APPLIED PHOTONICS
LASER SPECTROSCOPY SOLUTIONS

Test Report

17th February 2020

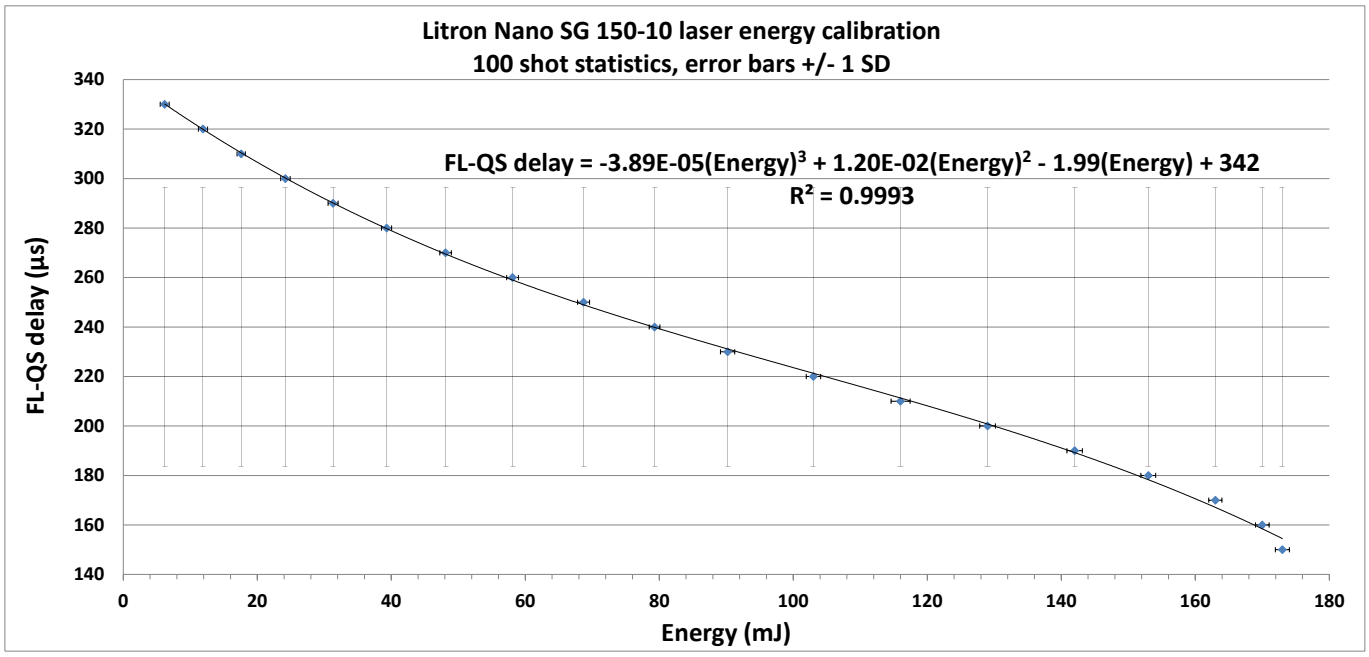
Customer: XXX

System Information	**Laser Information**
LIBS-6 (6-channel) Serial No: XXXX Manufactured: January 2020 AP-Nano Serial No: XXXX Manufactured: January 2020	Litron Nano SG 150-10 Laser head S/N: XXXX LPU350 S/N: XXXX LUCI S/N: XXXX Manufactured: November 2019
Sample Chamber Information	**Spectrometer Information**
XYZ-750 Serial No: XXXX Manufactured: January 2020	- Echelle Spectrograph, Model: EMU-120/65 UV-VIS-NIR, S/N: 029 (Catalina Scientific Instruments LLC) - EMCCD Camera, Model: Falcon 285, Model Number: FA285B-CL-OEM2, S/N: XXXX (Raptor Photonics Ltd) - Digital delay pulse generator, Model: Sapphire Plus, Model number: 9212+, S/N: XXXX (Quantum Composers Inc)
Software	**Fibre Information**
LIBSoft V18.9.3	S/N XXXX – FC-UV400-2-ME-SR 2 m long
Computer	
Dell Precision 3431 - Small Form PC Intel Core i5-9600, 256GB SSD, 16GB Ram, AMD Radeon Pro WX3200 Service Tag: XXXX Express Service Tag: XXXX 21.5” AOC monitor, S/N: XXXX	
Optional Extras	
IMG-HR High-resolution camera imaging kit	AVALIGHT-CAL-MINI Mercury Argon Calibration lamp, S/N: XXXX

Laser Energy Calibration

The laser beam energy was measured using a calibrated laser energy meter (Coherent LabMax TOP Laser Power/Energy meter with J-50MB-YAG detector head). The laser pulse energy was measured at the output of the LIBS-6, with the transparent nozzle aperture removed and the detector head positioned close to the optics array so that the laser beam diameter is relatively large (so as not to damage the detector). The energy measurements are therefore representative of the laser pulse energy at the sample. The laser energy calibration was performed varying the Flashlamp-Q-Switch (FL-QS) delay (FL-QS Delay values: 150 µs - 330 µs) and measuring the average, minimum and maximum energy as well as standard deviation of 100 shots. The repetition rate was set to 10 Hz. Prior to the measurements and for laser warm up/stabilization purposes, the flashlamp was operating without lasing for 10 min. The laser coolant temperature during the laser energy calibration measurements ranged from 29 to 33 ºC. **For an optimum laser performance, the coolant temperature should reach a minimum of 25°C. This is achieved by firing the flashlamp with the Q-Switch disabled until this temperature is reached.**

FL-QS Delay (µs)	Laser Energy				
	Mean (mJ)	SD (mJ)	RSD (%)	Minimum (mJ)	Maximum (mJ)
150	173	1.05	0.6	171	176
160	170	1.02	0.6	168	172
170	163	0.98	0.6	161	165
180	153	1.10	0.7	151	156
190	142	1.15	0.8	139	145
200	129	1.17	0.9	127	132
210	116	1.42	1.2	113	119
220	103	1.08	1.0	100	105
230	90.2	1.06	1.2	87.7	93.4
240	79.3	0.81	1.0	77.1	81.2
250	68.7	0.89	1.3	66.6	71.3
260	58.1	0.88	1.5	56.3	60.5
270	48.1	0.86	1.8	46.1	49.9
280	39.3	0.75	1.9	37.5	40.9
290	31.3	0.75	2.4	29.8	33.3
300	24.2	0.70	2.9	22.9	26.0
310	17.6	0.63	3.6	16.1	19.5
320	11.9	0.69	5.8	10.5	13.5
330	6.17	0.67	11	4.77	7.88

