

# Gas Exchange in Internal Combustion Engines



MTZ-KONFERENZ - MOTOR  
7. UND 8. NOVEMBER 2007 | STUTT GART



Ladungswechsel  
im Verbrennungsmotor



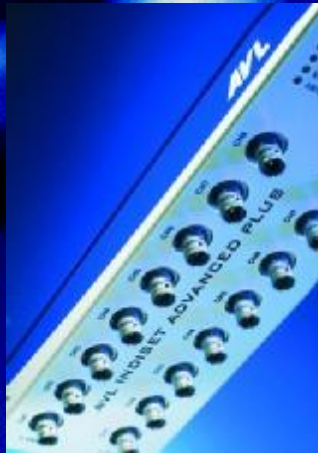


**Accurate determination of important gas exchange parameters directly at the test bed based on existing measured values**

**Dr. Robert Fairbrother, development simulation GCA**  
**Dipl.-Ing. Fernando Moreno Nevado, development gasoline engines,**  
**Dr. Thomas Leifert, product management GCA**

**AVL List GmbH**

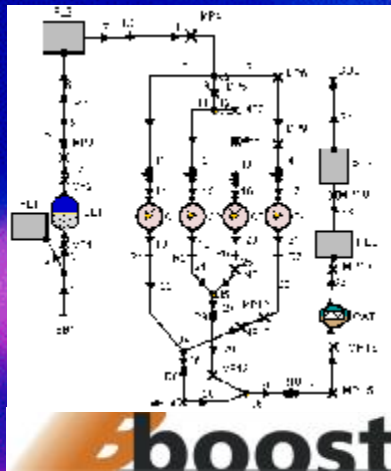
Indicating



Test Bed



# GCA



Simulation

## Contents



§ Principle

§ Analysis

§ Combustion

§ Gas exchange

§ Losses

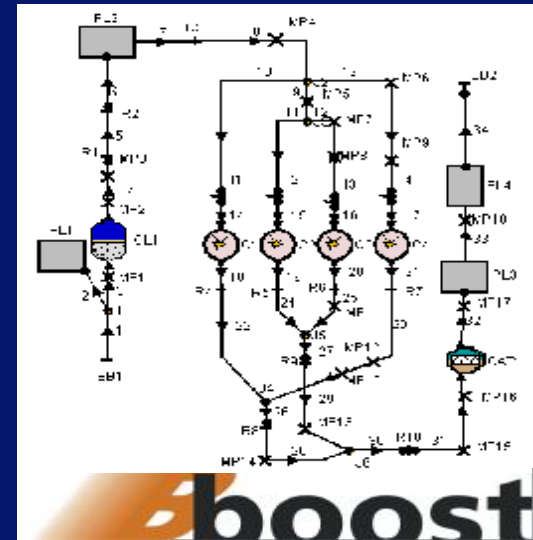
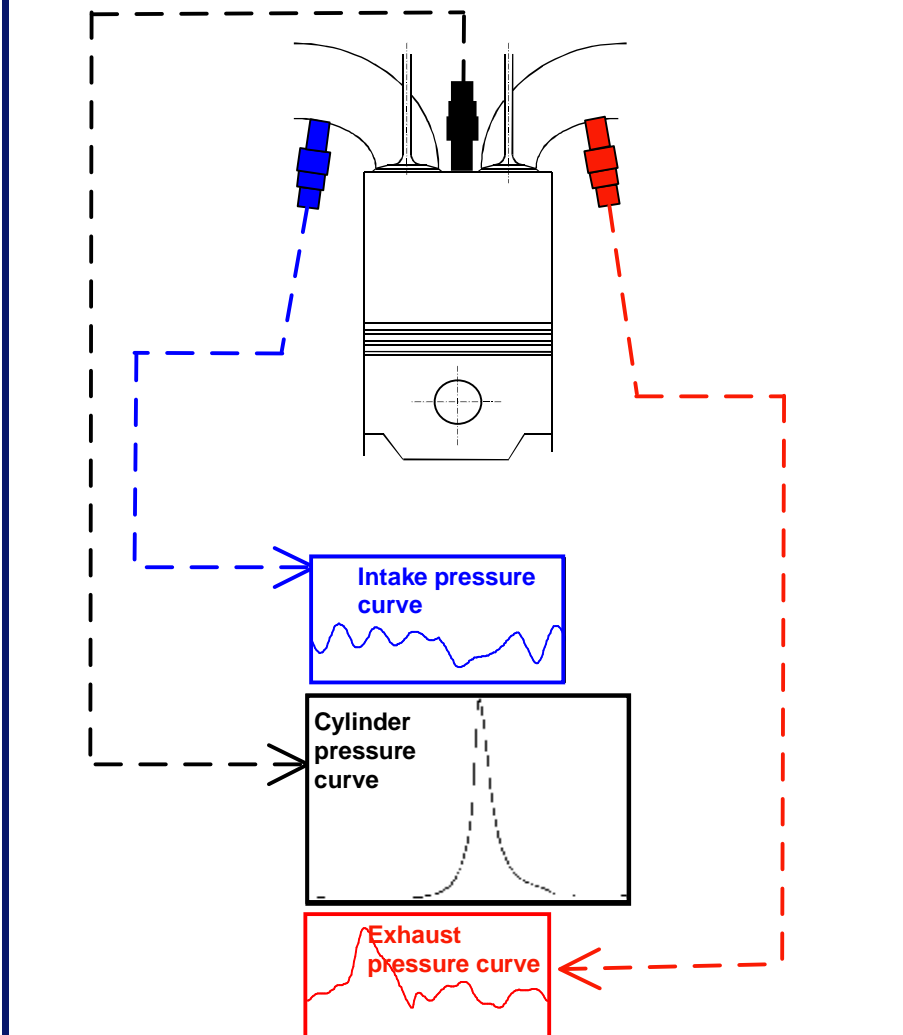
§ Test bed: an example

