Rigaku Analytical Devices

KT-100 Katana
Product Introduction

September 2016

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Rigaku's Mission

"To Contribute to the Enhancement of Humanity Through Scientific and Technological Development"

Hikaru Shimura, President & CEO

Rigaku provides solutions for a wide range of scientific and commercial industries:
Steel, Security, Petroleum, Pharmaceutical, Nanotechnology, Semiconductor, Academia, and other industries…

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Rigaku Corporate History

Rigaku more than 65 years old

- 1951 Rigaku Corporation (RC) was founded
- 1961 Rigaku Industrial Corp. (RIC) was founded
- 1972 Rigaku/USA, Inc. (RUSA) was founded
- 1989 Rigaku Mechatronics Inc. (RM) was founded
- 1992 Rigaku X-Ray Research Lab. was founded.
- 1996 Acquired Molecular Structure Corporation (MSC)
- 1999 Acquired Osmic, Inc. dba Rigaku Innovative Technologies (RIT)
- 2001 RUSA & MSC were merged to form Rigaku/MSC, Inc. (RMSC)
- 2002 Globalization Initiative
- 2003 ActiveSight and PharmAxess were established.
- 2004 Acquired Molecular Metrology, Inc. and the X-ray (CCD) camera assets of Dalsa Corporation
- 2005 Acquired RoboDesign International Corporation dba Rigaku Automation (RA)
- 2006 RMSC merged into a new corporation, Rigaku Americas Corp. (RAC)
- 2011 Rigaku Raman Technologies founded based around exclusive 1064nm portable Raman technology
- 2015 Rigaku Analytical Devices formed in Wilmington, MA

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RAD Mission & Quality Statements

RAD MISSION STATEMENT

- Rigaku Analytical Devices' mission is to develop and manufacture purposefully engineered portable spectroscopic analyzers aimed at:
  - Supporting the protection of public health and safety;
  - Aiding the advancement of scientific research and academic study;
  - Enabling the recycle and reuse of metal alloys; and
  - Ensuring quality of key metal alloy components in mission critical industries like aerospace and petrochemical.

RAD QUALITY STATEMENT

Rigaku Analytical Devices' core goal is to be recognized globally for quality, reliability and expertise in all aspects of our business. We are committed to providing quality products by continuously improving performance and functionality, resulting in high value to our customers. We strive to consistently meet or exceed our customers' expectations.

Rigaku is a reliable and highly responsive supplier and partner!

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RAD Product Portfolio

Highly ruggedized, purposefully designed and differentiated scientific tools based on optical technologies

Progeny-1064
Launched 2014
Targeted to Pharma, Chem, Academia

ResQ-1064
Launched 2015
Targeted to Safety & Security

KT-100 Katana
Launched 2015
Targeted to Scrap Metal Recycling

Strong Product Plan into Future

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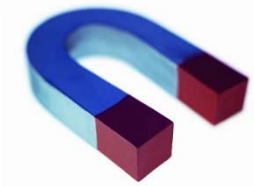
Alloy Sorting and ID Technology

- Common methods of metal sorting & analysis
  - Classical methods



- Spectrographic instruments
  - Different types of instruments
  - Performance capabilities & limitations
  - When to use the various technolog

Portable OES
(Optical Emission
Spectroscopy)

HH XRF
(X-Ray
Fluorescence)

HH LIBS
(Laser Induced Breakdown
Spectroscopy)

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Metals ID and Sorting

- 40 year old mobile OES and portable XRF application for alloy grade ID and chemical analysis
- Over 40,000 handheld XRF alloy analyzers installed

- New LIBS Technology
  - Hundreds installed
  - Can supplement or replace XRF for many applications
  - Can replace OES except for carbon, ppm testing and tramp elements
  - May replace XRF altogether in future?

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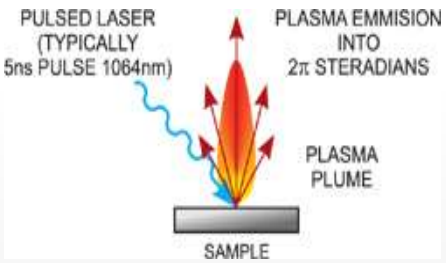
What is LIBS?

- LIBS is an acronym for **L**aser-**I**nduced **B**reakdown **S**pectroscopy
- It is a form of elemental analysis, based on atomic emission spectroscopy.
- Initially it was called **L**aser-**I**nduced **P**lasma **S**pectroscopy or LIPS, but because of the acronym's other meaning it was renamed to LIBS.
- Other terms one may encounter in association with laser based analytical methods:
  - Laser-Induced Fluorescence, LIF
  - Laser Absorption Spectroscopy, LAS



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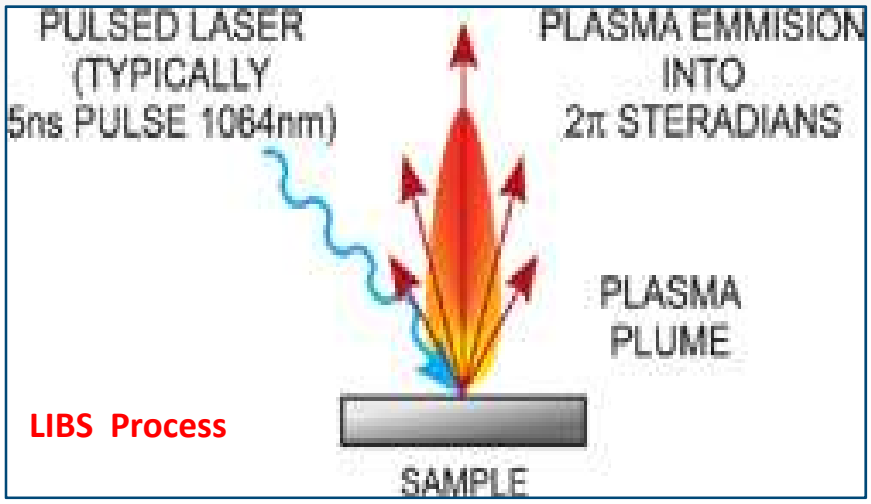
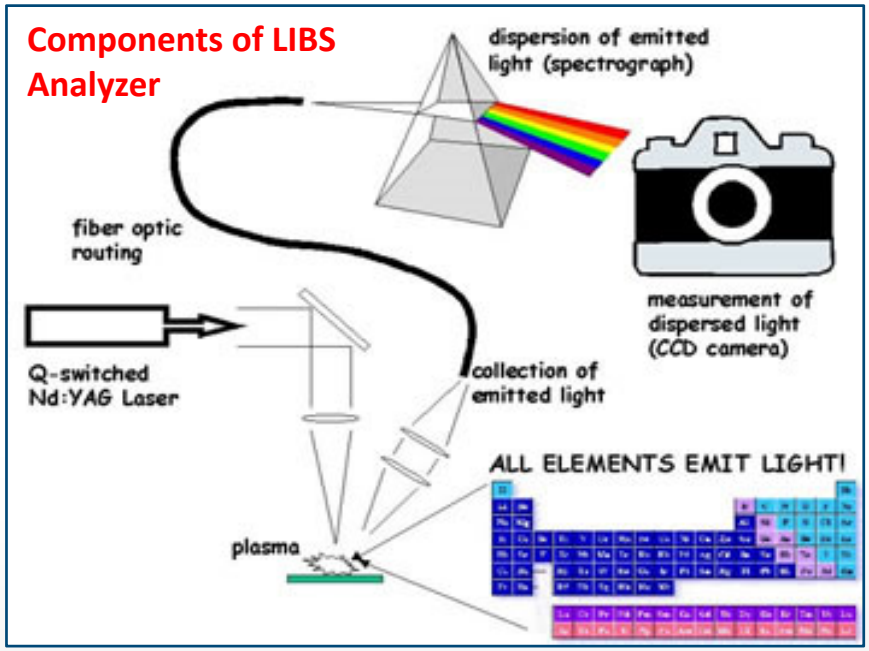
How does it work?

- A high power beam of focused laser light impinges on a sample and:
  - A small mass of the sample is converted to plasma in a process of ablation.
  - Atoms and ions excited in plasma emit their characteristic emission lines (wavelengths)
  - A spectrograph detects the emitted light
  - From those emission lines, the elemental composition of ablated material can be determined





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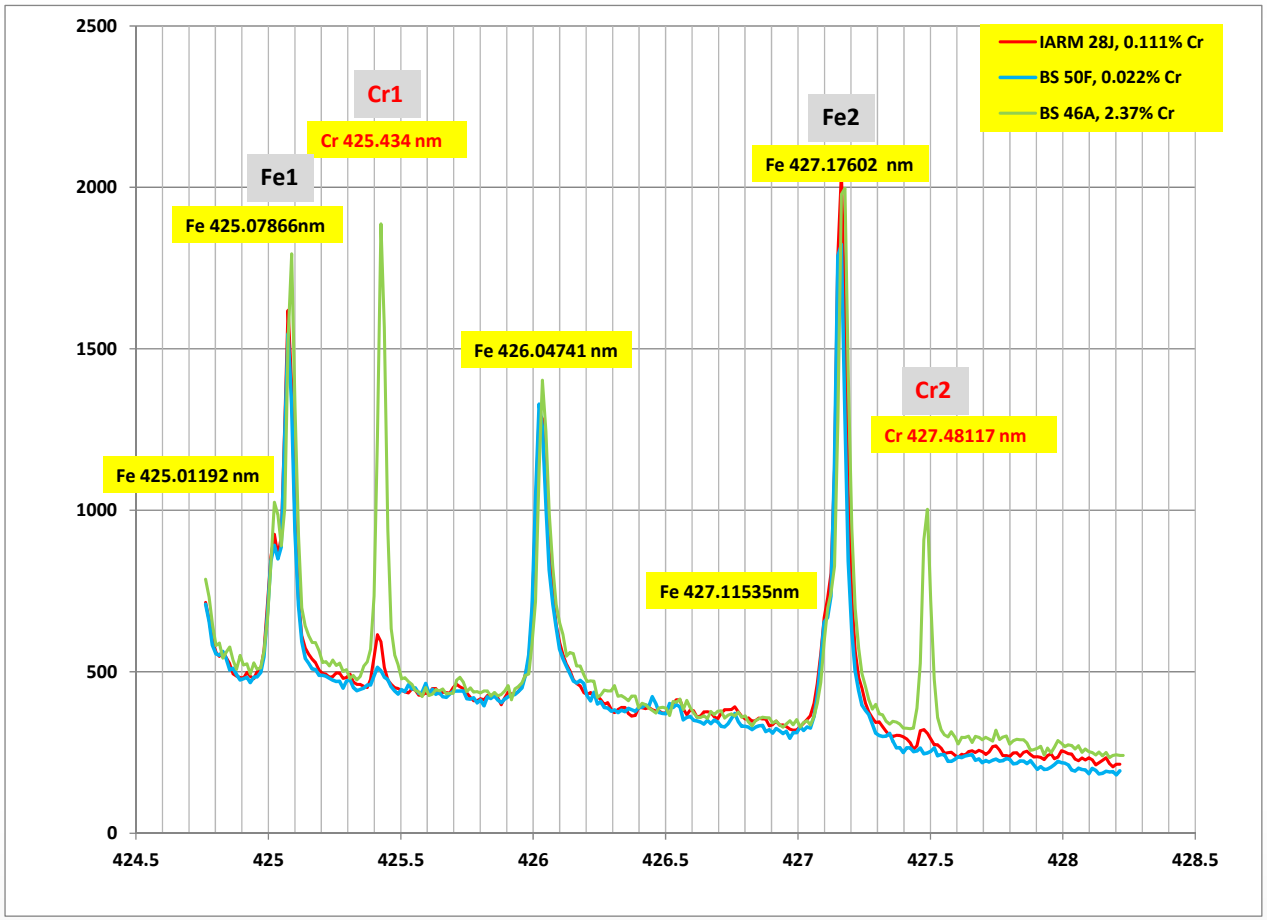
LIBS

- Electrons in plasma settle back to atomic orbitals; emit characteristic photons
- LIBS uses a grating, optics and CCD to measure wavelength (i.e. energy and number) of the photons
- Many more peaks (lines) than XRF; more complicated.
- Chemistry determined from empirical calibrations



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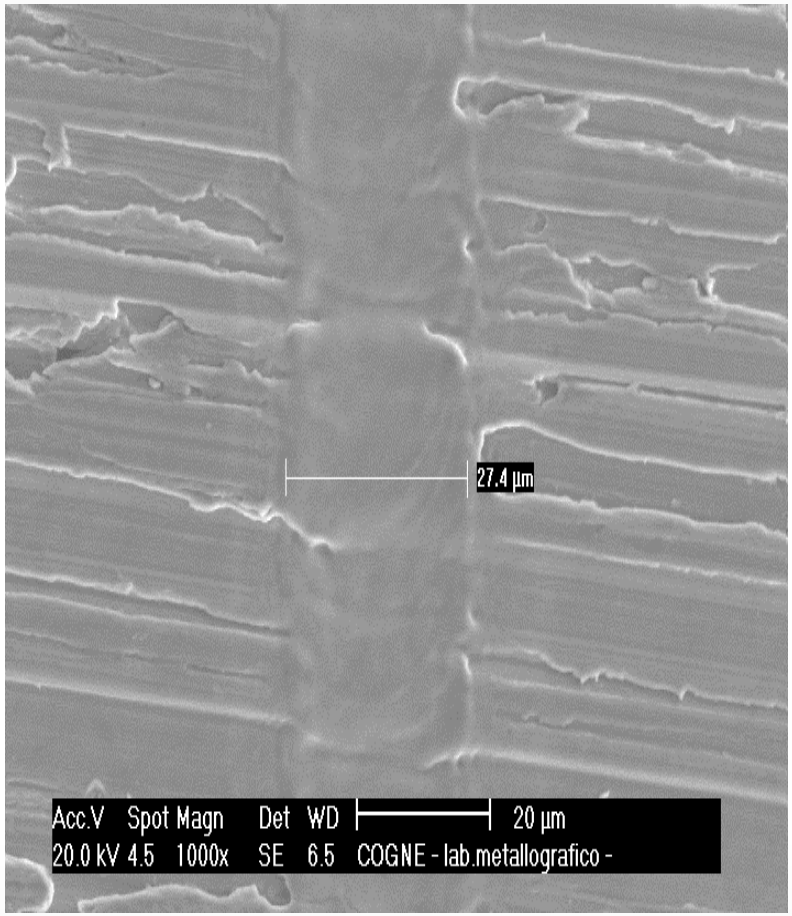
LIBS: Destructive or Non-destructive?

