DP27 FIRST OPERATION OF ECR ION SOURCE AT KUT

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1. Preface

To study fundamental science and to develop nano scale manufacturing by using ion beams, the facility to produce and irradiate heavy ion beams has been built at Kochi University of Technology (KUT). This facility includes ECR ion source (ECRIS), the beam transport and analysis system, and the beam irradiation system.

The first beam was extracted from ECRIS at January of 2003. To evaluate the performance of ECRIS which we built, the total current and the mass spectrum of extracted beam have been observed as a function of the voltage for the beam extraction and the RF power for ionization.

It is concluded from the present results that ECRIS built at KUT works well and is applicable to the fields mentioned above.

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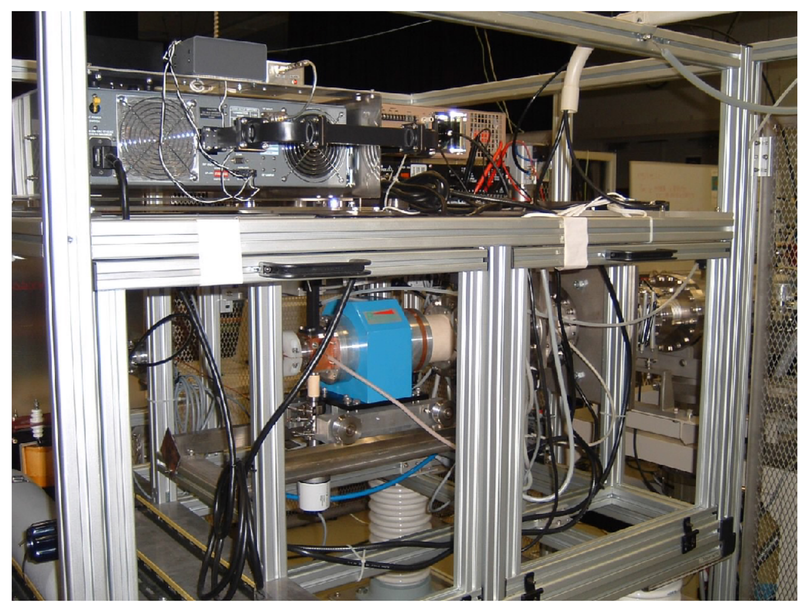
2. Facility built at KUT

2-1. ECRIS



10GHz-NANOGAN (PANTECHNIK Co.)

Voltage for beam extraction	: 0 ~ 30 kV
Voltage for beam acceleration	: 0 ~ 100 kV
Power of RF for ionization	: 0 ~ 80 W

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2-2. Beam transport and analysis system

Transport of ion beams
focused by einzel lens and electric Q-lens

Analysis of ion beams
mass analyzed by a dipole magnet
$\theta = \pi/2$ [rad]
$B\rho = 0 \sim 0.33$ [T-m]

