

High-resolution paleomagnetism techniques with a quantum diamond microscope

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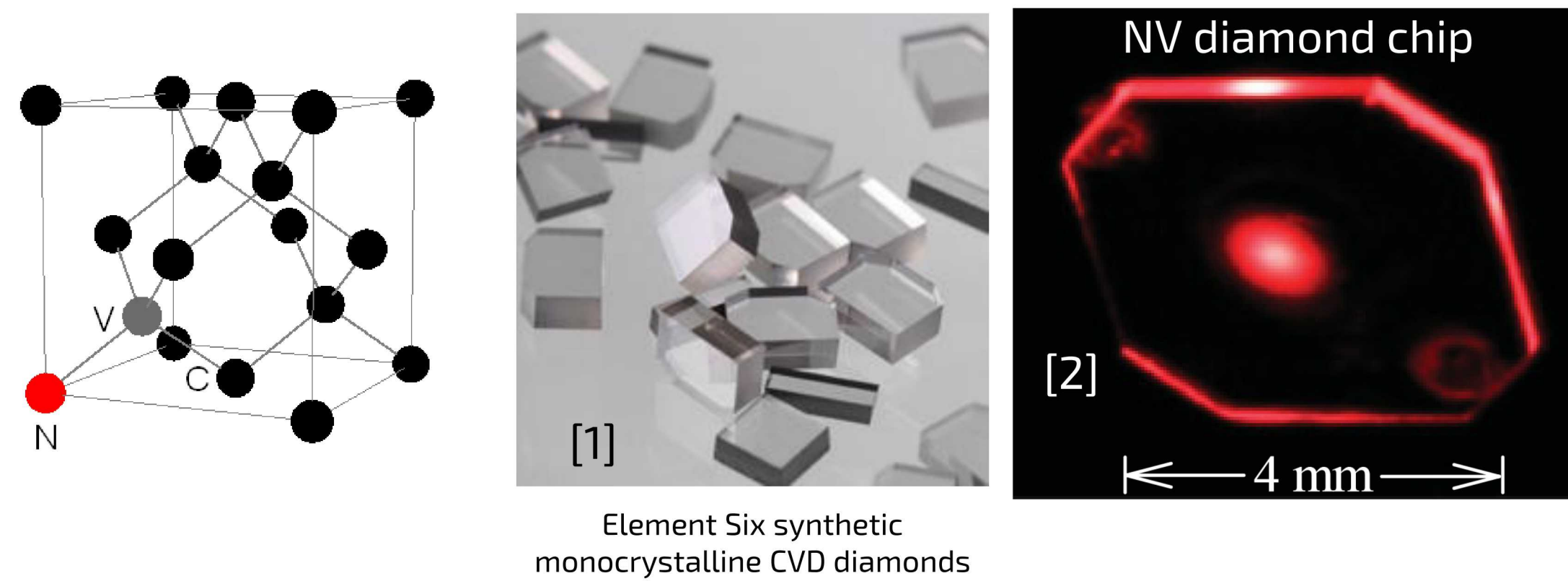
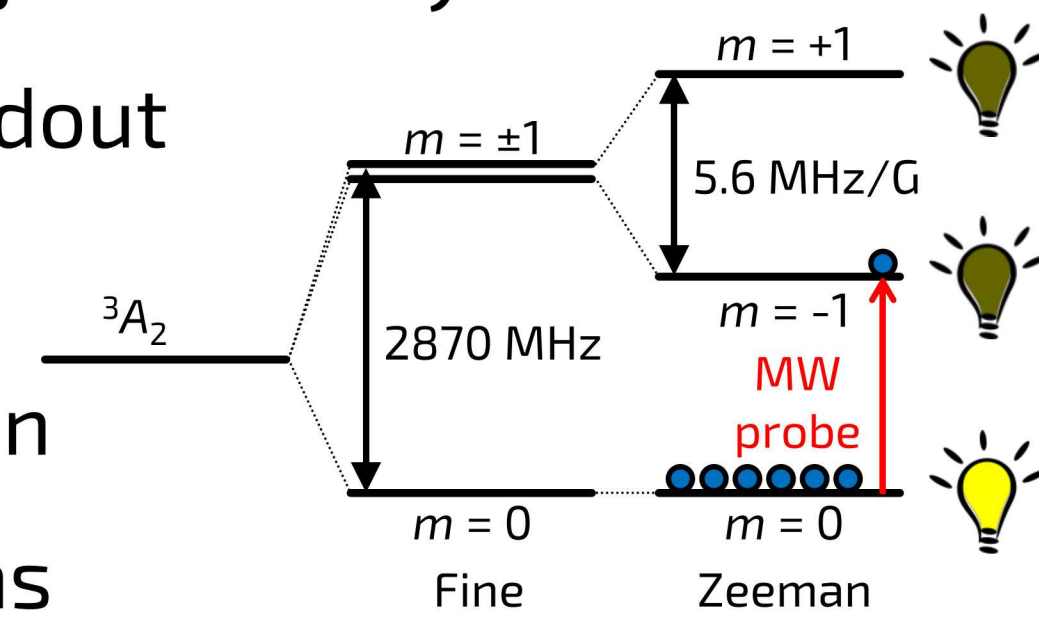
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NV diamond overview

