Project

TCFD – Comparison with CFX

1. Radial Pump: RP01
2. Radial Blower: RB01

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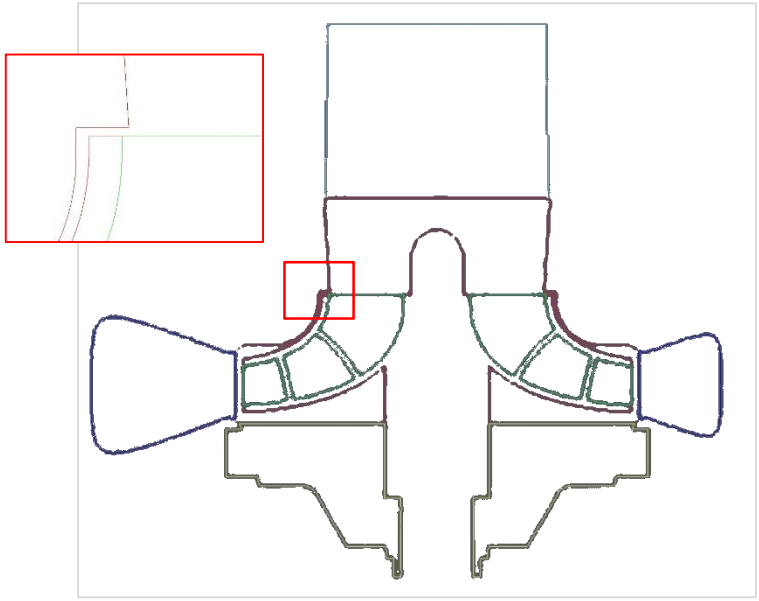
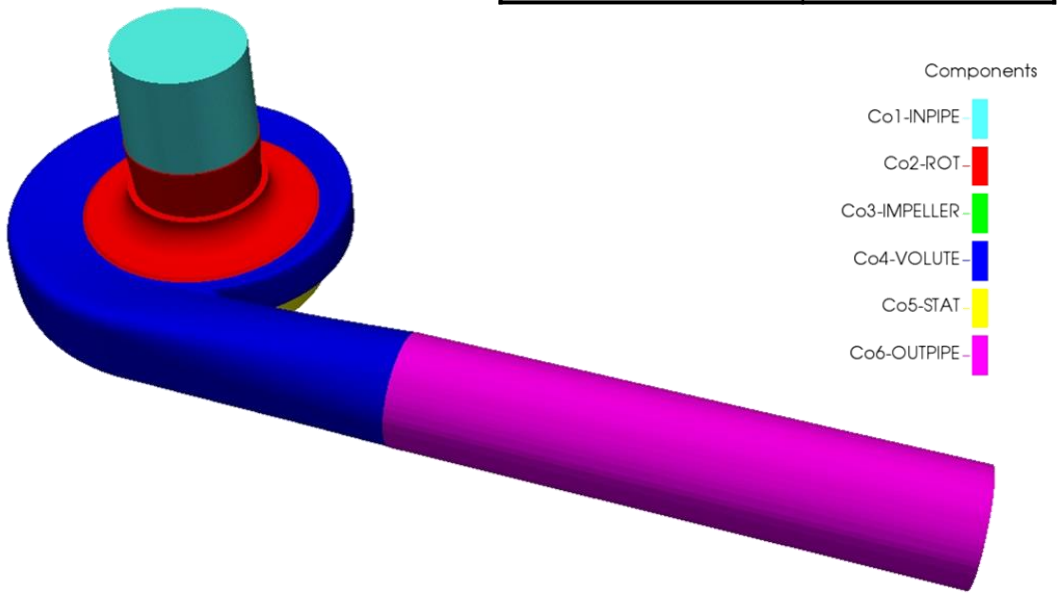
Radial Pump 01
BM_RP01

1.1 Case settings: Basic

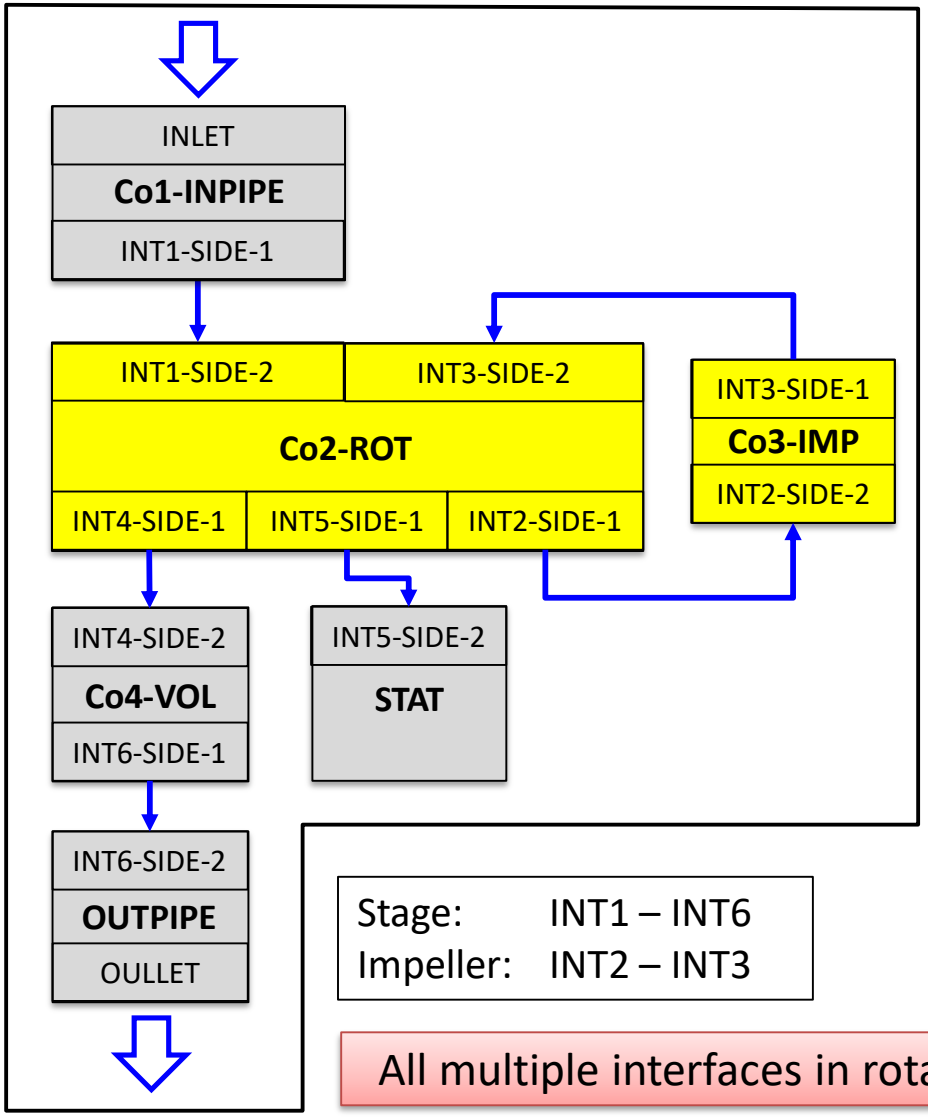
Physical settings (water)	
Dynamic viscosity	0.001 [kg/m·s]
Density	998.2 [kg/m^3]
Ref. Temperature	293 [K]
Ref. Pressure	101325 [Pa]

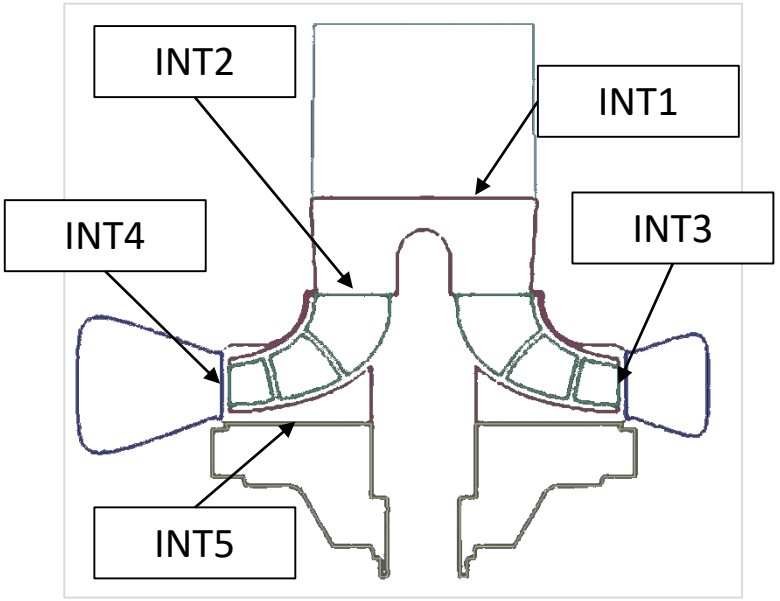
Operating conditions	
Rotating speed	1470 [rpm]
Flow rate [m^3/s]	
P1	0.02222
P2	0.03333
P3	0.045
P4	0.05
P5	0.05556
P6	0.06111

