

Forum „Innovations for Industry“

# Energy Transmission for Wireless Sensor Systems

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# Overview

- **Introduction of Fraunhofer ENAS**
- **Typical Sensor Applications**
- **Wireless Energy Sources**
- **Reference Applications**
- **Summary**

# Fraunhofer ENAS – University Cooperations

ENAS/ZfM, Chemnitz



ENAS-ASE/  
University of Paderborn

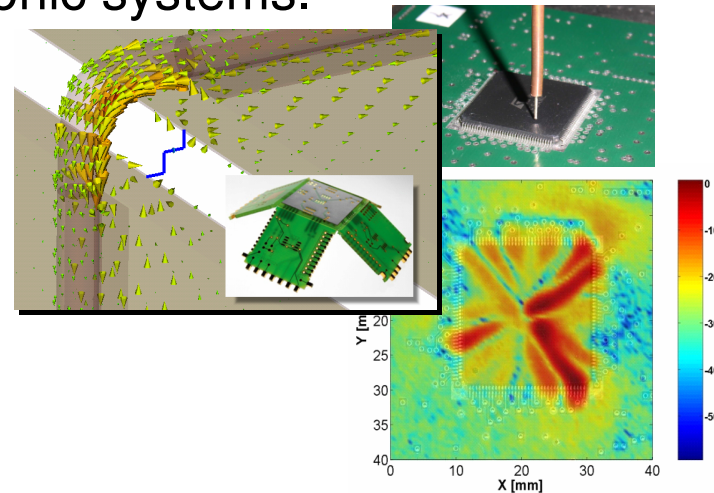


# Fraunhofer ENAS Advanced System Engineering

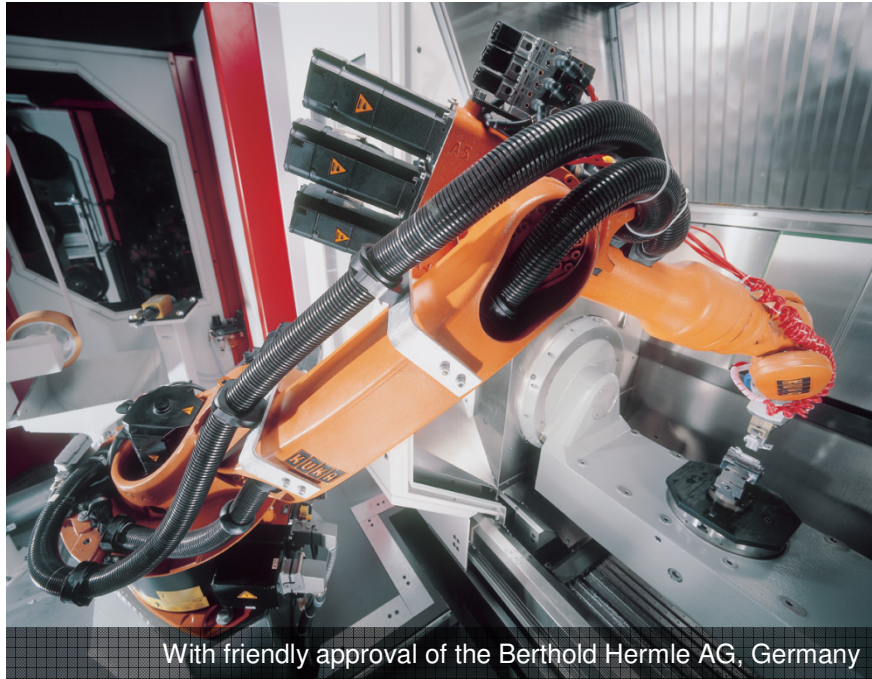
The department Advanced System Engineering located in Paderborn unites research and development for design, simulation and characterisation of micro and nano electronic systems.

## Main Skills:

- Intelligent Mobile Wireless Sensors
- RFID Antennas and Circuits
- Modelling of EMC and SI/PI Effects
- EMC/EMR of micro- and nano-elektronic Systems
- Nearfield Measurements
- Model-based Development Methods for heterogenes Systems