§ Conclusion

# AVL GCA : Working Principle and Motivation



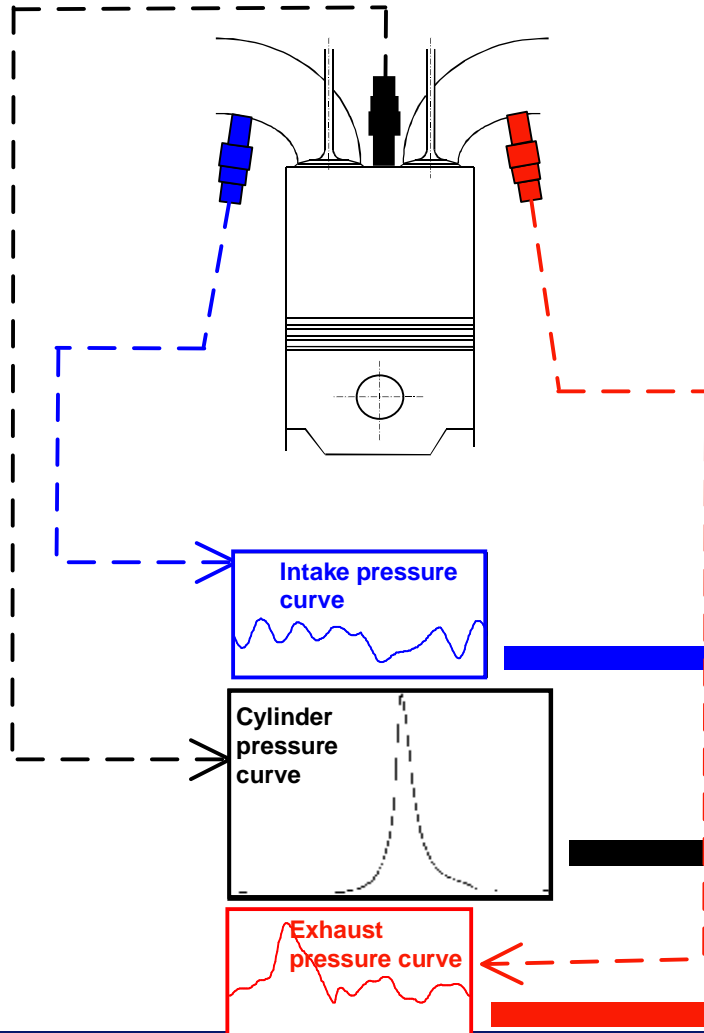
At the test bed



# AVL GCA : Working Principle and Motivation



## At the test bed



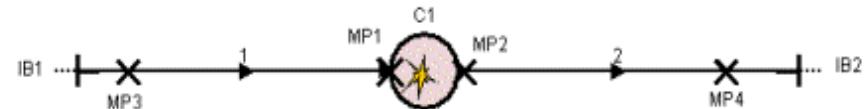
## In the simulation

Highly relevant, non-measurable in-cylinder parameters are made available (e.g. internal AGR).

- Accuracy high
- Calibrating effort low
- Calculation time low

b  
p  
p

Reduced AVL BOOST Model



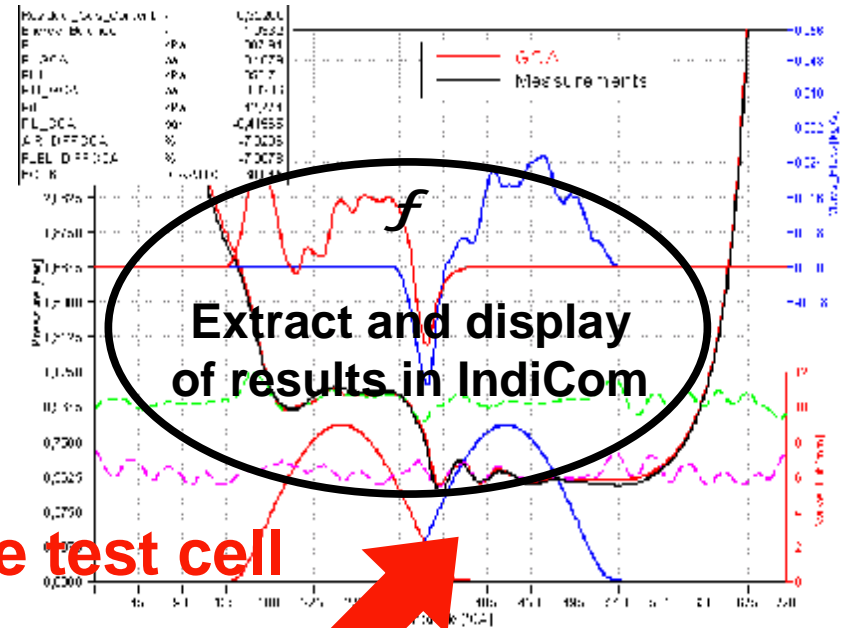
Combustion analysis



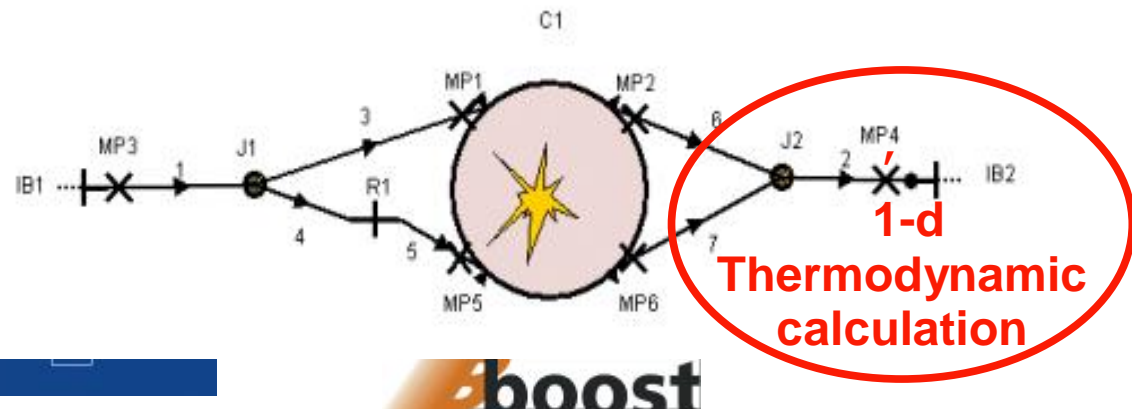
# AVL GCA : the Virtual Sensor



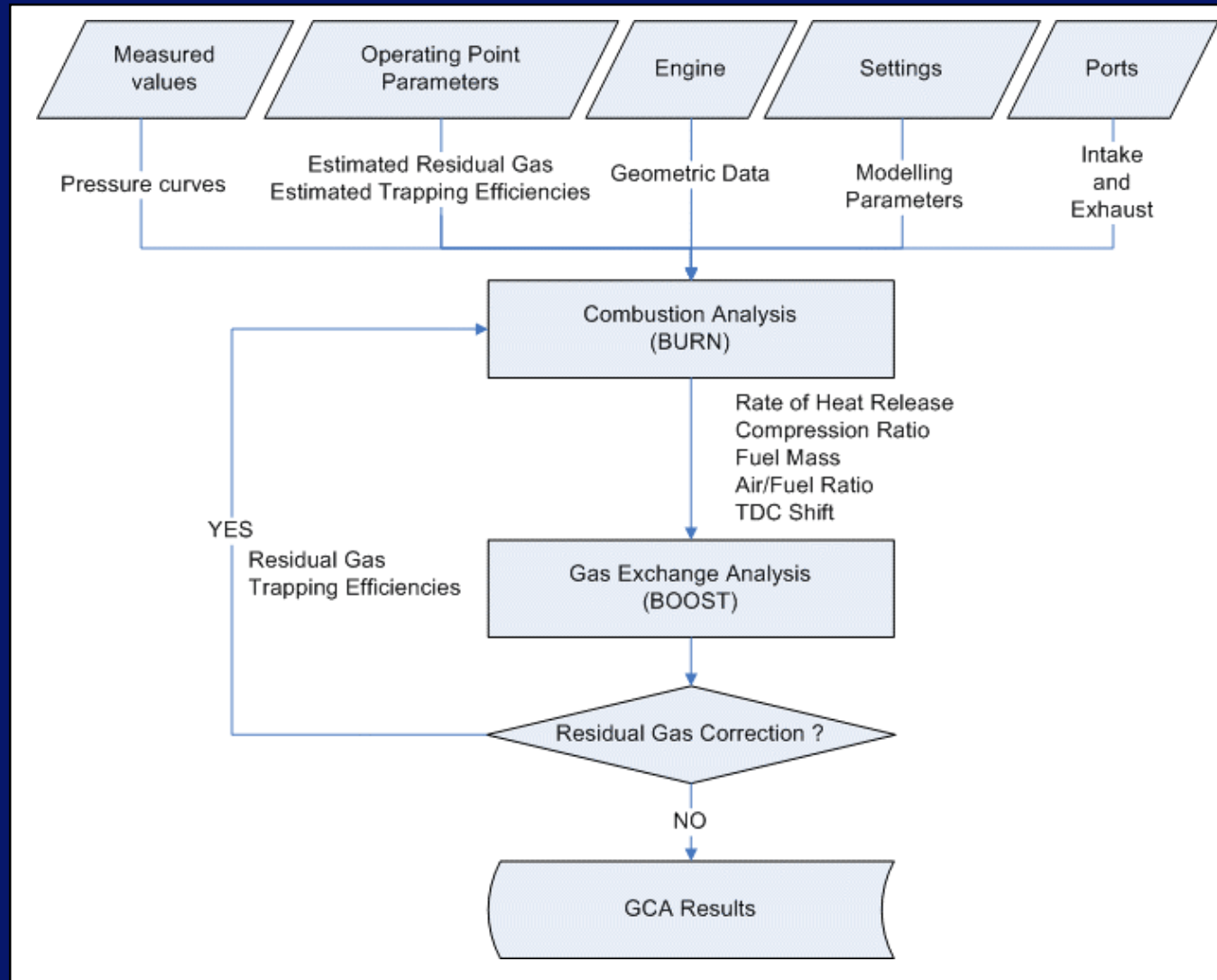
Automatical transfer of the measuring data to the single cylinder-model



