

An Unconventional Tradespace of Focused-Ion-Beam Machining

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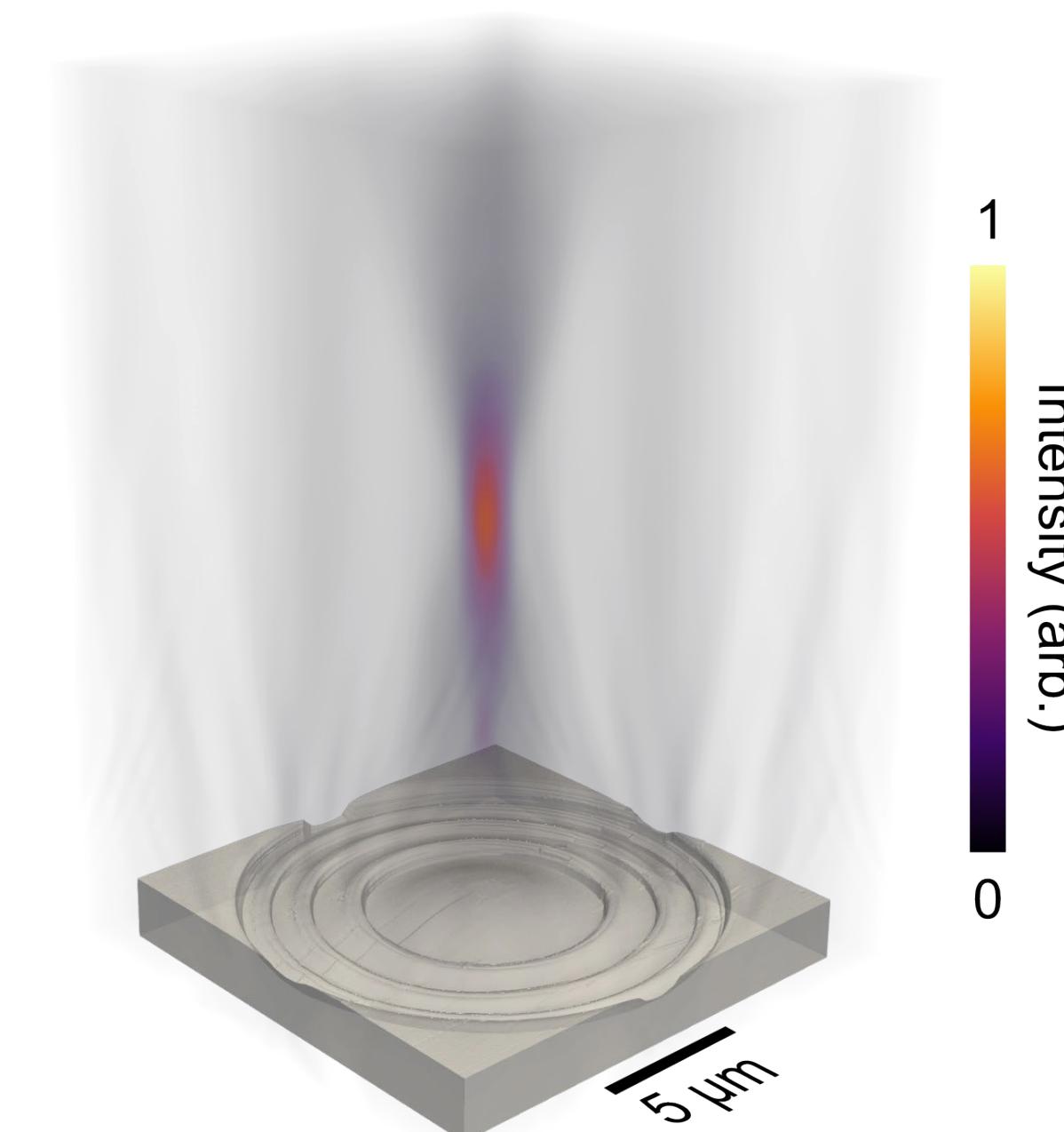
A Motivation

- Sacrificial masks are useful for super-resolving the edges of nanostructures formed by focused ion beam machining.
- But current understanding of the spatial masking process is incomplete.
- Our study suggests that the old paradigm of spatial masking to improve patterning resolution offers dramatic improvements to fabrication throughput, which we quantify.

