Liquid-Propellant Propulsion System Simulation

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Abstract

Next generation of space transport systems need not only to reduce costs with high perfoemance propulsion for a particular mission but also to meet requirements of various missions, for example moon lander, reusable upper stage rocket, Mars mission, and so on. Liquid-Propellant System Analysis has an important roll to develop the next generation space transport system. Utilizing 3D numerical simulation results of the liquid rocket compornents, componet models are developed for the system analysis. The system analysis will use for evaluation of the development and operation for liquid rocket or spacecraft.

Reasons and benefits of using JAXA Supercomputer System

Component models of liquid propulsion systems are conventionally very simple and sometimes not consistent with physics of fluid dynamis or structural behavior of propulsion systems. However, because of the recent development of computer science, even computationally expensive models can be used for numerical analysis for designs. In addition, high-fidelity CFD clarified physical phenomena in the component, and it enhances to develop more accurate component models. Concequently, high-fidelity CFD analyses are essential to clarify the phenomena in the liquid propulsion system. JSS enables us to carry out trade-off studies with a wide range of parameter, which contribute to build new models and find out new insights of liquid propulsion systems.

Achievements of the Year

Two-kinds of simulations were performed to develop the component model for liquid propulsion systems. Fig. 1 shows the velocity contour on the iso-surface of density with of supercritical jet simulation to develop the component model of liquid rocket combustion chamber. LS-HO developed by JAXA was used for the simulations. This experiment was performed at DLR. The simulated density was compared with the experimental data. Fig. 2 shows the iso-surface of the number of density for thruster plume interaction with the solid wall to develop plume heating model of thruster. This simulation was performed using UNITED, which was developed by JAXA. Based on the parameter study using this simulation tools, simple plume models on the system simulation tool were developed.

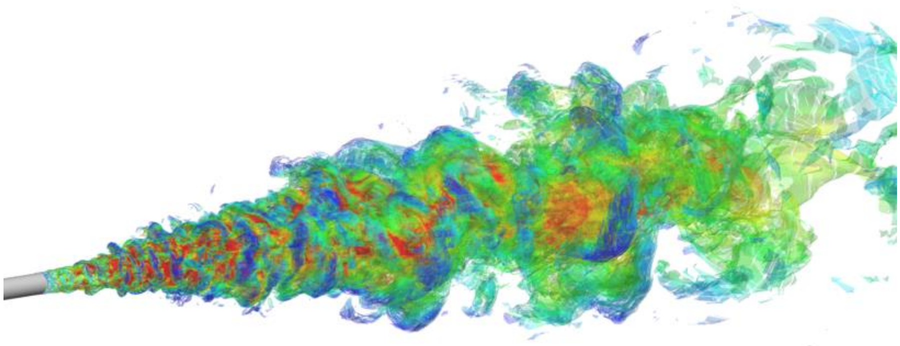

Fig. 1: Velocity contour on the iso-surface of density of supercritical jet

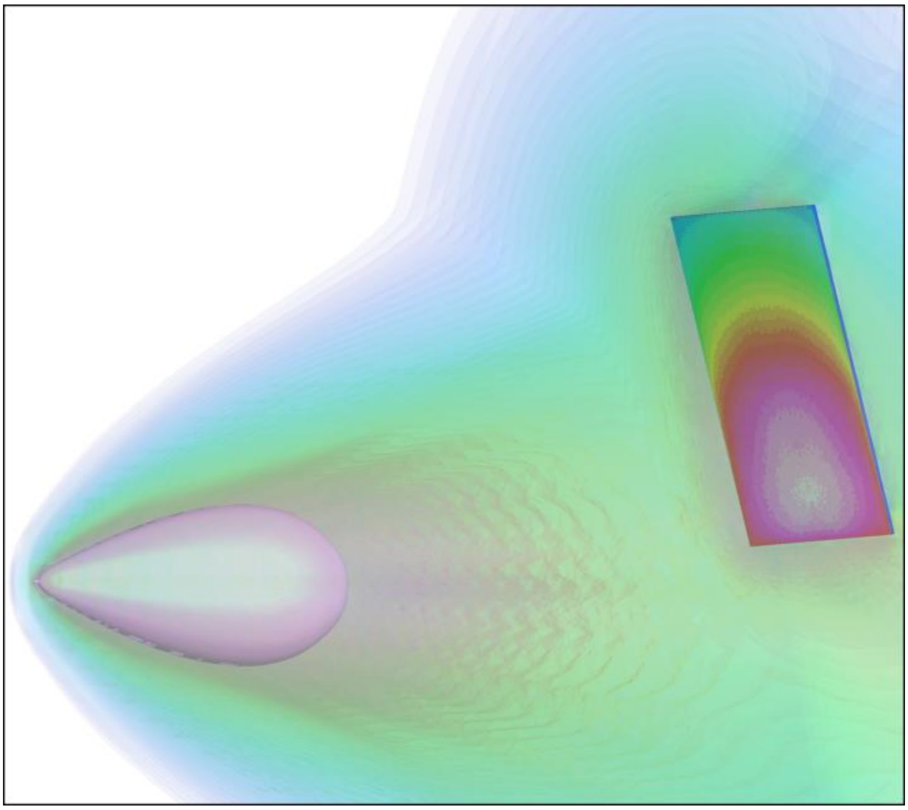

Fig. 2: Iso-surface of number of density and wall pressure of plume impingiment

- **Publications**

N/A

- **Usage of JSS**

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	1024
Elapsed Time per Case	517 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources*1(%): 1.85

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage*2(%)
TOKI-SORA	43,622,914.40	2.12
TOKI-ST	111,955.17	0.14
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	0.00
TOKI-TST	9.58	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	615.85	0.61
/data and /data2	42,849.42	0.46
/ssd	3,120.04	0.81

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	9.58	0.06

[*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)	527.76	0.37

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