Date

2025/11/16 23:40:41

Contents

1. File Report

Table 1. File Information for Turbine_001

Case	Turbine_001
File Path	D:/An_Cr_Files/Chapter8_Download/CASE_1/Turbine_001.res
File Date	04 August 2025
File Time	01:10:03 AM
File Type	CFX5
File Version	20.2

2. Mesh Report

Table 2. Mesh Information for Turbine_001

Domain	Nodes	Elements
R1	183690	170368
R2	128910	119294
S1	141346	131348
S2	109536	101370
All Domains	563482	522380

Table 3. Mesh Statistics for Turbine_001

Domain	Maximum Edge Length Ratio
R1	1579.39
R2	3156.83
S1	4021.08
S2	1614.52
All Domains	4021.08

3. Physics Report

Table 4. Domain Physics for Turbine_001

Domain - R1	
Type	Fluid
Location	Passage 2
Materials	
Combustion gas	
Fluid Definition	Material Library
Morphology	Continuous Fluid
Settings	
Buoyancy Model	Non Buoyant
Domain Motion	Rotating
Alternate Rotation Model	true
Angular Velocity	9.9700e+3 [rev min^-1]
Axis Definition	Coordinate Axis
Rotation Axis	Coord 0.1
Reference Pressure	0.0000e+0 [atm]
Heat Transfer Model	Total Energy
Include Viscous Work Term	True
Turbulence Model	SST
Turbulent Wall Functions	Automatic
High Speed Model	Off
Domain - R2	
Type	Fluid
Location	Passage 4
Materials	
Combustion gas	
Fluid Definition	Material Library
Morphology	Continuous Fluid
Settings	
Buoyancy Model	Non Buoyant
Domain Motion	Rotating
Alternate Rotation Model	true
Angular Velocity	9.6300e+3 [rev min^-1]
Axis Definition	Coordinate Axis
Rotation Axis	Coord 0.1
Reference Pressure	0.0000e+0 [atm]
Heat Transfer Model	Total Energy
Include Viscous Work Term	True
Turbulence Model	SST

Turbulent Wall Functions	Automatic
High Speed Model	Off
Domain - S1	
Type	Fluid
Location	Passage
Materials	
Combustion gas	
Fluid Definition	Material Library
Morphology	Continuous Fluid
Settings	
Buoyancy Model	Non Buoyant
Domain Motion	Stationary
Reference Pressure	0.0000e+0 [atm]
Heat Transfer Model	Total Energy
Include Viscous Work Term	True
Turbulence Model	SST
Turbulent Wall Functions	Automatic
High Speed Model	Off
Domain - S2	
Type	Fluid
Location	Passage 3
Materials	
Combustion gas	
Fluid Definition	Material Library
Morphology	Continuous Fluid
Settings	
Buoyancy Model	Non Buoyant
Domain Motion	Stationary
Reference Pressure	0.0000e+0 [atm]
Heat Transfer Model	Total Energy
Include Viscous Work Term	True
Turbulence Model	SST
Turbulent Wall Functions	Automatic
High Speed Model	Off
Domain Interface - R1 to R1 Blade Tip	
Boundary List1	R1 to R1 Blade Tip Side 1
Boundary List2	R1 to R1 Blade Tip Side 2
Interface Type	Fluid Fluid
Settings	
Interface Models	General Connection
Mass And Momentum	Conservative Interface Flux
Mesh Connection	GGI

Domain Interface - R1 to R1 Periodic 1	
Boundary List1	R1 to R1 Periodic 1 Side 1
Boundary List2	R1 to R1 Periodic 1 Side 2
Interface Type	Fluid Fluid
Settings	
Interface Models	Rotational Periodicity
Axis Definition	Coordinate Axis
Rotation Axis	Coord 0.1
Mesh Connection	Automatic
Domain Interface - R1 to S1	
Boundary List1	R1 to S1 Side 1
Boundary List2	R1 to S1 Side 2
Interface Type	Fluid Fluid
Settings	
Interface Models	General Connection
Frame Change	Stage
Frame Type	Rotating
Downstream Velocity Constraint	Constant Total Pressure
Pitch Change	Automatic
Mesh Connection	GGI
Domain Interface - R2 to R2 Blade Tip	
Boundary List1	R2 to R2 Blade Tip Side 1
Boundary List2	R2 to R2 Blade Tip Side 2
Interface Type	Fluid Fluid
Settings	
Interface Models	General Connection
Mass And Momentum	Conservative Interface Flux
Mesh Connection	GGI
Domain Interface - R2 to R2 Periodic 1	
Boundary List1	R2 to R2 Periodic 1 Side 1
Boundary List2	R2 to R2 Periodic 1 Side 2
Interface Type	Fluid Fluid
Settings	
Interface Models	Rotational Periodicity
Axis Definition	Coordinate Axis
Rotation Axis	Coord 0.1
Mesh Connection	Automatic
Domain Interface - R2 to S2	
Boundary List1	R2 to S2 Side 1
Boundary List2	R2 to S2 Side 2
Interface Type	Fluid Fluid
Settings	

Interface Models	General Connection
Frame Change	Stage
Frame Type	Rotating
Downstream Velocity Constraint	Constant Total Pressure
Pitch Change	Automatic
Mesh Connection	GGI
Domain Interface - S1 to S1 Periodic 1	
Boundary List1	S1 to S1 Periodic 1 Side 1
Boundary List2	S1 to S1 Periodic 1 Side 2
Interface Type	Fluid Fluid
Settings	
Interface Models	Rotational Periodicity
Axis Definition	Coordinate Axis
Rotation Axis	Coord 0.1
Mesh Connection	Automatic
Domain Interface - S2 to R1	
Boundary List1	S2 to R1 Side 1
Boundary List2	S2 to R1 Side 2
Interface Type	Fluid Fluid
Settings	
Interface Models	General Connection
Frame Change	Stage
Frame Type	Rotating
Downstream Velocity Constraint	Constant Total Pressure
Pitch Change	Automatic
Mesh Connection	GGI
Domain Interface - S2 to S2 Periodic 1	
Boundary List1	S2 to S2 Periodic 1 Side 1
Boundary List2	S2 to S2 Periodic 1 Side 2
Interface Type	Fluid Fluid
Settings	
Interface Models	Rotational Periodicity
Axis Definition	Coordinate Axis
Rotation Axis	Coord 0.1
Mesh Connection	Automatic

Table 5. Boundary Physics for Turbine_001

Domain	**Boundaries**	
R1	**Boundary - R1 to R1 Blade Tip Side 1**	
	Type	INTERFACE
	Location	SHROUD TIP GGI SIDE 1 2
	Settings	

