Title

Fan Report

Date

2025/07/27 14:27:46

Contents

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1. File Report

Table 1. File Information for Axial_Fan_Rotor_001

Case	Axial_Fan_Rotor_001
File Path	D:/An_Cr_Files/Chapter5_Download/CASE_1/Axial_Fan_Rotor_001.res
File Date	27 July 2025
File Time	02:00:13 PM
File Type	CFX5
File Version	20.2

2. Mesh Report

Table 2. Mesh Information for Axial_Fan_Rotor_001

Domain	Nodes	Elements
R1	215937	201820

Table 3. Mesh Statistics for Axial_Fan_Rotor_001

Domain	Maximum Edge Length Ratio
R1	1626.26

3. Physics Report

Table 4. Domain Physics for Axial_Fan_Rotor_001

Domain - R1	
Type	Fluid
Location	Passage
Materials	
Air Ideal Gas	
Fluid Definition	Material Library
Morphology	Continuous Fluid
Settings	
Buoyancy Model	Non Buoyant
Domain Motion	Rotating
Alternate Rotation Model	true
Angular Velocity	8.5000e+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 Interface - R1 to R1 Internal	
Boundary List1	R1 to R1 Internal Side 1
Boundary List2	R1 to R1 Internal 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

Table 5. Boundary Physics for Axial_Fan_Rotor_001

Domain	**Boundaries**	
R1	**Boundary - R1 Inlet**	
	Type	INLET

Location	INFLOW
Settings	
Flow Direction	Normal to Boundary Condition
Flow Regime	Subsonic
Heat Transfer	Stationary Frame Total Temperature
Stationary Frame Total Temperature	2.8815e+2 [K]
Mass And Momentum	Stationary Frame Total Pressure
Relative Pressure	1.0133e+2 [kPa]
Turbulence	Medium Intensity and Eddy Viscosity Ratio
Boundary - R1 to R1 Internal 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 - R1 to R1 Internal 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 - R1 to R1 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 - R1 to R1 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 - R1 Outlet	
Type	OUTLET
Location	OUTFLOW
Settings	
Flow Regime	Subsonic
Mass And Momentum	Average Static Pressure
Pressure Profile Blend	5.0000e-2
Relative Pressure	1.1000e+2 [kPa]

	Pressure Averaging	Average Over Whole Outlet
	Boundary - R1 Blade	
	Type	WALL
	Location	BLADE
	Settings	
	Heat Transfer	Adiabatic
	Mass And Momentum	No Slip Wall
	Wall Roughness	Smooth Wall
	Boundary - R1 Hub	
	Type	WALL
	Location	HUB
	Settings	
	Heat Transfer	Adiabatic
	Mass And Momentum	No Slip Wall
	Wall Roughness	Smooth Wall
	Boundary - R1 Shroud	
	Type	WALL
	Location	SHROUD
	Settings	
	Heat Transfer	Adiabatic
	Mass And Momentum	No Slip Wall
	Wall Velocity	Counter Rotating Wall
	Wall Roughness	Smooth Wall

Chart 1.

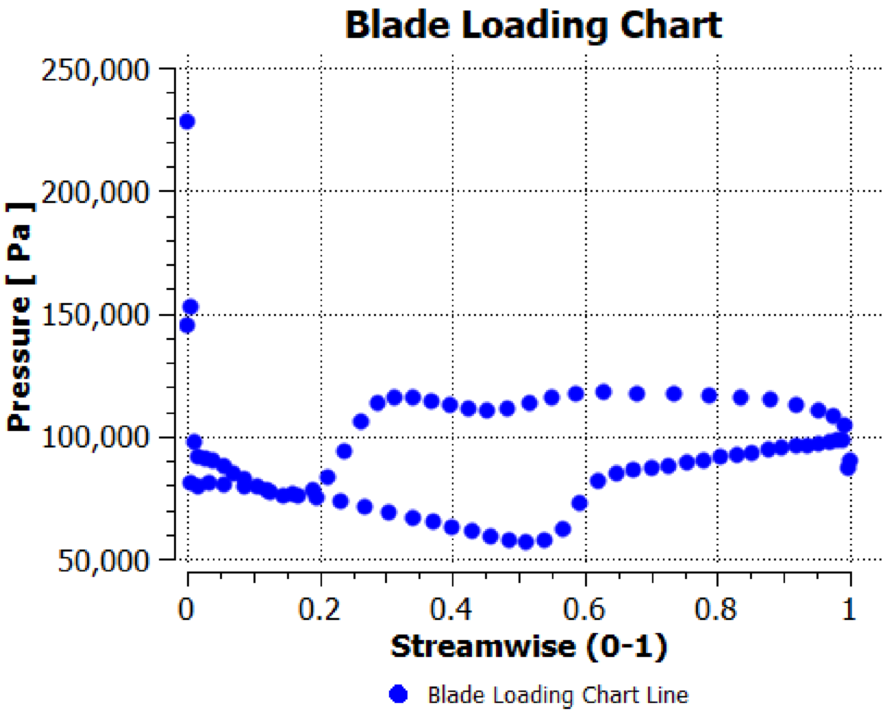


Chart 2.

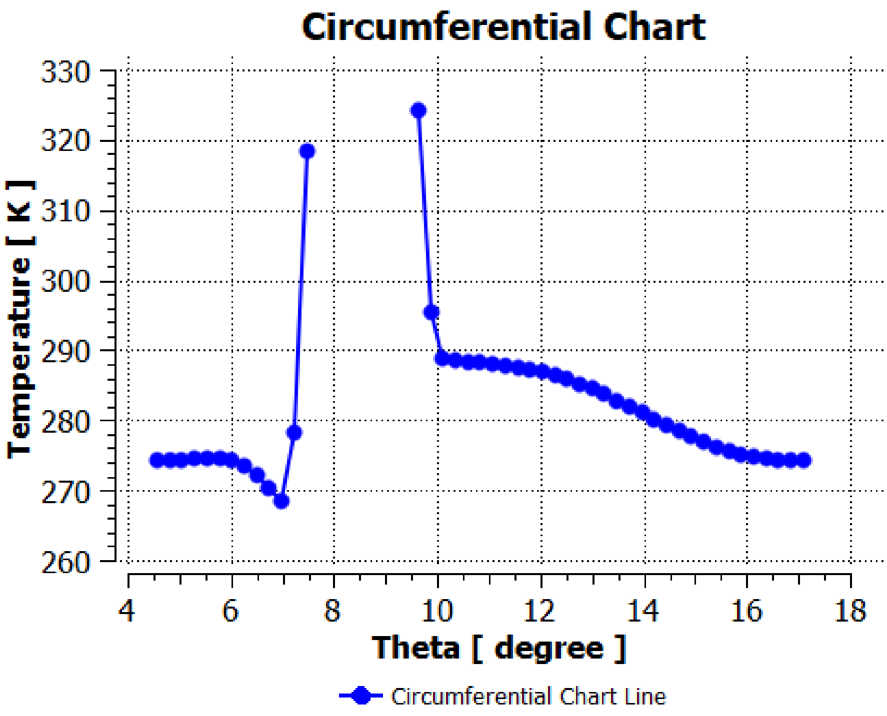


Chart 3.

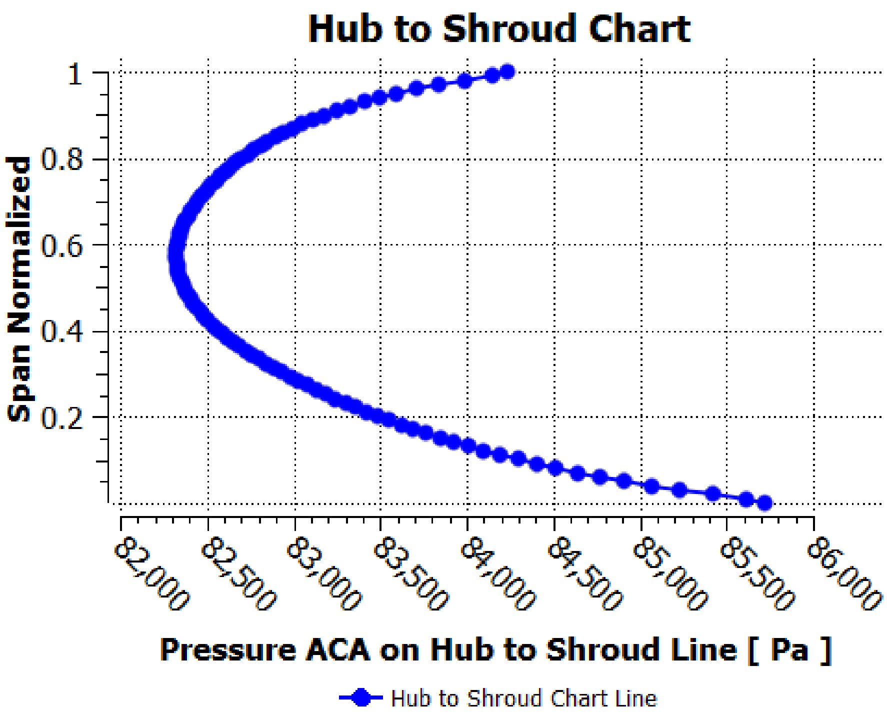
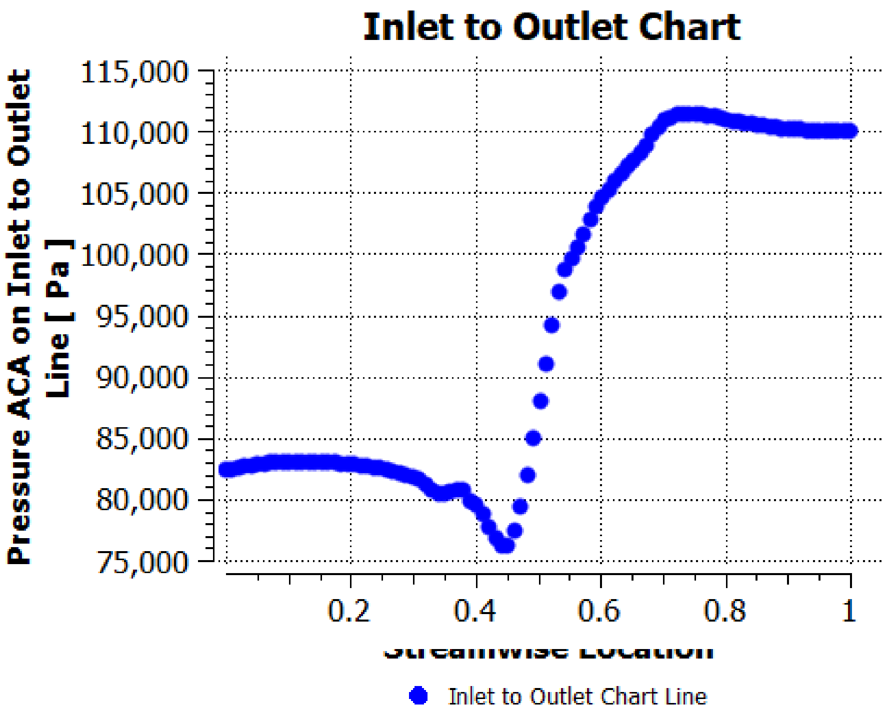


Chart 4.


Inlet to Outlet Chart
Pressure ACA on Inlet to Outlet Line [Pa]
115,000
110,000
105,000
100,000
95,000
90,000
85,000
80,000
75,000
0.2
0.4
0.6
0.8
1
Inlet to Outlet Chart Line

4. Tabulated Results

The first table below gives a summary of the performance results for the fan. The second table lists the mass or area averaged solution variables and derived quantities computed at the inlet, leading edge (LE Cut), trailing edge (TE Cut) and outlet locations. The flow angles Alpha and Beta are relative to the meridional plane; a positive angle implies that the tangential velocity is the same direction as the machine rotation.

Table 6. Performance Results

Rotation Speed	890.1180	[radian s^-1]
Reference Diameter	0.6563	[m]
Volume Flow Rate	80.3665	[m^3 s^-1]
Pressure Rise (IN-OUT)	46844.2000	[Pa]
Flow Coefficient	0.3193	
Head Coefficient (IN-OUT)	0.0588	
Shaft Power	3301970.0000	[W]
Power Coefficient	0.0364	
Total Efficiency (IN-OUT) %	114.0140	
Static Efficiency (IN-OUT) %	21.2091	

Table 7. Summary Data

Quantity	Inlet	LE Cut	TE Cut	Outlet	TE/LE	TE-LE	Units
Density	1.0559	1.0060	1.2500	1.2751	1.2426	0.2441	[kg m^-3]
Pstatic	82328.0000	77753.1000	108004.0000	110000.0000	1.3891	30251.0000	[Pa]
Ptotal	101286.0000	100967.0000	150643.0000	148130.0000	1.4920	49675.3000	[Pa]
Ptotal (rot)	101271.0000	99684.4000	97311.9000	95648.3000	0.9762	-2372.5500	[Pa]
Tstatic	271.5610	267.3710	297.9460	300.1930	1.1143	30.5749	[K]
Ttotal	288.1570	288.8350	326.8590	326.7910	1.1317	38.0246	[K]
Ttotal (rot)	288.1450	288.1450	288.1790	288.2850	1.0001	0.0332	[K]
Hstatic	-26706.4000	-30914.2000	-204.7960	2051.9600	0.0066	30709.4000	[J kg^-1]
Htotal	9784.3600	-9356.0600	28835.8000	11832.4000	-3.0821	38191.9000	[m]
Rothalpy	-10048.9000	-10048.5000	-10015.2000	-9908.0100	0.9967	33.3145	[J kg^-1]
Entropy	-34.1280	-29.4514	-21.6041	-16.8437	0.7336	7.8473	[J kg^-1 K^-1]
Mach (abs)	0.5525	0.6313	0.6940	0.6646	1.0993	0.0627	
Mach (rel)	1.0457	1.0875	0.7440	0.7196	0.6842	-0.3434	
U	291.3680	290.9960	292.1040	291.6180	1.0038	1.1085	[m s^-1]
Cm	182.4450	201.8880	180.7750	183.4160	0.8954	-21.1131	[m s^-1]
Cu	0.0244	3.6237	151.7980	135.4490	41.8910	148.1750	[m s^-1]
C	182.4450	205.5000	244.2950	229.7080	1.1888	38.7945	[m s^-1]

Distortion Parameter	1.0020	1.0341	1.0378	1.0104	1.0036	0.0038	
Flow Angle: Alpha	0.0073	2.0713	40.5396	36.6914	19.5723	38.4683	[degree]
Wu	-291.3440	-287.3730	-140.3080	-156.1690	0.4882	147.0660	[m s^-1]
W	344.9930	353.1890	237.6840	245.2650	0.6730	-115.5050	[m s^-1]
Flow Angle: Beta	-57.2856	-53.7602	-28.8795	-38.2855	0.5372	24.8807	[degree]

