Modelling heat transfer effects on the efficiency of radial turbine

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HOTSIDE CFD Research Activities

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Goals of HOTSIDE project

Goal 1

Improve understanding of the pulsating flow in complex manifolds and the effect on heat transfer

Goal 2

Characterization of the pulsating exhaust flow effects (different valve strategies) on turbocharger's efficiency

Goal 3

Understanding the reason for the failure of 1D and steady-state based tools for off-design operating conditions

Goal 4

Assessment of heat transfer and related looses for unsteady, pulsating, non-isothermal flows in the exhaust manifold and turbine of an ICE

Turbine performance validation with steady RANS on coarse mesh (~1M)

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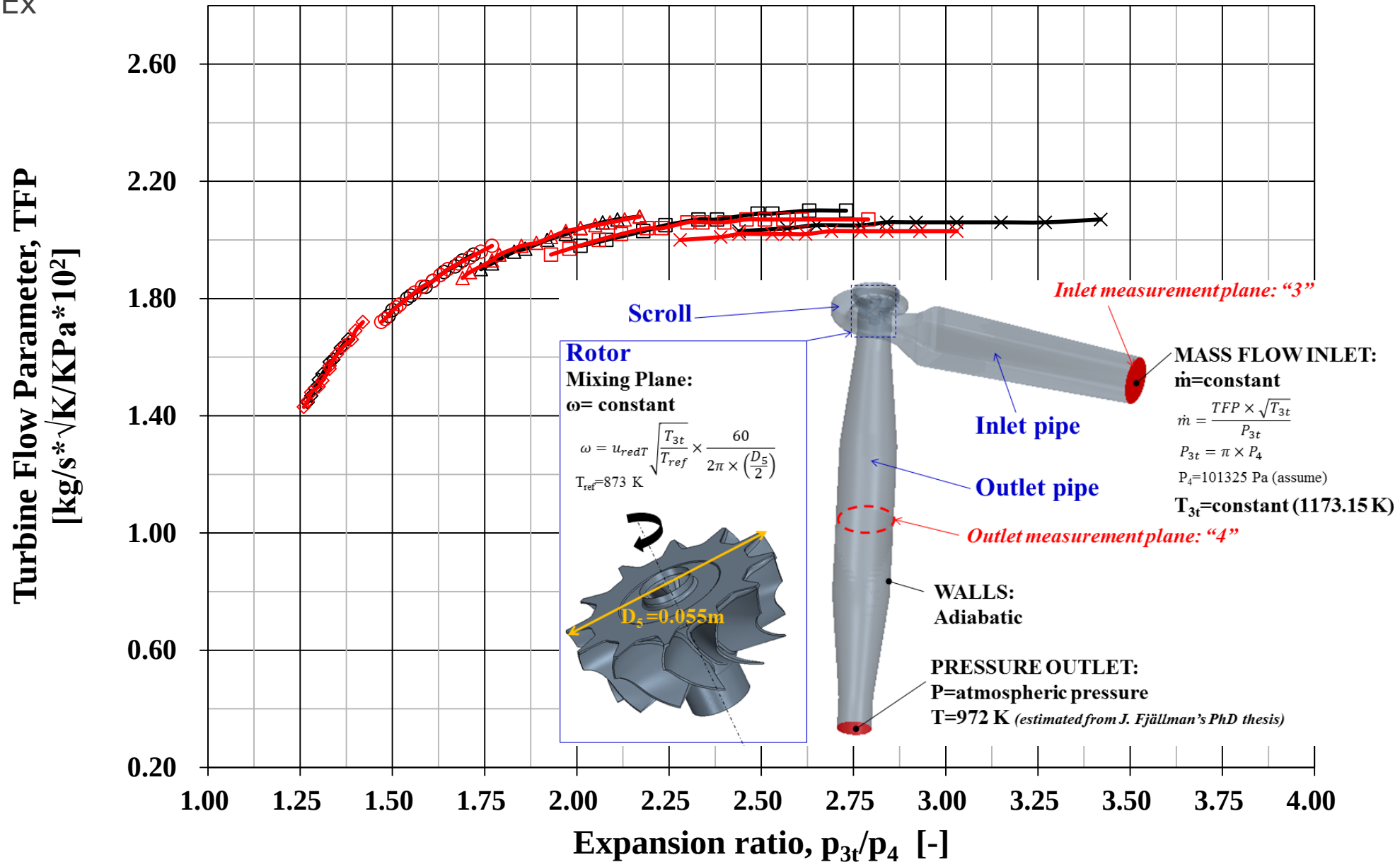

