

FT-IR



1. Syllabus

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1. FT-IR self-user training

- 1) Theory class (FT-IR manager Mi Sun Cho, 4034)
- 2) Operation class (FT-IR manager Mi Sun Cho, 4034)

2. Practice FT-IR yourself

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

3. Attend the FT-IR test

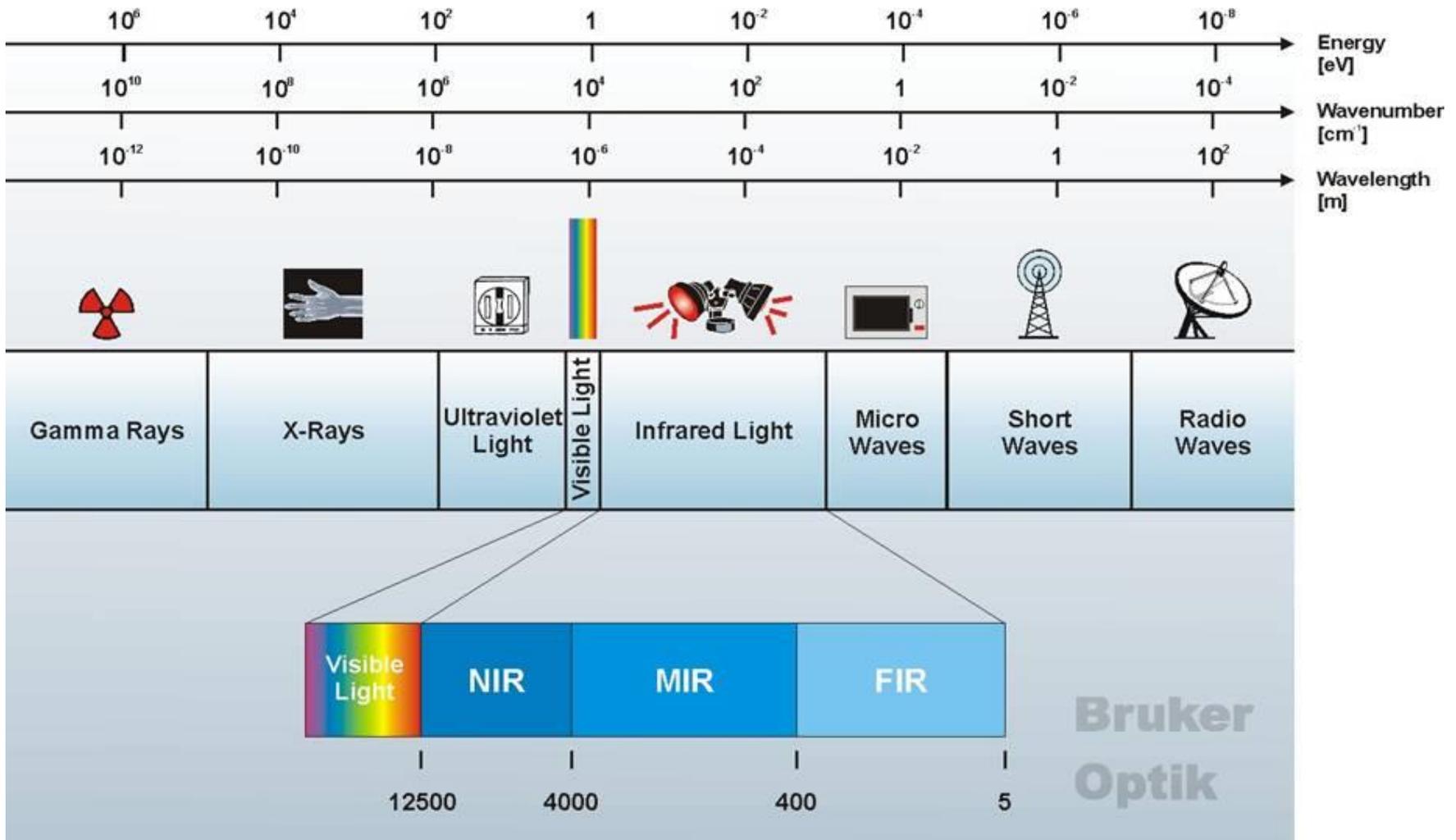
- 20 min.test
- Explain about IR and measurement methods.
- Sample measurement with ATR or other accessories.

2. Basic Principles

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Electromagnetic radiation



NIR : 12500 – 4000 cm^{-1} (0.8 – 2.5 μm , 1.55 – 0.5 eV)

- Overtones and combination vibrations
- low absorption coefficient \Leftrightarrow high sample concentrations
- Advantage : Quartz is transparent \rightarrow fiber optics, in glass vials
- Source : tungsten lamp
- Optical material : Quartz
- Detector : Ge, InGaAs

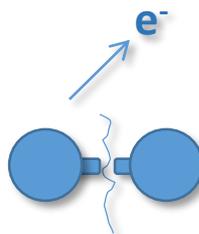
MIR : 4000 – 400 cm^{-1} (2.5 – 25 μm , 0.5 – 0.05 eV)

- Fundamental molecular vibrations : stretch and deformation vibrations
- high absorption coefficient \Leftrightarrow low sample concentrations
- Source : Globar
- Optical material : KBr, ZnSe
- Detector : DTGS, MCT

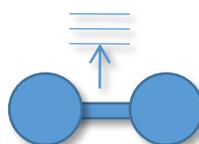
FIR : 400 – 5 cm^{-1} (25 – 1000 μm , 0.05 – 0.0012 eV)

- Backbone vibration of large molecules, molecules with heavy atoms
- low absorption coefficient, strong water vapor absorption \rightarrow vacuum spectrometer
- Source : Globar, Hg lamp
- Optical material : PE, Csl
- Detector : DTGS, Bolometer

Bond breaking and ionization



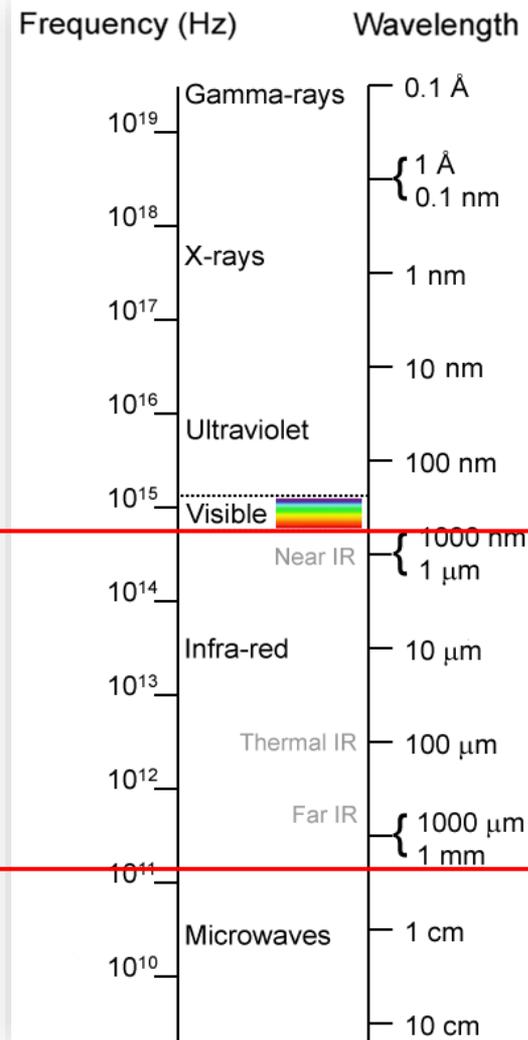
Electronic excitation



Vibration



Rotation

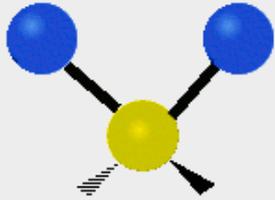


<http://upload.wikimedia.org/wikipedia/en/8/8a/Electromagnetic-Spectrum.png>

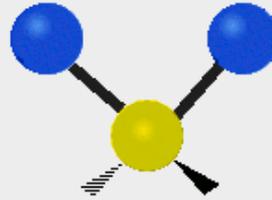
Molecular vibrations

https://en.wikipedia.org/wiki/Infrared_spectroscopy

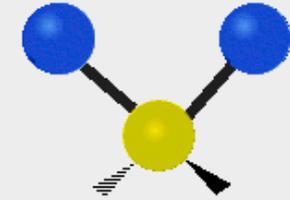
Symmetric stretching



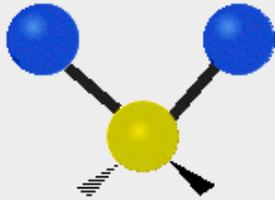
Asymmetric stretching



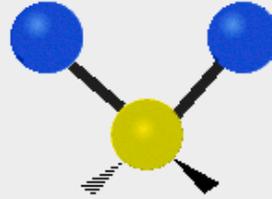
Scissoring(in-plane)



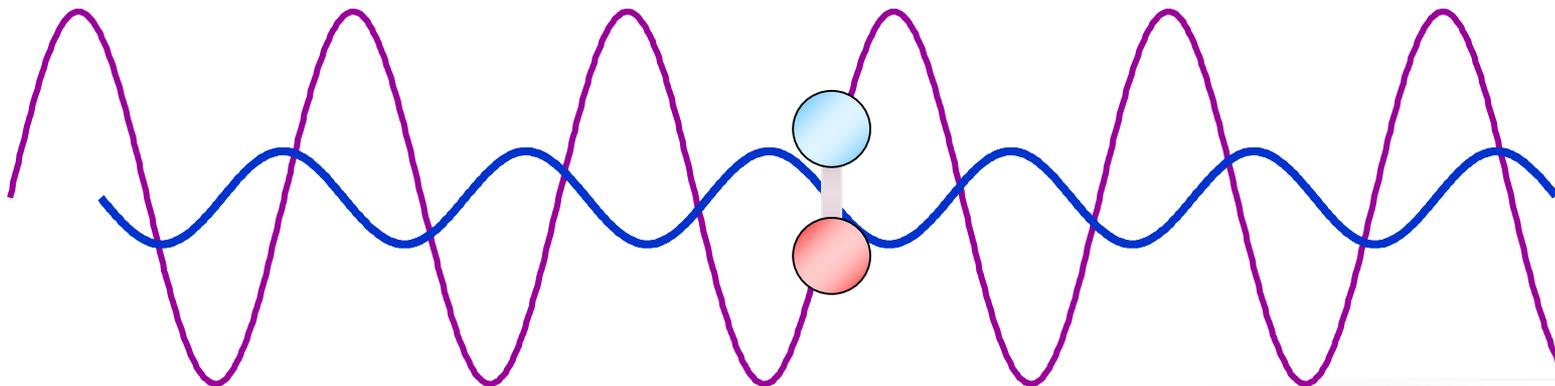
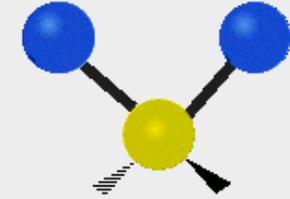
Rocking(in-plane)



Wagging(out-plane)



Twisting(out-plane)



❖ Selection Rules

A molecule will absorb infrared radiation if the change in vibrational states is associated with a change in the **dipole moment (μ)** of the molecule.

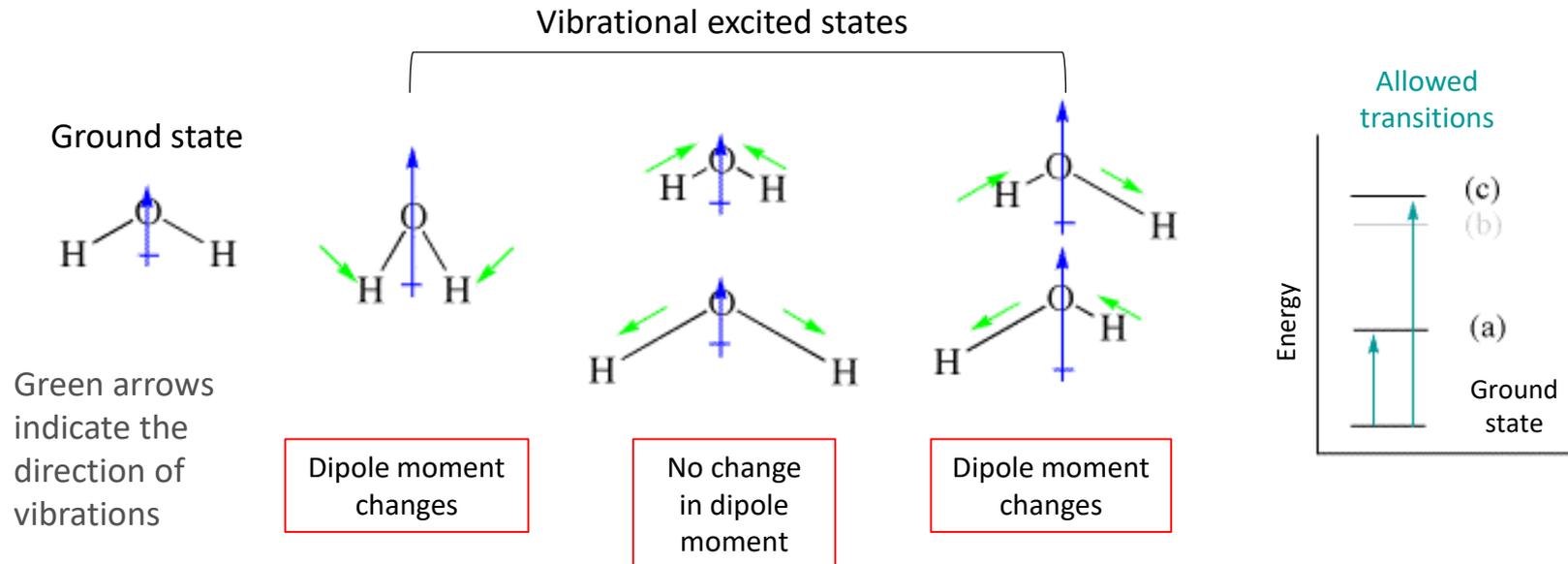
Dipole moment (μ)

A dipole moment is a quantity that describes two opposite charges separated by a distance.

$$\mu = q \times r$$

q: separated charge(positive and negative charge)

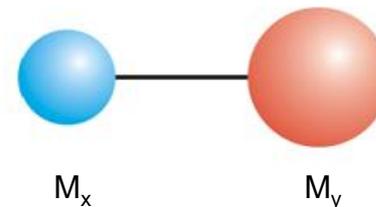
r: distance between center of charges



For a harmonic oscillator it is possible to calculate the vibrational frequency of a diatomic molecule as follows.

$$\nu = \frac{1}{2\pi c} \sqrt{\frac{k}{\mu}} = \frac{1}{2\pi c} \sqrt{\frac{k(M_x + M_y)}{M_x \cdot M_y}}$$

$$\mu = \frac{M_x \cdot M_y}{M_x + M_y}$$



ν = vibration frequency(cm^{-1})

c = Speed of light constant

K = Force constant of bond(dynes/cm)

M_x and M_y = Mass of each

Single bond $K \cong 5 \times 10^5 \text{ dyne/cm}$

$c = 19.8 \times 10^{-24} \text{ g}$, $H = 1.64 \times 10^{-24} \text{ g}$

$\nu_{CH} = 3040 \text{ (obs)} 2960 - 2850$

Bonding	Force constant f (dyne/cm)	Absorbance range (cm^{-1})	
		Calculation	Measurement
C — O	5.0×10^5	1113	1300 — 800
C — C	4.5×10^5	1128	1300 — 800
C — N	4.9×10^5	1135	1250 — 1000
C = C	9.7×10^5	1657	1900 — 1500
C = O	12.1×10^5	1731	1850 — 1600
C \equiv C	15.6×10^5	2101	2150 — 2100
C — D	5.0×10^5	2225	2250 — 2080
C — H	5.0×10^5	3032	3000 — 2850
O — H	7.0×10^5	3553	3800 — 2700

C = C bond

$$\bar{\nu} = \frac{1}{2\pi c} \sqrt{\frac{K}{M_x M_y / M_x + M_y}}$$

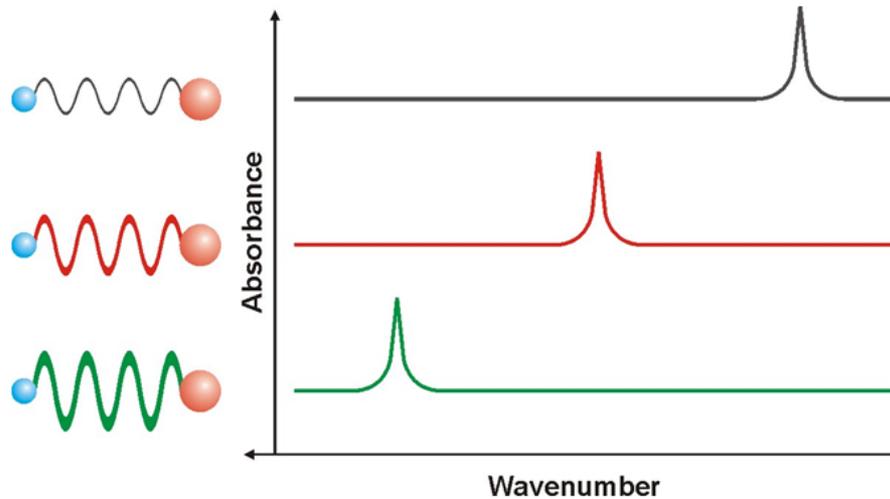
$$K = 10 \times 10^5 \text{ dynes/cm}$$

$$\mu = \frac{M_x M_y}{M_x + M_y} = \frac{(12)(12)/(6.023 \times 10^{23})^2}{12 + 12/6.023 \times 10^{23}} = \frac{6}{6.023 \times 10^{23}}$$

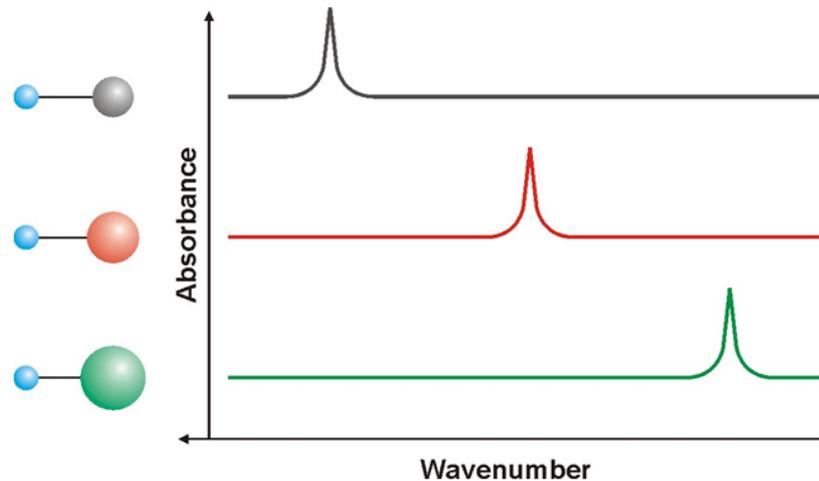
$$\bar{\nu} = \frac{1}{2 \times 3.14 \times 3 \times 10^{10}} \sqrt{\frac{10 \times 10^5}{6/6.023 \times 10^{23}}} = 1682 \text{ cm}^{-1} (\text{calculated})$$

$$\bar{\nu} = 1650 \text{ cm}^{-1} (\text{experimental})$$

1) The higher the force constant (k , the bond strength), the higher the vibrational frequency (wavenumber).

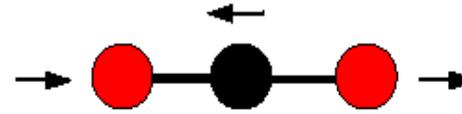


2) The larger the vibrating atomic mass, the lower the vibrational frequency.



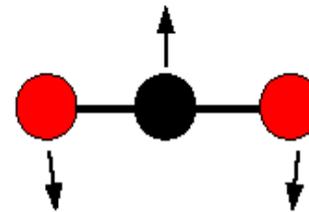
Example: CO₂

symmetrical stretching
1340 cm⁻¹

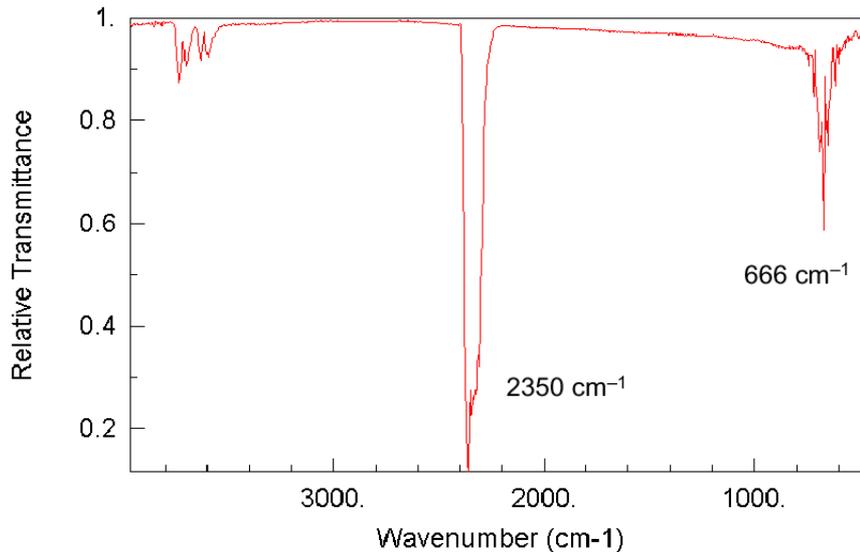


asymmetrical stretching
2350 cm⁻¹

scissoring bending
666 cm⁻¹



scissoring bending
666 cm⁻¹



The theoretical number of fundamental vibrations (absorption frequencies) will seldom be observed.

