



Prof. Dr.-Ing. Eckhard Kirchner

Product Development and Machine Elements (pmd), TU Darmstadt

Sensor-Integrating Machine Elements Congress

15 – 16 September, 2026 in Darmstadt, Germany

Sensor-Integrating Machine Elements
The DFG Priority Programme SPP 2305

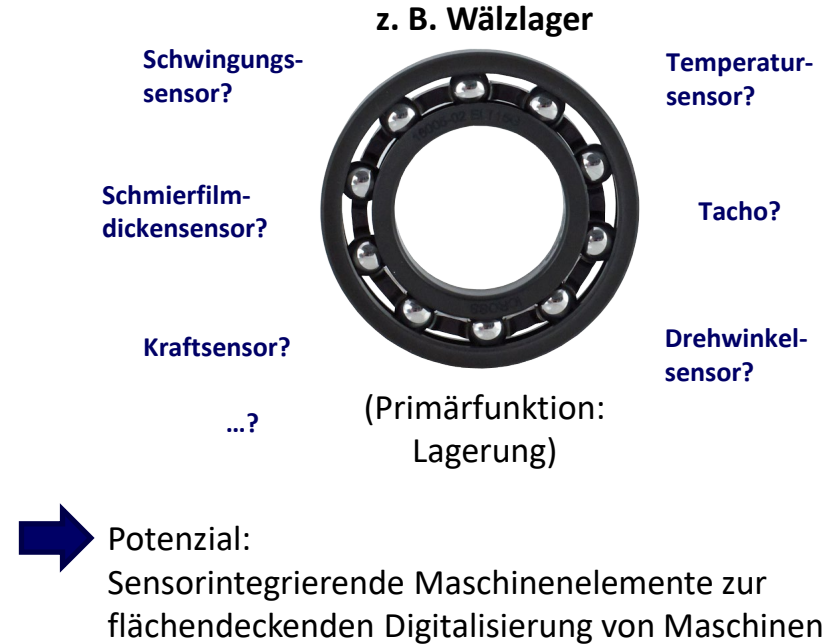
Vision – Sensorintegrierende Maschinenelemente

Digitalisierung von Gesellschaften



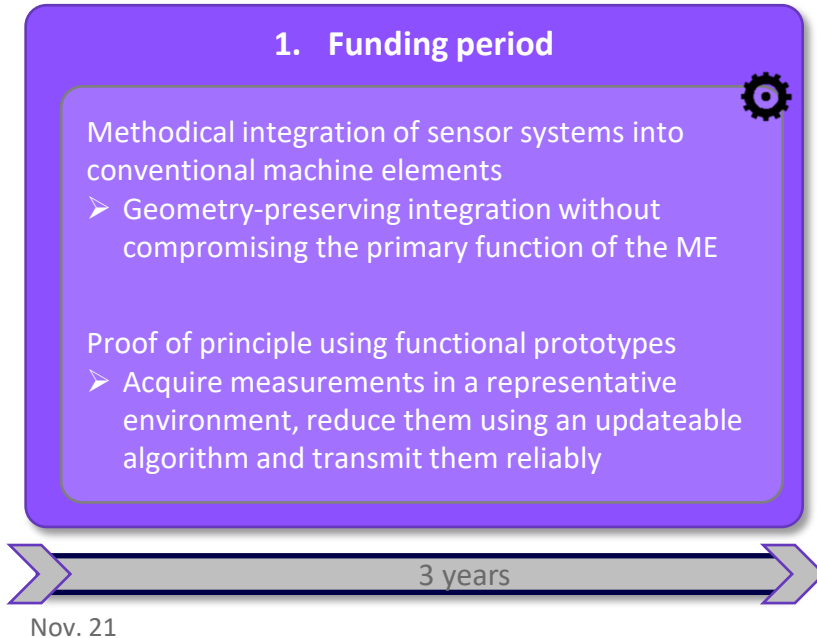
Quelle: entwickler.de - Sensoren in modernen Smartphones im Überblick (17. April 2024)

