ASPAC and its validation on TUDa-GLR-OpenStage

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Outline

1 CFD setup

2 Computational results

3 An introduction to ASPAC

CFD setup

CFD solver

ASPAC(Aerodynamic Simulation Platform for Axial Compressor)

- Developed by CARDC
- cell-centered finite volume method
- multi-block structured grid
- MPI parallel
- scheme: LU-SGS, Roe
- turbulence: SA model(nu_t/nu=35 at inlet)
- ideal gas model
- operating condition: N100(design speed)

CFD setup

Grid and B.C.

Grid

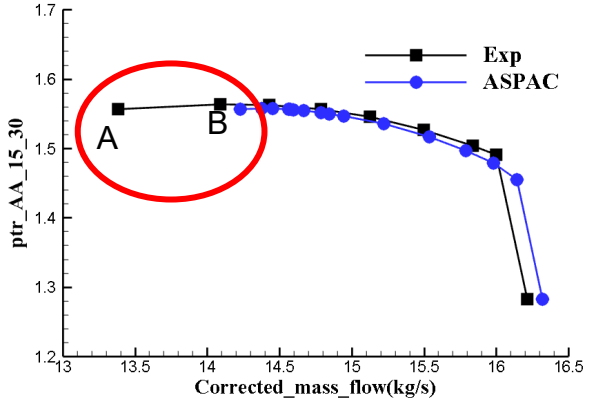
- official medium grid

B.C.

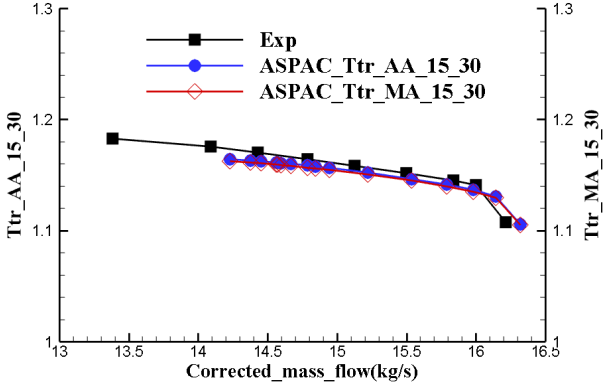
- inlet: from InletBC.input file
- outlet: radial equilibrium backpressure
- R/S interface: mixing plane, unconservative variables and nu_tilda are averaged based on absolute value of mass flow

Computational results

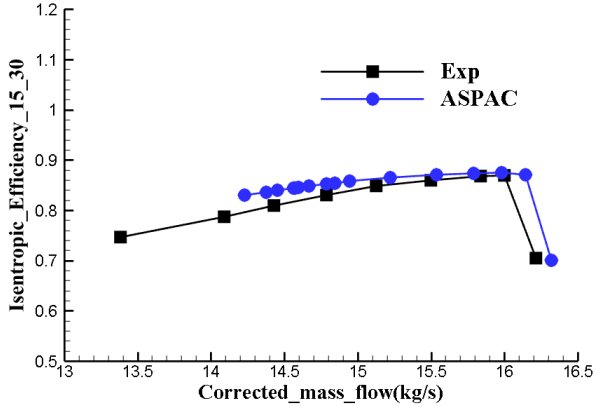
Overall performance



total pressure ratio



total temperature ratio



efficiency

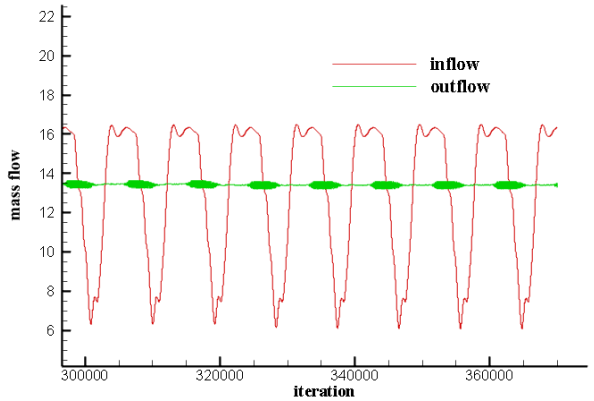
The speedline is generated through gradually increasing the back pressure

RANS simulation based on ASPAC can only reach point B.

