Research and Development of Sample Return Capsule for future planetary exploration

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Abstract

Hayabusa is the first sample return mission to an asteroid in deep space and proved its significance worldwide. The sample return mission will become one of the important missions in future planetary exploration. A sample return capsule is indispensable technology to realize it. The objectives of this activity are to take over its heritage and to enhance its technology in order to realize the flexible and attractive future sample return mission.

Reasons and benefits of using JAXA Supercomputer System

Computational fluid dynamics related the sample return capsule was carried out using super computer. These results will be reflected in the design of future sample return capsules. It is generally difficult to reproduce the fluid dynamic condition in free flight of sample return capsule in ground tests. The numerical simulation is useful to understand the fluid dynamics phenomenon. However, the numerical simulation related to fluid dynamics requires the large computational resource. So, the super computer is indispensable. Its complex fluid dynamics around the sample return capsule can be understood, combining the results of both ground tests and numerical analyses using a super computer.

Achievements of the Year

In this year, we continued to compare the unsteady CFD using the computation grid created last year (Fig. 1) with the flow field visualization result by the PIV measurement method carried out in the low-speed wind tunnel test. The evaluated in the RMS fields (Fig. 2) about the flow velocity. Also, estimation of the wake flow region at the back of the capsule that affects the parachute attitude-behavior (Fig. 3) and comparison with the aerodynamic data obtained by the transonic wind tunnel test (Fig. 4). The evaluation of CFD analysis in the subsonic region was progressed. In the future, this numerical method will be utilized for the development of the aerodynamic database and prediction for the aerodynamic stability to future sample return capsule design.

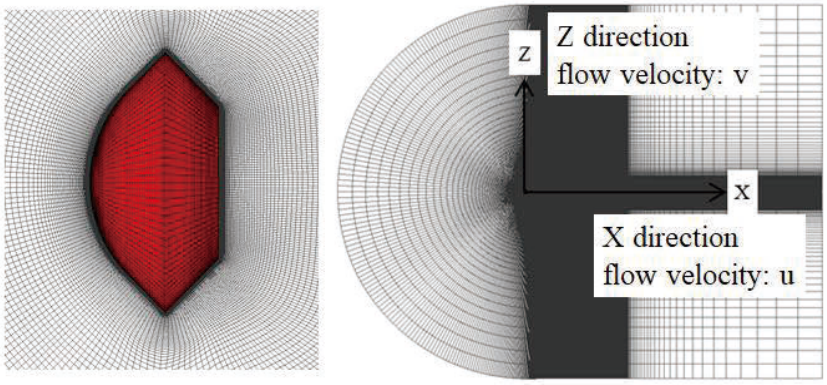

Fig. 1: Computational grid

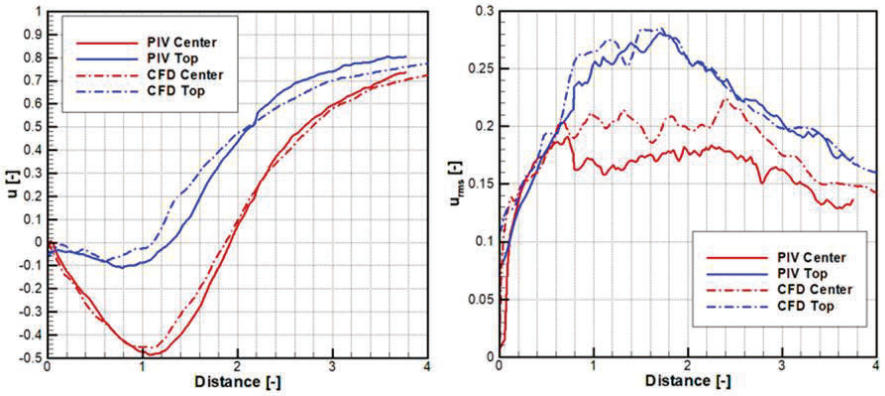

Fig. 2: Comparison with wind tunnel results and CFD analysis results about the distribution of u-velocity and u-RMS of streamwise velocity fluctuation in the wake flow along body axis.

