



# IC1301 – WiPE

## Wireless Power Transmission for Sustainable Electronics

### RFID Technologies and Applications at the Graz University of Technology

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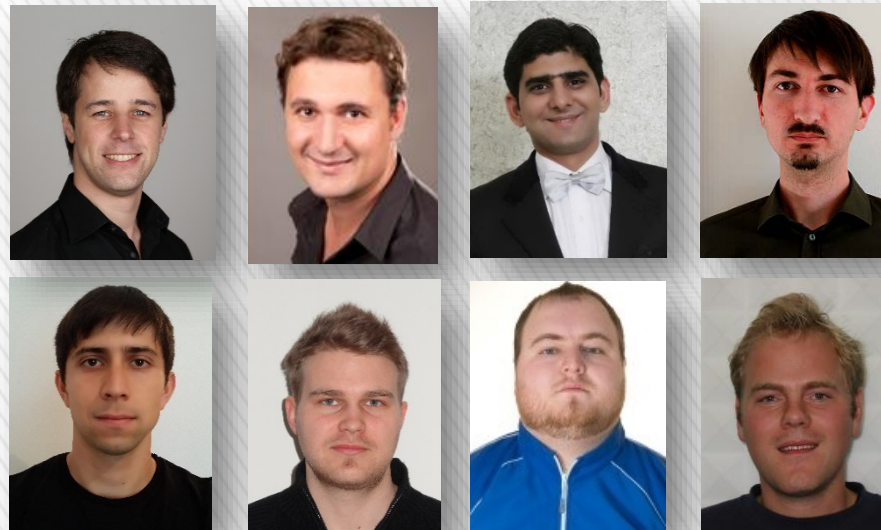
# RFID Technologies Group

## » Team

- > Prof. Wolfgang Bösch and Dr. Jasmin Grosinger

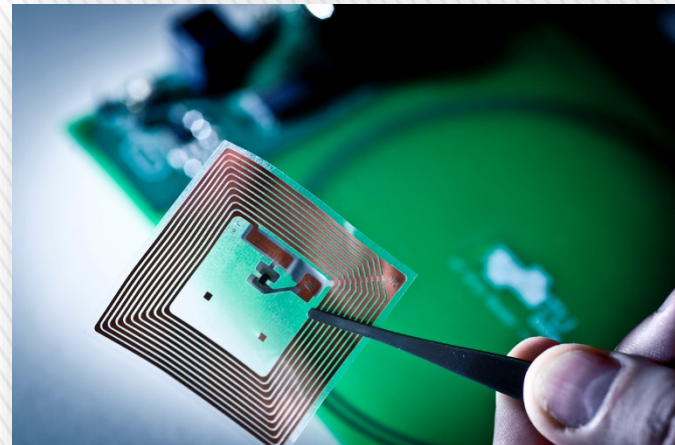


- > Seven predocs and one Master student closely related to industry



# RFID Technologies and Applications

- » Radio frequency identification (RFID) technologies at high frequencies (HF) and ultra high frequencies (UHF)
  - > Reader design
  - > Transponder (tag) design
  - > Radio frequency (RF) communication system design
  
- » RFID applications
  - > Automotive systems
  - > Home appliances
  - > Health issues
  - > Environmental sensing applications

