



Advanced Test Equipment Corp.

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SciAps HH-LIBS Analyzers

Z900 Series User Manual

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SciAps

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## 1. Contact Information:

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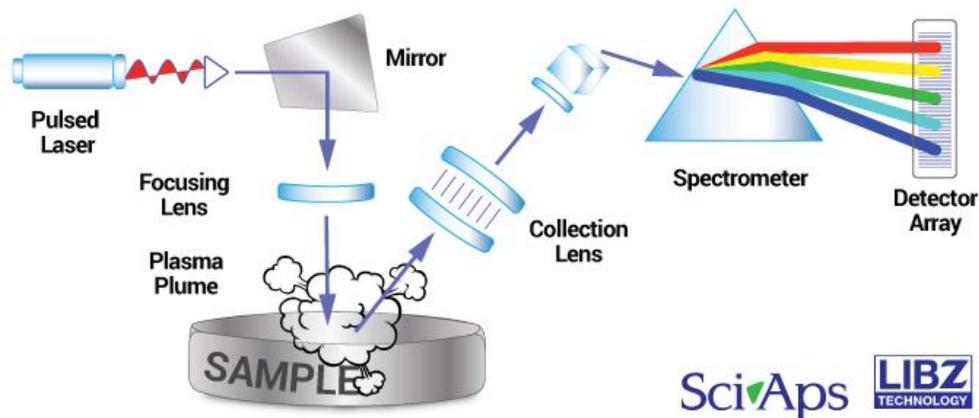
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## 2. Technology

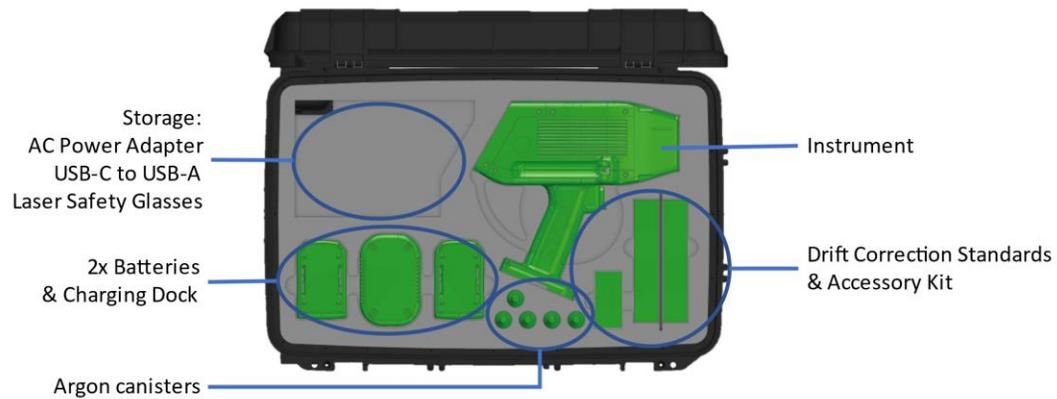
The Z is a handheld analyzer utilizing Laser Induced Breakdown Spectroscopy (LIBS), a type of atomic optical emission spectroscopy (OES). Since the early 19<sup>th</sup> century, scientists have known that elements emit specific colors of light. This combination of colors is a unique signature for each element. The wavelength (color) of specific lines reveals the elements present, and the intensity of the light at a given wavelength is related to the concentration of each element. Traditional OES has used sparks and flames to generate a plasma. The invention and recent developments of laser technology allow lasers to be used instead. This gives more precise control over the plasma formation. Unlike sparks and flames, the laser can generate plasmas on the surface of non-conducting, unprepared samples, like soils, rocks, or liquids.



Sample analysis is broken down into five steps (fig 2.1):

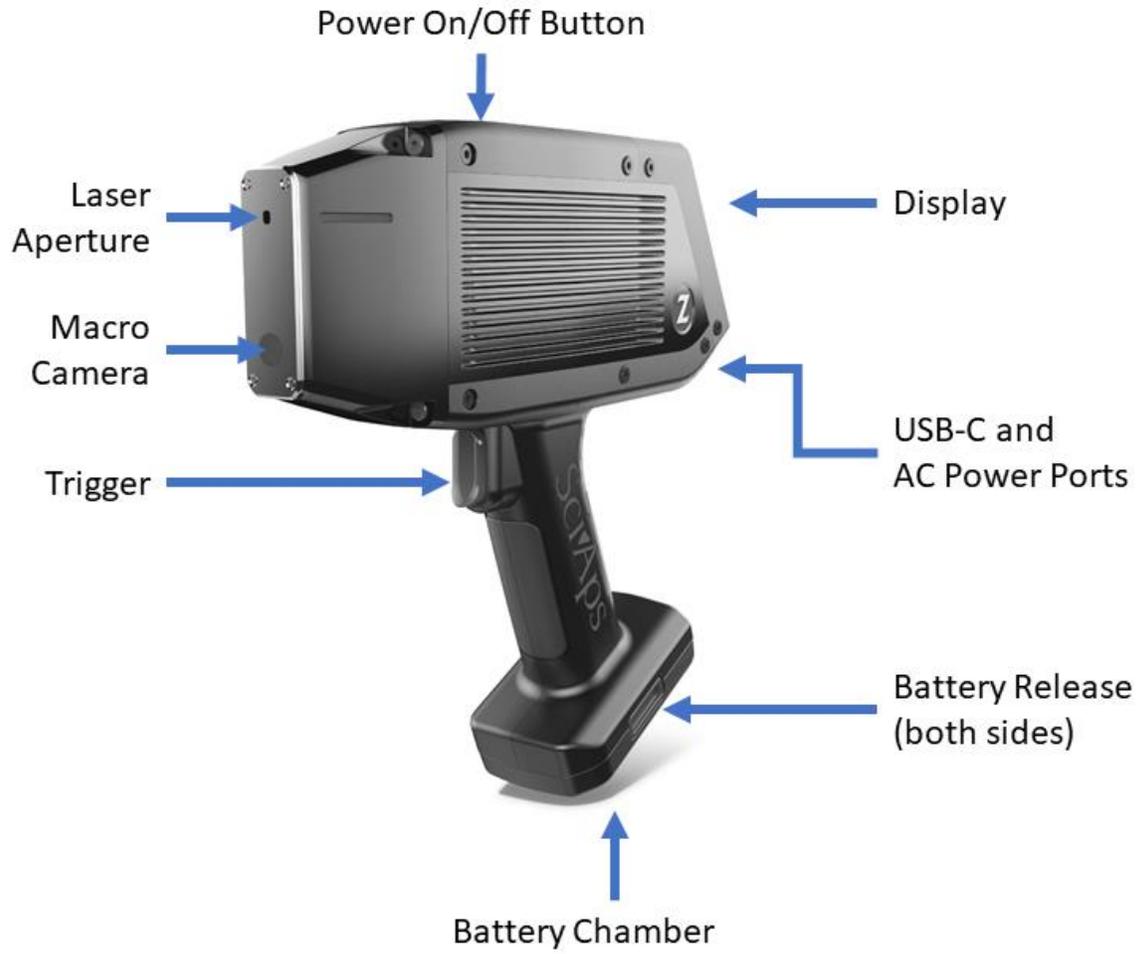
1. A high energy pulsed laser is focused on the sample. The high temperature of the laser on the sample results in ablation of a small volume of material (roughly 25  $\mu\text{m}$ : less than the thickness of a dollar bill) in plasma plume. The plasma contains the sample's excited atoms and ions.
2. As the plasma starts to cool, the electrons of the excited atoms and ions fall back down to their ground states. As they return to their ground states, light of specific wavelengths is emitted from the plasma and collected by the spectrometer.
3. The spectrometer separates all light emissions with high resolution optics to be detected by the charge-coupled device (CCD).
4. The elements detected in the sample can be viewed in a graph or spectrum. The graph charts the intensity of the emitted light as a function of the wavelength.
5. An on-board processor compares the height of specific peaks to a calibration. The calibrations are built by testing a series of Certified Reference Materials (standards of known chemical composition). This provides quantitative chemical results. Calibrations are added at the factory, or operators can create their own calibration routines.

### 3. What's in the Box?



- 1) 1x Hard Sided Instrument Case
- 2) 1x Instrument with Wrist lanyard
- 3) 2x Li-ion Batteries
- 4) 1x Battery Charging Dock
- 5) 1x AC Power Adapter
- 6) 1x USB-C to USB-A Cable
- 7) 1x Laser Safety Glasses OD 5+ for 1064 nm Laser
- 8) Accessory Kit:
  - a. 1x M2 Allen Wrench
  - b. 2x Replacement Splatter Shield
  - c. 1x USB Drive; with Calibration Certificate
  - d. Digital Copy of Instrument Manual
  - e. Profile Builder Desktop Software (if included)
- 9) Drift Correction Standards (configuration specific)
- 10) 5x Argon Cylinders (applicable models only)

## 4. Analyzer Overview



## 5. Safety

### General Safety Warnings



The main compartment contains high voltage electronics. Opening the main compartment will void the warranty and could potentially be hazardous to a user.



Do not attempt to service the Z. If there is a malfunction, contact the factory for assistance. Users may replace batteries, change the argon cylinder, and replace the analyzer window, but all other maintenance and repair procedures must be done with factory support or at the factory.



If the Z is damaged, do not attempt to operate it. Contact the factory for service.



Ensure that the correct external power source is used for operating the analyzer or charging the battery. Voltage should be (100V-240 V/ 50-60 Hz). Do not overload an electrical outlet.

### Battery Safety

The Z-900 uses a 14.4V Li ion rechargeable battery pack. Care should be taken with this battery. Avoid shorting it. Do not immerse it in water. Store in a cool, dry, and well-ventilated area. Avoid excessive physical shock or vibration. Do not dispose of battery in fire.



Never use a damaged battery.

Only charge batteries in the approved charger or in the analyzer. Never use a modified or damaged charger.

### Laser Safety

All Z-900 Series models use an embedded CLASS 3B laser per requirements of the US Federal Laser Product Performance Standard (FLPPS) contained in the regulations in 21 CFR Subchapter J except for deviations specific to Notices issued by the Department of Health and Human Services including Laser Notice No. 50, dated June 24, 2007. The maximum pulsed laser output is 7.5 mJ (50 Hz, 1064 nm).

The Nominal Ocular Hazard Distance (NOHD) describes the distance from the aperture where the laser can be hazardous to the eye. For the Z-900 Series, a 1064nm Nd Yag laser, the NOHD for a 10 second maximum permissible exposure (1.5mW/cm<sup>2</sup>) is 13.0 m.

The Z-900 Series uses fail-safe interlocks to function as engineering features to prevent the laser from being fired without a sample present. With these engineering features active, the system may be used as a CLASS 1M system following local Laser Safety Officer (LSO) approval.

Care should be taken to operate the instrument safely. Laser safety training is required for all operators. Laser safety goggles with an optical density of 5+ @850-1080 nm are recommended but not required. Extra laser safety goggles may be purchased through SciAps.

### Argon Safety



Argon is an inert gas and not flammable, however, the heat of a fire can build pressure in the cylinder and cause it to rupture. Do not expose the cylinder to extreme heat, or dispose of it in a fire. Recommended storage temperature: -30°C – 65° C.

## 6. Model Overview

Model	Configuration	Bases
Z-901	QuickSort	Al, Ti, Fe, SS, Ni, Cu, Co, Pures (airburn)
Z-901	Alloy	Al, Ti, Fe, SS, Ni, Cu, Co, Pures (argon)
Z-901	Dual Burn	Al, Ti, Fe, SS, Ni, Cu, Co, Pures (airburn) Al, Ti, Fe, SS, Ni, Cu, Co, Pures (argon)
Z-901	CSi	Fe(C, Si), Stainless (C)
Z-902	QuickSort+	Al, Ti, Fe, SS, Ni, Cu, Co, Pures (airburn)
Z-902	Alloy+	Al, Ti, Fe, SS, Ni, Cu, Co, Pures (argon)
Z-902	Dual Burn+	Al, Ti, Fe, SS, Ni, Cu, Co, Pures (airburn) Al, Ti, Fe, SS, Ni, Cu, Co, Pures (argon)
Z-902	Carbon	Fe+C, Stainless+C
Z-902	Carbon PREMIUM	Fe+C, Stainless+C, Al, Ti,, Ni, Cu, Co, Pures (argon)
Z-903	QuickSort+	Al, Ti, Fe, SS, Ni, Cu, Co, Pures (airburn)
Z-903	Alloy+	Al, Ti, Fe, SS, Ni, Cu, Co, Pures (argon)
Z-903	Carbon+	Fe+C, Stainless+C,
Z-903	Carbon+ PREMIUM	Fe+C, Stainless+C, Al, Ti,, Ni, Cu, Co, Pures (argon)
Z-903	Geo	Coming Fall 2021
Z-903	Empirical	Coming Fall 2021

## 7. Start Up & User Interface

### Inserting the battery

Batteries should be charged before use. A full charge cycle takes approximately 3 hours. Insert the keyed Li-ion battery into the handle of the instrument.

Note: The tapered end of the battery should face towards the nose of the instrument.



## Inserting Argon

Screw argon canister into regulator on side of instrument clock-wise. The regulator will pierce the single-use canister seal. Do not remove argon canister until the system reports that the canister is empty.

Each canister has enough argon for approximately 600 tests (varies with acquisition settings and averaged results).

Note 1 – Specific, carbon-grade argon is required for accurate carbon analysis.  
Note 2 – Argon canisters are single use and cannot be refilled.

Do not remove canisters that are still under pressure as it will cause premature deterioration of the regulator gasket.



## Powering on the system

Firmly press and release the power button on the top of the analyzer.

LED Indicator Light:

OFF = Off

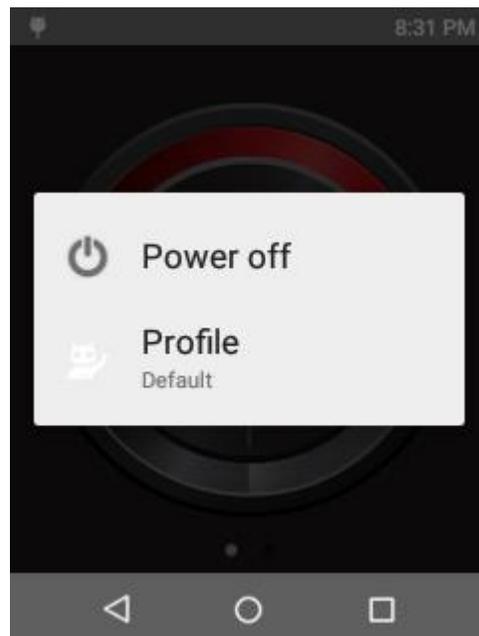
GREEN = On, laser has not been fired

RED = On, laser armed and ready to fire

To shut down the system, firmly press and hold the power button for 3 seconds then release.

When prompted, select Power Off. Wait for the LED light to turn off before removing the battery.

If required, hold the power button for 12 seconds to perform a hard shutdown.



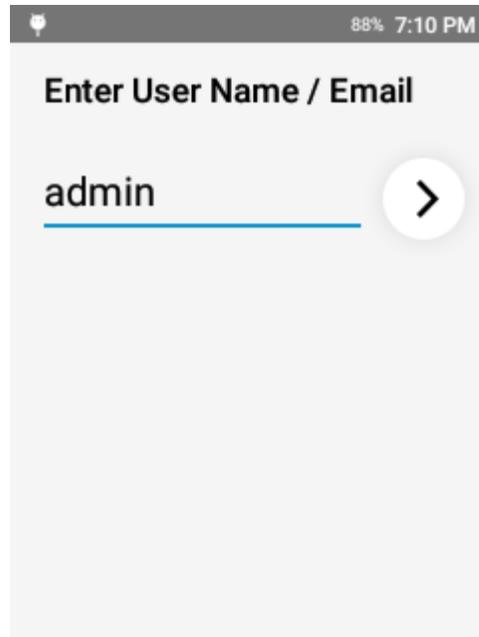
## System Login

After the analyzer starts, you will need to login.

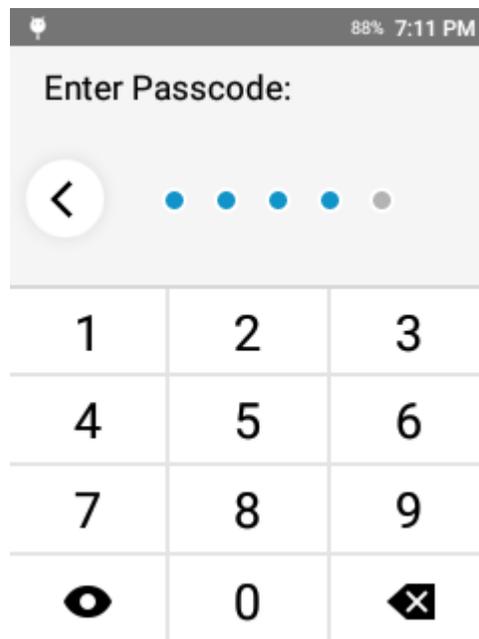
The default account is **admin**.

Simply press the > icon to continue.

Additional accounts may be generated when logged into the account.



The Admin passcode is **1 2 3 4 5**

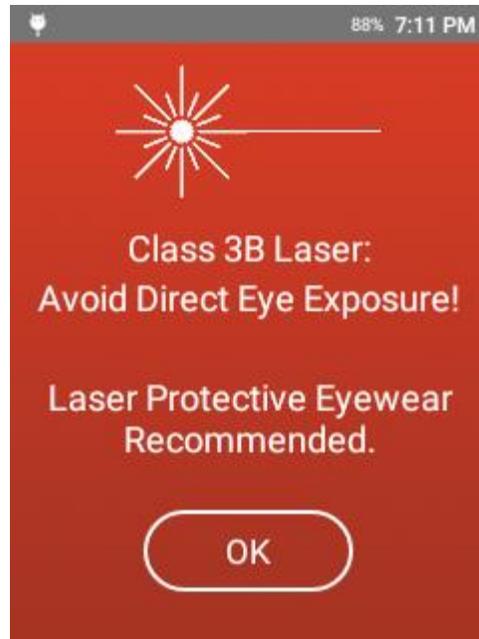


### Laser Safety Warning Message

After entering the passcode, you must accept the laser safety warning message to continue. Use should be limited to trained operators only.

The Z-900 Series analyzer utilizes an embedded Class 3B laser with engineering features to function as an interlock. This combination, with local Laser Safety Officer approval, allows the system to be operated under Class 1M conditions.

Operation should be limited to trained operators only, and the instrument should be controlled at all times.



### Launch Screen

Features 3 primary functions:

- Analyze
- Settings
- Results

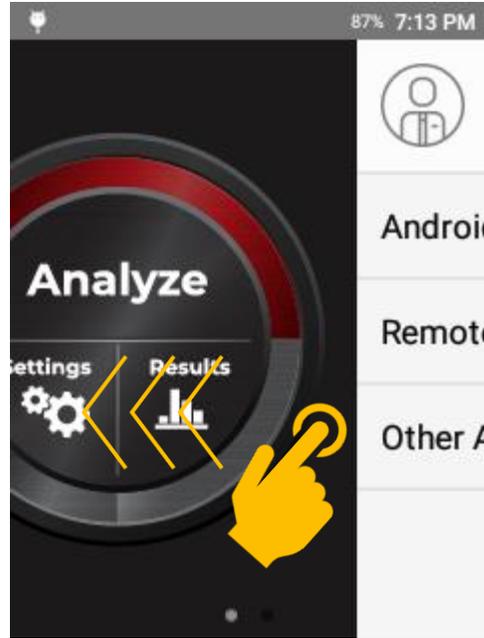
Analyze is used for all analytical testing and data collection.

Settings controls the analyzer settings. There are additional settings in the Android Settings menu.

Results allows the user to view, review, export, and manage previously captured data.



Swipe left to show additional features and options.

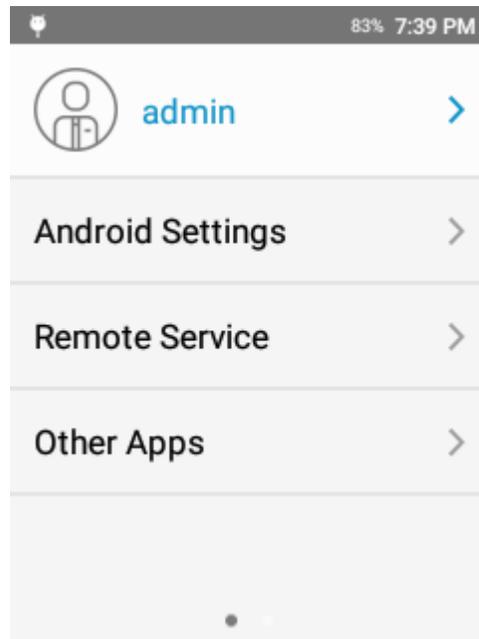


Additional options include:

User Management: change password, manage users

Android Settings: Access WiFi settings, Date and Time, and other non-analytical system settings

Other Apps: Includes SciAps Updater, and 3<sup>rd</sup> party apps such as Email or Contacts



## Navigation Bar

Swiping up from the bottom will show the navigation bar. In this bar, there are 3 options:

Back

Home

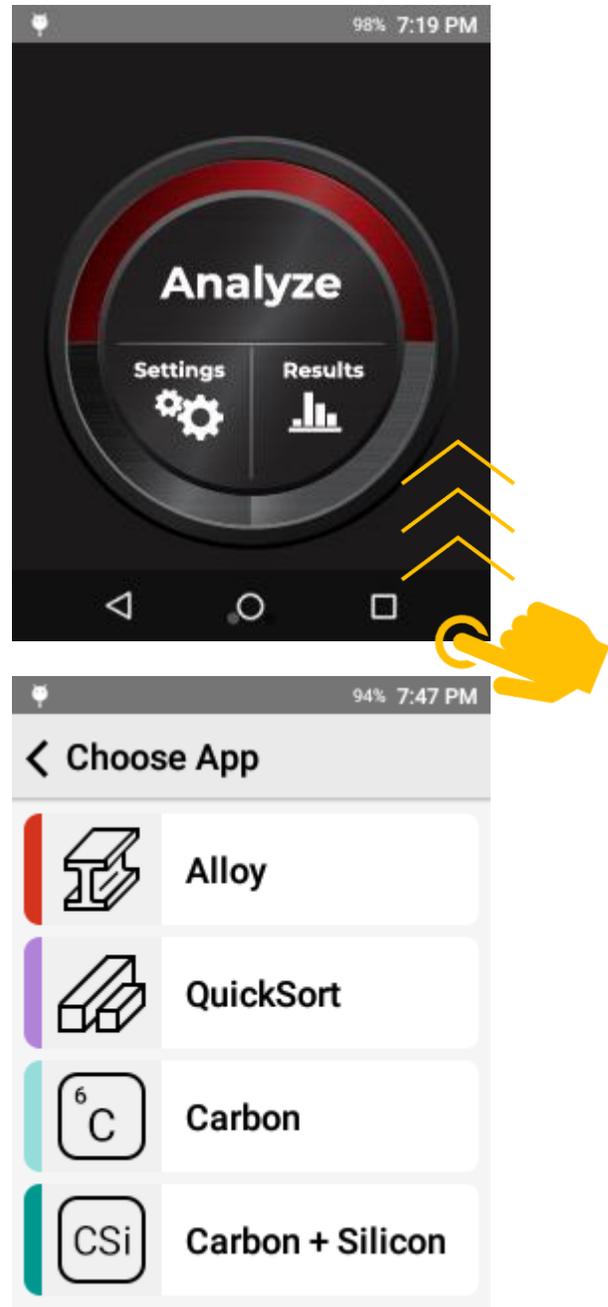
Open Apps

Back simply returns you to the previous screen.

Home returns you to the SciAps launch screen.

Open Apps shows all apps that are actively running. This allows the user to quickly switch between open apps or to close an app by swiping the app icon in this view.

To start testing – select “Analyze” and select an app.



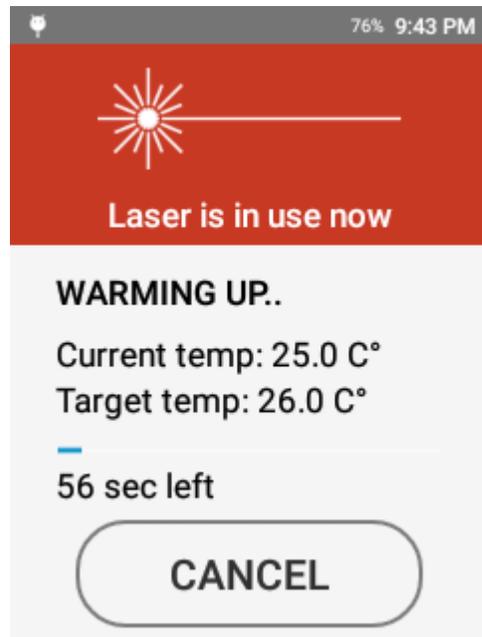
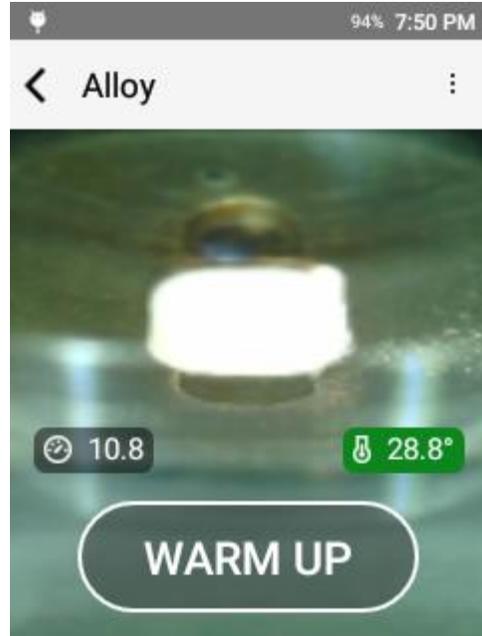
## Warm Up

The Z-900 Series has an optimal internal temperature between 25° C and 40° C.

When an app is opened, if the internal temperature is below 26° C, the system will prompt for WARM UP. Simply pull the trigger or tap Warm Up to continue.

In temperatures outside of the recommended operation range, additional measures may be required for optimal operation ( e.g. reduced duty cycle in high ambient temperatures).

By default, the system will run a 60 second warm up cycle. The system does not emit any laser pulses during warm up. A sample is not required for warm up.



### Repeat Warm Up

If the system does not reach the target temperature before the cycle is completed, the system will prompt the operator that the minimum recommended operating temperature has not been reached.

Warm up will repeat the protocol.

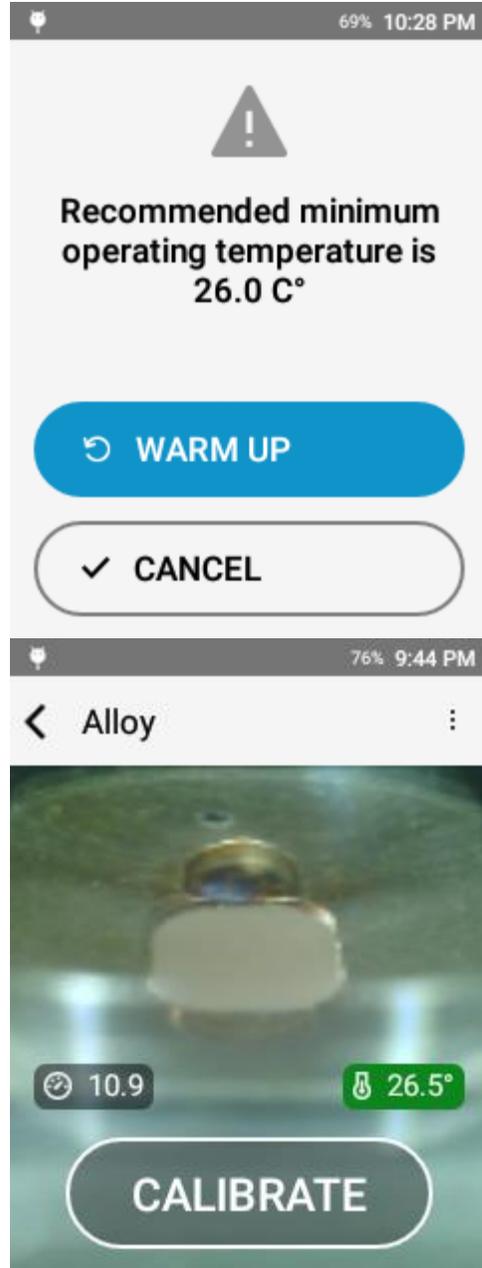
Cancel will take the operator to the testing screen.

Factory recommendation is to repeat Warm Up until the target temperature is reached. This is when the instrument is being operated in the recommended ambient temperature range.

### Wavelength Calibration

When the analyzer reaches the target temperature, the system will prompt for a wavelength calibration.

This is indicated by the text "CALIBRATE" on the button at the bottom of the screen.



## Wavelength Calibration

When prompted to calibrate, simply tap the on-screen "CALIBRATE" button or pull the trigger.

The system will shoot an internal standard. No sample is required for Wavelength Calibration.

Wavelength Calibration corrects for any wavelength drift in the spectrometer. Typically, a Wavelength Calibration is recommended every time the instrument is started, every four (4) hours of use, or when the internal temperature changes more than 7° C.

The instrument monitors time and temperature for these changes.

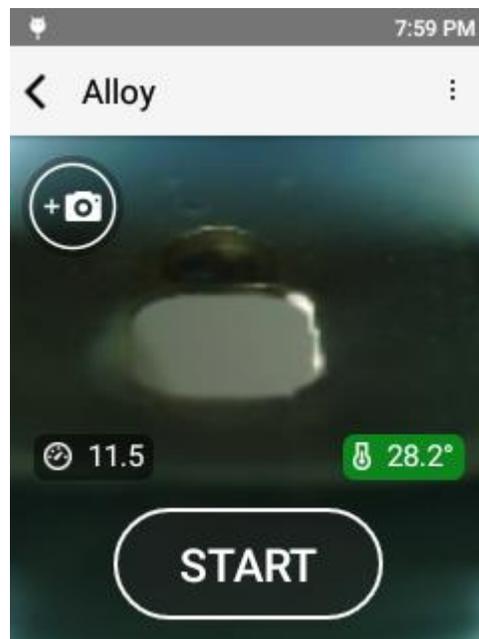
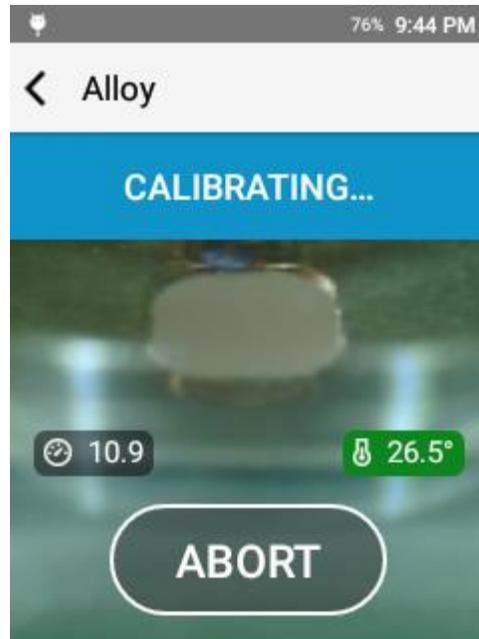
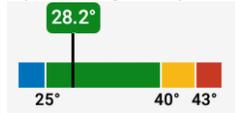
After the WL Calibration is complete, the button will read START. This indicates that the instrument is ready for testing.

When the instrument is ready:

If equipped, argon pressure will be indicated in the bottom left corner of the screen. It will typically be between 10 and 12 PSI.



Internal instrument temperature will be indicated in the bottom right corner of the screen. Ideal operating temperature is between 25° and 40° C.



To take a test, pull the trigger or press the start button.

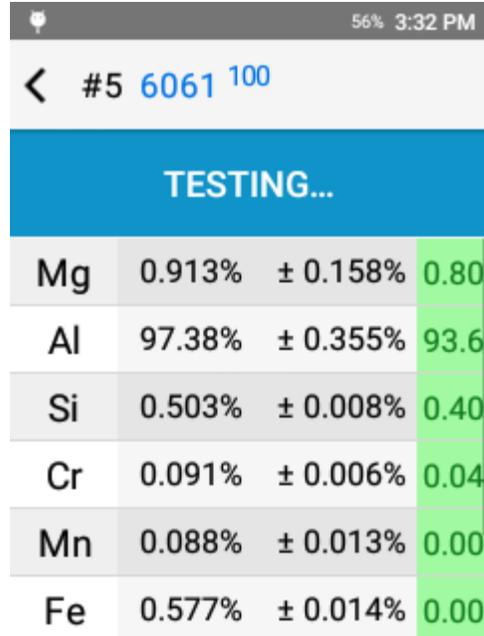
Be sure to hold the sample flush to the laser aperture and keep the sample still for the entire test.

### Result

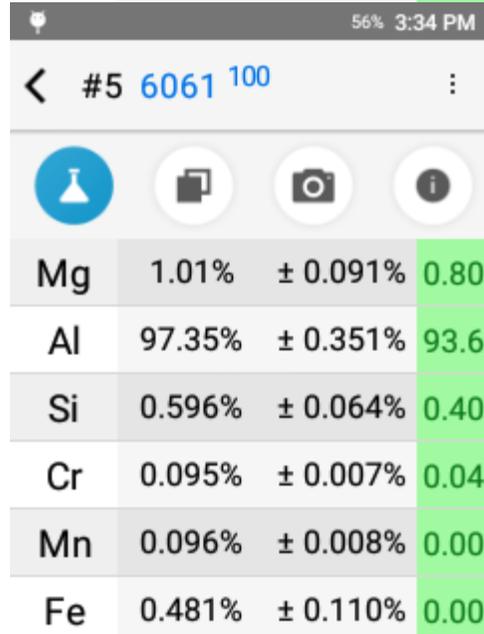
Comprised of 6 primary components:

1. Test Number
2. Grade Match
3. Chemistry
4. Grade Compare
5. Camera
6. Test Info

Grade Match indicates the top match for the measured chemistry compared to the instrument grade library. The Grade Match Score indicates the quality of the match. A score of 100 is considered a perfect match, meaning that all measured elements matching the alloy are calculated by determining if each specified element is in the specified range for the grade. If it is out of range, a penalty is calculated based on how far each element is out of range. The calculated penalty for each element is summed then subtracted from 100.



Element	Measured (%)	± Range (%)	Grade Match Score
Mg	0.913%	± 0.158%	0.80
Al	97.38%	± 0.355%	93.6
Si	0.503%	± 0.008%	0.40
Cr	0.091%	± 0.006%	0.04
Mn	0.088%	± 0.013%	0.00
Fe	0.577%	± 0.014%	0.00



Element	Measured (%)	± Range (%)	Grade Match Score
Mg	1.01%	± 0.091%	0.80
Al	97.35%	± 0.351%	93.6
Si	0.596%	± 0.064%	0.40
Cr	0.095%	± 0.007%	0.04
Mn	0.096%	± 0.008%	0.00
Fe	0.481%	± 0.110%	0.00

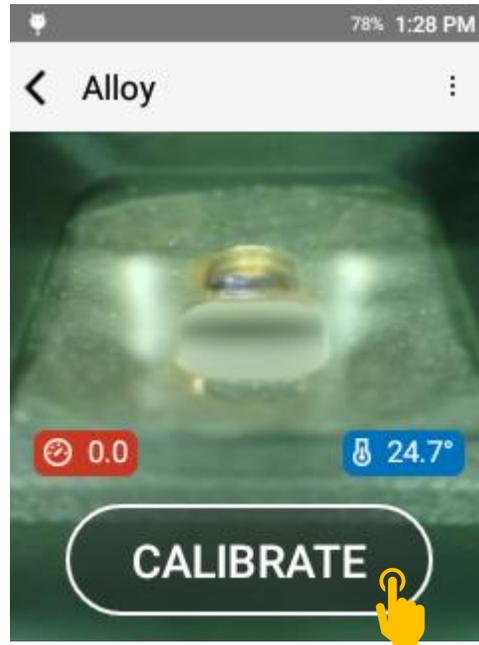
## 8. Calibration

### *Wavelength Calibration*

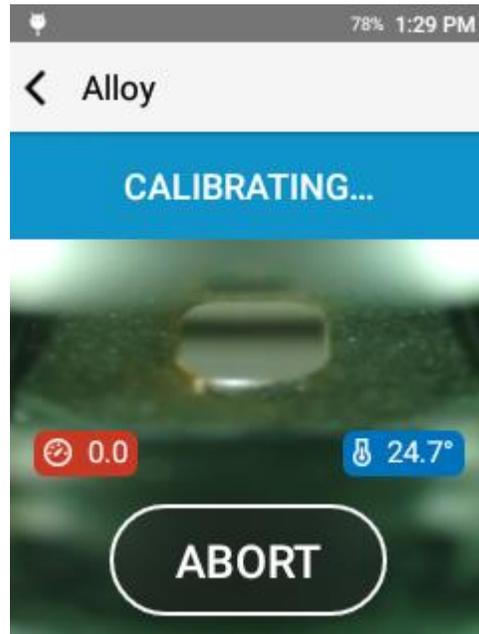
Wavelength Calibrations are standard and recommended practice for the SciAps Z-900 Series. This procedure verifies that the unit is operating properly and ensures that the wavelength scale is correct.

When a wavelength calibration is performed, the analyzer will fire the laser on a piece of metal inside the laser. No sample is required for a Wavelength Calibration. The image will be visible on the screen. When the procedure is complete, a message will appear on the screen indicating success.