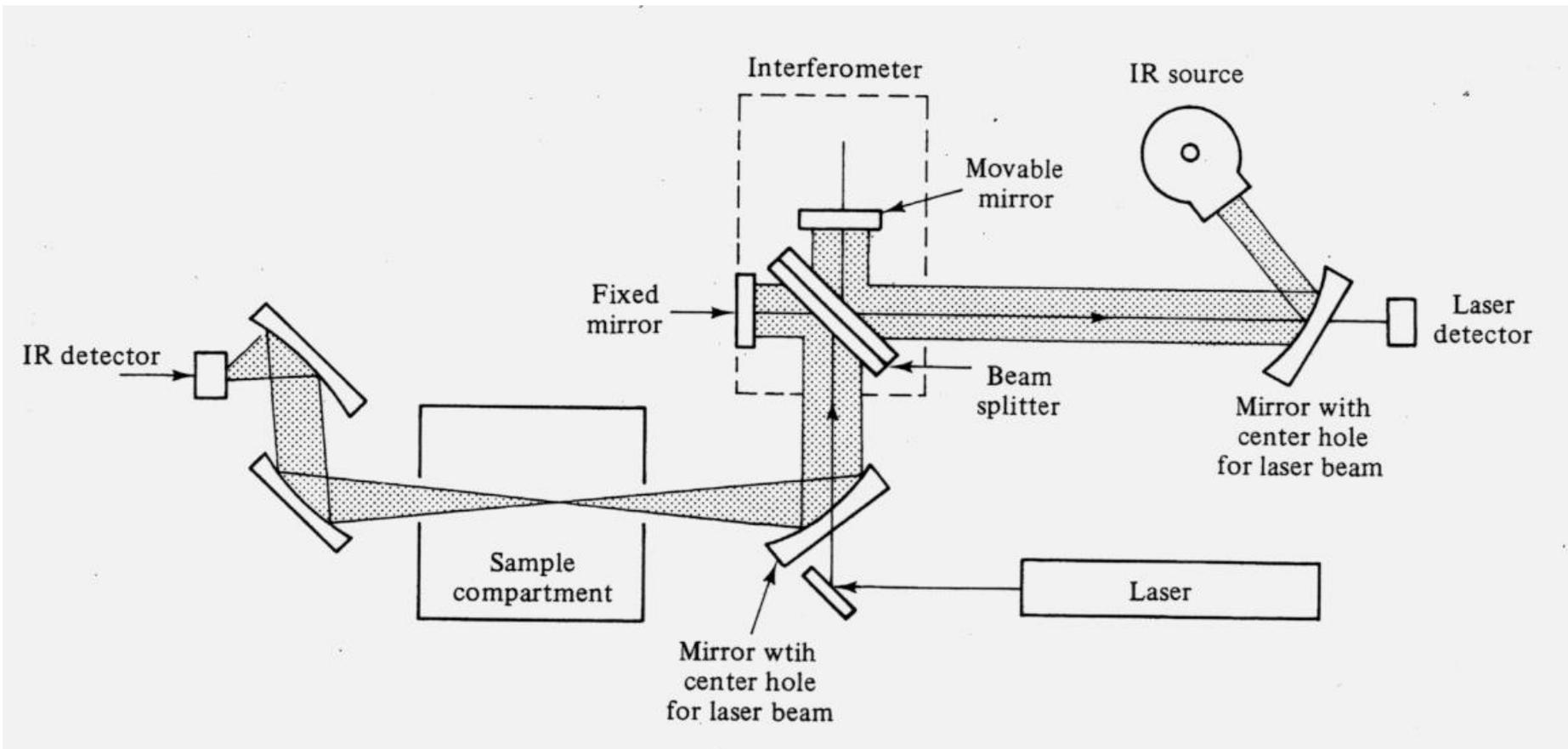
The overtones (multiples of a given frequency), combination (sum of two other vibrations) or difference (the difference of two other vibrations) tones increase the number of bands.

3. Hardware

The logo for UNIST, consisting of the letters 'UNIST' in a bold, blue, sans-serif font. The letters are slightly shadowed and appear to be floating above a dark blue background with a complex, glowing pattern of concentric circles and dots, resembling a digital or scientific visualization.

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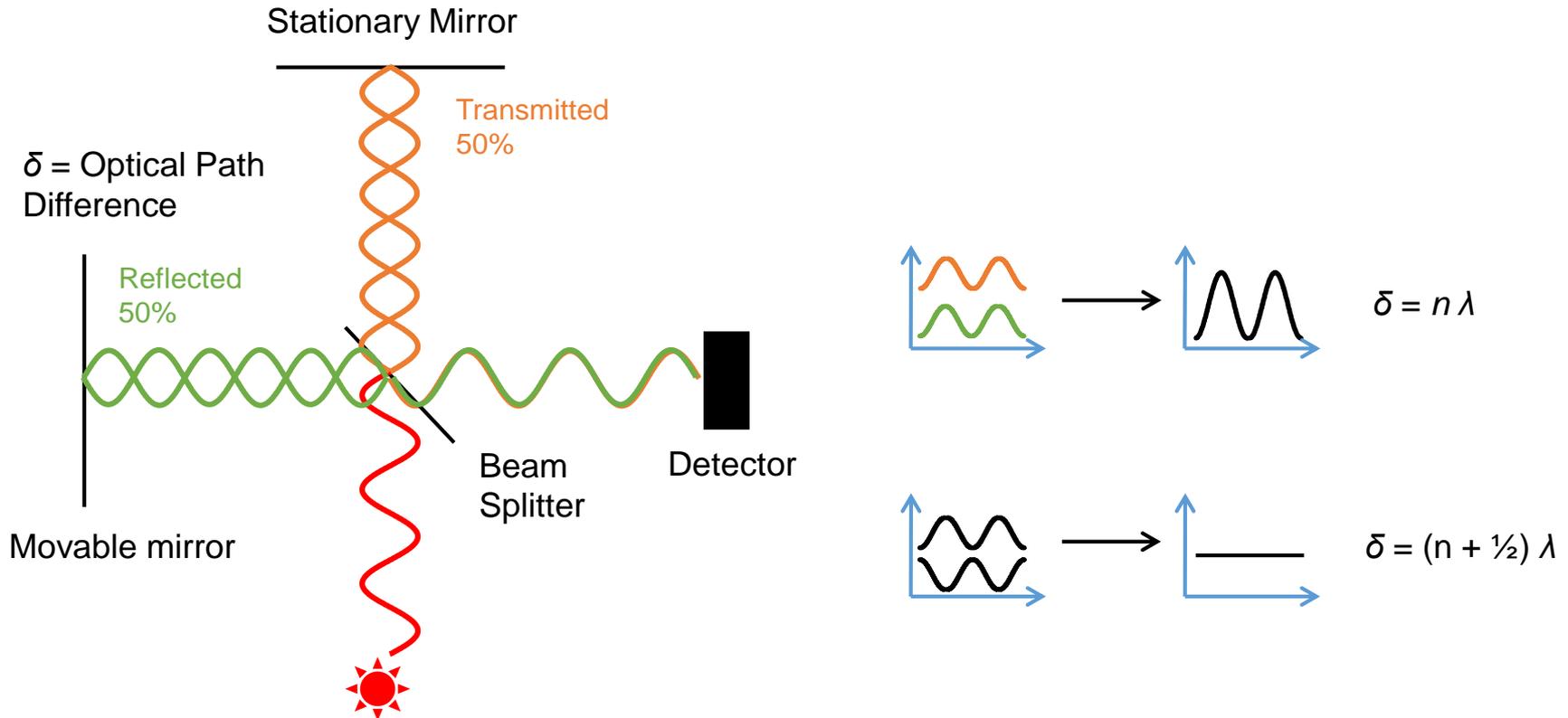
Single-beam FTIR Spectrometer



Fourier Transform Infrared Spectrometer (FT-IR)

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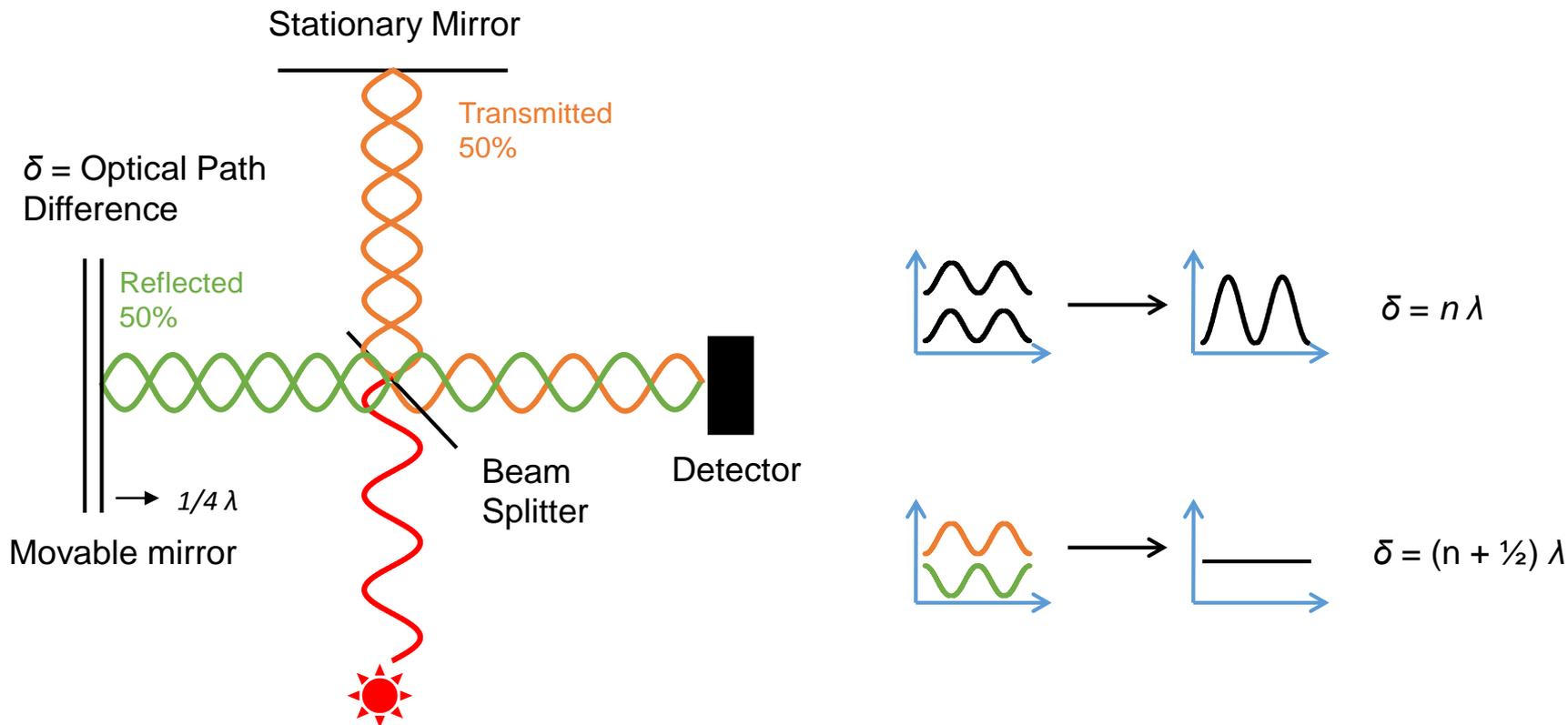
- ▶ 광원에서 조사된 빛이 빔 스플리터에 닿으면 절반은 투과되어 고정 거울로 진행하고, 절반은 이동 거울로 진행함.
- ▶ 각각의 거울에서 다시 반사되어 광원으로 오는 빛을 제외하고 검출기로 들어가게 되는데, 투과파와 반사파의 위상이 같으면 보강 간섭이 일어나고, $1/4 \lambda$ 만큼의 위상 차이로 인해 상쇄간섭이 발생함.



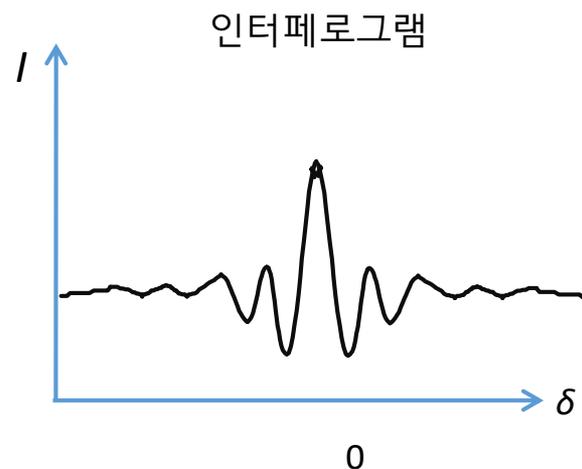
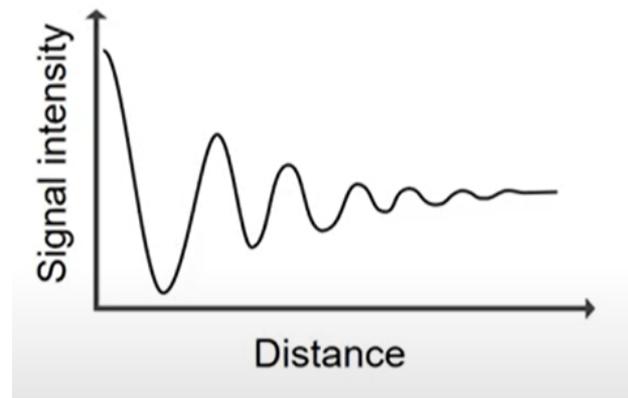
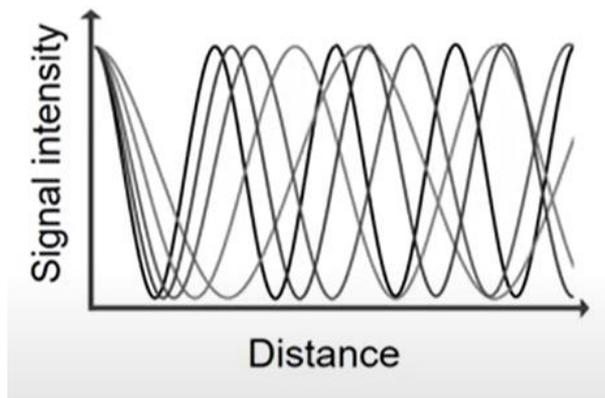
Fourier Transform Infrared Spectrometer (FT-IR)

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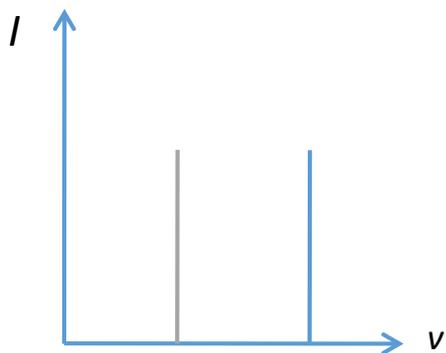


- ▶ 빛의 간섭 현상에 따른 적외선 시그널의 변화를 나타낸 것으로 광원에서 나오는 모든 파장에 대한 세기 정보를 포함.

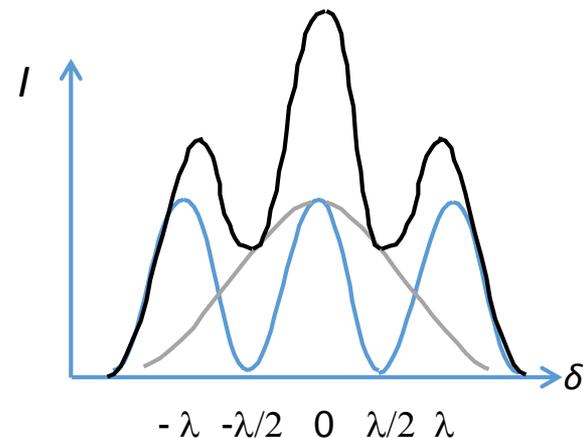


Fourier Transform Infrared Spectrometer (FT-IR)

Dichromatic source

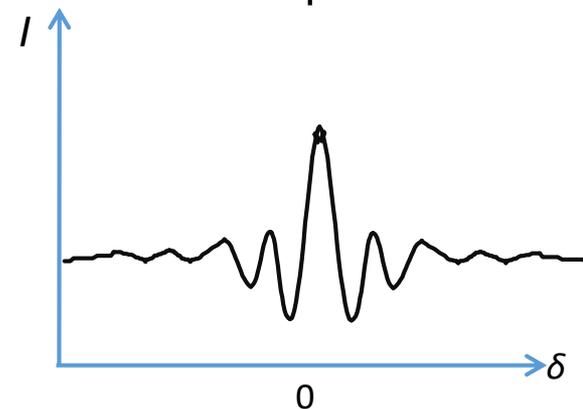
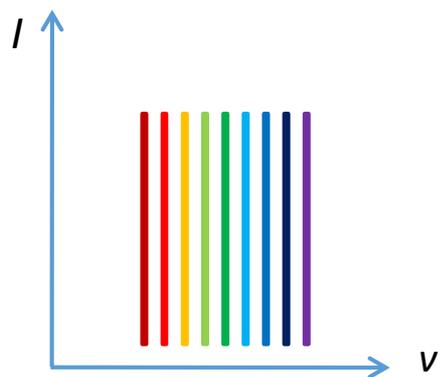


Interferogram

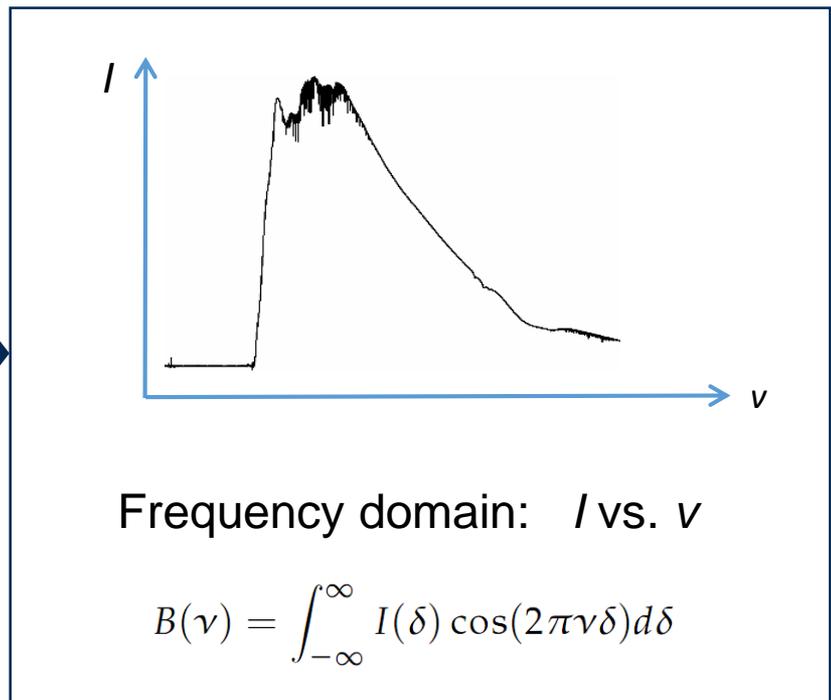
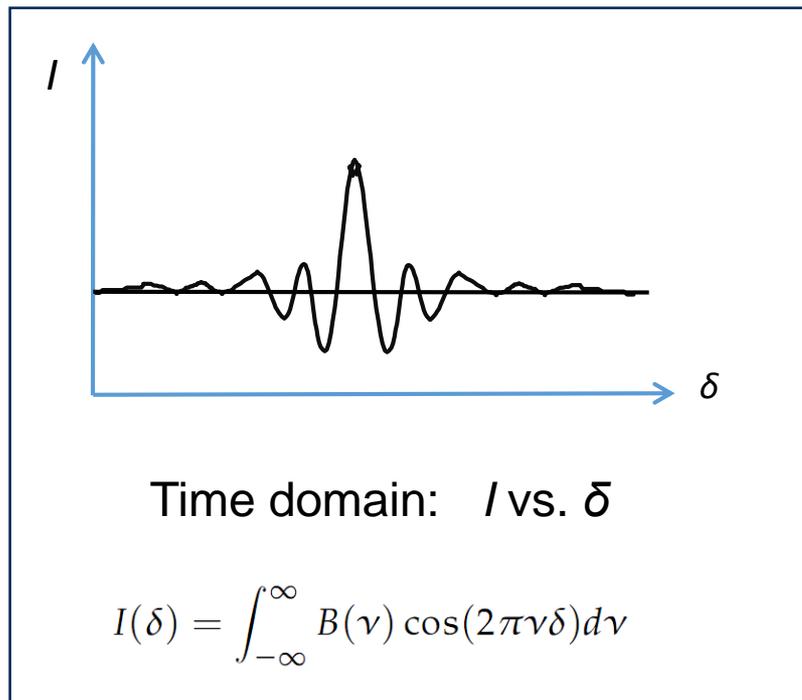


Moveable mirror

Continuous source



Continuous IR spectrum



❖ Advantages of FT-IR

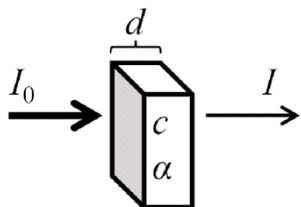
Throughput Advantage_Circular aperture, high signal intensity → high signal to noise ratio

