

Estimation of the Thermal Neutron Flux in a PET Cyclotron Room via Radioactive Analysis of the Bolts of a Wall Socket in the Room

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Abstract

Since positron emission nuclides for PET (Positron Emission Tomography) have short half-lives, they are mainly produced by on-site cyclotrons. Significant amounts of neutrons are generated together with the operating of the cyclotron, and then materials in the room are activated. To quantify the neutron flux density will lead the prediction of the extent of the activation. We tried to estimate the neutron flux of the room via the radioactive analysis of bolts in the room.

The cyclotron (Cypris HM-18, Sumitomo Heavy Industry) is able to accelerate protons and deuterons up to 18 and 10 MeV, respectively. The routine charge current is 20 μ A. The cyclotron is housed in a room with 1 m thickness concrete wall. A couple of bolts of a wall socket were removed to investigate the components and the radioactivities, which were analyzed by fluorescent X-ray spectroscopy and by gamma-ray spectroscopy, respectively. We compared the neutron flux estimated by the bolts analysis with the results measured by the gold foil activation method.

The weight sum of the bolts was 1.257 g. They were made of nickel plated brass, and predominantly consisted of Cu (63%) and Zn (34%). Four nuclides, ^{69m}Zn, ⁶⁵Zn, ⁶⁴Cu, and ⁶⁰Co, were detected in the bolts. The activity of ⁶⁴Cu, half-life of 12.7 h, led the last few days history of neutron flux, and the activity of ⁶⁵Zn, 244 d, led the last few years history. The analysis of the bolts activity estimated the thermal neutron flux at 4~6 $\times 10^5$ cm⁻² s⁻¹. This figure agreed with the value, 6~9 $\times 10^5$ cm⁻² s⁻¹, computed from the activated gold foil near the bolts. Bolts are quite generally installed in such a room. Therefore, the radioactive analysis of the bolts leads convenient and effective estimation of neutron flux there.

Consequently, the radioactive analysis of the bolts in the cyclotron room allowed us to estimate the neutron flux in the room.

KEYWORDS: *PET cyclotron; neutron flux; radioactive analysis; bolt.*

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