LAsers for Applications at Accelerator facilities

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LASERS

A KEY TOOL FOR PARTICLE BEAM GENERATION ACCELERATION AND DIAGNOSTICS

Particle accelerators are propellers for future science enabling fundamental research and new technological developments

Accelerators have numerous practical applications across many fields including medicine, electronics, environment and energy. New methods of ion generation will expand the boundaries of research and open up new practical applications for the everyday world. As the limits of performance are reached new methods for particle acceleration and beam optimization are needed. Lasers will play a key role in the development of accelerators by improving the generation of high brightness electron and exotic ion beams and through increasing the acceleration gradient. Lasers will also make an increasingly important contribution to the characterization of many complex particle beams by means of laser-based beam diagnostics methods.

The LA^{3}NET network is built around 17 early stage researchers working on dedicated projects to research and develop a complete spectrum of laser-based applications for accelerators. The network presently consists of an international consortium of more than 30 partner organizations including universities, research centres and private companies working in this field. This will provide a cross-sector interdisciplinary environment for beyond state-of-the-art research and researcher training while developing links and new collaborations.

LASERS R&D

Lasers and Accelerators – A unique combination for cutting edge research

The advancement of science and engineering in the past decades is inherently linked to the development of lasers. Ever higher laser beam powers, brightness and shorter pulse lengths have helped establish them as an invaluable tool for both a wide range of industry and medical applications, such as for example material treatment, precision measurements, laser cutting, display technologies, laser surgery, and for fundamental research. In fact, many of the most advanced experiments in astrophysics, atomic, molecular and optical physics, as well as in plasma research would be impossible without the latest laser technology.

Moreover, lasers have become increasingly important for the successful operation and continuous optimization of particle accelerators: laser-based particle sources are well suited for delivering the highest quality ion and electron beams, laser acceleration has demonstrated unprecedented accelerating gradients that might provide the alternative technology needed for the next generation of particle accelerators in the future, and without laser-based beam diagnostics it would not be possible to unravel the characteristics of many complex particle beams.

Laser-based particle sources

Lasers have been successfully used to provide high brightness electron beams and exotic ion beams that cannot be realized with any other technique. Wavelength tunable lasers are used for ion sources at Isotope Separator On-line (ISOL) facilities to achieve unmatched selectivity by performing multi-step resonance. Within LA^{3}NET, laser-based sources will be developed in four projects that will expand upon existing techniques and technologies.

Laser-driven particle beam acceleration

Very high field gradients for the acceleration of particle beams are highly desirable for many applications, both in fundamental sciences and in industry. There are significant engineering and physics challenges to realize and control such gradients. Laser-driven particle beam acceleration could help to substantially reduce the size of accelerator facilities, open avenues for providing beam currents above present limits and for advanced medical infrastructures for treatment and diagnostic purposes. Laser/optical fibre combinations may also enable the development of 'pocket accelerators'. There will be five LA^{3}NET projects in this area.

Lasers for beam diagnostics

Diagnostics systems are essential constituents of any accelerator; they reveal the properties of a beam and how it behaves in a machine. Without an appropriate set of diagnostic elements it would simply be impossible to operate any accelerator let alone optimize its performance. Lasers provide the highest time and spatial resolutions for transverse and longitudinal beam profile measurements, they allow the detection of density differences in particle beams with high dynamic ranges and permit measurements of very important machine parameters, such as the momentum compaction factor and beam emittance. Five projects will be carried out on beam diagnostics.

System integration

In a complex research environment, such as an accelerator facility, it is very important that all components interface smoothly with each other. The integration of laser systems regularly poses high challenges on the machine-wide control and timing system, interface cards and electronics. Often commercially available systems do not readily integrate into purpose-build systems at research centres, requiring considerable R&D effort. Interaction with private companies at all stages of the integration process is vital and a central element within LA^{3}NET. Whilst all projects within this consortium will contribute to this important topic, two focus specifically on research into system integration.

Laser and photon detector technology

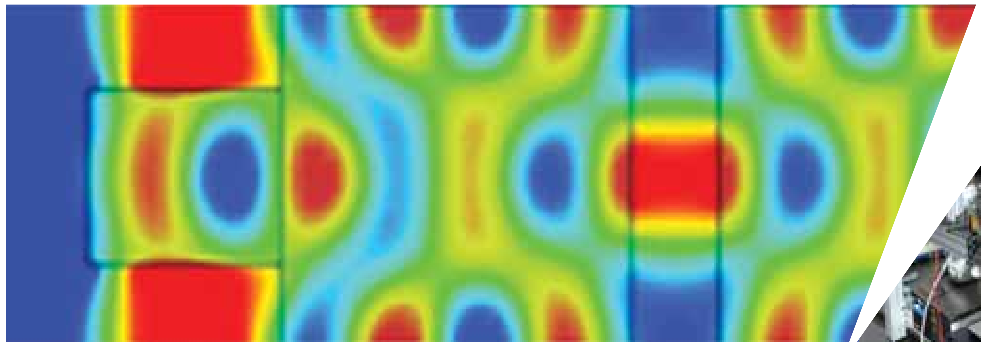
All partners are involved in this technology with all projects contributing by pushing the technological limits further. The technology will profit greatly from the expertise of the industry partners to fully exploit the potential of the developments within the network for applications, even beyond the field of accelerators. There is one project dedicated to this topic of detector R&D within the unique laser environment of the Extreme Light Infrastructure (ELI) facility.

UNIVERSITY OF LIVERPOOL

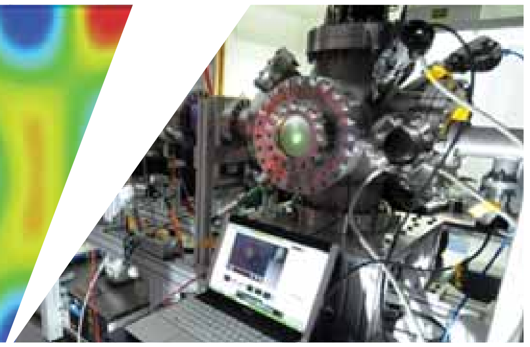
A member of the Russell Group of major research-intensive universities in the UK, the University of Liverpool has an enviable international reputation for innovative research. Currently around 20,000 students are enrolled into more than 400 programmes spanning 54 subject areas at its 3 faculties, including Health and Life Sciences; Humanities and Social Sciences; and Science and Engineering.

The Department of Physics at Liverpool is currently one of the very few academic departments in the UK to obtain top ratings for both teaching and research. It was recently awarded with a 24/24 score in the Teaching Quality Assessment and was very positively reviewed in the nationwide RAE. A rich variety of research is performed at Liverpool, including Particle Physics, Nuclear Physics, Condensed Matter Physics, Surface Science and Astrophysics.

Moreover, the University has the lead role in the Cockcroft Institute, an international centre of excellence for accelerator science and technology. Embracing academia, government and industry, it is unique in providing the intellectual focus, educational infrastructure and the essential facilities in innovating tools for scientific discoveries and wealth generation and the perfect environment for the coordination of a complex network such as LA³NET.



Simulation of electric field distribution in a micro accelerator



Gas jet beam profile monitor

Project:
Development of a compact, fibre optics-based electron accelerator

Recent developments in fibre optics provide interesting opportunities for minimizing the size of accelerators. This might open up avenues for a whole range of new applications, in particular for fundamental radiation biology and medical applications. Within this project the coupling of both laser light and electron beams into different fibre structures is being studied and optimized to maximize acceleration efficiency and enable quantitative measurements for both processes. This is complemented by numerical studies with the CST Particle Studio and VORPAL codes into field excitation and propagation in the fibre. The initial focus is on dielectric gratings structures due to their comparably simple geometry; studies centre around reachable acceleration gradients and beam quality. In a second step, photonic crystal fibres shall be analysed. Studies are being carried out in collaboration with experts from UCLA, the Universities of Tokyo and Manchester, Tech-X and KEK.

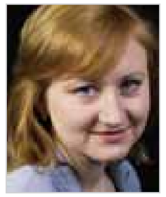
Researcher:
Aimierding Aimidula

Aimierding Aimidula was born in the Xinjiang Uighur Autonomic Region of China. He studied material physics as an undergraduate and focused on laser particle accelerations for his Master's, both at Xinjiang University.

His Master's thesis concerned numeric investigation of positron acceleration in the plasma wakefield driven by an asymmetric intense laser pulse. He also studied at Tokyo University and the Accelerator Research Organization of Japan (KEK) for one and half years as a research student. During this time, he worked on a fibre laser development laboratory project and computer simulation to design compact laser accelerators.

Project:
Development of a laser velocimeter

A curtain-shaped gas jet-based beam profile monitor has been developed by the QUASAR Group at the Cockcroft Institute as a least destructive monitor for various types of particle beams. The aim of this project is the development of a laser velocimeter for in-detail characterization of the gas jet allowing for investigations into the jet dynamics itself, simultaneously probing its density and velocity. For this purpose, laser self-mixing will be used for the jet analysis, providing unambiguous measurements from a single interferometric channel, realizable in a compact experimental setup that can be installed even in radiation-exposed environments. Investigations into jet seeding techniques will complement these studies.



Researcher:
Alexandra Alexandrova

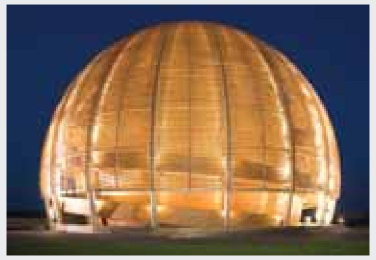
Alexandra Alexandrova studied physics and engineering at the National Research Nuclear University MEPhI (Moscow Engineering Physics Institute) from 2006 to 2012. Her specialty is condensed matter physics with the major subject, laser physics. Her specialization is concentrated flux of radiation – matter interaction. She has experience with laser interferometers and different laser systems. She developed the laser cleaning system for ITER (International Thermonuclear Experimental Reactor) and the Photonic Doppler Velocimeter for measurement of fast processes and detecting shock waves in matter explosions.

As a result of her studying Laser Physics, she has knowledge of setting up laser systems, light-matter interaction, laser light and signal processing (programming), speckle phenomena in laser light, laser interferometry, laser spectroscopy, generation and amplification of short laser impulses, physics of solid matter, and non-linear physics and instabilities. She also has experience in signal calculation by Fourier Transforms and solving Bloch equations.

CERN

CERN: The European Organization for Nuclear Research is a world leading center for fundamental nuclear, atomic and particle physics. It acts as a focal point for European physics and technology collaborations, each year hosting a community of over 10,000 visiting scientists from more than 600 institutes around the world.

CERN also functions as a hub for scientific training within Europe, with around 11,000 days of training facilitated annually. Consequently, this environment is ideal for early stage researchers (ESRs), who can benefit from the experience and infrastructure developed during the facility's illustrious history.

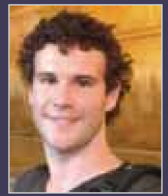


The Globe of Science and Innovation. Image courtesy CERN

Project: Developing optimal ionization schemes for the ISOLDE Resonance Ionization Laser Ion Source (RILIS)

The aim of this project is to improve the efficiency and reliability of the RILIS by developing new ionization schemes and modernizing the optical layout. The laser ion source of the ISOLDE on-line isotope separator is based on highly selective, multi-step resonance ionization by wavelength-tunable lasers. Recently, the addition of a UV pump beam and a set of three Ti:Sapphire lasers opens up possibilities for much broader choices of atomic transitions for the resonance ionization process.

The present technologies for generating wavelength tunable laser radiation: dye lasers, Ti:Sapphire lasers and optical parametric generators, will be exploited in the course of this project so that comprehensive ionization spectroscopy studies can be carried out. The exploration of future laser upgrade possibilities will require close links to the industrial sector.