B Key findings

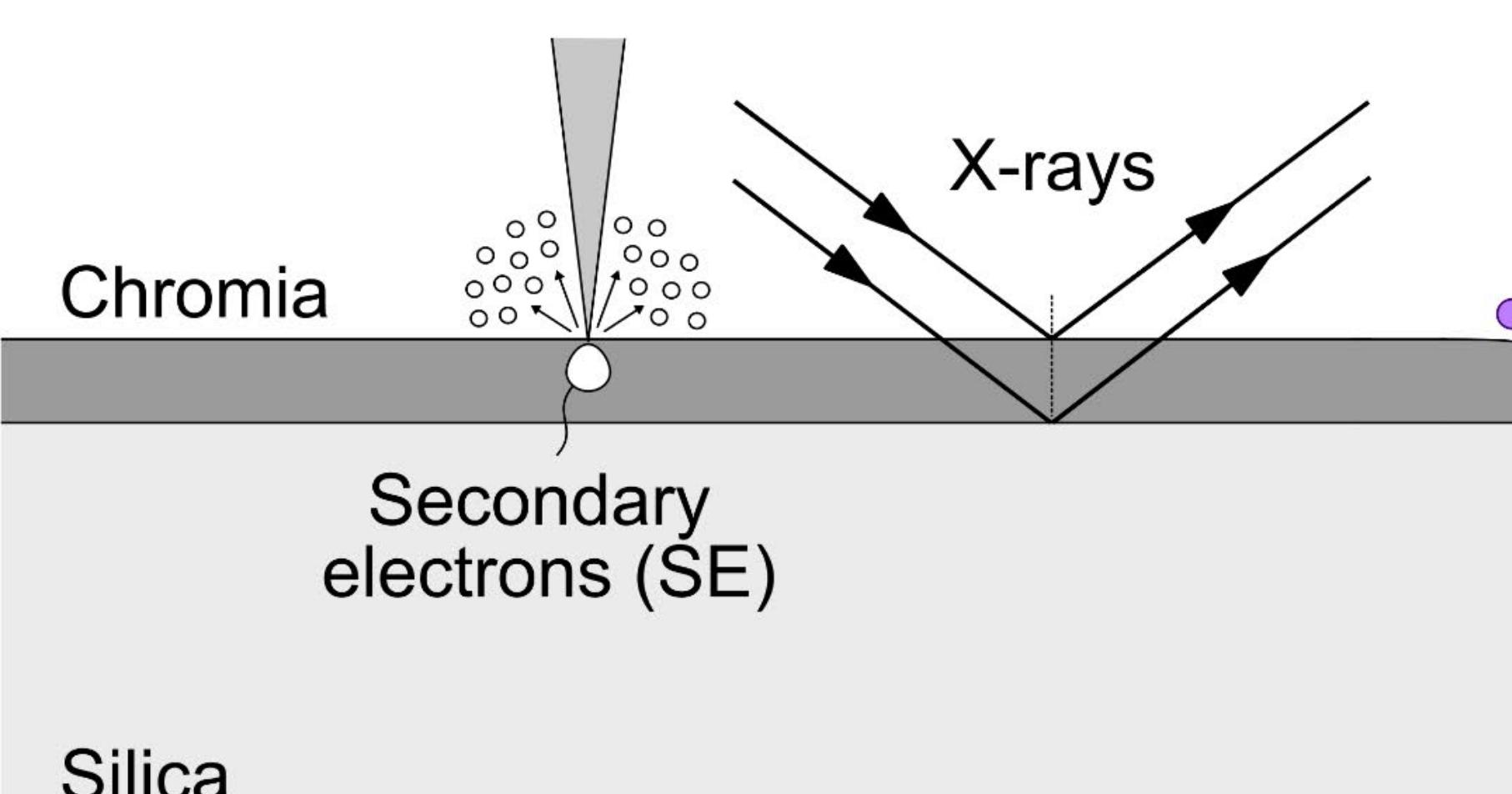
- Chromia (Cr_2O_3) sputter-deposits with nanometer roughness, is mostly amorphous, and resists charging.
- An efficient method of in-line metrology enables rapid and quantitative adjustment of the focus of the ion beam.
- We observe super-resolution factors as high as 6 ± 2 and model the effect with good experimental agreement.
- The dominant effect of the super-resolution process is temporal, improving throughput for equivalent resolution by 1 to 3 orders of magnitude.

C Future applications



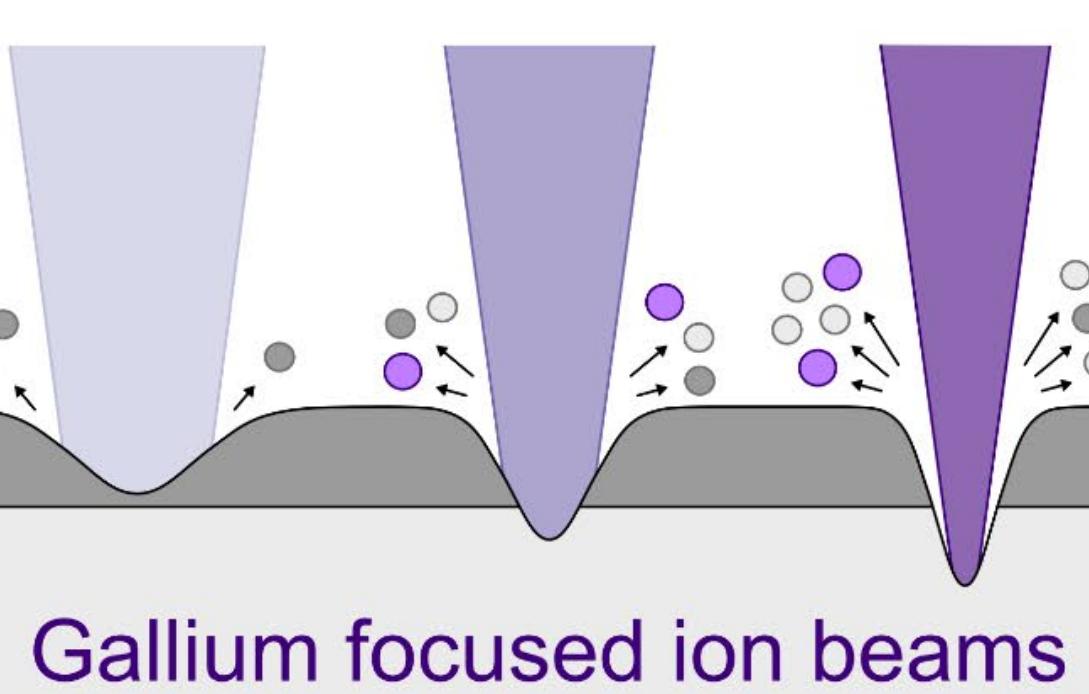
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Chromia characterization



