Study of the Effect of Boundary Layer Ingestion (BLI) on Aircraft Propulsion

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Abstract

In this study, evaluation of unsteady aerodynamics in aircraft fan under strongly distorted inflow condition simulating airframe/engine integration configuration with Boundary Layer Ingestion (BLI) benefit suited for future electric aircraft. Under these BLI conditions, aircraft fan suffers almost all the flight path strongly distorted inflow conditions, the present study investigates the fan flows in detail through the numerical simulations.

Reasons and benefits of using JAXA Supercomputer System

The srudy deals with fan aerodynamic flows under inlet conditions of asymmetric distorsion inflow. For the purpose, high-resolution and full-annula duct flow analysis is necessary with the use of JSS2 supercomputer.

Achievements of the Year

Fan rotor unsteady aerodynamic flow analysis was conducted under the inflow distortion condition simulating airframe/engine integration configuration suited for future electric aircraft. Figure 1 shows baseline and forward-swept rotor-blades. Figure 2 shows entropy distribution in peak efficiency point at 96% span with baseline (upper side) and swept (lower side) rotor-blade shapes under BLI condition. The figure indicates improvement due to change of blade shape in the distribution of entropy rise in the same distorted inflow condition. Figure 3 shows Mach number distribution for the same condition as Fig. 2. The figure indicates that modified flow with blade shape change contributes to loss reduction seen in Fig. 2

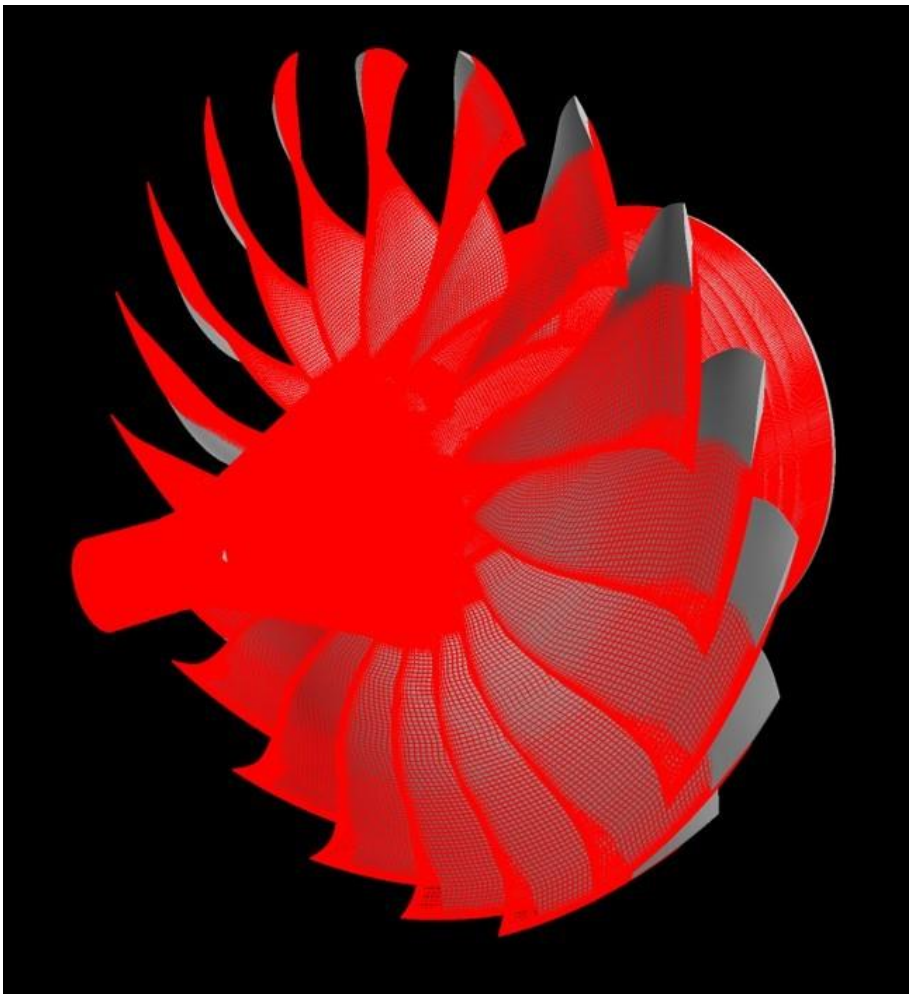

Fig. 1: Rotor-blade shape (baseline and swept)