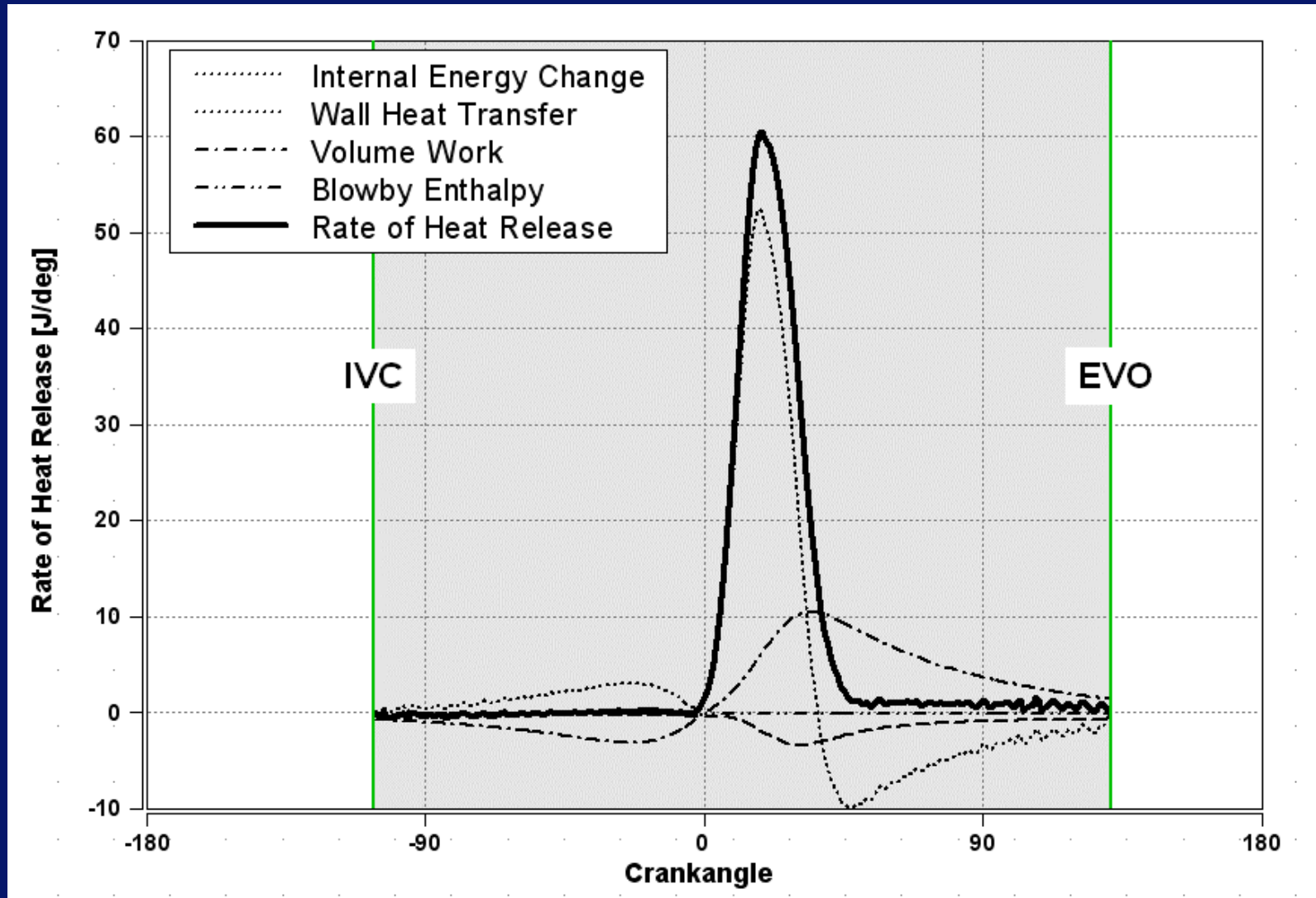
ONLINE at the test cell



# Workflow

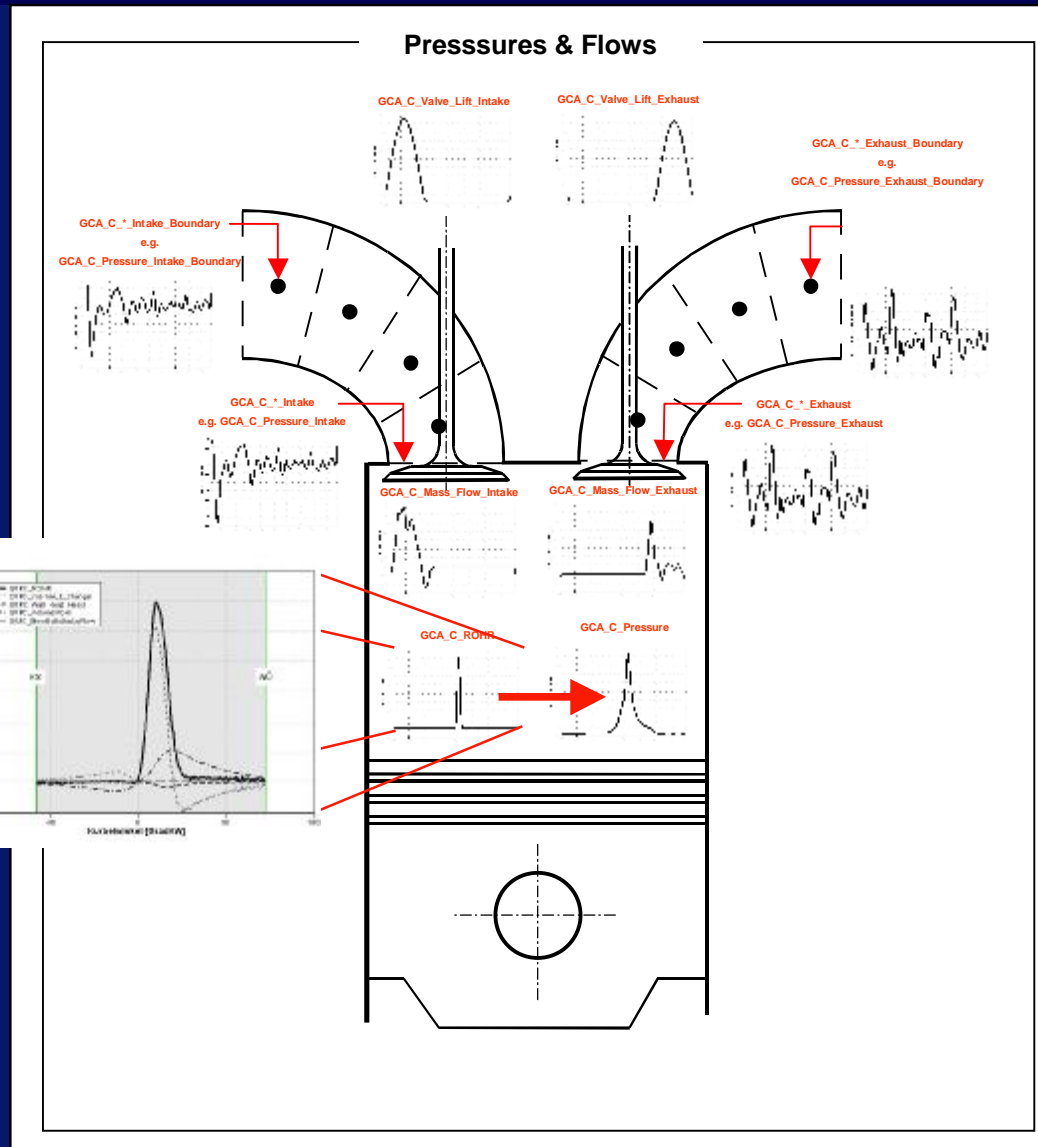


# Combustion Analysis

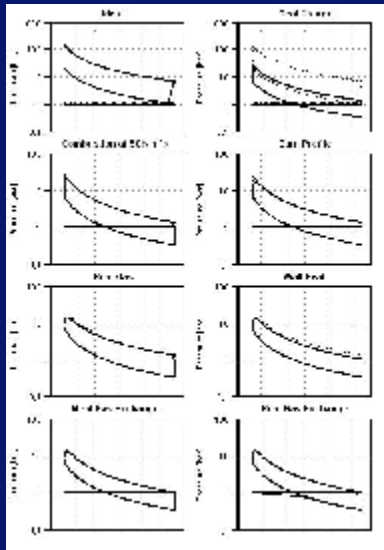




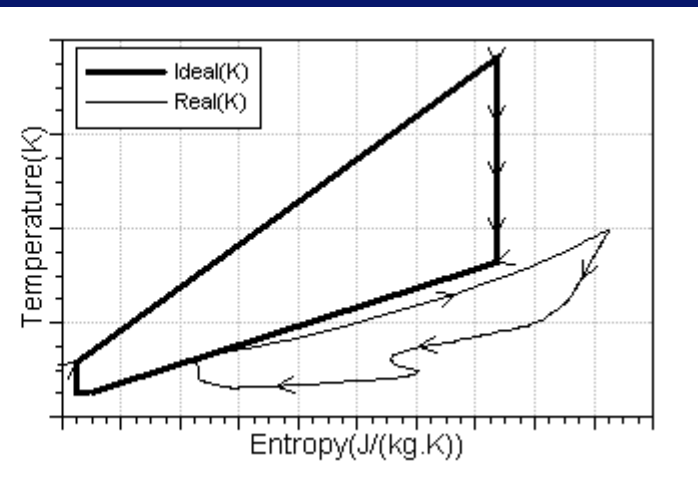
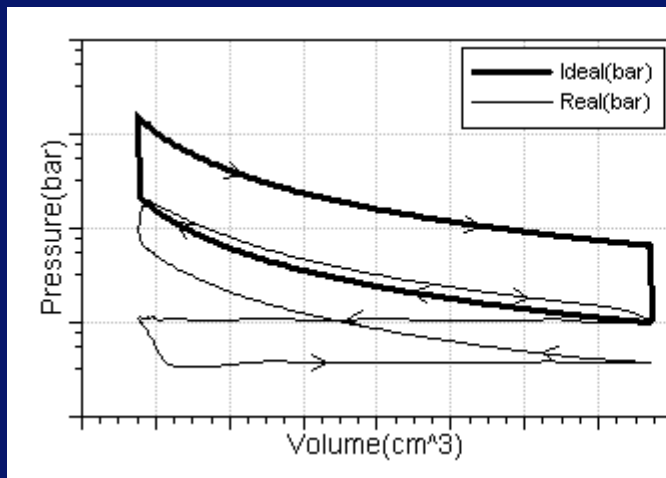
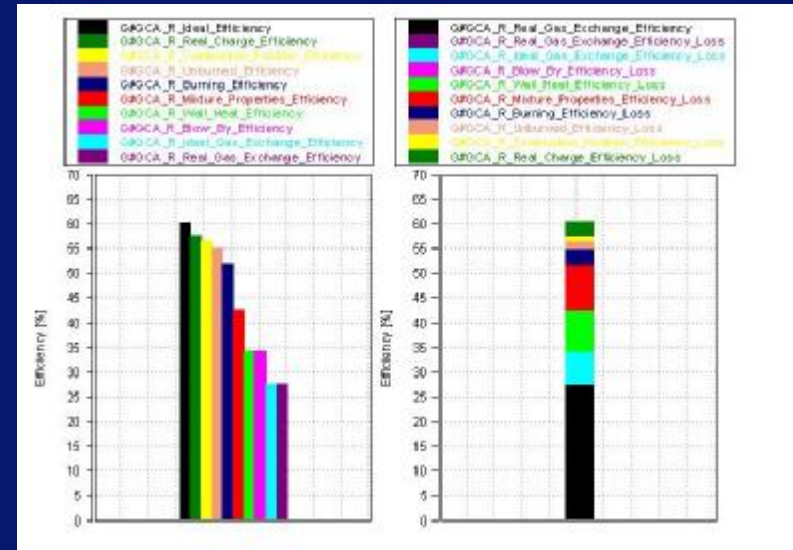
