

# Rotor 21

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## Original model

Rotor 21 is part of a research program to study the experimental performances of a stage when the design blade loading in the rotor tip region has been substantially reduced. In order to produce the same overall pressure ratio as a reference stage (rotor 11), the blade loading levels in the midspan portion of the present rotor blade had to be relatively high.

- Original technical report <sup>[1]</sup>:

```
@TechReport{schmidt1978design,  
author      = {Schmidt, James F. and Ruggeri, Robert S.},  
title       = {Performance With and Without Inlet Radial Distortion of a  
Transonic Fan Stage Designed for Reduced Loading in the Tip Region},  
institution = {NASA Lewis Research Center Cleveland, OH, United States},  
note        = {NASA-TP-1294, url~:  
\url{https://ntrs.nasa.gov/citations/19780022114}, 1978 }}
```

- Picture :

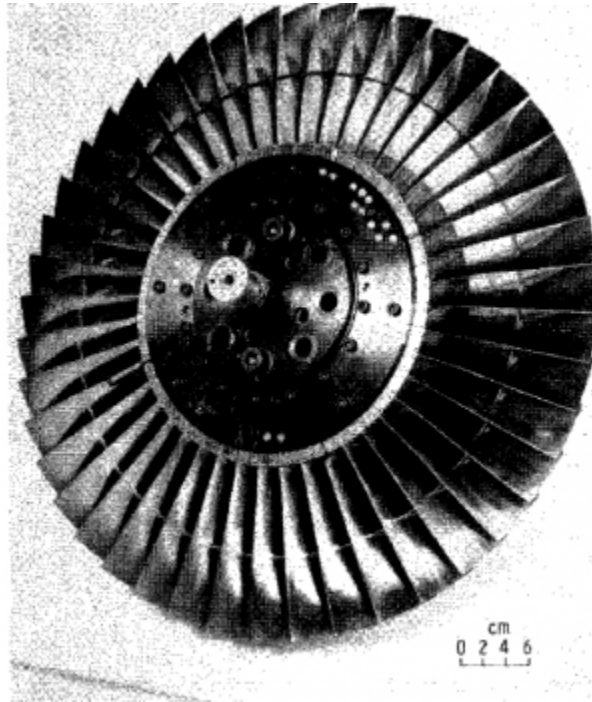


Fig1. <https://ntrs.nasa.gov/citations/19780022114> p.68

## Useful documents

- PDF of the NASA report :

rotor21.pdf

- CSV file of the blade geometry :

rotor21\_original.csv

## Geometry

The geometry of rotor 21 is described in the original NASA report by the following tables. The length are in centimeters and the angles in degrees.

TABLE IV. - BLADE GEOMETRY FOR ROTOR 21

RP	PERCENT RADII			BLADE ANGLES			DELTA INC	CONE ANGLE
	SPAN	RI	RO	KIC	KTC	KOC		
TIP	0.	25.184	24.859	67.16	68.45	66.50	2.49	-10.943
1	5.	24.720	24.321	65.46	66.09	63.55	2.68	-12.184
2	10.	24.209	23.783	63.63	63.54	60.68	2.91	-11.940
3	30.	21.977	21.630	57.00	53.33	50.06	3.95	-7.386
4	50.	19.509	19.478	51.69	43.35	37.36	5.12	-0.536
5	55.	19.186	19.209	51.09	42.21	35.65	5.27	0.386
6	55.	18.861	18.940	50.51	41.10	33.91	5.41	1.320
7	58.	18.534	18.671	49.93	40.04	32.15	5.56	2.257
8	60.	18.204	18.402	49.36	39.03	30.36	5.70	3.194
9	70.	16.863	17.326	47.12	35.49	23.43	6.26	6.996
10	90.	14.112	15.173	42.06	31.67	15.87	7.39	14.856
11	95.	13.420	14.635	40.49	31.40	16.47	7.70	16.870
HUB	100.	12.700	14.097	38.77	31.28	17.72	8.03	19.264

