Hall Probe Calibration System
User's Guide

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Version: 1.1

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Version Control

Release	Publish Date	Comments
1.0	7/31/2003	Draft for Review
1.1	8/7/2003	Review for Signature

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1. EXECUTIVE SUMMARY

The Hall Probes used to characterize the Insertion Devices need to be calibrated. The APS Magnetic Measurement Lab Hall Probe Calibration System consists of a Precision Magnet Power Supply System that generates even magnetic fields, a Hall Probe based Digital Teslameter system that provides reference field and temperature read outs, an Nuclear Magnetic Resonant (NMR) Teslameter that measures the absolute field strength, a Motorized NMR Probe Supporting Stage that positions the right NMR Probe in the right position, and a Precision Digital Multimeter that measures the Hall voltage of the Hall Probe under calibration.

A computer control software has been developed to coordinate and automate the calibration effort. This document provides the User's Guide information for the Hall probe calibration system. The current issue of the document provides system descriptions, software installation, and detailed step-by-step to the applications of the calibration system. The document is structured to provide descriptions/scenarios and application guiding information, in meeting the current and possible future needs of the scientists who use the system in the lab.

2. INTRODUCTION

The APS Magnetic Measurement Lab calibration software system seamlessly integrates and automates the following instruments (sub-systems):

1. Danfysik System 8000 MPS-853 Precision Magnet Power Supply System
2. Metrolab PT-2025 High Precision NMR Teslameter System
3. Motorized NMR Probe Support Stage System Powered by Animatics SmartMotor Servo Motors
4. Group 3 DTM-141 Digital Teslameter System
5. HP 3458A Multimeter System

The system provides user with friendly GUI interfaces. It allows user to set the calibration start field, step, and finish field, as well as the k constant provided by the Hall Probe manufacture, the zero field offset voltage, and user comments. During a calibration scan, the system provides real time plot of the calibration parameters from the MPS 853 absolute value and the value from the HP 3458A in the format of NMR lock-in field B (Gauss) – Constant K (provided by Hall Probe manufacture) X HP 3458A Voltage Measurement vs. NMR lock-in field B (B-kV vs. B). The system will then save the calibration data in a spreadsheet format along with all the constant, reference temperature, start and finish time stamps. The system also provides fine tuning interfaces for each of the above sub-systems.

This document provides the detailed User's Guide information for the APS Magnetic Measurement Lab Hall probe calibration software system. It includes a general overview of the calibration system, descriptions of all the sub-systems, and the step-by-step guide to the software system that integrates the sub-systems and automates the measurements. This document shall be revised to reflect the modification of the system. This is a living document.

3. SYSTEM OVERVIEW

All the Insertion Devices (IDs) at the APS are characterized and fine tuned against their design specifications at the Magnetic Measurement Lab before they get installed into the storage ring. The ID magnetic field spatial distributions are characterized by high precision Hall probe systems. These Hall probe systems need to be calibrated frequently. The Hall probe equipment calibration system is designed to calibrate the Hall probe systems. The calibration system comprises the hardware sub-systems and a software system

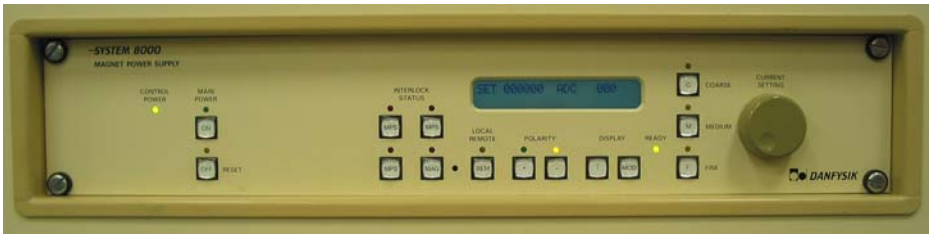
3.1 Hardware Sub-systems

The calibration system hardware consists the following sub-systems:

1. A Danfysik System 8000 Precision MPS-853 Precision Magnet Power Supply System and a large electromagnet to generate tunable uniform magnetic field.
2. A Group 3 DTM-141 Digital Teslameter System to provide the reference magnetic field measurements generated by the electromagnet and the reference temperature.
3. A Metrolab PT-2025 High Precision NMR Teslameter System to provide accurate magnetic field measurements generated by the electromagnet. It is based on the Nuclear Magnetic Resonant Effect to provide precise and absolute magnetic field measurements. In order to provide high precision measurements, it is equipped with a group of six (6) large probes to cover deferent field ranges. The probes positions are coordinated by motorized stages.
4. A motorized stage driven by an Animatic SmartMotor.
5. A Hall probe system to be calibrated. The readout unit of the system is an HP 3458A Multimeter System.

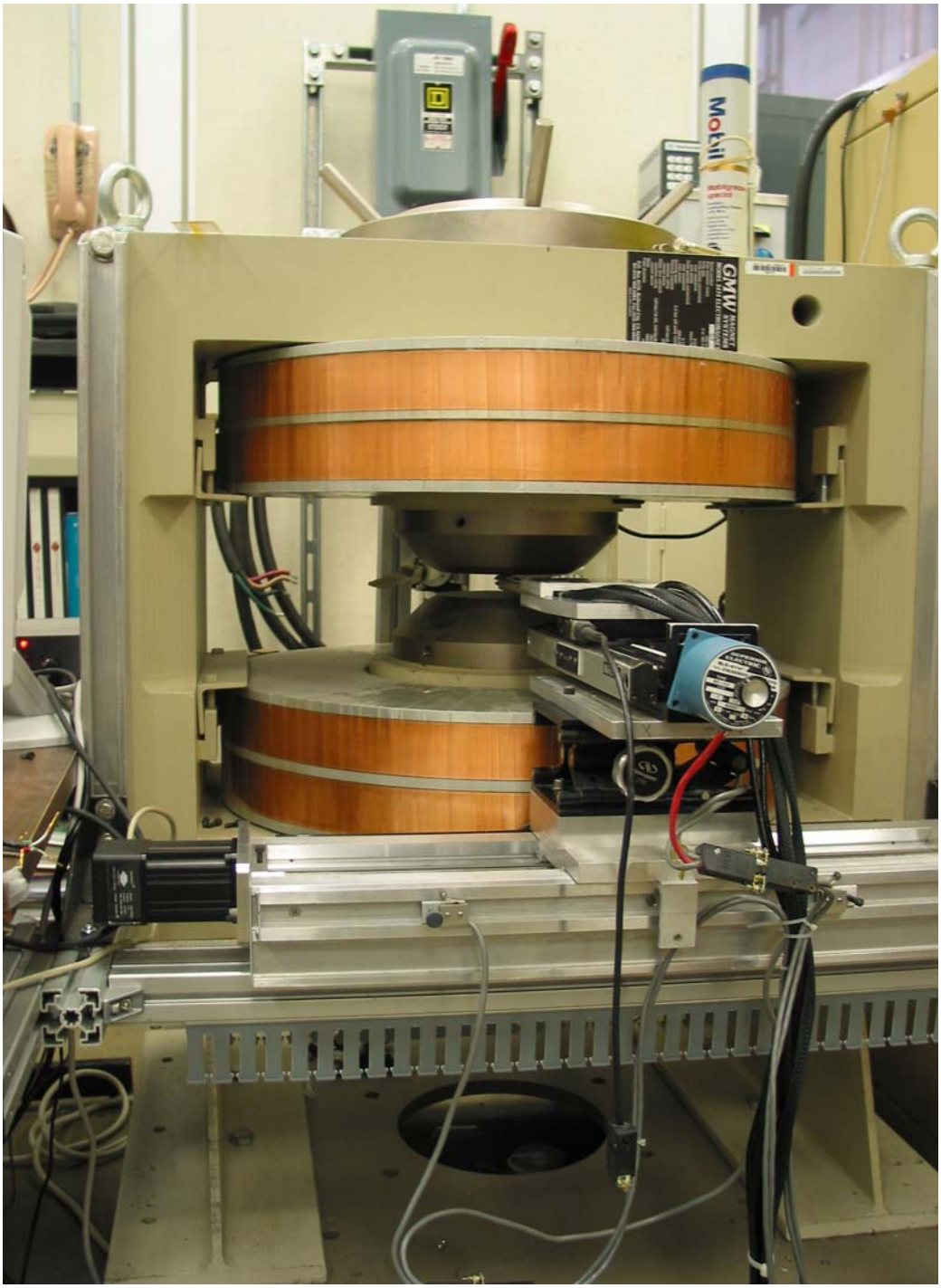
3.1.1 System 8000 Precision magnet Power Supply

