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University of Applied Sciences

Institut für Angewandte Forschung
IAF

Source: Continental

Crash Impact Sound Sensing - CISS

Research and Development at the Ingolstadt University of Applied Sciences

Bundesministerium für Bildung und Forschung

Continental

Outline

Crash Scenarios

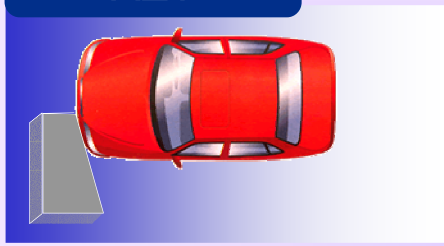
Wall 0°

27 - 56kph
rigid wall
0°

Angular

32 - 50kph
rigid wall
30°

AZT



15kph
rigid wall
40% overlap
10°

ODB

40 - 64kph
deformable barrier
40% overlap

Pole

20-29kph
pole (e.g. tree)

Other

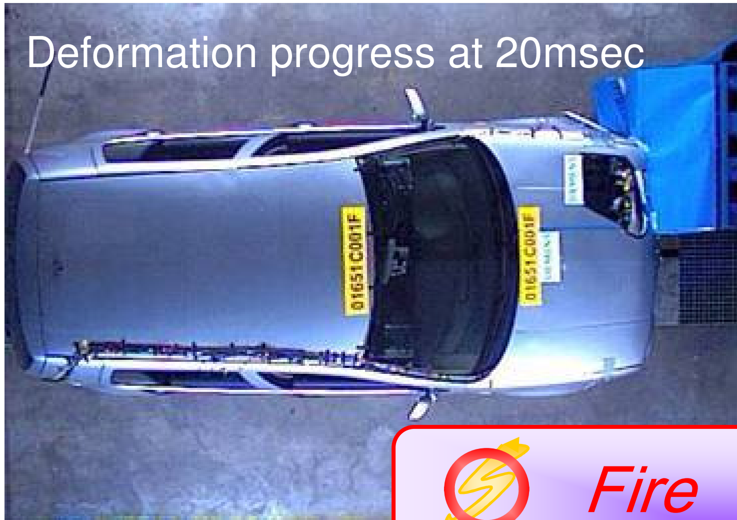
Car to Car
truck-underride
rear crash
…

Discrimination of AZT and ODB (Euro NCAP)

AZT (Allianz Zentrum für Technik)
- 15 kph / rigid barrier
- low severity

No Fire

ODB („5 Star Ranking“ Test)
- 64 kph / deformable barrier
- high severity



Fire

- only 20 – 30msec for activation of restraints (RTTF)
- only small deformation within RTTF

⇨ Discrimination difficult

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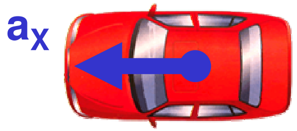
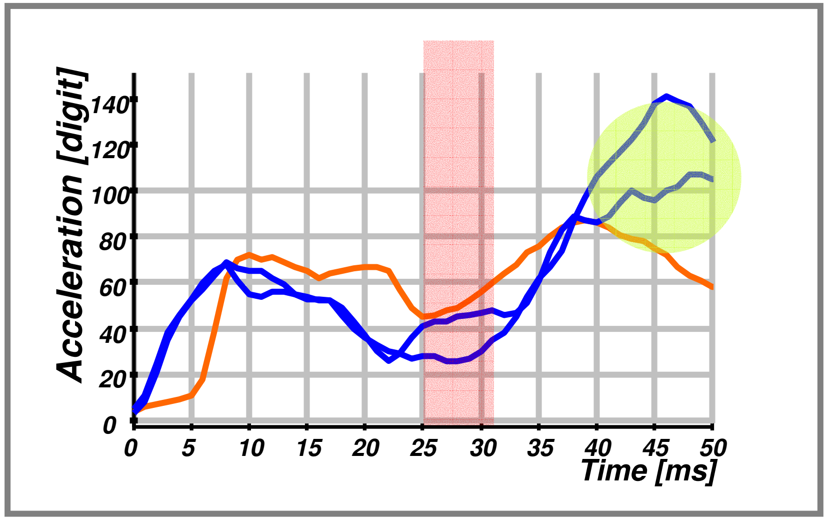
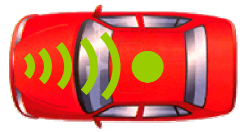
Crash discrimination capabilities AZT vs. ODB

