Magnetic Field Plotter Manual

by Devin Morin

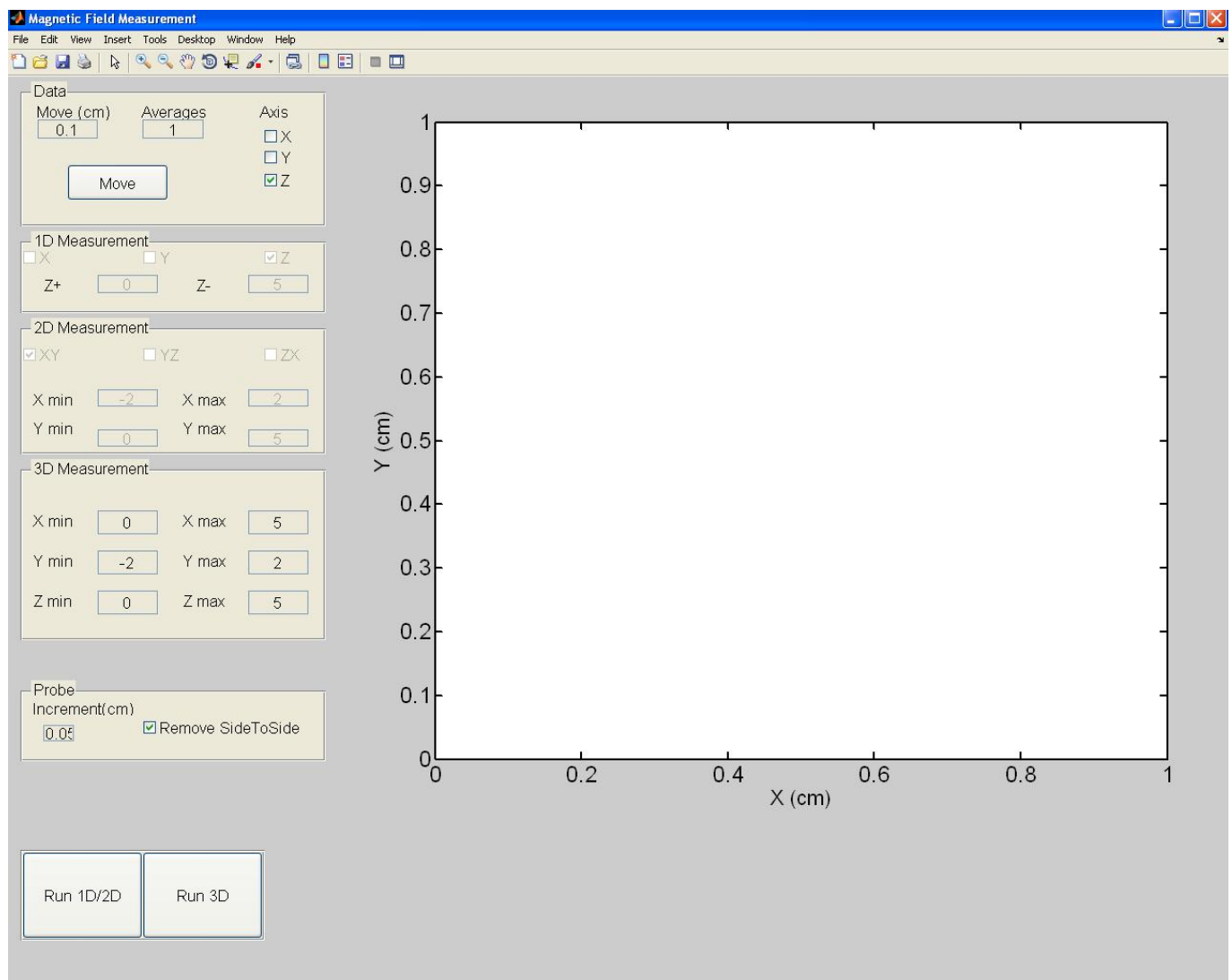**updated July 2019**

WARNING:

Careful when moving the probe as to not damage the probe tip. It's recommended that the sample is not in the velmex active area while making some of the larger jog movements to center the probe.