Digitalisierung von Maschinen



Bildquelle: handtmann01 (cc)

Objectives of SPP 2305 – Review of First Funding Period



- Different machine elements:
 - 3× bearings,
 - 2× shaft-hub connections,
 - 2× screws,
 - Radial seal ring,
 - Helical gear,
 - Coupling
- Different measured variables:
 - temperature, acceleration, rotational speed, strain, lubricant quality
- Different energy-management methods:
 - inductive transfer, photovoltaic, thermoelectric and piezoelectric conversion, battery storage
- One project addresses a methodology for designing SiME (screw as example)

Objectives of SPP 2305 - Second Funding Period

Research into the scientific foundations of Sensor-Integrating Machine Elements (SiME)

2nd funding period

- Assessment of SiME functional reliability and its influence on design calculations
- Manufacture of SiME prototypes for system investigations
- Systematic setup and operation of ad hoc SiME networks
- Development of a cross-domain framework
- Data management at system level

3 years

2024

2027

Key dimensions of the autonomy requirement: Data, Energy, Software

- All three dimensions must be considered equally!

Data

- Ensure lossless acquisition, preprocessing and transmission of sensor data
- The operating strategy of the sensor modules accounts for interactions between data and energy flows

Software

- Wireless updates for activating new functions or adapting the operating system

Energy

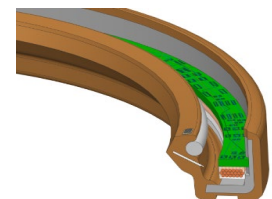
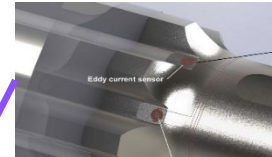
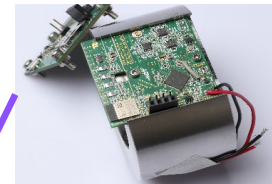
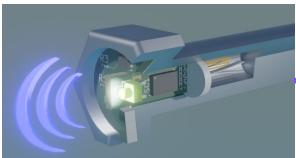
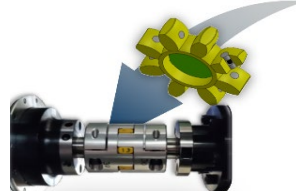
- The sensor module's energy balance, including sources and sinks, must be net-positive on average
- Energy-critical states should be detected and communicated
- The operating strategy should respond to the situation

The data and energy balance as well as the software must not limit the SiME service life!

SiME autonomy is a necessary prerequisite for acceptance in applications

Project Overview

Project title (some shortened)	Project lead
Sensorintegrierendes Zahnrad (SIZA)	TU München: Stahl, Vogel-Heuser HTWK Leipzig: Derbel
Integrierte Sensorik für intelligente Großwälzlager (ISiG)	Uni Hannover: Pape, Poll, Wurz
Auto-informative Gleitlager II	RWTH Aachen: Gemmeke, Jacobs
Gasfolienlager zur Zustands- und Betriebsüberwachung	TU Berlin: Gühmann, Liebich
Lastsensitive Zahnwelle mit sensorischem Werkstoff	TU Clausthal: Lohrengel Uni Hannover: Maier
Elastische Kupplungen mit dielektrischen Elastomersensoren	TU Dresden: Henke, Schlecht, Wallmersperger
SiSmaK 2 (Sensorintegrierende Schraube zur mehraxialen Kraftmessung)	TU Darmstadt: Hofmann, Kupnik KIT: Matthiesen
MiMoSe II (Mikroelektronischer Modulbaukasten für SiME)	TU Hamburg: Krause, Trieu TU Darmstadt: Kirchner
Radialwellendichtring zur Überwachung von Betriebszustand und Schmierstoffqualität	TU Kaiserslautern: Seewig, Thielen, Wehn



