Neutron spectroscopy for Boron Neutron Capture Therapy Beams Characterization

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Boron Neutron Capture Therapy (BNCT) is a therapeutic treatment for malignant tumors that utilizes the nuclear reactions that happen when thermal neutrons are captured by boron-10 (10B) atoms to selectively destroy designated cells. Boron 10 atoms are biochemically accumulated inside the tumor target which is then irradiated with thermal neutrons.

In recent years, the possibility to obtain accelerator based intense neutron beams has given a boost to the diffusion of BNCT also in Europe, removing the need of nuclear reactors. In this contest, the monitoring and characterization of the epithermal neutron beams dedicated to BNCT becomes an important issue.

This contribution presents the development of two different neutron spectroscopy systems devoted to the characterization of the *in-air neutron beam* spectrum and of the *in-phantom neutron field* spectrum respectively. The work has been carried out in the framework of the INFN ENTER_BNCT project. Both detectors are thought as a useful instrument for the beam characterization and quality assurance.

The directional neutron spectrometer called NCT-WES (Neutron Capture Therapy Wide Energy Spectrometer) is a single moderator neutron spectrometer composed of a polyethylene cylinder embedding six semiconductor-based detectors positioned at different depths along the cylinder axes. The position of the six detectors is studied in order to maximize the response of each one in a selected neutron energy range. The unfolding of the six simultaneous readings allows to reconstruct the incoming neutron energy spectrum as in a parallelized Bonner Sphere System. A cylindrical collimator situated in the front of the object makes the instrument sensitive to neutrons coming only from a wanted direction, this allows to exclude the contribution of the room scattered radiation.

The compact spectrometer for in-phantom measurement is called NCT-ACS (Neutron Capture Therapy-Activation Compact Spectrometer) and is based on neutron activation of different metals foils encapsuled in a 3 cm diameter polyethylene sphere. Resonances in the absorption cross section of the different materials allow to estimate the energy components of the neutron field through the measurement of the activity of the different foils.

The experimental validation of both spectrometers, obtained through several measuring campaigns, is reported and discussed.