Tracking down structure-borne sound

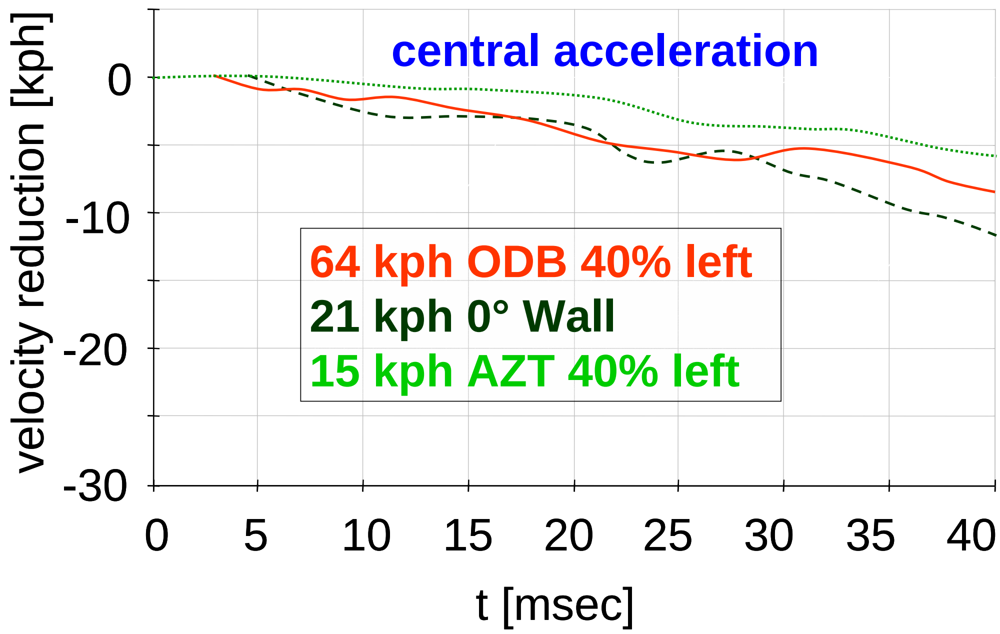
Enhancement and improvement of passive safety systems is an important issue in the automotive industry. Future sensors for controlling airbags, for example, are expected to respond even more sensitively, with electronics that will decide even faster on the activation of restraint systems such as airbag and seat belt tightener. Here the crash specialists from Continental break new ground. By measuring the characteristic structure-borne sound that occurs during a crash, the plastic deformation of the structure is captured. At the same time, different crash scenarios such as high or low speed, vehicle overlap, slant collision or collision against deformable objects can be distinguished very well.

The solution is called Crash Impact Sound Sensing (in short: CISS). CISS is the ideal supplement for accelerometers or pressure sensors traditionally used in crash investigations.

