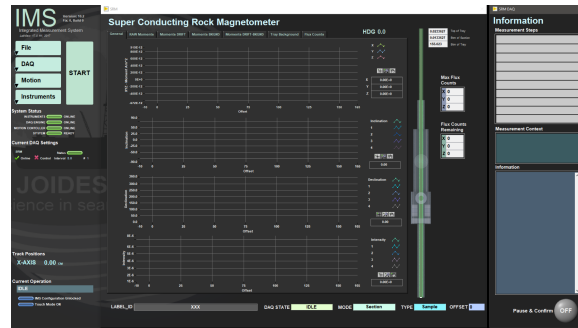


SRM User Guide

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Introduction:

This user guide provides an overview of the IMS-SRM version 10.2 software application for operating the 2G Cryogenic Magnetometer. The SRM software is capable of processing section halves and discrete samples.

Author(s):	Beth Novak
Reviewer(s):	Bill Mills, Katerina Petronotis
Editor(s):	
Supervisor Approval (Name, Title, Date):	
Audience:	Laboratory Specialists
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Domain:	Paleomagnetism Lab
System:	SRM

Launching the IMS-SRM application

The IMS-SRM software can be launched from the Windows Start menu or from a desktop icon (Figure 1).



Figure 1- SRM Desktop Icon

At launch, the program begins the following initialization process:

- Tests all instrument communications
- Reloads configuration values
- Homes the tray in the track
- Sets the degauss controller to a known state

After successful initialization, the main IMS-SRM window will appear (Figure 2).

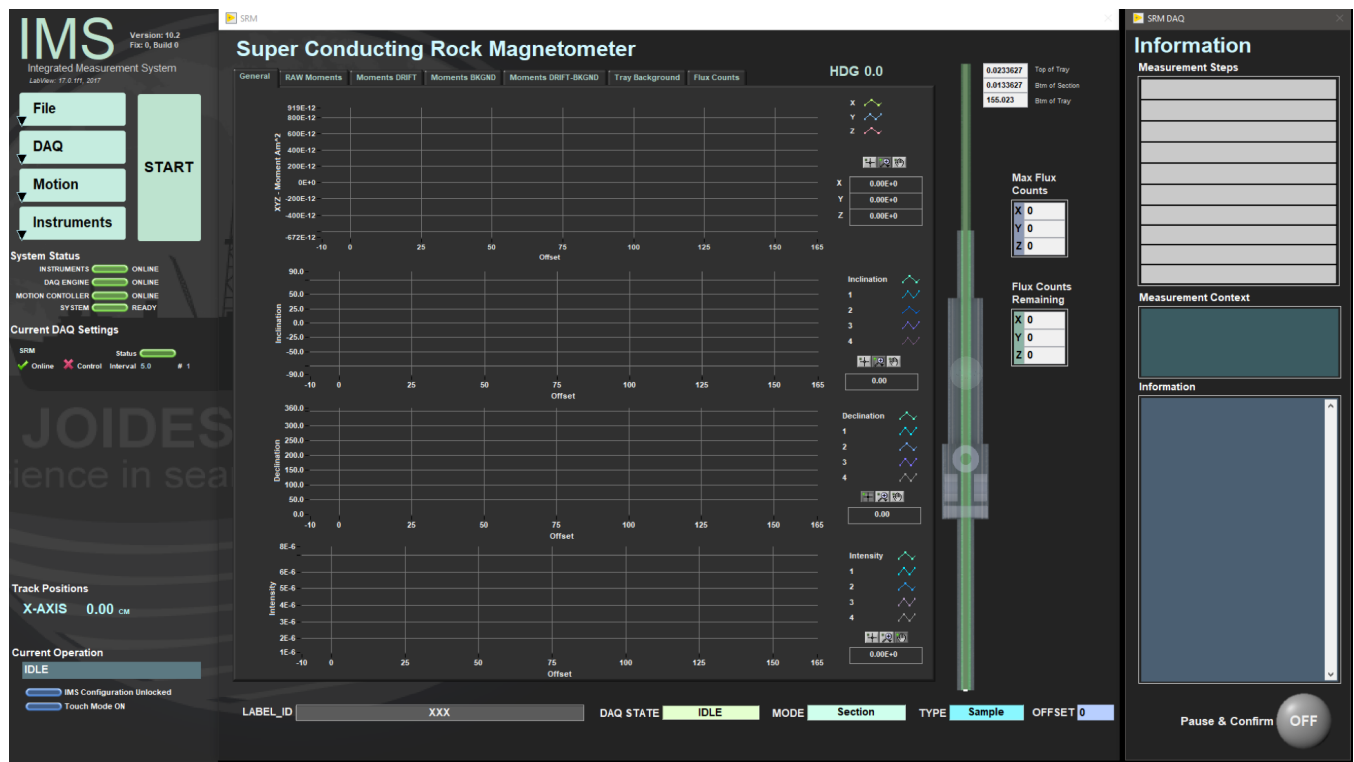


Figure 2- SRM IMS Main Window

A Quick Introduction to the IMS Program Structure

IMS is a modular program. Individual modules are as follows:

- INST plug-in: code for each of the instruments
- MOTION plug-in: code for the motion control system
- DAQ Engine: code that organizes INST and MOTION plug-ins into a track system

The SRM system, specifically, is built with one INST module (SRM), one MOTION module, and one DAQ Engine module.

The IMS Main User Interface (IMS-UI) calls these modules, instructs them to initialize, and provides a user interface to their functionality.

Each module manages a configuration file that opens the IMS program at the same state it was when previously closed and provides utilities for the user to edit or modify the configuration data and calibration routines.

The four buttons on the IMS-UI window provide access to utilities/editors via dropdown menus as shown in **Figure 3**.

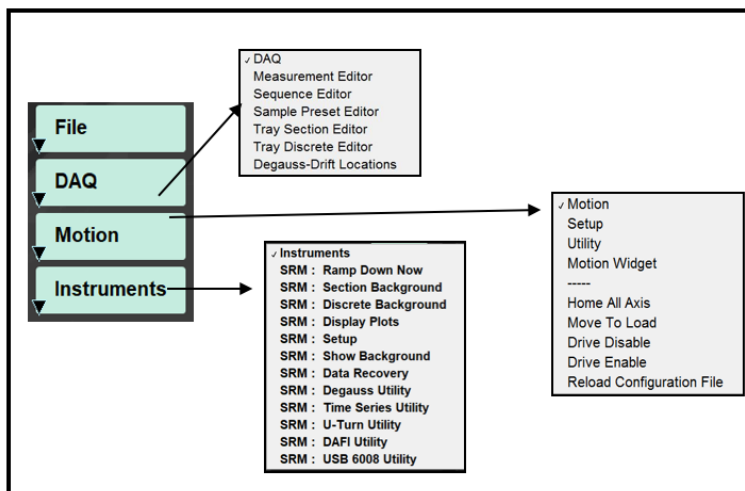


Figure 3- IMS Control Panel Drop Down Menus

Initial Instrument Setup

SRM Configuration

Configuration values should be set during initial setup and configuration by the paleomagnetism technician or scientist(s). There should be no need to change these values unless the configuration file is corrupted.

SRM Instrument General Setup

To open the SRM instrument setup window (**Figure 4**), select **Instruments > SRM: Setup** from the IMS panel menu (**Figure 3**).

- 1) Ensure the values in the window are set as shown in **Figure 4**.
 - The SQUID constant values are provided by 2G and should not be altered.
 - The response lengths values were determined through extensive testing and should not be altered without prior approval.
 - Once the offset to the SQUIDS is determined, this value should not change unless the track hardware is altered.
- 2) Click **OK** to save the changes and write them to the configuration file. Click **Cancel** to revert to previous values.

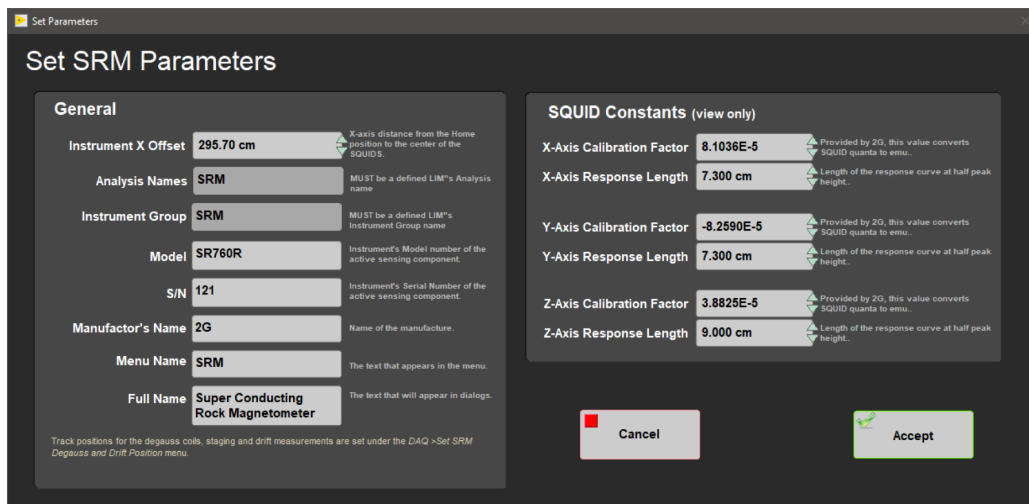


Figure 4- SRM Parameters Window

Degauss and Drift Locations Track Setup

This window is used set the distance to the drift measurement locations and the degauss staging positions. To open the Degauss and Drift setup window (**Figure 5**), select **DAQ > Degauss-Drift Locations** from the IMS panel menu (**Figure 3**).

- 1) Ensure the values in the window are set as shown in **Figure 5**.
 - These values should never change unless the hardware is replaced or the configuration file is corrupted.
 - These positions will ensure that a 160-cm section is outside of the SQUIDS during zeroing and outside of the degauss region while ramping the coils up and down.

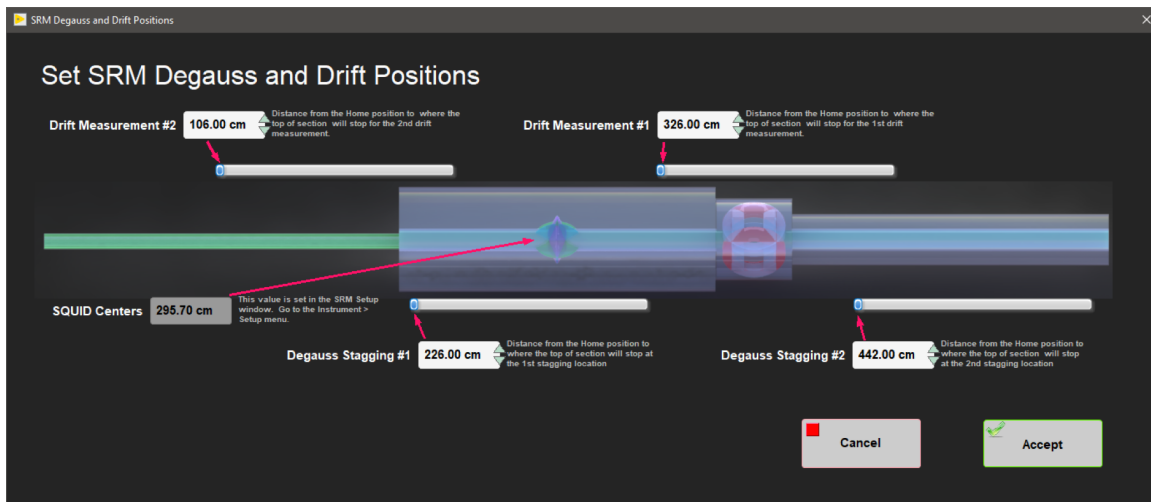


Figure 5- Degauss and Drift Position Configuration Window

Defining Section Half and Discrete Tray Setups

At the beginning of an expedition, or any time the tray is replaced, the scientist(s) or technician must define the two active tray definitions. The program will have in memory the values for just one section half tray and one discrete tray at a time. To open either the Section Tray or Discrete Tray editors, select **DAQ > Tray Section Editor** or **DAQ > Tray Discrete Editor** from the IMS panel menu (**Figure 3**).

- For section trays, define the distance from the home switch (edge of tray that strikes the home switch) to the location of the top of core (top offset). Set the total tray length (**Figure 6**).
- For discrete trays, define the discrete centers (offset from the tray's edge that strikes the home switch to the center of the position in which the specimens are placed). Set the total tray length (**Figure 7**). *When measuring the background of the discrete tray, only these specific locations will be measured. The user will select which positions are actually used later during sample entry.* To remove a discrete center, right click on the position and select **Delete element**.

Making changes to the tray settings will invalidate the background measurement. The user will be given a warning when they try to start a measurement. A new background will be needed before a measurement can be completed.

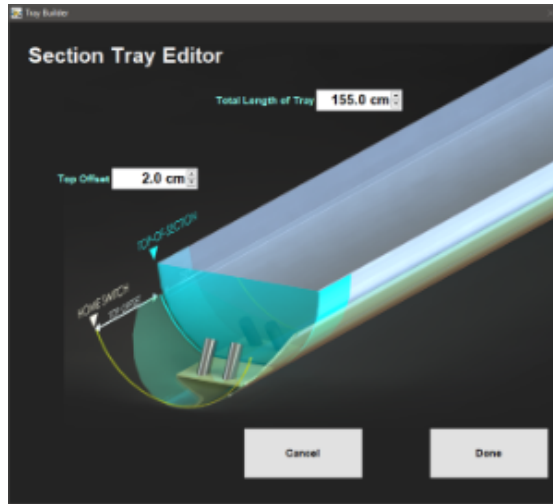


Figure 6- Section Tray Editor Window

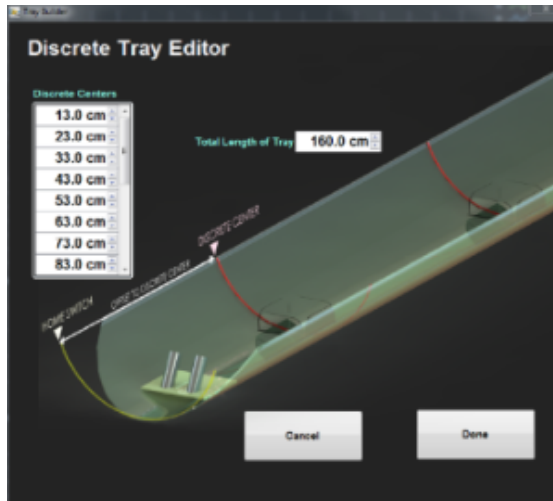


Figure 7- Discrete Tray Editor Window

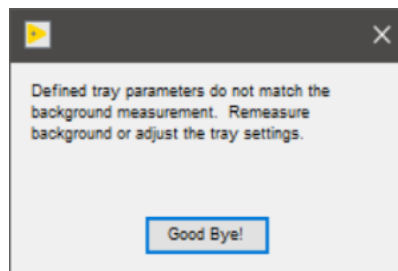


Figure 8- Warning window when current tray settings and last background measurement do not match

Setting Up for a Measurement

Prior to measuring section halves or discrete samples in the SRM the user must:

- Set the measurement interval
- Take a background measurement of the empty tray
- Create or select a measurement sequence
- Create or select a sample type preset

Setting the Measurement Parameters

To open the Measurement Editor (**Figure 9**), select **DAQ > Measurement Editor** from the IMS panel menu (**Figure 3**).

This window allows the user to view and adjust the SRM DAQ Parameters. The current settings are shown in the bottom left hand corner of the window.

- **Interval:** Interval in cm between measurements. This is only valid for SECTION HALF measurements. The measurement interval can range from 0.1 to 20 cm. The most common measurement intervals used are 2.5 cm, 5 cm, and 10 cm.
- **Average:** The number of measurements to take at each position. The measurements will be averaged and the mean will be written to the data files.
- **Leader/Trailer Length:** The distance in cm that is measured before and after the section. This is used in deconvolution processing.

Measurement Speed: User selects slow or fast speed, which determines the settling time and data filter. Slow speed reduces noise while fast speed completes measurements more quickly. Slow speed is recommended.

FLUX Alarm Threshold: The flux count value above which the SRM program will trigger a Flux Jump Alarm. Flux counts between the positive and negative threshold value will not trigger the alarm.

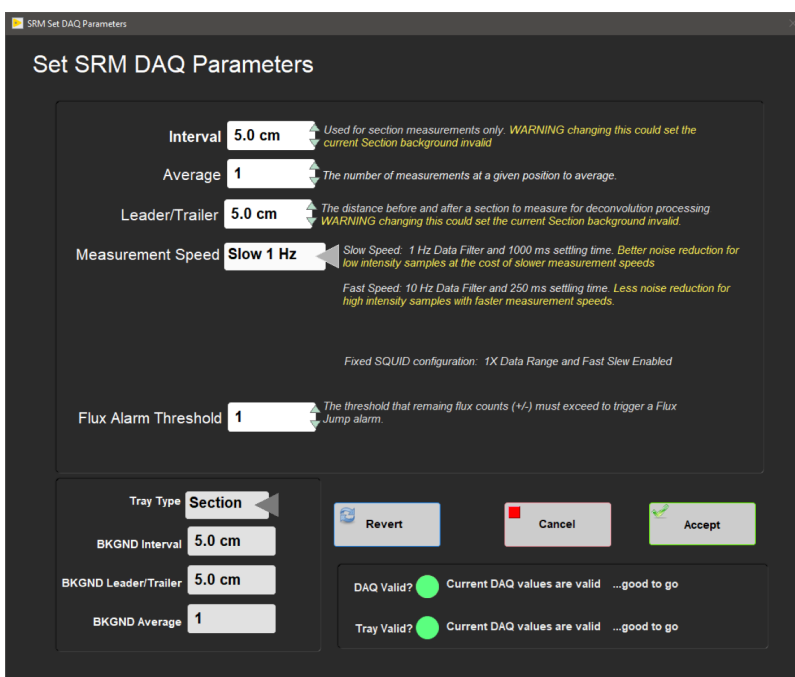


Figure 9- Measurement Editor Window

The SRM software is designed to check if the current measurement interval matches the current background tray measurement interval. If the intervals differ, the user must complete a new background measurement. The software will not allow the user to begin a measurement if the values differ. If a change is made, the user may see a red indicator next to DAQ Valid, indicating a new background measurement is necessary (**Figure 10**).

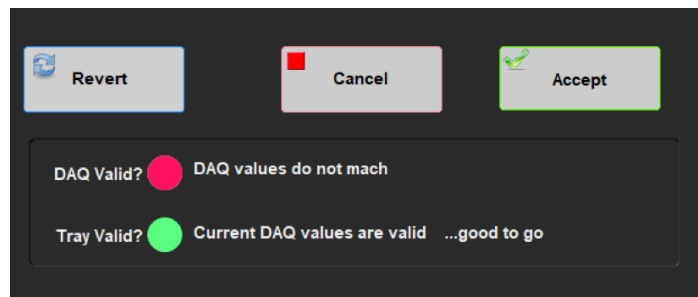


Figure 10- DAQ Invalid Warning in Measurement Editor Window

Click **ACCEPT** to exit the Measurement Editor Window once the parameters are set. Select **Revert** to return to the previous values or select **Cancel** to leave the window without saving any changes.

Measuring Tray Backgrounds

To measure the background of a section or discrete tray:

- 1) Select **Instruments > SRM: Section Background** or **Instruments > SRM: Discrete Background** (depending on the tray type used)(**Figure 11**) from the IMS panel menu (**Figure 3**).
 - The default action for the tray background measurement is to demagnetize the tray and then to measure the empty tray.
 - The user may adjust the demagnetization level (maximum of 80 mT) or choose to measure without demagnetizing the tray. The demagnetization level setting box will be disabled when the user has selected a background only (no demagnetization) measurement.

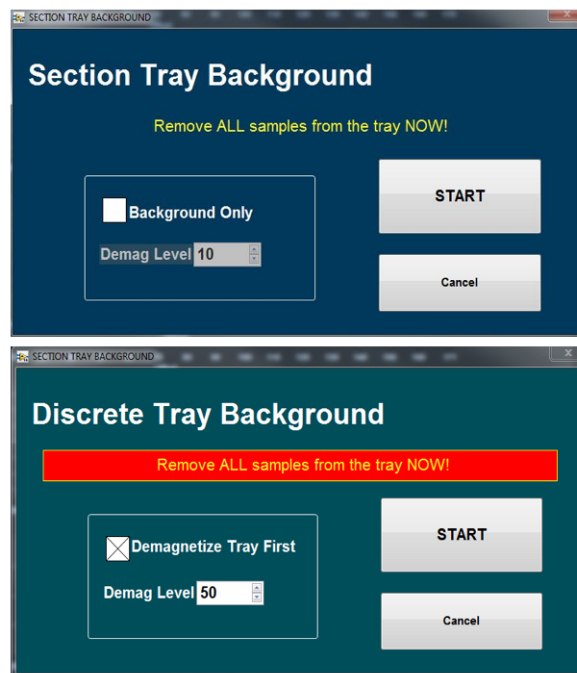


Figure 11- Section Tray and Discrete Tray Background Windows

- 2) Click **START** to begin the background measurement process.
- 3) When the process is complete the user will be prompted to **ACCEPT** and save background data (**Figure 12**). If the background data looks suspect (high values or peaks), select **CANCEL**.

If the data are saved, a new background tray file will be written. The most recent tray measured for each type (section or discrete) will be kept in memory.

These background data will be applied to all subsequent measurements of the same type.

