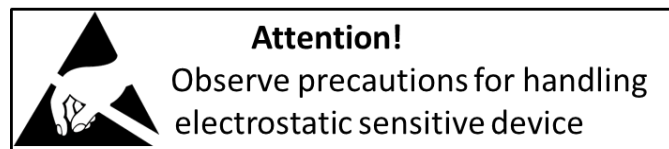# Installation instructions: CryoFMR for the PPMS, DynaCool, and VersaLab systems

Overview

This guide describes the installation and use of the CryoFMR spectrometer and the CryoFMR probe with all Quantum Design PPMS platforms.

Safety Instructions

Attention!
Observe precautions for handling electrostatic sensitive device

Please observe the following safety guidelines when using your system:

- Any changes or modifications to the system not expressly approved by NanOsc Instruments AB could void the user's authority to operate the equipment.
- To avoid damaging the system, verify that the system power requirements match the alternating current (AC) power available at your location.
- To prevent electrical shock, verify that the power supply adapter is properly grounded with a three-wire grounded plug.
- To prevent electrical shock, unplug the system before you install it, adjust it, or service it.
- Do not spill food or liquids on the system or its cables.
- Wear an ESD wrist strap and always discharge yourself to the side of the instrument before touching any of the front panel connectors or cables connected to the front panel.
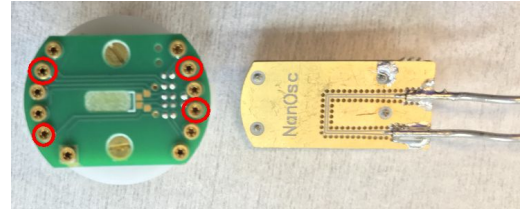
Warning:

The front end SMA connectors are easily damaged if too much torque is applied to them while tightening the SMA coaxial cables. To avoid this problem, please follow the proper installation instructions described in Section 5 of this document.
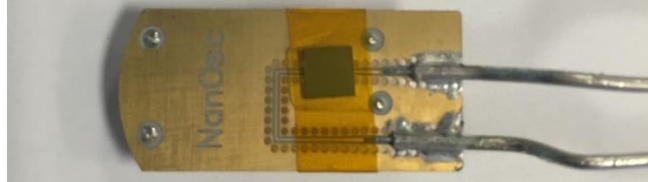
Contents

use the rotator adapter (green) for holding the CPW while taping the sample to the top surface.