5. Blade Loading Charts

Chart 5. Blade Loading at 20% Span

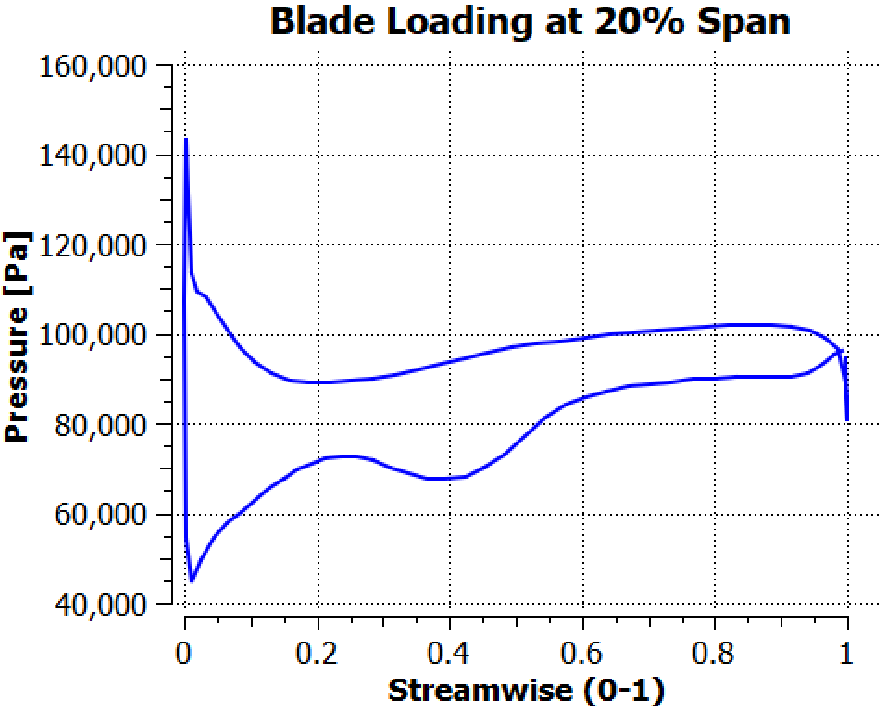


Chart 6. Blade Loading at 50% Span

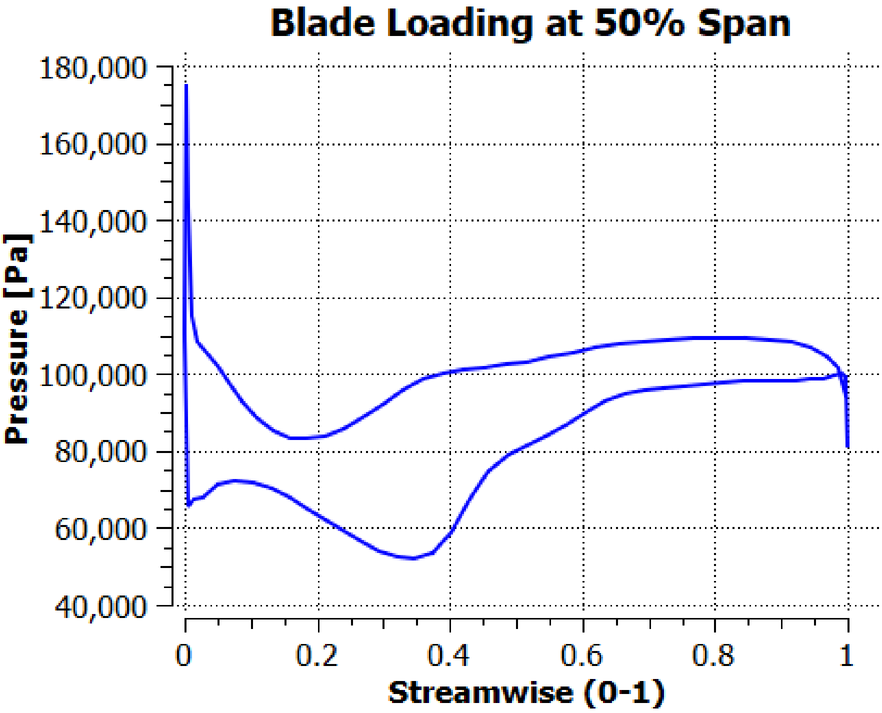
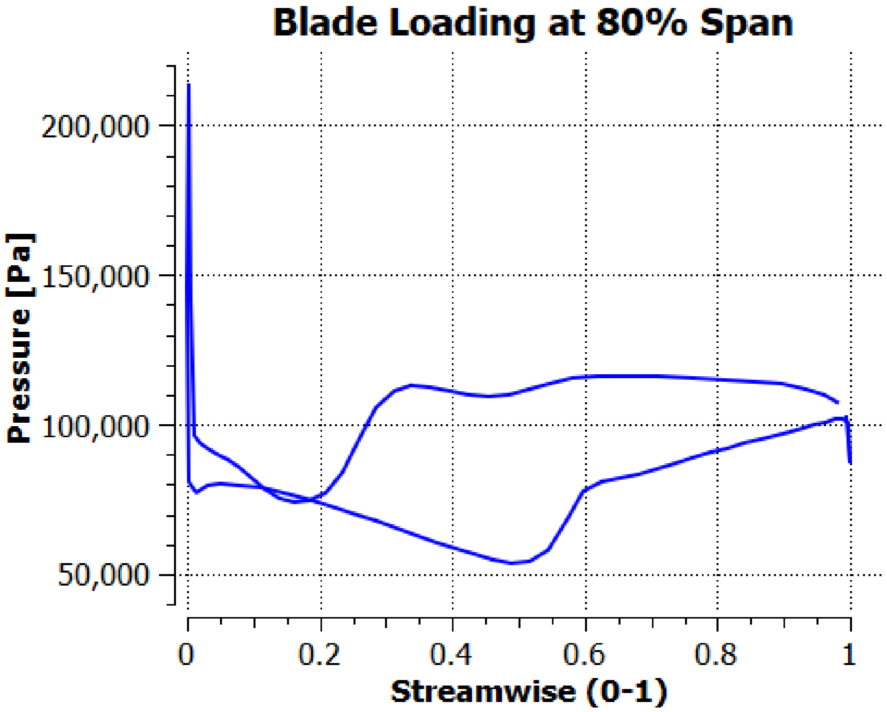


Chart 7. Blade Loading at 80% Span



6. Streamwise Charts

Chart 8. Streamwise Plot of Pt and Ps

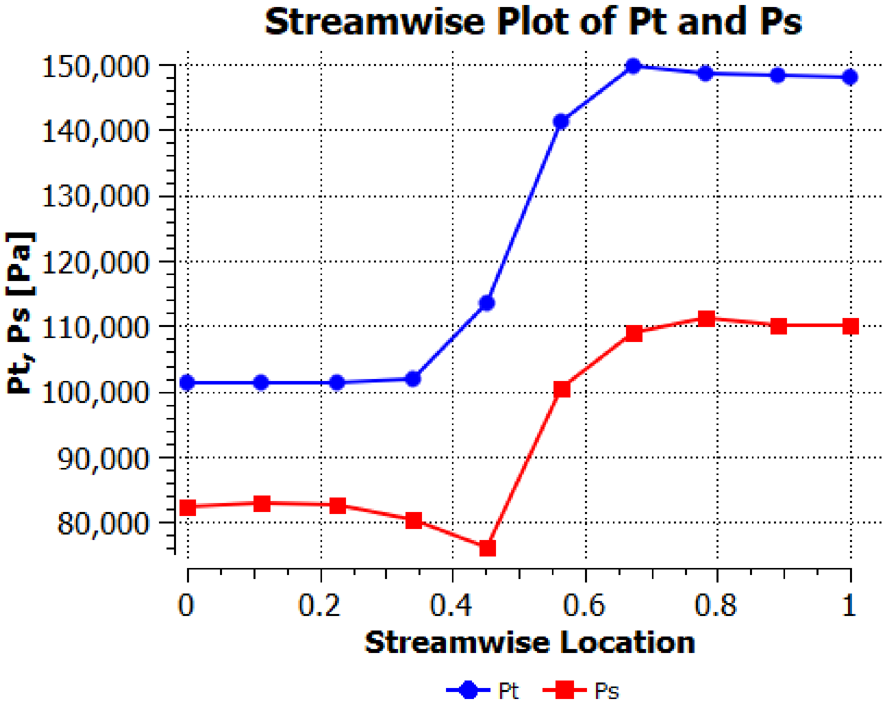


Chart 9. Streamwise Plot of C

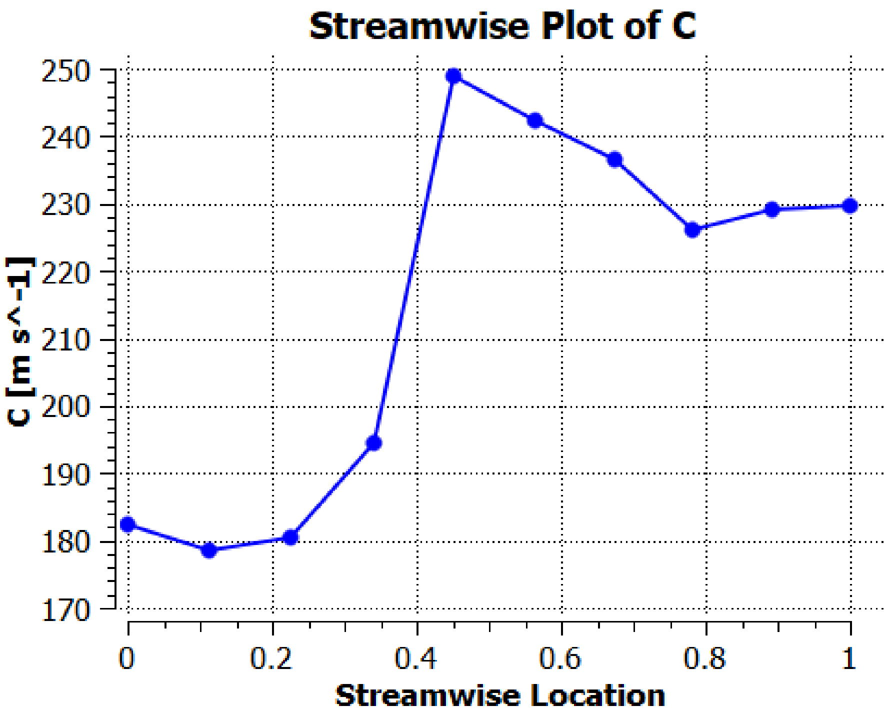


Chart 10. Streamwise Plot of W

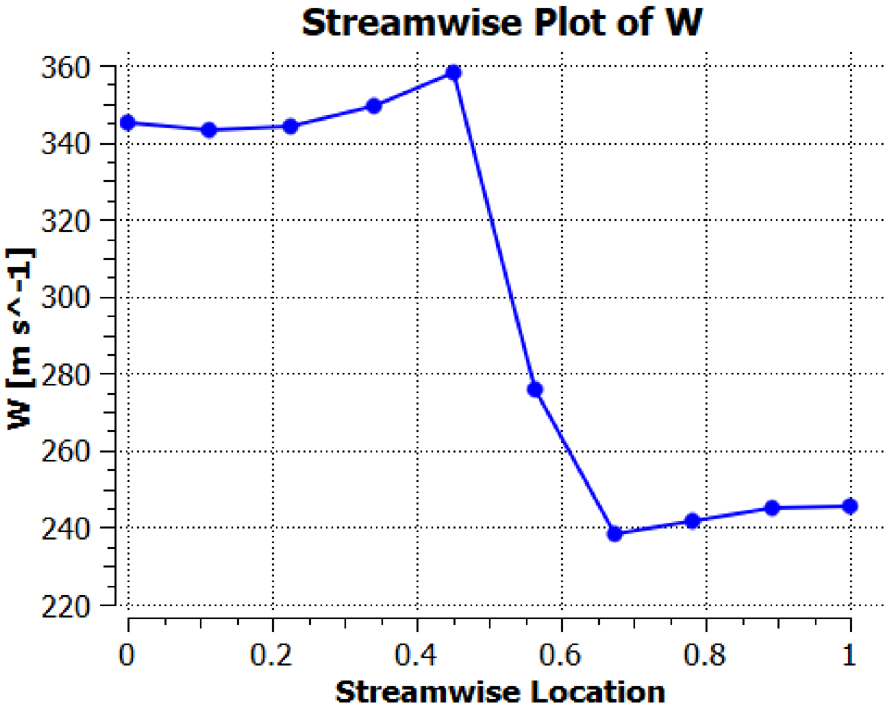
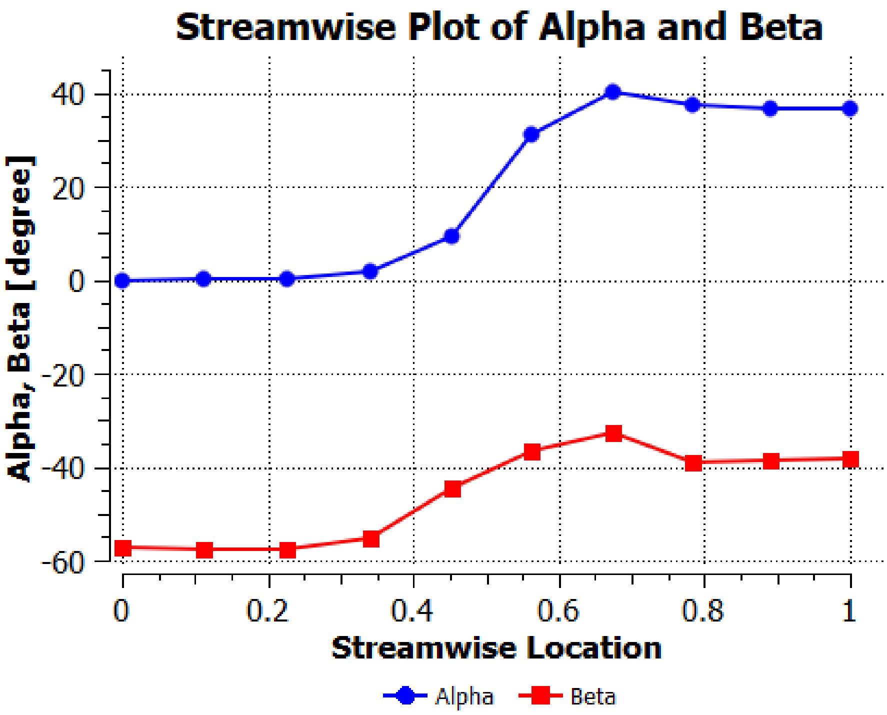


Chart 11. Streamwise Plot of Alpha and Beta



7. Spanwise Charts

Chart 12. Spanwise Plot of Alpha and Beta at LE

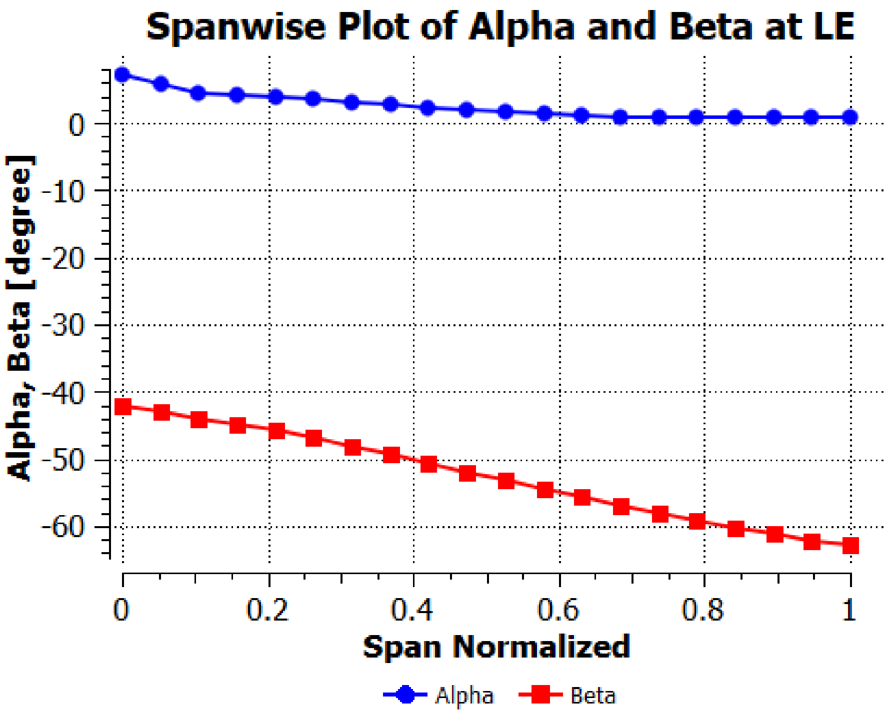
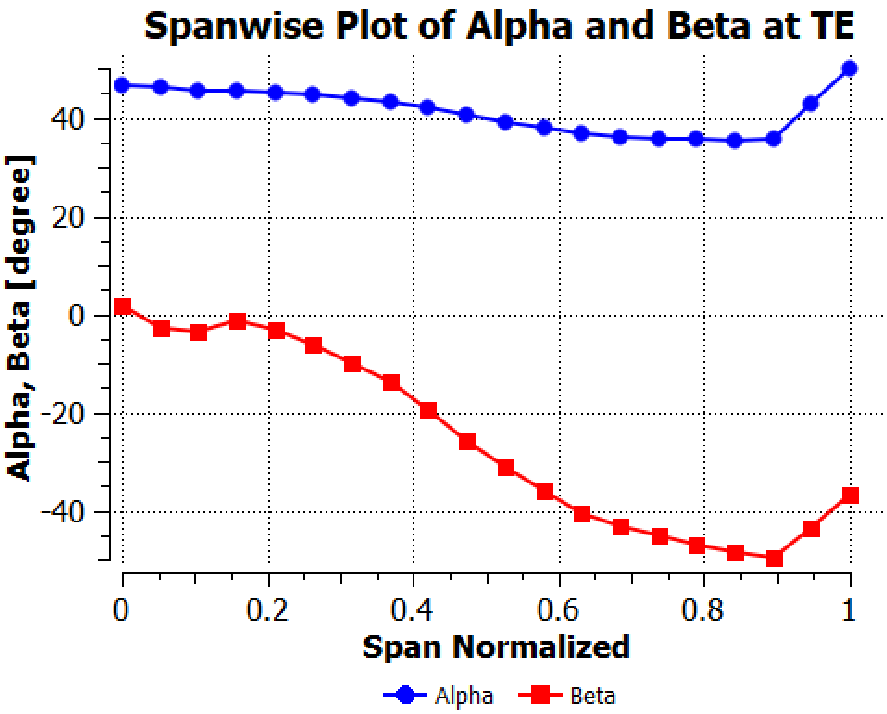


