AROMETRIX

AROMETRIX USER MANUAL

for Firmware Version 1.2.3

YOU MUST READ THIS MANUAL BEFORE USE

WARNING: NEVER LOOK DIRECTLY INTO THE LIGHT SOURCE

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IMPORTANT: Applications Other Than Short Path Distillation

The Arometrix system was designed initially for short path distillation. Thus, parts of this user manual may focus on how to operate the system for this distillation.

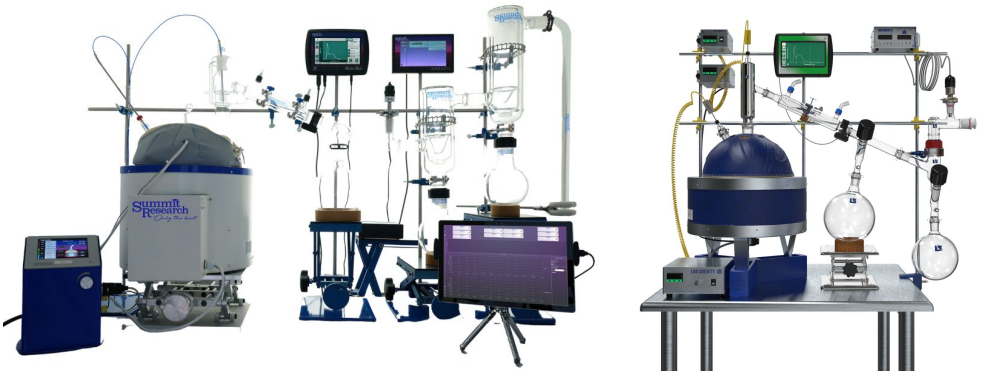
If you are using the system for another application -- including extraction, wiped film or thin film distillation, column chromatography, or conversion reaction -- please refer to our Application Notes on arometrix.com/resources, in addition to reading this user manual.

Section 1: Overview

The FRACTION FINDER is Arometrix's real-time molecular monitoring system for botanical processing. The technology utilizes fluorescence spectroscopy to detect and measure molecules in real-time. Knowing the flow and the relative concentration of botanical molecules, and whether that intensity is increasing, or decreasing can help operators make optimal process decisions. In our work, we found processors were proudest of their craft when they could get the purest, most consistent batches. It is with this goal in mind that the FRACTION FINDER was developed.

The ability to directly track molecules of interest during the process comes with a few key benefits:

- The data to improve purity and reduce by-products
- The information to improve process techniques and enhance process repeatability
- The ability to quickly train staff and have run traceability



What the FRACTION FINDER is not:

The FRACTION FINDER is not a quantitative measure. It provides qualitative process information that directly tracks the relative concentration of Cannabinoids. It is Arometrix's goal to amass enough spectral data from the FRACTION FINDER to eventually be able to determine quantitative purity in the ***future****.*

The FRACTION FINDER cannot replace good laboratory practice and experience. The FRACTION FINDER's data, in combination with temperature, vacuum, good laboratory practice, and experience will help technicians further perfect their craft.

Section 2: Fundamentals

The FRACTION FINDER is composed of two key components: the **sensor** and the **display**.

Sensor: The ***sensor*** contains the "eyes" of the system". The *sensor* is mounted on size 29 or 34 glass, depending on the sensor size option ordered. Adapters are also available to install the sensor on smaller glass, such as size 24 glass.

Display: The ***display*** contains the "brains" of the system. This 7 inch LCD TFT display consists of a compute module that creates a visualization for the user where both flow and relative potency are deduced. The *display* has a pole-mounting bracket installed in the back of it so it can easily be mounted to a lab pole.

Note: This unit is intended for lab use. Care should be taken not to spill anything on it, as it is not waterproof.

Section 3: Unpacking and Inspecting

After the instrument is received, it should be carefully unpacked and inspected for damage during shipment and to confirm that all components are present.

Each FRACTION FINDER comes with:

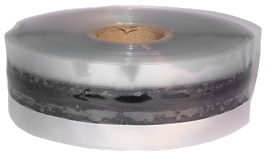
- Sensor *(Size 29 or 34)*
- Display
- Pole mounting bracket screw
- Sensor Cable, USB
- Light-Blocking Tape
- International Power Supply
- Adapter *(optional)*
- Warranty Card

Section 4: Installation

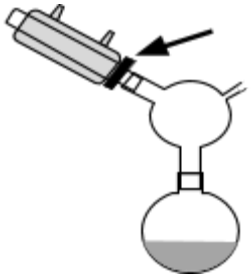
The equipment should be in a clean, dry environment for the best results. Care should be taken to avoid any spillage.

