

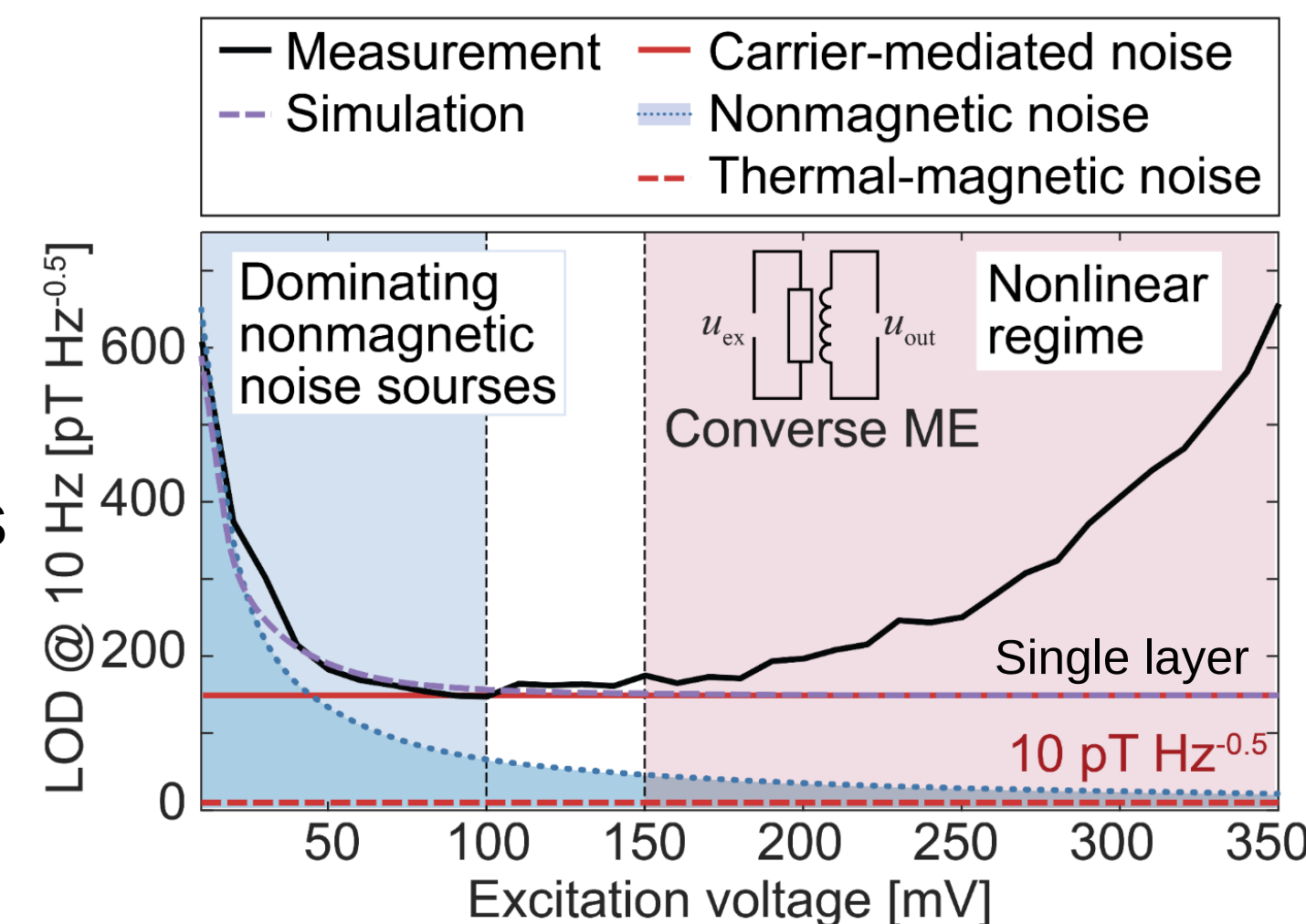
Motivation and Objectives

Magnetic noise + magnetoelastic nonlinearities [A10-8] – major limitations for sensor performance