- A (virtually) non-destructive technique
- A microscopic amount of material is consumed – as little as 1 billionth of a gram
- SEM indicates the burn channel may be 1 micron deep and less than 30 microns wide in steel.
- During the laser pulse the power density at the sample surface can exceed 1 Gigawatt per cm^2
- However, the average power delivered to the sample per test is much less than 1 Watt – almost no sample heating surrounding the test area



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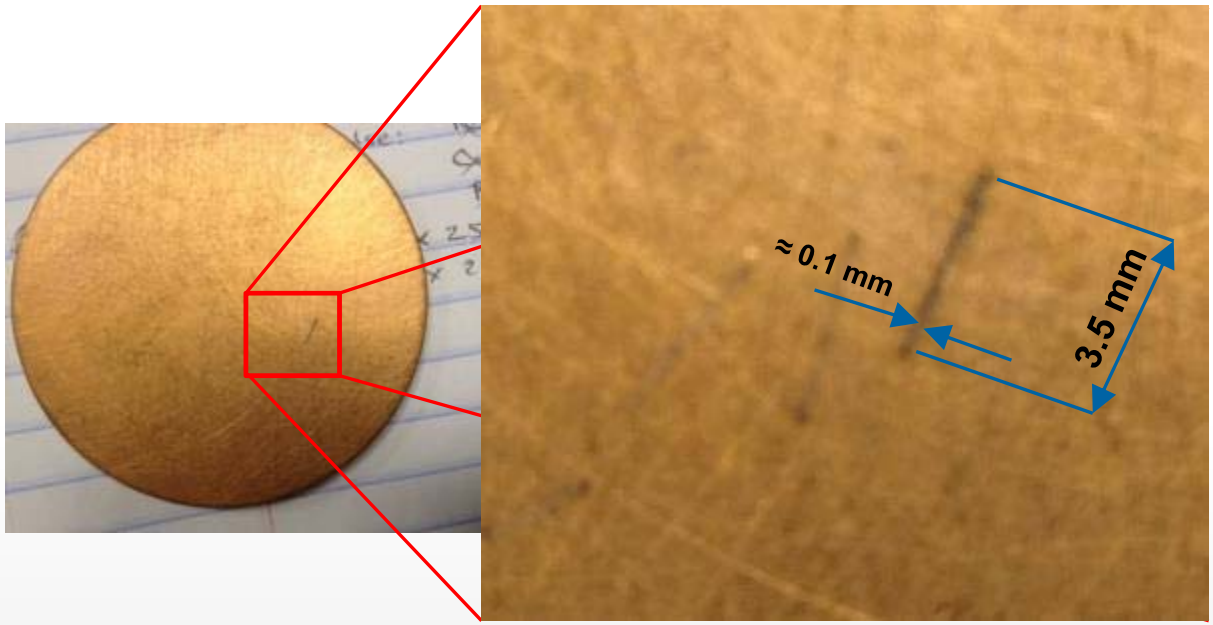
Specifics of µLIBS ("Micro-LIBS")

- LIBS using microchip lasers with peak power less than 1 mJ, as is found in the KT-100, is traditionally referred to as µLIBS (micro-LIBS).
- µLIBS signal decreases with time if laser beam is kept at the same spot on sample (oxidation processes, getting out of focus and higher threshold energy for molten metal than for the solid one)
- Sample needs to be translated in relation to the pulsed laser beam: <u>rastering</u>



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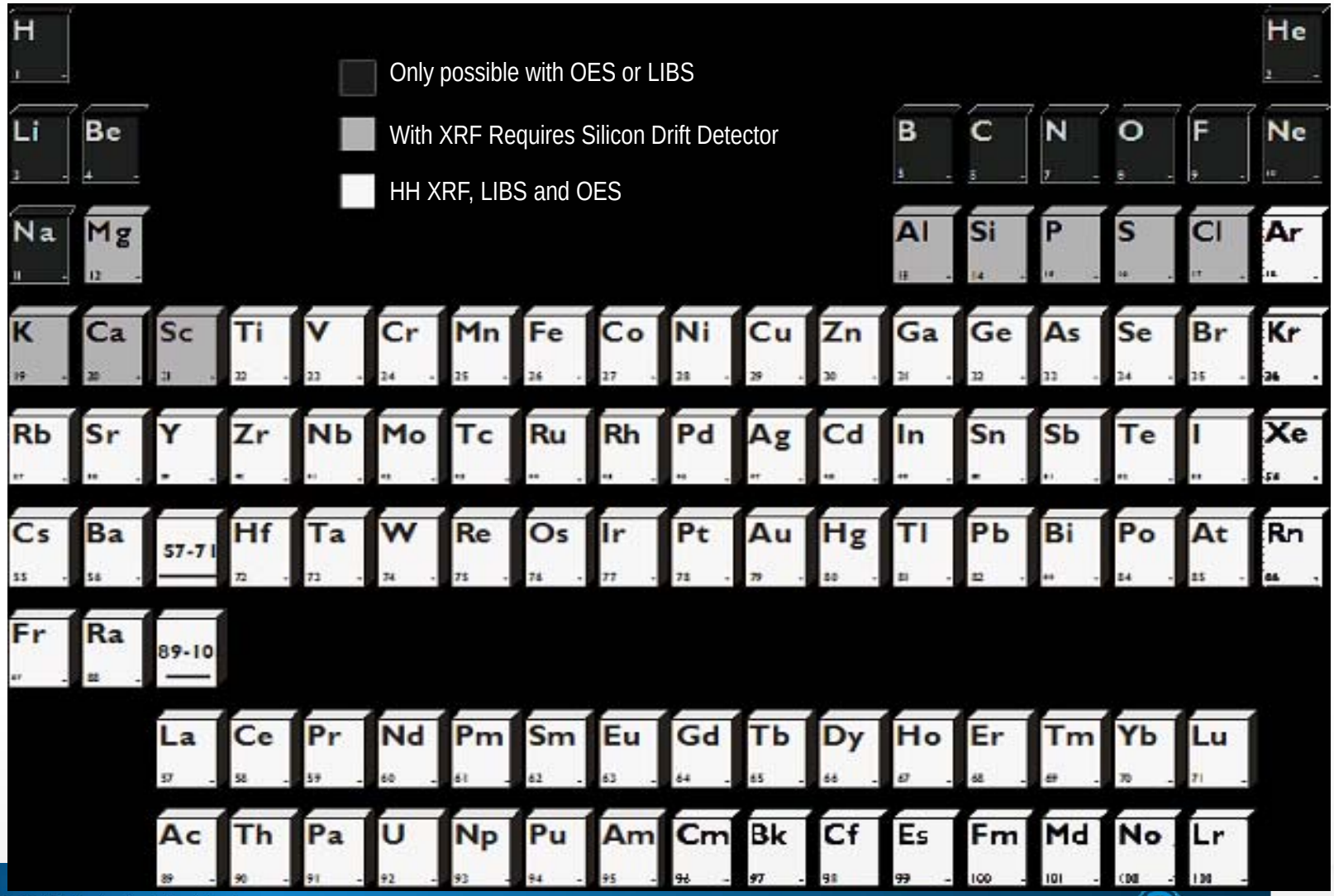
What elements are needed for accurate sorting?



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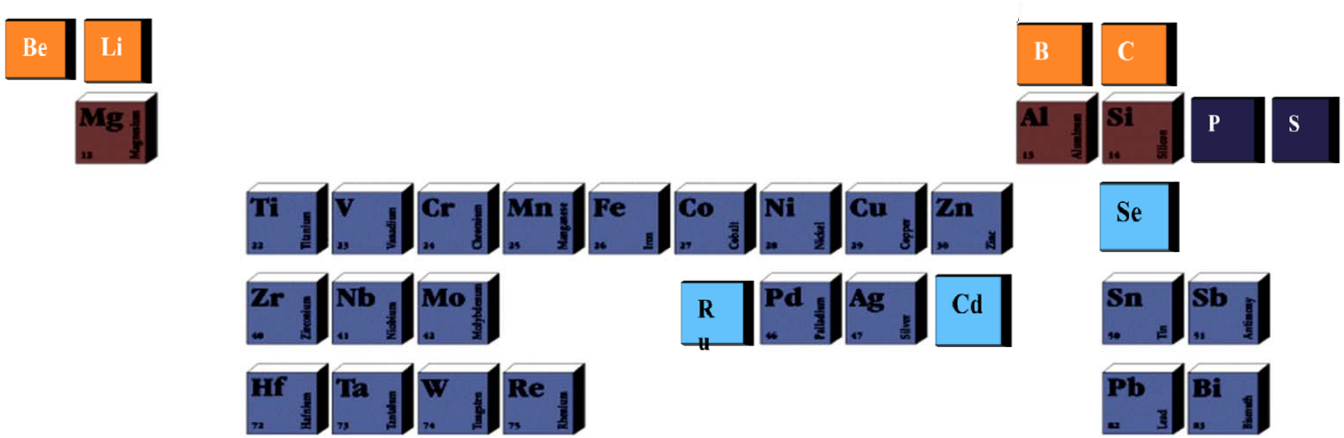
Selected Alloying Elements

Alloying Elements = 25 to 34

Alloy Library = 300 to 400



LIBS and OES can add light elements such as Be, Li, B, C and provide high performance with Mg, Al, Si

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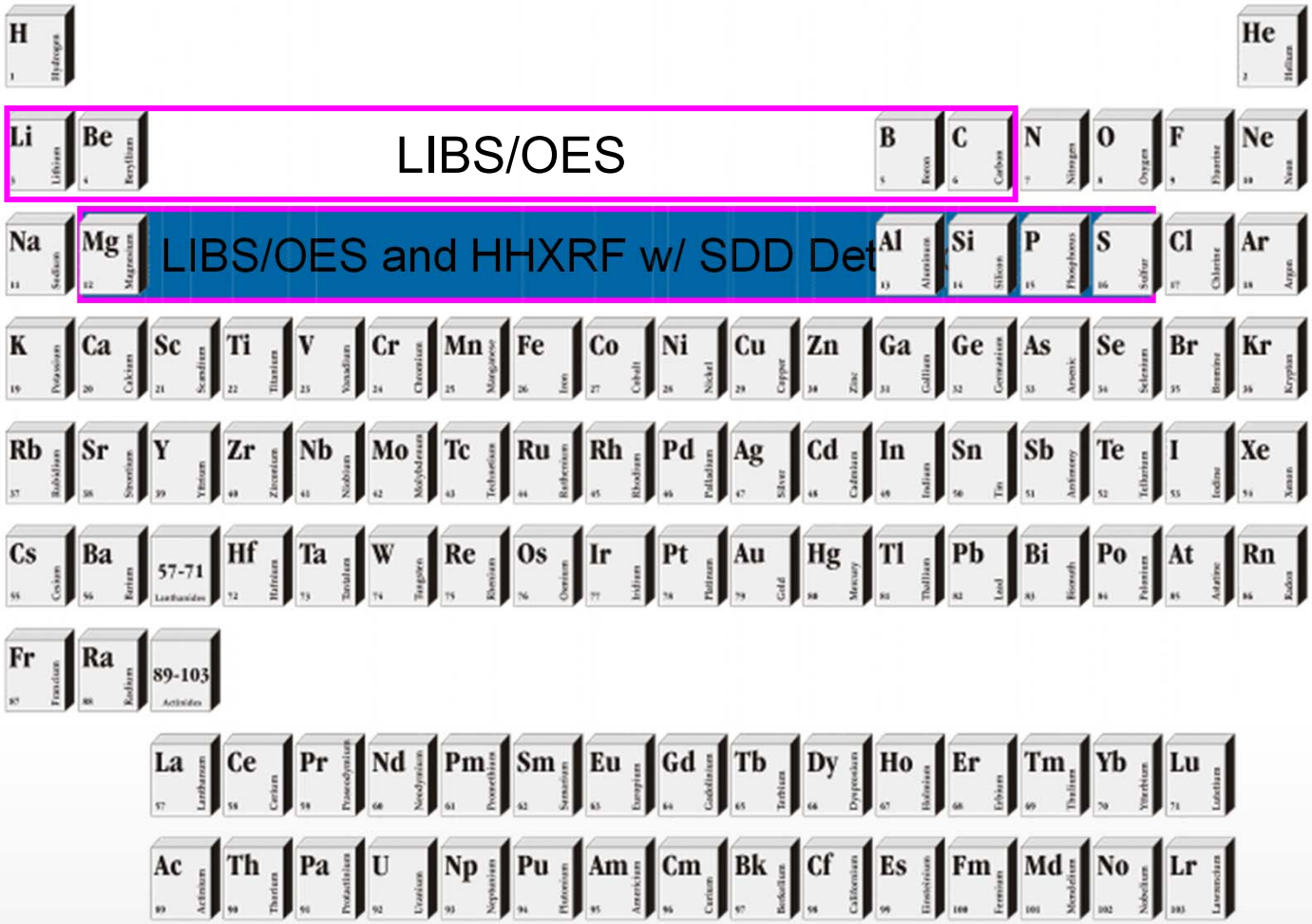
Do you need Light Element analysis capabilities?

LIBS/OES extends element range to Mg, Al, Si, P, S
(and Li, Be, B, C with High Performance LIBS)



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KT-100 Element Calibrations

Matrix	Elements
Al	Mg, Al, Si, Mn, Fe, Ni, Cu, Zn
Ti	Al, V, Ti, Cr, Mn, Zr, Mo
Low Alloy Steel	Si, V, Cr, Fe, Mn, Co, Ni, Mo, W
Stainless Steel	Al, Ti, Cr, Mn, Ni, Cu, Mo
Stainless (Co)	Cr, Mn, Co, Ni, Cu, Mo
Cu	Be, Al, Si, Mn, Fe, Ni, Cu, Zn, Ag, Sn, Pb, Bi
Ni	Ti, Cr, Mn, Fe, Co, Ni, Mo, W
Co	Al, Ti, Cr, Mn, Fe, Co, Ni, Mo, W

* Additional elements available if within performance capability

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Surface Preparation

- LIBS is a surface technique so contamination will be included with plasma and will impact the results.
- For that reason, KT-100 analysis time includes ~1 second of pre-burn to improve data quality.
  - Pre-burn **Drill Down** can be increased when there is visible surface contamination or oxidation.
  - For most surfaces, setting **Drill Down** to "Light" will improve data quality.
  - For heavier contamination, scale, or even anodization, use "Medium" or "Heavy" **Drill Down** setting.

