

CNI v3.0 software manual

The link to start the CNI software is located on the desktop of the touch screen computer included with your tool. There is also a folder, where you can start the 'Admin Tools', which are the system setup software and the RHE to system calibration software.

The Compact Nanoimprint (CNI) tool control software is designed for ease of use, while maintaining the highest possible flexibility in your process design and optimal control of the process runs.

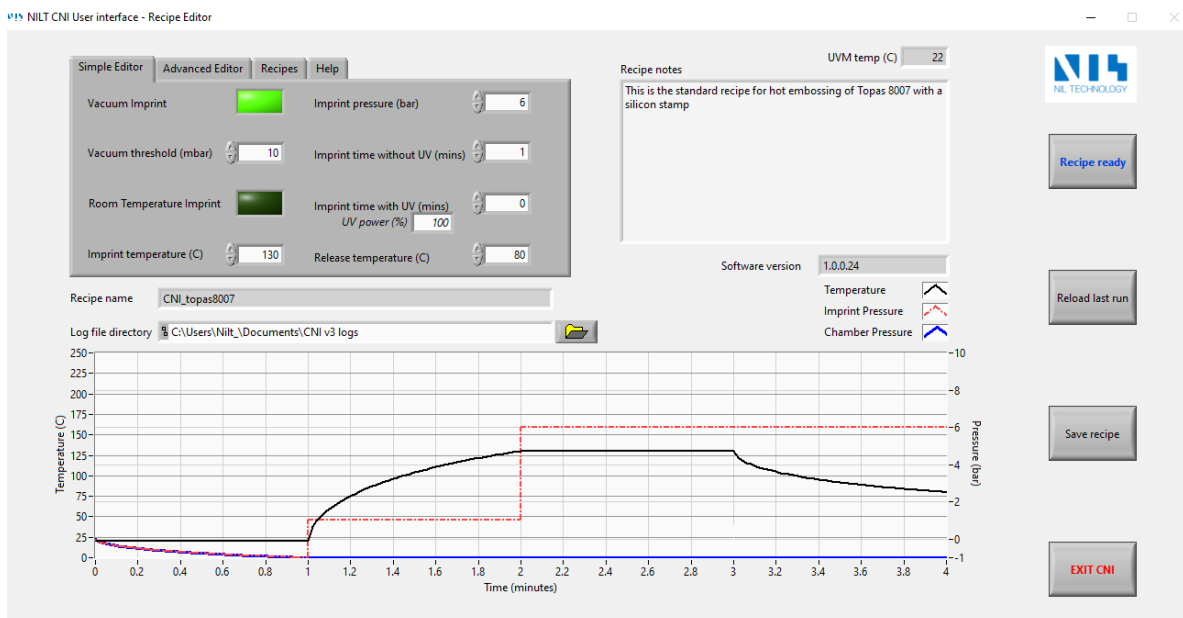
The software has three main screens that the user cycles through while using the system: "Recipe Editor", "Process Initialization", and "Process window". These three screens will be described below.

The software package also contains a "System Setup" program. This program will be briefly described at the end of the document.

Recipe Editor

When you start the CNI software, the "Recipe Editor" screen opens first. The tabbed control at the top left is where the magic happens. Here, you have access to the simple recipe editor that will suit the needs of most imprint processes. On those few occasions, where you need more flexibility than the "Simple Editor" offers, you can switch to the second tab called "Advanced Editor", where you will find unlimited possibilities for setting up your imprint process. The third tab allows you to load recipes, and the fourth tab is a short help page.

You can write and recall notes about your different recipes in the textbox next to the tabbed control. The control buttons are located on the far right; "Recipe ready" advances to the next screen, where you can start the imprint process; "Reload last run" reloads the parameters from the most recent process run; "Save recipe" allows you to save the recipe; and "EXIT CNI" exits the program. At the bottom there is a visual representation of the current recipe.