The System 8000 Precision Magnet Power Supply is a DC constant current output Power Supply designed for applications requiring very high stability and low noise. The current out put can reach up to 320 A with current stability of 4 ppm in over 8 hours. With a large electrical magnet (with over 1 meter diameter), the Magnet Power Supply (MPS-853) can generate up to 5 Tesla magnetic field with 0.1 Gauss resolution (1 Tesla = 10,000 Gauss). The MPS-853 system provides IEEE-488 GPIB computer interface.



System 8000 Magnetic Power Supply Control Panel

System 8000 Magnetic Power Supply System



Electrical Magnet System

3.1.2 Group 3 DTM-141 Digital Teslameter

Used with special miniature Hall probe, the Group 3 DTM-141 Digital Teslameter offers precision measurement of magnetic fields with direct digital readout in Tesla or Gauss. It also provides reference temperature read out of the probe temperature. The system provides IEEE-488 GPIB computer interface.

Group 3 DTM-141 Digital Teslameter

3.1.3 PT-2025 High Precision NMR Teslameter

The PT-2025 High Precision NMR Teslameter System consists of the following:

1. Bench-top main unit with IEEE 488 GPIB computer interface
2. Five 1H Probes (for B = 0.043 to 2.1 Tesla)
3. Amplifier

PT-2025 High Precision NMR Teslameter

Each Probe consists of a measuring head and detection circuit. The radio frequency oscillator in the teslameter has a frequency range of 30 to 90 MHz, which corresponds to the highest proton resonance field range of 0.7 to 2.1 Tesla. The other field ranges are obtained by dividing the frequency by 2, 4, 8 or 16. This results in a very comfortable overlap of the 5 field ranges.

An internal frequency counter measures the NMR frequency which is sent to the probe, the result is displayed in Tesla with a resolution of 0.1 μT (1 mGauss) or in frequency with a resolution of 1 Hz.

3.1.4 Animatics SmartMotor Servo Motor

For different magnetic field ranges, different NMR Probes need to be positioned into the center of field. This is accomplished by mounting the probes onto a motorized stage. The motorized stage is made of an aluminum stage and driven by an Animatics SmartMotor Servo Motor. During measurement, the Motor power supply is in the OFF mode to minimize the magnetic noise. The SmartMotor is a brushless DC servo-motor that uses a built in controller and amplifier to perform programmed motion. The servo controller uses closed loop PID control. The SmartMotor can be run from commands received from RS232 communication cable.

3.1.5 HP 3458A Multimeter

The Hall Probe systems need to be calibrated comprises a Hall Probe and a Multimeter. The voltage meter is used to read out the Hall voltage. Currently, HP 3458A Multimeters are used to read out the Hall voltages. The 3458A Multimeter is a fast, flexible, and accurate multimeter. It has 8 digital resolution. The DC voltage range is from 0.1 V to 1000 V with an accuracy of 100 ppm. It has a built in IEEE-488 GPIB computer interface as well.

HP 3458A Multimeter

3.2 Software System

Here is how the Hall Probe Calibration System operates. At a specific magnetic field strength point:

1. The System 8000 MPS-853 generate high DC current that produces a uniform magnetic field via an electrical magnet.

2. The Group 3 DTM-141 Digital Teslameter provides the reference field measurements.
3. The MPS-853 is then fine tuned to the setting field based upon the feedback readout of the DTM 141 Digital Teslameter.
4. The respective probe will be positioned into the center of the field accordingly via the motorized stage.
5. The PT 2025 then selects the right channel to search and lock onto the NMR frequency that yields the absolute field measurements.
6. Meanwhile, a number of voltage readouts of the Hall probe, the HP 3458A in this case, can be calibrated versus the absolute field measurements.
7. Repeat step 1 – 6 to scan across the magnetic field, typically from -20,000 Gauss to +20,000 Gauss with 50 Gauss per step.
8. During the scan, the data will be plotted in real time in the format of the absolute Magnetic Field B (Gauss) – Constant K (provided by Hall Probe manufacture) X Hall Probe Voltage together with the Standard Deviations, vs. Magnetic Field B (et. B-kV vs. B).
9. After the scan is finished, the Magnetic Field, the RMS Value of the Hall Probe Voltage, as well as the Standard Deviation of the Hall Probe Voltage Values, along with the field start, step, finish, the k constant, the zero filed offset, as well as the reference temperature and the time stamp will be saved into a file in a spreadsheet format.

All the sub-systems are controlled via GPIB interfaces, except the motorized stage, that is driven by an Animatic SmartMotor Servo Motors that has RS232 serial interfaces. The Hall Probe Calibration System Control Software provides users a GUI interface, coordinates and automates the above efforts, plus a real time visual data plot out and detailed control and fine tune of each individual hard ware modules.

4. PREPARATIONS

The system involves High Voltage, High Current, and High Magnetic Field. Extra safety precaution has to be taken. Users shall take proper safety training classes before operation of the system.

4.1 Hardware Connections

All the hardware sub-system shall be wired appropriately according to their user's manual. Make sure the IEEE-488 GPIB cables of the PT-2025 NMR Teslameter, the DTM-141 Digital Teslameter, the MPS-854 Magnetic Power Supply, and the HP 3458A Multimeter are daisy chained and connected to the back of the computer. Make sure the DB9 connector of RS-232 cable from the back of the Animatics SmartMotor mounted on the motorized probe stage is connected to the COM1 port of the computer.