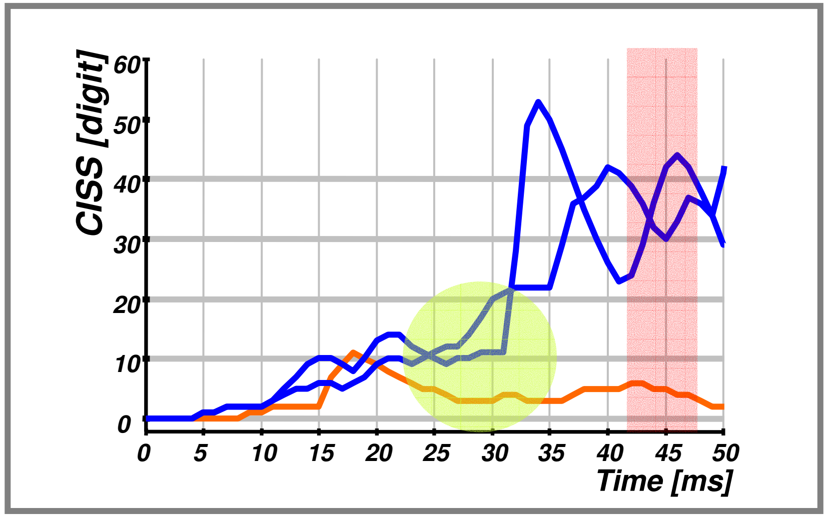
Standard acceleration



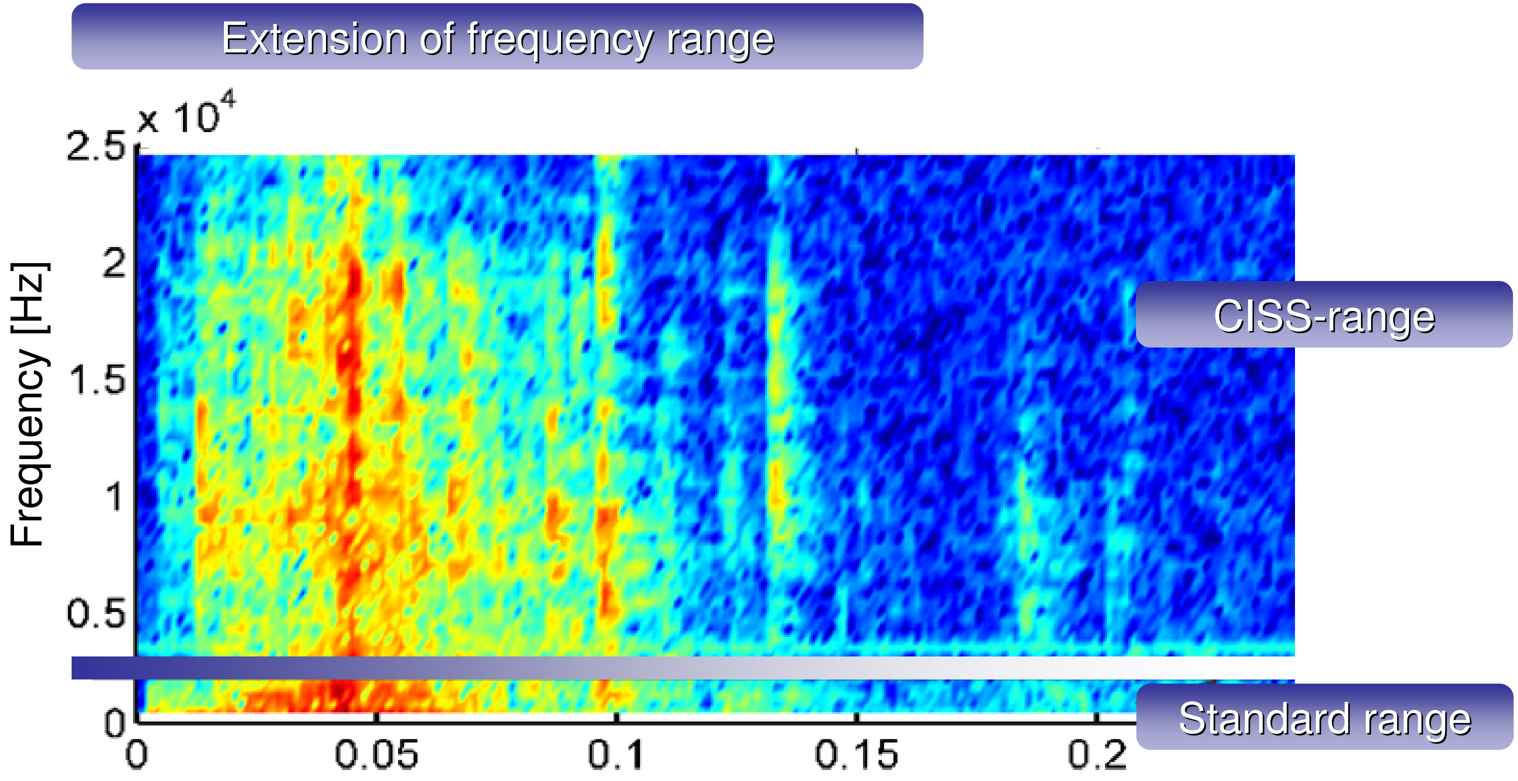


Crash Impact Sound





Frequency range



→ additional information for crash detection

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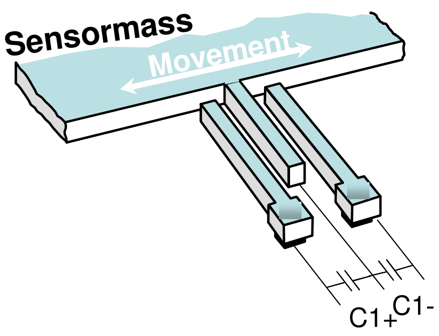
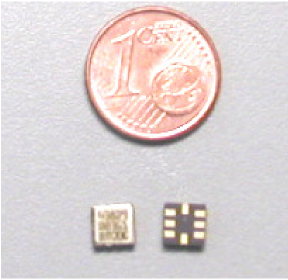
CISS Sensor

Crash Impact Sound Sensing

