UK news from CERN

Issue 21: 21 May 2013

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Outstanding results from ISOLDE

Two recent results from ISOLDE are keeping CERN's nuclear physics facilty ahead of the rest.

It's all gone pear-shaped

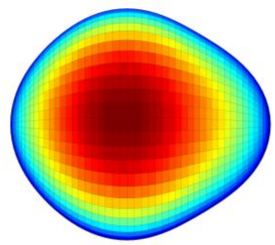
An international team using REX-ISOLDE has shown that some atomic nuclei can assume asymmetric, 'pear' shapes. The observations contradict some existing nuclear theories and will require others to be amended. The results were published in the journal Nature on 8 May and were featured on the front cover.

Most nuclei that exist naturally have the shape of a rugby ball. While state-of-the-art theories are able to predict this behaviour, the same theories have predicted that for some particular combinations of protons and neutrons, nuclei can also assume asymmetric shapes, like a pear. In this case there is more mass at one end of the nucleus than the other.

Until now, it has been difficult to observe pear shaped nuclei experimentally. However, a technique pioneered at ISOLDE has been used successfully to study the shape of short-lived isotopes Radon 220 and Radium 224.

Peter Butler (University of Liverpool) is part of the team: "We have been able to show that while Radium 224 is pear-shaped, Radon 220 does not assume the fixed shape of a pear but rather vibrates about this shape.

"The details of these findings are in contradiction with some nuclear theories and will help others to be refined."



The shape of ^{224}Ra deduced from the CERN measurements

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The experimental observation is also important because it can help experimental searches for electric dipole moments in atoms (EDMs). The EDM relates to the the separation of positive and negative charges within the atom.

The Standard Model predicts that the value of the EDM for the atom is so small that it will lie well below the current observational limit. However, many theories that try to refine this model predict EDMs that should be measurable and this could indicate new physics beyond the Standard Model.

"Our measurements will help direct the searches for EDMs currently being carried out in North America and in Europe, where new techniques are being developed to exploit the special properties of radon and radium isotopes," explains Peter, "Our expectation is that the data from our nuclear physics experiments can be combined with the results from atomic trapping experiments measuring EDMs to make the most stringent tests of the Standard Model."

Written and edited by Stephanie Hills, UK Communications and Innovation Officer @ CERN
Stephanie.hills@stfc.ac.uk or Stephanie.hills@cern.ch

A first (and a last) for the rarest element

A second team, using the resonance ionisation laser ion source (RILIS) has measured the ionisation potential of the rare radioactive element astatine for the first time. The results were published in Nature Communications on 14 May.

The measurement fills a long-standing gap in the periodic table; astatine is the last element present in nature for which this fundamental property remained unknown. It is of particular interest because isotopes of astatine are candidates for the creation of radiopharmaceuticals for cancer treatment by targeted alpha therapy (which blocks the growth of cancer cells).

"None of the many short-lived isotopes used in medicine exist in nature; they have to be artificially produced by nuclear reactions," says Bruce Marsh (University of Manchester).

The ionisation potential of an element is the energy needed to remove one electron from the atom, thereby turning it into an ion. This quantity is related to the chemical reactivity of an element and, indirectly, to the stability of its chemical bonds in compounds.

The value for astatine (9.31751 electronvolts) could help chemists to develop applications for the element in radiotherapy, and will serve as a benchmark for theories that predict the structure of super-heavy elements.

Astatine occurs naturally in only in trace amounts on Earth (in 1953 Isaac Asimov predicted that just 0.07g existed naturally) but physicists at ISOLDE can make artificial isotopes of astatine by bombarding uranium targets with high-energy protons.

Specialist skills to the rescue

Everyone who comes to work at CERN develops specialist skills that they take back to their own organisation. That is especially true for the UK fire fighters who are part of CERN's fire brigade.

"Above ground, CERN is very much like any commercial or industrial site," says Scott Jones, the newest recruit to the CERN fire brigade, "but below ground it's unique, with networks of tunnels and basements, and hazards ranging from high voltage equipment to chemicals, radiation and cryogenic gases."

It is the opportunity to acquire specialist skills that attracted Scott to CERN. He has just started a five year secondment from West Midlands Fire Service and his new job is very different. In the UK, fire services tend to have specialist teams to deal with rope rescues or risks such as radiation and chemicals, but at CERN these skills are routine and the team are acknowledged experts in several areas. For example, the Swiss fire service trains with CERN for handling radiation incidents.

Sharing expertise is important and many of the CERN team are experienced trainers in first aid, fire safety and use of the breathing apparatus that everyone who works in the LHC tunnel must carry.

Tom White is the longest serving member of the CERN fire brigade. Originally from Suffolk, he has been with the team for 27 years and he is a specialist in 'hot fires' – understanding flash-over or backdraft fires. Tom trains the Swiss and French fire services.

"We have a very good safety record at CERN" says Tom. "Fortunately, we don't have many fires, but even a small fire could have a catastrophic impact on operations. The international spotlight is on CERN so we're constantly improving our skills to minimise the impact of any incident. Increasingly, we're taking on a post-incident health and safety role to improve working procedures."

This commitment to continuous improvement extends to the clothing, tools and equipment that the fire brigade uses. "We are well-supported by CERN and have access to the best equipment that Europe has to offer", explains Tom. "Working with us enables recruits like Scott to gain experience of kit that they might not have access to in their home countries."