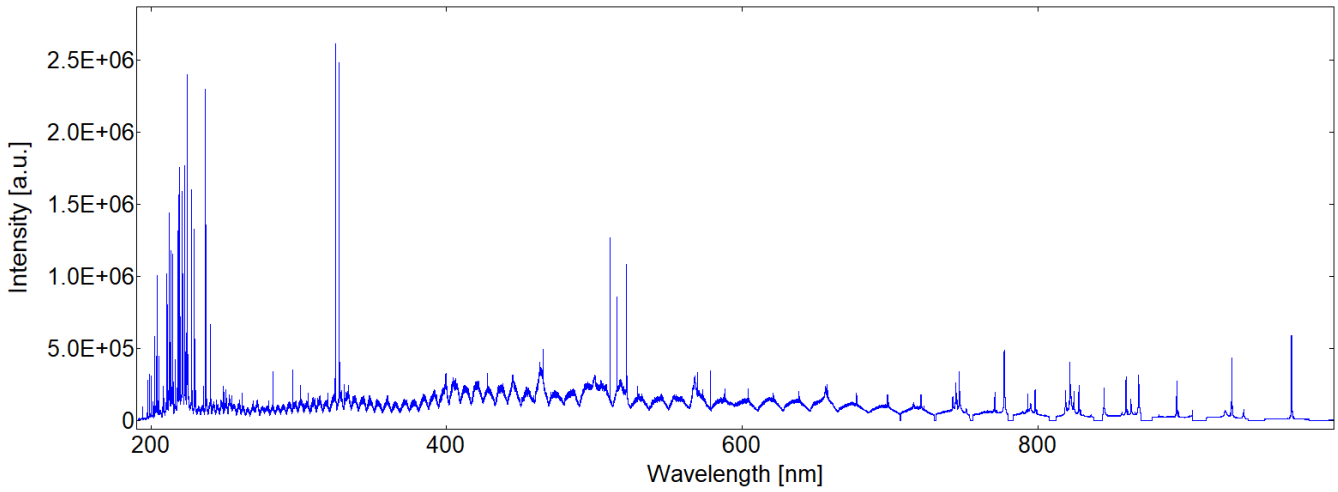


Test spectra

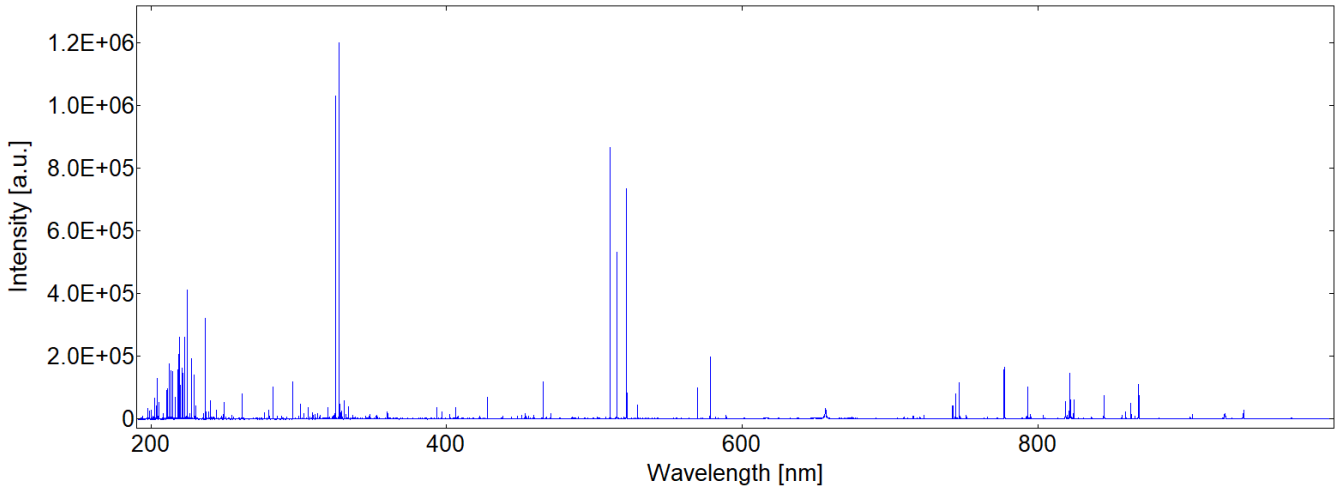
The spectra were acquired using the following parameters:

- Echelle dispersion cassette: UV3 (≈ 27,000 average resolving power), Slit size: 9 x 30 µm, Aperture Stop: 16 mm
- EMCCD Gain = 2800
- Wavelength step = 0.004 nm
- Integration time = 100 µs
- Integration delay = as stated in each spectrum
- Accumulation/Acquisition shots = 50
- Conditioning / Cleaning shots = 50
- Purge gas: Air or Argon (stated in each spectrum)

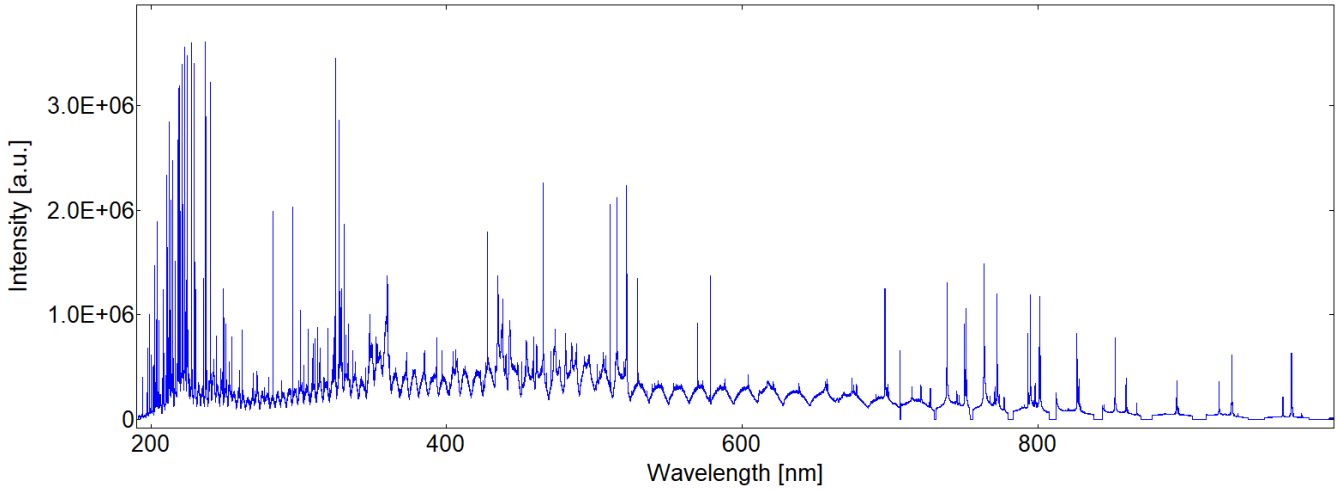
High purity copper (Air) 0.01 µs integration delay (minimum integration delay)



