AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Electric-field controlled spintronic devices (E-CONTROL)

Spatial distribution of fast Fourier transform spectrum from micromagnetic simulations

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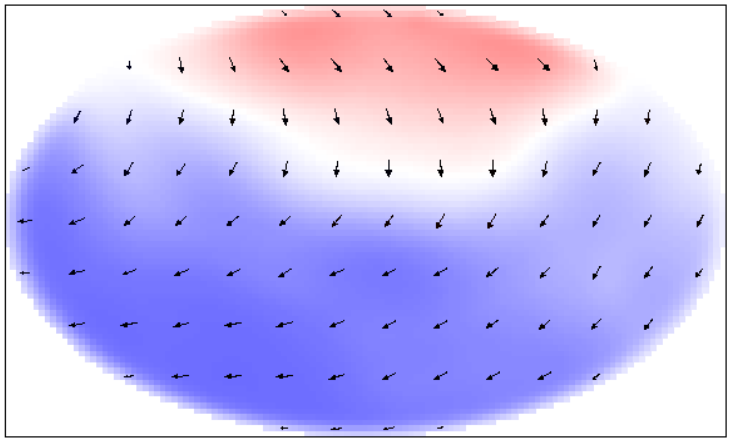
Outline

- Micromagnetic simulations
- Spatial Spectrum Analyzer
- Data processing
- Local analysis of magnetization modes
- Parallel computing
- Summary

Why micromagnetic simulations?

- Convenient, cost-effective way of investigating magnetic phenomena
- Applications in nanotechnology and spintronics devices
- Heterogeneous structures: domains, vortices, magnetic tunel junctions …



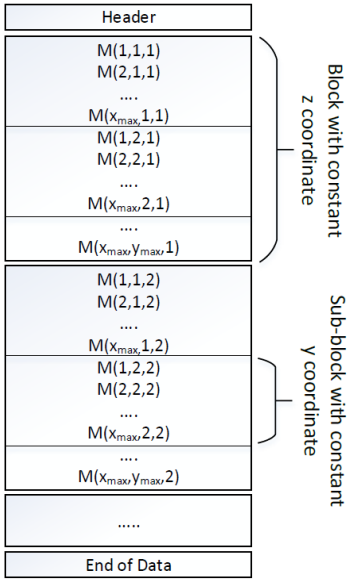
Basic concept: numerical solution of Landau-Lifszyc-Gilbert-Slonczewski (LLGS) equation

$$\frac{dm}{dt} = -\frac{\gamma}{1+\alpha^2}\left([m \times H_{eff}] + \alpha [m \times [m \times H_{eff}]] - \frac{\hbar j}{eM_S d} g(\theta)(\beta [m \times p] - [m \times [m \times p]]) \right)$$