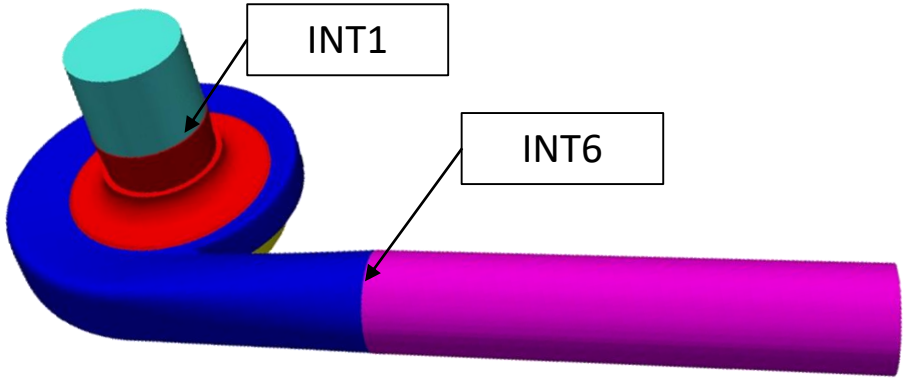




1.1 Case settings: Interfaces



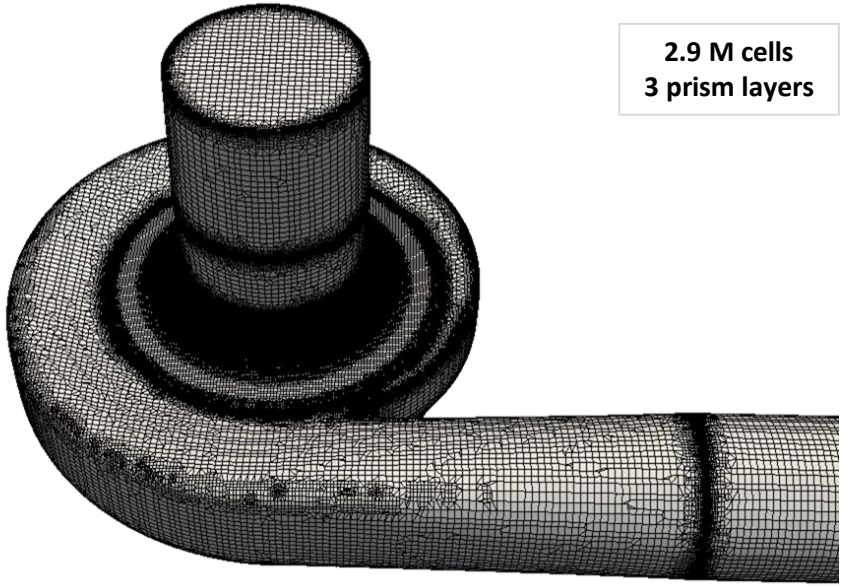




Stage: INT1 – INT6
Impeller: INT2 – INT3

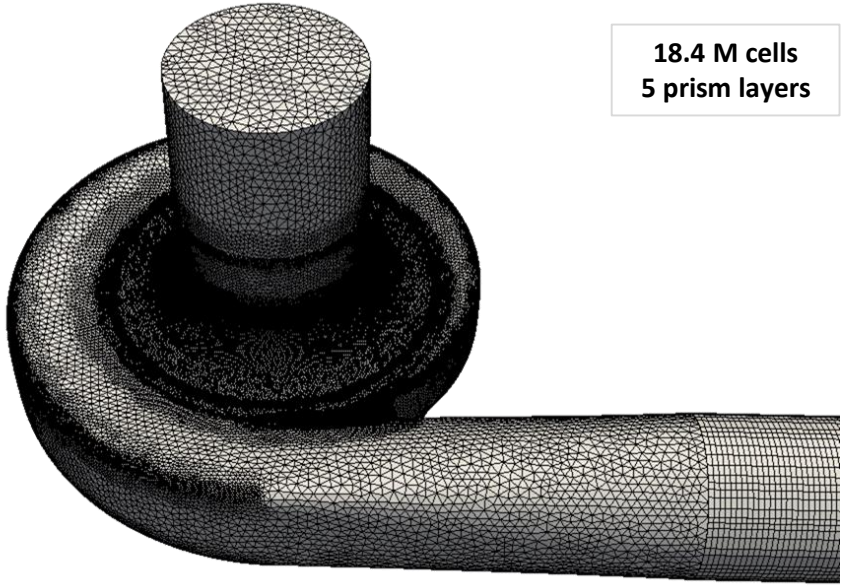
All multiple interfaces in rotating domain have to be set as AMI-interface

1.2 Mesh

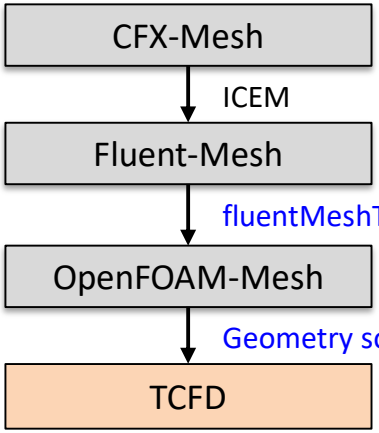


<TCFD Mesh>

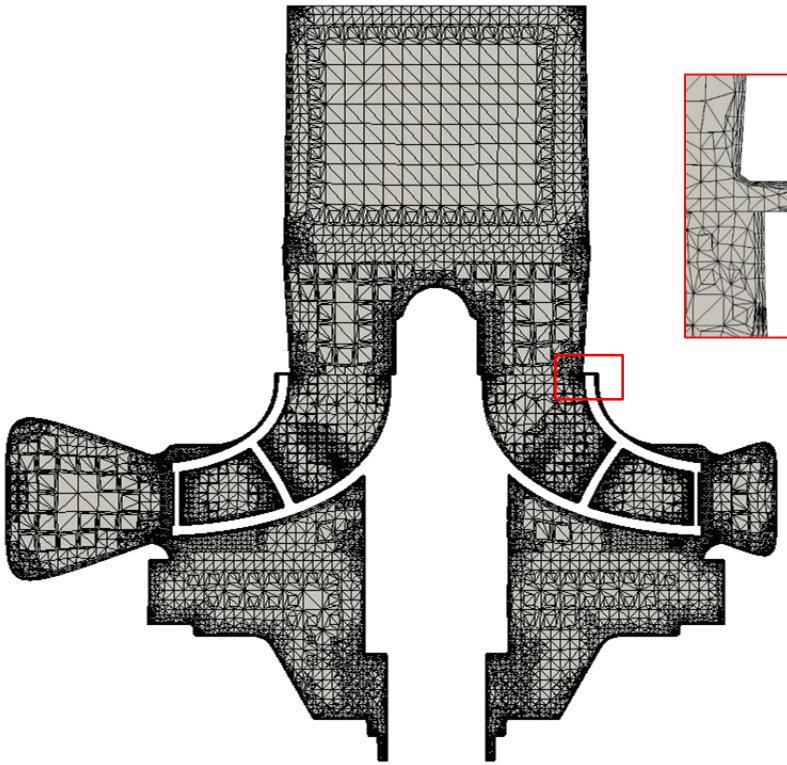
TCFD Mesh Settings	Value
Background mesh size	0.01
Co2_refinementSurfaces (SFP patch)	3 4
refinementSurfaces (rests)	1 4
No of Prism layers	3



