



## LASERLAB-EUROPE

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R = Report, P = Prototype, D = Demonstrator, O = Other	R
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## **1 Introduction and objectives**

Each member of the Laserlab-Europe Consortium possesses unique expertise in some domains of laser science and technology and infrastructure management. At the consortium level, the sum of this expertise is outstanding; at the individual level, the sharing of expertise benefits many members and increases the overall effectiveness of the Laserlab-Europe Consortium. The objective of this work package is to pool this distributed know-how and good practices concerning essential practical issues such as security, laboratory management and data acquisition procedures, as well as crucial scientific issues of relevance for many Laserlab-Europe participants. The outcome of this scientific and technological networking will be increasingly unified efforts from all members of the Consortium, pushing forward laser science and technology in the European Community at large.

## **2 Task 3: Thematic Networks**

Regular scientific and technological exchange is crucial, but it is especially fertile on the following two frontiers of laser science: high-energy laser systems, and ultra-high intensity ultrashort-pulse laser systems. Each of these areas fits into a pan-European large-scale project: HiPER and ELI, respectively. Those projects will benefit greatly from these networking activities which aim at stimulating all possible exchanges related specifically to such high-performance lasers, and which will strengthen the link between Laserlab-Europe and the respective consortia. The Task 3 participants will organise two research and technology networks within Laserlab-Europe. These networks are by nature open to all Consortium participants.

### **2.1 Task 3b) Networking Activity on High energy Lasers (NAHEL)**

Task leader: GSI-PHELIX

High energy lasers exceeding a kilojoule in pulse energy place very unique demands upon the optical components, operating procedures, staff training and safety precautions. Such high energy systems are presently operational in the Czech Republic (PALS), France (LULI and LIL), Germany (PHELIX), and Great Britain (Vulcan), and new facilities will be commissioned in the next few years (HiLASE). Since large optics and opto-mechanical installations are involved, these new developments are typically costly and difficult. In addition, instrumentation, data-taking requirements and even theoretical approaches demand different approaches from those typical at the other facilities. Therefore a linkage between these laboratories is of particular use for their quality and scientific value.

One aim of this network is to promote an efficient exchange of information on subjects related to the operation of mid-scale high-energy laser facilities. Specific workshops on technical and organizational issues are organized at the different locations, which comprise practical campaigns where procedures are demonstrated "hands on" at the given facility to the experts from the other facilities. These workshops are also used for the exchange with non-European laboratories. Another important line of action is a common outreach initiative to foster emerging industrial and medical applications at these high-end facilities.

The NAHEL network very much continues the successful format defined during the Laserlab II period and facilitates very specific technical discussions in small groups, taking place at the network annual meetings which are foreseen to be organized in all the participating laboratories. In addition to the four initial network participants, other Laserlab partners and external experts are invited to discuss specific topics when needed. In 2012, the first meeting was held in Abingdon, UK, organized by STFC-CLF; in 2013, the second meeting was organized in Palaiseau, France by LULI/Ecole Polytechnique. The third thematic NAHEL meeting took place in 2014 in Prague and was organised by PALS.

Among the recurring topics, issues related to the metrology of large-size lasers, storage and publication of machine parameters (database), control system and infrastructure requirements like radiation shielding are regularly covered. Information and reports on the progress of each group are usually given during the meetings so that synergies between laboratories can be found.

*2012 annual meeting NAHEL, 11-13 June 2012, Abingdon, UK*

The 2012 NAHEL workshop was hosted by the Central Laser Facility and held at the Cosener's House, Abingdon on the 11th & 12th June 2012. The introductory session was devoted to presentations by representatives of each of the attendee institutions (CLF, GSI, PALS and LULI) outlining the current status of the facilities and updates on development projects. This was followed by five discussion sessions covering a wide range of topics of importance for facility operations. Each session was presided over by a chair who had organized ahead of the meeting a series of questions to guide the discussion. During these sessions, PowerPoint slides were occasionally used as an aid to illustrate points, but no formal presentations were scheduled. The workshop concluded on the morning of 13th June with tours of the Central Laser Facility covering the Vulcan, Astra-Gemini, Artemis and Dipole laser systems and the Target Fabrication department.

