

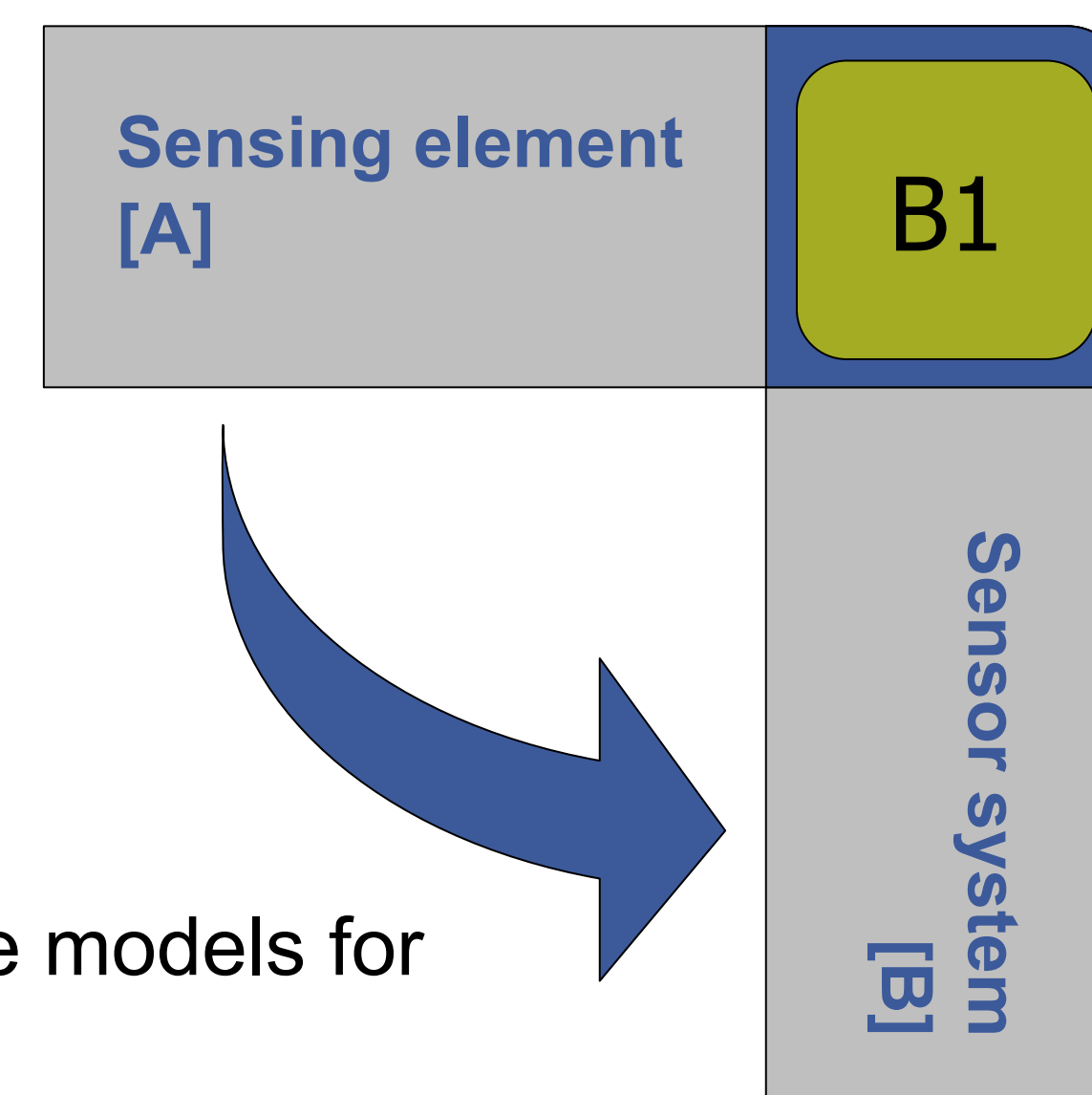
## Motivation and Objectives

### Motivation

The aim of this project is to provide application-specific sensor systems [for B projects] with the sensors [A] developed in the CRC on the basis of a comprehensive system analysis.