More information about micromagnetism and its applications – 12:05

Spatial Spectrum Analyzer

Raw simulation output

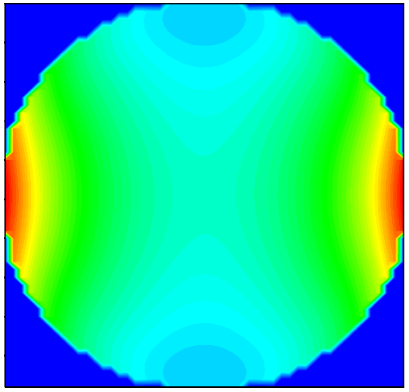


SSA

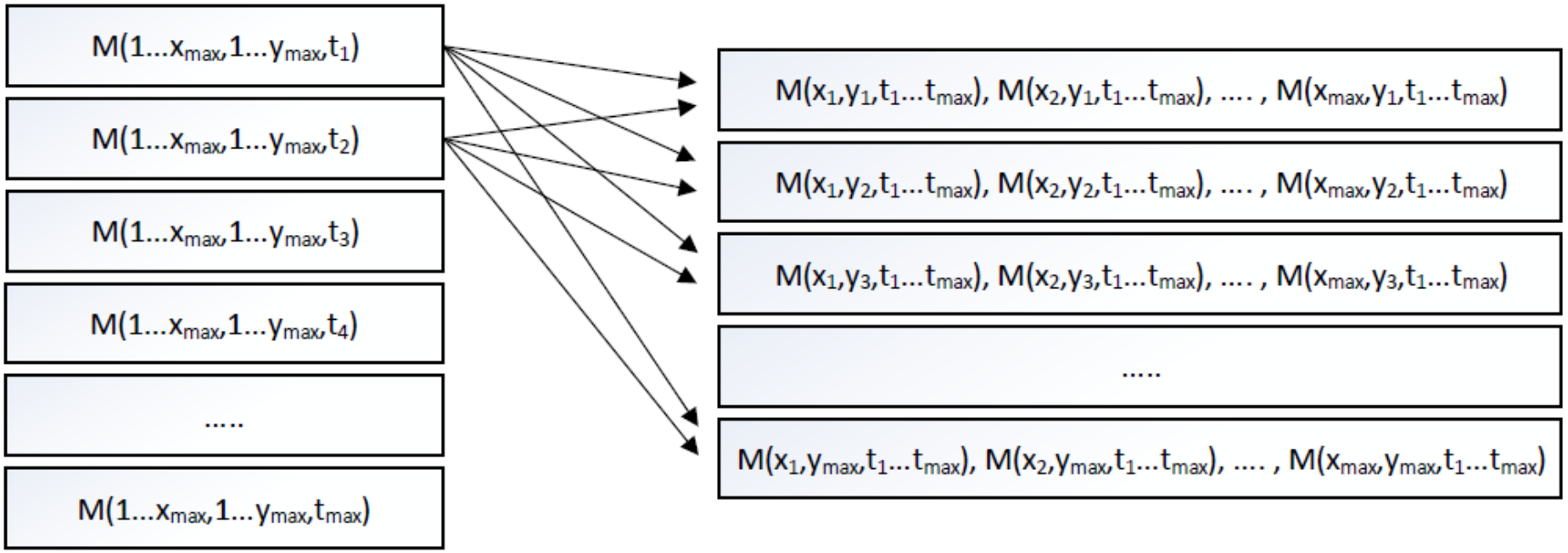
