EtchTemp Wafer™

User Manual

KLA Tencor

Accelerating Yield

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This manual applies to *EtchTemp Wafer*

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EtchTemp Wafer System Hardware

KLA-Tencor warrants that the EtchTemp Wafer **Systems** ("Products") sold will be free from defects in material and workmanship, and perform to KLA-Tencor's applicable published specifications for a period of 12 months after shipment for the Docking Station. The EtchTemp is warranted for a specified number of operating hours. Refer to the specification provided with your wafer for the exact warranty terms. The Products that comprise the System shall include the Docking Station. The liability of KLA-Tencor hereunder shall be limited to replacing or repairing, at its option, any defective Products that are returned F.O.B. to KLA-Tencor SensArray division plant in Santa Clara, CA. In no case are Products to be returned without the purchaser first obtaining SensArray's permission and Returned Materials Authorization [RMA] number. In no event shall SensArray be liable for any consequential or incidental damages. Products that have been subject to abuse, misuse, accident, alteration, neglect, or unauthorized repair or installation are not covered by this warranty. SensArray will make the final determination as to the existence and cause of any alleged defect. SensArray is not responsible for maintaining or supplying any consumable materials used in conjunction with this hardware. No warranty is made with respect to any customized equipment or Products supplied with EtchTemp Wafer systems where produced to Purchaser's specifications except as specifically stated in writing by SensArray in the contract for such Products. The purchaser will pay the shipping costs of returned materials to SensArray; SensArray will pay the cost of shipping repaired/replaced material to Purchaser. This Warranty is the only warranty made by SensArray with respect to the Product delivered hereunder and may be modified only by a written instrument that is signed by a duly authorized officer of SensArray and accepted by Purchaser. Except as provided above, SensArray makes no warrantees, expressed or implied, including any warranty of merchantability for a particular purpose.

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Some of the technology used in this product is acquired under license from the management and operating contractor of the Oak Ridge National Laboratory on behalf of the U.S. Department of Energy.

Radio Frequency Interference Compliance

Applies to the Storage Cases, RF Carrier Station and RF FOUP

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

For the RF Carrier Station and the RF FOUP, only the USB cable supplied with the equipment is authorized for use with this device; any other cable is not authorized and may cause undesired interference, etc. Refer to Chapter 3 for product installation.

RF Carrier Station USB Cable

RF FOUP USB Cable

Product Modifications

Applies to the Storage Cases and Carrier Station

Changes or modifications to this equipment not expressly approved by KLA-Tencor may void the user's authority to operate the equipment.

English	French
This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.	Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Using This Manual

Overview

This manual consists of the following sections.

- Chapter 1, Overview - Discusses features, components, and configurations of the EtchTemp Wafer System.

- Chapter 2, System Setup - Discusses unpacking the system components, preparing the equipment for the cleanroom, and connecting the system cables.

- Chapter 3, Using the Charge and Communication Carrier Station - provides an easy means to prepare the wafer for data acquisition and to perform data retrieval.

- Chapter 4, Using the SensArray tool Software - Discusses acquisition setup, acquisition features, and how to retrieve the measurement data using the Carrier Stations.

- Appendix A, Reference Information - Wafer sensor location information.

What You Need to Know

This user manual assumes that you are familiar with the version of the Windows operating system installed on your computer and can perform- as a minimum - the following tasks.

- Start (boot) the computer

- Log on to Windows

- Select from menus

- Select and open files

- Use a mouse or pointer, including how to point and click to select objects and operate controls such as buttons

- Use standard window controls such as scroll bars

Conventions Used in this Manual

Several standard conventions are used in the text of this manual to make the information presented a little clearer and easier to understand. Every attempt is made to be consistent in the application of these conventions.

Note:	Highlights important information.
Bold	Bold text indicates button names, icon names, and menu items.
italic	Italic text indicates the section and/or chapter name in a cross-reference. For example: See the *Using the Acquisition Setup Window* section of Chapter 3, *Acquiring Data*, for more information. Italic text can also be used to emphasize a word or phrase.
`Courier Typeface`	Courier typeface indicates file names, directories, and text that you enter. For example: The file is located in the `C:\Sensarray\Configs` directory.
<Key>	A word offset by angle brackets indicates a key on the computer keyboard. For example: After you specify the parameters, press the <Enter> key.

Indicates important safety information. The icon is usually associated with a Warning or Caution in the document describing potential for product damage or personal injury. Other international standard icons specific to a particular hazard or action may be used in place of the exclamation mark.

Chapter-1 Overview

The EtchTemp Wafer User Manual is designed to document the setup and use of the ET Wafer system in conjunction with the SensArray Tool. This manual is applicable for ET wafer only. This ET wafer will only work with SensArray Tool (Plasma Suites)

This chapter discusses the features of the EtchTemp Wafer System.

The EtchTemp Wafer System

The ET Wafer has a complete measurement system embedded in the wafer to record thermal surveys in semiconductor processing equipment without the need for wired connections. Embedding the components within the wafer allows it to be treated like a production wafer in most equipment, as long as it is within the operating temperature range of the wafer.

The ET wafer system consists of an EtchTemp Wafer, a carrier station/FOUP for communicating with and recharging the wafer, a USB cable, a laptop computer, and a CD containing the software and drivers needed by the system.

The systems can acquire data from 1 to 64 analog channels, depending on the model. The analog channels are divided into banks. Each bank is made up of up to 8 wafer sensors.

Measurements taken by the sensors are converted from analog to digital signals within the onboard electronics.

Acquiring Data

Utilizing the EtchTemp Wafer to acquire temperature data in your equipment is a simple process. Measurement parameters, such as sensors to be used, scan rate, time delay, etc., are set up using the Controller software. The wafer is then transferred to the measurement chamber from a FOUP or cassette via robotic arms, and the thermal measurement survey data is acquired. After the survey is complete, the data can be retrieved from the onboard memory through the RF FOUP or carrier station. The data may then be analyzed using SensArray Tool (Plasma Suites)

Analyzing Data

The data files acquired by the EtchTemp Wafer may be analyzed using SensArray tool. The **SensArray Tools** software enables users to maximize their fab's wafer yield, by capturing real-time tool or track conditions, and identifying the performance characteristics of chambers or plates with the highest yields. Users can then modify other chambers or plates to match those characteristics, as well as monitor tools or tracks over time, to fine-tune performance.

For more information on the use of the Analysis portion of the SensArray Tools, please refer to the *SensArray Tools (Plasma Suites) Manual*.

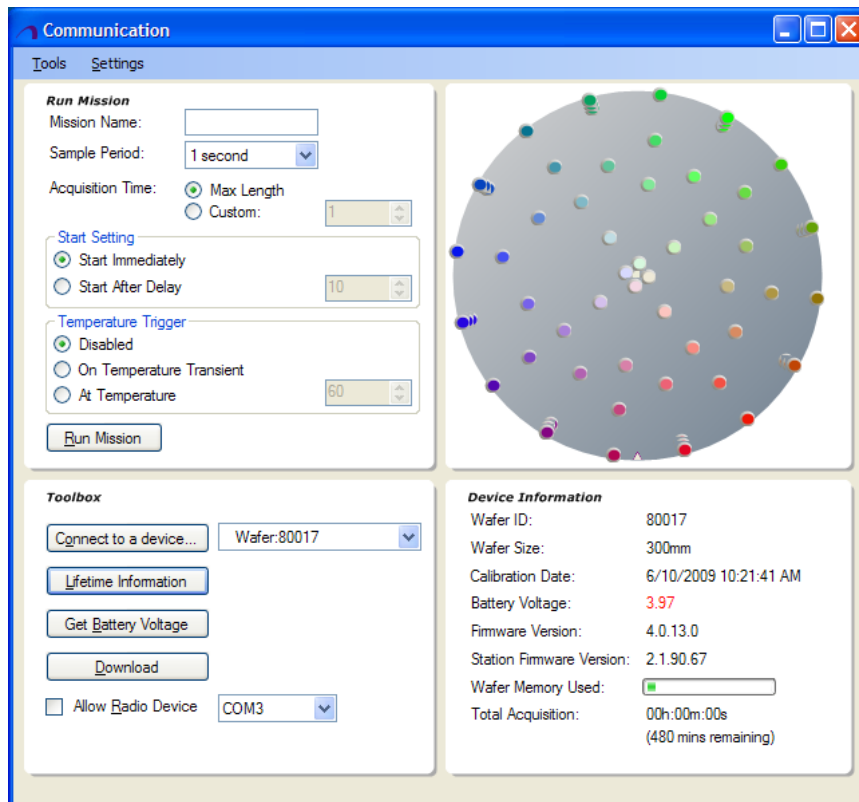**Figure 1-1 SensArray Tools Main Screen**

Figure 1-2 Mission Controller Screen

During acquisition, EtchTemp wafer performs computations on acquired data, such as determining the minimum, maximum, mean, range (max-min), and standard deviation of all wafer sensor values for the sample, and logs the results in columns. These computed values are referred to as *calculated* values.

After acquiring, linearizing, and storing the sensor data, you can display or print the data as a line plot graph, as shown in Figure 1-3. In addition, you can display data in a table or as a wafer map.
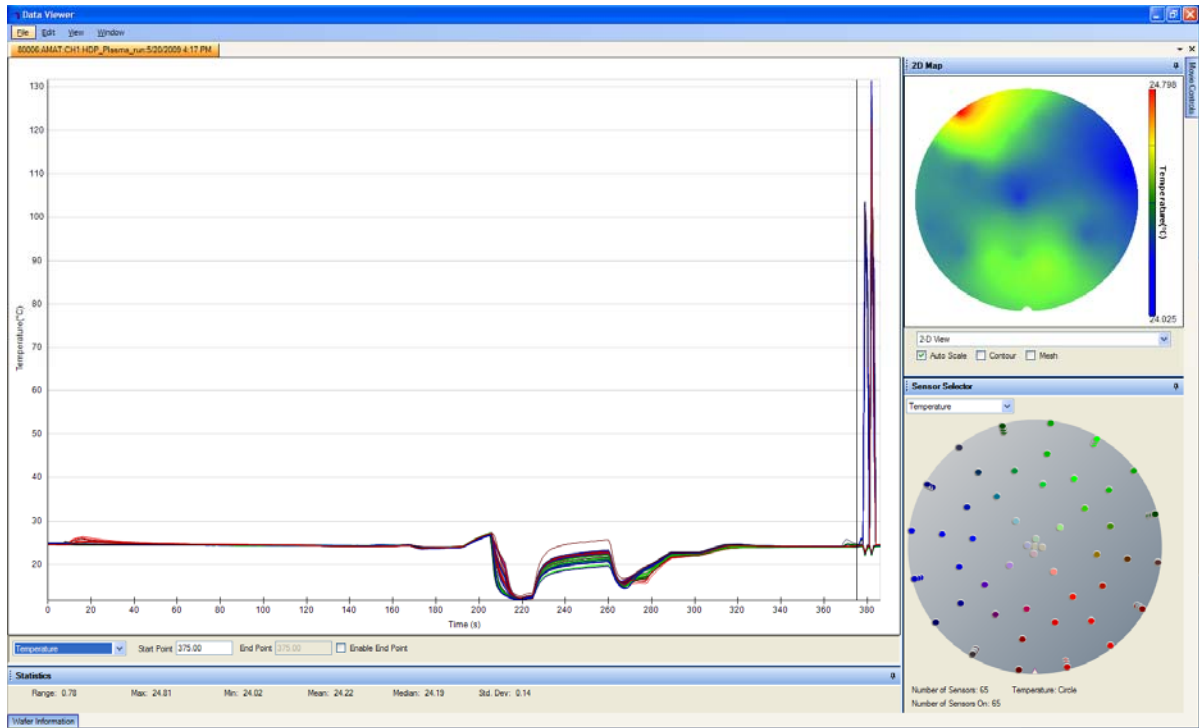

Figure 1-3 Displaying Data on a Line Plot Graph

Chapter-2 System Setup

Before you can begin working with the EtchTemp Wafer system, you need to unpack the system components, prepare the equipment for transfer to the Cleanroom, and charge the wafer batteries.

Before You Begin

Before using the EtchTemp Wafer, there are several safety and handling precautions that should be noted. Please read the information provided in this manual and become familiar with the EtchTemp Wafer before attempting your first thermal survey.

- Operation of EtchTemp outside of its specified temperature range could result in unreliable readings and/or damaged wafers. Please review the recommended operating range for your particular model of EtchTemp Wafer.

- Rotational speeds up to 5000 rpm have been tested and found to be safe. While it is possible that even higher rotational speed might be reached without damage to the wafer or spin plate, SensArray cannot provide any guarantees above 5000 rpm.

Proper Wafer Handling Procedures:

While the EtchTemp Wafer is designed to survive in a semiconductor fabrication environment, reasonable care must be taken to prevent damage to the components on the wafer, or breaking the wafer.

- Always wear gloves whenever you handle the wafer.

- Hold the wafer by the edges only or support from the backside of the wafer with your hand or with a vacuum wand. In some situations, you may have to grasp the edge of the wafer with your gloved fingers to prevent dropping the wafer, as when you try to insert the wafer into your equipment or a carrier station.

- Never place the wafer on an uneven surface. A small downward pressure on the wafer applied at the right point could cause the wafer to break or cause cracks within the silicon.

Unpacking Your System

Inventory all items and compare to the packing list included with the shipment.

⚠️ *Retain all packaging materials for the system. This is required for the return of the EtchTemp Wafer for repairs or recalibration.*

If any parts are missing or damaged, contact SensArray immediately. Be prepared to provide a list of the missing and/or damaged components, the Purchase Order Number, and the SensArray Sales Order Number.

NOTE: *Do not return components without contacting SensArray first and obtaining a Return Material Authorization. When returning components to SensArray, you must repack the equipment in the original packing material. Failure to properly pack the components may result in additional damage to the equipment.*

Removing the Wafer from the Storage Case:

The wafer storage case is designed to keep the EtchTemp Wafer batteries charged to the optimum level for an extended period of 1 to 2 years. This is done by periodically checking the status of the batteries and recharging the batteries when their voltage drops below a threshold.

⚠️ *CAUTION: The storage case is not designed to be used to recharge wafers after acquiring data. The storage case may not be used as a carrier station. It is used only to store a wafer when the wafer is not in use.*

The wafer will be maintained in the storage case until it is needed. To use the wafer, place the horizontal wafer Storage case right side up (electronic is at the bottom) on a clean work surface, as shown in Figure 2-1. To open the lid, place both thumbs on the rings on the lid as shown, lift both of your pointer fingers and open the lid completely. Locate the Charge and Communication (C/C) Carrier Station or RF FOUP near the storage case.
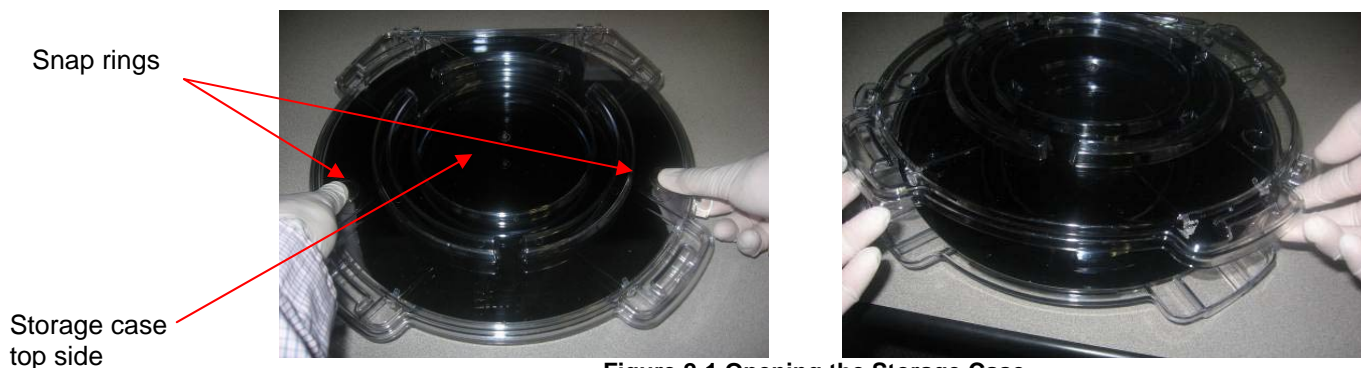
Snap rings

Storage case top side

Figure 2-1 Opening the Storage Case

For checking the wafer health using the storage case, make sure the storage case is completely closed. Flip the storage with the bottom side facing up as shown below. At the bottom of the storage case, there is an LCD screen that indicates the wafer serial number and battery voltage. If the wafer is not viable, the screen will indicate 'no wafer present'. The storage case must be reset to force it to search for a wafer by pressing the reset button. The module will then spend approximately 15 seconds looking for a wafer in its presence. If a wafer is present and the module is unable to detect the wafer, try to place the wafer in the carrier station to check the wafer state. If wafer looks healthy in the carrier, the storage case may be problematic. Contact SensArray technical support for help.
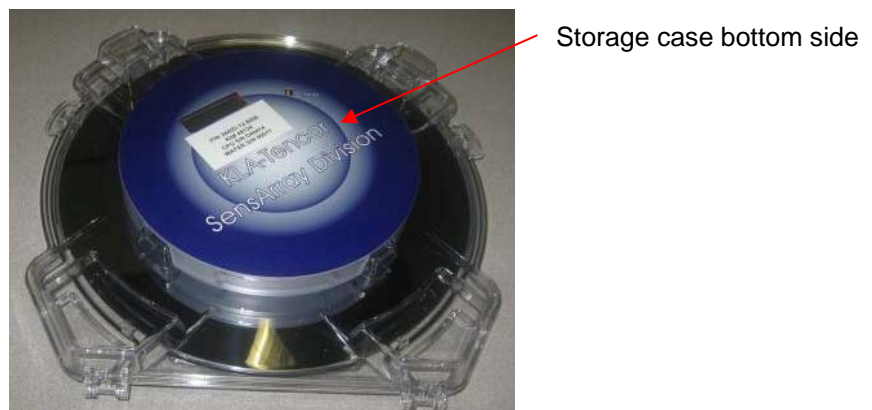
Storage case bottom side

Figure 2-2 Storage case bottom side

Charging the Equipment Before Use:

Place the EtchTemp Wafer into the carrier station shipped with the unit to maintain the charge on the internal batteries. Please see **Using the Charge and Communication Carrier Station** for more information on inserting and removing the wafer to and from the carrier stations.

Plug the laptop into the AC power supply and fully charge the laptop battery.

Setting up the Software

The EtchTemp Wafer system normally includes a SensArray qualified laptop computer that has been prepared with all needed software to setup, run, and retrieve data from the EtchTemp Wafer. Note that, EtchTemp wafer will only work with SensArray Tool 2.1 and above

Preparing Equipment for the Cleanroom

Cleaning the Equipment:

When installing a computer and an EtchTemp Wafer system in the Cleanroom, follow industry standards, including wiping down the computer and the exterior of the carrier station with Cleanroom wipes dampened with de-ionized (DI) water and/or isopropyl alcohol. Wipe down the EtchTemp Wafer itself.