### Objectives

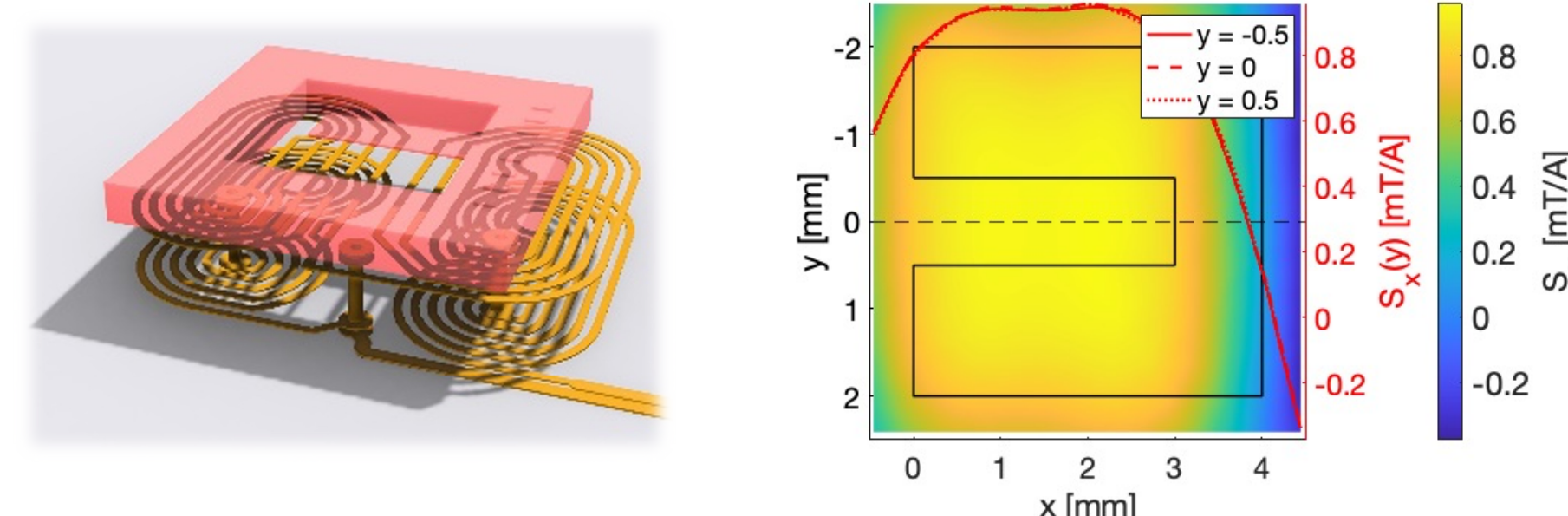
- Generating and analyzing in-depth noise models for ME sensors
- Implementation of analogue signal processing and sensor conditioning for various ME sensors with a focus on maximum signal to noise ratio (SNR) and minimum limit of detection (LOD)
- Investigation of ways for advanced sensor system integration using e.g. application specific integrated circuits (ASICs)
- Research into techniques with which LOD-optimized sensor systems can be operated in a magnetically unshielded environment.



## Results of the Second Funding Period

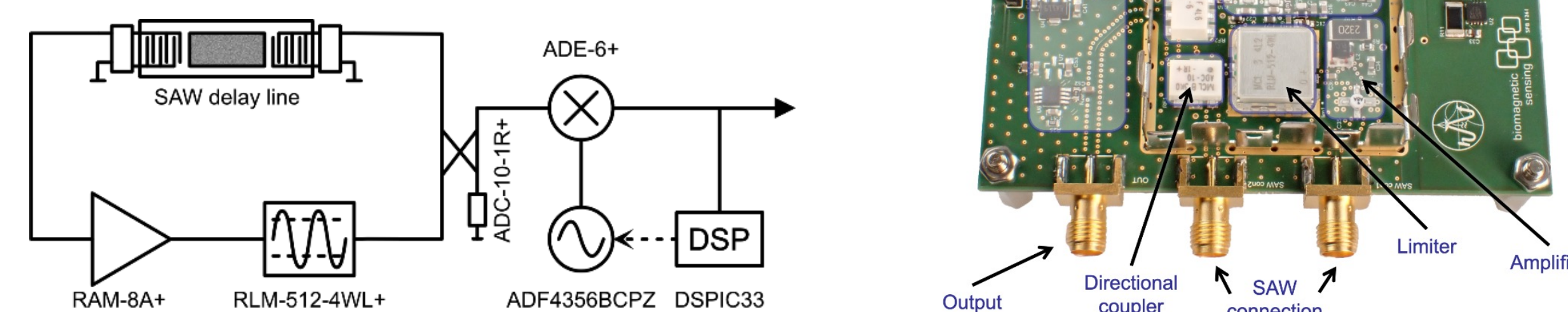
### PCB Coils for in situ characterization of ME Sensors