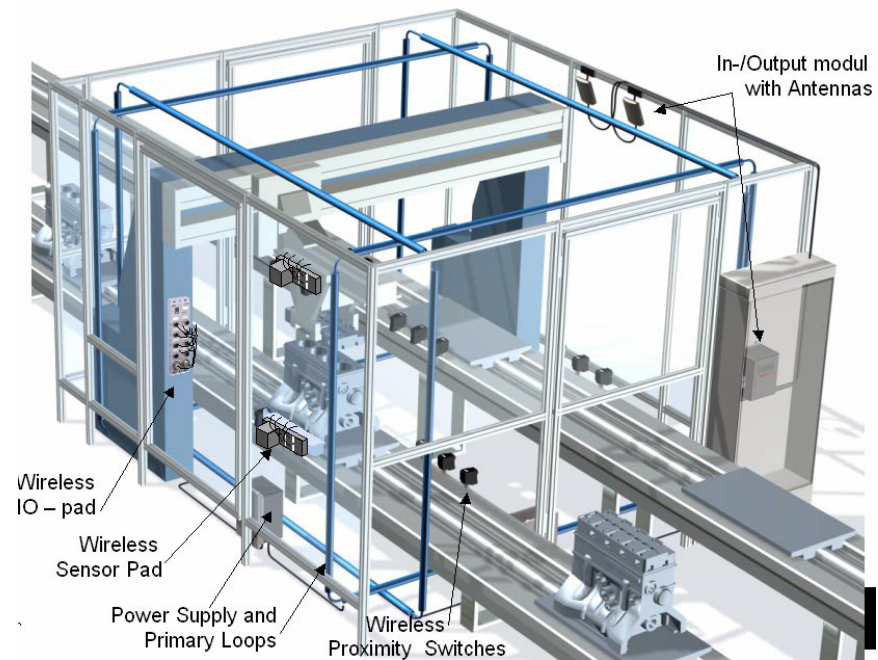


# Sensor Application: Wireless Automation Control



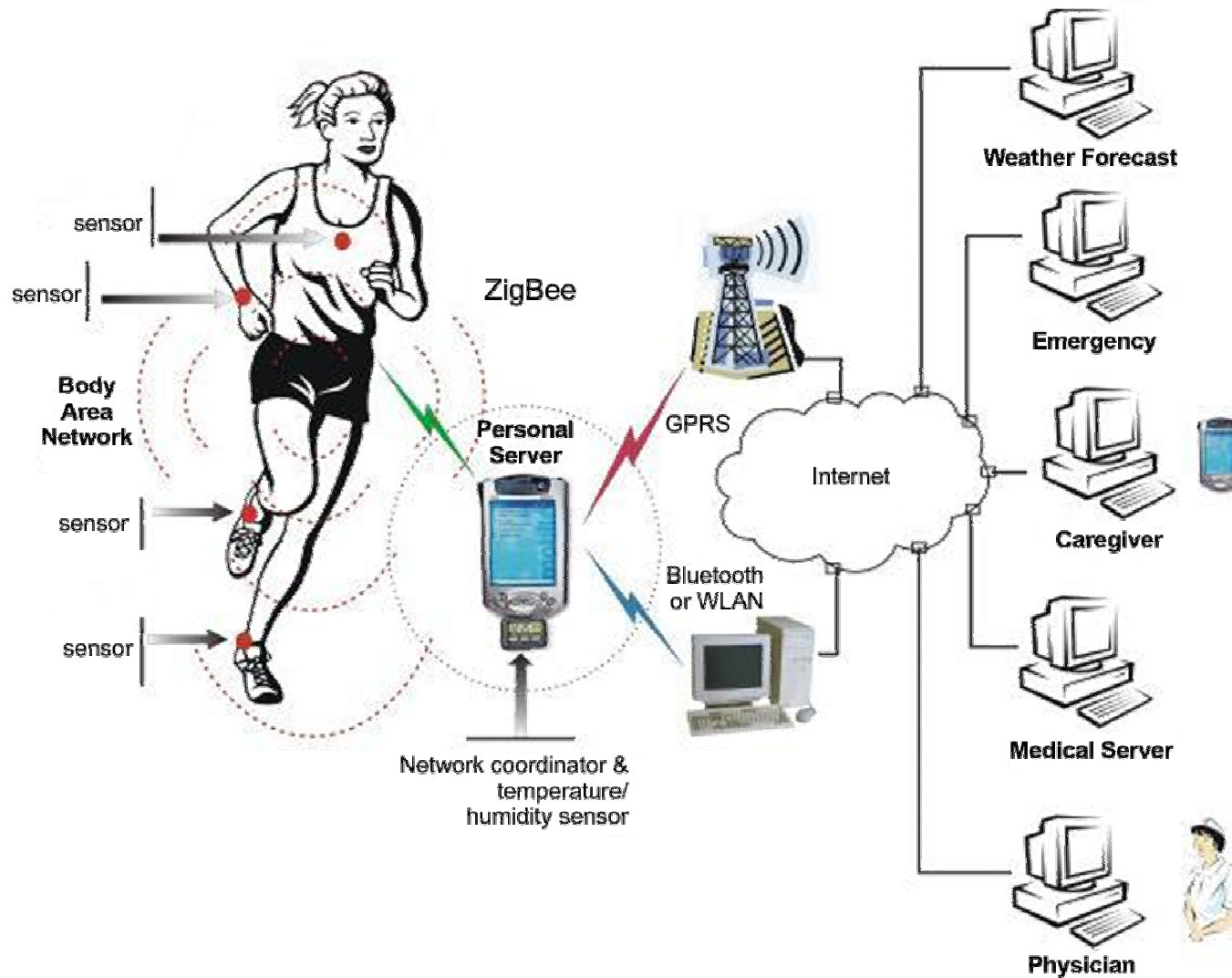
Industry robot with wired sensoric

Wireless sensor devices installed in a typical robot type production-cell (27 m<sup>3</sup>)