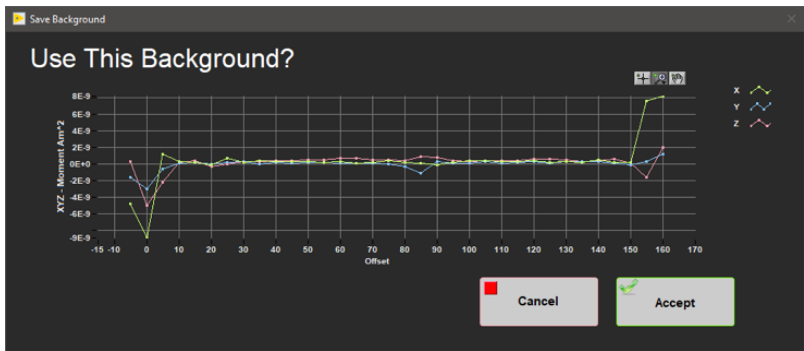


Figure 12- Background Confirmation Window

Creating a Measurement Sequence

1) Open the Sequence Editor (Figure 13) by selecting **DAQ > Sequence Editor** from the IMS panel menu (Figure 3).

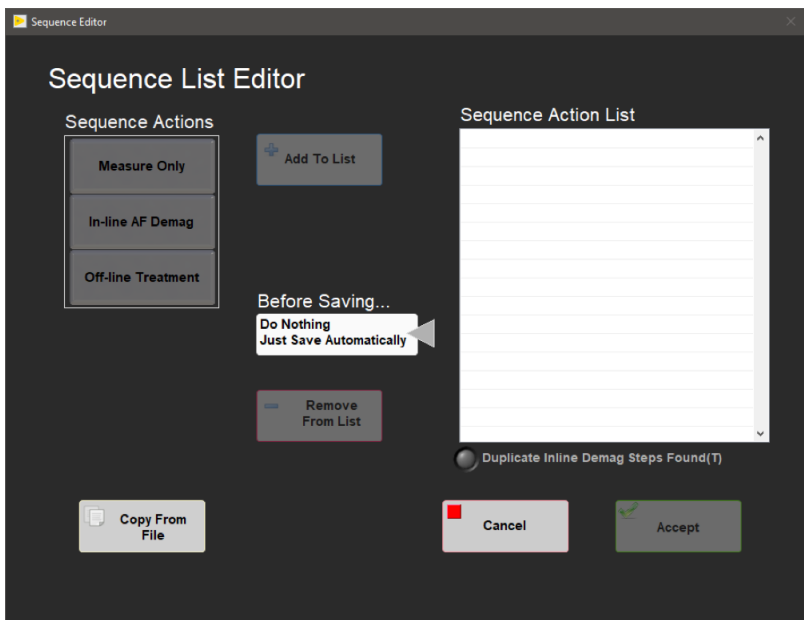


Figure 13- Sequence Editor Window

2) Select a sequence action on the left side of the window. In-line and off-line treatments are mutually exclusive. Once a treatment type is selected, the other treatment type will be disabled.

- **Measure only** should be used to make an NRM measurement.
- **In-line AF Demag** allows users to assign a degaussing step with a field ranging from 1 to 80 mT.
- **Off-line Treatment** will place an "off-line treatment" into the sequence list. Accept the sequence. A dialog box will be triggered (Figure 14) during the *measurement process* prompting the user to perform an offline treatment. The user may enter the type of offline treatment and comments regarding the treatment. The types of treatments available are shown in Figure 14. Click **Continue Sequence** to continue with the measurement and **Abort** to end the sequence.

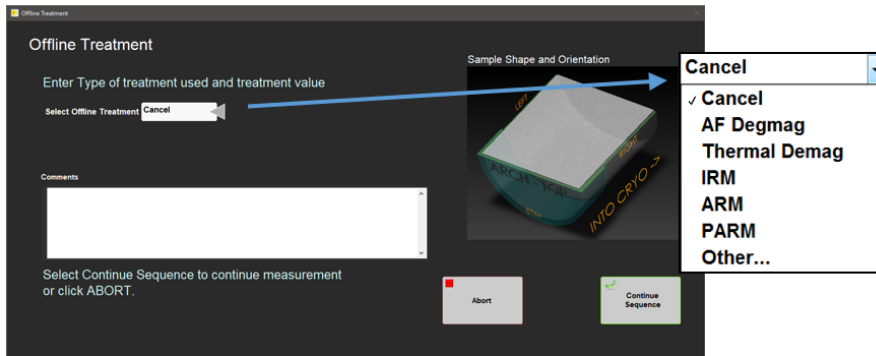


Figure 14- Offline Treatment Window

- 3) Users may copy an existing sequence from a file by clicking the **Copy From File** button.
 - A new window with a list of existing sequences will be displayed (**Figure 15**).
 - Select an existing sequence and press the **Copy** button.
 - Once selected, a sequence will be displayed in the *sequence action list* and the user may edit the sequence (**Figure 13**).

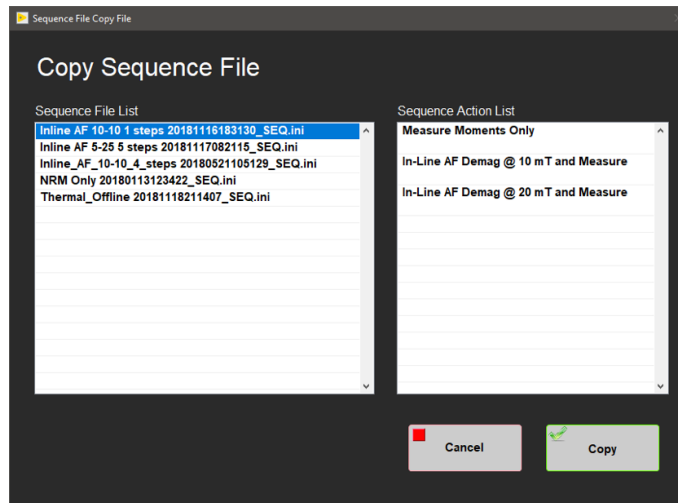


Figure 15- Copy Sequence File Window

- 4) Click **Add to List** to place a new step into the sequence action list.
 - In-line AF Demag steps will be automatically ordered by increasing value.
 - Each in-line AF Demag step automatically has a measurement step.
- 5) Once the list is completed, click **Ok Save** and name the sequence
 - The sequence will be saved with a new name or the user may save over an existing sequence.

Defining the Sample Presets

The data calculations for the SRM are volume dependent and therefore it is necessary to assign the appropriate shape and volume to the sample prior to measurements. In the sample preset editor window the user can set the sample shape, section half, and the orientation of the sample. The volume used for each shape is displayed, and in some cases, may be edited.

Create Sample Presets

- 1) To open the Sample Preset Editor (**Figure 16**), select **DAQ > Sample Preset Editor** from the IMS panel menu (**Figure 3**).
- 2) Select a sample shape from the left hand column.

Section Half-Piston and Discrete J-cube are the most commonly used presets.

- 3) Note the volume or area values.

1. The Section Half-Piston, Section Half-Rotary, Discrete IODP, Discrete J-Cube, and U-channel sample shapes have fixed volumes.
2. For all other sample shapes the user may edit the actual volume/area value. *Only one value may be assigned to a shape. Always check the volume/area value.*
3. For Section Halves, Select Section Half-Piston or Section Half-Rotary (**Figure 16**):
 - Verify the area. Piston cores should be 17.50 cm² and Rotary cores should be 13.40 cm².
- 4) Select the section half at the bottom of the window. In most cases this should be ARCHIVE for section halves.

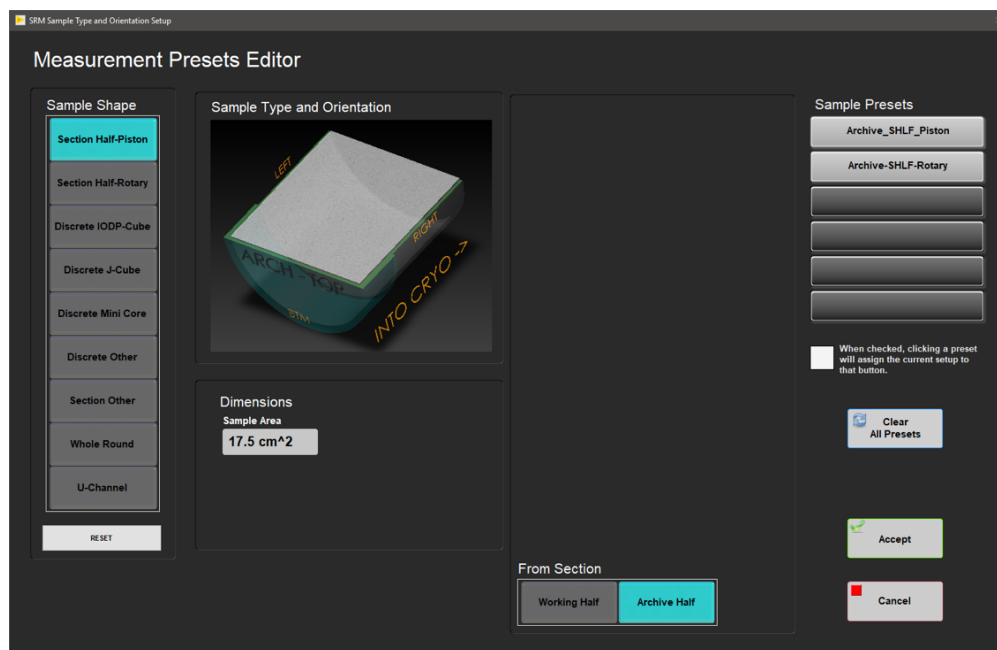


Figure 16- Sample Preset Editor Window: Section Half View

- 5) For Discrete Specimens, Select a Discrete Cube shape and orientation (**Figure 17**).
 - Shapes include: Discrete IODP-Cube, Discrete J-Cube, Discrete Mini Core, and Discrete Other.
 - Orientation includes **Face Orientation** and **Arrow Orientation**:
 - **Face Orientation** refers to which direction the **face of the cube with the arrow** is facing relative to the SRM (i.e., *Top* means the arrow is on the top of the cube, *left* means that the arrow is on the left side of the cube when looking toward the SRM).
 - **Arrow Orientation** refers to the direction the **arrow** is facing (i.e., *Into* means the arrow is pointing into the SRM, *Right* means the arrow is pointing to the right when looking toward the SRM).

The arrow in the diagrams indicates the arrow or hatch mark placed on the split face of the core section during sampling. The arrow points to the top of the core.

- There are 24 possible cube positions. *During Expedition 318 it was determined that three positions were sufficient for measuring discrete cubes. These three orientations were: **Top-Into**, **Top-Right**, and **Away-Up**.*

- 6) Select the face orientation and arrow orientation that the cube will be placed in the tray. Orientations are relative to the SRM when the user is looking from the load zone toward the SQUIDS.

Place the cube into the tray so that the cube arrow matches the preset display.

- 7) Select the section half at the bottom of the window. In most cases this should be WORKING for discrete samples.

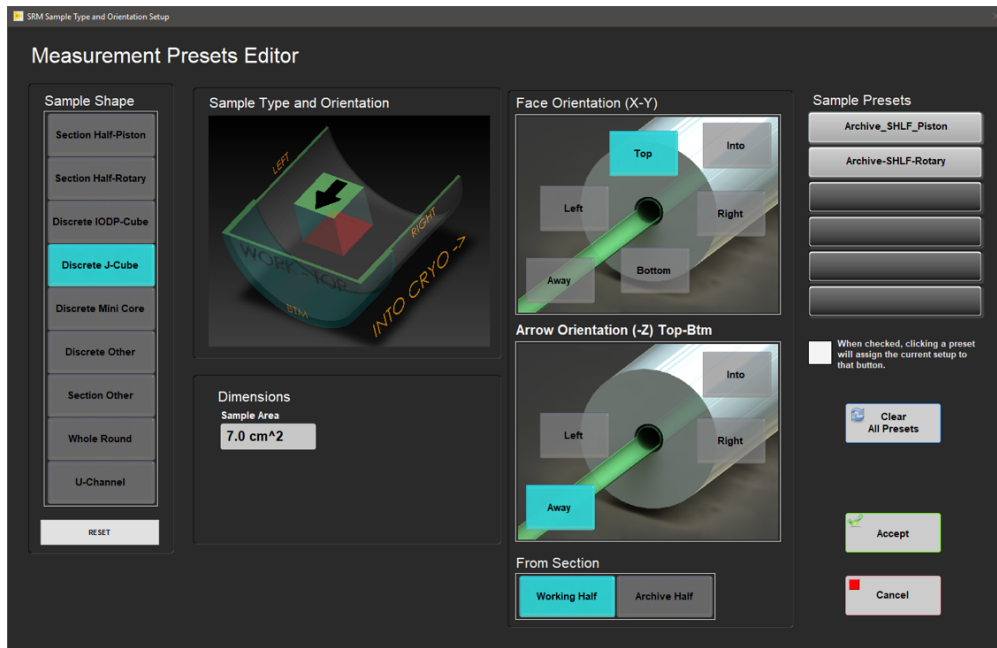


Figure 17- Sample Preset Editor: Discrete Sample View

Save the Sample Preset

- 1) Check the white square box on the right side of the screen (Figure 16 and Figure 17).
- 2) Click on one of the six sample preset buttons and a window will appear (Figure 18).

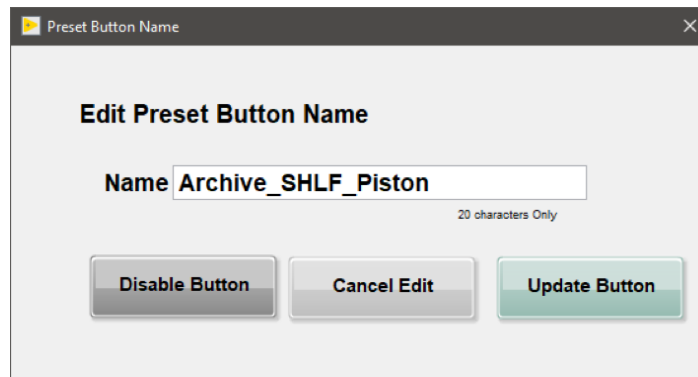


Figure 18- Edit Preset Window. Name a new preset, update an existing preset, or disable a preset button.

- 3) Enter a name for the button in the NAME field.
 - Include the orientation in the name (i.e., Archive, Working, Top-Away, etc.).
 - For section halves, include the type of core (i.e., Rotary or Piston).
- 4) Select **UPDATE BUTTON** to save the preset.
 - **Disable Button** will clear any preset already saved to this button.
 - **Cancel edit** will close the edit preset button name window without making any changes.
- 5) The preset name should be visible on the right hand side of the page. Figure 17 has two presets assigned: Archive_SHLF_Piston and Archive_SHLF_Rotary.

To review what has been assigned to a preset button, click the preset button once. The screen image will update to show the current preset.

To clear a preset

- 1) From a single button:

- Open the button as if to name a preset.
- Select **Disable Button**.

2) For all six buttons:

- Select the **Clear All Presets** button.
- User will be asked to confirm the deletion (**Figure 19**).

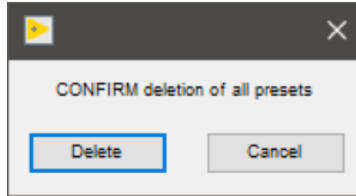


Figure 19- Clear Presets Confirmation Window

3) Select **OK** to exit the preset editor.

Starting Measurements

Sample Information Window

Click **START** on the IMS panel (**Figure 2**) to open the sample information window (**Figure 20–Figure 26**). This is where the user enters the sample ID for a section or discrete sample and initiates the measurement.

There are four available tabs on the sample information screen. The first 3 tabs allow the user to enter sample identification information using 3 different methods. The fourth tab allows the user to select a measurement sequence.

Sample Entry Tabs

- **Scanner**: Scan the IODP barcode to enter the sample's Text ID and Label ID values.
- **LIMS**: Select expedition, site, hole, core, and section values from a series of list boxes that are populated with data from the LIMS database.
- **Manual**: Manually enter the sample's Text ID and Label ID values and a length. The name fields will accept any name, so the user must be careful to enter the name properly. *If the name is incorrect a file will be created, but it may not upload properly.*

Measurement Sequence Tab

The user can select a premade measurement sequence in the **Measurement Sequence** tab (**Figure 20**). The last used measurement sequence will remain in memory and is displayed at the bottom of the sample information window. If the sequence displayed is correct, the user does not need to utilize the measurement sequence tab.

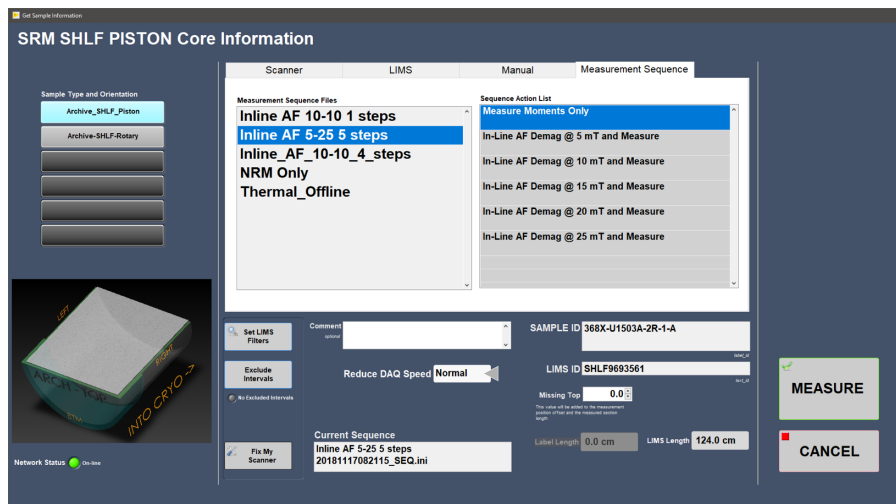


Figure 20- Sample Information Window: Measurement Sequence Selection

The user can select a premade measurement sequence in the **Measurement Sequence** tab (**Figure 20**). The last used measurement sequence will remain in memory and is displayed at the bottom of the sample information window. If the sequence displayed is correct, the user does not need to utilize the measurement sequence tab.

- Click on sequence name in the *Measurement Sequence Files* list to start a sequence with the first step.
- To begin at a specific step within a sequence, click on a step in the *sequence action* list and highlight it blue. **Be careful!** If a demagnetization step is highlighted blue in the *sequence action list*, the **demagnetization** process will start once the **MEASURE** button is pressed. **As of November 2018 this feature does not work.**

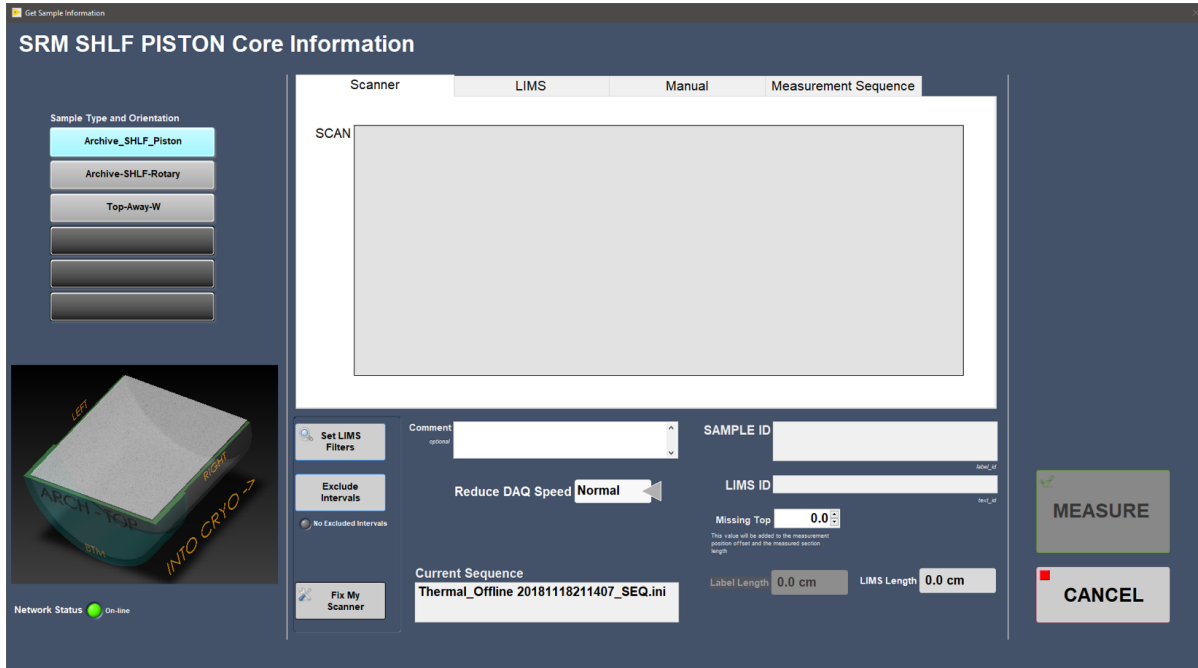


Figure 21- Sample Information Window: Section Half Scanner Sample Entry

Section Half Sample Entry

- 1) Select **START** on the IMS panel (Figure 2) to open the sample information window (Figure 21).
- 2) Select a measurement sequence in the **Measurement Sequence** tab (Figure 20). The sequence may already be selected and displayed in the lower portion of the window.
- 3) Select the appropriate sample type and orientation preset on the left side of the screen.
- 4) Enter the Sample ID Information
 - **Scanner** mode: Place cursor in the scan box; scan the section half label from the end cap (Figure 21).
 - **LIMS** mode: Select a section using the hierarchy columns (Figure 22). Only the sections/cores that match your preset will display (e.g., if you select an archive half section preset, only archive half sections will be displayed).
 - **Manual** entry mode: Type in the sample label ID (i.e., 362-U1480A-1H-1-A) and LIMS Text ID (i.e., SHLF7851761) and length of section (Figure 23).
 - Any entry will be accepted, but that does not guarantee the data will upload. The Text ID information must match an actual section in order for the data to upload.
 - Select **USE ME** to update the IDs and enable the **MEASURE** button.
- 5) Check that the displayed length of the section matches the section length.
 - To override the section length, first scan the label on the **Scan** tab and then select the **Manual** tab. The Sample ID and Text ID values will be copied. Enter the length in the **USER Length** numeric control and then click the **USE ME** button.
- 6) Click **MEASURE**.

