AROMETRIX

# FRACTION FINDER

*USER MANUAL for Firmware Version 1.2.3*

*with*

APPLICATION NOTES


**YOU MUST READ THIS MANUAL BEFORE USE**

**WARNING: NEVER LOOK DIRECTLY INTO THE LIGHT SOURCE**

# TABLE OF CONTENTS



**Application Notes:** ***Flip to the back of this manual to find Application Notes for Wiped/Thin Film Evaporation and Ethanol /Centrifuge Extraction.***

## Section 1: Description and Principles of Operation

The patent-pending FRACTION FINDER is the world's first in-line molecule monitoring system for botanical oil production. The technology uses "in-situ fluorescence spectroscopy" to measure molecules based on how they interact with light. The FRACTION FINDER is used to identify the contents of a flow through a glass tube in-situ, in real-time. Knowing the flow and the relative concentration of molecules, and whether that purity is increasing, or decreasing can help make optimal process decisions. In our work, we found processors were proudest of their craft when they could get the purest, most consistent batches for their clients. It is with this goal in mind that the FRACTION FINDER was developed.

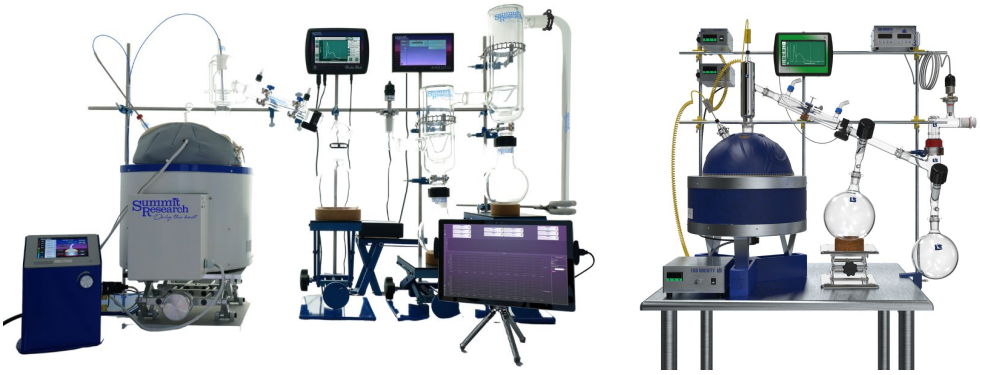
**The result is the FRACTION FINDER, a real-time process monitoring system that allows the user to see:**

- The relative concentration of Cannabinoids
- The flow of Cannabinoids

This spectroscopic technique was borrowed from other industries and empirically applied to in-situ Cannabinoid processing. Our research was conducted in processing labs that were running first and second pass short path distillation for the purpose of creating the purest Cannabinoids oils.

**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: Construction

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

**Sensor**: The ***sensor*** contains the "eyes" of the system". This optical transducer uses a light source and a full wavelength spectrometer along with signal conditioning circuitry and advanced analytics. The ***sensor*** is mounted on size 29 or 34 glass, depending on the sensor size option ordered. Adapters are also available for purchase to get 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. The information from the sensor is digitally transmitted via the sensor cable to the ***display***, where the spectra are cataloged, analyzed, graphed and displayed as a function of time. The ***display*** then does additional math on this multi-wavelength spectral temporal data (hence the term "compute module") and 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:**

- Fraction Finder Sensor *(Size 29 or 34)*
- Display *(with pole mounting bracket screw)*
- Sensor Cable, USB, 2 feet
- Light-Blocking Tape
- International Power Supply
- Glass Adapter (optional/if required)
- Warranty Card
- Instructions

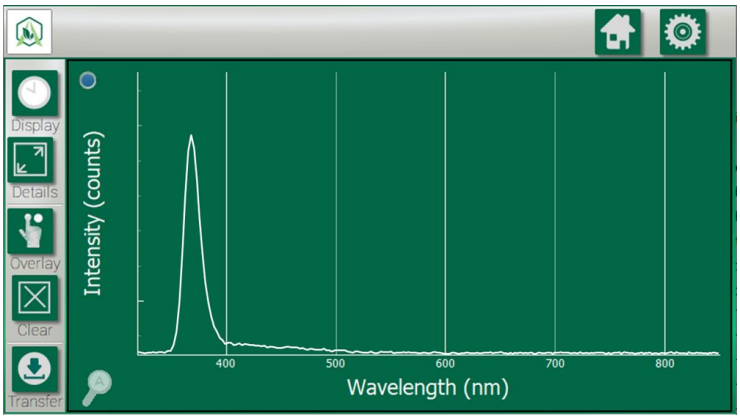
## Section 4: Understanding the Interface

After installation, the system is ready for immediate operation. The FRACTION FINDER is meant to be an additional reference to existing methods for determining the current part of the distillation fraction. NOTE: This section focuses on using the FRACTION FINDER for fractional distillation. If you are looking to use the unit for extraction or chromatography, visit arometrix.com/resources to read our different application notes.

## Layout of Software and 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:** Displays current background/ambient light corrected spectral measurement.

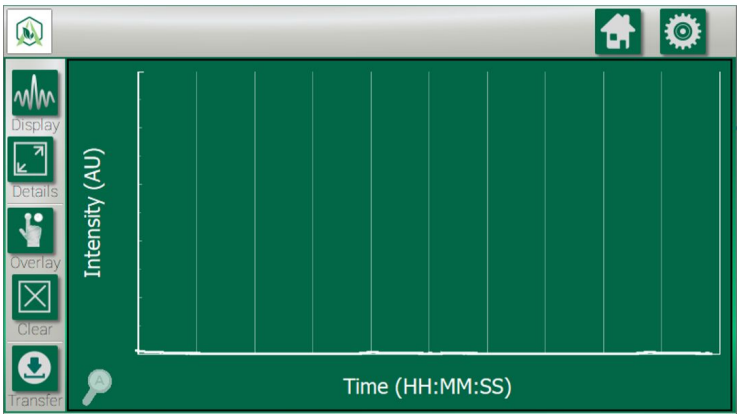
**How it should be used:**

1) Give a broad indication of whether the system is detecting Heads or Main Body/Tails
    a. This is an instantaneous representation of the current spectral state.
    b. This tab is difficult to track the Main Body and Tails change; use the Overlay button to assist with this.
    c. 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
2) Analyze current Exposure time and assist in "tuning" of exposure time parameter

**Understanding the Graph (X-Y Axis)**

- *X-axis = Wavelength (nm)*: The location of where the line shoots up (or fluoresces) indicates the molecule; 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.

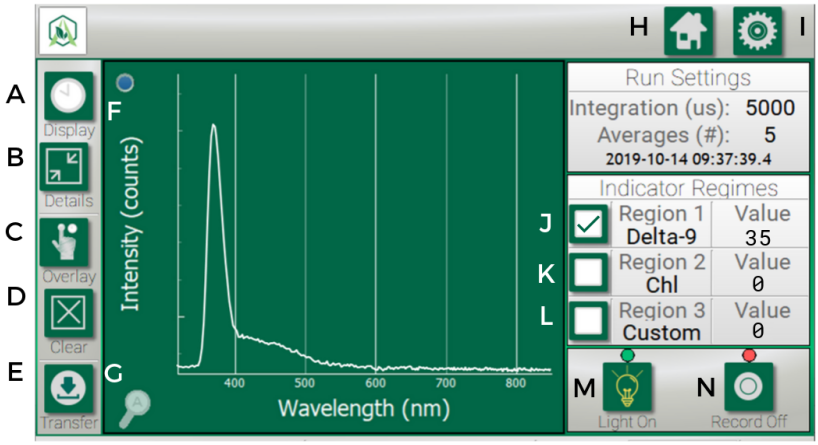
**How it should be used:**

1) Used to identify when the distillation is transferring from Heads to Main Body, or Main body to Tails
    a. Due to the massive amount of data reduction, this plot is hard to analyze when trying to assess issues with individual measurements from the FRACTION FINDER
2) Analyze noise in your measurement over time, and assist in "tuning" of scans to average
3) This view is especially useful for tracking particular chemical oddities that occur at specific wavelengths. (One example is tracking both Chlorophyll and D9 during an extraction run.)

