New era for fusion research centre

This month Sir Chris Llewellyn Smith takes over as director of the Culham fusion laboratory.

Edwin Cartlidge reports on his plans for the lab

It seems fashionable these days for plasma physicists and particle physicists to swap jobs. In December the CERN particle-physics laboratory appointed Robert Aymar, director of the ITER fusion project, as its next director general. Now the UK's national fusion centre at Culham in Oxfordshire has hired the former director general of CERN, Chris Llewellyn Smith, as its director.

Llewellyn Smith will certainly have plenty to keep him occupied when he takes over on 8 September. Culham, owned by the United Kingdom Atomic Energy Authority (UKAEA), operates the world's leading fusion experiment, the Joint European Torus (JET), on behalf of the European Fusion Development Agreement. It is also home to the Mega Amp Spherical Tokamak (MAST), one of the two largest spherical tokamaks in the world. And his appointment comes at a particularly important time for fusion research worldwide: the site for the \$5bn ITER device is due to be decided around the end of the year.

"The UKAEA wants someone to give scientific leadership and deal with governments," says Llewellyn-Smith, who was headhunted for the job. "I think these requirements are well matched to my experience. I have contacts throughout the world, having dealt extensively with people in Japan, the US, Russia and China. I am obviously not a plasma physicist, but the technology used in fusion research is quite similar to that used in particle physics."

Faith in fusion

Llewellyn Smith served as director general of CERN between 1994 and 1998, and then became provost and president of University College London (UCL). But he resigned from UCL last year following opposition to his plans for restructuring the university and returned to Oxford, where he has spent much of his career. He refuses to discuss his resignation, saying that he does not want to "add fuel to the debate". Since then he has been doing work in maths education, trying to find ways to help scientists in developing countries and has even carried out some research in theoretical physics. But his attention will now be firmly focused on developing fusion energy.

"The time is right to see if fusion works," he says. "Culham has a great track record and can play a crucial role in realizing fusion energy as quickly as possible. I believe that fusion is one of the very few sensible large-scale sources of power in the long term."

One of his main tasks at Culham will be

Under new management - Culham.

to ensure the continued success of JET. Since it started operating in 1983, JET has made a number of important steps towards the ultimate goal of realizing fusion as an energy source. In 1991 it became the first experiment to produce controlled fusion power in a deuterium-tritium mixture, and in 1997 it set records both for peak fusion power (16 MW) and the ratio of power output to power input (0.65). It is hoped that this ratio will be about 10 in ITER.

"Having established its own impressive performance levels, the progress made on JET makes us confident about the realization of ITER," says Michael Watkins, co-ordinator of JET's experimental programme. "In the future, JET will allow physicists to optimize ITER's operating conditions, test auxiliary systems needed for the larger device, and prepare for heating by alpha particles."

To carry out these tasks JET needs to be upgraded, and will be shut for much of next year to allow new components to be installed. But the construction of ITER could limit the extent to which these upgrades are exploited. ITER will consume up to €200m of the European Union's €750m fusion budget for the period 2002-06. To compensate for this, it may be easier to simply shut down JET - which costs about €55m a year to run - rather than taking money from several of the smaller national fusion projects.

"Funding for JET is only assured until the end of 2004," says Llewellyn Smith. "When ITER is approved, one could use money from JET, but on the other hand ITER will not be operating for another 10 years. I will argue strongly for more funds for JET, so that it can continue to do science and to test components for ITER."

The spherical route

As far as domestic fusion is concerned, Llewellyn Smith says there are three things that the UK needs to do to ensure that it stays at the forefront of research. He believes that physicists at Culham must build on their expertise in diagnostics, and take the lead in researching the materials needed for a fusion reactor. He also thinks there is a "very good case" for upgrading MAST, which started up in 1999.

Culham's first spherical tokamak, START, ran from 1991 to 1998 and showed that a spherical design could be potentially cheaper and generate electricity more efficiently than a conventional (doughnut-shaped) tokamak, such as JET or ITER. But the results obtained with START were only preliminary and need to be confirmed on much larger purpose-built devices such as MAST, according to Alan Sykes, physics team leader for the project.

"MAST is performing well, and has produced some extremely well characterized results," says Sykes. "These are having a significant impact both on the understanding of conventional tokamaks, and on predictions of possible future spherical-tokamak-based power plants."

MAST was shut down in July for eight months in order to upgrade its power supplies, auxiliary heating and plasma-facing components. A more substantial upgrade, as advocated by Llewellyn Smith, would require the machine to shut down for about a year, and the government's Office of Science and Technology has estimated that it would cost about £20m.

Changing perceptions

In addition to securing the future of JET and MAST, Llewellyn Smith will also be eager to nurture the next generation of plasma scientists and engineers, and to promote technology transfer. Indeed, two years ago Culham set up a new "incubator centre" to provide space for start-up companies wanting to benefit from the broad range of skills and equipment available on the site.

Last, but not least, Llewellyn Smith must overcome the deep-rooted scepticism that many people have of fusion energy. "Physicists and other scientists still have the mindset that fusion is another 50 years down the line," he says. "For a long time this was a reasonable position to take, but not any more. It is possible that we could see commercial fusion power plants in 30 years' time. This is a problem that can now be solved by major investment."