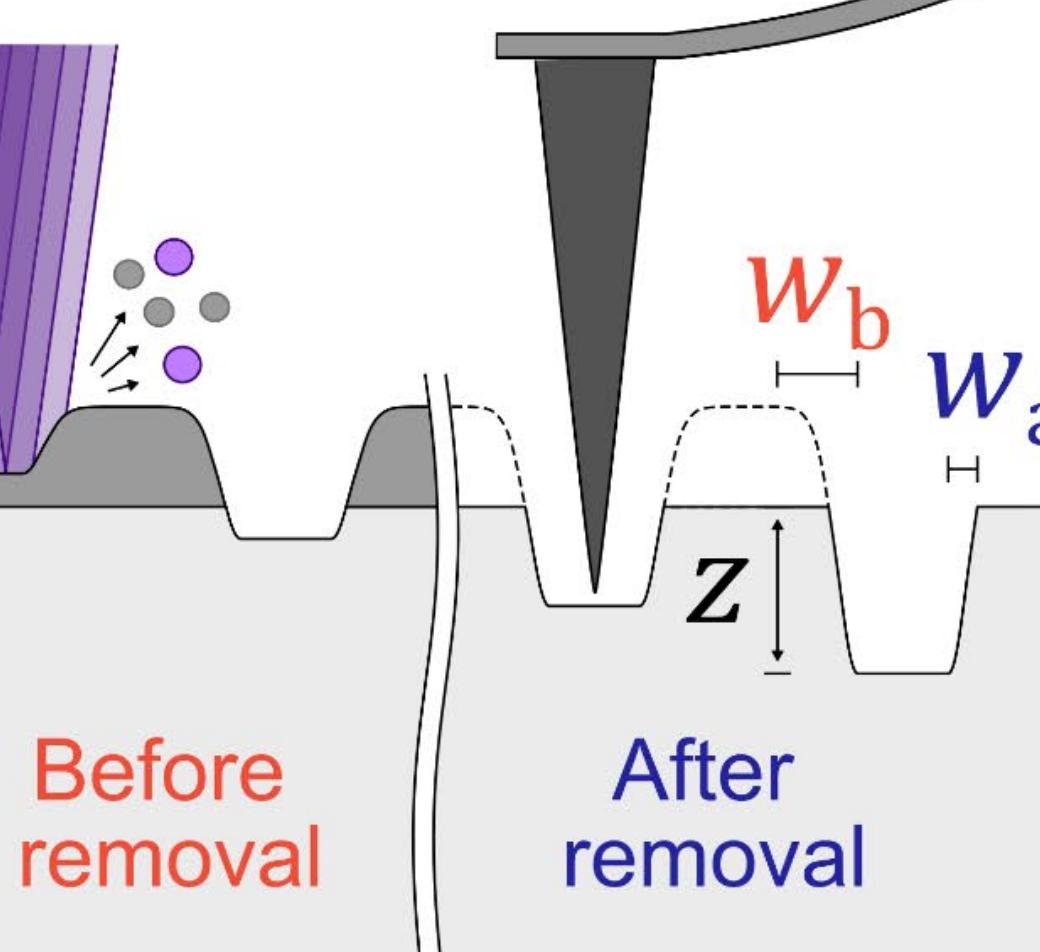
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In-line resolution metrology



