Using fibre lasers for ground-breaking particle acceleration technologies

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Scientists from the Optoelectronics Research Centre (ORC) at the University of Southampton are part of an international project that is investigating the use of fibre lasers in ground-breaking particle accelerator technologies, such as the Large Hadron Collider (LHC).

Laser particle acceleration is a new and potentially revolutionary technology, but is affected by two main issues: efficiency and repetition rates. The lasers used at present consume too much power, and can only produce the required ultrafast laser pulses around once per second to produce acceleration. For many applications needing high repetition rates – particle acceleration, X-ray and gamma ray generation – this makes the use of lasers economically unacceptable and impairs the spread of important scientific and societal laser applications in science, material science, environment, medicine and energy.

However, using fibre lasers may resolve this issue. Fibre lasers can operate at very high average powers, because of their ability to manage the heat generated by laser action. This allows the laser to produce pulses many thousands of times per second, allowing particle acceleration at high repetition rates necessary for real-world applications. Fibres should also improve the overall power efficiency of suitable lasers by a factor of a thousand, making them more economically feasible for experiments.

Ultrafast fibre lasers, however, can produce only lower energy pulses because of optical nonlinearities in the fibre medium, so don't have the

requirement for high energy physics.

The International Coherent Amplification Network (ICAN), a new EU-funded project, aims to harness the efficiency, controllability, and high average power capability of fibre lasers to produce high energy, high repetition rate pulse sources. This will be achieved through a novel laser system, which combines the output of thousands of pulsed fibre lasers.

Dr Bill Brocklesby from the ORC, project manager of ICAN, says: "High-energy ultrafast lasers have already been demonstrated but the challenge to produce high-energy ultrafast pulses at high rates is a specialty for the ORC. Our track record in the development and fabrication of new optical fibres is unparalleled."

The ICAN project, which will last 18 months, has four main laboratories involved – The Optoelectronics Research Centre (ORC) at the University of Southampton; Ecole Polytechnique, Paris; The Fraunhofer Institute for Applied Optics and Precision Engineering (Fraunhofer IOF); and CERN, the European Organisation for Nuclear Research and home to the LHC - world's largest and highest-energy particle accelerator. It also involves a large number of worldwide partners from the laser, fibre and high-energy physics communities and industry.

Provided by University of Southampton