



nanovisQ™ Solo

USER MANUAL



nanovisQ™ Solo User Manual

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For Research Use Only. Not for use in diagnostic or clinical procedures.

The nanovisQ™ instrument is intended for laboratory research applications and formulation development. It is not a medical device and is not approved or certified for diagnostic, clinical, or patient use.

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Safety and Specifications Information

Instrument specifications

- Instrument Name: nanovisQ™ Solo
- Dimensions: 24 x 14 x 18 cm
- Weight: 900 g
- Power Requirements:
 - Instrument powered via USB-A connection
 - Wall adapter: 120 V standard plug
 - Laptop: standard 120 V power source
- Connectivity: USB-A connection between instrument and laptop
- Intended Use: Research Laboratory use only; benchtop operation on a flat, stable surface
- Software includes audit trails aligned with 21 CFR Part 11. Manufacturing and testing processes follow 21 CFR part 820 principles.

Electrical Safety and Compliance

- The nanovisQ™ Solo is designed for low-voltage operation through USB-A interface
- Current configuration uses a direct 120 V wall adapter. CE marking is in preparation, and no technical barriers are anticipated for compliance.
- For U.S. use, the instrument operates safely under standard laboratory conditions. A UL/CSA pathway will follow CE marking.
- Until formal certifications are complete, the instrument is provided strictly for evaluation and research purposes.

Laboratory Safety Guidelines

- Personal Protective Equipment (PPE): safety glasses, lab coat, gloves, closed-toed shoes are recommended.
- Chemical Handling: follow SDS, proper waste disposal, no mouth pipetting
- Instrument Operation: use only as instructed; do not attempt unauthorized repairs.
- General Conduct: maintain clean workspace, follow site emergency procedures, no food/drink in lab.

QATCH-Specific Safety Notes

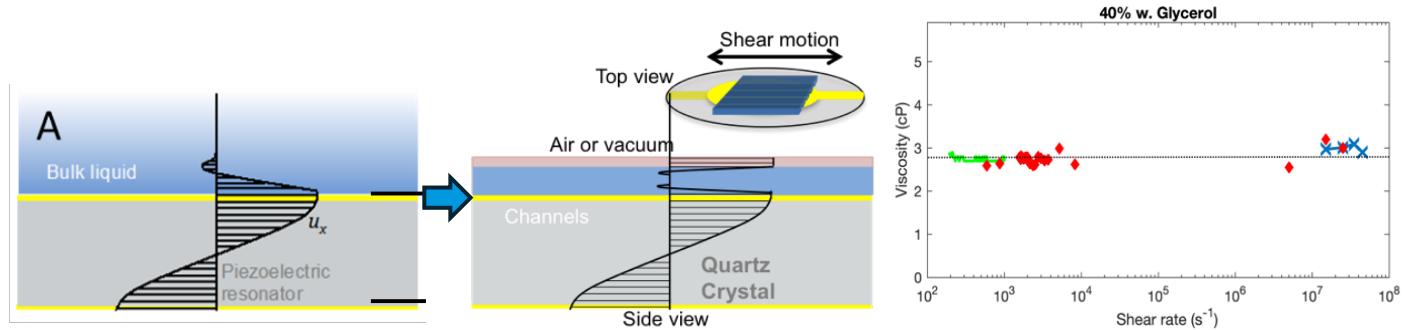
- Do not immerse or flood the instrument
- Do not place objects in the instrument
- Only use QATCH-provided disposable sensors; sensors are single-use only.
- Do not insert fingers or tools into the sensor housing
- Sensor pouches contain small ethanol-soaked wipes; store away from heat or open flame

Introduction

Microfluidics for Rheometry Microfluidic systems are of significant interest for small volume, high shear-rate rheometry because they i) provide small length scales and confinement, ii) provide viscosity data at high shear-rates without crossing over into the turbulent regimes, and iii) enable smaller sample volumes. However, as with conventional rheometers, **high shear-rates entail high flow rates**, which in-turn increases the fluid sample consumption.

Quartz Resonator Sensors to Characterize Viscosity Quartz resonator based sensors employ thin, piezoelectric AT-cut quartz crystals that have electrodes on both sides and have high resonance frequency and high-quality factor (Q-factor) thickness-shear modes (*i.e.*, the top and bottom half of the crystal moves in opposite directions). These sensors can measure small changes in fluid viscosity or mass coupled to their surfaces by monitoring the associated changes in resonance frequency and dissipation. The most common type of these sensors that users may be familiar with is quartz crystal microbalance (QCM) with dissipation monitoring, which is commonly used to measure biological binding events. QCM has been used to study viscosity using small volumes at the extremely high shear rates of the resonant frequency of the crystals. However, QCM still requires a significant amount of fluid under normal conditions.

Microfluidic Quartz Resonator (MQR) Sensors MQR, which lie at the core of nanovisQ™, are a recently developed sensor technology that combines microfluidics with quartz resonators. The orientation of the microfluidic channels determines how fluid is observed by the sensor. When the channels are oriented parallel to the shearing-motion, the quartz sensor behaves very similar to that of a polished crystal with matching dissipation and resonance frequency shifts due to fluid loading (Fig). The addition of microfluidics, therefore, enables three features of nanovisQ™. 1) we are able to manipulate the response of the MQR to fluids by changing the channel orientation. This means that we are able to sense viscosity in regimes similar to the rotational rheometer (low-shear), as well as at the ultra-high shear of the quartz resonance. 2) Channels can be filled by capillary flow, eliminating the need for external pumping. And 3) only extremely small sample volumes are necessary for measurements (2-6 μ L).



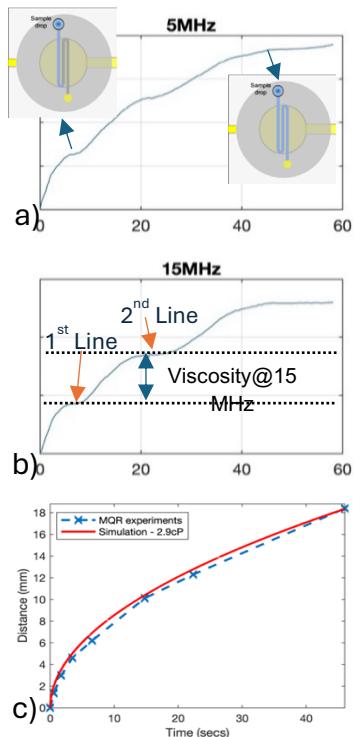


Figure. Dissipation shift after applying glycerol solution for a)1st, b)3rd, c) Position vs time is mapped using dissipation data.

Acoustic capillary viscometer function of nanovisQ™

nanovisQ™ employs serially-connected microfluidic channels that are aligned parallel to the shearing direction of the quartz crystal (below, panel a). The microfluidic channels are fabricated on the active region of a quartz resonator (where top and bottom electrodes overlap). Figure panels a-c shows the dissipation response of a 3-channel nanovisQ™ for 3 resonance modes when 5 μl of 40% wt. glycerol-water solution is applied to the inlet. This trace is characteristic of the nanovisQ™ technology. When the fluid front reaches the edge of the active region, the dissipation change slows down and thus creates plateau-like steps (marked with arrows) in the signal. The steps are more defined for the higher modes compared to the fundamental (1st, 5MHz) mode, because the shearing amplitude is more focused to the active region center for higher modes.³⁸ Current deployments of nanovisQ™ utilizes only 3rd mode, that is 15MHz signal. The steps in the dissipation signal, indicate completely filled channels , which can be mapped to distance vs time curve (panel c). Since the flow velocity decreases with \sqrt{time} in capillary flow of Newtonian solutions, the steps get wider (i.e., take longer time to fill) over time. The \sqrt{time} dependence can be seen in panel c (red line is the simulation for this sample). This regime is used to calculate viscosity in the first shear regime (100- 100,000 s^{-1}).

High shear-rate viscometer function of nanovisQ™

The amplitude of each step is used to calculate the viscosity at high shear-rates (panel b). Similar to conventional polished crystals, the dissipation observed is proportional to the $\sqrt{viscosity/shearrate}$. By tracking multiple, odd resonance modes of a quartz resonator, the viscosity can be measured at different high-shear-rates. Viscosity at 15 MHz is measured.

Product and Materials

Parts

Parts and Reagents Supplied by QATCH	Equipment to be supplied by User
nanovisQ™ solo Instrument	Pipettor and Tips
nanovisQ™ solo Sensors (30)	Laboratory wipes
nanovisQ™ solo User Manual	Control Laptop (if not supplied by QATCH)**
nanovisQ™ solo Power Adapter	
Dual-USB cable	
5 A fuse	
Barcode scanner with stand	
10 cP viscosity standard	
Control Laptop (if selected)*	

*nanovisQ™ software will be pre-loaded onto control laptops provided by QATCH

**nanovisQ™ software can be downloaded from <https://github.com/QATCH-Technologies/nanovisQ/releases/latest>. Scroll to “Assets” and select “QATCH.installer.exe” to download the installer. Once downloaded, run the installer and complete installation following the on-screen steps.

Computer Specifications

Operating System	Windows11 Home/Pro/Enterprise (64-bit)
Processor (CPU)	Mminimum: 4 physical cores (8 threads recommended) Architecture: x86_64 (Intel or AMD)
Memory (RAM)	Minimum: 32 GB
Storage	Minimum: 256 GB
GPU Accelerator	<i>Optional, but recommended</i> Minimum: NVIDIA GPU with 4 GB VRAM (CUDA-capable) Latest NVIDIA Game Ready or Studio Drivers CUDA Toolkit 12.9
Connectivity	2x HID-compatible USB ports (USB-A strongly recommended; USB 3.0 or higher)

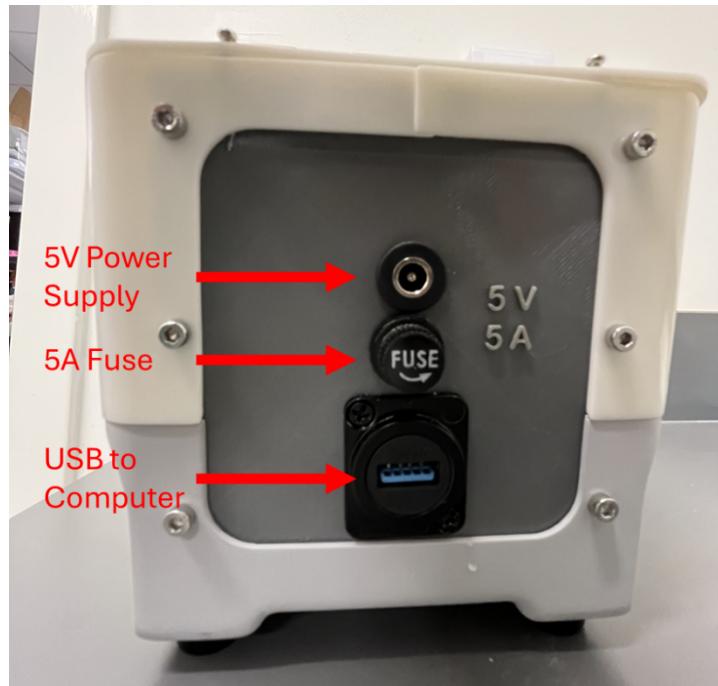
Measurement

Instrument Setup

1. Unpack your nanovisQ™ solo, which includes 1) nanovisQ™ Instrument, 2) nanovisQ™ sensor pouches, and 3) a barcode scanner.



2. First, connect the nanovisQ™ instrument to the laptop using the dual-ended USB connector. Connect the power-cord and plug into an outlet.



3. The nanovisQ™ data collection is powered via the USB connection. When connected, the nanovisQ™ instrument boots.

The power-cord connection powers the temperature control. The instrument will collect data at room temperature without this connection and will not alert the user of non-connection unless temperature control is initiated. The temperature reading will be inaccurate unless temperature control is active.



Attention!

The power supply on the back of the unit has to be connected when using the temperature control. If wall power is not connected, there will be no error messages until temperature control is initiated. It is recommended that wall power be connected at all times for improved internal ventilation.

Data Collection

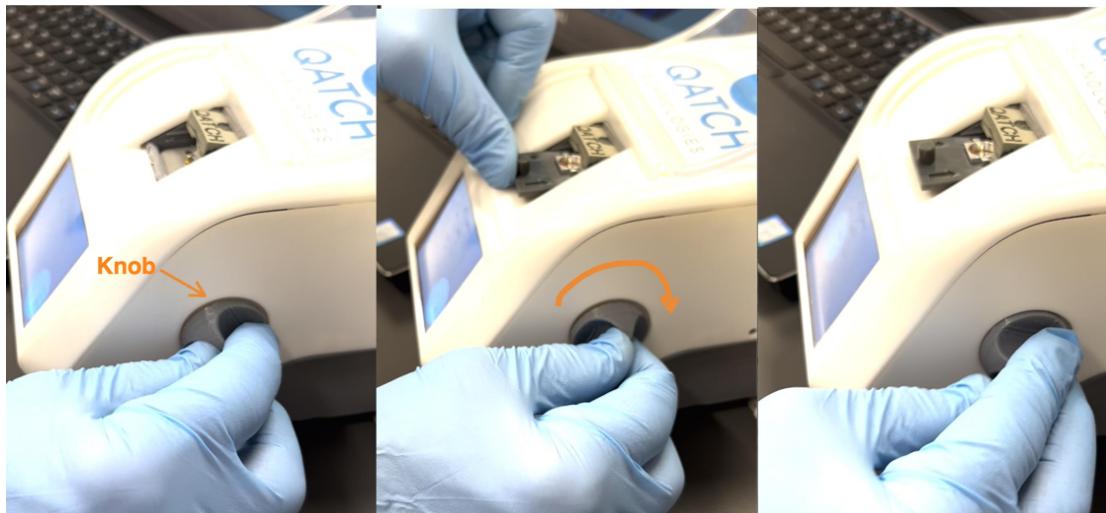
1. Open the nanovisQ™ software by double-clicking the desktop icon.



2. Tear a nanovisQ™ pouch open and do not discard the pouch (it contains information which will be entered later). Remove the sensor from the pouch, gripping the sensor by the end with the arrows, which show the correct orientation to insert into the nanovisQ™ instrument. The sensor is packed in ethanol. Allow the sensor to air-dry ~30 seconds.



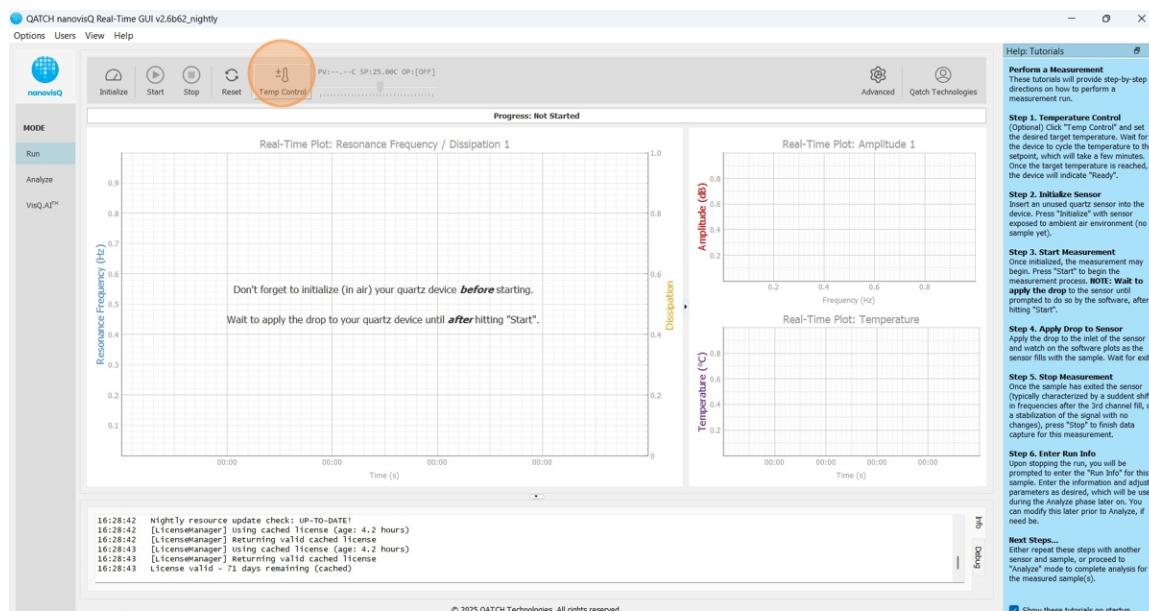
- Insert the sensor into the instrument housing. Turn the knob on either side of the instrument toward the rear (clockwise when looking at the right side of the instrument). One-quarter turn is sufficient. Slide the sensor into the instrument until fully seated. Release the knob to lock the sensor in place.



