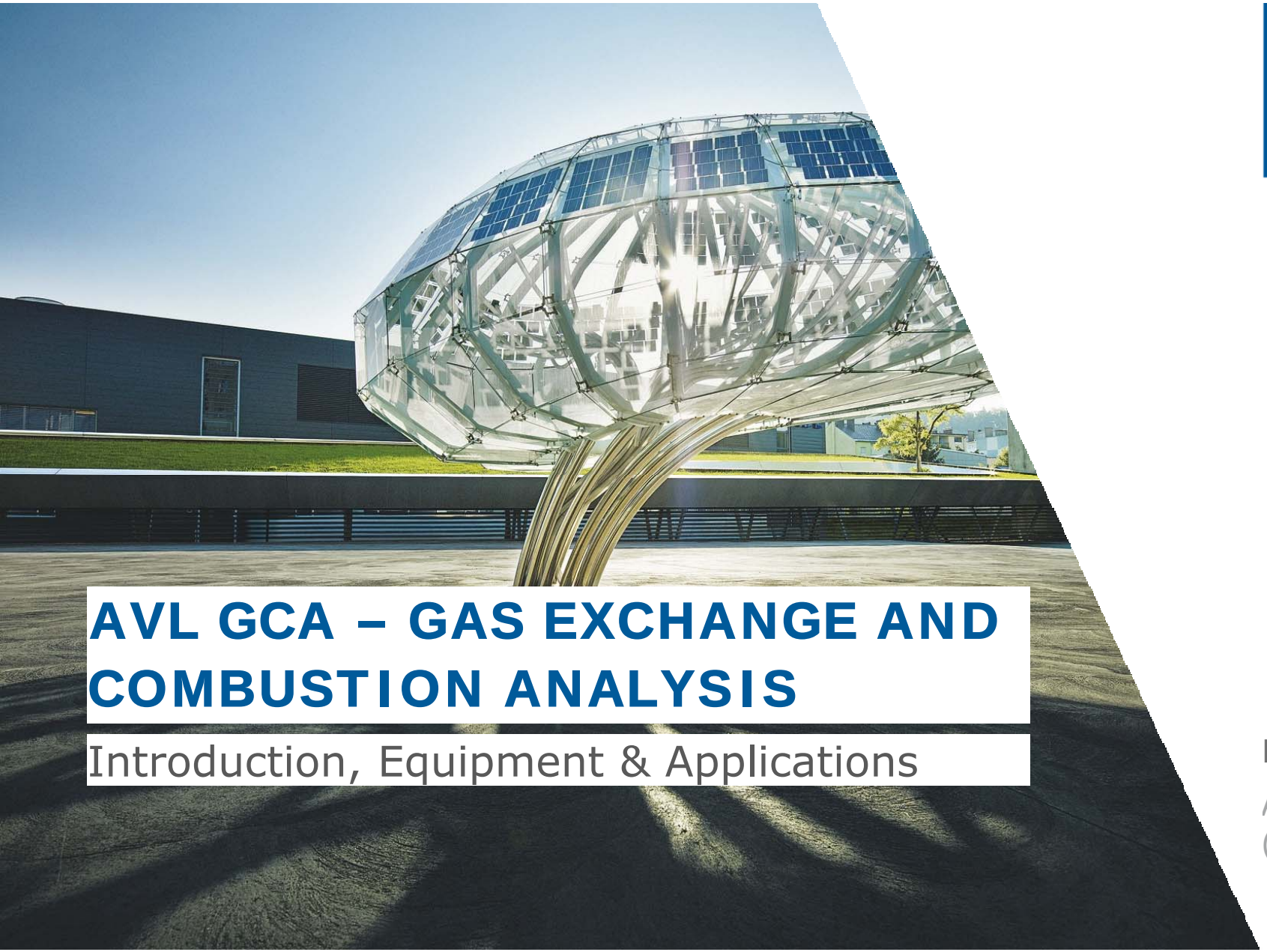
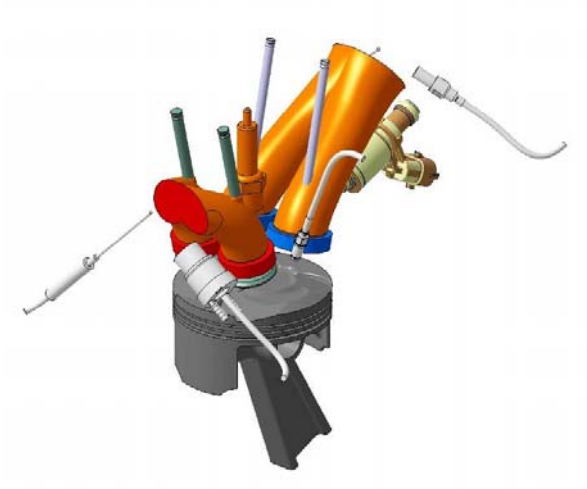


AVL GCA – GAS EXCHANGE AND COMBUSTION ANALYSIS

Introduction, Equipment & Applications

Daniel Leitner

AVL List GmbH
(Headquarters)

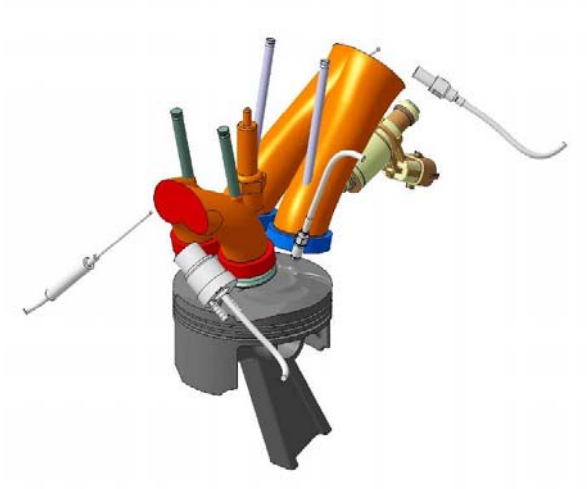


GCA ONLINE

SUPPORTING THE ENGINE CALIBRATION PROCESS BY FAST GAS EXCHANGE AND COMBUSTION ANALYSIS DIRECTLY AT THE TEST BED

Dr. Robert Fairbrother, development simulation GCA
Dipl.-Ing. Rudolf Gande, development gasoline engines
Georg Salentinig, development software
Dr. Thomas Leifert, product management GCA
Ing. Johann Krammer, product management BOOST