Researcher: Tom Day Goodacre

Tom studied a BSc in Mathematics at the University of Leeds, graduating in 2010. The course included a broad range of modules from Electromagnetism and Cosmology to Group Theory and Analysis.

Following his BSc, Tom did volunteer work with Raleigh International on ecological and sanitation projects in Malaysian Borneo. Upon returning, he completed an MSc in Photon Science at the University of Manchester, which comprised courses related to the theoretical underpinnings of laser physics and some of the cutting edge laser based systems in use today. Tom's dissertation focused on the effects of implanting Aperiodic Distributed Feedback (ADFB) gratings into THz Quantum Cascade Lasers (QCLs).

Following the end of his MSc, in September 2012, Tom joined the LA³NET project working at CERN. He will also work towards a PhD in Nuclear Physics with the University of Manchester.

Project: Research and development of photocathodes sensitive to visible laser beams for photoinjector applications

Irene Martini will work on photoinjector R&D within the Compact Linear Collider (CLIC) study. Photocathodes capable of producing high current over a long time period are required for production of high brightness electron beams at accelerators.

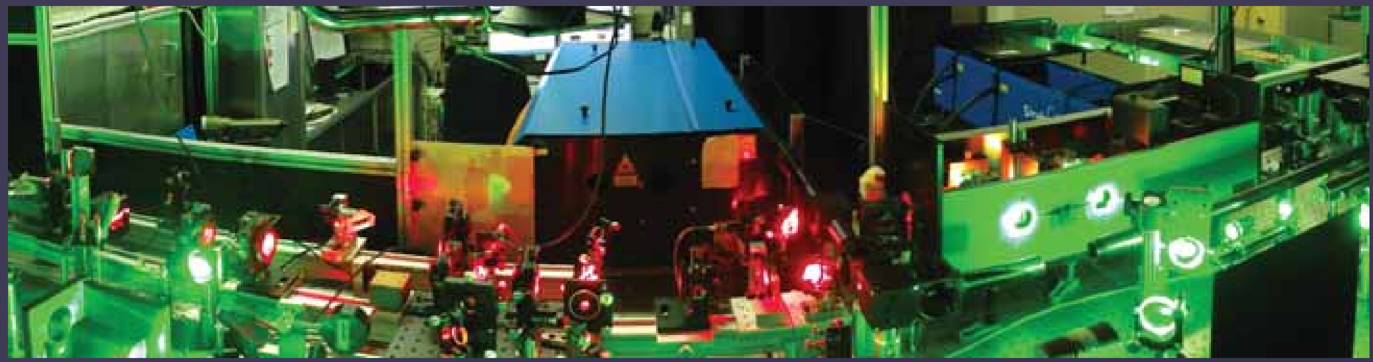
At present, CsTe photocathodes in combination with UV lasers are usually used for such purposes. Requirements for the sources of electron beams for future accelerators such as CLIC are more challenging and go beyond the performance of currently available UV lasers. However, lasers generating in the visible (green to near infrared) range could be used routinely if appropriate photocathode were available. To this end, different types of photocathodes are to be produced via a thin film deposition technique and studied by photoemission laser probing and surface analysis methods.

In this project, Irene will also be trained in operation, support and development of the laser installations used for photoinjectors at CERN.

Researcher: Irene Martini

Irene Martini studied Physics Engineering at Politecnico di Milano, obtaining a Bachelor's degree in 2009. The course comprised of mathematics, physics (both classical and quantum physics), as well as the basic engineering system. She then started a Master's degree in Nuclear Engineering. The main subjects of her studies were solid state physics, radiation-matter interaction and its applications. She worked on her Master thesis during an internship at CERN in the Vacuum, Surfaces and Coating group. This involved the measurement of electron stimulated desorption on copper, within the framework of the CLIC project, more precisely in the material studies for RF cavities. Part of her work was also dedicated to the study of hydrogen content measurement by laser ablation.

In July 2012, following the completion of her MSc, Irene joined the LA³NET project. During this fellowship she will be enrolled in the Material Engineering PhD School at Politecnico di Milano.



Panorama photograph of the RILIS setup at CERN (Image courtesy V. Fedosseev).

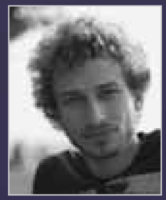
Project: Development of a laser emittance meter

The transverse emittance is one of the most important beam parameter at any particle accelerator. To develop an instrument which is able to determine this in a non-destructive manner is the aim of this project.

The parameters of the laser and the required optical components will be determined, the signals induced in a detector will be simulated and the most suitable detector type will be identified; a prototype setup will be designed, built up and tested directly on LINAC4 or on another machine with similar characteristics.

The trainee will be familiarized with the concept of a laser wire scanner, laser beam handling and manipulation techniques, as well as critical detector components at the beginning of the project.

The timing link between the laser and the beam, together with an envisaged real time monitoring put strong requirements on the photon detectors, the IT and control systems.



Researcher: Thomas Hofmann

In 2007 Thomas Hofmann finished his electrical engineering studies at the Georg-Simon-Ohm-Hochschule Nürnberg. Thereafter he continued with a Master's course on photonic engineering. In this time he acquired techniques for optical simulation and instrumentation as well as laser principles and applications. From 2009 Thomas worked for Thermosensorik GmbH, a company building infrared high precision camera systems.

His past projects were always application targeted. In his diploma thesis at Infratec GmbH in Dresden Thomas built a test station for a pyroelectric infrared detector with fabry-perot-interferometer. His Master's thesis which he did at the POF-Application Center concerned a CMOS-camera module for POF (Polymer Optic Fibres) and at Thermosensorik he worked at the calibration process for infrared cameras. All of these activities involved a combination of optical engineering and electrical engineering which is his main focus. Thomas Hofmann started at CERN in September 2012.

First half of CMS inner tracker barrel at the LHC © 2006 CERN

The Spanish Pulsed Laser Centre (CLPU) is a new research facility that has been created as a Consortium of the Spanish Ministry of Education and Science, the Regional Government of Castilla y León and the University of Salamanca, as part of the implementation of the Spanish Scientific Infrastructures Roadmap.

The objectives of CLPU are to build and operate a petawatt laser system, to develop ultra-short-pulse technology, and to promote the use of such technology in several fields such as physics, engineering, chemistry, or biomedicine.

The main system of CLPU is the VEGA laser. Based on titanium:sapphire, it delivers pulses of 30 femtoseconds at 800 nm in three different outputs at 20 terawatt, 200 terawatt and 1 petawatt. The three outputs are fully synchronized with the first two operating at 10 Hz and the third one having a maximum repetition rate of 1 Hz. CLPU aims at becoming a reference center for research in laser-plasma interactions and related applications such as laser particle acceleration. CLPU also hosts several state-of-the-art systems dedicated to attosecond, strong-field atomic physics, and microprocessing of materials.

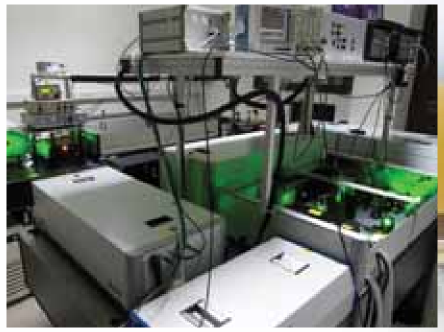
Project: Investigations into particle acceleration towards hadron therapy

High power lasers interacting with solid targets generate plasmas which are able to sustain huge electric and magnetic field gradients. These fields are in turn able to accelerate particles to high energies in a very short distance. By carefully selecting the parameters of the interaction, it is possible to produce ultra-low emittance beams of protons and ions with energies up to tens of MeV in regions of less than one millimetre. Such laser-generated beams are a potentially cheaper and more compact alternative to conventional proton accelerators, and therefore have great potential for medical applications. Laser-produced proton beams may be employed to generate short-lived isotopes to be used as radiotracers in Positron Emission Tomography (PET), or directly to treat tumours by hadron therapy, which is currently applied in costly cyclotron facilities.

However, there are some important technical obstacles that need to be solved before these applications may be realised. The main challenges are attaining a high enough proton energy, monochromaticity, energy stability, and average flux.

The aim of this project is to identify adequate parameter sets, target geometries, and beam shaping and control schemes to obtain proton and ion beams which could be used for nuclear radiotracers at lower energies and therapy at higher energies.

The trainee will first simulate the generation of particle beams by means of plasma codes before conducting experimental studies with CLPU's laser systems, as well as making experiments on proton acceleration at lower energies.



Laboratory arrangement for 20 TW laser

Researcher: Luca Christopher Stockhausen

Luca Christopher Stockhausen was born in Cologne, Germany. After successfully completing his school exams in 2008, he studied Physics at the University of Liverpool and attained his Master's degree in July 2012. In his Master's thesis he evaluated the feasibility of using a Compton camera detector system to analyse the gamma radiation released during Boron Neutron Capture Therapy (BNCT) to produce an image of the region being treated. BNCT is an advanced approach to treating cancer in humans. Luca has a strong focus on medical physics and radiotherapy and has been enrolled in several courses in this field. Besides he was active as student representative in various University committees.

In the LA³NET project he will investigate laser-driven particle acceleration for hadron therapy at CLPU under the supervision of Ricardo Torres and will in parallel be enrolled in the PhD programme of the University of Salamanca.

Luca is a passionate footballer and also enjoys travelling, skiing, good food and cooking.

Project: Femtosecond X-ray sources from laser-driven electron accelerators

Andreas Döpp will work on laser-driven electron acceleration and related femtosecond X-ray sources. Different targets and injection schemes will be evaluated using simulations in order to optimize either electron energy/charge or x-ray energy/brightness. On this basis the design for the first experiments on electron acceleration and x-ray emission with the VEGA facility at CLPU will be produced.

Andreas will also take part in experiments at partner institutes, in particular the Applied Optics Laboratory (LOA) in Paris where laser-accelerated electron beams will be used to create x-rays via the betatron process or Thomson/Compton backscattering at the new Salle Jaune facility. Furthermore it is envisaged that the first steps towards applications of these sources will be made, for example in phase contrast imaging.