Chart 13. Spanwise Plot of Alpha and Beta at TE



8. Blade Geometry Plots

Figure 1. Isometric 3D View of the Blade, Hub and Shroud

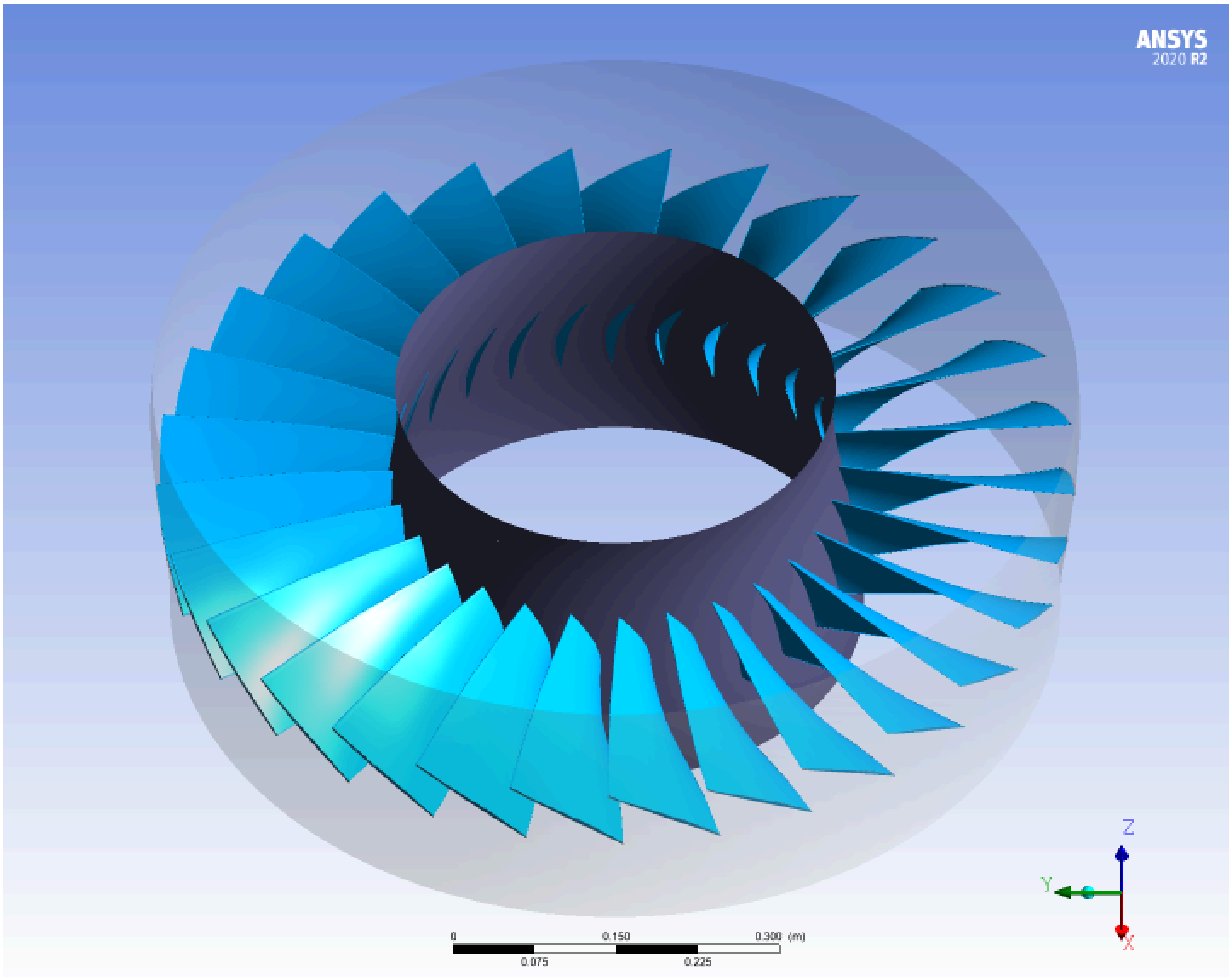
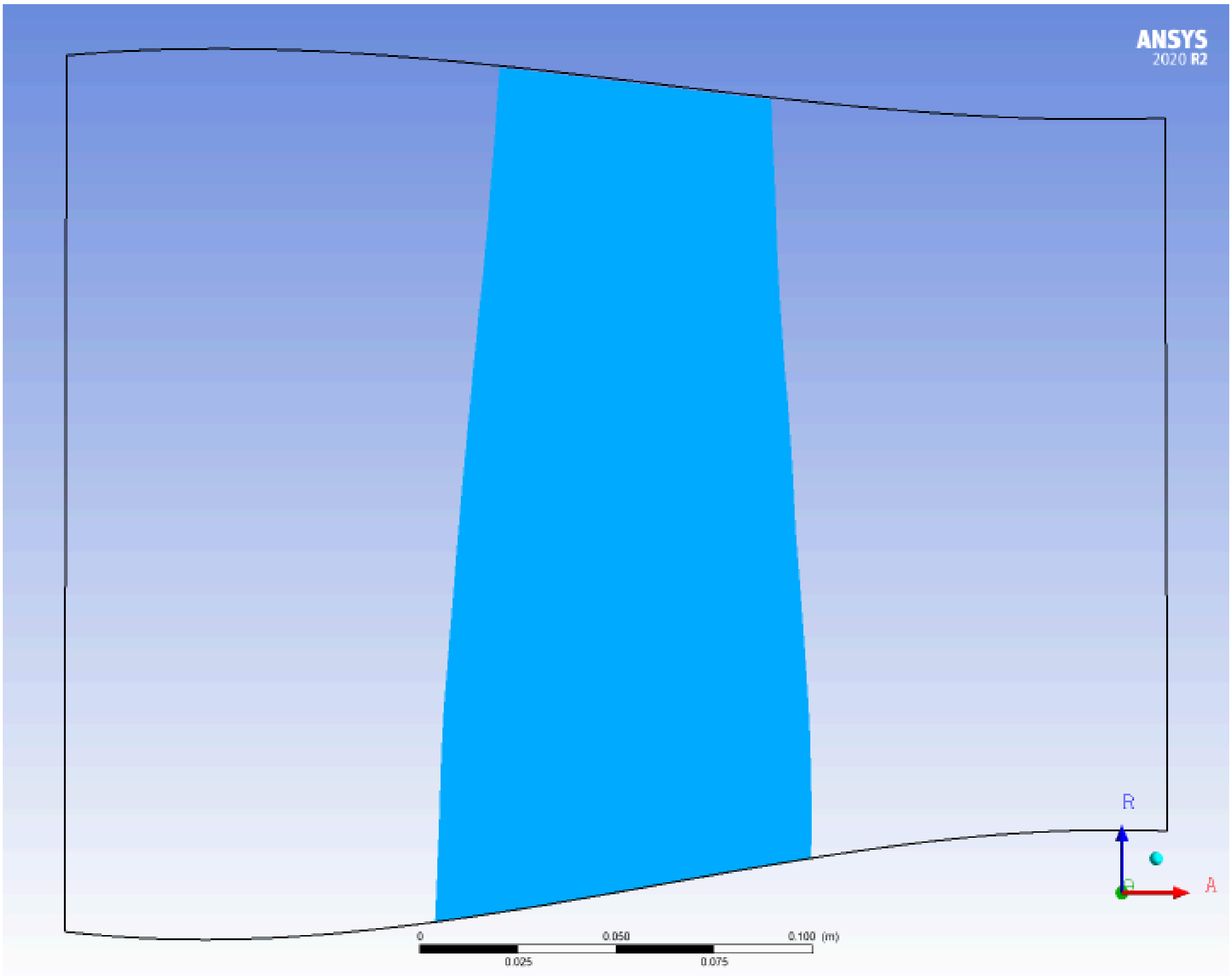
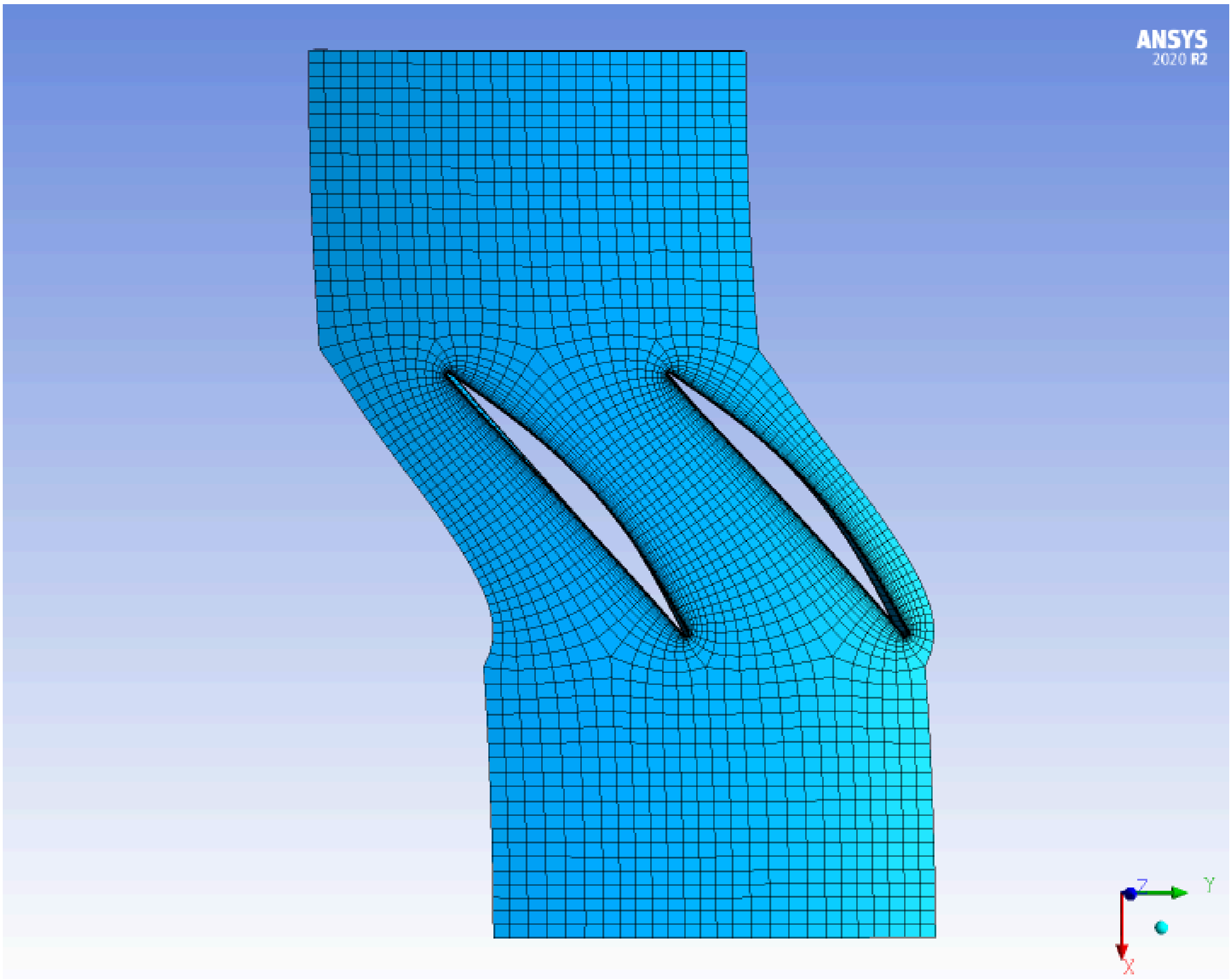