# Gas Exchange Analysis



# Loss Analysis



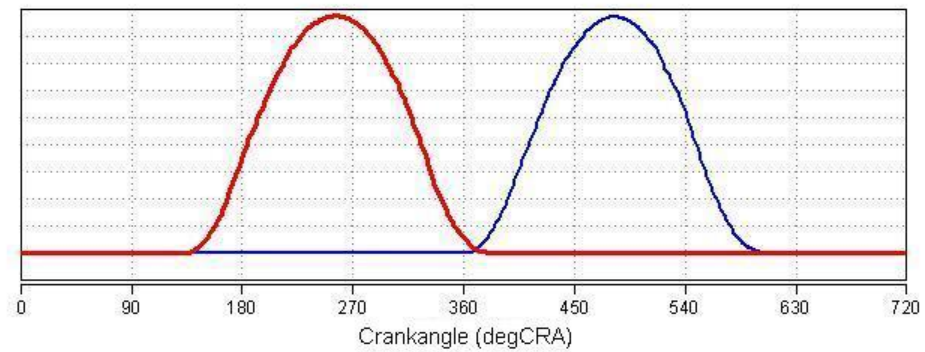
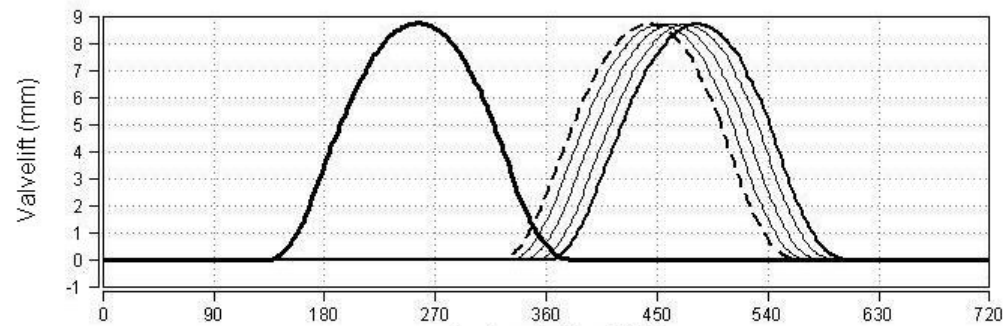
- Ideal engine
- Real charge
- Combustion position
- Unburned
- Burn profile (ROHR)
- Mixture properties
- Wall heat
- Blow by
- Ideal gas exchange
- Real gas exchange



