

GRYZINSKI -1: Overview of the Polish activity for BNCT

Michal.A.Gryzinski._Janusz Kocik

National Centre for Nuclear Research, Otwock, Poland

The MARIA research reactor is the only reactor in Poland, which is located at the National Centre for Nuclear Research. The MARIA reactor has eight horizontal channels, the H2 irradiation facility is located at one of them. This facility is dedicated to the Neutron Capture Therapy and consist of a horizontal intermediate channel, uranium converter and beam-shaping assembly (BSA) system. The converter is a system in which due to the reaction of thermal neutrons with uranium ^{235}U , fast neutrons are emitted. The next element of the structure is the horizontal intermediate channel, which is responsible for controlling the flow of neutron flux from the reactor to the irradiation facility. The last one is BSA system, system of filters and moderators, which has been designed to allow irradiation in the neutron energy: thermal, epithermal, and fast neutrons. The estimated epithermal neutron flux rate will be about $10^9 \text{ cm}^{-2} \text{ s}^{-1}$. Full commissioning of the facility is planned to 2022. The irradiation facility in MARIA reactor has research and training functions for scientists in such fields as physics, medical physics, biology, radiobiology, chemistry, radiochemistry and medicine.

While we ,as NCBJ started working on construction the BNCT research stand, the cooperation between people from Polish scientific society is being built. The history of activities affecting the dissemination of research on therapy dates back to 2015. In the same year, the first edition of the workshop on BNCT therapy took place. For four years, panicipants of the next workshop meetings operated as a science platfonn NeoBor-BNCT. In 2019 institutions operating within the scientific platform have signed an agreement to create a scientific consortium under the name "The Polish Consortium for boron-neutron therapy".

The consortium has four main goals: conducting basic research supporting the application of BNCT in Poland, research on new boron carriers, development of dosimetry methods and conducting activities focused on building a Polish clinical center treating BNCT.

According to the information above, one of the consortium's main tasks includes the development of novel boron carriers, determination of their physicochemical and biological properties in vitro, and assessment of in vivo biodistribution. We put the effort into the goal to circumvent the selectivity-uptake challenge of boron compounds, their solubility, stability, and toxicity. Moreover, research work on the evaluation of biological effects at the cellular and molecular level in BNCT therapy has started in the new radiobiological laboratory of NCBJ. Our research will provide new knowledge about novel molecular mechanisms in the process of DNA damage formation and repair after exposure to the neutron-mixed beam used in BNCT.

New methods of dosimetry of mixed beams are also being developed. The most used detectors for characterizing and controlling any neutron irradiation beam are activation foils and paired ionization chambers. In BNCT clinical dosimetry, ionization chambers are commonly used for phantom measurements because of their accuracy and practicality. Furthermore, in radiotherapy increasing interest in the application of both active and passive solid state detectors is observed. Nowadays as a golden standard dosimetry based on thermoluminescent (TL) dosimeters, gafchromic films or alanine-EPR is considered. To comply with the dosimetry canon, National Centre for Nuclear Research apply set of self- developed ionization chambers. Some of them are general purpose chambers and some are exclusively designed for application in BNCT. Due to its unique construction, all of them are classified as recombination chambers. It means that they exploit gas recombination for determination of absorbed dose as well as evaluation of high-LET beam constituents in the terms of radiation quality. Taking into account the physical phenomenon exploited in the recombination chambers, proposed detectors can serve as estimators of all four absorbed components which are specific for BNCT.