4.2 IEEE-488 GPIB Address Settings

The GPIB address settings have to be set to the following settings:

1. Danfysik System 8000 MPS-853 Precision Magnet Power Supply System: **5**;
2. Metrolab PT-2025 High Precision NMR Teslameter System: **11**;
3. Group 3 DTM-141 Digital Teslameter System: **20**;

4. HP 3458A Multimeter System: **22**

The Motorized NMR Probe Support Stage System is powered by Animatics SmartMotor Servo Motor. The motor is controlled via RS-232 interface. The DB9 connector of the RS-232 interface shall be connected to the **COM1** port.

4.3 Computer Requirements

A PC based computer quipped with:

1. CPU: ≥ 1 GHz
2. Memory: ≥ 256M
3. HD: ≥ 40G
4. COM1 Port
5. PCI-GPIB Interface (IEEE-488-2)
6. Windows XP Professional

4.4 Software Installation

The Hall Probe Calibration System Control Software Package includes the following files:

1. setup.exe
2. setup.ini
3. install.msi
4. InstMsi.exe
5. InstMsiW.exe
6. data.cab

If the package is on a CD, insert the CD into the CD ROM of the PC, double click the setup.exe file and follow the instruction to install the software package.

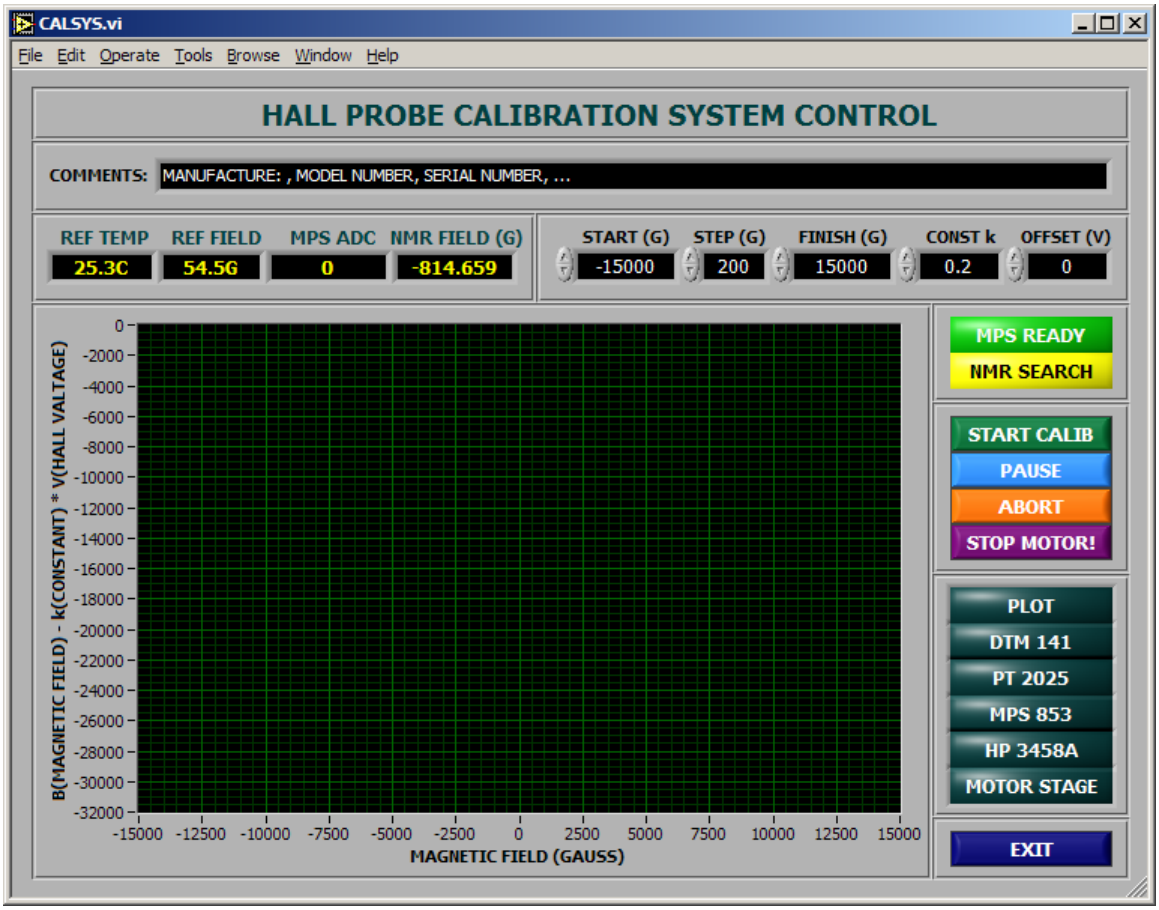
5. SYSTEM CONTROL SOFTWARE INTRODUCTION

The control software consists of the main control interface, and six sub interface modules. The sub-interface modules include:

1. Data File Read and Plot
2. DTM-141 Digital Teslameter Control Interface
3. PT-2025 NMR Teslameter Control Interface
4. MPS-853 Magnetic Power Supply Control Interface
5. HP-3458A Multimeter Control Interface
6. Motor Stage Control Interface

5.1 Main Control Panel

The Main Control Interface is a window that launches with the program. It provides the following control and display interfaces to the users as show in the diagram.



The Main Control Interface Window

5.1.1 Input fields

- **COMMENTS** field provides user a place to input any calibration related information and comments such as the manufacture, part number, and serial number of the probe. It can be multi-lines separated by a carriage return.
- **START (G)** field is the user input filed to specify the calibration start field in Gauss unit. The default value is -15000 Gauss (-1.5 Tesla.)
- **STEP (G)** field is the user input filed to specify the calibration step in Gauss unit. The default value is 50 Gauss (0.005 Tesla.)
- **FINISH (G)** field is the user input filed to specify the calibration finish field in Gauss unit. The default value is 15000 Gauss (-1.5 Tesla.)
- **CONST k** field is the user input filed to specify the calibration constant, usually provided by the probe manufacture.
- **OFFSET** field is the user input filed to specify the probe zero field offset voltage in volts. This value needs to be measured by put the probe head into a zero field enclosure, usually a can made of μ-metal, and measure the Hall voltage.

5.1.2 Display Fields and Indicators

- **REF TEMP** field displays the reference temperature in degree centigrade from the DTM-141 Digital Teslameter Probe Head.