Heat Transfer	Conservative Interface Flux
Mass And Momentum	Conservative Interface Flux
Turbulence	Conservative Interface Flux
Boundary - R1 to R1 Blade Tip Side 2	
Type	INTERFACE
Location	SHROUD TIP GGI SIDE 2 2
Settings	
Heat Transfer	Conservative Interface Flux
Mass And Momentum	Conservative Interface Flux
Turbulence	Conservative Interface Flux
Boundary - R1 to R1 Periodic 1 Side 1	
Type	INTERFACE
Location	PER1 2
Settings	
Heat Transfer	Conservative Interface Flux
Mass And Momentum	Conservative Interface Flux
Turbulence	Conservative Interface Flux
Boundary - R1 to R1 Periodic 1 Side 2	
Type	INTERFACE
Location	PER2 2
Settings	
Heat Transfer	Conservative Interface Flux
Mass And Momentum	Conservative Interface Flux
Turbulence	Conservative Interface Flux
Boundary - R1 to S1 Side 1	
Type	INTERFACE
Location	INFLOW 2
Settings	
Heat Transfer	Conservative Interface Flux
Mass And Momentum	Conservative Interface Flux
Turbulence	Conservative Interface Flux
Boundary - S2 to R1 Side 2	
Type	INTERFACE
Location	OUTFLOW 2
Settings	
Heat Transfer	Conservative Interface Flux
Mass And Momentum	Conservative Interface Flux
Turbulence	Conservative Interface Flux
Boundary - R1 Blade	
Type	WALL
Location	BLADE 2
Settings	

	Heat Transfer	Adiabatic
	Mass And Momentum	No Slip Wall
	Wall Roughness	Smooth Wall
	Boundary - R1 Hub	
	Type	WALL
	Location	HUB 2
	Settings	
	Heat Transfer	Adiabatic
	Mass And Momentum	No Slip Wall
	Wall Roughness	Smooth Wall
	Boundary - R1 Shroud	
	Type	WALL
	Location	SHROUD 2
	Settings	
	Heat Transfer	Adiabatic
	Mass And Momentum	No Slip Wall
	Wall Velocity	Counter Rotating Wall
	Wall Roughness	Smooth Wall
R2	**Boundary - R2 to R2 Blade Tip Side 1**	
	Type	INTERFACE
	Location	SHROUD TIP GGI SIDE 1
	Settings	
	Heat Transfer	Conservative Interface Flux
	Mass And Momentum	Conservative Interface Flux
	Turbulence	Conservative Interface Flux
	Boundary - R2 to R2 Blade Tip Side 2	
	Type	INTERFACE
	Location	SHROUD TIP GGI SIDE 2
	Settings	
	Heat Transfer	Conservative Interface Flux
	Mass And Momentum	Conservative Interface Flux
	Turbulence	Conservative Interface Flux
	Boundary - R2 to R2 Periodic 1 Side 1	
	Type	INTERFACE
	Location	PER1 4
	Settings	
	Heat Transfer	Conservative Interface Flux
	Mass And Momentum	Conservative Interface Flux
	Turbulence	Conservative Interface Flux
	Boundary - R2 to R2 Periodic 1 Side 2	
	Type	INTERFACE
	Location	PER2 4

Settings	
Heat Transfer	Conservative Interface Flux
Mass And Momentum	Conservative Interface Flux
Turbulence	Conservative Interface Flux
Boundary - R2 to S2 Side 1	
Type	INTERFACE
Location	INFLOW 4
Settings	
Heat Transfer	Conservative Interface Flux
Mass And Momentum	Conservative Interface Flux
Turbulence	Conservative Interface Flux
Boundary - R2 Outlet	
Type	OUTLET
Location	OUTFLOW 4
Settings	
Flow Regime	Subsonic
Mass And Momentum	Average Static Pressure
Pressure Profile Blend	5.0000e-2
Relative Pressure	1.5000e+2 [kPa]
Pressure Averaging	Average Over Whole Outlet
Boundary - R2 Blade	
Type	WALL
Location	BLADE 4
Settings	
Heat Transfer	Adiabatic
Mass And Momentum	No Slip Wall
Wall Roughness	Smooth Wall
Boundary - R2 Hub	
Type	WALL
Location	HUB 4
Settings	
Heat Transfer	Adiabatic
Mass And Momentum	No Slip Wall
Wall Roughness	Smooth Wall
Boundary - R2 Shroud	
Type	WALL
Location	SHROUD 4
Settings	
Heat Transfer	Adiabatic
Mass And Momentum	No Slip Wall
Wall Velocity	Counter Rotating Wall
Wall Roughness	Smooth Wall

S1	**Boundary - S1 Inlet**	
	Type	INLET
	Location	INFLOW
	Settings	
	Flow Direction	Normal to Boundary Condition
	Flow Regime	Subsonic
	Heat Transfer	Total Temperature
	Total Temperature	1.4000e+3 [K]
	Mass And Momentum	Total Pressure
	Relative Pressure	1.2000e+3 [kPa]
	Turbulence	Medium Intensity and Eddy Viscosity Ratio
	Boundary - R1 to S1 Side 2	
	Type	INTERFACE
	Location	OUTFLOW
	Settings	
	Heat Transfer	Conservative Interface Flux
	Mass And Momentum	Conservative Interface Flux
	Turbulence	Conservative Interface Flux
	Boundary - S1 to S1 Periodic 1 Side 1	
	Type	INTERFACE
	Location	PER1
	Settings	
	Heat Transfer	Conservative Interface Flux
	Mass And Momentum	Conservative Interface Flux
	Turbulence	Conservative Interface Flux
	Boundary - S1 to S1 Periodic 1 Side 2	
	Type	INTERFACE
	Location	PER2
	Settings	
	Heat Transfer	Conservative Interface Flux
	Mass And Momentum	Conservative Interface Flux
	Turbulence	Conservative Interface Flux
	Boundary - S1 Blade	
	Type	WALL
	Location	BLADE
	Settings	
	Heat Transfer	Adiabatic
	Mass And Momentum	No Slip Wall
	Wall Roughness	Smooth Wall
	Boundary - S1 Hub	
	Type	WALL
	Location	HUB

	Settings	
	Heat Transfer	Adiabatic
	Mass And Momentum	No Slip Wall
	Wall Roughness	Smooth Wall
	Boundary - S1 Shroud	
	Type	WALL
	Location	SHROUD
	Settings	
	Heat Transfer	Adiabatic
	Mass And Momentum	No Slip Wall
	Wall Roughness	Smooth Wall
S2	**Boundary - R2 to S2 Side 2**	
	Type	INTERFACE
	Location	OUTFLOW 3
	Settings	
	Heat Transfer	Conservative Interface Flux
	Mass And Momentum	Conservative Interface Flux
	Turbulence	Conservative Interface Flux
	Boundary - S2 to R1 Side 1	
	Type	INTERFACE
	Location	INFLOW 3
	Settings	
	Heat Transfer	Conservative Interface Flux
	Mass And Momentum	Conservative Interface Flux
	Turbulence	Conservative Interface Flux
	Boundary - S2 to S2 Periodic 1 Side 1	
	Type	INTERFACE
	Location	PER1 3
	Settings	
	Heat Transfer	Conservative Interface Flux
	Mass And Momentum	Conservative Interface Flux
	Turbulence	Conservative Interface Flux
	Boundary - S2 to S2 Periodic 1 Side 2	
	Type	INTERFACE
	Location	PER2 3
	Settings	
	Heat Transfer	Conservative Interface Flux
	Mass And Momentum	Conservative Interface Flux
	Turbulence	Conservative Interface Flux
	Boundary - S2 Blade	
	Type	WALL
	Location	BLADE 3