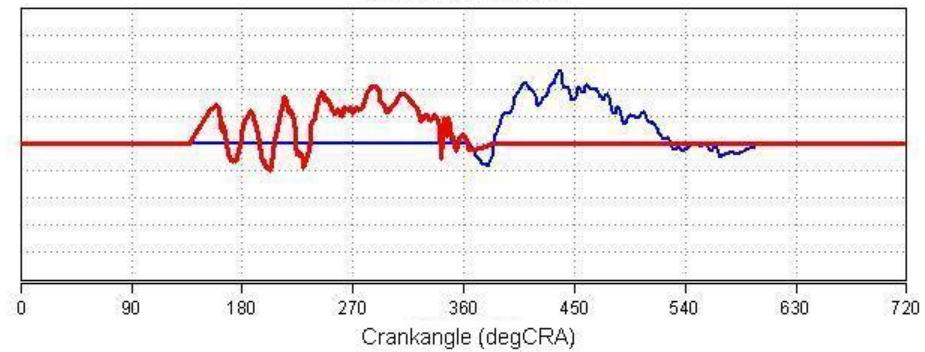
# Example: Valve Overlapping



Valve lift



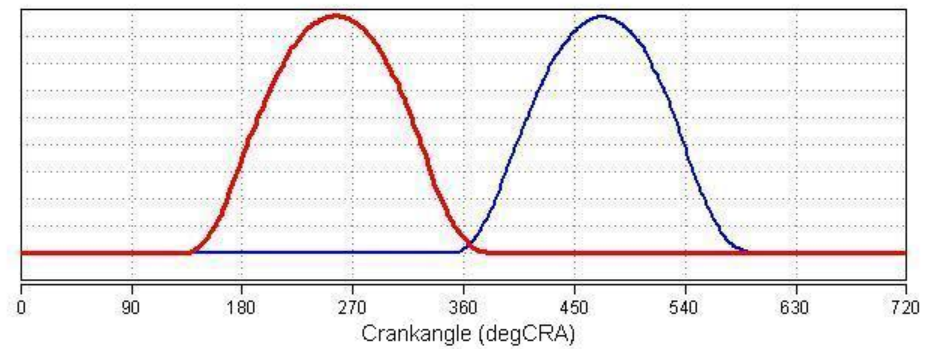
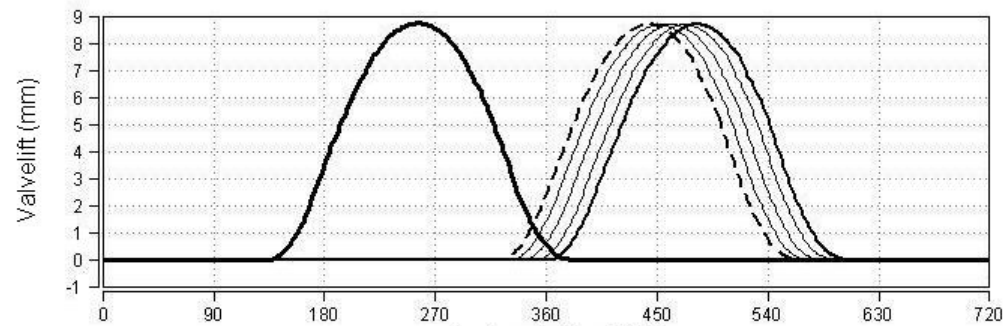
Exhaust / Intake mass flow



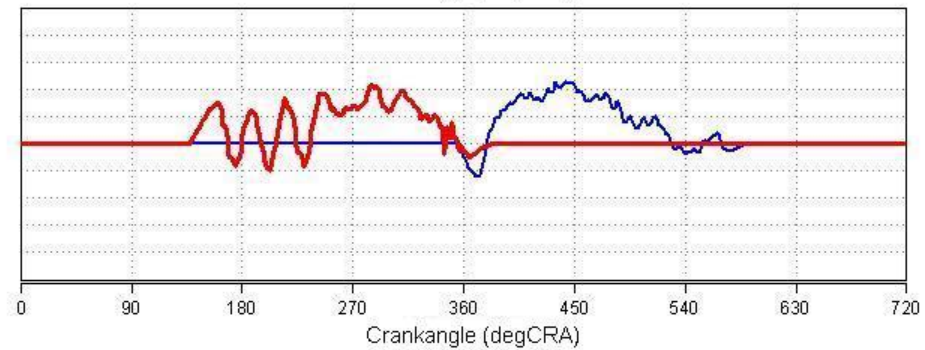
# Example: Valve Overlapping



Valve lift



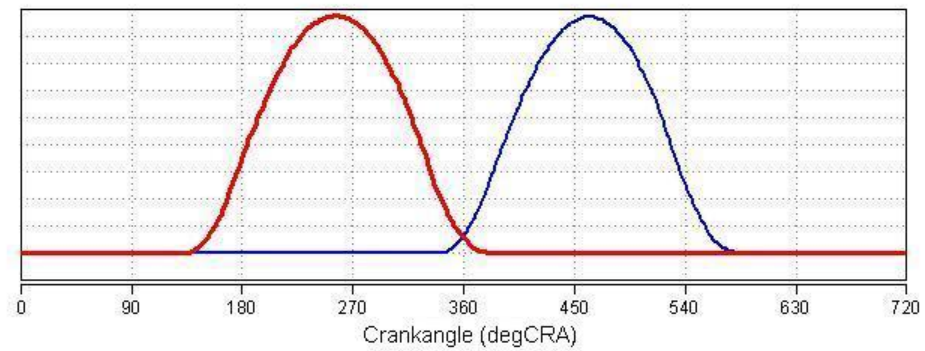
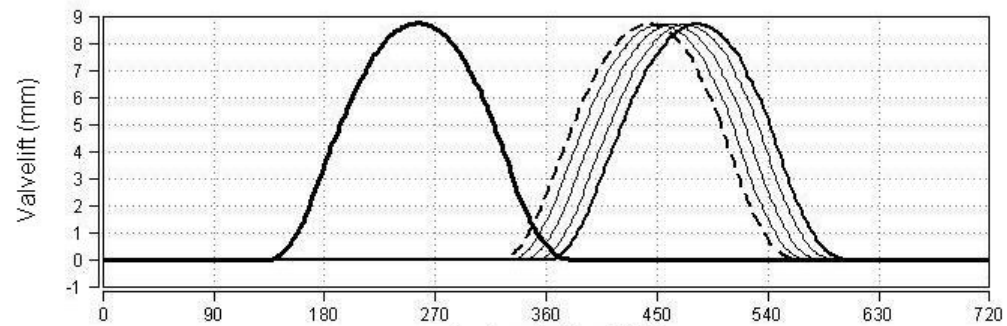
Exhaust / Intake mass flow



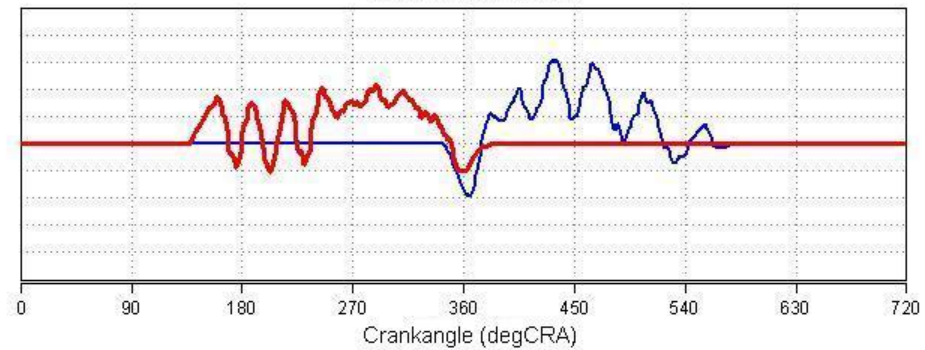
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Valve lift