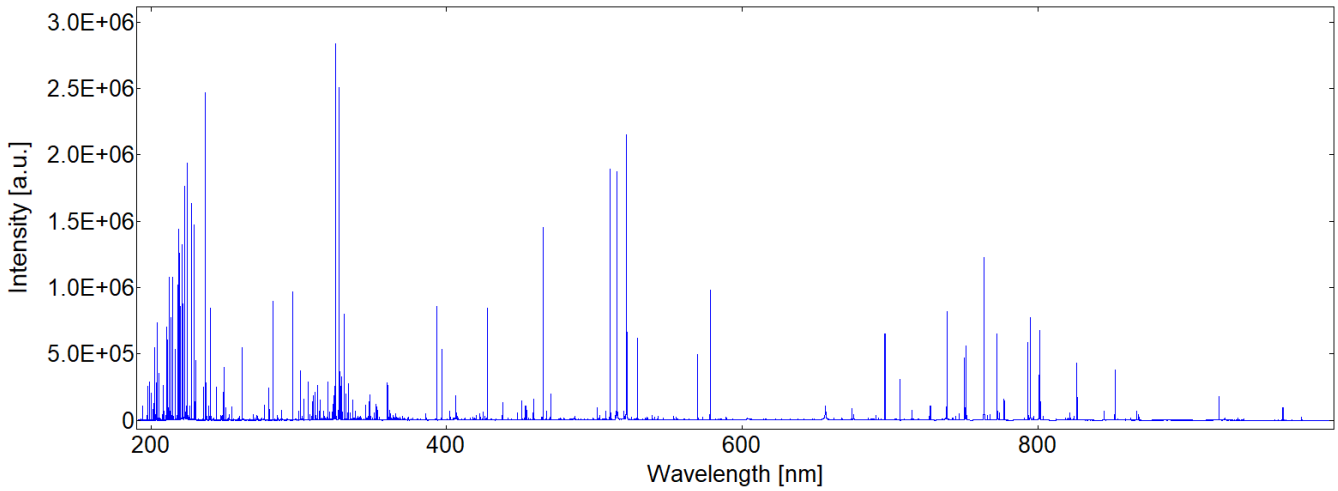
High purity copper (Air) 3 µs integration delay



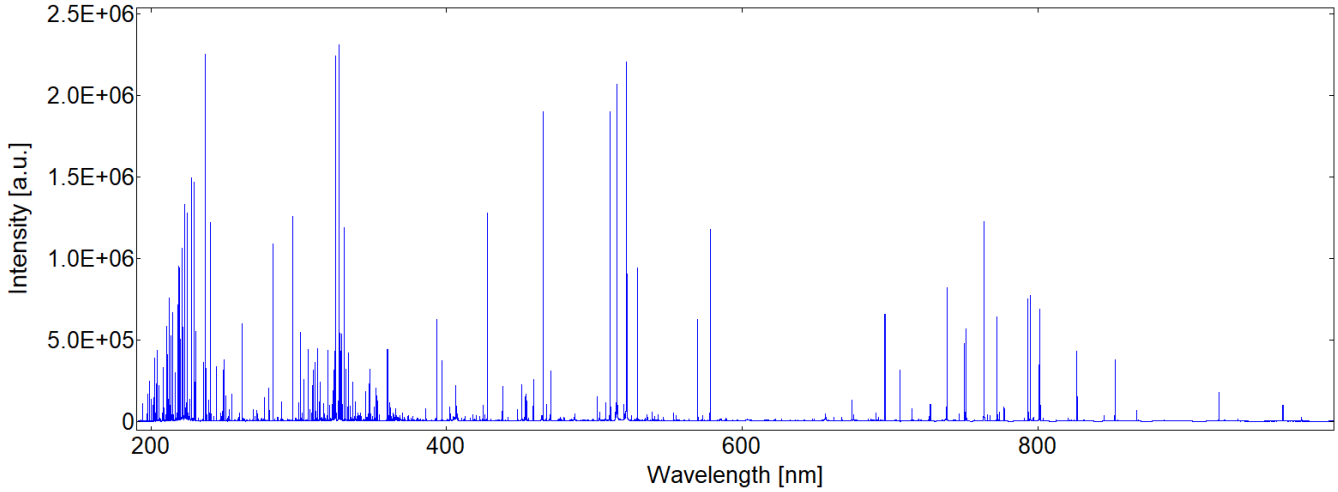
High purity copper (Argon) 0.01 µs integration delay (minimum integration delay)



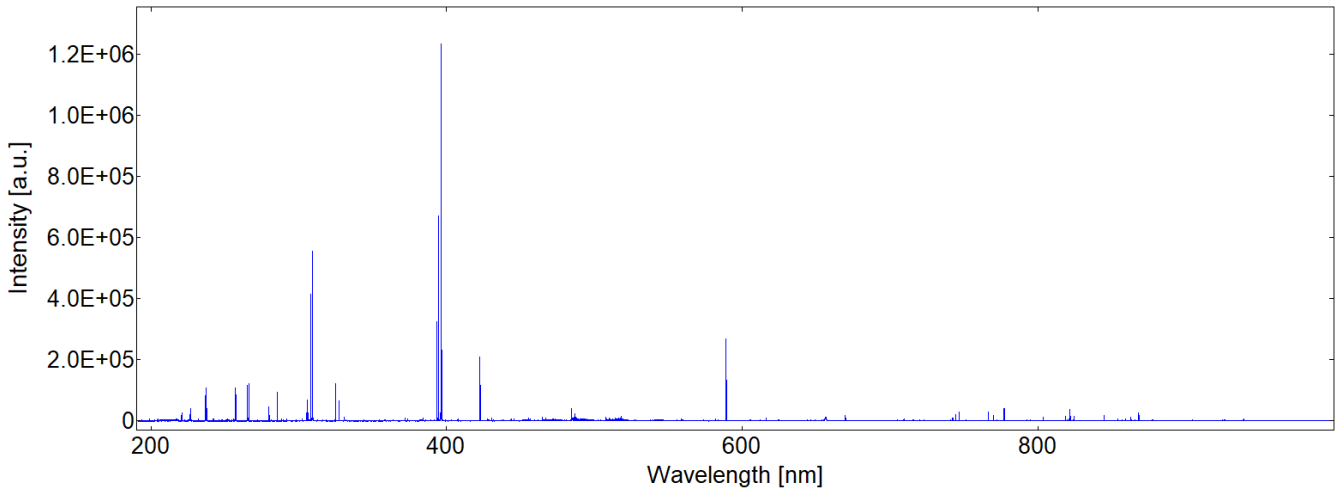
High purity copper (Argon) 3 µs integration delay