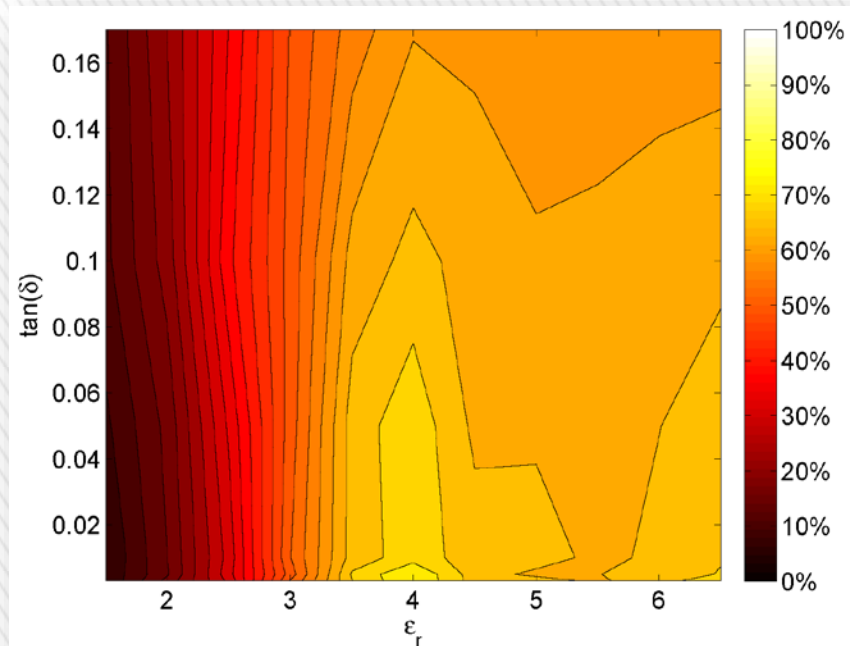


# Automotive Systems

## » RFID tag antenna design for car tire monitoring

- > Tire-specific antenna design to account for varying detuning effects
- > Broadband T-matched dipole antenna
  - + Power transmission coefficient of  $\tau=63\%$  at 864MHz, bandwidth of  $B_{\tau \geq 60\%} = 200\text{MHz}$

