as providing staff training and ongoing maintenance and support.

Co-founder of Quantum Cryotherapy David Thornton-Wood added: "There is growing interest in whole body cryotherapy, but there has not previously been a British company providing what we feel is really needed. We have unfortunately seen health clubs and spas experiencing problems after investing in cryotherapy chambers and discovering they cannot run them because the site-based support was not there. We have the expertise to ensure people can buy and run our cryotherapy chambers safely and effectively. Importantly, we aren't supplying through third parties, so our customers will get the support they need, when they need it."

Member's News

BCGA

BCC Executive Member and BCGA Technical Manager **Jake Lake** is now Chair of the cryogenic vessels BSI standards committee, PVE/18. In this excellent appointment, Jake will be encouraging BCC Members to take the opportunity to step up their participation and influence on development of standards, a truly important technical battlefield on which business is won and lost.

Distributors sought for cryopreservable 3D Tissue

Distributors sought for cryopreservable 3D tissue models that fit for ready-to-use toxicity tests

A German research enterprise, active in fields of air handling and refrigeration technologies, developed a cryopreservable 3D tissue model (e.g. for cytotoxicity examinations). It is a novel cryopreserved of-the-shelf system with tissue-typical complexity and overcomes limited transport & storage possibilities, capacities of 3D tissue models in cell culture plates. Partnership with companies from pharmaceutic or life science sector are envisaged in terms of distribution services agreements.

https://www.enterprise-europe.co.uk/opportunities/BODE20181123002

BCC Prize:

2019 - 2021

IEEECSC EVENTS CALENDER
http://ieeecsc.org/events

2019

20-21 March, Moscow, Russia
6TH LNG CONGRESS RUSSIA
https://www.lngrussiacongress.com/en/

22 March, Liverpool, UK
PARTICLE COLLIDERS - ACCELERATING INNOVATION SYMPOSIUM
https://indico.cern.ch/event/747618/

1 - 5 April, Shanghai China
LNG 2019 - 19TH INTERNATIONAL CONFERENCE & EXHIBITION ON LIQUEFIED NATURAL GAS
https://www.lng2019.com/

14-18 April, Baltimore USA
CRYOGENIC COOLING OF SENSING DEVICES.
http://spie.org/conferences-and-exhibitions/defense--commercial-sensing?utm_id=rsi19gb&SSO=1

2 May 2019, Los Angeles, USA
THERMAL MATERIALS SUMMIT
http://thermalsummit.com/

17-19 July, Connecticut, USA
28TH SPACE CRYOGENICS WORKSHOP
https://spacecryogenicsworkshop.org/

21-25 July, Connecticut, USA
CEC-ICMC 2019
https://www.cec-icmc.org/

24-30 August, Montreal Canada
25TH IIR INTERNATIONAL CONGRESS OF REFRIGERATION – ICR 2019.
https://icr2019.org/

1-5 September, SEC, Glasgow, UK
14TH EUROPEAN CONFERENCE ON APPLIED SUPERCONDUCTIVITY (EUCAS) 2019
http://www.eucas2019.org

22-27 September Vancouver, Canada
MT26 INTERNATIONAL CONFERENCE ON MAGNET TECHNOLOGY
http://mt26.triumf.ca/

7-8 October, Lund, Sweden
2019 EUROPEAN CRYOGENICS DAYS
https://www.cryoeurope.org/uploads/file/firstannouncementecd2019.pdf

2020

26-29 July 2020, IoR London UK
RANKINE 2020 - ADVANCES IN COOLING, HEATING AND POWER GENERATION
https://ior.org.uk/events/rankine2020

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You can find details of these companies on our website www.bcryo.org.uk

We need the support of all who have expertise in our field to make the BCC a learned society that speaks with a strong, professional voice on matters that concern us. If you are a Member and you know someone who is active in the field of cryogenics but has not yet joined, please encourage him or her to become a Member. Individual Membership is available at a rate of £10.00 per annum. The BCC is sponsored by the Institute of Physics and the Institute of Refrigeration. The BCC Executive Committee meets twice a year, usually in spring and autumn. Low Temperature News aims to be interesting, informative and to provide a forum for the exchange of views and information in the field of Cryogenics. Newsworthy contributions are always welcome – such as coming events and reports of conferences, developments, new products or research programmes.