New associated Project

Sensor-Integrating Elastomeric Bearing



Sensor-Integrating Elastomeric Bearing (SiEla) with a Combined Sensor-Generator System

Professor Dr.-Ing. Jürgen Maas, TU Berlin, Chair of Mechatronic Systems

Professor Dr.-Ing. Merten Stender, TU Berlin, Chair of Cyber-Physical
Systems in Mechanical Engineering

Project scope:

- Sensor-integrated energy-harvesting elastomeric bearings
- Simultaneous inductive sensing and harvesting
- Wireless IoT condition monitoring in harsh conditions
- Prototype with temperature reliability testing

Project was granted separately and successively associated to the Priority Program

Organisation of SPP 2305

Working groups, working-group leads and spokespersons

Postdocs and early-career researchers (ECRs) as working-group leads

- Data transmission and update capability:
David Riehl (TUDa)
- Functional-reliability testing:
Julian Peters (KIT) → Luca Häfner (TUDa)
- Energy management and harvesting:
Dr. Josephine Kelley (LUH)



Professors as mentors

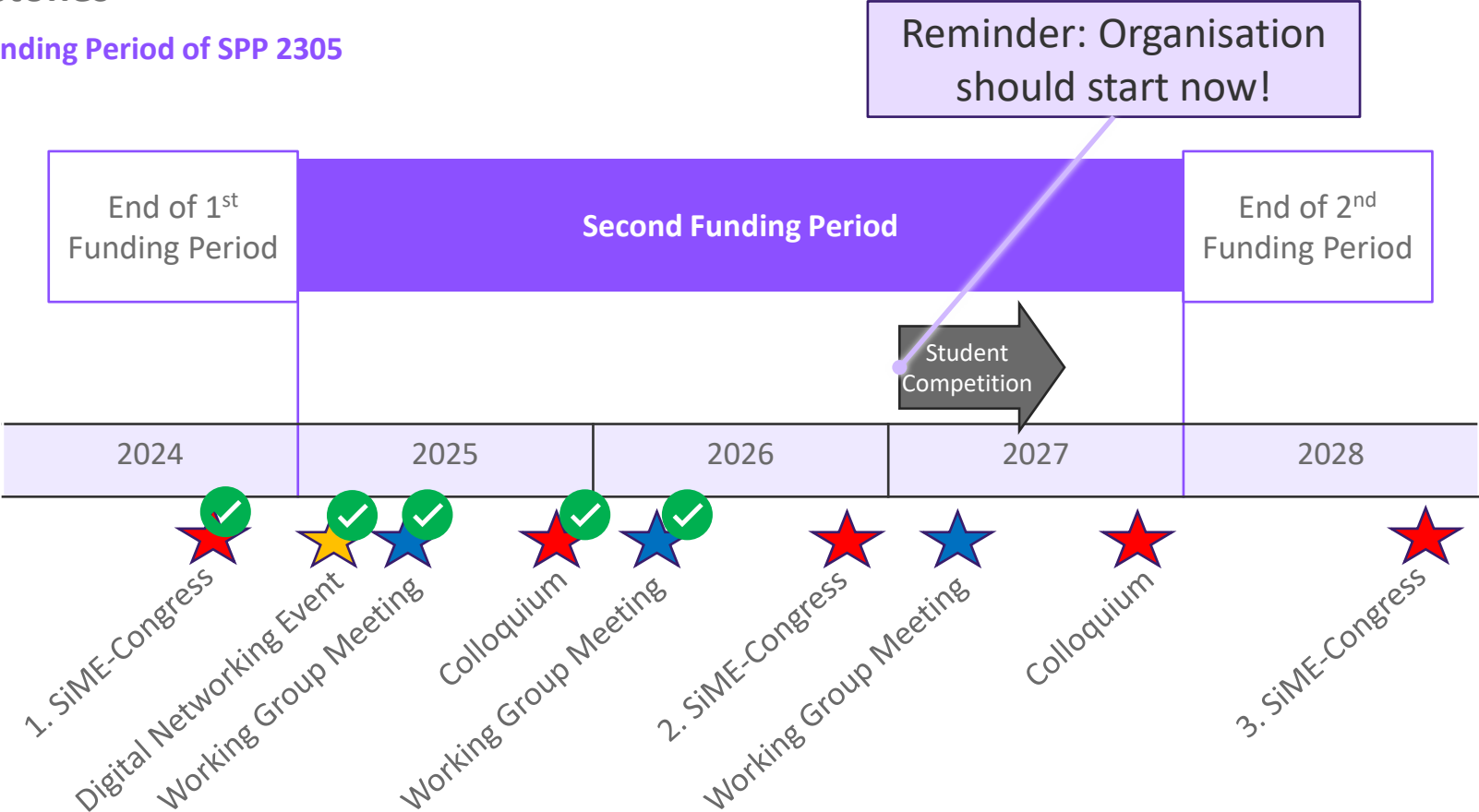
- Prof. Dr.-Ing. Birgit Vogel-Heuser (TUM)
- Prof. Dr.-Ing. Klaus Hofmann (TUDa)
- Prof. Dr.-Ing. Clemens Gühmann (TU B)