Simple editor

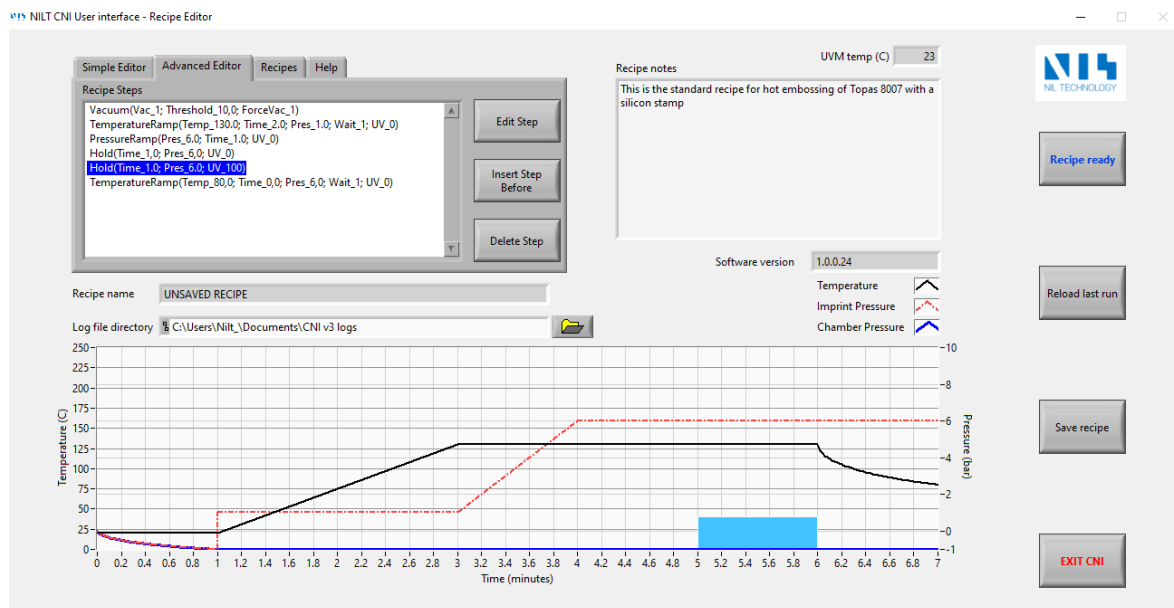
First, we will look at the simple editor. The simple editor always runs the same generic recipe, where you set key parameters to setup exactly the process you need. The generic recipe goes as follows

1. Evacuate Imprint and Force Chambers below the Vacuum threshold.
 - a. The threshold is defined in the editor.
 - b. This step can be bypassed completely by unclicking “Vacuum imprint”.
2. Heat up to the imprint temperature as fast as possible with a pre-imprint pressure in the force chamber of 1 bar.
 - a. The imprint temperature is set in the editor.
 - b. This step can be bypassed completely by turning on “Room Temperature Imprint”.
3. Hold the imprint temperature while applying the “Imprint pressure” for “Imprint time without UV” minutes.
 - a. If room temperature imprint is selected, the imprint temperature will be room temperature.
 - b. The set “Imprint Pressure” is applied during this step
4. With the UV source On. Hold the imprint temperature while applying the “Imprint pressure” for “Imprint time with UV” minutes.
 - a. If you do not wish to use UV, just set the “Imprint time with UV” to zero
 - b. The set “Imprint Pressure” is applied during this step.
5. Decrease the temperature to the release temperature as fast as possible while still applying the “Imprint pressure”.
 - a. The set “Imprint Pressure” is applied during this step
 - b. This step is bypassed, when “Room temperature imprint” is selected.

Take a minute to think about just how much you can do with this simple generic recipe. It is possible to set up a hot embossing process or a standard thermal nanoimprint process. In both cases, you can choose to run with chamber vacuum if needed. You can also do a room temperature UV imprint. You can even perform a UV nanoimprint at elevated temperature.

Advanced editor

The simple editor is great and very versatile, but it has limitations. The advanced editor gives you limitless possibilities in your process design within the CNI hardware specs.



CNI process recipes are composed of recipe steps. The advanced recipe editor allows you to have an unlimited number of recipe steps in any order, and you can set multiple parameters within each step.

It is often a good idea to start in the simple editor and get as close to the final recipe as possible, and then you enter the advanced editor to arrive at the final recipe.

There are four different types of recipe steps available in the advanced editor:

1. Temperature Ramp

2. Hold
3. Vacuum
4. Pressure Ramp

UV exposure is available with several of the step types but is most often part of a hold step.

