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A new **P**ressure **W**ave **S**upercharger concept for **less emissions** and **more efficiency**

Comprex™

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How does a **P**ressure **W**ave **S**upercharger **work and why use it**?

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Pros and Contras of the PWS:

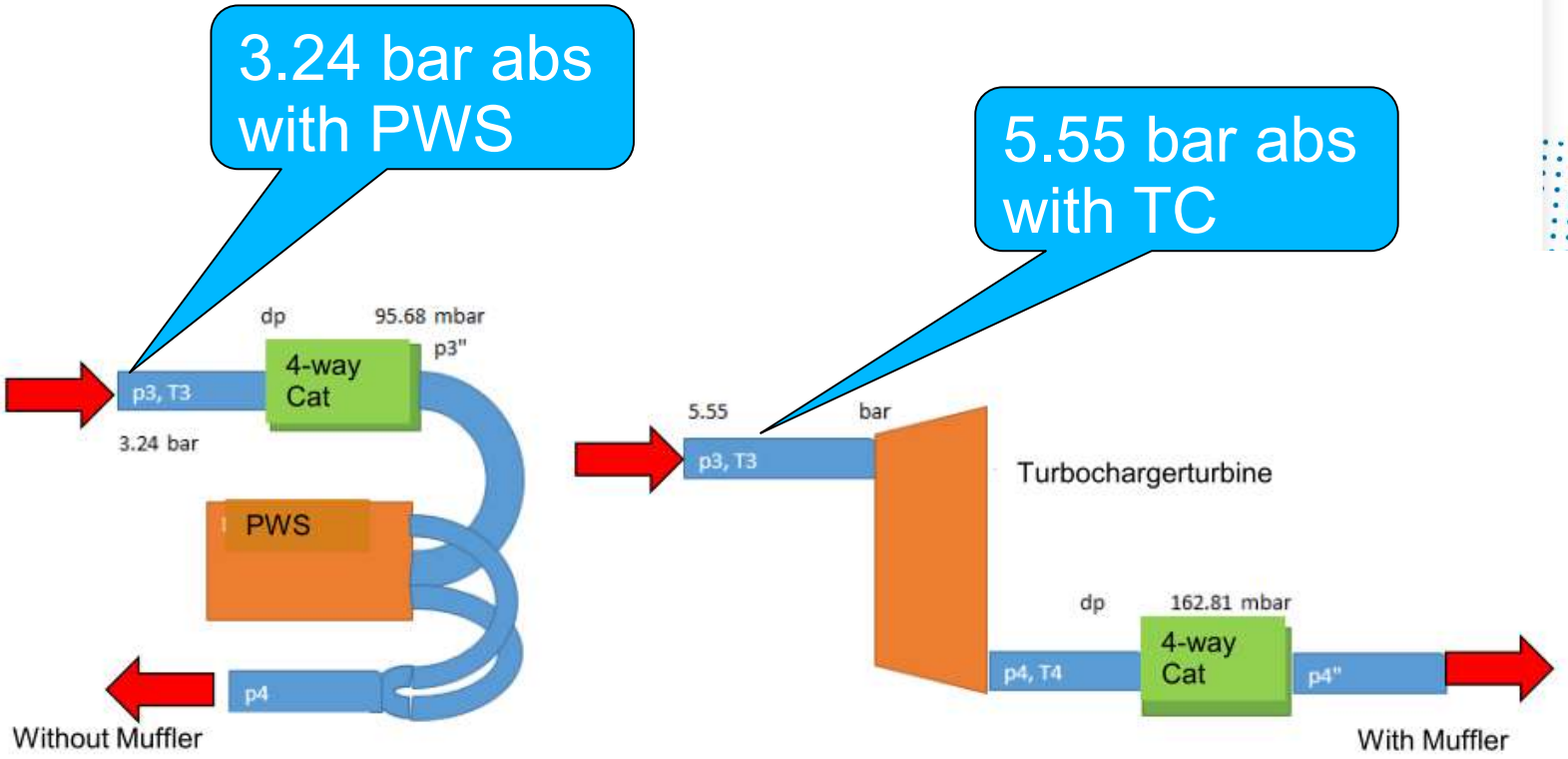
Pros:

- Very fast boost pressure response
- High boost pressure at low engine speed
- Its electric driver is used only for synchronisation of the charger compared to the engine speed and can be used for power recovery as well.
- Live time lubricated bearings, no impact on engine oil no blow by
- No speed reserve necessary, the PWS compensates every operational height
- The PWS already absorbs the engine noise. Therefore, only a very simple exhaust system without damper is needed

Pros and Contras of the PWS

- Very high compression efficiency, possible at low engine speed
- No surge limits as usual by using a turbo compressor
- Low backpressure of the EGS, allows reduction of fuel consumption, see following example
- The catalytic converter can be arranged between the engine and the PWS which leads to a quick light off and much less emissions.
- High EGR rates are easy to represent.
- Very good suitable for Downsizing

Example back pressure in EGS:



Pros and Contras of the PWS

Contras:

- Need for small back pressure on the low pressure side requires larger exhaust system cross sections. Also the same on the air intake side of the PWS.
- Cold start behavior of the PWS, more difficult to master in gasoline engines and gas engines. Thanks to the new concept significantly improved.
- Matching is more complicated, but can now be done in advance with simulation software such as GT Suite, AVL BOOST.

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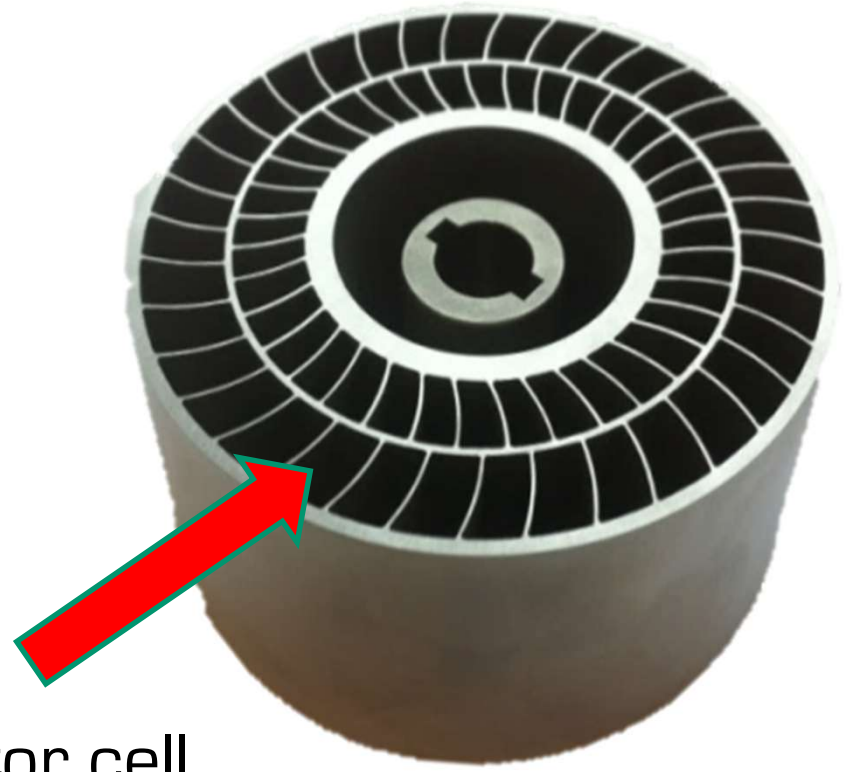
Example PWS rotor:



One Rotor cell

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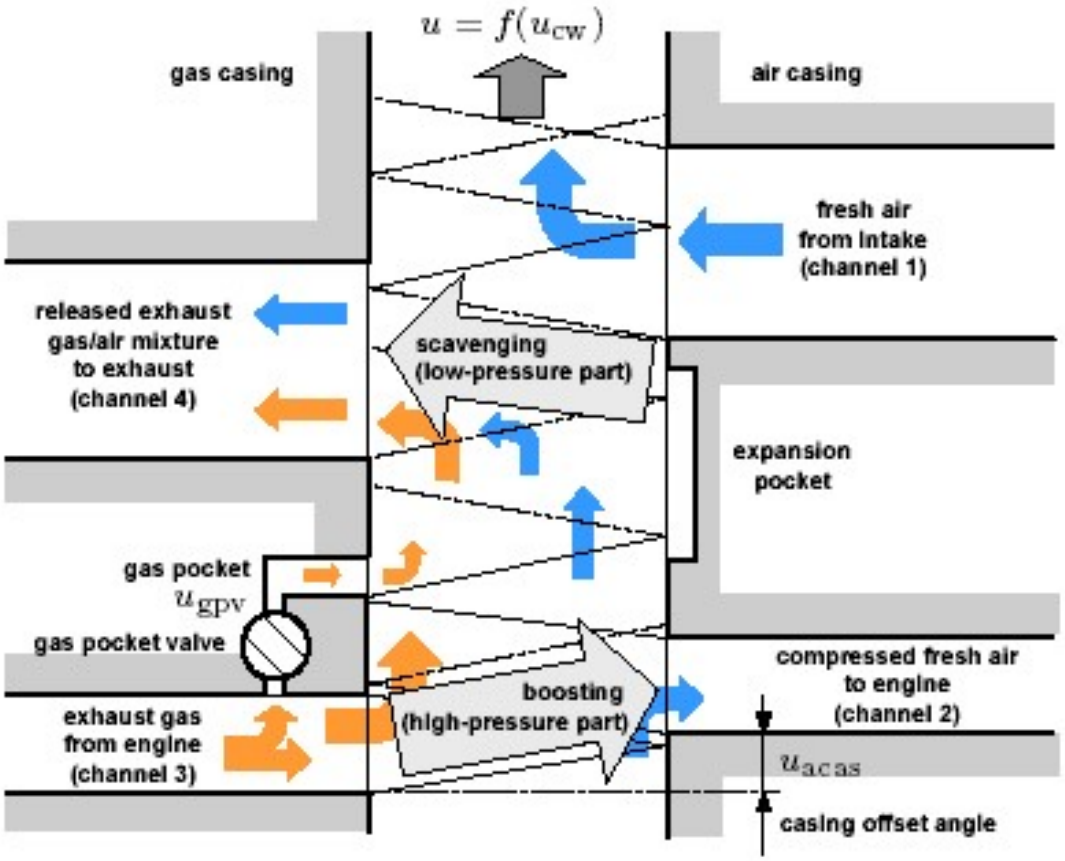
Function of PWS:



Flow and gas dynamics

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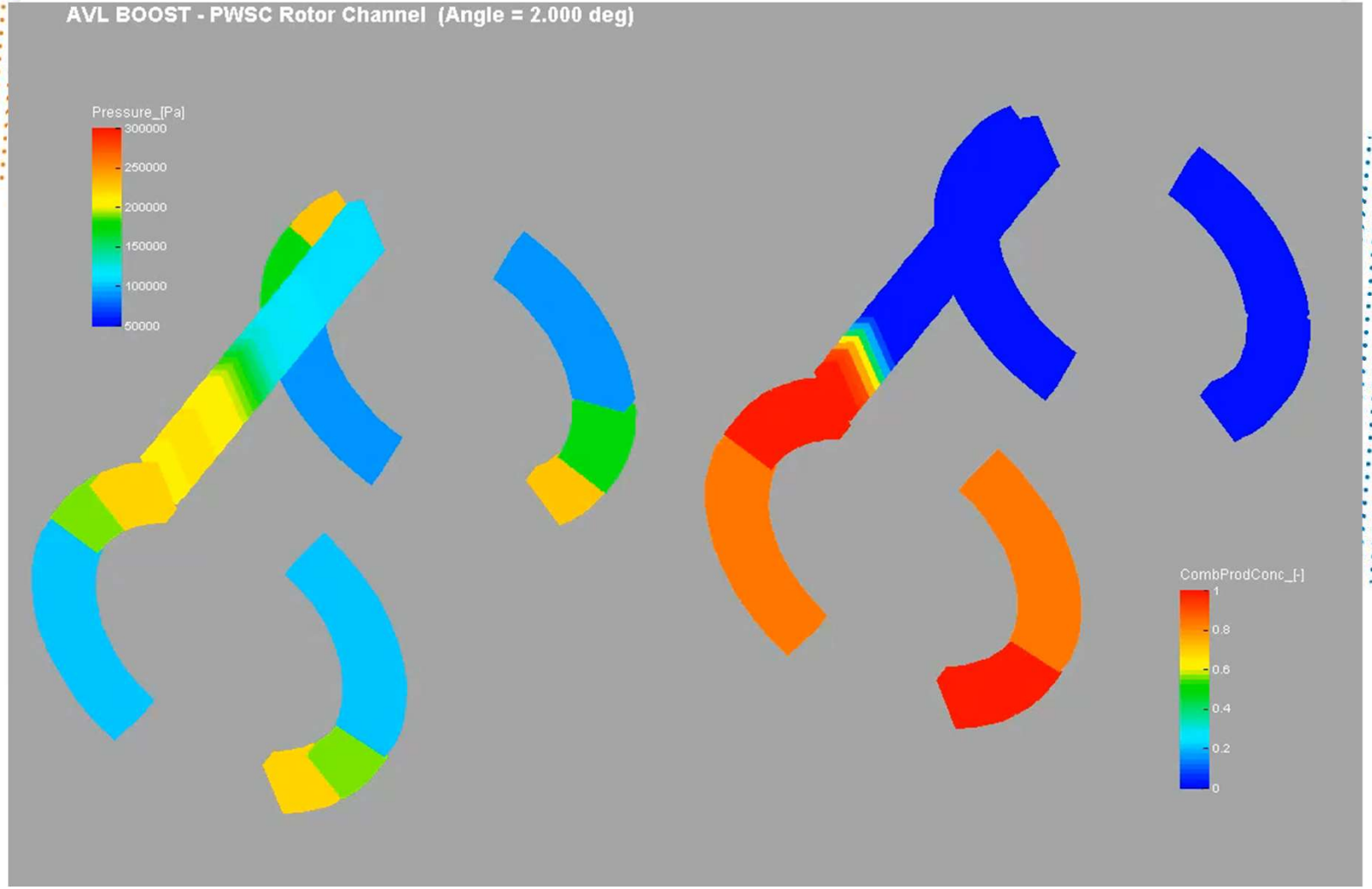
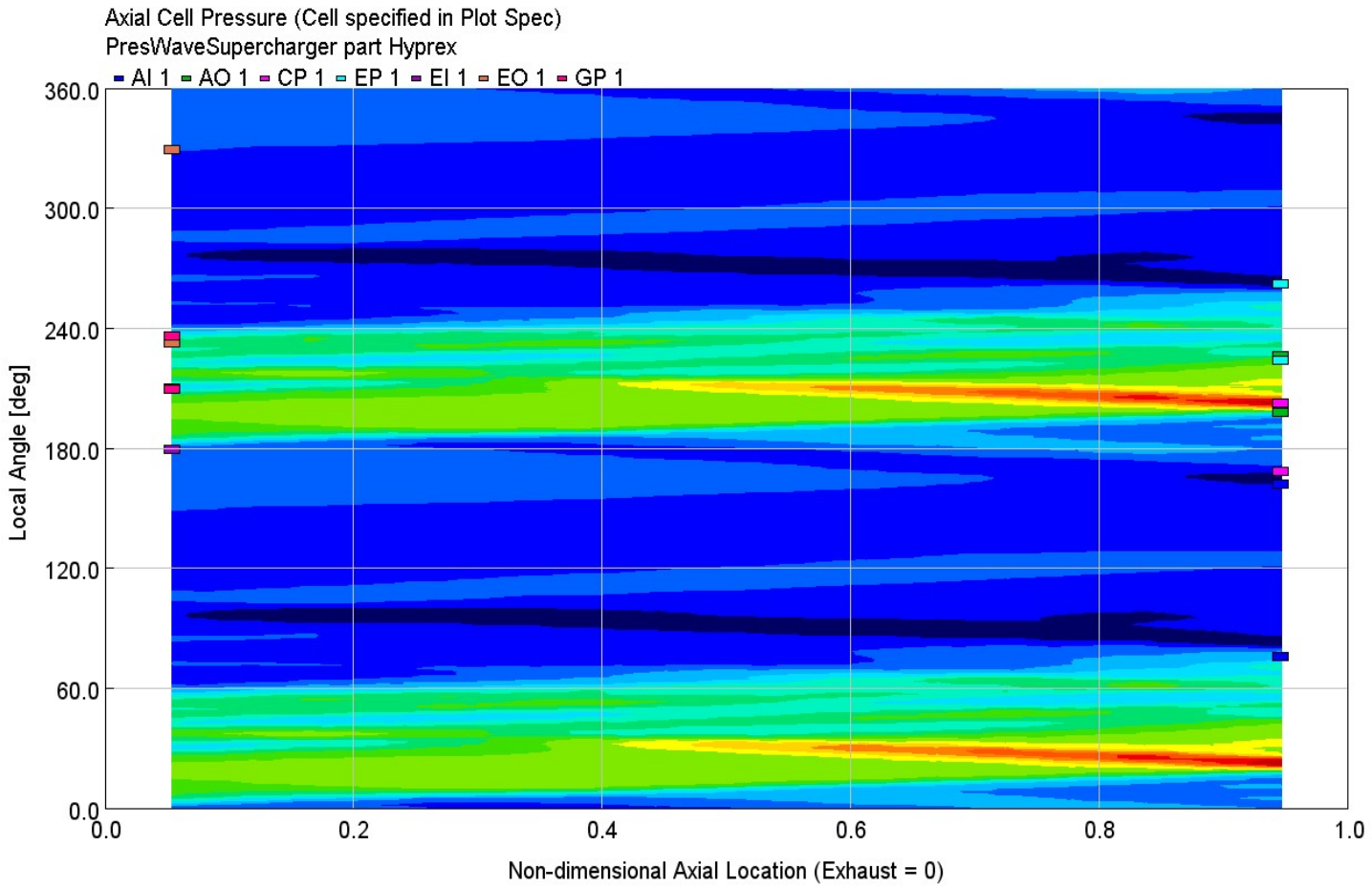
Function of PWS:

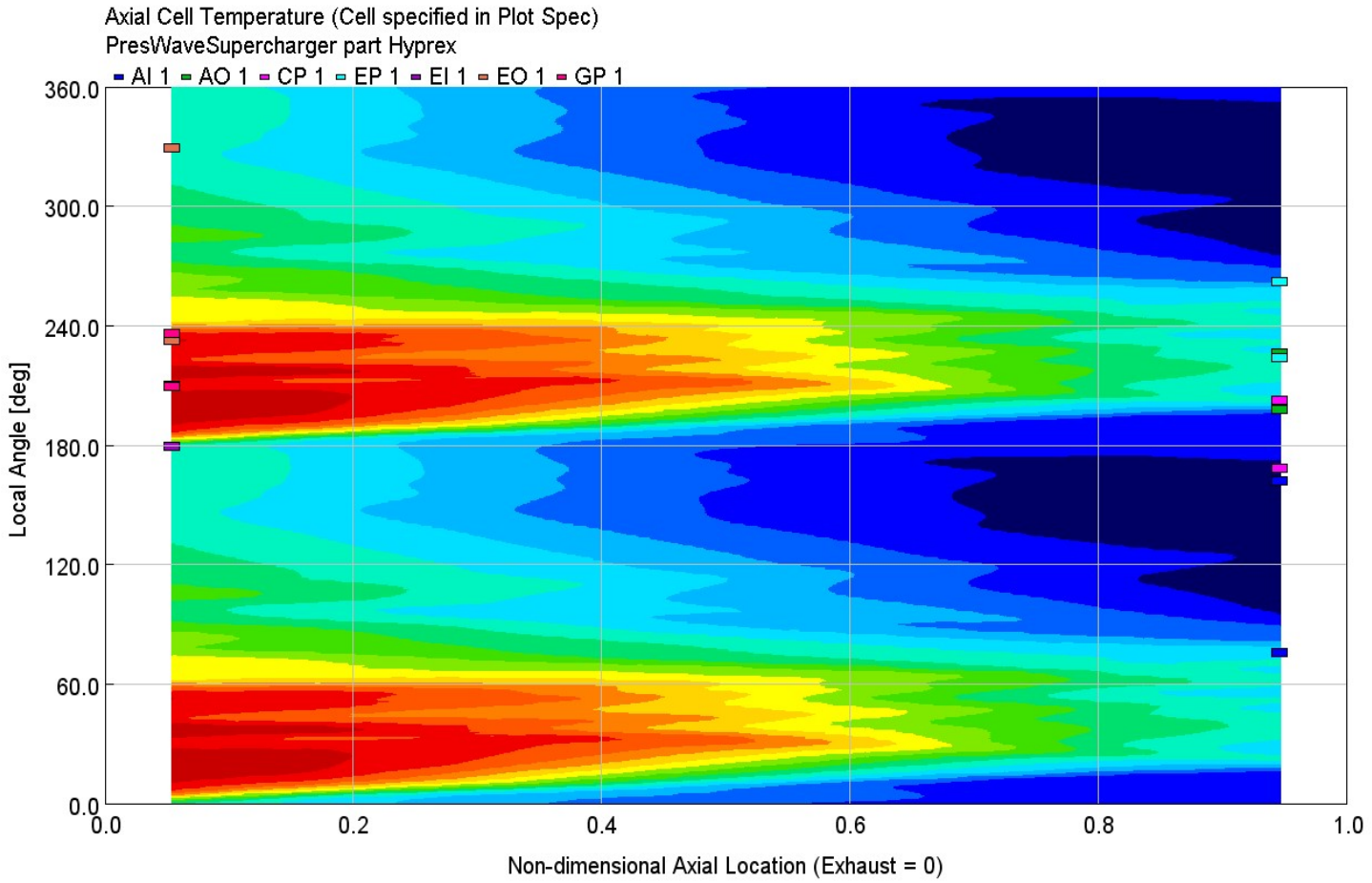


Function of PWS:



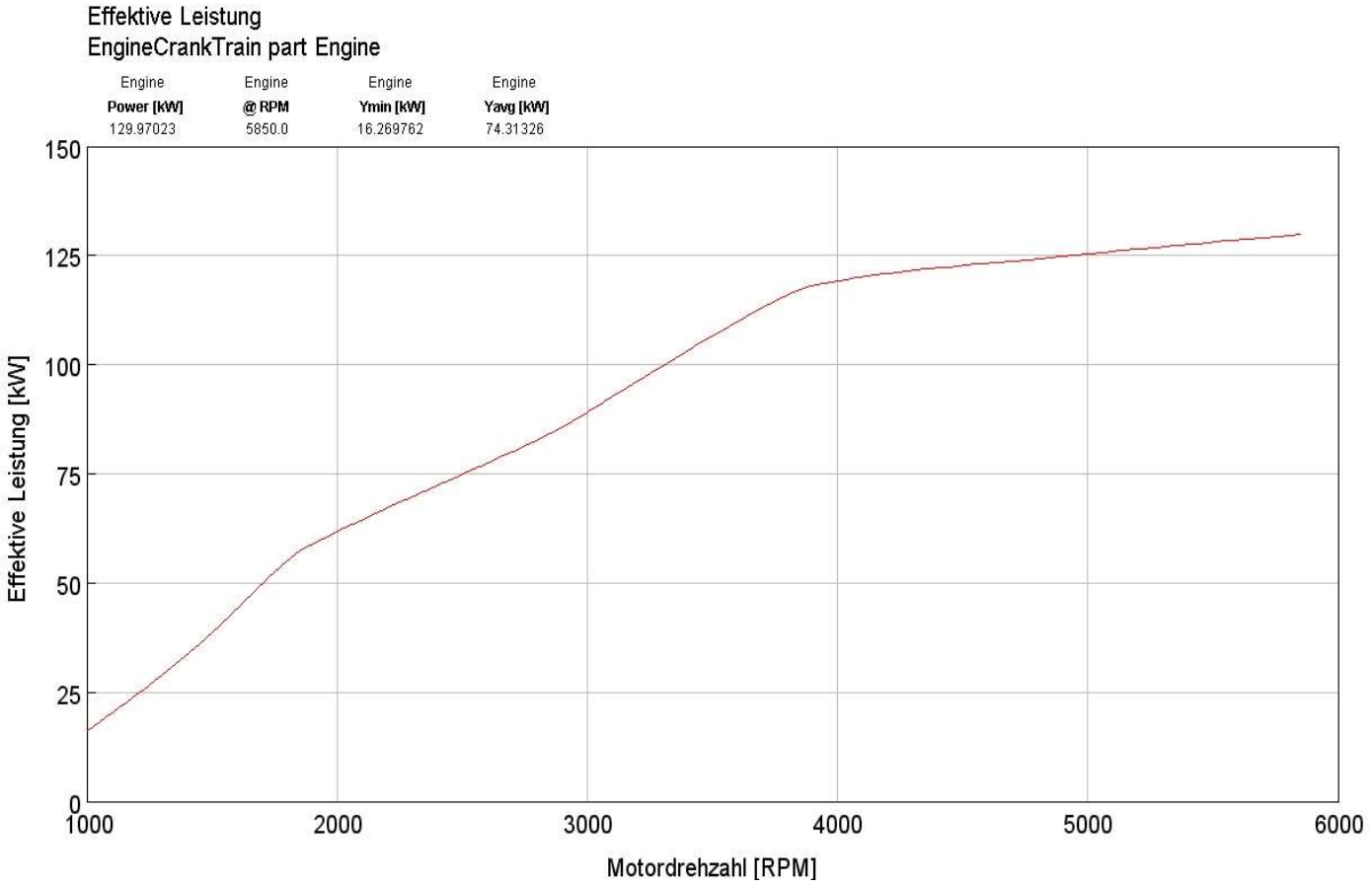
Highest Pressure in Red

Function of PWS:



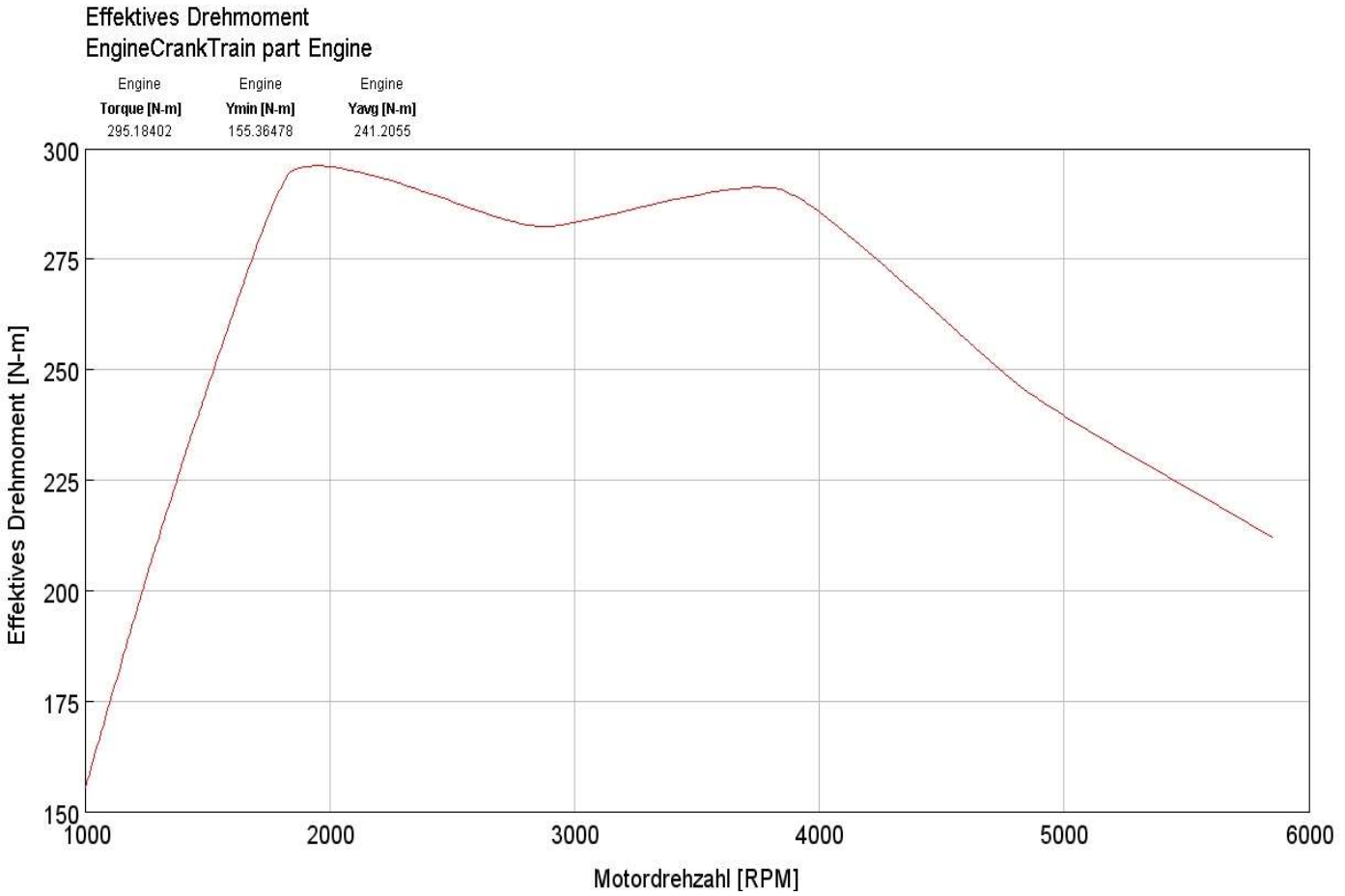
Highest Temperature in Red

Potential of PWS:



1.2 Liter Engine with 180 HP

Potential of PWS:



1.2 Liter Engine with 295 Nm

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Pressure Wave Supercharger Concepts

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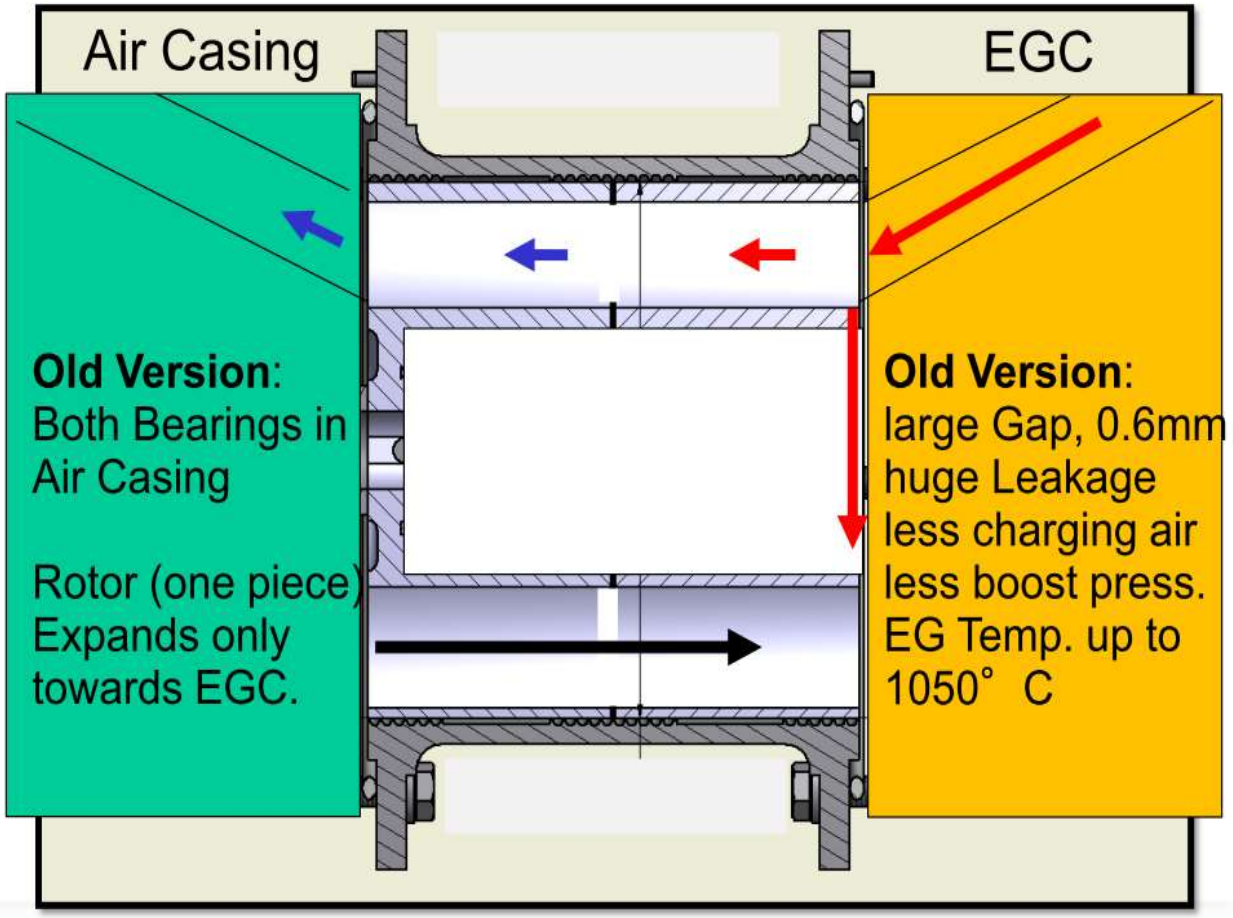
Old Concept of PWS:



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New Concept of PWS:

1. Watercooled **E**xhaust **G**as **C**asing

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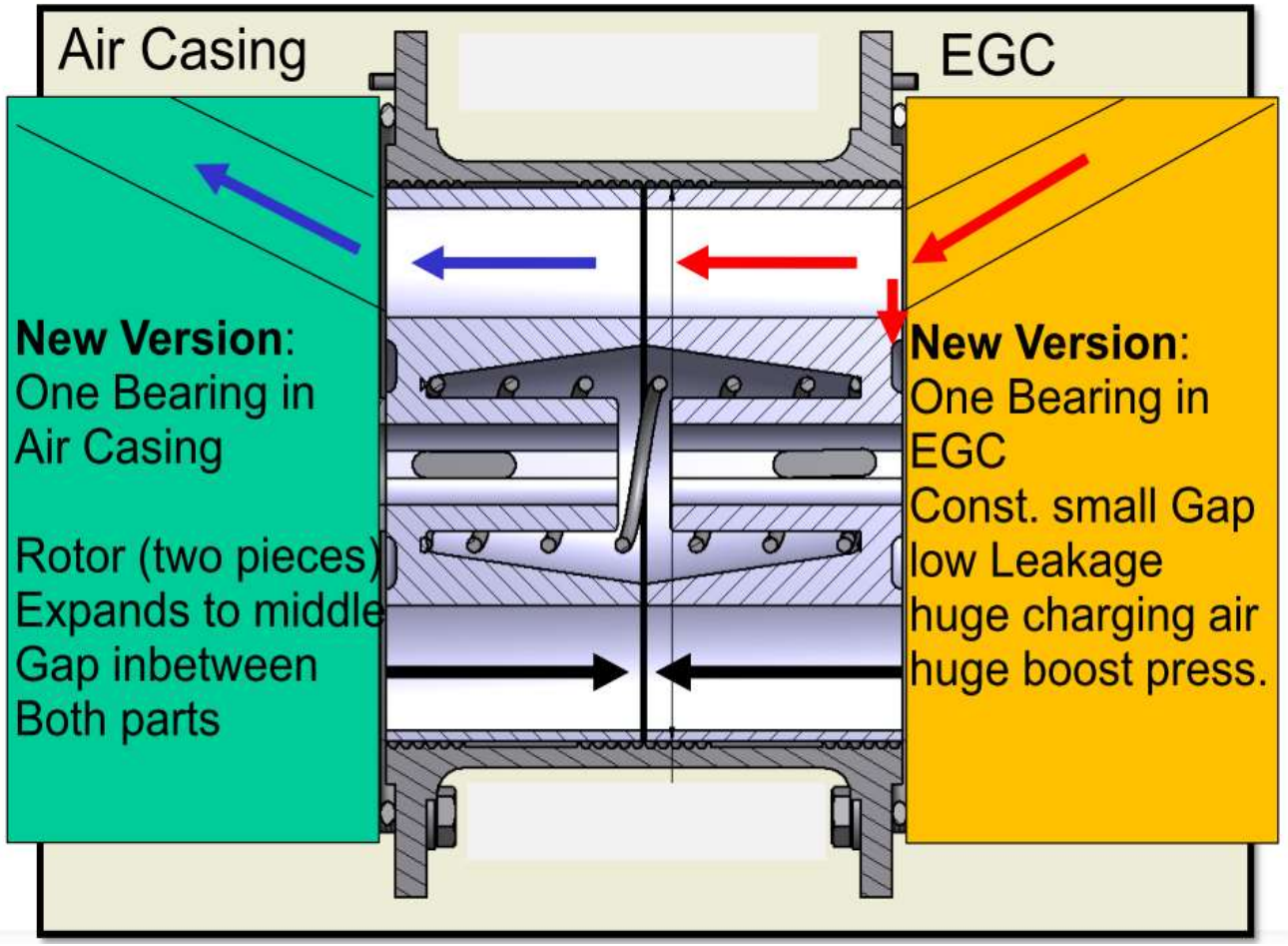
New Concept of PWS:



Watercooled gas housing

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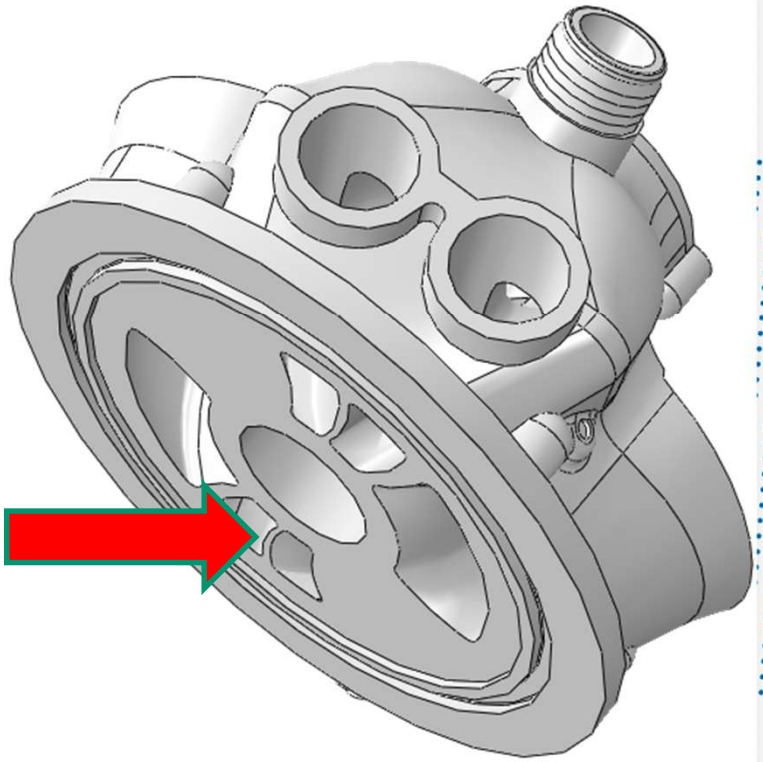
New concept of PWS:

Cooling of sensitive parts!

Aluminium vs. High speed flow with 1000° C designed by Antrova AG



Watercooled gas housing

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New Concept of PWS:

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2. Splitted Rotor

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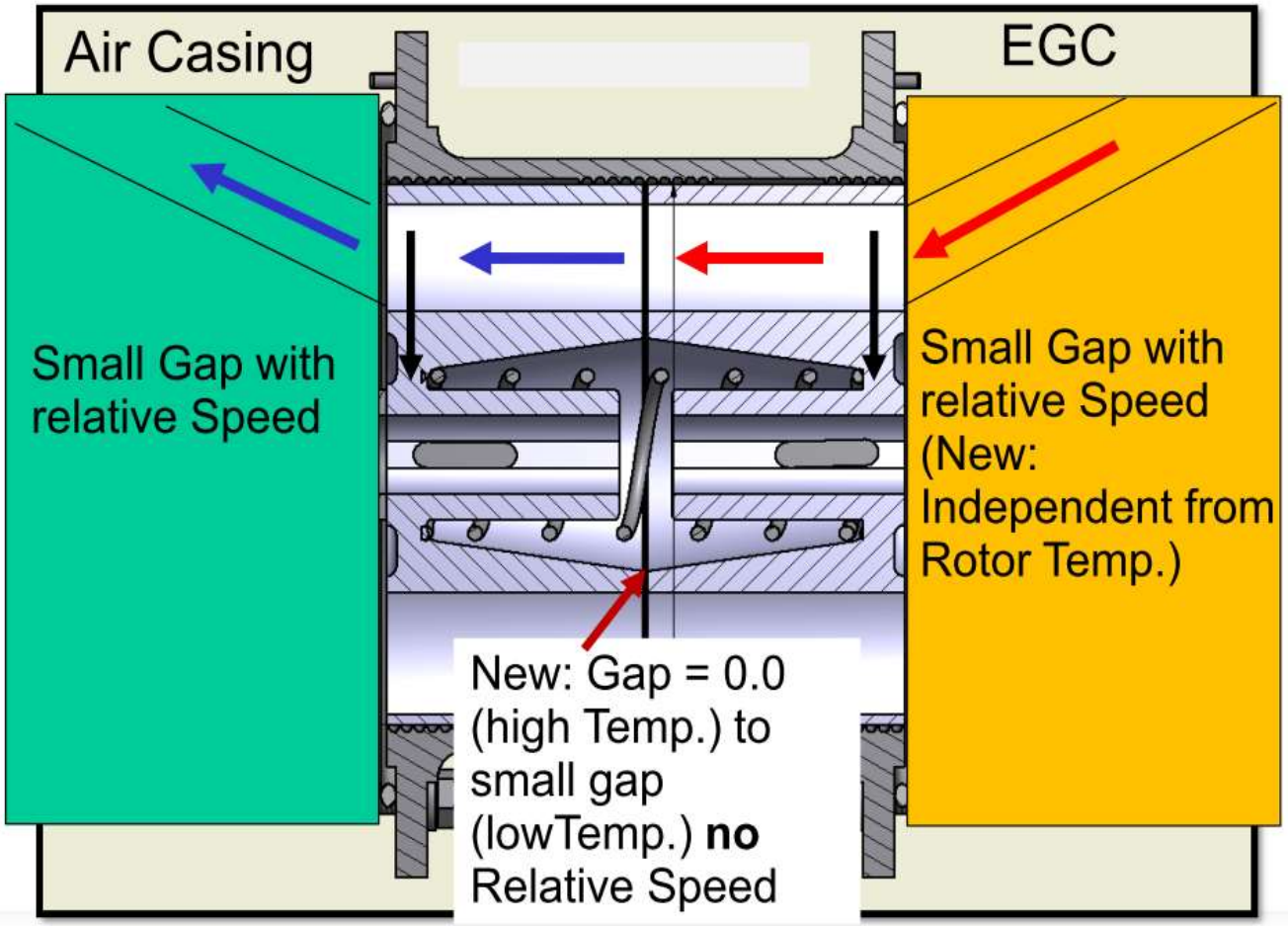
New Concept of PWS:



Splitted Rotor

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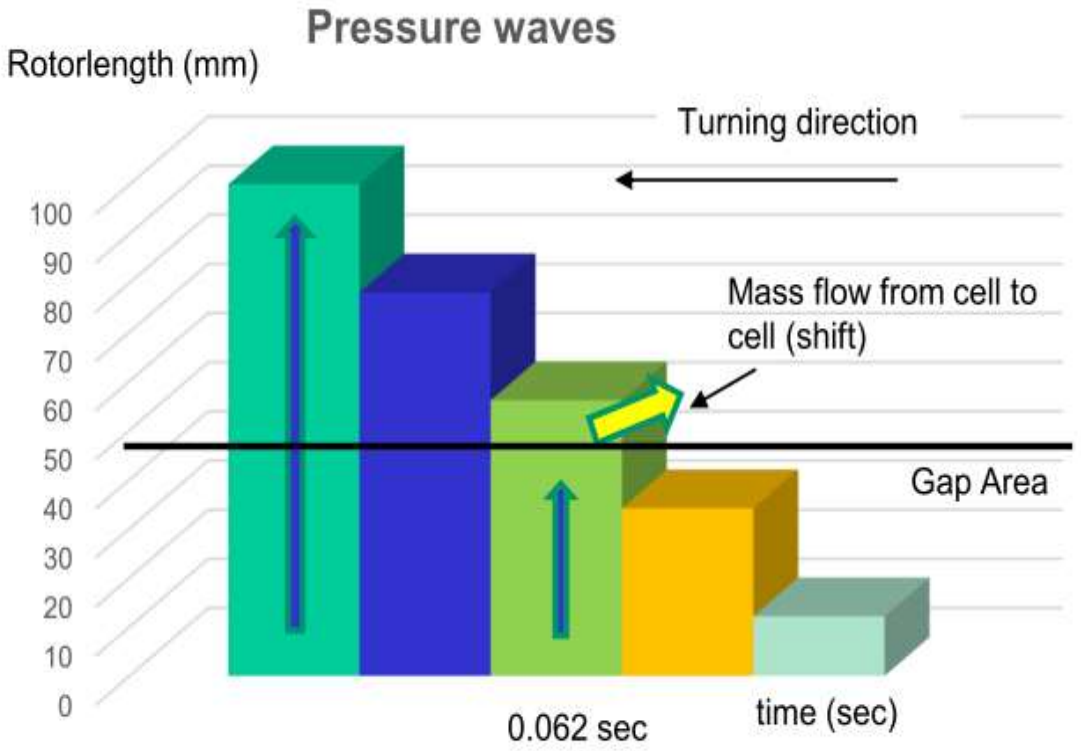
New Concept of PWS:



Splitted Rotor

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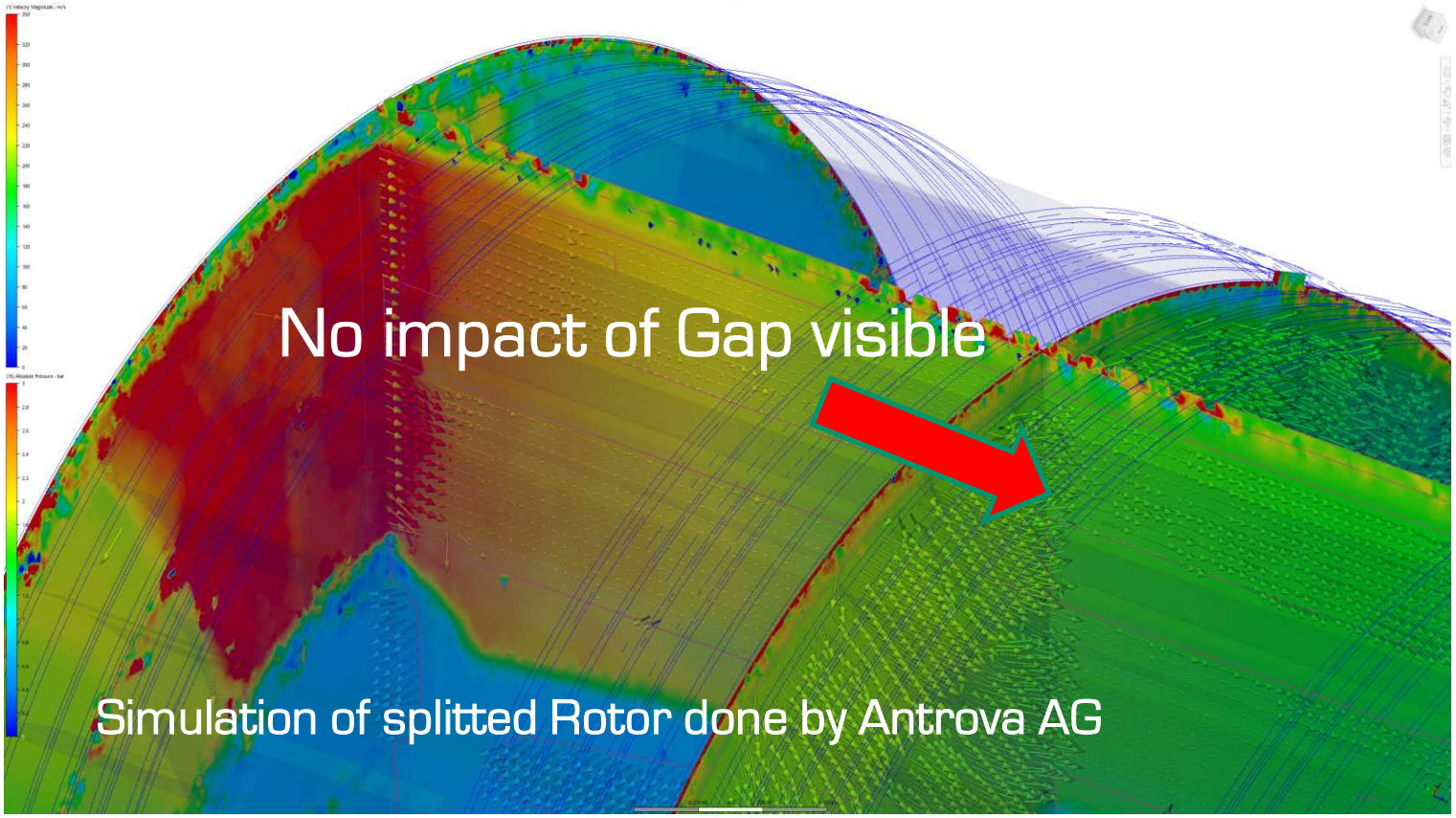
New Concept of PWS:



Splitted Rotor

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New Concept of PWS:

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3. Cycle switching

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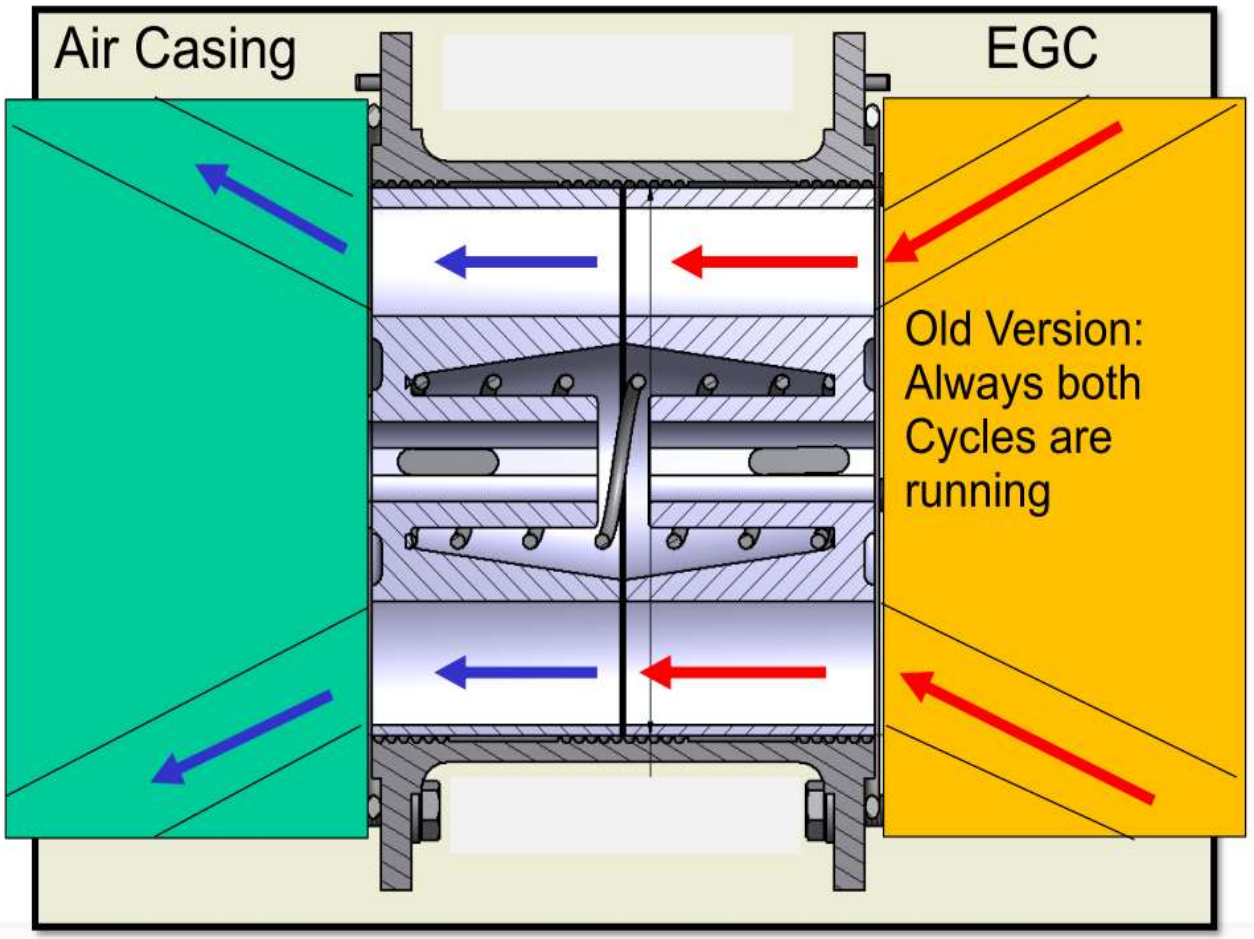
New Concept of PWS:



Cycle switching

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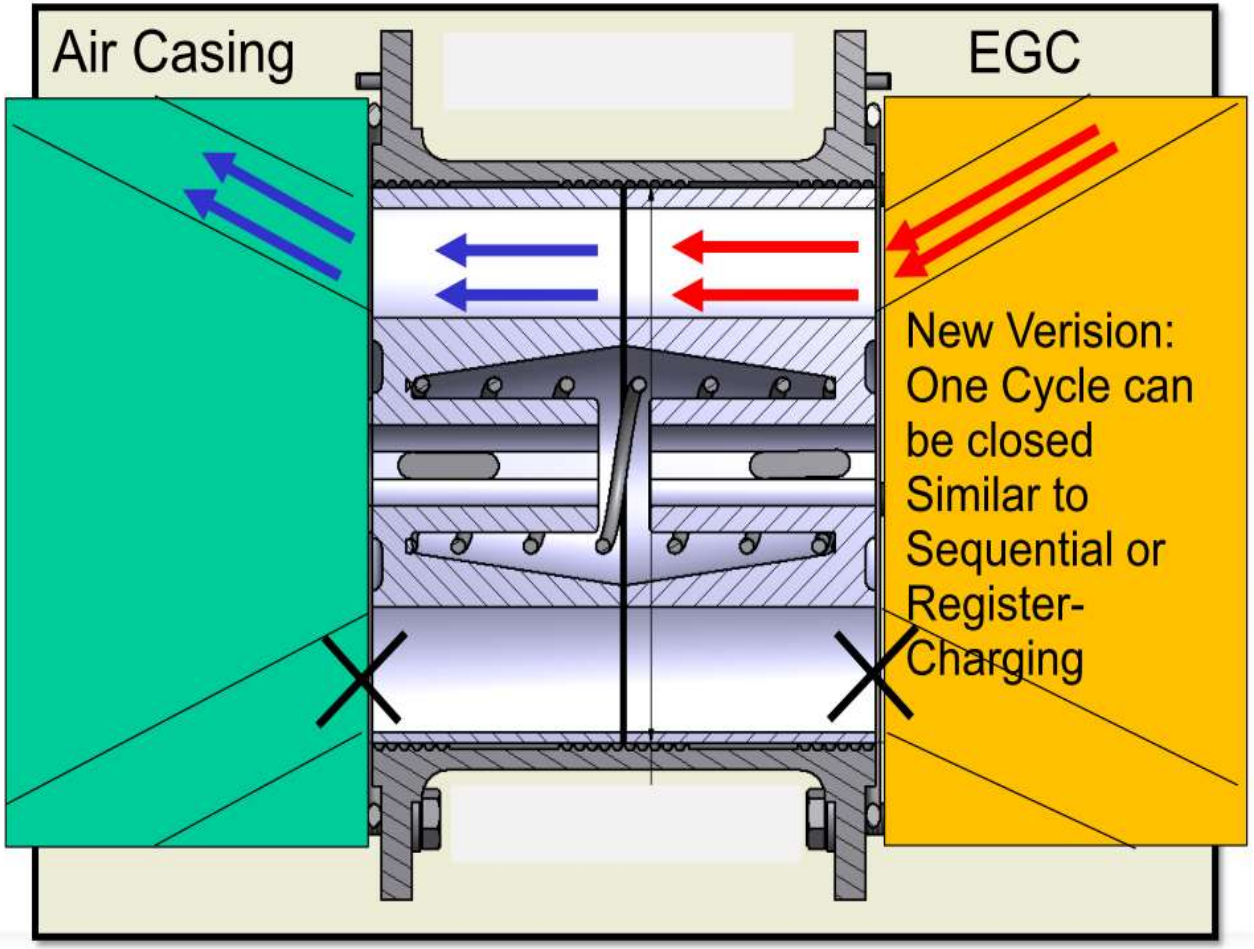
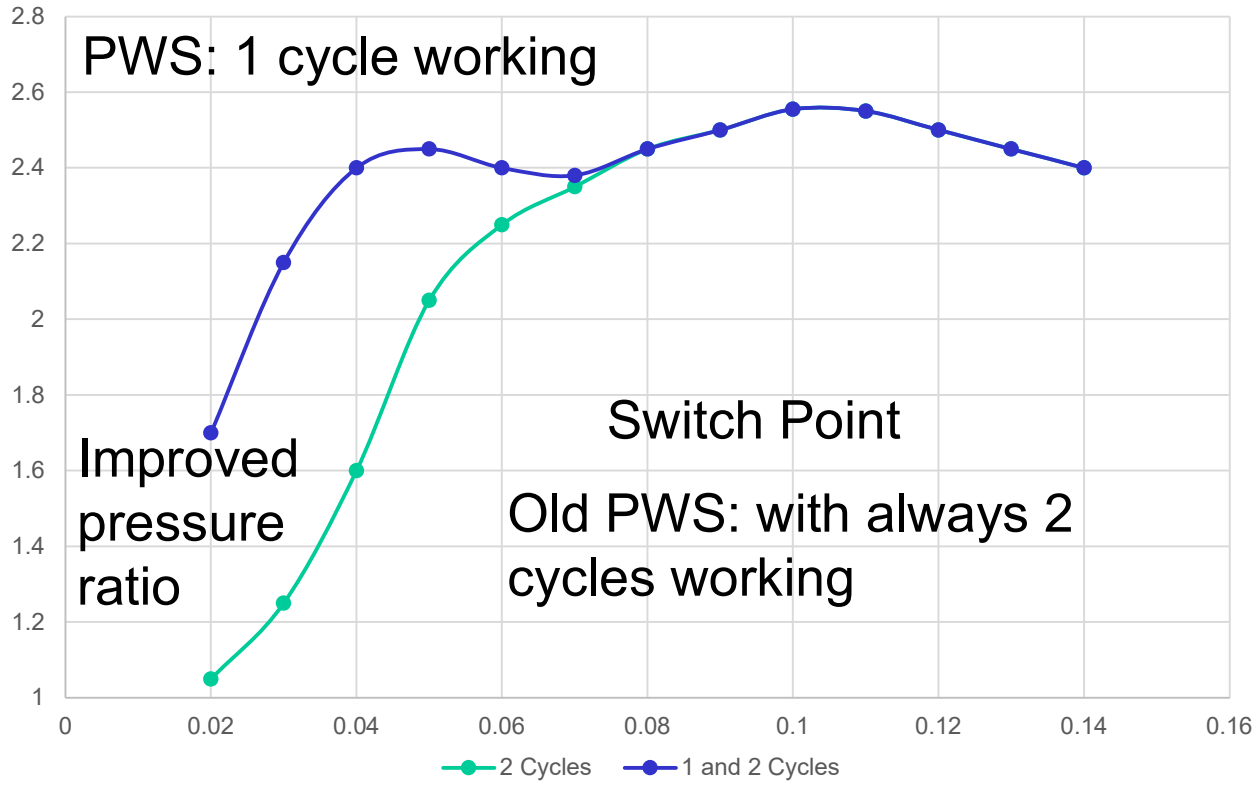
New Concept of PWS:



Cycle switching

New Concept of PWS:

: Impact of Cycle switching



Cycle switching

New Concept of PWS:

	Concept :	old	new	Rating new concept
1	Water cooling	no	yes	+++
2	Cycle shift	no	yes	++
3	Split rotor	no	yes	++
4	Capsuled bearings	no	yes	++
5	Aluminum hot gas casing without nickel	no	yes	+
6	Edge shift	yes	no	++
7	Casing geometry influenced by temperatures	yes	no	+++
8	Electric driver	yes	yes	++
9	Small speed variation	no	yes	++

