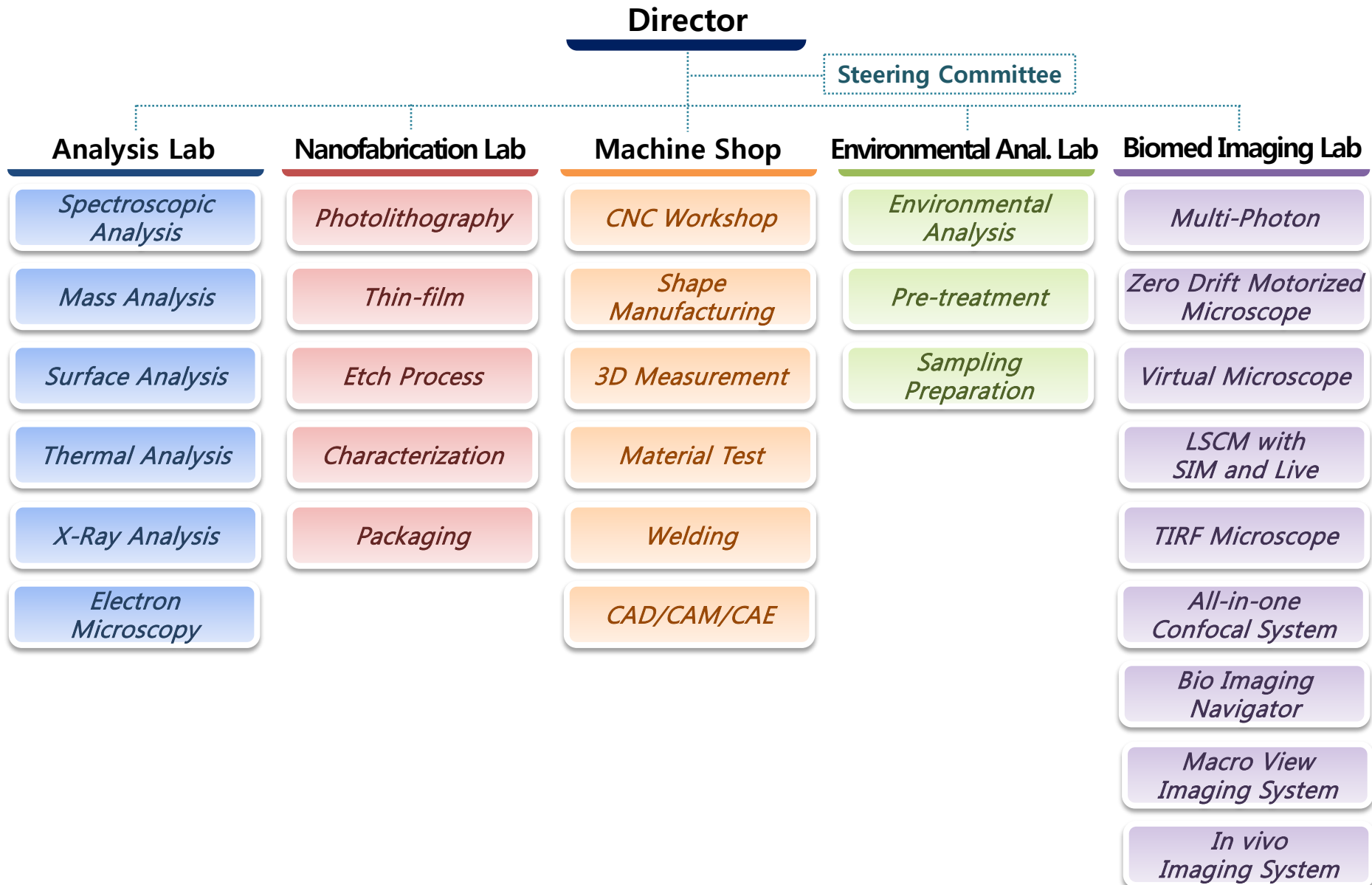


# Micro-Raman self-user training

---

SEON HYE SON

UNIST Central Research Facilities (UCRF)  
Ulsan National Institute of Science and Technology (UNIST)



## Other place

Site Manager

New\_Site

Site Name  
New\_Site

Host / IP / URL  
10.24.9.74

Advanced

Username  
djlim  Anonymous

Password  
\*\*\*\*  Don't save password

Port  
22

Timeout  
60

Retries  
2  Retry On

PASV  Use Proxy

Connection  
FTP

SSL Options  
 SSL Listings  SSL Transfer  Clear (CCC)  
 OpenSSL  Windows SSL

Comments

New Site New Category Connect Connect Manager Close

## In UCRF

Site Manager

New\_Site

Site Name  
New\_Site

Host / IP / URL  
100.100.100.30

Advanced

Username  
djlim  Anonymous

Password  
\*\*\*\*  Don't save password

Port  
22

Timeout  
60

Retries  
2  Retry On

PASV  Use Proxy

Connection  
FTP

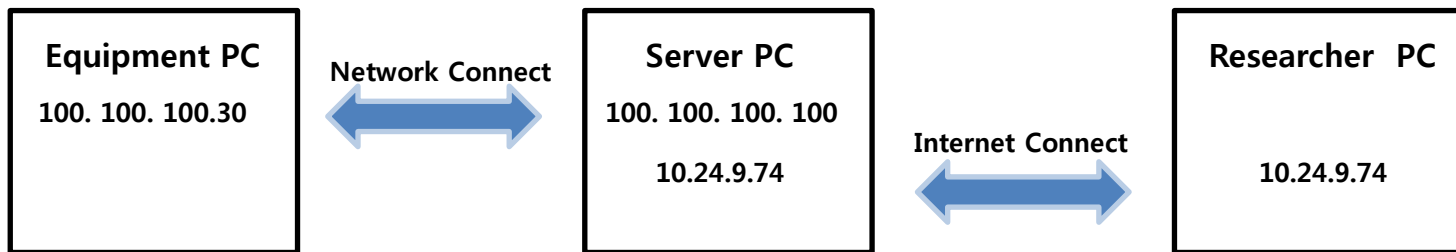
SSL Options  
 SSL Listings  SSL Transfer  Clear (CCC)  
 OpenSSL  Windows SSL

Comments

New Site New Category Connect Connect Manager Close

**Common ID : djlim**  
**Common PW : 0254**

# Log in System



Core FTP LE - 10.24.9.42:22

File View Sites Manage Help

250 CWD command successful. "." is current folder.  
 PWD  
 257 "." is current directory.  
 PASV  
 227 Entering Passive Mode (10,24,9,42,146,187).  
 LIST  
 Connect socket #1020 to 10.24.9.42, port 37563...  
 150 Opening data conn  
 226 File sent ok  
 Transferred 4,523 byte:

Analysis PC or My PC

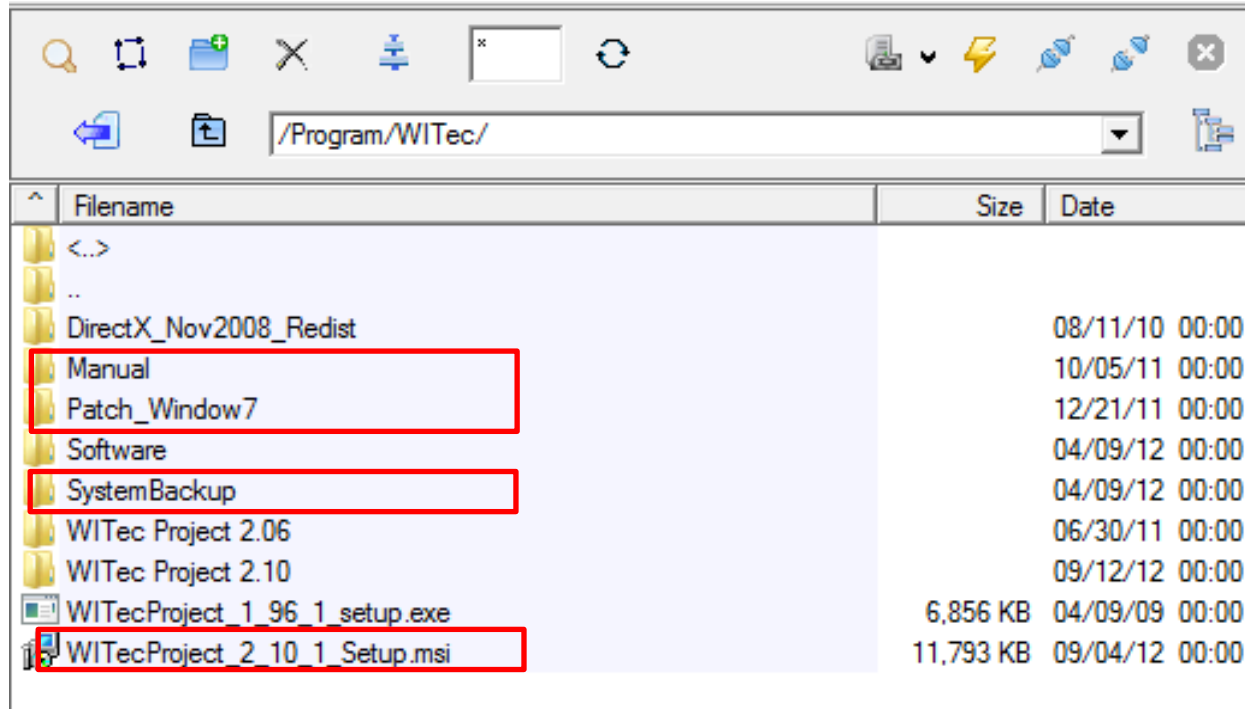
Server PC

Filename	Size	Date
..		09/13/13 09:07
Fax		08/13/13 11:28
Malvern Instruments		09/19/12 10:43
SAP		10/03/13 17:24
Scanned Documents		08/13/13 11:28
경남은행		08/07/13 15:49
Self 교육.xlsx	14 KB	09/26/12 17:59
XRF_data_보정.xls	112 KB	12/27/12 13:22
거래내역조회_2009_출력.pdf	45 KB	08/07/13 16:13
동위원소상기동률계산_박지혜.xlsx	32 KB	04/26/13 18:00

Filename	Size	Date
<>		
..		
Company		10/04/13 11:...
Labs		10/06/13 20:...
Program		09/02/13 12:...
toengineer		01/30/13 10:...
touser		10/04/13 15:...
UCRF		10/02/13 17:...
UCRF 로그관리		10/01/13 14:...
AFM 스캐너수리 요구내역.xlsx	0	04/27/13 15:...

# Raman Analysis Program

- Core FTP > Program
- Download :
  - 1) WITecProject 2\_10\_1 setup
  - 2) System Backup



## Article 1 (Purpose)

This guideline is intended to provide detailed requirements for operating the Central Research Facilities at Ulsan National Institute of Science and Technology (UNIST) (hereinafter referred to as “UCRF”) in accordance with Article 10, Operational Regulations of Central Research Facilities at UNIST.

## Article 2 (Scope)

This guideline shall apply to faculty, graduate students, undergraduate students and researchers at UNIST, as well as external clients, who request services from UCRF, and equipment managers.

## Article 3 (Definitions)

Terms used in this guideline shall be defined as follows:

“Autonomous use” means that UNIST faculty members or students use UCRF's equipment without any help from the equipment manager.

“Autonomous user” refers to users who have qualifications for the “autonomous use” of the equipment in paragraph 1 above, according to procedures set by UCRF.

“Request for analysis and processing” is a request to the equipment manager to perform a series of analyses and processes, so autonomous users can use UCRF's common equipment to obtain the results of a test analysis or process.

## Article 4 (Access Management)

- ① If any personnel want authorized access to laboratories with restricted access, they must fill out an application form and receive approval from the supervising professor and Center manager to register their ID.
- ② If any personnel needs to access laboratories for equipment maintenance and repair, they must be accompanied by a competent manager or have the manager's approval to gain access to the labs.
- ③ For laboratories that require safety training for personnel with access, approval for access will be withheld until they complete prior training, as specified for each laboratory.

## Article 5 (Requests for Analysis and Processing)

- ① If a client requests for analysis and processing that can be supported by UCRF, the client should discuss with the equipment manager beforehand.
- ② A client who requests analysis and processing shall cooperate with the equipment manager in identifying the necessary information needed to maintain the normal operations and safety of equipment or facilities.
- ③ Analysis and processing services will be available to clients on a first-come-first-serve basis. In any special circumstances such as equipment inspection and repair is needed, requests for such services may be reserved or cancelled at the equipment manager's discretion.

- ④ If there are no special requests from the client, each manager may discard any specimens that are seven days or older after the results-notice date, and may also discard the outcome or results data produced by the analysis and processing service three months from the day of said notice or later.

## Article 6 (Qualifications for Autonomous Use)

- ① Authorized persons who qualify for autonomous use shall be limited to graduate students, researchers, professors and authorized undergraduate students (with the supervising professor's approval) at UNIST.
- ② Qualifications for autonomous use shall be granted to any persons who satisfy the requirements specified by each laboratory (e.g. safety training, equipment user training, evaluation, etc.).
- ③ A list of autonomous users shall be updated every 6 months and shall be published on the UCRF homepage.
- ④ An autonomous user's qualifications may be cancelled if the equipment manager deems it necessary, or if the user does not frequently use the equipment (less than the minimum limit of 10 times in the last 6 months). In such cases, users may discuss with the manager and go through a re-orientation process to be qualified for autonomous use again.

## Article 7 (Responsibility of Autonomous Users)

- ① Autonomous users should follow the instructions for using the equipment as they learned during the orientation. If there is something significant to report, they must discuss with a competent manager and help operate and maintain the safety of the research equipment facilities.
- ② Autonomous users will be liable for any accidents, equipment damage, failure and loss incurred as a result of their negligence when using the equipment.
- ③ Equipment reservations should be made a day (24 hours) prior to when they need to use the equipment, and may be cancelled no later than 12 hours before the booked start time. If a user wants to cancel their reservation, they must inform the equipment manager via phone or e-mail during regular work hours (weekdays: 09:00 - 18:00) or via e-mail during off-hours.
- ④ Any reservations that are made less than 24 hours in advance may be cancelled before the booked start time. If users want to cancel their reservation, they must inform the equipment manager via phone or e-mail during regular work hours (weekdays: 09:00 - 18:00) or via e-mail during off-hours.
- ⑤ After using the equipment at night or during the equipment manager's off-hours, authorized users should make sure the laboratory is put back in order, the lights are turned OFF, and the entrance door is properly locked before leaving.

## Article 8 (Restrictions for Autonomous Use)

- ① For the convenience of other users, a comfortable research environment, and to promote proper use of the equipment, UCRF may sanction users.
- ② Sanction criteria from the above paragraph 1 shall follow "Table 1. Penalty Points and Sanction Criteria for Users of Common Equipment."

