PRESS RELEASE

ELI-ALPS Laser Research Centre, Szeged

Large international research infrastructures (RIs) have consistently promoted excellence in science and technology on a global scale for many decades now. In the spirit of this international practice, the European Strategy Forum for Research Infrastructures (ESFRI) established a roadmap for European Research Infrastructures (RIs). The Extreme Light Infrastructure (ELI) is one of the laser-based RIs that first appeared in the 2006 issue of the ESFRI Roadmap. Designed to provide the international scientific user community with access to some of the most advanced particle and radiation sources in the world, ELI is implemented as a distributed infrastructure with three pillars: ELI-Attosecond Light Pulse Source (ELI-ALPS) in Szeged, Hungary, ELI-Nuclear Physics (ELI-NP) in Magurele, Romania, and ELI-Beamlines (ELI-BL) in Dolní Břežany, Czech Republic. Inaugurated today, the Hungarian pillar, ELI-ALPS, will partially open to users in 2018 before reaching full operation in 2020. Its main scientific mission is to enable visualization of ultrafast structural dynamics of matter and therefore to give international users access to research equipment with the highest resolution in both space and time. In addition, the technological mission of ELI-ALPS is to contribute to the science and development of high-peak-power and high-average-power light sources.

The uniqueness of ELI-ALPS lies in the unparalleled performance of its laser sources in terms of photon flux, extreme spectral bandwidths, and sub-light-cycle control of the electromagnetic field. These primary laser sources are specifically engineered to drive cutting-edge secondary particle and radiation beamlines developed by expert teams from world-leading research institutions across Europe. Highly specialized user instrumentation, such as reaction microscopes, ion microscopes, surface science end-stations, VMI spectrometers complement the technological arsenal of ELI-ALPS.

Among the whole new class of laser systems commissioned by ELI-ALPS and pushing well beyond the current state of the art, we can mention the high-repetition-rate (HR) system, based on cutting-edge fiber laser technology, delivering TW peak power and < 6 fs pulses at 100 kHz; the future single-cycle (SYLOS) system, providing 20 TW and < 6 fs pulses based on optical parametric amplification; the PW-class high-field (HF) laser operating at 10 Hz repetition rate with close to 15 fs pulse duration. The performance of the above laser systems operating with central wavelengths in the range of 750 to 1030 nm is complemented by the mid-infrared (MIR) laser system, providing sub-4 cycle, tunable laser pulses at 100 kHz repetition rate with over 15 W average power.

As the flagship of the ELI-ALPS' secondary sources, High Harmonic Generation (HHG) in gas targets will provide EUV attosecond pulses at repetition rates ranging between 1kHz and 100kHz, pulse energies ranging from 1nJ to 1μJ respectively and pulse durations of the order of 0.5 fs, enabling detailed investigation through coincidence measurements, imaging techniques and/or non-linear EUV processes. Scientific communities ranging from physicists to chemists, material scientists to surface and condensed matter scientists and biologists will greatly benefit from the availability of these facilities. They are designed to optimally serve forefront research topics such as the investigation and control of ultrafast dynamics in correlated electron systems ranging from single atoms (from He to many-electron atoms) to condensed matter (superconductivity, magnetism, topological insulators, low dimensional materials, nano-plasmonics); non-adiabatic processes and energy transfer in molecular systems; ultrafast charge dynamics in macromolecules; quantum coherence in biological systems; and new opportunities in the largely unexplored field of ultrafast XUV astrochemistry, to mention but a few.

HHG from laser surface plasma gives access to attosecond x-ray pulses, opening up new venues for inner-shell and material science investigation. Looking at and/or controlling inner-shell dynamics and non-linear inner-shell processes will for the first time have reached attosecond precision. Techniques such as ultrafast x-ray diffraction or two-photon inner-shell fluorescence at attosecond temporal and nm spatial level, will enable 4D studies in the gas phase and 4D characterization of bulk materials at the highest spatio-temporal resolution.

Some examples of the opportunities that the high-intensity THz sources of ELI-ALPS offer are the investigation and use of non-linear THz processes; the extraction of 3D information on the chemical composition and/or other features of a sample; the steering of non-adiabatic dissociation (chemical reaction) dynamics; post acceleration of laser accelerated ions; and THz-assisted HHG.

The high-repetition-rate laser-based electron acceleration beamlines currently under consideration at ELI-ALPS are unique of their kind worldwide. The perspective of high-repetition-rate femtosecond-class electron beams brings notable advantages in ultrafast electron diffraction applications, allowing visualization of ultrafast dynamics in macromolecules and solids at the atomic spatio-temporal level. The planned PW laser-driven electron and ion sources complement the spectrum of the ELI-ALPS' facilities for material science and biomedical applications at regional level.

The vision and challenge of ELI-ALPS is to become the first international attosecond facility, fully dedicated to users, addressing a wide spectrum of scientific communities, offering them exclusive opportunities for large-scale experiments, forefront research, and scientific and technological excellence and breakthroughs. When this stage is reached, we will have succeeded in our mission. 23 May marks a key step towards this ambitious goal.

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