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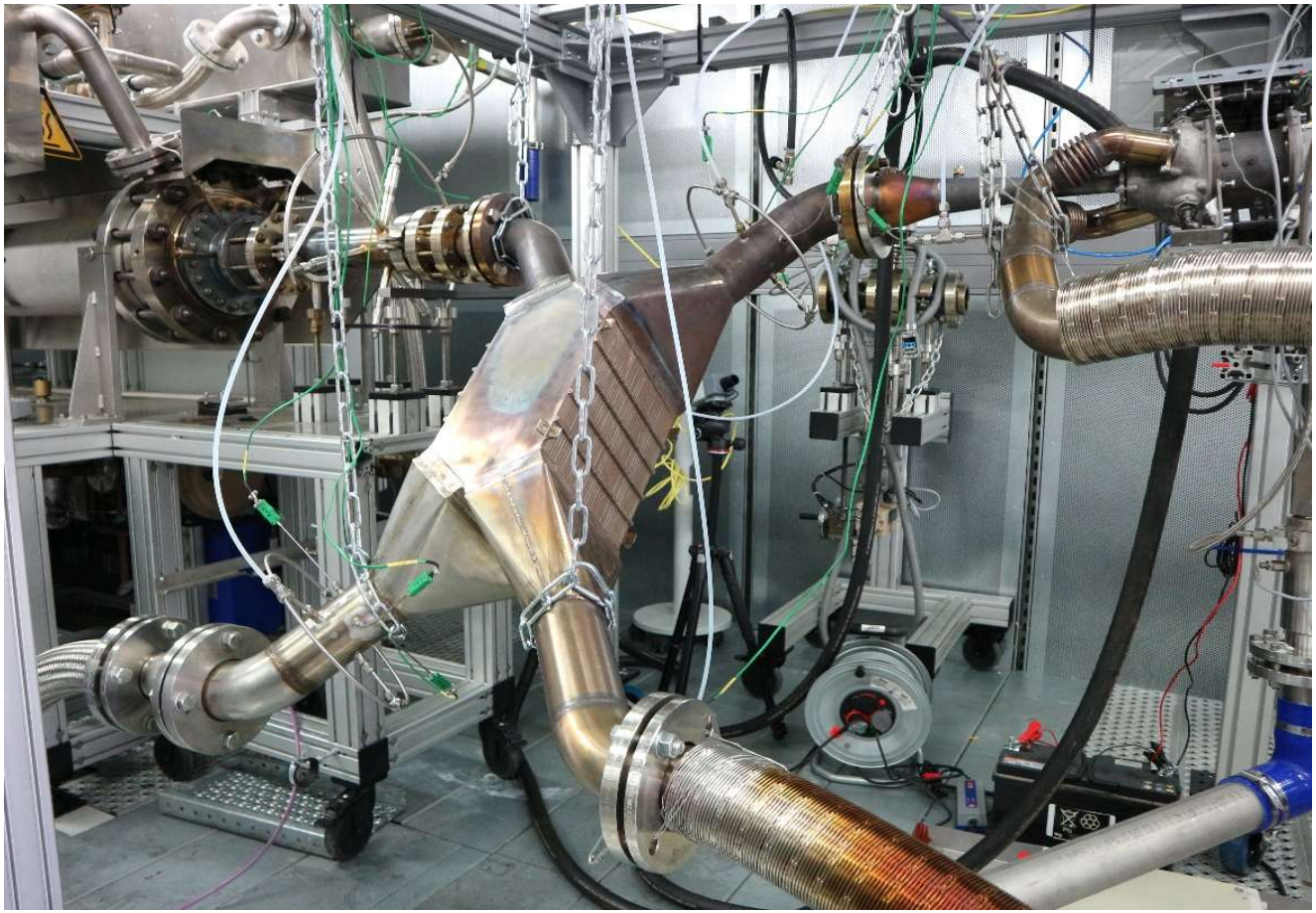
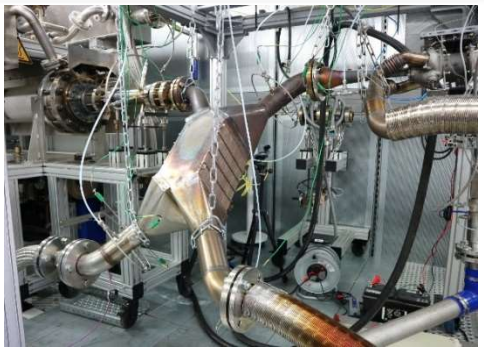
Theories are nice but what about Testing real hardware?

Hot gas Testing activities



Hot gas Testing activities



- Important for representative measurements is that the PWS creates the air for the hot gas entry by its own! The high pressure loop must be closed.

- Due to the fact that the turbocharger test stands cannot handle this for the time being a **hot gas heat exchanger** was used together with a Roots Blower to create a flow from charge air (m2) connection to hot gas inlet connection (m3).

- m3=m2+mfuel! Mfuel was represented by some additional air blown in to the high pressure circuit.

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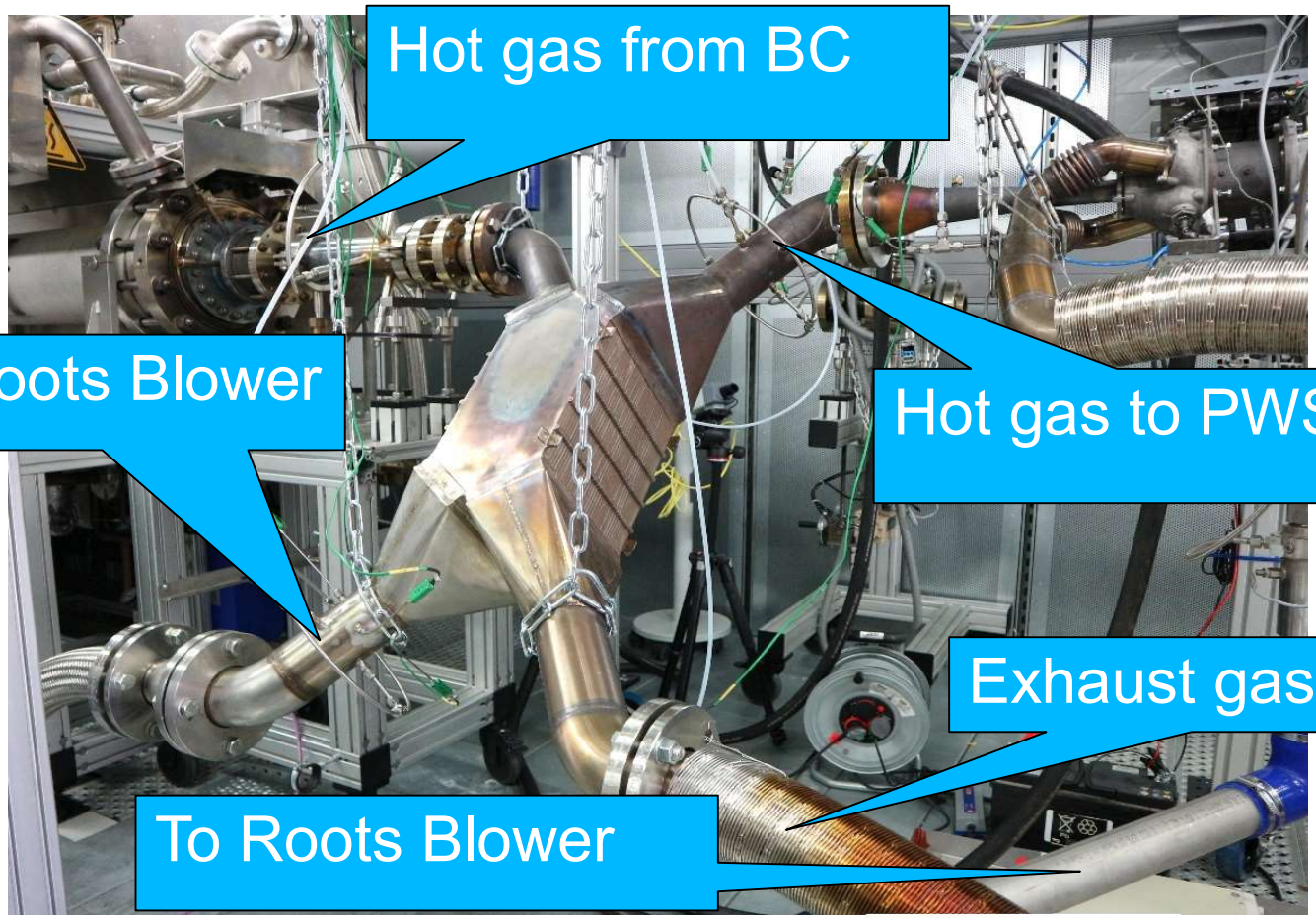
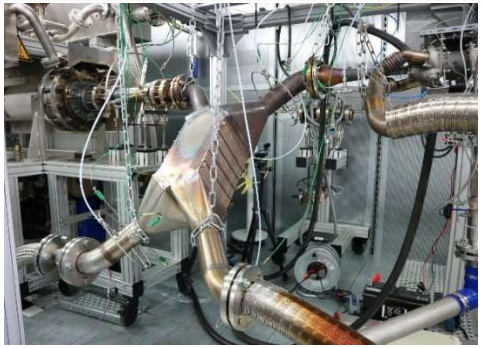
Hot gas Testing activities



Test stand in Karlsruhe

Fraunhofer ICT

Hot gas Testing activities



- We found good results and one interesting should be mentioned here.
- Concerning the splitted Rotor two measurement where made, one with a larger gap and one with a nearly closed rotor.
- Using only a lower temperature at hot gas inlet and a lower flow to make the system more sensible for a splitted rotor the difference between the two measured charge air pressures was only 0.036 bar abs.
- That proves the theory that the system is working in spite of a gap in between the Rotor.
- For more details see script

EngineTesting activities

EngineTesting activities

- Concerning the engine measurements there was first a petrol engine and later gas engine tested.
- On both engines the typical behaviour of the PWS could be found.
- Concerning the important question if the cold System of Engine and PWS is able to start without edge shift and with one open Cycle instead, we found a positive answer.
- Cold start works and proves the simulation that has shown a better performance using cycle switching instead of edge shift during engine start.
- With the gas engine a complete engine map was measured. Unfortunately the results cannot be presented this time.

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See more?

Come to the Exhibition
Disp. 9

Many thanks for your attention!


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