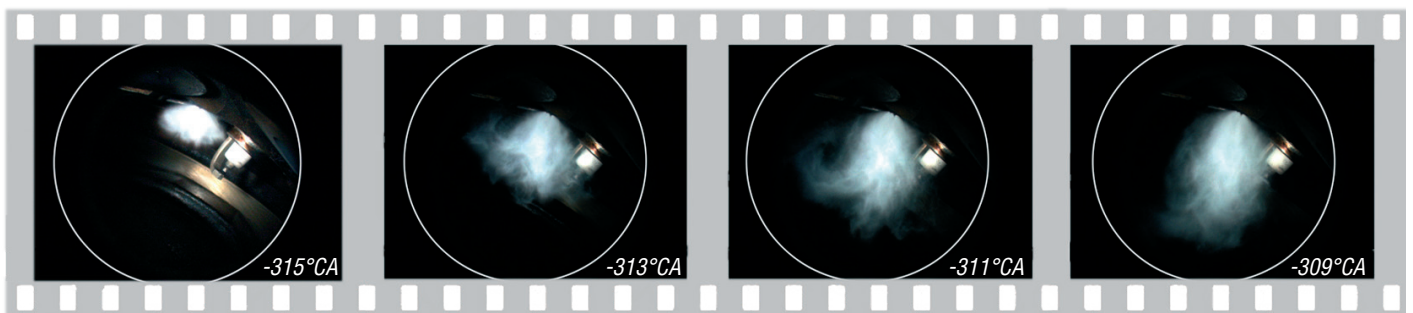


## EngineMaster *inspex*

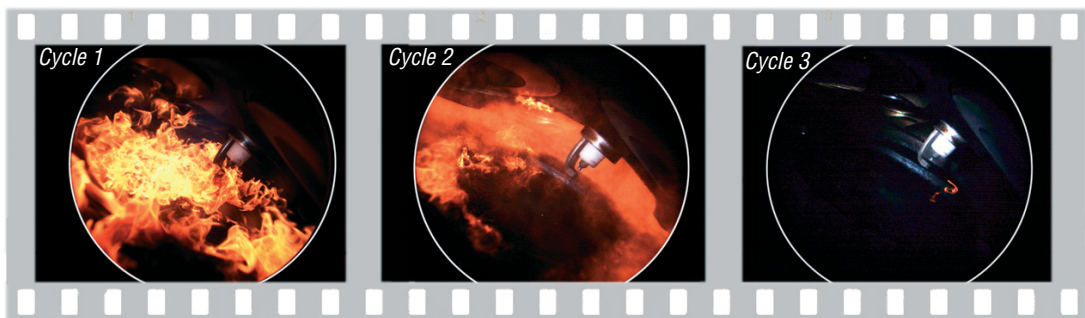
In-cylinder endoscopic imaging for  
spray and combustion visualization and  
quantitative optical indication  
in real engines

For the optimization of near-production engines endoscopic imaging can be applied to visualize in-cylinder phenomena. Key-hole imaging using endoscopes is a minimally invasive technique to monitor real-time in-cylinder processes such as fuel spray injection, ignition, combustion and soot formation. In combination with standard pressure indication endoscopic imaging links engine performance and emissions with in-cylinder phenomena such as pre-ignition, wall wetting and particle generation.

**EngineMaster inspex** imaging systems provide quantitative information on spray geometry, flame propagation as well as soot temperature and soot volume fraction (KL-factor) in combination with the appropriate analysis options.



*Crank-angle resolved spray imaging of gasoline direct ignition*



*Soot formation in GDI engine during first cycles of a cold start at fixed crank angle position*

- Applications**
- ▶ spray visualization: propagation, geometry, wall interaction (wetting)
  - ▶ combustion visualization: on-set of ignition, misfire, flame propagation, in-situ soot formation

- Indicated engine parameters**
- ▶ spray geometry
  - ▶ flame propagation
  - ▶ soot temperature and soot volume fraction (KL-factor)

- System features**
- ▶ direct visualization of the entire in-cylinder combustion cycle
  - ▶ quantitative imaging of engine parameters
  - ▶ full engine synchronisation with advanced triggering features
  - ▶ crank angle synchronized recording (standard)
  - ▶ crank angle resolved multiple cycle recording (high speed)
  - ▶ minimally invasive endoscopic illumination and imaging
  - ▶ high transmission endoscopes
  - ▶ high resolution digital color cameras
  - ▶ engine adaptation including engine sealing sleeves