- Sensor performance limited by magnetic noise
- Broad spectrum of magnetic noise types
- Magnetic noise on multiple scales

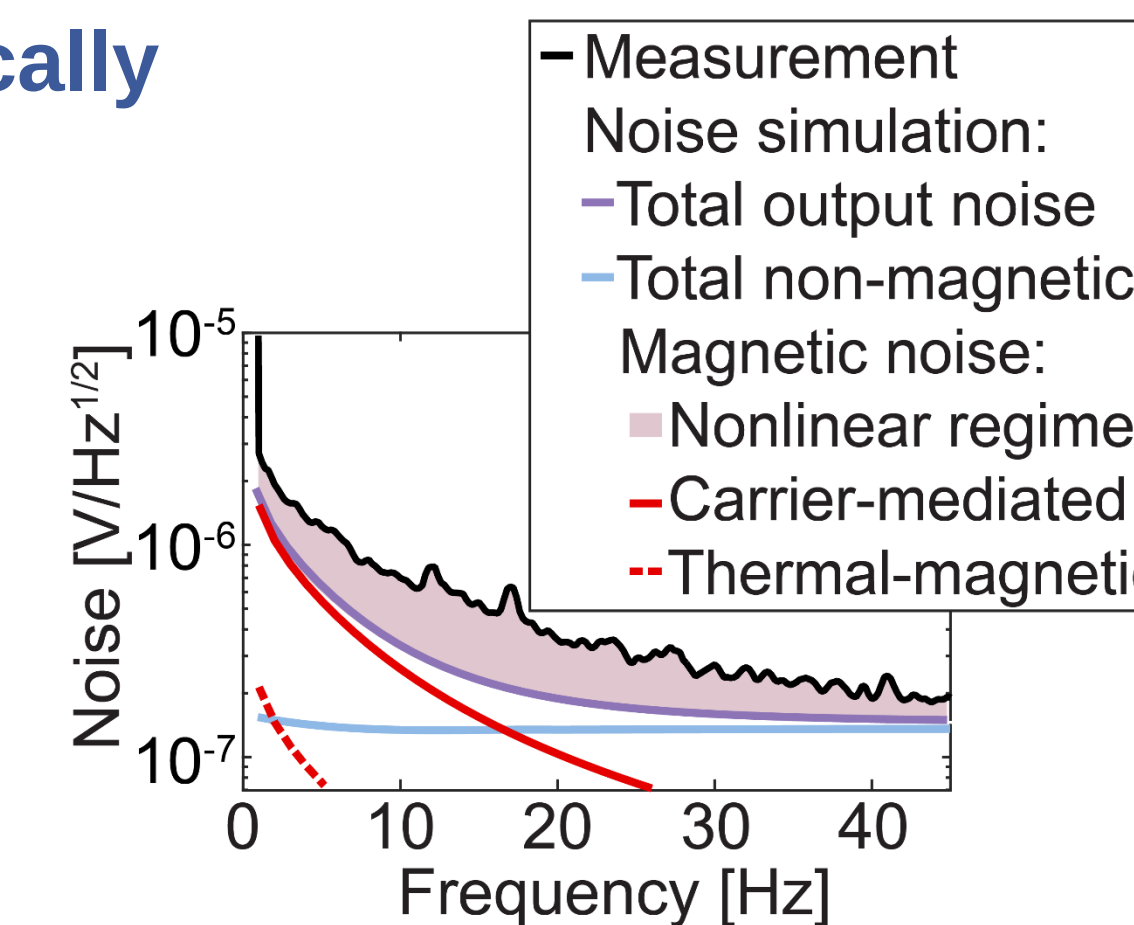
Main objectives

- Identify and quantify magnetic noise types in CRC sensors
- Provide input for sensor improvement
- Transfer noise knowledge from micro- to sensor-scale