- **REF FIELD** field displays the reference magnetic field in Gauss, from the DTM-141 Digital Teslameter Probe Head.
- **MPS ADC** field displays the ADC setting of the MPS-853 magnetic power supply. It corresponds to the magnetic field setting.
- **NMR FIELD (G)** field displays the PT-2025 NMR Teslameter Search Field Value. If the **NMR SEARCH/NMR LOCKED** turns to Green **NMR LOCKED** and indicates the NMR has been locked, the field displays the absolute magnetic field measurement. Otherwise, it is just a scan value.
- **MPS READY/MPS STANDBY** indicator shows the status of the MPS-853 Magnet Power Supply. If the indicator is Red **MPS STANDBY**, it means that the Power Supply is not ready and in Standby State. If it is Green **MPS READY**, it means that the Power Supply is ready. If the indicate stay in Red **MPS STANDBY**, you may click the MPS 853 Control Button to find out if there is any interlocks tripped off. Please refer to the MPS 853 Control Button in the Control Buttons Section bellow.
- **NMR SEARCH/NRM LOCKED** indicator shows the status of the PT-2025 NMR Teslameter Search/Lock status. If the Teslameter locked onto a field or frequency, the indicator will show Green **NRM LOCKED**. Otherwise, it stays in Yellow **NMR SEARCH.**

5.1.3 Calibration Controls

- **START CALIB** Control Button: Click once to start a calibration scan.
- **PAUSE/RESUME** Control Button: Click once to pause the scan if a calibration scan is in progress. In the Pause state, the control button becomes RESUME. Click second time to resume the scan.
- **ABORT** Control Button: Click once during a calibration scan will abort the scan. The scan will not be completed. However, the calibrated data along with all the user comments, **k** constant, and zero offset information will be saved into a file.
- **STOP MOROR!** Control Button: Click once to stop the motor if it is running. Click the **STOP MOROR!** Control Button will abort the scan. ***The control button is for emergency use only.***

5.1.4 Real-time Plotting

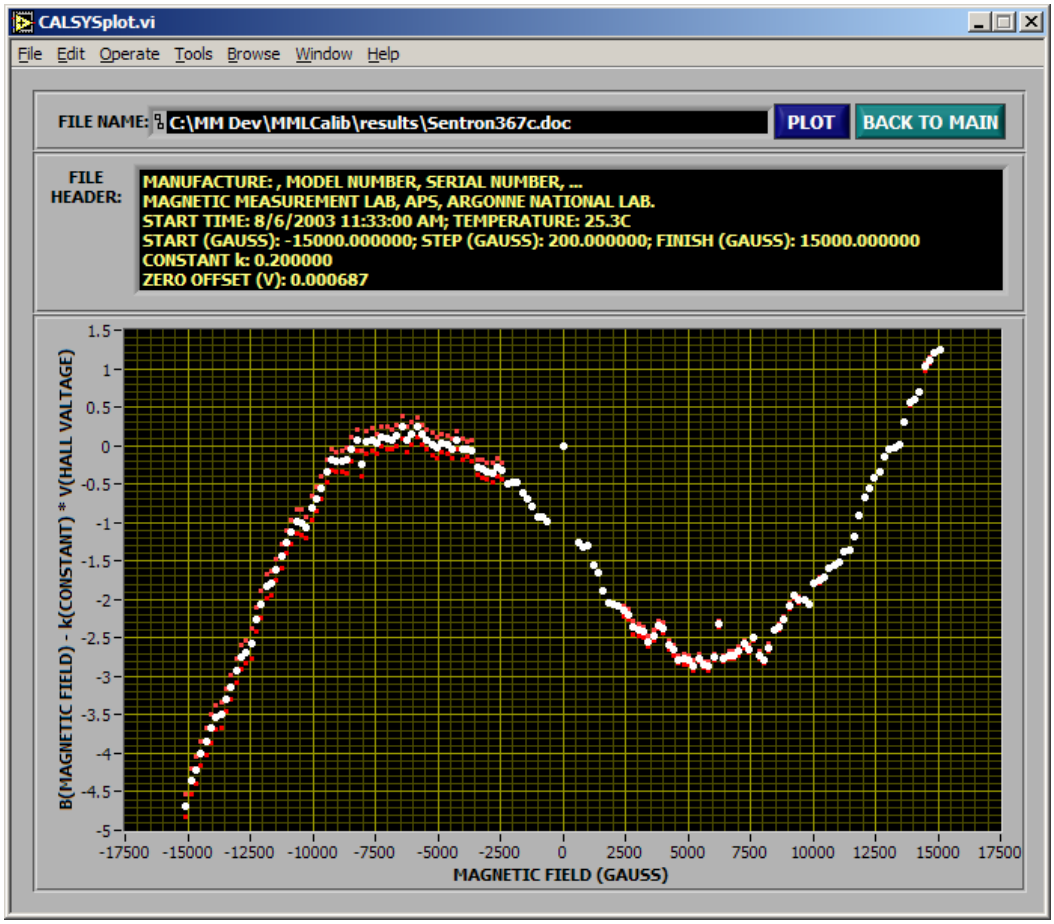
The main part of the main control panel is the real time plotting of the calibration results. The x-axis of the plot diagram is Magnetic Field in Gauss (**B**). The y-axis of the plot diagram is Magnetic Field minus the **k** constant times the Hall Voltage (**B-k*V**). Along with the calibration curve, it also plots the Standard Deviation of the measurement value **k*ΔV**.

5.2 Sub-Control Panels

There are six Sub-Control Panels under the Main Control Interface. To launch the sub-control panels, simply click the sub-control panel control buttons on the main control panel.

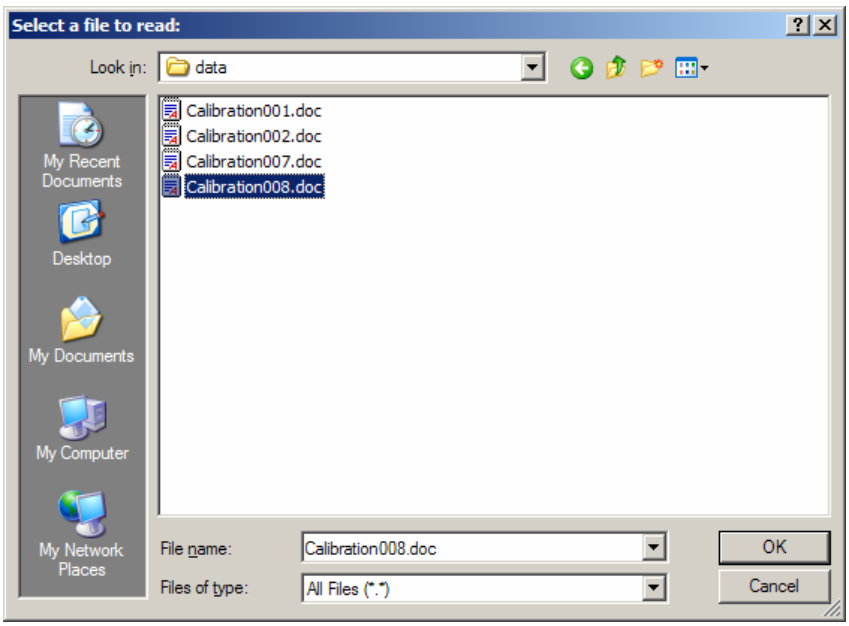
5.1.5 Data Plotting

Click the **PLOT** Control Button on the Main Control Panel, a PLOT Sub-Control Panel will display as shown below.



The Data Plotting Window

Click the PLOT control button once, a “Select a file to read” window will show up.