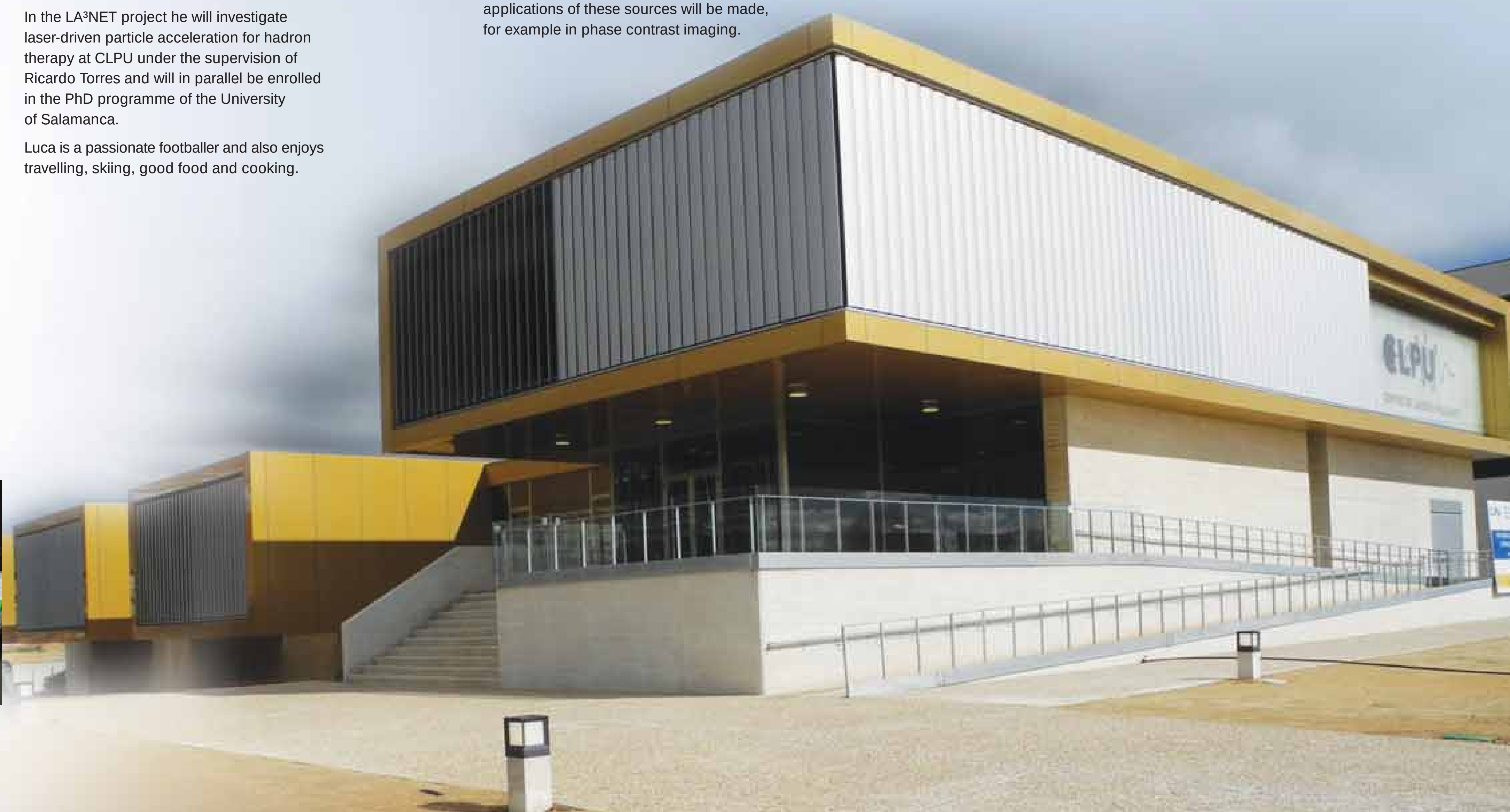
Researcher: Andreas Döpp

Andreas studied physics at RWTH Aachen University, the Swiss Institute of Technology in Lausanne (EPFL), University of Paris 11 and Imperial College London.

He started to work on laser-plasma interactions during his Bachelor's project on finite difference schemes for laser-pulse propagation in plasmas at RWTH Aachen. Thereafter he went to Lausanne where he specialized on high energy particle physics, while continuing to work on numerical schemes for plasma simulations at the Plasma Physics Research Center (CRPP). For his Master's project he first joined the Plasma Physics Laboratory (LPGP) at Paris 11 and later the Plasma Physics Group at Imperial College London.

His training also comprised participation in experiments at the Lund Laser Centre in Sweden and the Central Laser Facility at Rutherford Appleton Laboratory. In early 2012 he graduated at RWTH Aachen with an MSc on betatron radiation in laser-driven electron accelerators.

At CLPU Andreas is supervised by Camilo Ruiz and he will be responsible for research on electron acceleration. He will also continue to investigate femtosecond x-rays from laser-plasma accelerators and their applications, in which context he will be co-mentored by Kim Ta Phuoc from the Applied Optics Laboratory (LOA) in Paris. Beside these main objectives Andreas is interested in radiation physics for life sciences and as science ambassador he shares his passion for physics with the general public.



DANFYSIK

Danfysik has been driven by the fascination of accelerator technology in its most advanced form for more than 45 years.

What started in a humble farm house 'factory' with small scale development and production of components like magnet power supplies and accelerator magnets, has expanded towards building complete accelerator systems with great attention to customers' needs and demands.

Danfysik is today one of the world's leading companies within the development and manufacturing of high quality equipment for particle accelerator laboratories, healthcare and industry, and employs some of the most skilled, experienced and dedicated engineers and technicians. Danfysik has customers and partners all over the world.

Project:
Developing the current experimental research into laser acceleration to a pre-commercial level

One of the main challenges for laser-based acceleration systems is to control the six-dimensional phase space of particles and transport a well defined beam in a stable and industrially robust manner to the target or the application process. Similar challenges apply for reverse experiments like the interaction between electron beams and high power lasers.

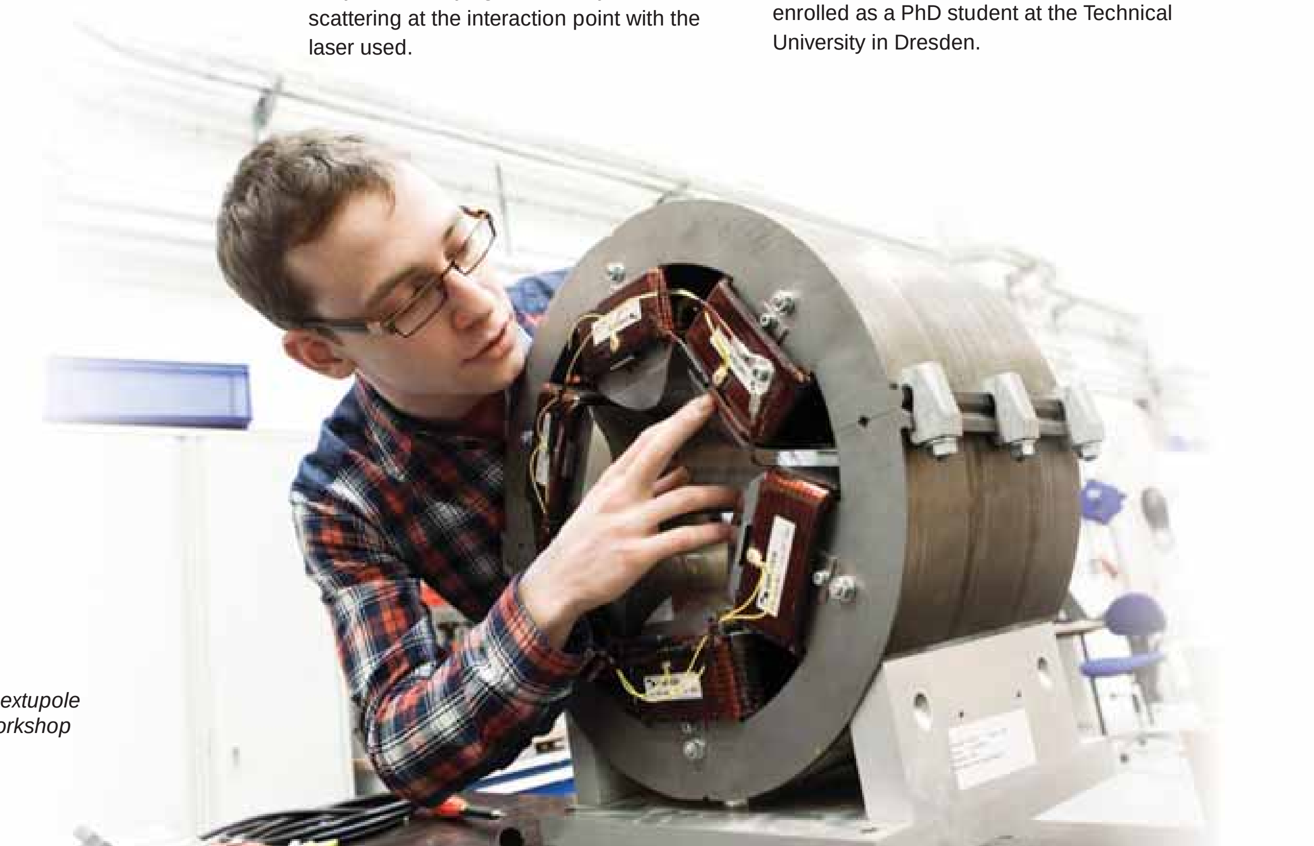
The focus in this project is hence to specify, design, build and test a final focus magnetic lens system to be used for Thomson scattering experiments at the ELBE facility at HZDR. The resulting prototype final focusing system, which facilitates spot sizes of ultra-short electron bunches beyond the chromaticity dominated limits, will be installed. After successful installation of the lens system the focussed electron beam from ELBE will be characterised and Thomson scattering experiments will be undertaken where the focussed electron beam is combined with a laser beam from either the petaWatt laser Penelope or the terawatt laser Draco to generate x-rays. This new focusing system should increase the yield of X-rays generated by Thomson scattering at the interaction point with the laser used.

In addition, the experience gained in designing magnets for this work will be applied to assist Danfysik in designing and testing magnets for other customers. Further work may also include collaboration with the Laser Acceleration Group at HZDR to investigate the use of permanent-magnet based lenses for collection and collimation of laser accelerated ions and the potential application of laser-accelerated ion beams.

Researcher:
Jakob Krämer

Jakob Krämer studied physics at the University of Duisburg-Essen, Germany obtaining his Master's degree in September 2012. During his master thesis studies he finished the commissioning of an irradiation facility for highly charged ions and investigated the defect creation in graphene on calcium fluoride. For his studies Jakob was awarded a scholarship by the Cusanuswerk, the scholarship body of the Catholic Church in Germany, which offers a comprehensive interdisciplinary education programme. For two years he was a delegate of a regional group of scholars and since June 2012 he has been a member of their board.

In October 2012 Jakob took up his position at Danfysik in the LA³NET project and is enrolled as a PhD student at the Technical University in Dresden.



Inspection of a sextupole magnet in the workshop

FOTON

FOTON is a Czech company specializing in designing and manufacturing of advanced scientific instrumentation. Its activities include high voltage supplies, special electronics systems, optoelectronics, micro positioning automation, plasma diagnostics, vacuum control technology and instrumental engineering.

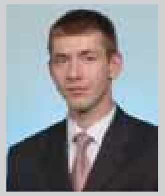
FOTON specializes in highly customized scientific instrumentation. Its products have been used in many prestigious scientific and technical projects, e.g. vacuum control technology for high-power laser labs and particle accelerators, high voltage supplies for nuclear technology, as well as the high temperature plasma diagnostic instrumentation.

During its 12 year's existence FOTON has designed and manufactured more than 100 innovative product prototypes for its customers, mainly special power supplies and vacuum controllers. High reliability, state-of-the-art design, long-time experience in scientific applications and a professional approach guarantee high quality of all products and an exceptionally high degree of customer satisfaction.

Project:
Computer-based modelling and experimental optimization studies into novel high voltage supplies and generators

High voltage (HV) supplies and generators are a requirement of many projects within LA³NET. At FOTON Kamil works on the design of novel HV power supplies and generators, carrying out tests and experimental work. Within the project he is responsible for optimization of circuit design performance with SPICE simulation and analyses. The SPICE environment allows him to reduce design errors and prototype faster. Printed circuit board (PCB) design is also a part of his everyday work on the optimization of HV instrumentation.

Hands-on work at FOTON on understanding different elemental blocks used in a HV power supplies allows him to accumulate comprehensive knowledge about overall efficiency, accuracy, electromagnetic compatibility (EMC) properties and thermal management of power supplies and create better solutions. Regular discussions with network partners about their HV requirements help to define future standards and also ensure a bi-directional knowledge exchange. Tests of developed systems in partner's laboratories will finalize this project.



Researcher:
Kamil Nowacki

Kamil studied Electronics and Telecommunications at the Military University of Technology in Warsaw, Poland. As a graduate with specialization in optoelectronic, he received a thorough education in the field of photonics and had the opportunity to participate in many theoretical and practical classes. The specific areas of his education were focused on: design and analysis of optical systems, laser optics and electronics, laser-matter interactions, and detection of optical signals etc. However, during his education he developed a keen interest in the subject of advanced power supply units and control systems.