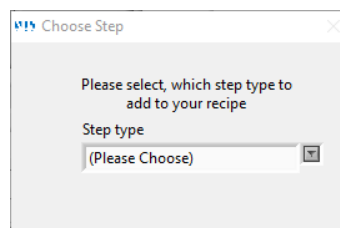
In the following, we will go through the parameters of each of these recipe step types. When using the touch screen, it is easier to use the buttons to the right of the Recipe Steps window, but if you connect a mouse and a keyboard, you can use these faster shortcuts.

- Double click on a recipe step to edit it.
- Double click on an empty line to add a new recipe step
- Hold down Shift while double clicking on a recipe step to insert a new step before it.
- Hold down Ctrl+Alt while double clicking on a recipe step to delete it.

Please be aware that no undo functionality is available.

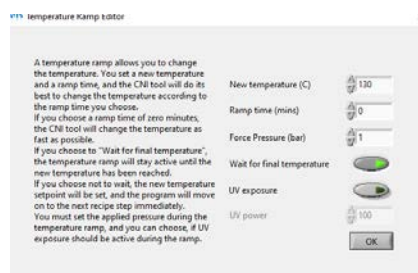
The initial state of the process is always a temperature set point of 20 °C and ambient pressure in both imprint and force chambers.

When you click to insert a new step, you get to this dialog with a drop-down menu



Click on the kind of step you want to go to its specific step editor

Here is the "Temperature Ramp" step editor



The temperature ramp always starts at the temperature selected in the previous step. The initial state of the process is always assumed to be 20 °C, so if the temperature ramp is the first step, the temperature set point ramps up starting at 20 °C.

A temperature ramp step ramps up the temperature set point, and the hardware will do its best to have the actual temperature keep up. It is possible to set a ramp time of 0 minutes. This means that the temperature setpoint changes to the new value instantaneously. The tool will then do its best to get the actual temperature to match the setpoint as fast as possible.

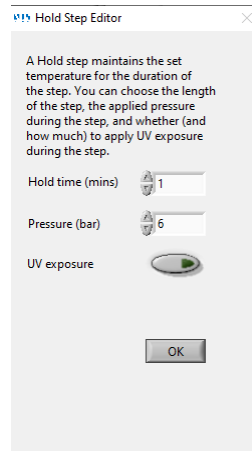
If you put a non-zero number in the ramp time field, the setpoint will be ramped linearly through that time. Again, the hardware will work to have the actual temperature follow the setpoint, but some ramps will be too fast for the hardware.

In the recipe editor graphical representation of the recipe, a zero-minute ramp will be represented by a curved ramp, while a non-zero-minute ramp will be represented by a straight line.

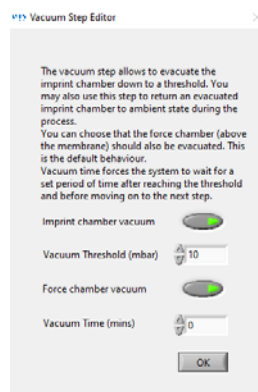
You set the Force Chamber pressure during the temperature ramp in the designated field.

Next, there is a button that determines whether the temperature should have stabilized at the final ramp temperature, before moving on to the next process step. Most often this control should be ON.

Finally, you can have the UV light on, while the temperature is ramping. Most often this control should be OFF.



In a hold step, the temperature is kept constant for the set Hold time. The Force Pressure can be set, and you can choose whether the UV source should be on during the hold step.



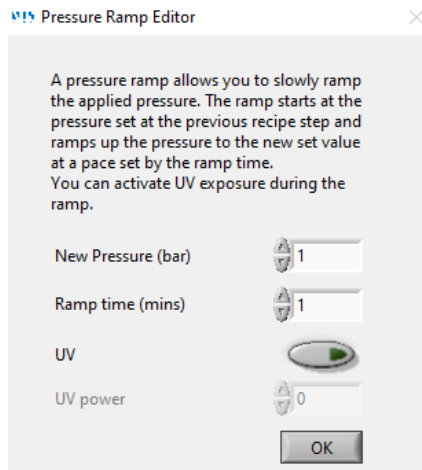
A vacuum step is inserted, when you want to evacuate or ventilate the imprint chamber. All vacuum and overpressures are automatically released at the end of each process run.

