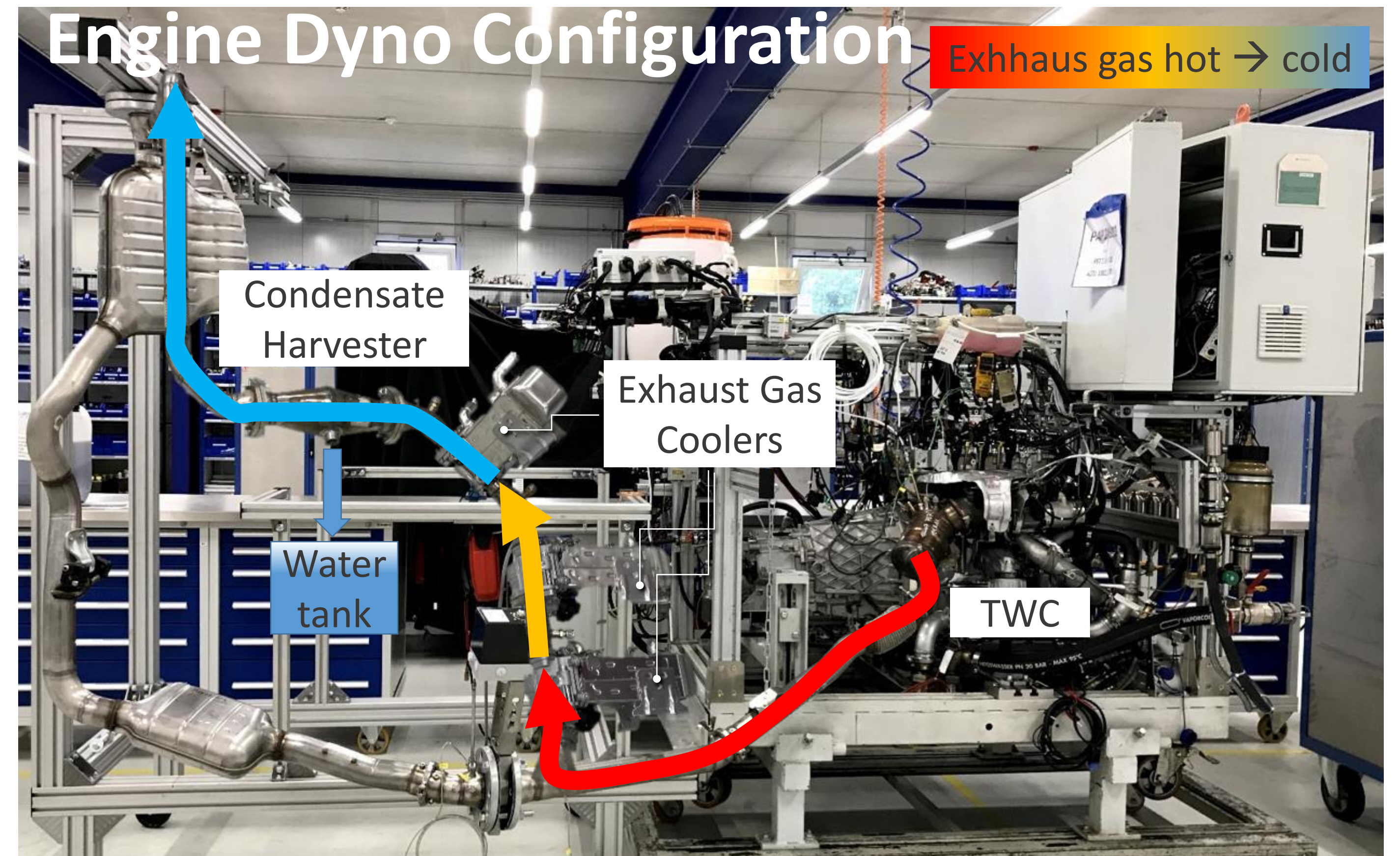


## Exhaust gas condensation system for high water injection rates in gasoline engines

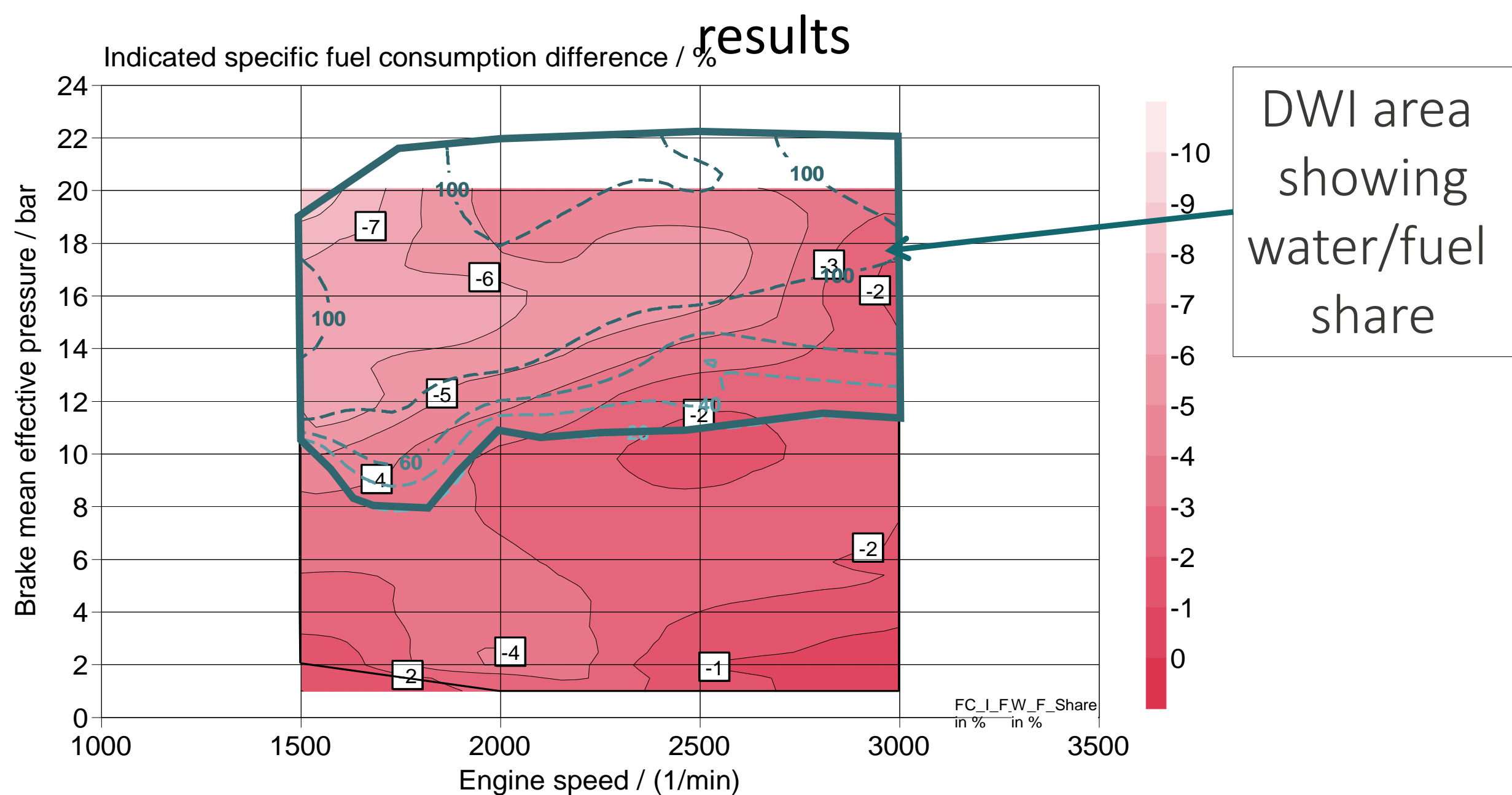
### Motivation

- ▶ Reduction of CO<sub>2</sub> emissions by increased engine compression ratio (CR)
- ▶ High water to fuel ratios for Direct Water Injection (DWI) to avoid engine knock limitation for increased engine efficiency
- ▶ Water recovery from exhaust gas condensation as enabler for self-sustaining water injection and increase of customer acceptance for water injection systems
- ▶ Stoichiometric air/fuel ratio in entire engine map for low CO<sub>2</sub> emissions and RDE compliance