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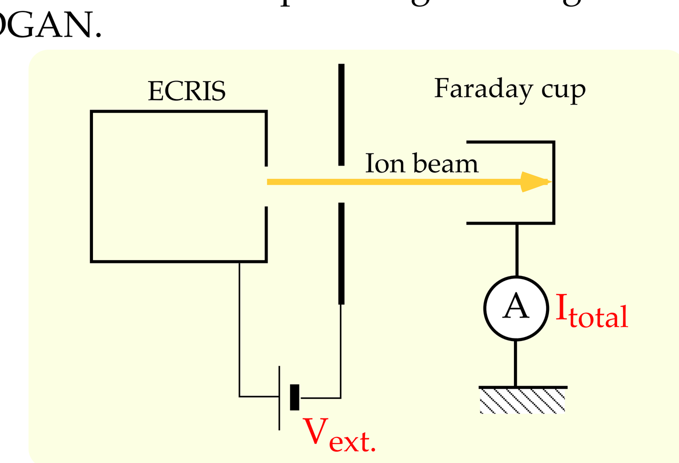
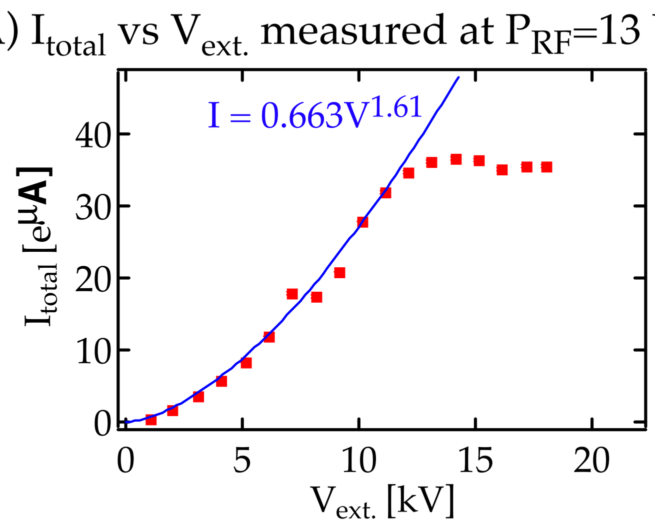
3. Measurements

3 - 1. I_{total} as a function of $V_{ext.}$

Total beam current I_{total} was measured as a function of the voltage applied for beam extraction $V_{ext.}$ by using Faraday cup placed before the dipole magnet. Ar gas was fed into NANOGAN.



A) I_{total} vs $V_{ext.}$ measured at P_{RF}=13 W



1) Well reproduced by power function for increasing part
2) Index of power function : 1.61(10)

Consistent with Chaild-Langmuir equation

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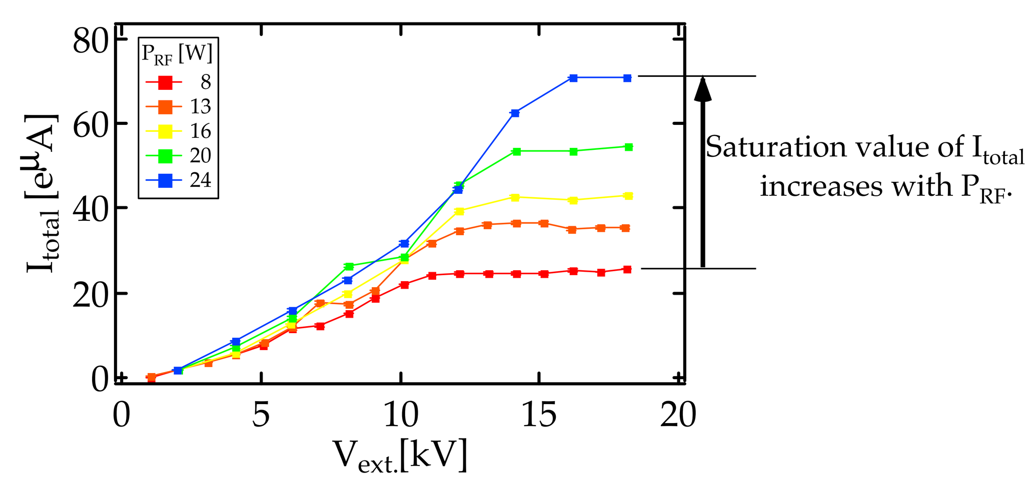
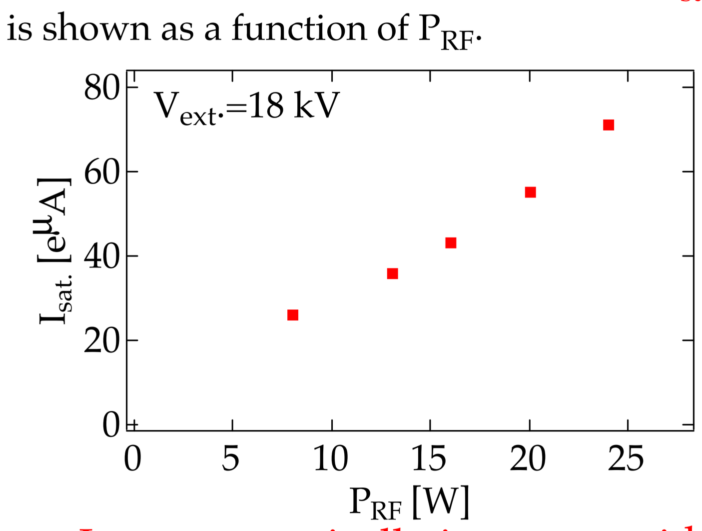
B) I_{total} vs $V_{ext.}$ measured at different P_{RF}



