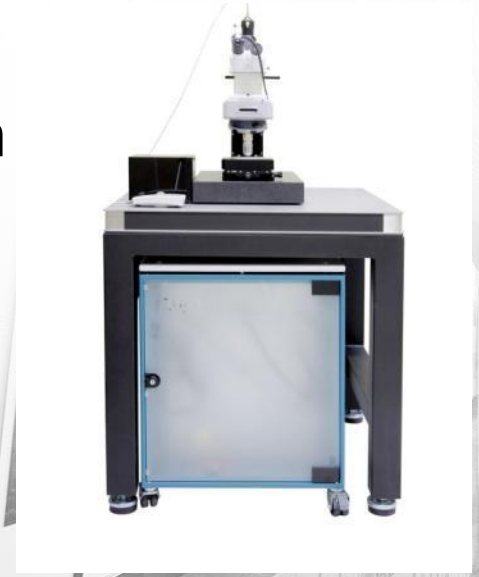
ULSAN NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY

Confocal-Raman

Normal Operation Training Course



1. Syllabus

Qualification for Raman operation

1. Raman self-user training

1) Theory class (Raman manager Yeong Bi Kang, 4168)

2) Operation class (Raman manager Yeong Bi Kang, 4168)

- Manager explains about Raman
- Each person practices with manager

2. Practice Raman yourself

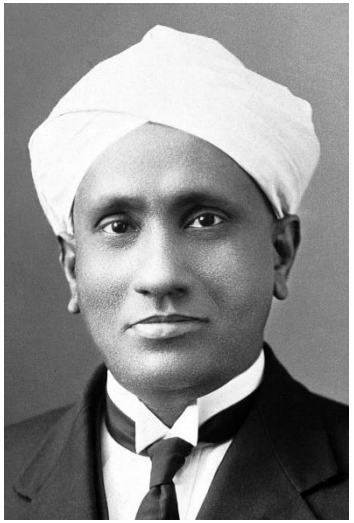
- Each person practice with manager 3 times.
- Please contact manager and make an appointment.

3. Attend the Raman test

- 30 min. test
- Explain about Raman and measurement methods.
- Sample measurement and laser power meter setting.

2. Basic Principles

The history of Raman spectroscopy



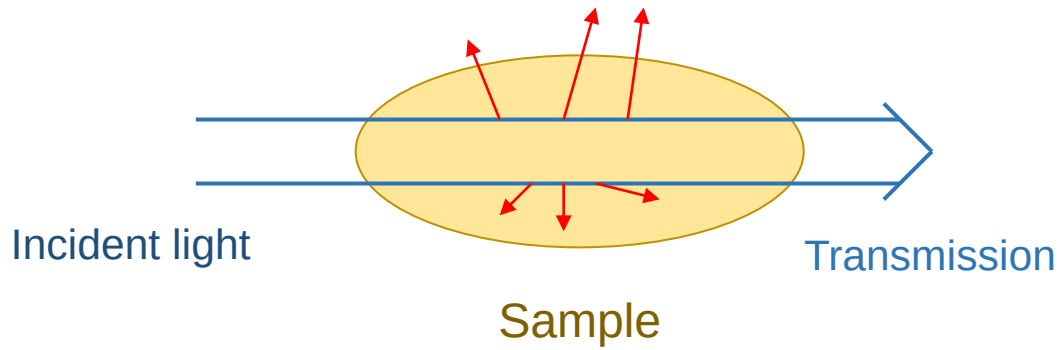
Chandrasekhara Venkata Raman

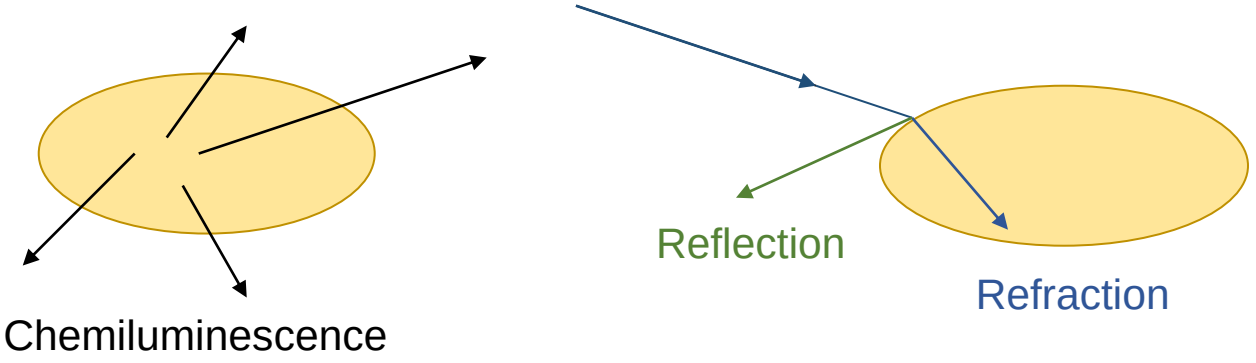
- November 7, 1888 ~ November 21, 1970
- In 1928, C. V. Raman discovers that small changed occur the frequency of a small portion of the light scattered by molecules
- Raman was awarded the **Nobel Prize** in Physics in 1930 for his discovery
- In the 1970's lasers made Raman much more practical. Near-IR lasers (1990's) allowed for avoidance of fluorescence in many samples. New continuous-wave(CW) and pulsed laser designs (2000's) have allowed for advances in Raman microscopy and other modes of Raman spectroscopy.

Raman spectroscopy

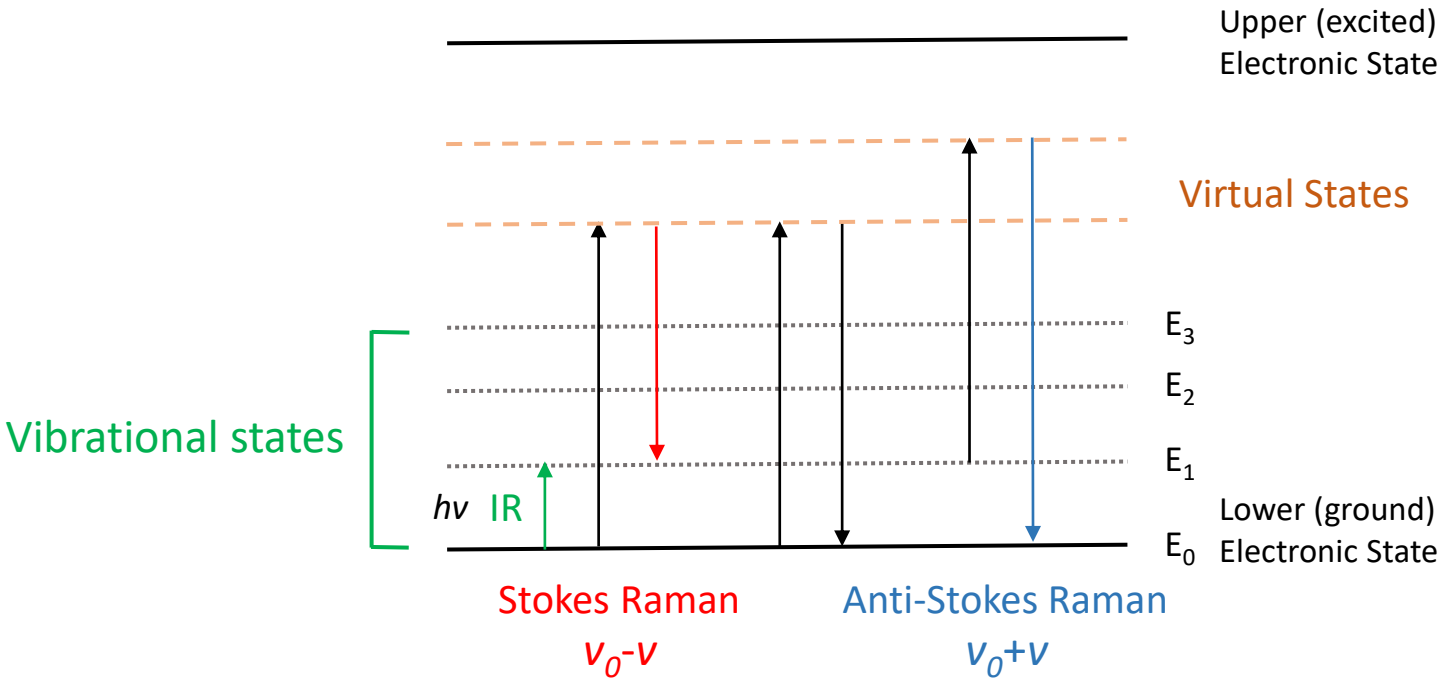
Types of interaction between radiation and matter.

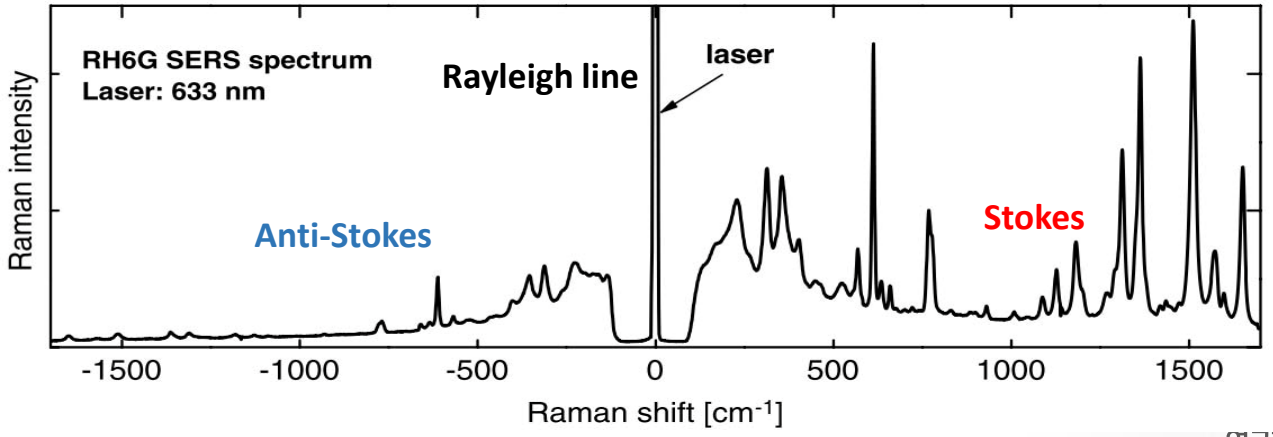
Scattering and Photoluminescence





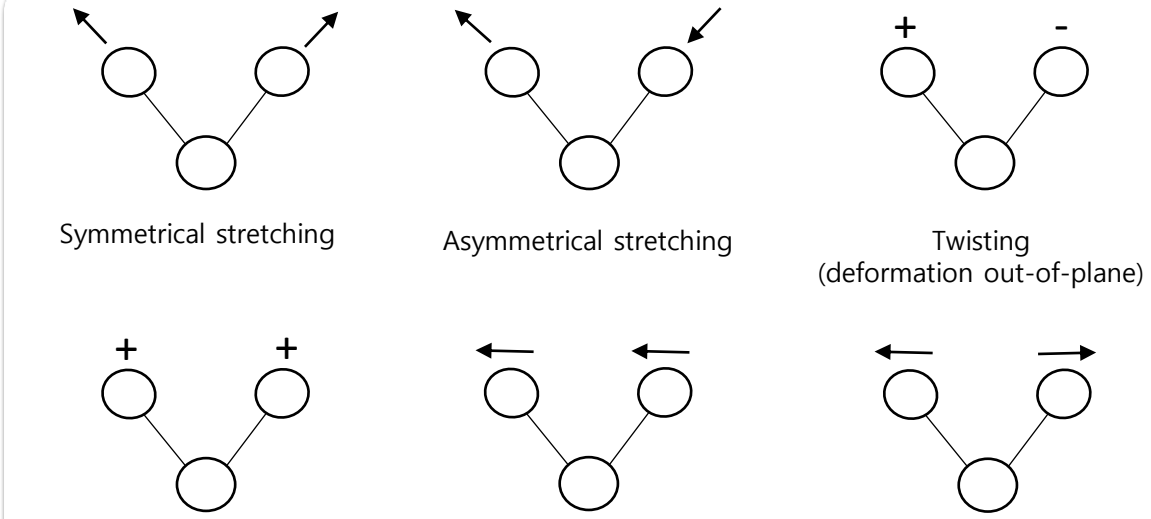
Raman spectroscopy



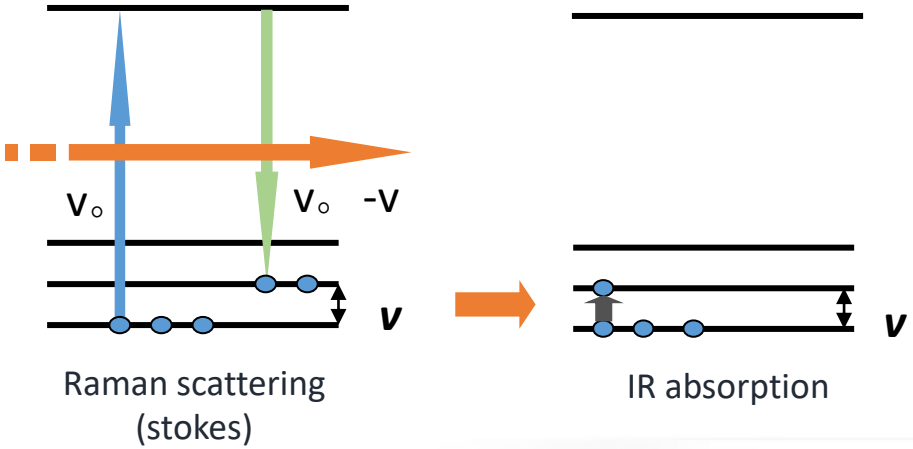


Raman spectroscopy

Molecular vibration



Selection rules	Vibration (CO_2)
IR active Dipole moment	Asymmetrical stretching Bending
Raman active Polarizability	Symmetrical stretching



Raman scattering
(stokes)

IR absorption

Raman spectroscopy

IR	Raman
Absorption	Emission of scattered laser light
Senses dipole vibrations O-H, N-H, C=O	Senses polarizable vibrations C=C, Aromatic group
Sample preparation necessary, short optical pathlength required	Little or no sample preparation, measure through transparent packaging
Non-aqueous samples	Aqueous samples

- Compounds for which Raman offers increased sensitivity

  - Weak IR absorbers -> strong Raman emitters

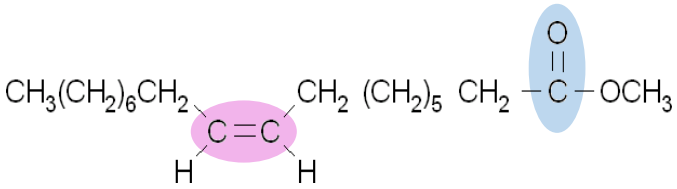
  - Symmetric bonds represented more (S-S, C-C, etc.)

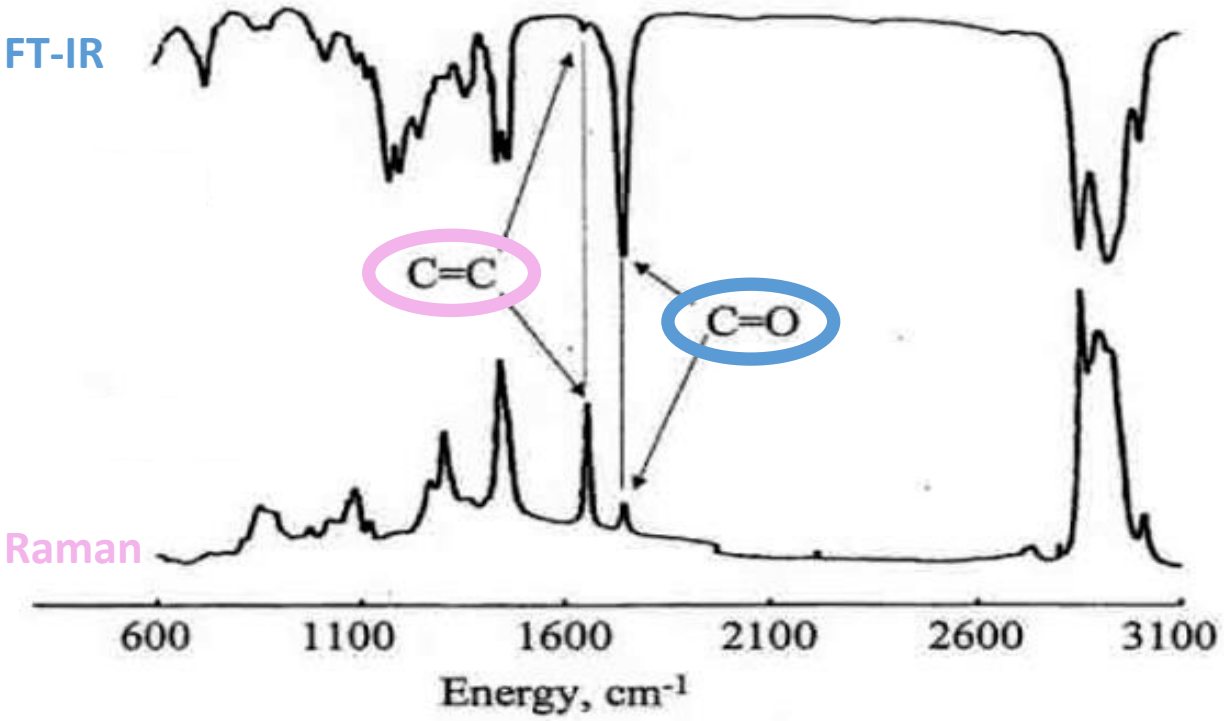
  - Molecular backbone emphasized more

  - End groups de-emphasized

  - Spectral range offers more information on inorganics

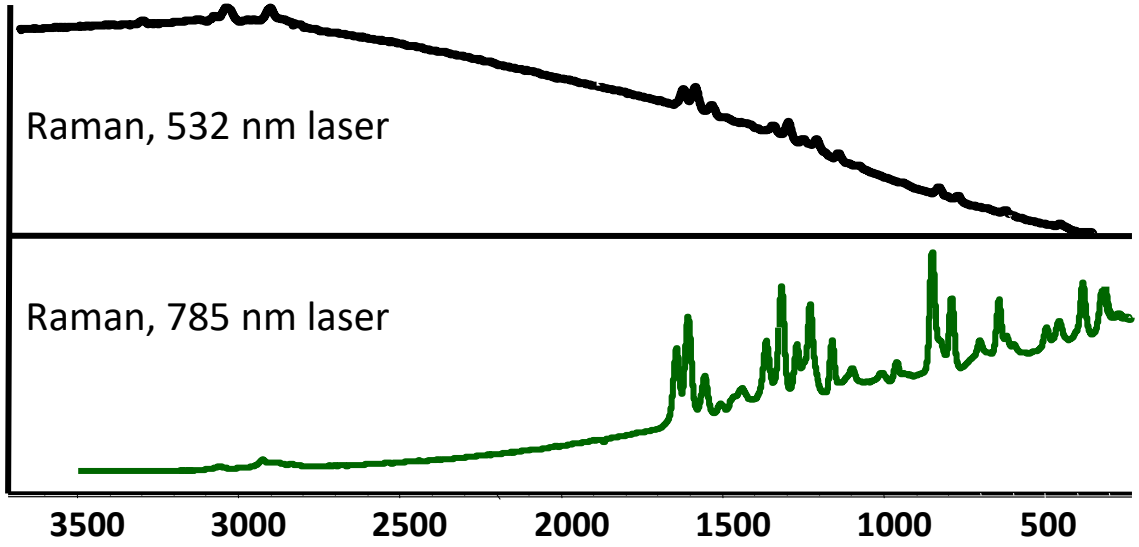
FT-IR & Raman spectrum of oleic acid methyl ester





Raman spectroscopy

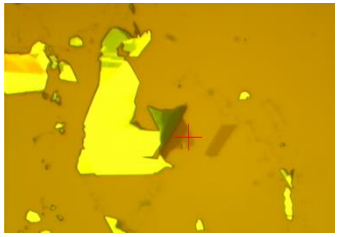
- In general spectrum is invariant with $\lambda_{excitation}$
- $I_{Rayleigh} = 10^6 \times I_{Raman}$
- $I \propto \frac{I}{\gamma^4}$, I_{Raman} proportional to $1/\lambda^4$ (5 times more effective for 400 nm than 600 nm)
- NIR or UV wavelengths have been used to avoid background fluorescence interference.