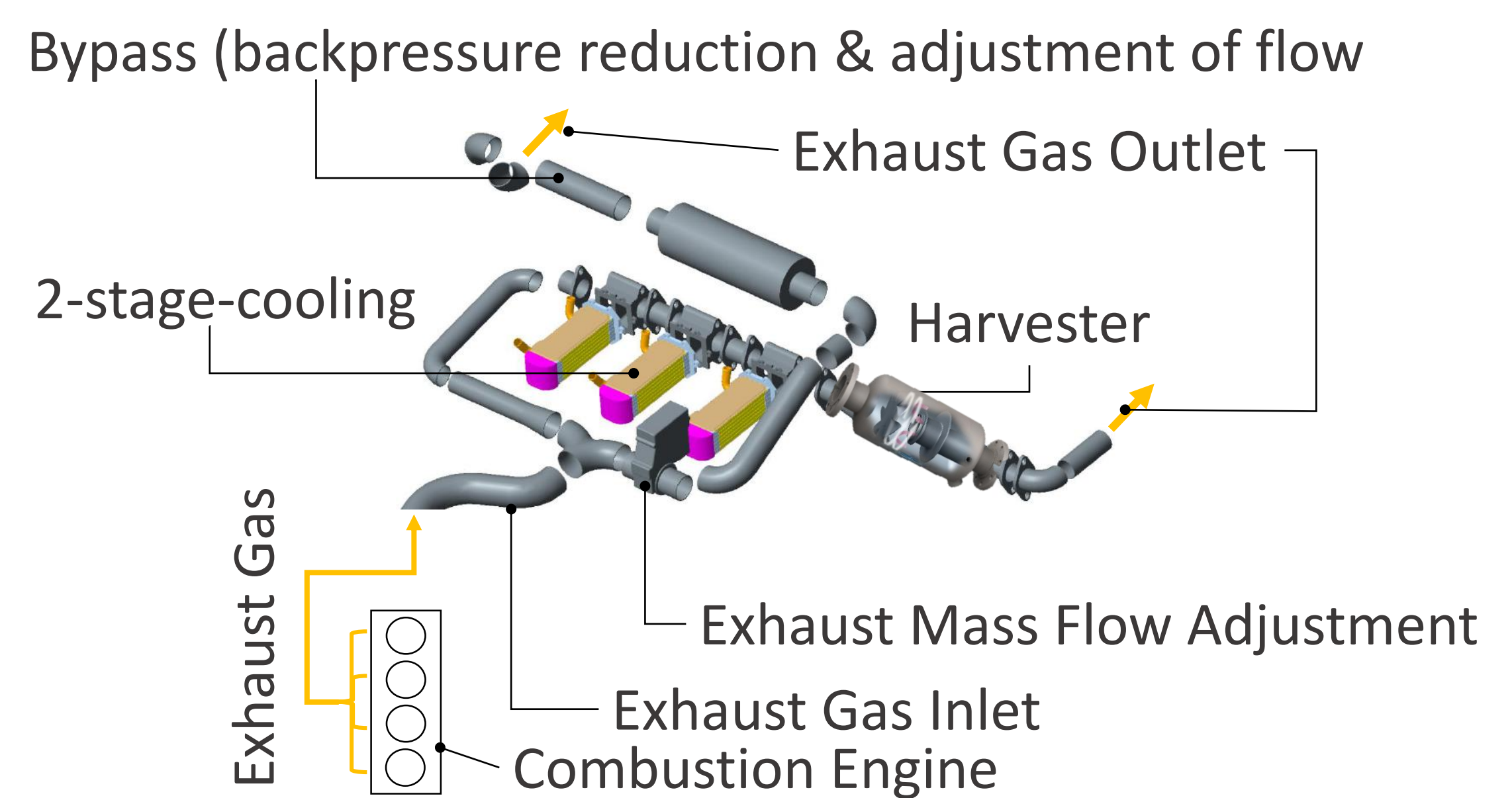
### Reduction of Fuel Consumption with DWI and CR 13.5:1

