SOLARIS — NATIONAL SYNCHROTRON RADIATION CENTRE, THE POLISH RESEARCH INFRASTRUCTURE ROADMAP FACILITY

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Interaction of the electromagnetic radiation with matter is fundamental to the universe. From the big bang up to the current times such interactions have been activating the processes and phenomena at the atomic level up to the scale of the whole Universe. The radiation influences short and long term processes on our globe at the micro and macro scales affecting such areas as the plant growth, earth atmosphere, climate changes, weather, *etc.*

In the Universe the Stars are natural sources of EM radiation. In our planetary system the Sun supplies the Earth with a very broad spectrum of electromagnetic radiation spreading from the infrared, through the visible region to X-rays. Significant part of the radiation interacts with and is absorbed by the atmosphere, the transmitted part interacts with the Earth ecosystem providing the necessary energy, catalyzing reactions and stimulating biological processes.

The knowledge and control of the radiation interaction with matter is therefore extremely important and allowing for understanding the ongoing reactions and processes and opening the possibilities of their control.

Until 1970 there was no man made source of such properties and intensities enabling for research of EM radiation stimulated processes in such a broad spectrum of energies. This situation has changed in 1970 when the first synchrotron radiation source was built.

The advent of synchrotron radiation sources and their constant development and improvement has revolutionized the research in many areas of fundamental as well as applied science. Since then the potential of such facilities has been widely recognized and led to the development and construction of very high intensity light sources (synchrotrons and free electron lasers) emitting the radiation of unprecedented properties:

- broad spectral range and tunability (opportunity of selection of a single energy),
- high collimation, with opportunity for focusing down to the size of the order of 10 nm,

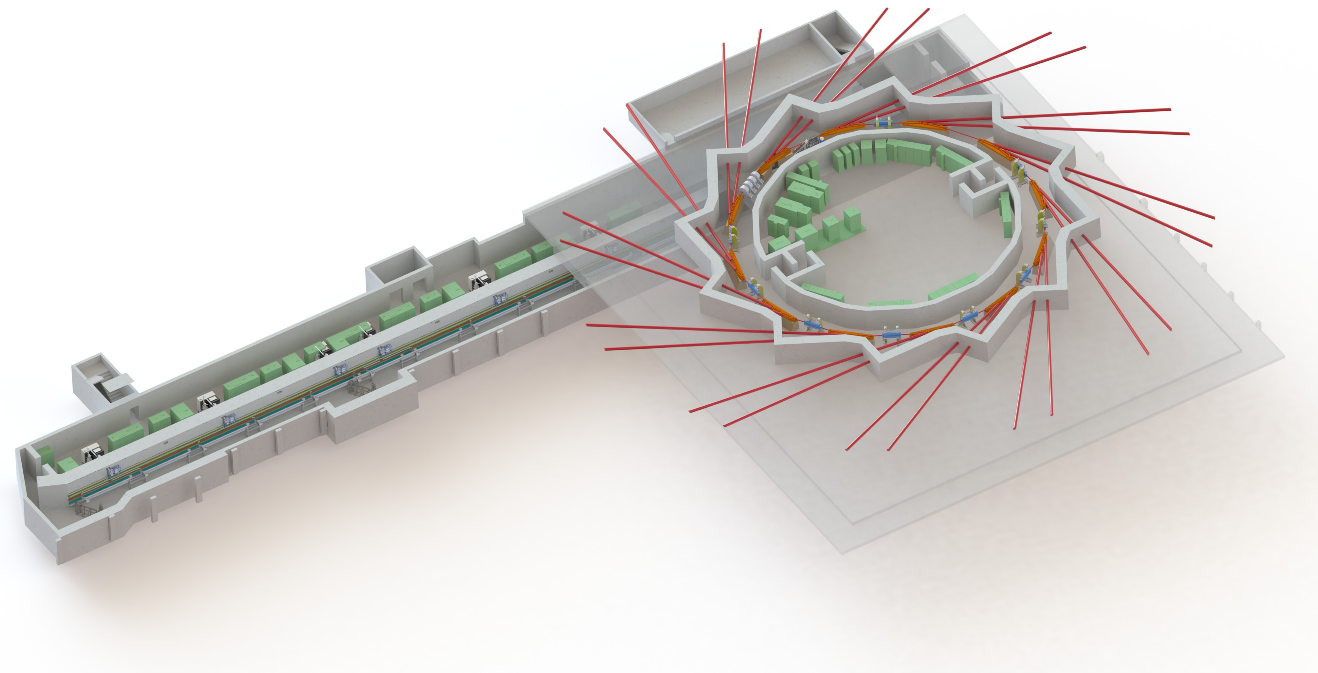

Figure 1: SOLARIS facility layout.

- high coherence,
- extremely high intensity,
- specific time structure (pulses down to femtosecond scale and up to gigawatt power).

Synchrotrons, despite being big devices (their circumference ranges from several tens to several thousand of meters), emit a very compact photon beam, which can be described as a light scalpel that can operate on the surface or inside the investigated objects. It is not only the photon beam size but also the precision of the applied photon energy that means the light scalpel has unique applications. This kind of site specific surgery opens up a vast range of research that is available only with synchrotron radiation. The systems investigated range from single atoms and molecules, through biological complex molecules (proteins, DNA) to bulk materials and crystals.

