
Section Half Multisensor Logger (SHMSL): User Guide

Manual Information

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Introduction

The Section Half Multisensor Core Logger succeeded the Archive-Half Multisensor Track (AMST) in the physical properties laboratory. The SHMSL simultaneously measures spectral reflectance and magnetic susceptibility on core section halves. Data generated from these sensors are used to augment the core descriptions.

Reflectance Spectrometry

–Percent reflectance plotted against depth supports lithology descriptions.

–Color parameters can provide a detailed time series of relative changes in the composition of the core material and can be used to correlate sections from core to core or hole to hole and to analyze cyclicity of lithologic changes.

–Spectral data can be used to estimate the abundances of certain compounds.

- Visible range provides semiquantitative estimates of hematite and goethite with better sensitivity than XRD.
- Near-infrared or near-ultraviolet ranges allow estimates of carbonate, opal, organic matter, chlorite, and some combinations of clay minerals.

Magnetic Susceptibility

Magnetic Susceptibility can be used to confirm whole-round core section magnetic susceptibility measurements. The SHMSL can measure magnetic susceptibility at a similar sampling point spacing to the whole-round measurements, or the user can select a completely different frequency of analysis.

MS data is used for correlation with other age-depth proxy measurements.

Theory of Operation

A split and scraped core section in a half-core liner is placed on the core track, where barcode scanner is used to scan the section ID (from the end cap) and imports sample information from the LIMS. The electronics platform moves along a track above the core section, recording the sample height in the core liner using a laser sensor. The laser establishes the location of bottom of the section. When this step is finished, the track will pull up out of the way of the user in order to facilitate the covering of the core section with GLAD® Plastic Wrap. When the user covers the core section and answers the prompt, the platform reverses the direction of movement, moving from bottom to top while recording point magnetic susceptibility and spectral reflectance data at user-specified data acquisition intervals (generally 2–10 cm).

Reflectance Spectrometry

–Measured from 380 to 900 nm at 2 nm intervals using both an LED and a halogen light source, covering a wavelength range through the visible spectrum and slightly into the infrared domain.

–Scanning the entire wavelength range takes ~5 s per data acquisition offset.

–Data are generated using the CIELAB L*a*b* color system:

- L* represents lightness, where 0 yields black and 100 indicates diffuse white;
- a* represents magenta to green tinting, where negative numbers indicate red/magenta shading and positive numbers indicate green shading; and
- b* represents yellow to blue tinting, where negative numbers indicate yellow shading and positive number indicate blue shading.

–Data are also stored and returned as CIELAB Tristimulus XYZ values. The definition of X, Y, and Z is complex and the reader should refer to reference materials for an explanation. Refer to the related documentation section below.

–Finally data are stored and returned as RGB values to facilitate comparison with the imaging logger RGB values; note however that the sampling interval is quite different between the imaging logger and the integration sphere.

Magnetic Susceptibility

–Measured at the same data acquisition rate as spectral reflectance using a contact probe with a flat 15 mm diameter sensor.

–The sensor can be configured for different integration times (1 Hz or 0.1 Hz) and different numbers of replicate measurements. Our standard conditions are 3 measurements at 1 Hz measurement frequency for each offset. These three results are averaged and uploaded to the database. Thermal drift is effectively eliminated by zeroing the meter before each section.

–Data are reported in dimensionless instrument units (SI). In order to use these data as SI magnetic susceptibility units, the appropriate volume correction must be applied, which varies by sensor type. The user should not use the cgs setting so that the data set is consistent with previous measurements and with the whole-round logger results.

Apparatus, Reagents, & Materials

Hardware

The SHMSL system consists of the following hardware components (Figure 1):

- Bartington MS2K or MS2E (Note: MS2E is not generally recommended because of its very small read area) magnetic susceptibility contact probe
- Bartington MS2 meter, run in serial communications mode
- Ocean Optics QE Pro visible spectrum spectrophotometer
- Ocean Optics HL-2000 Halogen Light Source with Attenuator and TTL-Shutter
- Ocean Optics Multi-LED BluLoop Light Source
- Ocean Optics 30 mm integrating sphere, with a 10 mm aperture
- Acuity AccuRange AR700 Laser
- Barcode scanner
- Instrument platform
- Hardware abort switch

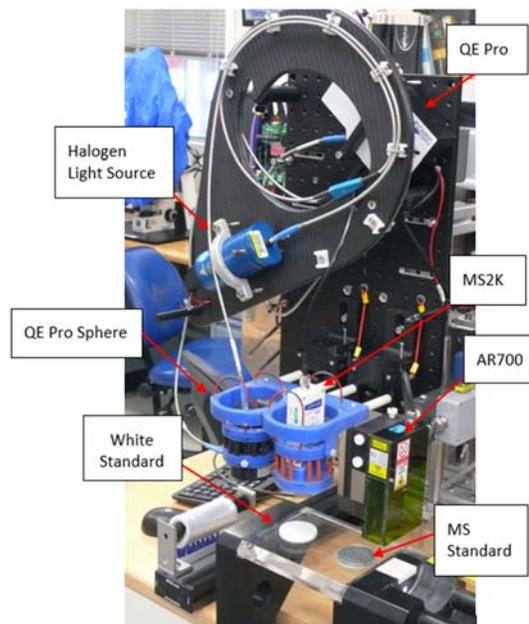


Figure 1. SHMSL Hardware

Bartington MS2K Probe Susceptibility Contact Probe

Specification	Value
Dimensions (mm)	165 x 145 x 50mm
Area of Response	15mm x 33mm diameter 25.4mm diameter
Operating frequency (kHz)	0.930
Depth of Response	50% at 3mm 10% at 8mm
Measurement period: X 1 range X 0.1 range	1.2 s SI 12s SI
Temperature induced drift	<2 x 10 ⁻⁵ SI in 5 min
Calibration (tip contact)	K x 10 ⁻⁵ SI (1cc)

Bartington MS2 Probe Susceptibility Meter

Specification	Value
Dimensions (mm)	241 x 158 x 50
Operating temperature range (°C)	-10 to +40
Linearity	1% to 9999

Ocean Optics QE Pro Hamamatsu S7031-1006S Detector

Specification	Value
Dimensions (mm)	182 x 110 x 47
Detector	TE Cooled, 1044x64 element CCD array
Detector range (nm)	185 – 1100 nm
Dynamic range:	
Typical	~85000:1
Single Integration Period	85,000:1(min)
100 Averages	850,000:1(min)
10,000 Averages	8,500,000:1(min)
Readout Noise	2.5 counts RMS (typical)
Corrected linearity (%)	0.5% nonlinearity (max)
Pixel size (µm)	1024 active
Integration Time	8 ms – 60 minutes
Signal to noise ratio	1,000:1 (typical)
Operating Temperature	0 – 50° C
Temperature stability	<0.1° C

Ocean Optics HL-2000 Halogen Light Source with Attenuator and TTL-Shutter

Specification	Value
Dimensions (mm)	58 x 59 x 140
Wavelength range (nm)	360–1700
Stability (%)	0.5
Drift (%/h)	<0.1

Bulb life (h)	2000
Bulb color temperature (K)	3,000
Operating temperature (°C)	5°–35
Operating humidity (%)	5–95 at 40°C

Ocean Optics Multi-LED BluLoop Light Source

Specification	Value
Dimensions (mm)	62 x 66 x 150
Wavelength range (nm)	395 - 750
Stability (%)	< 0.15%
Time to Stabilize (min)	15
Drift (%/h)	<0.01%
Bulb life (h)	>10,000
Bulb color temperature (K)	3,000
Room temperature (°C)	5°–35°
Operating humidity (%)	5–95 at 40°C
Lamp Power (W)	<12

Ocean Optics ISP-30-6-R-GT Integrating Sphere

Specification	Value
Body diameter (mm)	59
Body height (mm)	58 (plus trap)
Specular Trap	Yes (SCE measurements)
Aperture (mm)	10
Internal Surface	PFTE
Spectral Range (nm)	200-2500
PFTE reflectivity	>98% (400-1500 nm) >95% (200-2500 nm)
Fibre-optic connector	SMA 905

Acuity AccuRange 700 Triangulating Laser Displacement Sensor

Specification	Value
Laser (nm)	670 nm
Resolution	±0.03% of full scale
Operating temperature (°C)	0–60
Linearity/accuracy (%)	±0.2

Software

Open the SHMSL application by double-clicking the icon on the desktop (Figure 2, below). The application will begin by initializing the Acuity AR700 laser, the Bartington MS2K point source susceptibility probe, and the Ocean Optics QE Pro spectrometer. Ask the PP Tech for assistance in changing the instrument's measurement parameters (see [Setting Measurement Parameters](#)). Once initialized, the logger is ready to measure a section.



Figure 2. IMS Icon

The **Main Integrated Measurement System (IMS)** control screen provides access to data acquisition functions and utilities as well as:

Current measurement parameters

- Program state and system status
- Sample information
- Real-time data display during collection

The IMS immediately initializes the system hardware (Figure 3): the track system is initialized first, finding the home position for the Y- and then the Z-axes. Following that, the laser displacement sensor, magnetic susceptibility probe, and spectrometer are initialized (Figure 4).

