SPM-M Kit

Atomic steps in Si (111) measured with Mad City Labs AFM. Imaging probes: etched tungsten tip attached to quartz tuning fork (top left), and Akiyama probe (top right).

AFM constructed from the SPM-M Kit Shown with motorized XYZ, illuminator, and camera.

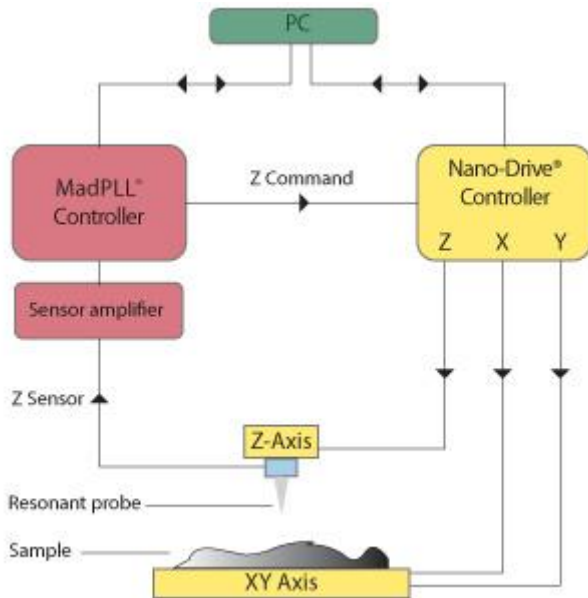# ⊟ Introduction

The SPM-M Kit combines the **MadPLL**® instrument package with Mad City Labs high resolution **nanpositioning systems** to form a high performance, closed loop, scanning **Akiyama probe** or **tuning fork** AFM. The seamless integration of hardware combined with the built-in automated control of MadPLL® means that you can concentrate on getting results, not tweaking parameters. Applications for the SPM-M Kit include nanoscale characterization and nanoscale fabrication applications such as optical antennas, nano-optics, semiconductors, data storage, and more. The SPM-M Kit is ideal for research and teaching laboratories offering high performance, versatility, simplicity and excellent value.

At left: Schematic of a typical AFM instrument based on the SPM-M Kit.

The SPM-M Kit includes:

MadPLL® Instrument Package
digital phase lock loop (PLL) controller
probe mounting boards
five **quartz tuning forks**
    Nano-SPM200 nanopositioning stage (XY)
    Nano-OP30 nanopositioning stage (Z)

3 axis closed loop **Nano-Drive**® controller
Z axis open loop/close loop switch (OCL option)
AFMView™ Software
AFMView™ Tutorial
Adapter plate between probe mount board and Nano-OP30
Application note: "AFM Kit with manual positioning"

MadPLL® is a powerful instrument package that allows the user to create an inexpensive, high resolution resonant scanning probe microscope using Mad City Labs **nanopositioning systems**. The MadPLL® package includes a digital phase lock loop (PLL) controller, software, sensor amplifier board, and resonant probe mounting board. MadPLL® includes five (5) each of the vertical, horizontal, Akiyama, and blank probe boards. In addition, each unit is shipped with five (5) **tuning forks**. Additional probe boards and tuning forks can be purchased

separately.

Available options:

Double walled isolation enclosure
Coaxial illuminator
Motorized or manual Z-axis approach
Motorized or manual XY-axis
Camera
SPM baseplate
SPM Etch Kit

Not included:

These items are described in the application note and are listed in the Bill of Materials (BOM)
L-Bracket
Fasteners or clamps

Recommended additional items:

Vibration isolation table

‒ Absolute Metrology

The SPM-M Kit incorporates the **Nano-SPM200** and **Nano-OP30** with a three axis **Nano-Drive**® controller for closed loop nanopositioning in X, Y, and Z. These systems incoporate Mad City Lab's proprietary **PicoQ**® **sensor technology** for closed loop feedback control, offering significant advantages in terms of image quality, accuracy and repeatability over open loop scanners. The sensor signal from all three axes can be read during AFM scans via the analog output signal or USB, thus minimizing the effects of hysteresis, curvilinear motion, and creep that result if data are analyzed using assumed commanded positions. Using position information from closed loop sensors also eliminates the need to scan a calibration grid in XYZ before scanning every sample. Scanning with closed loop nanopositioners saves time and improves image quality. Closed loop feedback also allows the nanopositioners to move and return to commanded positions with much more reliability than open loop systems, allowing users to return to previously scanned features for further analysis.

For further information about the PicoQ® sensors used in Mad City Labs nanopositioning systems, see the **PicoQ**® **sensor technology page** and our **Technical Information pages**

Instant AFM and nanoprobe instrumentation - just add science! View our AFM Video Tutorial.
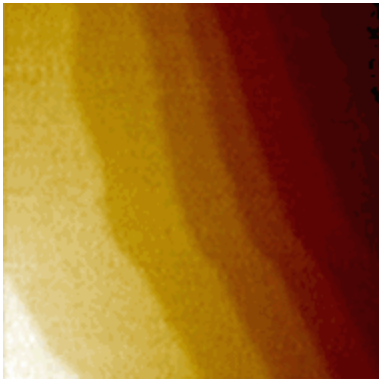
Atomic steps in Si (111) measured with Mad City Labs AFM, including MadPLL® controller shown below. Imaging probes: etched tungsten tip attached to quartz tuning fork (left) and Akiyama probe (right).
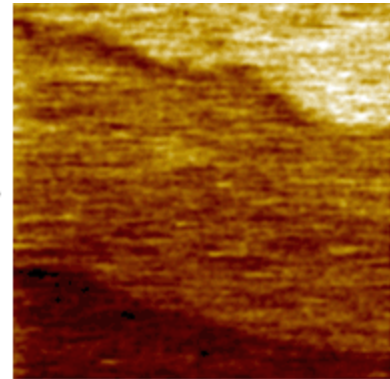
Introduction

MadPLL® is a powerful instrument package that allows the user to create an inexpensive, high resolution resonant scan probe microscope using Mad City Labs nanopositioning systems. In short, MadPLL® can be used to create an **"instant" closed loop AFM** or NSOM at a fraction of the cost of commercial systems.