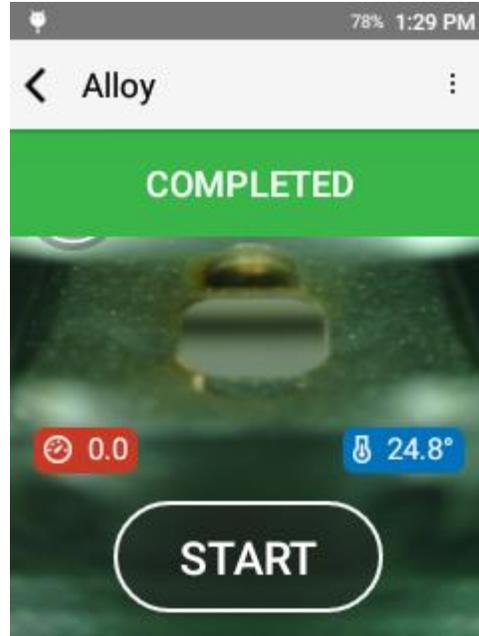
When a Wavelength Calibration is required, the START button will read CALIBRATE. Simply tap CALIBRATE or pull the trigger to start the Wavelength Calibration process. The process is fully automated.



During Wavelength Calibration, the laser and LED Spotlight will move to the top of the aperture and fire a series of laser pulses. The test status bar will read CALIBRATING...

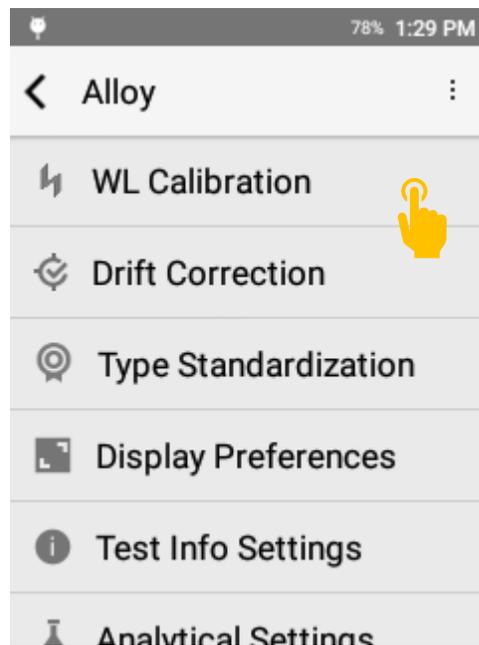


If the Wavelength Calibration is successful, the test status bar will read COMPLETED.



### Manual Wavelength Calibration

Can be performed by opening the options menu and selecting WL Calibration.



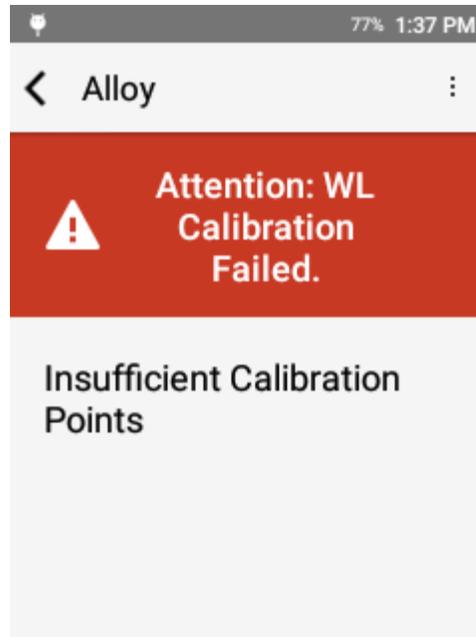
## Wavelength Calibration Failure

In the event of a failure, the system will prompt: Attention: WL Calibration Failed followed by a specific error message.

Please contact SciAps Support if the WL Calibration fails.

Basic Troubleshooting steps:

1. Repeat WL Calibration.
2. Confirm that the instrument is in the proper operating temperature range.
3. Remove nose plate and clean the quartz blast shield with a cotton swab.
4. Remove nose plate and clean the area directly above the aperture with a cotton swab.



## *Drift Correction*

Similar to all Optical Emission Spectroscopy techniques, the Z-900 Series analyzers can experience spectrometer drift due to temperature changes or other environmental and physical effects. Intensity Drift can be corrected through the Drift Correction feature described below.

It is recommended that users test known check standards as part of their standard operating procedure. If the instrument does not perform as expected on the check standards, then a Drift Correction can be applied to correct for spectrometer drift.

Drift correction requires the specific set of drift correction standards that was delivered with the instrument. Open the Drift Correction feature found in the three dots menu of the target testing app. Follow the steps below to complete a drift correction.

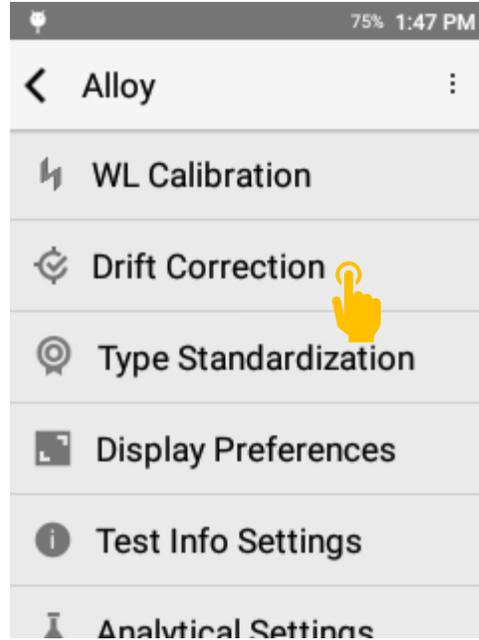
Note – drift correction is specific to the testing mode.

Prior to Drift Correction, SciAps recommends:

1. Cleaning the Quartz blast shield with a cotton swab
2. Performing a Wavelength Calibration

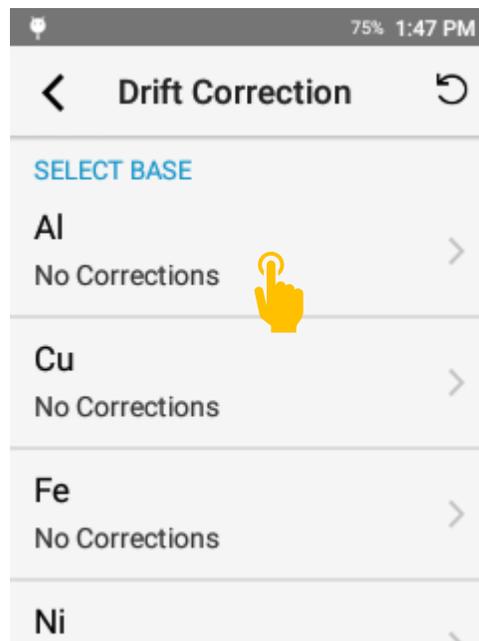
For Drift Correction in Carbon(+), Carbon+Silicon, and Pipeline, proper sample preparation is required prior to drift correction.

Access Drift Correction from the testing mode options menu.

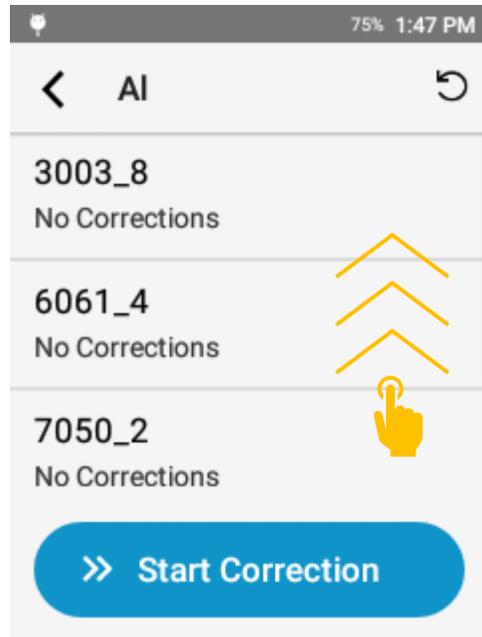


All available bases for drift correction will be listed in the following screen.

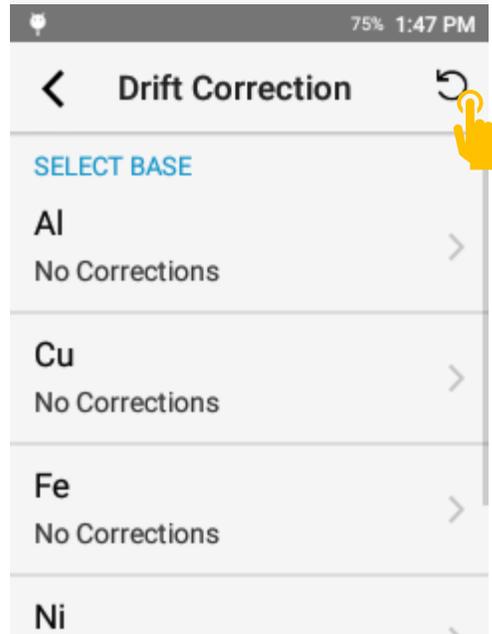
Tap a base to perform a drift correction for that base.



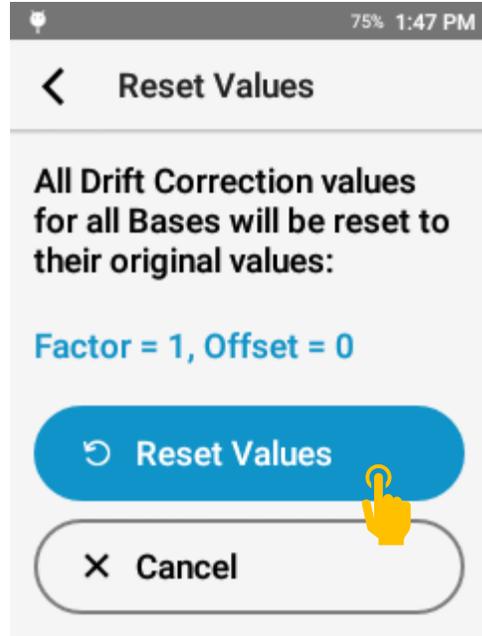
Some bases contain four standards. Simply scroll down to see the additional standards.



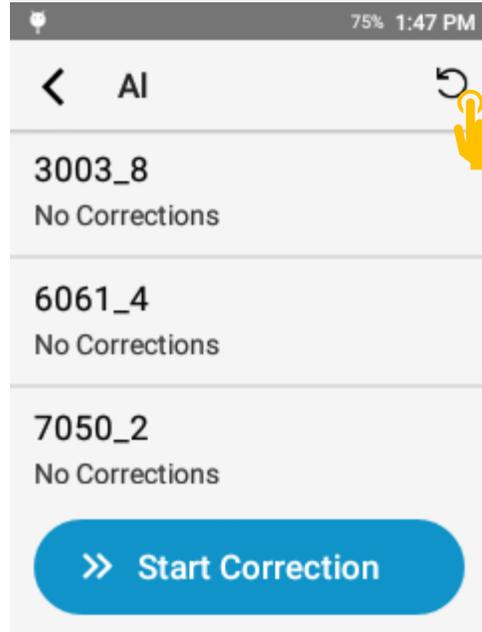
To clear all drift correction values, tap the reset button in the top corner of the drift correction menu.



Then accept the prompt by tapping Reset Values.

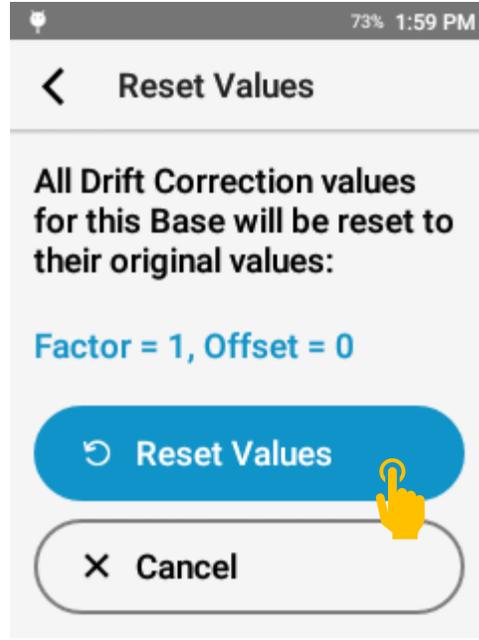


To reset drift correction values for a specific base, open that base then tap the reset button.



Then accept the prompt by tapping Reset Values.

This will not reset values for any other base.



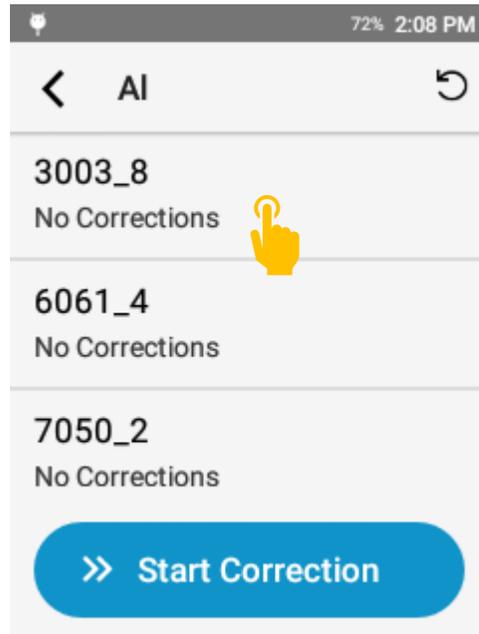
This automated drift correction procedure calculates factors and offsets for elements within the base.

A factor is typically used for higher concentration elements.

An offset is typically used for lower concentration elements.

To drift correct the Aluminum base, select aluminum from the main drift correction menu.

Tap a drift correction sample to select that sample.



Hold the specific sample – confirming that both the alloy (e.g. 3003) and the batch (e.g. 8) match between the standard and the on screen display – to the aperture.

Tap the START button or pull the trigger to start the sequence.

In Alloy(+) and Quick Sort(+) mode, the system will run 3 tests.

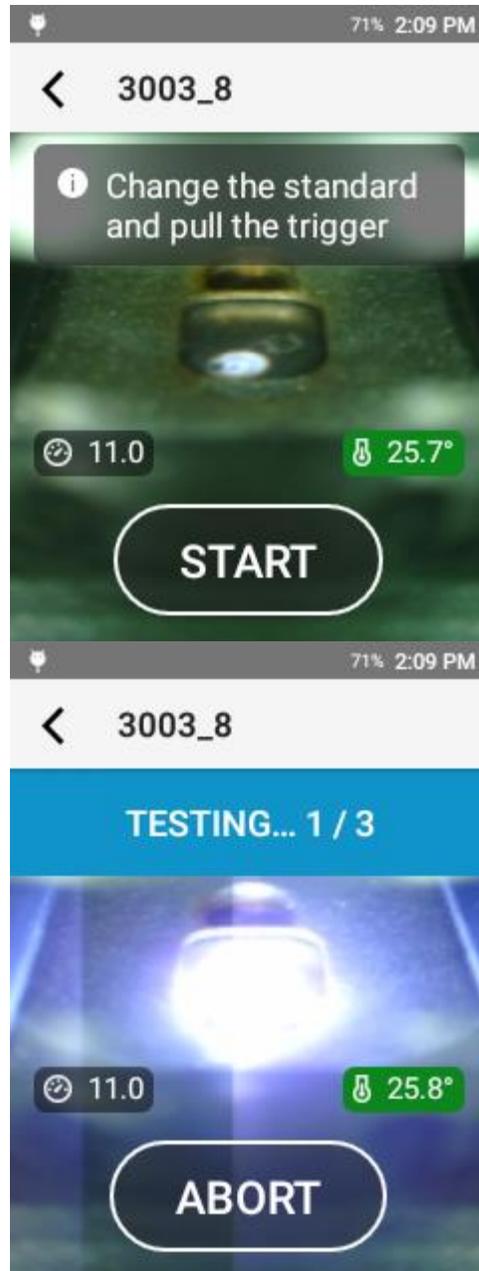
In Carbon+Silicon, Carbon(+), and Pipeline, the system will run a Pre-Burn as set in the Acquisition Settings menu then a series of 3 tests

When testing, the test status bar will indicate progress through the drift correction procedure.

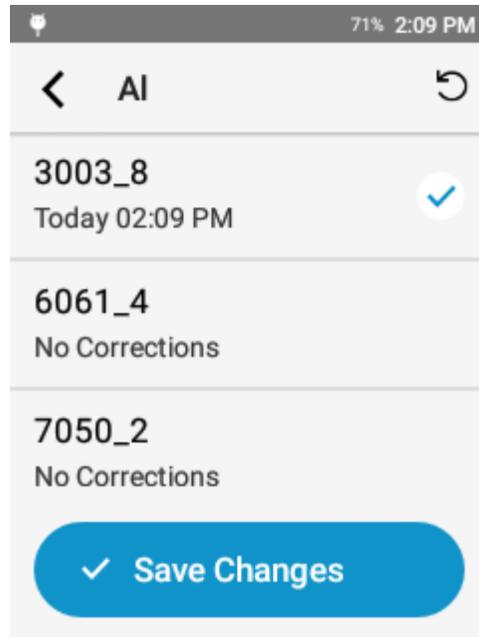
For Aluminum and Copper bases, SciAps recommends moving the sample between laser bursts.

For all other bases, SciAps recommends leaving the sample in the same location for all laser bursts.

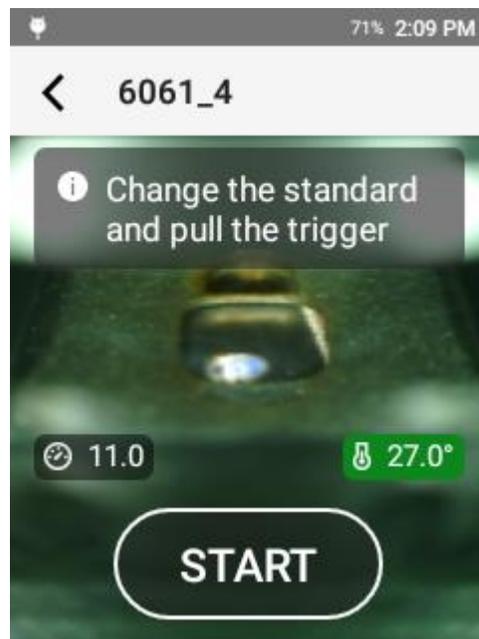
For Carbon based modes (C+Si, Carbon(+), Pipeline), the sample must stay in the same location for all tests.



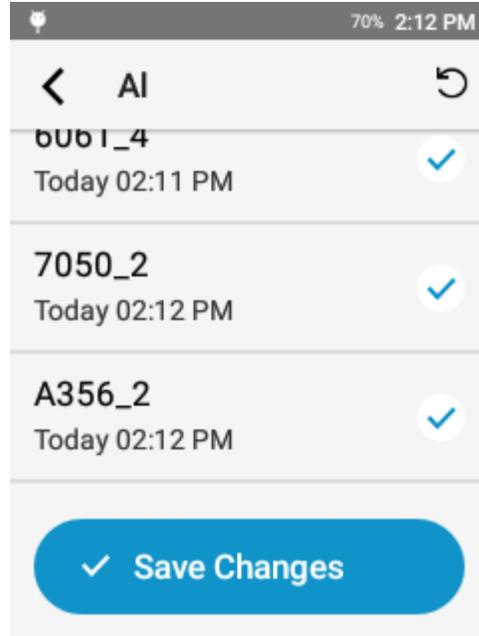
When a standard is complete, the system will return to the standard selection screen. The standard will be updated with a blue check mark and a time and date stamp.



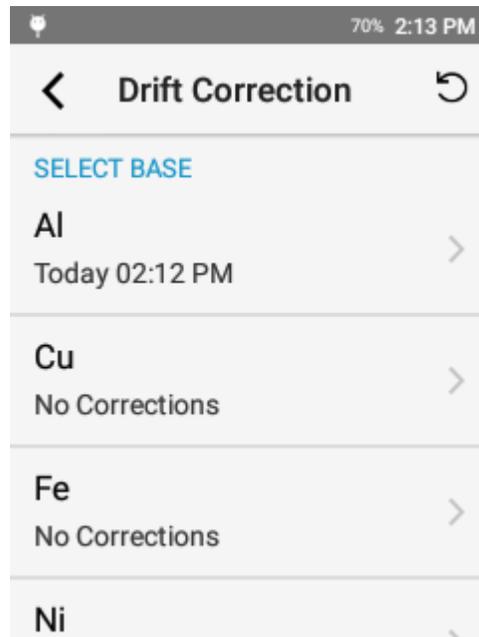
Tap the next standard in the list to continue the process.



When all standards in the list have a blue check mark, tap Save Changes. If you exit without saving changes, the correction values will not be saved or applied to the chemistry.



After saving changes, the time and date stamp will be updated for that base.



There is an internal check on the factors to confirm that they are reasonable values. If a standard is out of range, the system will prompt the user.

In the event of an Out of Range message, confirm:

1. The correct standard was shot
2. The standard is clean
3. The blast shield is clean
4. Instrument temperature is in the normal operating range
5. If Argon is required, the canister did not become empty during the test

If all of these basic criteria were met, reshoot the standard. If the same out of range error is produced, apply the factors and continue drift correction. When the drift correction process is complete, validate performance with a check standard. If the chemistry is out of range, it may be indicative of a hardware issue. In this case, please contact SciAps Support for assistance.

Drift Correction Standards

Aluminum Base

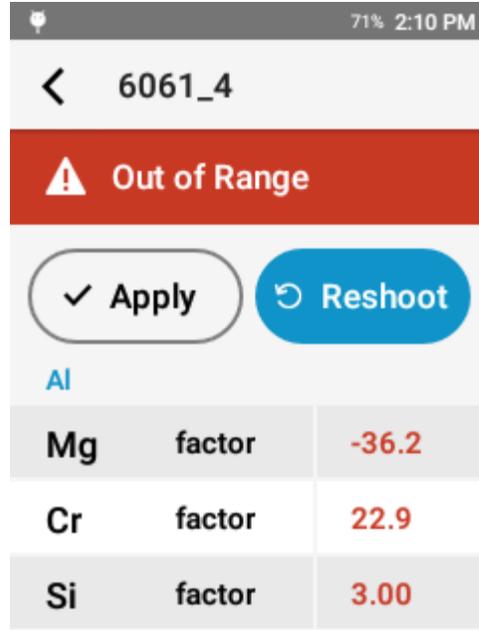
Copper Base

Iron Base

Stainless Base (Alloy\*, QuickSort\*)

Stainless Base (Carbon\*)

Nickel Base



Bases and standards are model and mode specific

3003

6061

7050

356

CDA 715

CDA 836

CDA 863

CP Iron

1030

8620

LAS1

317L

Custom 455

C350

Nitronic 60

316L

304

347H

Inconel 625

Rene 41

### Type Standardization

Type Standardization is a single point calibration that allows users to automatically adjust the calibration to match a particular Reference Material or Certified Reference Material. The Type Standardization will adjust the slope or offset each element's calibration curve so that the result will match the assay of

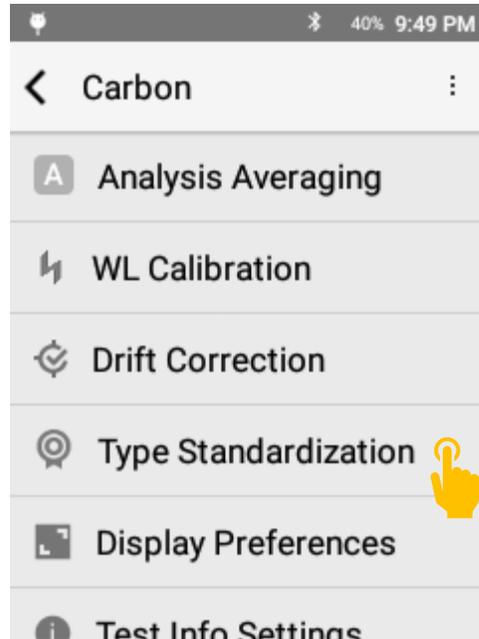
the standard. The slope is adjusted for high concentrations, and the offset is adjusted for trace levels. Typically, the cutoff for slope versus offset is 0.2%.

Type Standardization should be used for improved accuracy on a small sample range when the chemistry of the reference material, aka the Type Standard, is very similar to the material to be tested.

In order to perform a Type Standardization, you must have a Reference Material (RM) or Certified Reference Material (CRM) entered into the system. To enter an RM or CRM, connect to the database in Profile Builder, access the standards page, add your standard with assay values and designate the standard for Type Standardization.

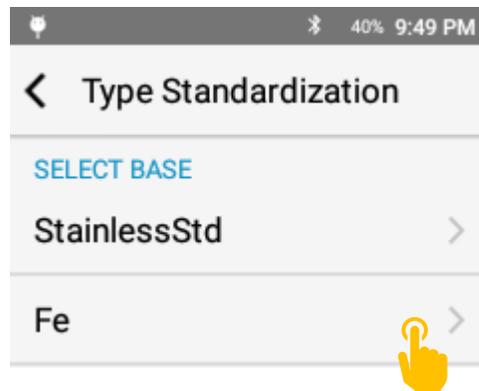
### **Type Standardization Setup**

To access Type Standardization, open the options menu and tap Type Standardization.

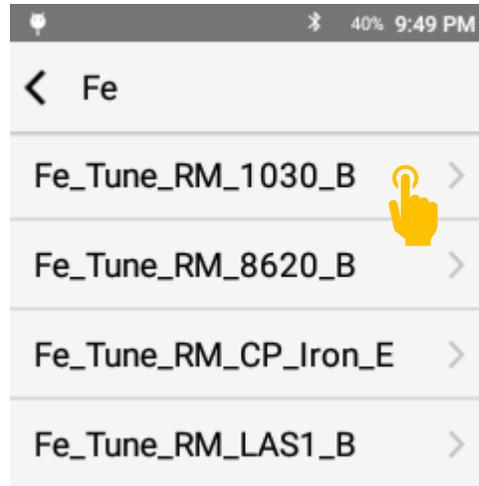


### **Select your RM or CRM**

Select the Alloy Type, aka Base, that contains your RM or CRM.

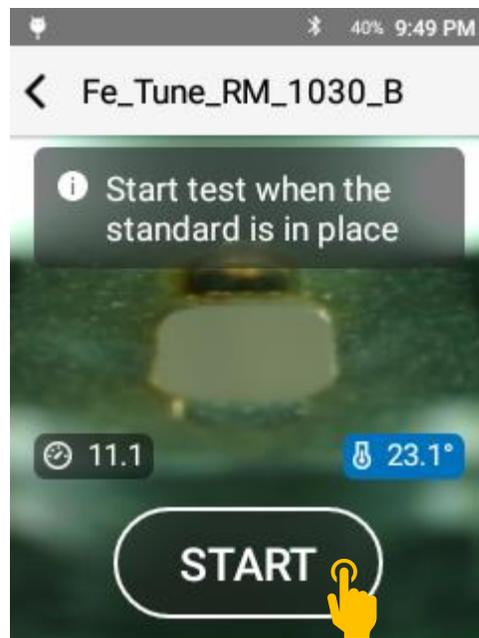


Then select the target RM or CRM from the subsequent list.

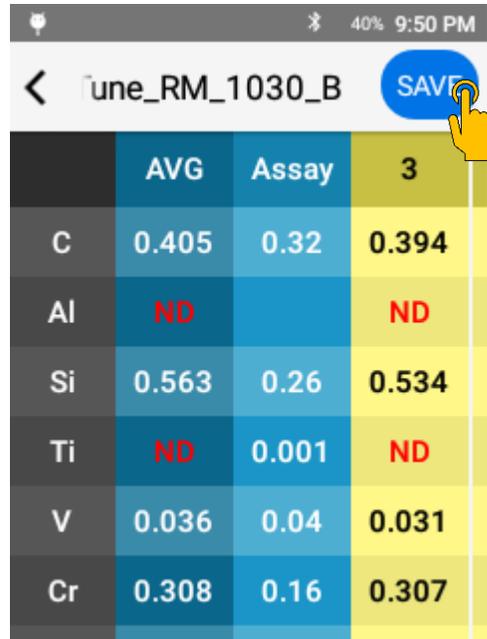


### **Test the Sample**

Prepare the sample and then shoot the sample using the start button or the trigger. Pre-Burn settings will be applied. The system will automatically run 3 repeats on the sample.



When the acquisition is complete, review the data and press save.



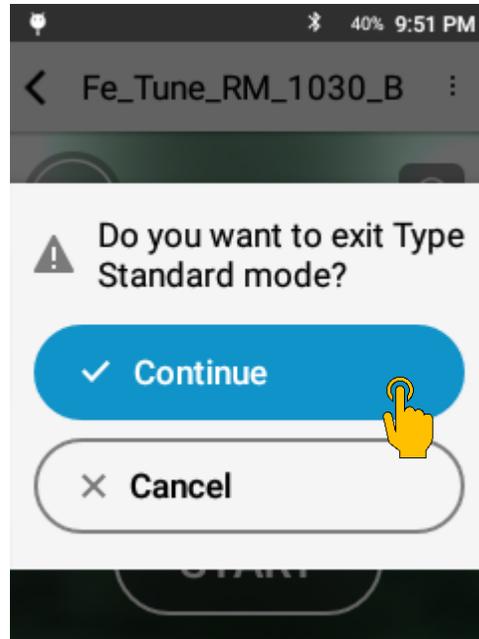
	AVG	Assay	3
C	0.405	0.32	0.394
Al	ND		ND
Si	0.563	0.26	0.534
Ti	ND	0.001	ND
V	0.036	0.04	0.031
Cr	0.308	0.16	0.307

You are now ready to test. When a Type Standard is applied, the selected standard will be listed in the header, and there will be a target icon in the top right corner.



### Exiting Type Standardization

Tapping the target icon or pressing the back button will exit that type standardization. Accept the prompt to exit or press cancel to maintain the Type Standardization.



## 9. Sample Preparation

While the Z-900 Series has effective cleaning protocols built into the system, LIBS is still fundamentally a surface test. For a heavily corroded, dirty, or plated surface, sample preparation may be required. Sample preparation is critical for carbon analysis.

If sample preparation is required, grind an area approximately 0.75 in/20 mm in diameter. The minimum sample prep area is 0.15 in / 4 mm. Then use the camera to align the test location in the center of the prepared area.

SciAps recommends the Milwaukee M12 Right Angle Die Grinder or the Milwaukee M12 Variable Speed Polisher/Sander and the Norton Saint Gobain Blaze R980P Quick Change disc (2" or 3" diameter, 50 grit).

Proper grinding technique will result in a shiny surface with linear grind marks (not swirls).



## 10. Alloy(+) Mode

### *Alloy(+) Mode Overview*

This testing app is used for quantitative analysis of alloys. The mode utilizes argon OptiPurge technology to purge the testing chamber with argon – an inert gas. The argon environment increases the plasma life, improving signal to noise ratio. Additionally, the argon atmosphere increases the overall intensity of the plasma and limits impact of atmospheric absorption.

Alloy and Alloy+ share the same user interface and functions. Alloy uses a single spectrometer covering 200 – 420 nm. Alloy+ uses two spectrometers to achieve an expanded wavelength range of 190 – 610 nm.

### *Element Suite*

#### **Alloy Mode:**

<b>Alloy Family</b>	<b>Elements Included</b>
Aluminum	Be, Mg, Al, Si, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Zr, Pb, Bi, Ag
Titanium	Al, Si, Ti, V, Cr, Mn, Fe, Ni, Zr, Nb, Mo, Sn
Low Alloy Steel (Fe)	Al, Si, Ti, V, Cr, Mn, Fe, Co, Cu, Ni, Nb, Mo, W, Pb
Stainless Steel	Al, Si, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Se, Nb, Mo, W
Nickel	Al, Si, Ti, Cr, Mn, Fe, Co, Ni, Cu, Nb, Mo, W, Hf, Ta, Re
Copper	Be, Al, Si, Cr, Mn, Fe, Co, Ni, Cu, Zn, Se, Ag, Sn, Pb, Bi

Cobalt	Al, Si, Ti, Cr, Mn, Fe, Co, Ni, Cu, Nb, Mo, W
Specialty **	V, Cr, Mn, Ag, Ta, Hf, Re, Pb, Zr, Mg, Zn, Mo, W, Sn, Nb

**Alloy+ Mode:**

<b>Alloy Family</b>	<b>Elements Included</b>
Aluminum	Li, Be, Mg, Al, Si, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Zr, Pb, Bi, Ag
Titanium	Al, Si, Ti, V, Cr, Mn, Fe, Ni, Zr, Nb, Mo, Sn
Low Alloy Steel (Fe)	Al, Si, Ti, V, Cr, Mn, Fe, Co, Cu, Ni, Nb, Mo, W, Pb
Stainless Steel	Al, Si, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Se, Nb, Mo, W
Nickel	Al, Si, Ti, Cr, Mn, Fe, Co, Ni, Cu, Nb, Mo, W, Hf, Ta, Re
Copper	Be, Al, Si, Cr, Mn, Fe, Co, Ni, Cu, Zn, Se, Ag, Sn, Pb, Bi
Cobalt	Al, Si, Ti, Cr, Mn, Fe, Co, Ni, Cu, Nb, Mo, W
Specialty **	V, Cr, Mn, Ag, Ta, Hf, Re, Pb, Zr, Mg, Zn, Mo, W, Sn, Nb

\*\* Identifies base only – no alloying or trace element analysis.

Additional bases or elements may be set up with factory support.

*Taking a Test*

Place sample over the laser aperture ensuring that you completely cover the window.

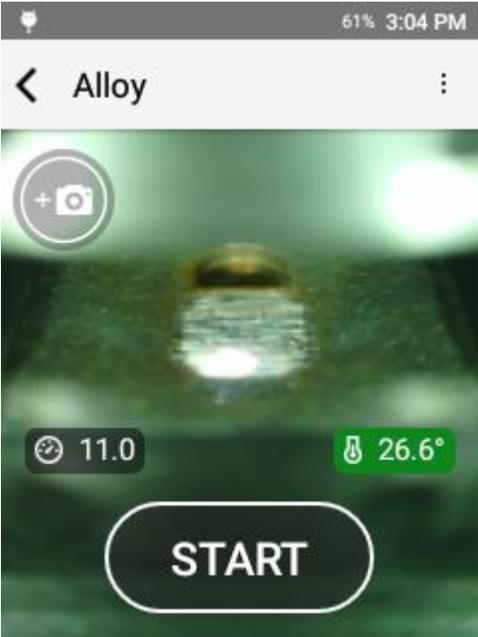
Be sure to hold the sample square to the instrument so that the laser LED Spotlight is in clear focus on the sample.

Hold the sample still for the duration of the test. The test will include 6 individual test points. The system automatically moves through the full raster pattern.

Raster pattern: 6 locations x 12 cleaning pulses x 16 data pulses

In alloy mode, we fire the laser 12 times in each location to clean debris from the surface then 16 times in each location to collect data.

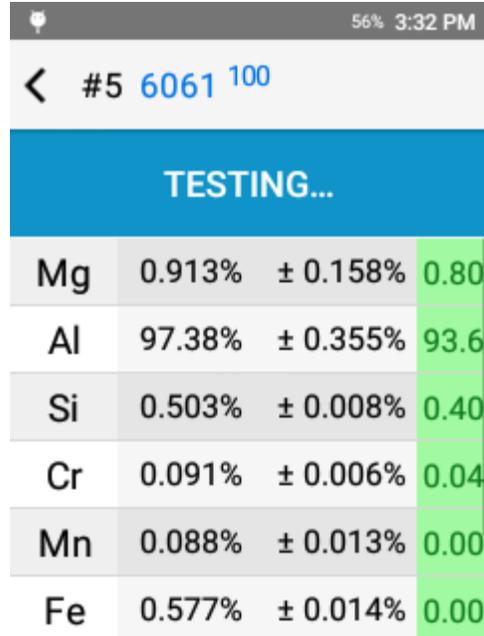
Rastering across the surface ensures a representative sample is collected.



### First Update

During a test, the system will deliver live updates to the chemistry as data is collected and processed.

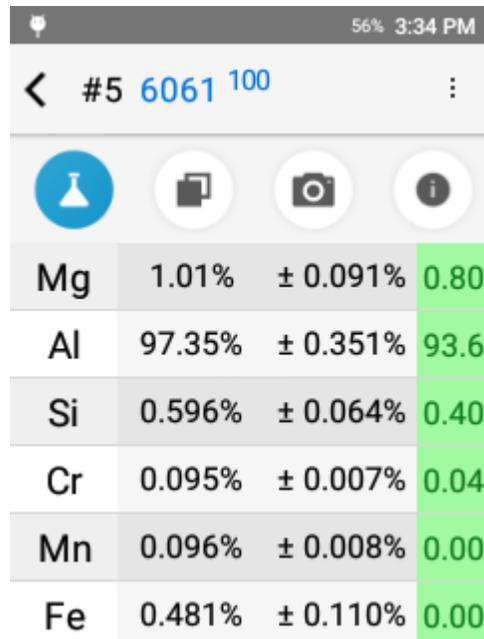
This phase is indicated by the test status bar. While the status bar reads TESTING... the test is still in progress. The sample should be kept in the same location throughout this phase.



TESTING...			
Mg	0.913%	± 0.158%	0.80
Al	97.38%	± 0.355%	93.6
Si	0.503%	± 0.008%	0.40
Cr	0.091%	± 0.006%	0.04
Mn	0.088%	± 0.013%	0.00
Fe	0.577%	± 0.014%	0.00

### Test Complete

Each test is a test to completion. A complete test is indicated on screen by the test status bar turning GREEN and reading COMPLETED.



