Quantum Design

Application Note 1500-013

SVSM Measurement Best Practices Amplitude: "Going Big"

The SQUID based VSM uses a new technique for determining magnetic moment of a sample. The system combines a traditional SQUID detection scheme with sample vibration electronics. This enables fast data acquisition, superior noise rejection, and enormous dynamic range. Since each sample has a unique set of characteristics, good mounting techniques combined with selecting the correct vibration amplitude should achieve the best possible results. If you have questions or concerns about measurement parameters please contact apps@qdusa.com for application specific advice.

The essential message for the SVSM is to measure with as large an amplitude as possible that does not cause rattling noise or cause the signal to exceed the range of the measurement. In contrast to other VSM measurements with a normal gradiometer which are linear with amplitude, the SQUID signal scales quadratically with the vibration amplitude. Thus, changing the vibration amplitude is an effective way to scale the signal when it is too large or too small. The instrument accounts for this signal dependence so the reported moment remains accurate when you change the vibration amplitude. Because the vibration amplitude range of the instrument is effectively one order of magnitude (0.5 mm – 8.0 mm), this technique yields two orders of magnitude in the instrument's dynamic range for magnetic measurements.

The two reasons for measuring with as large amplitude possible are increasing the sensitivity of the measurement and decreasing the dependence of geometric corrections. More information on the geometric correction can be found in application note (1500-015).

The larger amplitude measurements can lead to problems in several cases where one might want to reduce the vibration amplitude of the measurement. The first case is increased measurement amplitude leads to an higher likelihood of rattling during measuring. The rattling can cause increased SQUID noise or inability to collect data. It can also lead to temperature instability. A related problem is frictional heating which can cause problems at the lowest temperatures. Increasing the vibration amplitude increases the amount of heat caused by friction which can directly impact the temperature stability. Large measurement amplitudes can lead to moments being too large for the detection circuitry. The measurement window gives a good idea of the maximum possible moment that is measurable with the current measurement settings. The final situation where you would want to reduce the vibration amplitude is a sample that is sensitive to small changes in the magnetic fields. Since the magnetic field of a superconducting magnet is not going to be completely flat, you can minimize the edge effects of the magnet on the sample by reducing the vibration amplitude.

To summarize, use the largest amplitude as possible on the SVSM for your measurements. However, smaller amplitudes can improve the measurement quality or enable data acquisition in certain situations.