Solver Validation with the TUDa compressor

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Solver introduction

AeroX:

Multi-block structured mesh on Cartesian coordinate system
Spalart-Allmaras turbulence model

Spatial discretization:

- Convective fluxes: JST scheme with the scaled numerical disspation
- Diffusive fluxes: evaluate the gradient of the velocity, temperature and turbulence quantity at cell center using the Gauss's theorem, then use central scheme to get face fluxes

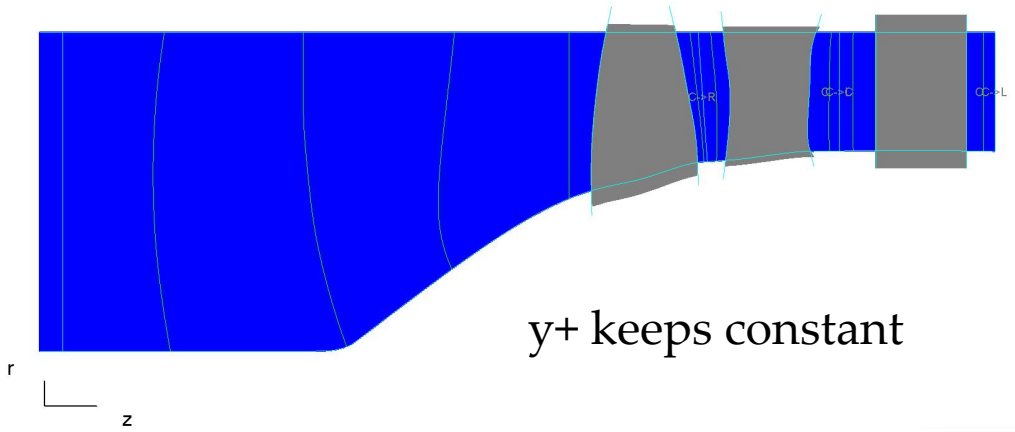
Time integration in pseudo time:

- Local time stepping
- Hybrid method combining explicit five stage Runge-Kutta method and implicit LU-SGS method

