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Plasma Characterisation of an Electron Cyclotron Resonance

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Abstract content
   (Max 300 words)

The ultimate aim of any multiply-charged ion source, like the electron cyclotron resonance ion source, is the production of multiply-charged ions, in sufficiently large quantities. These multiply-charged ions, in the case of the ECRIS, are created by a step-by-step ionisation process, whereby neutral atoms are ionised by very energetic electrons. The goal of our study was to gain an understanding of the relative importance of various ECRIS parameters on the production of these very energetic electrons. This was done by measuring the bremsstrahlung continuum emitted by the mirror confined plasma of an ECR ion source.

The measurements were done with a high-purity germanium detector and processed with the DGF Pixie-4 module. Analysis of the measured spectra was done with subroutines written in Root. From the measured result, we concluded that by increasing the incident microwave power from 50 W to 300 W, the spectral temperature increases by 14.01% for helium plasma and 7.88% for argon plasma. We also noticed evidence of saturation of spectral temperature and electron density with increasing microwave power, as reported by other groups investigating plasma bremsstrahlung. The increase of spectral temperature with neutral pressure we found was considerable, increasing by 20.23% as we decreased the neutral pressure in the plasma chamber of the ECRIS. This increase in spectral temperature was accompanied by a 40.33% decrease in electron density, which led us to conclude that the increase in spectral temperature was most likely due to an increase in the mean free path of the electrons.

The influence of the magnetic field configuration on both spectral temperature and electron density was also investigated. During this investigation, we increased one solenoid coil current, whilst keeping the other invariant. This amounts to moving the plasma volume around axially in the plasma chamber of the ECRIS. This we found significantly enhanced the spectral temperature and we attributed this effect to more efficient heating of the electrons near the resonance zone. The electron density on the other hand we found remain relatively constant, if one excludes the electron density as a result of one particularly setting of the solenoid coils. The decrease of electron density as a result of this particular setting of the solenoid coils enhanced the electron losses through

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