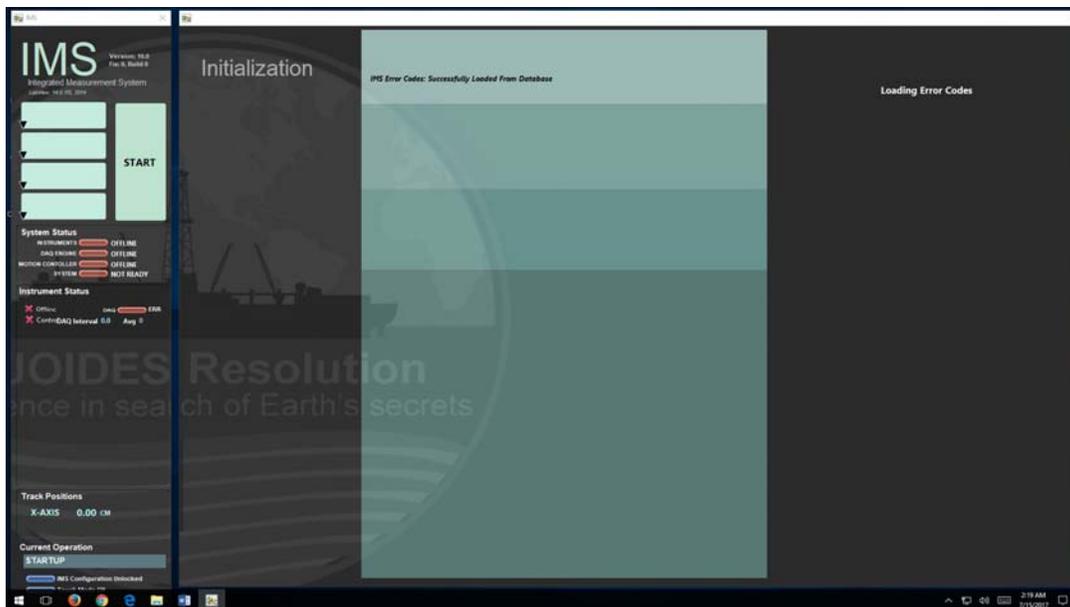


Figure 3. IMS Initialization

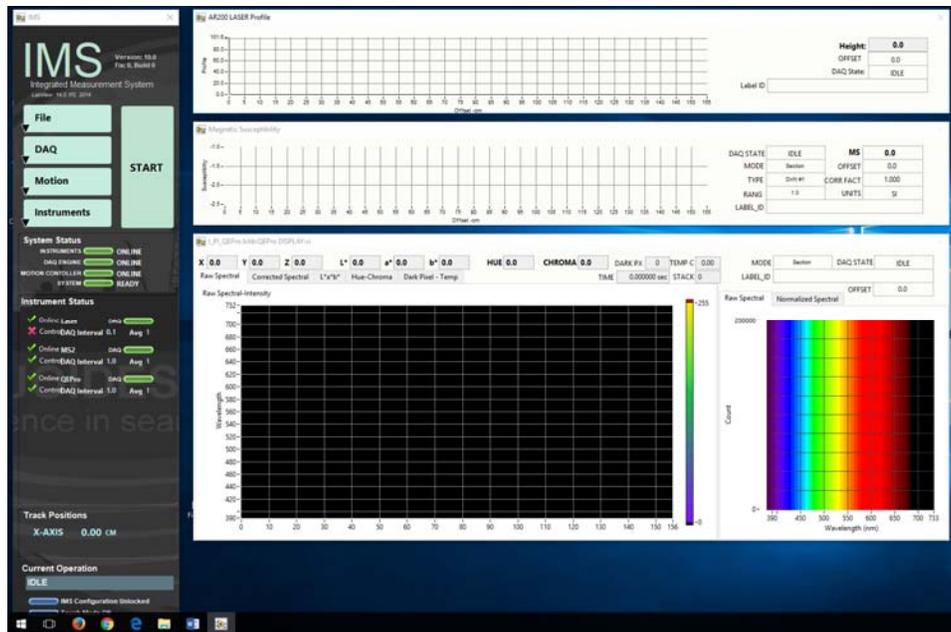


Figure 4. IMS Application Main Screen.

Laboratory Apparatus

- GLAD® Plastic Wrap (crystal clear polyethylene)

Note: This analysis requires clear polyethylene film such as GLAD® Wrap. Other types of plastic wrap (e.g., Saran Wrap™) will not serve.

Standards

Color Reflectance

- Labsphere, Inc. Spectralon® white standard, certified at 99% reflectivity
- Labsphere, Inc. diffuse color reflectance targets:
 - Grayscale: 99%, 50%, 20%, 2% reflectance
 - Color: Red, Orange, Yellow, Green, Cyan, Blue, Purple, Violet

Magnetic Susceptibility

- The MS standards are used to check for drift, not to calibrate the meter or sensor. The JRSO puck is used to check drift instead of the Bartington standard because it is less sensitive to centering the sensor.
- Bartington-issued MS puck (note: user must center this standard carefully to get the correct reading)
- JRSO-created verification puck ($\sim 48 \text{ Si} \times 10^{-6}$; mounted on track)

Setting up the Instrument Sensors

This section is for advanced users only!

Each instrument sensor is set up through **Instruments > Sensor Name > Setup** (Figure 5). The parameters discussed in this section are common for all sensors on the SHMSL.

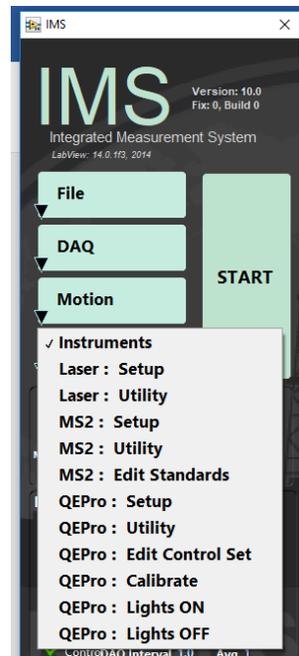


Figure 5. Setup Instrument Sensors

Instrument offset: track position of the laser where the center of the sensor is over the benchmarks zero edge.

Sensor/Contact width: physical width of the sensor that makes contact with the core's surface.

Analysis name: LIMS analysis component (must match LIMS component exactly).

Instrument group: LIMS instrument group logger name (i.e., SHMSL).

Model: model name of the sensor (from manufacturer).

S/N: serial number of the sensor (from manufacturer).

Menu name: value that appears as the instrument's menu name.

Full name: value that appears in instrument dialog boxes.

Description: instrument purpose; used in the *System Information* report.

Setting up the MS2K Parameters

As shown in Figure 6, below, the following parameters should be set:

General section

- **Range:** 1 or 10; **must** match the MS2 meter front panel setting!
- **Units:** set to SI per IODP standard practice. Do not use the cgs setting!

Calibration/Control section (Fig. 6, grayed-out portion)

- **Standard name:** standard's LIMS label_ID component value.
- **Text ID:** standard's LIMS text_ID component value.
- **Standard's value:** Value established by IODP is 48 +/- 2 SI
- **Standard X-offset:** track position (X-axis) of the laser when the center of the MS sensor probe is over the center of the standard.
- **Standard Y-offset:** lift position (Y-axis) when the MS sensor probe is in contact with the standard.

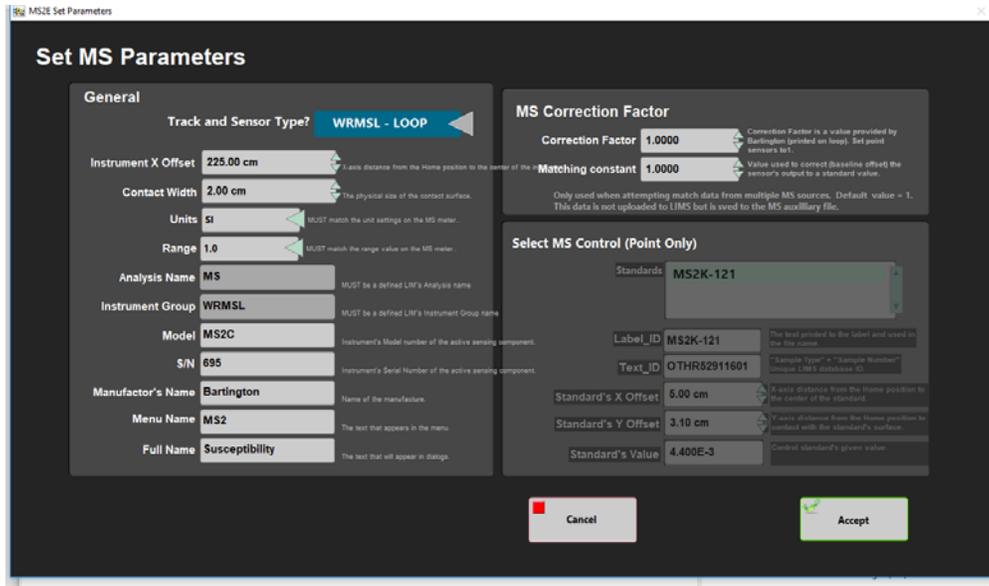


Figure 6. MS2K Parameters

Magnetic Susceptibility Utility

The SHMSL software also has a utility feature (shown in Figure 7, below) that allows the user to test the MS performance. The MS utility allows the user to zero the meter and to set it to continuous measurement.

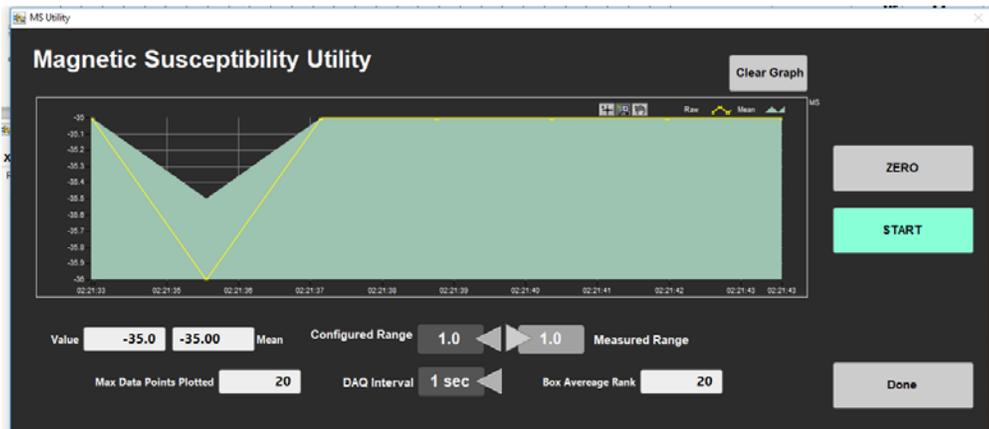


Figure 7. MS2K Utility

Setting up the QE Pro parameters

Parameter Setup Screen

The Ocean Optics QE Pro spectrometer can be set up using the screen shown in Figure 8.

