HAS Meeting Notices August 2014

1. Current News and Dates for your Diary

- The Committee HAS 20th Anniversary celebratory meal will be at Fairways on 22 November (cost about £24) with Howie Firth as speaker. If you'd like to come along (partners welcome) please see Pat at tea break.

- The Doors Open Day is on 6 September 2014. The observatory will be open from 1400 to 1800, but some of the Committee will be away at the Orkney Science Festival. If anyone would be willing to volunteer to help out at the Open Day, please contact Pat Escott or any committee member – again, Pat will have a sheet to sign at tea break. Many thanks for your help.

- Our updated 2014/15 Programme of Events is available at reception; the details are also on the website at: www.spacegazer.com

- Solar Saturdays continue, weather permitting – these take place at the Observatory at Culloden Moor from 2 to 4pm (park at the far back left of the NTS Battlefield car park, there is a grassy path to your left which leads to the Observatory). Please check the website before setting off to find out whether the session is running.

- **The next meeting is on 2 September** - this will be a Practical Astronomy evening led by HAS members. Information and advice on all aspects of star gazing, from how to set up your telescopes to advice on what are the best buys. Bring your questions or just browse – various equipment will be on display.

- **Suggestion Box** – at reception. Don't forget to let us know if you have any ideas you would like the committee to look at. This is your Society, please help the committee to provide what you are looking for. Or of course speak to a committee member.

- **Telephone alerts** – should you see an aurora, noctilucent clouds, or anything else of astronomical interest, please alert Paul (01667 456789) or Pauline (07751 112 586). It is never too late at night to let us know.

- **Talk on "The Life of Neil Armstrong"** by James Hansen, the only official biographer of Neil Armstrong. [His book, *First Man: The Life of Neil A. Armstrong,* was published by Simon & Schuster, 2005.]

  James Hansen is a friend of Ken MacTaggart (from Dundee) and has published many books related to space history. He has been teaching space history at Auburn University, Alabama, for 30 years.

  The talk will take place on **Wednesday 27th August** at **7.30 pm** at **The Town House**

Main Event

Our speaker tonight was James Hitchmough. He has been a member of HAS for five years and has just finished 6th year at Culloden Academy. James became interested in space and space travel after reading about the Apollo missions and over time progressed into an interest in stars, planets and galaxies. He also enjoys observing the night sky with his own 20x80 binoculars but also with the Society's 12" Dobsonian telescope and has been a great help at the observatory. He would like a career in observational astronomy and has had work experience at St. Andrew's University three times and really enjoyed it.

James was lucky enough to visit CERN along with three classmates and a teacher, and his talk is all about this experience. First James gave some background information on CERN, *(Conseil Européen pour la Recherche Nucléaire)* which today is known as the European Organisation for Nuclear Research and is the leading body in modern day particle physics. They operate the Large Hadron Collider as well as managing other research projects. It is situated on the Swiss French border and is 27 km in circumference.

