Industry engagement and innovation

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This article highlights the industrial user engagement, industry partnerships, and innovation activities of the Central Laser Facility for the reporting period April 2019 to March 2020.

Industrial users and engagement

This year saw the ground-breaking ceremony for the CLF's Extreme Photonics Application Centre (EPAC), a new national facility to support UK science, technology, innovation and industry. EPAC was successfully funded due to its strong partnership between UKRI, industry, MoD, and academia. EPAC will generate scientific breakthroughs and stimulate new solutions to challenging problems, to help advance UK science and technology, with emphasis on industrial applications helping to keep us safer, improve our healthcare and support a cleaner, more productive economy.

The CLF delivered 10 commercial contracts, amounting to 22 facility access weeks with industrial users this year, delivering experimental access to Gemini, Ultra and Octopus, and access to CLF scientific expertise. Work ranged from pharmaceutical applications of advanced spectroscopy, novel use of fluorescence lifetime microscopy in catalytic science, to providing data on technology readiness of laser driven MeV X-rays. Through utilisation of CLF's expertise in combination with its world-class facilities, the CLF continues to drive impact across a wide variety of industrial sectors and contribute advanced characterisation in industrial R&D.

The CLF is an active partner in the STFC Bridging For Innovators (B4I) programme – an ISCF funded scheme that has been introduced to boost industrial collaboration with national facilities. This year's B4I projects include optimisation of laser technology in commercial spectrometers, investigating the effect of oil pick-up on crisp structures, analysing novel sources of myosin production from invasive limpet species for biomedical applications, and characterising new catalysts for reduced CO_2 emissions.

A team of catalytic experts from SME Finden used their B4I funding for industry-led access to CLF's ultrafast Kerr-gate Raman spectroscopy technique. The B4I experiment studied new catalytic pathways in the production of dimethyl ether (DME) from methanol. Producing DME using methanol has the potential to reduce CO_2 emissions by 95% when compared to conventional fuels.

Collaborating with CLF scientists, PepsiCo Research Fellows and academic partners from Chalmers University of Technology in Sweden and Liverpool University utilised their matched B4I funding to access a number of advanced fluorescence imaging techniques, to determine their suitability for food manufacturing research. This year, further growth across agriculture and food manufacturing industrial sectors has taken place, opening a new collaborative community applying the facility's advanced microscopy and spectroscopy techniques. The CLF has actively supported STFC Food Network+ and the Food Standard Agency (FSA) in supporting SME scoping projects, assisting the STFC community in making a meaningful contribution to the UK food system.

Industry partnerships

The CLF's long-standing partnership with Johnson Matthey (JM) continues, with CLF-JM research fellow Dr Kathryn Welsby leading the research programme for STFC-JM fellows. The team of fellows have been working to encourage multi-facility collaborations

to solve industrial challenges and add insight into fundamental R&D for JM business units. JM is striving to lead on clean energy solutions and sustainability of resources, and JM's scientific interests at Harwell this year have included advanced characterisation of next generation battery technology, fuel cell characterisation, catalysis and clean air applications.

UKRI-EPSRC Innovation Fellow Dr Chris Thornton, in partnership with JM, Manufacturing Technology Centre and Warwick Manufacturing Group, has delivered a second imaging experiment focussing on soft X-ray generation. The experiment allowed for the successful collection of X-ray images that can be used for tomographic reconstruction of samples supplied by WMG and JM, contributing to an MTC report for a potential laser-plasma accelerator to be used for industrial imaging. The work highlighted the potential of the technology, and reaffirmed the importance of the work that the CLF does as a knowledge transfer body for technology innovation.

CLF scientist Dr Paul Donaldson has been awarded a UKRI Future Leaders Fellowship on molecular stopwatch measurements of dynamics in catalysts, battery electrolytes and ionic liquids in situ. The Fellowship has close links to industry, including JM and the UK Catalysis Hub, and will work towards future industrial applications of the advanced techniques being developed, looking to improve the science of catalysts and batteries, in the hopes of creating a greener future in transport.

International impact

The Tata Institute of Fundamental Research (TIFR) and the CLF have developed a strong collaboration on the science of laser-driven accelerators. This year saw the inauguration of the new jointly-funded hub for innovation, called the Extreme Photonics Innovation Centre (EPIC), that will drive innovation through development of cutting-edge technology.

CLF scientists from the newly established CLF Industrial Partnership and Innovation (IPI) group were collaborators on the HiLASE international workshop entitled *Trends and challenges in laser processing – aerospace*. This event in Prague brought together senior industry experts across the aerospace sector and scientific expertise in micro-machining, laser shock peening and 3D printing, to discuss technology readiness and advancements required for industrial deployment in aerospace manufacturing and inspection.

In collaboration with CLF scientist Dr Kathryn Welsby, industrial access at the CLF, for the first time, housed visiting scientists from the University of South Australia. The facility access utilised UoSA's Dr Craig Priest's research teams' expertise in working with industrial partners on minerals, water quality, health, and advanced manufacturing applications of microfluidic devices.

The D-100X laser for the European X-FEL was test commissioned during the autumn of 2019, meeting, and exceeding, its specification. The demonstrated performance underpins and extends the reputation of DiPOLE as the world leading technology for high efficiency, high repetition rate and high power lasers. D-100X was shipped to Hamburg in January 2020, and a joint HZDR/CLF team began the task of unpacking, reassembling and recommissioning.

Innovation

CLF's IPI group continues to scan for innovative concepts and technology transfer opportunities, to capture and drive forward the most impactful ideas and inventions.

This year, the CLF filed two new patent families, giving a current total of 21 active patent families, and eight invention disclosure forms were submitted for consideration for future patent filing. Additionally, three proof-of-concept projects were funded or ongoing, and two CLASP projects have been advanced. An ongoing CLASP-funded project to produce and exploit VUV from microwave plasma has successfully developed a device capable of both controlled ignition and subsequent stabilisation of a microwave plasma discharge at atmospheric pressure.

In conjunction with industrial (AstraZeneca, Oxford Nanoimaging (ONI)) and clinical (King's College London) collaborators, Professor Marisa Martin-Fernandez and her team at the CLF have successfully automated the STFC proprietary single molecule imaging method (Fluorescence localisation imaging with Photobleaching, FLImP), including using AI approaches to automatically recognise cells of interest and to extract the most useful information to characterise biological structures at the nanometre scale. Working with IRIS, SCD and STFC Innovations, a prototype, fully-automated, cloud-based FLImP data analysis pipeline has also been developed, to allow the rapid distribution of this exciting technique to academic and industrial partners.

CLF's POCF project on Shifted Excitation Raman Difference Spectroscopy (SERDS) with Charge-Shifting Charge-Coupled Device (CCD) was awarded the 2020 William F. Meggers Award from the Society for Applied Spectroscopy (SAS), for their outstanding paper published in the journal Applied Spectroscopy. This recognition goes to the CLF and Ferdinand-Braun-Institut team, Kay Sowoidnich, Michael Towrie, Martin Maiwald, Bernd Sumpf and Pavel Matousek. Their technique enables superior performance for application with handheld scanning devices in outdoor or variable lighting conditions. This new innovation can potentially be used for discriminating healthy cells from cancerous cells in non-invasive tissue scanning, and can deliver sub-surface inspection.