- Color center used for magnetometry

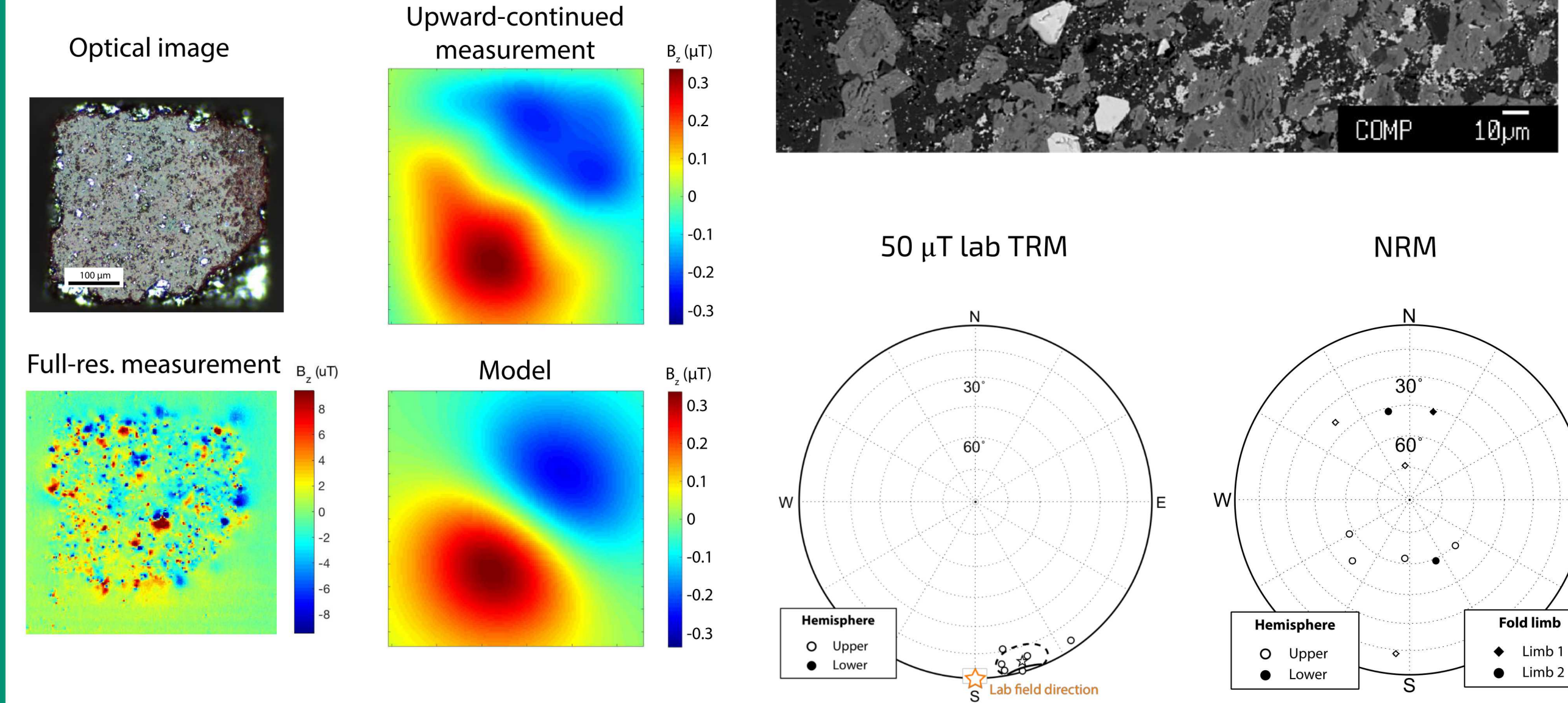
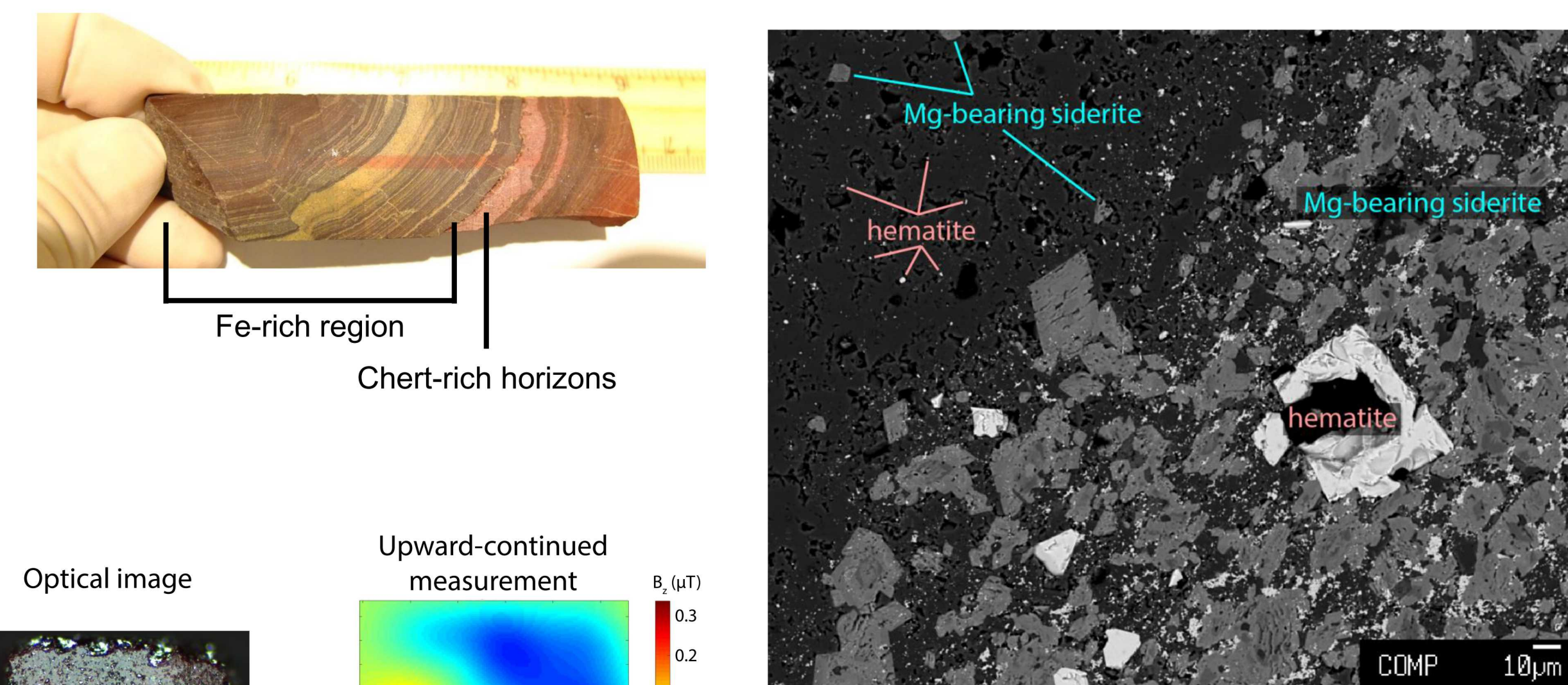
- Optical initialization & readout
- High spatial resolution
- Small NV-target separation
- Work at ambient conditions



Micro-fold test on banded iron formation (BIF)