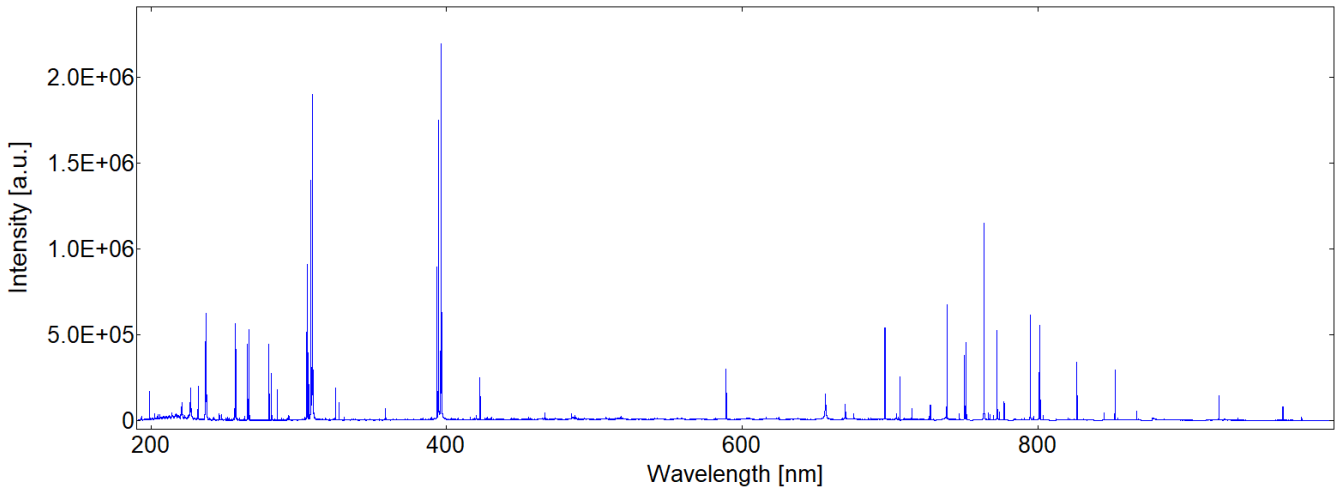
High purity copper (Argon) 10 µs integration delay



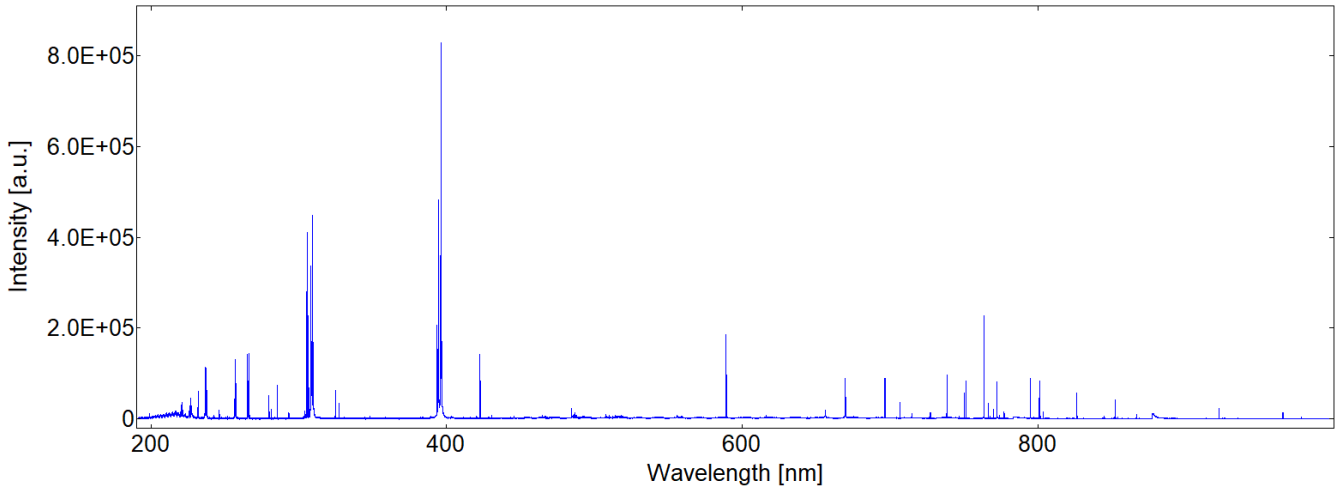
High purity aluminium (Air) 3 µs integration delay



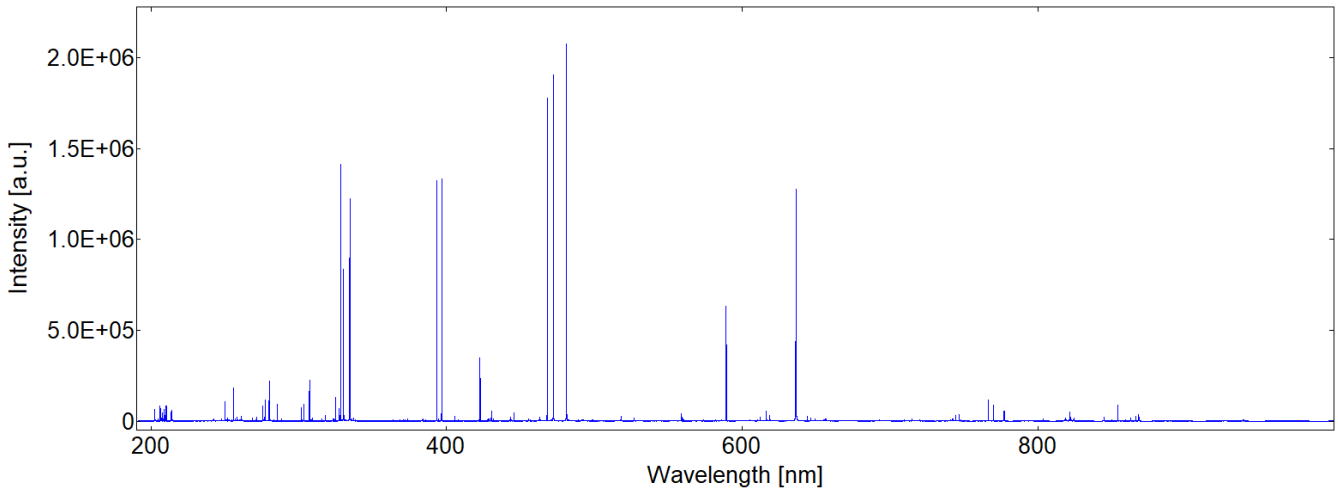
High purity aluminium (Argon) 3 µs integration delay