AVL List GmbH



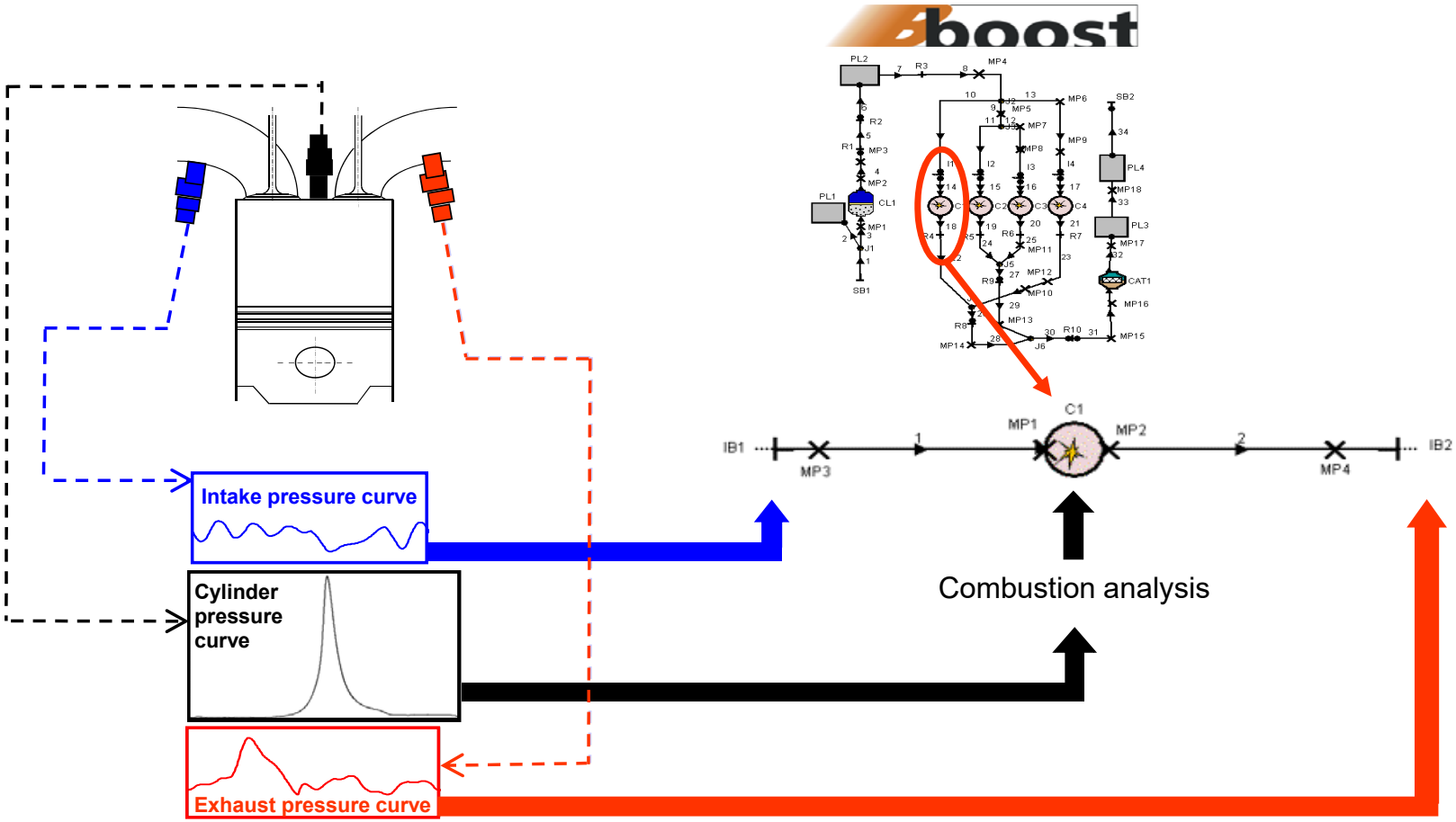
Everybody belives the test result

except the test engeneer.