In his Master's thesis, Kamil focused on developing a high power laser diode power supply with current and temperature stabilization for a project carried out by the Institute of Optoelectronics at the Military University of Technology in Warsaw. From 2008 he developed his professional competencies in the R&D department working for a private company operating in a CCTV market.

In June 2012, Kamil joined the LA³NET project enabling him to continue his research as a trainee at FOTON.

Cockcroft-Walton voltage multiplier in Multisim environment.

GRAND ACCELERATEUR NATIONAL D'ION LOURDS

GANIL is one of the four largest laboratories in the world dedicated to research using ion beams. Its experimental programme ranges from radiotherapy to the physics of the atom and its nucleus, from condensed matter to astrophysics.

In nuclear physics, work at GANIL has led to numerous discoveries related to the atomic nucleus, to its thermal and mechanical properties, and to so-called exotic nuclei, as these do not exist naturally on Earth. For 10 years, GANIL has been one of the major facilities in the world for delivering accelerated radioactive ion beams with SPIRAL1. As the host facility for the next generation RIB factory SPIRAL2, GANIL is naturally involved in the R&D programmes for the production of new radioactive beams.

Project: Integration of a resonant ionization laser ion source system into the existing off line test bench of the SPIRAL2 TISS

Jose Luis Henares will focus on the development of the new laser ion source for the SPIRAL2 facility by optimizing the resonant laser ionization of selected elements of interest while reducing, if possible, the contamination by unwanted species. For that purpose he will develop resonant laser ionization schemes and study the properties of different hot cavities. These results will be used in the SPIRAL2 ion source prototype conception and development for the integration of a resonant ionization laser ion source system into the existing off line test bench of the SPIRAL2 TISS. He will also participate in the off-line experiments to study RILIS for complete characterization of the system regarding ionization efficiency, selectivity, ion beam emittance and long term operation.

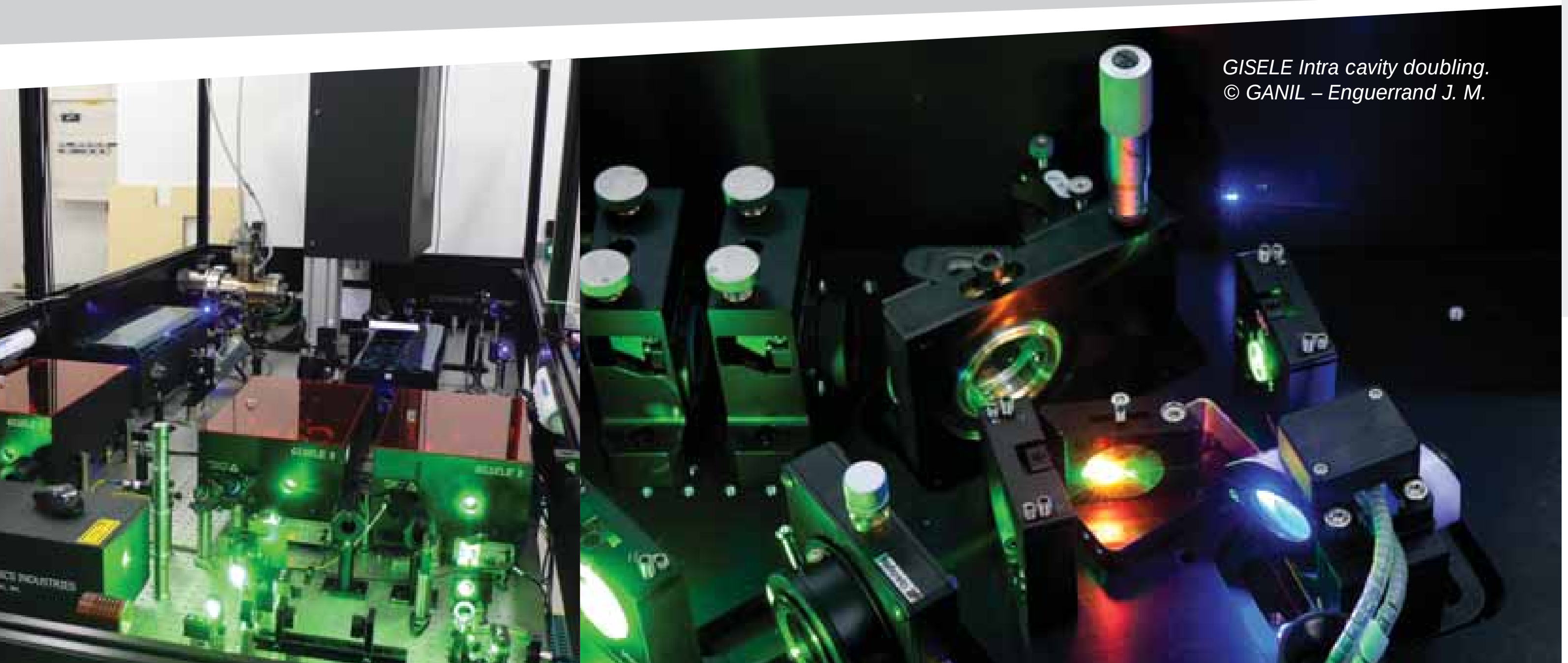
The Target and Ion Source System (TISS) has to be carefully designed, fulfilling the following requirements: high radiation hardness, long term reliability of no less than 3 months and high efficiency. The source has to be optimized to maximize the photo ionization efficiency of the element of interest while minimizing the surface ionization of unwanted elements present in the production target. Therefore different materials, ionizer forms, diameters and lengths, as well as field geometries will be studied.

Researcher: Jose Luis Henares

Jose Luis Henares was born in Palencia (Spain). He studied Materials Science Engineering in the University of Salamanca (Spain) and attained his Master's degree in June 2011. His Master's thesis concerned the study of the tribological properties of metallic surfaces structured with a femtosecond laser. The objective was to improve the life of mechanical parts subjected to wear strains.

Jose Luis worked 18 months for the University of Salamanca in a project of aluminium sinterization from workshop debris and he spent 10 months at the CLPU (Salamanca, Spain) employed to study radiation generation by femtosecond laser sources. He also received training on Industrial Design and Art History.

In 2012 Jose Luis obtained a Marie Curie fellowship from the LA^{3}NET project at the ion accelerator GANIL (Caen, France) and enrolled in the PhD programme of the University of Caen.



GISELE Intra cavity doubling.
© GANIL – Enguerrand J. M.

HELMOLTZ ZENTRUM DRESDEN-ROSSENDORF (HZDR)

Helmoltz Zentrum Dresden-Rossendorf (HZDR) is a public-funded research institute conducting research in those fields that are of great relevance to society such as health, energy, and matter.

The HZDR has been a member of the Helmholtz Association, Germany's largest research organization, since January 1, 2011. It is located at four sites in Dresden, Freiberg, Leipzig and Grenoble employing more than 900 people – 430 of whom are scientists including 160 doctoral candidates. PhD students are educated in collaboration with Dresden University of Technology and with other universities and research organizations in the Dresden area.

The HZDR organizes special lecture series and workshops for PhD students and young researchers. HZDR maintains three user facilities: the Radiation Source ELBE, the Ion Beam Center and the Dresden High Magnetic Field Laboratory.

The Radiation Source ELBE is a user facility based on a superconducting linear accelerator with high brilliance and low emittance. The electron beams are used to produce different kinds of radiations: gamma-ray, x-ray, infrared light from two free-electron lasers, neutrons and positrons. Together with the DRACO laser system (5 J in 30 fs to be upgraded to 500 TW in 2013), this facility is used in the education of young researchers and PhD students and a resource for research projects in accelerator physics, laser physics, laser-plasma acceleration, radiation physics, laser-beam interaction, application of radiation in semiconductor physics, material research and biology.

Project: Development of a high brightness superconducting RF photo injector for electron-laser interaction experiments

At HZDR, the worldwide first successful proof-of-principle Superconducting Radio Frequency (SRF) gun was installed and later a second one for the ELBE accelerator was developed, installed, and put into operation. However, critical components of the SRF gun still need further optimization and refinement, such as the superconducting cavity, photo cathodes, as well as the drive laser system.

Within the project the gun components and operation parameters will be optimized for an application of producing short-pulse, mono-energetic x-rays by inverse Compton scattering. In addition, approaches that will be tested are an increased acceleration gradient, RF focusing, the installation of a superconducting solenoid, shaped photo cathode surfaces, and an additional TE-mode wave coupling into the cavity.

The project activities include development and application of laser beam and electron beam diagnostics as well as beam dynamic simulations.

Researcher: Pengnan Lu

Pengnan Lu studied undergraduate physics at Peking University, China from 2005 to 2009. Specializing in accelerator physics he graduated with a Master's degree in 2012.

His work was devoted to space charge compensation in high intensity, low energy ion beams. A new model was set-up to simulate this effect. As a result of Pengnan's work parameters such as beam emittance, transport efficiency and beam focusing were obviously improved in both argon and krypton compensation. He designed new beam line components and developed a new emittance meter which reduced the error from 16 % to 4 %. The work included the software development for controlling beam diagnosis and for measurement data processing.

Pengnan joined LA^{3}NET in July 2012. He will mainly work on the development of a high brightness superconducting RF photo injector for electron-laser interaction experiments at the ELBE accelerator facility.

Superconducting Radio Frequency (SRF) gun

HELMOLTZ ZENTRUM DRESDEN-ROSSENDORF (HZDR)

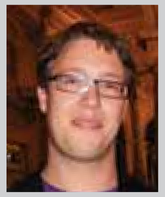
Project:
Laser particle acceleration and laser driven Thomson x-ray backscattering on electron sources

The DRACO laser system is a high power (5 J, 30 fs) laser system. Recent experiments with the DRACO system on laser wakefield acceleration (LWFA) have proven its capability to accelerate electron beams to high energies above 100 MeV in a much shorter acceleration length than required with conventional electron accelerators. With further development, it is believed that LWFA will be able to act as an electron source which is able to provide short (fs-range) and low emittance electron bunches. These LWFA electrons can be used as a driving beam for a laser-electron Thomson scattering x-ray source which produces ultrashort, bright x-ray pulses. In combination with ion sources, this opens new experimental opportunities for the generation and ultrafast probing of matter under extreme conditions (pump-probe experiments).

For example, by heating matter isochorically with laser-accelerated protons and probing on the sub-ps time scale the dynamics of the ion-induced melting and subsequent relaxation processes in the material. Such techniques are expected to be important for future research programmes at the Linac Coherent Light Source (LCLS) and X-ray Free Electron Laser (XFEL). Realizing such complex, multiple-species pump-probe experiments will require significant improvements in many aspects of LWFA, including spectral distribution, charge optimization and shot-to-shot stability and sources synchronization.

Jurjen Couperus will work in the framework of implementing such fast pump-probe experiments at the HZDR.

For this goal, he will work on developing new schemes and techniques for laser acceleration of electrons and implementing and testing them at the DRACO laser system and other collaborating laser facilities. He will also work on further developing the PHOENIX x-ray source, which relies on Thomson scattering of conventional accelerated electrons from the ELBE source with the DRACO laser system. This development is seen as a crucial stepping stone towards Thomson scattering on LWFA electrons. Ultimately x-ray and electron sources will be implemented for pump-probe experiments.



Researcher:
Jurjen Couperus

Jurjen studied Applied Physics at the University of Twente, the Netherlands. After finishing his Bachelor's degree in 2008, he continued his studies within the Optics and Biophysics master track of Applied Physics. During his education he developed a keen interest in lasers and their nonlinear applications. He became a student member in the Laser Physics and Nonlinear Optics research group.