Cleaning the EtchTemp Wafer:

Significant efforts are made to keep wafers clean during the manufacturing process. Due to the nature of some processes and demands by customers for cleaner wafers, the EtchTemp wafer is now offered as a cleaned product. It has gone through a SC1 and SC2 cleaning process to remove metals and organics. The cleaned wafer is packaged in the clean single polycarbonate storage case until it can be used.

Despite our best efforts, the EtchTemp Wafer may pick up contaminants from repeated handling. The ideal method of cleaning surface contaminants from the wafer is to blow a gentle stream of CDA or inert nitrogen across the surface. However, some forms of surface contamination cannot be removed this easily.

The wafer can be cleaned with IPA or DI water and a cleanroom cloth. Due to the design nature of the EtchTemp Wafer, scratches in the coating on the backside of the wafer may exist. This has not been shown to cause degradation in the performance of the wafer.

A gentle stream of DI water or IPA may be used to loosen surface contamination, and then use CDA or inert nitrogen to blow the surface dry.

> ⚠ *Never place the wafer in an ultrasonic cleaning bath. The vibration set up by the ultrasonics may damage the electronics inside and render the wafer inoperable.*

NOTE: After a period of usage under etch environment, there will be a deposited polymer ring at the bottom surface of the wafer, this may cause the chucking problem or temperature range is not in specification. Please refer to application note for the cleaning details for this polymer ring.

Cleaning the Carrier Station:

The carrier station is easily cleaned by wiping the surfaces with a cleanroom cloth dampened with IPA. Nothing harsher is needed to remove contamination from the surface. Be sure to clean the interior of the carrier station. Debris on the surface may cause stress points on the EtchTemp Wafer when the lid is closed. To avoid damage to the EtchTemp Wafer, only clean the interior of the carrier when the wafer is not present.

Recharging and Storing EtchTemp Wafer:

The carrier station contains removable, rechargeable lithium-ion batteries. The carrier station batteries should maintain a charge on the wafer batteries for up to three years. The carrier station batteries can be charged via USB or with the provided power adapter.

 VERY IMPORTANT! *Keep the wafer stored in a carrier station when not making thermal surveys. This will help ensure the maximum lifetime for the onboard wafer batteries.*

When storing the wafer in the carrier for extended periods of time, confirm that the LCD display reads "**Wafer Ready**". This indicates that the carrier station has established proper contact with the wafer and ensures that the wafer battery charge is being maintained.

Chapter-3 Using the Charge & Communication Carrier Station/RF FOUP

The Carrier Station/RF FOUP provides a method of charging and communicating with the wafer through an RF signal rather than a set of contact pins.

EtchTemp wafer will only work with SensArray Tool 2.1 and above.

Using the Carrier Station

Before using the carrier station with EtchTemp Wafer, make sure the carrier firmware version is compatible. **Carrier firmware version needs to be 2.1.90 or above.**

Please refer to the attached firmware upgrade document for further details.

The carrier station protects the Wafer and maintains the battery charge during storage. It also provides the communication link between the Wafer and the host computer.

The carrier station provides an easy, non-contact means of preparing the wafer for data acquisition and to perform data retrieval. It is important to follow proper procedures in removing and inserting the wafer in the carrier station to avoid damaging the wafer.

LCD Display

Wafer positioners

Coil printed circuit board for RF communication and charging between wafer and carrier

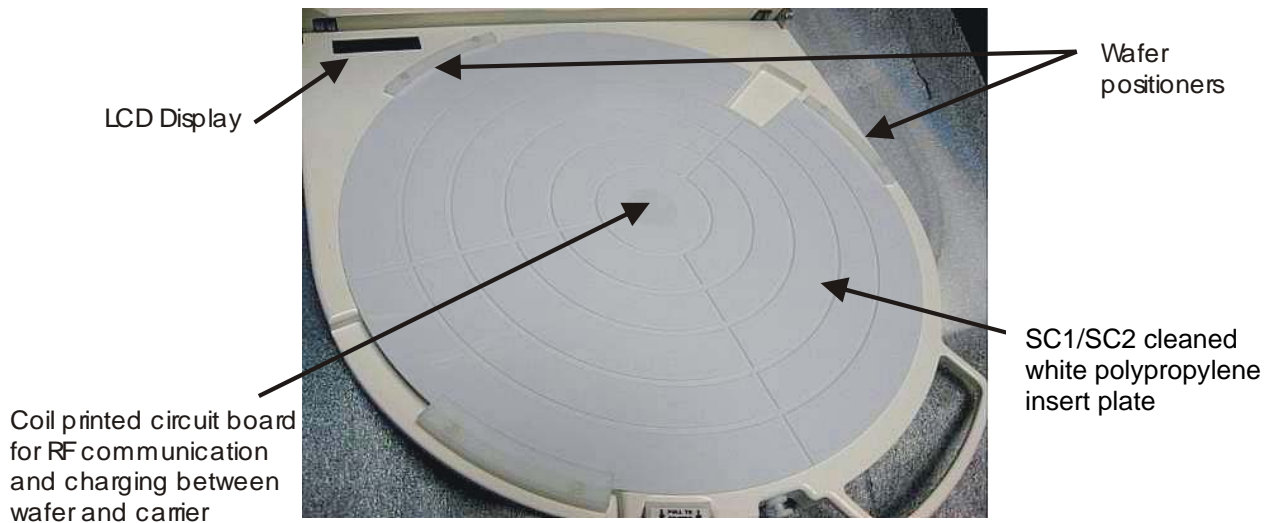SC1/SC2 cleaned white polypropylene insert plate

Figure 3-1 C/C Carrier Station Components

Figure 3-2 shows the C/C carrier station with USB port plug in. There are four LEDs on the left side of the carrier base, as referenced in Table 3-1. The green LED comes on when the USB cable is connected and there is communication between the host computer and the carrier station. The yellow LED will flicker when transferring data to and from the wafer. The red LED is on when the batteries are charging. When the red LED is flashing rapidly and solid, the unit is actively charging the batteries on the Wafer. It should typically take less than 10 minutes to fully charge the batteries. If it is flashing slowly, the battery charge is being maintained. Though the carrier will continue to maintain the batteries on the wafer, the red LED will flicker every 10 to 20 seconds when the USB cable is not connected to a power source. The blue LED blinks when a wafer is detected and communicating with the carrier.

Table 3-1: LED status indicators

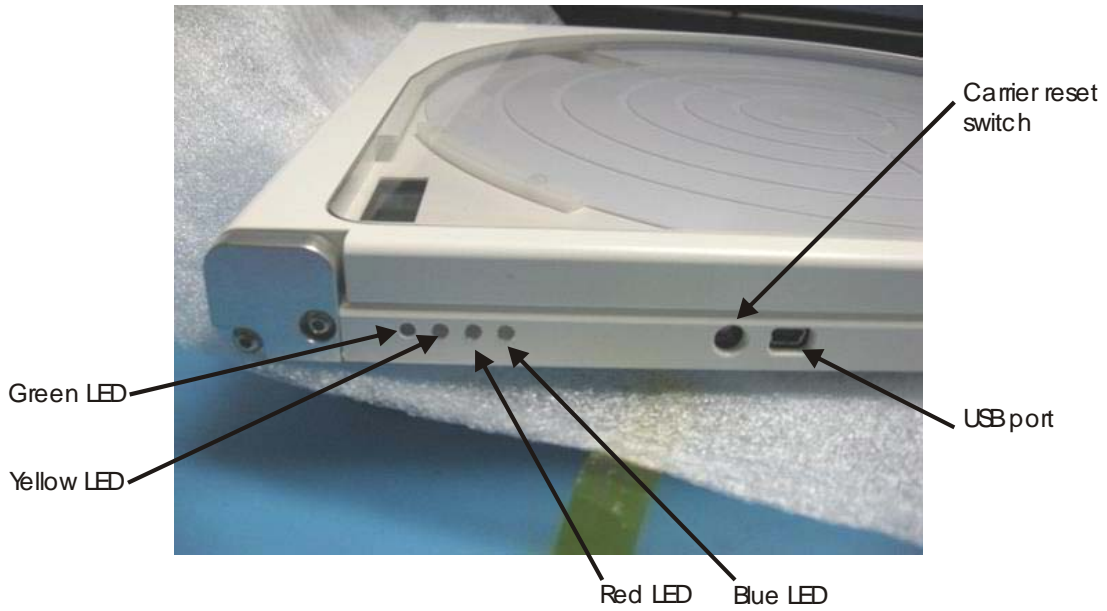| LED color	Indicates
Green	Successful USB connection to computer
Yellow	USB communications activity
Red	Wafer Charging
Blue	Communication received from wafer
Red/Blue alternating	Wafer measurement has been initiated

Figure 3-2 Connections and LED Indicators
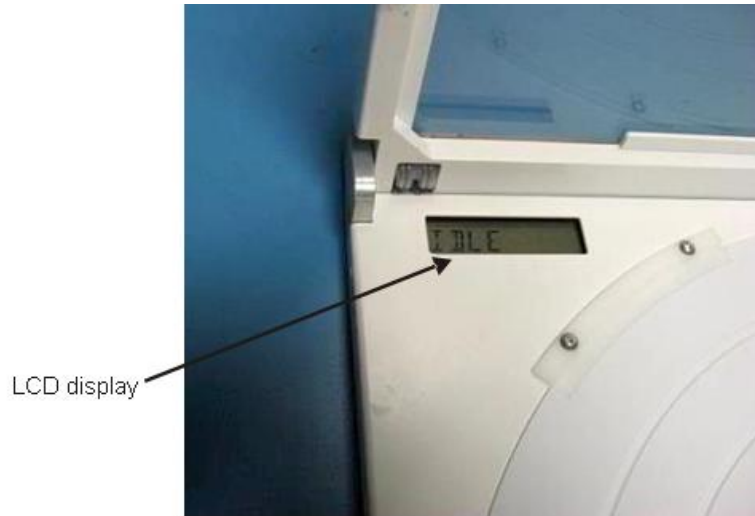

Figure 3-3 Backside of C/C Carrier

Figure 3-4 LCD Display

Figure 3-5 C/C Carrier Station Closed

To open the carrier station and gain access to the wafer, push in the white Delrin cover latch button as shown in Figure 3-6 and lift the handle attached to the lid.

Figure 3-6 Unlatching the Carrier Station

Once the lid is raised completely, spring tension will keep it open.
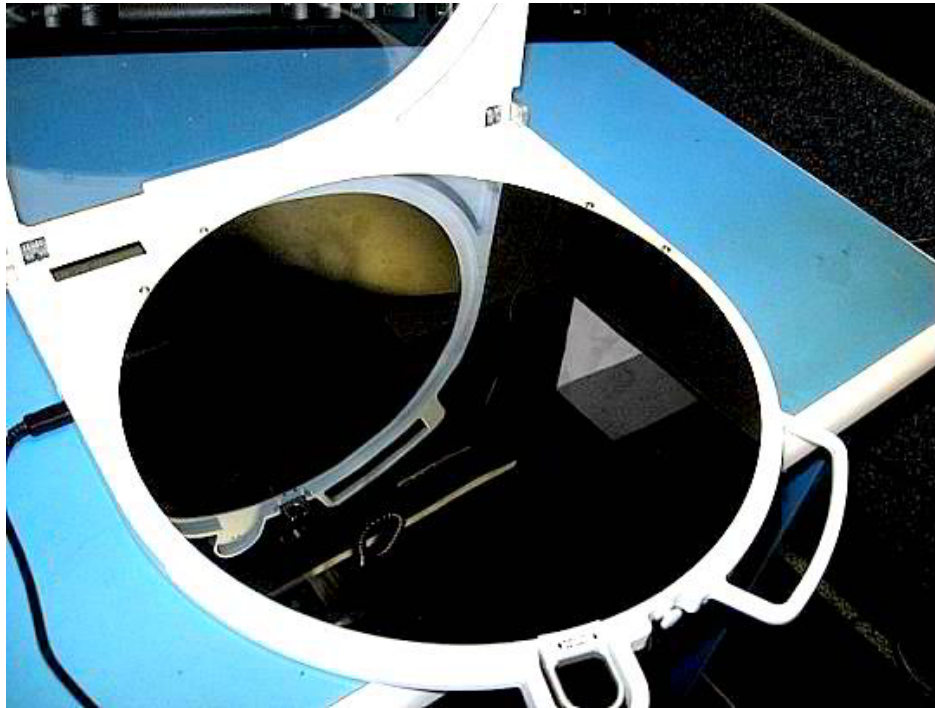
Figure 3-7 Carrier Station Open

CAUTION: Only handle the Wafer on the edges with gloves on.

The wafer is locked to the surface of the white plastic insert on the carrier station by a spring-loaded clamp mounted to the side of the carrier station. To unclamp the wafer, pull the wafer clamp straight out until it clears the side of the wafer carrier. Then press down until it aligns with the recess in the side of the carrier station. Allow the clamp to slide forward into the recess.

Wafer Clamp

Figure 3-8 Wafer Clamp

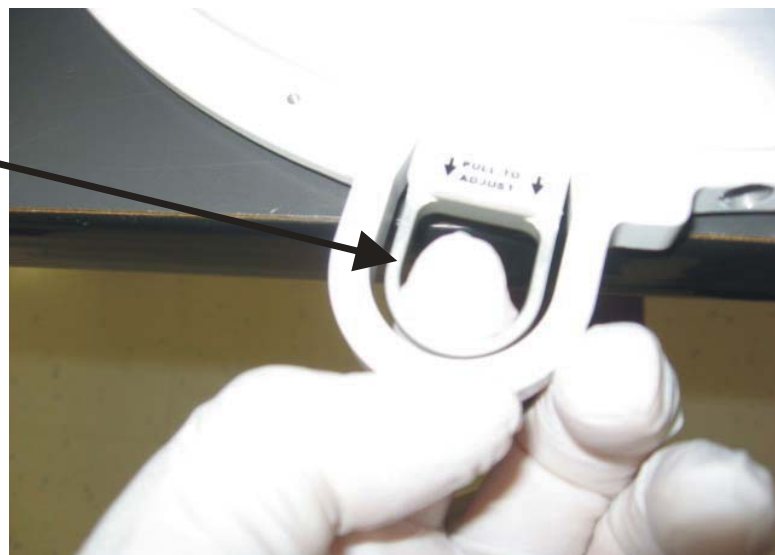# Removing the Wafer from the Carrier Station

While the Lid is opened, you can slide the wafer off the carrier plastic insert surface. A groove is provided on the right-hand side of the carrier station surface to allow you to get your finger below the side of the wafer as shown in Figure 3-9. Slide the wafer to the left until there is enough of the wafer free of the carrier plastic insert surface to put your other hand or a vacuum wand under the wafer. Remove the wafer completely. Do not pull the wafer too quickly off the plastic insert surface. Static attraction between the bottom of the wafer and the plastic insert surface may place undue stress on the Wafer and result in breakage.

Figure 3-9 Wafer Removal Points
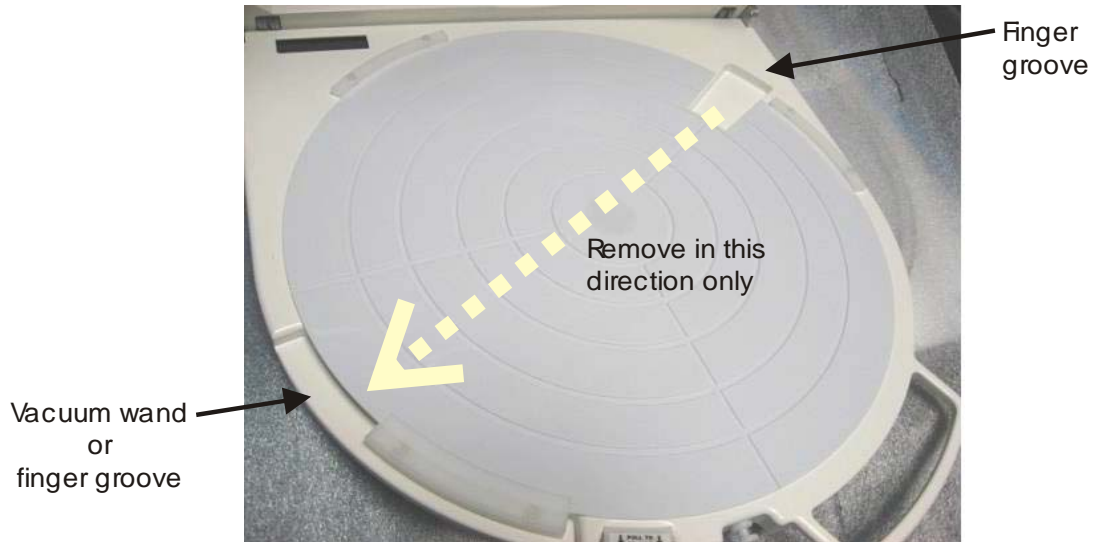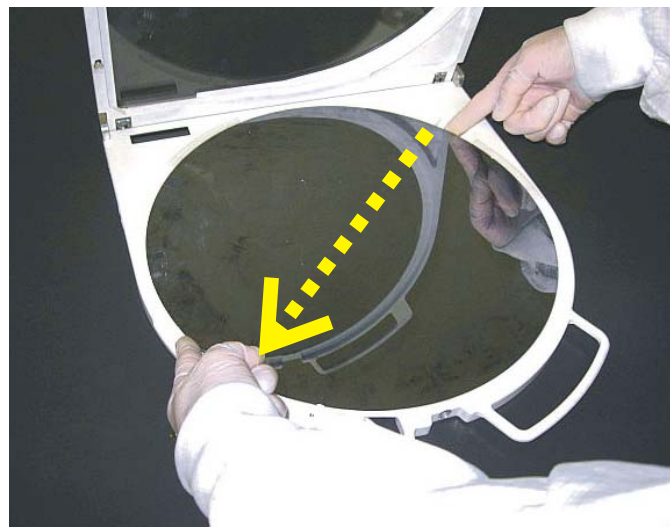

Remove wafer in this direction only

Figure 3-10 Removing the Wafer from the Carrier Station

You can now place the wafer in a wafer cassette or other loading mechanism to perform the thermal survey.

CAUTION: Only handle the wafer from the bottom or by the edges as much as possible. Always ensure the backside of wafer is cleaned of any particle or any other materials.

Using the Wafer with the Carrier Station

To place the wafer on the carrier station, first open the lid of the carrier station. Slide the wafer onto the plastic insert surface and slightly push the wafer against the wafer positioners. Make sure the edge of the wafer slides under the top surface of the positioners. Once the wafer is positioned correctly, pull the wafer clamp out from the recess, lift it up, and slowly slide the clamp forward until it presses against the wafer. Release the clamp.

Lower the lid until the latch contacts the locking pin. Press the locking pin in and lower the lid until the locking pin pops out as shown in Figure 3-11. The lid is now secure.