Figure 2. Meridional View of the Blade, Hub and Shroud



9. Blade Mesh Plot

Figure 3. Mesh Elements at 50% Span



10. Blade to Blade Plots

Figure 4. Contour of Pt at 50% Span

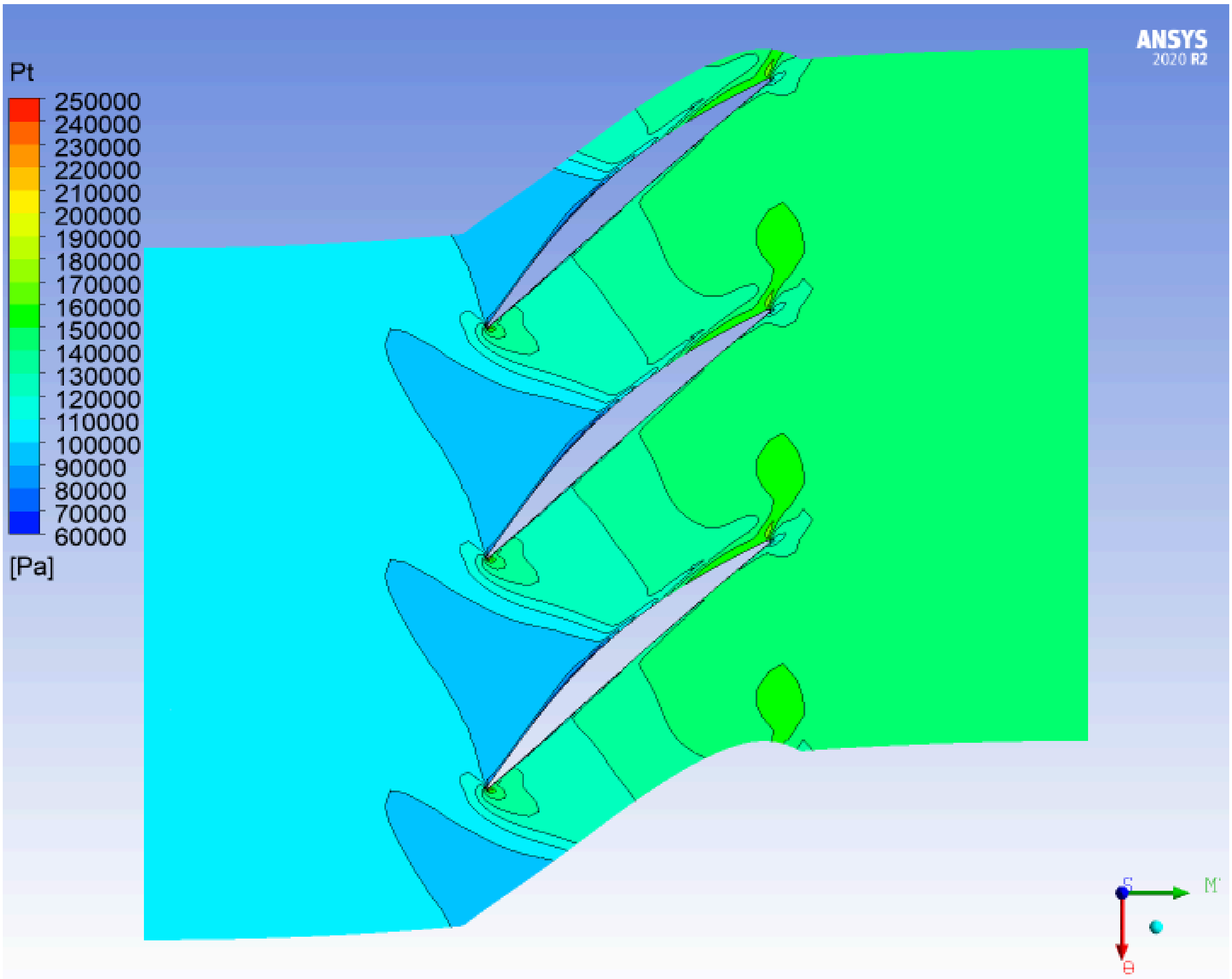


Figure 5. Contour of Ptr at 50% Span

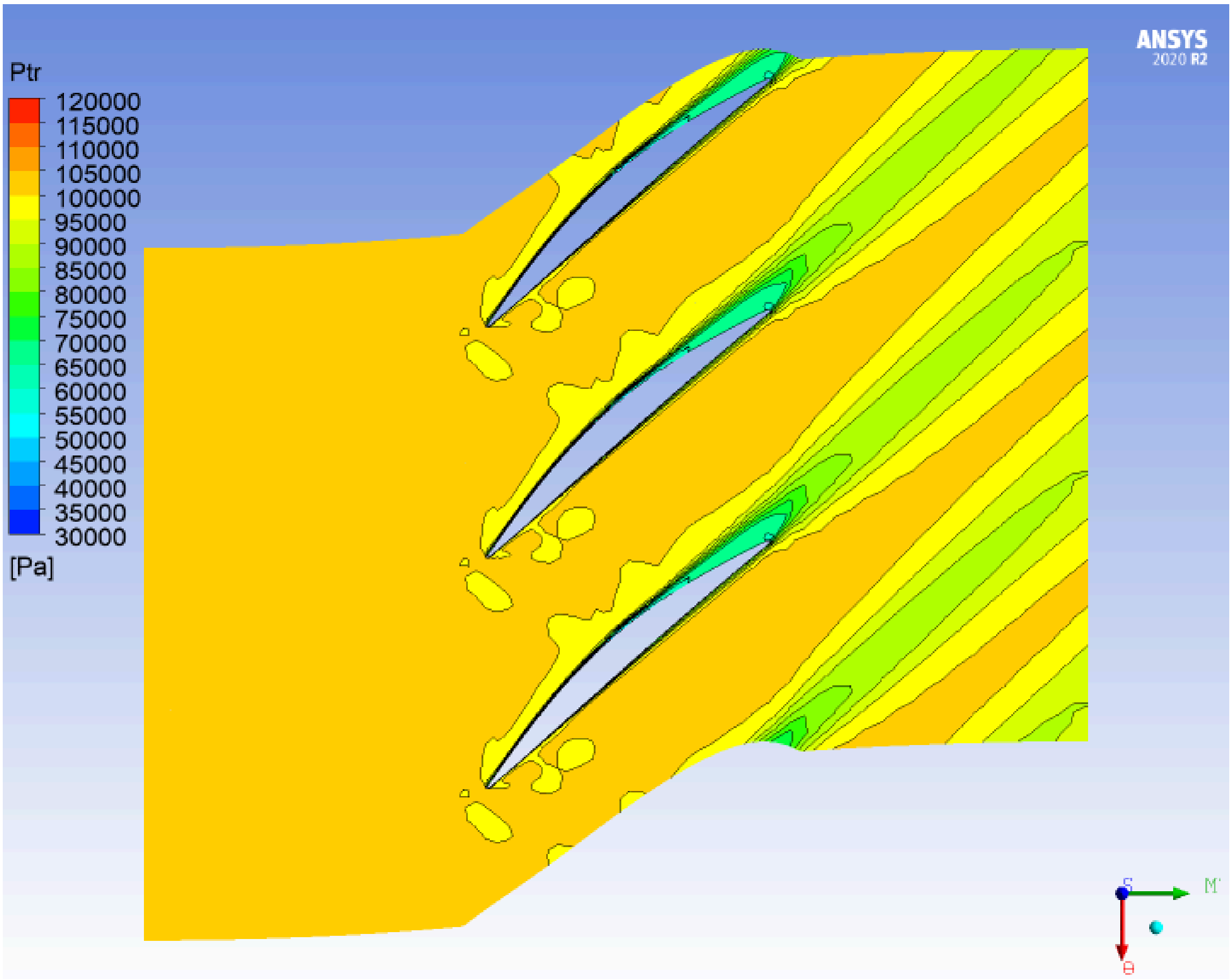


Figure 6. Contour of Ps at 50% Span

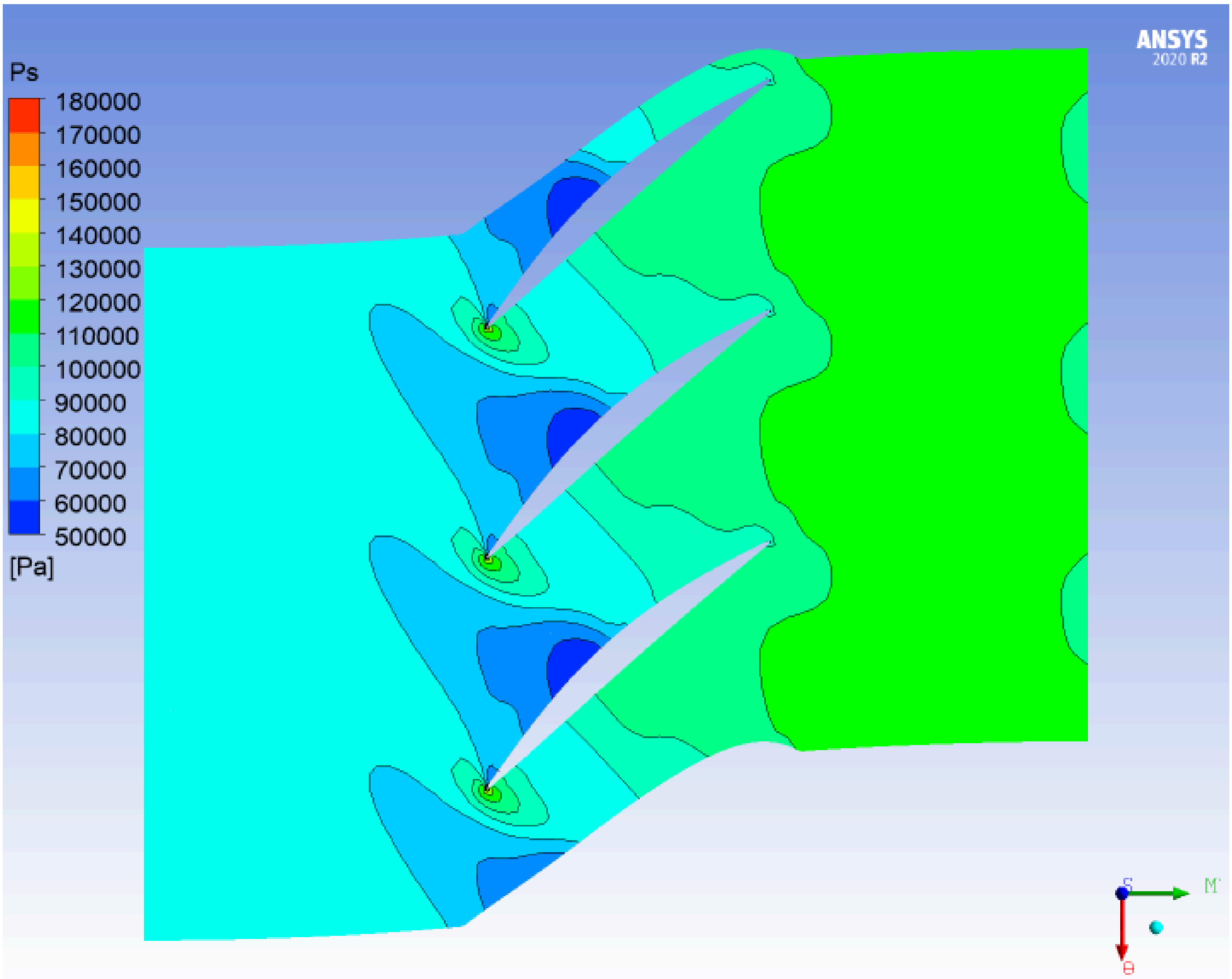


Figure 7. Contour of W at 50% Span

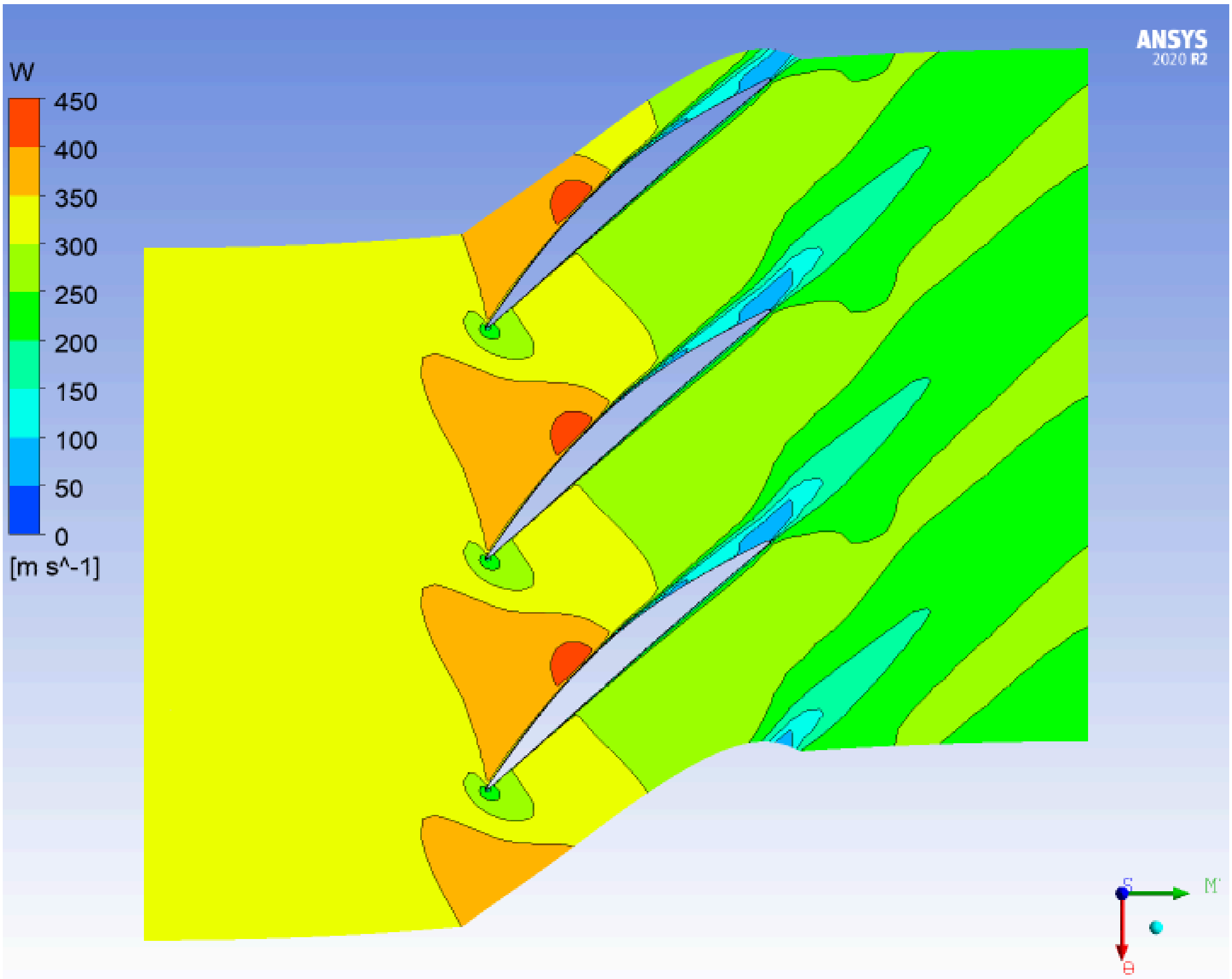


Figure 8. Velocity Vectors at 20% Span

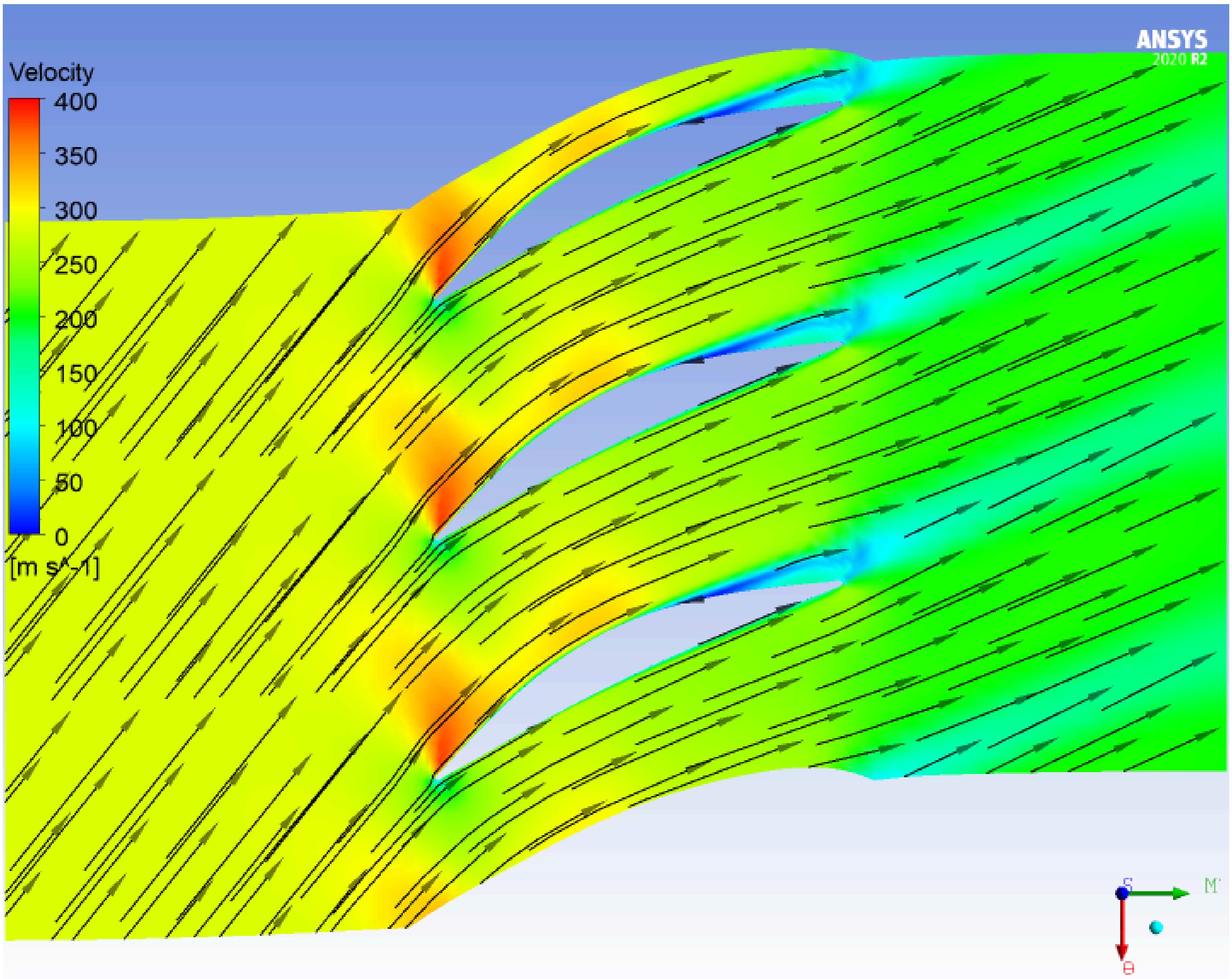