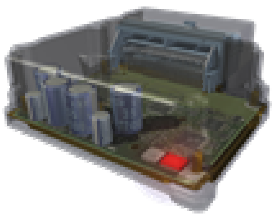
Capacitive g-cell



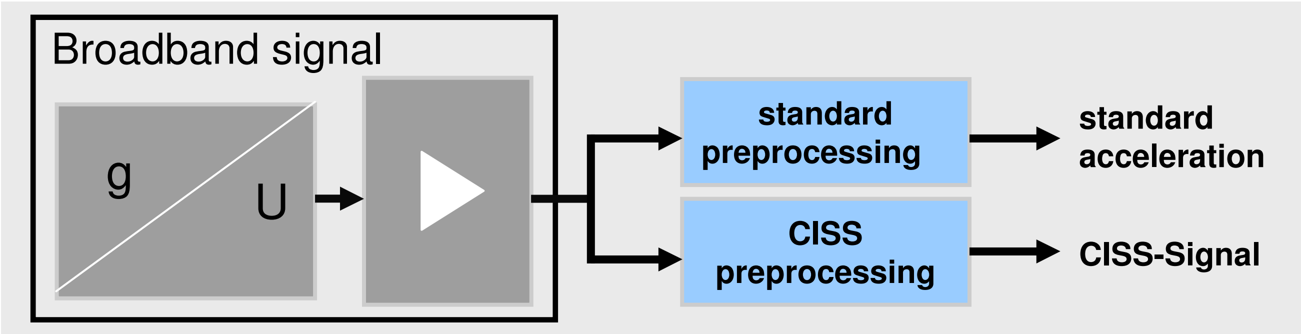
Integrated CISS Sensor



ECU integration



Signal chain



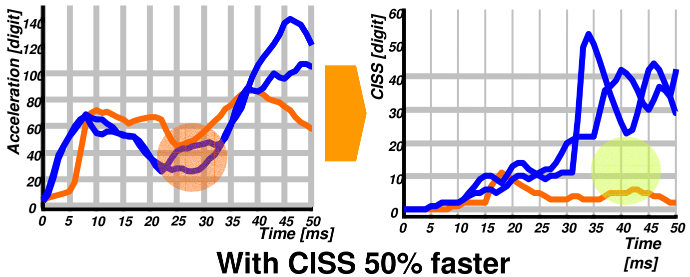
Picture source: Continental

CISS - Sensor Architecture

Step 1

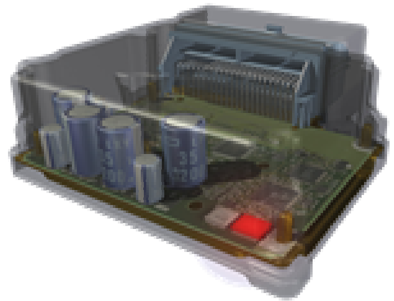
Single Point Sensing Performance Increase

