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Laserlab Europe

Laserlab Forum

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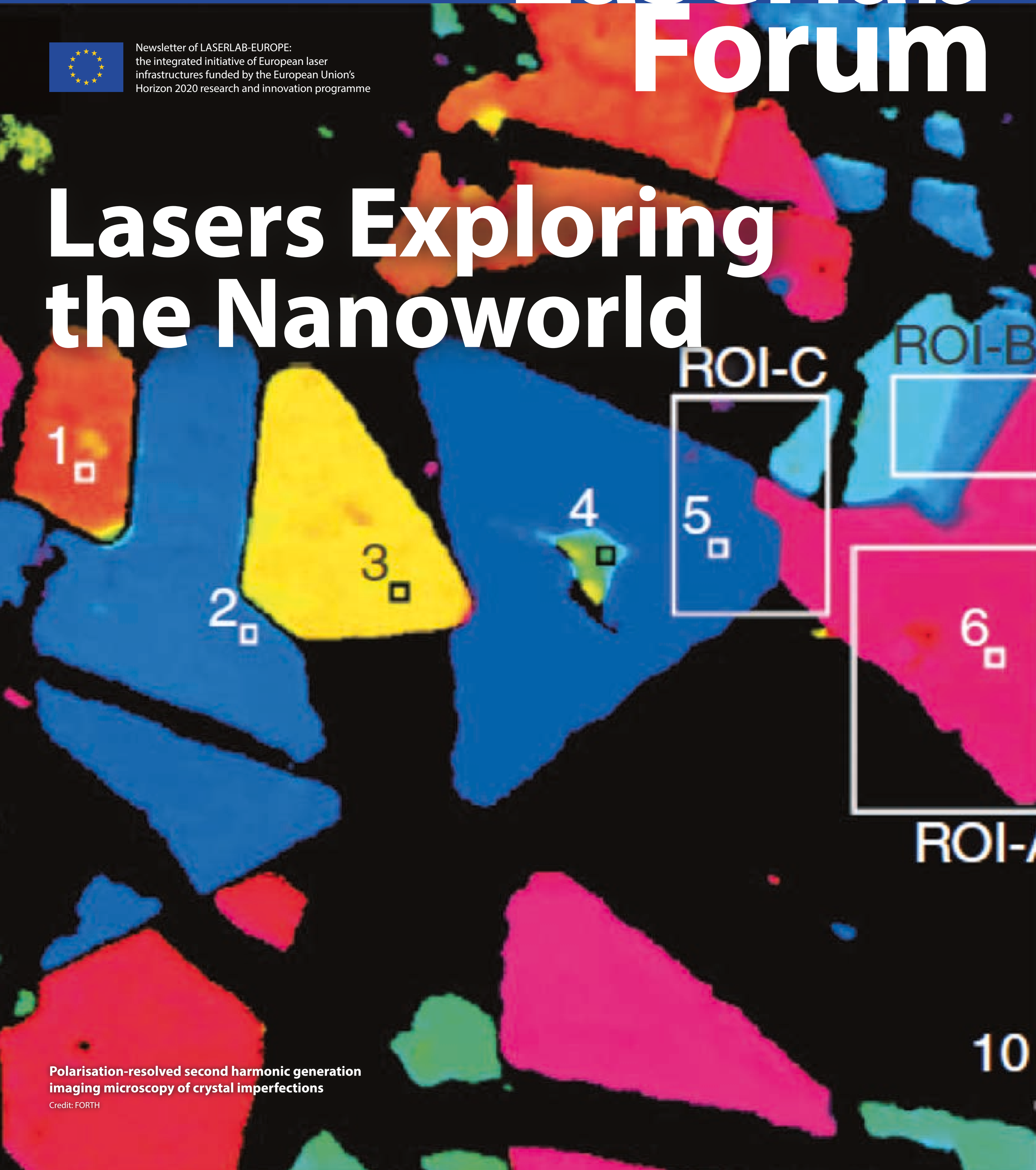
Lasers Exploring the Nanoworld



Polarisation-resolved second harmonic generation imaging microscopy of crystal imperfections
Credit: FORTH

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tosecond pulses can be generated spanning the photon energy range of 40 to 70 eV, covering the M2,3 band of Co (around 60 eV) and the O1 band of Tb (around 45 eV). This leads to the appearance of two different scattering spots on a CCD camera set a few centimetres downstream of the sample (see figure, left).