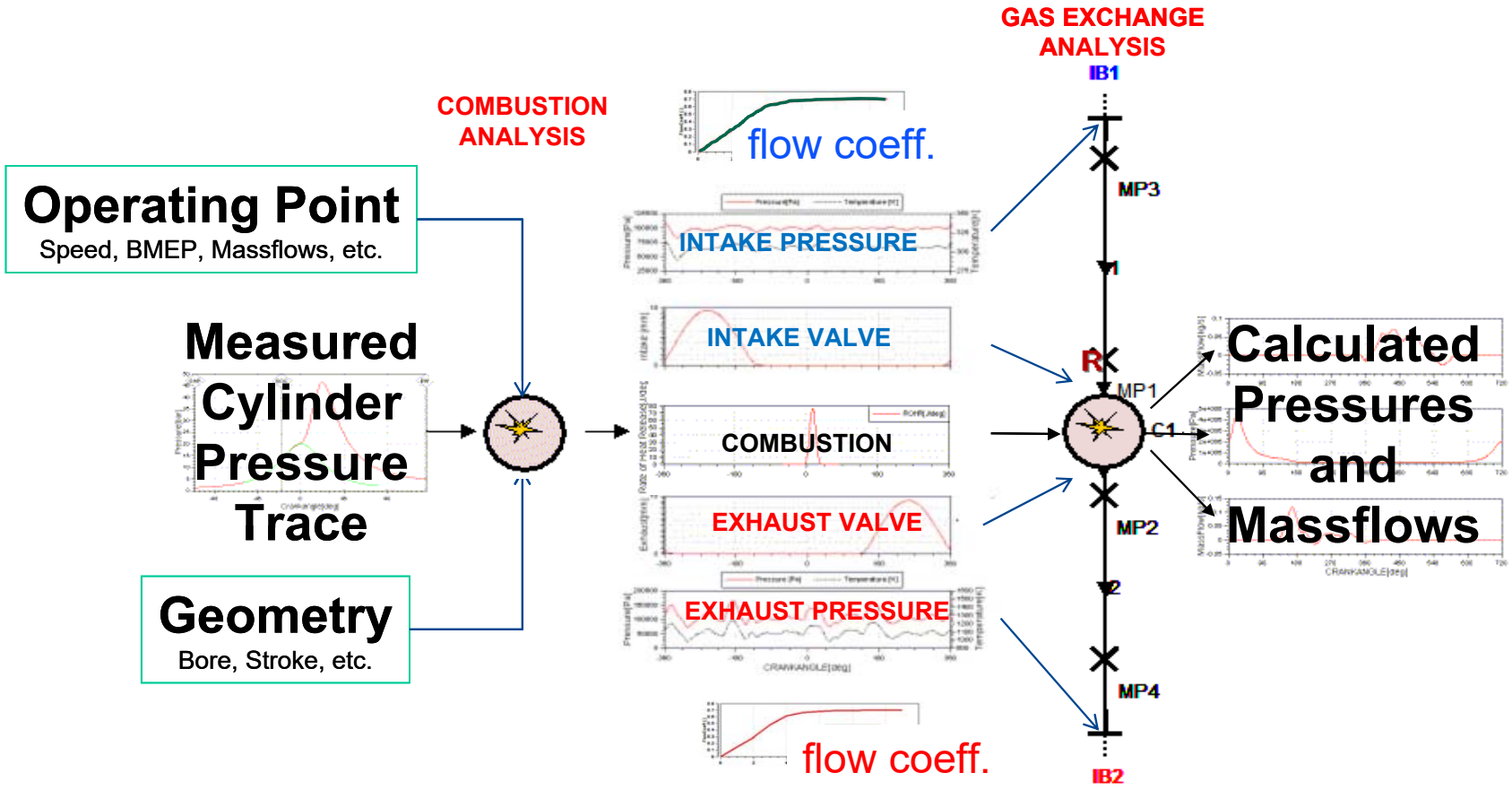
Nobody belives the analysis result

except the analyst.