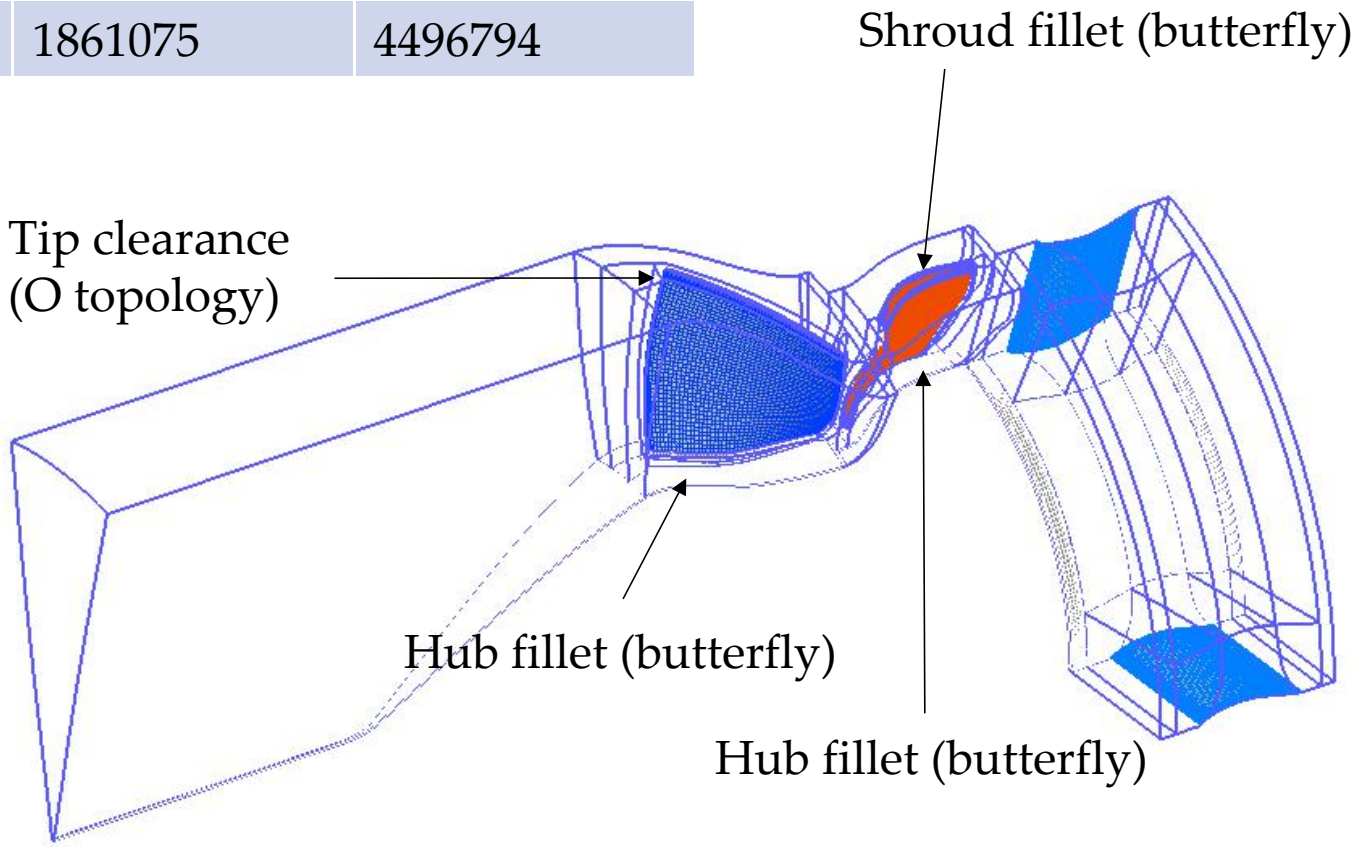
Mesh generation

Mesh	Row1	Row2	Row3	Total
Coarse	444875	260227	484071	1189173
Medium	874607	576715	899795	2351117
Fine	1646583	989139	1861075	4496794

