



NVH Challenges in context of ECO vehicles Automotive Testing Expo 2010

ECOLOGICAL Vehicle Engineering

> 170 Hybrid and Electrical vehicles

Government support

Government regulations

Buyers preference

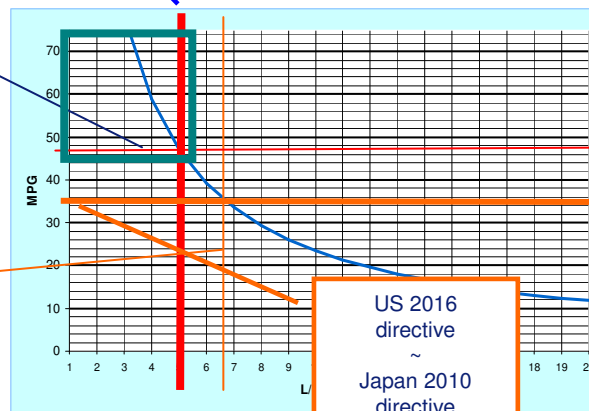
EU 2012 directive

US 2016 directive
~
Japan 2010 directive

<p>Ireland</p> <ul style="list-style-type: none"> The registration taxes is based on CO2 emissions. Rates range from 14% for cars <120g/km to 36% for cars >225g/km Hybrid and flex fuel vehicles will benefit from a tax relief of €2,500 The annual circulation tax will be based on CO2 emissions. Rates will vary from € 104 for cars up to 120g/km to €2,100 >225g/km 	<p>Germany</p> <ul style="list-style-type: none"> From July 1, 2009, the annual circulation tax will consist of a base tax and a CO2 tax. The rates of the base tax will be € 2 per 100 cc (petrol) and € 9.90 per 100 cc (diesel) respectively. The CO2 tax will be linear at € 2 per g/km. Cars with CO2 emissions below 120 g/km will be exempt (110 g/km in 2012-13; 95 g/km subsequently).
<p>United Kingdom</p> <ul style="list-style-type: none"> Annual circulation tax is based on CO2 emissions. Rates range from £ 0 (up to 100 g/km) to £ 400 (gasoline/diesel) / £ 385 (alternative fuel) for cars emitting more than 225 g/km. Company vehicle tax rates range from 10% of the vehicle price for vehicles emitting less than 120 g/km to 35% for vehicles emitting more than 235 g/km. Diesel vehicles pay a 3% surcharge. 	<p>Italy</p> <ul style="list-style-type: none"> Purchase of new cars emitting maximum 130 g/km (diesel) and 140 g/km (other fuel) respectively will receive an incentive of € 1,500 if a car that is 9 years old or more scrapped simultaneously. Higher incentives apply for alternative fuel vehicles (CNG, LPG, electricity, hydrogen).
<p>Spain</p> <ul style="list-style-type: none"> The registration taxes is based on CO2 emissions ranging from 0% (< 120g/km) to 7.75% (>200g/km). 	<p>France</p> <ul style="list-style-type: none"> Bonus-Malus system. Premium granted during new vehicle purchase when CO2 emissions are below 130 g/km, subject to a maximum of €5,000 for vehicles emitting below 60 g/km. Tax levied on new vehicle if CO2 emissions are more than 160 g/km, subject to a maximum of €4,500 for vehicles emitting more than 25 g/km of CO2.

Source: Frost & Sullivan

Fig 3: CO2 Based Taxation for Key Countries in Europe



eco-ICE

hybrid

electric vehicles

micro

mild

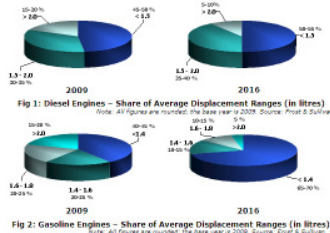
full

plug-in

range-extender

B/FEV

ECO-Internal Combustion Engine NVH Impact

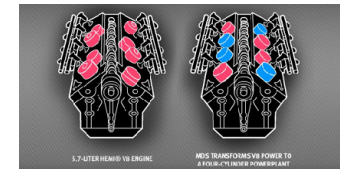


Downsizing

Increased unbalance - Higher dynamic motion causing more vibrations at mounts
 Increased torsional vibrations

Cylinder de-activation

Increased transients - driveline torsional vibrations
 Increase risk for crankshaft or engine bending mode excitation

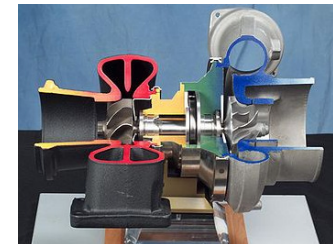


Homogeneous Charge Compression Ignition

High combustion noise - Impulsive combustion noise
 Increased Peak-to-Mean torque – more torsional vibrations

