Synergies and collaboration opportunities in applications-oriented research with and within ENSAR

All along the ENSAR project, EFINION team led actions to identify and ease the possible collaborations in matter of applications-oriented research.

The first action was to perform a preliminary survey of past and present multidisciplinary and application-oriented research within ENSAR consortium (deliverable 6.1).
An important event was the EFINION workshop (deliverable D6.2) where most ENSAR infrastructures presented and discussed their applications-oriented research work.
In addition, the work on the Catalogue of multidisciplinary applications-oriented research activities of ENSAR (deliverable 6.4) allowed further highlighting of the similarities between infrastructures in this domain.

It is worth noting that during the course of ENSAR the beam-time requests to perform applications-oriented experiments at all ENSAR TNA Laboratories has been continuously increasing. This fact has been clearly underlined in the reports given by the Programme Advisory Committee (PAC) chairpersons of the ENSAR TNA Laboratories at the Facility Coordination Group (FCG) meetings. Hence, at GANIL, e.g., almost 15% of the users relate with interdisciplinary and industrial applications. Similar numbers hold for ALTO at IPN Orsay, France. Another example is the case of GSI that has organised User Selection Panels dedicated to applications, such as Biophysics and Radio-Biology or Materials Research. It is worth mentioning that, on the average, almost 30% of the beam time delivered by the GSI accelerator complex is directed to the research topics mentioned above. Almost similar numbers hold for the case of KVI-CART. Moreover, the applications-oriented proposals approved by the PAC of the Accelerator Laboratory of the University of Jyväskylä, Finland, amounts to 15% of the total PAC approved proposals. In these, requests for commercial services are not included. Similarly, almost 10% of the beam-time provided by the INFN-LNL Laboratory at Legnaro, Italy, is aimed at applied physics experiments, whereas in the case of the INFN-LNS at Catania, the number is higher, i.e. 10% for Radiobiology experiments and Proton Therapy and another 15% for interdisciplinary applications. At ISOLDE/CERN, the portion of the beam-time devoted to Materials research and biophysics ranges from 15 to 20%.

The impact of nuclear physics research goes far beyond the purely scientific and reaches out to applications of great benefit to society and other disciplines. The EFINION study shows that many successful activities are currently performed in Europe in order to develop applications with heavy-ion beams.

Three main domains of possible collaborations were identified:

- Health and medicine: cancer treatment
- Space industry: reliability of satellites
- Materials sciences and biophysics: materials for future

Potential collaborations and synergies

Cancer treatment
The transfer of expertise from nuclear physics to medicine has a long tradition. The birth of modern physics was the discovery of X-rays by Röntgen and the first application of this was to medical imaging. This tradition continues up to today with medical applications of nuclear physics gathering pace by the year. Nuclear medicine encompasses all aspects of cancer diagnosis and therapy. Europe is a leader in the provision of therapy using ion beams and a vigorous programme exploring exotic isotopes for diagnosis and therapy is currently underway.

Diagnoses: GSI, INFN-LNS, CERN-ISOLDE
Therapy: GSI, GANIL, INFN-LNS, KVI-CART, CERN-ISOLDE

Reliability of satellites
The environment, in which satellites orbit the Earth, is extraordinarily hostile to the sensitive electronics, which are contained on-board. Yet these satellites are increasingly an element of our day-to-day lives be it for GPS systems or communications. Ensuring complete reliability is a considerable task and, due to the immense cost of producing satellites, needs to be assured of well in advance of the satellite's launch. Europe has developed a network of facilities benefitting from progress in nuclear physics for re-producing this environment: a direct result of work producing radioactive ion beams at its principal nuclear physics facilities.

Electronics: GANIL, KVI-CART
Space radiation simulation: JYFL, ALTO

Materials for the future
The use of radioactivity in materials science has almost as long a tradition as in medicine. The attractions are obvious: by utilising a radioactive isotope one obtains sensitive and unique information about the local environment in a material or can chemically label processes which may otherwise remain unknown. Nowadays research in this area encompasses all facets of materials science and is increasingly finding innovative applications to unravelling previously hidden mechanisms in biophysics and biochemistry.

Development of new materials: INFN-LNL, JYFL, CERN-ISOLDE
Biophysics: INFN-LNL, KVI-CART, CERN-ISOLDE

European infrastructures for applications

The success of the ENSAR transnational access programme, supporting access to particle accelerators for European scientists, in bringing together scientists from different domains and fields cannot be underestimated. A considerable number of the developments and innovations have their origins in the synergetic combination of scientists coming from a variety of scientific disciplines, e.g., nuclear physics, life sciences and medicine. Without such support,

it is likely that many fewer innovations would have been transferred beyond the confines of the nuclear physics laboratory.

Europe stands at the forefront not only of nuclear physics research, but also in applying this knowledge to many other fields. The next generation of large-scale facilities is now under construction. This will provide new opportunities for research in basic science but also in applications to other areas. By maintaining and developing the links, which exist between nuclear science and other fields, one thing is certain: it will be society as a whole which benefits.

Conclusion and outlook

The EFINION study shows that the potentiality of collaborations and synergies on application research is high in the ENSAR consortium. The Facility Coordination Group eased a lot the information flux between infrastructures, especially on application activities that increased during the ENSAR project.
At the beginning of the ENSAR project, each laboratory was developing applications mostly on its own, often local, ecosystem, with a lot of success and numerous links with industry. Today, application-research teams within ENSAR are starting to discuss a possible common organisation in order to further strengthen applications, innovation and technology transfer in the European Research Area.