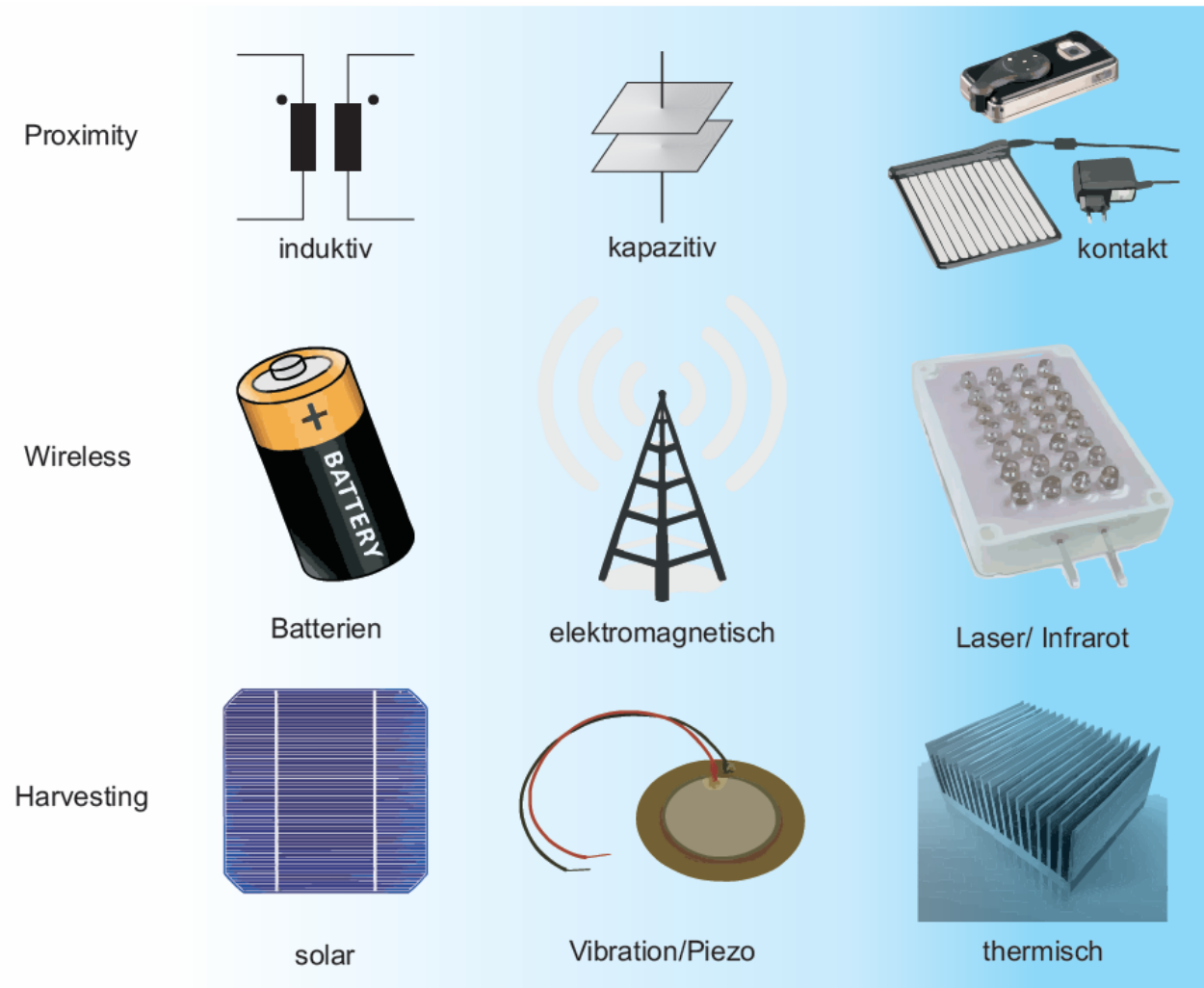


Reference: Introduction to WISA - Wireless Interface for Sensors and Actuators  
ABB, V2.0, July 2006

# Sensor Application: Body Area Network



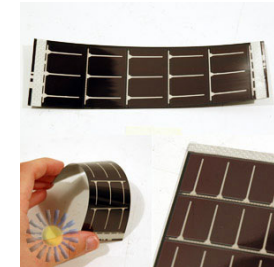
# Overview Energy Sources for mobile Devices



# Energy Harvesting: Typical Sources

## Solar Cell

- In interiors mostly only low lighting  $< 1.000 \text{ lx}$
- In outdoor environment big potential
- Container surveillance: Containers mostly located outdoors, lighting  $> 2.000 \text{ lx}$ , but mechanically high load, shadowing effects based on stacked containers