Relative difference to engine with PWI and CR 12:1 engine testing results



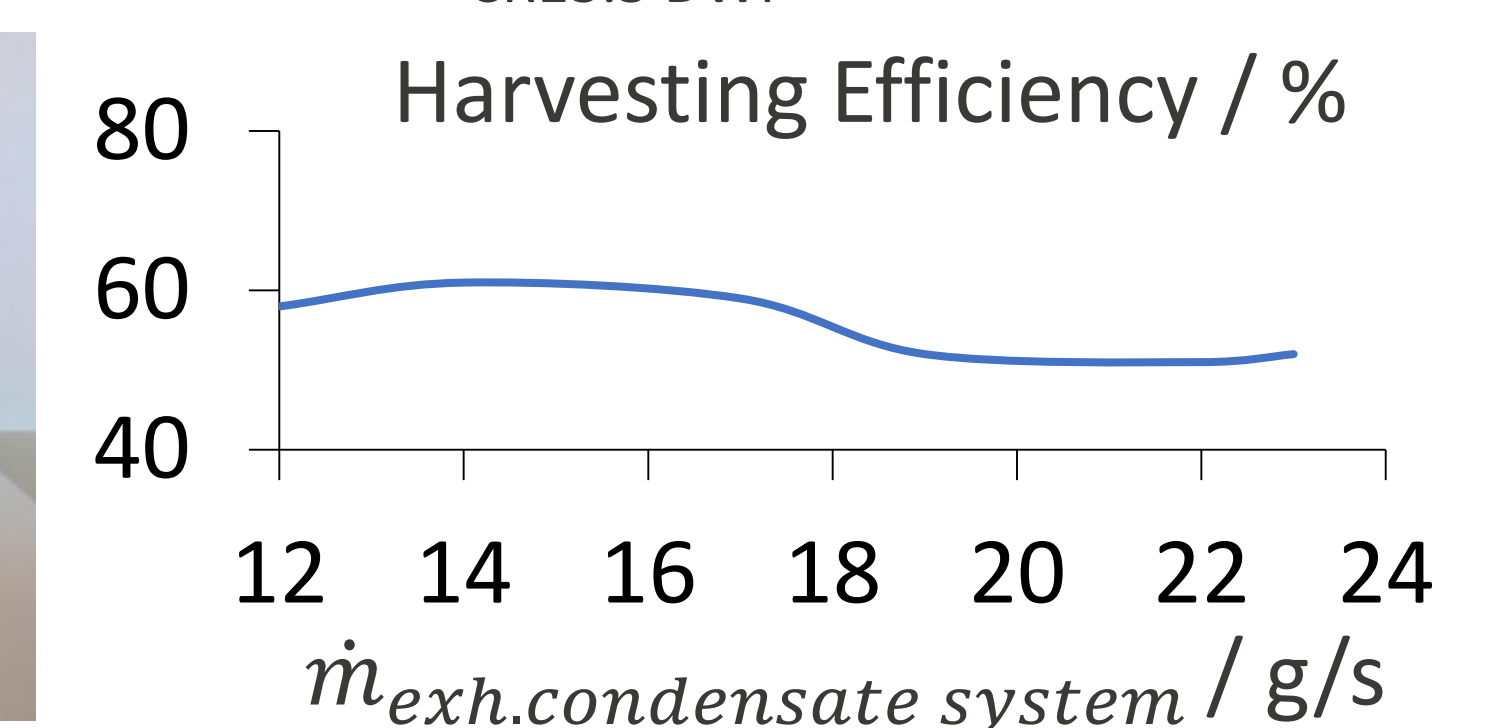
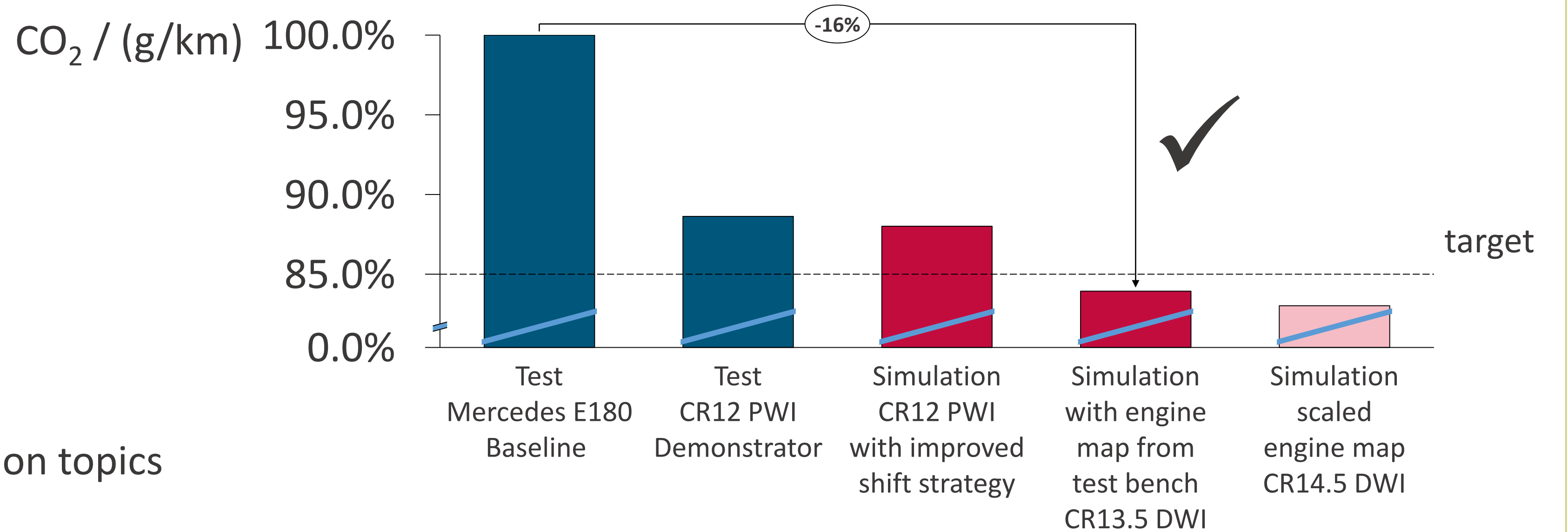
### Package & Vehicle Integration