RP	BLADE THICKNESSES			AXIAL DIMENSIONS			
	TI	TM	TO	ZIC	ZMC	ZTC	ZOC
TIP	0.051	0.149	0.051	1.100	1.947	2.326	2.782
1	0.051	0.157	0.051	1.033	1.949	2.314	2.880
2	0.051	0.166	0.051	0.960	1.951	2.296	2.976
3	0.051	0.208	0.051	0.661	1.943	2.109	3.334
4	0.051	0.255	0.051	0.379	1.925	1.766	3.663
5	0.051	0.261	0.051	0.347	1.925	1.716	3.699
6	0.051	0.268	0.051	0.315	1.921	1.664	3.735
7	0.051	0.274	0.051	0.285	1.919	1.612	3.769
8	0.051	0.280	0.051	0.255	1.917	1.560	3.801
9	0.051	0.306	0.051	0.148	1.910	1.350	3.915
10	0.051	0.361	0.051	0.018	1.911	0.989	4.020
11	0.051	0.375	0.051	0.007	1.912	0.918	4.013
HUB	0.051	0.391	0.051	0.000	1.914	0.850	3.997

## Aerodynamic design

	unit	values
pressure ratio	[-]	1.57
mass flow	[kg/s]	29.5
tip speed	[m/s]	425
tip solidity	[-]	1.28
aspect ratio	[-]	2.5
number of blades	[-]	44
rotative speed	[rad/s]	1686

## Material properties

The original material of the rotor 21 is not defined in the NASA report.

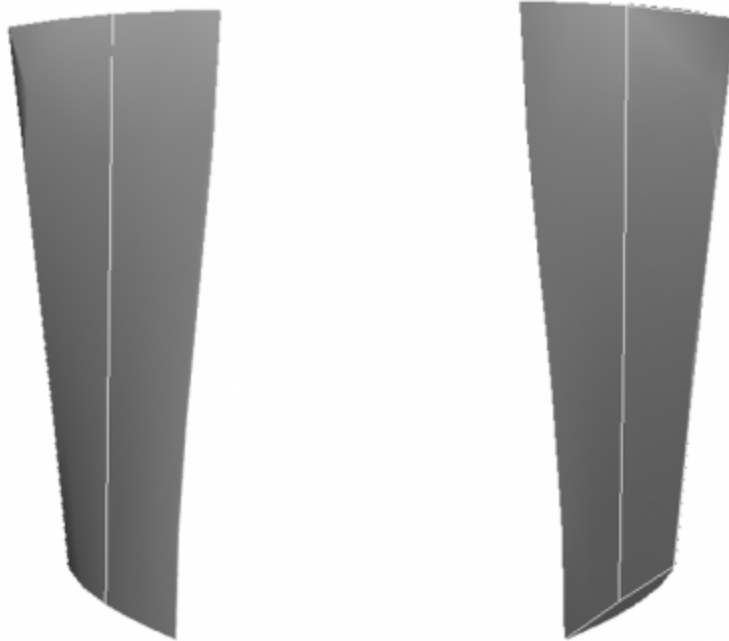
Considered properties: Ti-6Al-4V, generic titanium :

	unité	valeurs
alloy	[-]	Ti-6Al-4V
Young's modulus	[GPa]	108
density	[kg/m <sup>3</sup> ]	4400
Poisson's ratio	[-]	0.34
yield stress	[GPa]	0.824

First three natural frequencies (with clamped root) for the mesh:

1. (1B): 1506.6 rad/s / 239.8 Hz
2. (2B): 5763.2 rad/s / 917.2 Hz
3. (1T): 8745.6 rad/s / 1391.9 Hz

## CAD



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## Modèle original

Le rotor 21 fait partie d'un programme de recherche visant à étudier les performances expérimentales d'un étage de soufflante lorsque la charge des aubes dans la région de l'extrémité du rotor a été considérablement réduite. Afin de produire le même taux de compression global que l'étage de référence (rotor 11), les niveaux de charge des aubes dans la partie médiane de l'aube du rotor actuel ont été relativement augmentés.

