Improvement of simulation of internal flow of turbomachine

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Abstract

In the turbomachine internal flow, the separation on the blade surface and the behavior of the vortex have a large influence on the aerodynamic performance. In numerical analysis using RANS, it is difficult to simulate the separation and vortex in detail, so we analyze using LES for predicting highly accurate aerodynamic performance, and improve accuracy of aerodynamic performance prediction.

Reasons for using of JSS2

Since the mesh required for LES analyses becomes large scale, supercomputers are necessary.

Achievements of the Year

Numerical calculations by UPACS developed by JAXA were performed on a vaneless diffuser centrifugal compressor (Krain, 1988) in which the geometry and measurement results (performance curve, static pressure distribution on the wall surface, L2F in the cross section of the flow passage) are published. Computation by RANS and LES at two or more operating points is performed for two kinds of mesh, coarse (5 M points) and fine (18 M points), with imposing a periodic boundary condition in the circumferential direction. In the numerical prediction of the performance curve, the loss tends to be lower than the experimental value and the estimation performance tends to be overestimated compared with the experimental data. But in general aprediction results by LES are closer to the experiment data than the RANS.It is suggested that LES captures the generation and loss of vortices more accurately than RANS. On the other hand, the numerical prediction result overestimates the performance even in LES on the high rotating speed and high pressure ratio side. It is a future task to clarify the cause as a result.

