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Optimizing neutron yield for active interrogation

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ABSTRACT

Neutrons are commonly used for many applications, including active interrogation and cancer therapy. One critical aspect for active interrogation efficiency is neutron yield, which is more important for successful resolution than the energy spectrum. The typical approach for improving neutron yield entails producing more neutrons, which has motivated multiple studies using the interaction of increasingly more powerful tabletop lasers with plastic targets to generate protons or deuterons that are absorbed by another target to create neutrons [1]. Alternatively, one may use lenses to focus the neutrons to increase yield rather than simply generating more neutrons with more powerful lasers [2]. Assessing either approach requires a comprehensive model simulating neutron generation and transport to optimize the target material, system geometry, and neutron yield. A complete model from laser source to neutron generation is beyond the scope of the current study, so this project focuses on simulating the interaction of deuterons with typical target materials, such as lithium or beryllium. We use the neutron transport code Monte Carlo N-Particles (MCNP), which applies the Monte Carlo method to track particles [3]. The simulations accurately reflected experimental results from several groups [4]. Future analyses will assess improvements in neutron yield and directionality through strategically incorporating neutron lenses.

KEYWORDS

Active interrogation, neutron yield, neutron focusing, collimator

REFERENCES

[1] M. Roth, D. Jung, K. Falk, N. Guler, O. Deppert, M. Devlin, A. Favalli, J. Fernandez, D. Gautier, M. Geissel, R. Haight, C. E. Hamilton, B. M. Hegelich, R. P. Johnson, F. Merrill, G. Schaumann, K. Schoenberg, M. Schollmeier, T. Shimada, T. Taddeucci, J. L. Tybo, F. Wagner, S. A. Wender, C. H. Wilde, G. A. Wurden. “Bright Laser-Driven Neutron Source Based on the Relativistic Transparency of Solids,” *Phys. Rev. Let,* vol. 110, art. no. 044802, Jan. 2013.

[2] M. R. Eskildsen, P. L. Gammel, E. D. Isaacs, C. Detlefs, K. Mortensen, D. J. Bishop. “Compound refractive optics for the imaging and focusing of low-energy neutrons,” *Nature*, vol. 391, pp. 563-566, Feb. 1998.

[3] MCNPX User’s Manual, 2nd ed., 2008.

[4] H. I. Amols, J. F. Dicello, M. Awschalom, L. Coulson, S. W. Johnsen, R. B. Theus. “Physical characterization of neutron beams produced by protons and deuterons of various energies bombarding beryllium and lithium targets of several thicknesses,” *Med. Phys.,* vol. 4, pp. 486-493, Nov. 1977.