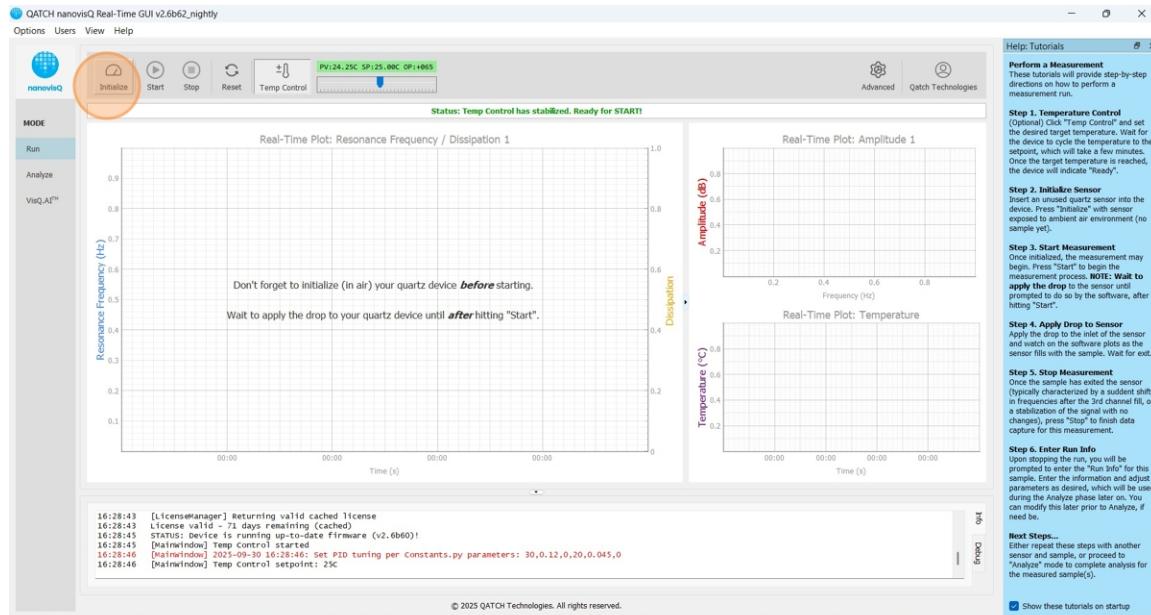
Attention!

Do not force the sensor in or out without turning the knob. Doing so may cause permanent instrument damage.

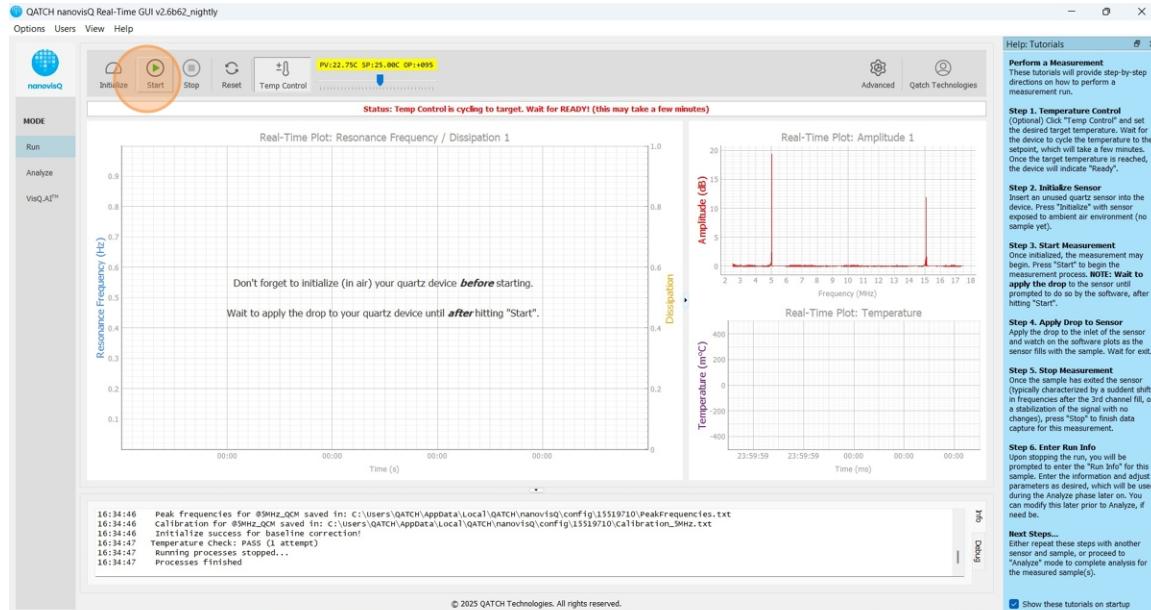
- In the nanovisQ™ software, click "Temp Control". Once activated, use the slider to the right to indicate setpoint temperature.



5. Click "Initialize". after the current temperature (PV) is close to the set-point temperature (SP). A few seconds after "initialize", "Real-Time Plot: Amplitude 1" shows two peaks. The first peak has to be close to 20 and the second peak has to be at least over 12.



6. Click "Start" after the temperature bar turns green. This will start the measurement on the sensor. Two lines will appear, one is the Dissipation and the other is the Frequency, with mirroring behavior. The baseline dissipation on the screen is expected to be between 18 and 40.



7. If there exists drift in the dissipation signal with negative slope, it is likely due to evaporation of residual packaging ethanol. Baselines must be stable for high data quality. If drifting, or if the sensor is out of the acceptable range, wait a few more minutes, "Initialize" and "Start" again. If the traces are noisy, it may indicate a contact problem, and the sensor should be removed and inserted again.



8. After the measurement is started with stable baselines, apply 3-5 microliters of the drop to the inlet of the sensor. When placing a drop, it is recommended to expel the drop from the pipette by depressing the plunger to the first stop, thereby suspending the droplet from the tip of the pipette. Then, gently place the droplet on the inlet of the sensor, withdrawing the pipette tip from the sensor once the droplet has been applied. A training video covering drop placement is available at https://www.youtube.com/watch?v=wakJ_btcP18



- If you are testing a biological solution, especially with high concentration, it is recommended to increase the humidity of the chamber by applying a wet kim-wipe around the sensor and closing the lid. Make sure that the kim-wipe does not touch the sensor.

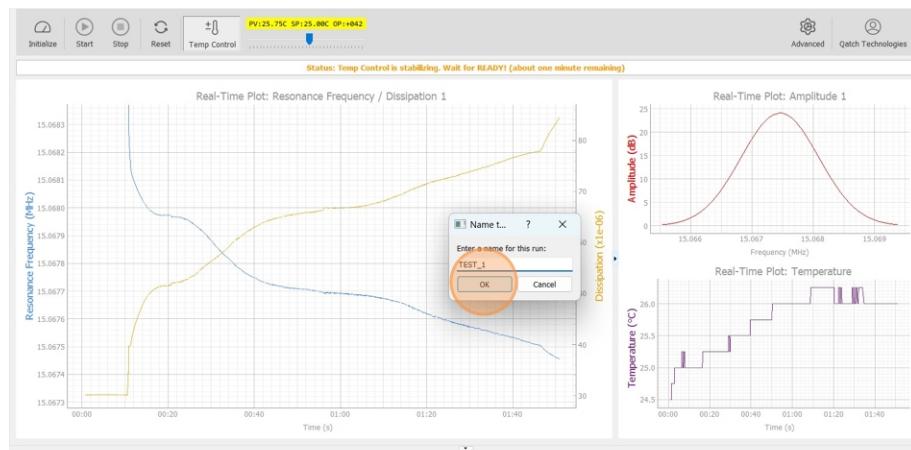


- The measurement baselines will change rapidly as the user applies the drop to the sensor. Two lines will appear, one is the Dissipation (yellow) and the other is the Frequency (blue), with mirroring behavior. Once you observe 3 steps or 3 obvious inflection points, Click "Stop".

For very viscous samples, you may only observe only 1 or 2 steps in 10 minutes, it is again recommended to click "Stop" in 10 mins. Viscosity will be calculated with the available data. If 3 channels are not observed during the measurement, either due to high viscosity material or premature stopping of the measurement, the “Auto-fit” function in data analysis may yield errorous results and manual adjustment may be needed to analyze the data. The temperature may drift one degree around the target temperature during the measurement. This drift will be lower if you wait longer for the temperature to stabilize.

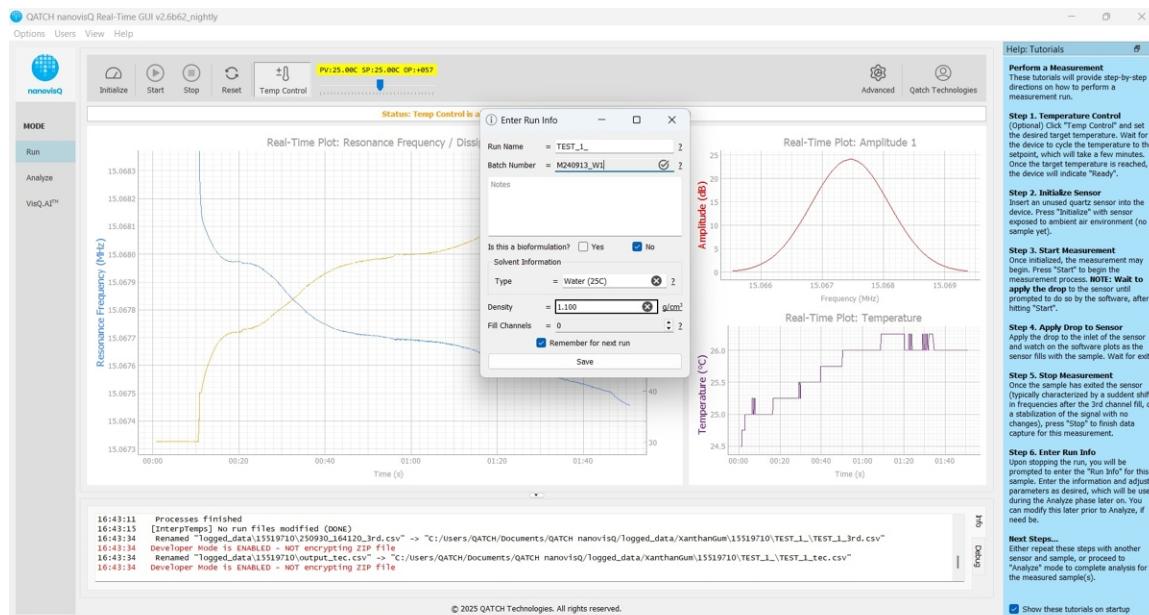


11. The software will ask for a name to record the data. Enter a unique name and then Click "OK".



12. A window will appear to enter "Run info" specific to the sensor and the sample. "Run Name" will autofill from your entry in the previous pop-up. The second field, "Batch Number" will be highlighted. Scan the barcode printed on the sensor pouch using the barcode scanner to import the calibration parameters. A checkmark will appear in the right side of the box. If, instead, an "x" appears, check to make sure it was entered properly. The "Notes" field is for user to enter details that may help them when revisiting the data. The notes taken here will save as a ".txt" file in the data folder for future reference.

Below the "Notes" field, select whether the sample is a bioformulation or not. For this analysis, protein and viral vector samples are considered bioformulation. If the answer is "No", select the primary solvent of the solution. Solvents in database will appear as you type, and density will autofill if you select a pre-loaded solvent. If, however, the concentration of solutes or co-solvents is sufficient to change the density of the solution, you may enter the correct value.

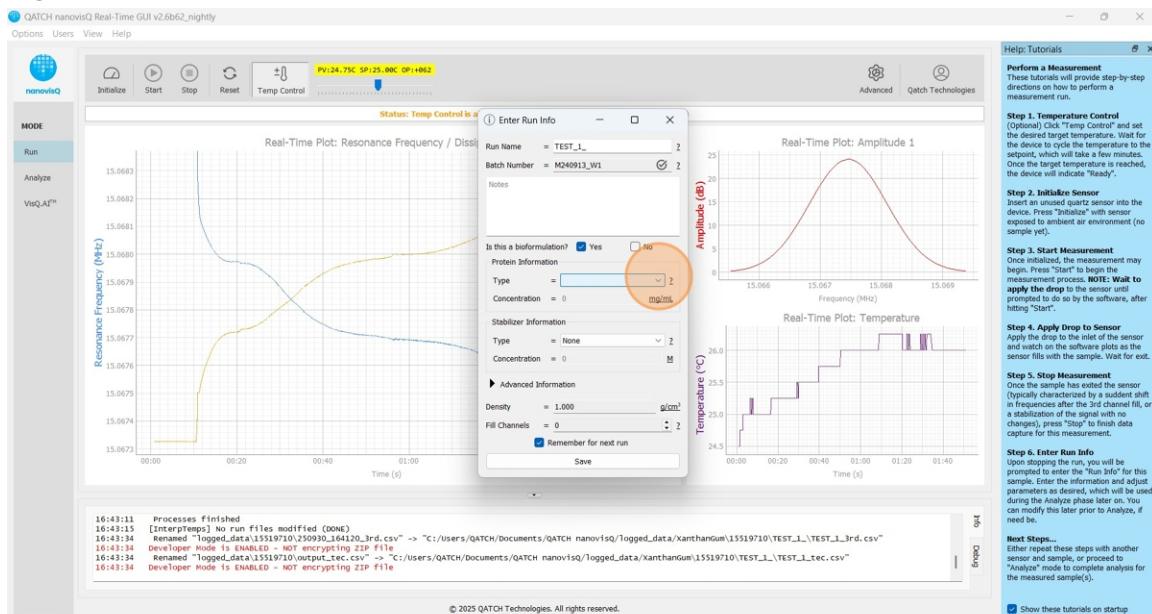




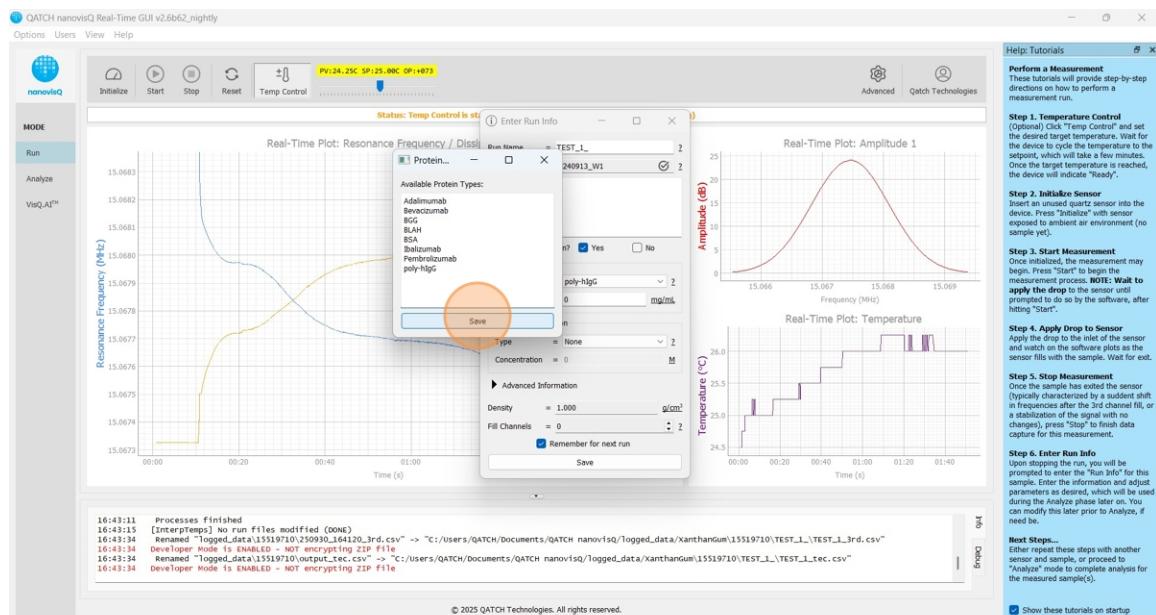
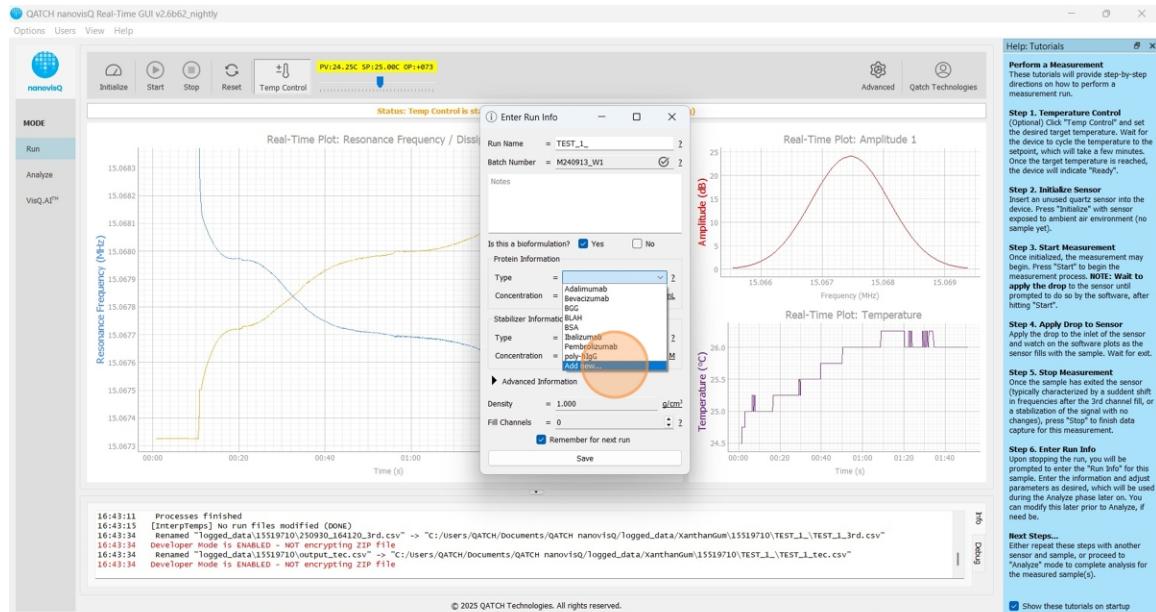
Tip!