Multiplex Advantage_All frequencies are measured at the same time

Precision Advantage_Internal laser control the scanner – built in calibration

y axis is %T or A

x axis is wavenumber (or wavelength)



$$T = I/I_0$$

$$\%T = 100 I/I_0$$

T transmission /
transmittance

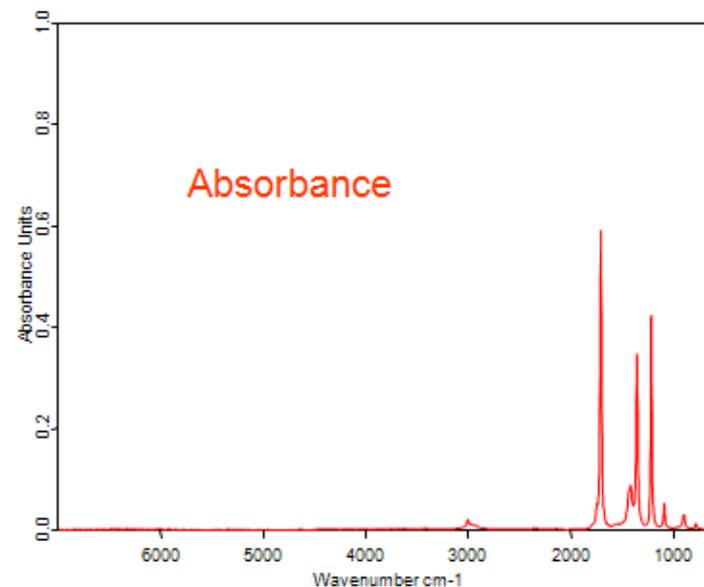
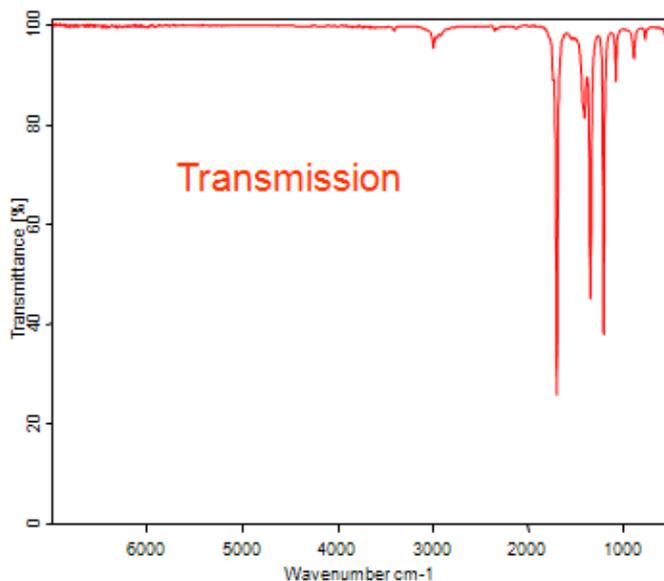
$$A = -\log T$$

$$A \text{ absorbance (no units)} = c d \alpha$$

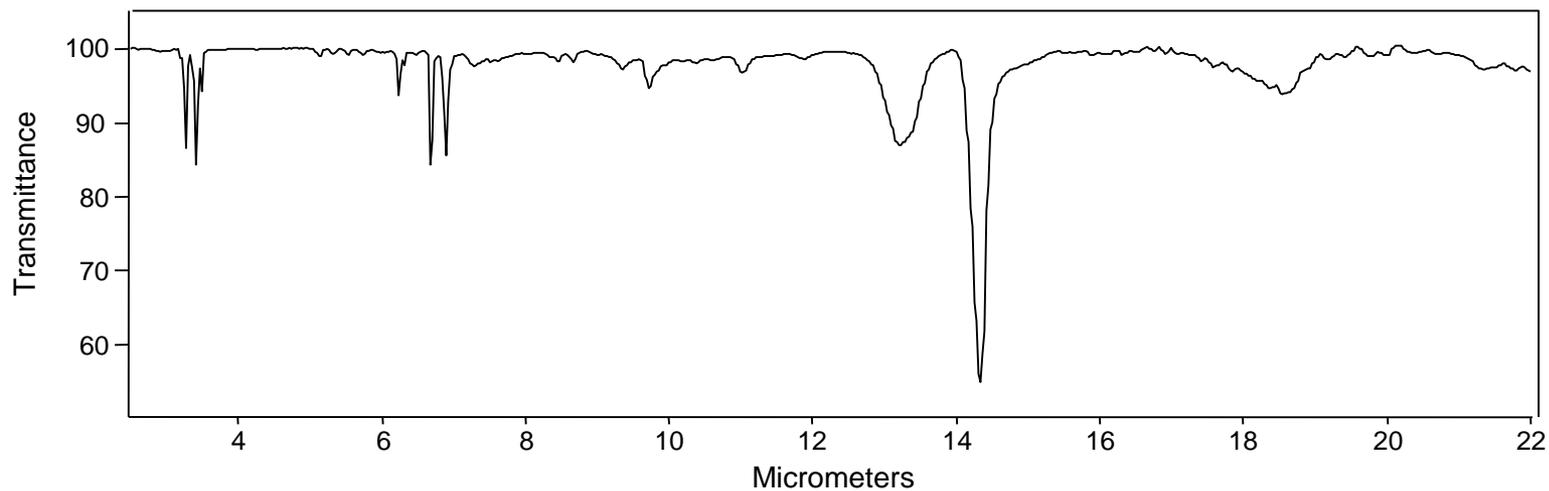
(Note A (but not T) \propto concentration) d = sample thickness

c = absorbant concentration

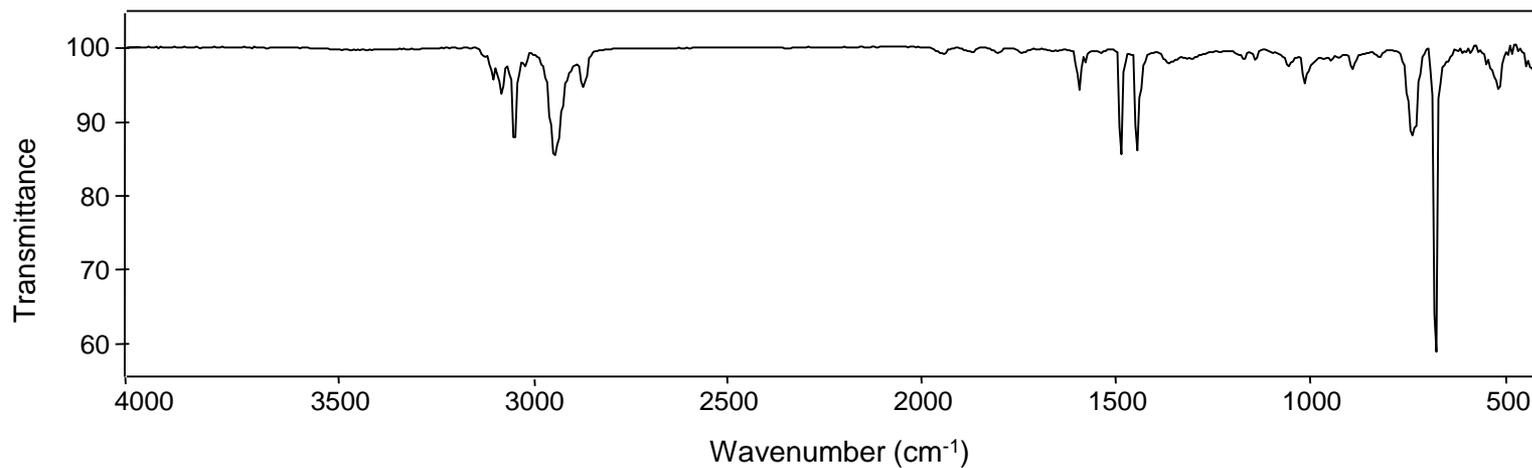
α = absorption coefficient

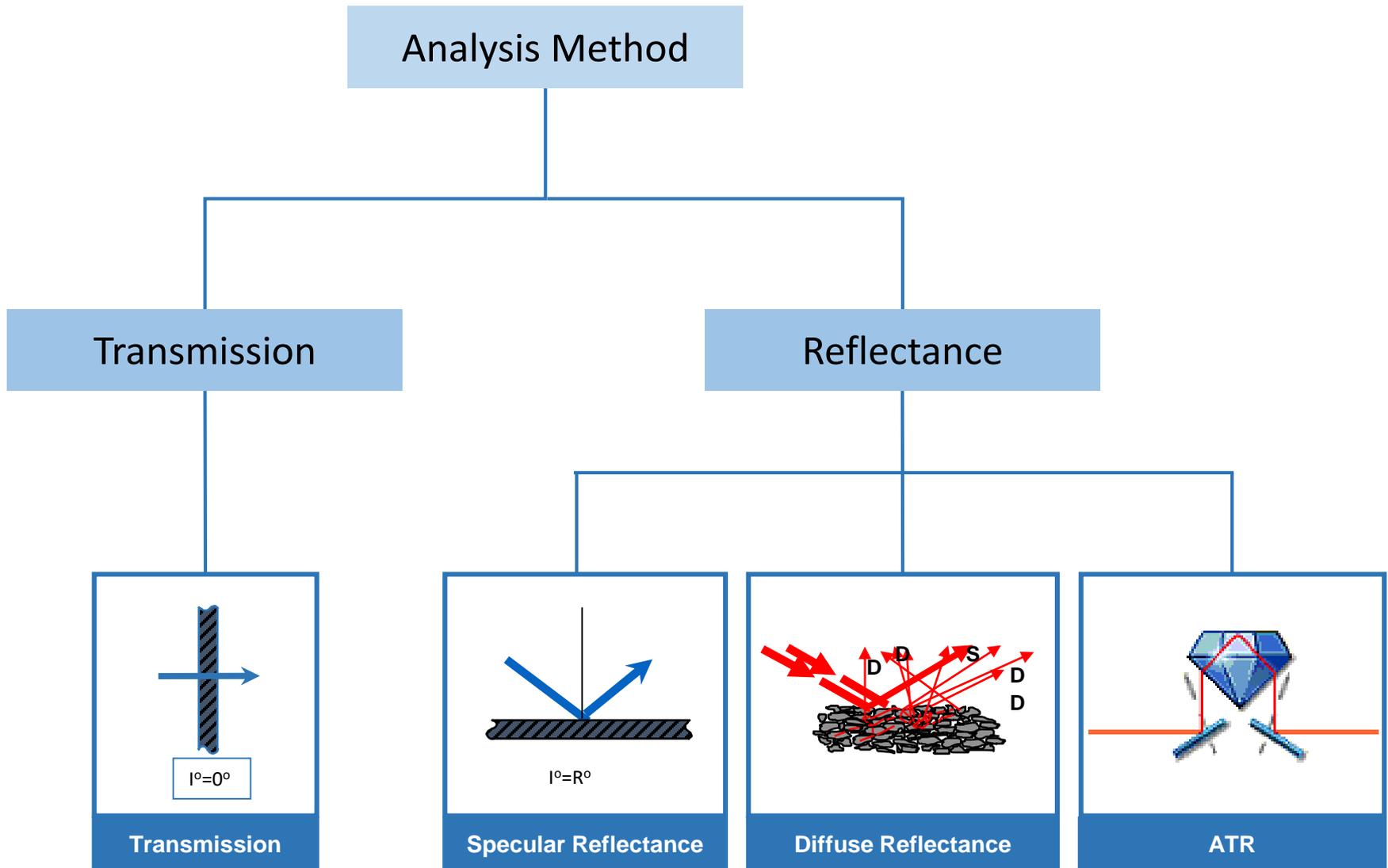


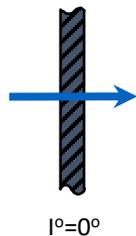
IR Spectrum in Wavelength (μm)



IR Spectrum in Wavenumber (cm^{-1})





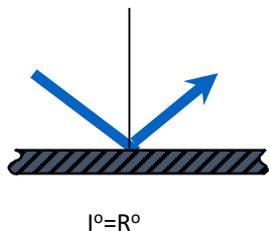


Transmission

(Powder, Drugs-KBr pellet/Films, Coatings, Paints-film holder/Liquid-window cell)

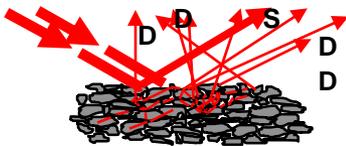
Absolute reference measurement

Sample preparation can be difficult and time consuming



Specular Reflectance

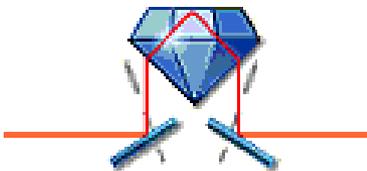
Sample must have a back reflective layer or must be on a mirror (layer thickness = single molecule)



Diffuse Reflectance

Solids and powders, diluted in a matrix of KBr or KCl

Analysis of non-reflective materials



ATR (Attenuated Total Reflectance)

(Powder, Drugs, Films, Coatings, Paints, Liquid, Rubber)

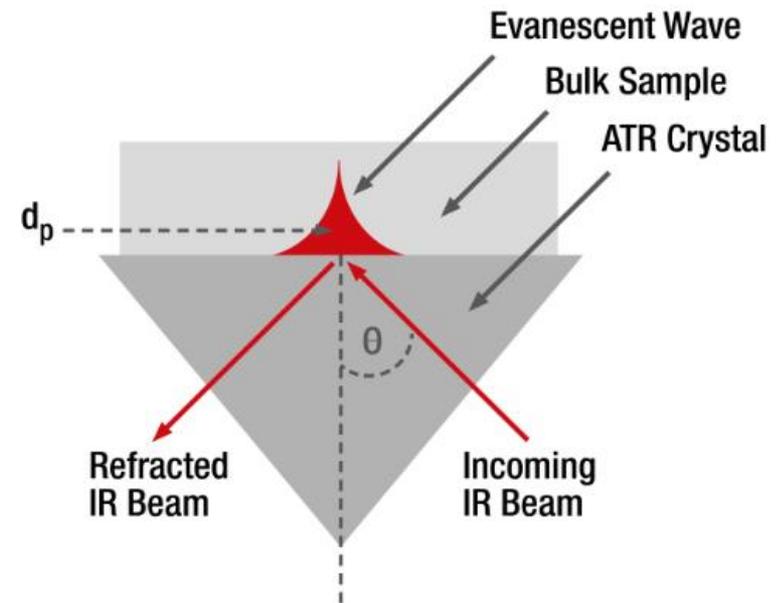
The infrared beam is focused into a crystal

Creating an evanescent wave about 1 – 2 microns deep

No sample preparation

ATR (Attenuated Total Reflectance)

- ATR spectroscopy utilizes the phenomenon of total internal reflection
- A beam of radiation entering a crystal will undergo total internal reflection when the angle of incidence at the interface between the sample and crystal is greater than critical angle
- In this way, an evanescent wave penetrates into the sample in contact with the crystal, producing a spectrum of the sample

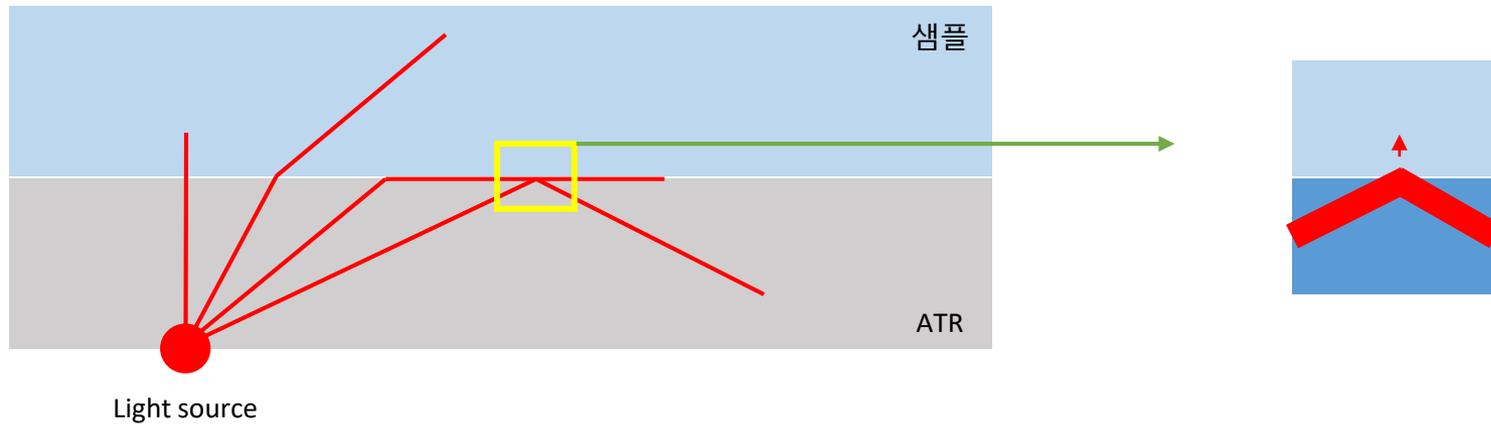


- Evanescent wave resulting from total internal reflection

Total internal reflection

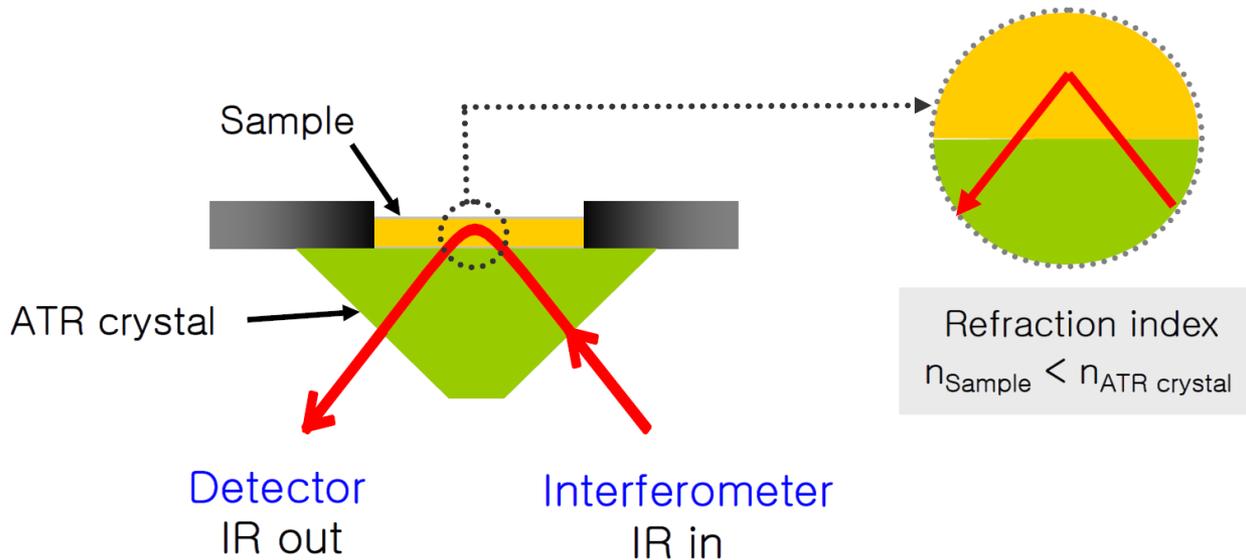
When an infrared light beam hits the surface between two optical media which are characterized by two different refractive indices at a certain angle of incidence, the light is totally reflected.

This angle is called the critical angle and can be calculated using Snell's law.