When the “Imprint chamber vacuum” is ON, the tool will start to evacuate the imprint chamber. When the “Vacuum Threshold (mbar)” is reached (from above), the software will move on to the next recipe step, but the vacuum pump will continue to evacuate the chamber.

When the “Imprint chamber vacuum” is OFF, the tool will start ventilating the imprint chamber. When the “Vacuum Threshold (mbar)” is reached (from below), the software will move on to the next recipe step, but the chamber ventilation will continue.

The vacuum time control will keep the process in the Vacuum step after reaching the vacuum threshold, before moving on to the next step.

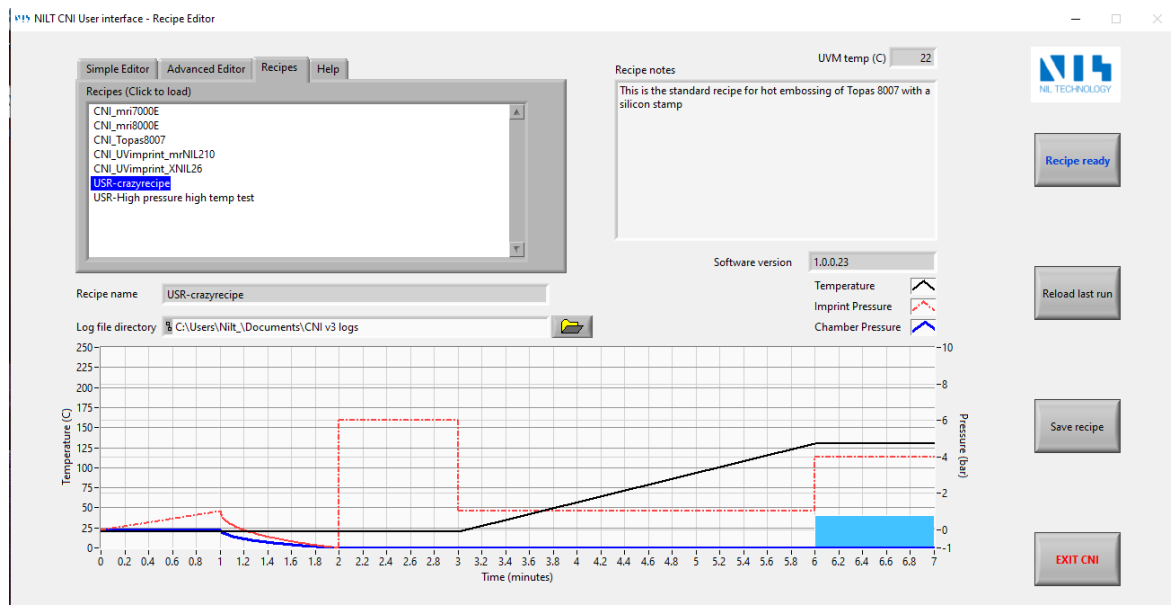
“Force Chamber Vacuum” controls whether the force chamber should be at the same pressure/vacuum level as the Imprint chamber. This control should almost always be on, while evacuating the imprint chamber. If the force chamber is left at ambient while the imprint chamber is pumped down to vacuum (1 mbar), there will be a net pressure from the force chamber onto the imprint stack of 1 bar, and this can cause air to be trapped inside the imprint stack.



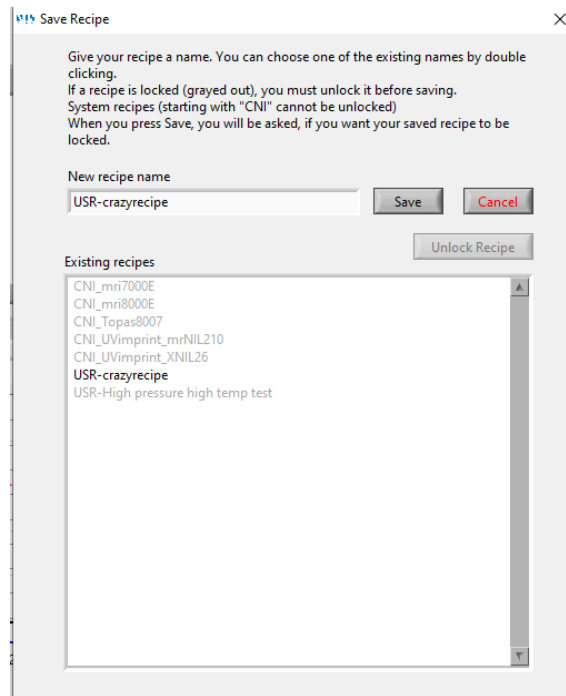
A pressure ramp step allows you to apply or remove pressure at any rate you might desire with or without UV exposure applied. Sometimes, ramping up the pressure slowly works better than applying the pressure instantaneously.