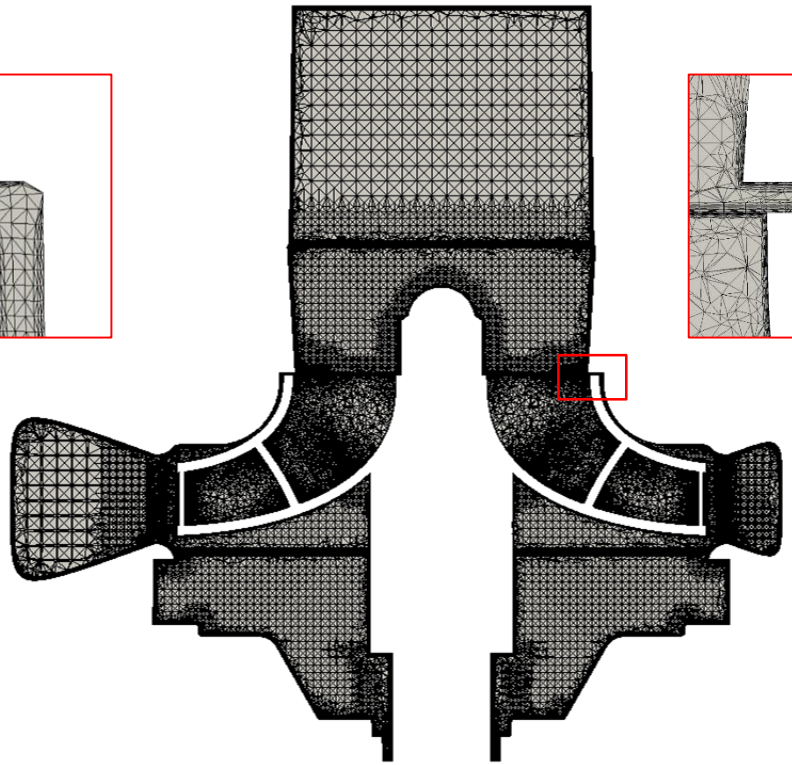
<CFX Mesh>



1.2 Mesh

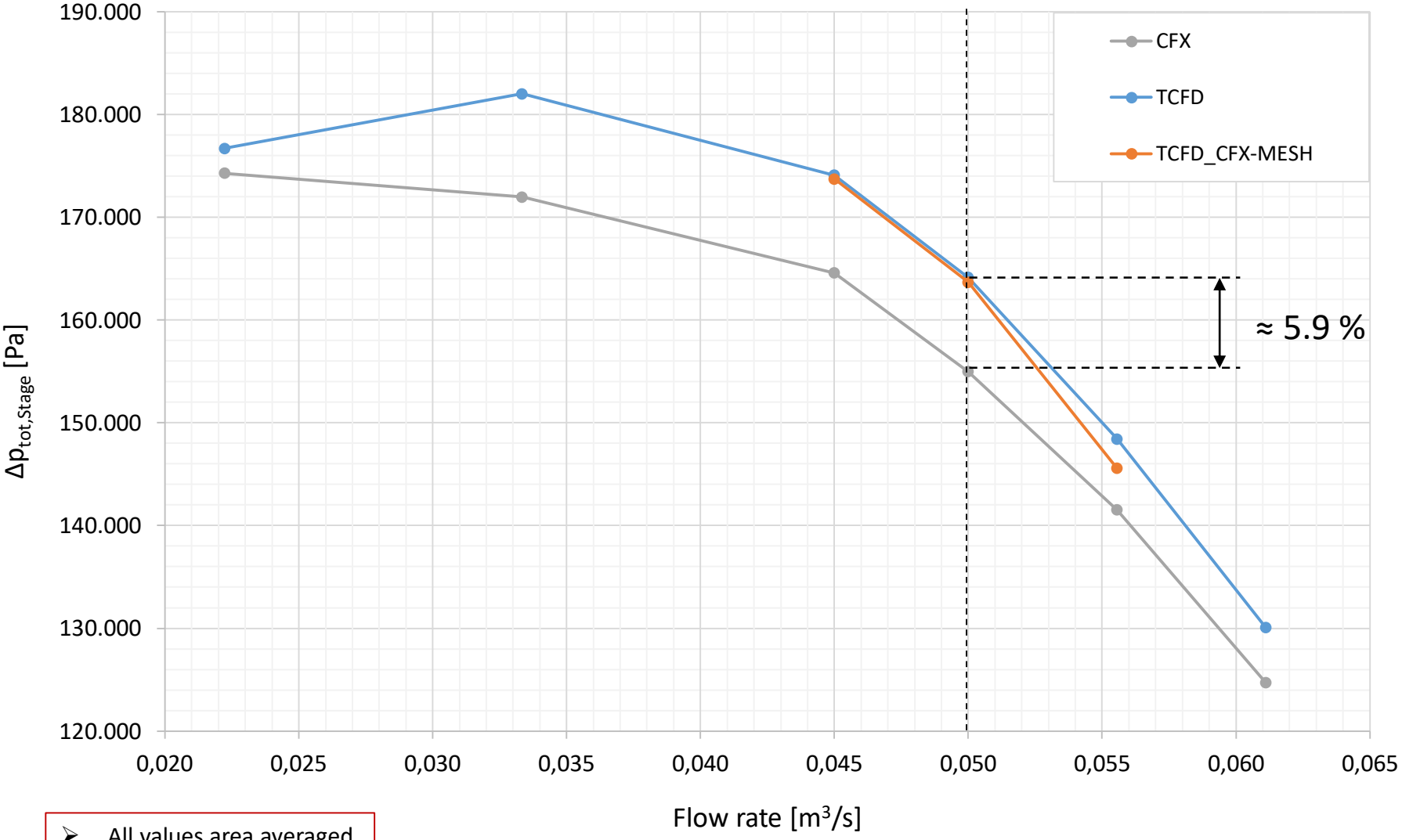


<TCFD Mesh>



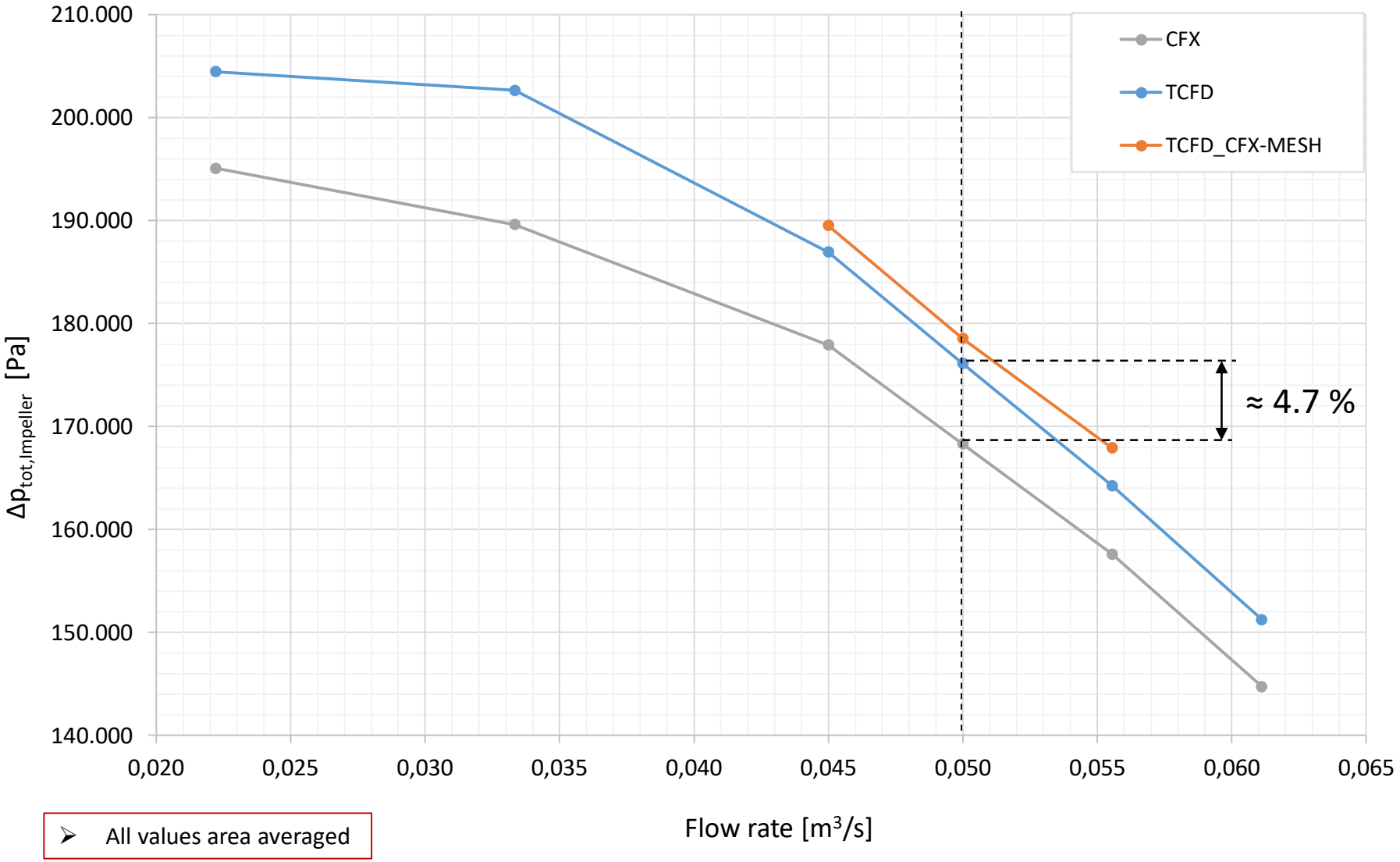
<CFX Mesh>

1.3 Result: Total pressure difference - Stage



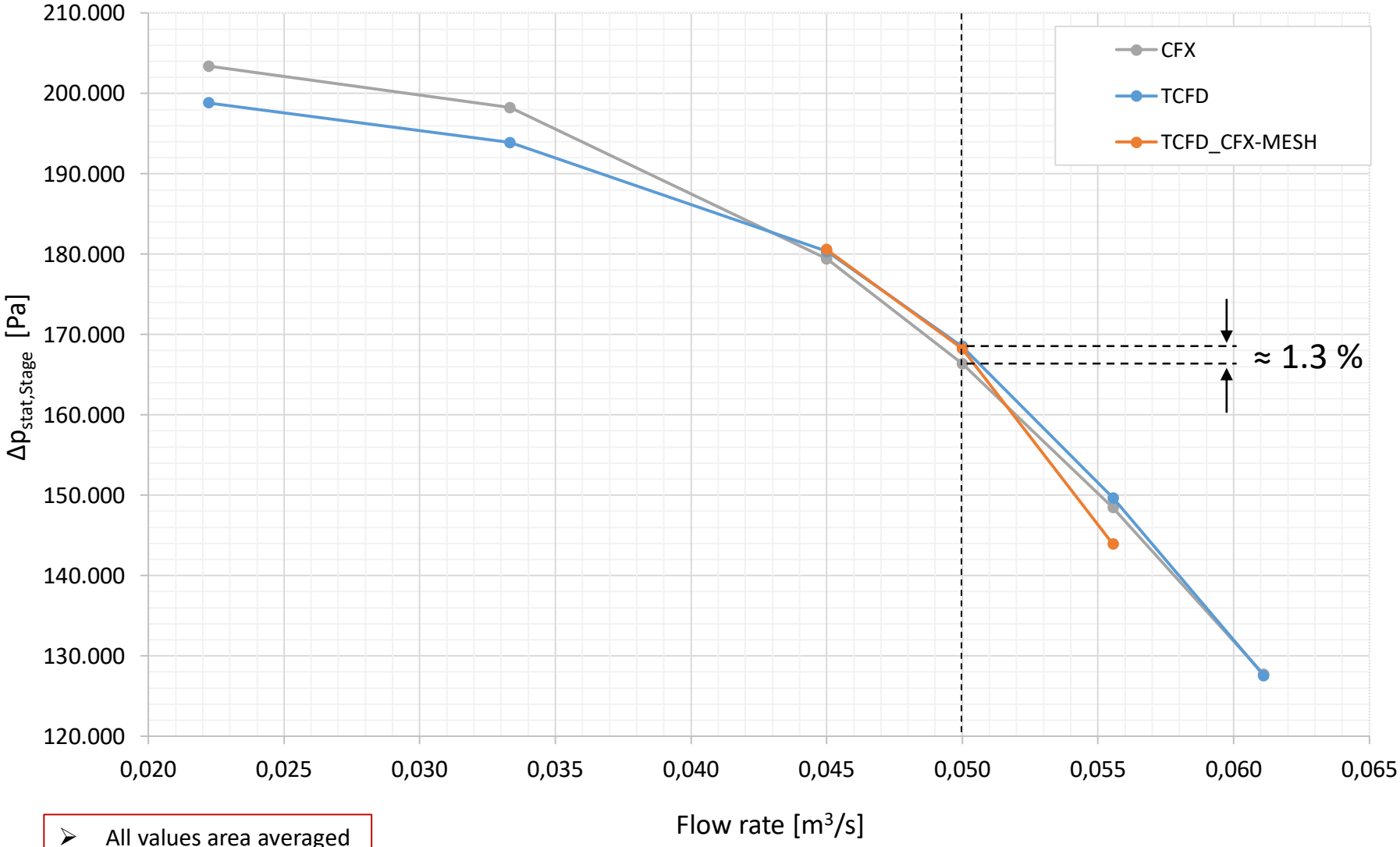
- All values area averaged

1.3 Result: Total pressure difference - Impeller



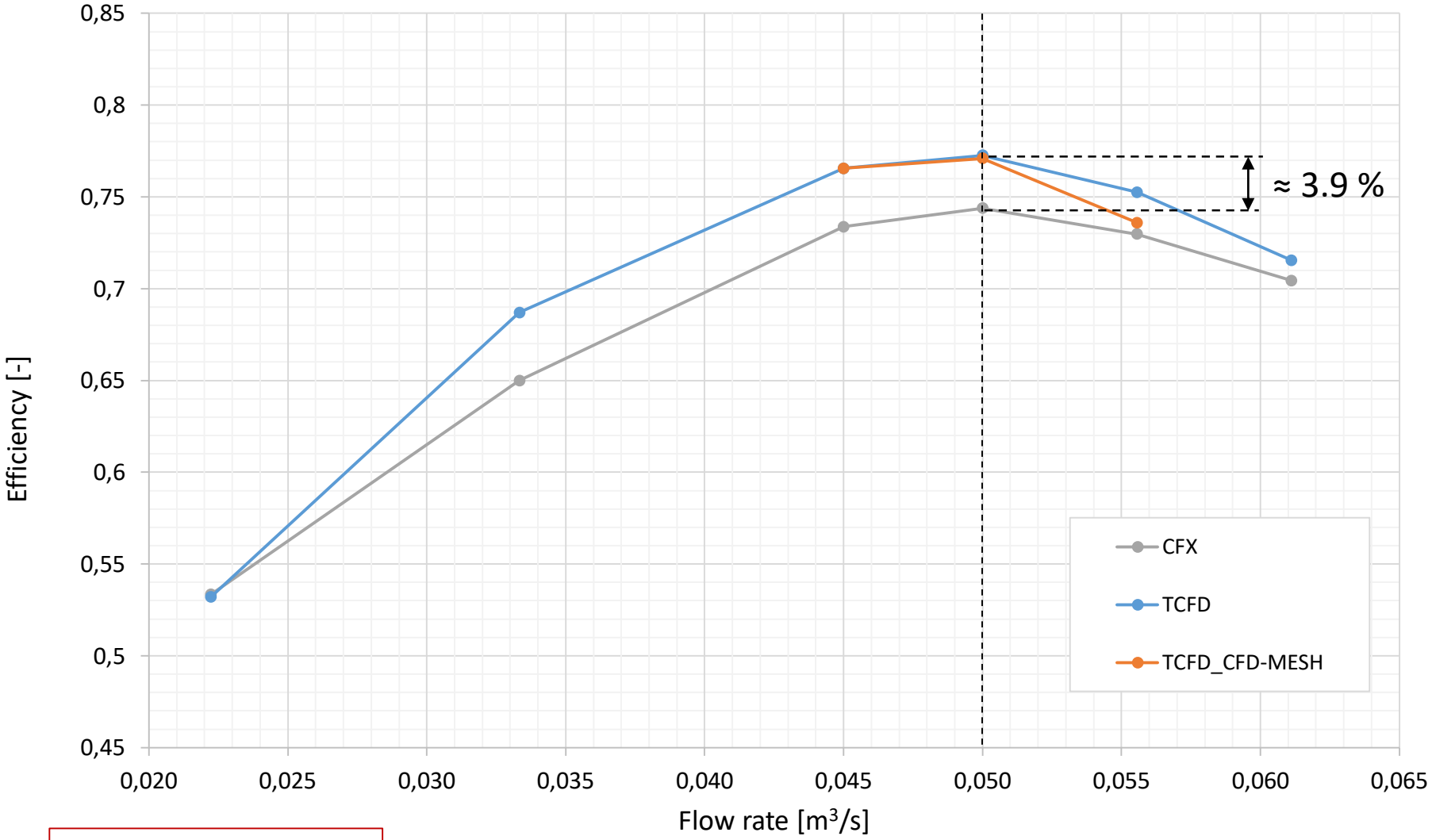
➢ All values area averaged

1.3 Result: Static pressure difference - Stage



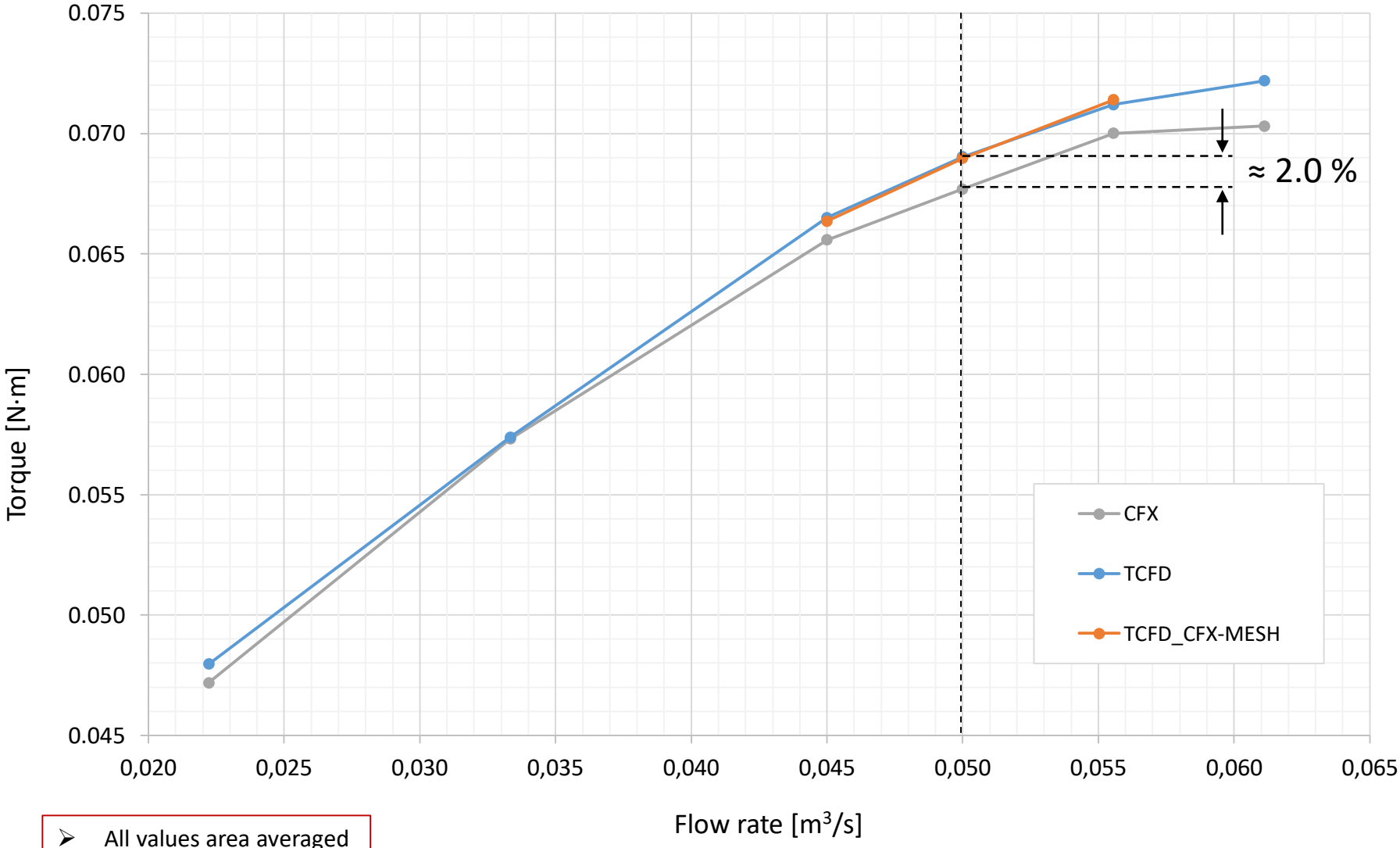