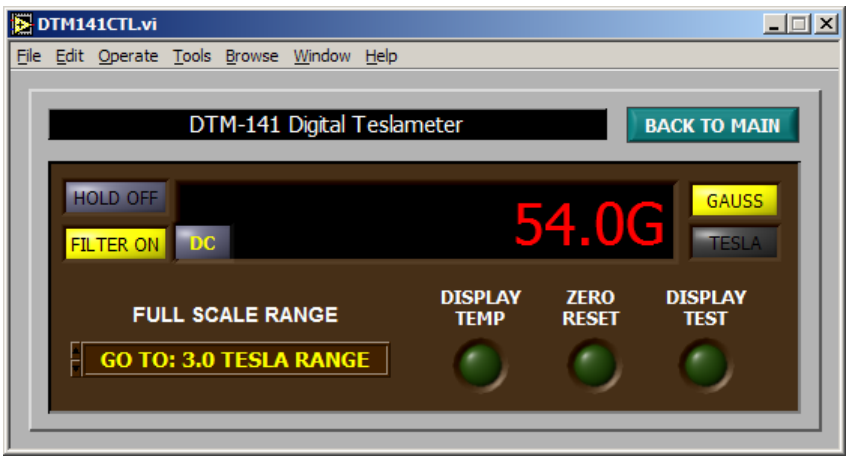
"Select a file to read" Window

Select the appropriate data file and click the OK button, the file name, file header information, along with the data will be displayed in the panel.

Click the **BACK TO MAIN** Control button will close the sub-panel and go back to the main control panel.

5.1.6 DTM-141 Digital Teslameter Control Panel

Click the **DTM 141** Control Button on the Main Control Panel, a DTM-141 Digital Teslameter Control Panel will display as shown below.



DTM-141 Digital Teslameter Control Panel

Click **TESLA** Control Button, the panel will display the field measurement in Tesla.

Click **GAUSS** Control Button, the panel will display the field measurement in Gauss.

Click **DISPLAY TEM** Control Button once, the panel will display the temperature measurement. Click **DISPLAY TEM** Control Button again, the display will go back to the previous display mode.

Click the **HOLD OFF/HODL ON** Control Button, it becomes **HOLD ON**, the panel will display the peak field measurement. Click the Control Button again, it becomes **HOLS OFF,** the panel will display the real field measurement.

Click the **FILTER ON/FILTER OFF** Control Button, it becomes **FILTER ON**. It turns on the digital filtering. Click the button again, it becomes **FILTER OFF**. It turns off the digital filtering.

Click **DC/AC** Control Button, it switches to **AC**. The panel displays the AC field measurement. Click the button again, it switches to DC. The panel displays the DC field measurement.

Click the **ZERO RESET** will set the current reading to zero. ***The Zero Reset shall be used only when the Hall probe is inside a µ-metal zero field enclosure***.

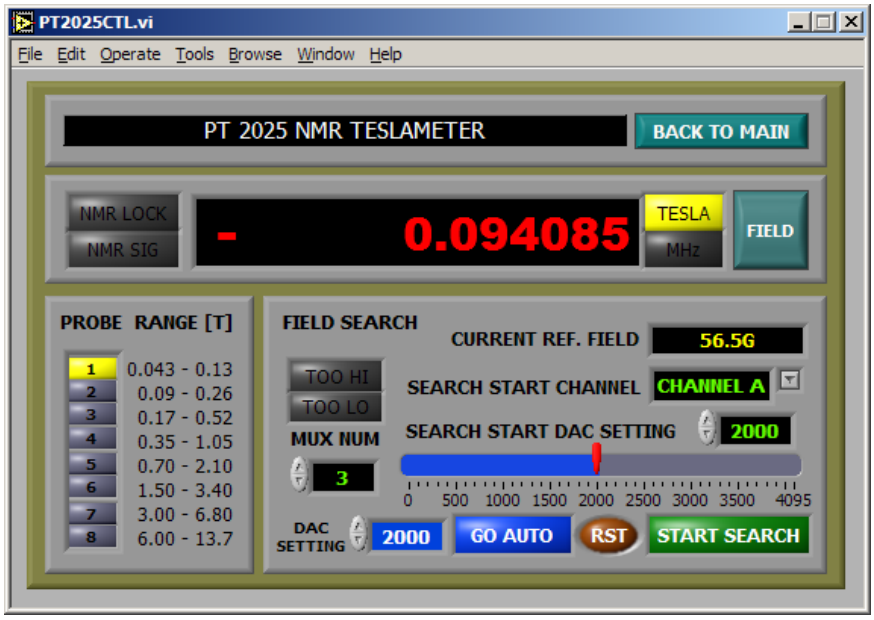
Click **DISPLAY TEST** Control button will test the display.

The **FULL SCALE RANGE** Pull Down Manual allows user to select the full scale display range.

Click the **BACK TO MAIN** Control button will close the sub-panel and go back to the main control panel.

5.1.7 PT 2025 NMR Teslameter Control Panel

Click the **PT 2025** Control Button on the Main Control Panel, a PT-2025 NMR Teslameter Control Panel will display as shown below.



PT-2025 NMR Teslameter Control Panel

Click the **TESLA** control button, it becomes yellow highlighted and the MHz control button becomes grey. The display will show measurement in Tesla.

Click the **MHz** control button, it becomes yellow highlighted and the TESLA control button becomes grey. The display will show measurement in MHz.

The **CURRENT REF. FIELD** field displays the current reference filed measurement from the DTM-141 Digital Teslameter.

Click the **FIELD** control button to change the field sense. If the **CURRENT REF. FIELD** shows negative field, click the **FIELD** control button to make sure the left hand side of the panel display shows negative display as well.

User may select a **DAC SETTING** by put a DAC number into the field and click the **GO AUTO** control button. The control button becomes **GO MANUAL**. If the DAC setting is within 5% of the measurement field, the system will automatically lock onto the field. Please refer to page 47 of the PT-2025 user's manual for DAC setting versus NMR frequency/magnetic field. Click the **GO MANUAL** to quit Auto.

Click **RST** control button to flash the system.

To do a search, set the **SEARCH START CHANNEL** from its pull down manual and the **MUX NUM** to select the number of NMR probes need to be included. Normally, if the **CURRENT REF. FIELD** field displays 3685.3G, you may look at the **PROBE RANGE [T]** and find out which field range it falls in, in this case, probe number 3. You then select **CHANNEL C** as you **SEARCH START CHANNEL**, select a DAC number according to the chart listed on page 47 of the PT-2025 user's manual or just use the default setting, select 1 in the **MUX NUM** field, and click **START SEARCH** control button, the system will search and lock onto the field.

When the system senses an NMR Signal, the **NMR SIG** Status Button will become yellow highlighted.