LOA researchers have recently studied similar samples at the Free Electron Laser FERMI (Trieste, Italy) and were able to follow for the first time the ultrafast dynamics of the magnetic anisotropy in these alloys, a key parameter that must be precisely controlled for the realisation of magnetic recording devices [2]. Comparing to this study, the work at LOA allows to simultaneously look at the photons in resonance with the Co and Tb bands thanks to the large bandwidth of the high harmonic source. In this particular case, very similar magnetisation dynamics for Co and Tb are observed, contrary to the previous investigations (see figure, right). This on-going work will allow to fine-tune the composition of the alloy and optimise its properties for particular applications.

Boris Vodungbo (Laboratoire de Chimie Physique-Matière et Rayonnement) and Guillaume Lambert (LOA)

[1] C. D. Stanciu et al., Phys. Rev. Lett. 99: 047601, 2007
[2] M. Hennes, Phys. Rev. B 102: 174437, 2020

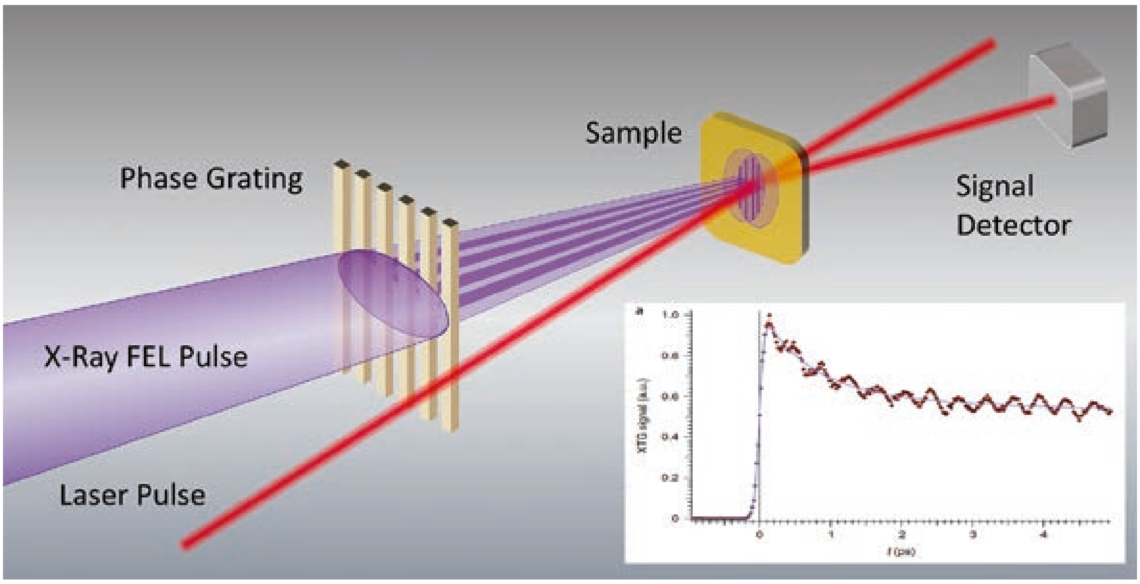
Transient X-ray grating spectroscopy for nanoscale measurements (LACUS, Switzerland, LENS and FERMI, Italy)

Measuring a variety of transport phenomena at the nanoscale is becoming vital with the miniaturisation of devices. Yet it remains elusive due to the lack of methods which are precise at such length scales. Transient grating (TG) spectroscopy is the traditional tool for measuring transport phenomena. It uses two laser pulses to activate a medium by creating an interference pattern, or grating, from stripes of excitations that can be thermal, electronic, magnetic or even structural. The modulation depth of the grating can be measured by using it to diffract a third, time-delayed probe beam, which monitors the grating evolution as it fades away due as the initial excitation propagates through the material. The grating spacing is determined by the wavelength of the laser pulses used to create it and is on the order of hundreds of nanometres to microns in the visible-ultraviolet range.

Transport properties at the nanoscale are expected to greatly differ from those at the meso- and larger scales. In particular, a change of regime from ballistic to diffusive is known to occur, yet it has not yet been unambiguously observed. Harnessing such nanoscale transport phenomena calls for the use of short-wavelength radiation and, in particular, X-rays. However, crossing two X-ray beams in order to generate a grating with nanometre step sizes is a challenge. In an international collaborative effort led by the Paul-Scherrer-Institut (PSI), Switzerland, and involving several Laserlab-Europe partners (LACUS, LENS and FERMI), the Talbot effect (see figure) was exploited to create such gratings using beams of 0.17 nm wavelength at the Swiss Free-Electron Laser (SwissFEL, PSI). The evolution of the generated grating was probed by a time-delayed 400 nm probe pulse. The results, revealing the optical and acoustic response in the form of coherent phonon oscillations over hundreds of femtoseconds to tens of picoseconds (Figure inset), appeared in *Nature Photonics*. This first demonstration of hard X-ray transient grating spectroscopy opens the way to novel and exciting developments in the study of nanoscale transport phenomena. The next step will be to replace the 400 nm probe pulse by a hard X-ray probe pulse, thus permitting access to the nano length-scale directly.

