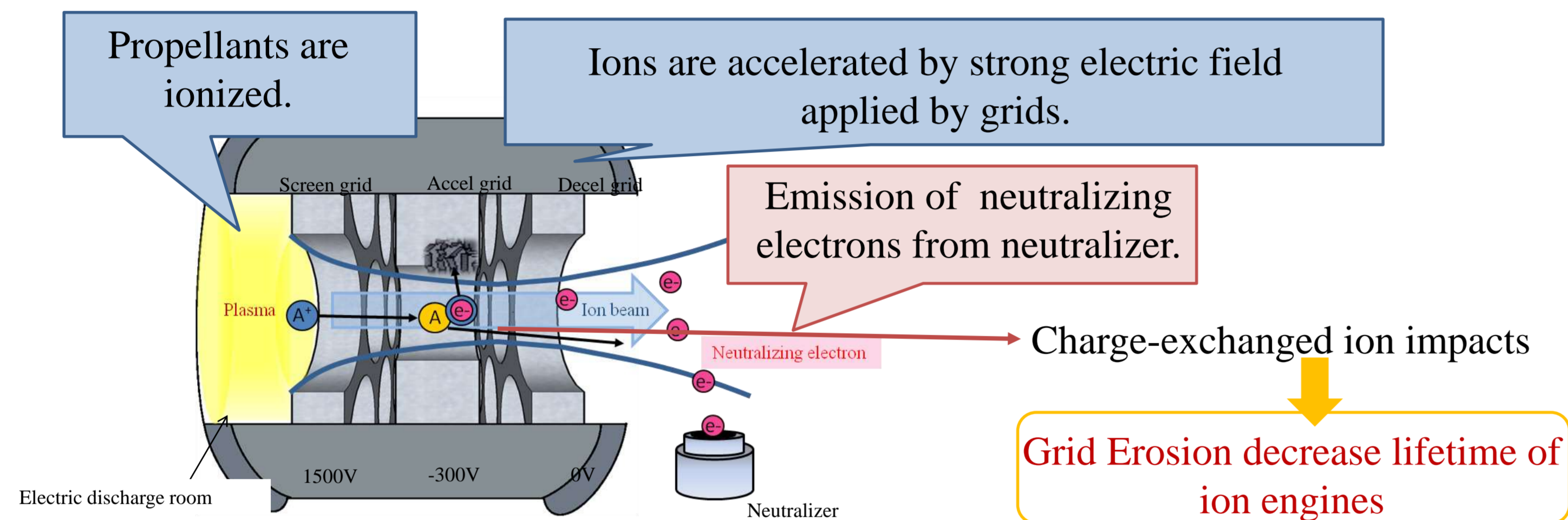


Full-PIC Analyses on Ion Engine Operations Using SOR Method

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Back Grounds

Ion Engine : Grid erosion by ion impacts



Grid currents have been evaluated by Full-PIC analyses at Gifu University.

- Influences of non-equilibrium electron on electric potential distribution that affected on ion impact were clarified.

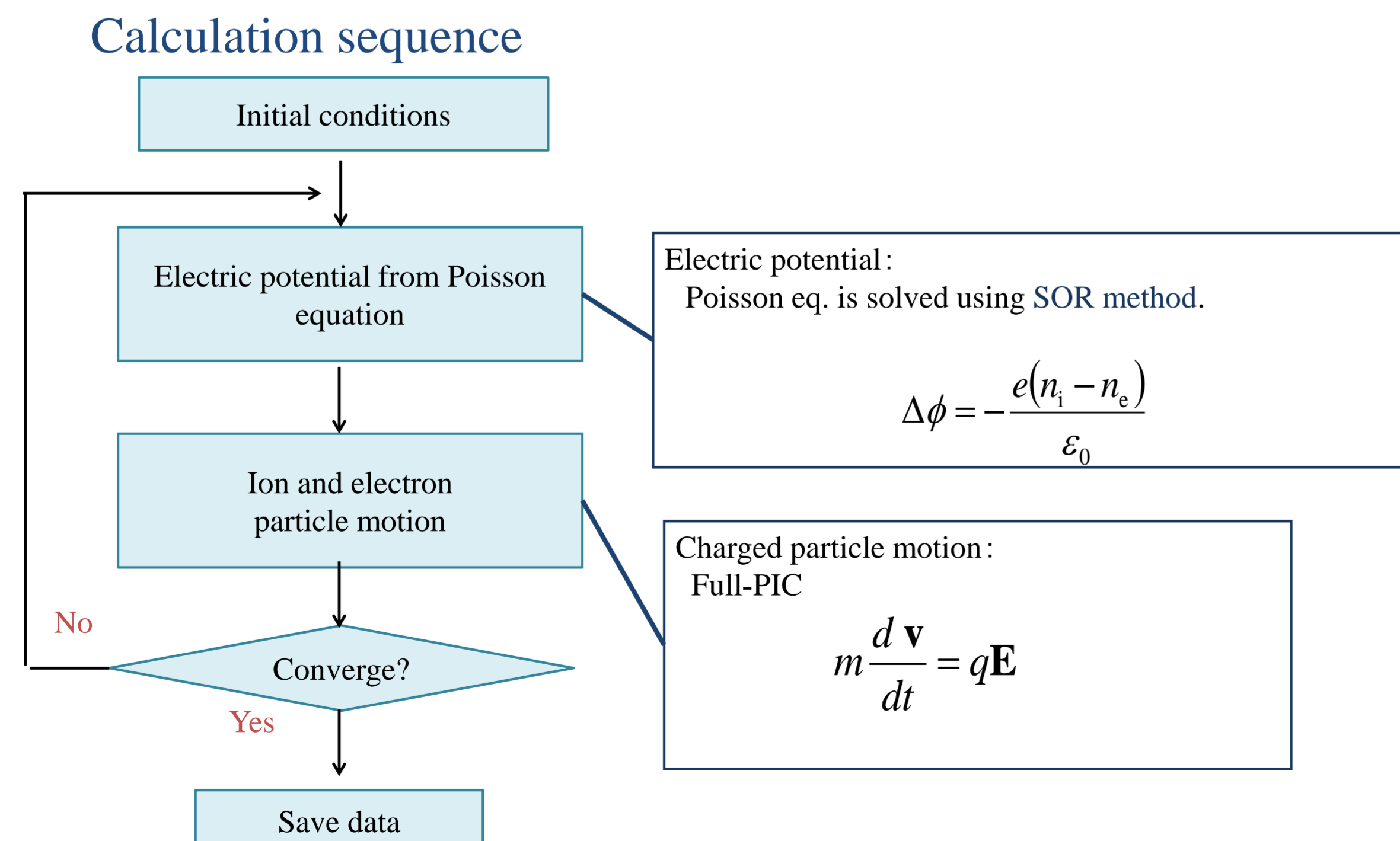
$$\text{derived Modified Boltzmann relation } n' = n_{ref} \exp\left\{\frac{e(\phi - \phi_{ref})}{kT_e}\right\} \times \frac{\int_{\Delta E} G(E)dE}{\int_0^{\infty} G(E)dE}$$