Unlatched	Latched
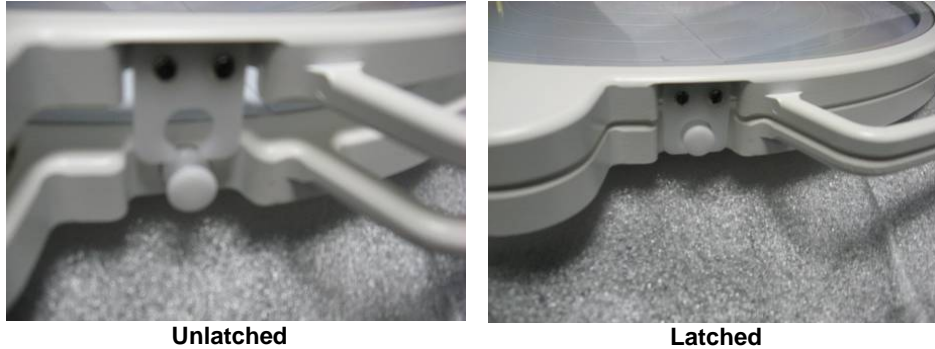
Figure 3-11 Lid Locking Pin

The C/C carrier has an LCD on top left corner. When lid is opened, the message **System Idle** should be displayed.

LCD Display

White insert
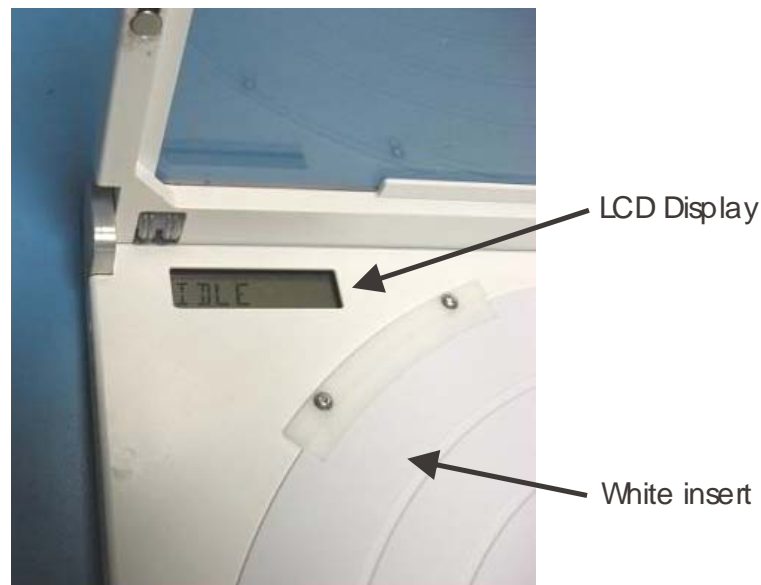
Figure 3-12 Idle Message Displayed

When wafer is present and lid is closed, the LCD will display **Loading Wafer.** Once the wafer is detected, the message **Wafer Ready** will display and the blue LED will blink.

Figure 3-13 Wafer Ready Displayed

If you close the LID and no wafer is inside the carrier, you will see the message **No Wafer detected**.

There may be a delay between the carrier LCD display messages and the SensArray Tool mission controller application message on your laptop. Do not use the wafer until you actually see the message display on the mission controller screen. Also, only perform the survey when the wafer voltage is >4.10V. This would help to improve the lifetime of the EtchTemp wafer.
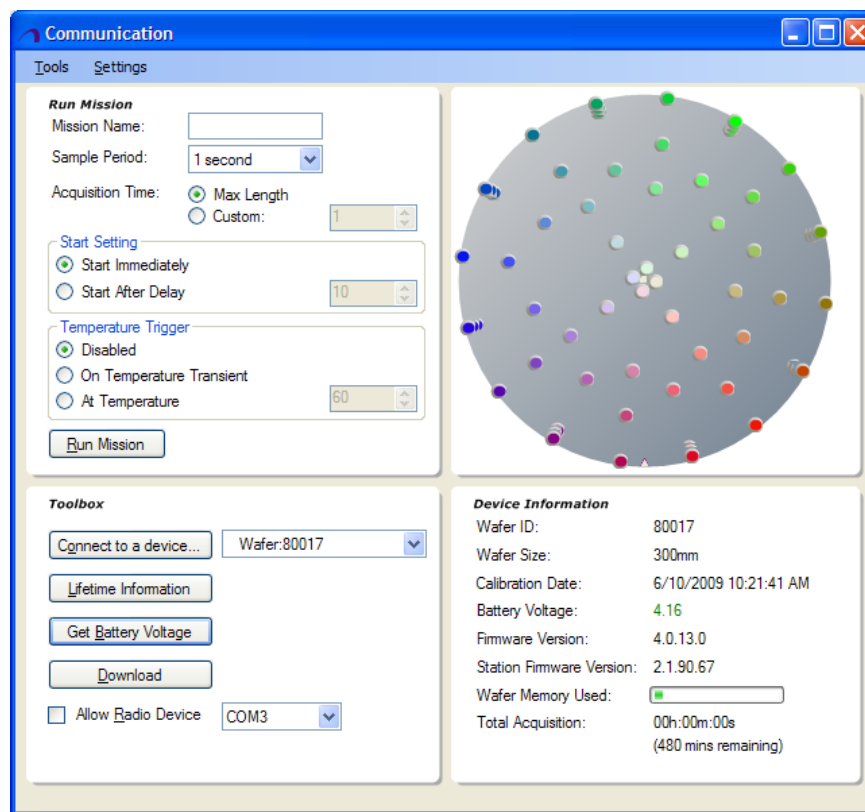
Figure 3-14 Mission Controller Screen (SensArray Tool)

Using the RF FOUP

The RF FOUP protects the Wafer and maintains the battery charge during storage. It also provides the communication link between the Wafer and the host computer through the USB port.

- When wafer is present, the LCD will display **Loading Wafer.** Once the wafer is detected, the message **Wafer Ready** will display.

- There may be a delay between the RF FOUP LCD display messages and the SensArray Tool mission controller application message on your laptop. Do not use the wafer until you actually see the message display on the mission controller screen.
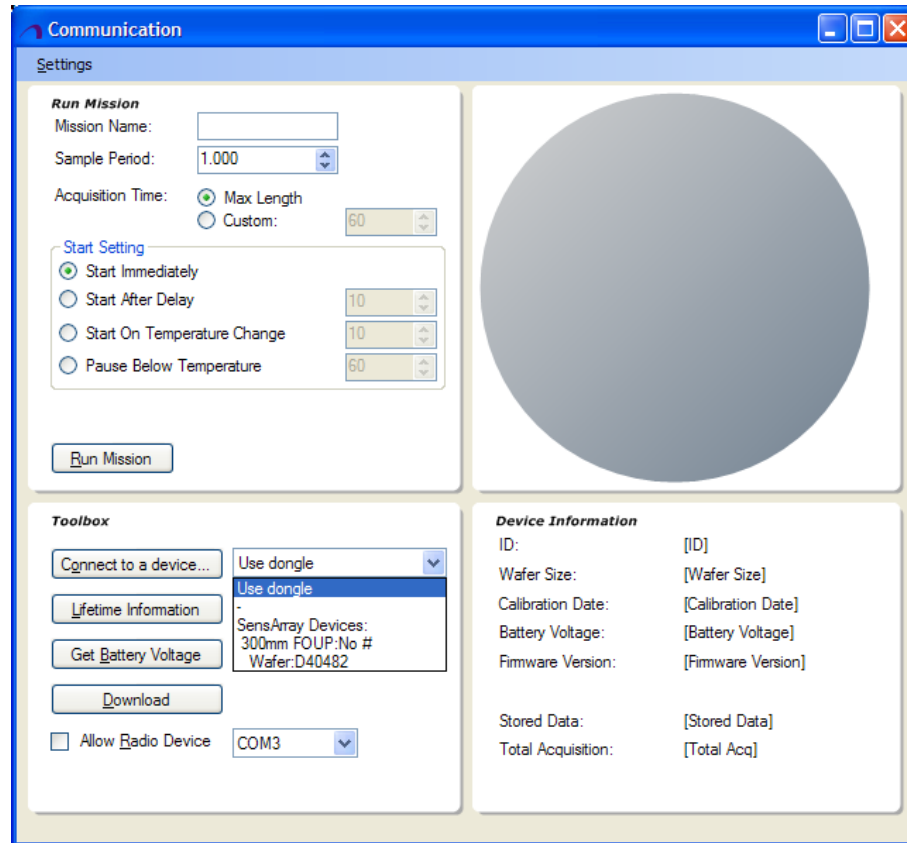
Figure 3-15 Mission Controller Screen (Settings)

- Communicating between RF FOUP and EtchTemp wafer is the same as between Carrier Station and EtchTemp wafer.

- Start the mission is identical for both RF FOUP and Carrier Station.
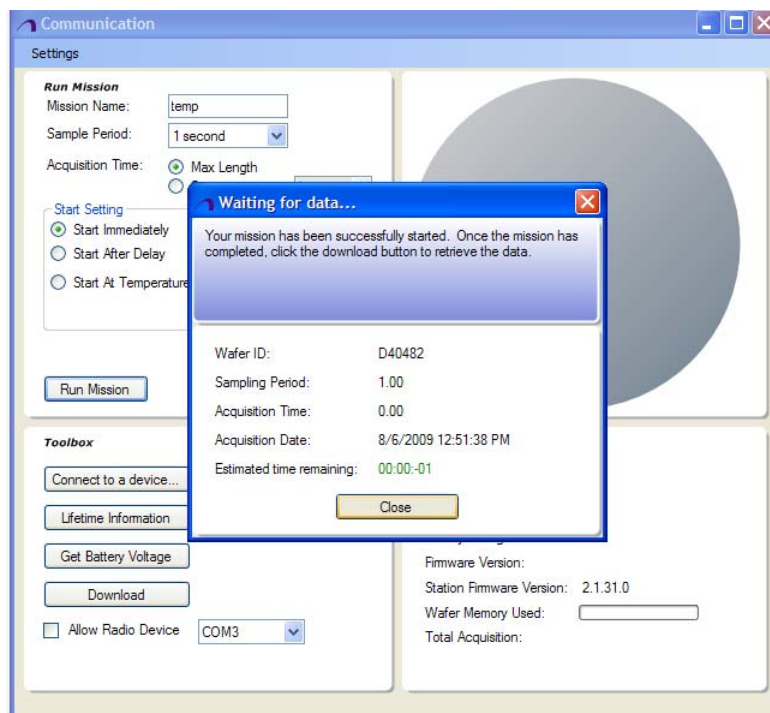
Figure 3-16 Retrieving the Data

- After the survey, when the wafer going back to the RF FOUP, the data from the wafer will be stored in the FOUP. Select the latest data file and click OK to retrieve the data file.
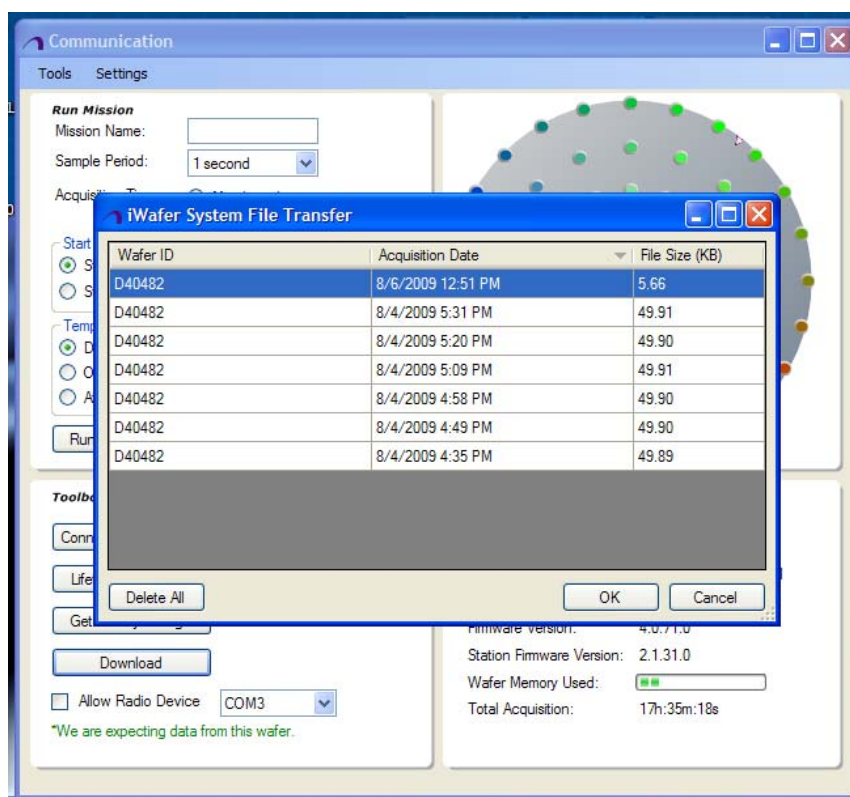
Figure 3-17 iWafer System File Transfer

NOTE: The RF can only stored up to 12 data files only.

Chapter-4 Using the SensArray Tool Software

The SensArray Tool is a software program that communicates with the EtchTemp Wafer through the carrier station or RF FOUP. It monitors the status of the system, retrieves data from completed thermal surveys, and sets up the parameters for the next set of surveys.

Before using the SensArray Tool, please read instructions on using the Carrier Station. See the *Using the Carrier Station* section of Chapter 3 for more information. **For setup and using SensArray Tool, please see SensArray Tool manual.**

Starting the Program

Connect the carrier station to the computer with the USB cable. Start the SensArray Tool program by double-clicking the desktop icon.

The **PlasmaSuite** window opens
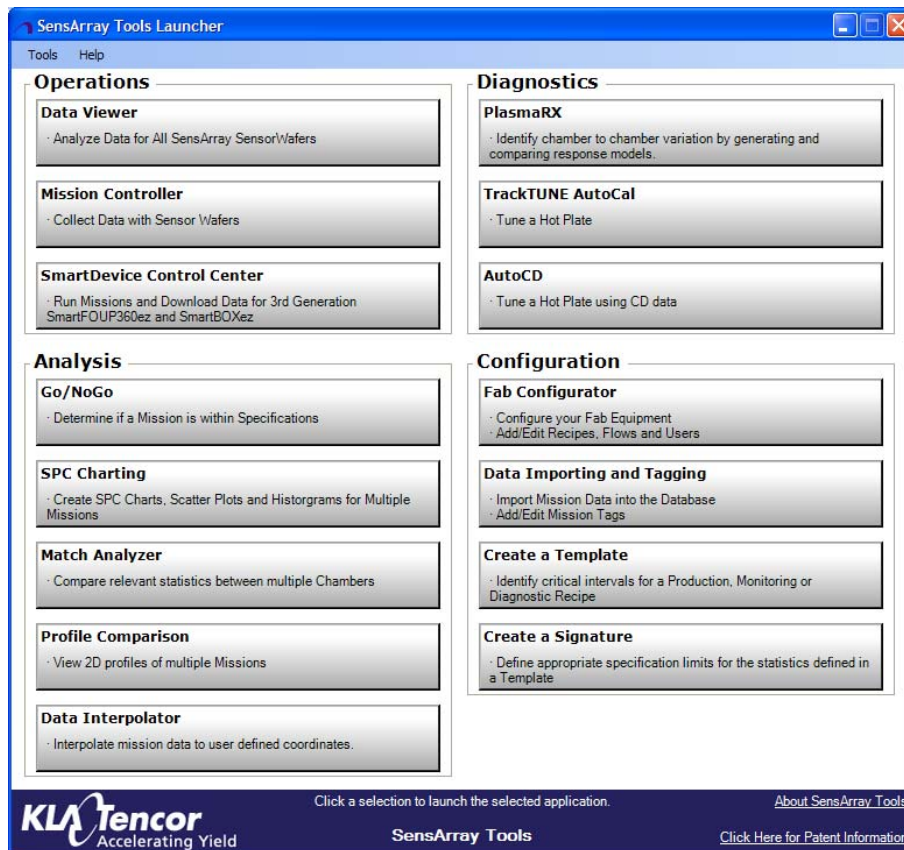
Figure 4-1 SensArray Tool

Product License at Startup

The computer should come with the correct license. However, if an **Error** dialog box appears similar to Figure 4-2 or Figure 4-3.
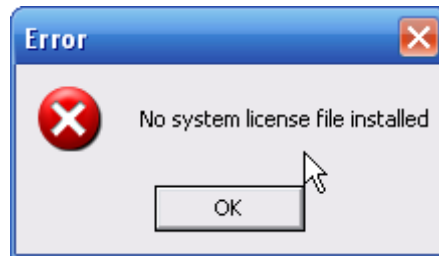
Figure 4-2

Or
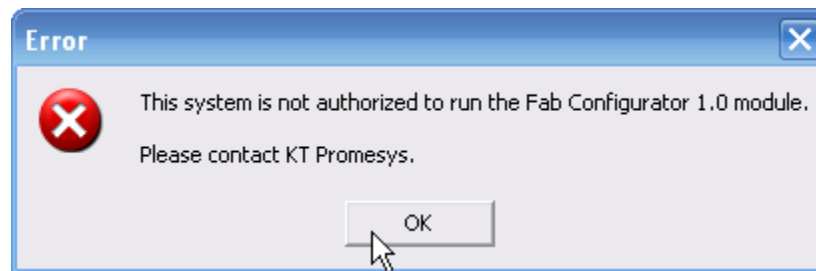
Figure 4-3

Or if a license upgrade is needed, click the **OK** button, then use the **License File Manager** to resolve the issue.

To use the License File Manager

1. Select Tools on the PlasmaSuite or LithoSuite window menu bar, then License File Manager. The License File Manager window opens.
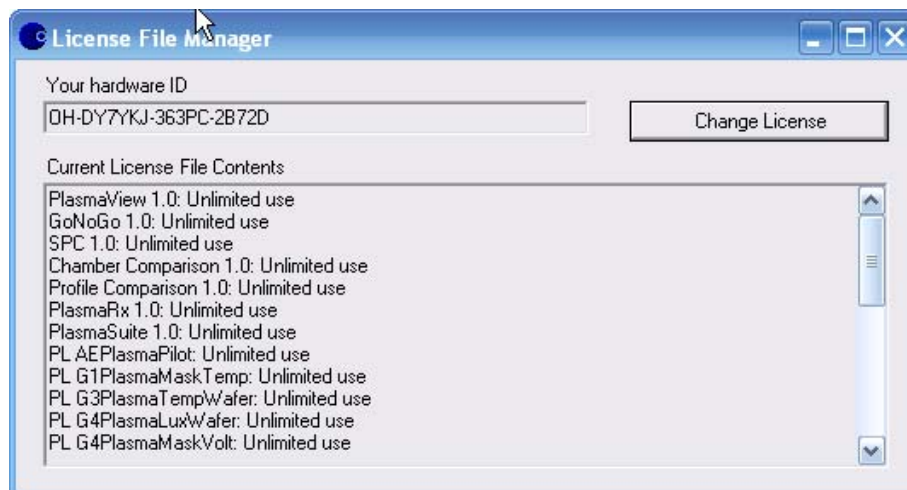
Figure 4-4 License File Manager Window

2. Send the computer's hardware ID to Support Services at customer.support-sensarray@kla-tencor.com. They will send an updated license. Download the new license.