Settings	
Heat Transfer	Adiabatic
Mass And Momentum	No Slip Wall
Wall Roughness	Smooth Wall
Boundary - S2 Hub	
Type	WALL
Location	HUB 3
Settings	
Heat Transfer	Adiabatic
Mass And Momentum	No Slip Wall
Wall Roughness	Smooth Wall
Boundary - S2 Shroud	
Type	WALL
Location	SHROUD 3
Settings	
Heat Transfer	Adiabatic
Mass And Momentum	No Slip Wall
Wall Roughness	Smooth Wall

4. Solution Report

Table 6. Boundary Flows for Turbine_001

Location	Type	Mass Flow	Momentum		
			X	Y	Z
R1 Blade (R1)	Boundary	0.0000e+0	-1.9265e+2	6.7341e+2	1.9493e+2
R1 Hub (R1)	Boundary	0.0000e+0	9.4058e+1	-1.4092e+1	5.7381e+2
R1 Shroud (R1)	Boundary	0.0000e+0	1.7740e+1	2.0073e+1	-1.0295e+3
R2 Blade (R2)	Boundary	0.0000e+0	-3.6455e+2	7.1287e+2	8.6666e+1
R2 Hub (R2)	Boundary	0.0000e+0	2.7973e+1	-4.7164e+0	2.1627e+2
R2 Outlet (R2)	Boundary	-9.3302e-1	-9.5010e+2	-1.6215e+2	-9.7860e+0
R2 Shroud (R2)	Boundary	0.0000e+0	5.9654e+1	2.2789e+1	-4.8268e+2
S1 Blade (S1)	Boundary	0.0000e+0	-1.4419e+3	-1.0343e+3	1.5974e+2
S1 Hub (S1)	Boundary	0.0000e+0	8.6000e+1	5.8285e+1	3.4461e+3
S1 Inlet (S1)	Boundary	1.7241e+0	3.9168e+3	1.1449e-4	3.7150e-3
S1 Shroud (S1)	Boundary	0.0000e+0	4.4328e+2	-7.0927e+1	-4.6980e+3
S2 Blade (S2)	Boundary	0.0000e+0	-1.0242e+3	-9.2486e+2	-5.4923e+0
S2 Hub (S2)	Boundary	0.0000e+0	1.6512e+2	-5.6271e+0	7.5704e+2
S2 Shroud (S2)	Boundary	0.0000e+0	3.0740e+2	3.9824e+1	-1.2931e+3
R1 to R1 Blade Tip Side 1 (R1)	Domain Interface	-1.1790e-2	-9.7714e+0	1.4715e+1	8.5144e-2
R1 to R1 Blade Tip Side 2 (R1)	Domain Interface	1.1790e-2	9.7702e+0	-1.4715e+1	-8.5207e-2
R1 to S1 Side 1 (R1)	Domain Interface	1.1015e+0	1.9259e+3	-6.5960e+2	-2.6262e+1
R1 to S1 Side 2 (S1)	Domain Interface	-1.7241e+0	-3.0042e+3	1.0195e+3	5.7956e+1
R2 to R2 Blade Tip Side 1 (R2)	Domain Interface	-4.3432e-3	-4.1255e+0	4.8494e+0	-4.9488e-2
R2 to R2 Blade Tip Side 2 (R2)	Domain Interface	4.3432e-3	4.1249e+0	-4.8502e+0	4.9010e-2
R2 to S2 Side 1 (R2)	Domain Interface	9.3302e-1	1.2270e+3	-5.5341e+2	-2.5063e+1
R2 to S2 Side 2 (S2)	Domain Interface	-1.5251e+0	-2.0045e+3	9.0203e+2	5.7276e+1
S2 to R1 Side 1 (S2)	Domain Interface	1.5251e+0	2.5561e+3	2.2905e+1	5.4849e+1
S2 to R1 Side 2 (R1)	Domain Interface	-1.1015e+0	-1.8450e+3	-1.6632e+1	-3.8788e+1

5. User Data

Chart 1.

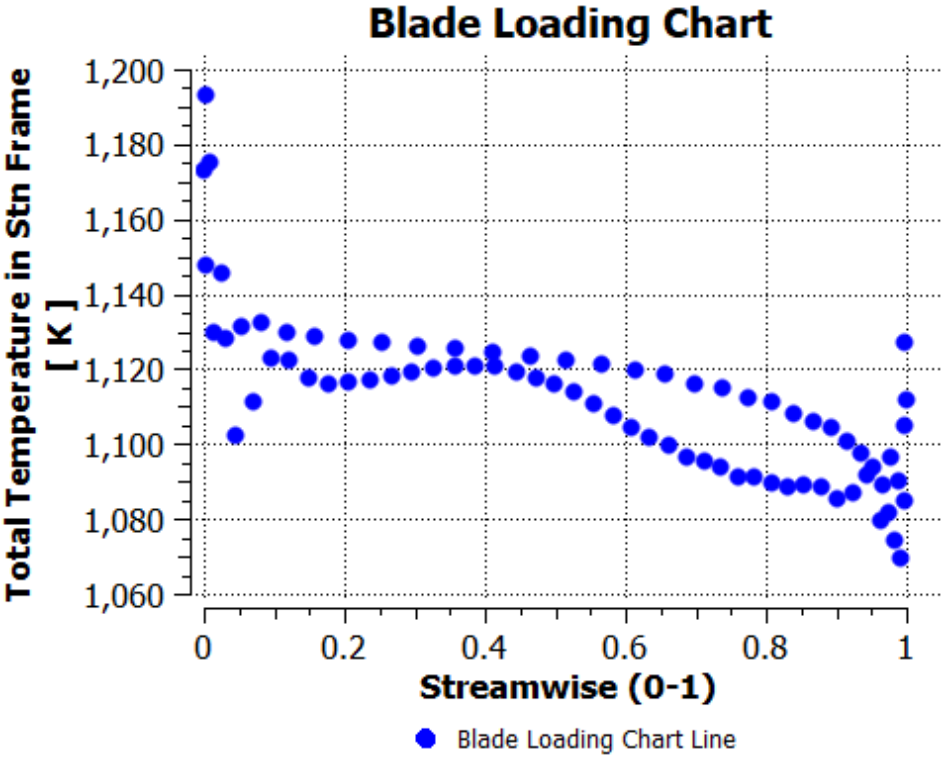
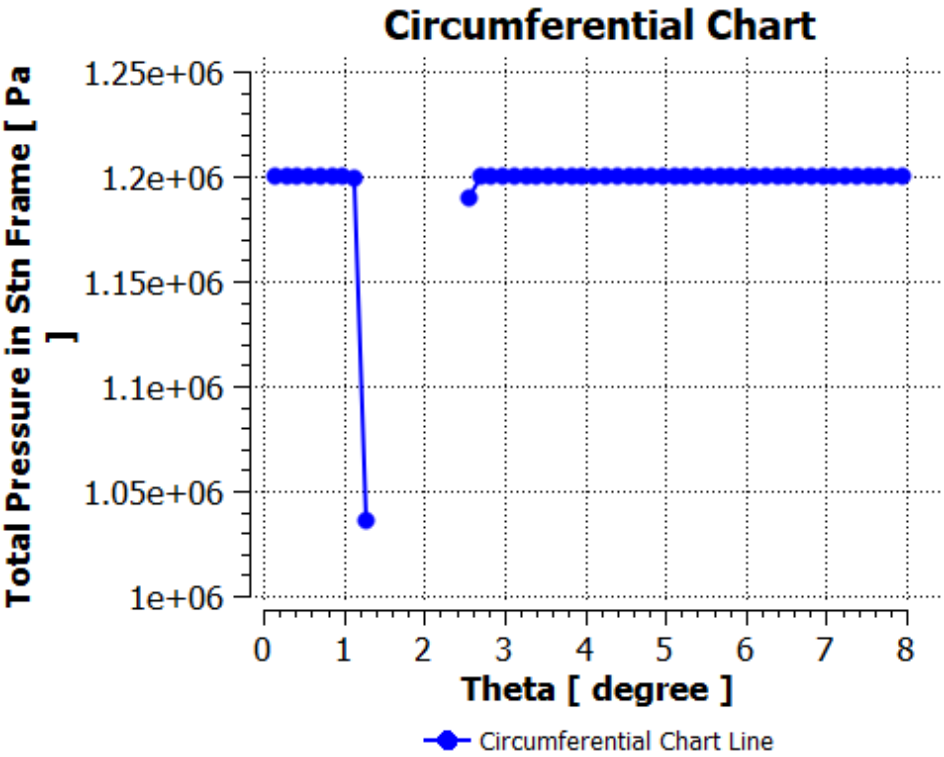


