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Simulation of aluminum activation experiment at CERN/CHARM/CERN/CHARM でのアルミニウム放射化実験の模擬計算

An activation experiment using aluminum samples at the CHARM [1] of CERN was simulated for a benchmark on the radiation shielding of high energy accelerators. Na-24 production in aluminum samples set in the irradiation room and corridor of the CHARM was calculated. Additionally, measurable feasibility of other activated nuclides produced in the aluminum sample was checked.

Two radiation transport codes: PHITS [2] and GEANT4 [3] were used to simulate the experiment at the CHARM. The calculation geometry was largely constructed with the size of 21 m wide, 30 m long, and 16 m height. Spherical output regions of 10 cm in diameter were located in the irradiation room and corridor. Proton beam with the energy of 24 GeV/c was hit on a copper target of 8 cm in diameter and 50 cm length, and produced particles were transported. As output of calculation, particle type, position, direction, energy, and weight of a particle were acquired when the particle was incident into the output region.

Production of activated nuclides in aluminum was derived by a connective calculation using acquired data and activation cross sections. Cross sections of ^{7}Be, ^{22}Na, ^{24}Na, and ^{27}Mg productions for neutron and proton incidences were checked by comparing experimental, evaluated, and calculated values, and were implemented into the connective calculation. The particles based on acquired data were produced as a source, and attenuated in the geometry consisting of a cylindrical aluminum set in a sphere filled with air. The productions were calculated in attenuation.

As an example of PHITS calculations, productions (1/atom/primary) at 1.5 m far away from the copper target are 2×10-32 for ^{7}Be, 7×10-31 for ^{22}Na, 4×10-30 for ^{24}Na, and 5×10-30 for ^{27}Mg. Productions of ^{24}Na and ^{27}Mg are suitable to observe neutron streaming since neutron induced productions of were occupied. Be-7 production is good to observe the contribution by proton from production ratio of ^{7}Be to ^{24}Na, however, the measurement would be difficult due to the long half-life. Na-22 which has a longer half-life than 7Be cannot be measured.

References

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