Condensate system can be integrated in OEM vehicle packages



### Results of Water Injection & Condensate Harvesting Efficiency & Quality

- ▶ CO<sub>2</sub> improvement of >15% can be realized
- ▶ Harvesting of more condensate than injected is possible
- ▶ Harvesting efficiency investigated and >60 %
- ▶ Condensate quality after GPF nearly free of particles, neutral pH-values – no disadvantages in combustion or emission topics
- ▶ Different condensate harvesting points compared – best position after exhaust aftertreatment (GPF)
- ▶ Same advantages for emissions and combustion for condensate compared with distilled water

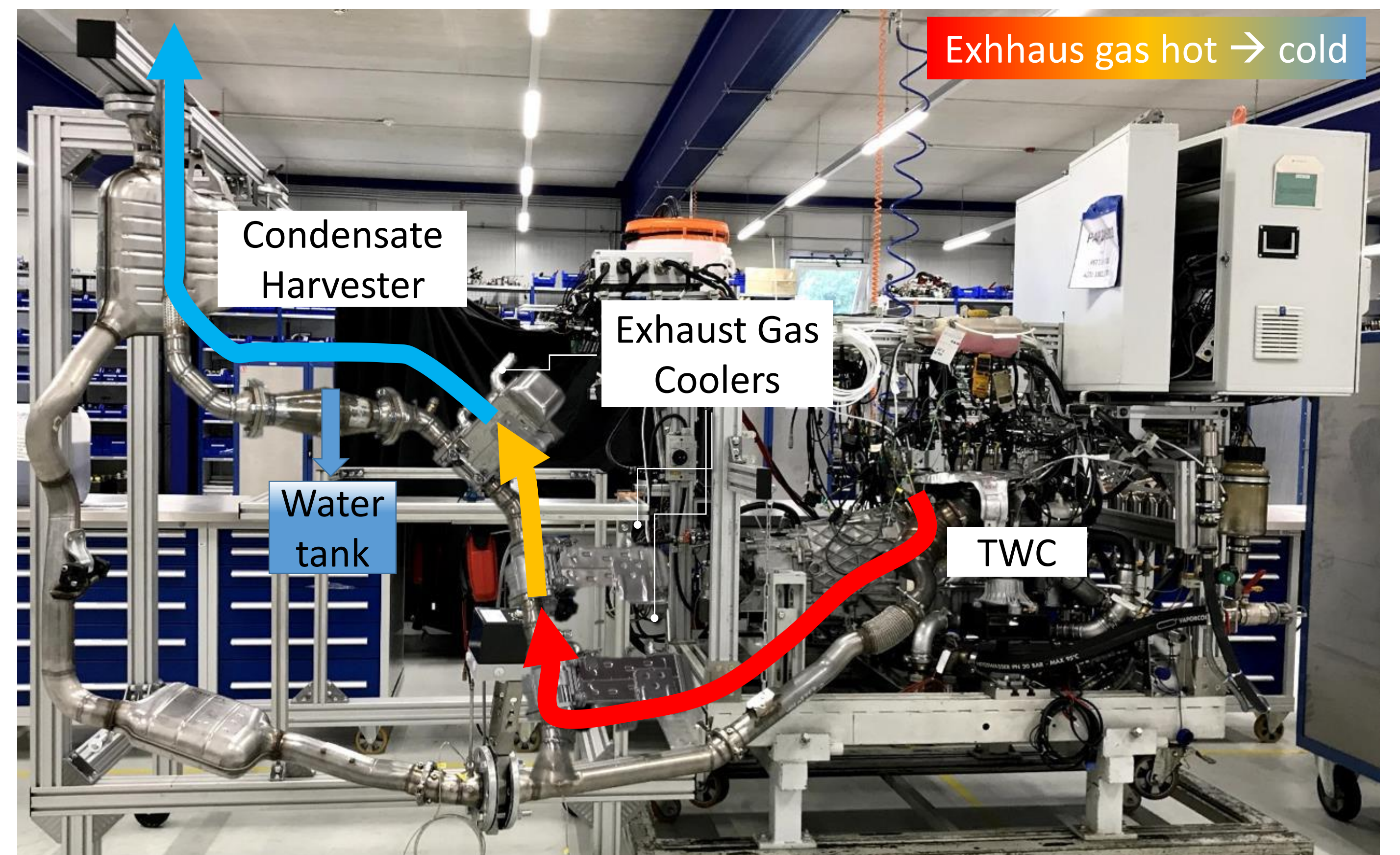


## Exhaust Gas Condensation System for high Water Injection Rates on Gasoline Engine

### Motivation

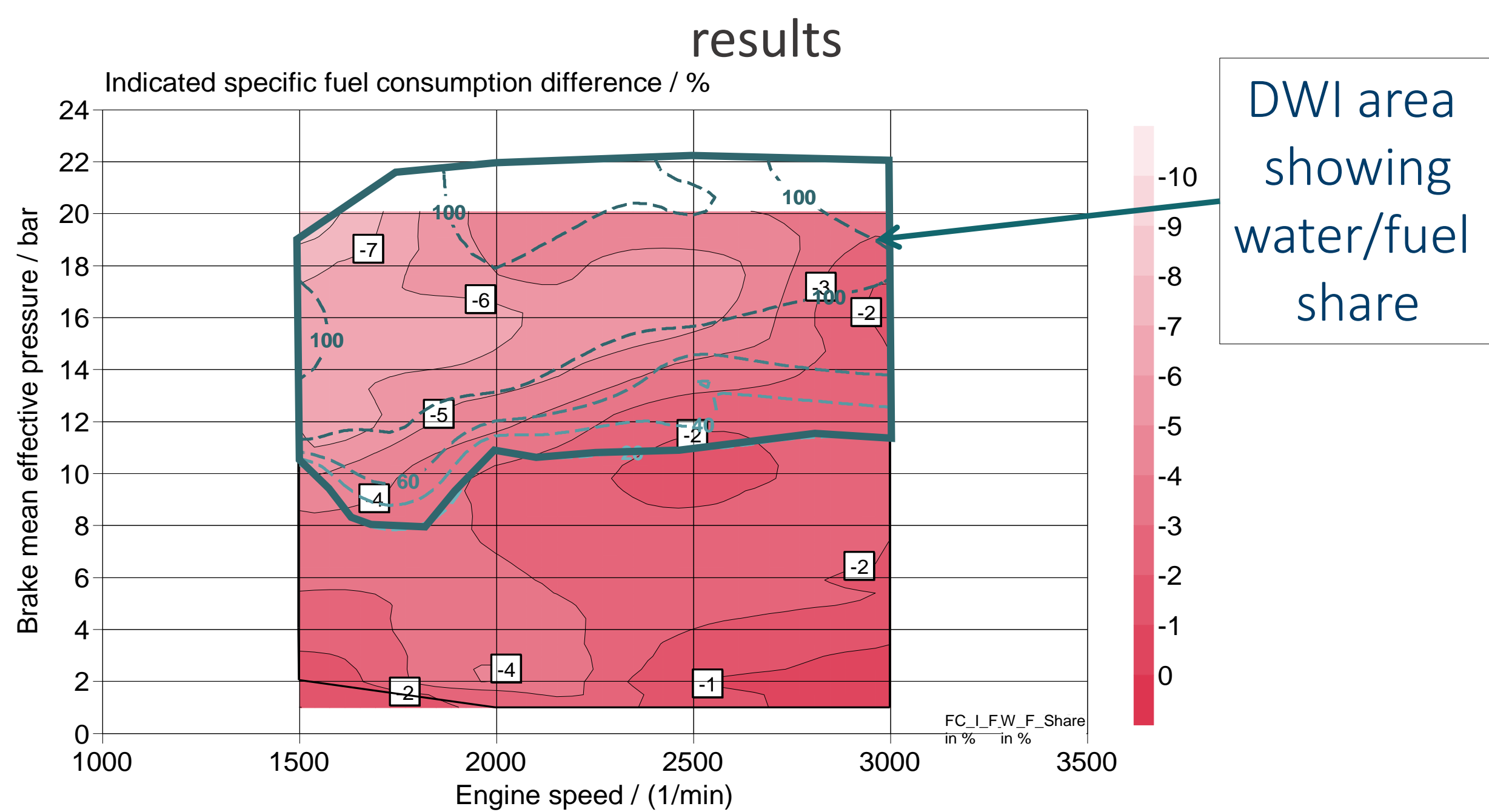
- ▶ Reduction of CO<sub>2</sub> emissions by increased engine compression ratio (CR)
- ▶ High water to fuel ratios for Direct Water Injection (DWI) to avoid engine knock limitation for increased engine efficiency
- ▶ Water recovery from exhaust gas condensation as enabler for self-sustaining water injection and increase of customer acceptance for water injection systems
- ▶ Stoichiometric air/fuel ratio in entire engine map for low CO<sub>2</sub> emissions and RDE compliance

