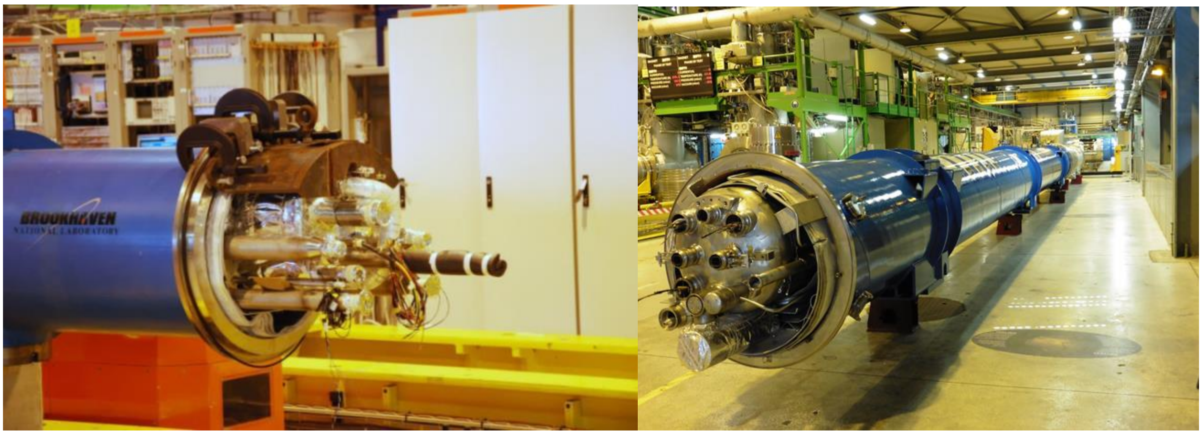
Visit to CERN Geneva to find out more about much less – 19th July 2014

We arrived at the CERN complex which is just inside France from the Swiss border, for an early 9:00 a.m start. The project is funded by over 100 nations, it employs around 10,000 people worldwide and the majority are Engineers.

The Large Hadron Collider (LHC) started up on 10 September 2008 and is the world's largest and most powerful particle accelerator. The LHC consists of a 27-kilometre ring of superconducting magnets with a number of accelerating structures to boost the energy of the particles along the way.

Inside the accelerator, two high-energy particle beams travel at close to the speed of light (0.999999991 times the speed of light at top energy (energy = 7000 GeV)) before they are made to collide. This means that the particle beams travel around the 27 kilometre ring approximately 11,000 times per second. The beams travel in opposite directions in separate beam pipes – two tubes kept at ultrahigh vacuum. They are guided around the accelerator ring by a strong magnetic field maintained by superconducting electromagnets. The electromagnets are built from coils of special electric cable that operates in a superconducting state, efficiently conducting electricity without resistance or loss of energy. This requires chilling the magnets to -271.3°C – a temperature colder than outer space. For this reason, much of the accelerator is connected to a distribution system of liquid helium, which cools the magnets, as well as to other supply services.

After an initial briefing on the CERN facility and Large Hadron Collider (LHC) Project we were taken by mini bus to our fist port of call which was a the Cyrogenic Test Facility. In this building we learned about the significant engineering challenges that had been overcome in building the LHC facility. Some facts are the LHC magnets use superfluid helium at 1.9 K (or -271.3ºC). The LHC dipoles use niobium-titanium (NbTi) cables, which become superconducting below a temperature of 10 K (–263.2°C), that is, they conduct electricity without resistance. A current of 11 850 Amps flows in the dipoles, to create the high magnetic field of 8.33 Tesla, required to bend the 7 TeV[1] beams around the 27-km ring of the LHC. Cooling is achieved by use of liquid helium. At these low temperatures helium demonstrates remarkable properties, as a superfluid helium has a very high thermal conductivity, which makes it the coolant of choice for the refrigeration and stabilization of large superconducting systems.