Estimated Parameters that have been modified from their recommended values will indicate the grey circular “X” button on the right side of the text box (see Density in the above image). You can click on an “X” to restore the recommended value for the corresponding parameter to match the given solvent or concentration entries.

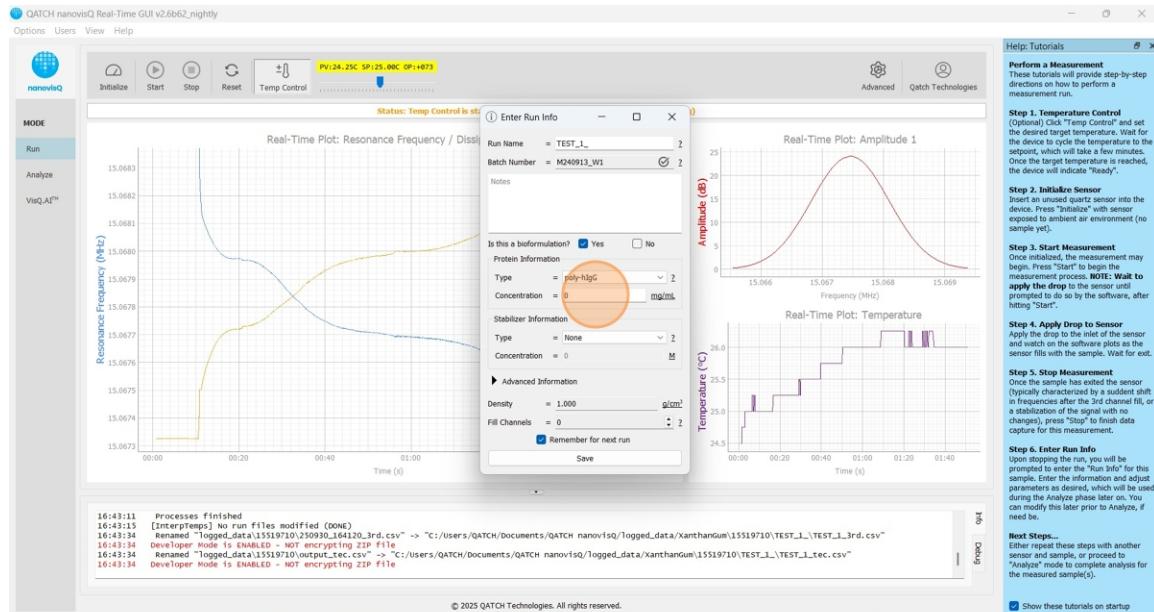
13. If you had applied a bioformulation, select "yes". In the first panel, select your protein from the dropdown menu and enter the concentration in mg/ml. If viral vector is being tested, the concentration should be the "mg/ml" equivalent of the capsid mass, which is usually less 2 mg/ml.



14. If you applied a protein which is not in the dropdown menu, you can enter a new protein by selecting “Add new”. Enter the name of the new protein in the pop-out menu and select “Save”. The protein name being entered is again for the user’s records and does not change the analysis.



15. Repeat this process for each panel to enter the buffer system, stabilizers, surfactants, and salts. Some panels may be hidden and are accessible by selecting “Advanced Information.” As with non-biological samples, the density will auto-populate but can be manually entered as well.

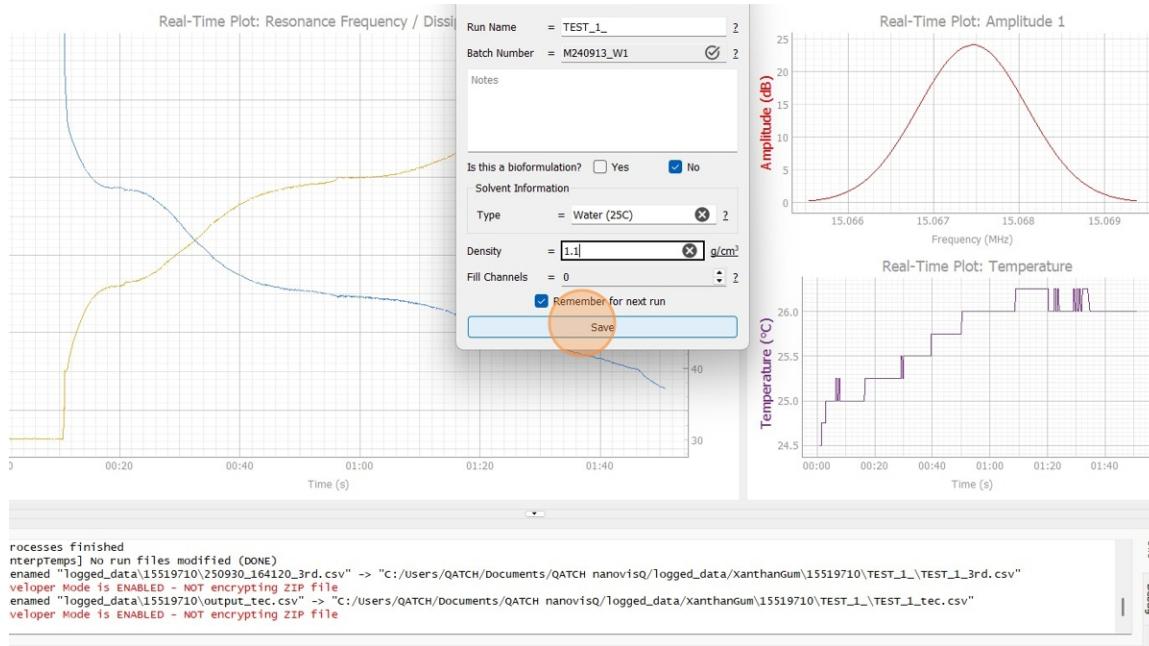


Tip!

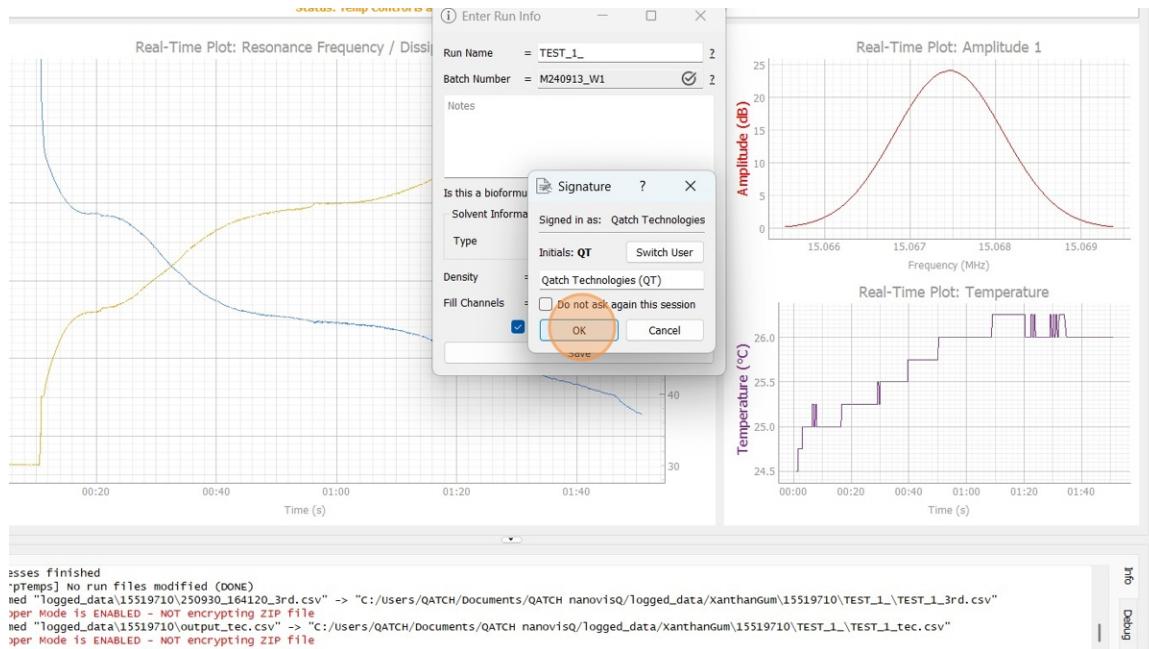
The Identity of the protein is not critical for analyzing the viscosity. It is stored as metadata to help the user identify trends across proteins. The viscosity reading will return the same regardless of which protein is selected.

Protein concentration, however, may impact data analysis. If an independent measure of density is available, it is advisable to enter this number directly. However, the software will calculate density based on the inputs the user provides if an independent measure is not available. Density only affects the 15 Ms^{-1} data point and it is enough to be within %10 of the actual value.

16. Once you are done entering the "Run Info", click "Save".



17. Check if the user doing the test is the same as the user shown here. If not, switch user. Then, click "OK".



18. If you want to test another sample, remove the nanovisQ™ cartridge while turning the knob clock-wise. Then, repeat starting from Step 4.

19. If you are done taking measurements, turn off the "Temp Control". The instrument will vent for four minutes.



Tip!

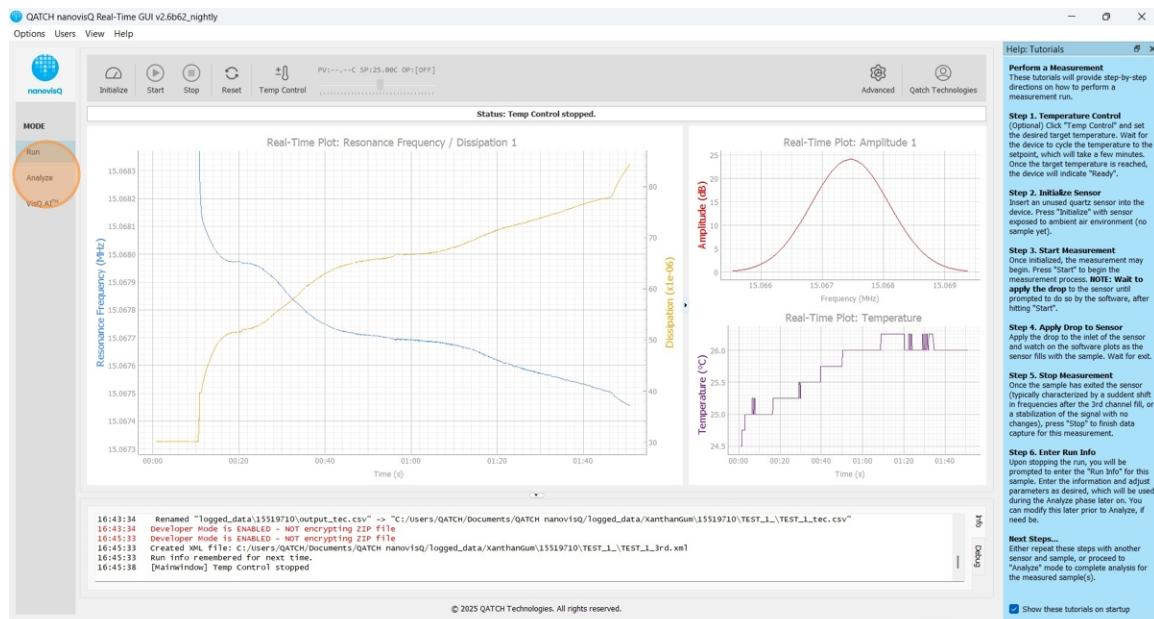
To streamline your data collection, it can be useful to establish your workflow thusly for all but your first and final run:

- 1) Open your next sensor approximately 2 minutes before your current run will end.
For low-viscosity samples, open the next sensor before pressing “start”. For high viscosity samples, open approximately when you hit the second plateau.
- 2) Finish your existing run, as normal.
- 3) Before moving on to data analysis, insert the new sensor and initialize.
- 4) Analyze data from existing run. The time spent analyzing the data from your current sample will give ample time for ethanol evaporation and temperature equilibration on your next sample.
- 5) Return to “Run” tab to run your next sample.
- 6) Repeat as necessary

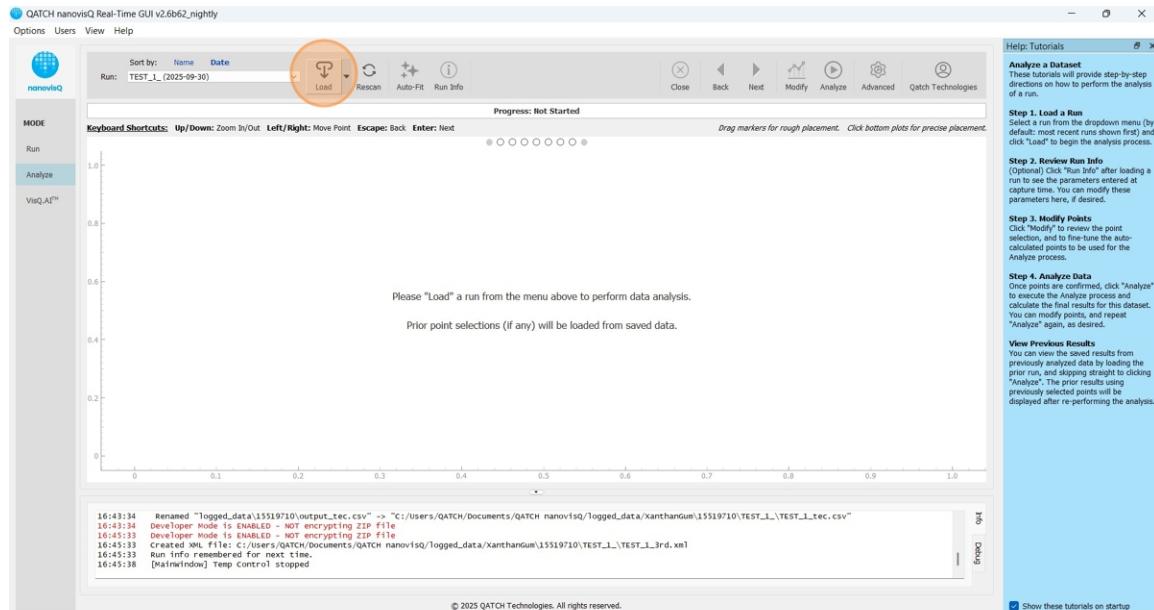
Data Analysis

Individual Analysis

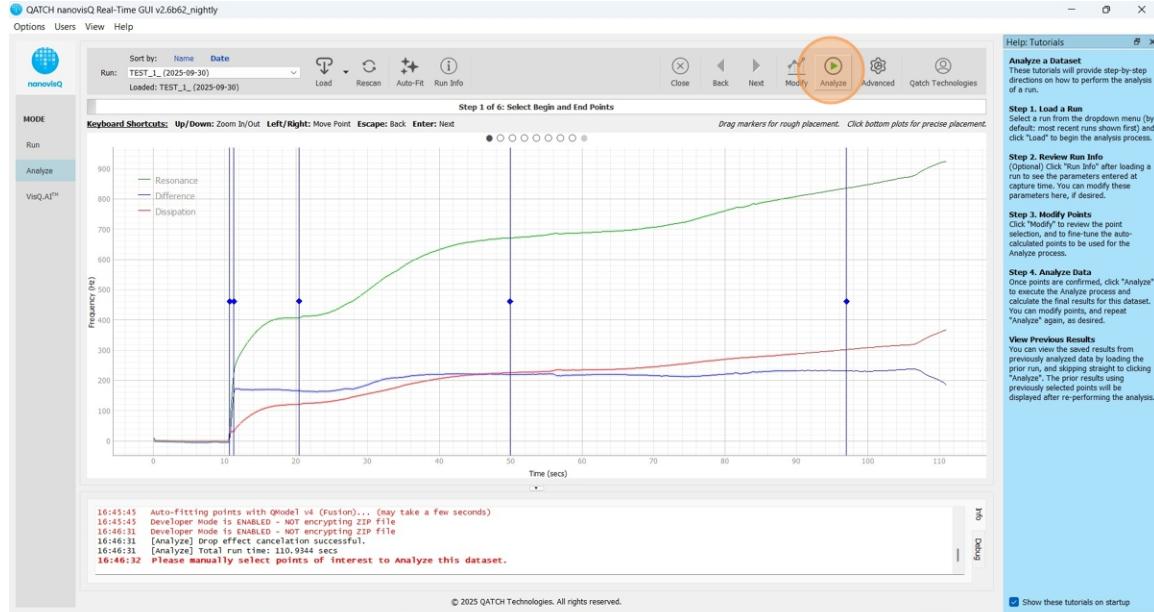
- To analyze your nanovisQ™ data, select the "Analyze" tab from the side-panel.