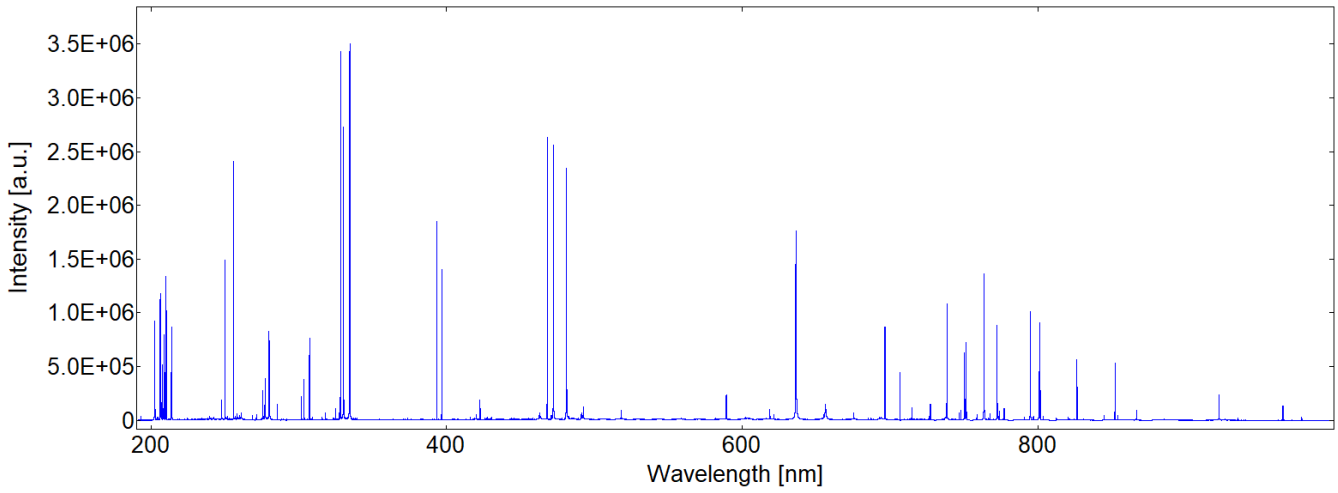
High purity aluminium (Argon) 10 µs integration delay



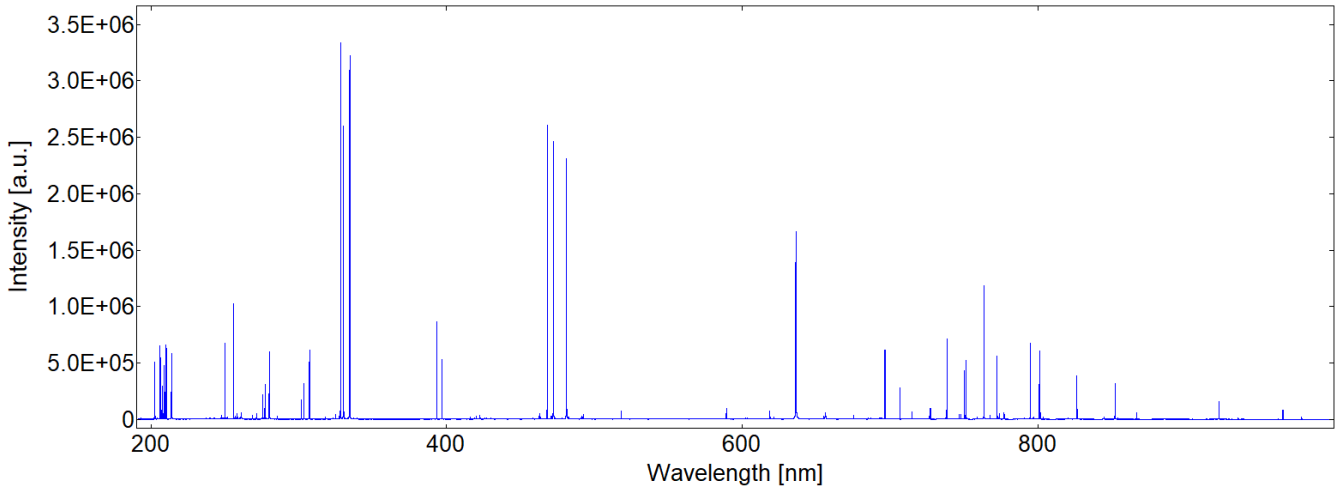
High purity zinc (Air) 3 µs integration delay



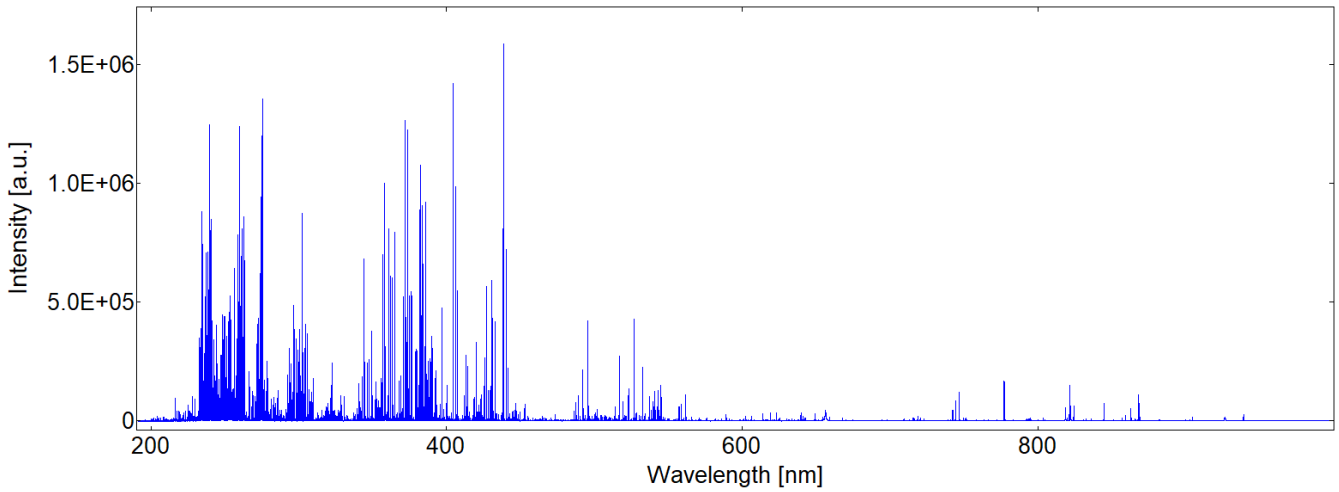
High purity zinc (Argon) 3 µs integration delay