3. To load the new license, return to the **License File Manager** window, then click the **Change License** button. The **License Upgrade Wizard – Choose License Manager Action** window opens.
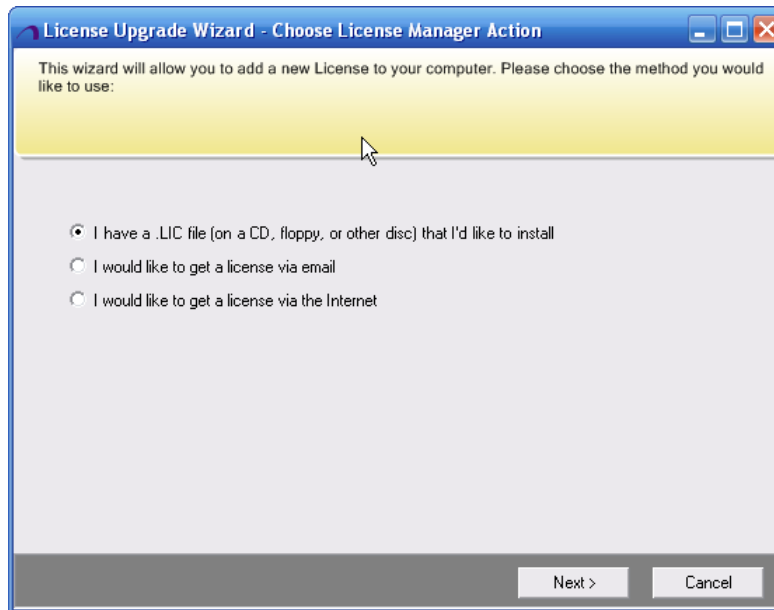
Figure 4-5 Choose License Manager Action Window

4. Select the first option, then click the Next > button. The License Upgrade Wizard – Add License Form File window opens.
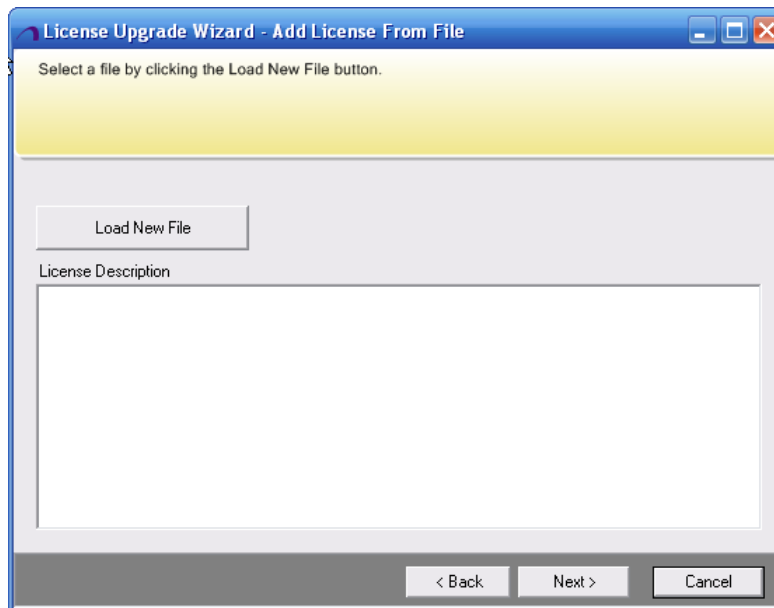
Figure 4-6 License Form File Window

5. Click the **Load New File** button. The **Choose the license to load** window opens.

6. Select the new license, then click the Open button -or- double-click the new license. The license contents are listed in the License Description panel of the License Upgrade Wizard - **Add License From File window.**

7. Click the Next > button. The License Upgrade Wizard - Confirm License File Change window opens.

8. Click the Finish button, then close the License File Manager window. The new license is in effect.

SensArray Tools Process Flow
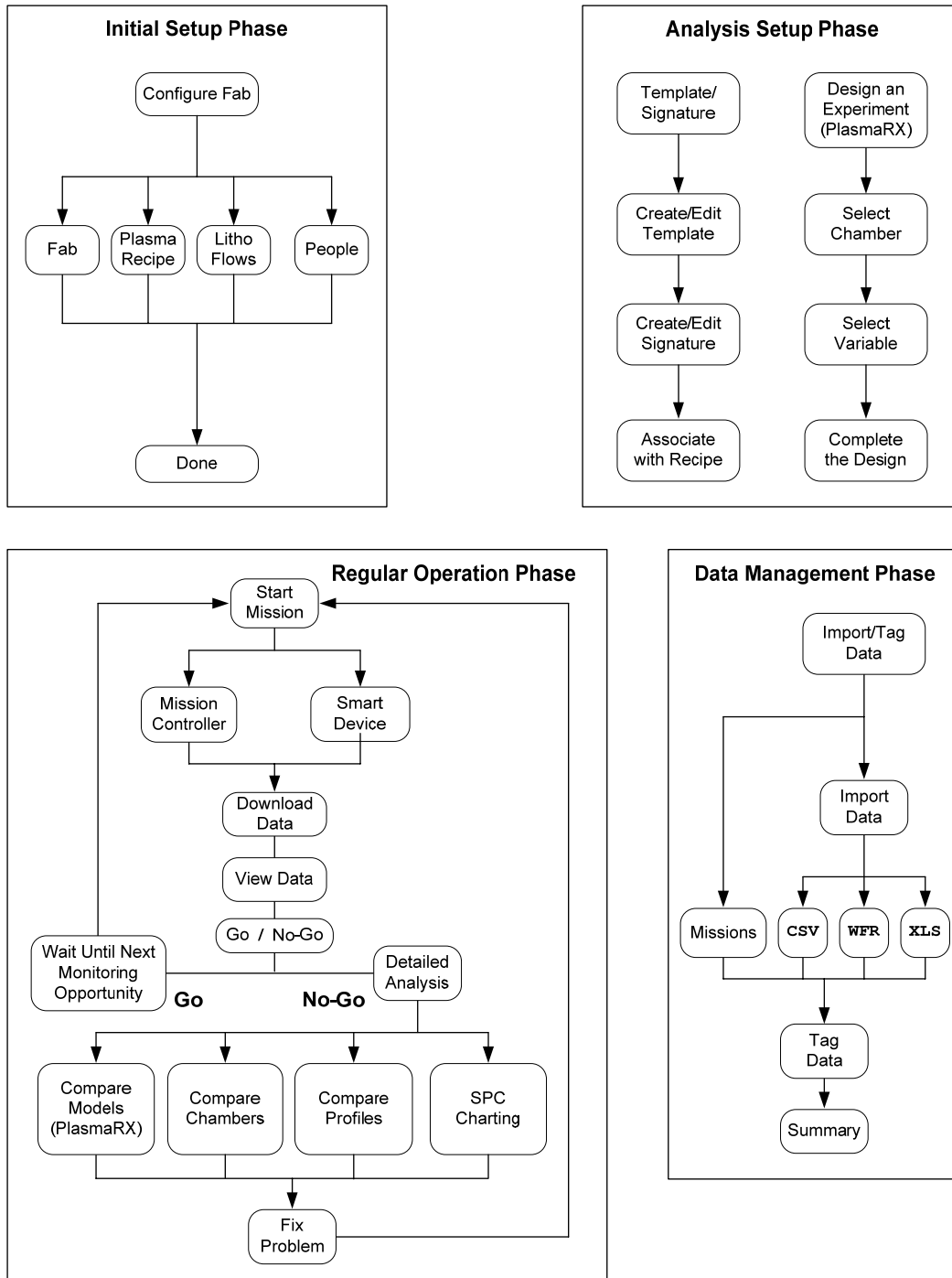
For the configuration setup, please refer to SensArray Tool user manual.

Acquiring Data Using the Mission Controller

The process of acquiring data, using the Mission Controller to run a mission, is comprised of the following steps:

- Step 1 - Start the Application
- Step 2 - Run a Mission
- Step 3 - Download and Tag Mission Data
- Step 4 - Check Tagged Data
- Step 5 - View Mission Data

Step 1 - Start the Application

To start the application:

1. From the **PlasmaSuite** window, select **Mission Controller**. The **Communication** window opens.
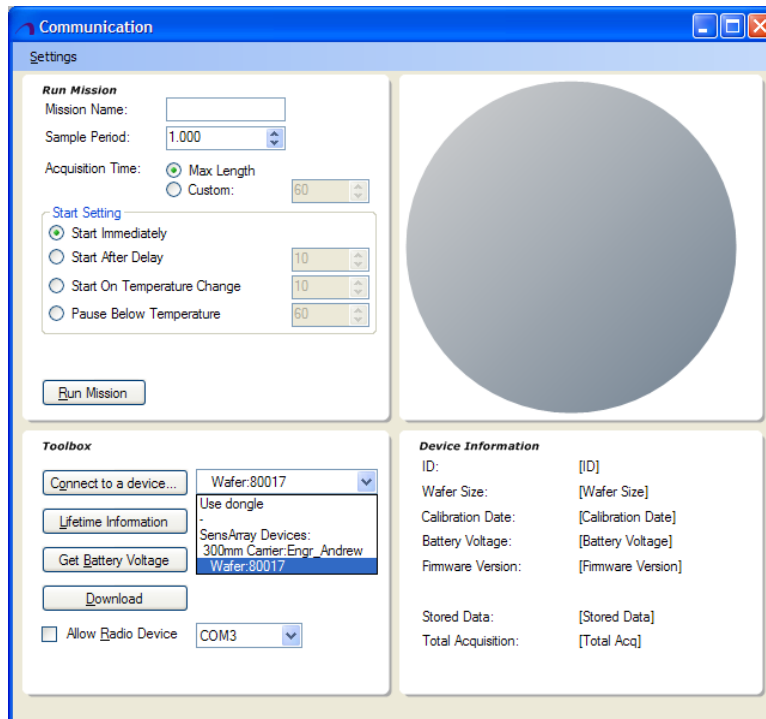
Figure 4-7 Communication Window

Proceed to Step 2 - Run a Mission.

Step 2 - Run a Mission

To run a mission:

1. In the **Run Mission** panel, enter the *Mission Name*, *Sample Period* (sample the entire wafer every *X* seconds; one second is the standard); *Acquisition Time* (total mission time in seconds; maximum value depends on the particular wafer being used); and *Start Condition*.

Start Condition **options are:**

- **Start Immediately** - Mission starts when the wafer is taken from its bay station.
- **Start After Delay*** – Mission starts after the specified time expires.
- **Start at Temperature**

*When a delay is combined with a temperature trigger, the delay will not start counting down until **after** the temperature trigger condition is met.

Use a direct connection to the wafer:

2. Connect a cable from the computer USB port to the port on the FOUP or carrier station. Select the *Wafer ID* from the drop-down list, and then click the **Connect to a device** button in the **Toolbox** panel. The wafer information is read from the wafer and added to the **Device Information** panel.
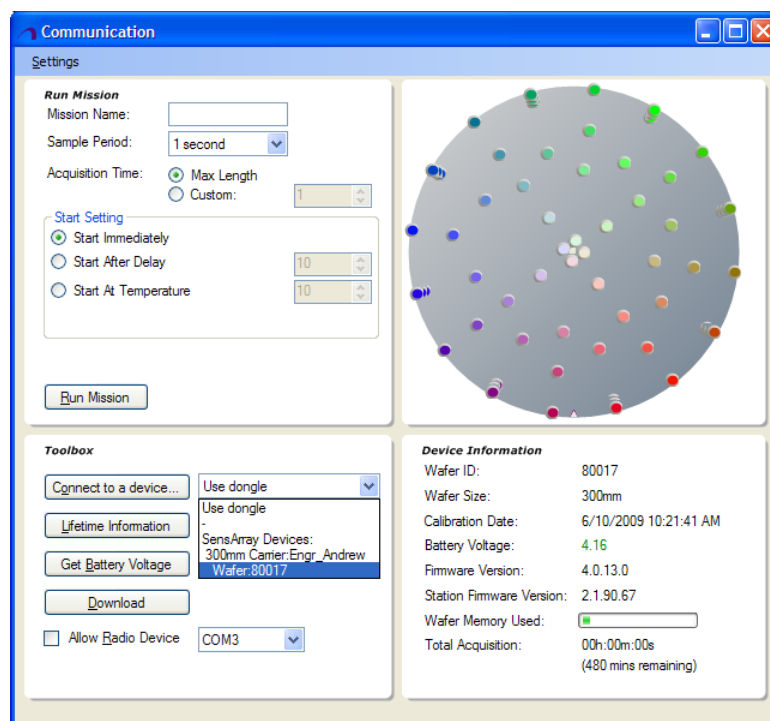
Figure 4-8

To check the wafer battery:

1. Click the **Get Battery Voltage** button in the **Toolbox** panel. If the wafer voltage is displayed in **red**, wafer can not be started. If the wafer voltage is displayed in **green**, the wafer is ready to run another mission.

2. Place the wafer into the processing equipment, then click the **Run Mission** button to run the mission. The **Waiting for data…** window opens. This window is merely a rough status indicator for the wafer, and is present for convenience only. It can be closed at any time without affecting the wafer.
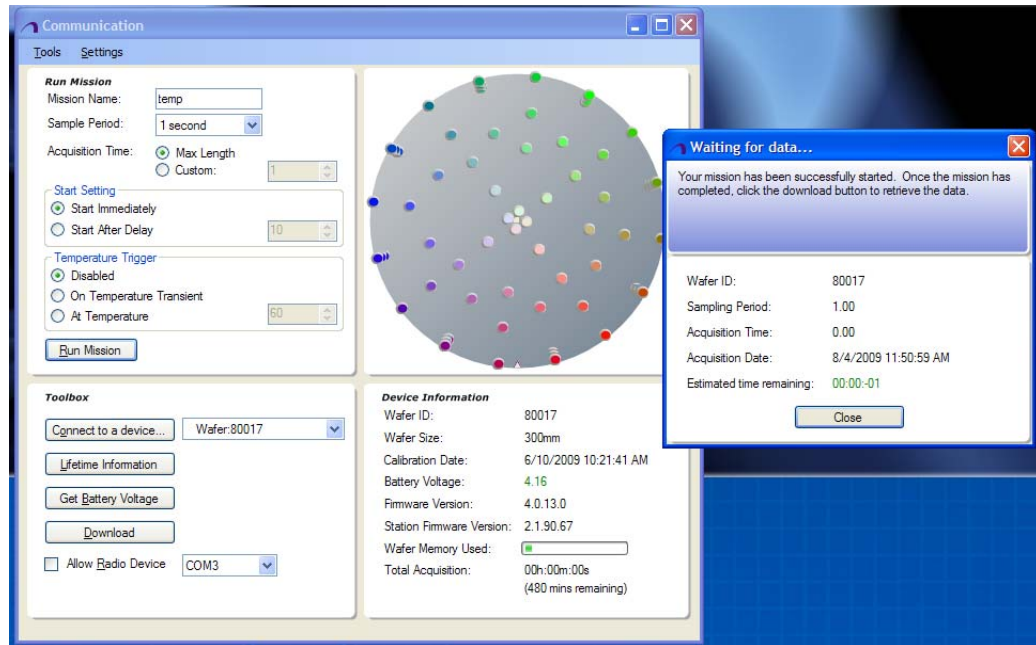
Figure 4-9 Waiting for data Window

To place the wafer into the process chamber, process it, then bring the wafer back

a. If the wafer is in a wafer carrier:

b. Transfer the wafer to a standard FOUP.

c. Place the FOUP onto the equipment's load port and instruct the equipment to process the wafer.

d. After the run is complete, instruct the equipment to unload the wafer, back to the FOUP.

e. Transfer wafer from FOUP to wafer carrier.

3. If the wafer is in a RF FOUP:

a. Place the RF FOUP onto the equipment's load port;, then instruct the equipment to process the wafer.

b. After the run, instruct the equipment to unload the wafer back to the FOUP.

Running the mission is now complete.

Proceed to Step 3 - Download and Tag Mission Data, to view the collected data.

Step 3 - Download and Tag Mission Data

To download mission data

1. After the mission run is complete, return the wafer to its base station (RF FOUP or Carrier Station).
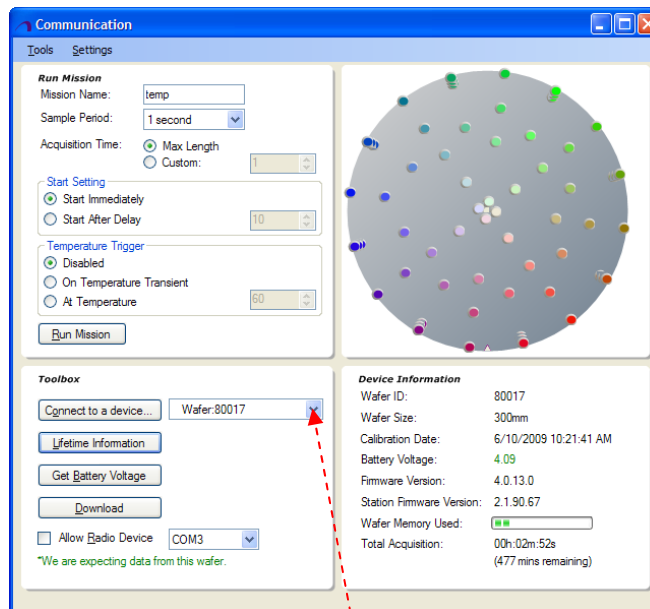
Figure 4-10 Slecting the Wafer ID

2. Select the *Wafer ID* from the drop-down list, and then click the **Connect to a device** button in the **Toolbox** panel. The wafer information is read from the wafer. At bottom left corner, the message "We are expecting data from this wafer" appears.

