Issue 3 **February 2007**

Laserlab Europe

Laserlab Forum

Newsletter of Laserlab-Europe the integrated initiative of European laser infrastructures in the Sixth Framework Programme of the European Union

Editorial

Laserlab-Europe has entered the final year of the present FP6 contract. The 2007 Annual Participants Council at the Kensington Close Hotel in London provided a good opportunity to review the balance for the past three years. In one word: the overall situation seems very healthy. This is, for instance, reflected by the budget which has arrived at 70% of the total available expenditures after $^3/_4$ of the contract duration.

Looking into details, our concept of "Dynamic Access" has once again shown an amazing performance. While the 14 host facilities enjoyed (and utilised) a considerable flexibility in their response to user demands, the overall access record is, for the third year in a row, exactly on target. The number of access days is at 75% of the 4-year deliverable, while both the number of projects and users are even slightly higher. We consider this as a very satisfactory success of our model, which would not be possible without close monitoring and thoughtful steering by the Access Board. The scientific quality is controlled by our external Selection Panel under its Chair Wolfgang Demtröder.

Not surprisingly, the users seem to appreciate such services very highly. This became apparent both during the 2006 Users Meeting in Milan, Italy, and by the first evaluation of our internal user questionnaire issued earlier in the year. So it is good news for our users that ACCESS WILL CONTINUE IN 2007 AND 2008 - please don't hesitate to continue submitting proposals!

Similarly, our two JRA activities FOSCIL and OTTER showed an impressive wealth of results in their annual report for 2006 - too much to fit into a few-page document, and certainly much more than one would expect from the relatively modest JRA budget. Clearly the European add-on value lies in the synergy and co-ordination between otherwise autonomous research activities. Consequently, it was very satisfying to see two laser projects in the ESFRI Roadmap: ELI and HiPER. They represent the laser community's first serious efforts towards multi-national large scale facilities, and can be directly linked to the FOSCIL and OTTER consortia of Laserlab-Europe.

Altogether, Laserlab-Europe appears reasonably well positioned to enter the race for FP7, despite the hard, if not brutal competition one should expect under the foreseeable financial conditions. First concepts for a possible LASERLAB II were developed in a rather intense strategy session of all laboratory directors during the London meeting. In particular, Laserlab-Europe is very conscious about its obligation to observe the scenario of emerging new facilities, and to consider ways to bind them into a Europe-wide network. Also we expect internal proposals for potential JRA projects to be submitted by early May; they will undergo an internal review and selection procedure under participation of all partners. If we work it right there is every reason to look with some optimism towards FP7.

A final word: The present Newsletter has again been prepared by our experienced editorial team Armelle de Bohan and Tracey Potts. Sadly enough for us, but with high expectations from her side Armelle recently informed us that she is looking forward to a career change. Incidentally, Tracey Potts is facing no lesser challenges: she is expecting a baby, which will certainly need all her attention during the coming months. Our congratulations and best wishes go to Tracey and Armelle - many thanks to both of you for the excellent work during the past year!

Professor Wolfgang Sandner
Laserlab-Europe Coordinator

IN THIS ISSUE

First FP7 information days in France

Support measures to ensure continuity of early FP6 I3s like Laserlab

On 16 November 2006, the French Ministry for Research organised a special information day about Research Infrastructures (RI) in FP7. Mr Hervé Péro, Head of the RI unit of the European Commission DG RTD was invited to present the main features of the RI work programme. He announced support measures to ensure continuity of early FP6 I3s like Laserlab-Europe to be implemented on the first call.

Among the €50 billion budget of the 7th Framework programme, roughly €1,7 billion will be dedicated to Research Infrastructures (RI); which is a 30% increase compared to FP6. Approximately €1 billion will go to the optimization of existing infrastructures implemented through the I3 instrument of which €400 million will be allocated for ICT based infrastructures. On the basis of the European Strategic Forum for Research Infrastructure (ESFRI) roadmap, support to new infrastructures will benefit from a rough €600 million budget.