Effects of near-wall modelling to the turbine performance

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- Mass flow inlet

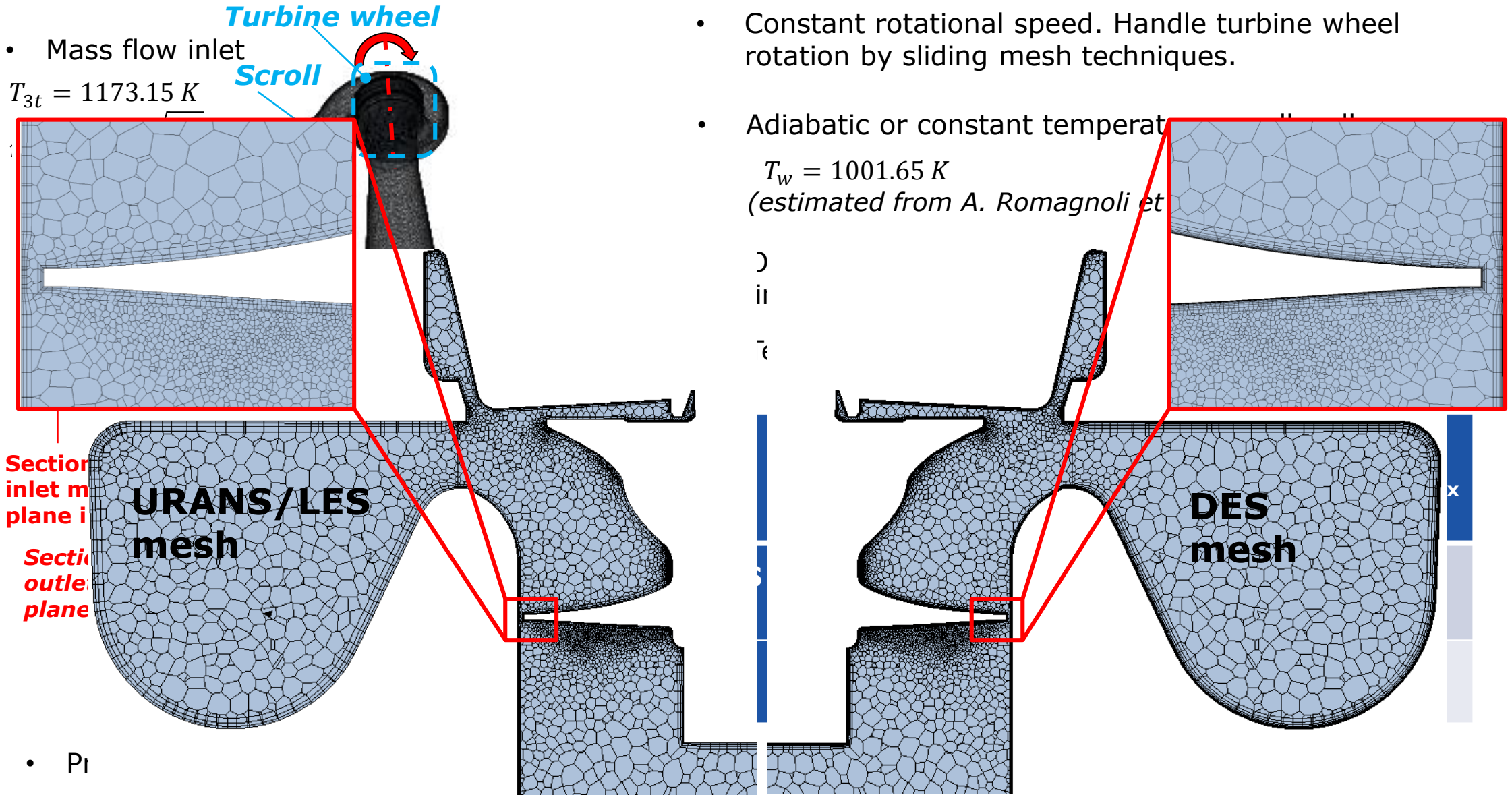
$T_{3t} = 1173.15\ K$

- Constant rotational speed. Handle turbine wheel rotation by sliding mesh techniques.
- Adiabatic or constant temperat

$T_w = 1001.65\ K$

(estimated from A. Romagnoli et

- Pl



Lim, S. M., **Dahlkild, A.** and **Mihaescu, M.** (2015) *Wall Treatment Effects on the Heat Transfer in a Radial Turbine Turbocharger*. International Conference on Jets, Wakes and Separated Flows, ICJWSF15, Stockholm.

