On the track of the ignition miss...

Ultra-fast measurement technology from LTT on engine test benches

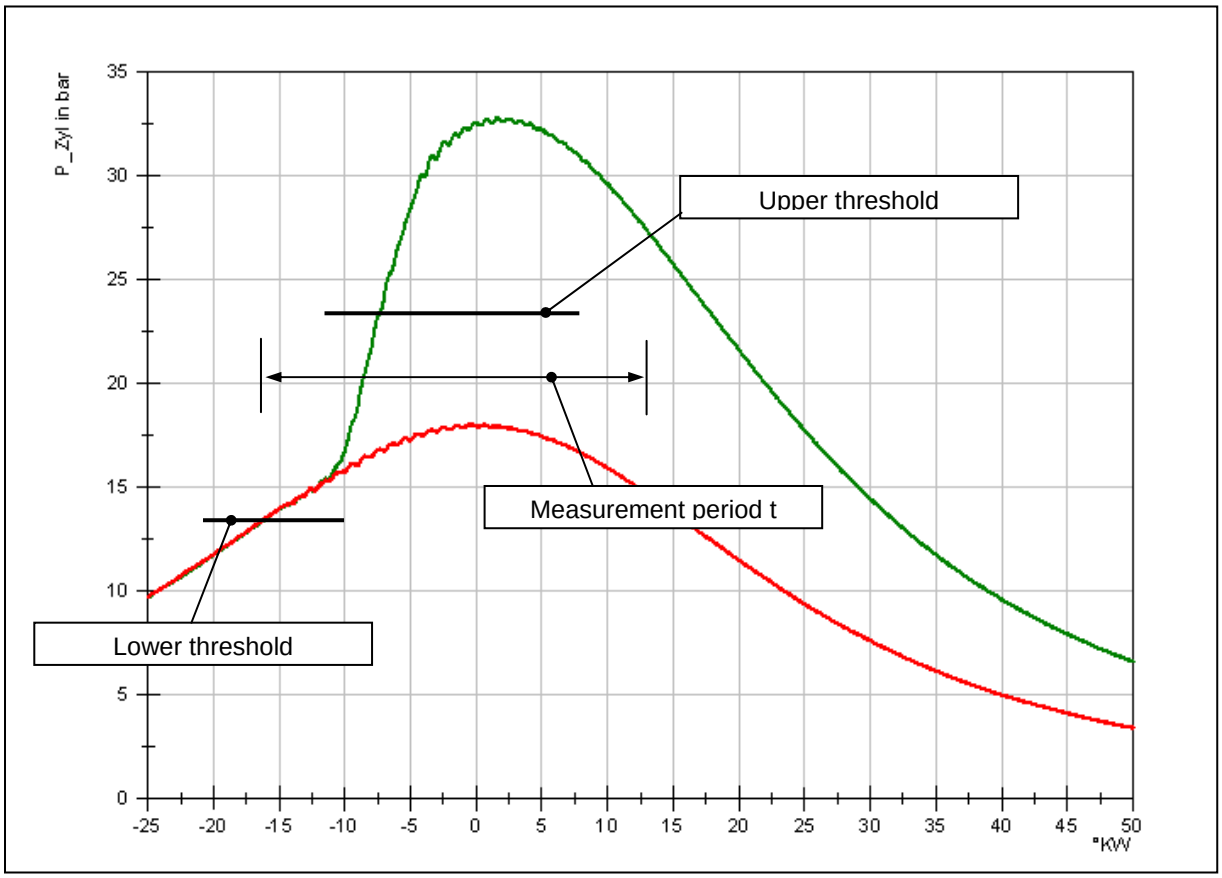
Extremely transient combustion processes at high engine speed – engine measurement technology has always been associated with high demands on data acquisition. Digital storage oscilloscopes provide the required sample rates, but lack the comfort of the PC. The PC alone, however, is overburdened with the flood of data. This difficulty is overcome with the intelligent front-end systems from LTT Labortechnik Tasler GmbH that are optimised for high transfer rates.