"The financial effort of the EC on Research infrastructures should be concentrated over the first five years of FP7 implementation" specified Hervé Péro during his talk while presenting the details of the two first calls. The first one, to be opened by the end of the year will put an emphasis on existing e-infrastructures (€89 million).

Interestingly, the head of the RI Unit also announced that some support measure will be implemented especially for early FP6 I3 finishing before March 2008. Among these existing I3, Hervé Péro notably mentioned Laserlab-Europe as one of the successful I3 which deserves to be supported by FP7 in order to ensure continuity in its activities.

Laserlab-Europe will end by 31 December 2007, just when the call for integrating activities (mainly I3) is launched. Therefore, a potential "Laserlab II" contract would come into force almost a year after Laserlab stopped.

In one way or another, these support measures would fill the one year gap in the activities of Laserlab-Europe until the first I3 call and support proposals from all fields of science as well as targeted approachs with topics defined by FP7 themed areas. ICT based infrastructure will get specific financial support reaching €115 million whereas an overall budget of €275 million will be attributed to 25 to 30 RTD bottom-up projects.

Among which a renewed Laserlab - Europe initiative?

Editor's note

The article was written before FP7 call was officially launched on 22 December 2006. As announced by H Péro in November, the "Infrastructure" call for proposals contains a specific topic INFRA-2007-3.6 with €4 million budget entitled "Support to ensure the continuity of FP6 actions". It will allow continuation of networking and transnational access for a maximum of one year.

Visit the call page on the Cordis website for details
http://cordis.europa.eu/fp7/dc/index.cfm?fuseaction=UserSite.CapacitiesDetailsCallPage&call_id=15

"Mr Hervé Péro, presenting the Infrastructure specific programme at the first French FP7 Info days in Paris"

Pan European research infrastructure to preserve the memory of our past

Our European Cultural Heritage (CH) might be one of our greatest assets. People's interest in works of art and monuments keeps on growing: in 2005, the Louvre Museum in Paris has welcomed 7.55 millions visitors, 10% more than in 2004. That same year, in the Italian cities of art, the tourism flow reached 55 million people.

In that context, preservation of CH is, of course, a main issue: any monuments or works of art degrade through natural aging process but also by their exposure to pollutants. Moreover, forgeries are another major threat to CH.

Undoubtedly, there is a need for techniques to preserve, identify and certify cultural heritage. In 2002, €855 million was spent in France alone for maintenance purposes, evidence of the importance of CH conservation in the European economic competitiveness. As far as laser technology is concerned, five European manufacturers dominate the laser cleaning market.

This market will develop further boosted by the existence of Research infrastructures (RI) which can establish new scientific methodologies and trigger the innovation process.

In Europe, an important number of RIs already provide state-of-the-art scientific tools and services to museum archives, libraries, excavation sites and monuments records. EUR-ARTECH, an FP6 I3 routinely provides access to a single ion beam infrastructure (AGLAE) where non-destructive elemental composition studies are carried out with high sensitivity and precision.

Moreover, neutron, laser and synchrotron facilities are developing analysis and conservation techniques which have proved to be efficient. The VII century BC Corinthian bronze helmet displayed at the Manchester Museum, *Les Demoiselles d'Avignon* by Picasso, the *Madonna dei Fusi* by Leonardo, the *San Sebastiano* by de La Tour: these are few of the many examples of artefacts and masterpieces we now have a better understanding of, thanks to the use of such RIs. In some case, they were even restored to the original splendor.

Within I3 net[1], representatives of such physical science (PS) infrastructures, among which Laserlab-Europe[2], have met to share expertise. Their discussions emphasized the high potential for a future cross distributed infrastructure. The proposal, labelled after EURICA[3], would aggregate the competences of Conservation scientists and art historians together with the high technology capacities of PS RIs in order to provide access adapted to the needs of the CH community. In EURICA, these different communities are joining forces to allow regular updates of CH knowledge and to ensure the best training to young researchers.