The Arometrix system was designed initially for short path distillation. Thus, the installation instructions in this standard user manual focuses on how to operate the system for this specific application. If you are using the system for another application, refer to our Application Notes on arometrix.com/resources.

1. Apply the ***light-blocking tape*** to the glassware apparatus, leaving an area for the sensor to be installed. This is important as it will block ambient light from saturating your sensor's readings.



2. Install the sensor ***with the thicker part of the sensor down***. The ***sensor*** should be installed on the condenser just before the cow as shown.
    (1) Having the glass be of high quality will help increase the signal to noise ratio – which will yield better information.
    (2) The sensor fits on most glass, but in some cases may require an adapter; visit our website.



3. Insert the ***sensor cable*** into the back of the ***sensor***.
4. Connect the other end of the ***sensor cable*** to the bottom of the ***display***. The ***sensor's*** light will begin to "blink", indicating that it has turned on. Give the sensor ~2-5 minutes to boot up.
5. Mount the ***display*** to a lab pole. The back of the display has a pole-mounting bracket pre-installed. Simply use the ***screw for the mounting bracket*** on the bracket to install and keep it snug on the pole. Alternatively, it can be placed on a desktop by placing the unit in a separate tablet stand.
6. Use the supplied AC adapter to power your display. This adapter provides clean short protected power to protect and ensure the accuracy of the internal circuitry.
7. The display will take a few seconds to turn. You will see splash screens, followed by the interface screen.
8. Ensure that the Device Status and Server Status indicator on the bottom left-hand side of the ***display*** are green – *If not, make sure the cords are properly connected.*
9. Ensure that the "Light On/Light Off" toggle button is turned on. The light above it should be green.

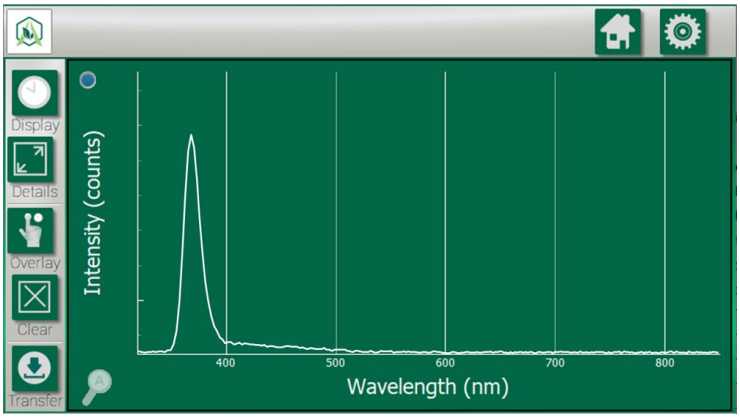
Section 5: Understanding the Interface

After installation, the system is ready for immediate operation.

Different Viewing Options

There are currently two viewing options: the ***Spectrum view*** and the ***Wavelength view***. These display options can be toggled between each other by tapping the "display" button (located in the top-left corner).

Spectrum View (Spectrograph)



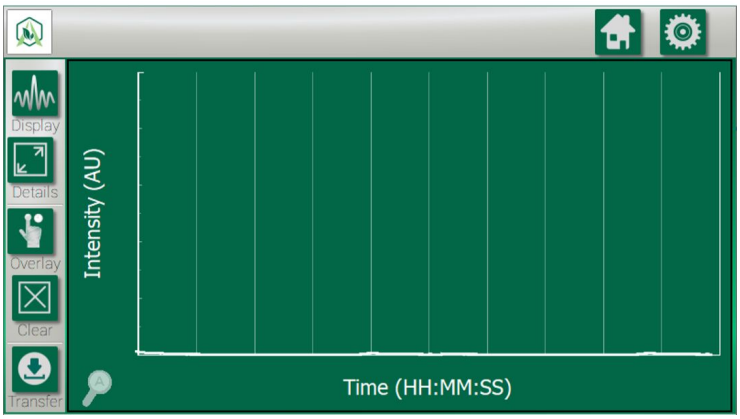
What it does: This is an instantaneous representation of the current spectral state. It displays the current background/ambient light corrected spectral measurement.

Important Note: The peak at 360-390nm is an internal excitation/reference peak (not a process indicator); tap the small circle on the top-left corner of the graph to remove this peak

Understanding the Graph (X-Y Axis)

- *X-axis = Wavelength (nm)*: The location of where the line shoots up (or fluoresces) indicates the molecule(s) passing through; different molecules have different wavelength regions
- *Y-axis = Intensity (counts)*: The height of this line, *in general,* indicates how much of that substance is present at that moment relative to earlier.