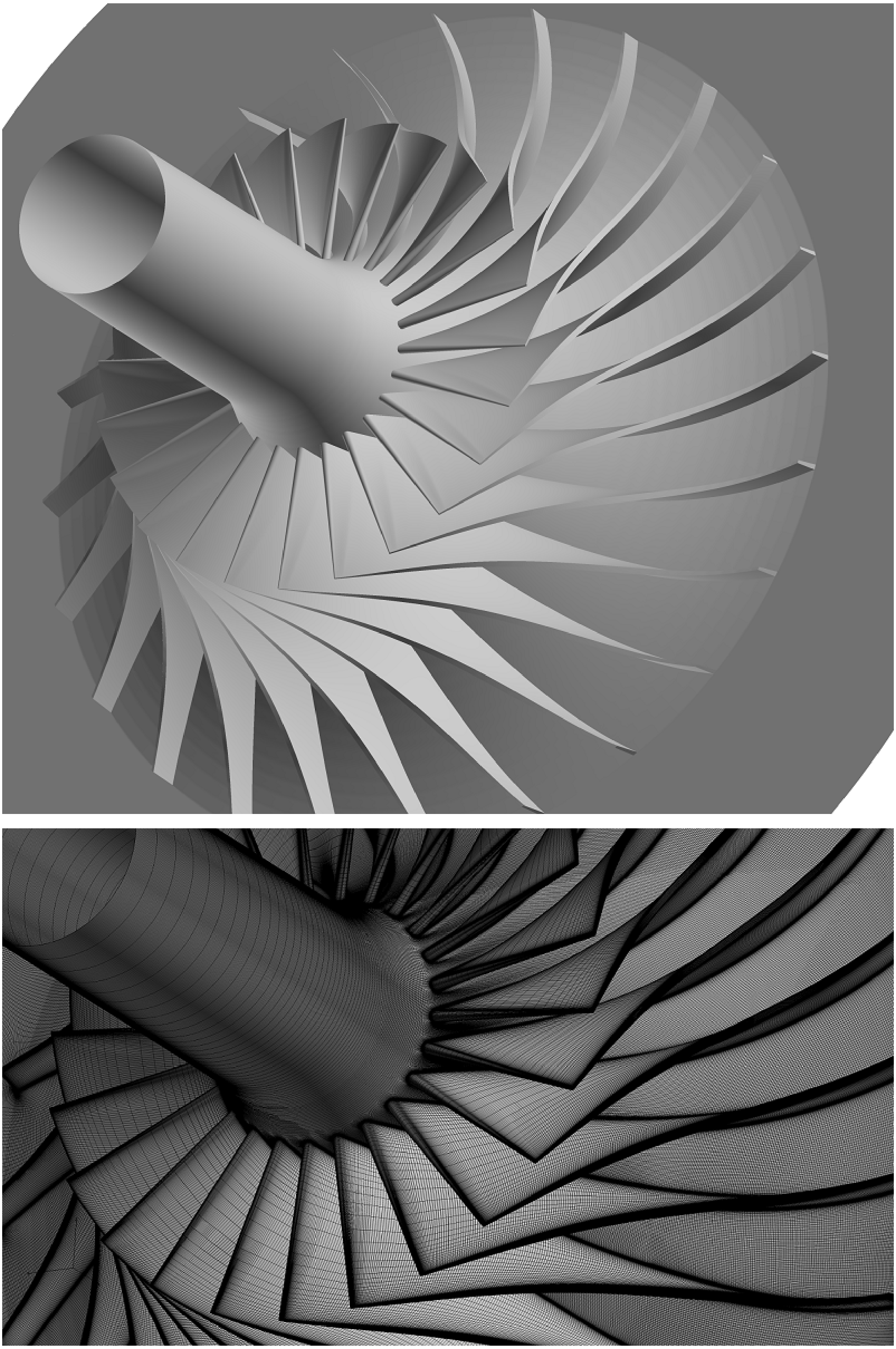

Fig.1 Centrifugal compressor shape and mesh

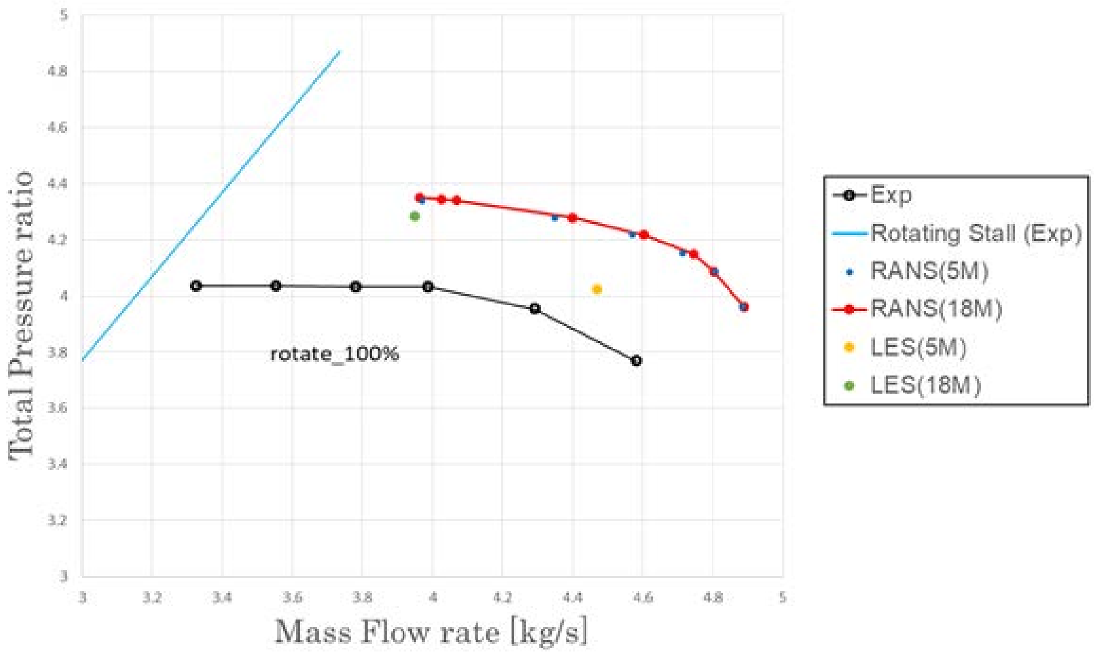

Fig.2 Performance curve of centrifugal compressor

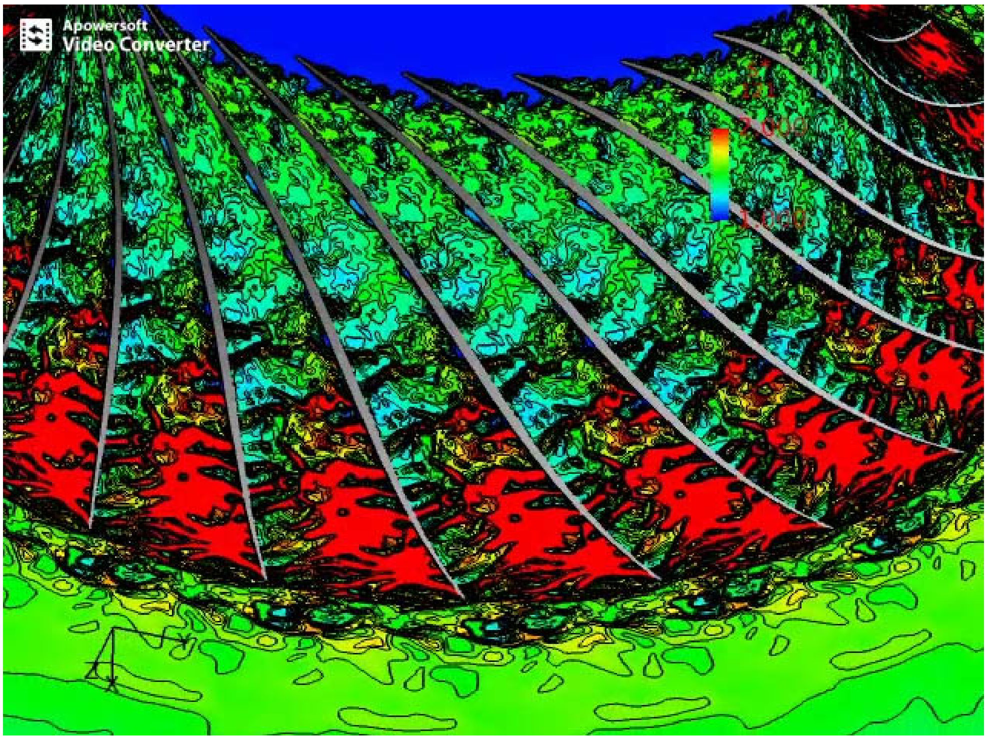

Fig.3 Entropy distribution (animation)

Publications

N/A

Usage of JSS2

Computational Information

Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	51 - 58
Elapsed Time per Case	165.00 hours

Resources Used

Fraction of Usage in Total Resources*1 (%): 0.13

Details

Computing Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage*2 (%)
SORA-MA	0.00	0.00
SORA-PP	199,682.19	2.50
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	010.22	0.01
/data	960.49	0.02
/ltmp	2,092.63	0.16

Archiver Resources		
Archiver System 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