## Article 9 (Billing for Test Analysis Fees)

- ① Clients or autonomous users will receive bills for test analysis fees in the following month after the analysis and processing has ended, and may only pay for these bills to UCRF's bank accounts.
- ② Clients or autonomous users shall follow the specified procedures to pay bills charged under the standards of test analysis fees in accordance with Article 8, "Operational Regulations of Central Research Facilities at UNIST."
- ③ The standards of test analysis fees, as stipulated in Article 7, Operational Regulations of Central Research Facilities at UNIST, may be provided to clients or users before request or use.
- ④ If this is their first request or first time using the equipment, clients and users should submit copies of their business license and their bank book to UCRF's administrative offices.
- ⑤ When there is any change to the business license, they shall inform the administrative manager of the change and send a copy of the new business license to the manager.
- ⑥ Bills for test analysis fees shall be issued by UCRF's administrative office, and clients or users shall pay the bill to UCRF no later than 1 month after the bill is sent to them. If the payment is overdue, UCRF may stop supporting services for users and laboratories in arrears.
- ⑦ If more time is required for analysis and process due to negligence on the part of clients, additional test analysis fees may be charged.



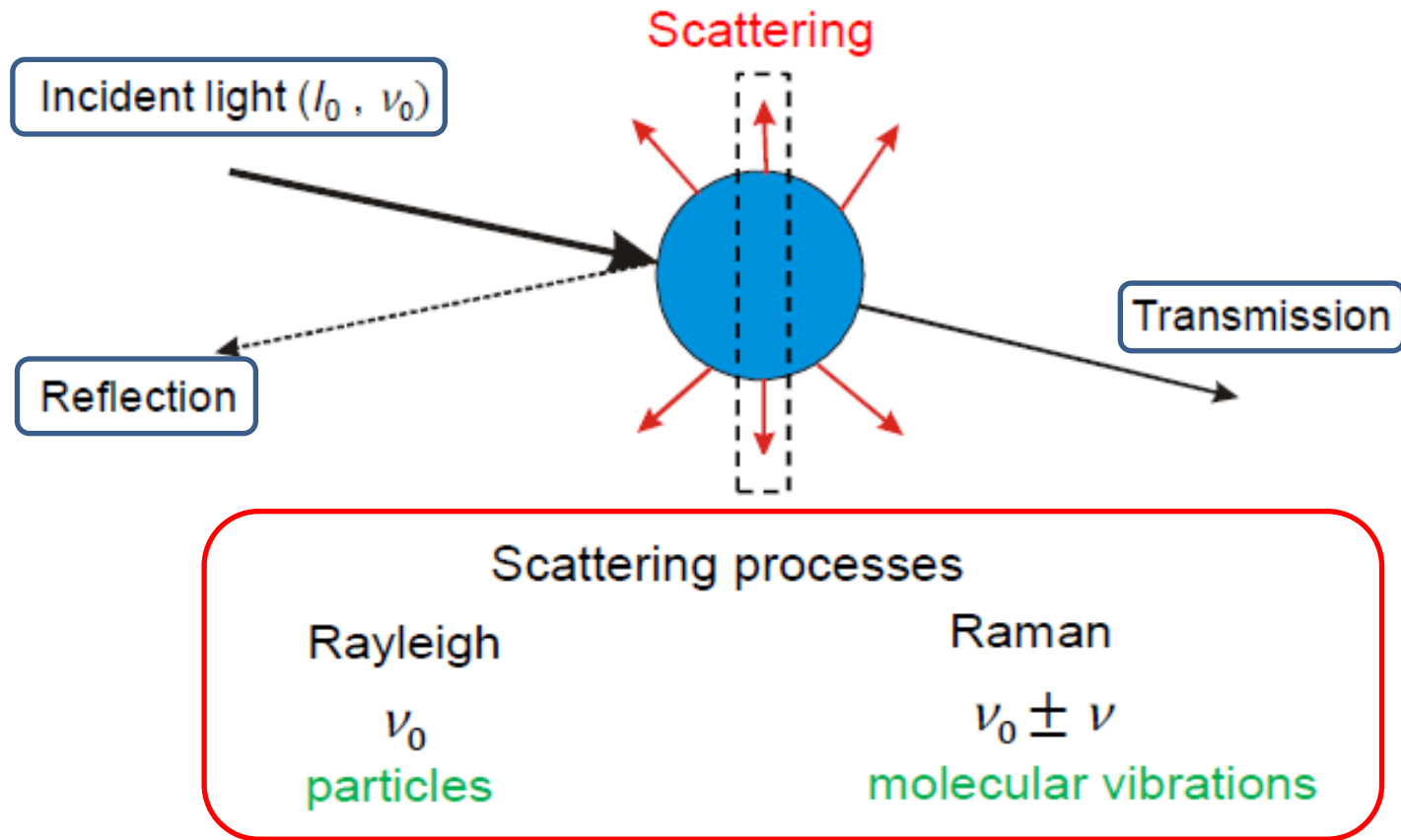
# Penalty Points and Sanction Criteria

	Behaviors subject to penalty points	Penalty pts
[Eligibility to use equipment]		
1	Unauthorized use of equipment without permission	5
2	Use of equipment without a reservation	3
3	Someone other than the equipment lessee used the equipment	3
[Reservations for using equipment]		
4	Reserved and used equipment outside of permitted hours	1
5	Use of equipment beyond the time reserved without making another reservation beforehand for extra time	1
6	Failed to use the equipment during the reserved time and did not cancel reservation in advance	3
7	Cancelling reservations for equipment after the cancellation deadline, under Article 7, Guideline for the Operation of the UNIST Central Research Facilities (UCRF)	1
8	Use of any equipment without giving a prior notice to the equipment manager, after making a reservation	1
[Careless behaviors]		
9	Using functions on the equipment that are not permitted	3
10	Failure to promptly notify the manager of any errors or failures detected during use	3
11	Negligence that resulted in damages or failure to the equipment	5
12	Negligence that resulted in loss or damage to an equipment component or part	5
13	Failure to record in the equipment usage log after using any equipment, or misrepresentation or partial representation of the facts	1
14	Failure to provide specimen information required by the equipment manager to ensure normal operations and safety of equipment or facilities, thus resulting in damage or failure to the equipment	3
15	[Careless behaviors]	3
16	Using functions on the equipment that are not permitted	5
17	Failure to promptly notify the manager of any errors or failures detected during use	5

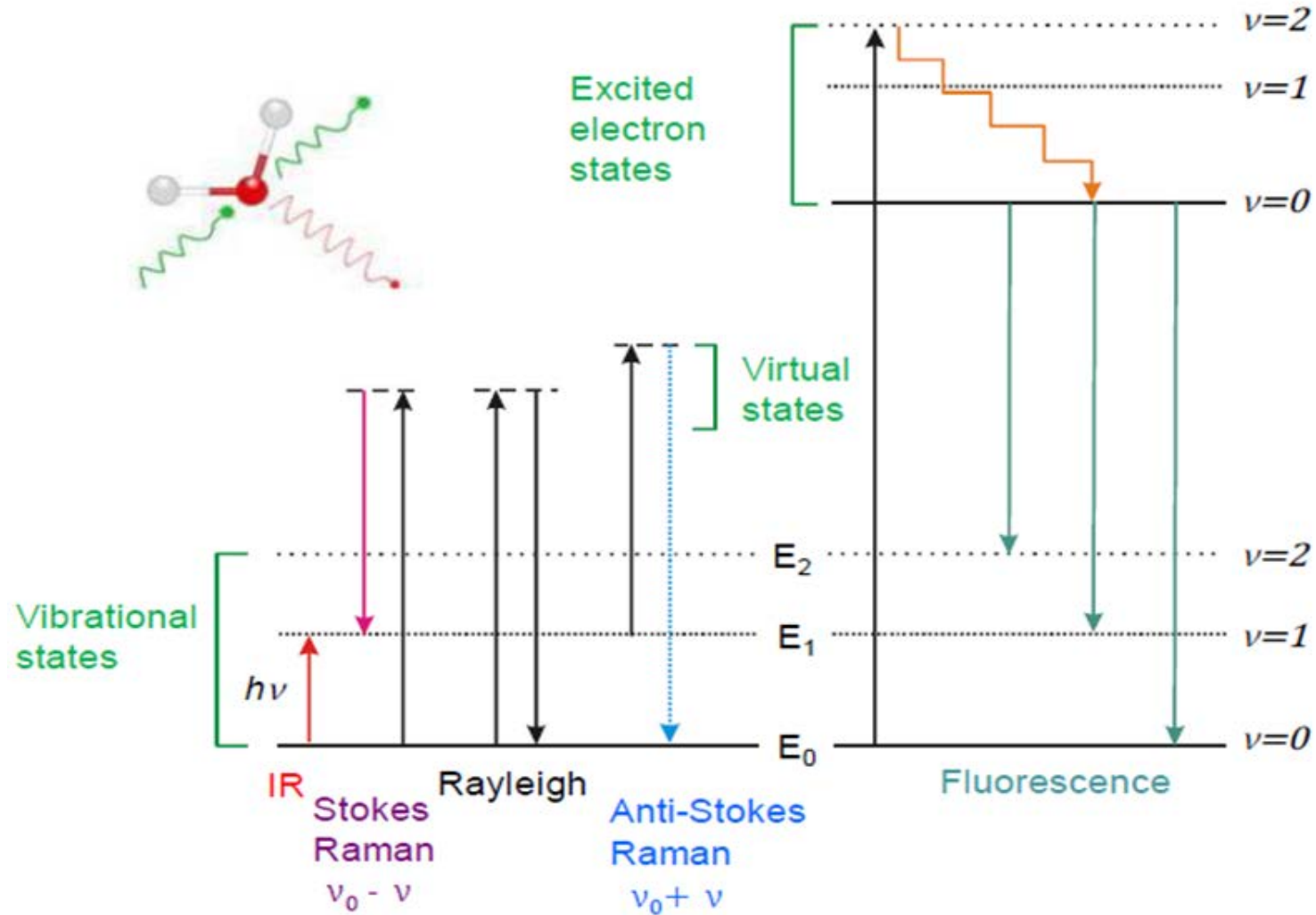
# Penalty Points and Sanction Criteria

Classification	Penalty pts.	Follow-up actions
(Individual users of equipment)		
Sum up penalty points imposed to individuals	≥ 5 points	Equipment manager will notify user(s) and their supervising professor by email of their penalty points total, and shall post the details of their penalty points on the bulletin board of the equipment room. Users with penalty points 8 points or higher may not use the relevant equipment for 3 months.
	≥ 8 points	Equipment manager will notify user(s) and their supervising professor by email that the user(s) may not use the relevant equipment for 3 months until they complete the re-orientation course; will also forward an official notice to their supervising professor; and will post details of their penalty points on the bulletin board of the equipment room.
(User's laboratory)		
Sum up penalty points imposed on the students in the laboratory for the same equipment in the same laboratory	≥ 12 points	Equipment manager will notify the user(s) and their supervising professor by email that user(s) with penalty points 15 points or higher may not use the relevant equipment in the laboratory for 3 months.
	≥ 15 points	Equipment manager will email the supervising professor to inform that the user(s) may not use the relevant equipment in the laboratory for 3 months; will also forward an official notice to their supervising professor; and will post the details of their penalty points on the bulletin board of the equipment room.
Sum up penalty points imposed on the students in the laboratory for all UCRF equipment in the same laboratory	≥ 20 points	UCRF will notify students and their supervising professor by email that the user(s) with 25 penalty points or higher may not use any UCRF equipment in the laboratory for 1 month.
	≥ 25 points	UCRF will notify students and their supervising professor by email that user(s) may not use any UCRF equipment in the laboratory for 1 month; will also forward official notice to their supervising professor; and will post details of their penalty points on the bulletin board of UCRF.

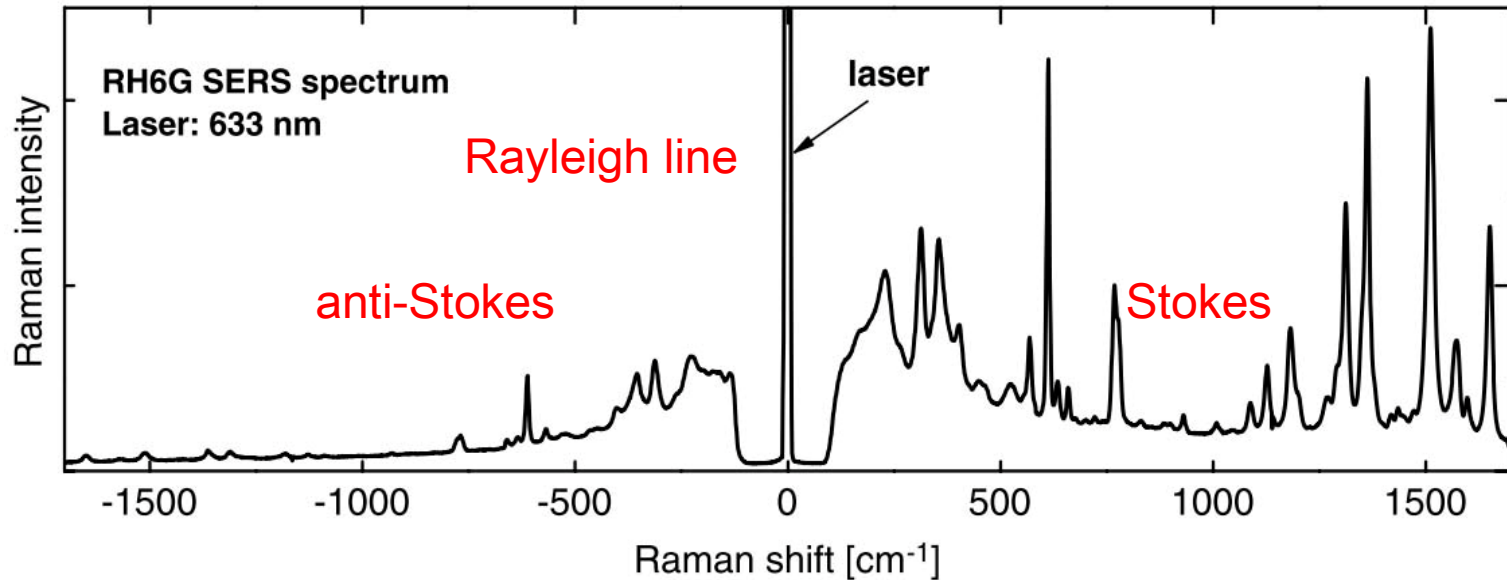
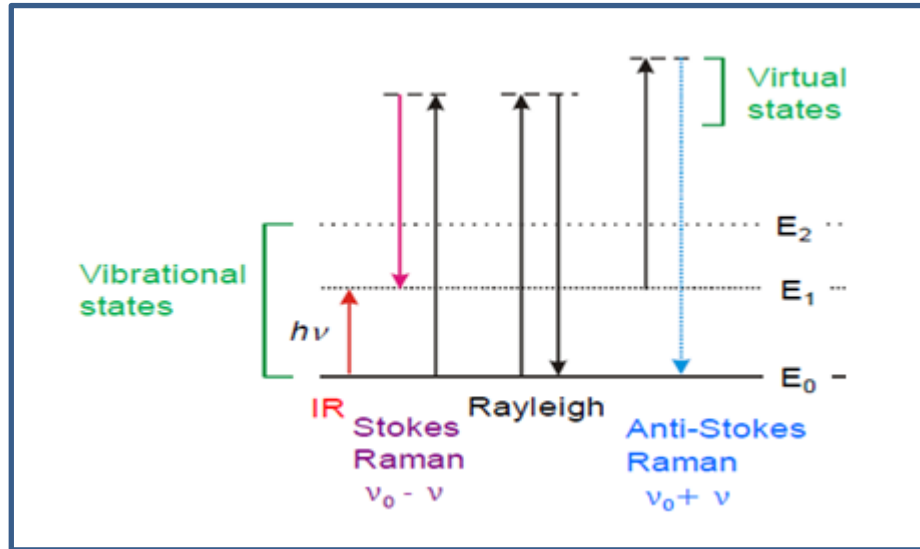
# Raman Spectroscopy



