

3rd HiPER NEWSLETTER – DECEMBER 2009

HiPER preparatory phase is half way through and several important steps have been taken during the past months to move safely towards the next phase. This newsletter covers recent events as well as the latest science news from the community. It also includes highlights from the HiPER research fellows working at different institutions for the technical workpackages.

HiPER Mid-Term review

The mid-term review of the project took place in Abingdon on September 17, 2009. The HiPER Executive Board scrutinized the status and perspectives of HiPER. A review of the roadmap for the physics of fusion and for the technology of lasers was presented and discussed. It was recognized the importance of a wide international collaboration of HiPER with large existing programmes including Omega (US), Firex (J) and the NIF (US). This collaboration will focus on the exploration of the fast-ignition scheme of Inertial Fusion Energy and will also explore alternative ignition schemes.

Recruitment in HiPER

Funding of the technical activity within HiPER enabled recruiting of young researchers to carry out risk reduction activity in critical areas for HiPER, including modelling and experimental fusion programme and laser technology development.

Basic science (WP12) is moving rapidly towards the definition of a unique experimental platform for astrophysics relevant experiments on HiPER. Luca LABATE, HiPER research fellow at CNR, Pisa reports: *“In the last decade, laboratory astrophysics experiments have been made possible, investigating astrophysical phenomena such as Supernova (SN) explosions, evolution of Supernova remnants, Gamma Ray Bursts and radiative astrophysical jets flowing at high Mach numbers. Due to the high energy available and the pulse time structure flexibility, the HiPER facility will offer a new opportunity to carry out this class of experiments. A report is now being prepared by the WP12, in particular concerning a fully 3D model experiment of a SN explosion and shock propagation through multiple interfaces”*.

The experimental programme (WP10) has a great deal of results to report, from collaborative experiments on fast electron transport at RAL (F Perez *et al* 2009 *Plasma Phys. Control. Fusion* **51** 124035), to advances in diagnostics. Petra KÖSTER, HiPER fellow at CNR, Pisa, tells us about her research activity



Group Picture of the “Fast electron transport in Compressed Matter” HiPER collaborative experiment in Target Area EAST at the Rutherford Appleton Laboratory. From left to right: Petra KÖSTER, Luca LABATE, Carlo BENEDETTI, Maria RICETTA, Benjamin VAUZOUR, Rashida JAFER, Frédéric PEREZ and Ioao SANTOS.

and her contribution to HiPER WP10: *“My research activity focuses mainly on experimental studies on fast electron generation and propagation in high-intensity laser-solid interactions. Within the HiPER project, my activity includes fast electron transport studies and the development of new diagnostic approaches suitable for experimental studies relevant for fast ignition, including participation to the validation of a novel diagnostic technique (Energy Encoded PinHole Camera) for X-ray imaging with spectral resolution. This technique is suitable for fast electron transport studies and was tested in several experiments in different interaction conditions”*.

Hans-Peter SCHLENVOIGT, HiPER fellow at LULI (France), with a PhD on synchrotron radiation from laser-accelerated relativistic

electrons, also focuses on Fast Ignition with special attention to studies of X-ray imaging and/or spectroscopy at high photon energies (> 20 keV), to be used for electron transport studies within a strategy for hard X-ray diagnostics at LULI presently under development. Christos KAMPERIDIS, HiPER fellow at CPPL, TEI of Crete, Greece, is studying electron and proton generation and transport from the interaction of short pulse high intensity lasers with plasmas as well as development of relevant diagnostics. Apart from the traditional experiments using the large scale facilities (i.e. Vulcan etc.), he is also involved in experiments for electron & proton generation using sub 8 fs phase stabilised laser pulses.

WP10 also benefits from the collaboration of Rashida JAFER and Yas ALHADITHI, HiPER fellows at Università Bicocca, Milan, Italy, where they investigate ion/proton accelerators to obtain smooth radial distribution of energy and their use for fast ignition and imaging techniques of imploding objects.

Progress towards an integrated modelling platform for fusion design is the ultimate goal of the WP9. Angelo SCHIAVI, HiPER fellow at the University of Roma, La Sapienza explains his role in the project: *“I took part in the preliminary design of the baseline HiPER target investigating target performance at reduced total driver energy. I also carried out a detailed analysis of fast electron beam energy deposition in the dense compressed shell redefining the estimates for the driver energy threshold. Presently I am conducting investigations on the target tolerance to fabrication asymmetries and non-uniform irradiation patterns”*. Within WP9 activities, HiPER fellow Arnaud DEBAYLE, PhD in 2008 at the Université de Bordeaux with a thesis on "Theoretical study of ultra high intensity laser-produced high-current relativistic electron beam transport through solid targets" is now participating to WP9 modelling activity on fast electron generation and transport in the fast ignition scenario. Dhananjay K. SINGH, HiPER fellow at GoLP, IST Lisbon is now doing theoretical studies and simulations on laser channeling for fast ignition. HiPER fellow Samuel MICHEAU, PhD in atomic and plasma physics at the University of Bordeaux in 2007, and now at Queen's University of Belfast, UK, is now looking into fast electron transport phenomena like resistive filamentation and collimation of relativistic electron beams in the fast ignition scenario. WP9 activity is completed by studies on equation of state of high energy density matter which is also the subject of investigation of Manuel COTELOO, now at the Institute of Nuclear Fusion of the Universidad Politécnica Madrid (UPM).