### LaVisionUK Ltd

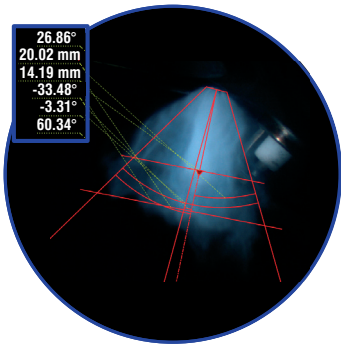
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Bicester, Oxon / OX26 6QB / United Kingdom  
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### LaVision GmbH

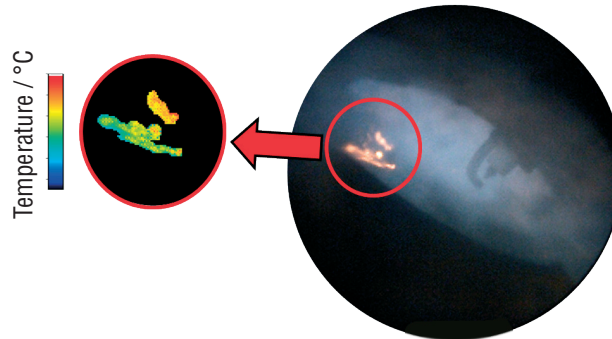
Anna-Vandenhoeck-Ring 19  
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### LaVision Inc.

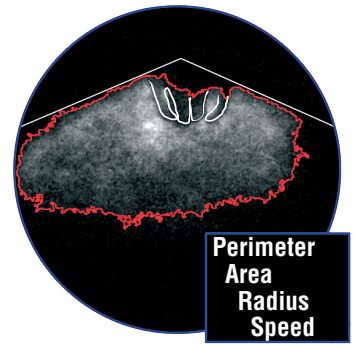
211 W. Michigan Ave. / Suite 100  
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Spray geometry



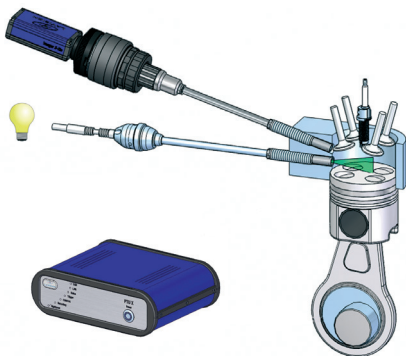
Temperature and KL-value from soot pyrometry



Flame propagation

**EngineMaster inspex configurations**

LaVision offers three different types of turnkey endoscopic imaging systems for in-cylinder spray and combustion visualization. The systems combine endoscopic illumination for spray and background contour illumination, a high quality imaging endoscopes and a choice of three different camera types. All systems come with full engine synchronization electronics and laptop computer with recording and visualization software. Software packages allow quantitative imaging of in-cylinder parameters. Engine sealing and equipment mounting is also provided by LaVision.



**EngineMaster inspex applications**

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

May-17

EngineMaster inspex	Standard	High-speed	High-speed laser
<b>Description</b>	Crank angle sync. cycle-based imaging	Crank angle resolved imaging	Crank angle resolved imaging
<b>Recording rate</b>	~1 image / cycle	~1 image / crank angle	~1 image / crank angle
<b>Time resolution</b>	8 μs flash width	Typical exp. 1-200 μs	~170 ns @1 kHz
<b>Light source</b>	Stroboscope (0 - 200 Hz)	Cold light source (cw)	High-speed laser (10 kHz)
<b>Illumination endoscope</b>	Engine illumination unit with fibre coupling (ø 8 mm; ø 4 mm for HS-laser) for in-cylinder contour and spray illumination		
<b>Camera endoscope</b>	Camera endoscope for visible wavelength range (ø 8 mm)		
<b>Camera</b>	High sensitive color CCD camera 17 Hz (1392x1040 pix)	Compact high-speed CMOS color camera 3.26 kHz (1280x800 pix) 11.5 kHz (512x512 pix)	High-speed CMOS color camera 7.53 kHz (1280x800 pix) 25 kHz (512x512 pix)
<b>Engine sync.</b>	PTU X engine synchronization unit		

	Standard	High-speed	High-speed laser
<b>Visualization</b>	Spray + combustion		
<b>Quantitative analysis</b>	<b>Spray geometry</b>	★★	★★★
	<b>Flame propagation</b>	★	★★★
	<b>Soot temperature + KL-factor</b>	★★★	★★★
<b>OH* imaging</b>	Requires EngineMaster inspex UV system with intensified camera and endoscope		

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