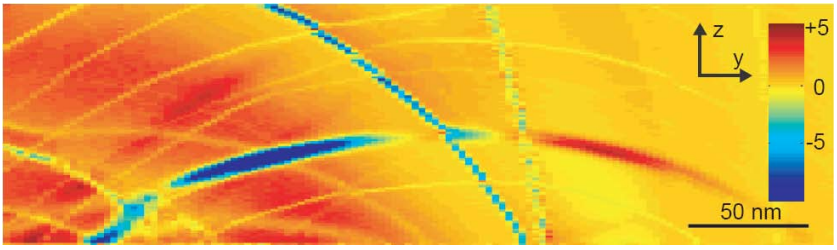
NANONIS APPLICATION NOTE

OPTIMIZING PLL FEEDBACK PARAMETERS: NANONIS perfectPLL™

Setting up a phase-locked loop (PLL) for use in non-contact applications is difficult. Four free feedback parameters for amplitude and phase control and two additional free parameters for the z-feedback leave a lot of room for incorrect settings and unwanted tip-crashes. Therefore we wanted to find a simple and reliable way to set up our PLL.

We measured the transfer function of the Nanonis Oscillation Controller with the integrated Lock-In Detector and modeled it applying linear control theory. With the help of this model we can derive the optimum feedback parameters for the PLL and z-feedback. All we need to know is the resonance curve of the tuning fork and the desired detection bandwidth. Then, all feedback parameters can be set up before the tip reaches the surface. This avoids any tip crash due to poorly chosen feedback parameters. One free parameter is all we are left with. It allows us to set the speed of the z-feedback and optimize noise against bandwidth.

The results of our work are now included as the perfectPLL™ module in the automatic setup procedure of the Nanonis Oscillation Controller. With perfectPLL™ the use and operation of a non-contact AFM like ours has become much simpler. We have never again crashed a tip due to a wrong estimate for the feedback parameters.



Equipotential lines above a quantum dot. The colors indicate resistance through the dot measured with the integrated Lock-In Detector.

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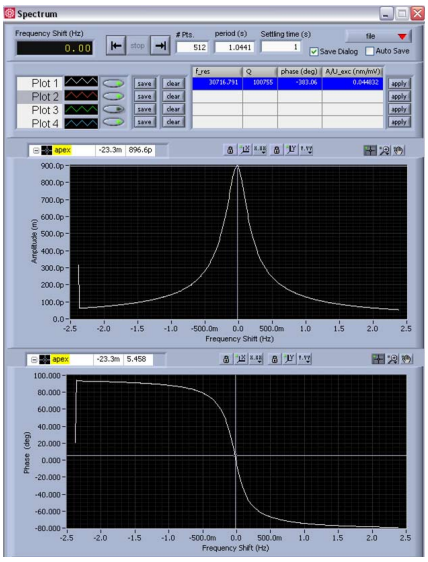
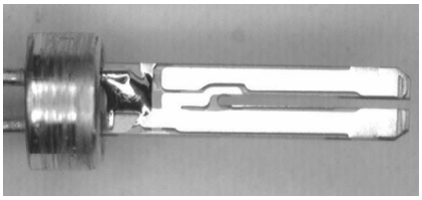


Resonance curve of a tuning fork.



Bare tuning fork used for non-contact AFM.

Nanonis Modules in Use:

- Base Package
- Oscillation Controller
- Lock-In Detector Module

System:

- Home-built LT in dilution refrigerator

Reference:

Gildemeister et al., Construction of a dilution refrigerator cooled scanning force microscope, Rev. Sci. Instrum. 78, 013704 (2007)

NANONIS
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