A NEW APPROACH COULD BRING NUCLEAR FUSION A STEP CLOSER TO REALITY

This month, a consortium of researchers from Finland, the Czech Republic, Germany and the UK have launched an ambitious project targeting a breakthrough in renewable energy generation by making the long-standing goal of nuclear fusion feasible.

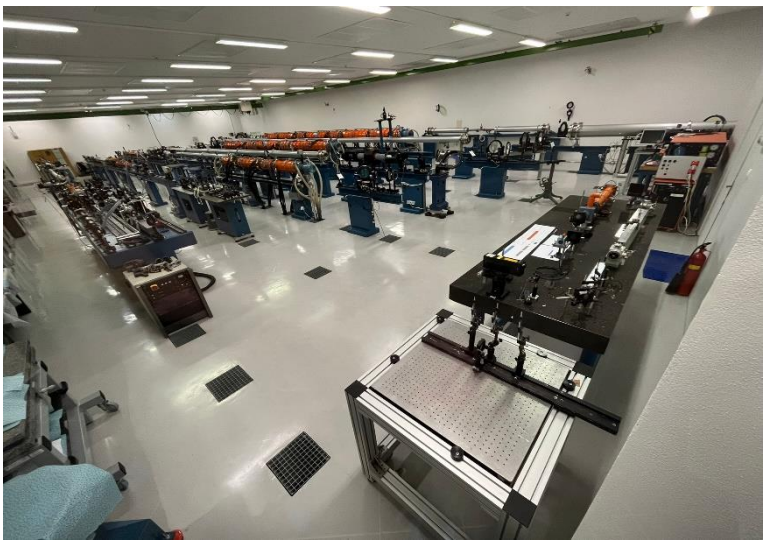
V4F aims to show proof-of-principle of a new technology capable of unprecedented control over interactions of light with specially synthesised targets that significantly improve the energy balance of aneutronic fusion reactions.

New concepts and advanced simulations of inertial confinement of aneutronic fusion reactions and particle acceleration will inform pioneering experiments in high-energy light/matter-interactions. Results could offer the prospect of breakthrough increases in alpha-particle yields from fusion reactions and mitigate the instabilities found in conventional fusion reactions.

The research consortiums first meeting at the Vila Lanna, Prague

This work offers the tantalising possibility of aneutronic fusion as a waste-free nuclear energy source and radical new configurations of particle accelerators, leading to efficient positron beam acceleration. The results will benefit society with game-changing new approaches to clean, safe energy production and significant downscaling of positron accelerators with dramatic impacts in medicine, industry and fundamental science.

Recent results from the National Ignition Facility at Lawrence Livermore National Laboratory in California have demonstrated fusion 'energy-gain' – where more fusion energy is output than input. The challenge addressed by V4F is to enable reproduction of the same effect much more easily, reproducibly and cheaply in order to make the possibility of unlimited green-energy fusion a reality.



The PALS Tera-Watt pulse laser will be used for many of the experiments

An additional benefit arising from the technology being developed is that it could enable the construction of positron beam accelerators 1,000 times smaller than is currently possible. As such, the future International Linear Collider planned in Japan with a length of 31 km, could be as short as 31 m.

The capability to design an efficient positron beam system could impact the potential use in proton beam therapy treating specific types of cancer and this could be developed within 10 years.

NOTES TO THE EDITOR:

Consortium partners

1. TAMPERE UNIVERSITY (FINLAND - Coordinator)
2. INSTITUTE OF PLASMA PHYSICS AS (CZECH REPUBLIC)
3. LEIBNIZ INSTITUTE FOR PHOTONIC TECHNOLOGIES E.V. (GERMANY)
4. AMPLICONYX OY (FINLAND)
5. INSTITUTE OF INORGANIC CHEMISTRY AV CR (CZECH REPUBLIC)
6. RESEARCH CENTER JÜLICH GMBH (GERMANY)
7. MODUS RESEARCH AND INNOVATION LIMITED (UK)

Funding:

The project has a budget of €3 million over a period of 4 years.

Acknowledgement:

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101096317.

UK participants in the Horizon Europe Project V4F are supported by UKRI grant numbers 10062154 (MODUS)."

Horizon Europe is the EU's key funding programme for research and innovation with a budget of €95.5 billion. It tackles climate change, helps to achieve the UN's Sustainable Development Goals and boosts the EU's competitiveness and growth.

The programme is built around three main pillars – excellent science, global challenges and industrial competitiveness, and innovative Europe.

Five missions relating to climate change, cancer, oceans and water, carbon-neutral cities and soil health, also form an integral part of Horizon Europe.

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Finland Partners:

TAMPERE UNIVERSITY will coordinate the project under the scientific leadership of Dr Regina Gumenyuk, a young emerging research leader who has assembled and leads the consortium represented in V4F. TAMPERE UNIVERSITY research developed and patented some of the fundamental high-power laser concepts and will be closely involved in the design and development of the innovative V4F laser. They aim to maximise the economic and societal benefits by their technology transfer to the Industrial sector.

