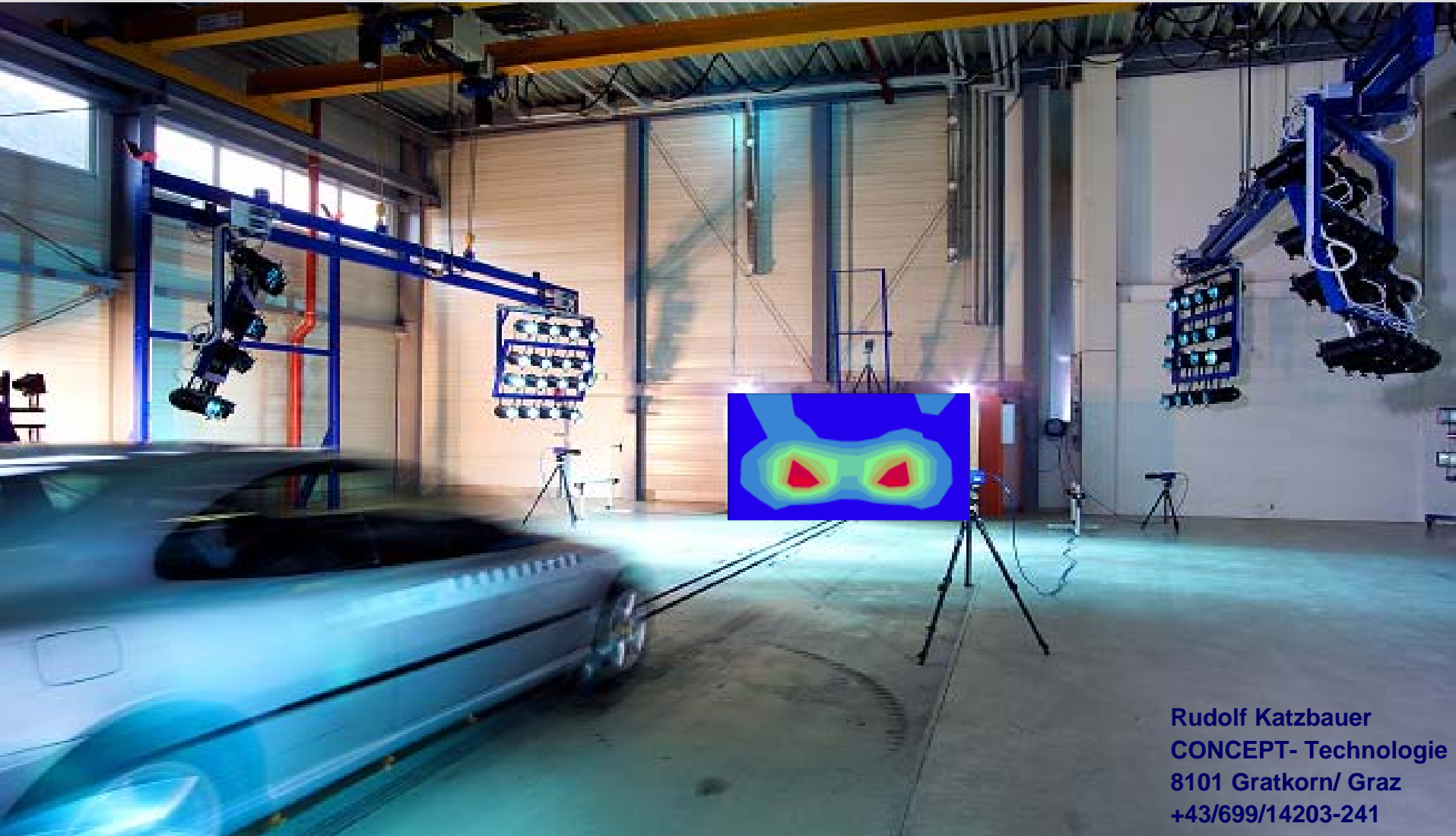


Testing Expo- Stuttgart 2005

Magnetostriktive Measurement Method with Load Cell Walls



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From User for User

CONCEPT- TECHNOLOGIE Introduction

**Design
Simulation**

**Testing
Test Bench Development**



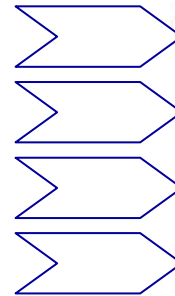
Current Compatibility Issues David against Goliath

