Issue Ten May 2000

Fusion BUSINESS

Inside..

WIND TURBINE PROJECT TURNS TO FUSION TECHNOLOGY

Staff in the Optics and Fluid Dynamics Department at the Risø National Laboratory in Denmark have gained experience of using CO_2 lasers in anemometers during a project aimed at measuring velocity fields in plasmas, where a clear link has been demonstrated between plasma confinement and intensity of turbulence. They are now applying this experience to develop new technology for use in wind turbines.

Dr. René Skov Hansen and Dr. Sten Tronaes Frandsen from Risø are using technology developed in fusion to build a laser-based anemometer and a new control system which will give the turbines greater flexibility and make them more efficient.

The Scottish company Ferranti Photonics Ltd. together with Risø are responsible for developing the laser and two Danish companies, NEG-Micon and WEA Engineering, are working on testing and control system development.

The idea is to have wind turbines with pitchable blades and variable rotor speeds to cope more efficiently with variations in wind speed. To make maximum use of this flexibility a new and expanded control system is needed which will include a way of forecasting the wind speed a few seconds ahead.

The anemometers currently being used are far from ideal because of flow disturbance close to the rotor and because they measure wind speed behind the rotor.

Lasers would be an effective alternative, but for a number of reasons the ones which have been used in other wind power projects are unsuitable. Now it is thought that technological advances mean it would be possible to design, build and apply a laser anemometer at an acceptable cost and size.

More information from René Skov Hansen, Ph.D.
email: rene.skov.hansen@risoe.dk

FEEDBACK

Thank you to all those who have sent us suggestions for future articles in Fusion Business. Following the last edition, we have also had a number of requests for further information on fusion issues and have arranged meetings to follow up those initial contacts.

If you have any suggestions for articles or would like further information about any aspect of the Fusion Industry programme, please email miriam.mason@ukaea.org.uk or call 01235 464104.

MEASURING THE LIGHT FOR MAST

A vital part of fusion research is the continual measurement of conditions in the plasma. Photomultipler Tubes (PMTs) are used to monitor the behaviour of the fuel gas as it is ionised at the plasma boundary.

However, the immediate environment of the plasma is hostile to sensitive measuring equipment because of the intense radiation, covering the spectrum from x-ray to infrared.

On the Culham Science Centre's MAST (Mega Amp Spherical Tokamak) machine, light detectors are remotely located 50 metres from the plasma. Light is piped down a 1mm optical fibre, passing through a narrow band filter tuned to 656nm, and is detected by a PMT. There are eight of them, monitoring different parts of the plasma. As only a small fraction of the emitted light is collected by the fibre, the actual light level at the detector is very low and signal-to-noise performance becomes the critical consideration.

Culham chose 9658 photomultipliers, developed by Electron Tubes Limited of Ruislip, Middlesex, because of their high gain (operating up to 10^7), low noise, long life and proven reliability.

Further information from Tony Wright on 01895 630771 or email: agw@electron-tubes.co.uk

FUSION AND INDUSTRY: CONFERENCE & EVENTS DIARY

June 12-16 - 27th EPS Conference on Controlled Fusion and Plasma Physics, Budapest, Hungary.

July 10-21 - 37th Culham Plasma Physics Summer School, Abingdon, Oxon.

September 11-15 - 21st Symposium on Fusion Technology (SOFT), Madrid, Spain.

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

October 12-16 - Workshop on Confinement and Stability of Alternative Fusion Concepts, Varenna, Italy.

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

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

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

ADVANCED WELDING PROCESS SEALS FUSION AND INDUSTRY CONTRACTS

Developments in electron beam welding (EBW) by The Welding Institute (TWI) of Cambridge, UK are being used by a UKAEA/EFDA fusion project as well as in marine and nuclear industries. In particular, the technology is being developed for use on deep-sea oil and gas pipeline applications and in long term disposal of nuclear fuel.

Culham Science Centre hosted a TWI-sponsored meeting in April on the topic "Electron Beam and Laser Processing of Materials in High Energy Physics and Fusion." The meeting was attended by 30 delegates from a number of EU countries with a variety of presentations, including power beam applications to components for ITER (International Thermonuclear Experimental Reactor).