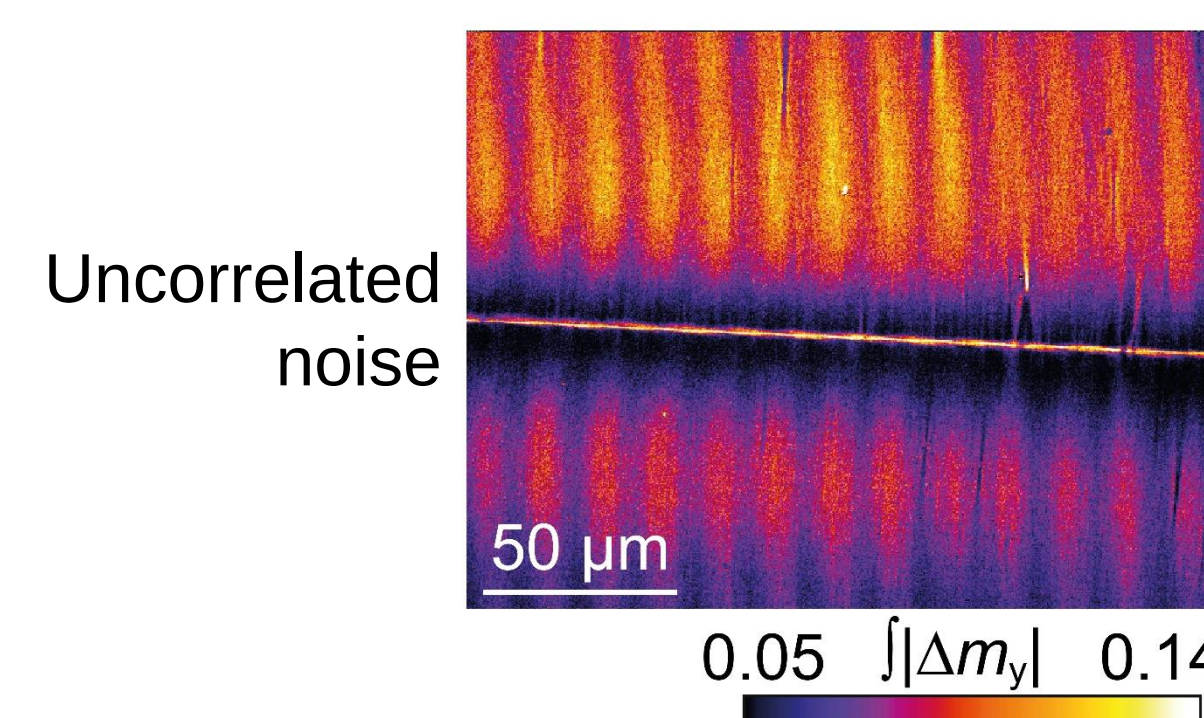


Magnetic Noise in ΔE -effect and Electrically Modulated Sensors [A10-8]

- Correlation between magneto-elastic nonlinearity and increased noise
- Carrier-mediated noise determines lowest LOD of multi-domain samples
- Theoretical minimum of LOD defined by the thermal-magnetic noise
- Similar noise behavior observed for other sensor types