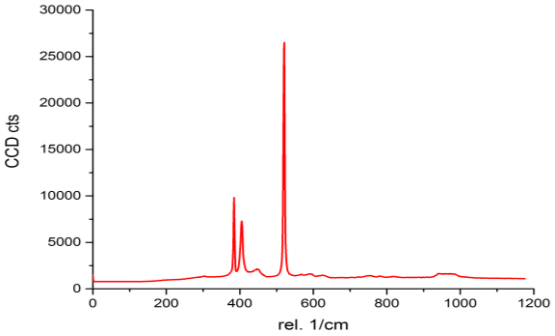


Raman applications

Raman spectrum

Single spectrum





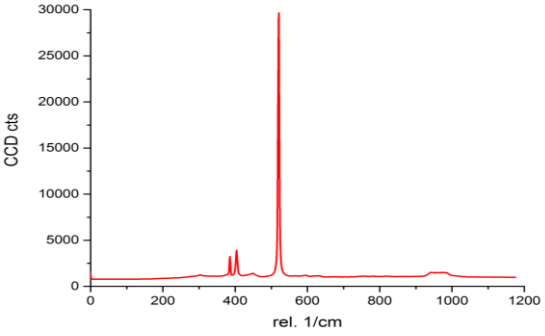
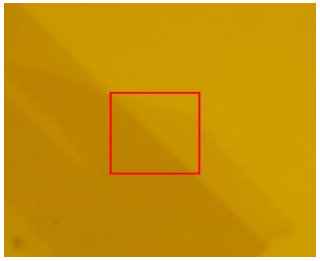
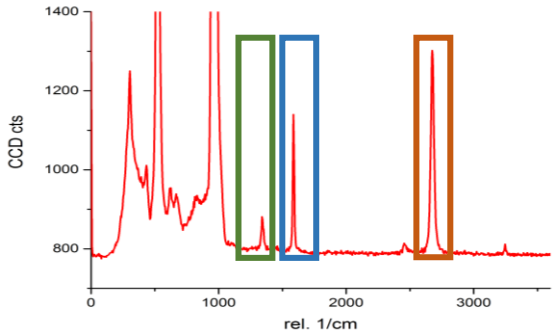
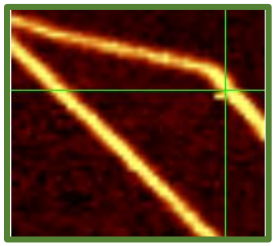


Image scan(mapping)

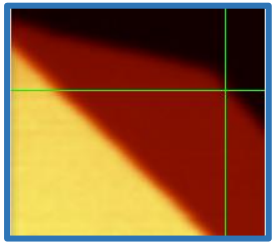




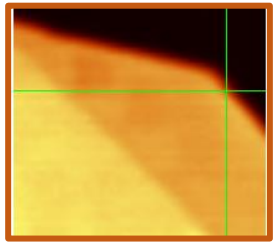
1310-1380 cm^{-1}



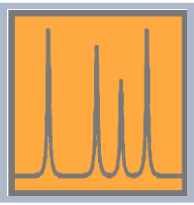
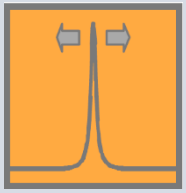
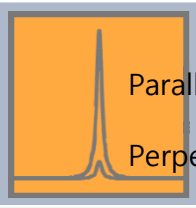
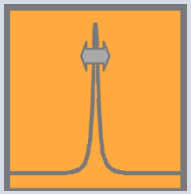
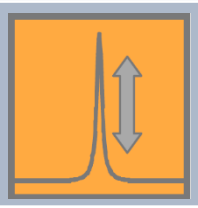
1530-1630 cm^{-1}



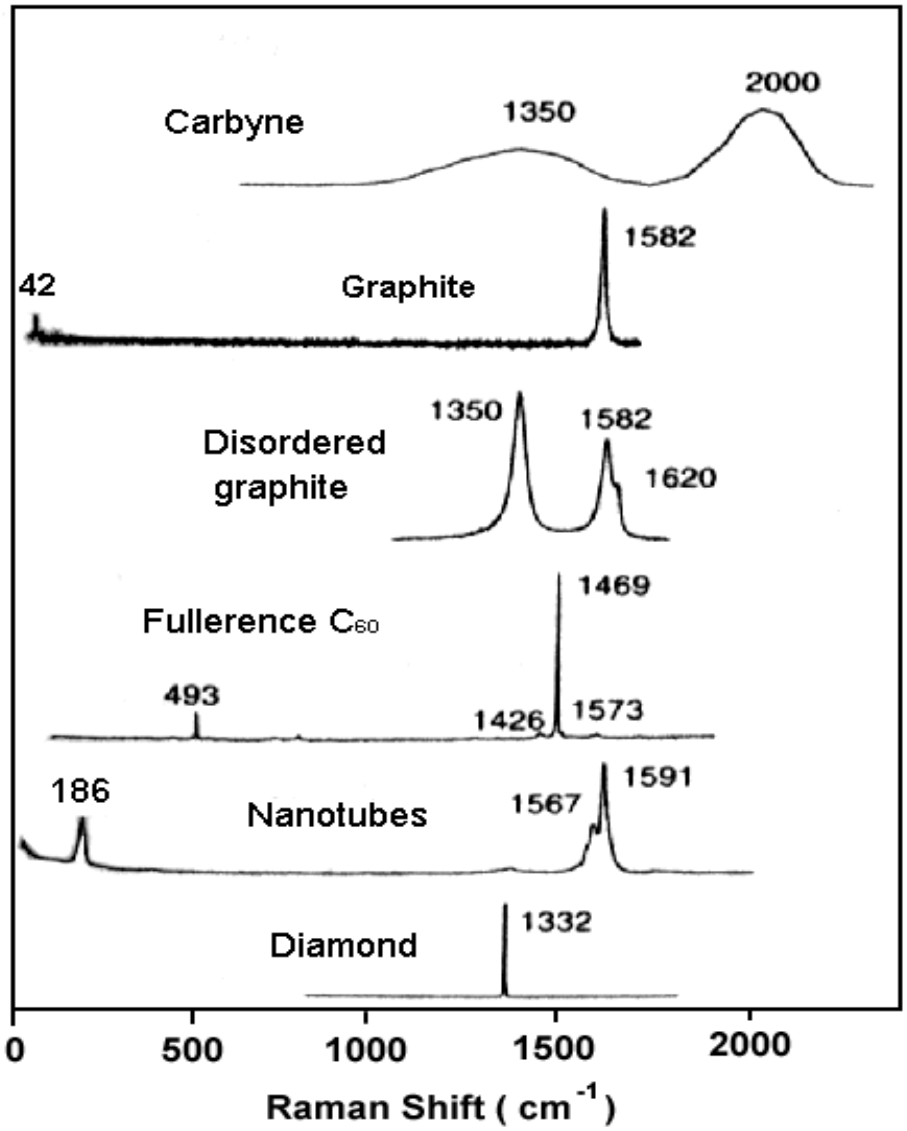
2605-2740 cm^{-1}



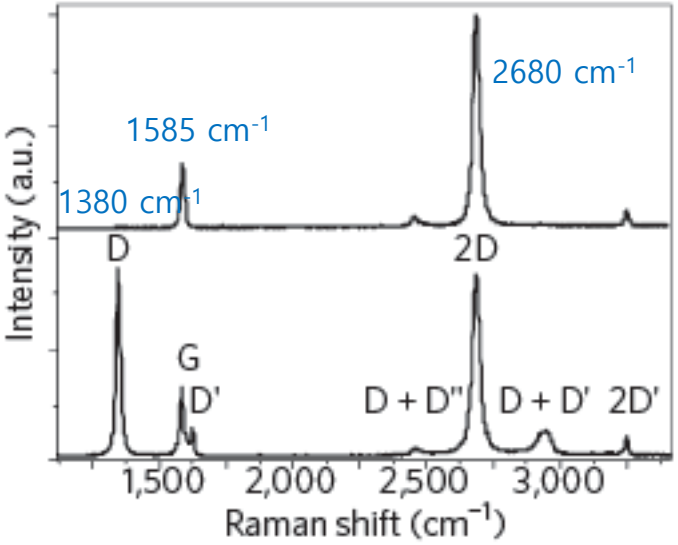
Raman applications

Raman spectrum	Information
 Characteristic Raman frequencies	Composition of material
 Changes in frequency of Raman peak	Stress and strain state
 Parallel Perpendicular Polarization of Raman peak	Crystal symmetry and orientation
 Width of Raman peak	Quality of crystal
 Intensity of Raman peak	Amount of material

Various Carbon



Raman spectrum of graphene



Raman spectra of pristine (top) and defected (bottom) graphene. The main peaks are labelled.

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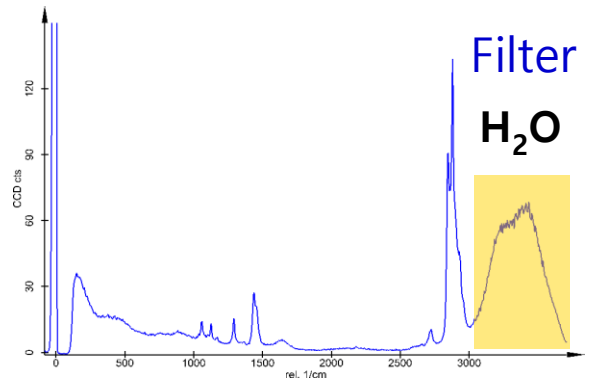
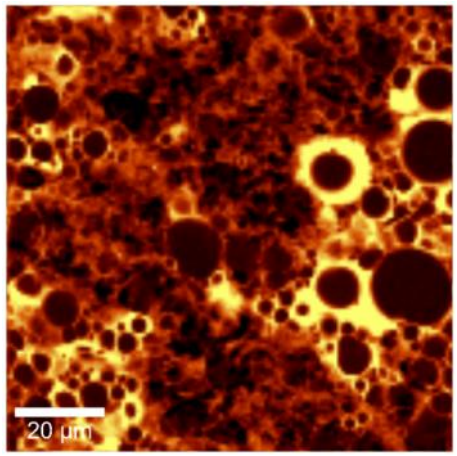
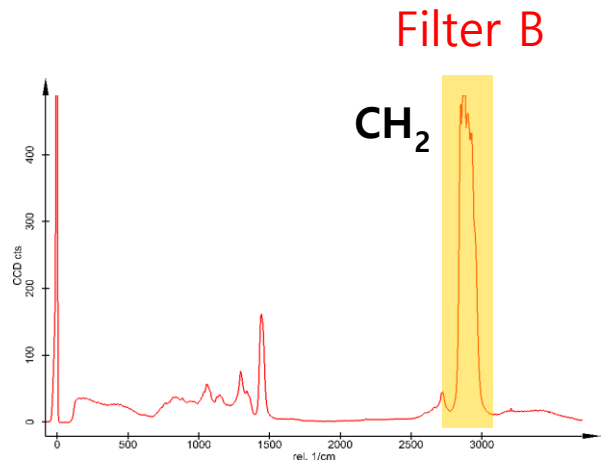
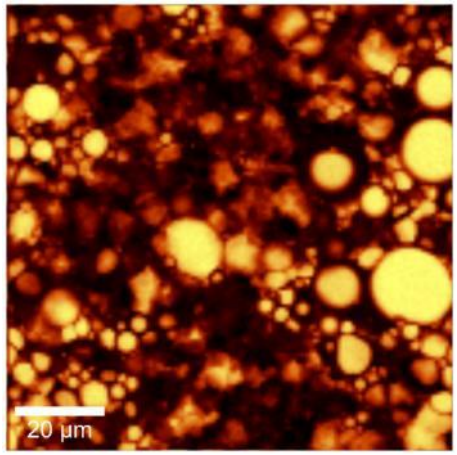
Raman applications

Spectral Imaging (Mapping)









Sample: Oil/Water Emulsion
Excitation: 532 nm, 2 mW
Scan Range: 100 μm^2
Resolution: 180 x 180 point
40ms/spectrum, 22 min

Optical Terminology

Working Distance(W.D.)

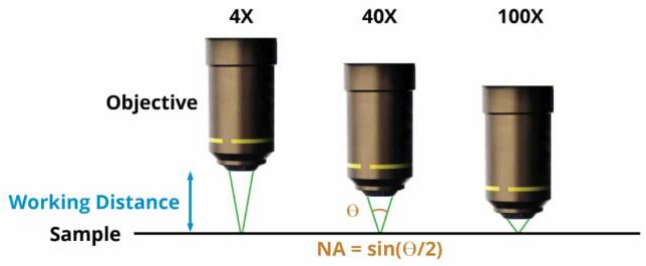
The distance between the front edge of the objective lens and the specimen surface (with the surface of the cover glass in case of the cover glass objective lens) when the Specimen is focused.

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 :

$$N.A. = n \times \sin\theta$$



n = refraction rate of the medium between specimen and objective lenses.
(air : n=1, oil : n=1.515)
θ = angle which is made by the optical axis and refraction of the light farthest from the center of lens.

Optical Terminology

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.

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

λ : wavelength or radiation in use
N.A. : objective lens N.A.

Focal depth of Microscope

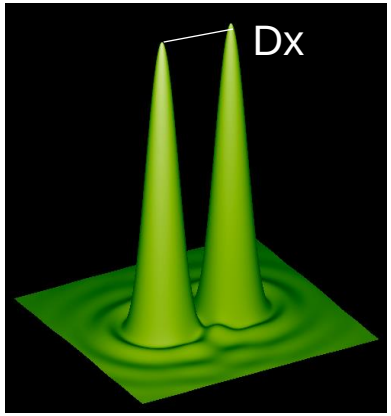
The focal depth refers to the depth of the specimen layer which is in sharp focus at the same time, even if the distance between the objective lens and the specimen plane is changed when observing and shooting the specimen plane by microscope.

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

ε : resolving power
N.A. : objective lens N.A.

Raman applications

Resolving power



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

Magnification	N.A.	Λ [nm]	△x [nm]
50x	0.5	532	649
		633	772
		785	957
50x	0.8	532	405
		633	482
		785	598
100x	0.9	532	360
		633	429
		785	532

For example. Image scan : 30x30 ㎛
with Raman 532nm, 100x 0.9 objective

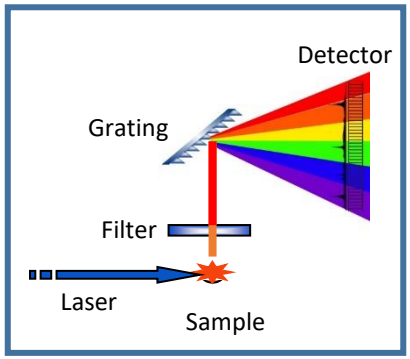
$$\text{Point/Line (Line/Image)} = \frac{\text{Geometry Width (Height)}}{\text{Resolution } (\triangle x)} = \frac{30{,}000 \text{ nm}}{360 \text{ nm}} = 83 \text{ Point}$$

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.

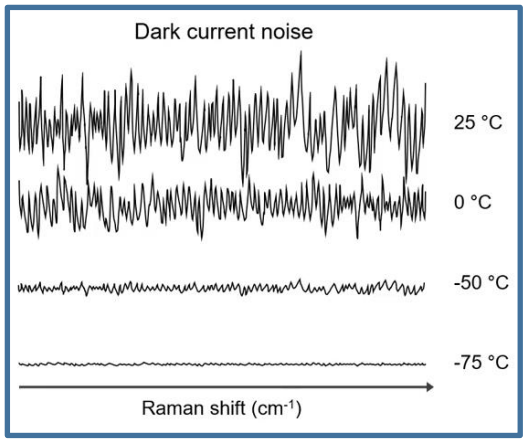
- **Optical Resolution: 200 nm/ laterally, 500 nm/ vertically**
- **Spectral Resolution: 0.02 wavenumbers**

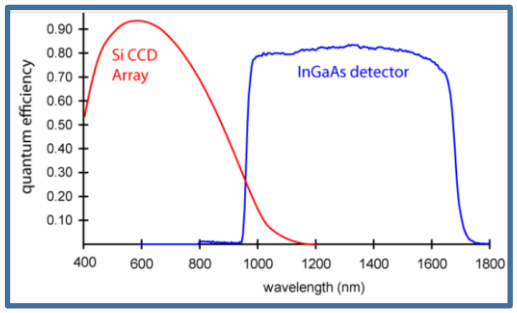
3. Hardware

Conceptual Raman Spectrometer



Grating spectrometer





Si CCD Detector

ν_o-ΔE_{vib}

Rayleigh Rejection Filter (Notch filter)

ν_o-ΔE_{vib} Raman

ν_o

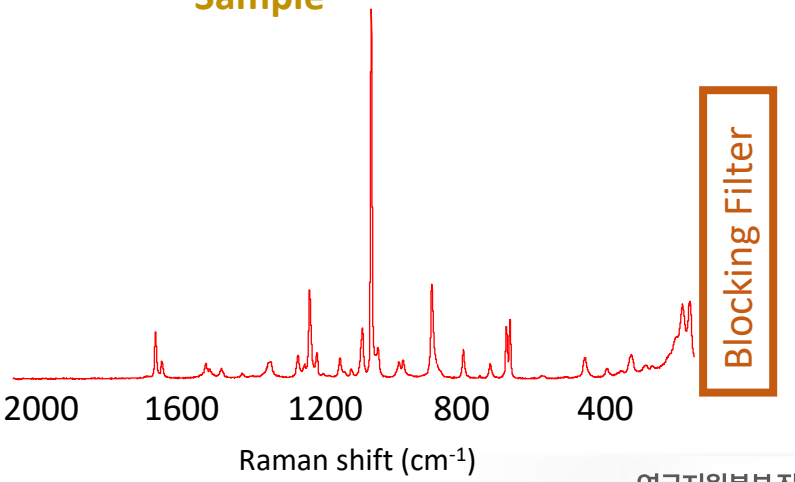
Excitation Laser
Monochromatic light source typically a laser

Rayleigh and Raman Scattered light

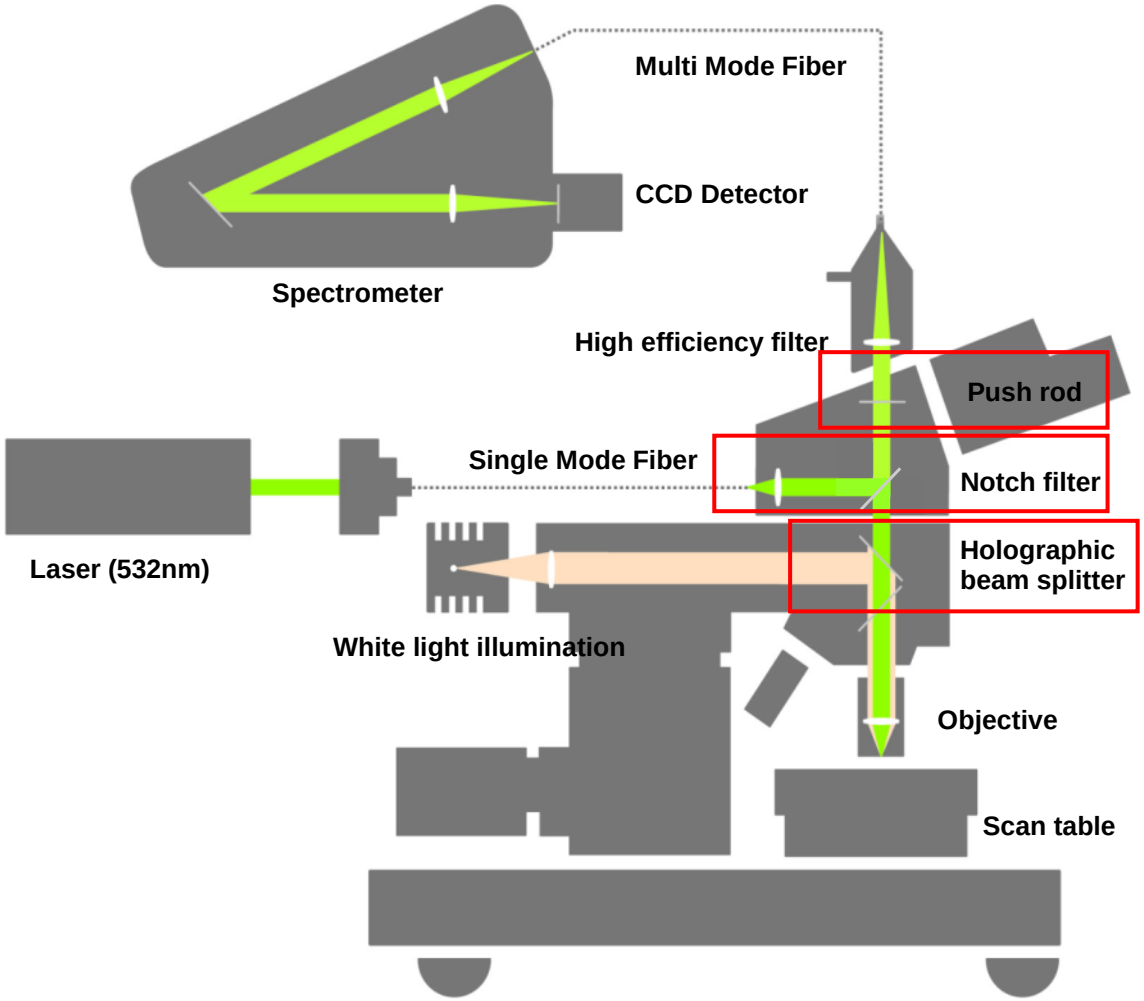
$I_{Rayleigh} = 10^6 \times I_{Raman}$

Rayleigh

Sample



Raman spectrometer



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

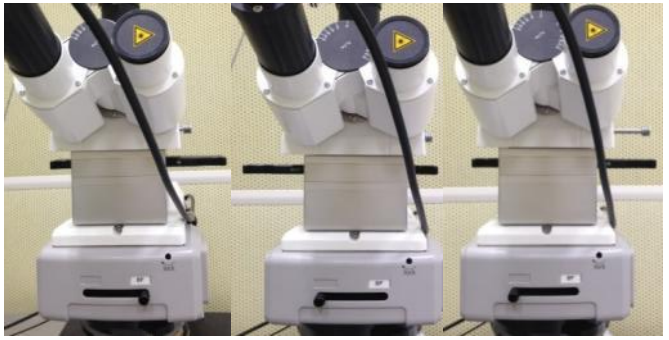
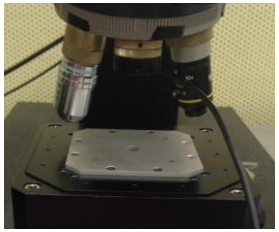
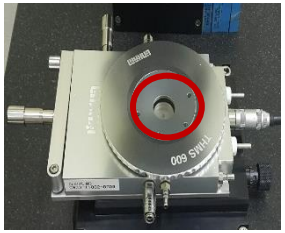


Image Mode Laser Mode Raman Mode

Raman spectrometer

장비명	Confocal-Raman	AFM-Raman
		
위치	**102- B107**	**102- B107**
사용	**의뢰/자율사용 가능**	**의뢰/자율사용 가능**
모델명	Alpha300R	Alpha300S
시료	Powder, liquid, film	Powder, liquid, film
Measurement mode	Single scan, Image scan	Single scan, Image scan, SNOM
Laser source (nm)	532	532, 633, 785
Objective (N.A., WD mm)	50x (0.8, 0.54), 50x (0.5, 10.6), 10x (0.25, 7.0)	100x (0.9, 1.0), 50x (0.5, 10.6), 20x (0.4, 3.8)
Temperature controller	사용 가능	

Raman scan table

※ No sample holder

① **Max. sample size**
Scan table: 120 mm in x- and y-direction, 25 mm in height
Temperature control scan table
: 10 mm in x- and y-direction, 4 mm in height

② **Min. sample size**
: 2 mm in x- and y-direction

③ **Flat & Smooth Surface**

Temperature controller	
Temperature range	-185 ~ 300 ℃ (~600 ℃ with cooling system)
Temperature stability	< 0.1 ℃
Hold time at 77K	About 3 hrs