Reduced pressure EBW equipment

EBW has been used to produce high precision components such as aeroengine stators for several decades. A machine typically will consist of a high voltage gun generating a beam of electrons that is focused onto the workpiece joint line. The process produces a deep and narrow weld in one pass with little component distortion. However, conventional EBW requires the component to be welded in a vacuum of <0.005mbar. For large components, sealing difficulties, component outgassing, long evacuation times and high pumping costs are prohibitive. It is possible to weld without a vacuum but electron scattering currently limits the working distance range to some 25mm and reduces weld quality.

Industrial demand for a process with the beam intensity and working distance range of high vacuum EBW, yet avoiding the limitations of atmospheric EBW, has led the EBW Group at TWI to develop a new process - 'reduced pressure' EBW-requiring a vacuum of only 0.5-5.0mbar. Furthermore a 100kW beam has a working distance range of over 500mm.

More details from Allan Sanderson on 01223 891162 or by email to asanderson@twi.co.uk

COULD FUSION RESEARCH BE THE ANSWER FOR BANK ONE?

Researchers at the Culham Science Centre are working with the staff of a major City bank to see if principles of fusion research can be applied to financial risk management.

The Strategic Risk Management Advisory (SRMA) team at Bank One - the 4th largest bank holding company in the US - are keen to explore new methods that could be used to manage foreign exchange risk.

The SRMA team are based in the London office and provide risk advisory services to clients of the bank. They advise on all aspects of financial risk but the majority of work is related to the risks generated by foreign exchange rate fluctuations.

Bank One strategist Dr. Mark Thomas says: "Research with Culham is likely to focus on two main areas. Firstly it would be useful to be able to predict when sudden large moves are likely to occur in foreign exchange rates. Such 'shocks' have been likened to 'phase changes' in the market and it may be possible to employ the physics of phase changes in matter, to devise a method of prediction.

"Another area of interest relates to systematic rule-based trading strategies that Bank One have successfully used over recent years. These use statistical models of the way the markets have behaved in the past to make future trading decisions. Again it is hoped to apply mathematical methods previously used in fusion research to the financial markets."

The 10-week project will be extended if preliminary results are positive. For more details call 01235 464104 or email miriam.mason@ukaea.org.uk

---

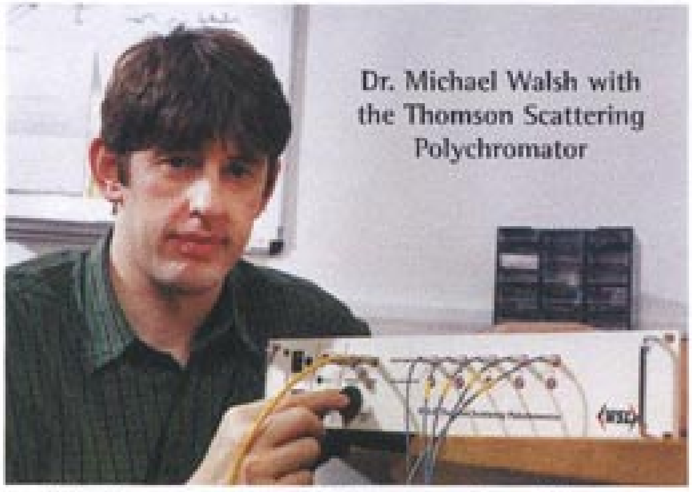
FUSION SPIN-OFF WINS IN BRAZIL

Walsh Scientific Ltd, a spin-off company from EURATOM/UKAEA's fusion project, has won a contract to supply optical diagnostics equipment to the Brazilian Space Institute.

The company's PL5-R Thomson Scattering Polychromator collects scattered laser light to measure temperatures above 100 million °C and density at multiple locations within plasma formed during fusion research.

Until now fusion researchers around the world have had to develop their own bespoke temperature and density diagnostics equipment, but it is a lengthy and expensive undertaking. The Walsh Scientific polychromators can be installed and operational in a few days, so experiments can begin more quickly.

Based at UKAEA Culham Science Centre, Walsh Scientific specialises in optical and laser diagnostic equipment. Managing Director, Dr. Michael Walsh, says: "The polychromator is our first product for the international fusion market and we're delighted to win the Brazilian Space Institute contract. Culham is the ideal base for a company in our field because it's known and respected world-wide as a centre of fusion research excellence."