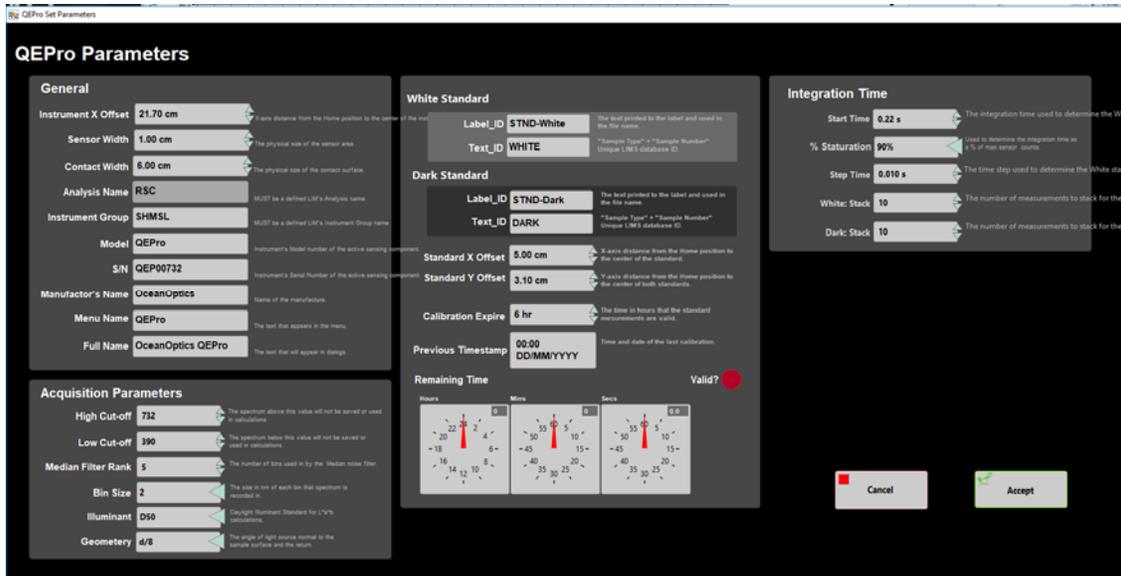


Figure 8. QE Pro Sensor Setup

Fixed Acquisition Parameters section

- **Hi cut-off** and **Low cut-off**: determine region of interest (ROI) in the spectrum.
- **Bin size**: width of each channel.

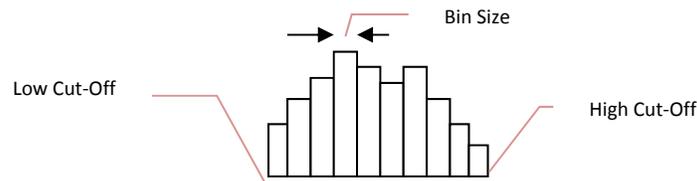


Figure 9. Illustration of high and low cut-off and bin size.

- **Median filter rank**: number of adjacent channels used to filter noise from the signal.
- **Illuminant**: = D65; International Commission on Illumination (CIE) standard illuminant used in color calculations (also called daylight illuminant).
- **Geometry**: = d/8; references integration sphere measurement technique: illumination from a diffuse light source viewed 8° from normal (d/8); includes a gloss trap to exclude spectral reflections.
- **Observer**: = 10 Degree-2; indicates usage of CIE 1965 standard function in tristimulus calculations.

Temperature Section

- **Current temperature**: temperature of the spectrophotometer
- **High-temperature threshold**: set the alarm level during calibration; based on experience, 30°C is appropriate. Higher temperatures allow signal deterioration.

Integration time section

- **Integration time**: time the CCD is exposed; if too short, noise will be high; if too long, the sensor will saturate and clip data.
- **% saturation of the total response**: used by WHITE calibration to determine sample integration time by calculating the integration time required to reach the specified saturation (70%–95%). Note: if cores are light colored, increase throughput by using a low saturation level; if cores are dark colored, use a high saturation level to improve signal-to-noise ratio.

- **Starting integration time:** beginning time (in seconds) value for WHITE calibration; set to 0.5 for new bulbs and up to 1 for aged bulbs. This setting has no effect on data from subsequent measurements.

White and Dark calibration Section

- **White standard name:** LIMS label_ID component value (STND-White).
- **White standard LIMS Text ID:** LIMS text_ID component value (WHITE).
- **White standard X-offset:** track position (X-axis; in cm) of laser when the center of the integration sphere sensor is over the center of the white standard.
- **Dark standard name:** LIMS label_ID component value (STND-Dark).
- **Dark standard LIMS Text ID:** LIMS text_ID component value (DARK).
- **Dark standard X-offset:** track position (X-axis; in cm) of laser when the center of the integration sphere sensor is over the center of the dark standard.
- **Standard Y-offset:** lift position (Y-axis) when the integration sphere is in contact with the White or Dark standard (same value for both).
- **Calibration expire:** time in hours between calibrations.
- **Current timestamp calibration:** date and time of last calibration (read only).
- **Remaining time:** time remaining until next calibration (read only).

Reflectance Utility

The software has a utility for the QE Pro that allows the user to run instantaneous or continuous measurements of the spectrum being acquired by the spectrometer. Different spectra (e.g., light standard, dark standard) can be overlaid and the user has a number of other options, as shown in Figure 10.

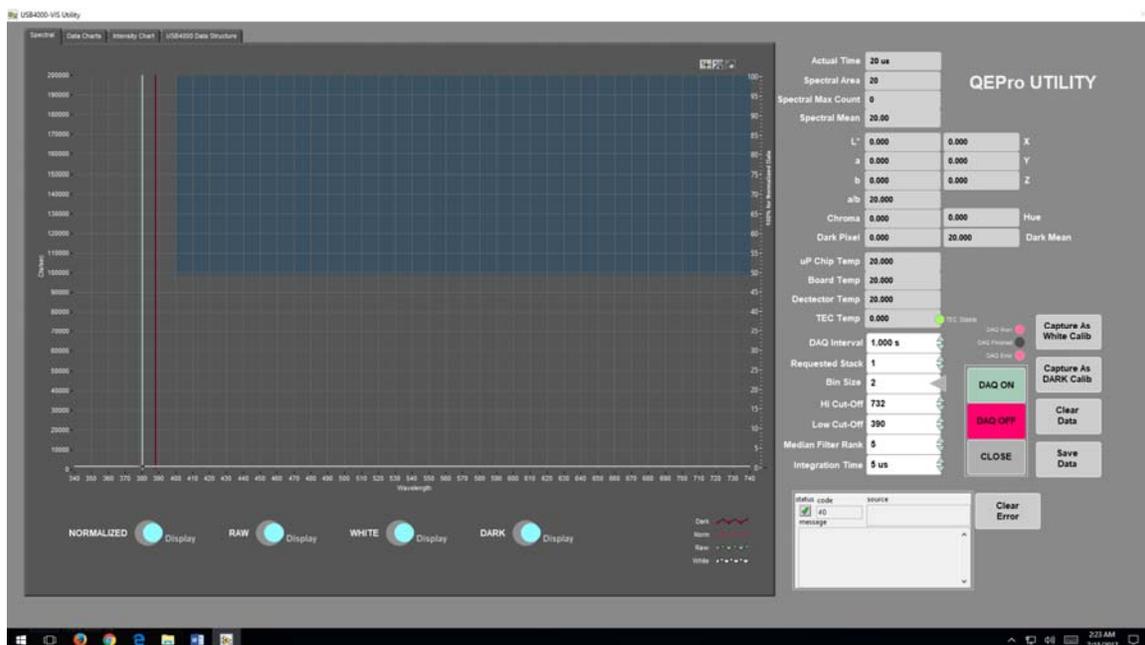


Figure 10. QE Pro Utility

Reflectance Standard Set Editor

The standards used for the calibration of the QE Pro (99% white Spectralon® standard and the “dark” standard, achieved by turning off the lights) are defined using the tool shown in Figure 11. **Do not use this screen if you are not trained!**

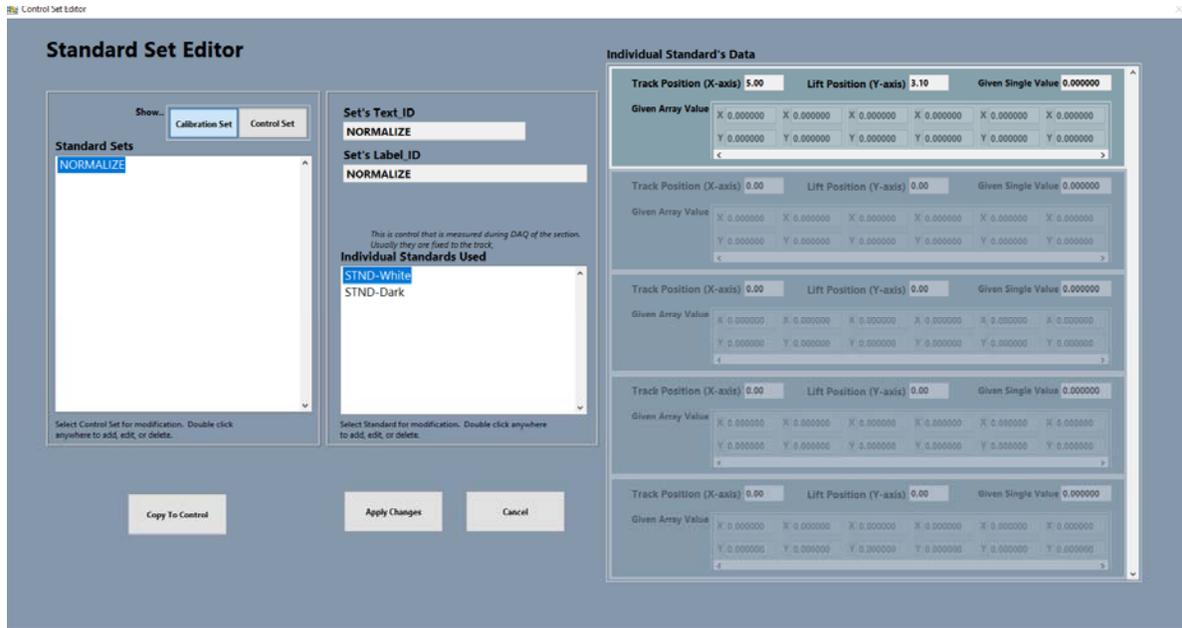


Figure 11. QE Pro Standard Editor

Setting the AR700 Parameters

The AR700 parameters are metadata and do not have an effect on the measurements. Their nominal values are shown in Figure 12.

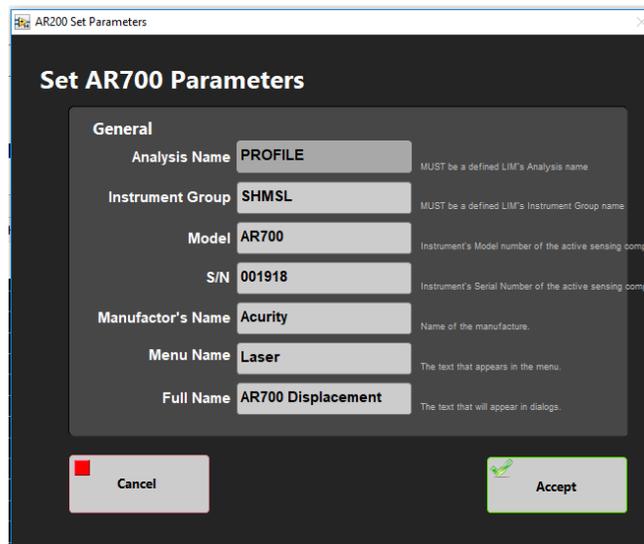


Figure 12. AR700 Sensor Setup

The AR700 configuration screen, shown in Figure 13, show the options available for the laser. These parameters are loaded to the AR700's on board memory and their values are returned in the AR700 Config Report panel (lower left). The utility can also be used to measure distances of a known metric to ensure that the laser is returning true distance values.