➢ All values area averaged

1.3 Result: Efficiency - Stage



➢ All values area averaged

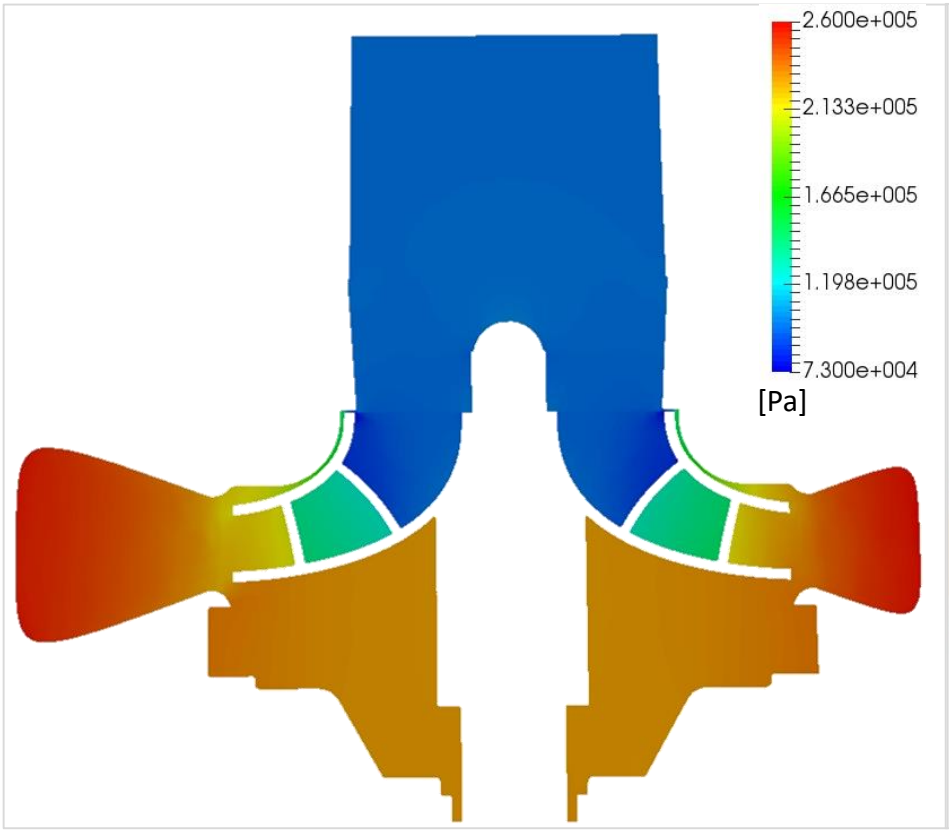
1.3 Result: Torque



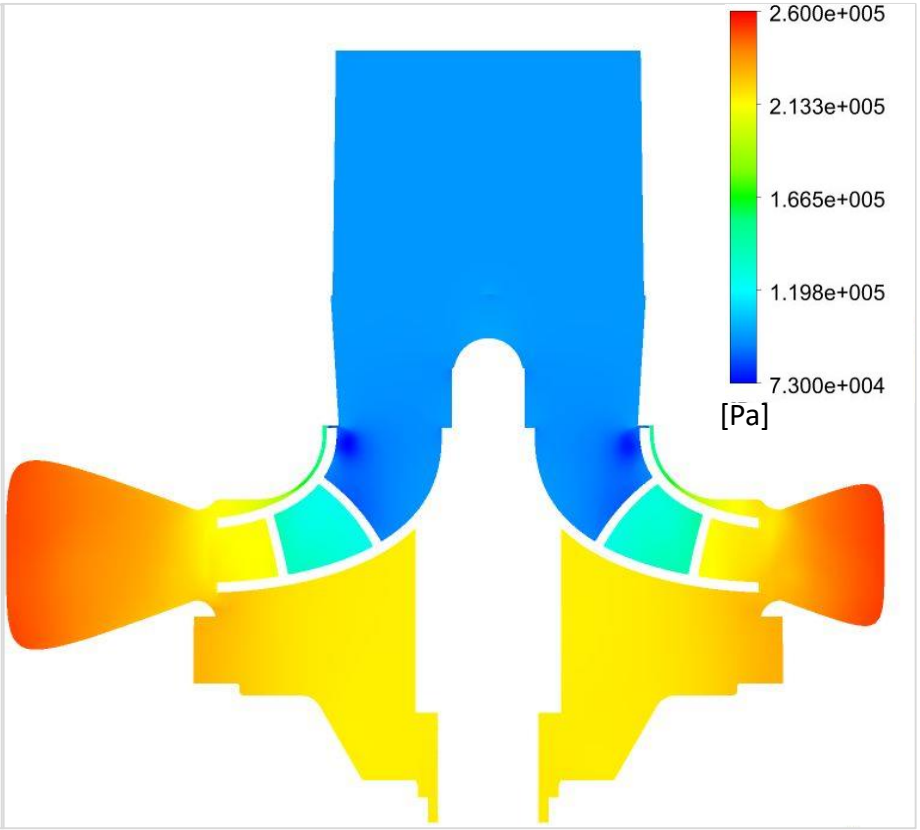
➢ All values area averaged

1.3 Result: Static pressure

Vflowrate: 0.05 [m3/s]



<TCFD>

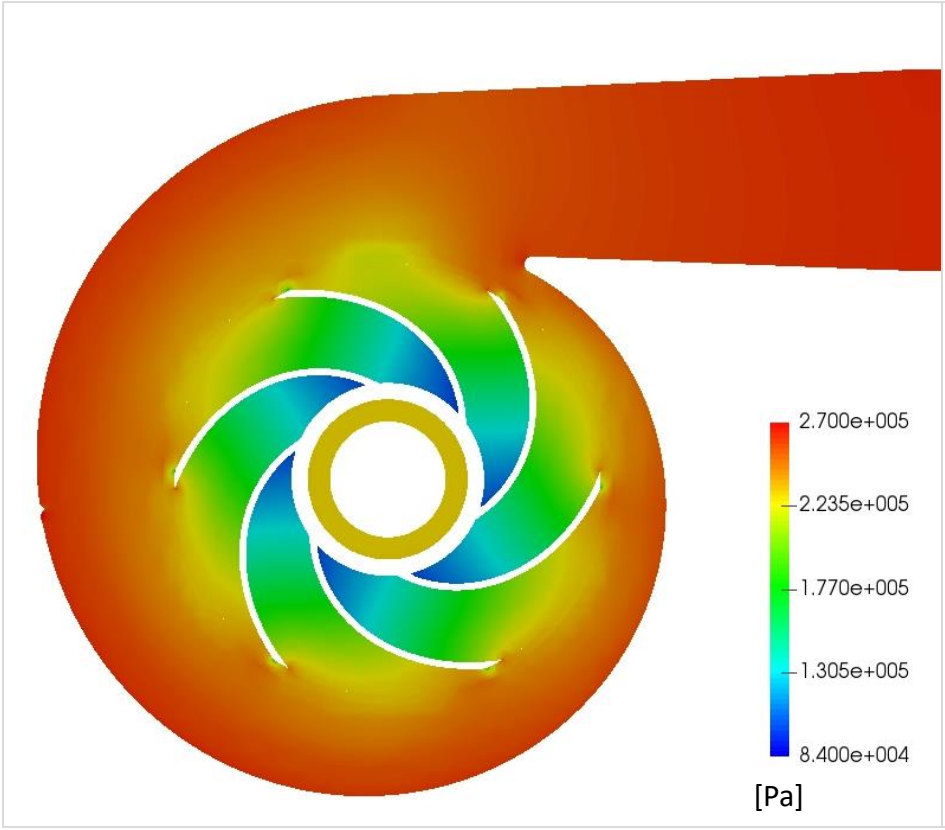


<CFX>

✓ Treatment of pressure in paraview:
p_{stat} = p*density – p@INLET of TCFD + p@INLET of CFX

1.3 Result: Static pressure

Vflowrate: 0.05 [m3/s]



