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Repetitive Laser Driven Neutron Source and Organic Scintillation Crystal for Fast Neutron Detection

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We are carrying out a project of development of laser driven neutron source under the support of Japan Science and Technology agency (JST). We will introduce about the present status of the project, especially focused on repetitive neutron pulse generation system and 2D fast neutron imaging system using our original organic scintillation crystal for fast neutron detection.
We are investigating a possibility to develop a compact neutron source with ion beams driven by high-intensity short-pulse laser. The laser driven neutron source (LDNS) has the potential to be a unique compact neutron source because of some features such as; (a) realization of a compact neutron source by closely locating a laser-driven particle source and a neutron generating target, (b) a small size neutron source which is advantageous for high resolution radiography, and (c) neutrons with short pulse duration leading to a possibility for time-of-flight measurements in material analyses and imaging. However, neutron flux per laser pulse energy is relatively small in comparison with that in the accelerator driven neutron source. There are several ways to compensate the lack of flux. One is increasing the energy conversion efficiency of laser energy into ion beam energy. Another is increasing repetition rate. Modern ultra-intense laser systems which are adopted as the driver laser can be operated in 10Hz or more. We use the diode pumped ultra-intense laser system of Hamamatsu photonics as the driver laser. It can be operated in 10 Hz of repetition rate. The irradiation target supplying system is also important for realizing repetitive neutron generation.
Our neutron generation scheme is so-called pitcher-catcher system. There are two targets. The first “pitcher” target is laser irradiation target. The target material is deuterated polystyrene. The ultra-intense laser pulse is focused on to the target. Then the deuteron beam is generated by laser driven ion acceleration such as TNSA (target normal sheath acceleration) mechanism. The generated deuteron beam hits the second “catcher” target. The material is also deuterated polystyrene. At the second target D-D nuclear reaction is occurred. Then fast neutron beam is generated. The energy is 2.45MeV. We are constructing target supplying system for 10Hz operation. For realizing 10Hz operation, we adopted tape-shaped target. The target tape is loaded on the target drive mechanism like a movie projector. However thin deuterate polystyrene tape is too week to drive by such a mechanism. Therefor we developed composite tape consisting of thin deuterate polystyrene tape and tape with sufficient strength. Currently the performance is evaluating.
We also developing 2D fast neutron imaging system. The imaging system consist of scintillators with grid structure and multi-anode phot multiplier tube. We developed organic scintillation crystal for fast neutron detection. The melting point of the crystal is more than 200 degrees Celsius. The decay time is less than 6nsec. The light output is more than twice of trans-stilbene. We succeeded in growing a large diameter crystal of over 1 inch. Currently we are dicing and polishing crystal to constructing 2D imaging system.
We will introduce the current status of our project in the presentation.

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