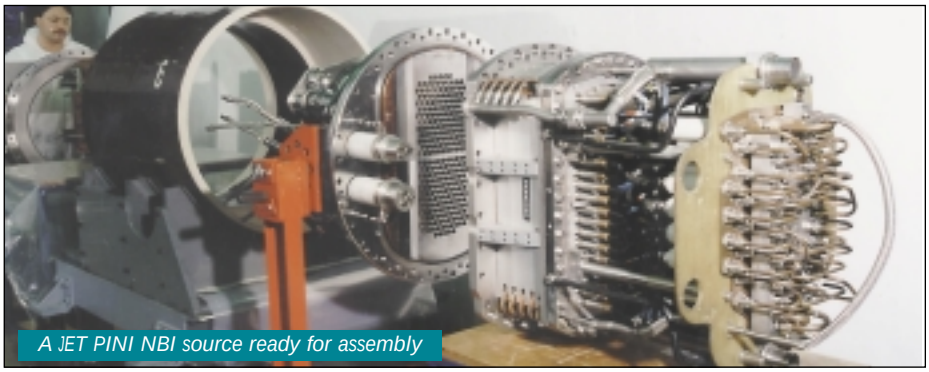
A Guide to Fusion - Part 9
Neutral Beam Injection (NBI)

NBI is presently carried out at Culham on both the MAST (see page 3) and EFDA JET facilities. The injection of high-energy neutral atoms is an established means of providing heating and current drive in tokamak and stellerator plasmas. This is achieved by acceleration of an ion beam followed by passage through a gas target to neutralise a fraction of the beam. This neutral beam can cross the magnetic fields confining the plasma, and then become ionised and trapped, leading to heating and current drive. Similar technology is also used for diagnostic beams, such as those provided by UKAEA and AEA Technology for Princeton, USA, NIFS, Japan and COMPASS at Culham.

Key technology items required for high power NBI are: high-speed vacuum pumps, such as the large cryo-pumps used on JET (capable of millions of litres/s pumping speed), and the development of target panels capable of handling high heat fluxes (10-15MW/m^2), such as the actively-cooled hypervapotrons on JET.

On MAST, two injectors on loan from Oak Ridge National Laboratory, USA are being commissioned to inject powers up to 2.5MW per injector for pulse lengths up to 0.5s; and 2MW per injector for pulse lengths between 0.5s and 5s. The ORNL injectors use duopigatron ion sources, which are being upgraded to operate at increased beam energies and pulse lengths.

Two injector systems are installed on the JET device, each equipped with eight Positive Ion Neutral Injector (PINI) beam sources. Two types of PINI are used, operating at 80kV/60A and 140kV/30A respectively. The present 140kV injection system is due to be significantly upgraded over the next 2½ years to increase the beam current from 30A to 60A, doubling its power output.



A JET PINI NBI source ready for assembly

NEWS IN BRIEF

ITER VISITORS

Culham has hosted a visit by a senior delegation from Canada – one of the countries in the running to host the International Thermonuclear Experimental Reactor, which is the planned 'next step' for fusion energy research.

The delegation of MPs was led by the CEO of ITER Canada, Peter Barnard.

The aim of their visit was to see at first hand the social and economic impact of hosting an international project like JET.

As well as visiting the JET facility, operated by UKAEA under the JET Operation Contract, delegates also met local community representatives including Oxford West & Abingdon MP, Dr Evan Harris and local council members.

Chris Carpenter (left) guides Canada ITER visitors (from left): Jerry Pickard, Marlene Jennings and Bernard Patry.

TENDER & CONTRACTS UPDATE

Five UK companies have been nominated so far this year for work on European fusion projects. The latest projects include:

- Coil Handling Tool/Mounting Stands Type I and Mounting of Half Modules for W7-X at Greifswald, Germany.
- 3 repetitively pulsed, high power lasers for the Thomson Scattering Diagnostic at Lausanne, Switzerland.

If your company would like to be added to our database for future fusion projects, please email fusion.industry@ukaea.org.uk

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Fusion BUSINESS

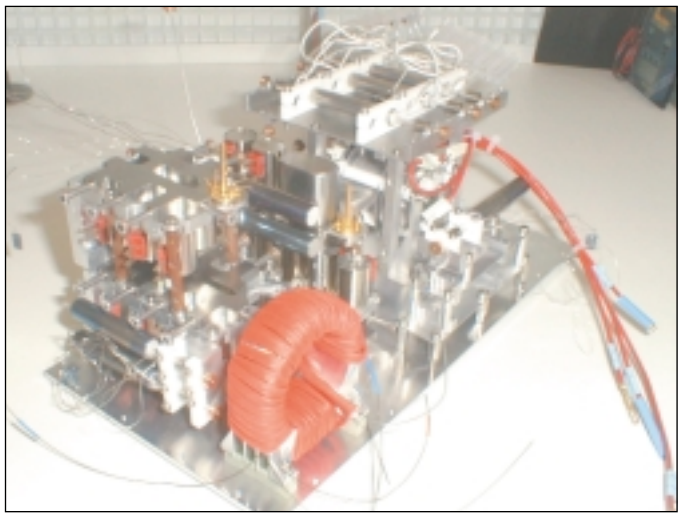
Inside ...