**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: Use only when in Wavelength viewFor 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. ThisRegions setting can be adjusted and edited in Settings.*
*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 Page Tutorial

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

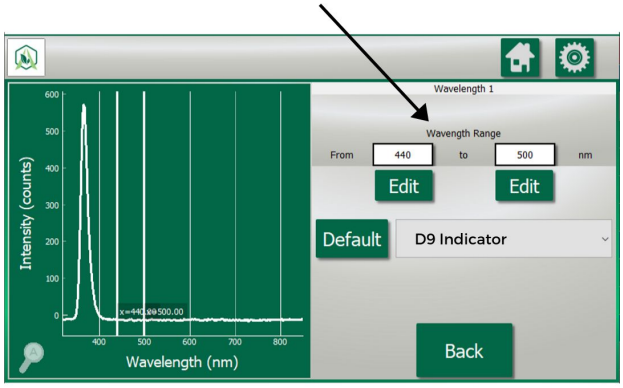
- Wavelength Settings
- Set Integration Time
- Set Scans to Average
- Clock Settings
- System Data

***Wavelength Settings***

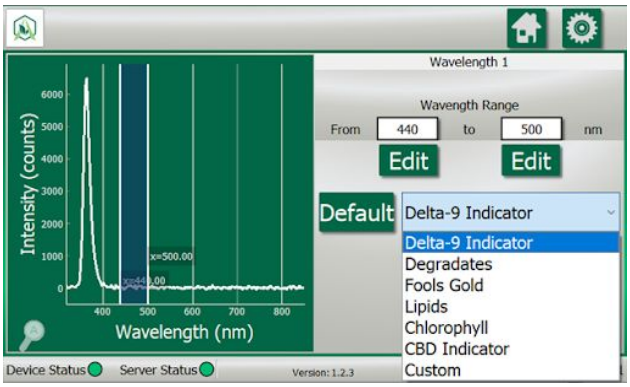
In this tab, you will see:

- 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.

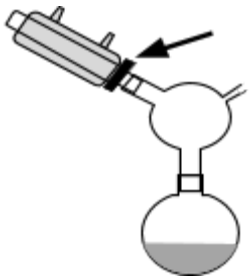
***System Data***
This will display “Bytes Available”, “Bytes Used”, and “Bytes Total”. It will also show you % memory used, and give you an option to “Clear Data”.

## Section 5: Installation

The equipment should be in a clean, dry environment for the best results. Care should be taken to avoid any spillage. ***NOTE: If you are using the system with a Wiped Film Evaporator and/or Extractor, please also read the Application Notes in Section 7 and Section 8, respectively.***

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 optical sensor ***with the thicker part of the sensor down***. For short-path distillation, 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 a slight extension; on Arometrix.com/shop, there are adapters that will satisfy a wide range of applications, including short-path distillation systems with Size 24 glass or “Hot Tech” condensing processes, as well as wiped film evaporators and extractors.



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. *(**Section 5** will delve further into the interface.)*

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 6: General Procedure for Short-Path Distillation

The Fraction Finder was designed initially for short path distillation applications. Thus, the general procedure in this standard user manual focuses on how to operate the Fraction Finder for this specific application. However, the Fraction Finder can also integrate into processes such as Wiped Film Evaporation, Ethanol Extraction, and soon Chromatography. ***NOTE: If you are using the system with a Wiped Film Evaporator and/or Extractor, you may advance to Sections 7 and Section 8, respectively. Once you've read the appropriate application note, continue at Section 9 to learn more about how to troubleshoot issues and more.***

### 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

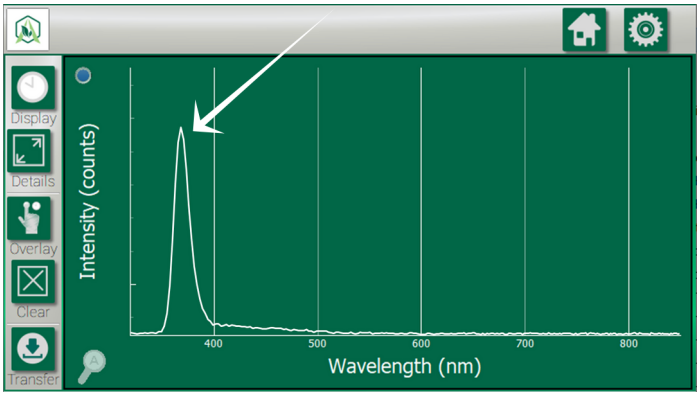
To set sensor ***Integration Time***: Tap the Settings gear icon. Tap "Set Integration Time". There is an AID (Auto) checkbox on the bottom-left corner of the display. Tap the checkbox - a check will appear, indicating that auto-integration determination has been enabled. This is *strongly recommended* 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.

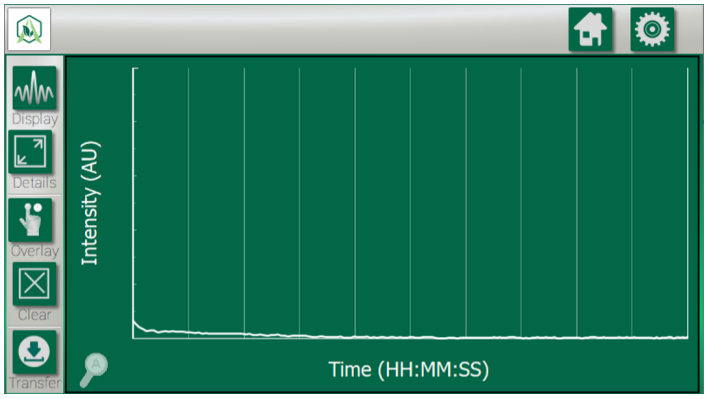



*Note: Arrow on graph is for illustration purposes only.*

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.

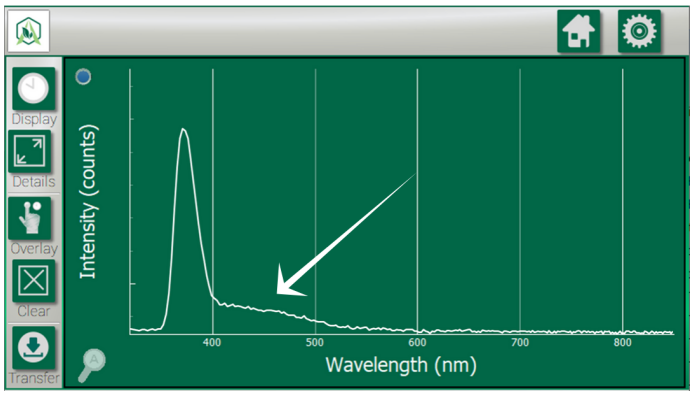



If you would like to Record your run, and export the run data afterward, now would be an optimal time to press the "Record" button. The circle above this button will turn green to indicate that it is recording.

