Status of IH and RFQ linacs in the Daejeon Ion Accelerator Complex at KAERI

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1. Introduction

The Daejeon ion accelerator complex (DIAC) is being built at Korea atomic energy research institute (KAERI) in order to fulfill an increasing demand for heavy ion beam facilities for various purposes including structural material study, biological research and nanomaterial treatment. Based on devices of the Tokai radioactive ion accelerator complex (TRIAC) given from the high energy accelerator research organization (KEK), Japan, the dedicated accelerators in the DIAC are designed to produce stable heavy ion beams with energies up to 1 MeV/u and beam currents up to 300 μA. [1–4] In this article, recent construction status of the DIAC are presented and discussed.

2. Overview of the DIAC Construction

The stable heavy ion beam line of the DIAC consists roughly of an electron cyclotron resonance (ECR) plasma ion source as a charge breeder, a radio-frequency quadrupole (RFQ) linac and an interdigital H-type (IH) linac as shown in Fig. 1.

Fig. 1. Panoramic view of the DIAC beam line.

The ECR ion source plays a role in producing and extracting multi-charged ions. Considering beam utilization, two ECR ion sources will be operated in the DIAC. One is an 18 GHz ECR ion source given from the KEK. With a metal oven, it will be used for making metal ions. The other is a 14.5 GHz ECR ion source developed by KAERI and will be employed for production of multi-charged non-metal ions. The 25.96 MHz RFQ linac accelerates ions up to 178 keV/u. Then, the accelerated ions by the RFQ reach to the 51.92 MHz IH linac via a transport system composed of a rebuncher and two sets of quadrupole doublet. The IH linac can re-accelerate the ions up to 1 MeV/u.

Up to now, (1) assembly of the ECR ion source and linacs delivered in pieces (2) installation of power supply, coolant circulation system and vacuum pump system, (3) operation test of the ECR ion source (4) full-power tests of power amplifiers for providing RF power to the RFQ and IH linacs have been completed. Since all tests were successful, it is supposed that the DIAC is now ready for beam tuning. Presently, construction of radiation shields for the DIAC facility is ongoing and three target rooms are being designed. The following section gives some full-power test results of the power amplifiers regarding the RFQ and IH linacs.

3. Full-Power Test of the RFQ and IH Linacs

3.1 Full-Power Test of the DIAC IH Linac

To check performance capacity of the reinstalled IH linac, measurement of Q factors of the IH cavities and stored electromagnetic energy of the cavities as a function of peak RF power were carried out.

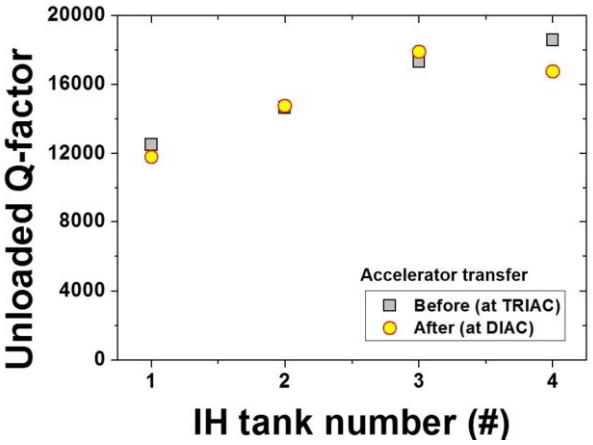

Fig. 2. Measured Q factors of the IH cavities before and after the linac transfer.

As shown in Fig. 2, Q factors of IH cavities reassembled at DIAC are almost the same to those in the TRIAC. This indicate that there is no degradation in the performance capacity during the transfer and assembly. Fig. 3 shows measured RF pickup loop voltages in the IH tanks versus peak RF power up to their full power (i.e., IH1: 12 kW, IH2: 22 kW, IH3: 30 kW, and IH4: 50 kW). The square of RF pickup loop voltage was nearly linear to the peak RF power. Since the total stored electromagnetic energy is proportional to square of RF pickup loop voltage, it implies that the IH linac can accelerate ions without a serious loss of the electromagnetic energy in the cavities.

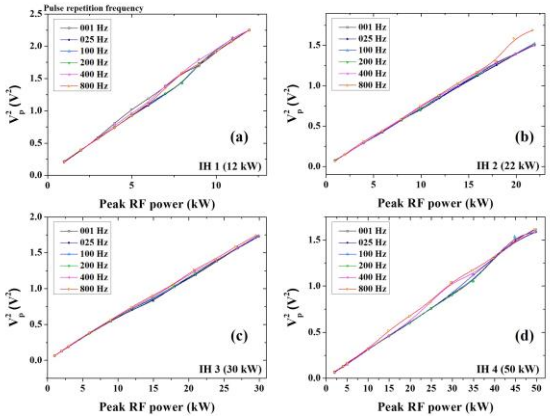

Fig. 3. Measured RF pickup loop voltages in the IH tanks versus peak RF power up to their full power.

3.2 Full-Power Test of the Amplifiers associated with the DIAC RFQ Linac

Unlike the IH linac, the RFQ linac does not have lead shields yet so that full power test of the RFQ linac is restricted. Alternatively, we tested power amplifier system of 350 kW using a dummy load, and finally we succeeded in applying full power to the dummy load after several trials to tune its impedance. This favorable test result enable us to expect that the RFQ linac will have no problem for the operation. Figure 4 represents the characteristics of amplifier power depending on frequency tuning, obtained from the test.

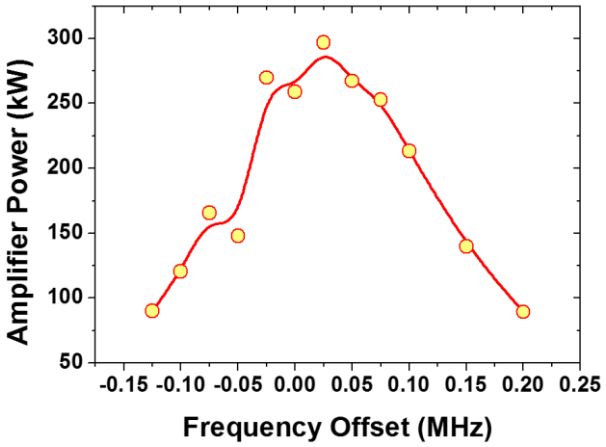

Fig. 4. Amplifier power as a function of frequency offset at the RFQ operating frequency (25.96 MHz).

4. Conclusion

From the successful full-power test results, we confirmed that the IH and RFQ linacs work properly and then they are ready to accelerate heavy ions up to 1.09 MeV/nucleon. The construction of lead shields on DIAC devices is now in progress, and the beam tuning and test will be done soon until the end of this year.

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