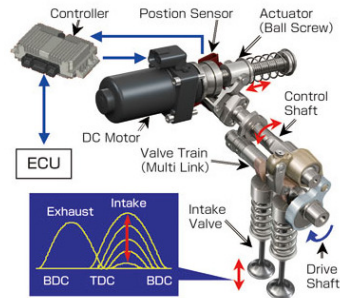
Optimized Turbo-charging

Series-Parallel configuration may lead to modulation



eco-ICE

ECO-Internal Combustion Engine NVH Impact

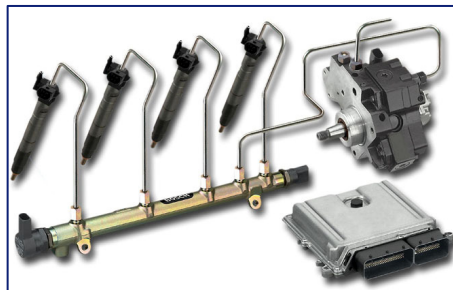


Source Hitachi Automotive Systems

(Variable) Valve Train

Transients

Valve bounce, Valve impact noise



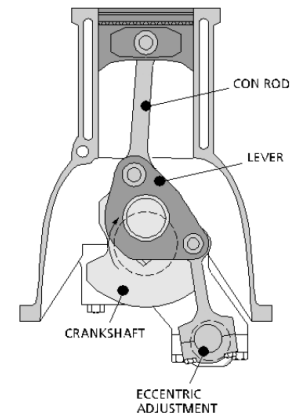
Direct Injection

Injector related impulsive noise

Pump related noise

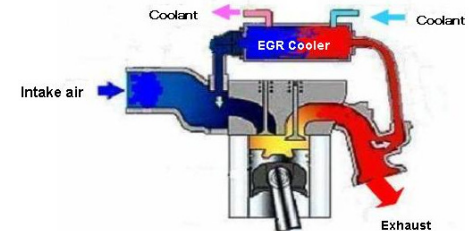
Variable Compression Ratio

Increased unbalance



Exhaust Gas Recirculation

Changed exhaust modes



eco-ICE

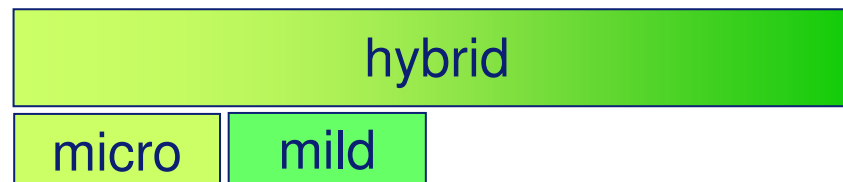
Micro-Mild Hybrid NVH Impact



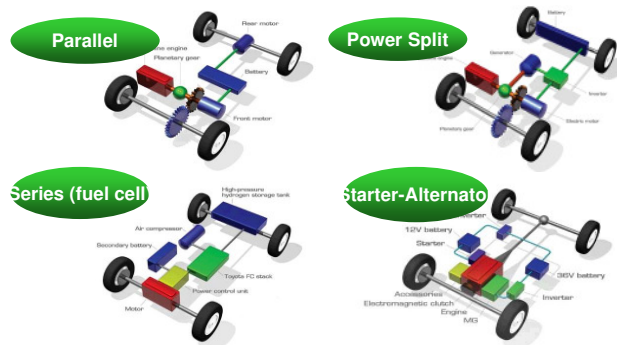
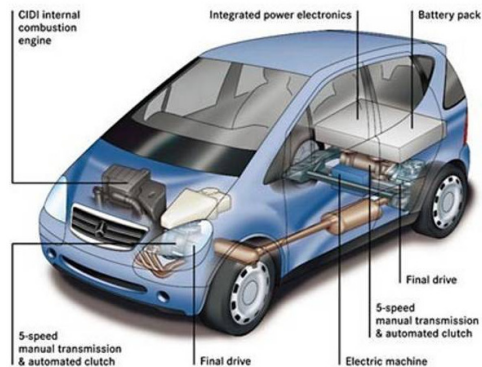
Engine Start-Stop