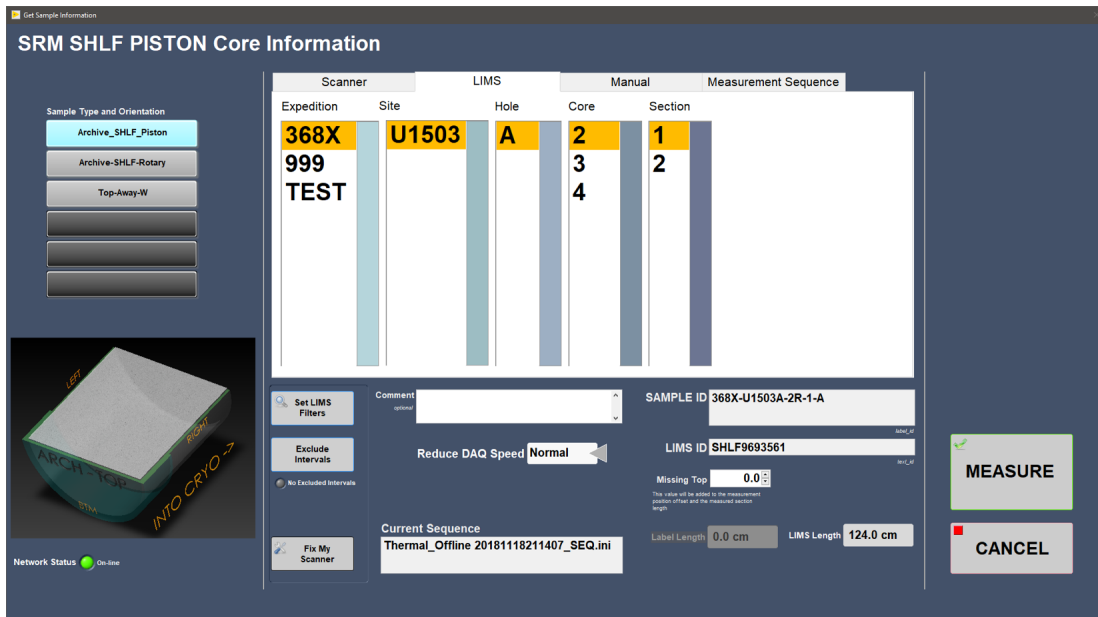


Figure 22- Sample Information Window: Section Half

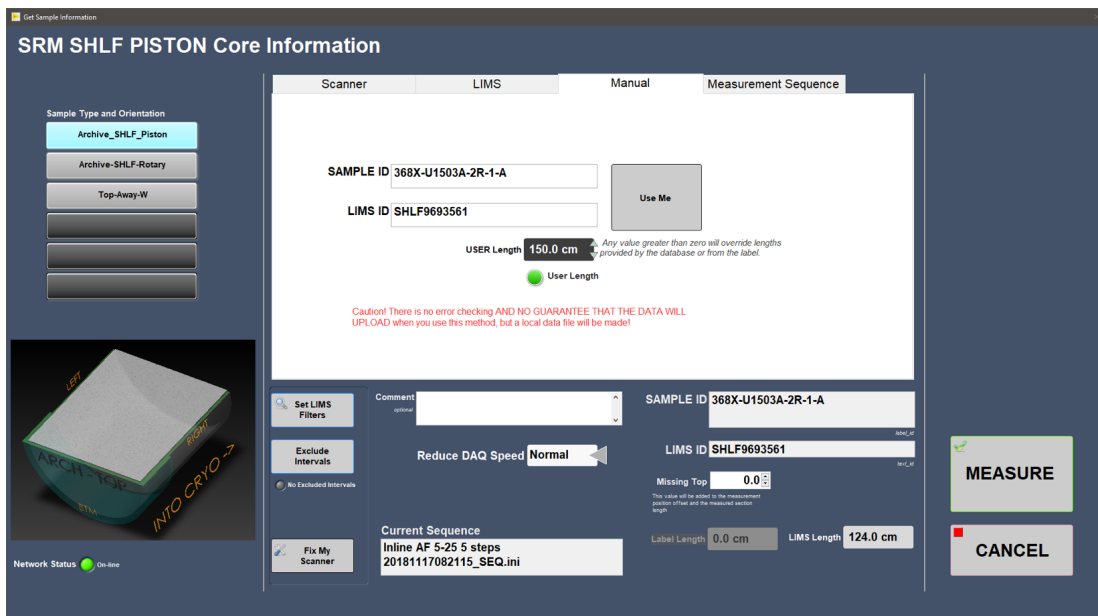


Figure 23- Sample Information Window: Section Half Manual Entry

Discrete Sample Entry

- 1) Click **START** on the IMS Control Window (Figure 2) to open the sample information window (Figure 21).
- 2) Select the appropriate discrete sample type and orientation preset on the left side of the screen.
- 3) Select a measurement sequence in the **Measurement Sequence** tab (Figure 20).
- 4) Enter the Sample ID Information:
 - **Scanner** mode: Place cursor in the scan box and scan the discrete cube label (Figure 24). The sample will be immediately assigned to the tray position highlighted on the right side of the screen.
 - **LIMS** mode: Use the hierarchy selection columns to select a discrete sample (Figure 25). You must select a sample from the Discrete Sample list box before you can assign it to a tray position. Double click on the **Tray Position** list to assign it to a tray position.

- Samples can be listed by core or section and filtered by sample type and/or code. *See the special features: LIMS Filter Section of this guide for further information.*
- Remember that only samples that match the preset's sample source (Archive or Working) will be displayed. *For example, if you select an archive preset then any samples from the working half will **not** be displayed.*
- **Manual** entry mode: Type in the sample label ID (i.e., 362-U1480B-1H-2-W 117/119-PMAG) and LIMS Text ID (i.e., CUBE7990351) (**Figure 26**). *Anything will be accepted, but that does not guarantee the data will upload. The ID information must match an actual sample in order for the data to upload.*
 - Click the **USE ME** button to use the ID information. Double click on a **Tray Position** to assign the ID information to that tray position.
 - The Sample ID and LIMS ID should be displayed below the manual entry tab as seen in **Figure 26**.

5) Click **MEASURE** to begin measuring the discrete samples

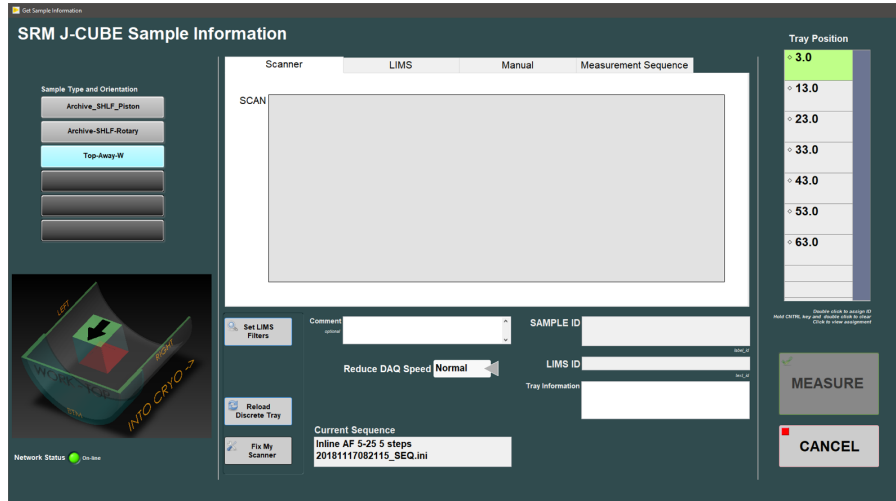


Figure 24- Sample Information Window: Discrete Scanner Entry

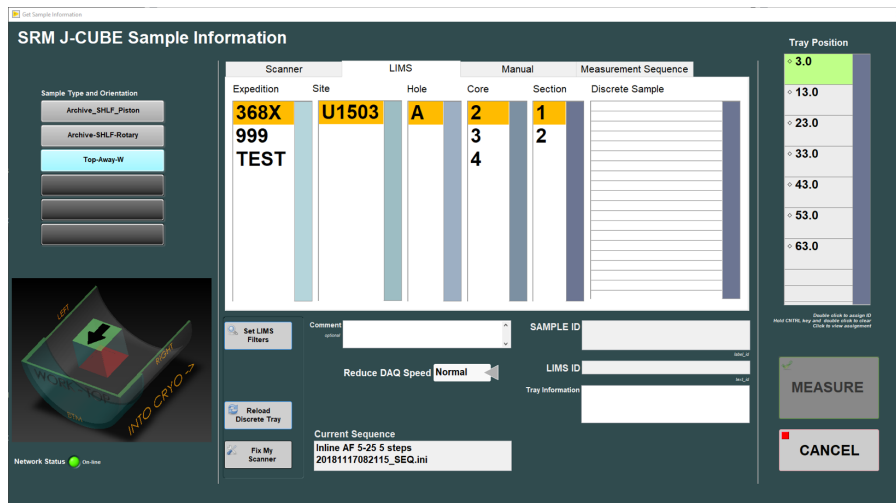


Figure 25- Sample Information Window: Discrete LIMS Entry

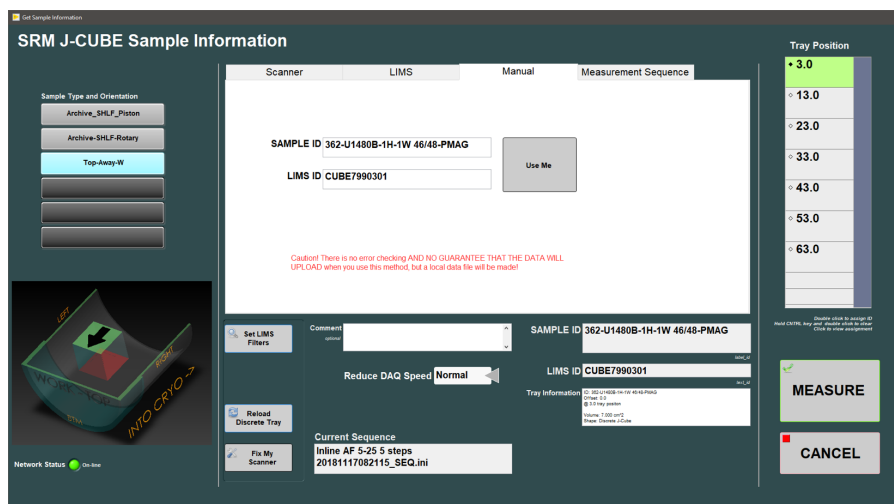


Figure 26- Sample Information Window: Discrete Manual Entry

Other features

- A black diamond next to the tray position number indicates that a sample has been assigned to this position. Click on the tray position to display information about the discrete sample in the tray information box in the lower right hand side of the window (Figure 27).
- To clear a tray position, hold the CONTROL key on the keyboard and double click the tray position you would like to clear.
- The **Reload Discrete Tray** button reloads the sample names of the last **measured** tray of discrete specimens. *Make sure that the physical samples are placed in the tray in the correct order and position.*
- Each discrete sample can only be assigned to one position in the tray. If the user tries to assign the same sample ID to two positions in the tray, an error message will appear (Figure 28). *Change the Sample ID.*

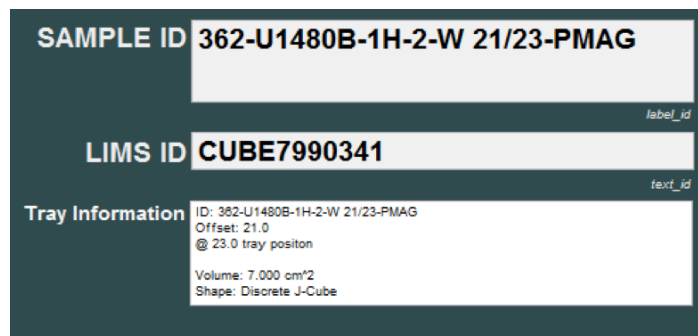


Figure 27- Entry fields on Discrete Sample Entry. Note the ID in the Tray Information window must not be blank or no name will be assigned to the measurements during the saving process.



Figure 28- Discrete Sample Entry Error Message: Appears when the user tries to assign one sample name to multiple tray positions.

Database Validation

Whenever there is a live network connection to the LIMS database, IDs entered with either the **Scanner** or **LIMS** tabs will be validated and values such as section length for sections halves or sample offset for discrete samples will be updated with the most current value. If the connection fails when either the **LIMS** tab is selected or when scanning a barcode, the user will see this error message (**Figure 29**). If you click **Check Connection**, the program will attempt to connect with the LIMS database, opening the window shown in **Figure 30**.

If **Disable LIMS** is clicked or the reconnection fails, the **LIMS** tab is disabled, the **Network Status** indicator turns **red**, and a button labeled **Connect to LIMS** appears (**Figure 31**). Clicking this button will attempt a LIMS reconnection.

When the **Network Status** indicator is red, the program will use the information stored in the barcode. Generally, for sections this information is correct but if the core has been curated and the length changed, the length value may be wrong and there is a possibility that measurement will not include all of the material. It is always good practice to check the length against the meter stick on the sample handler.

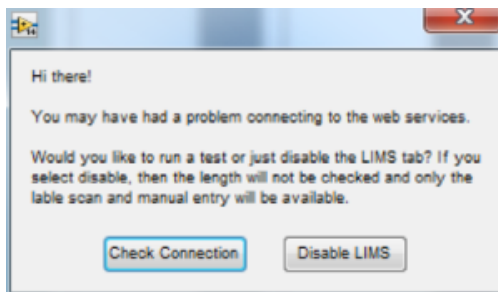


Figure 29- Web Services Connection Error



Figure 30- Checking LIMS-JR Web service Connection Window

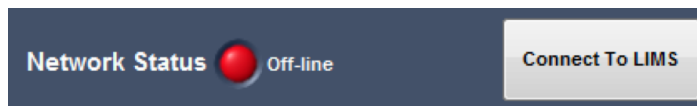


Figure 31- Network Status Indicator

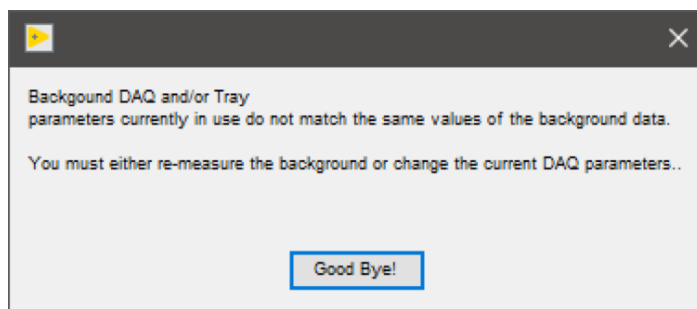


Figure 32- Invalid background measurement warning message

Sample Entry Caveats

- If **START** is pressed and the background interval and measurement interval are mismatched, the user will receive an error (**Figure 32**) and be sent back to the IMS-SRM main window.
- This prevents the user from measuring a section or discrete samples with invalid or mismatched background data.
- The preset must match the label type (i.e., working half preset will only accept a working half label ID). If the preset and label do not match, the user will be notified (**Figure 33**).

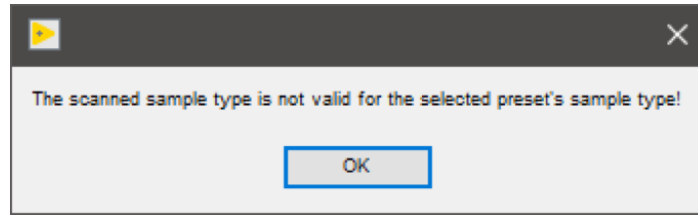


Figure 33- Mismatched label and preset warning message

During a Measurement

Active Display

- Once **MEASURE** is selected, the central IMS-SRM panel (**Figure 34**) displays. The data are graphed as each measurement is acquired.
- As sequential demagnetization steps are completed, new lines in a new color are added to the display, allowing monitoring of changes in the inclination, declination, and intensity with each step.
- A variety of graphs can be chosen to view during measurements by selecting a different tab at the top of the screen (**Figure 34**). These tabs include:
 - General view (XYZ moments, inclination, declination, and intensity)
 - RAW moments
 - Drift-corrected moments
 - Background-corrected moments
 - Background and drift-corrected moments
 - Tray Background
 - Flux Counts
- The current active measurement step is highlighted under measurement steps in the Information Panel.
- During the degaussing process, the active coil, the field being applied, and the status of the coil are displayed on this screen (Ramping up, Tracking, Ramping Down).
- If the Degausser Internal error window (**Figure 35**) appears, abort the sequence or repeat the sequence step once the problem has been corrected.
- The maximum flux counts recorded during each step and the remaining flux counts at the end of measurement step can be monitored to identify flux jumps. *See the **Special Features** section for more information on flux jump monitoring.*
- When a sequence is completed, the program returns to the sample information window.



Figure 34-SRM Display during Measurement



Figure 35-Degausser Internal Error Window

Emergency Procedures

There are multiple features available in the IMS-SRM software and hardware for addressing SRM measurement emergencies. These features are:

- SRM Software Abort button
- SRM Hardware Abort buttons (2)
- Degausser Ramp Down Now command
- Loss of Ship's Chill Water

SRM Software Abort Button

The SRM Software **Abort** button is on the left side of the screen during measurements (**Figure 34**). Clicking this button brings up a window with three options (**Figure 36**).

- **ABORT Return to Load:** Return the section to home. If the **Abort** was clicked during a degaussing step, the degausser will ramp down before the core is moved to the load position.
- **ABORT Do Not Move:** Leave the core exactly where it was when **Abort** was clicked and exit the measurement process. This feature is useful if a core is jammed and further action is needed before moving the tray to the load position. Motor power is shut off and the user is given a warning when this option is selected (**Figure 37**)
- **Continue:** Continue the sequence from the exact point that **Abort** was clicked.



Figure 36- SRM User Abort Window

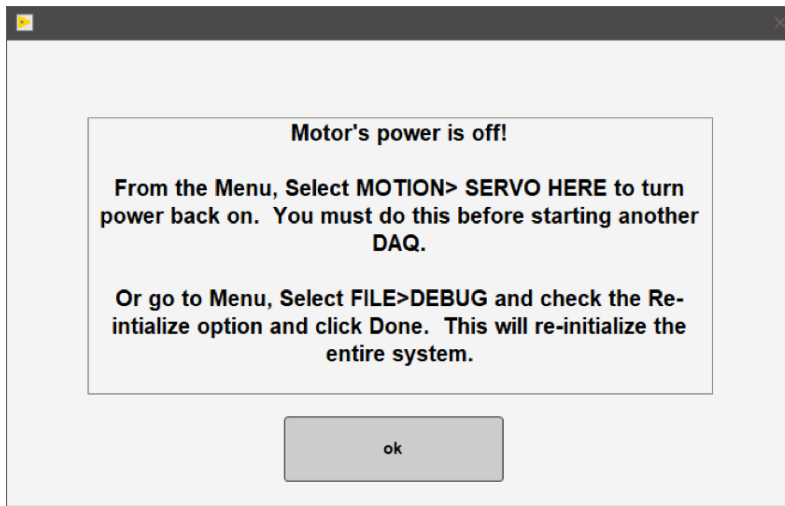


Figure 37 Motor Power Turned off Warning

If the user aborts during a degaussing step a dialogue box will appear and the system will automatically begin ramping down (Figure 38). In this status window, the user has multiple options:

- **Ramp Down:** If the system does not automatically begin ramping down, the user may attempt to use the ramp down command. The degausser will not accept a command if it is ramping up or down.
- **Continue:** Move the core back to the first degauss staging position and ramp up the first coil and begin the sequence again. (Currently this behavior is malfunctioning and moves the core to finally staging position and then sends another dialogue box).
- **ABORT Return to Load:** Return the section to home position
- **ABORT Do Not Move:** Leave the core exactly where it was when **Abort** was clicked and exit the sequence.
- **Get Status:** Ask the degausser for its status and display the results. See the degausser manual for specifics on what each of these codes means (Figure 39).

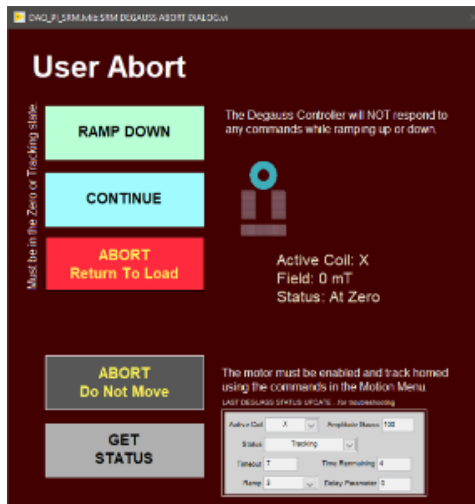


Figure 38- Degauss Abort Warning Window

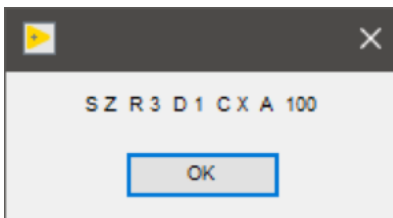


Figure 39- Degausser status window

SRM Hardware Abort buttons

- There are two hardware Abort buttons for the SRM track system. One is positioned next to the load zone of the track (**Figure 40**), and the other is above the SRM computer monitors. These emergency stop buttons will immediately stop track motion. These buttons remain locked in position until the user manually unlocks them by twisting the red knob.
- The user abort dialogue box (**Figure 36**) will appear when the hardware abort buttons are pressed. The hardware abort does not control the degausser behavior.



