

Estimation of a Propeller Performance

Report Number: R22EDA201D01

Subject Category: Aeronautical Technology

URL: <https://www.jss.jaxa.jp/en/ar/e2022/20813/>

● Responsible Representative

Masashi Harada, AviationTechnology Directorate, Aviation Safety Innovation Hub

● Contact Information

Masashi Harada(harada.masashi@jaxa.jp)

● Members

Hirokazu Higashida, Masashi Harada, Junichi Kazawa, Hideji Saiki

● Abstract

Development of Propeller and Ducted Fan Design Tools to Maximize the Static Thrust

● Reasons and benefits of using JAXA Supercomputer System

Verification of propeller performance designed with a propeller design tool that maximizes the static thrust. Calculation of detailed velocity distribution of the propeller wake for use in tool refinement.

● Achievements of the Year

The performance of a propeller optimally designed with OptRotor, a propeller design program that maximizes static thrust, the position and shape of the blade tip vortices, and the distribution of thrust on the blades were calculated using CFD. The movement of the blade tip vortex is shown in (Fig. 1). As observed in the experiment, the blade tip vortex moves radially inward immediately after its formation. This causes the spiral vortex formed by the wing tip vortices to contract. Downward induced velocity develops inside the spiral vortex, but no downward induced velocity develops outside the spiral vortex. This situation is shown in (Fig. 2). The optimum design of the propeller blade by OptRotor has a bulge at the tip of the propeller, which actively generates lift at the tip where the downward induced velocity is small. The radial thrust distribution (Fig. 3) shows that the most thrust is generated near the tip (200 mm). On the other hand, the distribution of absorbed power in the radial direction (Fig. 4) shows that there is a region of reduced absorbed power near the tip (200 mm), indicating that the propeller tip bulge obtained with the OptRotor is highly efficient in generating thrust where absorbed power is small, thus demonstrating the validity of the OptRotor design.

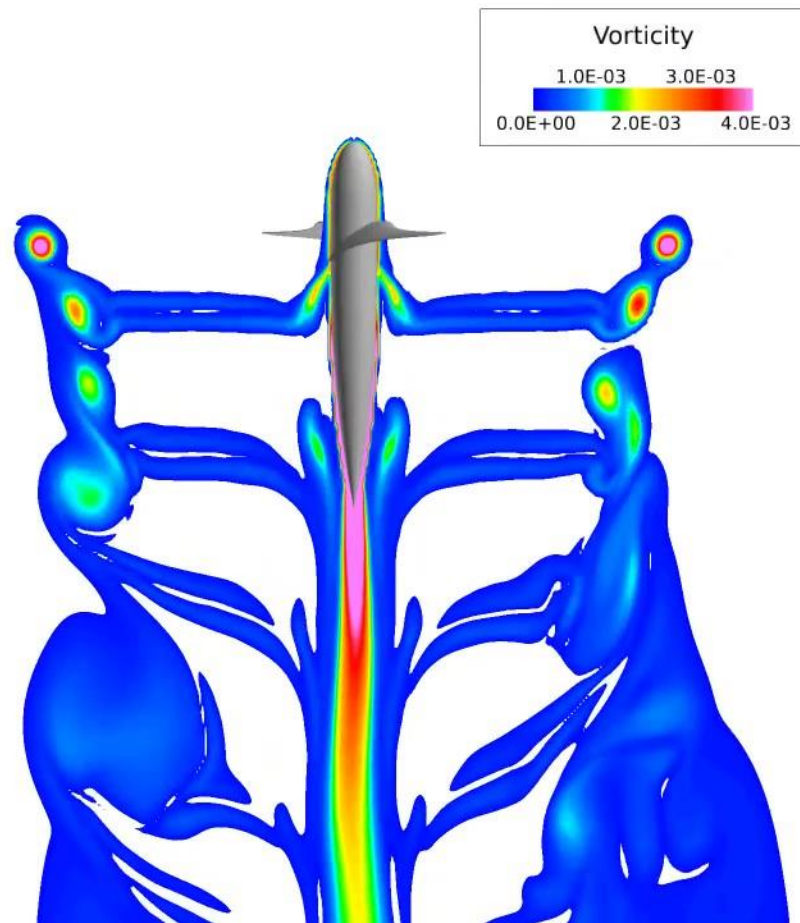


Fig. 1: The movement of the blade tip vortex (Video. Video is available on the web.)