Evaluations of effects of grid erosions on thrust performance are required.

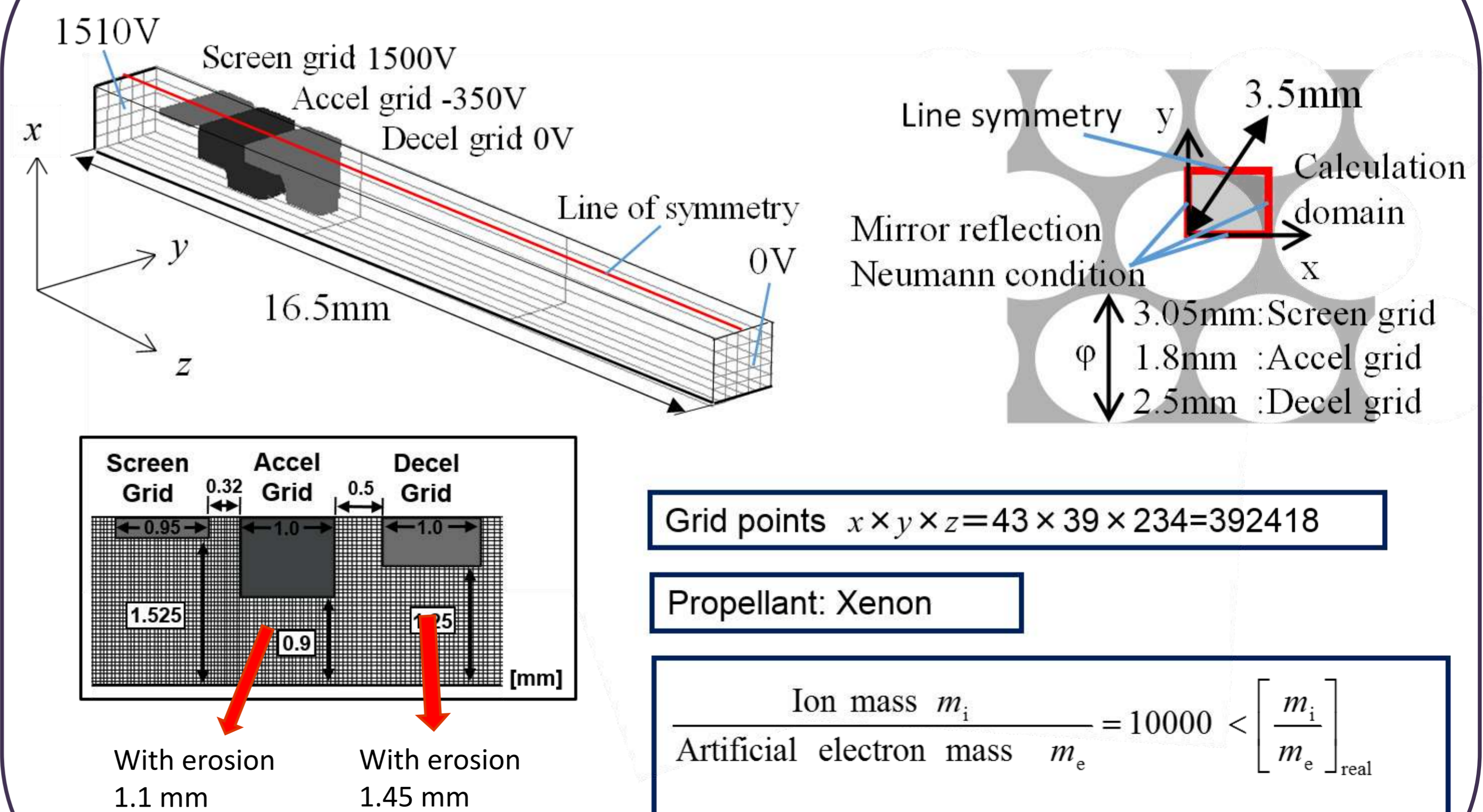
Purposes of This Study

Procedure of Numerical Simulation

To reduce the memory consumption, SOR method is employed for solving the Poisson equation.

