Tilt removing problem in rotational scanning atomic force microscopy

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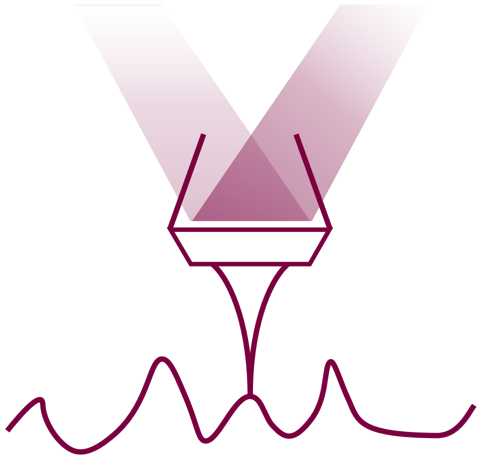
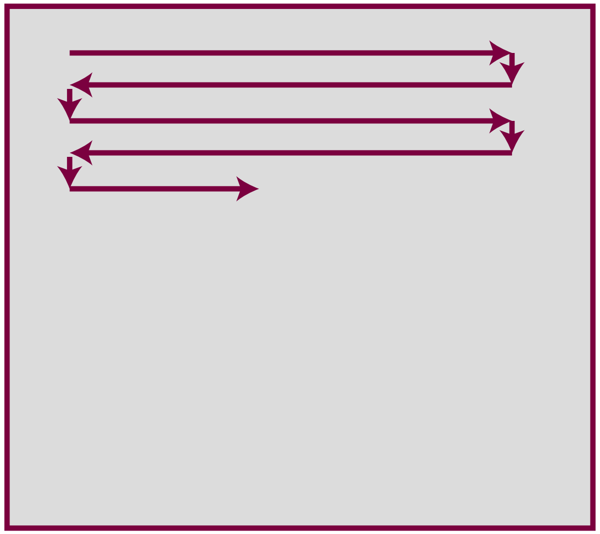
Working principle of atomic force microscopy

A very narrow tip (having only several atoms at the end of the tip) touches a surface and shifts up and down depending on the surface topography. Such movements can be measured by a lazer beam which reflects from the head of the tip.



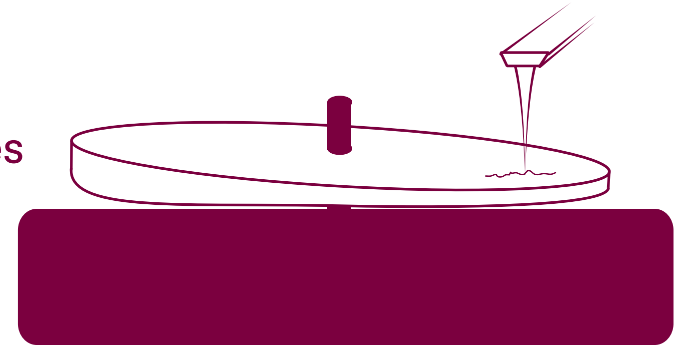
A most common scanning method is when the tip performs a snake-type (raster scanning) motion along the surface. Such a scanning method requires precise and slow steering of the tip along the surface of the sample. For example, the left-right and right-left segments should be of the same length, or the up-down segment should be very short. This leads to a long scanning time and only small areas can be scanned.



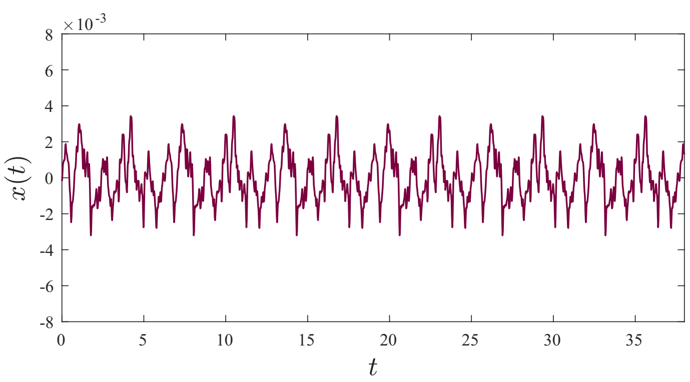
Principle of rotational scanning technique

In the paper [A. Ulčinas and Š. Vaitekonis: Rotational scanning atomic force microscopy, Nanotechnology **28(10)** (2017)] the authors propose a fast scanning technique based on sample rotation. Such a method reminds the working principle of a gramophone.