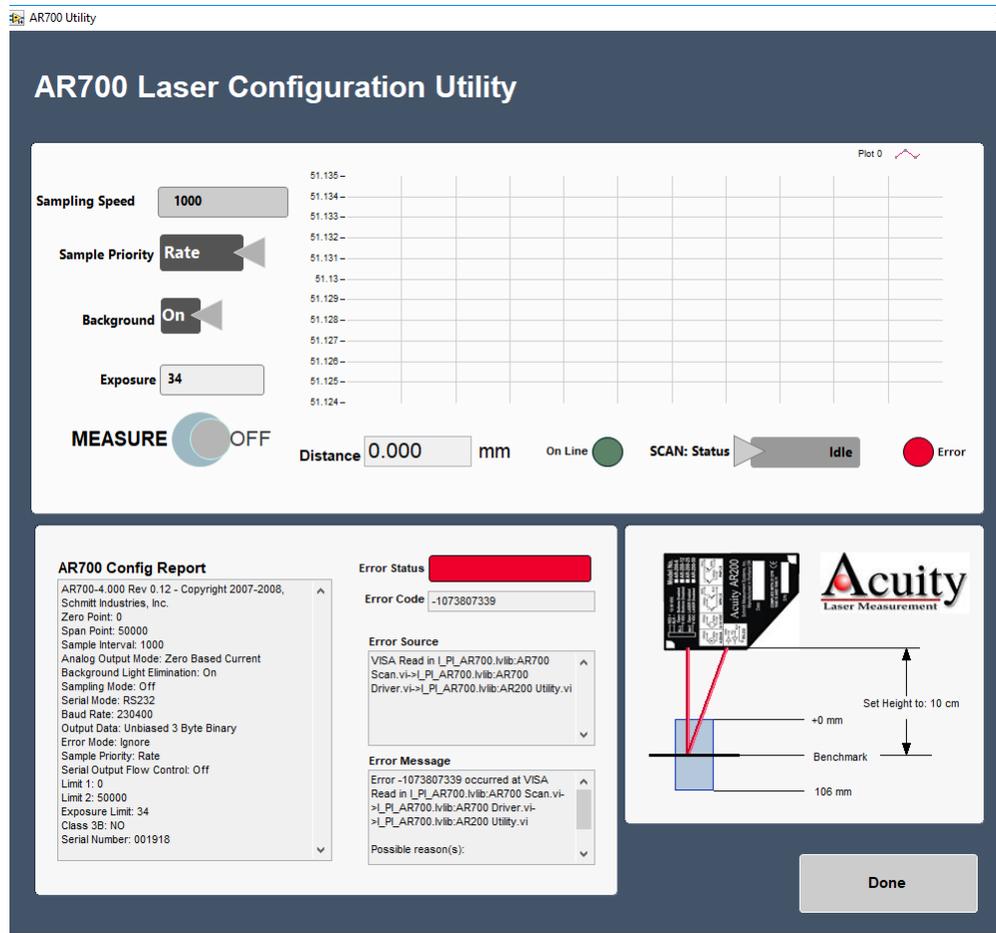


Figure 13. AR700 Configuration

Setting up the M-Drive Motion Control

This section is for advanced users only!

1. To access the motion controller setup window, select **Motion > Setup** (Figure 14).



Figure 14. M-Drive Motor Control

From the M-Drive Motion Setup window (Figure 15, five setup panels can be accessed:

- Track Configure: Motor and Track Options
- Track Configure: Limit and Home Switches
- Track Configure: Fixed Positions
- Motion Profiles
- Y-Axis Setup

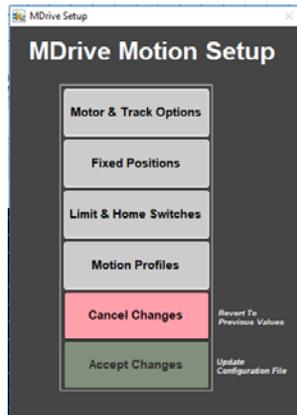


Figure 15. M-Drive Motion Controls

Track Configure – Motor and Track Options

Before using this panel you should be familiar with the M-Drive hardware and command manuals. Values 1 thru 4 (shown in Figure 16, below) are used by IMS to set motion controller parameters and convert encoder pulses into \pm position values in centimeters. The correct settings for the SHMSL are as follows:

X-Axis Track Motor Setup Settings

- Encoder Pulses/rev: 2048
- Screw Pitch: 2.00000E+0
- Gear Ratio: 4.00000
- Direction of Positive Motion: CCW for positive encoder counts

Y-Axis Track Motor Setup Settings

- Encoder Pulses/rev: 2048
- Screw Pitch: 1.00000E+0
- Gear Ratio: 1.00000
- Direction of Positive Motion: CW for positive encoder counts

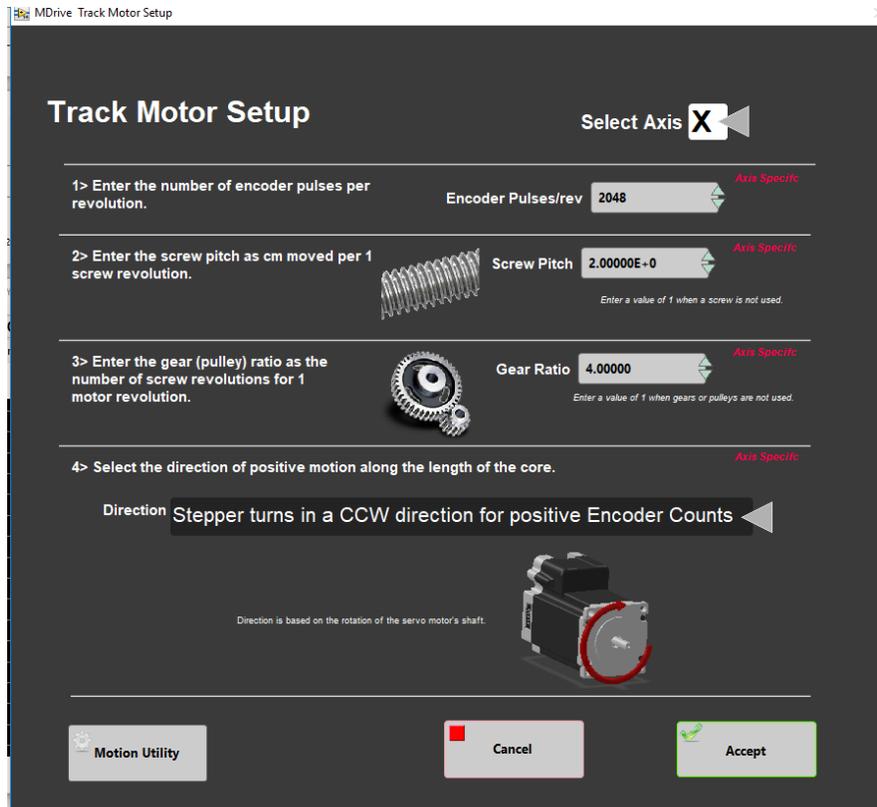


Figure 16. Track Motor and Options

Once these values have been properly set you should never, never have to change them. This panel is only used for the initial setup.

Track Configure – Fixed Positions

The screen shown in Figure 17, below allows the user to configure the fixed positions of the track and the limit switches. The correct values are as follows for each axis:

X-Axis Fixed Position Settings

- Max Section Length: 160.0 cm
- Track Length: 200.0 cm
- Load Position: -4.0 cm
- Unload Position: 170.0 cm
- All “PUSH Track Only” settings = OFF (or 0.0, as appropriate)

Y-Axis Fixed Position Settings

- Max Section Length: not configurable for this axis
- Track Length: not configurable for this axis
- Load Position: -3.0 cm
- Unload Position: -3.0 cm
- All “PUSH Track Only” settings = OFF.

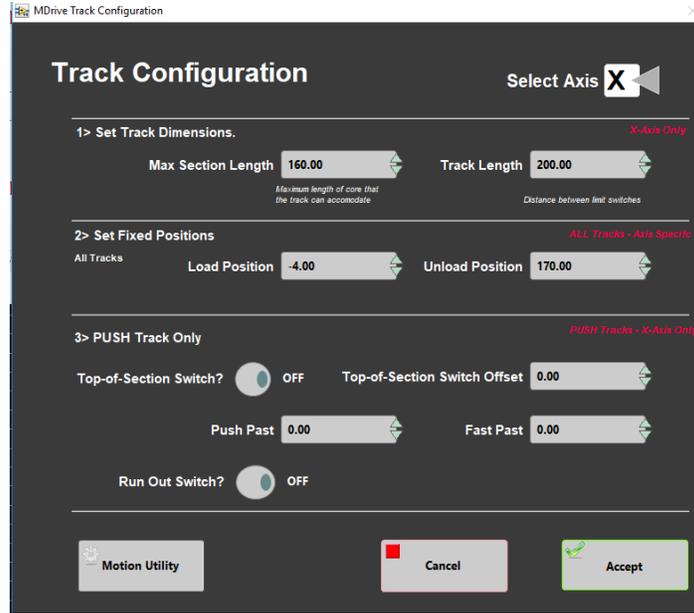


Figure 17: Track Configuration

Track Configure – Limit & Home Switches

The screen shown in Figure 18 allows the user to configure the motion logic of the track. The SHMSL X-axis (down-core motion) and Y-axis (vertical sensor motion) are configured using this screen. As shown, the X-axis is “CW Look @ CCW Edge” logic (the first option). The Y-axis is “CCW Look @ CCW Edge” logic (the third option).



Figure 18. Limit and Home Switch Configuration

Track Configure – Motion Profile

The following table shows the motion profile settings for the SHMSL X and Y axes controlled by the interface shown in Figure 19, below.