Chart 2.



6. Noise Analysis

This analysis has been supplied to assist in the evaluation of tonal noise levels generated by low speed fans (Mach Number less than 0.4). The equations were obtained from available literature, however some equations may have alternate definitions. It is **your responsibility** to verify the accuracy of these definitions.

6.1. Noise input data

This data is based on the input to the Fan Noise macro. To change the input values, select Turbo tab > Fan Noise macro, change parameters and select Calculate to re-generate the report.

Table 7. Noise input data

Domain	R1	
Blade Region	BLADE 2	
Number of Blade Rows	72	
Angular Velocity	1044.0600	[radian s^-1]
Number of Harmonics	6	
Observer Location (radius)	1.0000	[m]
Observer Location (theta)	0.0000	[degree]
Loading Coefficient	2.2000	
Reference Pressure	2.0000e-5	[Pa]
Reference Power	1.0000e-12	[W m^-3]
Rotational Mach Number	1.0377	

6.2. Sound Pressure Levels

Table 8. Sound Pressure Levels

Harmonic	Frequency [Hz]	Sound Pressure Level - Lp [dB]
1	11964.0000	123.0166
2	23928.0000	115.7919
3	35892.0039	111.5657
4	47856.0000	108.5672
5	59820.0000	106.2413
6	71784.0078	104.3410

6.3. Sound Power Levels

Table 9. Sound Power Levels

Harmonic	Frequency [Hz]	Sound Power Level - Lp [dB]
1	11964.0000	131.0795
2	23928.0000	123.8548
3	35892.0039	119.6286

4	47856.0000	116.6301
5	59820.0000	114.3043
6	71784.0078	112.4039

6.4. Directivity

6.5. Overall Noise

Table 10. Overall Noise

Sound Pressure Level [dB]	124.2601
Sound Power Level [dB]	132.3231

6.6. Broadband Noise

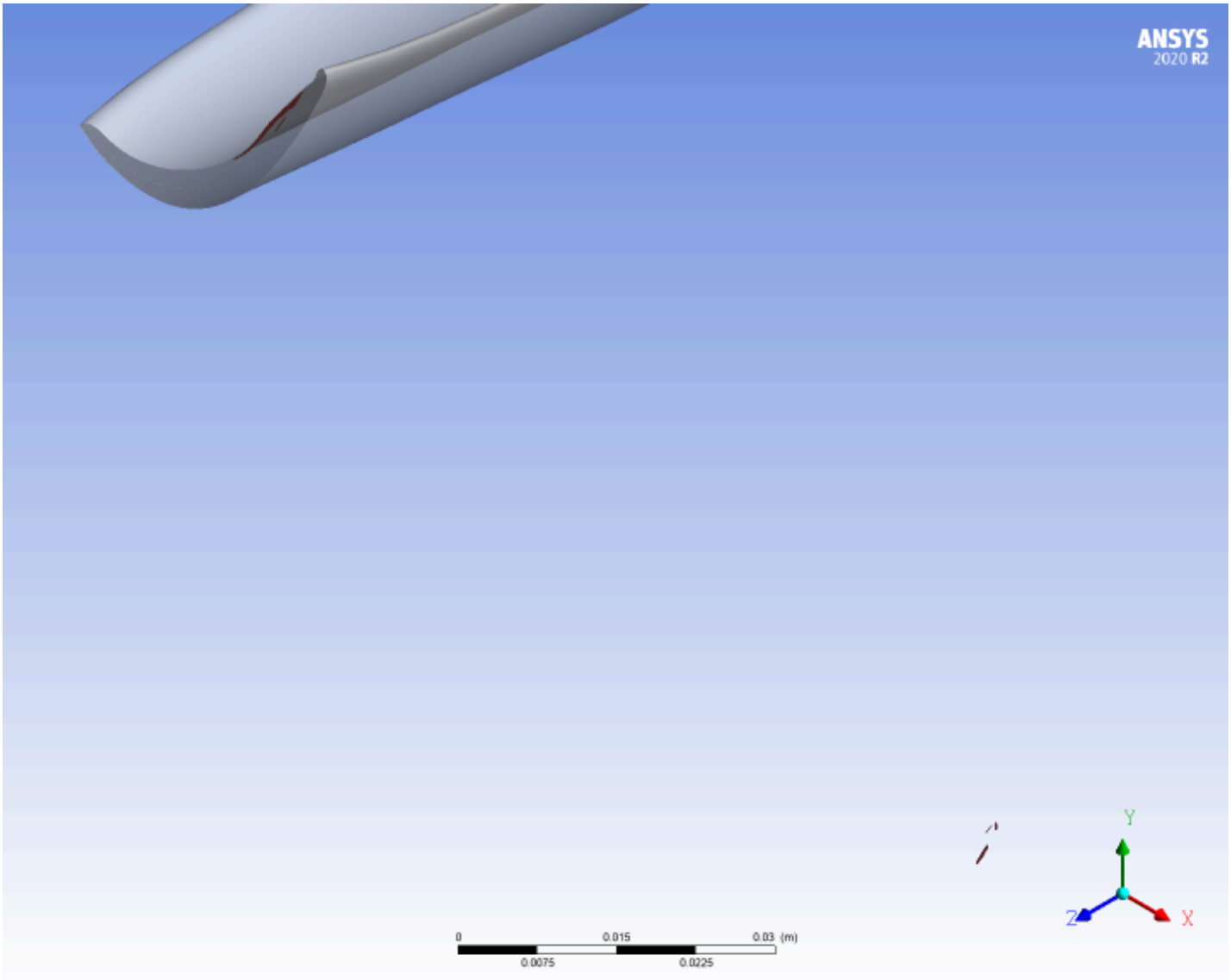
Broadband noise model is derived from Proudman's formula (see expression *Proudman Sound Power Exp*), which predicts overall sound power. Associated variable (*Proudman Sound Power*) is evaluated on the entire domain, allowing visualization of isosurfaces that can be used to locate the portion of the flow that is responsible for noise generation.