J. R. Rouxel and M. Chergui (LACUS), S. Catalini and R. Torre (LENS), D. Fainozzi and C. Masciovecchio (FERMI), R. Mankowsky and C. Svetina (PSI)

J. R. Rouxel et al., Nat. Photonics 15: 499-503, 2021



X-ray TG setup scheme: The XFEL pulse (in purple) is diffracted by a transmission phase grating, generating a Talbot carpet on the sample, which induces a TG excitation with spatial periodicity. A delayed optical pulse (in red) monitors the temporal evolution of the XTG via transient diffraction. In the inset, XTG signal from a bismuth germinate sample at 7.1 keV with an excitation grating pitch of 770 nm. The fast oscillations are attributed to a coherent optical phonon.

ELI's establishment as an ERIC and start of operations

ELI Beamlines in Dolní Břežany, Czech Republic

On 30 April 2021, the Extreme Light Infrastructure (ELI), one of Laserlab-Europe's close collaborators, was granted the legal status of European Research Infrastructure Consortium (ERIC) by the European Commission. The establishment of ELI ERIC opens the door for researchers, industry and countries to gain access to the world's largest collection of super powerful and ultra-fast lasers for science and enable cutting-edge research in physical, chemical, materials, and medical sciences, as well as breakthrough technological innovations.

The Czech Republic hosts the ELI ERIC statutory seat in Dolní Břežany at the ELI Beamlines facility. A second facility, ELI-ALPS, is hosted by Hungary in Szeged. Italy and Lithuania also joined as founding members, while Germany and Bulgaria are founding observers. A third ELI facility is under construction in Romania in the field of nuclear photonics and is expected to complement the current ELI ERIC facilities in the future.

The integration of the ELI facilities into a single organisation is planned to take place over the next two to three years. During that time, management, technical and scientific procedures in the different facilities are being harmonised. The merger is being facilitated by a 20 million euro grant, called "IMPULSE", from the European Union under the Horizon 2020 programme.

ELI ERIC has officially started operations with the first General Assembly meeting on 16th June 2021 resulting in the appointment of Allen Weeks as Director General of ELI ERIC and Caterina Petrillo as Chair of the ELI ERIC General Assembly.

ELI-ALPS in Szeged, Hungary

Laserlab-Europe AISBL Expert Working Groups

With the goal to boost collective action among its members and to strengthen the quality and impact of the research carried out at each facility, Laserlab-Europe AISBL is establishing Expert Working Groups for topics of strong common interest. The first four Expert Groups address the following areas:

- Laser science for cancer research
- Lasers for clean energy
- Laser-generated electromagnetic pulses
- Micro- and nano-structured materials for experiments with high-power lasers

Kick-off meetings of the Expert Working Groups have been held earlier this year, providing a platform for all participants to showcase their research in the respective field. External interested collaborators bring in additional expertise so that the groups cover a broad range of research and applications. Together, the groups are developing strategies for new collaborations and joint approaches to complex problems. Brief descriptions can be found at *www.laserlab-europe.eu/aisbl/expert-groups*.

Laserlab-Europe AISBL is established as a not-for-profit organisation. It currently has 45 members from 22 countries and is open to new members and new joint activities triggered by the participants.

How to apply for access

Interested researchers are invited to contact the Laserlab-Europe website at www.laserlab-europe.eu/transnational-access, where they find relevant information about the participating facilities and local contact points as well as details about the submission procedure. Applicants are encouraged to contact any of the facilities directly to obtain additional information and assistance in preparing a proposal.

Proposal submission is done fully electronically, using the Laserlab-Europe Proposal Management System. Your proposal should contain a brief description of the scientific background and rationale of your project, of its objectives and of the added value of the expected results as well as the experimental set-up, methods and diagnostics that will be used.

Incoming proposals will be examined by the infrastructure you have indicated as host institution for technical feasibility and for formal compliance with the EU regulations, and then forwarded to the Access Selection Panel (ASP) of Laserlab-Europe. The ASP sends the proposal to external referees, who will judge the scientific content of the project and report their judgement to the ASP. The ASP will then take a final decision. In case the proposal is accepted, the host institution will instruct the applicant about further procedures.

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