No idling noise – no masking of ancillaries e.g. HVAC noise

Vibration transient at engine re-start – keyon-keyoff issues



Full and Plug-In Hybrid NVH Impact



Vehicle Layout

Different weight distribution

Multiple powering units

Transient/non-stationary N&V, even for stationary conditions

Gearbox

Whining noise, no longer masked by ICE

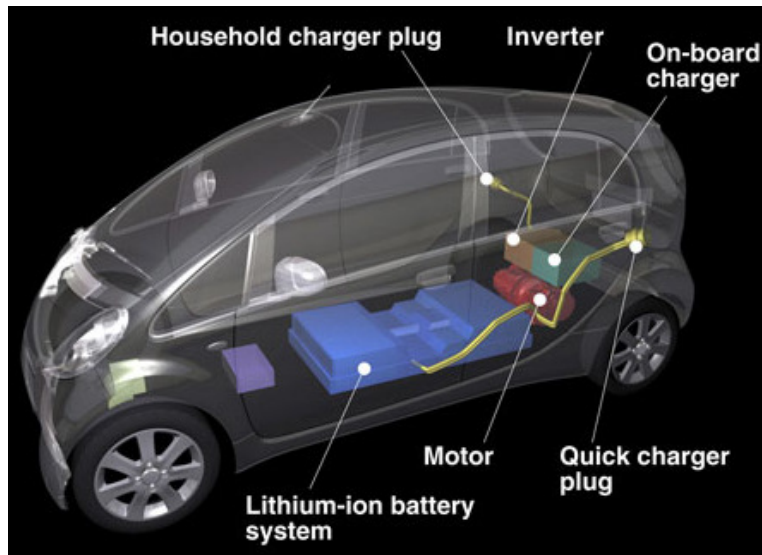
Roadnoise – Windnoise

Less masking by EM

Changed tire design – Increased tire pressure

Electric motor & power electronics noise

Electric Vehicle NVH Impact



Vehicle Layout

Different weight distribution

Different powertrain component structural stiffness

Body

Reduction of body weight – more composites

Different connection points

Transparency for Mid-High frequency noise

Interior sound design (Active noise control, ...)

Subframes

Important changes to known configurations

Accessories

Less masking (HVAC, Fan, ...)

electric vehicles

range-extender

B/FEV

Electric Vehicle NVH Impact



Electrical Motor & Power electronics

High torsional load at low rpm

Electro-Magnetic excitation of motor-housing

Operation as motor or generator

Very well balanced

Off-zero modulation (power electronics)

Batteries

Battery cooling NVH

Additional accessories (pump)

Road noise – Wind noise

See Hybrid

Pedestrian safety

Warning sounds

electric vehicles

range-extender

B/FEV

3 levels

Subsystems & Auxiliaries

Performance optimisation

Powertrain &
Transmission choices

Powertrain & Transmission transients

Vehicle Integration

Vehicle layout modifications
Powertrain integration
New target setting



LMS Scadas Mobile

LMS Test.Lab

eco-ICE

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B/FEV

Subsystems & Auxiliaries

Variable valve train testing

Subsystems & Auxiliaries

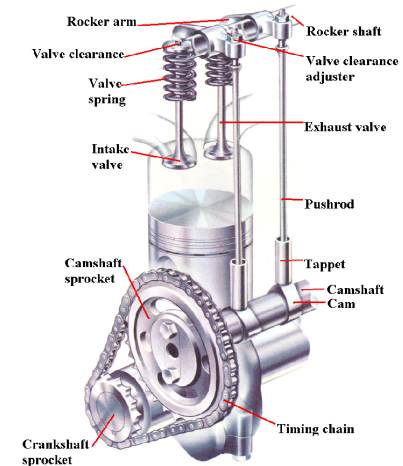
Performance optimisation – Variable valvetrain testing

Powertrain &
Transmission choices

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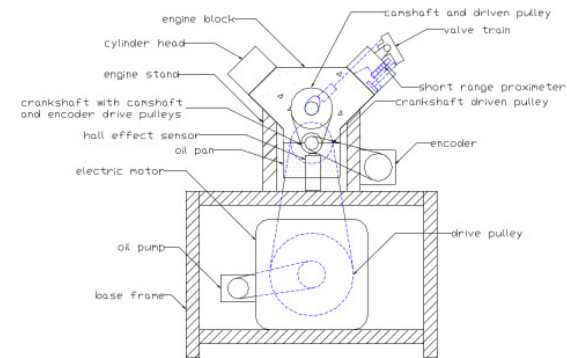
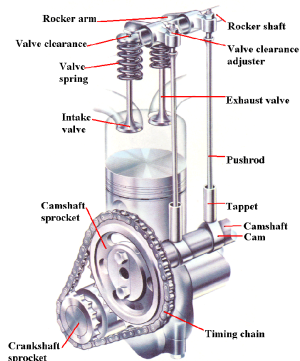
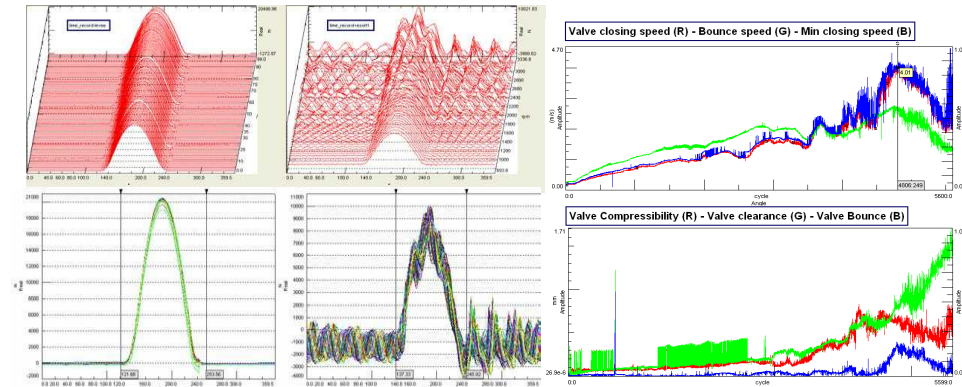
range-extender

