SHU-1: Design Recommendations and Considerations of Clinical AB-BNCT Facility

Wei-Lin Chen[1], Songling Bai[1], Silva Bortolussi[2,3], Weihua Lu[1], Valerio Vercesi[2], Diyun Shu[1,4], Yuan-Hao Liu[1,4]

[1]*Neuboron Medtech Ltd., Nanjing, Jiangsu Province, P.R. China*

[2]*Istituto Nazionale Di Fisica Nucleare (INFN), Unit of Pavia, Italy*

[3]*Department of Physics, University of Pavia, Pavia, Italy*

[4]*Nanjing University of Aeronautics and Astronautics, Nanjing, Jiangsu Province, P.R. China*

Since the 90's, many groups had made great efforts to bring BNCT into a real and recognized cancer treatment modality and an approved medical device – unfortunately, none has successfully reached the goal with the reactor-based neutron source. Nonetheless, the presence of accelerator-based neutron beam has made it possible, and the Japanese group already reached the goal first in March 2020. Presently, there are more than a dozen of accelerator-based BNCT (AB-BNCT) facilities that have been built, under construction, or planned; most of them are in hospital environment. Unlike the reactor-based facility, the AB-BNCT is mostly for clinical facility and must not only consider the aspect of radiation regulation, but also take into account the clinical needs, which is not commonly considered in the past. This presentation will give an overall overview of the design recommendations and considerations of AB-BNCT clinical facility, basing on the real practices of the THOR BNCT Center (RB-BNCT), the Pavia BNCT facility (RB-BNCT), the Xiamen Humanity Hospital BNCT Center (Neuboron^{TM} AB-BNCT System), and the CNAO BNCT Center (INFN AB-BNCT System).

For the facility planning, a complete and independent BNCT clinical facility should be able to conduct all the BNCT related clinical activities, as well as analysis/measurement tasks on site. Although it is not necessary to be in one building, it is highly preferable to be in the same place for the efficiency. It consists of at least the following areas and rooms. **A. Machine/Equipment Area**: The AB-BNCT System area consists at least of the following regions: 1) accelerator room, 2) maintenance halls, 3) auxiliary rooms for ventilation, heat exchange, electricity etc., and 4) HEBL room, and 5) accelerator control room. These rooms should be arranged close by for the sake of energy efficiency. **B. Treatment Area**: One should consider the number of treatment rooms basing on the footprint limitation, economic aspects, and the number of expected patients. It is recommended to equip 2 to 3 treatment rooms having a better irradiation efficiency (larger patient capacity) and for a redundant reason. For 3 or more treatment rooms, the marginal utility decreases dramatically. The Xiamen BNCT Center equips 2 horizontal beams and 1 vertical beam while the CNAO design includes two horizontal beams. The choice between horizontal and vertical beams depends on the need of treatment targets/indications. The dimension of treatment room should be no less than 4.5 m wide, 5 m long, and 4 m high, where the maze is not included and should be considered separately. Next to each treatment room, there is a Medical Control Area/Room. In addition, an Emergency Treatment area should be setup right close to the treatment room exit with clearance. **C. Functional Area**: The Functional Area consists of 1) NAA/Medical Physics Lab, 2) Boron Analysis/Biochemical Lab, 3) Pharmacy/Drug Storage Room, 4) Simulation/Patient Positioning Room, 5) Planning/Computer Cluster Room, and 6) Medical Treatment Room. **D. Patient Administration/Preparation/Recovery Area**: Patient administration desk may be shared with other department somewhere else; however, preparation room(s) is necessary for medical examination and boron drug infusion before irradiation. It is recommended to be setup close by. Because of the radioactivity induced by the neutrons, the patient is hot after BNCT, and they should be placed for rest/recovery and be monitored for the radioactivity level as well as for cooling/decay, in an independent space under monitoring and access control; similar concept can be found in brachytherapy and radiology diagnosis (i.e. PET) department.

Regarding the medical facility safety and radiation safety, they are the other two key factors that need to be thoroughly considered and planned in advance. Further design recommendation, considerations and details, such as pathway design, waste management, etc., will be given in the presentation and the ISNCT Working Group Report Series (to be published).