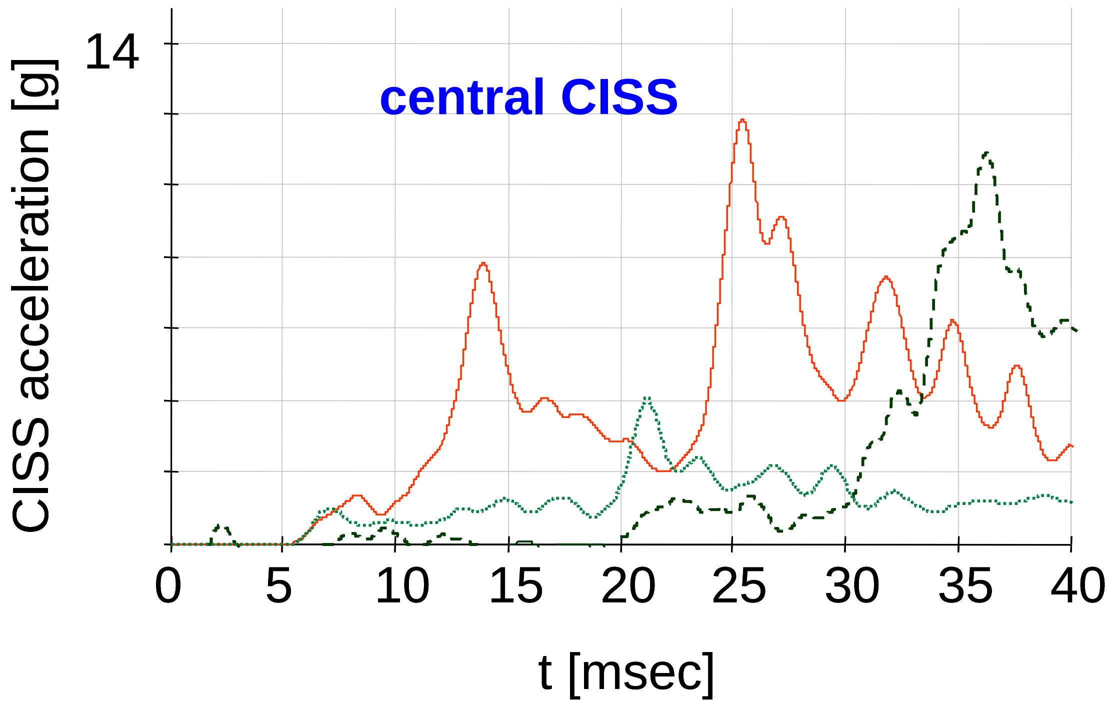
Picture 1: Airbag ECU with CISS sensor

Combined evaluation of the two physical effects “delay” and “structure-borne sound” can distinguish reliably between car accidents and misuse situations where the restraint systems must not be activated. Another example for the capabilities of the new technique is the reliable differentiation between “no-fire crashes” at low speed where the airbag is not actuated, such as parking damage, and “fire crashes” at high vehicle speed where the airbag is fired.

Structure-borne sound occurs when force variations are introduced into a mechanical structure. This applies also to deformation of materials outside the elastic range, such as folding and bending deformation, collapse and breakup of structures or crack formation. Structure-borne sound propagates through the structure as an elastic strain wave – frequency-dependant – with very high velocities up to 5 m/ms. An impact sound sensor, integrated in the central airbag control device, will thus be able to capture crash scenarios very fast and precisely, even at peripheral points of the vehicle.