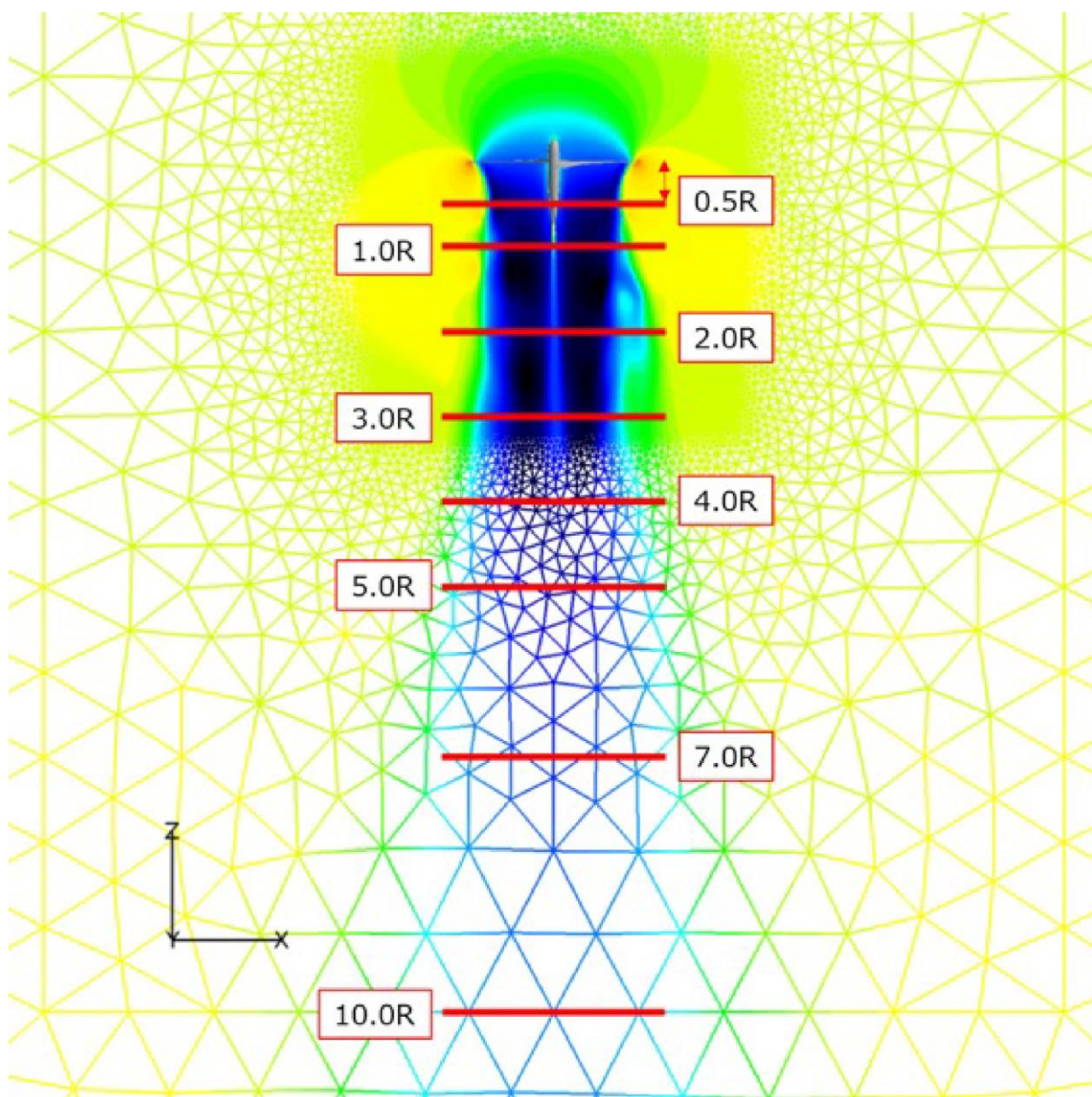


Fig. 2: Axial velocity distribution

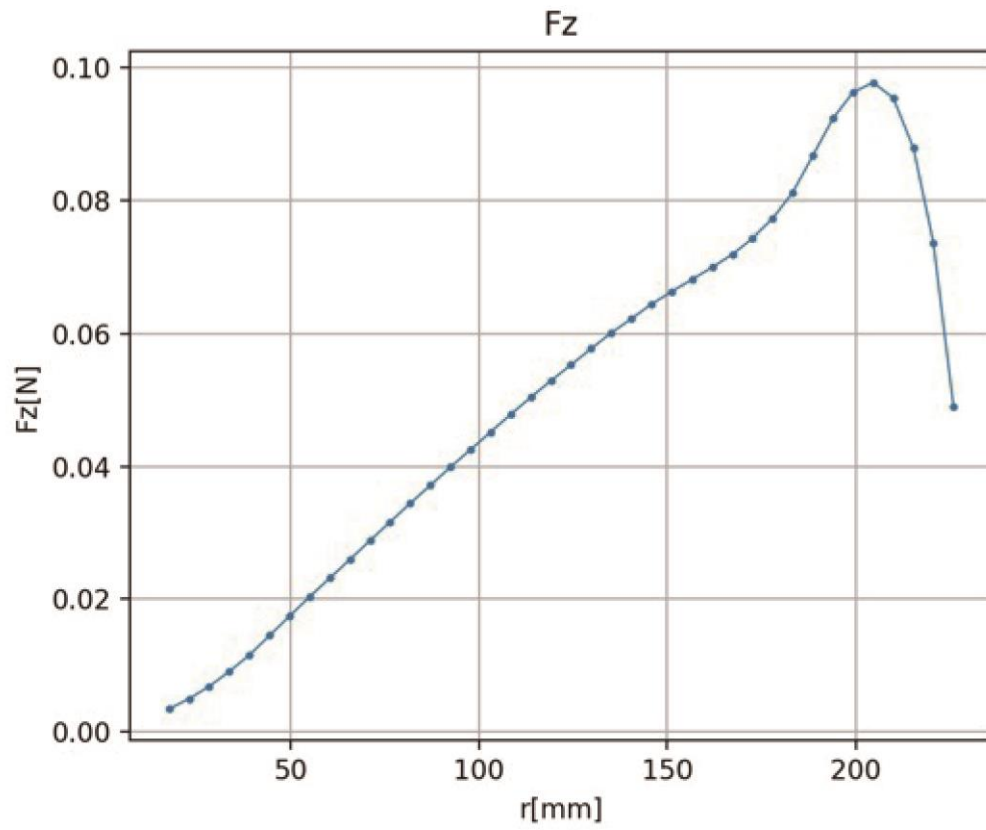


Fig. 3: Distribution of thrust in radial direction

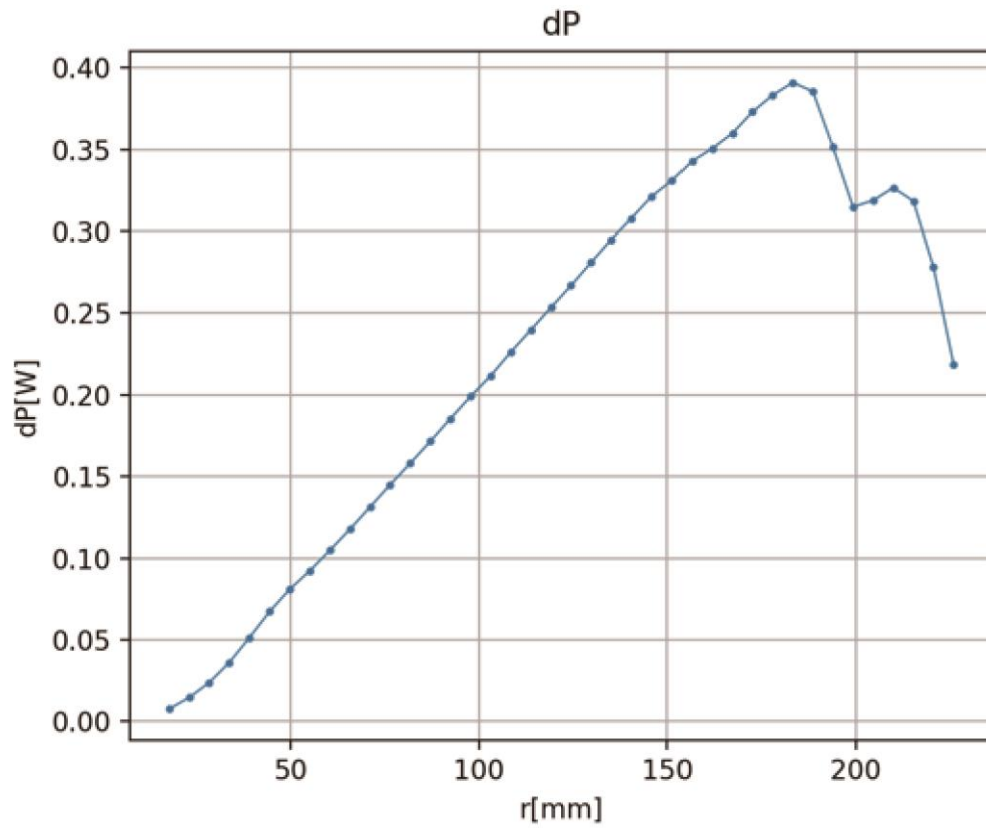


Fig. 4: Distribution of absorbed power in radial direction

- **Publications**

N/A

- **Usage of JSS**

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	960
Elapsed Time per Case	636.3 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources*1(%): 0.03

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage*2(%)
TOKI-SORA	807,721.20	0.04
TOKI-ST	795.54	0.00
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	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	13.70	0.01
/data and /data2	16,547.78	0.13
/ssd	289.63	0.04

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)	0.00	0.00

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