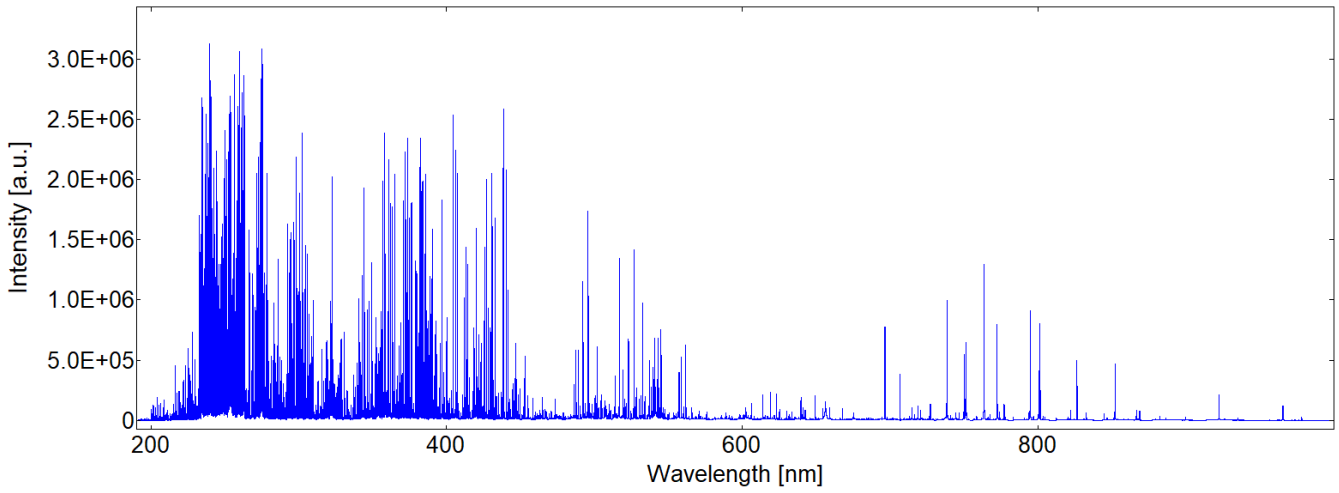
High purity zinc (Argon) 10 µs integration delay



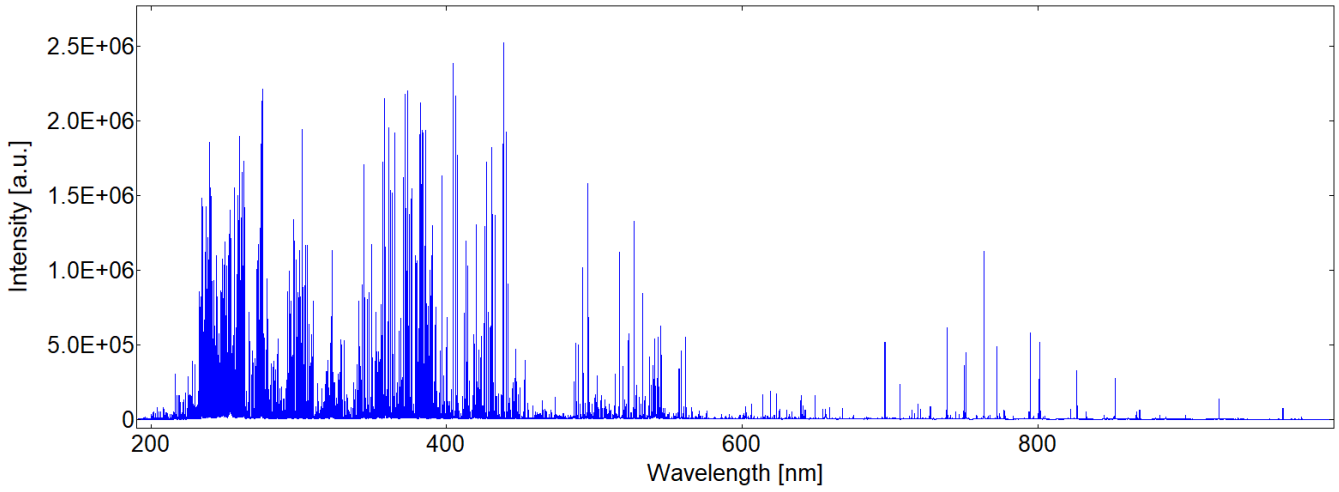
High purity iron (Air) 3 µs integration delay