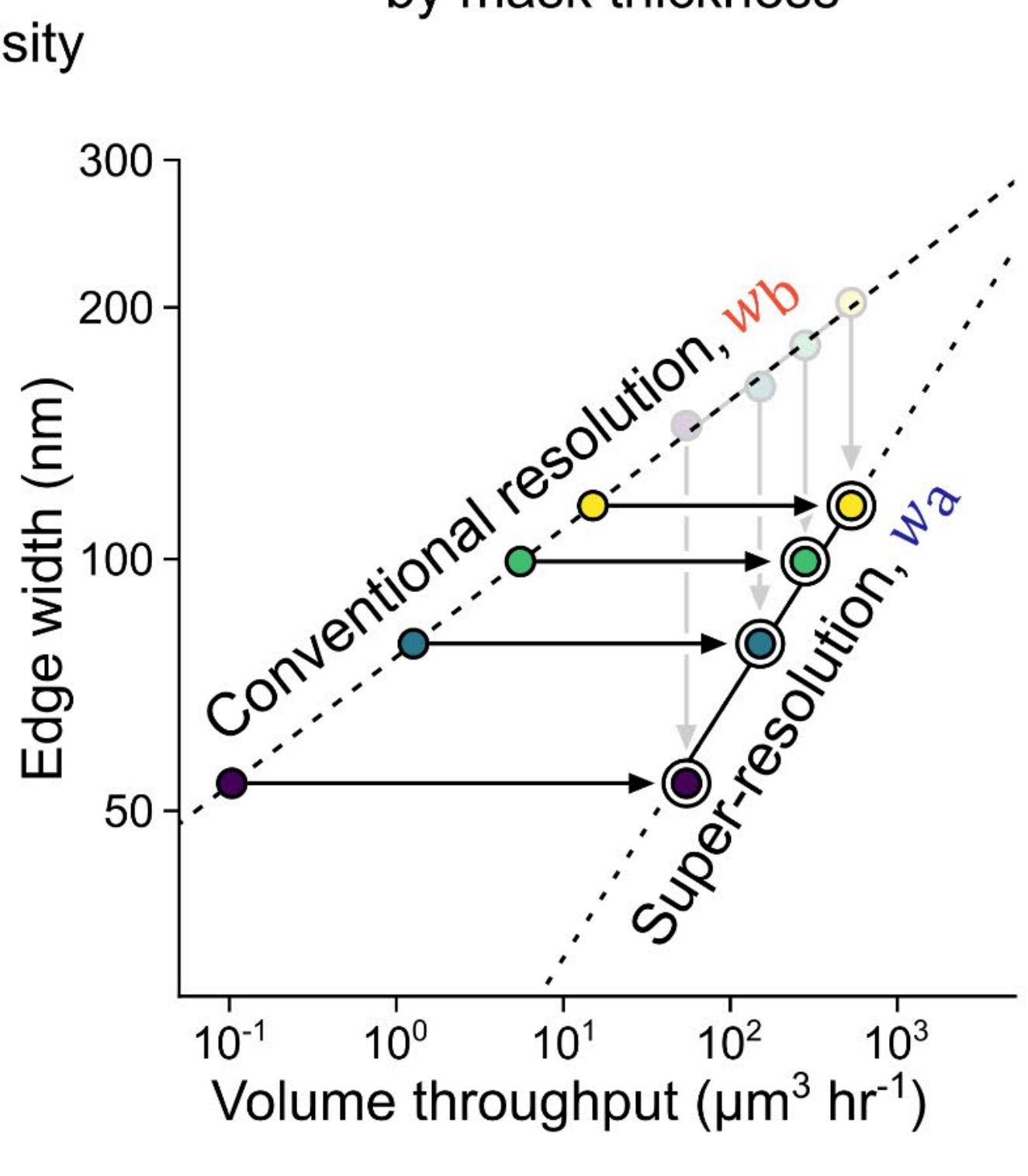
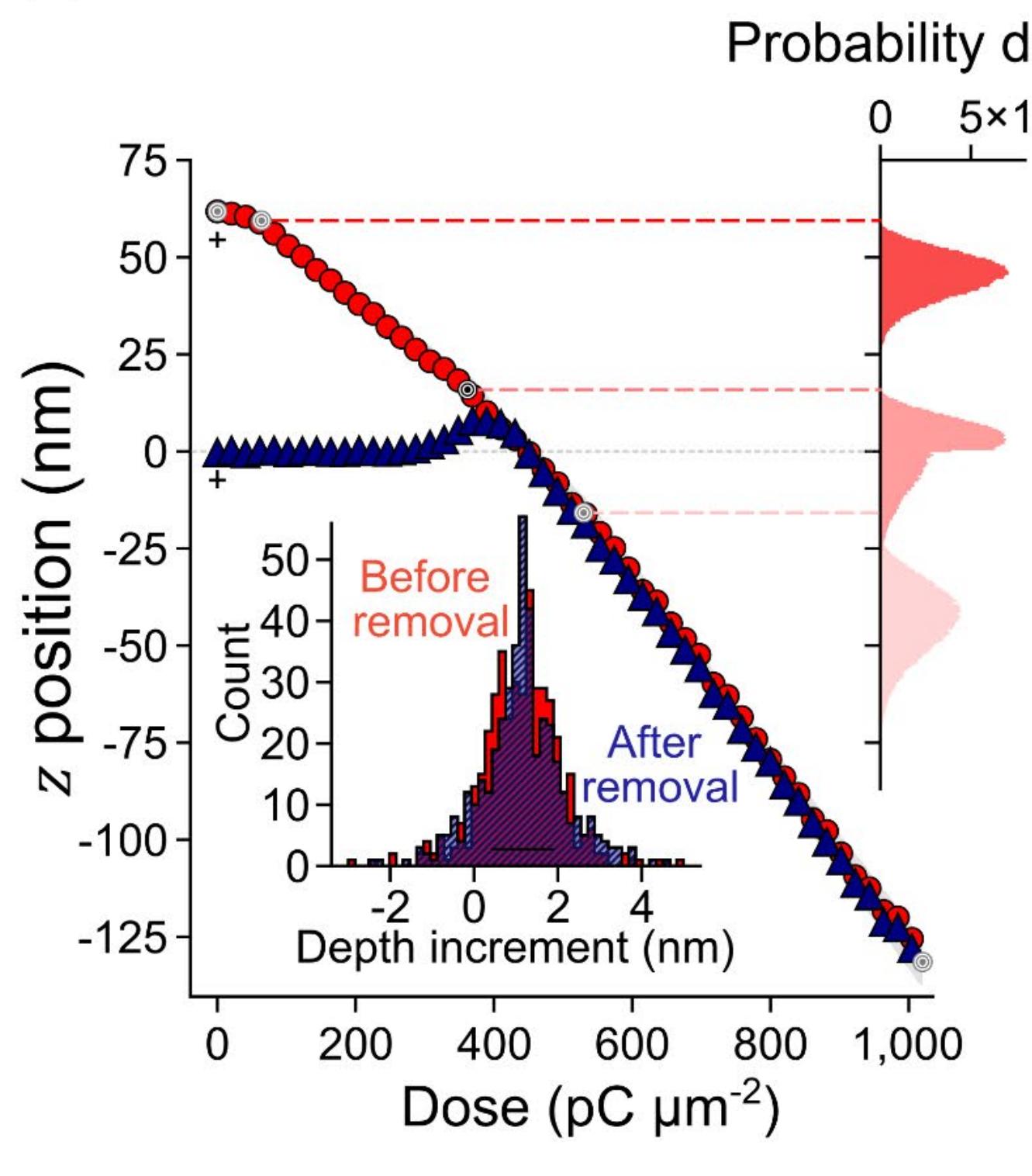
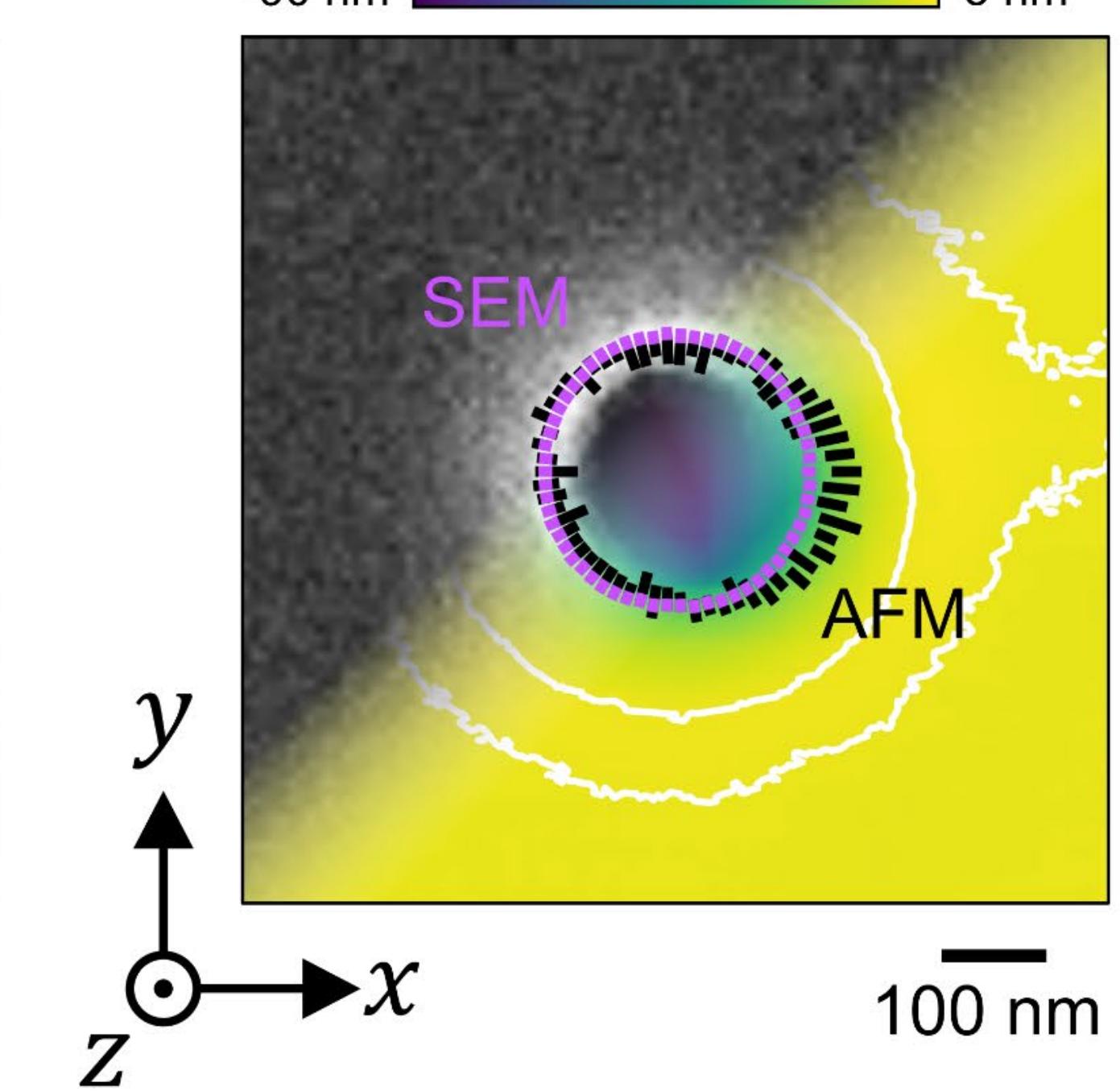
