

Initial Plasma Experiment in the Levitated Ring Trap RT-1

H. Saitoh, Z. Yoshida, Y. Ogawa, J. Morikawa, S. Watanabe, Y. Yano, and J. Suzuki
 Graduate School of Frontier Sciences and High Temperature Plasma Center, The University of Tokyo, Kashiwa, Chiba, JAPAN



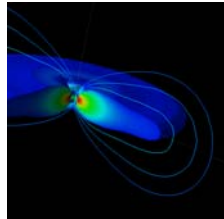
Background: Laboratory magnetospheric plasma

Experimental study on the structure of flowing plasmas

Relaxation states of two-fluid flowing plasmas:

Double Beltrami equilibrium (Mahajan-Yoshida Theory) - including the effects of the flow of plasmas

Flow velocity v and β value of the plasma satisfies the relation $\beta + (v/v_A)^2/2 = const.$ v_A : Alfvén velocity

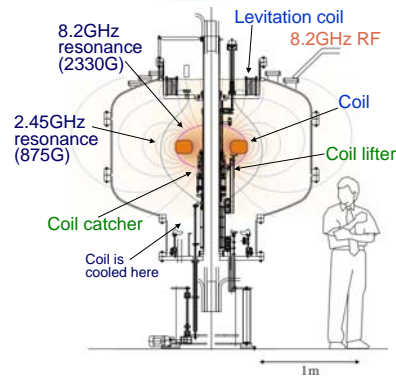


- Possibility of Ultra-high β (including $\beta > 1$) equilibrium state due to the dynamic pressure of plasma flow, when the plasma has fast flow comparable to v_A (Hall MHD)
- Application for advanced fusion, magnetospheric plasmas around Jupiter, other space plasmas

Jupiter's magnetosphere confines high-energy plasma. The mechanism of high-efficiency plasma confinement is explained by the hydrodynamic effect of high-speed spinning object.

J. Shiraishi, Z. Yoshida et al., Phys. Plasmas 12, 092901 (2005).

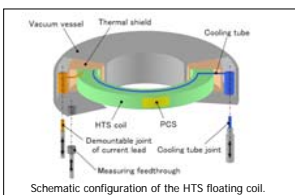
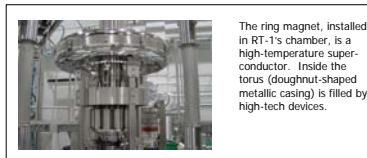
Construction of RT-1



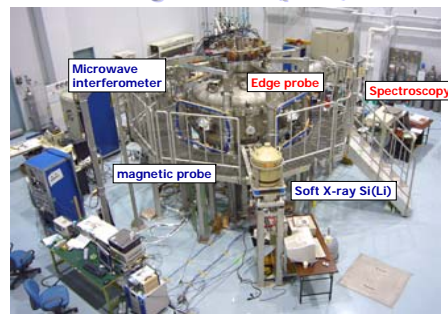
Super conducting Ring Trap

| | | |
|------------------|-----------------|---------------------------|
| levitated magnet | Size | R=250mm w195mm h150mm |
| | Current | 250kA (2160turns) |
| | Weight | 110kg |
| | Operating temp. | 20K - 32K |
| lifting magnet | Current | 88kA (68turns) |
| | dynamic range | < 10Hz (feedback control) |
| chamber | Size | R = 1000mm, h=560mm |
| RF (1) | Frequency | 8.2 GHz |
| | Power | 100kW (1sec pulse) |
| RF (2) | Frequency | 2.45GHz |
| | Power | 20kW (2 sec pulse) |

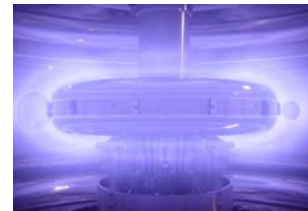
Cross-sectional view and parameters of RT-1



Diagnostics (plan)

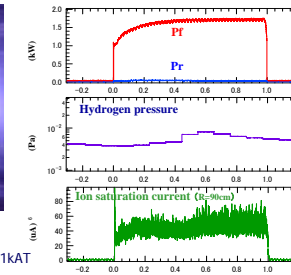


Plasma formation and initial measurement



RT-1 ECH plasma with levitated coil

Dipole coil current 250kAT + Levitation coil current 21kAT
 Microwave 8.2GHz 1.7kW, H₂ pressure 4 × 10⁻³Pa (26mm from support structure)

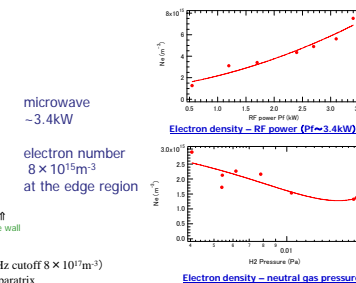
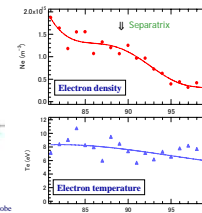
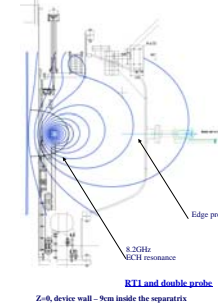


Temporal evolution of RF power, neutral pressure, I_s



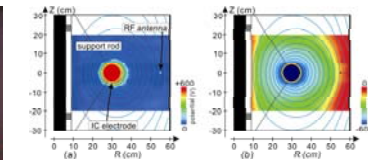
Double Langmuir probe

Edge Langmuir probe measurement



- Number density ~10¹⁵m⁻³ (cf 8.2GHz cutoff 8 × 10¹²m⁻³)
- No significant density drop near separatrix -- Possibly due to coil support structure?

Perspective toward the generation of flow



Summary

The Ring Trap 1 (RT-1) is a novel device to investigate magnetospheric plasma in a dipole magnetic field configuration. The high-Tc superconductor (Bi-2223) ring with a total coil current of 250kAT is magnetically levitated in a vacuum chamber using a feedback control system. After conditioning period for the catcher system, geomagnetic error field, correction of the coil balance, etc., we have recently started a plasma diagnostic experiment with a magnetically levitated coil. The initial experiment was conducted using 8.2GHz and 3.5kW microwave and generating ECH plasma. The plasma is stably confined in the magnetospheric configuration of RT-1, and at the edge region, Ne=8 × 10¹⁵m⁻³ and Te=10eV.

References

- [1] Z. Yoshida et al., Plasma Fusion Res. 1 (2006) 008.
- [2] S. M. Mahajan and Z. Yoshida, Phys. Rev. Lett. 81, 4863 (1998); Z. Yoshida and S. M. Mahajan, Phys. Rev. Lett. 88, 095001 (2002).
- [3] H. Saitoh, Z. Yoshida et al., Phys. Rev. Lett. 92 (2004) 255005; H. Saitoh, Z. Yoshida et al., Phys. Plasmas 11 (2004) 3331.