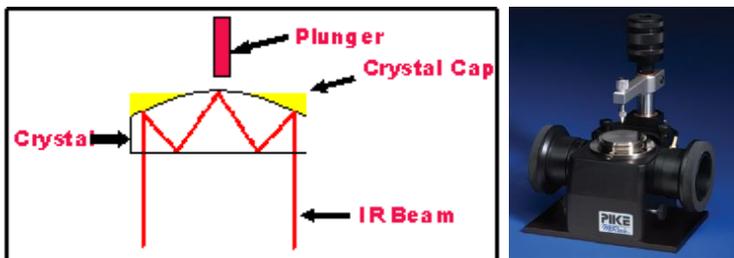


- Light is perpendicular to the material: no refraction
- Incident angle < Critical angle : refraction
- Incident angle = Critical angle : the angle of refraction is 90 degrees
- Incident angle > Critical angle : **total internal reflection**

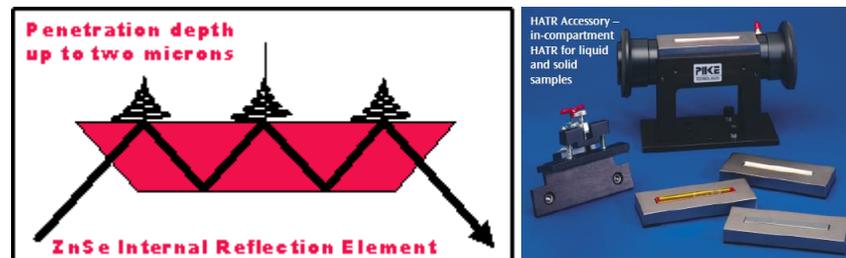
ATR (Attenuated Total Reflectance)



< ATR system >



Single-bounce ATR



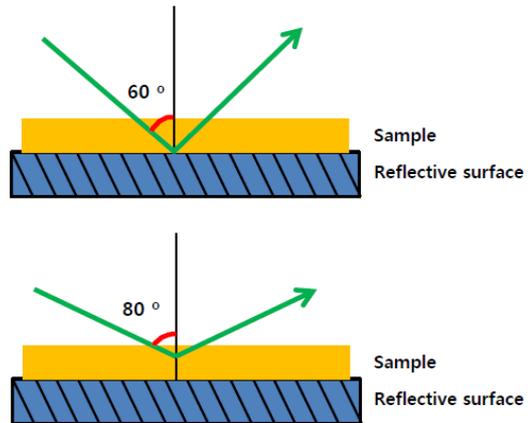
Multi-bounce ATR

ATR crystal

Material	ATR Spectral Range (cm ⁻¹)	Refractive Index	Depth of Penetration (μ) (at 45° & 1000 cm ⁻¹)	Uses
Germanium	5,500 - 675	4	0.66	Good for most samples, especially strong absorbing samples, such as dark polymers
Silicon	8,900 - 1,500 & 360-120	3.4	0.85	Resistant to basic solutions
AMTIR	11,000 - 725	2.5	1.77	Very resistant to acidic solutions
ZnSe	15,000 - 650	2.4	2.01	General use
Diamond	25,000 - 100	2.4	2.01	Good for most samples. Extremely caustic or hard samples

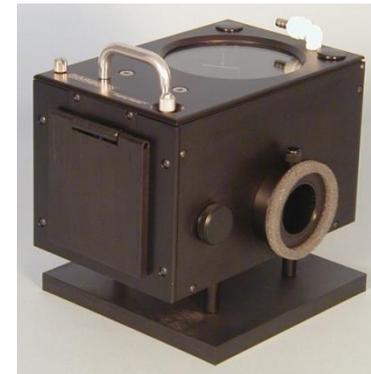
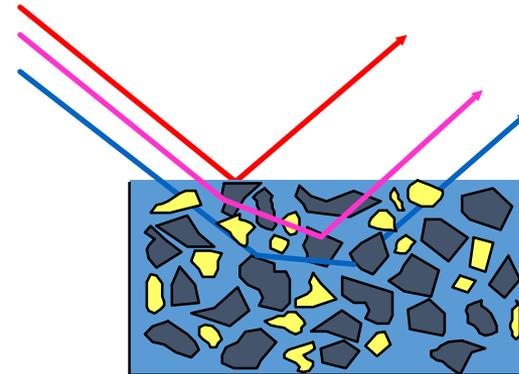
Reflectance method

Specular reflectance



Seagull

Diffuse reflectance (DRIFTS)



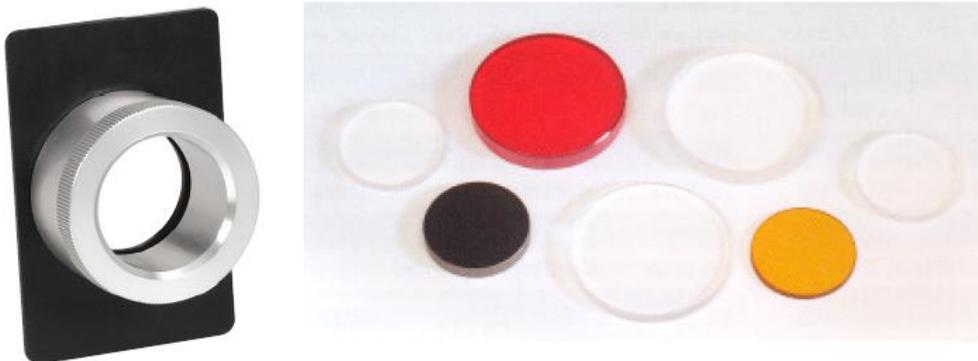
Praying Mantis

Transmission_Powder, Drugs, Film

Pellet sample (13 mm die) and film sample



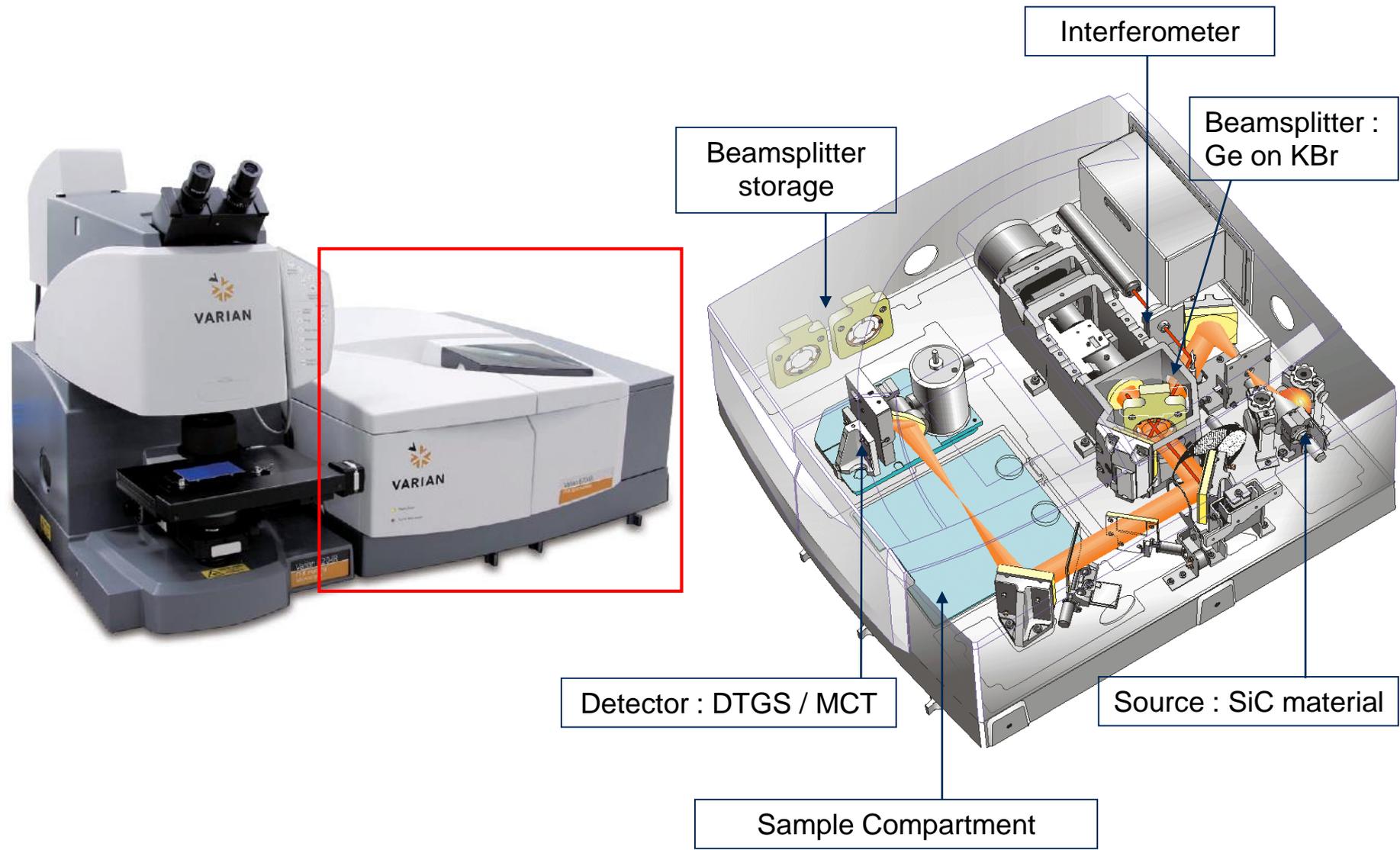
Transmission_Liquid sample (window material)



Type of window materials for liquid sample

Material	Comments	Max. Temp. in air (°C)	Transmission Range (cm ⁻¹)	pH Range	Solvents which attack material
AgCl	Silver Chloride	200	25000-360	N/A	Complexing agents
Al ₂ O ₃	Sapphire	1700	20000-1780	1-14	acids, alkalies
AMTIR	SeAsGe glass, brittle	300	1100-593	1-9	alkalies
BaF ₂	Barium Fluoride	500	65000-700	5-8	NH ₄ ⁺ , salts, acids
CaF ₂	Calcium Fluoride	900	70000-1100	1-9	NH ₄ ⁺ , salts, acids
CsI	Cesium Iodide	200	40000-200	N/A	Lower alcohols "wet" solvents
Diamond	Diamond	750	40000-2500 & 1667-33	1-14	K ₂ Cr ₂ O ₇ , H ₂ SO ₄
Ge	Germanium	270	5500-625	1-14	H ₂ SO ₄ aqua regia
KBr	Potassium Bromide	300	40000-400	N/A	Lower alcohols "wet" solvents
KRS-5	Thallium Bromide/Thallium Iodide, extremely toxic!	200	17900-204	5-8	Complexing agents
NaCl	Sodium Chloride	400	40000-625	N/A	Lower alcohols "wet" solvents
Si	Silicon, strong IR absorbance between 624-590 cm ⁻¹	300	8900-624	1-12	HF, HNO ₃
SiO ₂	Silicon Dioxide (Quartz)	1200	40000-2500	1-14	HF, some hot acids and bases
ZnS	Zinc Sulfide	300	17000-690	5-12	acids
ZnSe	Zinc Selenide	300	20000-454	5-9	Acid, strong alkalies

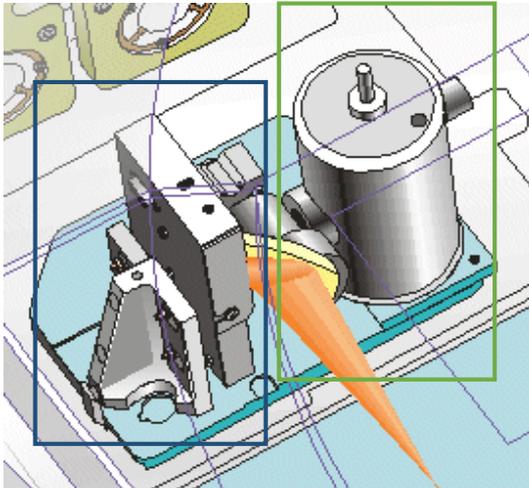
670 FT-IR Systems



❖ Source

Nernst Glower	heated rare earth oxide rod (~1500 K)	1-50 μm (mid- to far-IR)
Globar	heated SiC rod (~1500 K)	1-50 μm (mid- to far-IR)
W filament lamp	1100 K	0.78-2.5 μm (Near-IR)
Hg arc lamp	plasma	50 - 300 μm (far-IR)
CO2 laser	stimulated emission lines	9-11 μm

❖ Detector



- DLaTGS (Deuterated, L-alanine doped TriGlycine Sulfate)**
 Pyroelectric detector (mid IR)
 DLaTGS detector provides linear response over a very wide range of FT-IR throughput, which is beneficial in qualitative and quantitative FT-IR sampling.

- MCT (Mercuric Cadmium Telluride)**
 Quantum detector
 High MCT sensitivity will produce a large signal in a low-flux measurement. It demonstrates a relatively constant signal versus data-collection speed.

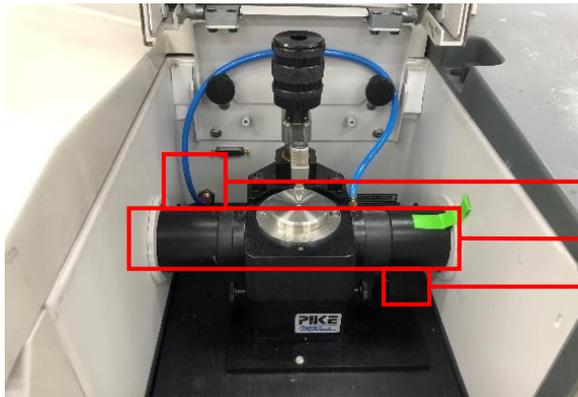
4. FT-IR Operation

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SCIENCE AND TECHNOLOGY

❖ before using the equipment

① Check 3 items

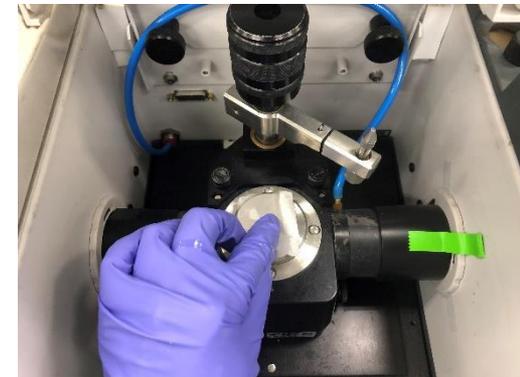
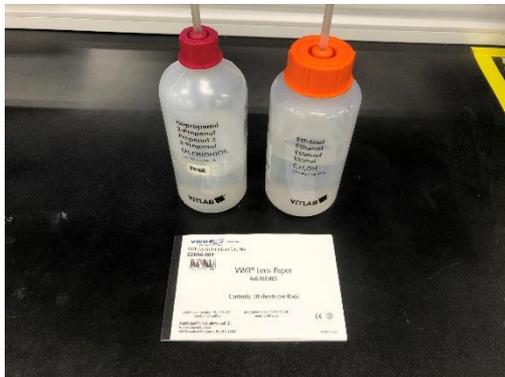


Fitted hose
Connected pipe
Locked volt

② Fill the LN₂ in the LN₂ Tank
(If you use MCT detector)

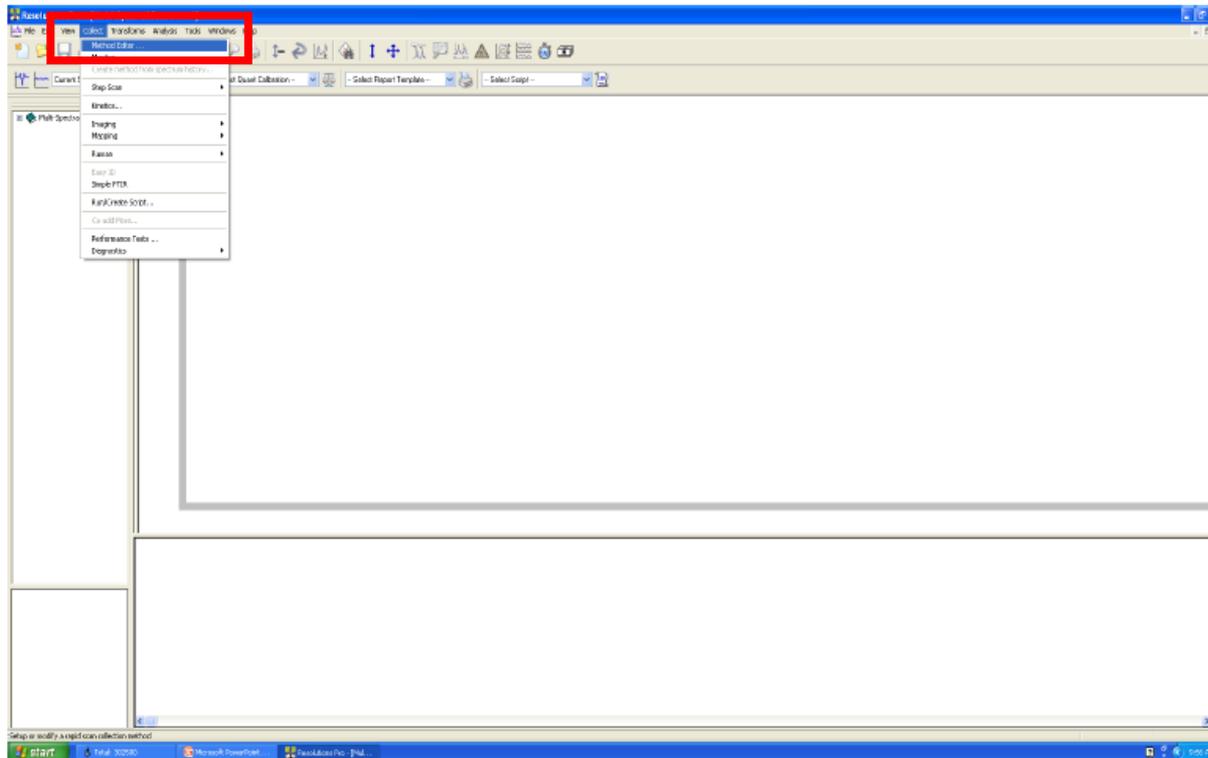


③ Clean ATR using lens paper with two kinds of solvent(isopropanol, ethanol)

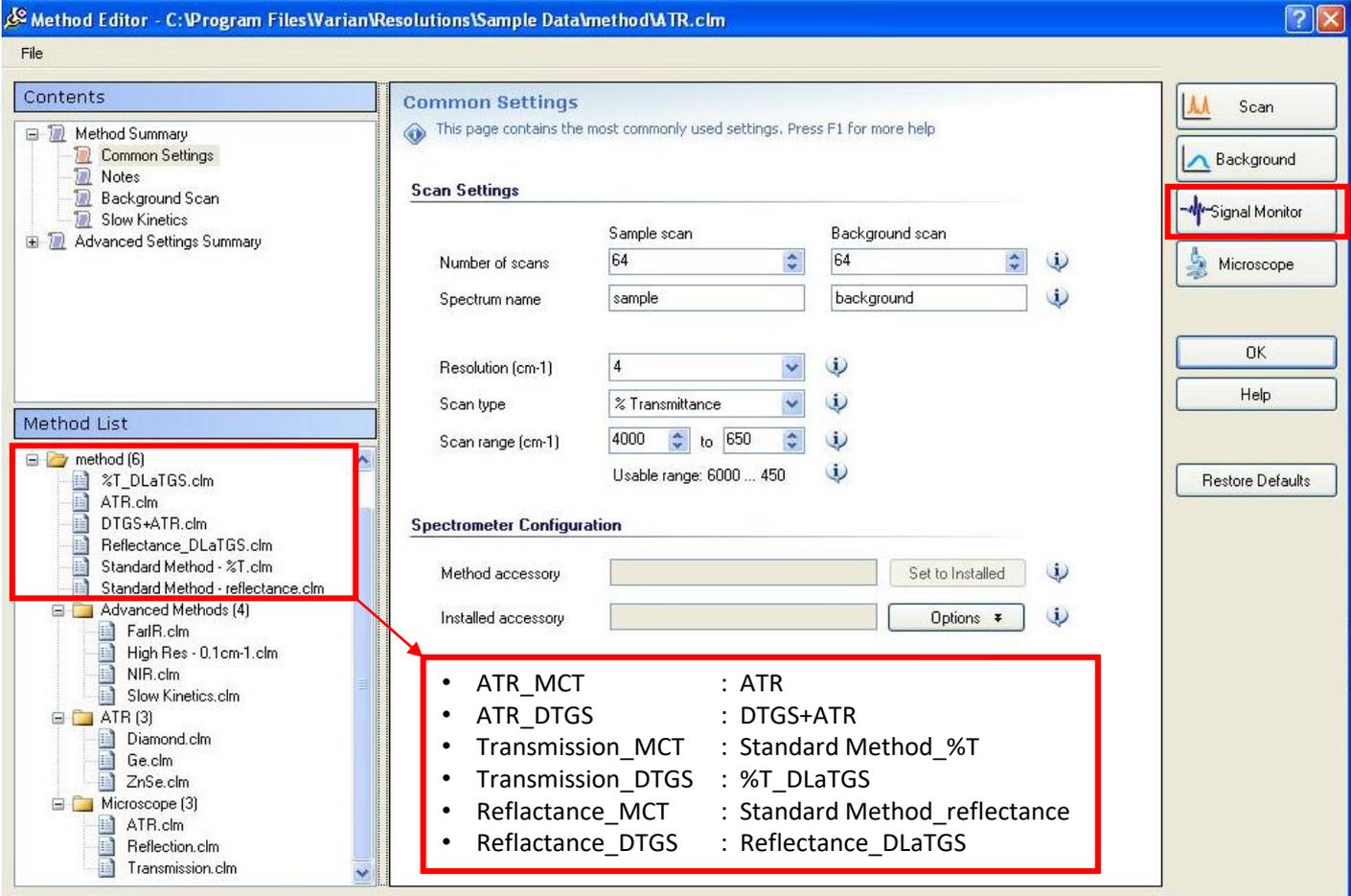


1. Agilent Resolution Pro. START
(Check the knob at the bottom of the equipment, gas line, and the ATR screws.)

2. Collect → Method Editor



3. Method List → select method(check the scan range)



Method Editor - C:\Program Files\Warian\Resolutions\Sample Data\method\ATR.clm

Contents

- Method Summary
- Common Settings
- Notes
- Background Scan
- Slow Kinetics
- Advanced Settings Summary

Method List

- method (6)
 - %T_DLaTGS.clm
 - ATR.clm
 - DTGS+ATR.clm
 - Reflectance_DLaTGS.clm
 - Standard Method - %T.clm
 - Standard Method - reflectance.clm
- Advanced Methods (4)
 - FarIR.clm
 - High Res - 0.1cm-1.clm
 - NIR.clm
 - Slow Kinetics.clm
- ATR (3)
 - Diamond.clm
 - Ge.clm
 - ZnSe.clm
- Microscope (3)
 - ATR.clm
 - Reflection.clm
 - Transmission.clm

Common Settings

This page contains the most commonly used settings. Press F1 for more help

Scan Settings

	Sample scan	Background scan
Number of scans	64	64
Spectrum name	sample	background
Resolution (cm-1)	4	
Scan type	% Transmittance	
Scan range (cm-1)	4000 to 650	
	Usable range: 6000 ... 450	

Spectrometer Configuration

Method accessory		Set to Installed
Installed accessory		Options

- ATR_MCT : ATR
- ATR_DTGS : DTGS+ATR
- Transmission_MCT : Standard Method_%T
- Transmission_DTGS : %T_DLaTGS
- Reflectance_MCT : Standard Method_reflectance
- Reflectance_DTGS : Reflectance_DLaTGS