Wavelength View

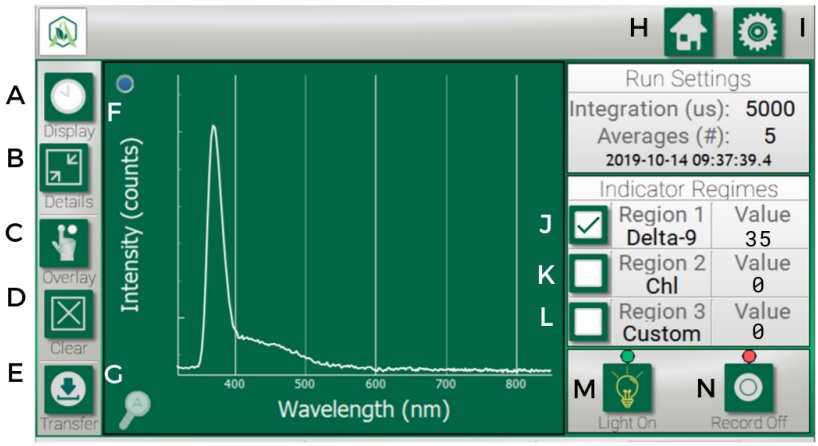


What it does: Displays and tracks the interpreted values from your measurement. This plot reduces the raw data and shows you the "highlights" of the run. This view is especially useful for tracking particular chemical oddities that occur at specific wavelengths.

Understanding the Graph (X-Y Axis)

- *X-axis = Time (HH:MM:SS)*: As opposed to the Spectrum view, this tracks fractions as a function of time.
- *Y-axis = Intensity (AU)*: The height of this line indicates how much of that substance is present at that moment relative to earlier. (*Note: These are AU as in Arbitrary Units; this is not quantification of potency.*)

Setup Screen Tutorial



List of buttons:

A. Display: Toggles between the two viewing options (Spectrum View & Wavelength View)
B. Details: Expands the graph and removes the data on the right-hand side
C. Overlay: Traces or "overlays" a peak of interest so you can compare it to a future peak
D. Clear: Clears an "overlay" that you no longer want to track
E. Transfer: Transfers recorded run data to a flash drive
F. Reference Peak Remover: Removes the internal reference/excitation peak from Spectrum view
G. Auto-Zoom: Returns zoom view to normal. You can zoom with 1 finger by drawing a bounding box.
H. Home: Returns you to the Home if you are in Settings
I. Settings: Allows you to adjust settings, such as Auto Integration Time, Scans to Average, and the Wavelength Tracker
J. Region 1-3 Checkboxes: For Wavelength View - By checking this box, it will populate the Wavelength plot with the corresponding molecule tracking. For Spectrum View - By checking this box, it will highlight the Spectrum plot with the region that molecule fluoresces at.
K. Region 2 Checkbox: *See I.*
L. Region 3 Checkbox: *See I.*
M. Light on/off: Turns the light on. This toggles between states.
N. Record on/off: Turns the recording mode on. This toggles between states.

Settings Tutorial

When you tap the *Settings* button, you will see:

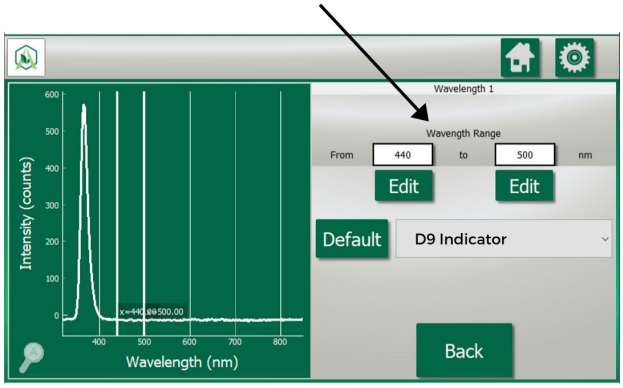
- Wavelength Settings
- Set Integration Time
- Set Scans to Average
- Clock Settings
- System Data