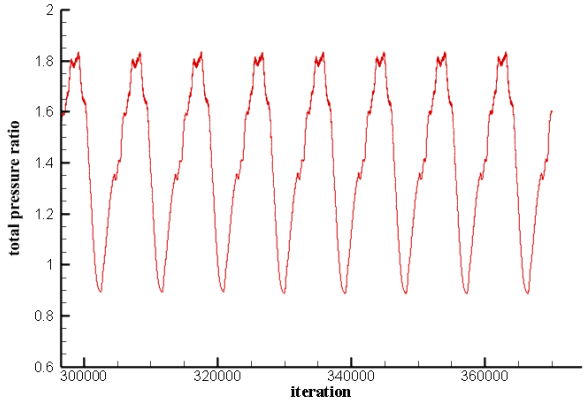
The mass flow condition is applied at outlet trying to simulate flow at point A, but the result is unphysical

Computational results

Overall performance



mass flow



total pressure ratio

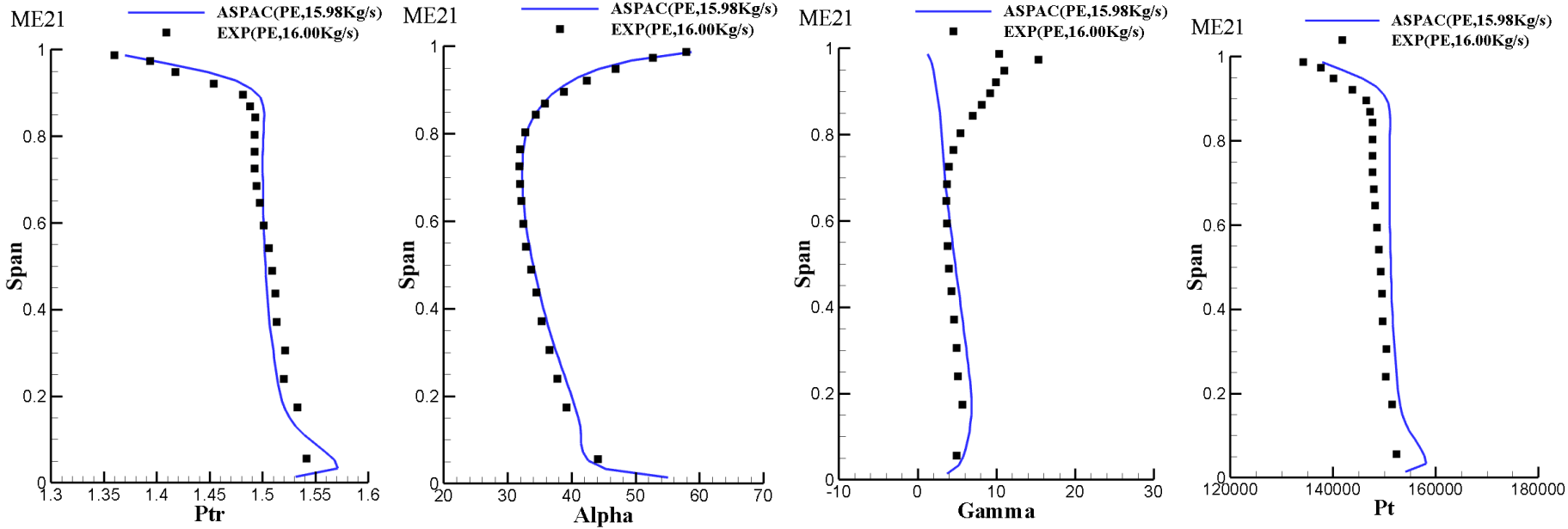
Mass flow condition at outlet: 13.4Kg/s

The global parameters are oscillating

The averaged total pressure ratio is about 1.4, which is much lower than the experiment(1.56)