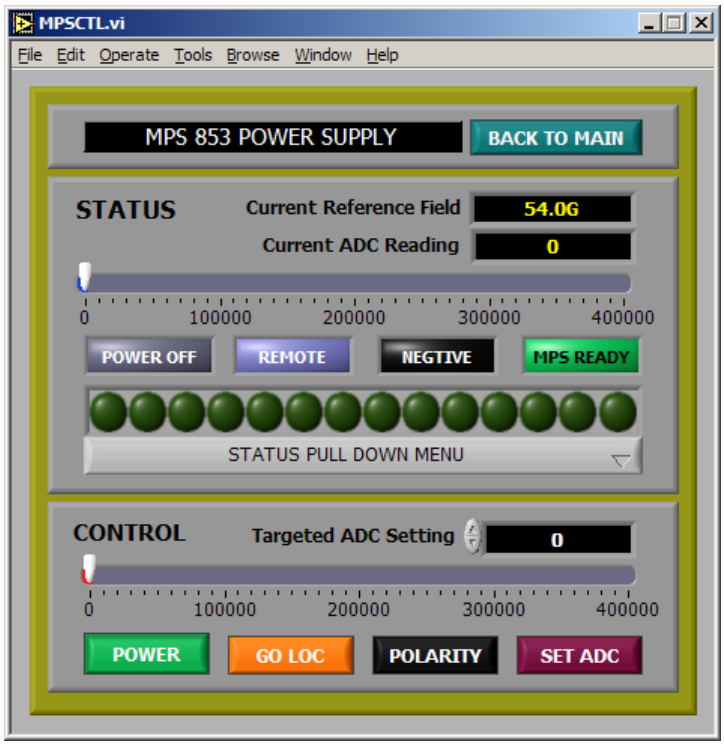
When the system locks onto an NMR resonant frequency, the **NMR LOCK** Status Button will become green highlighted.

The PROBE number will become yellow highlighted when the system scans the correspondent probe chanel.

Click the **BACK TO MAIN** Control button will close the sub-panel and go back to the main control panel.

5.1.8 MPS-853 Magnetic Power Supply Control Panel

Click the **MPS 853** Control Button on the Main Control Panel, a MPS-853 Magnetic Power Supply Control Panel will display as shown below.



MPS-853 Magnetic Power Supply Control Panel

The **Current Reference Field** displays the current reference filed measurement from the DTM-141 Digital Teslameter.

The Current ADC Reading displays the current power supply ADC setting. It is an 18 Bit register that controls the current setting.

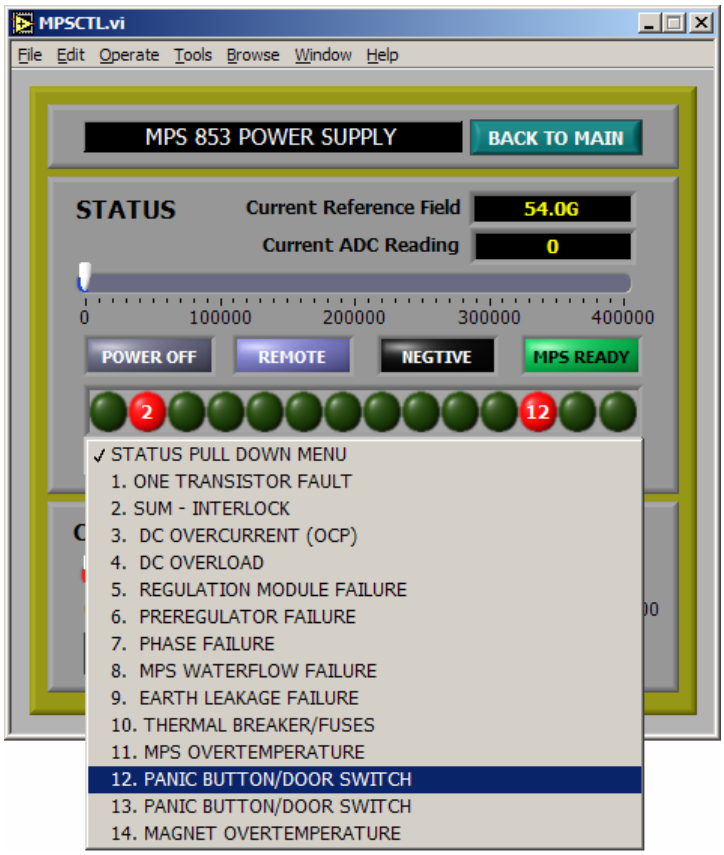
The **POWER OFF/POWER ON** status indicator shows the power supply power off/on status.

The **REMOTE/LOCAL** status indicator shows the power supply control remote/local status.

The **NEGTIVE/POSITIVE** status indicator shows the power supply DC output polarity.

The **MPS READY/MPS STANDBY** status indicator show the status of the power supply power out put.

The STATUS LED INDICATE along with the STATUS PULL DOWN MENU shows the power supply interlock status. If the interlock status is “healthy”, all the LEDs shall be green. If any one of the LEDs are red, user may click the pull down menu to fine out which interlocks are tripped off, as in the diagram shown bellow.



MPS-853 Control Panel Status Pull Down Menu

In this case, the Door Switch was tripped off by opening the back door of the power supply. If any interlock switches have been tripped off, a manual reset has to be performed on the front panel of the physical power supply control panel to clear the interlock switch alarms.

The **Targeted ADC Setting** field allows users to enter the ADC setting numbers. It can be any value from 0 to 400,000. At 400,000, it roughly translates into 20,000 Gauss or 2 Tesla.

The setting will net take effective till the user click the **SET ADC** control button.

The **POWER** control button turns ON/OFF the power supply out put power.

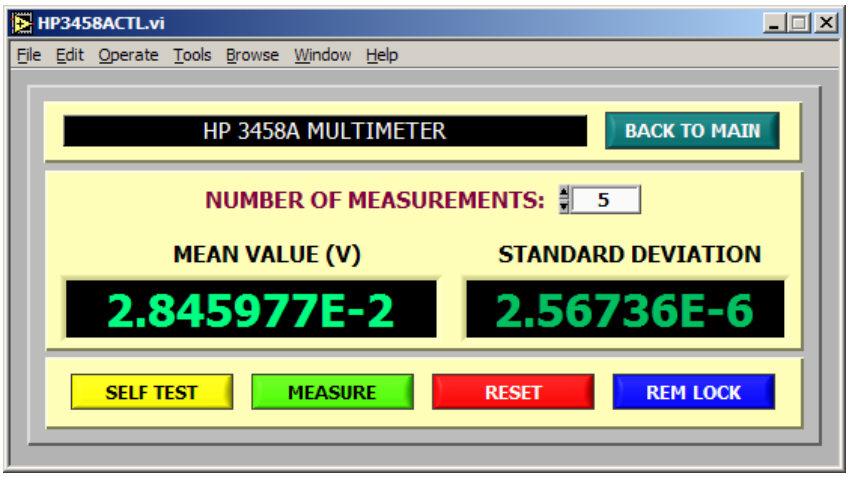
The **GO LOC/ GO REM** control button switches the power supply to local or remote control mode.

The **POLARITY** control button changes the polarity of the DC power out put.

Click the **BACK TO MAIN** Control button will close the sub-panel and go back to the main control panel.