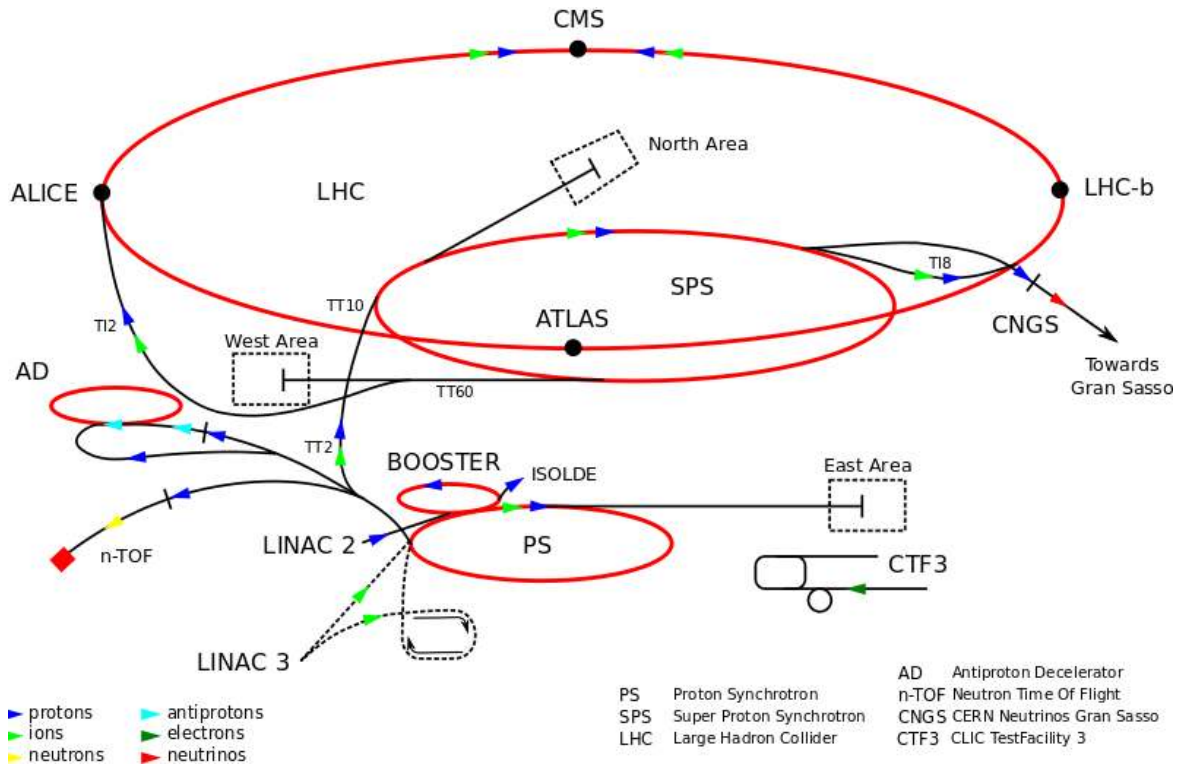
History

Originally set up by a council of 12 European countries in 1952, CERN itself was actually founded in 1954. Initially, it was concerned with the structure and behaviour of the atomic nucleus but after a few years the laboratory began studying high-energy physics and particle interactions. CERN has also been at the forefront of Internet technology and was the birthplace of the World Wide Web.

The Large Hadron Collider

The Large Hadron Collider (LHC) is the world's largest and most powerful particle accelerator. It is a 27 km ring of superconducting magnets and accelerating structures that boost the energy of the particles on their journey around the ring.

Perhaps surprisingly, all the protons required for the collisions come from a three feet high bottle of compressed hydrogen, which should last for 35 years. The hydrogen is fed into a series of systems that isolate the proton from each hydrogen atom.



LINAC-2 is the first machine to accelerate the protons and ejects them at an energy of 50 MeV (one electron volt is a unit of energy equivalent to 1.6×10^{-19} Joules). The Booster accelerates the particles to 1.4 GeV and these are then injected into the 628m long Proton Synchrotron which increases the proton's energies to 25 GeV. Then they are sent to the Super Proton Synchrotron (as James points out, not a very imaginative name), which has a circumference of 6.9 km and here the protons are accelerated to 450 GeV. At last they enter the LHC in opposite directions (via T12 and T18) to be accelerated to 7 TeV where they will collide with a total energy of 14 TeV.

