H- Acceleration by the 930 AVF Cyclotron

著者	Endo T., Fujita M., Yamazaki A., Miyashita Y., Kan S., Chiba S., Omiya Y., Matsumura A., Yokokawa S., Yokoi T., Honma T., Shinozuka T.
journal or publication title	CYRIC annual report
volume	2003
page range	36-39
year	2003
URL	http://hdl.handle.net/10097/50226

II. 5. H^- Acceleration by the 930 AVF Cyclotron

Endo T., Fujita M., Yamazaki A., Miyashita Y., Kan S.[*], Chiba, S.[*], Omiya Y.[*], Matsumura A.[*], Yokokawa S.[*], Yokoi T.[**], Honma T.[***], and Shinozuka T.

Cyclotron and Radioisotope Center, Tohoku University
SHI Accelerator Service Ltd.[*]
Tokin Machinery[**]
National Institute of Radiological Sciences[***]

Introduction

As one of the projects at CYRIC new cyclotron, high intensity neutron beam has been planned by the negative hydrogen acceleration for various applications. The goal of this project is to supply 300μA proton beam. High intensity neutron beam is expected to be use in nuclear physics, material irradiation and study of BNCT cancer therapy.

Instruments & Methods

Figure 1 illustrates a layout of the new AVF cyclotron and injection- and extraction-lines. Ion sources are located on the under ground level. A negative ion source is installed in another room on the BF1 floor, then ions are injected upward into the central acceleration-region through an inflector electrodes. In negative ion acceleration mode, magnet field directions of bending magnets, main coil and the electric field of inflector electrodes are inverted against these in positive ion acceleration mode. Negative hydrogen (H^-) ions are accelerated in the same rotation direction of positive ion acceleration, then their electrons are stripped by the stripper foil, thus converted into H^+; the H^+ ions after the electron of H^- ions stripping are extracted through the residual magnetic field as shown in the fig.1. The extraction beam line for negative ion acceleration mode consists of one dipole magnet and three quadrupole magnets, then it is connected to the switching magnet at the junction with the beam line for positive acceleration mode.

The multicusp type ion source (BLAKE-V[1]) is used for the negative ion source it can extract 300μA H^- beam. One third of the H^- beam(100 μA) is transported to a faraday cup at the inlet of the cyclotron and one third of the H^- beam at the cyclotron entrance(30 μA@main probe) is injected into the central region of cyclotron with the aid of the beam buncher[2)].

The position of foil stripper, which is thin carbon foil of 50μg/cm^2 is able to move its radial position and azimuthal angle in the cyclotron. These two parameters, which determine the energy and starting point of H^+ ions' trajectory, are adjusted to obtain the optimum extraction trajectory.

Acceleration test & results

Before H^- acceleration test, the preparations of each components have been tuned for the ion source, test of magnet inverting, attaching carbon foil to the moving arm and the test of RF operation under the inverted magnetic field of main coil. Figure 3 shows H^- current profile along the radial direction of acceleration chamber. The beam intensity of H^- doesn't decrease by the gas dissociation or electric stripping[3)] of negative ions.

In order to obtain the optimum parameters for the radial position and the azimuthal angle, beam current is measured by the Faraday cup in front of the first Q-magnet in the extraction beam line. Figure 4 shows the position parameters in which H^+ beam after stripping is extracted from cyclotron.

Since the source position of H^+ ion is definitely set at the foil stripping, the beam transport is easily tuned and, finally, 95% of the beam current of accelerated beam is transported to the switching magnet.

Concluding remarks

Now we are making effort to achieve 300μA high intensity H^- beam with the 930 AVF cyclotron. Instruments have already been prepared and acceleration test is now underway. So far, 22μA and 95% extraction efficiency was achieved.

References

1) Mori Y., Rev. Sci. Instrum. **65** (1994) 4.
2) Suzuki H., ibid.
3) Richardson J. R., Progress in Nuclear Techniques and Instrumentation vol.**1** (1965) 3.