Also, ensure that the probe tip will not hit the sample while performing a measurement.

Contents

UI Elements

The above image is the MagFeildMeas.m program. This is used to measure
magnetic field in 1D, along either X,Y, or Z; 2D either XY, YZ, or ZX; in
3D. All of which have configurable bounds, increment sizes, and number of
measurements to average per data point.

Firstly, the program is broken up into two main sections: a measurement column, and plot column. To
the left, all data associated with taking the measurement, such as increment size, number of points to
average, and ranges for axes will be inputted. The large white box to the right is a graph of the
measurements. Here, only the 1D measurements are plotted live, and the 2D measurements plotted
after a couple passes of the probe.

In the top left, the '**Data**' tab will store the number of measurements to collect and average per data
point. The 'Axis' column has three checkboxes which allow for either X,Y, or Z to be selected.
Selecting an axis, and pressing the 'Move' button, will move the probe by an amount that is described
in the box under 'Move(cm)'. For example, if the Z axis box is checked, and the move amount is set to
1, the probe will move 1cm in the positive Z direction. It's important to know that the positive Z

direction points towards the floor. Check the labels on the Velmex system to find the directions of the axes.

Below the 'Data' tab, is the '**1D Measurement**' tab, which will hold some information needed to take a 1D measurement. Selecting either X,Y, or Z will change the measurement to occur in such an axis. To change the bounds of the measurement, fill in values for 'Z+' (the max position of the probe), and 'Z-' (the min position of the probe). For example, checking the 'Z' axis box, and setting the 'Z-' to -1, and 'Z+' to 5 will make the probe go down 1cm, and measure all the way up to +5cm above it's original position.

In the '**2D Measurement**' tab, selecting either XY, YZ, or ZX will determine the plane that the measurements will take place. As before, setting the min and max position for the given axes will determine the range of the probe. Keep in mind, that compared to 1D measurements, 2D measurements will take significantly longer.

Finally, the '**Probe**' tab will contain the increment size, and a checkbox for 'Remove SideToSide'. The increment size will determine how large of a step between measurements the probe will take. This applies to every axis. So, if the increment size is set to 1mm, and a 3D measurement is taken, the probe will take a step of 1mm on the Y axis, until the Y limit is reached. Then, it takes a step of 1mm on the X, and repeats the Y axis again. When the X axis limit is reached, it then either raises/lowers (depending on the limits set on Z) 1mm, and repeats this process until completed.

Describing the 'SideToSide' element

In the case where the 'SideToSide' box is left unchecked, the probe will move in such a way as to expose the direct sensitive side to the center of the probe area, and take a measurement. Since the exact sensitive area of the probe tip is only on two sides of the square tipped probe, the motion will move to one side by exactly one half of the probe tip diameter, then back to it's original position. Then, it will move in such a direction as to expose the other side of the sensitive area, and take a measurement. Once this is done, it will average both measurements to give the data point for the position.

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Tip: Disabling 'SideToSide' may allow for the probe tip to take
measurements in tighter spots, and will greatly decrease acquisition times,
at the expense of accuracy.
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How to Measure

This section will describe how to take a measurement of a sample in the Z direction, with the probes initial point starting directly above the sample.

To take a measurement, place the sample underneath the probe tip in the Velmex system. If the probe is off center, realign it by selecting either X, Y, or Z in the axis bar, in the 'Data' tab. Then, insert the amount the probe tip should move by, under 'Move(cm)', and select the 'Move' button. It would be wise to remove the sample in the Velmex system before realigning the probe, as to avoid damaging the probe if you overshoot the target area. Once, X and Y axes are roughly aligned with the probe tip (and Z is corrected if the sample is too large), slowly decrease the height of the probe tip by moving the Z axis. Be careful as to not overshoot the target area as this could damage the probe tip.

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Tip: According to the 'Velmex Motor Controller Manual', the E01 stepping
motor can make an increment of 0.00025 inches, so the step size can be
quite small in order to get as close to the sample as possible.
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Once the probe is in place, fill in a suitable value in the 'Data' tab for 'Averages'. Then, since in this case a 1D measurement is being taken, adjust the 'Z-' and 'Z+' values. If a measurement from the initial probe position, to 5cm above was needed, then Z+ should be set to 0, and Z- set to 5. This may seem confusing, but the 'MagFieldMeas' program is set to be the same axis definition set by the Velmex system. As can be seen on the system itself, the axes are defined by labels. The Z axis is vertical, with the negative going upwards, and positive going downwards.