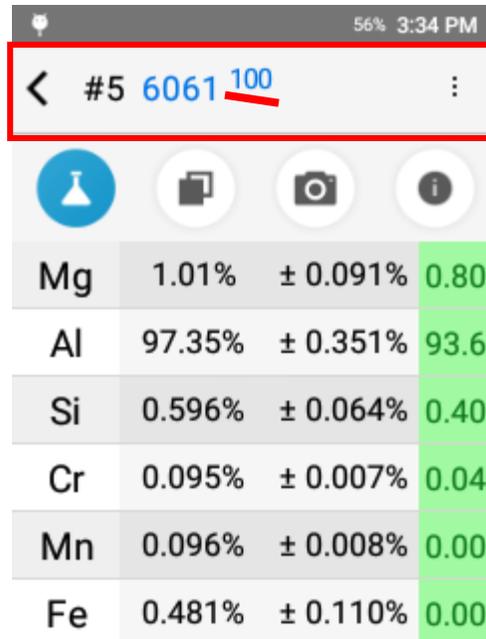
COMPLETED			
Mg	1.01%	± 0.091%	0.80
Al	97.35%	± 0.351%	93.6
Si	0.596%	± 0.064%	0.40
Cr	0.095%	± 0.007%	0.04
Mn	0.096%	± 0.008%	0.00
Fe	0.481%	± 0.110%	0.00

### Alloy Result

Comprised of 6 primary components:

1. Test Number
2. Grade Match
3. Chemistry
4. Grade Compare
5. Camera
6. Test Info

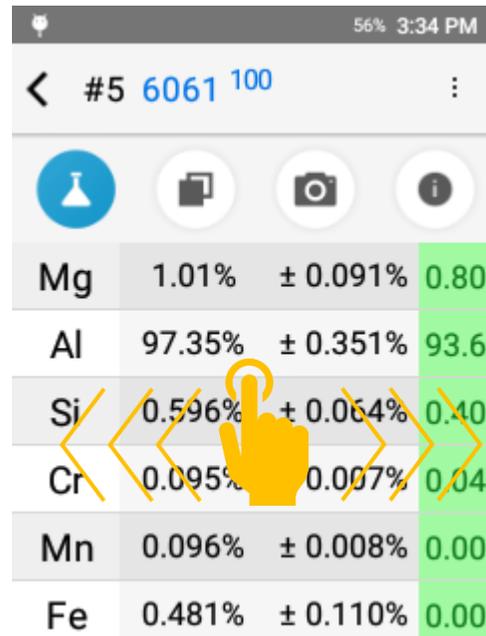
Grade Match indicates the top match for the measured chemistry compared to the instrument grade library. The Grade Match Score indicates the quality of the match. A score of 100 is considered a perfect match, meaning that all measured elements match the alloy specification. The Grade Match Score is calculated by determining if each specified element is in the specified range for the grade. If it is out of range, a penalty is calculated based on how far each element is out of range. The calculated penalty for each element is summed then subtracted from 100.



Element	Measured (%)	Tolerance Range (%)	Match Score
Mg	1.01%	± 0.091%	0.80
Al	97.35%	± 0.351%	93.6
Si	0.596%	± 0.064%	0.40
Cr	0.095%	± 0.007%	0.04
Mn	0.096%	± 0.008%	0.00
Fe	0.481%	± 0.110%	0.00

### Navigating Results

Swipe left to go to an earlier result or swipe right to go to a more recent result.



Element	Measured (%)	Tolerance Range (%)	Match Score
Mg	1.01%	± 0.091%	0.80
Al	97.35%	± 0.351%	93.6
Si	0.596%	± 0.064%	0.40
Cr	0.095%	± 0.007%	0.04
Mn	0.096%	± 0.008%	0.00
Fe	0.481%	± 0.110%	0.00

**Chemistry**

Chemistry lives on the first page and lists all measured elements including their concentration, the precision of the measurement (+/-), and, if there is a grade match, the grade specification for each measured element.

ND indicates non-detect. This means that the measured value failed to meet the criteria for a valid measurement. In order for an element value to be considered detected, the measured value must be greater than the 3σ standard deviation.

See display preferences section for more information about non-detects.

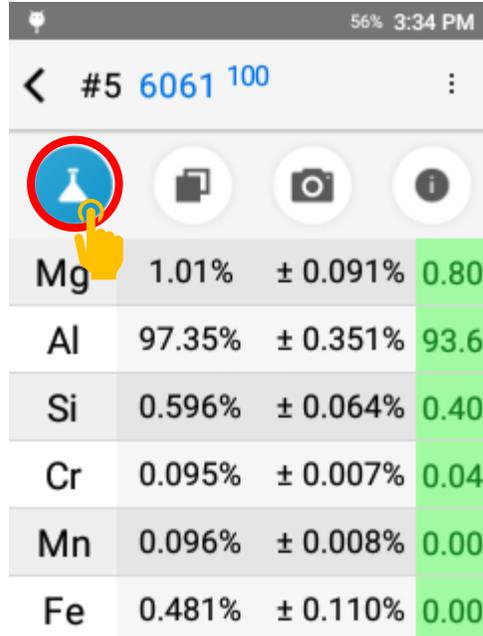
**Grade Specification Comparison**

Tap the grade specification column to expand the grade specification (hiding the precision column).

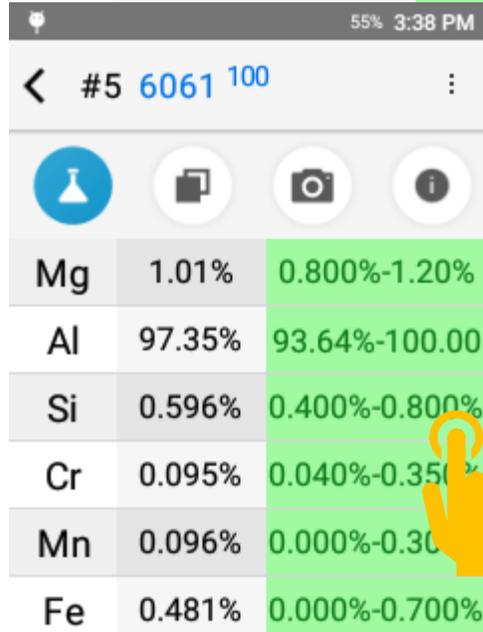
Green indicates that the chemistry is within the specified value for the grade.

Red indicates that the chemistry is outside of the specified range.

Yellow indicates that, when considering the precision of the measurement, the reported chemistry may fall into the grade specification.



	Concentration	Precision	Grade Spec
Mg	1.01%	± 0.091%	0.80
Al	97.35%	± 0.351%	93.6
Si	0.596%	± 0.064%	0.40
Cr	0.095%	± 0.007%	0.04
Mn	0.096%	± 0.008%	0.00
Fe	0.481%	± 0.110%	0.00



	Concentration	Expanded Grade Spec
Mg	1.01%	0.800%-1.20%
Al	97.35%	93.64%-100.00
Si	0.596%	0.400%-0.800%
Cr	0.095%	0.040%-0.350%
Mn	0.096%	0.000%-0.300%
Fe	0.481%	0.000%-0.700%

### Compare Grade

The Grade Compare function lives on the second page and allows the user to compare measured chemistry against any grade in the active grade library.

Tap the grade compare icon to see the top three grade matches. The grade match score is listed for each grade.

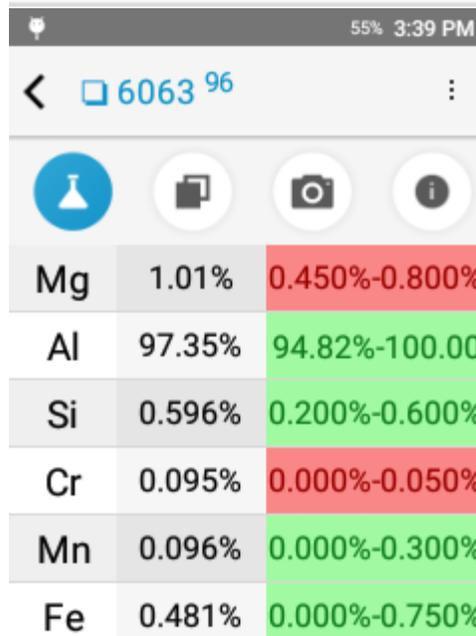
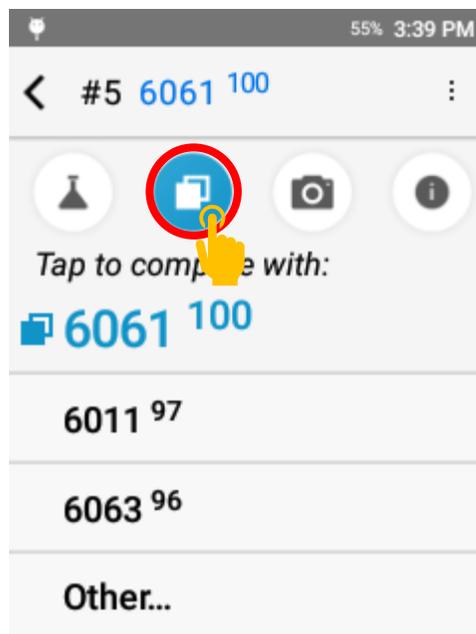
Tap Other... to see additional grade matches.

To compare with the non-top grade, tap another entry in the list.

### Compare Grade

Selecting a “ compare with” grade will return the system to the chemistry page.

Using the grade comparison feature, the system will visually indicate what elements are out of range for lower matches.

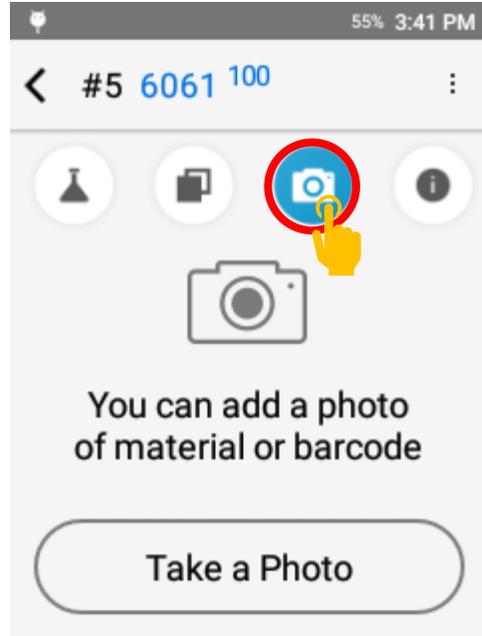


Mg	1.01%	0.450%-0.800%
Al	97.35%	94.82%-100.00%
Si	0.596%	0.200%-0.600%
Cr	0.095%	0.000%-0.050%
Mn	0.096%	0.000%-0.300%
Fe	0.481%	0.000%-0.750%

## Camera

The Camera function lives on the third page and allows the operator to capture and attach a micro or macro image to a result for photo documentation.

Tap the camera icon to enter the camera utility. Simply tap Take a Photo to open the camera view.

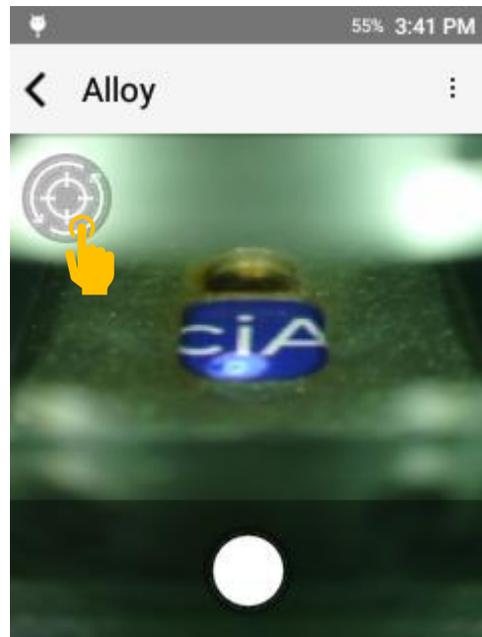


## Camera

The camera opens in the micro view for capturing an image of the test site. Tap the switch icon in the top left corner to switch to the macro camera for capturing an image of the entire sample.

Tap the white button to capture an image.

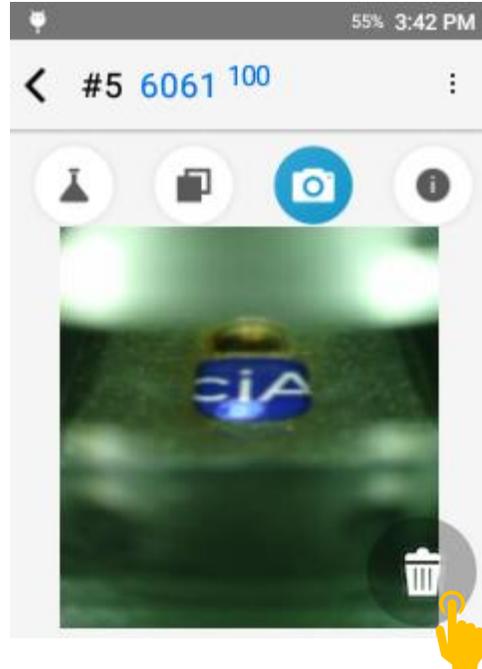
After capturing an image, the user may save the image or retake the image.



### Delete an Image

If an image is already present, the image will be displayed in the camera page.

Tap the trash can icon to delete the image.

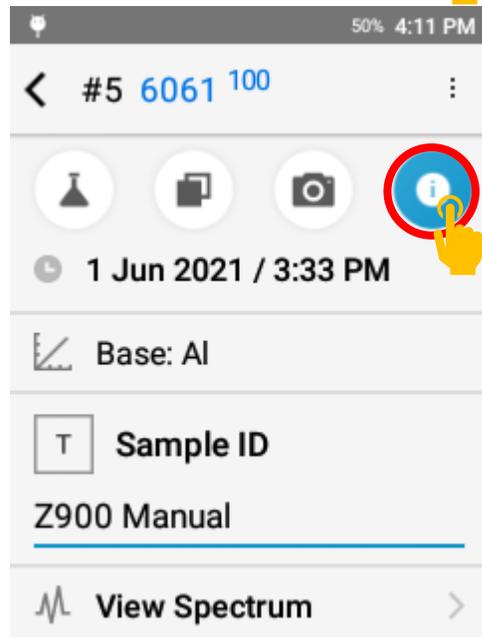


### Test Info Page

The Test Info component lives on the fourth page. This page includes test metadata including date and time, calibration model used for calculation, and the ability to enter test info for record keeping.

Tap the  icon to access the page.

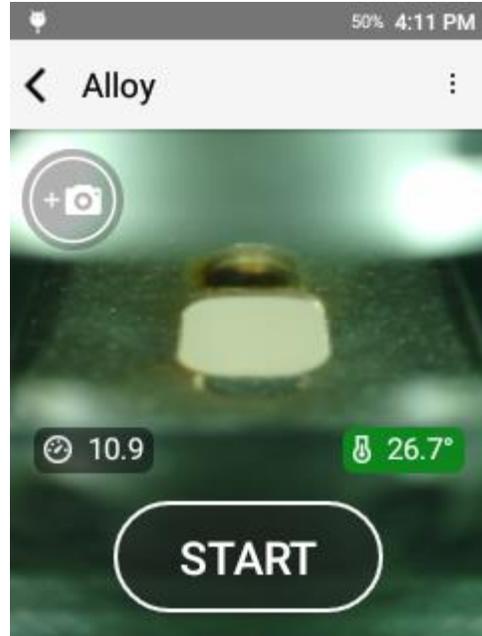
Sample ID and, if activated, Test Info fields can be populated after the test is taken.



### **Next Test**

To take the next test, pull the trigger or tap the back button to return to the targeting screen.

Position your sample and pull the trigger again or tap START.

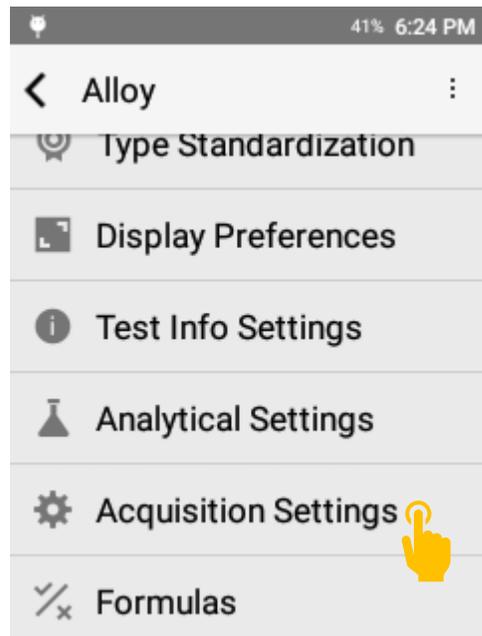


### *Test Setup*

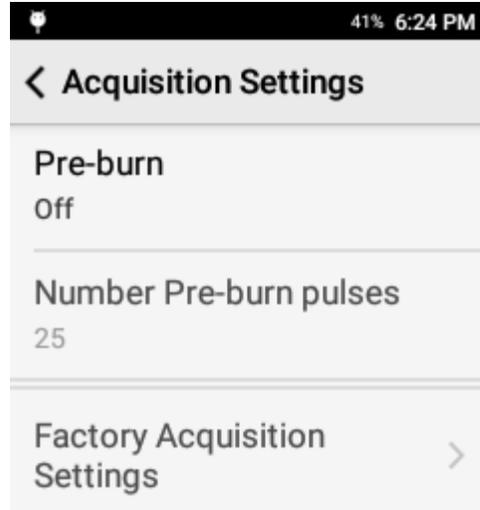
The Z-900 has factory default acquisition settings that are set at the factory level. Changing these settings may impact the instrument calibration and should not be done without factory authorized support. Beyond factory acquisition settings, the user or operator has the option to add in a Pre-Burn. The Pre-Burn increases the cleaning of the sample prior to taking a test and may be used for dirty or plated samples. For heavy corrosion or thick plating, grinding is recommended. When using Pre-Burn, it is important to keep the sample in the same position until the test is completed.

### **Activating Pre-Burn**

To activate Pre-Burn, select Acquisition Settings from the options menu.



Tap Pre-Burn to open Pre-Burn options.



### Pre-Burn Options

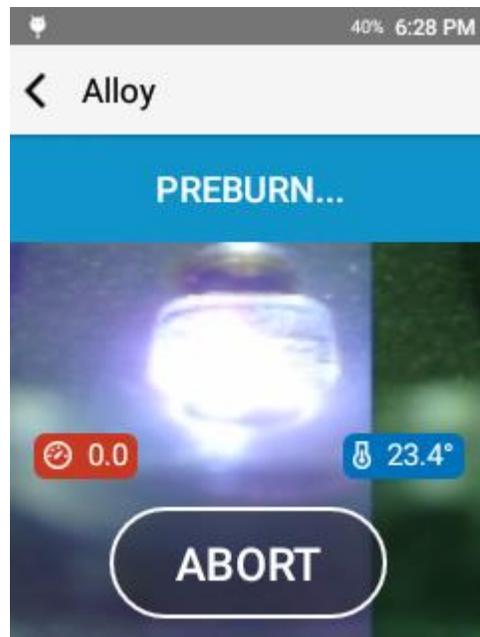
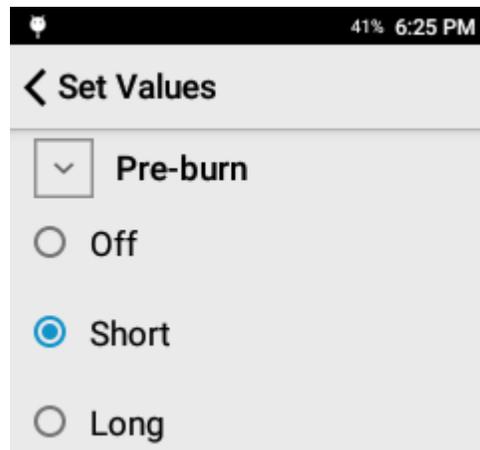
Off indicates no Pre-Burn.

Short indicates a single Pre-Burn (approximately 3 seconds).

Long indicates two back to back Pre-Burn cycles (approximately 6 seconds).

The longer the Pre-Burn, the more surface material is ablated or removed prior to collecting data.

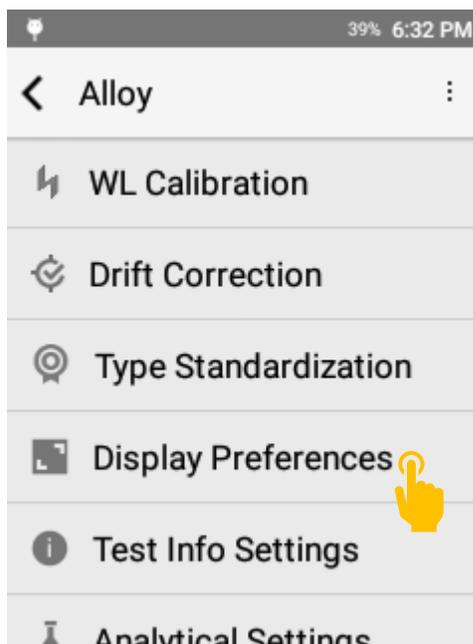
When testing with Pre-Burn, the test status bar will indicate that the Pre-Burn is active.



## Display Preferences

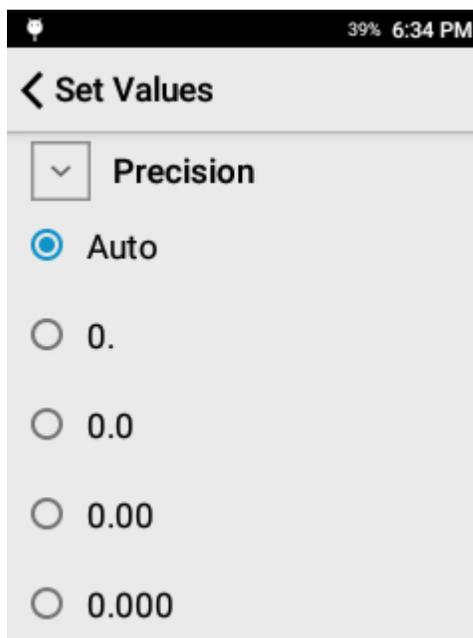
The Z-900 is designed to be customized to the operator's needs. One of the primary ways we allow customization is the setup of the display preferences. This includes element display order, user selectable confidence interval, and customizable limit of detection cutoffs.

To access display preferences, open the options menu and tap display preferences.



## Precision

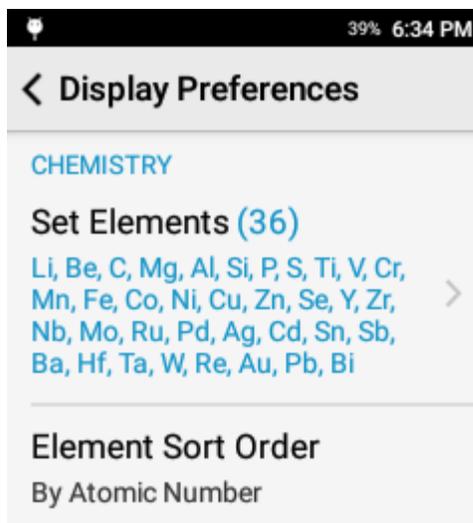
The precision setting controls the number of digits to display after the decimal point. This setting is respected in both the onscreen display and any exported report (CSV or PDF).



## Chemistry

Set Elements allows the user to select what elements should be displayed (if detected) on the instrument screen.

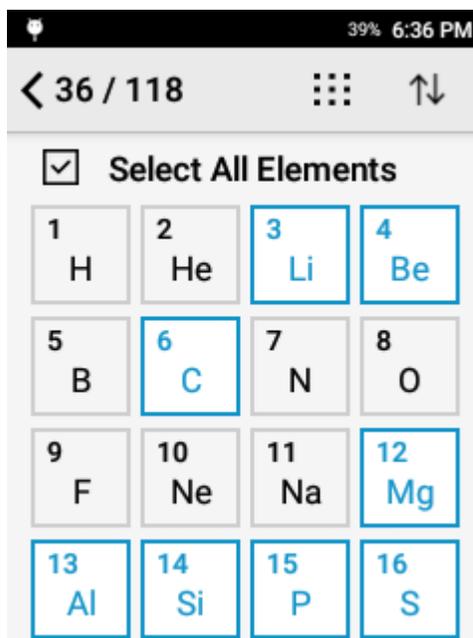
Element Sort Order allows the operator to quickly select the order of appearance for all elements.



## Selecting Elements

To choose what elements are displayed, tap Set Elements.

Elements highlighted with blue will be displayed if measured. Use the select all elements and deselect all elements to quickly make bulk changes.



## Element Sort Order

Determines the order of appearance on the result screen.

Atomic Number will display elements based on the specific element's atomic number, or, more simply, will rank the elements by their weight. This will sort elements from the lightest element to the heaviest element.

By Concentration sorts the elements by the measured concentration from high to low concentration.

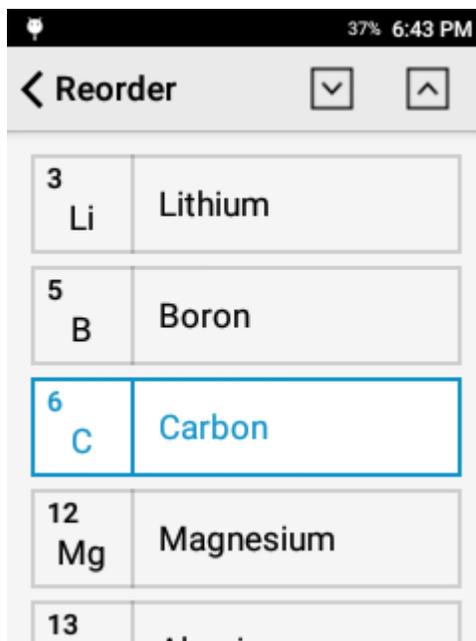
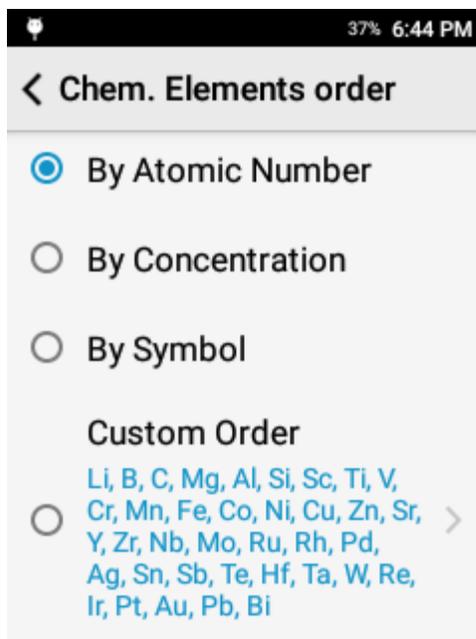
By Symbol sorts elements alphabetically by symbol.

Custom Order allows the user to determine the preferred order of elements.

### Creating a Custom Element Sort Order

To create a custom order, select Custom Order to open the Reorder wizard.

Then tap the element you want to move and use the up and down arrows in the top right corner to move the element.



## Grade Display Settings

Number of Grades to Display controls the number of grades displayed in the Compare Grade page and the number of grades displayed in the PDF export.

Min Grade Match Number determines the cutoff for No Grade Match response.

Closeness to Best Match screens for alloys that are very similar in chemistry. Some alloys are so similar that they cannot be sorted on chemistry alone. If activated, this feature flags a result that has more than one grade within the set value of the top grade match.

A screenshot of a mobile application interface titled "Display Preferences". At the top, there is a status bar showing a battery icon, 37% battery, and the time 6:45 PM. Below the title bar, there is a back arrow icon and the text "Display Preferences". The main content area is divided into sections by horizontal lines. The first section is titled "GRADE" in blue. It contains three settings: "Number of Grades To Display" with a value of 3, "Min Grade Match Number" with a value of 0, and "Closeness To Best Match" with a value of 0.

## Detected Elements

For an element to be considered detected, the measured value must be greater than the 1 sigma precision multiplied by the LOD Sigma. Thus, a higher LOD Sigma will result in less detected elements.

The system has the option to either hide or display non-detect elements. It is highly recommended to activate Show Chem < LOD as ND when Show non detect elements is active.

The LOD Sigma is defined as 3.0. The user may adjust this value if they desire.

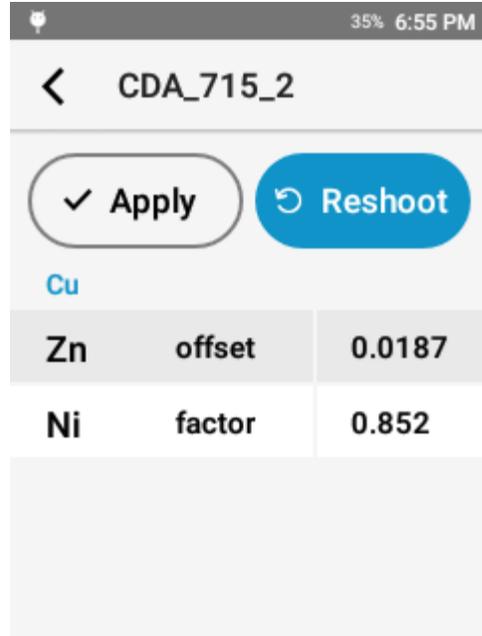
The Display Sigma is a multiplier applied to the calculated precision. It is expected that the result will have analytical agreement with a certified value approx. 95% of the time.

A screenshot of a mobile application interface titled "Display Preferences". At the top, there is a status bar showing a battery icon, 37% battery, and the time 6:47 PM. Below the title bar, there is a back arrow icon and the text "Display Preferences". The main content area is divided into sections by horizontal lines. The first section is titled "DETECTED ELEMENTS" in blue. It contains two settings: "Show non detect elements" with an unchecked checkbox, and "Show Chem < LOD as ND" with an unchecked checkbox. Below these are two more settings: "LOD Sigma" with a value of 3.0, and "Display Sigma" with a value of 2.0.

### Correction Factors

Always show correction factors, when activated, will list all calculated drift correction and type standardization factors in the calibration workflow.

This can be a powerful tool for advanced users or for troubleshooting but is typically not recommended for general usage.



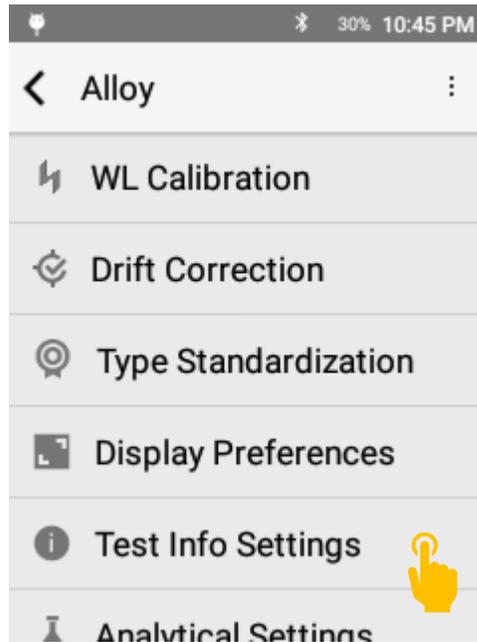
CDA_715_2		
<input checked="" type="checkbox"/> Apply <input type="button" value="Reshoot"/>		
Cu		
Zn	offset	0.0187
Ni	factor	0.852

### *Test Info Fields*

Test Info Fields are a useful tool for attaching metadata or testing notes to a result.

### Test Info Setup

Test Info setup is accessed through Test Info Settings



## Test Info Settings

Test Info is driven by a template. To customize Test Info Fields, tap Template Setup.

Prompt for Test Info will prompt the user before each test to populate the Test Info Fields.

Clear All will reset all Test Info fields except for Sample ID.

## Template Setup

Modify existing fields or add new fields. Users may add a maximum of 8 fields.

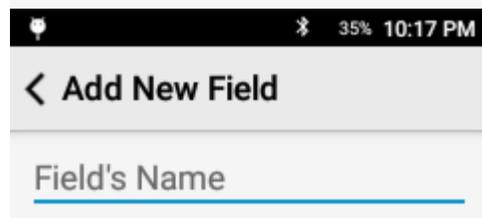
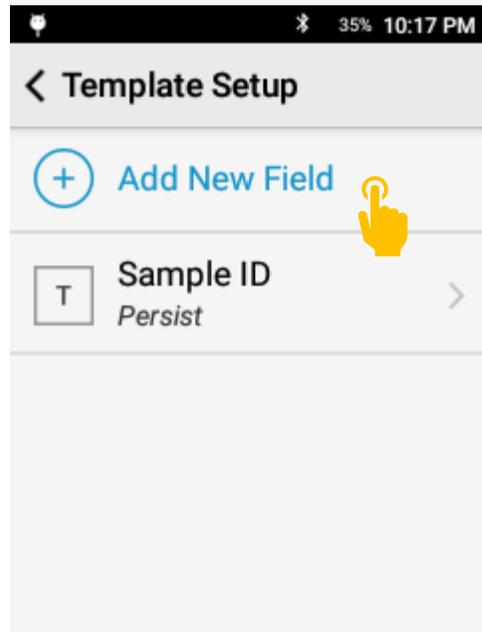
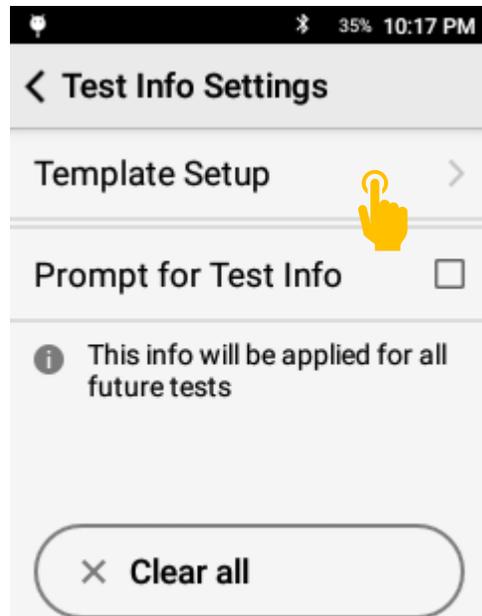
To add a new field, tap Add New Field.

To modify an existing field, scroll through the list and select the target field.

Sample ID is a factory enabled field and cannot be deleted.

## Enter Field Name

Each field must have a name. The name will appear in the test info page and on exported data.

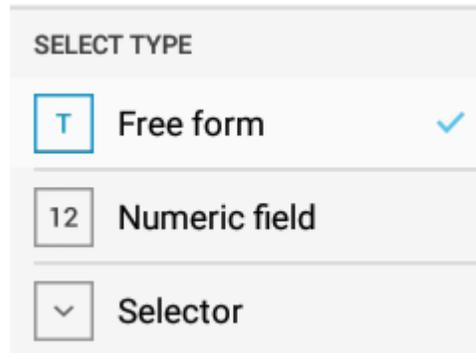


### **Select Field Type**

Free form is a general text entry.

Numeric field is numbers 0 – 9 only.

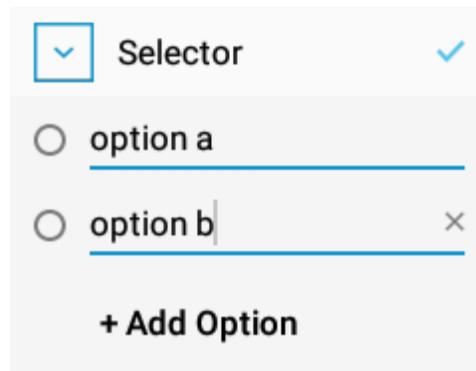
Selector gives the user a drop down menu.



A screenshot of a 'SELECT TYPE' menu. It contains three options: 'Free form' with a 'T' icon and a checkmark, 'Numeric field' with a '12' icon, and 'Selector' with a downward arrow icon.

### **Selector Field**

Add multiple options for the user to select from a dropdown menu. This is a great option for consistent descriptions.



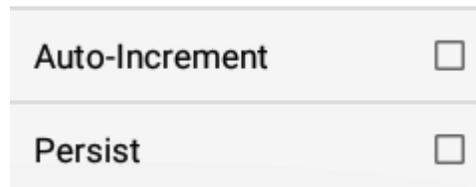
A screenshot of a 'Selector' field configuration. It shows a dropdown menu with two options: 'option a' and 'option b'. The 'option b' option has a blue underline and a small 'x' icon to its right. Below the options is a '+ Add Option' button.

### **Field Rules**

After Selecting a Field Type, the user has the option to apply a rule.

Auto-Increment will increment the input for a field by +1 for each subsequent test.

Persist will maintain the input for a field until the user changes that field.

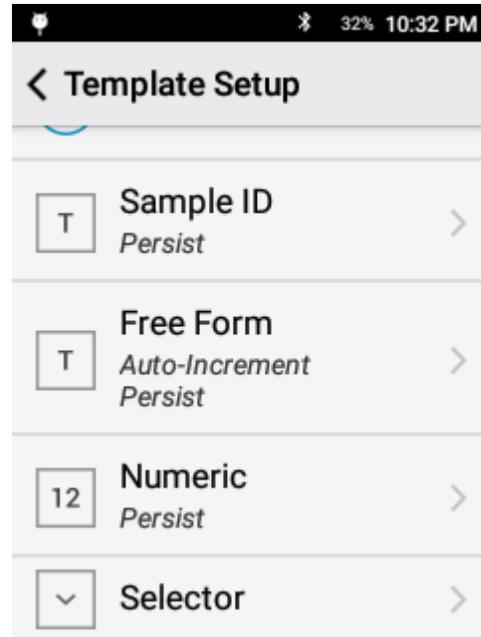


A screenshot of the 'Field Rules' section. It contains two checkboxes: 'Auto-Increment' and 'Persist', both of which are currently unchecked.

### Using Test Info

After configuring the Test Info Template, Test Info Fields are ready to be used.