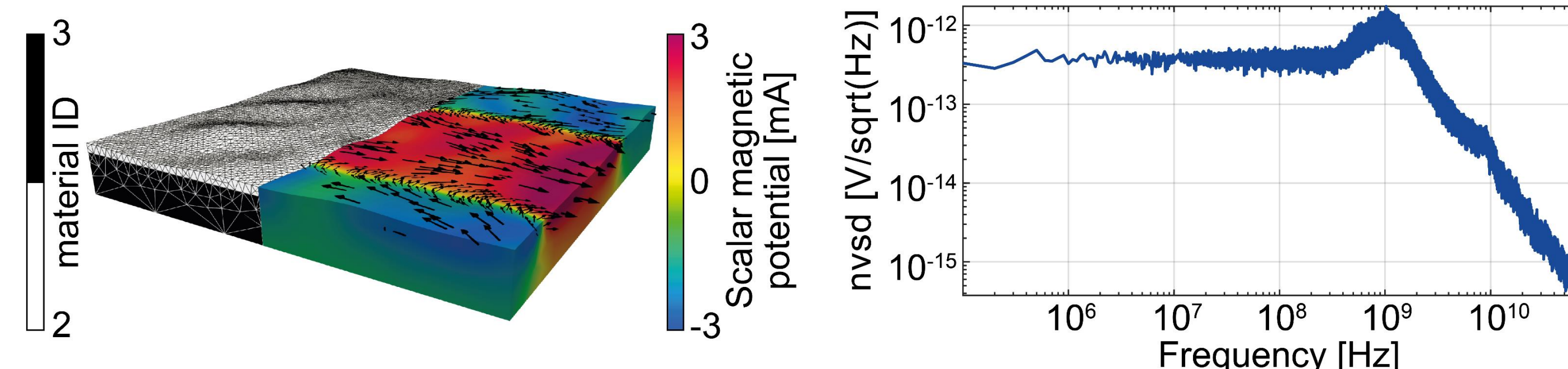
Magnetic Noise and Domain Walls in SAW Sensors [A10-3, A10-4]



- Correlation between losses, noise, and magnetic domain behavior
- Domain walls modify magneto-mechanical response
- Source of noise in SAW operation magnetic

Results of the Second Funding Period

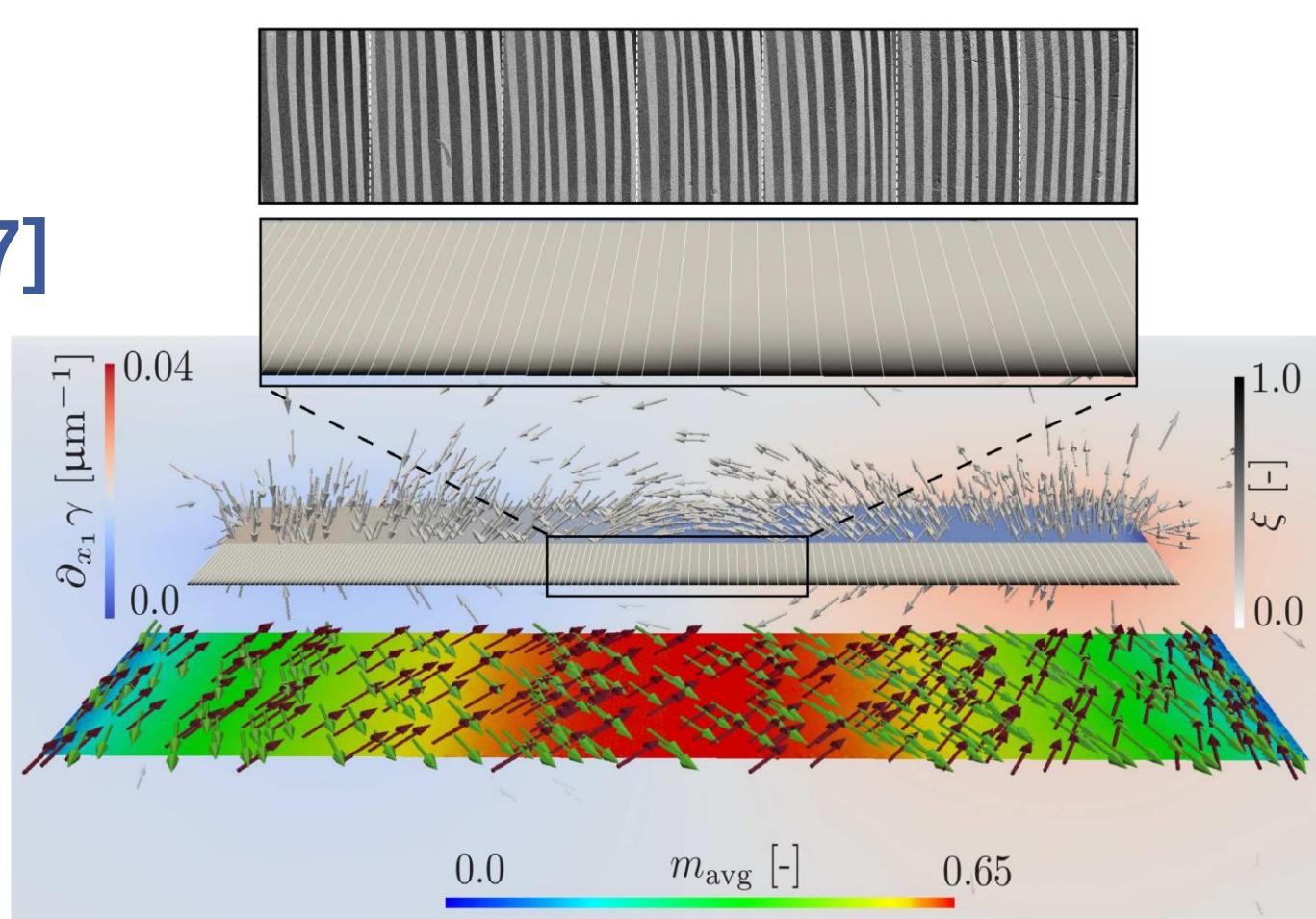
Barkhausen Noise Spectra Simulation [A10-10]