[B1-1] [B1-10]  
In situ calibration  
of ME sensor  
systems



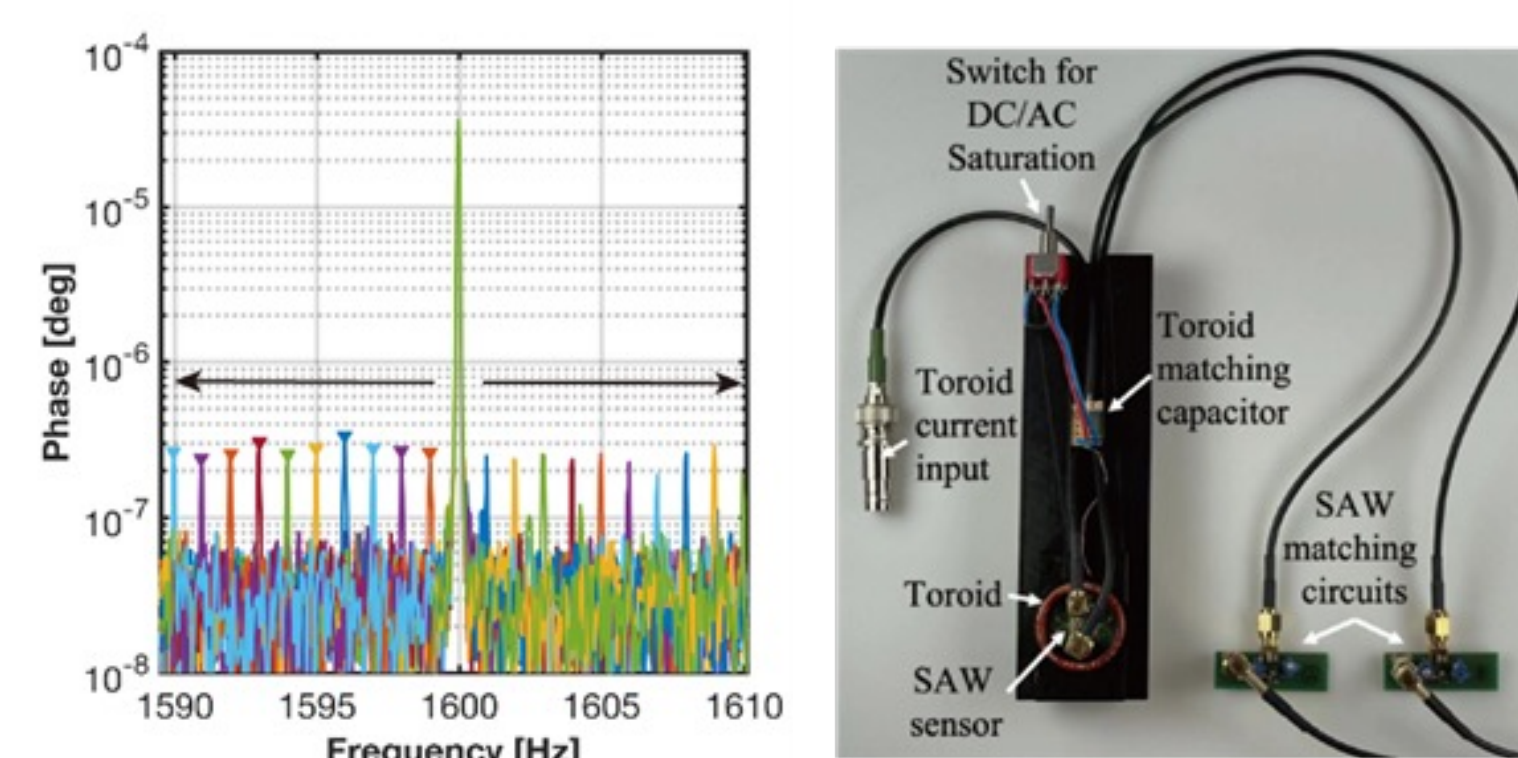
### SAW sensor systems for use in arrays