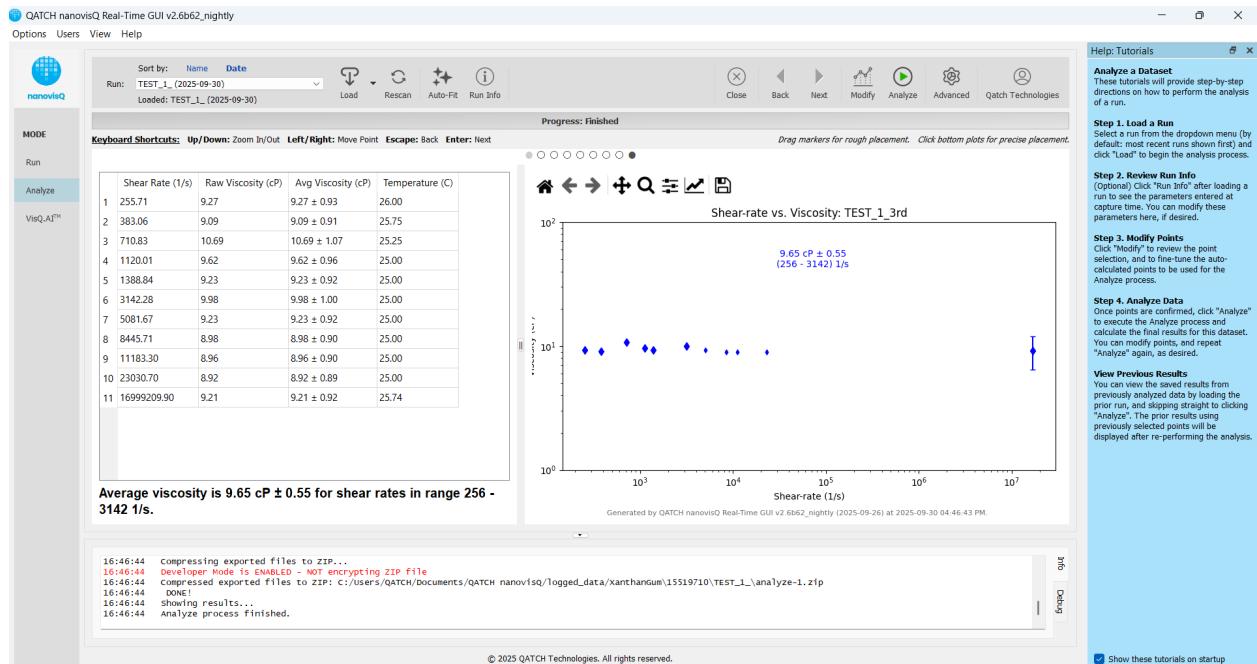
- Select the data to be analyzed from the “Run” dropdown menu. The most recent data will be loaded first, and often does not need to be changed. Click "Load".



3. After the data is loaded, the software uses a feature-recognizing machine learning algorithm to select points of interest to guide the user. 5 blue vertical lines will appear on the data, with two appearing immediately after drop application and one at each inflection point. Visually verify that the points occur in the correct locations, and select “Analyze”.

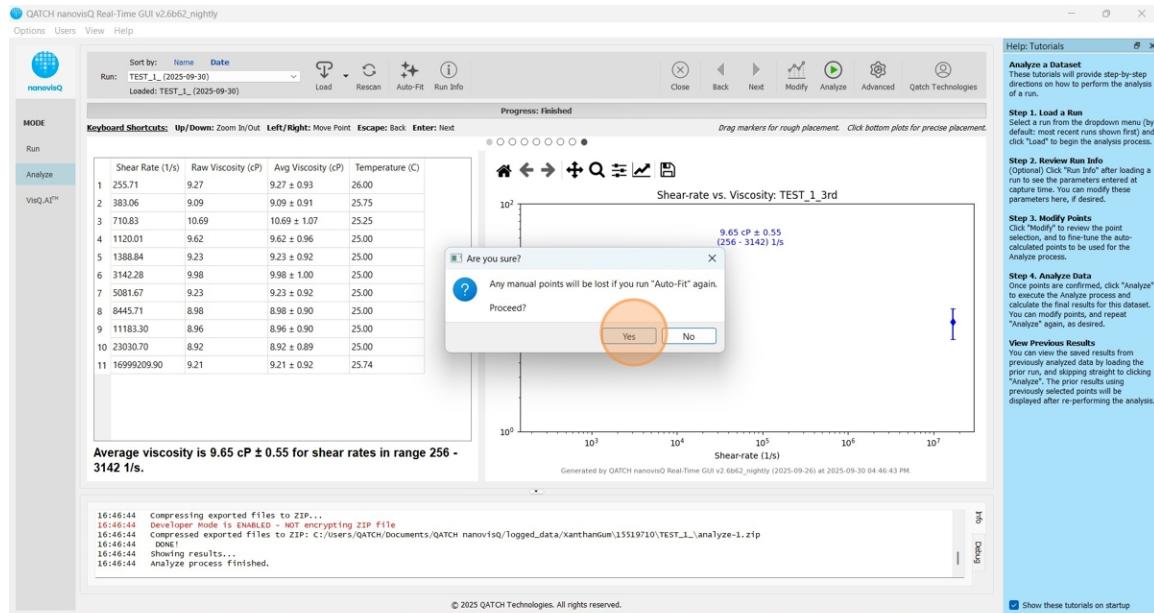


4. The software will analyze the run and calculate viscosity at various shear rates. A table with shear-rate, viscosity, and temperature data will be displayed to the left. On the right side, a logarithmic plot will display viscosity vs shear-rate. The plot and the table are also saved in a folder under the file-name for future use. An average over low-shear is calculated and reported on the graph and below the tabular data.

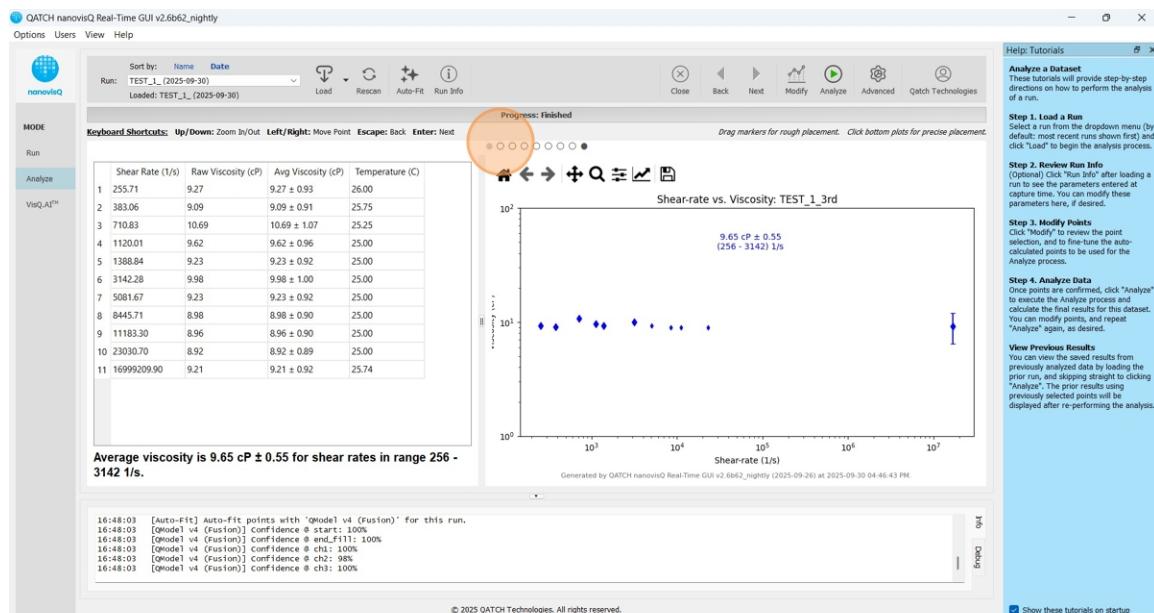


Manual Point Selection

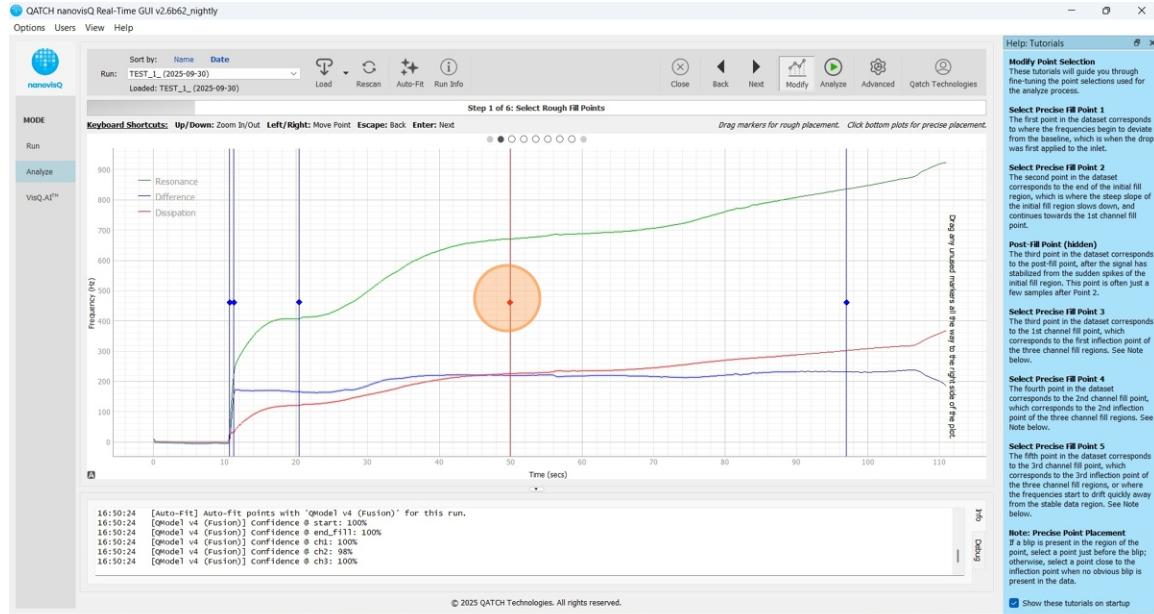
- Automatic point selection is typically sufficient for most samples. However, for some datasets, you may need to select the points manually. If you had previously moved any of the points-of-interest and would like to revert back to the ML-generated points, click "Auto-Fit". When prompted to verify your changes, select "yes".



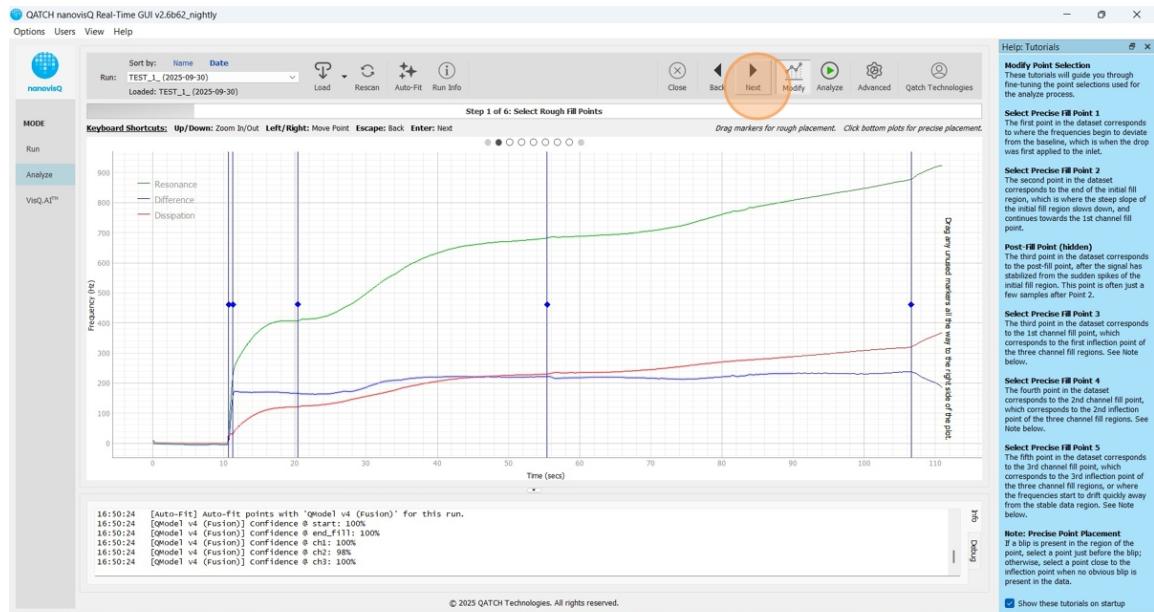
- If you'd like to manually select points-of-interest, click the first "O".



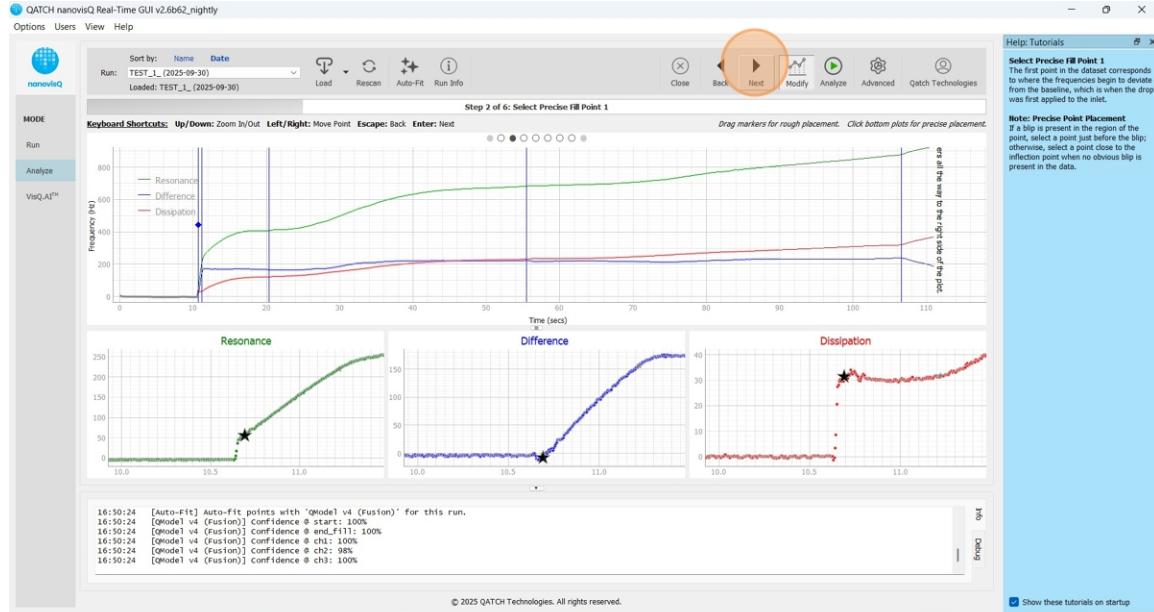
3. Manually adjust rough POI locations by dragging the vertical lines. If any points are to be discarded (for example, if only two plateaus appear), drag any unused points all the way to the right and they will not be included in the analysis.