- [Rapport technique original](#) <sup>[1]</sup>:

```
@TechReport{schmidt1978design,  
author      = {Schmidt, James F. and Ruggeri, Robert S.},  
title       = {Performance With and Without Inlet Radial Distortion of a
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Transonic Fan Stage Designed for Reduced Loading in the Tip Region},
institution = {NASA Lewis Research Center Cleveland, OH, United States},
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- Photographie :

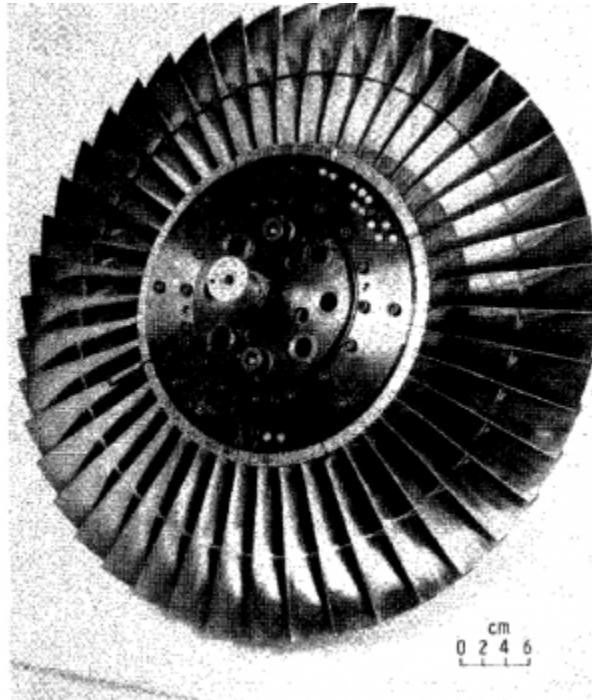


Fig1. <https://ntrs.nasa.gov/citations/19780022114> p.68

## Documents utiles

- PDF du rapport de la NASA : [rotor21.pdf](#)
- Fichier CSV de la géométrie : [rotor21\\_original.csv](#)

## Géométrie

La géométrie du rotor 21 est décrite dans le [rapport d'origine de la NASA](#) par les tableaux suivants. Les grandeurs sont en centimètres et en degrés.

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11	0.051	0.375	0.051	0.007	1.912	0.918	4.013
HUB	0.051	0.391	0.051	0.000	1.914	0.850	3.997

## Caractéristiques aérodynamiques

	unités	valeurs
taux de compression	[-]	1,57
débit massique	[kg/s]	29,5
vitesse en tête	[m/s]	425
solidité en tête	[-]	1,28
allongement	[-]	2,5
nombre d'aubes	[-]	44
vitesse de rotation	[rad/s]	1686

## Propriétés matériau

Le matériau original du rotor 21 n'est pas défini dans le rapport de la NASA.

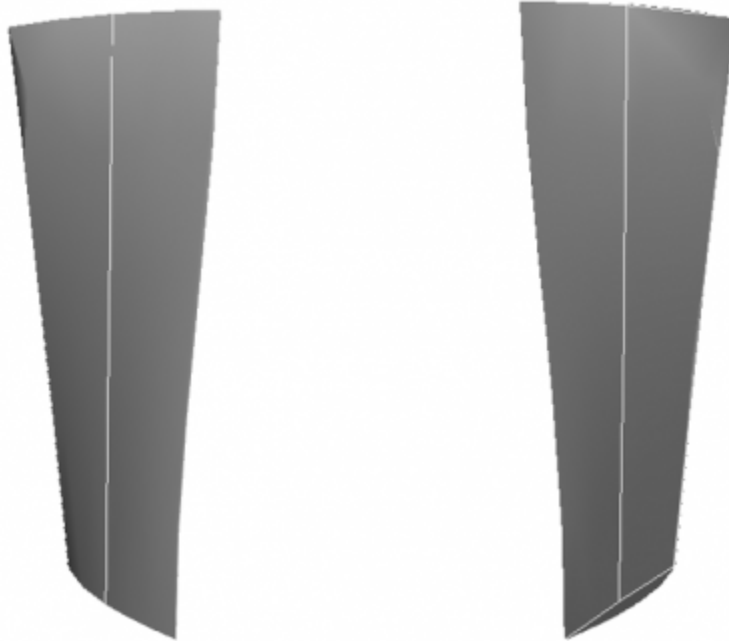
Propriétés considérées : alliage de titane Ti-6Al-4v :

	unité	valeurs
alliage	[-]	Ti-6Al-4v
module d'Young	[GPa]	108
masse volumique	[kg/m <sup>3</sup> ]	4400
coefficient de Poisson	[-]	0,34
limite élastique	[GPa]	0,824

Fréquences des trois premiers modes (noeuds de la base encastrés) pour le maillage :

1. (1B): 1506,6 rad/s / 239,8 Hz
2. (2B): 5763,2 rad/s / 917,2 Hz
3. (1T): 8745,6 rad/s / 1391,9 Hz

## CAO



1. <sup>a, b</sup> Schmidt. «Performance With and Without Inlet Radial Distortion of a Transonic Fan Stage Designed for Reduced Loading in the Tip Region » 1978. [pdf](#)

Document issu de la page wiki:

[https://lava-wiki.meca.polymtl.ca/public/modeles/rotor\\_21/accueil](https://lava-wiki.meca.polymtl.ca/public/modeles/rotor_21/accueil)

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