Computational results

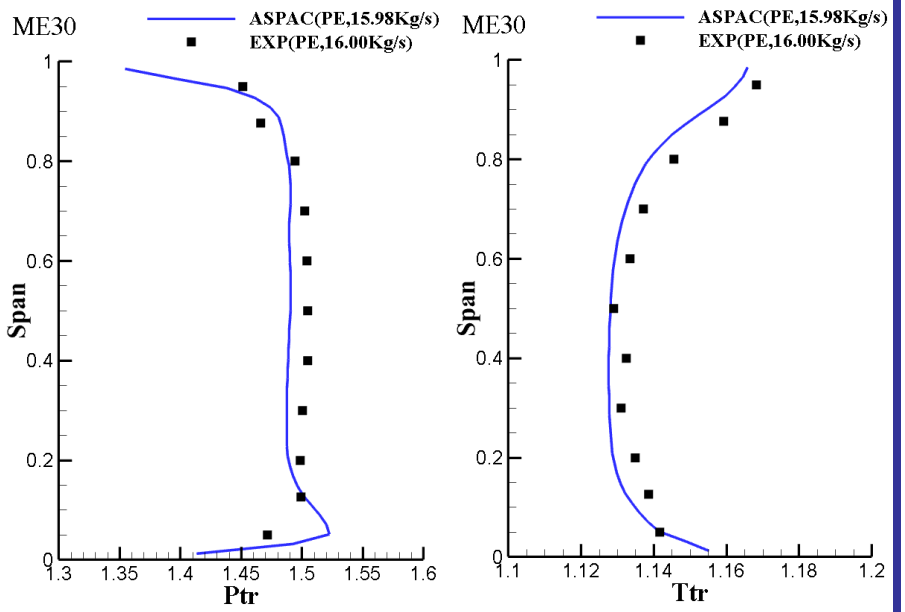
Spanwise distribution: PE at ME21



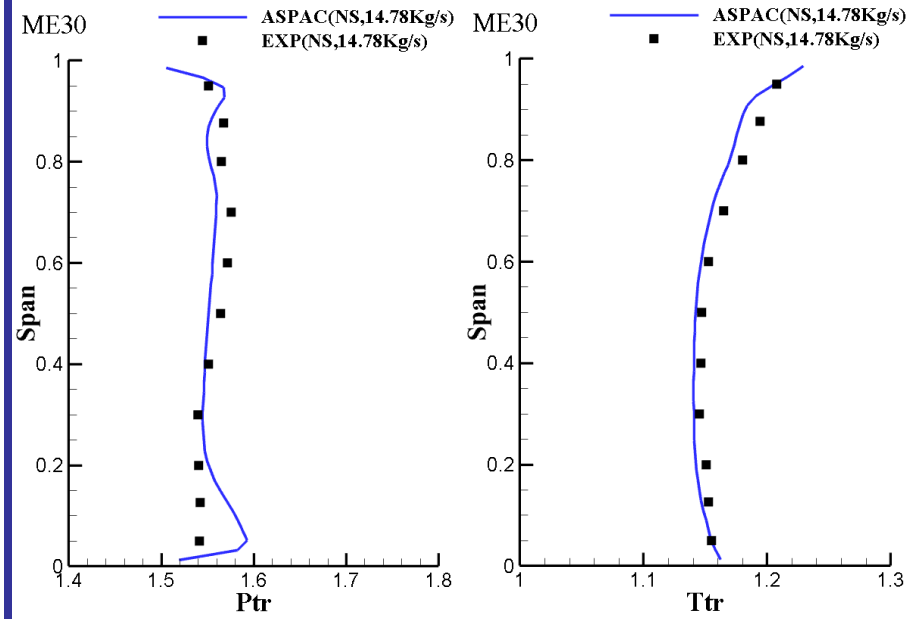
Gamma is different above 70% span

Computational results

Spanwise distribution: PE & NS at ME30



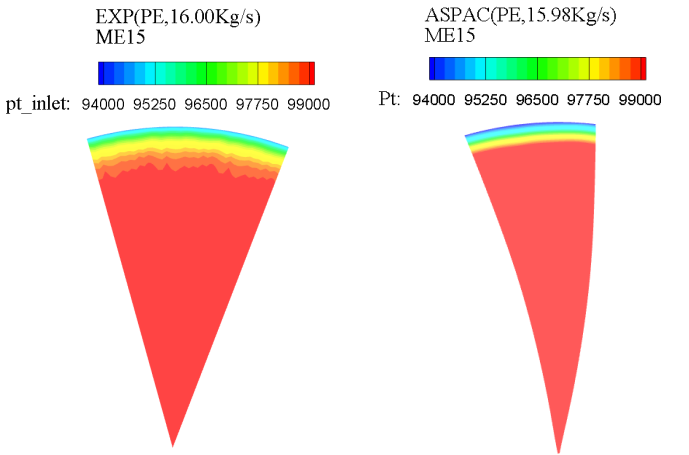
PE



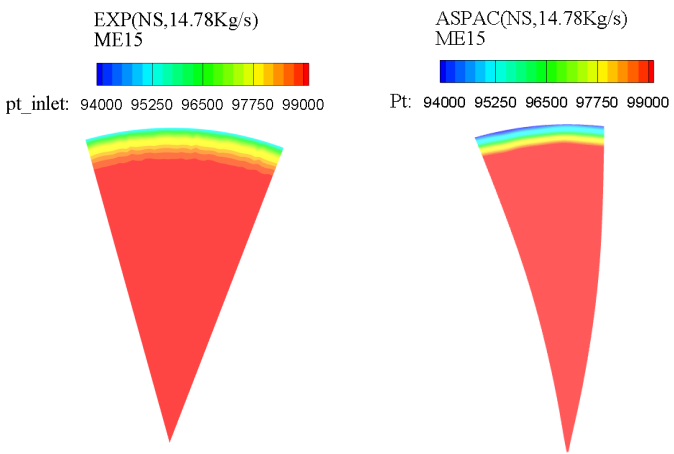
NS

Computational results