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.***

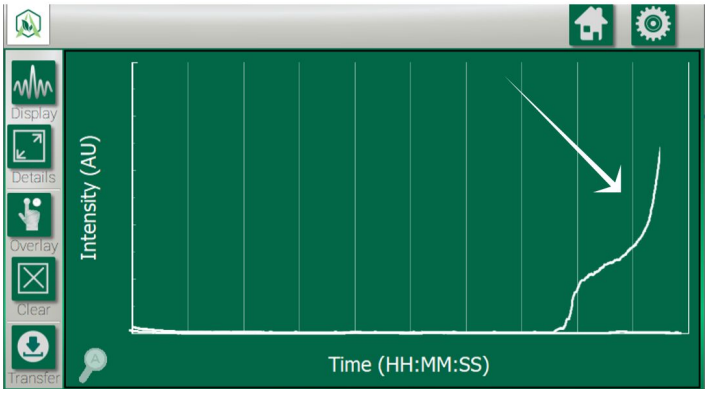
**For the actual Heads to Main Body Transition,** there are two separate methods for identifying this:

**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.




*Note: Arrow on graph is for illustration purposes only.*

**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.




*Note: Arrow on graph is for illustration purposes only.*

### 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.

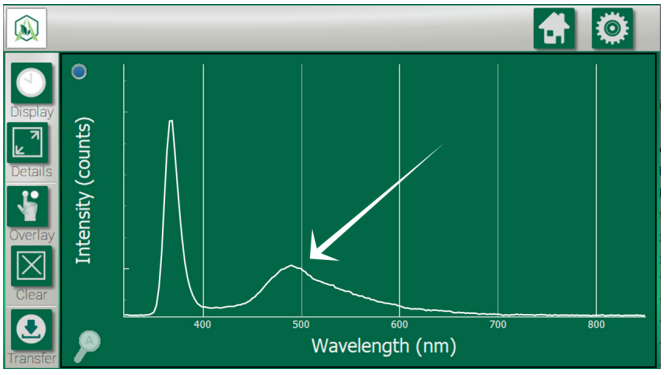
### Step 6) Identify Transition from Main Body to Tails

1) After 20 minutes from the flask transfer from Heads to the Main Body, the signal will become more stable

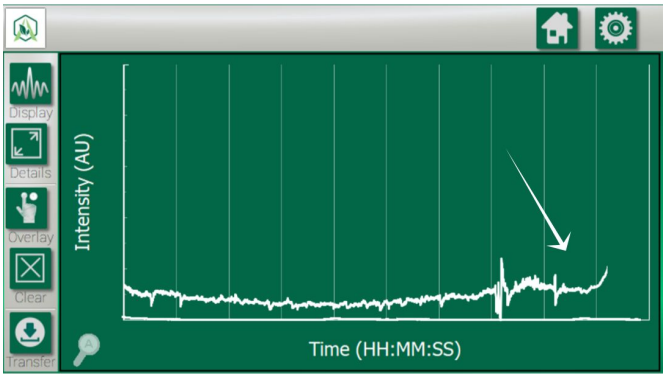
2) Check the Wavelength View
3) A sharp increase of the signal at the beginning will likely be shown, followed by a sharp drop-off of the signal to a stable moderate level
    a. This initial increase is very concreted Main Body initially coming through the system as well as any oxidized/degraded fluid 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.




*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 either using the AID AUTO or following the procedure outlined in step 5
    c. Ensure that the Scans to Average is set to 5
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 calling or texting (240) 492-6556
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. Contact customer service by calling (240) 492-6556 extension 3 if the above problems persist
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/shop. 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 and education on fluorescence spectroscopy available at arometrix.com/arometrix-academy
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 customer support, 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. Read below for important instructions on how to go about this download.

**Please visit arometrix.com/software to update your software.**

## Section 9: Factory Repairs

The FRACTION FINDER assembly is designed to provide years of trouble-free service. No field servicing of the unit is recommended. The unit should come with a 1-Year Warranty Card.

## Section 10: 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 11: Specifications

| **SYSTEM** | |
|---|---|
| Creator | Arometrix, Inc. |
| Application(s) | FRACTION FINDER - Distillation (short path, wiped film, thin film)<br>EXTRACTION FINDER - Extraction (ethanol, cryo-ethanol, centrifuge) |
| State of Materials | Distillates; extracts |
| Expected Life Span | 10+ years |
| Shipping Weight | 5 lbs |
| Shipping Dimensions | 10″ x10″ x8″ |
| Technology Validation Reference | Peer-reviewed research article, published by Cannabis Science & Technology |
| **SENSOR** | |
| Type | Standard or Ultra-Sensitive |
| Technology | In-situ fluorescence spectroscopy sensor (contains an optical light pulse and UV fluorescence detector) |
| UV Domain | Near UV |
| Size(s) | Size 29; Size 34 |

| | |
|---|---|
| Interface Requirements | Size 29 Glass (28-30mm outer diameter)<br>Size 34 Glass (31-34mm outer diameter)<br>AMP Sight Glass, Size 34 |
| 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) |
| | |
| **SIGHT GLASS** | |
| Creator | AMP Equipment |
| FDA/USDA/ABS Certified Gaskets | PTFE |
| Other Steel Parts | 304l |
| Tube | Borosilicate glass (pyrex) |
| Stainless parts | 304L |
| Surface Finish | <63u |
| Sanitary End Clamps | 1.5” (2” extender available) |
| Maximum Pressure | 30 Psi |

| | |
|---|---|
| Max Temperature | 350F |
| Min Temperature | -70C |
| Product Dimensions | 6.94in (length) x 4.98in (width) |

## Section 12: 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)

## Section 13: Terms and Conditions

### TERMS OF USE, LIMITED WARRANTY & LIABILITY WAIVER

Arometrix offers all of its products with the following terms and conditions and notices as follows. By accepting and/or using an Arometrix product, you hereby acknowledge and agree to the following terms and conditions, and acceptance of these terms and conditions are a condition precedent to any purchase/sale agreement between you and Arometrix.

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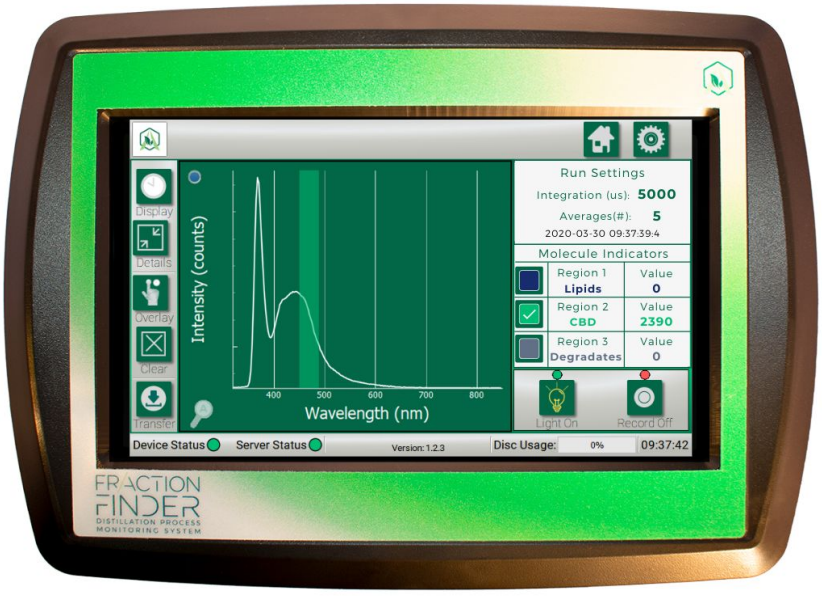
AROMETRIX

# FRACTION FINDER

*APPLICATION NOTE FOR*
*WIPED/THIN FILM EVAPORATION*




**YOU MUST READ THIS MANUAL BEFORE USE**

**WARNING: NEVER LOOK DIRECTLY INTO THE LIGHT SOURCE**

# TABLE OF CONTENTS

# Section 1: Description and Principles of Operation

The Fraction Finder detects the presence of distillation molecules via induced fluorescence. While many molecules can show fluorescence simultaneously, looking at the wavelength of the fluorescence peaks helps inform the distillation operator what molecule is being detected.