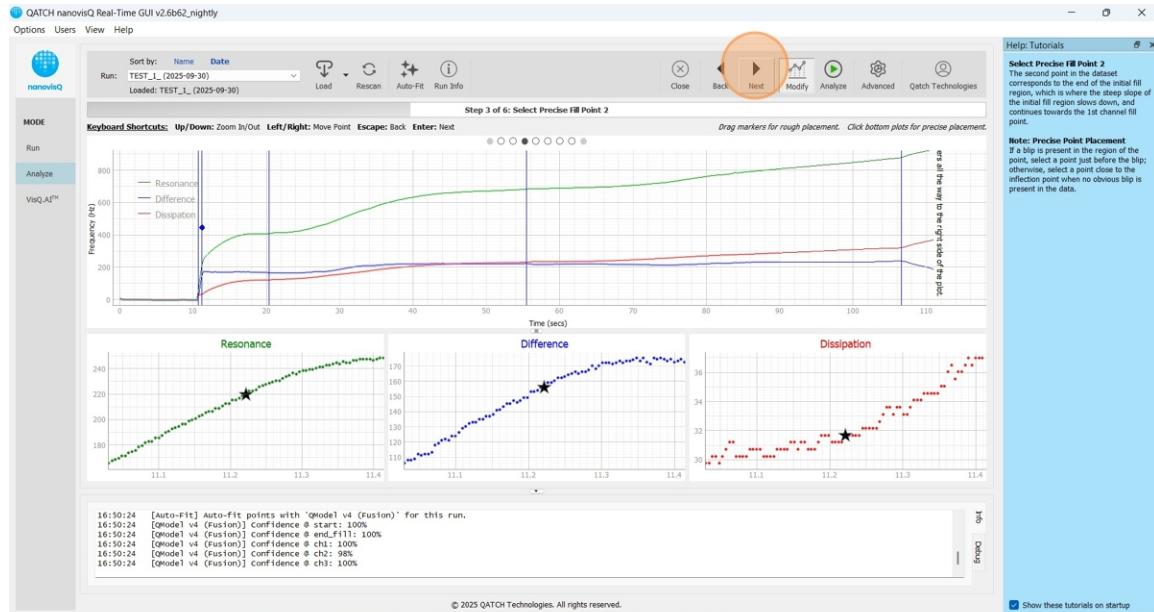
4. Use the Back/Next arrows on the ribbon or click to the desired point on the screen to pick the right location for the 1st point (black star).



5. The next series of panels will be used to fine-tune the location of the POIs. The first point marks the exact moment the solution is drawn into the channels. Therefore, it should be placed after "Dissipation" (the figure most to the right) is increased and the "Difference" (center figure) starts rising above the baseline. When you are done, click "Next".

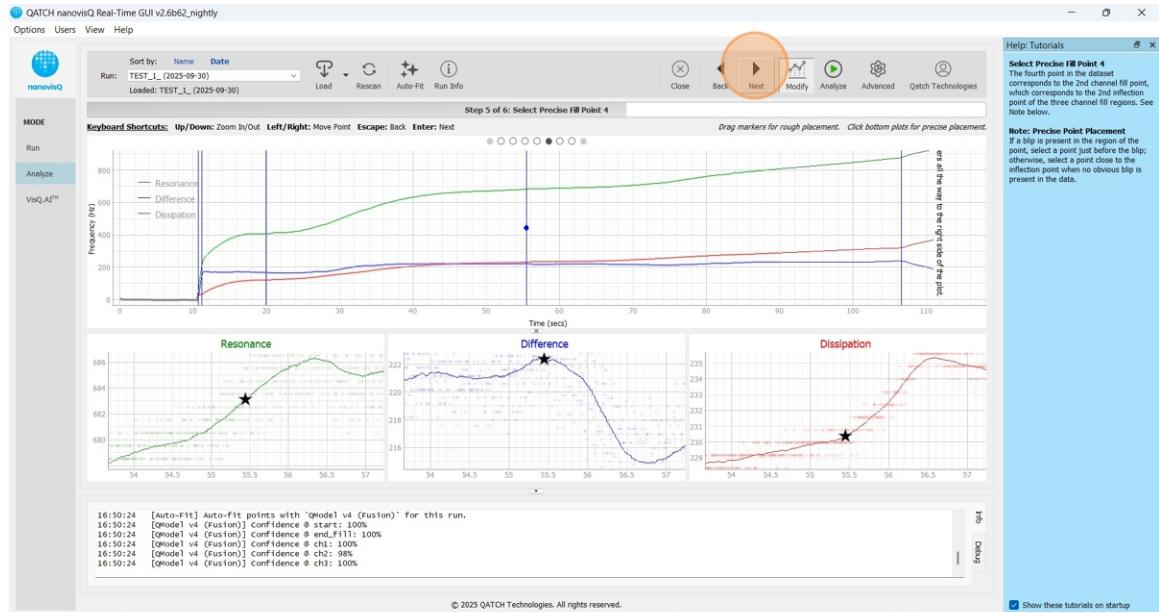


6. The next point shows when the first rapid filling region is reached. The point has to be placed to a location that is before the "Dissipation" starts rising rapidly and before the change in the "Difference" curve slows down. After picking the point (black star) by arrows in the keyboard or clicking the desired point, click "Next".

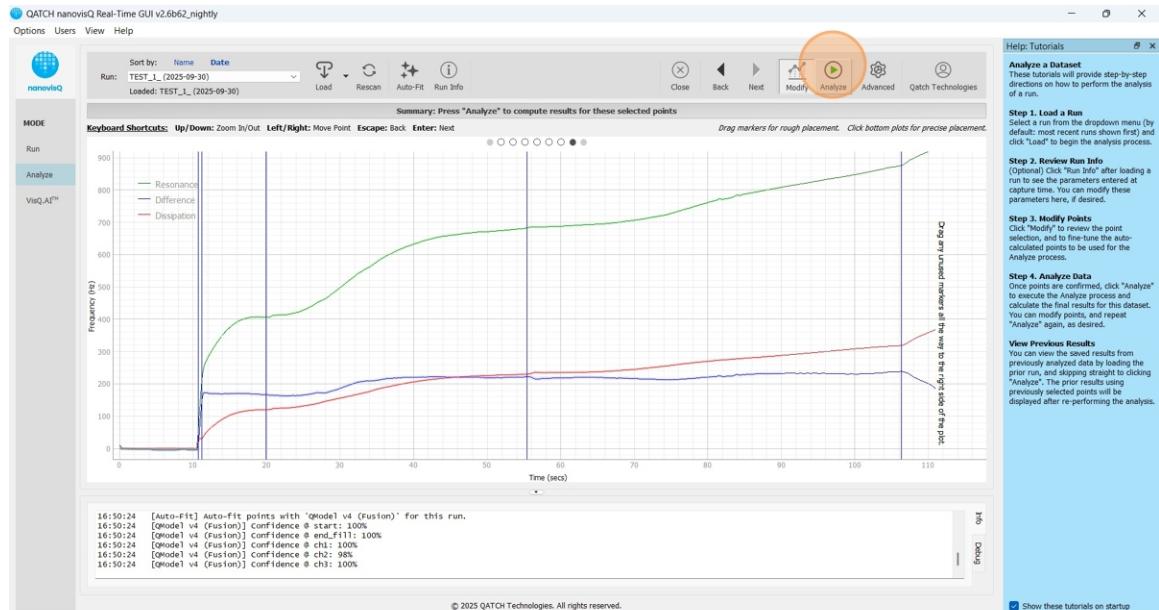


7. Discrete points will not be shown for the 3rd, 4th, or 5th point. For each of these POIs, the point should be placed before the dissipation inflects upward. This also often corresponds to a local peak in the difference plot. Note that, for higher viscosity samples this inflection may not appear, and the dissipation would rather appear a long plateau. In this case, pick the center of this plateau.

The 5th POI shows the exit of the sample solution from microfluidics. For some samples, this will be an abrupt change in "Dissipation", "Difference", and/or "Frequency". For some samples, it may look like a prolonged plateau and pick the point where the change stops. Once satisfied with the each point, click "Next" to progress to the next POI.



8. After selecting all 5 POIs, select "Analyze".



If you want to go back to doing another measurement, click "Run", remove the sensor from the instrument while turning the knob clock-wise (if not removed earlier) and repeat from Step 6.

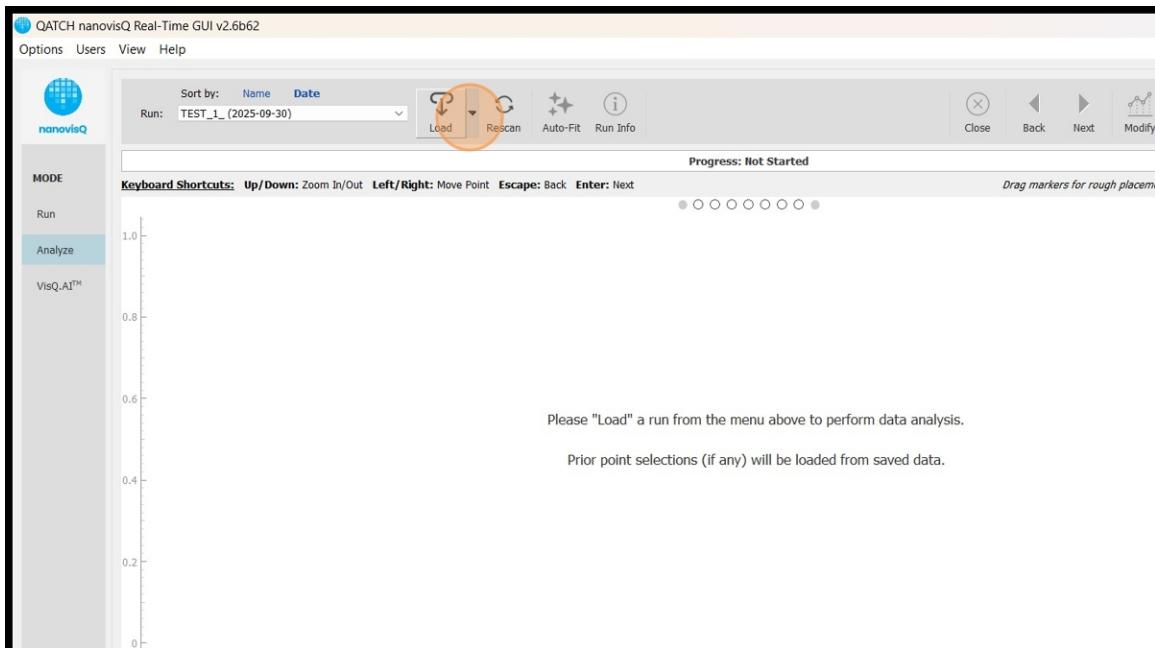


Tip!

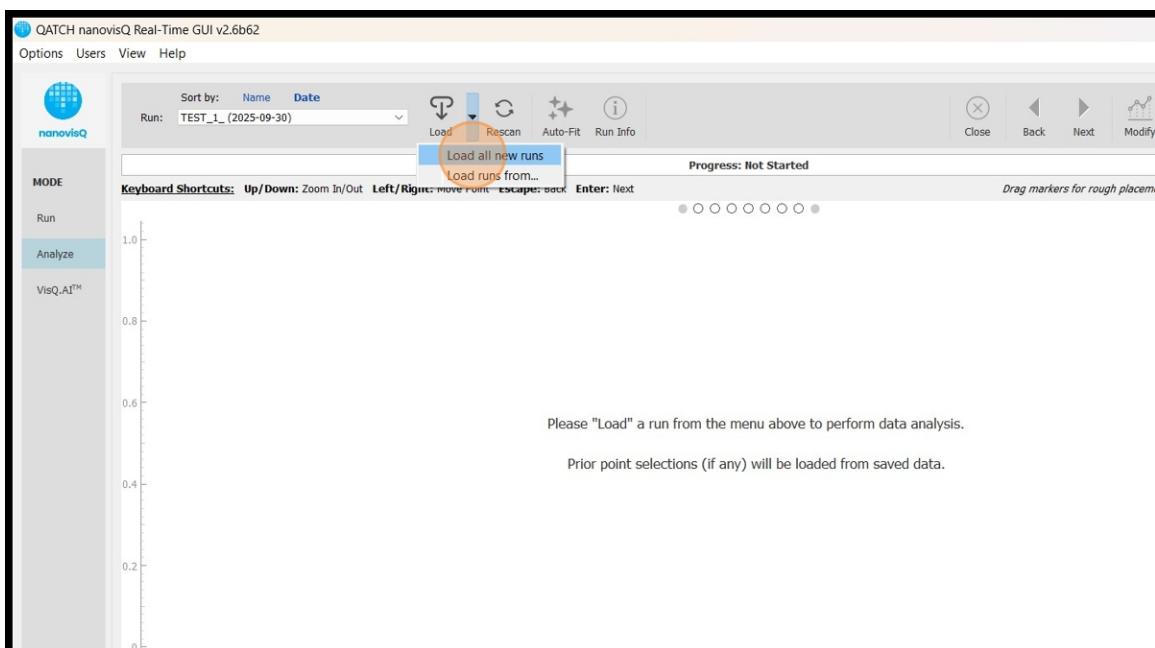
Your data, exported files, and .pdf graphs can be found within Documents>logged_data>[device ID]>[Run Name], where [] indicate folders with variable names. Your device ID will be a string of numbers and run name will be user defined when saving data.

Batch Analysis

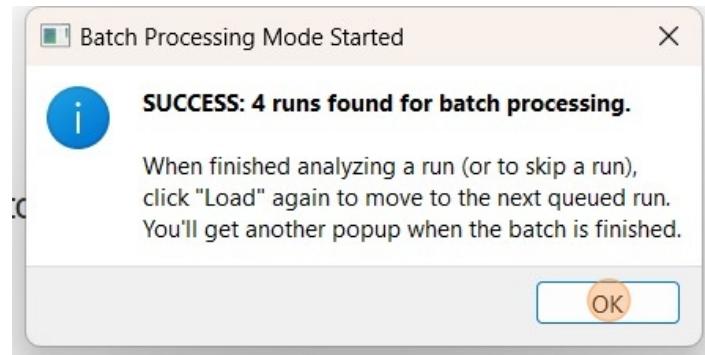
- If you chose to collect all of your data and analyze all at once, you can expedite your data processing by performing “Batch Analysis”. Click the down arrow next to “Load”.