[B1-5] Compact LOD optimized electronics for evaluating SAW sensors

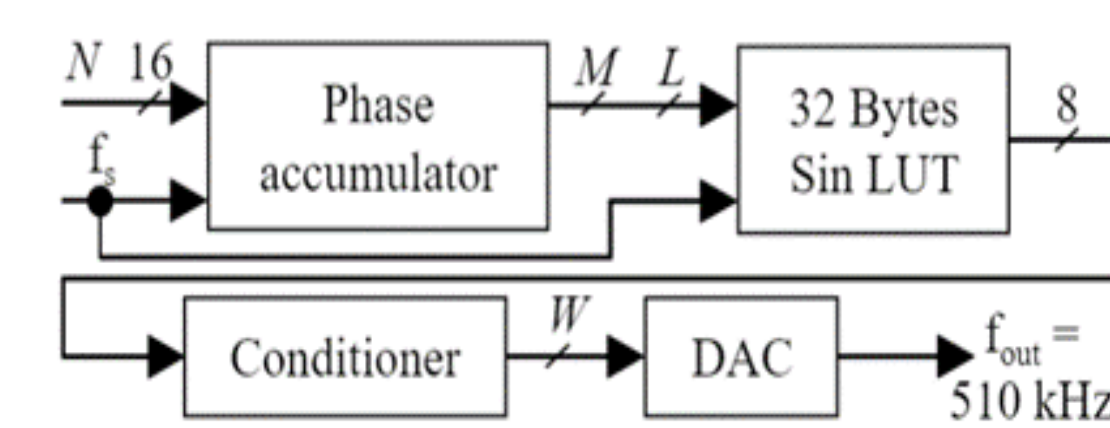


### Chopping Flux Modulation: A Preliminary Study

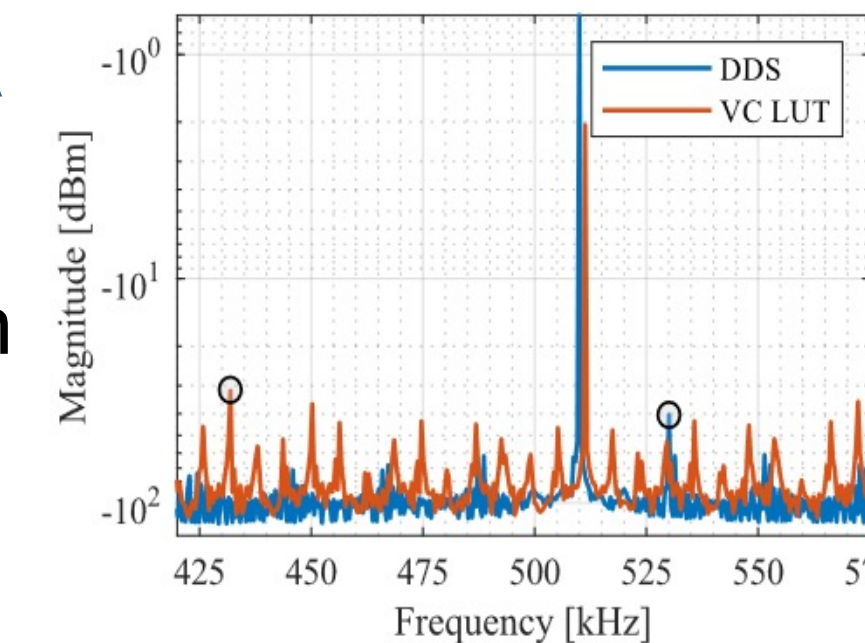
[B1-3] Mag. flux modulation approach from low to intermediate frequency to avoid the flicker noise and artifacts but dealing with magnetic losses