# Raman Spectroscopy



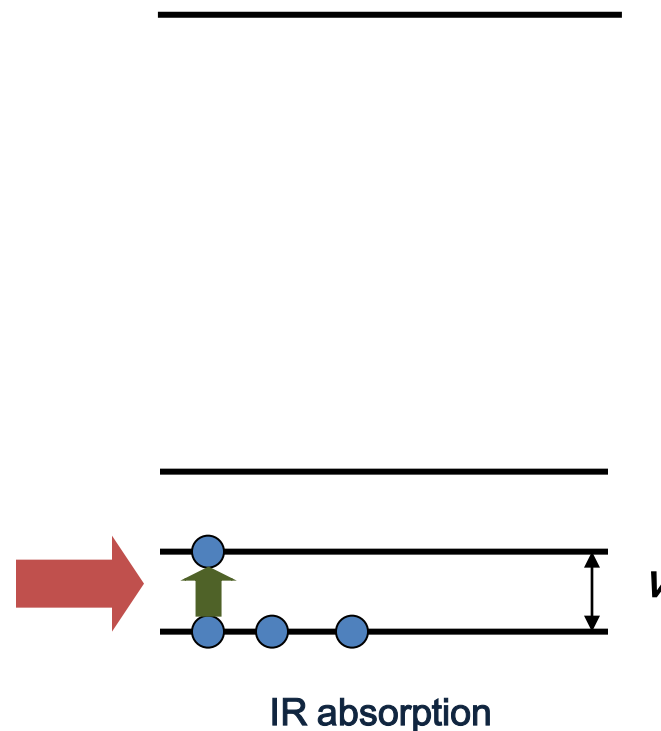
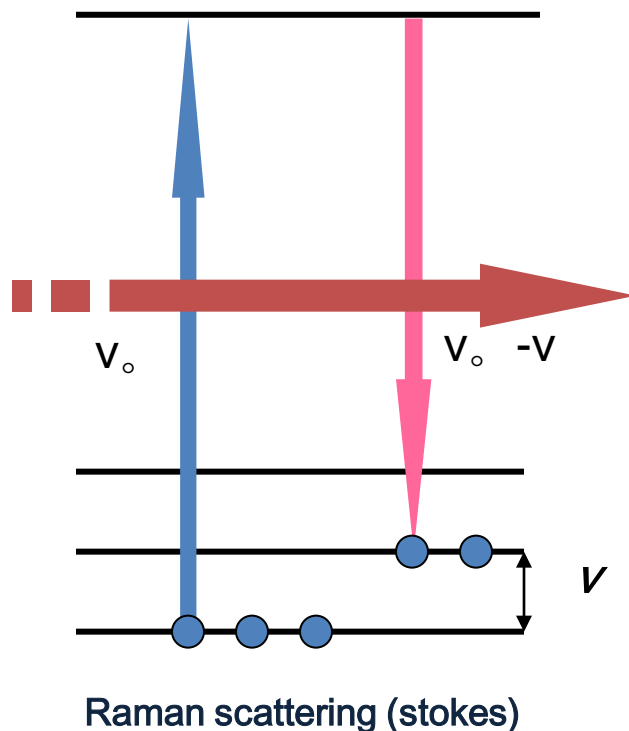
# Stokes and anti-Stokes



# Raman and IR

IR and Raman spectroscopy - **Vibrational spectroscopy** :  
 □ → probing well-defined vibrations of atoms within a molecule

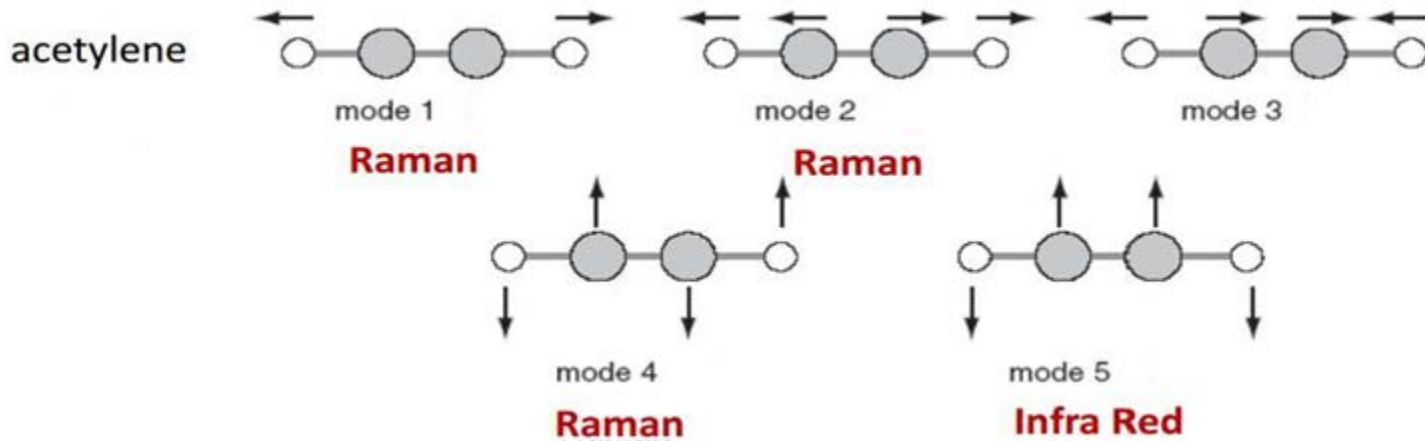
	Raman	IR
Spectroscopy	Scattering	Absorption (Transmission)
Selection rules	Polarizability	Dipole moment



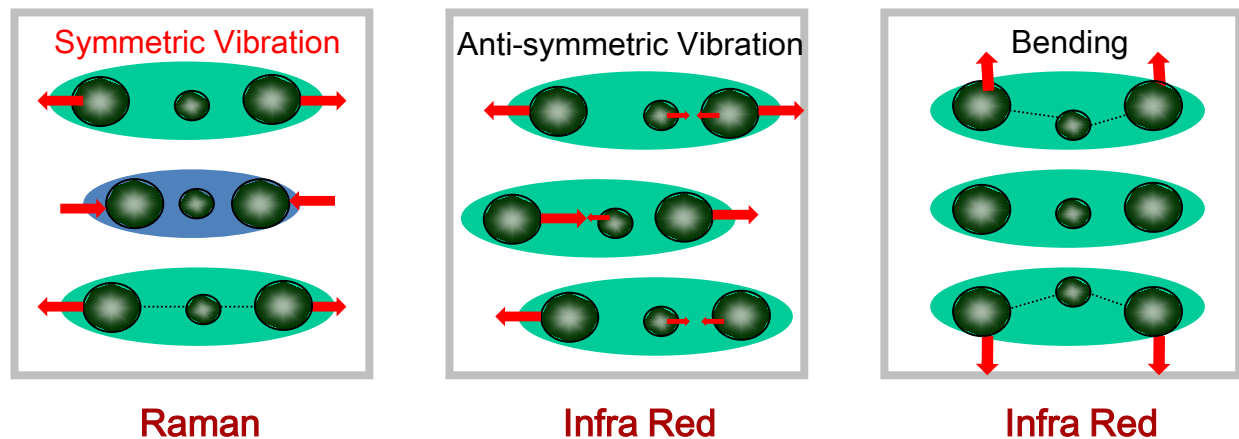
# Characteristics of Raman

## Selection rules

- The polarizability must change during the vibration (Symmetric vibration)
- In a centrosymmetric molecule (i.e., one with a center of inversion symmetry) a vibration mode may be either IR active or Raman active, but not both.



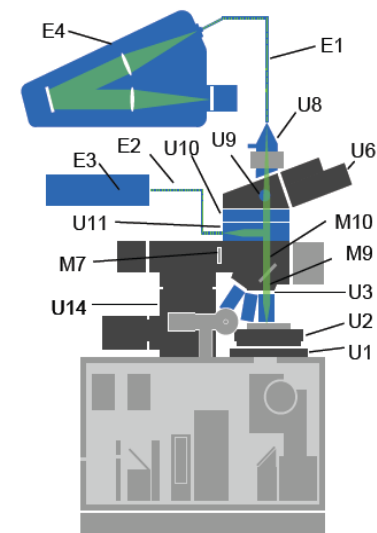
CO<sub>2</sub>



## Model : Alpha300R (WITec, Germany)

### Specifications

- Only Raman mode
  - Single Spectrum
  - Line Spectrum
  - Image Scan
- Scan area : 50  $\mu\text{m}$  x 50  $\mu\text{m}$   
line by point : 512 x 512
- Laser wavelength
  - 532 nm
- Objectives : x50, x10
- Heating cryostat
  - temperature range : -96 ~ 600°C
  - Up to 130°C/min heating
  - Temperature stability <0.1°C
- Freezing cryostat
  - temperature range : 77 ~ 300K
  - temperature stability :  $\pm 0.1$  K (over 10 min.)
  - hold time at 77K : 15 hrs



Confocal Raman mode

### ◆ Objective lens

Type	N.A.	WD
x50	0.8	0.54 mm
x10	0.25	15.34 mm



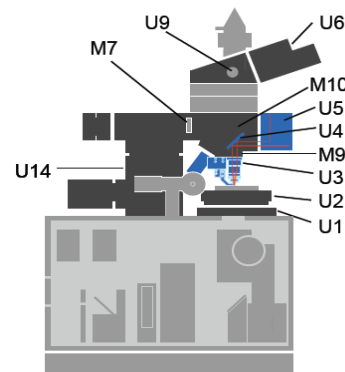
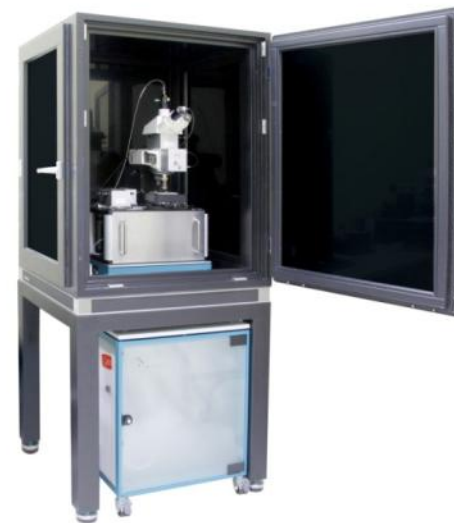
## Model : Alpha300S (WITec, Germany)

## Specifications

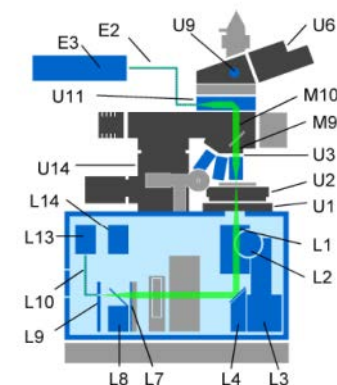
- Modes
  - SNOM (Scanning near-field optical microscope)
  - AFM (Acoustic AC, contact mode)
  - Confocal Raman (single, line, and image scan)
- Laser wavelength
  - 532nm/ 633nm/ 785nm
- Objectives : x100, x50, x20
- Inverted microscope system : x60 objective

## ◆ Objective lens

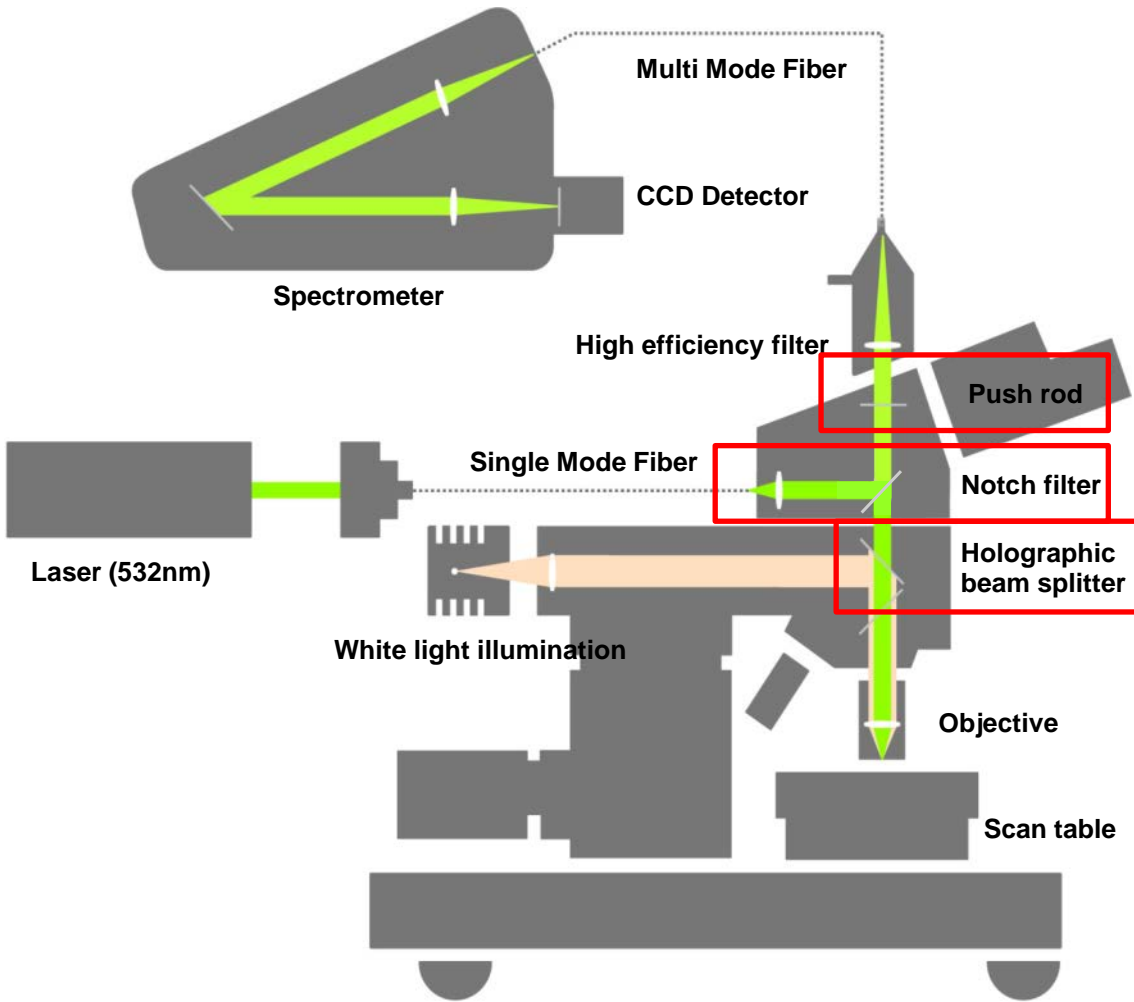
Type	N.A.	WD
x100	0.9	1.0 mm
x50	0.5	10.6 mm
x20	0.4	3.8 mm