The number of grid points is twice as much as the coarser mesh

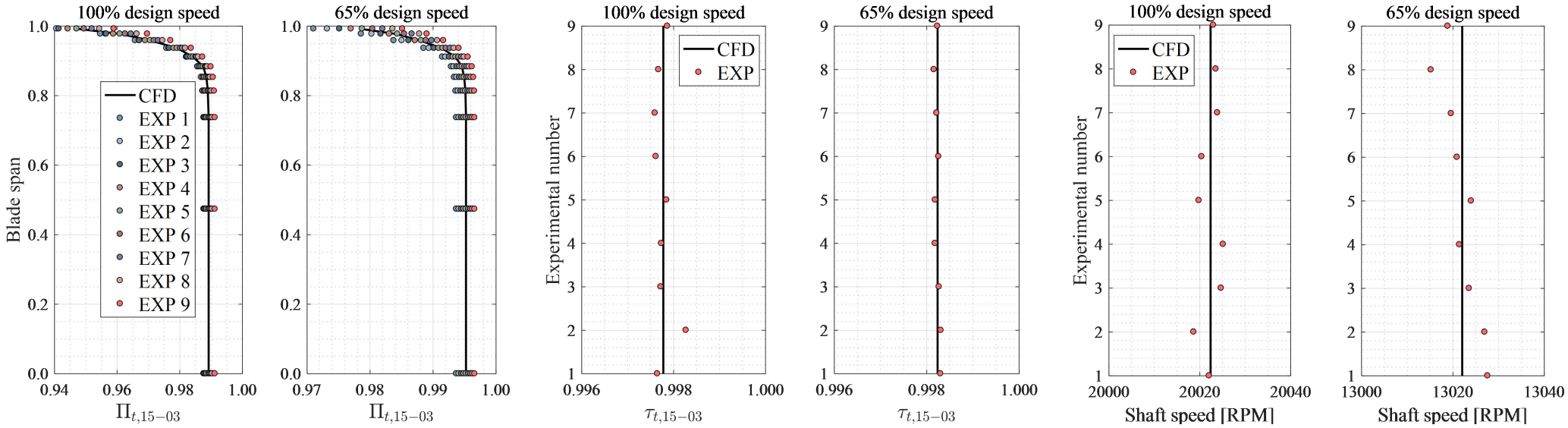


y+ keeps constant



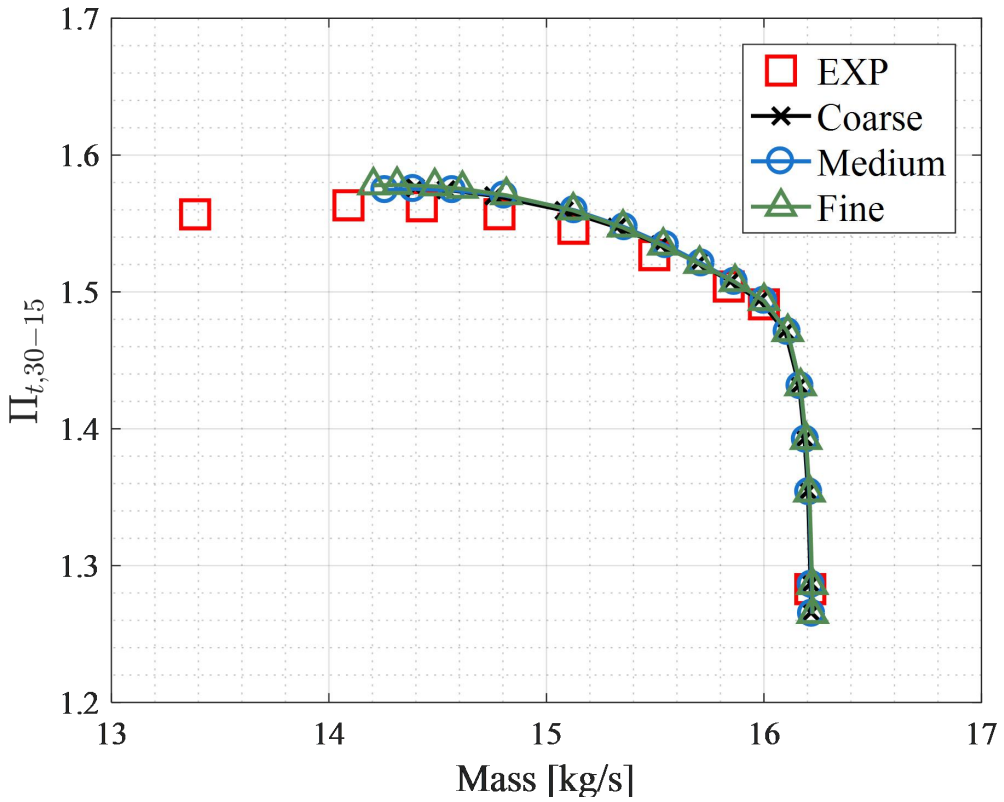
Inlet boundary settings

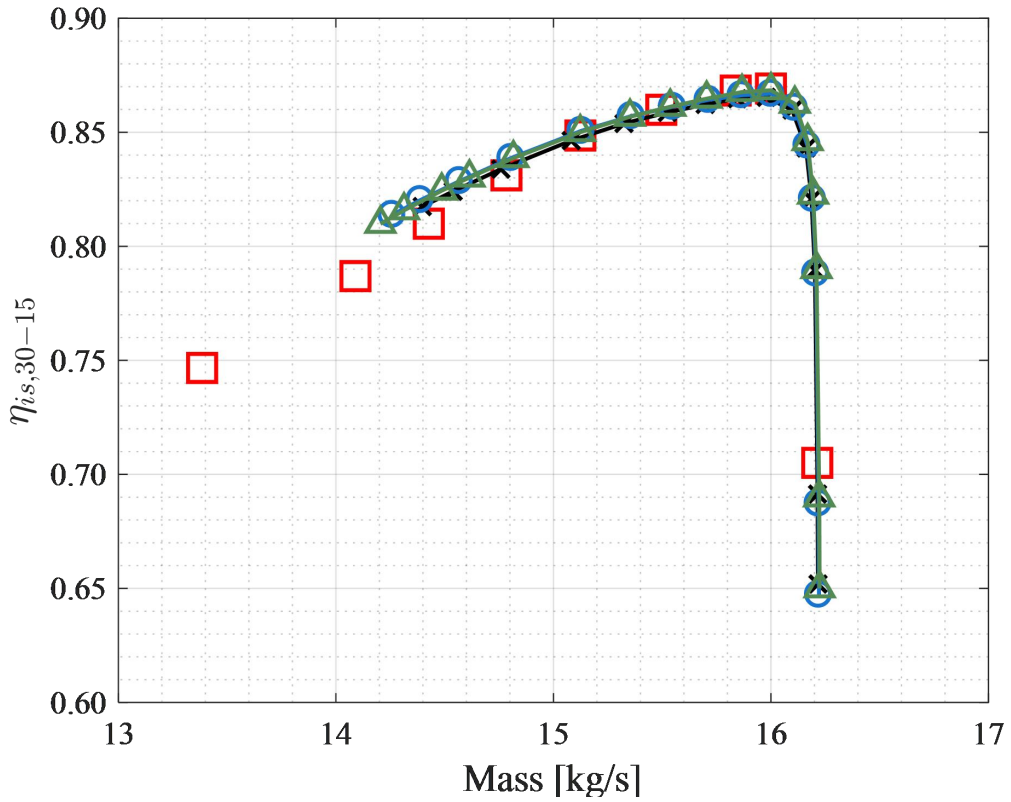
Inlet boundary (ME15) conditions: converted to ideal gas model: 101325Pa/288.15K