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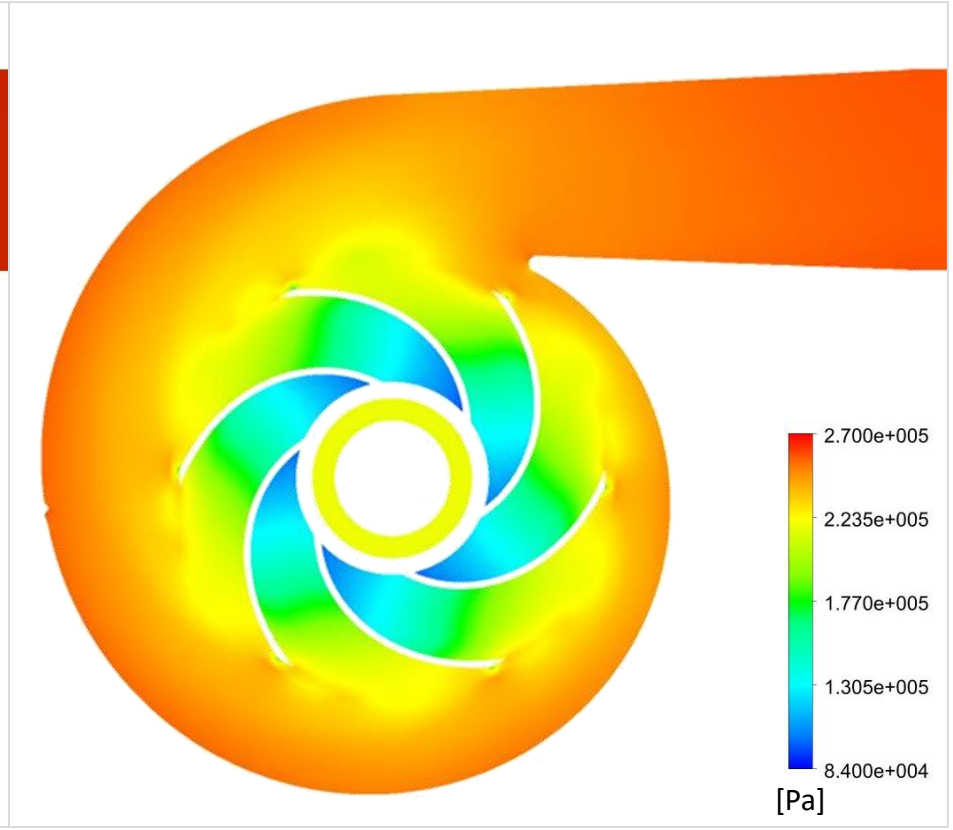


<CFX>

✓ Treatment of pressure in paraview:
p_{stat} = p*density – p@INLET of TCFD + p@INLET of CFX

1.4 Summary

1) **AMI interface has to be used for rotating component with Multiple interfaces**
   - mxp setting value: “0“
   - Mixing plan interface for multiple interface causes error during the interation

2) **TCFD overestimates the total pressure difference compared to result of CFX**
   - Maximum gap in total pressure difference: ~ 6 %

3) **The results from TCFD mesh and TCFD simulation with CFX mesh are almost overlapped**

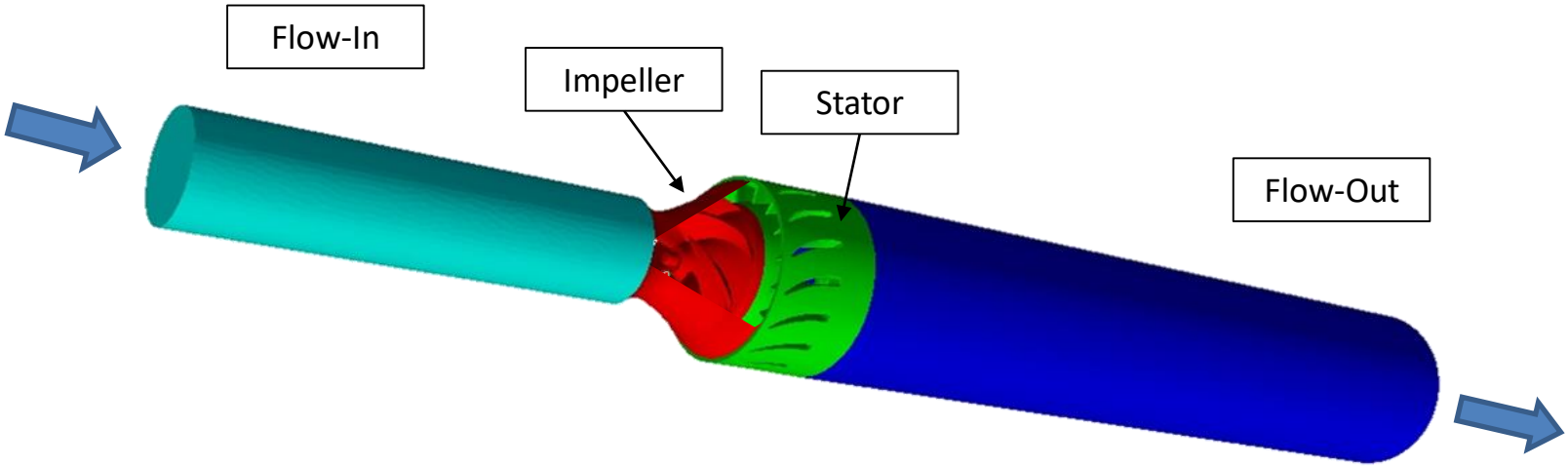
4) **The cause of the difference with CFX result is not about MESH**
   - 3 % – 6 % gap in result can be caused by difference of solver.

Radial Blower 01
BM_RB01

2.1 Case settings

Physical settings (Air)	
Dynamic viscosity	1.831e-05 [kg/m·s]
Ref. Density	1.19 [kg/m^3]
Ref. Temperature	293.15 [K]
Ref. Pressure	100000 [Pa]
Compressible	Yes

Operating conditions	
Rotating speed	82500 [rpm]
Flow rate [m^3/s]	
P1	0.015
P2	0.016
P3	**0.017**
P4	0.018
P5	0.020

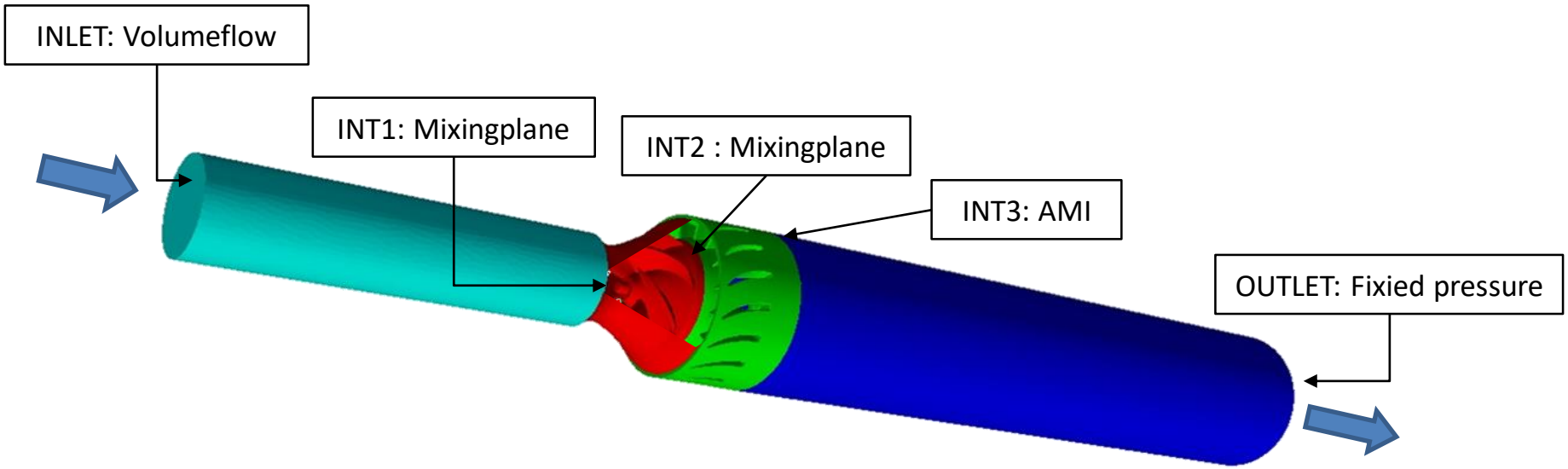


2.1 Case settings

Pressure settings	
Max/Min pressure	± 1,000,000 [Pa]
Outlet pressure	110,000 [Pa]
Initial pressure	100,000 [Pa]

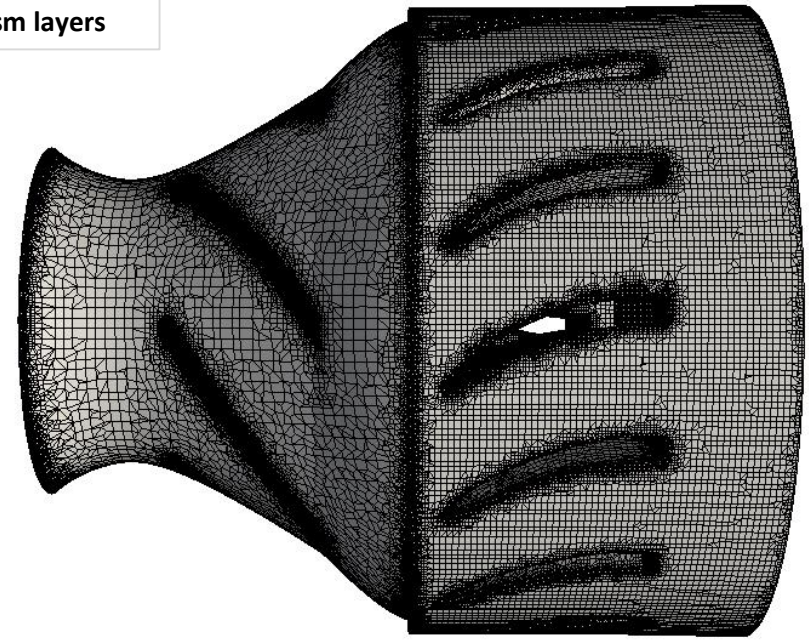
Relaxation factors	
Pressure	0.3
Velocity	0.7
Temp. & Turb.	0.1
Density	0.1

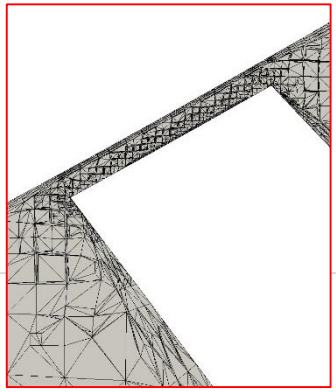
Mesh settings	
Background mesh size	0.003 (Co1 & Co4) 0.0016 (Co3) 0.0014 (Co2)
refinementsurface (Diffusor wall)	2 4
Blade cap gap	0.00015 [m]
No. of layers	3