FUSION EXPERTISE BEHIND EUROPEAN SPACE PROBE

UKAEA Fusion scientists have designed and manufactured key elements of a European Space Agency probe.

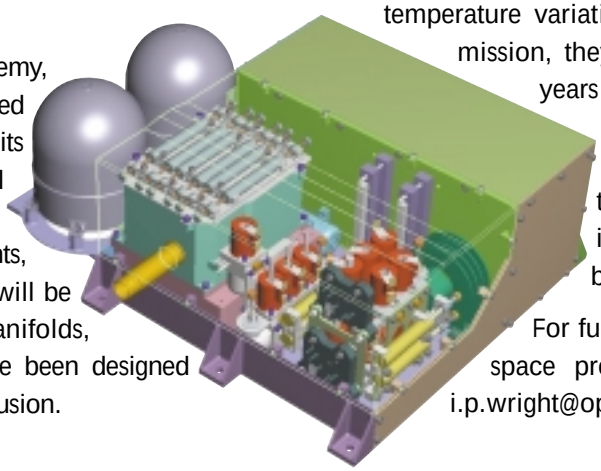
An orbiter/lander combination called Rosetta will be launched in 2003 to visit a comet known as 46P/Wirtanen. The aim of the mission is to take pictures of the comet and carry out a variety of scientific investigations.

One activity will involve a drill and coring device taking samples of the frozen cometary nucleus and returning them to the lander for analysis. The Planetary Sciences Research Institute at the Open University (Milton Keynes) is responsible for providing one part of this package, known as Ptolemy, in association with the Space Science and Technology Department at the Rutherford Appleton Laboratory. Ptolemy consists of a miniaturised gas chromatograph and mass spectrometer and is designed to determine the isotopic compositions of the constituents of the comet. These measurements will help shed light on the role of comets in determining the course of events on the primitive Earth 4-4.5 billion years ago, when biologically important elements and molecules rained down from outer space and seeded a previously sterile surface.



Prototype instrument under construction, courtesy of Open University
below: CAD model, courtesy of Rutherford Appleton Laboratory

To achieve the goals of Ptolemy, cometary ices must be converted into gases and passed through its miniature laboratory. The all important connections between the different science components, through which the gases flow, will be made using specialised manifolds, pipework and fittings that have been designed and manufactured by UKAEA Fusion.



Dr. Ian Wright at the Planetary Sciences Research Institute says: "The requirements for these items are exceptional – they must not leak, they must not contribute contaminants, they must be resilient to the analysis gases, they must survive to low temperatures and be able to withstand wide temperature variations, and, most unusually for a space mission, they must be able to survive intact for 8 years after launch before they are even used. They also have to connect to a range of different material types – ceramics, titanium, aluminium etc. All being well, in 2012 we'll hopefully be able to report back that they were successful!"

For further information on Ptolemy and other space projects involving the Institute contact i.p.wright@open.ac.uk.

UKAEA

Fusion Working with Europe

18 in running for ITER work

Six UK companies have been nominated by UKAEA to join the lists of those qualified to work on European fusion projects. Twelve further companies, who qualified for a place on the lists in either 1993 or 1996, have been nominated again.

The listings are divided into seventeen specialised technology areas considered essential as progress is made towards fusion's 'next step' machine ITER (International Thermonuclear Experimental Reactor).

Once nominations were made, the European Commission began sending out formal invitations and asking for a detailed assessment of each company's capabilities. The criteria for a successful application include: experience in the field and past performance, technical capabilities including the number and qualifications of personnel, technical support and resources, and a commitment to participate.

The UKAEA nominees will be considered alongside companies nominated by other European fusion associations and laboratories. The European Commission will then submit a list to the Leader of EFDA (European Fusion Development Agreement) for final approval.

Industry Programme at 'Venturefest'

The Fusion Industry team attended the Venturefest exhibition held at Oxford Brookes University in June, sharing a stand with the UKAEA Central Property Unit.

Their aim was primarily to promote the excellent business facilities and support services available at the recently opened Harwell Innovation Centre and at Culham Science Centre, where resident companies have the additional benefit of access to fusion technology and expertise. The team had a successful two days and made a number of new contacts including entrepreneurs, start up company management consultants, legal advisers and funding bodies, many of whom were keen to explore the opportunities Culham and Harwell are able to offer.

More details from miriam.mason@ukaea.org.uk

Twinning trip forges new research links

New links could be forged between the UKAEA Fusion Industry Programme and a group of French research laboratories.

Industry Liaison Co-ordinator, Miriam Mason, joined Oxfordshire councillors, business leaders and academics on a visit to Meylan, Grenoble, to explore possible links between UK and French business and research centres.