B/FEV

ECO-ICE

Validation of performance optimisation

Valvetrain Dynamic Performance Testing



SCM + TL

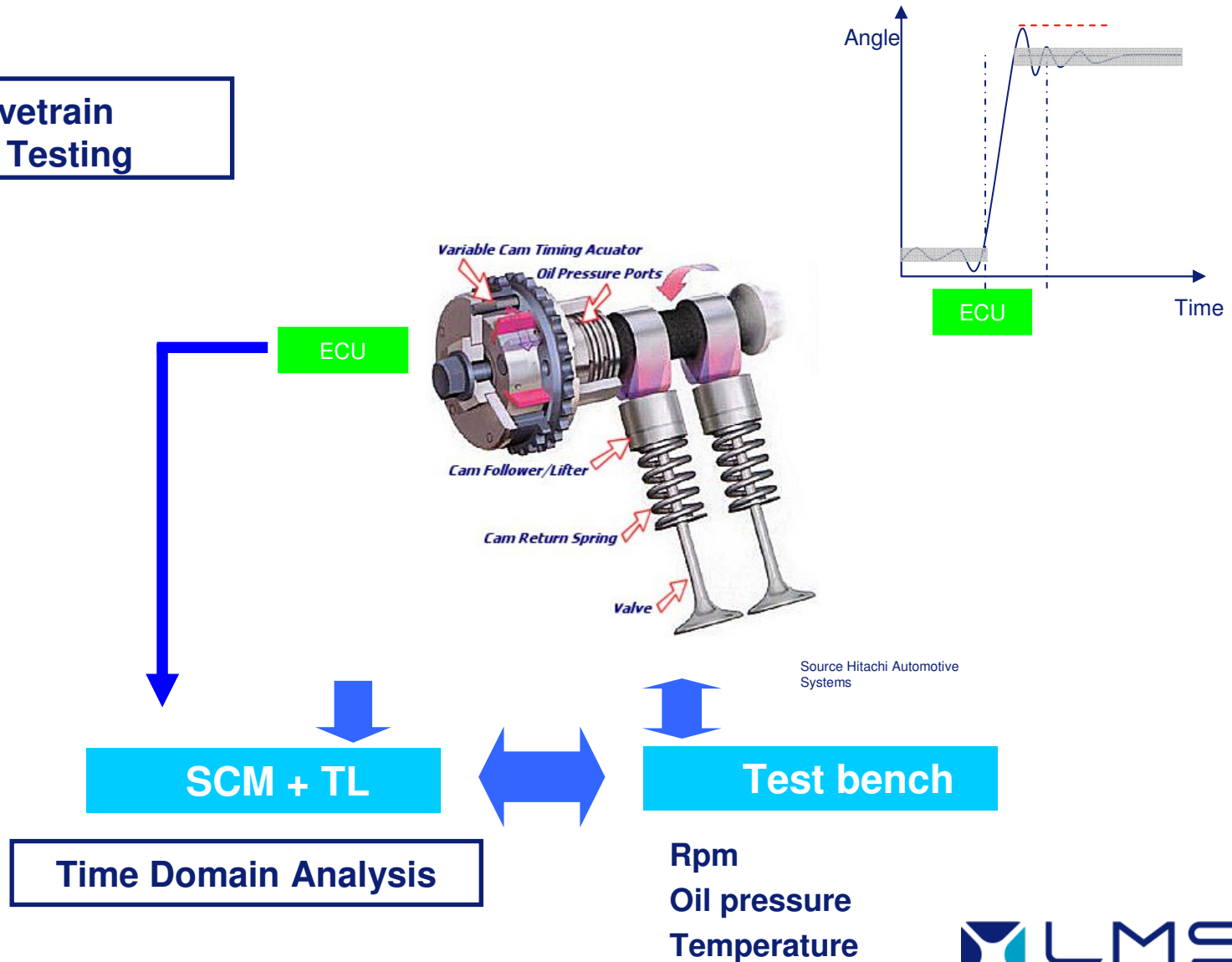
Test bench

Angle Domain Analysis

ECO-ICE

Validation of performance optimisation

Variable Valvetrain Switching Testing

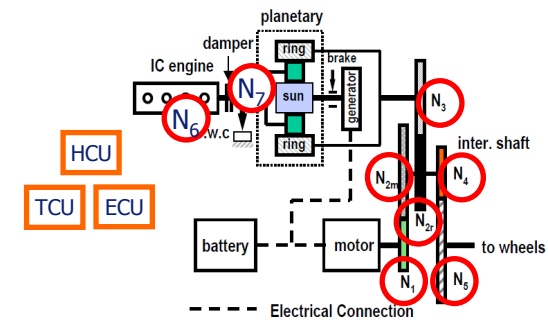


ECO-ICE

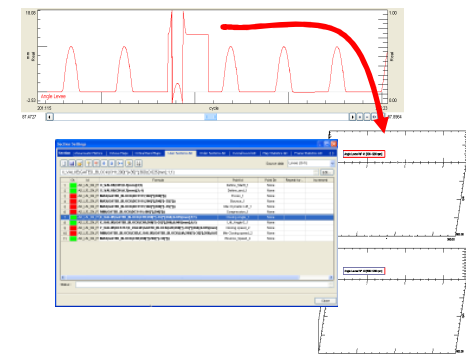
Validation of performance optimisation

LMS Value Proposition

- **Accuracy**
 - Sampling rates & angular resolution
 - Synchronized acquisition of linear & rotational vibrations, ECU and slow parameters
- **Integrated solution - Convenience**
 - Single box for all quantities, analog-digital or IE tacho devices, dynamic and static, analog or digital (ECU), NVH and other
 - Single Multi-domain solution