The Institut für Motorenbau Prof. Huber (in short: IMH) is a servicer provider and partner for the automotive industry and their suppliers in the field of engine development. The IMH, founded by PhD engineer Eugen Wilhelm Huber as a private research facility in 1948, is today a member company of the MBtech Group and therewith a part of the Daimler car corporation. Their products and services range from order development and testing of engines and engine components, manufacturing of prototypes and development of specific measurement equipment to cooperation within product development of systems and part systems. This includes the operation of several test benches for improvement and further development of diesel and spark-ignited engines at the locations Munich and Stuttgart.

Required: Sample rates in the MHz range

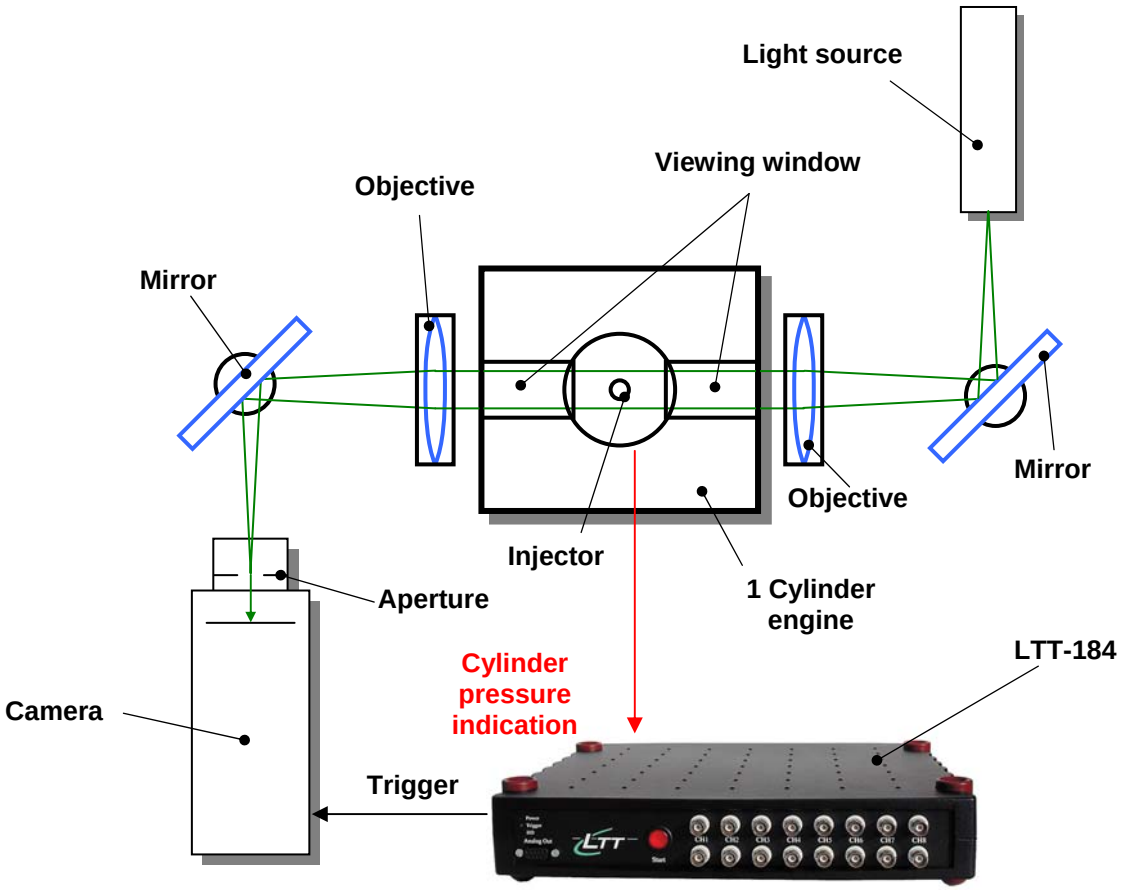
The actual tasks include studies of combustion improvement for spark-ignited engines, in particular detection and analysis of ignition misses. Data acquisition from the running engine requires very fast and precise measurement techniques with sample rates up to the MHz range.

