Automation of a Vibrating Sample Magnetometer using LabVIEW

R.N.John Supervisor: M.R.Lees
Department of Physics, University of Warwick

Aim and Achievements

A set of programs was successfully written to control and automate a vibrating sample magnetometer (see below for details of operation) using LabVIEW.
Advantages over the existing control software:

- Flexible and expandable, programs can be modified by the operator to suit their individual needs.
- Compatible with all other measurement systems in the group (and beyond).
- Educationally more useful (LabVIEW module in year 2).

Vibrating Sample Magnetometer

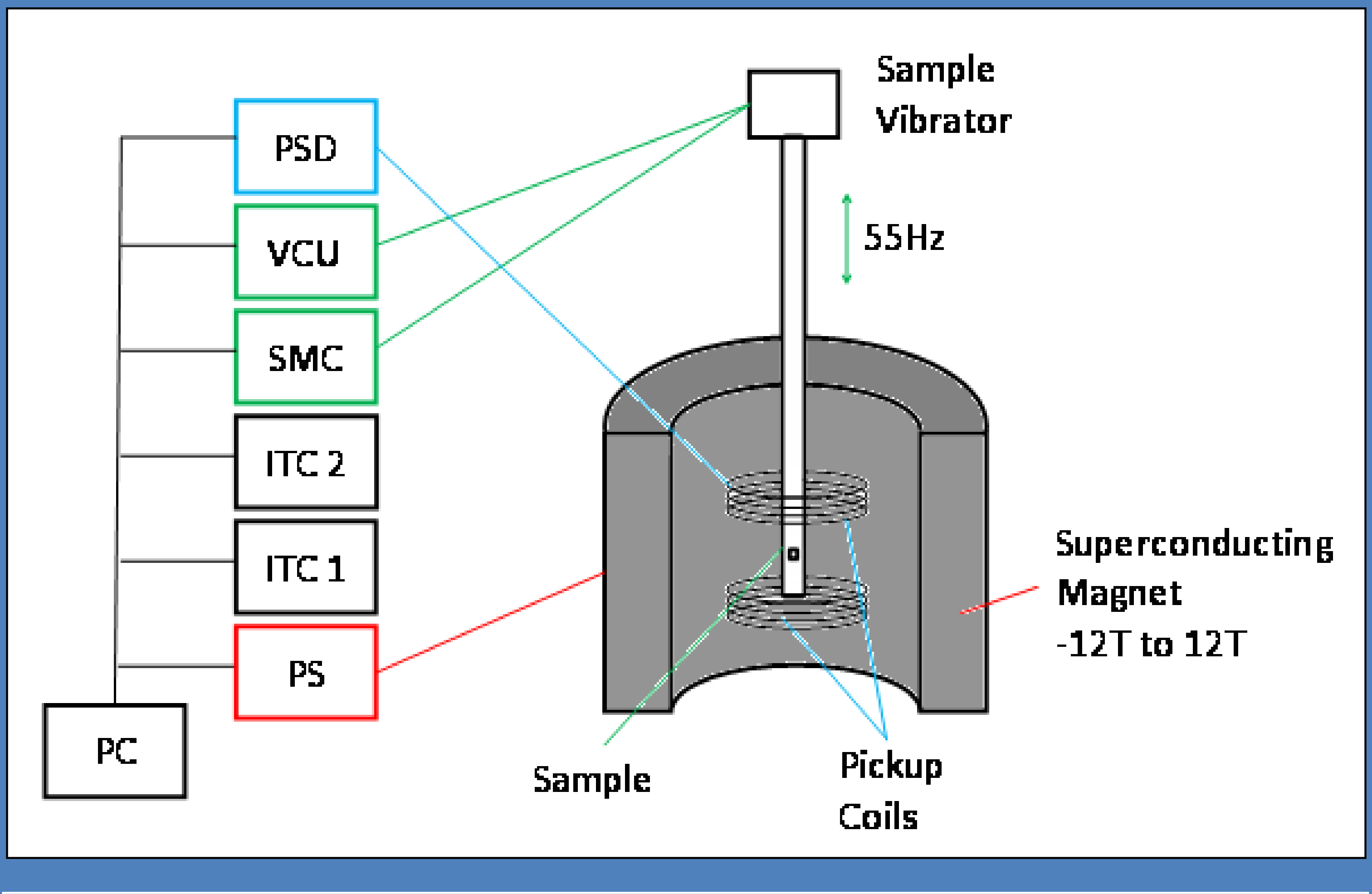

Figure 1. Diagram of a VSM including controlling electronics

A VSM is a piece of equipment used to measure the magnetic response of magnetic materials as a function of temperature or applied magnetic field. It composes a superconducting magnet which generates between ±12T (1T is 10,000 times the Earths field) controlled by the power supply (PS).
The sample temperature is controlled using the Intelligent Temperature Controller (ITC) and can be varied between 1.4K (-271.6°C) and 1000K when using the optional furnace attachment.
The sample being investigated is attached to a rod and centred between the pick-up coils using the stepper motor control unit (SMC) and vibrated vertically at a frequency of 55 Hz by the vibrator control unit (VCU). The phase sensitive detector (PSD) looks for a signal with the same frequency as the vibrating sample allowing it to extract the correct signal.

How the VSM works

A VSM operates by placing the sample to be studied in a magnetic field. If the sample is magnetic, this magnetic field will magnetise the sample by aligning the magnetic domains, or the individual magnetic spins, with the field.
As the sample is moved up and down, the magnetic field due to the sample is changing as a function of time and can be sensed by a set of pick-up coils.