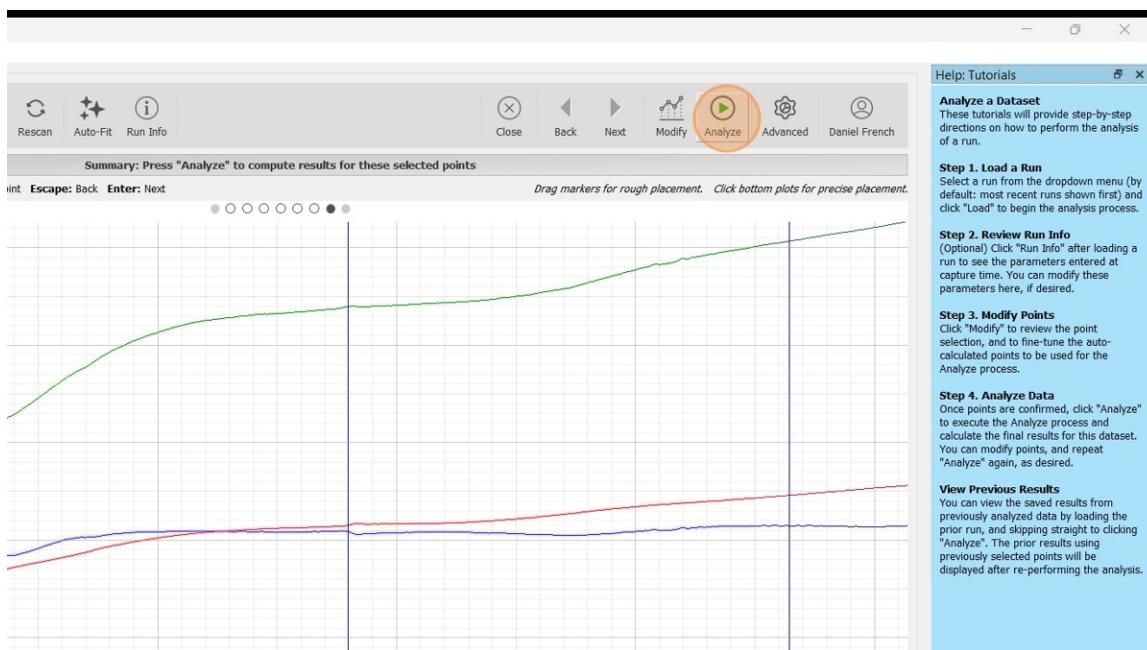
- Click "Load all new runs"



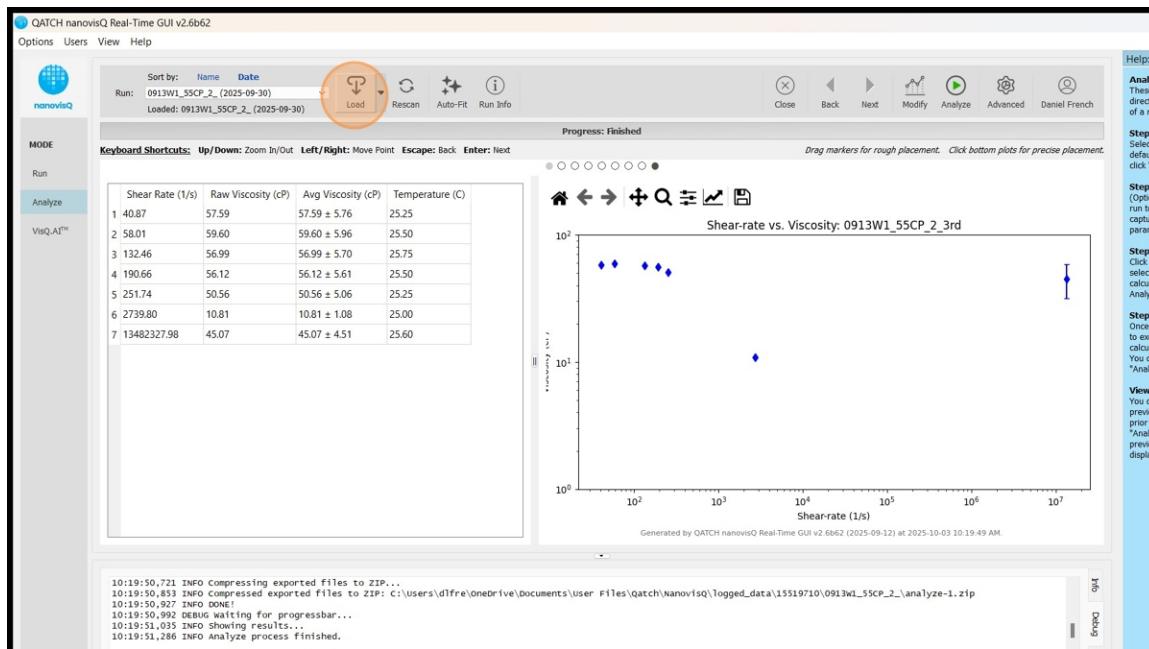
11. The software will find all runs in the current working directory which have not yet been analyzed. Click "OK".



12. Perform "Analyze", as normal.

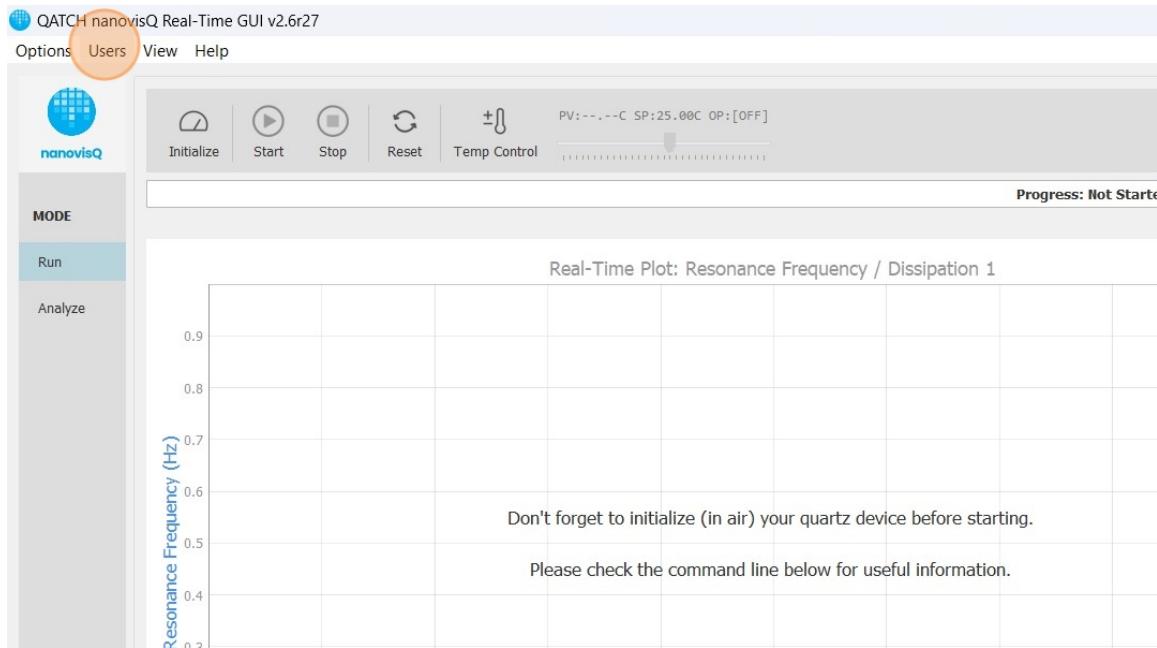


13. Instead of having to use the dropdown and find which specific files haven't been analyzed, you can now click "Load", and the software will load the next un-analyzed dataset. Repeat for as many samples as desired.

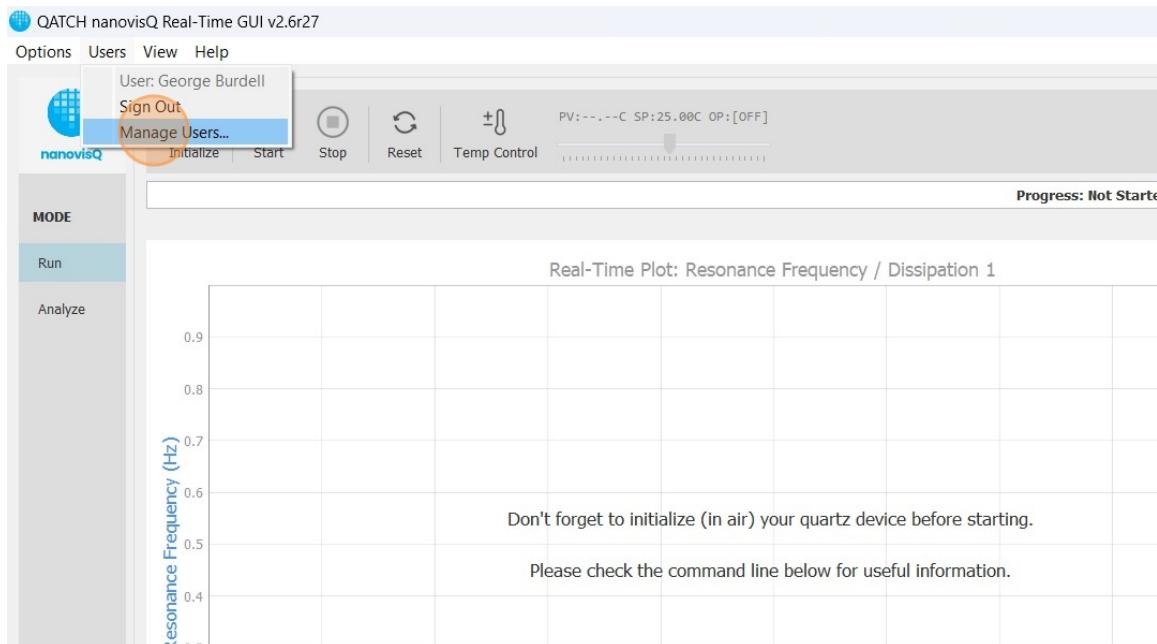


Adding and Managing Users in QATCH Software

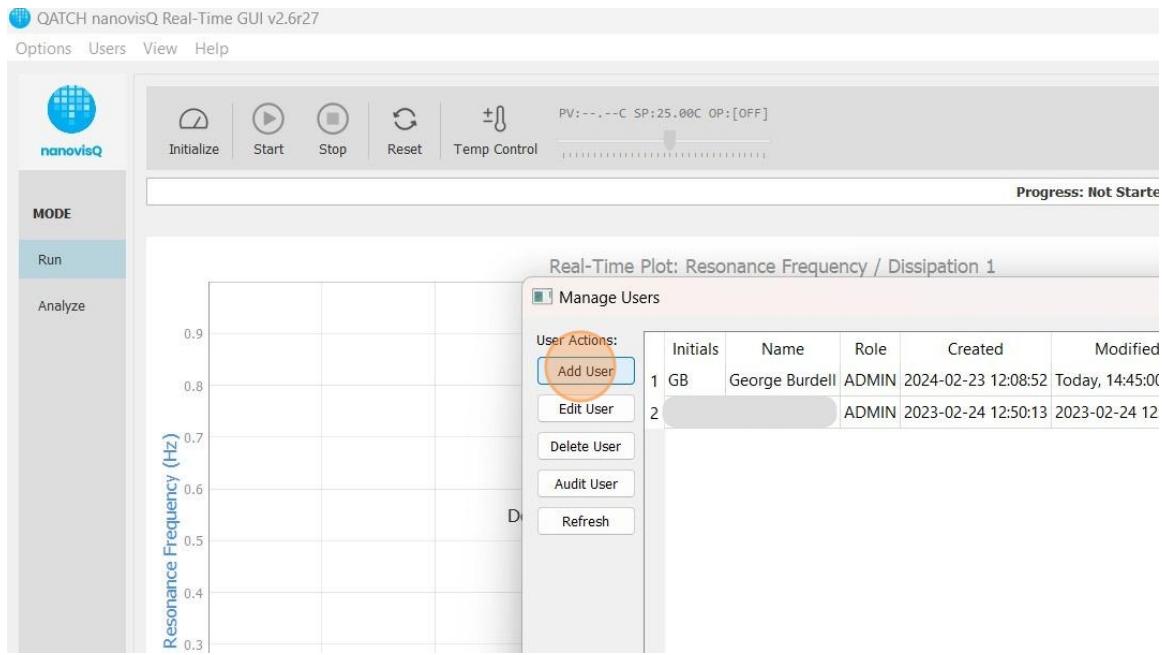
1. If you are using a computer supplied by QATCH, the software will have an administrator user account created by the QATCH Support. If you supplied your own computer, you will be prompted to create your first Admin user upon clicking “Users”. To create/modify existing users, click "Users".



2. Click "Manage Users..."



- To create a new user account, click "Add User"



- Pick what the appropriate role for this new user.

Roles:

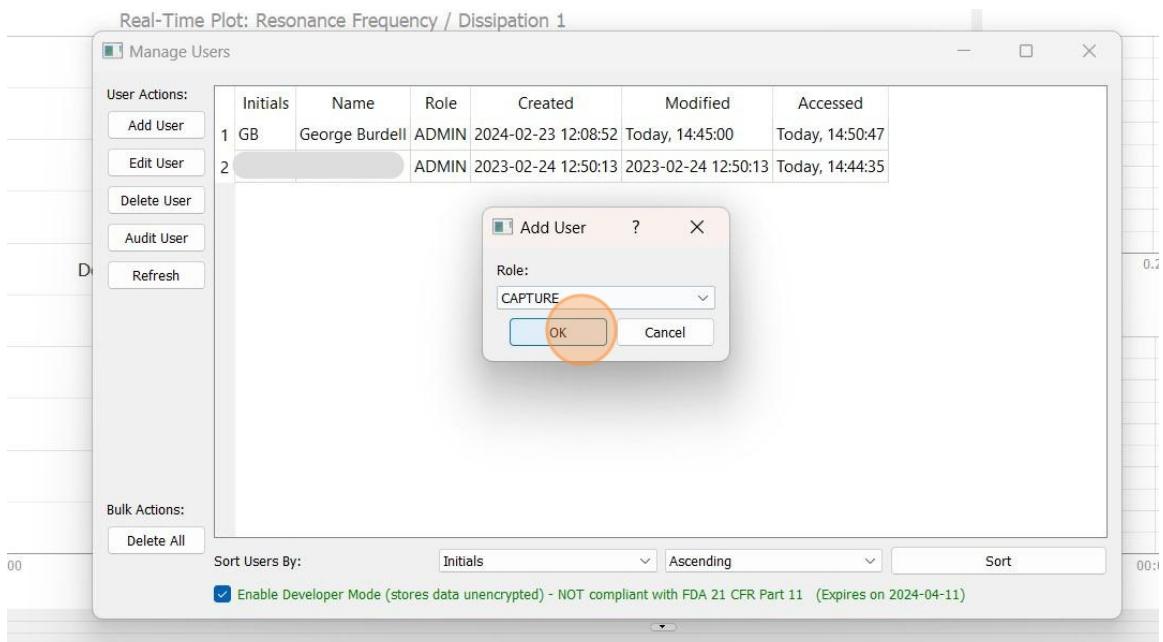
CAPTURE: Can only capture data but is not allowed to analyze.

ANALYZE: Can only analyze data but is not allowed to capture new data.

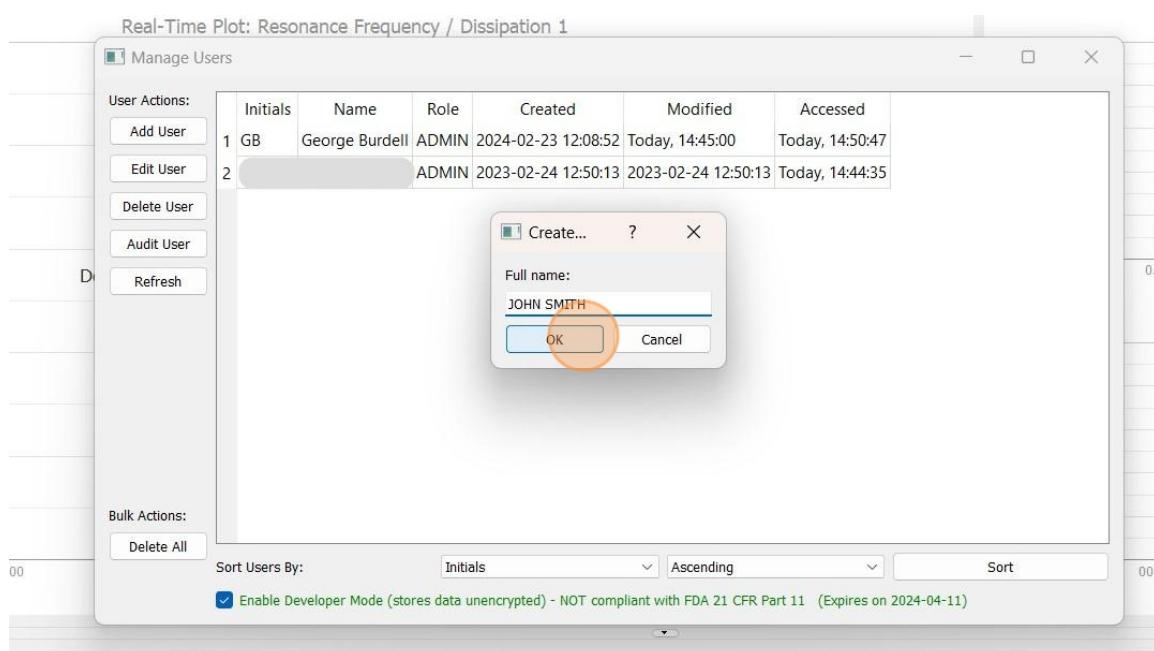
OPERATE: Can capture and analyze the data.

ADMIN: Can operate the system (capture and analyze) and also can add/edit/delete users.