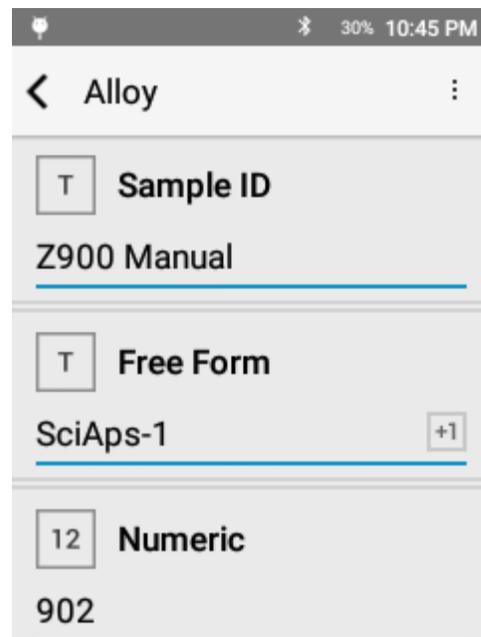
For training purposes, the following fields have been setup:

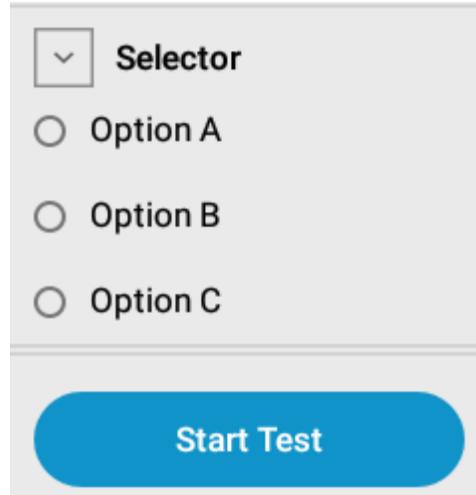


### Prompt For Test Info

To enter values prior to a test, activate Prompt for Test Info in the Test Info Settings page.

When a test is started, the system will prompt the user to input the test info values. Enter the values then.



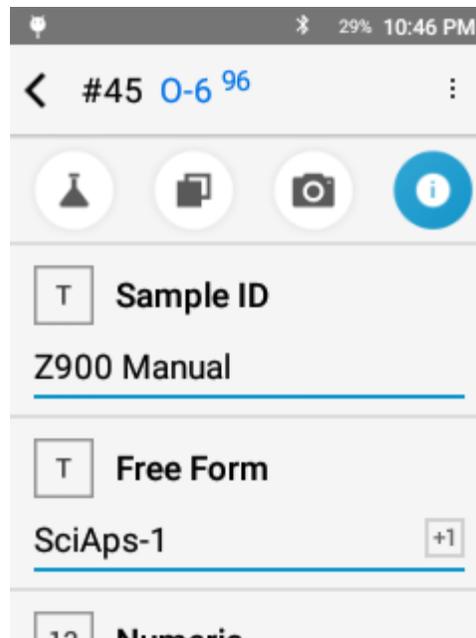


### **Review Values**

The user may enter in all desired values.

Tap Start Test or Pull Trigger to start.

After the test is completed, the values may be reviewed and edited in the Info tab.



## 11. QuickSort(+) Mode

### *QuickSort(+) Mode Overview*

This testing app is used for quantitative analysis of alloys. This air-burn mode is designed for rapid alloy analysis and alloy sorting.

QuickSort and QuickSort+ share the same user interface and functions. QuickSort uses a single spectrometer covering 200 – 420 nm. QuickSort+ uses two spectrometers to achieve an expanded wavelength range of 190 – 610 nm.

### *Element Suite*

**QuickSort Mode:**

<b>Alloy Family</b>	<b>Elements Included</b>
Aluminum	Be, Mg, Al, Si, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Zr, Pb, Bi, Ag
Titanium	Al, Si, Ti, V, Cr, Mn, Fe, Ni, Zr, Nb, Mo, Sn
Low Alloy Steel (Fe)	Al, Si, Ti, V, Cr, Mn, Fe, Co, Cu, Ni, Nb, Mo, W, Pb
Stainless Steel	Al, Si, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Se, Nb, Mo, W
Nickel	Al, Si, Ti, Cr, Mn, Fe, Co, Ni, Cu, Nb, Mo, W, Hf, Ta, Re
Copper	Be, Al, Si, Cr, Mn, Fe, Co, Ni, Cu, Zn, Se, Ag, Sn, Pb, Bi
Cobalt	Al, Si, Ti, Cr, Mn, Fe, Co, Ni, Cu, Nb, Mo, W
Specialty **	V, Cr, Mn, Ag, Ta, Hf, Re, Pb, Zr, Mg, Zn, Mo, W, Sn, Nb

**QuickSort+ Mode:**

<b>Alloy Family</b>	<b>Elements Included</b>
Aluminum	Li, Be, Mg, Al, Si, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Zr, Pb, Bi, Ag
Titanium	Al, Si, Ti, V, Cr, Mn, Fe, Ni, Zr, Nb, Mo, Sn
Low Alloy Steel (Fe)	Al, Si, Ti, V, Cr, Mn, Fe, Co, Cu, Ni, Nb, Mo, W, Pb
Stainless Steel	Al, Si, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Se, Nb, Mo, W
Nickel	Al, Si, Ti, Cr, Mn, Fe, Co, Ni, Cu, Nb, Mo, W, Hf, Ta, Re
Copper	Be, Al, Si, Cr, Mn, Fe, Co, Ni, Cu, Zn, Se, Ag, Sn, Pb, Bi
Cobalt	Al, Si, Ti, Cr, Mn, Fe, Co, Ni, Cu, Nb, Mo, W
Specialty **	V, Cr, Mn, Ag, Ta, Hf, Re, Pb, Zr, Mg, Zn, Mo, W, Sn, Nb

\*\* Identifies base only – no alloying or trace element analysis.

Additional bases or elements may be set up with factory support.

### Taking a Test

Place sample over the laser aperture ensuring that you completely cover the window.

Be sure to hold the sample square to the instrument so that the laser LED Spotlight is in clear focus on the sample.

Hold the sample still for the duration of the test. The test will include 6 individual test points. The system automatically moves through the full raster pattern.

Raster pattern: 3 locations x 24 cleaning pulses x 32 data pulses

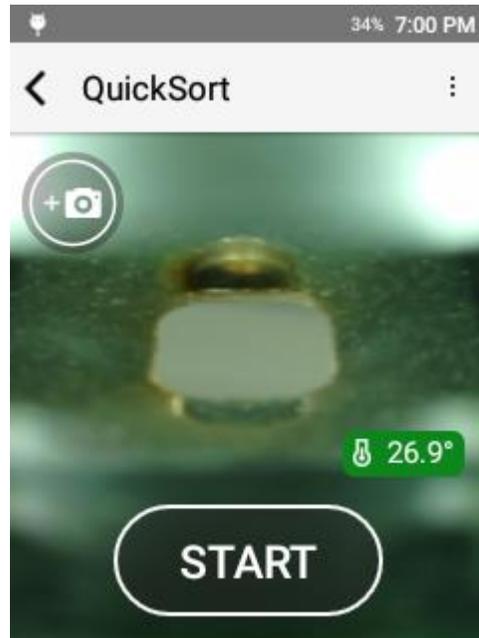
In QuickSort(+) mode, we fire the laser 24 times in each location to clean debris from the surface then 32 times in each location to collect data.

Rastering across the surface ensures a representative sample is collected.

#### **First Update**

During a test, the system will deliver live updates to the chemistry as data is collected and processed.

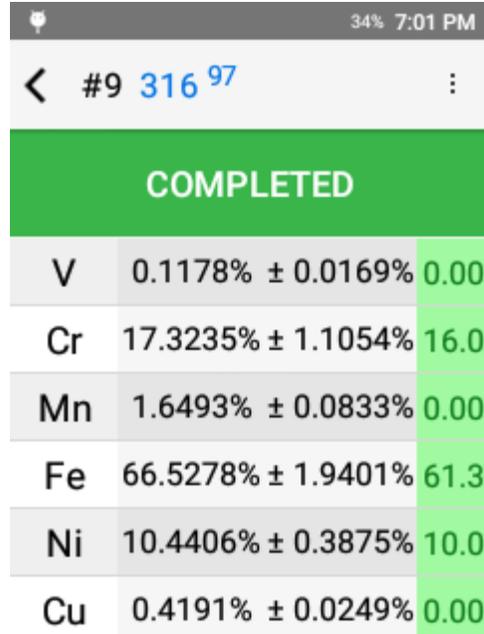
This phase is indicated by the test status bar. While the status bar reads TESTING... the test is still in progress. The sample should be kept in the same location throughout this phase.



TESTING...		
Si	0.2183% ± 0.0616%	0.00
V	0.1379% ± 0.0047%	0.00
Cr	18.0051% ± 2.3329%	18.0
Mn	1.6706% ± 0.0912%	0.00
Fe	65.2129% ± 2.8897%	57.2
Ni	10.7407% ± 0.0709%	11.0

### Test Complete

Each test is a test to completion. A complete test is indicated on screen by the test status bar turning GREEN and reading COMPLETED.



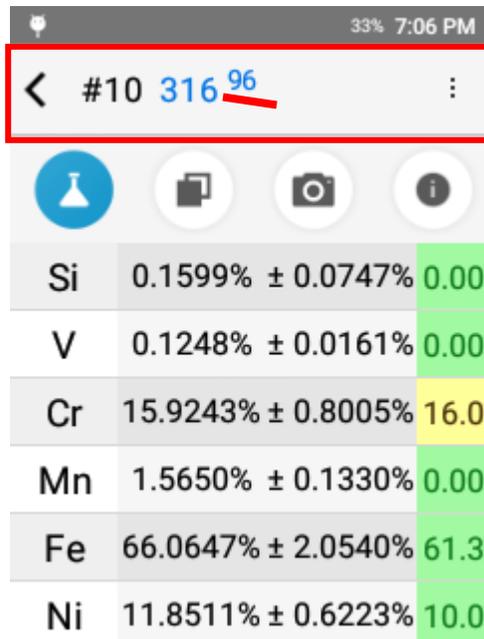
Element	Measured (%)	Tolerance (%)	Grade Match
V	0.1178%	± 0.0169%	0.00
Cr	17.3235%	± 1.1054%	16.0
Mn	1.6493%	± 0.0833%	0.00
Fe	66.5278%	± 1.9401%	61.3
Ni	10.4406%	± 0.3875%	10.0
Cu	0.4191%	± 0.0249%	0.00

### QuickSort Result

Comprised of 6 primary components:

1. Test Number
2. Grade Match
3. Chemistry
4. Grade Compare
5. Camera
6. Test Info

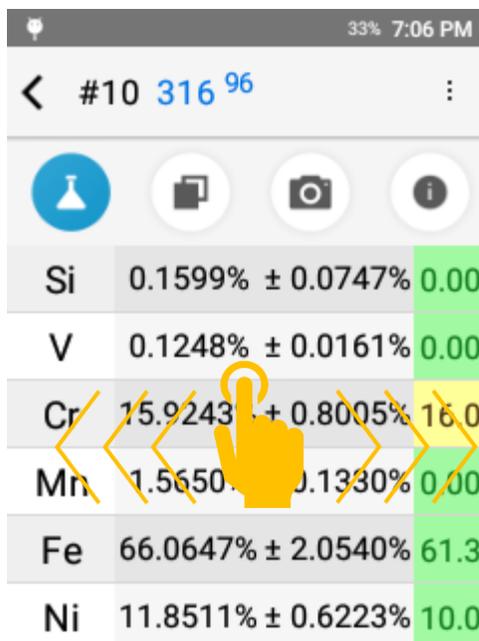
Grade Match indicates the top match for the measured chemistry compared to the instrument grade library. The Grade Match Score indicates the quality of the match. A score of 100 is considered a perfect match, meaning that all measured elements match the alloy specification. Grade Match Score is calculated by determining if each specified element is in the specified range for the grade. If it is out of range, a penalty is calculated based on how far each element is out of range. The calculated penalty for each element is summed then subtracted from 100.



Element	Measured (%)	Tolerance (%)	Grade Match
Si	0.1599%	± 0.0747%	0.00
V	0.1248%	± 0.0161%	0.00
Cr	15.9243%	± 0.8005%	16.0
Mn	1.5650%	± 0.1330%	0.00
Fe	66.0647%	± 2.0540%	61.3
Ni	11.8511%	± 0.6223%	10.0

## Navigating Results

Swipe left to go to an earlier result or swipe right to go to a more recent result.



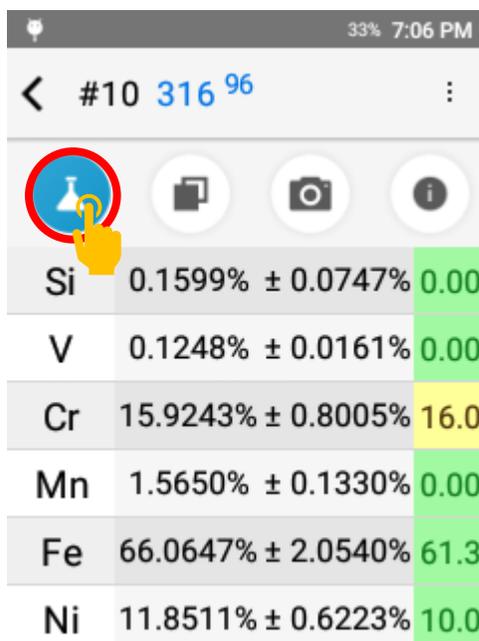
Element	Concentration	Precision	Grade
Si	0.1599%	± 0.0747%	0.00
V	0.1248%	± 0.0161%	0.00
Cr	15.9243%	± 0.8005%	16.0
Mn	1.5650%	± 0.1330%	0.00
Fe	66.0647%	± 2.0540%	61.3
Ni	11.8511%	± 0.6223%	10.0

## Chemistry

Chemistry lives on the first page and lists all measured elements including their concentration, the precision of the measurement (+/-), and, if there is a grade match, the grade specification for each measured element.

ND indicates non-detect. This means that the measured value failed to meet the criteria for a valid measurement. In order for an element value to be considered detected, the measured value must be greater than the  $3\sigma$  standard deviation.

See display preferences section for more information about non-detects.



Element	Concentration	Precision	Grade
Si	0.1599%	± 0.0747%	0.00
V	0.1248%	± 0.0161%	0.00
Cr	15.9243%	± 0.8005%	16.0
Mn	1.5650%	± 0.1330%	0.00
Fe	66.0647%	± 2.0540%	61.3
Ni	11.8511%	± 0.6223%	10.0

### Grade Specification Comparison

Tap the grade specification column to expand the grade specification (hiding the precision column).

Green indicates that the chemistry is within the specified value for the grade.

Red indicates that the chemistry is outside of the specified range.

Yellow indicates that, when considering the precision of the measurement, the reported chemistry may fall into the grade specification.

### Compare Grade

The Grade Compare function lives on the second page and allows the user to compare measured chemistry against any grade in the active grade library.

Tap the grade compare icon to see the top three grade matches. The grade match score is listed for each grade.

Tap Other... to see additional grade matches.

To compare with the non-top grade, tap another entry in the list.

The first screenshot shows a table of chemical analysis results for grade #9 316 97. The table has three columns: Element, Measured Value, and Specified Range. The specified range column is highlighted in green, indicating that the measured values are within the specified range.

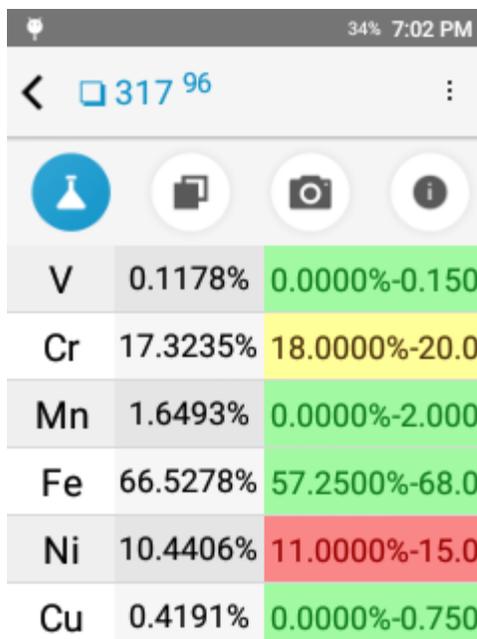
Element	Measured Value	Specified Range
V	0.1178%	0.0000%-0.150
Cr	17.3235%	16.0000%-18.0
Mn	1.6493%	0.0000%-2.000
Fe	66.5278%	61.3500%-72.5
Ni	10.4406%	10.0000%-1
Cu	0.4191%	0.0000%-0.750

The second screenshot shows the 'Compare Grade' function. The 'Compare Grade' icon (a document with a checkmark) is circled in red. Below the icons, the text 'Tap to compare with:' is displayed. A list of grades is shown, with the top three matches highlighted in blue: 316 97, 317 96, and 321 78. An 'Other...' option is also present at the bottom of the list.

### Compare Grade

Selecting a “compare with” grade will return the system to the chemistry page.

Using the grade comparison feature, the system will visually indicate what elements are out of range for lower matches.

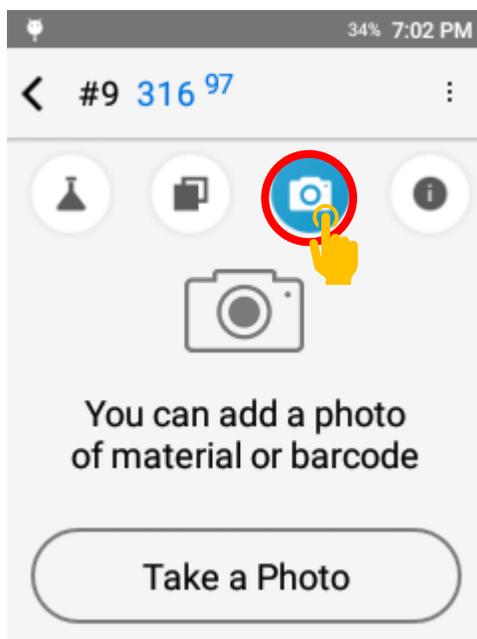


Element	Measured	Target Range
V	0.1178%	0.0000%-0.150
Cr	17.3235%	18.0000%-20.0
Mn	1.6493%	0.0000%-2.000
Fe	66.5278%	57.2500%-68.0
Ni	10.4406%	11.0000%-15.0
Cu	0.4191%	0.0000%-0.750

### Camera

The Camera function lives on the third page and allows the operator to capture and attach a micro or macro image to a result for photo documentation.

Tap the camera icon to enter the camera utility. Simply tap Take a Photo to open the camera view.



## Camera

The camera opens in the micro view for capturing an image of the test site. Tap the switch icon in the top left corner to switch to the macro camera for capturing an image of the entire sample.

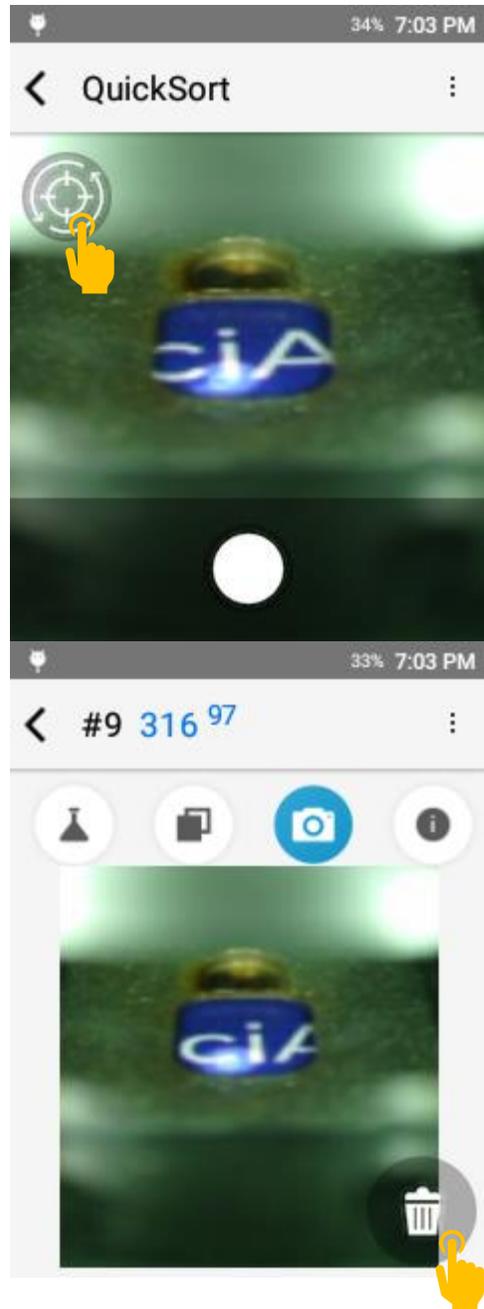
Tap the white button to capture an image.

After capturing an image, the user may save the image or retake the image.

## Delete an Image

If an image is already present, the image will be displayed in the camera page.

Tap the trash can icon to delete the image.

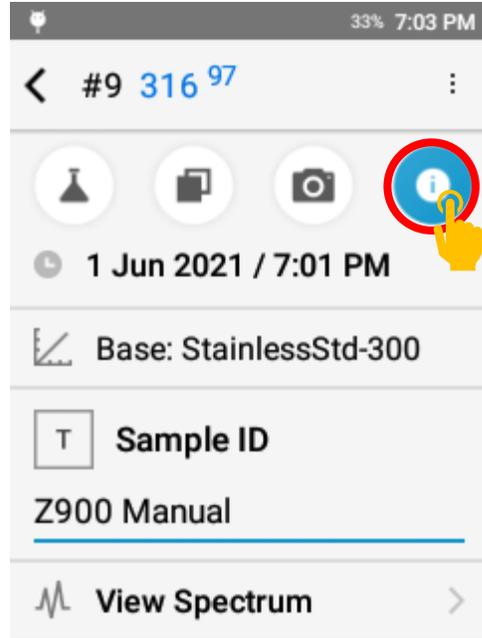


### Test Info Page

The Test Info component lives on the fourth page. This page includes test metadata including date and time, calibration model used for calculation, and the ability to enter test info for record keeping.

Tap the **i** icon to access the page.

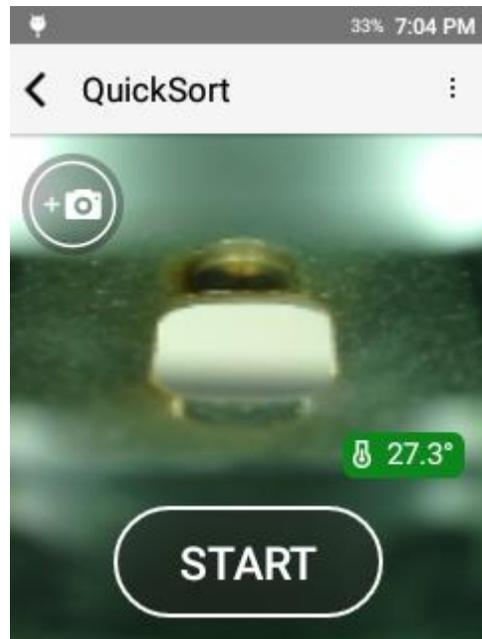
Sample ID and, if activated, Test Info fields can be populated after the test is taken.



### Next Test

To take the next test, pull the trigger or tap the back button to return to the targeting screen.

Position your sample and pull the trigger again or tap START.

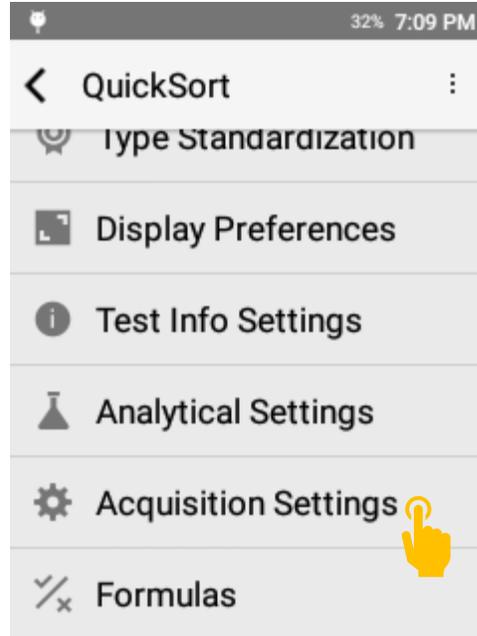


### *Test Setup*

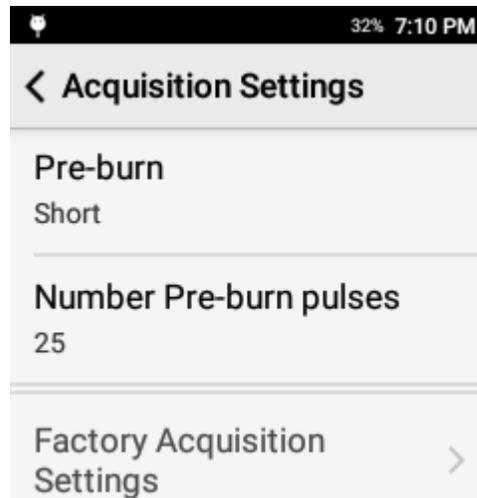
The Z-900 has factory default acquisition settings that are set at the factory level. Changing these settings may impact the instrument calibration and should not be done without factory authorized support. Beyond factory acquisition settings, the user or operator has the option to add in a Pre-Burn. The Pre-Burn increases the cleaning of the sample prior to taking a test and may be used for dirty or plated samples. For heavy corrosion or thick plating, grinding is recommended. When using Pre-Burn, it is important to keep the sample in the same position until the test is completed.

### Activating Pre-Burn

To activate Pre-Burn, select Acquisition Settings from the options menu.



Tap Pre-Burn to open Pre-Burn options.



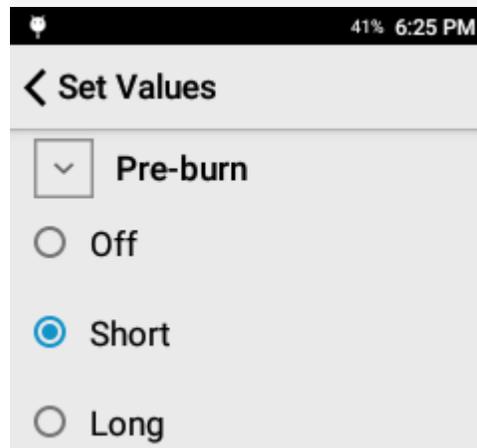
### Pre-Burn Options

Off indicates no Pre-Burn.

Short indicates a single Pre-Burn (approximately 3 seconds).

Long indicates two back to back Pre-Burn cycles (approximately 6 seconds).

The longer the Pre-Burn, the more surface material is ablated or removed prior to collecting data.



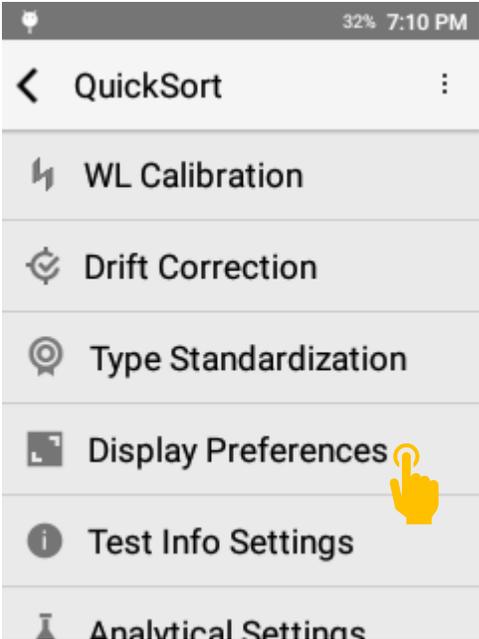
When testing with Pre-Burn, the test status bar will indicate that the Pre-Burn is active.



### Display Preferences

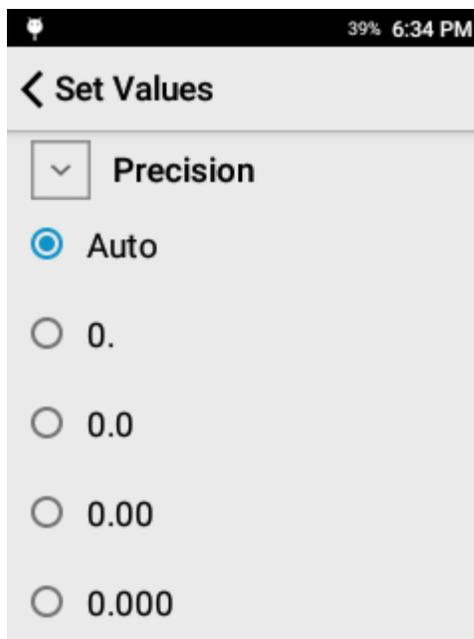
The Z-900 is designed to be customized to the operator's needs. One of the primary ways we allow customization is the setup of the display preferences. This includes element display order, user selectable confidence interval, and customizable limit of detection cutoffs.

To access display preferences, open the options menu and tap display preferences.



## Precision

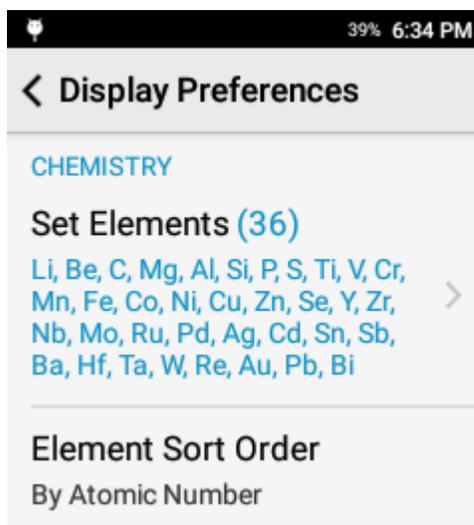
The precision setting controls the number of digits to display after the decimal point. This setting is respected in both the onscreen display and any exported report (CSV or PDF).



## Chemistry

Set Elements allows the user to select what elements should be displayed (if detected) on the instrument screen.

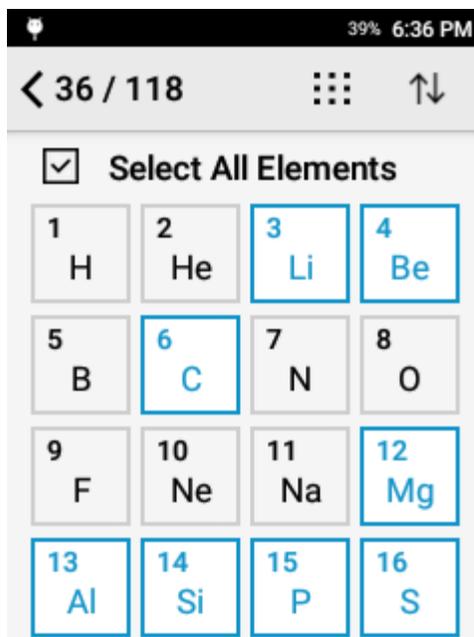
Element Sort Order allows the operator to quickly select the order of appearance for all elements.



### Selecting Elements

To choose what elements are displayed, tap Set Elements

Elements highlighted with blue will be displayed if measured. Use the select all elements and deselect all elements to quickly make bulk changes.



### Element Sort Order

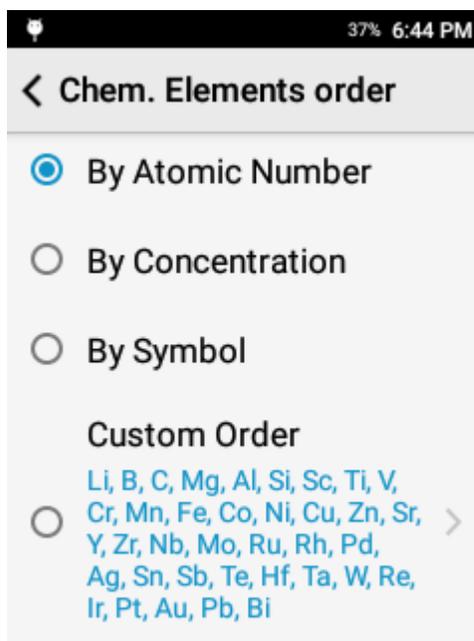
Determines the order of appearance on the result screen.

Atomic Number will display elements based on the specific element's atomic number, or, more simply, will rank the elements by their weight. This will sort elements from the lightest element to the heaviest element.

By Concentration sorts the elements by the measured concentration from high to low concentration.

By Symbol sorts elements alphabetically by symbol.

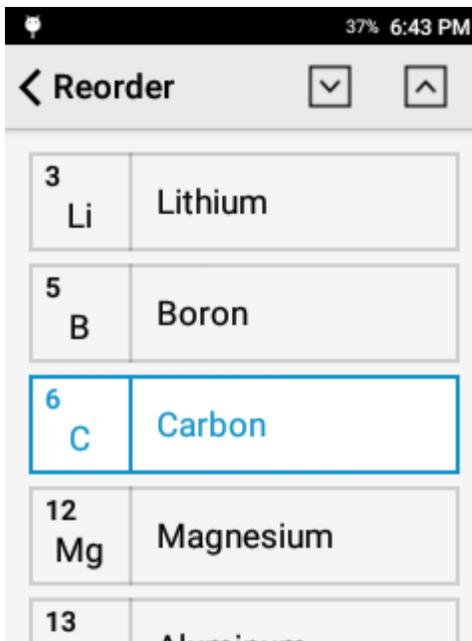
Custom Order allows the user to determine the preferred order of elements.



### **Creating a Custom Element Sort Order**

To create a custom order, select custom order to open the Reorder wizard.

Then tap the element you want to move and use the up and down arrows in the top right corner to move the element.

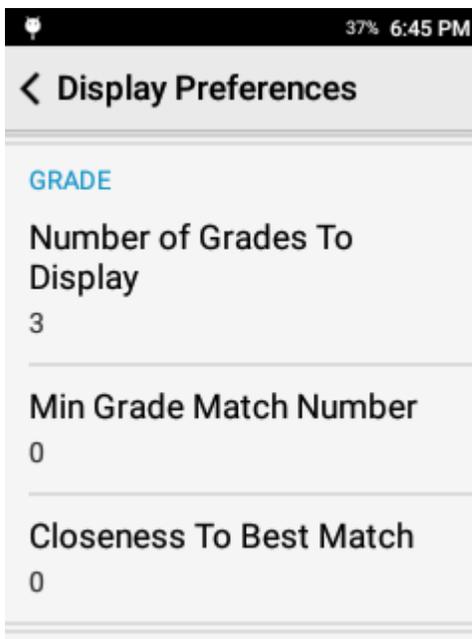


### **Grade Display Settings**

Number of Grades to Display controls the number of grades displayed in the Compare Grade page and the number of grades displayed in the PDF export.

Min Grade Match Number determines the cutoff for No Grade Match response.

Closeness to Best Match screens for alloys that are very similar in chemistry. Some alloys are so similar that they cannot be sorted on chemistry alone. If activated, this feature flags a result that has more than one grade within the set value of the top grade match.



### Detected Elements

For an element to be considered detected, the measured value must be greater than the 1 sigma precision multiplied by the LOD Sigma. Thus, a higher LOD Sigma will result in less detected elements.

The system has the option to either hide or display non-detect elements. It is highly recommended to activate Show Chem < LOD as ND when Show non detect elements is active.

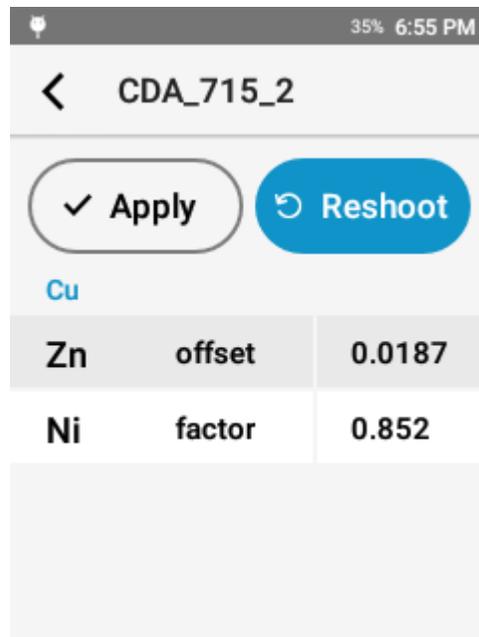
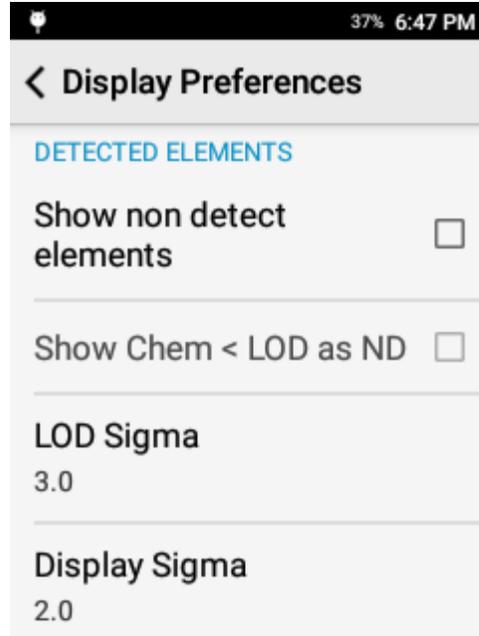
The LOD Sigma is defined as 3.0. The user may adjust this value if they desire.

The Display Sigma is a multiplier applied to the calculated precision. It is expected that the result will have analytical agreement with a certified value approx. 95% of the time.

### Correction Factors

Always show correction factors, when activated, will list all calculated drift correction and type standardization factors in the calibration workflow.

This can be a powerful tool for advanced users or for troubleshooting but is typically not recommended for general usage.

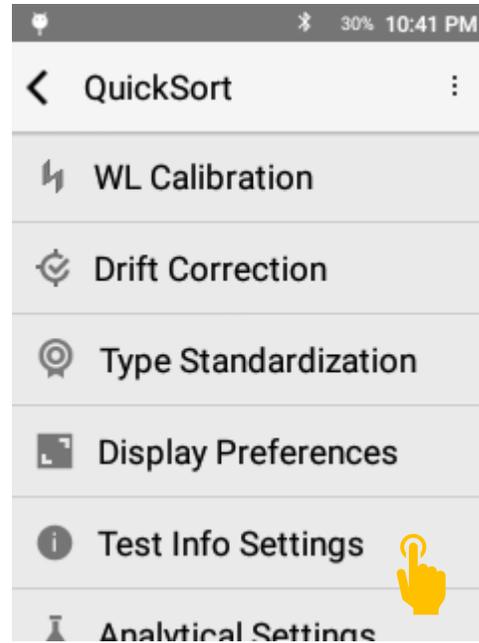


### *Test Info Fields*

Test Info Fields are a useful tool for attaching metadata or testing notes to a result.