Flexible Solar cell  
0,7g, 24cm<sup>2</sup>



Thermo Generator  
25 mg, 8,44 cm<sup>2</sup>



Vibration generator  
289 g, 133 cm<sup>3</sup>

## Thermoelectric Generator

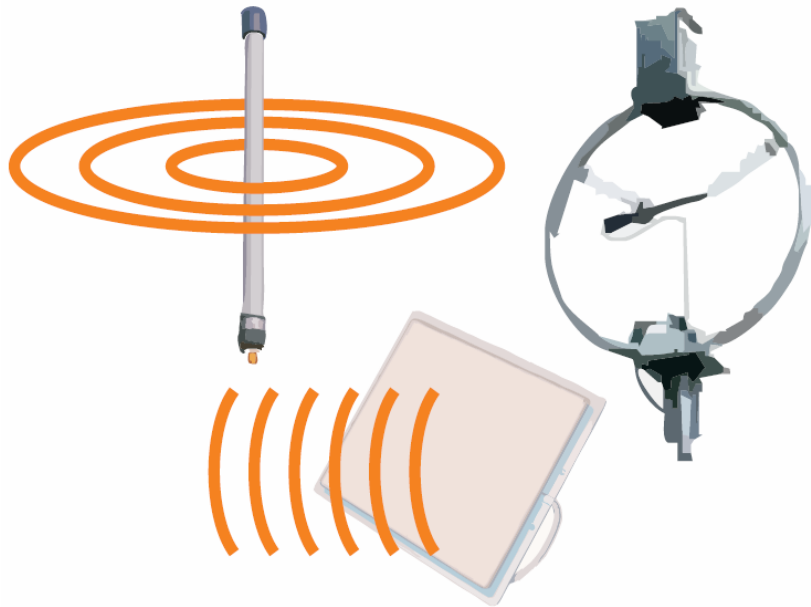
- Significant temperature difference needed
- Application at human body reasonable (difference temperature body/air 10-15K)
- hardly reasonable for Cargo applications, because only low temperature difference

## Vibration Generator

- Rotating machines:  
high Vibration of fixed frequency (up to 0,7 g)



# Wireless Power Supply: Electromagnetic Coupling



Electromagnetic Waves transport the energy!

## Advantages

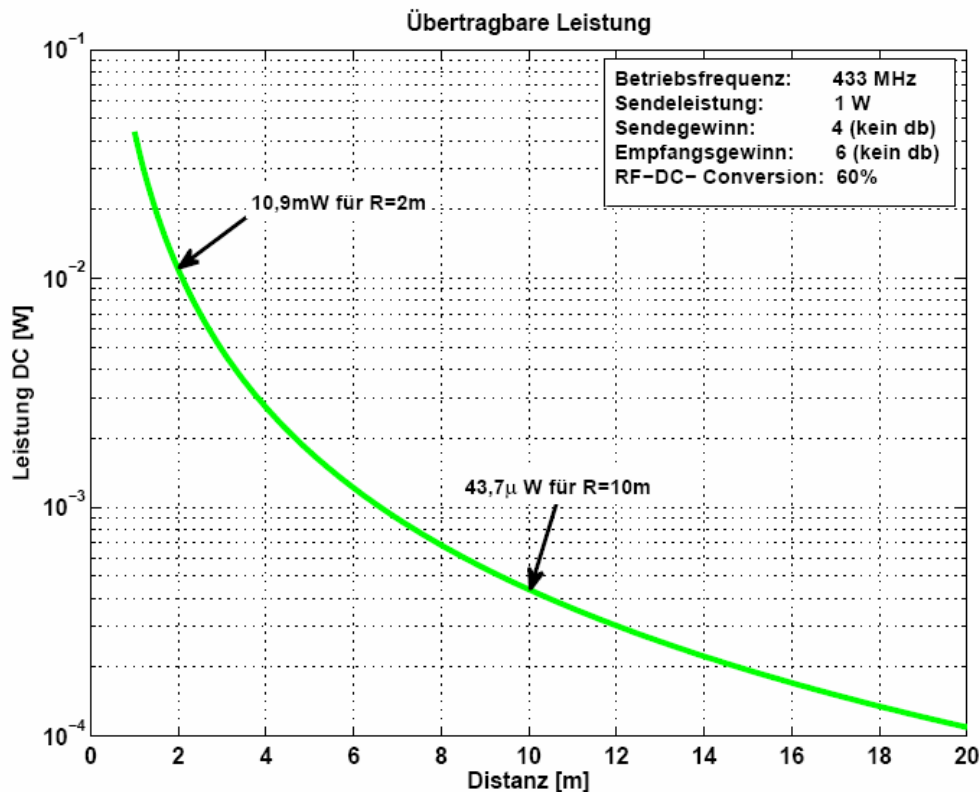
- High reach
- Existing antenna can be used
- Small dimensions

