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Development of a calculation system contributing to the consideration of production methods for Auger electron emitters/オージェ電子放出核種の生成法の検討に資する計算システムの開発

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Recently nuclear medicine therapy using nuclides emitting α rays and Auger electrons is gathering attention [1]. α rays and Auger electrons have a higher linear energy transfer than β rays and are expected to enable the therapy with little damage to normal cells surrounding the tumor. Especially Auger electron emitters have an advantage that their daughter nuclei are less likely to decay compared to α ray emitters. Since there are many Auger electron emitters, and their production reactions and paths are diverse, the best nuclide for practical use and its production method have not been established at present. We are also working for improving the accuracy of nuclear data considering three-body nuclear forces. Based on the above situation, we have developed a system to calculate and illustrate nuclide production cross sections and Thick Target Yield (TTY) from various nuclear reactions for contributing to the consideration of wide range of possibilities on production for Auger electron emitters.

The developed system can calculate and illustrate arbitrary nuclide production cross sections and TTYs from light particle (*n*, *p*, *d*, *t*, ^{3}He, α, γ) injection reactions. The nuclear reaction model calculation code CCONE [2] is used to calculate reaction cross sections. In addition, when illustrating, the CCONE calculated values are converted to ENDF-6 format. Therefore, existing nuclear data library values in ENDF-6 format, such as JENDL and TENDL, can also be illustrated and compared. Injection particles, incident energies, and targets including natural compositions can be selected, and the sum of multiple nuclide production cross sections (e.g., ^{77}Br+^{77}Kr (decays to ^{77}Br with a half-life of 1.24 hours)) can also be output.

Using this system, we investigated the optimal production method for Auger electron emitters. For example, when the incident energy is from 1 to 50 MeV and a natural composed target is used, the production cross section of ^{77}Br, which is one of the Auger electron emitters, is the largest for α+^{75}As around 25 MeV, while TTY of ^{77}Br is the largest for *p*+^{nat}Se when isotope separation is considered. In this poster presentation, we will also report the results of other Auger electron emitters. Furthermore, we will refer about the evaluation of unwanted nuclides that may be produced, time variation of TTY, and comparison with experimental values and other libraries. In the future, we plan to apply this system to nuclides other than Auger electron emitters to improve the accuracy of nuclear data.

References

[1] D. Filosofov, E. Kurakina, V. Radchenko, "Potent candidates for Targeted Auger Therapy: Production and radiochemical considerations", Nucl. Med. Biol. 94-95, (2021), pp. 1-19.

[2] O. Iwamoto, N. Iwamoto, S. Kunieda *et al.*, "The CCONE Code System and its Application to Nuclear Data Evaluation for Fission and Other Reactions", Nucl. Data Sheets 131, (2016), pp. 259-288.

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