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Surface Preparation continued

- Utilize an angle grinder or Dremel to prep surface of samples that may have non-representative surfaces
  - Pb precipitating in Cu alloys
  - Elevated Si on surface of cast Al alloys
  - Elevated Ni on surface of in-service petrochem high temp alloys
- Wires or turnings
  - Best if flattened and straightened with pliers
  - Calibration has normalization, so sample does not need to cover entire raster track
  - Focal Point is very important! Be aware of distance to sample surface.
- Samples should be dry
  - Use a towel if samples are wet

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Example of LIBS Quantitative Results

2 second measurement time

Sample Measured	Identified as:		Match Quality	Al	Ti	Cr	Mn	Fe	Ni	Cu	Mo
SS 304	SS 304	Aver:	0.946	0.023	0.02	18.775	1.935	69.367	8.785	0.432	0.663
		Stdev:	0.038	0.005	0.000	0.874	0.106	0.986	0.346	0.054	0.215
SS 316	SS 316	Aver:	0.938	0.024	0.017	17.756	1.517	66.561	11.885	0.407	1.83
		Stdev:	0.058	0.010	0.005	0.955	0.059	1.187	0.404	0.033	0.398

Sample Measured	Identified as:		Match Quality	Mg	Al	Si	Mn	Fe	Ni	Cu	Zn
AA 7050	AA 7050	Aver:	0.808	2.212	85.769	0.21	0.087	0.333	0.006	2.674	8.705
		Stdev:	0.045	0.086	0.322	0.064	0.044	0.048	0.019	0.119	0.106
AA 7075	AA 7075	Aver:	0.936	2.317	89.18	0.151	0.129	0.565	0.024	1.271	6.367
		Stdev:	0.045	0.112	0.316	0.036	0.035	0.084	0.048	0.047	0.172

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Strengths and Benefits versus HHXRF

Strengths of Handheld LIBS Technique / KT-100:

- Light elements with good accuracy and precision in a single 2-second shot; saves time/money! More capabilities for Al and Cu alloys versus HHXRF
- Ruggedized! No repair pain-points like HHXRF. Saves ordinary HHXRF upkeep costs in replacing detector/tube of ~ USD 7k - 12K
- Use in harsh environments (IP 54); no weather-related delays
- No breakage when dropping from 1 meter (Mil-Spec 810G); saves down time and costs
- No radiation safety issues/danger of exposure to ionizing radiation
- No x-ray registration or isotope licensing issues; no worries/no hassles
- Fast, effective alloy sorter, ideal for all small and medium scrap yard 'money' alloys; payback can be weeks to months
- Improves sort table throughput for large yards leading to increased profits
- Off the shelf batteries, less expensive, saves $
- Long battery use time: 6+ hours plus spare battery = 12 hours
- Flip up screen: easy to view under any conditions of testing
- Optional GPS for asset security

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Rigaku KT-100 LIBS Specifications

- ✓ Proprietary Laser/Optics package
- ✓ Optimized Miniaturized CCD Spectrometer
  - ✓ Wavelength range: 220-480 nm; Resolution: <0.2 nm;
- ✓ Rastering and user selectable DRILL DOWN for improved analysis of heterogeneous samples or non-representative surfaces
- ✓ Easy to use, simple User Interface
- ✓ Redundant interface w/ keypad, touchscreen and quick launch buttons
- ✓ Flip-up screen for easy viewing in any lighting condition
- ✓ Integrated camera for capturing macro images
- ✓ Environmental and Ergonomics
  - Rugged, ergonomic form factor; 5-40 C;
  - IP 54 rating
  - Mil Spec 810G
  - 1.5 Kg, 200 x 90 x 300; pistol shape, pointed nose, trigger actuated
- ✓ Integrated GPS Module (optional)
- ✓ Industry leading battery life
- ✓ Unique “kick stand” foot for sitting analyzer in optimum viewing and grabbing position

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Included with KT-100

Each KT-100 package includes:

- KT-100 analyzer
- Two rechargeable batteries
- External docking station with battery slots for charging batteries
- 12-volt AC adapter compatible with both the docking station and the analyzer
- USB stick with KT-100 software and *User Manual* (in PDF format)
- USB cable for docking station or direct analyzer data backups
- Factory Calibration Certificate
- *KT-100 Analyzer Quick Start Guide*
- Rugged carrying case

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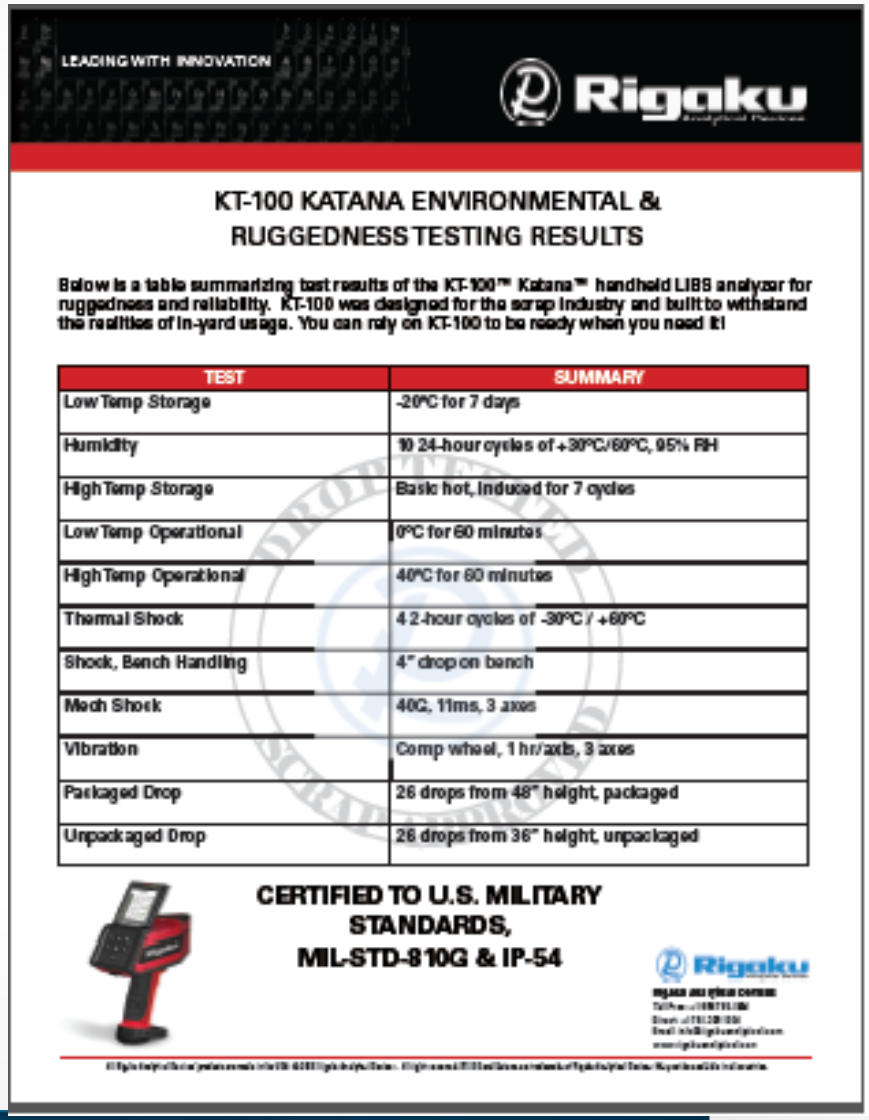
KT-100 Mil Spec Testing



LEADING WITH INNOVATION

Rigaku

KT-100 KATANA ENVIRONMENTAL & RUGGEDNESS TESTING RESULTS

Below is a table summarizing test results of the KT-100™ Katana™ handheld LIBS analyzer for ruggedness and reliability. KT-100 was designed for the scrap industry and built to withstand the realities of in-yard usage. You can rely on KT-100 to be ready when you need it!

TEST	SUMMARY
Low Temp Storage	-20°C for 7 days
Humidity	10 24-hour cycles of +30°C/60°C, 95% RH
High Temp Storage	Basic hot, induced for 7 cycles
Low Temp Operational	0°C for 60 minutes
High Temp Operational	40°C for 60 minutes
Thermal Shock	4 2-hour cycles of -30°C / +60°C
Shock, Bench Handling	4" drop on bench
Mech Shock	40G, 11ms, 3 axes
Vibration	Comp wheel, 1 hr/axis, 3 axes
Packaged Drop	26 drops from 48" height, packaged
Unpackaged Drop	26 drops from 36" height, unpackaged

CERTIFIED TO U.S. MILITARY STANDARDS, MIL-STD-810G & IP-54

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Key to the Rigaku HH-LIBS Solution

Feature: Mil-Spec 810G

Advantage: Only truly rugged hand-hand-held analyzer on the market. True drop tested reliability.

Benefit: Hand-held analyzer finally built for the way people work and the environment they work in. Reliability with durability is the number one pain point for HHXRF users in the Scrap markets. HHLIBS, finally, offers the promise of an alternative and comparable technology that can be fully and truly ruggedized

Feature: Small, efficient purpose-built Micro-LIBS laser

Advantage: Smaller, lighter unit with longer battery life

Benefit: less fatigue and downtime. Significantly lower costs than SciAps and TSI unit.

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Key to the Rigaku HH-LIBS Solution

Feature: Best in class algorithm and calibration

Advantage: better accuracy, better alloy sorting library utilizing vast in-house knowledge of metal alloys and calibrations

Benefit: better results equals more money for customer

Feature: Rigaku brand

Advantage: service, support, application knowledge, quality

Benefit: opportunity as new player in market but with established reputation to win over people looking for a fresh start

Feature: Purpose built integrated processor and software interface

Advantage: Less distraction of apps and games for users and No data hacking issues.

Benefit: User analyzes sample with fewer bugs and lock-ups. Also, there is more opportunity for ruggedization, less reliance on third party products, and longer battery life.

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Guide to using the Rigaku KT-100 Katana

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KT-100 Top View

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KT-100 Side View

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KT-100 Connections

Power and micro USB connectors

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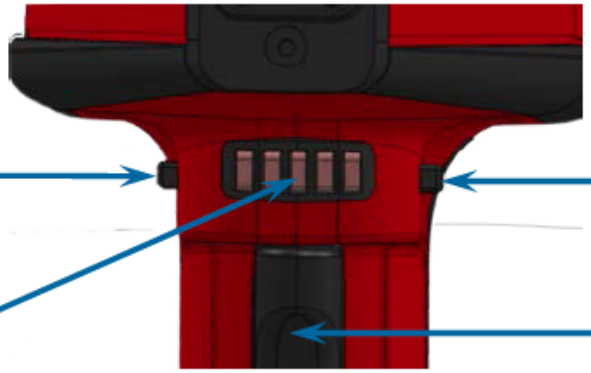
KT-100 Charging Batteries

Figure 12. Katana Docking Station Connector



Once the analyzer is in the cradle, the docking station's analyzer status light shows the charge status:

- Red—Analyzer is still charging.
- Green—Analyzer is charged.

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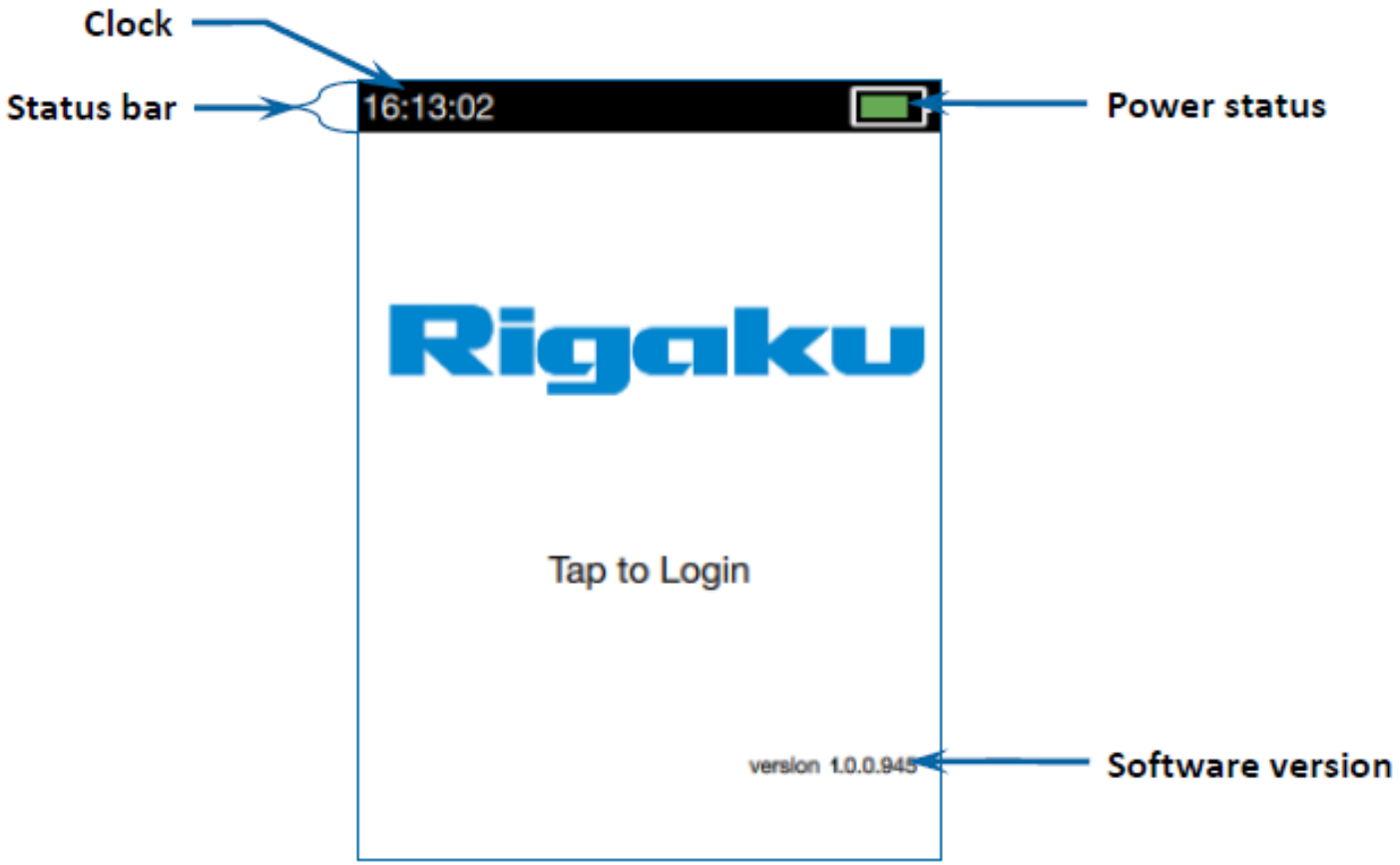
Home Screen