Targeted development of researchers as working-group leads through a mentoring concept

Milestones

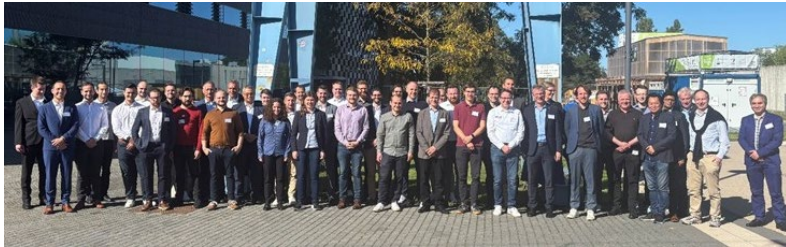
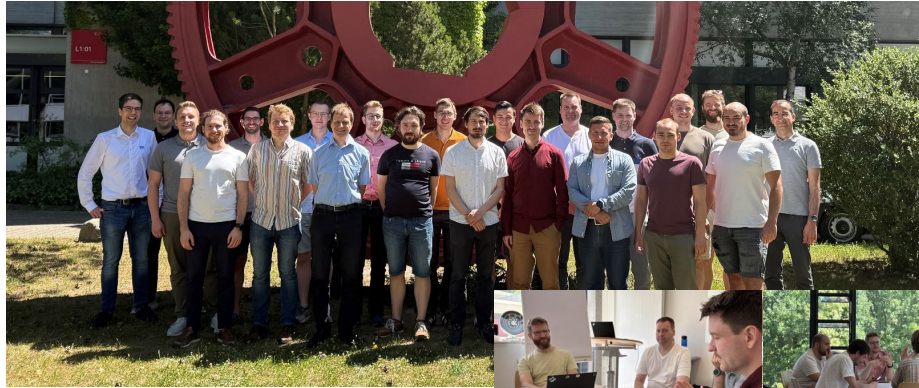
2nd Funding Period of SPP 2305



Important Events Since SiME Congress 2024

Working Group Meeting

- June 23-24, 2025, TU Darmstadt
- WG 1: Energy management and harvesting
- WG 2: Data transmission and updateability
- WG 3: Testing for functional reliability



SiME Kolloquium 2025

- Sept. 18–19, 2025, TU Darmstadt
- Shift in research focus: Moving beyond proof-of-concept toward energy autonomy and wireless communication
- Main Topics:
 - Energy harvesting as key enabler
 - Wireless communication & OTA updates

Outlook: Publications and Final Reports

Established and future special sessions at national and international conferences

