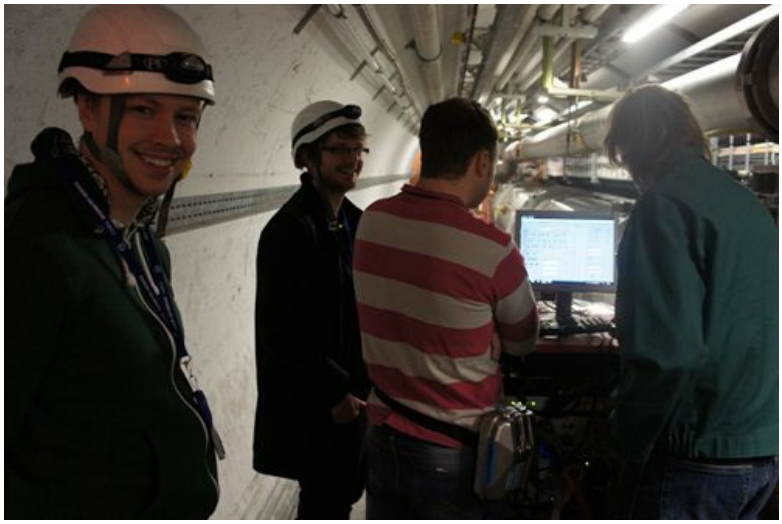
# A typical day in an atypical place—life in the CERN tunnel

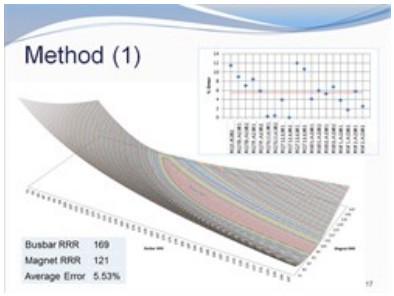
Posted on Friday 19th July 2013



Working in the Large Hadron Collider (LHC) combines the extraordinary with the (relatively) ordinary. It involves utilising the state-of-the-art equipment and technologies of this £4.4b experiment, as well as time wandering around the 27km of refrigerated tunnels—the magnets used need to be cooled to -271.3°C, colder than outer space! But it also akin to life at Birmingham, from proposing tests to giving presentations. It truly is a blend of the expected, and the unexpected.

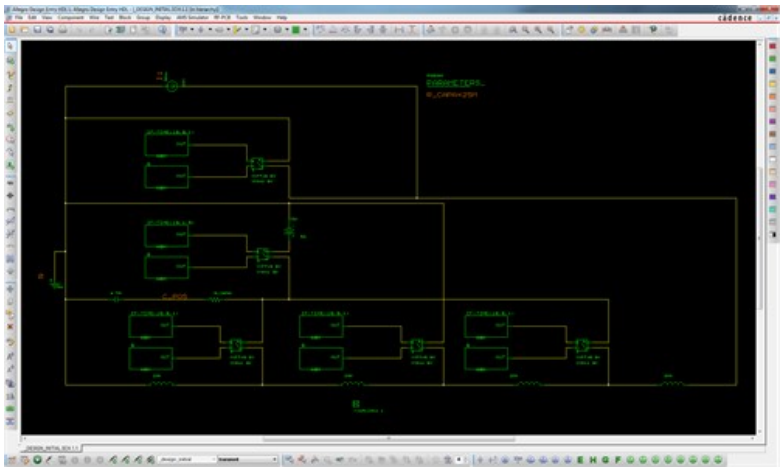
**Measure, analyse, and interpret**

As may be expected, a typical day is spent taking measurements, analysing data, creating computer simulations to model systems and circuits of interest, or presenting findings to my section (a tense experience, but more on that later) So far, I have taken measurements from inside the LHC tunnel on the machine itself and also in a cryogenics laboratory on the surface. Recently, a new method for taking measurements was tested, and now that the concept has been proven we can carry out a huge number of tests on the LHC remotely from the control room in a much shorter time. This is planned for the future, and I am excited to be a part of that.




Often the thing we want to measure cannot be done so directly, and so different tests have to be carried out on the same circuit. These tests shed light on one or more aspects of the system until the parameter of interest can be determined. The first test campaign I was involved in was to measure the residual resistivity ratio (or 'triple R') of various circuits of the LHC. This parameter indicates the purity of the copper which surrounds the superconducting material. To do this, three tests were carried out: We measured the temperature, the equivalent resistance and a frequency transfer function test measured the change in phase at different frequencies. These tests provided enough information to allow us to determine the triple R value accurately.