Over the last three decades, synchrotron light has supported cutting-edge research in physics, chemistry, biology and material sciences, and has opened up many new areas of research in fields such as medicine, geological and environmental studies, structural genomics and archaeology. The synchrotron radiation centers are truly multidisciplinary and multi-user facilities.

Many tens of such sources have been built in all developed countries having population of 40 million or more, but also in less populated Canada, Australia, Switzerland, Taiwan, Sweden, Denmark and Singapore or just developing Brazil and Thailand. Each of the existing sources is surrounded by tens of beamlines where specific tasks are performed by the users. It is difficult to imagine a technologically advanced country without at least one intense light source; the number of sources in each of most developed countries, USA and Japan, is of the order of twenty.

The unique properties of the radiation and the huge research and development potential offered by synchrotron light sources have been explored by the community of Polish scientists from the very beginning and their scientific output is perceptible, especially in the time following the access to European Community. The synchrotron radiation users in Poland have formalized the existence of their community by creation of Polish Synchrotron Radiation Society (PSRS) in 1990. In 1998 the efforts to construct a synchrotron radiation source in Poland emerged. The goal was achieved in 2010 when the project "National Centre of Electromagnetic Radiation for Research Applications" (stage I) was granted. The project is run by Jagiellonian University and the facility will be located within the new University campus area, the new location for the Science Faculties and the site of the Jagiellonian Centre of Innovation - the Life Science Park.

Construction of the building accommodating the Polish Synchrotron "SOLARIS" started in December 2011, the project completion is scheduled for September 2014. The SOLARIS building (for an artistic view see Fig. 1) will be ready in autumn 2013 and then the installation of the machine will start. The project is run in a very close collaboration with MAX-lab in Lund. SOLARIS synchrotron ring (96 m circumference) is a twin to the new 1.5 GeV facility of MAX IV project. Using the same design allowed for a fundamental reduction of the development and construction costs. Moreover, the modern, technologically advanced, novel Swedish design leads to improved parameters of the ring. The storage ring is composed of 12 magnet blocks forming a 12 double bend achromatic structures. Differences between the two projects will include the injector and the beamlines. SOLARIS, and its twin Swedish counterpart, are the first facilities in the new generation of compact, high current, high brilliance 1.5 GeV synchrotrons.

The synchrotron will be capable of delivering radiation in a broad spectral range. Its characteristics:

- particle energy 1.5 GeV (injection 0.6 – 0.7 GeV),
- current 500 mA,
- radiation energy at bending magnets — optimal at 0.1 – 5 keV (nominal critical energy 2 keV),
- radiation energy at wigglers — optimal at 2 – 20 keV, radiation available at still higher energies ($\sim$ 30 or more) (nominal critical energy 6 keV),
- radiation energy at undulators — individually tuned in a broad range beamlines

are considerably better than those for older 1.5 GeV machines.

Both, the bending magnets and insertion devices installed in the straight sections will be used for generation of radiation. Installation of up to 20 beamlines and still more experimental end stations will be possible. There is an opportunity to build 10 beamlines at bending magnets and 10 beamlines at wigglers (undulators). Each beamline may have more than one endstation, so there is a perspective that the number of endstations will be of the order of 40. The formal and financial status of the beamlines is under consideration. The budget of the project includes one experimental line. However, the initiatives for the next beamlines have emerged. The applications for funding of EXAFS beamline (led by University of Silesia), U-ARPES beamline (led by Jagiellonian University), have been submitted and further two applications for: diffraction beamline with 3 endstations (led by A. Mickiewicz University), and for in the infrared range studies beamline (led by University of Rzeszów,) are being completed. The community is asked to provide new beamline projects.

There are various scientific, economic, educational and social benefits which SOLARIS will bring to the community:

- as all intense light sources, it will become a center of modern materials science, solid state physics and chemistry and will be helpful in other domains (medicine, mineralogy, archaeometry, biology, forensic studies, ...),
- SOLARIS will attract foreign groups to conduct or participate in experiments here, promoting thus the experiment-base scientific exchange and collaboration on the basis of its unique beamlines,
- SOLARIS is going to be the first research infrastructure of such substantial size and potential constructed of the region. It will thus reduce the asymmetry still observed between the older and newer parts of EU, and hopefully will initiate further actions of this kind in the region (an important example is the project for building a free electron laser, POLFEL, in Świerk near Warsaw),
- it will play an important role in education at the graduate and post graduate level,
- as for the first time advanced material and device studies will become possible, Polish enterprises having access to SOLARIS will have an opportunity to become internationally competitive,
- reduction of the outflow of highly qualified manpower.

It is noteworthy, that on 20th March 2010, the SOLARIS Project has been awarded by the European Medal for the Functional and Application Program and Technological Concept of SOLARIS (Fig. 2). The award was given in concert by three institutions: Integration office of European Union, Business Centre Club and the Socio-Economic European Committee.

Figure 2: The European Medal for the Functional and Application Program and technological Concept of SOLARIS awarded in 2010 after acceptation of the project by the Ministry.

(For more details see pages 1 – 4 of this issue.)