In 2010, he did a 3.5-month internship in the Laser Particle Acceleration Division at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) in Germany. There he focused on the development and implementation of on-site diagnostic for the 150 TW high power DRACO laser system.

In his Master's thesis, Jurjen focused on Laser Wakefield Acceleration (LWFA) of electrons. In a cooperation programme between the University of Twente and the HZDR, he realized an interferometric setup where helium gas-jet targets for LWFA can be analysed. Using these target characterisations together with theory scaling laws, a set of initial parameters was determined for experiments with the DRACO laser system. In experiment, this lead to the first laser accelerated electrons at the HZDR.

In March 2012, Jurjen joined the LA^{3}NET project enabling him to continue his research as a trainee based at the HZDR. His work focuses on laser particle acceleration and laser driven Thomson x-ray backscattering on electron sources.

INSTITUTUL NATIONAL PENTRU FIZICA SI INGINERIE HORIA HULUBEI (IFIN-HH)

IFIN-HH is the central institute for nuclear and atomic physics research in Romania. Its more than 400 scientists are collaborating with numerous institutes in almost all fields of fundamental and applied nuclear physics.

IFIN-HH has a very strong record as a national training centre and extensive experience in hosting Diploma and PhD students. The Department of Nuclear Physics IFIN-HH is a multidisciplinary research unit in the field of nuclear and atomic physics. The department's mission lies in the areas of basic and applied research, particularly in the fields which are relevant for sustainable development and the national endeavor for integration in the European Union. Moreover, the Nuclear Physics (NP) pillar of the Extreme Light Infrastructure (ELI) has been approved by the European Commission for construction by IFIN-HH on its premises in partnership with other research institutes in the Magurele Campus and in a growing international collaboration. Once completed, the ELI-NP will be the most powerful, exawatt-class laser in the world.

ELI-NP is a very complex facility which will host two machines of extreme performances:

- A very high intensity laser, where beams from two 10 PW lasers are coherently added to get intensities of the order of 10^{23} - 10^{24} W/cm^2 and electrical fields of 10^{15} V/m;
- A very intense (10^{13} γ/s), brilliant beam, 0.1 % bandwidth, with E_γ > 19 MeV, which is obtained by incoherent Compton back scattering of laser light off a very brilliant, intense, classical electron beam (E_e > 700 MeV) produced by a room temperature linac.

ELI-NP will create a new European laboratory to consistently investigate a very broad range of science domains, from new fields of fundamental physics, new nuclear physics and astrophysics topics, to applications in material science, life sciences and nuclear materials management.

The IFIN-HH Tandem accelerator

Project:
Development of a 3D neutron detector for complex geometries

The high power laser pulses will be able to accelerate electrons and heavy ions at high energies, inducing a huge number of nuclear reactions events and intense fluxes of radiations including X-rays, gamma-rays and neutrons. Whether for the optimization of laser driver neutron generators or for the characterisation of heavy ion acceleration mechanisms, a complex neutron detection system will be a valuable tool to measure the energy and angular distribution of generated neutron flux taking advantage of neutron time of flight to coupe with huge prompt gamma ray flash. This project requires an integral approach into the simulation of the experimental conditions, i.e. the events triggered by the laser system, and the response of the full detector matrix. The trainee will carry out numerical studies, detector development including associated fast electronics and data acquisition systems and will participate in experiments, off-line data analysis and the dissemination of results in conferences and articles. They will be embedded into an international collaboration and will profit from the experience at IFIN-HH, at the neighbouring Institutul National de Fizica Laserilor, Plasmei si Radiatiei (INFLPR) and European partners where high power lasers system are in operation. The trainee will also be trained in the development of latest control system technologies, an important element of the overall system integration.

KARLSRUHE INSTITUTE OF TECHNOLOGY (KIT)

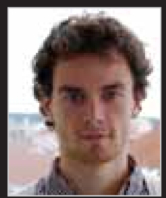
KIT was founded on the first of October 2009 by a merger of Forschungszentrum Karlsruhe and Universität Karlsruhe. KIT bundles the missions of both precursory institutions:

A university of the state of Baden-Wuerttemberg with teaching and research tasks and a large-scale research institution of the Helmholtz Association conducting programme-oriented research on behalf of the Federal Republic of Germany. With 8,000 employees, more than 18,000 students and an annual budget of €700 million, one of the largest research and teaching institutions worldwide was established.

The ANKA Synchrotron Radiation Facility at the KIT is responsible for the operation and expansions of the storage-ring based light source ANKA. Research and development in accelerator physics currently under way at ANKA includes the optimization of coherent Terahertz (THz) radiation production in the storage ring with the use of low momentum compaction factor (low-alpha) optics. A broad research programme on the characterization of coherent THz radiation as well as on the properties of the low-alpha mode has been established including both single particle dynamics issues as well as collective effects. These activities are also part of a longer term effort towards the realization of a state-of-the-art LINAC based coherent THz source currently under design: the TBONE (THz Beam Optics for New Experiments) facility. A test facility for a versatile, compact linac-based source of coherent THz radiation, FLUTE, is currently under construction at KIT.

Project:
Measurement of the longitudinal bunch shape with electro-optical techniques in an electron accelerator

This project aims at the realization and use of a high resolution electron bunch length and shape detection system. It is based on electro-optical techniques and measures the transient electric field of the electron bunch. Special care must be taken for the system to be suitable for the specific operation conditions at the new linear accelerator currently being designed at KIT. The goal of this project is to design new diagnostics for short bunches and to further the understanding of beam dynamics effects.



Researcher:
Andrii Borysenko

Andrii studied physics in the Taras Shevchenko National University of Kyiv, Department of Nuclear Physics and Engineering.

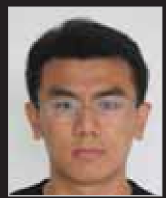
In 2010 he obtained his Bachelor's degree and was a participant in a summer student programme at the Institute for Nuclear Physics of the Research Center Jülich. There he worked on developing track-finder software for processing the data from the anti-proton annihilation at Darmstadt (PANDA) detector (a component of the Facility for Antiproton and Ion Research (FAIR)).

After that Andrii enrolled in the Master's programme in Nuclear and High Energy Physics in the Taras Shevchenko National University of Kyiv. During this time he had a two-month internship at the Max Planck Institute for Nuclear Physics. There he gained experience with the investigation of beam-target interactions at storage rings. He graduated in 2012 with specialization in "Nuclear physics, high-energy, and particle physics".

Project:
Precision determination of electron beam energy with Compton backscattered laser photons at ANKA

One of the most important parameters of a storage ring is the electron beam energy and has to be known very accurately. So far at ANKA, the method of resonant depolarization is used to determine the energy at around 2.5 GeV precisely.

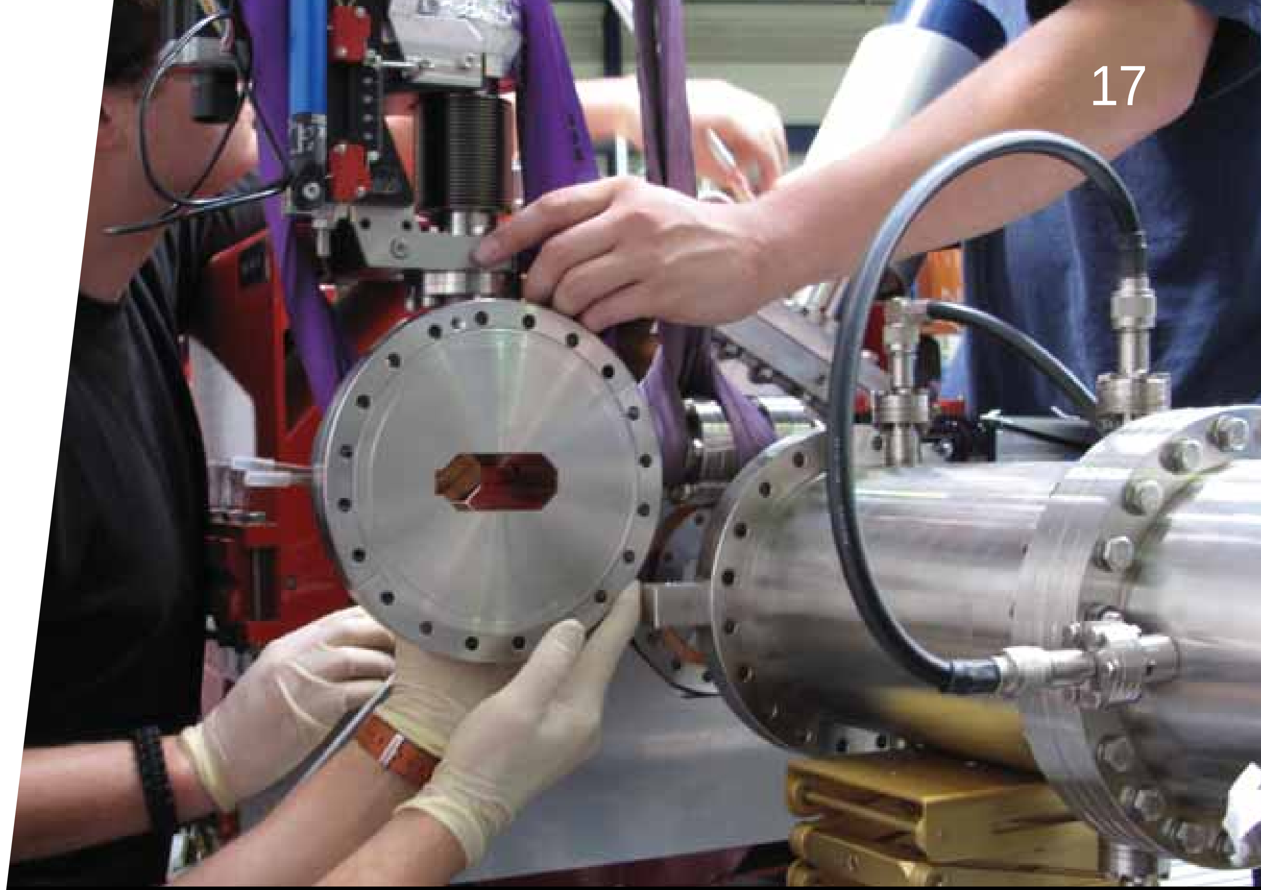
At lower beam energies, however, this method becomes cumbersome and alternatives have to be found. One such method is the detection of Compton backscattered photons. A setup for such an energy determination will be developed at the booster of ANKA at an energy level of 500 MeV.



Researcher:
Cheng Chang

Cheng studied physics at Peking University (China) and continued as a Master student in the Institute of Heavy Ion Physics in the field of accelerator physics. He attained a Bachelor of Science in physics and a Master of Engineering in nuclear technology and applications, both from the Physics Department of Peking University in China.