Axis →	X-Axis			Y-Axis		
Profile ↓	Speed	Accel.	Decel.	Speed	Accel.	Decel.
DAQ Move	5.0	30.0	30.0	3.0	5.0	5.0

Limit Seek	3.0	10.0	80.0	3.0	10.0	80.0
Home Final	0.5	2.0	80.0	1.0	10.0	80.0
Load/Unload	15.0	10.0	10.0	10.0	5.0	5.0
Top/Profile	5.0	30.0	30.0	N/A	N/A	N/A
User Defined	5.0	5.0	5.0	N/A	N/A	N/A
Lift-Up	N/A	N/A	N/A	5.0	5.0	5.0
Lift-Down	N/A	N/A	N/A	3.0	5.0	5.0
Lift-Down Slow	N/A	N/A	N/A	1.0	5.0	5.0

Table: Motion Profile by Axis for SHMSL

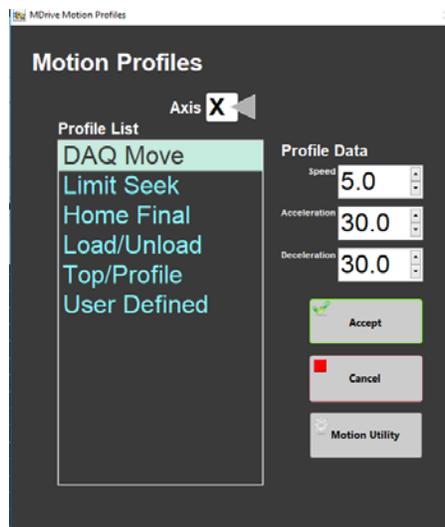


Figure 19. Motion Profiles

Y-Axis Setup

Y-Axis Setup is found in the DAQ menu option as shown in Figure 22, below. The Y-Axis setup is used to define the working distance for the AR700 laser. The screen shown in Figure 20, below, shows a typical set of standoff values for the various parameters, but if anything is changed on the Y-axis mount, these values should be determined experimentally.

- To determine the distance to benchmark, click the “Get Benchmark Data” button. This value is normally between 46.1 to 46.5 mm.
- The Touch Down Offset value is 3.80 cm.
- The Safe Clearance value (usually set to 1.0 cm) is used to prevent the sensors from running into something (e.g., a tall rock piece) that is higher than the section half liner.
- The Touch Compression value (usually set to 0.5 cm) is used to push downward gently after the landing to flatten the sensors against the core section.

Note: For very soft sediments, it may be necessary to set the Touch Compression to 0.0 cm.

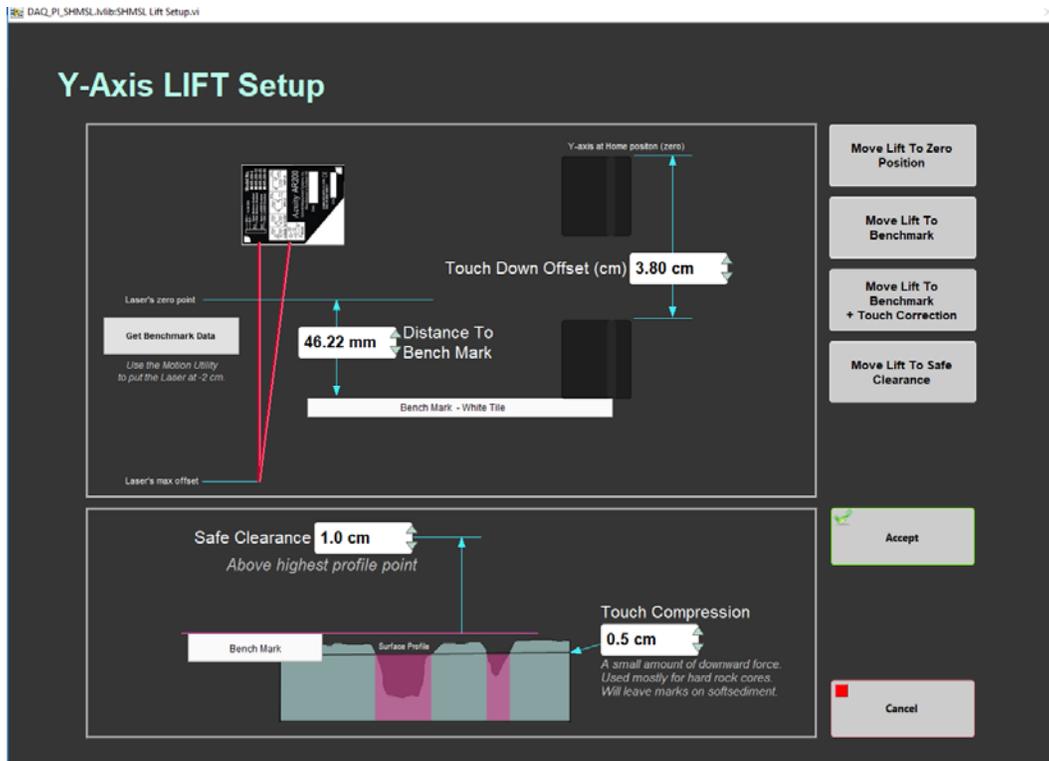


Figure 20. Y-Axis Lift Setup

Setting Measurement Parameters

This section is for advanced users only!

Before measurement parameters can be set or changed the IMS must be unlocked. *Note: Changing setup parameters can cause problems. Make sure you know what you are doing before changing any setup parameters.*

Under **File**, select **Unlock Setup** as shown in Figure 21 below, then have the laboratory specialist type the unlock code into the keypad window (Note: this only has to be done if the setup has been locked, it usually remains unlocked).

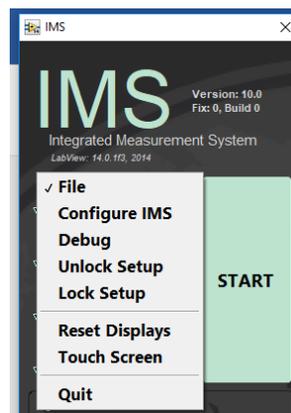


Figure 21. IMS Control

To open the measurement editor, select **DAQ > Measurement Editor** as shown in Figure 22.

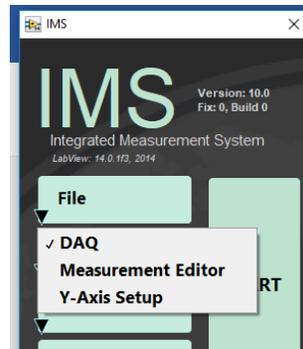


Figure 22. DAQ Control

Measurement Editor

In the **Measurement Editor** window, loaded instruments are shown in the **Select Instrument** fields. Click on an instrument to see its measurement parameters in the **Instrument Parameters** field.

Click the **Instrument Parameters** window to open the editor for that instrument. This will invoke the screen shown in Figure 23.

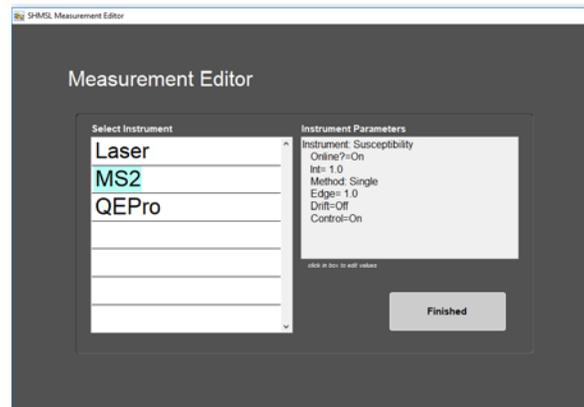


Figure 23. Measurement Editor Screen

The MS2K and QE Pro have similar editor screens (Figures 24 and 25, respectively). From each screen you can set the following parameters:

Interval (cm): set to 0.1 to 20 cm; intervals for both the MS and reflectance should either be the same or multiples of one another and whole number divisors of the distance between the sensors. If they are not whole number divisors, an inefficient landing schedule will be developed, taking much longer to analyze a core section.

Edge (cm): how close to measure to an edge (top and bottom of a section as well as edges of voids within the section). The distance is measured from the center of the sensor (MS2K sensor width = 4 mm or 10 mm, depending on orientation; QE Pro sensor width = 8 mm). Edge width = 1.0 cm works well.

Control (on/off): whether to measure a mounted control standard at the end of every section measurement.

Online (on/off): set the instrument online or offline.

MS-Specific Parameters

Average: (MS parameter only) number of measurements to take at each position (averaged for the final reported value).

QEPro-Specific Parameters

Method: this is a selector between single or stacked (average) measurements.

Stack #: set the number of measurements to stack and average.

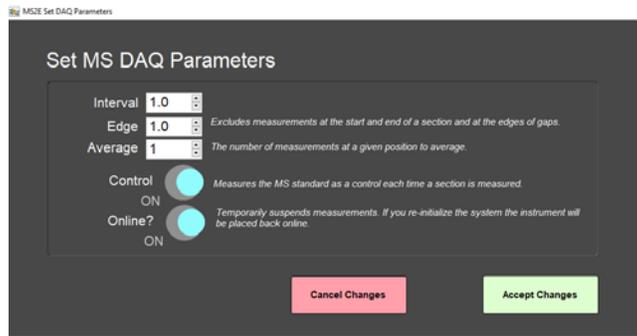


Figure 24. MS2K Measurement Parameters

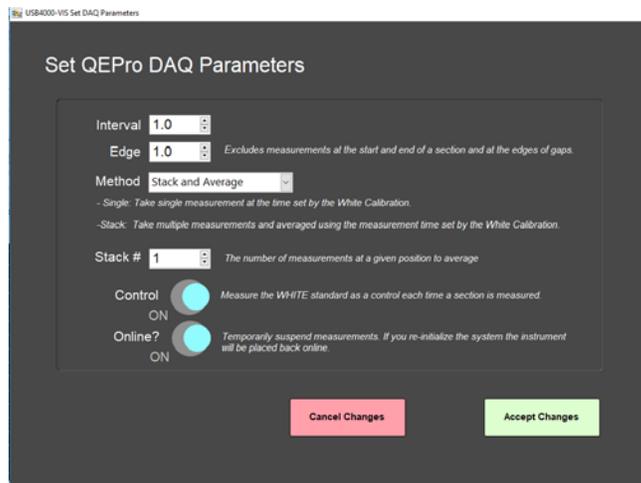


Figure 25. QE Pro Measurement Parameters

Click **OK** to save settings to the instrument configuration file and return to the **Measurement Editor**.

Only one parameter can be set for the laser, and that is **Gap Detection Offset** shown in Figure 26. This is the height below the benchmark which will be tagged by the system as a gap and will therefore not be measured. For piston cores, the recommended gap offset should be set to 10 mm or less. For hard rock cores, the gap offset should be set between 20 and 30 mm.

