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ITS LEIF: Ion Technology and Spectroscopy at Low Energy Ion Beam Facilities

European scientists will be able to boldly go where none have gone before thanks to a four-year EU-funded scheme to promote the use of state-of-the-art, low-energy ion beam equipment and open up research to an exciting range of new scientific fields. The ITS LEIF Integrated Infrastructure Initiative combines the efforts of five existing research centres in five EU countries, creating a facility available to researchers from across Europe and a new platform for interdisciplinary research. The scheme involves more than 30 individual research groups. Cutting-edge instruments are expected to open up a wide spectrum of possibilities in areas like physics, biomolecular science, chemistry, medicine and - potentially even allowing scientists to shed light on the origins of life itself - astrobiology. The project has its roots in the previously EU-funded Infrastructure Cooperation Network LEIF. The Network coordinates the scientific and technological developments at relevant research centres in various European countries.

BEAM ME UP

Ion beams - streams of charged atomic particles - are relevant for a wide range of scientific disciplines and thus represent an important field of research. The ITS LEIF project counteracts fragmentation in this area by fostering mutual exchange of personnel and instrumentation. Emphasis is also placed on supporting and training young scientists.

Research within ITS LEIF mainly takes place at five centres which together form a Distributed European Facility offering access to research infrastructures to scientists from other countries. The five centres are ARIBE in Caen, France; H-EBIT in Heidelberg, Germany; ZERNIKE-LEIF in Groningen in the Netherlands; ELISA in Aarhus, Denmark; and QU-LEIF in Belfast in the United Kingdom.

Project activities help to keep instruments at the cutting edge of technology so as to improve and extend research performance. This aspect of the ITS LEIF scheme focuses on development of sources and beams for complex ions; generation of high quality, low-energy atomic ion beams; production of nanobeams by using ion guiding in nanocapillaries; construction of electrostatic storage rings and traps, and production and characterisation of biomolecular targets.

Developments in ion equipment are expected to produce results in a number of specific research fields including low-energy ion-induced radiation damage in biomolecular systems, anti-microbial

ion pinning on medical devices and nanostructuring of insulator surfaces and thin films induced by low-energy ions.

Many initiatives have been undertaken to ensure cooperation between different research projects, to guarantee - by publishing a series of newsletters - an efficient internal and external communication, to disseminate the knowledge obtained, and to develop fruitful collaborations and joint strategies for further progress and applications.

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EXPLORING NEW FIELDS OF SCIENCE

Ion beams already have many uses in electronics manufacturing and other industries. The new instrumentation and specific ion beams that will be developed thanks to ITS LEIF will open up research infrastructures to new fields of science so far only sparsely represented at the existing facilities.

Research will be strongly supported in new areas like astrobiology - an interdisciplinary field focusing primarily on the study of the origin, distribution and evolution of life - and radiation damage in biomolecular systems. Other new areas will include chemistry on surfaces, fusion- and astrophysics-related research as well as the physics of atomic and molecular clusters.

Another important field concerns the controlled nanostructuring of surfaces and nanolithography – the science of etching, writing or printing at a microscopic level. This wide range of research possibilities should attract new user groups and foster the low-energy ion beam community.

There are several practical examples of ITS LEIF research work. For instance, there has been great interest recently in the interaction with DNA of various forms of radiation, and much experimentation has already been done involving electron interactions with DNA. But there has been little work so far using low-energy ions. At different installations like Queen's University Belfast in the UK or at KVI in Groningen in the Netherlands, experimental systems have been built for just such a purpose. The apparatuses are being made available to scientists outside these countries.

CIMAP (Centre de recherche sur les Ions, la MAtière et la Photonique) in Caen, France, has successfully tested a flexible new beam line that can select metal or semiconductor clusters of a particular size ranging from several to several thousand atoms.

On nanostructuring, research has shown that highly charged ions (HCIs) carry a large amount of potential energy which is released upon impact on a surface. This energy can give rise to changes in the surface under certain circumstances, and so this form of impact can be considered a promising tool for future nanostructuring efforts. Detailed HCI measurements have been performed by the project partner TUW, the University of Technology in Vienna in Austria.

Electrostatic storage ring devices, called DESIREE and CSR, kept at very low temperatures (2 to 4 Kelvin), are under construction at Stockholm University in Sweden and at the MPIK in Heidelberg in Germany , respectively, with a view to making possible a new generation of studies concerning complex systems.

Several ITS LEIF partners are participating in the development of nanobeams by studying the guiding of HCIs through nanocapillaries. Once they have been successfully developed, these devices will be made available to users of the infrastructures.

Moreover the Institut für Ionenphysik and Angewandte Physik (the institute for ion and applied physics) in Innsbruck, Austria, boasts a new experimental set-up allowing for nanolithography work with nanoclusters made of silicon.

ION TECHNOLOGY AND SPECTROSCOPY AT LOW ENERGY ION BEAM FACILITIES IN SUMMARY

Project acronym: ITS LEIF
Funding scheme (FP6): Integrated Infrastructure Initiative (I3)
EU financial contribution: €4.8 million
EU project officer: Maria Douka
Duration: 48 months
Start date: 1 January 2006
Completion date: 31 December 2009
Project webpage: www.its-leif.org
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