Figure 40- Hardware Emergency Stop Button

Ramp Down Now

- Selecting **Instruments > SRM: Ramp Down Now** from the IMS panel menu (**Figure 3**) will immediately send the ramp-down command to the in-line degauss controller. If successful, the active coil will ramp down to zero.
- **ALWAYS** check that the degausser control box tracking light is off and the zero light is on after using this command. The manual commands on the degausser should be used if for some reason the computer/software stops communicating with the degausser unit.

Loss of Ship's Chill Water

The ship's chill water is used to cool the Cryomech compressor, which keeps the helium lines under pressure and the SRM at superconducting temperatures. Without chill water the Cryomech compressor will shut down and the SRM will not be operational. **See the compressor and the backup chill water system manuals for detailed instructions.**

Special Features

A few special features are available in the IMS-SRM software to help the user facilitate the measurement process on a variety of materials. These features include:

- Pause and Confirm
- Exclude Intervals
- MagSpy data visualization program
- Flux Jump Alarm
- LIMS Filters

Pause and Confirm

Typically, a user sets a measurement sequence and lets the program complete the sequence to the last step. But if a user decides they wish to monitor the data collection more closely, a feature called Pause and Confirm is available.

This feature can be turned on or off by selecting the button on the bottom right side of the screen (**Figure 41**). The button turns blue when pause and confirm is activated. If this feature is on, the IMS-SRM program will pause when it reaches the end of a measurement step and display the pause and confirm window (**Figure 42**).

There are 6 available actions for the user to select in the Pause and Confirm screen.

- **Save Data?:** When activated, the most recent measurement data are written to a file and placed in the IN folder for upload. *The program defaults to saving all data; the user must choose to not save.*
- **Repeat Measurement?:** Repeats the *measurement* that just concluded.

- **Repeat Sequence Step?:** Repeats the *demagnetization process* and the *measurement* of the most recent step. (Currently restarts the entire sequence, not just the particular step)
- **End Sequence?:** Ends the sequence immediately; program returns to the sample information window
- **Insert a New Sequence Step?:** Inserts a new step to the sequence during a run *without* stopping the measurement sequence process. If an additional step is added the sequence will be saved with a new name.
- **Reduce Speed:** User may choose to reduce all movement speeds by 10 or remain at the normal operating speed.

Select **ACCEPT** to initiate the IMS-SRM program to perform the actions selected in the Pause and Confirm window.

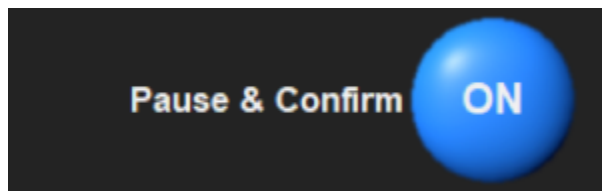


Figure 41- Pause and Confirm Button

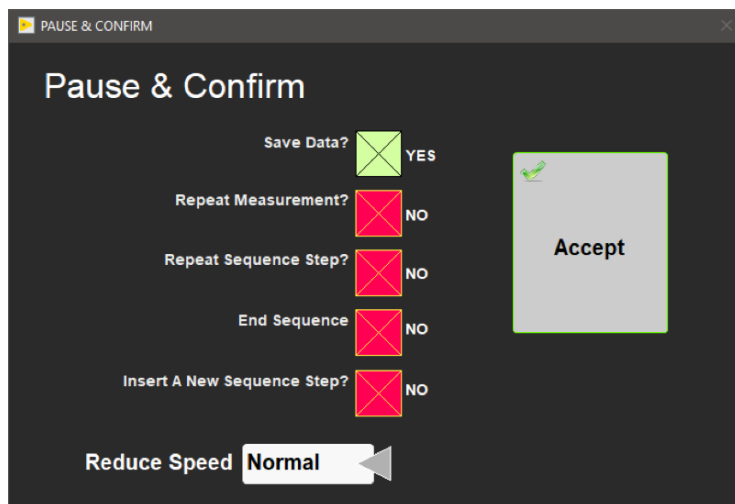


Figure 42- Pause and Confirm Window

Exclude Intervals

The Exclude Intervals feature is available in the Sample Information Window (**Figure 21**) and applies only to section halves, whole rounds, and U-channels. This feature is especially useful when measuring cores with sandy intervals or hard rock pieces that are surrounded by bins of rumble.

To turn Exclude Intervals ON:

- 1) Click **Exclude Intervals** to open the Exclude Intervals window (**Figure 43**).
- 2) Enter the top and bottom offset of the interval to exclude from measurement. *Multiple intervals may be selected at a time.*
- 3) Select **OK** once all intervals are set. The program returns to the Sample Information window.

The indicator next to the exclude intervals button on the sample information window should now be green (Figure 44).

The excluded intervals will be automatically cleared once the measurement sequence has completed.

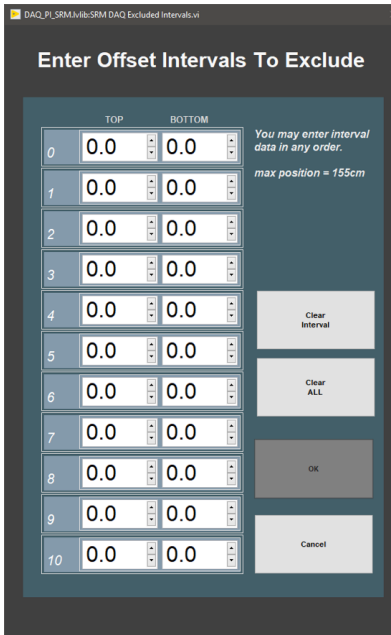


Figure 43- Exclude Intervals Window



Figure 44- Exclude Intervals Indicator

To manually turn off or edit the excluded intervals:

- 1) Click **Exclude Intervals** to open the Exclude Intervals window
- 2) Select **Clear All** to remove all excluded intervals OR select the specific interval to be cleared and select the **Clear Interval** button. Click **Exclude Intervals** to open the Exclude Intervals window
- 3) Click **Cancel** to exit out of the window

The green indicator next to the exclude intervals button on the sample information window should now be gray.

Caution! The entire section will still be demagnetized! Only the measurement process is controlled by the Exclude feature.

MagSpy Data Visualization Program

MagSpy is opened by selecting *Instruments > SRM: Display Plots* from the IMS Panel menu (Figure 3), or it can be opened by double clicking the desktop icon (Figure 45).



Figure 45- MagSpy Desktop Icon

Move the red vertical bar along the intensity plot to scroll through each measurement point for a section or each discrete sample in a tray. Plots include: an equal area diagram, Zijdeveld plot, demagnetization graph, and graphs of inclination, declination, intensity, and XYZ moments for each discrete sample or point measured on a section (Figure 46).

- Only current data can be viewed.
- MagSpy includes the ship's heading data from the WinFrog navigation system (via the JRData Server). If the data is not available, the heading will not update. *No error notice will be given.*

- The **Print Current View** Button prints the current Zijdeveld plot, equal area diagram, and demagnetization plot. The command is sent immediately to the PC's default printer.

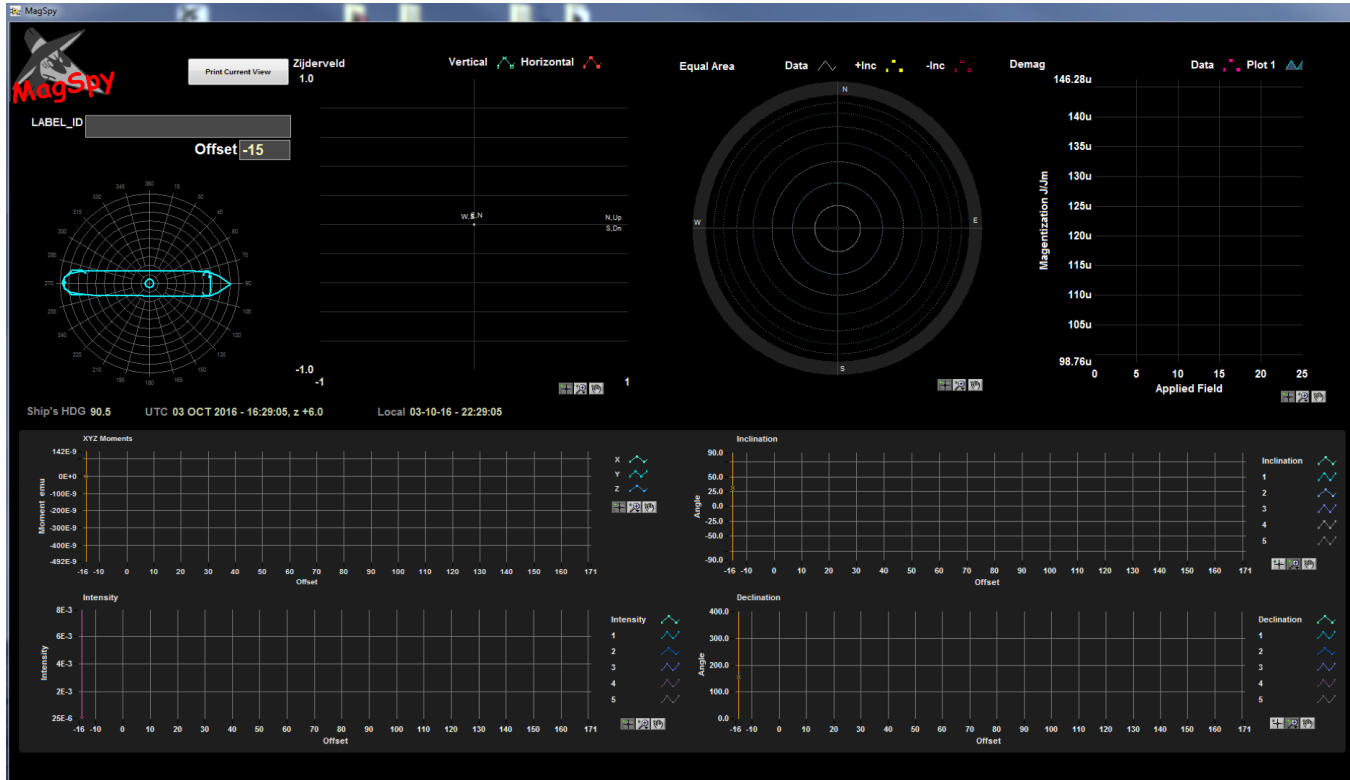


Figure 46- MagSpy Data Visualization Window

Flux Jump Alarm

This feature notifies the user if the remaining negative or positive flux counts during a measurement exceed a user-determined threshold value.

- The flux jump alarm threshold parameter is set in the Measurement Editor window found under **DAQ > Measurement Editor (Figure 3)**.
- The SRM Parameters window will open and the user may alter the Flux Alarm Threshold value (**Figure 9**).
- If the remaining flux counts at the end of a measurement sequence exceed the flux alarm threshold, the Pause and Confirm window will open with a flux jump warning message (**Figure 47**).
- The user may adjust the data acquisition speed to reduce the likelihood of flux jumps:

Two options are available for DAQ speed reduction (**Figure 48**).

The speed reduction control is available in the pause and confirm window (**Figure 42**) and in the sample information windows (**Figure 21–Figure 26**).

- There is no method for shutting the flux jump alarm feature off. To avoid receiving the message the user may simply adjust the flux jump threshold to a higher value.

Caution! If you are receiving a large number of flux jumps, check for cell phones or laptops in the area around the load zone that may not be in airplane mode or may be connecting via the Wi-Fi.

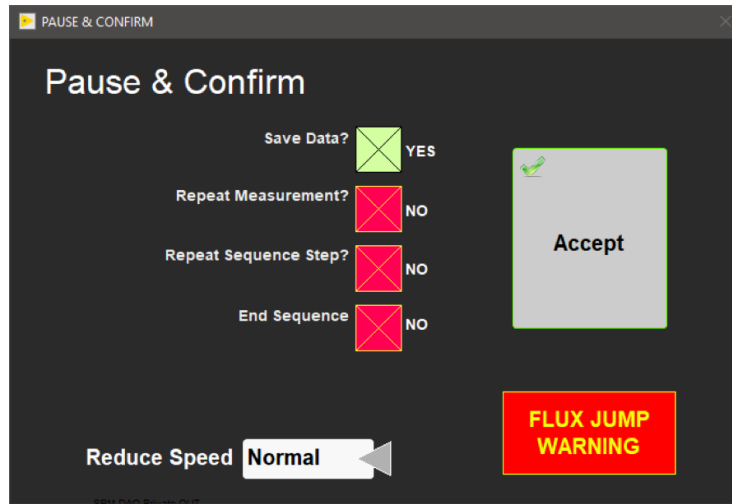


Figure 47- Flux Jump Warning after a measurement



Figure 48- Reduce Speed Drop-down Menu

LIMS Filter

The LIMS filter on the sample information window (**Figure 21**) allows the user to reduce the number of samples they must search through when entering *discrete* specimens. This feature is not available for section halves.

- Click **LIMS Filter** to open the LIMS Filter setup window (**Figure 49**).
- To filter for PMAG samples only, enter PMAG in the sample name field.
- To save the filter, click **Done**. Only the discrete samples that match the filter criteria will be shown in the LIMS hierarchy search.
- To clear the filter options, select **Clear All**. Click **Done** to clear the filter from memory.

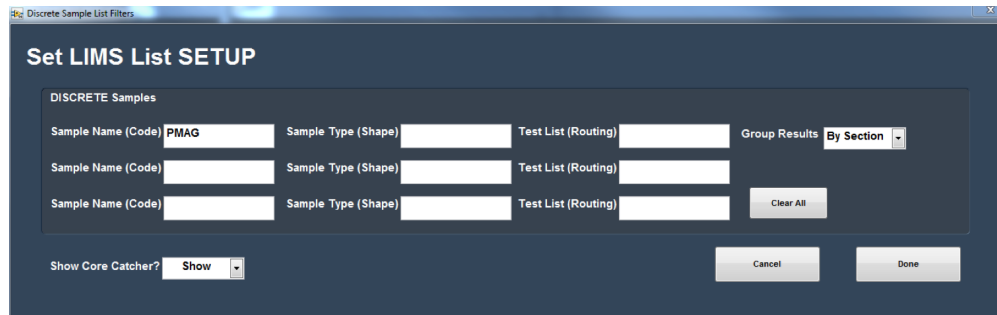


Figure 49- LIMS filter setup window

Utilities

There are six main utilities currently available within the IMS-SRM software. These can be found under the Instruments menu (**Figure 3**). The six utilities are:

- 1) Time Series Utility
- 2) DAFI Utility
- 3) Uturn Utility
- 4) USB 6008 Utility

- 5) Data Recovery
- 6) Degauss Utility

Time Series Utility

The Time Series Utility runs a background measurement over an extended period of time. During this measurement, the tray is not in the SRM. Open the Time Series Utility (**Figure 50**) selecting **Instruments > SRM: Time Series Utility** from the IMS Panel menu (**Figure 3**). The ship's heading is recorded along with the X, Y, Z moments.

- SQUID Meter settings: The user can adjust the SRM settings with controls on the right side of the screen. Options in bold are the default settings used for the SRM.
 - Filter: 1, 10, 100 Hz or WB
 - Range: 1X, 10X, 100X or EXT
 - Slew: **On**, OFF
 - Feedback: Open, **Close**
 - Period box: Set the frequency of measurements
 - Time Unit Switch: Set time series units to minutes or seconds with the control on the top of the screen.
 - Select **START** to begin the measurement (button label will toggle to **STOP**).
 - Select **STOP** to end the measurement process.
 - Clear graphs: Use **Clear Graphs** to clear any previous data from the screen.
 - Save data: Select this button to output the data currently shown on the graphs to a .csv file
 - Note: Right click on the individual graphs to open a context menu and export the data for that graph directly to MS Excel. This will only output the data for the selected graph.
 - Select **Done** to close the Time Series Utility.

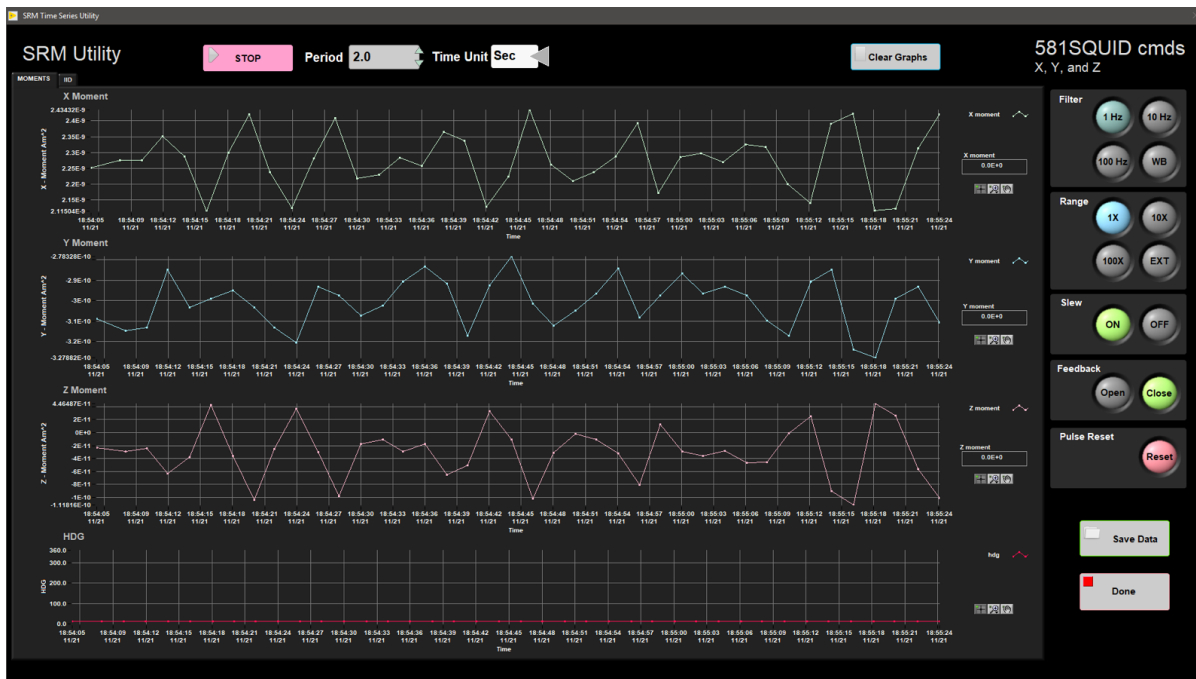


Figure 50- Time Series Utility during Measurement

DAFI Utility

The DAFI utility collects and displays 3 channels of data from the National Instruments USB-6008 Multifunction I/O device (or any equivalent DAXmx compliant device) against track position. This means that the USB-6008 can be connected to the XYZ analog output of the 2G Applied Physics 520 Fluxgate or the single channel analog output of the LE Model 6010 Gauss/Teslameter (Hall Probe) and used to measure the field in the SQUID measurement region or to measure the field produced by the degauss coils.

This is best done as a two-person experiment so someone can monitor the cables as the instruments are run through the SRM.

The DAFI Utility (**Figure 51**) is opened by selecting **Instruments > SRM: DAFI Utility** from the IMS Panel menu (**Figure 3**).

- 1) Secure the Fluxgate or Hall probe in the section-half boat and note the position of the measurement sensor.
- 2) Enter the position of the measurement sensor into the 'In Tray Offset' field. Recommended position is 140 cm.
- 3) Set the measurement interval in the 'DAQ Interval' field and the number of measurements to average at each position in the 'Average' field.
- 4) If you are using the Fluxgate magnetometer, set the range of the probe in the 'Range' field. Recommended range is 10 mOe.

- 5) Set the Start and End offset for the measurements. *The tray will move to place the sensor at the Start offset before any measurements are taken.*
 - Example: If you wish to begin measurements at 160 cm from the home position, enter 160 cm in the start offset field.
- 6) Click **START** and monitor cables as the tray moves into the SRM. The measurement window will open (**Figure 2**) and the measurements will begin.
- 7) Data will be saved automatically to C:\AUX_DATA\DAFI when measurements are successfully completed.

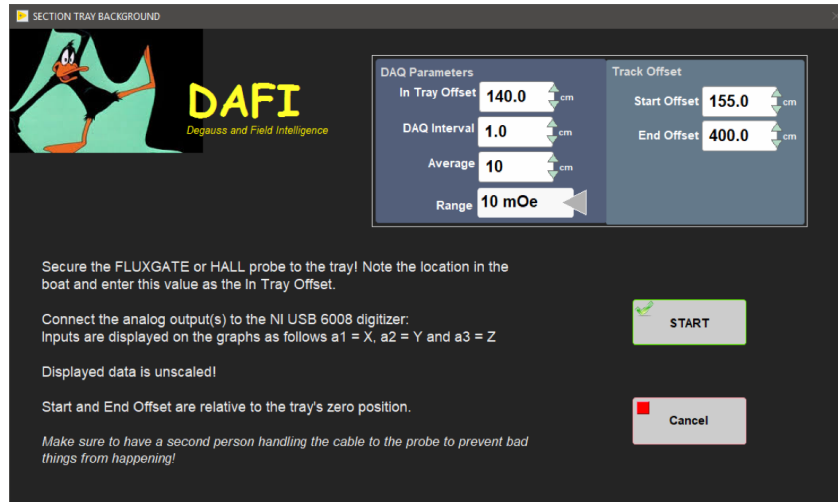


Figure 51- DAFI Utility Setup Window

U-Turn Utility

The U-turn utility is used when a core has been put into the SRM with the top of the core nearest the SRM. The background data is applied incorrectly in this situation, and therefore the values need to be recalculated. This utility performs the recalculations and produces data files for upload.