Power transmission coefficient



$\epsilon_r$  ... relative permittivity  
 $\tan(\delta)$  ... loss tangent

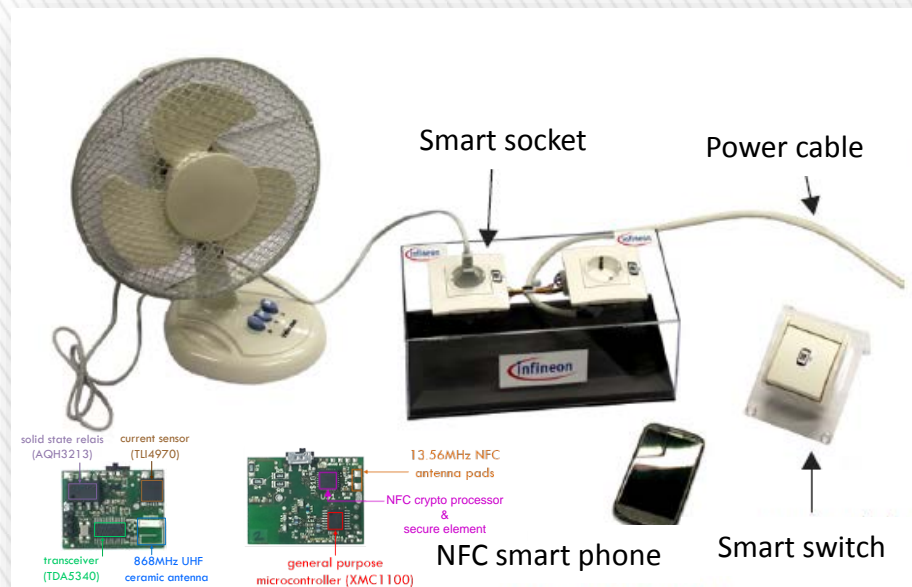


# Home Appliances

## » Smart RFID technologies for a connected world

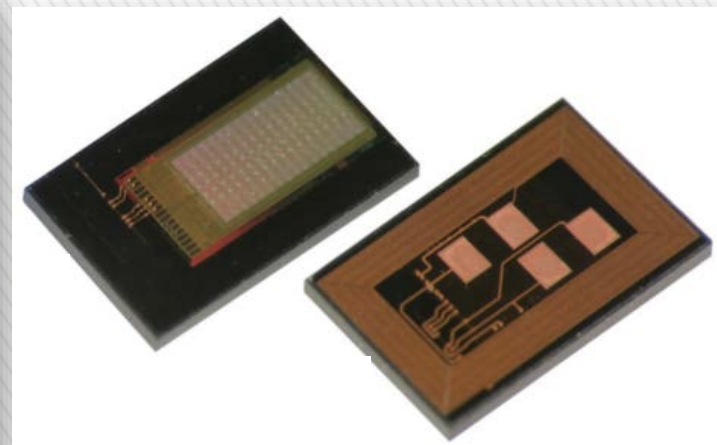
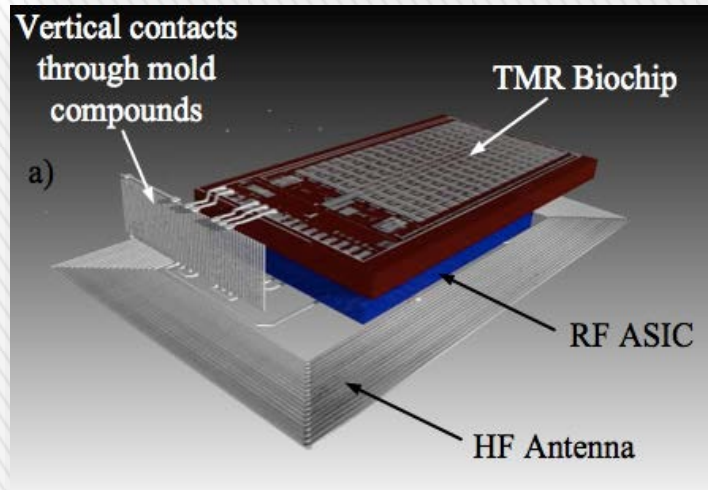
- > Near field communication (NFC) enhanced wireless sensor network node for a smart home demonstrator
  - + NFC link at 13.56MHz for device pairing (system configuration)
  - + Active UHF link at 868MHz for current sensor data transmission (energy metering)

Smart home demonstrator



# Health Issues

- » RF powered sensor grain for micro labs
  - > 3D embedded wafer-level ball grid array (eWLB) system in package (SiP) sensor grain
    - + HF RFID for wireless energy and data transfer at 13.65MHz
    - + Size of eWLB SiP: (5.6x3.6x0.7)mm



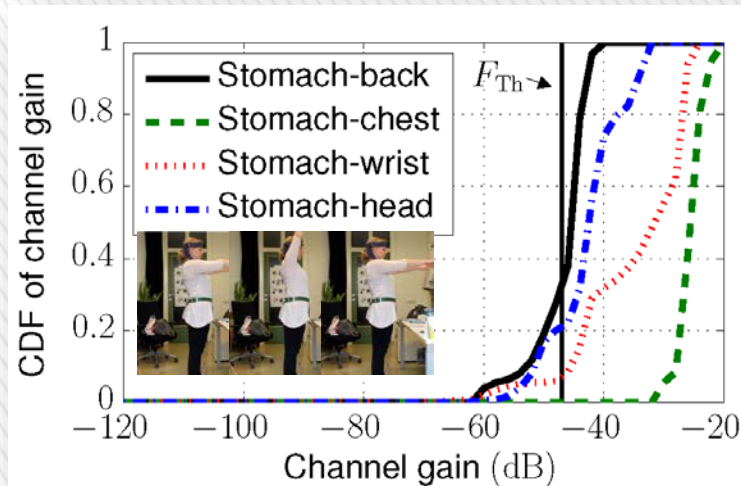
TMR ... tunnel magneto resistance  
 ASIC ... application-specific integrated circuit

# Health Issues

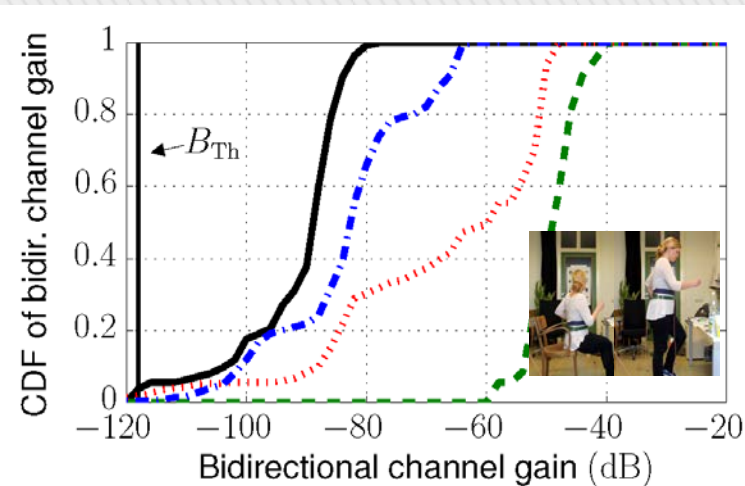
## » On-body RFID system for remote health monitoring