Purpose of using the Fraction Finder for wiped film evaporation (WFE):

- **Parameter Feedback -** WFE parameters and setpoints are not adjusted often; however, they might be adjusted when first setting up the WFE, when changing source material, when the seasons change, or when changing pre-processing methods. The Fraction Finder's readings can provide parameter feedback for temperature and wiper speed.
- **In-Line Quality Assurance -** The Fraction Finder's readings can provide quality assurance and indicate oddities. Users can recognize in real-time if there are "undesirables" in their line. This is especially useful if there is no in-house HPLC.
- **High Efficiency -** The Fraction Finder's readings can indicate if cannabinoids are being rejected in the residue stream; this information can be used to adjust parameters in order to minimize rejected cannabinoids, therefore, optimizing efficiency. *See "Installation" section for more details on this.*

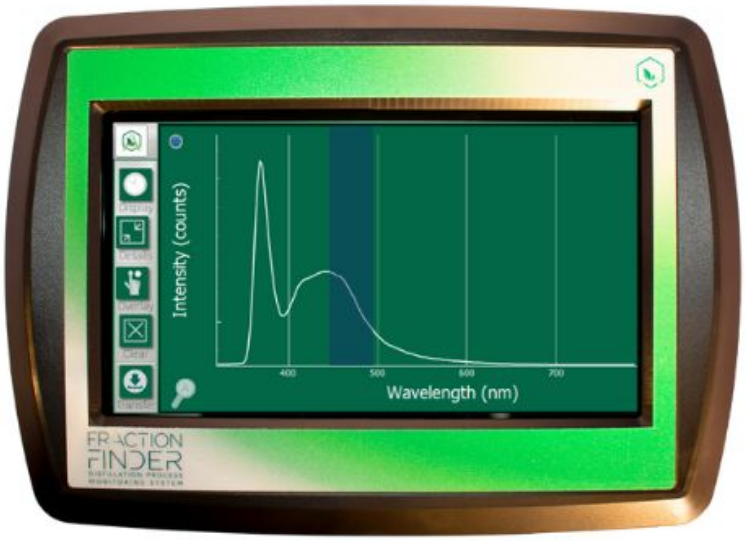
The relevant molecules that the Fraction Finder can detect during WFE, and their respective wavelength regions are:

- **Reference Peak @** 360-370 nm
    - The Reference/Excitation peak is from the sensor device and is not indicative of any distillation fractions or molecules.
- **$\Delta^9$-THC** @ 440-500 nm
- **CBD Indicator** @ 450-490 nm
    - CBD and THC fluoresce at similar wavelengths, but have different waveforms. Note: The FRACTION FINDER does not distinguish between CBD and THC simultaneously.
- **Degradates (degraded THC/Cannabinoids)** @ 510-550 nm, centered at 490 nm
- **Chlorophyll**; may show 1 or 2 peaks @ 680 nm and 710 nm
- **Lipids** @ 550-620 nm
    - Lipids aren't one chemical, but a class of chemicals. For the purpose of this document, a lipid that exhibits fluorescence at 535 nm is shown.
- **"Fool's Gold"** @ 405-435 nm
    - "Fool's Gold" is a colloquial term for a chemical component commonly seen during distillation which is golden in color and looks like a desirable cannabinoid. The molecular species that is "Fool's Gold" is currently unknown.

***NOTE**: See our "Chemical Cheat Sheet" for an updated list of chemicals that the unit can detect.*

## Section 2: Screenshots - *Desirables*

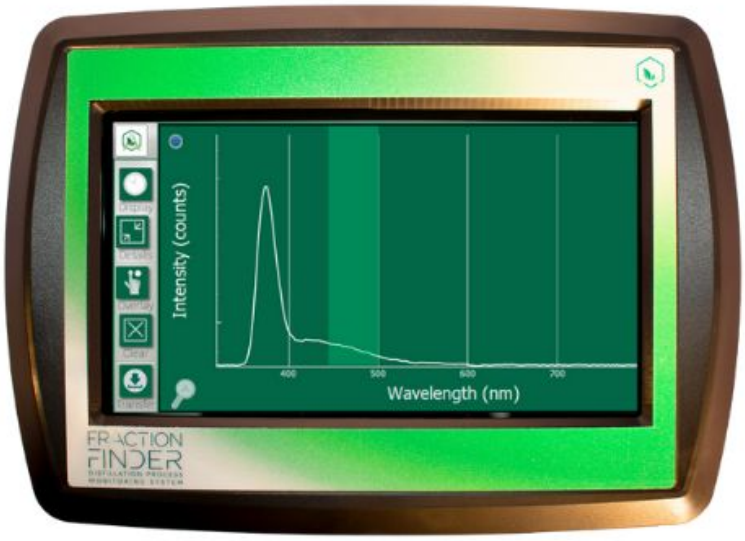
### **CBD Indicator |** Wavelength: 450-490 nm




**TIP**: WFE of hemp oil with the goal of producing CBD-dominant distillate is becoming increasingly popular. The Fraction Finder can provide an indication of when CBD is passing through.

The CBD Indicator appears as a *sharp* peak.

### **Delta-9 THC |** Wavelength: 440-500 nm




**TIP**: Similarly to CBD, Delta-9 THC is considered a "desirable" during WFE of THC. In these processes, the Fraction Finder can assist operators in collecting the most amount of this molecule as possible by indicating when it is passing through.

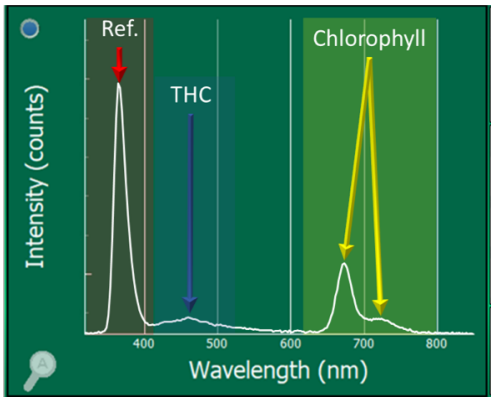
The THC Indicator appears as a *short, broad* peak.