BASH MODULE

MATLAB MODULE

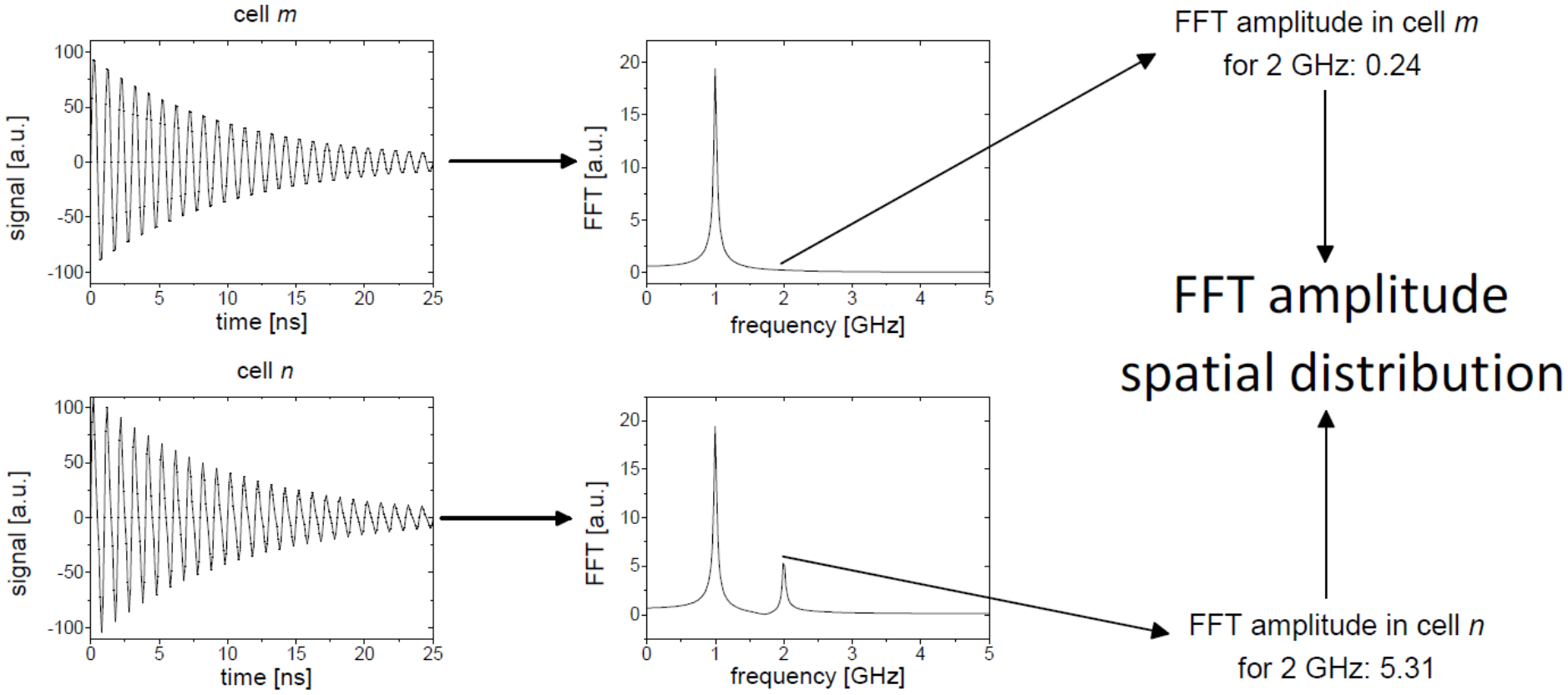
FFT amplitude spatial distribution



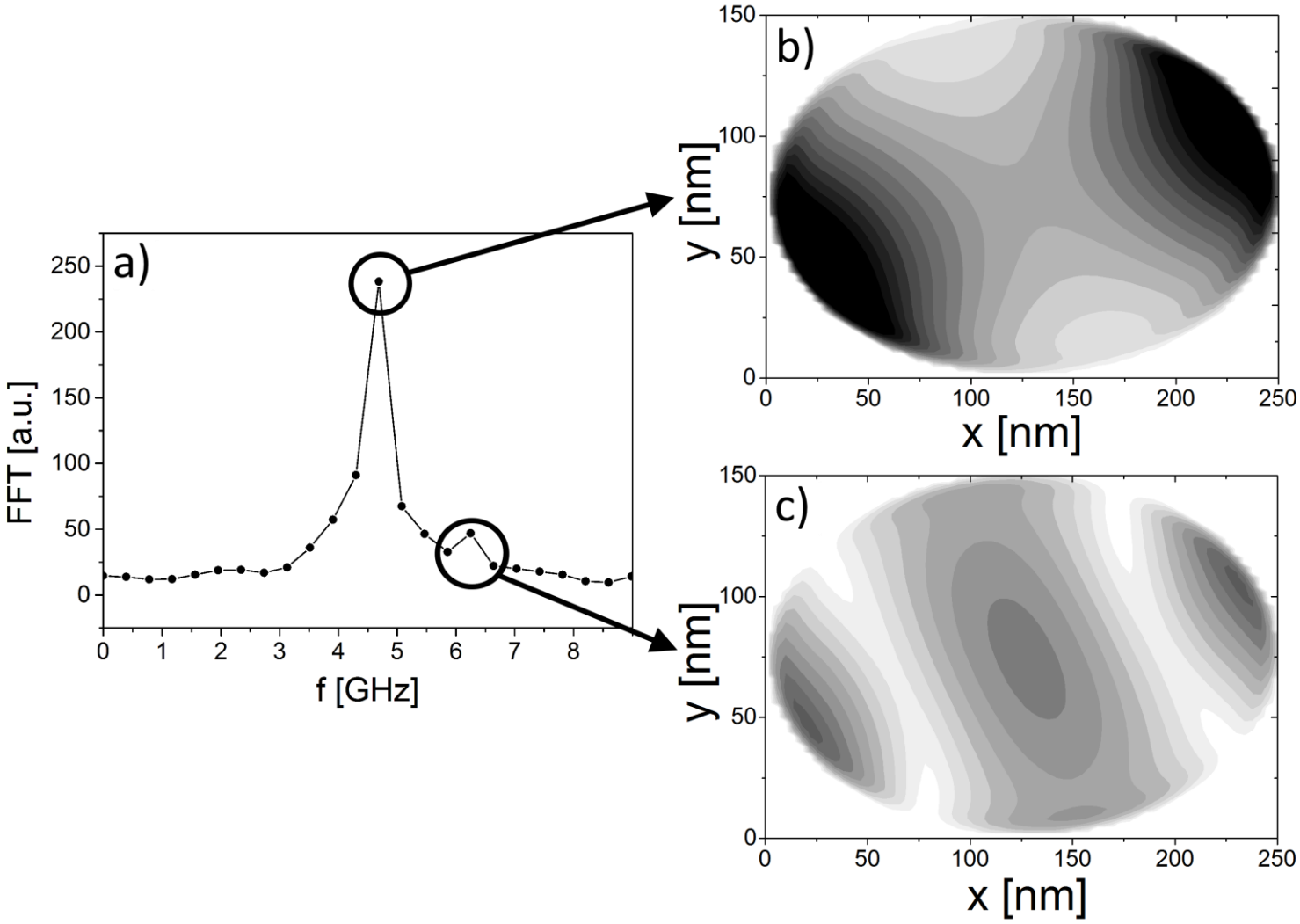
Object-Oriented Micromagnetic Framework (OOMMF) data structure