## Test Info Setup

Test Info setup is accessed through Test Info Settings.

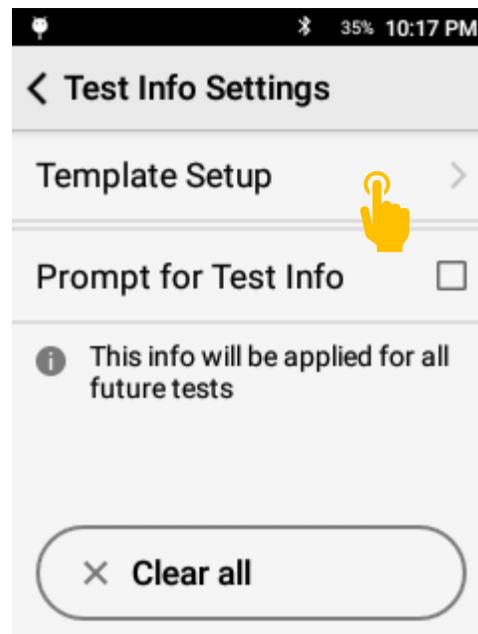


## Test Info Settings

Test Info is driven by a template. To customize Test Info Fields, tap Template Setup.

Prompt for Test Info will prompt the user before each test to populate the Test Info Fields.

Clear All will reset all Test Info fields except for Sample ID.



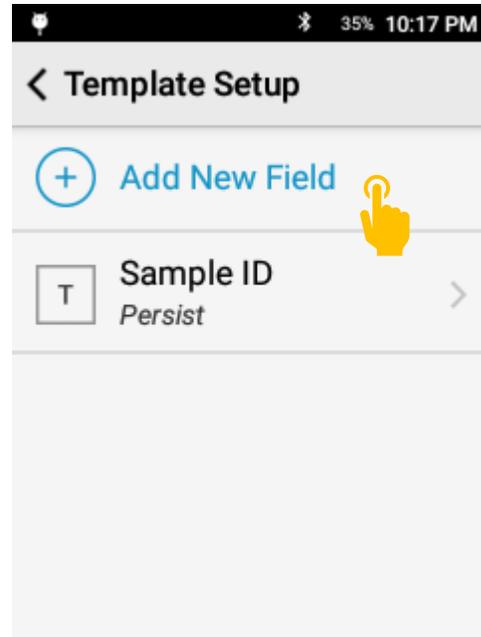
## Template Setup

Modify existing fields or add new fields. Users may add a maximum of 8 fields.

To add a new field, tap Add New Field.

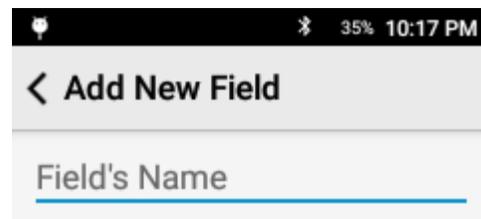
To modify an existing field, scroll through the list and select the target field.

Sample ID is a factory enabled field and cannot be deleted.



## Enter Field Name

Each field must have a name. The name will appear in the test info page and on exported data.

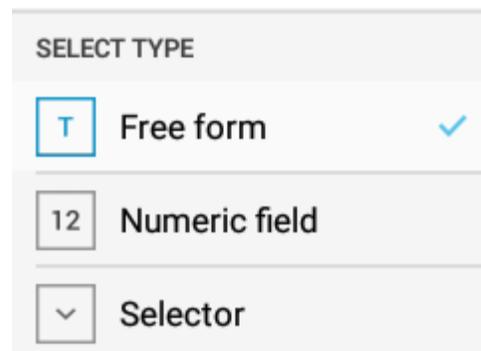


## Select Field Type

Free form is a general text entry.

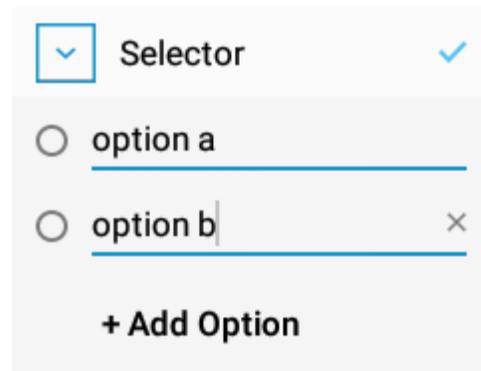
Numeric field is numbers 0 – 9 only.

Selector gives the user a drop down menu.



## Selector Field

Add multiple options for the user to select from a dropdown menu. This is a great option for consistent descriptions.



### Field Rules

After Selecting a Field Type, the user has the option of applying a rule.

Auto-Increment will increment the input for a field by +1 for each subsequent test.

Persist will maintain the input for a field until the user changes that field.

### Using Test Info

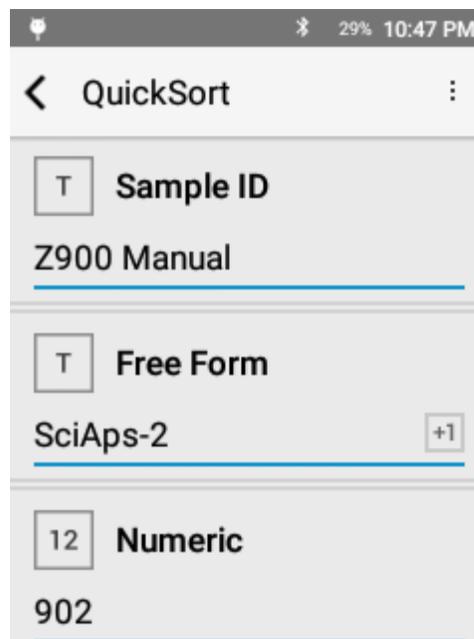
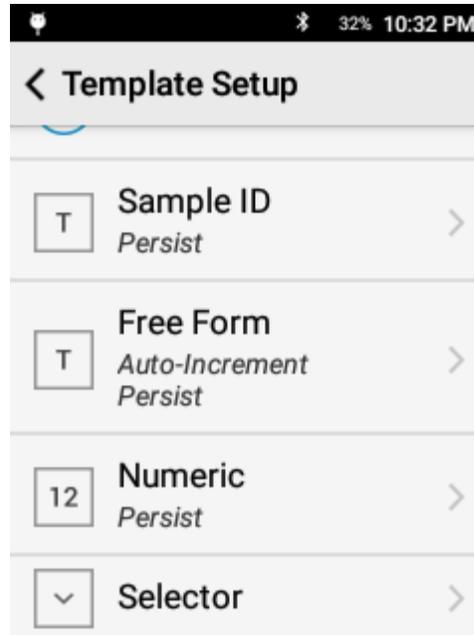
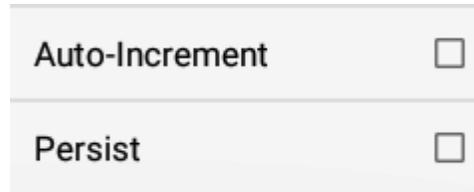
After configuring the Test Info Template, Test Info Fields are ready to be used.

For training purposes, the following fields have been setup:

### Prompt For Test Info

To enter values prior to a test, activate Prompt for Test Info in the Test Info Settings page.

When a test is started, the system will prompt the user to input the test info values. Enter the values then.

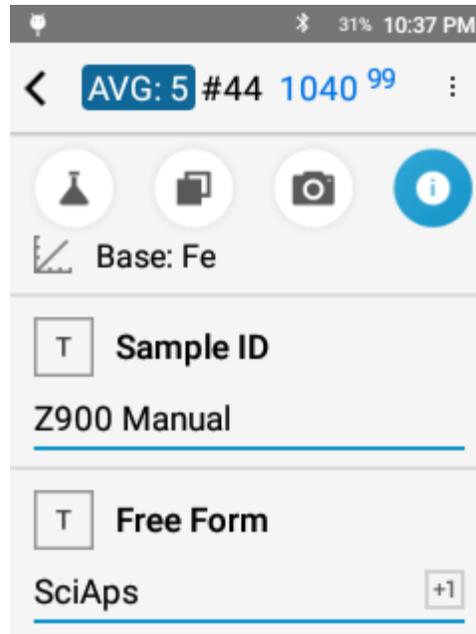
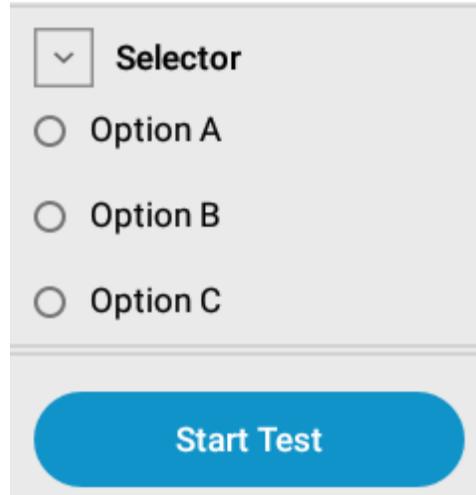


### **Review Values**

The user may enter in all desired values.

Tap Start Test or Pull Trigger to start.

After the test is completed, the values may be reviewed and edited in the Info tab.



## 12. Carbon(+) Mode

### *Carbon(+) Mode Overview*

The Carbon and Carbon+ apps are used for quantitative analysis of carbon as well as a broad range of other alloying and trace elements for Positive Material Identification, the determination of Carbon Equivalent value, and grading stainless steel. The mode utilizes argon OptiPurge technology to purge the testing chamber with argon – an inert gas. The argon environment increases the plasma life improving signal to noise ratio. An argon atmosphere is critical for carbon analysis to limit the impact of atmospheric absorption. Additionally, this mode adds in Analysis Averaging to improve accuracy and precision by averaging multiple tests with the added functionality of data rejection.

Carbon and Carbon+ share the same user interface and functions. Carbon uses 2 spectrometers covering 190 – 420 nm with a dedicated spectrometer for carbon analysis, delivering improved spectral resolution for superior carbon performance. Carbon+ uses three spectrometers to achieve an expanded wavelength range of 190 – 610 nm while maintaining a high resolution, dedicated carbon spectrometer.

*Element Suite*

**Carbon Mode:**

<b>Alloy Family</b>	<b>Elements Included</b>
Low Alloy Steel (Fe)	C, Al, Si, Ti, V, Cr, Mn, Fe, Co, Cu, Ni, Nb, Mo, W, Pb
Stainless Steel	C, Al, Si, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Se, Nb, Mo, W
<i>Additional Option Bases (included in Premium Model)</i>	
Aluminum	Be, Mg, Al, Si, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Zr, Pb, Bi, Ag
Titanium	Al, Si, Ti, V, Cr, Mn, Fe, Ni, Zr, Nb, Mo, Sn
Nickel	Al, Si, Ti, Cr, Mn, Fe, Co, Ni, Cu, Nb, Mo, W, Hf, Ta, Re
Copper	Be, Al, Si, Cr, Mn, Fe, Co, Ni, Cu, Zn, Se, Ag, Sn, Pb, Bi
Cobalt	Al, Si, Ti, Cr, Mn, Fe, Co, Ni, Cu, Nb, Mo, W
Specialty **	V, Cr, Mn, Ag, Ta, Hf, Re, Pb, Zr, Mg, Zn, Mo, W, Sn, Nb

**Carbon+ Mode:**

<b>Alloy Family</b>	<b>Elements Included</b>
Low Alloy Steel (Fe)	C, Al, Si, Ti, V, Cr, Mn, Fe, Co, Cu, Ni, Nb, Mo, W, Pb
Stainless Steel	C, Al, Si, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Se, Nb, Mo, W
<i>Additional Option Bases (included in Premium Model)</i>	
Aluminum	Li, Be, Mg, Al, Si, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Zr, Pb, Bi, Ag
Titanium	Al, Si, Ti, V, Cr, Mn, Fe, Ni, Zr, Nb, Mo, Sn
Nickel	Al, Si, Ti, Cr, Mn, Fe, Co, Ni, Cu, Nb, Mo, W, Hf, Ta, Re
Copper	Be, Al, Si, Cr, Mn, Fe, Co, Ni, Cu, Zn, Se, Ag, Sn, Pb, Bi
Cobalt	Al, Si, Ti, Cr, Mn, Fe, Co, Ni, Cu, Nb, Mo, W
Specialty **	V, Cr, Mn, Ag, Ta, Hf, Re, Pb, Zr, Mg, Zn, Mo, W, Sn, Nb

\*\* Identifies base only – no alloying or trace element analysis.

Additional bases or elements may be set up with factory support.

*Taking a Test*

**Carbon Mode User Interface:**

Carbon(+) mode combines Pre-Burn, Multi-Shot averaging, and Data Rejection to provide quantitative analysis of C and other alloying elements.

A carbon test is considered the average of multiple individual results. Each individual test is not considered a result and should not be used for reporting or grading material.

## **Sample Preparation**

Sample preparation is required for accurate carbon analysis.

Grind a minimum area of approximately 0.75 in (20 mm) in diameter. The minimum sample prep area is 0.15 in / 4 mm. Then use the camera to align the test location in the center of the prepared area.

SciAps recommends the Milwaukee M12 Right Angle Die Grinder or the Milwaukee M12 Variable Speed Polisher/Sander and the Norton Saint Gobain Blaze R980P Quick Change disc (2" or 3" diameter, 50 grit). Grinding discs should be changed regularly to avoid cross-contamination.

Proper grinding technique will result in a shiny surface with linear grind marks (not swirls).

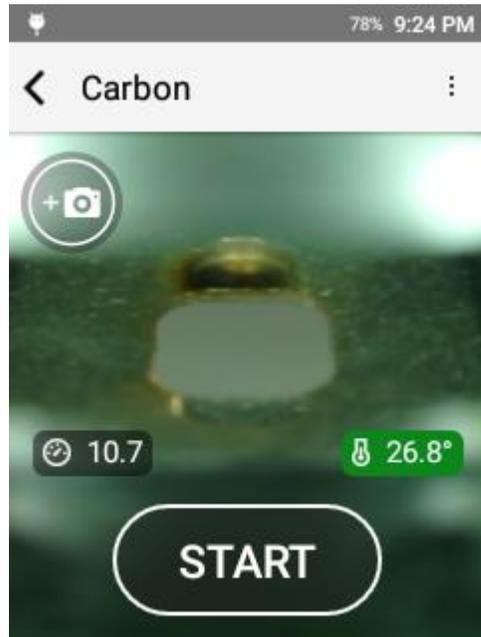
Place sample over the laser aperture ensuring that you completely cover the window.

Be sure to hold the sample square to the instrument so that the laser LED Spotlight is in clear focus on the ground portion of the sample.

Hold the sample still for the duration of the test. The test will include pre-burn and multi-shot average across 6 unique raster points. The system automatically moves through the full raster pattern.

Typical Raster pattern: 1-2 Pre-Burns, 3-5 shot average, each individual test: 6 locations x 12 cleaning pulses x 16 data pulses

Rastering across the surface ensures a representative sample is collected.



## Pre-Burn

Pre-Burn is critical for removing any additional contamination from the surface that is left after grinding. The factory recommendation is to use a Short Pre-Burn with 25 Pre-Burn pulses per location.

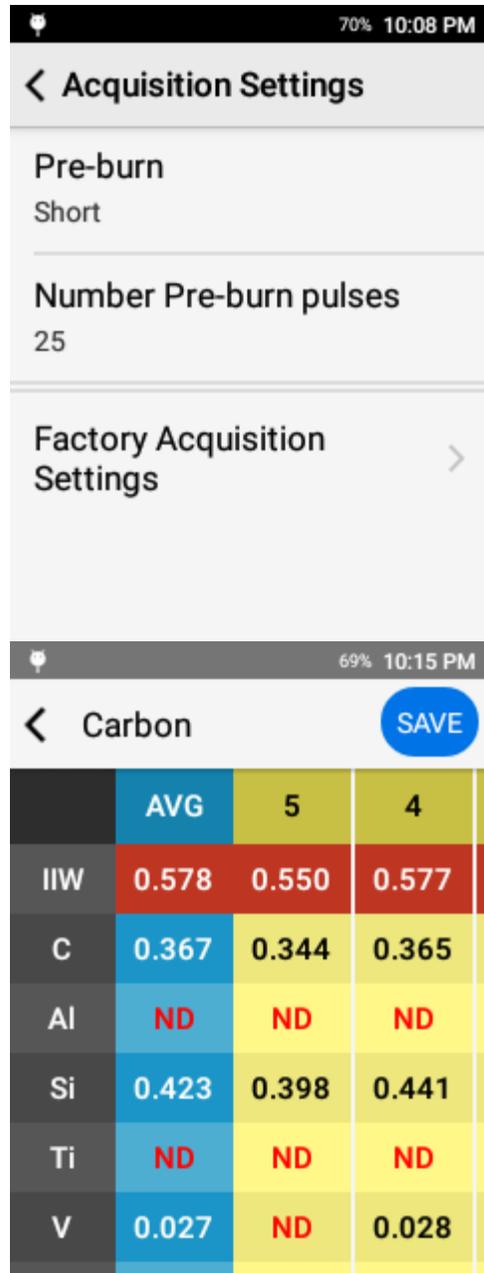
## Matrix View

After the Pre-Burn, the system will populate a matrix with each individual test. All measured elements will be reported in the matrix.

The Matrix view includes:

- Formulas (e.g. IIW) and elements (grey column)
- the average of all selected tests (blue column)
- Each individual test

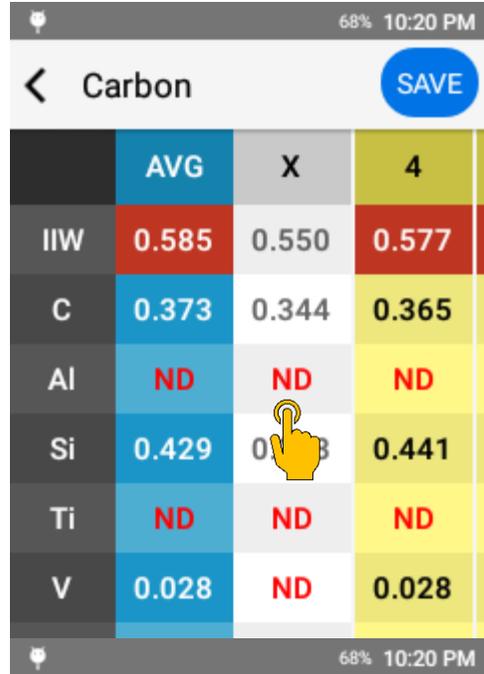
Pan up and down by swiping on the screen.



**Data Rejection**

To account for outliers in the data (typically a product of movement during the test or carbon inclusions in the material), the user may tap a column to reject that test from the average.

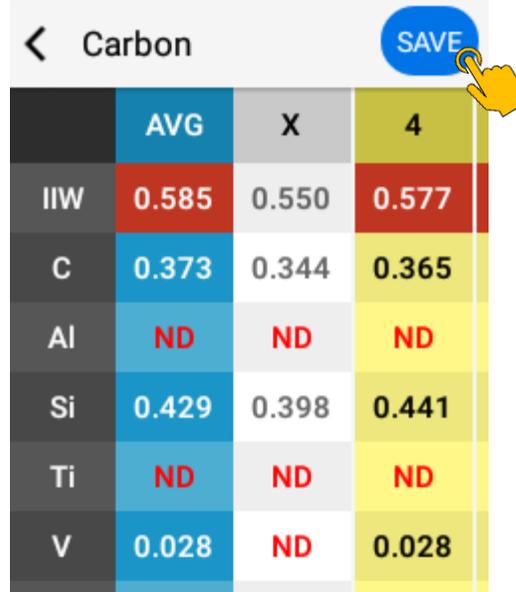
A rejected test will be greyed out and the number will be replaced by an X.



	AVG	X	4
IIW	0.585	0.550	0.577
C	0.373	0.344	0.365
Al	ND	ND	ND
Si	0.429	0.398	0.441
Ti	ND	ND	ND
V	0.028	ND	0.028

**Save Test**

After qualifying the data and rejecting outliers, press save to generate a Carbon Result.



	AVG	X	4
IIW	0.585	0.550	0.577
C	0.373	0.344	0.365
Al	ND	ND	ND
Si	0.429	0.398	0.441
Ti	ND	ND	ND
V	0.028	ND	0.028

### Carbon Result

Comprised of 7 primary components:

1. Average Indicator
2. Test Number
3. Grade Match
4. Chemistry
5. Grade Compare
6. Camera
7. Test Info

Grade Match indicates the top match for the measured chemistry compared to the instrument grade library. The Grade Match Score indicates the quality of the match. A score of 100 is considered a perfect match, meaning that all measured elements match the alloy. The Grade Match Score is calculated by determining if each specified element is in the specified range for the grade. If it is out of range, a penalty is calculated based on how far each element is out of range. The calculated penalty for each element is summed then subtracted from 100.

Element	Measured	Tolerance	Grade Match Score
IIW	0.585%	± 0.066%	
C	0.373%	± 0.025%	0.37
Al	ND	< 0.010%	0.00
Si	0.429%	± 0.013%	0.00
Ti	ND	< 0.001%	0.00
V	0.028%	± 0.002%	0.00
Cr	0.177%	± 0.015%	0.00
Mn	0.777%	± 0.054%	0.60
Fe	97.78%	± 0.181%	0.00
Ni	ND	< 0.012%	0.00
Cu	0.273%	± 0.007%	0.00
Nb	ND	< 0.042%	0.00

### Navigating Results

Swipe left to go to an earlier result or swipe right to go to a more recent result.

Element	Measured	Tolerance	Grade Match Score
IIW	0.585%	± 0.066%	
C	0.373%	± 0.025%	0.37
Al	ND	< 0.010%	0.00
Si	0.429%	± 0.013%	0.00
Ti	ND	< 0.001%	0.00
V	0.028%	± 0.002%	0.00

## Formulas

Any active formulas will be displayed at the top of the result and color coded according to configured action levels.

See formulas for more information. Available factory formulas include:

- Dearden O'Neil CE
- AWS CE
- CSA Z662
- Critical Metal Parameter (Pcm)

## Chemistry

Chemistry lives on the first page and lists all measured elements including their concentration, the precision of the measurement (+/-), and, if there is a grade match, the grade specification for each measured element.

ND indicates non-detect. This means that the measured value failed to meet the criteria for a valid measurement. In order for an element value to be considered detected, the measured value must be greater than the  $3\sigma$  standard deviation.

See display preferences section for more information about non-detects.

65% 10:33 PM			
AVG: 5 #37 1005 100			
IIW	0.026%	± 0.034%	
C	0.009%	± 0.005%	0.00
Al	ND	< 0.008%	0.00
Si	0.084%	± 0.021%	0.00
Ti	ND	< 0.000%	0.00
V	ND	< 0.002%	0.00

67% 10:23 PM			
AVG: 4 #26 1040 100			
IIW	0.585%	± 0.066%	
C	0.373%	± 0.025%	0.37
Al	ND	< 0.010%	0.00
Si	0.429%	± 0.013%	0.00
Ti	ND	< 0.001%	0.00
V	0.028%	± 0.002%	0.00

### Grade Specification Comparison

Tap the grade specification column to expand the grade specification (hiding the precision column).

Green indicates that the chemistry is within the specified value for the grade.

Red indicates that the chemistry is outside of the specified range.

Yellow indicates that, when considering the precision of the measurement, the reported chemistry may fall into the grade specification.

Element	Measured Value	Specification Range
IIW	0.026%	
C	0.009%	0.000%-0.060%
Al	ND	0.000%-0.000%
Si	0.084%	0.000%-0.300%
Ti	ND	0.000%-0.000%
V	ND	0.000%-0.030%

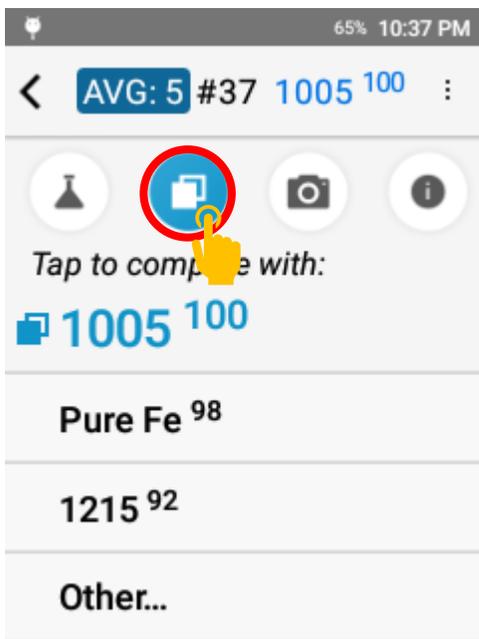
### Compare Grade

The Grade Compare function lives on the second page and allows the user to compare measured chemistry against any grade in the active grade library.

Tap the grade compare icon to see the top three grade matches. The grade match score is listed for each grade.

Tap Other... to see additional grade matches.

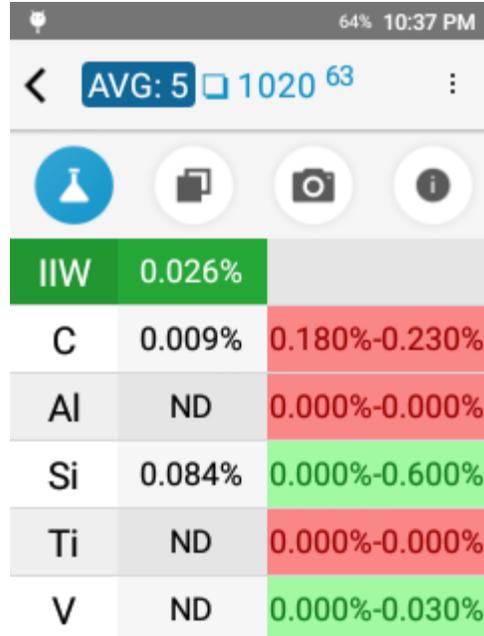
To compare with the non-top grade, tap another entry in the list.



### Compare Grade

Selecting a “ compare with” grade will return the system to the chemistry page.

Using the grade comparison feature, the system will visually indicate what elements are out of range for lower matches.



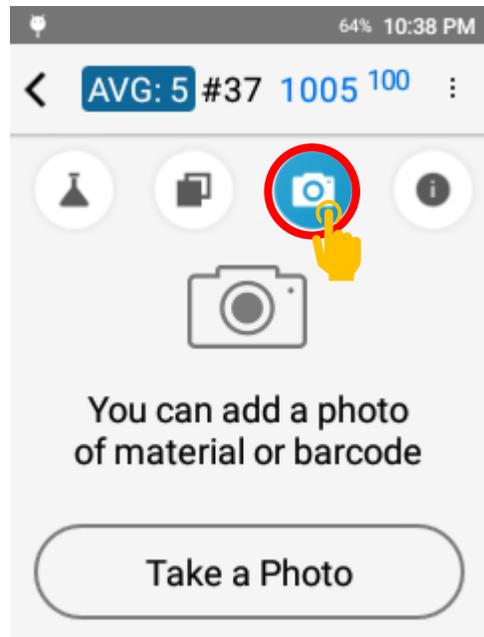
The screenshot shows a mobile application interface with a status bar at the top indicating 64% battery and 10:37 PM. Below the status bar is a navigation bar with a back arrow, a blue box containing 'AVG: 5', a blue box containing '1020', and a blue box containing '63'. Below the navigation bar is a row of four circular icons: a blue circle with a white flask, a white circle with a black document, a white circle with a black camera, and a white circle with a black 'i'. Below the icons is a table with the following data:

IIW	0.026%	
C	0.009%	0.180%-0.230%
Al	ND	0.000%-0.000%
Si	0.084%	0.000%-0.600%
Ti	ND	0.000%-0.000%
V	ND	0.000%-0.030%

### Camera

The Camera function lives on the third page and allows the operator to capture and attach a micro or macro image to a result for photo documentation.

Tap the camera icon to enter the camera utility. Simply tap Take a Photo to open the camera view.



## Camera

The camera opens in the micro view for capturing an image of the test site. Tap the switch icon in the top left corner to switch to the macro camera for capturing an image of the entire sample.

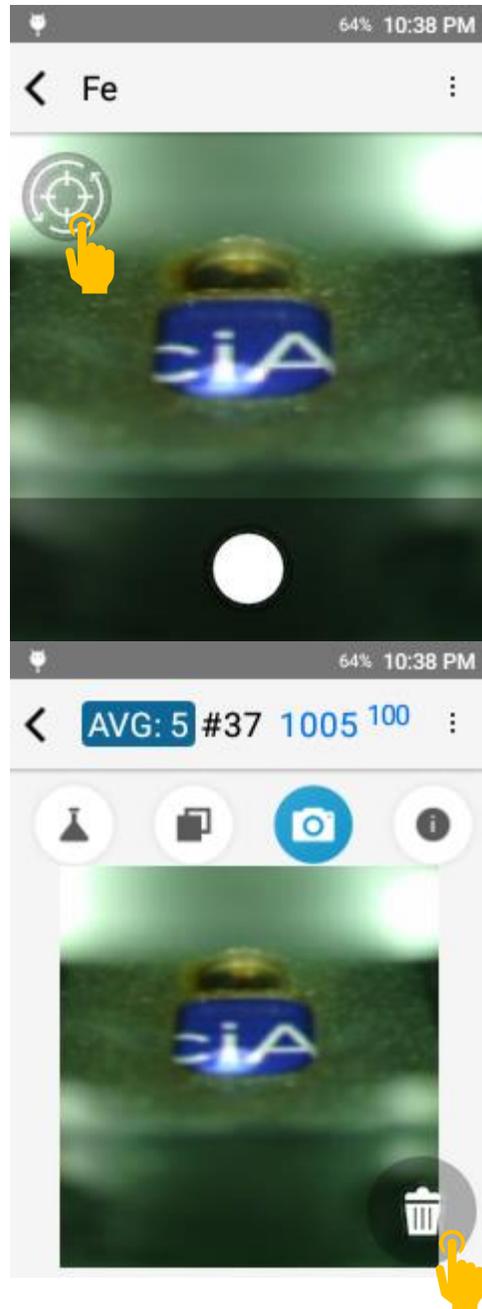
Tap the white button to capture an image.

After capturing an image, the user may save the image or retake the image.

## Delete an Image

If an image is already present, the image will be displayed in the camera page.

Tap the trash can icon to delete the image.

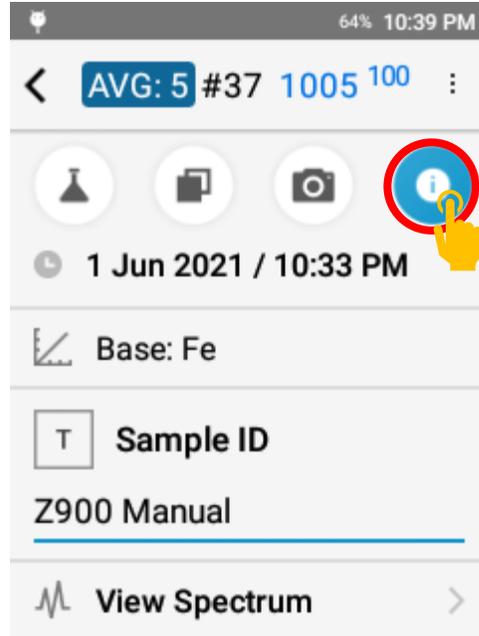


### Test Info Page

The Test Info component lives on the fourth page. This page includes test metadata, including date and time, calibration model used for calculation, and the ability to enter test info for record keeping.

Tap the  icon to access the page.

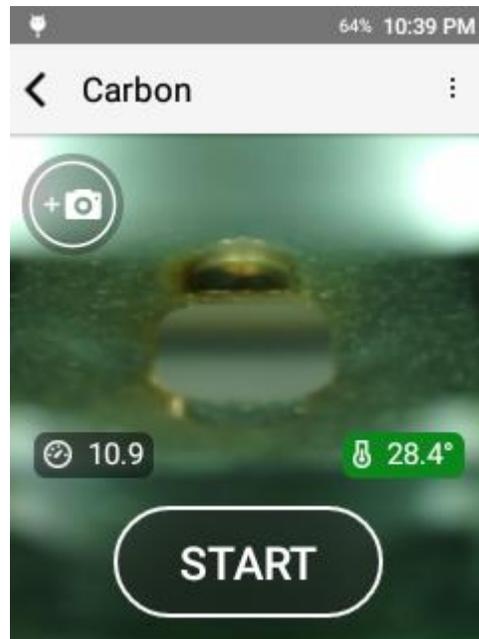
Sample ID and, if activated, Test Info fields can be populated after the test is taken.



### Next Test

To take the next test, pull the trigger or tap the back button to return to the targeting screen.

Position your sample and pull the trigger again or tap START.



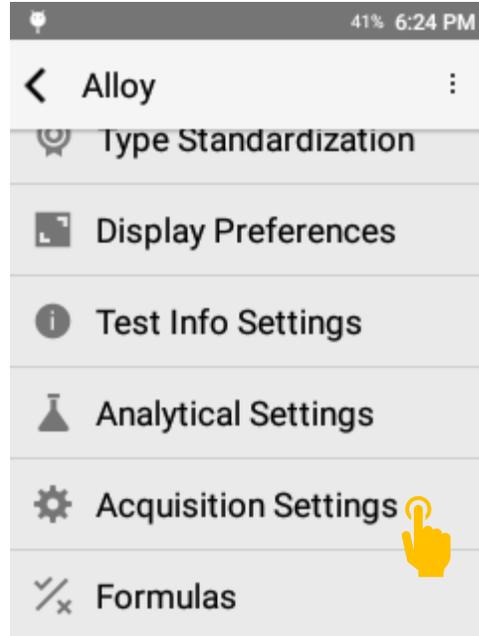
### *Test Setup*

The Z-900 has factory default acquisition settings that are set at the factory level. Changing these settings may impact the instrument calibration and should not be done without factory authorized support. Beyond factory acquisition settings, the user or operator has the option to add in a Pre-Burn. The Pre-Burn increases the cleaning of the sample prior to taking a test and may be used for dirty or plated samples. For heavy corrosion or thick plating, grinding is recommended. When using Pre-Burn, it is important to keep the sample in the same position until the test is completed.

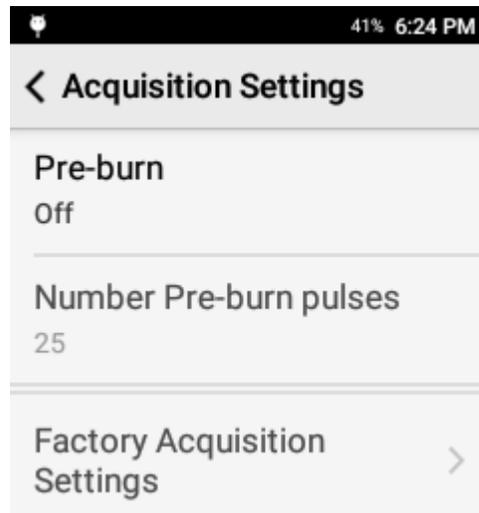
## Managing Pre-Burn

To activate Pre-Burn, select Acquisition Settings from the options menu.

A minimum of a short Pre-Burn is recommended.



Tap Pre-Burn to open Pre-Burn options.



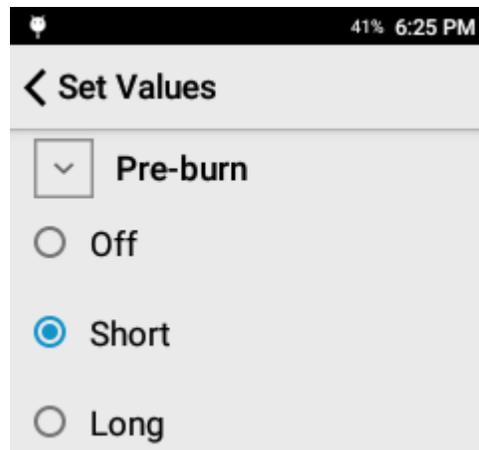
## Pre-Burn Options

Off indicates no Pre-Burn.

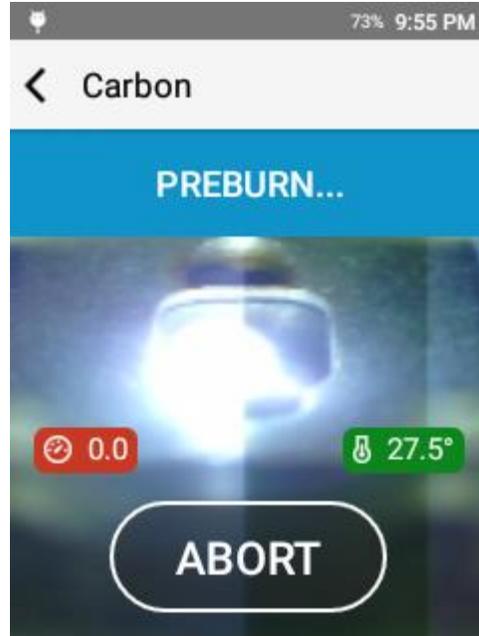
Short indicates a single Pre-Burn (approximately 3 seconds).

Long indicates two back to back Pre-Burn cycles (approximately 6 seconds).

The longer the Pre-Burn, the more surface material is ablated or removed prior to collecting data.