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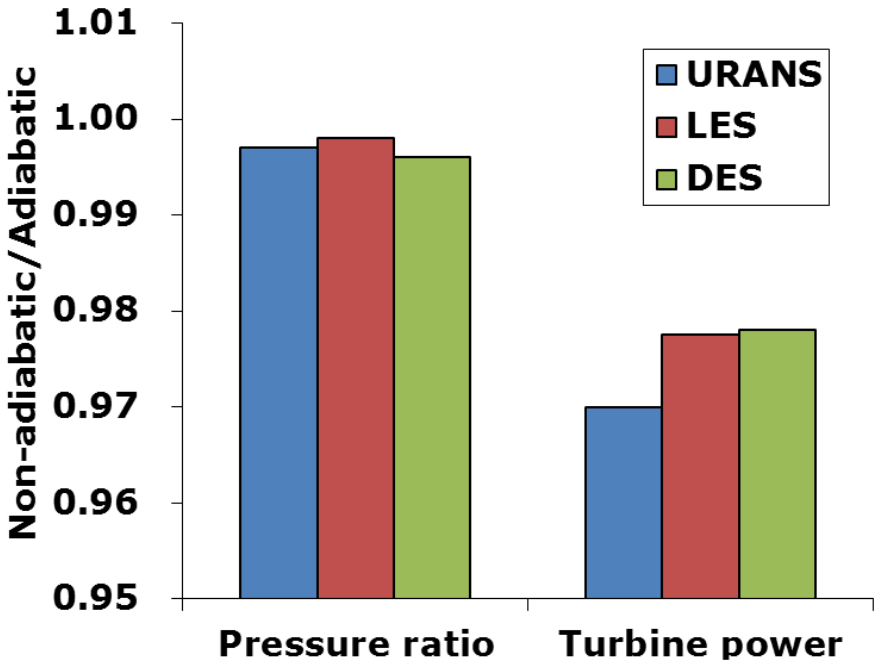
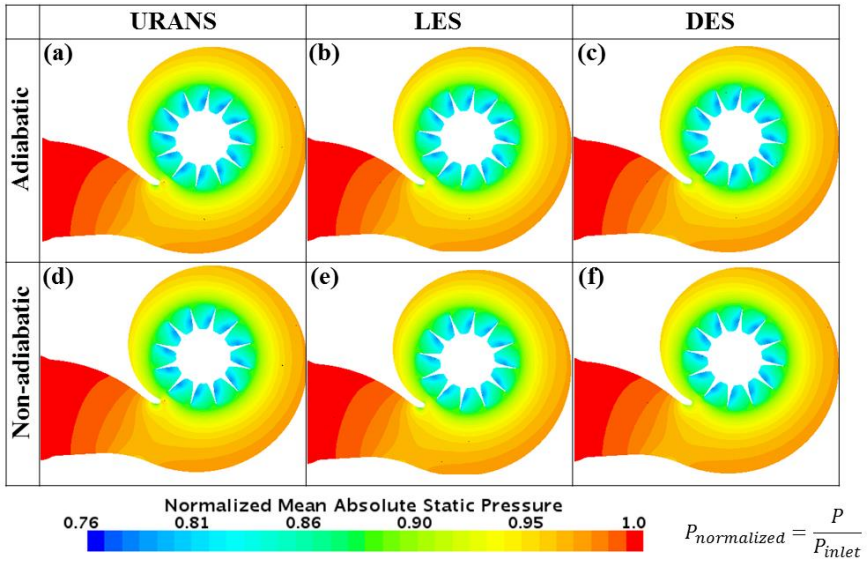
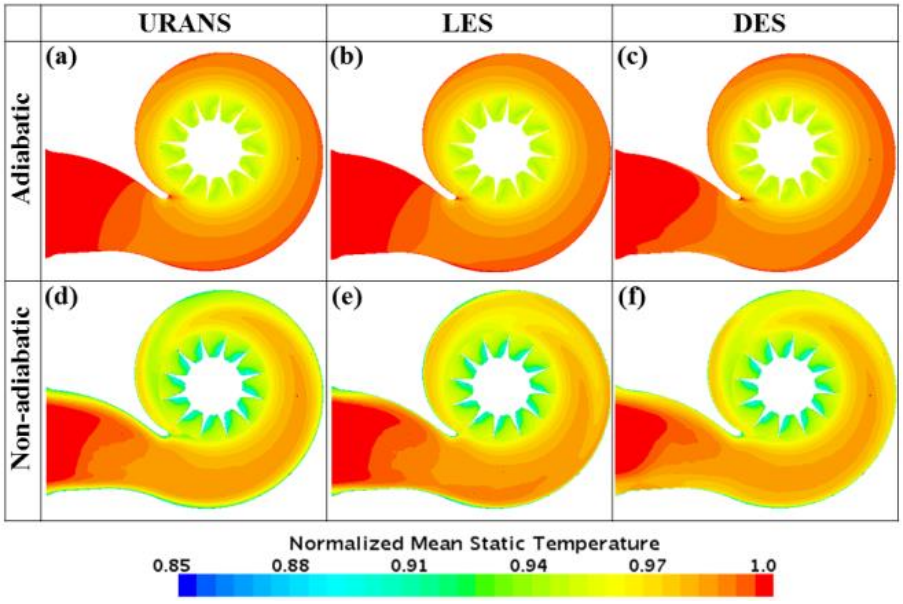
Selective results: performance & flow field comparisons



Pressure



Temperature



Under continuous flow condition,

- heat transfer effect on pressure ratio is insignificant (<1%), but significant on turbine power (~3%).
- Turbine power is highly dependent on the rotor's inlet temperature prediction.