- > Performance of a passive ultra high frequency (UHF) RFID system based on outage probabilities
- > Forward link gain threshold of  $F_{Th} = -47\text{dB}$
- > Backward link gain threshold of  $B_{Th} = -118\text{dB}$

900MHz monopole reference antennas



900MHz monopole reference antennas

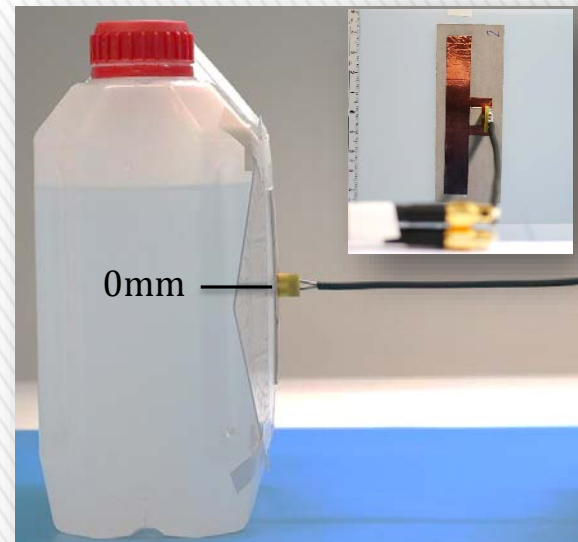
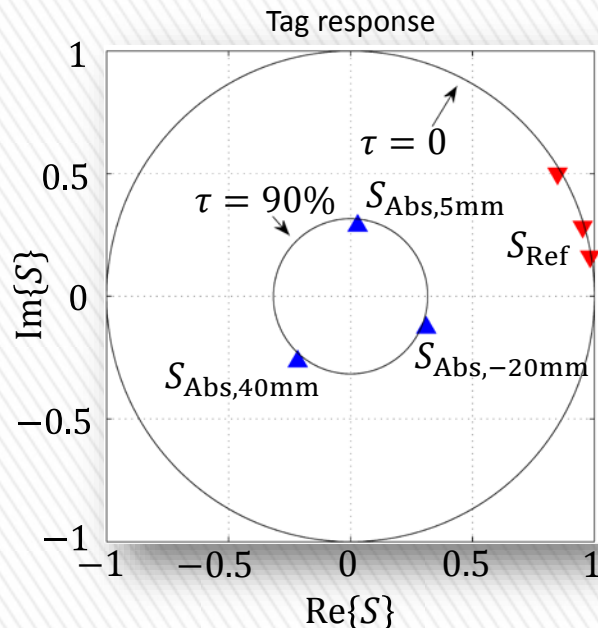


CDF ... cumulative distribution function

# Environmental Sensing Applications

## » Passive RFID sensor tag for liquid level sensing

- > Antenna transducer prototype: antenna acts as sensing element
  - + Sophisticated antenna impedance design to assure a high sensor performance
  - + Stable power supply to passive tag chip (power transmission coefficient of  $\tau \geq 90\%$  at 868MHz)