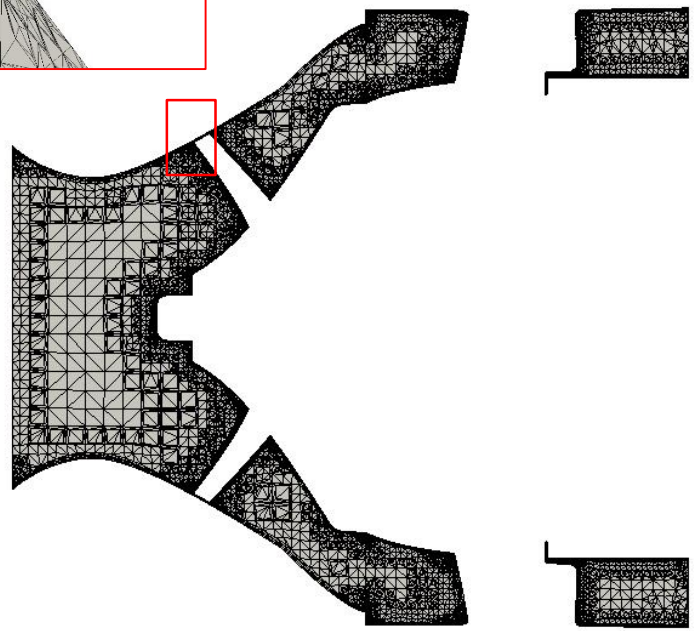


2.2 Mesh

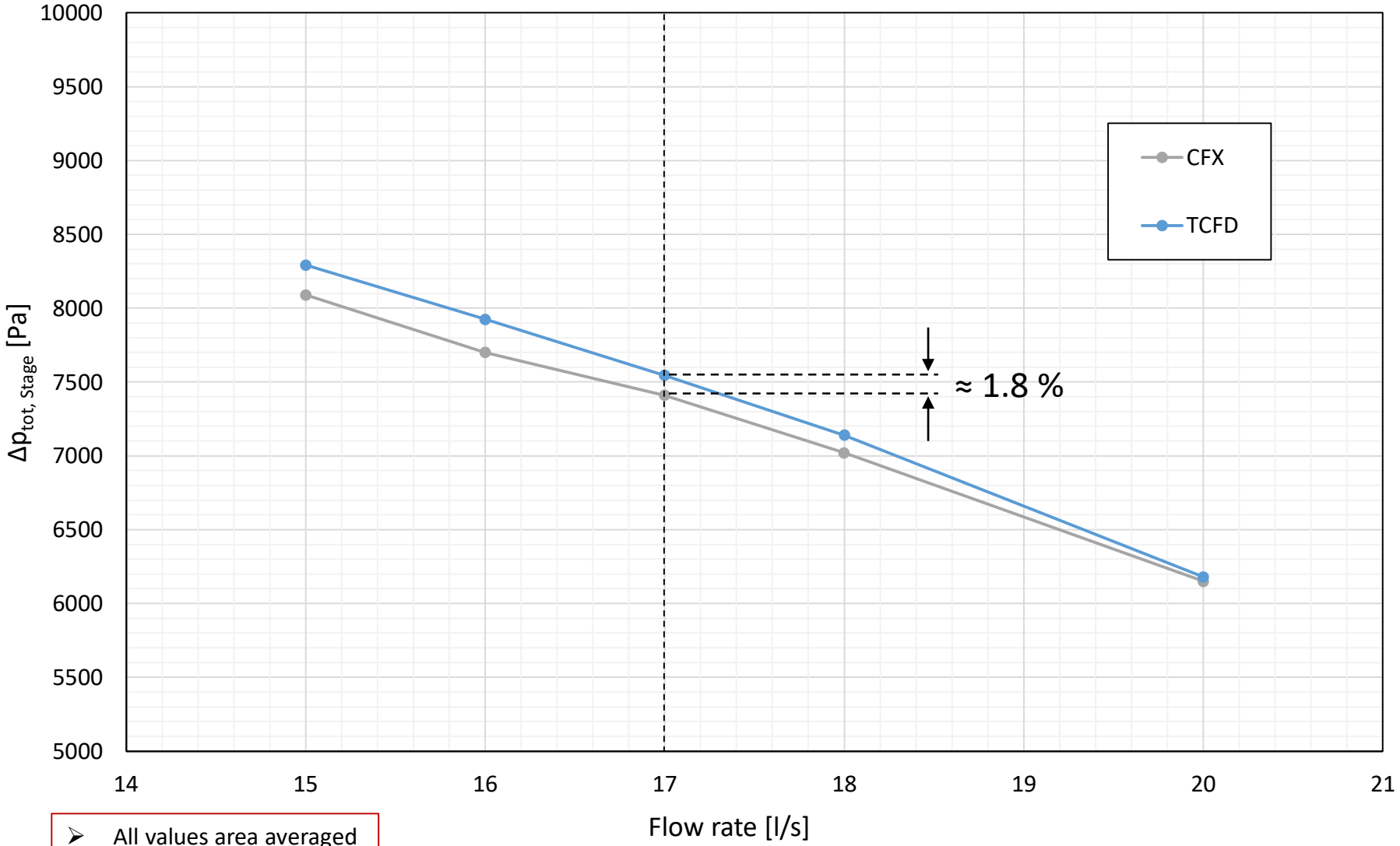
3.0 M cells
3 prism layers





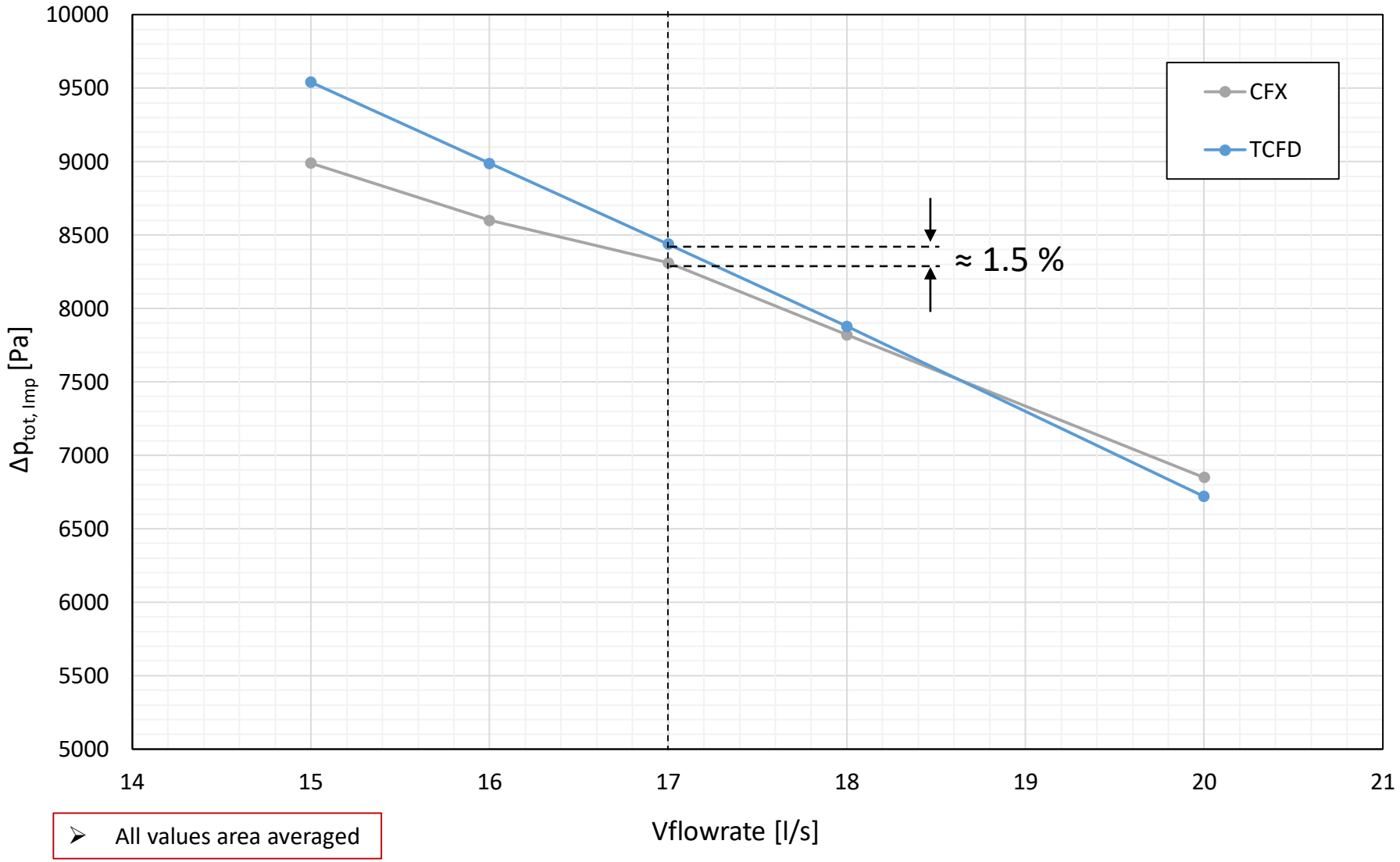


2.3 Result: Total pressure difference - Stage



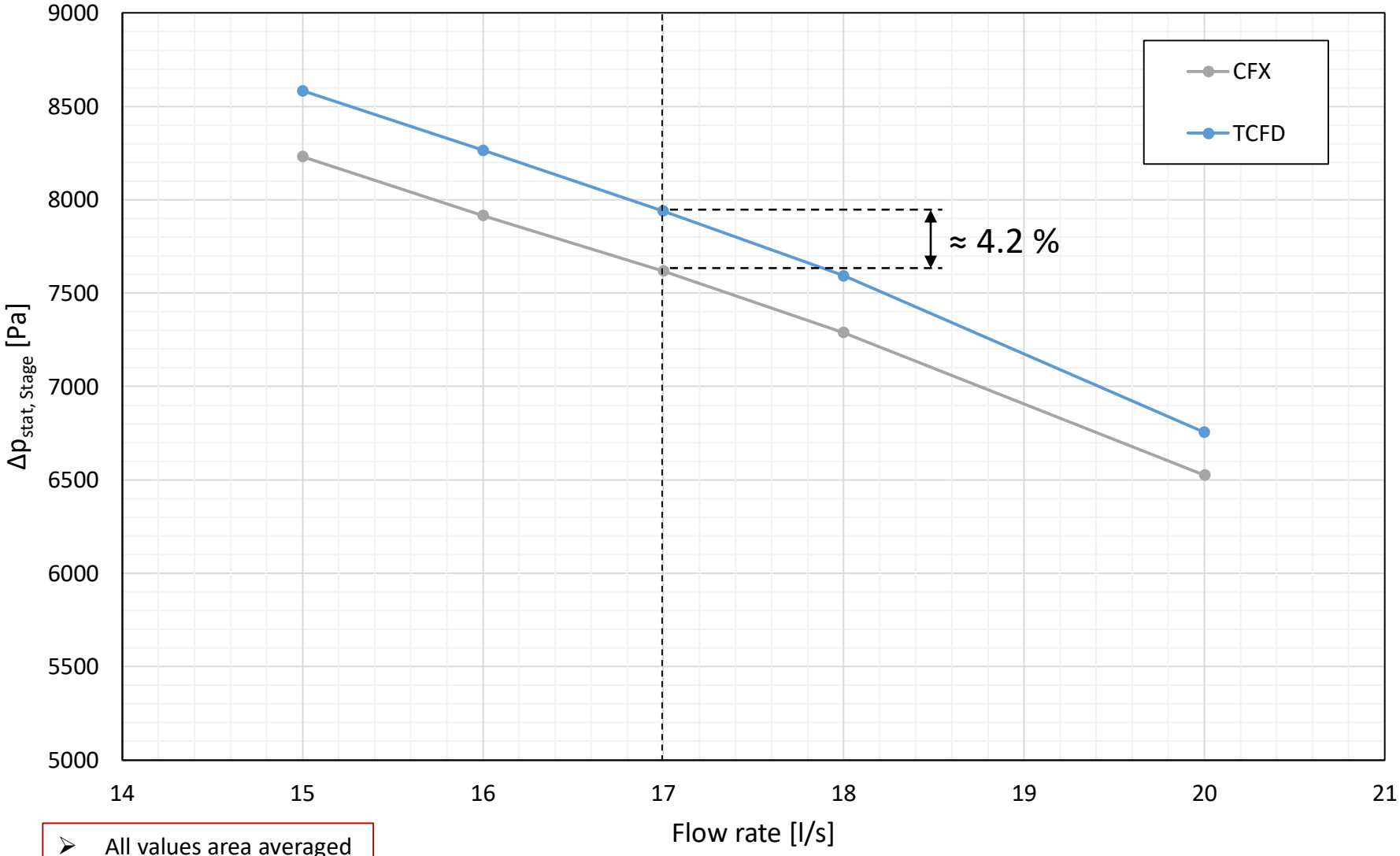
➢ All values area averaged

2.3 Result: Total pressure difference - Impeller



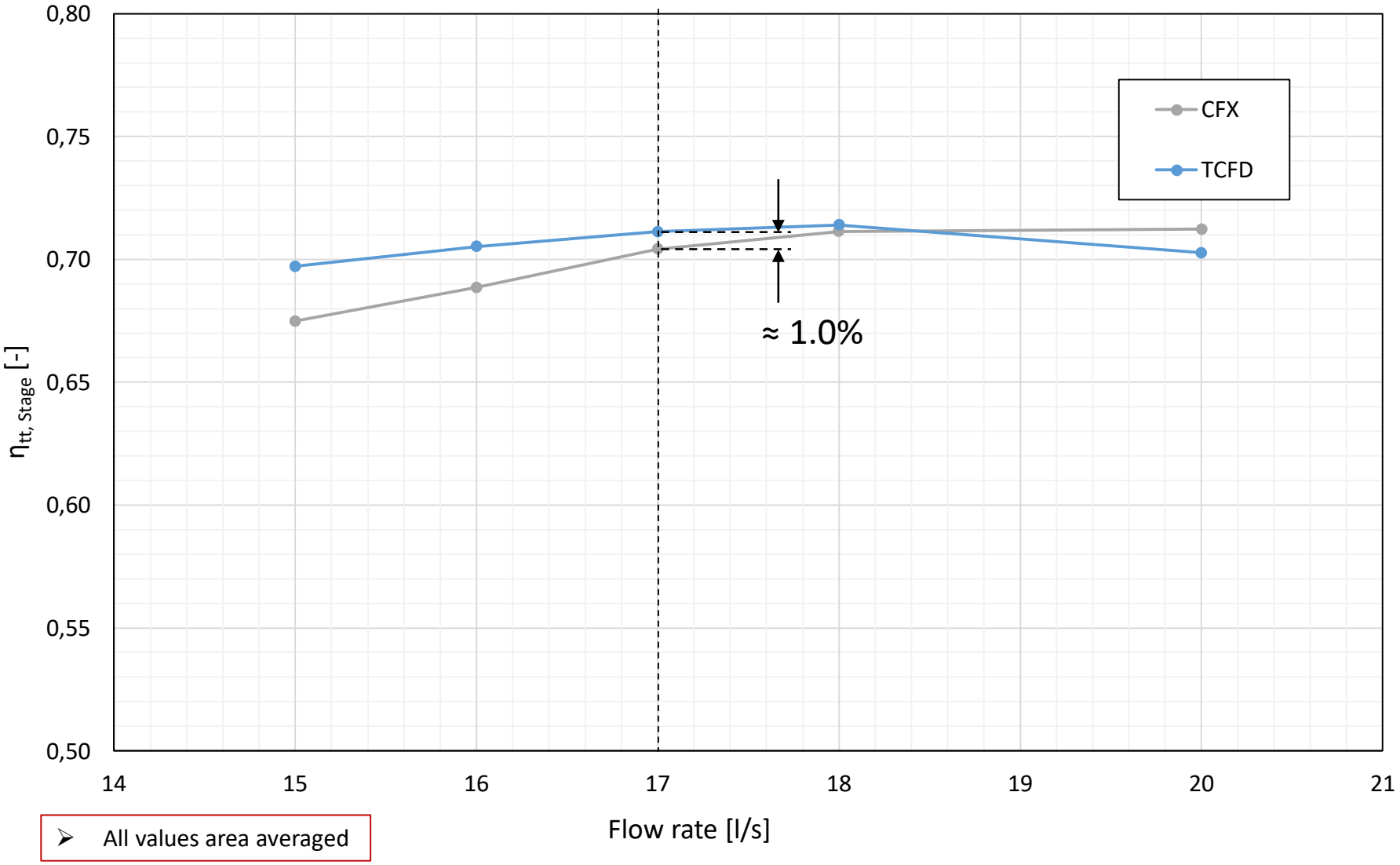
➢ All values area averaged

