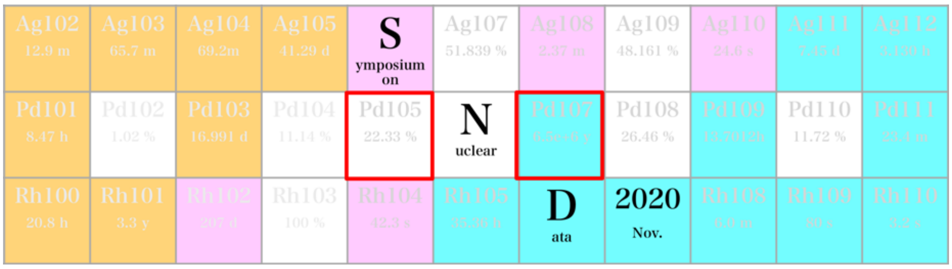

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Study on characteristics of neutron and γ-ray fields at compact neutron source RANS-II facility by simulation by the PHITS code / PHITS による p-Li 反応を用いた中性子源 RANS-II の放射線場特性に関する研究

Thursday, 26 November 2020 17:09 (1h 41m)

RIKEN Accelerator driven compact Neutron Source-II (RANS-II) based on the ^{7}Li(p, n)^{7}Be reaction for neutron production with 2.49 MeV proton beam, has been under beam commissioning to demonstrate specific performance of the system. RIKEN has a prospect of realizing novel non-destructive neutron inspection for infrastructures with the use of RANS. As prominent characteristics, RANS-II has the maximum neutron energy of 0.8 MeV, which is lower than that of 5 MeV at RANS based on the ^{9}Be(p, n)^{9}B reaction with 7 MeV proton injection, and gives extremely forward favored angular distribution with respect to the proton beam direction. Also, it should be emphasized that RANS-II system is installed in a relatively small space isolated by concrete shield with boron containment. Accordingly, there should be quite large differences in neutronic performances between RANS-II and RANS in terms of neutron spectrum and angular distributions. In preparation of experiments at RANS-II, the simulation of radiation fields for neutron and γ-ray in RANS-II experimental hall plays a critical important role for designing experimental set-up in low background.

Then, we have performed simulations to characterize radiation fields of RANS-II The cross section libraries implemented in PHITS are utilized in neutron and γ-ray transportations. Several important conditions of RANS-II modeling are as follows:
・The lithium (Li) target is made by depositing thin Li layer of about 100 μm on a 5 mm thick Cu substrate cooled by water in the target station.
・The target station with about 90 cm side cubic shape, configures five layers; polyethylene, lead, borated polyethylene, lead and iron, to reduce the radiation leakage.
・There is a hole with a 15 × 15 cm^2 cross section in the forward direction.
・The experimental hall has dimensions of 14 × 5.5 × 3.0 m^3 surrounded by floor and wall made of concrete (partly the borated concrete) and polyethylene ceiling.

As a result, the neutron and γ-ray distribution spreads widely in the experimental hall due to the wide openings in the target station. The scattered radiation could be the major contributor to the background of experiments. On the other hand, primary neutrons produced at the target are shielded reasonably by the target station. To design effective collimators for high quality beam extraction, we have calculated neutron beam profiles with parameters of collimator diameters and materials. It is shown that there is an optimized collimator configuration to extract suitable beam.

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