Scan

Background

Signal Monitor

Microscope

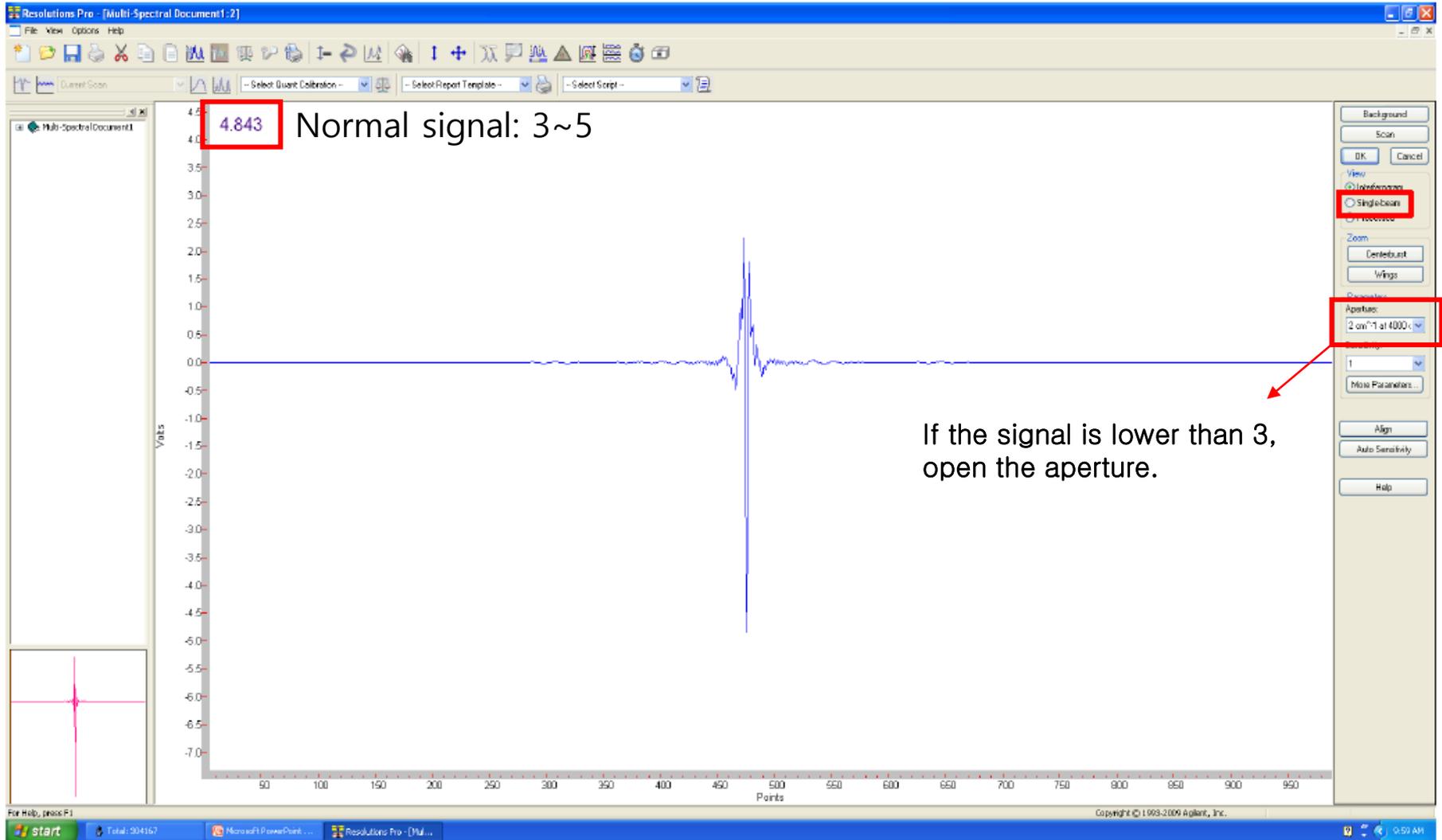
OK

Help

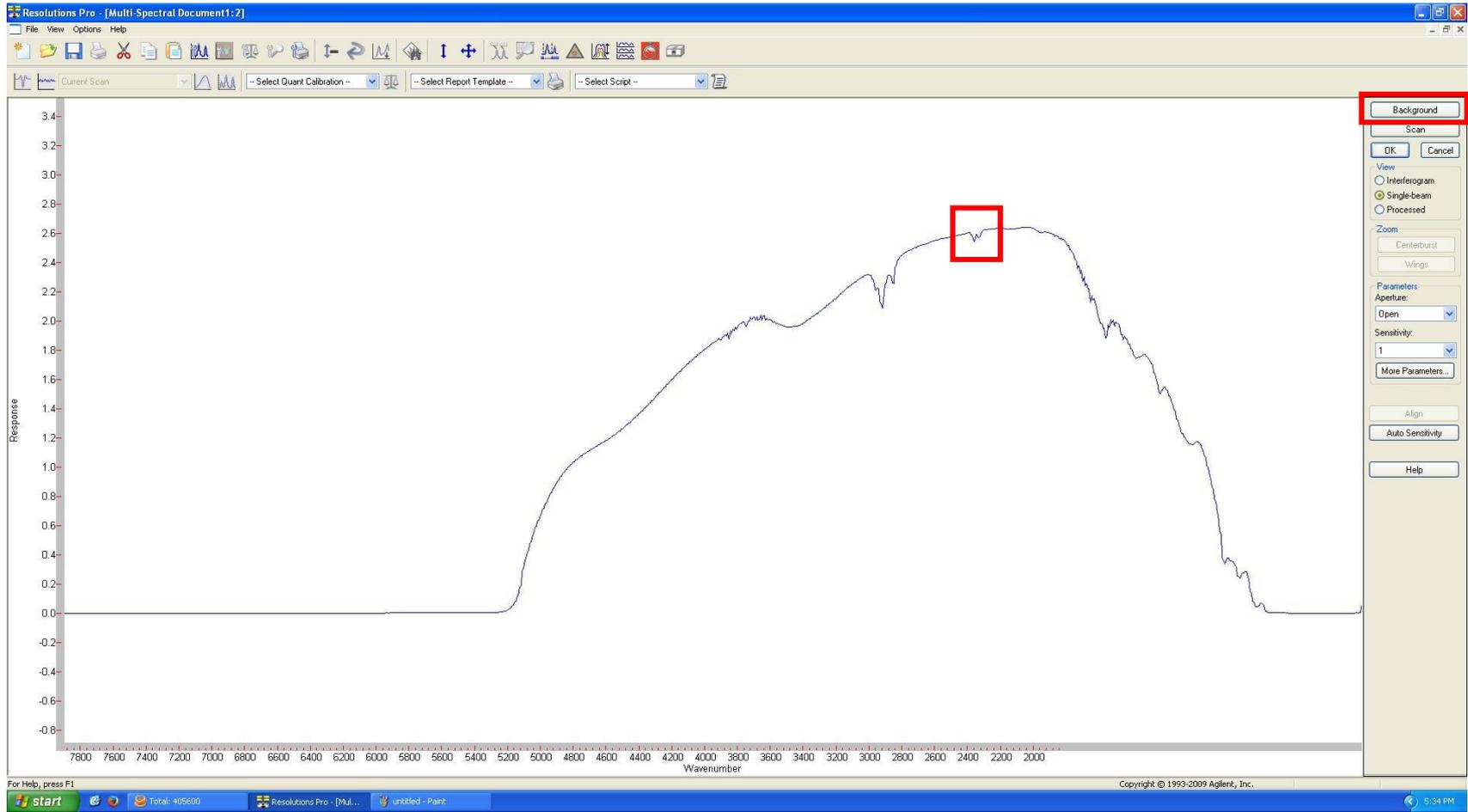
Restore Defaults

4. Signal Monitor click

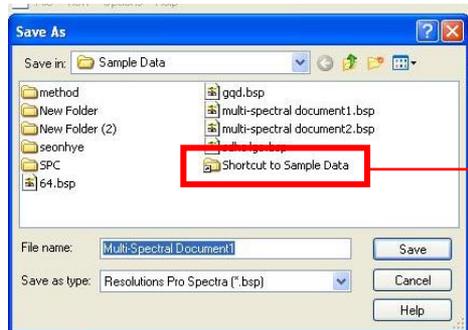
5. Check the signal click single beam



6. Check the CO₂ peak(2350cm⁻¹) → Click background

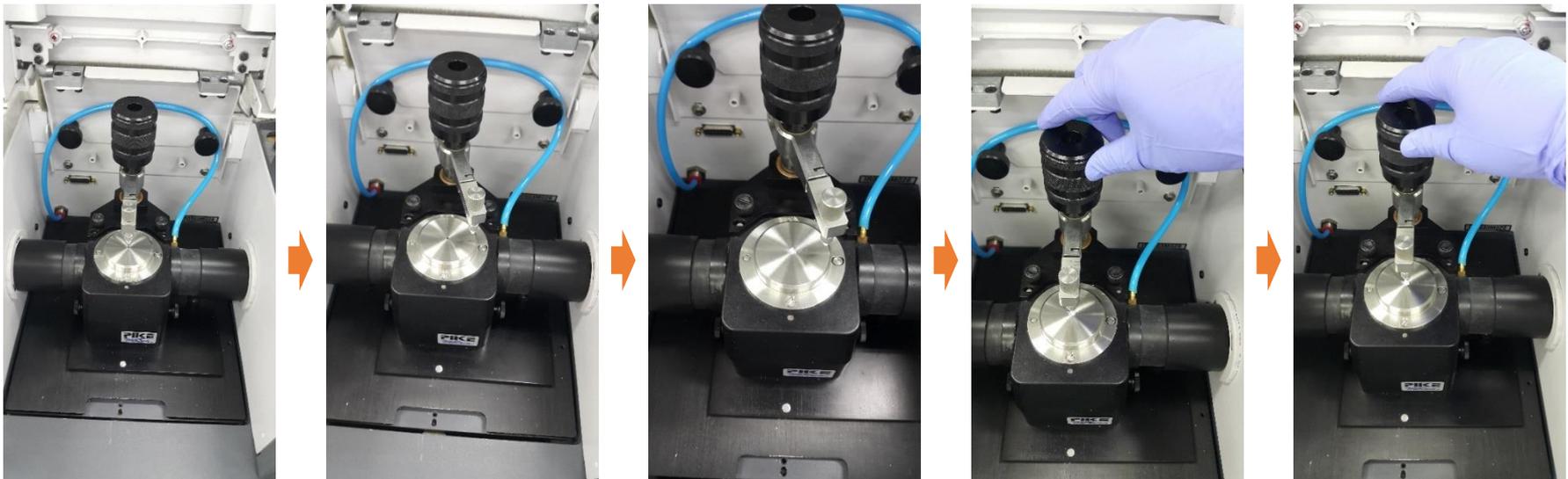


7. Save the file



Shortcut to sample data(Desk top) →
Lab/Professor name → user name → date

8. Load the sample and press



9. Monitor live spectrum click

The screenshot displays the Resolutions Pro software interface. The main window shows a live FT-IR spectrum plot with 'Response' on the y-axis (0.0 to 3.5) and 'Wavenumber' on the x-axis (7500 to 500 cm⁻¹). A red box highlights the 'Monitor Live Spectrum' button in the toolbar. Below the plot is a table with the following data:

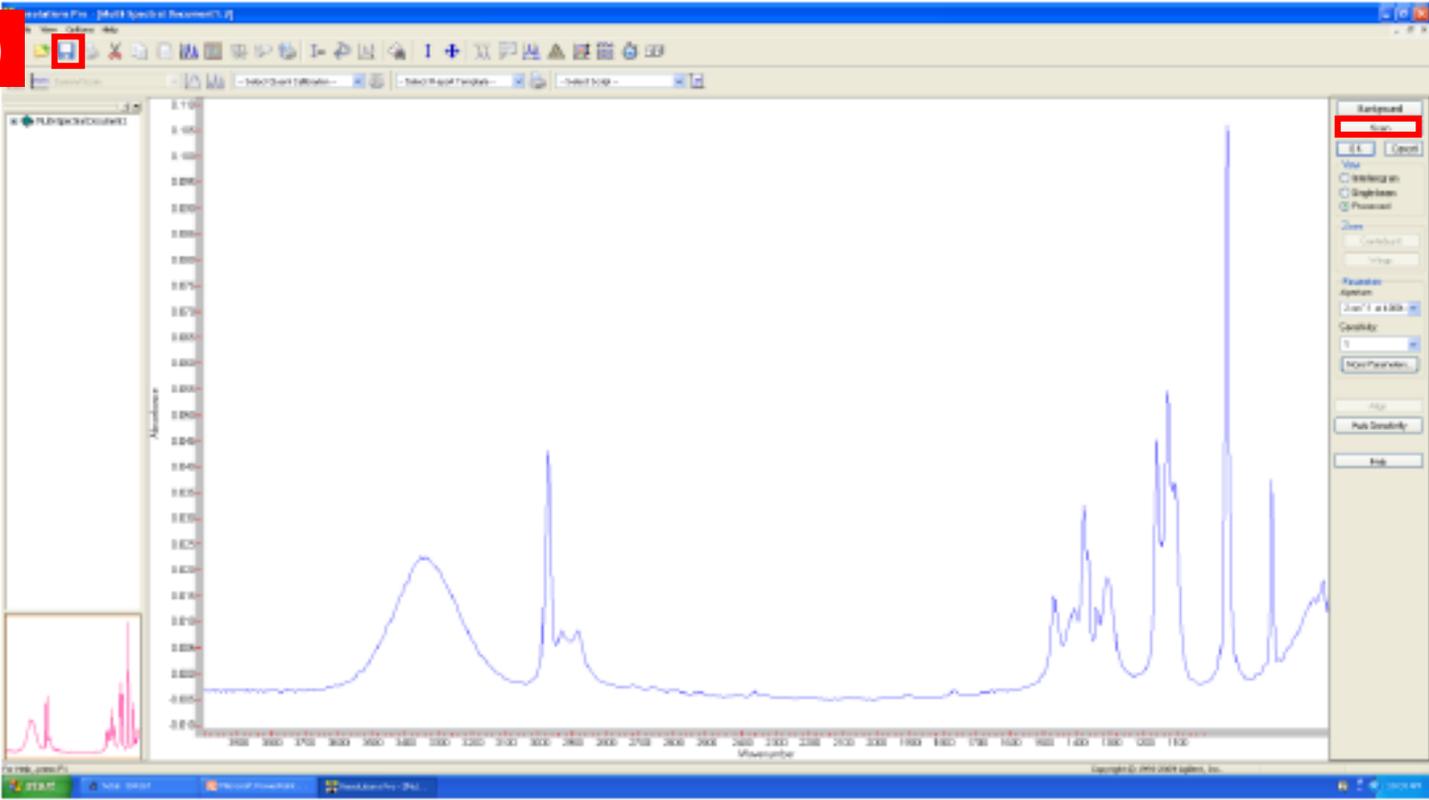
	Name	Spectrum	Created Scan	Created Scan	1730: 2920	1165	1453	1494	3030	2340	TmplPk2	TmplPk3	Peak23	sugar (Predicted)
1	background		Done	Background										
2	sample		Done											
3	background		Done											

Displays a live "real-time" processed spectrum

Copyright © 1993-2009 Agilent, Inc.

10. Click Scan → Change the sample name → Click on save icon

(3)

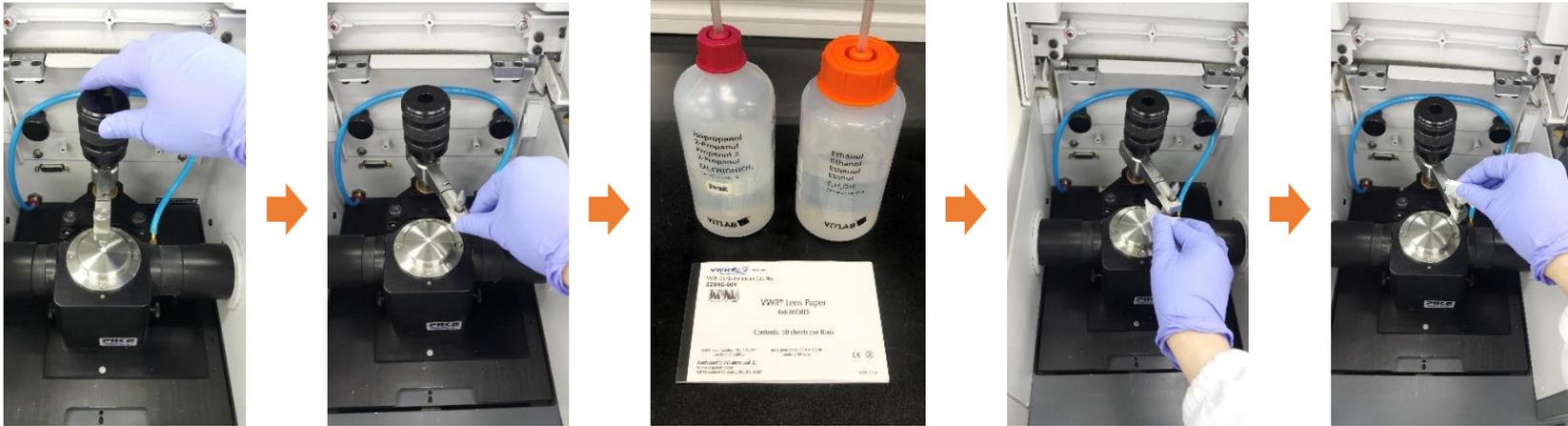


(1)

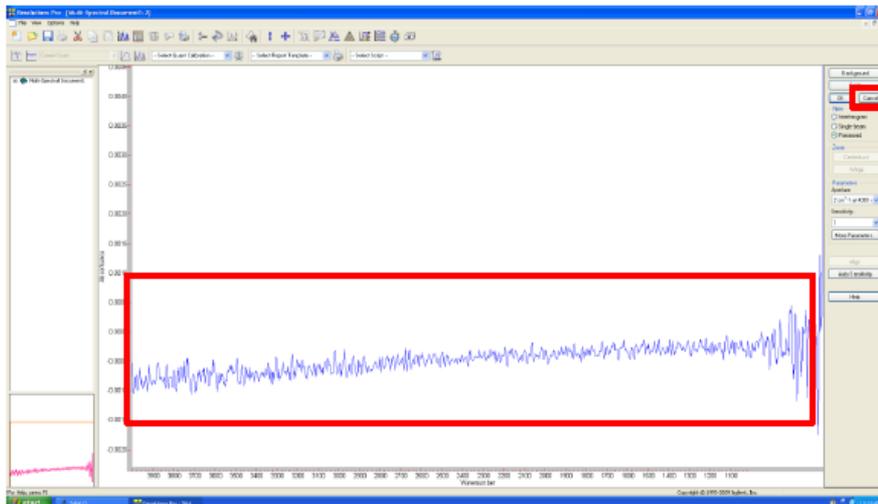
(2)

Name	Spectrum	1730:2920	1165	1453	1494	3030	2340	TmpltPk2	TmpltPk3	Peak23	sugar (Predicted)	TmpltPk1	Created Scan	Created Scan Background	Interferogram
KCM													Done		
CM													Done		
background													Done		

11. Clean the ATR using two kinds of solvent

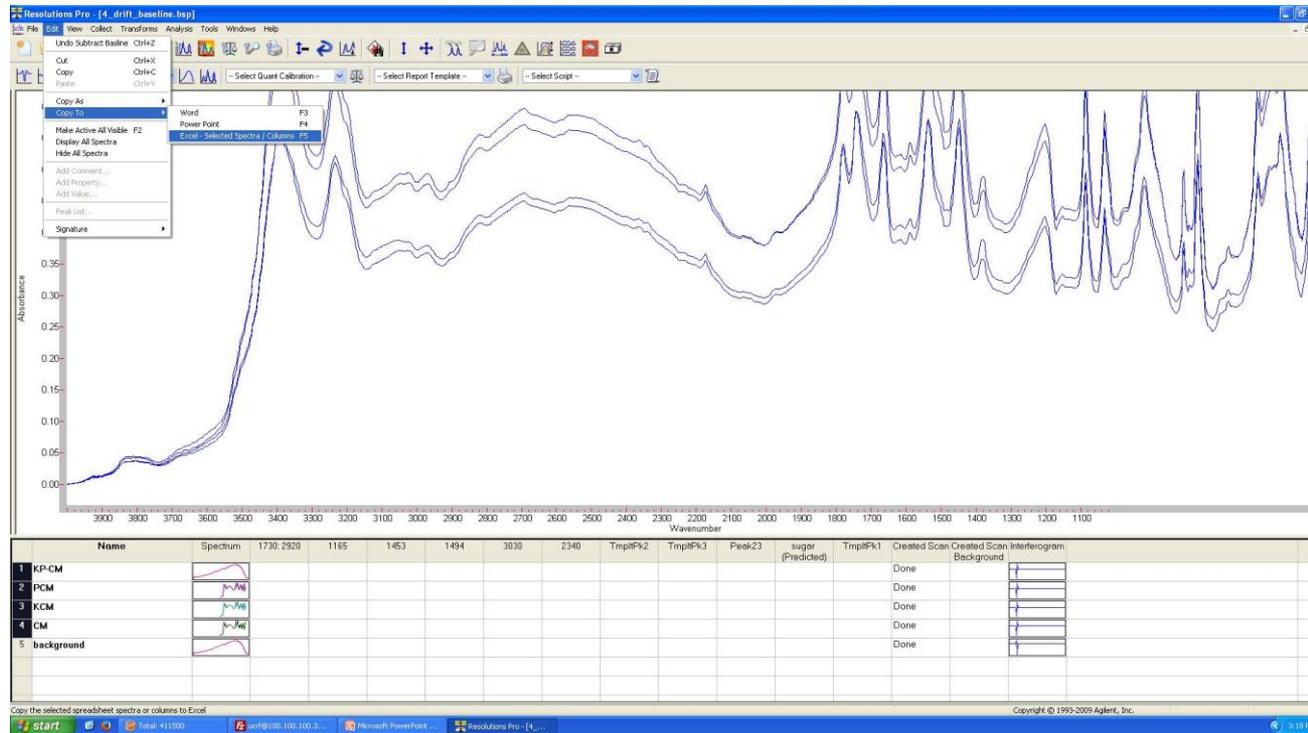


12. Click the remaining sample



(Click monitor live spectrum →
If there is no peak, click cancel)

13. Select all sample spectrum(Shift + click) → edit → copy to → excel → save



14. Program off

15. Data translation(NAS server)

Cautions



Shutter close
- Signal detection off



Shutter open
- Signal detection on

5. Pre-treatment(Use ACC)

- 시료 준비
- 전처리

Transmission_powder sample

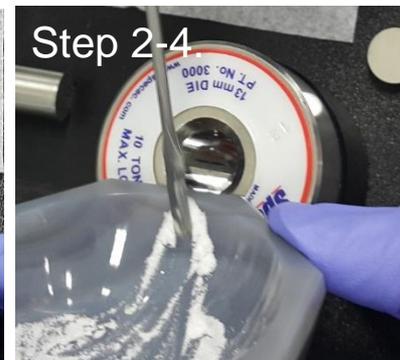
Preparing KBr Pellets



Step 1. The powder sample and KBr must be ground to reduce the particle size to less than 5 μ m in diameter. Otherwise, large particles scatter the infrared beam and cause a slope baseline of spectrum.