Figure 9. Velocity Vectors at 50% Span

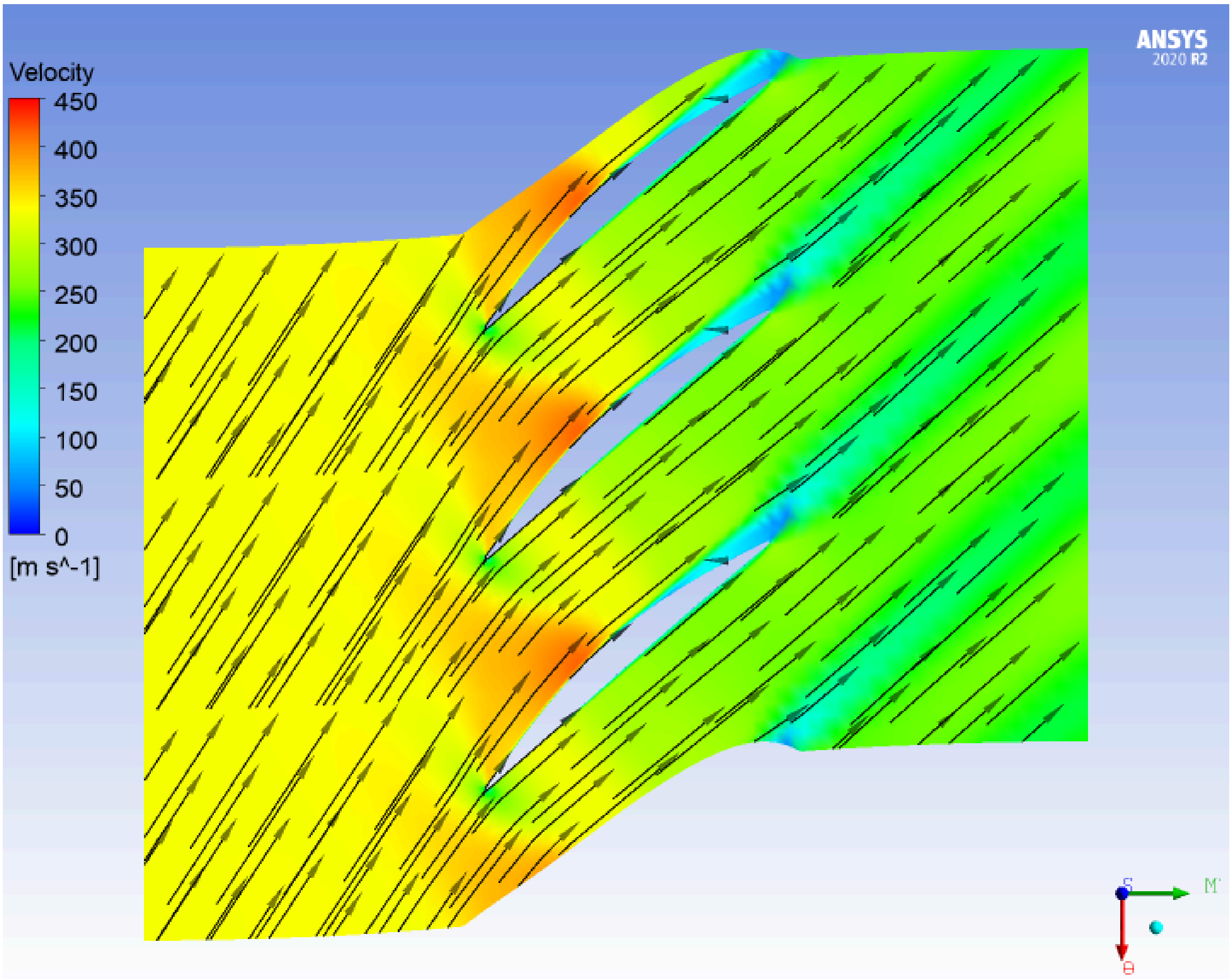
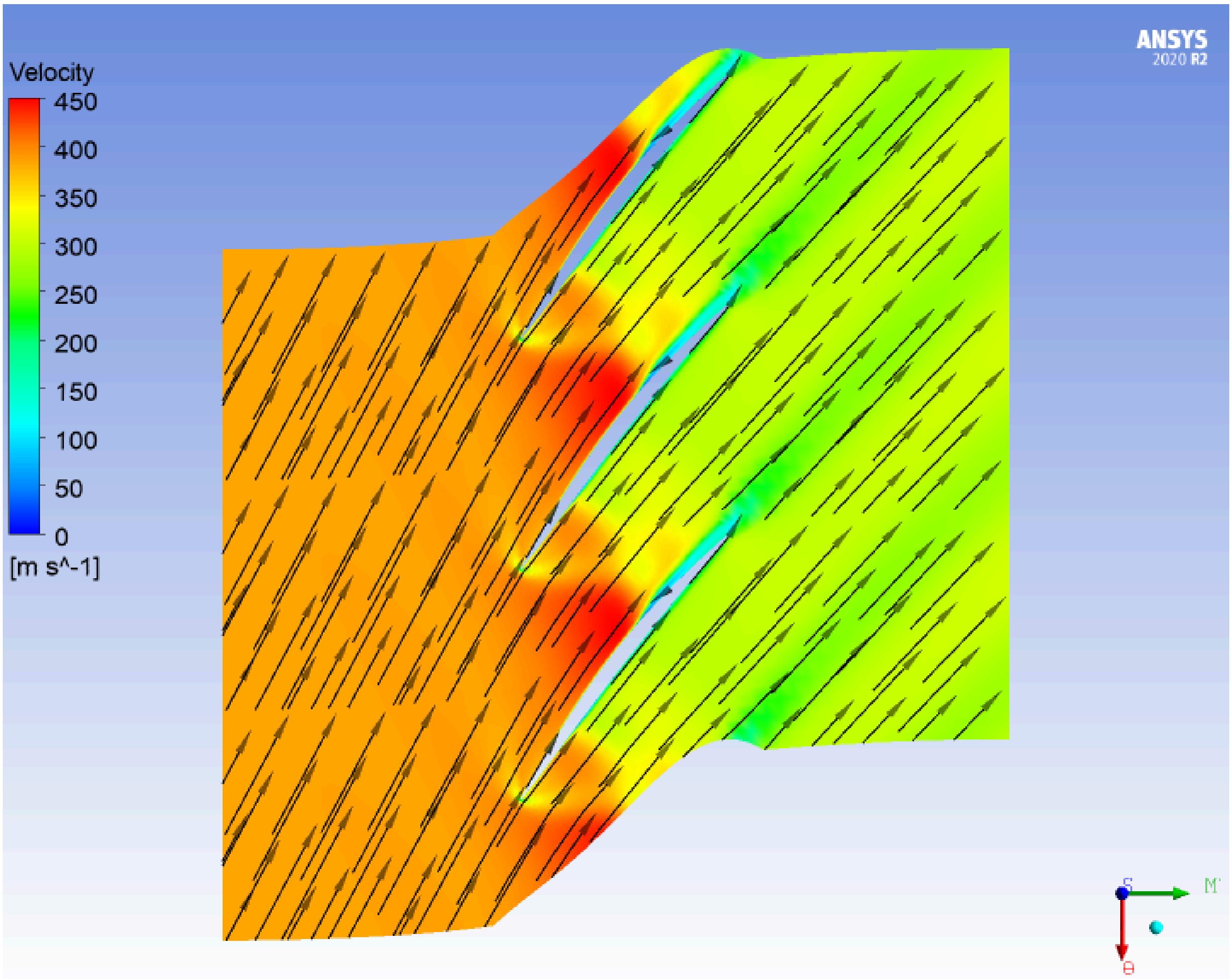


Figure 10. Velocity Vectors at 80% Span



11. Meridional Plots

Figure 11. Contour of Mass Averaged Pt on Meridional Surface

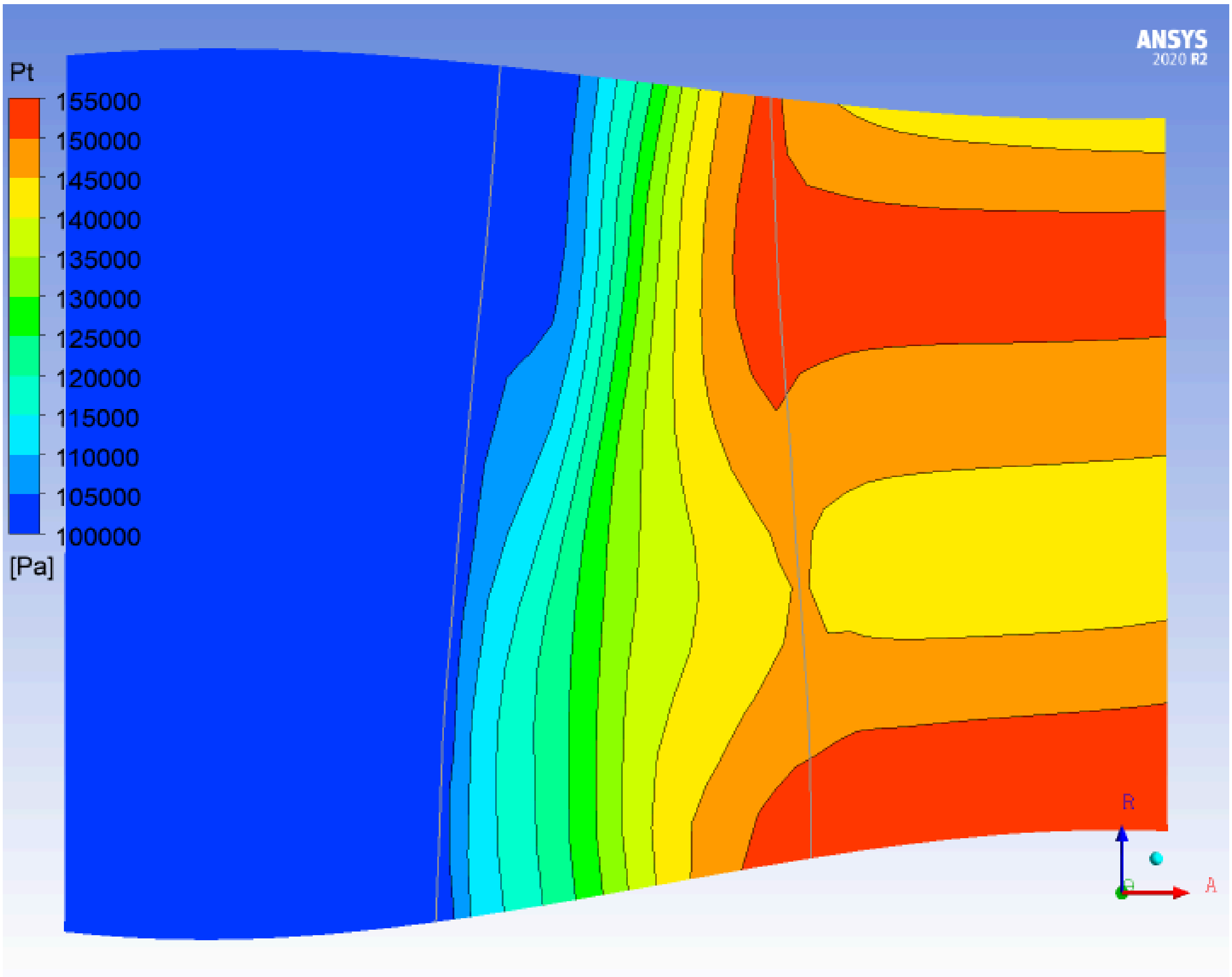


Figure 12. Contour of Mass Averaged Ptr on Meridional Surface

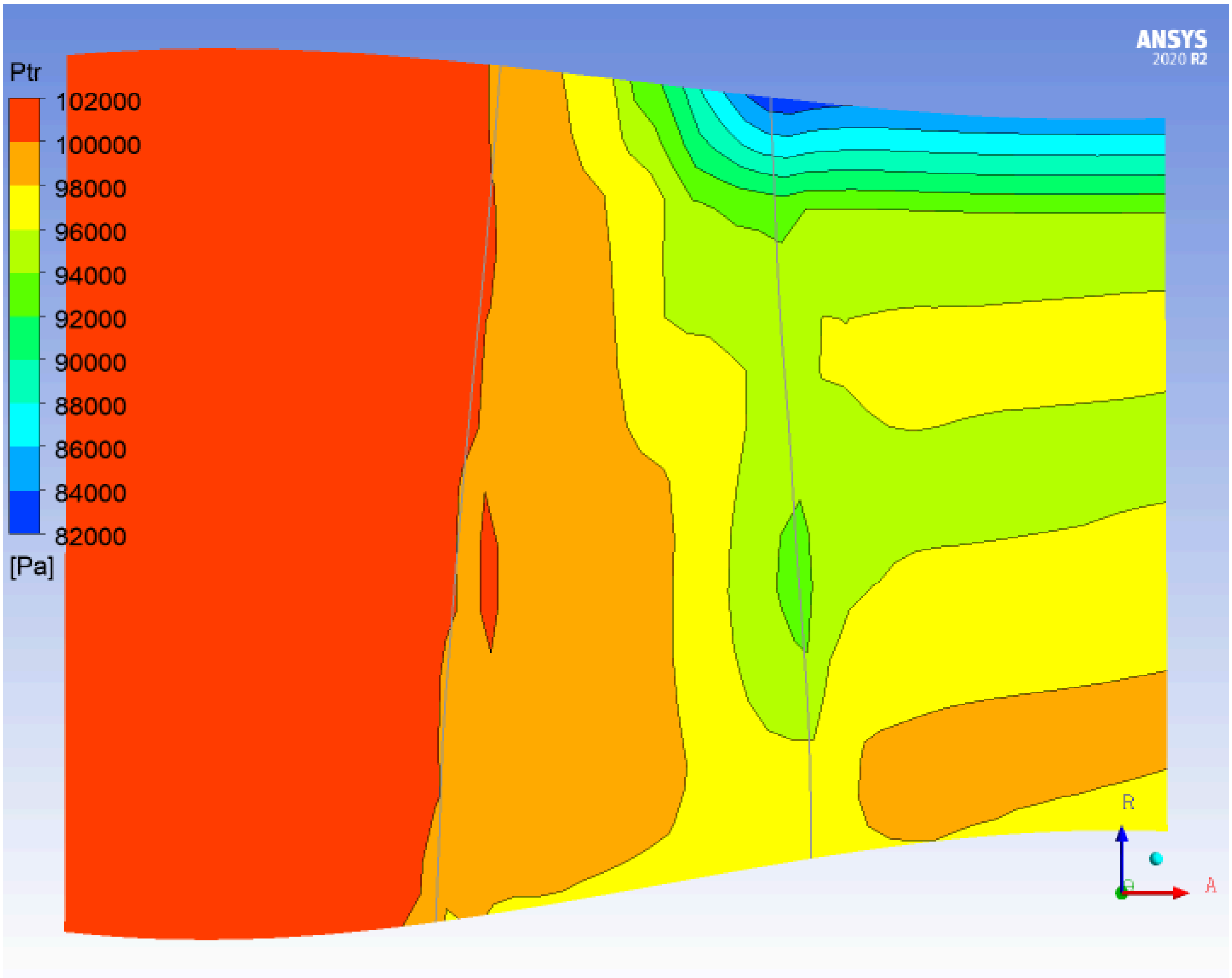


Figure 13. Contour of Mass Averaged W on Meridional Surface

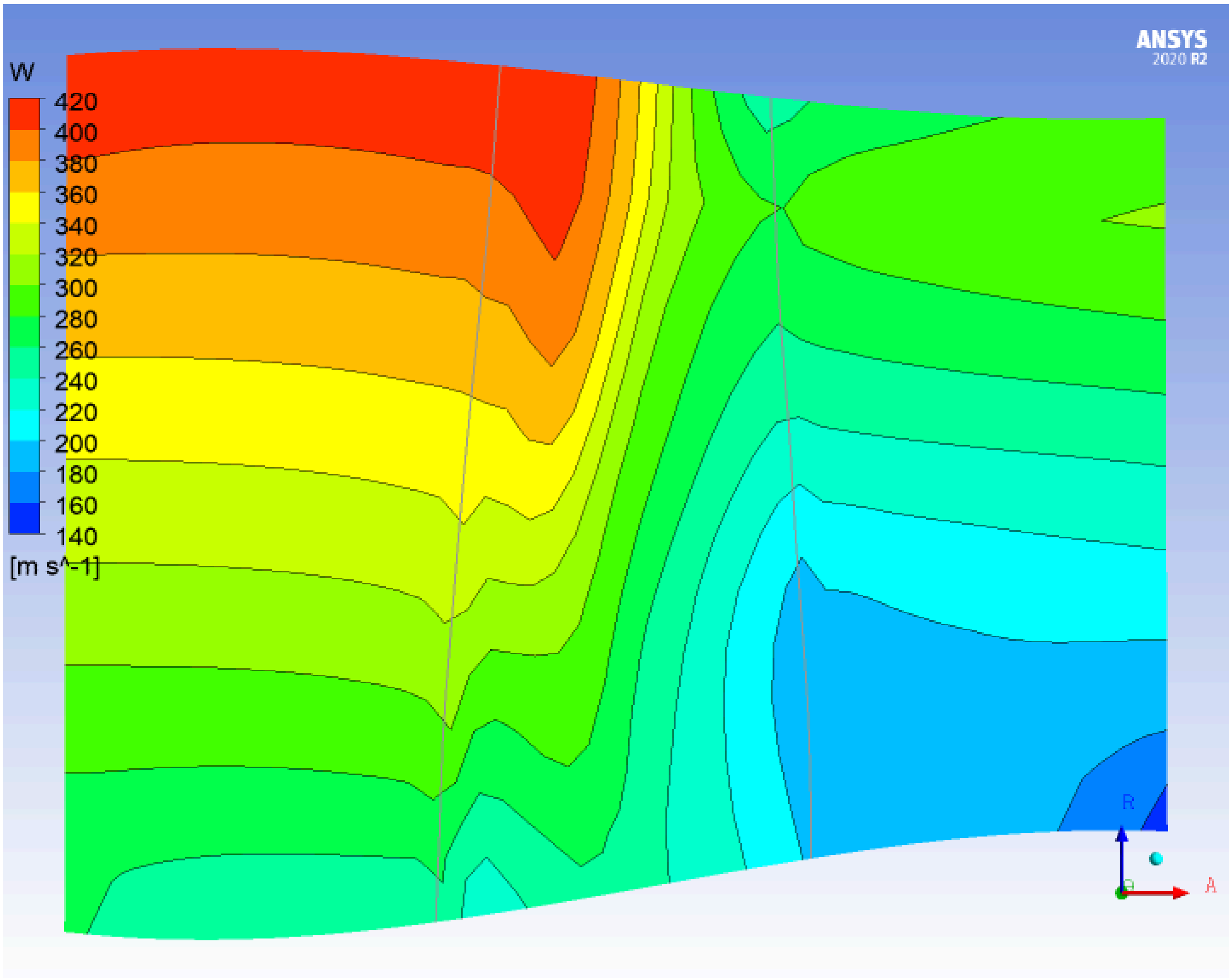
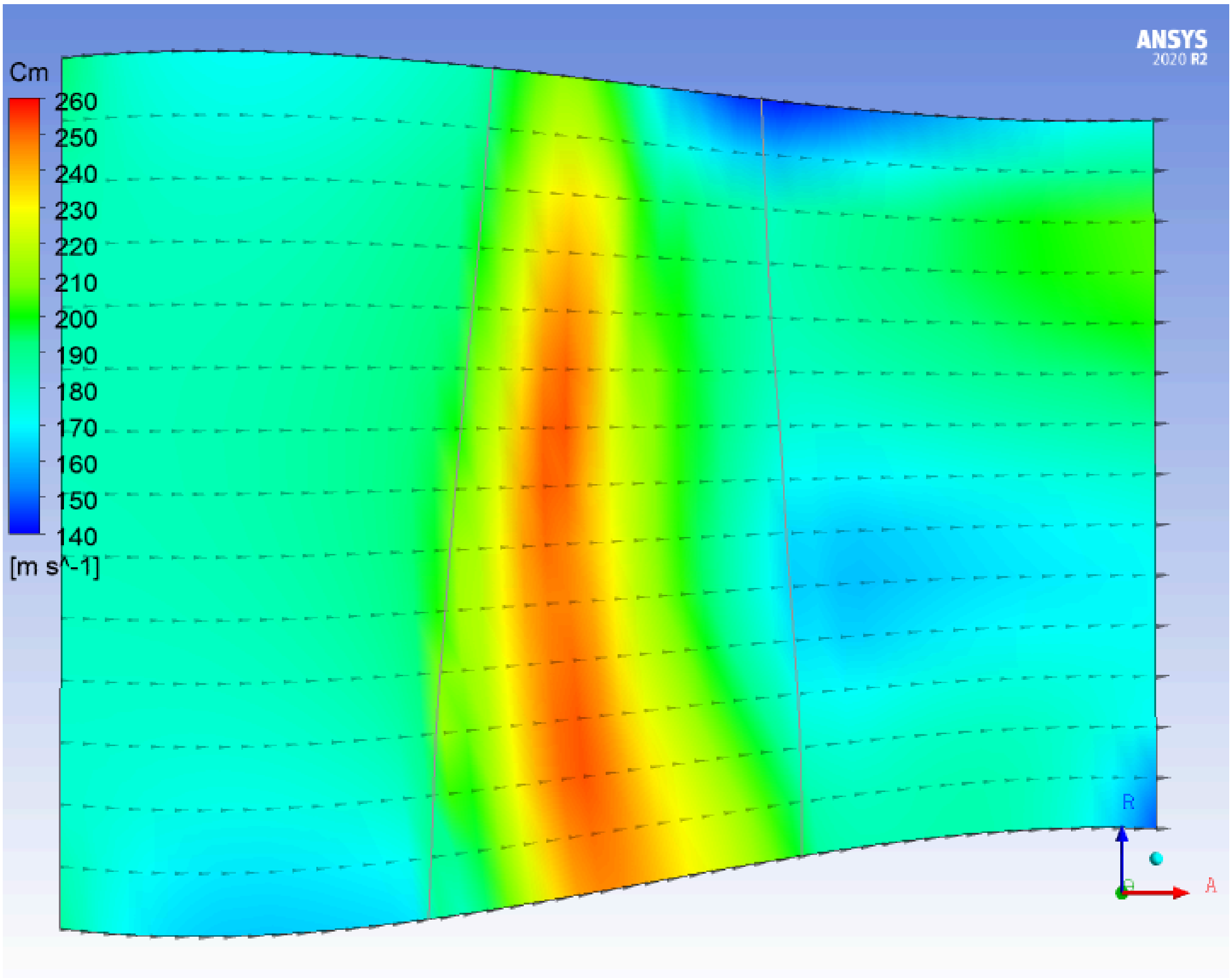