## Disadvantages

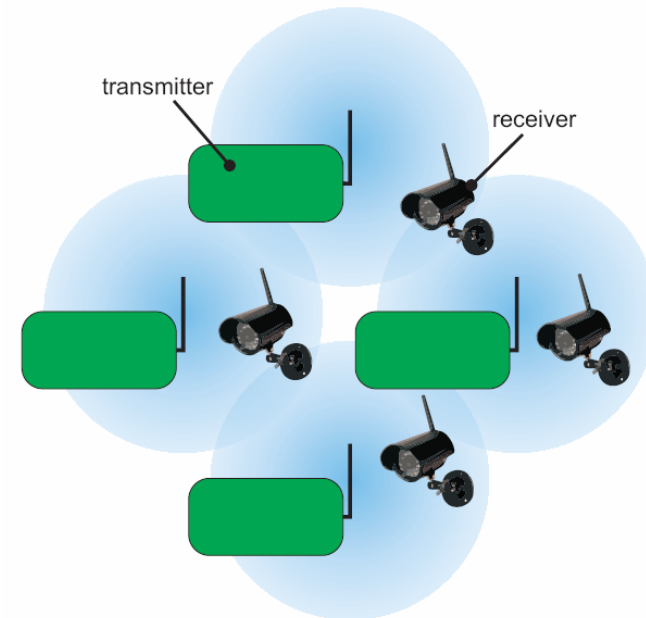
- Very bad efficiency in free environment
- Restrictive standards for high frequencies
- Energy will be transmitted independently of the load

# Wireless Power Supply: Electromagnetic Coupling

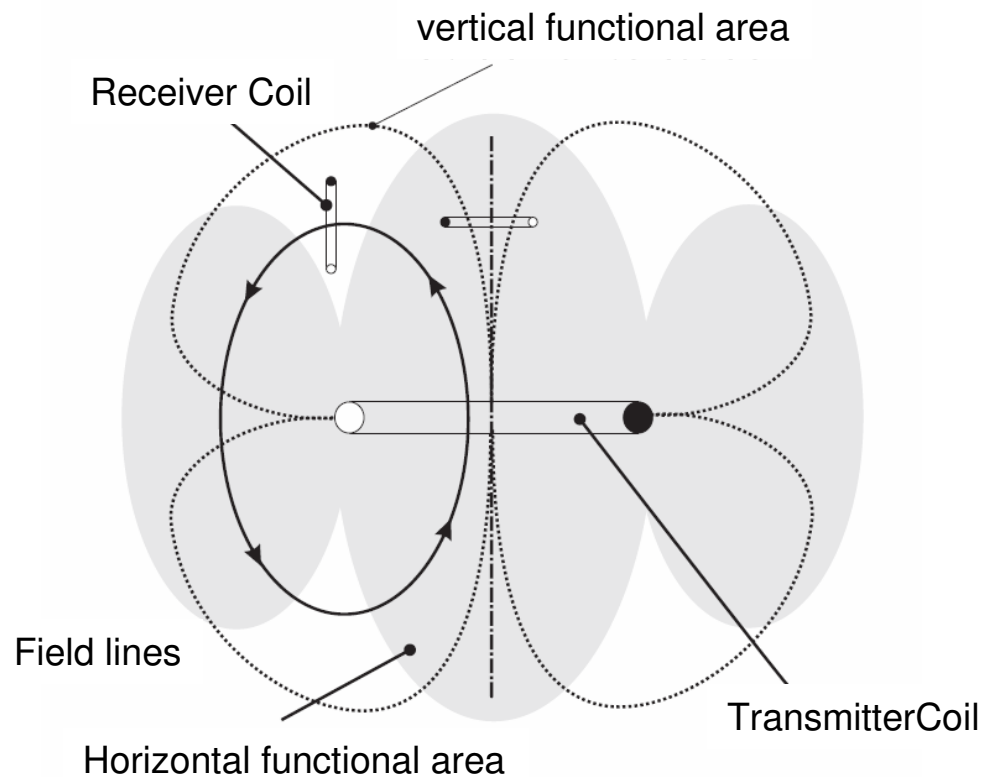
## Calculation Example



An optimum illumination of the functional area is better to be reached by many distributed transmitters, than by only one strong.