The workshop was useful to highlight the operational issues common to all the facilities. Reliably diagnosing the laser properties delivered to target is a major challenge, in particular the measurement of the pulse duration and the focal spot. The amount of information provided to users varies across the facilities and automated post-processing of laser data is not generally performed. Plasma mirrors are in common use for contrast enhancement and thin pellicles are used for optic protection. High repetition rate operations are currently only of serious concern for the CLF (Gemini) but will affect upcoming facilities. The implications of moving to of order 1Hz operations in terms of mass production of targets and the necessary improvements in target positioning and data acquisition systems will have an impact on the cost of running facilities. The level of support provided by facilities for the users was also discussed. Planning of experiments begins 3 - 6 months before the start date with some facilities assigning a link scientist to co-ordinate the activity. The user training courses run by the CLF have been very successful and there is potential to extend this to a Laserlab-wide activity.

*2013 annual meeting NAHEL, 4-5 November 2013, Palaiseau, France*

The 2013 NAHEL workshop was organized by LULI and held in the Salle du Conseil, Institut Optique on 4-5 November. This meeting was organized in three parts: Two oral presentation sessions: the first one, on November the 4th, was devoted to the current status of the facilities and updates on development projects given by representatives of each of the working group members (LULI, CLF, GSI and PALS). The second one, on November the 5th, focused on the new and upcoming facilities (Orion, Salamanca and ELI). These two sessions were followed by five discussion sessions covering a wide range of technical topics, identified for improving facility operations. Each session was presided over by a chair who gave a kick-off talk introducing a series of questions to guide the discussion. The workshop concluded with tours of the LULI laser facilities (LULI2000, ELFIE, LUCIA project). The ELI beamlines together with PALS have agreed to host the next NAHEL workshop in 2014.

*2014 annual meeting NAHEL, 6-7 October 2014, Prague, Czech Republic*

The 2014 Networking Activity on High Energy Lasers (NAHEL) Workshop was organized by the Prague Asterix Laser System (PALS) Research Infrastructure and held in the main lecture hall of the Institute of Plasma Physics of the Academy of Sciences of the Czech

Republic (Prague) on 6-7 October 2014. The workshop was attended by 39 participants from the Czech Republic, France, Germany, the UK, and Poland.

The meeting was organized in three parts: two oral presentation sessions, three discussion sessions, and laboratory tours. The first oral presentation session was devoted to the current status of the facilities and updates on development projects given by representatives of each of the working group members (LULI, CLF, GSI and PALS). The second one focused on the new and upcoming facilities in the Czech Republic (HiLASE, [www.hilase.cz](http://www.hilase.cz) and ELI-Beamlines, [www.eli-beams.eu](http://www.eli-beams.eu)). These two sessions were followed by three discussion sessions covering a wide range of technical topics important for smooth operation of high-power laser facilities. During each session an appointed chairman introduced a series of questions to guide the discussion. Two co-chairmen from the host institution took care of the minutes of the meeting.

The first of these sessions was about safety issues and electromagnetic pulse protection (EMP). B. Zielbauer (GSI) organized the discussion on EMP measurements and protection, during which the participating laboratories shared the experience with the facility and target grounding and shielding of delicate equipment like oscilloscopes and computers. There are problems with protecting computers against EMP in all the laboratories. Recommended solution: Faraday cage with electro-optical converters for each computer (RAL) or big Faraday cage housing the whole diagnostic assembly (PALS). Stefan Götte (GSI) organized the discussion on radiation protection and radiation safety procedures used in individual laboratories. Problem: TLD and other dosimeters are fitted to ms pulses, not to ps or fs ones. Recommended practice: Restricted access during laser shots, maps of dosimeters, read out after each experiment, Responsibility: Radiation Officer (RAL).

The second session was devoted to key issues of laser system performance and plasma diagnostics. Vincent Bagnoud (GSI) organized the discussion on pulse contrast measurements. Different aspects of improving and measuring the contrast were discussed. All labs use Pockels cells either for pulse extraction and/or for improvement of contrast in the laser chain. Plasma mirrors routinely used only at RAL, sometimes at LULI. Sequoia third-order cross-correlator used for temporal contrast measurements over 10 orders of magnitude at RAL and LULI. Good experience with EOT 4000 (GaAs) and EOT 3500 (InGaAs) fast photodiodes (PALS). Ultra-high Contrast Third-order Autocorrelator TUNDRA versus Sequoia - no one has experience with both systems for comparison yet. In the second part of this session Roman Dudzak and Jan Dostal (PALS) spoke about the target diagnostics and precise time synchronisation of different laser systems used at PALS and discussed methods of protection of optics against target debris.

