NLC: two-center (Krakow-Warsaw) facility in Poland

Bogdan Fornal

Institute of Nuclear Physics, Polish Academy of Sciences, Kraków, Poland

The National Cyclotron Laboratory (Polish acronym NLC) was formed in Poland as a consortium of two institutions: Heavy Ion Laboratory (Polish acronym ŚLCJ) of the University of Warsaw and Institute of Nuclear Physics of the Polish Academy of Sciences (Polish acronym IFJ PAN). These two scientific centers operate 4 cyclotrons for basic research and medical applications.

At SLCJ in Warsaw, the U-200 (K=160) cyclotron provides heavy-ion beams of energies from 2 to 10 MeV/A and intensities up to a few hundreds pnA. In addition to beams of gaseous elements and of elements available from gaseous compounds ranging from boron to argon which are presently available, metallic ion beams and ones of much heavier elements (e.g., krypton, silver) will be delivered soon. Experimental teams may take advantage of permanent set-ups installed on the beam lines. Available apparata include: EAGLE - the germanium multidetector γ-ray spectrometer (which can be coupled to ancillary detectors like internal conversion electron spectrometer, charged particle 4π multiplicity filter, scattering chamber equipped with 100 PIN-diode detectors, 60-element BaF_2 γ-multiplicity filter, sectored HPGe polarimeter or plunger), IGISOL – a Scandinavian type on-line separator, CUDAC – a PIN-diode array particle detection system, JANOSIK – a multidetector system consisting of a large NaI(Tl) crystal with passive and active shields as well as a 32-element multiplicity filter, and ICARE, a charged particles detector system. Recently, at SLCJ UW, the Radiopharmaceuticals Production and Research Centre (RPRC PET-UW), which serves as a research centre and a producer of radiopharmaceuticals mainly used in the technique of Positron Emission Tomography (PET), was open. It is equipped with the medical cyclotron GE-PETtrace which accelerates protons up to the energy 16.5 MeV (it is also possible to accelerate the deuterons of energy 8.4 MeV).

In 2012, a new Proteus-235 proton cyclotron delivered by the IBA company became operational at the IFJ PAN in Kraków. Together with the existing cyclotron AIC-144, it is a part of the Cyclotron Center Bronowice (CCB). The new cyclotron, equipped with a dedicated energy selector, is able to deliver a fairly monoenergetic beam of protons in the energy range between 70 MeV and 230 MeV, and currents between 1 nA and 500 nA. Although the primary objective of the facility is proton cancer therapy, an extensive research program at this cyclotron is conducted in the field of nuclear physics, radiobiology, dosimetry and medical physics. The nuclear physics projects that have been proposed so far and approved by the International Advisory Committee of CCB encompass: gamma-ray spectroscopy of giant nuclear resonances, investigations of the dynamics of few-nucleon systems with emphasis on three-body forces, investigations of (p,2p) reactions in order to identify the deep, single-particle proton-hole states, studies of (p, pα) process for assessing the degree of clusterization in ^{12}C. The detection systems which are available at CCB include: the Big Instrument for Nuclear reaction Analysis (BINA) (formerly used at KVI Groningen), the gamma-ray array HECTOR consisting of 8 large BaF_2 scintillator detectors, the Kraków Triple Telescope Array (KRATTA) for charged particle detection. The CCB has become also a testing laboratory for devices developed by international collaborations within projects pursued at large facilities like FAIR, SPIRAL2 or SPES - a series of tests of the response functions to monoenergetic protons for various $LaBr_3$ detectors has been performed at CCB by research teams from various European laboratories.

There is much optimism that the research program in the field of in-beam nuclear structure and nuclear reaction physics in Poland will greatly benefit from the recent developments and that the National Cyclotron Laboratory will serve as an efficient collaboration platform for those studies. This optimism has recently been busted by the fact that the joint Krakow-Warsaw Laboratory, NLC, was granted the status of a facility with Transnational Access within the European Nuclear Science and Applications Research – 2 (ENSAR-2) project.