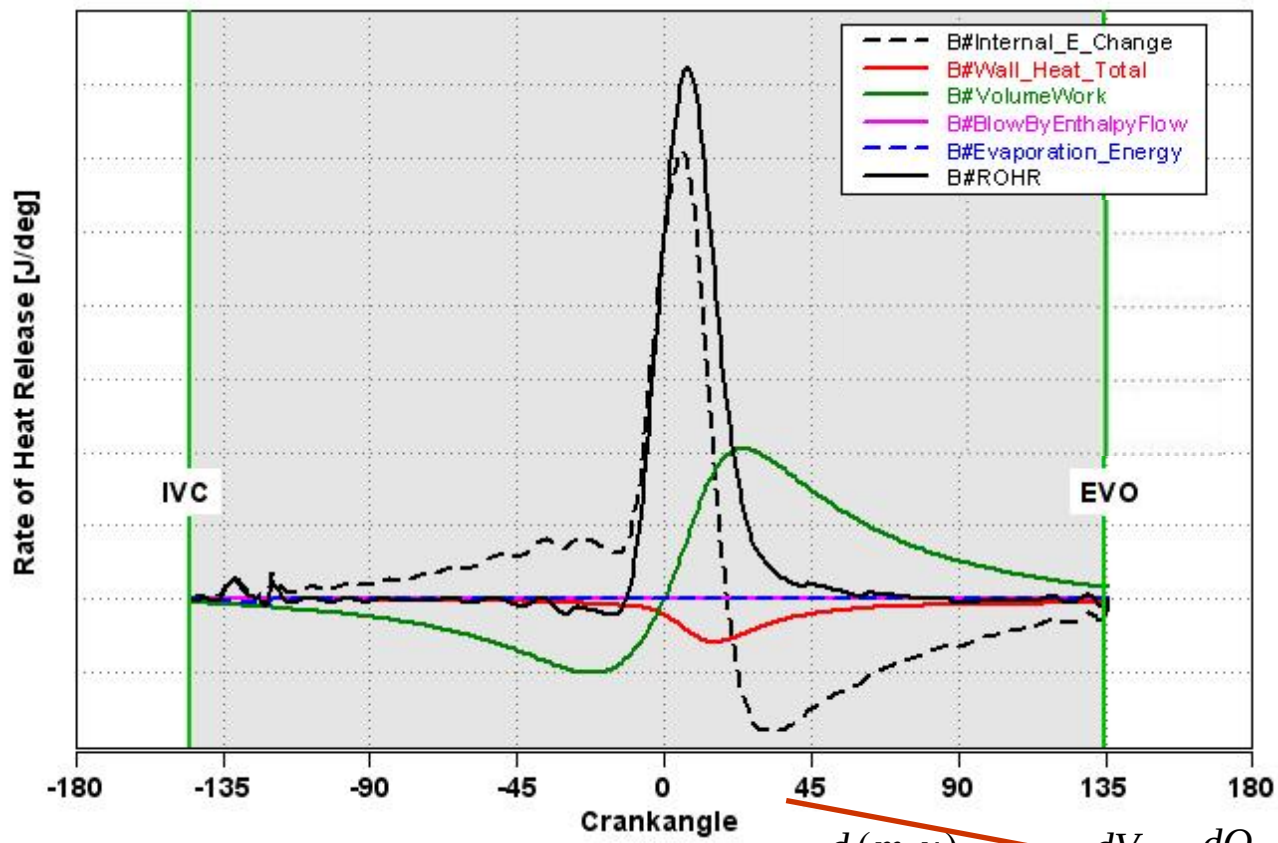
AVL GCA: WORKING PRINCIPLE



GCA WORKFLOW



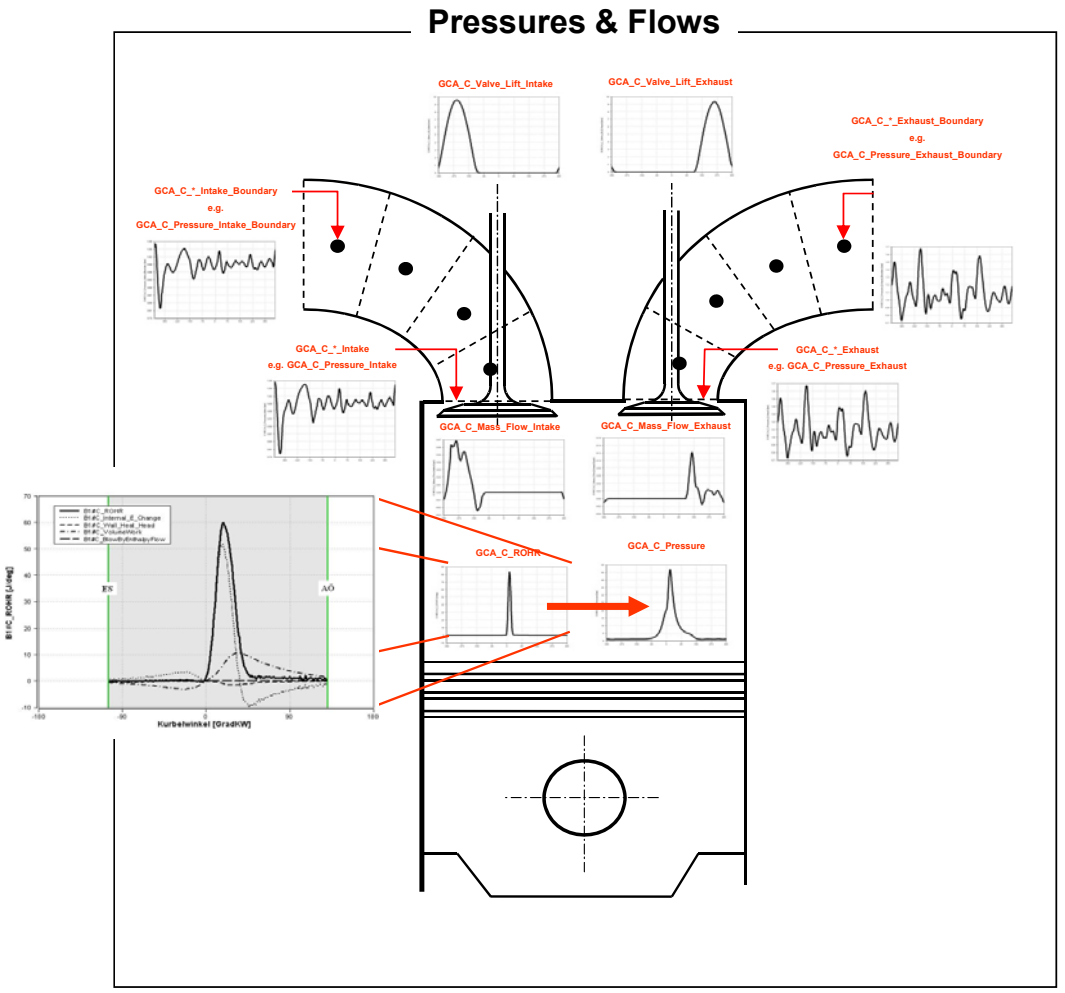
COMBUSTION ANALYSIS



$$\frac{d(m_c u)}{d\alpha} = -p_c \frac{dV}{d\alpha} + \frac{dQ_f}{d\alpha} - \frac{dQ_W}{d\alpha} - h_{BB} \frac{dm_{BB}}{d\alpha}$$

dQ_f: heat release by combustion after fuel injection

GAS EXCHANGE ANALYSIS



MEASUREMENT EQUIPMENT FOR GCA

E.G.: GASOLINE APPLICATION

PRESSURE:

- P_CYL … in-cylinder pressure
- P_IN … pressure trace intake
- P_EXH … pressure trace exhaust
- P_IN_Abs … absolute pressure intake (for pressure level adjustment)
- P_EXH_Abs … absolute pressure exhaust (for pressure level adjustment)

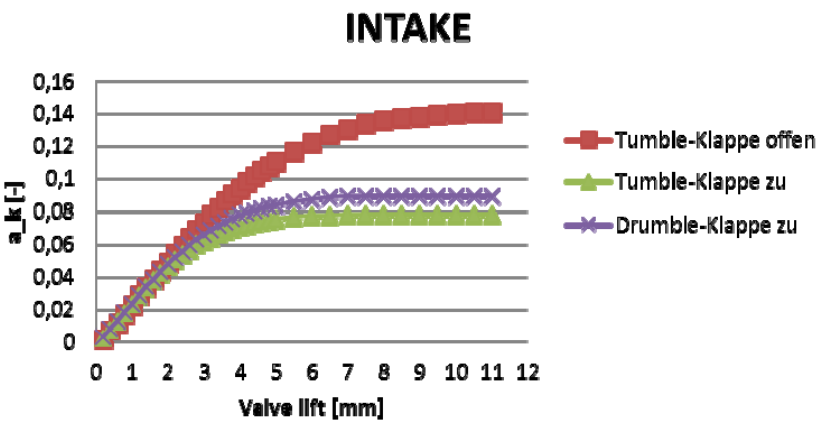
FUEL:

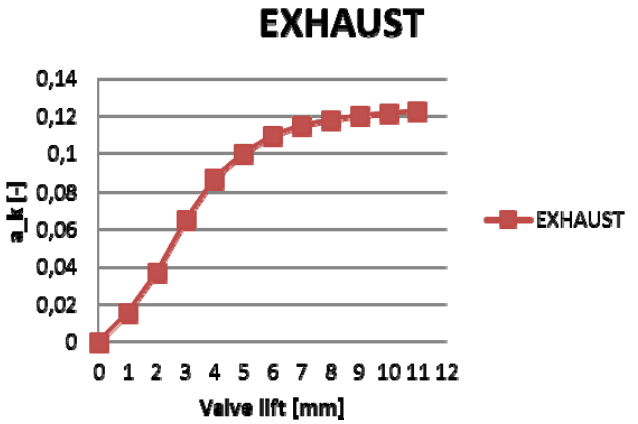
- TI … fuel injection duration (current clamp)
- P_RAIL … fuel rail pressure (pressure indication or from ECU sensor)

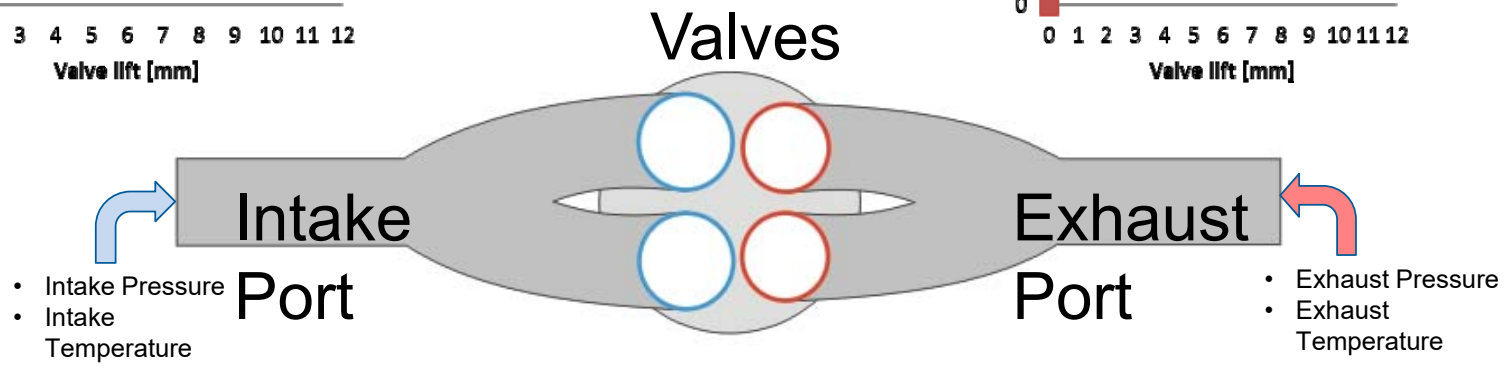
GAS (AIR):