5.1.9 HP 3458A Multmeter Control Panel

Click the **HP 3458A** Control Button on the Main Control Panel, a HP 3458A Multimeter Control Panel will display as shown below.



HP 3458A Multimeter Control Panel

Click **SELF TEST** control button will set the multimeter to perform self test. It takes about one minute to finish the test. The software will issuer a statement to the user if passes or fails the self test.

Click RESET control button will reset the multimeter.

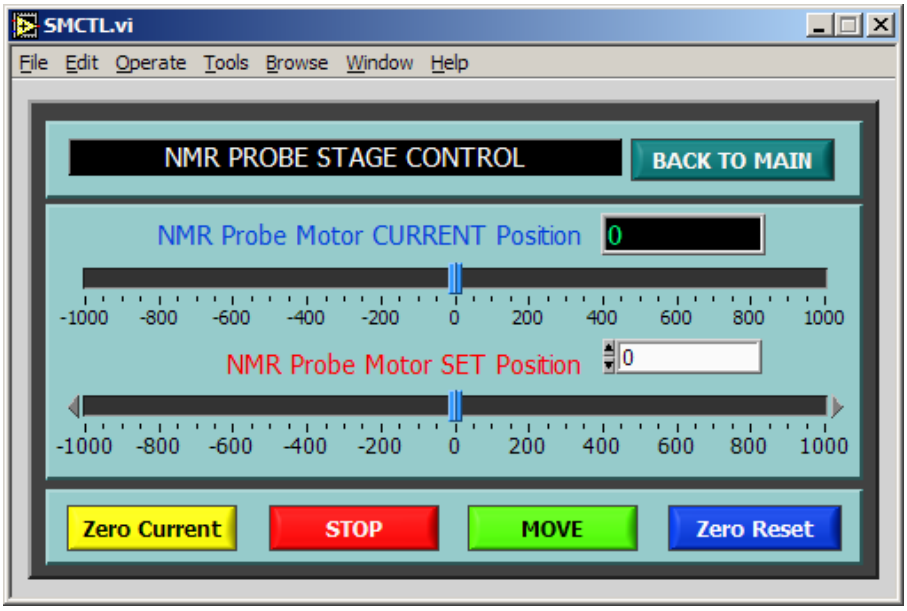
Click REM LOCK/REM UNLOCK will lock or unlock the remote control of the multimeter.

To do a measure, user shall set the **NUMBER OF MEASUREMENTS** field to the number of measurements needed, and click the **MEASURE** control button. The MEAN VALUE (V) and the STANDARD DEVIATION fields will then display the Mathematical Mean value and the Standard Deviation value of the measurements.

Click the **BACK TO MAIN** Control button will close the sub-panel and go back to the main control panel.

5.1.10 NMR Probe Stage Control Panel

Click the **MOTOR STAGE** Control Button on the Main Control Panel, an NMR Probe Stage Control Panel will display as shown below.



NMR Probe Stage Control Panel

The **NMR Probe Motor CURRENT Position** filed show the current position of the stage.

Click the **Zero Reset** control button resets the current stage position to zero.

Click the **Zero Current** control button sets the stage motor to the OFF state with zero holding current.

To move the stage to a new position, first set the poison in the NMR Probe Motor SET Position, and then click the **MOVE** control button.

To stop the motion during the stage movement, click the Red **STOP** control button.

Click the **BACK TO MAIN** Control button will close the sub-panel and go back to the main control panel.

6. SYSTEM CALIBRATION PROCEDURES

A detailed system calibration procedure includes the following steps:

1. System Setup.
2. System Preparation.
3. System Alignment.
4. System Calibration.

If you are sure that the system has been properly set up and aligned, you may skip Steps 9 and 12.

5.3 System Setup Procedure

Before launching the software system, the hardware sub-system connections have to be checked and powered on. If any of the sub-system is not connected and powered on appropriately, the software system will inform you that the specific hardware system is connected or power up or set to the correct GPIB address.

The Magnetic Power Supply MPS 853 system and the Electrical Magnet have to be water cooled. The water supply has to be turned on. Otherwise, the MPS 853 Power Supply will not function and its software module will generate interlock messages inform the users that the water interlock system is tripped off. Therefore, all the interlock alarms have to be cleared before the system can be operated appropriately.

Step 1. Check all the cables, GPIB cables, Serial cables, Power cables, NMR Probe and their amplify signal cables, as well as the Hall probe cables (for bother DTM-141 and HP 3458A) are properly connected and secured.

Step 2. MPS 853 Electrical Magnet Power Supply Water Cooling Valve is ON.

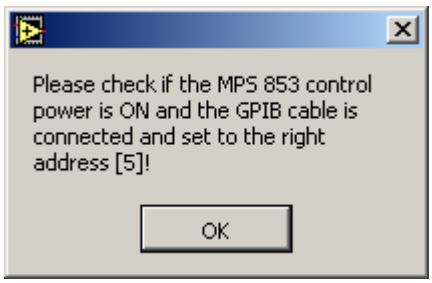
Step 3. MPS 853 MPS 853 Electrical Magnet Power Supply Main Power Switch is OFF.

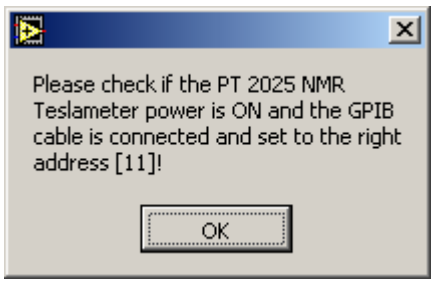
Step 4. Turn on all the power switches of the sub-systems including:

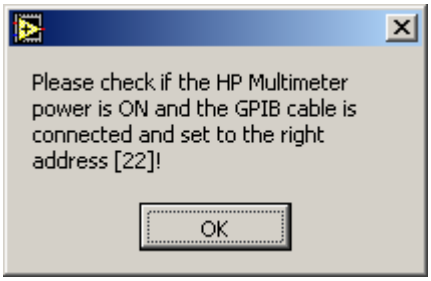
- The power supply of the SmartMotor that controls the NMR Probe Stage.
- The DTM-141 Digital Teslameter Power.
- The PT-2025 NMR Teslameter Power.
- The HP-3458A Multimeter Power
- The MPS-853 Electrical Magnet Power Supply Control Power.
- The MPS-853 Electrical Magnet Power Supply Output Power.

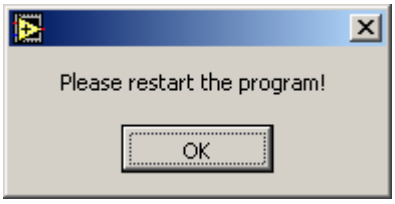
Step 5. Launch the Calibration Control Software by double click the CALIBsys icon on the Windows Desktop.

Step 6. If any of the following windows pop out, click OK buttons, check the appropriate cable connections, power cables, and address settings, and restart the program.









5.4 System Preparation Procedure

Before the calibration, collect all the information about the probe needs to be calibrated. Therefore, the preparation includes the following steps:

Step 7. Collect the Hall probe information including:

- The manufacture.
- The part number.
- The serial number.
- The **k** constant (Tesla per Volts).
- Other information as necessary.