AFM mode

SNOM in transmission mode  
(Inverted microscope)

# Raman Mode



	Beam Splitter	Notch Filter	Push Rod
Image Mode	BF	IN	IN
Laser Mode	DF	OUT	IN
Raman Mode	DF	IN	OUT

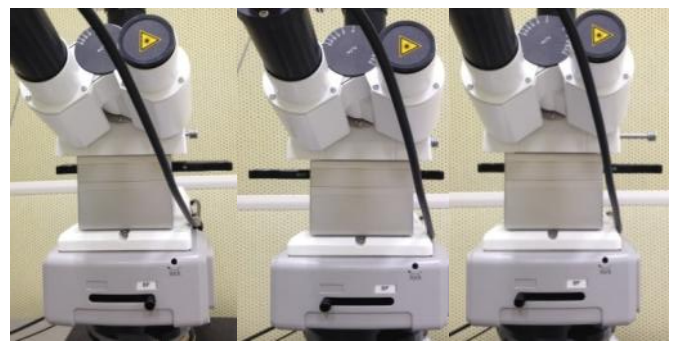
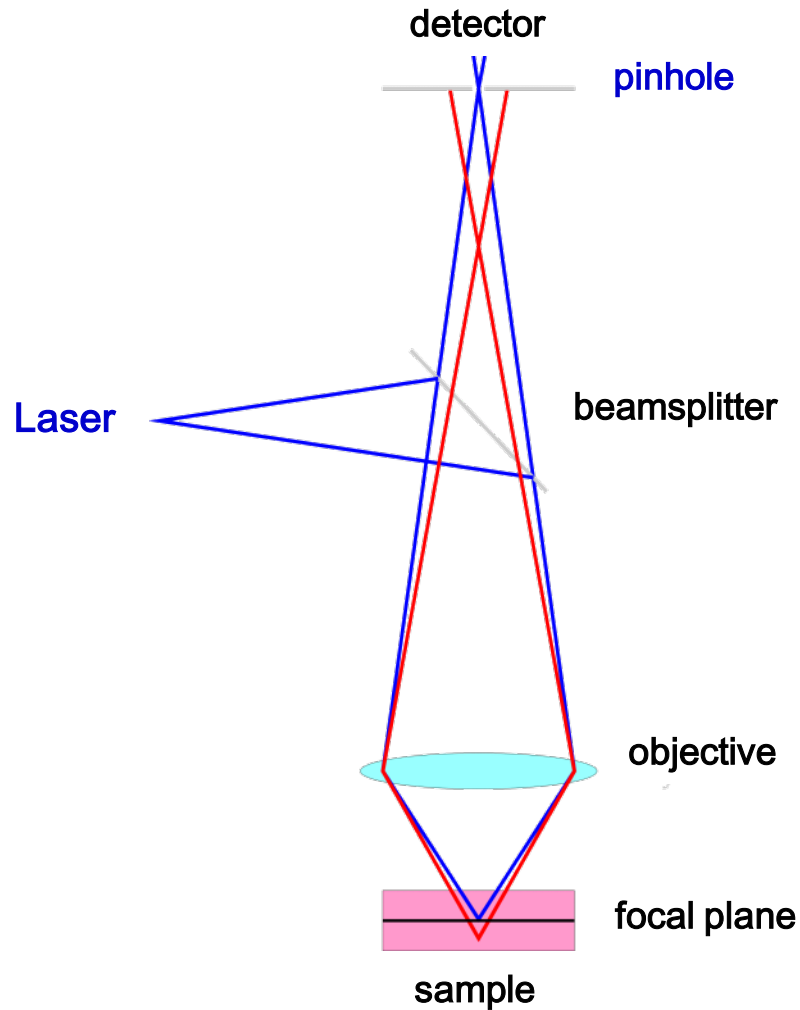


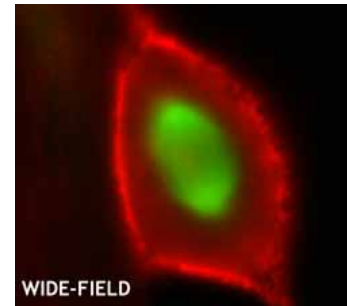
Image Mode      Laser Mode      Raman Mode

# Confocal Microscopy

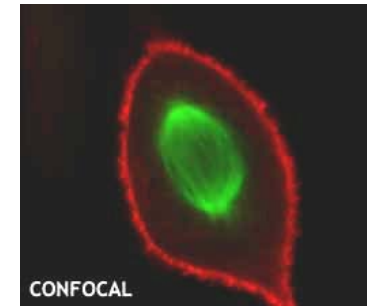


## Confocal Microscopy

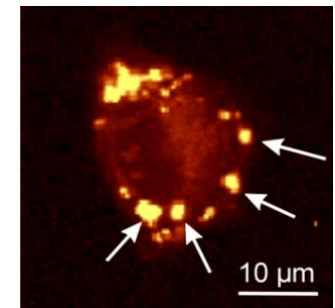
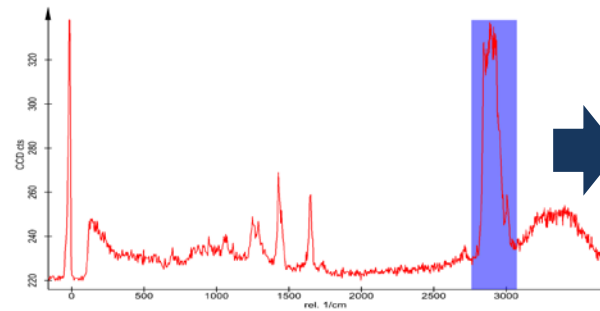
- much smaller background
- 3-D information
- slightly higher resolution



Without pinhole

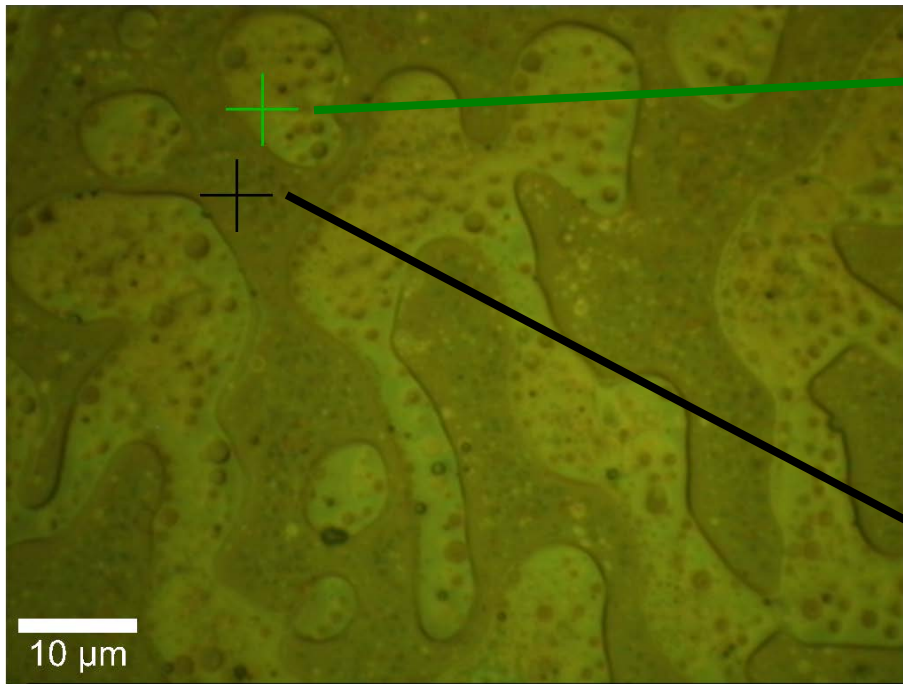


With pinhole

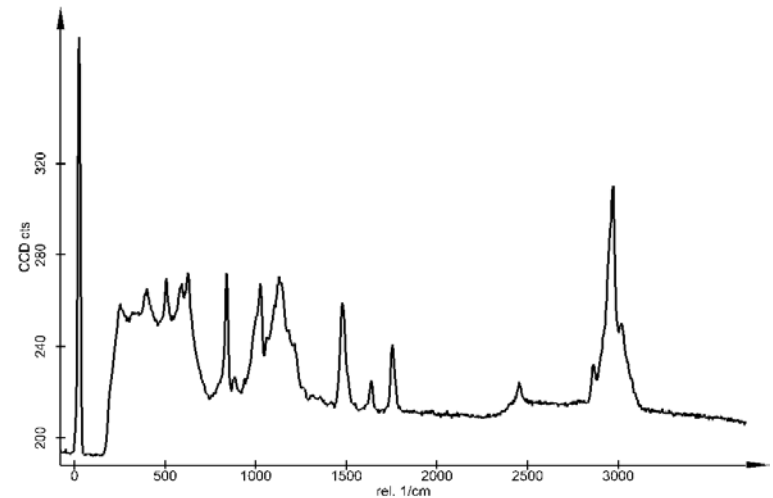
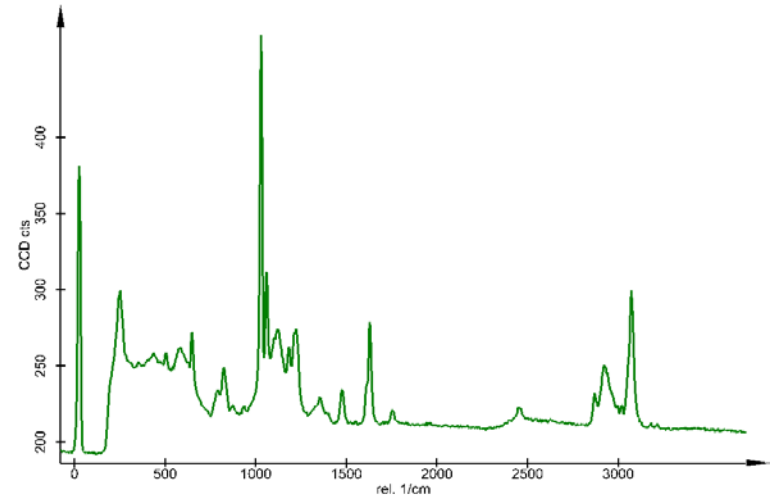


**Confocal Microscopy + Raman Spectroscopy → 3-D Imaging with chemical sensitivity**

Sample: PS-PMMA on Glass



White light image



Single spectra of selected positions

# Spectral Imaging (Mapping)

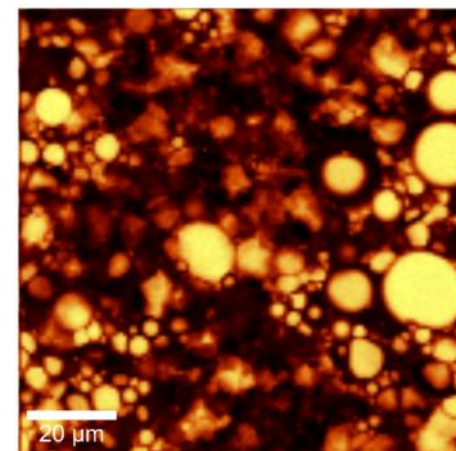
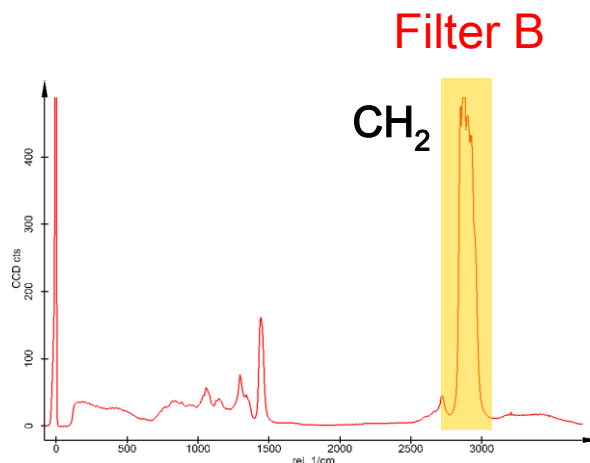
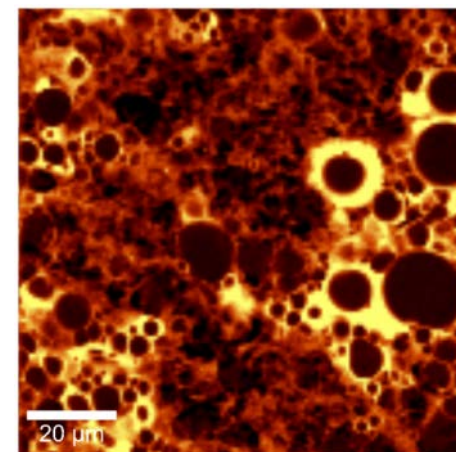
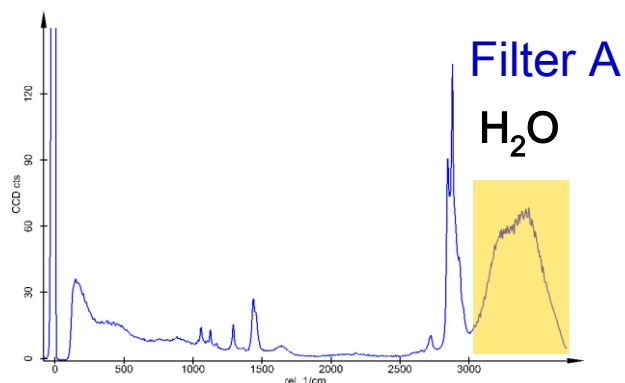
Sample: Oil/Water Emulsion

Excitation: 532nm, 2 mW

Scan Range: 100  $\mu\text{m}^2$

Resolution: 180 x 180 point

40ms/spectrum, 22 min



## Working Distance(W.D.)

The distance between the front edge of the objective lens and the specimen surface (with the surface of the cover glass in case of the cover glass objective lens) when the Specimen is focused.

## Numerical Aperture (N.A.)

The numerical aperture is a key factor to the performance of objective lens (resolving power, focal depth and brightness). The N.A. is determined by the following formula :

$$\text{N.A.} = n \times \sin\theta$$

$n$  = refraction rate of the medium between specimen and objective lenses. (air :  $n=1$ , oil :  $n=1.515$ )

$\theta$  = angle which is made by the optical axis and refraction of the light farthest from the center of lens.

## Resolving power

The resolving power of an objective lens is measured by its ability to differentiate two lines or points in an object. The larger the N.A., the higher the resolving power.

$$\varepsilon = 0.61 \times \frac{\lambda}{\text{N.A.}} \quad (\text{Reyleigh formula})$$

$\lambda$  : wavelength or radiation in use

N.A. : objective lens N.A.

## Focal depth of Microscope

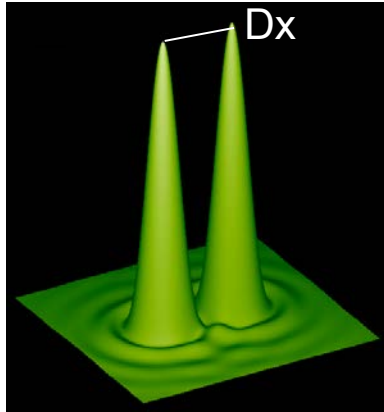
The focal depth refers to the depth of the specimen layer which is in sharp focus at the same time, even if the distance between the objective lens and the specimen plane is changed when observing and shooting the specimen plane by microscope.

$$\pm \text{D.O.F.} = \frac{\omega \times 250,000}{\text{N.A.} \times M} + \frac{\lambda}{2(\text{N.A.})^2} \quad (\mu\text{m})$$

$\omega$  : resolving power

N.A. : objective lens N.A.

