# Application of the Cartesian grid and an IB method to the analysis of aircraft engine comustors

Report Number: R24EDA102G31
Subject Category: Aeronautical Technology
URL: https://www.jss.jaxa.jp/en/ar/e2024/27306/

## Responsible Representative

Taisuke Nambu, Aviation Technology Directorate, Aircraft Digital Transformation Technology Demonstration Project Team (XANADU)

## Contact Information

Taisuke Nambu(nambu.taisuke@jaxa.jp)

## Members

Dan Hori, Taisuke Nambu, Kei Shimura

## Abstract

The evaluation of key factors in thermal-fluid phenomena of aero-engine combustors and fundamental characteristics as a fluid solver is conducted using HINOCA-AE, the potential for expanding the application of numerical analysis to combustor design is explored in collaboration between JAXA and IHI.

## Reasons and benefits of using JAXA Supercomputer System

Massive-parallel large scale simulation, Large number of simulations for software validation

## Achievements of the Year

Combustion analysis for a realistic combustor using a solver employing orthogonal grids and the Immersed Boundary (IB) method was performed. Total temperature non-uniformity at the combustor exit was captured; the total temperature tended to be higher and RTDF (Radial Temperature Distortion Factor) also showed a peak at mid span. Investigation of the differences in the radial distribution of total temperature between the present results and experiments remains future studies. The flow analysis past a cylinder was also performed and the fundamental characteristics as a solver were investigated. Improving mesh resolution for increasing AMR (Adaptive Mesh Refinement) level high brings the wake depth at x/D = 1 closer to the experiments.

Reference of experiment: Cantwell, B., and Coles, D., "An Experimental Study of Entrainment and Transport in the Turbulent Near Wake of a Circular Cylinder", J. Fluid Mech., 136-1, pp. 321-374 (1983).

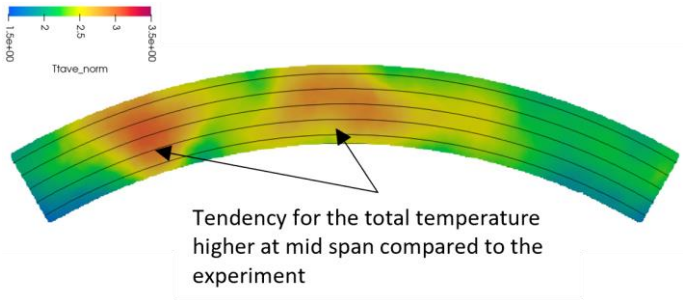


Fig. 1: Total temperature distribution at combustor exit

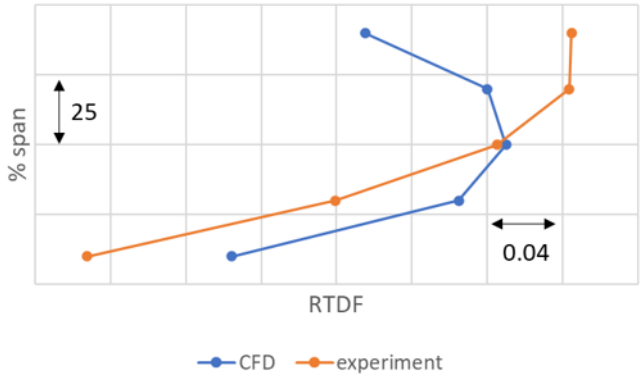


Fig. 2: Radial Temperature Distortion Factor (RTDF) at combustor exit

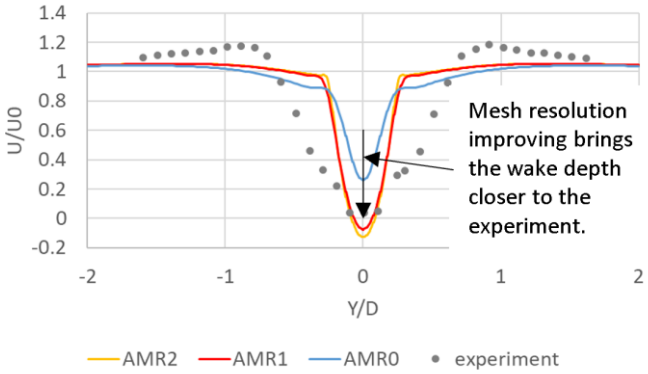


Fig. 3: Mean streamwise velocity in the vicinity of wake (X/D=1)

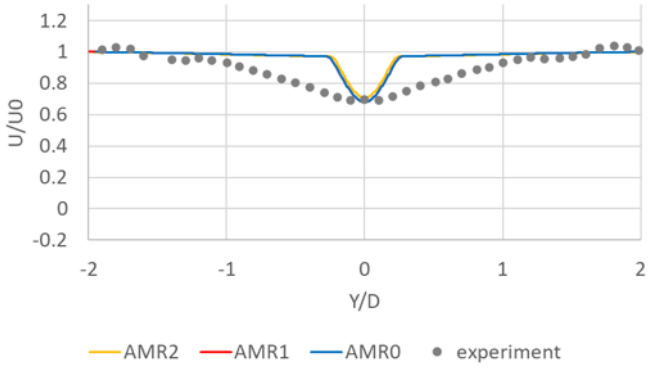


Fig. 4: Mean streamwise velocity in the vicinity of wake (X/D=3)

- **Publications**

  N/A

- **Usage of JSS**

- **Computational Information**

| | |
|---|---|
| Process Parallelization Methods | MPI |
| Thread Parallelization Methods | OpenMP |
| Number of Processes | 1 - 14400 |
| Elapsed Time per Case | 610 Hour(s) |

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 1.43

Details

| Computational Resources | | |
|---|---|---|
| System Name | CPU Resources Used (core x hours) | Fraction of Usage[*2](%) |
| TOKI-SORA | 37,659,655.24 | 1.72 |
| TOKI-ST | 211,878.69 | 0.22 |
| TOKI-GP | 0.00 | 0.00 |
| TOKI-XM | 0.00 | 0.00 |
| TOKI-LM | 40,432.02 | 2.92 |
| TOKI-TST | 0.90 | 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 | 1,545.22 | 1.04 |
| /data and /data2 | 138,337.78 | 0.66 |
| /ssd | 36,018.89 | 1.93 |

| Archiver Resources | | |
|---|---|---|
| Archiver Name | Storage Used (TiB) | Fraction of Usage*2 (%) |
| J-SPACE | 1.80 | 0.01 |

*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) | 286.24 | 0.20 |

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