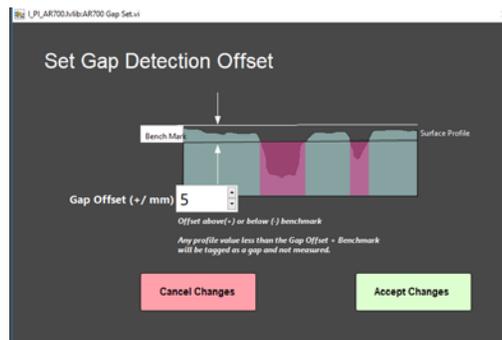


Figure 26. Gap Detection Offset

Running Samples

Core-half sections are measured on the SHMSL as soon as possible after splitting so that drying and oxidation do not affect ephemeral sample properties such as color reflectance. Sample preparation includes scraping to clean the core surface and covering wet core samples with plastic wrap to prevent contamination of the contact sensors (see Figure 33, below, but note that the sample must be laser-profiled before the wrap is applied).

Preparing Samples

1. Use a spatula or smear slide to clean the cut surface of the core by lightly scraping away any material that was smeared across the surface during core splitting.
2. Bring the endcap of the section half (usually A for archive half) to be measured to the SHMSL. Use the endcap rather than the label on the bottom of the section to scan the barcode for sample information, to prevent accidentally dropping the section half.
3. Place the archive section in the core tray with the blue endcap up against the benchmark. The benchmark is the white square at the head of the rails that hold the section halves (Figure 27).

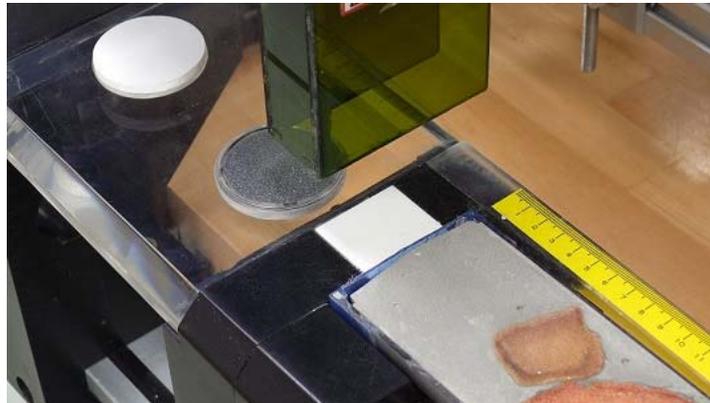


Figure 27. Benchmark

4. Adjust the section so that it is as flat as possible with respect to the plane of the benchmark. There is a limit to how much the sensor heads can float when they land on a tilted section.
5. **Do not wrap the cores yet.** The Acuity AR700 laser cannot reliably see through the plastic to measure an accurate profile of the section half surface.

Measuring Samples

1. Click the **Start** button (Figure 28) to open the *Section Information* screen (Figure 29).

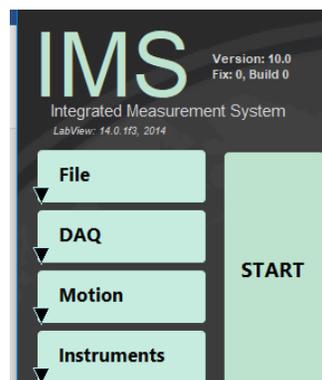


Figure 28. Start Scan

Figure 29. Section Information Screen

- Place the cursor in the **SCAN** text field (circled in black in Figure 29, above) so that the barcode information will be parsed appropriately. Pull the trigger on the barcode scanner; at the beep, the information will automatically fill for Expedition, Site, Hole, and so on.
- (Optional) Enter any comment needed into the **Comment** field.
- If material is missing from the top of the section, enter the distance in the **Missing Top** field (circled in red in Figure 29, above).

Note: If material is missing at the top of the section, be sure the section half is positioned all the way up to the top of the rail. The software will add the missing top interval to all of the measurements in the database. For example, if a 150 cm section half has a missing 10 cm at the top, the yellow endcap should be placed against “0 cm” at the top of the instrument’s rails. The user should enter 10.0 in the **Missing Top** (cm) field. The logger will measure the section, and all measurements will be placed at the correct offsets in the database.

- Additional intervals can be specified for omission from measurement by clicking the **Exclude Interval** button (top left of Figure 29, above). Enter the top and bottom offsets of the areas to be excluded during the measurement pass as shown in Figure 30. The excluded intervals apply to all enabled sensors.

Enter Intervals To Exclude

	TOP	BOTTOM
1	0.0	0.0
2	0.0	0.0
3	0.0	0.0
4	0.0	0.0
5	0.0	0.0
6	0.0	0.0
7	0.0	0.0
8	0.0	0.0
9	0.0	0.0
10	0.0	0.0
11	0.0	0.0

You may enter interval data in any order.

Skip intervals will be combined with gaps detected by the laser to exclude measurement positions for all sensors.

max position = 155cm

Clear Interval

Clear All

Accept

Cancel

Next
Additional Rows

Figure 30. Exclude interval

- When the required minimum sample information has been entered, the **Measure** button becomes active. Click it to start the measurement. If the QE Pro does not require calibration (see Calibrating the Sensors, below), proceed to the next step.
- The sensor assembly will move down the track while the laser acquires a profile of the split surface of the section. When the software has detected a gap, it will indicate regions that will not be measured by the MS and reflectance sensors on the screen in red.

Note: (Gap detection parameters are configurable; ask the PP tech for assistance in modifying them.)

Acquisition of this profile is why the section is not yet wrapped in plastic wrap—sometimes the laser will profile the wrap rather than the sediment beneath it and give incorrect heights to the gap detection routine.

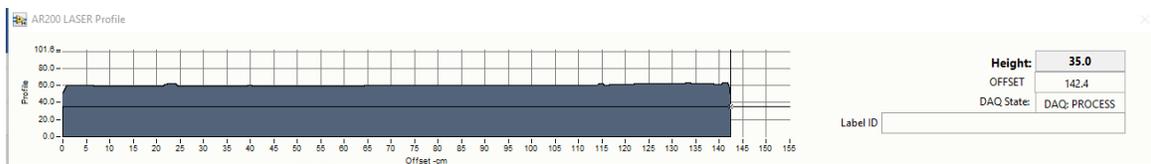


Figure 31. Laser Profile

- After the surface profile is completed, the measured section length as determined by the laser is displayed (Figure 32). Apply GLAD® Plastic Wrap to the surface of sediment cores as demonstrated by the PP Tech (Figure 33). Adjust the displayed length if needed in the **Scan Length** field and click **GO** to start the section measurement.

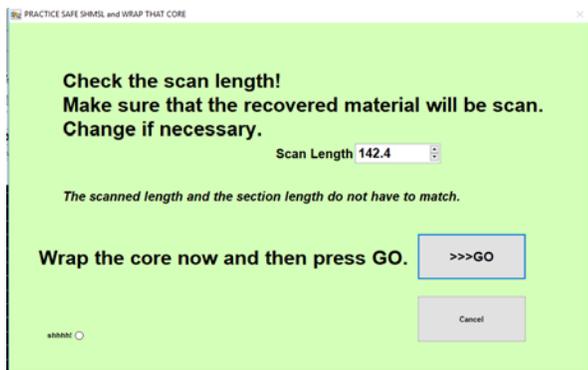


Figure 32. Final Sample Preparation

IMPORTANT!!! Before pressing GO, it is necessary to cover the core section with GLAD® Plastic Wrap in order to avoid damage to the integration sphere. Any mud that gets inside the sphere will ruin it!

IMPORTANT! Do not cover the standards with GLAD® Plastic Wrap; they will give erroneous results if you do.

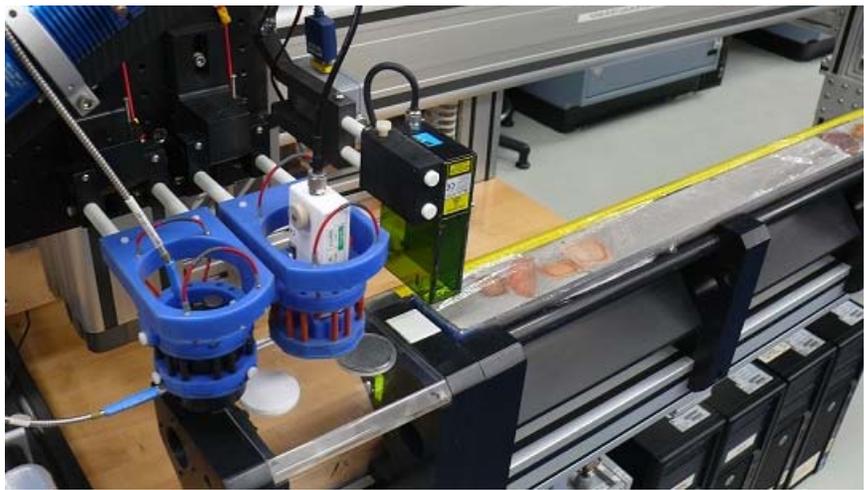


Figure 33. Wrapped Sample Ready to Analyze.

5. The measurement sequence begins. For efficiency, measurements begin at the bottom of the section and move upcore. Results are displayed during acquisition on instrument graphs on screen. Note that the QE Pro has several tabs that display different views of the color reflectance data. Tabs can be changed during the measurement sequence. The **Normalized Spectra** tab shows the corrected percent color reflectance being measured at each point.

