Numerical Study on Ionization Structure and Shock Wave Propagation for Improving Flight Performance of Beaming Propulsion Vehcile

● **Responsible Representative**

Masayuki Takahashi, Associate Professor, Tohoku University

● **Contact Information**

Masayuki Takahashi, Tohoku University(masayuki.takahashi.c8@tohoku.ac.jp)

● **Members**

Koki Ito, Maho Matsukura, Hiroyuki Suzuki, Soichiro Suzuki, Masayuki Takahashi, Sakira Uno

● **Abstract**

Objective of this study is elucidating mechanism of the ionization-front propagation induced by high-power microwave beam in microwave rockets.

● **Reasons and benefits of using JAXA Supercomputer System**

In this study, we conduct a multi-dimensilnal coupling simulation between electromagnetic wave propagation, plasma fluid, and heavy-particle fluid to examine the discharge phenomena induced by an intense microwave. Since the computational cost is large, the use of JAXA supercomputer system is required.

● **Achievements of the Year**

A multi-dimensional simulation code coupling millimeter-wave propagation, plasma fluid, and heavy-particle fluid models has been developed to reproduce the plasma-front propagation process. It was found that ionization is induced by the expansion of heavy particles due to Joule heating and the increase of local reduced electric field, which sustains the plasma-front propagation. In addition, a cutoff density plasma is generated at the ionization wavefront, which causes a portion of the incident millimeter wave to be reflected. Since the millimetre wave reflection contains internal information of the plasma that cannot be observed by optical visualisation such as a high-speed camera, numerical simulations have shown that observing the millimetre wave with an antenna such as a rectenna allows an internal diagnosis of the plasma, as if a CT scan of the plasma were performed.

● **Publications**

N/A

🔵 **Usage of JSS**

● **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	8 - 960
Elapsed Time per Case	24 Hour(s)

● **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 0.06

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	79,686.56	0.00
TOKI-ST	475,491.29	0.49
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	0.00
TOKI-TST	0.00	0.00
TOKI-TGP	0.00	0.00
TOKI-TLM	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[2] (%)
/home	510.00	0.34
/data and /data2	11,040.00	0.05
/ssd	0.00	0.00

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[2] (%)
J-SPACE	0.00	0.00

[1]: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

[2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.

● **ISV Software Licenses Used**

ISV Software Licenses Resources		
	ISV Software Licenses Used (Hours)	Fraction of Usage[2] (%)
ISV Software Licenses (Total)	0.00	0.00

[2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.