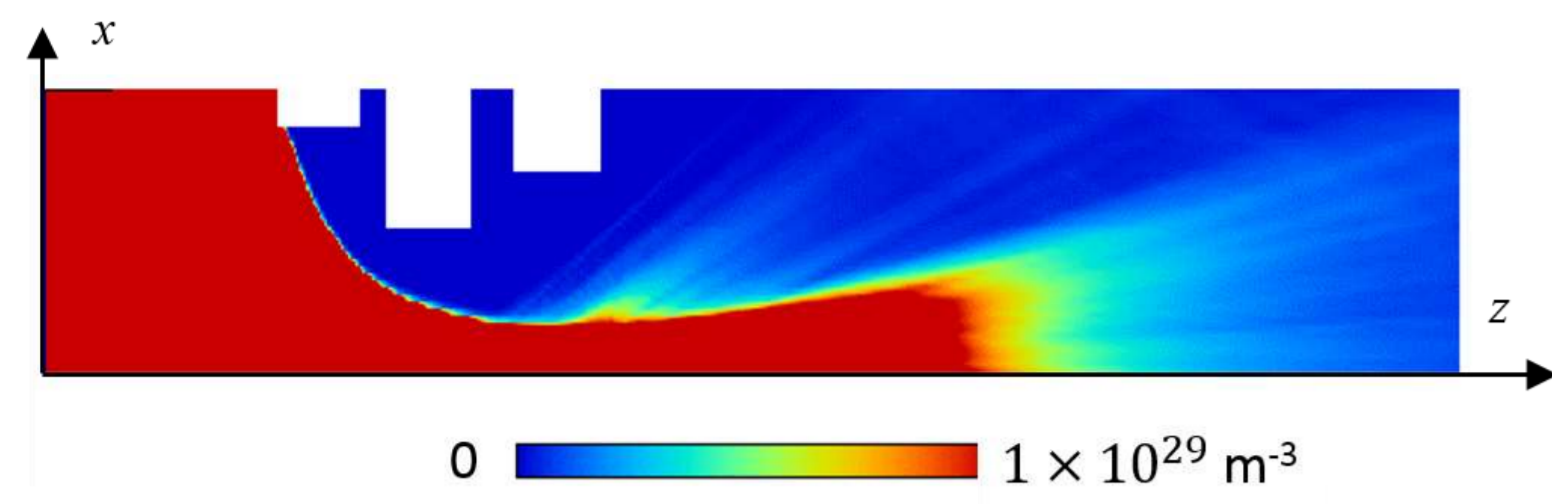


Calculation Domain and Boundary Conditions

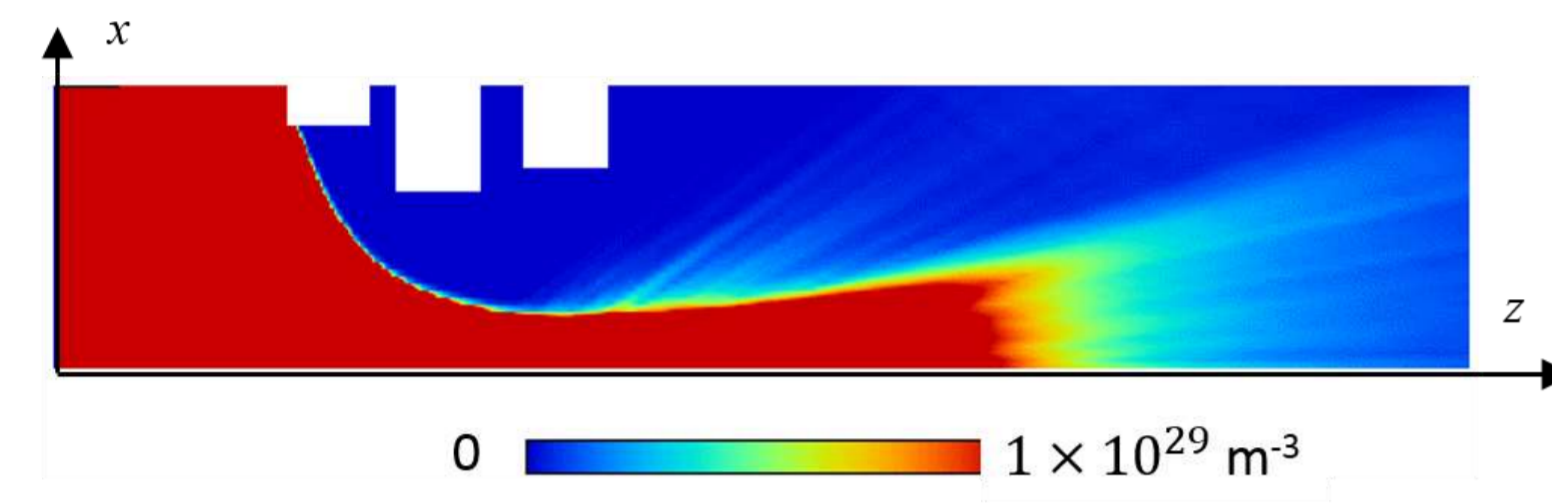


Influences of Accel Grid Erosion on Thrust Performance