During his Master degree Cheng gained experience in designing a Compton backscattering (CBS) x-ray source based on superconducting technology and an energy recovery linac. This work involved both analytical calculation and simulation, mainly concerning electron beam-laser interaction including a laser pulse storage cavity. He also has broad work experience related to superconducting accelerator physics and engineering issues such as Cs_2Te photocathode fabrication, superconducting cavity tuning, and Radio Frequency (RF) studies and applications, etc



Installation works in the ANKA storage ring

Electro-optical crystal (GaP) mounted on support

SCIENCE AND TECHNOLOGY FACILITIES COUNCIL (STFC)

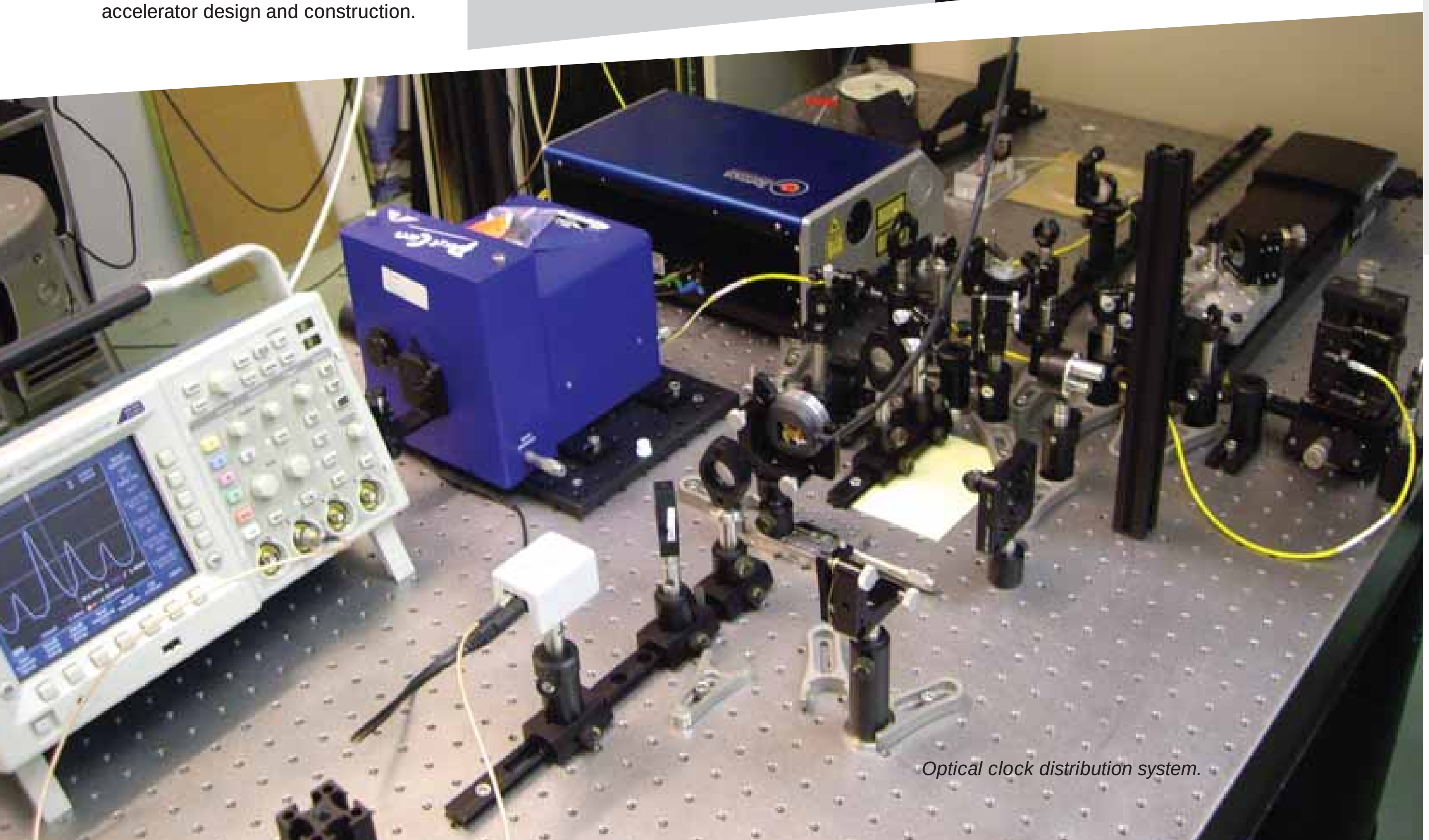
STFC is the UK organization responsible for providing large scale accelerator facilities within the UK, and UK involvement in international accelerator programmes.

The Accelerator Science and Technology Centre (ASTeC) is a distinct department with STFC which has the remit to undertake advanced research and development activities that will allow STFC to provide or contribute to current and future accelerator projects, both with the UK and internationally. ASTeC is responsible for the operation, and the setting of R&D priorities, for the ALICE (Accelerators and Lasers in Combine Experiments) superconducting energy recovery test accelerator at Daresbury Laboratory. It has a lead role in delivering the EMMA (Electron Machine with Many Applications) project, the world's first non-scaling Fixed Field Alternating Gradient (FFAG) accelerator, in which it has significant responsibility for the accelerator design and construction.

Project: Accelerator Timing Monitor with Femtosecond Precision

The next generation of accelerators require unprecedented stability and precision in the synchronization of free electron lasers, laser wakefields and time-resolved spectroscopy. Leading technological techniques to providing such precision is based on laser optical clocks and actively stabilised optical fibre distribution systems. These deliver better than 5 femtosecond stability and are advancing rapidly towards the attosecond regime. The Versatile Electron Linear Accelerator (VELA) is a new accelerator with a high performance, modular injector currently being built at Daresbury Laboratory, which will deliver a capability for the cutting edge development of advanced accelerator systems.

The fellow will join the Accelerator Science and Technology Centre (ASTeC) Lasers and Diagnostics Group on developing a high stability optical synchronisation system for advanced accelerators. The PhD project will aim to develop single-shot techniques for measuring the arrival time of electron bunches and high power lasers with respect to optical clock pulses. The use of nonlinear optical materials with ultrafast response times will be targeted to achieve femtosecond level precision in determining arrival times, and the arrival time monitors will form a critical part of the optical timing system. The project will be a mixture of theoretical and experimental activities, requiring an understanding of the physics of non-linear optics and short pulse propagation, and apply this understanding to practical experimental tests. The student will have the opportunity install and carry out tests of arrival monitoring concepts on the VELA.



Optical clock distribution system.

UNIVERSITY OF DUNDEE

The University of Dundee is one of the UK's leading universities, internationally recognized for its expertise across a range of disciplines including science, medicine, engineering and art.

The Carnegie Laboratory of Physics at Dundee has a history of world leading research into photonics, materials, biophysics and communications. Many advances and world firsts have been achieved including thin film electronics and flat panel displays. It now focuses strongly on photonics, nano-materials, biophysics, sustainable energy and imaging. Its laboratories are equipped with state-of-the-art facilities for miniature laser development, bio-photonics, biomedical physics and optical manipulation, materials deposition and laser processing, nano-scale materials research, and organic materials.

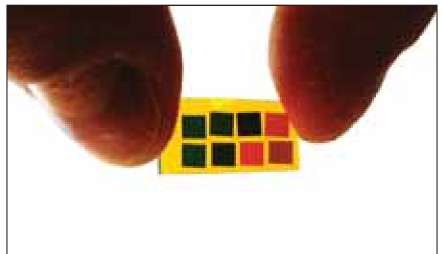
Laser processing lab

Project: An advanced electro-optic bunch time profile monitor for the CERN CLIC Project – development of novel materials and techniques

This project aims at pushing the limits of electro-optic (EO) techniques to measure relativistic electron bunches with a time resolution better than 20 femtoseconds. Such an ambitious extension requires advances in both the theoretical and experimental aspects of the problem, and will require work on new optical materials and advanced laser techniques.

The ability to measure electron bunches with this time resolution would have a significant impact on coherent light sources such as the Linac Coherent Light Source (LCLS) or X-ray Free Electron Laser (XFEL), since the generation of coherent x-ray beams from these machines depends critically on maintaining an ultrashort bunch length and direct measurement is not currently feasible. Measurements will be carried out with a number of (inorganic and organic) optical materials such as GaSe, DAST, MBANF, and on a range of poled organic polymers.

In addition, the group is also experimenting with the development of novel nanostructured metamaterials based on metal-dielectric nanocomposites (MDN). These silver-doped glass nanocomposites are processed using short-pulsed laser systems to yield thin detectors exhibiting a useful EO effect, and could in principle solve many of the problems associated with the 'classical' materials.



Silver nanoparticles embedded in glass and irradiated with laser beam to change their shape. Dichroism from polarised light penetrating the sample.

Researcher: Mateusz A. Tyrk

Mateusz Tyrk was born in Gdańsk in Poland in 1987. He studied applied physics in the Faculty of Applied Physics and Mathematics at the Gdańsk University of Technology (Politechnika Gdańska), and graduated in 2011 defending his Master's thesis on the subject of 'The DtN and NtD methods for the interior Helmholtz problem'. He gained there a great experience from the interfaces of applied physics, mathematics and numerical analysis. He has gained an expertise in a number of laboratory techniques that he used during his studies, as well as the ability to plan and organize a complex piece of work, solve problems in an effective manner and write a detailed analytical report.

After moving to Scotland in 2012 he started working as a laser systems engineer in Coherent Glasgow – the Scottish branch of one of the biggest laser manufacturers in the world. In September 2012 he joined the LA³NET consortium in a research project based at the University of Dundee.

TRAINING

Training the next generation of particle accelerator experts

Future generation scientists & engineers

The multi-disciplinary nature of the accelerator field is an ideal training ground for future scientists and engineers. The LA³NET consortium combines developments into laser technology and sensors with their application at advanced accelerator facilities, providing complex beams ranging from the highest brightness electron beams in fourth generation light sources to high intensity proton beams in spallation sources. The partners cover a very broad, yet closely interconnected, experimental programme that combines many different scientific disciplines, such as for example mechanical and radio frequency engineering, physics, electronics, IT, material sciences and medical applications.

This creates a truly collaborative network within a strong interdisciplinary environment that will provide an excellent basis for the training of researchers. The contribution of industry partners to the definition phase of all research projects and their continued active role ensures that the transfer of industry-relevant skills is an integral part of all individual research and training projects.

Consequently, the skill-sets gained by the researchers through LA³NET will be valuable for application across a wide range of disciplines both in academia and industry. This will be the perfect launch pad for the careers of the researchers while contributing to the European Research Area (ERA) and the future economic competitiveness of Europe.

Now is the Time!

Now is the perfect time for training motivated early stage researchers at the interface between accelerator R&D and laser technology as this field will play a crucial role in the future development of accelerators:

- Laser-based particle sources are well suited for delivering the highest quality ion and electron beams
- Laser acceleration has demonstrated unprecedented accelerating gradients and could potentially be a better alternative for conventional particle accelerators in the future
- Laser-based beam diagnostics provide the only way to characterise many complex particle beams

Secondments

Cross sector work experience is very important to help researchers making their career choices. An extensive secondment scheme has been set up to enable all LA³NET fellows to spend time working at other institutions within the network. This will provide them with hands-on training in specific relevant techniques and give them broader experience including different sectors. The established consortium is continuously expanding with new adjunct partners joining to provide additional training opportunities as the project progresses.

LA³NET Training Programme

The fundamental core of the training is a dedicated cutting edge research project for each researcher. Most trainees will be in post for 36 months and will also be registered into a PhD programme. Their training will hence be to a large extent through research, but will be complemented by secondment opportunities and a series of network-wide events that will also be open to the wider scientific community.

International Schools and Workshops

The first International School on Laser Applications in October 2012 kick-started a packed series of events to be delivered by the end of 2015 by LA³NET. This ranges from **complementary skills training** for all LA³NET fellows to **Schools** and **Topical Workshops.** These events will bring together experts from across the world in focused research areas to discuss the present state-of-the-art and review challenges with the LA³NET scientists and researchers.

Schools:

The First School on Laser Applications was a five day event hosted by LA³NET partners GANIL, France and followed the successful format pioneered in the DITANET project. Renowned lecturers covered topics such as introduction to lasers, beam shaping, laser ion sources, laser acceleration, laser based beam diagnostics, industrial applications and knowledge transfer.

The School brought together researchers from the laser and accelerator communities in the perfect environment for learning and discussion. In addition to the lectures there were study groups, poster sessions and two seminars on major international initiatives in the laser and light sources field.

