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# Spectroscopic measurement of the cold component of electrons in ICH heating experiments on RT-1 plasma

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## 1. Introduction

The laboratory magnetosphere, RT-1, confines extremely plasma in a dipole magnetic configuration, generated by levitating a super conducting coil. The main constituents of the confined plasma are ions and two components of electrons-the hot component and the cold component; typically, both the components have

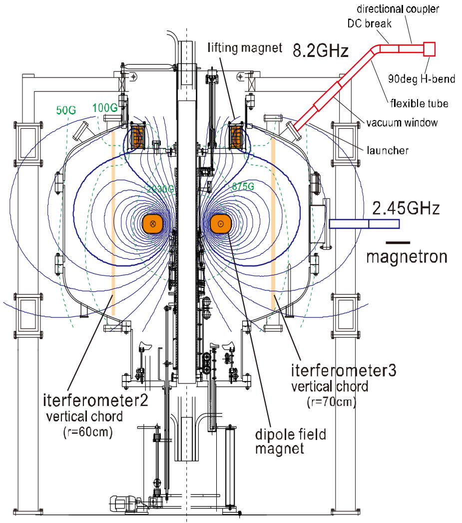



Fig.1 Cross-sectional view of RT-1

comparable fractions. The total electron density has been interpolated with the help of the line averaged densities obtained from interferometry, and the temperature of the hot component of electron has been measured to be around 10~50 keV. However, temperature and density profiles of the cold component of electron has yet not been measured. The hot component of electrons due to its high energies decouple with ions. The cold component of electrons due to their low energies are able to interact with ions, and could be responsible for heating up ions. More recent experiments with Ion Cyclotron Heating (ICH) have shown the heating of ions as well as the cold component of electron due to ICH- during levitation. In order to delineate the energy balance of ions inside RT-1 plasma, it`s important to perform the measurement of the cold component of electrons. The temperature and density profile of the cold component of electron, are estimated using helium I line intensity ratio method, and a pair of line intensity ratios- one sensitive to electron temperature and other sensitive to the electron density- are used in concert to find the self-consistent solution, both for electron temperature and density of the cold component of electron [2].

## 2. Spectroscopic Measurement

1) Helium line intensity ratio method

In this method, a pair of suitable helium line intensity ratios are used to estimate the temperature and density profile of the cold component of electron. After careful investigation of various ratios, the helium line intensity ratio 501.6 nm/471.3 nm was used to estimate the temperature profile and 492.2

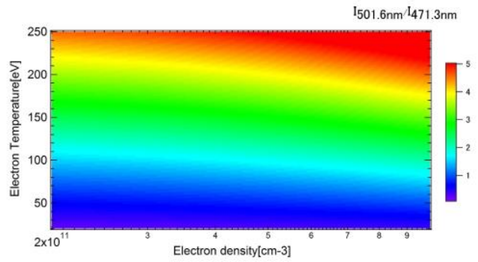



Fig.2 Database of 501.6 nm/471.3 nm w.r.t electron density and temperature

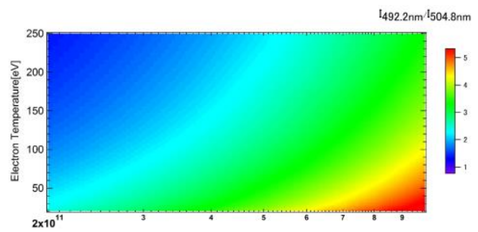
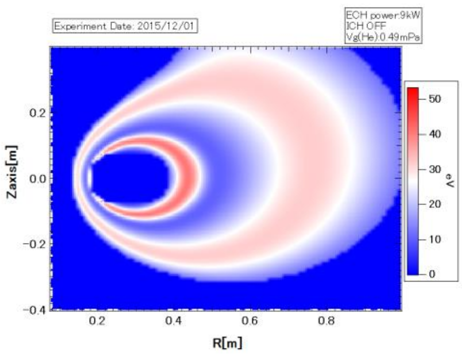



Fig.3 Database of 492.2 nm/504.8 nm w.r.t electron density and temperature

nm/504.8 nm was used to find the density profile of the cold component of electrons. The line intensity ratios were chosen such that in the density regime of RT-1, the ratios were either a strong function of electron density or electron temperature. Figure 2 and 3 show the database of the aforementioned ratios w.r.t electron density and electron temperature, created using ADAS database [1].