 - Single provider for Hardware and Software
- **Process automation - Productivity**
 - Automatic data clean-up
 - User-programmable metrics
 - Minimal user-interaction
 - Test scheduling (test bench integration)



Time Data Analysis
Frequency analysis
Angle Domain Analysis
Torsional Vibration Analysis
And much more



Vehicle integration

Vehicle layout

Subsystems & Auxiliaries

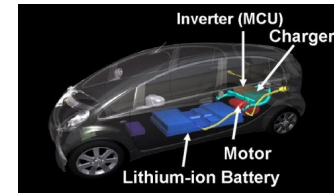
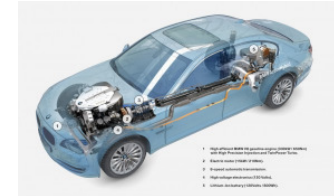
Performance validation

Powertrain & Transmission choices

Powertrain & Transmission transients

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New target setting



eco-ICE

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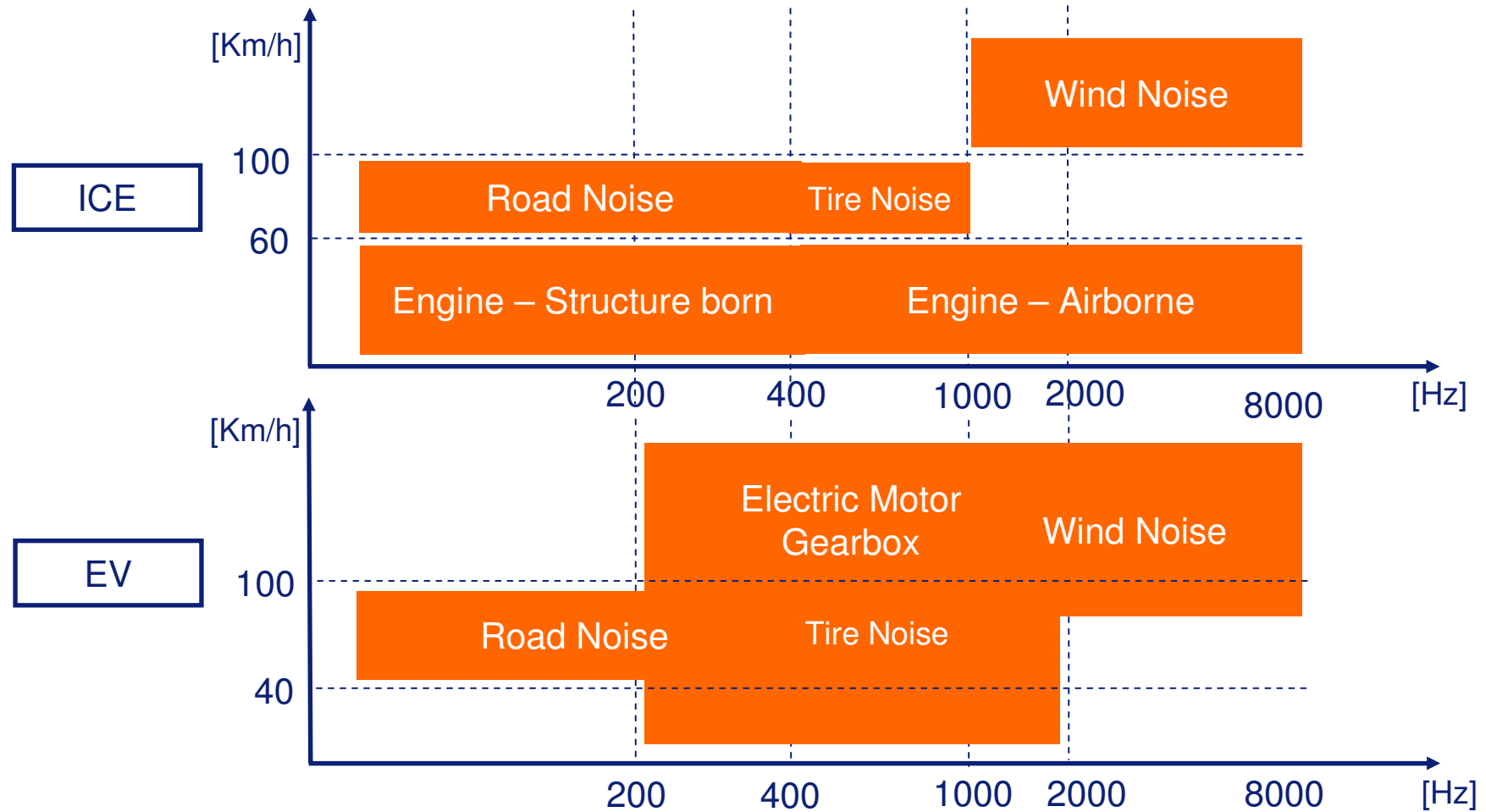
full

