

## Reply to editor comments

[Authors] We thank the associate editor for the provided feedback. Please find below the detailed reply to the raised comments.

In addition to the reviewer comments, the associate editor has the following comment:

It is not clear if this manuscript is a good fit for Plasma Sources Science and Technology as it largely focuses on the comparison of numerical algorithms rather than any novel or enhanced understanding of the underlying physics. The authors will need to carefully revise their manuscript to address this and similar concerns noted by the reviewers.

In response to the editor's concern and the reviewer comments, we have thoroughly revised the manuscript to better highlight the physical insights gained through our study. We have also modified the title of the manuscript to avoid the impression that the study focuses on a comparison of numerical algorithms, which does not reflect the actual content of the work. Instead, our study focuses on the physical phenomena governing the behavior of the plasma in the near plume of Hall effect thrusters (HETs). On the one hand, the proposed global plume condition (GPC) is shown to capture significantly more accurately the physics of a current-free expanding plasma plume. On the other hand, the analysis of the cathode location is not a numerical or algorithmic study, but rather addresses the influence of cathode position on the physics of the plasma plume, including the cathode-beam coupling, the plasma current maps and the main thruster performance figures. The trends with the cathode position found in thrust, cathode coupling voltage, discharge efficiency and plasma divergence are shown to be consistent with published experimental and numerical studies, which support the claim that the GPC improves the physical fidelity of the simulation results. Only the analysis of the plume domain size can be regarded as a sensitivity study, aimed at evaluating the impact of the numerical constraint that the simulation domain must be finite, and has contributed to reveal the flaws of the widely adopted local plume condition (LPC). Our results demonstrate that, compared to the LPC, the GPC:

- 1) Limits artificial electron detachment from magnetic lines in the near plume, yielding electron current maps representative of the still well-magnetized electron population in the near plume
- 2) Avoids distortions caused by the LPC on the electron potential and temperature maps in the lateral plume, which is central for near plume diagnostics (including the accurate characterization of charge-exchange ions),
- 3) Enables the estimation of the potential at infinity, a key physical parameter of the plume expansion not accessible through the LPC,
- 4) Provides the electron energy flux and energy per particle at the downstream boundary in a physically grounded manner, instead of relying on ad hoc assumptions as the LPC,

- 5) Minimizes plume size effects on the plasma solution, especially when laterally-mounted cathodes are located outside the magnetic separatrix, a common configuration in HETs for which LPC results are highly unreliable.

We believe that the reviewers' feedback has significantly contributed to improving the quality of the manuscript and that the revised version is well aligned with the scope of *Plasma Sources Science and Technology*.