Quantum Design PPMS DynaCool:
Vibrating Sample Magnetometer (VSM)

Quick Start Guide

- More detailed instructions are found in the VSM Manual found on Pharos library at Quantum Design website. You need to set up an account but it only requires the serial number of the DynaCool system which is posted on the Wiki here.
- Start your session in iLab: this powers up the monitor on the PPMS and connects it to internet (so it shows up on Teamviewer).
- In the PPMS log sheet binder, start a new sheet with your info.
- The PPMS computer lock screen password is written in beginning of the MSDS binder in the lab, if you forget it.
- PPMS should be at 300 K, zero field, and purged chamber. If it is NOT, please tell Neil and note this in your log sheet.
- First we need to determine which VSM detection coil set will be used here:
    - *Most common case:* For measuring samples <4mm wide (using quartz or small brass holders), use the Standard Coil set in the VSM User Kit. Serial number = 571.
    - For samples between 4mm and 10mm in transverse size (including those mounted in straws or the large brass holders) use the Large Bore Coil set in the VSM Large Bore User Kit. Serial number = LB721.
    - Open the file `vsm.ini` in the folder `c:\qddynacool\vsm\system` and edit it so the correct coil set serial number is being called out.For example, this is how it will look if you're using the **Standard** coil set : `COIL SERIAL=571`
      otherwise for **large bore** coil set : `COIL SERIAL=LB721`
      and do NOT change any other lines in the file! Thank you ☺
    - Save the `vsm.ini` file and close it.
- Under *Instrument > Chamber…* or by double-clicking chamber area at bottom of screen, press the Vent/Seal button and wait for chamber to get above 760 torr.
- Release the KF clamp at the top of the chamber, remove the baffle set, and put the baffle set in one of the clear vertical storage tubes on the side of the PPMS.
- In preparation for installing the VSM coil set puck, ensure there is no puck currently in the chamber: step up and look into chamber. If you can't tell whether the chamber is empty, get the extraction tool and try to remove a puck.
- Using extraction tool to remove a puck from the chamber:
    - The storage tool is a sensitive instrument, please do not bump or drop it, especially the thin walled stainless steel tube at the bottom, as this can break it.
    - Remove the extraction tool carefully from the storage tube, open the lever at the top (lever in vertical position), and lower the tool down into the chamber until it comes to the bottom. Rotate it a bit to make sure it's at the bottom.
    - Close the lever (horizontal), and if there's a puck in the chamber you will feel resistance when you try to pull up.

    - Pull out the extraction tool from the chamber, which will be carrying the puck, and DO NOT MESS WITH THE LEVER at top of extraction tool in this step. It's critical that we fully remove the puck and not drop it.
    - Once extraction tool is out of chamber, secure it with your other hand and take to the lab bench where you will cup that hand under the bottom end of the tool while you release the lever (put it in vertical position), which releases the puck.
    - Put the extraction tool back in the storage tube to protect it.
- Using extraction tool to insert the VSM coil set puck into the chamber:
    - With one hand, hold top of extraction tool and open the lever (vertical position).
    - With other hand, cup the bottom of extraction tool and hold puck between thumb and first finger.
    - Insert puck into extraction tool and gently rotate it to ensure it is seated evenly at the stop.
    - Close the lever at top of tool and see that the puck is held firmly.
    - Note the position of the key on the puck which will face to the front of the chamber when fully inserted.
    - Take the tool to the PPMS chamber, insert fully into the chamber, and rotate around until you feel the key slip into the notch. Once you feel this, push down firmly (a few kg of force) another ~5mm.
    - Release the lever (vertical position) at top of the extraction tool and you should be able to lift it without resistance from the engaged puck.
        - If you feel the puck is still engaged, close the lever again, remove tool/puck from the chamber, and repeat the process of inserting the puck.
        - If it still is not working, then remove tool/puck, put in baffles, purge/seal, and call Neil or Mike.
- About the VSM guide tubes and sample rods: please use the standard set, and NOT the large bore set which are painted yellow on top and used only in special cases. If your sample diameter is more than 7.3mm please see Neil about using the large bore set.
- Insert the VSM guide tube (stored in tube storage at side of Dynacool) into chamber, making sure the o-ring is present and is clean. When inserted, the o-ring should be in contact with the sample chamber's top KF-40 flange. Do NOT put any flange clamp on at this point.
- Install the VSM motor onto the post on top of the guide tube
    - CAUTION: the motor weighs about 10 kg so these steps should be done by someone who is tall and strong enough for this. If you have ANY doubts, please contact Neil before proceeding.
    - The wooden storage box for the VSM motor is kept at the right of the PPMS.
    - Ensure the clasps are tight at the base, so that the lid is held firmly to the base.
    - Pick up the box, keeping it vertical at all times, and take it close to the PPMS.
    - Unclasp the lid, lift up the clasp hinges and remove the lid from the box by lifting vertically until it clears the top of the motor.
    - Inspect the motor to make sure the bottom (similar to KF-40) flange is open so that the motor can be put on the chamber.
    - Grasping motor around the main body and keeping it vertical, lift it carefully onto the guide tube post.