# Wireless Power Supply: Inductive Coupling



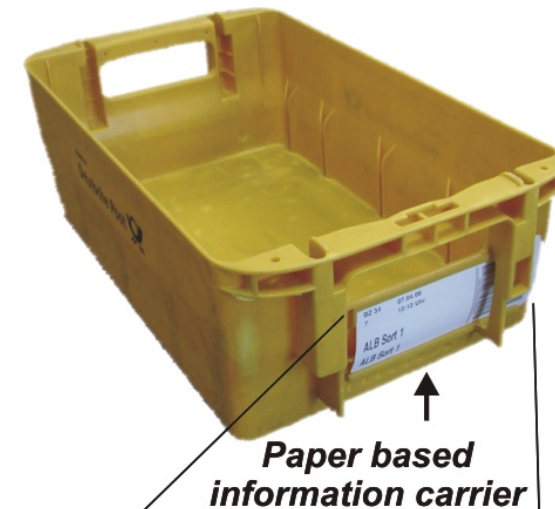
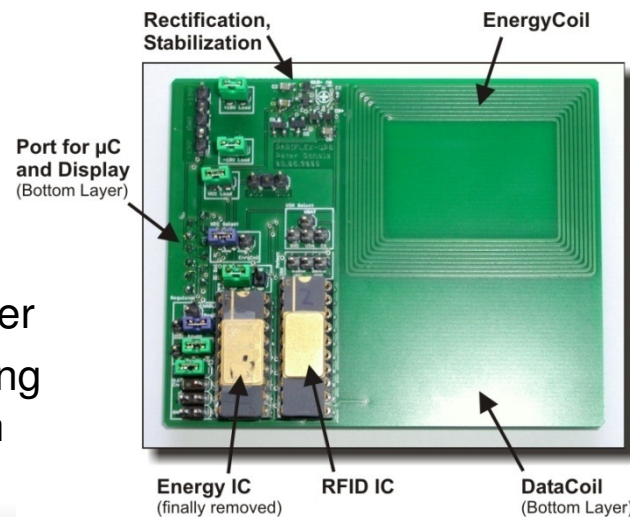
## Functional Area

- An inductive coupling is bound to a precise adjustment of the antenna coils
- The functional area for the vertical adjustment of the antenna differs from the horizontal adjustment
- Magnetic field lines are always closed

# Reference Applications

## RFID Label with bistable Display (PARIFLEX)

- Inductive Energy Transfer
  - Transfer of 80 mW to the Label
  - Various Orientations, Range: up to 5 cm
- Antenna Design
  - Optimisation of Energy and Data Transfer
  - Decoupled Antennas for Energy and data transfer on the same Frequency
- Reader Design
  - Increased Output Power
  - Optimised Field coupling for minimised radiation



# Reference Applications

## Wireless Energy Transmission

### Magnetomotive Force (MMF)

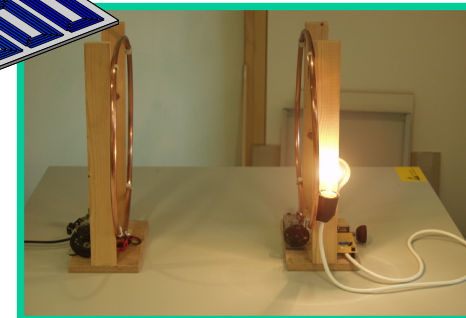
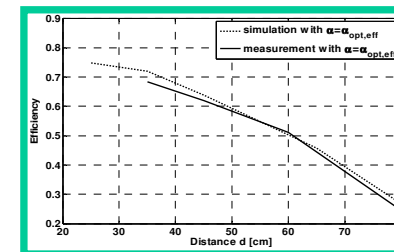
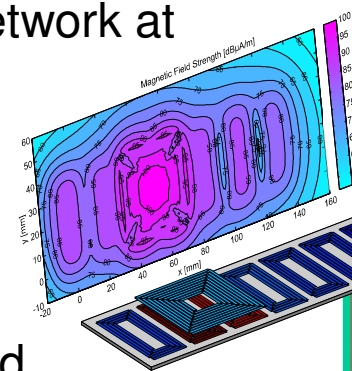
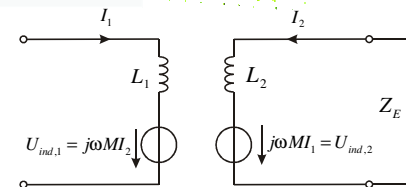
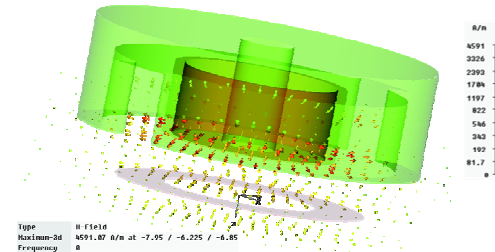
- Low electromagnetic emission
- Sensing of receiver possible: allows a “stand-by”-mode

### Antenna Design

- efficiency Optimized by a matching network at transmitter and receiver
- good efficiency can be achieved by higher operating frequency

