

RACE Newsletter

February 2017



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New CEO at UKAEA

Professor Ian Chapman took over the role from previous CEO Steve Cowley on the 1st of October. Ian will lead the UK's magnetic confinement fusion research programme at Culham Science Centre as the new MAST Upgrade experiment approaches its 2017 launch – and the operation of the world's largest nuclear fusion device, JET, on behalf of European scientists.

He will also take forward UKAEA's increasing range of hi-tech activities at the Culham site near Oxford, including the recently-opened Materials Research Facility, the RACE robotics centre, and the Oxford Advanced Skills apprentice training facility. At 34, Ian is one of the youngest CEOs of a major research centre – something he sees very much as a positive.



Professor Ian Chapman, UKAEA CEO



Remote Applications in Challenging Environments

Operational & doing business

Officially opened by the UK Science Minister Jo Johnson in May 2016 at the UKAEA's Culham Science Centre in Oxfordshire.

RACE develops and builds robotics and remote operation systems with a particular focus on the nuclear sector. It also collaborates with experts in space exploration, petrochemical and infrastructure to ensure that the UK maximises opportunities to transfer technology between sectors.

RACE has already been a key element in UK industry notching up over €100m in global orders, centred around its autonomous robotic remote handling technologies, developed to meet the challenges of maintaining systems for JET, the Joint European fusion reactor.

Robotics and Artificial Intelligence

We live in an era of unprecedented change: to our businesses, our economies and our societies. Technological advancement is becoming a key driver of this change especially with the increasing maturity of machine learning in all its guises.

Nations and industries that participate and lead in this 4th industrial revolution will shape the next technological wave and enjoy improved international

competitiveness, productivity and economic growth.

The seminal report by McKinsey in 2013 estimated that the application of advanced robotics could generate a potential economic impact of \$1.9 trillion to \$6.4 trillion per year by 2025.

RACE was established at a time when the UK Government recognised Robotics and Autonomous Systems (RAS) as one of the Eight Great Technologies.

More recently Robotics and Artificial Intelligence (RAI) has been identified as a key theme within the UK's industrial strategy, driving efforts to rebalance the UK economy and create jobs and growth.

Our vision is to be part of creating a

viable RAI ecosystem in the UK that will develop skills and allow ideas and innovation to be created and tested in the marketplace, ahead of international competitors.

Technological innovations must be demonstrated in real world environments because RAI tools will be expected to work reliably and efficiently in these places.

Addressing this will also involve shaping key regulatory and standards issues, so that success attracts commercial investment.

Through a co-ordinated approach and targeted investment, the UK can become an internationally leading nation in capturing the value from invention through innovation to delivery of products and services.



Minister Jo Johnson (right) opening RACE with Steve Cowley ex-CEO (left) and Rob Buckingham (centre)

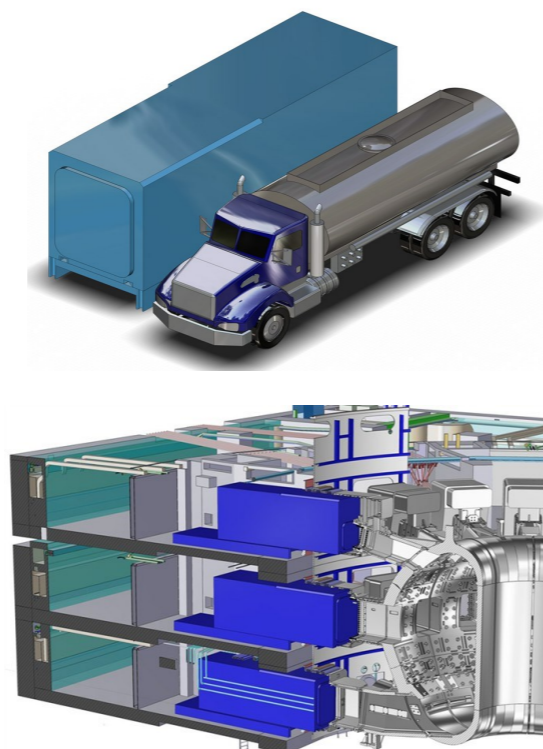
RACE helps industry secure ITER Cask & Plug contract worth nearly €100 million

RACE is delighted to be part of the Airbus Safran Launchers/Nuvia Limited/ Cegelec led partnership now tasked with the development of the ITER international fusion energy projects Cask and Plug Remote Handling System.