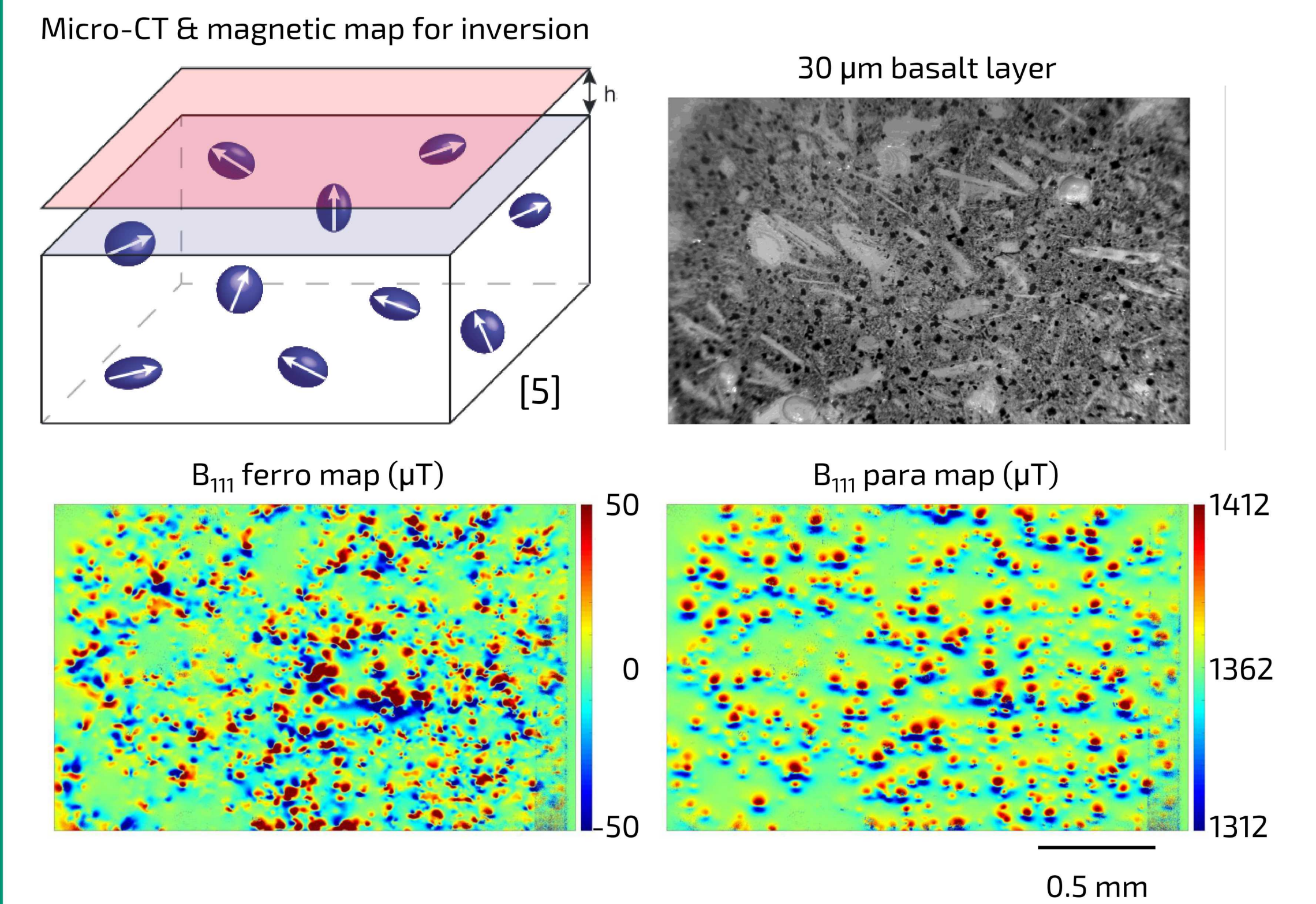
- Barberton greenstone belt ICDP core

- Test mobility of Kaapvaal Craton at >3.0 Ga



