INNOVATIVE RADIOTRACER TECHNIQUES APPLIED TO THE DEVELOPMENT OF ENGINES AND LUBRICANTS
DSi founded in 2000
18 employees including 9 highly qualified engineers
1 new production facility in Tournai-Ouest, Belgium
1 test / engineering facility (3 engine test beds + 1 friction test rig)
2 additional test tools to be installed in 2015-2016

Within 15 years has become the world leader in radiotracer techniques applied to the automotive and lubricant industries

4 worldwide patents – 12 scientific publications (SAE, CIMAC...)
Continuous R&D programs (investment of 7% of yearly turnover)

**Our mission is to offer our customers innovative tools for speeding up their R&D programs**
Benefits of radiotracing techniques:

- Real-time results
- Very high sensitivity
- Non intrusive
- No dismantling
- Reduced test durations

Other key product:

Fluid conditioning systems for test rigs (oil and water)
KEY PRODUCT N 1: ON-LINE WEAR (TLA/RNT) MEASUREMENT

- **WIDE RANGE** OF EQUIPMENT FOR TEST BENCHES, TEST RIGS AND TRIBOLOGY MACHINES

- DSi TLA-RNT EQUIPMENT ARE COMPATIBLE WITH ANY SUPPLIER WORLDWIDE FOR IRRADIATION SERVICES

- IN-HOUSE AND ON-SITE SERVICES INCLUDING EQUIPMENT HIRE

- 100% INTERNAL KNOW-HOW → CONFIGURATIONS ADAPTED TO YOUR NEEDS!

**USE OF HIGH RESOLUTION PROBES:**
- INCREASED SENSITIVITY UP TO 1 NANOMETER
- UP TO 5 PARTS MONITORED SIMULTANEOUSLY
TLA / RNT WEAR MEASUREMENT : 2 types of measurement configuration
Impact of oil additive on wear

Additive package added after 28 hours of engine run

Cam wear measurement – 50h test
Turbocharger bearing measurement – 4h test in different conditions
TLA / RNT MEASUREMENT: TYPICAL APPLICATIONS

Conrod bearing wear measurement – 3h test

Bearing wear measurement – impact of load
# TYPICAL ENGINE PARTS FOR TLA MEASUREMENT

<table>
<thead>
<tr>
<th>Gears</th>
<th>Cylinder sleeves</th>
<th>Timing chain</th>
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<td>Camshafts</td>
<td>Turbocharger bearing</td>
<td>Waste gate</td>
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<td>Piston rings</td>
<td>Valves and valve seats</td>
<td>(turbocharger)</td>
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<td>Conrod bearings</td>
<td>Piston axes</td>
<td>DLC coated parts</td>
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<td>Crankshaft bearings</td>
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<td>Etc.</td>
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KEY PRODUCT N 2: ON-LINE FUEL DILUTION MEASUREMENT
D-LUBE : ON-LINE FUEL DILUTION MEASUREMENT

- Reference methodology for gasoline and diesel engines
- Convenient whatever the size of the engine
- Ideal tool for optimising fuel injection strategies
- On-line results during engine operation
- Sensitivity: better than 0,1 % fuel content
- Absolute calibration without the need of external services
- Low levels of activity and no radioactive wastes (40 hours half-life)
- Methodology is validated by Ford, PSA, Perkins, Total, Federal Mogul…
ON-LINE FUEL DILUTION MEASUREMENT: OPERATING PRINCIPLE:

Step 1: a radiotracer (Ge-69) is added and mixed to the engine oil.
Step 2: volumic activity of oil is measured continuously with a radiation probe.

\[ \gamma \text{-ray emission in measuring chamber decreases with fuel content in oil} \]
ON-LINE FUEL DILUTION MEASUREMENT

DILUTION/EVAPORATION PHASES ON TURBO DIESEL ENGINE EQUIPED WITH DPF

- Dilution phases
- Evaporation phases

Elapsed time (hour)

Oil Dilution (%) vs. Oil temperature (°C)
KEY PRODUCT N 3: ON-LINE OIL CONSUMPTION MEASUREMENT
MONITORING ENGINE OIL CONSUMPTION WITH C-LUBE

Use of a new radiotracer compound (Ge-69), which is representative of the lubricant (4 molecules available from light to heavy oil fractions)

Combustion of Ge → GeOx ashes → trapped in the exhaust line

Global engine oil consumption performed through emission measurement

Automatic conversion in g/hour (calibration process)

Real-time results and high sensitivity – OC map within 12 hours

Discrimination between LOC of engine block, ventilation circuit and turbocharger
EXAMPLE OF DATA RESULTS: Global Oil Consumption Map

Raw data: accumulation of Ge-69 ashes in the exhaust filter

Global oil consumption map performed on a 2L gasoline engine (nat. aspirated)
Methodology for measuring oil consumption downstream the oil separator system (Blow-by circuit)

- Inlet air
- Engine oil separator
- Absolute filter (oil trap)
- Radiation probe
- On-line measurement of oil consumption after separator system
- Blow-By gases
→ Made of stainless steel.
→ NaI 12'X4' detector type, installed in a cooling jacket, in the middle of the filter.
→ The filter is an industrial cartridge especially developed for such application. The filter material contains polyamide + PTFE, it resists 200 °C and it is specifically convenient for efficient oil trapping (99.9 % at 0.3 µm).
→ Two configuration are used (PTFE in white).
Pressure losses determination at CRITTM2A facilities

To check pressure losses and sealing at high air flow (up to 500 m³/hr), the equipment chamber has been installed on a turbocharger bench that reproduce hot air flow rates.

→ Very limited P losses at every flow rate
MONITORING OIL CONSUMPTION WITH C-LUBE

Discrimination between LOC of engine block, ventilation circuit and turbocharger

Direct measurement in the exhaust line

Additional probe in the ventilation system

Independent lubrication system for turbocharger (TC-Lube)
ABSOLUTE CALIBRATION IN GRAM PER HOUR
CORRELATION BETWEEN THE RADIOTRACER METHOD AND DRAIN MASS

Drain mass method: 30.8 g/h
Radiotracer method: 31.4 + 1.1 + 0.2 = 32.7 g/h

Performed on a 1.4 turbodiesel engine

Drain mass method: 7.5 g/h
Radiotracer method: 6.1 + 1.2 + 0.1 = 7.4 g/h
BENEFITS OF C-LUBE METHODOLOGY:

- **On-line results** during engine operation

- **Real oil consumption measurement:**
  - Tracer is 100% representative of base oil molecules
  - No change of oil properties
  - Burned and unburned oil fractions are taken into account

- Separation of oil **consumption sources**

- Very **high sensitivity** → short test durations

- **Absolute calibration** in g/hour

- Excellent **repeatability**
KEY PRODUCT N 4: MONITORING LUBRICANT AERATION

**Air-X**, the reference tool for monitoring engine oil aeration

- **Standard model for test rigs**
- **Compact model for til test beds & in-board**
MONITORING LUBRICANT AERATION

*Air-X*, the reference tool for monitoring engine oil aeration

**Operating principle:**

Use of a static X-ray source
For oil density measurement

Real-time data acquisition & display
Measuring range: 0-100% - Accuracy: 0.15%
Response time: 1 sec - Self-calibration procedure
FLUID CONDITIONING SYSTEMS

TC-Lube: separate lubrication system for turbochargers

Fluid conditioning system for friction test benches

F1 engine simulator (oil + aeration generator)
CUSTOMERS WORLDWIDE:
THANK YOU FOR YOUR ATTENTION