Dr. Michael Walsh with the Thomson Scattering Polychromator

Walsh Scientific is renting research facilities at Culham such as spectrometry equipment and high performance data acquisition equipment under the Industry initiative. The initiative aims to encourage spin-off technology from the fusion programme, and help start-up companies enter the global market in plasma exploitation.

Walsh Scientific was founded in 1991.

For more information call Dr. Michael Walsh on (01235) 463688 or visit their website at www.walshscientific.com

VISIT BOOST FOR PFEIFFER VACUUM

"New Products in Vacuum Technology" was the theme for a recent one-day exhibition held at the Culham Science Centre by Pfeiffer Vacuum.

Exhibits on view included the latest in leak detection, mass spectrometry, vacuum gauges and vacuum pump technology.

Pfeiffer Vacuum sales engineer Peter Knight says: "For us a one day exhibition at a large site like this allows existing contacts to see and experiment with new equipment, and attracts new contacts.

For staff at the site it's a chance to see and discuss new products, without spending the half or full day away you need for off site exhibitions. We were pleased with the day and made a number of new contacts."

As well as supplying sites like Culham in the UK, Pfeiffer Vacuum provides vacuum equipment throughout the world to the semiconductor, analytical instrument, display technology, and chemical/pharmaceutical industries.
Contact Peter Knight on 01908 364502.

TENDER & CONTRACTS UPDATE

Two UK companies have been nominated for work on the latest European fusion programme projects. In all, 15 companies were asked if they would like to be considered for work on four projects:

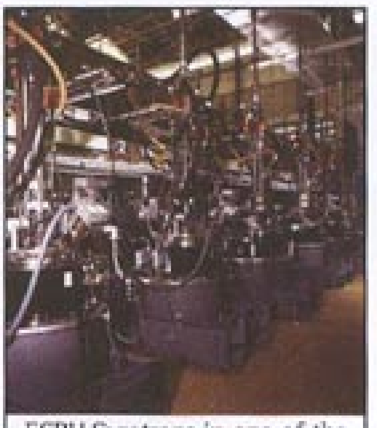
- Manufacturing of High Heat Flux Components for ITER/EFDA CSU at Garching, Germany.
- Plasma Spraying of Stainless Steel Plates for the TJ-II Stellarator at CIEMAT, Madrid.
- Fabrication of Infrared Cameras & a Data Acquisition System for the Tore Supra (CIEL Project), CEA, Cadarache, France.
- Toroidal Field Coil Cases Design Study for the TOSKA facility, Karlsruhe, Germany.

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

A GUIDE TO FUSION – PART 8

Microwaves

An extensive range of high power microwave systems is employed in the various fusion experimental tokamaks at Culham (COMPASS-D, MAST and the EFDA JET facilities), primarily to heat and drive current within the plasma. These systems are also a key tool in inhibiting the growth of plasma instabilities and optimising the plasma start-up phase. Heating the plasma towards thermonuclear temperatures and maintaining its resilience to plasma instabilities are two of the key issues to be addressed if commercial fusion power is to become a reality.



ECRH Gyrotrons in one of the high voltage areas

A 60GHz Electron Cyclotron Resonance Heating (ECRH) microwave system, which has delivered >1.5MW into plasma, has been used extensively to heat the plasma and control instabilities in the COMPASS-D tokamak and has recently begun operation in the new MAST spherical tokamak.

Energy is transferred from the ECRH waves into the plasma electrons when the wave frequency matches the rotation frequency of the electrons around the magnetic field lines in the plasma.

The system comprises eight gyrotron microwave sources (situated in two high voltage areas) transmitting the waves to either tokamak via long (>50m) waveguides. Careful design of the waveguide transmission line (in particular the waveguide bends) ensures that the power lost in transmission is minimised.

In addition, a 1.3GHz Lower Hybrid Current Drive (LHCD) microwave system is available to effectively drive current in the COMPASS-D tokamak. By driving plasma current in this non-inductive way, the demand on the inductive poloidal field power supplies is reduced, resulting in longer plasma discharges.

The LHCD system consists of two klystrons capable of delivering up to 400kW of power into COMPASS-D, via an 80m waveguide transmission line. This line is split into eight waveguides which feed a 'phased array' antenna, specially designed to efficiently couple the microwave power into the plasma.