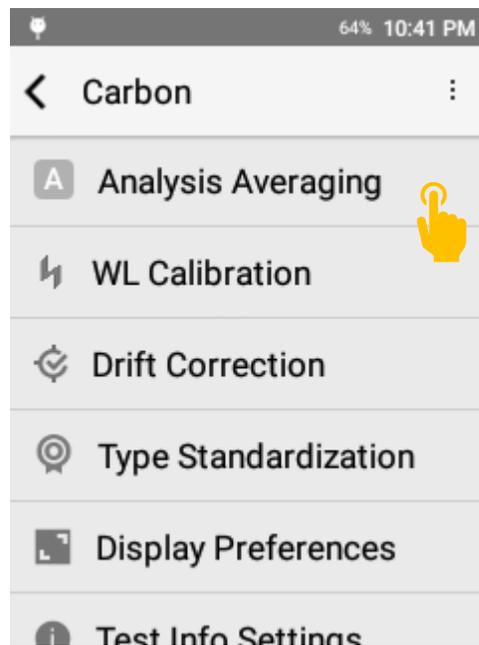


When testing with Pre-Burn, the test status bar will indicate that the Pre-Burn is active.



### **Analysis Averaging**

Analysis Averaging is controlled from a dedicated menu in the Options menu.

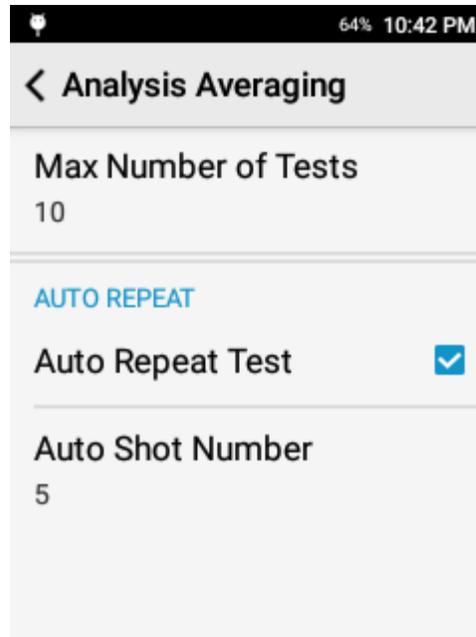


### Analysis Averaging Options:

**Max Number of Tests:** Sets an upper bound for the number of tests that can be included in a Carbon Result.

**Auto Repeat Test:** When active, only one trigger pull is required to run Pre-Burn and the Auto Shot Number of tests. Essentially, 1 trigger pull to collect all of the required tests.

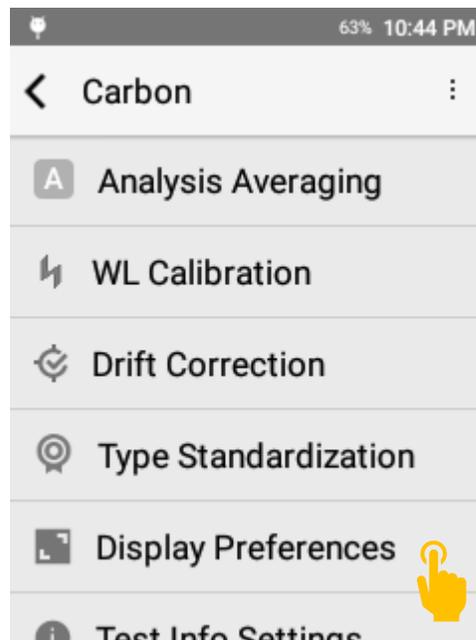
**Auto Shot Number:** Target number of tests for Carbon Result.



### *Display Preferences*

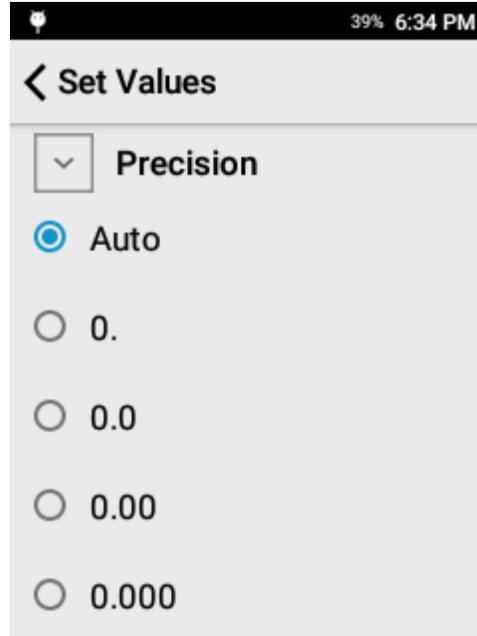
The Z-900 is designed to be customized to the operator's needs. One of the primary ways the user may customize is the setup of the display preferences. This includes element display order, user selectable confidence interval, and customizable limit of detection cutoffs.

To access display preferences, open the options menu and tap display preferences.



## Precision

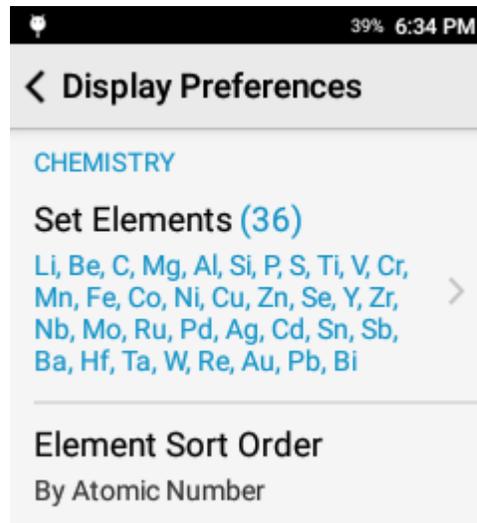
The precision setting controls the number of digits to display after the decimal point. This setting is respected in both the onscreen display and any exported report (CSV or PDF).



## Chemistry

Set Elements allows the user to select what elements should be displayed (if detected) on the instrument screen.

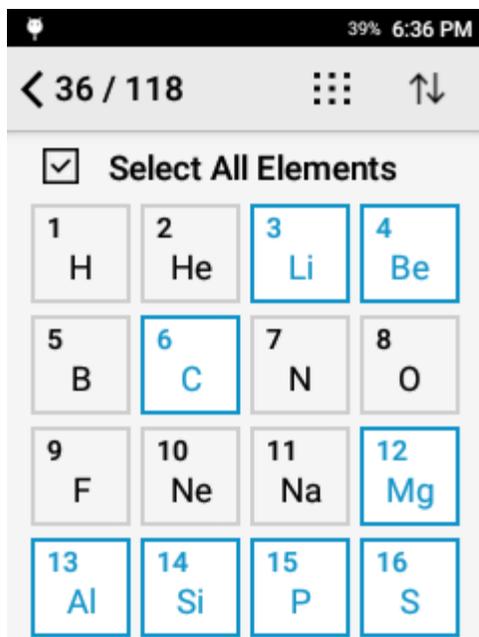
Element Sort Order allows the operator to quickly select the order of appearance for all elements.



## Selecting Elements

To choose what elements are displayed, tap Set Elements.

Elements highlighted with blue will be displayed if measured. Use the select all elements and deselect all elements to quickly make bulk changes.



## Element Sort Order

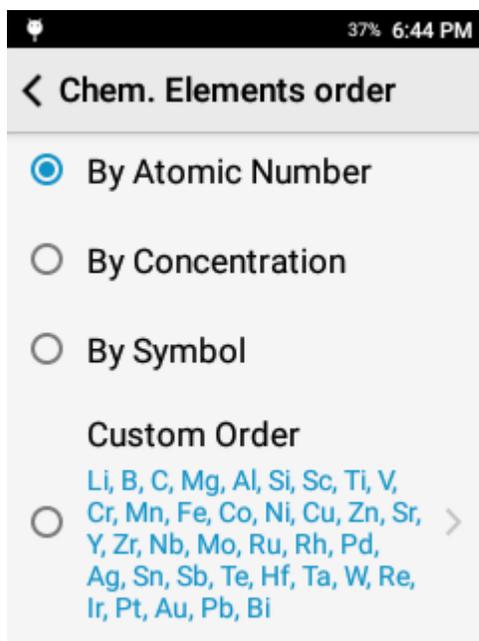
Determines the order of appearance on the result screen.

Atomic Number will display elements based on the number of protons in the element's nucleus or, more simply, will rank the elements by their weight. This will sort elements from the lightest element to the heaviest element.

By C oncentration sorts the elements by the measured concentration from high to low concentration.

By Symbol sorts elements alphabetically by symbol.

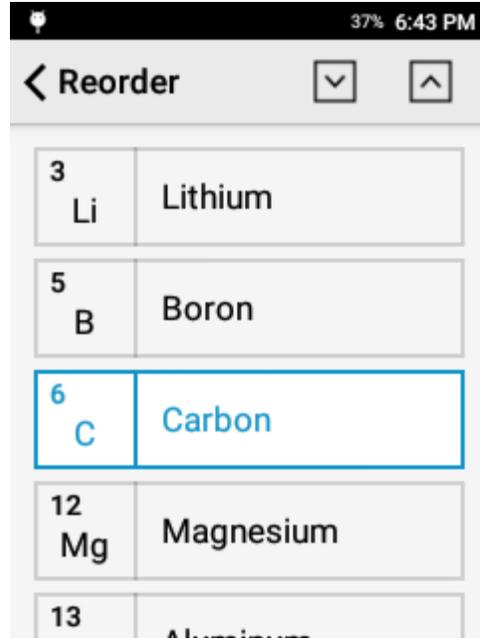
Custom Order allows the user to determine their preferred order of elements.



### Creating a Custom Element Sort Order

To create a custom order, select custom order to open the Reorder wizard.

Then tap the element you want to move and use the up and down arrows in the top right corner to move the element.

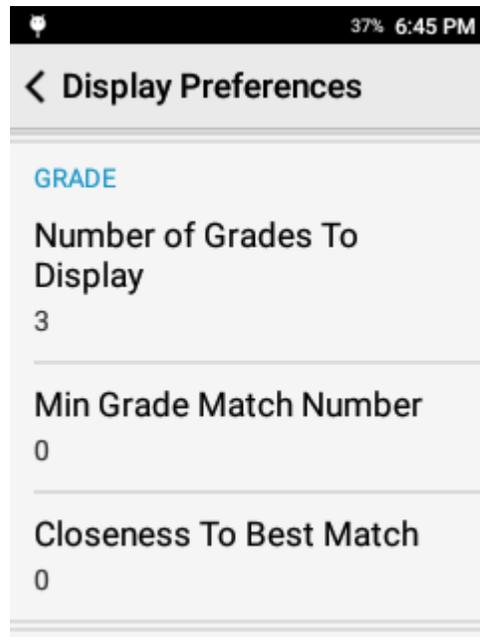


### Grade Display Settings

Number of Grades to Display controls the number of grades displayed in the Compare Grade page and the number of grades displayed in the PDF export.

Min Grade Match Number determines the cutoff for No Grade Match response.

Closeness to Best Match screens for alloys that are very similar in chemistry. Some alloys are so similar that they cannot be sorted on chemistry alone. If activated, this feature flags a result that has more than one grade within the set value of the top grade match.



### **Detected Elements**

For an element to be considered detected, the measured value must be greater than the 1 sigma precision multiplied by the LOD Sigma. Thus, a higher LOD Sigma will result in less detected elements.

The system has the option to either hide or display non-detect elements. It is highly recommended to activate Show Chem < LOD as ND when Show non detect elements is active.

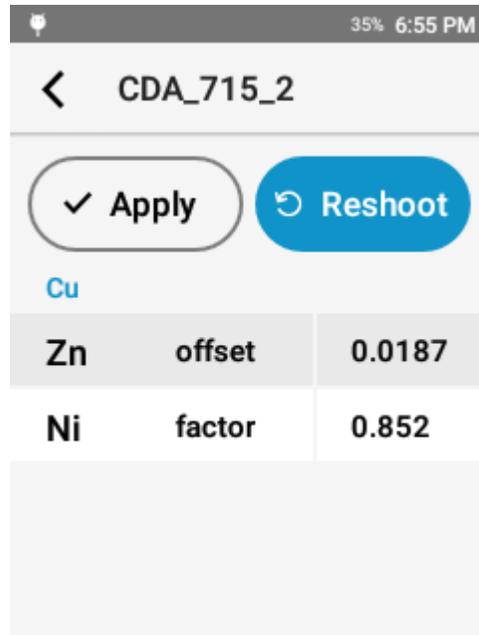
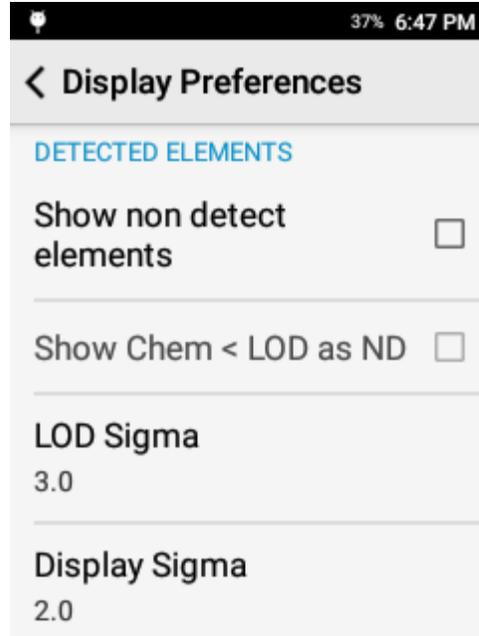
The LOD Sigma is defined as 3.0. The user may adjust this value if they desire.

The Display Sigma is a multiplier applied to the calculated precision. It is expected that the result will have analytical agreement with a certified value approx. 95% of the time.

### **Correction Factors**

Always show correction factors, when activated, will list all calculated drift correction and type standardization factors in the calibration workflow.

This can be a powerful tool for advanced users or for troubleshooting but is typically not recommended for general usage.

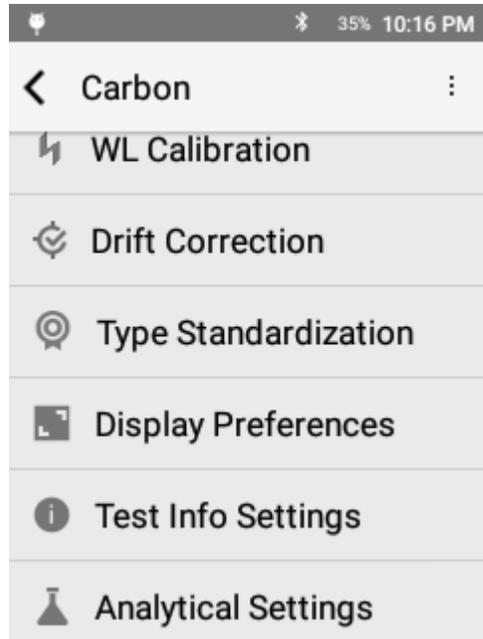


### *Test Info Fields*

Test Info Fields are a useful tool for attaching metadata or testing notes to a result.

### Test Info Setup

Test Info setup is accessed through Test Info Settings.

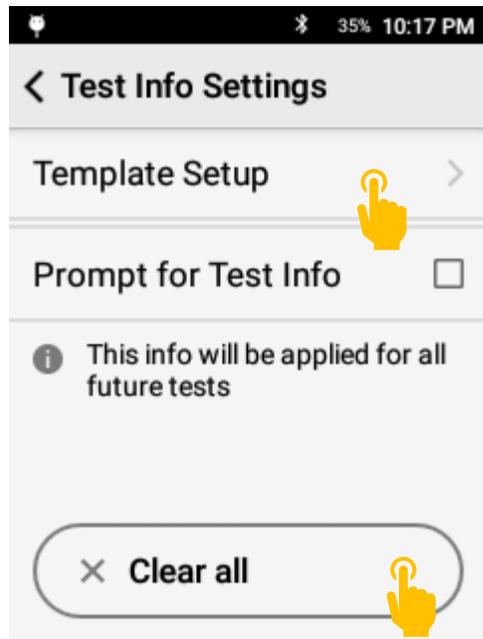


### Test Info Settings

Test Info is driven by a template. To customize Test Info Fields, tap Template Setup.

Prompt for Test Info will prompt the user before each test to populate the Test Info Fields.

Clear All will reset all Test Info fields except for Sample ID.



## Template Setup

Modify existing fields or add new fields. Users may add a maximum of 8 fields.

To add a new field, tap Add New Field.

To modify an existing field, scroll through the list and select the target field.

Sample ID is a factory enabled field and cannot be deleted.

The image consists of three vertically stacked screenshots of a mobile application interface, likely for configuring a test template. The top screenshot shows the 'Template Setup' screen with a back arrow, a plus icon, and the text 'Add New Field'. A yellow hand icon is pointing at the plus icon. Below this is a list item for 'Sample ID' with the subtext 'Persist' and a right-pointing arrow. The middle screenshot shows the 'Add New Field' screen with a back arrow, a text input field labeled 'Field's Name', and a section titled 'SELECT TYPE'. Under this section are three options: 'Free form' (with a plus icon and a checkmark), 'Numeric field' (with a '12' icon), and 'Selector' (with a dropdown icon). The bottom screenshot shows the 'Selector' option selected, with a dropdown icon and a checkmark. Below this are two radio button options: 'option a' and 'option b'. The 'option b' input field contains the text 'option b' and has a small 'x' icon to its right. At the bottom is a '+ Add Option' button.

## Enter Field Name

Each field must have a name. The name will appear in the test info page and on exported data.

## Select Field Type

Free form is a general text entry.

Numeric field is numbers 0 – 9 only

Selector gives the user a drop down menu.

## Selector Field

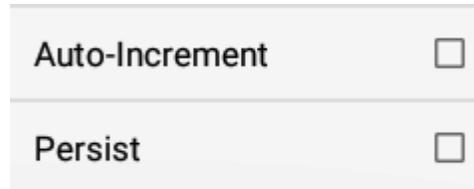
Add multiple options for the user to select from a dropdown menu. This is a great option for consistent descriptions.

### Field Rules

After Selecting a Field Type, the user has the option of applying a rule.

Auto-Increment will increment the input for a field by +1 for each subsequent test.

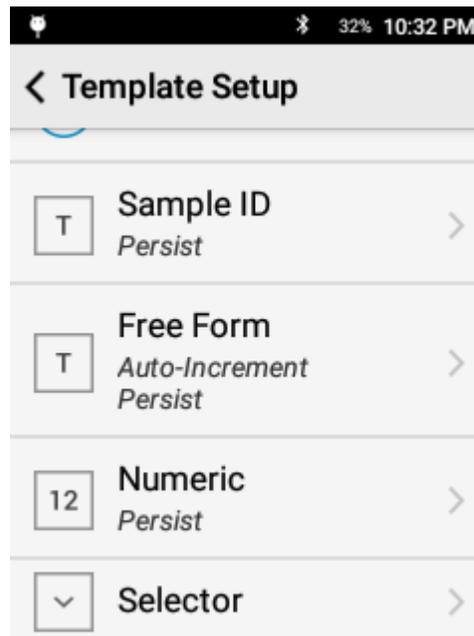
Persist will maintain the input for a field until the user changes that field.



### Using Test Info

After configuring the Test Info Template, Test Info Fields are ready to be used.

For training purposes, the following fields have been setup:



### Prompt For Test Info

To enter values prior to a test, activate Prompt for Test Info in the Test Info Settings page.

When a test is started, the system will prompt the user to input the test info values. Enter the values then.

The screenshot shows a mobile application interface for a test titled "Carbon". The status bar at the top indicates 32% battery and 10:33 PM. The interface consists of several input fields and a "Start Test" button. The first field is labeled "Sample ID" with a 'T' icon, containing the text "Z900 Manual". The second field is labeled "Free Form" with a 'T' icon, containing the text "Enter Value" and a "+1" icon. The third field is labeled "Numeric" with a "12" icon, containing the text "Enter Value". The fourth field is labeled "Selector" with a dropdown icon, containing three radio button options: "Option A", "Option B", and "Option C". A blue "Start Test" button is located at the bottom of the screen.

Carbon

T Sample ID  
Z900 Manual

T Free Form  
Enter Value +1

12 Numeric  
Enter Value

Selector  
 Option A  
 Option B  
 Option C

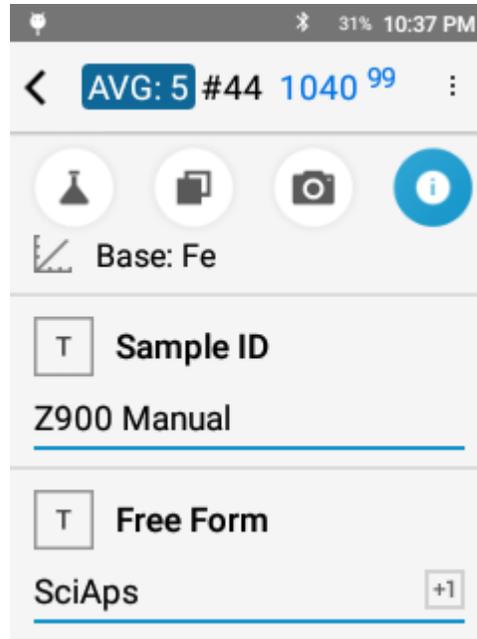
Start Test

**Review Values**

The user may enter in all desired values.

Tap Start Test or Pull Trigger to start.

After the test is completed, the values may be reviewed and edited in the Info tab.



*Formulas*

**Factory Formulas**

The Carbon(+) mode comes standard with the following Factory Formulas

American Welding Society (AWS)	$AWS = \%C + \frac{\%Mn + \%Si}{6} + \frac{\%Cr + \%Mo + \%V}{5} + \frac{\%Cu + \%Ni}{15}$
Dearden and O’Neill (IIW)	$IIW = \%C + \frac{\%Mn}{6} + \frac{\%Cr + \%Mo + \%V}{5} + \frac{\%Cu + \%Ni}{15}$
Critical Metal Parameter (Pcm)  <i>*B is a nominal value of 0.007 per ASTM 415</i>	$P_{cm} = \%C + \frac{\%Si}{30} + \frac{\%Mn + \%Cu + \%Cr}{20} + \frac{\%Ni}{60} + \frac{\%Mo}{15} + \frac{\%V}{10} + 5 \times \%B$
CSA Z662 (CSA)  <i>*B is a nominal value of 0.007 per ASTM 415</i>	$CSA = \%C + F \left( \frac{\%Mn}{6} + \frac{\%Si}{24} + \frac{\%Cu}{15} + \frac{\%Ni}{210} + \frac{\%Cr + \%Mo + \%V + \%Nb}{5} + 5 \times \%B \right)$

	<b>Compliance factor (F) — Carbon equivalent formula</b> (See Clause 7.6.4.4.)			
	<b>Carbon content, %</b>	<b>F</b>	<b>Carbon content, %</b>	<b>F</b>
	Less than 0.06	0.53	0.14	0.85
	0.06	0.54	0.15	0.88
	0.07	0.56	0.16	0.92
	0.08	0.58	0.17	0.94
	0.09	0.62	0.18	0.96
	0.10	0.66	0.19	0.97
	0.11	0.70	0.20	0.98
	0.12	0.75	0.21	0.99
	0.13	0.80	Greater than 0.21	1.00
Seferian CE	$Sef = \%C + 0.111(\%Mn + \%Cr) + 0.055(\%Ni) + 0.078(\%Mo)$			
API 5L	$NbV = \%Nb + \%V$ $NbVTi = \%Nb + \%V + \%Ti$			
Hydrofluoric Alkylation (API 751)	$CNC = \%Cr + \%Ni + \%Cu$ $NiCu = \%Ni + \%Cu$ $VNb = \%V + \%Nb$			
Schaeffler modified Delong	$CrQ = \%Cr + \%Mo + 1.5*\%Si + 0.5*\%Nb$ $NiQ = \%Ni + 30*\%C + 0.5*\%Mn + 30*\%N$			

### 13. Pipeline Mode

Pipeline is a dedicated app for determining chemical composition and Carbon Equivalent value for Pipeline Integrity Management in accordance with API 5L Specifications. In addition to the features offered in Carbon(+) mode, the Pipeline mode offers:

#### Fixed Acquisition Settings

Pipeline mode standardizes the acquisition settings to:

- Pre-Burn = Long
- Number of Shots = 5
- Standard Carbon Raster Pattern

### Automated Data Rejection

When the Pre-Burn and 5 intermediate tests have been taken, the system will automatically exclude the intermediate tests with the highest and lowest C value from the average.

	AVG	5	4	X	2	X
IIW	0.519	0.526	0.526	0.533	0.505	0.498
C	0.317	0.330	0.311	0.340	0.310	0.293
Al	ND	ND	ND	ND	ND	ND
Si	0.234	0.237	0.237	0.250	0.227	0.230
Ti	ND	ND	ND	ND	ND	ND
V	0.047	0.044	0.052	0.045	0.043	0.046

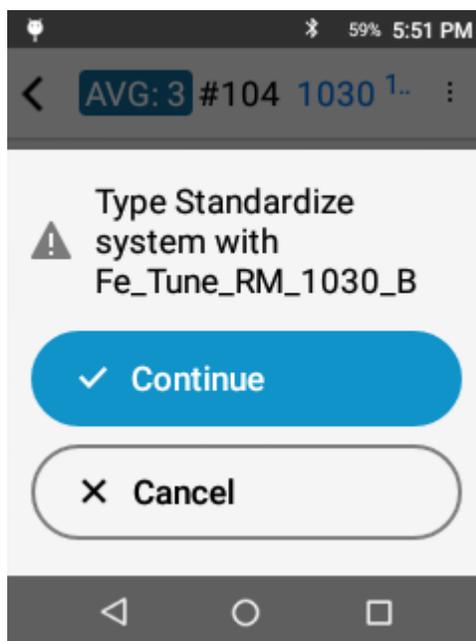
### Type Standardization Prompt

If CE value is between 0.4 and 0.5, the system will prompt for a Type Standardization.

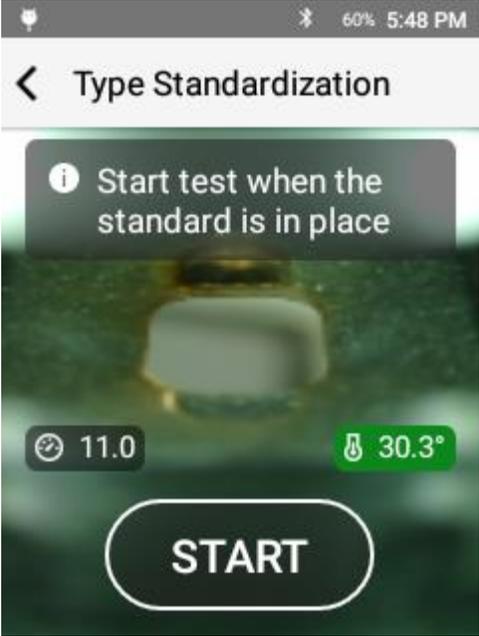
If the CE value is 0.4 to 0.45, the system will prompt the operator to perform a Type Standardization with RM 1020 which has an approximate CE value of 0.4.

If the CE value is 0.45 to 0.5, the system will prompt the operator to perform a Type Standardization with RM 1030 which has an approximate CE value of 0.5.

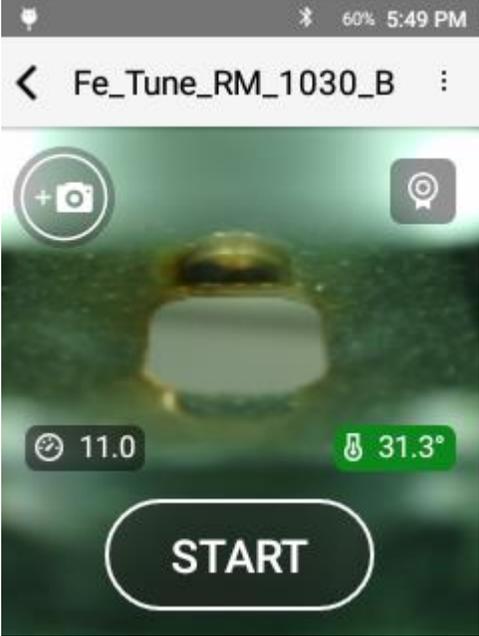
This ensures the highest quality analysis possible when a value is near the action level.



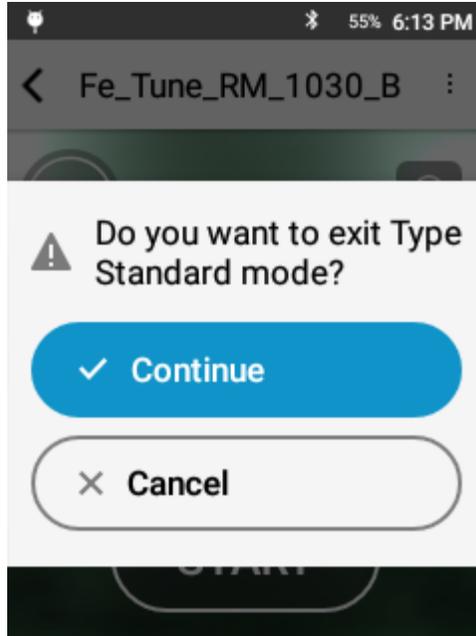
Tapping Continue will take the user directly to the Type Standardization Screen for the appropriate standard.



After performing the Type Standardization, the system is ready to retest the sample. When Type Standardization is active, the standard will be listed in the header.

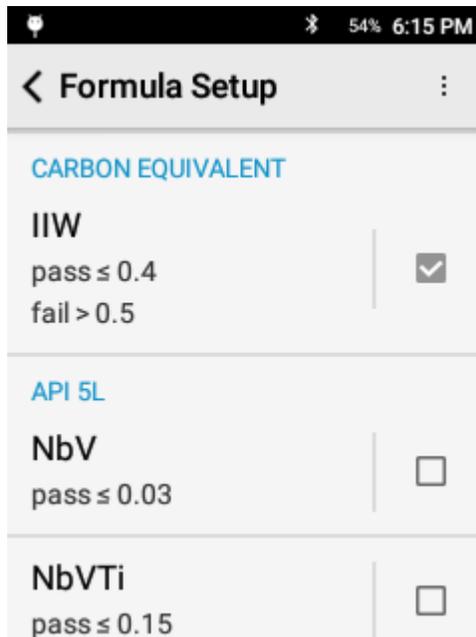


Tap the Type Standardization icon in the top right corner to exit Type Standardization.



### Formulas

Pipeline mode requires that one CE formula (IIW, AWS, Pcm, CSA) is selected. Additional non-CE formulas may also be included.



## 14. Results

All results are stored in the Results App. Use Results to review data, generate PDF reports, export data to CSV, delete data, and update Test Info.

*Navigating Results*

Access Results from the main home screen.



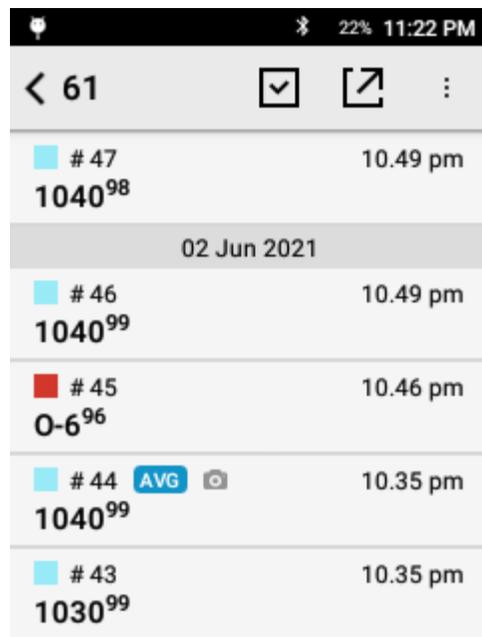
The header contains:

- Total number of tests in current view
- Multi-result selector tool
- Share Tool
- Options Menu

Results will be grouped under a header date.

Each result line will contain:

- A color coded indicator for testing mode
- AVG icon for calculated average tests
- Camera icon for results with a photo attached
- Grade Match & Grade Match Score
- Time Stamp

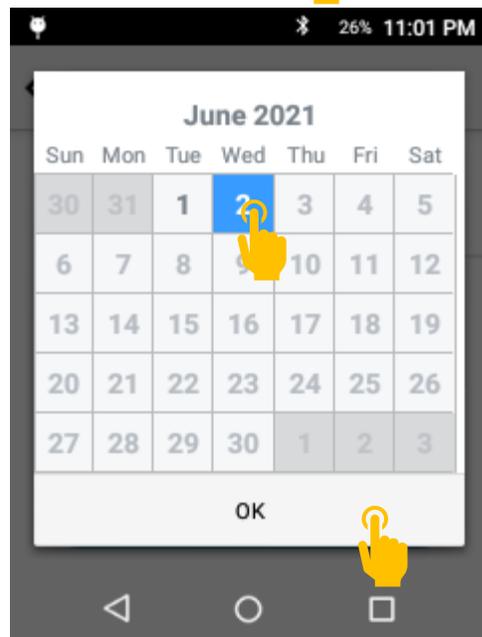
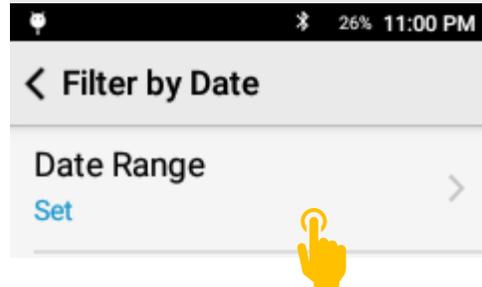
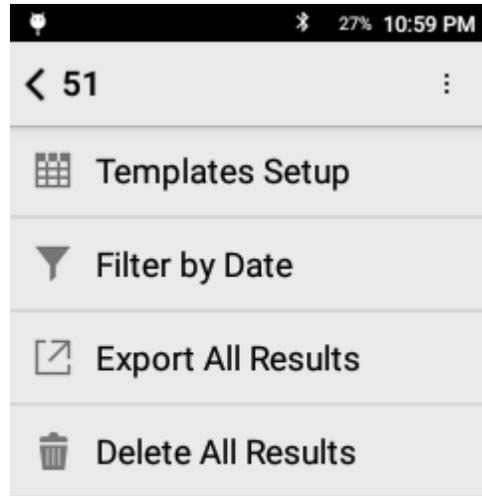


The Options may include :

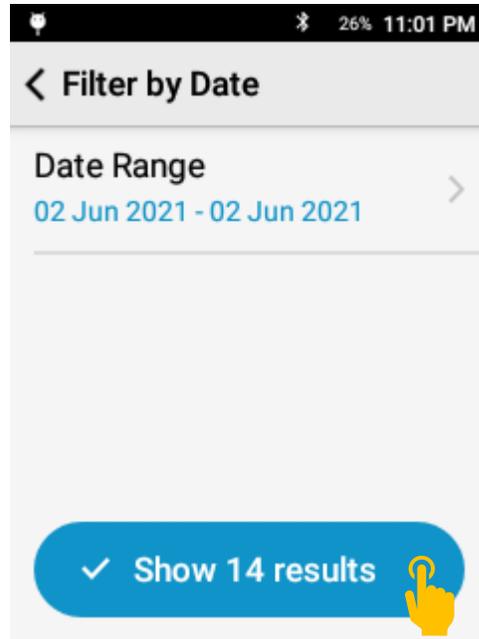
- Templates Setup for customizing Excel export option
- Filter by Date to filter results by a date or date range
- A quick Export All Results key
- Function to Delete All Results

### Filter by Date

Tap Set Date Range then select either a range or a single date and tap okay.

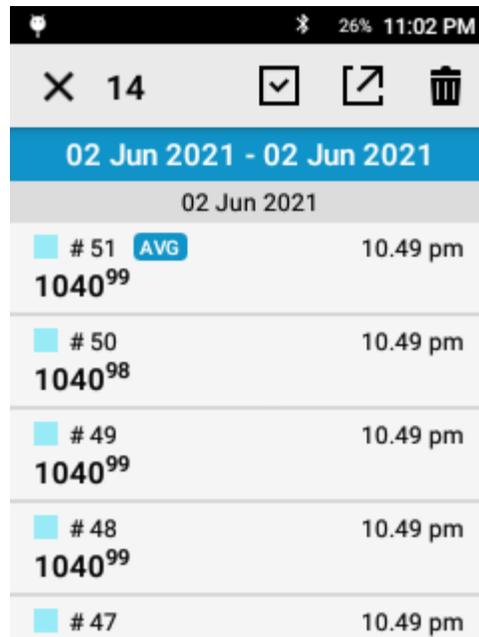


This will limit results to those taken on the days in the date range.



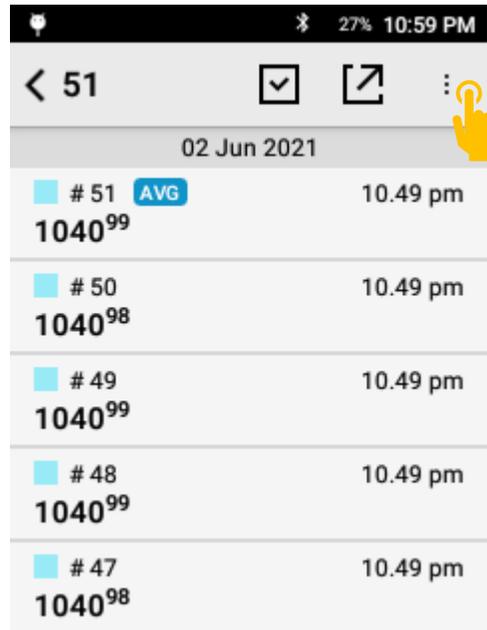
Once applied, the list will be limited to those specific results.

Exporting all results or Deleting all results from the filtered view will only include tests in the specified date range.