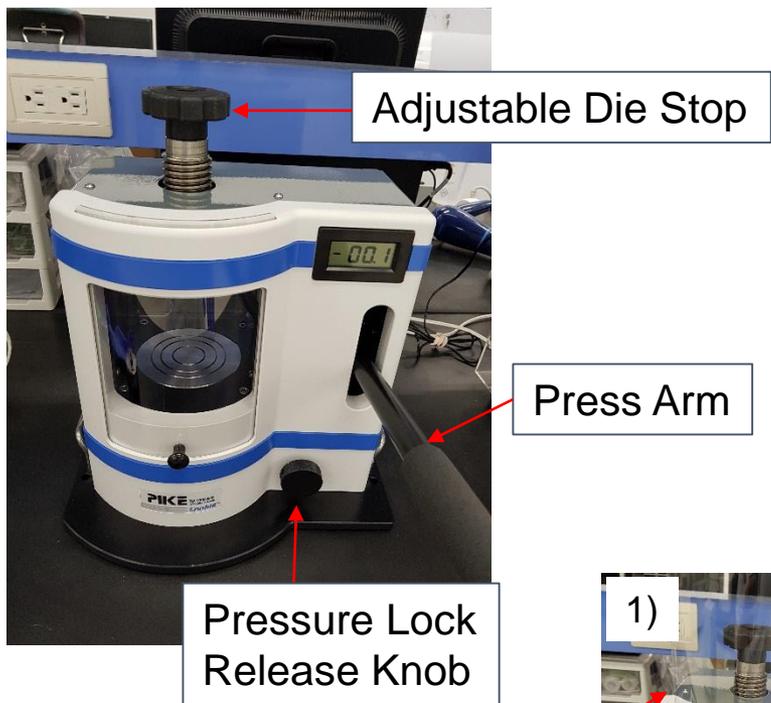
Step 2. Take two stainless steel disks. Place a piece of the precut cardboard on top of one disk and fill the cutout hole with the finely ground mixture.

Put the second stainless steel disk on top.
(Fill the ground sample on more smooth side of disk.)

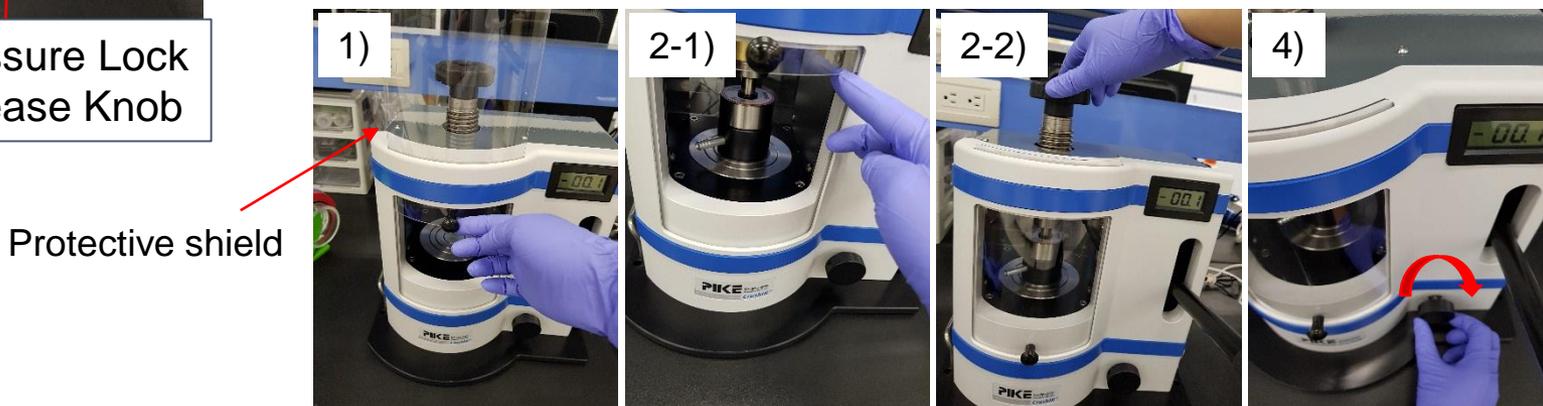


Preparing KBr Pellets_Pressing pellet

Step 3. Pressing pellet

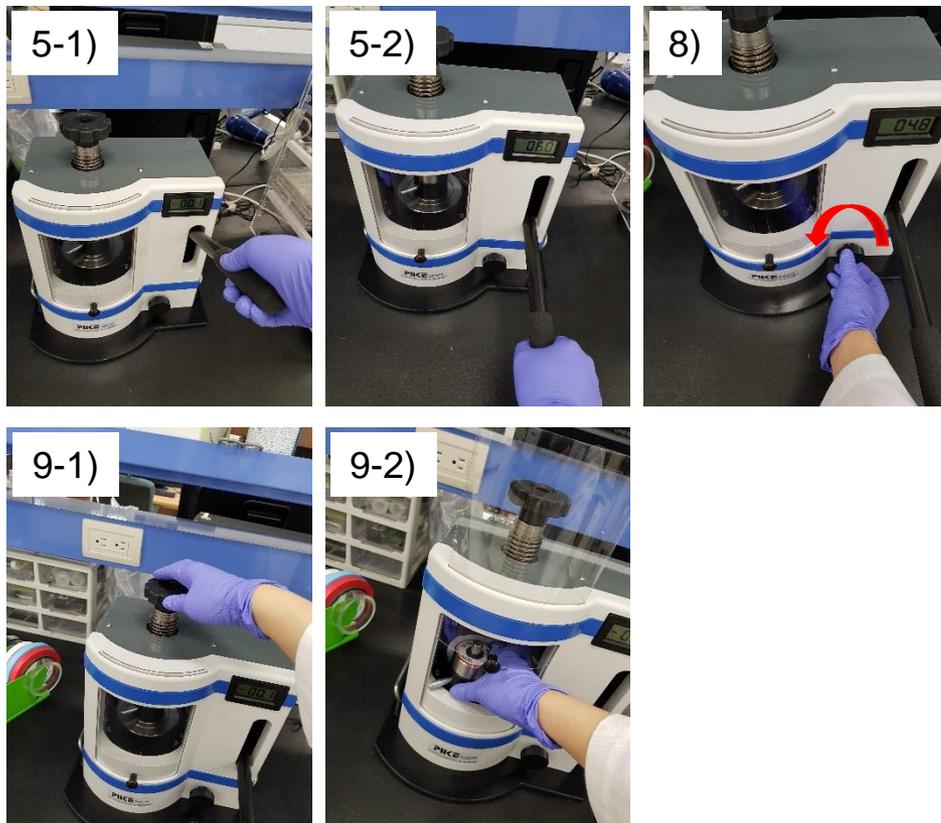


- 1) Place your pellet press into the CrushIR adjusting the die stop as needed to provide a comfortable amount of clearance.
- 2) Position the pellet press so that it's top and bottom are centered relative to the die stop and the hydraulic ram.
- 3) Close the protective shield.
- 4) Turn the pressure lock/release knob fully clockwise to close.



Preparing KBr Pellets_Pressing pellet

Step 3. Pressing pellet



- 5) Apply force to the pellet press by pumping the press arm up and down.
- 6) Continue applying force to the pellet press until you reach its maximum rating.

In the case of the PIKE Evacuatable Pellet Press, the maximum load is **10 US tons**.
WARNING - Never exceed the maximum force rating of the pellet press.

- 7) Allow the force to stay at the maximum value for about 1 minute.
- 8) Then release the force by turning the pressure lock/release knob counterclockwise.
- 9) Open the protective shield and remove the pellet press to extract the pellet.

NOTE: KBR POWDER IS SOFT AND COMPRESSIBLE. WHEN MAXIMUM FORCE IS APPLIED TO THE POWDER IT IS NORMAL FOR THE DIGITAL READING TO DROP INITIALLY BEFORE IT SETTLES AND REACHES A STEADY-STATE READING.

Transmission_powder sample

Preparing KBr Pellets_Pressing pellet

Step 4. Disassemble the die set and put the pellet onto the sample holder.

Step 5. Please clean the die after you finish your experiment.

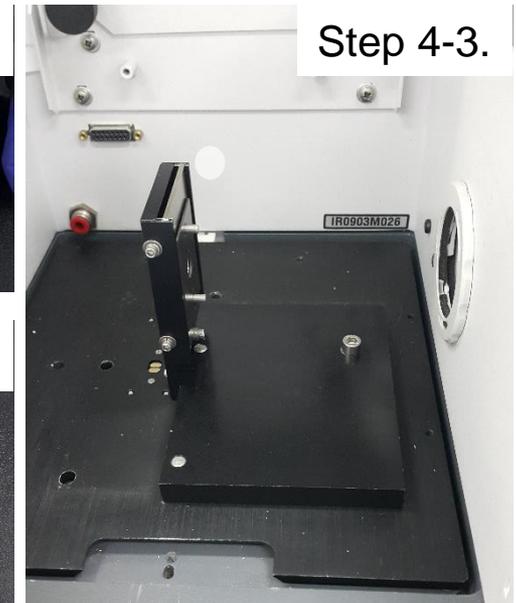
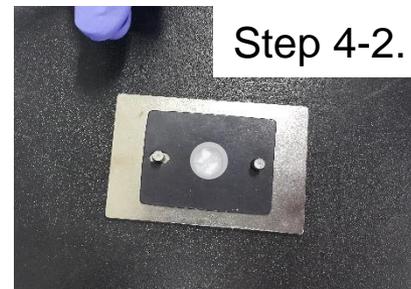
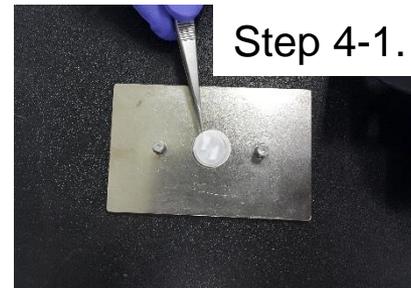
Step 6. Measurement background spectrum.

Step 7. Take a small amount of powder sample (about of 0.1-1% of the KBr amount) mix with the KBr powder. Subsequently grind the mixture for 3-5 minutes.

Step 2~6.

Step 8. Measurement sample spectrum.

- ✓ A good KBr pellet is thin and transparent. Opaque pellets give poor spectra and white spots in a pellet indicate that the powder is not ground well enough, or is not dispersed properly in the pellets.



Step 1. Choice the window material.(ZnSe or CaF_2)

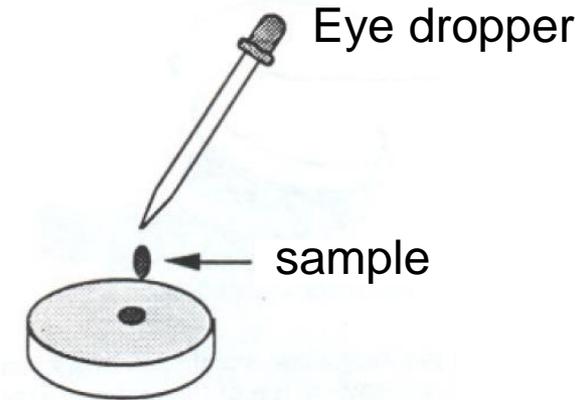
Step 2. Measurement background spectrum with window material.

Step 3. Place a small amount of sample onto the window using the eye dropper or spatula.

Step 4. Once enough sample is deposited on the window, place the other infrared window on top of the sample.

Step 4. Twist the windows together in opposite directions to get rid of air bubbles and to decrease the pathlength.

Step 5. Measurement sample spectrum with sample and window material.

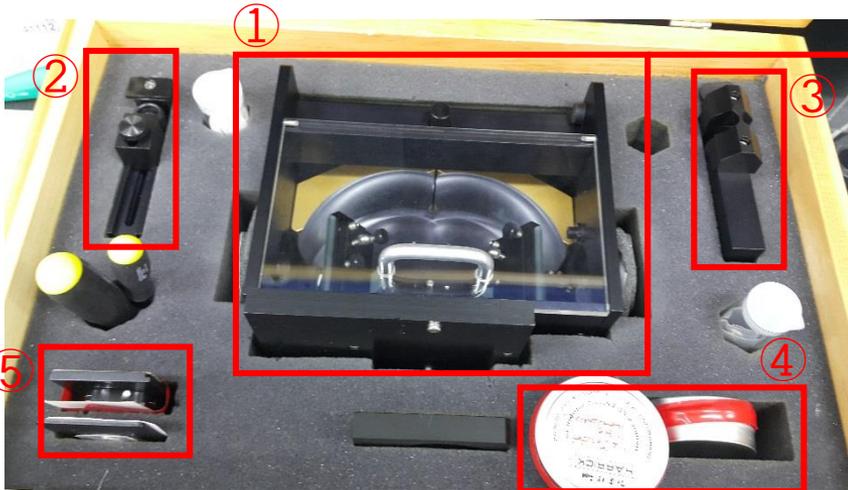


Apply pressure and twist top window

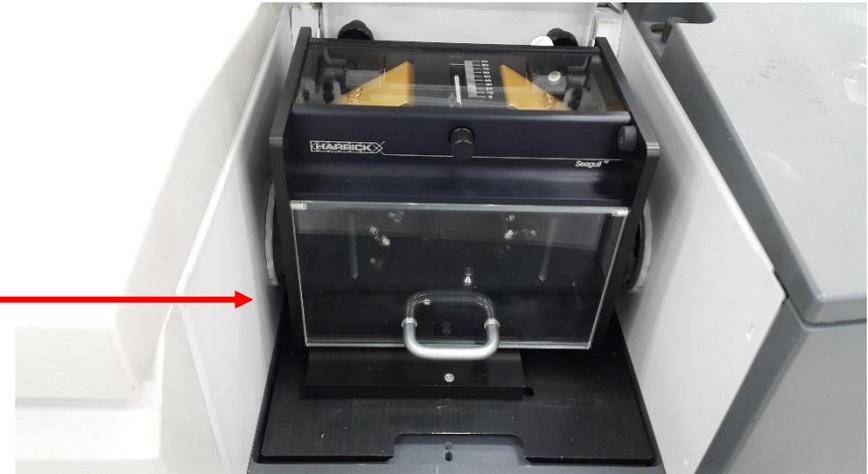


Apply pressure and twist bottom window

PREPARATION OF SEAGULL

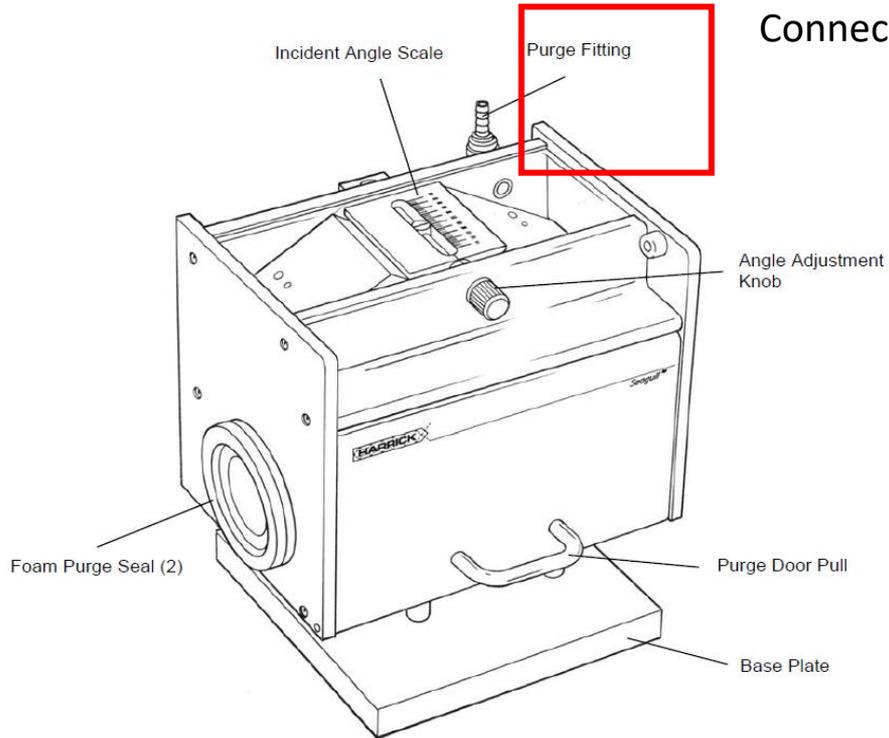


Place Seagull part to FT-IR main body.

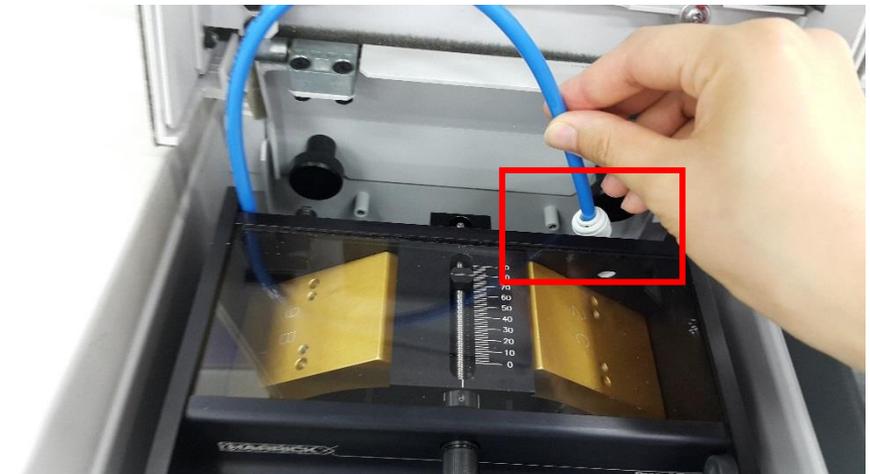
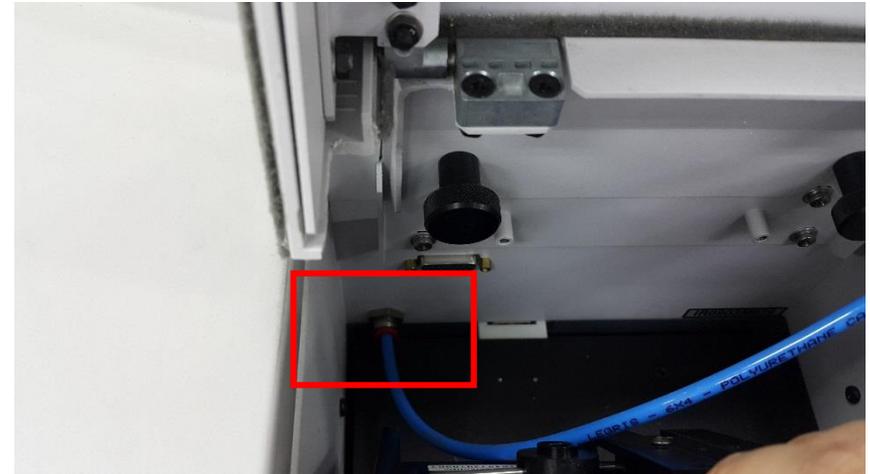


- ① Seagull part
- ② Sample holder
- ③ ATR sample holder
- ④ ATR crystal(Ge and ZnSe)
- ⑤ Polarizer

PREPARATION OF SEAGULL

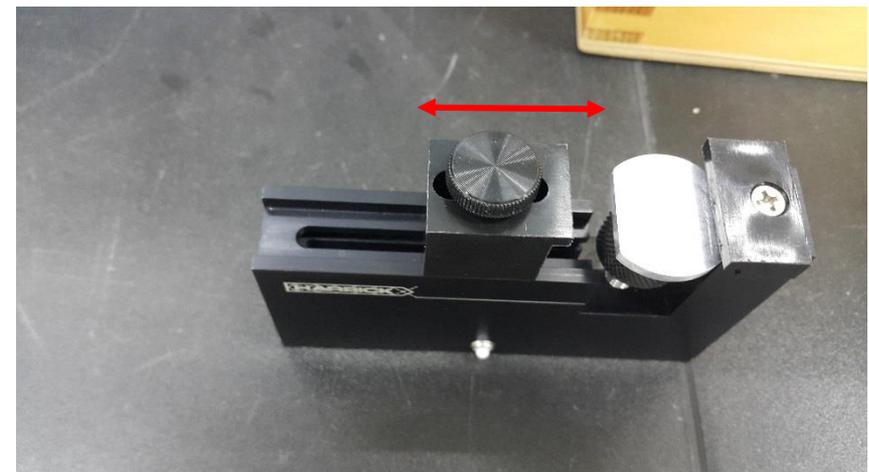
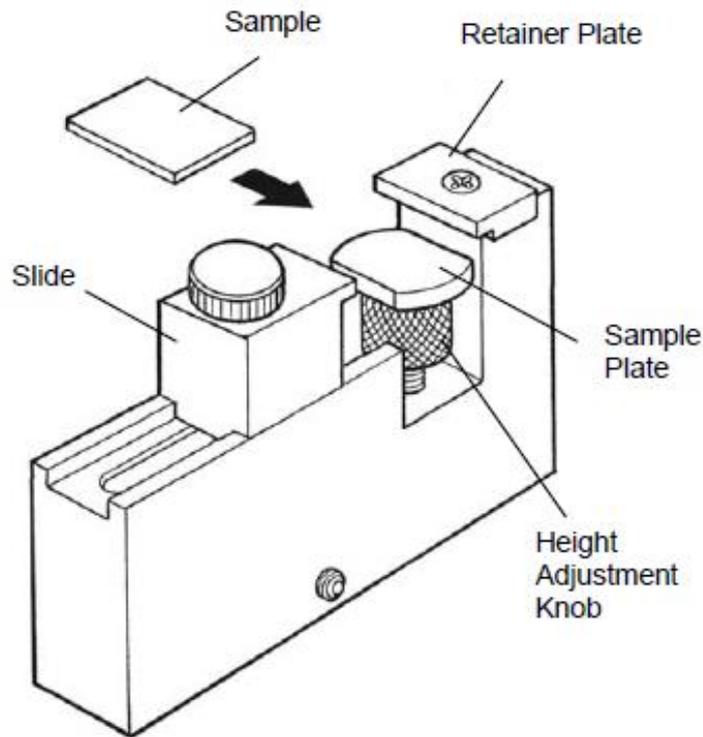


Connect an additional purge line to the fitting on the Seagull.