Structural Interaction

Stiffness matching

Passenger compartment strength

Mass ratio



Fork effect

Intrusion

Intrusion

$$m_1 \cdot v_1 = m_2 \cdot v_2$$



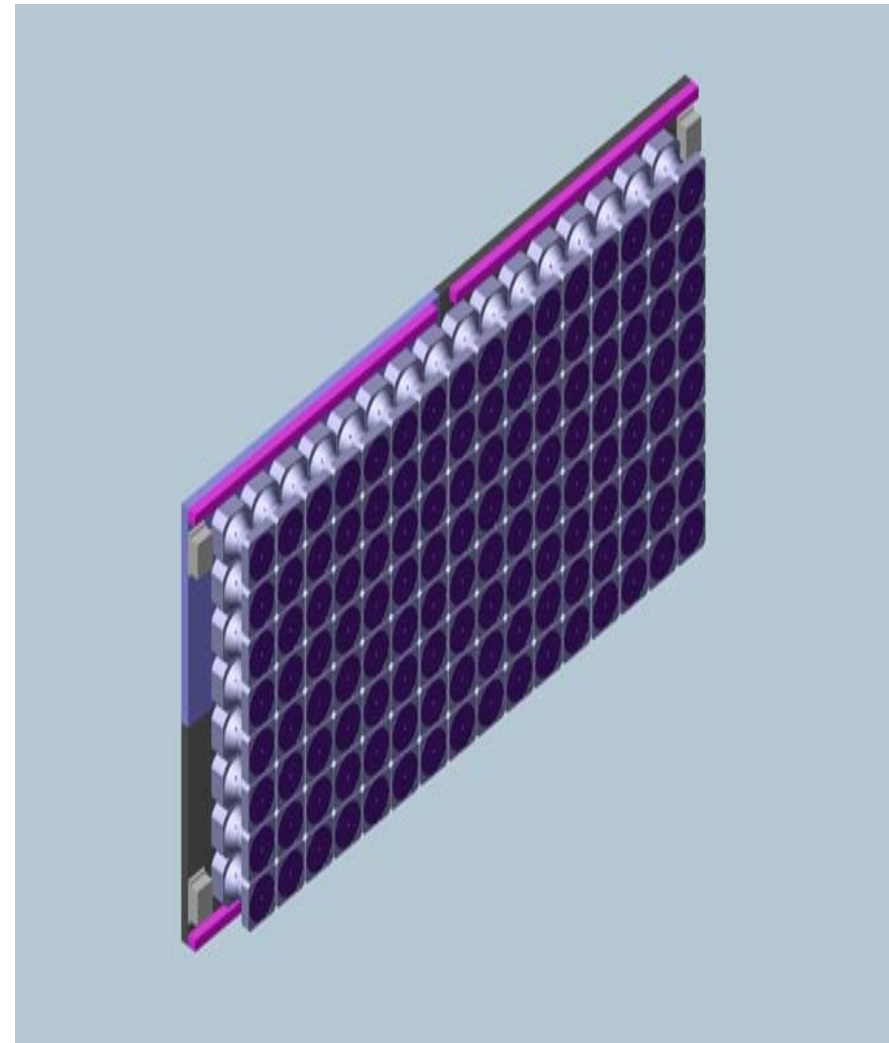
Compatibility is a balance between vehicle Aggressivity and Vulnerability

Picture with allowness from ADAC

Function Description

The CONCEPT- Technologie magnetostriction unique high dynamic Load Cell Wall is designed for 2- dimension measurement of force distribution useable for uni-axial and tri- axial measurement regarding SAE J211 as well.

Basically it provides a qualitatively visualizing of force distribution of different vehicle front ends due to high sampling rate.



Load Cell Barrier Customer Requirements

- ⇒ Visualising of forces in different areas
- ⇒ Force crashtime history
- ⇒ Separate measuring of force- vectors
- ⇒ High load- resolution for Airbag tests
- ⇒ Light weight sensor for mobile barriers
- ⇒ High measurement repeatability
- ⇒ High Natural Frequency
- ⇒ Small failure in eccentricity
- ⇒ Saving on investment costs
- ⇒ Long life span less calibrating necessary
- ⇒ Assessing of deformable barriers





CONCEPT- Load Cell Wall

How Do You Benefit ?

