

# Reevaluation of Neutron Energy Spectrum in Kyoto University BNCT Irradiation Field Using Multifoil Activation Method/多重箔放射化法による京大炉のBNCT 照射場の中性子エネルギースペクトルの再評価

Thursday, 14 November 2024 16:00 (2 hours)

The Heavy-Water Thermal Neutron Facility at the Kyoto University Research Reactor (KUR) has been used for boron neutron capture therapy (BNCT) since 1974. After facility upgrades in 1996, it was renamed the Heavy-Water Neutron Irradiation Facility (HWNIF), and the neutron energy spectrum was measured using the multifoil activation method. In 2010, KUR switched from high- to low-enrichment fuel, but the neutron spectrum in the KUR-HWNIF has not been reevaluated precisely since then. Detail of neutron energy spectrum data in BNCT irradiation fields is essential for various purposes, such as comparing irradiation characteristics across BNCT facilities, developing detectors and spectrometers, and calculating absorption dose.

This study aimed to reevaluate the neutron energy spectrum for the standard epithermal-neutron irradiation mode at KUR-HWNIF using the multifoil activation method. The previous evaluation irradiated the multifoil at 5 MW for 10 hours. Currently, KUR operates at 1 MW for 47 hours and 5 MW for only 6 hours each week. Due to limited 5 MW operation time, we utilized 1 MW power to irradiate the multifoil. With a lower thermal operation power, some foils used in the previous evaluation yielded lower counts during the measurements. In this study, the types of foils used for irradiation, the irradiation time, and the irradiation setup were adjusted from a previous study to obtain measurable results from the irradiated foils.

The neutron energy spectrum was evaluated using selected foils and optimized irradiation times, suited for measuring the spectrum in the epithermal and fast neutron ranges, which are predominant in the standard epithermal-neutron irradiation mode. The neutron energy spectrum unfolding process was performed by UMG package which included MAXED and GRAVEL unfolding code [2]. The previous evaluated nominal neutron energy spectrum [1] data was used as initial guess for unfolding process. Comparing with two different unfolding result of UMG package, GRAVEL gave a better evaluation result without any irregularities. Based on the reevaluated results from GRAVEL unfolding code, the epithermal- and fast-neutron fluxes increased by approximately 34% and 19%, respectively. The neutron absorption dose rate at evaluation point was approximately 17% lower than the previous one; however, it remained acceptable from the perspective of BNCT biological irradiation.

## References

- [1] Y.Sakurai, T.Kobayashi, "Spectrum evaluation at the filter-modified neutron irradiation field for neutron capture therapy in Kyoto University Research Reactor", Nucl Instrum Methods Phys Res A 531, (2004), pp. 585-595.
- [2] M.Reginato, "The 'Few-Channel' Unfolding Programs in the UMG Package: MXD FC33 and GRV FC33 and IQU FC33", 215 Technical Report, Braunschweig, (2004).

**Primary author:** PRATEEPKAEW/プラティップケーウ, Jakkrit/ジャックリット (Kyoto University/京都大学)

**Co-author:** SAKURAI/櫻井, Yoshinori/良憲 (Kyoto University/京都大学)

**Presenter:** PRATEEPKAEW/プラティップケーウ, Jakkrit/ジャックリット (Kyoto University/京都大学)

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