♣ **Resolving power** : Capacity of an instrument to resolve two points which are close together.



$$\Delta x = \frac{0.61 \times \lambda}{\text{N.A.}}$$

Magnification	N.A.	$\lambda$ [nm]	$\Delta x$ [nm]
20x	0.4	532	811
		633	965
		785	1197
50x	0.8	532	405
		633	482
		785	598
100x	0.9	532	360
		633	429
		785	532

For example. Image scan : 30x30  $\mu\text{m}$  with Raman 532nm, 100x objective

$$\text{Point/Line (Line/Image)} = \frac{\text{Geometry Width (Height)}}{\text{Resolution } (\Delta x)} = \frac{30,000 \text{ nm}}{360 \text{ nm}} = 83 \text{ Point}$$

Image scan (Point/Line & Line/Image) will be 83 point and it is enough good.



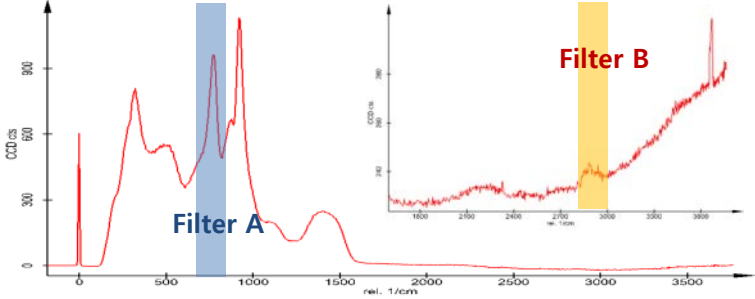
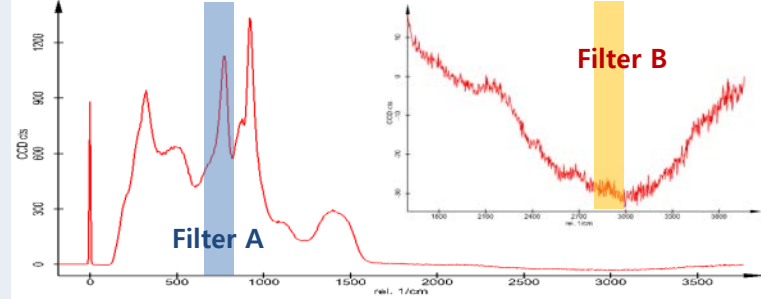
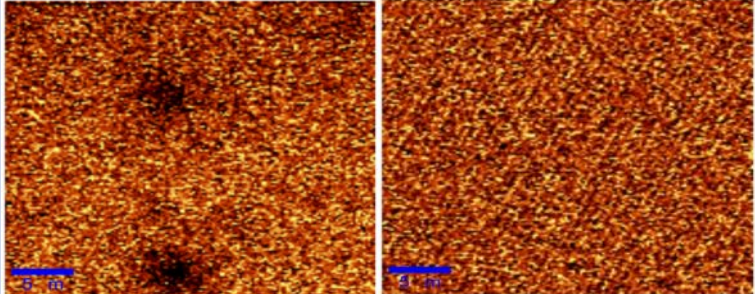
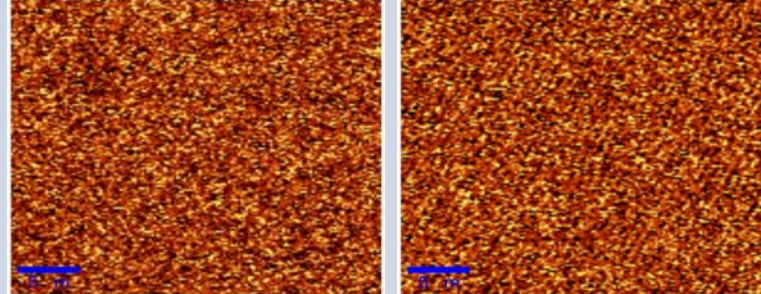
To improve image scan, Image scan can be multiple three times by 83 points.

Why three times? That's a kind of statics.

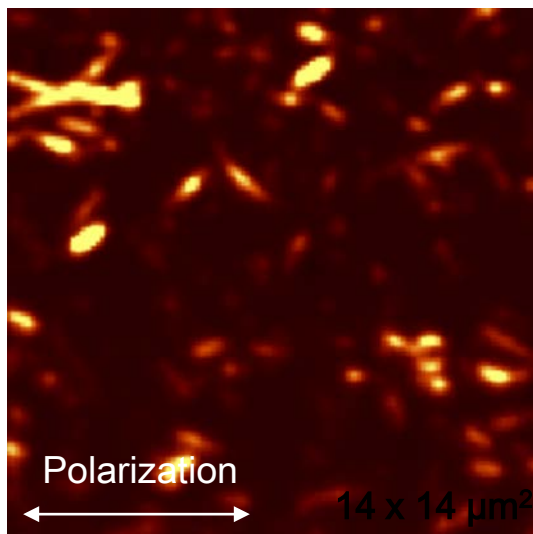
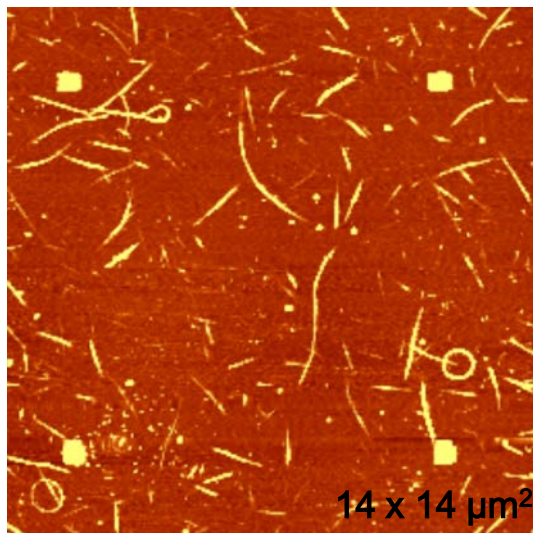
The more you do image scan double, triple and four times, the more you get the better image.

However, measurement time is increasing. Triple is enough.

- **Optical Resolution:** 200 nm/ laterally, 500 nm/ vertically
- **Spectral Resolution:** 0.02 wavenumbers

Name	A	B
Confocal Image		
Single Spectrum		
Scan Image		





## AFM AC Mode

topography image of nanotubes spin coated on Si substrate.

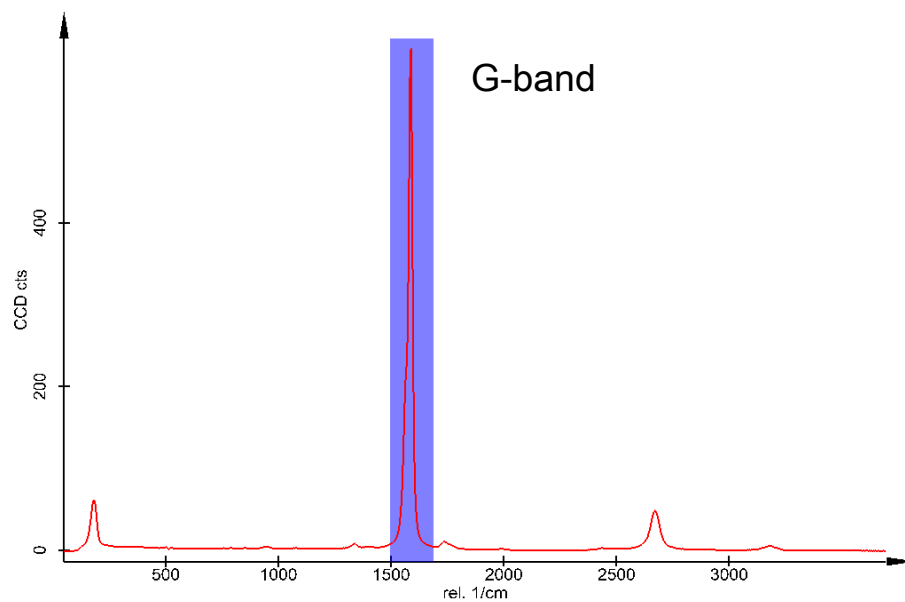
## Raman Spectral Imaging

Nikon air objective, @ 532 nm

600 g/mm grating, BLZ 500 nm

150x150 spectra (pixel);

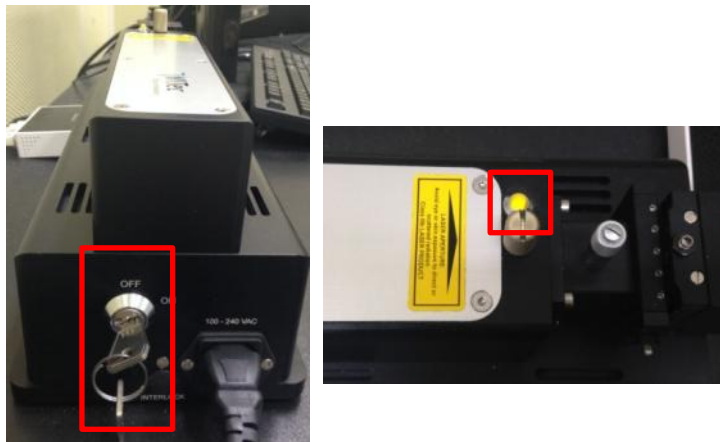
integration time: 50 ms/spectrum (total acquisition time = 20 min)



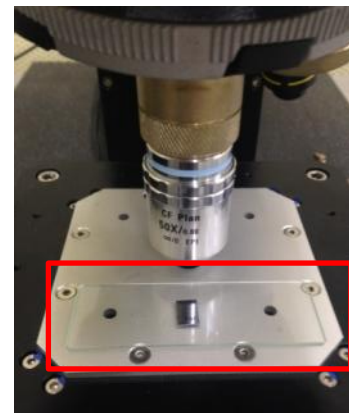
**=> intensity of G-band depends on the polarization of the laser**

# Manual - Calibration

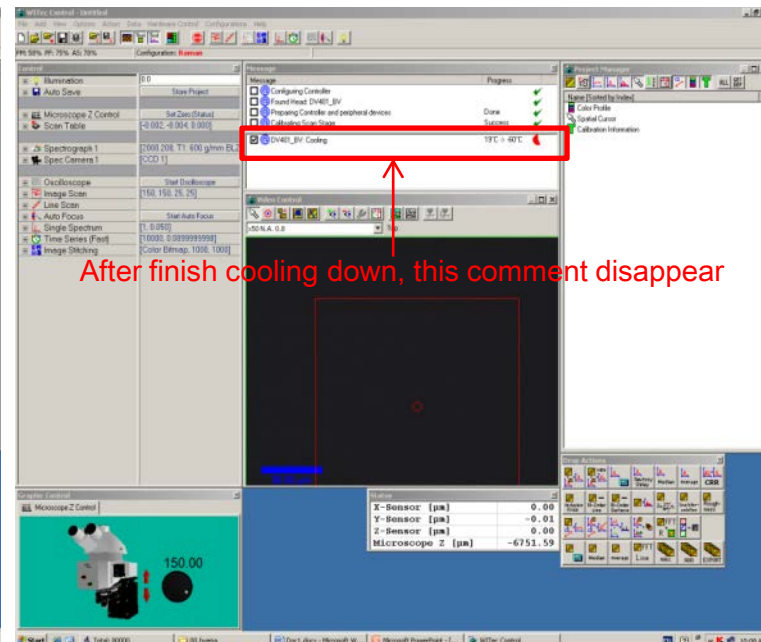
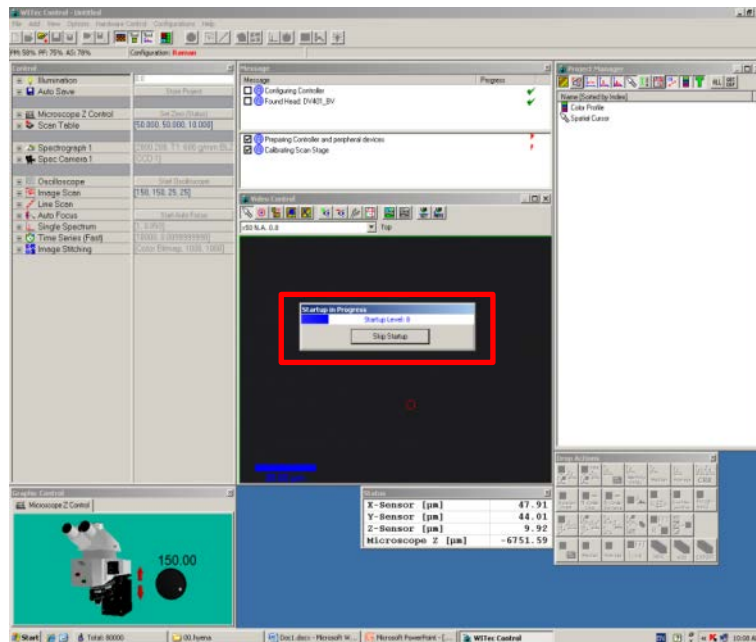
1. Laser on → warm up (10 min)



3. Put down a Si substrate (reference) on a slide glass



2. WITec Control Pro. START → wait cooling down (10 min)



## 4. Image Mode → Control → Illumination = 100, Speed 100 → down

The screenshot displays the WITec Control software interface. The 'Illumination' control panel is highlighted with a red box, showing a value of 100.0. The 'Auto Save' option is also visible. The 'Message' window shows a progress bar and status indicators for 'Found Head: DV401\_BV', 'Preparing Controller and peripheral devices', 'Calibrating Scan Stage', and 'DV401\_BV'. The 'Video Control' window shows a live image of a sample with a red box indicating the field of view and a scale bar of 30.00 μm. The 'Graphic Control' window shows a 3D model of the microscope with a red box around the '101.24' value. The 'Status' window displays sensor readings: X-Sensor [μm] 0.00, Y-Sensor [μm] -0.01, Z-Sensor [μm] 0.00, and Microscope Z [μm] -6711.48. The 'Project Manager' window shows a list of items: Color Profile, Spatial Cursor, and Calibration Information. The 'Drop Actions' window shows various processing options like Max, Median, Average, CRR, etc.