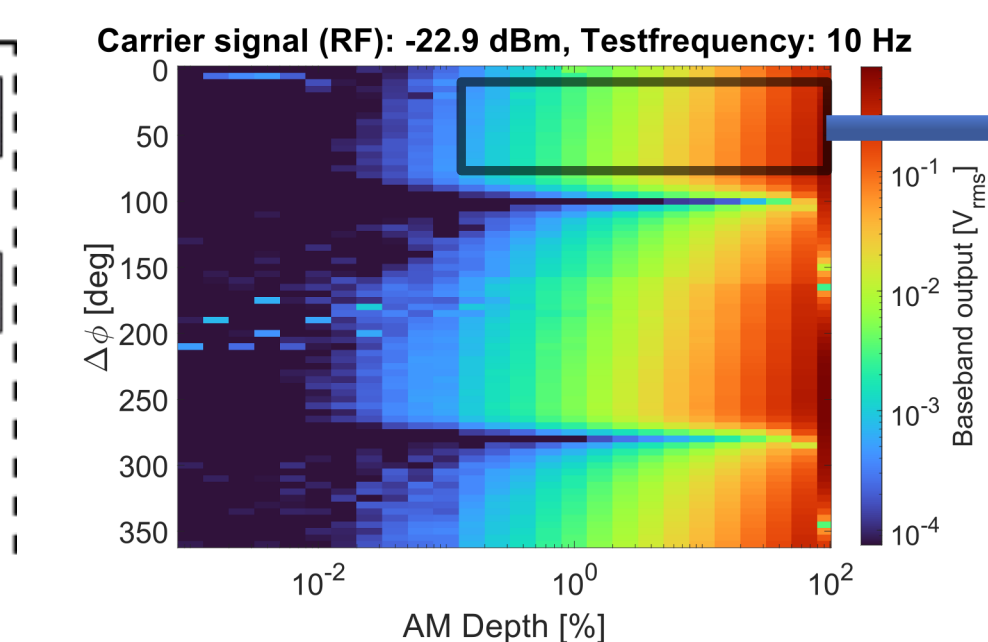
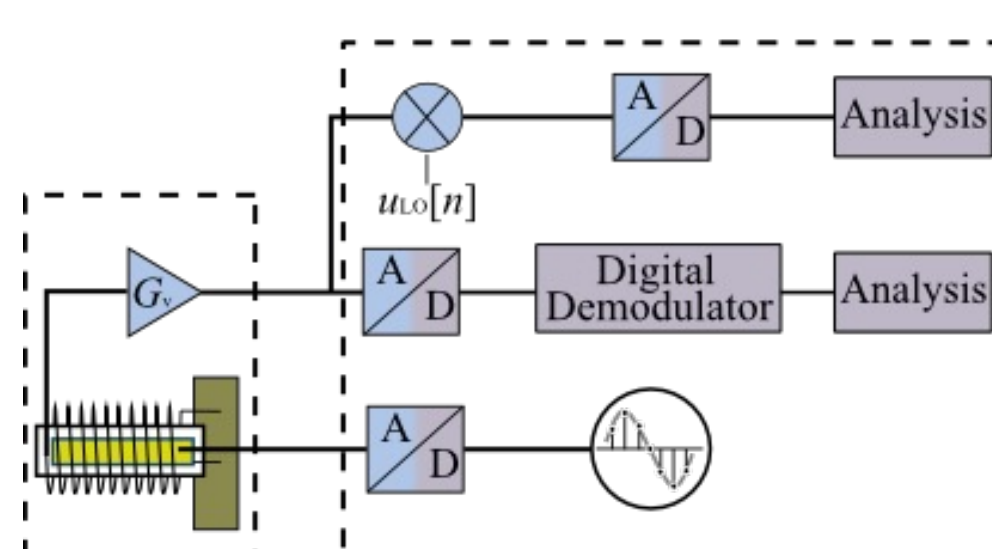
### DDS Signal Generator Implemented in a FPGA



FPGA and ASIC alternative for high frequency resolution



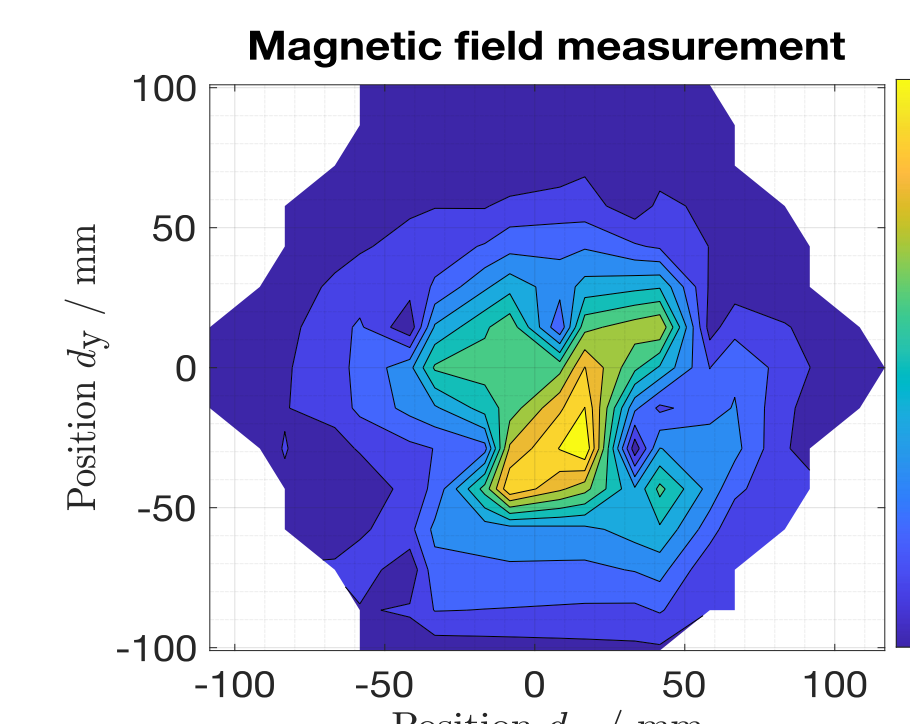
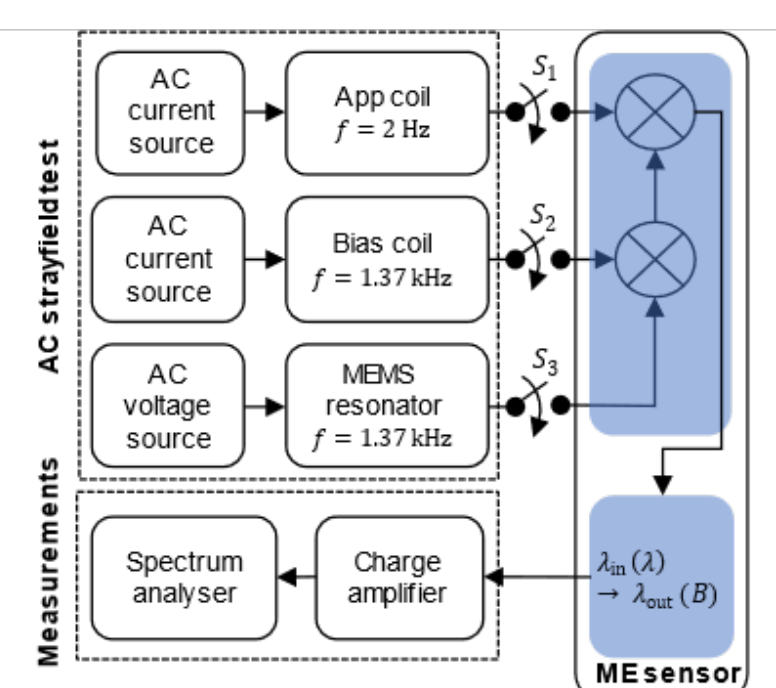
### In-depth analysis on demodulation techniques for converse effect ME sensors