Recipes

The Recipes tab lists all your saved recipes. Click the recipe name to load the recipe. The recipe notes load to the recipe notes window, and you will see the graphical representation of the recipe. You can always load the last run recipe using the "Reload last run" button.



If you press "Save recipe", you will be taken to the dialog below



Write a name for your recipe and press “Save”, or press “Cancel” if you change your mind.

The CNI software is preprogramed with built-in recipes. These recipes are prefixed with “CNI_”, and they cannot be overwritten.

When you create your own recipe name and press “Save”, you will be asked in a dialog, if you wish your recipe to be locked after saving.

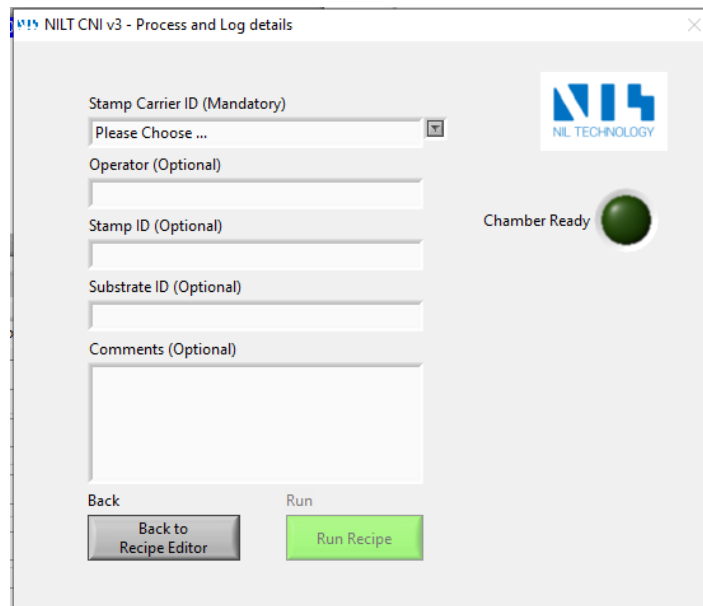
A locked recipe shows up in the “Existing recipes” overview as grayed out (look at the bottom recipe for an example). It is possible to unlock a locked recipe by using the “Unlock Recipe” button.

If there are many users of the tool, we recommend that you agree to prefix your recipe names with your initials. In the example above, user “USR” has two recipes. This makes it easy for all users to find their own recipes.

If different users should not be able to edit or even see other users’ recipes, we recommend they use different Windows logins on the tool touchscreen. Accordingly, users will only be able to see recipes associated with that specific Windows login.

