BMW Club Oxford Section visit to Culham open evening

# Trip Report:
# Culham Centre for Fusion Energy
## Wednesday 15th March, 2017

On 15th March, twenty-three members of the Oxford Section attended one of the regular open evenings held at the Culham Centre for Fusion Energy (CCFE). We were lucky enough to get more than our initial allocation of spaces, as Culham offered us some extra slots that had come free at the last minute.

Inside the full-size replica of JET – used for training

After getting our badges and enjoying tea or coffee and biscuits in the Welcome area, we had a fascinating introductory talk by Sarah Fell into what they are exploring at Culham. She explained that fusion energy is very complex to achieve, and will take many more years to develop, but is one possible technology which offers the hope of a sustainable power source that is also very safe: if anything goes wrong, the reaction will just stop. It is based on a mix of two isotopes of hydrogen, Deuterium and Tritium which, when heated to a very high temperature to form a plasma, yields Helium and a neutron and Energy. In terms of the resources needed, thirty years of a person's energy needs could be obtained from half a bath tub of seawater and a laptop battery. Of course, it is not quite as simple as that, and one of the reasons for the complexity is the need to reach temperatures around 150 million degrees Celsius. By comparison, the core of the sun is about 15 million degrees Celsius, but a fusion reactor on Earth needs a much higher temperature because it is somewhat smaller than the sun.

## Looking over JET

Having become somewhat more informed about fusion energy, we set off in groups to tour some of the experimental facilities. The Oxford Section members made up a couple of these groups, and in one of these we were first taken to see the Joint European Torus (JET). JET is currently in a shutdown period, enabling us to get quite close up. We were also free to take photographs, as Culham is an open site, but not to touch anything! JET is a "Tokamak", a Russian acronym which translates roughly as "Torus-shaped container with magnetic coils", which describes it pretty well. The magnets are used to shape and contain the plasma, and also to heat it: a central coil forms the primary winding of a transformer together with the plasma as the secondary coil. Additional heating is now also applied via a 'neutral beam injection' system. As well as looking at JET in the flesh, we also went into a full-scale replica used for training, part of which is formed by a spare segment that was never needed for the real JET. We also saw some detailed scale models, which were initially used to test out designs before the days of CAD.

Model of JET in the 'Model Room'

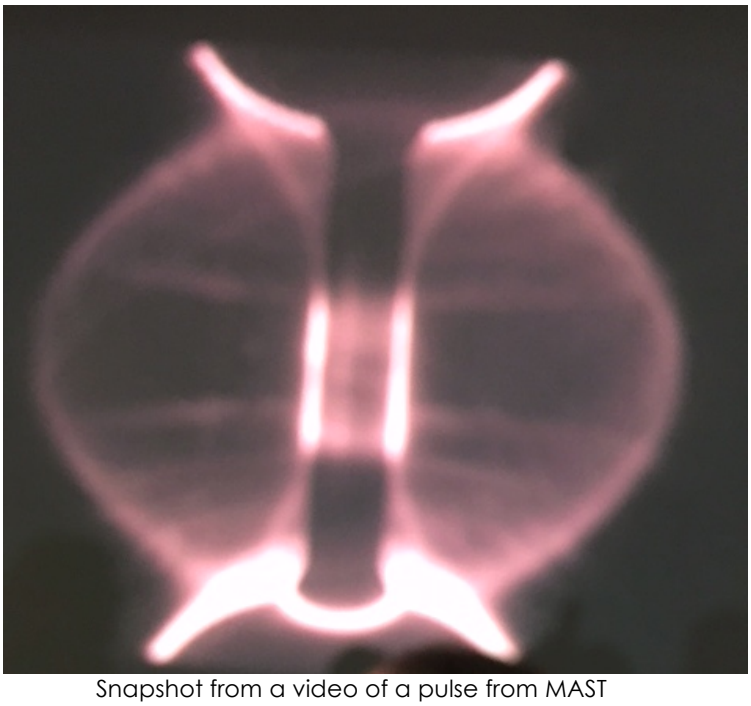
## On to MAST

Walking across the site, we then visited MAST (Mega Amp Spherical Tokamak), which is a very different shape and scale from JET, with all components contained within a cylinder, making it more compact. MAST has been under reconstruction for a number of years, to try out some new design features, but MAST-U (MAST-Upgrade) will be firing up soon. As well as looking at MAST - from a distance - and the thick concrete walls which will surround it when it is operational again, we also saw the old central coil removed from the previous MAST, and a cut-away model that illustrates the new design. This design includes a clever system that it is hoped can remove the

'exhaust' materials into a separate cooler area, to avoid them interfering with the main plasma.

MAST upgrade from a distance

We visited the future MAST control room, and watched a video of one of the 'pulses'. Each pulse is used to investigate various features of fusion with input from the science teams. The pulse length of about 0.5 seconds in the old MAST could be increased up to 2-4 seconds in MAST-U. The hottest areas of the plasma are invisible, but where it is cooler (towards the edges, or where the jets of Deuterium and Tritium are introduced), it can be seen in colours in the visible spectrum.



Snapshot from a video of a pulse from MAST

As yet, JET and MAST consume more energy than they produce, but the experiments being carried out at Culham contribute to a global effort, with a much larger version of the JET Tokamak being constructed at the ITER (International Thermonuclear Experimental Reactor) in Provence. This is still experimental but is of the scale of a potential future fusion plant, and it is believed this can be followed by the first experimental facility that generates fusion power. If you want to learn more, or arrange to attend an open evening at Culham, see http://ccfe.ac.uk/

Everyone at Culham was very helpful and knowledgeable and excited about what they are helping to create. We all had plenty of questions, and our guides were very good at answering them. It was really exciting to be inside a working science facility.