A powerful new class of lasers is in the making

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Credit: ELI

Laser intensities have increased dramatically in recent years, opening up a whole new world of applications. To boost scientific research and economic competitiveness the EU is backing a bold new project to create the world's most powerful lasers and build related research infrastructure in three European countries.

ELI (Extreme Light Infrastructure) is a partnership charged with creating the ELI-Beamlines Facility in the Czech Republic, the ELI-Attosecond Facility in Hungary and the ELI-Nuclear Physics Facility in Romania.

"Construction funds for the projects in the Czech Republic and Romania

have already been approved, and we're waiting for the Hungarian project to be approved very soon," says Professor Wolfgang Sandner, Director General and CEO of the ELI-DC International Association.

A professor of physics at TU Berlin in Germany and former director of the Max Born Institute, also in Berlin, Sandner is well placed to oversee the ambitious trans-European project.

Construction of the buildings and procurement of major equipment is well under way in the Czech Republic and Romania, and total investment in construction is expected to amount to around EUR 850 million.

The Romanian infrastructure will boast unparalleled power of 2x10 petawatts (each petawatt is a thousand trillion watts) and will be located on a surface equivalent to two football stadiums. The whole ELI infrastructure and its facilities are expected to be ready for use in 2017.

The location of a fourth facility, representing the highest intensity laser at an impressive 200 petawatts, is still to be decided, and is expected to open up a whole new area of study in science. This will include cutting-edge investigations into nuclear, particle, gravitational, ultrahigh-pressure and high-energy physics, as well as advanced astrophysics and cosmology.

Through this formidable set of integrated facilities, ELI is focusing on the development and application of a special class of lasers, namely high-power short-pulse lasers.

"ELI pushes the technological and scientific forefront of these devices and their applications through lasers which exceed the presently available power or repetition rate by at least one order of magnitude," explains Sandner.

Besides scientific progress, ELI's societal and economic benefits are manifold, arising mostly from secondary sources of particles and photons which will be derived from the primary high-power ELI lasers. The technology, for example, will boost materials research, including novel materials for microtechnologies, nanotechnologies, and photovoltaics.

On another front, the technology provides novel sources of short-wavelength radiation such as x-rays and gamma-rays, with applications in medical diagnostics and therapy.

"We also envision applications of laser-accelerated particles such as protons and ions for future improved cancer therapy or materials research," says Sandner, "as well as accelerated electrons for various applications in science and technology."

The professor also explains how gamma rays, created by the backscattering of laser photons from relativistic electrons, which themselves stem from conventional or even laser-based accelerators, will be mainly used for nuclear studies, with applications in nuclear waste management, materials diagnostics, medical research, and other areas.

For example, the facility in Romania will be capable of studying the neutralisation of nuclear waste, addressing one of the planet's major 21st century challenges.

Overall, the consortium is making progress on what is considered the first international research facility worldwide for scientists who need lasers for their work.

"The progress achieved so far is impressive, despite some technical, administrative and political problems that had, and still have to be, overcome," says Sandner.

Lasers and photonics are indispensable for society, the economy and the environment, and can help address many of today's major challenges, including health, mobility, energy supply and environmental protection. These are also priority issues for Horizon 2020, the EU's research funding programme for the next seven years.

More information: For more information, visit: www.extreme-light-infrastructure.eu/

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