Beam transmission for inductively coupled plasma stripper*

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Introduction

Currently for all over the world, the beam stripping methods for accelerators are mainly gas stripping and foil stripping devices. The former's stripping ability does not reach sufficiently high charge states while the latter has the difficulty with long lifetime. However, the plasma stripping method can solve both problems very well. As a consequence, this novel stripper is proposed for the project FAIR (Facility for Antiproton and Ion Research).

Initially, our plasma stripper was realized as the theta pinch which is inductively pulsed device [1, 2, 3, 4, 5]. Differing from the z-pinch, it has no problem with the electrodes erosion which reduces the device lifetime. This theta pinch installed with a differential pumping system was integrated into the accelerator for the beam-plasma interaction experiment on Oct. 2012. The results show a poor beam transmission [6]. To overcome this issue, the theta-pinch device was modified. Meanwhile, another kind of inductively pulsed device named "screw pinch" is developed as an alternative. In this paper, we will describe the beam transmission for this "screw-pinch" device.

Experiment

The "screw pinch" additional owns a z-direction current besides the theta direction which is described well in [4, 5]. This design results in a complicated magnetic field. Hard plastic supports fix coils to reduce their movement during discharge. The differential pumping system also has been improved.

A pulsed beam of Au^{26+} with the energy of 3.6 MeV/u was available for our experiment at Z6, GSI. Considering the discharge time of our "screw pinch", a beam pulse duration of about 1 ms is applied to cover the cold gas and discharge states. As a benchmark for beam transmission, the detected beam signal after the cold gas with the same initial pressure is applied. Here, we both use pure hydrogen of 40 Pa for the cold gas case and discharge case. The total capacitance is 25 μF while the operation voltage for discharging is 18 kV.

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Results

The beam transmissions both for cold gas and discharge conditions are shown in Fig. 1. The black line below gives the benchmark beam signal. The above red line presents the values for the subsequent shot when the target has the discharge condition which starts at about 402 μs as shown on the oscilloscope. Different from the distinct discrete signal in [6], the beam signal represented by the red lines does not show this enormous discontinuity, big gaps in signals, after discharge. As the signal height after discharge are comparable to the benchmark one, the beam transmission for the "screw pinch" as a plasma stripper is pretty good.

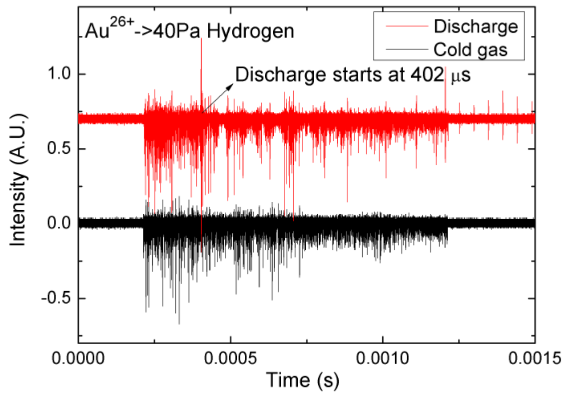

Figure 1: Comparison of beam signals with the cold gas and discharge conditions

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