Micro-conglomerate test

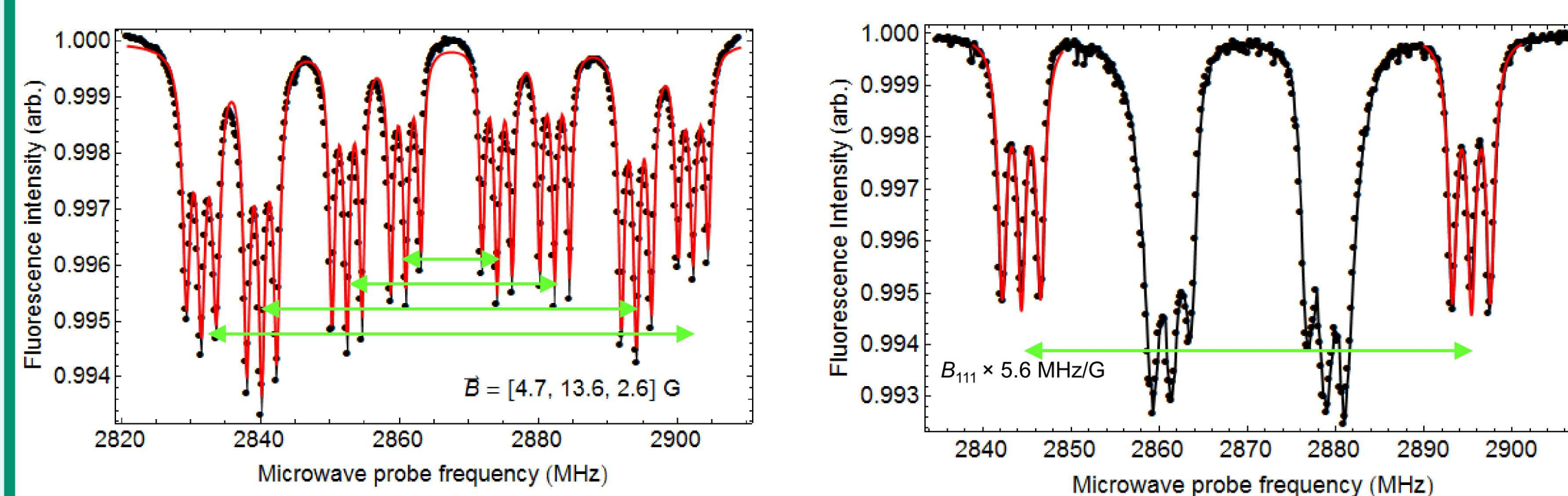
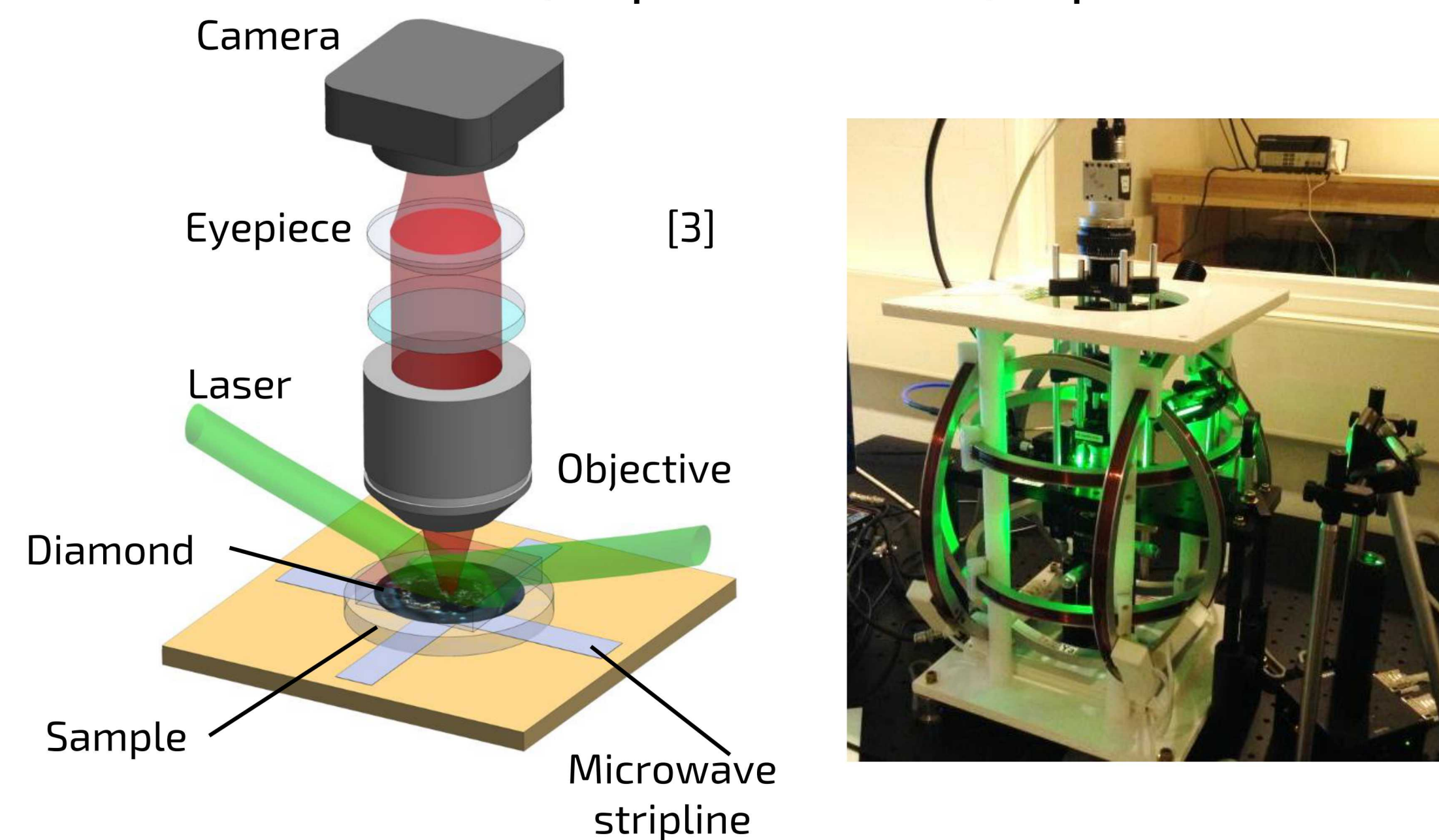
- Sum single-domain grains only



