Title: Measurement of continuous degradation of a stripper foil during six months operation with 300 kW beam power in the 3-GeV RCS of J-PARC

Authors: P.K. Saha, M. Yoshimoto, Y. Yamazaki, H. Harada, H. Hotchi, K. Okabe, M. Kinsho and Y. Irie

Abstract:

We have clearly measured a continuous degradation of the stripper foil used for H^- stripping injection in the 3-GeV RCS (Rapid Cycling Synchrotron) of J-PARC (Japan Proton Accelerator Research Complex). An HBC (Hybrid-type Boron doped Carbon) stripper foil of 200 μg/cm^2 was used for stripping nearly 99.7% of an H^- beam of 181 MeV so far and is changed to 340 μg/cm^2 for the recently upgraded injection energy of 400 MeV. The main motivation of the present study is to know a real lifetime of a foil through measuring foil degradation such as a change of the foil thickness and/or pinhole formation caused by the radiation. A foil thinning increases the partially stripped H^0 component, while pinhole formation increases the un-stripped H^-, resulting an increase of the waste beam and consequently heat load on the beam dump. A foil thickening on the other hand increases uncontrolled foil scattering beam loss in the injection area. A proper monitoring of the waste beam during operation including accurate measuring of the H^0 and H^- waste beams are thus very important in order to know detail of the foil degradation so as to ensure a reliable operation as well as for a proper uses of the stripper foils.

Our earlier result as reported in the previous conference was obtained for comparatively a low beam power of the RCS operation and there was thus no clear indication of the foil degradation. However, the present measurement differs from the earlier one not only for an order of magnitude higher cumulative hit particles on the foil but also for 1.5 times higher injected beam power itself. Starting with a new foil in autumn 2012, we monitored the waste beam online as well as measured both H^0 and H^- components of the waste beams in every 2 weeks during six months operation with an output beam power of 300 kW. The cumulated injected together with circulating beams at the end of 6 months operation were as high as 1.6×10^{23}. The foil was measured to be 20% thicker than its initial thickness, where the measurement accuracy was better than 2%. The present experiment is the first time of this type in order to directly measure an absolute change of the foil thickness during operation. As the beam power was less than one third of the designed 1 MW, we continued user operation without replacing the foil with a new one.

The RCS operation with 400 MeV injection and with same beam power of 300 kW has just started but we have already observed similar foil degradation although degradation rate seems to be slightly different as compared to that for the 181 MeV injection. However, none of the measurements show any foil thinning or pinhole formation, which may requires continuing the measurement for further longer time range. The latest measurement results of the foil degradation along with some related results in any other similar accelerators will be presented.