Finally, change the increment size in the 'Probe' tab, and select if the 'SideToSide' motion should be disabled. For a detailed explanation behind the 'SideToSide' motion, refer to 1. UI Elements.

Further Improvements

Limit Switches Sticking-

Very rarely, the stepper motor will push the system slightly over the limit switches. This means that when the probe is told by the program to move away from the limit switch, it instantly activates the stop for the motor since it has gone too far over the limit switch. One possible fix to this issue, would be to change the jog rate of the system to a lower value. This would allow for the system to come to a stop before overshooting the limit switches. However, this would lead to much longer acquisition times.

**Measurements continously being taken while limit switch is pressed-**

If measurements are configured to go beyond the active area of the system (active area is defined by the limit switches), then the program will continously take measurements while the probe rests in the same position. Ideally, the system will throw an exception and stop taking measurements once any one of the limit switches is pressed. However, it seems as though the limit switches only communicate to the stepper motor. This means that there is no way to send a signal from the stepper motor to the computers communication port and break the loop. One way around this problem may be to add a 'try' statement to stop the motor in the middle of the loop. If the stop statement throws an exception, then the limit switch must have been activated during the move statement. If the 'try' statement throws an exception, it should catch a 'break;', and display an error message to terminate the acquisition.

Data Comparisons

B_o of BA11-3 | 0.02cm increment | Avg=3
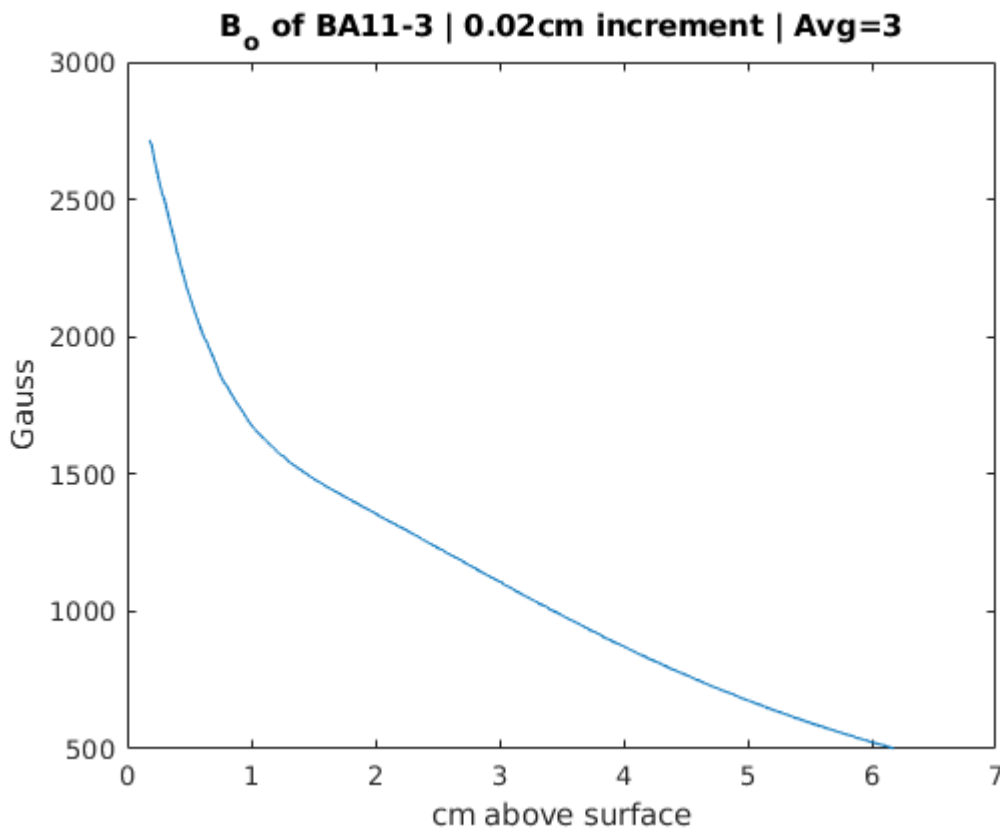
The above image is a plot of a BA11-3 magnet, with a probe increment of 0.02cm. This plot shows magnitude of magnetic field as the probe tip moves upwards along the Z axis. The probe tip started directly on top of the magnet, and moved to a distance of 6cm. The horizontal data is shifted by the distance from the probe tip, to the sensitive area. (As defined in the manual for this given probe, the tip to sensitive area is about 0.18cm). Three measurements were averaged per data point in order to reduce error.