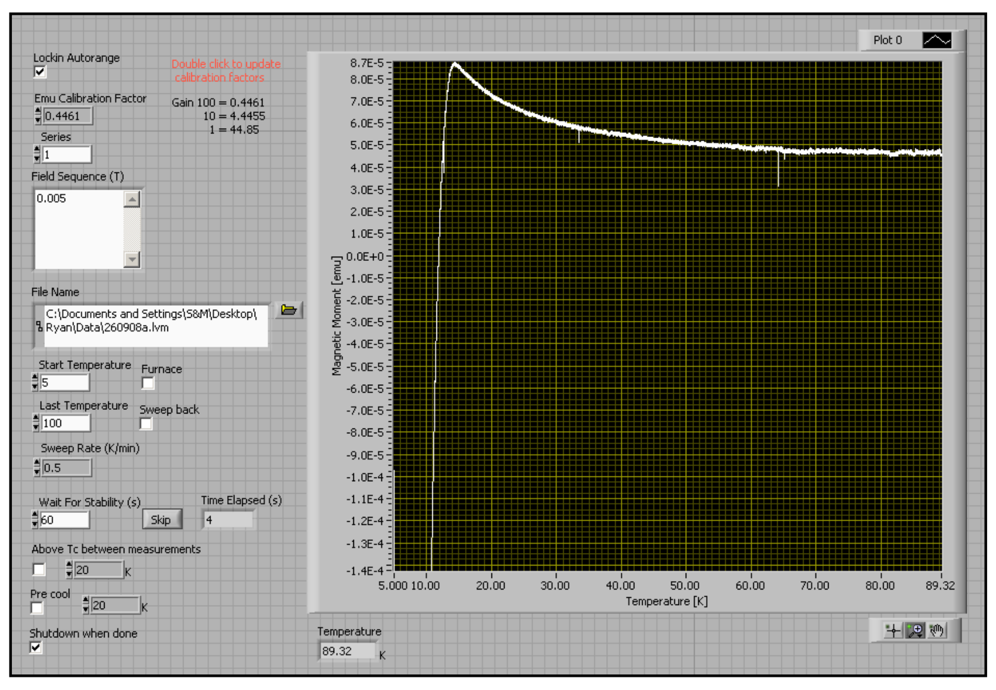

Figure 2. m vs. T front panel

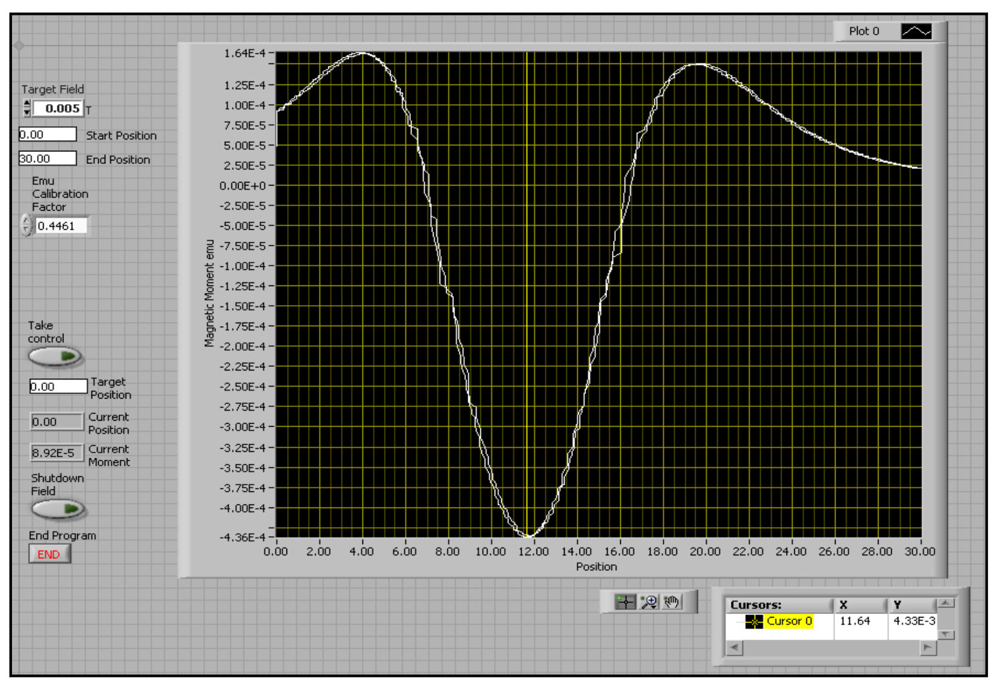

Figure 3. centre front panel

The Programs

The following programs were written to automate the VSM:

- Degauss, reduces the unwanted trapped field within the system.
- Centre, the sample is moved between the coils find the largest signal which occurs directly between the coils.
- m vs. H, temperature is held constant and the applied magnetic field is varied based on parameters inputted by the user.
- m vs. T, the magnetic field is held constant and temperature is varied.
- Shutdown, sets the system into a state of minimum consumption of power and cryogens

Experiments

The following data was taken using the completed programs.