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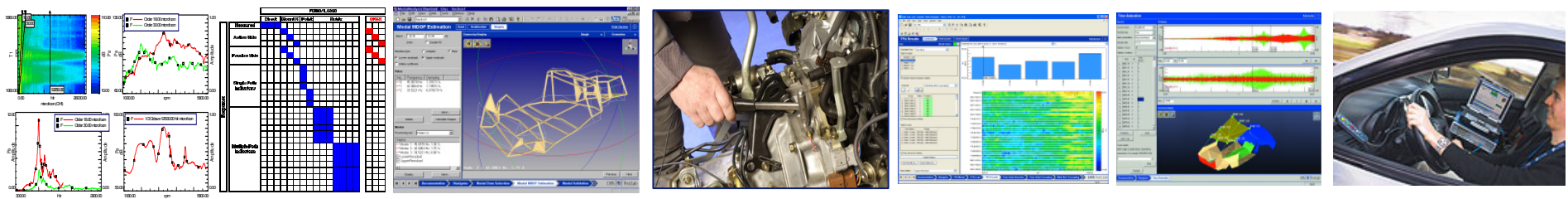
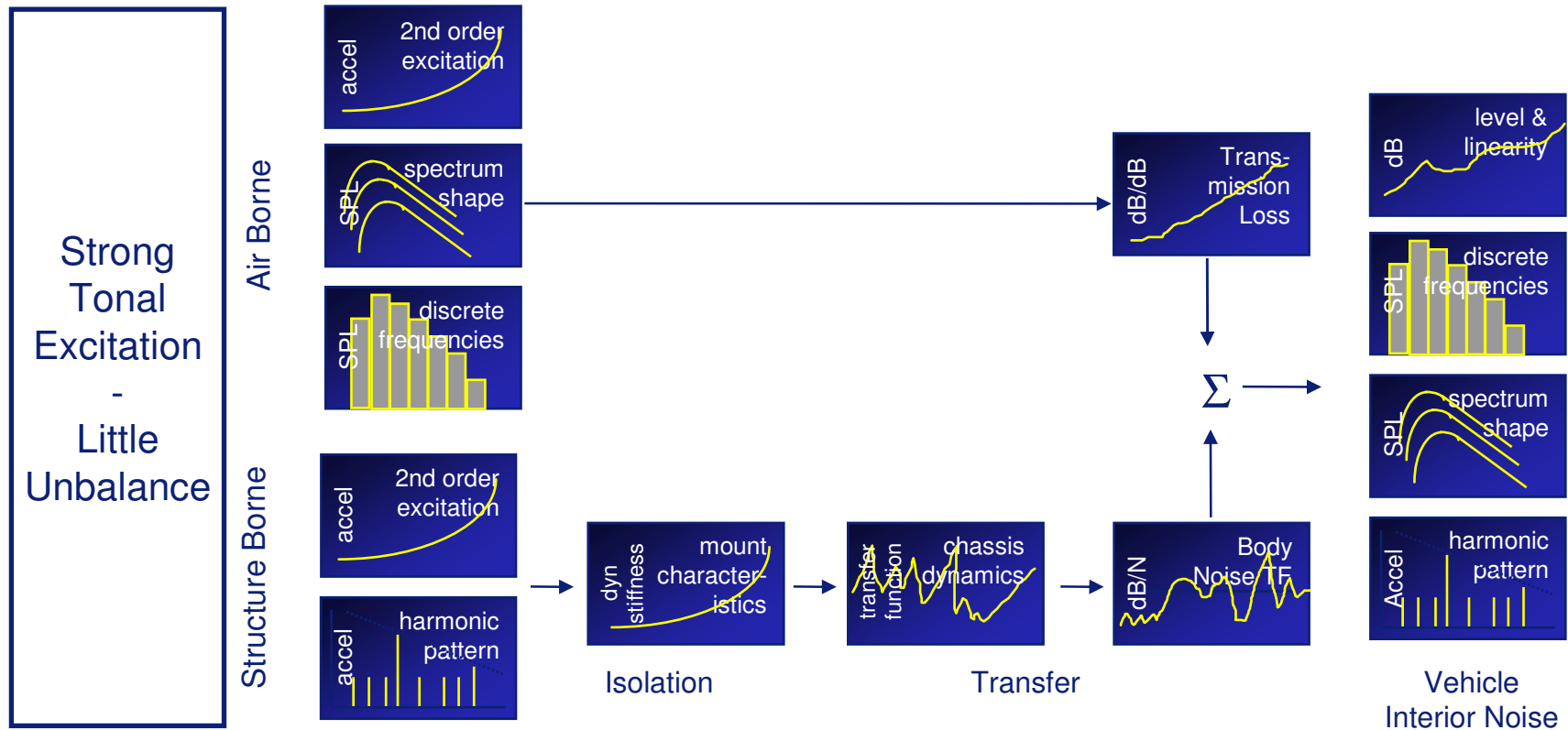
range-extender

