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Construction of Heavy Ion Beam Facility and its Application Plan

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1. Introduction

A heavy ion beam facility, which is based on the transferred heavy ion accelerator TRIAC (Tokai Radioactive Isotope Accelerator Complex) [1] from KEK of Japan, has been constructed at KAERI with a new name DIAC (Daejeon Ion Accelerator Complex). Three target beam lines (Fig. 1) are designed for material irradiation test, nano cell development and micro beam application. On the preferential basis the material test beamline has been constructed at first in the 45° angle line.

The performance of the DIAC linear accelerator system has been confirmed by beam acceleration and energy measurement experiments up to 1.0 MeV/u.

2. DIAC System

The designed beam line of the DIAC heavy ion beam facility is shown in Fig. 1. The facility is composed of DIAC linear accelerator system including ECR ion source [2], a RFQ and IH linear accelerators [3], and irradiation target. The final beam line will be completed by adding a new ECR ion source and two other target beam lines in a straight and 90° angle.

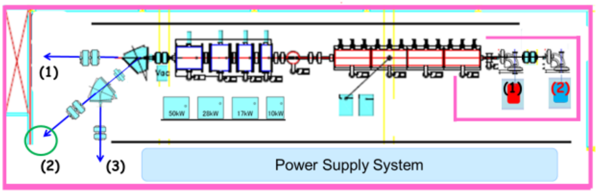


Fig. 1. Layout of the designed DIAC facility.

2.1 ECR Ion Sources

The 18 GHz ECR ion source [2], which had been developed as a charge breeder in Japan is being used as an ECR ion source to produce highly charged ion beams. Because of its different uses in DIAC some modification will be made in the future to increase beam current.

2.2 RFQ and Linac

To accelerate heavy ions up to 1 MeV/nucleon, a RFQ and four IH tanks are used. Table 1 shows the beam energy and energy spread with the TRIAC system, and Fig.2 shows the assembled linear accelerator system.

Table 1. Beam energy and energy spread with RFQ and 4 IH tanks, which were made by TRIAC team during his first tuning.

	Output Energy T (keV/u)		Energy Spread ΔT/T (%)	
	measured	calculated	measured	calculated
RFQ	172	172	1.56	1.03
IH-tank1	293	295	1.65	2.80
IH-tank2	476	476	1.97	2.79
IH-tank3	726	728	1.15	1.45
Variable	900	879	2.32	2.08
IH-tank4	1059	1053	1.12	1.17

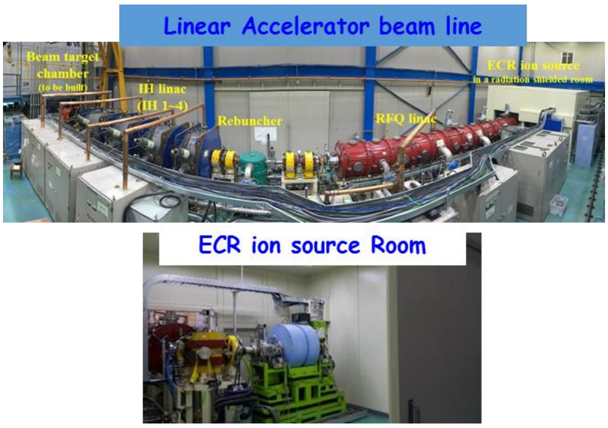


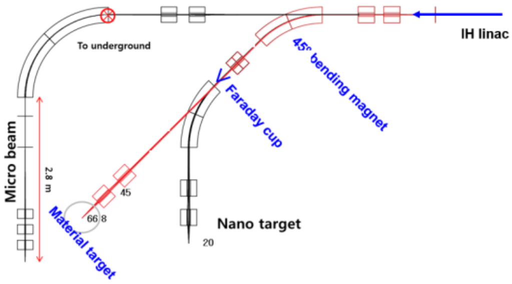
Fig. 2. The assembled linear accelerator system

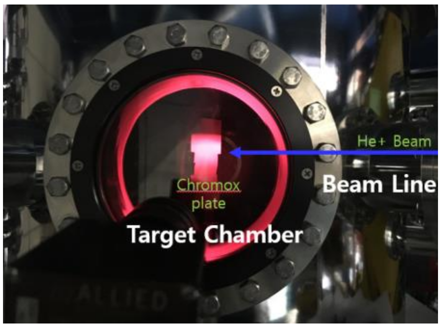
2.3 Target System

To give wide opportunities to the internal researchers, three target rooms are designed. But at this moment, only a material test beamline is settled down. With this beamline simulation experiments on radiation damage of the reactor materials for advanced and fusion reactors will be started. A vertical irradiation port for micro beam application will be installed to support bio and cell unit experiments, and a pure and highly focused heavy ion beamline will be made at the 90 degree direction to support nano related R&Ds including challengeable topics.

3. Beam Acceleration Result and Beam Tuning

He^+ beam is used in tuning the accelerator system. To measure the accelerated beam energy and beam current, a 45° bending magnet and Faraday cup is used as shown in Fig. 3. Depending on beam energies accelerated by RFQ, and 4 IH tanks in series one by one, the beam currents were measured by Faraday cup. Beam current of more than 3 micro ampere was measured with all of the linacs (1 MeV/u). Fig. 4 shows a chromox luminous light by 1 MeV/u He beam at a material target.





4. Future Plan

As the performance of the DIAC linear accelerator system has been confirmed with He beam, the next missions in a short term are as follows;

- other heavy ion beam tuning (Table 1)
- beam stabilization for material irradiation test
- start heavy ion beam service.

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And long term plans include installing other two target beam lines and developing a metal ion source to expand its application area.

Table 1. Possible gas heavy ions in DIAC

Gas (mass no.)	Energy (MeV)	Current (pμA)	A/q ~ 4	A/q ~ 6	A/q ~ 8
He (4)	4	5	+1		
Ar (40)	40	~	+10	~ +7	+5
Kr (84)	84	~	+21	+14	~ +10
Xe (130)	130	~	~ +32	~ +21	~ +16

REFERENCES

[1] TRIAC Collaboration (edited by S.C. Jeong), “TRIAC Progress Report”, KEK Progress Report 2011-1, 2011.

[2] S.C. Jeong, N. Imai, M. Oyaizu, S. Arai, Y. Fuchi, Y. Hirayama, H. Ishiyama, H. Miyatake, M. Okada, M.H. Tanaka, Y.H. Watanabe, S. Ichigawa, A. Osu, T.K. Sato, H. Kabumoto, Nuclear Instruments and Methods In Physics Research B, Vol.266, p.4411, 2008.

[3] H. Delagrange, Nuclear Instruments and Methods In Physics Research B, Vol.105, p.345, 1995.