Configuration: **Raman**

PM: 58% PF: 74% AS: 77%

**Illumination** 100.0  
Auto Save Store Project

Microscope Z Control Set Zero (Status)  
Scan Table [-0.002, -0.004, 0.000]

Spectrograph 1 [2000.208, T1: 600 g/mm BLZ  
Spec Camera 1 [CCD 1]

Oscilloscope Start Oscilloscope  
Image Scan [150, 150, 25, 25]  
Line Scan  
Auto Focus Start Auto Focus  
Single Spectrum [1, 0.050]  
Time Series (Fast) [10000, 0.00999999998]  
Image Stitching [Color Bitmap, 1000, 1000]

Message Progress  
Found Head: DV401\_BV  
Preparing Controller and peripheral devices Done ✓  
Calibrating Scan Stage Success ✓  
DV401\_BV Stabilized at -60°C ✓

Video Control  
x50 N.A. 0.8 Top  
30.00 μm

Graphic Control  
Microscope Z Control  
101.24

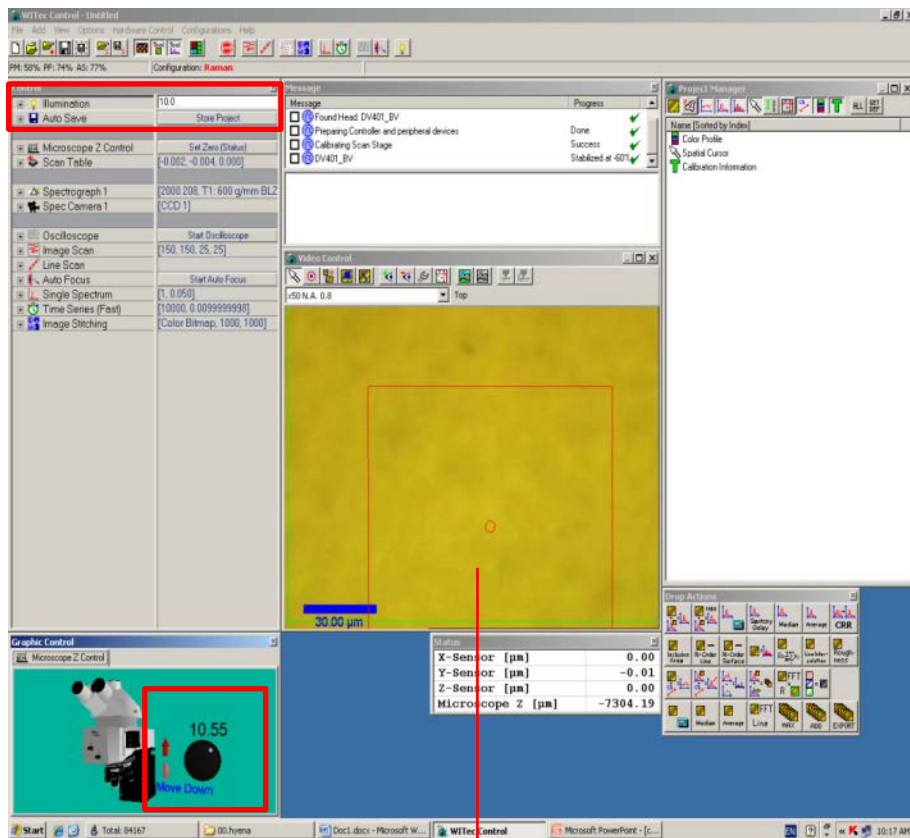
Status  
X-Sensor [μm] 0.00  
Y-Sensor [μm] -0.01  
Z-Sensor [μm] 0.00  
Microscope Z [μm] -6711.48

Project Manager  
Name (Sorted by Index)  
Color Profile  
Spatial Cursor  
Calibration Information

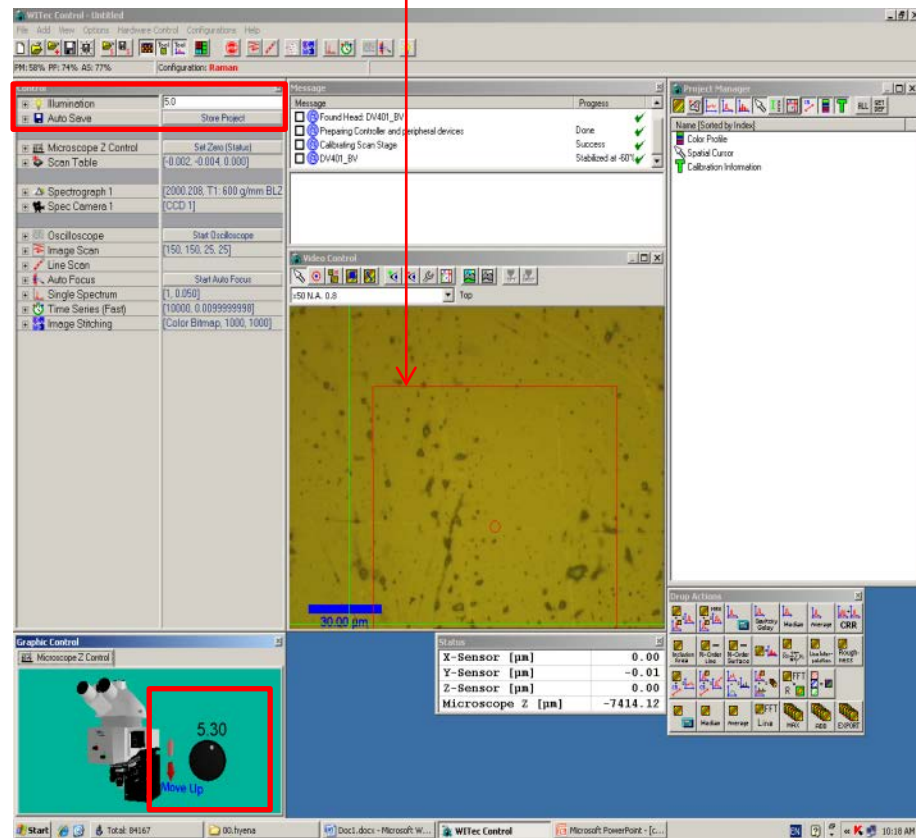
Drop Actions  
Max Median Average CRR  
Inclusion Area N-Order Line N-Order Surface R-1/N-Order Line Interpolation Roughness  
Median Average Line FFT MAX ADD EXPORT

down

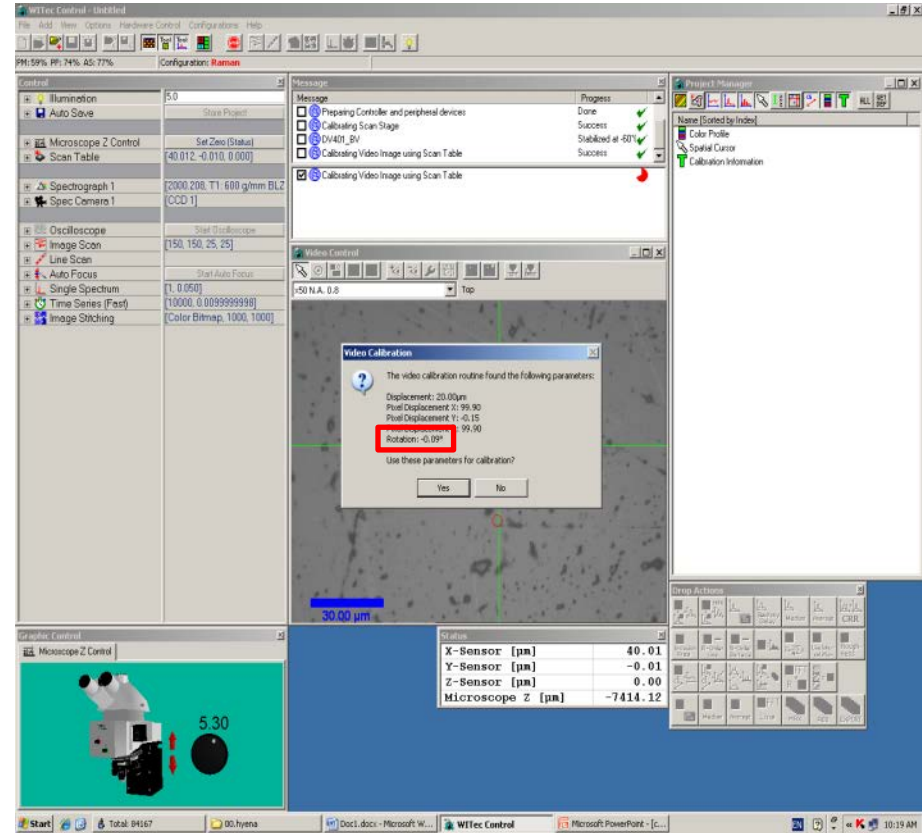
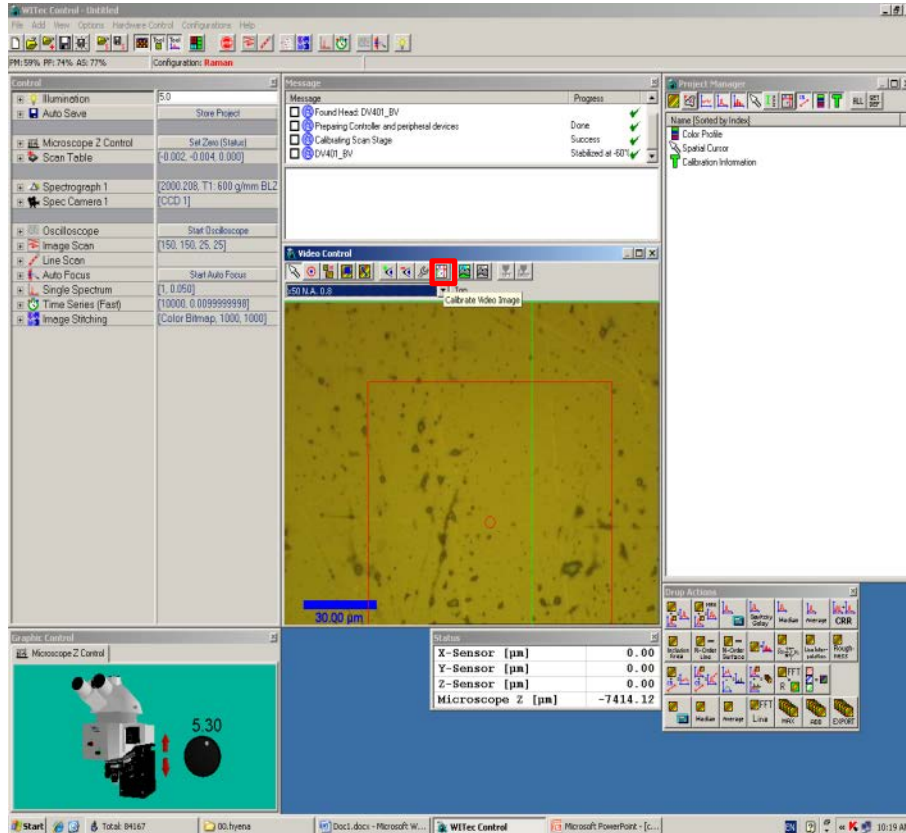
5. Illumination = 50, Speed 50 → down → Illumination = 30, Speed 30 → down → Illumination = 10, Speed 10 → down → Illumination = 5, Speed 5 → down (take a focus)



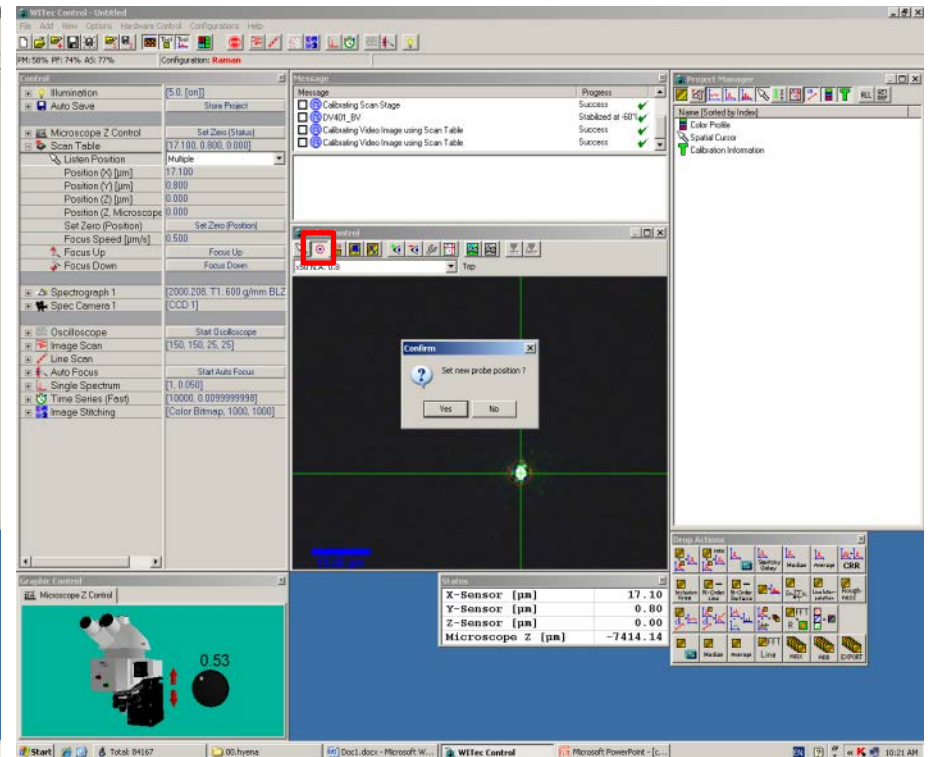
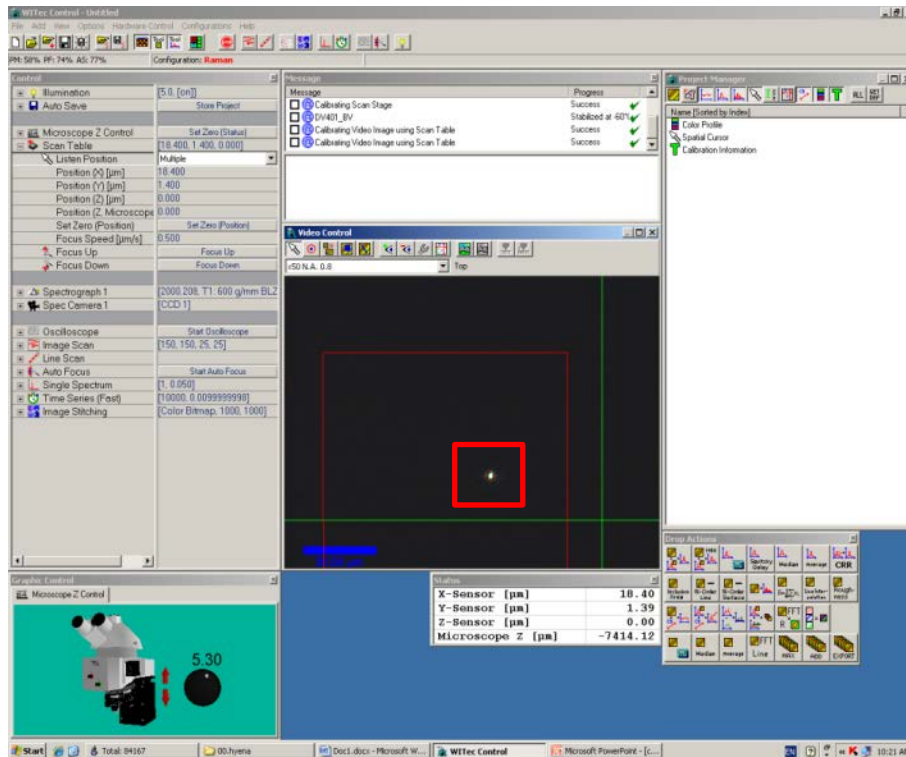
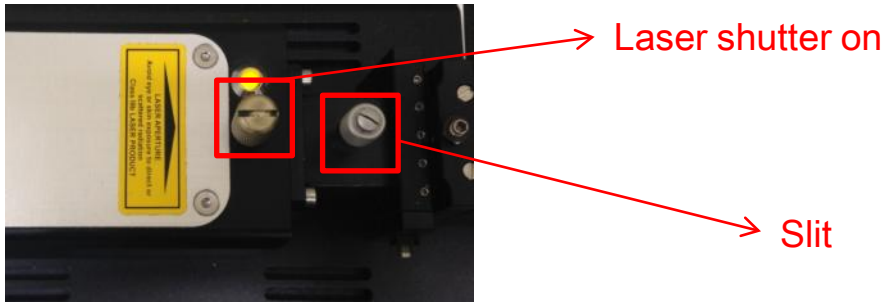
Diffuse layer