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Influence of pulse profiles on turbine performance (preliminary study)

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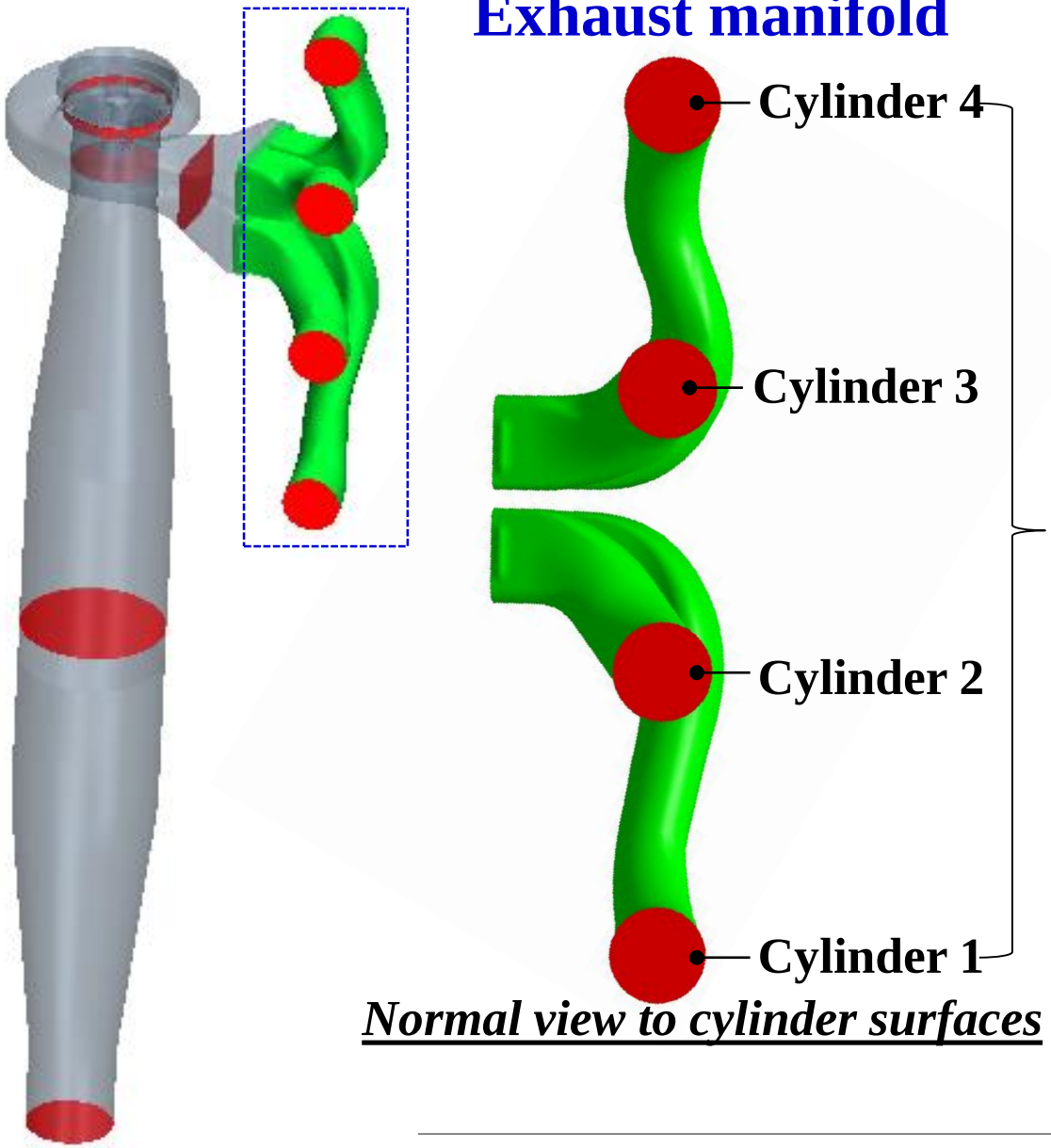
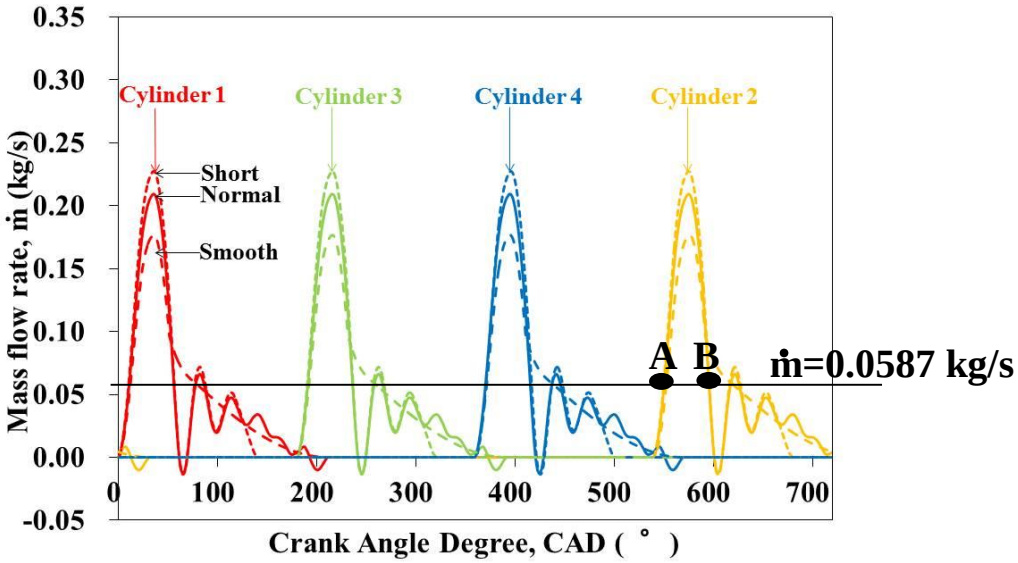
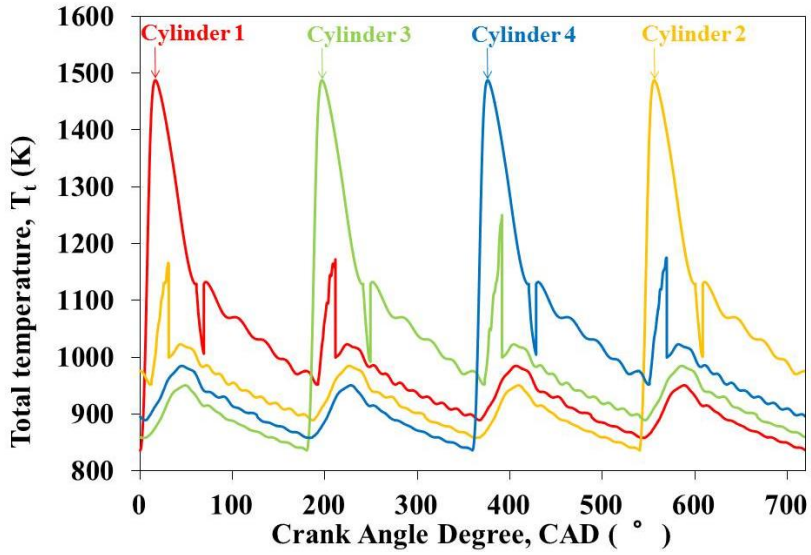