1 Adhere reference 10nm thick NiFe sample to coplanar waveguide (CPW) suitable for in-plane applied field measurements:

Sample is placed <u>face down</u> (*i.e.* shiny side closest to CPW) and adhered with Kapton tape. It is <u>critical that the sample be placed on either of the two horizontal portions (as oriented above) of the CPW.</u> Do not place sample on the corner of the CPW. Best to wrap the Kapton tape completely around the CPW. Some customers have also successfully used a thin layer of N-grease to adhere the sample to the CPW.
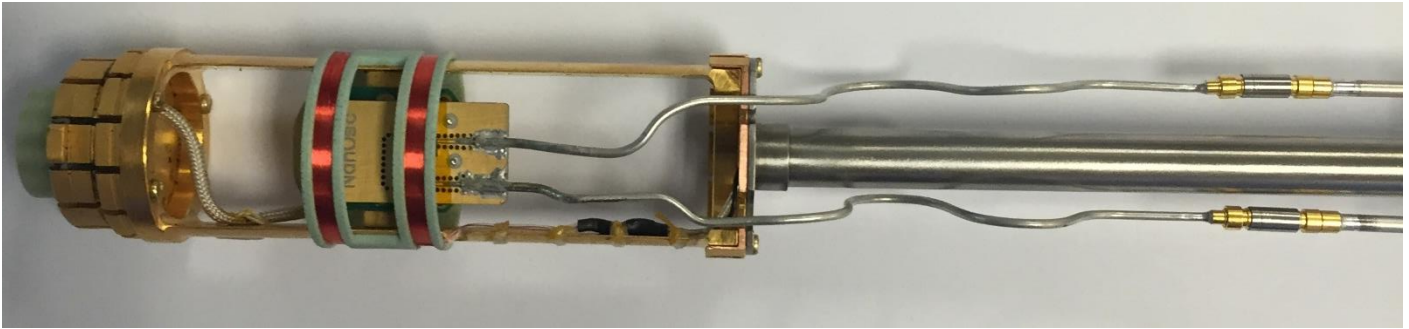
2 Connect the CPW with sample to the CryoFMR probe:
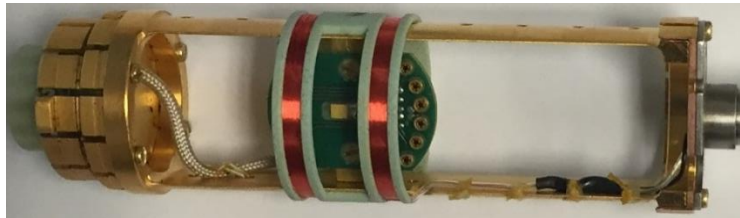
Ensure that the sample stage is facing upwards (that is with the key on the puck and the onboard cernox thermometer facing up). This can be adjusted by loosening the two screws on either side of the sample stage. Be sure to then tighten the screws once the stage is in place. **Note:** these brass screws are quite soft and the slot at the top can become worn if one is not careful, *e.g.* using too small of a screwdriver or overtightening.
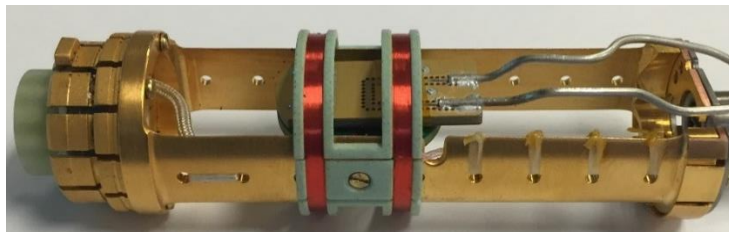
Engage the 4 pins in the CPW into the sample stage. This can be a little difficult the first time but be patient and do not bend the pins. The backside of the CPW will face the cernox thermometer. The sample will be under the right Helmholtz coil in the picture above. Exact centering of the sample under the Helmholtz coil is not critical.

Engage the SMP connectors from the CPW to the long cryo-coaxial cables. Light pressure is all that is needed to engage these connectors.
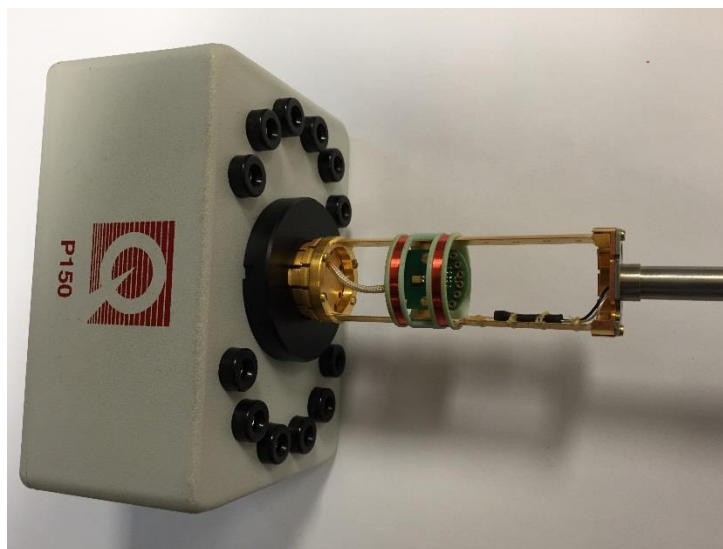
Note: as the CryoFMR probe can roll around on the table, the CryoFMR probe can be inserted into the sample wiring test station (8084-400), as shown above, for added stability.