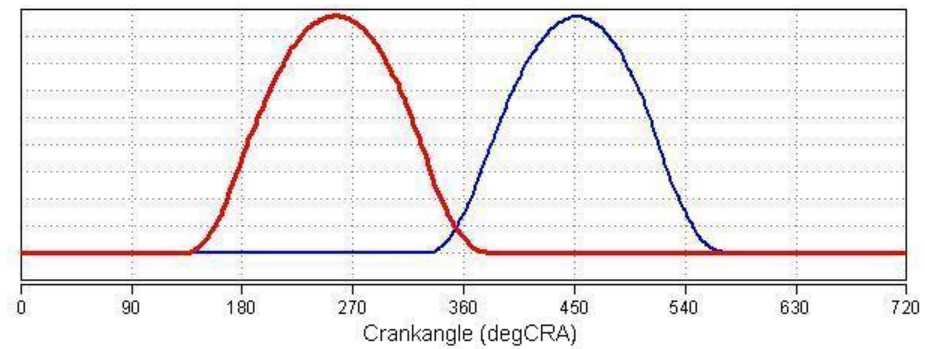
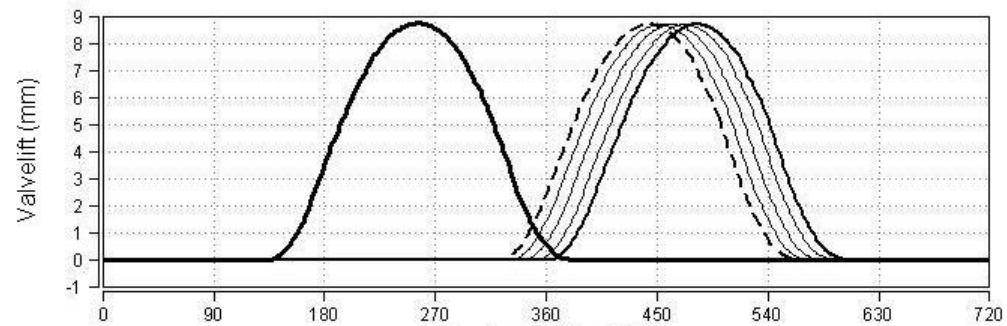
Exhaust / Intake mass flow



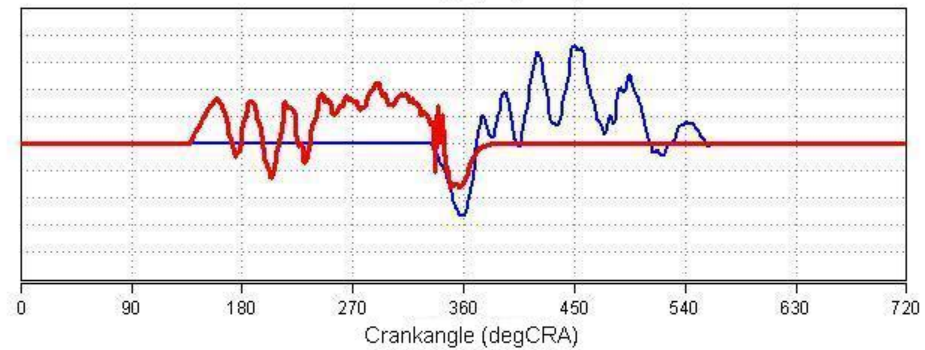
# Example: Valve Overlapping



Valve lift



Exhaust / Intake mass flow

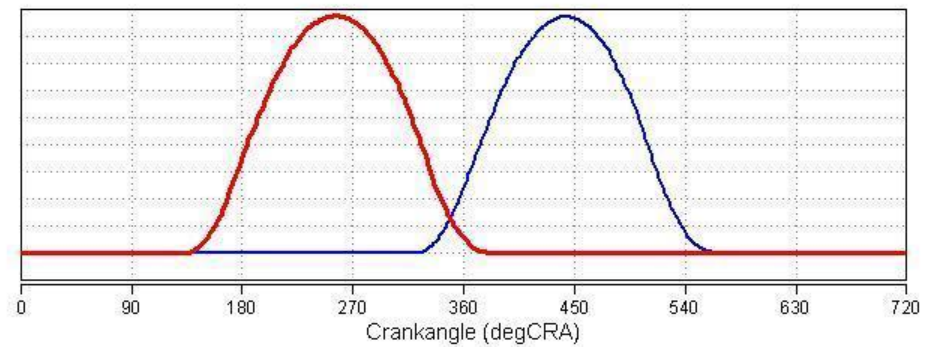
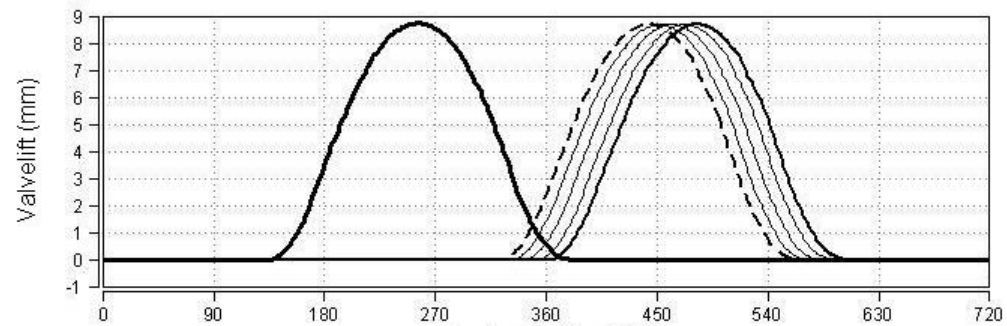




