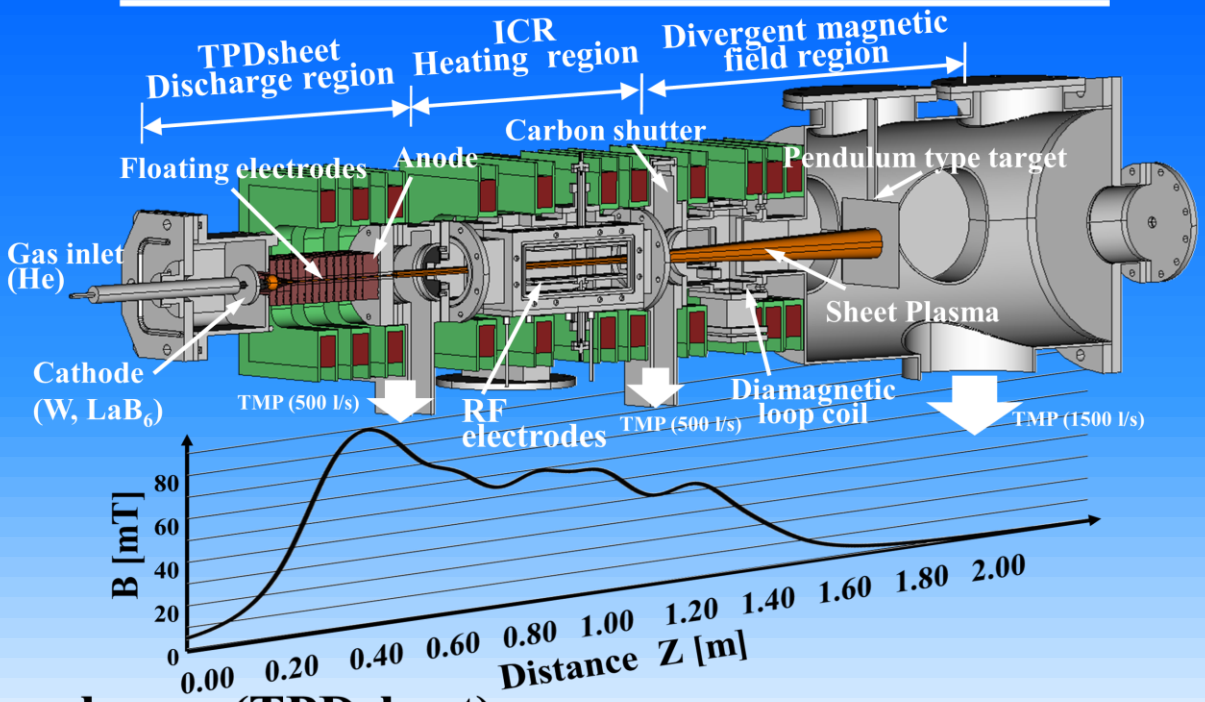
Basic Characteristics of Plasma Thruster using ICR Heating in Sheet Plasma

Akira TONEGAWA, Kai AOYAGI and Toshikio TAKIMOTO

Tokai University, 4-1-1 Kitakaname, Hiratsuka, Kanagawa, Japan

A series of proof-of-principle experiments of a new plasma thruster, TPDsheet device using ion cyclotron resonance (ICR), have been conducted with a helium sheet plasma. The resonance frequency of ICR heating is $\omega_r \approx 1.3\,\omega_{ci}$ and this shift is in good agreement with the value predicted by the excitation of electrostatic ion cyclotron wave EIC. The propellant gas is helium at 1.34×10^{-7} kg/s, DC discharge power is 13.5 kW, the stationary magnetic field is about 0.077 T. The thrust force depends the RF power of ICR heating and discharge current. At the discharge current of 60 A, the thrust force and specific impulse is obtained 6.7 mN and ~ 5100 s at the RF power of 300 W, respectively.

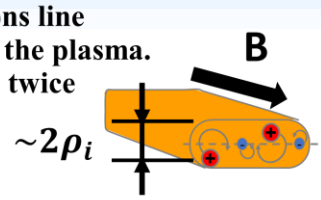
Plasma Thruster TPDsheet device



★Sheet plasma (TPDsheet)

(i) The guiding centers of gyrating ions line in the vicinity of the mid-plane of the plasma.

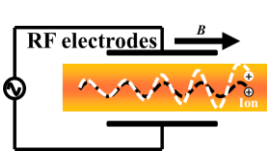
(ii) The plasma thickness is as thin as twice the mean ion Larmor radius.



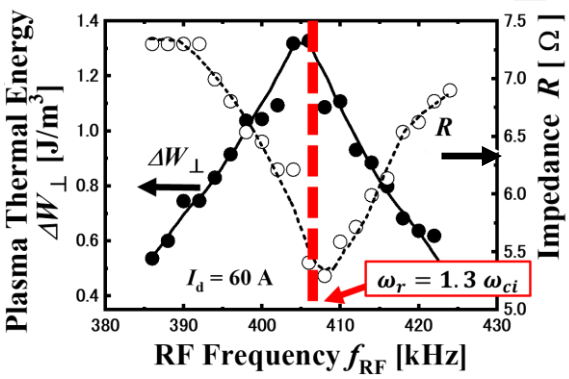
★The RF field could be coupled easily to gyrating ions.

★The favorable ion heating even if the plasma density is so high.

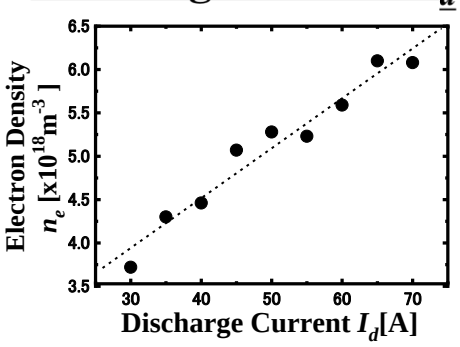
★Plasma acceleration of high density sheet plasma can be succeeded by an low power ICR heating



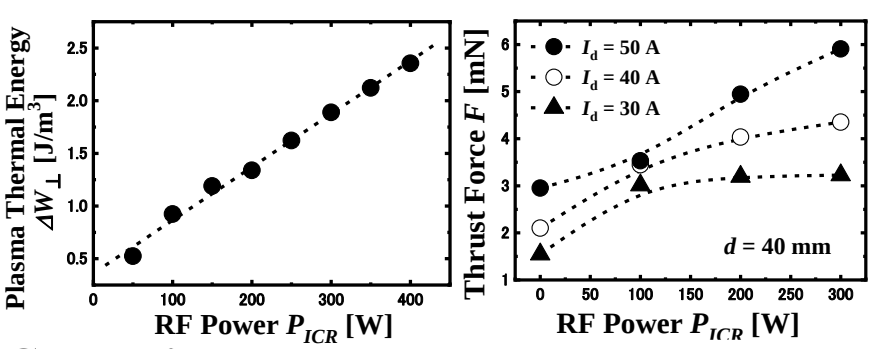
Impedance R and the thermal energy $\Delta W_\perp$



Electron density n_e vs discharge current I_d



Thermal energy $\Delta W_\perp$ and Thrust force F vs RF power P_{ICR}



Conclusions

Experimental results indicate that the acceleration of the high density sheet plasma above 10^{18}m^{-3} is successful by the single passage of ions through the ICR heating region of the low RF power.