



# UK news from CERN



Issue 55: 16 December 2014

## In this issue:

- A window to another world – launching a new international experiment
- Terrestrial tunnelling tool – UK company develops innovative feasibility tool
- Straining to find a solution – low-tech solution for high-tech project
- Self-styled CERN
- Dates for the diary

**UK news from CERN is taking a festive break and we'll be back in January. In the meantime, we wish all our readers a very merry Christmas and a happy new year!**

## A window to another world

A new scientific collaboration is getting underway, and one of its first meetings was held at CERN. The experiment itself, the Long Baseline Neutrino Facility (LBNF), will be split across two sites in USA, but like CERN, it will be a thoroughly international affair, and the UK is already involved.

LBNF is going to investigate whether neutrinos exhibit CP violation, the subtle difference between matter and antimatter that has led to us living in a Universe made of matter. Weak CP violation has been observed in quarks, most notably using the LHCb experiment – but the effect is not considered to be sufficient to explain the asymmetry between matter and antimatter.

“We don’t know whether neutrinos also show CP violation,” says Stefan Soldner-Rembold (Manchester), one of the UK members of the international board responsible for bringing the new collaboration together, “but neutrino physics is the sector of particle physics where the most unexpected effects [such as oscillations] and first deviations from the Standard Model have been found. They are very strange particles – neutral and light – and lots of researchers believe that they offer a window into physics beyond the Standard Model.”

This ‘other worldliness’ leads Stefan and his international collaborators to believe that they will find CP violation in neutrinos. Their plan is to send a beam of neutrinos 1300km from Fermilab near Chicago to a detector deep underground in the Sanford Laboratory in the former Homestake Mine in South Dakota. The beam will travel through rock up to 30km below the surface.

“Eventually the detector will comprise approximately 40 kilotonnes (40,000 tonnes) of liquid Argon cooled to  $-184^{\circ}\text{C}$ ,” says Stefan, “but it will be installed as modules, with the first of those installed and ready to detect the neutrino beam in 2021. If everything goes to plan, we should have our first results two years later.”

The fact that LBNF could be operational so quickly is attributed to two separate project proposals, one in Europe and the other in the US, which had similar goals and methodologies. Bringing the R&D work for both projects together, along with the engineering and scientific expertise, has created an even stronger collaboration for LBNF. More than 100 institutes around the world are involved, including CERN and 10 groups from the UK. In particular, the UK is leading development of technology for the Liquid Argon Time Projection Chambers (LArTPCs), novel detectors designed



Science & Technology  
Facilities Council

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

[Stephanie.hills@stfc.ac.uk](mailto:Stephanie.hills@stfc.ac.uk) or [Stephanie.hills@cern.ch](mailto:Stephanie.hills@cern.ch)

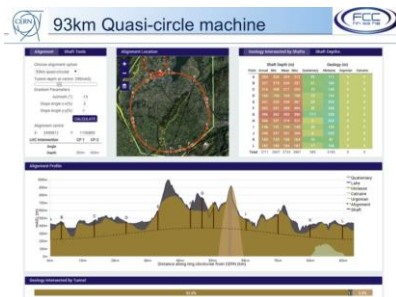


to have exceptional neutrino detection efficiency and background capabilities.

LBNF will be launched officially in January 2015.

## Terrestrial tunnelling tool

UK-based engineering consultancy, Arup has developed an innovative 3d interactive tool that is proving essential to feasibility studies for the Future Circular Collider – a proposed successor to the LHC. In fact, it's such a useful tool that the International Linear Collider project is also interested.



Modelling the FCC with Arup's Building Information Modelling tool.

The FCC Building Information Modelling (BIM) tool combines sets of data that allow the user to generate 'what if' scenarios that will help to assess the feasibility, cost and realisation risks associated with different tunnel layouts of a large, circular collider with a circumference of up to 100 km. The BIM includes geological data from French and Swiss sources, satellite imagery, topographical and street map information as well as details from geothermal drillings and environmentally sensitive areas like water reserves in the area in and around Geneva.

The key feature of the tool is that it's interactive. Because it includes a range of data such as soil composition, hydrology, environmental and sociological constraints, and programmable risk factors, if you alter one parameter - e.g. tilting the proposed tunnel by a degree or locating it deeper underground – the tool gives you a detailed profile of tunnels, shafts, access points and their respective location in the rock.