3 Insert CryoFMR probe into the sample chamber:

Ensure the sample chamber is at room temperature (T > 295 K) and venting (*i.e.* flooding) before slowly inserting the probe.
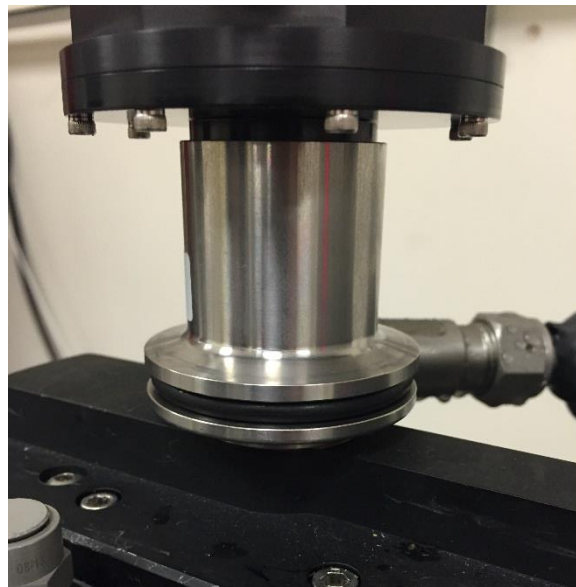
Ensure that the key and 12-pin connector at the bottom of the CryoFMR probe are properly seated at the bottom of the sample chamber. Ensure that the o-ring at the top of the sample chamber is properly seated and affix a clamp before initiating a Purge/Seal of the chamber. Note the top KF flange can slide downwards to ensure a proper seal.

4 Check DC resistances at probe head:
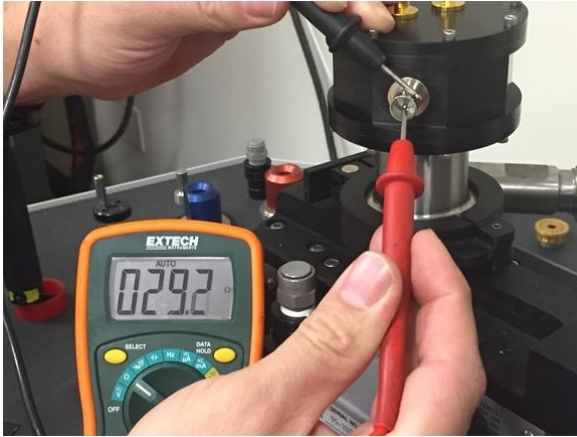
The DC resistance of the Helmholtz coils tested at the BNC should be 29-30 Ohms, see image above left. With the CPW in place the DC resistance through the center contacts of the RF SMA feedthroughs should be less than 1 Ohm, see image above right. **Note:** be careful when probing the center contacts of the RF SMA feedthroughs, do not apply excessive pressure which may damage them.
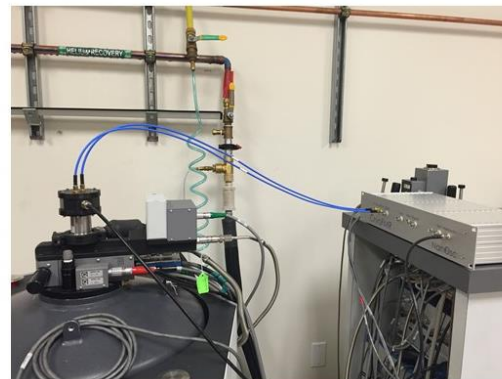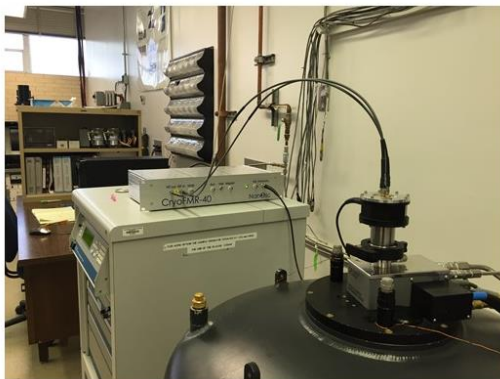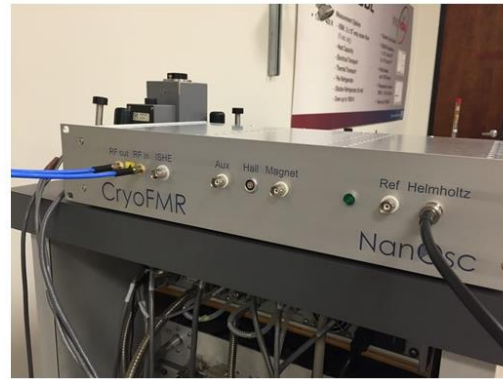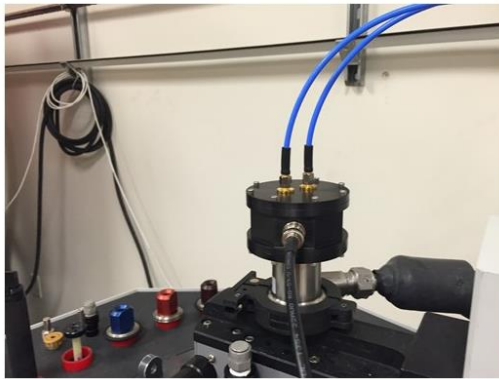
5 Connect the CryoFMR probe to the CryoFMR instrument:

The CryoFMR instrument box should be close to the PPMS/DynaCool/VersaLab itself. If the PPMS instrument rack is near (approximately 2 feet) the PPMS it is at an ideal height to ensure that the 36 inch long RF cables can reach without undue tension or kinking. See the above picture for examples at two instrument installations for a PPMS. An additional instrument rack or stand may be necessary for the DynaCool and VersaLab systems.

Note: the RF connectors on the front panel are sensitive to electrostatic discharges and the internal electronics may easily be damaged. Make sure to always observe precautions for handling electrostatic sensitive devices, such as wearing an ESD wrist strap. Make a habit of always discharging yourself to the side of the instrument before touching any of the front panel connectors or cables connected to the front panel.

Connect **RF in** and **RF out** on the CryoFMR instrument to the two SMA-type RF connectors on the top of the CryoFMR probe using the provided 36 inch long RF cables. Note, it does not matter which connector is used for **RF in** and **RF out**. **DO NOT OVER TIGHTEN** the threaded SMA RF connectors. Use your fingers to tighten and then a suitable SMA torque wrench to make a snug connection, light pressure is all that is needed. Be careful not to cross-thread the connection. Use the provided BNC cable to attach the Helmholtz drive to the BNC connector on the CryoFMR probe. Connect the CryoFMR spectrometer to the computer with the provided USB cable. Connect the provided power supply adapter to the mains and to the DIN connector at the back of the spectrometer. Turn on the CryoFMR spectrometer with the push button on the back. The green LED on the front panel will indicate that the power is on.

6 Utilize the cernox thermometer on the sample stage for temperature control (optional):

6(b) DynaCool

(i) Connect cable 3084-010-02

First esnsure that the BRT module is installed in the CAN rack. Then ensure that cable 3084-010-02 is connected between the 14-pin grey-LEMO to the 4-pin LEMO on the BRT module.

(iv) Activate Multifunction Probe in MultiVu (Version 1.0.2.7 or later)

Activate the MFP by selecting: *Utilities→Activate Option*

Select Multi-Function Probe. Click *activate*

The software will initialize and read the SROM in the BRT module.

Select the FMR probe number. **FMR-020**

Check *Enable User Temp* to control using the thermometer on the cryoFMR probe.