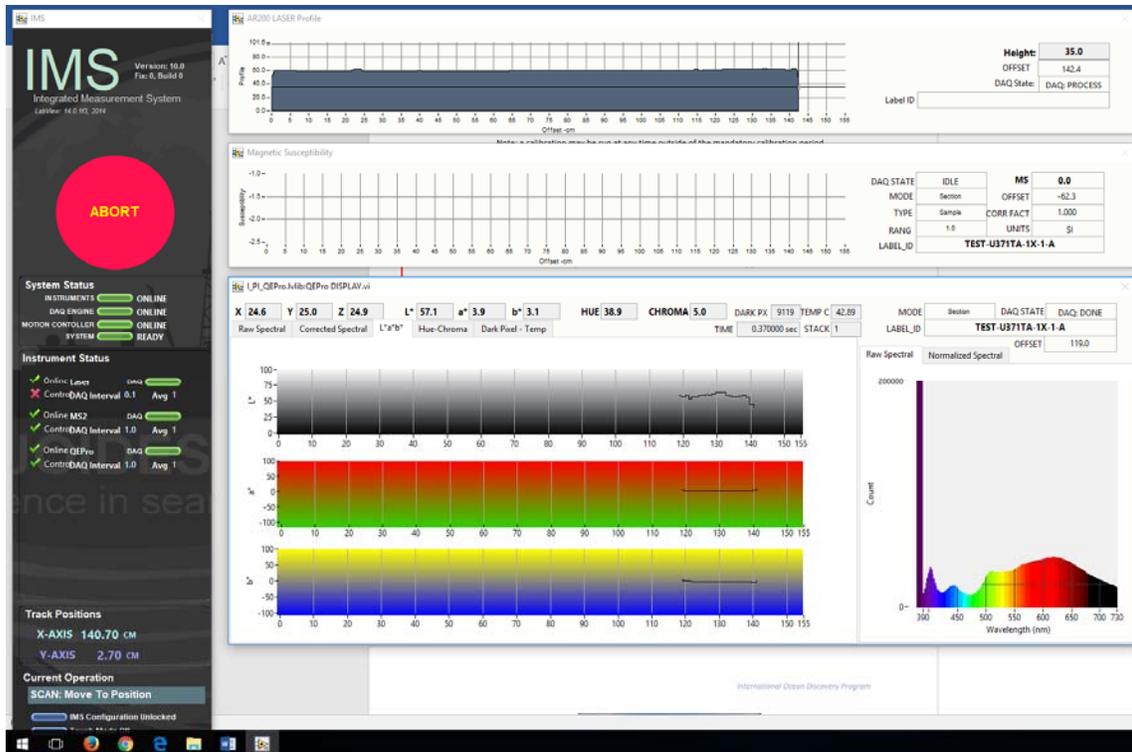


Figure 34. Data Acquisition Screen

- After the section has been measured, the logger takes measurements using the MS2K and WHITE standards as check standards if the control sample measurement was set up in the measurement parameters.

Calibrating the Sensors

Before running the first sample, the software will check the status of each instrument's calibration. If any instrument needs calibration, a prompt will appear listing out of date calibrations. It is recommended that the user select every instrument that needs calibration and click the **Calibrate** button before continuing. There is an option to ignore one or all calibrations (click **Cancel**), but the calibration list will reappear with every run until the calibrations are completed and data run without a calibration update will be flagged as **calibration invalid** in LIMS.

Color Reflectance Spectrophotometer (Auto Calibration)

The color reflectance spectrophotometer calibrates on two spectra, pure white (Spectralon® WHITE standard) and pure black (DARK standard – lights off), mounted in the track's bench. Color calibration is required approximately every 6 hours. The control program will notify when calibration is due and automatically open the **Calibrate** routine.

Note: a calibration may be run at any time, even if the mandatory period has not elapsed.



Figure 35. WHITE Spectralon® Calibration Standard

1. If the QE Pro is out of calibration, the **Instrument Calibration List** screen will appear.
2. Before beginning the calibration, ensure the WHITE standard is clean (Figure 35). If the Spectralon® standard appears even the least bit gray or discolored, contact the technician to clean or replace the standard! It may be useful to compare a clean, new piece of white paper to the standard—if the paper seems whiter, the standard is quite dirty!
 - a. The Spectralon® standard can be cleaned according to the Spectralon® Reflectance Standards Care and Handling Guidelines, found in the Cumulus database under SHMSL>Diffuse Color Standards.
3. Click the **Calibrate ALL CHECKED Instruments** button to begin the calibration process. The logger moves the QE Pro integrating sphere over the WHITE calibration standard and lowers the sensor until it touches. The sensor takes some preliminary measurements to establish the integrating time based on an 80% saturation level of the total response (see Figure 36, below). These measurements take about 0.30 to 0.55 seconds for the current dual-light source configuration, assuming the bulbs are new.

Note: If integration times increase to more than 1 second, alert the IODP technician. The halogen bulb or the LED source may need replacing.

4. Click **Accept** to accept the suggested integration time. The logger will then take 20 measurements of the WHITE standard at the calculated integration time. On the screen (Figure 37):
 - **Max Counts:** current highest value
 - **Target Counts:** percent saturation value as set in the instrument parameters (range = 32,000 counts)
 - **Integration Time:** measurement period where the highest wavelength count is equal to or exceeds 80 percent of the spectrophotometer's range.



Figure 36. White Calibration Screen

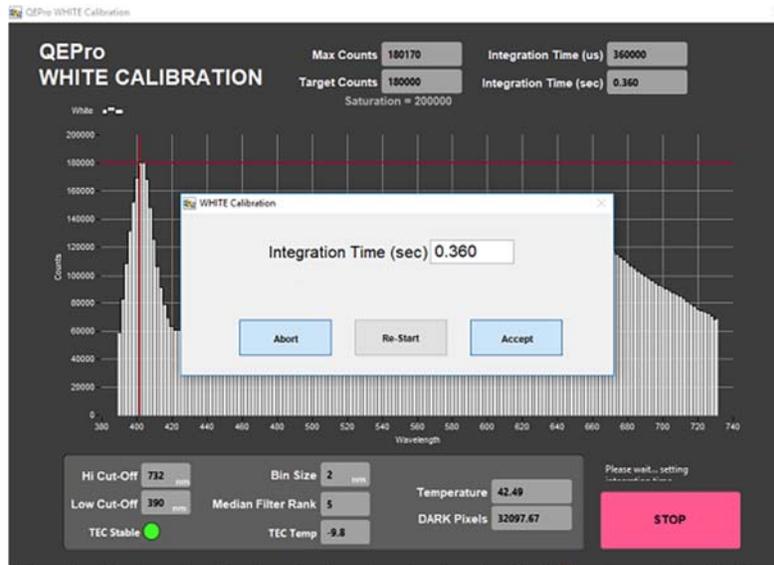


Figure 37. Integration Time

5. After the WHITE measurements are completed. The shutters on the light sources will close and the DARK measurement will acquire 20 measurements. The dark measurement is a baseline measurement that includes thermal noise of the system. On the screen (Figure 38):

- **Temperature:** should remain below 50°C; note that the TEC temperature is usually about -9°C (accessed through the QE Pro Utilities screen).
- **Spectral Mean:** mean of the entire spectrum (at the line across the display plot). This should be only about 200 counts higher than the Dark Pixel count. With plastic wrap, it should not exceed 500 counts.
- **Dark Pixels:** 20 pixels that have been deliberately masked to allow no light. These counts represent the thermal noise of the spectrophotometer.

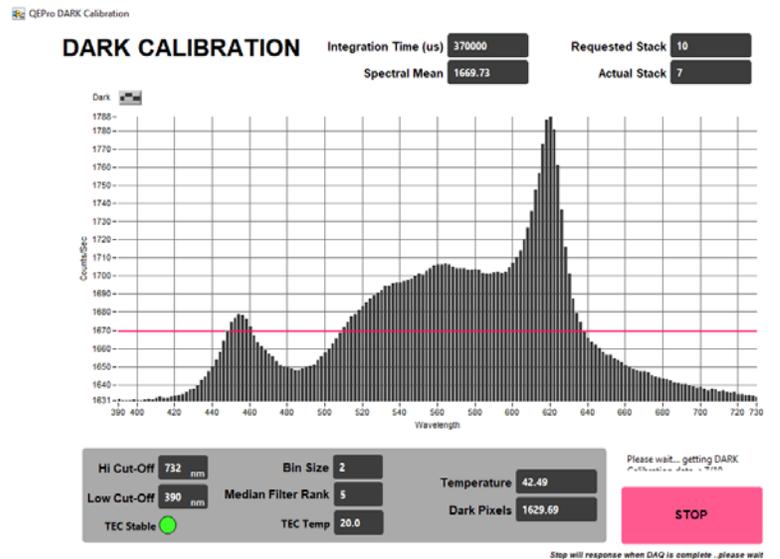


Figure 38. DARK Calibration Screen

6. The final screen shows the normalization of spectra that will occur with the just-acquired calibration (note: low values are better than high values because of signal-to-noise ratio). Ideally, the graph would display a straight line at zero value. However, a normalization factor is required to be applied to the XYZ and $L^*a^*b^*$

color indexes. Normalization amplifies the noise as well as the signal. If core flow allows, the data quality can be increased by averaging multiple measurements (in **Measurement Editor** increase the **Average** parameter).

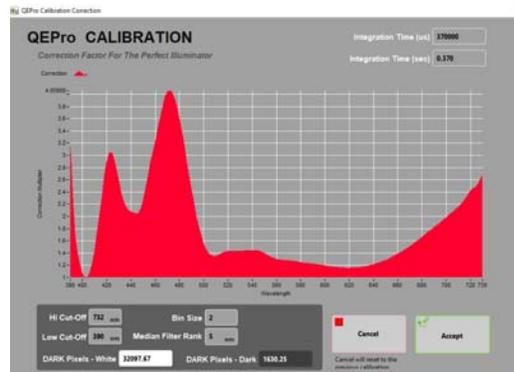


Figure 39. Calibration Normalization Factor

7. If this was a mandatory calibration the laser profile will start automatically, followed by the normal measurement sequence.

Spectrophotometer (Manual Calibration)

To perform calibration manually (not when specified by the software), follow these steps:

1. From the Main control screen, select **Calibration > Calibrate**. Follow the instructions on the screen.
2. Continue from Step 3 in Auto Calibration

Point Magnetic Susceptibility Meter

The point magnetic susceptibility meter is calibrated by the manufacturer (Bartington, Ltd.). The probe is zeroed in air before the core section is measured, so drift is not a significant factor. It is not necessary to calibrate the MS2K or MS2E probes (or the MS2C loops on the whole-round loggers), but the calibration check standard can be used to demonstrate consistent results.

Sensor Calibration Triggers

1. **Time:** Calibration expiration time can be set in the **Instrument Setup** screens. Calibration expiration can be set from 1 to 24 h (default = 6 h). The time trigger is independent of number of samples run.

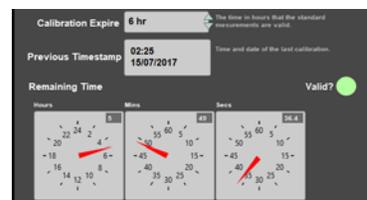


Figure 40. Calibration Time Trigger

2. **Core number or section number change:** Set this option in **Track > Calibrate Setup**.
3. **Manual override.**

Data Handling

After the core section has been measured, the software generates the following files/reports, which are uploaded into the LIMS upon acceptance (see LIMS Integration):

C:\data\IN

- Section half L* a* b* and XYZ data
- MS2K check standard result
- MS2K (MSPOINT) data file
- QE Pro white check standard result
- Laser profile file

C:\AUX_DATA\PROFILE

Laser profile data in 0.1 mm steps

C:\AUX_DATA\RSC\CALIB

White and Dark calibration spectral data per wavelength (380–900 in 2 nm steps)

C:\AUX_DATA\RSC\CNTRL

Raw spectra and normalized (% color reflectance) spectral data per wavelength (380–900 in 2 nm steps) for the white check standard at the end of a run

C:\AUX_DATA\RSC\RUN

Raw spectra and normalized (% color reflectance) spectral data per wavelength (380–900 in 2 nm steps) for the measured section

Quality Assurance/Quality Control

Analytical Batch

The analytical batch is defined by the number of samples run between each spectrometer calibration. Each sample in the batch run with the current calibration is associated with that calibration data in the LIMS. If a calibration problem is discovered, all samples in the batch can be identified and rerun.