Wavelength Settings

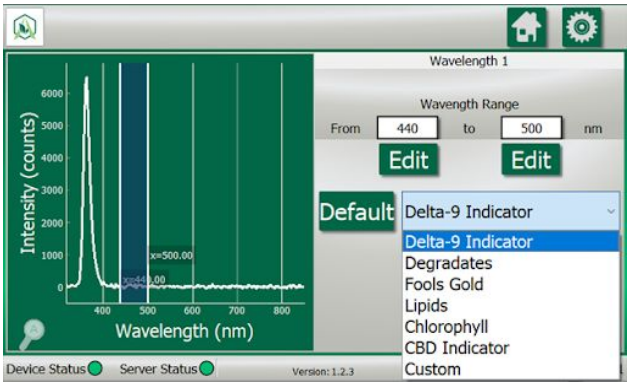
In this tab, you will see:

- Edit Wavelength 1
- Edit Wavelength 2
- Edit Wavelength 3

These correspond with the Region 1, Region 2, and Region 3 that are shown on the plots. When you press one of these, you will see a Wavelength range. These will come preset with manufacturer's defaults; however, you can edit the *From* and *To* how you see fit. *See below.*



Click "Default" to return back to manufacturer default. Next to the "Default" button, you will see a molecule dropdown. When you press the Molecule Indicator dropdown, you will see different molecule tracking options. You can select any of them, or set your own "Custom" molecule and region. *See below.*



Set Integration Time

This is meant to enable "AID (Auto)" by clicking the checkbox in the bottom-left corner of the screen. Auto integration ensures that the signal from the spectrometer is maximized. It is **not recommended** to manually tune Integration Time, but it is feasible. *See Appendix for more information on manual tuning.*

Set Scans to Average

This sets how many optical readings the sensor takes before plotting and displaying a result. More readings that are averaged imply less noise, but less information. Arometrix recommends that you select 5.

Clock Settings

This should be set during initial acquisition. Set the Date Settings and the Time Settings. Then, Submit.

System Data

This will display "Bytes Available", "Bytes Used", and "Bytes Total". It will also show you % memory used, and give you an option to "Clear Data".

Section 6: General Procedure for Short-Path Distillation

The Arometrix system was designed initially for short path distillation. Thus, the general procedure in this standard user manual focuses on how to operate the system for this specific application. If you are using the system for another application, please refer to our Application Notes on arometrix.com/resources.

Overview

1) Set Up Distillation System and Install Fraction Finder Equipment *(as detailed in **Section 4**)*
2) Set Integration Time to Auto
3) Set Scans to Average to 5
4) Identify Transition from Heads to Main Body
5) Perform Flask Transfer & Let Distillation System Equilibrate
6) Identify Transition from Main Body to Tails
7) Perform Flask Transfer & Let Distillation System Equilibrate
8) Turn off Recording

Step 1) Set Up Distillation and Install Fraction Finder Equipment

1) Set up your short path distillation system as you usually would initially
2) Follow all steps in *Section 4 Installation*
    a. Reminder: Ensure that the Device Status and Server Status indicator on the bottom of the ***display*** are green.
    b. Reminder: Ensure that the light is on. If the light is not on, turn it on and wait for the indicator light above the button to turn green.
3) Let the distillation system reach desired vacuum temperature and pressure

Step 2) Set Integration Time to Auto

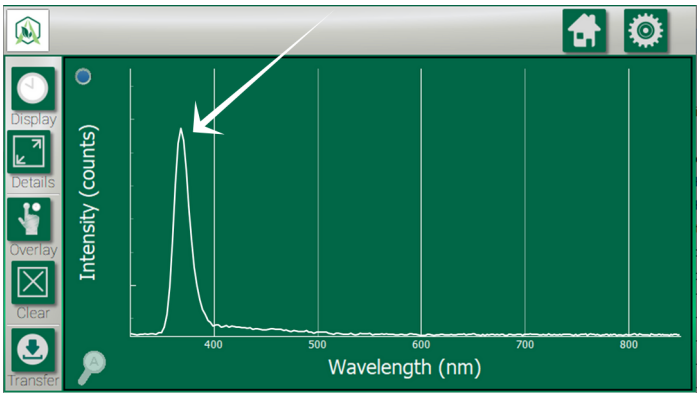
To set sensor ***Integration Time***: Tap the Settings gear icon. Tap "Set Integration Time". There is an AID (Auto) checkbox on the bottom-left corner of the display. Tap the checkbox - a check will appear, indicating that auto-integration determination has been enabled. This is *strongly recommended* as it will auto-determine an optimal integration time for the sensor throughout the entirety of the distillation. It is not recommended to manually tune Integration Time, but it is feasible. See Appendix.

Step 3) Set Scans to Average to 5

To set sensor ***Scans to Average***: Tap the Settings gear icon. Tap "Set Scans to Average". A typical value between 1 and 5 – It is strongly suggested that the scans to average is not set significantly larger than this value.