### Challenge!

Dynamic range of ME sensor approx. 98dB (LOD equivalent to a modulation index of 0.2%) [Z2]

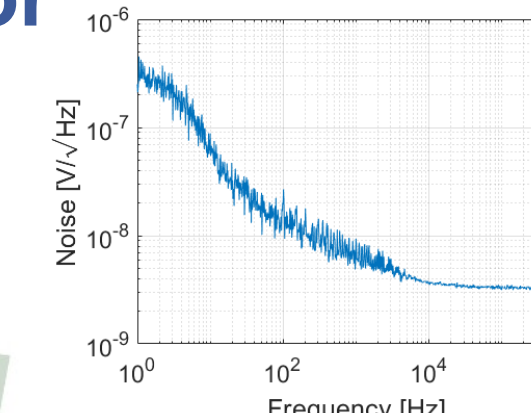
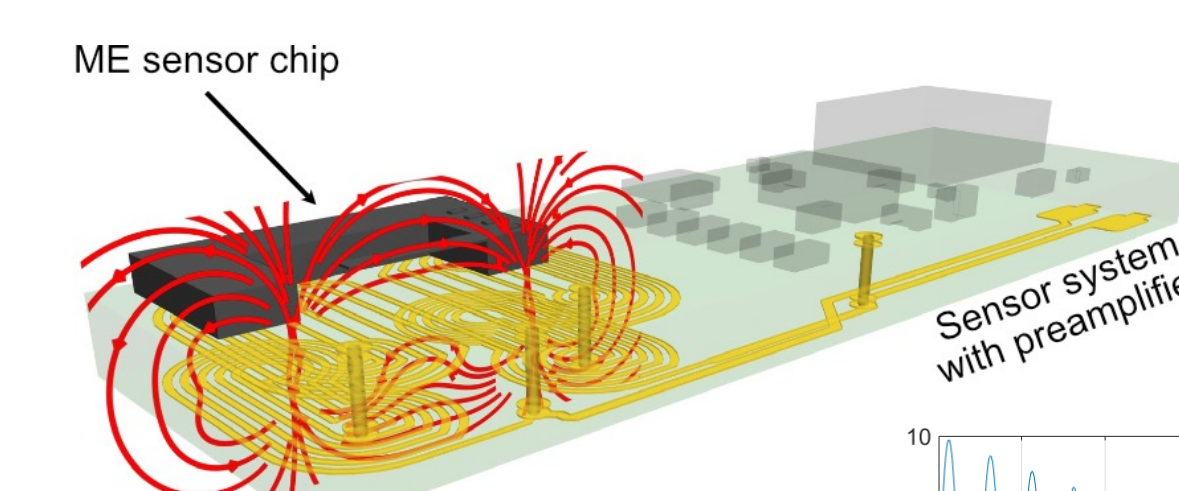
### MEMS Magnetic Field Flux Generator



