BSA and evaluate their performances in combination with the Dynamitron as a compact neutron source for BNCT.

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Study on the design of the miniature cyclotron for accelerator based BNCT

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The miniature cyclotron accelerator is designed by China Institute of Atomic Energy. Based on the accelerator and the Be target, the different proton energy changes with yield of neutron and the neutron yield changes with the Be thickness are calculated by MCNP. The optimization of configuration and material of the Beam-shaping-assembly (BSA) is also calculated by MCNP.
The neutron yield increases linearly when the proton energy between 10 Mev and 28 Mev will increase, and will decreases while the proton energy is more then 28 Mev. The relation between the neutron yield and Be thickness is calculated with the neutron energy of 10 Mev, 20 Mev and 30 Mev, the neutron yield will reach the saturation for 10 Mev when the Be thickness is more then 1 mm. According to the calculation results,

The proton energy with 10 Mev is selected as the design base of Beam-shaping-assembly, the final result is that the epithermal neutron flux rate generated by 10 Mev protons with 500μA current is 1.97 n/cm^2 s, the ration of fast neutron dose rate to epithermal neutron flux rate is 1.17×10^{-12} Gy cm^2, the ration of Gamma dose rate to epithermal neutron rate is 3.1×10^{-12} Gy cm^2, the ration of J to epithermal neutron flux rate is 0.63. The optimization of configuration and material of the Beam-shaping-assembly can meet the requirements for clinical treatment using the miniature cyclotron accelerator with 10 Mev proton and 500μA current.

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Development of the injector for Vacuum Insulated Tandem Accelerator

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For development of the accelerator based BNCT concept it is proposed and developed the tandem accelerator with vacuum insulation. In the experimental tandem accelerator, built at Budker Institute of Nuclear Physics, the negative hydrogen ions are accelerated by the positive potential of the high-voltage electrode, converted into protons in the stripping target inside the electrode, and

further protons are accelerated again by the same potential. Entrance aperture of the accelerator is a strong electrostatic lens, which makes the beam injection more complicate. Existing injector includes the source of negative hydrogen ions, providing stable generation of up to 5 mA beam current, focusing solenoids, correctors. Vacuum volumes of the ion source and low energy beam line are pumped by turbomolecular pumps with the capacity of 1500 l/s and 450 l/s, respectively. The experiments presented that this injector configuration is not optimal: a long and narrow tube of low energy beam line leads to the significant neutralization of hydrogen ions by the residual gas, besides the stripping gas of the tandem accelerator can reach the ion source, affect to its work stability and contribute to the beam neutralization. To create the facility for therapeutic usage the accelerated beam current of 10 mA or higher is required. To provide the injection of such a current in the tandem accelerator new injector configuration is proposed with the ion source capable to generate of 15 mA beam and with preliminary beam acceleration up to 200 keV, which would make the beam transportation through the accelerator system more stable.
The paper presents the design of the new injector with the calculations results.

PS2 P 20

Optimum design of a beam shaping assembly with an accelerator-driven subcritical neutron multiplier for boron neutron capture therapies

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It is most preferable that accelerator-based facilities for the production of treatment beam for the BNCT should be designed so that they are driven by small accelerators that generate protons of the energy below 5 MeV in low beam currents, since there are great benefits of easy construction of accelerators. The ^{7}Li (p, n) and ^{9}Be (p, n) reactions in this energy range have relatively large yields of neutrons and are suited for producing low energy neutrons. The author had designed a beam shaping assembly (BSA for abbreviation) equipped with the Be target driven by protons of the energy of 5 MeV, since higher proton energy leads to larger yield of neutrons and the Be target is much easier than the Li target to make and handle. However, the neutron yield per proton beam current is rather low and it turned out that high beam currents of the accelerator were needed to produce an adequate intensity of the treatment beam. For dropping the beam currents of the accelerator, the author studied a BSA that is combined with a subcritical neutron multiplier (SNM for abbreviation) equipped with the Be target driven by protons of the energy of 5 MeV.

Here, the SNM of 40 x 37 x 13 cm^3 in size fueled with 11.4 kilogram low-enriched uranium moderated by water was designed so that the BSA with the SNM had an effective reproduction constant (k_{eff}) of 0.990. The rectangular BSA prism including a part of the radiation shield is 120 x 120 x 135 cm^3 in size, and has a hole through the prism axis from end to end for the entrance of proton beam from the accelerator and the port of the treatment beam, and contains the Be target having an irradiation area of 12 x 12 cm^2, the SNM in which neutrons multiply about a hundred times, the slabs of Pb and MgF_2 which have an area of 50 x 50 cm^2 and make the proper neutron spectrum at the beam port, and so on. The dependence of the intensity of epithermal neutrons (0.5 eV < E < 10 KeV)