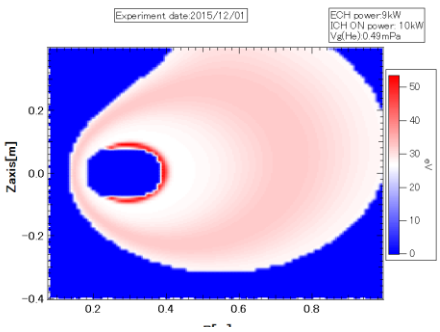
2) Abel Transform
Electron temperature is assumed to be the function of magnetic flux and electron density is assumed to be a function of magnetic flux and mirror ratio. Line integrated ratios along the lines of observations are calculated and fitting is performed to the experimental data to obtain electron temperature and density profile. The temperature and density profile are dependent on each other, and obtained profiles are further fed into each other, and the process is repeated until a self-consistent solution for both electron temperature and density of the cold component of electron were obtained.

## 3. Temperature profile during levitation



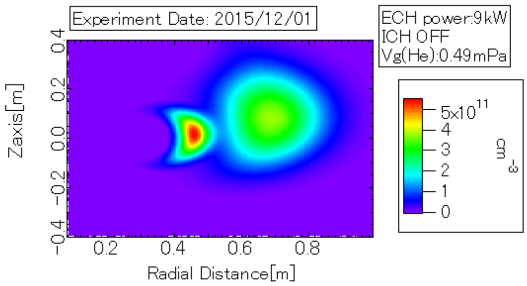

Fig, 4 Temperature profile in case of levitation for ICH Off

Figures 5 and 6 show the temperature profile of



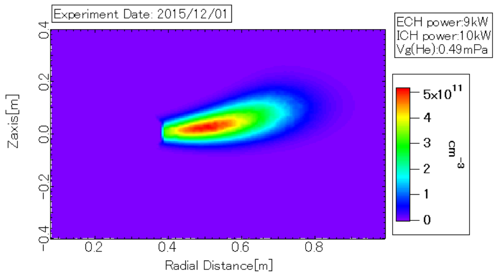

Fig, 5 Temperature profile in case of levitation for ICH On

the cold component of electron during levitation, for both- with ICH and without ICH. The heating effects of ICH are clearly visible in figure 5, in region between r=0.40 m and r=0.57 m. In both the cases, two peaks are visible, with the main peak occurring near the coil and the secondary peak occurring around r=0.7 m.




Fig, 6 Density profile in case of levitation for ICH OFF

## 4. Density profile during levitation




Fig, 7 Density profile in case of levitation for ICH On

Figure 6 and 7 show the density profile of the cold component of electron, in case of ICH off and ICH on respectively. The peak density is same for both the cases; however, the density profile is very different for each case. Double peak is visible in case of ICH off, and for ICH on a profile resemble a narrow strip is obtained. The density and temperature profile of the cold component of electron in case of support is shown in the presentation.

## 5. Summary and Discussion

The spectroscopic method for the measurement of the cold component of electrons was successfully developed in this research. As an application of it, we estimated the density and temperature profile of the cold component of electron in case of levitation and support- for both ICH on and ICH off scenarios.
The electron temperature is found higher than ion temperature for both ICH on and ICH off. The electron density estimated by this method is found to be higher than the one obtained from interferometry.

## 6. References


[1] ADAS, access provided by NIFS
[2] S.Sasaki et al. Rev. Sci. Instrum. 67, 3521 (1996)