An emerging idea

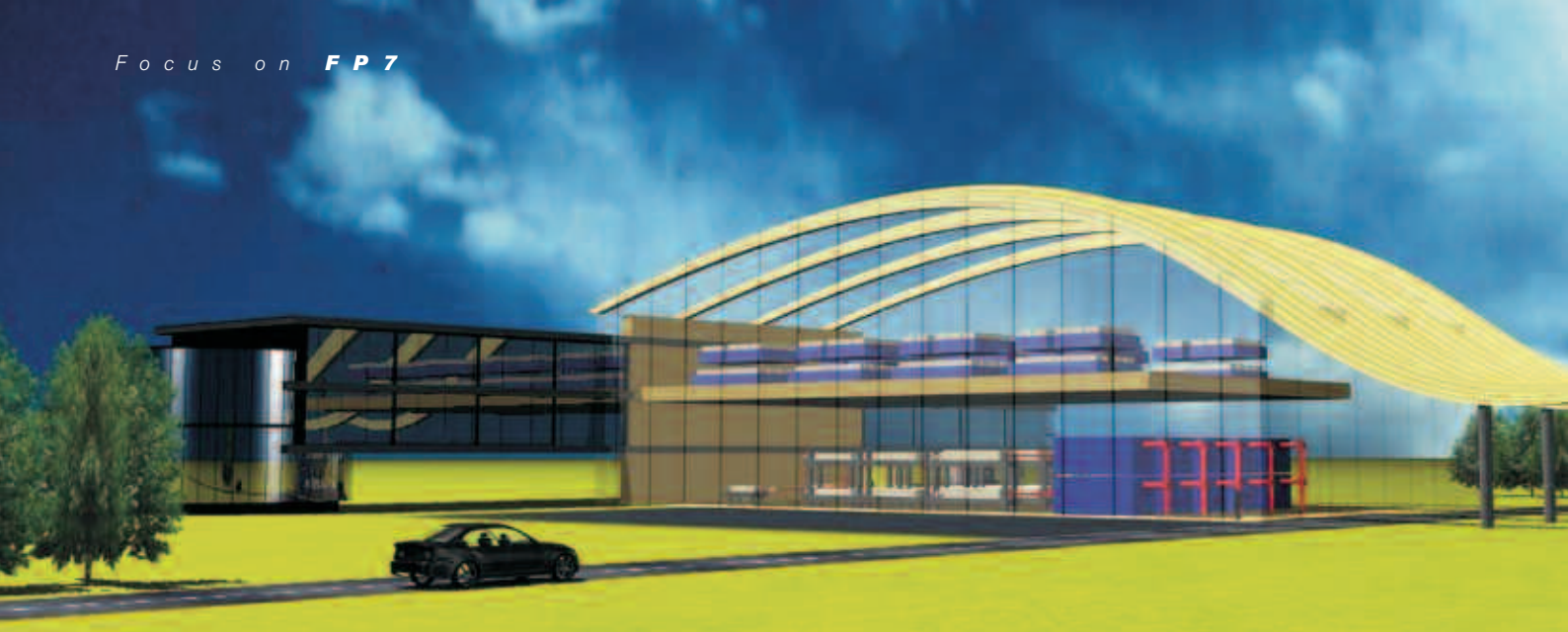
The complexity, high expertise and high costs of the instrumentation are not available at a national level. By creating such a pan European cross disciplinary RI, fragmented skills across EU could be coordinated. Eventually, EURICA was considered as an "emerging idea" Research Infrastructure in the ESFRI Roadmap. In this context, it may be the basis for a proposal within FP7 for the sake of Our Cultural Heritage.

AdB

[1] introduced by Prof. McGreevy in Laserlab Forum no.2

[2] Among Laserlab partners, LLC (Sweden), LENS and CUSBO (Italy), ULF-FORTH (Greece) are involved in Cultural activities.

[3] European Research Infrastructure for Conservation and Analysis.



ELI
Extreme laser light to investigate the strata of matter from virus to quark

What is the most powerful laser researchers can build?

Theorists say an intense enough laser field would rip photons into electron-positron pairs, dousing the beam. But no one knows whether it's possible to reach that point.