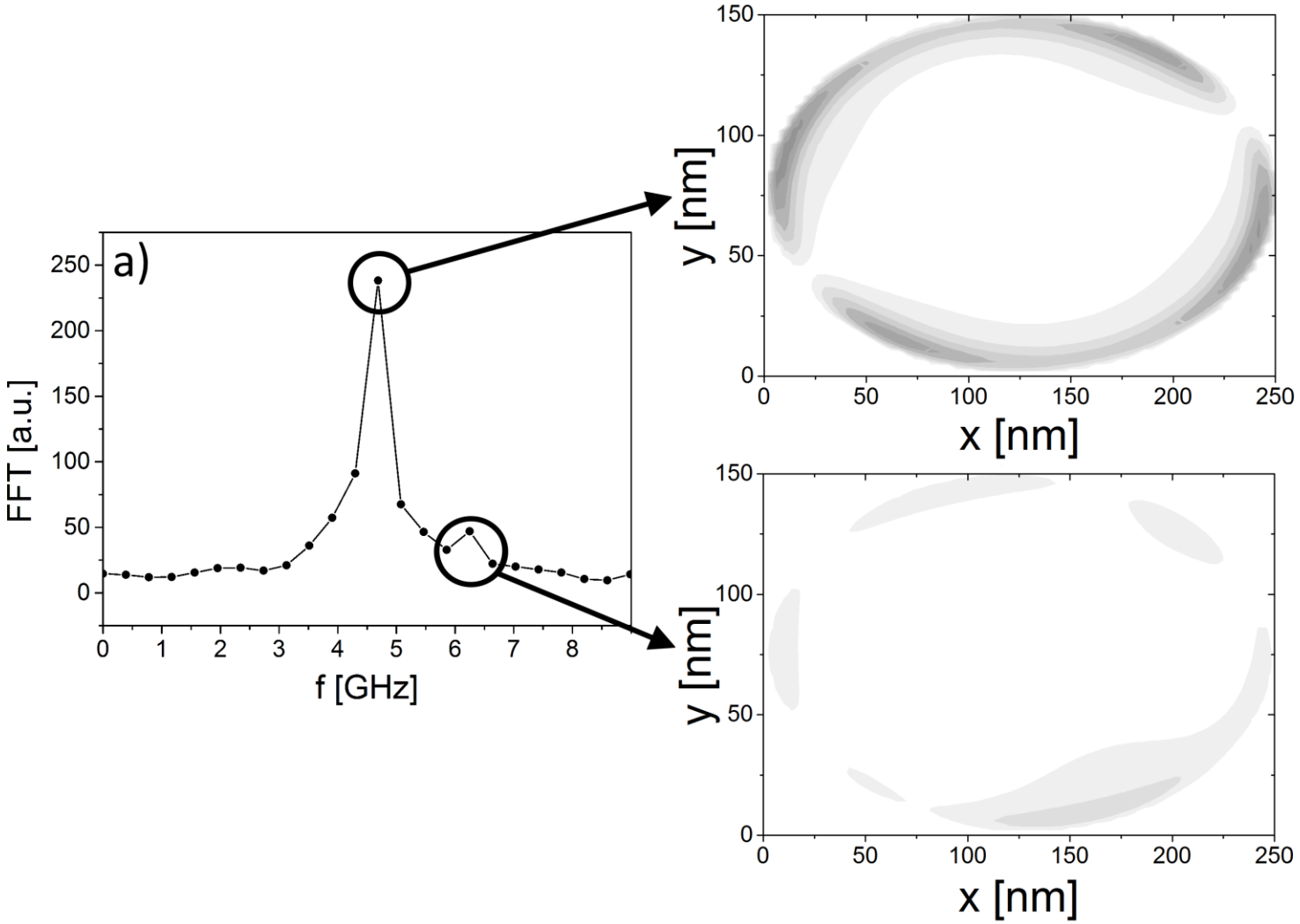
FFT spatial distribution



Results - local analysis



Results - local analysis



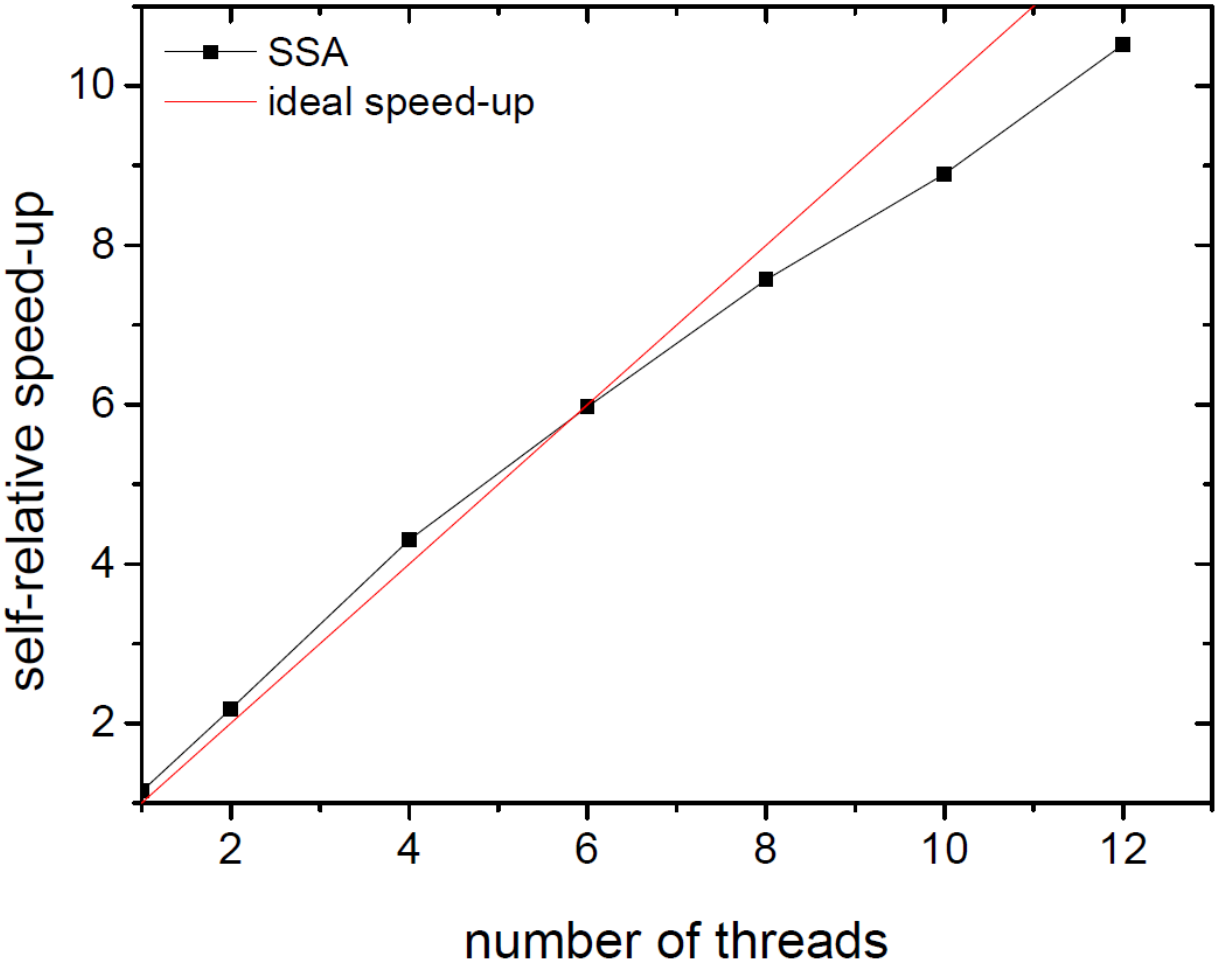
Computations efficiency and scalability

- Investigations of large systems (10-100 GB for a single simulation)
- Computations may take up to several days
- The simulation itself only lasts 1-2 days

Not Practical !

Solution: parallel computing utilizing the PL-Grid infrastructure

Computations efficiency and scalability



Summary

- We have developed open-source tool for generation of the spectral density maps from a set of micromagnetic simulation output files
- Oscillation modes and nodes of spin waves can be precisely localized
- Parallel computations using the PL-Grid infrastructure have allowed for significant decrease in the analysis time

Acknowledgements

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