The contract covers the development, testing and installation of a system for the remote handling of containers transporting active equipment from the reactor vessel of the experimental fusion reactor at ITER, currently under construction near Marseilles.

This is an essential part of the maintenance system for the reactor, and will be a challenging design because it will have to function in an extremely confined space. The casks are similar in size and shape to standard shipping containers. When fully loaded the casks can weigh as much as 100 tonnes and must move with millimetre accuracy.

The casks are designed to contain components from inside the ITER tokamak, where exposure to the high-energy neutron flux produced by nuclear fusion will render everything too active for human contact. Items needing attention will be placed robotically inside the casks, which will then be transported within the ITER Hot Cell complex. The Remote Handling system needs to be self-powered, remotely controlled and self-recoverable in the event of a failure.



3D image of the ITER Port cells and casks, part of the Remote Handling system Copyright: ITER IO



RACE in collaboration with NIST has opened Britain's first facility for testing the performance of remote-operated and robotic systems against international standards.

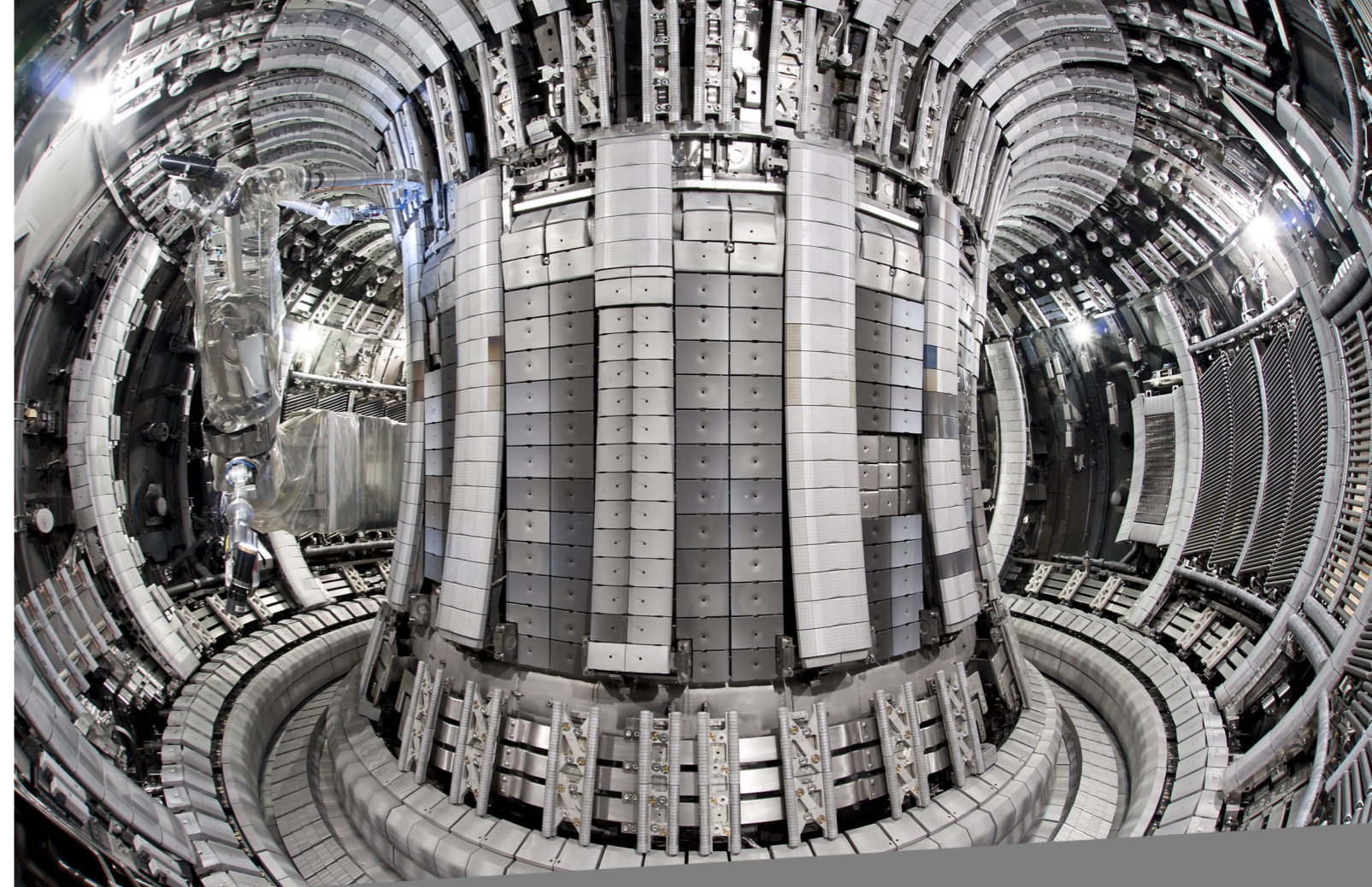
The RACE Test (Test Evaluate Standards Training) facility is based at the RACE robotics centre. Test tracks are now operational for aerial and track vehicles. Soon to come will be facilities for articulated arm and through the wall manipulator configurations.