B$_z$ of BA11-3 | 0.2cm increment | Avg=3
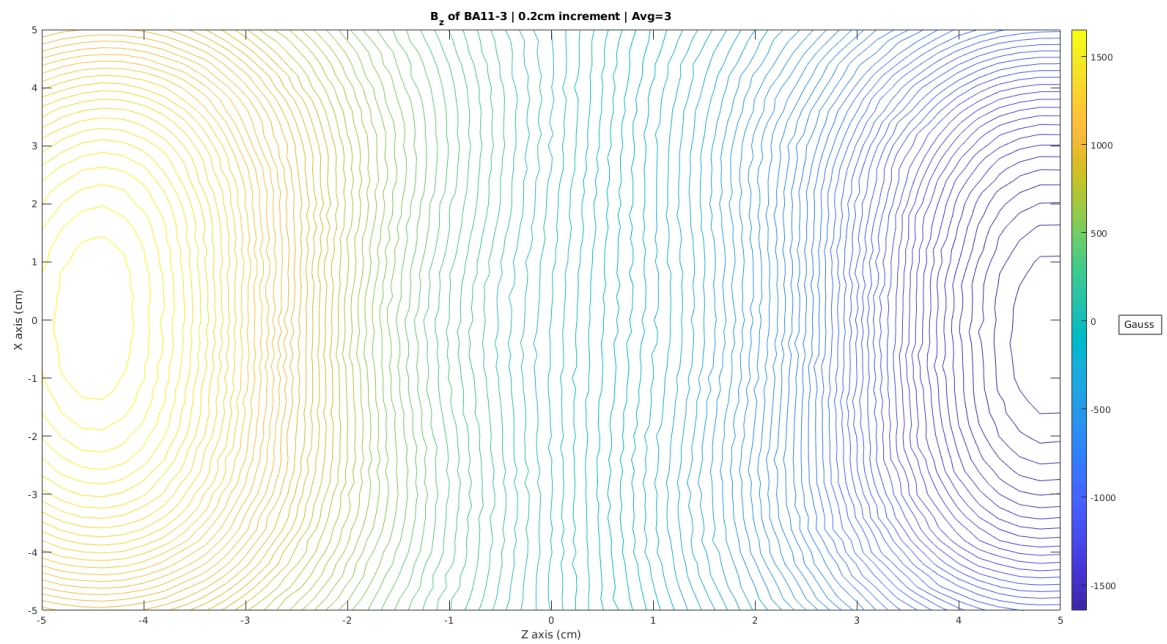
The above image is a plot of a BA11-3 magnet, with a probe increment of 0.2cm. This plot shows the Bz field in the ZX plane, at a height of 2cm above the magnet. As seen in the image, the Bz component of the plotters frame of reference is very large, and moves towards the right, then down into the page.

Resources

Velmex Stepper Motor Controller Manual

https://www.velmex.com/Downloads/User_Manuals/vxm_user_manl.pdf

Velmex Stepper Motor Website

https://www.velmex.com/Products/Controls/VXM_Controller.html

Velmex Driver Install Guides

https://www.ftdichip.com/Support/Documents/InstallGuides.htm

Lakeshore 460 Gaussmeter Specifications

http://www.sal.wisc.edu/whirc/archive/public/datasheets/lakeshore/460.pdf

Lakeshore 460 User Manual

http://www.sal.wisc.edu/whirc/archive/public/datasheets/lakeshore/460_Manual.pdf