3. Click the **Download** button in the **Toolbox** panel. The **Please provide some information about this data** window opens, to allow tagging information about the run to be entered.
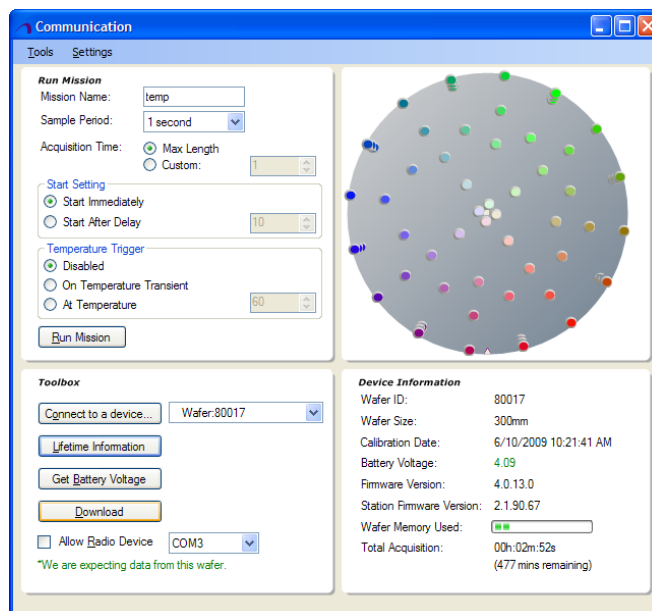
Figure 4-11

4. Tag each mission by specifying by whom the data was collected, and the chamber and recipe associated with the mission. **All missions must be tagged before proceeding.**

TIP: *To tag more than one mission with the same information, select multiple files by pressing and holding the <CTRL> key while selecting additional missions. If multiple missions are selected, anything selected on the right is applied to every mission currently selected.*
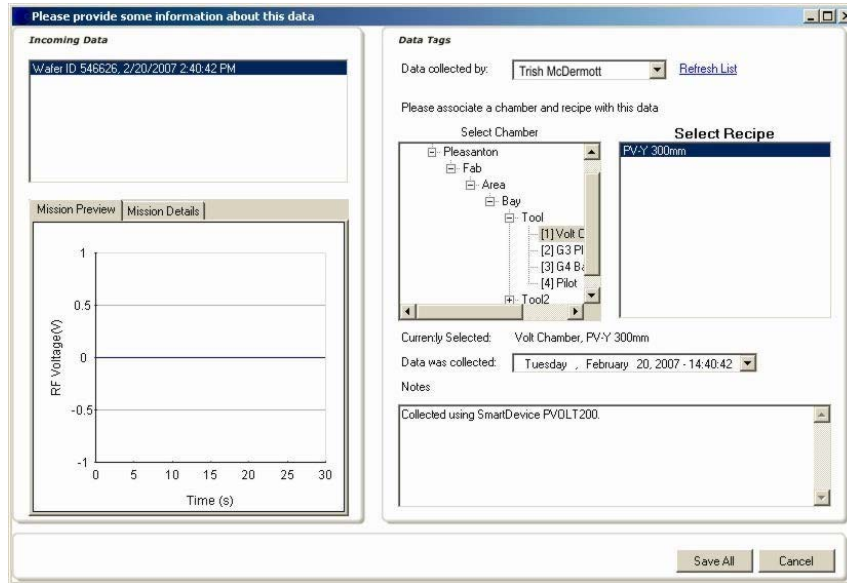
Figure 4-12

To tag selected data (for PlasmaSuite)

1. Select a fully qualified *path name* from the **Incoming Data** panel.

2. Select a *name* from the **Data collected by** drop-down list to associate with the selected data.

3. Open the *fab to the chamber level* in the **Select Chamber** list, then select the *chamber of interest*.

4. Select a *recipe* from the **Select Recipe** list to associate with the selected chamber.

5. The selected *chamber* and *recipe* are listed in the **Currently Selected** field. Click those selections before clicking the **Save All** button.

Step 4 - Check Tagged Data

The **Summary** page table lists all data tags that were added or updated.

To check tagged data:

1. If any information is incorrect, click the **< Back** button and correct it.

2. If the data is correct, click the **Finish** button. The **PlasmaSuite** window opens.

NOTE: If there is a problem with the tagged data, a **Warning** dialog box opens, listing the problem parameters, and the **Launch Go/No-Go** window pinpoints the out-of-spec information. Correct the information before proceeding.

To view the data collected, proceed to .

Step 5 - View Mission Data

1. On the **PlasmaSuite** window, select **Data Viewer**, then select **View Data** from the **File** menu. The **Mission Selection** window opens.

2. Select the mission to be viewed, then drag it to the **Selected Missions** panel. Click the **OK** button. The **Data Viewer** window opens, with this mission displayed. The left panel plots the sensor data versus time. To display the data at that time point as a 2D or 3D graph, click the left panel. To display the data as a histogram, click the right panel.
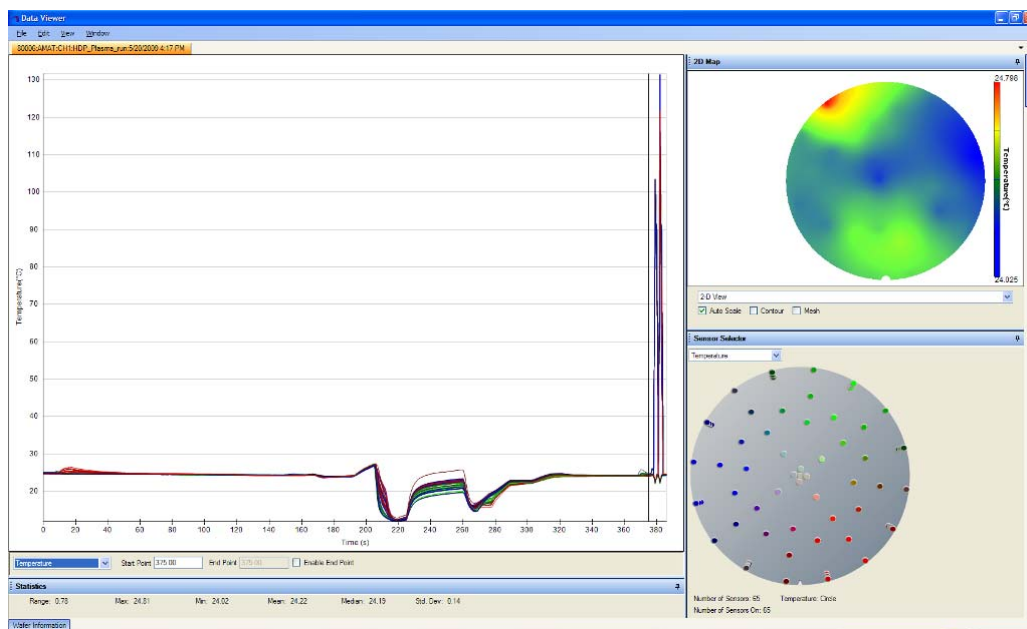
Figure 4-13 Data Viewer Window

3. Visually assess the resulting graphical comparison of missions. If the graphs look basically similar, the results are acceptable. If they are significantly dissimilar, investigate further with the **Advanced Analysis** tools.

4. Close the **Data Viewer** window when finished.

The process of collecting data from the mission is now complete.

The Data Viewer enables the following tasks:

- Viewing Data from Previous Missions
- Viewing Data from File
- Identifying Data to Be Analyzed Using a Template

From the **PlasmaSuite** window, select **Data Viewer**.
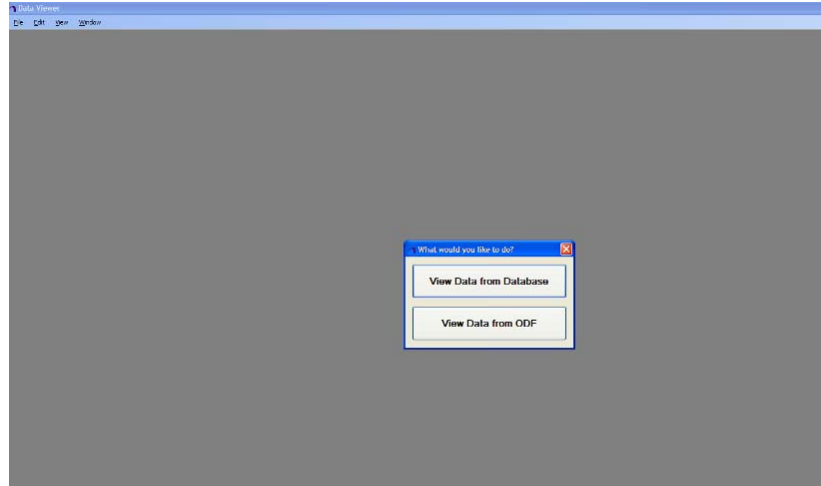
Figure 4-14 Data Viewer Window

Viewing Data from Previous Missions

Select **View Data** to view data from previously run missions.

To view data:

1. Select **View Data** in the **File** options on the **Data Viewer** menu bar. The **Mission Selection** window opens.

2. Apply various filters in the **Mission Filters** panel, to narrow the search. After a satisfactory selection of missions is viewed, drag one or more missions into the **Selected Missions** panel.

3. Information about the mission(s) is displayed in the **Selected Missions** panel, and graphed in the panel below. Click the **OK** button. A **Data Viewer** window for each selected mission opens.

4. The left panel plots the sensor data versus time. To display the data at that time point as a 2D or 3D graph, click the left panel. To display the data as a histogram, click the right panel.

NOTE: The menu bar options for the mission-specific **Data Viewer** are more extensive than those of the general **Data Viewer** (before a mission is loaded).

File options include:

- *View Data -* Returns to a **Mission Selection** window

- *View Data From File* - Opens the **Select an ODF to load** window (ODF = OnWafer data file)

- *Save Data To File* - Opens a **Save As** window

- *Mission Controller* - Opens the **Mission Controller** window

- *Export Data To Excel* - Opens the **Export to Excel** window

- *Export Statistics/Graphs To Excel* - Opens the *Select Information to Include* window

- *Export Graph to Image File* - Opens the *Save graph to file* window

- Close Window

- Exit

Edit option allows copying of a selected graph to the Windows Clipboard.

Graph options include:

- ***Synch All Graph Scales To:***

- ***Synch All Graph Intervals To:***

- ***Line Graph options***

  - ***Set Scale***

  - ***Auto Scale***

  - ***Zoom***

  - ***Zoom Settings***

  - ***Set Background Color***

View option is **Lifetime Information**.

Window option allows tiling windows horizontally and vertically, and window cascading.

Help option provides **Data Viewer** version information.

5. Review data to ensure the results are as expected. If so, close the window.

Viewing Data from File

1. Opens a **Select an ODF to load** window. (ODF = OnWafer data file.)
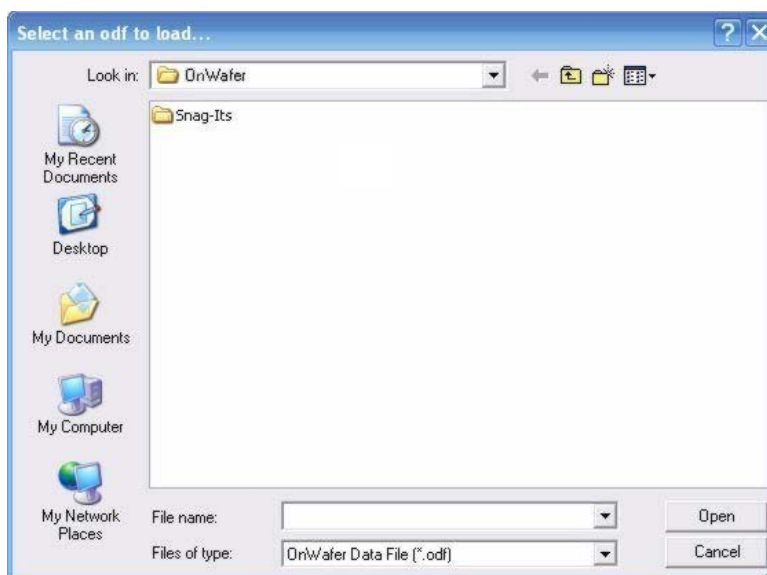
Figure 4-15 Select an ODF to load window

Identifying Data to Be Analyzed Using a Template

A template defines the regions of interest within a mission run using a specific recipe. It also defines the important statistics for each region (*such as* mean, range, and standard deviation).Templates are an important part of **SensArray Tools** analysis modules, because they are used to extract key information from the raw data. This section is a guide to the template creation process.

The process of identifying data to be analyzed using a template, is comprised of the following steps:

- [Step 1 - Create a Template]
- [Step 2 - Define the Intervals of Interest for this Recipe]
- [Step 3 - Define the Parameters]

Step 1 - Create a Template

To create a template

1. Start the **Create a Template** module from the **PlasmaSuite** window. The **Templates - Available Templates** window opens.

NOTE: If this is the first time the utility is started, the **Available Templates** list is empty, and no graph data is displayed.
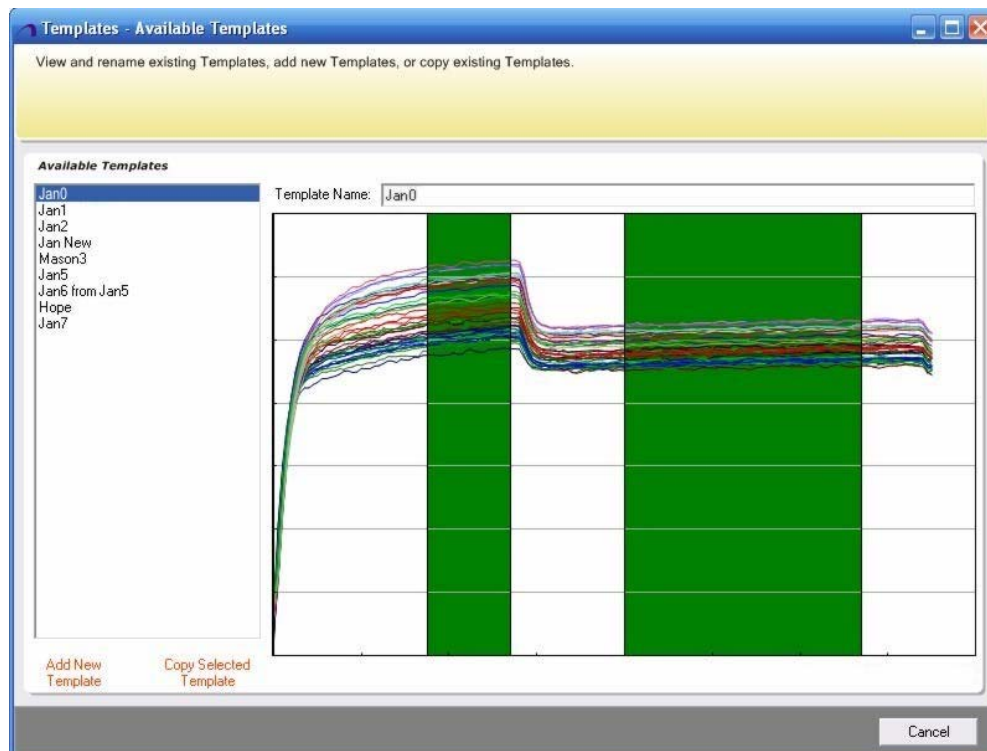
Figure 4-16 Templates - Available Templates window

2. Click the **Add New Template** button to start the **Template Wizard** to create a template, -or- the **Copy Selected Template** button to copy an existing template. The **Mission Selection** window opens. This allows a choice of reference mission, which should be a good representative of mission data collected using the recipe of interest.
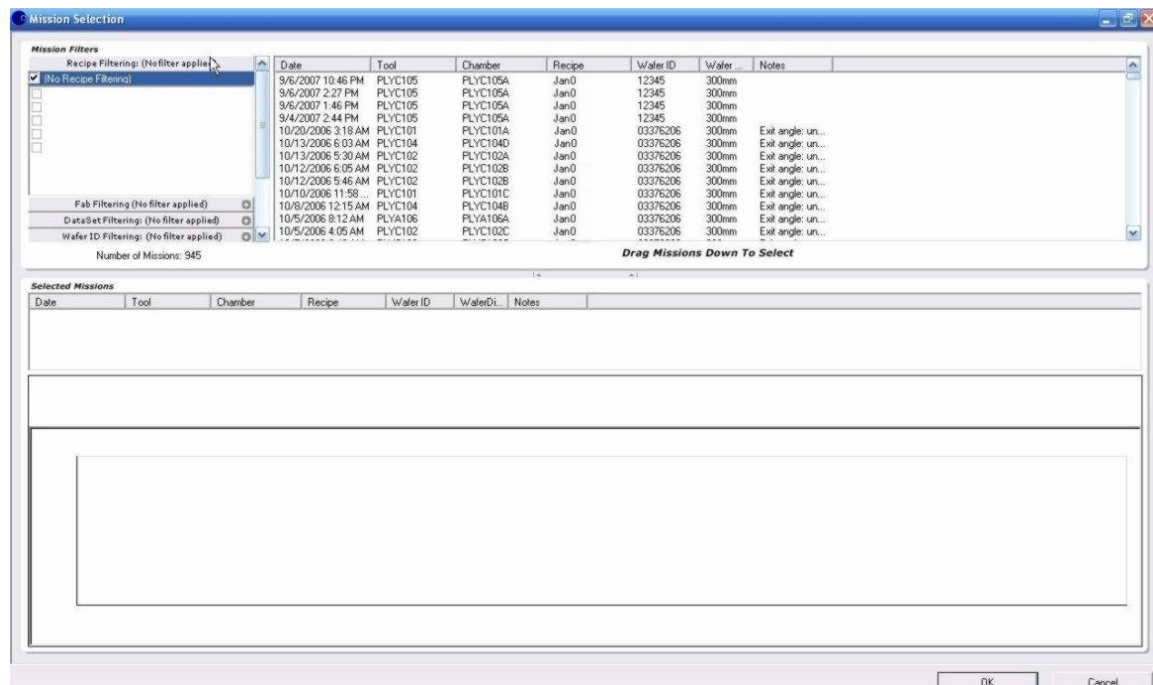
Figure 4-17 Mission Selection Window

3. Filter the missions by *Recipe*, *Fab*, *DataSet*, *Wafer ID*, *Date*, *Included Missions*, *Data Type*, *Notes*, or *Diameter*, to limit the number of missions from which to select.

NOTE: More than one mission can be selected for this step, to ensure that the program is able to properly analyze other missions from the same recipe.

4. Drag the selected *missions* to the **Selected Missions** list.

*TIP: When selecting a single mission using the **Mission Selector** window, it is not necessary to drag the mission to the **Selected Missions** list. Instead, select the mission to be analyzed, then click the **OK** button.*

5. After all missions are selected, click the **Next >** button. The **Templates – Interval Definition** window opens.

Proceed to Step 2 - Define the Intervals of Interest for this Recipe.

Step 2 - Define the Intervals of Interest for this Recipe

Intervals of interest are periods of time within the data that contain "interesting" information. Typically, these are the steady state portions of the graph, where the data is not significantly rising nor falling.

To define recipe template intervals of interest:

1. Select which *mission* to list as the reference mission in the **Selected Missions** box. If there are no missions in the list that represent the needed data, return to Step 1 - Create a Template.