Requirement: 25ms

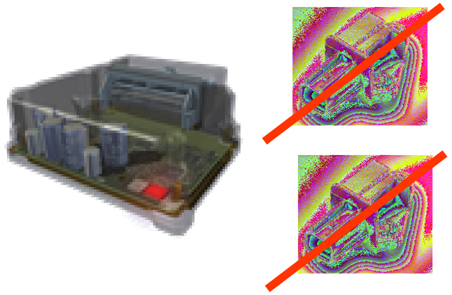


With CISS 50% faster

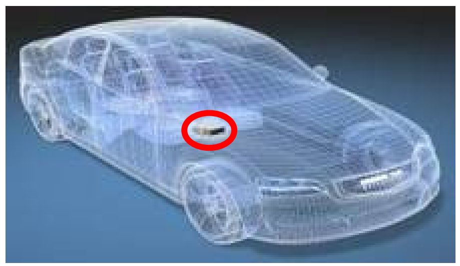
Single Point Sensing Control Unit



Step 2



Sensor Reduction



System Simplification

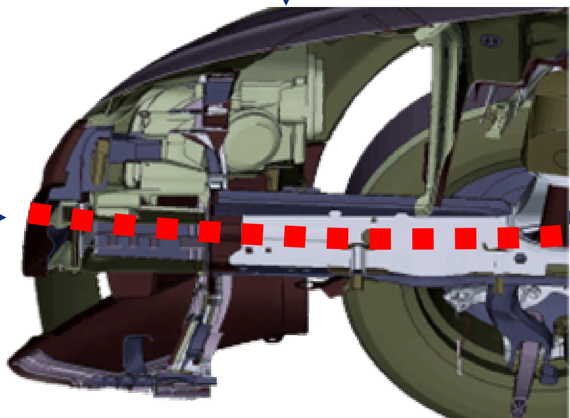
Picture source: Continental

Acoustic emission (AE) based crash detection

Crash

AE Generation | AE Propagation | AE Measurement

Source mechanisms



Influence of Measurement Position

Influence of Propagation

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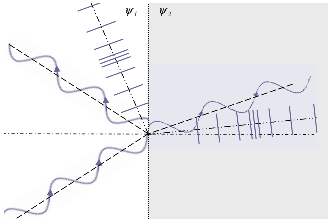
Research at the IAF – AE propagation

Theory

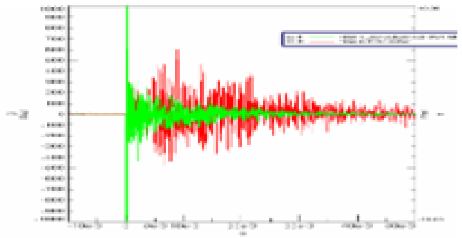
- Estimation of effects and variables



$$\sigma_{ij} = \frac{Gb}{2\pi\left(x_1^2 + x_2^2\right)} \begin{pmatrix} 0 & 0 & -x_2 \\ 0 & 0 & x_1 \\ -x_2 & x_1 & 0 \end{pmatrix}$$

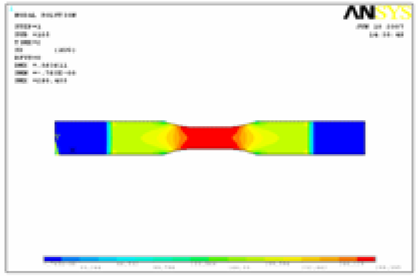
Test

- Test of components and vehicles
- Structural analysis
- Benchmark of car bodies and designs
- Validation tests



Simulation

- Collateral simulations
- Development of new, adapted simulation methods



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Research at the IAF – AE generation

Analysis of Deformation

- Deformation zone within RTTF
- Deformation characteristics
- Identification of crack-propagation characteristics

Analysis of Materials

- Specific AE power
- Fracture tendency and influence of velocity

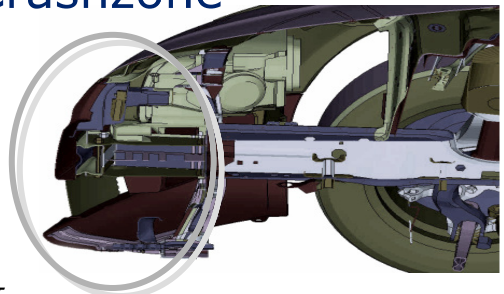
Estimation of AE

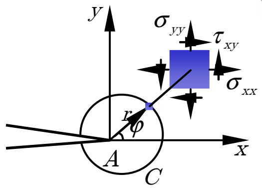
- Calculation from deformation and specific AE power