Performance map is obtained by increasing the back pressure

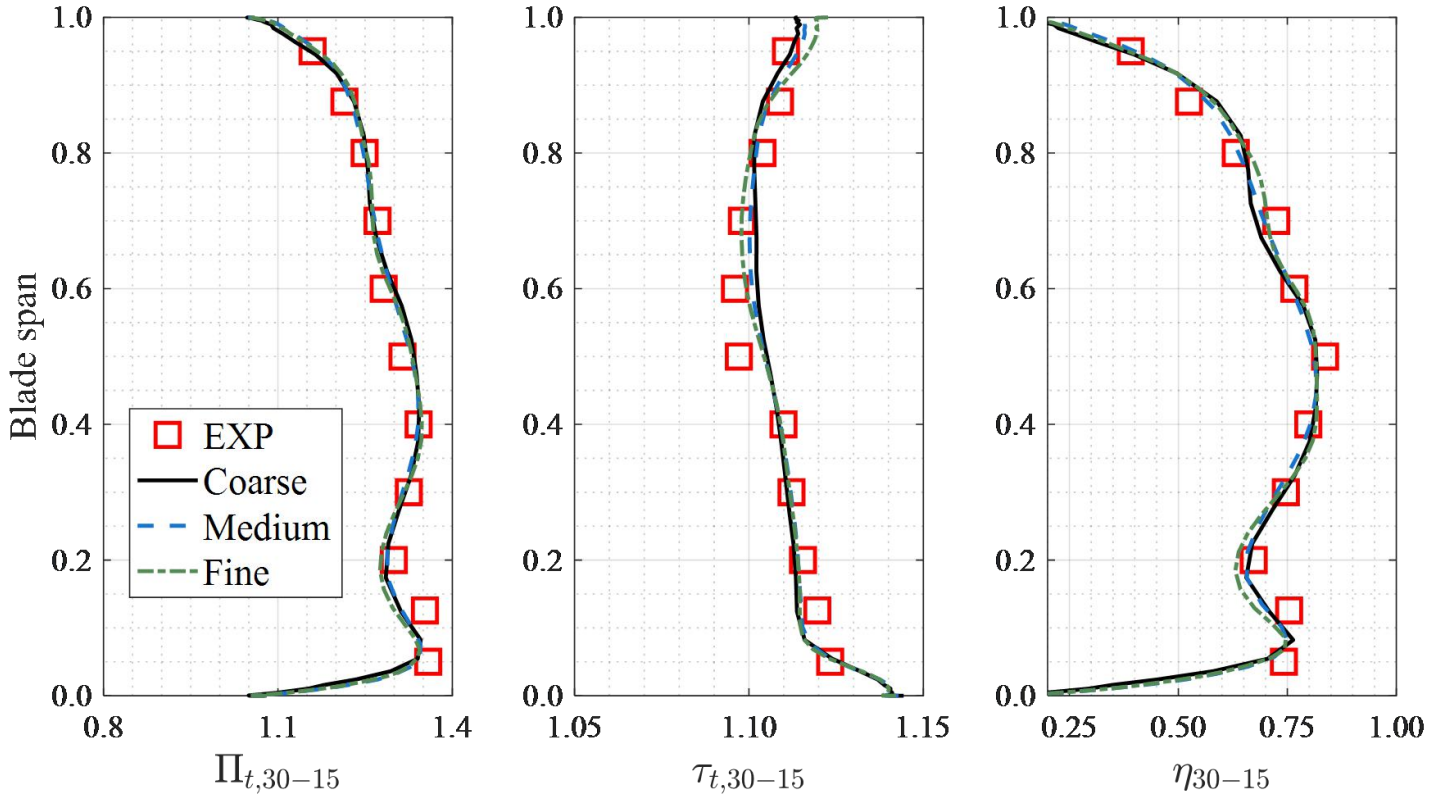
Performance map – 100% design speed





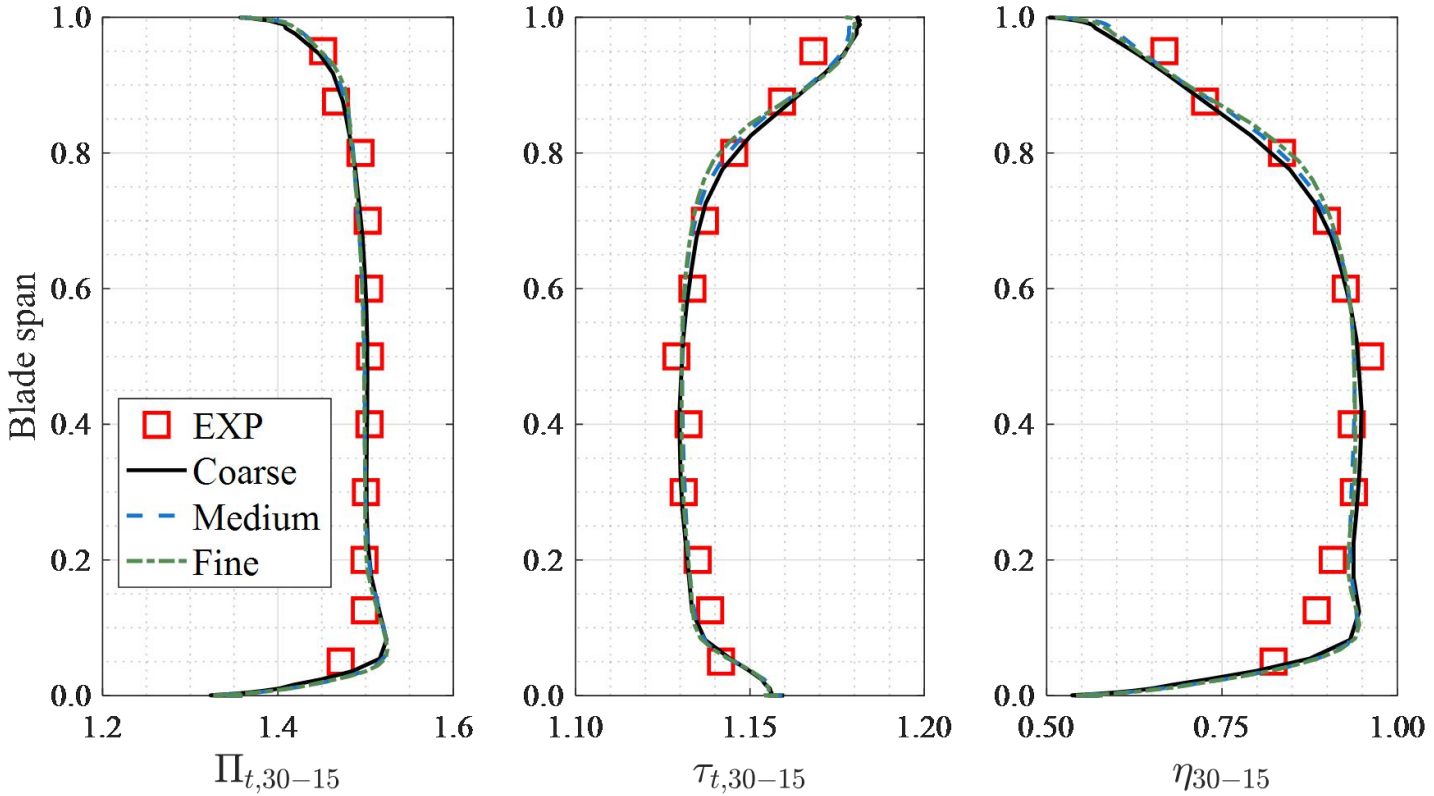
Radial profile (ME30 stator exit 100% speed)