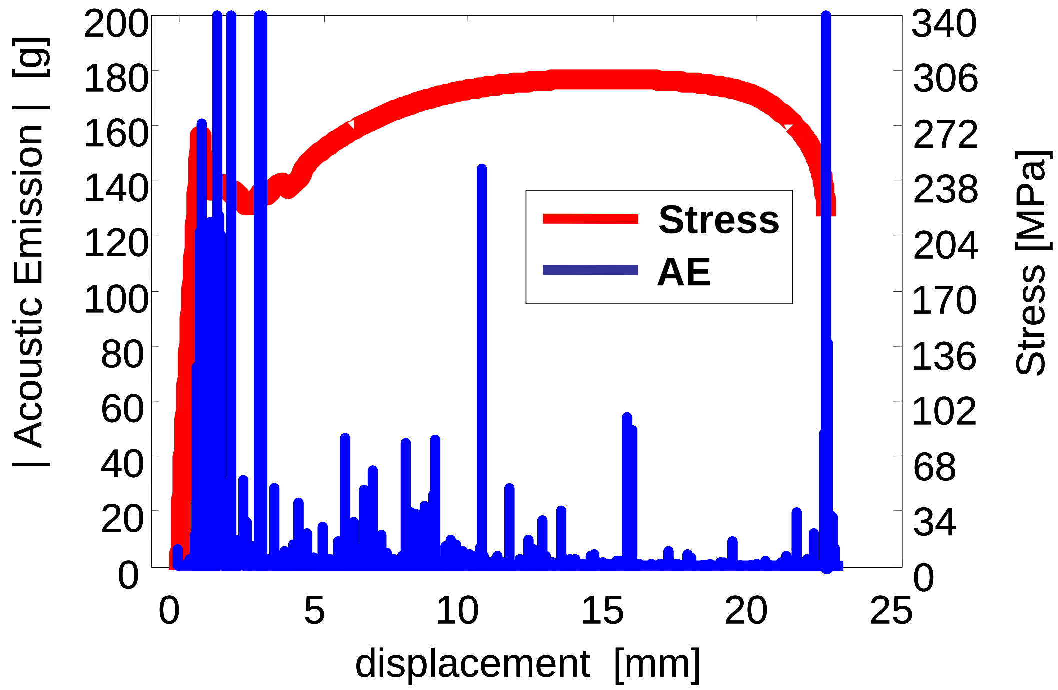


Picture 2: Acceleration during crash. ODB: 40% offset on deformable barrier. AZT: 40% offset on non-deformable barrier.