2017-01-03

7 Ensure communication of the PhaseFMR software to MultiVu:

Make sure both MultiVu and the PhaseFMR software are running. When opening the PhaseFMR software it will prompt the user for a valid calibration settings file, if that file has not already been copied to the <userhome> folder. Open the settings by pushing the *Settings* button at the lower right. And check the *Quantum Design Integration* box at the bottom of the screen and select *QD Integration* to the left:
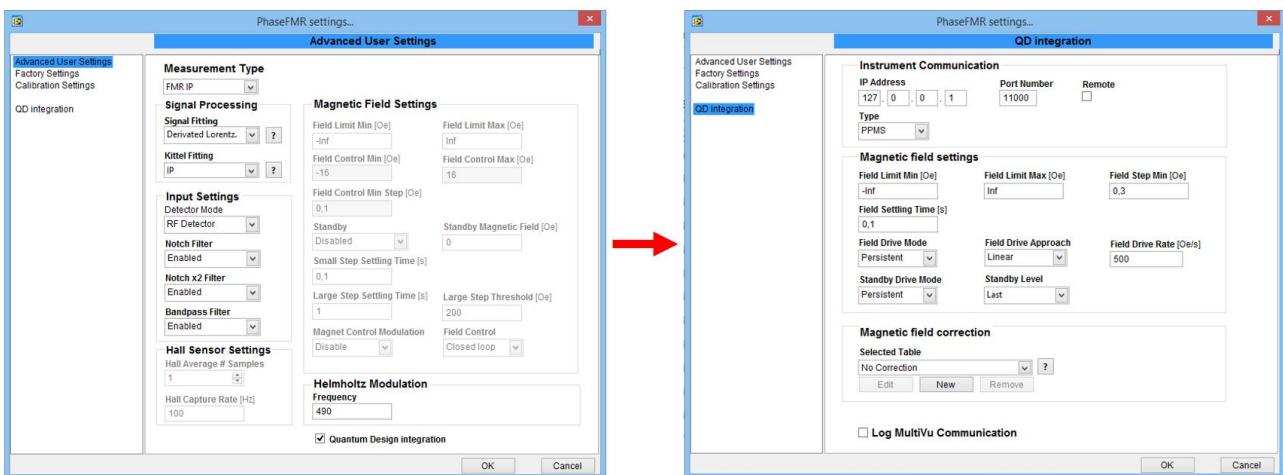
→ The *Magnetic field correction* box allows the end user to upload a file that characterizes the field errors of their particular magnet.
Make sure that the correction "...D133_9T.csv" is in use, and do NOT proceed with "No Correction" unless you are working at low fields (< 1000 Oe) and know the magnet remanence.

See also Quantum Design's Application Note 1070-207 for advice on Using PPMS Superconducting Magnets at Low Fields.

8 Hall calibration and Magnet calibration are not needed

The PhaseFMR software has support for calibration of both the Hall sensor and the magnet control function that are provided for room temperature set-ups using regular electromagnets. These two calibrations are not needed with the Quantum Design PPMS platforms.

