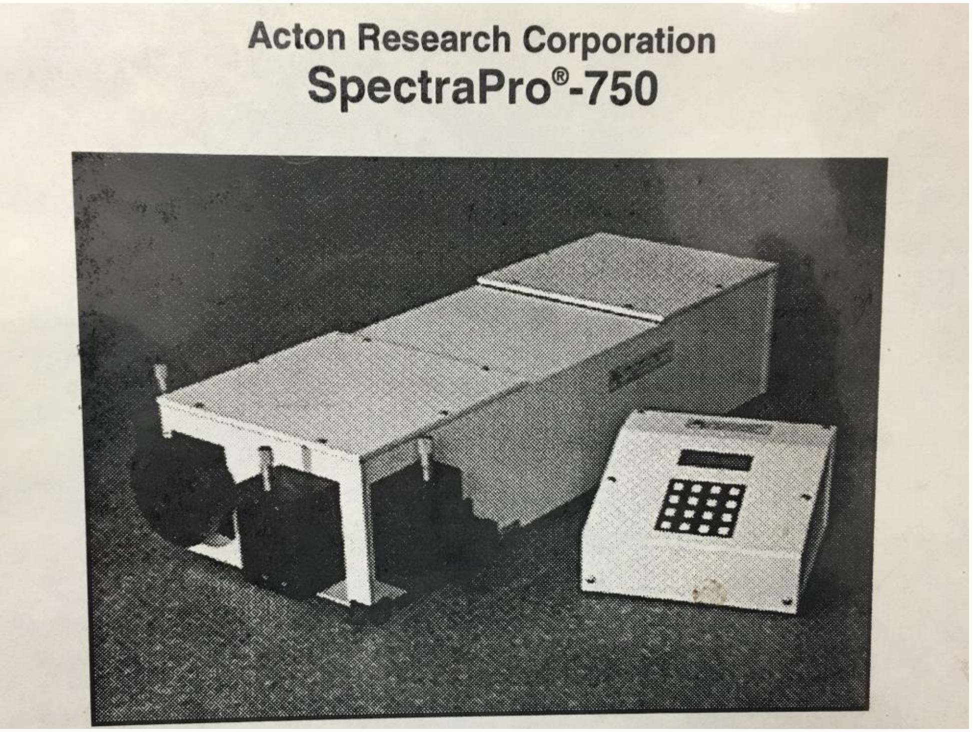
Acquiring Luminescence Spectra using the Acton SpectraHub Detector Interface + SpecraPro® 750



Disclaimer

- Safety –the first !!! This presentation is not manual. It is just brief set of rule to remind procedure for simple measurements. You ***should read manual first.***

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Luminescence

is a process in which an excited material emits light (electromagnetic radiation)

For example, the following types of luminescence caused by different excitation processes could be classified as :

Chemoluminescence, is the emission of light as the result of a chemical reaction

Light production in fireflies is due to a type of chemical reaction called bioluminescence

Photoluminescence(PL) is a process in which a material absorbs photons (electromagnetic radiation) and then re-radiates photons

Banknote photoluminescence after excitation by UV light from flash lamp

Electroluminescence(EL) is an process in which a material emits light in response to an electric current passed through it, or to a strong electric field.

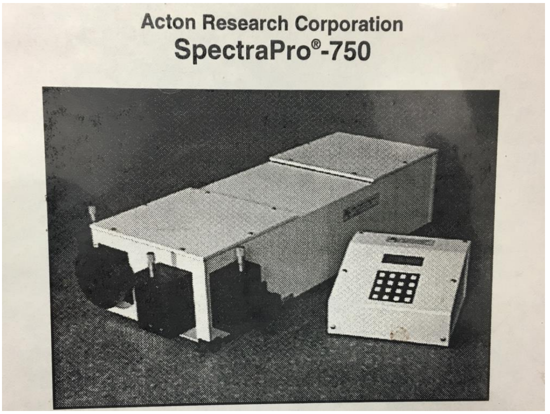
Parameters of the Luminescence

- Luminescence **spectra** shows how intensity of the luminescence depends on wavelength
- Luminescence **lifetime** refers to the average time the molecule/ion stays in its excited state before emitting a photon (or how long luminescence could be observed)
- The luminescence **quantum yield** gives the efficiency of the luminescence. It is defined as the ratio of the number of photons emitted to the number of photons absorbed.

Goal: Measurement of luminescence spectra using lock-in amplifier and SpectraHub Detector Interface

Experiment Background

- First of all, we need excitation source to transfer our sample into excited (high energy) state. Here we will consider only optical excitation. It means that we will use optical radiation to excite sample



- Second, we need optical system to collect the luminescence and direct it to detector. Also we need select luminescence from the excitation radiation. For these proposes we can use optical filter or monochromator which can help select radiation only at required wavelength.

- We need to detect optical signal (convert intensity of the optical radiation into electrical signals) and then convert signal into digital format

SpectraPro® 750

Optical design: Czerny –Turner

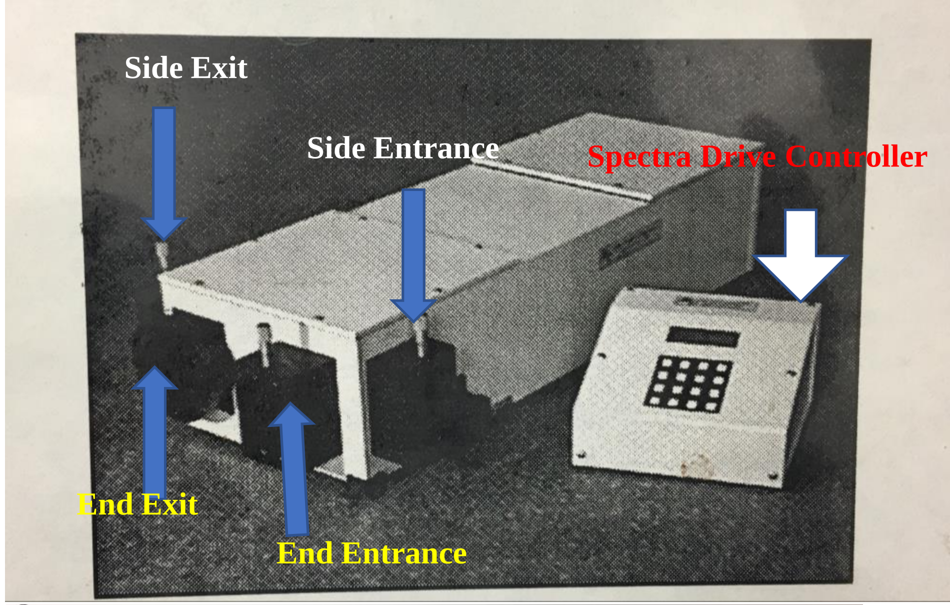
Two swing-Away mirror for exit and entrance port selection.

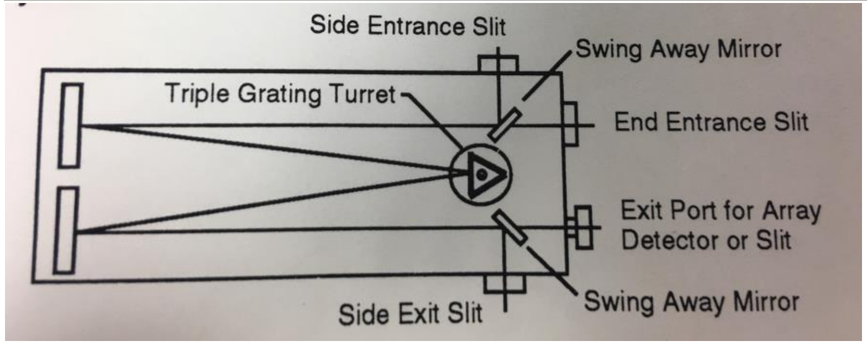
Focal length 750mm

Resolution: 0.023 with 1200g/mm at 438.8nm (10µm wide × 4mm high slit)