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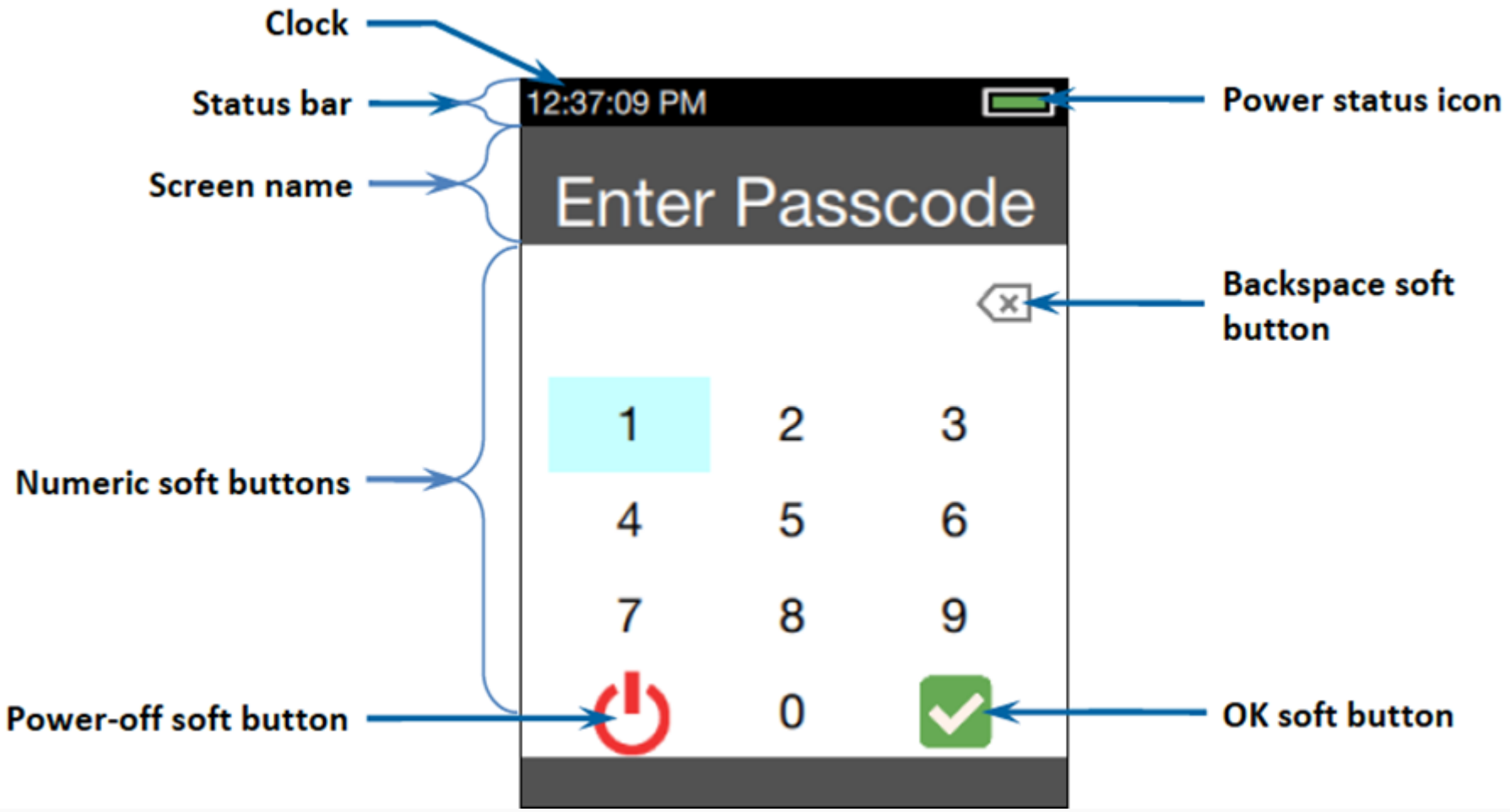
Password Screen



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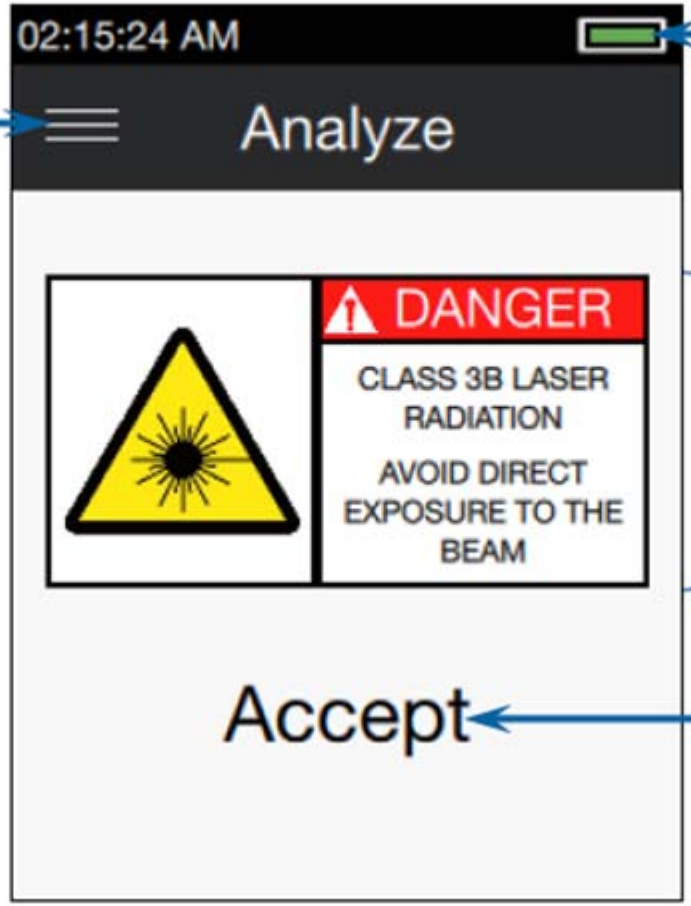
Laser Warning Screen



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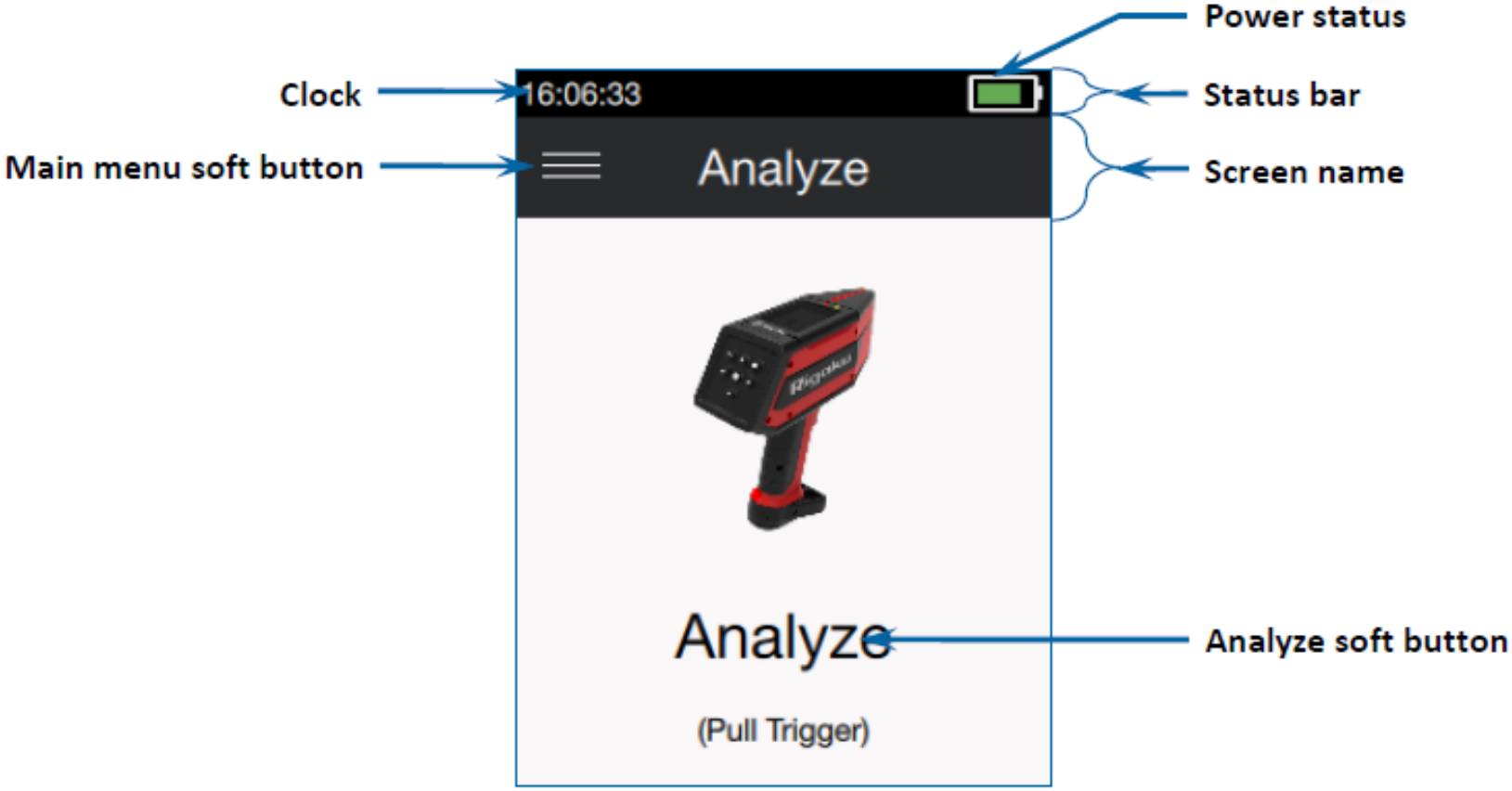
Analyze/Ready to Test



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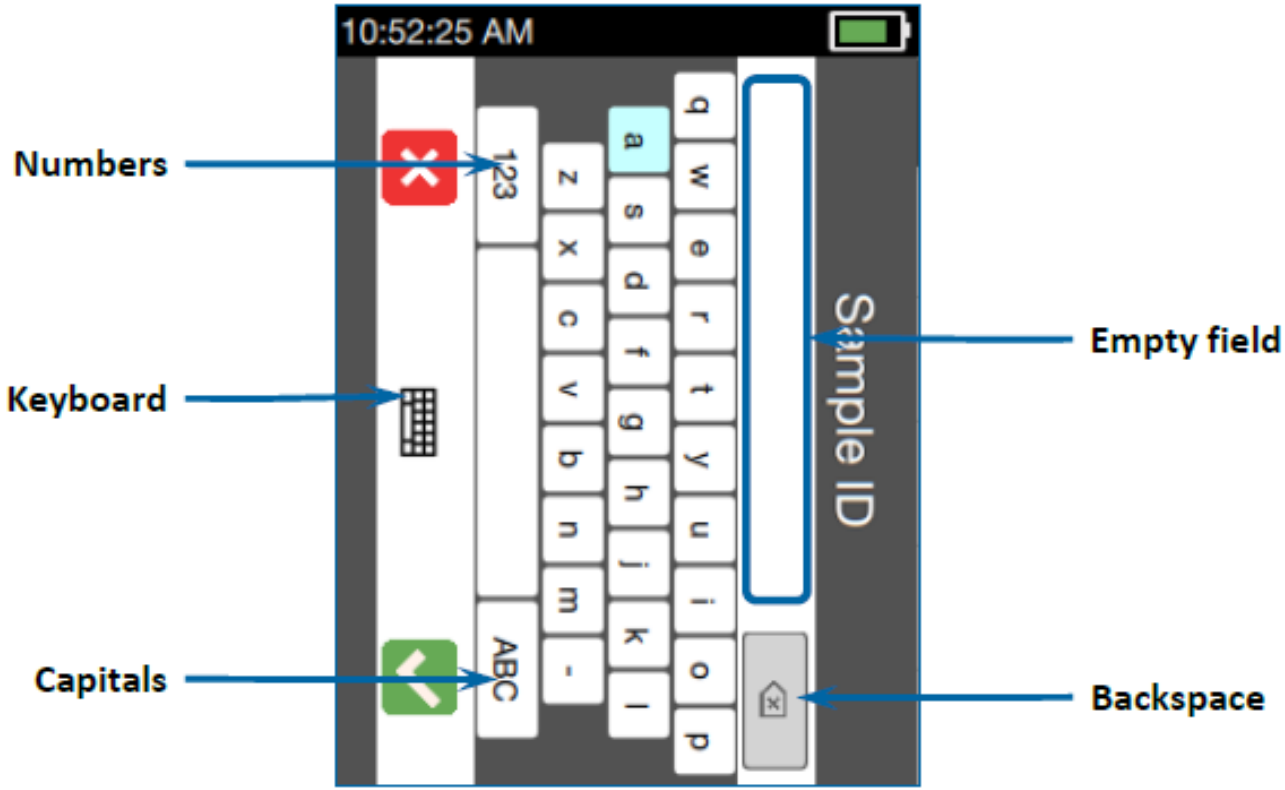
Data Entry Screen