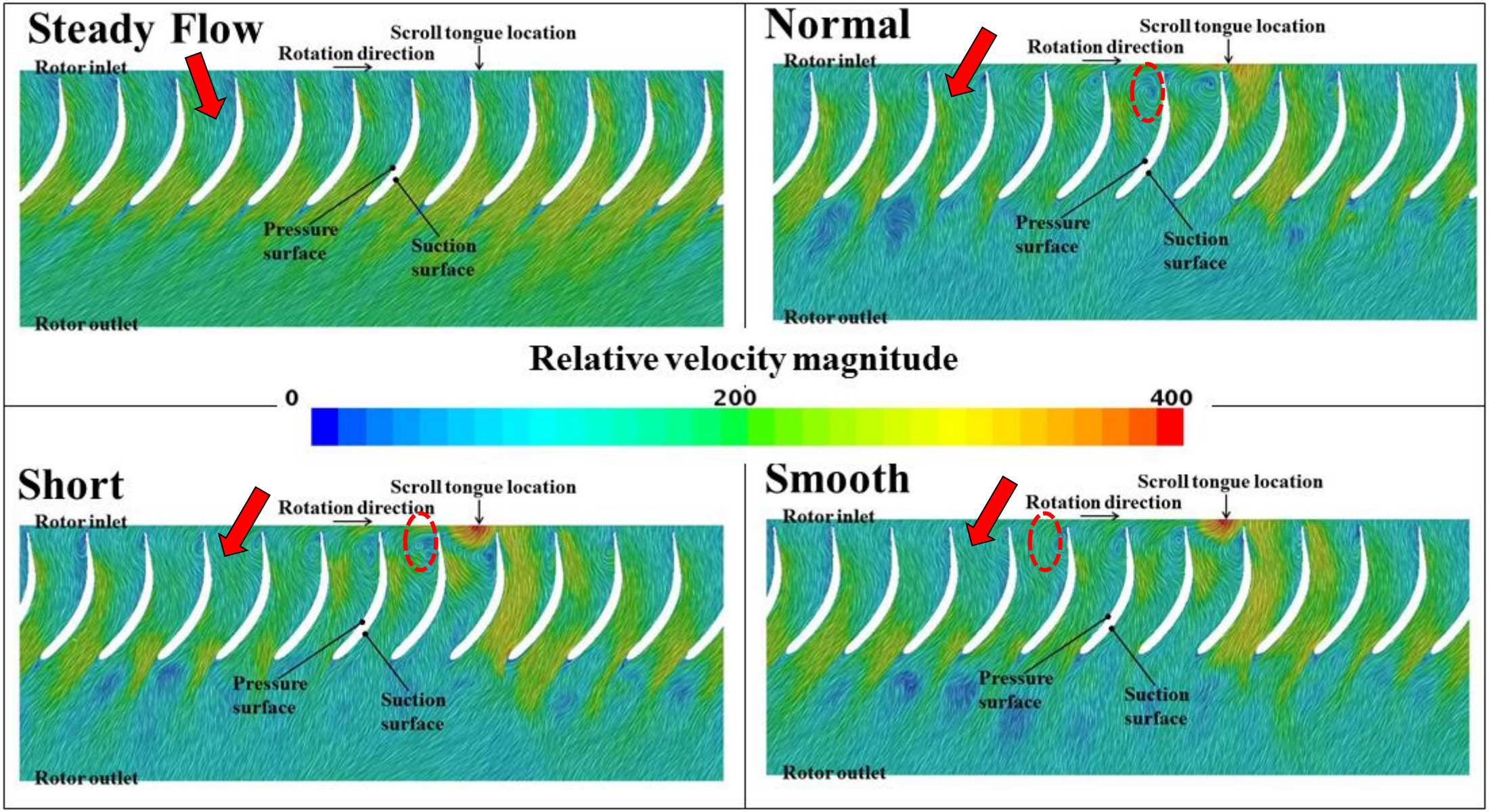




note: pulse profiles used in preliminary study are adapted from literatures

Lim, S. M. and **Mihaescu, M.** (2015) *Turbocharger Turbine Performance; a Sensitivity to the Boundary Conditions*. 14th International Symposium on Unsteady Aerodynamics and Aeroelasticity of Turbomachines, ISUAAAT14, Stockholm, I14-S14-1.