- **Easy to gain simulation data** due to optional 3- dimensional measurement.
- **Cost saving** due to the **easy modular enlargement opportunity** from a one up to three axial sensors.
- **Higher force- time resolution** is provided due to a very high sampling rate of 20kHz
- **Easy useable on moveable barriers** due to light weight sensors < 3 kg for rear and side crashes.
- **High reproducible measuring results** due to low **non- linearity of <0,1%** and low **repeatability error of 0,02% fs** .
- **Higher measurement bandwidth** is guaranteed due to high Natural Frequency of >4 kHz caused by higher stiffness and low mass.

$$\omega_n = \sqrt{\frac{D}{m}} = 2.\pi.f_n$$



CONCEPT- Load Cell Wall

How Do You Benefit ?

- **Very low eccentricity failure due to special system design guarantees true values across the whole surface.**
- **Resistant to dirt, humidity (98%), temperature (70%) and dust due to particular hermetic design. (No random vibration)**
- **Wear- and maintenance- free** due to robust steel design with nitrided steel front plates and non contact measurement system.



Technical Insight

| | |
|---|--|
| Segment Size: [mm] | 125 x 125 x 120 (up to 208 pc.) |
| Assembly mass 2: | ca. 3 with integrated milled head plate |
| capacity X- axis: [kN] | 210 (max. 420), |
| Capacity (Y, Z)- axis: [kN] | 110 |
| Non- linearity: [% fs] | < 0,1 |
| Eccentricity: [% fs] | < 0,5 |
| Hysteresis [% fs] | < 0,75 |
| Temperature: [°C] | -20 +70 (calibration temp. 22 ± 1) |
| Matter head plate: | nitrided steel |
| Output voltage [V] | 0..5 / linearized |
| Repeatability Error [% fs] | < 0,02 |
| Crosstalk [% fs] | typical < 1 |
| Sampling rate [kHz] | 20 p. channel(16 bit) |
| Natural mechanic frequency [kHz] | > 4 kHz |
| Protection category | IP 68 |

What's the Magnetostruktive Sensors' task ?

Primary Sensor- Sensor HOST (SH)

Ferromagnetic steel 14CrNi 14

Magnetically encoded region

Converts physical stress into changes of magnetic signature

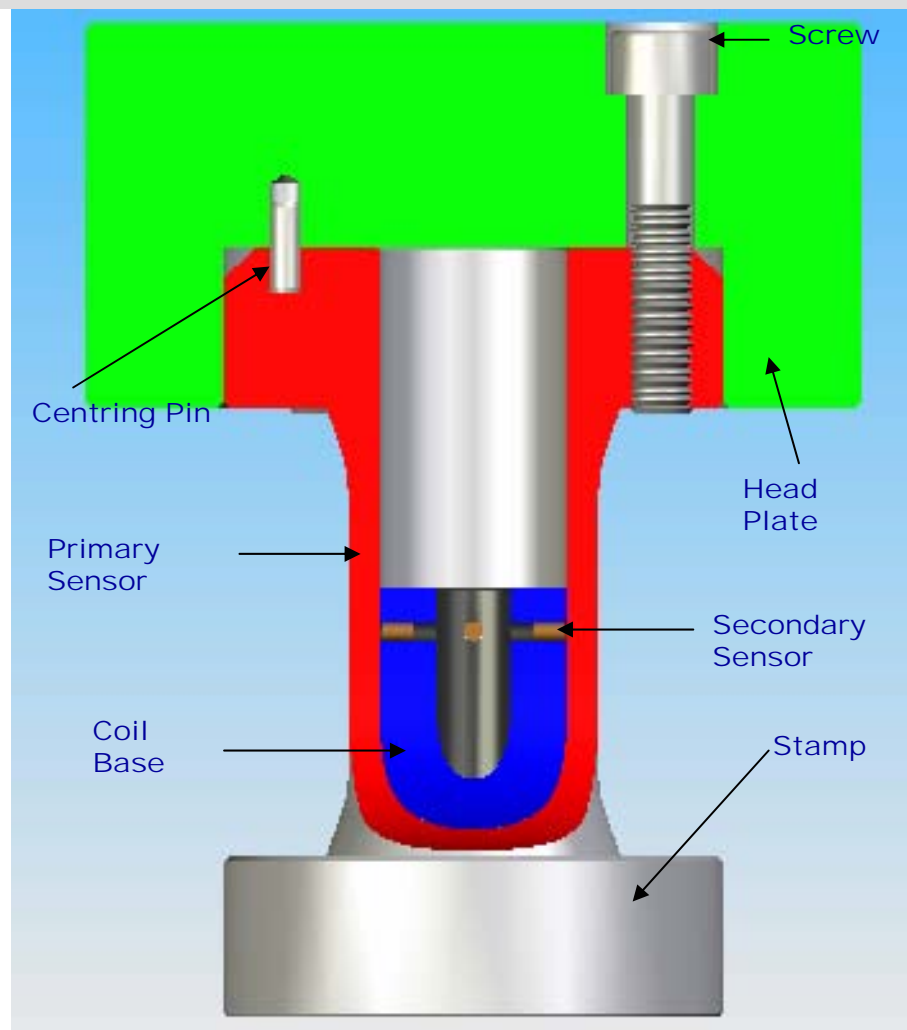
Secondary Sensor (MFS)