Process initialization

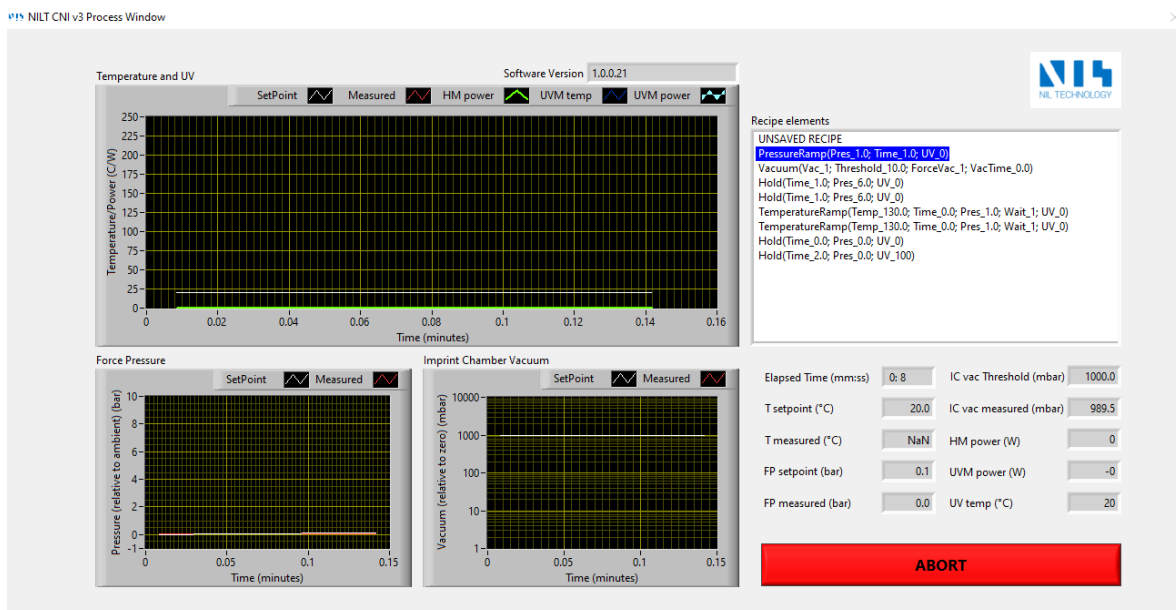
When you press the “Recipe Ready” button, you will be taken to the following dialog.



You must enter the ID of your Replaceable Heating Element (RHE) here as it is used by the imprint software to run the process. Entries in the “Operator”, “Stamp ID”, “Substrate ID”, and “Comments” fields are optional. This information is saved in the log file. The log file name begins with the “Substrate ID”. If you leave “Substrate ID” blank, the log file name will begin with “_”.

The Chamber Ready indicator light will turn green when the Imprint Chamber is closed. The “Run Recipe” button becomes available when the chamber is ready and a RHE ID has been chosen. Press this button to run the recipe.

Process window



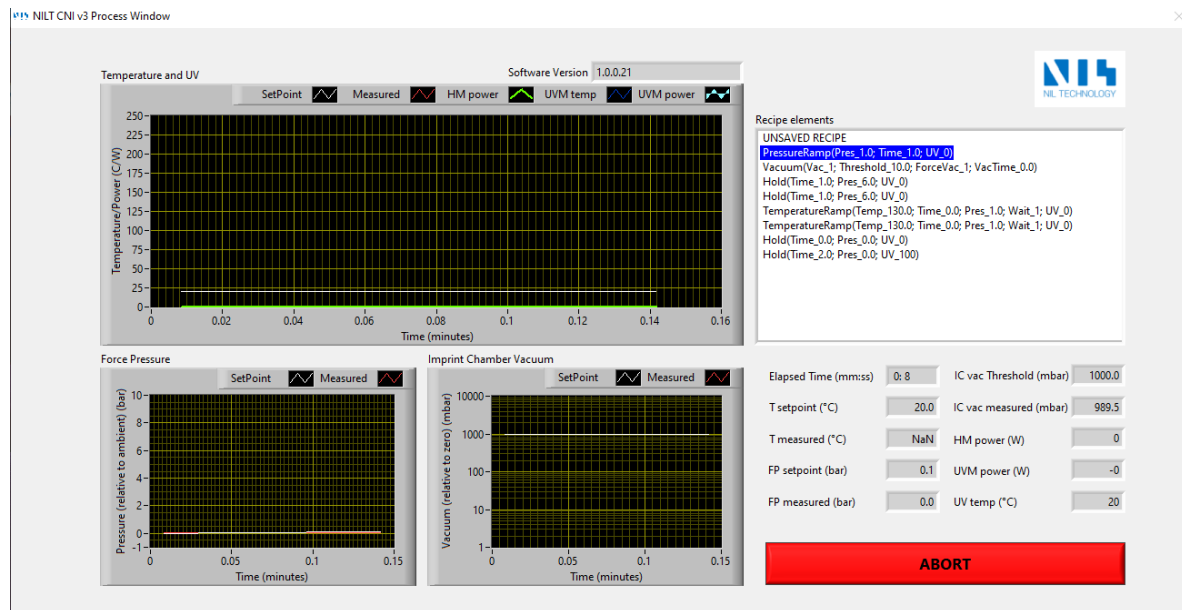
While the process is running, you can follow all the process parameters in real time. The recipe overview as well as all relevant settings are located to the right. Graphics of the process history are also included.