Selective results: instantaneous velocity flow field (”A”- accelerating phase)



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Selective results: instantaneous velocity flow field (”B”- decelerating phase)

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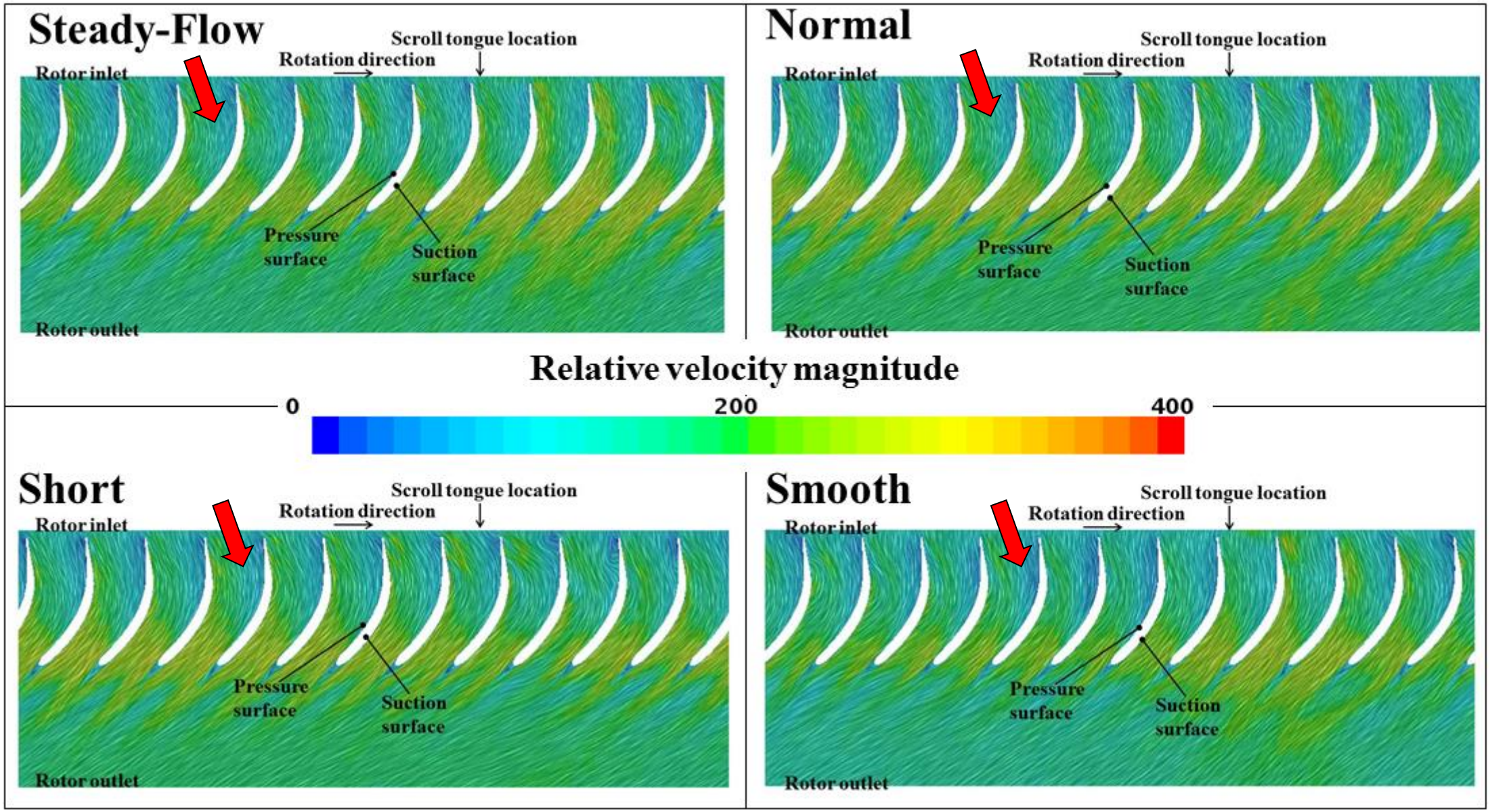