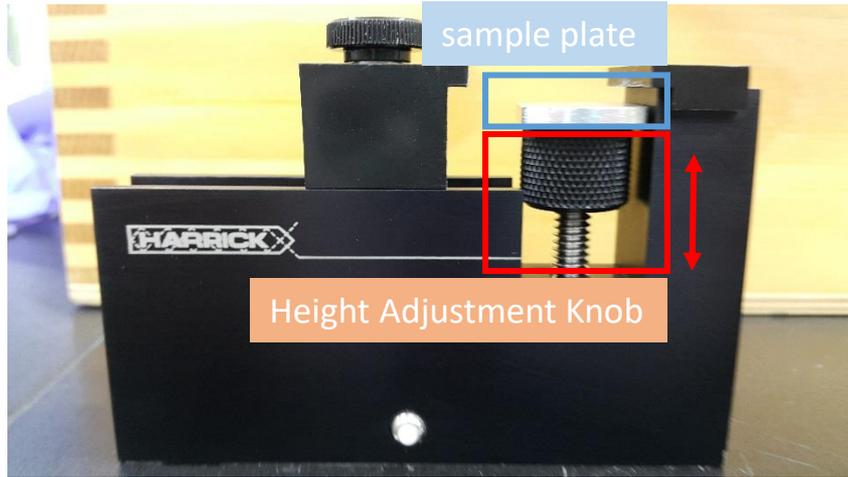


PREPARATION OF THE SAMPLE HOLDER

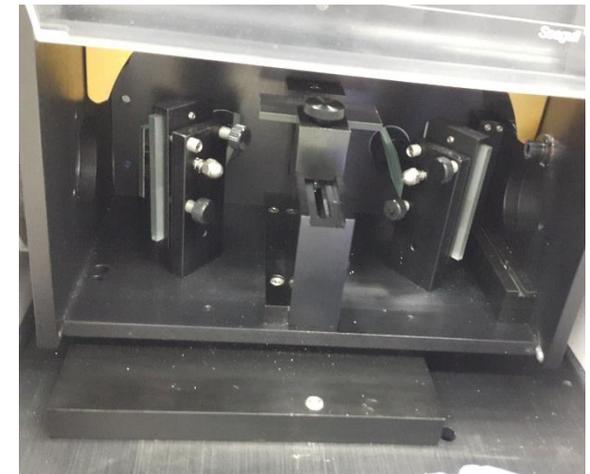
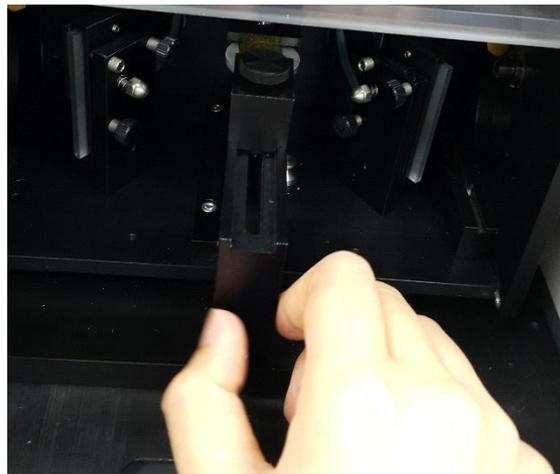
- 1) Turn the slide knob on the external reflection sample holder clockwise (Figure) until the slide is free to move.



PREPARATION OF THE SAMPLE HOLDER

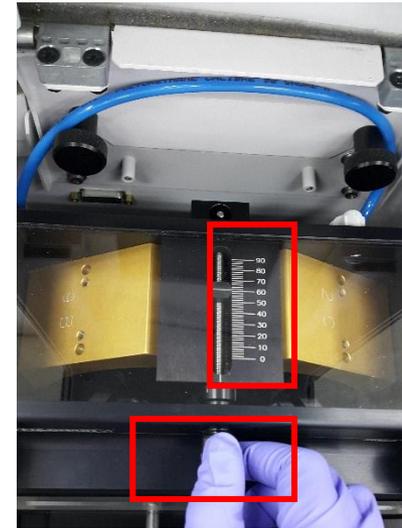
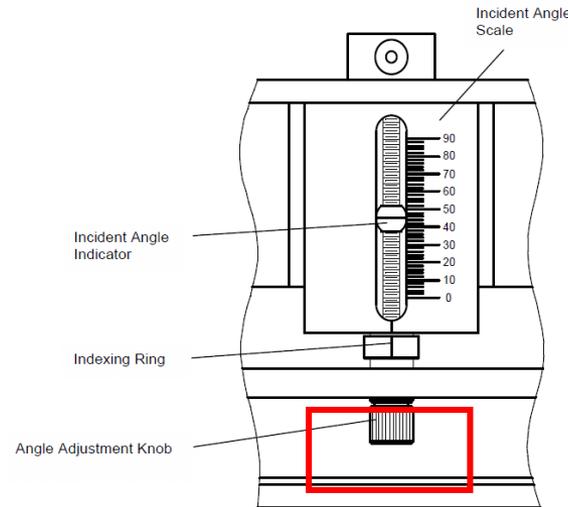
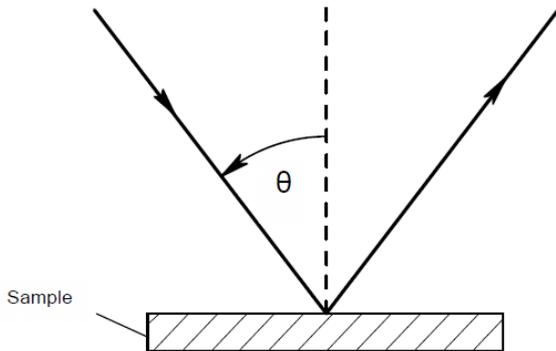


- 2) Lower the height adjustment knob by rotating it clockwise.
- 3) Locate the sample plate on the height adjustment knob.
- 4) Place the reference face up on the sample plate and move the slide so it lightly touches the reference.
- 5) Secure the slide by turning the slide knob clockwise.
- 6) Elevate the reference by rotating the height adjustment knob counterclockwise until the mirror is held in place against the retainer plate and slide.
- 7) Open the purge door and slide the sample holder into the Seagull™.



INCIDENCE ANGLE AND REFLECTANCE OPERATION

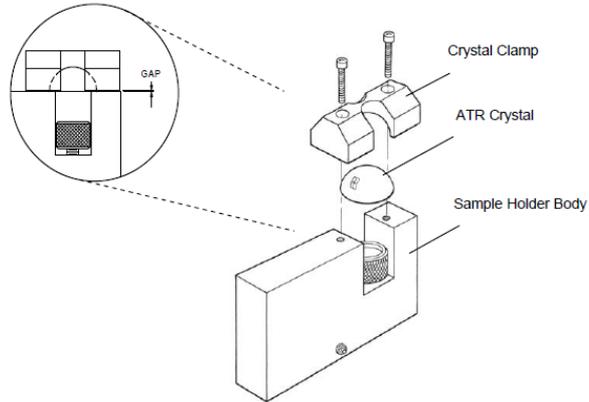
The incident angle θ (Figure 5) is read from the scale on top of the Seagull.



- 8) Set the incident angle.
- 9) Collect the background spectrum.
- 10) Replace the reference with the sample.
- 11) Collect the sample spectrum.

ATR SAMPLE HOLDER

The ATR sample holder is used for ATR operation.



MOUNTING THE ATR CRYSTAL

1) Mount the ATR crystal into the ATR sample holder using a 7/64" ball driver undo the two screws on the crystal clamp of the ATR sample holder.

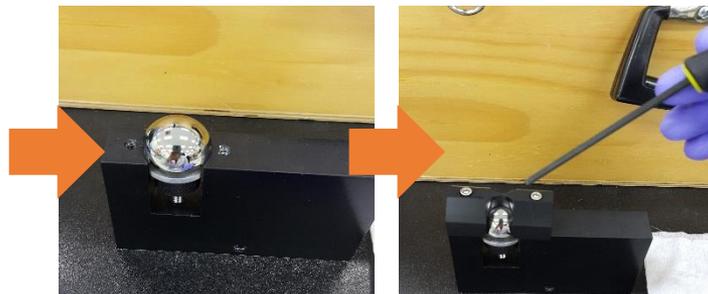
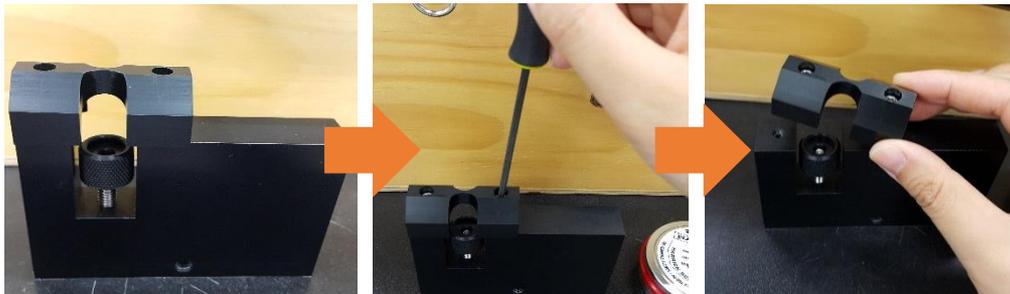
2) Remove the crystal clamp.

3) Carefully place the crystal on the ATR sample holder body as shown in Figure.

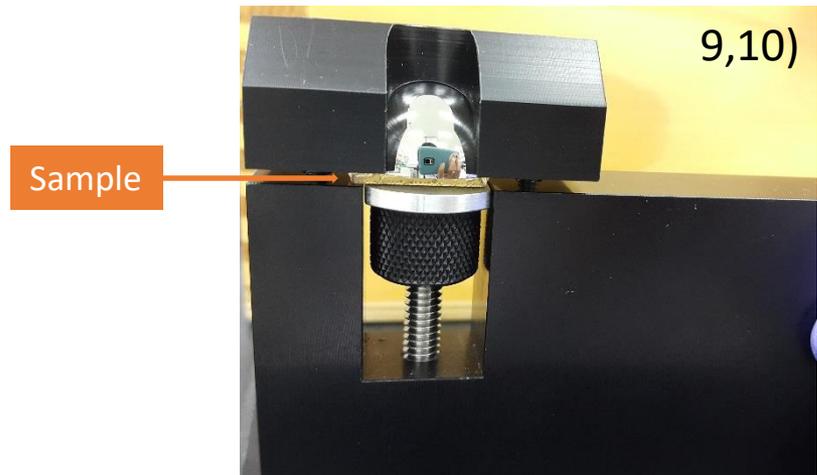
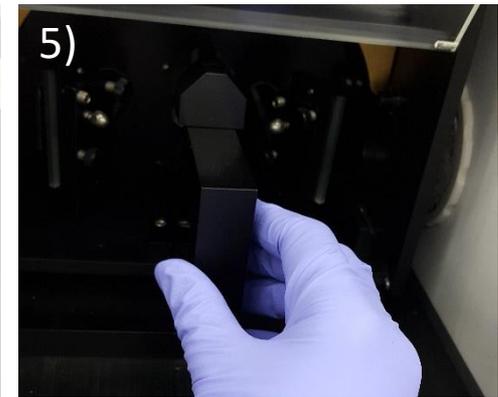
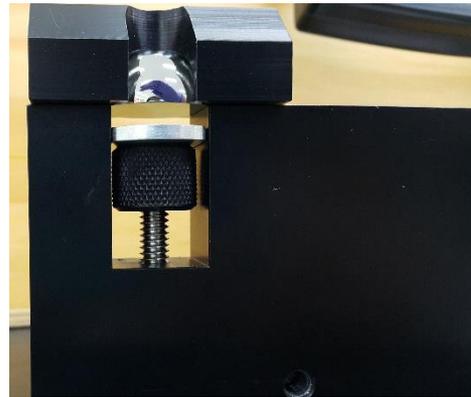
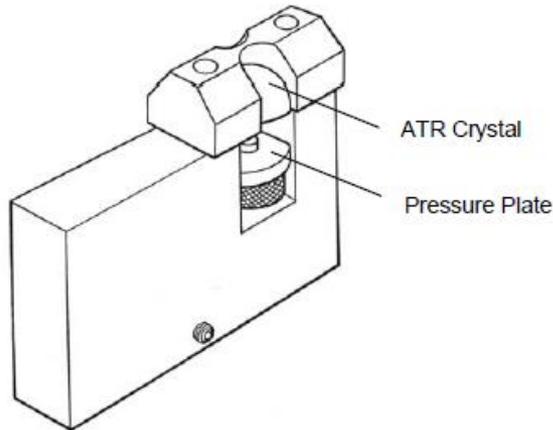
4) Carefully replace the crystal clamp and tighten the screws evenly so the crystal clamp is seated with equal gaps on both ends.

CAUTION:

The ATR crystal scratches easily so it should be handled with care. Wipe only with damp lens tissue or cotton swabs.



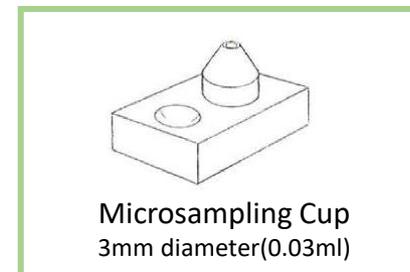
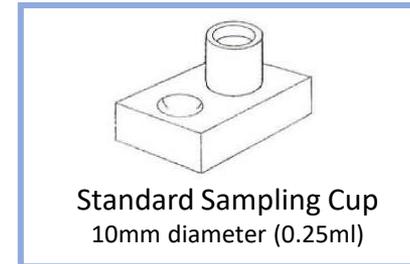
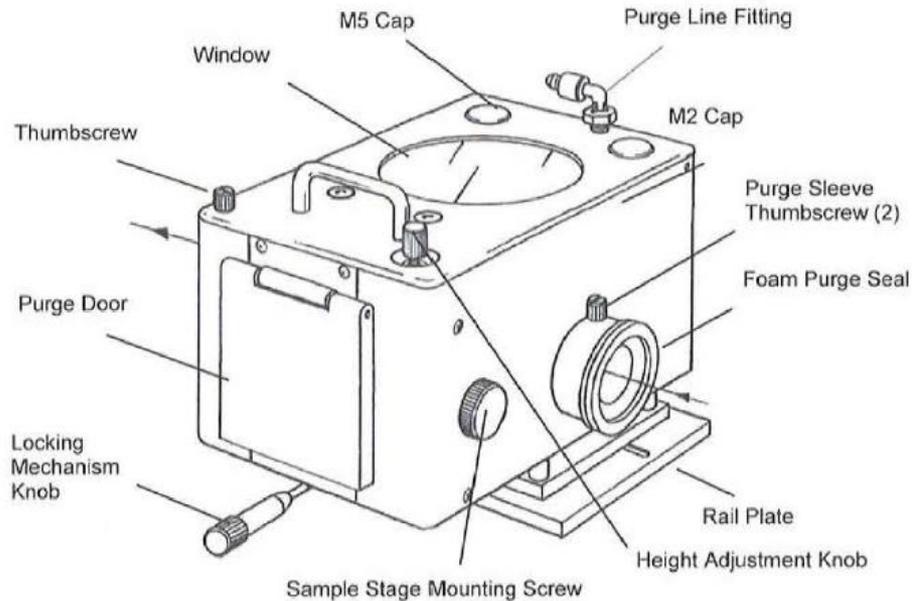
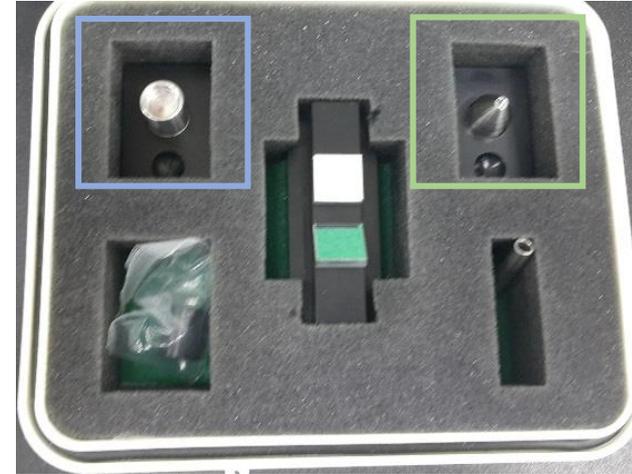
ATR SAMPLE HOLDER



To use the ATR sample holder:

- 5) Install the ATR sample holder into the Seagull™.
- 6) Set the desired incident angle.
- 7) Collect the background spectrum.
- 8) Locate the pressure plate on the height adjustment knob of the ATR sample holder.
- 9) Place the sample on the pressure plate.
- 10) Raise the pressure plate to make contact between the crystal and the sample.
- 11) Collect the sample spectrum.
- 12) Clean the crystal with lens paper and IPA.

DRIFT(Diffuse Reflectance Infrared Fourier Transform)_Praying Mantis



DRIFT(Diffuse Reflectance Infrared Fourier Transform)

- Factors for high quality DRIFT

Particle Size

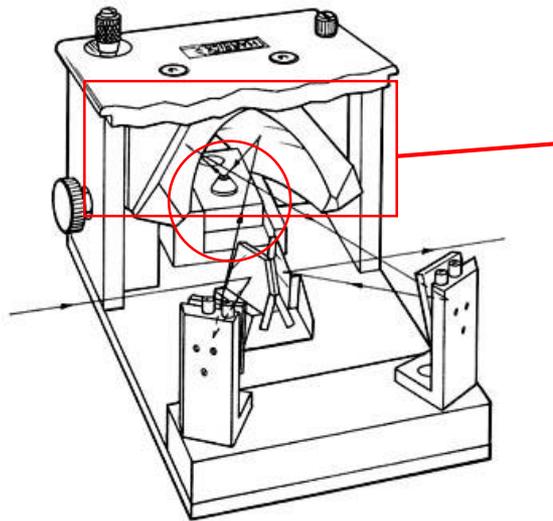
Smaller particles ($\leq 10 \mu\text{m}$) improve the quality of spectra.

Refractive Index

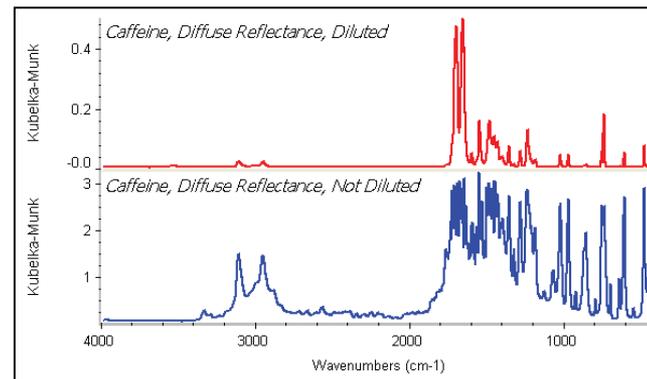
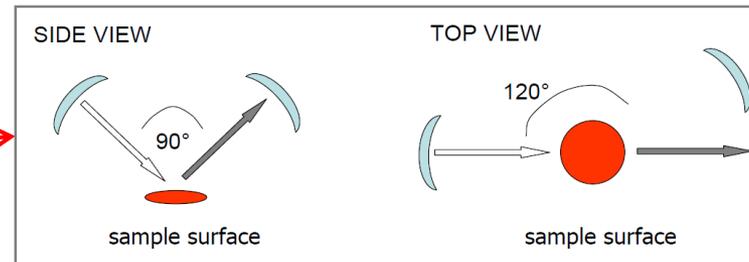
Sample dilution reduce the distorted spectra by Specular reflectance component.

