Construction Status and Test Operation of the DIAC at KAERI

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1. Introduction

KEK (High Energy Accelerator Research Organization) TRIAC (Tokai Radioactive Ion Accelerator Complex) was a radioactive isotope accelerator that can provide beams of uranium fission fragments with a maximum energy of 1.1 MeV/nucleon produced by protons of 30 MeV and 1 μA (30 W in beam power, actually deposited in the production target) from the JAEA Tandem Accelerator. Because of the critical limitations in the reaccelerated energy and intensity of available RIBs (Radioactive ion beams), TRIAC seriously considered an upgrade program, but it was canceled. Finally the complex was closed at the end of 2010, and it was transferred to KAERI (Korea Atomic Energy Research Institute) after being disassembled to promote new availability in Korea.

KAERI staff named the facility DIAC (Daejeon Ion Accelerator Complex). The DIAC team has a plan to reassemble this device as a stable ion beam accelerator with a minimized change for the low energy beam line including the ion source and the target system. The new stable ion accelerator will be used not only for basic research but also for the application of heavy ion beams.

Until recently, most of power supply, the cooling water supply and vacuum pump systems have been installed for a performance evaluation of the DIAC. The experimental results of the plasma generation in the ECR ion source are presented.

2. Construction Status

2.1 Tokai Radioactive Ion Accelerator Complex

Fig. 1 shows a schematic drawing of the TRIAC facility. The TRIAC is based on an isotope separator on-line (ISOL) and the radioactive nuclei are produced via proton-induced fission of ^{238}U or heavy-ion reactions with the primary beams provided by a tandem accelerator [1]. The produced radioactive nuclei are singly charged and mass-separated by the ISOL. They are fed to the 18 GHz electron cyclotron resonance ion source for charge-breeding, where the singly charged ions are converted to multi-charged ions. The charge-bred radioactive ions, usually with a mass to charge-state ratio of around 7, are extracted again and fed to the post accelerator for re-acceleration. The post accelerator consisting of two linear accelerators, a split-coaxial radio-frequency quadrupole (SCRFQ) linac and an interdigital-H (IH) linac, can accelerate the radioactive ion beam to the energy up to 1.1 MeV/A at the maximum [2].

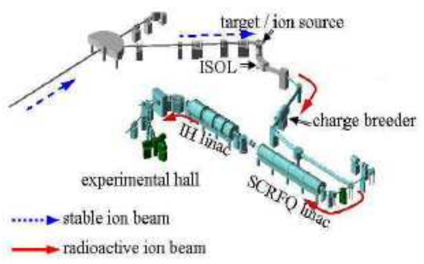

Fig. 1. Layout of the TRIAC

2.2 Daejeon Ion Accelerator Complex

The layout of the DIAC is presented in Fig. 2. The basic structure of the DIAC is similar to those of the TRIAC. The installed power distribution station and cooling water recirculating facility view are shown in Fig. 3.

Fig. 2. Layout of the DIAC

Fig. 3. Power distribution station (left) and cooling water recirculating facility (right) of the DIAC

The installed incoming panels for the components of the DIAC have the capability to supply 200 V / 1.3 MVA and 400 V / 0.3 MVA. The thermal loads and flow rates for the cooling system are listed in Table I for each component.

Table I: The specification of thermal loads and flow rates for the cooling system

	Thermal load (kW)	Flow rate (L/min)	Pressure (kg/cm^2)
Magnetic mass separator	100	150	5
ECR charge breeder	250	250	7
SCRFQ, IH cavity (pure water)	160	1800	8
RF power supply	165	250	4
Electromagnet	230	250	5
IH cavity (normal water)	61	700	8

3. Components Test Operation

A cross sectional view of the ECR ion source (the same facility as the TRIAC's charge breeder) and an installed image at KAERI are shown in Fig. 4. Energetic electrons, high plasma density and a good ionic confinement are important ingredients for high charge breeding efficiency, leading to the effective production of highly charged ions.

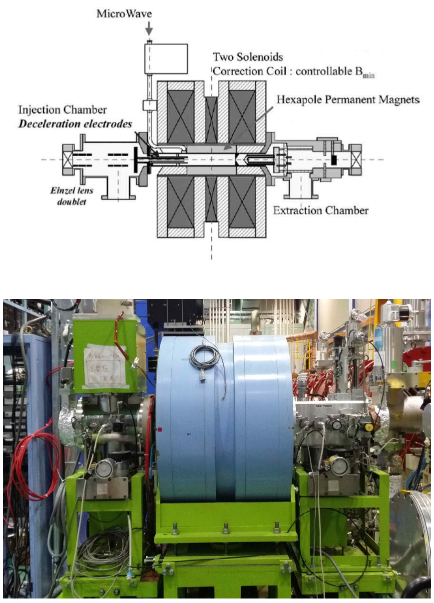

Fig. 4. 18 GHz ECR ion source

The detailed conditions performed for the plasma generation test are the following:

- Vacuum: 4.62×10^{-6} mbar (gas injection area), 6.95×10^{-7} mbar (beam extraction area)
- RF power: 200, 300 W
- Solenoid coil current: 460/300A
- X-ray measuring time: 5 min
- Injection gas: ^4He
- Detector: NaI (Tl)

The X-ray spectrum is produced via plasma generation in the ECR chamber. As shown in Fig. 5, high RF power leads to an increase of the maximum X-ray energy and the X-ray yield.

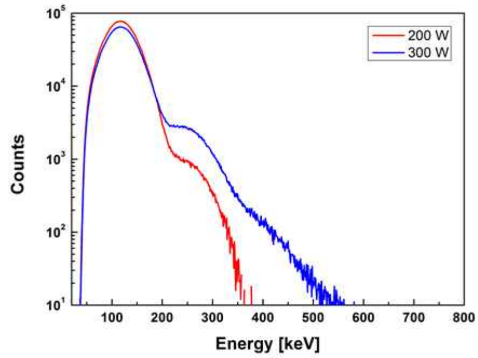

Fig. 5. The generated X-ray spectrum from the 18 GHz ECR ion source

The X-ray spectrum is produced via plasma generation in the ECR chamber. As shown in Fig. 5, high RF power leads to an increase of the maximum X-ray energy and the X-ray yield. The quality (Q) factor measurement tests for RF characteristics check of IHs were conducted. The results of measured loaded-Q are similar (relative error: < 10%) to those of TRIAC (See Fig. 6).

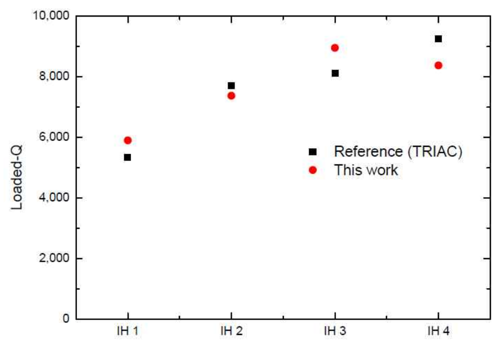

Fig. 6. Comparison of loaded-Q values in the DIAC and TRIAC

4. Future plan

We are planning to evaluate a radiation shielding analysis for an operation permit and perform the beam transport experiments from the ECR ion source to the IH linac by the end of next year.

REFERENCES

[1] S. C. Jeong, et al., TRIAC Progress Report, High Energy Accelerator Research Organization, 2011
[2] Y. X. Watanabe, S. Arai, Y. Arakaki, Y. Fuchi, et al. Tokai Radioactive Ion Accelerator Complex (TRIAC), The European Physical Journal Special Topics 150, 259-262, 2007