Solutions for Safety and Fusion technology and Targetry are also being actively pursued within WP8 and WP11. HiPER fellows Jesus ALVAREZ, Santiago CUESTA, Rafael JUAREZ, Flora OGNISSANTO and David PORTILLO are part of the team of UPM investigating target chamber design and damage issues. Latest work includes modelling of thermomechanical response of vacuum chamber to heat deposition. Santiago CUESTA is part of the same group at UPM and is collaborating to the large effort on HiPER target manufacturing and characterisation coordinated by Martin TOLLEY at the Rutherford Appleton Laboratory.

HiPER Laser workpackages including Laser Architecture (WP13) and Laser DPSSL Options (WP14) are also requiring a large effort to fulfill the HiPER rep-rate requirements. WP13 is concentrating on laser architecture and beams configuration for optimisation of energy deposition and absorption efficiency of direct irradiation of fusion capsules. Jonathan PHILLIPS, Ph.D. from St Andrews University, Scotland, now HiPER fellow at RAL, brings to WP13 his experience with fibre lasers in timing and optical pulse synchronisation. Laser options (WP14) are being explored by several HiPER fellows. Antonio LUCIANETTI from LULI, CNRS, Palaiseau, France, is looking at HiPER Active mirror concept modeling, laboratory scale experiments definition and operation, Mikayel ARZAKANTSYAN (LULI as well) is working on Yb:YAG gradient doped crystal growth, experimental demonstration at mJ amplifier level, and modelling study for HiPER amplifiers. Markus WOLFF, FSU, Jena, Germany, is working on Design, Simulation and Test of CaF₂ based cryo-cooled amplifiers as an option for a HiPER facility and identification of technical bottlenecks, Magdalena SAWICKA, IoP, Prague, Czech Republic is working on modeling of diode beam shaping optics and fluorescence decay in laser amplifier. Paul MASON, RAL, UK is working on theoretical and experimental studies on high energy DPSSL amplifiers.

HiPER gears up for engagement with industry

Through October, members of the HiPER team began the process of engagement with industry – a key step in moving the Project forward. The aim is to encourage representatives of a wide range of industries to engage with the HiPER Project, forming partnerships to seek the most effective solutions to the technical and scientific challenges ahead. A small team went to the annual “PhotonEx” show, where HiPER was the featured new industry challenge. Here the talk was mainly of the path towards delivery of a suitable diode pumped laser scheme, capable of meeting the needs of the HiPER facility. The following week, HiPER was represented at “MM-Live”, the UK show which brings together all industry players involved in precision manufacture on the very small scale. Many new contacts were made and these will be followed up in an effort to



communicate the requirements for HiPER Laser, Targetry and Fusion technology. The process of solving the technology challenges for HiPER is expected to reap benefits beyond the immediate field, yielding intellectual property and spin outs in the short to medium term.

Highlight from technical WorkPackages

The *Laser technology roadmap* took off as a joint WP13 and WP14 activity aimed at delivering a credible conceptual design of the HiPER laser, including laser, beam line architecture and focusing geometry following the HiPER laser requirements. A meeting on HiPER Laser requirements was held on February 26, 2009 at the CNR Research Campus in Pisa, Italy. The meeting was dedicated to the identification of the requirements of laser parameters for HiPER, based on the preliminary report prepared within WP13.

J-C Chanteloup, coordinator of WP 14, reports: *“Four laser technology options are presently on the table that will lead to the identification of an efficient, high repetition rate laser for HiPER. WP14 is coordinating effort at a European level to deliver a credible and affordable solution for Diode Pumped Solid State laser beamline for HiPER. Our building blocks are the solid experience of European teams with active projects in this area and the strong links with international programmes in US and Japan”*

The *Physics roadmap* identifies priorities in the simulations to move towards a fully modeled, full scale, fast ignition scheme. Intermediate steps include scaled model experiments. The physics roadmap also includes the execution of experiments at medium scale facilities. In this framework, the WP10 HiPER dedicated experiments carried out at the RAL-TAW on Nov-Dec 2008 to study fast electron transport in compressed matter is the first collaborative experiment of this kind in EU. More recently, experiments were carried out at the PALS to perform X-ray imaging with advanced diagnostics and shock propagation tests.

HiPER publications and outreach

The latest IFSA conference held in S. Francisco, was a great opportunity for HiPER to present the status of the preparatory phase. A series of invited and regular talks were presented by HiPER delegates, covering an overview of the project and all of the technical activities, including laser technology, experimental programme and target design. The IFSA 2009 proceedings will be published by IOP's [Journal of Physics Conference Series \(JPCS\)](#).



Jean-Christophe CHANTELOUP during his Plenary Talk at the IFSA 2009 Conference in San Francisco

Recent HiPER publication include “Studies on targets for inertial fusion ignition demonstration at the HiPER facility” published on *Nuclear Fusion* 49 (2009) 055008 and “Fast ignition of fusion targets by laser-driven electrons” published on *Plasma Phys. Control Fusion* 51 (2009) 01400, "Impact of variable doped gain medium on HiPER multiple kJ / ~10Hz diode pumped beam lines design" Advanced Solid - State Photonics Topical Meeting and Tabletop Exhibit (ASSP), Denver, Colorado, USA, 1-4 February 2009. For a full list visit the HiPER web site at www.hiper.org

NEXT MAJOR EVENT

Participants' and Technical Forum Meetings, Prague 3rd and 4th March 2009.

The next Participants' forum will be a rich event, covering all of the above and more, with input directly from scientists who have been actively working on modelling, experiments and laser design. **The Technical Forum** will provide an opportunity for **HiPER fellows** to present their work to the whole HiPER community.

This event will provide a unique opportunity to meet and to evaluate the science and technology contribution vs. challenges of all workpackages to the HiPER programme. More info on both events will be posted in the members area of the HiPER web-site early in the new year.