Left or right Quick Launch Button
From Analyze Screen

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Drill Down Menu

Right arrow

From Analyze Screen or set up as a quick launch function

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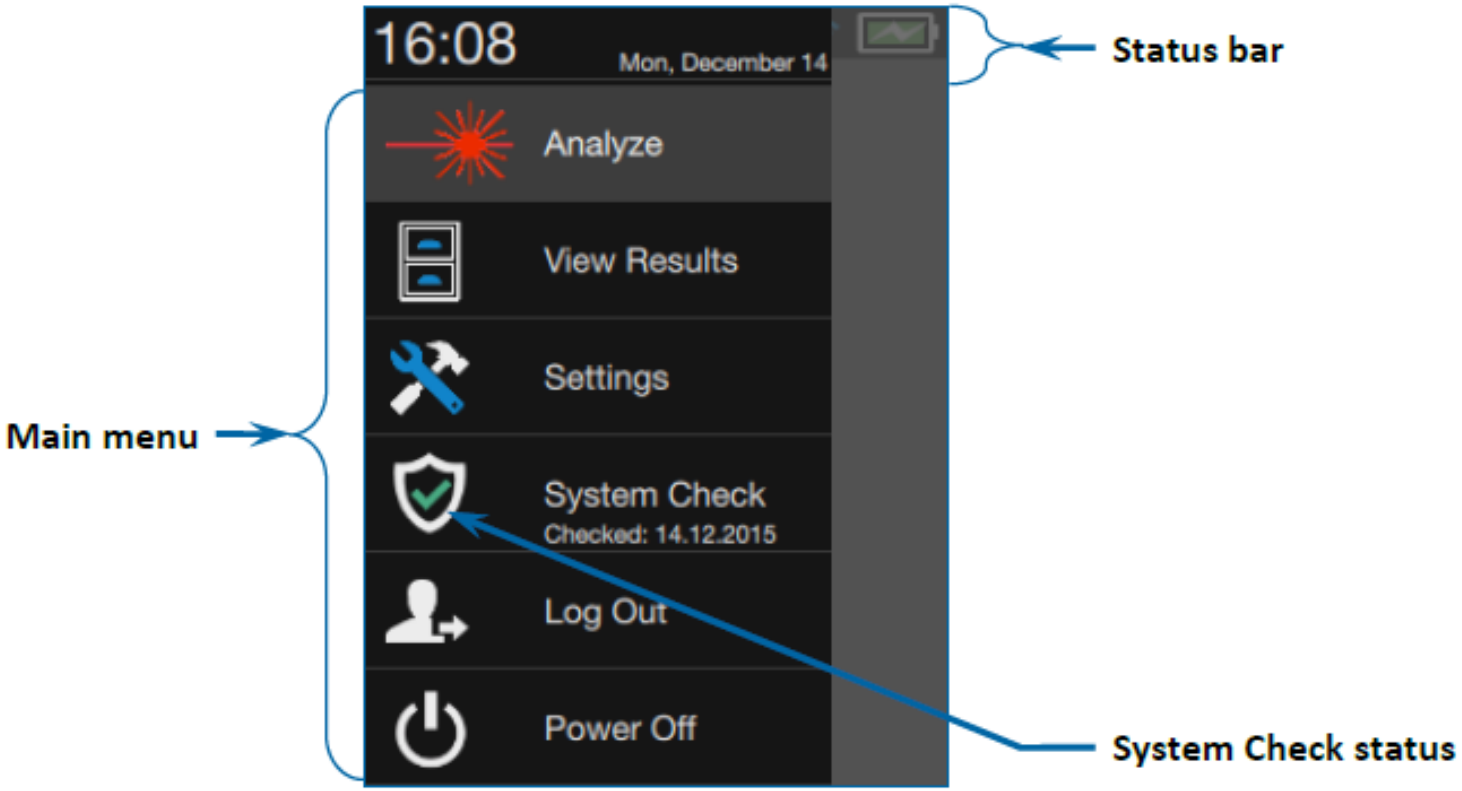
Main Menu



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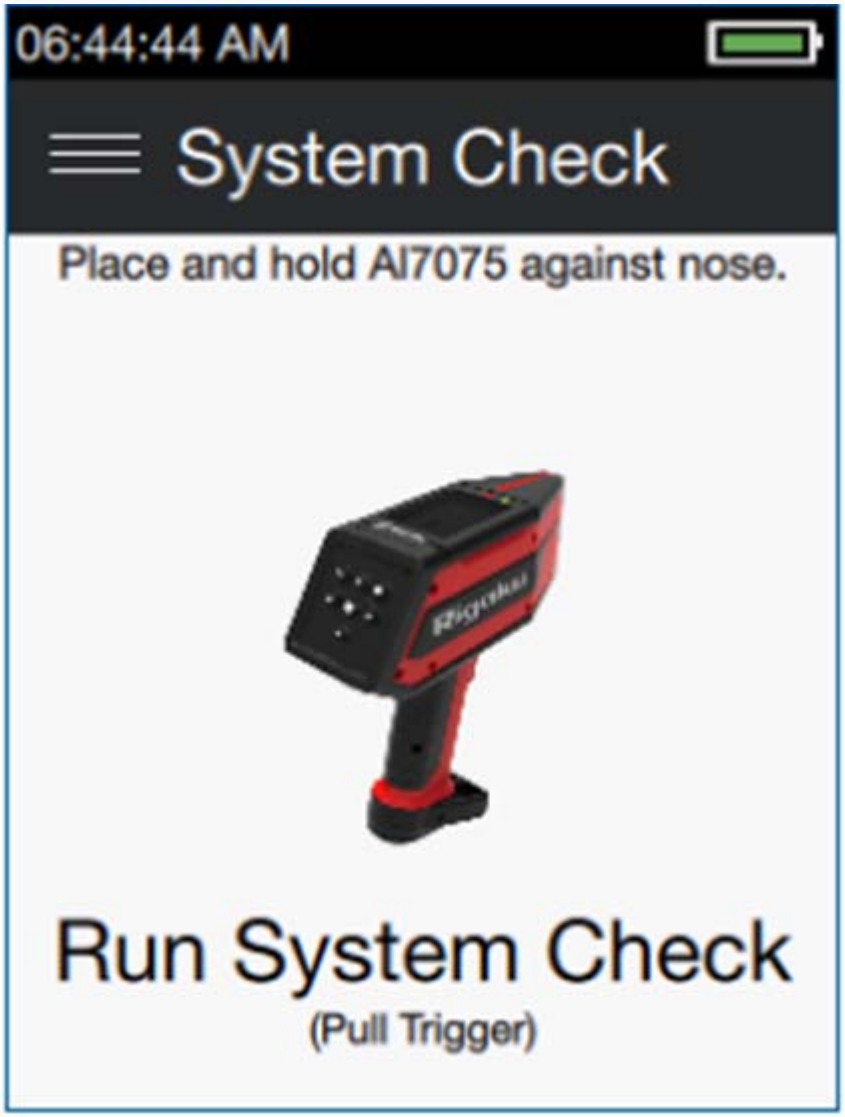
System Check Screen



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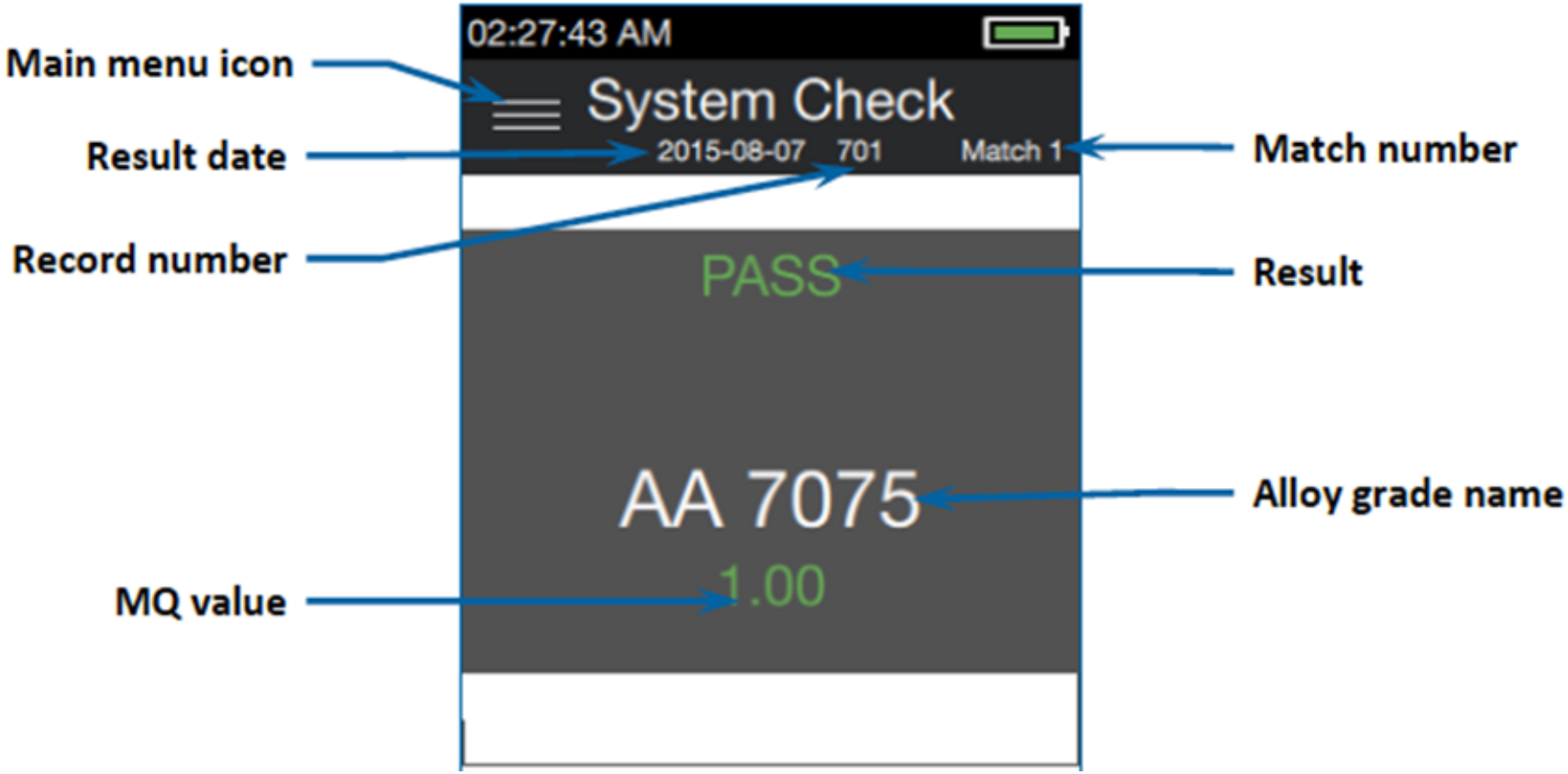
System Check



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Select View Screen

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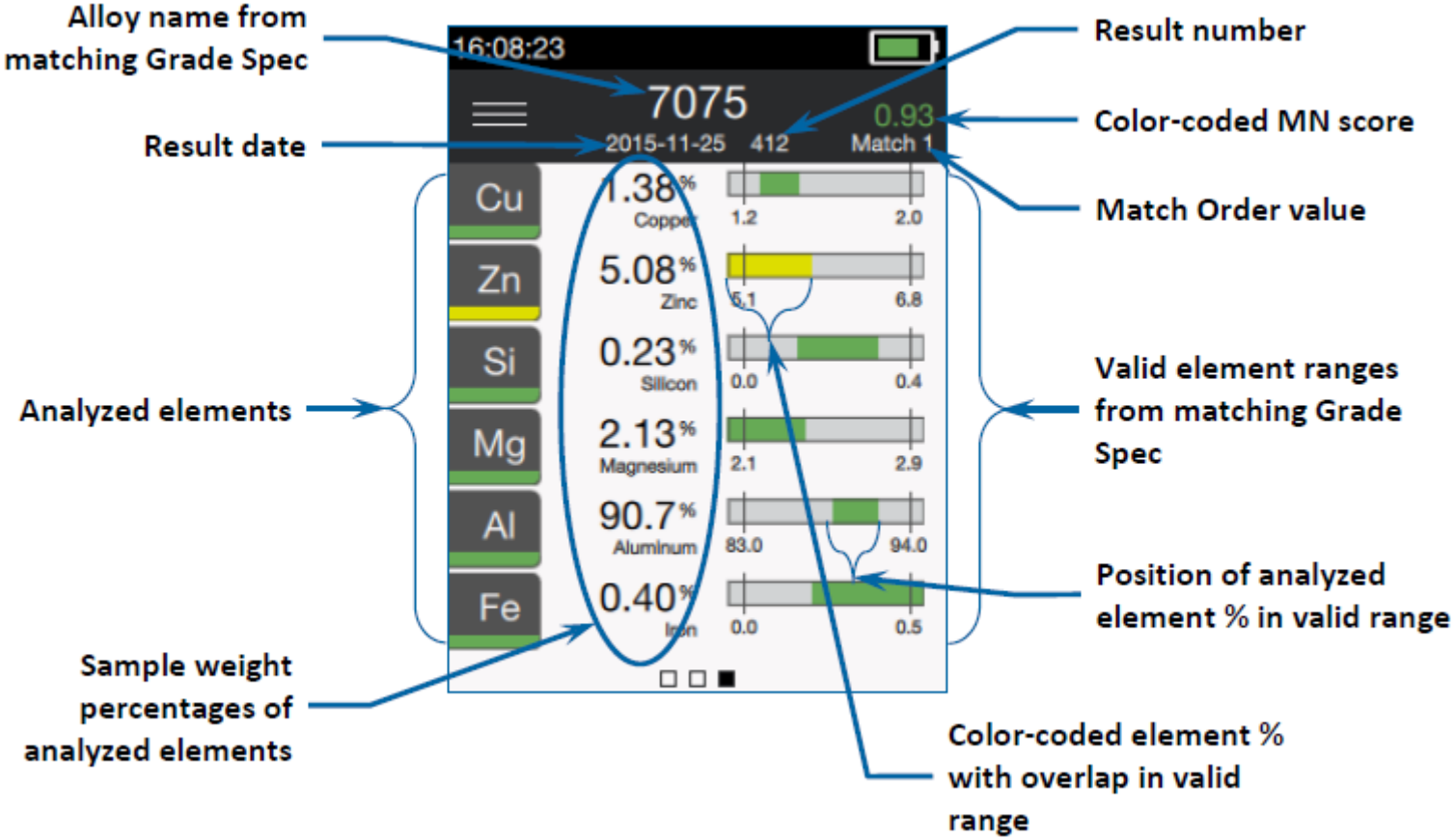
Results