The U-Turn Utility (**Figure 52**) is opened by selecting *Instruments > SRM: U-Turn Utility* from the IMS Panel menu (**Figure 3**).

- Select a mode for correcting the data (**Figure 53**).
 - **Change to Working** flips the data so that the data is in working coordinates
 - **Change to Archive** flips the data so that the data is in archive coordinates
 - **Flip Top to Btm** corrects the data when a core is placed in the track with the top of the core toward the SRM
- Select a file or a folder of files to correct
 - Select **Read File** to correct one file
 - Select **Process Folder** to correct a large number of files. Before selecting process folder, place the files to be corrected in a new folder.
 - Once the **Read File** or **Process Folder** button is selected, a browser window will open. User should select a file or folder of files to correct.
 - The folder of processed data is output as soon as **Process Folder** is selected in the browser window
 - For a single file, user must select **Confirm** to output the files on the U-turn screen to output the file

The files are written directly to C:\Data\IN

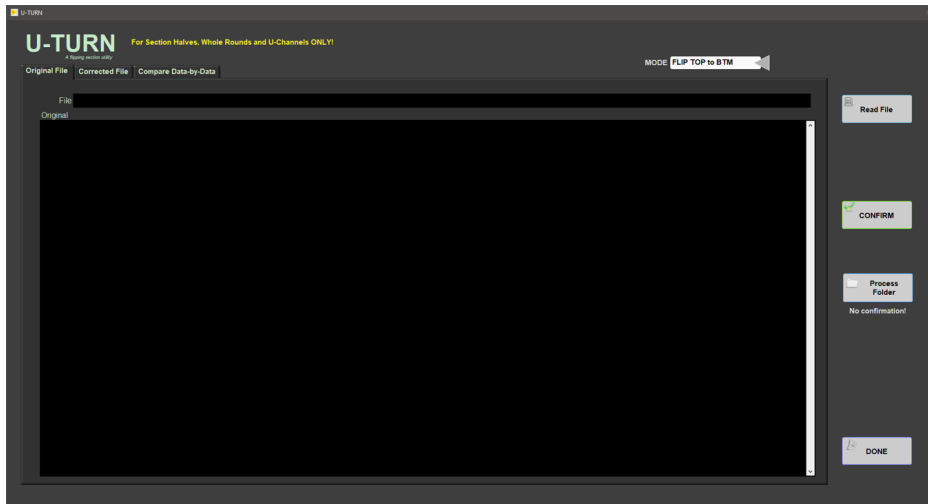


Figure 52- U-Turn Utility Window

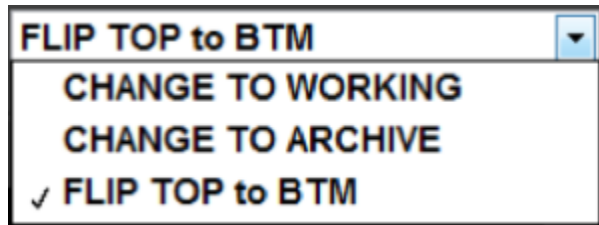


Figure 53- Close up of U-Turn Mode Selection Drop Down Menu

When a single file is processed the U-Turn utility will display the original file, the corrected file (Figure 54), and a sample comparison window (Figure 55). The user can page between each of these windows using the tabs. *Nothing will be displayed if the Process Folder button is used.*

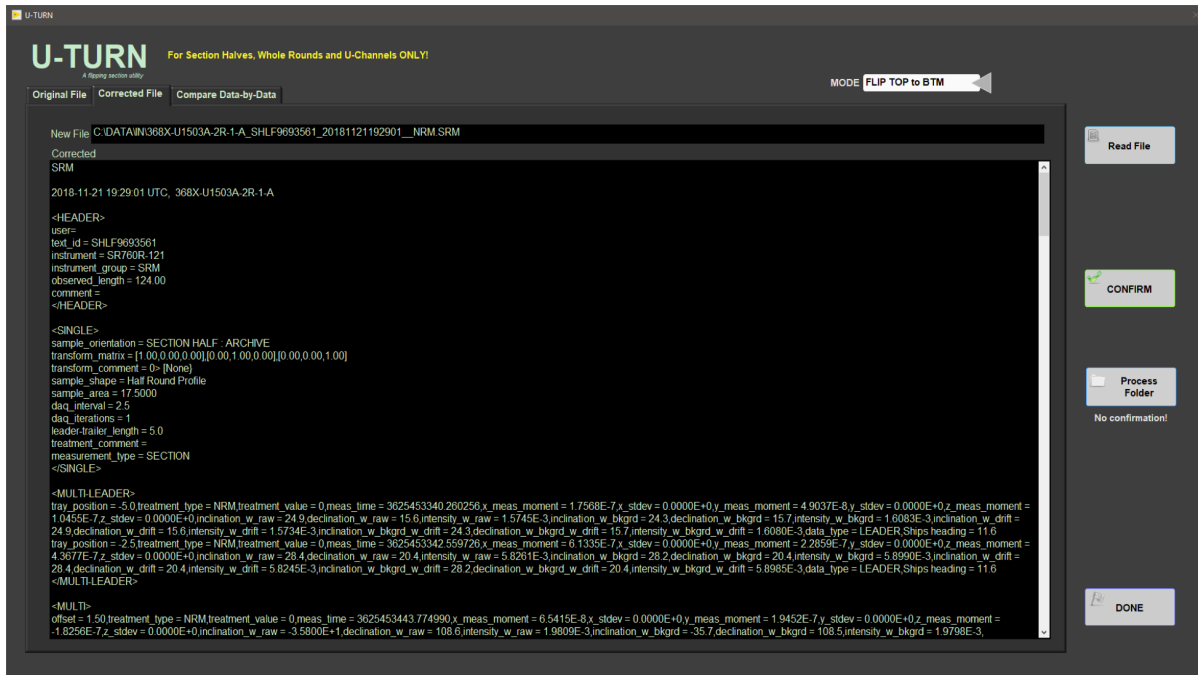


Figure 54- U-Turn Utility Corrected File Display

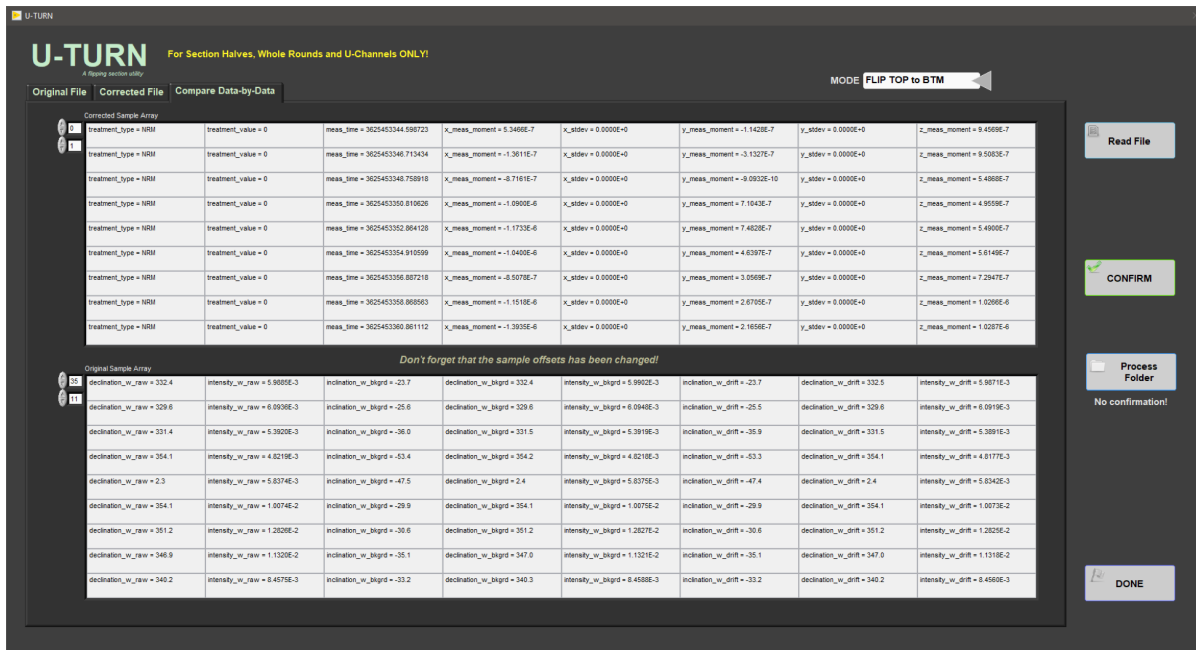


Figure 55- U-Turn Utility Sample Comparison Window

USB6008 Utility

The USB6008 Utility is a free-form utility designed to allow the user to hook up any instrument to the USB6008 (Figure 56). This can be particularly useful in locating the position of the SQUIDS and Degauss Coils when used with the Motion Widget control. During field trapping, the USB6008 can be attached and the signal of each SQUID can be monitored with this utility.

Open the Motion Widget window by selecting **Motion > Motion Widget** from the IMS front panel (Figure 3).

- This step is necessary if you wish to dynamically adjust the position of a hall probe, fluxgate, or other device while using the USB6008 utility.
- In the Motion Widget window the tray position can be adjusted using relative or absolute moves (Figure 57).

The USB6008 utility is opened by selecting **Instruments > SRM: USB6008 Utility** from the IMS front panel (Figure 3).

- The utility immediately begins to measure (Figure 58).
- Adjust the position of the sensor and tray using the motion widget.
- When measurements are complete, click **Done** to exit.



Figure 56- USB6008 Device

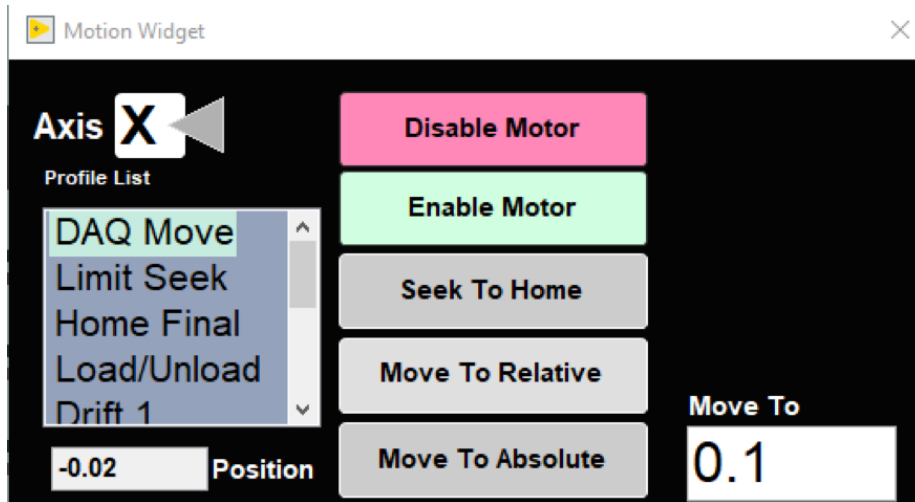


Figure 57- Motion Widget Window

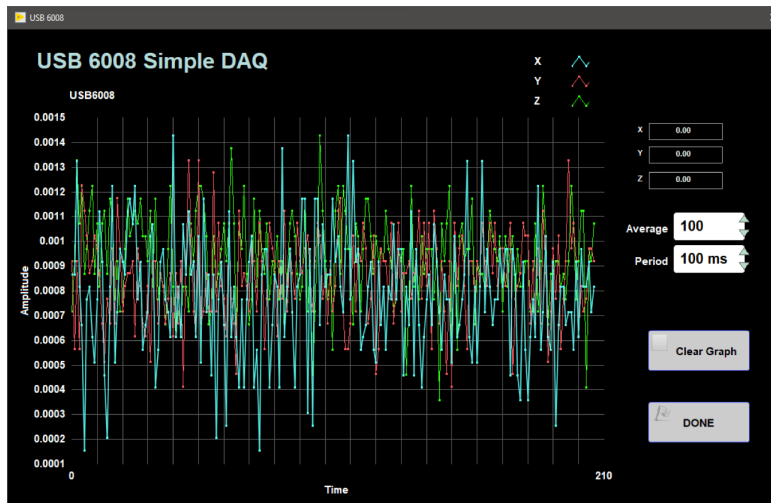


Figure 58- USB6008 Utility Window

Data Recovery Utility

During normal and background data acquisitions, all pertinent data is recorded to a LabVIEW data log file in real-time as a means to recover data in case of a hardware/software crash or file corruption.

NOTE, this data is overwritten each time a new measurement starts (when the first drift measurement is taken). Recovery of previous data must be completed prior to the first drift measurement.

To recover data from the data log file select *Instruments > SRM: Data Recovery* from the IMS panel menu (Figure 3). Data from the data log is immediately written to both the SRM load (data upload file format) and the standard backup file (csv format). The data recovery window opens to confirm completion of operations (Figure 59).

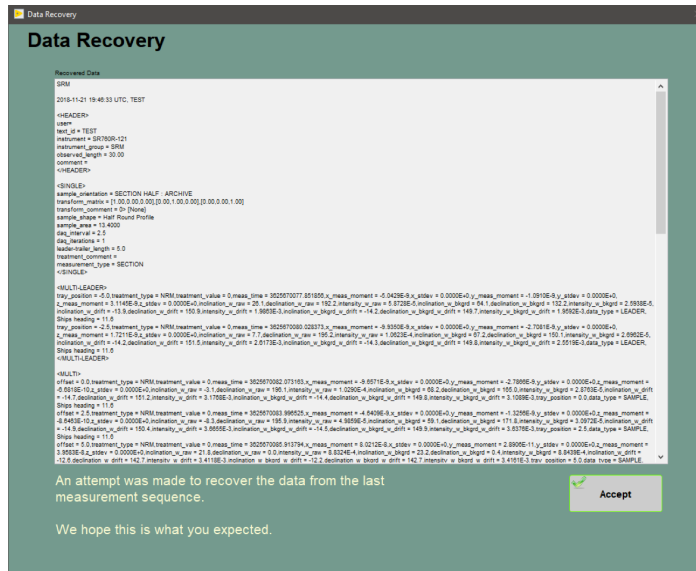


Figure 59- Data Recovery Utility Window

Degauss Utility

The degauss utility can be used to send commands to the degauss controller and to retrieve the status of the degauss controller (**Figure 60**). The user can ramp up, ramp down, and get the current status of each coil. The utility will automatically ramp down after a set amount of time to prevent over heating the coils.

- **Get Status** can be pressed while the system is ramped up or down. If the status window appears blank, try again. The system may have been between commands when the **Get Status** command was sent.
 - The value behind the letter **A** is the field the degausser is at in Gauss.
 - The letter following the **C** is the active coil.
 - See the degausser vendor manual for further details on what the values in the status window mean.

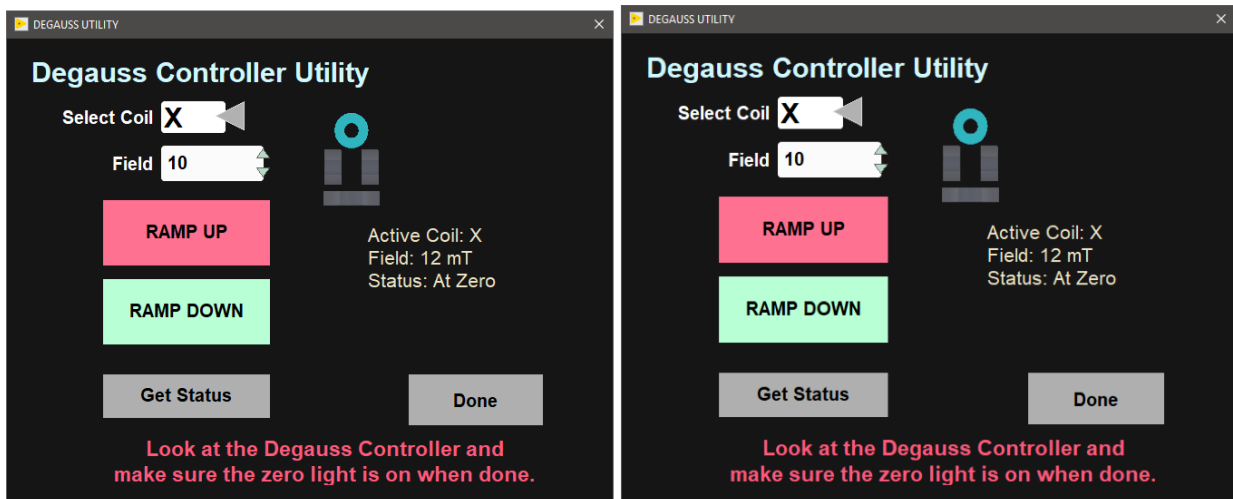


Figure 60 Degauss Controller Utility. The status window displayed in the right side image appears when Get Status is pressed.

File Formats and File Uploading

Data Upload Files

Data upload files are text files used by the MUT application to load acquired data into LIMS. Files with the SRM extension contain section (whole round and U-channel) data, and files with the DSC extension contain discrete data. Either file is written to the C:\DATA\IN folder where MUT will process them and then move them to the C:\DATA\ARCHIVE folder. Any file that fails to upload is moved to the C:\DATA\ERROR folder.

Sections

SRM data files are written for each sequence step and in addition to the section data, include the leader, trailer, and the two drift measurement data points.

Discrete

DSC data files are written for each sequence step and each discrete sample. These files include discrete specimen data and the two drift measurement data points (duplicated for each file). There is no leader or trailer data in this context.

Auxiliary Files

Auxiliary files are csv formatted text files written for both section and discrete data types. These are "kitchen sink" files that contain both final and intermediate calculation data, rotational data, flux counts, process values (demag level) etc. *One file of this type is referenced in the data upload file between the <FILE> tags and is archived in the ASMAN database.*

Sections

In a section file, each row is a single measurement starting with the Drift #1, Leader, Section, Trailer, Drift #2. File names are Sample ID, Text ID, Time stamp, and Demag level; therefore there is only one file per section per sequence step.

Section data is saved in the folder: C:\AUX_DATA\SRM\SECTION.

Discrete

In a discrete file, each row is a single measurement ordered as Drift #1, Sample, Drift #2. File names are Sample ID, Text ID, Time stamp, and Treatment; therefore there is only one file per discrete sample but it contains all of the sequence steps for that sample. *Note, because of the format, repeated measurements for discrete samples will end up in the same file.*

Discrete data is saved in the folder: C:\AUX_DATA\SRM\DISCRETE.

Background Files

Background files are text files written in a standard csv format. They contain the acquisition parameters, tray definition, and include both the raw and drift correct values for the SQUID's XYZ values. *Either the section or the discrete file is referenced in the data upload file between the <FILE> tags and is archived in the ASMAN database.*

Sections

The filename contains the type of tray, time stamp, and treatment.

File is saved in the folder: C:\AUX_DATA\SRM\SECTION-BKGND.

Discrete

The filename contains the type of tray, time stamp, and treatment.

File is saved in the folder: C:\AUX_DATA\SRM\DISCRETE-BKGND.

Measurement Sequence File

The sequence file is a text file written in a standard ini format and contains the data that describes each sequence step (process values). *This file is referenced in the data upload file between the <FILE> tags and is archived in the ASMAN database.*

File is saved in the folder: C:\IMS\SRM CONFIG\Measurement Sequence\User.

SRM Configuration File

The configuration file is a text file written in a standard ini format. There is only one current configuration file that contains a snapshot of all the pertinent data that was used during acquisition. *This file is referenced in the data upload file between the <FILE> tags and is archived in the ASMAN database.*

File is saved in the folder: C:\IMS\CONFIG\CURRENT.

Motion Control Setup:

Motion control should be set during initial setup and further changes should not be necessary. Motion control setup can be accessed by selecting *Motion > Setup* from the IMS panel menu (Figure 3). The M-Drive Motion Setup control panel will open (Figure 61).

- The user may select between four setup panels from this window.
 - Motor and Track Options
 - Fixed Positions
 - Limit and Home Switches
 - Motion Profiles

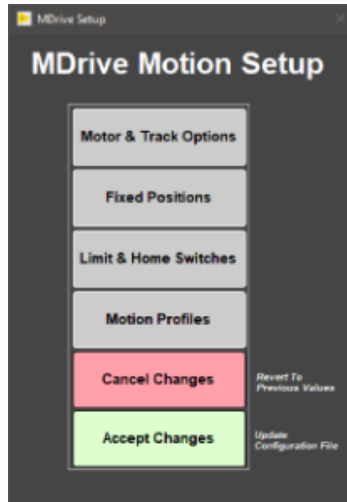


Figure 61- M-Drive Motion Setup

Motor and Track Options menu

Once these values have been properly set, they should not change. This panel is only for initial setup.

- Make sure to use the values shown for the SRM (Figure 62).

The relationship between motor revolutions and linear motion of the track is defined in this window and is critical to both safe and accurate operation. User should be familiar with the M-Drive motor system prior to adjusting these settings.

- **Select Axis:** In the case of the SRM it is always X.
- **Encoder Pulses/rev:** Defined by the manufacturer of the M-Drive as 2048.
- **Screw Pitch:** Set to 0.0627 (the ratio of 2048 steps per revolution and chain displacement (cm) as a function of the drive gears diameter).
- **Gear Ratio:** There is not a reduction gear so this value is set to 1.
- **Direction:** Clockwise rotation moves the tray in a positive direction (from home to end of track).
- Click the **Motion Utility** button to open the Motion Utility window (Figure 63) and test the settings. Click **Close** to exit this window.

Click **Done** to save the values or **Cancel** to return to previous values.