### Engine Dyno Configuration



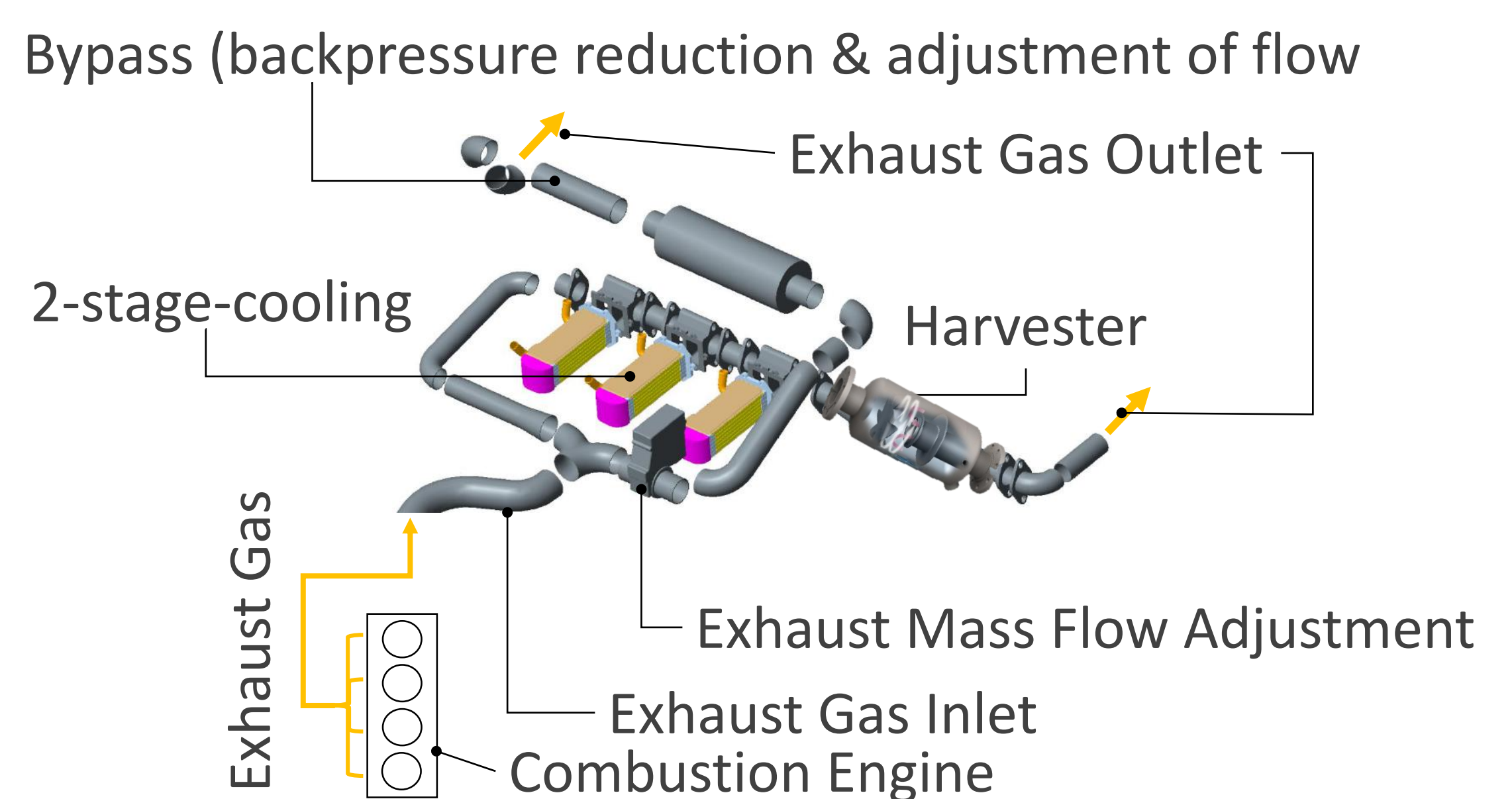
### Reduction of Fuel Consumption with DWI and CR 13.5:1