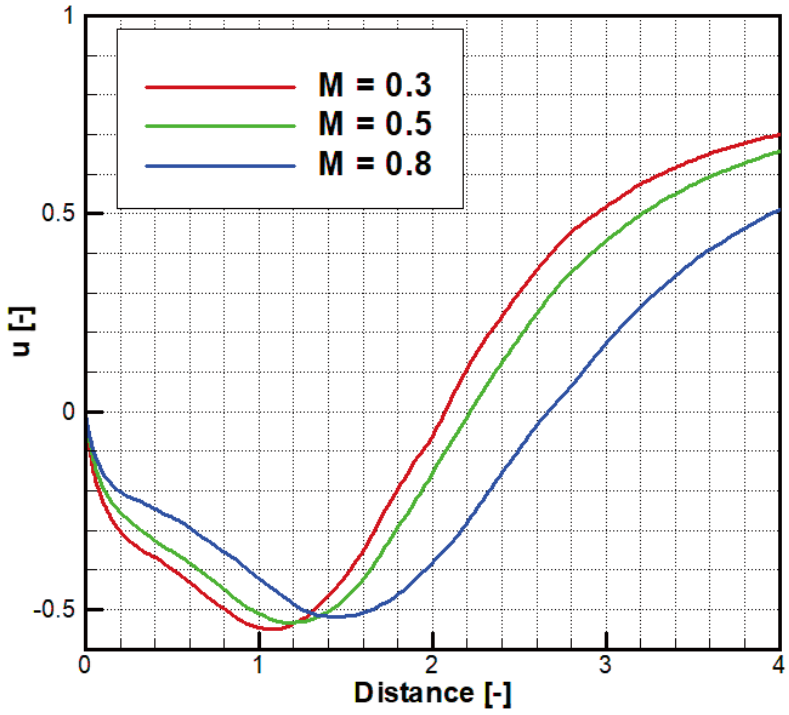

Fig. 3: Comparison of the u-velocity in the wake flow along body axis at Mach number=0.3, 0.5 0.8.

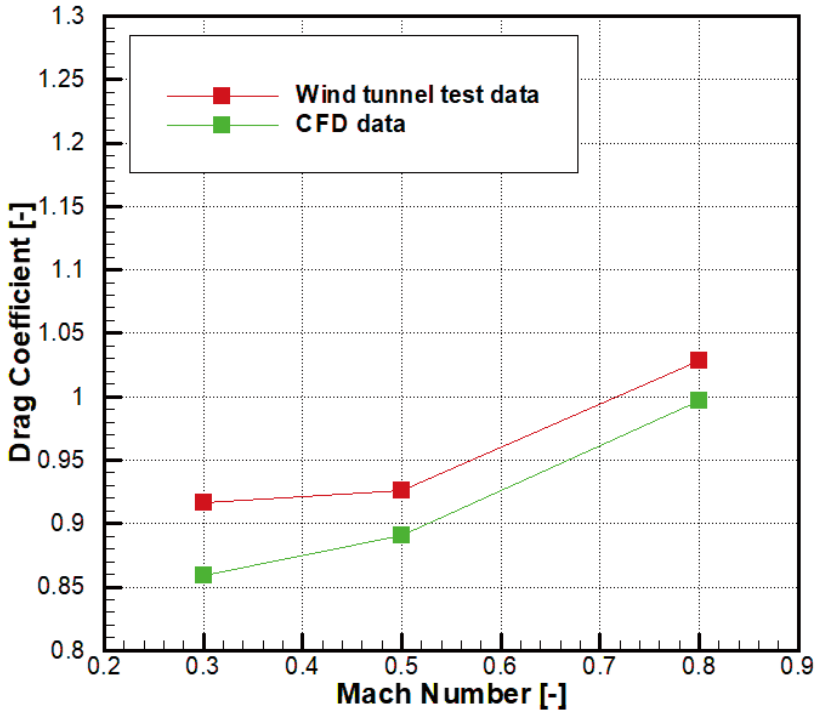

Fig. 4: Comparison with wind tunnel results and CFD analysis results about the drag coefficient.

Publications

- Oral Presentations

Kazuki Nohara, Kazuhiko Yamada, Nobuyoshi Fujimatsu, "A study on Hayabusa Type of Sample Return Capsle Downstream Flow Field",International Symposium on Space Technology and Science, Fukui, Japan, 2019e-53

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	128 - 256
Elapsed Time per Case	350 Hour(s)

Resources Used

Fraction of Usage in Total Resources[*1](%): 0.05

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
SORA-MA	400,143.00	0.05
SORA-PP	27.00	0.00
SORA-LM	0.00	0.00
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2(%)
/home	17.48	0.01
/data	174.84	0.00
/ltmp	3,580.73	0.30

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2(%)
J-SPACE	2.87	0.07

*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.