    - Once in place, put on the plastic KF clamp to hold motor onto sample chamber.
- Connect cables: Motor Module into back of motor; VSM module into user port on right side of PPMS.
- Activate VSM under *Utilities > Activate Option* in MultiVu.
- Wait for the motor to home and option to load (about 1 minute).
- The temperature reading should have a blue background and should be very close to 300 K. If not, you probably have the wrong coil set selected in the `VSM.INI` file or there's a connection issue at puck or VSM detection cable.
- To mount your sample to a sample holder, consult *VSM Sample Mounting* application note in the MPMS-3 Training binder in the lab.
- Use the Install/Remove sample wizard in the VSM software to install the sample.
    - Seal the chamber after it vents, so that it does not continue to flood.
    - In order to induce a moment in the sample, set a magnetic field of 100-5000 Oe (depending on sample signal) if you want to use *Scan for Sample Offset* .
    - If you are going below room temperature, click "Use Extended Purge" checkbox at end of install wizard, and wait 10 minutes while the extended purge completes before cooling down.
- Example sequences can be found in :
  `C:\QdDynacool\Sequence\Example sequences to get you started`

- **Mental checklist ANY time you step away from the machine:**
    - **Is the cap on the chamber?**
    - **Is the chamber purged AND the pressure <10 torr (MPMS) or <50 torr (PPMS)?**
    - **Is the system going to be left at 300 K and zero field at conclusion of my run?**
    - **Is MultiVu software running?**
    - **Are all tools put away and the benchtop clean for the next user?**

- When done with measurements, remove all VSM hardware, following same guidelines as above:
    - using Sample Install Wizard, press *Open Chamber* to remove the sample rod and put it in one of the back (longer) storage tubes on the side of PPMS.
    - *Seal* the chamber so that it does not continue flooding, and *Cancel* out of wizard.
    - Deactivate VSM option and wait for motor indicator to fall to lowest position.
    - Remove motor and VSM detection cables.
    - Put motor back in storage box, put on lid, and turn clasps to clamp down and secure the lid.
    - Put the motor box back on the left side of the MPMS-3.
    - Remove VSM guide tube and VSM coil set.
    - Put baffle set back in chamber and KF clamp on flange.
    - *Purge/Seal* chamber.
    - If you used the Large Bore coil set, please revert to standard coil set in the software by editing the `vsm.ini` file again (most of us will be using standard coil set).
- "**Virgin" sample measurements not possible:** some materials require a measurement starting from zero applied field where the sample is in a virgin state (no history of magnetic field applied to it). Note that your sample will experience a vertical magnetic field, in both the positive and

negative directions, of **+ and – 150 Oe** when inserting through the VSM linear motor. If this is unacceptable, please consult Neil about the magnetic shield for VSM which is a steel shield which protects the sample during insertion through the motor and reduces the fields experienced by the sample down to +/- 3 gauss.

Interpreting the VSM Data

- Please see the discussion of this topic from the MPMS-3 training on the BNC Wiki which will have many parallels. Note that to view links from BNC Wiki you must first log in to Wiki then click the link.

  There are a few differences between PPMS VSM and MPMS-3 on this topic:
  - There are NO SQUID drifts because this is a copper coil-based VSM detection.
  - However, there ARE flux jumps in the superconducting magnet seen while sweeping the magnet and these cause spikes and brief dropouts in the data if measuring while sweeping the field. This is a property of this particular magnet design for the DynaCool and is unavoidable. Here is how to mitigate these effects:
    - In VSM M(H) command, use “stable at each field” instead of “sweep continuously”; this will make data collection much slower so the number of fields should be reduced.
    - If you prefer to sweep, you can improve the data quality by using Fixed range for VSM detection in the 2nd tab of VSM M(H) command.
  - Sample geometry correction due to coupling to coil set: the correction is different than in MPMS-3. There is a more primitive software facility and instructions to help users try to correct for samples which are not point-dipoles and these are available on Pharos at QDUSA.com : https://www.qdusa.com/pharos/browse.php?fFolderId=707