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# The influence of impurities on the ion temperature measured by a retarding field analyzer

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## Abstract

In the magnetically confined plasma, the ion temperature ($T_i$) is one of the basic characteristic parameters. Hence, how to develop an effective method to measure the $T_i$ is still an open issue for the plasma researches. The retarding field analyzer (RFA) is considered as one of the most effective tools to measure the ion temperature ($T_i$) in the plasma boundary [1]. However, there are some inaccuracies in the measured $T_i$ by the RFA due to impurities in the plasma. Kǒcan and Gunn [2] have simulated the influence of impurities on the ion temperature measured by the RFA, and found that the simulated $T_i$ is about 20% lower than real one due to the impact of impurities. However, in their simulation, only a single impurity has been considered. The effect of the charge and mass of diverse impurities on the $T_i$ measurement has not yet been mentioned.

In this work, the influences of impurities on the $T_i$ measured by RFA have been analyzed in hydrogen isotope plasmas with both low-*Z* and high-*Z* impurities [3]. The analytical results show that $T_i$ is underestimated in $H^+$ (also $D^+$ and $T^+$) plasma when the fuel ion charge is taken as the charge number and the analyzed $T_i$ in $H^+$ plasma are all larger than that in $D^+$ and $T^+$ plasmas, exhibiting the isotope effect. With the increase of the concentration of low-*Z* impurity ($\eta_l = n_l/n_f$, $n_l$ and $n_f$ are the densities of the impurity ion and the main ion, respectively), the analyzed $T_i$ decreases and the $T_i$ is about 20% underestimated with $\eta_l$~12%. Comparison of different charge numbers and masses of low-*Z* impurities shows that larger charge number and smaller mass of low-*Z* impurities lead to the analyzed $T_i$ being more underestimated. The high-*Z* impurities impose almost no impact on the $T_i$ because of their small current contribution. Moreover, experimental measurements of $T_i$ by the RFA and edge rotational diagnostic (ERD) system [4] have been compared, which displays good agreement with the analytical results.

## References

[1] Pitts R. A. and Chavan R., 2003 *Rev. Sci. Instrum.* **74** 4644
[2] Kočan M. and J. P. Gunn, 2011 *Plasma Phys. Control. Fusion* **53** 085016
[3] Shao J. *et al*, 2020 *Plasma Phys. Control. Fusion* ***62*** 025027
[4] Cheng Z. F. *et al*, 2014 *Rev. Sci. Instrum.* **85** 11E423