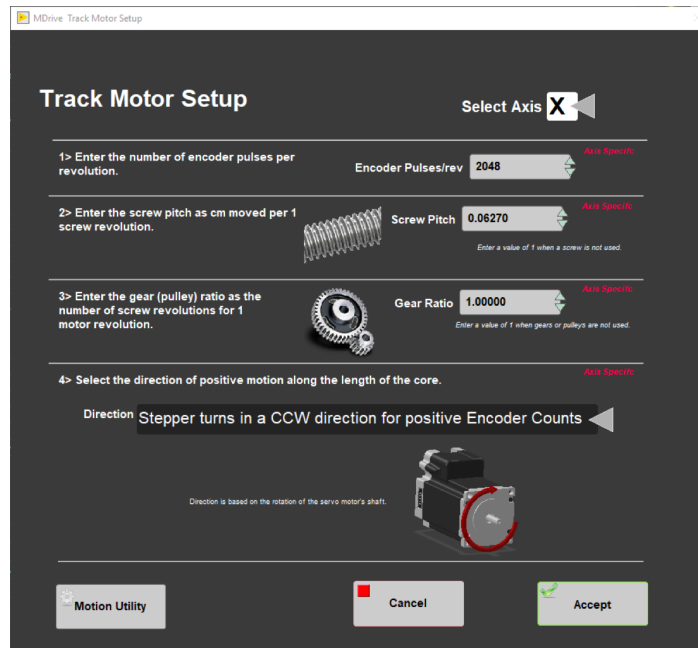


Figure 62- SRM Motor and Track Options Setup Window

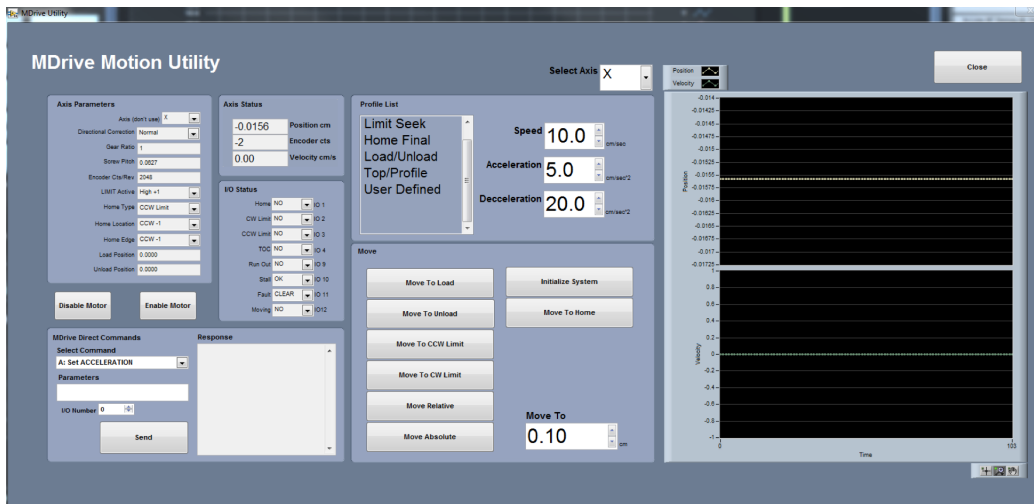


Figure 63- Motion Utilities Window

Fixed Positions menu

Once these values have been properly set, they should not change. This panel is only for initial setup.

In this window the user may define fixed track locations used by IMS motion control. For the SRM make sure to use these value unless there has been a physical change to the system (**Figure 64**).

- **Select Axis:** In the case of the SRM it is always X.
- **Max Section Length:** Maximum length of section that can be placed in the track. This value is set to 160 cm.
- **Track Length:** Distance in cm between the limit switches. Use the Motion Utility (**Figure 63**) to determine this value by moving from limit switch to limit switch plus the length of the tray used.
 - **Load and Unload:** For the SRM set to 0. This will always bring the tray back to the sample load end after a measurement sequence.
 - **Top-of-Section Switch?:** Not used.
 - **Top-of-Section Switch Offset:** Not used.
 - **Push Past:** Not used.
 - **Fast Past:** Not used.
 - **Run Out Switch?:** Not used.
- Click the **Motion Utility** button to open the Motion Utility window (**Figure 63**) and test the settings. Click **Close** to exit this window.
- Click **Done** to save the settings. Click **Cancel** to return to previous values.

Note, these values along with the positions set in the Degauss-Drift Location window and the SQUID offset set in the SRM setup window are necessary to fully define the track geometry. Take a lot of care in setting these values!

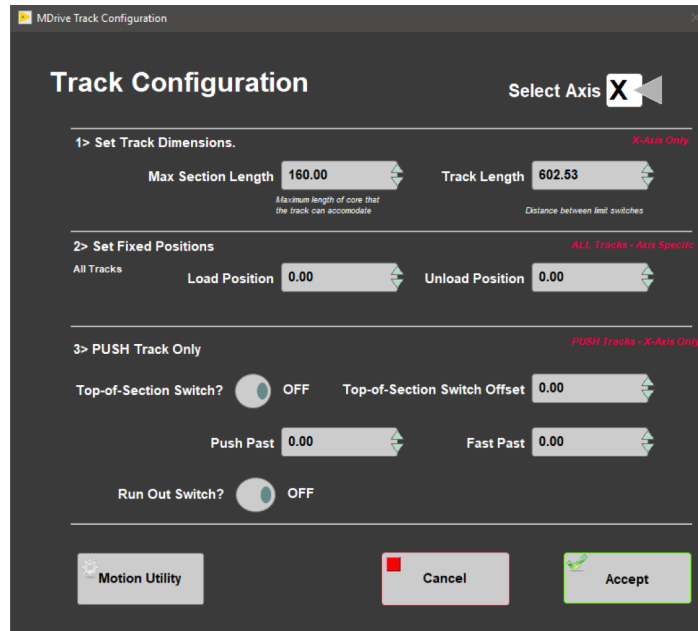
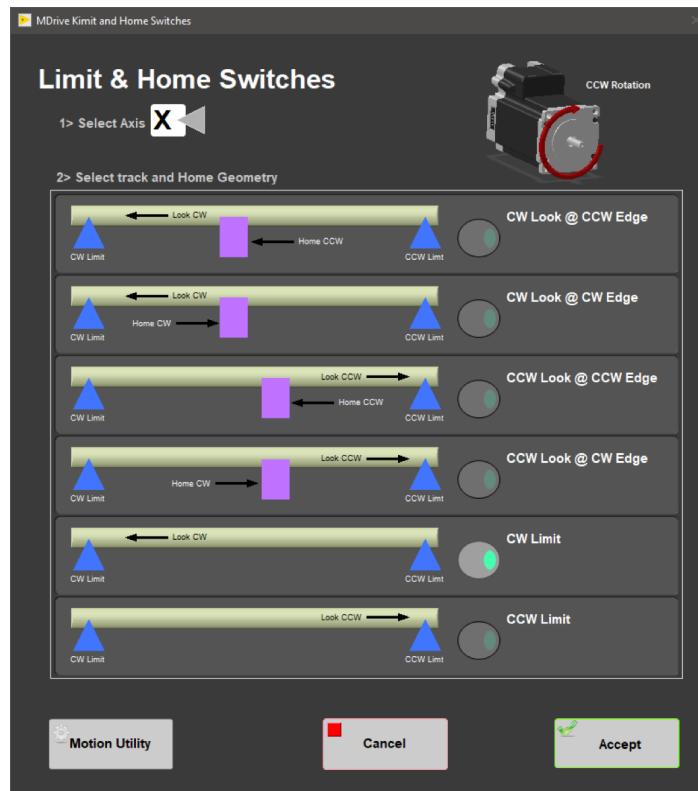


Figure 64- SRM Fixed Positions Window

Limit and Home Switches Window

Once these values have been properly set, they should not change. This panel is only for initial setup.

- This panel is used to define the orientation of the track system, limit switches, and the home switch (**Figure 65**). The MDrive can be used with either a dedicated Home switch or a limit switch as a home switch. In the case of the SRM track we use only a limit switch. There is no home switch installed.
 - **Select Axis:** In the case of the SRM it is always X.
 - **Select Track and Home Geometry:** For the SRM, select CW limit.
 - Click the **Motion Utility** button to test the settings.
 - Click **Accept** to save the settings. Click **Cancel** to return to previous values.



Motion Profiles

The motion profiles window can be used to adjust the speed and acceleration profiles used by the track (**Figure 66**) for various types of movements.

Setting the correct values for the motion profile takes a little experimentation to make the track run efficiently and safely. It is not unusual to modify these values as the lithology changes to balance the need for speed without inducing flux jumps.

- **DAQ Move:** This profile controls moves between measurement positions (leader and trailer measurements included) and the move to the drift 2 position. Set this to a reasonable speed with gradual acceleration and watch out for flux jumps. In addition, when you use the speed reduction feature to control flux jumps, this value is the base value for the reduction.
- **Limit Seek:** This profile is used for the following moves:
 - This profile finds the limit switch location. *Do not exceed 3 cm/sec. Do not use a large acceleration value, but always use a large deceleration value.*
 - **Home Final:** This profile finds the final location of the home switch. *Do not exceed 3 cm/sec. Do not use a large acceleration value, but always use a large deceleration value.*
 - **Load/Unload:** This profile is used for moving the tray in and out of the SRM for general movements and moving out of the SRM to the final position prior to ending a measurement or beginning the next degaussing step.
 - **Drift 1:** This profile is used to move to the drift 1 position and to move from the last trailer position to the drift 2 position
 - **Drift 2:** Unused
 - **Degauss Stage:** This profile is used to move to the degauss start position
 - **Degaussing:** This profile is used to move the section/discrete samples from degauss stage position through the in line AF degauss coils for X, Y, and Z.
- **User Define:** This profile is used for testing only in the **Motion Utilities (Figure 63)** program.
 - Click the **Motion Utility** button to open the **Motion Utility (Figure 63)** window and test the settings.
 - Click **Done** to save the settings. Click **Cancel** to return to previous values.

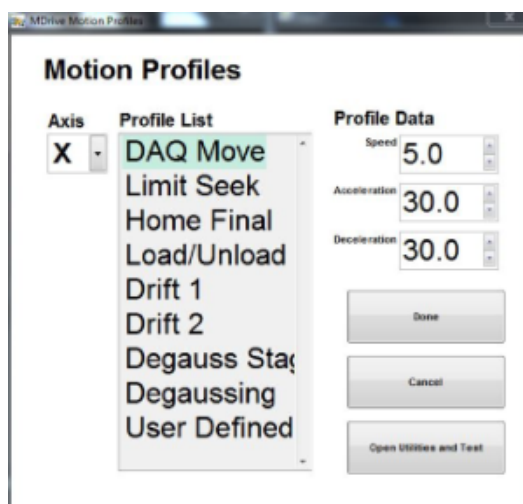


Figure 66- Motion Profiles Window

SQUID, Degauss Controller and USB 6008 Communication and Control Setup

Data communication and control is USB based and managed via National Instrument's Measurement & Automation Explorer (NI-MAX). When you open NI-MAX and expand the Device and Interface section it should appear as seen in **Figure 67**. On the following pages is an edited version of the NI-MAX report. Text in italics are additional comments for context. To have a pain free experience use these parameters and follow the advice.

The technician should fully understand how to use this information and setup the hardware.

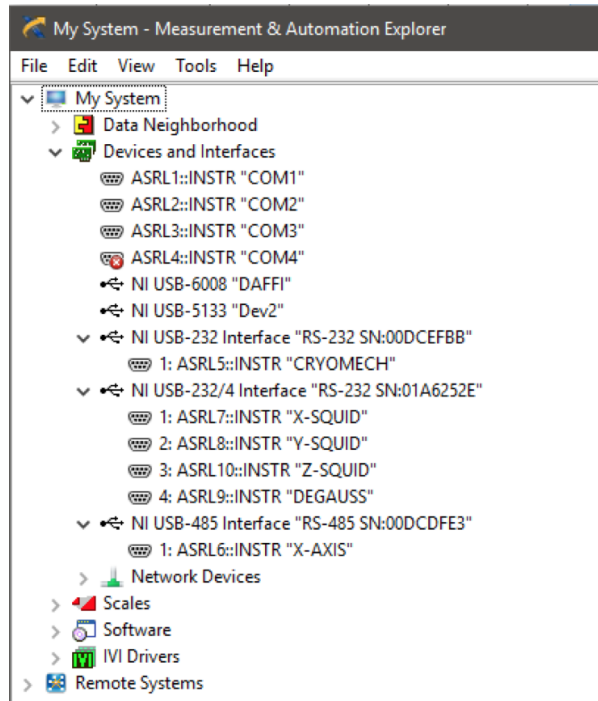


Figure 67- NI Max Device and Interface Menu

MAX Configuration Report

4/10/2018 3:39:21 AM

Devices and Interfaces

- NI USB-232/4 Interface "RS-232 SN:01A6252E" *SQUID and DEGAUSS CONTROLLER*
 - 1: ASRL7::INSTR "X-SQUID"
 - 2: ASRL8::INSTR "Y-SQUID"
 - 3: ASRL10::INSTR "Z-SQUID"
 - 4: ASRL9::INSTR "DEGAUSS"
- NI USB-485 Interface "RS-485 SN:00DCDFE3" *MOTION CONTROL*
 - 1: ASRL6::INSTR "X-AXIS"
- NI USB-6008 "DAFFI" *Analog input device used by DAFI and USB 6008 Utilities*
- NI USB-232 Interface "RS-232 SN:00DCEFB"
 - 1: ASRL5::INSTR "CRYOMECH"

NI USB-232/4 Interface "RS-232 SN:01A6252E"

This is a four port USB to RS-232 serial device. With this device we connect the serial port cables from the three SQUID meters and the Degauss Controller.

It is extremely important that the alias names shown here be used. This is how the IMS software knows which instrument it is connected to. So, make sure that the alias named "X-SQUID" is actually connected to the SQUID meter and that the meter is connected to the X-axis output of the SRM. The other two axis should be treated in the same manner.

Also, be aware that if you change hardware, NI-MAX will know. You will have to delete any previously set alias names and reassign them to the correct serial ports. You must also reset the serial port communication parameters.

- Name RS-232 SN:01A6252E *(if this number changes you must reconfigure!)*
- Vendor National Instruments
- Model NI USB-232/4 Interface
- Serial Number 01A6252E
- Name X-SQUID
- Slot Number 1
- Port Binding COM7
- Port Description Unknown
- VISA Resource Name ASRL7::INSTR
- Port Settings
 - Baud rate 1200

- Data bits 8
- Parity None
- Stop bits 1
- Flow control None
- Property Value
- Resource Name ASRL7::INSTR
- Device Type Serial Port
- VISA Alias on My System X-SQUID
- Device Enabled True
- Name Y-SQUID
- Slot Number 2
- Port Binding COM8
- Port Description Unknown
- VISA Resource Name ASRL8::INSTR
- Port Settings
 - Baud rate 1200
 - Data bits 8
 - Parity None
 - Stop bits 1
 - Flow control None
 - Property Value
 - Resource Name ASRL8::INSTR
 - Device Type Serial Port
 - VISA Alias on My System Y-SQUID
 - Device Enabled True
 - Name Z-SQUID
 - Slot Number 3
 - Port Binding COM10
 - Port Description Unknown
 - VISA Resource Name ASRL10::INSTR
 - Port Settings
 - Baud rate 1200
 - Data bits 8
 - Parity None
 - Stop bits 1
 - Flow control None
 - Property Value
 - Resource Name ASRL10::INSTR
 - Device Type Serial Port
 - VISA Alias on My System Z-SQUID
 - Device Enabled True
 - Name DEGAUSS
 - Slot Number 4
 - Port Binding COM9
 - Port Description Unknown
 - VISA Resource Name ASRL9::INSTR
 - Port Settings
 - Baud rate 1200
 - Data bits 8
 - Parity None
 - Stop bits 1
 - Flow control None
 - Property Value
 - Resource Name ASRL9::INSTR
 - Device Type Serial Port
 - VISA Alias on My System DEGAUSS
 - Device Enabled True

1: ASRL7::INSTR "X-SQUID"

2: ASRL7::INSTR "Y-SQUID"

3: ASRL10::INSTR "Z-SQUID"

4: ASRL9::INSTR "DEGAUSS"

NI USB-485 Interface "RS-485 SN:00DCDFE3"

This is a single port USB to RS-485 serial device. With this device we connect to the M-Drive interface board.

It is extremely important that the alias name "X-AXIS" is used. This is the means by which IMS knows which USB is connected to the M-Drive that moves the X-axis (sample handler).

Also, be aware that if you change the USB to 485 cable NI-MAX will know. Each cable has a serial number. You will have to delete any previous alias names and reassign them to the correct serial ports. You must also reset the serial port communication parameters.

- Name RS-485 SN:00DCDFE3
- Vendor National Instruments

- Model NI USB-485 Interface
- Serial Number 00DCDFE3
- Name X-AXIS
- Slot Number 1
- Port Binding COM6
- Port Description Unknown
- VISA Resource Name ASRL6::INSTR
- Port Settings
 - Baud rate 9600
 - Data bits 8
 - Parity None
 - Stop bits 1
 - Flow control None
 - Property Value
 - Resource Name ASRL6::INSTR
 - Device Type Serial Port
 - VISA Alias on My System X-AXIS
 - Device Enabled True

1: ASRL6::INSTR "X-AXIS"

NI USB-6008 "DAFFI"

This is an optional device and only needs to be connected should these utilities be used.

- Name DAFFI
- Vendor National Instruments
- Model NI USB-6008
- Serial Number 0164AF4C
- External Calibration
 - Calibration Date 9/17/2011 12:00:00 AM
 - Recommended Next Calibration 9/17/2012 12:00:00 AM
 - Property Value
 - ProductType USB-6008
 - DevSerialNum 0x164AF4C
 - ProductNum 0x717A
 - BusType USB

NI USB-232 Interface "RS-232 SN:00DCEFBB"

This device is connected to the Cryomech Compressor to enable monitoring of the system.

1: ASRL5::INSTR "CRYOMECH"

- Name CRYOMECH
- Slot Number 1
- Port Binding COM5
- Port Description Unknown
- VISA Resource Name ASRL5::INSTR
- Port Settings
 - Baud rate 115200
 - Data bits 8
 - Parity None
 - Stop bits 1
 - Flow control None
 - Property Value
 - Resource Name ASRL5::INSTR
 - Device Type Serial Port
 - VISA Alias on My System CRYOMECH
 - Device Enabled True

SRM Maintenance Procedures

The following section includes instructions on how to:

- Release Trapped Flux from within the SRM
- Measure the Response Lengths of the SQUIDS
- Check the Degauss Coil Function
- Collect a Field Profile within the SRM
- Check the Calibration Factors for the SQUIDS

Releasing Trapped Flux

When magnetically strong materials are passed through the SQUID measurement region it is possible to trap flux within the SRM. This is particularly a problem after hard rock expeditions. The best way to recognize trapped flux is by monitoring the SQUID readouts for extra noise and drift. Trapped flux cannot be measured with the Fluxgate magnetometer.

To release trapped flux:

1. Connect the oscilloscope to the SRM so that the signal wave form can be monitored
 - a. Oscilloscope Aux IN to Model 581 DC SQUID System Z axis SYNC
 - b. Oscilloscope Channel 1 to Model 581 DC SQUID System Z axis AC Output
 - c. Do not hook up the nulling coil cables. 2G recommends attempting to release the trapped flux without the nulling coils first and checking the resulting field and performance of the SQUIDS.
 - d. Heat up the SQUIDS using the Model 202 Control Monitor until the oscilloscope signal becomes a flat line.
 - i. Turn on the SQUID and Stripline heaters. Press and hold the shield heater button until the red indicator turns on.
 - ii. The oscilloscope signal should be lost when the temperatures reach 7 K. Once the signal has become noisy, continue to step 3.
 - iii. Turn off the heaters and allow the system to cool
 - iv. Measure the trapped field within the SQUID region using the Fluxgate magnetometer
 1. Measure a full field profile and save the data to the Field Profile folder in IODP Share: Pmag Documents
 2. If it appears that a high field was trapped within the SQUIDS it may be necessary to go through the entire field trapping procedure (See appendix B).
 3. Record the temperatures of the shields and SQUIDS on the SRM log sheet once the system has settled.

Measuring SQUID Response Lengths

Each SQUID has a unique response length based on the geometry of the system and the SQUID orientation. To measure the response lengths of each SQUID you may use a point source. The point source must be moved through the sensor region of the SRM over a distance longer than the length of the response functions. The measurements must be made 3 times, once for each axis. The point source will need to be adjusted between each measurement so that the axis of the source is aligned along each of the axis of the magnetometer. The point source should be centered in the bore of the SRM. Using the discrete boat, but running the system as a section half can help facilitate this. Recommended point sources for these measurements are the AGICO JR6 standard (Do not demagnetize this standard!), black plastic cube with a metal pin, or the Applied Physics Calibration coil. The recommended method is using a cube with a point source. *Using the calibration coil for these measurements is time consuming and labor intensive.*

Measuring a Response Curve using a point source cube:

1. Set the measurement interval to 2 mm in the **DAQ> Measurement Editor** menu and set the Leader/Trailer length to 0 cm (**Figure 9**).
2. Set the tray length to 50 cm in the **DAQ> Section Tray Editor** menu (**Figure 6**).
3. Collect a section half background measurement for the empty tray by selecting **DAQ> SRM: Section Background** from the IMS-SRM menu.
4. Place the point source in the discrete sample boat with the point source in the X position. Make sure the point source is positioned so that it is centered in the bore of the SRM.
 - a. Positioning the cube at 20 cm in the tray is recommended.
5. Select **Start** in the IMS-SRM software (**Figure 2**).
6. Select an archive section half sample type and orientation on the left hand side of the screen (**Figure 22**).
7. Ensure the measurement sequence is set to NRM only (**Figure 20**). **DO NOT DEMAGNETIZE THE STANDARD!**
8. Select the Manual sample entry tab and enter a sample ID and LIMS ID for the test (**Figure 23**).
 - a. Suggested naming convention includes which axis is aligned with the SQUID. i.e. Sample ID: Standard Cube; LIMS ID: Response Length-X axis
9. Enter a User Length for the 'core'
 - a. A length of 20 cm on each side of the point source should cover the entire response region for all three axes. i.e. If the cube is at 20 cm the user length should be set to at least 40 cm.
10. Select **USE ID and Length Values** and press the **Measure** button
11. The tray and sample will move through the measurement region collecting a measurement every 2 mm over the selected user length.
12. When the measurements are complete, the data will be written to a standard .SRM file and placed in the IN folder and to a .csv file in the AUX Data: SRM: Section folder. The .csv file will be the most useful.
13. Reposition the point source so that the Y axis is aligned with the Y SQUID and complete steps 8-10 again.
14. Reposition the point source so that the Z axis is aligned with the Z SQUID and complete steps 8-10 again.