Reciprocal linear dispersion : 1.1nm/mm with 1200g/mm

Aperture ratio: f/10





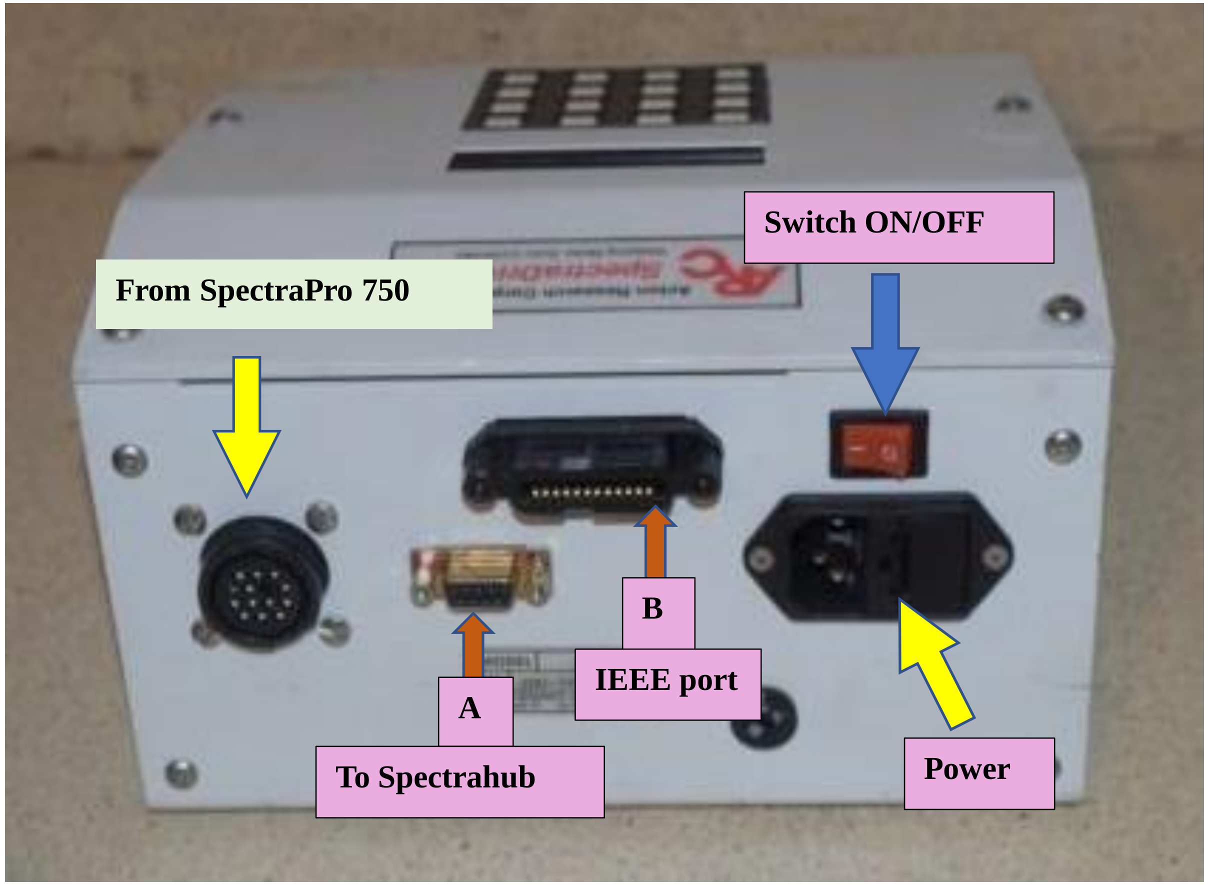
Turret 1:

1. 2400g/mm, BLZ=HOL,
2. 1200g/mm, BLZ= HMM, (λ_{cut}=1400nm)
3. 600g/mm, BLZ= 1 µm , (λ_{cut}=2800nm)

Turret 2:

4. 300g/mm, BLZ=2 µm, (λ_{cut}=2800nm)
5. 150g/mm, BLZ=500nm, (λ_{cut}=2800nm)
6. 500g/mm, BLZ= 1.2 µm, (λ_{cut}=2800nm)

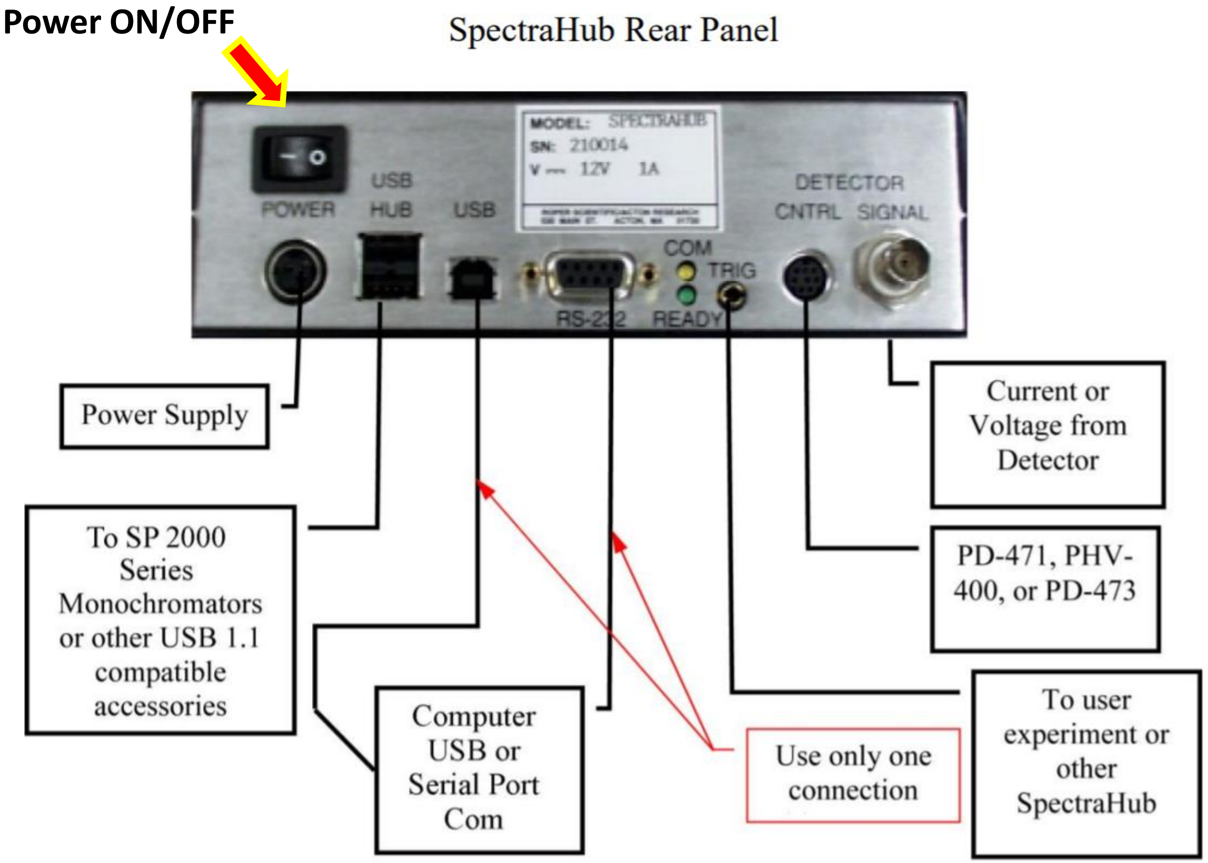
Spectra Drive controller



Note: IEEE Port is OPTIONAL

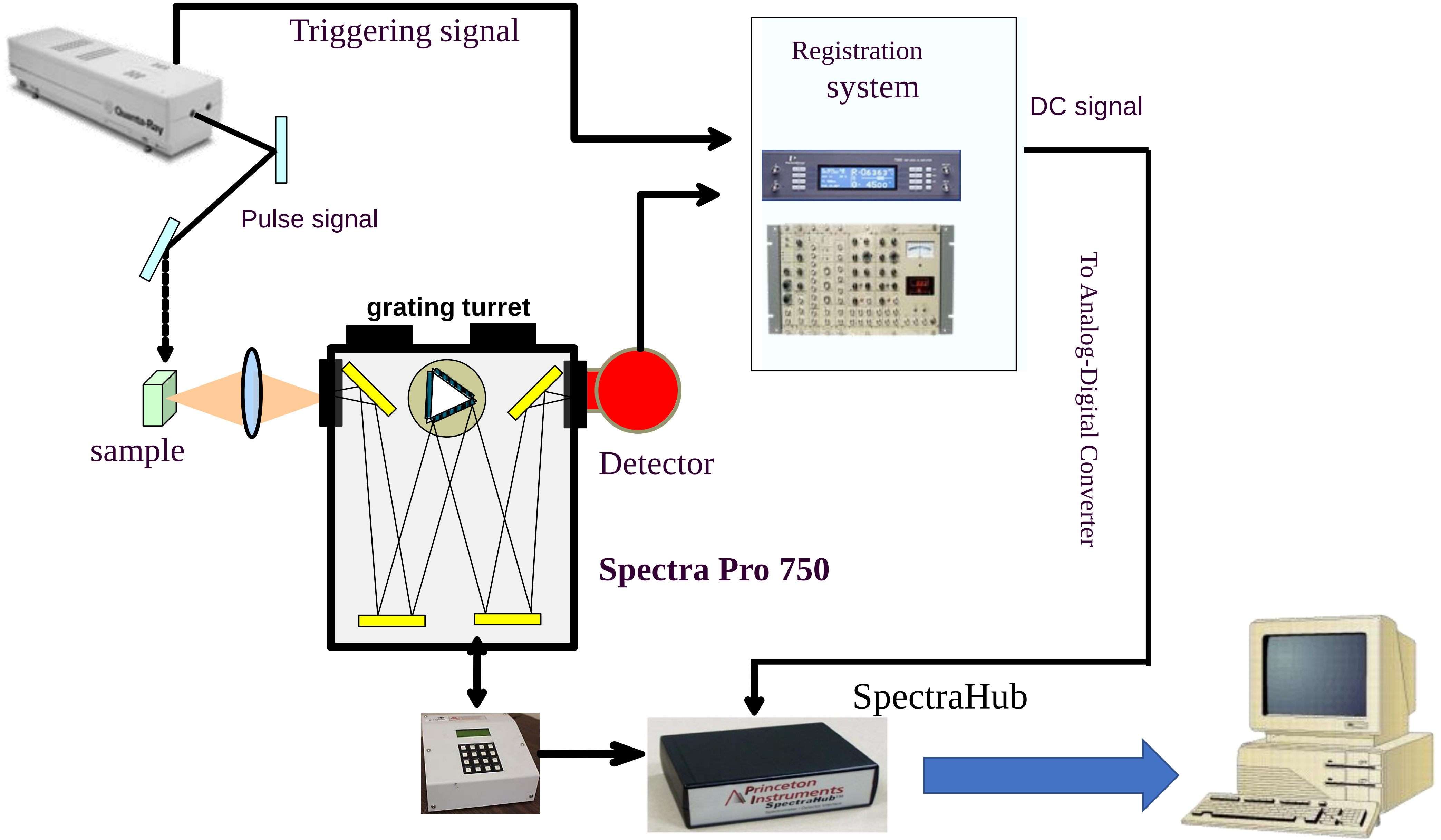
If you use RS232 port to connect to SpectraHub, IEEE connection is not required.