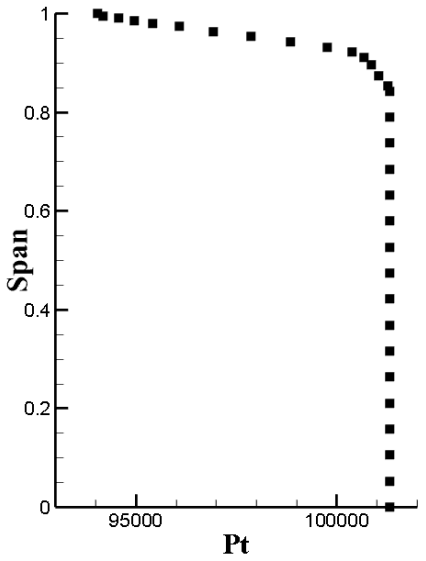
2D flow field: inlet



PE



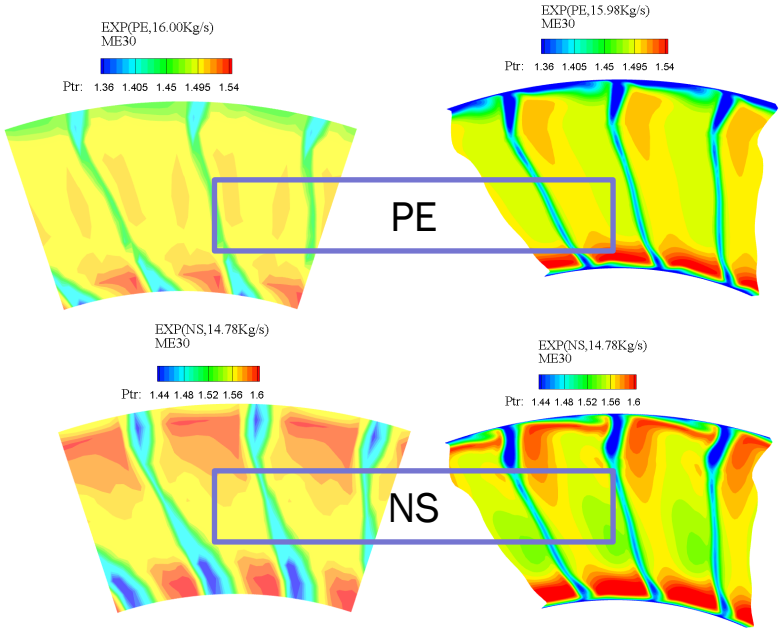
NS



Pt idstribution of inletbc.input

Computational results

2D flow field: PE & NS, ME30



Total pressure ratio

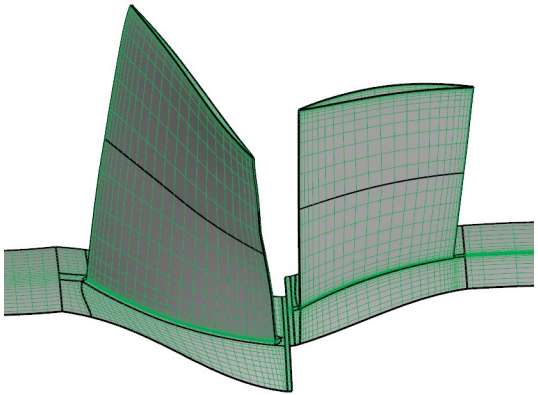
Ptr_15_30	EXP	ASPAC	Difference
PE	1.491	1.476	-1.0%
NS	1.557	1.552	-0.3%