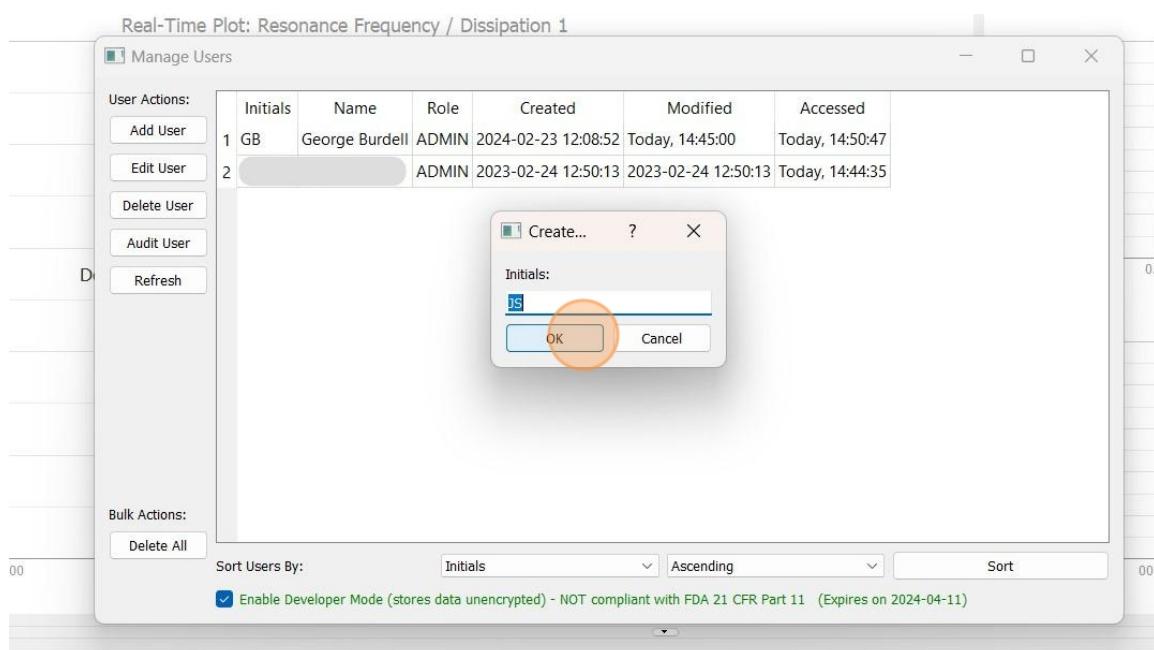
Click "OK"



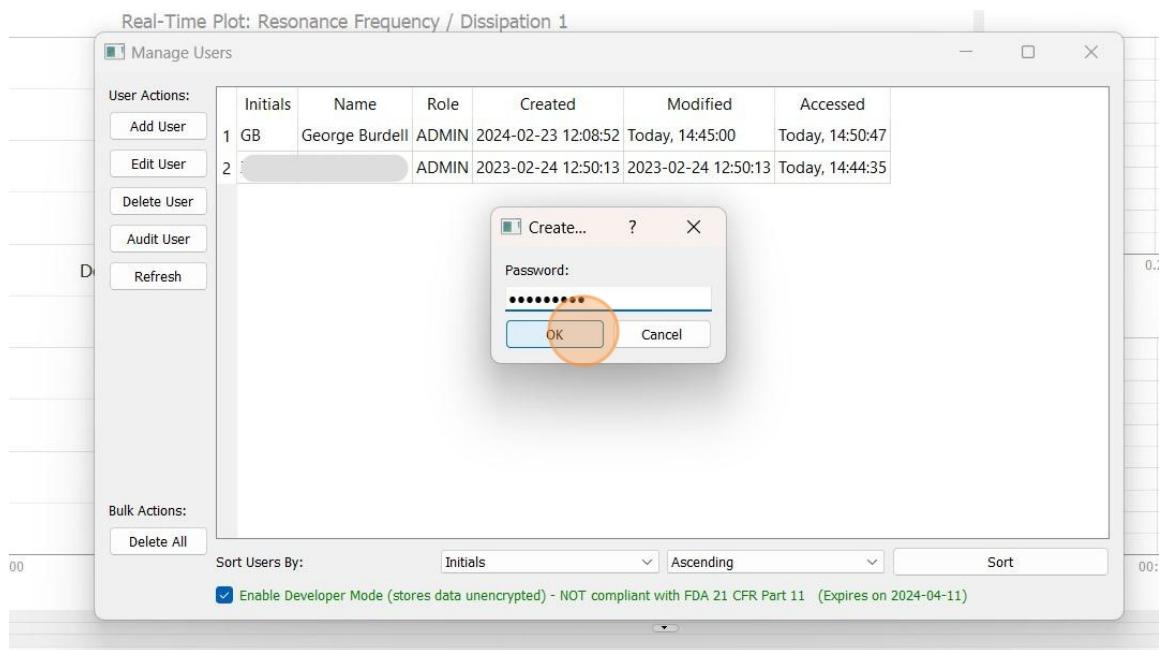
5. A dialog box will ask for the "Full Name" of the user. Enter the name and then Click "OK".



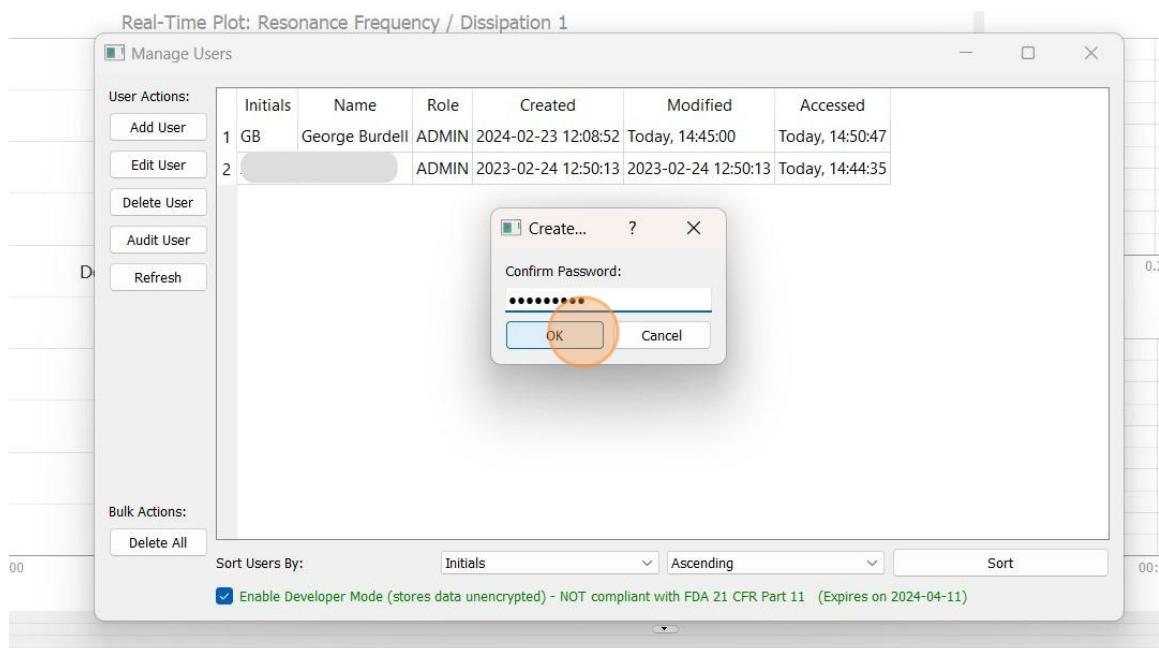
6. A dialog box will suggest initials for this user. You can change the initials or accept as is. Then, click "OK".



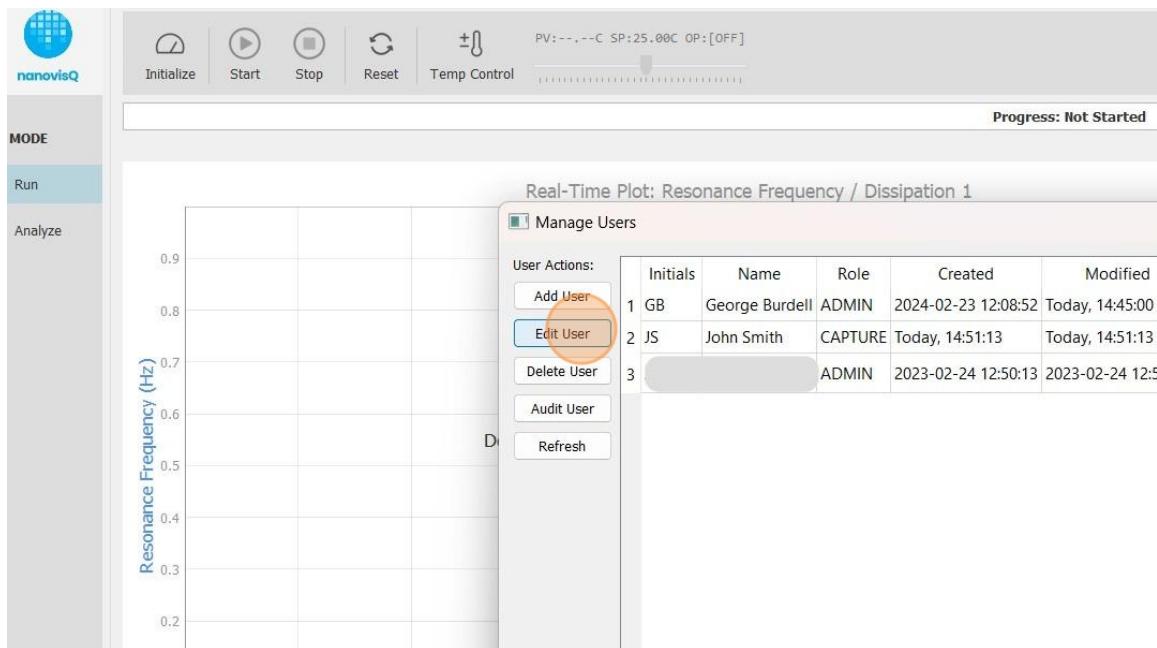
7. A dialog box will ask for a password. Enter a password and then click "OK".



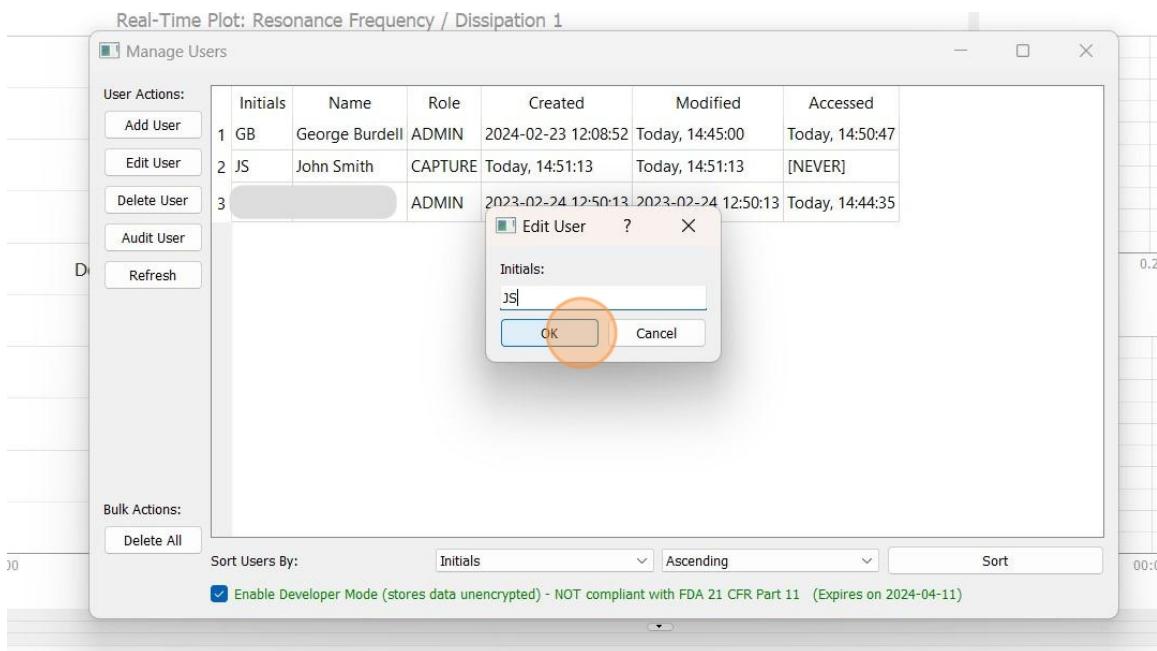
8. A dialog box will ask to confirm the password. Enter the same password. Click "OK"



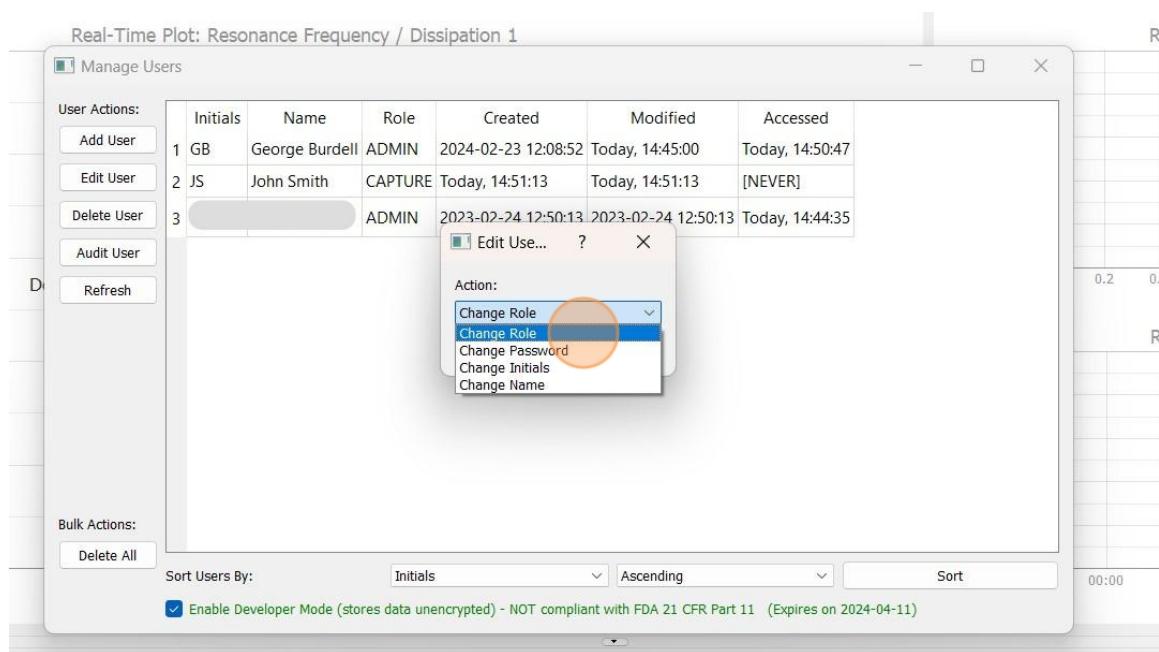
9. If you want to change "Role", "Name", "Initials", or "Password" of an existing user, click "Edit User"



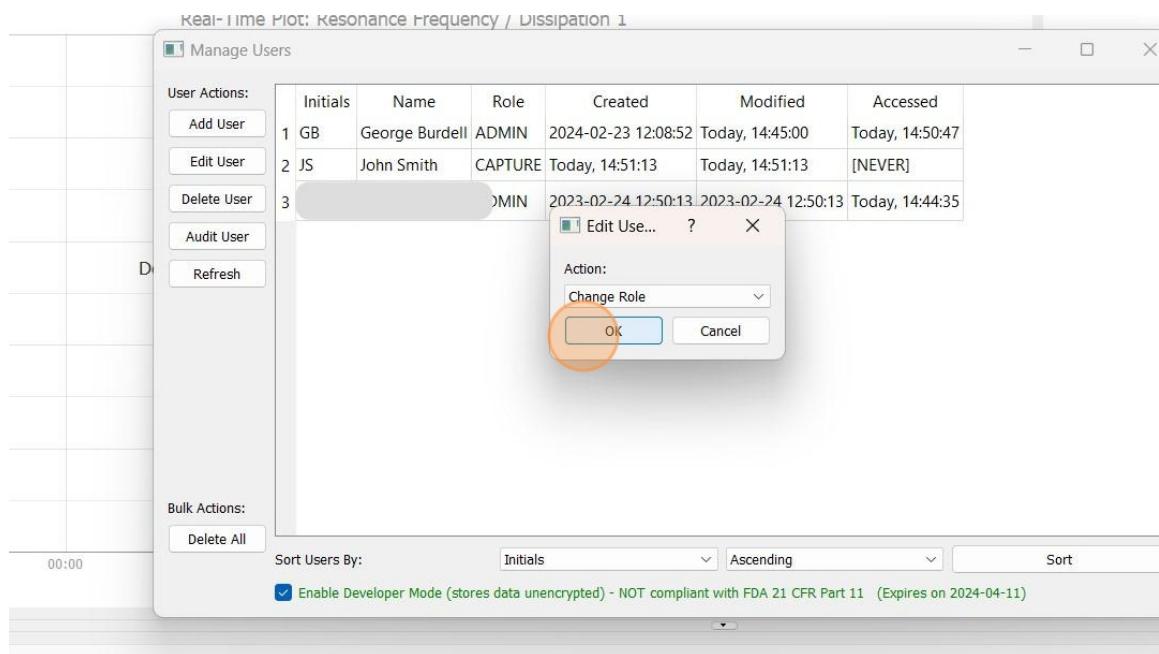
10. Enter the initials of the user you want to edit and click "OK".