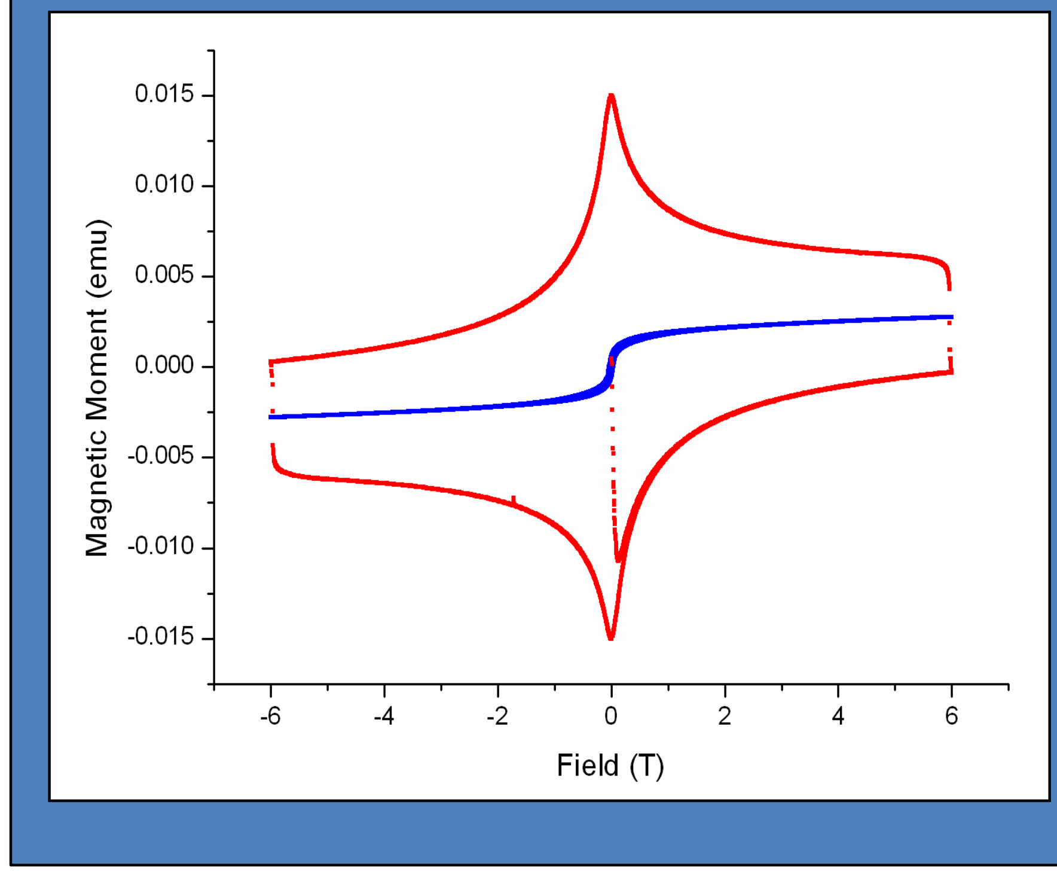

Figure 4. Magnetic moment versus field strength for a sample of $FeSe_{0.5}Te_{0.5}$. The red line shows the superconducting state at 1.6K. The blue line shows the ferromagnetic state at 16K.