B/FEV

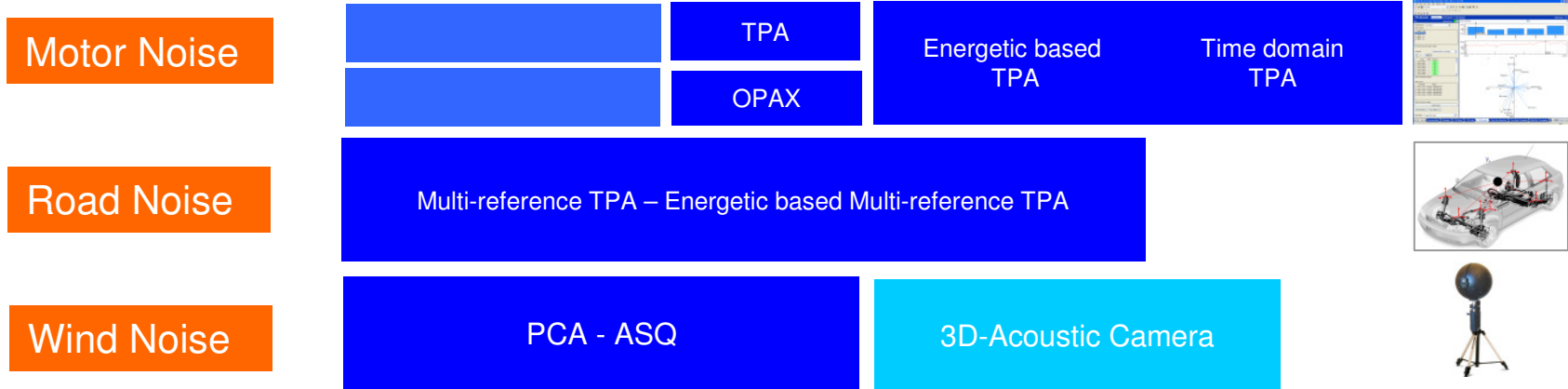
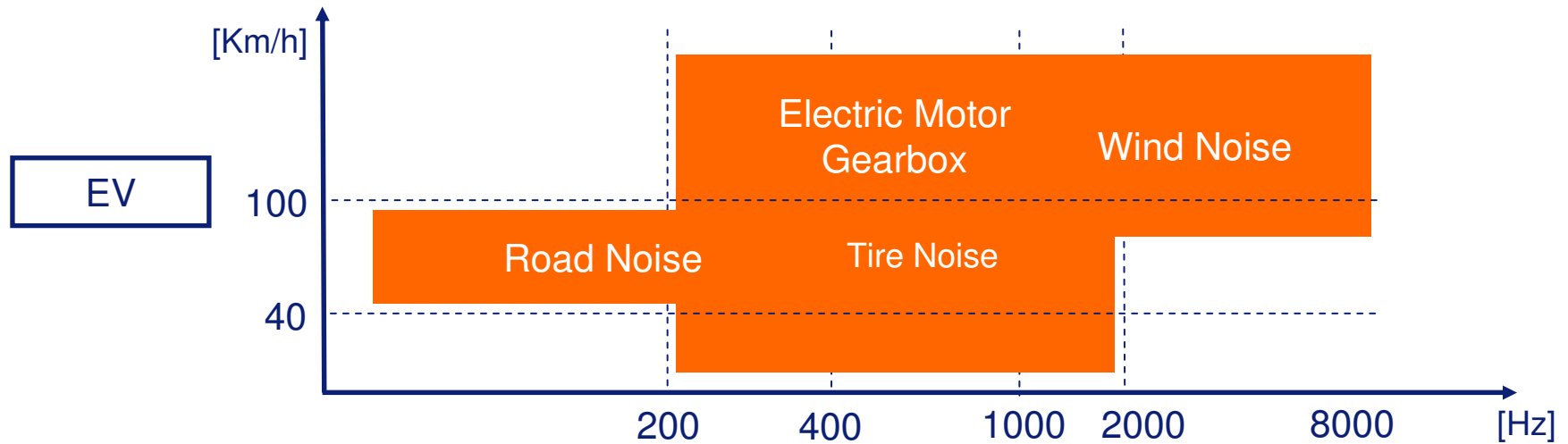
Electrical Vehicle Vehicle Layout