Step 8. Measure the Hall probe zero field offset:

- Put a zero field μ-metal can on the probe.
- Click the **HP 3458A** control button on the main control panel.
- Click the **MEASURE** control button on the HP 3458A control panel.
- Write down the measurement value in volts.
- Click the **RETURN TO MAIN** control button on the HP 3458A control panel to quit the sub-control panel.

5.5 System Alignment Procedure

After the preparation, the system needs to be properly aligned, before calibration scan can be executed.

Step 9. Align the NMR probes in the FRONT half of the Electric Magnet. Manually center the probes vertically by adjust the vertical stage. Adjust the probes so that they are parallel to the Electric Magnet surfaces.

Step 10. Click the **MPS 853** control button on the main control panel to launch the MPS-853 power supply control panel. Enter 5,000 to the **Targeted ADC Setting** field and click the **SET ADC** control button. Click the **POWER** control button to turn on the power switch. You hall hear the power supply power switch relay clicks.

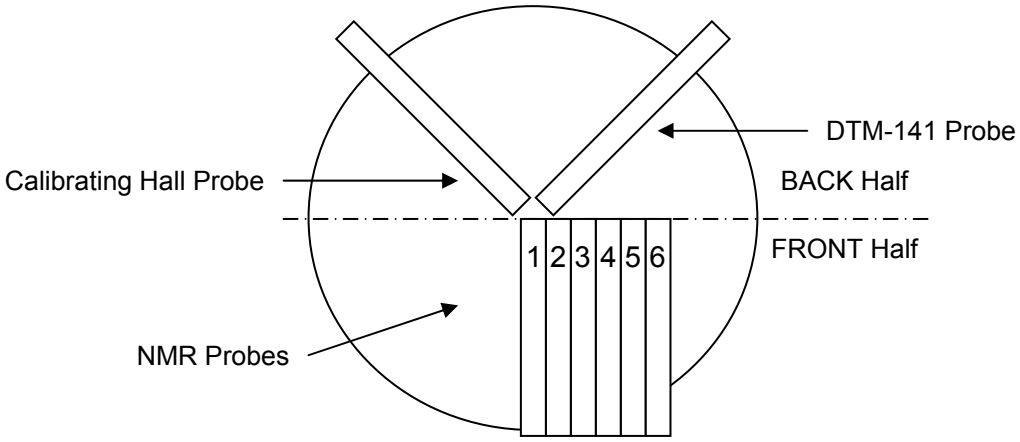
Step 11. Click the **RETURN TO MAIN** control button on the **MPS 853** control panel to quit the sub-control panel.

Step 12. Align the DTM-141 Digital Teslameter Hall Probe in the BACK Right quarter of the Electric Magnet. ***Make sure the probe is clear with the NMR probes along with the center line that divides the front and back halves.*** Center the probes vertically. Slightly rotate the probe to maximize the reading of the **Current Reference Field** on the sub-control panel.

Step 13. Click the **RETURN TO MAIN** control button on the **MPS 853** control panel to quit the sub-control panel.

Step 14. Click the **HP 3458A** control button on the main control panel.

Step 15. Align the Hall probe needs to be calibrated to the BACK Left quarter of the Electric Magnet. ***Make sure the probe is clear with the NMR probes along with the center line that divides the front and back halves.*** Center the probes vertically. Click the **MEASURE** control button on the HP 3458A control panel. Slightly rotate the probe to maximize the measurement of the HP 3458A control.



Step 16. Click the **RETURN TO MAIN** control button on the HP 3458A control panel to quit the sub-control panel.

Step 17. Click the **MOTOR STAGE** control button on the main control panel to launch the motor stage control panel.

Step 18. Move the NMR #1 probe into the center of the magnet as shown in the diagram above. Reset the position to zero by click the **ZERO RESET** control button.

Step 19. Click the **RETURN TO MAIN** control button on the **MOTOR STAGE** control panel to quit the sub-control panel.

5.6 System Calibration Procedure

Before you click the **START CALIB** control button, the following Steps have to be completed.

Step 20. Enter the Manufacture, Part Number, and Serial Number information of the probe needs to be calibrated into the **COMMENTS** field.

Step 21. Enter the **k** constant provided by the manufacture into the **Constant k** field, in Tesla/Volts.

Step 22. Enter the calibration scan start, step, and finish fields in the **Start, Step**, and **Finish** fields, in Gauss unit. If the numbers you enter exceed their limits, the program will pop out a window to warn you that the numbers are out of the limits.

Step 23. Click the **START CALIB** control button to start the scan. The program will pup out a window ask you to enter file name for the data to save. Enter a name and click OK. You may then sit back and relax. A typical calibration scan with

Start: -15,000 Gauss
Step: 200 Gauss
Finish: +15,000 Gauss

takes about 4 hours and 15 minutes to complete.

During a calibration scan, the **PAUSE/RESUME, ABORT,** and **STOP MOROR!** Control Buttons are activated.

- **PAUSE/RESUME** Control Button: Click once to pause the scan if a calibration scan is in progress. In the Pause state, the control button becomes RESUME. Click second time to resume the scan.
- **ABORT** Control Button: Click once during a calibration scan will abort the scan. The scan will not be completed. However, the calibrated data along with all the user comments, **k** constant, and zero offset information will be saved into a file.

- **STOP MOROR!** Control Button: Click once to stop the motor if it is running. Click the **STOP MOROR!** Control Button will abort the scan. ***The* STOP MOROR! *control button is for emergency use only.***

Step 24. After the scan is finished, the program will set the MPS-853 Magnetic Power to zero current and turn off the output power, move the motorized stage back to zero (probe #1) position, and pop out a window to inform you that the scan is successfully completed. Click **OK** to finish the task. You may go back to **Data Plotting** section to find out how to plot the calibration data.

7. TROUBLE SHOOTING

If the **MPS READY/MPS STANDBY** indicator stays in **MPS STANDBY** during a calibration scan, you may have to abort the scan and go to the MPS Control Panel by clicking the MPS 853 control button on the main control panel, check the interlock status menu.

If any interlocks of the MPS 853 Magnetic Power Supply are tripped off, you have to go to the Power Supply physical control panel to reset the alarms by press the Reset Button on the control panel after you clear all the alarms.

If the DTM-141 reference field is much smaller then the NMR measurement, which means the DTM-141 Hall Probe is not well aligned to the field. Go to Step 12 of the System Calibration Procedures to re-align the Hall Probe.

If the Calibration data offsets negatively reference to the zero field, with the zero offset point, which means the Hall Probe under calibration is not well aligned to the field. Go to Step 15 of the System Calibration Procedures to re-align the Hall Probe.

8. OPEN ISSUES

9. ACRONYM LIST

APS	Advanced Photon Source
GPIB	General Purpose Interface Bus
GUI	Graphic User Interface
ID	Insertion Device
NMR	Nuclear Magnetic Resonance