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Current Status of the Daejeon Ion Accelerator Complex at KAERI

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1. Introduction

The Daejeon ion accelerator complex (DIAC) is being constructed 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. The accelerators in the DIAC are designed to produce heavy ion beams with energies up to 1 MeV/u and beam currents up to 300 μA. [1–4] In this article, current status of the DIAC construction is presented and discussed.

2. Overview of the DIAC Construction

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

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

The DIAC facilities are designed to handle stable non-radioactive beams. According to user demand, the separated two ECR sources (i.e., an 18 GHz KEK – the high energy accelerator research organization ECR ion source with a metal oven and a 14.5 GHz KAERI ECR ion source) together with low energy beam transport line (LEBT) can supply linacs with both metal and non-metal ions. The 25.96 MHz RFQ linac accelerates ions up to 178 keV/u. Then, the ions accelerated by the RFQ reach to the 51.92 MHz IH linac via a transport system composed of a RB and two sets of quadrupole doublet. Finally, 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 from the KEK (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 IH and RFQ power amplifiers, (5) construction of radiation shielded room for the ECR ion sources as x-ray sources, (6) tests on the RFQ, RB, and IH RF tuners, and (7) reorganization of the integrated control system have been completed. The following section gives results on the full-power test of the RFQ/IH linacs and the reorganization of the DIAC integrated control system.

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

The values of squares of RF pickup loop voltages in the IH tanks as a function of peak RF power up to full powers (i.e., IH1: 12 kW, IH2: 22 kW, IH3: 30 kW, and IH4: 50 kW) were measured. Because the square of RF pickup loop voltage is proportional to electromagnetic energy in the cavity, the result represents the relationship between the output power of RF amplifier and the electromagnetic energy.

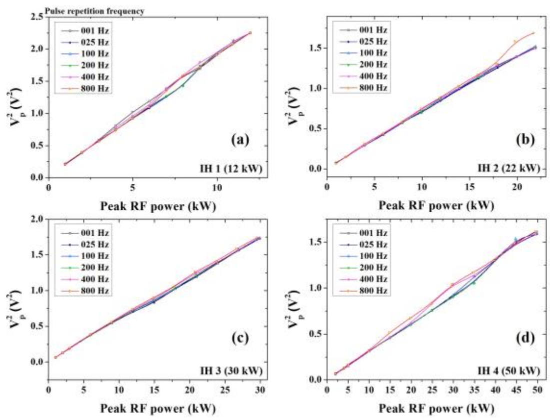

Fig. 2. The values of squares of RF pickup loop voltages in the IH tanks as a function of peak RF power.

As shown in Fig. 2, the values of squares of RF pickup loop voltages are nearly linear to the applied RF powers, indicating that the IH linacs can accelerate ions without a serious loss of the electromagnetic energy in the cavities.

Fig. 3 shows the full-power (350 kW) test result on the RFQ RF amplifier using a dummy load. The output power of RF amplifier increases with power level of the low level RF system and then saturates to the maximum power value with few reflected power. This means that the full-power of the power amplifier can be applied to the load.

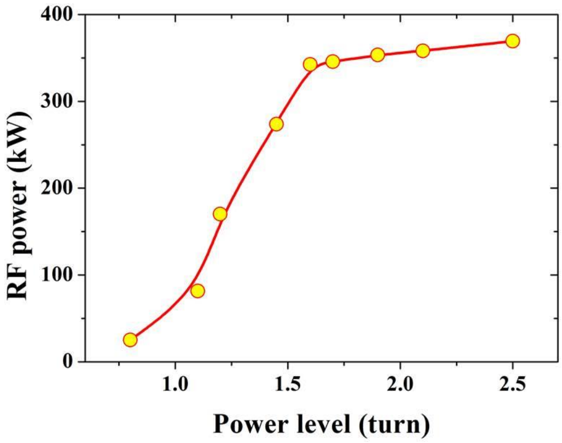

Fig. 3. The applied RF power as a function of power level in the RFQ RF amplifier.

4. Reorganization of the Integrated Control System

Based on system of the Tokai radioactive ion accelerator complex (TRIAC), we reorganized the integrated control system. Fig. 4 illustrates the DIAC integrated control system.

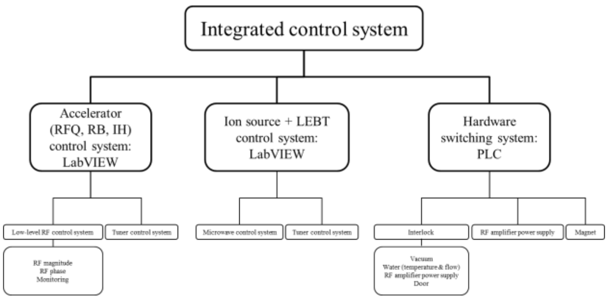

Fig. 4. The DIAC integrated control system.

The integrated control system consists of two control systems for accelerator and ion source/LEBT, respectively, including feedback control system (Fig. 5) and a hardware switching system. The switching system controls RF amplifiers (power on/off), electromagnets, and interlocks (Fig. 6). A LabVIEW program and a PLC program, developed by KEK, handle the control system and switching system, respectively. We have modified the programs and converted old LabVIEW codes to formats that are supported by the latest version of LabVIEW for the DIAC system. Wiring between the integrated control system and individual devices is under way.

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.

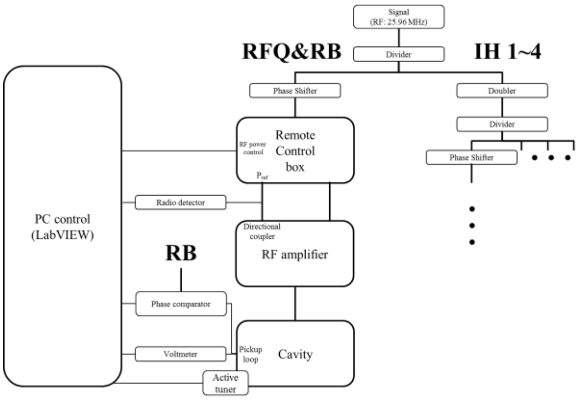

Fig. 5. Schematic diagram of the DIAC feedback control system.

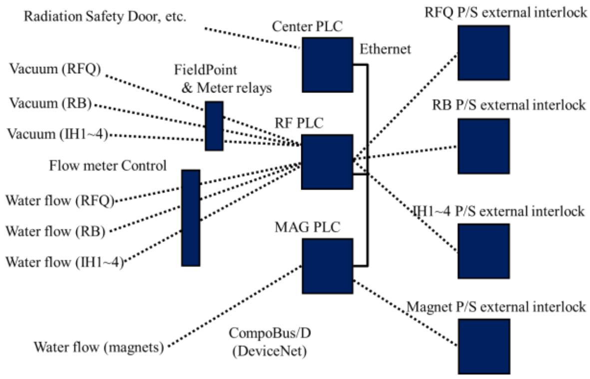

Fig. 6. Schematic diagram of the DIAC interlock system.

Since all tests and reorganization of the integrated control system were successful, it is supposed that the DIAC is now ready for beam tuning. Presently, construction of radiation shielded walls and radiation safety licensing are now in progress. It is expected that the beam tuning test will be done soon until the end of this year.

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