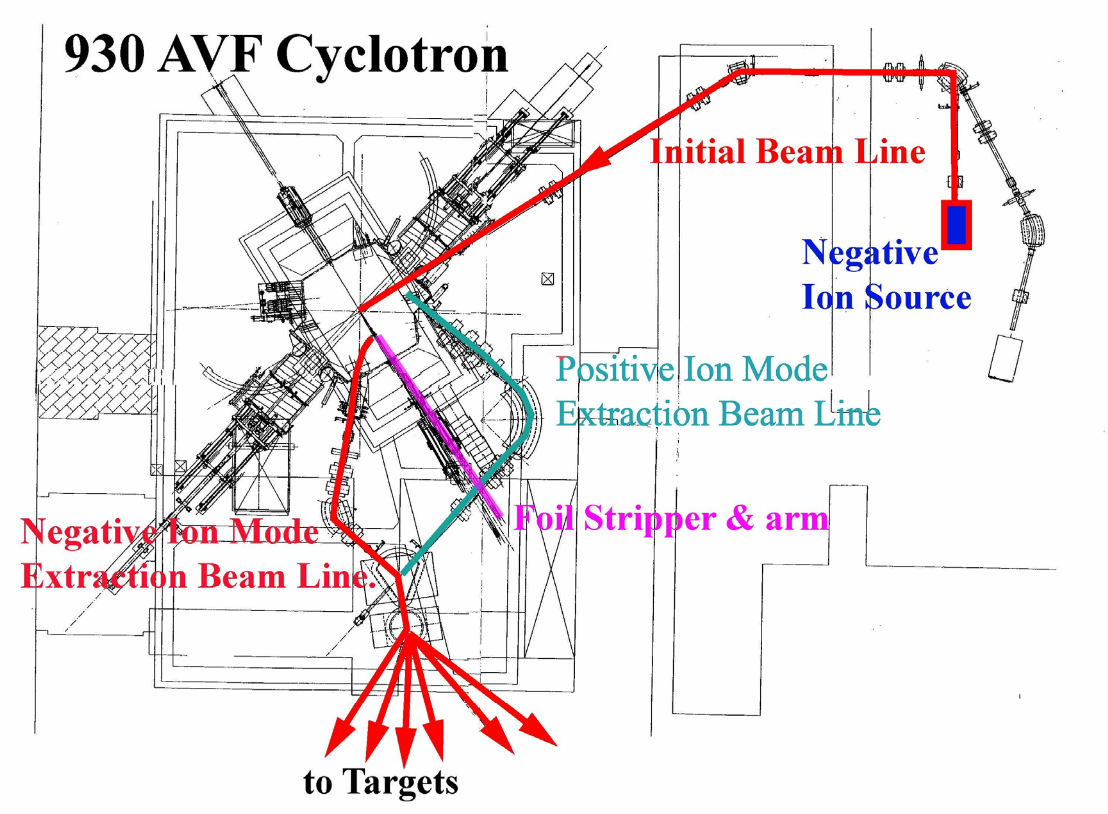

Figure 1. 930 AVF Cyclotron and initial & extraction beam lines.

