6 - 10 Successful High Power Test of Hsc Type Injector for Cancer Therapy in IMP*

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A Hybrid single cavity (HSC) linac, which is formed by combining a radio frequency quadrupole (RFQ) structure and a drift tube (DT) structure into one interdigital-H (IH) cavity, is fabricated and assembled as a proof of principle (PoP) type injector for cancer therapy synchrotron according to the culmination of several years' researches[1−4]. The injection method of the HSC linac adopt a direct plasma injection scheme (DPIS), which is considered to be the only method for accelerating an intense current heavy ion beam produced by a laser ion source (LIS). According to numerical simulations, the HSC linac could accelerate a 6 mA C^{6+}beam which meets requirement of the needed particle number for cancer therapy use ($10^{8\sim9}$ ions/pulse).

In our preliminary experiments, the calibration of energy channel for SSD was used a radioactive source: ^{241}Am, which could mainly emit α particles with energy of 5.486 MeV (85%)[5]. A beam acceleration system, the layout of the system shown in the Fig. 1, was built to measure the beam current. There are two meshes, one is the exit of the HSC cavity one is behind the FC, which were set to cut off the ions. The transmission of mesh 1 and mesh 2 are 50% and 5%, respectively. In our injection system, the LIS could provide 17.5 mA C^{6+} ions. That implies the HSC could only accelerate 5 mA C^{6+} ions because the transmission was only 30%, and the actual injection point was drawn back 12 mm. The peak of the accelerated C^{6+} ion reaches 5 mA, shown in the left part of the Fig. 2, which agreed well with simulations and transmission calculations. And as shown in the right part of the Fig. 2, the Canberra SSD confirmed the accelerated C^{6+} ion beams under operations with the average 110 kW of RF power, and showed the C^{6+} beam energy is 25.7 MeV (2.14 MeV/u). Both the detected results of the transmission and the beam energy agree very well with the simulations.

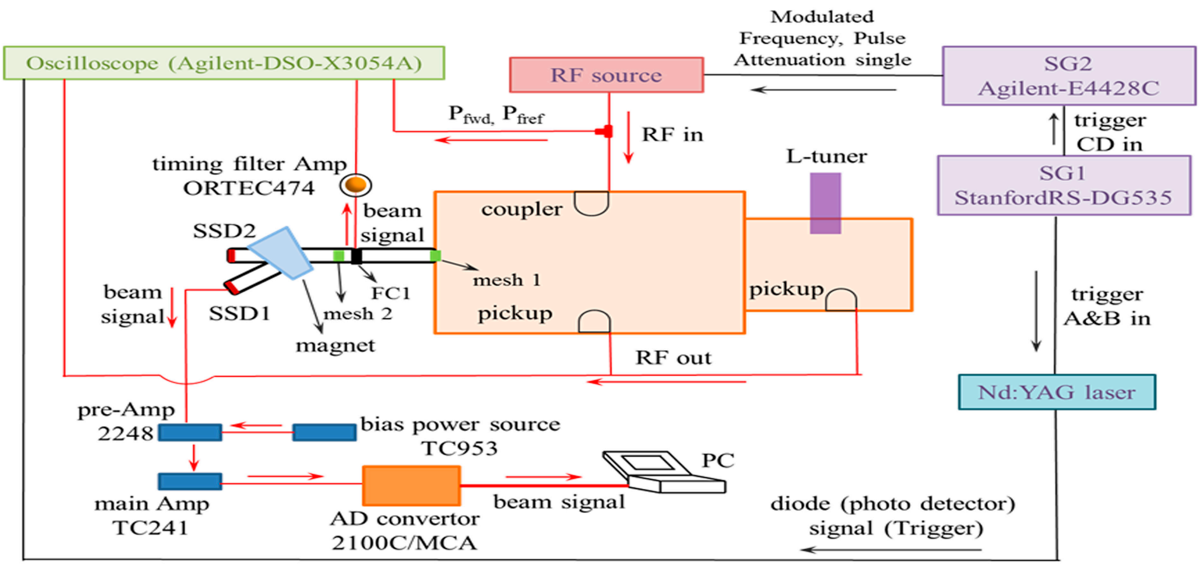

Fig. 1 (color online) Layout of the beam acceleration system. The FC, SSD1, SSD2, SG1 and SG2 refer to a faraday cup, solid state detector 1 and solid state detector 2, signal generator 1 and signal generator 2, respectively.