Note that this model predicts overall noise levels, not at a specific observer location.

Table 11. Proudman Sound Power

Minimum	4.7	[dB]
Maximum	212.2	[dB]
Average	147.7	[dB]
Total Power	4.5478e-1	[W]

Figure 1. Isosurface at 95% of Proudman Sound Power



6.7. Noise Sources

This section reports on Monopole, Dipole and Quadrupole noise sources, derived from Ffowcs Williams and Hawkings (FW-H) equations. These sources can be compared with each other and with the broadband noise to determine the dominant noise source in the design.

Monopole source is related to the movement of the source surface. It defines the volume displacement of the source. It is usually called self noise.

Dipole source describes the interaction between the fluid and the surface of the source. It defines the loading fluctuations exerted on the surface.

Quadrupole source is related to the turbulence fluctuation levels of the fluid. It is also called self noise.

Table 12. Summary of noise sources at the blade and at the final timestep

	Monopole Source Strength	Dipole Source Strength	
Minimum	0.0	148278.0	[Pa]
Maximum	918.8	857083.0	[Pa]
Average	328.8	551169.0	[Pa]

Figure 2. Monopole Source

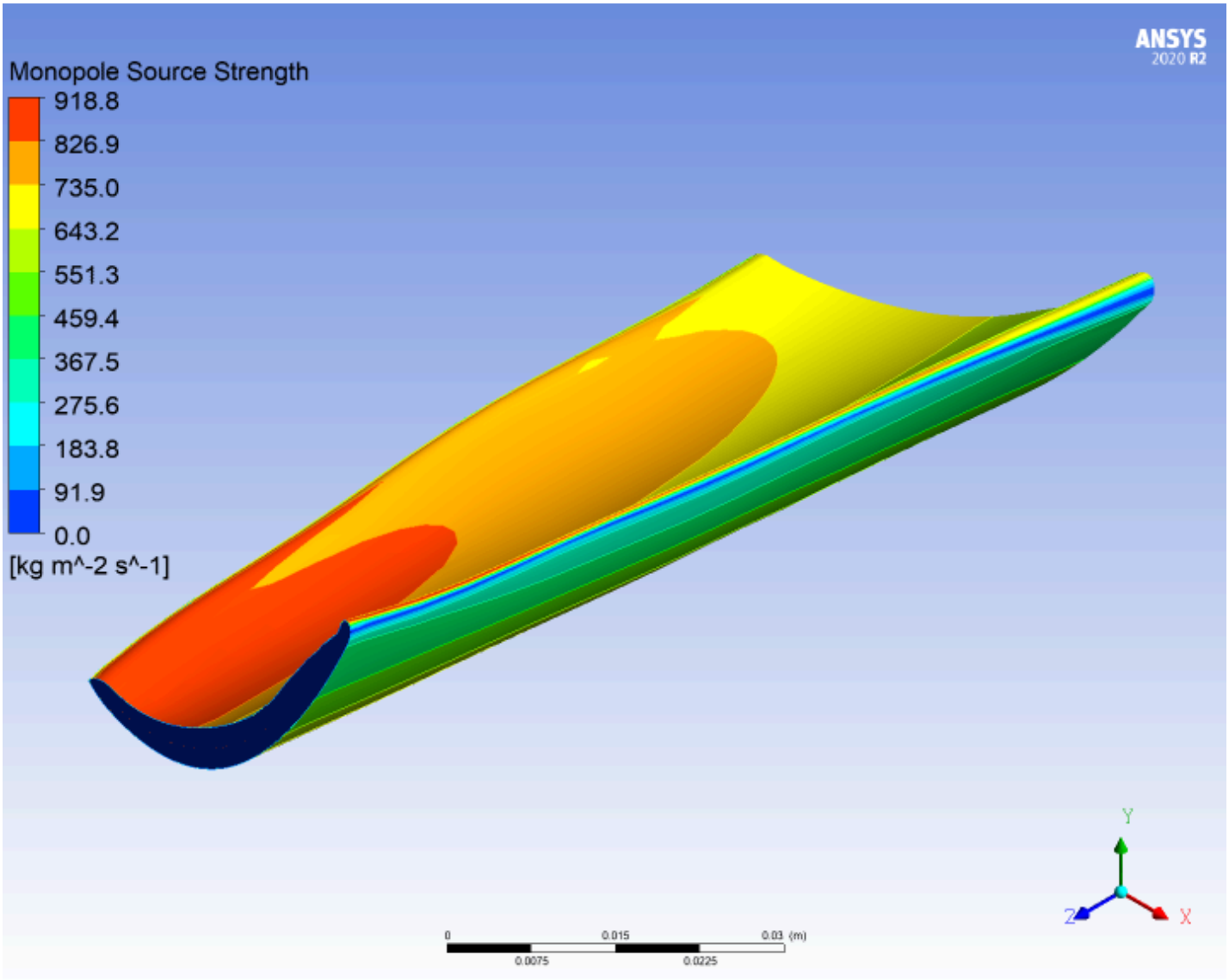


Figure 3. Dipole Source

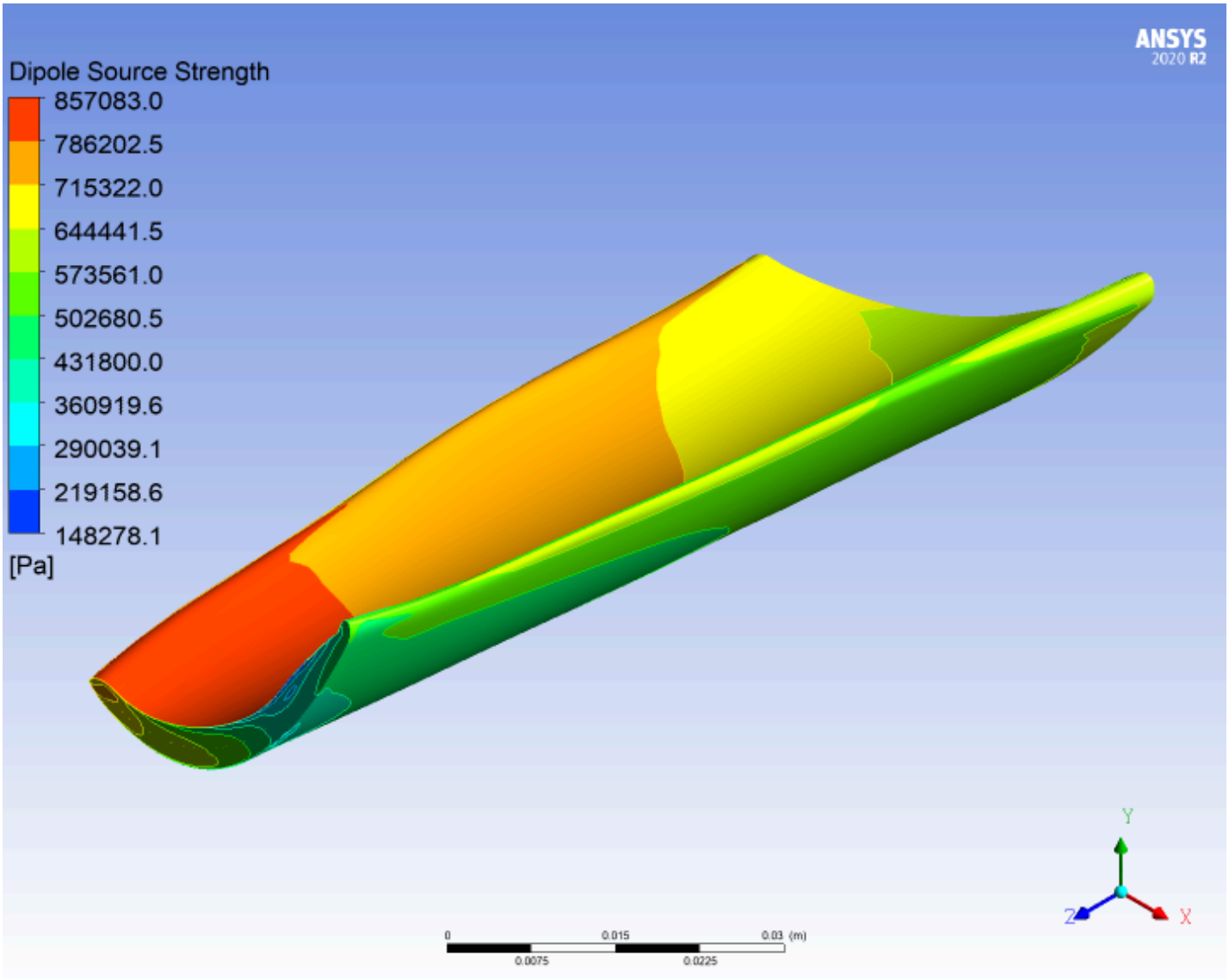


Table 13. Summary of quadrupole sources at the final timestep

	Quadrupole Source Strength	
Minimum	0.0	[Pa]
Maximum	652876.0	[Pa]
Average	108130.0	[Pa]