The distribution simulated by ASPAC is similar to that of EXP

The difference of Ptr between EXP and ASPAC is less than 1% as a whole

Computational results

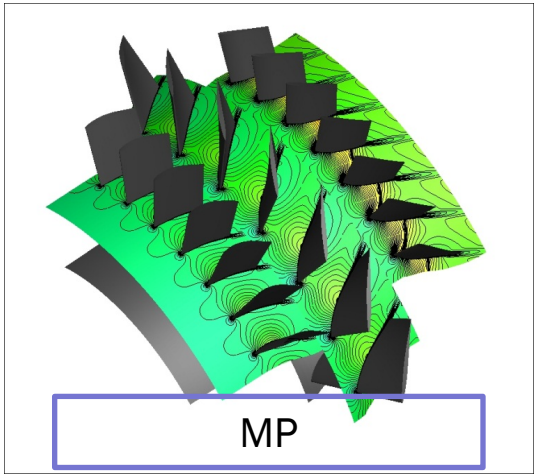
An introduction to ASPAC: Grid generation module



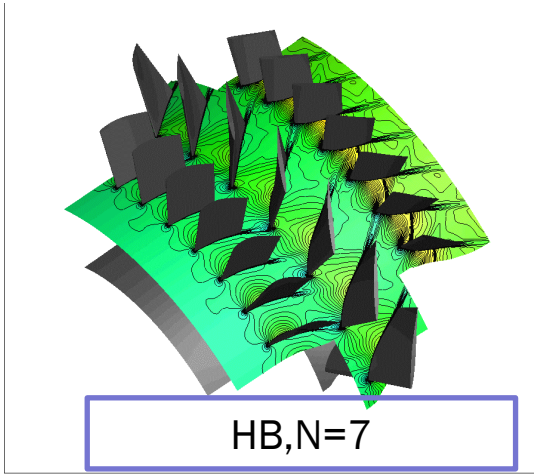
Grid generation software
Automatic generation of multi-block structured grid for turbomachinery