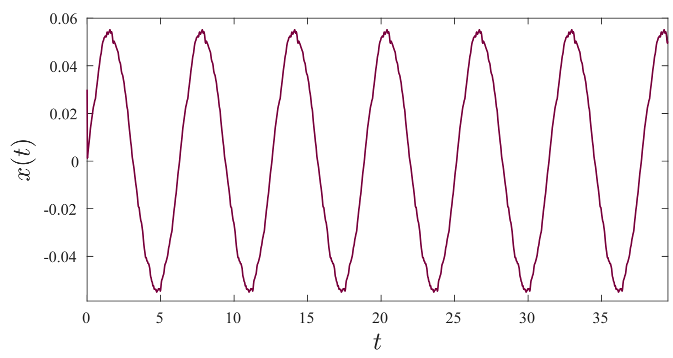
However, this technique has another problem: the sample is always tilted with respect to the horizontal axis of the tip. This tilt is especially problematic for large areas because it becomes more expressed once we go further away from the rotation center. The consequence of the tilt is that the measured signal contains a large first (parasitic) harmonic which does not have the information on the topography.

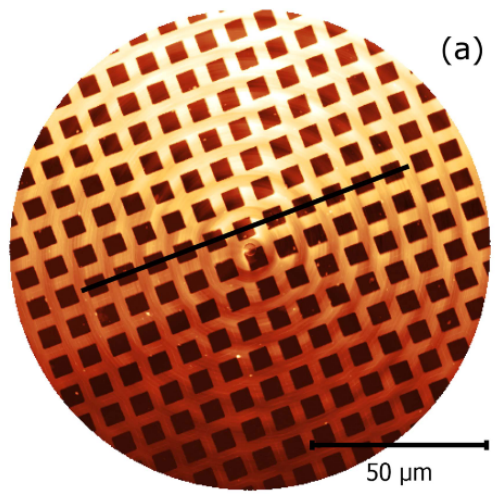


We want to measure:



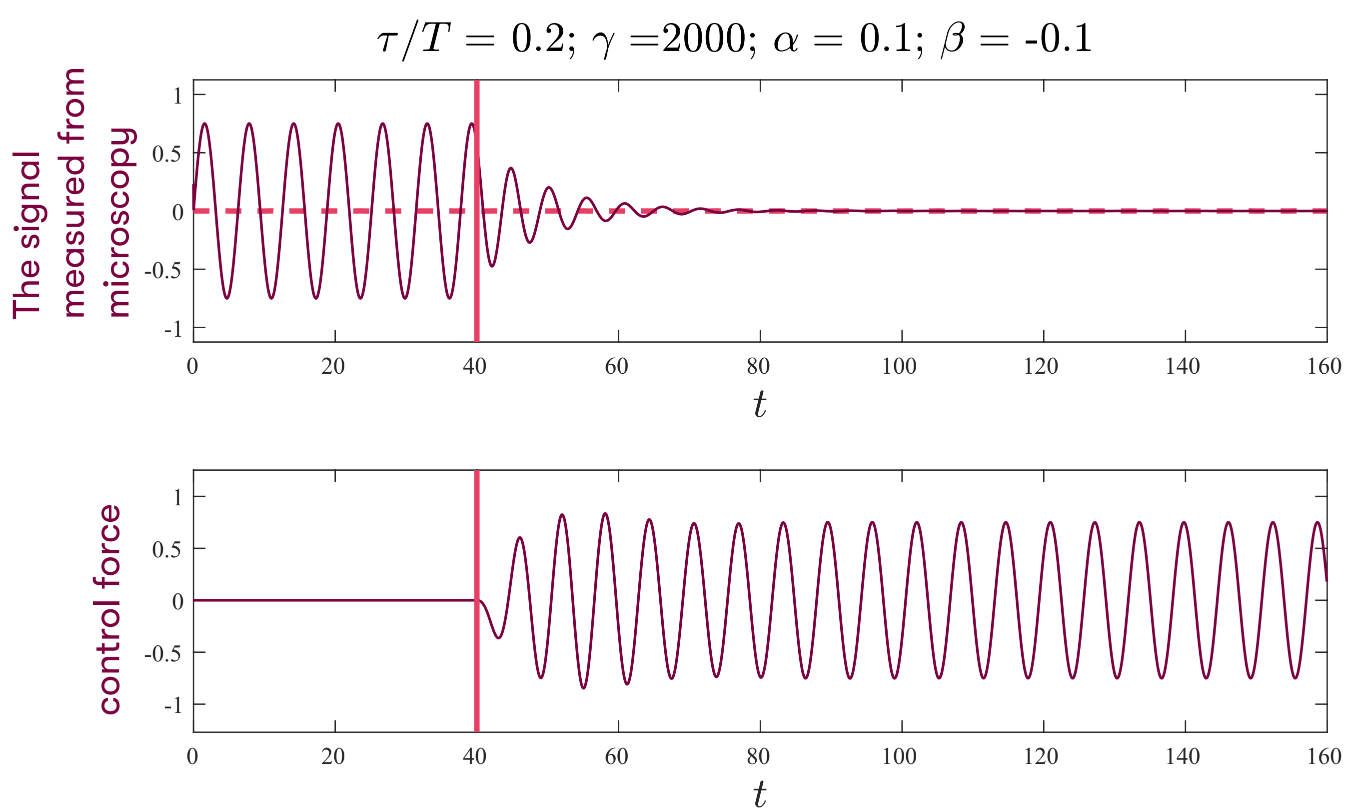
We actually measure:





Algorithm to compensate first (parasitic) harmonic in measured signal

Along with rotation, we can move the sample up and down to eliminate the first (parasitic) harmonic in the measured signal. However, here we deal with another problem - a delay time. Mostly it appears because of the finite reaction time of a motor which moves the sample up and down. We emphasize that the delay is essential: it can not be avoided and it is a priori unknown. Moreover, it can depend on many factors (temperature, humidity, etc.).



My algorithm is able to detect how the sample should be moved up and down in order to get rid of the first harmonic in the measured signal. Here a numerical demonstration of my algorithm is depicted.

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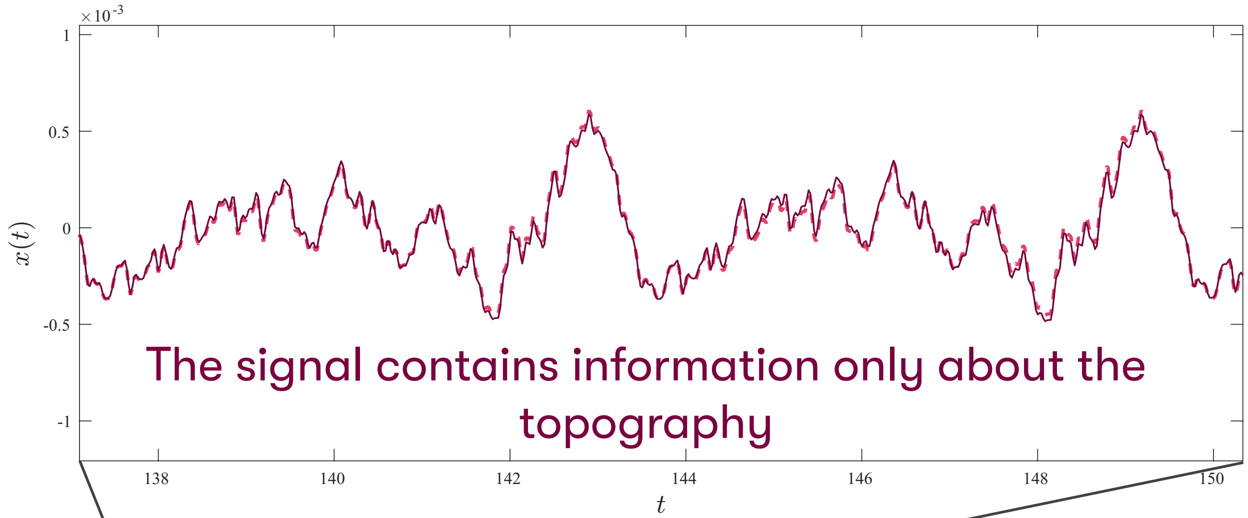