Coil diameter 0,08 mm

Contactless measurement

Converts changes of magnetic fields into electrical signal



What's the effect of Magnetostriction

Magnetostriction Effect

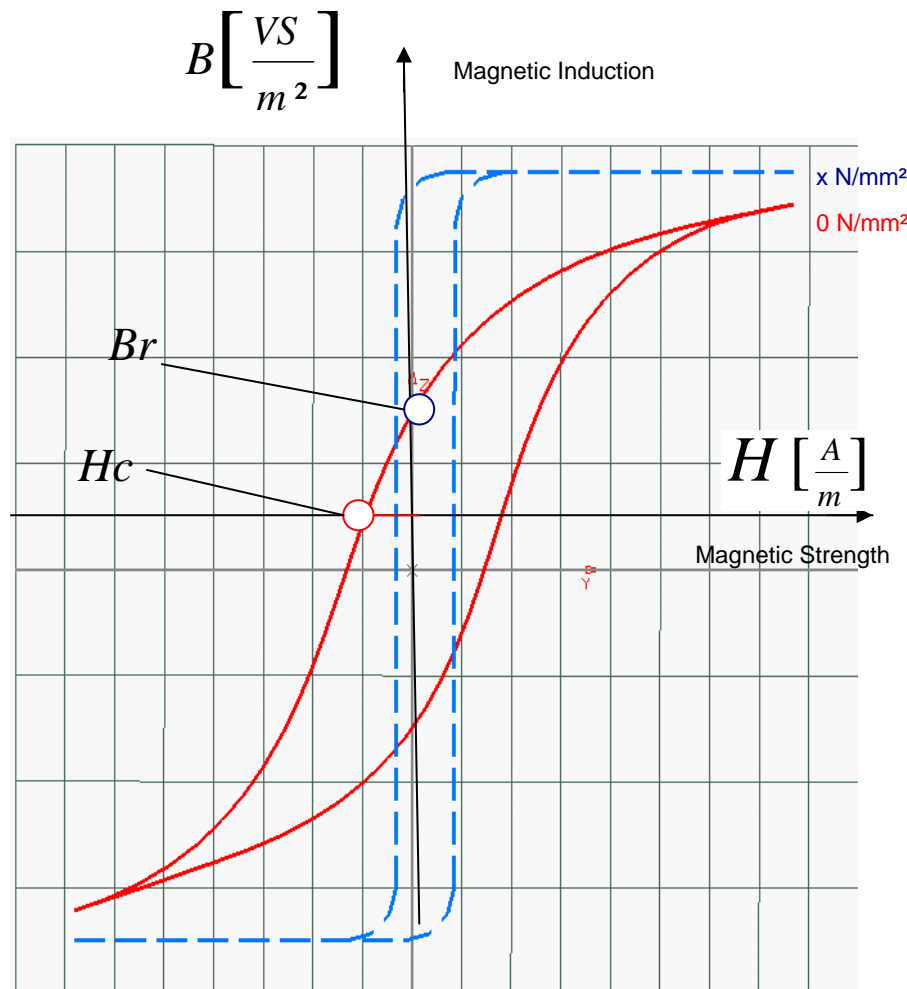
$$\mathcal{E} = \frac{\Delta l}{l} = d \cdot H + e \cdot \sigma$$

Magnetoelastic Effect

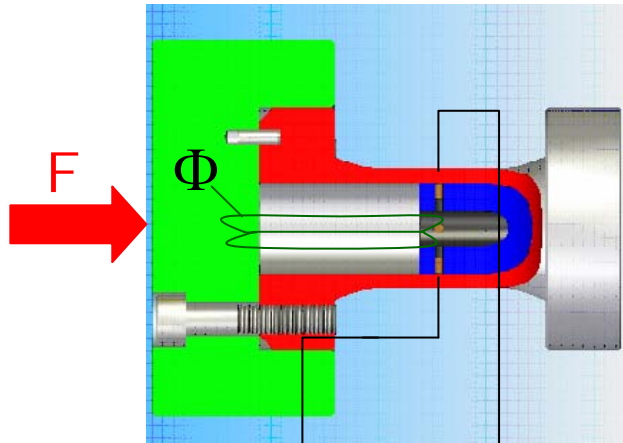
$$B = d \cdot \sigma + \mu \cdot H$$

- Interaction between mechanic and magnetism
- Villary Effect is used as a method of detection
- Diameter an length are alternating