This is one of the 20th fundamental questions to be answerered. (http://www.sciencemag.org/cgi/content/full/309/5731/78b) from Science, July 2005.

Laser science and technology is progressing rapidly as illustrated by the ongoing and successful joint research activities inside Laserlab-Europe. In particular, the frontiers of ultra- high intensity and ultra-short pulses are pushed toward even higher and shorter limits. The time has certainly come to design the facility so that the whole community can benefit from these innovative laser technologies which will deliver multi kJ and attosecond pulses. Professor Gérard Mourou, head of LOA, one of the French Laserlab partners is the coordinator of the Extreme Light Infrastructure (ELI) project which appears on the ESFRI roadmap. Professor Mourou outlines the background and the outlook of the whole project.

What kind of light sources will ELI deliver once it is open for access?

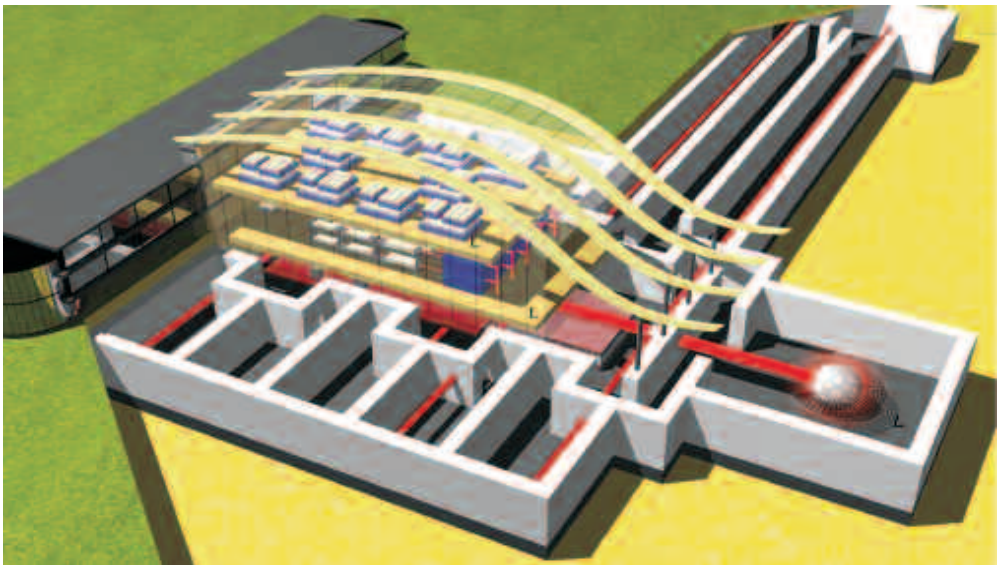
ELI will rest on the duality pulse intensity-pulse shortness. Not only will pulse shortness provide intensity but conversely pulse intensity will provide pulse shortness. ELI will be the first facility in the world dedicated to operating in the ultra-relativistic regime for laser intensity beyond 10^{24} W/cm^2, more than three orders of magnitude higher than the current most powerful laser! Until now the field was in the so called relativistic regime where only the electrons were oscillating with relativistic velocity in the laser field. Relativistic intensities are typically above 10^{18} W/cm^2. We define the ultra-relativistic regime as the regime where the protons become relativistic in the laser field. The mass of the proton being 1800 times the mass of the electron, the required intensities to reach the ultra relativistic regime will be a million times greater which means above 10^{24} W/cm^2. In fact above this ultra-relativistic threshold it is not only the proton that become relativist but all ions. It is a novel and truly important regime that will be ushered in. It will be characterised by an efficient beam generation of photons and particles with superior beam quality (low emittance).

ELI will be modular, starting at the petawatt level at a kHz repetition rate where attosecond science will be the prevailing theme. It will allow the exploitation of relativistic light-electron interaction at a solid surface for creating a source of attosecond UV, VUV and SXR light. This

Attosecond Light Source (ALS) will surpass present-day attosecond sources in terms of both peak and time-averaged brightness by 8-10 orders of magnitude and by a couple of orders of magnitude in terms of pulse duration. With two additional stages the peak power will be further extended to the sub-exawatt (10^{18} W) at a rate of 1 shot per minute.