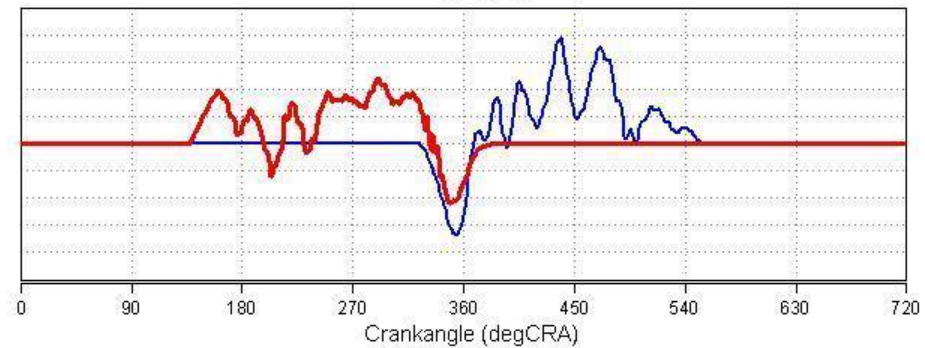
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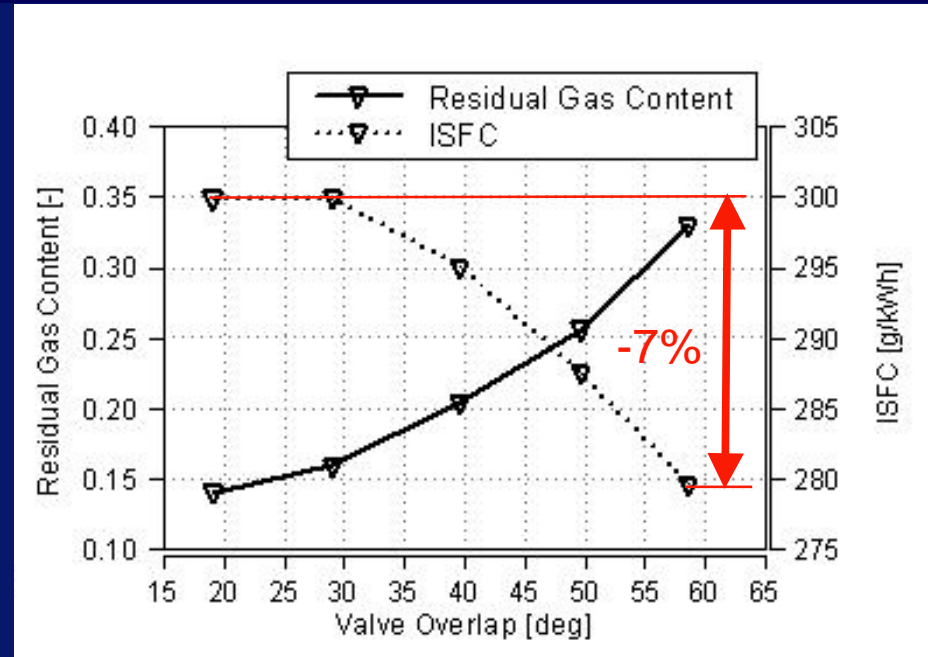
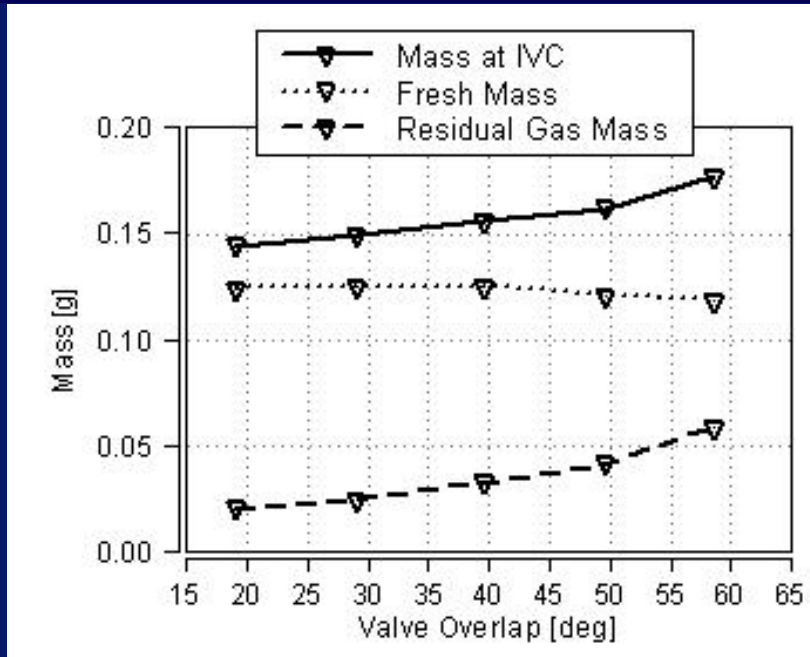
Valve lift



Exhaust / Intake mass flow



# Results at speed 2000 rpm, BMEP = 2 bar, $\lambda = 1$

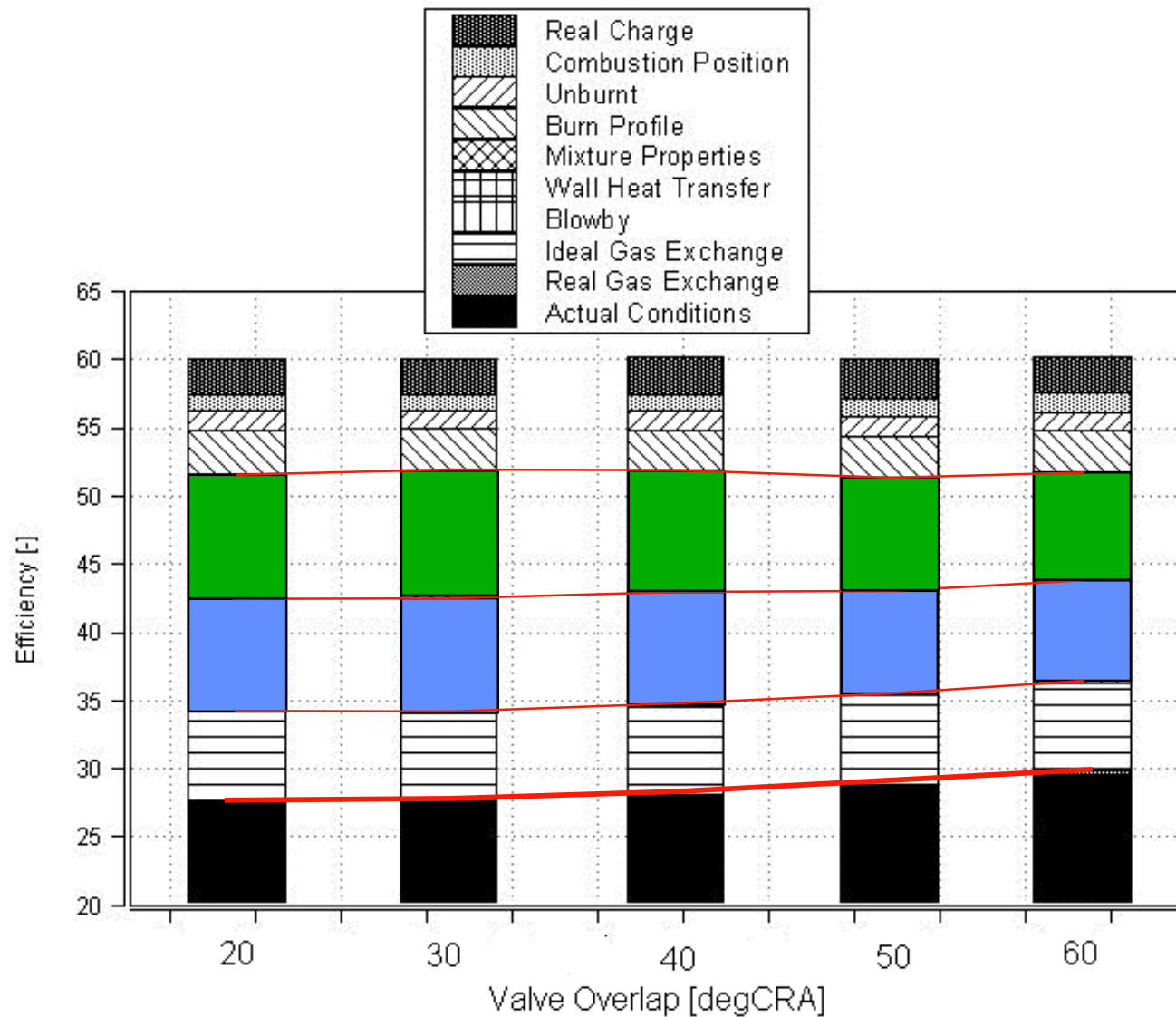


Increasing valve overlapping means:

- Increase of total mass and residual gas at IVC
- Lower amount of fresh charge
- Increase of residual gas content
- Lower specific fuel consumption
- Increase of efficiency