Figure 33. Alloy Composition Result with Matches



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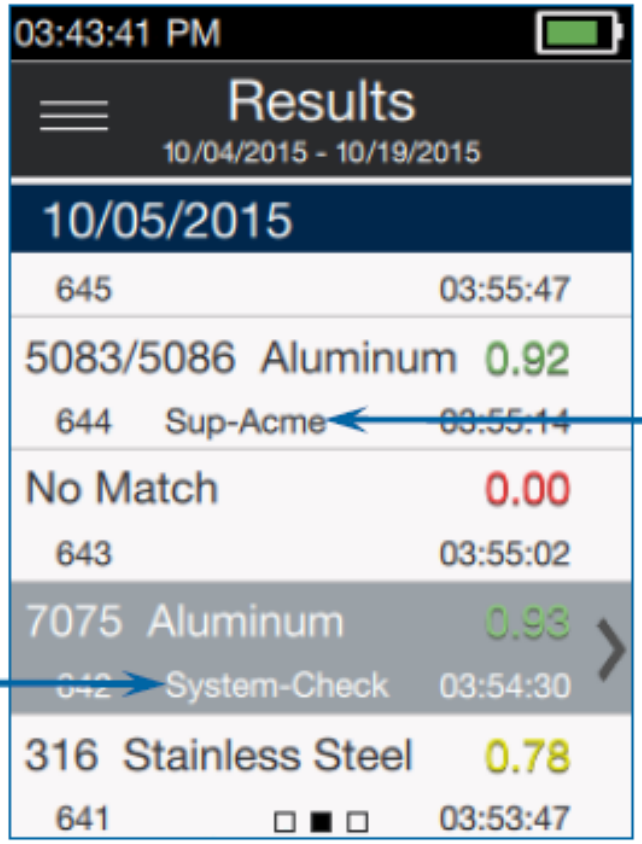
Results List Screen



Sample ID

Result type

Left arrow

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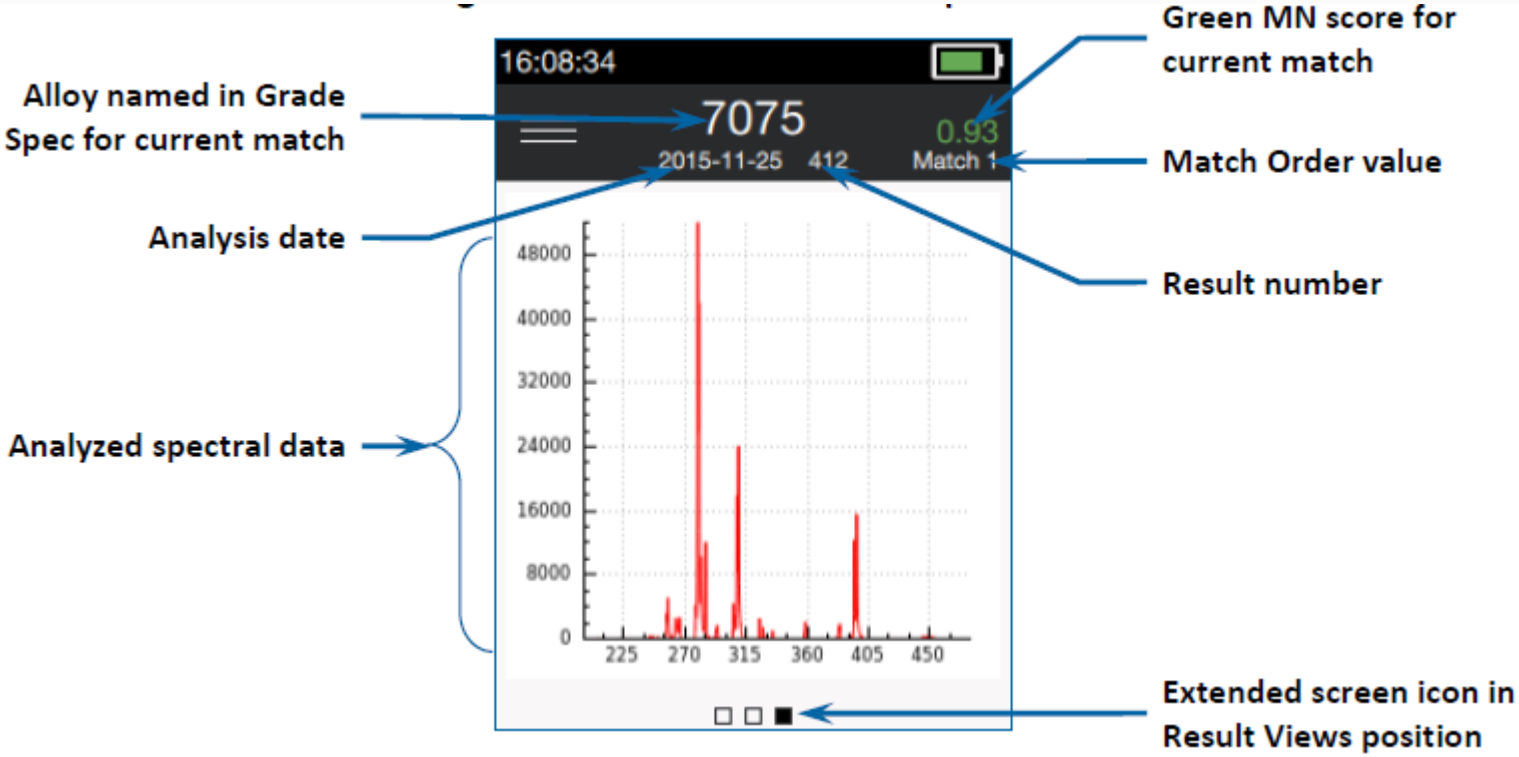
Spectra/Graph



Right arrow

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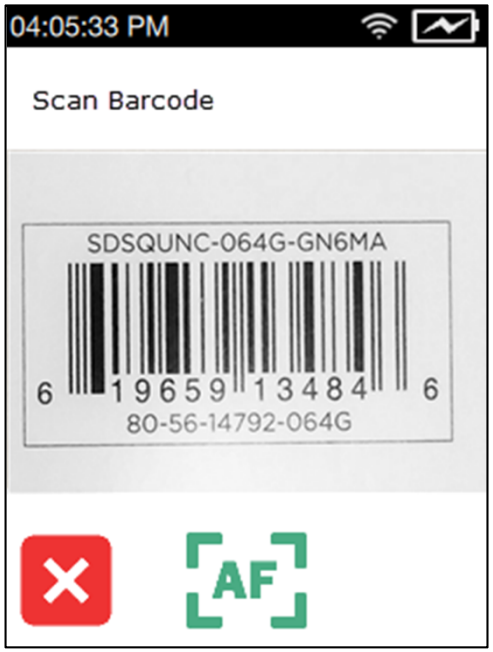
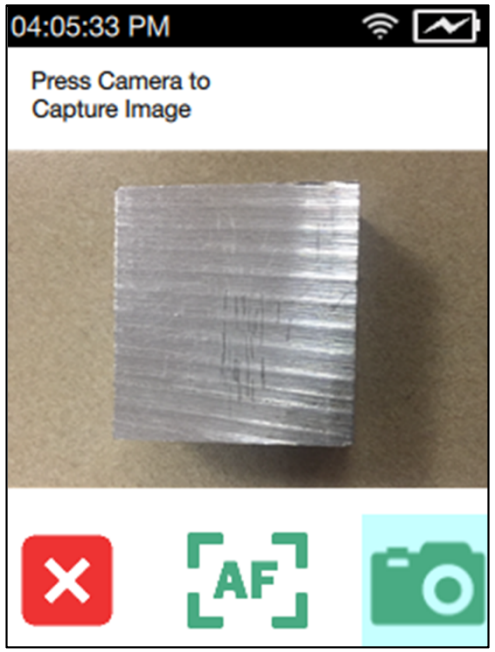
Camera / Barcode Functionality



Use Camera to scan and input barcode information into memory



And / or use Camera to image sample for memory and report generation

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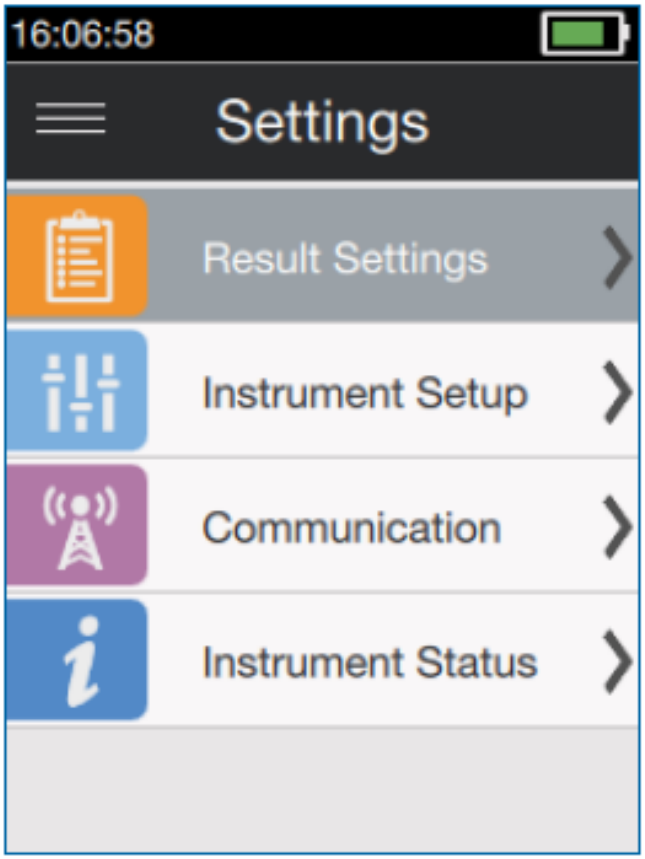
Setting Page



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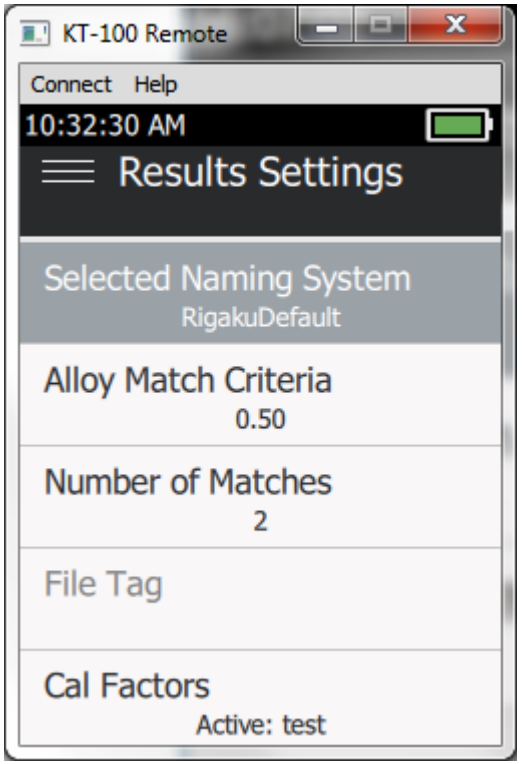
Results Setting



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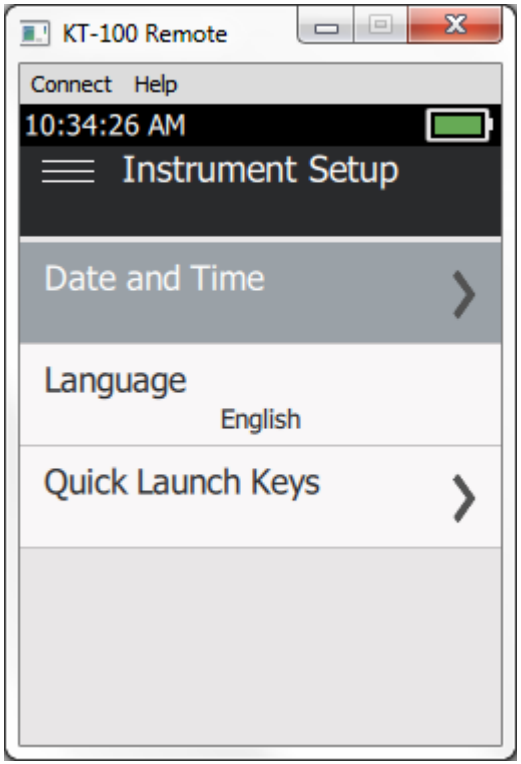
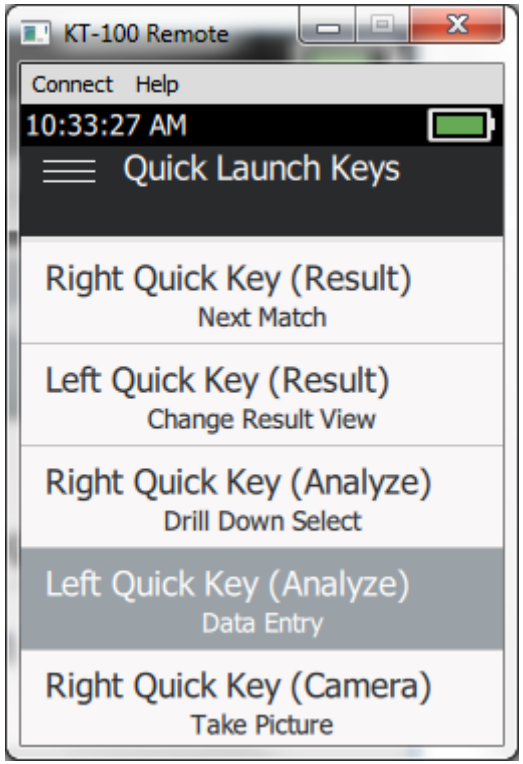
Quick Launch Keys





