

Maintenance of radio-activated stripper foils in the 3GeV RCS of J-PARC

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In the 3-GeV Rapid Cycling Synchrotron (RCS) of the Japan Proton Accelerator Research Complex (J-PARC), we adopted thick Hybrid type Boron-doped Carbon (HBC) stripper foil for the multi-turn H⁻ charge-exchange injection. The HBC foil has a great advantage of its longer lifetime against high irradiation. Until now, deformation of the HBC foil is observed, but has not broken during 6 months user operation. However there are high residual dose in the RCS injection area. The highest residual dose is observed at the downstream of titanium chamber flange where the stripper foil is placed. The residual dose was increased with the LINAC energy upgrade from 181MeV to 400MeV.

In order to understand the reason for such high residual dose around the stripper foil, a numerical simulation was done by using PHITS Monte Carlo code. It shows that secondary neutrons and protons generated by nuclear reactions in the stripper foil at high energy and high power beam irradiation are the major sources for high residual dose at the injection area. Furthermore, the nuclear reactions at the stripper foil induce the radio-activation of the stripper foil itself and the foil frame. The residual dose rate after retrieving the irradiated foil measured by a GM survey meter was several mSv/h on contact and nuclear species of Be-7 and Na-22 were observed by a handy type of Germanium (Ge) semiconductor detector. The radio-activation of the stripper foil itself is an intrinsic problem and thus maintenance scenario of the stripper foil at the highly-dosed environment is one of the most important issues for the high intensity accelerators.

In the J-PARC RCS, the foil exchange devices were improved according to the new maintenance scenario which aims to keep radiation exposure to staffs as low as possible and to reduce the risk of the radioactive foils break up or disperse. In addition, various analyses of the irradiated stripper foils can be carried out if the foils can be retrieved from the tunnel without breaking.