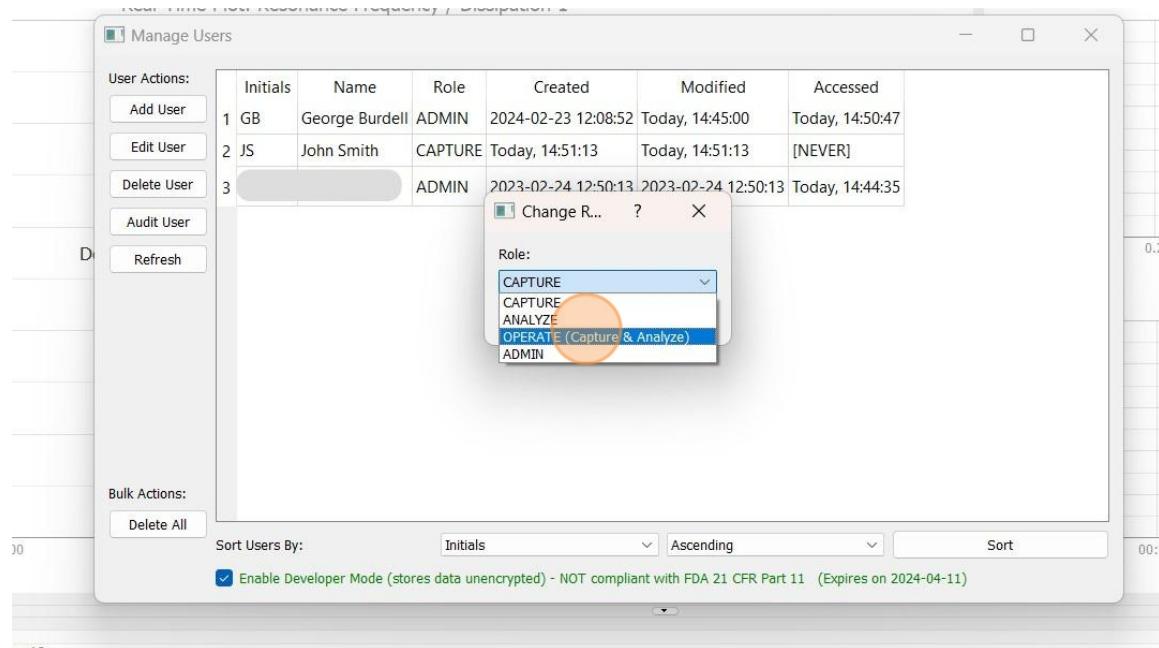
11. From the drop-down list, pick what you want to change about the user.



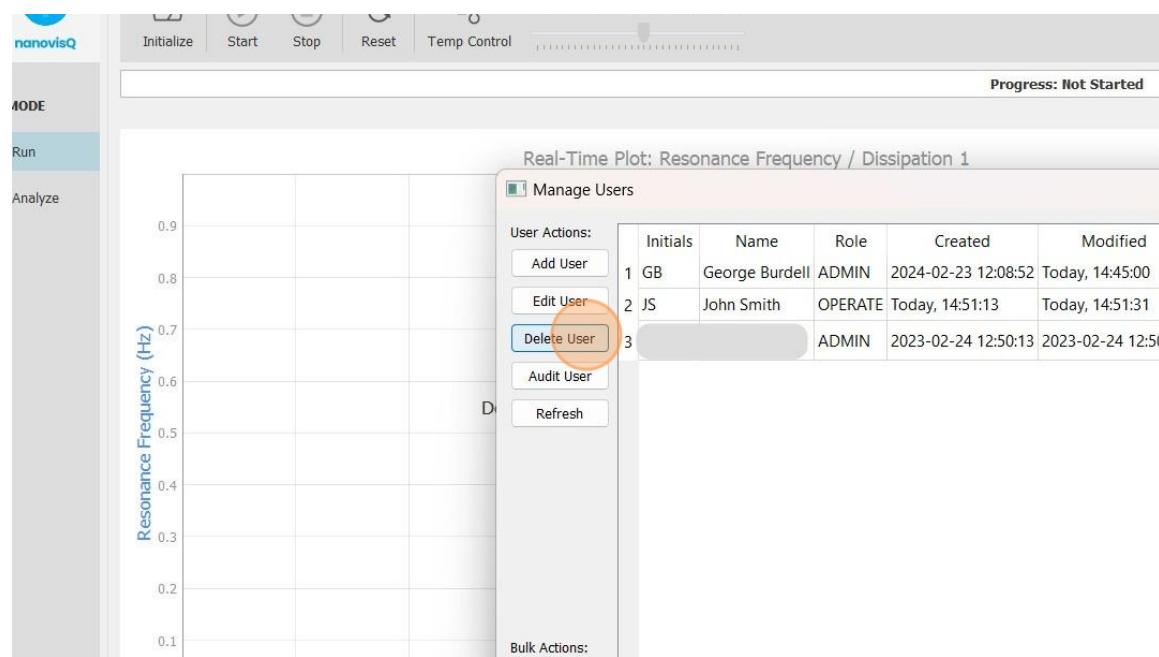
12. Click "OK"



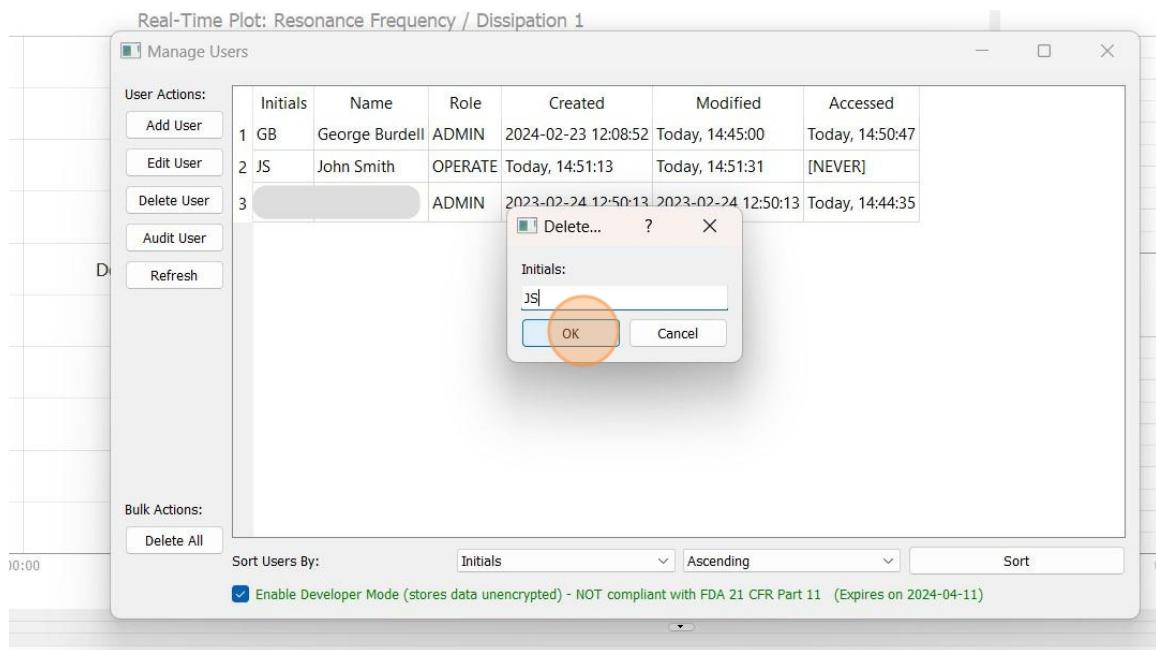
13. If you selected "Change Role", you will encounter a dialog box with drop-down menu. Pick the desired role and then click "OK".



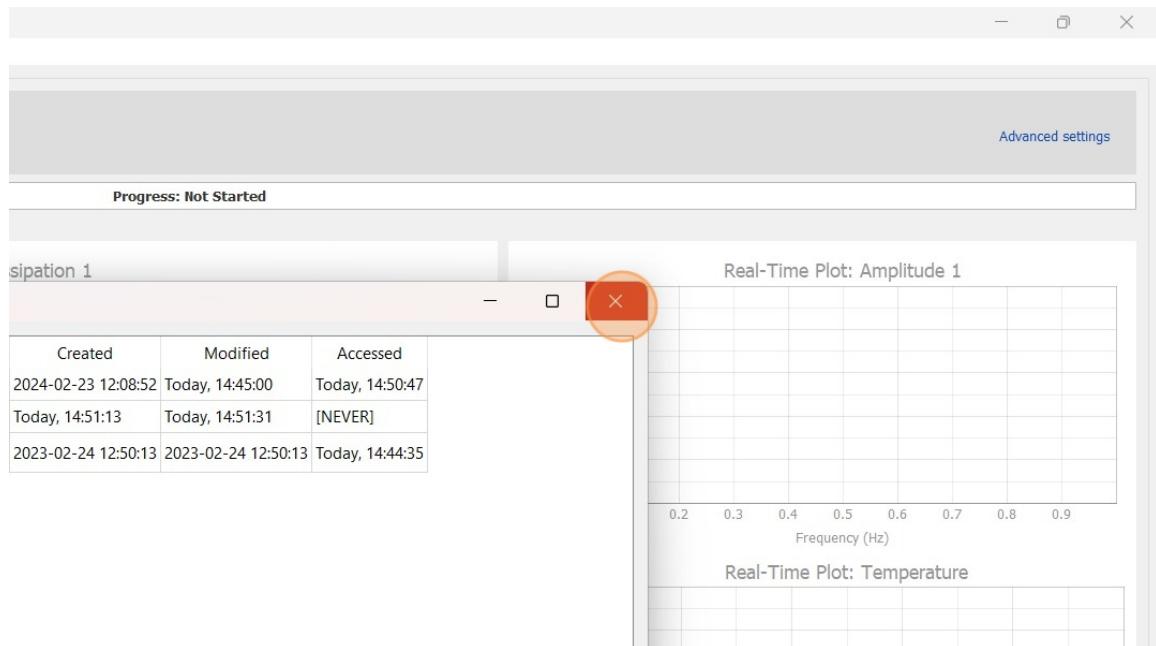
14. If you want to remove a user account, click "Delete User".



15. Enter the initials of the user, that you want to delete and then click "OK".



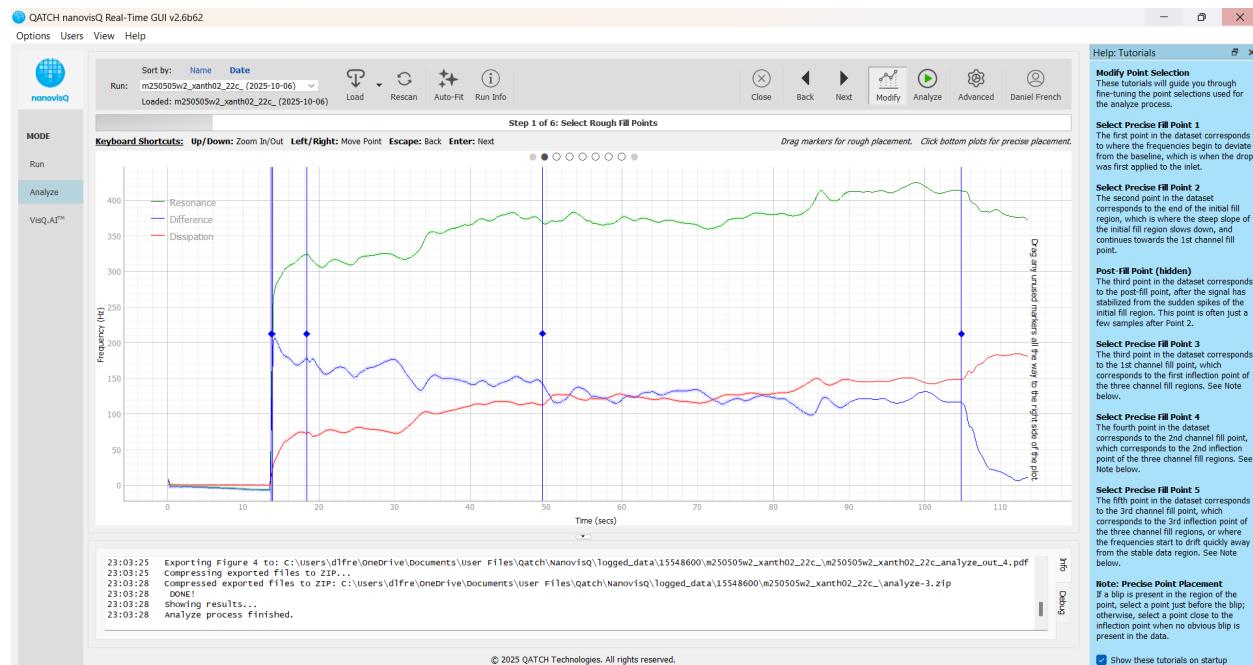
16. To return to the main menu, click "X".



Troubleshooting Guide

Reduce Temperature to improve S/N

Data quality is sample-dependent and can make point selection during analysis challenging. Especially for samples with heavy shear-thinning and close to water viscosity at very high-shear-rates, “noisy” data may be observed as the below figure. The feature-detection of machine learning software may struggle to find the exact inflection points for these kinds of samples. Manual point selection may be necessary to refine the point selection. S/N can sometimes be improved by lowering temperature, which decreases the noise in the system by increasing viscosity.



Frequently Asked Questions

I plugged in my device and it is powered, but the software is not recognizing a device.

Unplug the USB and reconnect. If not properly connected, the device can receive power without being able to send information back to the computer based on USB plug design. Also, click “Reset” on Run screen twice with 10 seconds interval to ensure that software detects the right port.

I started the measurement, but dissipation is too high (>40).

You can start the measurement and observe the trend. If the dissipation is in general trending lower, it means the sensor is still drying. If after a few minutes, the dissipation is erratic or not trending down, you may need to remove the sensor and plugging it in again (with the help of the knob). If it still does not work, it may be that the knob has not bounced back fully and you may need to turn it very little towards yourself. If this still does not work, try a new sensor. If it is observed often, the instrument may need an adjustment. If it is only one sensor, that may be a sensor defect, and we can send replacement sensors.

Can I reuse the sensor? I just tested it with water.

No. The data will not be reliable.

Do I need to calibrate the sensors in any way?

No. Each sensor is factory-calibrated. When you scan the sensor barcode, the associated calibration file is automatically loaded for analysis.

Is there a size limit for particles or molecules?

The system is validated with small molecules and very large polymers (>8 MDa). Samples should be fluid; for particulate systems, the most reliable results are achieved when particle size is **below 100 nm with volume ratio being less than 10%**.

I don't think autofit found the right points (obviously not inflections) but I also am not sure if I picked the right points.

We totally understand that learning the patterns of nanovisQ may take some time. Please reach out to techsupport@qatchtech.com so we can either analyze the data for you or we can schedule a call to go over points with you.

I don't know the density or the protein concentration of my sample exactly. Will the results be wrong because of that?

The density of the sample is only used in equations for viscosity at 15MHz shear-rate. A 10% error in density (like entering 1.05 gr/ml instead of 1.155 gr/ml), may result in 10% error in viscosity measurement at 15 MHz. However, this data point typically carries an inherent error margin greater than 10% and is displayed with error bars reflecting that range. Therefore, unless the entered density is substantially incorrect, it only needs to be accurate to one decimal place. The protein concentration (and stabilizer information for biologic formulations) can be used to estimate the sample density. While exact concentration values are not required for data analysis, the entered

concentration should be within one order of magnitude of the true value to ensure proper estimation.

How good is the density estimation for biologics in the software?

We had tested this equation with different proteins with wide range of molecular weights and concentration and found it to be within 10% of the actual value.

What if I don't want to enter the name of my protein (or buffer, stabilizer, surfactant info)?

You can pick a name from the list or make-up a name (protein-2). It will not affect the viscosity results. The buffer, surfactant, and salt info are also for recording purposes. However, stabilizers may change the density of the formulation and it is recommended to enter an approximate value if a stabilizer is present.