9 Start a measurement
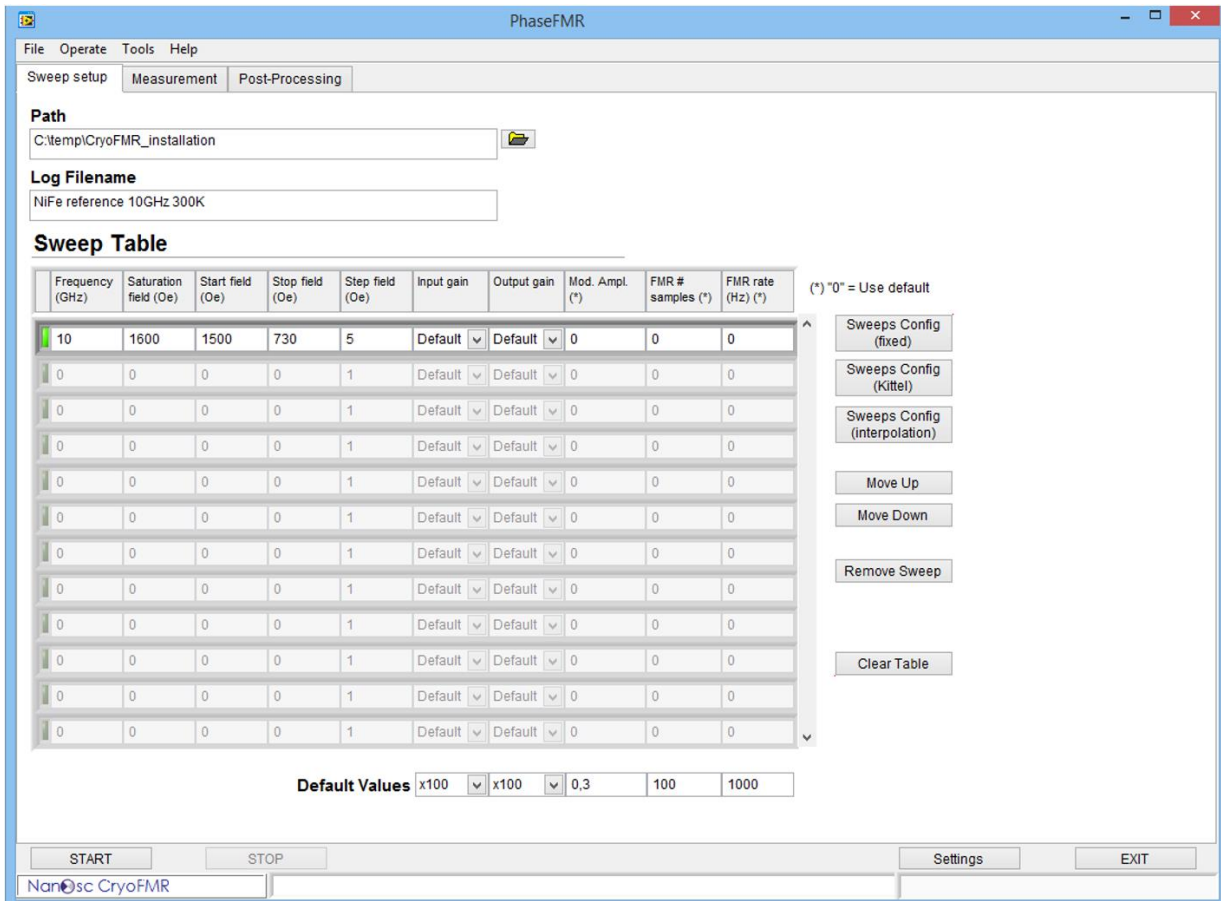
Above are suitable parameters for the NiFe reference chip at 300 K. These parameters will first saturate the sample in 1600 Oe then sweep the applied field from 1500→730 Oe and measure every 5 Oe. Default values for the Input gain, Output Gain, Mod. Ampl., FMR # samples, and FMR rate are utilized. See the main user manual for more detailed descriptions of these measurement parameters.
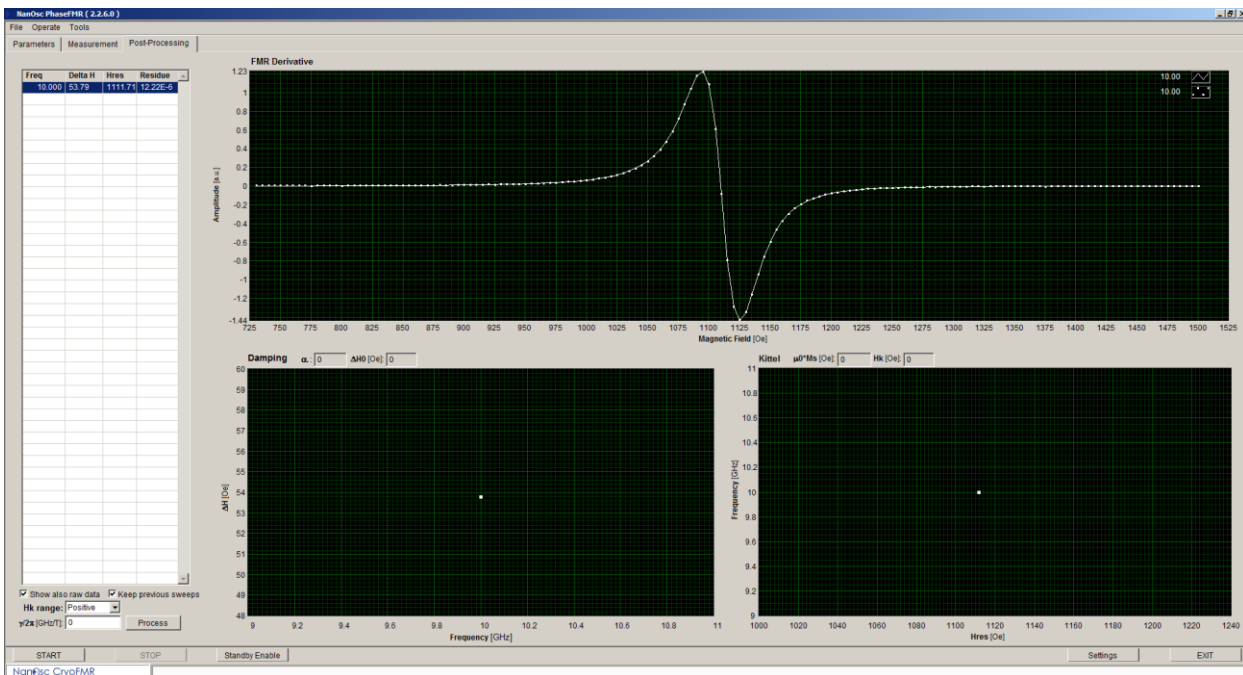
Above is the resulting processed sweep (measured with an older software version). Note that due to slight variations in the NiFe reference chip the Delta H (53.79 Oe) and H_{res} (1111.71 Oe) may vary slightly from what is presented above and should be used only as a guide.