***Note**: The FRACTION FINDER does not distinguish between CBD and THC **simultaneously**; while they have different waveforms, they fluoresce at the same wavelength location. However, if one fraction comes out before the other, such as during Chromatography, it is possible to determine the change.*

# Section 3: Screenshots - *Undesirables*

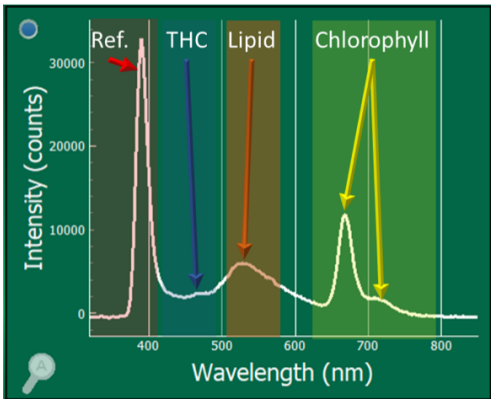
As you will learn in this section, other molecules can fluoresce at the same time that the main cannabinoid fluoresces. This is when parameter feedback is most relevant. For these examples, we use THC as the desired cannabinoid.

## THC and Chlorophyll



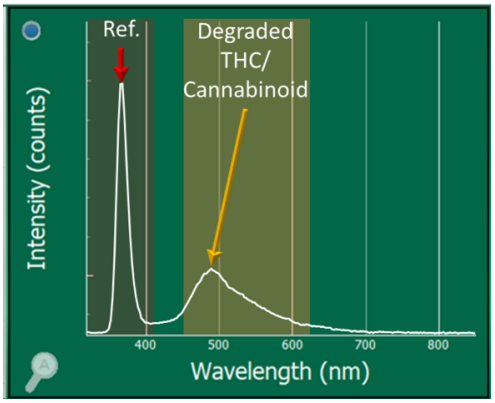

**TIP**: If a WFE operator sees the Chlorophyll signal, s/he should perform a carbon scrub (or other chlorophyll remediation) before starting distillation or on the distilled product. If Chlorophyll is detected on the distillate line of the cannabis refining pass, wiper speed should likely be increased or WFE internal chamber temperature decreased.

## THC, Chlorophyll, and Lipid




**TIP**: If a WFE operator sees the signal for Lipid (a peak that is centered between 530-620 nm), this indicates that their lipids removal is not removing all the fats.

## Degraded Cannabinoids




**TIP**: Degraded THC/cannabinoids are typically considered “undesirables” and should not be collected.

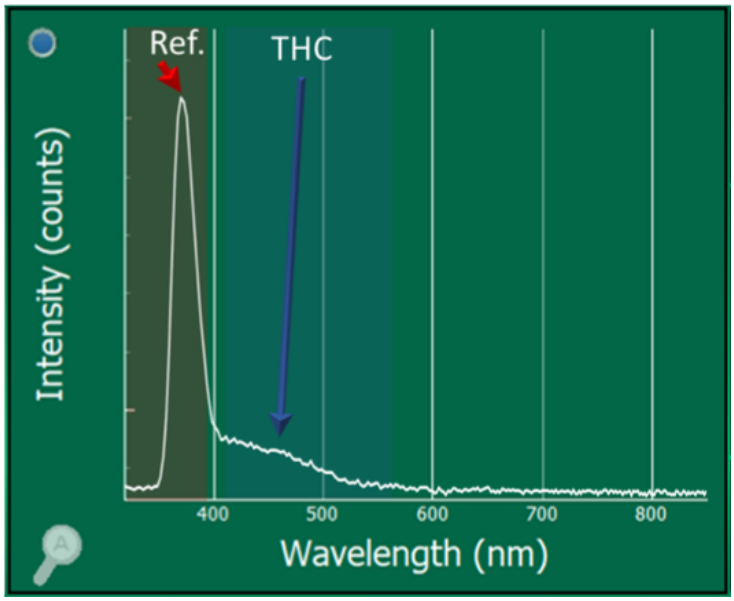
# Section 4: Terpene Stripping Pass - What to Expect

The relatively low-temperature terpene-stripping pass is typically performed before trying to distill the desired cannabinoid. During this pass of a WFE, the temperature is intentionally set slightly lower than the boiling point of the desired cannabinoid, so that only terpenes, degraded terpenes, residual solvents, and other undesirables boil off. In this example, it is assumed this is a $\Delta^9$-THC distillation.

## Residue Side (Crude without Terpenes)

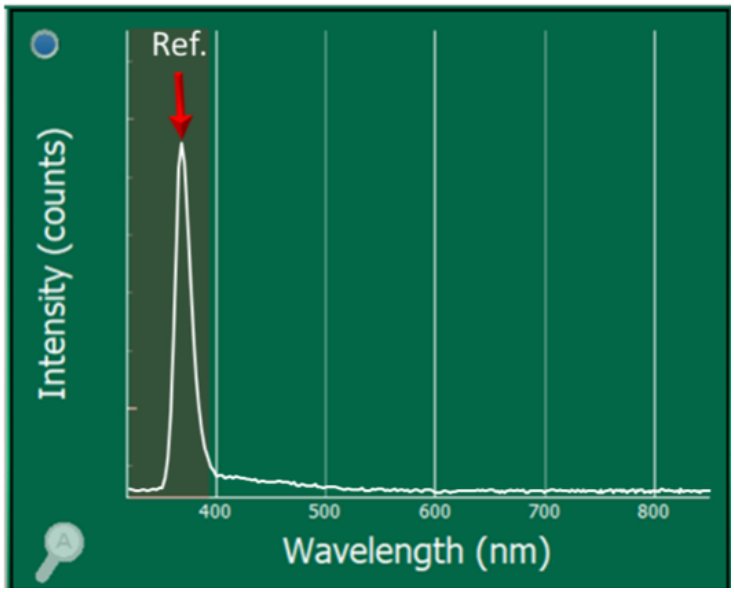
This side should not have terpenes, degraded terpenes, etc. What is left is all the molecular species from the crude, and as such, the majority of the spectra will be cannabinoids, degraded cannabinoids, and chlorophyll/lipids if they were present in the crude material. The THC signal should be very low in intensity. A labeled example of what to expect from the Fraction Finder is given.

***WARNING** – if the fluid coming out the residue side is either very low flow or very dark the chemical analyzer/sensor may not be able to detect the chemicals flowing through the sensor.*




## Distillate Side (Terpene Enriched Effluent)

This side should have only terpenes, degraded terpenes, etc... This line may also contain some “Fool’s Gold” at 410 nm if it is present in the crude; it should be ejected with the terpenes as it is typically not wanted in the final product. As the Fraction Finder is insensitive to the majority of solvents and terpenes, only the reference peak will likely be observed. A labeled example of what to expect from the Fraction Finder is given.



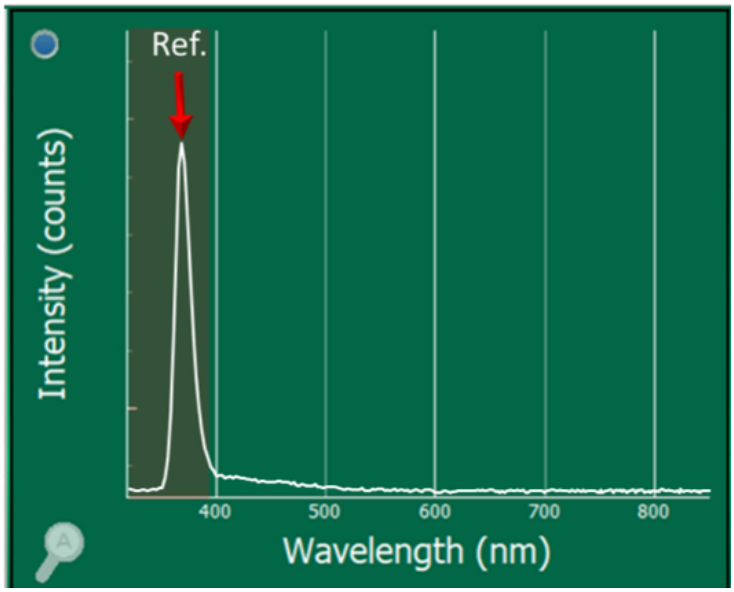
# Section 5: Cannabis Refining Pass - What to Expect

The relatively high-temperature cannabinoid refining pass is typically performed after a terpene stripping pass. Only the desired cannabinoids are distilled while all other molecular components get rejected to the residue side of the WFE. In this example, it is assumed this is a $\Delta^9$-THC distillation.