Figure 4. Isosurface at 80% of Quadrupole Source Strength

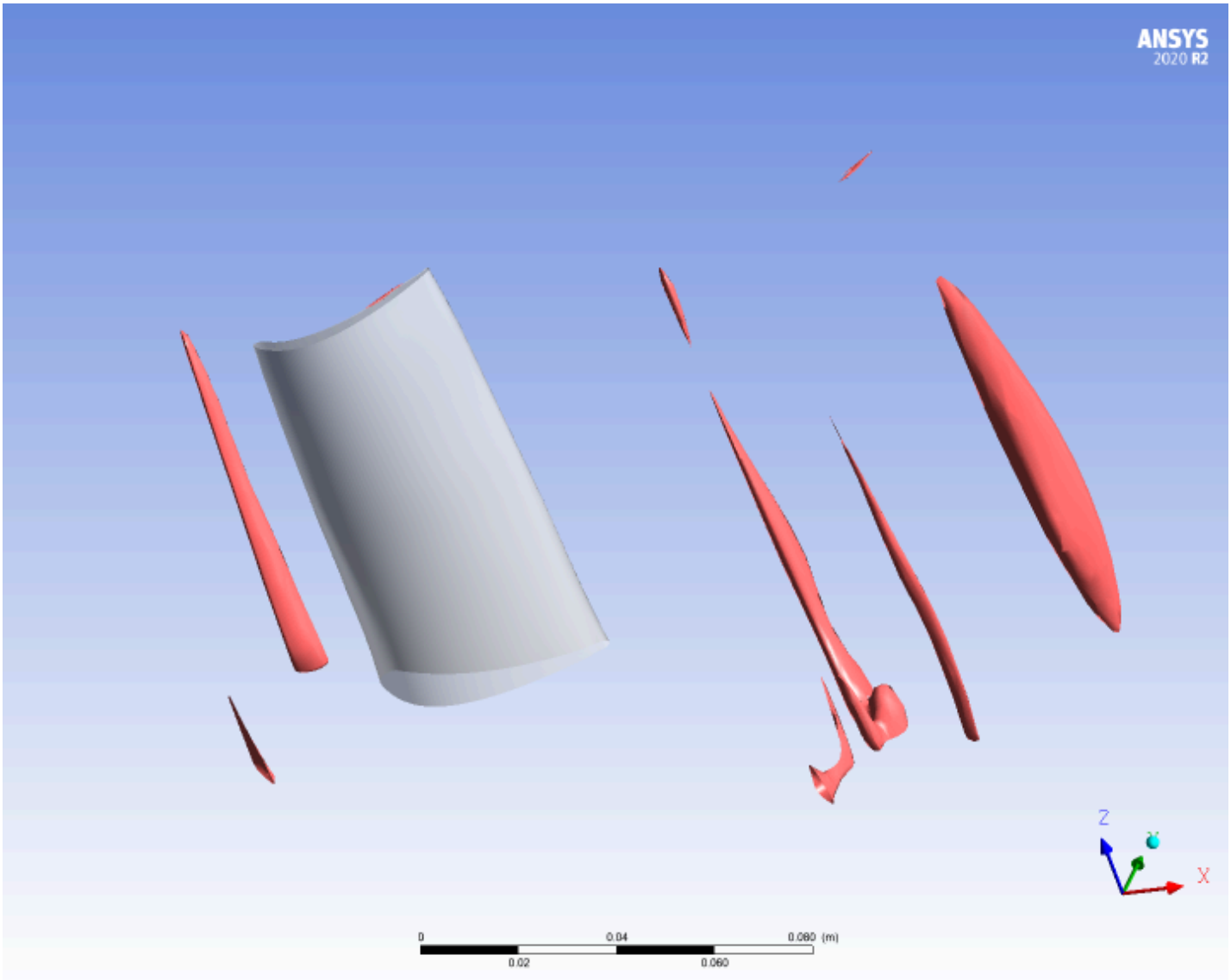


Chart 3. Sound Pressure Levels

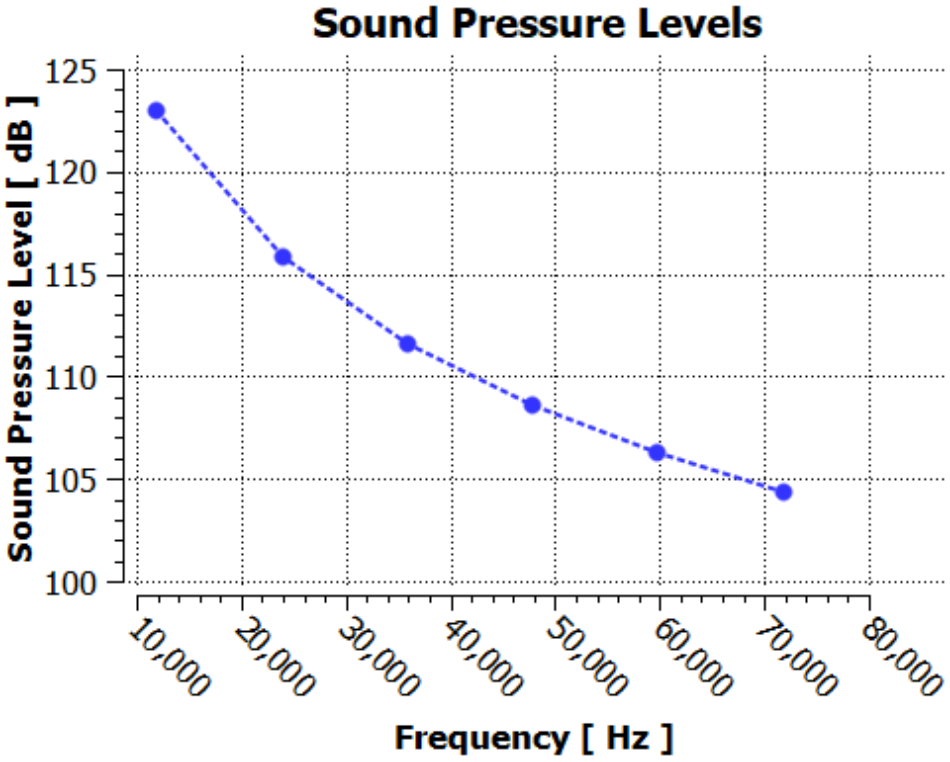