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Future works

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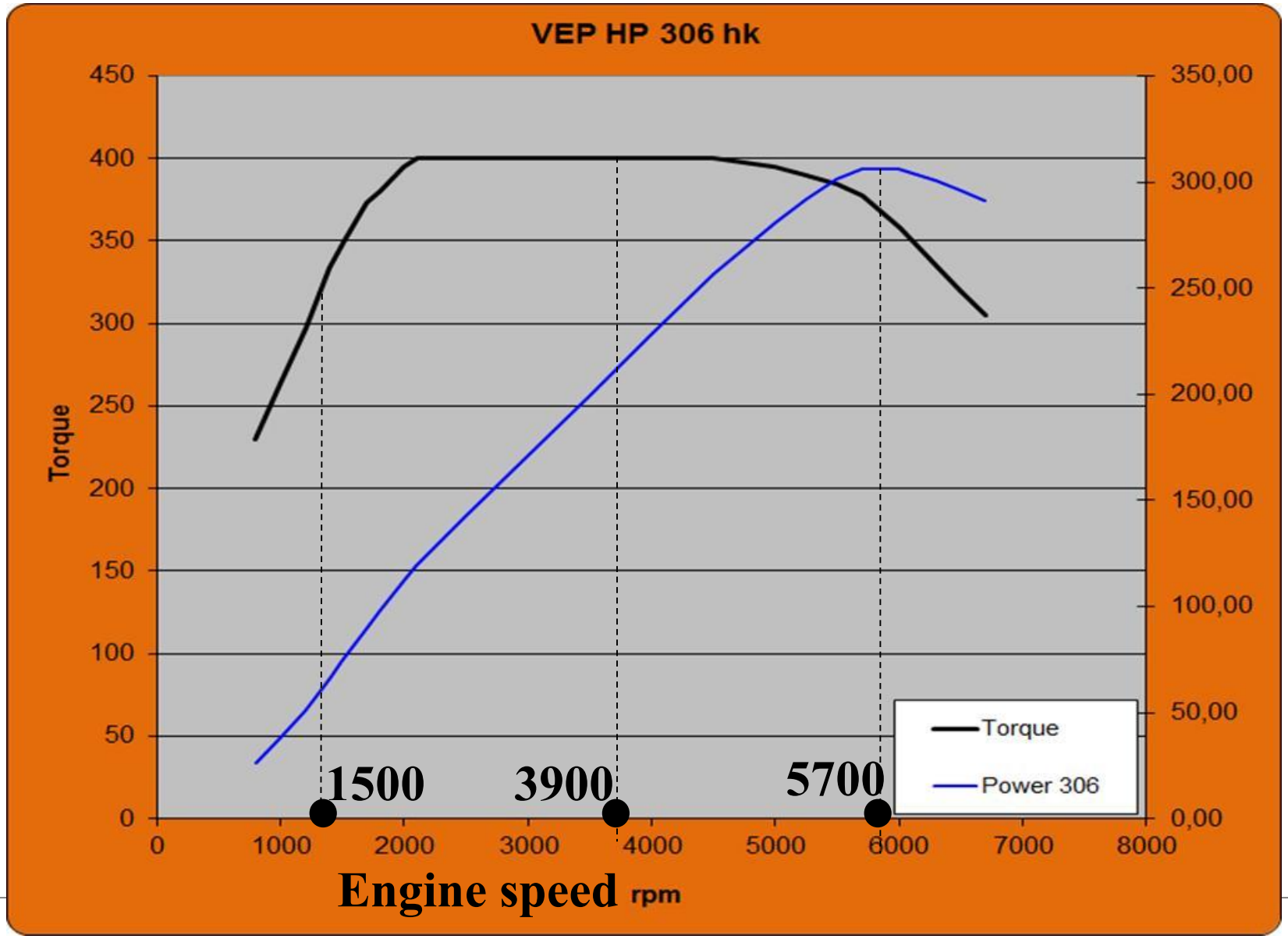
OPs for pulsating flow CFD with Volvo Cars' GT-Power data as bc.