# Solution: Loss Analysis



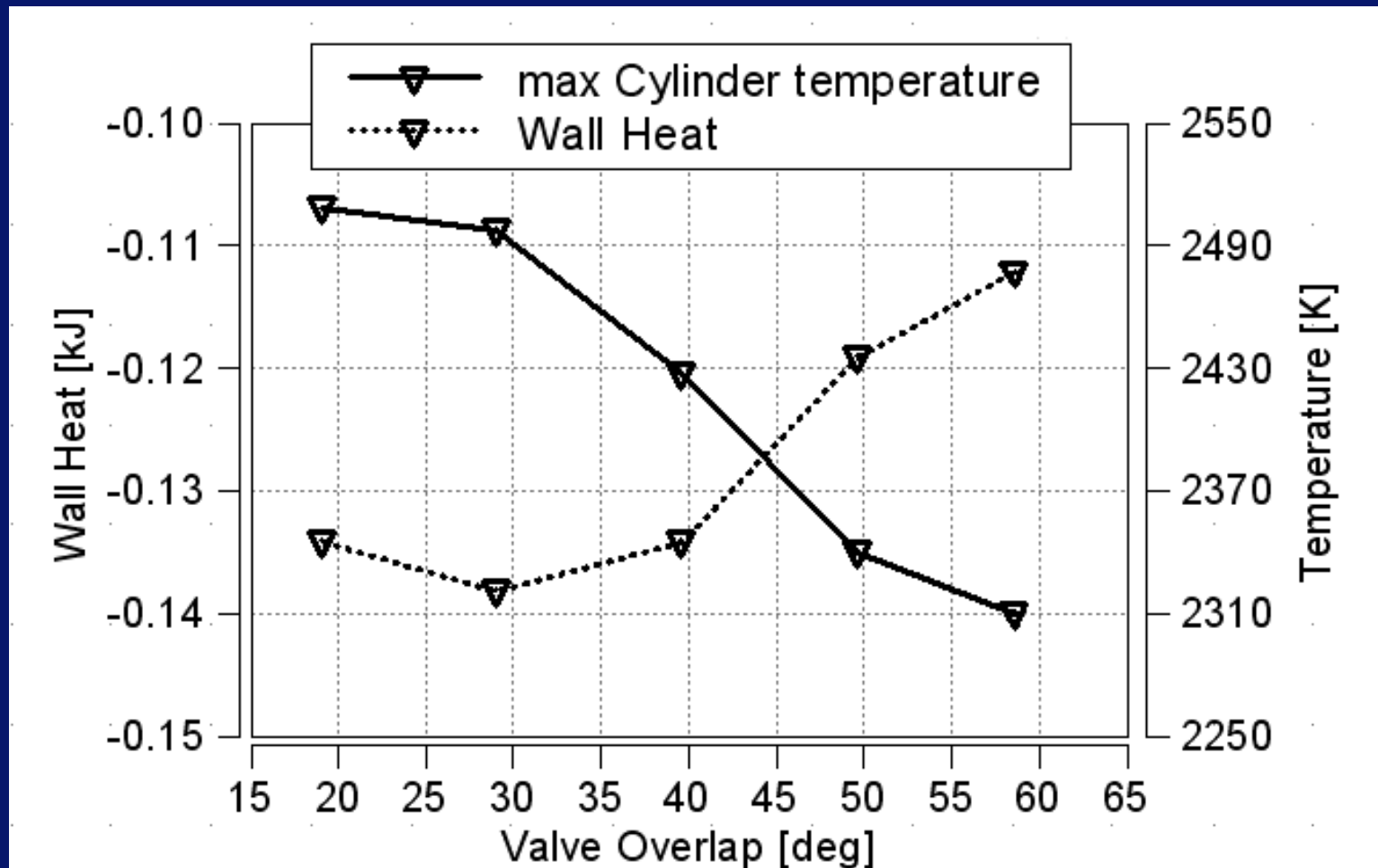
Mixture properties

Wall heat

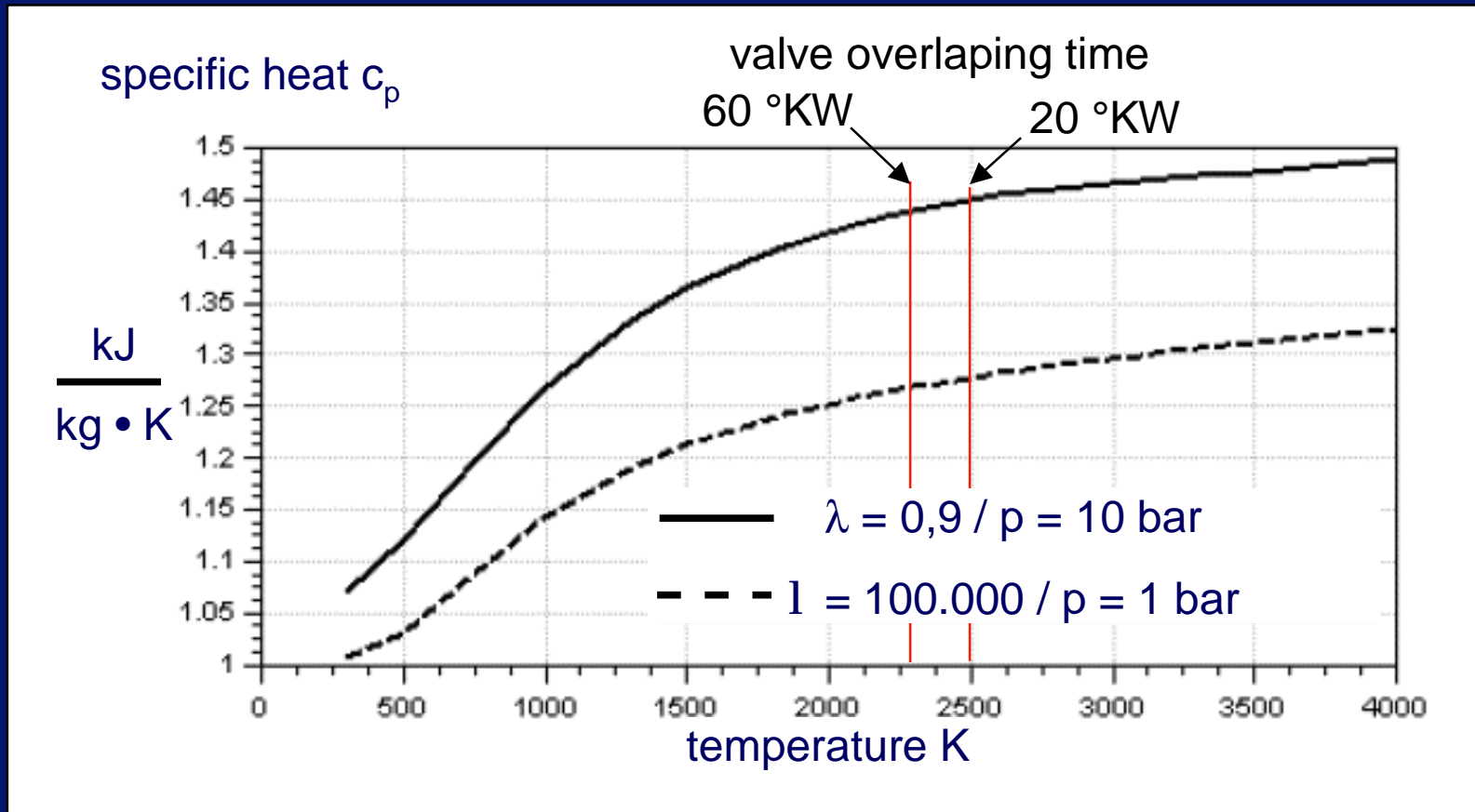
Efficiency

+2%

# Wall Heat Loss



# Mixture Properties



## Conclusion



Accurate determination of important gas exchange parameters  
directly at the test bed based on existing measured values



AVL-GCA  
**boost**