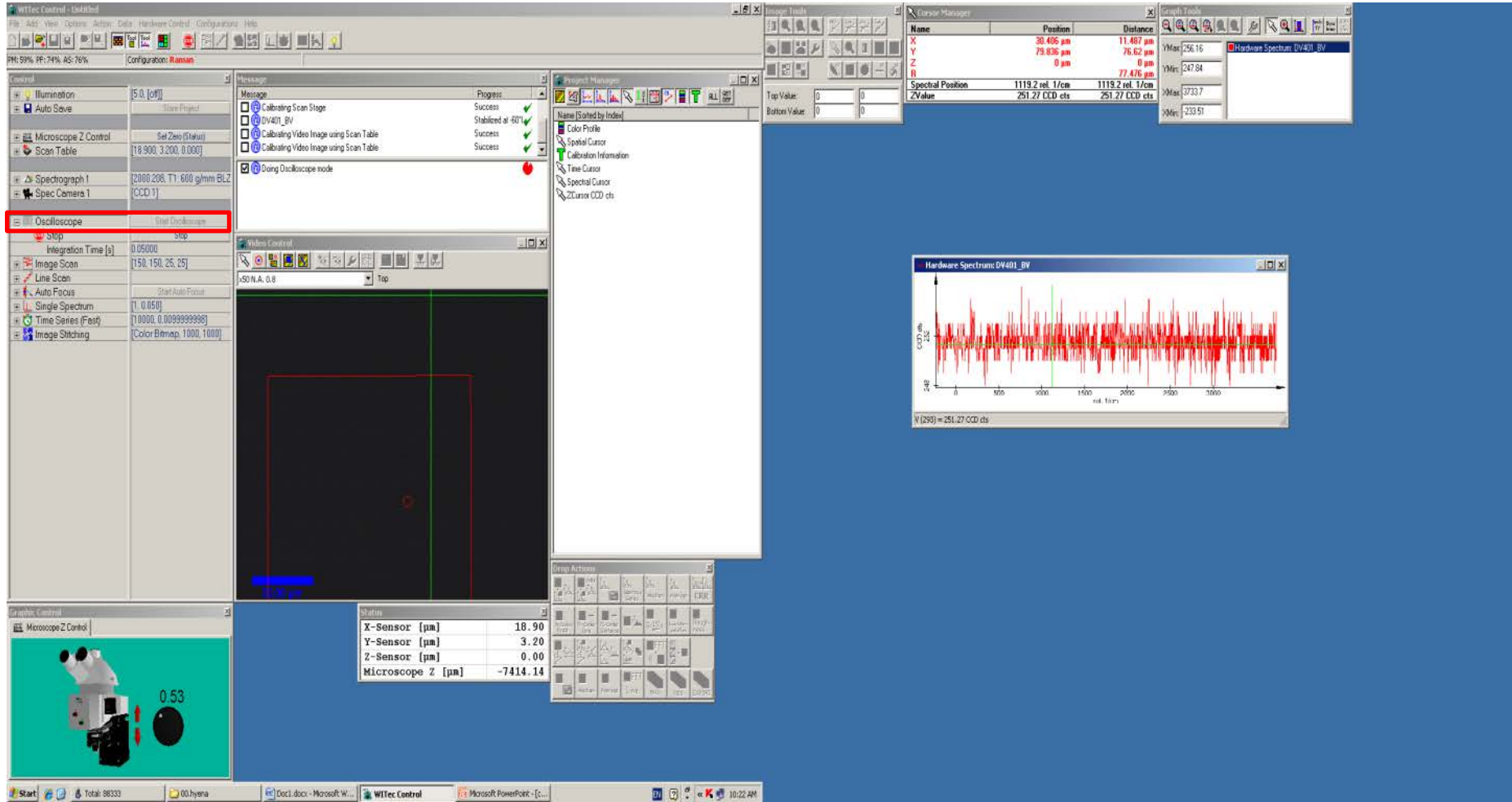
## 6. Video Control → Calibrate Video Image click → Rotation $\leq \pm 1$



7. Laser Mode → Laser shutter on → Slit decrease → Laser position = red circle  
 (Video Control → Set Video Origin click → Laser position click)



## 8. Raman Mode → Control → Oscilloscope Start (Integration Time = 0.05 S) → Slit increase



The screenshot displays the WITec Control software interface during a Raman Mode calibration process. The main window shows the 'Control' panel on the left with the 'Oscilloscope' option selected and highlighted in red. The 'Integration Time [s]' is set to 0.05000. The 'Message' window in the center shows a list of calibration steps, with 'Doing Oscilloscope mode' currently active and marked with a red stop icon. The 'Status' window at the bottom right displays the following sensor readings:

Parameter	Value
X-Sensor [μm]	18.90
Y-Sensor [μm]	3.20
Z-Sensor [μm]	0.00
Microscope Z [μm]	-7414.14

On the right side, the 'Cursor Manager' window is open, showing a table of cursor positions:

Name	Position	Distance
X	30.406 μm	11.487 μm
Y	79.836 μm	76.62 μm
Z	0 μm	0 μm
W	77.435 μm	77.435 μm

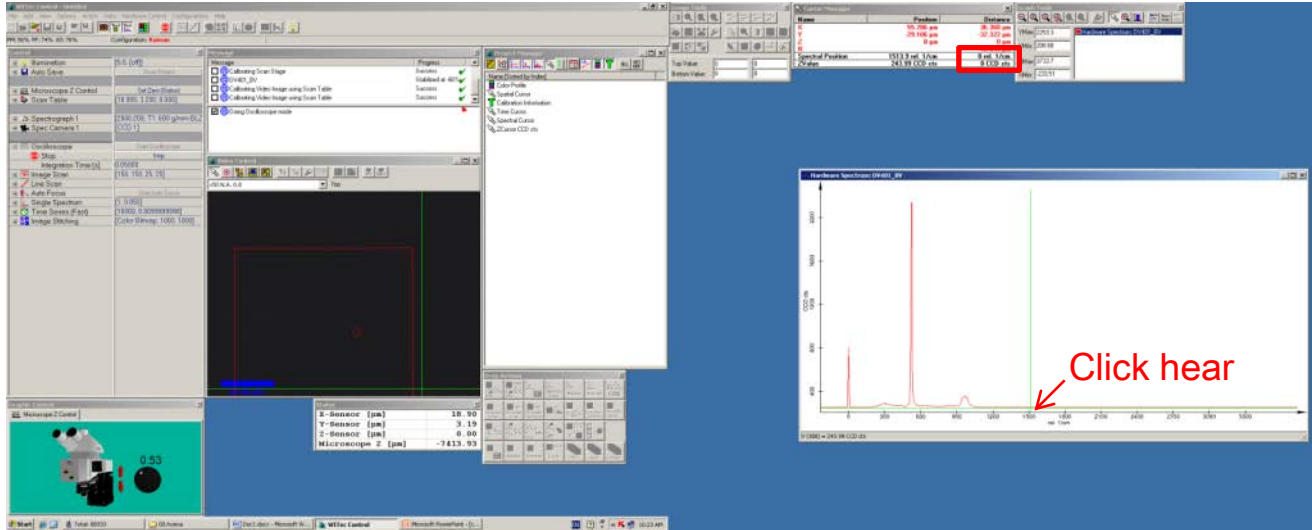
Below the cursor manager, the 'Spectral Position' window shows:

Spectral Position	1119.2 rel. 1/cm	1119.2 rel. 1/cm
ZValue	251.27 CCD cts	251.27 CCD cts

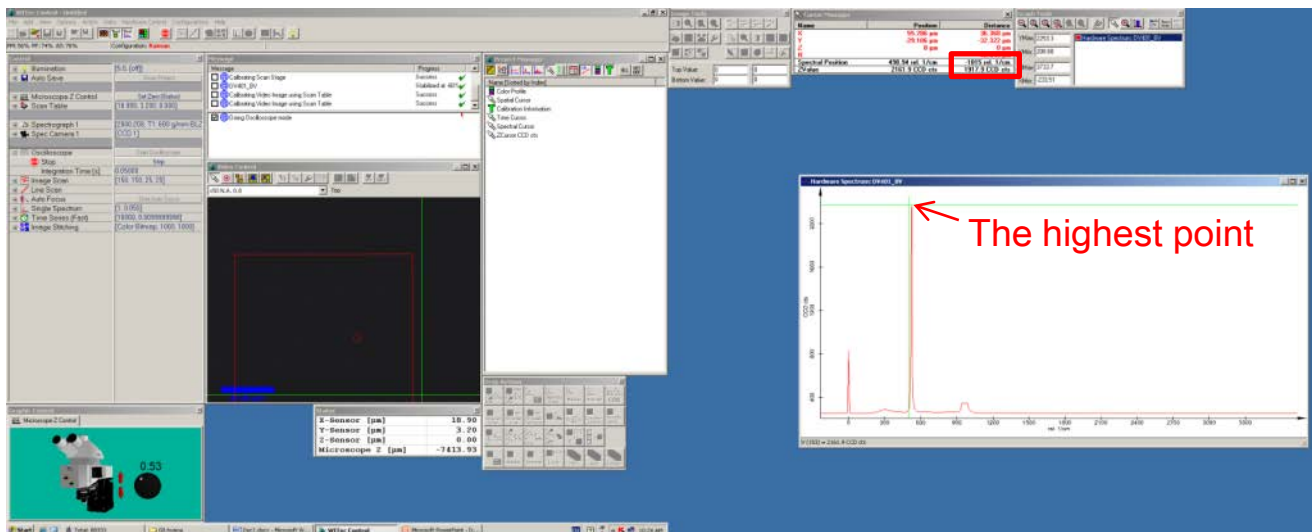
The 'Hardware Spectrum DW401\_BV' window on the right shows a Raman spectrum plot with a red signal and a green vertical line at approximately 1119.2 cm⁻¹. The y-axis is labeled 'Counts' and the x-axis is 'rel. 1/cm'. The status bar at the bottom indicates 'V [299] = 251.27 CCD cts'.

# Manual - Calibration

9. Real Time Spectrum → Lowest point click → Cursor Manager →  
Distance: Spectral Position = 0, Z Value = 0

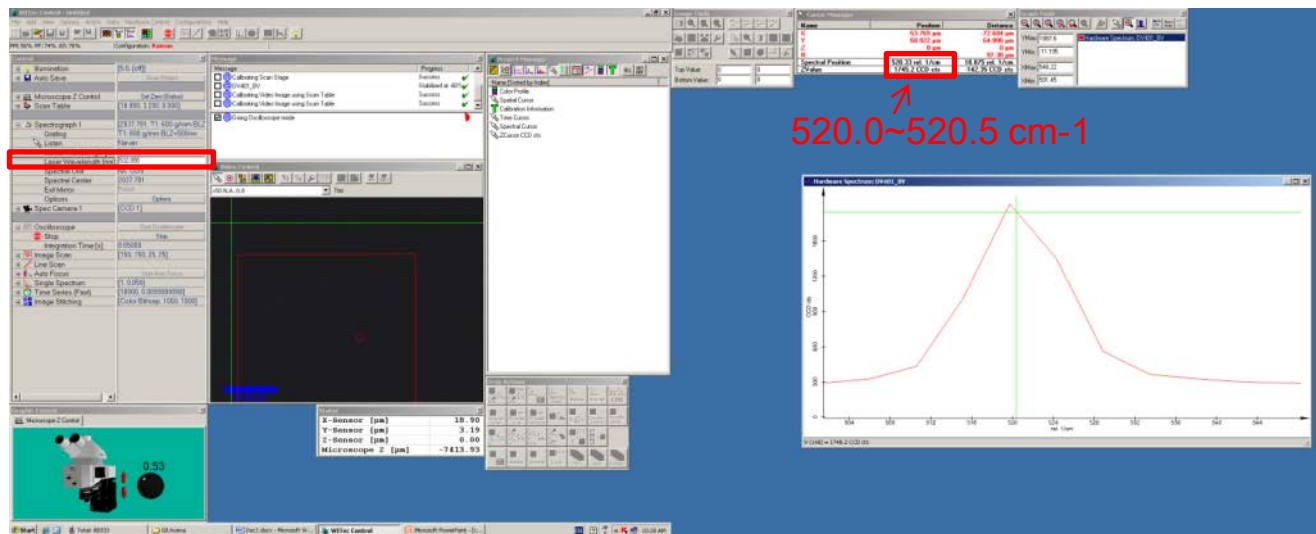
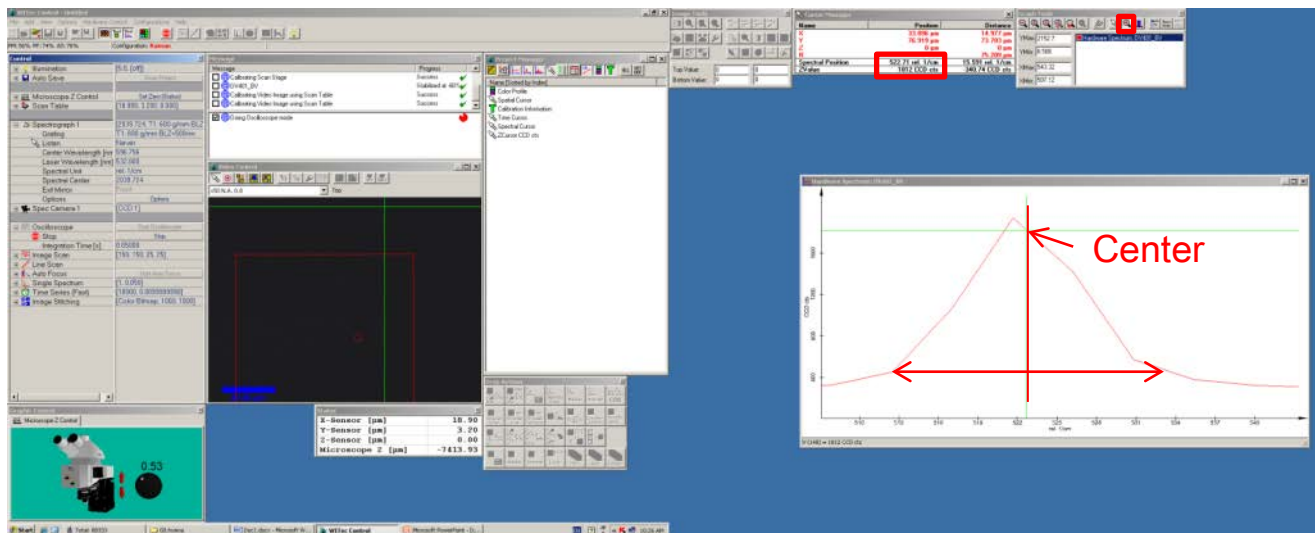