Figure 14. Vector of Area Averaged Cm on Meridional Surface



12. Circumferential Plots

Figure 15. Contour of Pt at Blade LE

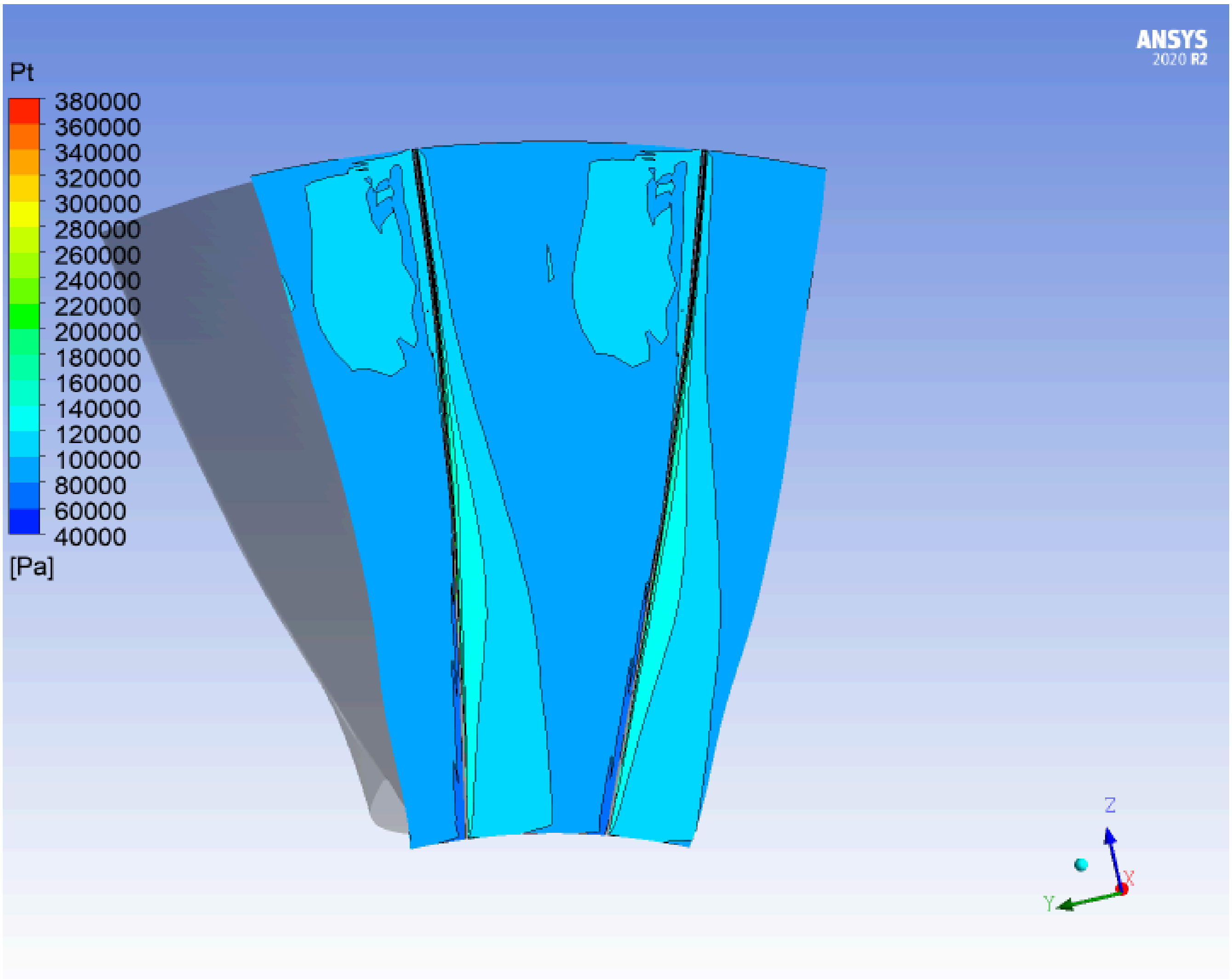


Figure 16. Contour of Ptr at Blade LE

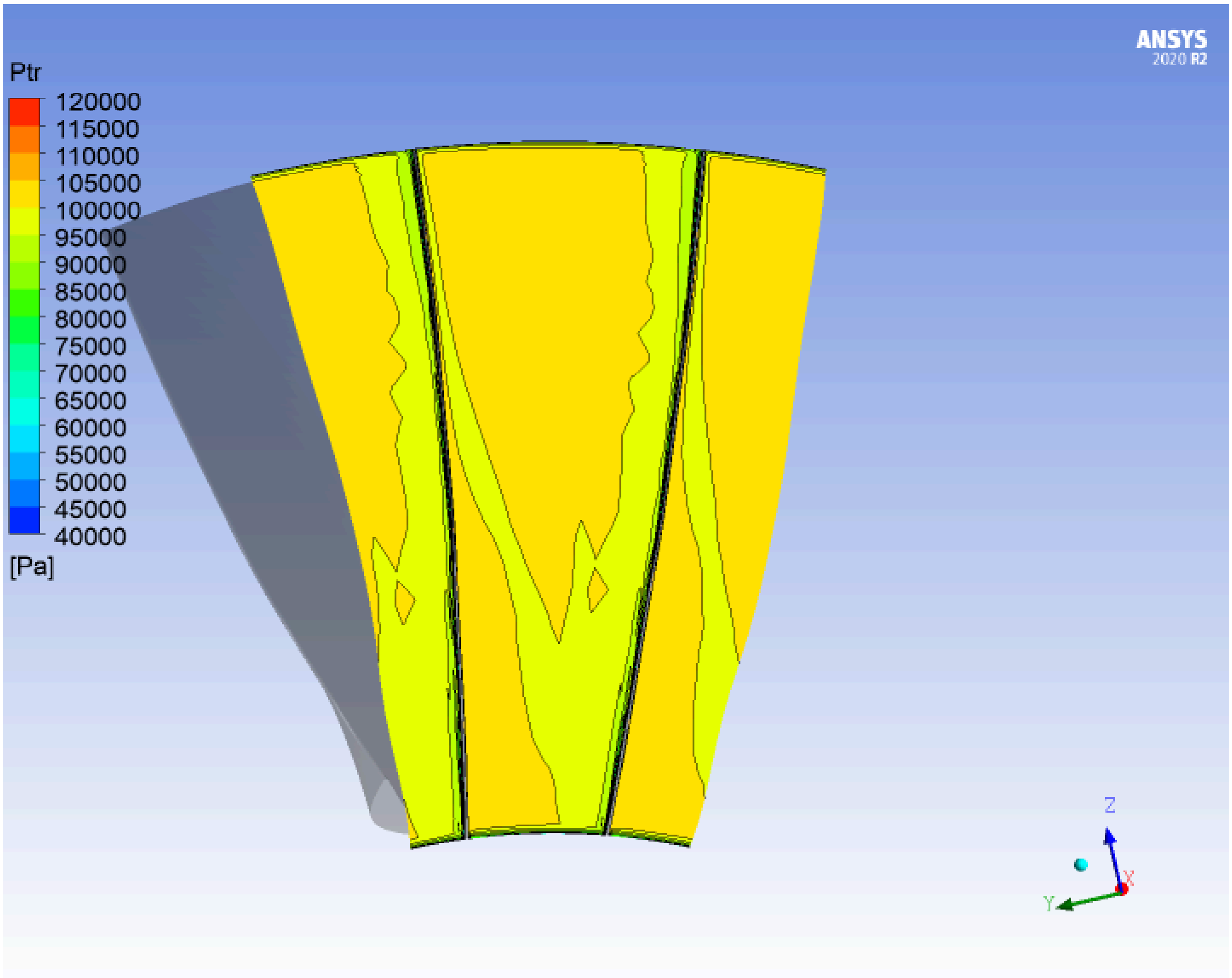


Figure 17. Contour of W at Blade LE

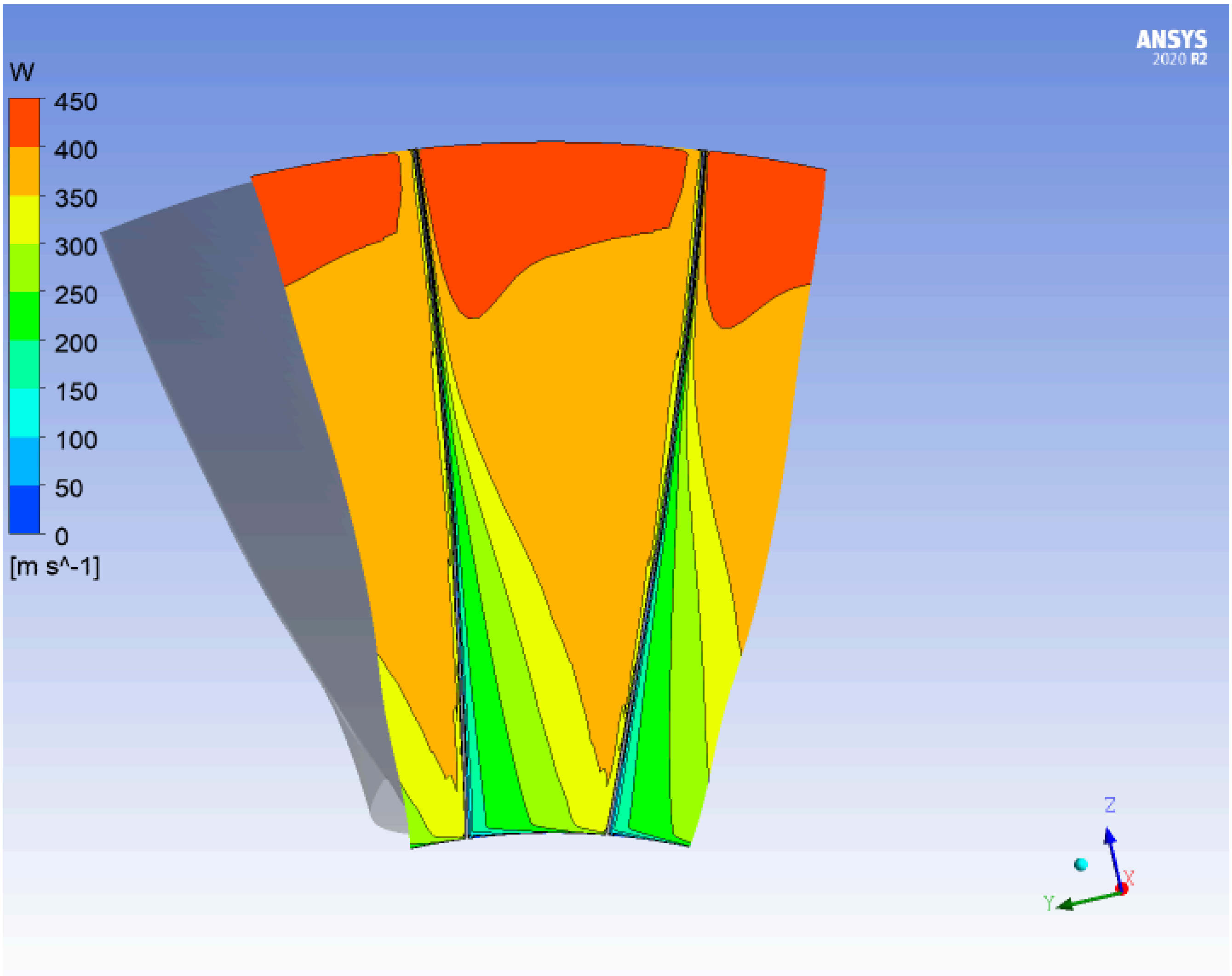


Figure 18. Contour of Pt at Blade TE

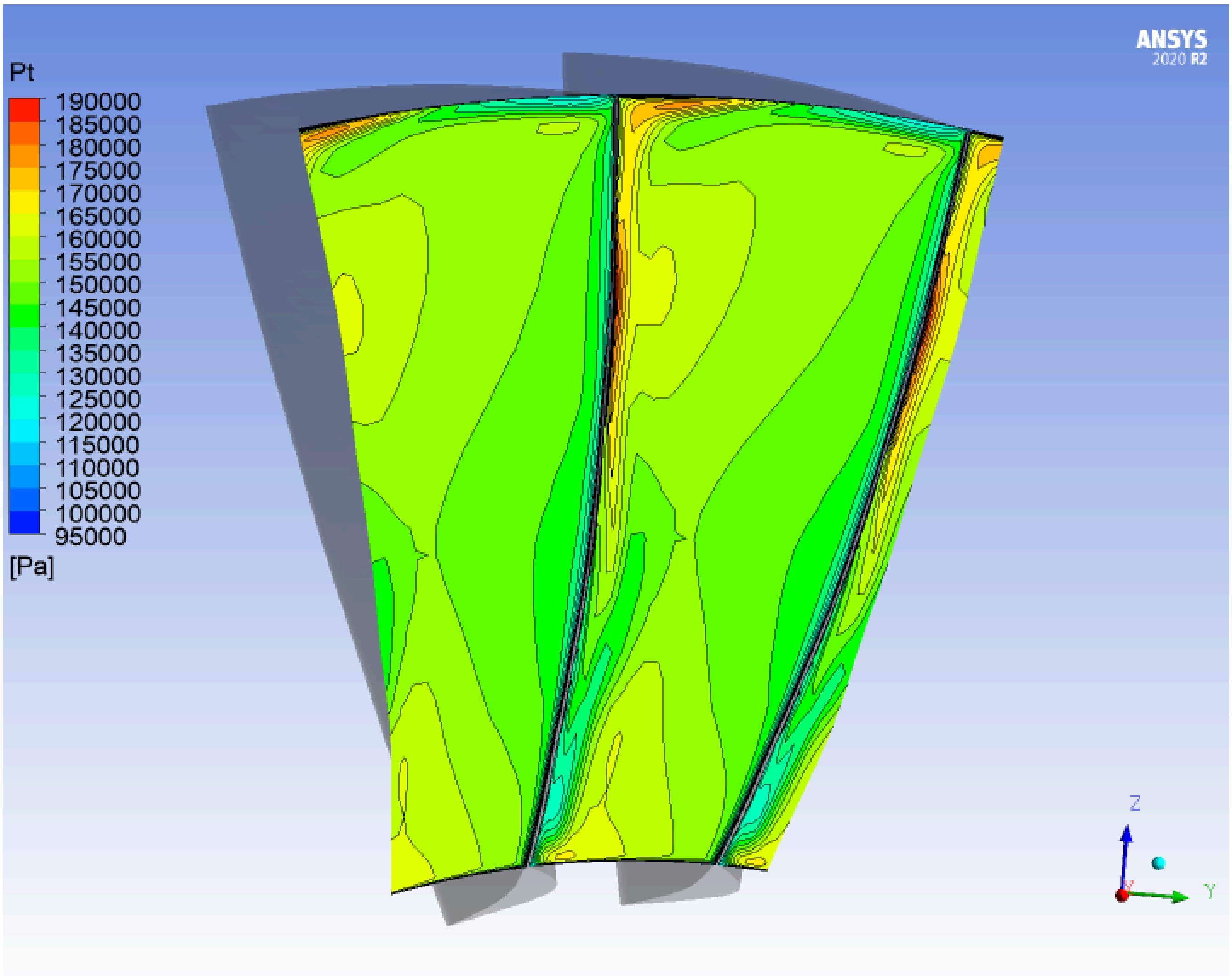


Figure 19. Contour of Ptr at Blade TE

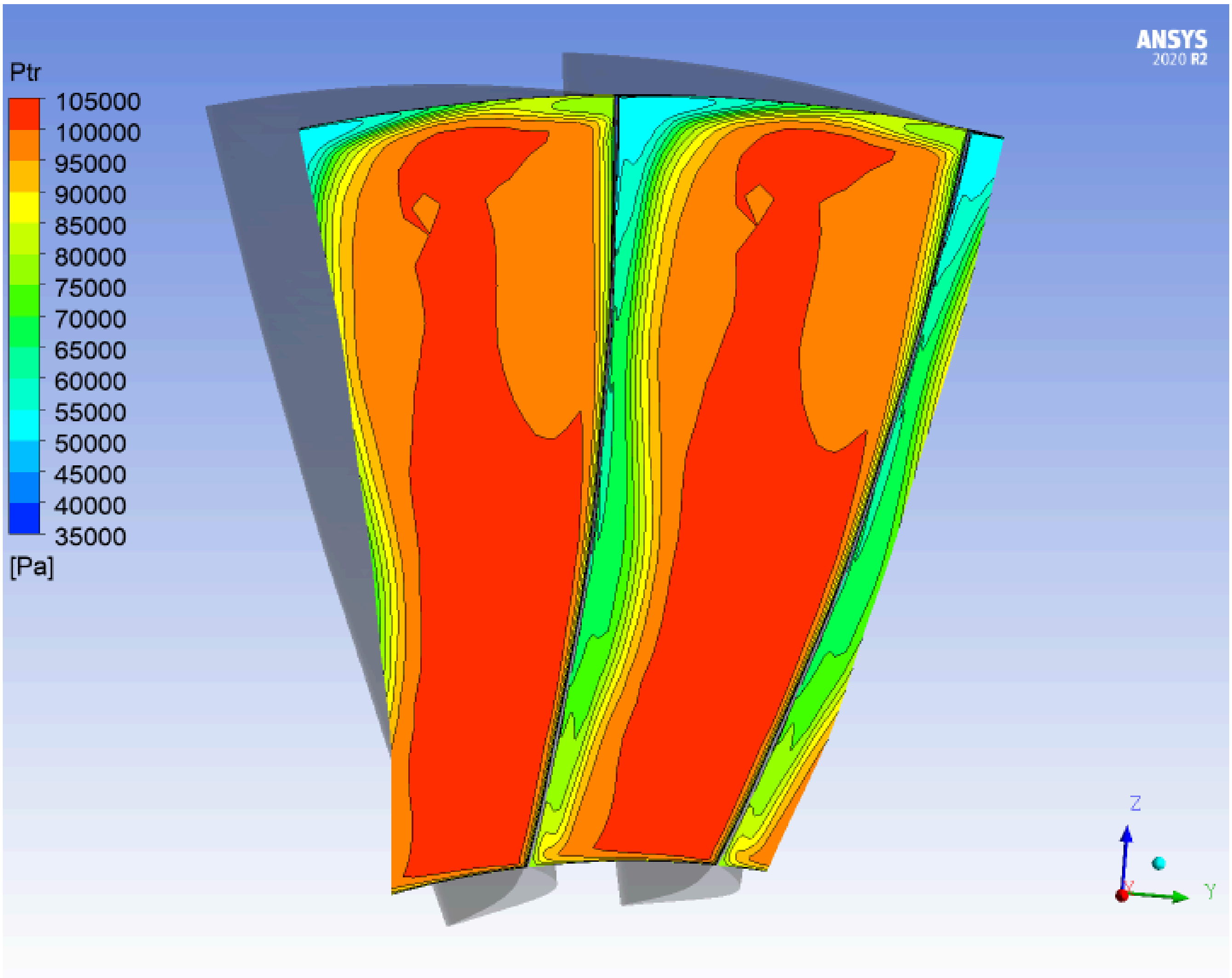
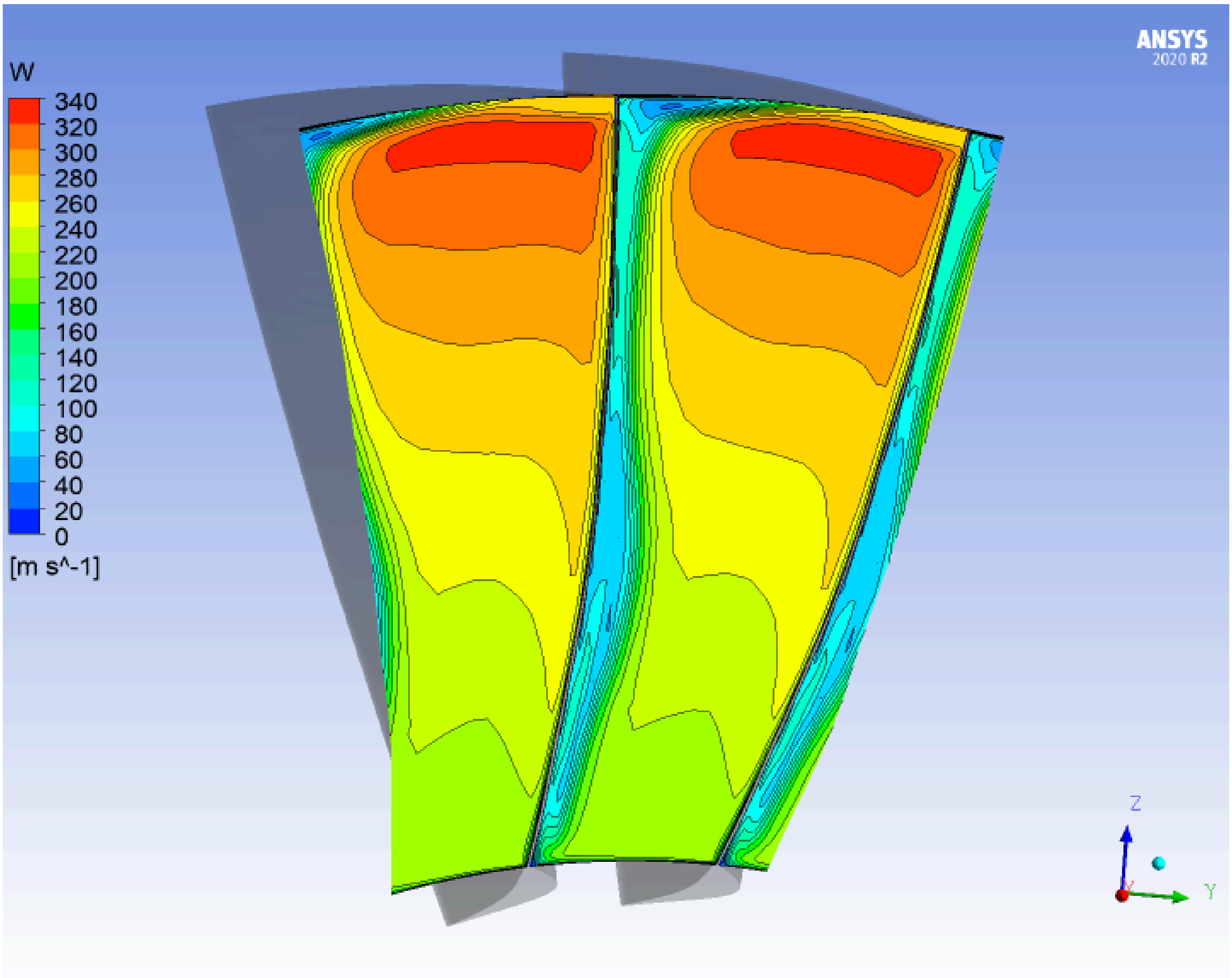
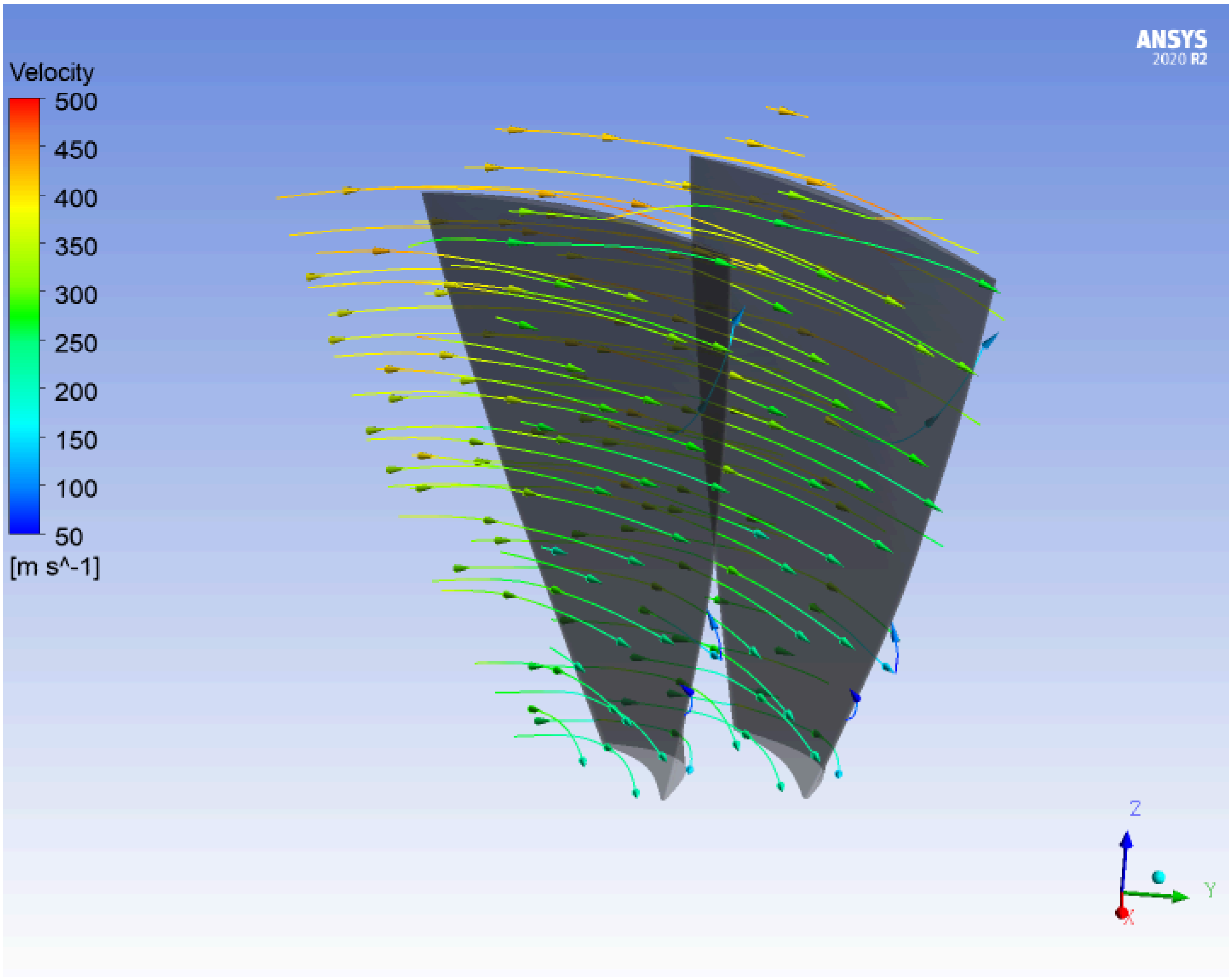


Figure 20. Contour of W at Blade TE



13. Streamline Plot

Figure 21. Velocity Streamlines at Blade TE



14. 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.