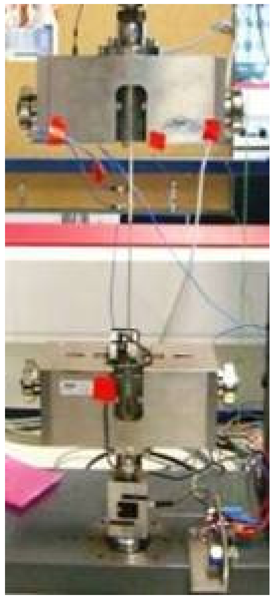
Methods

- Tensile tests
- FEM-Crash-Simulations
- Trolley tests
- Crashtest data
- Analytical studies

Crashzone

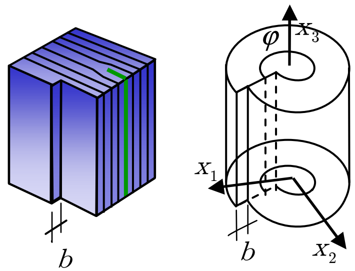




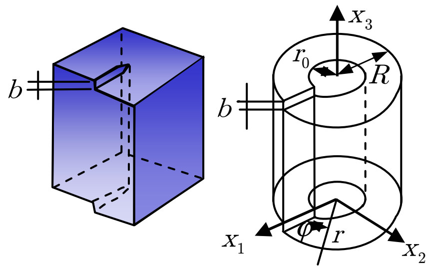


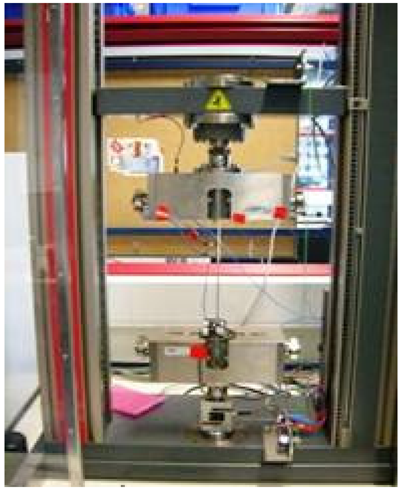
Example: Investigation of AE-generation by microscopic effects

Edge dislocation



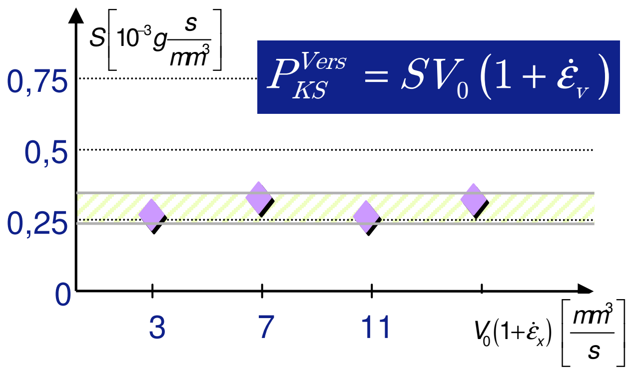
Screw dislocation



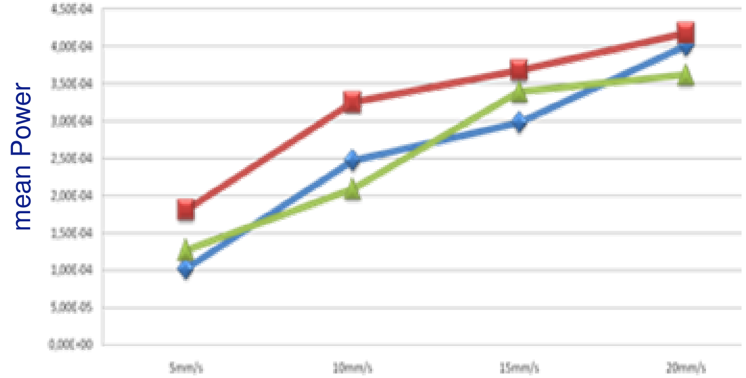


- Dislocations: Imperfections of atomic lattice
- Acoustic Emission proportional to strain-rate

Specific AE Power



Power from plastic deformation 6-20kHz



Conclusion and outlook

- Structure-borne sound: additional physical effect for crash detection
- Up to 50% faster firing times with CISS
- Development of CISS required extensive analysis and testing of generation and propagation characteristics
- SOP in 2008

Next Steps

- Improvement of side crash detection with CISS
- active CISS

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Thank you for your attention!

Source: Continental