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The effect of the oscillation of plasma parameters on the beam extraction in RF negative ion source

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In RF negative ion sources, the extracted beam involves AC component oscillating with the RF frequency [1]. The oscillation component causes the beam loss and damage the device. Therefore, the beam oscillation should be suppressed, but its physical mechanism is still unclear.

In this study, the numerical analysis was conducted using a 3D PIC model to understand the time evolution of the beam extraction mechanism in RF negative ion sources. In particular, variation of the plasma meniscus, which is beam emitting surface, is calculated. In the previous studies [2], dependence of the meniscus shape on the plasma density has been analyzed in steady-state simulation. The simulation model is modified to take into account the oscillation of particle and energy fluxes incoming to the extraction region, which are assumed to be results of the RF heating.

In the modified simulation, the meniscus shape and the beam current shows time variation with the same frequency as the plasma density oscillation. On the other hand, no significant time variation was observed on the meniscus profile in the case where only plasma temperature oscillates. These results show that upstream plasma density oscillation by RF heating affects the temporal beam profile.

In the presentation, difference of the meniscus behavior between the two cases: plasma density and temperature oscillation are discussed with detailed information: dependence of amplitude of source oscillation, the phase difference between the source oscillation and the beam oscillation, etc.
[1] T. Shibata, et al., AIP Conference Proceedings 2373, 050002 (2021)
[2] K. Hayashi, et al., 20th International Conference on Ion Source, Victoria Canada, 2023

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