Ion number density distribution



(a) Without erosion

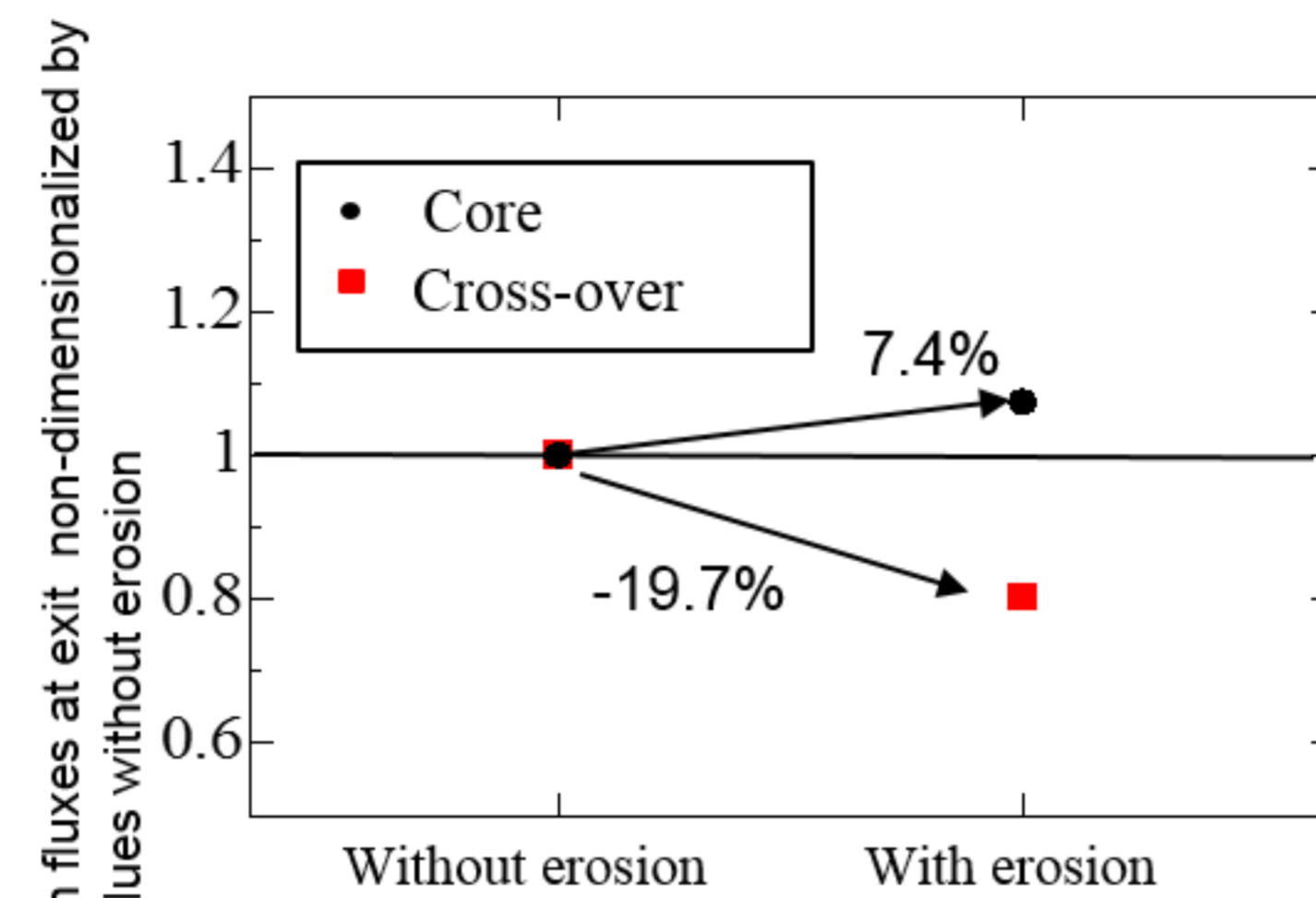


(b) With erosion

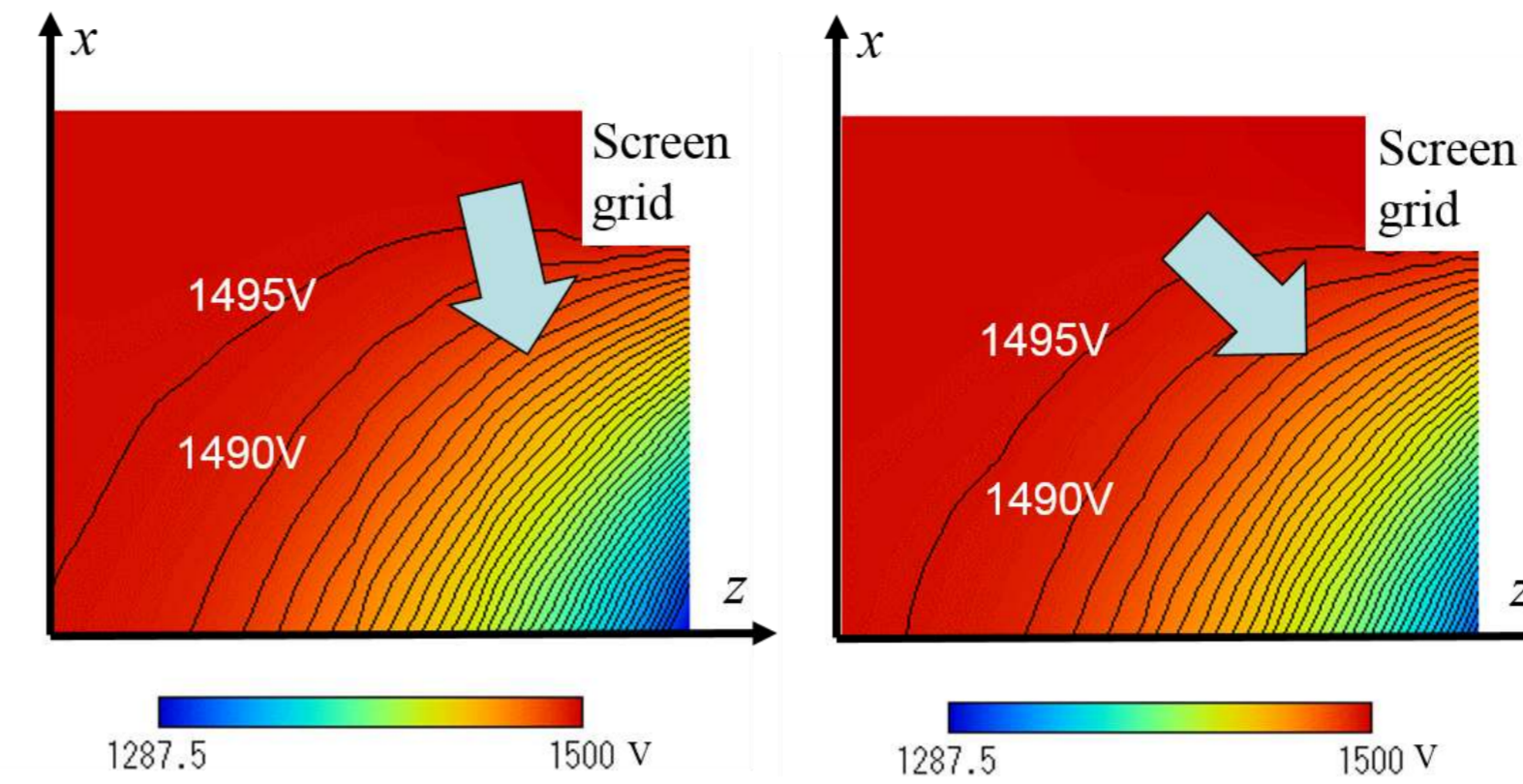
Cross-over part of ion beam for accel grid with erosion decreased 19.7% relative to that for that without erosion.

⇒ Increase in averaged ion axial velocity at exit.