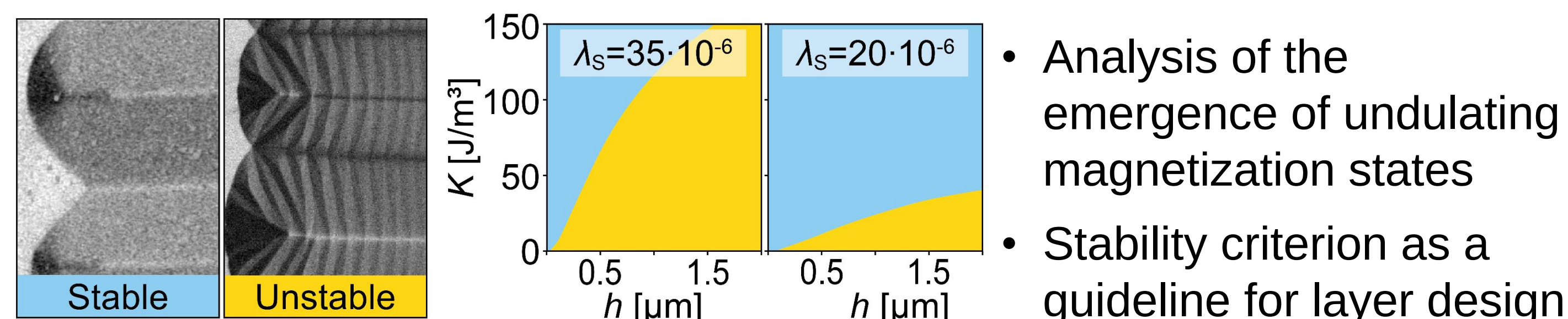
- Novel solution scheme for the study of the interaction of domain walls and structural defects
- Noise computation scheme based on ensemble averaging

Thin-film Stripe Shaped Magnetic Domain Continuum Theory [A10-7]

- Efficient meso-simulations compared to micromagnetics
- More microstructural details compared to macro models
- Basis for upscaling of noise



Stability Analysis of Undulating Magnetization States



- Analysis of the emergence of undulating magnetization states
- Stability criterion as a guideline for layer design

Work Plan for Third Funding Period

WP1 Establishing Preconditions

- Mesoscopic continuum theory and exchange-bias model
- Reconfiguration of magnetooptical imaging setup