NOTE: When selecting the reference mission, start with a well-functioning chamber or track that has missions running the same recipe or flow. Identify, as the reference mission, the template that most or all the selected missions match. To do this, select each mission, in turn, as the reference mission, then compare the results by clicking the **Preview** button.
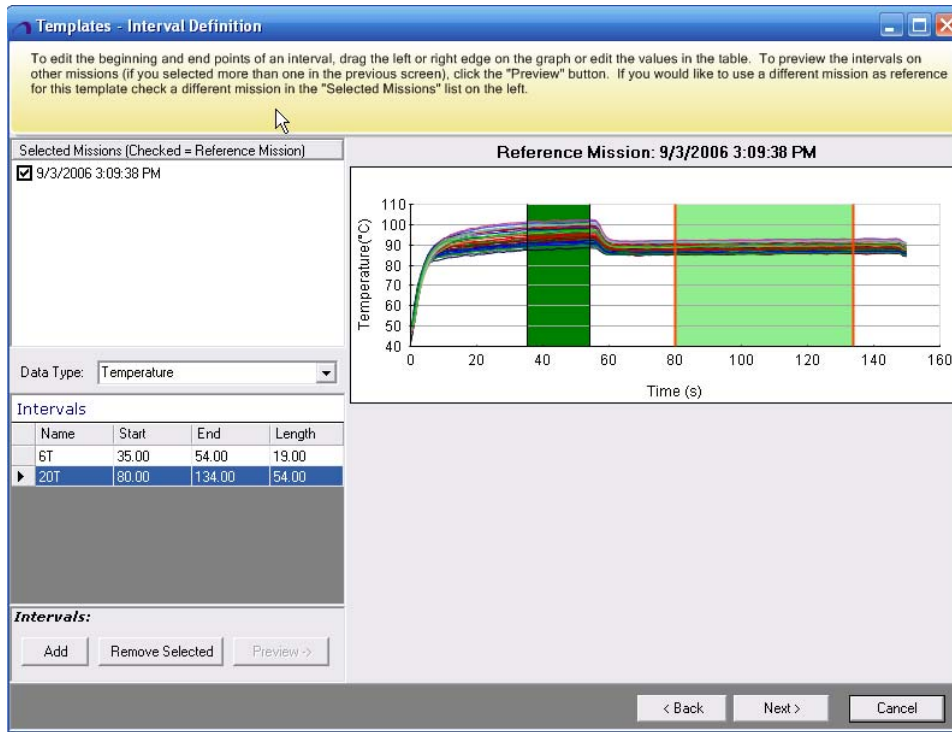
Figure 4-18 Templates - Interval Definition Window

2. Click the **Add** button, to add an *interval*. An interval defines the mission subset to be analyzed.

TIP: To edit the interval start and end time, change the values in the **Intervals** table or on the graph. To change the values on the graph, click an interval (bordered in **orange**) to select it. Then press and hold the <CTRL> key while dragging a portion of the interval. Drag the beginning part of the interval to alter the start time. Drag the end of an interval to change the end time. To move the entire interval, drag the middle of the interval.

3. Click the **Preview** button, to see whether the intervals created are correctly matched in other missions. The preview graphs in the lower-right sector updates with the matching intervals.

4. To remove an interval, select the *interval to be removed*, then click the **Remove Selected** button.

5. If the selected intervals are satisfactory, click the **Next >** button. The **Templates - Parameter Definition** window opens.

   Proceed to <u>Step 3 - Define the Parameters</u>.

Step 3 - Define the Parameters

The final step in creating a template involves defining the values to be extracted from the data inside each defined interval. *For example*, during a plasma etch step, it may be important to measure the average wafer temperature and cross-wafer range. During this step, these extracted parameters are specified and the template is named. In addition, these statistics can be extracted from a subset of the sensors, to extract regional information. *For example*, it may be interesting to extract the mean temperature at the edge of the wafer only, in addition to the entire cross-wafer average.

To define template parameters:

1. Click the **Add New Parameter** button to add a *parameter*. A new row appears in the **Interval Parameters** list, with a drop-down list for **Interval**, **Statistic**, and **Sensor Pattern**.
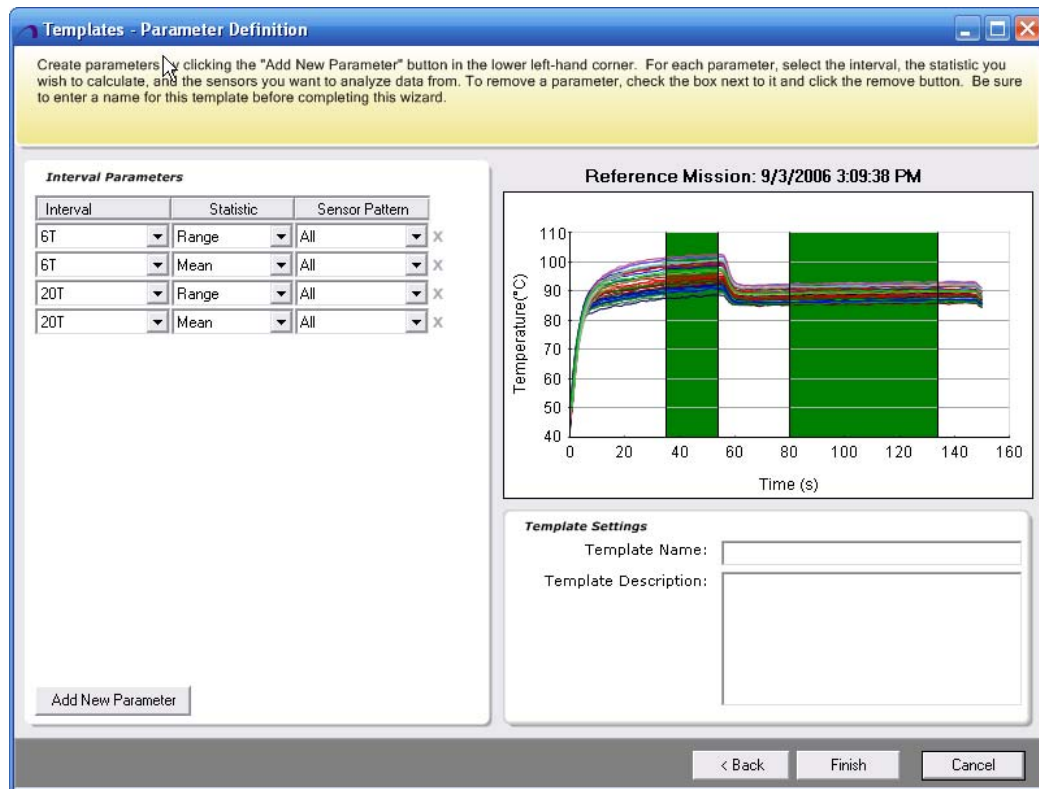
Figure 4-19 Templates - Parameter Definition window

2. Select the *interval* to which the parameter applies.

3. Select the *statistic to calculate* for that interval. Available options are *Mean*, *3Sigma*, *Max*, *Min*, *Range*, *Median*, *MaxAverage*, and *MinAverage*.

4. Select the *sensor pattern*, to select the sensors to use in the calculations. Available options are *All*, *None*, *Outer Ring*, *Inner Disc*, *Mask Edge*, and *[new pattern]*. By default, all sensors on the wafer are used.

NOTE: When a sensor pattern is selected, a **Sensor Pattern** window opens. It is possible to edit the selected sensor pattern characteristics or load a different pattern to edit. To create a new pattern, associate a different pattern name with the result. The button options are **Select All**, **Clear All**, **Save**, **Save New**, and **Cancel**.

5. Name the *template* (on the lower-right of the window).

6. Click the **Finish** button to save the input. A dialog box opens, to confirm template creation. Click the **Yes** button to confirm.

After the template is created, the first **Template Wizard** window re-opens, where another template can be added. If this task is complete, close the window and start the **Create a Signature** module from the **PlasmaSuite** window.

Identifying Data to Be Analyzed Using a Signature

A signature allows limits to be associated with a template, to indicate the expected values for the calculated statistics. *For example*, if a recipe template calculates the mean of a steady-state period, the signature for that template would specify the minimum, maximum, and average values expected for that mean.

The process of identifying data to be analyzed using a signature, is comprised of the following steps:

- Step 1 - Create a Signature
- Step 2 - Create a DataSet
- Step 3 - Associate the Signature with a Recipe
- Step 4 - Verify and Complete the Signature

Step 1 - Create a Signature

To create a signature:

1. Start the **Create a Signature** module from the **PlasmaSuite** window. The **Signature Creator Wizard - Create or Edit** window opens.
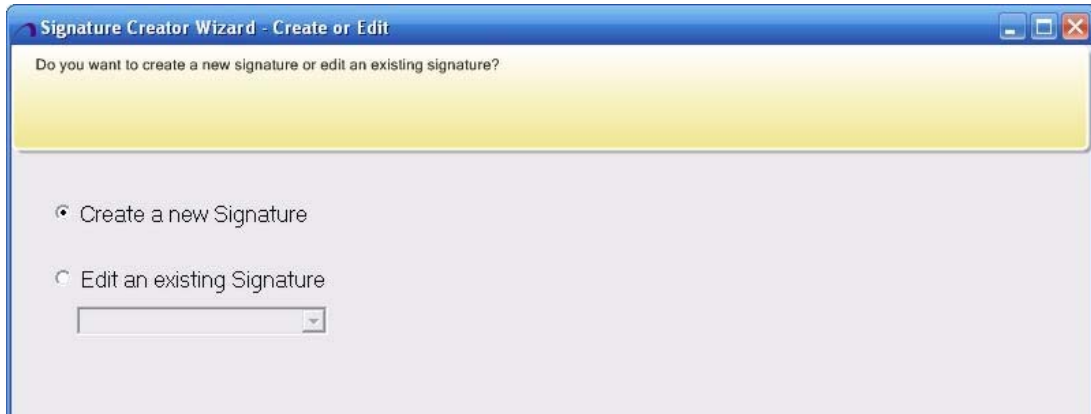
Figure 4-20 Signature Creator Wizard - Create or Edit window

2. Select Create a new Signature or Edit an existing Signature, then click the Next > button. The **Signature Creator Wizard - Select Template** window opens.
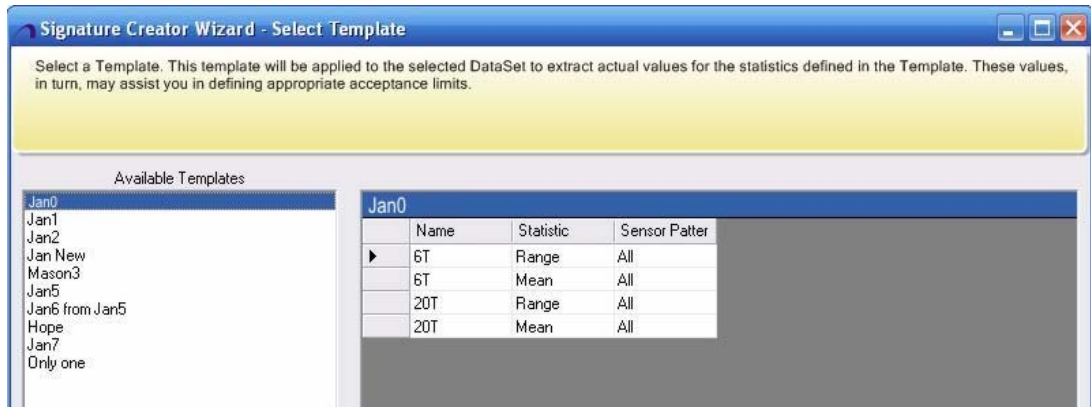
Figure 4-21 Signature Creator Wizard - Select Template Window

3. From the Available Templates list, select the template for which the signature is to be created. The defined interval parameters for that template are listed to the right. Click the Next > button. The **Signature Creator Wizard - Define Acceptance Limits** window opens.
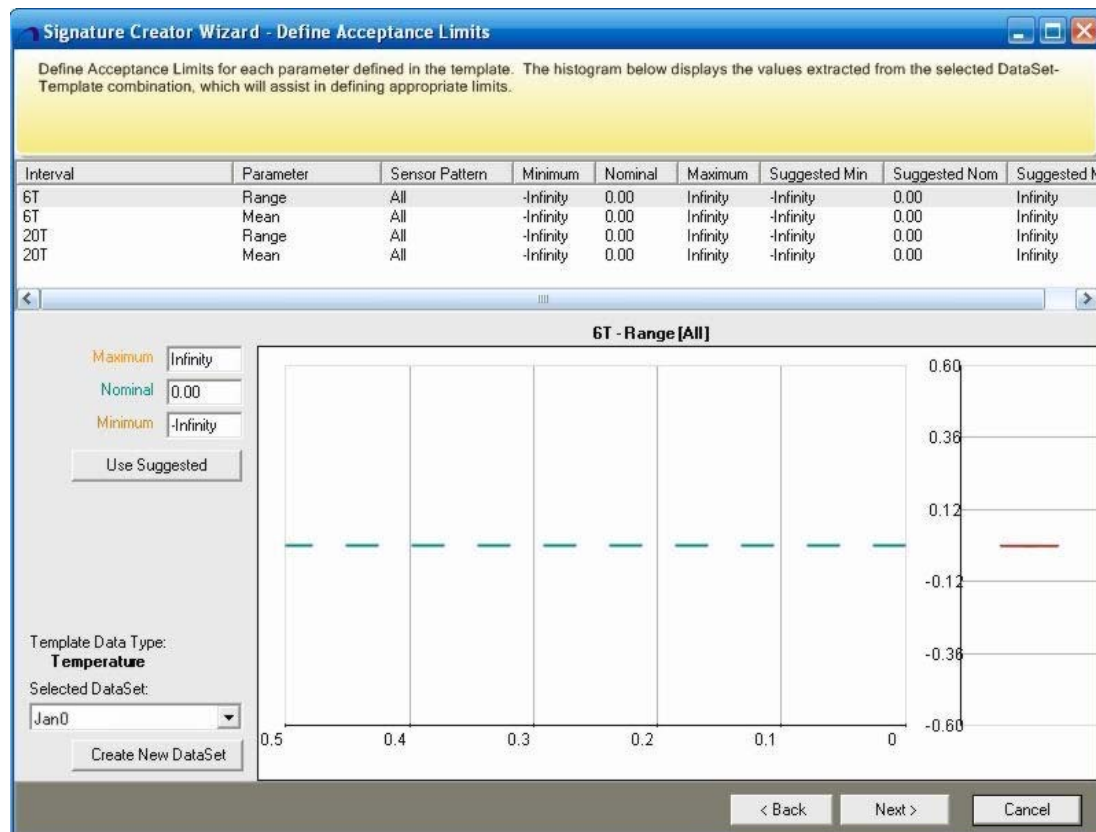
Figure 4-22 Signature Creator Wizard - Define Acceptance Limits window

4. Define a collection of missions for the program to generate a suggested set of limits. Click the **Create New DataSet** button. The **Create DataSet** window opens.

    Proceed to Step 2 - Create a DataSet.

Step 2 - Create a DataSet

To create a DataSet:

1. Select a set of missions that reflect standard running conditions for the recipe. Enter a dataset name, then click the Save button to return to the Signature Creator Wizard – Define Acceptance Limits window. Select the created dataset from the drop-down list, to ensure it is selected.

NOTE: Name the new dataset before proceeding.
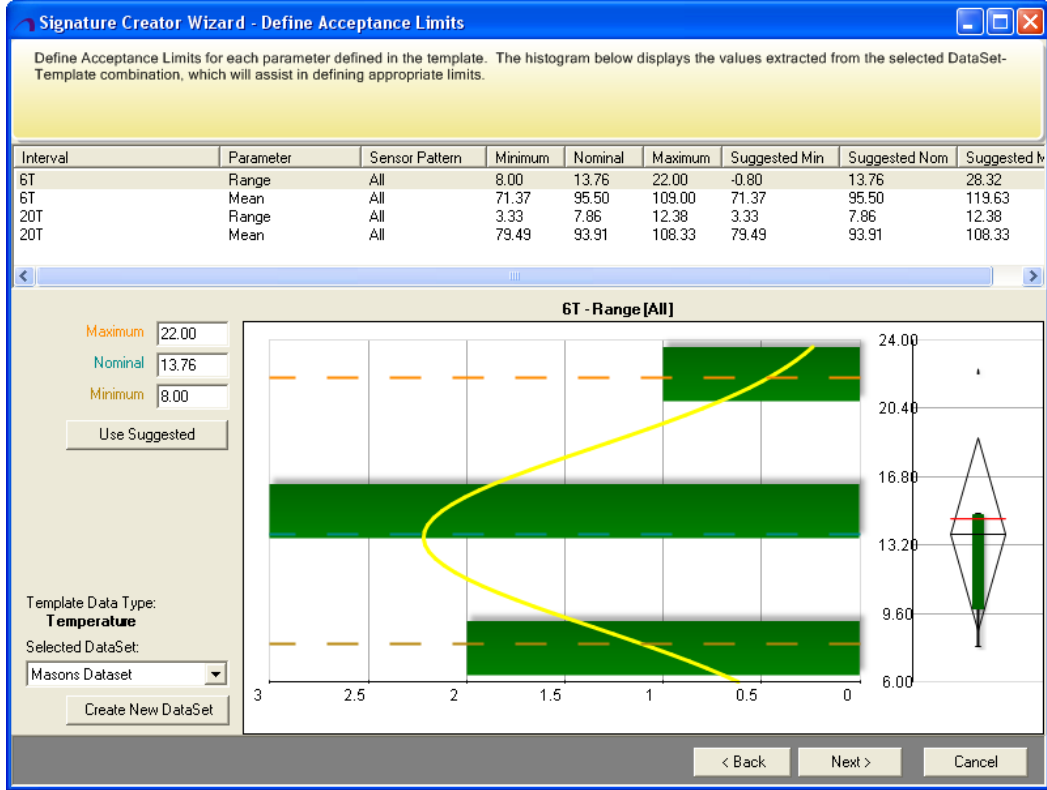
Figure 4-23

2. Examine each parameter and assign a *maximum*, *nominal*, and *minimum* value, to define the acceptance limits for this signature. To use the suggested values calculated from the dataset, click the **Use Suggested** button. Click the **Next >** button. The **Signature Creator Wizard - Associate Recipes** window opens.

Proceed to .

Step 3 - Associate the Signature with a Recipe

To associate the signature with a recipe

1. Select **Yes, associate this signature with one or more recipes**, then click the **Next >** button.

Figure 4-24
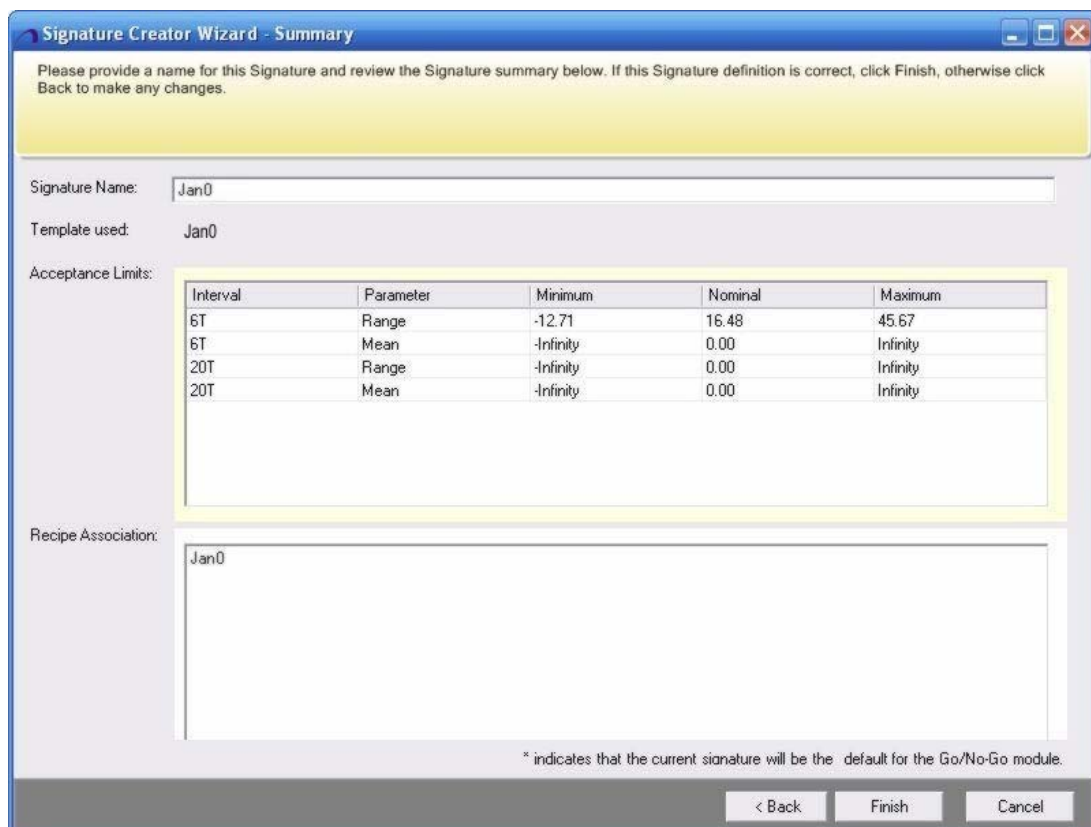
2. A signature can be assigned as the "default" for a given recipe; in that case, it is automatically loaded by **Go/No-Go** for missions run using that recipe. To assign a signature as the default for a recipe, use the **Signature Creator Wizard – Assign Default Recipe** window. Select a *signature*, then click the **Next >** button. The **Signature Creator Wizard – Summary** window opens.