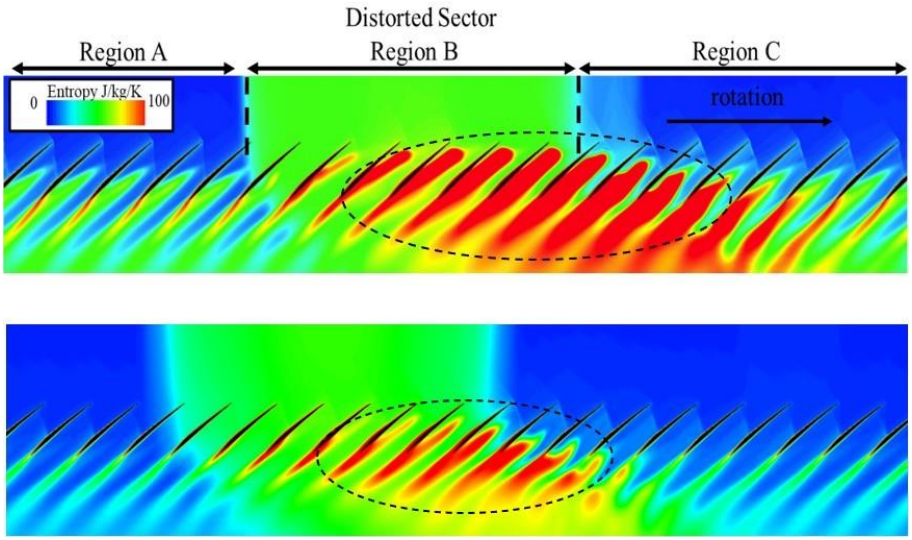

Fig. 2: Entropy distribution at 96% span (Baseline (upper side), Swept (lower side))

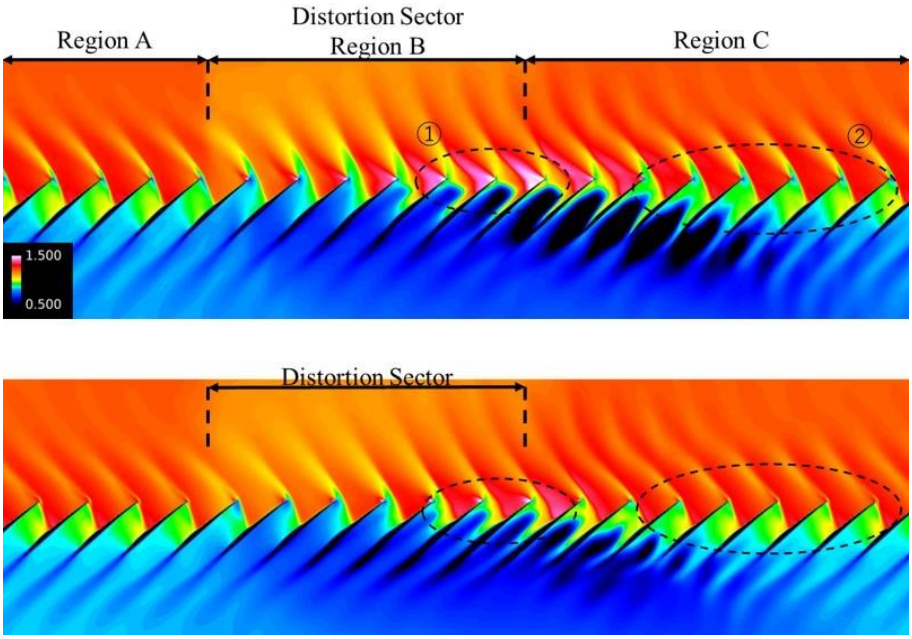

Fig. 3: Mach number distribution at 96% span (Baseline (upper side), Swept (lower side))

Publications

- Oral Presentations

Masaki, A., Kono, M., Sato, T., Okai, K., Kazawa, J., Masaki, D., Numerical analysis of the effect of blade inclination on fan performance under total pressure distortion simulating Boundary Layer Ingestion, 49th Annual Meeting Gas Turbine Society of Japan (GTSJ), October 2021.

Usage of JSS

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	486 - 630
Elapsed Time per Case	10 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 0.01

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	234,058.51	0.01
TOKI-ST	27,690.17	0.03
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	23.67	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	782.88	0.78
/data and /data2	43,407.88	0.46
/ssd	441.06	0.11

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	0.16	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)	370.26	0.26

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