This successful acceleration has proved the HSC could be used for cancer therapy as an injector. The injection system adopted HSC injector with the method of DPIS can make the existing multi-turn injection system and the stripping system unnecessary, and also can make the beam pipe of the existing synchrotron magnets downsize which could reduce the whole cost of synchrotron (estimated millions dollars) for one heavy ion cancer therapy facility. That could lighten the burdens for millions patients.

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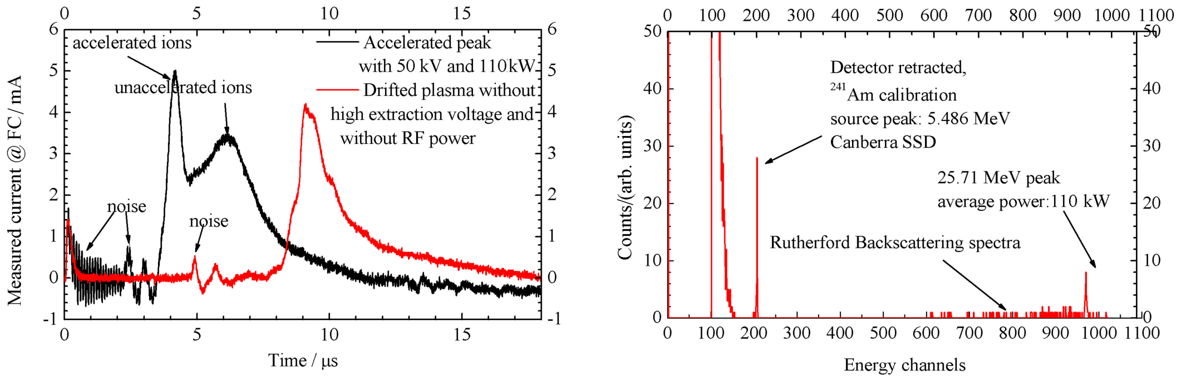

Fig. 2 (color online) Measured signals from FC and the SSDs.

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6 - 11 Mechanical Design of the Bead-Pull and Tuning Test Device for the CH Cavity at IMP

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The copper model CH cavity was designed and fabricated at IMP for Injector II of CIADS project operating at frequency 162.5 MHz, β=0.065[1]. To research the electromagnetic mode evaluated by the electric field distribution and the tuning properties of the CH cavity the bead-pull and tuning test device was set up. It included two parts, the beadpull mode and the tuning test mode. A brief description of the equipment design is shown in Fig. 1

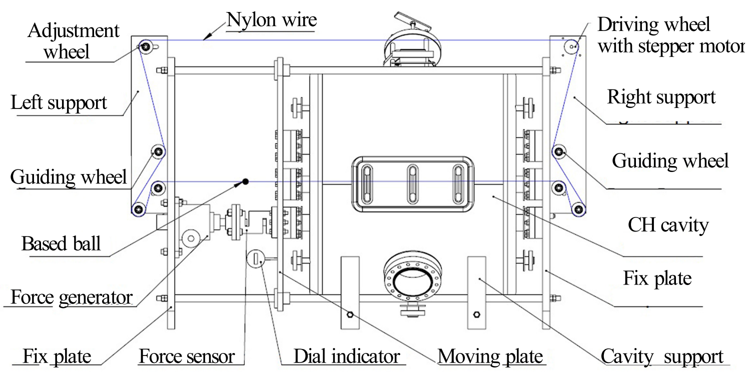

Fig. 1 The detail of the bead-pull and tuning test device.

The bead-pull mode measures the field distribution along the axial by the perturbation method, which consists of the pulley system, a Network Analyzer, and other tiny parts such as an Aluminum bead[2]. The pulley system was composed of a driving wheel with stepper motor, adjustment wheel and several guiding wheels. When the pulley system guided the motion of the bead through CH cavity via the nylon wire, a Network Analyzer is used to take the RF measurements. Fig. 2 shows the comparison between the measured electric field along the axis and