### Measurement Setup

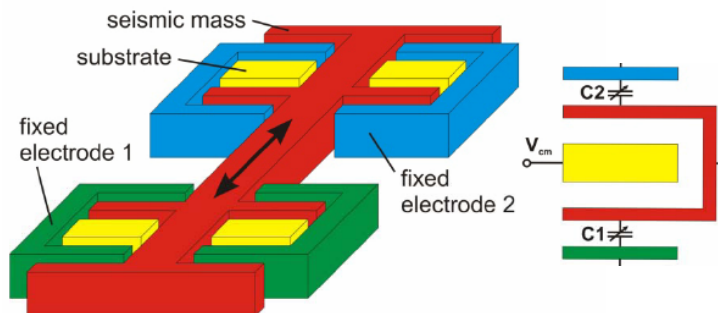
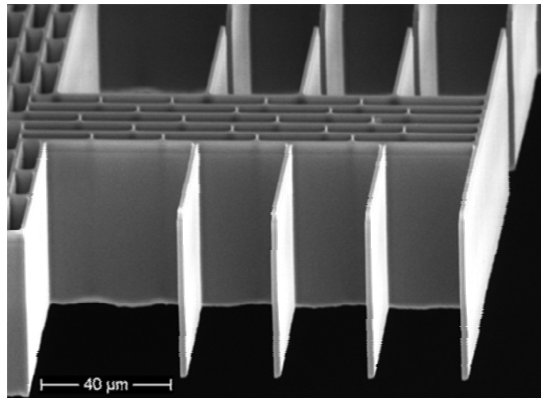
- Transmission of 15 W / 230 V to the load
- Operating range up to 120 cm
- ISM-frequency of 13.56 MHz