1) Increasing part is not depend on P_{RF}.
2) Saturation value of I_{total} increases with P_{RF}.

3 - 2. Saturation value of I_{total} vs. P_{RF}

Saturation value of total beam current $I_{sat.}$ derived from 3-1 B) is shown as a function of P_{RF}.



$I_{sat.}$ monotonically increases with P_{RF}.

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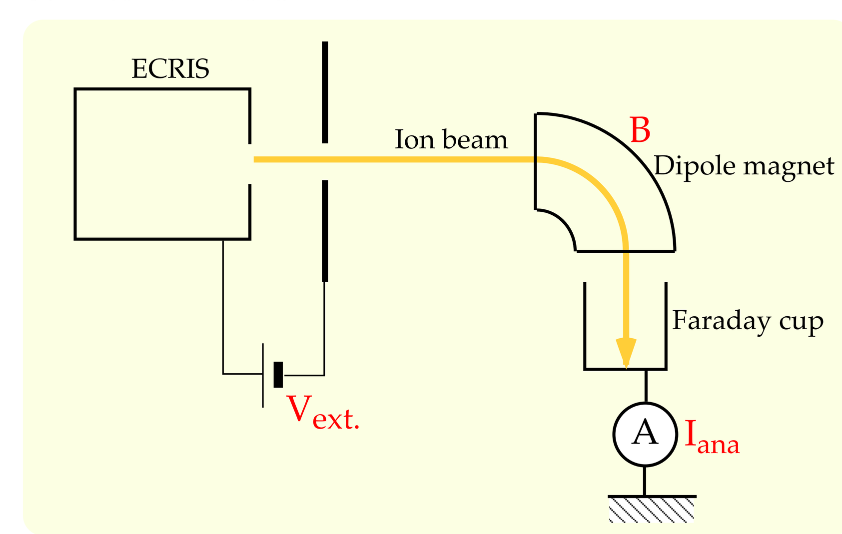
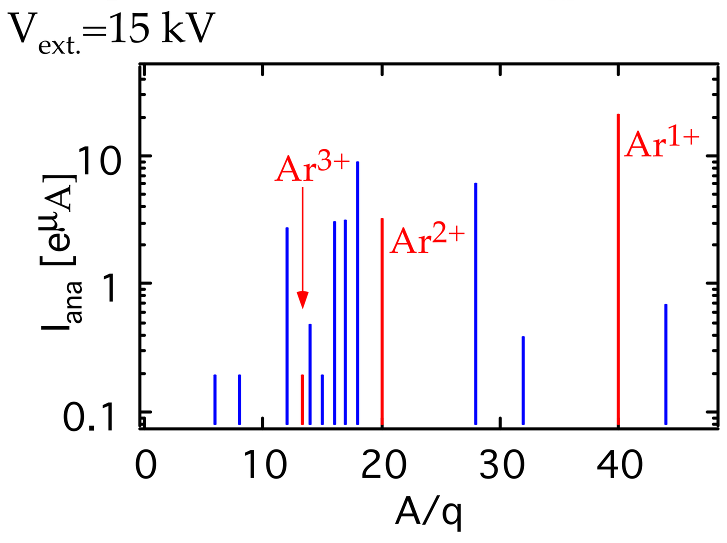
3 - 3. Mass spectrum

Mass spectrum of ion beam extracted from NANOGAN was observed. Beam current I_{ana} was measured by Faraday cup placed after the dipole magnet as a function of the magnetic field applied by the dipole magnet, B . Ar gas and air was fed into NANOGAN.