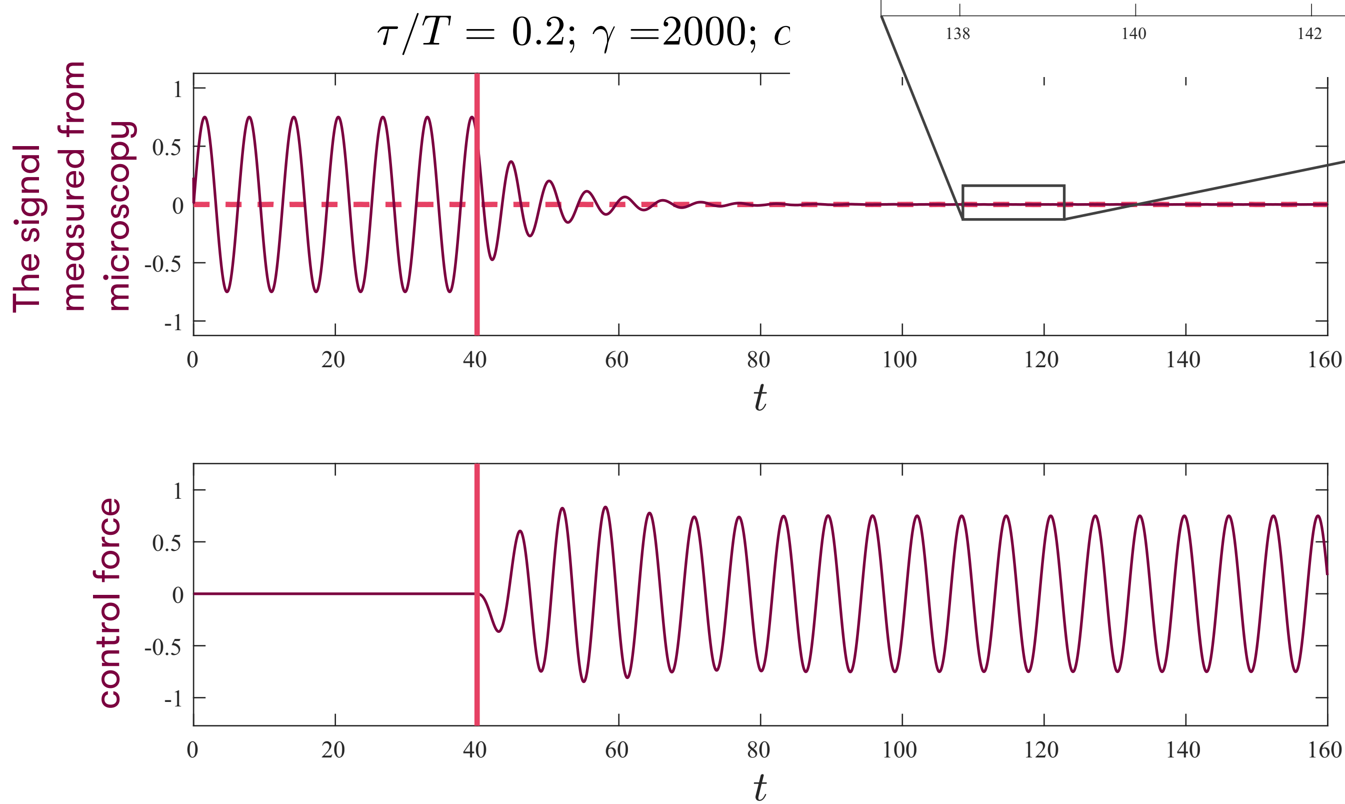

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