Ion number fluxes at exit: Core, Cross-over

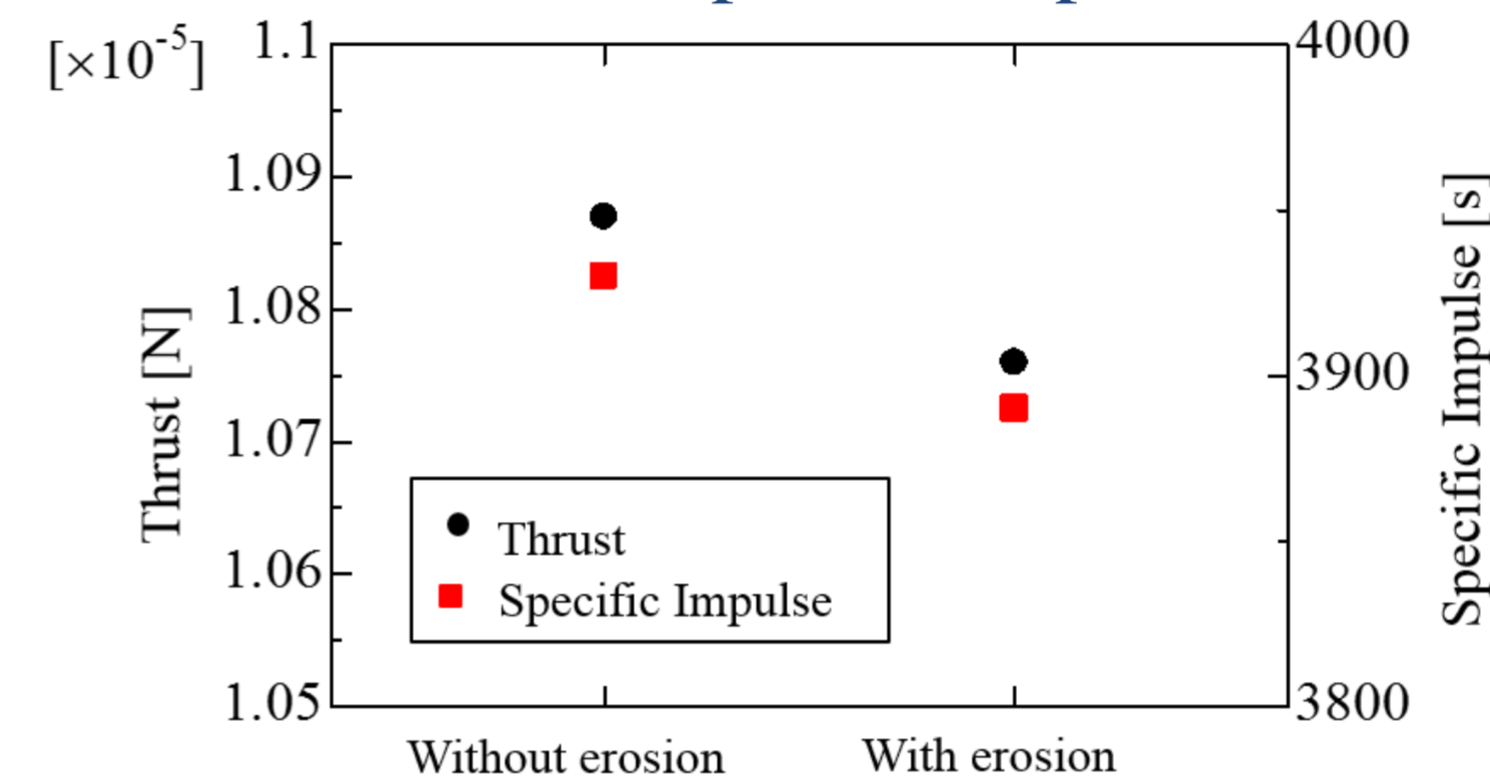


Electric potential distribution in the vicinity of screen grid

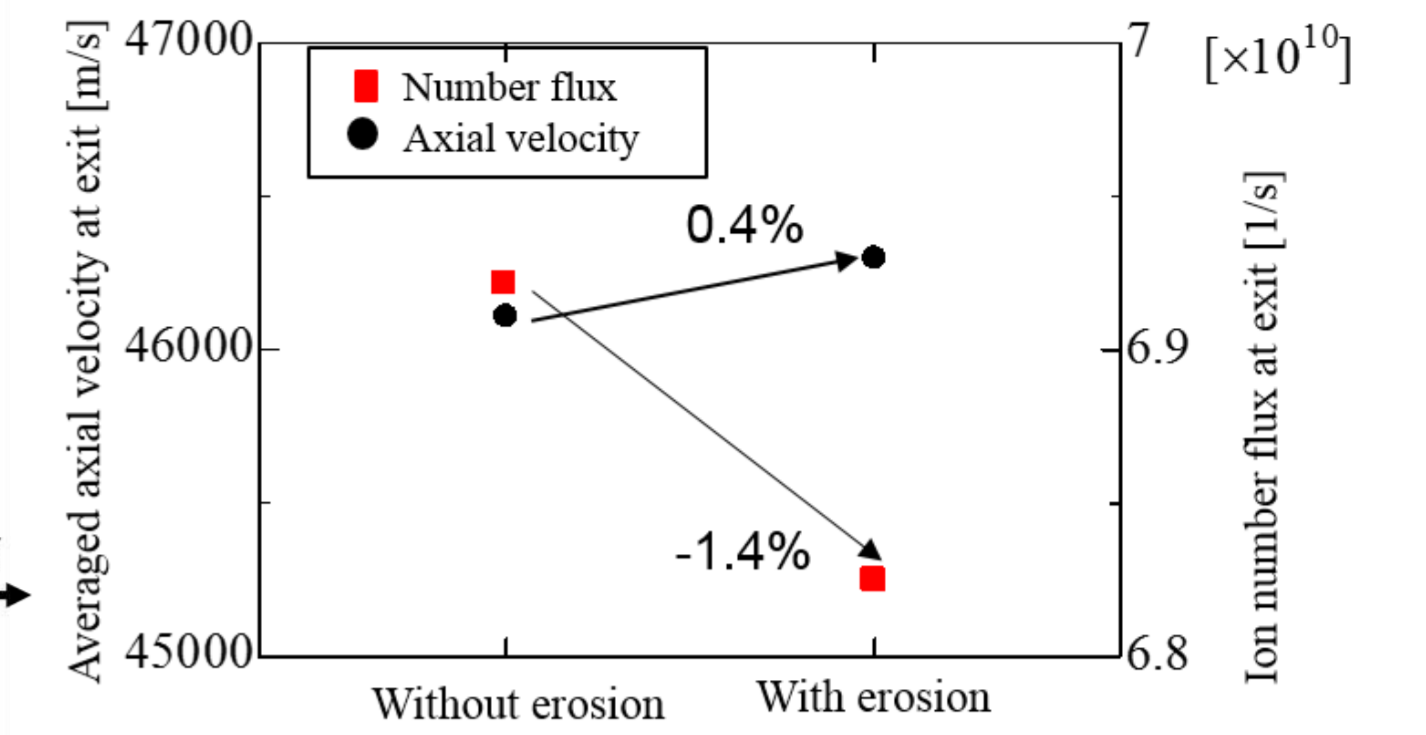


For accel grid with erosion, low gradient of electric potential in the vicinity of screen grid increased screen current. ⇒ Decrease ion beam