A section of the LHC showing beam tubes, magnets and cooling supply system

Thousands of magnets of different varieties and sizes are used to direct the beams around the accelerator. These include 1232 dipole magnets 15 metres in length which bend the beams, and 392 quadrupole magnets, each 5–7 metres long, which focus the beams. Just prior to collision, another type of magnet is used to "squeeze" the particles closer together to increase the chances of collisions. The particles are so tiny that the task of making them collide is akin to firing two needles 10 kilometres apart with such precision that they meet halfway. At the operating conditions the force generated from the magnetic field is pushing the tubes apart amounts to several hundred tonnes and as if this was not a big enough problem the design has to allow for contraction of the LHC of 80 Metres over the 27 Km

[1] 1 TeV: a trillion electronvolts, or 1.602×10−7 J, about the kinetic energy of a flying mosquito

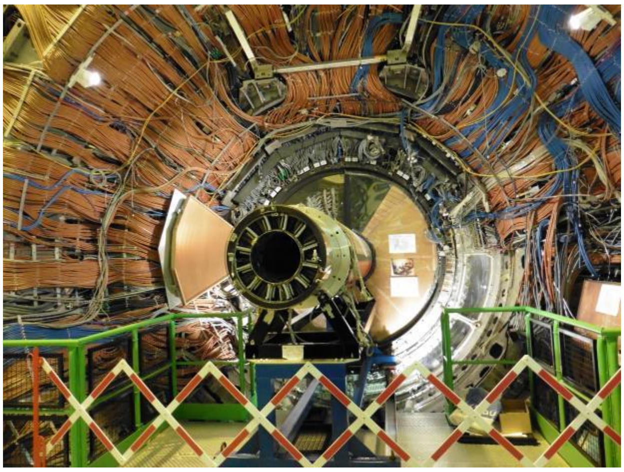
length when at its operating temperature. Making joints in the sections to contain the vacuum, transfer electrical energy and cryogenic cooling is a significant challenge for the engineers.

Magnets surrounding the beam tube

Cryogenic Test Facility

By contrast our second visit was to the Alpha Magnetic Spectrometer (AMS) Payload Operations Control Centre (POCC). The POCC is located at CERN, and collects data in real time from primordial cosmic rays that traverse a detector located on the International Space Station. In this centre we learnt about the work to seek out dark matter, antimatter and missing matter from a module attached to the outside of the International Space Station by analysing the cosmic radiation being emitted from deep space.

After lunch two small parties were able to visit separate detector stations; the Large Hadron Collider beauty (LHCb) and The Compact Muon Solenoid (CMS). Both of these are used for collecting data on the particles travelling in the LHC ring. All the controls for the accelerator, its services and technical infrastructure are housed under one roof at the CERN Control Centre. From here, the beams inside the LHC are made to collide at four locations around the accelerator ring, corresponding to the positions of four particle detectors – ATLAS, CMS, ALICE and LHCb.



View of the LHCb detector specializes in investigating the slight differences between matter and antimatter by studying a type of particle called the "beauty quark", or "b quark".

The Compact Muon Solenoid (CMS) is a general-purpose detector at the Large Hadron Collider (LHC). It is designed to investigate a wide range of physics, including the search for the Higgs boson, extra dimensions, and particles that could make up dark matter

In the initial 18 month period of space operations, from 19 May 2011 to 10 December 2012, AMS analysed 25 billion primary cosmic ray events. Of these, an unprecedented number, 6.8 million, were unambiguously identified as electrons and their antimatter counterpart, positrons. The 6.8 million particles observed in the energy range 0.5 to 350 GeV

So what has CERN and the LHC done for us? The information generated is free source to the scientific community around the world but the spin off from this work is now part of our everyday lives. The World Wide Web was invented by Sir Tim Berners Lee at CERN in 1989. He had no commercial interest as it was primarily a tool to form a network of computers to analyse all the data being generated from the CERN experiments. Today we have the Internet which has had a major impact on our lives. The detector technology is now part of medical science and is leading to better scanning diagnostic systems such as MRI and CT. Microelectronics and other work developed at

CERN is incorporated into every day devices, and of course some of the materials technology in super conducting and power engineering applications may at some point lead to a more efficient electrical supply systems.

We were of course grateful to all the CERN guides and presenters who gave such a valuable insight and fee access into a remarkable experiment.

To round off the day an enjoyable traditional Swiss meal was attended by all with alpine entertainment, and we even had an Alpenhorn demonstration by Elsa Martin.