WP2 Magnetostrictive Material Properties

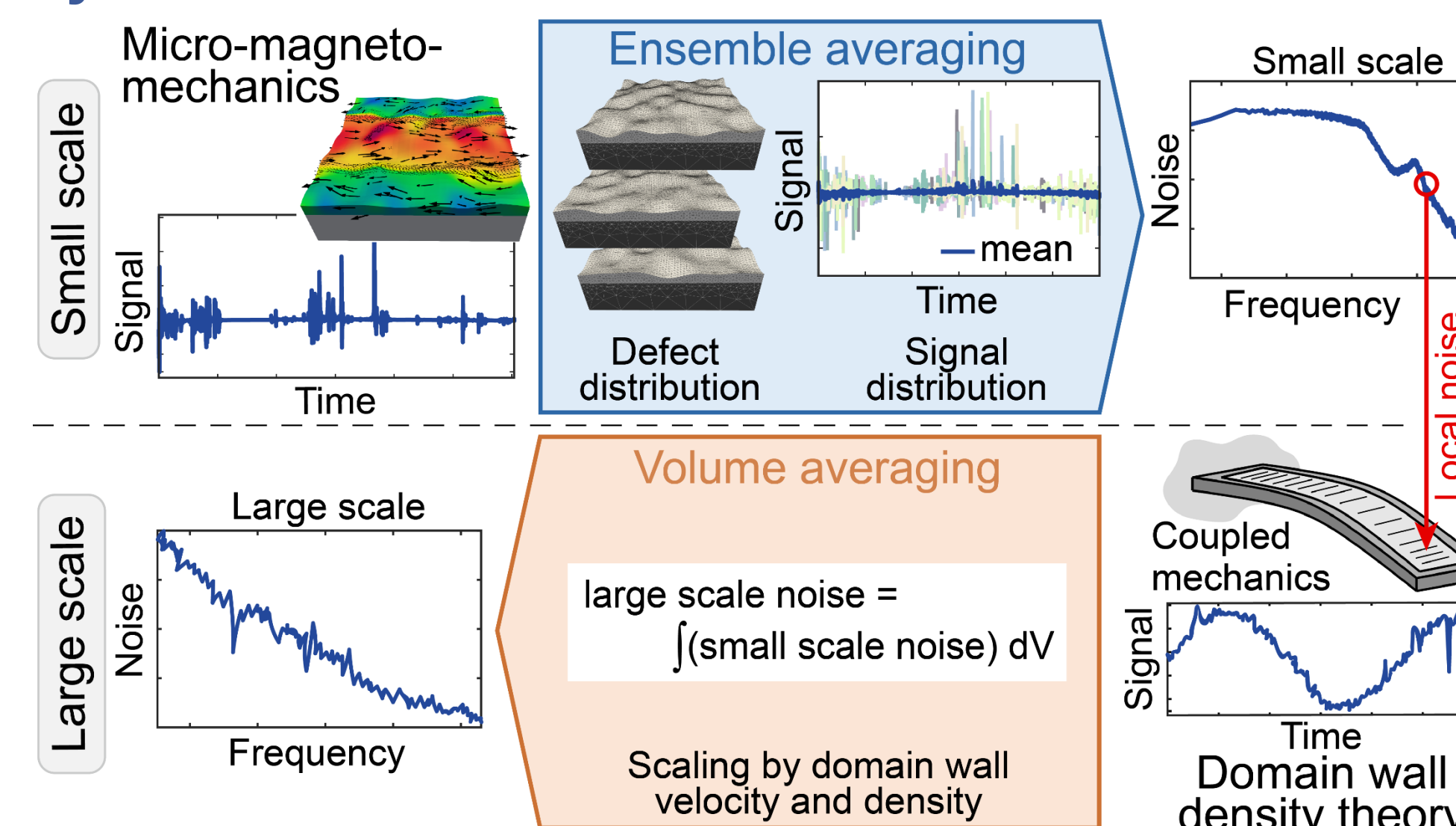
- Thermal noise based on χ'/χ'' phase diagrams (fluctuation-dissipation)
- Influence of heterogeneous effective magnetic properties