SpectraHub Detector Interface



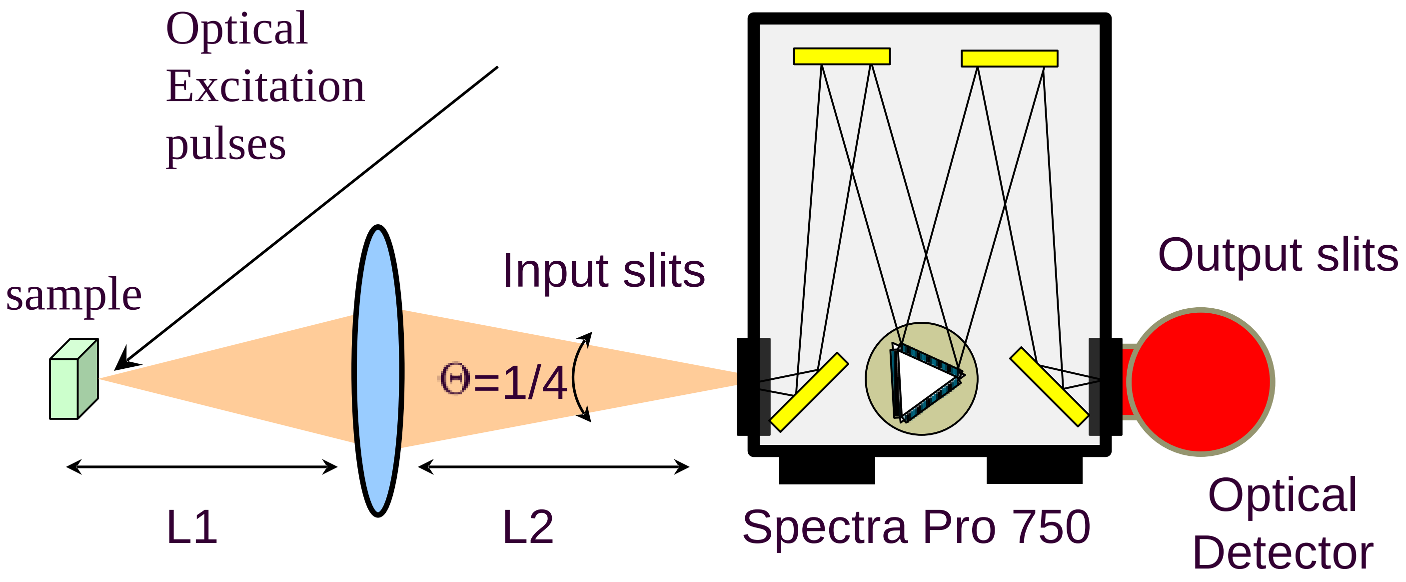
Connections of the SpectraHub with the Acton SP series monochromator

Experimental setup (Principal Scheme)



Optical Setup

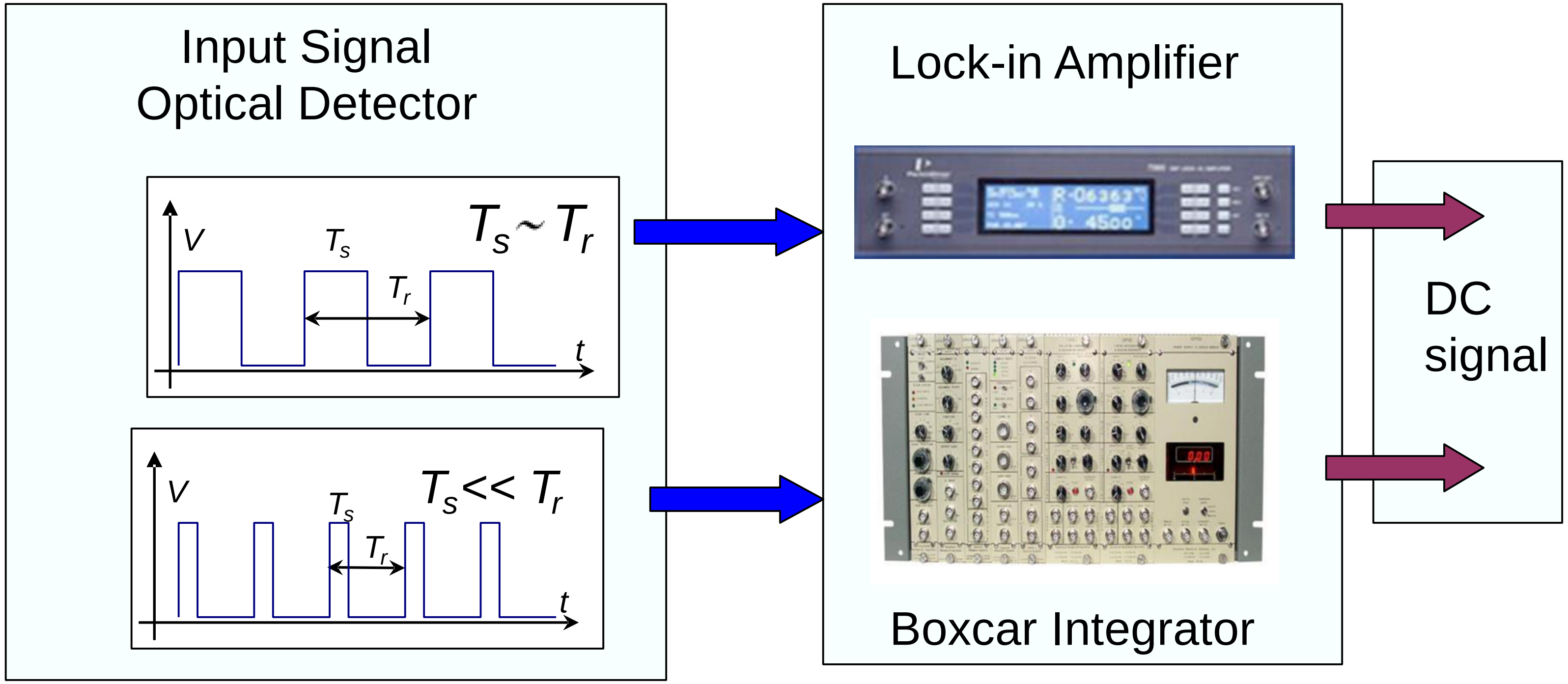
a) Avoid reflection of the excitation radiation to the measurement system!! You can used suitable filters.



b) Acceptance angle of Spectra Pro 750 is Θ =1/4. Therefore lens diameter should be D>LΘ (for L2=L1=2F configuration D>F/2)

Two type of the electronic registration system

depends on the ratio of the signal duration (Ts) and period between pulses (T_r); **duty cycle**



- Lock-in Amplifier for signals when $T_s \sim T_r$
- Boxcar Integrator for signals when $T_s << T_r$

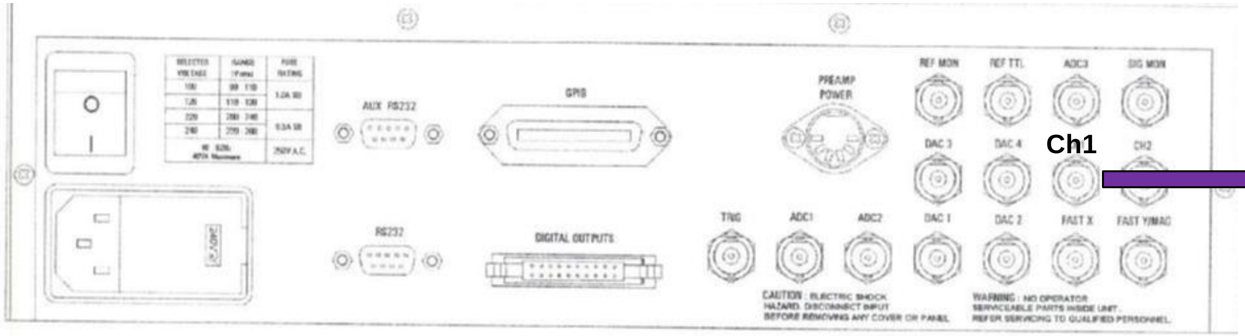
Lock-in Amplifier Connections

A lock-in amplifier can extract a signal amplitude at frequency of the reference signal and phase shift with respect to reference signal.