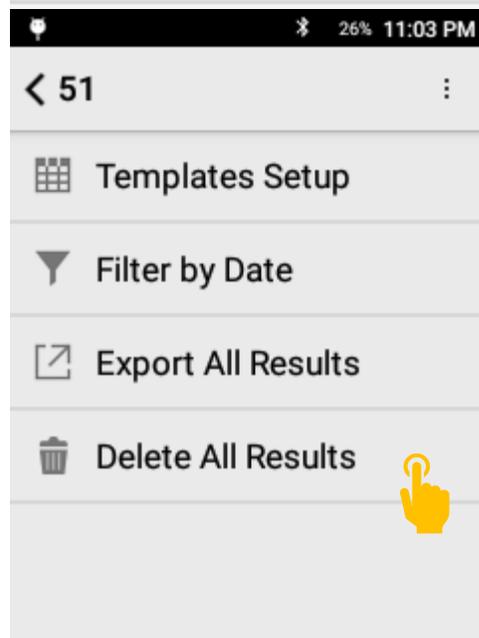


## Data Management

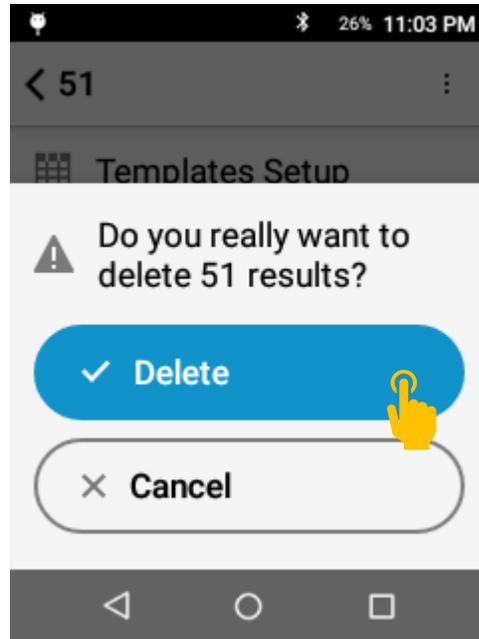
To Delete all test results, open the options menu.



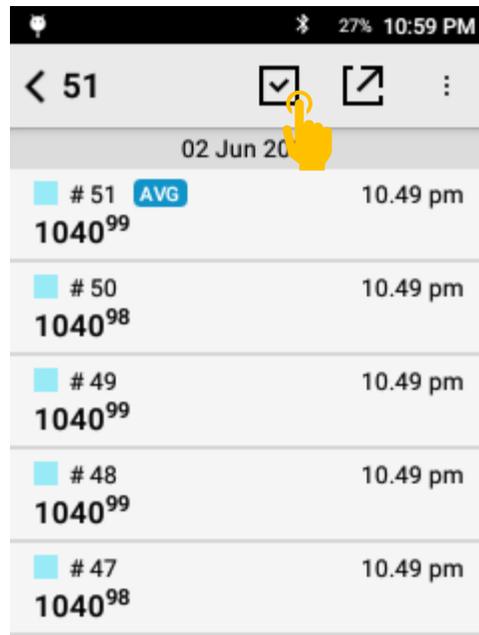
Then select Delete All Results.



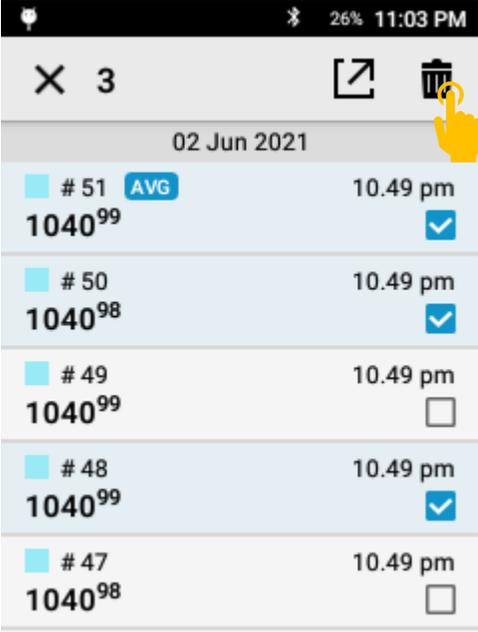
Tapping Delete will permanently delete the selected results.



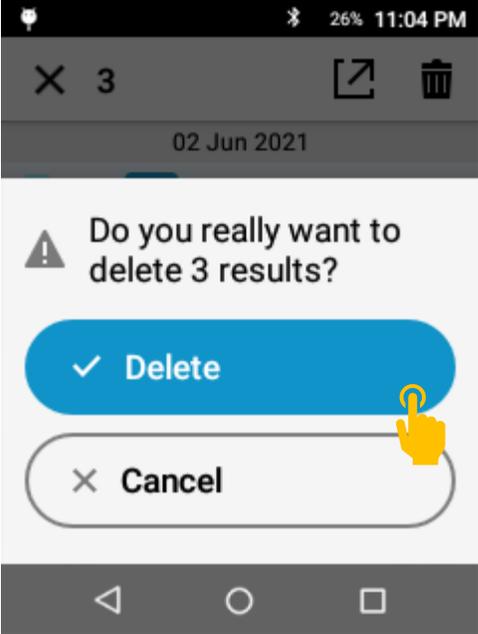
To Delete a subset of results, use the selector button in the header row.



Select the results to delete by tapping the row then tap the delete icon.



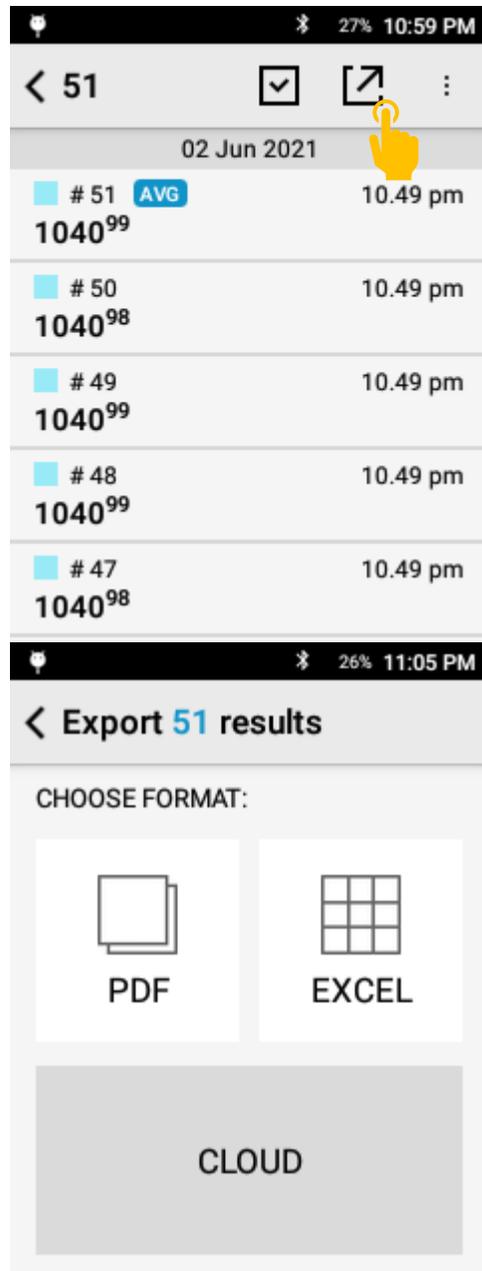
To permanently delete those results, tap Delete.



*Exporting Results*

Tap the share icon to export results.

You may select a subset of the results using the Filter by Date feature or the Selector function.



There are two options for exporting results:

A formatted PDF report (see appendix for example)

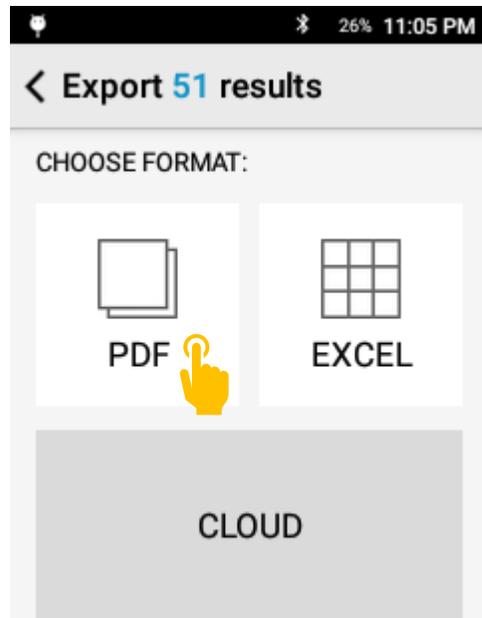
PDF Export will respect display settings for:

- Active formulas
- Elements to display
- Precision
- Limits of Detection and Detected element display rules

An Excel (.csv) file for additional data handling or multiple tests in a single file

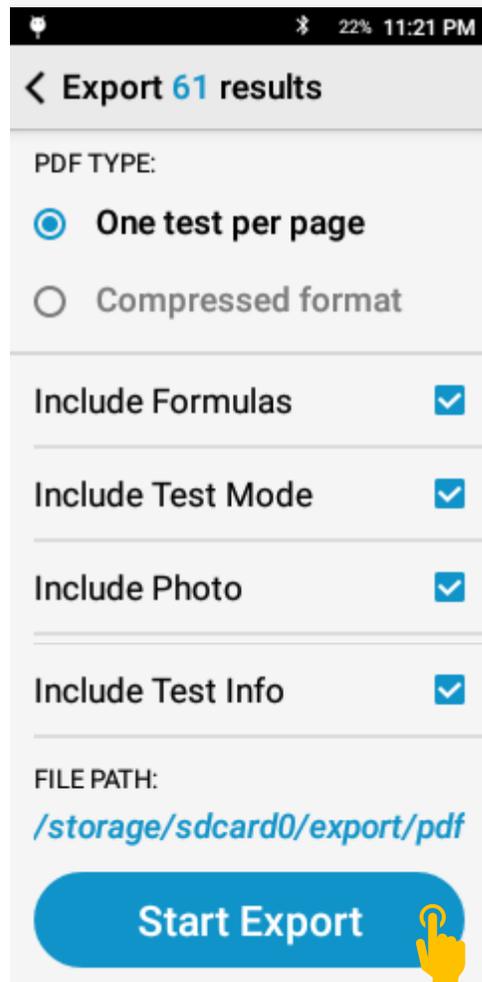
## PDF Export

To set up PDF Export, tap PDF from the format selection screen.



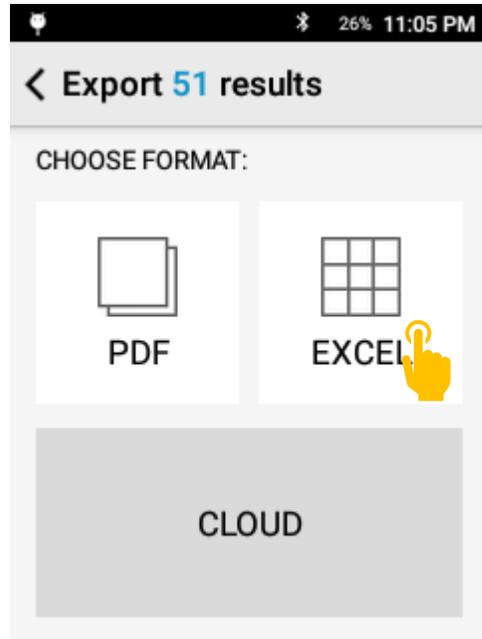
## Customize Output

Select what fields to include then tap Start Export.

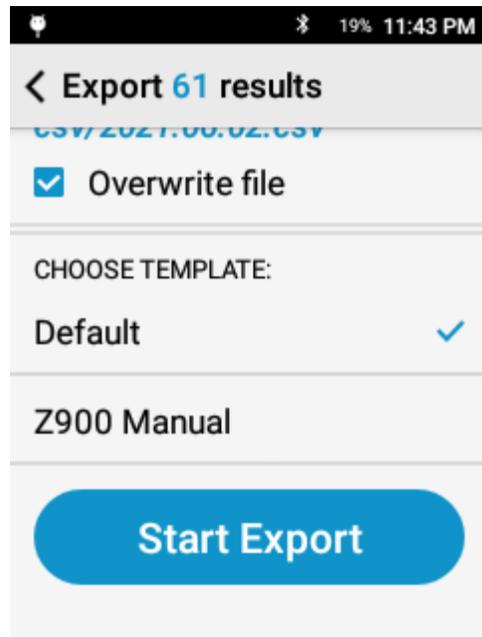


Export to CSV

Tap Excel.

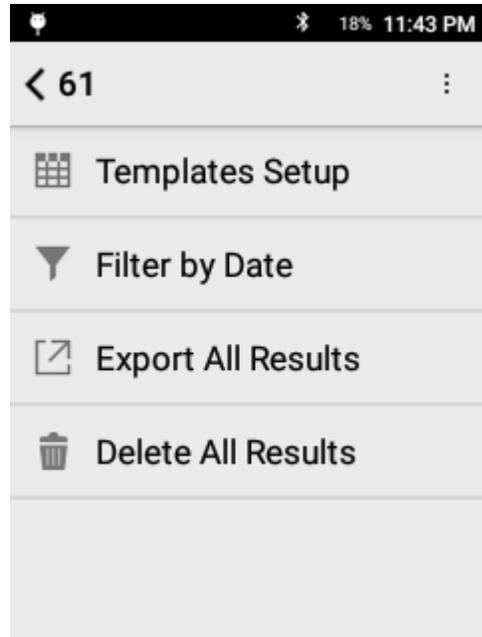


Select export template

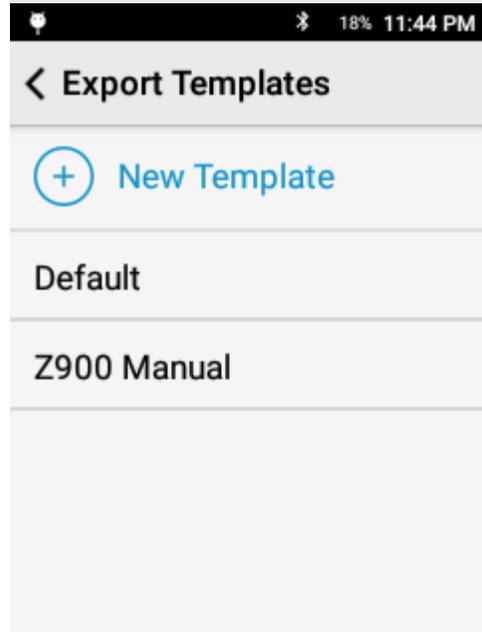


## Custom Templates

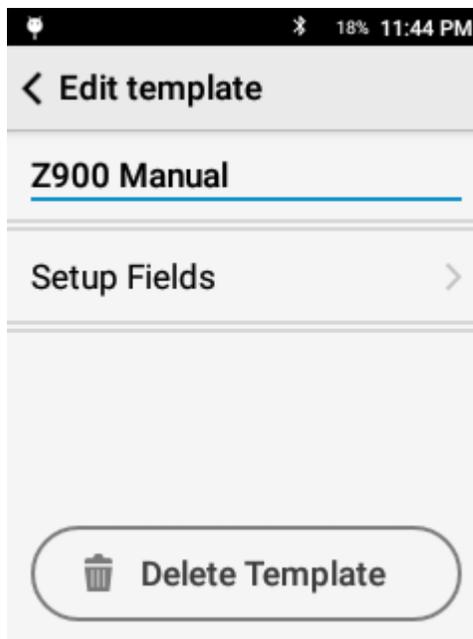
Select Template Setup from the Options menu.



Create a new template or modify an existing template

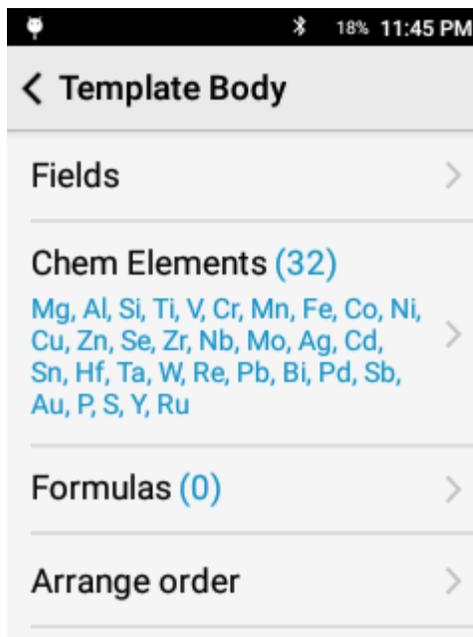


Name template and select setup fields



Select Fields to include, Elements to include, Formulas, and Arrange order.

Additionally, may include uncertainty for each element and test info for each result.



All reports are saved to This PC\NGL\SD card\export in either the PDF or csv folder.

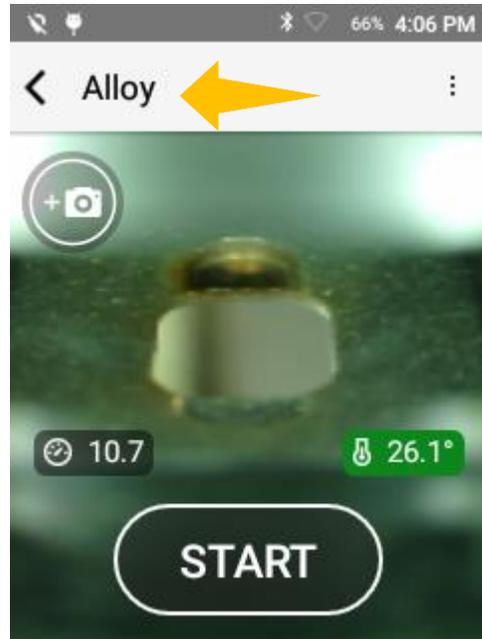
## 15. Analytical Settings

### *Force Base*

All quantitative modes on the SciAps Z-900 Series have built-in automated base identification. However, some alloys or custom bases may cause issues for the automated base identification system. Take manual control over the system with Force Base.

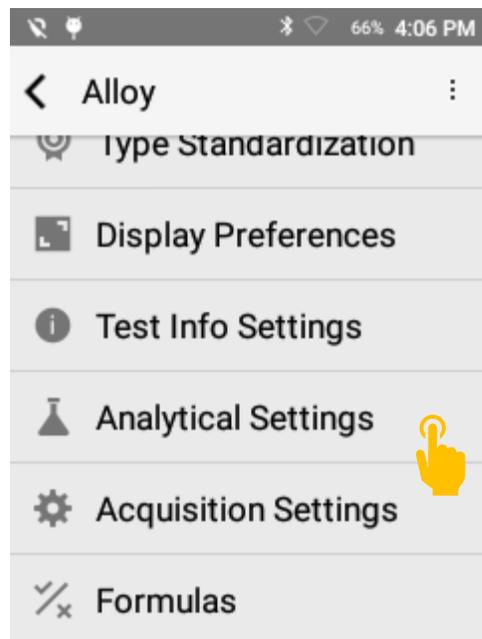
### Standard Operation

When Force Base is not active, the top bar will display the name of the active mode.

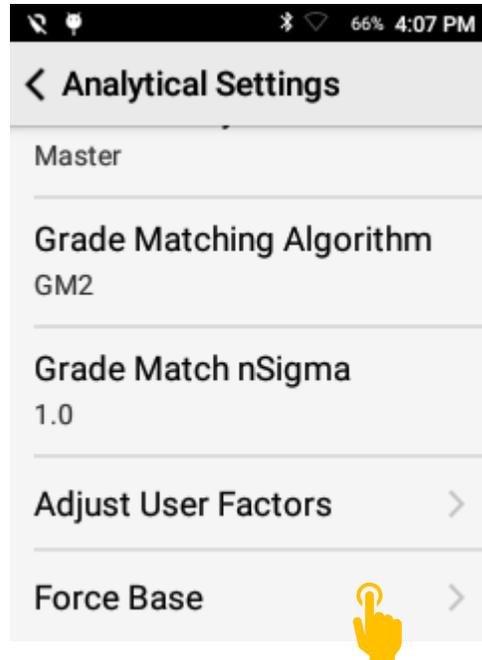


### Activating Force Base

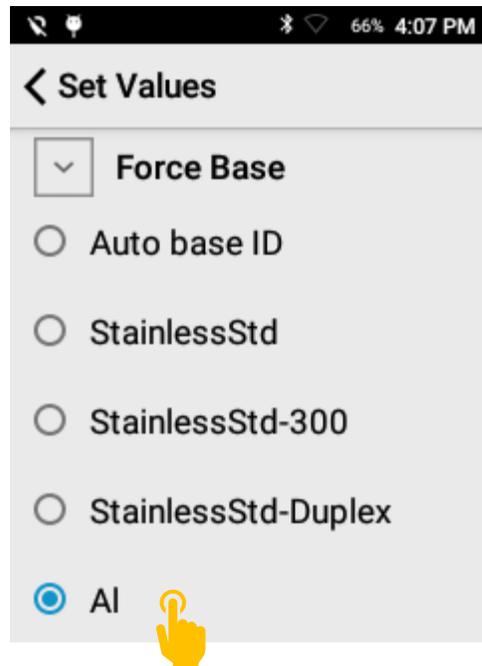
To activate Force Base, open the options menu and select Analytical Settings.



Select Force Base

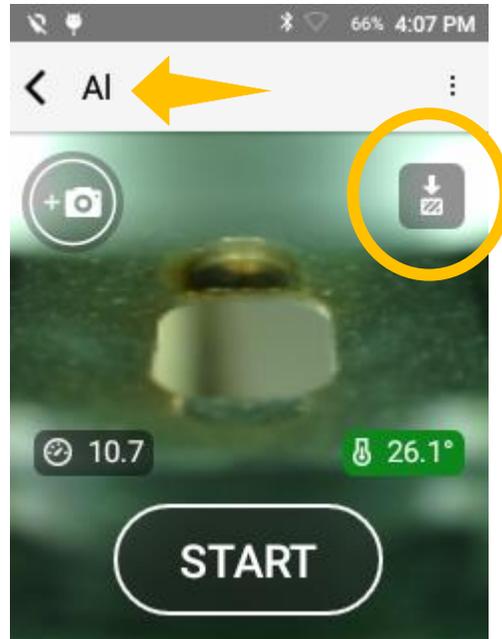


Select target base (e.g. AI [Aluminum]) and then click back to the testing screen.

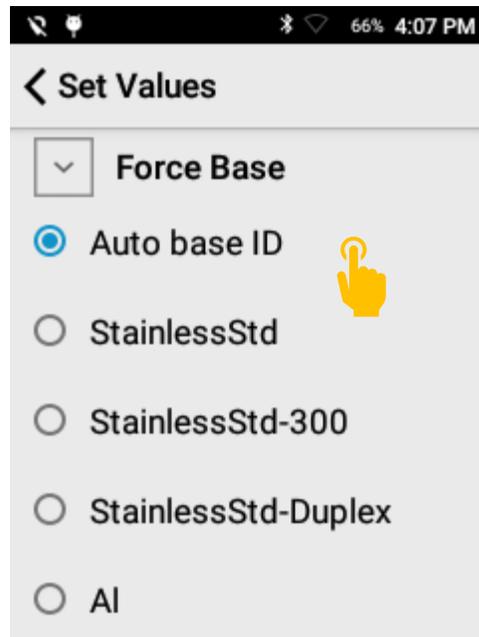


When Force Base is active, the header will display the selected base (e.g. Al) and an icon will appear in the top right corner of the camera view.

At this stage, no matter what material type is tested, the system will use the aluminum models to determine chemistry.



Tapping the icon will return the system to the Force Base menu. Select Auto base ID to return to standard, automated base identification.

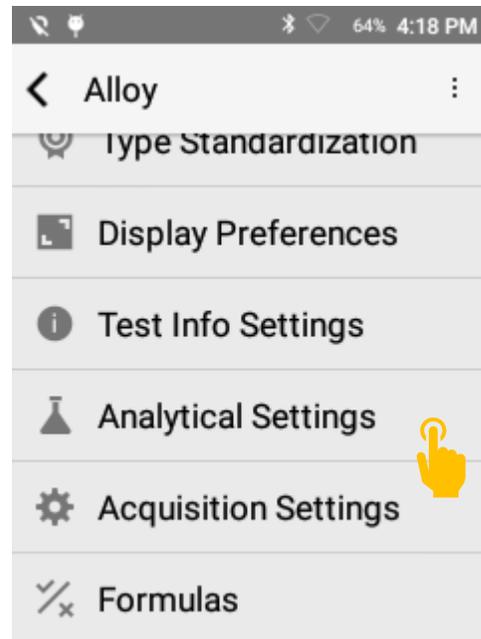


### *Adjust User Factors*

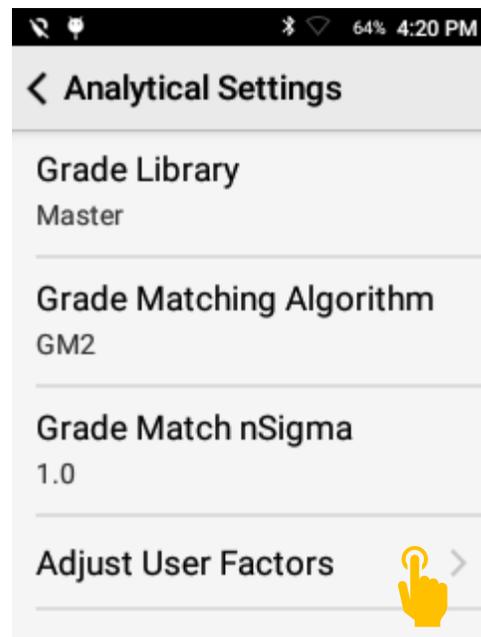
Adjust User Factors allows the user to apply factors and offsets on a base and element specific basis to adjust chemistry. All adjustments are made to the final result. Adjust User Factors should be limited to advanced users only but can be a powerful way to adjust repeatable but biased data.

## Activating Adjust User Factors

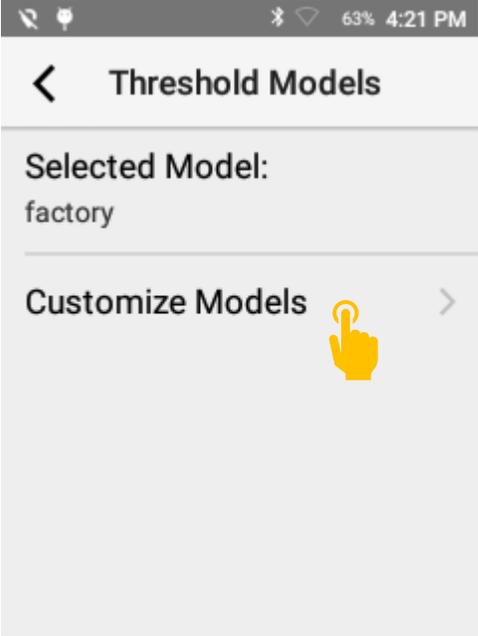
From the target testing mode, select the options menu and select analytical settings.



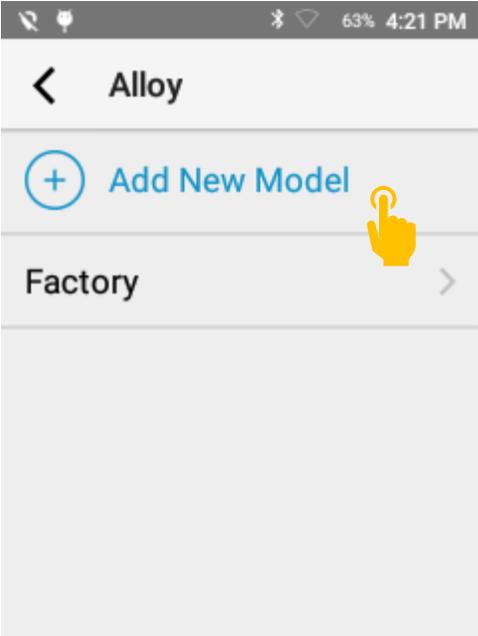
## Select Adjust User Factors



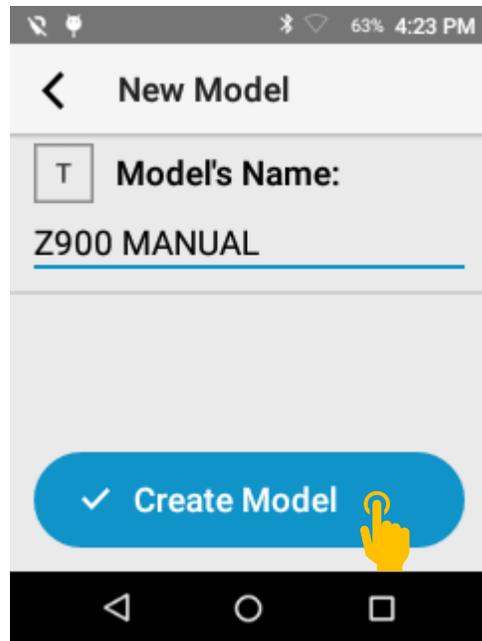
Tap Customize Models



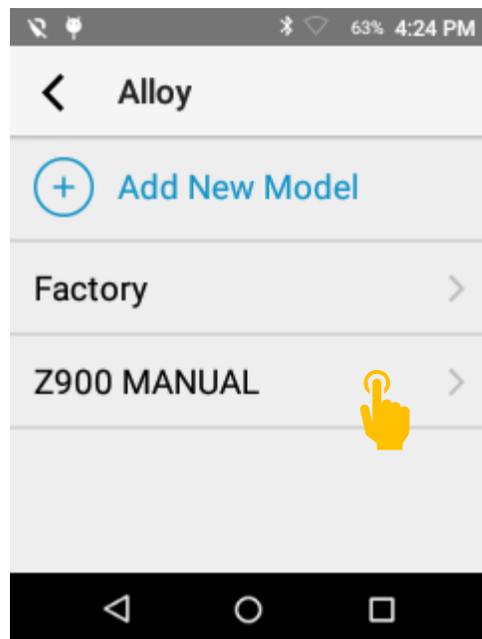
Tap Add New Model



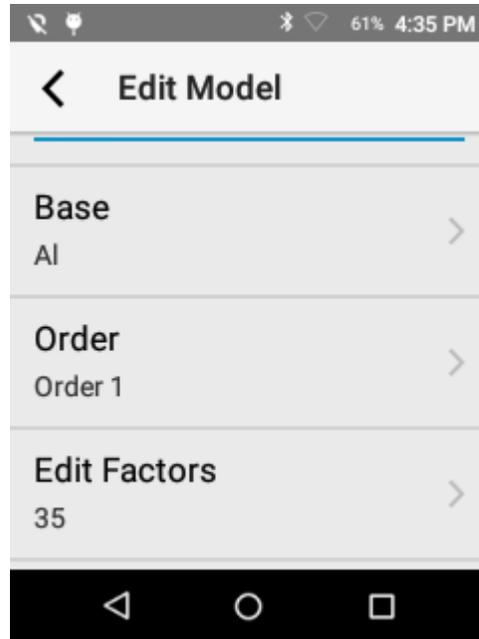
Name Model and tap Create Model



To customize, select the new model (e.g. Z900 MANUAL).



Select Base and Order to filter factors. Order is used for split curves where Order 1 is standard and Order 2 is used for low concentrations. Most elements only have Order 1. Split curves address large concentration ranges (e.g. Zn in Copper alloys).



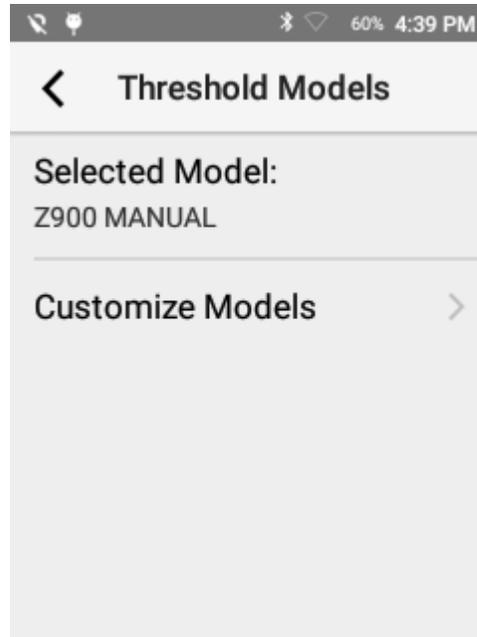
Adjust factors, offsets, LOD sigma and % threshold. Then return to the Adjust User Factors home Screen.

61% 4:37 PM

### AI / Z900 MANUAL

elem	factor	offset	sigma	% thr.
Li	1.0	0.0	3.0	0.06
Be	1.0	0.0	3.0	1.0E-4
Mg	1.0	0.0	4.0	0.06
Al	1.0	0.0	3.0	0.06
Si	1.0	0.0	3.0	0.06

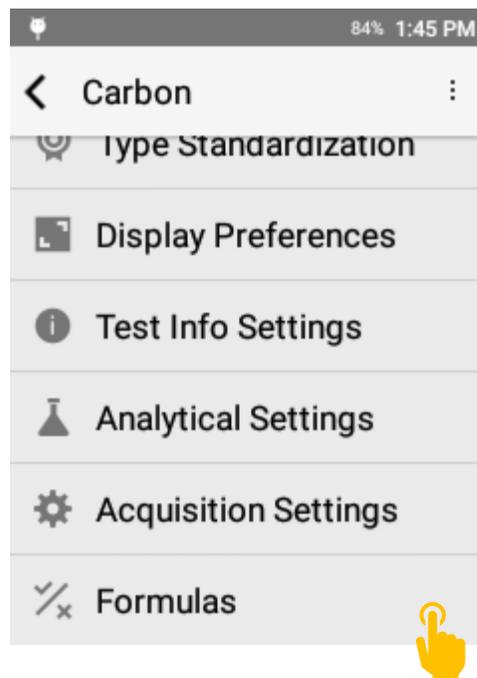
To activate your new adjusted user factors, select the new model from Selected Model drop down.



## 16. Formulas

Create or load formulas to elevate your instrument functionality. Set single element formulas to screen for hazardous materials, load Carbon Equivalent or other complex formulas to save time on calculations. With the added ability of action levels, take the guesswork out of analysis.

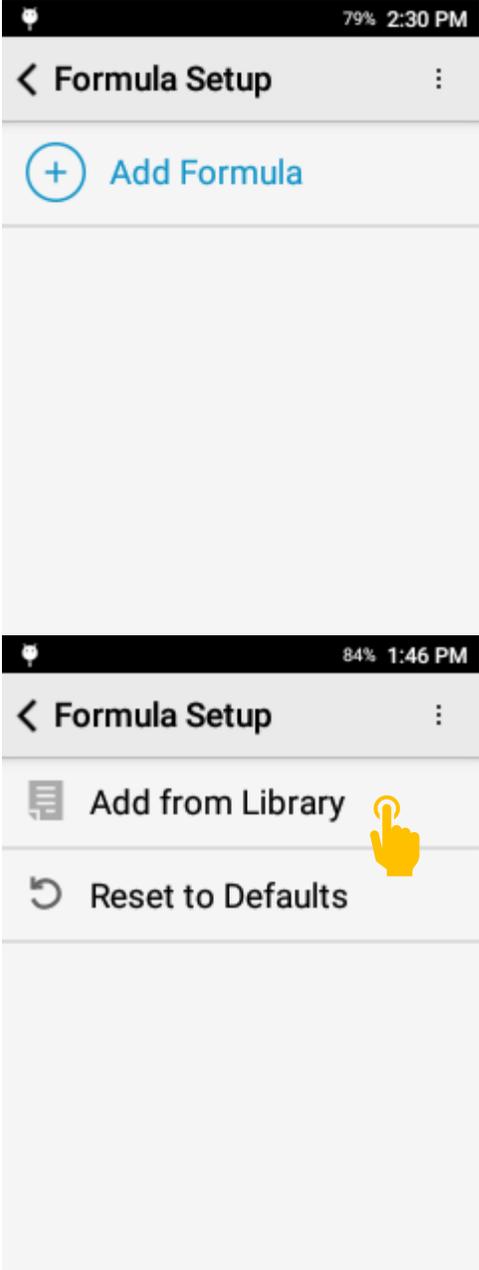
Formulas



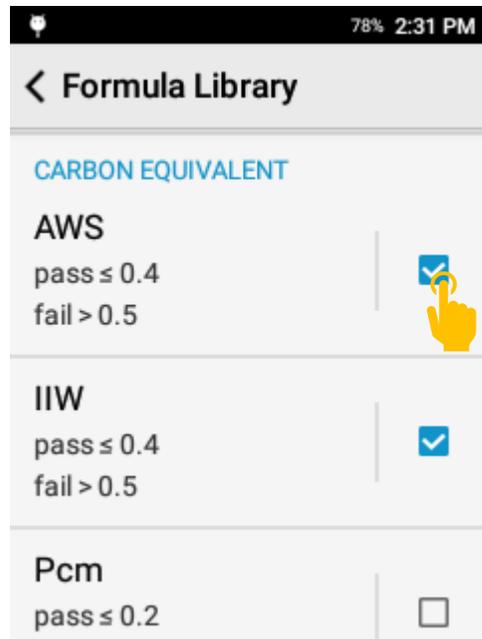
The software supports adding custom formulas or importing formulas from the Factory Library.

**Adding Factory Formulas**

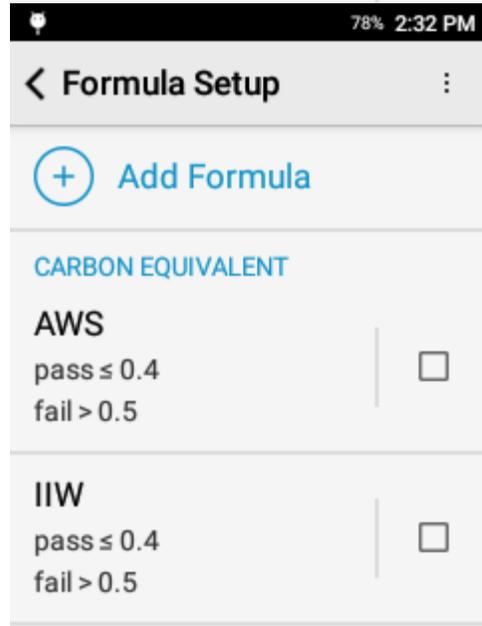
Select Options and tap Add from Library.



Select all formulas to be added and return to the previous screen.