Choose the functionality for your ***Quick Launch keys***

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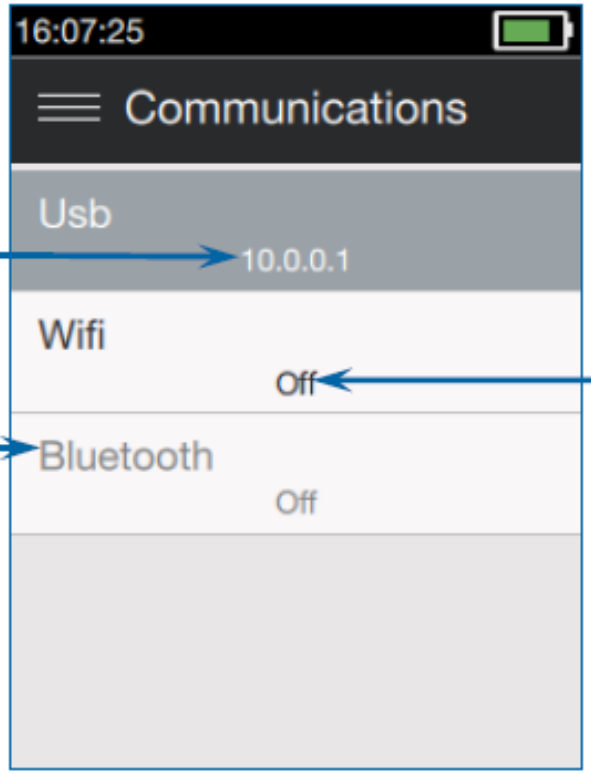
Connection Page



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Data Download

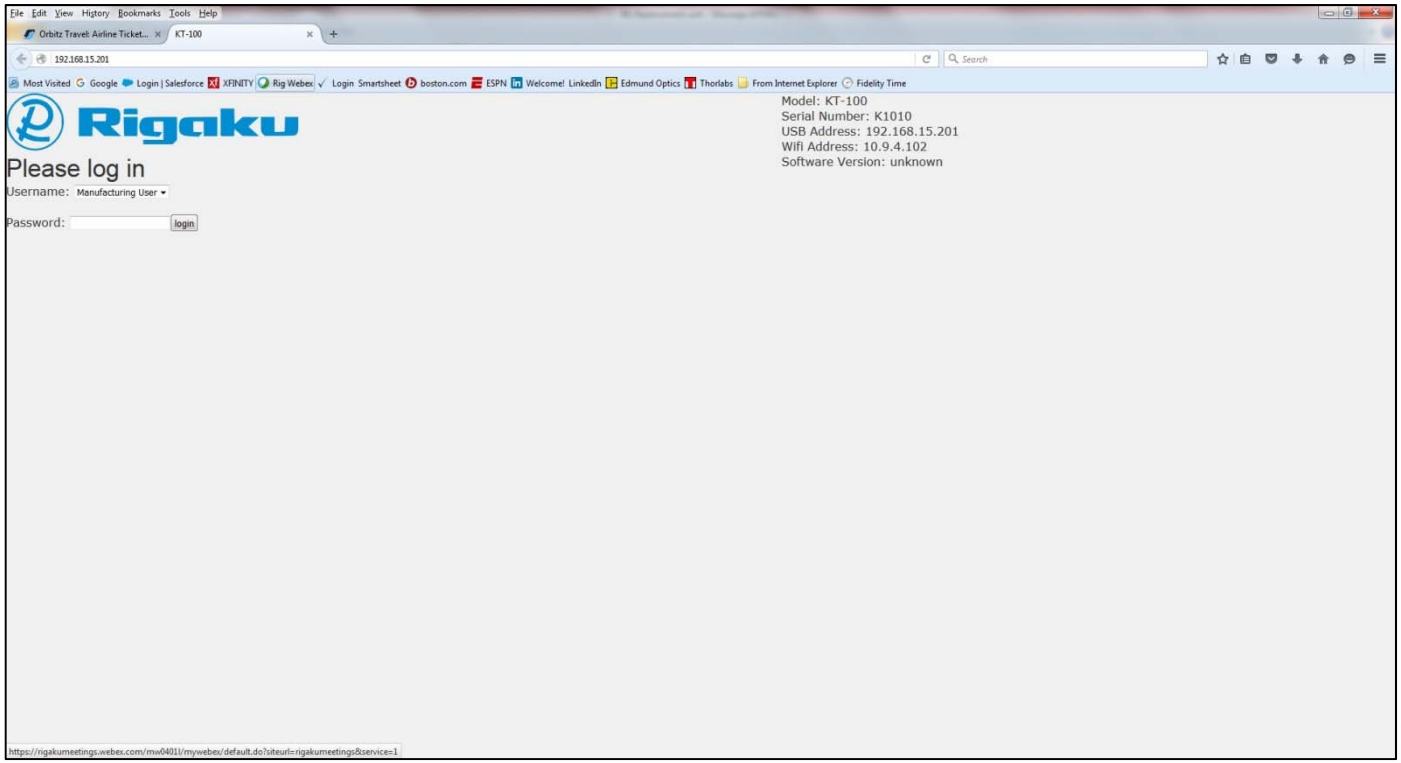
Data download facilitated through internet browser interface

Operator

- Allows for data download

Administrator

- Allows for data download and library/software upgrades



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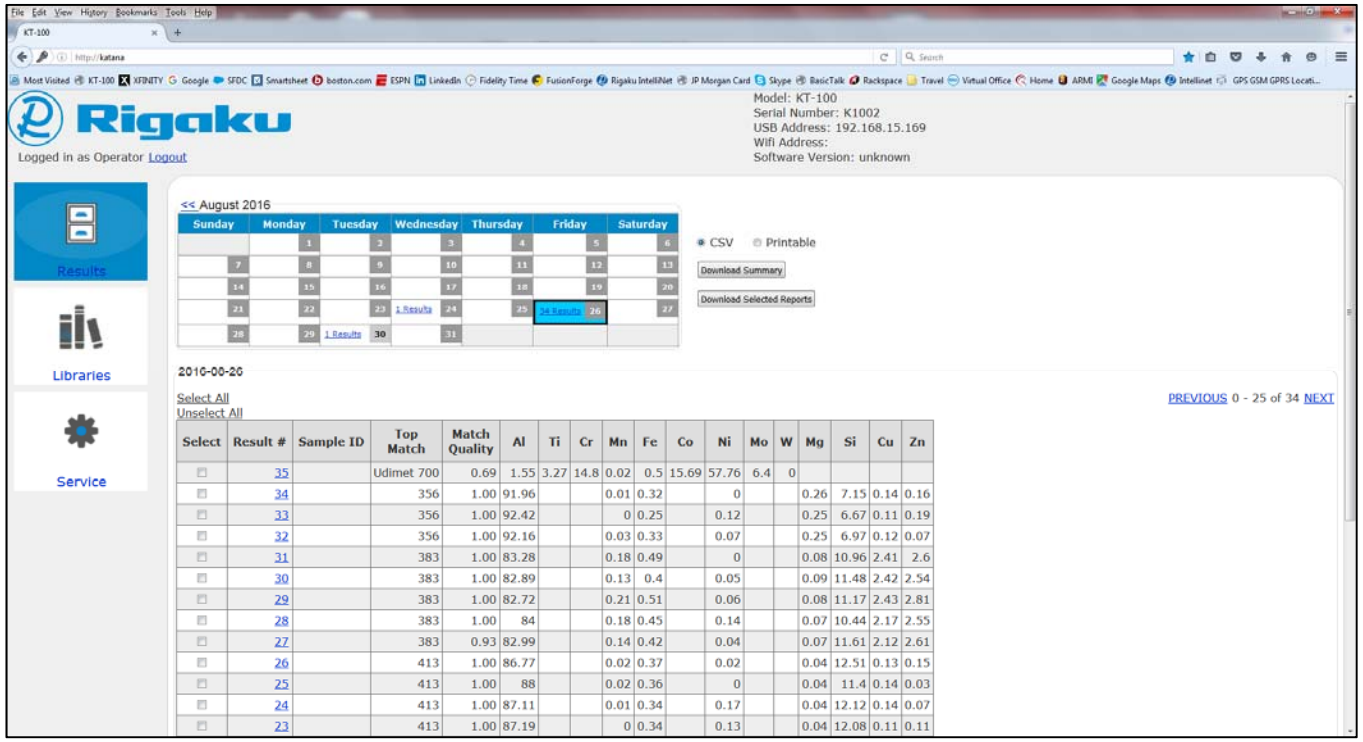
Data Download



Select	Result #	Sample ID	Top Match	Match Quality	Al	Ti	Cr	Mn	Fe	Co	Ni	Mo	W	Mg	Si	Cu	Zn
	35		Udimet 700	0.69	1.55	3.27	14.8	0.02	0.5	15.69	57.76	6.4	0				
	34		356	1.00	91.96			0.01	0.32		0			0.26	7.15	0.14	0.16
	33		356	1.00	92.42			0	0.25		0.12			0.25	6.67	0.11	0.19
	32		356	1.00	92.16			0.03	0.33		0.07			0.25	6.97	0.12	0.07
	31		383	1.00	83.28			0.18	0.49		0			0.08	10.96	2.41	2.6
	30		383	1.00	82.89			0.13	0.4		0.05			0.09	11.48	2.42	2.54
	29		383	1.00	82.72			0.21	0.51		0.06			0.08	11.17	2.43	2.81
	28		383	1.00	84			0.18	0.45		0.14			0.07	10.44	2.17	2.55
	27		383	0.93	82.99			0.14	0.42		0.04			0.07	11.61	2.12	2.61
	26		413	1.00	86.77			0.02	0.37		0.02			0.04	12.51	0.13	0.15
	25		413	1.00	88			0.02	0.36		0			0.04	11.4	0.14	0.03
	24		413	1.00	87.11			0.01	0.34		0.17			0.04	12.12	0.14	0.07
	23		413	1.00	87.19			0	0.34		0.13			0.04	12.08	0.11	0.11

From the calendar, select the day and the last 25 analysis of that day will be displayed

Data can be exported to table or pdf report

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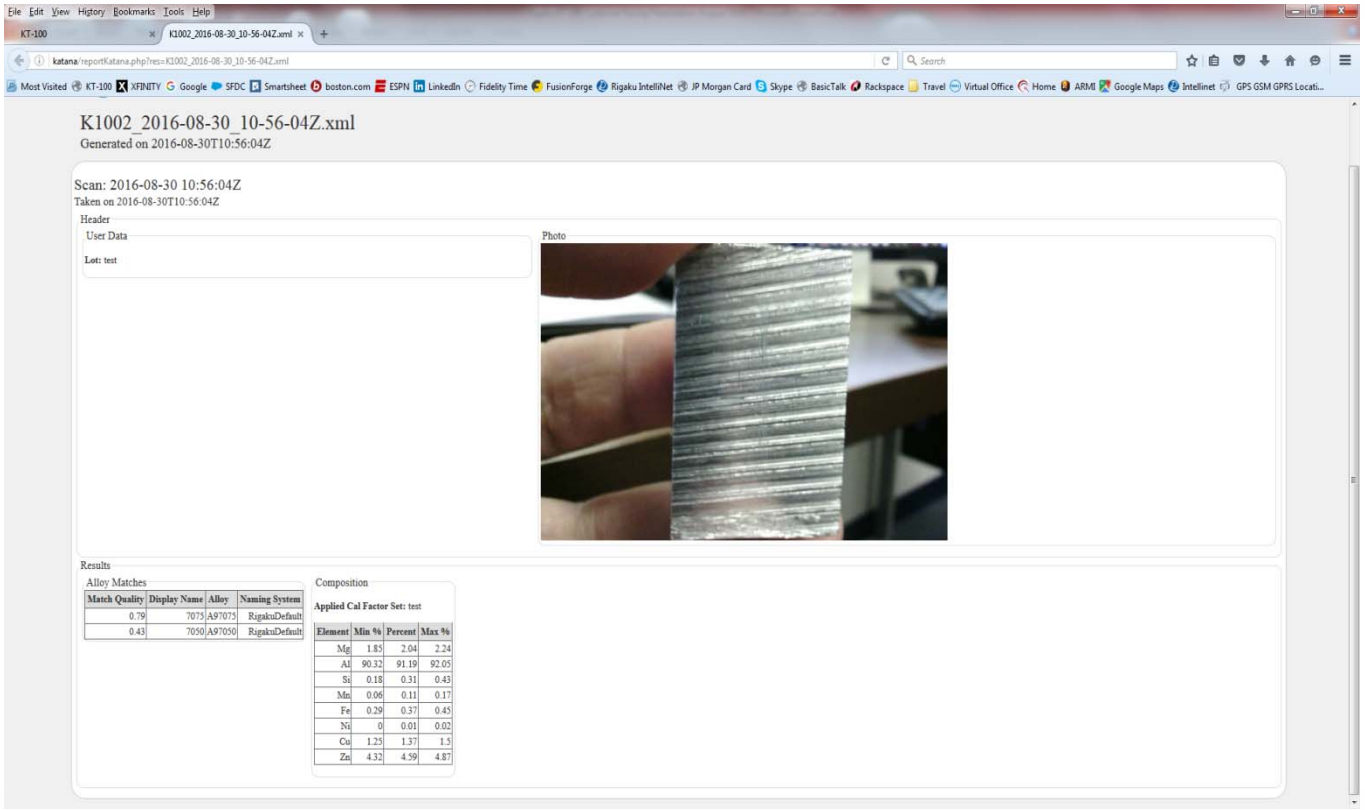
Result Reports



K1002_2016-08-30_10-56-04Z.xml

Generated on 2016-08-30T10:56:04Z

Scan: 2016-08-30 10:56:04Z

Taken on 2016-08-30T10:56:04Z

Header

User Data

Lot: test

Photo

Results

Alloy Matches

Match Quality	Display Name	Alloy	Naming System
0.79	7075	A97075	RigakuDefault
0.43	7050	A97050	RigakuDefault