- VVT_IN … valve timing intake
- VVT_EX … valve timing exhaust
- T_IN … temperature intake (same position as pressure transducer)
- T_EX … temperature exhaust (same position as pressure transducer)
- A/F-ratio … oxygen sensor

INPUT REQUIREMENTS
PORTS AND VALVES





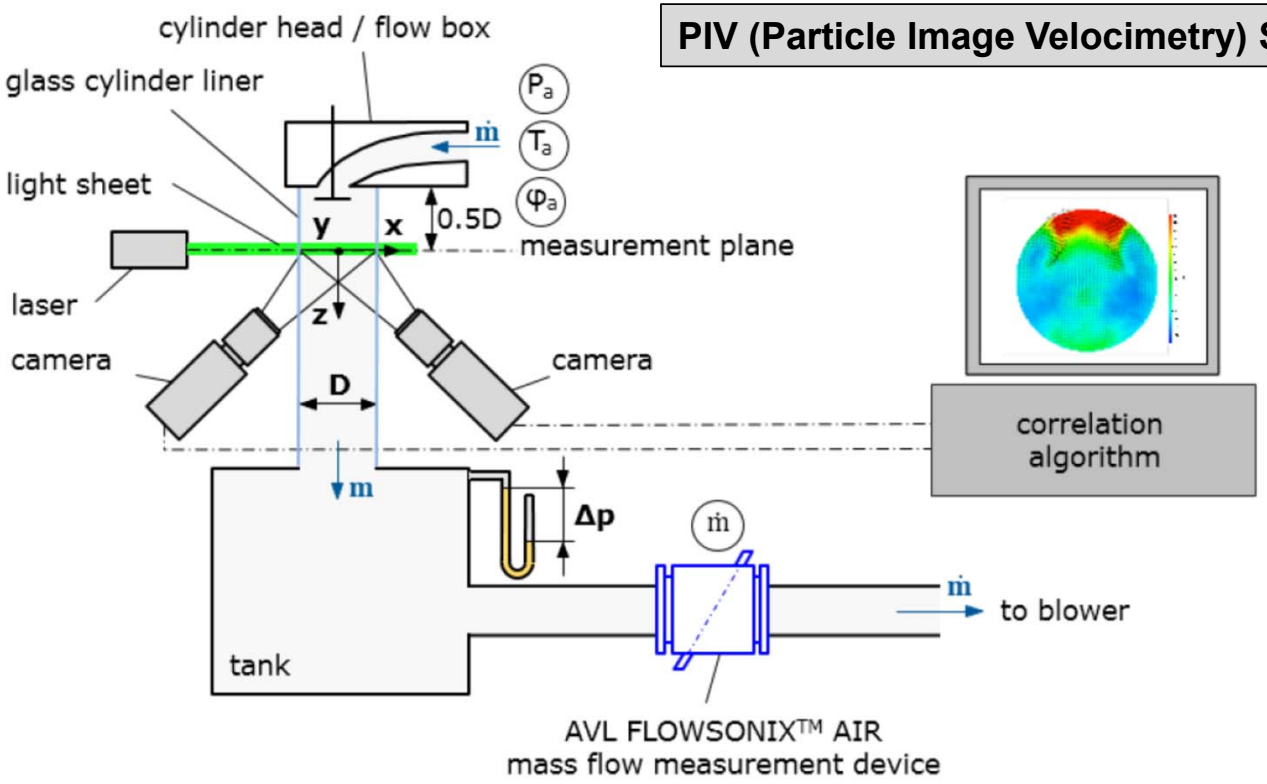


For calculation of gas-exchange **Port** and **Valve Data** for Intake and Exhaust are needed:

- Valve seat diameter, lift curves
- Port flow characteristics
- Port length, diameter and surface area

PORT FLOW INVESTIGATION
SETUP PRINCIPLE

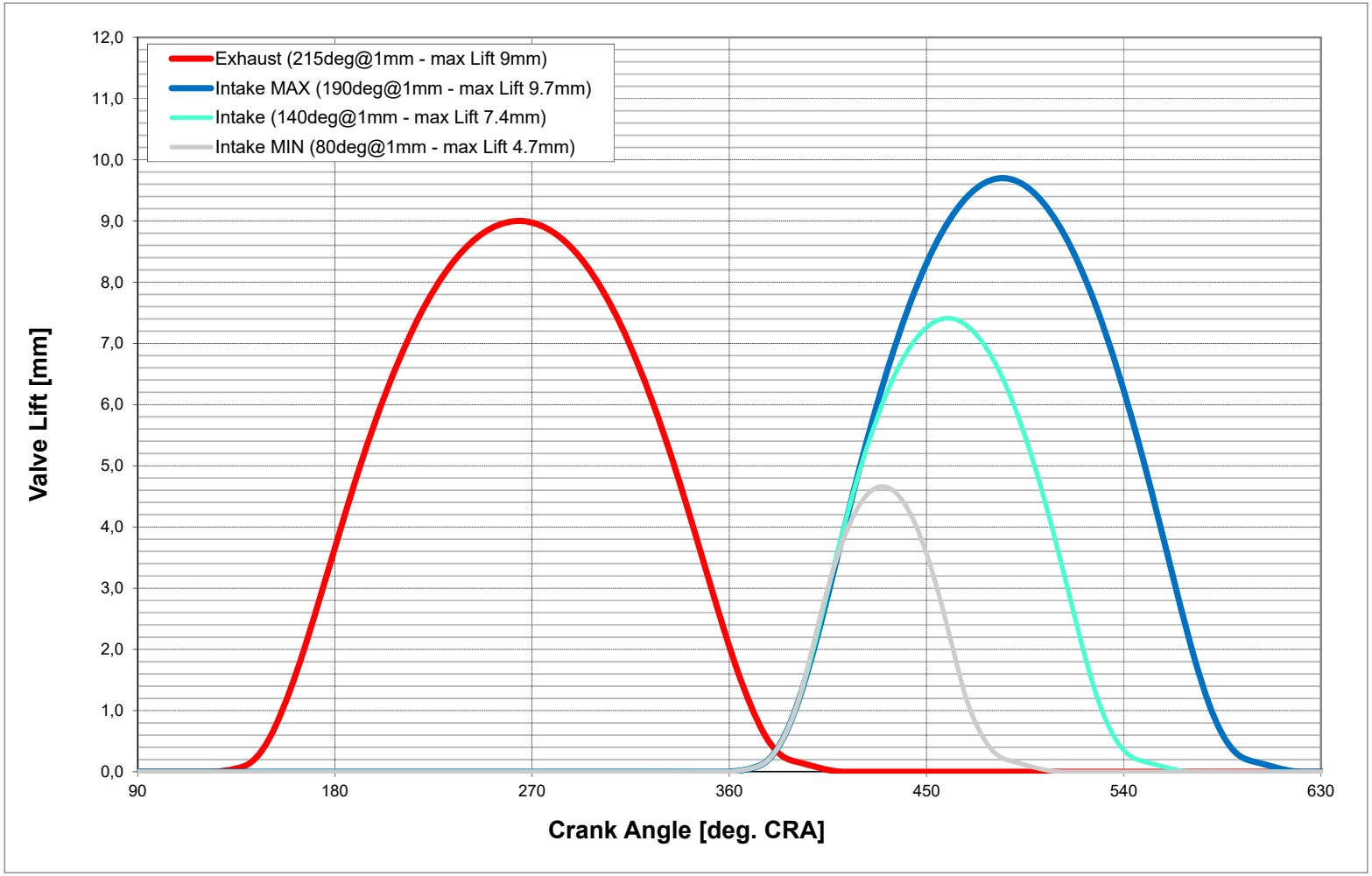
PIV (Particle Image Velocimetry) System Setup