Output signal (from the BNC connector "Ch1" on the rear panel) should be directed to the Analog-Digital Convector in the *Spectral Measurement System* ,ARC

Input Signal (from Optical Detector)

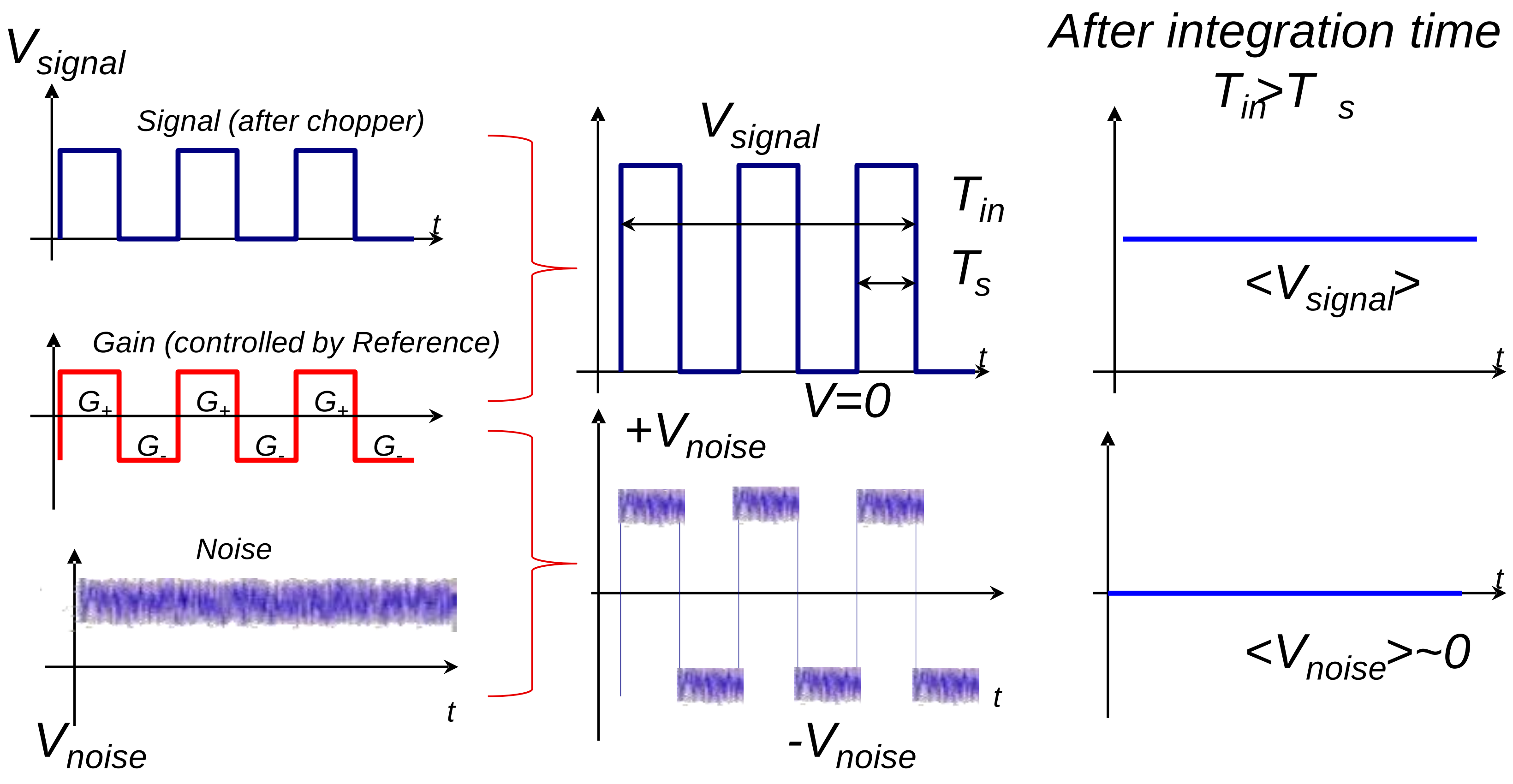
Reference Input (from Chopper)



Signal output

To Analog-Digital Converter
(Ch1 in SpectraPro-750
CONTROL unit i.e.SpectraHub)

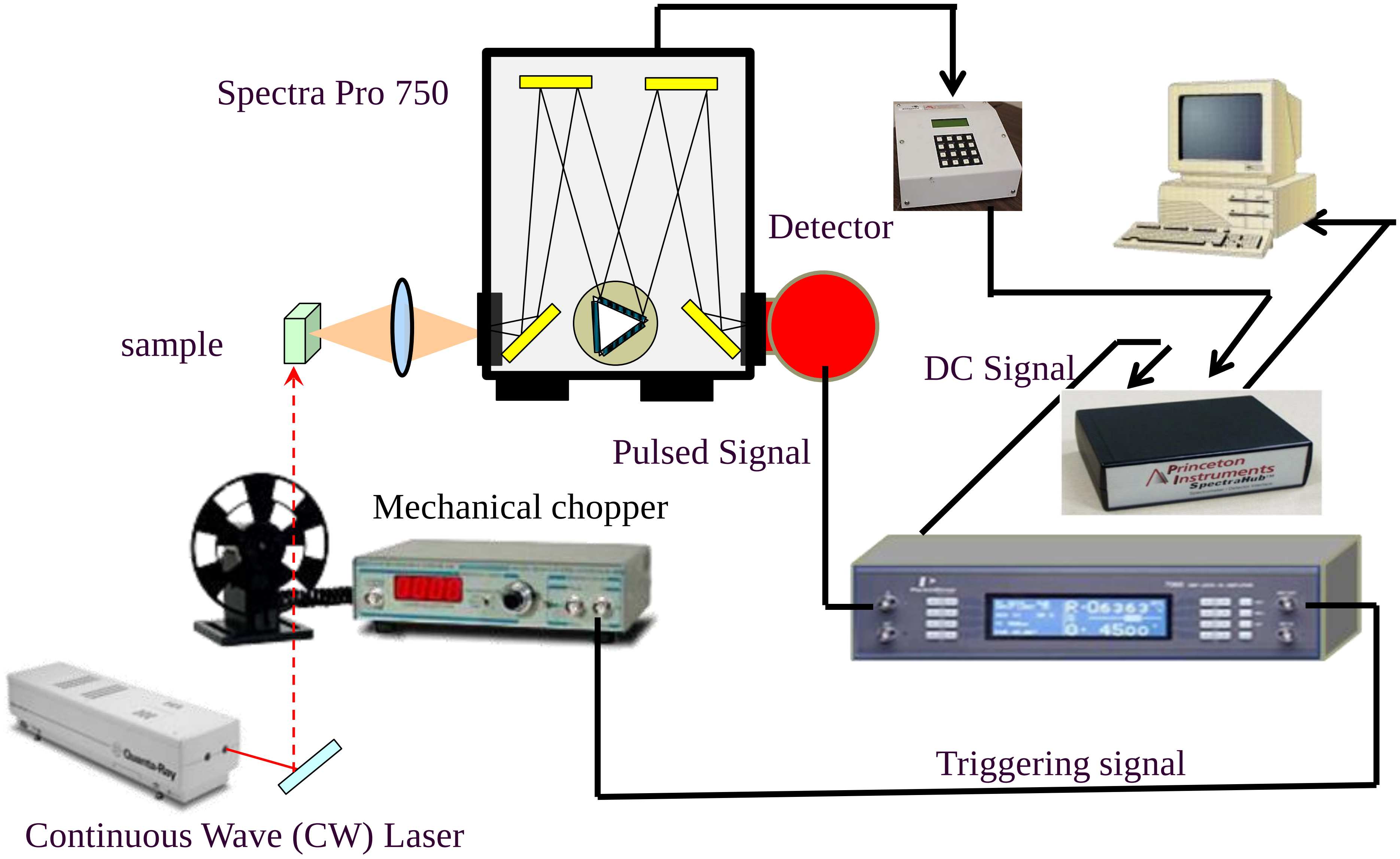
Basic principals of the Lock-in Amplifier



V_{noise}~V_{signal}

V_{noise}<<<V_{signal}

Experimental setup



Operation Procedure

Step 1.Switch on :

a) Mechanical chopper (see manual)

b) Detector Power Supply (see manual)

c) Lock-in-Amplifier (see manual)

Step 2. Switch on Spectra Pro 750 :

A-Switch on PC connected with the Spectrometer

B-Switch on Spectra Drive Controller

C- Switch on Controller Unit (SpectraHub)

Do not switch ON Laser on yet !!!