Chart 4. Sound Power Levels

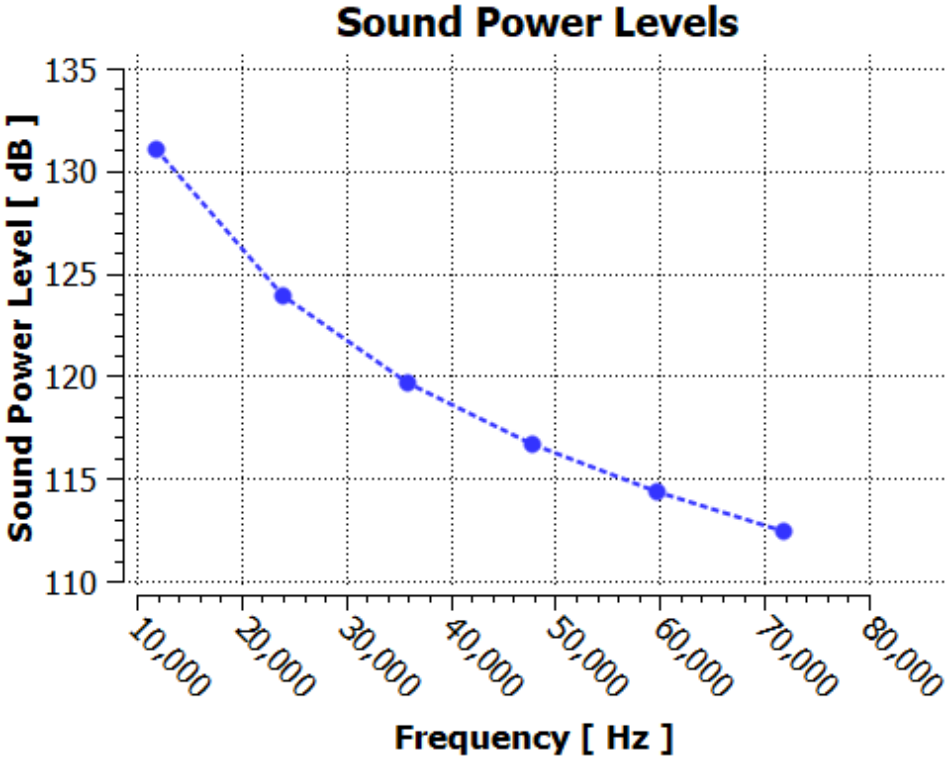


Chart 5. Directivity

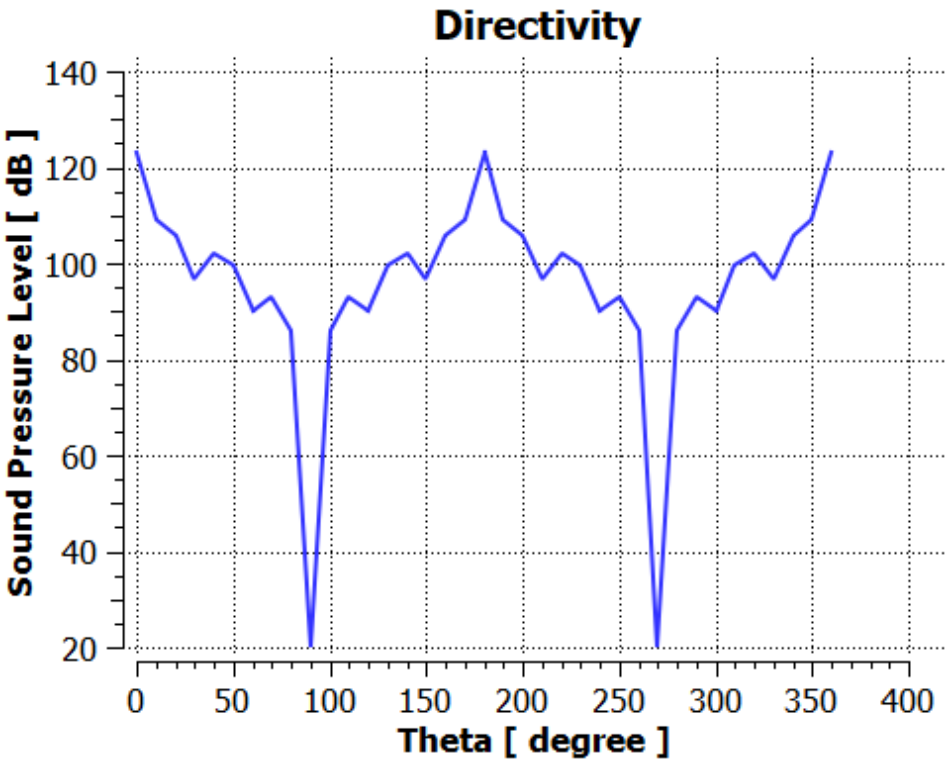


Figure 5.