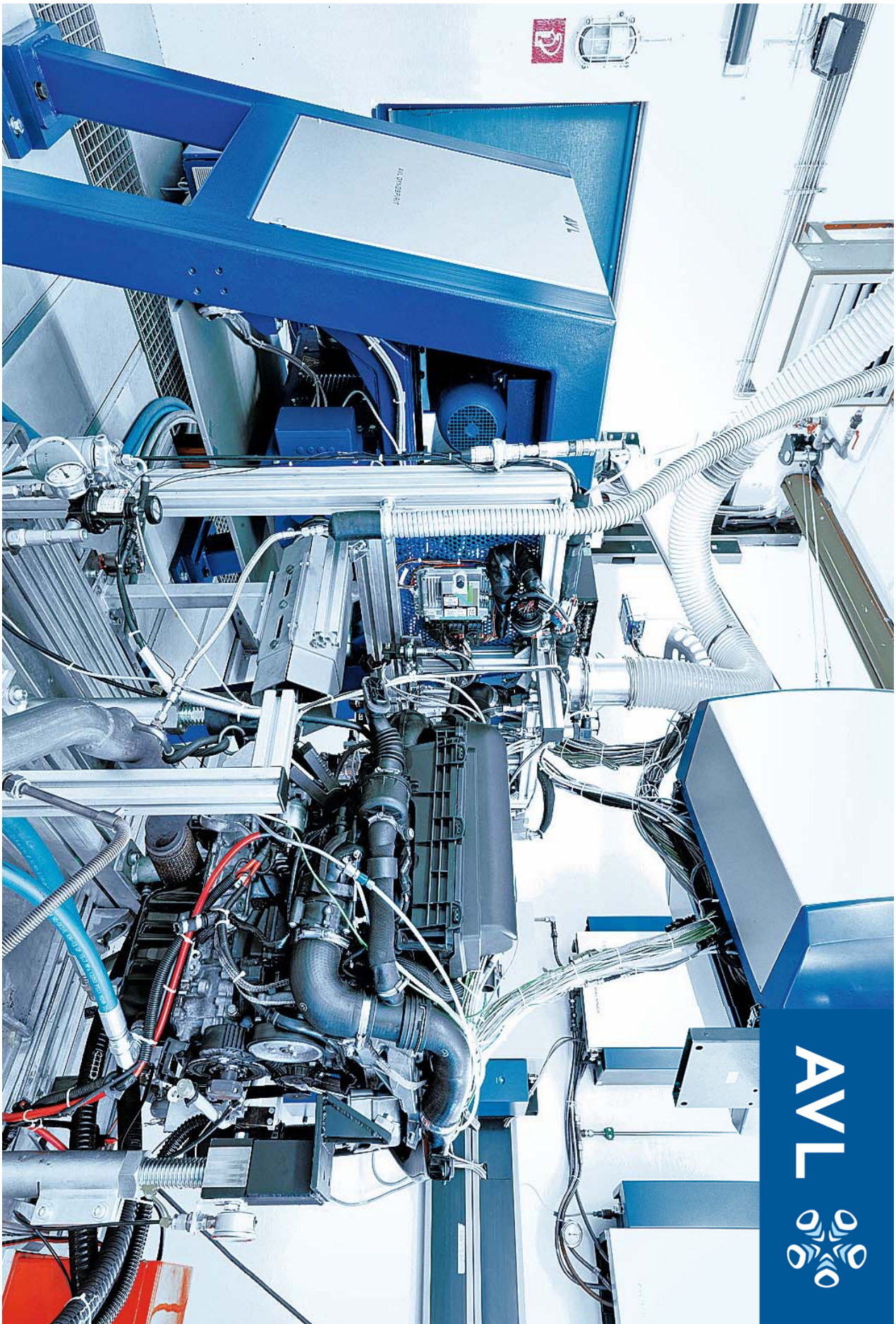
P_a	ambient pressure
T_a	ambient temperature
φ_a	ambient humidity
$\dot{m}$	mass flow

INPUT REQUIREMENTS

VALVE LIFT CURVES (E.G.: VARIABLE VALVE LIFT)



Testbed solution



NEW HIGH-SPEED ACQUISITION PLATFORM

One single high-speed platform that covers all applications:

- Indicating and Visio
- Rotation analysis and acoustics
- E-power analysis
- Fast generic recorder