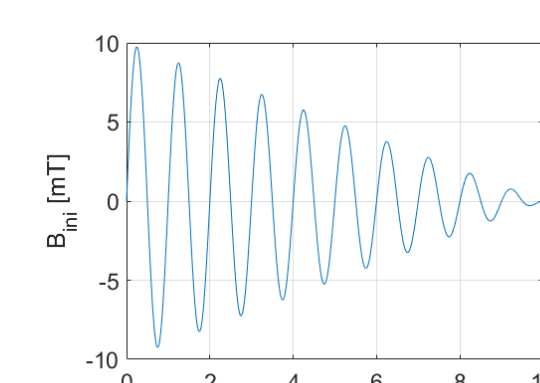
[B1-6] MEMS used on frequency conversion approach, further characterization for future application using SQUID (VMS-304, PTB-Berlin)

## Work Plan for Third Funding Period

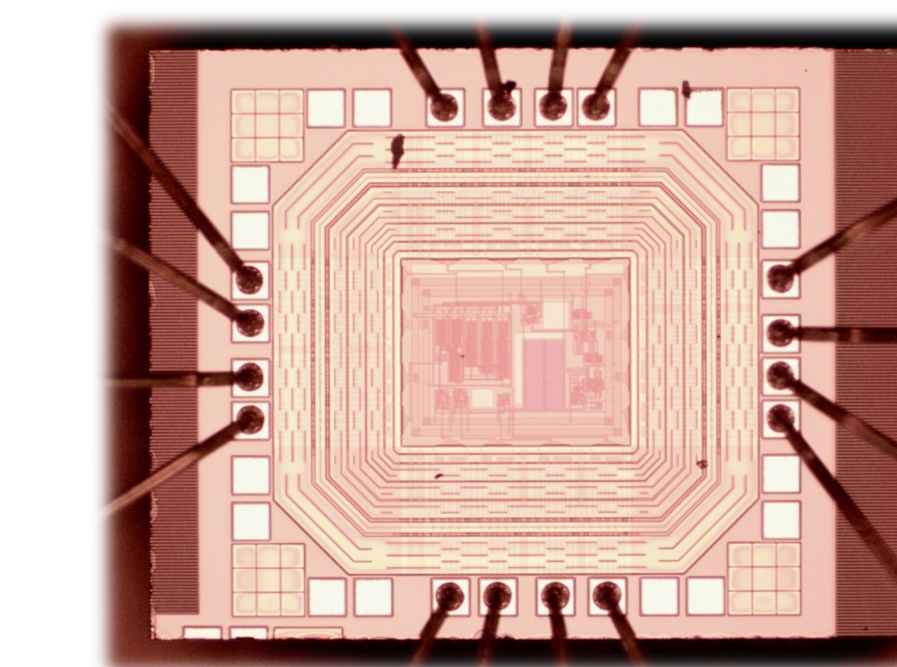
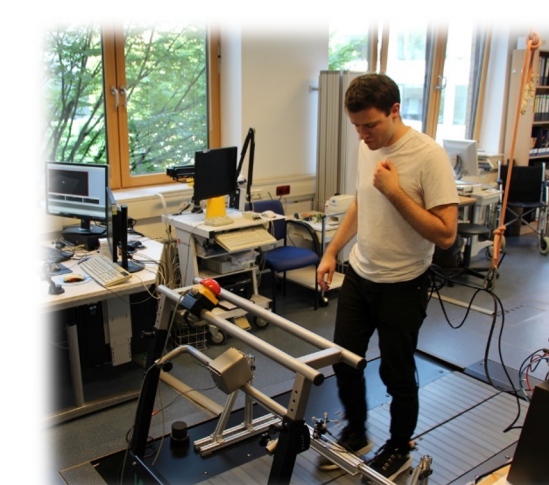
### WP1: Experimental and theoretical analysis of sensor system noise performance