The formulas will now be available.



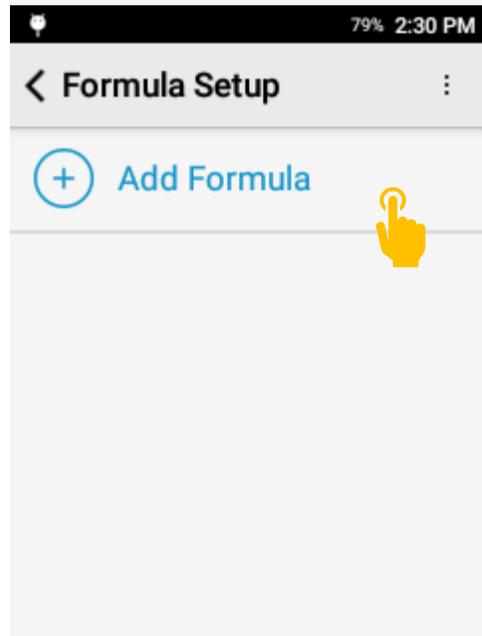
To activate a formula in the app, check the box to the right of the formula.

Multiple formulas may be selected at the same time.

To deactivate a formula, simply uncheck the box.

### Adding a Custom Formula

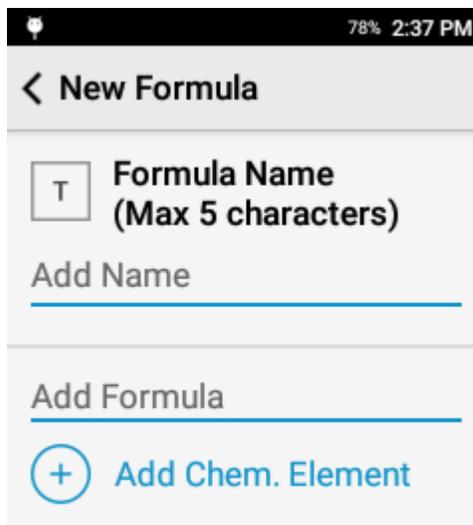
Tap + Add Formula



Enter a Formula Name & Enter the formula.

Addition, Subtraction, Multiplication, and Division are supported for multi-element formulas.

Single element formulas are also supported.



78% 2:37 PM

< New Formula

Formula Name  
(Max 5 characters)

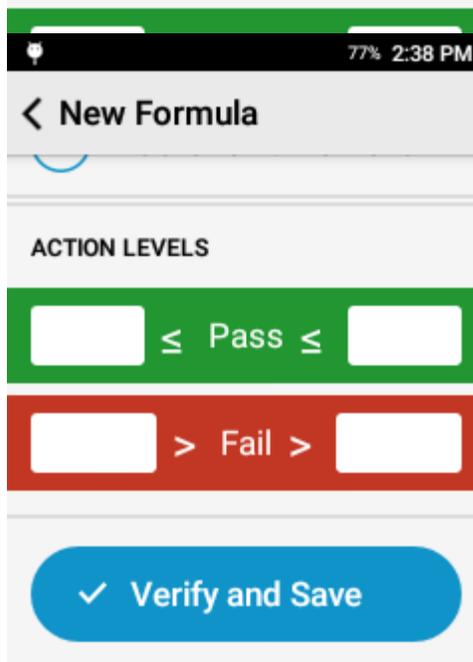
Add Name

Add Formula

+ Add Chem. Element

If you'd like to include an action level, enter a minimum or maximum passing level.

For a simple Pass/Fail setup, only enter a Passing threshold.



77% 2:38 PM

< New Formula

ACTION LEVELS

≤ Pass ≤

> Fail >

✓ Verify and Save

Less than or equal to 1: Pass  
Greater than 1: Fail



≤ Pass ≤

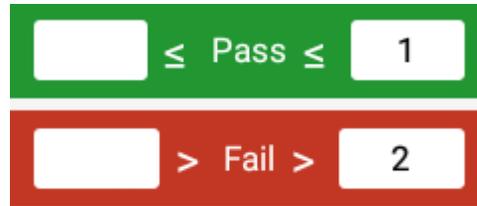
Greater than or equal to 1: Pass  
Less than 1: Fail



≤ Pass ≤

If you'd like to include an inclusive zone, include both a maximum and a minimum.

Less than or equal to 1: Pass  
Greater than 2: Fail  
Between 1 and 2: Inconclusive



Greater than or equal to 2: Pass  
Less than 1: Fail  
Between 2 and 1: Inconclusive

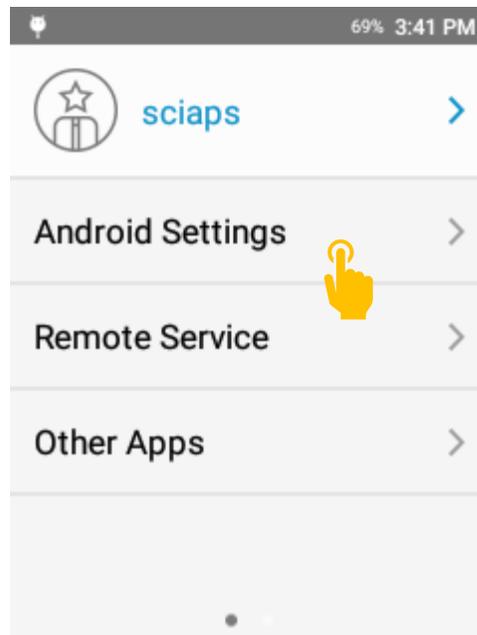


## 17. System Features

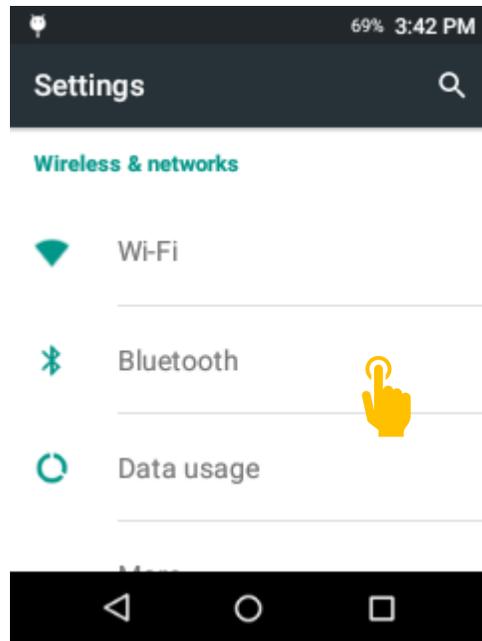
### *Bluetooth*

#### **Activating Bluetooth**

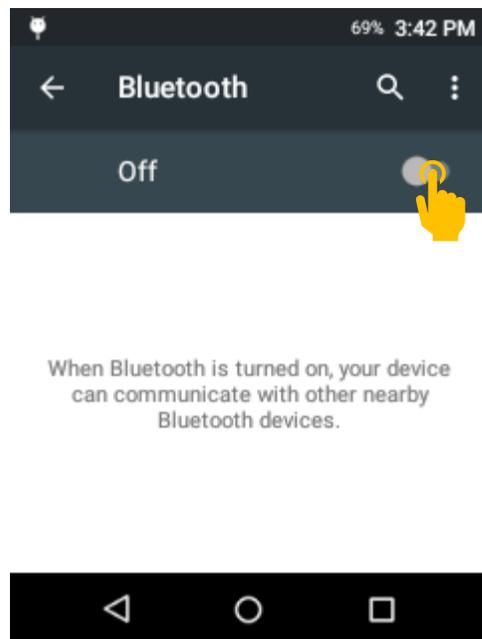
Open Android Settings



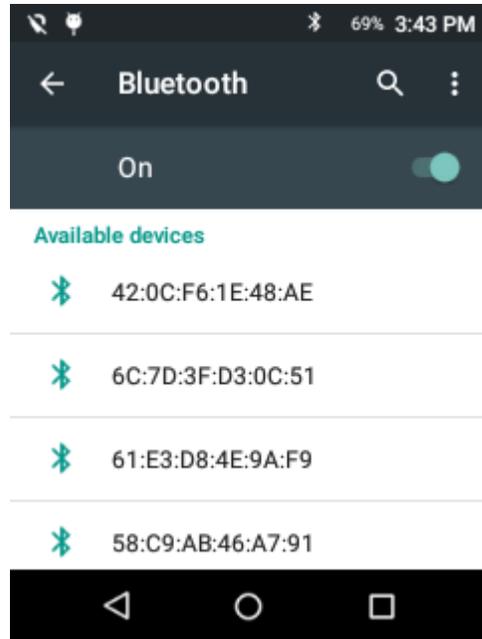
Select Bluetooth



Ensure the slider is turned on



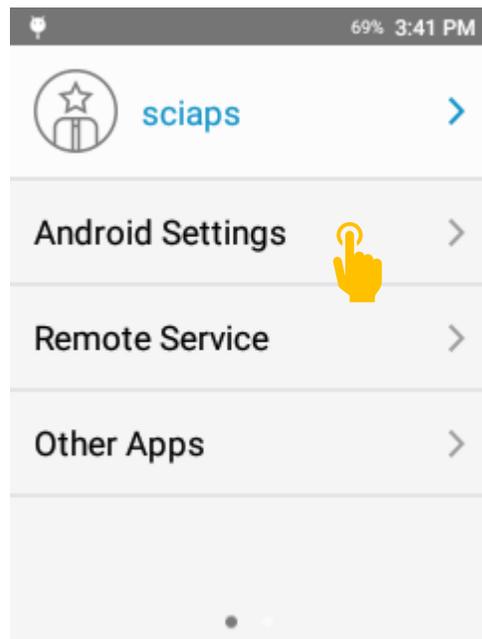
Select your device from the list of Available Devices



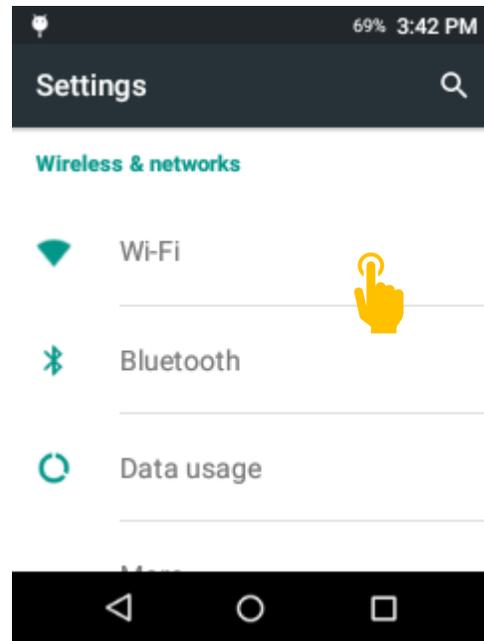
*Wi-Fi*

**Activating Wi-Fi**

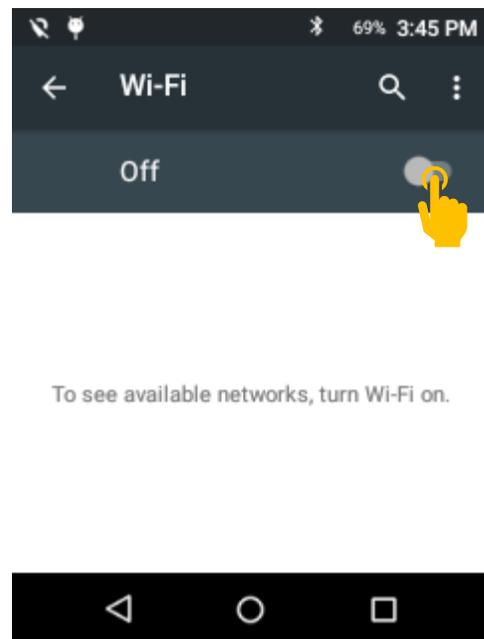
Open Android Settings



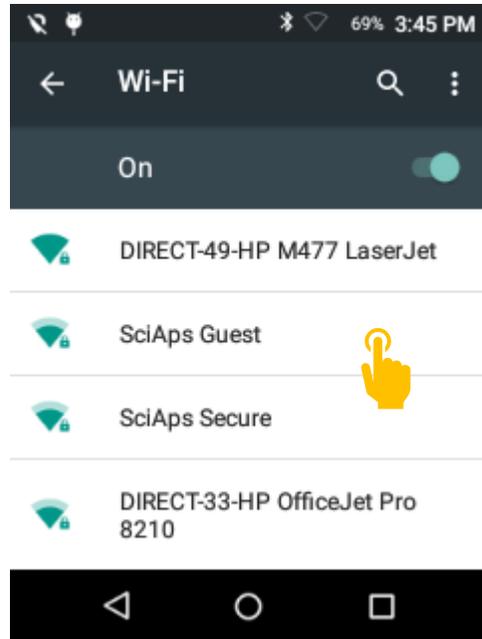
Select Wi-Fi



Turn on Wi-Fi by tapping the slider

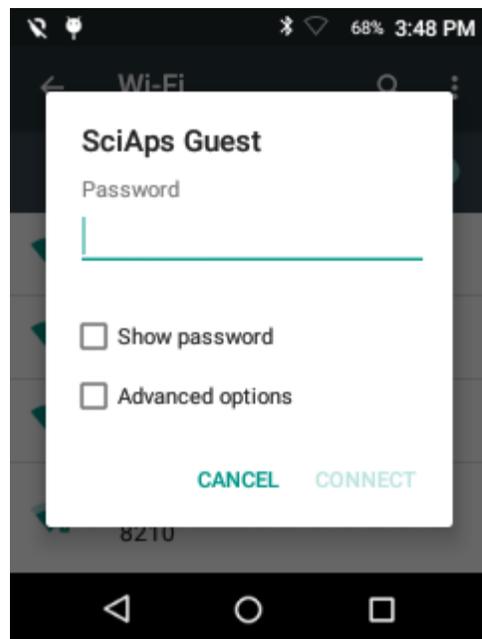
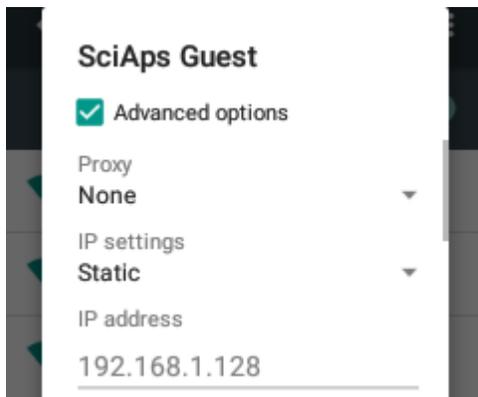


Select your target network



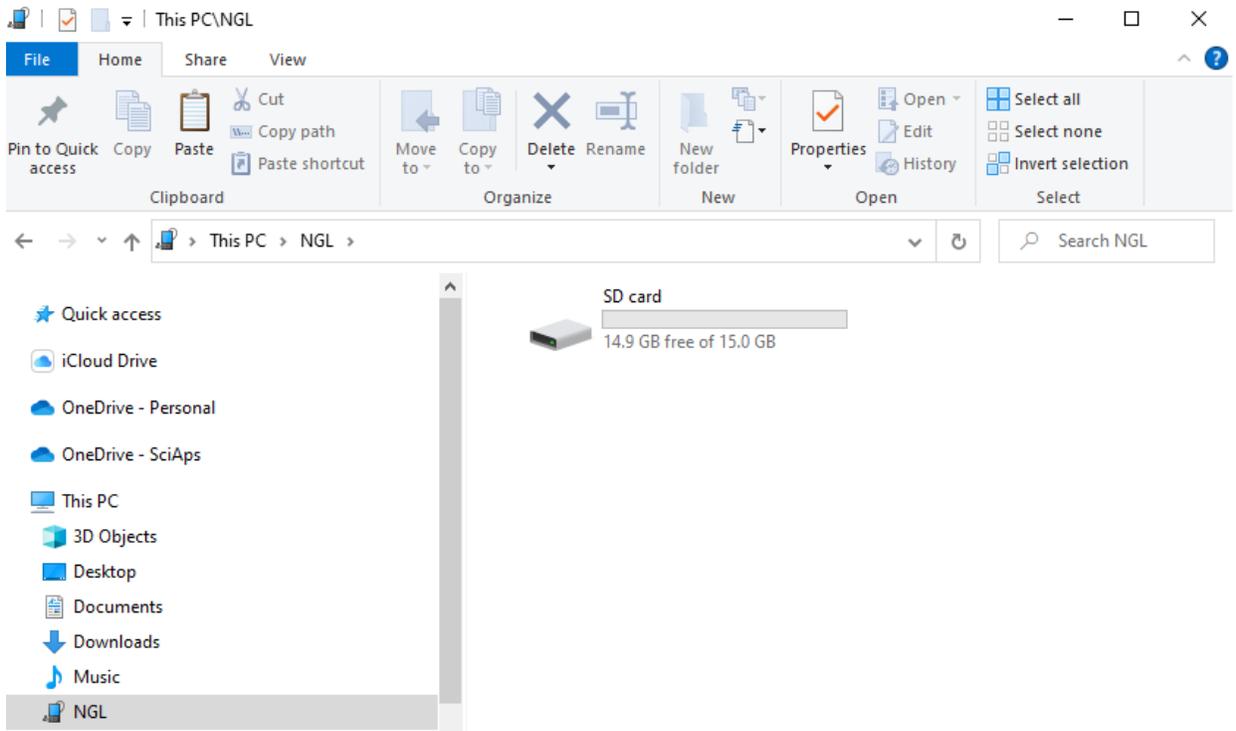
If required, enter Password then click connect.

If the system will not connect, try setting a static IP in the Advanced Options Menu.



### *USB Connectivity*

Connecting by USB is the simplest way to transfer data from your system to a computer. Connect the provided USB-C to USB-A cable to both the analyzer and the target computer. The device will appear under /This PC/ NGL/ SD Card.

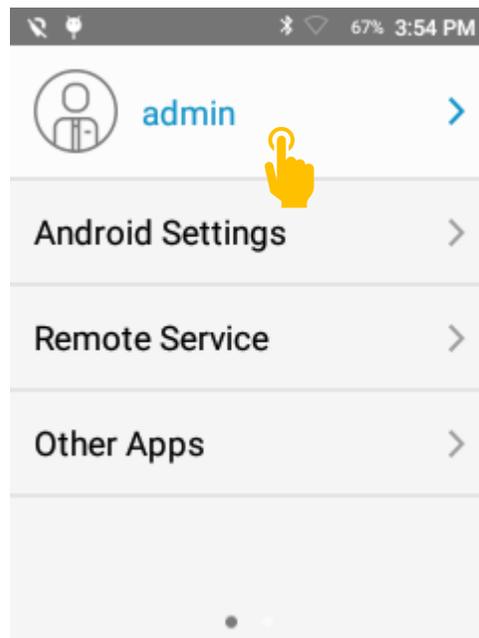


## *User Management*

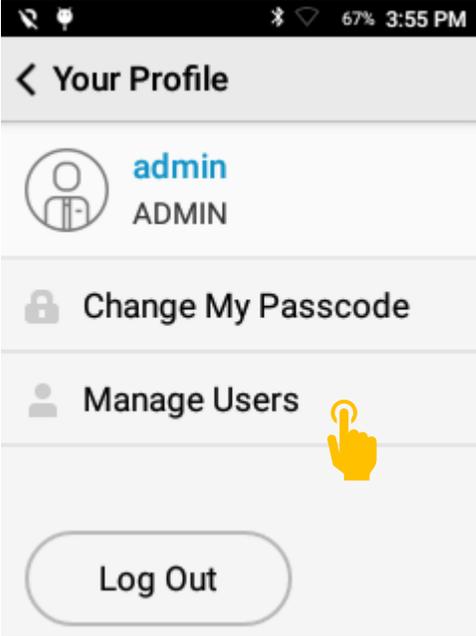
User Management allows the admin to create additional accounts, manage permissions, and reset passwords. Only an Admin can create and manage accounts unless specific permissions are given to an account.

### **Accessing User Management**

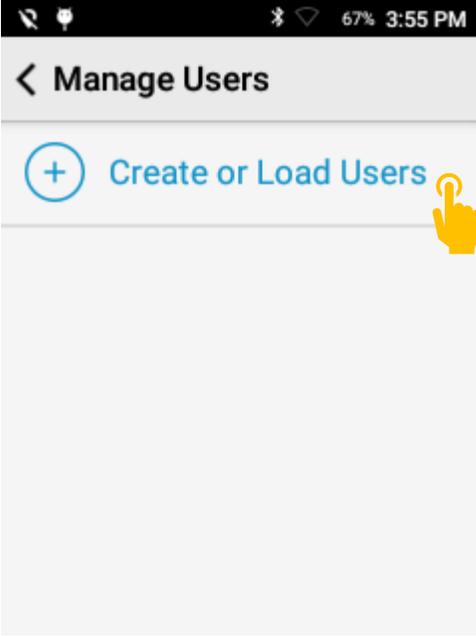
Navigate to the settings page and tap the user icon.



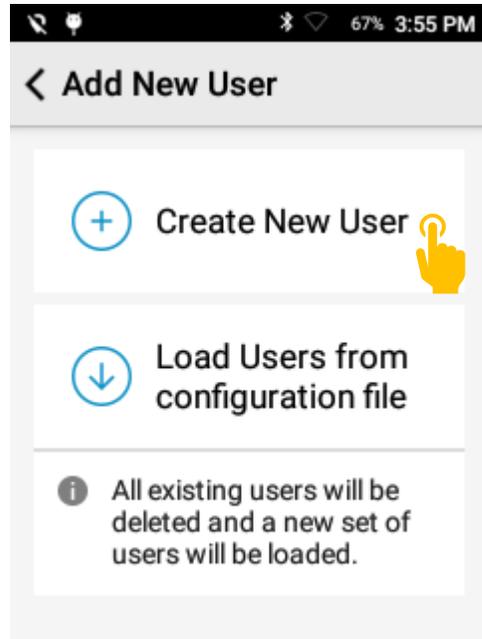
Tap Manage Users to create or manage additional user profiles.



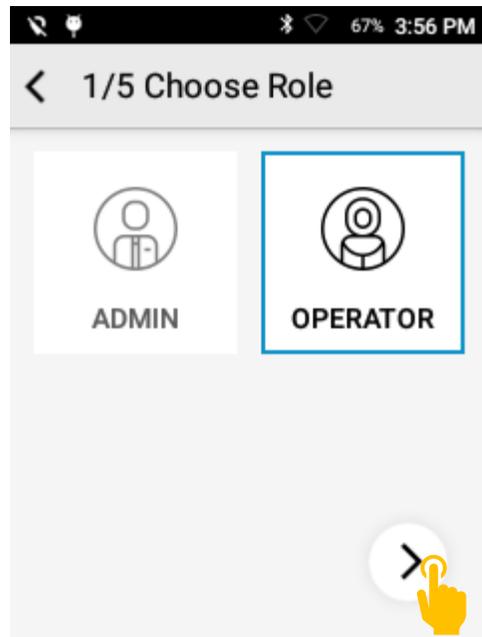
Tap Create or Load Users.



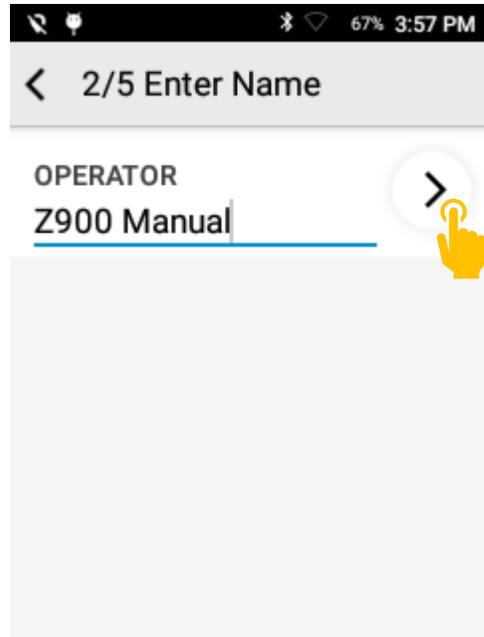
Tap Create New User.



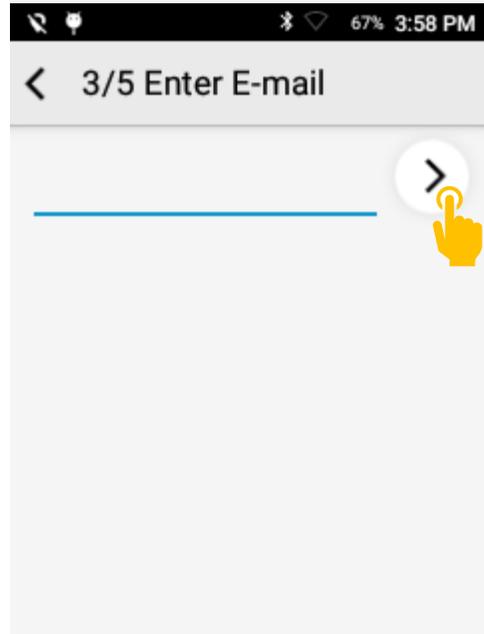
Select Operator or Admin then press > to continue.



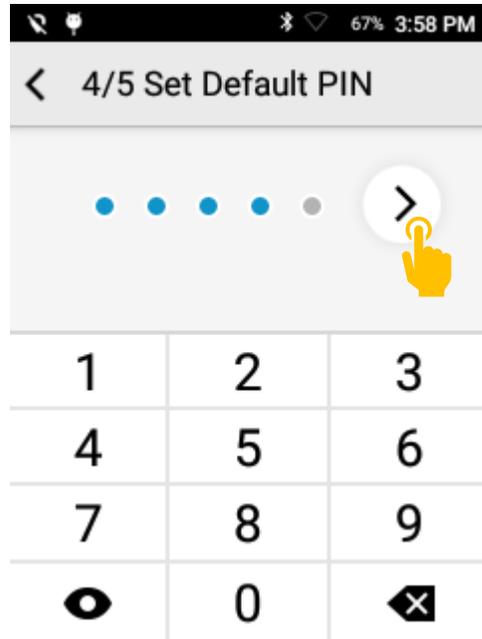
Enter Operator Name then press > to continue.



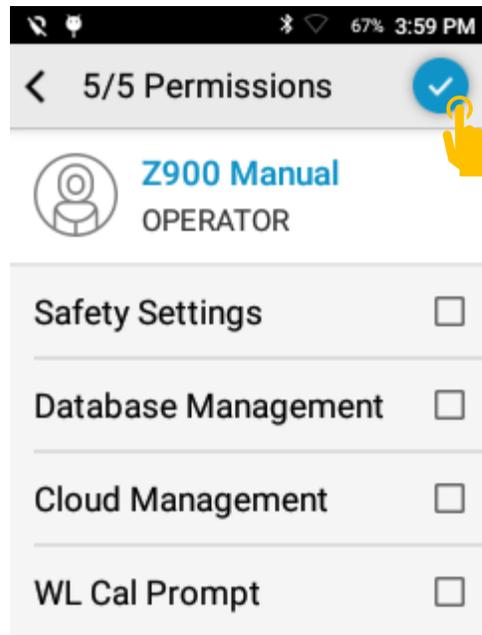
Optional: Enter Email then press > to continue.



Enter 5 digit PIN then press > to continue.



Select Permissions and click the save button.



## 18. Instrument Ownership

### *Maintenance*

The Z-900 Series requires basic periodic maintenance.

#### *Quartz Blast Shield*

Primarily, the quartz blast shield requires regular cleaning. Frequency varies with the number of tests taken. On systems with argon purge, typically the window should be cleaned every 500-

1000 tests. This will vary with environment and material tested. For air-burn systems, the blast shield should be cleaned every 100-500 tests. For low melting point materials, e.g. tin or lead solder, more frequent cleaning may be required.

To clean the blast shield, shutdown the system and remove the two nose plate screws. Using a cotton swab, thoroughly wipe the quartz surface. Note – the black foam gasket should be towards the outside of the system.

The purchase of a Z-900 includes two spare blast shields in addition to the blast shield in the system. If there is significant build up of debris or pitting to this blast shield, it may need to be replaced. Frequent cleaning extends the life of the blast shield.

Note – do not use alcohol or other similar cleaning agents to clean the blast shield on units used for measuring and quantifying carbon. Using alcohol may result in contamination to the system.

#### *Argon*

The argon canister (if equipped) should be replaced when prompted.

In addition to replacing the argon canister, there is a gasket in the regulator that may wear with time and usage. If the system is not delivering the expected number of tests per canister, contact SciAps support – you may need a new argon regulator gasket.

#### *Li-Ion Batteries*

Given normal storage and usage, users can expect the battery to deliver 80% or more of its initial capacity after 300 charge/discharge cycles.

#### *Storage & Transportation*

The SciAps Z-900 Series should always be stored, transported, and shipped in the included protective case with form-fitting foam. Always shutdown the system and remove the battery before putting the instrument into the case. For extended storage, keep the system in an ambient temperature of 50° F – 95° F 10° C – 65° C and humidity between 0 and 95%.

Check travel and shipping restrictions for details about proper handling of Li-ion batteries and argon canisters. Regulations vary by location and vendor.

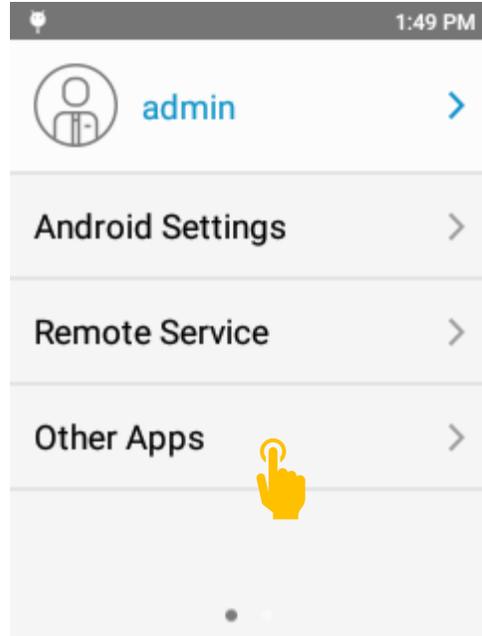
Note – some airlines have restrictions on argon canisters. Check with your airline for specific policy.

#### *Software Updates*

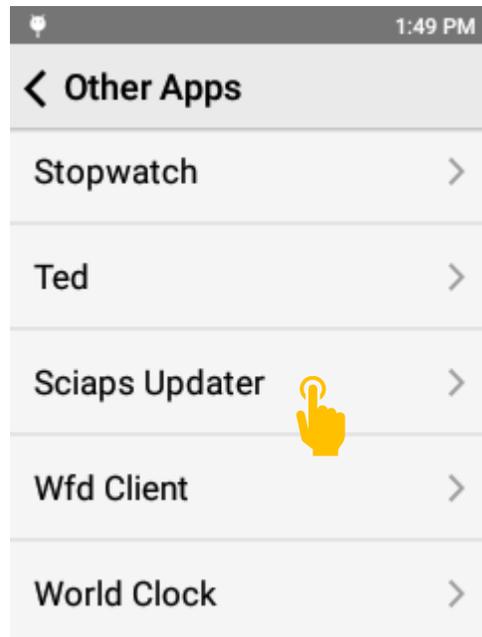
SciAps periodically releases software updates that add features, fix software bugs, and offer other general improvements. Some updates may require the instrument to be returned to the factory, but generally, software updates can be completed remotely.

When a compatible software update is available, SciAps will reach out with an updater file in a .sup format. To run the update, copy the file to the analyzer's SD Card then follow the directions below:

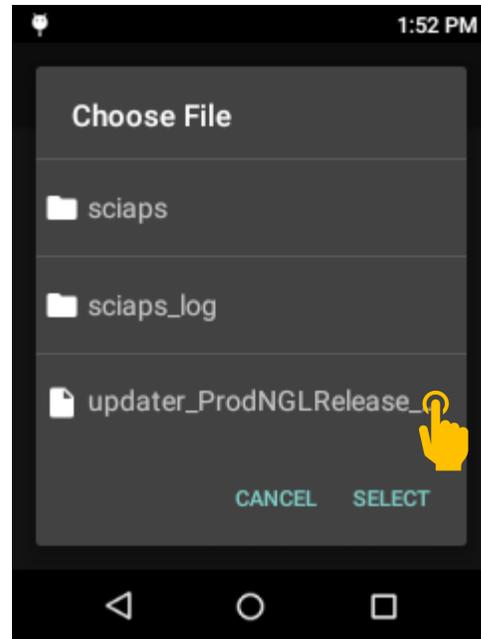
Software updates are driven through the SciAps Updater app. This app can be accessed through Other Apps option.



Scroll to the bottom and select SciAps Updater.

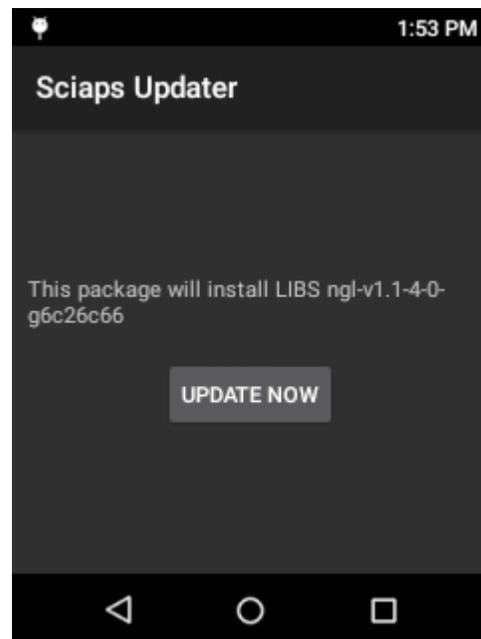


Scroll through the list to find the provided file.  
Select the file and tap SELECT.



The SciAps Updater app will give a brief summary of the contents of the update. Click UPDATE NOW to continue.

The system will often automatically restart after a software update.





## Appendix: Grade Library Management

The Z-900 Series uses a highly user -friendly CSV file format. In the Z-900 Series, the grade library is saved as a csv file. Each library will be app specific and stored in:

SD Card/ sciaps/ App Name e.g. quicksort/ gradetables

The naming convention is:

appname\_LibraryName.csv

App	Filename	Location
Alloy	<b>alloy</b> _Master.csv	SD Card\sciaps\alloy\gradetables
QuickSort	<b>quicksort</b> _Master.csv	SD Card\sciaps\quicksort\gradetables
CSi	<b>carbonsi</b> _Master.csv	SD Card\sciaps\carbonsi\gradetables
Alloy+	<b>alloyplus</b> _Master.csv	SD Card\sciaps\alloyplus\gradetables
QuickSort+	<b>quicksortplus</b> _Master.csv	SD Card\sciaps\quicksortplus\gradetables
Carbon	<b>carbon</b> _Master.csv	SD Card\sciaps\carbon\gradetables
Carbon+	<b>carbonplus</b> _Master.csv	SD Card\sciaps\carbonplus\gradetables

Note 1 – file and folder names are case sensitive.

Note 2 – Only the LibraryName (e.g. Master) will appear in the system UI.

Note 3 – The system only supports csv files – not excel files.

The format of the csv file uses the following approach:

Alloy name	Alloy family*	Standard source*	Personal notes*	Eligible for GM	Element abbrev.*	Element abbrev.**	Match Weight*
name	base	Reference	Comments	enabled	Z_min	H_max	H_MW
1100	Al	A91100	Upd 2020-01-13	TRUE			
2014	Al		Upd 2020-01-13	TRUE			
2024	Al	A92024	Upd 2020-01-13	TRUE			
CDA 197	Cu	C 19700		TRUE			
316	SS			TRUE			
317	SS			TRUE			

\*optional

\*\* A min value should be included if there is a max value

\*\*\*If no max value specified, sw assumes 0

Note 1: Must include a specification for the base element. Simply set from 0 to 100 or calculate by:

Min=100-SUM(max<sub>all other elements</sub>)

Max=100-SUM(min<sub>all other elements</sub>)

In practice, it is a good idea to add a buffer to base elements.

# Appendix: Sample PDF Report



Material Report

10:49 pm, 06/02/2021  
AVG #51



## CARBON

**1040** 98.7

2 - 10L40 95.0

3 - 1030 94.5

### CHEMICAL ELEMENTS

<b>C</b> Carbon	0.374%	± 0.016%
<b>Al</b> Aluminum	ND	< 0.013%
<b>Si</b> Silicon	0.483%	± 0.018%
<b>Ti</b> Titanium	ND	< 0.000%
<b>V</b> Vanadium	0.038%	± 0.002%
<b>Cr</b> Chromium	0.186%	± 0.013%
<b>Mn</b> Manganese	0.709%	± 0.031%
<b>Fe</b> Iron	97.66%	± 0.159%
<b>Ni</b> Nickel	ND	< 0.018%
<b>Cu</b> Copper	0.282%	± 0.006%
<b>Nb</b> Niobium	ND	< 0.043%
<b>Mo</b> Molybdenum	0.225%	± 0.023%
<b>Pb</b> Lead	ND	< 0.012%

### TEST INFO

Free Form  
SciAps-7

Numeric  
902

Selector

Sample ID  
Z900 Manual

CARBON

**1040** 98.7

CHEMICAL ELEMENTS

<b>IIW</b> C+Mn/6+(Cr+Mo+V)/5+(Cu+Ni)/15	0.640% fail	± 0.042%
<b>C</b> Carbon	0.416%	± 0.018%
<b>V</b> Vanadium	0.038%	± 0.002%
<b>Cr</b> Chromium	0.177%	± 0.008%
<b>Mn</b> Manganese	0.700%	± 0.030%
<b>Fe</b> Iron	97.59%	± 0.137%
<b>Ni</b> Nickel	ND	< 0.012%
<b>Cu</b> Copper	0.287%	± 0.010%
<b>Mo</b> Molybdenum	0.217%	± 0.016%

TEST INFO

Free Form  
SciAps-17

Numeric  
902

Selector

Sample ID  
Z900 Manual