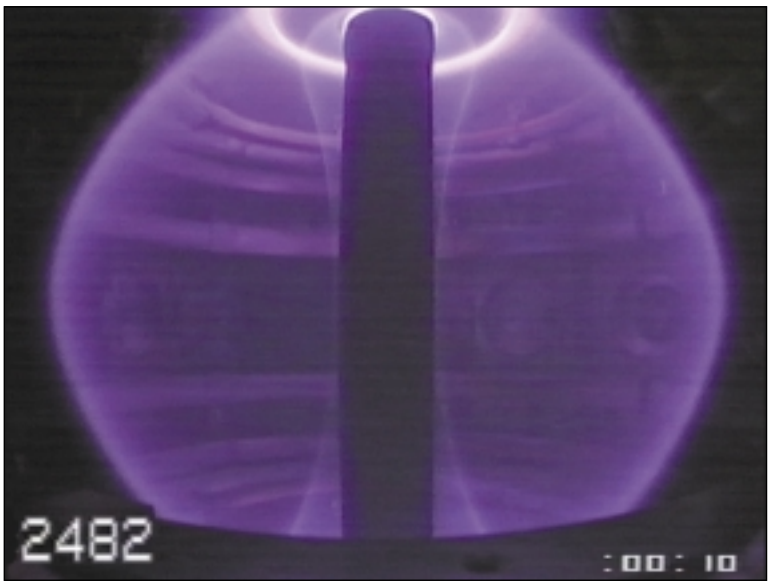
The trip included a visit to the Prozirst business park in Meylan, one of 42 industrial parks in France in a network known as 'France Technopole'. It is home to some 250 companies including CEA and Alstom. Presentations by senior staff at the park were followed by a group discussion (pictured) during which the French delegates expressed keen interest in collaboration with innovation centres in South Oxfordshire.

Another of the meetings was hosted by Grenoble Alpes Incubation (GRAIN), a group established by government-owned research laboratories in the Alpes region. Miriam Mason says : "We discussed staff and student exchanges along with exchange of material, to help identify opportunities for further collaboration and technology spin-offs."

Companies with existing links in the area or who would like to establish new links should contact miriam.mason@ukaea.org.uk or call 01235 464104.

MAST ACHIEVES 1 MEGA-AMP!

The new spherical tokamak at the Culham Science Centre, MAST, (Mega Amp Spherical Tokamak) has lived up to its name, by achieving a plasma current of more than one million amperes.



The plasma has an overall diameter of approx. 2.6 metres; the central column has an overall diameter of 0.4 metres.

On Wednesday 17th May, shot 2482 (pictured here) obtained current in excess of 1MA for over 30ms. Heated by Neutral Beam Injection of ~650kW (using an injector on loan from Oak Ridge National Laboratory), the plasma attained central electron and ion temperatures of over 10 million˚C at the time this picture was taken.

As was the case on MAST's predecessor, START, neutral beam injection is remarkably successful, providing both efficient heating and a significant improvement in plasma stability.

MAST has also successfully used a process called boronisation on the vacuum surface inside the machine, to reduce impurities. Physics Team Leader Alan Sykes says: "Boronisation has enabled us to reduce plasma impurities by a factor of ten, resulting in much higher current discharges and improved confinement modes."

Under control with 'Fuzzy Logic'

Business intelligence software specialist, Applai has won a contract to supply 'fuzzy logic' software and consultancy on MAST.

The MAST fusion chamber has more than 700 sensors to measure, amongst other things, the magnetic field produced by plasma during fusion. The results are used to control electromagnetic coils that optimise the shape of the plasma.

Until now the sensors' operation was checked manually before each experiment, a painstaking and time consuming task. Altrincham-based Applai's FuzzyTECH software is automating the sensor checking as well as providing valuable information on the status of each sensor. It also assesses the viability of proceeding with an experiment.

Mikhail Gryaznevich, MAST Experimental programme manager, said, "FuzzyTECH gives us a complete sensor 'signature' for each experiment. This is very important in assessing the quality of the experiment especially when we come to sharing our results with the international fusion research community."

For further information contact: Bill Edisbury on 0161 718 9195 or email bill@applai.com

Fusion and Industry: Conference & Events Diary

September 3-7 PPARC Advanced Summer School in Solar System Plasmas, Warwick, UK.

September 4-8 21st Symposium on Fusion Technology (SOFT), Madrid, Spain.

October 4-10 18th IAEA Fusion Energy Conference, Sorrento, Italy.

October 12-14 Workshop on Plasma Diagnostics & Industrial Application of Plasmas, Trieste, Italy.

October 15-19 14th Topical Meeting on Technology of Fusion Energy, Park City, Utah, USA.

October 23-27 42nd APS Division of Plasma Physics Annual Meeting and 2000 International Congress on Plasma Physics, Quebec, Canada.

June 17-22 2001 28th IEEE International Conference on Plasma Science in conjunction with 20th IEEE International Pulsed Power Conference, Las Vegas, Nevada, USA.

June 18-22 2001 European Conference on Controlled Fusion & Plasma Physics, Funchal-Madeira, Portugal.

More details from deniese.willis@ukaea.org.uk. Please note events may be subject to change.