This event will serve as the perfect template for subsequent schools which will include a follow-up on Laser Applications at Accelerators to be hosted by CLPU, Spain in 2014.

Complementary Skills Training:

A good set of complementary skills will help the researchers achieve the greatest impact from any technical or scientific knowledge they gain. Complementary skills will also make the researchers more attractive to employers and give them a valuable advantage in the competitive jobs arena. These skills are transferable and so make them more robust and flexible; ready to take advantage of cross-sector opportunities between industry and academia or to work better at an interdisciplinary level.

The LA³NET researchers are receiving training in complementary skills through an established quality school programme. This is providing them with the non-technical skills that will be invaluable for their future careers whether that be in academia or industry. The second LA³NET School on Complementary Skills was held in Liverpool and included training on presentation skills, scientific writing, career planning, project management and team working.

One aspect of the training involved working in small teams to develop and plan an outreach event. This entailed application of the skills learnt and familiarized the trainees with the challenges linked to managing event organization and the preparation of funding bids.

Building on this school, a two day workshop on ‘Knowledge Transfer and Spin-off Development’ will be organized by Research Instruments (RI) in the final year of the project. It will focus on the important differences that exist in research projects in academia compared to in the industry sector. This will familiarize the trainees with Intellectual Property Rights (IPR), knowledge protection, patent regulations and University-specific laws in different countries. An overview of opportunities for start-up funding will also be covered.

Topical Workshops:

A series of Topical Workshops will be delivered covering all important research areas of the LA³NET project. A typical Topical Workshop will bring together 25-50 experts and will last 2 or 3 days.

The First Topical Workshop on Laser Based Particle Sources took place at CERN in February 2013. The Fraunhofer Institute for Light Technology will host a workshop on Laser Technology and Optics Design delivered through a training course to take advantage of the institute's unique expertise. Acceleration Techniques will be the focus of a third workshop delivered by HZDR and a Beam Diagnostics workshop will be hosted by The Cockcroft Institute/STFC later in the programme. Participation is open to researchers from outside the consortium and often scholarships can be provided to support contributions from researchers from outside the network.

Final LA³NET Conference:

The researchers will be involved in the organization of a three day international conference in the last year of the LA³NET project. This will promote the developed techniques and research outcomes from LA³NET and other current research projects and enable the network fellows to engage with interesting university groups and private companies. The conference will also present the opportunity to pave the way for follow-up activities between the LA³NET members and with participating scientists from outside the network. The conference will be widely publicised and will showcase the achievements of the network. An estimated participation of 100 scientists from the wider scientific and industry communities is expected. This event will also serve as a career platform for all of the network's researchers who will get the opportunity to present the outcomes of their research projects in oral as well as poster contributions.

Symposium on Accelerators & Lasers for Science and Society:

In order to bring together the outreach activity results an event will be organised with the Cockcroft Institute, UK. This will present the project findings in an understandable way for the general public emphasising the possible applications of the technologies concerned.

DISSEMINATION & OUTREACH

Prize-giving at the First Laser Applications School at GANIL including presentation of the LA³NET Prize 2012.

The project disseminates its research results via leading peer reviewed journals and at symposia, conferences and workshops. Preprints of publications are also available via the project web site www.la3net.eu.

The site is regularly updated with consortium news. This is complemented by the LA³NET Facebook page and a quarterly newsletter that addresses the wider scientific community and public at large. A booklet on laser applications at accelerators will be produced by the consortium which shall serve as the future reference in this field.

Dialogue with laser and accelerator workers from outside LA³NET will be promoted through the series of LA³NET events open to external participants. Additional institutions will be able to join the project as adjunct partners to be directly involved in project activities and make a sustained contribution.

The LA³NET researchers will be the driving force behind the network's outreach activities including engagement with local colleges and high schools. Summer programmes will familiarize students with the LA³NET research activity. Current arrangements with schools in the area have established routine placements of pupils for work experience and where appropriate fellows will be given the responsibility of mentoring to supervise on-site activity. Open days will also be organized taking advantage to demonstrate the laboratories and accelerator facilities. This will educate and stimulate those that attend from the general public, school parties and teachers who will also be helped with materials that could be used to enhance their teaching.

The LA³NET researchers will also directly contribute to outreach activities by producing video web casts about their individual research projects. These videos will be made available via the project web page and public platforms such as YouTube.

RESEARCHER PRIZE

The Consortium awards an annual prize of 1,000 € to a researcher in the first 5 years of their career who has made a substantial contribution in the field of laser application at accelerator facilities. Applications are invited from network partners and the wider research community.

MANAGEMENT STRUCTURE

The Steering Committee

The Steering Committee is responsible for the overall network strategy and takes all decisions concerning the network.
It presently consists of the following elected members:

Dr. Rob Ashworth, the project manager for LA³NET is a biochemist and a corporate member of CIWEM with a PhD in sewage treatment using reed bed systems in the UK and Egypt. He also coordinated the FP7 research support role of the Enterprise Europe Network in England's North West.

Dr. Arnd Baurichter, VP Sales and Marketing of Danfysik, Denmark, is representing industry in the Steering Committee and has worked at international research centres and universities before moving to the industry sector.

Andrii Borysenko is the researcher elected to represent the fellows. He will be working on measurements of the electron bunch shape with electro-optical techniques in an electron accelerator at the Karlsruhe Institute of Technology (KIT), Germany.

Dr. Enrique Conejero Jarque is working at the University of Salamanca and Centro de Láseres Pulsados Ultracortos Ultraintensos (CLPU), Spain on laser-plasma interactions in the ultra-short ultra-intense regime.

Prof. Allan Gillespie has held the Chair of Photonics at the University of Dundee, UK since December 2004. His research currently focuses on FELs and lights sources, mobile computing and nanomaterials.

Dr. Nathalie Lecesne is leader of the Resonant Ionization Laser Ion Source (RILIS) project at GANIL, France. She studied in Orsay and Caen and has also worked at TRIUMF, Canada.

Prof. Carsten P. Welsch initiated the LA³NET project and is the scientific coordinator on behalf of the University of Liverpool based at the Cockcroft Institute, UK. His research is in accelerator R&D with a focus on low energy accelerators and beam instrumentation.

EU Project T.E.A.M.

A dedicated EU Project T.E.A.M. has been established at the University of Liverpool and is based at the Cockcroft Institute, UK to assist the project coordinator in the day-to-day running of LA³NET. Dr. Rob Ashworth is the project manager, Sue Davies is responsible for the financial project administration, Helen Williams provides administrative support via the coordinator and Alexandra Welsch is responsible for developing and managing the web presence and newsletters.

The Supervisory Board

Each partner is represented on the Supervisory Board which meets annually to monitor progress and ensure training is of highest standard and remains relevant, particularly in relation to industry.

Partners

LA³NET comprises eleven beneficiary partners, twelve associated partners and a growing number of adjunct partners. The beneficiary partners all host between one and three early stage researchers (ESRs), each dedicated to a specific research project. Associated and adjunct partners play a role in the network-wide training and some provide secondment places for ESRs in relevant scientific or technological areas. Ten of the 30 partners currently engaged are from industry.

ASSOCIATED & ADJUNCT PARTNERS

Aquenos GmbH5

aquenos
software & more

Aquenos GmbH develops software solutions, provides system and network administration, as well as IT consulting for customers from different sectors and with diverse backgrounds and needs. Its product portfolio includes integrated solutions as well as purpose-developed key components for specific client needs.

The company has extensive experience in the maintenance of Linux- and windows-based systems, in particular within heterogeneous IT environments. The company vision is to be the partner of choice for IT Strategy, Implementation and Outsourcing. It aims to be the trusted technology advisor to companies applying pragmatic IT strategy and rock-solid, cost-effective implementation.

Cobolt AB

Cobolt AB develops manufactures and supplies diode-pumped solid-state lasers (DPSSLs) in the visible and near infrared spectral ranges. The company provides a broad range of market-adapted laser products built on a wavelength flexible, power-scalable and robust technology platform. The lasers are particularly suitable for OEM integration, but do also comply with applicable standards and directives for use as stand-alone devices in a laboratory environment.

Cobolt is committed to supplying innovative laser products that meet or exceed the market's expectations concerning quality, reliability and performance. The lasers are designed and manufactured to ensure a high level of reliability, and operation of the company using qualified and established processes assures the quality of the company's products. Cobolt maintains world-leading design expertise and proprietary technology in lasers as well as in non-linear materials.

Cosylab

Cosylab is developing next generation technologies for global niche markets and is a fast growing technological company, committed to creating innovative products and services intended for demanding markets and customers. The company started in a laboratory at the Jožef Stefan Institute, the largest Slovenian research institute. Due to first-hand experience of working in major accelerator facilities it soon became the largest company specialized in developing control systems for particle accelerators.

Cosylab specializes in the field of control systems for particle accelerators and other large experimental physics facilities. They cover hardware and software products and accompanying services such as customization and integration of already existing solutions, custom development, consulting and tutoring. The team combines research level know-how with a professional business approach on a daily basis. Their experience has accumulated with years of work on successful projects in collaboration with international partners, including the development of control systems for the Swiss Light Source (PSI), Australian Synchrotron, Diamond Light Source, ANKA, ESO and many others.

EdgeWave GmbH

Laser technology has become an indispensable part of many aspects of modern life. It has brought about lasting changes in the fields of industrial manufacturing, medical and environmental engineering, micro- and nano-technology and ICT. Founded in 2001, EdgeWave has successfully commercialized the INNOSLAB technology. This robust and efficient laser design enabled the development of high power pulsed laser systems. EdgeWave holds a number of world records in this area and is still pushing the limits with a brand new 400 W ps laser.

The INNOSLAB technology is based on advanced diode-pumped solid state laser technology. The special geometry enables a compact resonator with excellent stability and low thermal lensing effects. These advantages make the INNOSLAB systems particularly well suited for high power and pulsed lasers. They allow for short pulses with high peak powers, while maintaining high beam quality at high average power. Another advantage is the flexibility in beam profile: the laser resonator supports beam shaping from circular, through line shaped one dimensional top-hat, to two dimensional top-hat with rectangular cross section.

High Q Laser

High Q Laser develops, manufactures and distributes a complete range of solid-state pico- and femtosecond oscillators and amplifiers. In this field, High Q Laser is a world leading supplier for scientific, medical and industrial markets offering standard as well as individually customized ultrafast laser systems. By employing a modular product concept, High Q Laser can quickly tailor ultrafast products for use in OEM, imaging, medical, nano-processing, semiconductor and research applications.

The High Q Laser product range comprises four different laser series: compact, all-diode-pumped, solid state laser fs- and ps-oscillators up to 50 W, all-in-one regenerative amplifier systems up to 30 W, cavity-dumped systems and tunable systems by utilizing OPO and NOPA technology. High Q features class 100 clean room production and sealed-off technology which leads to long life times and low cost of operation of its systems.

INFN – Laboratori Nazionali del Sud (LNS)

Laboratori Nazionali del Sud (LNS) is one of the four national laboratories of INFN, Italy. Founded in 1976 it currently employs about 150 people and is an advanced development center for technology and instrumentation. The research activity is mainly devoted to the study of the structure and properties of atomic nuclei in collaboration with researchers coming from several countries.

At LNS two particle accelerators are available: a 15MV Tandem Van De Graaff that started to be used for the first experiments in the early '80s and a K800 Superconducting Cyclotron in full operation since 1996. The EXCYT facility for the production of exotic beams based on the coupled operation of these two accelerators is already in operation.

LNS is also currently involved in research and development of particle accelerators and beam diagnostics, as well as new acceleration techniques using high power lasers.