A) Mass spectrum measured at P_{RF}=24 W
$V_{ext.}$=15 kV



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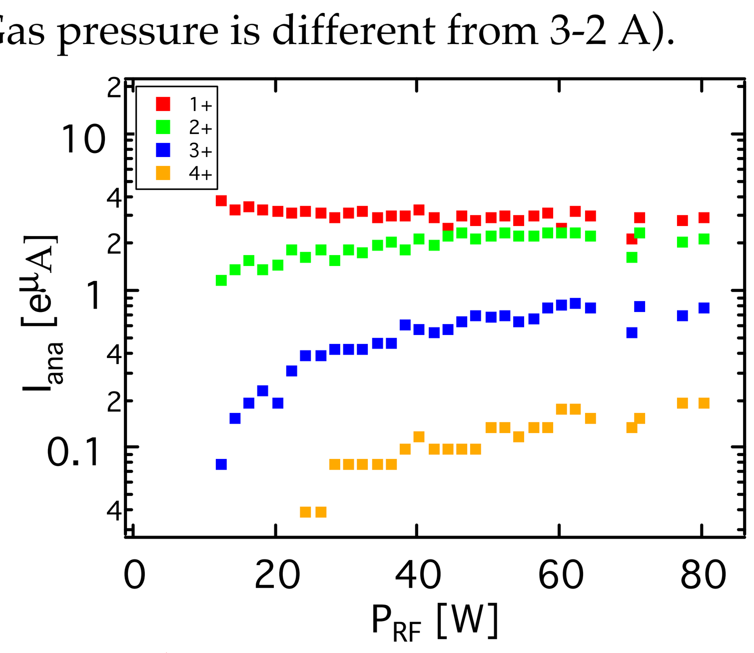
Detected ions
- Ar ions
  Ar^{1+}, Ar^{2+}, Ar^{3+}
- Other ions
  C^{1+}, C^{2+}, N^{1+}, N^{2+}, O^{1+}, O^{2+}
- Molecular ions
  H_2O^{1+}, CO_2^{1+}, N_2^{1+}, NH^{1+}, NO^{1+}, O_2^{+}, OH^{2+}

Other ions and molecular ions were produced from air.

B) Beam current of Ar-ions as a function of P_{RF}
$V_{ext.}$ = 15 kV
Gas pressure is different from 3-2 A).



$I(Ar^{1+})$ decreases with P_{RF} gradually.
$I(Ar^{2+\sim4+})$ increases with P_{RF}.

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4. Conclusions

In this measurements, the followings are confirmed.

1) Extraction of ion beams from ECRIS
Total beam current of ion beam measured as a function of $V_{ext.}$ was well reproduced by Chaild-Langmuir equation.

2) Ionization in ECRIS
All of atoms and molecules fed into NANOGAN could be ionized. The productivity of more highly charged ions increases with P_{RF}.

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It is concluded that ECRIS system built at KUT works normally.

Things to do next
- To get more highly charged ion beams, we should optimize the operation parameter.
- To get various ion beams, we should operate NANOGAN with gases other than Ar.

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5. Future plan

5 - 1. Development of the facility
A) Irradiation system
B) Beam profile monitor

5 - 2. Application of heavy ion beams

A) Basic science
- Plasma physics
- Interaction between highly charged ions and materials

B) Nano scale manufacturing
- Implantation of ions into carbon nano tube
- Sputtering of materials by highly charged ions

C) Material science
- Materials for fuel cell