Accuracy

Magnetic Susceptibility

Measure a well-characterized magnetic susceptibility control sample and compare results with true value and/or whole-core track results.

Reflectance

Measure a second standard, standard reference material, or characterize a material in-house to use as a control. Measuring the BCRA-calibrated tiles ensures the desired accuracy is being maintained. This should be done periodically throughout each expedition.

Precision

Run samples or standard reference materials more than once (separate measurement runs) and calculate the standard deviation. This should be done every ~20-section halves allowing for a comparison between runs and estimation of uncertainty based on precision.

LIMS Integration

LIMS Components

Results are stored in the LIMS database associated with an analysis code and an analysis component. Analysis codes and their components and units are listed below.

Magnetic Susceptibility

Analysis	Component	Definition	Unit
MSPOINT	comment	User entered comment	None
	config_asman_id	ASMAN ID number of configuration file	None
	config_filename	ASMAN filename of configuration file	None
	instrument_group	Logger sensor is mounted on	None
	magnetic_susceptibility	Magnetic susceptibility of sample	SI x 10 ⁻⁶ (unitless)
	offset	Offset of measurement on section half	cm
	run_asman_id	ASMAN ID number of runtime file	None
	run_filename	ASMAN filename of runtime file	None

Color Reflectance Spectrophotometry

Analysis	Component	Definition	Unit
RSC	calibration_valid	Y or N Boolean for valid calibration	None
	chroma	Chroma value of sample in hvc notation	None
	cielab_a_star	a*	None
	cielab_b_star	b*	None
	cielab_l_star	L*	None
	comments	User-entered comment	None
	config_asman_id	ASMAN ID number of configuration file	None
	config_filename	ASMAN filename of configuration file	None
	geometry	d/8 specular component excluded (SPE)	None
	hue	Hue value of sample in hvc notation	None
	illuminant	Illuminant standard used	None
	instrument_group	Logger sensor is mounted on	None
	observer	Observer geometry used	None
	offset	Offset of measurement on section half	Cm
	rsc_norm_asman_id	Normalized (percent reflectance) spectral file ASMAN ID	None
	rsc_norm_filename	Normalized (percent reflectance) spectral file name	None
	rsc_raw_asman_id	Raw spectral file ASMAN ID	None
	rsc_raw_filename	Raw spectral file name	None

run_asman_id	Runtime file ASMAN ID	None
run_filename	Runtime file name	None
sample_time	Spectral acquisition time	ns
tristimulus_x	Tristimulus X value of sample	None
tristimulus_y	Tristimulus Y value of sample	None
tristimulus_z	Tristimulus Z value of sample	None

Uploading Data to LIMS

As with most laboratory data, uploading SHMSL data to the LIMS database is executed via the **MUT** application. Look for an icon on the bottom menu of the Desktop (shown by the red triangle below in Figure 41) or the more prominent “Puppy” MUT Icon (usually on the Desktop). Double-click on one of these application launchers.



Figure 41. MUT Icons

The user must log in using database credentials to use MUT. Once the application is activated, it displays a table-like list of files in the C:\DATA\IN directory as shown in Figure 42, below. Files are ready to be uploaded if they have a green check mark next to them.

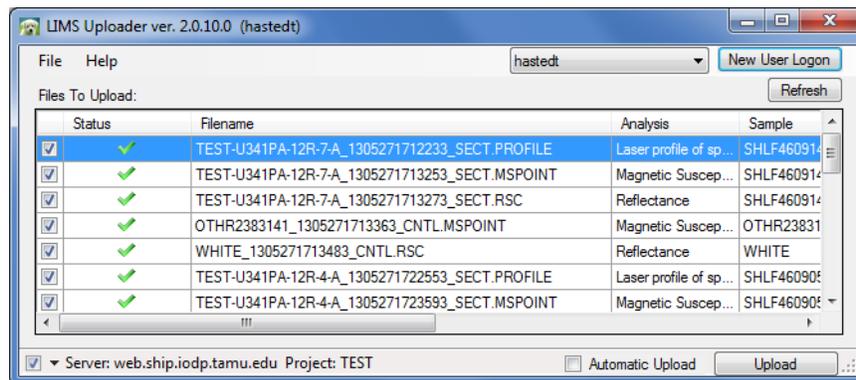


Figure 42. SHMSL MUT Screen

Once the **Upload** button is clicked or the **Automatic Upload** option is checked, files will be transferred to the LIMS database via MUT and then moved to the *archive* folder. The presence of files in the *Archive* folder is the indication that they have been uploaded to the database.

- Purple question marks on files in MUT indicates that MUT cannot identify them.
- Red and white X icons on files in MUT indicate errors associated with the files.

Please ask a technician for help if you see these indications.

Data Management

Once all sections for the Expedition have been sent through the track, all data needs to be placed in the appropriate folders on data1 (S:\data1). **Be sure to include AUX_DATA.**

1. Copy RSC files from archive and place them in the 7.1 Petrophysics SHMSL – RSC reflectance spectrophotometry colorimetry folder. Confirm relocation. Delete all RSC files off the local drive.
2. Copy MSPOINT files from archive and place them in the 7.2 Petrophysics SHMSL – MSPOINT point susceptibility folder. Confirm relocation. Delete all MSPOINT files off the local drive.
3. Copy PROFILE files from archive and place them in 7.3 Petrophysics SHMSL – PROFILE split section surface profile folder. Confirm relocation. Delete all PROFILE files off the local drive.

Health, Safety, & Environment

Safety

- Keep extraneous items and body parts away from the moving platform, belt, and motor.
- The track system has a well-marked emergency stop button to halt the system if needed.
- Do not look directly into the spectrometer light source.
- Do not look directly into the laser light source.
- Do not attempt to work on the system while a measurement is in progress.
- Do not lean over or onto the track.
- Do not stack anything on the track.
- This analytical system does not require personal protective equipment.

Pollution Prevention

This procedure does not generate heat or gases and requires no containment equipment.

Waste Management

Dispose of soiled GLAD® Plastic Wrap in an approved waste container.

Maintenance/Troubleshooting

Common Issues

Problem	Possible Causes	Solution
MS sensor: baseline drift	Temperature variations	Ensure operating temperature is constant and preferably cool
		Make sure samples have equilibrated to room temperature
MS sensor: systematic offset from MS2C data	MS2K/MS2E zeroing environment not the same as that for the samples	Check that the zeroing height is roughly equivalent to the height of a sample, and that no large metal objects have been introduced to the area
MS sensor: reading fluctuations greater than ± 1 least significant digit	External electrical noise	Check the operation area for: <ul style="list-style-type: none"> - large ferrous objects - heavy electrical machinery - radio frequency source devices
Track is “stuck”	Gantry flag has tripped the end-of-travel limit switch	Adjust gantry flag and run sample again
	Current limit on motors was exceeded	Check the motor for LED error indicators. Call PP tech or ET to reset motor controller

	Torque limit on motors was exceeded.	Call PP tech or ET to reset motor controller
	Power supply <i>voltage</i> too low	Call PP tech or ET to check power supply input voltage
RSC values nonsensical/too bright	Ambient <i>light</i> level too high	Reduce ambient light level/ensure integration sphere makes flat contact with sample
Laser sensor: no laser light/no laser range data	Configuration data lost	Press function button to restore factory default configuration
	Calibration data lost	Contact manufacturer
Laser sensor: LED flashes continuously at 1 Hz	Laser configuration incorrect	Call PP tech or ET to reset laser sensor

Scheduled Maintenance

Daily

- Keep contact sensors and laser window clean by wiping with a Kimwipe.
- If necessary, use isopropyl alcohol to remove soil from sensors and laser window.
- Do **not** use **any other solvent!**

Annually

- Remove the end covers on the linear actuators and check if the motor belts need tightening.
- Examine the cable management system for abraded cables or other indications of wear.
- Remove the top covers of the linear actuators and check the ball screws to see if they need cleaning or additional lubrication.

When Needed

- If the reflectance standard becomes nicked or soiled, it can be smoothed, flattened, and cleaned.

Vendor Information and Part Numbers

Reflectance Spectrometer

Vendor

Ocean Optics, Inc.
www.oceanoptics.com
info@OceanOptics.com
 727-733-2447

Parts:

Spectrometer: PN QE PRO
 Light source: PN HL-2000-FHSA or HL-2000-FHSA-LL
 Spare bulb: PN HL-2000-B or HL-2000-LL-B
 Reflectance standard: PN WS-1-SL

Magnetic Susceptibility Meter

Vendor:

Bartington Instruments, Ltd.
www.bartington.com
sales@bartington.com
 44-1993-706565

Parts:

Meter: PN MS2
Sensor: PN MS2K

Laser Displacement Sensor

Vendor:

Acuity Laser Measurement
www.acuitylaser.com
702-616-6070

Parts:

Sensor: PN AR200

Related Documentation and Links

- AccuRange 700 laser displacement sensor data sheet: ar700-data-sheet.pdf
- Acuity Laser Measurement User Manual: ar700-users-manual.pdf
- Ocean Optics Halogen Light Source Operation Manual: hl2000fhsa.pdf
- Ocean Optics Fiber Optic Spectrometer Operation Manual: USB4000operatinginstructions.pdf
- Microscan MS-4 Ultra-Compact Imager data sheet: ms4spec.pdf
- Bartington MS2 Magnetic Susceptibility sensors data sheet: MS2 sensors D50020.pdf
- Bartington MS2 Magnetic Susceptibility system operation manual: OM0408 MS2.pdf
- “Environmental Magnetic Susceptibility Using the Bartington MS2 System”: OM0409 J_Dearing_Handbook_iss7.pdf
- Hunt, R. W. (1998). *Measuring Colour* (3rd ed.). England: Fountain Press. [ISBN 0-86343-387-1](https://www.fountainpress.com/ISBN-0-86343-387-1). See pgs. 39–46 for the basis in [human eye](#) physiology of three-component color models, and 54–57 for chromaticity coordinates.
- Hunter Lab application note Vol 8. No. 1 http://www.hunterlab.com/appnotes/an04_96a.pdf