Testimonies of users of transnational and virtual access to research (e-) infrastructures

European Nuclear Science and Applications Research – ENSAR 2

Short description
ENSAR2 is the integrating activity for European nuclear scientists who are performing research in three of these major subfields: Nuclear Structure, Nuclear Reactions and Applications of Nuclear Science.

Its core aim is to provide access to eleventh of the complementary world-class large-scale facilities: GANIL-SPIRAL2 (F), joint LNL-LNS (I), CERN-ISOLDE (CH), JYFL (FI), ALTO (F), GSI (D), KVI-CART (NL), NLC (P), IFIN-HH/ELI-NP (RO) and to the theoretical physics facility: ECT* (I).

Website: http://www.ensarfp7.eu/

These accelerators provide stable and radioactive ion beams of excellent qualities ranging in energies from tens of keV/u to a few GeV/u.

Few Facts:

- ENSAR 2 is a project funded under the H2020-INFRAIA-01-2014-2015 call for integrating activities
- Duration: 01/03/2016 – 29/02/2020
- Budget: EUR 10M
- Coordinator: GANIL, Caen, France
- Contact: ensar@ganil.fr
- N° of partners: 30

Dr. Fabio Crespi, researcher from the Department of Physics of the University of Milan / Italian Institute of Nuclear Physics

Can you explain your main research interest and briefly describe the research project that you have submitted to ENSAR2?
My research activity is in the field of experimental nuclear physics. In general, the aim of our research is to understand the nuclear structure and the way the protons and neutrons interact inside the atomic nucleus. The advance of the knowledge in nuclear structure has also significant impact in related ones. For example, it has to be considered that more than 99% of the mass of visible matter in the universe is nuclear matter, that nuclear fusion reactions are the source of the energy provided by the sun and that nuclear fusion in stars and other nuclear processes at the end of stellar life have formed the variety of elements we observe in nature. However, experimentally, how do we probe the structure of such a microscopic object like a nucleus? A general way to learn about the properties of a system is to subject it to external stress and then observe its response. To this aim accelerated ion beams are necessary to overcome the coulomb repulsion and bring nuclei into contact. We can then observe the response of the nuclear systems we want to study by measuring the electromagnetic radiation that is emitted following the motion of the charged protons: these are the gamma rays. Detecting gamma rays emitted from excited states of nuclei can tell us about the energy, spin or angular momentum, parity and lifetime of the state. In addition they can give us information on the quadrupole moment, magnetic moment and shape of the nucleus.

Why did you choose this particular infrastructure? Explain how crucial it is for your project?
In the case of this experimental program at the Bronowice Cyclotron Centre (in Polish - Centrum Cyklotronowe Bronowice, CCB) we are interested to study collective vibrational modes of the nucleus. The combination of proton beams and the detection setup that are provided here fits our

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need. The atomic nucleus is a quantum mechanical system that exhibits a fascinating variety of shapes and excitation modes. One of the most studied and better known vibrational modes of nuclei is the so called giant dipole resonance (GDR), originating by a collective oscillation of all the protons against the neutrons. Recently, a new kind of collective mode has been proposed in neutron rich nuclei, originated from the oscillation of the core of the nucleus (with an equal number of protons and neutrons) against the neutron skin (formed by the excess neutrons). This has been called the pygmy dipole resonance (PDR). Despite the relatively small strength exhausted by this mode (the name comes from this fact), the existence and the characteristics of the PDR have important implications. For example, the occurrence of such low-lying dipole strength plays an important role in predictions of neutron-capture rates in the r-process nucleosynthesis, and consequently in the calculated element abundance distribution. This research field is very active and new experimental data on the subject are highly demanded: the measurements done using the proton beams and the detector setup at the CCB combined with the measurements at other laboratories will definitely contribute to the understanding of the nature of the PDR mode. Nuclear vibrational modes of other multipolarities (like the giant quadrupole resonance, GQR) will also be studied. To this aim a very efficient detection system for high energy gamma rays (10-20 MeV) is needed and this is available here at CCB and there are not so many setups like this in the world.

What is the meaning of your research – purely basic or applied?

My research can be defined as purely scientific, in fact its aim is to understand the nuclear structure and the way the protons and neutrons interact inside the atomic nucleus. However, it has to be mentioned that major progresses in nuclear physics research have been often prompted by advances in radiation detection techniques. In particular for the case of nuclear structure studies the technological advance in the gamma spectrometers was of particular relevance. Historically, such novel technologies (initially developed with the only aim of pure scientific research) always found applications in different fields of social relevance. Let's think for example about the instrumentation for nuclear medicine (x-ray, magnetic resonance imaging and positron emission tomography) or radiation therapies for cancer treatment.

What is your opinion on the visit? Can you tell us also a bit on the practical details (submission process, arrangements for your visit,…)?

I am presently here at the CCB for the realization of an experiment that was proposed in close collaboration with researchers from the Henryk Niewodniczanski Institute of Nuclear Physics (IFJ PAN). The data taking is currently ongoing. However, it has to be mentioned that before this phase there is a time consuming preparatory phase that is crucial because we have to deal with complicated detection, electronics and data acquisition systems that need to be ready at the moment the proton beam is provided. This work was done in an excellent way by my colleagues from the IFJ PAN. The application procedure was very smooth and clear: I made a presentation in front of the Advisory Committee, explaining if the experiment is suitable for the equipment accessible in CCB, and answered questions that referees were asking. I am contributing now to the so called online analysis of the data that is crucial to obtain a first idea of the quality of the data we are acquiring and eventually to take some decision to change parameters in the experimental setup. However, the final results of the experiment will be obtained only after a subsequent offline data analysis that usually lasts for several months. Apart from the experiment realization itself, I would like to stress the importance of these visits also for the opportunity of having discussions with my colleagues with are scientifically productive in respect of clarifications of some aspects of our work and, most important, for prompting new ideas for the future activity.