2.3 Result: Static pressure difference - Stage



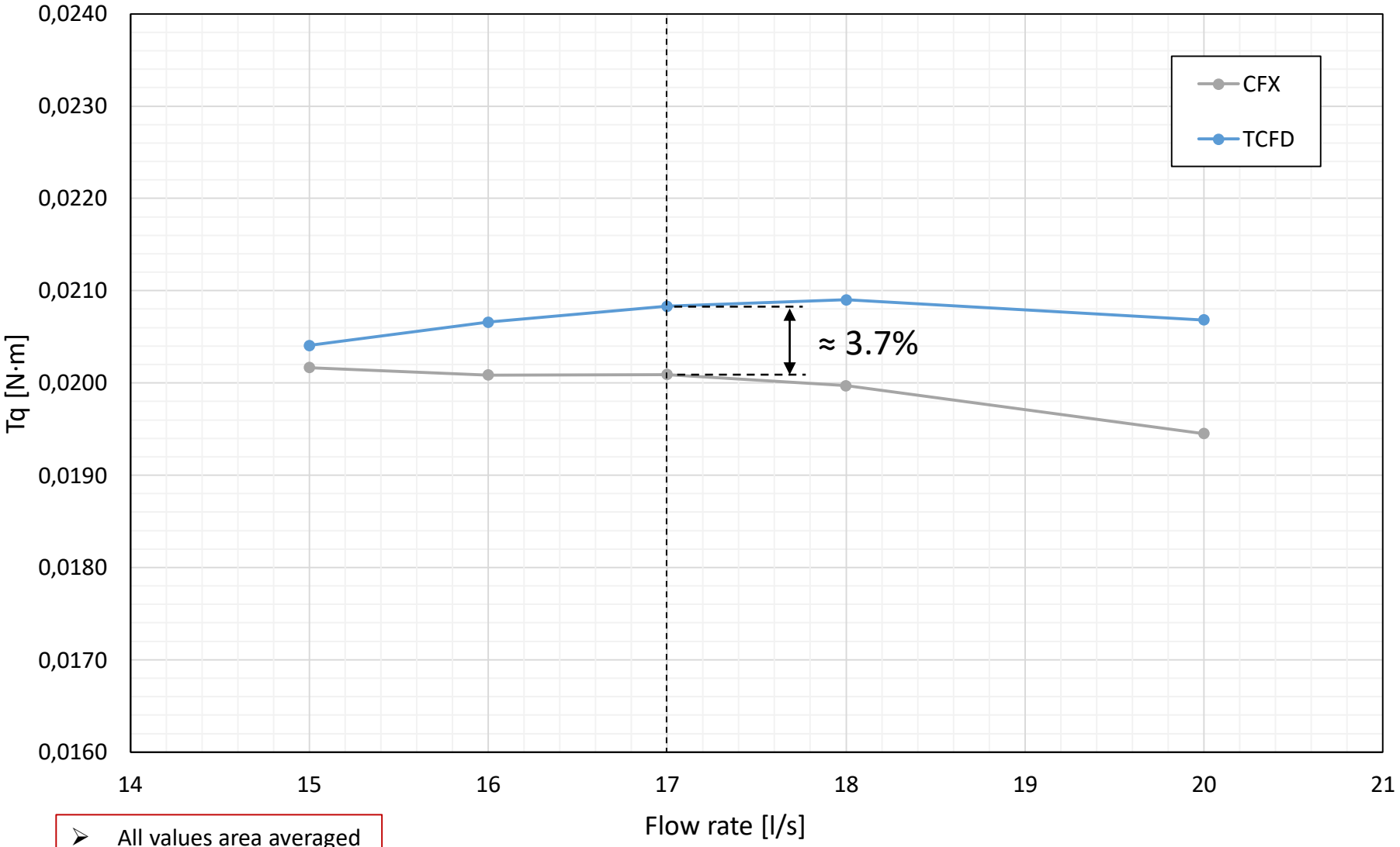
➢ All values area averaged

2.3 Result: Efficiency - Stage



➢ All values area averaged

2.3 Result: Torque

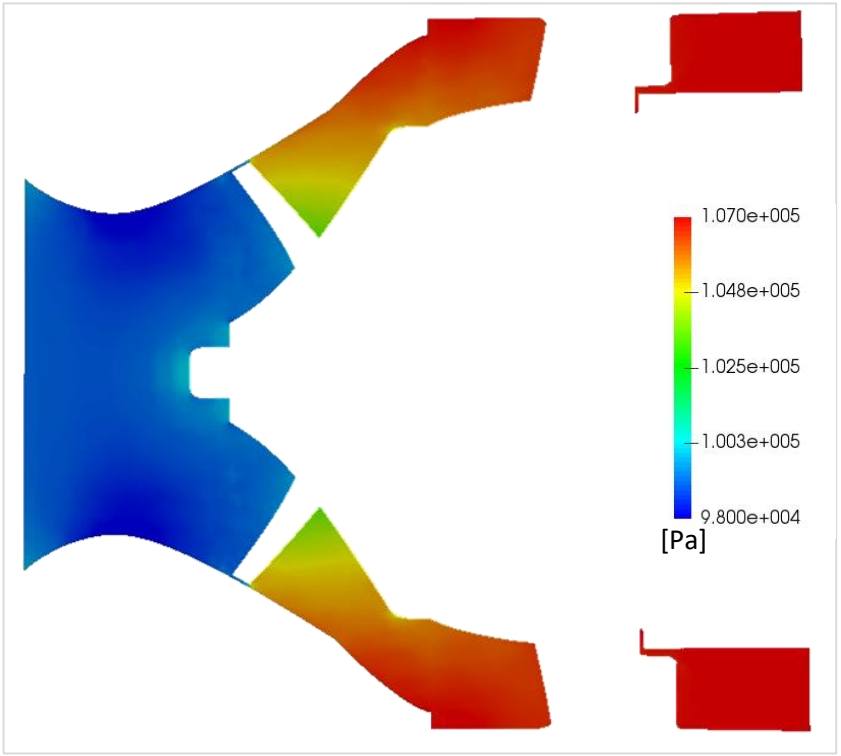


➢ All values area averaged

2.3 Result: Static pressure

X-normal cross-section (x=0)

Vflowrate: 0.017 m^3/s



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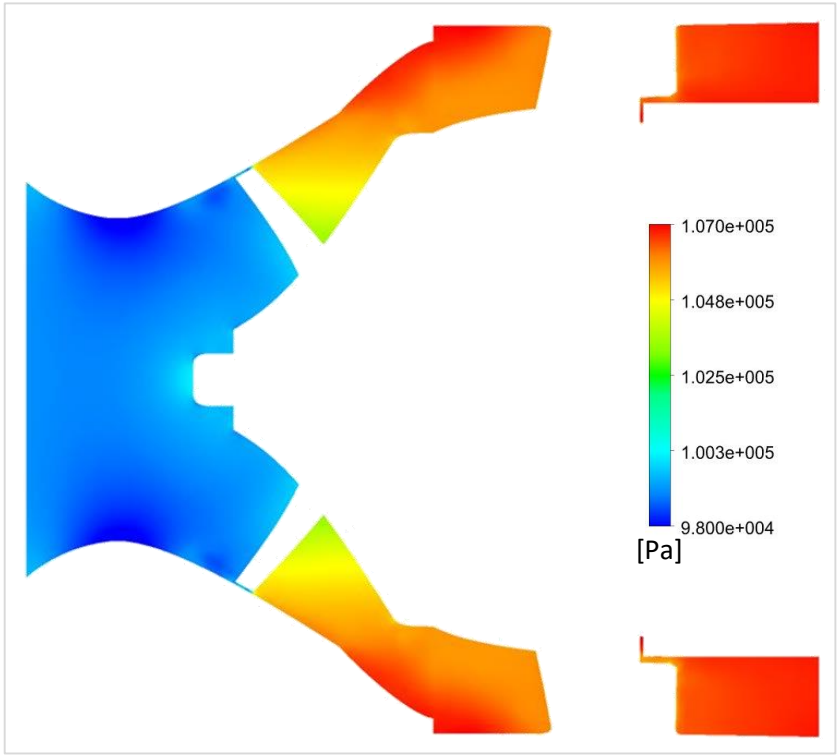


