MEDICAL ACCELERATORS

Hiroshi MATSUMOTO, Thursday October 29, 8:30 - 10:00 at KEK

In this session, I will concentrate on accelerator technologies for high intensity proton accelerators that can be used to realize advanced cancer therapy modalities such as **B**oron **N**eutron **C**apture **T**herapy (BNCT).

More than 5000 medical accelerators are efficiently working every day around the world providing treatment for various cancers. The majority of these accelerators use electrons, protons or carbon ions to disrupt the DNA chains of tumor cells. They are very efficient against compact tumor structures. However, it is difficult to use them in the case of non-compact or widely disseminated tumors, because of the difficulty in protecting normal cells from the particle knife. Because it does less damage to normal cells, BNCT was proposed in 1932 and the first clinical investigation was carried out at Brookhaven in 1951.

The process for BNCT begins with a pharmaceutical agent that carries a neutron capture agent containing ^{10}B (Boron 10) selectively into tumor cells. Thermal or epi-thermal neutrons then interact with the ^{10}B and produce α and ^{7}Li-particles. Both of these particles have very high Linear Energy Transfer (LET). Therefore, α-particles (9-micro-meter) and ^{7}Li-particles (4-micro-meter) lose almost all of their energy within a distance comparable with the size of a tumor cell as can be seen Fig. 1.

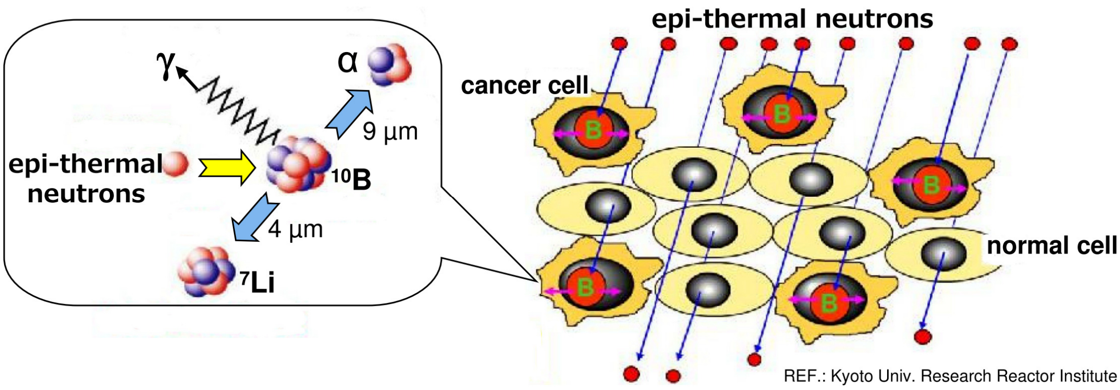

Figure 1: A basis of BNCT (Boron Neutron Capture Therapy).

The promising results shown by BNCT trials give the promising hope that it could become an indispensable treatment modality for many types of cancers. However, heretofore neutrons for BNCT have been provided only by nuclear reactors, because a neutron intensity of $1x10^{9}$ n/cm 2 /s, with energies between 0.5-eV and 10-KeV is required. Now recent proton accelerator technologies such as seen in the front end of J-PARC (RFQ and DTL) could possibly be used to provided as high an intensity neutron beam as a nuclear reactor, with the benefit of improved size and safety such that they could be installed in a hospital setting.

A prototype accelerator-based BNCT facility is now under construction and the entire system needed for a complete patient treatment facility will be installed in the Ibaraki Medical

Center for Advanced Neutron Therapy (tentative name). Photographs of an 8-MeV proton linac and a beryllium-based neutron production target for BNCT are shown in Figures 2 and 3.

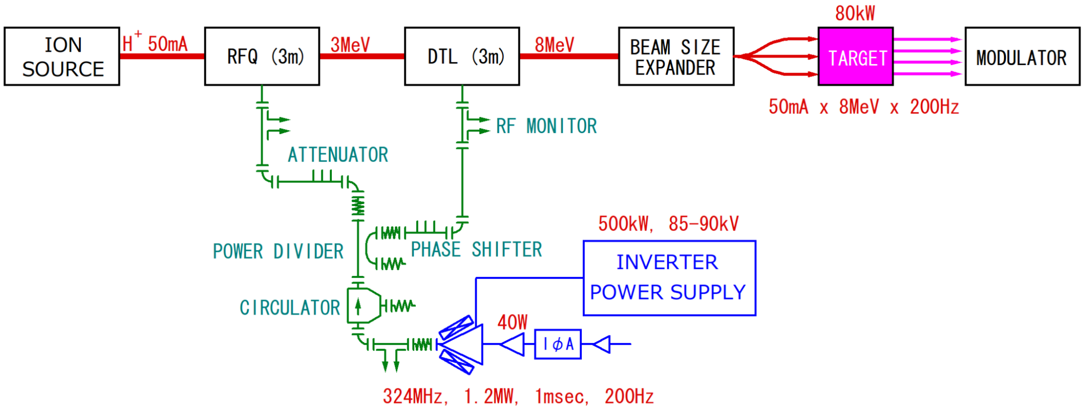

Figure 2: A block diagram of accelerator system.

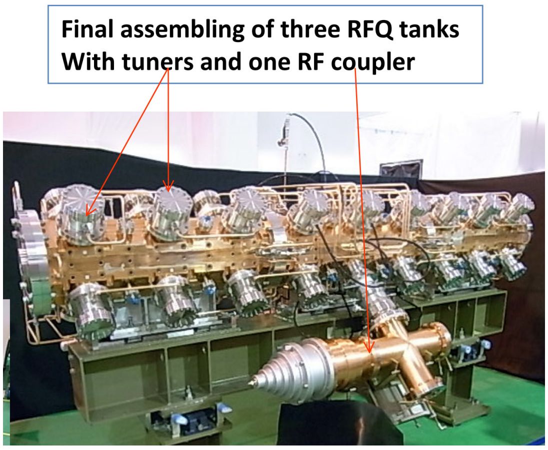

Figure 3a: 3 MeV RFQ.

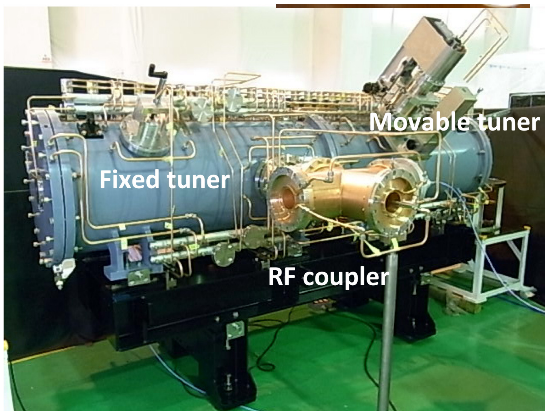

Figure 3b: 8 MeV DTL.