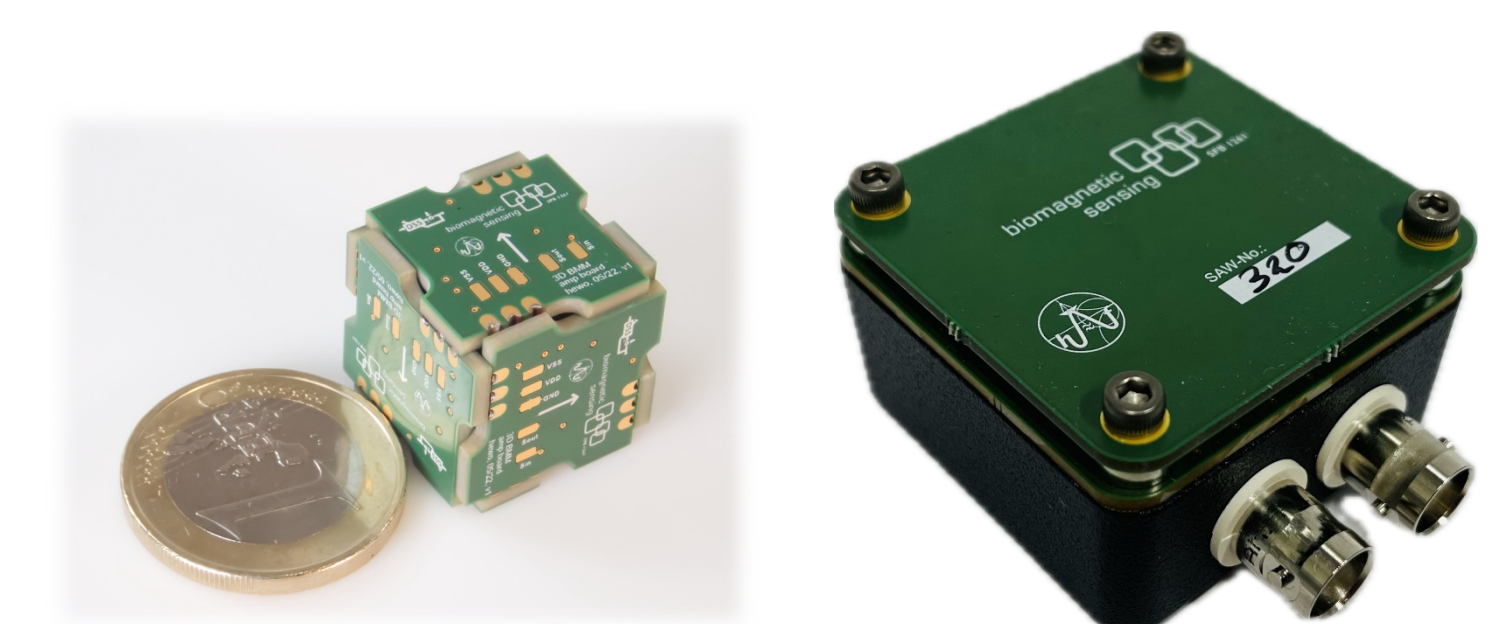
### WP2: Research on concepts for sensor and sensor system conditioning



### WP3: Enabling sensor systems to operate in unshielded environments



**WP4: Advancing our research on analogue front ends for the realization of application specific sensor systems**



### WP5: Providing array-capable hardware

### Workplan

|      | 2024 |   | 2025 |   | 2026 |   | 2027 |   | 2028 |   |
|------|------|---|------|---|------|---|------|---|------|---|
|      | 3    | 4 | 1    | 2 | 3    | 4 | 1    | 2 | 3    | 4 |
| WP1: |      |   |      |   |      |   |      |   |      |   |
| WP2: |      |   |      |   |      |   |      |   |      |   |
| WP3: |      |   |      |   |      |   |      |   |      |   |
| WP4: |      |   |      |   |      |   |      |   |      |   |
| WP5: |      |   |      |   |      |   |      |   |      |   |

(Main work done by: blue: Prof. Höft, red: Prof. Rieger, violet: both)

## Collaborations

- A1:** Investigation and characterization of magnetic noise
- A2:** Low-noise amplifiers, determination of sensor noise performance
- A4:** MEMS cantilever samples ↔ fitted electronic circuits
- A7:** Readout electronics/noise model for EFC and inductive readout
- A8:** Noise models → more general multiscale numerical modeling
- A9:** Measurement to arrive at highly detective SAW sensors
- A10:** Investigation and characterization of magnetic noise
- B2:** Optimal interface between analogue and digital signal processing
- B9:** Amplifiers for wearable sensor systems and multidimensional sensors
- B10:** Sensor front ends for cardiologic applications
- B11(N):** Dedicated amplification boards and sensor calibration procedures
- B12(N):** Readout electronics developed in close interaction
- B13(N):** Analog excitation electronics for the MEMS magnetic probe
- Z1:** Reception of ME cantilever sensors for noise investigations
- Z2:** Transfer of research results for sensor system electronics

### Participation in focus groups

F2: Modelling; F3: Comparison of Sensor Concepts; F4: Magnetoelectric Sensors; F5: Concepts based on ΔE effect

## Funds Requested

2 Doctoral researchers, consumables: 60.5 k€