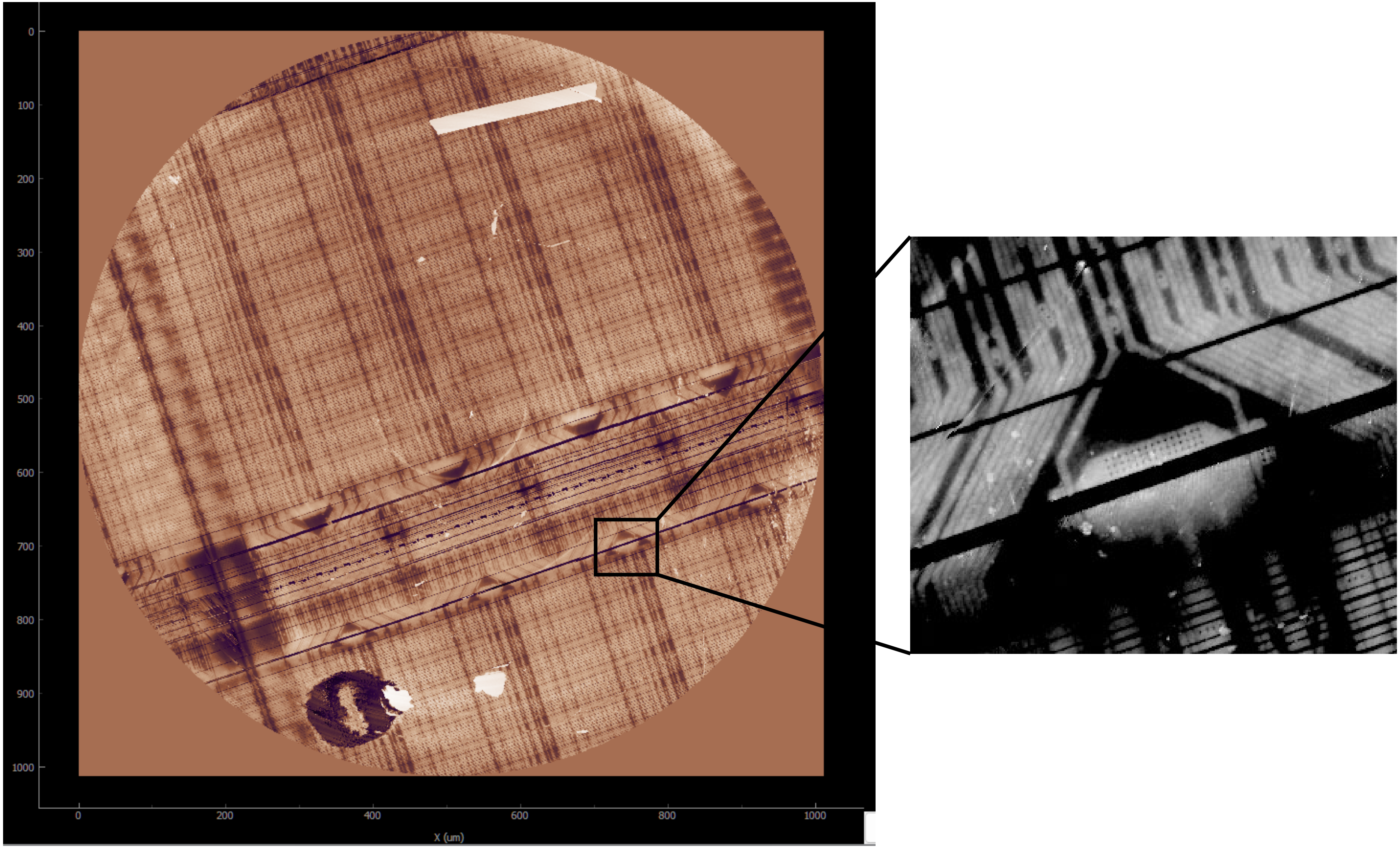
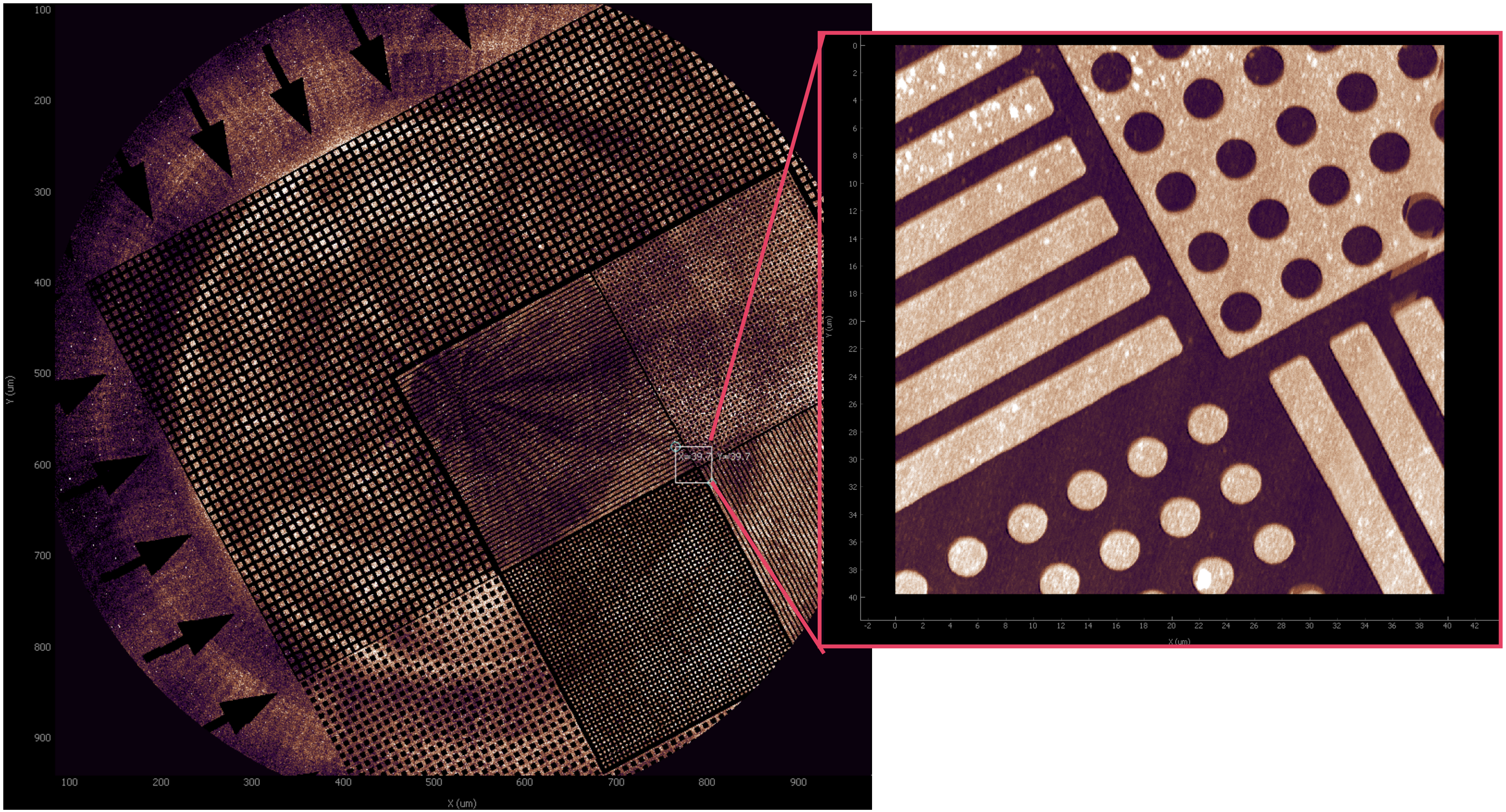
Our performed scanning example (diameter 1 mm)



Another scanning example (diameter 1 mm)



The end

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