Step 4) Identify Transition from Heads to Main Body

While you are in "Heads", you should see **ONE** single peak at ~365 nm (x-axis) on the ***Spectrum view***. This is NOT a process indicator. This is the internal reference peak that the system uses.

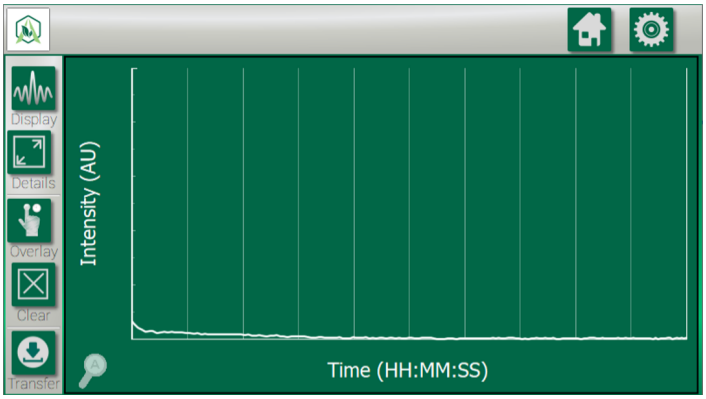


Note: Arrow on graph is for illustration purposes only.

Depending on the software version that you are using, this peak can be removed by tapping a small button on the display. **Once removed, during Heads, you should see NO peaks in the Spectrum view.**

However, if you see **MULTIPLE** peaks, this means that either: You have bad light contamination from lighting in the workspace (*Solution*: use the light-blocking tape) OR, if the peak is at 400-500 nm (x-axis value) the column is probably not clean and contains a contaminate from a previous distillation (*Solution*: Either stop the distillation and clean inside of glassware ***OR*** just make a note of it – it will likely be cleaned when the vaporized Heads flow through the column).

If you switch to the ***Wavelength view***, you will also see no fluorescence, as depicted in the image below.

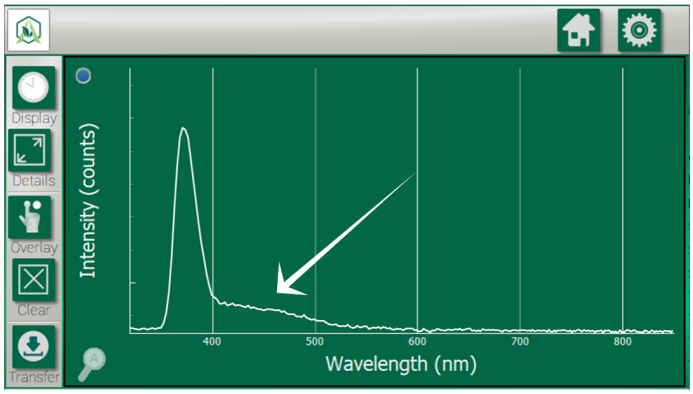


If you would like to Record your run, and export the run data afterward, now would be an optimal time to press the "Record" button. The circle above this button will turn green to indicate that it is recording.

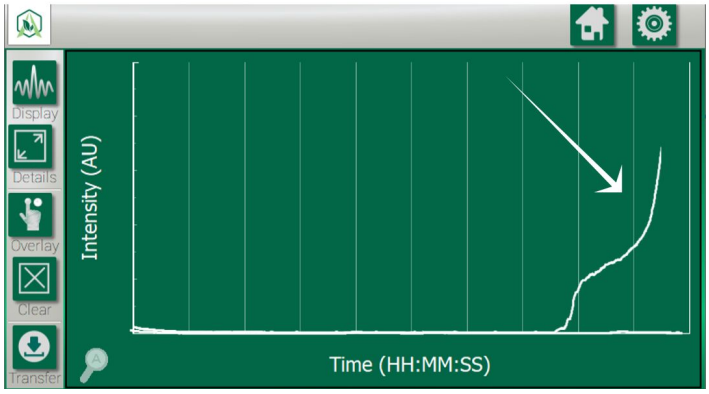
Prior to the Main Body fraction, you will likely see a signal at around 420 nm. This is what is referred to as "Fool's Gold". "Fool's Gold" is an unidentified species that looks gold in color. Due to its golden hue, during short-path distillation, it "fools" the operator to thinking that the desired Cannabinoid has appeared; but, in actuality, it is not. The wavelength region for "Fool's Gold" is 405 nm – 435 nm. The waveform for "Fool's Gold" is sharp. ***Refer to our Chemical Cheat Sheet for more information on this.***

For the actual Heads to Main Body Transition, there are two separate methods for identifying this:

Option A - Spectrum View: The other indicator is that a broad peak shows up in the Spectrum plot between 440-450nm. An example plot is shown below; keep in mind peak location and intensity may vary. See our "Chemical Cheat Sheet" to learn about where and how each molecule fluoresces on the unit. Arometrix recommends that you use the Spectrum plot for an absolute indicator of the Heads to main body transition.