Just as a new aircraft has to be fully tested and certified before it takes to the sky, this comprehensive suite of standard test methods enables independent evaluation of robotic devices' capabilities with quantifiable results. Standards have been developed to measure remote

systems' mobility, sensors, energy consumption, communications, dexterity, durability, reliability, logistics, safety, autonomy, and operator proficiency.

This will help robotics developers identify their operational needs, understand emerging remote system capabilities, guide purchasing and deployment decisions and provide focused training for operators. Adam Jacoff, of US NIST's Intelligent Systems Division, added:

"We look forward to more collaborations with the UKAEA RACE TEST facility and with other commercial and academic organisations who expressed interest in getting involved with our standards development effort."



HOTTER THAN THE SUN MASCOT

Servicing and maintaining the JET nuclear fusion reactor at Culham (above), which reaches temperatures 10 times hotter than the sun, required the development of a remote handling system called MASCOT which can adapt to the changing configurations and conditions of the machine.

Because of the highly specialised and complex nature of a large number of tasks required it was not possible to use a pre-programmed or robotic type of maintenance system for JET. Instead the system makes use of special manipulators to extend the operators own arms into the active environment.

These manipulators provide the operator with a sense of touch and feel and together with the associated CCTV system, create a sense of being inside the machine. The units are linked by computer, not mechanically, so that the

slave unit can be operated at any distance from the master.

MASCOT is used to undertake a wide range of tasks including welding, cutting, bolting, handling and inspection. Many of these are performed using special tooling which in the majority of cases was designed and developed at UKAEA.

Fusion has the potential to provide an almost limitless clean, safe, renewable energy source for future generations.

Our scientists and engineers are working with partners around the globe to develop fusion as a new source of cleaner energy for tomorrows power stations.

One way of achieving fusion is to trap a hot gas (or plasma) of fuels with a magnetic field and heat it up to temperatures 10 times hotter than the sun in a doughnut-shaped device called

a 'tokamak'. JET is currently the world's largest tokamak experiment.

The amount of fuel inside the tokamak is extremely low, weighing about as much as a postage stamp. JET's central chamber is a mildly active and chemically hazardous environment.

So to keep JET maintained, scientists and engineers at Culham, drawing on 20 years' and 30,000 hours' of experience, have developed a suite of remotely operated robots – some up to 12 metres in length, and weighing 10 tonnes – that can work inside the JET vessel, performing tasks including welding, attachment of tiles, diagnostics, and detailed surveys.

This wealth of experience, expertise and cutting-edge technologies paved the way for the new government - funded RACE robotics/remote handling facility at Culham.

PAVE - People in Autonomous Vehicles in Urban Environments

Driverless car technology has the potential to deliver transformative economic and social benefits to the UK.

Until now, there has been no UK study into what the public thinks about driverless cars. There are a number of reasons why a study is important:

- **The Government requires public support to make regulatory changes and commit funding to the development of the sector**
- **There needs to be consumer demand for driverless cars to encourage private investment in developing the technology**
- **The industry needs to truly understand what people are concerned about**