Measuring a Response Curve using the Applied Physics Calibration Coil:

1. Position the Applied Physics coil in the section half boat. Center the coil in the bore using putty or foam to raise the coil off the bottom of the tray.
2. Connect the calibration coil to the calibration coil power supply via a BNC cable.
 - a. The cable should be long enough to allow the coil to travel through the measurement region while the power supply remains on the desk.
3. Set filter on Model 581 DC SQUID system box to 100 HZ.
4. Connect multimeter to the Output of the X axis SQUID. Set the multimeter to measure AC voltage.
5. Set the power supply box to AC and turn on the power supply
6. Open the IMS-SRM Motion Widget
7. Move the calibration coil into the SRM while monitoring the voltage read out on the multimeter. Find the peak voltage.
 - a. This position will vary depending on where the coil is positioned in the boat.
 - b. According to Bill Goodman the peak voltage for Z axis should be approximately 1.05 V but the transverse coil value will be reduced by a factor of two.
8. Move the coil back toward home by 20 cm
9. Record the position of the tray from home and the AC Voltage displayed on the multimeter for this position
10. Move the coil forward by 1 cm and record the voltage again.
 - a. Repeat this process until you have gone 20 cm past the center of the coils.

- b. A smaller measurement increment can be used if more resolution is desired.
- 11. Move the calibration coil back to the home position.
- 12. Reposition the coil for the Y axis and connect the BNC cable from the multimeter to the Y axis SQUID display. Repeat steps seven through 11.
 - a. To switch to the Y axis, rotate the entire coil wand 90 degrees
- 13. Reposition the coil for the Z axis and connect the BNC cable from the multimeter to the Z axis SQUID display. Repeat steps seven through 11.
 - a. To switch to the Z axis carefully unscrew the coil from the wand and reorient the coil and reattach
- 14. Compile the recorded data (offsets and voltages) into a single spreadsheet.

Calculating Response Length:

1. Open the .csv files associated with the response length measurements in Excel to view the X, Y, and Z moments.
2. Compile a worksheet with the following columns: Offset, X moment, Y moment, and Z moment
 - a. The X moments should be taken from the measurement when the point source was in the X position, etc.
3. Response length calculations will not work if the peak moment is a negative value. If the axis was measured in the negative direction, multiply all of the moment values for that axis by -1.
4. Normalize each set of moment values
 - a. Find the peak moment value for X and divide all of the X moments by this value. Do the same for Y and Z.
5. Open Kaleidagraph and insert the offset and normalized moment data into the data table (**Figure 68**). Make sure the columns are formatted as numbers and not as text.

	A	B	C	D	E
0	0.0000	-8.9100e-04	-0.0017500	4.5200e-06	
1	0.20000	-1.0100e-03	-0.0017700	4.3200e-05	
2	0.40000	-1.0600e-03	-0.0018800	7.9300e-05	
3	0.60000	-1.8400e-03	-0.0019900	6.8800e-05	
4	0.80000	-1.1800e-03	-0.0021100	5.0600e-05	
5	1.0000	-1.2900e-03	-0.0022300	5.3700e-05	
6	1.2000	-1.3600e-03	-0.0023600	7.5300e-05	
7	1.4000	-1.4400e-03	-0.0025000	9.7700e-05	
8	1.6000	-1.5300e-03	-0.0028300	0.00012300	
9	1.8000	-1.6300e-03	-0.0027900	0.00014300	
10	2.0000	-1.7200e-03	-0.0029700	0.00014800	
11	2.2000	-1.8300e-03	-0.0031500	0.00014700	
12	2.4000	-1.9300e-03	-0.0033400	0.00017800	
13	2.6000	-2.0500e-03	-0.0035300	0.00024000	
14	2.8000	-2.1800e-03	-0.0037300	0.00027200	
15	3.0000	-2.3100e-03	-0.0041300	0.00027800	
16	3.2000	-2.6400e-03	-0.0041900	0.00029900	
17	3.4000	-2.5900e-03	-0.0044400	0.00034300	
18					

Row : 0 Column : 0

6. Plot 3 scatter plots of normalized moment vs offset, one for each axes
 - a. The graphs should have a bell curve shape with slight negative lobes (**Figure 69**).
7. Integrate the area under each curve. The integrate- area function in Kaleidagraph works well for this calculation.
 - a. When the data table (**Figure 68**) is selected in Kaleidagraph, a MACROS menu is available at the top of the page. Select Integrate-Area from this menu.
 - b. In the next window, enter which column of data is the X axis and which is the Y axis of your plot (**Figure 70**). X should be offset and Y should be the moment values. Select OK.
 - c. In the next dialogue box enter the maximum and minimum X values (**Figure 71**). These values should be set so that the negative lobes of the curves are included in the calculation. The Yref value should be set to 0. Select OK.
 - d. The value reported is equal to the response length (**Figure 72**). These values should range from 7 to 9 cm depending on the SQUID axis.

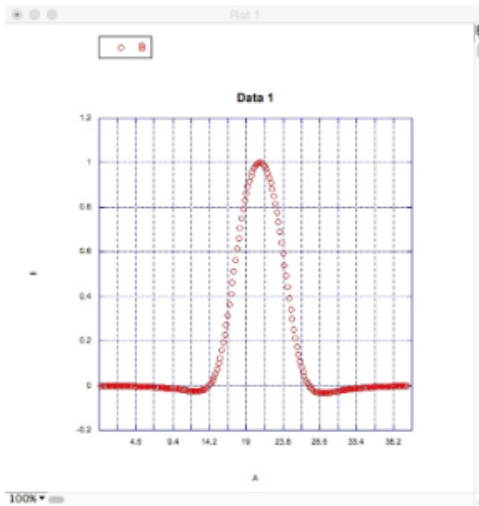


Figure 69- Example graph of normalized moments vs offset.

Prompt

Integrate:

0 X Column

1 Y Column

Cancel OK

Figure 70- Prompt window allowing user to select data to use for the integrate area function.

Prompt

Integrate:

5 Xmin

35 Xmax

0.000000 Yref

Cancel OK

Figure 71- Prompt window allowing user to select the area of the curve to use for the integrate function.

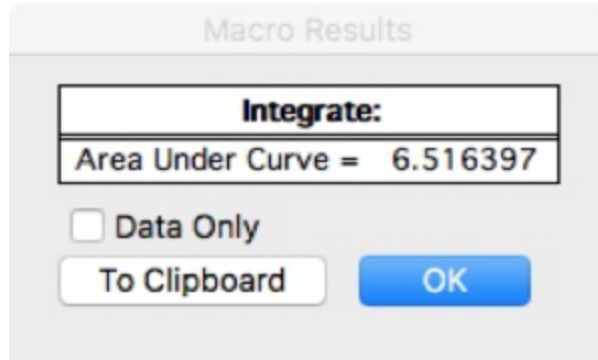


Figure 72- Integrate Area Results window.

8. Compare the results obtained in these response length measurements with the response length values stored in the SRM setup window (**Figure 4**). *Make sure you are confident in the values you calculate before considering changing the values used in the SRM software.*

Check Degauss Coil Function

The function of the degauss coils should be checked periodically to ensure the desired fields are being produced. For this procedure, you will need the axial and transverse Hall probes and the model 6010 Gauss meter. Each coil will require a separate measurement. The Z coils is measured using the axial probe. The X and Y axes are measured using the transverse probe.

Measuring the field produced by the degauss coils:

1. Secure the Axial probe in the section half tray with probe end centered at 140 cm from the home switch. The probe should be centered in the bore (**Figure 73**).

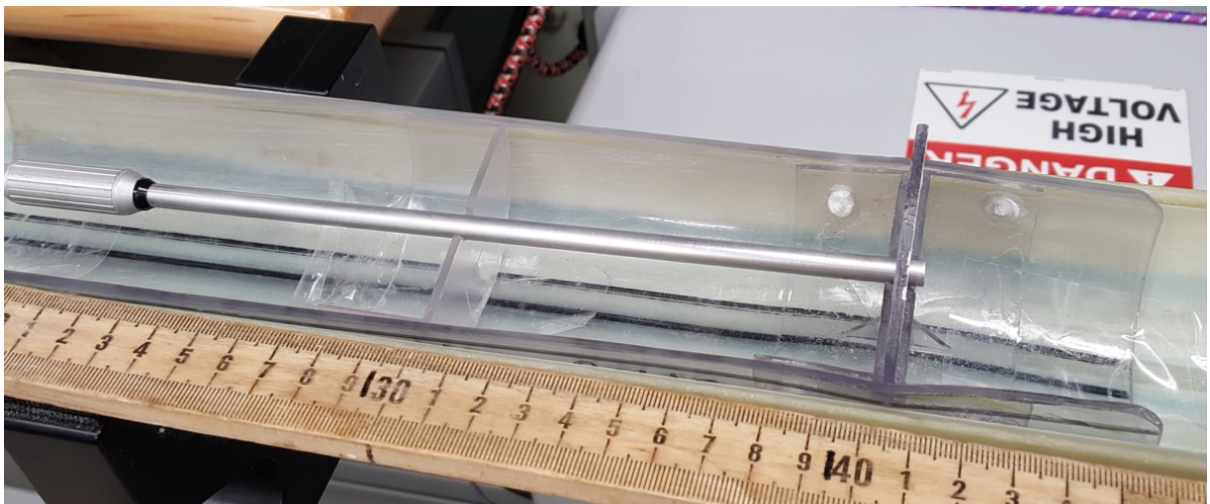


Figure 73 Hall probe in the Z axis orientation

2. Set the Degausser System Controller to Manual mode. And set the axis selector to Z (**Figure 74**).



Figure 74 Degausser Control unit. Red box indicates the toggle switch for switching to manual mode.

Green box indicates the dial for setting the alternating field in Gauss. Blue box indicates the axis selector control.

3. Connect probe to Gauss Meter and turn the meter on.
4. Set the units to mT and select AC mode on the Gauss Meter. Make sure the meter is in automatic range mode.
5. Select **Motion> Motion Widget** from the IMS menu.
6. Move the tray into the SRM so that the Hall probe is positioned within the Z degauss coil region.
 - a. For the Z axis with the probe near 140 cm in the tray, the peak field should be found near 261 cm from the home switch.
7. Set the maximum field value on the Degausser controller.
 - a. The controller is operated in Gauss, so a value of 200 on the dial is equal to 20 mT. **Do not set a high field.** The coils will be on for an extended time during the tests and may heat up.
8. Press the Ramp Up command on the degausser controller.
9. Once the Tracking light turns on adjust the position of the Hall probe using the motion widget until the peak value is found.
 - a. Using the HOLD (Max) features of the meter may help to identify the actual peak value as the meter is moved through the degauss coil region.
10. Record the peak value.
 - a. The value displayed on the Guass meter in AC mode is a true RMS value of the waveform with the dc component removed. To correct the read out value to mT multiply by the RMS correction factor of 1.414.
 - b. Example: Degauss unit set at 20 mT. Read out on Guass meter is 15.81 mT. Actual produced field is 22 mT.
11. Press the Ramp Down button on the degausser controller.
12. Move the tray to the Home position using the motion widget.
13. Remove the axial probe from the tray and place the transverse probe in the tray. Position the probe to read the X coil (**Figure 75**).

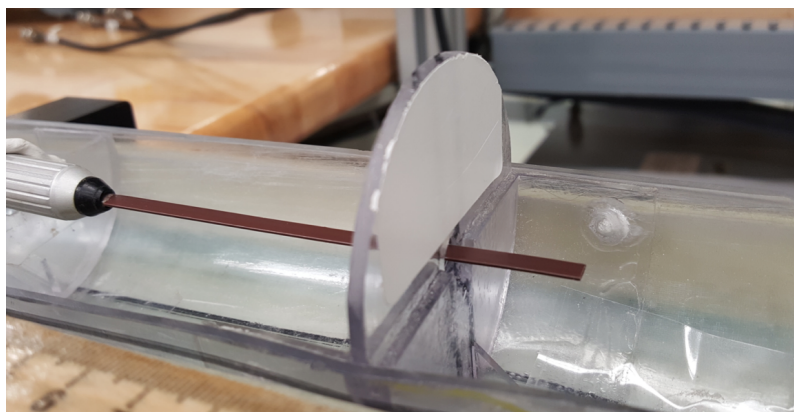


Figure 75 Hall probe in the X axis orientation

14. Set the axis selector on the degausser controller to X.
15. Use the motion widget to move the probe into the X degauss region and repeat steps 8 to 12.
 - a. If the probe is positioned at 140 cm in the tray, then the peak field should be found near 243 cm from the home switch.
16. Reposition the probe to read the Y coil output (**Figure 76**).

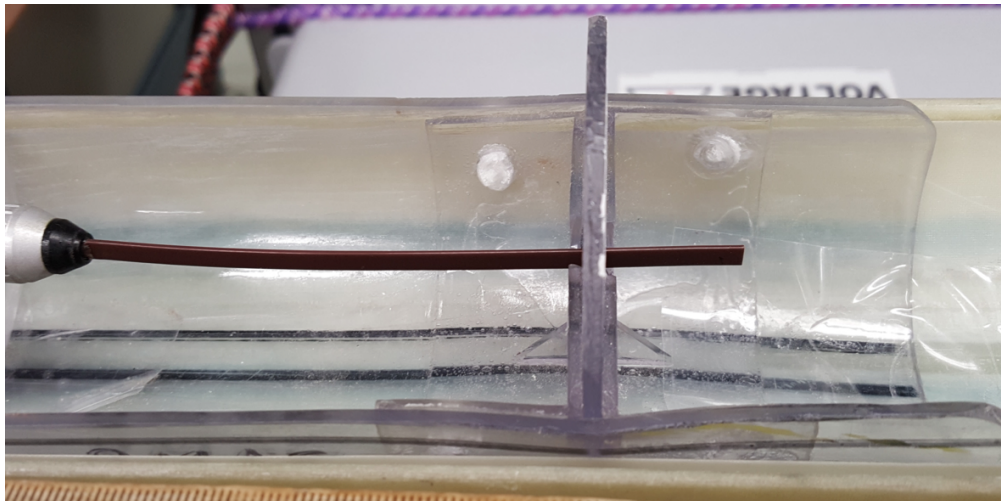


Figure 76 Hall probe in the Y axis orientation

17. Set the axis selector on the degausser controller to Y.
18. Use the motion widget to move the probe into the Y degauss coil region and repeat steps 8 to 12.
 - a. If the probe is positioned at 140 cm in the tray, then the peak field should be found near 277 cm from the home switch.
19. When finished with testing, set the degausser controller back to computer mode. The IMS software may need to be restarted after the mode has been changed back.

Measuring the Field Profile within the SRM

At the start of each expedition, the field profile within the SRM should be measured using the Fluxgate magnetometer and the DAFI utility in the IMS-SRM software. This data is retained in IODP Share> Pmag Documents: SRM: Field Profiles as .xlsx files. The field within the SQUIDS should be in the 0 to 20 nT range. If the field within the SRM is determined to be high, the field trapping procedure outlined in Appendix B should be followed.

Collecting a field profile:

1. Position the Fluxgate magnetometer in the section half boat. The magnetometer should be centered near the 140 cm mark to ensure there is enough cable to measure along the entire track.
2. Connect the USB6008 BNC cables to the back of the Fluxgate Control box.
3. Set the range of the fluxgate to 10 mOe.
 - a. This range will be too sensitive for outside of the shields, but should be appropriate within the measurement region.
4. Open the DAFI program in the IMS-SRM program
5. Set the in tray offset, DAQ Interval, average, and range in the DAFI window.
6. Set the start and end offset.
 - a. These are the track positions between which the measurements will be taken with the DAFI program. The Fluxgate will be moved to the start position before any measurements are taken.
 - b. Recommended offsets if Fluxgate is positioned at 140 cm in the tray are:
 - i. Start offset: 150 cm.
 - ii. End Offset: 400 cm.
7. Select Start and monitor the cable of the fluxgate as the tray moves through the SRM.
8. A .csv file will be written to C: AUX_Data\DAFI.
 - a. These files contain the X, Y, and Z meter values in mOe as they would be read from the Fluxgate magnetometer displays and the meter values converted to nT.

9. Save the file as an .xlsx file in the IODP Share> Pmag Documents: SRM: Field Profiles folder

- a. It is recommended that a plot of the field along each axis vs offset be created.
- b. Monitor for significant changes in the field or areas of leakage in the shielding.

It may be necessary to conduct multiple measurements using different ranges of the fluxgate, depending on what information is desired. The field around the shield joints will be too high for the 10 mOe range, but the 1000 mOe will not be sensitive enough for the measurement region of the SRM.

Checking SQUID Calibration Factors

Applied Physics provided calibration factors for the SQUIDS upon delivering the SRM. This procedure is done using a speciality calibration coil which is used for each system they produce. Applied Physics also provided a calibration coil to IODP, but it is not identical to the original coil.

The Applied Physics coil calibration constant is:

$$C = 3.252 \text{ emu/A}$$

The calibration factors should not be altered in the SRM software without serious consideration. The IODP coil can be used to check the calibration factors if the user wants to verify the systems function.

The calibration coil uses a small power supply box that reduces issues with RFI while using the coil. The power supply use two 9 volt batteries. The values produced are usually 1-3 percent different than the values supplied by the Applied Physics coil due to manufacturing differences. The calibration coil can be repositioned on the rod to measure the axial and transverse signals (**Figure 77**). A multimeter is used to read the output voltages from the coil and the calibration factor is calculated based on these values.

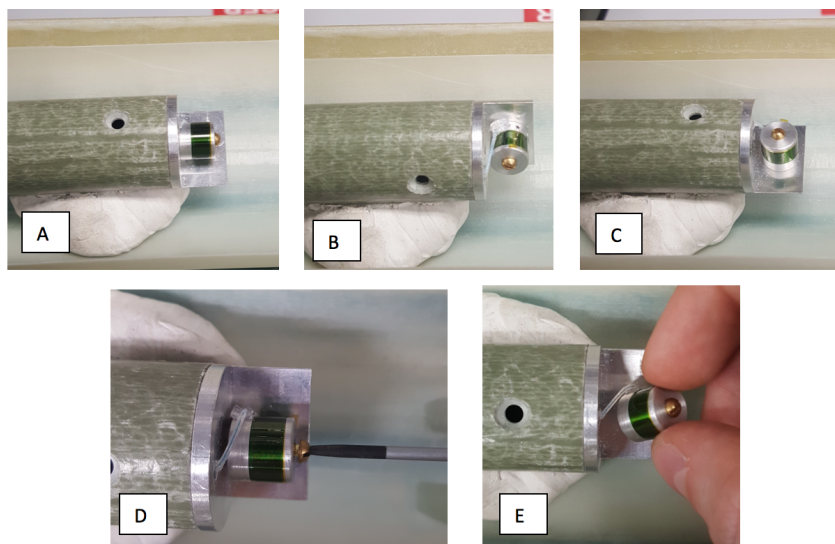


Figure 77 Calibration coil orientations. A) Z axis, B) Y axis, and C) X axis.

D and E illustrate how to reposition the coil on the wand.

Be aware that proper experiment setup is critical to obtaining valid results. If the coil is not centered in the SQUIDS, the SQUID signal and voltages measured will be inaccurate. It is best to do these measurements when the ship is stable.

Applied Physics calibration constants for the SQUIDS:

$$C_x = 8.1036 \text{ E } -5 \text{ emu}_0$$

$$C_y = -8.2590 \text{ E } -5 \text{ emu}_0$$

$$C_z = 3.8825 \text{ E } -5 \text{ emu}_0$$

Supplies needed:

1. 4 BNC cables
2. Oscilloscope
 - a. Adjust the settings to a horizontal scale of approximately 4.00 μ s and the vertical scale to approximately 2 V.
 - b. Set the oscilloscope source to AUX
3. Multimeter
4. Applied Physics calibration coil and power supply

Measuring and Determining the SQUID Calibration factors:

1. Connect the Calibration coil to the power supply and set supply to DC mode
2. Connect Aux In on the oscilloscope to the Sync on the back of the Model 581 DC SQUID system
 - a. The coil orientation should correspond with the Model 581 DC SQUID system, i.e. if connected to the Z axis Model DC SQUID system, ensure the coil is in the Z position
3. Connect Channel 1 on the oscilloscope to the AC Out on the back of the Model 581 DC SQUID system
4. Adjust the potentiometer (pot) on the calibration coil power supply to zero (turn knob all the way counter clockwise)
5. Set the Model 581 DC SQUID system to 100 HZ filter
6. Center the coil in the SQUIDS.
 - a. To find the center of the SQUIDS with the calibration coil:
 - i. Connect the multimeter to the Output on the front of the Model 581 DC SQUID system. The SQUID should be locked.
 - ii. Set the calibration coil power supply and the multimeter to AC
 - iii. Move the coil into the SQUIDS using the Motion Widget utility in the IMS software.
 - iv. Find the peak voltage. This should be the center of the SQUIDS.

