Research on Future Launch Vehicle in Terms of Combined Cycle Engine

● **Responsible Representative**

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● **Abstract**

Research on future launch vehicle, namely a winged vehicle with air-breathing engines, with emphasis on propulsion system such as supersonic combustion ramjet, an activity of Tohoku Univ. - JAXA collabolative course.

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

A high computational performance was required for high load computation such as 3D RANS/LES Hybrid CFD calculations, so that using JSS was necessary and helpful.

● **Achievements of the Year**

Reacting flow field within a supersonic combustor was simulated using a RANS / LES hybrid method.　By applying the hybrid method, both flow field (evaluated via pressure distribution, Fig. 1) and mixing phenomena (evaluated via fuel contour at the exit of the combustor, Fig. 2) were nicely simulated in comparison to the RANS method alone.

A method to mimic disturbance on the incoming flow to a combustor from the upstream inlet section was evaluated with CFD.　Both flow fields within an engine model with inlet section and a direct-connect combustor with a shock wave generator were simulated with RANS method (Fig. 3), showing validity of the shock wave generator.
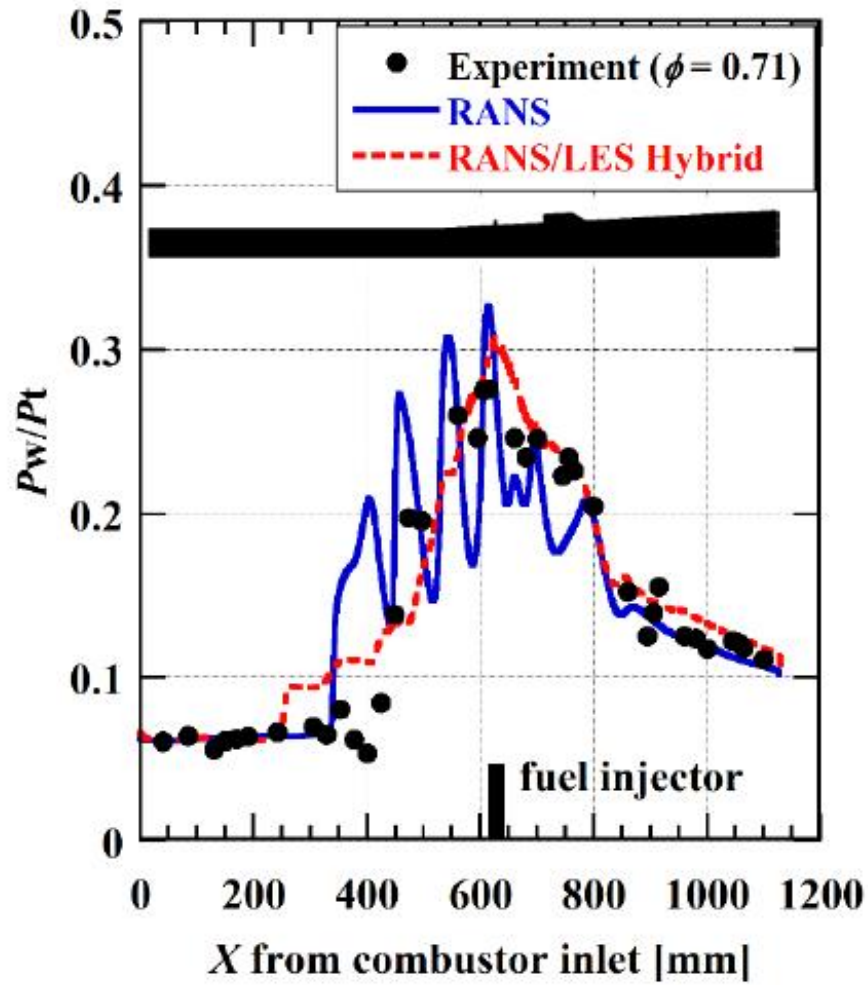
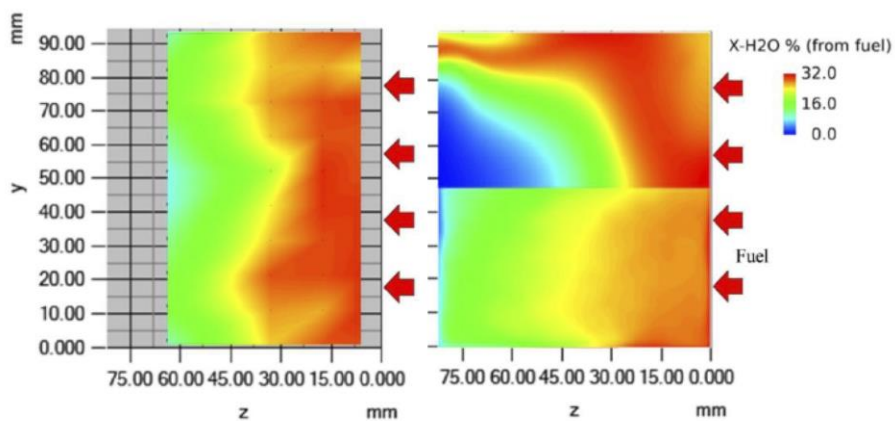Fig. 1: Comparison of wall pressure distributions, experimental, with RANS and with hybrid method

Fig. 2: Comparison of fuel contours at exit of combustor, experimental, with RANS and with hybrid method
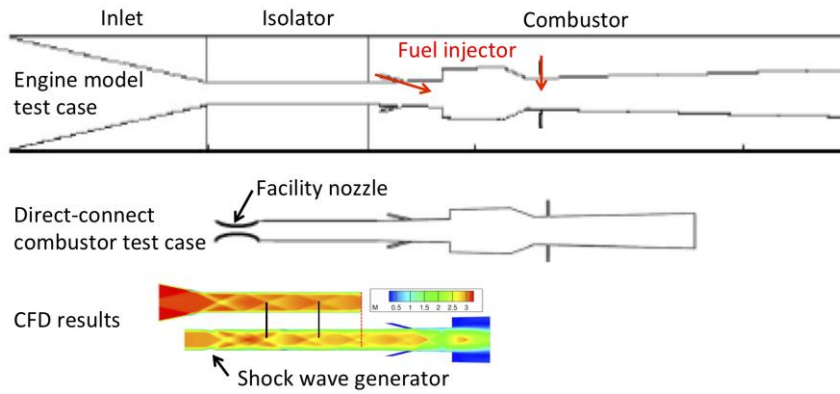
Fig. 3: Comparison of pressure contours in cases with engine model and with
direct-connect combsutor equipping shock wave generator.

● **Publications**

- Non peer-reviewed papers

Nishiguchi, H., et al., 'Unsteady Numerical Analysis of a Dual-Mode Scramjet Combustor with Cavity,' ISTS paper 2022-a-10, 2022.

- Oral Presentations

Nishiguchi, H., et al., 'Unsteady Numerical Analysis of a Dual-Mode Scramjet Combustor with Cavity,' ISTS paper 2022-a-10, 2022.

● **Usage of JSS**

● **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	512 - 8192
Elapsed Time per Case	61 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 0.52

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	2,677,407.69	0.13
TOKI-ST	2,172,885.90	2.68
TOKI-GP	0.00	0.00
TOKI-XM	41.30	0.03
TOKI-LM	10,366.83	0.77
TOKI-TST	3,278.05	0.07
TOKI-TGP	0.00	0.00
TOKI-TLM	0.01	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2](%)
/home	932.50	0.93
/data and /data2	29,856.00	0.32
/ssd	2,573.00	0.66

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)	6,502.15	4.55

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

- **ISV Software Licenses Used**