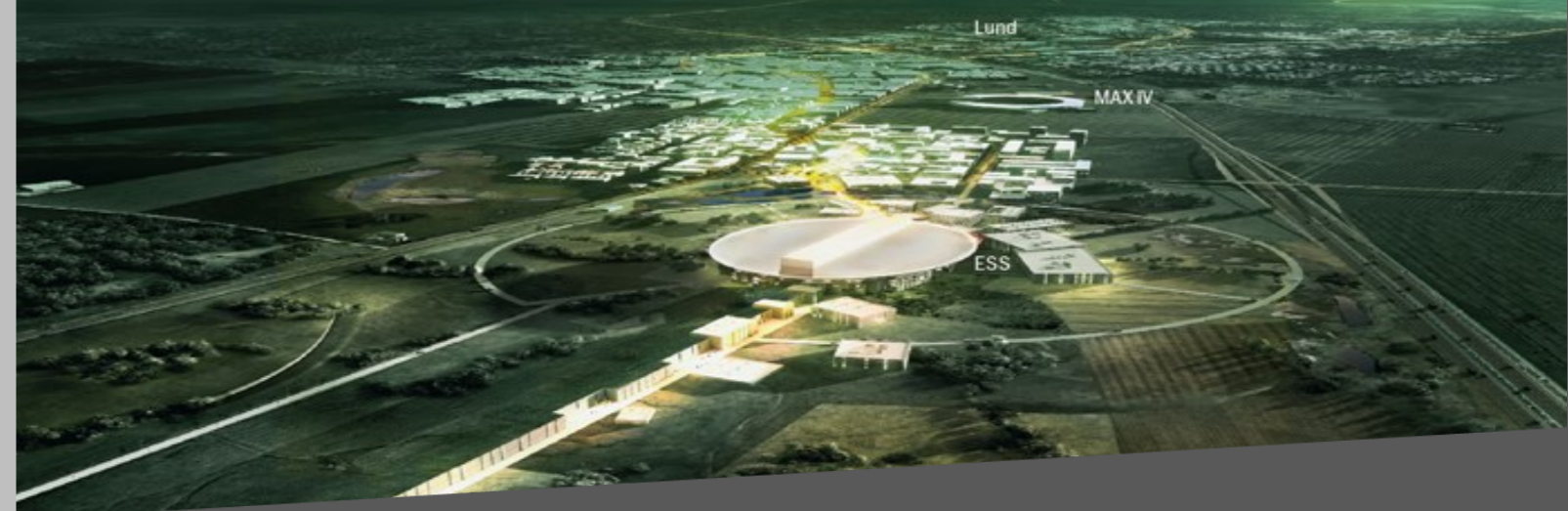
Members of PAVE (People in Autonomous Vehicles in Urban Environments) include Amey, Westbourne Communications, Siemens, RACE and Oxbotica, a spin-out from

Oxford University's internationally acclaimed Mobile Robotics Group.

The PAVE consortium has run a series of workshops and other events to gather views from councillors, travel planners, emergency services, industry experts, policy makers and the public, with a view to understanding from a range of key perspectives the perceived benefits and challenges autonomous vehicle technology poses.

The consortium was awarded the funding following a lengthy examination process conducted by Innovate UK, which is overseeing a £20 million fund for investment in collaborative R&D projects.

PAVE were awarded funding for a feasibility study to test public perceptions towards driverless vehicles in recognition of ongoing public apprehension. The findings of the research project could inform future Government policies and decisions related to driverless cars over the coming decades.



Opportunities for UK Industry to engage with ESS

RACE – have been selected to supply the Hot Cell Remote Handling Facility for the new €1.84 billion European Spallation Source (ESS), one of the largest science and technology infrastructure projects of our time, currently under construction in Sweden.

The creation of this giant powerful neutron microscope will allow scientists to better observe the world and the universe. This brings with it the potential to discover materials for faster planes, new and better computer chips, new drugs and super long-life batteries. Thirty times more powerful than the microscopes we use today and the size of 140 football pitches, this technology will create and secure thousands of jobs.

The Hot Cell is a critical downstream support facility to handle and process components from the target station. The Hot Cell consists of handling equipment such as power manipulators and cranes, processing equipment for remote cutting and welding, shielding and transit cases, all fully remote-controlled via a central control system.

The UK's overall contribution to the ESS project is led by the Science & Technologies Facilities Council (STFC) project and there are significant opportunities for UK industry to supply services and equipment as part of this contribution.

Sixty delegates recently attended an industry information day jointly held by RACE and STFC to explain those opportunities in more detail. Information presented during the day explained the wide range of technology involved and the expected delivery timelines which included:

Category	Tender Due
Confinement and Shielding	
Intrabay Door	Q1 2017
Floor Valves	Q1 2017
Container Transporter	Q3 2017
Handling	
Lifting and Hoist	Q2 2017
Remote Handling	Q2 2017
Size Reduction	
Milling Station	Q2 2017
Band Saw	Q2 2017
Lifting Adaptors	Q3 2017
Safety	Q3 2017

Upcoming events

There are several exciting events planned for the RACE team over the next few months. Come and meet the team, we would love to speak to you if you are attending these shows and welcome you to take a look at some of our activities.