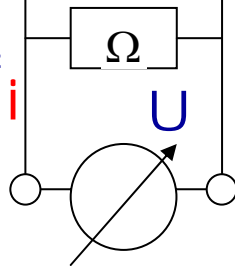
Hysteresis Cycle



How is the measurement done?



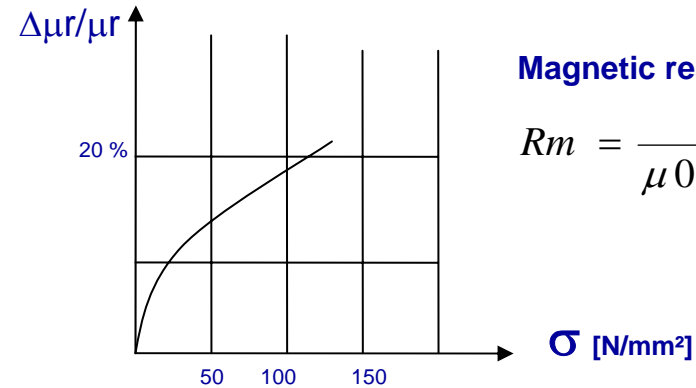
Current impulse is sent



Electric Voltage

$$U_{Mess} = N \times \frac{\delta\Phi}{\delta t}$$

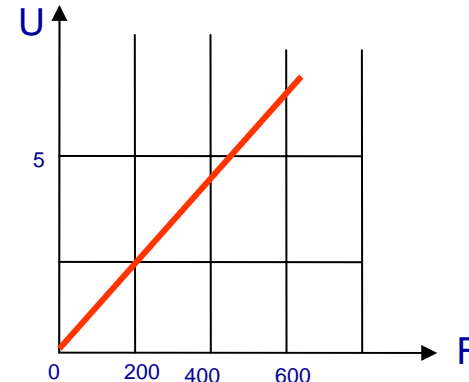
Permeability- Tension



Magnetic resistance

$$R_m = \frac{l}{\mu_0 \cdot \mu_r \cdot A} [1 / H]$$

Linearization of Voltage- Force Ratio





Applications of Load Cell Walls

Full Frontal Barrier test with Load Cell

rigid wall with or without deformable elements

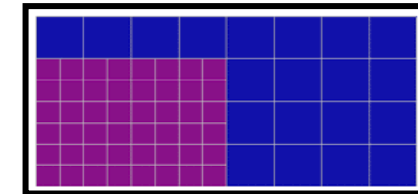
40% ODB 48 cells [125x125]



Offset Deformable Barrier (ODB) with Load Cells

Passenger Compartment Integrity Test Using (ODB)

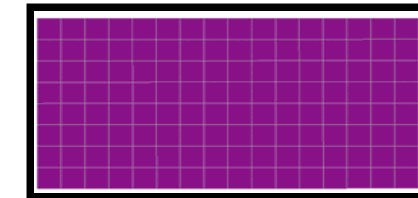
48 cells [125x125] and 20 cells [250x250]



Progressive Deformable Barrier (PDB)

Moving Deformable Barrier

0 % ODB 128 cells [125x125]



Applied crash loads are different !

Test example:

128 pc 125x125 load cells, 16x8 matrix,
100% ODB, 1.150 displacement

Peak Force on the LCW e.g. 440 kN

Peak Force of 1 single cell e.g. 120 kN

Peak Force in compartment e.g. 300 kN

Current state of Dimension:

Load Cell face dim. 125x125 mm

Load cell length 120 mm



Estimated loads with moveable Load Cells

ECE R95
950 kg
50 km/h

FMVSS 214
1.368 kg
54 km/h

Displacement ca. 300 mm
16 Load Cells

$$F_{tot} / n = F_{(Loadcell)}$$

$$\frac{m.v^2}{2} = F.s \Rightarrow F = \frac{m.v^2}{s}$$

F_{max.} per Load Cell = approx 64 kN



Concept provides the whole barrier with integrated LCW



Always a step ahead !
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