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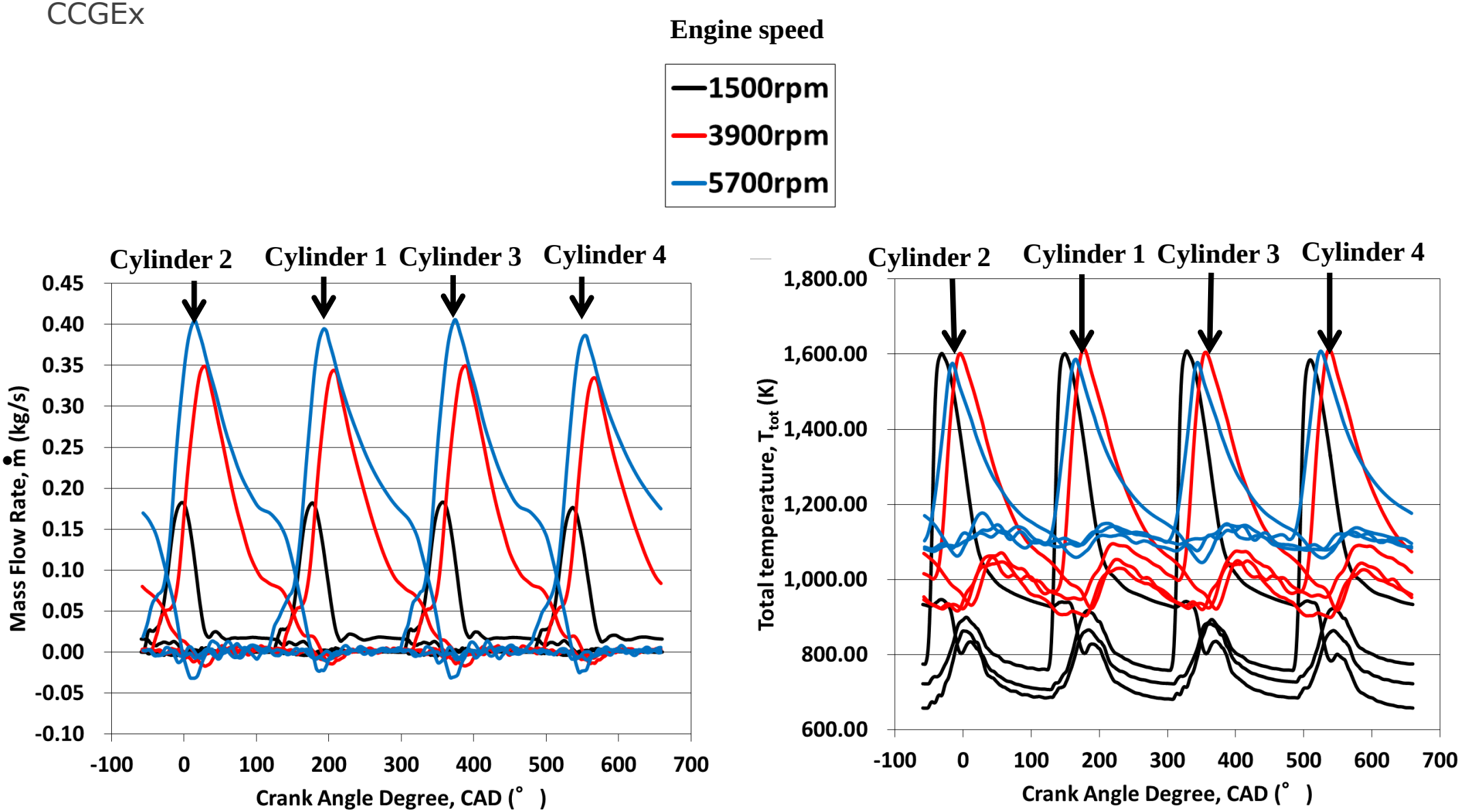
Pulse profiles from Volvo Cars GT-Power data



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Thank You