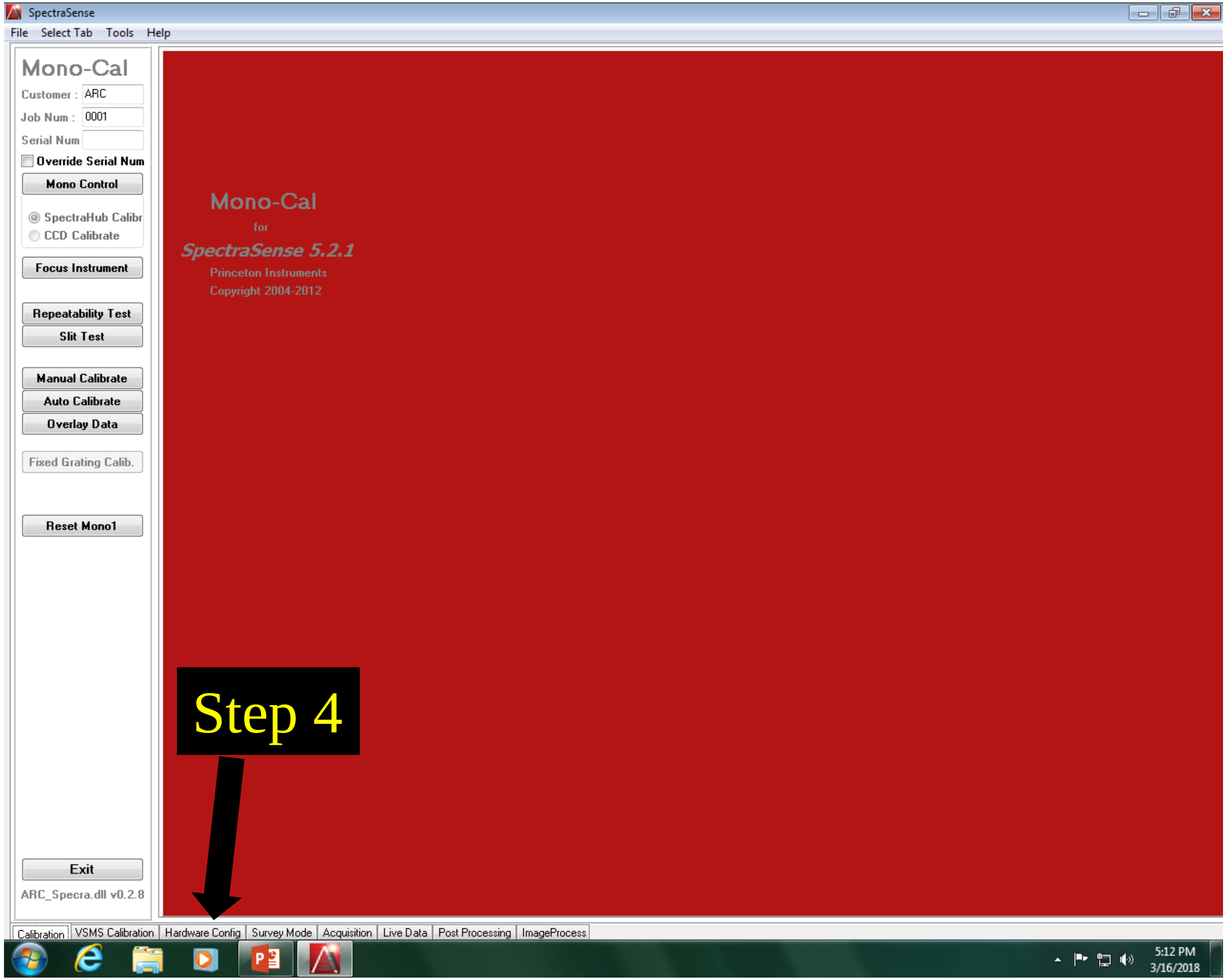
Operation Procedure

Step 3. Run Spectra Sense Software by double clicking the software icon and run it as an administrator.

Note: SpectraHub detector interface is supported in SpectraSense software version 4.3 or later!!!

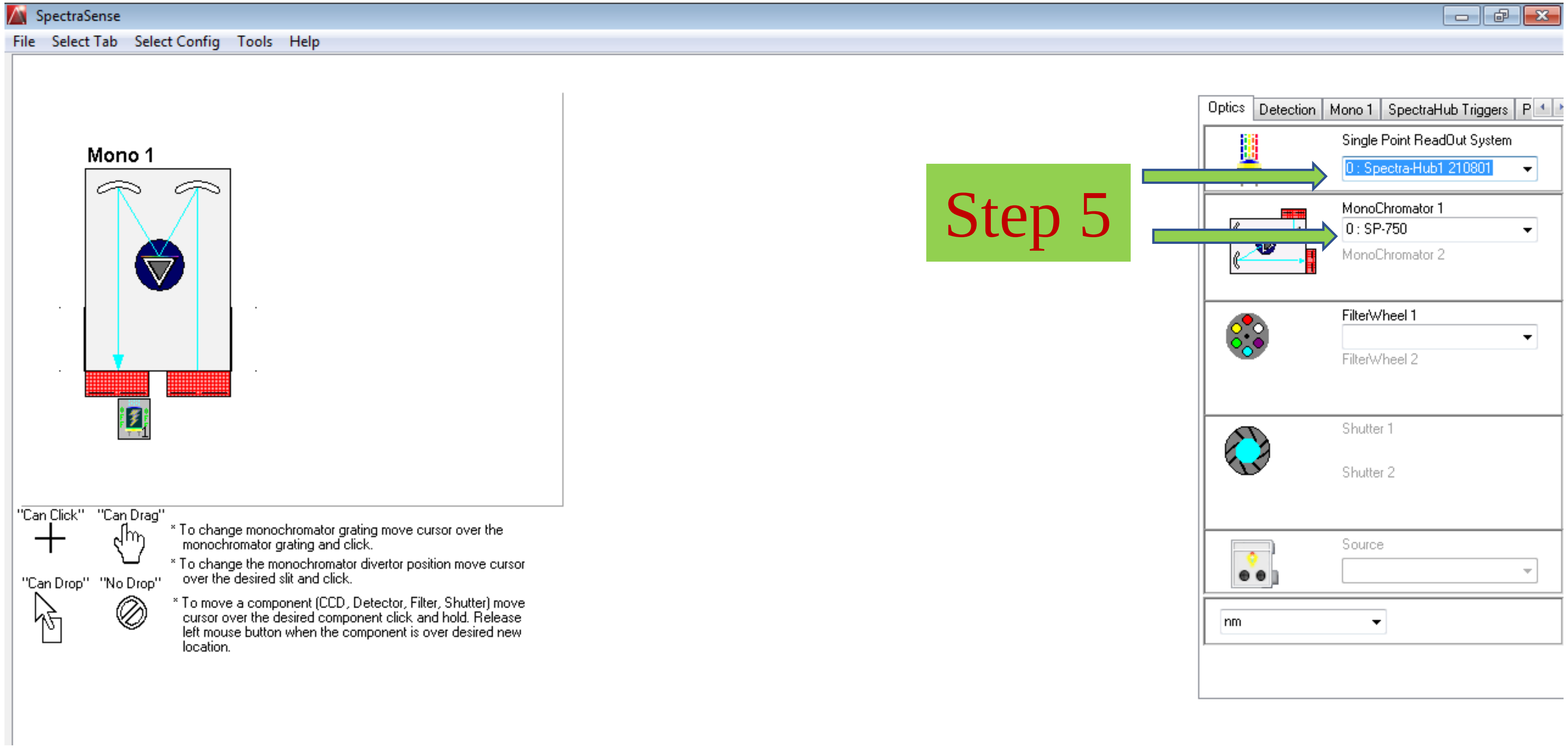
Operation Procedure

Step 4. Go to “Hardware Config” tab on the left side of the corner.