Relative difference to engine with PWI and CR 12:1 engine testing results



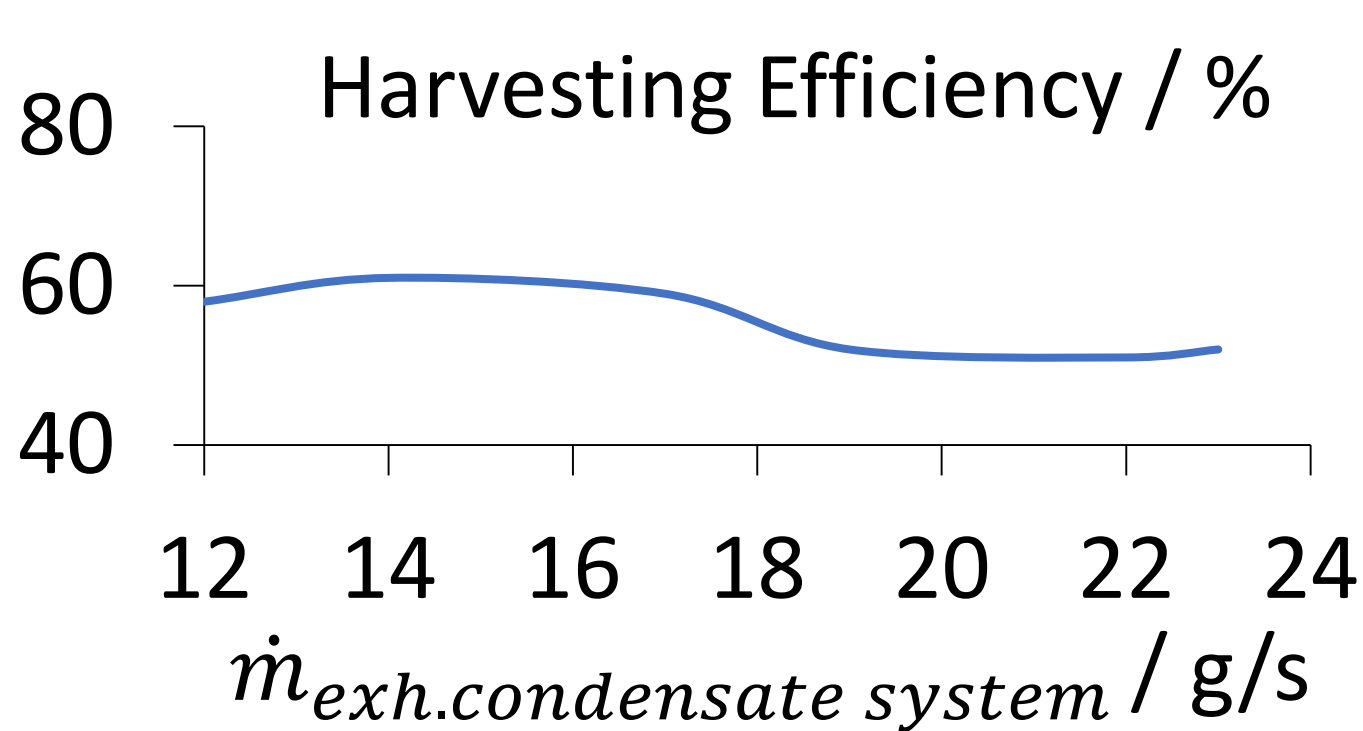
### Package & Vehicle Integration

Condensate system can be integrated in OEM vehicle packages



### Results of Water Injection & Condensate Harvesting Efficiency & Quality

- ▶ CO<sub>2</sub> improvement of >15% can be realized
- ▶ Harvesting of more condensate than injected is possible
- ▶ Harvesting efficiency investigated and >60 %
- ▶ Condensate Quality after GPF nearly free of particles, neutral pH-values – no disadvantages in combustion or emission topics
- ▶ Different condensate harvesting points compared – best position after exhaust aftertreatment (GPF)
- ▶ Same advantages for emissions and combustion for condensate compared with distilled water



Engine: i1259 - PaREGEEn

Investigation, Fuel, Operation: Comparison of osmosis and condensate DWI