Option B - Wavelength View: This view will show that there is a big peak in the value of the wavelength plot. An example plot is shown below. The Wavelength View is recommended to identify when the distillation is transferring from Heads to Main Body.



Step 5) Perform Flask Transfer & Let Distillation System Equilibrate

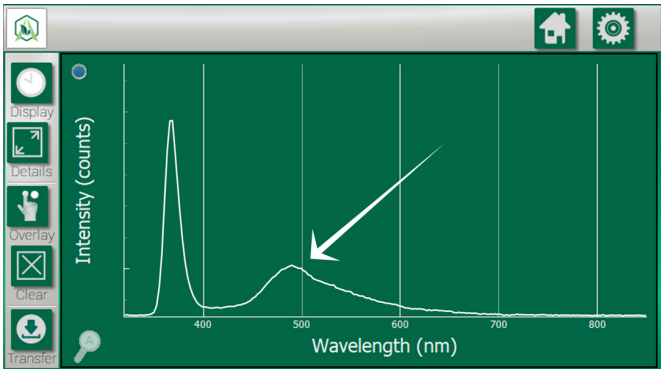
1) Once you've entered Main Body, proceed as you typically would with a flask transfer.
    a. It is advised that the Heads be allowed to distill for ~10 minutes before performing a flask to ensure that no solvents contaminate the Main Body.
    b. There is no need to turn off or hit the clear button on the FRACTION FINDER, unless you want to.
2) After flask transfer, let the system come to its equilibrated point (let pressure and temperature become relatively constant) before using the FRACTION FINDER
    a. Keep in mind that the signal will be very low and all ambient lighting effects will greatly increase
    b. Equilibration time will depend on system size. A 5L SPD can take 5-10 mins. A 10L SPD can be 10-15 minute. Mantle quality and pump quality are also factors for equilibration time.

Step 6) Identify Transition from Main Body to Tails

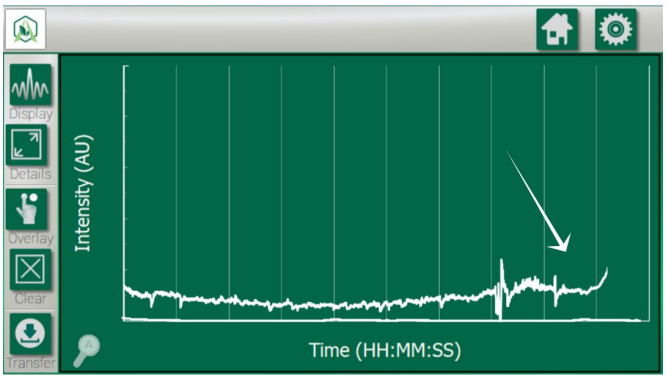
1) After 20 minutes from the flask transfer from Heads to the Main Body, the signal will become more stable
2) Check the Wavelength View
3) A sharp increase of the signal at the beginning will likely be shown, followed by a sharp drop-off of the signal to a stable moderate level
    a. This initial increase is very concreted Main Body initially coming through the system as well as any oxidized/degraded fluid that may have been generated during the vacuum release while performing a flask transfer
4) This signal will likely stay constant for the next 1 – 1.5 hours, then will slowly start to raise. An example plot is shown below.
5) The constant increase or significant increase of signal at this point indicates that the distillation may be entering Tails, but the signal also could vary slightly with:
    a. Significant changes in vacuum pressure
    b. Significant changes in flow rate
    c. Background light gets brighter
6) If a raise is observed that does not seem to track with the three outlined changes above, the distillation has entered Tails

For the Main Body to Tails Transition, there are two separate methods for identifying this:

Option A - Spectrum View: This view will show that there is a peak shift to the right, with the peak centered at around 490-510nm. An example plot is shown below. ***Note: Our "Degradates" indicator is equivalent to the Tails fraction. Refer to our Chemical Cheat Sheet for more information on this.***



Option B - Wavelength View: This view will show that there is a sharp increase in the value of the wavelength plot. An example plot is shown below. This view is recommended for this change, as well.