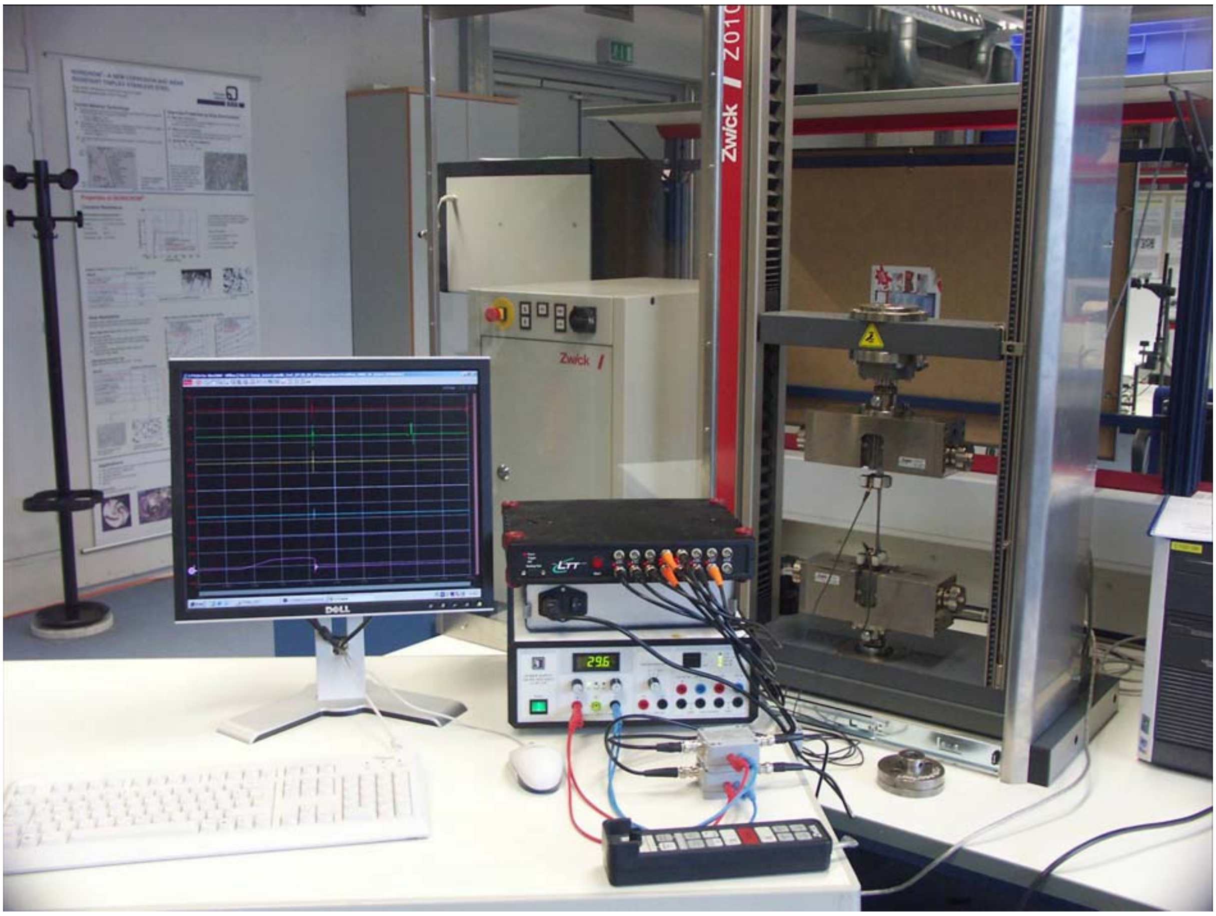


Picture 3: Accustic emission with CISS sensor. ODB and AZT as picture 3.

Continental, the Audi AG and the Institute for Applied Research (IAF) of the University of Applied Science Ingolstadt are cooperating in several research projects, subsidised (amongst others) by the Federal Ministry of Education and Research, that investigate structure-borne sound generated in car crashes. This includes testing of material samples from the deformation zones of the vehicle to determine structure-borne sound characteristics – such as potential sound energy density – for specific materials and body parts.



Picture 4: Acoustic emission [AE] during tensile test.