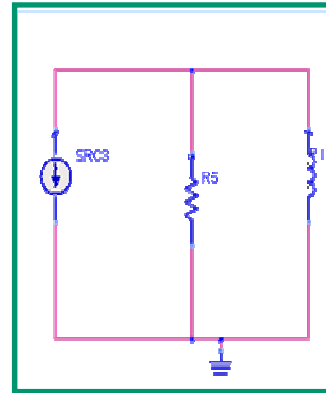
# Reference Applications

## Wireless Acceleration Sensor

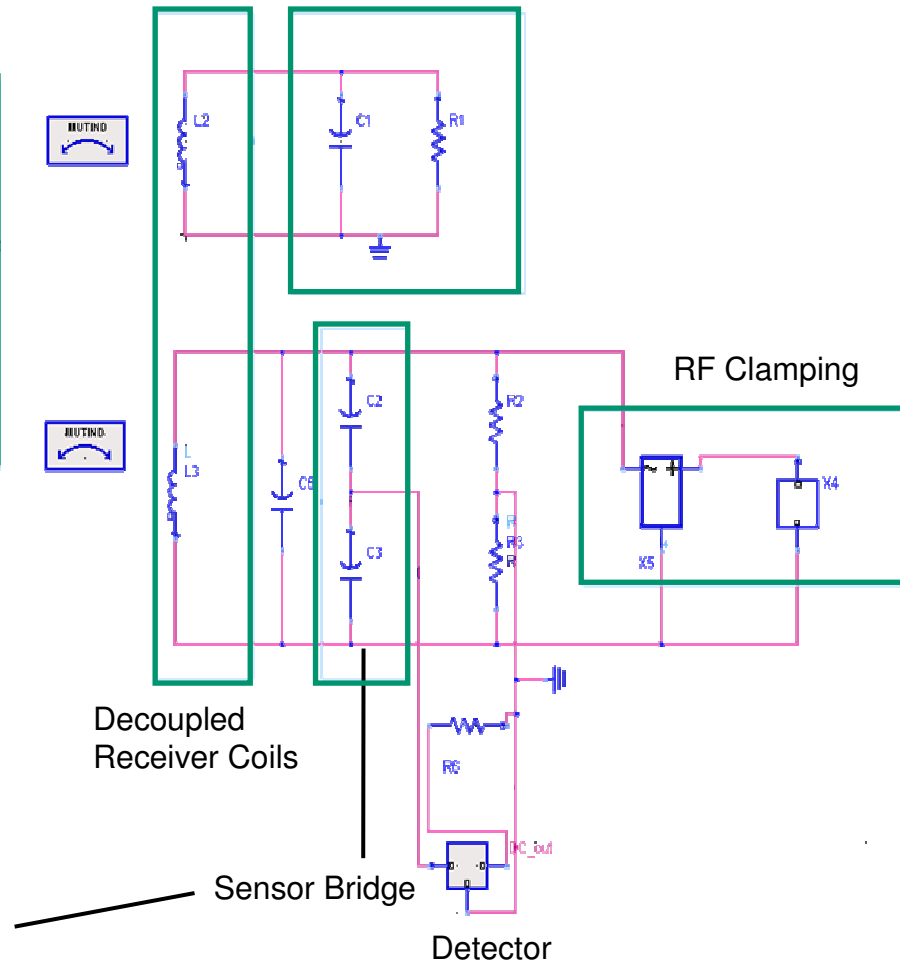
High Aspect Ratio Microstructure



Reader Model

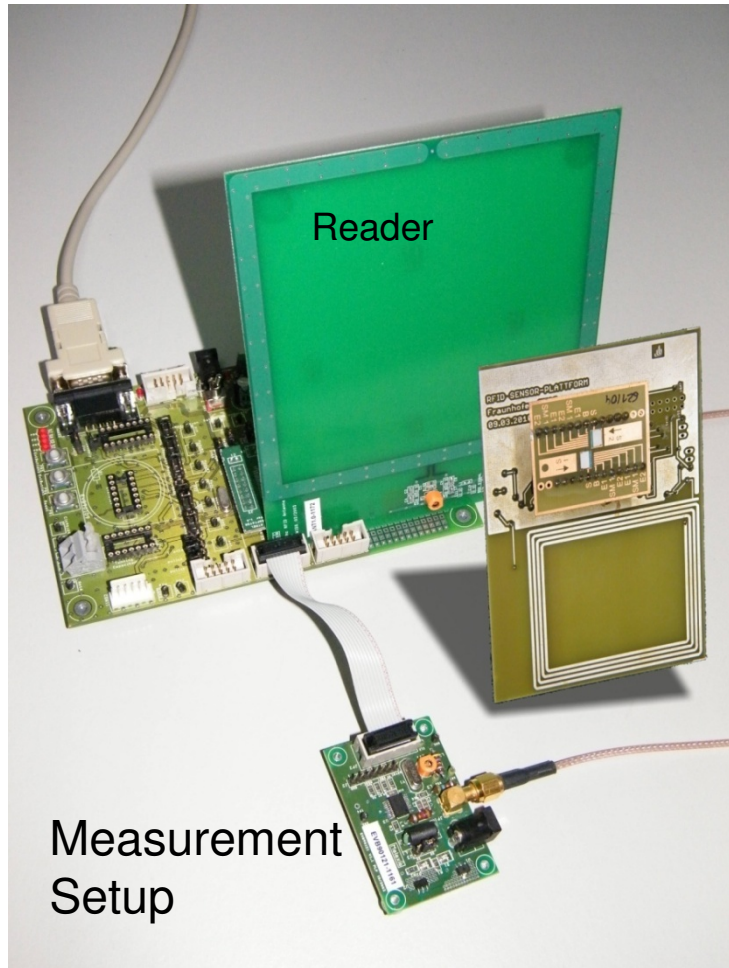


RFID Front End



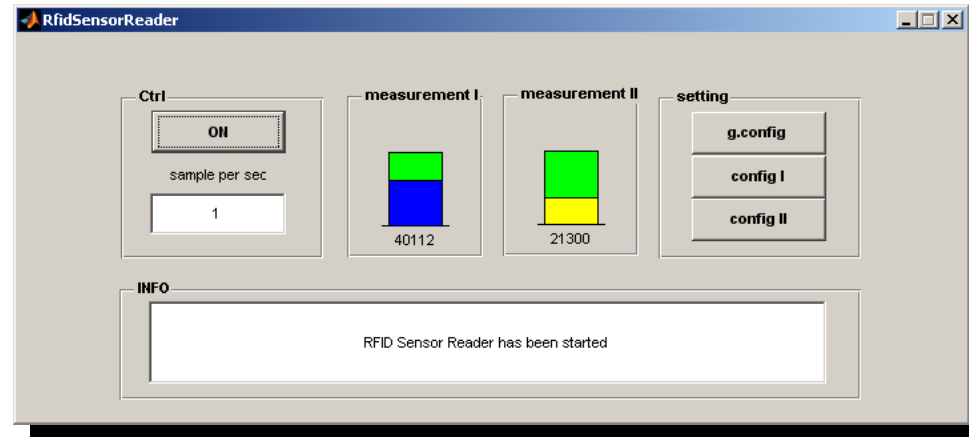
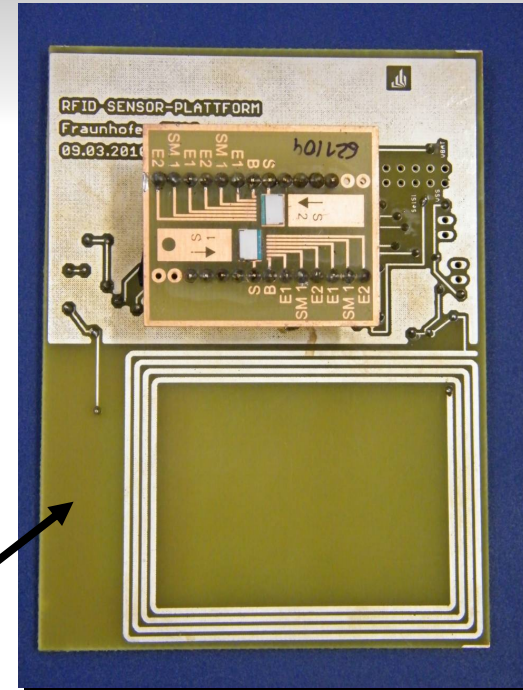
# Reference Applications

## Wireless Acceleration Sensor



Acceleration  
Sensor MEMS

Wireless Sensor  
Module



User Interface

## Summary and Conclusion

- **Wireless sensors are needed in a wide area of industrial and consumer applications**
- **While wireless data transfer is well known, the wireless energy supply is still an open task**
- **Energy harvesting could be an option for specific low power applications**
- **For most applications wireless energy sources are needed**
- **Further development is needed**



# Thank you for your attention!

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