The third session was devoted to wavefront control and focal spot quality issues. One of the key issues was how to measure spatio-temporal characteristics of short-pulse laser beams, the discussion on that subject being organized by Jaroslav Nejdrl (PALS). One of the key questions was the possibility of spatially resolved measurement of the laser pulse shape of short pulse lasers. RAL reported good experience with wave front control by means of adaptive optics at Gemini and Vulcan lasers: focal spot size near the diffraction limit can be achieved.

In the last two discussion blocks Donald A. Peyrot and Roberto Ziano (ELI-Beamlines) posed the questions and organized the discussion on the issues important for the current phase of preparation of the ELI-Beamlines project, such as the focal spot measurements, how to assess the focal spot profile at high power/energy in particular, automatic beam alignment, pointing accuracy in laser facilities, adaptive optics loop operation, etc.

An integral part of the workshop was a guided tour to the HiLASE Research Centre and the building site of ELI-Beamlines facility in Dolni Brezany near Prague.

*2015 NAHEL meeting at ILOW (International Laser Operations Workshop), 7-9 April 2015, Bordeaux, France*

In 2015 large scale facilities in Europe and the USA held their biennial workshop (ILOW) on the operation of large-scale laser facilities in Le Barp, Bordeaux, France. ILOW provides a forum for operating organizations of large scale laser facilities to discuss issues and exchange information related to laser facility operations, governance, maintenance, diagnostics, safety and security, and technology. The workshop brings together operations managers of large laser facilities from around the world, and presents a significant opportunity for laser operations staff to establish professional contacts and pick up new ideas and share lessons learned to strengthen the international community.

The 3-day thematic workshop has a large overlap with NAHEL whose members were invited to participate; it also covers new aspects particular to large-scale laser facilities like the NIF and Laser Megajoule (LMJ) that are rarely covered in the NAHEL meeting. NAHEL representatives from LULI, GSI and STFC contributed to the meeting and gathered information of general interest to the Laserlab community, preparing the basis of the next NAHEL meeting to be held in 2016.

### **3 Conclusions**

NAHEL (Networking Activity on High- Energy Lasers) brings together 4 mid-scale laser facilities from GSI, CNRS/Ecole Polytechnique, STFC/RAL und PALS to discuss issues related to operation and organization of such laser facilities. This network very much continued the successful format defined during the predecessor project and favors very specific technical discussions in small groups, taking place at the network annual meeting which is organized in turn at all the participating laboratories. In addition to the four network participants, other interested Laserlab partners as well as representatives from external institutions are welcome to participate and discuss specific topics. In 2012, the first meeting was held in Abingdon, UK and organized by STFC/RAL. In 2013, the second meeting was organized in Palaiseau, France by the Ecole Polytechnique. The 2014 annual meeting took place in Prague, organized by PALS. In 2015, the annual meeting was merged with the ILOW meeting (international laser operation workshop) on the operation of large-scale laser facilities in Le Barp, France. This 3-day thematic workshop has a large overlap with NAHEL and also covers new aspects particular to large-scale laser facilities like the NIF and laser megajoule that are seldom covered in the NAHEL meeting.

NAHEL offers a valuable environment to create synergies between the participants. The in-depth discussions on technical aspects not often covered in conferences are truly unique; the format of the meeting helps each member explore and get feedback on technologies and methods before they are implemented. One of these meetings was, for instance, the starting point for common developments on deformable mirrors between RAL and GSI. Diagnostics are often discussed during NAHEL meetings as a recurring theme because of the rapid evolution of the technology. Here the meeting served as a forum to share experience on the new Gigabit Ethernet communication protocol for cameras used in many lasers coming to the consensus that this new protocol is probably offering the best performance with high-power lasers at the moment.

Finally NAHEL outreached to the wider community, and topics related to the ELI beamlines ESFRI project were covered during the 2014 Prague meeting. Here the goal of having an exchange forum where the more established facilities offer their expertise in best practices and metrology was successfully reached, providing extremely valuable advice to the project, exactly at a time when technical decisions were important. This outreach is an essential integration tool that will be a central aspect in the networking activities of Laserlab IV.