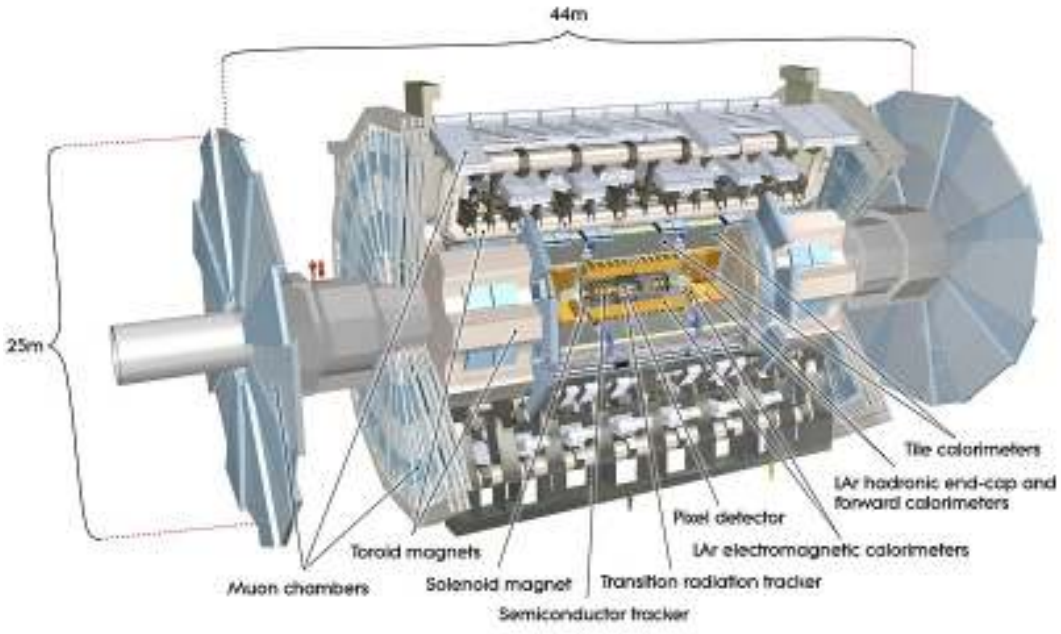
The LHC is a massive machine considered to be the pinnacle of modern engineering and high-energy physics. Taking ten years to build, it uses the 27 km tunnel already in place that had originally been used for the Large Electron-Positron Collider which was dismantled to make way for the LHC. 15 m long sections house the beam pipes and each of the 1600 superconducting magnets each weighing 27 tonnes and whose job it is to keep the protons focused into a tight beam.

At the end of a magnet you can see two parallel beam pipes, much wider than required for their tiny passengers. The cables, which are draped on top of the beam pipe, carry a current of 13,000 amps – required to produce the magnetic field to steer the protons. They appear too thin to be able to carry this amount of current but by cooling them to 1.9 K (-271.15^{o} C) they can conduct electricity with zero resistance. If the magnets, and thus the cables, are not cooled down to their operating temperatures even the tinniest of electrical resistance can cause a catastrophic meltdown, which is what happened when the LHC was turned on for the first time in 2008. Furthermore, an electrical discharge wrecked the liquid helium enclosure leading to a violent release of coolant that went on to damage 53 of the magnets.

When running at full power, protons collide at 14 TeV after travelling at almost the speed of light. The proton thus travels around the 27 km ring in 90 microseconds, completing 11,000 revolutions per second. The protons are separated into 2,808 bunches containing 115 billion protons each. On collision they create a ripple effect of interactions.

Detectors and ATLAS

The data collection is accomplished by seven particle detectors; ATLAS (A Toroidal LHC Apparatus) and CMS (Compact Muon Solenoid) are general purpose detectors, the five others are more specialised e.g. ALICE (A Large Ion Collider Experiment) detector studies the collision of heavy lead ions to investigate quark-gluon plasma.