10. Real Time Spectrum → Move a cursor to the highest point (520 cm<sup>-1</sup> peak) →  
Distance: Z Value ≥ 15000 CCD cts (If, Distance: Z Value < 15000 CCD cts → Speed 0.5 → down or up)



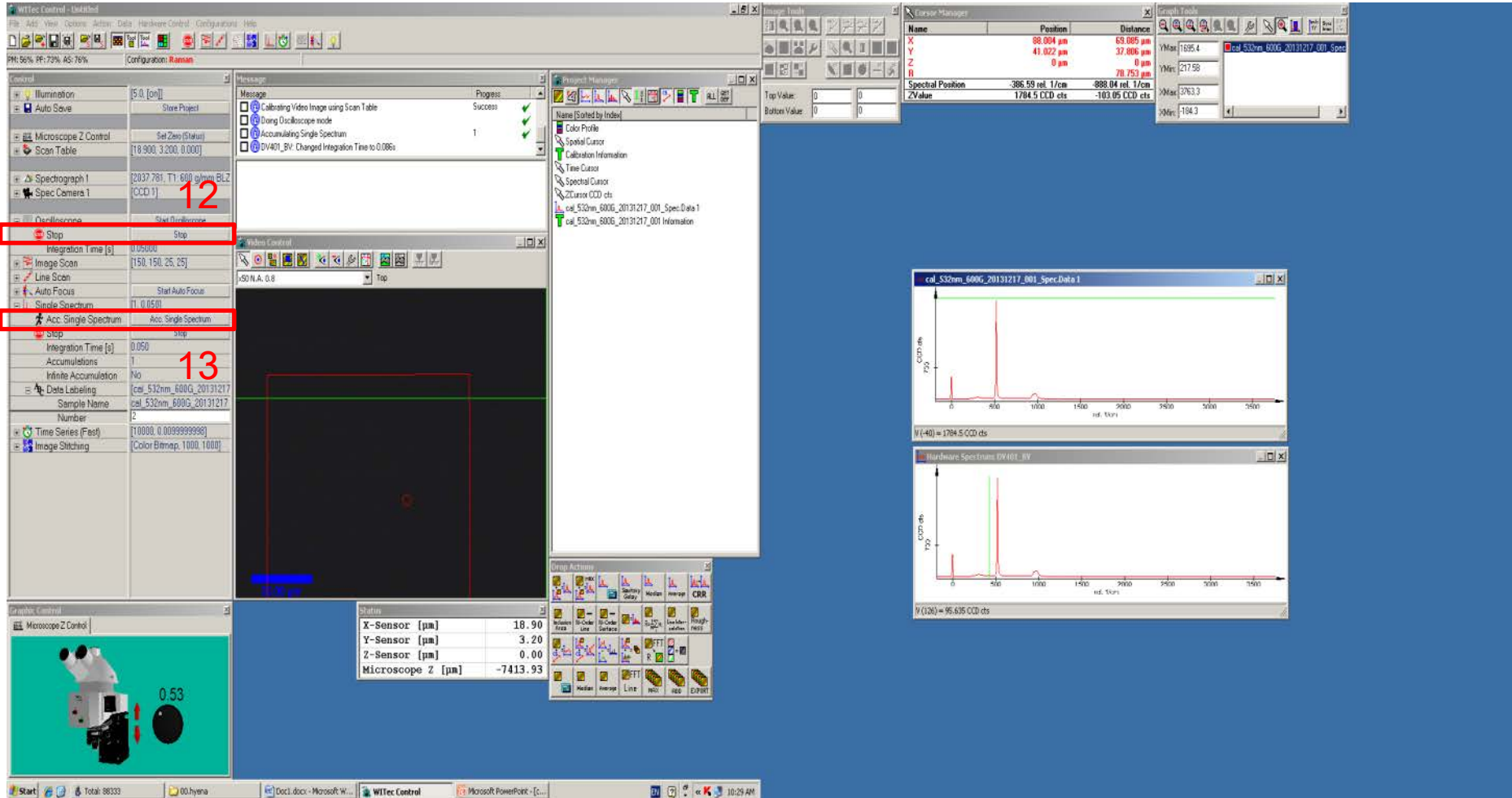


11. Graphic Tool → Zoom click → Zoom in 520  $\text{cm}^{-1}$  peak →  
Center point of 520  $\text{cm}^{-1}$  peak = 520.0 ~ 520.5  $\text{cm}^{-1}$  (Position → Spectral Position) →  
Control → Spectrograph → Laser Wavelength change



## 12. Oscilloscope Stop

## 13. Control → Single Spectrum → Acc. Single Spectrum click (Integration Time = 0.05 S)



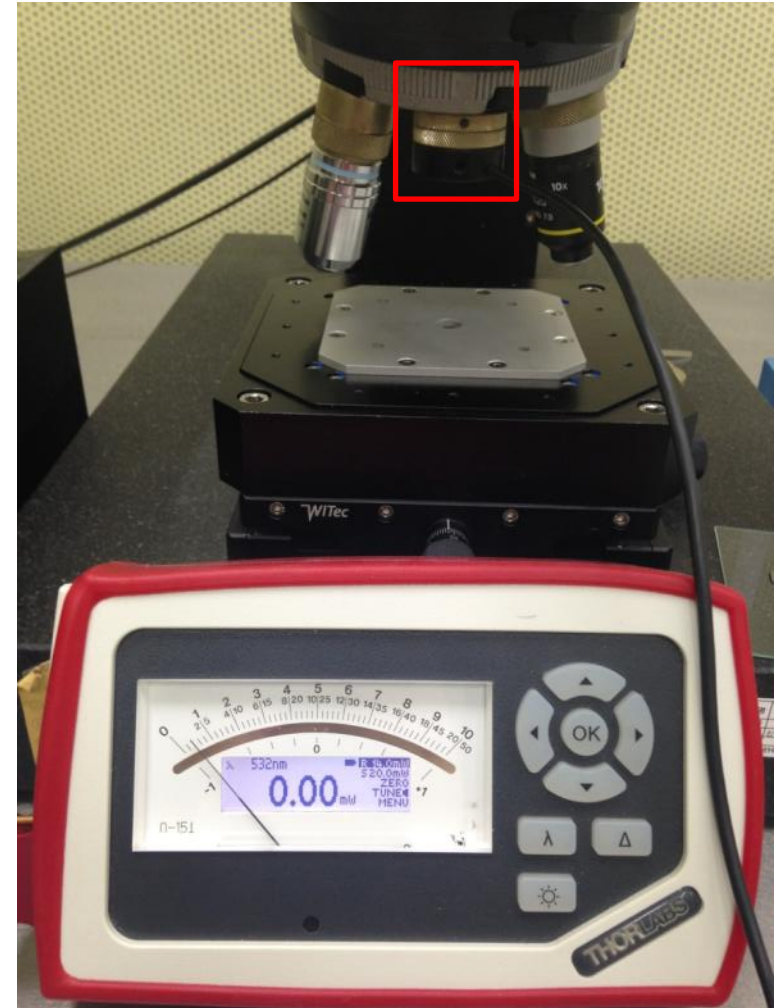
The screenshot displays the WITec Control software interface during a calibration process. The main window is divided into several panels:

- Control Panel (Left):** Contains various control options. Step 12 is indicated by a red box around the 'Oscilloscope' section, where the 'Stop' button is highlighted. Step 13 is indicated by a red box around the 'Single Spectrum' section, where the 'Acc. Single Spectrum' button is highlighted. The 'Integration Time [s]' is set to 0.05000.
- Message Panel (Top Center):** Shows a success message: "Calibrating Video Image using Scan Table Done Oscilloscope mode Accumulating Single Spectrum DV401\_BV Changed Integration Time to 0.086s".
- Cursor Manager (Top Right):** A table showing cursor positions and distances.
 

Name	Position	Distance
X	88.004 $\mu\text{m}$	69.085 $\mu\text{m}$
Y	41.022 $\mu\text{m}$	37.806 $\mu\text{m}$
Z	0 $\mu\text{m}$	0 $\mu\text{m}$
R		70.753 $\mu\text{m}$
Spectral Position	-386.59 rel. 1/cm	-888.04 rel. 1/cm
ZValue	1784.5 CCD cts	-103.05 CCD cts
- Image Control (Center):** Shows a grayscale image of a sample with a red rectangular region of interest (ROI) overlaid.
- Microscope Z Control (Bottom Left):** Shows a 3D model of the microscope and a '0.53' value.
- Status Panel (Bottom Center):** Displays sensor positions:
 

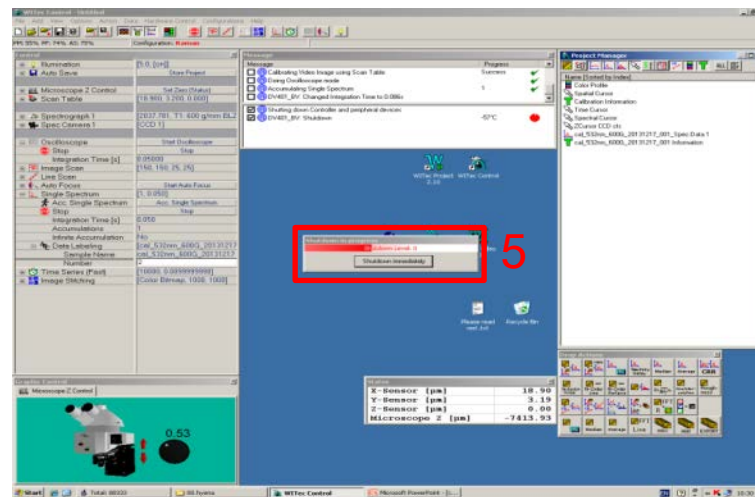
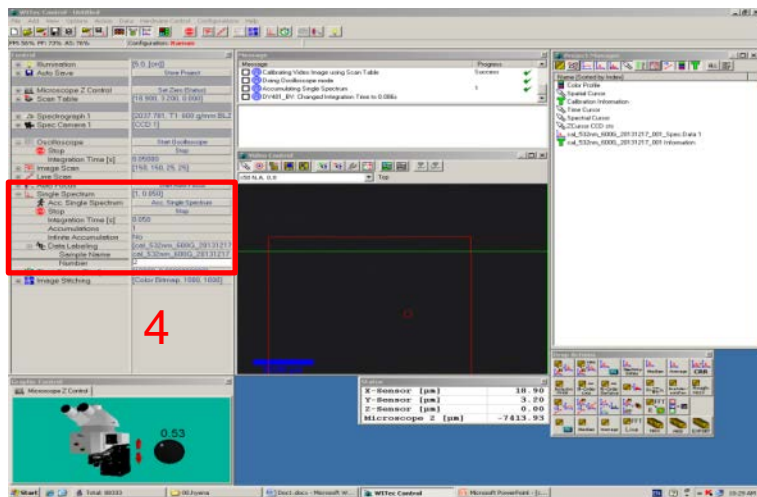
Sensor	Value [ $\mu\text{m}$ ]
X-Sensor	18.90
Y-Sensor	3.20
Z-Sensor	0.00
Microscope Z	-7413.93
- Project Manager (Middle Right):** Lists project files, including 'cal\_532nm\_600G\_20131217\_001\_Spec.Data 1'.
- Graphs (Right):** Two spectral plots are shown. The top plot is titled 'cal\_532nm\_600G\_20131217\_001\_Spec.Data 1' and shows a sharp peak at approximately 500 nm. The bottom plot is titled 'Hardware Spectrums DV401\_BV' and shows a similar peak. Both plots have 'Y-axis: CCD cts' and 'X-axis: rel. 1/cm'.

## 14. Laser Power Meter (power setting)- in Raman Mode

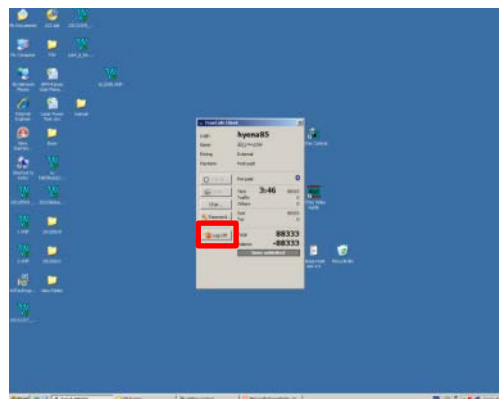


# Manual - Calibration

1. After calibration, Image Mode → Put down your sample on a slide glass
2. Take a focus (calibration 4,5 repeat)
3. Raman Mode → Oscilloscope Start → Increase main peak (Speed 0.5 → down or up)
4. Control → Single Spectrum → Parameter change → Acc. Single Spectrum click

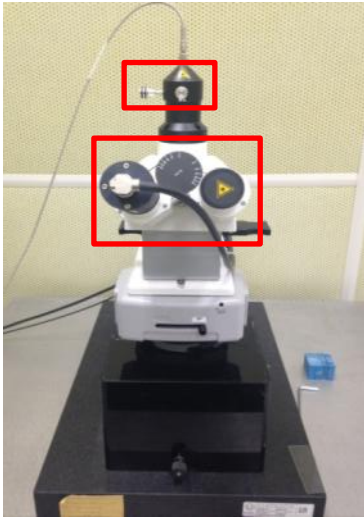


5. WITec Control Pro. CLOSE → wait heating (10min)
6. Laser off
7. Log off True Cafe



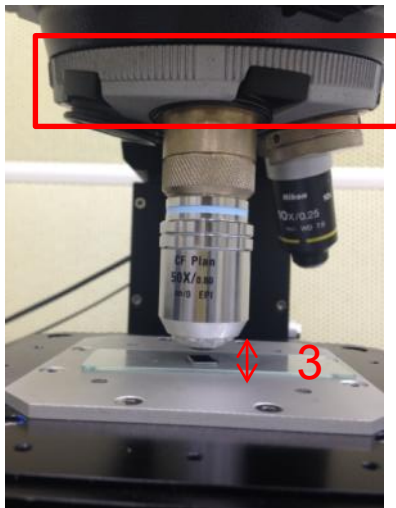
# Cautions

1. Don't touch this part

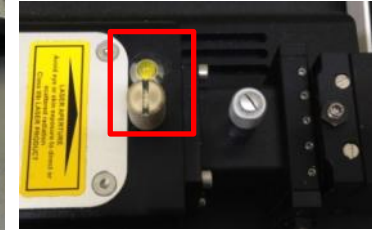


2. Hold this part, NOT lens

3. Lens up, whenever you change a sample



4. Laser off



5. Power Meter head is very sensitive



		Micro-Raman
UNIST students	Client(70%)	17,500/hr
	Self-user(50%)	12,500/hr

True Café using time	Charging time
0.1~0.7 hr	0.5 hr
0.8~1.2 hr	1.0 hr
1.3~1.7 hr	1.5 hr
1.8~2.0 hr	2.0 hr
...	...