Proceed to .

Step 4 - Verify and Complete the Signature

To verify and complete the signature

3. Enter a *signature name*. A summary of the values and recipes are listed. If everything is correct, click the **Finish** button.

Figure 4-25

4. The **Save Signature** or **Save as New Signature** window opens. Click **Yes** to confirm. The window closes and the **PlasmaSuite** window opens.

The Signature creation process is complete. Select **Go/No-Go** from the **PlasmaSuite** window, to analyze the mission.

Validating Process Readiness – Go/No-Go

This module allows users to quickly determine whether the process is within spec. To analyze missions with **Go/No-Go**, a **template** and **signature** must be defined for the mission to analyze.

To validate mission readiness

1. Select **Go/No-Go** from the **PlasmaSuite** window. The **Go/No-Go** window opens.
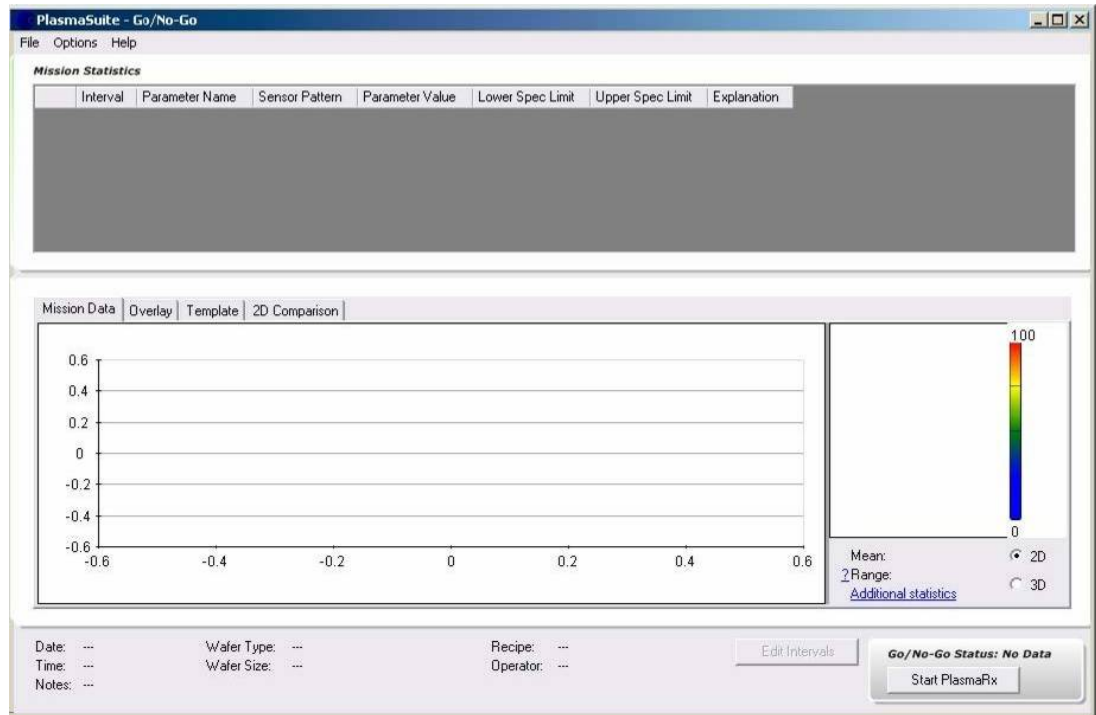
Figure 4-26

2. Select **Open** from the **File** menu, to select the mission to analyze. The **Mission Selector** window opens. Filter the missions by *Recipe*, *Fab*, *DataSet*, *Wafer ID*, *Date*, *Included Missions*, *Data Type*, *Notes*, or *Diameter*, to limit the number of missions from which to select.

3. Drag the *mission* that is to be analyzed, into the **Selected Missions** list.

TIP: When selecting a single mission using the **Mission Selector** window, it is unnecessary to drag the mission to the **Selected Missions** list. Instead, select the mission to be analyzed, then click the **OK** button.

4. Click the **OK** button. The **Go/No-Go** window opens, defaulted to the **Mission Data** tab. The mission is loaded and the analysis results are presented. If the mission is within spec, the data and the **Go/No-Go Status** area are shaded **green**.
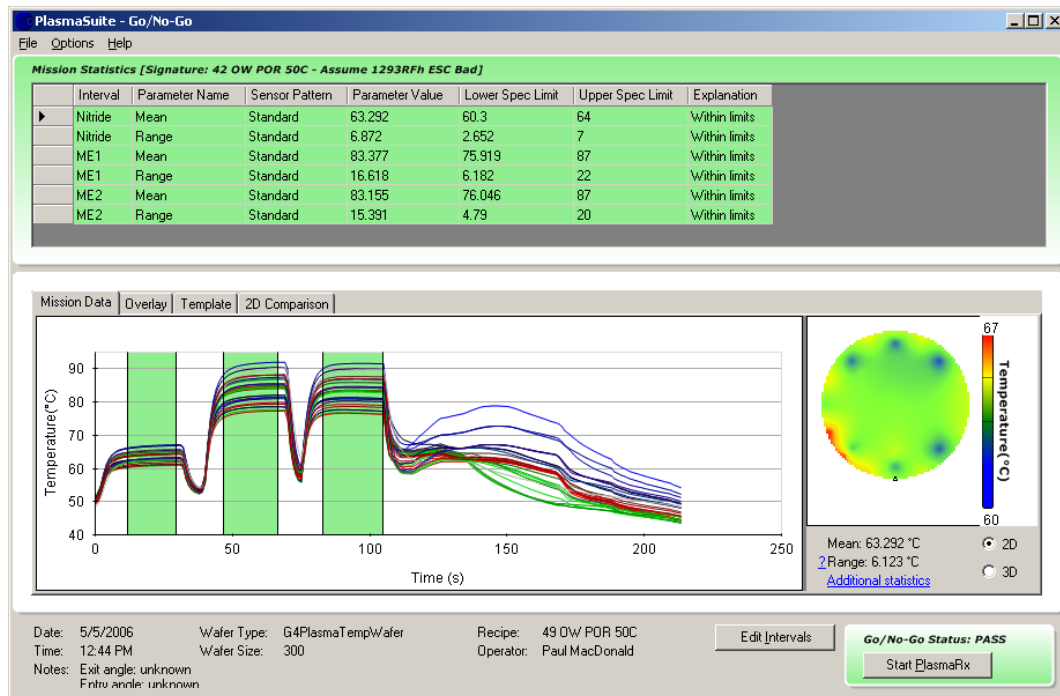
Figure 4-27

5. If any parameters are out of spec, the data and/or the **Go/No-Go Status** area are shaded **red**, to alert that the mission did not pass.

NOTES:

▪ The **Overlay** tab presents a graph of the selected mission mean, compared to the template mission mean.

▪ The **Template** tab presents, for reference, the original mission used for the template.

▪ The **2D Comparison** tab provides surface plots of the selected and template missions. The **Difference** graph presents the differences between the selected mission and template.

6. To select a different interval, click a different row of the data table at the top. Selecting a different interval updates the 2D surface plots.

7. If the mission is **red**, further analysis of the process can be performed, using **PlasmaRX**. To access the application, click the **Start PlasmaRX** button (located in the lower-right area of the window).

PlasmaRX

The **PlasmaRx** module allows the user to model fab chamber behavior. The generated model displays the effect that modifying different equipment parameters has on the measured wafer data. *For example*, **PlasmaRx** can be used to show the temperature rise (at all points on the wafer) of an increase in source power. Models can then be compared (tool-to-tool, or day-to-day) to determine whether tools are performing optimally, and to help pinpoint problem components.

SPC Charting

The **SPC** (Statistical Process Control) **Charting** module allows the user to view SPC charts, scatter plots, and histograms for multiple missions. This provides the ability for the users to

review trend information for a specific chamber, to ensure the chamber remains within spec over time. **SPC Charting** requires a template for the recipe to be analyzed. If an appropriate template is not available, refer to the [Identifying Data to Be Analyzed Using a Template - Step 1 - Create a Template](#) section.

*NOTE: If the **Warning** dialog box, "Some missions could not be matched to template and were removed from analysis," opens when running **SPC Charting**, it means:*

- *The mission does not resemble the reference template. Click the **Show Mission** button in the **Warning** dialog box, to verify that the excluded missions do not match the template.*

- *Choose a better template as the reference.*

- *Contact **KLA Tencor SensArray**, if neither of the above actions resolve the problem.*

Match Analyzer

The **Match Analyzer** module allows the user to compare two or more chambers running the same recipe. The data provided from this module allows the user to easily identify chambers that have fallen out of spec. **Match Analyzer** requires a template for the recipe to be analyzed. If an appropriate template is not available, refer to the [Identifying Data to Be Analyzed Using a Template - Step 1 - Create a Template](#) section.

Profile Comparison

The **Profile Comparison** module simultaneously displays line graphs and 2-D surface plots for two or more missions. Profile comparison requires a template for the recipe to be analyzed. If an appropriate template is not available, refer to the [Identifying Data to Be Analyzed Using a Template - Step 1 - Create a Template](#) section.

AutoCal - Temperature Optimization

The **AutoCal** module accurately measures, monitors, and calibrates the thermal dose in the post-exposure bake (PEB) step of the lithography process. Ensuring uniform temperature control across the wafer results in significant improvement in critical dimension (CD) uniformity, thereby increasing wafer yield.

AutoCal includes **Create Track** and **Create Litho Flow Wizards**, to aid in setting up the lithography fab.

See OnWafer Technologies, *AutoCal 2.0*, user documentation for further details.

AutoCD - Critical Dimension Optimization

Critical dimension measures transistor gate sizes on the wafer. The more uniform the gate size, the higher the total wafer yield. The object is to counteract non-uniformity resulting from previous production steps. In this case, it may not be a uniform temperature across the wafer that maximizes the critical dimension, but a different temperature on different parts of the wafer in subsequent production steps.

AutoCD automatically tunes the post-exposure bakeplate settings, to achieve the desired critical dimension results on the wafer.

AutoCD includes **Create Track** and **Create Litho Flow Wizards**, to aid in setting up the lithography fab.

This section provides instructions for the following data management tasks:

- Importing Files and Data
- Backing Up and Restoring the SensArray Tools Database

Importing Files and Data

A data tag is a set of metadata for a mission. This metadata includes the name of the person who collected the data, the chamber and recipe upon which the mission was run, the date the mission was run, and notes. The information for the metadata tags was input during Fab Configuration. The **Data Importing and Tagging** module is used to import legacy data formats, and modify existing data tags. Legacy data is saved to the *SensArray Tools* database and a data tag is created for each file imported.

Legacy formats currently include OnWafer data files (`WFR`), SensArray Excel files (`XLS`, `TXT`), and AE Pilot wafer data (`CSV`).

NOTE: Use files with the proper file extension (such as, `CSV`, `TXT`, `WFR`, `XLS`), in a location accessible by **SensArray Tools**.

The process of importing files and data, is comprised of the following steps:

- Step 1 - Import Data
- Step 2 - Select Data of Interest –or–
- Step 2 - Select Missions (to import missions that were previously tagged and saved)
- Step 3 - Tag Selected Data
- Step 4 - Check the Tagged Data

Step 1 - Import Data

To import data

1. Start the **Data Importing and Tagging** module from the **PlasmaSuite** or **LithoSuite** window. The **Data Import - Select Desired Action** window opens.
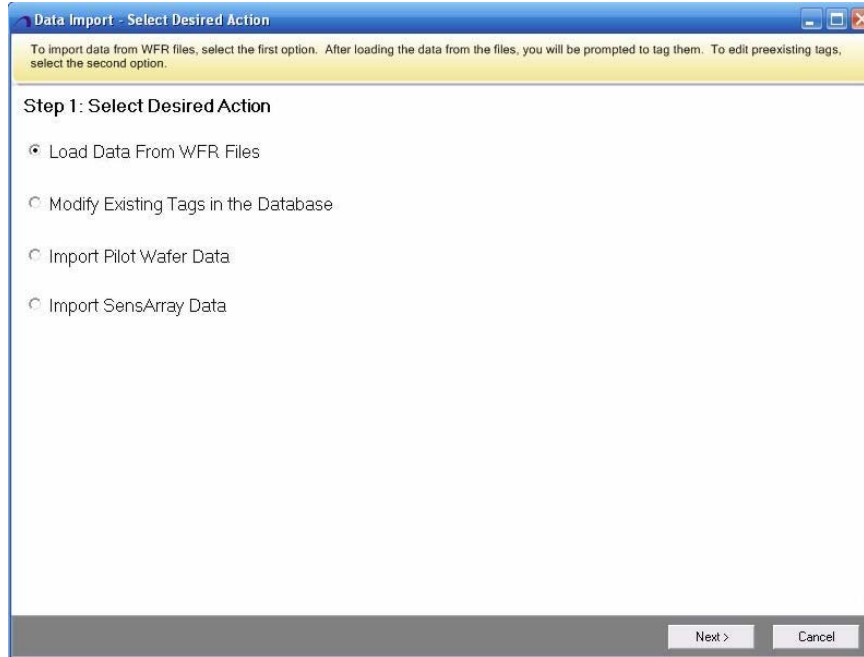
Figure 4-28

2. Select one of the following options:

- **Load Data From WFR Files**
- **Modify Existing Tags in the Database**
- **Import Pilot Wafer Data**
- **Import SensArray Data**

3. Click the **Next >** button. The window for the second step in the process opens. If an option was not selected, a **Warning** dialog box opens, with a reminder to select one of the options.

Proceed to -or- (to import missions that were previously tagged and saved).

Step 2 - Select Data of Interest

The window for the second step looks basically the same for importing all data file formats – legacy-format OnWafer data files (WFR), SensArray Excel files (XLS, TXT), and AE Pilot wafer data (CSV).

NOTE: Use files with the proper file extension (such as, CSV, TXT, WFR, XLS), in a location accessible by **SensArray Tools**.
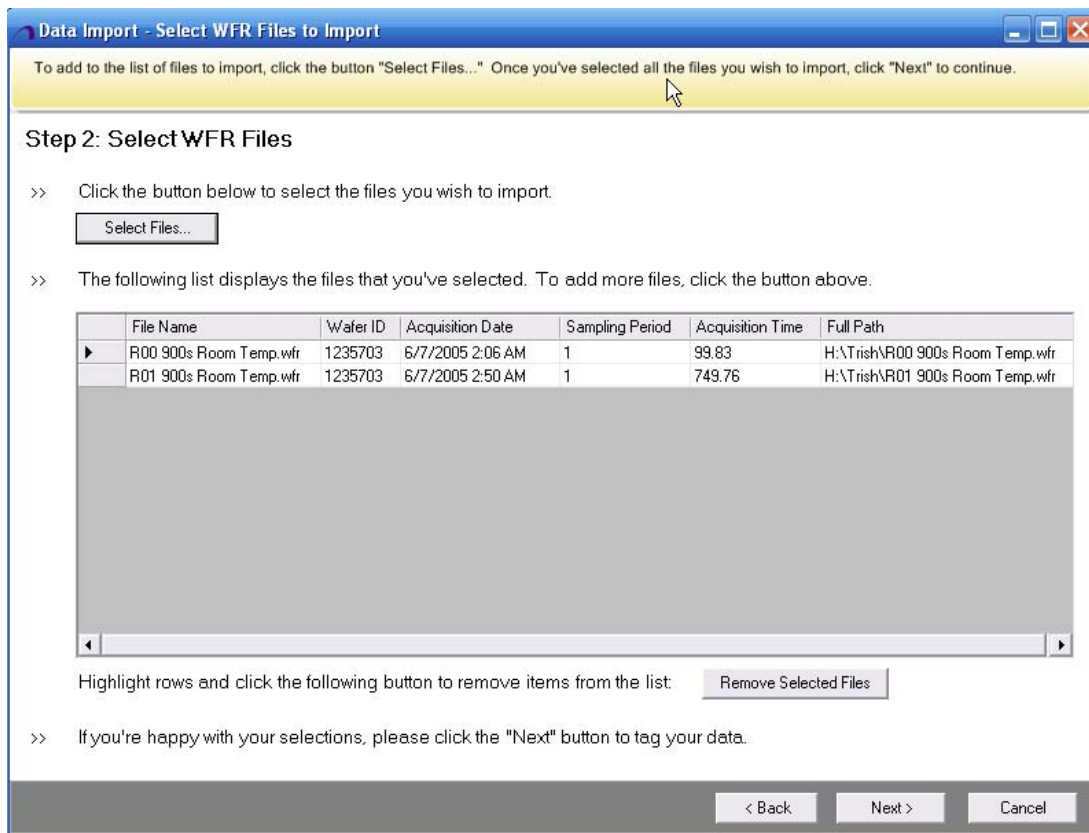
Figure 4-29

To select data of interest:

1. Click the **Select Files…** or **Import Another File…** button, located under the first instruction. The **Open** window lists available files of the selected data type.

2. Select the *file of interest*, then click the **Open** button or double-click the *file name*. The file appears in the panel below the button.

   Repeat sub-steps 1 and 2, until all files of interest are selected.

3. To remove one or more files from the list, select the *file* to be deleted, then click the **Remove Selected Files** button.

   NOTES:

   ▪ *If the file is a Pilot Wafer file, select the wafer size that collected the data – 200 mm or 300 mm.*

   ▪ *Using the Remove Selected Files button deletes the file from the list only – it does not delete the file from its original location.*

4. After the file(s) are selected, click the **Next >** button to tag the data.

   Proceed to .