NV magnetic microscopy

- Image NV fluorescence with microscope

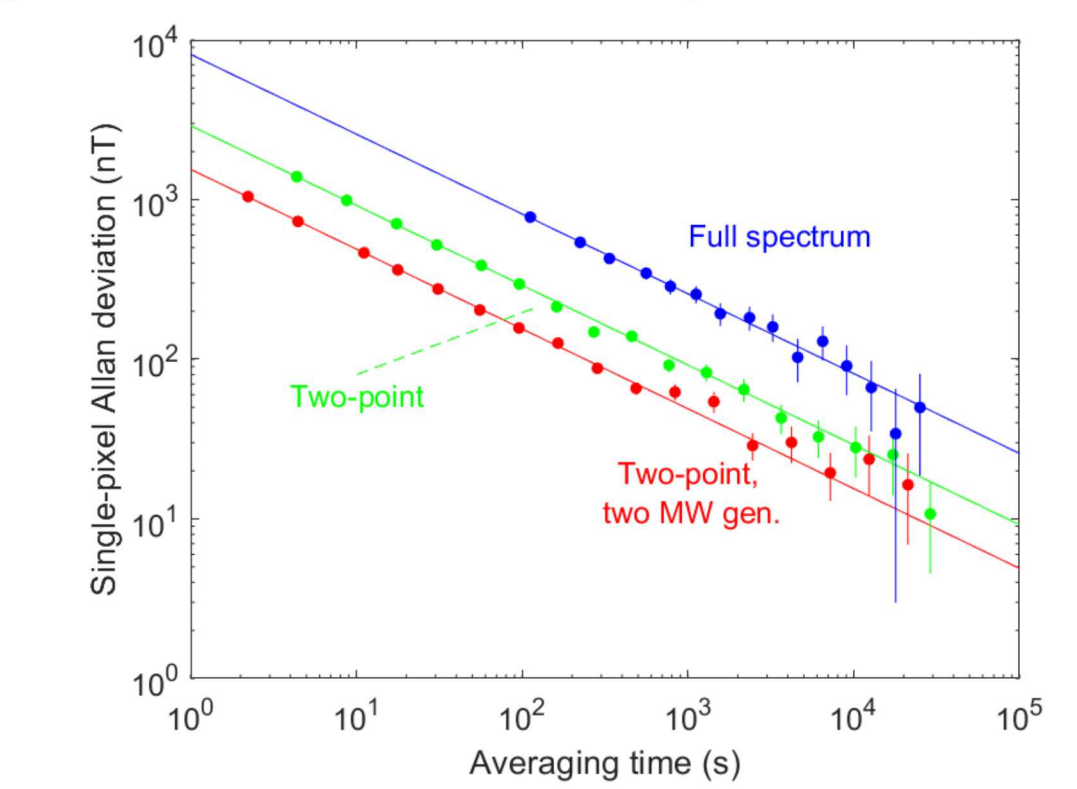
- Resonance spectrum in each pixel indicates local B
- Correlate optical, SEM, and magnetic images
- 2.1 × 1.3 mm FOV, ~1 μm resolution, ~1 μT/Hz^{1/2}