Composition

Applied Cal Factor Set: test

Element	Min %	Percent	Max %
Mg	1.85	2.04	2.24
Al	90.32	91.19	92.05
Si	0.18	0.31	0.43
Mn	0.06	0.11	0.17
Fe	0.29	0.37	0.45
Ni	0	0.01	0.02
Cu	1.25	1.37	1.5
Zn	4.32	4.59	4.87

Results including qualitative data entry and sample image

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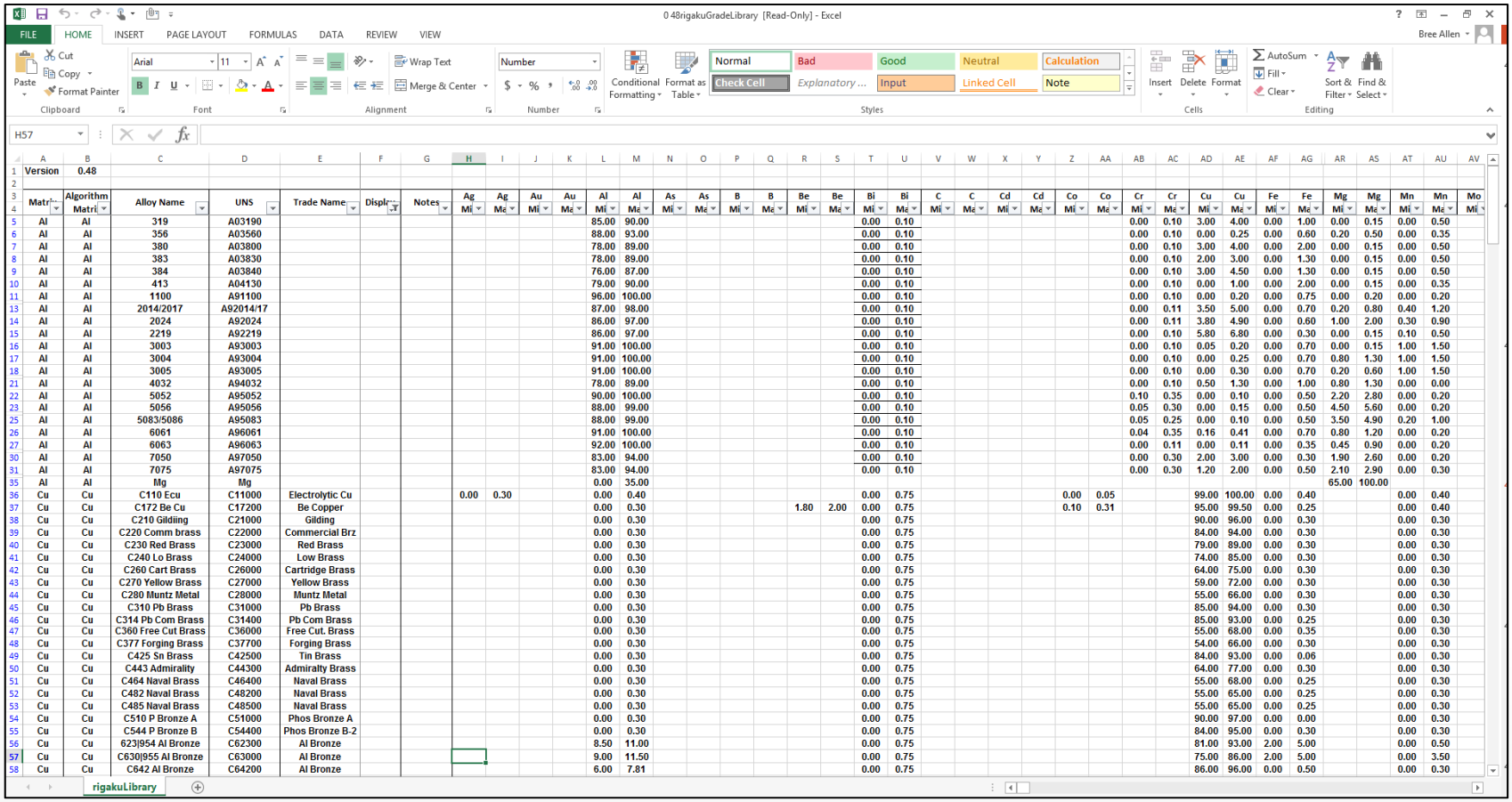
Alloy Grade Library

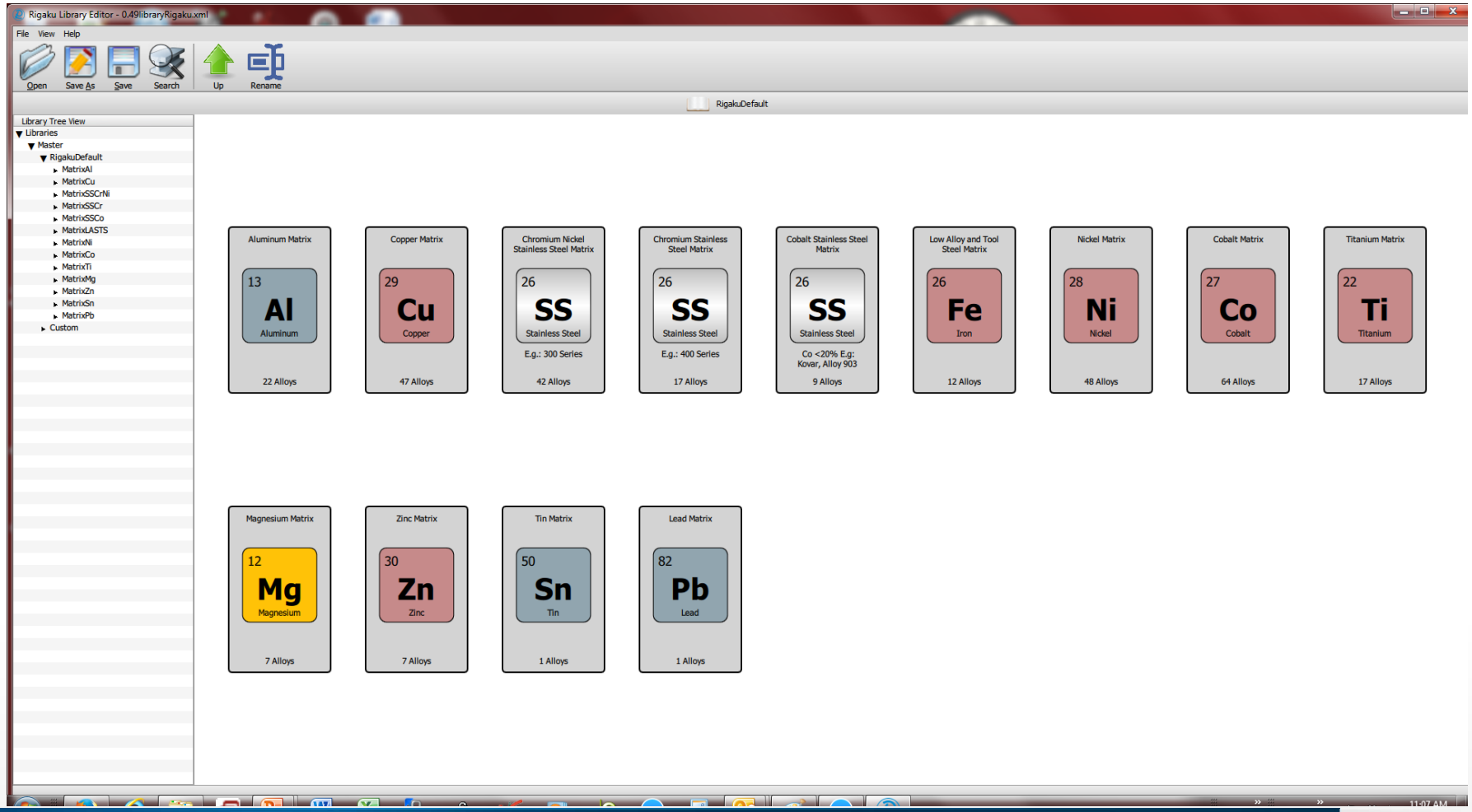
Comprehensive and user-editable alloy grade library contains ~ 400 grades



| Version | 0.48 | | |

Rigaku KT-100 Library Editor

Choose your base to view current alloy grades



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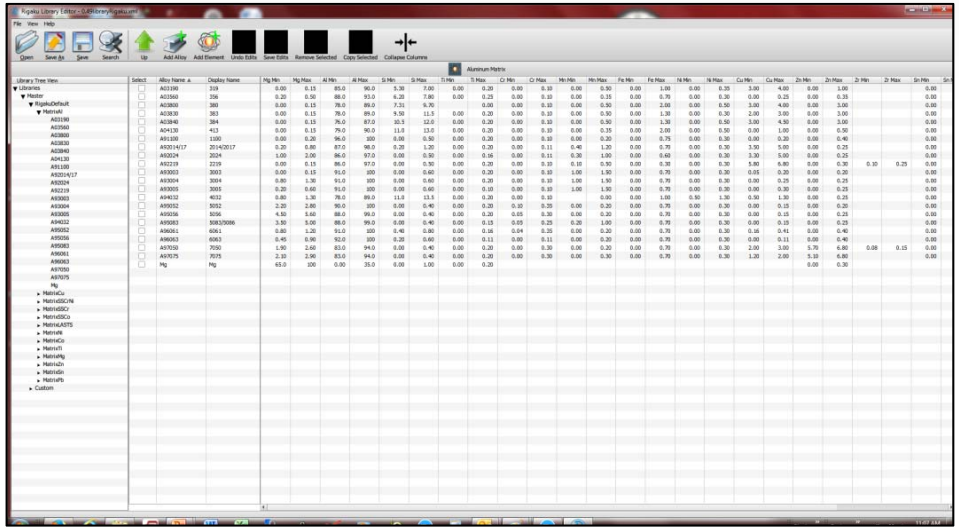
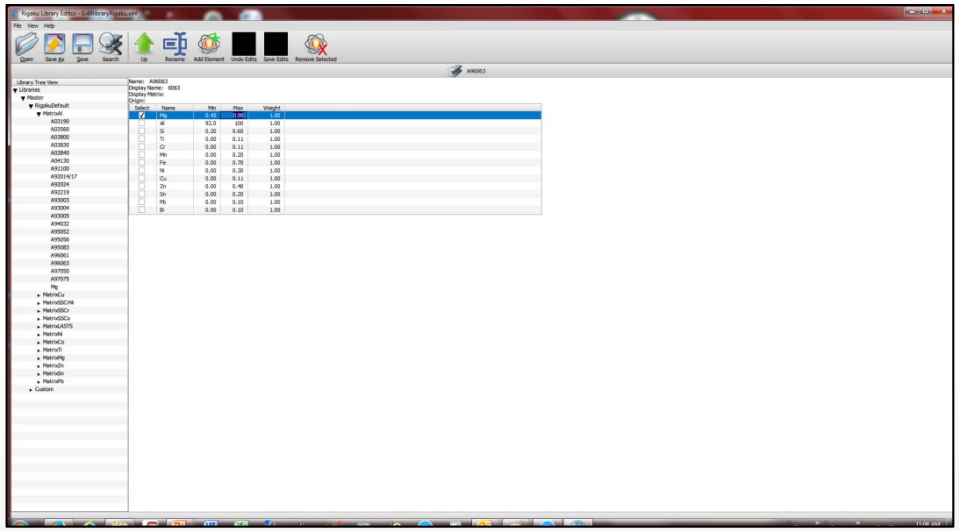
Rigaku KT-100 Library Editor





View / Modify / Add
Alloy grades

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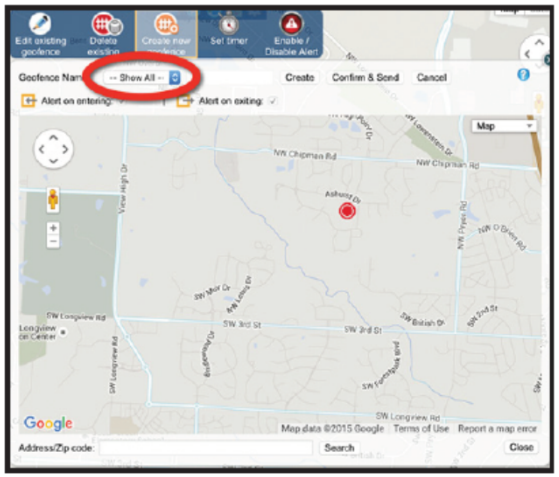
Trimble LP2 GPS Module (optional)

L2P Features common to all devices:

- Access to the L2P portal
- Over speed alerts
- Entry / exit of GeoFence alerts
- Real time tracking based on time and/or distance
- Position history
- G-Force sensor
- Flexible reporting intervals; pings every 15 minutes or once a day or once a week
- Multi carrier Global SIM, GSM / GPRS worldwide coverage
- Remote over the air configuration
- A-GPS, Assisted GPS, tracks indoors and outside
- Exportable historical reporting
- Smartphone App



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GPS Alerts

FW: Alert by 355504063965513 - Message (Plain Text)

FILE MESSAGE

Ignore Junk Delete | Reply Reply All Forward Meeting More | Tanis Team Email Reply & Delete To Manager Done Create New | Move Rules OneNote Actions | Mark Unread Categorize Follow Up | Translate Find Related Select | Zoom

Delete Respond Quick Steps Move Tags Editing Zoom

Fri 5/6/2016 11:27 AM

David Mercuro

FW: Alert by 355504063965513

To Bree Allen

Cc Claude Robotham

Bing Maps

Regards,
Dave

-----Original Message-----
From: alert@l2pgateway.com [mailto:alert@l2pgateway.com]
Sent: Monday, February 08, 2016 6:03 PM
To: David Mercuro
Subject: Alert by 355504063965513

David,

L2Pe belongs to Station-21174147(ID: 355504063965513) is powering off at 05:10:39, 11/11/2015, Location: Ramp 11, Louisville, KY 40209, USA.
Position's coordinates: 38.160882,-85.733392

Click the following link to see the map.
http://maps.googleapis.com/maps/api/staticmap?center=38.160882,-85.733392&zoom=15&size=640x480&markers=color:orange%7Clabel:H%7C38.160882,-85.733392&sensor=false

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Any Questions?

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