Operation Procedure

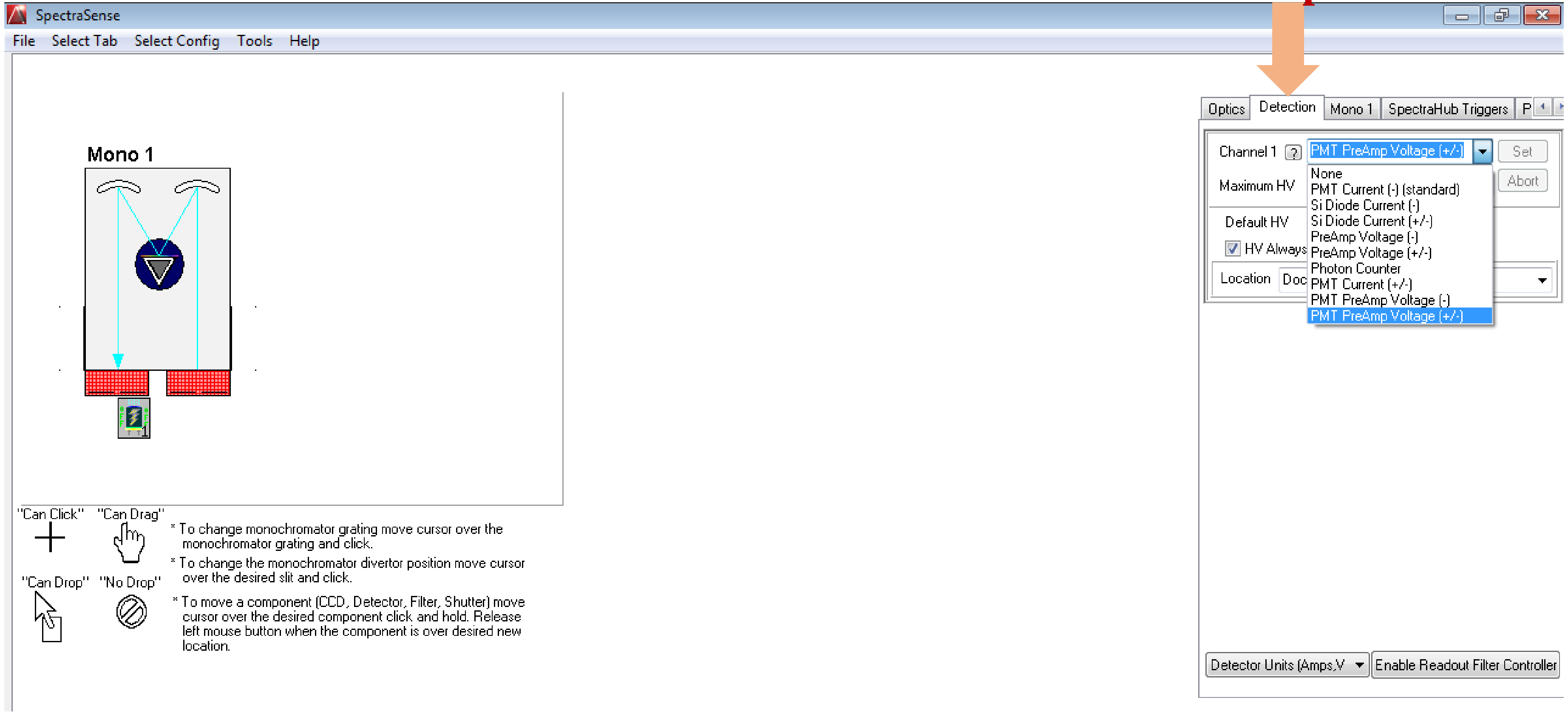
Step 5. Choose the controller and spectrometer name under the “Optics” tab.



Operation Procedure

Step 6: In the "Detection" tab, select the type of detector you are using.

Step 6

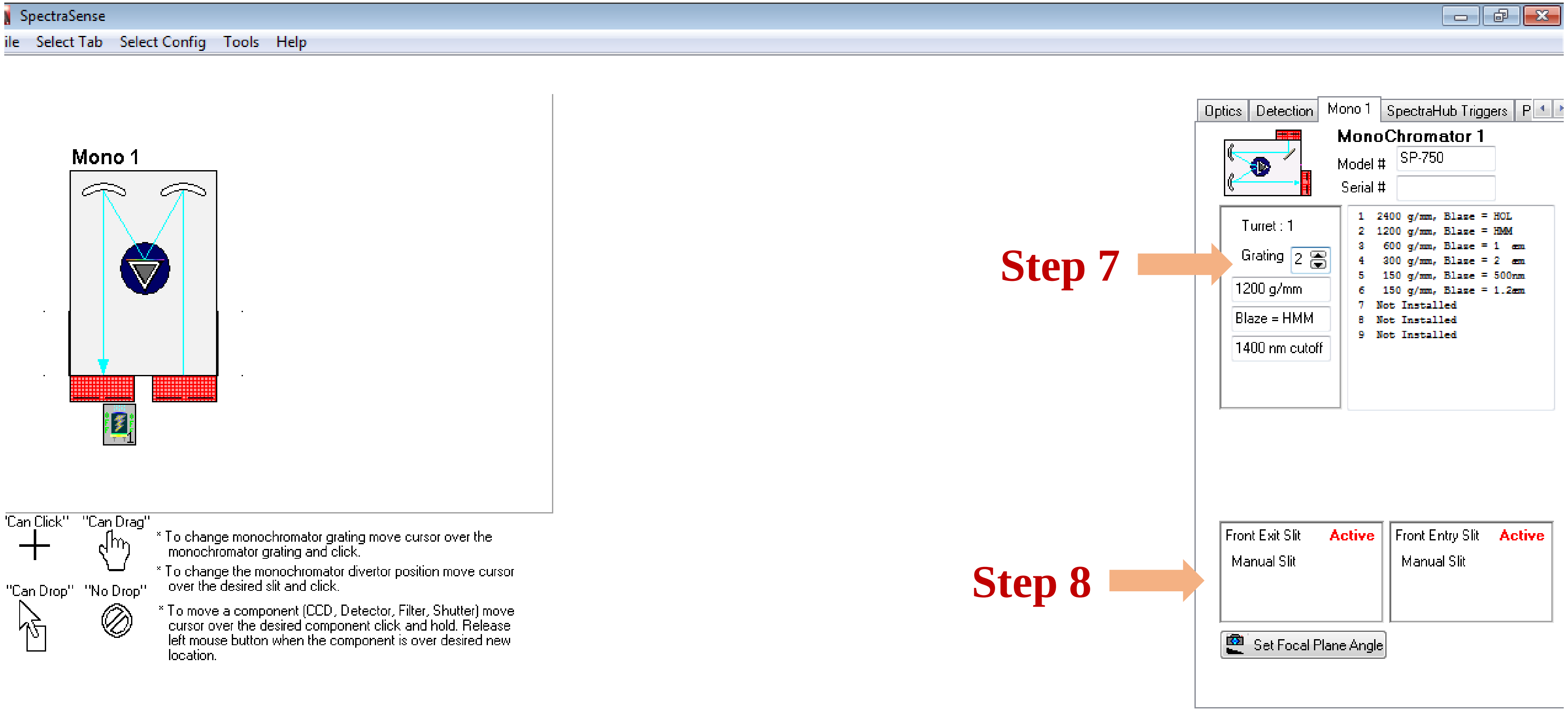


Operation Procedure

Under the “Mono” tab:

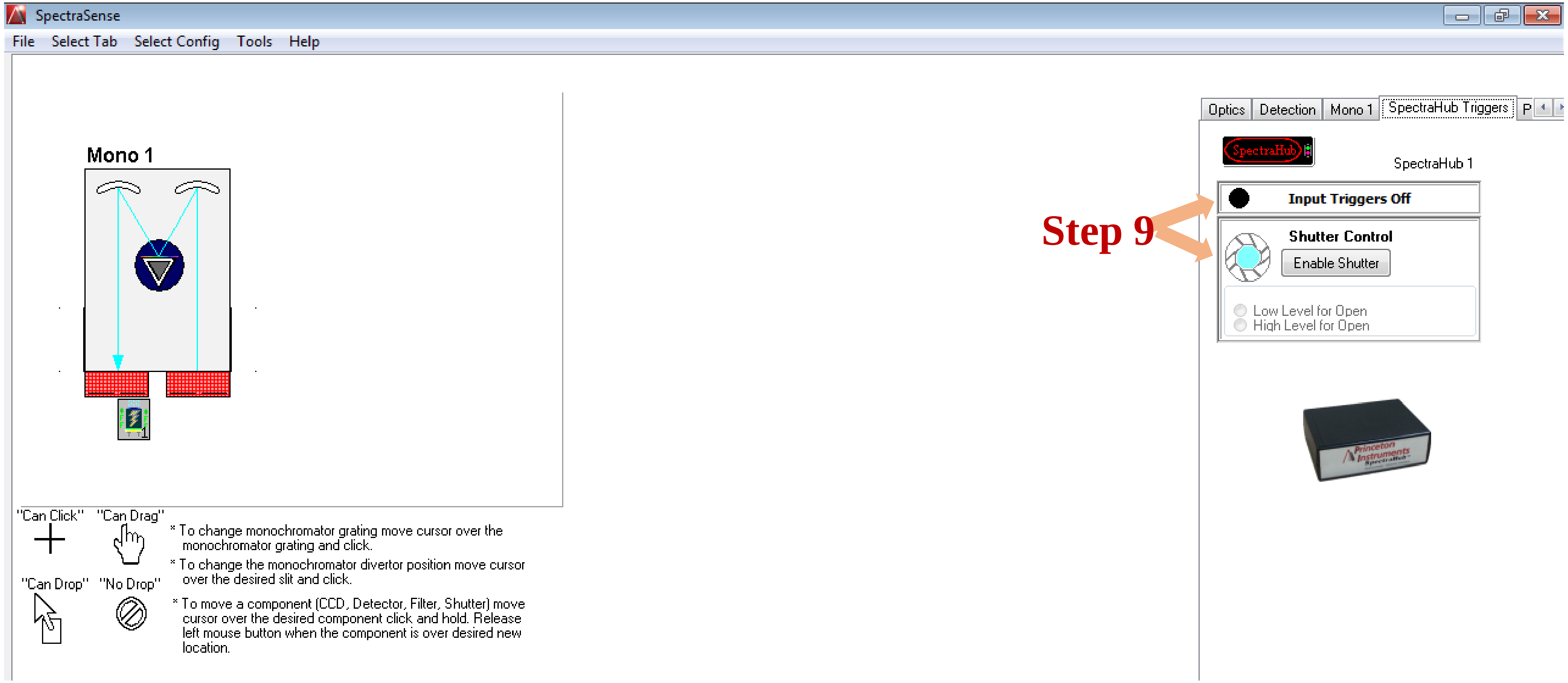
Step 7: Select suitable grating # for your experiment.