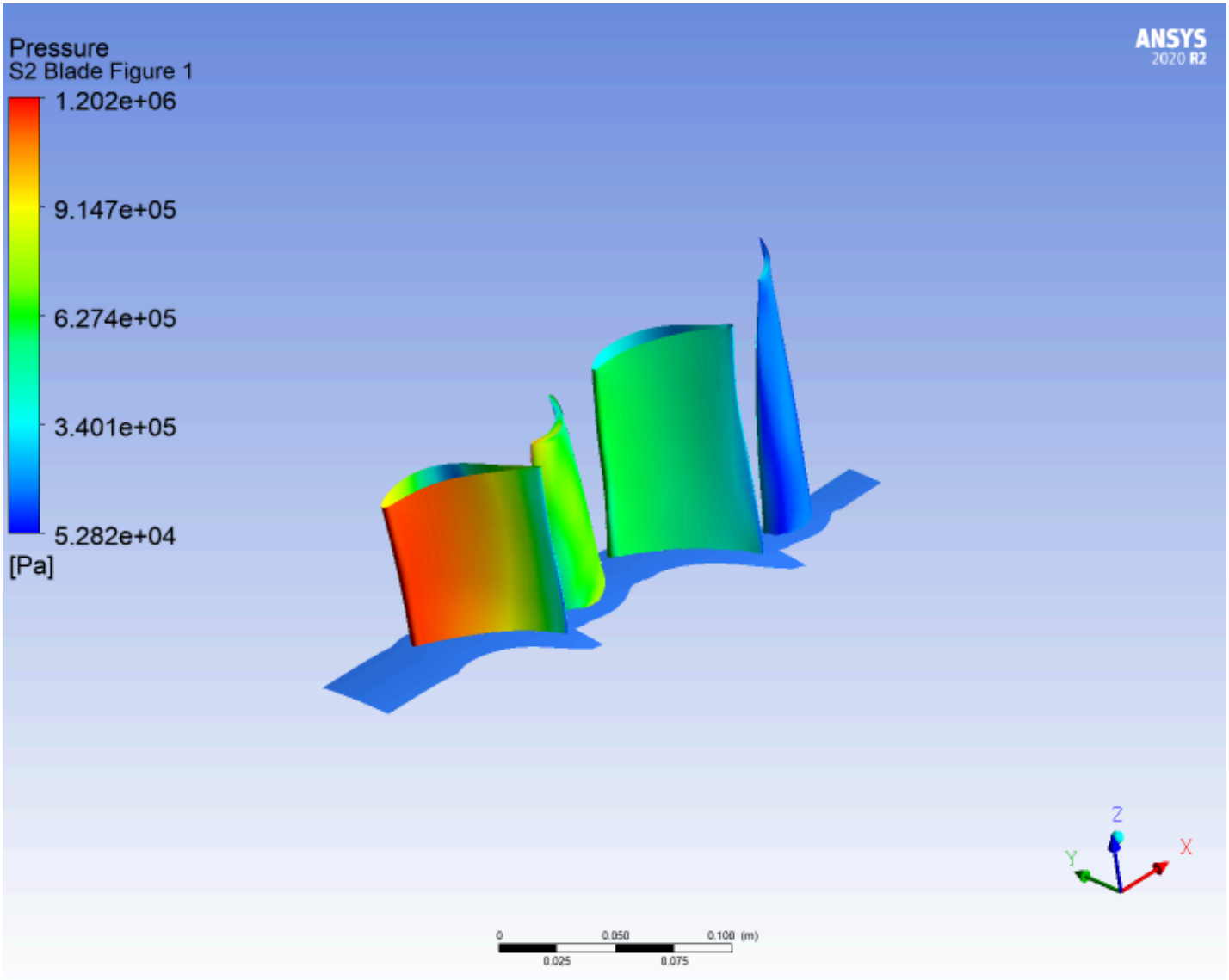


Chart 6.

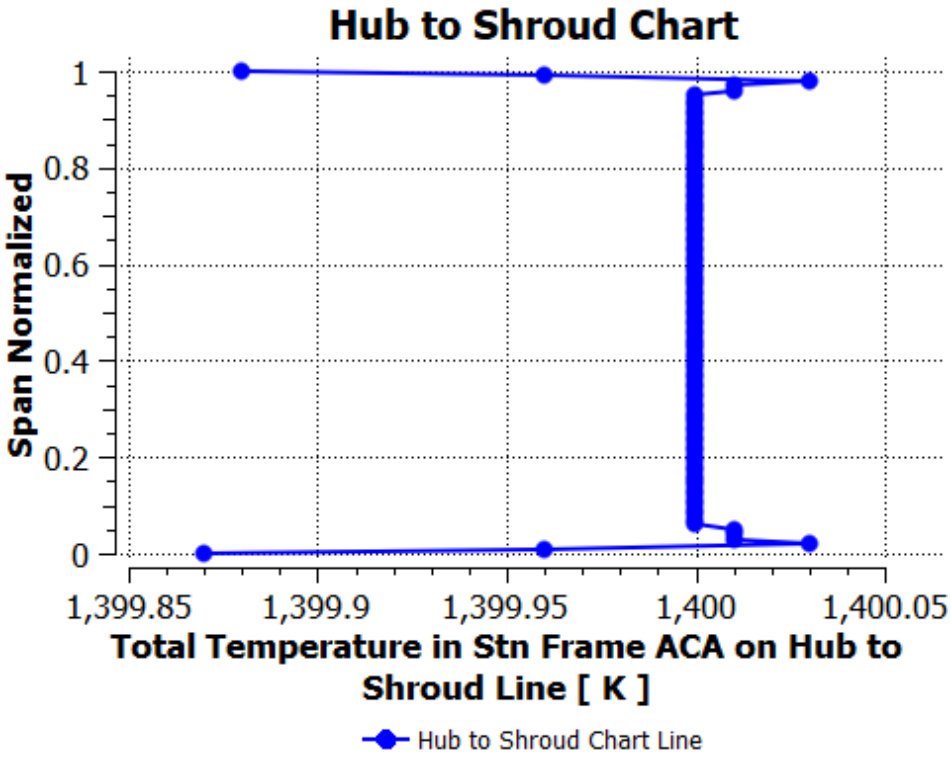
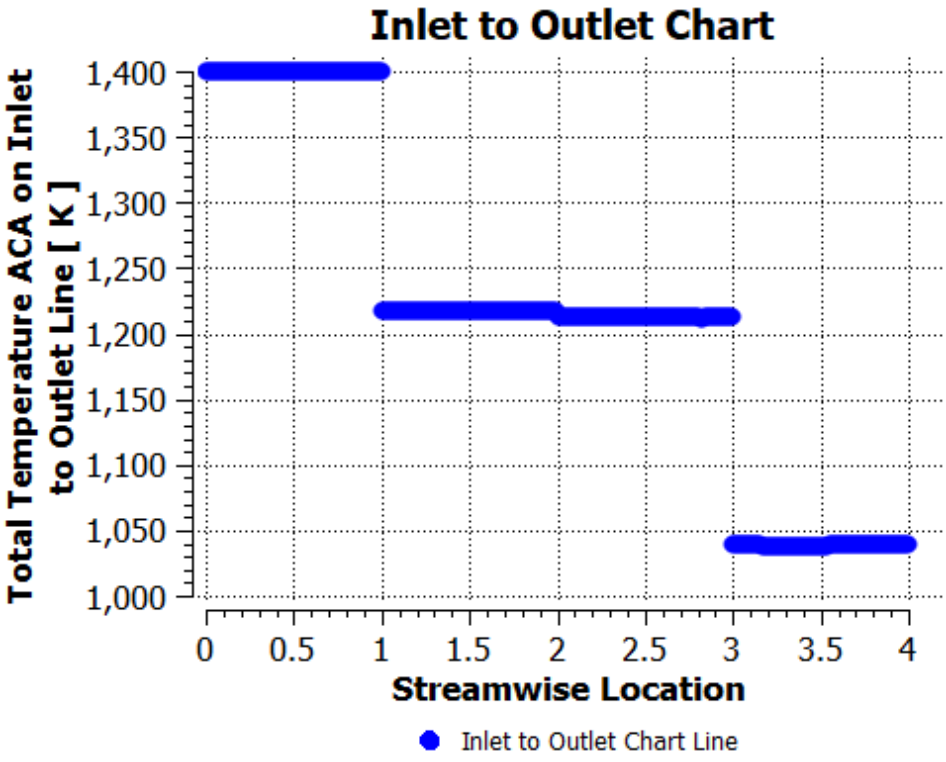


Chart 7.


Inlet to Outlet Chart
Total Temperature ACA on Inlet to Outlet Line [K]
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
0
0.5
1
1.5
2
2.5
3
3.5
4
Streamwise Location
Inlet to Outlet Chart Line