Thrust and specific impulse



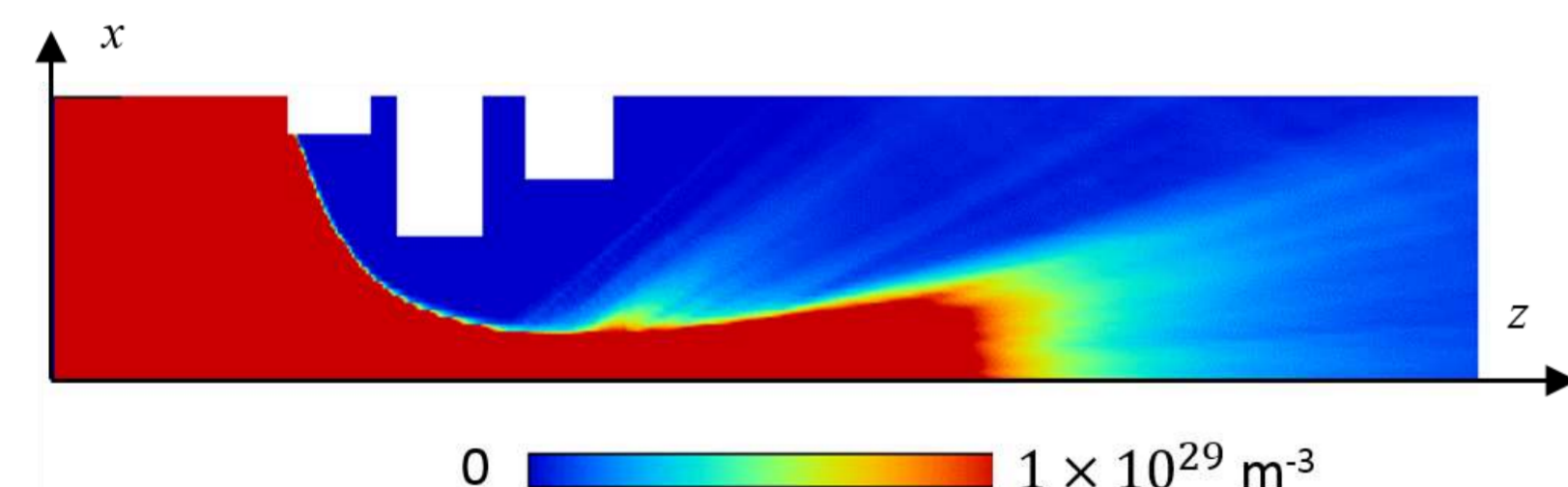
Averaged ion axial velocity and ion number flux at exit



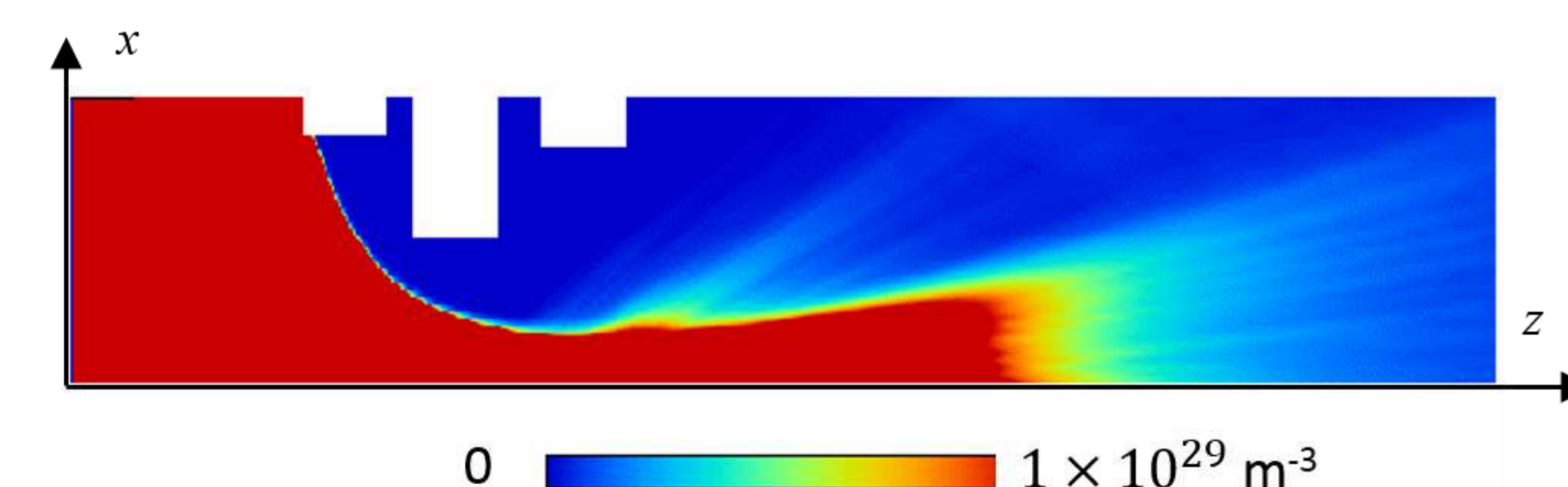
Erosion of accel grid decreased ion number flux by 1.4% and increased averaged ion axial velocity by 0.4%. Consequently, thrust and specific impulse decreased approximately 1%.