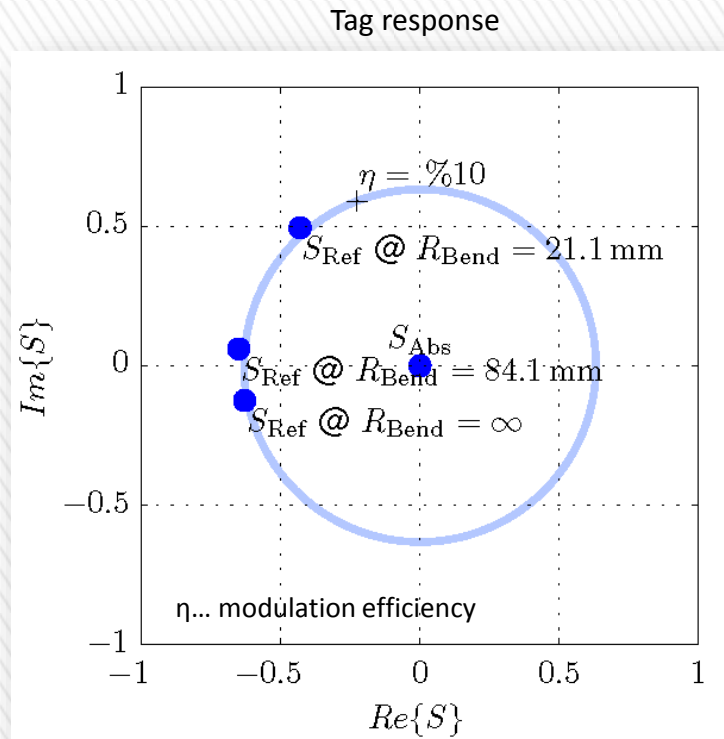


S ... reflection coefficients



## » Passive RFID sensor tag for curvature monitoring

- > Chip transducer prototype included in tag reflecting state  $S_{\text{Ref}}$
- > Stable power supply to passive tag chip (tag absorbing state:  $S_{\text{Abs}}$ )
- > Monitoring of three bend radii  $R_{\text{Bend}}$  at 5.8GHz



# Awards and Prices

- > 1st price of the Loughborough Antennas & Propagation Conference non-student paper competition, 2014
- > 2nd place of the IEEE RFID Technology and Applications Conference student contest, 2014
- > 1st prize of the “Fahrzeugverband Jubiläumstiftung” by the Industrial Union of the Austrian Automotive Industry, 2013
- > Winner of the International EURASIP Workshop on RFID Technology best paper award, 2012



# Teaching

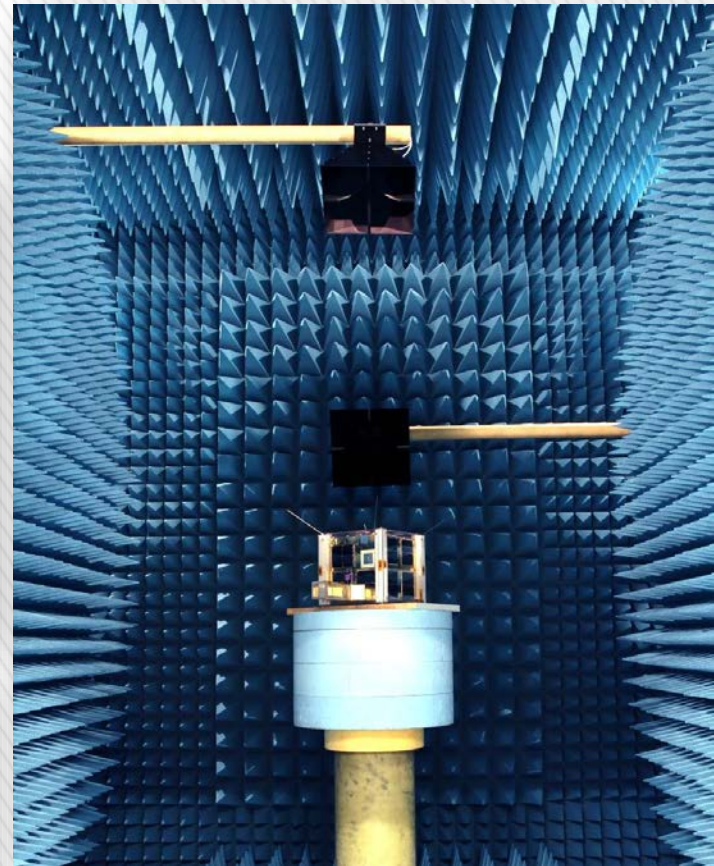
## » RFID qualification network Austria

- > RFID courses for companies in the Graz region
  - + RF measurement lab
  - + RFID antenna theory and design, propagation
  - + Advanced RFID lab



# Microwave Laboratory

- » Measurement devices
- » Automated wafer prober (110GHz)
- » Dedicated cleanrooms
- » Anechoic chamber





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