Step 2 - Select Missions

Use this version of Step 2 to import missions that were previously tagged and saved.
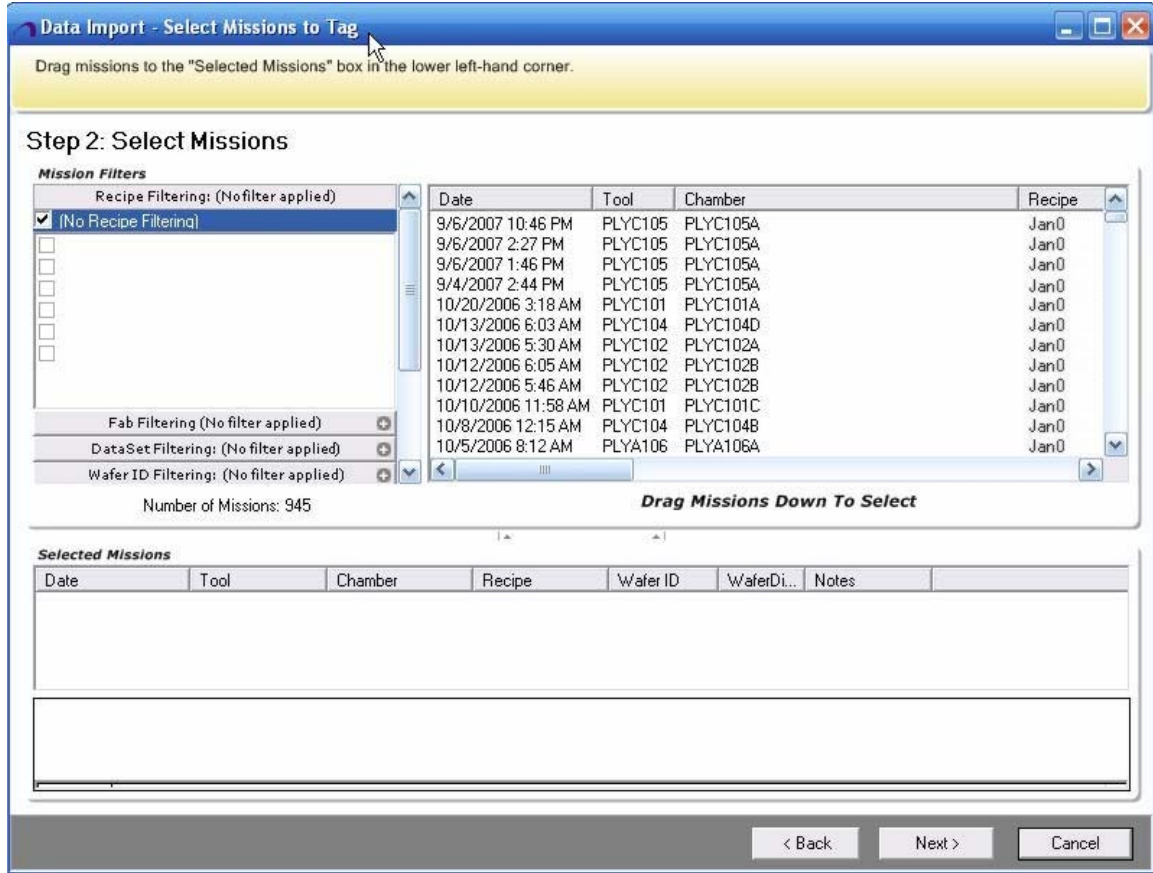
Figure 4-30

To select missions

1. To narrow the number of missions selected, apply filters in the **Mission Filters** panel. Missions can be filtered by *Recipe*, *Fab*, *DataSet*, *Wafer ID*, *Date*, *Included Missions*, *Data Type*, *Notes*, and *Diameter*. The **Number of Missions** field lists the number of missions available before filtering, and as each filter is applied.

   TIP: To limit processing time, limit the number of missions selected.

2. The filtered missions appear in the right panel. Headings include *Date*, *Tool*, *Chamber*, *Recipe*, *Wafer ID*, *Wafer Diameter*, and *Notes*. Drag missions that are to be re-tagged, to the **Selected Missions** panel.

   When a mission is dragged to this panel, the field at the lower part of the panel fills with the above information, in report format, and includes **Operator** and **Graph Data Type** (available options are *Temperature*, *Module Temperature*, and *Supply Voltage*).

3. After all (needed) missions are selected, click the **Next >** button, to tag the data.

   Proceed to Step 3 - Tag Selected Data.

Step 3 - Tag Selected Data

Tag each mission by specifying by whom the data was collected, and the chamber and recipe. **ALL missions must be tagged before proceeding.**

TIP: To tag more than one mission with the same information, select multiple files by pressing and holding the <CTRL> key while selecting additional missions. If multiple missions are selected, anything selected on the right is applied to every mission currently selected.

To tag selected data (for PlasmaSuite)

1. Select a fully qualified *path name* from the **Incoming Data** panel.
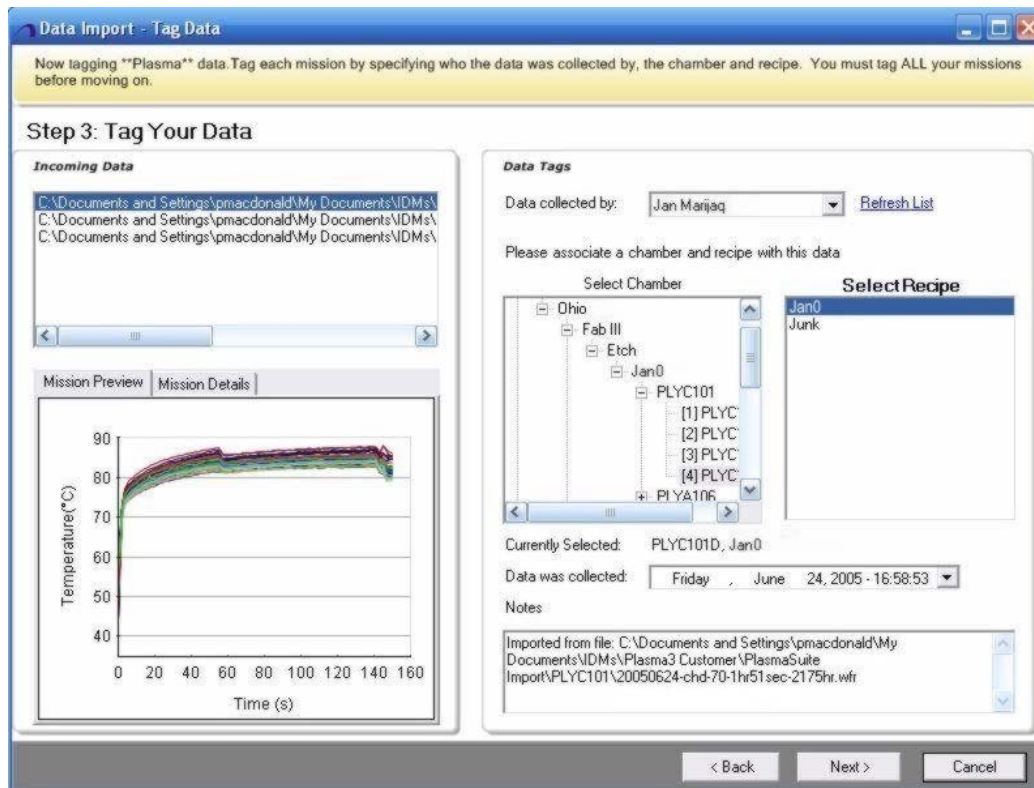
Figure 4-31

2. Select a *name* from the **Data collected by** drop-down list to associate with the selected data.

3. Open the *fab to the chamber level* in the **Select Chamber** list, then select the *chamber of interest*.

4. Select a *recipe* from the **Select Recipe** list to associate with the selected chamber.

5. The selected *chamber* and *recipe* are listed in the **Currently Selected** field. Click those selections before clicking the **Next >** button.

   Proceed to Step 4 - Check the Tagged Data.

Step 4 - Check the Tagged Data

The Summary page table lists all data tags that were added or updated.

To check tagged data:

1. If any information is incorrect, click the **< Back** button and correct it.

2. If the data is correct, click the **Finish** button. The **PlasmaSuite** or **LithoSuite** window opens.

NOTE: If there is a problem with the tagged data, a **Warning** dialog box opens, listing the problem parameters, and the **Launch Go/No-Go** window pinpoints the out-of-spec information. Correct the information before proceeding.

Backing Up and Restoring the SensArray Tools Database

On the **PlasmaSuite** window, click **Tools** on the menu bar. Select the **Database Manager** option.

See release notes for the latest troubleshooting information. Release notes were copied to `C:\Program Files\KLA-Tencor SensArray\SensArray Tools\releasenotes.txt` at the time of software installation.

To report bugs or submit requests for additional functionality, send an email message to customer.support-sensarray@kla-tencor.com.

Include the following information within the email message:

- Description of the problem or request (be specific)

- Exact wording of the error message(s) received and process steps that led to the error

- If the error dialog box includes a **Details** button, include a text file of the text that appears when the **Details** button is clicked

  *TIP: Copy the **Details** text to the Windows Clipboard, then save to a **Microsoft Wordpad** file.*

- Supporting files (*for example,* screen captures, mission data, and so forth)

  TIPS:

  - ***Screen Captures.*** *Press <ALT>+<Print Screen> to copy the **Error** dialog box to the Windows Clipboard, then paste into **Microsoft Paint** and save as a `GIF` or `JPG` file, or into the same **Microsoft Wordpad** file that includes the message details.*

  - ***Mission Data.*** *To save mission data, use the **File → Save As File…** from the **Data Viewer** window to export an `ODF` file.*

- Your name, company, location, telephone number, and email address

  Support staff will respond to the request as soon as possible.

Acquisition Time. Total mission time in seconds; the amount of time it takes a process (plasma recipe or litho flow) to run.

AutoCal. Proprietary software program that automatically calibrates advanced bake plates.

AutoCD. Proprietary software program that directly optimizes the critical dimension for lithograph and photomask applications.

Bake Plate. Device upon which the wafer is heated.

Bake process. Overall process of preheating hot plate surfaces to known temperatures, loading the wafer onto each hot plate for a specific length of time for baking, cooling between each hot plate on a chill plate or chill paddle, and promptly removing the wafer upon cycle completion.

Boxplot. Method for showing different types of data populations; the spacing between the various parts of the box help indicate variance, skew, and identify out-of-specification values.

Critical Dimensions (CDs). Width of a patterned line or the distance between two lines, monitored to maintain device performance consistency; also, the dimension of a specified geometry that must be within design tolerances.

Data Tag. Set of metadata for a mission, which includes the name of the person who collected the data, the chamber and recipe upon which the mission was run, the date the mission was run, and notes.

Data Viewer. Allows viewing of data from the current mission run or from previously saved data, and to start the Mission Controller and SmartDevice Control Center to run new missions.

Dataset. *Collection of missions* for the program to generate a suggested set of limits.

Dongle. Infrared device used to communicate with a wafer contained in a wafer carrier.

Etch. Process for removing material in a specified area through a wet or dry chemical reaction or by physical removal, *such as* by sputter etch.

Fab Configurator. Part of the *SensArray Tools* software that allows the user to represent the fab so that *PlasmaSuite* or *LithoSuite* can monitor the fab.

Fabrication. Integrated circuit manufacturing processes.

Fabrication Yield. Percent of wafers arriving at wafer sort compared with the number started into the process.

Flow. Computer program, rules, specifications, operations, and procedures, which are organized in steps and are performed each time to produce/process a wafer. Used in *LithoSuite*. Each plate in the fab must have a flow associated with it.

FOUP. Front-Opening Unified Pod. Docking station used for storing, protecting, loading, and unloading wafers, as well as communicating with and recharging INtegrated Wafers.

Go/No-Go. Determines whether a mission is within specification.

Histogram. Graphical display of tabulated frequencies; a graphical version of a table that shows what proportion of cases fall into each of several or many specified categories. The histogram differs from a bar chart in that it is the *area* of the bar that denotes the value, not the height.

Import. Process of loading data sets (files) into the *SensArray Tools* database. Available by selecting **Data Importing and Tagging** from the **Configuration** menu on the **PlasmaSuite** or **LithoSuite** window.

Interval. Defines the portion of the recipe or flow template to be compared and analyzed.

Litho Flows. Processes used to run *LithoSuite* sensor wafer products.

Lithography. Process of pattern transfer; when light is utilized, it is termed photolithography; and when patterns are small enough to be measured in microns, it is referred to as microlithography.

Lithography Fab Hierarchical Levels. These consist of customer, location, fab, bay, track, block, stack, and plate.

LithoSuite. *SensArray Tools* software for analyzing litho fab performance.

Match Analyzer. Compare relevant statistics between multiple chambers or multiple plates.

Mean Temperature. Arithmetic mean/average of two or more channels over a specific time slice.

Median Temperature. Middle value of two or more channels over a specific time slice.

Mission. One set of data collected by a sensor wafer. The mission specifications are set by using the Mission Controller or SmartDevice Control Center.

Mission Controller. Software that allows the user to set up and run missions to gather fab data for analysis.

Mission Filters. Apply filters to narrow the number of missions selected for comparison. Missions can be filtered by *Recipe*, *Fab*, *DataSet*, *Wafer ID*, *Date*, *Included Missions*, *Data Type*, *Notes*, and *Diameter*.

Parameters. Defines the statistics to be calculated for the selected template interval, and the pattern of sensors to use in the calculations.

Plasma. High-energy gas made up of ionized particles.

Plasma Etch. Dry-etch process using reactive gases energized by a plasma field.

Plasma Fab Hierarchical Levels. These consist of customer, location, fab, bay, tool, and chamber.

Plasma Recipes. Processes used to run *PlasmaSuite* sensor wafer products.

PlasmaSuite. *SensArray Tools* software for analyzing plasma etch fab performance.

Profile Comparison. View 2D profiles of multiple missions.

Recipe. Computer program, rules, specifications, operations, and procedures, which are organized in steps and are performed each time to produce/process a wafer. Used in *PlasmaSuite*. Each chamber in the fab must have a recipe associated with it.

Recipe Step. Single action within a recipe.

Sample Rate. Speed of acquisition during data collection. *For example*, a sample rate of 2 means that data will be collected from all sensors on the wafer every 2 seconds.

Scatter Plot. Chart that uses Cartesian coordinates to display values for two variables. Data is displayed as a collection of points, each having one coordinate on the horizontal axis and one on the vertical axis.

Sensor. Device that responds to an environmental variable (*such as* temperature).

Sensor Pattern. Select the sensors to be used in calculating template parameters during a mission run. Available options are *All*, *None*, *Outer Ring*, *Inner Disc*, *Mask Edge*, and *[new pattern]*. By default, all sensors on the wafer are used.

Signature. Allows numbers to be associated with a template, to indicate the expected values for the calculated statistics. *For example*, if a template for a recipe calculated the mean of a steady-state period, the signature for that template would specify the minimum and maximum values expected for that mean.

SmartDevice Control Center. Software that allows the user to set up and run missions to gather fab data for analysis. Used with 3rd generation **SmartFOUP360ez** and **SmartBOXez** devices.

SPC (Statistical Process Control) Chart. Tool used to determine whether a manufacturing or business process is in a state of statistical control or not. If the chart indicates that the process being monitored is not in control, the pattern it reveals can help determine the source of variation to be eliminated to bring the process back into control. A control chart is a specific kind of run chart.

Steady State. Stable condition that does not change over time, or in which change in one direction is continually balanced by change in another.

Tag, Tagging. Set of metadata for a mission. This metadata includes the person who collected the data, the chamber and recipe (or track and flow) on which the mission was run, the date the mission was run, and notes.

Template. Defines the regions of interest within a mission run using a specific process (recipe or flow). It also defines the important statistics for each region (*such as* mean, range, and standard deviation). Identifies critical intervals for a production, monitoring, or diagnostic process (recipe or flow).

Track. Enclosed system used to heat, process, and cure semiconductor wafers.

USB (Universal Serial Bus). Replaces various kinds of serial and parallel port connectors with one standardized plug and port combination. Connect USB-compliant devices (*for example*, the provided portable computer), by way of a USB cable connected to the devices' USB port(s), then power-on the devices.

Wafer. Thin round slice of a semiconductor material from which chips are made.

Wafer Carrier. Used to protect wafers during the wafer fabrication.

Wafer Fabrication. Series of manufacturing operations that places the circuit or device in and on the wafer.

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Appendix A Reference Information

Sensor Bank Reference

Sensor	Sensor Name	Radius(mm)	Angle	X(mm)	Y(mm)
S0	A01	0	0	0	0
S1	B02	9	352.5	8.9	-1.2
S2	B03	9	82.5	1.2	8.9
S3	B04	9	172.5	-8.9	1.2
S4	B05	9	262.5	-1.2	-8.9
S5	C06	37	307.5	22.5	-29.4
S6	C07	37	37.5	29.4	22.5
S7	C08	37	127.5	-22.5	29.4
S8	C09	37	217.5	-29.4	-22.5
S9	D10	74	307.5	45	-58.7
S10	D11	74	352.5	73.4	-9.7
S11	D12	74	37.5	58.7	45
S12	D13	74	82.5	9.7	73.4
S13	D14	74	127.5	-45	58.7
S14	D15	74	172.5	-73.4	9.7
S15	D16	74	217.5	-58.7	-45
S16	D17	74	262.5	-9.7	-73.4
S17	E18	92.2	330	79.8	-46.1
S18	E19	92.2	15	89.1	23.9
S19	E20	92.2	60	46.1	79.8
S20	E21	92.2	105	-23.9	89.1
S21	E22	92.2	150	-79.8	46.1
S22	E23	92.2	195	-89.1	-23.9
S23	E24	92.2	240	-46.1	-79.8
S24	E25	92.2	285	23.9	-89.1
S25	F26	110	307.5	67	-87.3
S26	F27	110	352.5	109.1	-14.4
S27	F28	110	37.5	87.3	67
S28	F29	110	82.5	14.4	109.1
S29	F30	110	127.5	-67	87.3
S30	F31	110	172.5	-109.1	14.4
S31	F32	110	217.5	-87.3	-67
S32	F33	110	262.5	-14.4	-109.1
S33	G34	140	330	121.2	-70
S34	G35	140	15	135.2	36.2
S35	G36	140	60	70	121.2
S36	G37	140	105	-36.2	135.2
S37	G38	140	150	-121.2	70
S38	G39	140	195	-135.2	-36.2
S39	G40	140	240	-70	-121.2

S40	G41	140	285	36.2	-135.2
S41	H42	144	330	124.7	-72
S42	H43	144	15	139.1	37.3
S43	H44	144	60	72	124.7
S44	H45	144	105	-37.3	139.1
S45	H46	144	150	-124.7	72
S46	H47	144	195	-139.1	-37.3
S47	H48	144	240	-72	-124.7
S48	H49	144	285	37.3	-139.1
S49	J50	147	307.5	89.5	-116.6
S50	J51	147	330	127.3	-73.5
S51	J52	147	352.5	145.7	-19.2
S52	J53	147	15	142	38
S53	J54	147	37.5	116.6	89.5
S54	J55	147	60	73.5	127.3
S55	J56	147	82.5	19.2	145.7
S56	J57	147	105	-38	142
S57	J58	147	127.5	-89.5	116.6
S58	J59	147	150	-127.3	73.5
S59	J60	147	172.5	-145.7	19.2
S60	J61	147	195	-142	-38
S61	J62	147	217.5	-116.6	-89.5
S62	J63	147	240	-73.5	-127.3
S63	J64	147	262.5	-19.2	-145.7
S64	J65	147	285	38	-142

Correlating Sensor Coordinates