14.1. 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 8. Noise input data

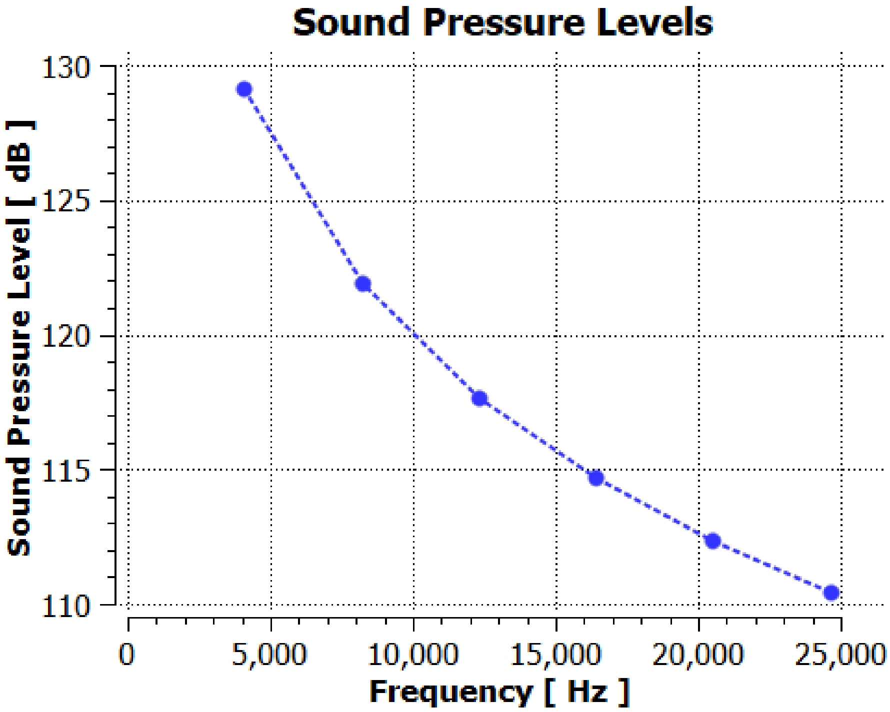
Domain	R1	
Blade Region	BLADE	
Number of Blade Rows	29	
Angular Velocity	890.1180	[radian s^-1]
Number of Harmonics	6	
Observer Location (radius)	1.0000	[m]
Observer Location (theta)	0.0000	[degree]
Loading Coefficient	2.2000	
Reference Pressure	2.0000e-5	[Pa]
Reference Power	1.0000e-12	[W m^-3]
Rotational Mach Number	0.8578	

14.2. Sound Pressure Levels

Table 9. Sound Pressure Levels

Harmonic	Frequency [Hz]	Sound Pressure Level - Lp [dB]
1	4108.3335	129.1006
2	8216.6670	121.8758
3	12324.9990	117.6496
4	16433.3340	114.6511
5	20541.6660	112.3253
6	24649.9980	110.4249

