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# 単結晶CVDダイヤモンド検出器を用いたブランケット模擬体系内の高速中性子束と燃料生産性の評価

# Evaluations of fast neutron flux and fuel production in blanket mock-ups using single crystal CVD diamond detector


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## Introduction

In a deuterium–tritium (DT) fusion reactor, tritium breeding ratio (TBR), the rate of bred tritium in blanket to consumed tritium in plasma, must be greater than unity for a continuous operation. In our previous study, by using a compact discharge-type fusion neutron source generating deuterium-deuterium (DD) fusion neutrons, tritium production rates in breeding blanket mock-ups were successfully evaluated with a single-crystal diamond detector with a $^6$LiF convertor [1]. The method should be tested in 14.1 MeV DT fusion neutron environment for the application of fusion neutron diagnostics. In this study, fast neutron flux and tritium production rate were measured by the single crystal chemical vapor deposition (CVD) diamond detector and the results were compared with the results of activation foils and simulations.

## Methods

Three blanket mock-ups composed of polyethylene moderator, graphite reflector, and lithium carbonate ($Li_2CO_3$) tritium breeder were irradiated with DT fusion neutrons at the OKTAVIAN facility (acceleration voltage: 240 kV). Geometry 1 had no $Li_2CO_3$ block, while geometry 2 and 3 had one and two of 5 cm thick $Li_2CO_3$ layers, respectively. Neutrons in the mock-up were measured by a single-crystal CVD diamond detector with a $^6$LiF convertor calibrated with an unsealed $^{241}$Am source. The neutron measurements were also done with activation foils of Au, Dy, and Nb. Neutron transport and activation of the foils were calculated by using MCNP6 and FISPACT codes.

## Results and Discussion

Each of the blanket mock-up was irradiated for 2 hours. The total numbers of source neutron for geometry 1, 2, and 3 were $2.40 \times 10^{13}$, $3.28 \times 10^{13}$, and $3.20 \times 10^{13}$ with the deviations of approximately 10%. The online measurements of tritium production rate were carried out by integrating triton peak via $^6$Li(n,t) appeared in the deposition energy range of 2.0–3.0 MeV. The energy spectra measured by the diamond detector had a large background, deriving from elastic reaction of $^{12}$C. The obtained triton count rates are shown in Fig. 1. The count rates in geometry 2 and geometry 3 were $7.6 \times 10^{-9}$ and $7.0 \times 10^{-9}$ and clearly lower than that of geometry 1, because of thermal neutron capture by $^6$Li in $Li_2CO_3$. On the other hand, the count rates of the $^{12}$C(n,α) reaction (threshold energy: 6.18 MeV) peaks were almost equivalent in these geometries. In the presentation, the results of the activation foils as well as the simulation results will be reported.

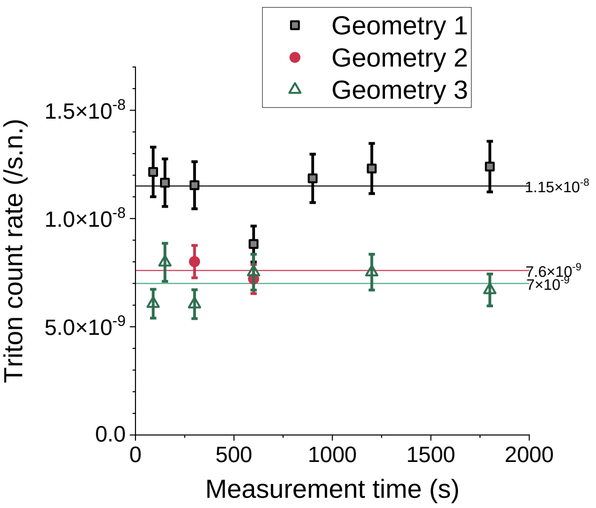


Fig. 1 Triton count rate per source neutron (s.n.) measured by the single crystal CVD diamond detector with a $^6$LiF converter.

## Reference


[1] K. Mukai *et al. Nucl. Fusion* 61 (2021) 046034