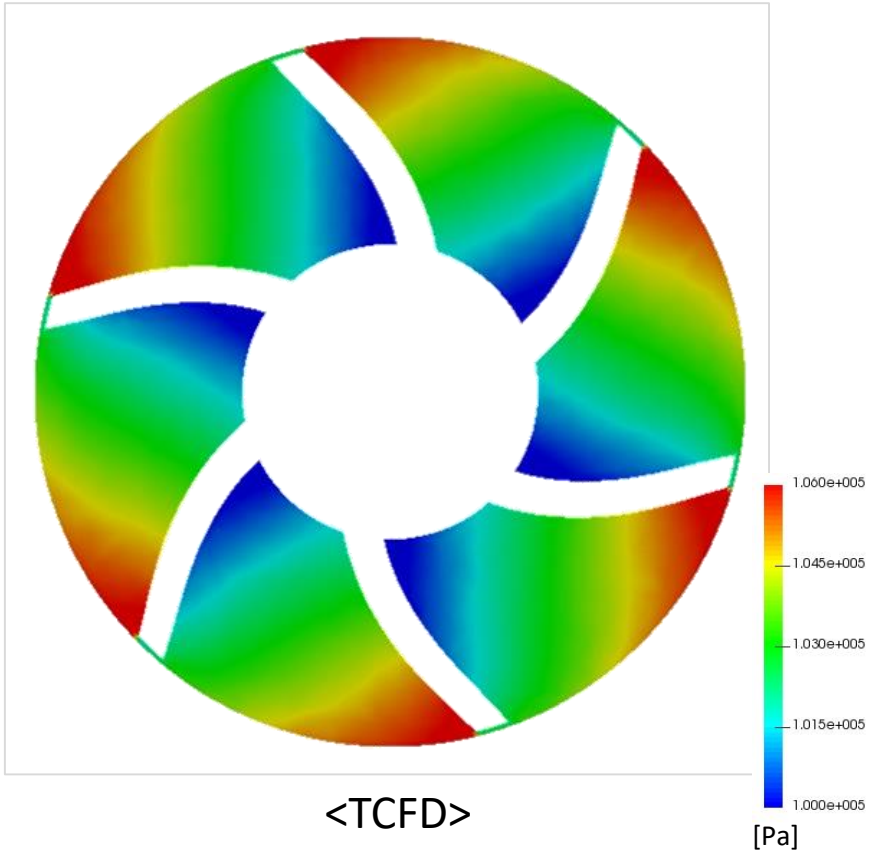
<CFX>

✓ Treatment of pressure in paraview:
p_{stat} = p – p@INLET of TCFD + p@INLET of CFX

2.3 Result: Static pressure

Z-normal cross-section (z=0.015)

Vflowrate: 0.017 m^3/s



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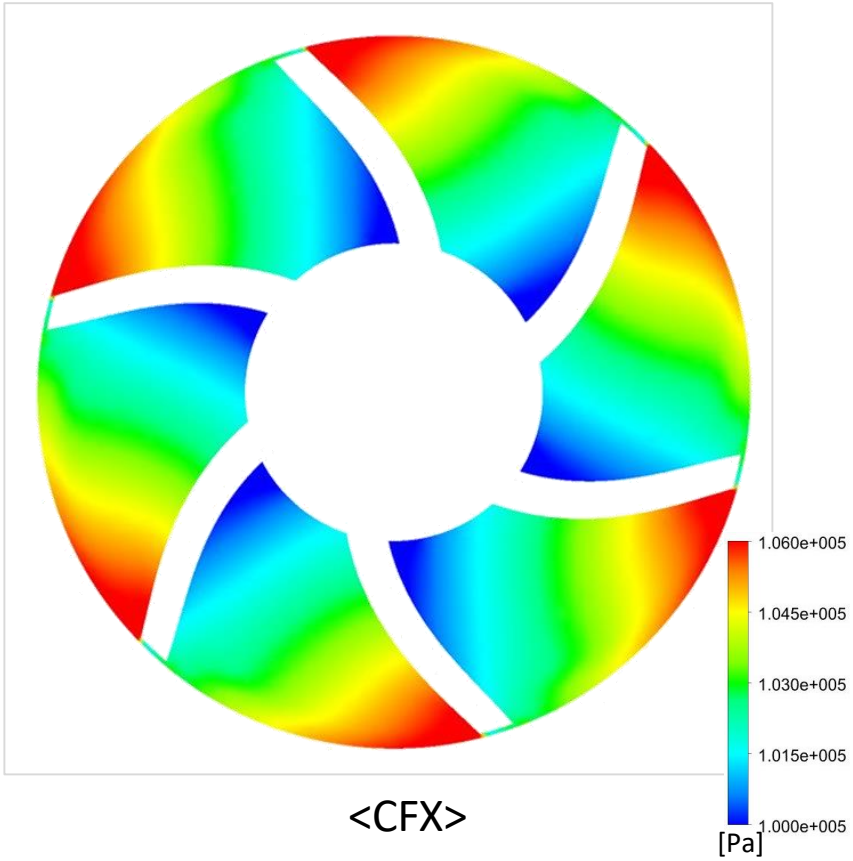

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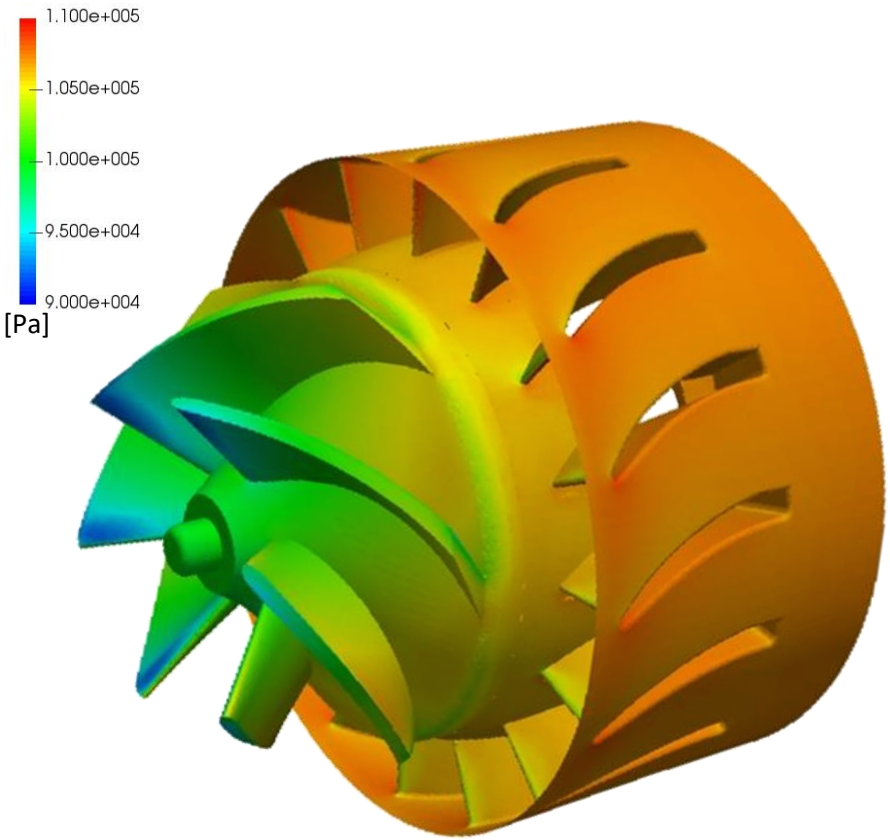
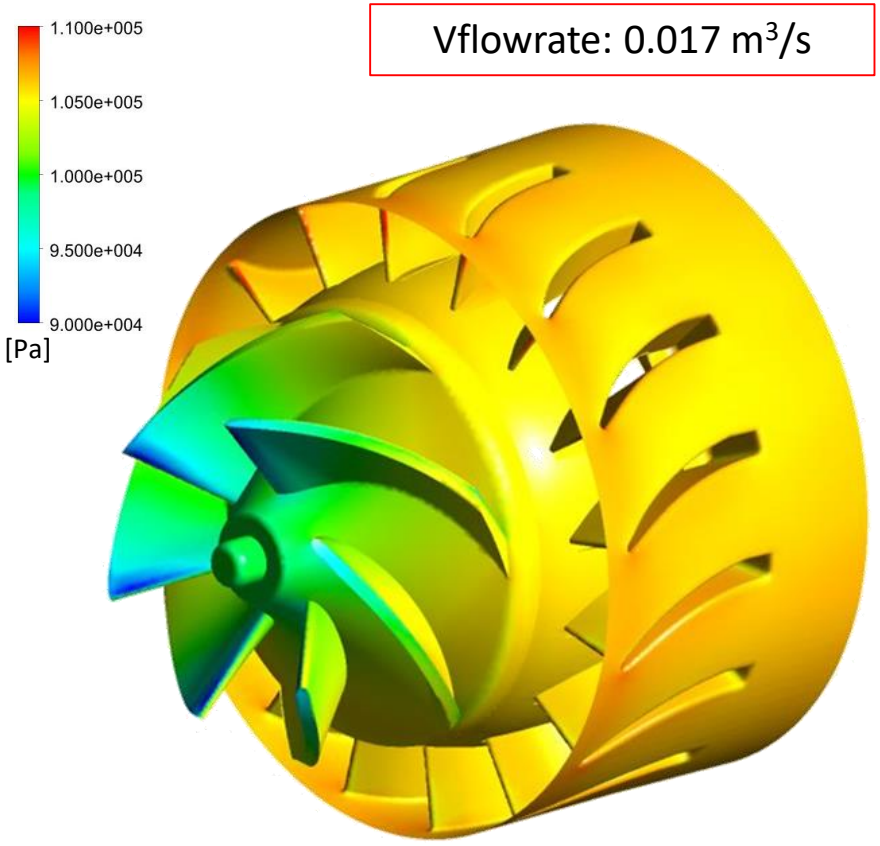
✓ Treatment of pressure in paraview:
p_{stat} = p – p@INLET of TCFD + p@INLET of CFX

2.3 Result: Static pressure



<TCFD>

Vflowrate: 0.017 m^3/s



<CFX>

✓ Treatment of pressure in paraview:
p_{stat} = p – p@INLET of TCFD + p@INLET of CFX

2.4 Summary

1) **Recent version of TCFD supports the Mesh at the clearance**
   - Refinement factors are changed automatically by specifying the length of gap

2) **Compressible settings**
   - Pressure setting for outlet should be higher than surroundings
   - Recommended relaxation factors for fan case:

p_relaxation	0.2/0.3
U_relaxation	0.5/0.7
Rho_relaxation	0.01/0.1
Turb. & T_relax	0.01/0.1

3) **TCFD overestimates the pressure difference and torque compared to result of CFX.**
   - Gap in total pressure difference: 1.5% - 1.8 %

4) **TCFD simulation with CFX mesh was not possible**
   - due to the different size of INT2 in each side (different diameter of outlet of impeller and inlet of diffusor)
   - Mis-match of each side of interface patch causes high fluctuation of variables