Influences of Decel Grid Erosion on Thrust Performance

Ion number density distribution

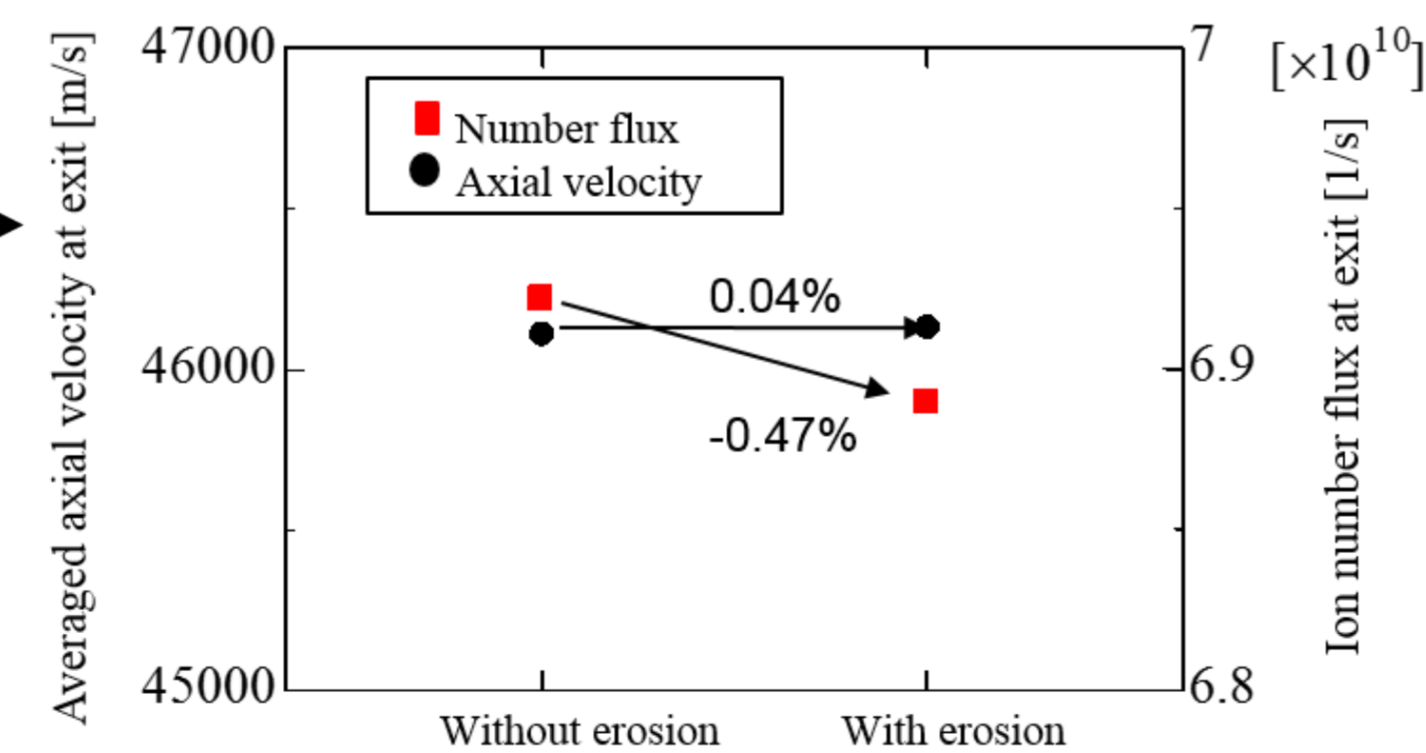


(a) Without erosion



(b) With erosion

Averaged ion axial velocity and ion number flux at exit



Erosion of decel grid decreased ion number flux by 0.47% and increased averaged ion axial velocity by 0.04%. Consequently, thrust and specific impulse decreased approximately 0.4%.

Conclusions

Three-dimensional full-PIC analyses for accel and decel grids with and without erosion using the SOR method produced the following results.

1. Erosion of accel grid decreases ion flux at exit by 1.4% due to low gradient of electric potential in the radial direction in the vicinity of screen grid.
2. Erosion of accel grid increases averaged ion axial velocity at exit by 0.4%.
3. Difference in thrust for accel grids with and without the erosion is almost 1%.
4. Erosion of decel grid has negligible impact on thrust.