Step 8: Specify active Entry and Exit Slits.



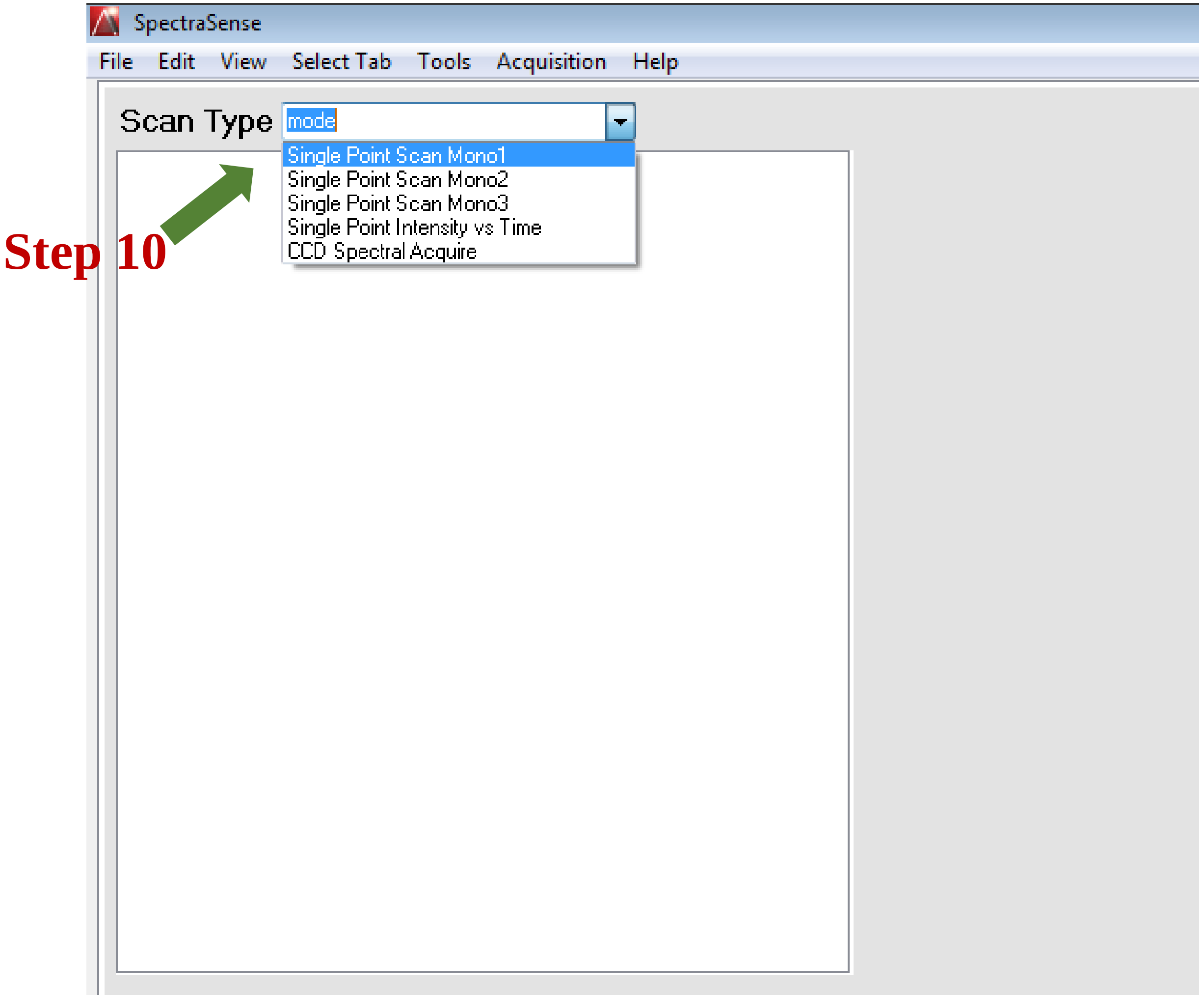
Operation Procedure

Step 9: Click “Input Trigger” to Off position if you are not synchronizing another SpectraHub controller. Also, Disable “Shutter Control” if you are not using any of these.



Operation Procedure

Step 10: Click on the "Acquisition" tab and select the monochromator under the "Scan Type" menu.



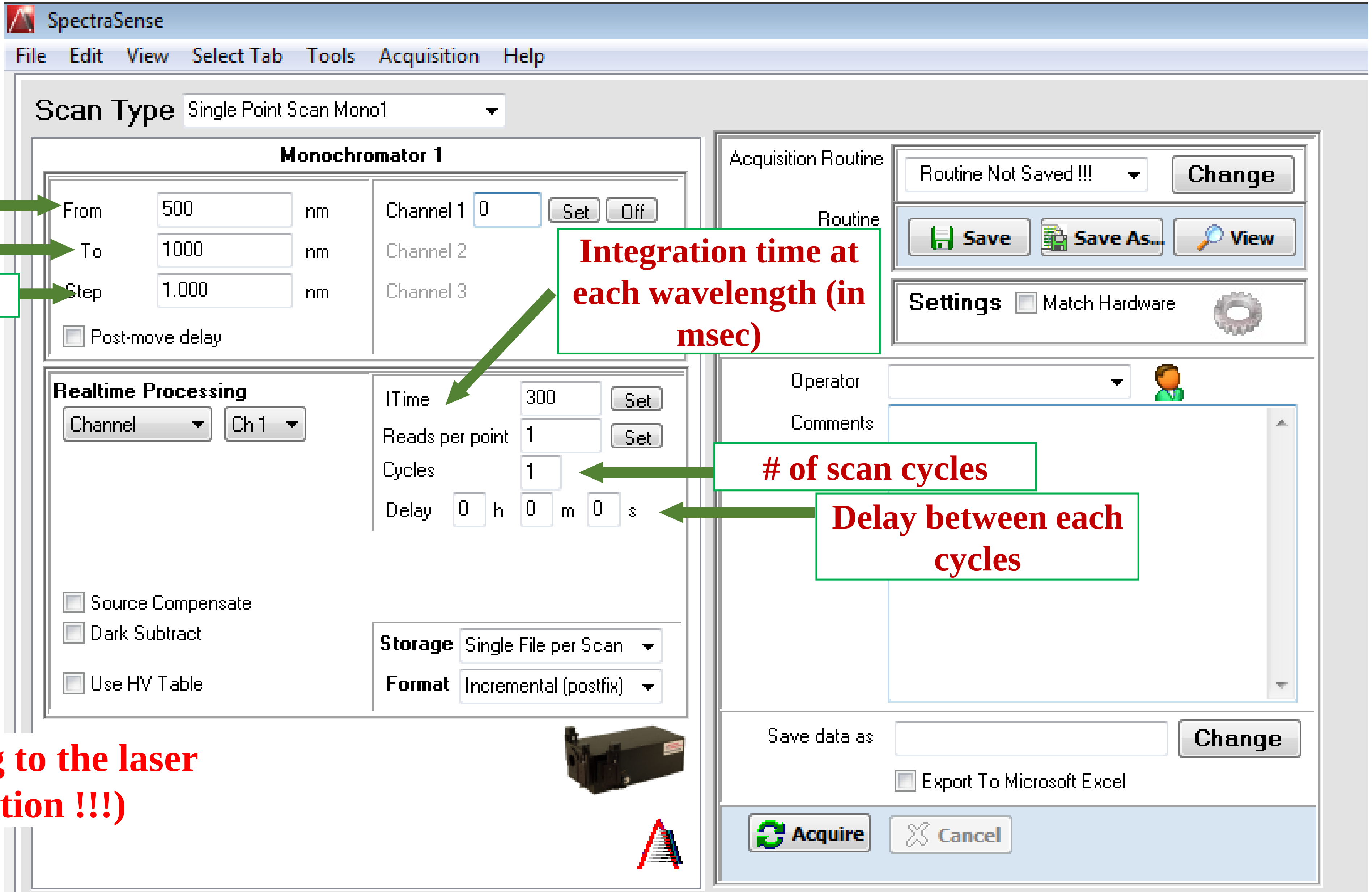
Operation Procedure

Step 11: Select Scan Parameters

Initial wavelength

Final wavelength

Step size



Integration time at each wavelength (in msec)