4. Raman operation

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Mode setting

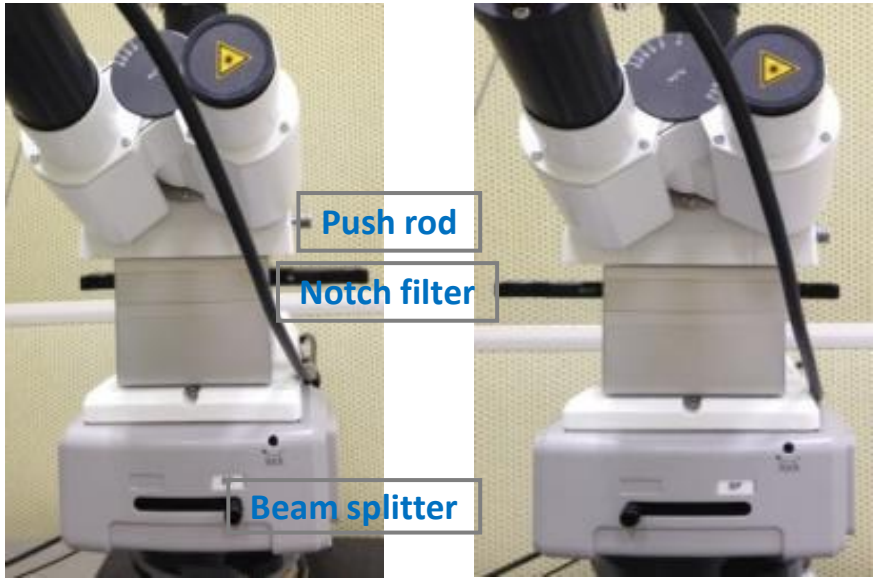


Image Mode

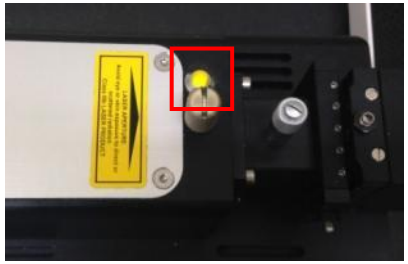
Laser Mode

Raman Mode

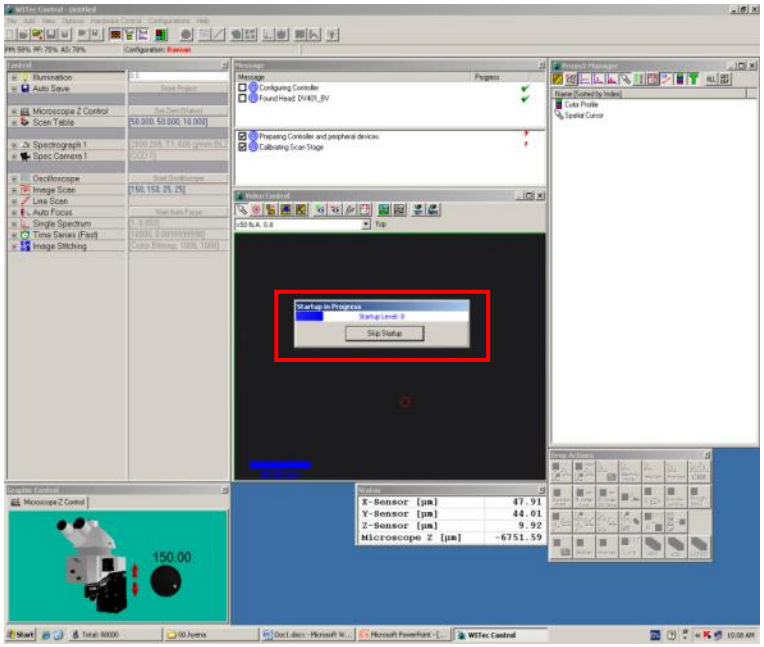
	Beam Splitter	Notch Filter	Push Rod
Image Mode	BF	IN	IN
Laser Mode	DF	OUT	IN
Raman Mode	DF	IN	OUT

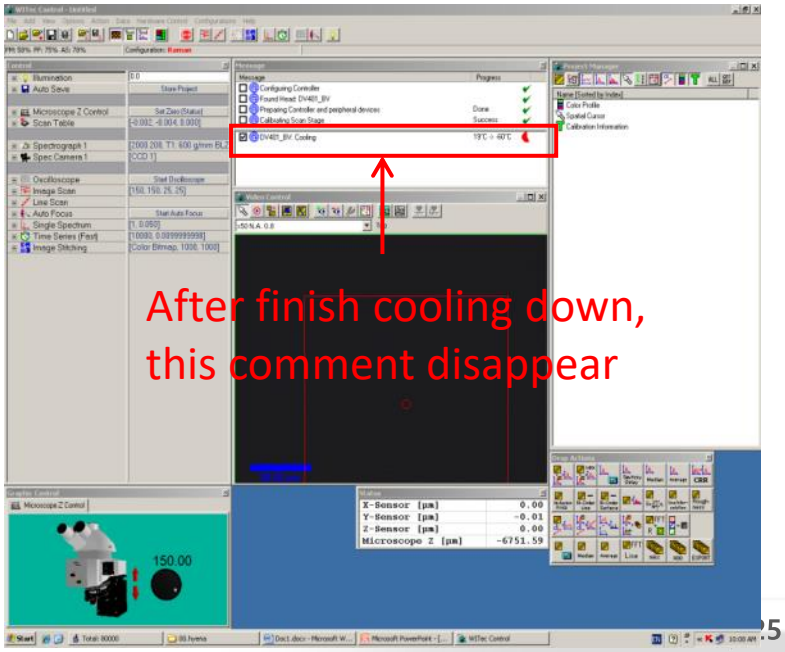
Si calibration

1. Laser on→ warm up (10 min)



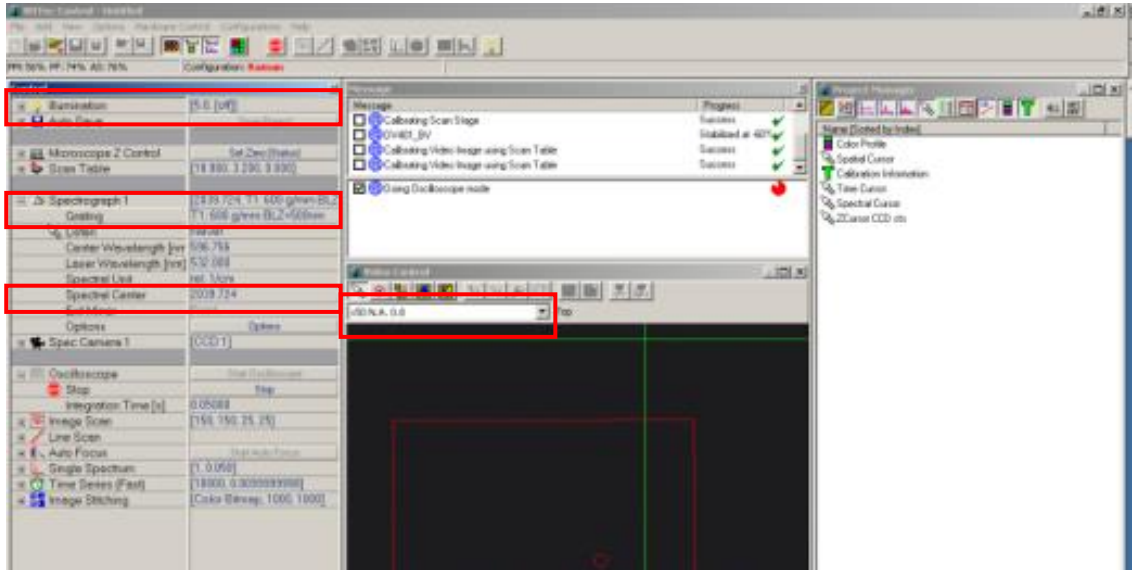
2. WITec Control Pro. START→ wait cooling down (10 min)





Si calibration

2-1. Program setting

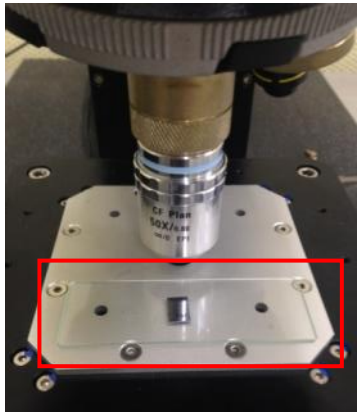


- Illumination: 100
- Spectrograph1
- Grating: 600 g or 1800 g
- Spectral center: 2040 or 600
- Video control: lens choice
- Image mode

	Beam Splitter	Notch Filter	Push Rod
Image Mode	BF	IN	IN

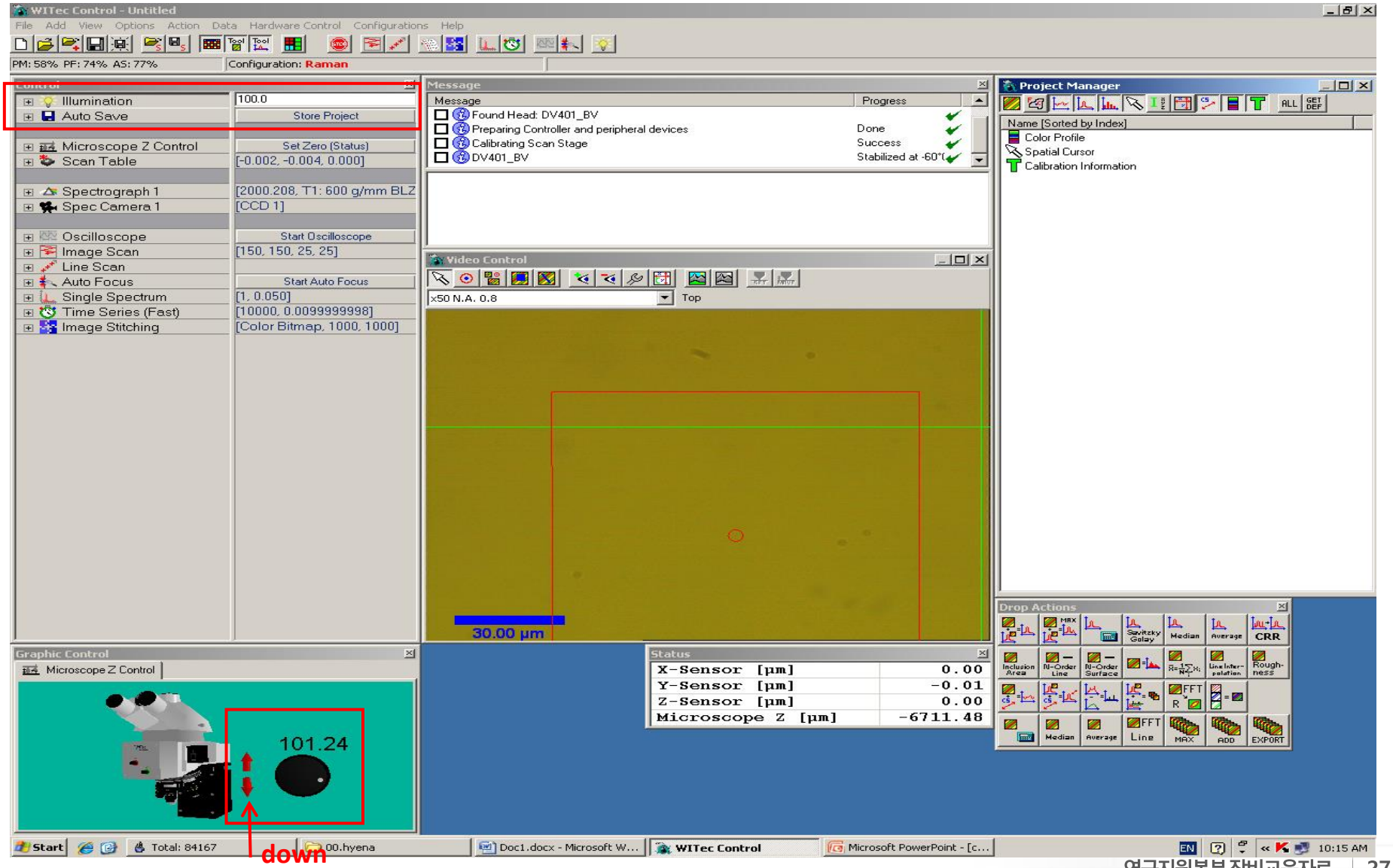
- X50 lens setting
- Lens – stage distance check
- Lens position center check