WP3 Exchange Bias – Antiferromagnetic Layer Effects

- Influence of antiferromagnetic layer on noise
- Attribution of noise to ferromagnetic and antiferromagnetic layers

WP4 Magnetic Multilayer Stacks

- Exchange bias, anisotropy, magneto-statics for single-domain state
- Magnetically soft layers with good sensitivity

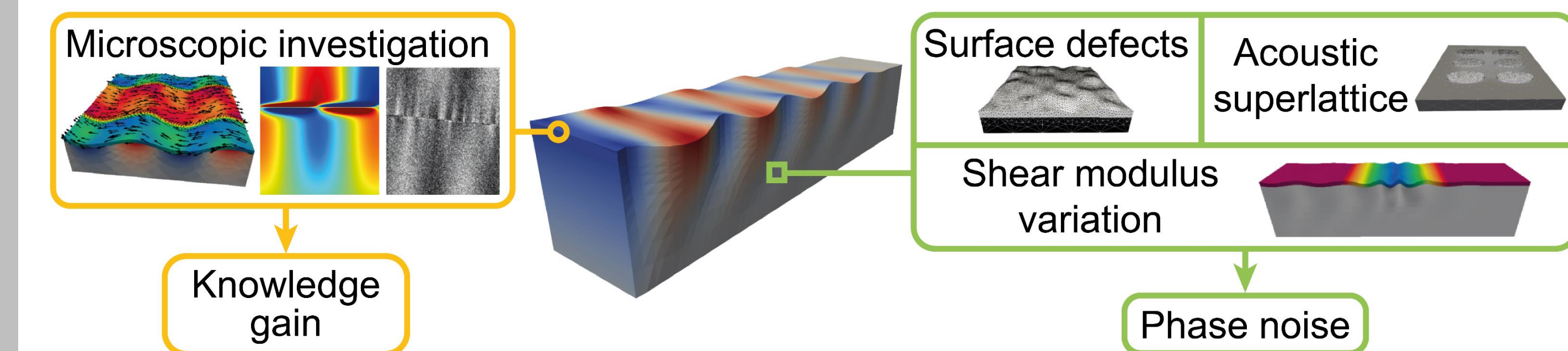


WP5 Noise – Magnetic Domains and Nonlinearities

- Upscale noise using mesoscopic continuum theory
- Pointwise incorporate microscale noise results from the current period

WP 6 Sensor Investigations

- Application and validation of noise computation scheme from WP5
- Phase noise simulation of SAW sensor in the frequency domain
- Small-scale investigation to understand vibrational domain wall modes



	Group McCord	2024		2025			2026			2027			2028				
	Group Wulfinhoff	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
WP1	Establishing preconditions																
WP2	Magnetostrictive material properties																
WP3	Exchange bias effects																
WP4	Magnetic multilayer effects																
WP5	Noise, magnetic domains, nonlinearities																
WP6	Sensor investigations																

Collaborations

- A1: Layer preparation/characterization, model validation
- A2: Simulation of the micro and macro composite system
- A4: ΔE sensor preparation/characterization, noise modeling and validation
- A6: Structural parameter investigation
- A7: Converse ME sensor preparation/characterization, model validation
- A8: Exchange of modeling results from different scales
- A9: SAW sensor preparation/characterization, noise model validation
- B1: Compact noise model development
- B10: Include sensor models and findings in forward model
- B11: Include sensor models and findings in forward model
- Z1: General sensor preparation
- Z2: Joint sensor characterization (ME properties and noise spectra)

Participation in focus groups

- F1: Modeling
- F2: Sensor Concepts
- F3: Comparison of Sensor Concepts
- F5: Concepts based on Delta-E Effect

Funds Requested

1 Doctoral researcher, 1 Postdoctoral researcher, direct costs: 13.0 k€