"For FCC, we have already looked at around 20 different possible layouts for the collider, each with pre-defined shafts and injection points from

the LHC," explains John Osborne, head of civil engineering for Future Accelerator Studies at CERN. "When you move one thing, everything else shifts as well, and we can see at a glance whether the configuration would work or not. A shaft with an access point on top of a mountain and the shaft going 500m down to the collider location is not the preferred option, for example!"

Obviously, once a site is deemed acceptable by the tool, a host of additional information about the location is needed before it can be confirmed as appropriate – but it's a good first approach.

Using a BIM is unusual so early in a project, says Matt Sykes of Arup, "Big decisions about large engineering projects are often made with the least information; using the BIM at this stage in the FCC feasibility study is a far-sighted decision by CERN."

One of the key features of the BIM is that it highlights uncertainties or missing information. For example, if one particular layout looks promising but borehole data is missing for a specific location, the BIM will spot this. "The tool makes the most of the data that you have, and saves you time and money by telling you exactly what data you need, and where," adds Matt.

This is the first time that Arup has used the 3d interactive alignment tool, and the civil engineering team for the ILC is hoping to adapt the BIM for studies at one of the proposed sites for the ILC in Japan.

The ILC machine-detector interface and detector design groups recently suggested moving the interaction region (where electrons and positrons would collide) by 800m, allowing vertical shafts that would make it easier to lower high-tech detector equipment. But that would have consequences for the rest of the accelerator, which would have to shift by 800m as well. "The tool could make a scan around the shaft and tunnel points, we can give tunnels a maximum acceptable slope, and the tool lets us study different configurations for the access points," says John. It also highlights difficult

areas, if for example caverns come too close to rivers due to the changed layout. With the ILC at a stage where the R&D is concentrating on site-specific designs, the tool from its circular cousin could prove to be key.

There are, of course, applications for the BIM outside the world of accelerators and Arup is developing similar tools for potential clients such as Network Rail, London Underground and utility companies.

## Physics joins the Zooniverse

If you fancy your chances as a Higgs Hunter but don't know where to start, a new citizen science project could be just what you need.

Part of the successful Zooniverse citizen science initiative set up by Chris Lintott (Oxford), [Higgs Hunter](#) gives you the chance to search for unknown exotic particles in data from the ATLAS experiment.

There are 25,000 images of collisions captured by ATLAS, and your mission (should you choose to accept it) is to look for offset vertices. If you're thinking, "I have no idea what an offset vertex is...", don't panic! There's a user-friendly tutorial that will give you enough info to get you started on the real data within minutes.

Specifically, the project is hoping to identify exotic decays of the Higgs boson and you can join an active community of Higgs Hunters who are already comparing and sharing plots that they've classified.

## Straining to find a solution

These days it tends to be only tea aficionados who need a tea strainer. But two tea strainers are proving to be invaluable tools in the construction of the first cryomodule for the HIE-ISOLDE project.

The cryomodules, featured in [UKNFC 50](#), require each component, no matter how tiny, to be cleaned in a jet of pressurised dry nitrogen to remove every particle of dirt or dust.



Progress - Graeme Barlow with the first cryomodule for HIE-ISOLDE. Every nut in this picture has been carefully cleaned.  
© CERN

Faced with the challenge of cleaning hundreds of tiny screws in the jet of gas, the team came up with the ingenious idea of welding two tea strainers to a pair of pliers. The screws are placed in the tea strainers and can be thoroughly cleaned without any danger of spillage.



Another great engineering solution brought to you by CERN!

© K Anthony Kittelsen/CERN

## Self-styled CERN

In the week beginning 5 January, BBC Radio 4 will be broadcasting five programmes featuring Will Self walking around the LHC. 'Self Orbits CERN' was recorded in June 2014 and will include Will's musings as he visits numerous locations around the LHC, meeting the people who work there and finding out what motivates them.

You can read more about the making of the programme in [UKNFC 44](#). The 15-minute programmes will be broadcast at 13:45 GMT every day, starting on 5 January.

## Diary dates

[A world a particle](#) in Liverpool - until 8 January  
Particle physics community meeting – 1 April  
CERN Council - 16-19 March