A study on development of remote-changeable Bonner sphere spectrometer for characterization in BNCT irradiation field

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[Introduction]

Various characterization methods for BNCT irradiation field have been developed and improved at Institute for Integrated Radiation and Nuclear Science, Kyoto University (KURNS). As a part of the development, we are developing a Bonner-sphere neutron-energy spectrometer that can change the moderator material and moderator thickness by remote control. For this spectrometer, a multi-layer concentric-spherical shells are prepared and liquid moderator is used. One of the studies on this remote-changeable Bonner-sphere spectrometer is reported.

[Materials and Methods]

The optimization simulation was performed for the structure of the Bonner sphere assuming the following conditions.

· Acrylic five-layered concentric-spherical shells are used.

· Liquid moderators are pure water and 0.15 wt% boric acid water (45 g/L solubility at 20 °c)

· The thicknesses of the five layers are same to be 10 mm or 20 mm.

· The wall thickness of the five sphere-shells are same to be 1 mm, 2 mm, 3 mm, 4 mm or 5 mm.

· LiCaF scintillation detector with 0.2 mm diameter is used.

· The energy range of the incident neutron beam is 1×10^{-10} to 1×10^{2} MeV.

The simulation was performed using the Monte Carlo calculation code, PHITS. Ten types of the five-layered concentric spheres were modelled: two kinds for the layer thickness and five kinds for the shell-wall thickness. For the injection of the moderators, thirty-three patterns were modelled. Totally, three hundred and thirty patterns for the spectrometer are simulated. Finally, the best pattern was selected in the viewpoint of the largely-different response functions.

[Result]

The structure of the finally-optimized Bonner sphere is as follows: the acrylic wall thickness is 3mm, the layer thickness is 20mm, and the number of the patterns for moderator injection is six.

[Conclusion]

We have a plan to make a prototype of the remote-changeable Bonner-sphere spectrometer based on this optimization study, and to perform the experiment using BNCT facilities at KURNS to confirm the effectiveness of this spectrometer.