A large “ABORT” button is provided should you want to stop the process immediately at any given time. This will release all pressures and turn off heat and UV power.

Log files

The program saves log files automatically. You control, where to save the log files in the Recipe editor window. Two log files are saved for each process run; 1) an XML file with all relevant data saved in plain text 2) a .png file with a screen shot of the final state of the process window.

This is an example of such a .png log file.



The log files are named “SubstrateID”_“YYYYMMDD_HHMMSS”.xml/png

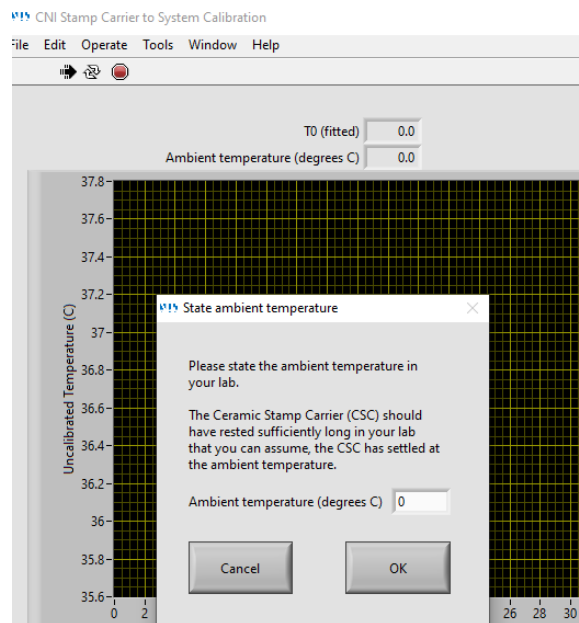
The XML file contains all information entered by the user, all data points, the entire recipe, RHE calibration data, and all system setup data.

Replaceable Heating Element to System Calibration

The RHE System Calibration software is located in the “Desktop\CNI Software\AdminTools” folder. NILT performs a full calibration of all replaceable heating elements before shipping, and each heating element comes with its own calibration file. However, we measure small resistance changes to measure the temperature, and there may be small differences in wire resistance from system to system. Therefore, it is recommended that you run this program, when you receive a new Replaceable Heating Element (RHE). This will eliminate any offset between your system and the system used to measure the calibration curve of your new RHE.

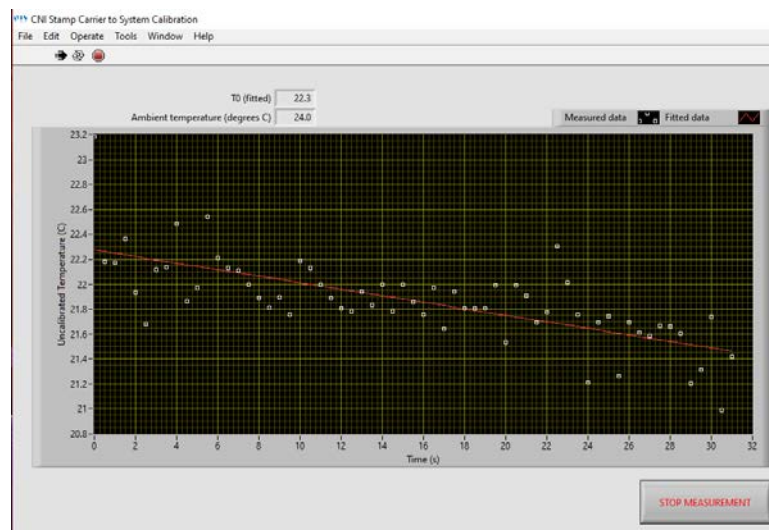
Before running the software, you should make sure that both the Replaceable Heating Element and the chamber is at room temperature.

When you start the software. You will be asked to state the room’s ambient temperature.