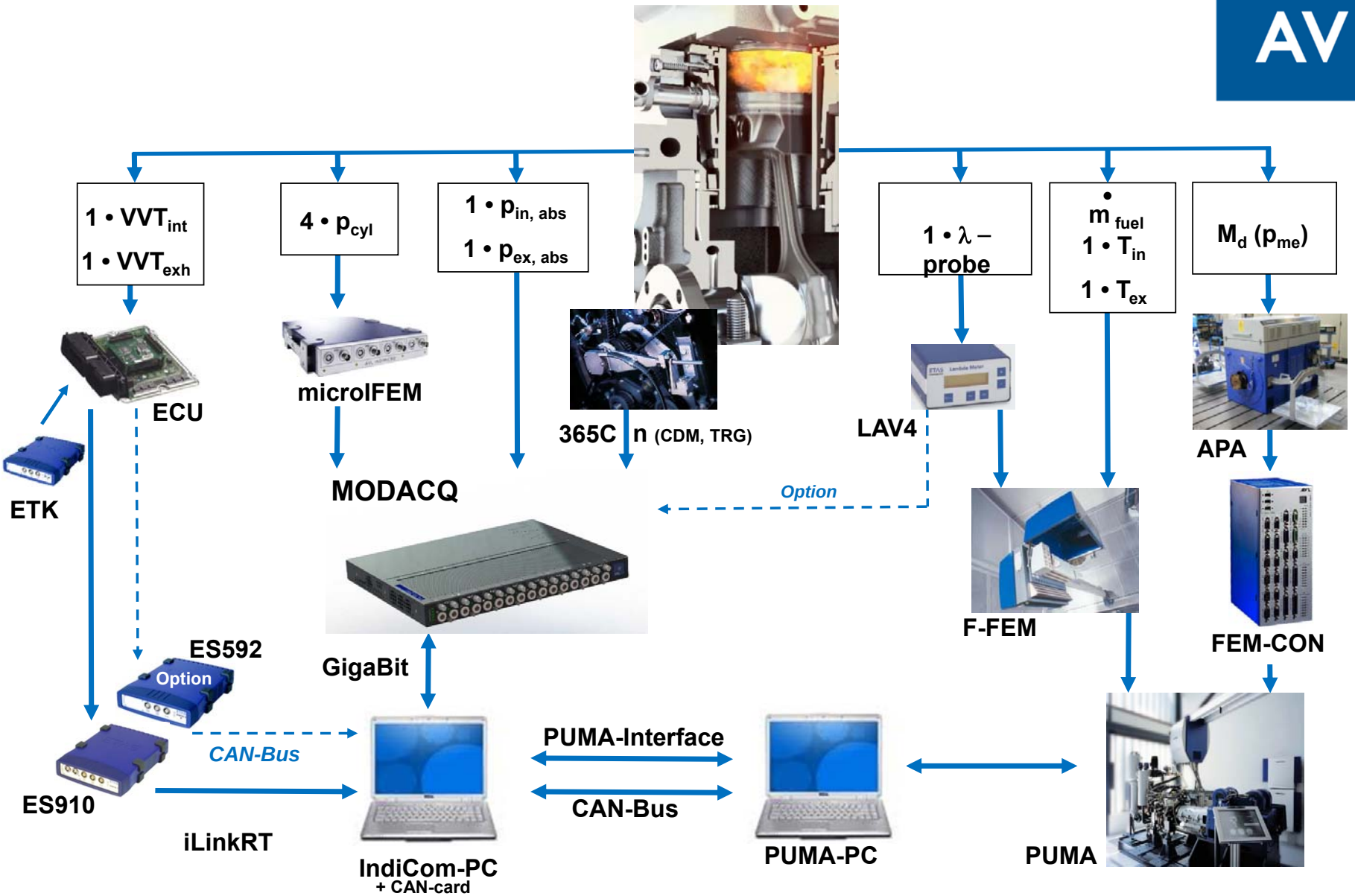
NEW AVL DATA ACQUISITION PLATFORM:

Cascadeable acquisition and real-time processing system, with modular application-specific acquisition plug-ins

NEW HIGH-SPEED ACQUISITION PLATFORM

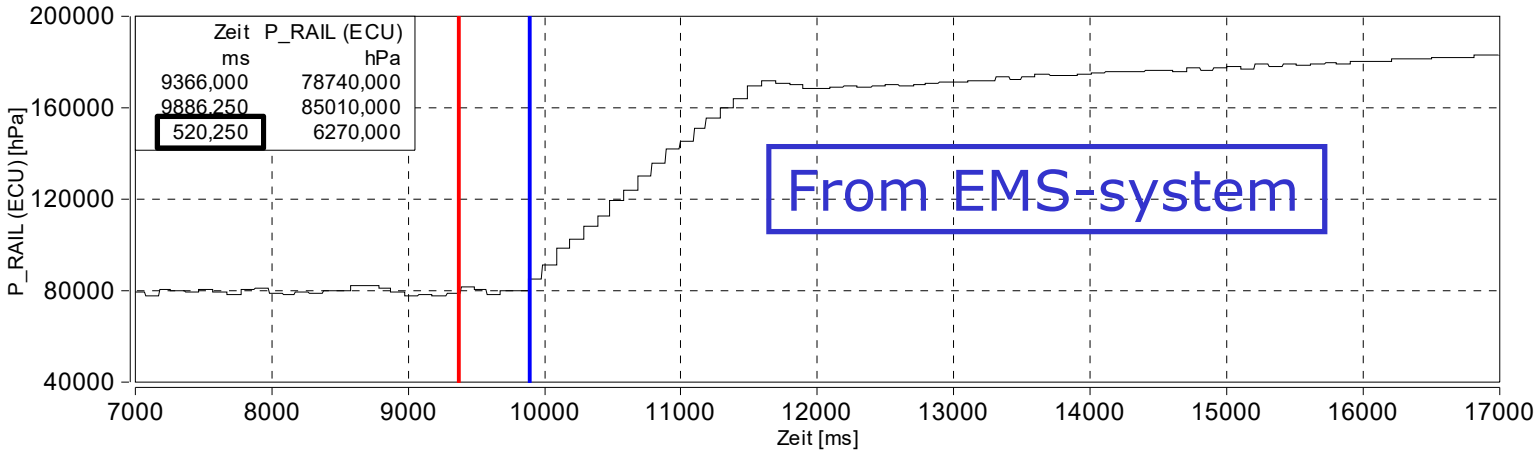
BASE UNIT

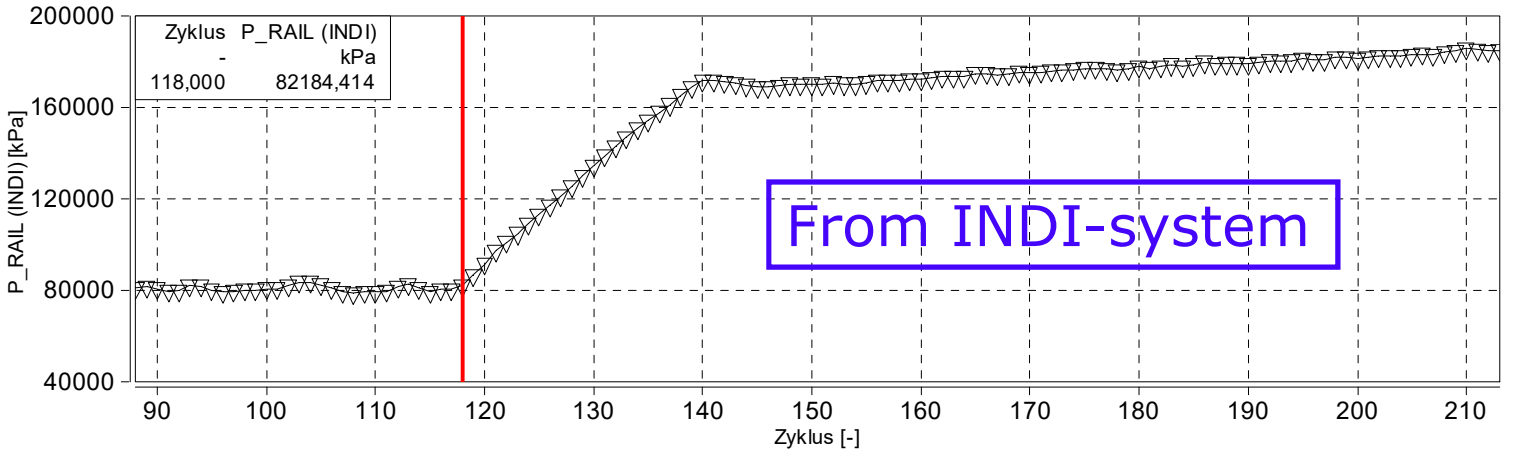
- 1HU x 19''
- 3x CAN-Bus interfaces
- 2x Gigabit ports (1 Gbit/s)
- Supply 12-36VDC
- 16x DIG IN (UTC)
- Direct connection of AVL 365, AVL 363 (absolute angle encoder), inductive and Hall sensors
- RS232 for connection with MicroIFEMs
- Further extensions:
  - EtherCAT module for RTP output