MadPLL® has been specifically designed for resonant probes such as **tuning forks** and **Akiyama probes**. MadPLL® is fully compatible with Mad City Labs' high resolution nanopositioning systems, giving users seamless integration of hardware and software with flexibility and performance not available in commercial scanning probe microscopes.

Features

Low cost
Software, sensor amplifier, and probe boards included
2 additional ADC connections for instrument versatility
Low noise, atomic step resolution

Automated software control
Auto PCC control
High resolution Auto Q calculation & resonant frequency detection
Integrated Z axis PI loop
Fully compatible with Mad City

What is MadPLL®?

MadPLL® is an integrated solution that includes the digital phase lock loop (PLL) controller, software, sensor amplifier, probe board mount, and resonant probe mounting board. Simply add your **Akiyama probe** or **tuning fork** to the probe board to create a powerful force sensor for scanning probe measurements with no optics required.
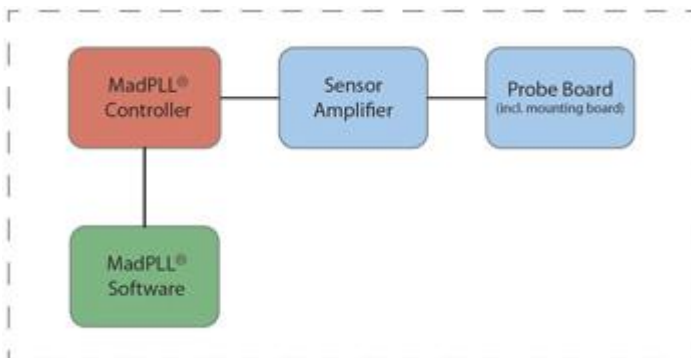
The MadPLL® package includes the MadPLL® digital PLL controller, sensor board, probe board, and MadPLL® software. Ease of integration with resonant probes and Mad City Labs' low noise nanopositioning systems give users the ability to create high performance, low cost NSOM and AFM instruments.

The PLL controller contains a digitally controlled proportional integral (PI) loop designed to work seamlessly with Mad City Labs' nanopositioning systems. The addition of closed loop nanopositioners adds to the high performance of MadPLL®. Additional options are available for multi-axis closed loop nanopositioning control.

The PLL controller has three operational modes: self oscillation, PLL driven, and lock-in/DDS driven. The probe can be controlled in constant excitation or constant signal mode. Measured outputs from the controller include changes in frequency, amplitude or phase shift.
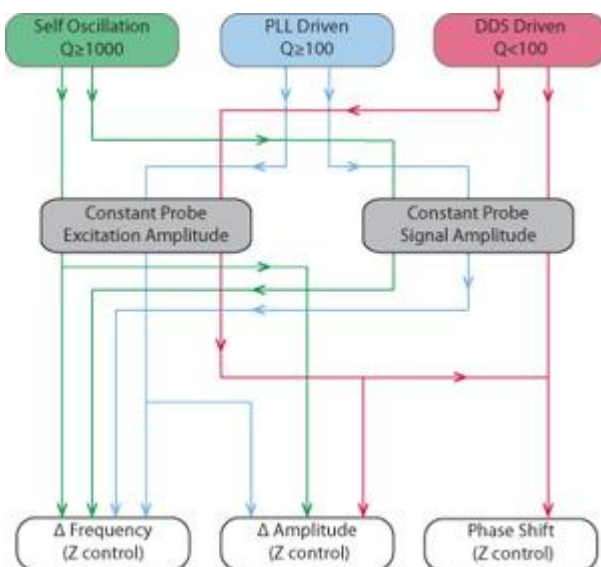
The digital MadPLL® controller has three operational modes: self oscillation, PLL driven, and DDS driven. The probe can be controlled in constant excitation amplitude or constant signal amplitude. Changes in frequency, amplitude, or phase are measured for Z control.

The sensor amplifier is the interface between the MadPLL®controller and the probe. The sensor amplifier contains a preamplifier, an excitation signal attenuator, and a parasistic capacitance compensation (PCC) circuit. The probe board mount and probe board assemblies are compact and can be fitted to existing instrumentation. The probe board simply plugs into the probe board mount. The mount can be fixed to a precision positioner such as a closed loop nanopositioning system. The probe board has been designed for use with **tuning forks** and **Akiyama probes**. These probes are easy to mount and alignment free.

MadPLL® *includes a sensor amplifier, probe boards, and intermediate probe mount. The probe boards are designed for use with* **tuning forks**, **Akiyama probes** *and Accutune probes.*

⊟MadPLL® Software

MadPLL® software simplifies the control of your scanning probe microscope. All of the functions of MadPLL® are fully automated but accessible via individual software control. Among the software features are automated setup, configuration control, auto-Q calculation and automatic parasitic capacitance compensation (PCC) control. These included features are designed to simplify setup and accelerate the data acquisition process. MadPLL® software integrates seamlessly with Mad City Labs' AFMView™ software. AFMView™ software is part of our complete SPM development system