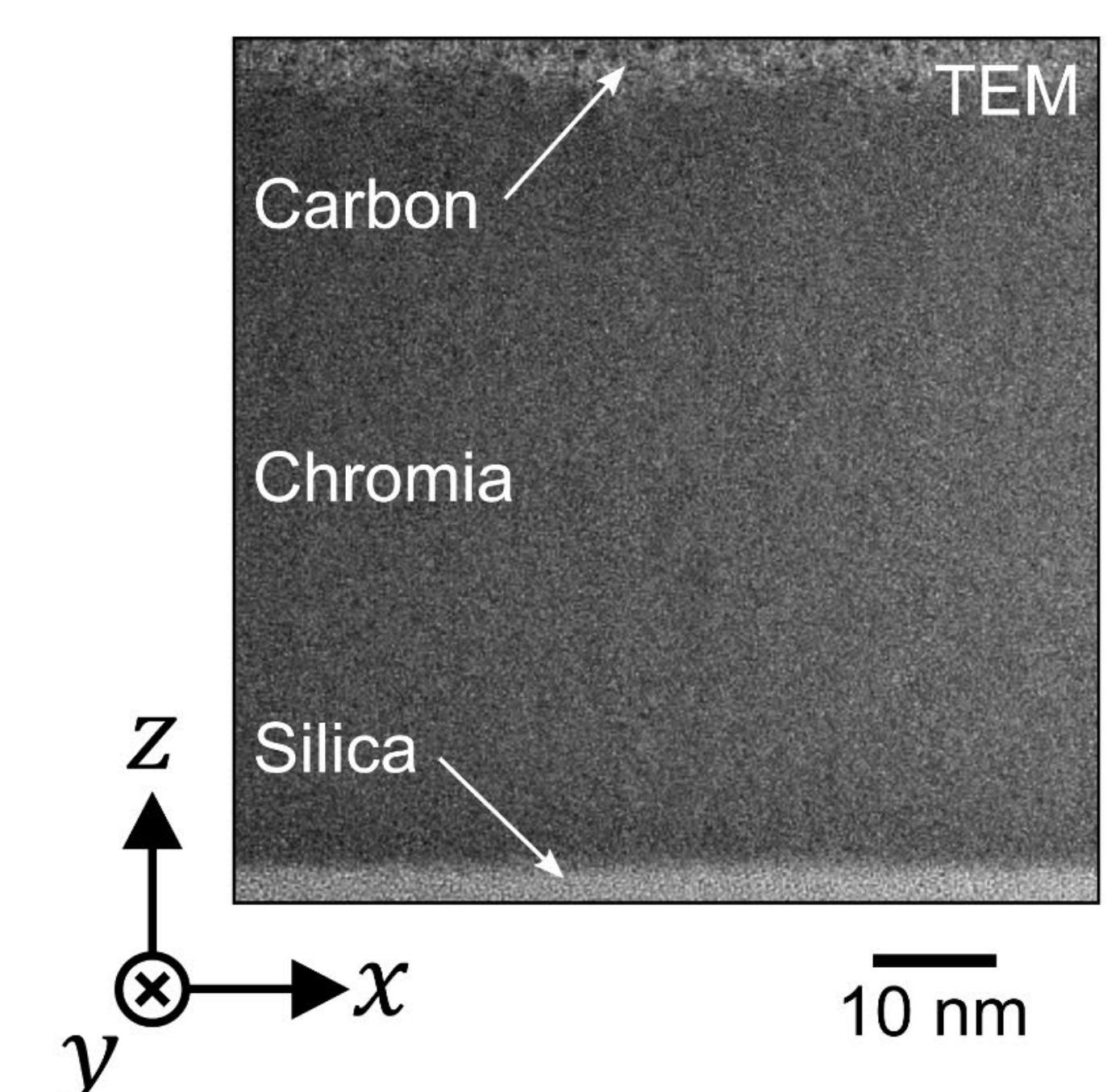
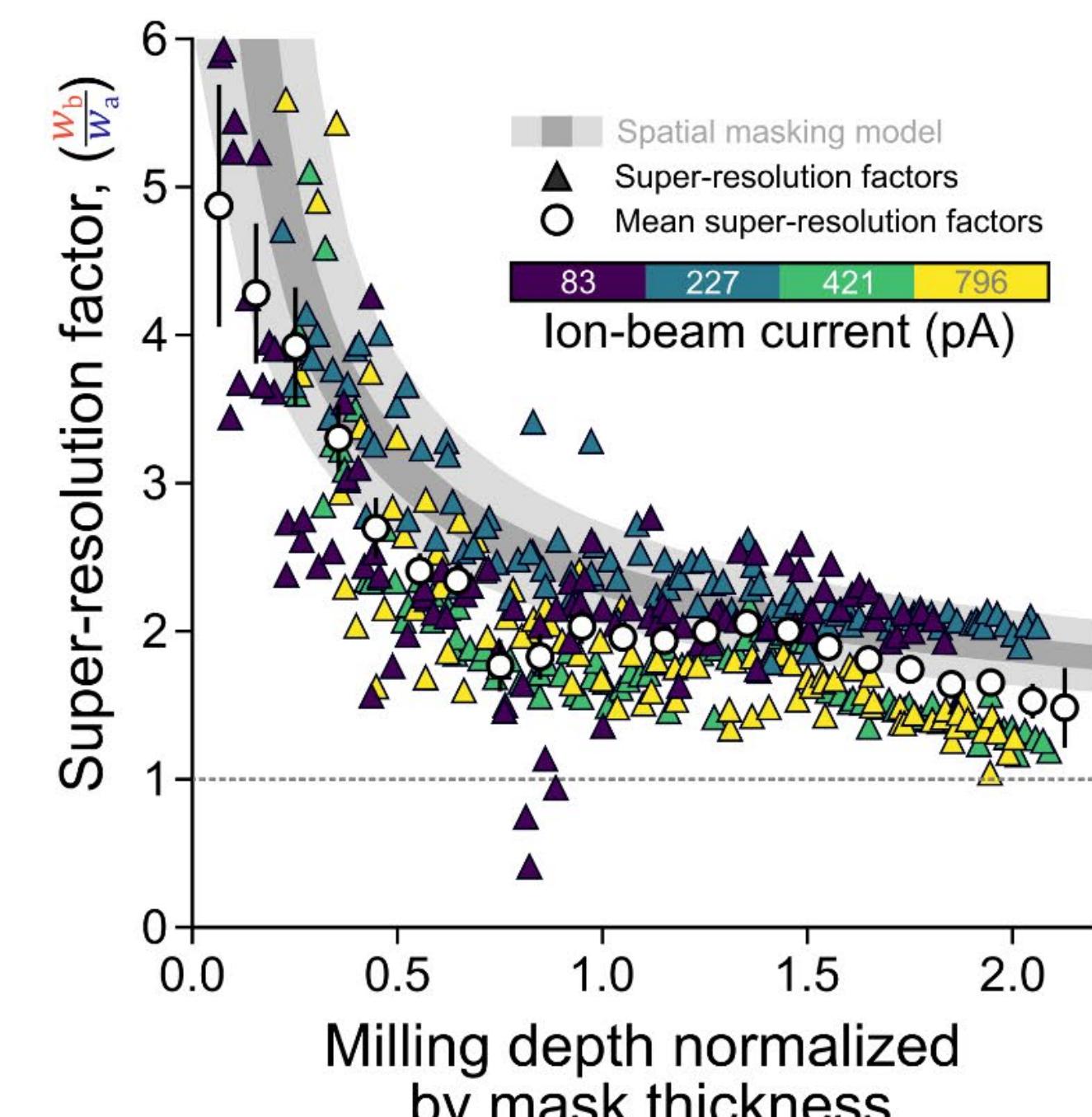
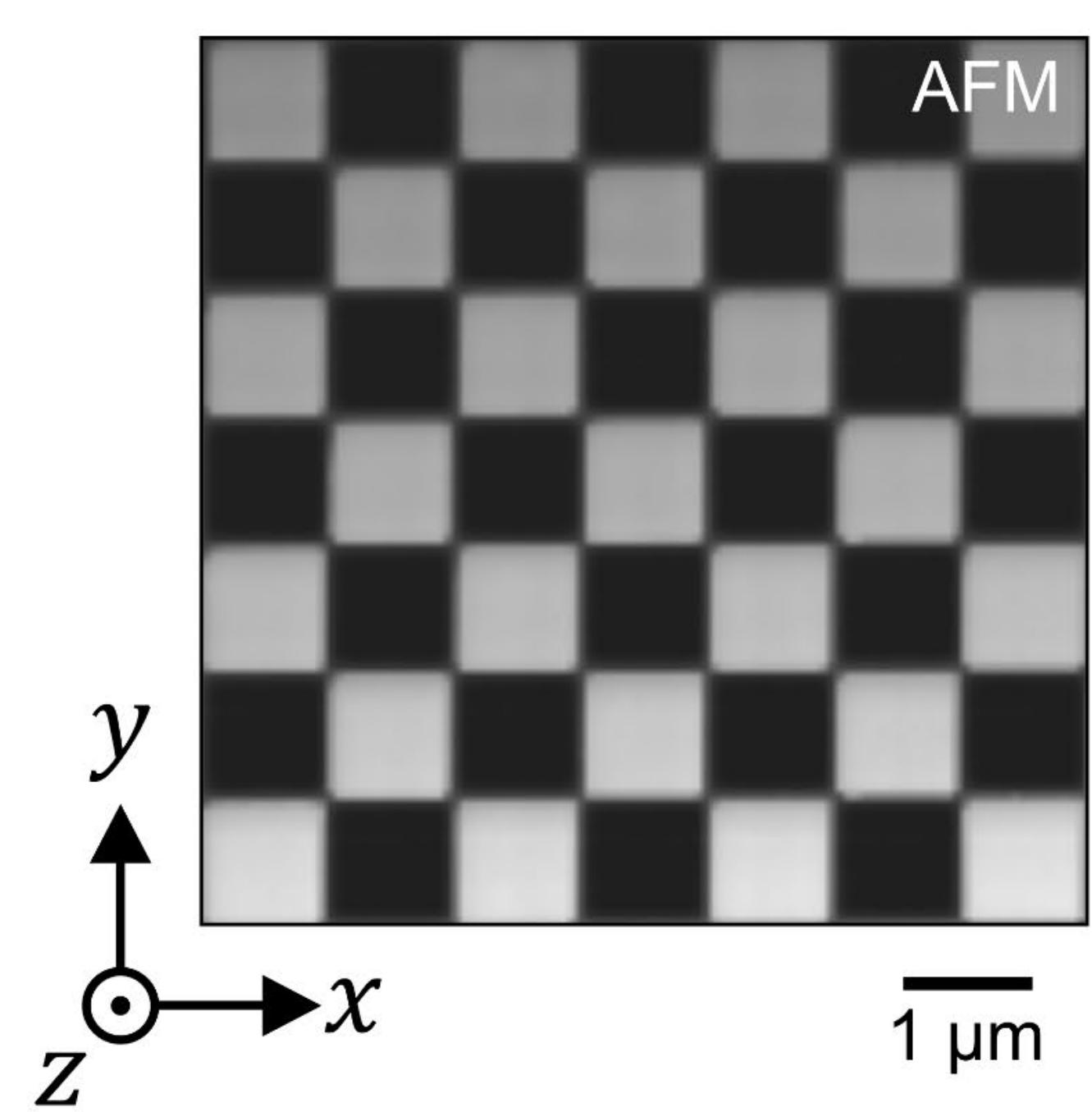
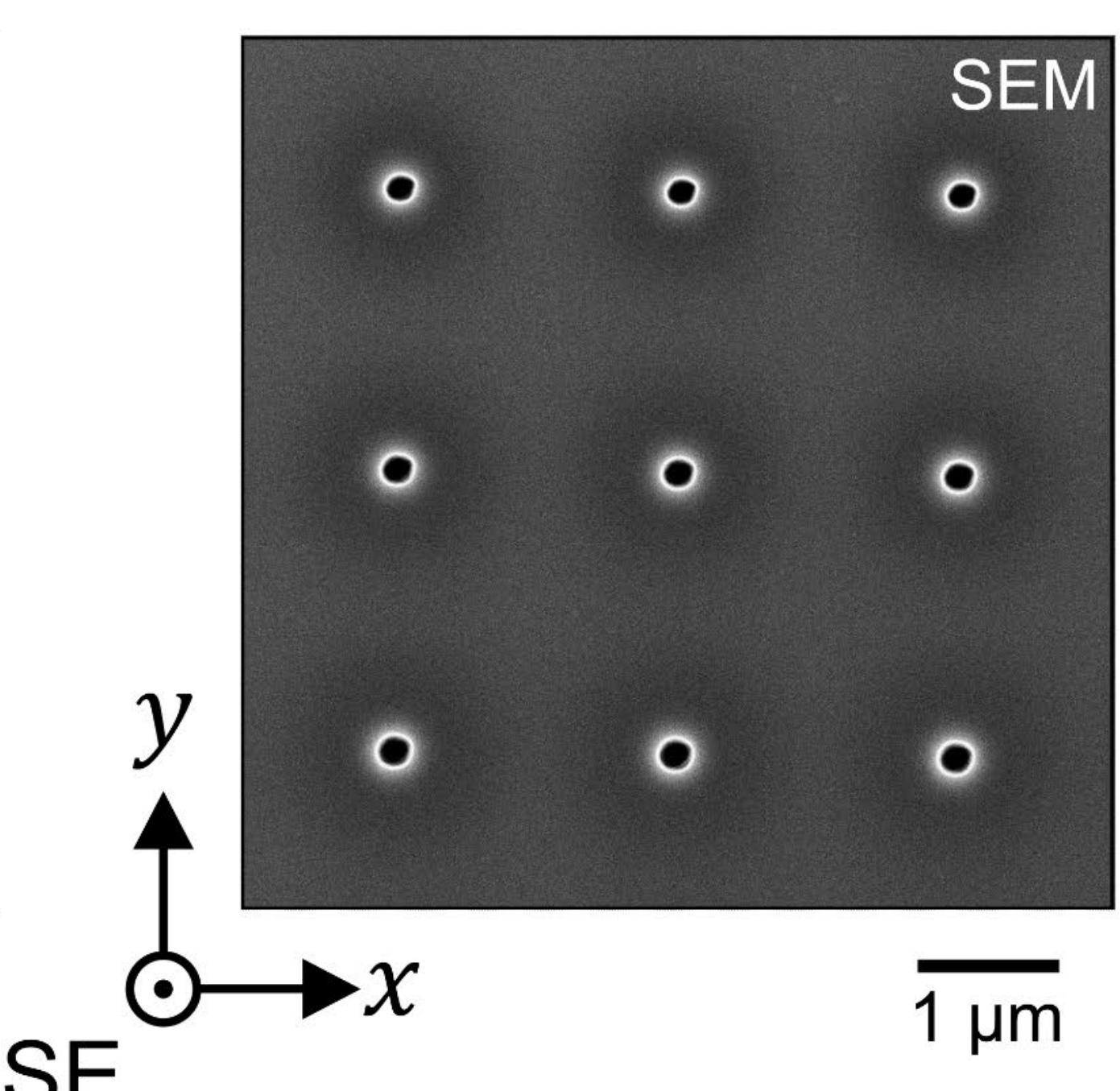