Note: The PhaseFMR software does not control the temperature of the PPMS. This must be done separately in MultiVu.

10 Saving default settings / Ending measurements

There are two ways to save all settings: as new default values and as User Settings. When the software is started, the default values of all parameters and settings that control the spectrometer are loaded from the configuration settings file .phasefmrconfig_2.0.ini. During operation the user can modify all parameters and settings except the factory calibration settings. The modified values can be saved as new default values in the configuration settings file with the command Save Current Values As Default under the File menu option at the top. If the user would like to keep a second group of settings as an alternative to the default values, then save them in a User Settings file. This is a convenient way of storing different set-ups for different sample types or users. The User Settings file can be loaded whenever those settings are needed. The commands for saving and loading User Settings files are also available under the File menu option at the top.

When the software is started it loads the file named .phasefmrconfig_2.0.ini. under <userhome>. If there is no file with this name, for instance if the leading . is missing in the file name, then the user will be prompted for another configuration settings file. This other file is also where the new default settings will be stored when selecting the command Save Current Values As Default. We recommend to store the QD integration parameters as new default settings in the file <userhome>\.phasefmrconfig_2.0.ini to avoid having to type them in every time.

When finished: stop any FMR scans, close PhaseFMR software, deactivate MFP option in MultiVu, turn off PhaseFMR electronics, unplug USB cable, remove BNC cable from mod coil, remove SMA coax cables carefully using torque wrench to loosen at BOTH ENDS before fully unscrewing cables from probe, vent/ seal chamber, remove probe and put on the bench in secure holders, put in PPMS baffle set, purge/seal chamber, remove board from probe and sample from FMR board, put all parts back in kits/storage tube.