To pre-book a meeting please email: contactus@race.ukaea.uk

- **European Robotics Forum**
Edinburgh - 22-24 March 2017
- **Robots for Resilient Infrastructure Challenge 2017**
Leeds - 27-28 June 2017
- **Towards Autonomous Robotic Systems (TAROS-2017)**
University of Surrey - 19-21 July 2017
- **ISFNT13 - International Symposium on Fusion Nuclear Technology**, Kyoto, Japan - 25-29 September 2017



People at RACE

Apprentice Emily Swatton



Emily is 19 years old and currently studying for her HNC at Newbury College. She is hoping to complete her HNC and move on to further education to gain a degree.

She is working with the RACE team to develop a robot build kit to send out to colleges, sixth forms and apprentices to help increase interest in engineering both as a subject to study and as a career path.

It will consist of 3D printing, electronics and programming a Raspberry Pi. This will culminate in a competition which will take place on site. The project is still in its early stages but a moving prototype is just around the corner...

Outside of work Emily has an interest in makeup artistry but doesn't get much of a chance to look glamorous as she often takes part in mud and obstacle runs. On the weekends, you can find her climbing walls, jumping in lakes or trekking through very deep mud!

RAS Expo proves a hit with UK robotics community

Around 100 robotics experts from a wide range of industries gathered at RACE on 28 September for the first “RAS (Robotics and Autonomous Systems) in Challenging Environments” Expo. The event featured over 30 sessions and exhibitions from more than 23 different organisations.

It aimed to display the latest developments in robotics and remote handling and discussing how the RAS community can work together on common technologies and issues.

Exhibitors and speakers showed how robotics is helping them to work in ‘challenging environments’ from nuclear, deep sea, big science and others. There were also presentations on RAS in transport, manufacturing, smart cities – and on how a common UK RAS strategy could help take the R&D forward to capitalise in this multi-trillion pound emerging market.



RACE unveiled two new projects at the event. Firstly, a national facility for independent testing of robotic performance against common industry standards. It is the first such benchmarking system for robotic testing in the UK. Specialists from the U.S. National Institute of Standards and Technology (NIST) were on hand at the Expo to give demonstrations with drones and mobile robots.

RACE’s control system technology was also highlighted at the Expo. Lead technologist Rob Skilton showed RACE’s innovative software for controlling multiple robotic devices, with live displays during the event.

He explained “Many robotic and remote handling systems are a combination of devices, some old and others new, some bespoke and others off-the-shelf, often made by different manufacturers. If each system has its own control software, it makes operations and maintenance more complex – especially in nuclear or other challenging environments. Our new software solves this problem by integrating all the devices into one control system, which updates automatically as new components are added. It’s inspired by the JET remote handling system but has lots of potential applications outside fusion – the amount of interest we’ve had at the Expo is very encouraging.”



Part of the RACE team shortly after the facility was opened by Minister Jo Johnson MP in May 2016. The team now exceeds 110 people.

RACE contributes expertise

In recent months RACE has contributed to a number of strategic documents and enquiries in support of the Governments' Robotics and Artificial Intelligence agenda including:

- Report on Robotics and Artificial Intelligence, by The House of Commons Select Committee on Science and Technology
- Report on Autonomous Vehicles, to be published early 2017 by The House of Lords Select Committee on Science and Technology
- Lloyds Register Foundation Foresight Review RAS
- Pioneer Special Edition 17 on Robotics, published by EPSRC



For further information visit www.uk-ras.org

RACE apprentices part of the UKAEA team from Culham



Brathay Trust and the National Apprenticeship Service announced UKAEA are the winners of the 2016 apprentice team of the year.

The eight finalists were selected from 80 teams and 700 apprentices who entered the Challenge. Since last February, the teams have worked hard to spread the word about apprenticeships, recruited over 400 new employers and visited nearly 400 schools, careers fairs and youth groups to encourage young people to consider an apprenticeship. The apprentice teams have also reached out to their local communities and delivered 45 community projects to benefit young people.

To win the Brathay Apprentice Challenge, teams undertook a series of exciting and interactive work-related challenges to develop new skills and showcase their employer by engaging with young people and businesses to promote the benefits of apprenticeships. The challenges are designed to ensure that the teams demonstrate their teambuilding, leadership, logistical and communications abilities.

Apprentices gain new skills and have an enhanced apprenticeship experience. Apprentices also benefit by becoming more confident, more aware of their own capabilities and ultimately more employable. The competition also increased the local profile of their organisations through positive PR and Corporate Social Responsibility opportunities.



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