## Residue Side (Waste Effluent)

This side should have everything but the desired cannabinoid. While during SPD, this would typically include a lot of degraded cannabinoids, the heating time for the crude in WFE is low enough that it is atypical to see a significant presence of degraded cannabinoids. A labeled example of what to expect from the Fraction Finder is given.

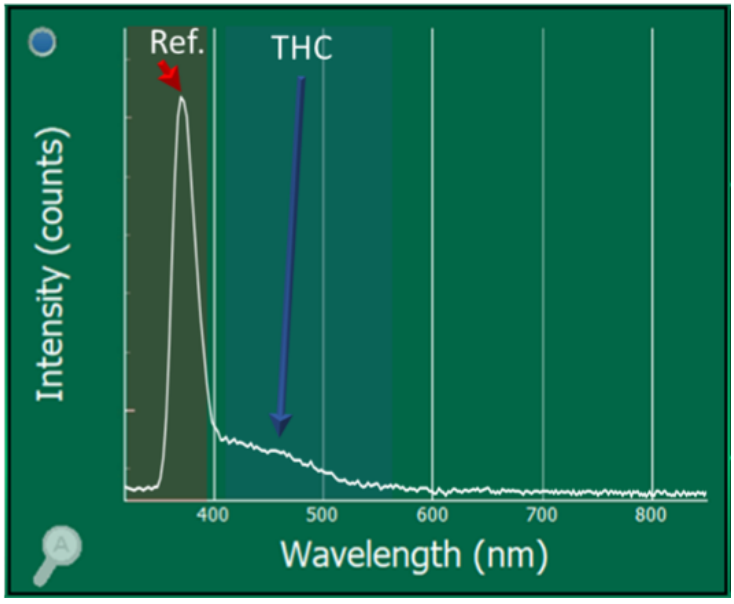
***NOTE** – If there is a (small) bump at 490-510 nm, that is OK – it is the chemical signature associated with degraded cannabinoids.*




## Distillate Side (Desired Product Effluent)

This side should have just the desired cannabinoid. A labeled example of what to expect from the Fraction Finder is given. If Chlorophyll is detected on the distillate line of the cannabis refining pass, wiper speed should likely be increased or WFE internal chamber temperature decreased.

***NOTE** – The spectra used here is representative and used here for learning purposes. This THC intensity should not be analyzed, as intensities will vary. On the distillate side of the cannabis refining pass, the THC signal will be intense (more intense than it was during the terp strip).*

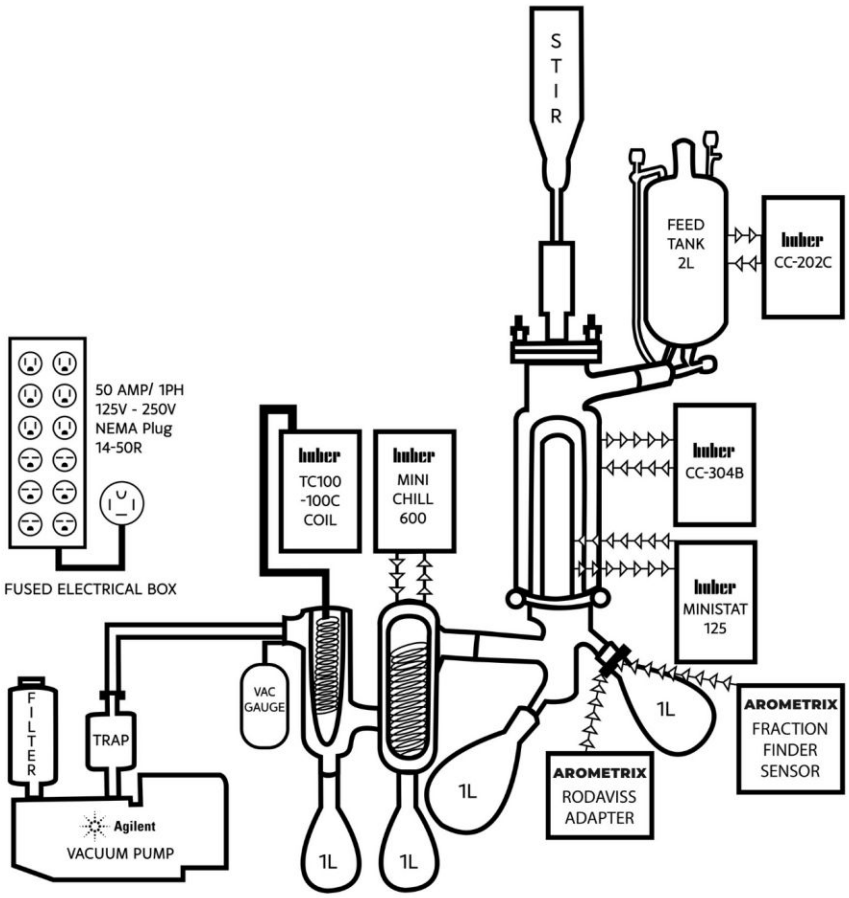


# Section 6: Unpacking and Inspecting

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:**

- Fraction Finder Sensor *(Size 29 or 34)*
- Display *(with pole mounting bracket)*
- Sensor Cable, USB, 2 feet
- Light-Blocking Tape
- International Power Supply
- Warranty Card
- Glass Adapter (optional)
    - *If Root Sciences/VTA, Prescott, Pope, or WFE with gear pump* → Collection Jar Bundle
    - *If PurePath100* → PUREPATH Rodaviss Adapter OR PUREPATH Rodaviss Neck Flask
    - *If Deutsche or WFE with metal connections* → 1.5” or 2” Sanitary Flange Sight Glass
    - *If Lab Society HVE Thin Film* → KF25 to 35/25 Ball Joint Adapter




***Featured: Cascade Sciences PUREPATH100 with Fraction Finder & Rodaviss Adapter***

# Section 7: Installation for Wiped Film Evaporation

Users can select if they would like to operate with ***1 or 2*** Fraction Finder systems.

| **Installation with *1* Fraction Finder** | **Installation with *2* Fraction Finders** |
|---|---|
| If operating with *1* Fraction Finder, Arometrix recommends that users:<br>● Install the sensor ⟶ on the **residue** line during **terpene stripping pass**<br>● Swap the sensor ⟶ to the **distillate** line during **cannabis refining pass** | If operating with *2* Fraction Finders, Arometrix recommends that users:<br>● Install the sensor ⟶ on the **residue** line during **both passes**<br>● Install the sensor ⟶ on the **distillate** line during **both passes** |
| *Note: If you select to operate with ONE Fraction Finder, please disregard the "Terpene Stripping Pass - Distillate Side" and "Cannabis Refining Pass - Residue Side" sections; they will not be relevant.* | *Note: The added value of operating with TWO Fraction Finders is the "High Efficiency" bullet point mentioned in the "Overview", as users can additionally monitor for cannabinoid rejection.* |

### General Installation Instructions

1. Apply the light-blocking tape to the glassware apparatus. This is ***especially*** important in labs with a lot of ambient light, as it will block the light from saturating your sensor's readings.