Method	Mass	$\Pi_{t,30\text{-}15}$	$\eta_{is,30\text{-}15}$
EXP	16.2130	1.2828	0.7051
Coarse	16.2143	1.2870	0.6914
Medium	16.2191	1.2861	0.6873
Fine	16.2219	1.2857	0.6899



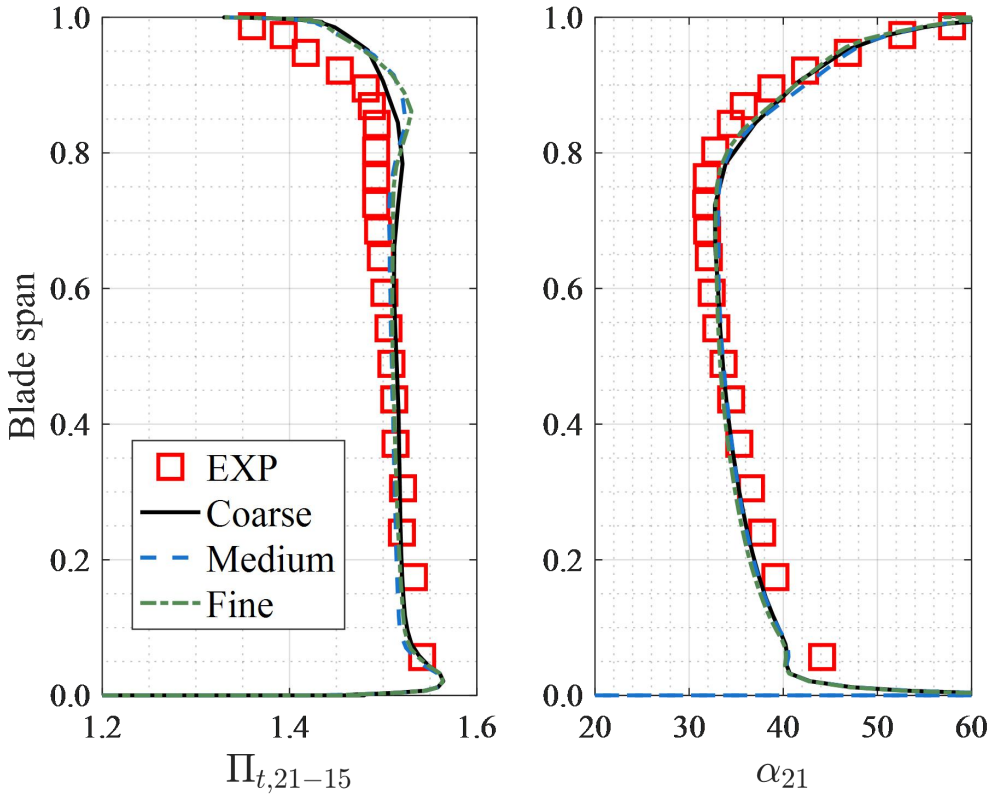
Radial profile (ME30 stator exit 100% speed)