Computational results

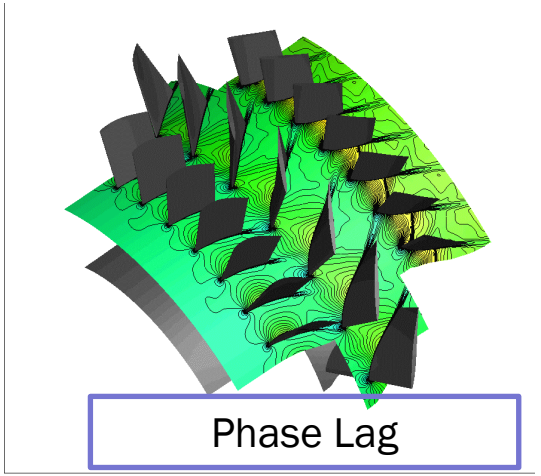
An introduction to ASPAC: different CFD models



MP



HB,N=7



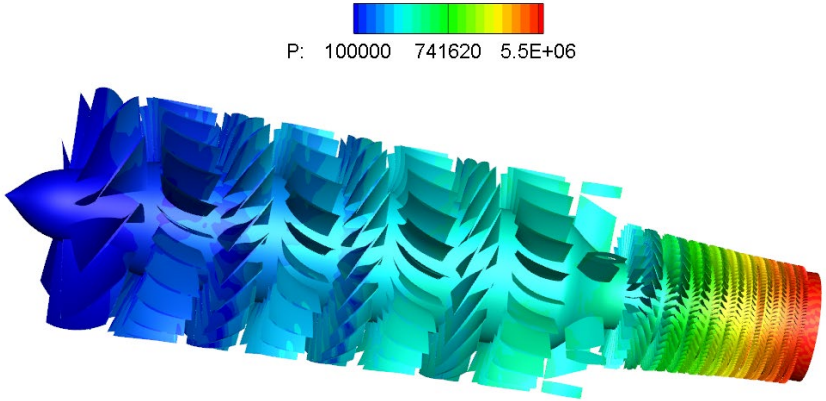
Phase Lag

axial mach number

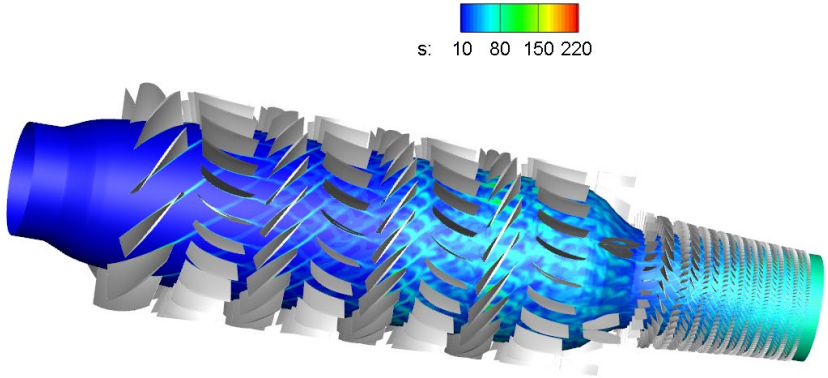
harmonic balance method: multi-stage and multi base frequencies
phase lag method: multi-stage and multi base frequencies

Computational results

An introduction to ASPAC:Large scale simulation



instantaneous static pressure



instantaneous entropy distribution at 50% span

Double bypass duct compressor:4stage LPC(9500rpm) +9 stage HPC(-19780rpm)
design point
800 million grid cells, 10240 ARM V64 CPU cores
2 weeks

CARDC

Thanks for Your Attention!