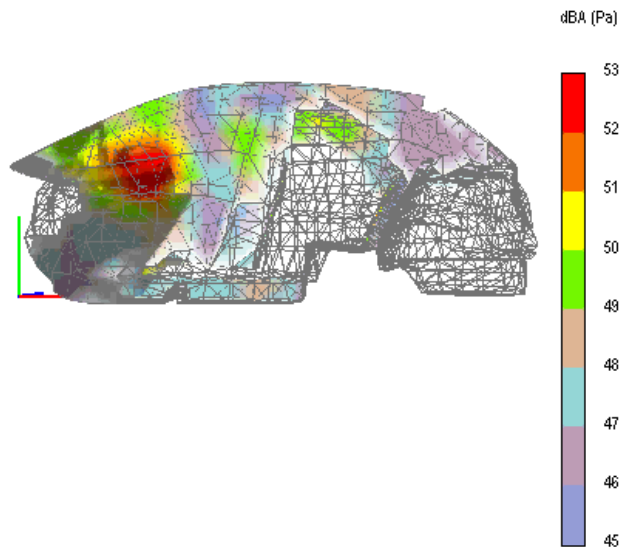
Electrical Vehicle Road Noise & Vehicle Layout



Electrical Vehicle Road Noise & Vehicle Layout



Electrical Vehicle - Road Noise & Vehicle Layout 3D Acoustic Camera



- **One shot** sound sources localization in complex 3D sound field
- **Geometry scanning:** exact geometry can be automatically scanned.
- **Clear understandable** geometry, with picture superimposed, based results
- **One solution from low to mid frequency**



Import or scan geometry

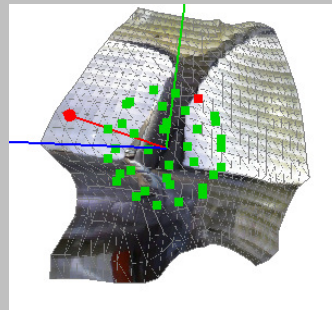
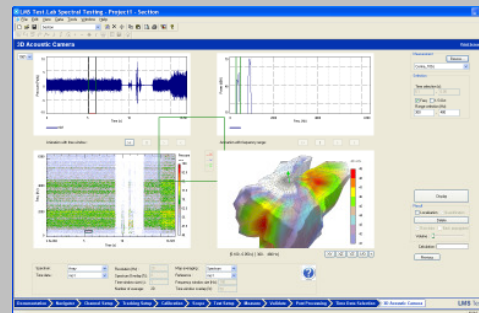
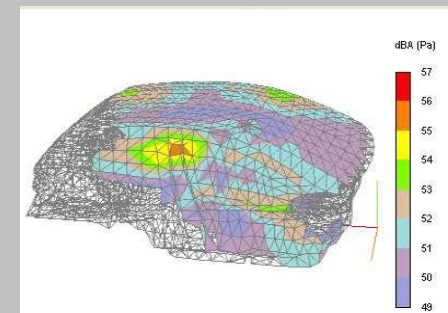


Photo realistic



Interactive analysis



Animated reporting

Summary

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