3. Put down a Si substrate(reference) on a slide glass (Turn the lens sideways and place the sample)



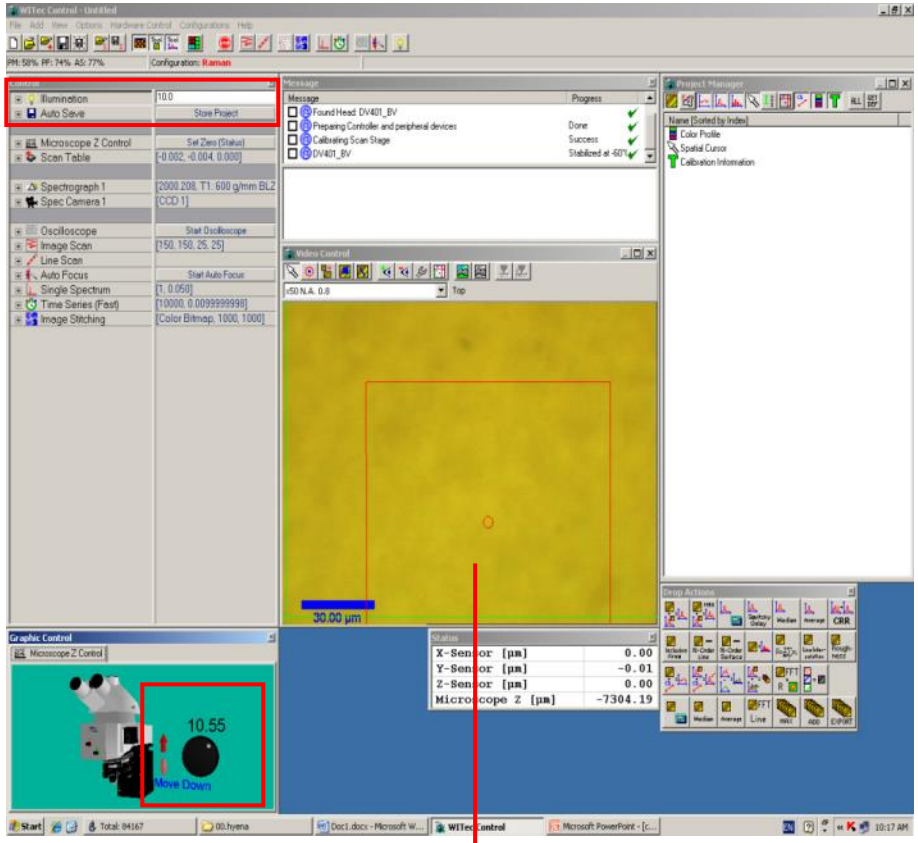
Si calibration

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

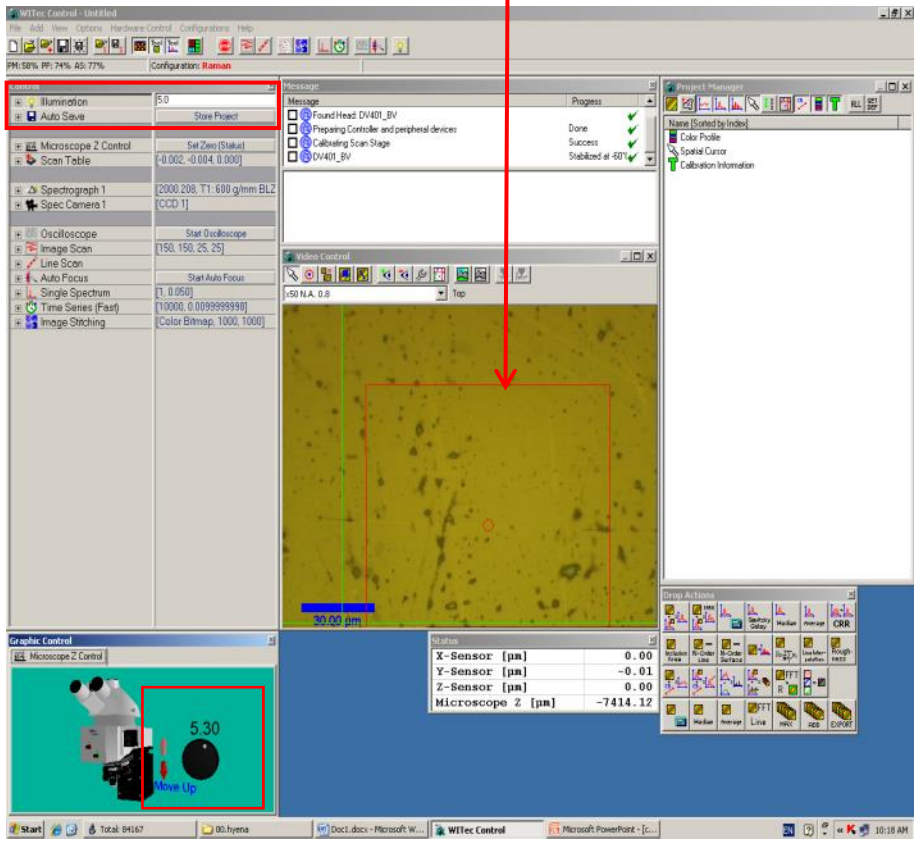


Si calibration

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



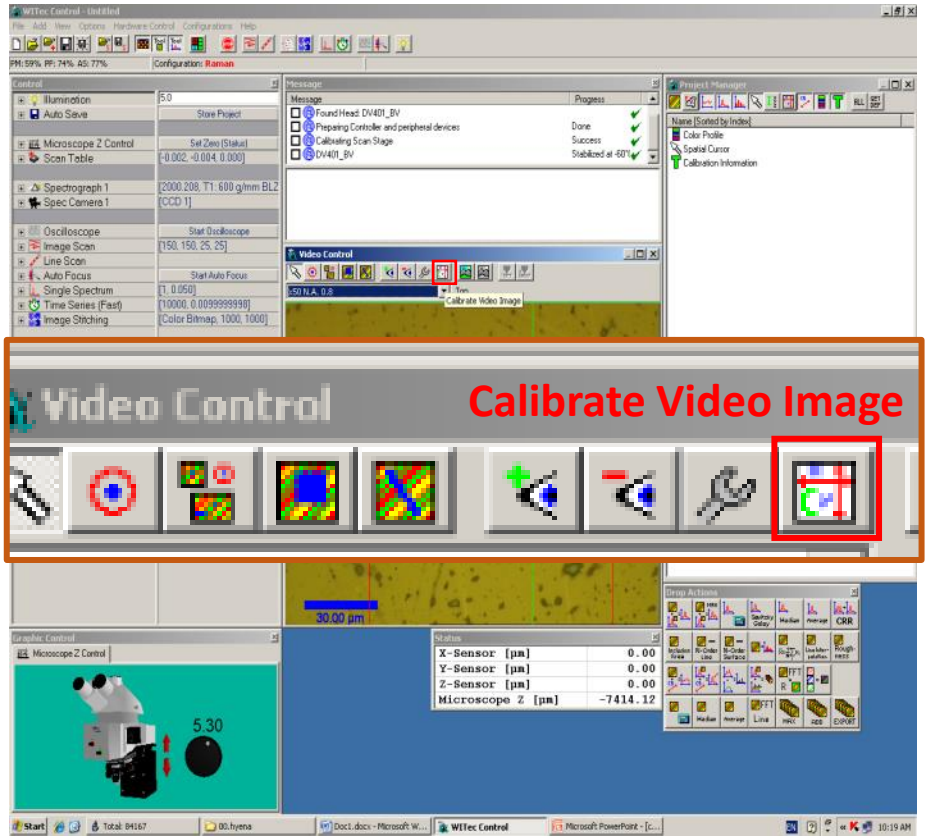
Diffuse layer

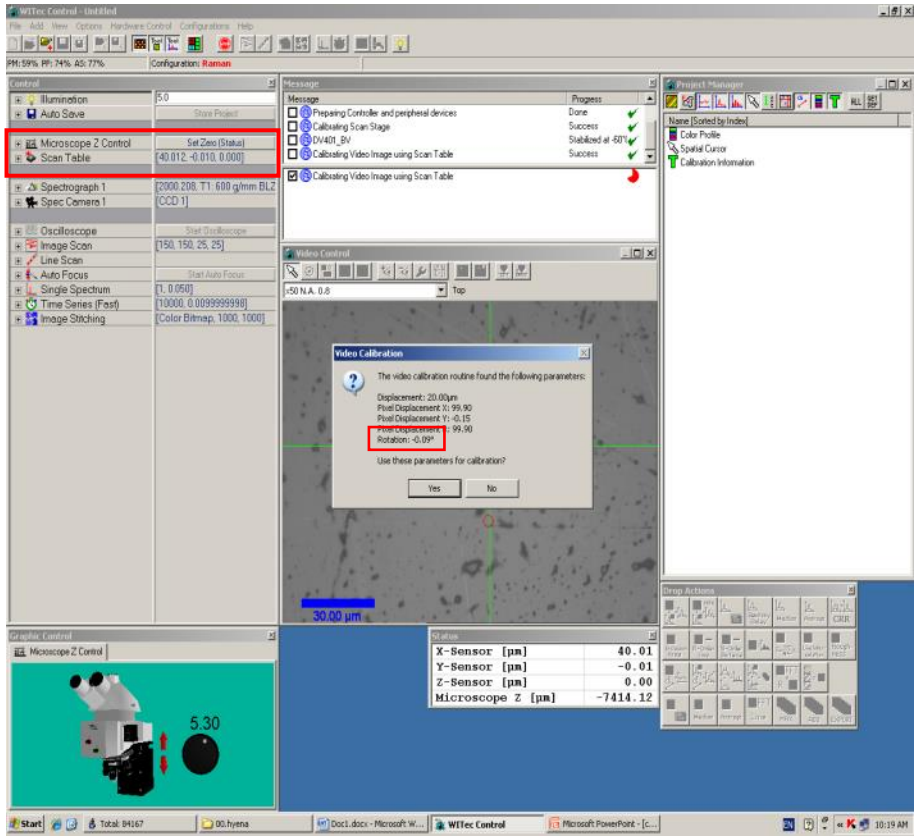


Si calibration

6. Video Control→ Calibrate Video Image click→ Rotation < ± 0.1

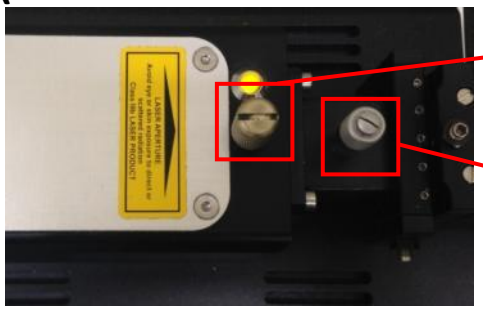
6-1. Scan Table → X,Y,Z=0



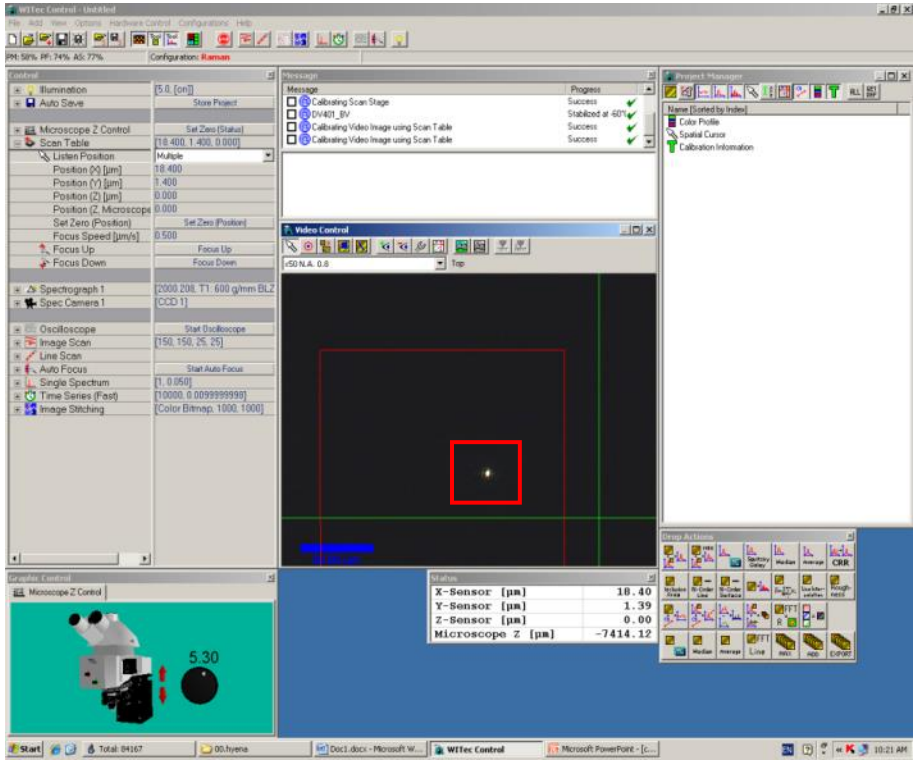


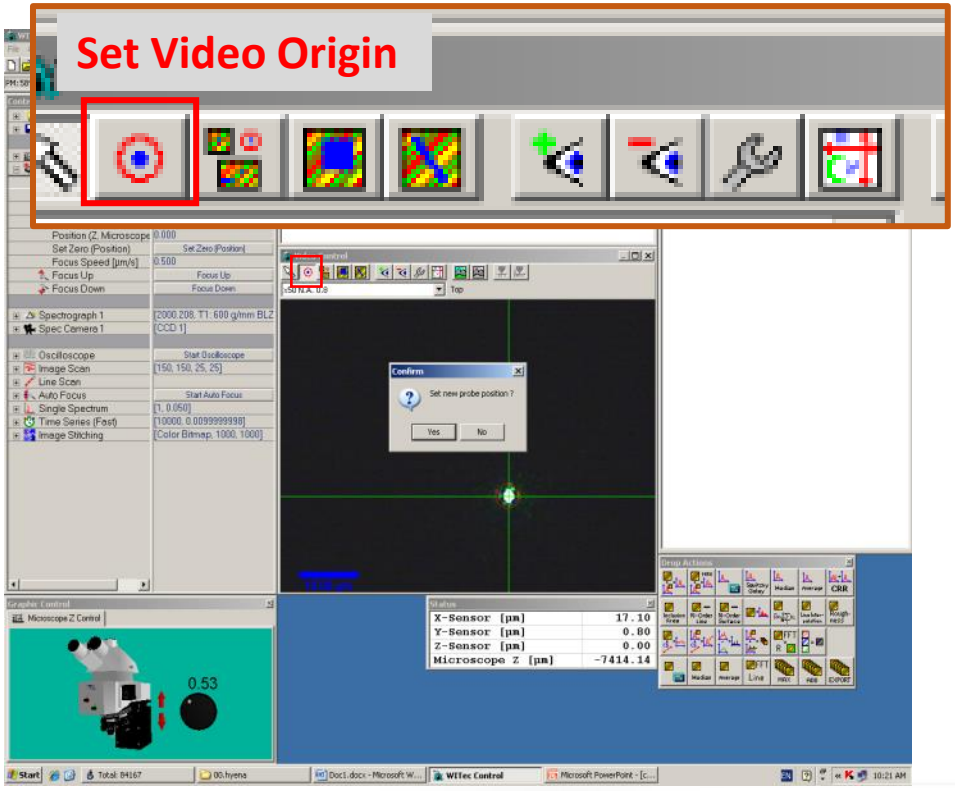
Si calibration

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



	Beam Splitter	Notch Filter	Push Rod
Laser Mode	DF	OUT	IN

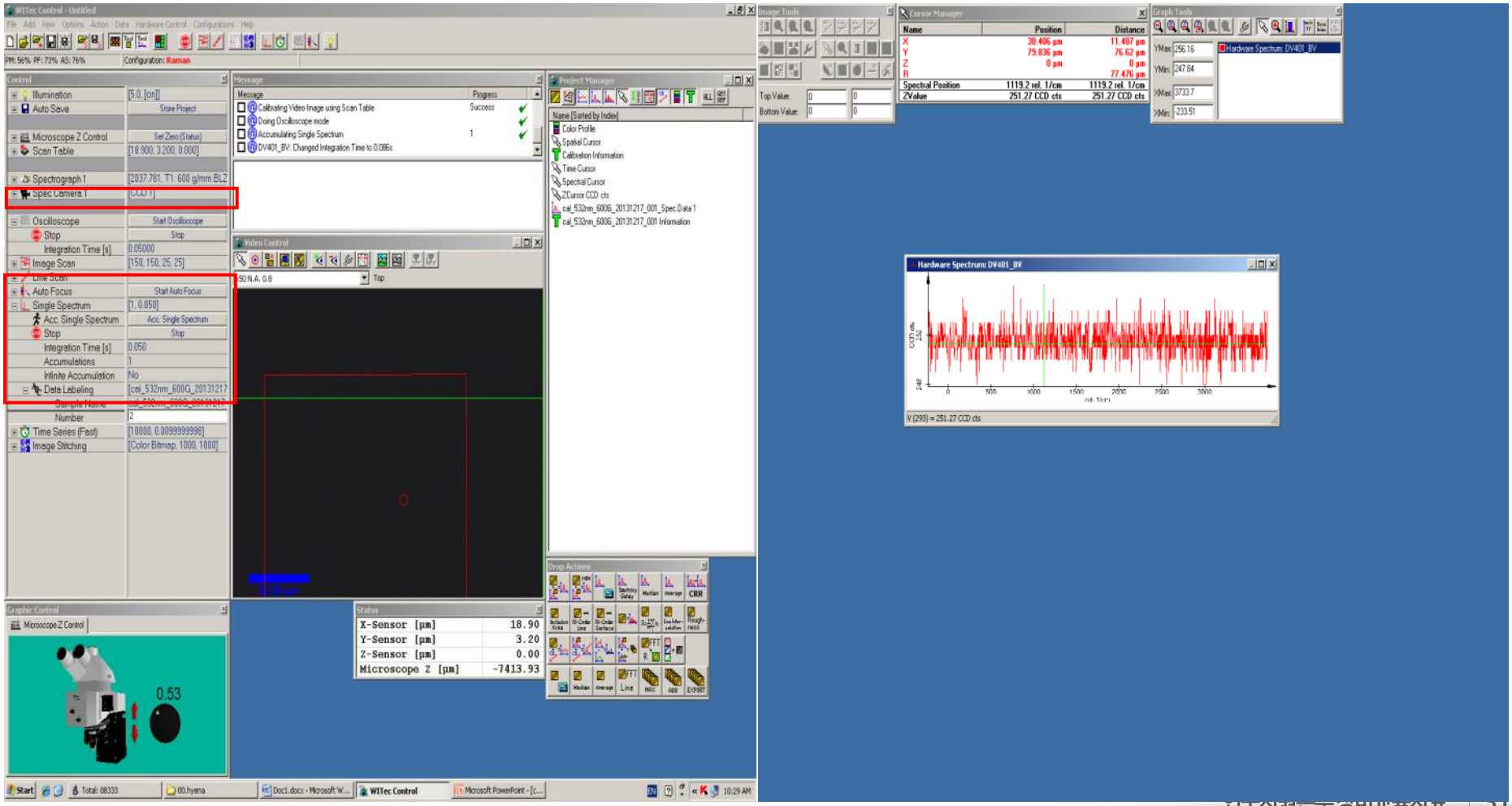




Si calibration

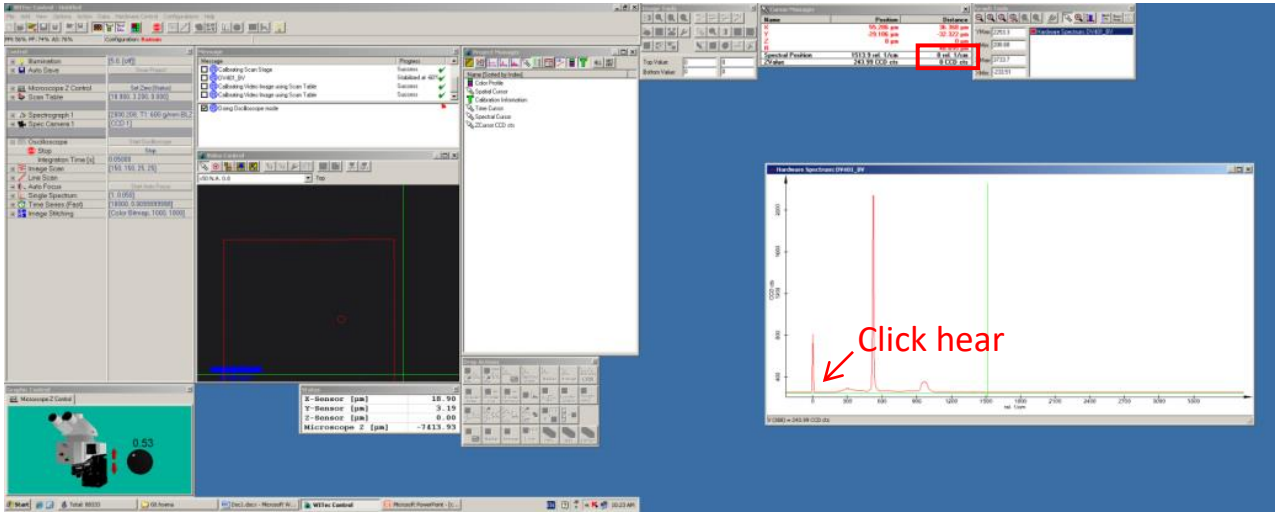
8. Raman Mode→
→ Control→ Oscilloscope Start (Integration Time = 0.05 S)
→ Slit increase -> Maximize peak intensity

	Beam Splitter	Notch Filter	Push Rod
Raman Mode	DF	IN	OUT

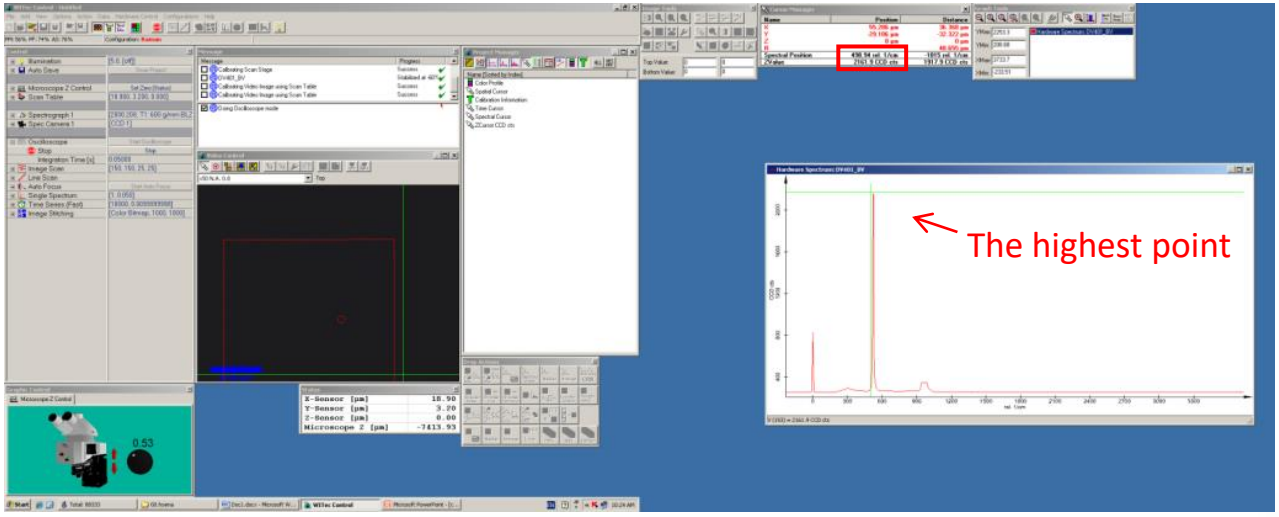


Si calibration

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

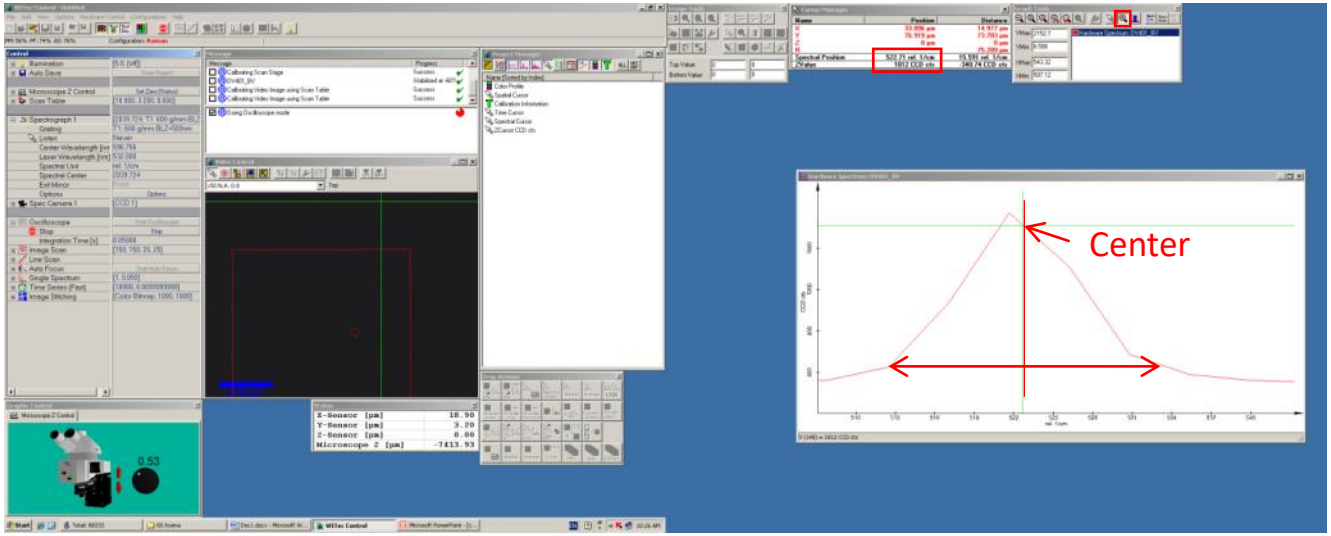


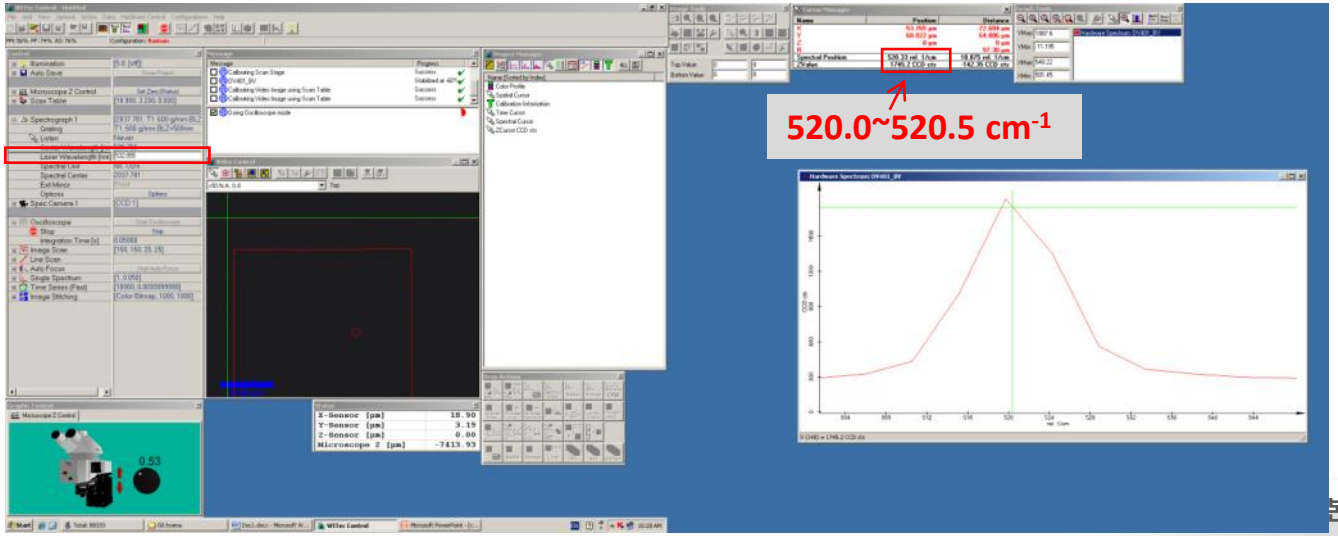
10. Real Time Spectrum→ Move a cursor to the highest point (520 cm^{-1} peak) →
Z Value ≥ 7,000 CCD cts (If, Z Value < 7,000 CCD cts→ Z axis Speed 0.5→ down or up, Maximize peak intensity)



Si calibration

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



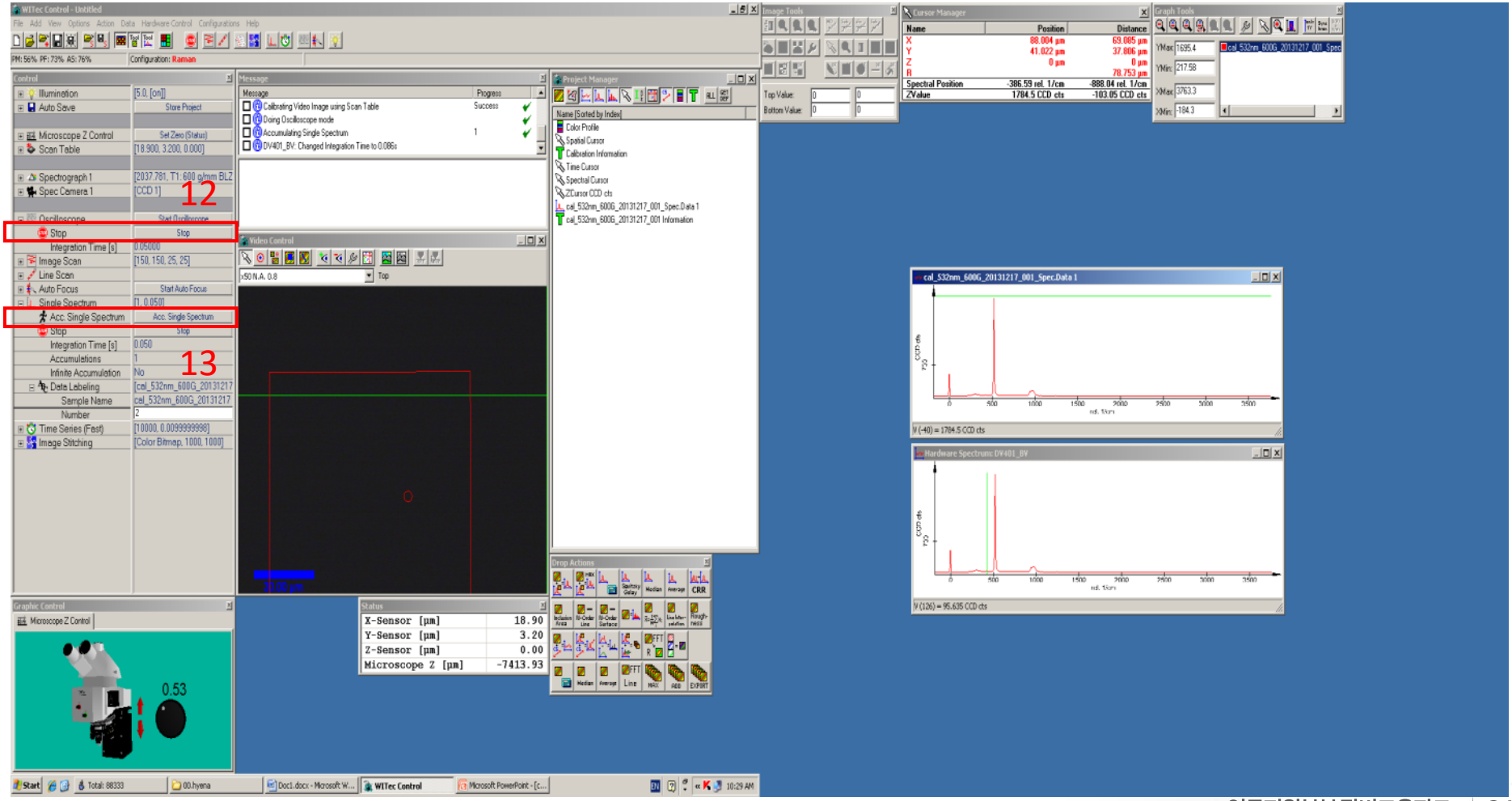


Si calibration

12. Oscilloscope Stop

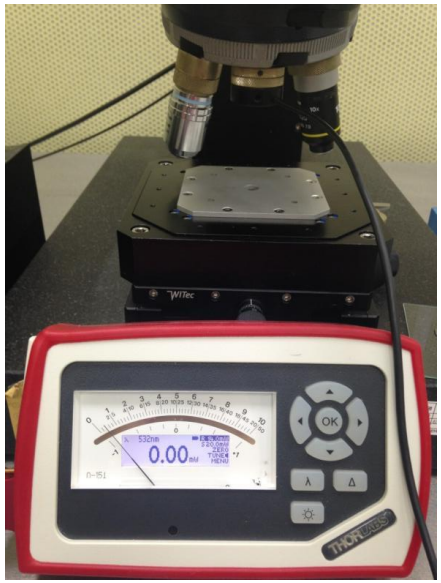
13. Control→ Single Spectrum→ Acc. Single Spectrum click(Integration Time = 0.05 s, 1 scan)

14. Data labeling(2025XXXX_Si_Cal.)



Laser powermeter calibration

Laser Power Meter (power setting)- in Raman Mode



1. Remove a laser powermeter cover
2. Connect a connector -> put on the laser powermeter connection point
3. Lase powermeter power on
4. Set the “zero” point
5. Laser shutter on
6. Set the measurement power by rotating slit
7. Laser powermeter power off

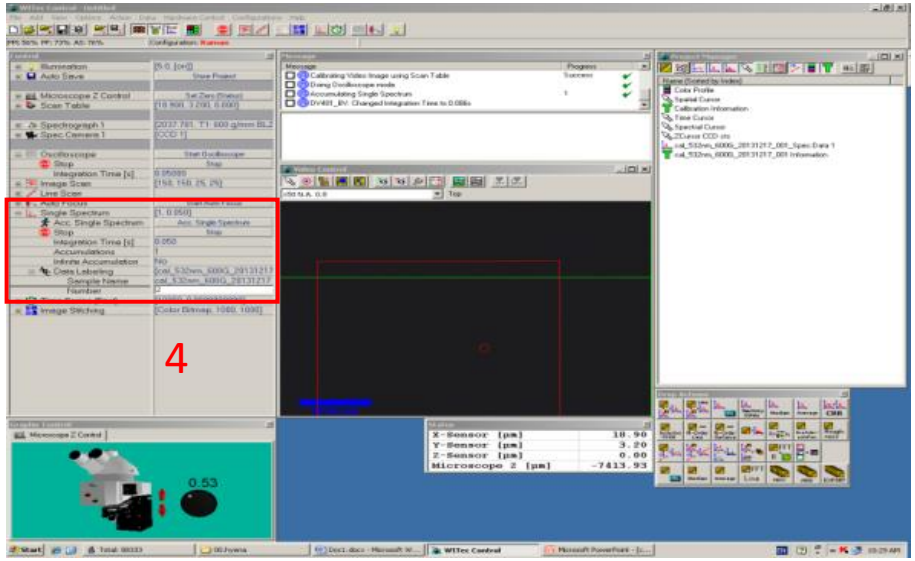
Sample measurement_Single spectrum

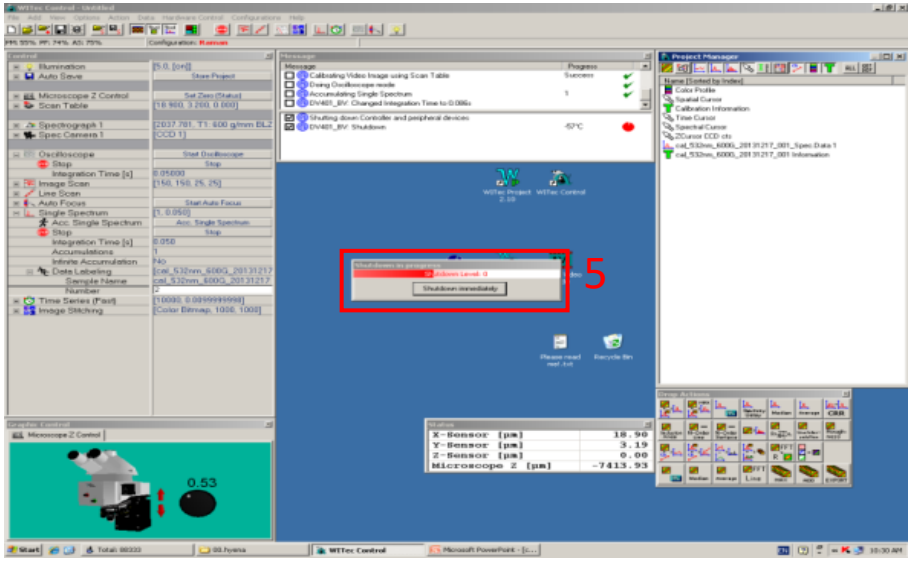
1. After calibration, Image Mode→ Put down your sample on a slide glass