2. Install the optical sensor with the thicker part of the sensor down. The sensor should be installed on, or directly above, the collection vessel. *(See image of Fraction Finder and Collection Jar Bundle installed on the VTA.)*

3. Plug the sensor cable into the sensor and the display. Give the sensor ~2-5 minutes to boot up.

4. Mount the display to a lab pole using the mounting bracket screw.

5. Use the supplied AC adapter to power your display. Allow it to boot.

6. Ensure: (1) That the Device Status and Server Status indicator; (2) that the "Light On/Light Off" toggle button is turned on

7. In Settings: (1) Set Scans to Average to 5; (2) Turn AutoIntegration (AID) on by tapping the checkbox

AROMETRIX

# EXTRACTION FINDER

## *APPLICATION NOTE FOR ETHANOL & CENTRIFUGE EXTRACTION*

**YOU MUST READ THIS MANUAL BEFORE USE**

**WARNING: NEVER LOOK DIRECTLY INTO THE LIGHT SOURCE**

*Arometrix, Inc.* *(240) 492-6556* *brains@arometrix.com* *arometrix.com*

# TABLE OF CONTENTS

# Section 1: Description and Principles of Operation

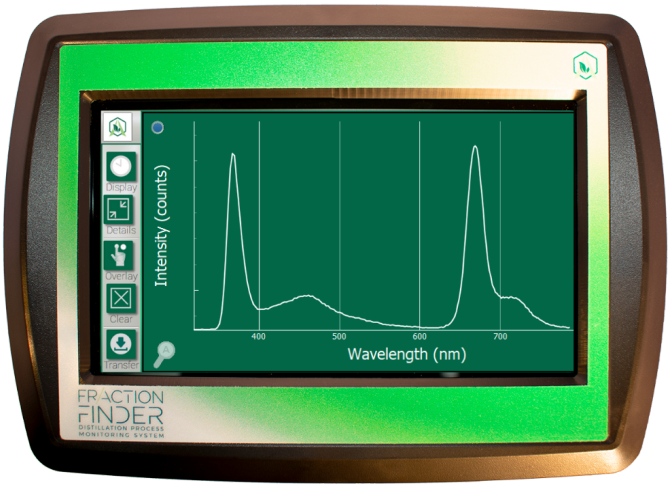
The Fraction Finder detects the presence of extraction molecules via induced fluorescence. While many molecules can show fluorescence simultaneously, looking at the wavelength of the fluorescence peaks helps inform the extraction operator what molecule is being detected. By monitoring key molecules' intensity over time, users can find the precise end of their extraction.

**Purpose of using the Fraction Finder for Ethanol Extraction:**

- **Instantaneous Molecule Graphing -** The system detects key molecules during extraction: Cannabinoids and Chlorophyll. It can also broadly detect Lipids.
- **Extraction Endpoint -** The system can be used to determine the end of the extraction. Operators can watch when the readings are showing that the solvent is no longer efficiently extracting cannabinoids. In turn, operators can avoid wasted time and cut process duration.

The relevant molecules that the Fraction Finder can detect during Ethanol Extraction, and their respective peak positions are:

- **Reference Peak @** 360-370 nm
    - The Reference/Excitation peak is from the sensor device and is not indicative of any distillation fractions or molecules.
- **Cannabinoids** @ 450-470 nm
- **Chlorophyll**; may show 1 or 2 peaks @ 680 nm and 710 nm
- **Lipids** @ 530-630 nm
    - Lipids aren't one chemical, but a class of chemicals.
    - Lipids might not always be detected. If Lipids are detected during cryogenic ethanol extraction, your ethanol is not cold enough OR you have over-extracted your plant material.



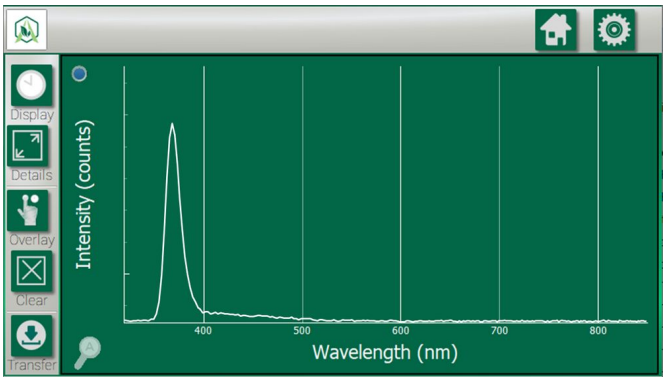
# Section 2: Spectrum View

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). In this section, we will go over the Spectrum view, which is an instantaneous representation of what molecules are passing through the sensor.

## Graph 1 - Spectrum View

### Understanding the Graph

- *X-axis = Wavelength (nm)*: The location of where the line shoots up (or fluoresces) indicates the molecule; 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.

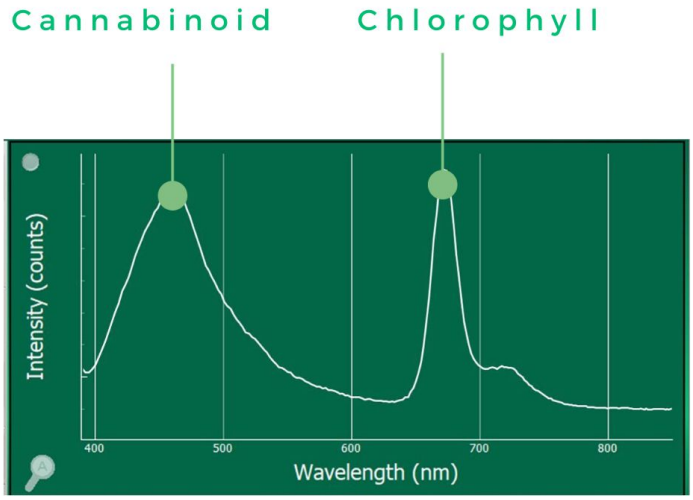



**Note**: The signal shown at 360-370 nm is the reference peak from the sensor’s light source. To remove this peak from view, press the blue “Reference Peak” remover button (available in 1.2.3.). Graph 2 below depicts what the Spectrum View looks like without the reference peak.

## Graph 2 - Molecule Analysis in Spectrum View

### Understanding the Graph

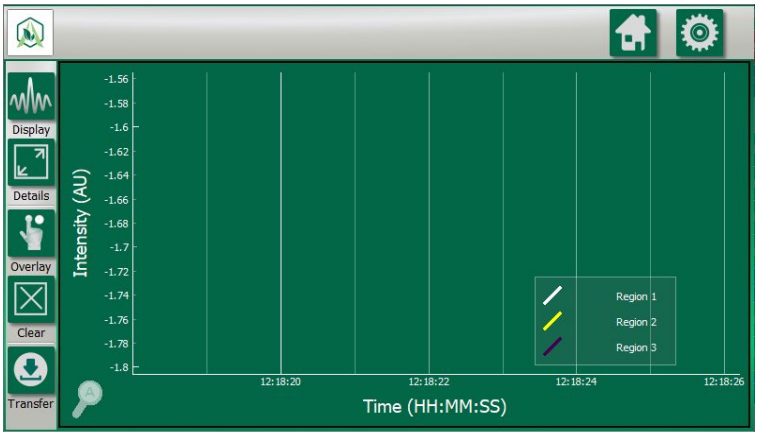
As stated in the Overview section, more than one molecule can fluoresce at a time. This is what makes the Fraction Finder useful to extractors: the ability to track both Cannabinoid content and Chlorophyll content simultaneously. Cannabinoids fluoresce at a peak centered at 460 nm, while Chlorophyll fluoresces as doublet peaks (680 nm and 710 nm) or as a singular peak.