In addition to the cylinder pressure, primarily electric parameters such as ignition current and ignition voltage are recorded, but also, for example, the fuel pressure. The cylinder pressure provides the trigger conditions – both for the start of the combustion cycle and for the detection of ignition misses.



The progress of the cylinder pressure triggers the data acquisition of the high-speed camera. The lower threshold starts the measurement, if the upper threshold is not reached, an ignition miss has occurred (red curve).

The evaluation also requires the allocation of the crank shaft angle with a resolution of 0.01°. In the field of combustion chamber analysis, the IMH has special expertise in optical measurements (such as schlieren method) on transparent engines.



Schematic measurement setup for schlieren photography:
The camera system is triggered according to the cylinder pressure indication

The schlieren method was developed as early as around 1900 and is based on visualisation of light refraction processes. These processes rely on density differences caused by pressure or temperature gradients or evaporation of fuel. To allow imaging of the fluid part as well as fuel vapour and the propagation of the flame core, a high-speed camera is used to capture the combustion cycles with up to 40,000 pictures per second. The instrumentation must trigger the camera within the range of microseconds to capture the essential events.

With the LTT-184, the IMH has a measurement system at its disposal that lives up to the high demands. This front-end system, developed and produced by LTT, a specialist in ultra-fast measurement technology based at Würzburg, extends the scope of conventional PC measurement technology to dimensions never reached before. The sample rates per channel vary – dependent on the resolution required – between 1 kHz and 2.5 MHz for 16 Bit or up to 20 MHz for 12 Bit. The single device offers up to 16 differential inputs. Cascading allows several hundred parallel channels to be captured synchronously. Separate A/D converters and amplifiers for each input channel allow simultaneous sampling on all channels and channel-specific amplification with input ranges from ± 1 Volt to ± 50 Volt. Each input is equipped with an adaptive anti-aliasing filter.

Patented LTT measuring method

The fast data transfer to the PC is achieved via a specific, patented SCSI-II Interface or optionally via USB 2.0. The measuring device does not require any driver installed on the PC – it is self-configurating and immediately ready when turned on. Its internal hard drive is automatically recognised by Windows as a system hard drive, allowing direct access to the data with any application software. The provided software is not only used to perform the complete hardware configuration, but also the parameter settings for the measurement. This includes the choice of recording mode (single or endless loop recording) and different digital and analogue trigger options. Two types of sampling are available – equidistant in time or externally clocked. This allows indication of the measured data with respect to the crank angle. Up to 16 different configurations for stand-alone operation can be stored in the unit. The captured data are recorded to a 128 MB high-speed RAM (optionally up to 512 MB) or to the built-in shock-proof 40 Gigabyte hard drive. When connected to the PC, the signals can be displayed and processed on-line. Post-processing and analysis of the recorded data can be performed in any commonly used software format (Diadem, FAMOS, µ-Graph, etc.).

Company profile of LTT

LTT – Labortechnik Tasler GmbH, founded by Michael Tasler in 1996, is a specialist in development and production of PC-based real-time measurement systems that unite extremely high speed, precision and high channel counts. LTT holds patents worldwide, including a patented method for extremely fast real-time processing. Additionally to the established product series LTT184 and LTT186, the range includes a version with Strain Gauge, Volt and ICP inputs – the LTT SensorCorder. All series are available as single units with 8 or 16 input channels. The units can be cascaded in any combination with up to 4096 channels or integrated in 19” slots. For distributed measurements on large objects such as gas turbines, the measurement systems are interconnected via Gigabit LAN.

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