Method	Mass	$\Pi_{t,30\text{-}15}$	$\eta_{is,30\text{-}15}$
EXP	16.00	1.4949	0.8691
Coarse	15.98	1.4939	0.8653
Medium	16.00	1.4936	0.8669
Fine	16.00	1.4933	0.8684

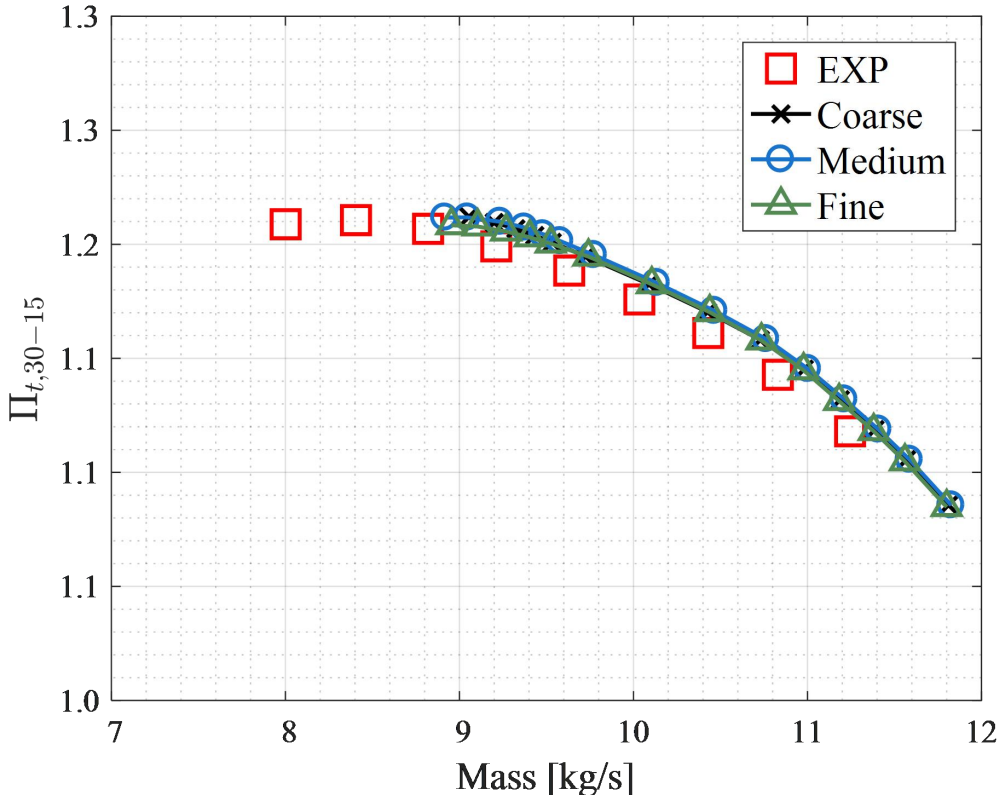


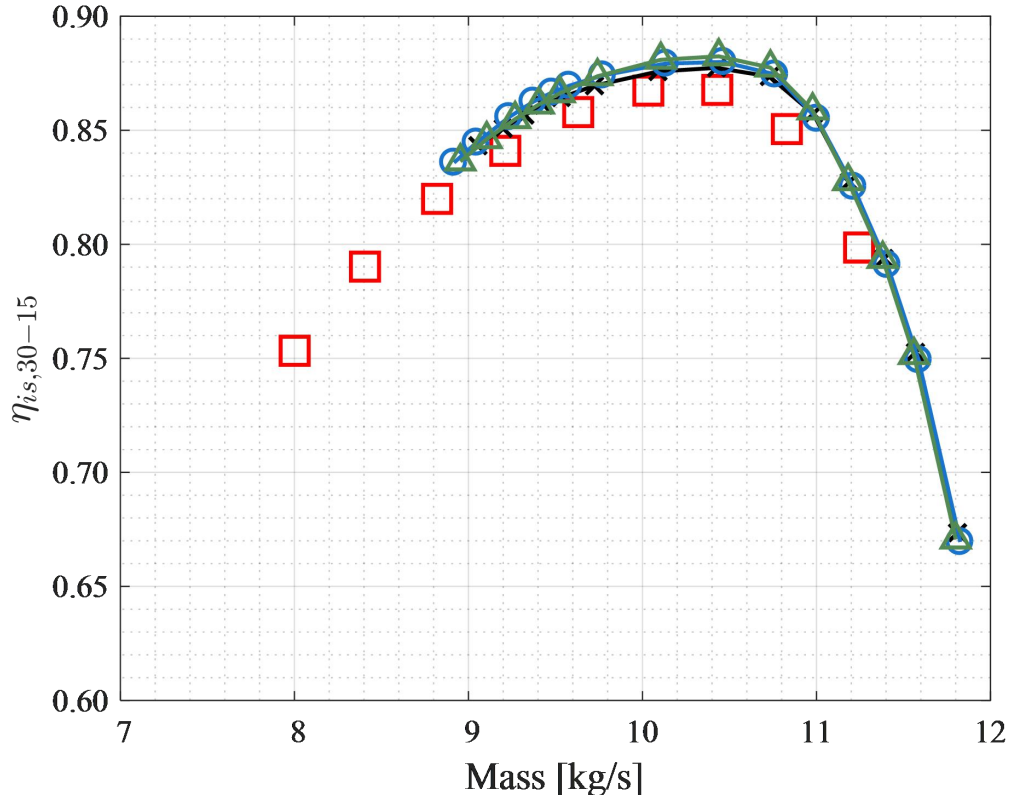
Radial profile (ME21 rotor exit 100% speed)