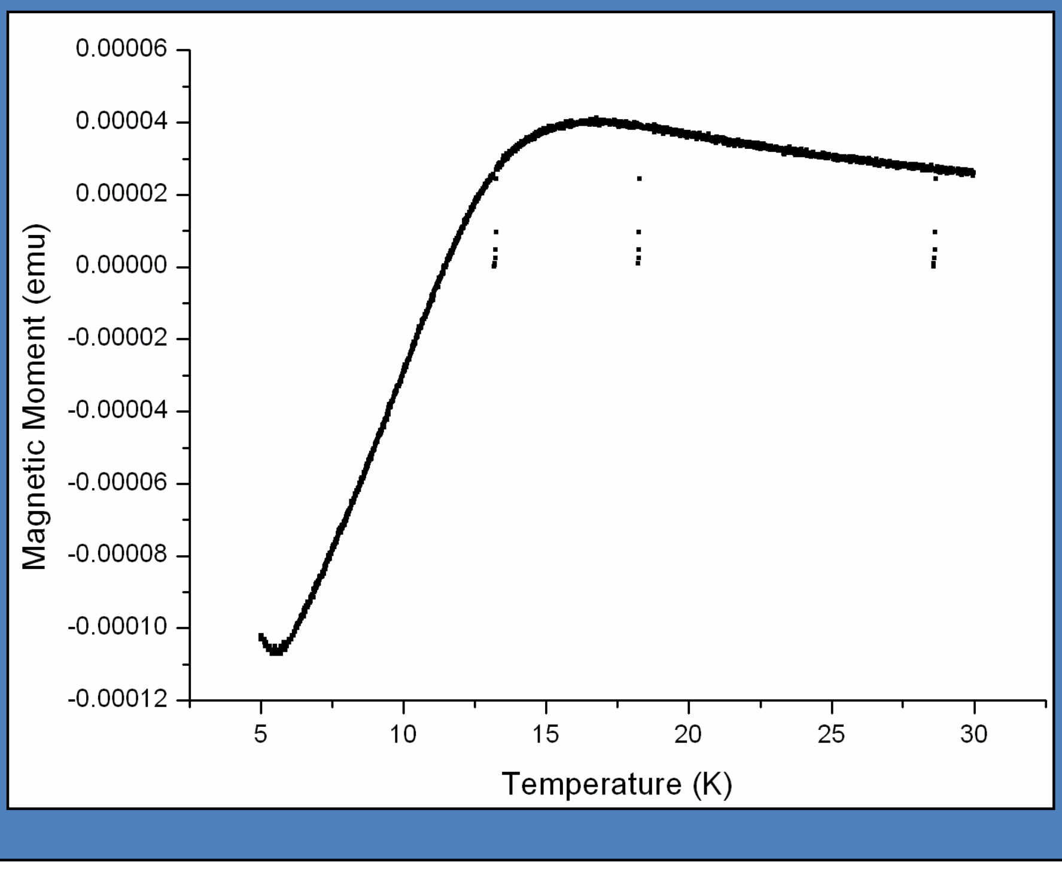

Figure 5. Magnetic moment versus temperature for a sample of $Nd_{1.85}Ce_{0.15}CuO_4$ showing the transition out of the superconducting state above T_c.