1 • VVT int
1 • VVT exh
4 • p cyl
1 • p in, abs
1 • p ex, abs
1 • λ – probe
m fuel
1 • T in
1 • T ex
M d (p me)
ECU
microIFEM
365C n (CDM, TRG)
LAV4
APA
ETK
MODACQ
Option
GigaBit
F-FEM
FEM-CON
ES592
Option
CAN-Bus
PUMA-Interface
CAN-Bus
ES910
iLinkRT
IndiCom-PC
+ CAN-card
PUMA-PC
PUMA

P_RAIL-INDICATION

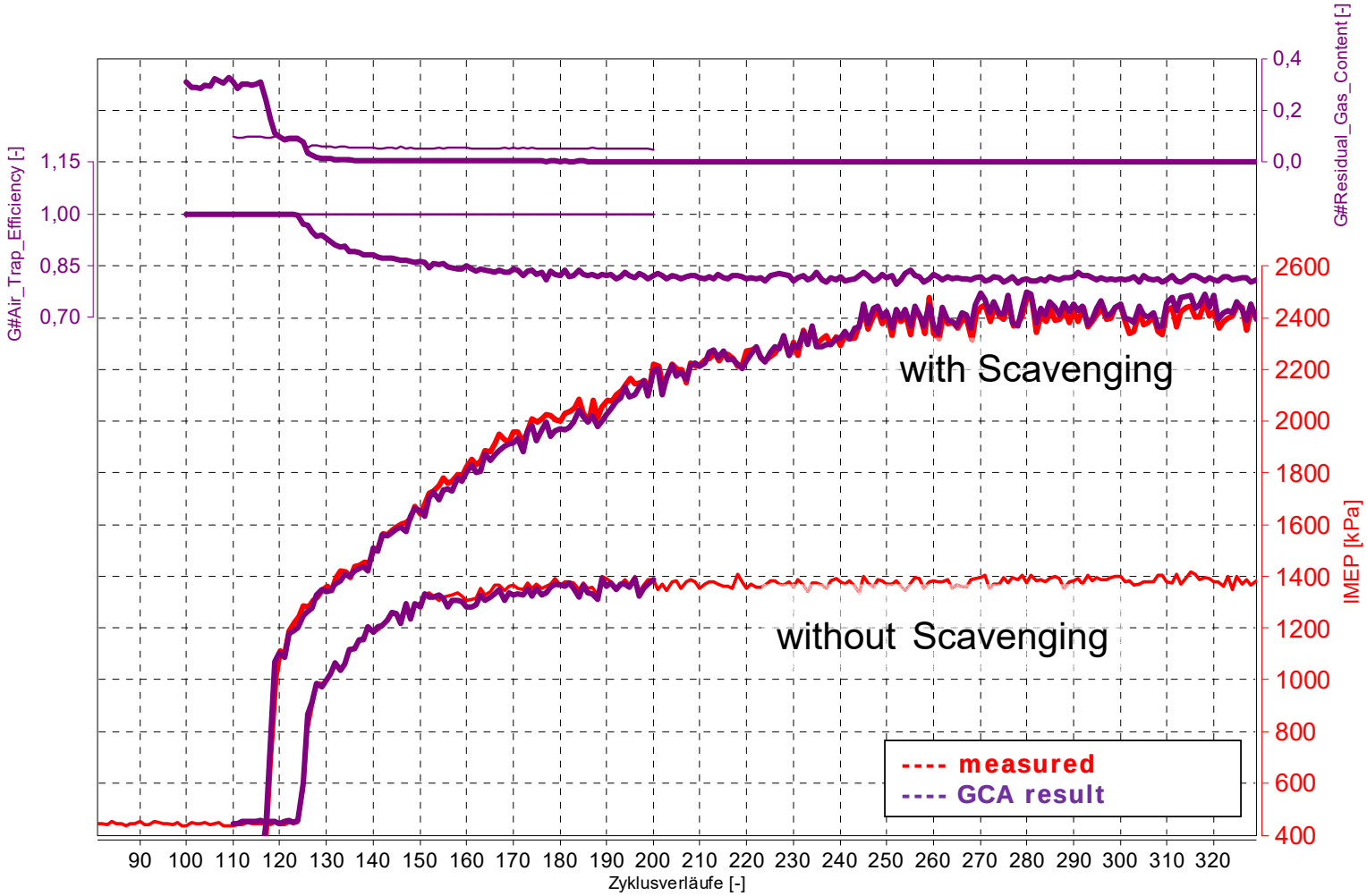
TIME DELAY OF EMS-VALUES VIA CAN-BUS





TRANSIENT ANALYSES

TIP-IN OF TGDI-ENGINE AT CONSTANT SPEED



CONCLUSIONS

- GCA as a complete gas exchange and combustion analysis tool was introduced which can be used for steady state as well as for transient investigations
- Can be used online at the test bed or on the vehicle or for offline data evaluation (post-processing with INDICOM)
- The tool can be used to overcome the limitations of slow feedback of available sensors (eg: Lambda, mass flows) as well as providing important additional thermodynamic information (rate of heat release, residual gas content,…)
- Development engineers at the test bed have immediate and direct access to accurate gas exchange and combustion analysis data that cannot be measured

Everybody belives the test result

even the test engeneer.

Everybody **belives the analysis result**

not only **the analyst.**