# of scan cycles

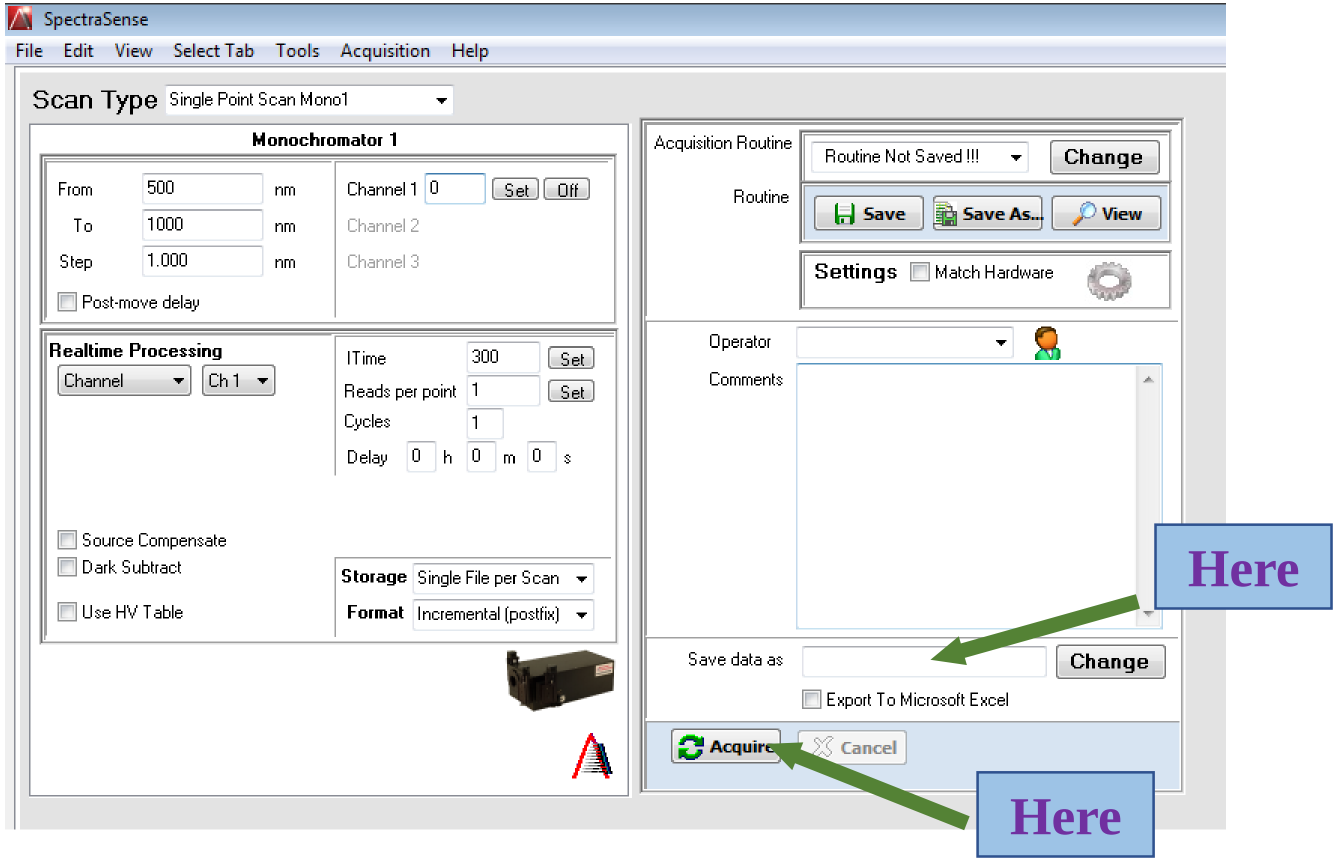
Delay between each cycles

Switch laser on according to the laser manual (see safety instruction !!!)

Operation Procedure

To save the data;

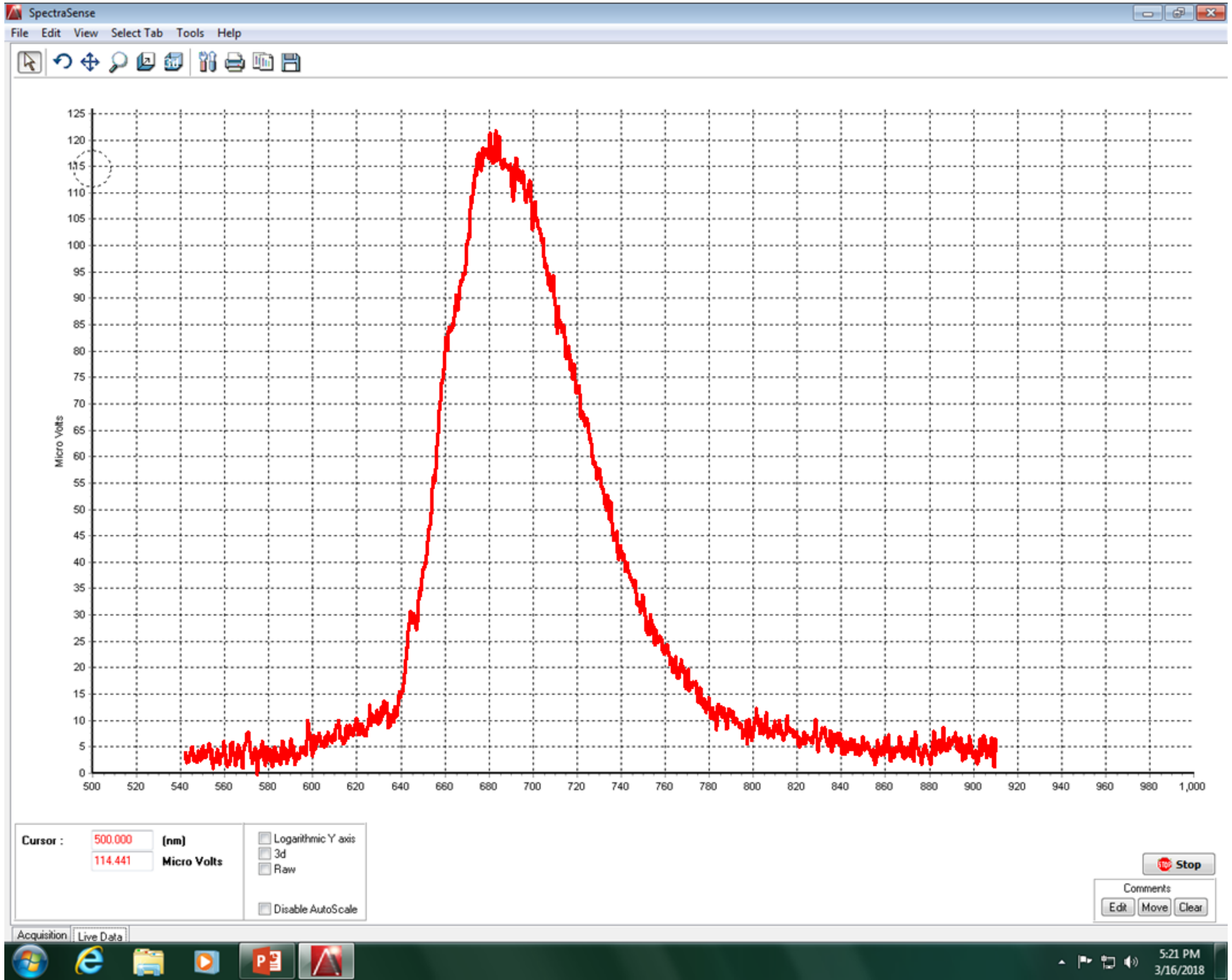
Step 12: Type file name and browse the file location where you want file to be saved and click on the "Acquire" to scan.



Note: File name needs to be entered before you start scanning!!!

Operation Procedure

Step 13: Wavelength (nm) vs signal (micro volts) graph will be displayed as a live data and .ARC File will be recorded and saved under the file name you typed in step 11.



GOOD JOB :)

Shut Down Procedure

After experiment is done

To Shutdown the system:

Turn OFF

- ❑ Laser system (according to the manual)
- ❑ Detector Power Supply Unit
- ❑ Chopper
- ❑ Lock-in –Amplifier
- ❑ SpectraHub Controller
- ❑ Monochromator power supply unit
- ❑ Close the Slits (Entrance and Exit Slits both)