Chart 14. Sound Pressure Levels

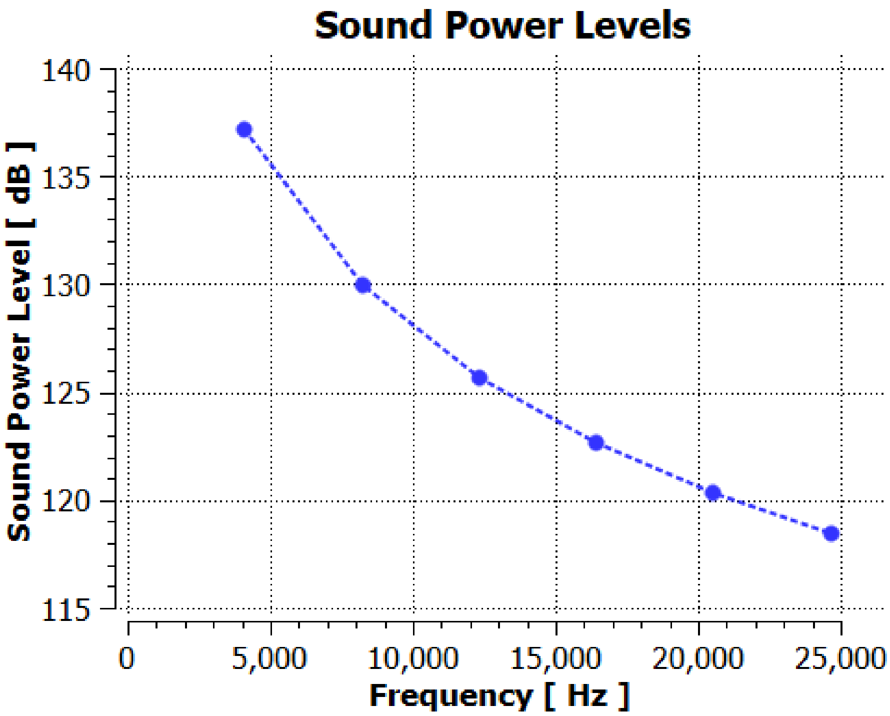


14.3. Sound Power Levels

Table 10. Sound Power Levels

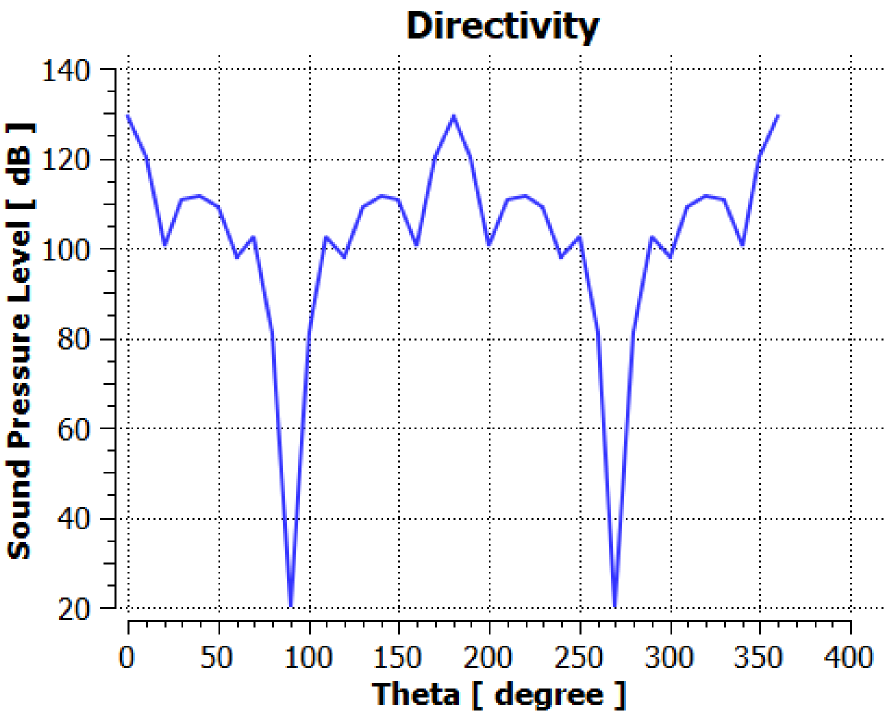
Harmonic	Frequency [Hz]	Sound Power Level - Lp [dB]
1	4108.3335	137.1386
2	8216.6670	129.9139
3	12324.9990	125.6877
4	16433.3340	122.6892
5	20541.6660	120.3633
6	24649.9980	118.4630

Chart 15. Sound Power Levels



14.4. Directivity

Chart 16. Directivity



14.5. Overall Noise

Table 11. Overall Noise

Sound Pressure Level [dB]	130.3441
Sound Power Level [dB]	138.3821

14.6. Broadband Noise

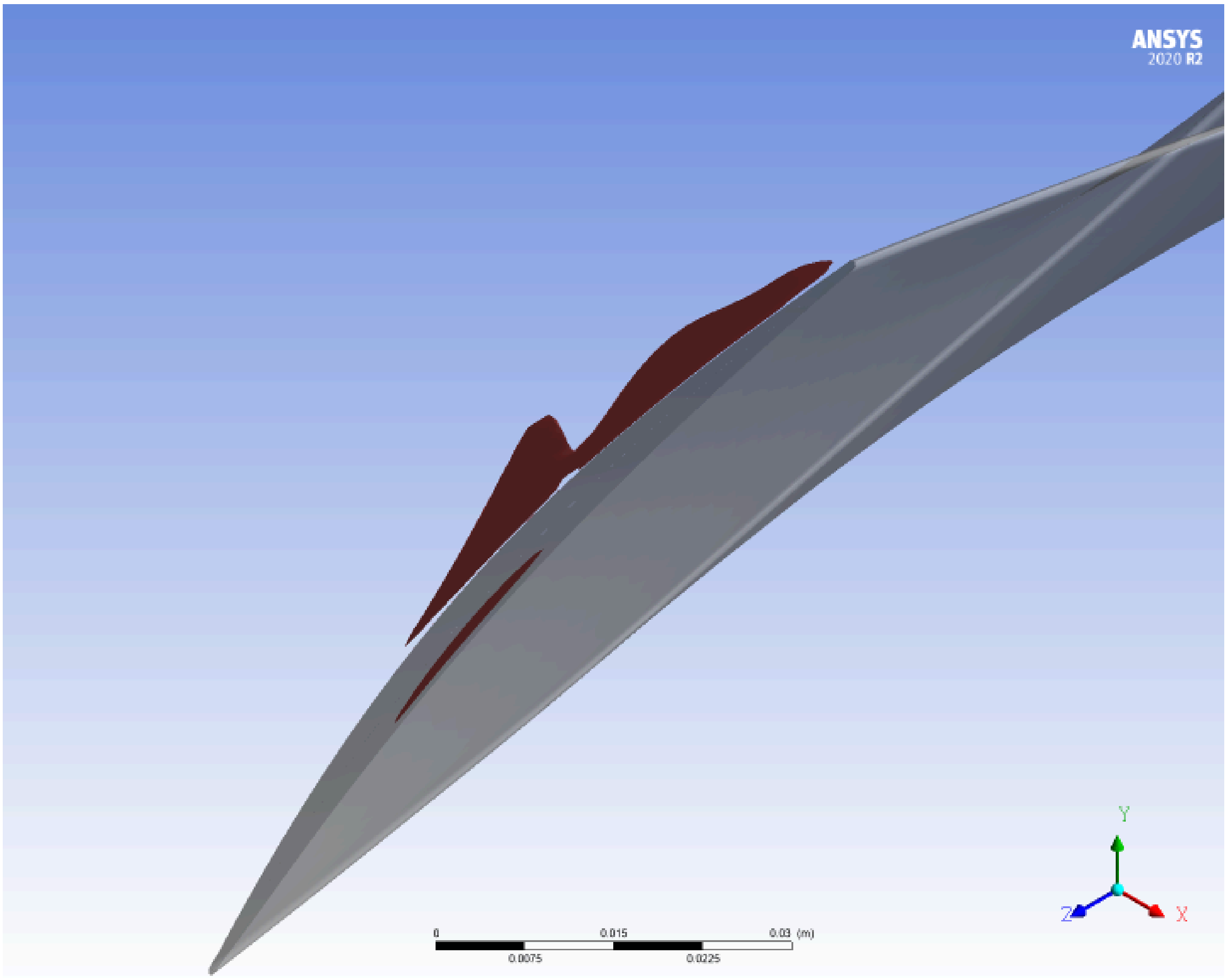
Broadband noise model is derived from Proudman's formula (see expression *Proudman Sound Power Exp*), which predicts overall sound power. Associated variable (*Proudman Sound Power*) is evaluated on the entire domain, allowing visualization of isosurfaces that can be used to locate the portion of the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

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

Table 12. Proudman Sound Power

Minimum	14.6	[dB]
Maximum	177.8	[dB]
Average	111.6	[dB]
Total Power	9.1954e-2	[W]

Figure 22. Isosurface at 95% of Proudman Sound Power



14.7. 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 13. Summary of noise sources at the blade and at the final timestep

	Monopole Source Strength	Dipole Source Strength	
Minimum	0.0	32852.1	[Pa]
Maximum	784.9	232395.0	[Pa]
Average	318.7	88275.0	[Pa]

Figure 23. Monopole Source

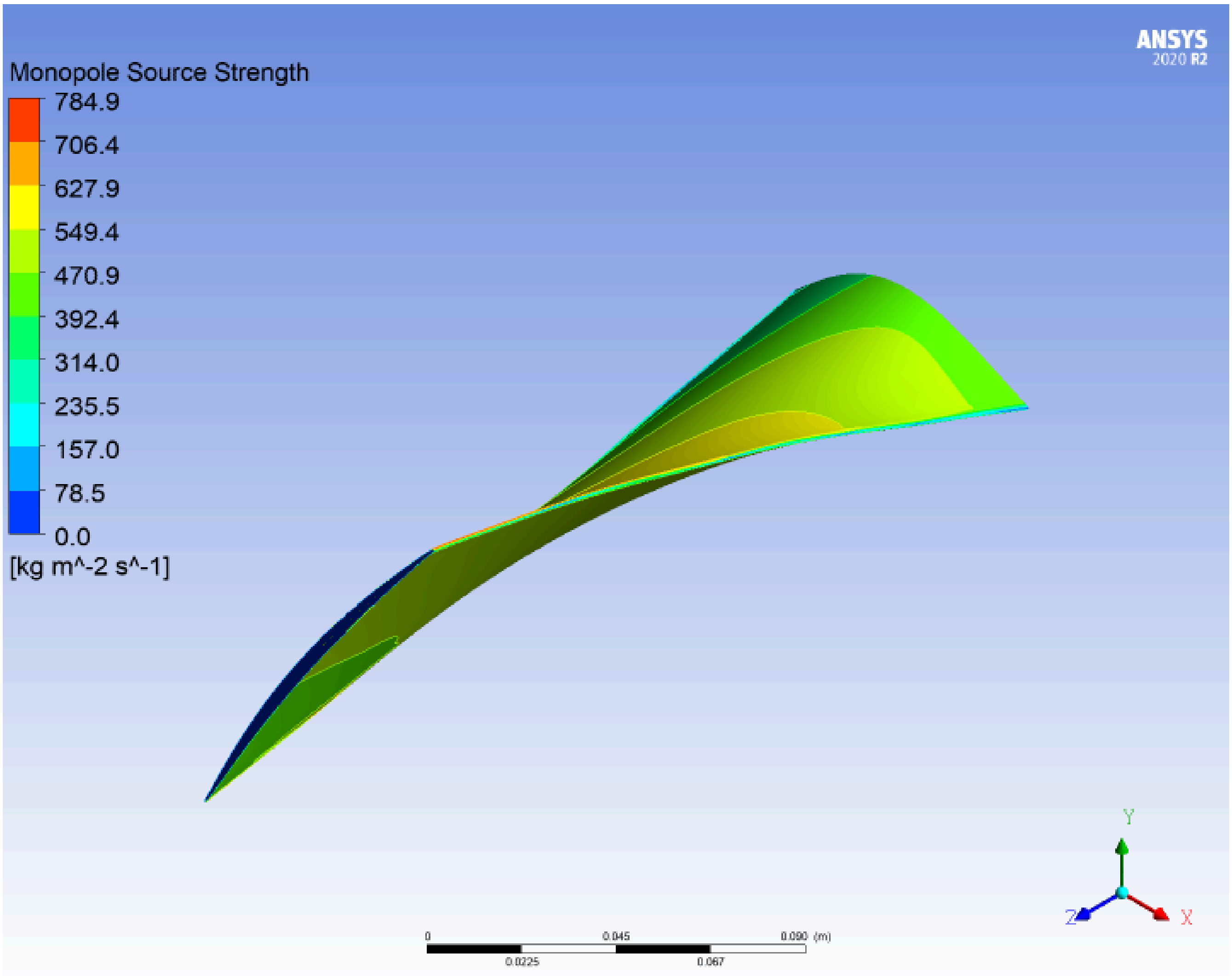


Figure 24. Dipole Source

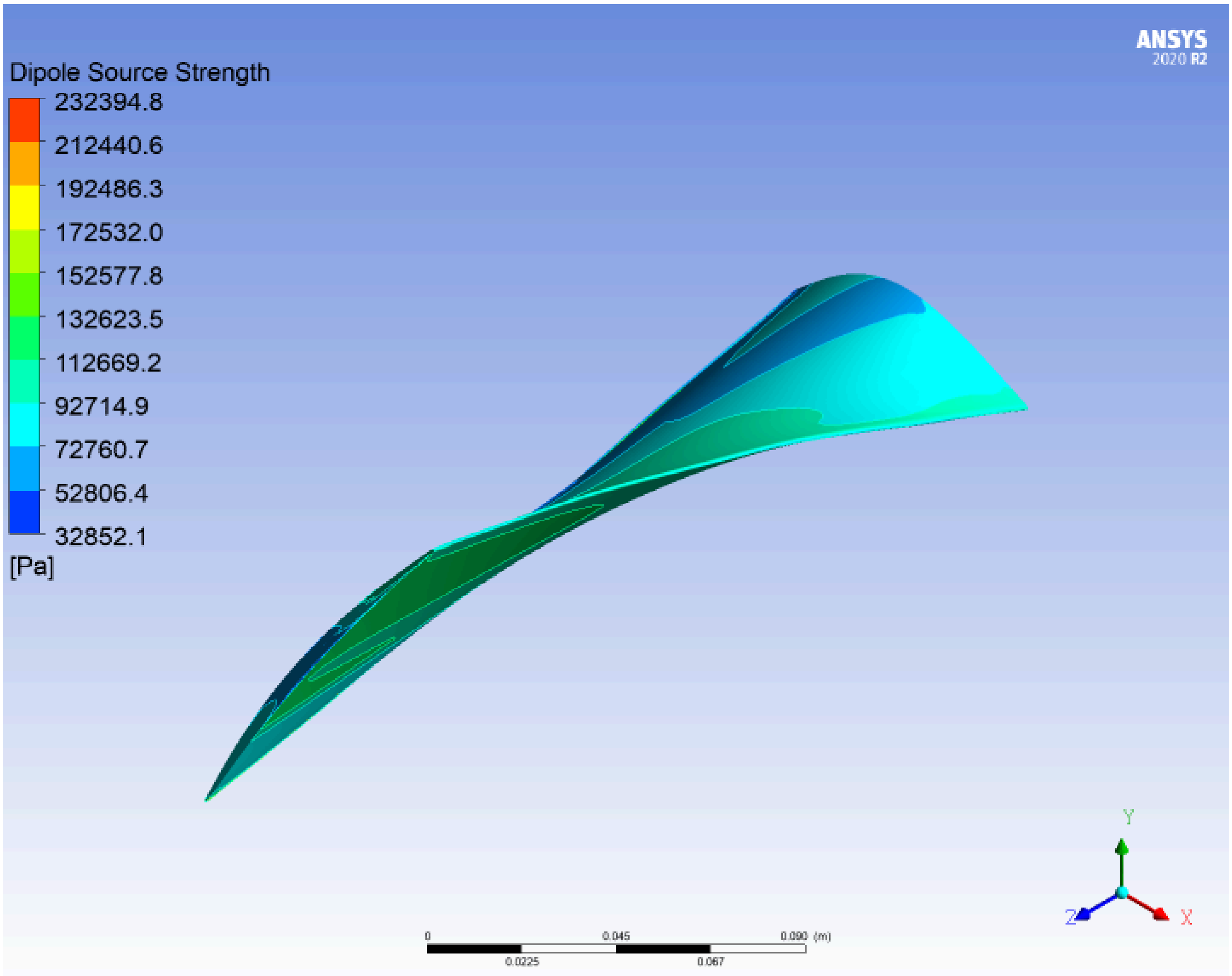


Table 14. Summary of quadrupole sources at the final timestep

	Quadrupole Source Strength	
Minimum	0.0	[Pa]
Maximum	166907.0	[Pa]
Average	59337.1	[Pa]

Figure 25. Isosurface at 80% of Quadrupole Source Strength