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



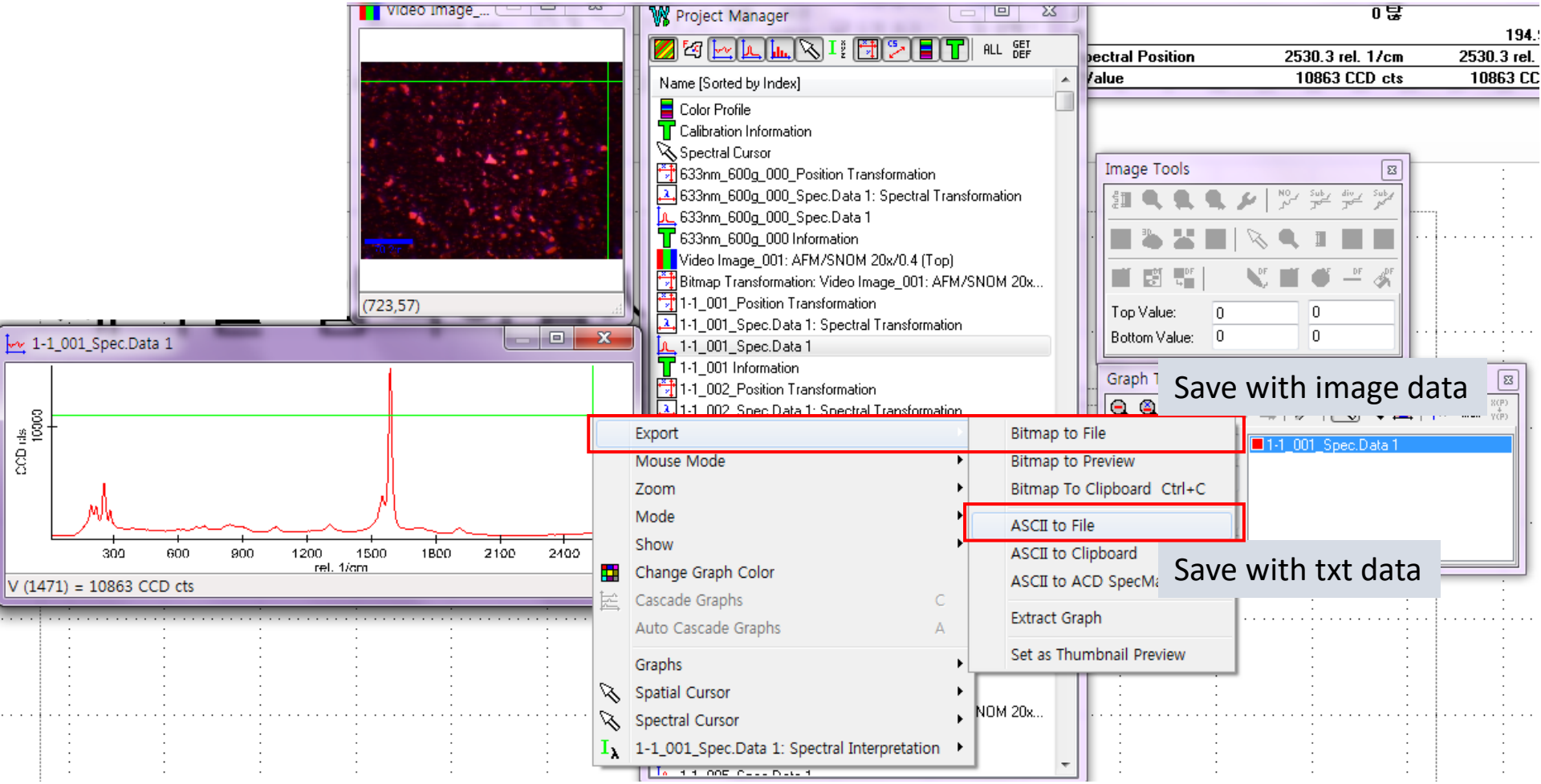


5. WITec Control Pro. CLOSE→ wait heating (10min)

6. Laser off

Data processing

7. Open video image data or spectrum data → Click on the right mouse button → Export



Sample measurement_Image scan

1. Si calibration

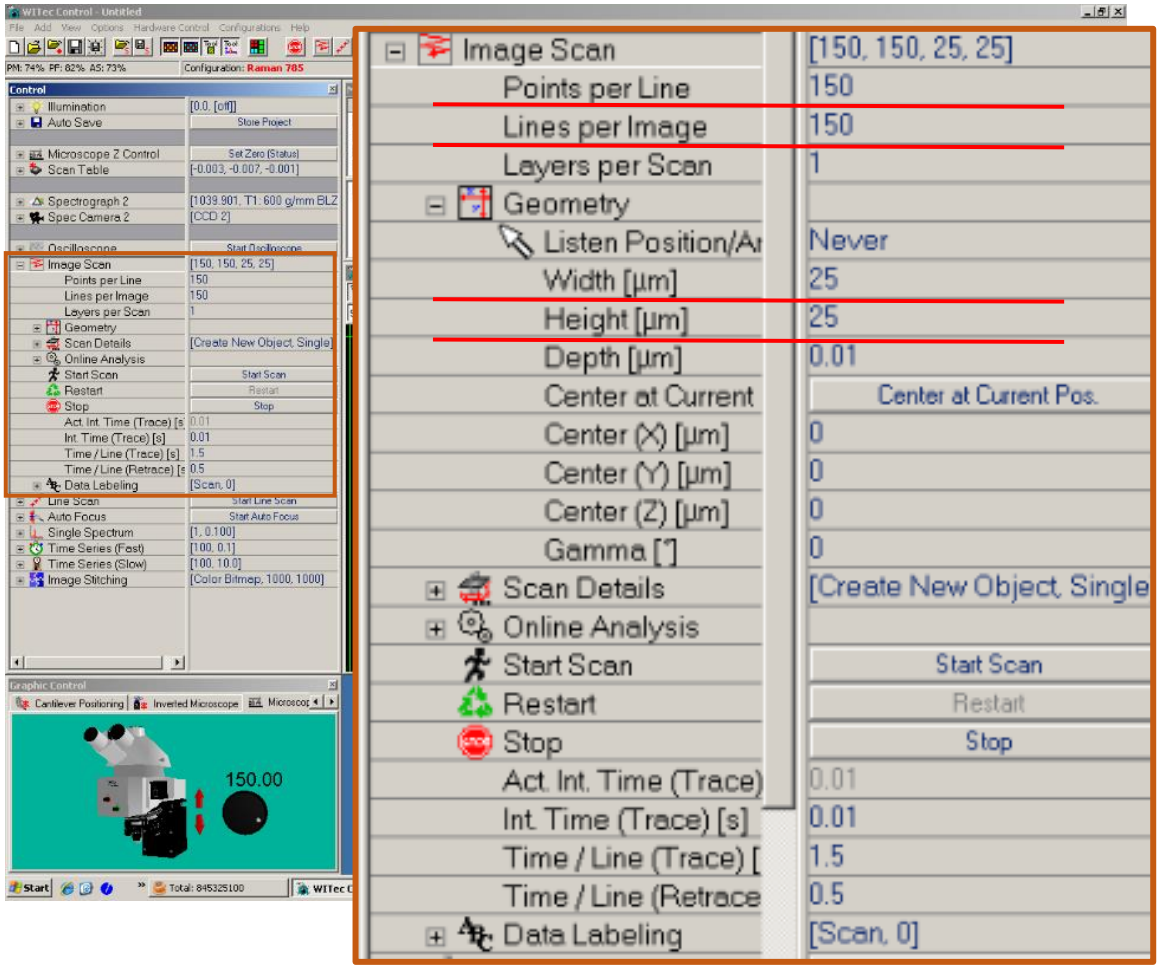
2. Check the Raman peak
on your sample with **single spectrum measurement**

3. Open Image scan

1) Geometry

- Insert **Width and Height** value. The max. value is **50um**.

- Insert **Points per Line** and **Line per image** after consider resolution. (PPT page 14).



Sample measurement_Image scan

3. Open Image scan

2) Center of the image scan

- Center at Current Pos.

When you want to make the position measured single spectrum to the center of Image scan, please click **Center at current Pos.**

- Center (X), (Y)

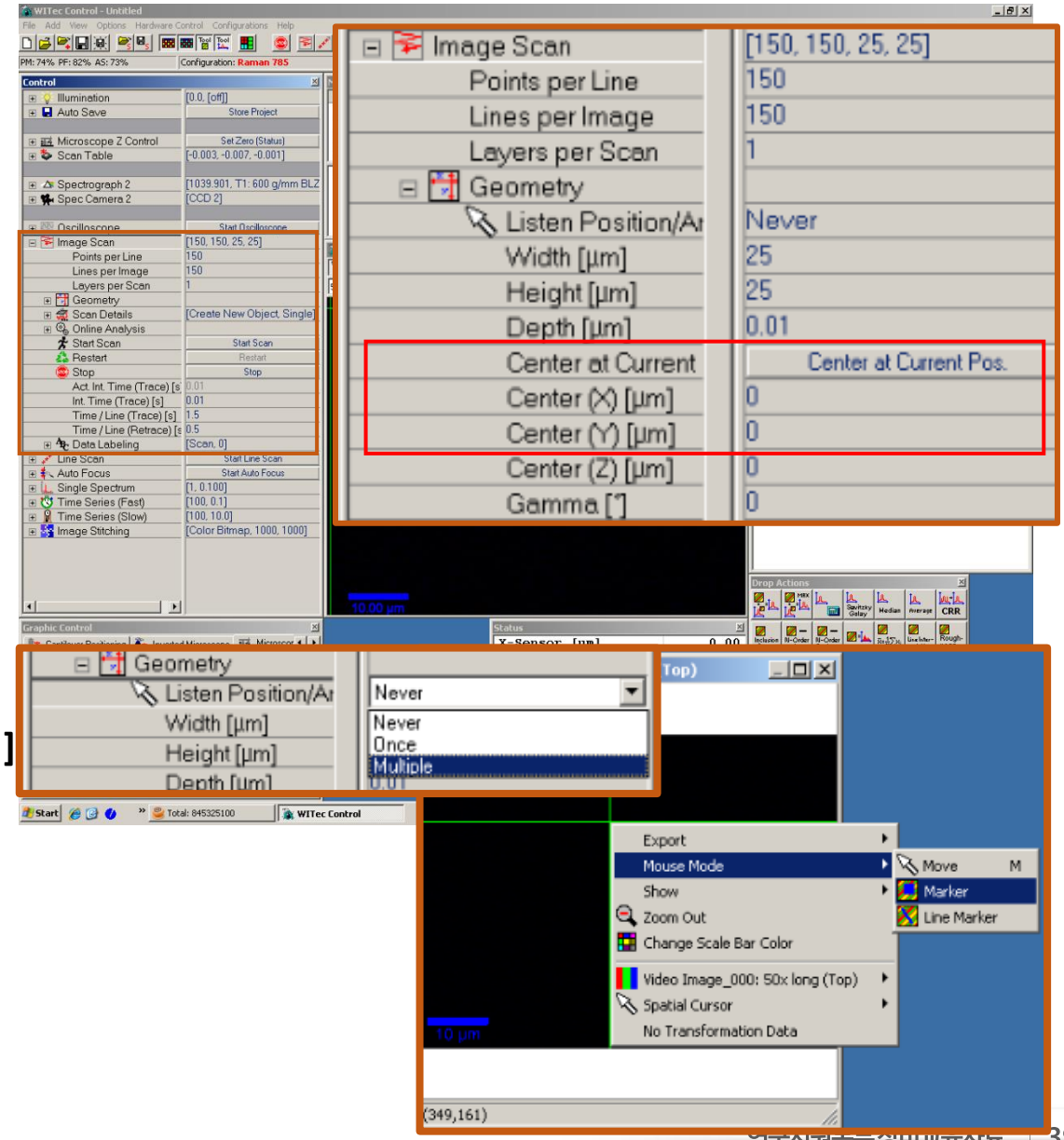
When you want to make the center with X,Y value, please insert specific value at **Center(X) and (Y)** part.

- Select the region of the image scan

[Geometry - Listen Position_Mutiple]

Open the -**Optical image** - Click the right button of mouse - Select the **[Mouse mode** - **Marker**]

Drag the area where you want to scan with mouse.

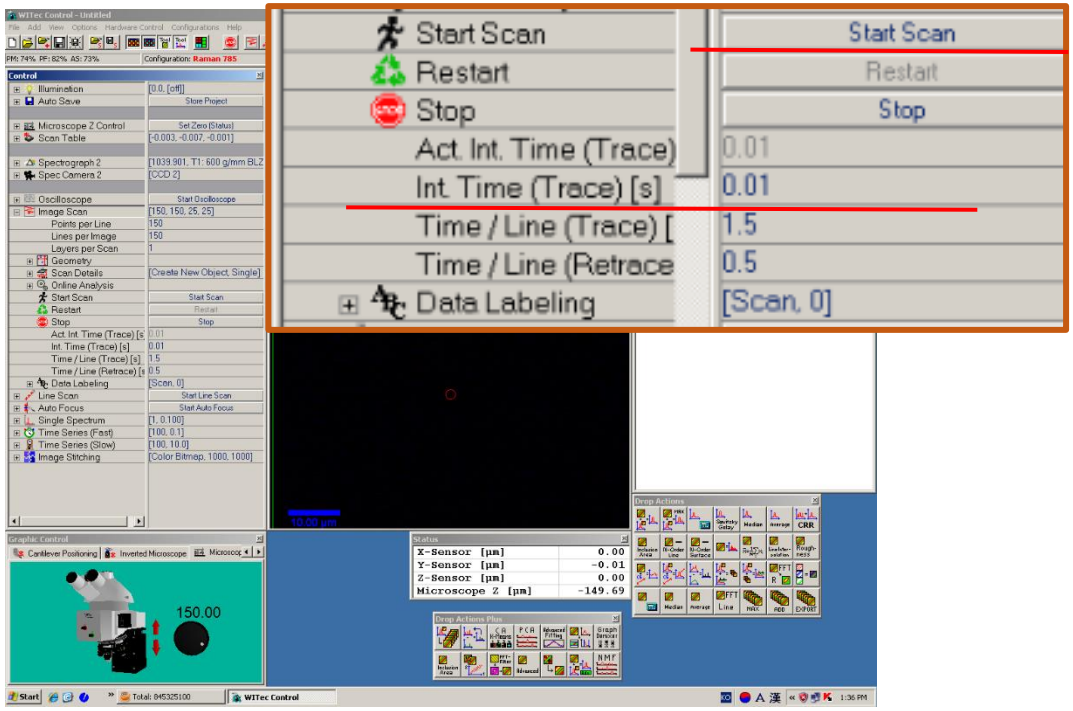


Sample measurement_Image scan

3. Open Image scan

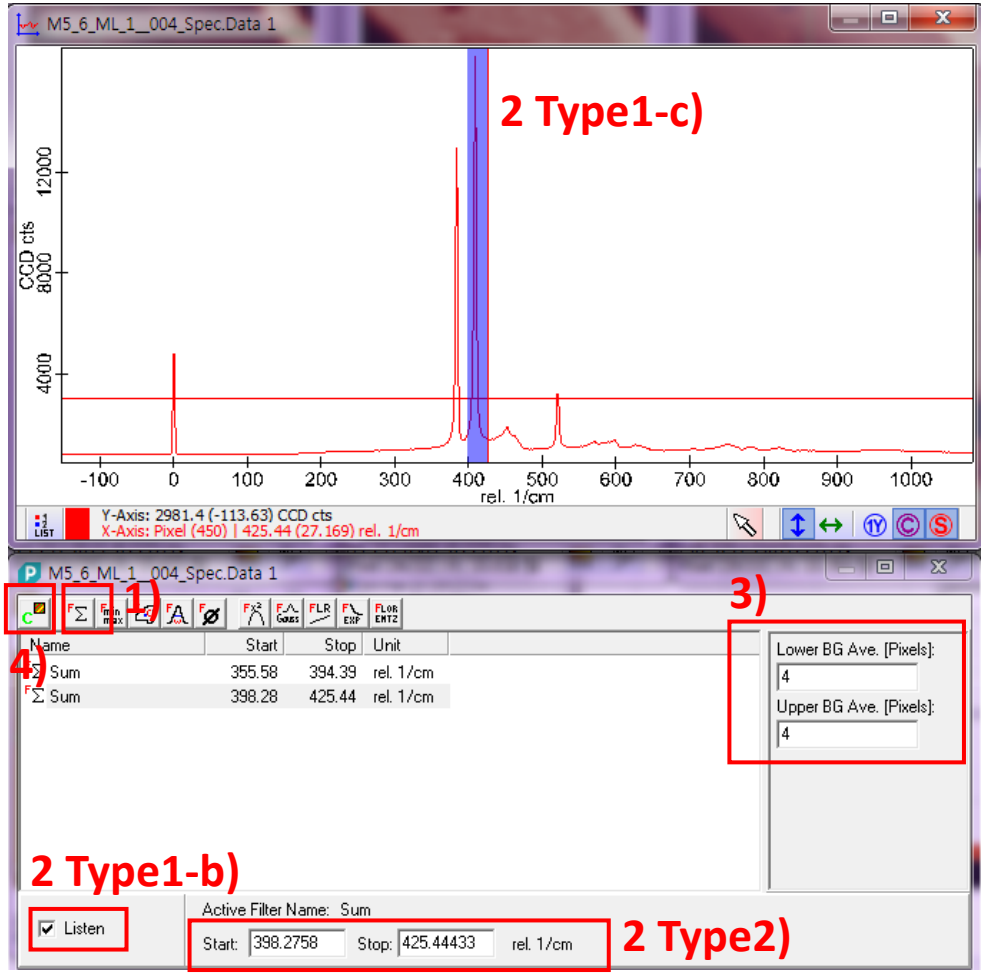
3) Set the Int. Time

4) Start Scan



Sample measurement_Image scan

4. Filter the spectrum peak with Filter manager

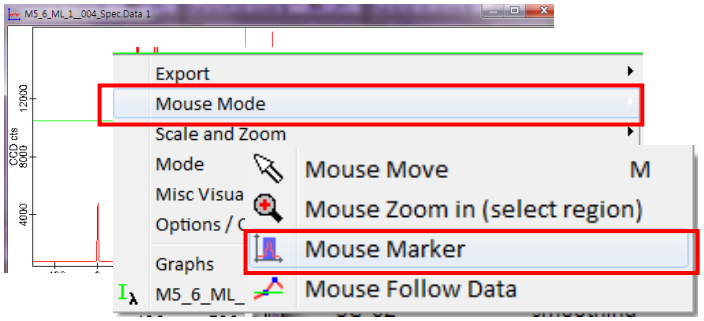


1) Click add sum filter.

2) Select area

Type 1

a) Click right button of mouse at **spec data**



b) Check **Listen** at filter manager

c) Drag the region of peak at the **spec data** window which you want to make mapping Image

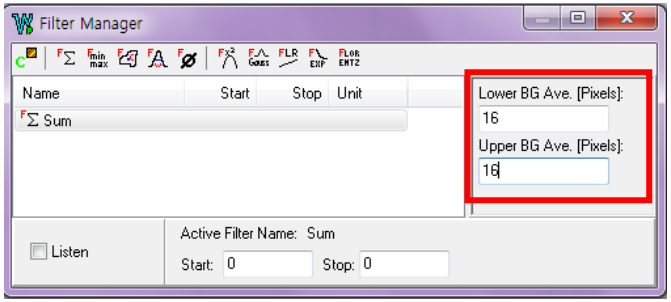
Type2

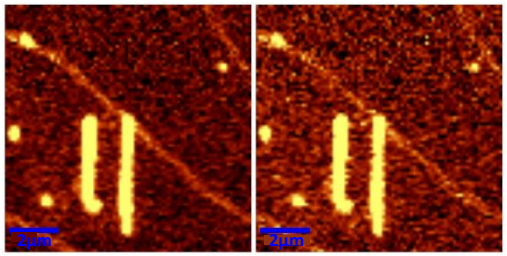
Insert **Start and Stop wavenumber** at filter manager.

3) Change the BG Ave.[Pixel]

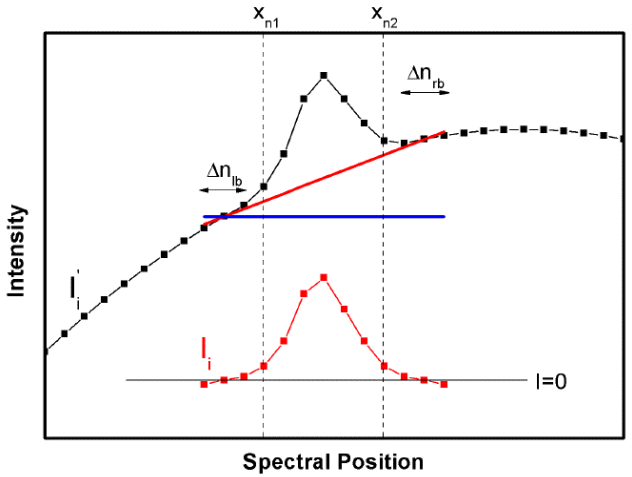
4) Click calculate

Image scan_BG Ave.