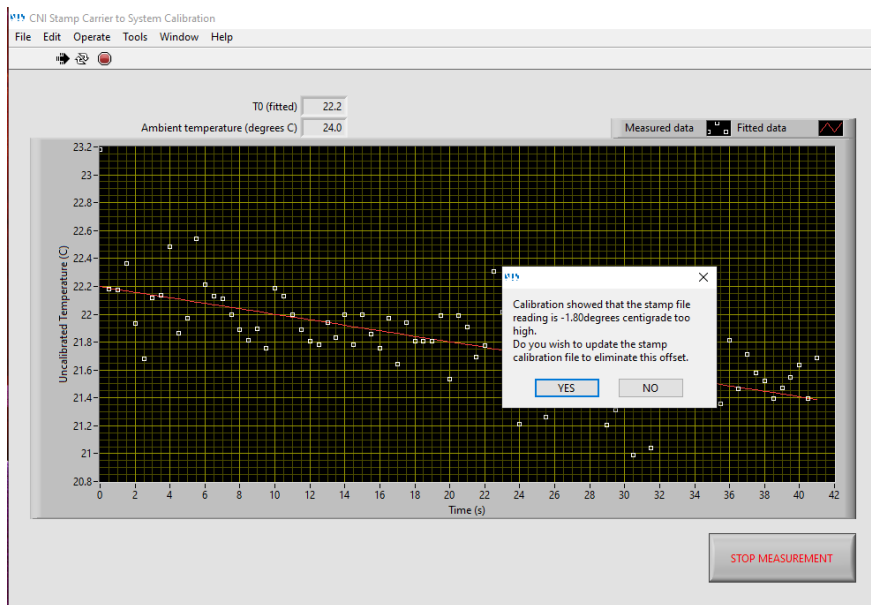
Enter the room's ambient temperature and press OK.

Next you will be asked to confirm that the Heating Element is loaded, and the chamber is closed. When you press OK, the process starts



The tool will pass current through the replaceable heating element and measure the temperature. Since we pass a small current through the RHE, Joule heating may cause the temperature to increase slightly. The software will make a straight line through the measurements to find the temperature at time 0. You can stop the measurement as soon as the red line has stabilized such that the measurement at time 0 is stable within 0.2 degrees. If you do not stop the measurement, the measurements will continue for 1 minute.

When the measurements have stopped. You get this screen.



If you press yes, the software will update the calibration file and make it available in the CNI software. If you press No, the software will do nothing. You can still import the calibration file in the CNI software. Then it will just happen without calibration. Our recommendation is to always press YES.

System Setup program

The setup program is accessed through the "Desktop\CNI Software\AdminTools" folder.

This program must be run as part of the initial tool setup. The program generates a SystemSetup.xml file that is necessary for the CNI software. It should never be necessary to change the SystemSetup.xml file after first installation.

The program connects to the control, heater, and/or UV modules. Also, it is possible to limit the voltage, current, and power that can be passed through the system. The tool PID parameters can be set as well.

The screenshot shows the 'CNI v3.0 System Setup Page' software interface. The page is divided into several sections: 1. Control Module Setup, 2. Chamber size, 3. Heater Module Setup, 4. UV Module Setup, and 5. Cooling Module Setup. Each section contains various input fields, checkboxes, and buttons for configuration. A 'Save and Exit' button is visible on the right side.

The controls are mostly self-explanatory, but below a few words about the heater module are given.

The Chamber size is the basis for the factory default settings in the dark grey area.

The Heater Module measures the resistance of the RHE continuously as it is indicative of its temperature. The heater module measures two voltages that needs to be translated into a resistance value. This translation follows a straight line, and the “HM Calibration Constant” and “HM Calibration Correction” are the parameters of this straight line.

Prior to shipment of each system, a calibration is performed using the “Run Calibration” button. This functionality requires a calibration tool – Contact NIL Technology, if needed.

The dark grey box contains the heater module settings. The heater module heats the heating element by resistive heating. The top line limits the power delivered to the carrier. These should not be changed. The minimum current is passed though the carrier, when minimal power should be delivered. A finite current is necessary to measure the resistance and hence temperature of the replaceable heating element.

The five remaining parameters are parameters of the tool’s PID routine. P, I, and D are your standard PID parameters. “N reset” is the number of data points used to calculate the Integrated and Differential errors. We find that values of 5-10 work the best. 5 is most often the best choice. “D exp” is a noise damping factor. Even the smallest amount of noise can lead to large changes in the differential error. Higher number of “D exp” will dampen such noisy behavior.

If you press the “Reset to Factory Settings” button, the parameters in the PID, N reset, and D exp parameters will be reset to the factory settings.