Improvement of the Cryostat System performance of 28 GHz Electron Cyclotron Resonance Ion Source of the BIBA by a radiation shielding

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Status of BIBA (Busan Ion Beam Accelerator)

1. Ion implantation/surface modification
   - Extraction: ~ 12 keV/u

2. Ion beam based analytic instruments
   - Linear accelerator I: Radio Frequency Quadrupole (RFQ)
   - Linear accelerator II: Drift Tube Linac (DTL)
   - Neutron Facility

3. Future Plan
   - Neutron application
     - Neutron production
       - p(7Li, n)7Be Inverse kinematics

New high-tech research facility.
28GHz ECR ion source of BIBA

The effect of exiting current:
As the current increases, the cooling margin unexpectedly decreased.

The effect of X-ray:
Pressure is increased.
Upgrade of Cryostat

Add one Cryocooler

Spare port upto 6 Cryo

Adding the one cryocooler

Increasing the surface area of a pin-type heat exchanger

A Study on the Performance of the Cryostat System for the 28-GHz Electron Cyclotron Resonance Ion Source at the Korea Basic Science Institute

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The IBBA (Ibusan Beam Accelerator) is a compact linear accelerator facility using the 28 GHz ECRIS (Electron Cyclotron Resonance Ion Source) at the KBRI (Korea Basic Science Institute). The superconducting magnets of the 28 GHz ECRIS produce high magnetic fields for strong confinement of plasma in an ion source chamber. For stable operation of the superconducting magnets, performance of cryostat system is very essential. However, the cryostat system produces significant quantities of the heating due to conduction from room temperature. In addition, part of the X-ray radiation produced by the collisions of the electrons within the ion source chamber is absorbed by the cold mass of the superconducting magnet, leading to an additional heat load in the cryostat system. The goal of this study was to investigate the performance of the cryostat system including superconducting magnets, cryocoolers, HTS current leads and thermal radiation. The performance of the cryostat system was evaluated using analytical and experimental tests.
X-ray measurement on 28GHz ECR ion source

❖ Setup of CZT detector

❖ Energy Calibration by check source

❖ Specification of the CZT detector
X-ray shielding on 28GHz ECR ion source

- Measured x-ray spectra with respect to the RF power.

<table>
<thead>
<tr>
<th>MW power</th>
<th>X-ray energy concentration below 600 keV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 kW</td>
<td>97.5 %</td>
</tr>
<tr>
<td>3 kW</td>
<td>96.5 %</td>
</tr>
<tr>
<td>5 kW</td>
<td>95.9 %</td>
</tr>
</tbody>
</table>

- Measured x-ray spectra with respect to the thickness of Pb sheets

<table>
<thead>
<tr>
<th>Pb Sheet</th>
<th>Shielding rate (&lt;600 keV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mm</td>
<td>60 %</td>
</tr>
<tr>
<td>2 mm</td>
<td>75 %</td>
</tr>
<tr>
<td>3 mm</td>
<td>82 %</td>
</tr>
</tbody>
</table>
Improving the cooling efficiency: As the current increases, the cooling margin was found to decrease 13 W and then saturated.

Installation of X-ray radiation shielding bore: As the plasma ignition, the pressure was not increased.

Heat power and pressure according to excitation of the superconducting magnets.
Conclusion

• For stable operation of the superconducting 28 GHz ECRIS, we modified some components of the cryostat system.

• The cooling margin was sufficient to permit the magnet and cryostat system.

• Also, the test results of X-ray emission on cryostat system with radiation shield performance is satisfied for stable operation..