Note: Intensity and trends may vary. The important thing is the signal starts increasing.

Step 7) Perform Flask Transfer

Once the Tails are identified, perform a flask transfer as per usual. Keep in mind that the signal will be very low and all ambient lighting effects will greatly increase

Step 8) Turn Off Recording (optional) If you recorded your run, tap "Record Off". The circle above this button will turn red. Then, plug in a USB stick to the bottom of the display. Press "Transfer" to transfer your run data to a USB stick. It will upload a file in CSV format, easy to work with in Excel.

Section 7: Issues

1) If the signal is an abnormally low signal, a few things should be checked:
    a. Ensure that the alignment of the FRACTION FINDER sensor is correct. This can be done by trying to align the screw in the "light shield" and the top of the light shield with the cooling water port of the condenser; if they are aligned, the alignment is optimal. The "light shield" is the half-circle piece of hardware adjacent to the light source.
    b. Ensure that the integration time is set correctly by using the AID (Auto Integration) AUTO in Settings. The checkbox should be checked off.
    c. Ensure that the Scans to Average is set to 5.
    d. Are you distilling THC? Our THC Indicator is a short, broad signal; however, it is still easily discernible. See our Chemical Cheat Sheet.
    e. If none of the above seem to be the origin of the problem, please take a photo of both your spectrum plot and your wavelength plot, then email brains@arometrix.com.

Optimal Sensor and Light-Blocking Tape Orientation

2) If the signal looks sporadic and very abnormal, a few things should be checked:
    a. If it is right after a flask transfer, wait a few minutes – this is normal behavior
    b. If the vacuum pressure is still changing quickly, wait for the pressure to become more constant
    c. If the boiling flask is heating significantly, wait for the boiling flask temperature to become more constant
    d. The issue could be attributed to background light
        i. Use the light-blocking tape provided in the kit
    e. Ensure that the integration time is set correctly by either using the AID AUTO or following the procedure outlined in step 5
    f. Increase the scans to average
        i. This should not be set significantly higher than 5 - keep the value below 15
    g. If none of the above are the problem – ensure that liquid is still flowing
    h. If none of the above seem to be the origin of the problem, please take a photo of both your spectrum plot and your wavelength plot and contact customer service by emailing brains@arometrix.com or submitting the Support Request form on our website
3) If the system is not detecting the sensor (bottom left light on panel is red or yellow)
    a. If the system was turned on, give the system up to 5 minutes, it may detect
    b. Ensure that all cables are connected securely – especially the cable connecting the display unit to the sensor
        i. It may be easier just to disconnect and reconnect the cables from the display unit and the sensor unit
    c. Try identifying and using a new source of power to power the Fraction Finder display
    d. If none of the above seem to be the origin of the problem, please take a photo of both your spectrum plot and your wavelength plot and email brains@arometrix.com.
4) Warnings about safe operating conditions for the FRACTION FINDER:
    a. Currently, the FRACTION FINDER is specified to work up to 100 degrees Celsius. Please do not raise your condenser fluid temperature above this. Should this be a part of your SOP, then order the “Hot Tech Adapter” from Arometrix.com. This will relocate the sensor to just prior to the collection flask.
    b. The FRACTION FINDER housing (both the sensor and the display unit) are sensitive to distillate and extract, to increase sensor lifetime and reduce the likelihood of damage:
        i. Wipe down the outside of the glass that the FRACTION FINDER will clamp onto before installing the sensor with ethanol, isopropanol, or another alcohol. **DO NOT USE ACETONE** | WARNING: ENSURE THAT GLASSWARE IS NOT HOT!

ii. If an accidental spill occurs, try to wipe it off the sensor/display unit with a damp, not soaked, cloth/towel as quickly as possible. Dry off the area immediately afterward.

Other issues and suggestions:

1) We have all of our Fraction Finder resources (including different application notes and our Chemical Cheat Sheet) available at arometrix.com/resources.
2) We are constantly working to fix any issues with the system, and appreciate you reporting any abnormal behavior, we will not leave you hanging and will address any issues you have ASAP.
3) If you find anything in this manual confusing or unclear, please **email us at brains@arometrix.com**; we are more than happy to assist you, and do our best to do so in a timely manner.
4) If you want to see something new in the software please let us know and give your suggestion, we strive to make the FRACTION FINDER the tool that works for you!