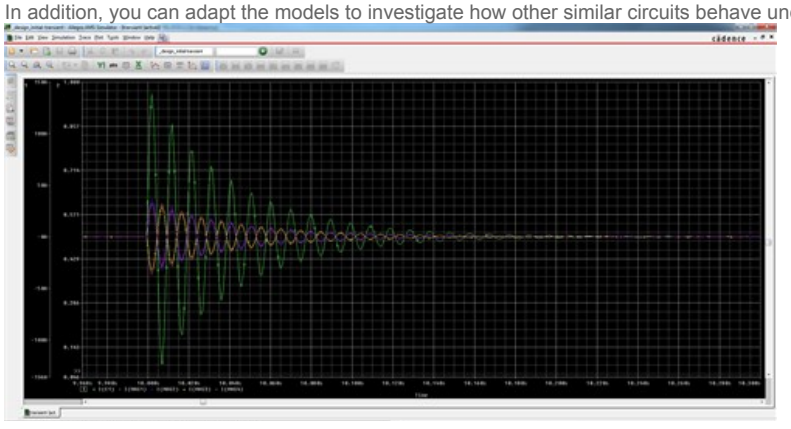
The analysis usually takes much longer than the measurement process. I tend to use MS Excel and MATLAB to carry this out, as we do in our Birmingham labs. To analyse the results of the tripe R test campaign a number of corrections and calculations had to be made. The test equipment itself introduces an offset error which is effectively the unwanted addition of some constant value which can be determined and removed from the data. The temperature measurement is also required to correct measured values as different parts of a circuit are at different temperatures (the circuits span tens or even hundreds of metres) and the material properties differ significantly with temperature. Other sources of error must be identified and corrected. Once the pre-analysis phase is complete, the triple R value can be determined for each circuit and then we look for trends: Do similar circuits have similar values? Are there any outliers? Why is this? What is the standard deviation? There are so many fascinating questions to keep one preoccupied!



**Presentation skills honed**

Once the analysis is complete, we present our findings to the section—this usually happens every four to six weeks. I did my first presentation three weeks into the job and everybody knew more about the topic than I did! It was quite nerve-wracking but I got through it. At CERN (or at least in my section) presentations are quite informal and rather than asking questions at the end, colleagues are free to ask questions throughout and discuss interesting points. It's very different to presentations I am used to giving at Birmingham and if you are not completely knowledgeable on any part of the presentation there's no chance to gloss over it. They don't miss a trick and will jump on anything you say if they disagree! I remember the section head stopped me once and asked why I have a certain value on this slide when 10 slides ago I had a slightly different value. As off-putting as that can be, it teaches you to be precise and to make sure you understand your subject in detail.

After all this has been done, and the results gathered and presented, we create models using PSpice (an analog circuit and digital logic simulation program) to simulate the system and gain a greater understanding of the system dynamics. The benefit of doing this is to provide another layer to the measurements. If there is strong agreement between the model and the measurements you have more certainty that the experiment was well carried out and no significant errors were introduced. Also, the model provides insights as to why the system behaves in a certain way. It allows you to change parameters and see the effects to further develop understanding. In addition, you can adapt the models to investigate how other similar circuits behave under different conditions.



**All work and no play?**

As for CERN in general, the atmosphere is much like a university. There are many young people working here and anybody above a certain age is generally considered authoritative. I work at the main site in Meyrin, which is huge. Half of the site is in Switzerland and the other half (including my office) in France. At lunchtime I walk to the restaurant in Switzerland which sounds like a great undertaking but it's actually only about 15 minutes away. Sitting in the restaurant you can hear people talking about all manner of scientific topics, from proton beams to accelerator upgrades. It is very easy to spark debate among people. The best reaction I have seen was when one of my friends revealed that he does not believe in evolution—it caused complete chaos! The whole table rounded on him in incredulity. When I finished my lunch and was walking out I could still hear people talking about dinosaurs and carbon dating techniques!

Aside from work, a number of events and presentations take place, all providing great networking opportunities. Recently NASA representatives visited to give a presentation on the Alpha Magnetic Spectrometer particle detector mounted on the International Space Station. And the folks from Google were here to use their Google glasses inside the LHC tunnel to take recordings and make a movie.

And if that wasn't enough, there are often TV cameras and visits from famous people, which adds a bit of glamour to the day. A friend of mine saw Professor Brian Cox (of TV fame) in the local pub, but was too overawed to say 'hello'. I realised that his email address would be in the address book but I refrained from sending him any emails… I don't think he would appreciate it!

During September the site will be opening to the public and there will be tours to all of the particle detectors and the LHC tunnel. Over 100,000 people are expected, so if you ever wanted to visit, CERN, then this September is your best chance.

So all in all, CERN continues to amaze and intrigue, and as I settle down into my role at this brave new world of scientific and engineering exploration, I reflect on the work that has gone into making CERN a success so far and the plans for the future. Right now, a great deal of work is being carried out to ensure the LHC operates safely at 7 TeV (that's 7 trillion electron-volts of energy per particle!) and I am excited to see what exotic particles emerge from collisions at this higher energy. I feel very lucky to play a role in this extraordinary undertaking, and to be a living part of scientific and human history

*You can read about Kevin's first few month's here:* ***http://www.birmingham.ac.uk/university/colleges/eps/eps-community/news/student/cern-1.aspx*** **(http://www.birmingham.ac.uk/university/colleges/eps/eps-community/news/student/cern-1.aspx)**