* If the coil is not properly centered, the oscilloscope signal and voltage reading will be inaccurate and the final SQUID calibration constant will be incorrect.
7. Disconnect the multimeter from the output of the Model 581 DC SQUID system.
8. Connect the multimeter to the calibration coil power supply X mon port
9. Set multimeter and calibration coil power supply to DC
10. Unlock the SQUID using the black button on the front of the Model 581 DC SQUID system
11. While monitoring the signal on the oscilloscope, adjust the pot on the calibration coil power box to the first double frequency point, and then continue to the second double frequency point.
12. Record the voltage from the multimeter while at the second double frequency point.
 - a. This voltage will be used to determine the SQUID calibration constant
13. Return the tray and coil to the home position using the IMS Motion Widget
14. Repeat steps 4 through 13 for the remaining two coil axes.
 - a. Remember to switch the BNC cables to the appropriate Model 581 DC SQUID system ports.

*Once measurements are complete, make sure to LOCK the SQUIDS.

Calculating the SQUID Calibration Constants

Using the formulas and $C_{x,y,z} = C \times I$, calculate the coil calibration factor,

V= Voltage measured

R = 500,000 Ω = Resistance

I= Current

C=3.252 emu/A =Coil Calibration Constant

$C_{x,y,z}$ =Coil calibration factor (emu/ Ω)

Example Calculation of SQUID calibration constant:

If the measured voltage is 12.27 V,

Multiply this value by the coil calibration constant to get the Calibration Constant for the SQUID:

The resultant values should be similar to those provided by Applied Physics.

IODP measured calibration constants for the SQUIDS during Exp 372:

$$C_x = 8.66 \text{ E } -5 \text{ emu}/\Omega$$

$$C_y = -8.19 \text{ E } -5 \text{ emu}/\Omega$$

$$C_z = 3.56 \text{ E } -5 \text{ emu}/\Omega$$

Appendix A: SRM Field Trapping Procedure

This guide is intended to assist technical staff with trapping a low magnetic field inside of the SQUID response region. This procedure will need to be done any time the SRM warms to temperatures above superconducting (7 K) or if a large trapped field is suspected within the SQUID response region.

Prior to beginning this process, check the fluxgate zeros in a mu-metal shield. Zero the fluxgate if necessary. Measure the field trapped inside the SRM prior to heating and retrapping a field to obtain a baseline measurement. For further instructions on measuring the trapped field, see the the DAFI utility instructions.

Items needed for trapping a low field:

- Fluxgate probe: Used to measure the field in the SQUID response region (**Figure A1**)
- SRM nulling cable: Used to null the field inside the SQUID response region (**Figure A2**)
- 2G Enterprises Model 202 Control Monitor (**Figure A3**)
- Model 581 C DC SQUID System Z axis SQUID box (**Figure A4**)
- Oscilloscope: Used to monitor the signal and noise during field trapping
- 2 BNC cables
- An empty section half boat
- Small screw driver for adjusting the nulling coil potentiometers



Figure A1: Fluxgate magnetometer probe and control box



Figure A2: SRM nulling coil



Figure A3: Model 202 Control Monitor for SRM



Figure A4: Model 581 DC SQUID System box

Trapping a Low Field

1. Position the fluxgate probe in the section half boat. Center the fluxgate in the bore (**Figure A5**). Note the position of the fluxgate from zero.
 - a. It is recommended to center the fluxgate coils around 150 cm in the boat.
 - b. Put the fluxgate control box in range 10 mOe for measurements within the SRM shielding.



Figure A5: Fluxgate Magnetometer probe positioned in the section half boat. Center the probe in the bore.

Position the coil center of the probe to be at 150 cm.

2. Connect the oscilloscope Aux IN to the SYNC on the Z axis SQUID box and connect oscilloscope Channel 1 to the AC Out on the back of the Z axis SQUID box. (**Figure A6**)

a. The axial field (along the Z axis) is the highest due to the orientation along the opening of the shielding, which makes the Z axis the best signal to monitor.

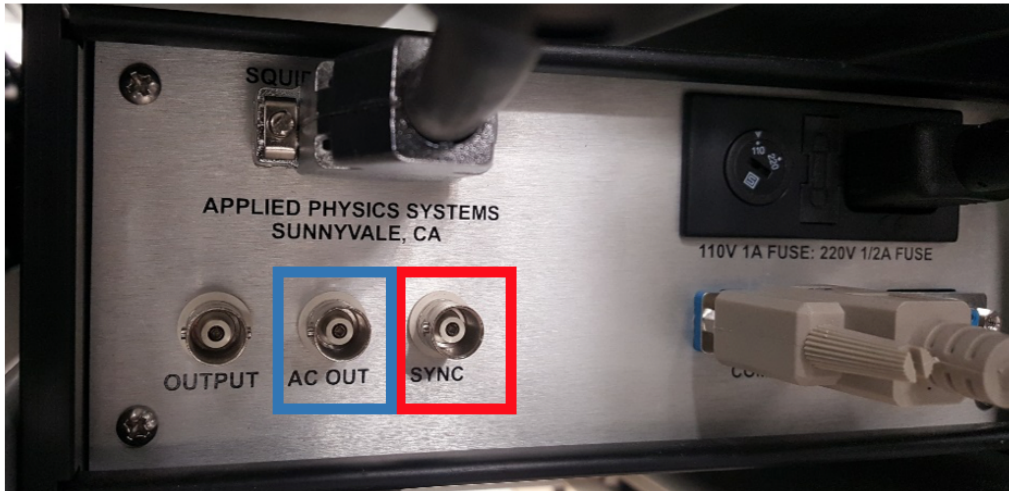


Figure A6: Back of the Z axis 581 DC SQUID Box. Connect AC Out (Blue box) to Channel 1 on the oscilloscope.

Connect SYNC (Red Box) to AUX IN on the oscilloscope.

3. Connect the nulling cable to the back of the Model 202 Control Monitor and to the ports near the junction between the measurement region and the degauss region (Figures A7 and A8)

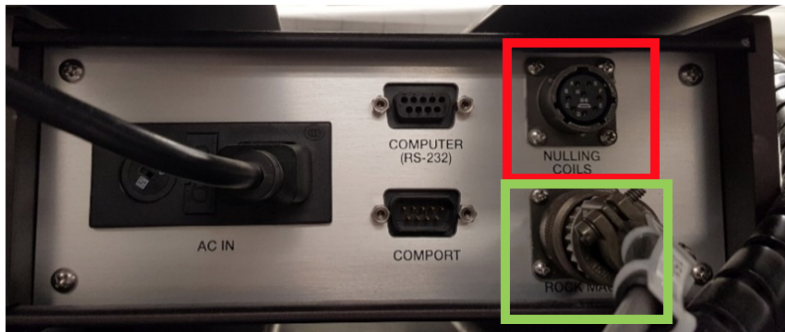


Figure A7: Back of the Model 202 Control Monitor. Note the Nulling Coils Connector in the red box.

The rock mag port (green box) is used to connect the control box to the cold head and read the shield and SQUID temperatures. This cable is always connected to the control monitor, but must be left disconnected from the cold head when not in use.

Connect the RS232 cable to the cold head when temperature readings are taken.

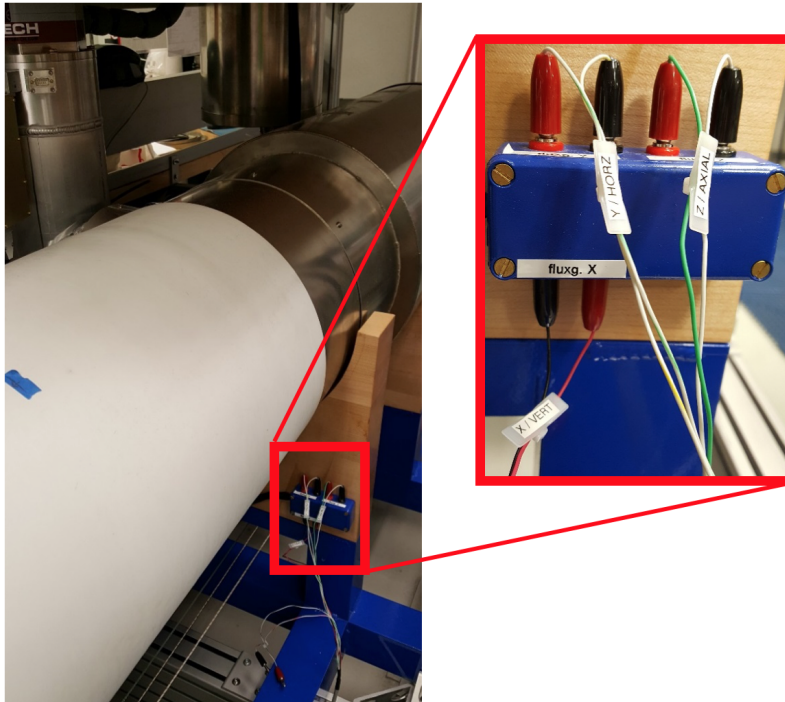


Figure A8: Nulling cable connection ports near the junction between the SQUID measurement region and the degaussing region of the SRM.

Connect the red plugs to the red terminals, black plugs to black terminals, matching the X, Y, and Z labels. The cables labeled “coil” will not be used.

4. Connect the Model 202 Control Monitor Rock Mag port to the RS232 port on the cold head (Figure A9).

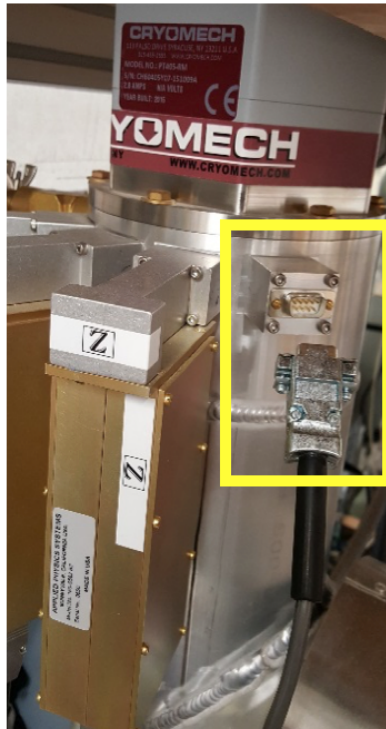


Figure A9: RS232 port on the Cryomech Cold head (yellow box).

Connecting this cable to the cold head and Model 202 Control monitor allows a user to monitor temperatures within the SRM.

5. Turn on the power to the Model 202 Control Monitor. The display should include the current temperature of the shield (TSH) and the SQUIDS (TSQ). T2S will be open. No heaters should be on at this time (Figure A10).



Figure A10: Model 202 Control Monitor Display

6. Move the Fluxgate into the SRM using the motion utility or motion widget in the IMS SRM software.
 - a. If you want to watch the trapped field during warming, move the Fluxgate magnetometer probe to a position 20 cm from the center of the SQUIDS. As the system warms, it will be possible to see the SQUID signal disappear on the oscilloscope.
 - b. If the fluxgate is centered in the SQUIDS, the SQUID signal will not be visible on the oscilloscope. The oscilloscope will only show noise.
7. Turn on the heaters by pressing the black buttons on the front of the Control Monitor (**Figure A11**).
 - a. The SQUID and STRIPLINE heaters will stay on once they are pressed until they are manually shut off.
 - b. To turn on the SHIELD heater, press and hold the black button until the light illuminates. The heater will shut off periodically.
 - c. If you are monitoring the signal on the oscilloscope, the signal should become noisy/disappear after the temperatures reach 7 -8 K. Once the signal is gone, move the fluxgate magnetometer to the center of the SQUID response region.
 - d. To speed up the heating process, you may shut down the SRM Cryomech Compressor during heating. If the compressor is shut down, reduce the chill water flow to the compressor to prevent over cooling the oil in the compressor.

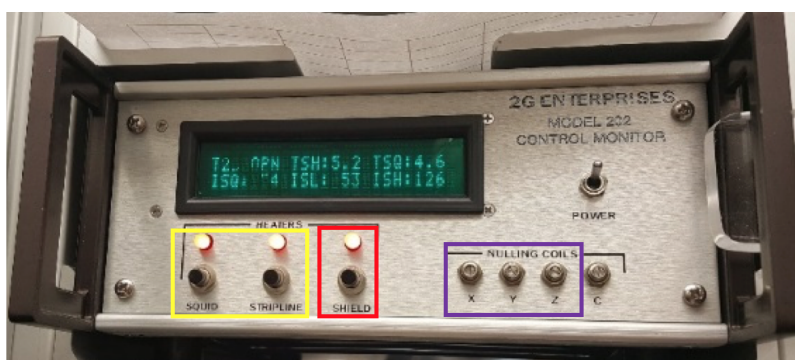


Figure A11: Model 202 Control Monitor with heaters on. The heater temperatures are now visible on the display.

The SQUID and Stripline heaters (yellow box) will stay on until the switch is pressed again. The Shield heater (red box) needs to be held until the light above the switch illuminates.

The shield heater will shut off periodically and light will turn off. Press the switch again to continue heating the system. The nulling coil potentiometers (purple box) are used to null the field.

8. Keep turning on the Shield heater while monitoring the TSH and TSQ temperatures. When TSH and TSQ are approximately 11-12 K, turn off all of the heaters.
9. Center the fluxgate magnetometer in the SQUIDS using the Motion Widget utility. The SQUIDS are 295.7 cm from the home switch.
10. If the compressor is off, turn it on and increase the water flow rate.
11. While monitoring the readouts on the fluxgate, use a small screw driver to turn the nulling coil potentiometer on the control monitor box (**Figure A11 and A12**). Adjust the fluxgate readouts to as close to zero mOe as possible.
 - a. The nulling coil potentiometers do not correspond to the fluxgate axis. The X nulling pot adjusts the Y axis, the Y nulling pot adjusts the X axis, and the Z nulling pot adjusts the Z axis.
 - b. The values are in mOe so a value of 2.14 on the fluxgate in range 10 mOe is equal to 214 nT.

- c. The X, Y, and Z readouts correspond to the fluxgate magnetometer axes, not the SRM axes.
- d. The Z axis readout is missing its decimal point. The decimal should be in the same position on each readout.

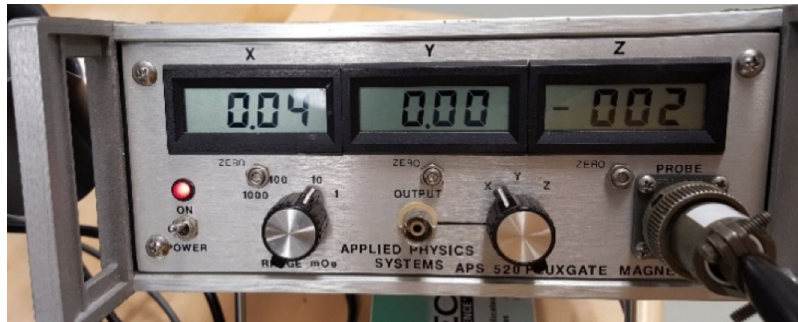


Figure A12: Fluxgate Magnetometer display during field nulling. This display currently reads 0.04, 0.00, and -0.02 mOe on the X, Y, and Z fluxgate axis respectively. These values are equal to 4, 0, and -2 nT.

12. Continue monitoring the fields and the TSH and TSQ temperatures as the system cools down. Superconducting temperatures are around 7 K.
 - a. It is possible to continue adjusting the fields until the shield goes superconducting. It will be evident that the shield has gone superconducting when the adjustment of the nulling currents no longer has an effect on the field.
13. Once the system is superconducting, move the fluxgate 20 cm towards home. A clean signal should be visible on the oscilloscope.

You will notice some fluctuation on all axes, but the Z axis may show significant drift after trapping a new field. Allow the system to settle before taking any measurements. Use the fluxgate magnetometer and DAFI utility in the IMS SRM software to measure the trapped field across the SQUID centers once the system has settled.

Appendix B: Mathematical Explanation of IMS- SRM

This document is intended as a brief explanation of the mathematical calculations done in the IMS-SRM program beginning with the initial SQUID meter readings and ending with the inclination, declination, and intensity values.

The values displayed and recorded directly from the SQUID meters are in units of ϕ_0 . The SQUID meters have two display options, analog or DVM, and counts. The combination of these two outputs results in the total signal, S_{ϕ_0} .

$$(1) \quad \text{Total Signal, } S_{\phi_0} = \text{Analog}_{\phi_0} + \text{Count}_{\phi_0}$$

To convert S_{ϕ_0} to magnetic moment units, S_{ϕ_0} is multiplied by the system calibration constant in emu per flux quanta (emu/ ϕ_0). The calibration constant is specific to the axis on which the measurement was taken. To convert the magnetic moment from emu to Am^2 , use the conversion factor of 10^{-3} .

$$(2) \quad \text{Moment}_{\text{meter}} (\text{Am}^2) = \frac{S_{\phi_0} * \text{Calibration Constant}_{x,y,z} (\text{emu}/\phi_0)}{1000}$$

The calibration constants for the IODP SRM are:

$$X = 8.1036E-5$$

$$Y = -8.2590E-5$$

Z=3.8825E-5

This magnetic moment value is written to the .csv file as the Meter value.

To account for the initial offset in the SQUID readings at the time of the first measurement, the first drift value is subtracted from each measurement. This value is then recorded as the raw moment value.

$$(3) \quad \text{Moment}(Am^2) = \text{Moment}_{meter}(Am^2) - \text{Moment}_{Drift1}(Am^2)$$

The IODP and SRM instruments coordinates differ. To correct the data from instrument coordinates to the IODP coordinate system the sign of the Z axis is flipped immediately after the raw magnetic moment value is calculated. The correction for working vs. archive half or any related rotations for cubes are then applied to the raw moments. This is accomplished through matrix rotations.

The raw magnetic moment values are then corrected for response length of the individual SQUID axis and for the sample volume. The resulting value is the volume corrected magnetization, M_v .

$$(4) \quad M_v(A/m) = \frac{\text{Moment}(Am^2)}{(\text{Squid length}(cm) * \text{Sample Volume}(cm^3)) / 100^3}$$

*Note that the division by 100^3 is a conversion from cm^3 to m^3 .

The Inclination, Declination, and Intensity values are calculated from the volume corrected magnetization values. The inclination and declination values are given in degrees while the intensity values are reported in A/m.

$$(5) \quad \text{Inclination}(degrees) = \frac{\text{atan}\left(\frac{z}{\text{sqrt}(x^2+y^2)}\right)}{\text{Pi}} * 180$$

$$(6) \quad \text{Declination}(degrees) = \frac{\text{atan}\left(\frac{Y}{X}\right)}{\text{Pi}} * 180$$

$$(7) \quad \text{Intensity}(A/m) = \text{sqrt}(x^2 + y^2 + z^2)$$

Each of these values is reported as the raw values in the data files. IODP also reports inclination, declination, and intensity values corrected for drift, background, and for both background and drift.

Drift Correction Process:

This section describes the steps taken to correct the magnetic data for instrument drift.

First, the rate of drift over the measurement time is calculated using the moments and measurement times for the drift 1 and drift 2 measurements. The drift 1 measurement is taken when the top of the tray is at 326 cm from the home position and drift 2 is taken when the top of the tray is 106 cm from the home position.

$$(8) \quad \text{Rate of Drift} \left(\frac{A}{sec} \right) = \frac{(\text{Moment}_{\text{Drift 2}} - \text{Moment}_{\text{Drift 1}})}{(\text{Time}_{\text{Drift 2}} - \text{Time}_{\text{Drift 1}})}$$

Next, the amount of drift between the first drift measurement and the individual sample measurement is calculated. Linear drift is assumed.

$$(9) \quad \text{Drift} \left(\frac{A}{m} \right) = (\text{Time}_{\text{Measurement}} - \text{Time}_{\text{Drift 1}}) * \text{Rate of Drift} \left(\frac{A}{sec} \right)$$

Finally, the amount of drift is removed from the raw moment value, resulting in the drift corrected moment, M_{DC} .

$$(10) \quad M_{DC} \left(\frac{A}{m} \right) = \text{Moment} \left(\frac{A}{m} \right) - \text{Drift} \left(\frac{A}{m} \right)$$

Background Correction Process:

This section covers the process for correcting the volume corrected magnetic moment data for the instrument background. The background measurement is an empty tray measurement taken prior to sample measurements. The same background data will be applied until a new measurement is initiated by the user.

The moments measured along the empty sample tray ($\text{Moment}_{\text{bkgd}}$) are subtracted from the measured moments along the core at the same position, resulting in the background corrected moment, M_{BC} .

$$(11) \quad M_{BC} \left(\frac{A}{m} \right) = \text{Moment} \left(\frac{A}{m} \right) - \text{Moment}_{\text{bkgd}} \left(\frac{A}{m} \right)$$

Background and Drift Correction Process:

This section describes the process for correcting the magnetic moment data for both instrument background and drift.

The background moments, $\text{Moment}_{\text{bkgd}}$ are removed from the previously calculated drift corrected moments, resulting in the background and drift corrected moment, M_{BDC} .

$$(12) \quad M_{BDC} \left(\frac{A}{m} \right) = \text{Moment}_{DC} \left(\frac{A}{m} \right) - \text{Moment}_{\text{bkgd}} \left(\frac{A}{m} \right)$$

The corrected moments are then input into formulas 5, 6, and 7 to calculate the corrected directions and intensities for each measurement. These values are then output to the data files (.srm and .csv).