Dr Regina Gumenyuk the project coordinator said: "*The formidable high-quality and multi-disciplinary expertise of the V4F consortium partners positions the project to uncover new knowledge of light-generation and light-matter interactions which could pave the way towards a breakthrough new technology."*

AMPLICONYX OY will develop a novel configuration of high-power fiber amplifying module based on its active tapered double clad fiber technology and additional novel laser generation techniques. One of the world-leading companies in medical equipment and optical fibre production Ceramoptec SIA recently acquired the pulsed fiber lasers manufactory Ampliconyx Oy. Ampliconyx Oy was founded in November 2016 as a spin-off from Optoelectronics Research Centre of Tampere University of Technology – the home of Finland's photonics industry. The company is the owner of the patented technology for active tapered fibres, which is one of the most competitive approaches to boost output peak and average power to an unpreceded level. Ampliconyx sells a range of gain modules and amplifiers ideally suited for amplification of ultrashort laser pulses, both nanosecond and

picosecond, offering its customers unmatched performance from all fiber solution. Ampliconyx has already established a strong customer base including established laser manufactures and research centres worldwide.

Dr.Valery Filipov, CEO of Ampliconyx said *"Our involvement in this exciting project will enable us to develop a completely new class of laser with characteristics far beyond existing laser systems"*

Czechia Partners:

INSTITUTE OF PLASMA PHYSICS has a long history of research in nuclear fusion. In the Academy of Sciences, the problem of laser fusion is experimentally addressed by the Prague Asterix Laser System (PALS) laboratory (joint workplace of the Institute of Plasma Physics and the Institute of Physics) and the European research centre ELI Beamlines . The backbone of the PALS Research Centre is a giant laser system, one of the three largest lasers in Europe. the peak pulse power of the laser is enormous – up to 3 TW, i.e. 3 million megawatts.

Dr Miroslav Krůs from the PALS Centre said, "*The first-of-a-kind experiments we will perform using the unique capabilities of the PALS laser system will be of great interest to the laser plasma community*"

INSTITUTE OF INORGANIC CHEMISTRY has expert knowledge of synthetic methods, photochemistry, solid state analysis, analytical and quantum chemistry, catalysis and other areas of chemistry enabling it to actively work on a number of multidisciplinary projects.

Dr Michael Londesborough who leads the study of new aneutronic fuels said, "*Our institute has contributed to the discovery of new molecules, nanomaterials and materials with specific properties such as luminescence, laser gain media, sorption, catalysis and is ideally situated to design, synthesise and tailor new fuels for aneutronic fusion*."

German Partners:

LEIBNIZ INSTITUTE OF PHOTONIC TECHNOLOGY research light-based solutions for issues and challenges in the fields of health, environment, medicine and safety. For the development and manufacturing of innovative fiber concepts, the Leibniz IPHT is scientifically at the forefront and actively supports external partners from research and industry in joint R&D projects. The Leibniz IPHT expertise and excellent infrastructural facilities includes such diverse areas as material and preform production, fiber drawing, fiber functionalization, fiber and material characterization, as well as modelling and simulation.

Dr Katrin Wondraczek said "*The project will enable IPHT to build on the advanced chemistry processes for high purity optically active materials necessary for pioneering fiber laser technologies. "*

RESEARCH CENTER JÜLICH GMBH research campus in Jülich is one of the largest scientific centres in Europe with globally unique cutting-edge research. With the mission of "Shaping Change", more than 7,000 people work hand in hand at Forschungszentrum Jülich, including 672 visiting scientists from 62 countries. It is a member of the Helmholtz Association, contributing to solving the major social challenges of our time. Julich will host Europe's first exascale supercomputer JUPITER.

Jülich physicist Prof. Markus Büscher said "*We aim to generate new simulations of light matter interactions based on a novel approach which may point the way towards major breakthroughs in plasma physics.*"

UK Partners:

MODUS RESEARCH AND INNOVATION LIMITED is a not for profit with the objective facilitating collaborative research and innovation across the academic and business sectors. MODUS operates in the space between business and academia, interacting with many R&D intensive businesses as well Universities and Research Institutes. MODUS

offers expertise in the concept development, planning and management of collaborative research and innovation projects. MODUS also supports the dissemination and communication of the V4F results.

Dr Neil Stewart, the V4F Project Lead at MODUS Research and Innovation said: "*This is a truly innovative project with genuine prospects to revolutionise the potential to generate energy from fusion and reap huge economic benefits for Europe. The exceptionally strong group of partners have all the necessary talents to accelerate the developments. The project is also a great example of what the UK will miss and lack the benefits of in the absence of association to the Horizon Europe EU programme."*