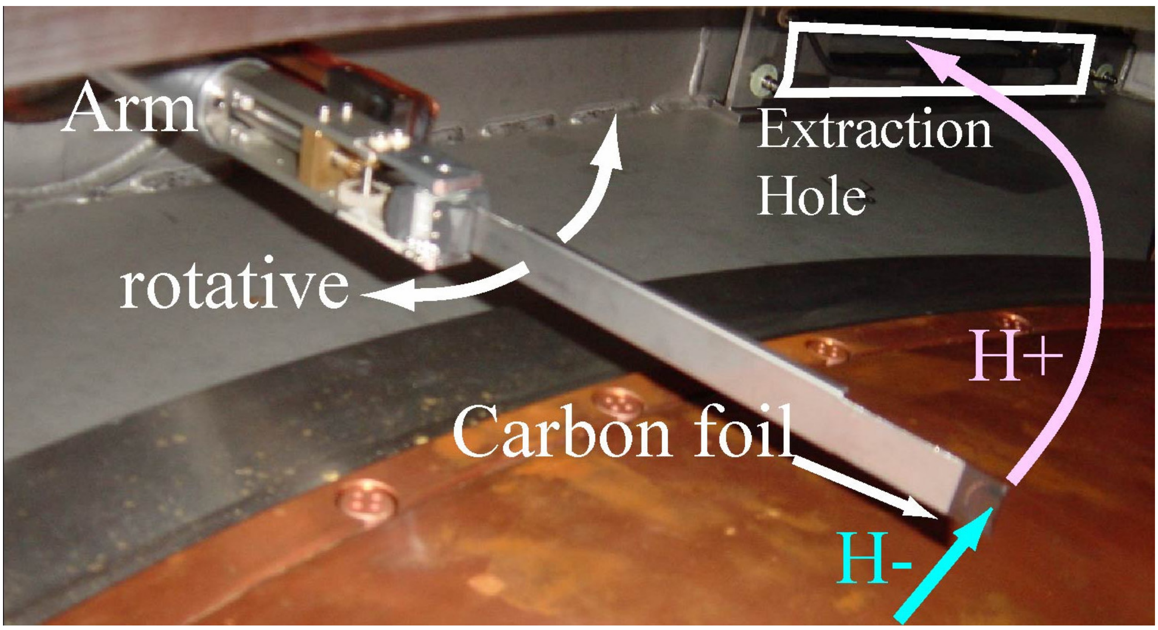

Figure 2. Foil Stripper & arm. A 50μg carbon foil, looks black, put on the tip of the arm.

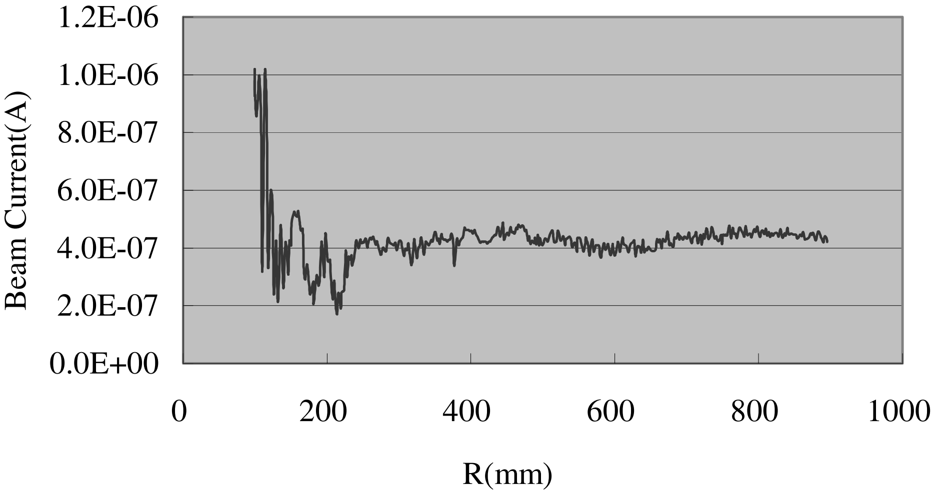

Figure 3. Change of beam current on the R-direction. It is almost flat except for central region.

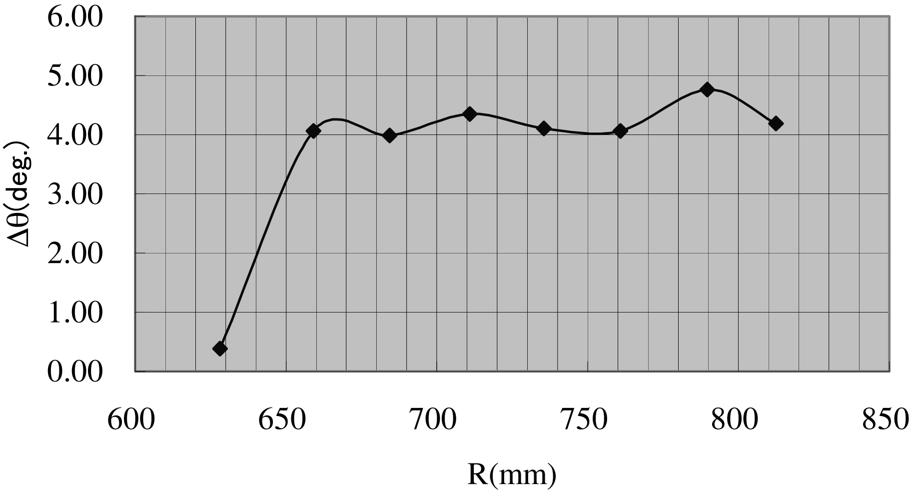

Figure 4. Plot of positions of foil stripper when beam current is observed at the entrance of extraction beam line.