High purity iron (Argon) 3 µs integration delay



High purity iron (Argon) 10 µs integration delay

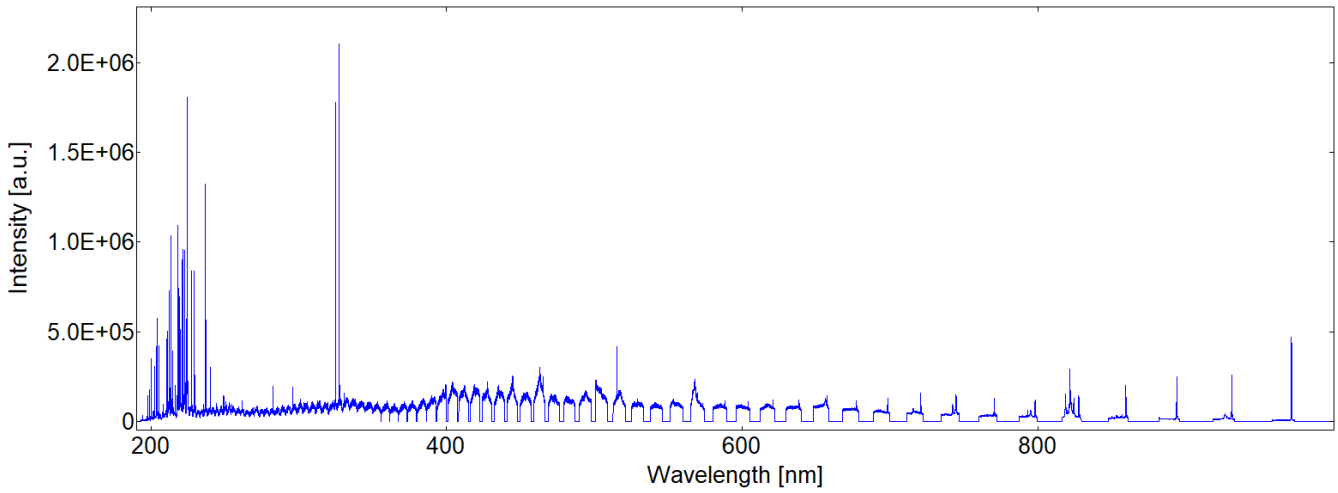


Test spectra

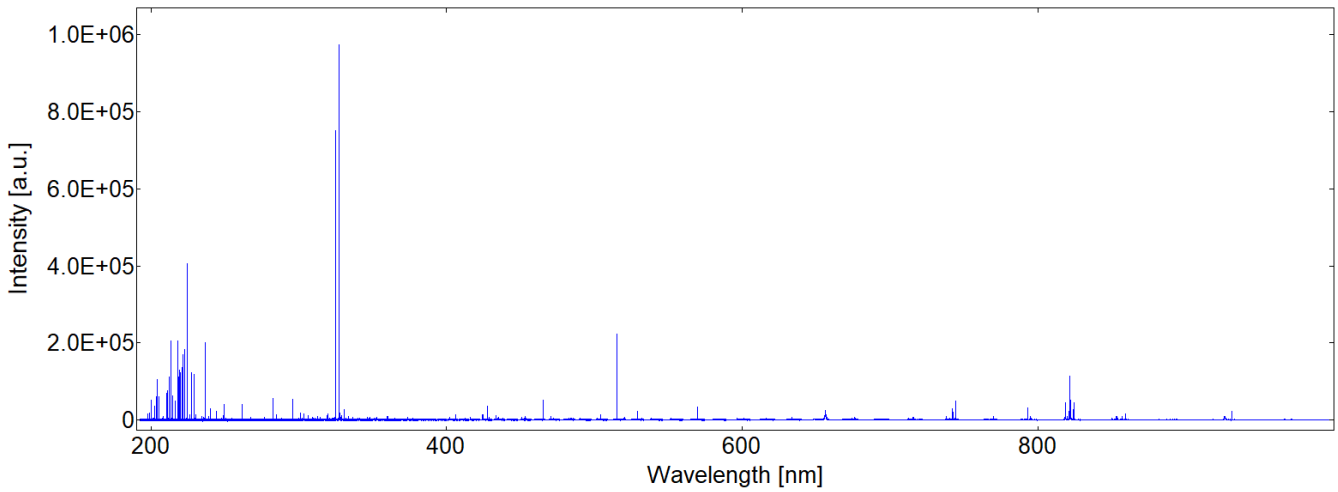
The spectra were acquired using the following parameters:

- Echelle dispersion cassette: IX1 (≈ 46,000 average resolving power), Slit size: 10 x 30 µm, Aperture Stop: 16 mm
- EMCCD Gain = 2800
- Wavelength step = 0.004 nm
- Integration time = 100 µs
- Integration delay = 3 µs (unless otherwise stated)
- Accumulation/Acquisition shots = 50
- Conditioning / Cleaning shots = 50
- Purge gas: air at atmospheric pressure

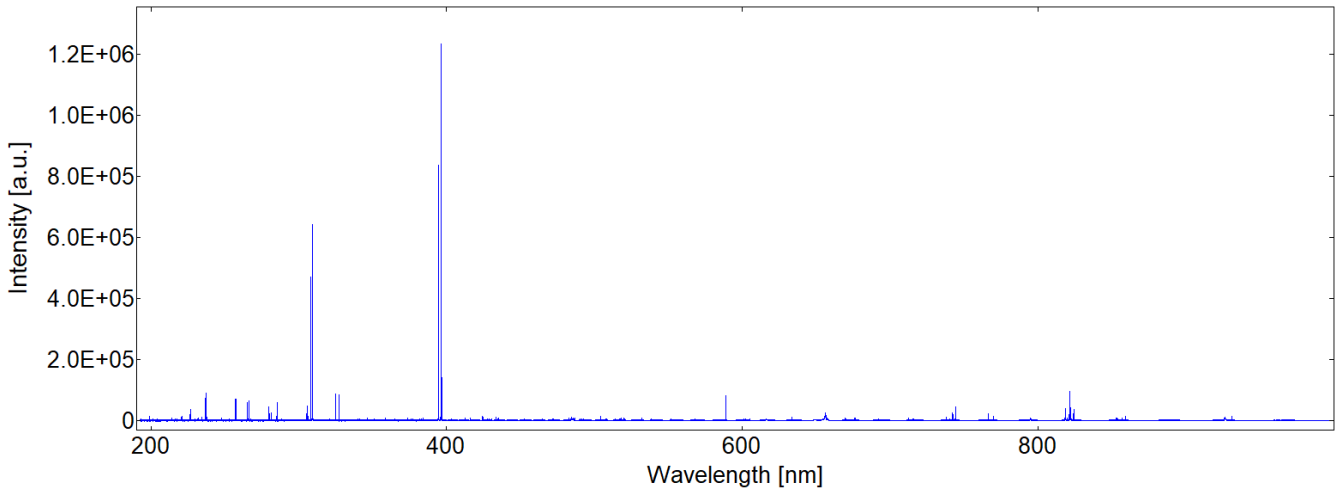
High purity copper (Air) 0.01 µs integration delay (minimum integration delay)



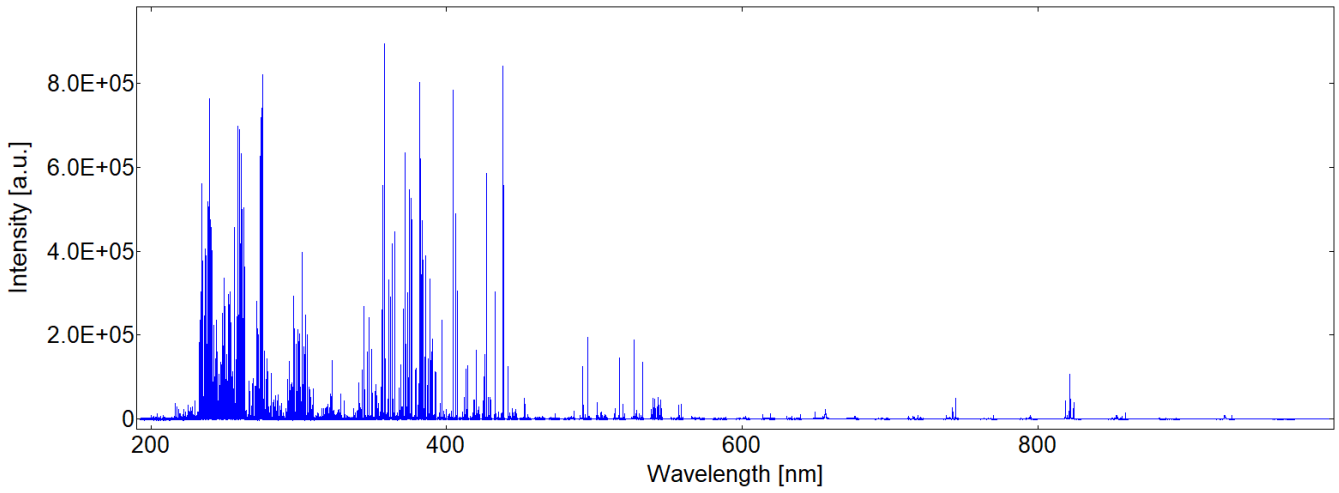
High purity copper (Air)



