

ICOS- Temperature

for time-resolved in-cylinder
temperature and water concentration
analysis

The **Internal Combustion Optical Sensor (ICOS-Temperature)** system from LaVision allows analysis of time-resolved in-cylinder temperatures in an internal combustion engine. The minimally invasive sensor is available with a choice of in-cylinder probes. The system delivers crank angle resolved single cycle temperature curves. For example, the often unknown compression stroke temperature rise can be captured. Such information gives important insight for engine optimization, analysis of cycle by cycle variations and validating numerical analysis. The system also measures the in-cylinder water vapour concentration for analysing effects of EGR-distribution or water injection.

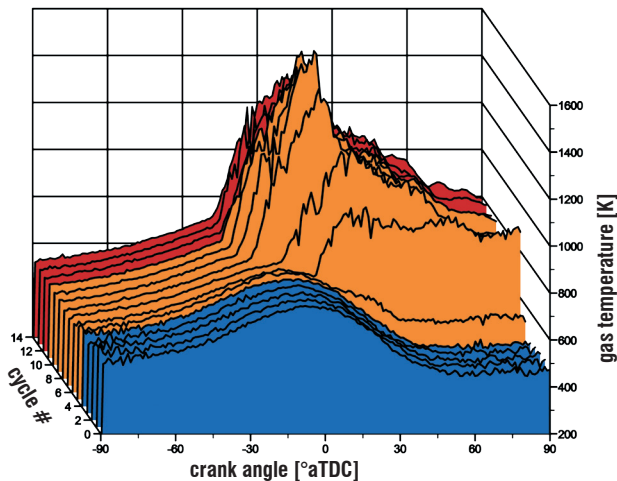


Applications

- ▶ gas temperature and water concentration indication during mixture formation
- ▶ EGR influence on charge temperature
- ▶ charge cooling using water injection
- ▶ supercharging, downsizing, HCCI
- ▶ simulation validation

Advantages of the Internal Combustion Optical Sensor system

- ▶ highly time resolved for crank angle resolution
- ▶ no gas sampling, measures directly inside the cylinder
- ▶ precise single cycle analysis
- ▶ fully resolved consecutive cycles for measurement of transient phenomena
- ▶ choice of non-invasive and minimally invasive probes



The high temporal resolution of the **ICOS** systems allows the analysis of in-cylinder temperatures during transient operation. The diagram shows the transient behaviour of the temperature during a tip-in (load change) operation for 15 engine cycles. The engine is coasting over the first 5 cycles. After this the accelerator pedal is pushed down resulting in a load step and transient firing behaviour over 7 cycles. The combustion process then stabilizes in the following cycles. The shown temperature profiles are averaged over 10 repeated tip-ins.

Optimizing engines under transient operation is becoming increasingly important to meet RDE requirements.

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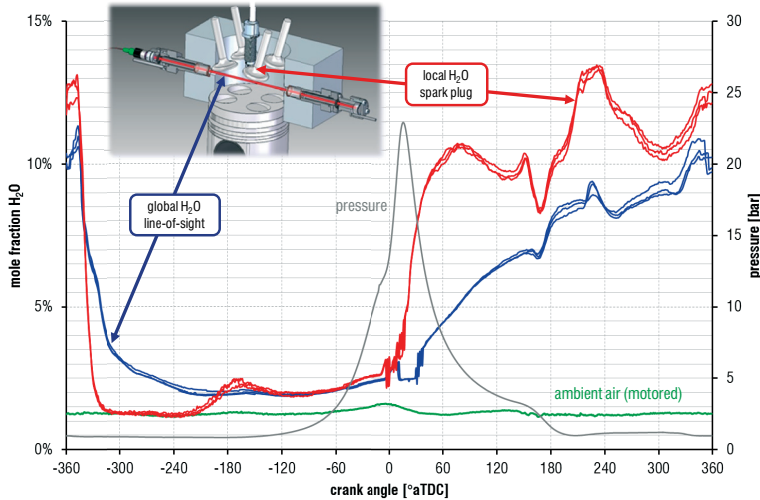
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Downsizing direct injection gasoline engines at elevated power density involves several challenges of engine design. Water injection has a high potential to deliver a feasible solution between several trade-offs. Advantages of charge cooling by water injection:

- ▶ increased performance
- ▶ lower particulate (PM) emission
- ▶ component protection

The water concentration can be detected at different locations in the cylinder giving insight to the mixture formation process. The line-of-sight probe, located at the engine's liner or cylinder head, measures integrated across the cylinder and reveals the average in-cylinder temperature. In contrast to that, the spark plug probe measures the local water concentration. Water concentration measurements of three individual cycles with the spark plug probe and the line-of-sight probe clearly highlight local differences at the spark plug location.

Access to your engine

The **ICOS-Temperature** system has three different options of optical access:

Probe	Advantages
Line-of-sight probe	Suitable for any engine condition, especially high loads, measures the integral average across the cylinder. Recommended choice for temperature measurements.
Spark plug probe	Very convenient access to any production type engine by replacing the spark plug by the M12 or M14-probe, while maintaining full ignition capability. Measures locally at the spark plug.
M5 probe	Minimally invasive probe fits into standard M5 pressure transducer bores. Measures locally at the cylinder wall.

Please refer to our "**ICOS Probes**" datasheet for more details.

Operating principle

The measurement system is based on the interaction of light with water molecules: infrared light is absorbed within a certain wavelength range by the presence of water molecules. A light source generates a fast flashing burst of infrared light at 23 kHz. A built-in spectrometer derives temperature and water concentration information from a spectral fingerprint in the light returning from the probe after passing through the measurement section.

ICOS family in-cylinder quantification

The **ICOS** product family provides even more quantified in-cylinder data. Our other ICOS systems measure additional quantities from inside the cylinder without any gas extraction at high temporal resolution:

- ▶ exhaust gas recirculation
- ▶ lambda value (gasoline, CNG)
- ▶ mixture formation

Please refer to our **ICOS** brochure and product datasheets for more details.

Data provided by LaVision is believed to be true.
However, no responsibility is assumed for possible inaccuracies or omissions. All data are subject to change without notice.

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