Method	Mass	$\Pi_{t,30\text{-}15}$	$\eta_{is,30\text{-}15}$
EXP	16.00	1.4949	0.8691
Coarse	15.98	1.4939	0.8653
Medium	16.00	1.4936	0.8669
Fine	16.00	1.4933	0.8684



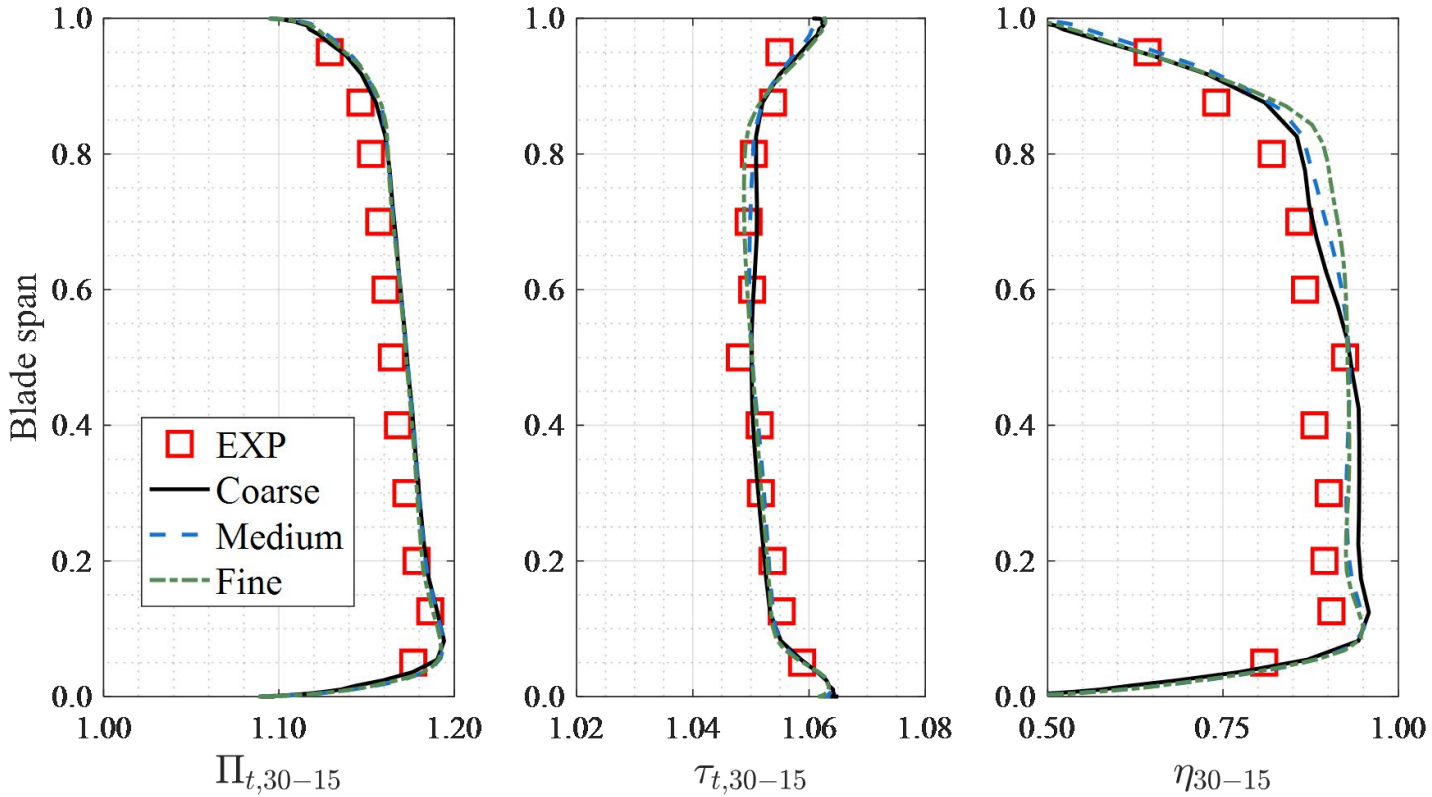
Performance map – 65% design speed





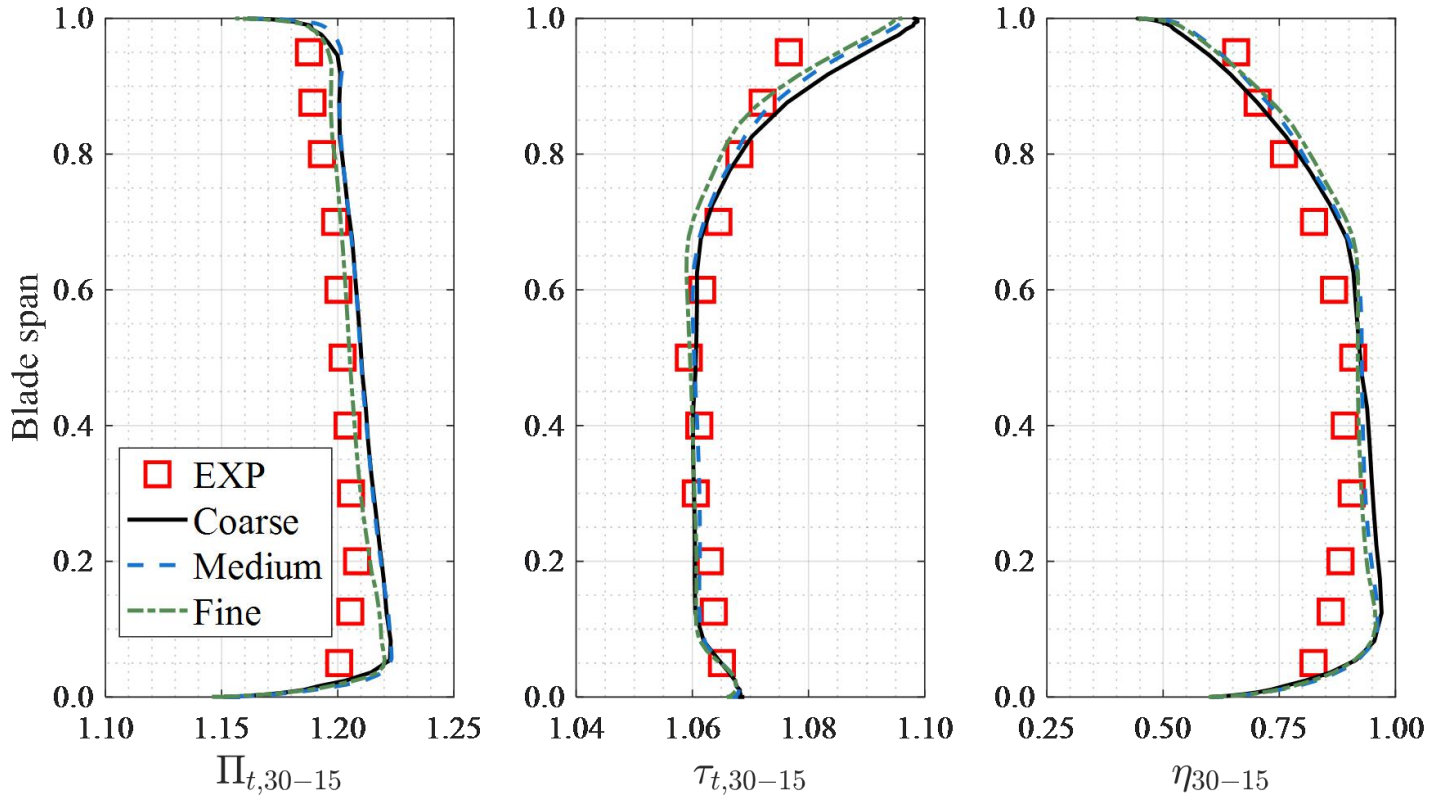
Radial profile (ME30 stator exit 65% speed)

Method	Mass	$\Pi_{t,30\text{-}15}$	$\eta_{is,30\text{-}15}$
EXP	10.43	1.1611	0.8677
Coarse	10.42	1.1705	0.8774
Medium	10.46	1.1709	0.8800
Fine	10.44	1.1702	0.8824



Radial profile (ME30 stator exit 65% speed)

Method	Mass	$\Pi_{t,30\text{-}15}$	$\eta_{is,30\text{-}15}$
EXP	9.212	1.1991	0.8410
Coarse	9.200	1.2096	0.8508
Medium	9.234	1.2099	0.8558
Fine	9.268	1.2056	0.8549



Conclusion

- TUDa compresser
  - The solutions by the three in-house meshes show a very low grid dependency for both the performance map and the radial profiles, at both the 100% speed and 65% speed
  - The solution predicted by AeroX has a good quantitative agreement with the experimental data in general

THANKS FOR YOUR ATTENTION