# Section 3: Wavelength View (Recommended)

As opposed to Spectrum view, the Wavelength view on the Fraction Finder tracks fractions as a function of time. This view can be toggled by tapping the "display" button (located in the top-left corner). Whereas the Spectrum View is instantaneous, this view will show the entire run progress from start to finish over time. **Arometrix recommends that users use this view to determine the endpoint of their extraction process**.

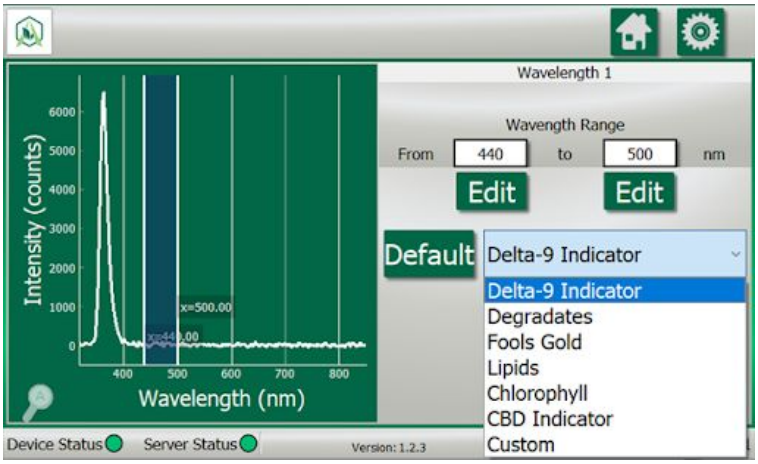
## Graph 3 - Wavelength View




### Understanding the Graph

- *X-axis = Time (HH:MM:SS)*: 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.

### Understanding the Range/Region Setting




On the bottom-right side of the display, you will notice "Region 1", "Region 2", and "Region 3". These correspond to different wavelength ranges that users can select and set. These correspond with the Region 1, Region 2, and Region 3 that are shown on the ***Wavelength View***. When you press one of these, you will see a Wavelength range. These will come with manufacturer defaults; however, you can edit the *From* and *To* how you see fit.

To set ranges, go to Settings, select "Wavelength Settings", and select a Region.

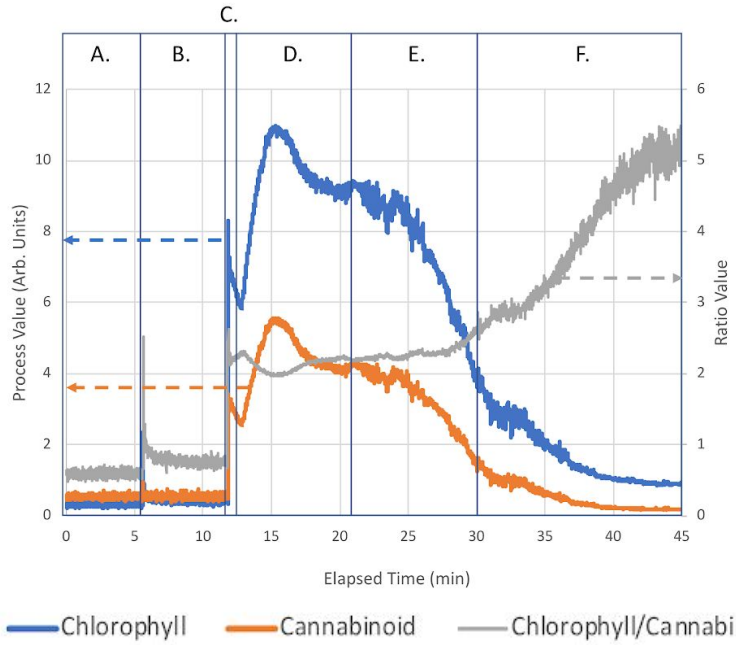
Arometrix recommends that operators use presets and perform the following settings:

- Set Region 1 as THC (or as CBD)
- Set Region 2 as Chlorophyll
- Set Region 3 as Custom. Perhaps, set Custom to 530-630 nm (this is our broad fluorescence range for common cannabis Lipids).

## Section 4: Wavelength Run Data

Below is a real graph of a full extraction run using the Fraction Finder in Wavelength View. The Fraction Finder tracked Chlorophyll (blue) and Cannabinoid (orange) signals. *Note: The Chlorophyll/ Cannabinoid ratio (grey) signal is for the purposes of this manual only.*

### Graph 4 - Full Cryo-Ethanol Extraction Run with the Fraction Finder




A. Filling System (Flow Off)
B. Agitation Then Soak (Flow Off)
C. Flow Started/Equilibrating Flow
D. Recirculating
E. Emptying System Using $N_2$ Gas
F. Emptying Residual Alcohol from Extractor Reservoir

**A. Filling System** - *The extractor was being filled with ethanol*
   a. No flow over sensor; no signal

**B. Agitation Then Soak -** *The extractor was agitated then went through a soak cycle*
   a. No flow over sensor; initial signal noise due to mechanical vibrations

**C. Flow Started/Equilibrating Flow -** *The flow for recirculation began*
   a. Full flow over sensor; signal spikes then drops after initial fluid flow

**D. Recirculating** - *Extractor recirculated ethanol over system*
   a. Full flow over sensor; signal increases/decreases as Cannabinoid concentration equilibrates and becomes homogeneous in ethanol
   b. End point determined by both Cannabinoid and Chlorophyll signals (and their ratio) becoming stable/unchanging

**E. Emptying System using $N_2$ Gas** - *Endpoint detected (solvent saturated)*

a. Extractor being emptied with nitrogen gas and system no longer chilled; Signal of both Cannabinoids and Chlorophyll decrease

**F. Emptying Residual Alcohol from Extractor** - *Extractor reservoir emptied*

a. Decrease in both Cannabinoid and Chlorophyll signals; increase in ratio of Chlorophyll to Cannabinoid from system heating (ethanol preferentially extracting Chlorophyll in reservoir)

## Section 5: 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:**

- Fraction Finder Ultra-Sensitive Sensor *(Size 34)*
- Shielded Sight Glass (comes standard with 1.5” tri clamp connections; 2” inch extender available)
- Display *(with pole mounting bracket)*
- Sensor Cable, USB, 10 feet
- Light-Blocking Tape
- International Power Supply and Power Supply Extension, 10'
- Glass Adapter (optional)
- Warranty Card
- Instructions

## Section 6: Installation

Operators that order the Fraction Finder for Ethanol Extraction bundle will receive a Shielded Sight Glass, containing the Fraction Finder Ultra-Sensitive Sensor, Light-Blocking Tape, and Sensor Cable 10’. Therefore, installation is simple and involves the following steps:

1. Attach the sight glass to the extractor's sanitary end clamps.
2. Install the Fraction Finder display.
3. Connect and power the system, then prepare extraction as you typically would.
4. Set integration to AID (Auto) in Fraction Finder Settings.
5. Set scans to average to 5 in Fraction Finder Settings.
6. Toggle the Record button to On to record your run.
7. Observe Cannabinoid and Chlorophyll levels, referencing both plots, but especially the Wavelength View
8. Toggle the Record button to Off to save that run data file.