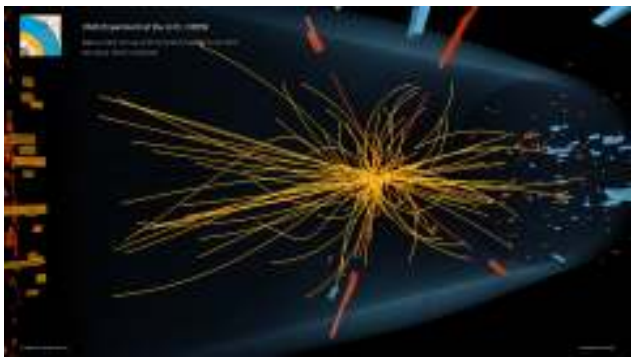


This is a cutaway drawing of the ATLAS detector showing the beam pipes at either end. The central parts, the Pixel Detector and Transition Radiation Tracker measure the paths of the charged particles. The next section has the calorimeter devices which measure the energies of particles and after this is the muon spectrometer which measures the tracks of muon particles.

This video on the CERN website tells you about the ATLAS detector and how the physicists determine what the different particles are.
http://www.atlas.ch/multimedia/html-nc/feature-episode2.html

Data collection and analysis

Raw collision data produce 40 million recorded events per second producing 40 Petabytes of data (40 million Gigabytes) per second. This amount of data is unmanageable so irrelevant data is discarded in three stages, first by the detector itself and then by two other computers until there is 'just' 100 Megabytes of data per second. This is still too much for the computers at CERN to manage so the Worldwide LHC Computing Grid, comprised of 170 computing centres in 36 countries, was set up to analyse the data.



Personal experience at CERN

James then spoke about his Advanced Higher physics class trip to CERN. He and another class member looked into the feasibility of the trip and it was approved by the Headmaster. Four classmates and one teacher flew from Edinburgh to Geneva on Saturday the 15th March. The day after their arrival they visited the Geneva Motor Show and it wasn't until the Monday that they reached their destination – the CERN Meyrin site. They were able to wander around the indoor exhibits all about understanding the secrets of matter and they also got a chance to see the very first particle accelerator, a cyclotron, which is only a few centimetres in diameter. The CERN garden was full of old particle accelerators and the physicists even made use of smaller pieces as coffee tables. Their tour consisted of visits to experimental areas, a talk about the background of the engineering involved in building CERN and then they got into a lift which took them down to where ATLAS was kept. James took numerous photographs but it was just not possible to do justice to this huge piece of equipment and James said they were all overwhelmed by the sheer size of this amazing place.

Thank you James for an amazing and personal insight into this extraordinary place of high-energy particle physics.

More information on the LHC on the CERN website:
http://cds.cern.ch/record/1165534/files/CERN-Brochure-2009-003-Eng.pdf

Sky Highlights

Next, in Sky Highlights, Antony explained what Noctilucent Clouds (NLCs) are as there had been a good display during July and both Pat Williams and myself were able to supply photos.

Noctilucent means night-shining. These diaphanous clouds are electric blue in colour that can be seen in the summer months at latitudes between 50^0 and 70^0 N and S of the equator when illuminated by the Sun which has to be between 6^0 and 16^0 below the horizon . They are made of of tiny crystals of water ice probably forming when moisture condenses on dust particles from micrometeorites or volcanic eruptions. They occur in the mesosphere at altitudes of 76 – 85 km far above the troposphere where weather clouds are formed.

Now that the nights are drawing in again look out for the Summer Triangle made up of three bright stars, Vega, Deneb and Altair. Close to Vega is a planetary nebula called the Ring Nebula (M57). Close to a little constellation called Sagitta is a globular cluster (M71) and just a short hop away is a formation of stars that looks like an upside down coat hanger called the Coathanger. A little above M71 is the Dumbbell Nebula (M27) another planetary nebula, and at the end of the Eagle's tail (constellation of Aquila) is the Wild Duck star cluster (M11). All these objects are well worth a look with binoculars but some require a telescope.

Next month we have our practical astronomy night so if you have any questions about observing or any telescopes that you are not sure how to work or simply want advice on observing, do come along. Tea and biscuits will be available whilst you chew over which telescope you would like to buy next. Until then, clear skies!

Pauline Macrae