Section 8: Software Update Instructions

At Arometrix, we strive to tailor-make all our products to our customers' needs. As we advance our algorithms, add features, fix bugs, etc., we release software/firmware updates. These are field-updatable. If you own a FRACTION FINDER, you can download our latest, free Firmware update to your software in the field: Version 1.2.3 - (if you do not already have it). This update will make FRACTION FINDER systems more cohesive and user-friendly. **Please visit arometrix.com/software to update your software.**

Section 9: Optical Measurement

The FRACTION FINDER displays optical information in AU (arbitrary intensity units), named to highlight the fact that the unit is for reference, indication, and to assess trends. It is not currently for quantitative analysis. Quantitative measurement is a number that represents a characteristic in known, well-understood units. For example, your speedometer reads a quantitative number – speed. You know how fast you are going based on that number. Qualitative measurement lacks the reference of a number. The FRACTION FINDER gives qualitative measurement – and is used to assess trends, not absolute potency.

Section 10: Specifications

SYSTEM	
Creator	Arometrix, Inc.
State of Materials	Oils; extracts
Expected Life Span	10+ years
Shipping Weight	5 lbs
Shipping Dimensions	10″ x10″ x8″
SENSOR	
Type	Standard or Ultra-Sensitive
Technology	In-situ fluorescence spectroscopy sensor (contains an optical light pulse and UV fluorescence detector)

Size(s)	Size 29; Size 34
Interface Requirements	Size 29 Glass (28-30mm outer diameter) Size 34 Glass (31-34mm outer diameter)
Cable Length	2'-30'
Max Temp	100 C
Min Temp	5C
Optical Detection Range	300 – 1000 nanometers
Lower Detection Limit	1 mg/mL (at a volume of 1 cubic centimeter of oil)
Accuracy	Spectral resolution: 15 nm max
Margin for Error	*Not applicable to qualitative measurements*
Reading Speed	> 1 second
Flow Rate Limits	No flow rate limit
Min Fill Level	1/8 volume
Calibration	No
DISPLAY	
Type	7 inch LCD TFT display (contains a compute module with advanced software)
Power	100-240VAC 50/60 Hz CE Rated (12 Volt 1 Amp into Display)
Power Supply	Yes
Mount	Mounts to a laboratory stand bracket (pole up to ½" thick)
Units	Wavelength Nanometers (nanometers); Wavelength Intensity Values (arbitrary units)
Plots	Spectrogram; Wavelength Intensity graph
Metric Type	Qualitative
Telemetry Options	USB
PLC Communication Type	Serial UART (BAUD: 115200, DATABITS: 8, STOPBITS: 1, PARITY: NONE)

Section 11: Appendix

Manually Tuning Integration/Exposure Time - It is highly recommended to use the AID as the AID algorithm will do all the adjustment autonomously. However, manual setting is feasible.

Manually Setting Integration Time for Heads - Tune the Integration Time based on your desired parameters

1. Tune the exposure time so that the maximum intensity value (y-axis) is between 500-800 AU
    a. The exposure time is pseudo-linear to the intensity (i.e. if the exposure time is doubled, the intensity will approximately double; if the exposure time is halved, the intensity will also approximately be halved)
    b. The exposure time for the Heads typically is very small – the exposure time probably will not be above 2 ms (2000 µs on exposure time setting panel), and may be lower than 0.1 ms (100 µs on exposure time setting panel)

c. WARNING: The update time for the plot will increase with increased exposure time and decrease with decreased exposure time. Distillation is a slow process, so this will not be an issue
    i. It is more important that there is a good signal than to have a fast update speed, so tuning to higher exposure times (as long as the intensity does NOT go above 800 AU – y-axis value), will ensure that the unit will work as intended.

Manually Setting Integration Time for Main Body

1) Go to the Spectrum tab
    a. If the maximum signal value is lower than 500 AU or above 850 AU
        i. Hit the Light On/Off button to turn light off
        ii. Wait for a new scan of the background light in the room
        iii. If the maximum value of this spectra is above 700 AU:
            1. Adjust the exposure time so that this value is less than 700 AU by decreasing it
            2. The exposure time is pseudo-linear to the intensity
        iv. Hit the Light On/Off button to turn light on
2) For the next ~20 minutes, the exposure time will need to be adjusted as the signal change
    a. Factors that increase how often it will need to be adjusted are:
        i. The darkness of the distillate (darker increase frequency of exposure time adjustment)
        ii. Turbulent flow rate (increases the of frequency exposure time adjustment up to a point, then will not have an effect)
            1. This is more of an issue for Tails than the Main Body
        iii. Background light (more ambient/background light will increase the frequency of adjustment; higher ambient/background light will also reduce the overall signal)

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