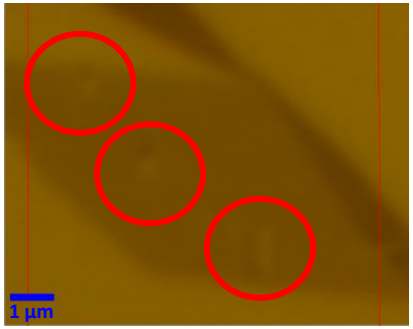


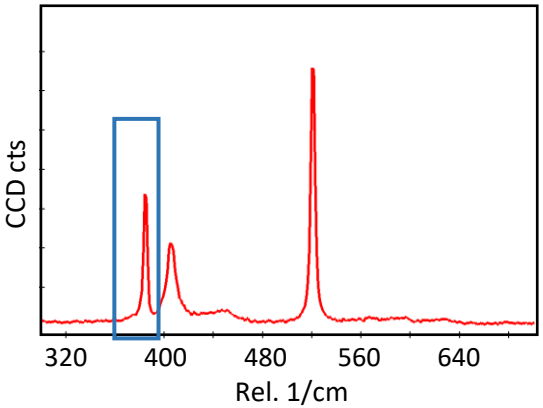


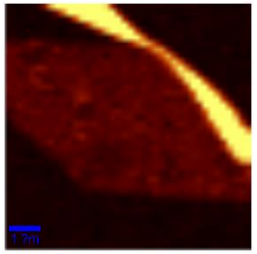
BG Ave. 16 BG Ave. 4

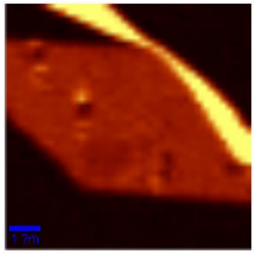


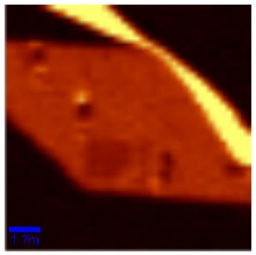
- **Sum Filter_BG Ave.**











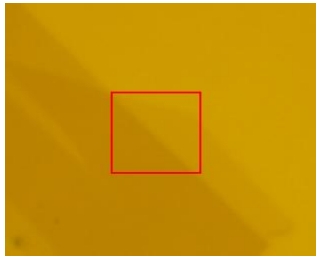
BG Ave. 16 **BG Ave. 8** **BG Ave. 4**

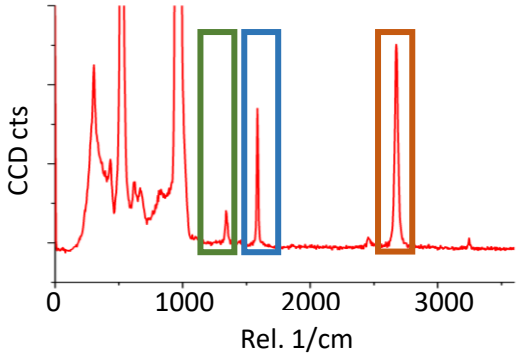
Image scan_Filter manager

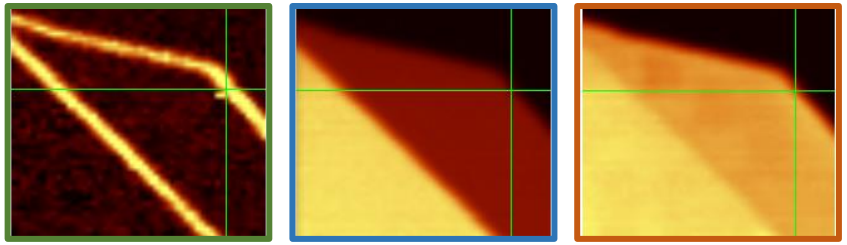
- **Sum Filter**

$$\text{Sum} = \sum_{i=n_1}^{n_2} I_i$$

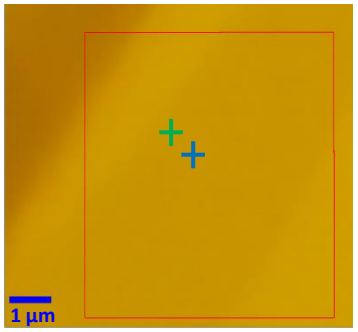
SUM filter create a new image data object with the dimension X, Y and integrated intensity Which can then be displayed as an image.
The output unit is the same as the z-interpretation of the spectrum(CCD counts).

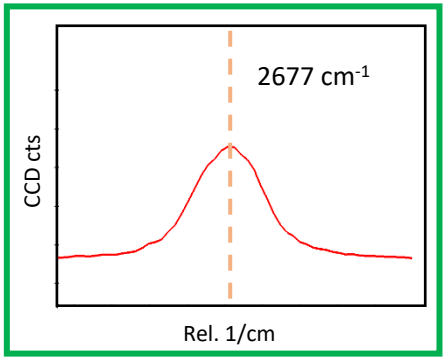


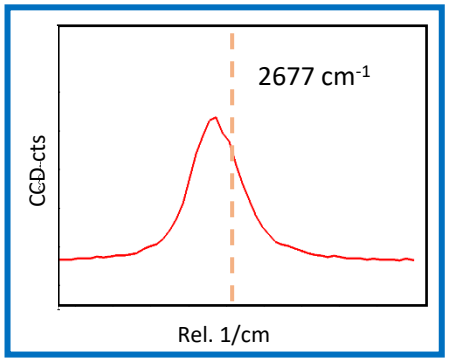




- **Center of Mass Filter** The center-of-mass filter calculates the intensity-weighted spectral position.







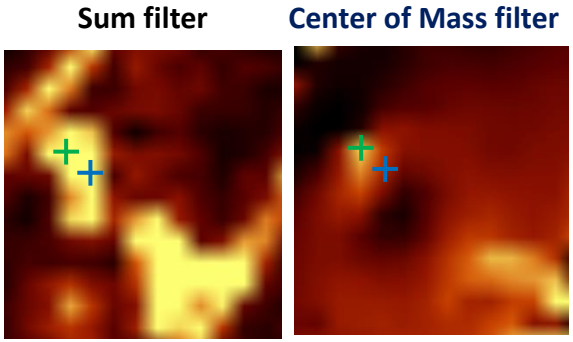
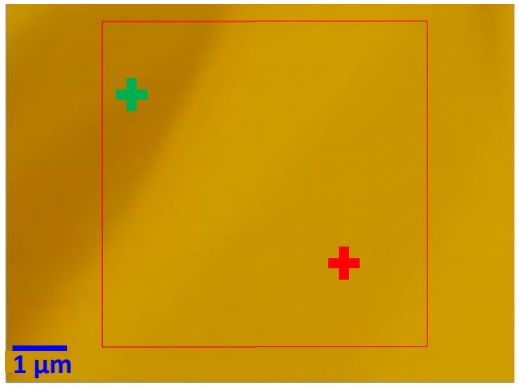
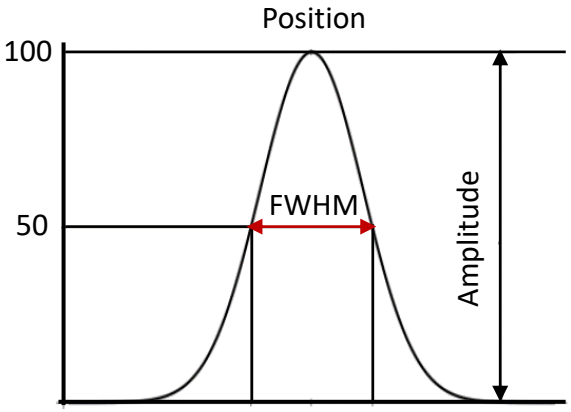
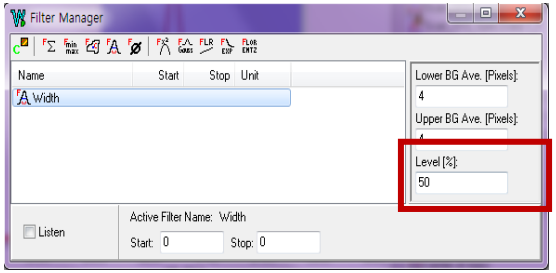


Image scan_Filter manager

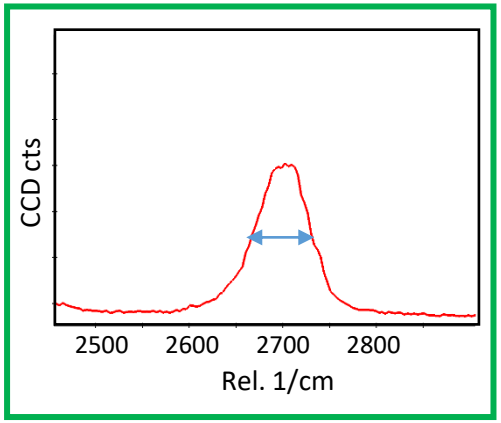
- **Width Filter**

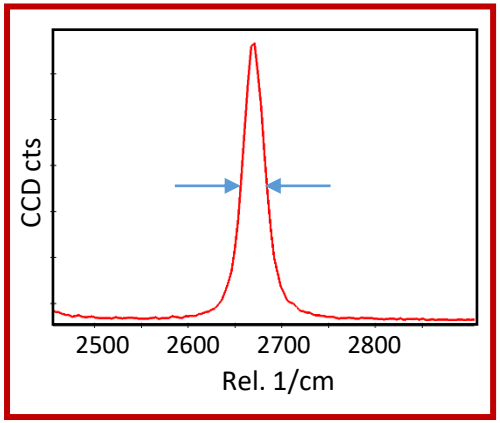




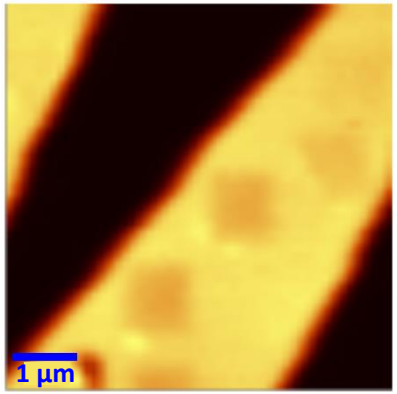


Level (%) 1~99

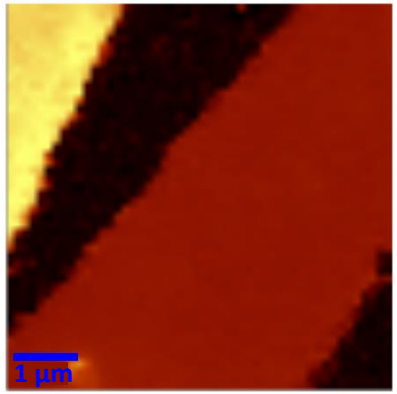




Sum filter



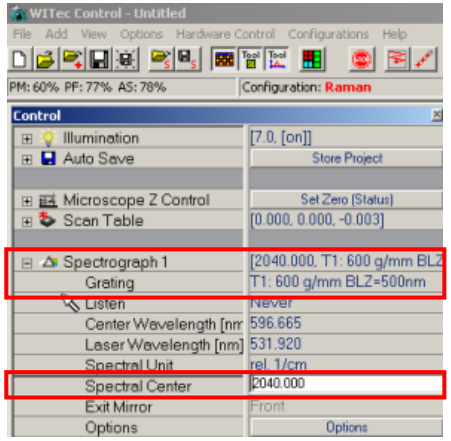
Width filter

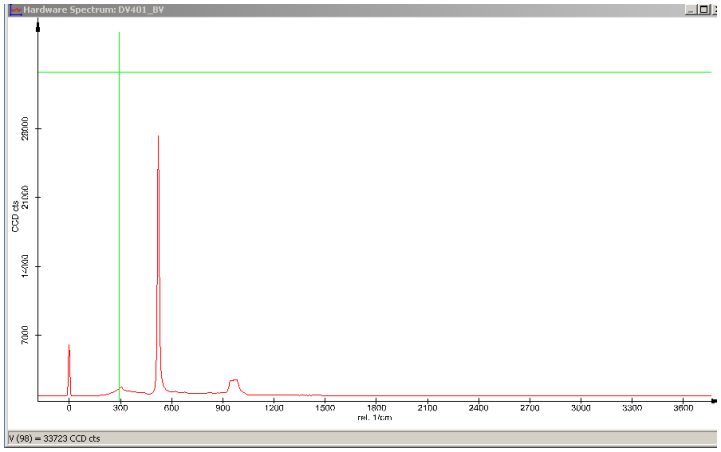


Spectrograph_Grating

600g/mm

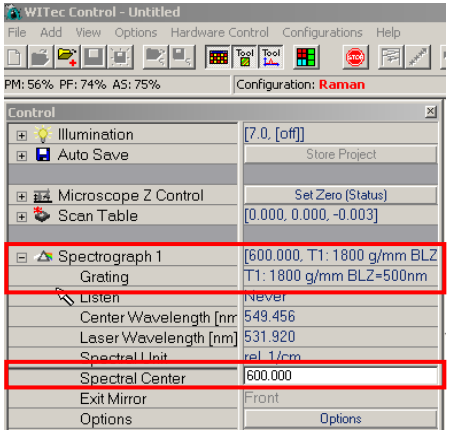
The resolution of X axis is about 3~4 cm^{-1}. You can see the whole range of Raman spectrum when the 'Spectral Center' is 2040 cm^{-1}.

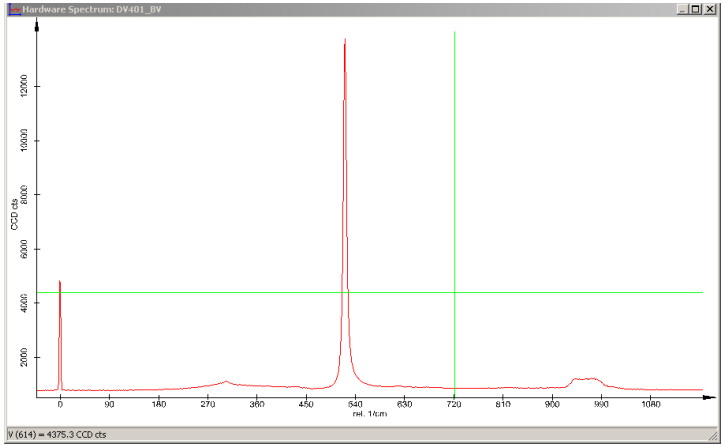




1800g/mm

The resolution of X axis is about 1 cm^{-1}. You can see the spectrum that the range is about 1000 cm^{-1}.
Please input the 'Spectral Center' value differently for your sample peak.
When you input 500~600 cm^{-1} at 'Spectral Center', you can see the Si peak during calibration.



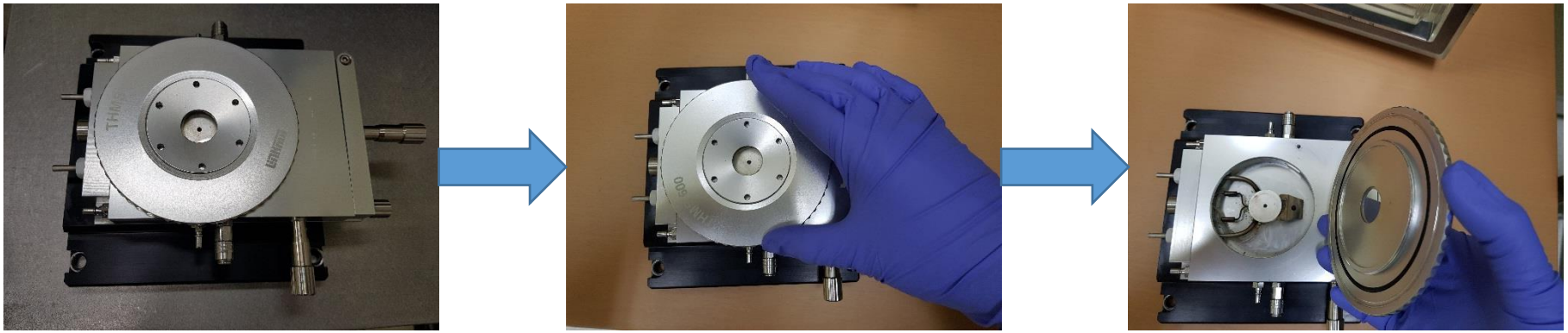


Check 'Spectral Center' when you change the grating condition.

Temperature control measurement

1. Si calibration
2. Prepare temperature controller stage

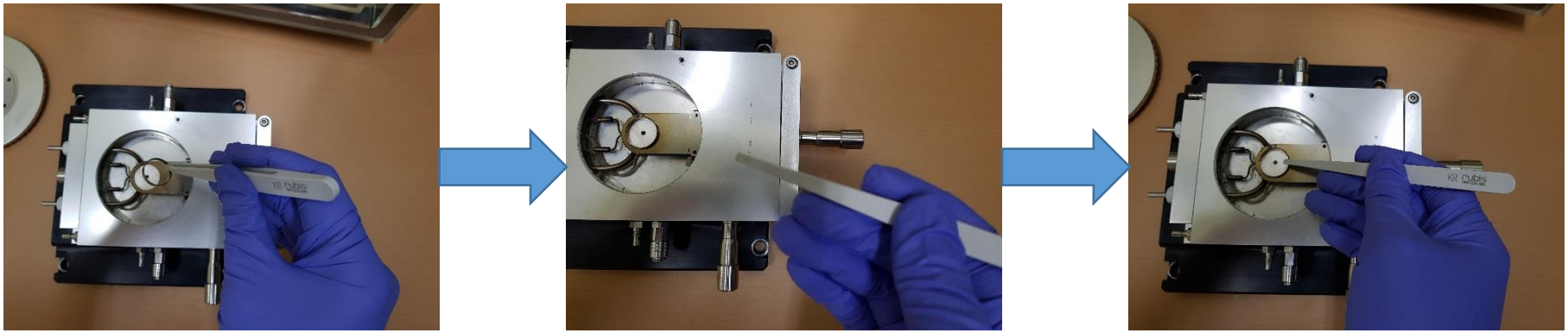
1) Open the top of sample stage



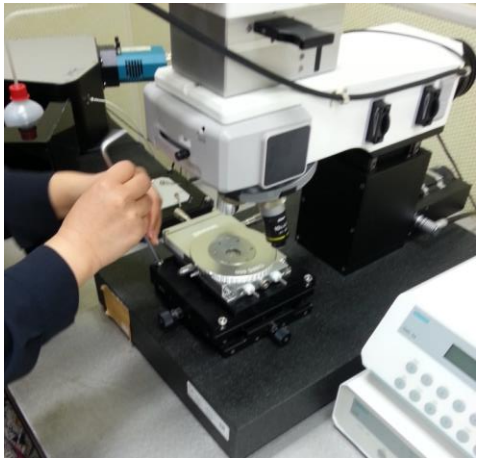
2) Prepare sample position

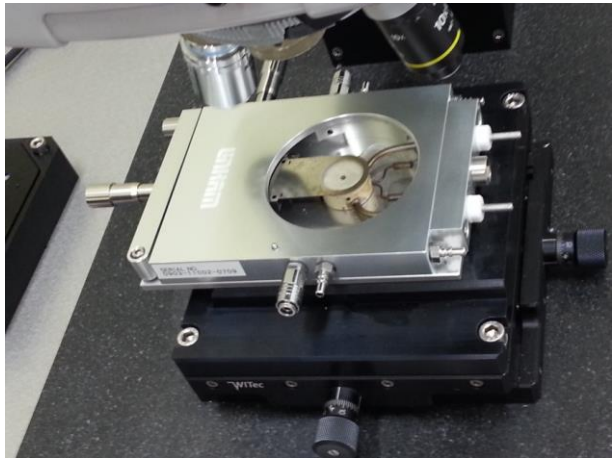
Temperature control measurement

- Place the stainless steel ring
- Cover the glass slip into the stainless steel ring



3. Exchange the sample stage for temperature controller stage





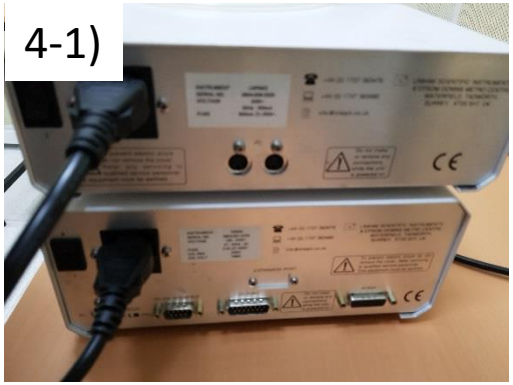
4. Load the sample on the stage and close the cover

Temperature control measurement

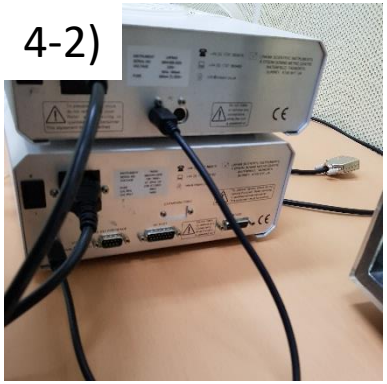
5. Prepare LNP and Temperature controller

1) Connect power connection
2) Connect the LNP with controller
3) Connect the stage with controller

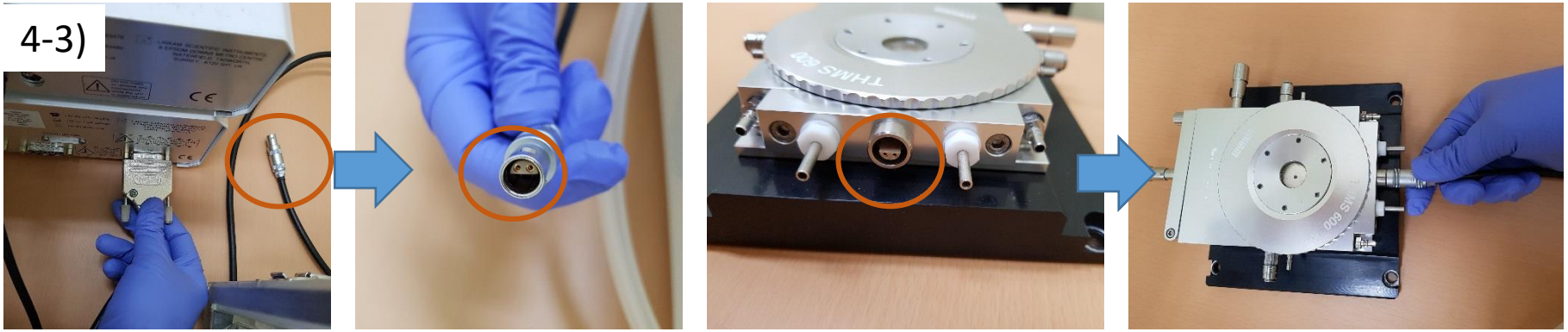
4-1)



4-2)



4-3)

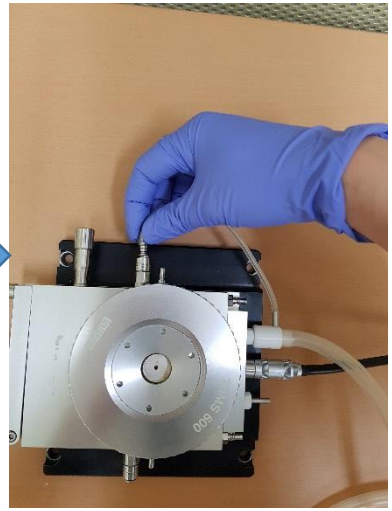


The stage lead carries data to the temperature controller and supplies power to the stage.
The stage lead is specific to THMS600 stage.
The connector contains a chip with information required for temperature control, rates and limits.