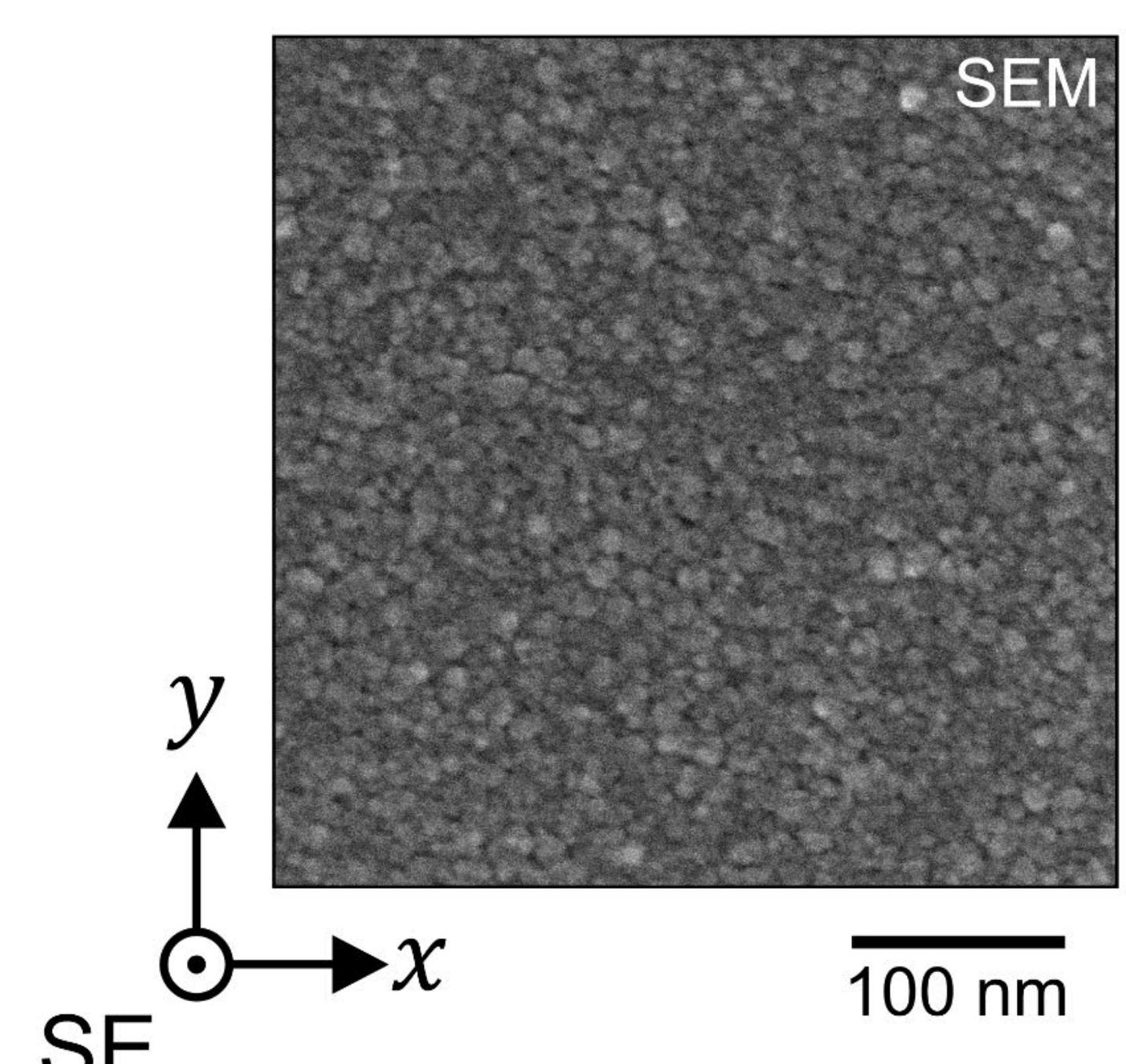
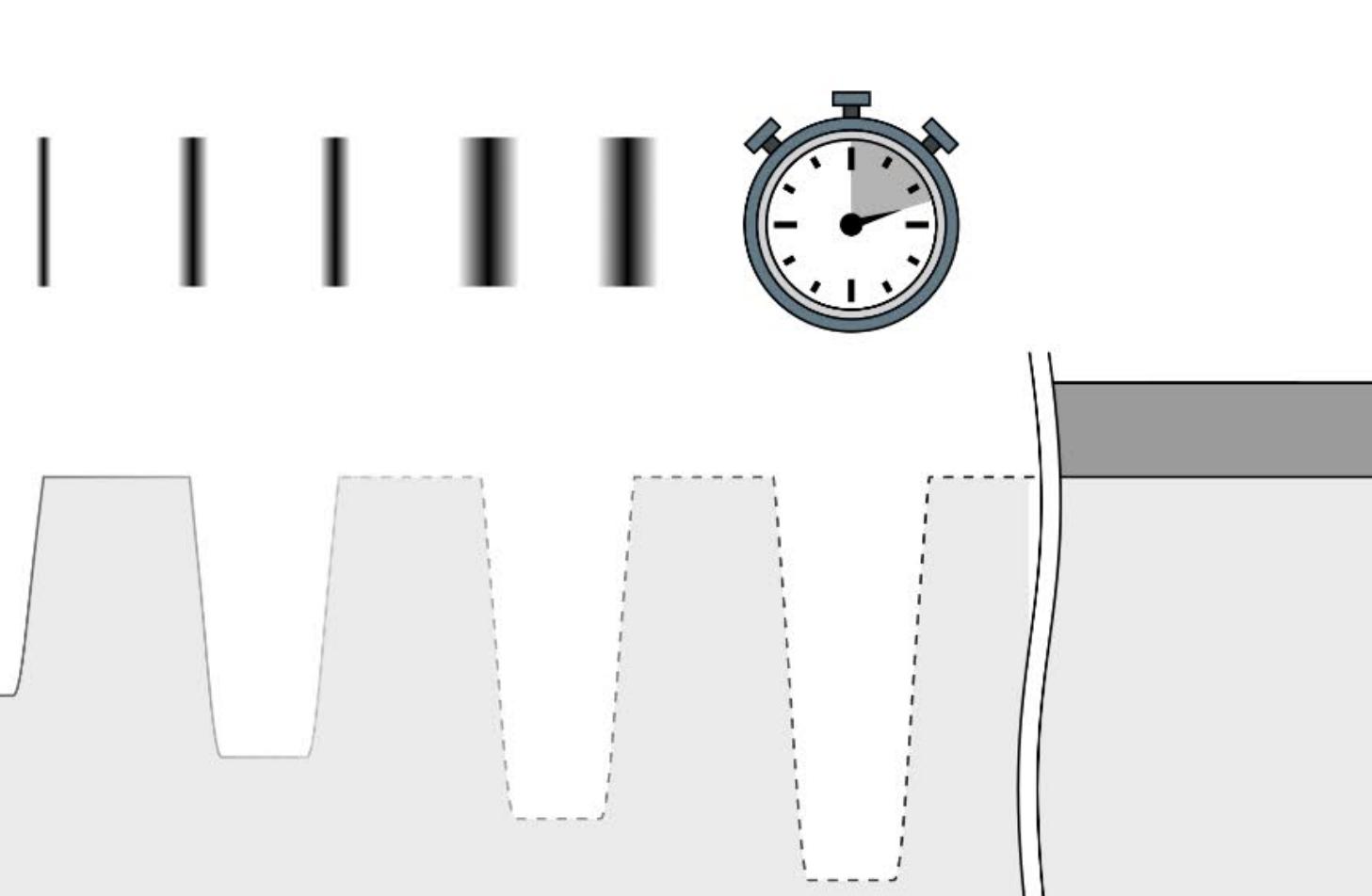
F

Complex test structures



G

Resolution and throughput



H References

A. C. Madison, et al. Super-resolution and ultrahigh-throughput of focused-ion-beam machining, *arXiv* (2020).



I Funding

The National Research Council supports this work through a postdoctoral fellowship administered by the Research Associateship Program.