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Another important difference is that, in common with many European countries, the CERN fire and ambulance services are combined, so Scott will also be working as a paramedic.

With fire fighters (male and female) from seven different countries, communication is obviously a priority and Scott spent his first three weeks at CERN doing an intensive language course. "We need to be able to communicate clearly and effectively in English and French [the two working languages at CERN]. The course was quite tough – but it covered the vocabulary we need to do our job such as tools and equipment as well as giving first aid."

It's not just communication within the team. Another important part of Scott's new role will be to take shifts in the control room. "In the UK, emergency calls are routed via dedicated call handling centres so taking the calls direct is not something that I'm used to. But everyone in the team takes shifts and that includes me."

Scott is already enjoying being part of the team. Like Tom, he was looking for a challenge and he is embracing every opportunity that comes his way. "It took some convincing to get West Midlands to let me come to CERN, and I'm going to make the most of my time here so that I can share what I've learnt when I return."

"Coming to CERN is a marvellous opportunity for British fire fighters," adds Tom. "It really broadens their horizons and I hope we can attract more early-career fire fighters like Scott. When they return to their home countries they will have the skills and experience to move into decision making roles where they can really make a difference."

Scott and his colleagues have put together a light-hearted video about their training.

Precision counts

Making high precision scientific measurements requires components that have been engineered to very tight tolerances. UK SME, HV Wooding has been working with CERN for three years, mainly supplying precision engineered components for superconducting magnet assemblies.

"We don't have any products of our own," explains Sales Director, Paul Allen, "but we offer a specialist precision engineering service to our customers in a wide range of industry sectors."

The company's first contract with CERN was to machine the magnetic yokes, stainless steel collars and filler components for a prototype quadrupole (focussing) magnet that is being developed for the next major upgrade of the LHC. They took a novel approach to the manufacturing which proved to be very successful.

"We use different techniques to machine components, depending on the tolerances [levels of precision] required. Obviously, the smaller the tolerance, the higher the cost. We wanted to offer CERN a competitive price so we worked closely with CERN engineers to decide which parts of each component needed the smallest tolerances. For example, some areas needed to be machined to an accuracy of less than 10 microns, whilst for others it was only 50 microns."

Glyn Kirby (l) and Paul Allen with the MQXC Quadrupole Magnet Assembly

© HV Wooding

Bearing in mind that 50 microns is approximately half the width of a human hair, these are tiny amounts, but they can make a huge difference to the performance of a superconducting magnet.

"It quickly became apparent that the team at HV Wooding were capable of really adding to the performance of the components we were developing," says Glyn Kirby of CERN's Technology Department. "They were not content with just providing what was initially required, they wanted to optimise both price and performance.

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Stephanie.hills@stfc.ac.uk or Stephanie.hills@cern.ch

Having agreed the tolerances with the CERN engineers, HV Wooding was then able to decide which technique – wire erosion, laser cutting, or CNC machining - to use for each part. The components were independently inspected to check that they met the specifications, and this initial success has led to further contracts with CERN. The company is currently working with CERN on components for an 11 Tesla dipole magnet, parts of which require a tolerance of just seven microns.

It is a manufacturing approach that has proved popular with existing customers, and crucially, attracted new ones. Based on the success of the first contract with CERN, HV Wooding has also worked with Brookhaven National Laboratory.

"Working with CERN has been pivotal for HV Wooding," explains Paul. "We can now offer a more cost effective method of manufacturing and that has helped us access new markets and increase our customer base."

For a small company with a turnover of €15M and 115 employees, that matters.

LHC finishes UK tour

After travelling the length and breadth of the UK, the LHC on Tour exhibition drew to a close at Queen's University in Belfast on 10 May.

The exhibition was organised by STFC, but depended on the support (and enthusiasm) of the UK particle physics community and CERN staff. At each venue, the exhibition was manned by students and staff from UK universities as well as STFC and CERN staff. They shared their knowledge and excitement about their roles on the LHC experiments with schools, colleges, members of the public, and local, regional and national politicians and policy makers.

The exhibition has been to 16 venues over the last 14 months, and travelled 4200 miles. It formed the centre piece for the London announcement of the discovery of a Higgs boson, inspired 50,000 school students at the Big Bang Fair, and visited the Houses of Parliament, National Assembly for Wales and Scottish Parliament, as well as attracting lots of attention at venues including Jodrell Bank and the Bristol Balloon Fiesta.

Unlike the real LHC, the exhibition tunnel is made of rigid paperboard and is fully recyclable. It is seen here with Miss Edinburgh. She loves children, animals and particle physics.
©STFC

In total, more than 605,000 people have seen the exhibition of which 66,000 were part of school groups. In addition to the people who saw the exhibition in person, the LHC has inspired countless others through extensive local media coverage at every venue.

A huge thank you to everyone who took part – whether you were setting up the exhibition, manning it, giving interviews to the media, delivering inspiring public talks, engaging with VIPs at the receptions or planning the logistics - you helped to bring the LHC alive for people around the UK.

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Diary dates

CERN Council Week – 19-21 June
CERN public open days – 28 and 29 September

Written and edited by Stephanie Hills, UK Communications and Innovation Officer @ CERN
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