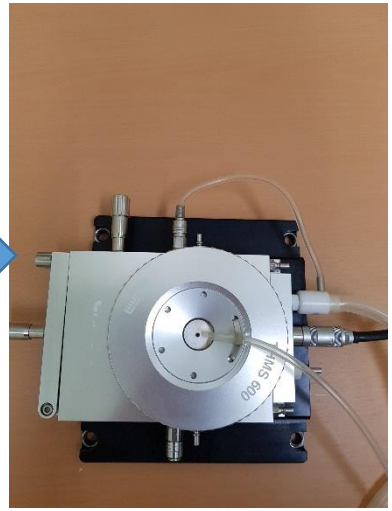
Temperature control measurement

5. Prepare LNP and Temperature controller

4) Connect the LNP line



Insert purging tube into the gas valve to Purging air from stage and avoid Condensation forming on sample.



Place window tube onto lid to blow N_2 gas across Window and eliminate external condensation

Temperature control measurement

6. Prepare Liquid Nitrogen
1) Open the top of dewar
2) Fill dewar approximately 3cm from top
3) Close the top

❖ Do not fasten catches until the bubbling noise from boiling off Nitrogen subsides.

7. Connect the liquid nitrogen line with the stage

Temperature control measurement

LNP supply liquid nitrogen to the stage
TMS94 is temperature controller

7. Switch on the SNP and TMS94
   TMS94 – Press **Start** button

Temperature control measurement

8. Set the TMS94 temperature controller

1) Change the temperature (℃)

Limit – Press the number- **Enter**

2) Change the existing rate (℃/min)

Rate – Press the number - **Enter**

Temperature control measurement

8. Set the TMS94 temperature controller

3) Change the hold time (min.)

Hold – Press the number- **Enter**

4) Exit the program

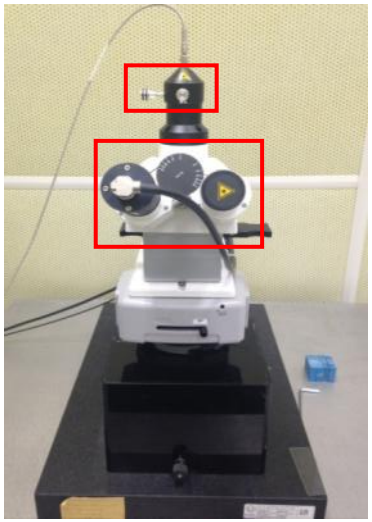
Set the temperature 25 ℃ and wait the stabilization.

Press **Exit - Enter**

5. Cautions

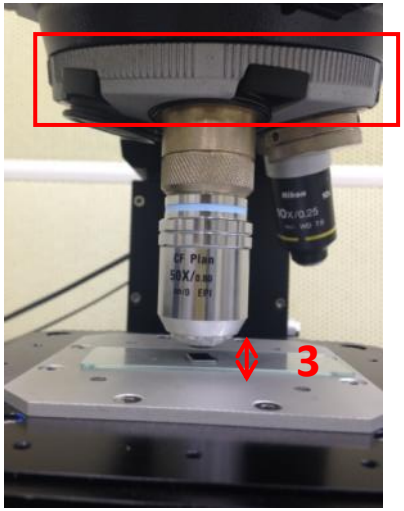
Cautions

1. Don’t touch this part

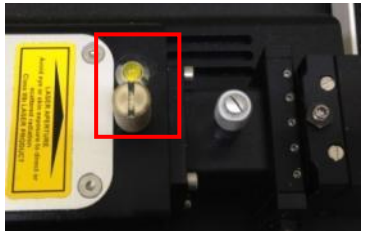


2. Hold this part, NOT lens

3. Lens up, whenever you change a sample



4. Laser off



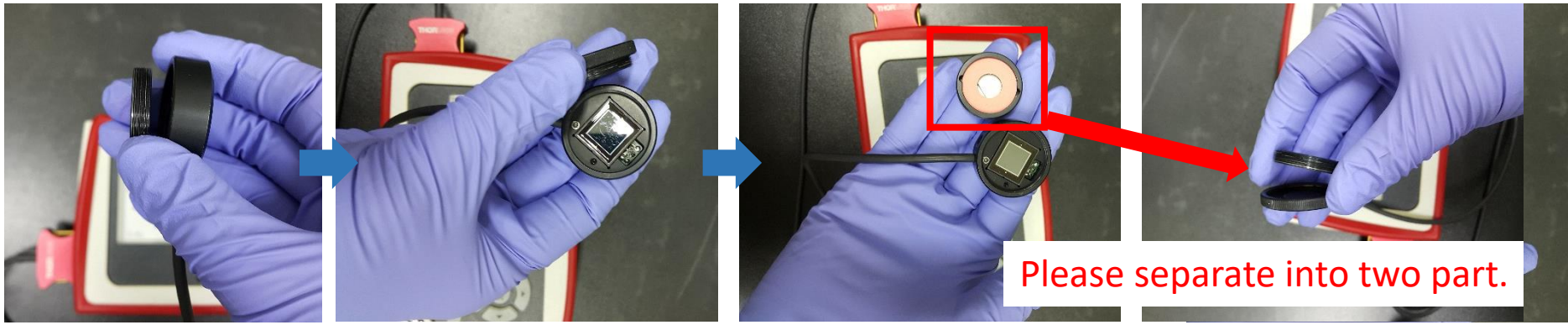
5. Laser Power Meter

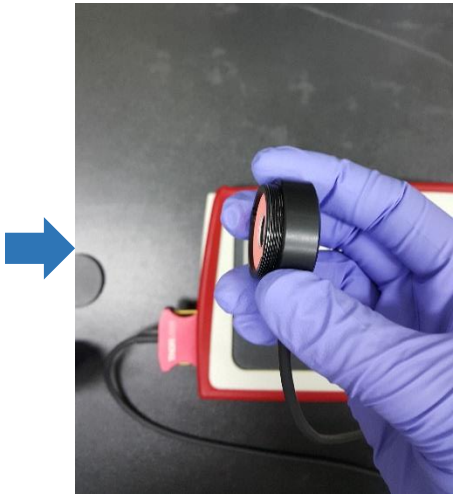
- The head is very sensitive

Cautions

6. Laser power meter

When you have trouble using the laser power meter as shown in the image below,





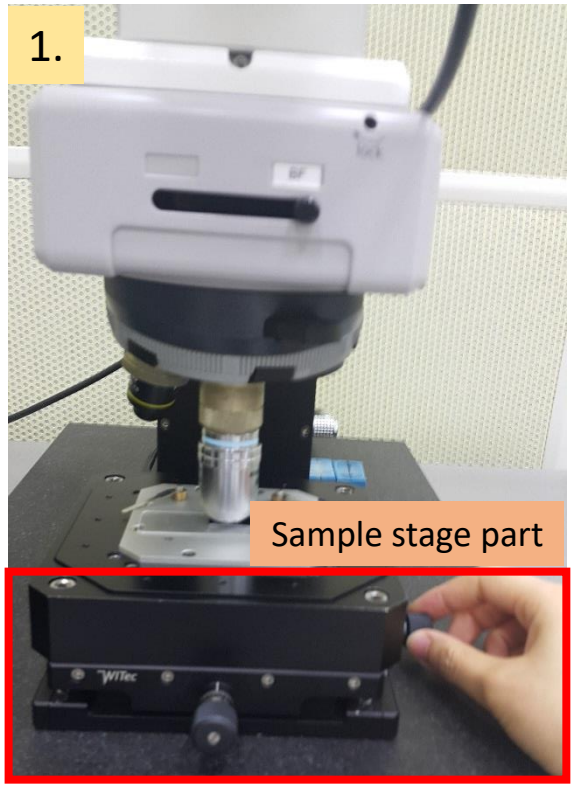
Please reassemble the sensor part.

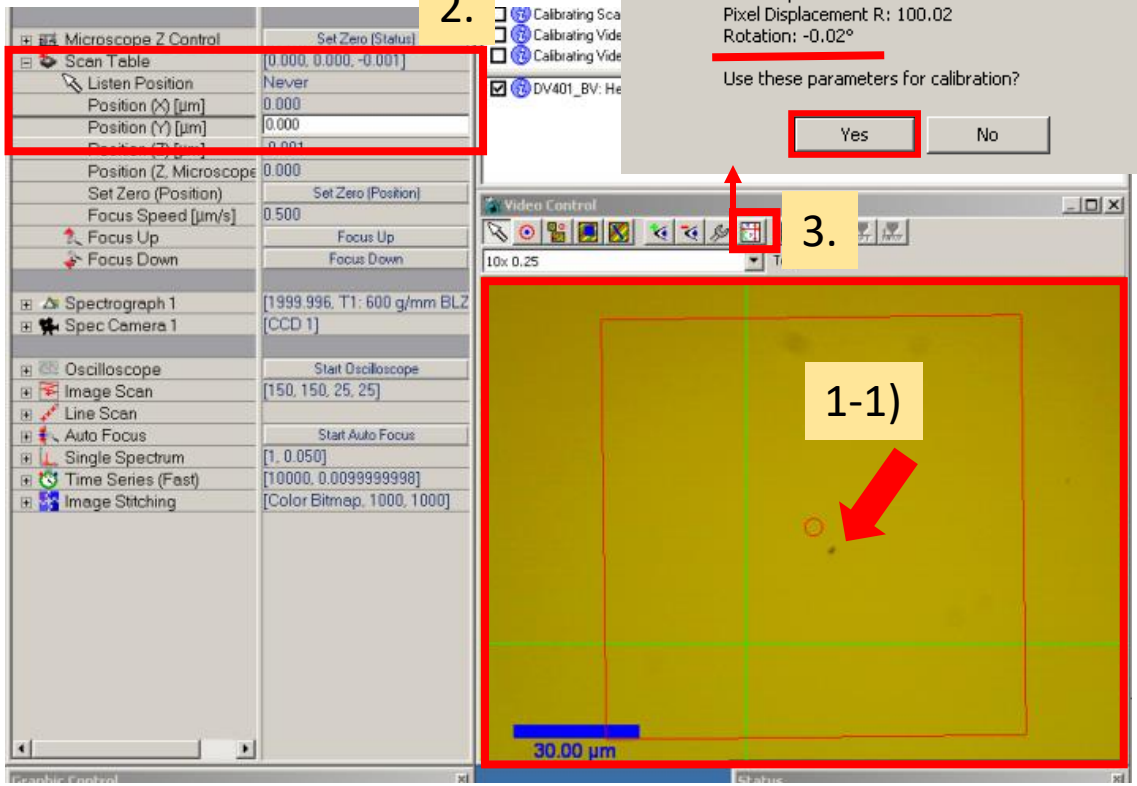
< Caution >
Please put on gloves and be careful not to touch the sensor part.

Calibrate video image

If the rotation value is not within the range(-0.1<rotation value<0.1),

1. Please find the another position on the sample surface with sample stage part and focus again.
   1) You have to find the position where a perceptible change in image.
2. Please input ‘0’ at the Position(X), (Y).
3. Click calibrate video image and check the rotation value again.

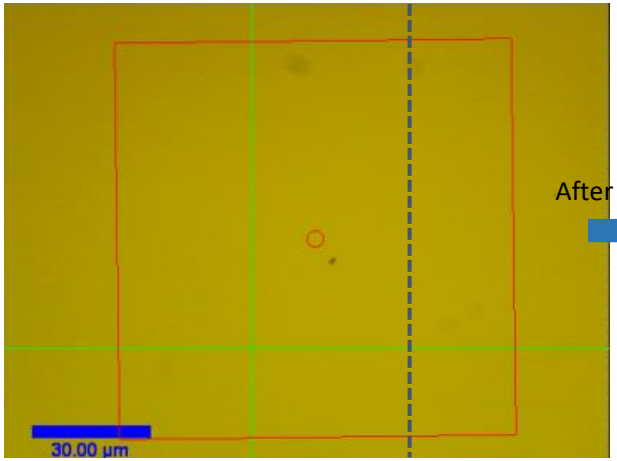




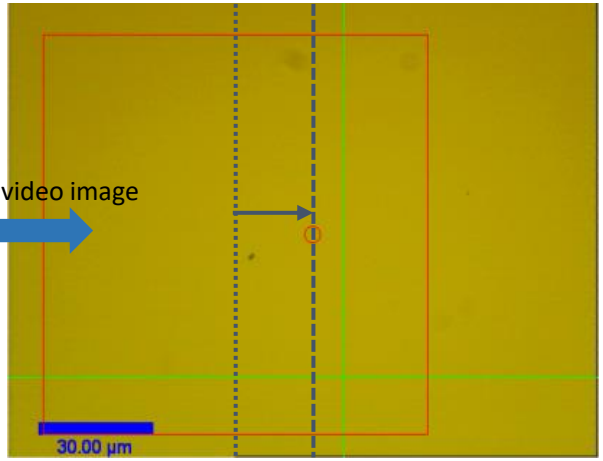
If the rotation value is not within the range after this process and show similar wrong value repeatedly, please contact manager.

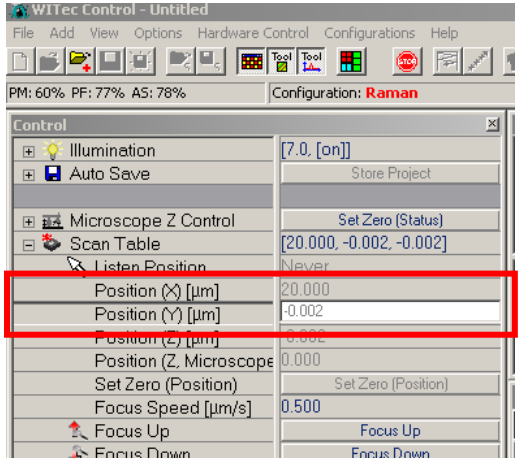
Calibrate video image

When you click calibrate video image, the Position(X) of measurement point(red circle part) move to +20 um(with 50x lens).
The program can detect the change of image detecting the movement of measurement point.
We need detectable surface image to calibrate video image successfully.

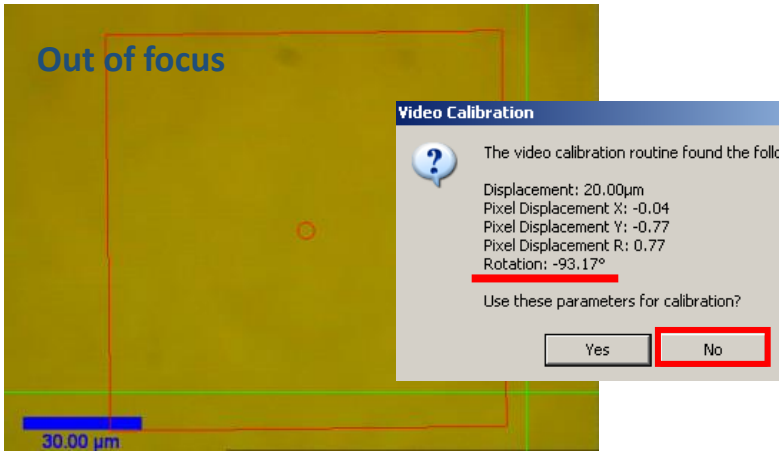


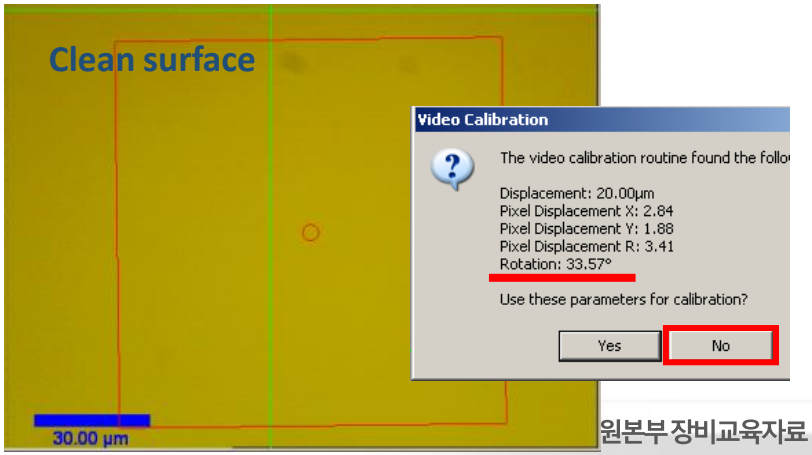
After calibrate video image





You will fail 'calibrate video image' when the surface image is out of focus and very clean surface because program cannot detect the change of image.





Penalty points for users of equipment

- 벌점 부과 기준

No.	벌점 부과 내용	벌점
[장비 사용 자격]		
1	해당 장비에 대하여 직접 사용이 허가 되지 않은 사용자가 기기를 사용	5
2	장비 예약하지 않고 장비 사용	3
3	장비 예약자 본인이 아닌 자가 장비를 사용	3
[장비 사용 예약]		
4	허용시간 이외의 시간에 장비 예약 및 사용	1
5	장비 예약시간을 초과하여, 예약시간 종료 전에 초과시간에 대한 예약없이 장비 사용	1
6	장비 예약 취소 사실 통보 없이 해당 시간에 장비 사용하지 않은 경우	3
7	「연구지원본부 운영지침」제7조의 내용을 기준으로, 장비 예약 취소 기한이 지나서 예약을 취소한 경우	1
8	예약 후 장비담당자에게 통보하지 않고 기기 사용	1
[부주의한 행동]		
9	장비 사용 중 허용되지 않은 기능 조작	3
10	장비 사용 중 장비의 이상이나 고장 발견 후 담당자에게 즉시 고지하지 않은 경우	3
11	사용자 부주의로 기기 손상 및 고장	5
12	사용자 부주의로 장비 부속품 분실 또는 파손	5
13	장비 사용 후 장비사용일지를 작성하지 않거나 허위 작성 또는 일부만 작성	1
14	담당자가 장비 또는 시설의 정상적인 작동과 안전을 유지하는 데에 반드시 파악해야할 시료의 정보를 제공하지 않아 장비 손상 및 고장을 초래	3
15	야간 또는 장비 담당자의 정규 근무시간이 아닌 때에 장비 사용 후 소등. 출입문단속. 주변 정리 등을 확인하지 않고 퇴실	3
16	유독 물질 및 가스의 누출 또는 화재 발생의 위험을 초래	5
17	타인의 개인물품(분석 및 공정 소모품 및 기자재)을 사전 동의 없이 사용하거나 훔치는 행위	5

Penalty points for users of equipment

- Penalty points criteria

No.	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 durng 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	Leaving the laboratory without putting the laboratory back in order, without turning off the lights, or without properly locking the entrance door, after using equipment at nighttime or during the equipment manager's off-hours	3
16	Causing leakage of toxic substances, gases, or causing risk of fire	5
17	Using or stealing someone's personal items (e.g. supplies, equipment or materials for analysis and process) without prior consent	5

Penalty points for users of equipment

- Follow-up Actions after Imposing Penalty Points

구분	벌점	조치내용
[장비사용자 개인]		
개인에게 부과된 벌점 합산	≥ 5 points	장비 담당자가 사용자 및 지도교수에게 이메일로 통보(벌점 8점 이상일 시 장비 사용이 3개월간 금지됨을 공지)하고 해당 사용자의 벌점 내역을 기기실에 게시
	≥ 8 points	장비 담당자가 사용자 및 지도교수에게 사용자의 해당 장비 사용이 3개월간 금지되고 재교육 후 사용이 가능함을 이메일로 통보하고 지도교수에게 공문 발송, 해당 사용자의 벌점 내역을 기기실에 게시
(사용자 소속 연구실)		
동일 연구실에서 동일 장비에 대하여 연구실 소속 학생들에게 부과된 벌점 합산	≥ 12 points	장비 담당자가 지도교수와 해당 사용자에게 벌점 15점 이상일 시 해당 연구실의 해당 장비 사용이 3개월간 금지됨을 이메일로 통보
	≥ 15 points	장비 담당자가 지도교수에게 해당 연구실의 해당 장비 사용이 3개월간 금지됨을 이메일로 통보, 지도교수에게 공문 발송, 해당 사용자의 벌점 내역을 기기실에 게시
동일 연구실에서 연구지원본부 전체 장비에 대하여 연구실 소속 학생들에게 부과된 벌점 합산	≥ 20 points	연구지원본부에서 지도교수와 소속 학생에게 벌점 25점 이상일 시 해당 연구실의 연구지원본부 전체 장비 사용이 1개월간 금지됨을 이메일로 통보
	≥ 25 points	연구지원본부에서 지도교수와 소속 학생에게 해당 연구실의 연구지원본부 전체 장비 사용이 1개월간 금지됨을 이메일로 통보, 지도교수에게 공문 발송, 해당 벌점 내역을 연구지원본부 게시판에 게시

Penalty points for users of equipment

- Follow-up Actions after Imposing Penalty Points

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.