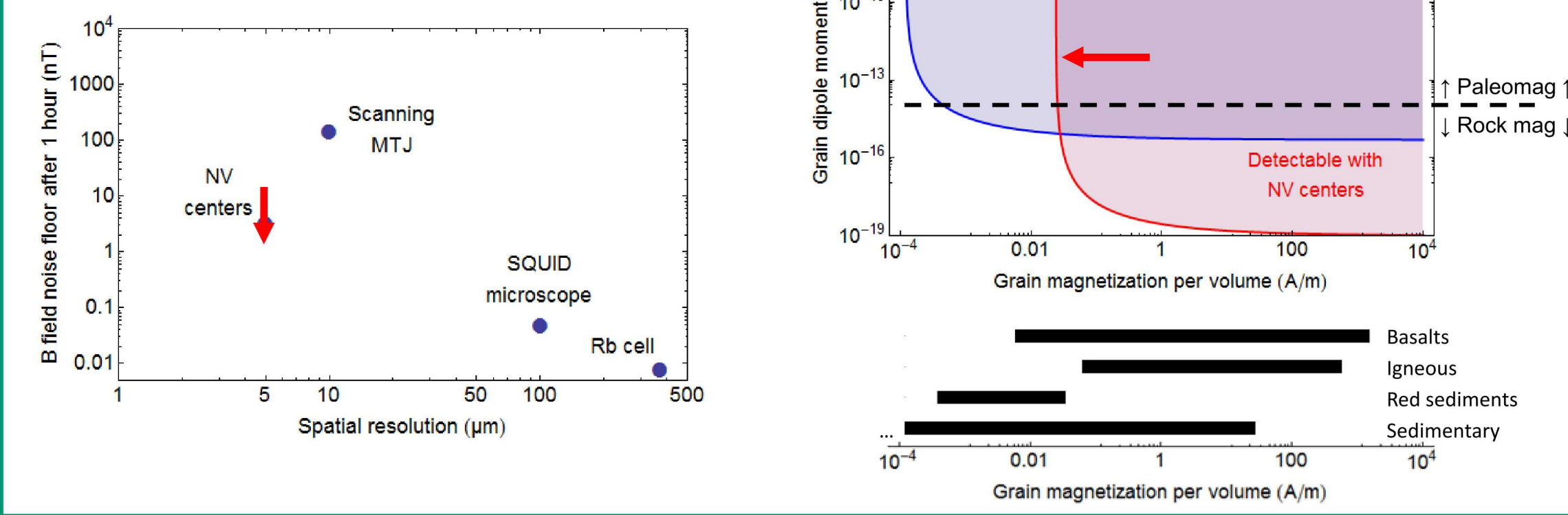
Technical improvements & scope

- Get ~10× better sensitivity with new setup

	B_{min} in 1 s (1 μm pixel)
Prototype, typical [3]	56 μT
Prototype, best-case	14 μT
New setup, full-sweep	8.6 μT
New setup, two-point method	3.1 μT
New setup, two-source method	1.6 μT