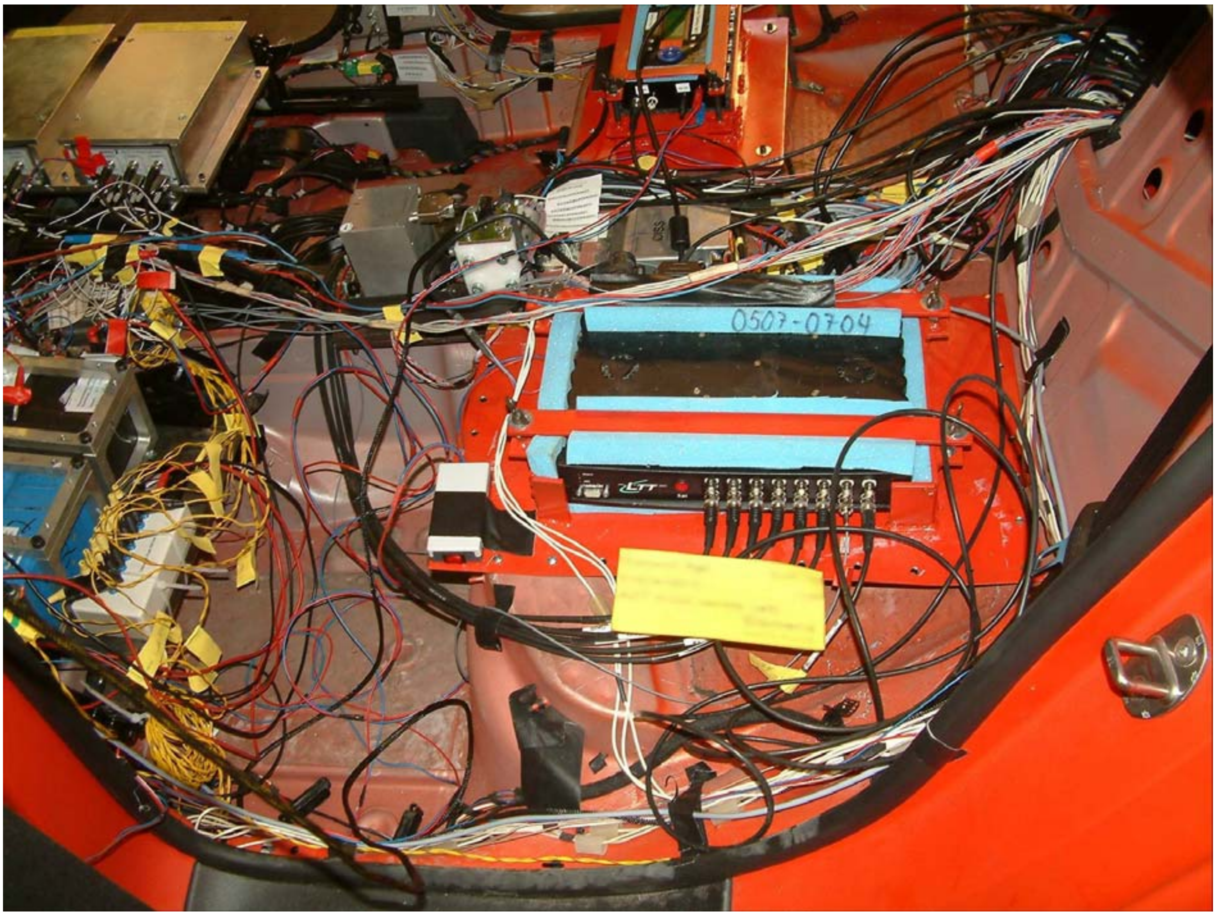


Picture 5: LTT186-16 during material tensile test in laboratory.

The obtained characteristics are then used for the assessment of signals that occur during a real crash test. Another test scenario is used to assess so-called dynamic and static misuse situations (such as extreme driving manoeuvres, hammer strokes, kicks) in order to distinguish them reliably from a real crash.

These investigations require a powerful data acquisition system that meets the particularly high demands: The system must be able to operate self-sustained (not computer-aided) and allow longer recording times in the minute range. It should provide a high signal bandwidth up to 1 MHz for as many channels as possible – combined with highest precision. Last not least, the system must be "crash-immune", that is, withstand accelerations of more than 70g under operating conditions.

Picture 6: LTT186-16 of Labortechnik Tasler GmbH www.tasler.de



Picture 7: LTT186-16 build-in condition at crash car.

Continental chose the Transient Recorder LTT 186-16 by LTT Labortechnik Tasler. It offers 16 analogue differential inputs with 1 MHz bandwidth and 16-bit resolution; bandwidths from DC – 6.5MHz are possible with 12-bit resolution. Its integrated hard disk with a memory depth of 40GB allows longer recordings independent from a PC. The device has proved successful both on stationary test benches and in mobile “crash operations”. An optional flash disk provides higher data integrity.

Investigation of structure-borne acoustic emission is not only relevant for the development of crash sensors. Acoustic emission sensors (AE sensors) are used to monitor processes, tools and machines in metal cutting and forming operations. Other possible applications include non-destructive testing of mechanically loaded components such as pressure vessels and pipeline systems. Transient Recorders from LTT provide the perfect connection to AE sensors and cover exactly the sensor's operating range with typical bandwidths from 50 kHz to 1000 kHz. With 8 or 16 differential analogue inputs, they allow to capture several AE sensor signals simultaneously and to record them together with other machine parameters. The connection to the PC is established via Ethernet, USB or SCSI.

With LTTview, intuitively operated software is provided to control data acquisition and enable visualisation with integrated online arithmetic. The measured signals can be stored directly in the requested format – DIAdem, Famos, µGraph or LTT format without the need for exporting data. Additional file formats such as Matlab, Dasylab and ASCII are provided for data export.

<u>Contact:</u>

LTT Labortechnik Tasler GmbH
Wolfgang Ziehers
Friedrich-Bergius-Ring 15
D-97076 Wuerzburg

Phone +49-931 / 3 59 61 - 0
Fax +49-931 / 3 59 61 - 50
www.tasler.de

<u>Editorial contact:</u>

Joachim Hachmeister
PR- und Marketing-Beratung
Josef-Jägerhuber-Str. 6
D-82319 Starnberg

Phone +49-8151 / 74 64 84
Fax +49-8151 / 74 64 83
j_hachmeister@t-online.de