6. Information

Information

☐ 국가연구시설장비 정보 등록증

고정자산관리번호	14004475	연구시설, 장비 구분	주장비
취득 방법	구매	모델명	Alpha300S
제작사	Witec	제작 국가	독일
취득금액 (원)	697,575,270 원	취득일자	2009-06-10
활용 범위	공동활용서비스 가능	장비용도	분석
장비 등록 번호	NFEC-2012-09-171092	등록 일자	
한글명	주사 근접장 광학현미경 및 공초점 라만 현미경 시스템		
영문명	Combined SNOM & Confocal Raman Microscope System		

☐ 연구시설·장비의 운영 인력

성명	소속부서명	연락처 (사무실)	이메일
강영비	연구지원본부	052-217-4168	ybkang@unist.ac.kr

☐ Witec Application Specialist

성명	소속부서명	직급	연락처	이메일
성광익	㈜나노인스텍	이사	02-486-7930	sung@nanoinstech.co.kr

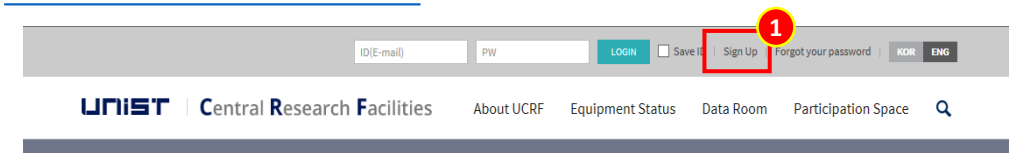
Reservation control information

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

Reservation time unit	Daily maximum reservation time	Cancelable timing
30 min.	3.0 hr	2.0 hr

Create Account

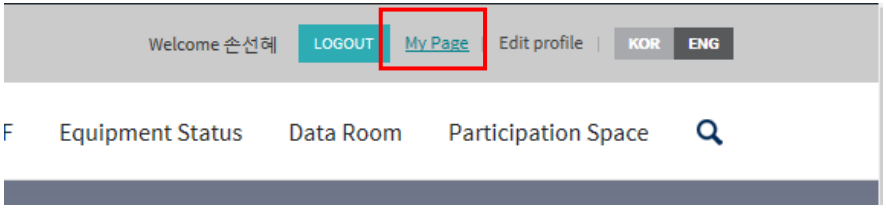
www.ucrf.unist.ac.kr

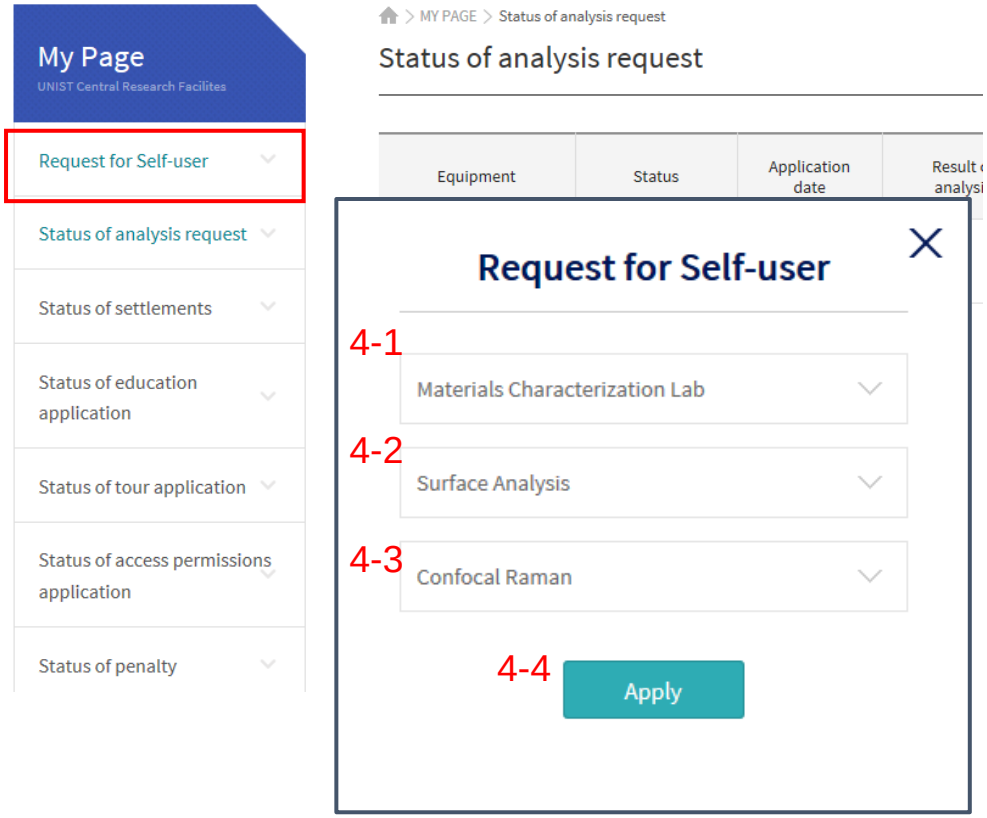


1. Click [Sign up].
2. Click [UNIST Member].
3. Input [Portal id/pw]_Click [Confirm].
   Please check your information.
4. Input professor name in [Principal investigation]
   _Click [Professor search]_Click professor name.
5. Click [Create Account].

Request for Self-user

www.ucrf.unist.ac.kr



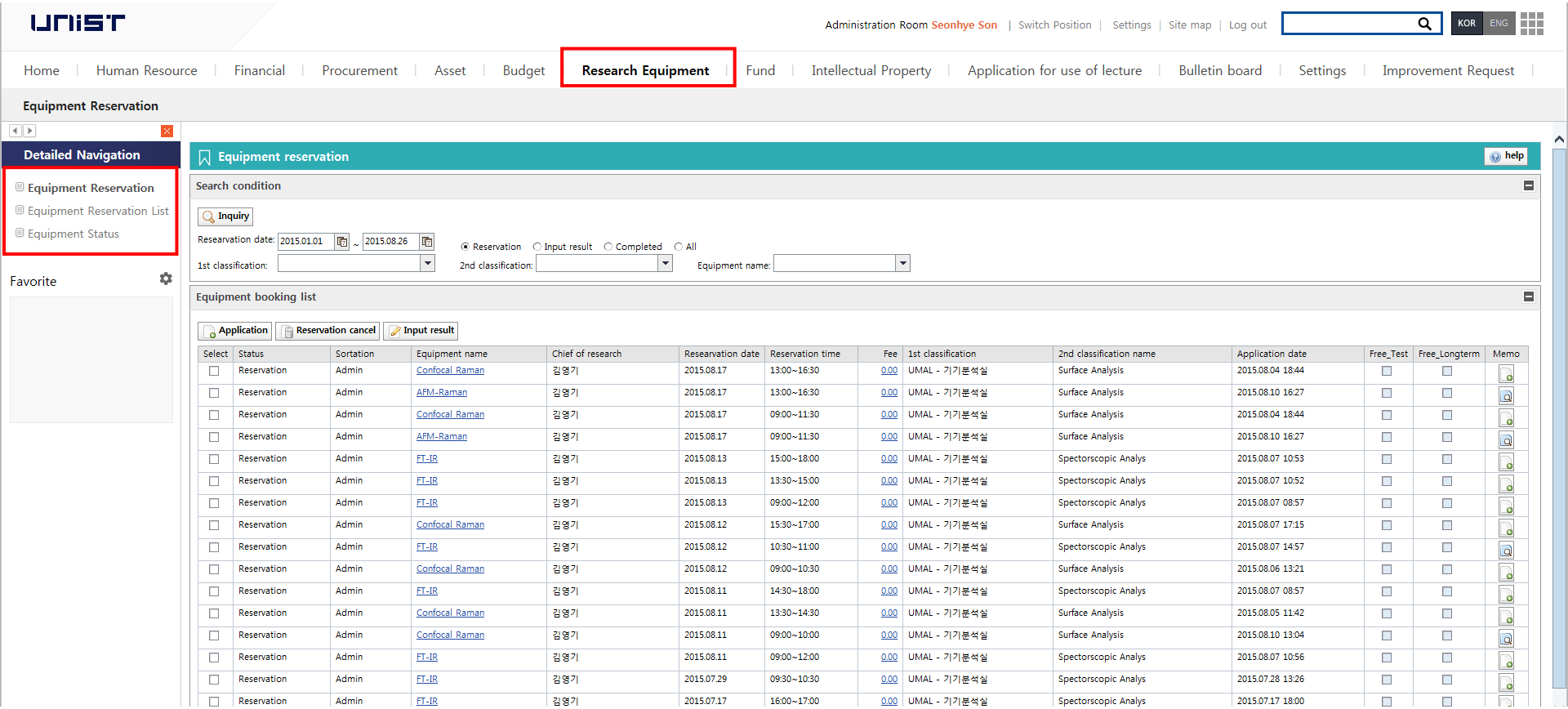


After pass the test,

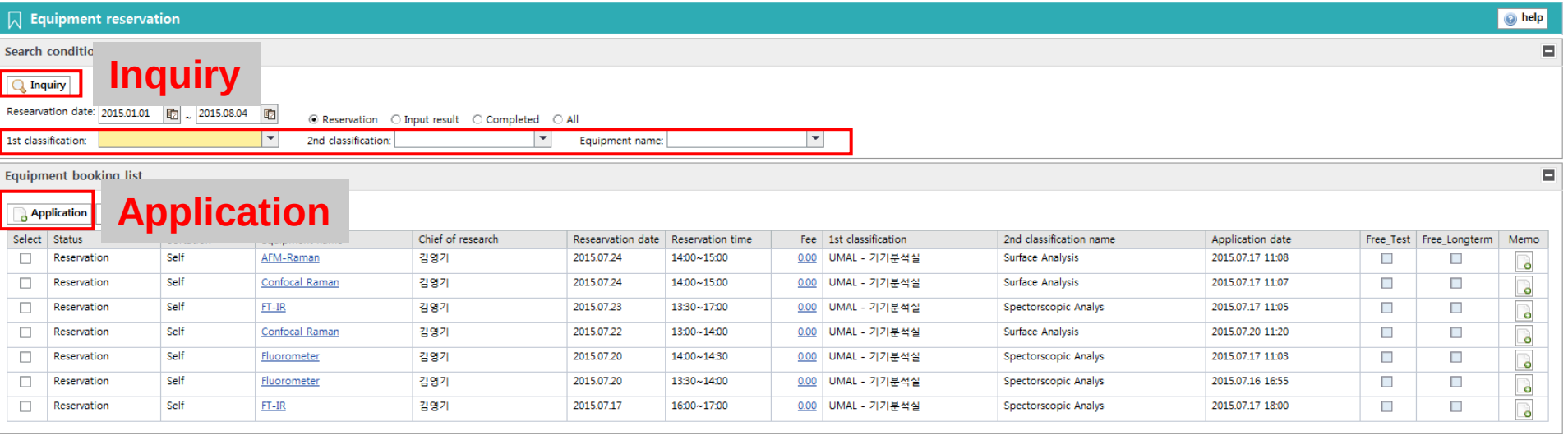
1. Login UCRF website.
2. Click [My Page].
3. Click [Request for Self user].
4. Select the equipment.
    1) Select [Materials Characterization Lab].
    2) Select [Surface Analysis].
    3) Select [Confocal Raman].
    4) Click [Apply].

Reservation

portal.unist.ac.kr – Research Equipment– Equipment reservation/input result



Reservation

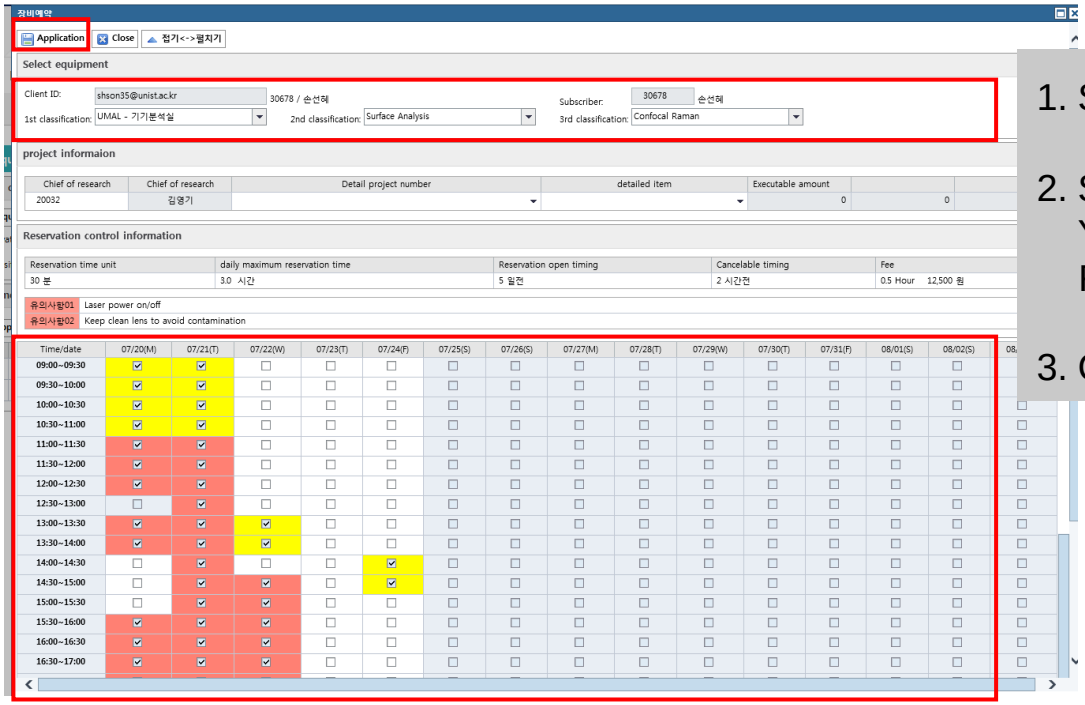


Select	Status			Chief of research	Reservation date	Reservation time	Fee	1st classification	2nd classification name	Application date	Free_Test	Free_Longterm	Memo
☐	Reservation	Self	AFM-Raman	김영기	2015.07.24	14:00~15:00	0.00	UMAL - 기기분석실	Surface Analysis	2015.07.17 11:08	☐	☐	
☐	Reservation	Self	Confocal Raman	김영기	2015.07.24	14:00~15:00	0.00	UMAL - 기기분석실	Surface Analysis	2015.07.17 11:07	☐	☐	
☐	Reservation	Self	FT-IR	김영기	2015.07.23	13:30~17:00	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.07.17 11:05	☐	☐	
☐	Reservation	Self	Confocal Raman	김영기	2015.07.22	13:00~14:00	0.00	UMAL - 기기분석실	Surface Analysis	2015.07.20 11:20	☐	☐	
☐	Reservation	Self	Fluorometer	김영기	2015.07.20	14:00~14:30	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.07.17 11:03	☐	☐	
☐	Reservation	Self	Fluorometer	김영기	2015.07.20	13:30~14:00	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.07.16 16:55	☐	☐	
☐	Reservation	Self	FT-IR	김영기	2015.07.17	16:00~17:00	0.00	UMAL - 기기분석실	Spectorscopic Analys	2015.07.17 18:00	☐	☐	

3

1

2

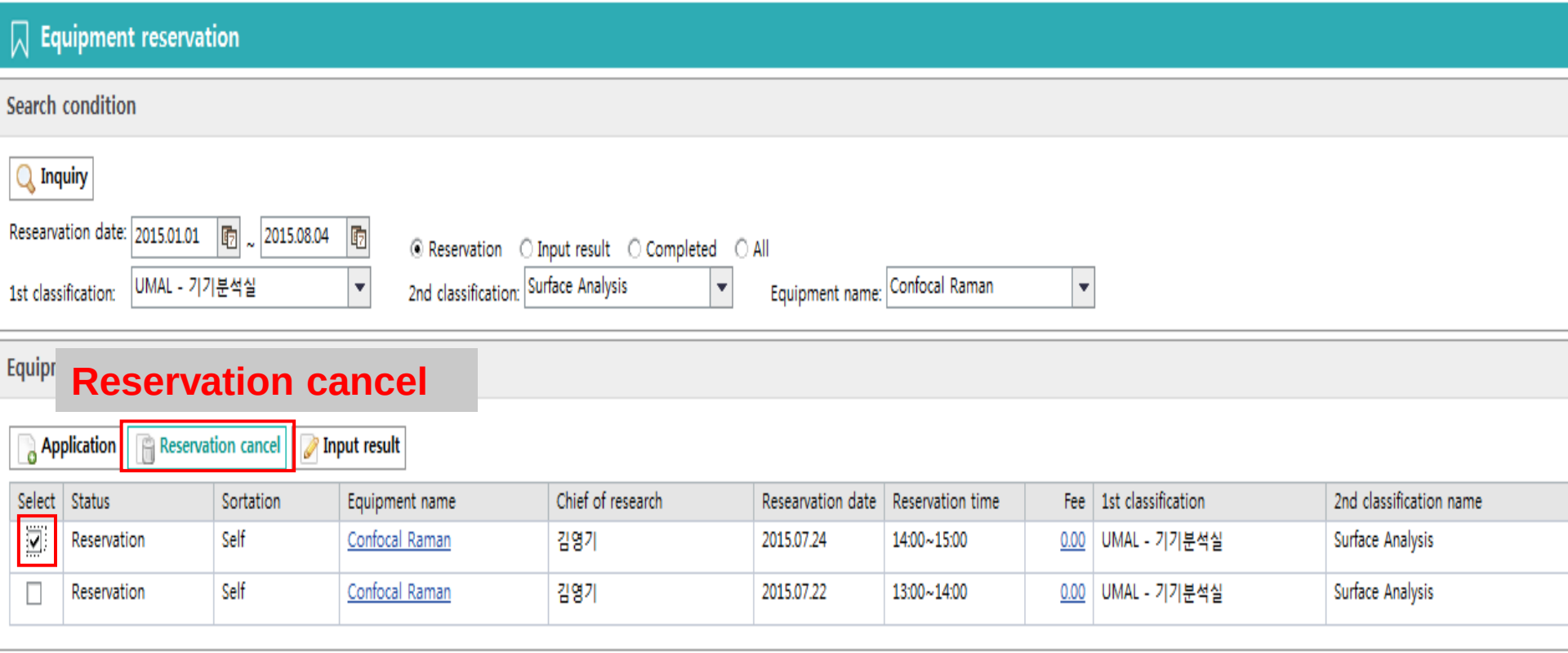


1. Select the classification and equipment

2. Select the time you want on white box.
   Yellow box : my reservation
   Red box : others reservation

3. Click [Application].

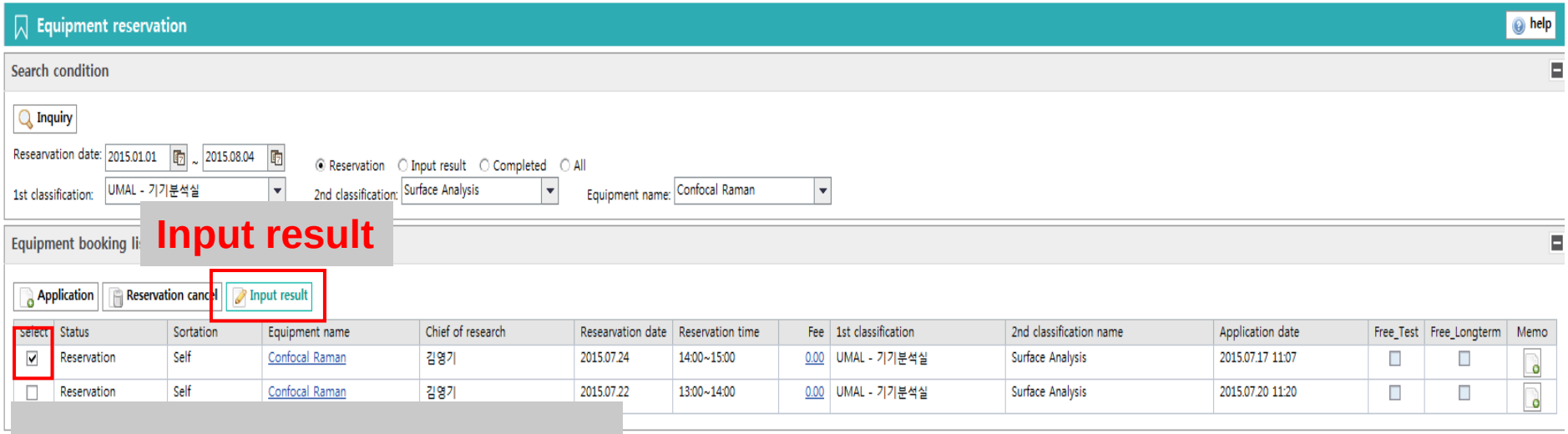
Reservation cancel



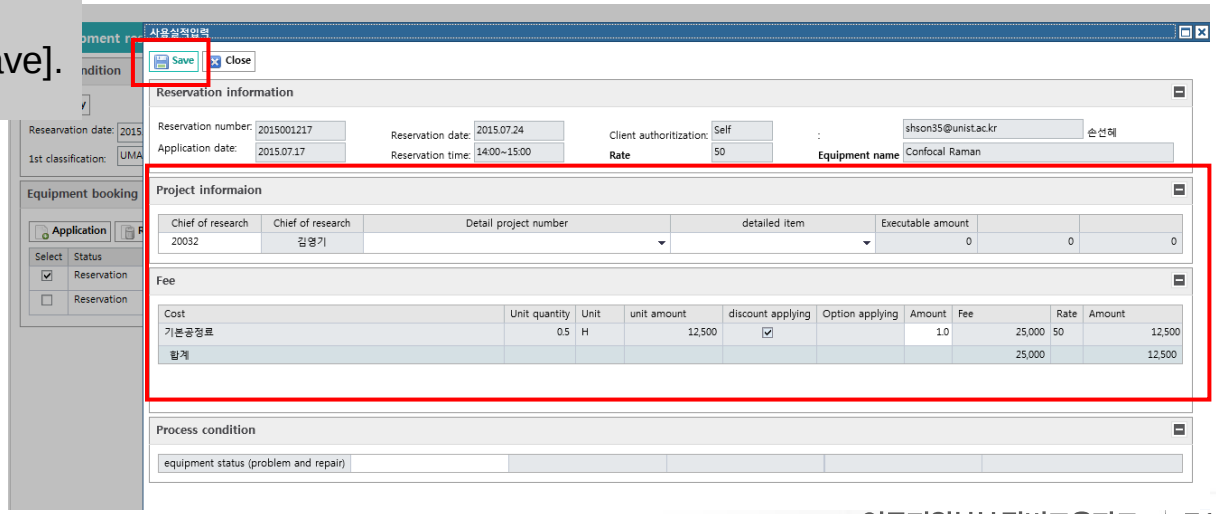
1. Select the reservation.
2. Click the [Reservation cancel].

Input result

After measurement, you have to input result instead of filling in log sheet



1. Select the reservation.
2. Click the [Input result].
3. Check the information and click [Save].



7. Emergency

ULSAN NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY

Emergency

연구실 번호 (Laboratory No.)	제1공학관 B107호
연구실명 (Laboratory Name)	AFM-Raman
연구실 안전담당자 (Safety Manager)	강영비 (Yeong Bi Kang) 내선(4168)

★ Please do not hesitate to contact "**Safety Manager**", if you have any queries or urgent business.
(문의 사항 또는 급한 용무가 있을 시, "**연구실 안전담당자**"에게 연락 요망)

원외 주요 연락처

External Main Telephone

소방서 Fire Station	119
경찰서 Police Station	112
좋은삼정병원 Hospital	052)220-7500

화재,폭발,가스・화학약품 누출 등 응급상황 발생시

Fire, Explosion, Gas and Chemical Leak etc.

응급상황 발생시
Emergency Call

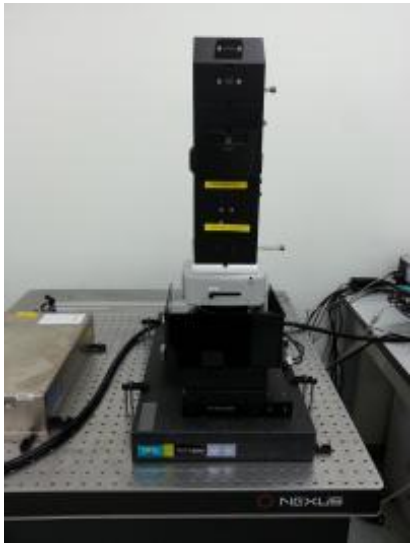
052) 217-0119

8. Related Equipment

ULSAN NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY

자외선-가시광선 영역 공초점 라만이미징시스템 (UV-Vis Confocal Raman Imaging System)

Microscope, Laser, Raman Laser Coupler, Controller 로 구성된 본 장비는 라만 효과를 이용하여 시료에 대한 결함 분석, 극미량의 분자 구조 분석 등 시료 표면의 구조를 관찰할 수 있다.



보유기관	기초과학연구원 (IBS in UNIST)
연구책임자	Rodney S. Ruoff
제작사/모델명	Witec / Alpha 300M+
장비 정보	micro-Raman with mapping functionality, with highest sensitivity for 266nm, 488nm and 532 nm excitation wavelength, High Throughput Configuration using 2 Spectrometer and 2 CCD Cameras. 자외선-가시광선 영역 공초점 라만이미징시스템는 레이저와 전자구조간의 공명으로 인해 라만 분광법을 이용하여 소재의 진동모드나 포논모드를 측정할 수 있다.일반적인 488 nm, 532 nm 의 레이저 외에 추가로 266 nm를 갖춘 라만 분광 장비이다.