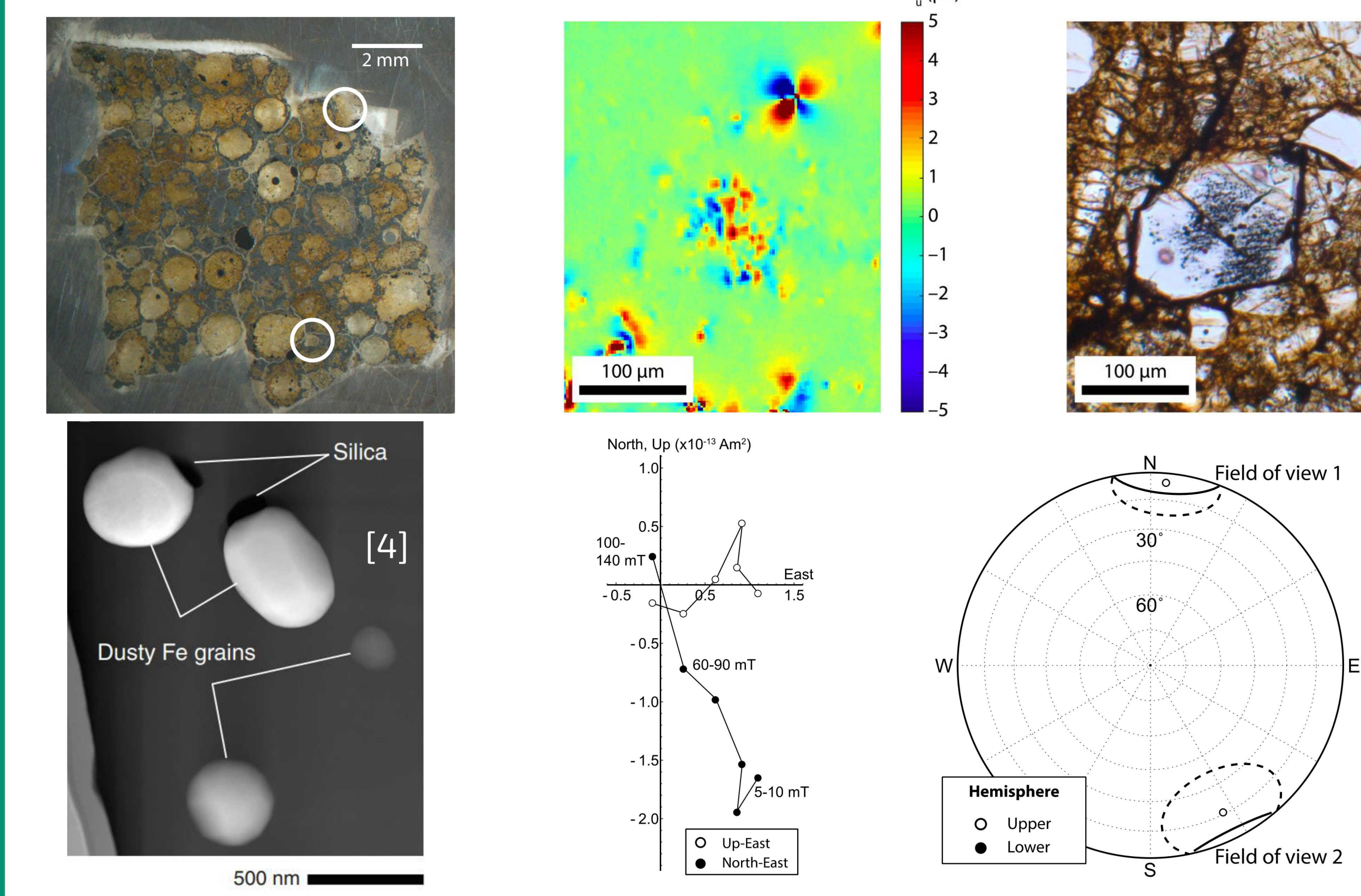


- Best for high-res magnetic imaging



Micro-conglomerate test in GRA 95229 thin section

- How long did the protoplanetary disk B field persist?



References

1. Element Six CVD synthetic diamond; <https://bit.ly/2w8q45K>
2. D. Le Sage *et al.*, Phys. Rev. B 85, 121202(R) (2012).
3. D. Glenn *et al.*, GGG 18, 8 (2017).
4. R. R. Fu *et al.*, Science 346, 6213 (2014).
5. L. V. de Groot *et al.*, Geophys. Res. Lett. 45, 2995–3000 (2018).