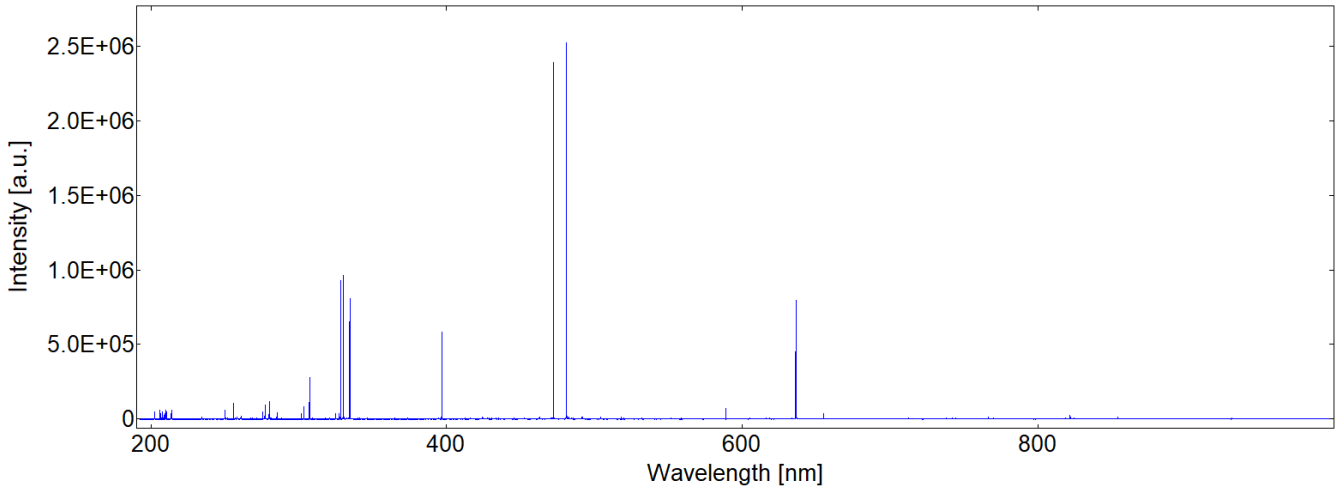
High purity aluminium (Air)



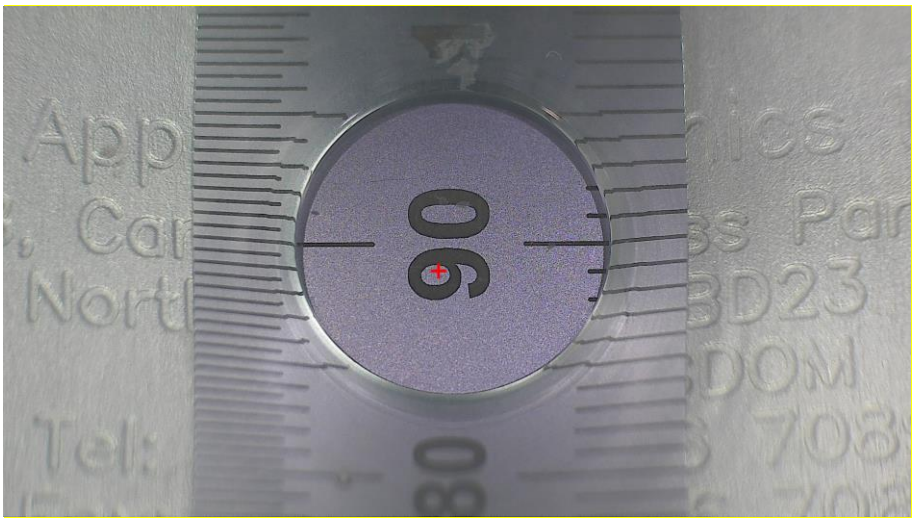
High purity iron (Air)



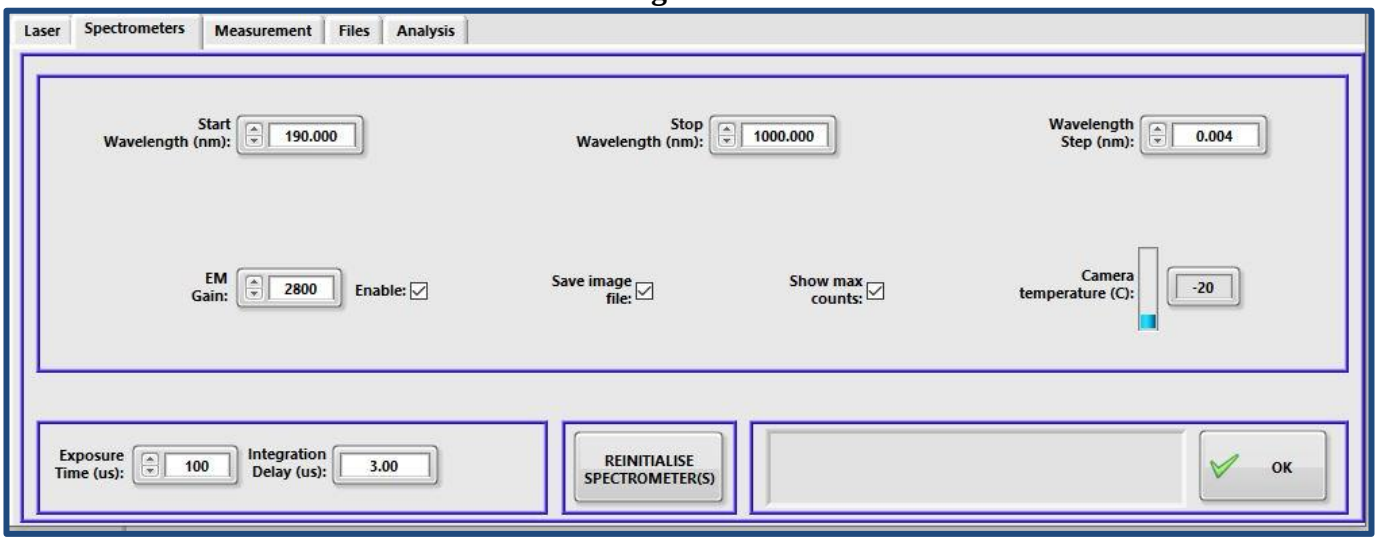
High purity zinc (Air)



Test of sample imaging camera
Screenshot from LIBSoft



EMU configuration screen



End of Test Report