This ultra-relativistic regime of intensity will push forward the limit of particle acceleration through laser-plasma interaction. The Exawatt range that we intend to achieve with ELI will make it possible to produce an electron beam with energy extended from 1 GeV up to the 100-1000 GeV and ion beam energy from 100MeV to 10GeV!

This ultra-high peak power, which will be 200 times the peak power of the French megajoule laser project in Bordeaux, will be obtained with exceedingly short pulse duration, in the femtosecond range (1 fs =10^{-15} s). The laser power would be boosted accordingly, offering the potential of intensities exceeding 10^{25} W/cm^2.



It is difficult to imagine the potential applications for such high intensities, could you give us some examples?

In fundamental Physics, this new ultra-high intensity and ultra-short pulse laser facility will afford unprecedented new opportunities to study, hot, dense matter, which is crucial to understanding the interiors of planets, cool dense stars, and inertial confinement implosion. The laser pulse-plasma interaction would allow exploration of the fundamental properties of vacuum and its breakdown via electron-positron pair creation which represents a general process of quantum field theory. In essence, ELI intensities could help to unify nuclear physics, high-energy physics, astrophysics and cosmology.

In addition, attosecond light source will provide the opportunity to perform time-resolved science in the attosecond regime in gases, solids and plasmas. It will create the conditions for attosecond XUV pump/probe experiments for real-time observation of electronic dynamics in a wide variety of systems. These include intra-atomic processes in complex biomolecules, dynamics in clusters, electron transfer on surfaces and motion in semiconductor nanostructures.

ELI will address some real world applications. ELI's laser technology is expected to revolutionise the field of particle acceleration by ushering in the discipline of relativistic microelectronics and relativistic micro-photonics. One of the applications will be particle radiotherapy by making very compact treatment units routinely available in the hospital environment. Indeed, particular advantages of the laser-driven accelerators are their compact size ('table-top' devices) and low investment and operation costs. This would significantly reduce the size and cost of hospital-based proton and light-ion cancer treatment facilities. As a result, many more patients would benefit from highly precise and effective radiation treatment with energetic particle beams.

Finally, another important application of relativistic microelectronics will concern the aging of nuclear reactor materials. It is still challenging to elucidate the ultra-fast processes leading to defect creation or phase transformation when materials are submitted to high energy particle fluxes. ELI's secondary ultra-short particle bunches and attosecond light pulses synchronized with the laser might prove useful in order to obtain observations of the target state in the first few picoseconds after irradiation. Experiments of this type could bring decisive progress in radiation physics which is at the heart of the economic and environmental performances of nuclear technologies.

What are the steps to take before access on ELI can be opened?

Since ELI is appearing on the ESFRI roadmap, the European Commission should fund the infrastructure preparatory phase which will aim at consolidating the organisational and economic planning of the future Pan European Extreme Light Infrastructure before starting the construction.

With partners from 12 other member states already involved in the project, we are turning towards an organisational model such as the European Synchrotron Radiation Facility (ESRF) based in Grenoble (France) with a European status. It is a well tested model with a well established track record.

As to ELI's location, the ILE (Institut de la Lumière Extrême) is a candidate and, in 2007, we would like to start the construction of a single beam line prototype under regional fundings regardless of the final decision about ELI's final location. The beam line would operate in the Petawatt regime. We expect to obtain 20 PW by 2009.

Afterwards, according to the results on ELI's prototype and the decision by the member states on the final location, we will start the construction of the whole ELI infrastructure in a new building. ELI's final system, will be ten times larger than the ILE one!

According to our timetable, the first access to ELI's full power shots could be scheduled for 2012 - 2013. But remember that ELI is modular and its activities will take place at intermediate levels before the full system becomes operational.

Website:
http://www.extreme-light-infrastructure.eu/