Institute for Laser Technology (ILT), Fraunhofer

ILT has more than 250 employees and 10,000m² of usable floor space and is one of the most important development and contract research institutes of its specific field in the world. ILT activities cover a wide range of areas such as the development of new laser beam sources and components, the use of modern laser measurement and testing technology and laser-supported manufacturing. This includes for example laser cutting, caving, drilling, welding and soldering as well as surface treatment, micro-processing and rapid prototyping.

Furthermore, the ILT is engaged in laser plant technology and process control as well as the entire system technology. Besides solving questions of laser technology, the institute develops high-energy sources for soft X-rays for use in semiconductor production and in X-ray microscopy.

Laser Quantum GmbH

Laser Quantum GmbH is a world class manufacturer of femtosecond lasers and oscillators. The company has a long history in the research, design and manufacture of ultracompact Ti:Sapphire oscillators with repetition rates from 333MHz to 1GHz and is a provider of advanced ultrafast time-domain and THz spectroscopy systems and components.

Since 1999, the beginning of a true revolution in precise optical frequency metrology, the company has served the need of scientists for high repetition rate oscillators at a high output power level combined with an unsurpassed system compactness. In 2005, the company greatly advanced the field of ultrafast time-domain spectroscopy by introducing high-speed asynchronous optical sampling as a time-delaying technique without mechanical scanners.

Litron Lasers Ltd

Litron Lasers is a UK company specializing in the design and manufacture of pulsed Nd:YAG laser systems for scientific and industrial applications. They are the market leader in high power, high repetition rate lasers offering both standard and custom options. Litron currently has an installed base of several thousand units, many of which are used in industrial 24/7 applications.

A large proportion of Litron's products are being used in scientific applications and so this market has been targeted for future growth and expansion. In addition, Litron are receiving an increasing number of enquiries from customers who are interested in exploiting laser technology in new scientific fields of research relating to accelerator facilities. Litron is involved in many different areas of research that use lasers in accelerator based applications at CERN, SLAC and numerous other research institutes across the globe in applications ranging from Ti:Sa to OPO pumping.

Max Planck Institute for Nuclear Physics (MPI-K))

MPI-K is one out of 80 institutes and research establishments of the Max Planck Society for the Advancement of Science, which was founded in 1948 succeeding the Kaiser-Wilhelm-Gesellschaft and is committed to basic research.

The institute's research programme presently concentrates on two interdisciplinary research fields, namely Astroparticle Physics and Quantum Dynamics. The institute has a long standing research background in accelerator R&D. Many of the institute's research activities strongly rely on the use of lasers.

The institute is heavily involved in national and international collaborations, as well as a number of EU projects. In many of its key research areas it has unique expertise and produced outstanding scientific results.

Paul Scherrer Institute (PSI)

The Paul Scherrer Institute is the largest research centre for natural and engineering sciences in Switzerland with its research activities concentrated on three main subject areas: Matter and Material; Energy and the Environment and Health. The PSI develops, constructs and operates complex large-scale research facilities, such as the SINQ neutron source, the Swiss Light Source (SLS) and the S S muon source. A hard x-ray free electron laser, named SwissFEL, is currently under construction and will go on-line in 2017.

The SwissFEL laser group covers the competence in operating the different gun laser systems and develops advanced laser beam shaping schemes in the deep UV for the production of low-emittance electron beams. We furthermore develop laser-based sources providing intense radiation in the THz (0.1-10 THz) and soft x-ray spectral region (up to several hundred eV) and explore novel types of laser-driven electron sources based on multifilamentary cathodes.

Research Instruments GmbH

Research Instruments develops and provides special products for physics and energy research as well as for medical applications focusing on radio frequency cavities and systems, linear accelerators, particle sources, beam lines and diagnostics.

Through their company history of Interatom, Siemens, ACCEL and now as part of Bruker Corporation they are continuously developing turn-key accelerator systems and key components for large scale accelerator facilities. Many of these projects were carried out in partnership with Universities and research centres from around the world.

Royal Holloway University of London

Royal Holloway was a founding member of the John Adams Institute (JAI) together with Oxford University and the UK Science and Technology Facilities Council (STFC). Central to the mission of the JAI is the training of accelerator physicists at PhD level. This includes world-leading efforts in the developments of laser wire scanners for high energy particle accelerators as well as investigations into the measurement of longitudinal beam profiles.

The group has been involved in many research and training programmes at the national and international level and has successfully collaborated with a number of the LA³NET partners in the past.

SLAC National Accelerator Laboratory

Home to the world's longest particle accelerator and top-notch research facilities, SLAC National Accelerator Laboratory attracts thousands of users, visiting scientists and students from all over the world each year. The same 2-mile-long linear accelerator that has enabled Nobel prize-winning discoveries in particle physics now powers a revolutionary X-ray free electron laser, the Linac Coherent Light Source (LCLS). Launched in 2009, the LCLS pushes photon science to new frontiers with ultrabright, ultrashort X-ray pulses that allow atomic-scale snapshots of material dynamics in the femtosecond regime.

SLAC's other premier user facilities include the Stanford Synchrotron Radiation Light source which provides bright, broad-spectrum X-rays for research in areas ranging from nanotechnology to human health. Other major research areas with close coupling to Stanford include basic photon science, particle physics, astrophysics and cosmology.

Thorlabs

Thorlabs strives to provide worldwide researchers with adapted tools and share its know-how and expertise to facilitate efficient research. Founded 21 years ago, Thorlabs is one of the leading suppliers of scientific equipment for research and development in the field of photonics offering more than 12,000 products ranging from simple lenses and mirrors to advanced laser stabilization feedback systems or 2 photon confocal microscopes. Thorlabs has a worldwide presence producing more than 90% of its products directly and offering a large number of customized solutions.

Thorlabs is expanding in directions going beyond the mere photonics field in various ways such as the integration with existing companies, the creation of new branches of Thorlabs e.g. Thorlabs Imaging Systems and finally through collaboration with strategic partners such as Menlo Systems, Boston micromachines, Idesta QE or Picoluz.

University of Bari

The University of Bari hosts more than 56,000 students and 2,000 teachers offering a broad range of courses to its students. It has a central site in Bari with 11 campuses and 2 off-site branches in Taranto and Foggia with a total of 15 Faculties and 63 Departments.

The Department of Physics promotes and coordinates teaching and research activities in the following areas: condensed matter physics; optoelectronic and quantum devices; laser physics; applied physics; theoretical and computational physics; particle physics; nuclear physics; planetary and space physics; teaching and history of physics. It scored top of the list in the last Italian university ranking. The department hosts the CNR-INFM center "Laser Innovation Technology Transfer and Training (LIT3)", the "Center for innovative technologies for image detection and processing (TIRES)" and two clean-room facilities for the photolithographic fabrication and testing of semiconductor micro and nanodevices.

University of Nova Gorica

The University of Nova Gorica, Slovenia is an independent, research oriented and student friendly university that serves around 800 students. The University has five major research centres and six research laboratories which includes the research unit on Quantum Optics linked to LA³NET. In recent years the activities of Nova Gorica University in the field of laser science and technology developed along three main lines: 1) Design and implementation of a seeded free-electron laser on the Elettra storage ring at Sincrotrone Trieste; 2) Design and commissioning of the single-pass seeded free-electron laser FERMI@Elettra at Sincrotrone Trieste and 3) Development of a state-of-the-art light source based on the principle of laser high-order harmonic generation in gas.

University of Seville / Centro Nacional de Aceleradores (CNA)

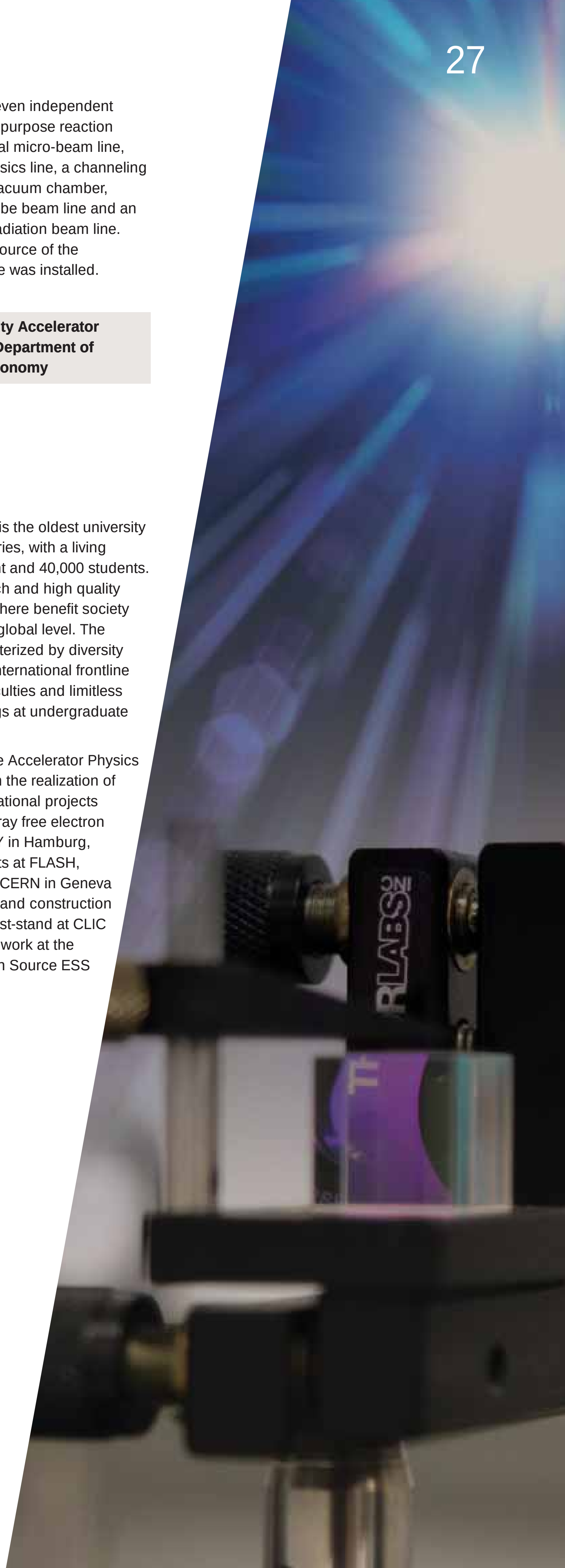
The University of Seville's CNA is the national Centre of Excellence for particle accelerator based interdisciplinary research and carries out fundamental and applied research. The laboratory is composed of a 3MV tandem van de Graaff, a 18 MeV proton cyclotron and 1 MV tandem Cockcroft-Walton for accelerator mass spectrometry. Beside these instruments, the centre has sample preparation laboratories as well as an installation for radiopharmaceutical production. A small positron emission tomograph for animal studies completes the cyclotron laboratory.

At CNA there are seven independent beam lines: a multi-purpose reaction chamber, an external micro-beam line, a basic nuclear physics line, a channeling line, an ultra-high vacuum chamber, a nuclear micro-probe beam line and an ion implantation-irradiation beam line. In 2008 a new ion source of the Duoplasmatron type was installed.

Uppsala University Accelerator Physics Group, Department of Physics and Astronomy

Uppsala University is the oldest university in the Nordic countries, with a living cultural environment and 40,000 students. World-class research and high quality education pursued here benefit society and business on a global level. The University is characterized by diversity and breadth, with international frontline research at nine faculties and limitless educational offerings at undergraduate and master levels.

The members of the Accelerator Physics Group participate in the realization of several large international projects ranging from the X-ray free electron laser X-FEL at DESY in Hamburg, seeding experiments at FLASH, various activities at CERN in Geneva such as the design and construction of the Two-beam Test-stand at CLIC test facility CTF3 to work at the European Spallation Source ESS in Lund, Sweden.



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