Previous conferences with successful SiME sessions

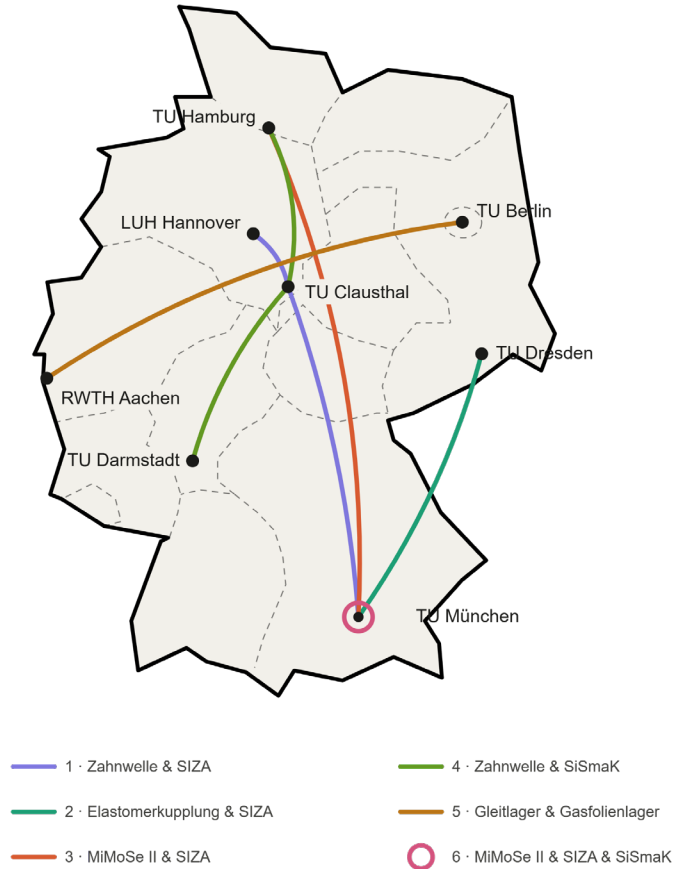
- Dresden Machine Elements Colloquium 2022, 2024 and 2026 (B. Schlecht, focus: machine elements)
- ECCOMAS Symposium SMART 2023 (Patras) and 2025 (Linz) (T. Wallmersperger, focus: simulation)
- VDI/VDE Conference Mechatronics 2026 (Berlin) (C. Gühmann, focus: system integration)

Current submission opportunities

- SiME Congress 2026: publication in Engineering Research, submission deadline 30 Nov.
- SMART 2027: mini-symposium
Focus on simulation and energy harvesting planned
- Final reports as a collection in Engineering Research, Q4/2027
Focus on autonomy and functional reliability



Joint Projects



Applications are still being accepted!

- Funding of up to €15,000 per SPP 2305 project
→ Collaborative project can receive more in total
- Number of collaborative projects not limited, BUT a minimum of 2 required!
- Financial settlement must be completed by the end of SPP 2305
- Registration form has already been sent, if missing or for other questions contact: marius.crucius-kilian@tu-darmstadt.de

Upcoming transfer period – knowledge transfer

- **Prerequisite:** Completed fundamental research project with quality-assured results
- **Clustering** of proposals is recommended to facilitate reviewer selection
 - Discussion in 2027 between academia and industry recommended
 - Time to be used to achieve consensus on cooperation contract (required for submission!)
- **Time line**
 - Submission of cluster proposal by Q2/28 (target) after completing the SPP 2305 projects
 - Review process 4-6 Months
 - Potential start Jan 2029



Use tomorrow's workshop to identify potential partners

Next SiME Congress

2027

- Conclusion of the 2nd funding period of SPP 2305
 - DFG reviewers will be present
 - Submitted publications should summarize project results and can serve as a basis for the final reports
- Anticipated: Kick-Off to the transfer period
 - Presentation of planned transfer projects
 - Further ideation on projects
- We hope for further support of FVA GmbH.
At this point we like to extend a heartfelt **THANK YOU!!**
to FVA GmbH for organizing this year's congress