Packing

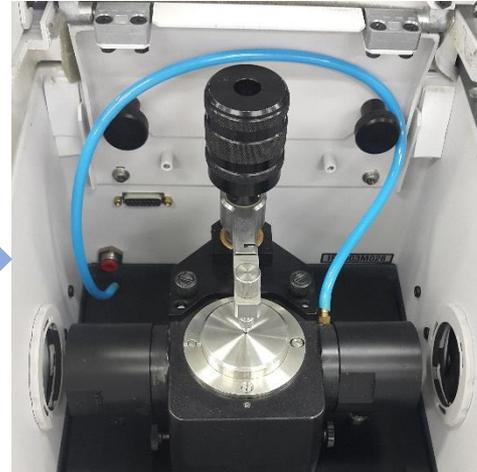
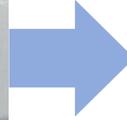
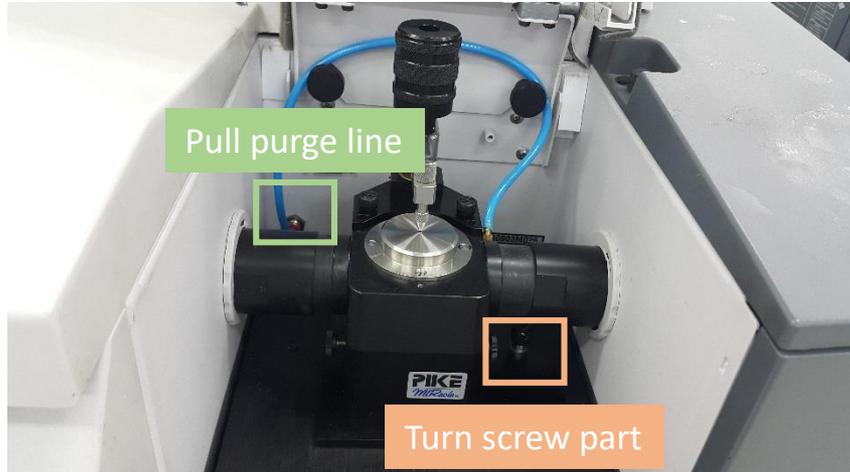
Loosely packing maximize IR beam penetration and minimize spectral distortions.



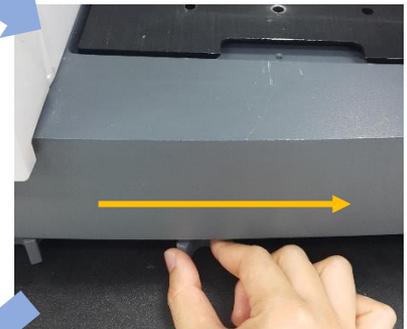
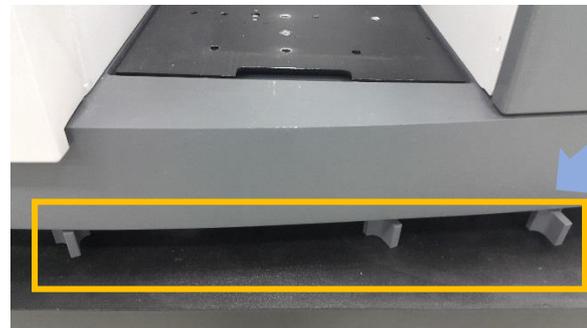
Interior View of the Praying Mantis



PREPARATION OF PRAYING MANTIS



Remove ATR part



The plate can be removed from FT-IR main body when this lever move from the left to the right.

PREPARATION OF PRAYING MANTIS



1)



2)

Rail plate



3)



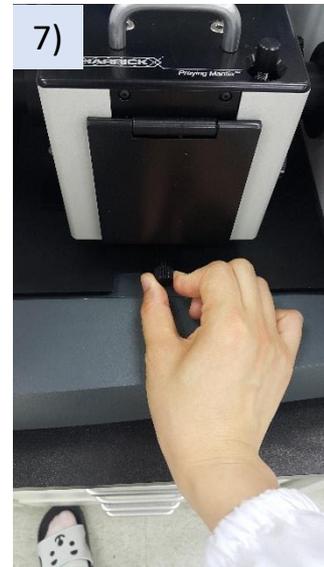
4)



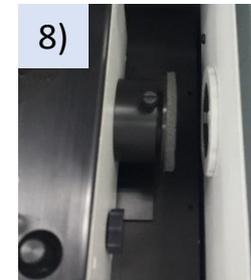
5)



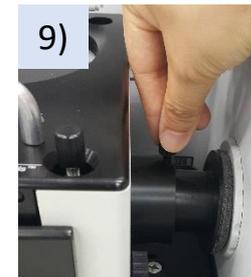
6)



7)



8)



9)

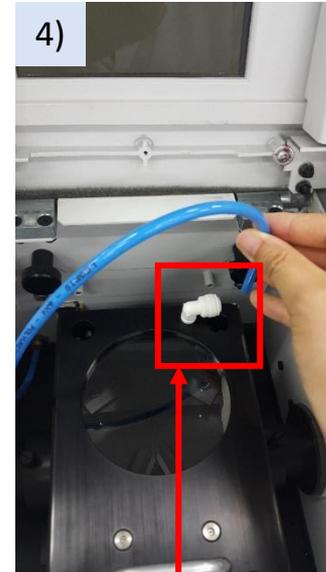


10)

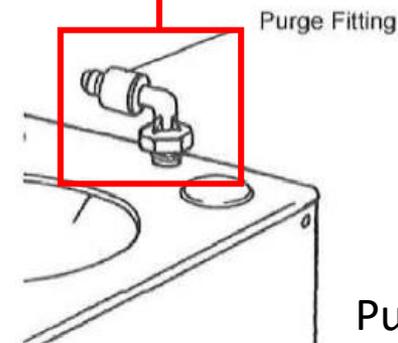
- 1) Remove the plate.
- 2) Change to the rail plate.
- 3,4) Change the lever position to fix the rail plate.
- 5) Put the Praying Mantis on the rail plate.
- 6) Move the Praying Mantis along the rails until the spectrometer focal point is in the center of the attachment.
- 7) Lock the Praying Mantis in place by tightening the locking mechanism knob.
- 8~10) Extend the purge sleeves until they firmly contact the sides of the sample compartment. Lock the purge sleeves in place with the thumbscrews.

PREPARATION OF PRAYING MANTIS

For quicker purging, connect an additional purge line to the fitting on the Praying Mantis.

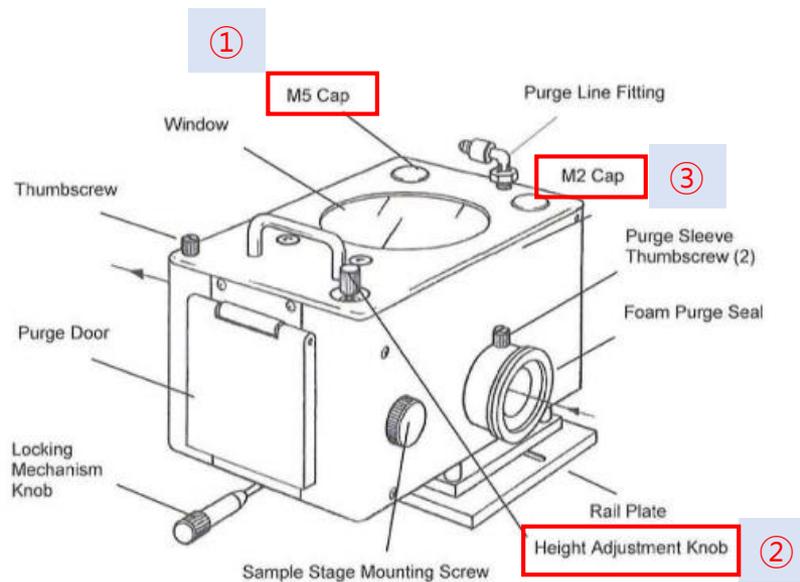
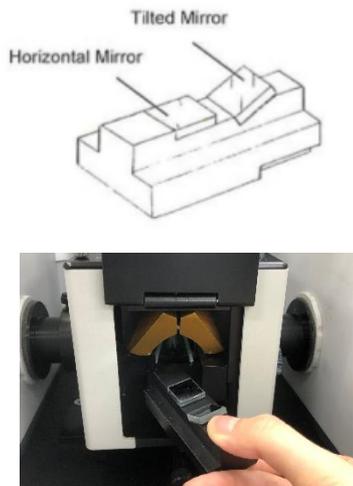


- 1) Prepare additional line.
- 2,3) Connect the line to the main body.
- 4,5) Connect the line to the Praying Mantis part.

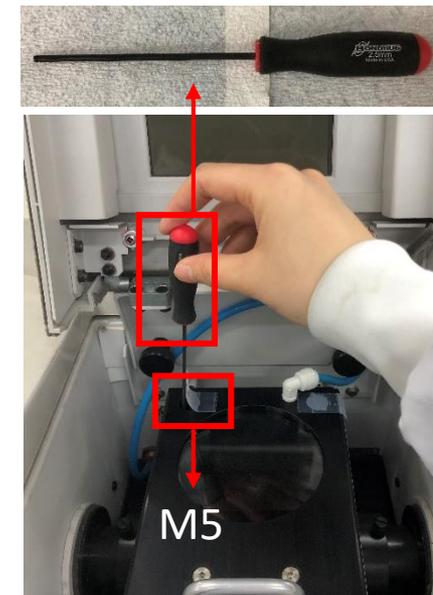


PREPARATION OF PRAYING MANTIS

The Praying Manti has been pre-aligned prior to shipment.

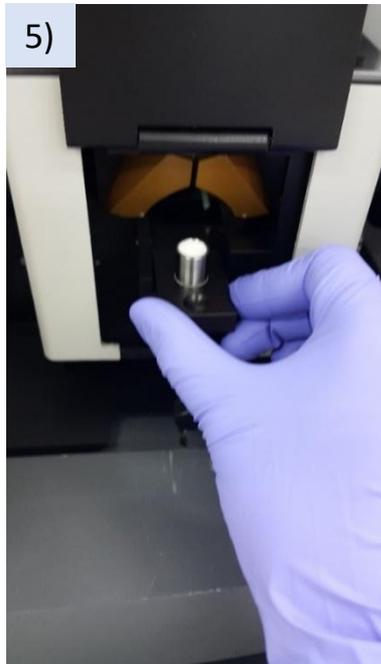
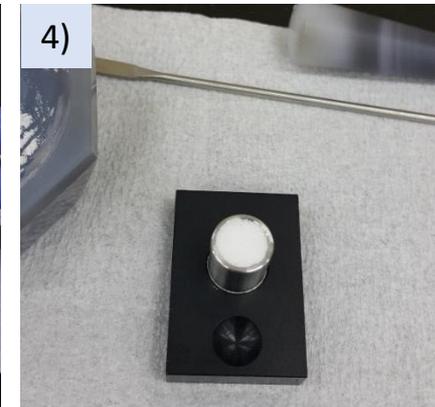
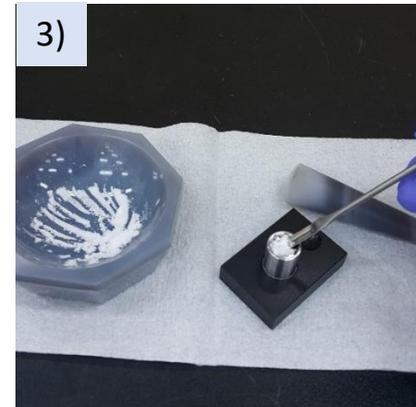
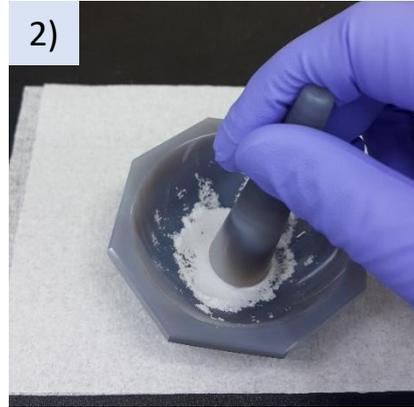


2.5mm



- 1) Open the door on the front of the attachment. Slide the alignment fixture into the Praying Mantis, with the horizontal mirror going in first. In this orientation, the tilted mirror is in the sampling position
- 2) Remove the plastic caps over mirrors M2 and M5.
- 3) Adjust the turn and tilt controls for M5(①) until the signal on the detector is maximized.
- 4) Adjust the height of the alignment fixture with the height adjustment knob(②) to maximize the signal.
- 5) Adjust the turn and tilt controls for M2(③). Repeat this sequence until there is no further increase in the signal on the detector.
- 6) Slide the sample holder. Adjust the height of the alignment fixture with the height adjustment knob(②) to maximize the signal.

BACKGROUND SPECTRUM



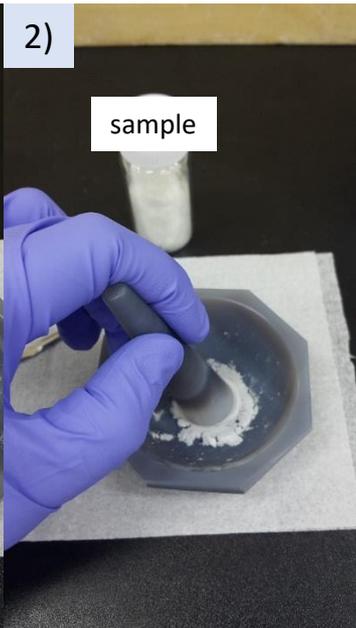
- 1) Prepare reference material.
- 2) When the reference material is KBr, grind the powder with mortar and pestle. The particle size should be smaller than 10 μm (i.e. not exceeding the wavelength of the incident radiation).
- 3) Overfill one of the sampling cups with the reference material (i.e. KBr).
- 4) Level off the surface using a flat blade.
- 5~6) Open the purge door and slide the sampling cup into the Praying Mantis, pushing it in against the stop.
- 7) Find the center of laser position on sample surface turning the Height adjustment knob.
- 8) Measure background spectrum.

SAMPLE SPECTRUM

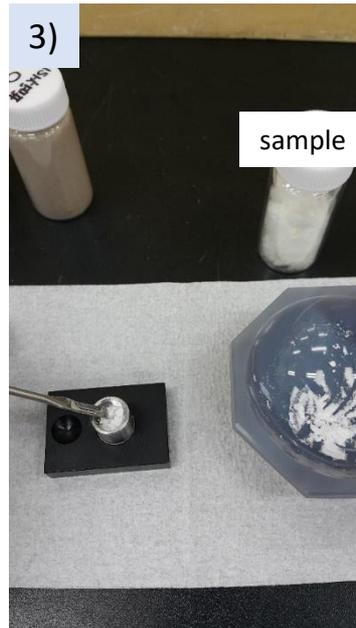
1)



2)



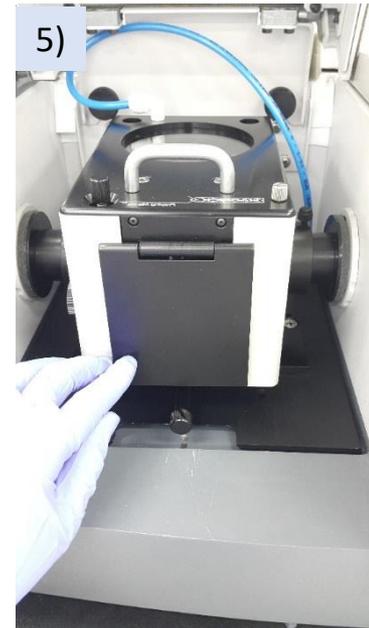
3)



4)



5)



1) Add sample to reference material(i.e. KBr).

2) Grind the sample with reference material.

If the sample is a strong absorber it may need to be diluted (approximately 1~5%) in a nonabsorbent reference matrix.

3) Overfill one of the sampling cups with the sample and level off the surface using a flat blade.

4) Open the purge door and slide the sampling cup into the Praying Mantis, pushing it in against the stop.

5) Close the purge door.

6) Measure sample spectrum.

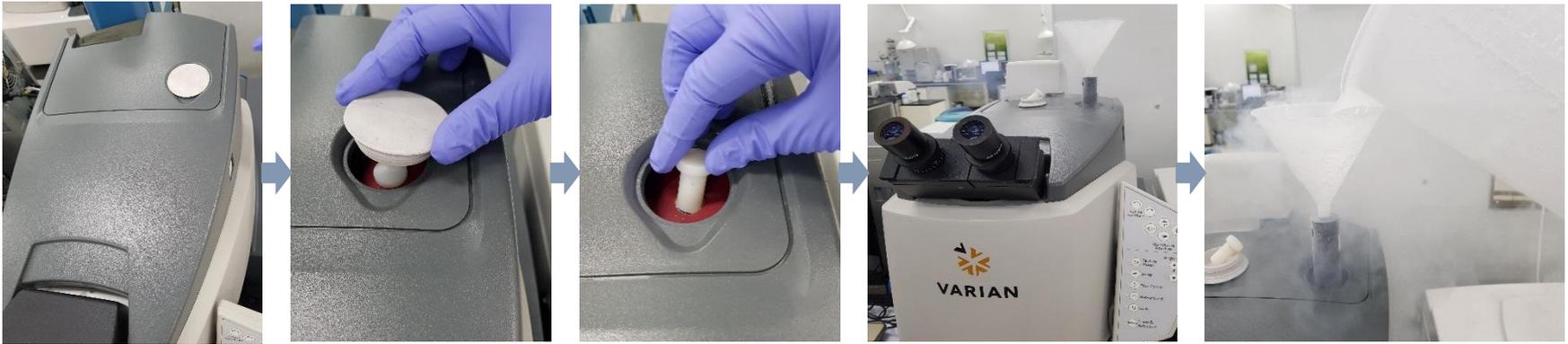
6. Microscope

UNIST

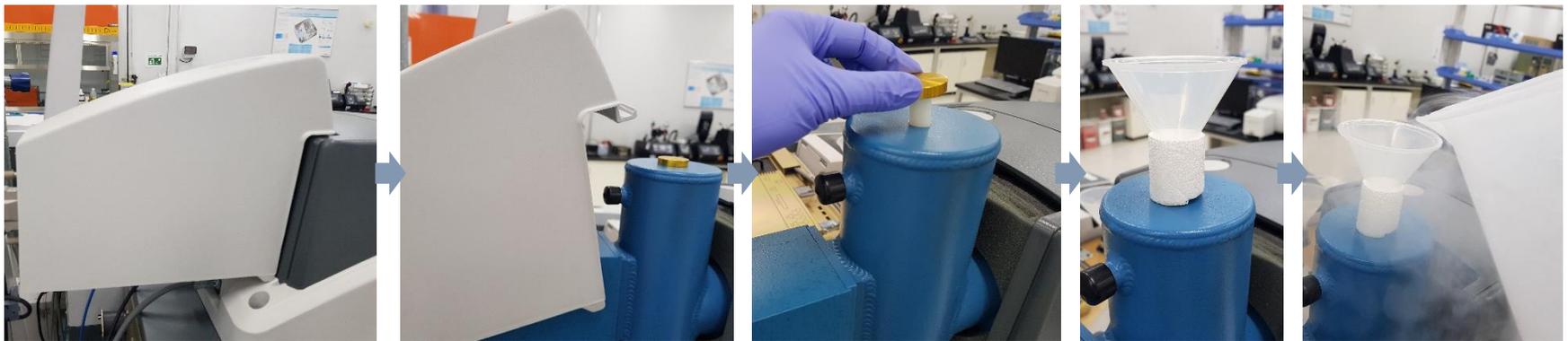
ULSAN NATIONAL INSTITUTE OF
SCIENCE AND TECHNOLOGY

- Fill the detector with Liquid Nitrogen.

1) Microscope MCT detector(for single spectrum) need about 500mL liquid nitrogen.

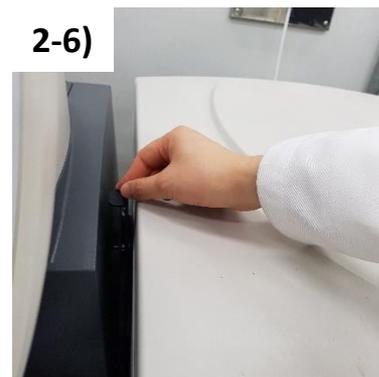
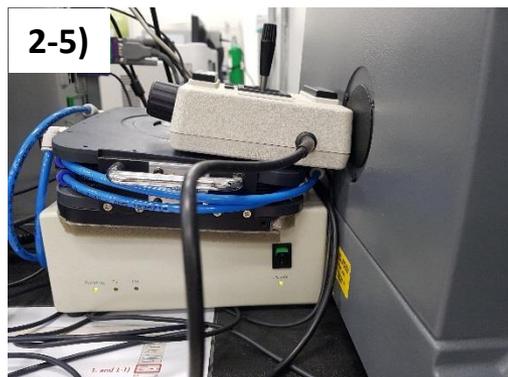
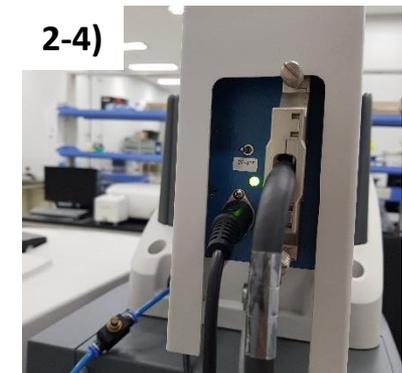
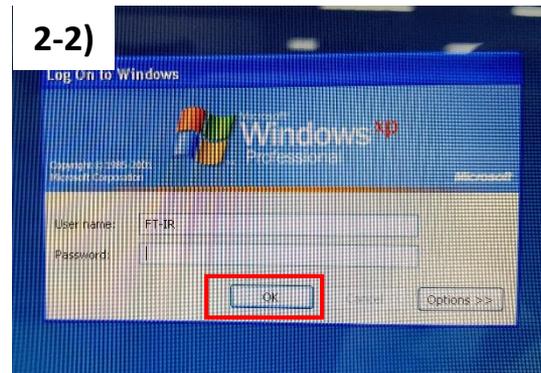
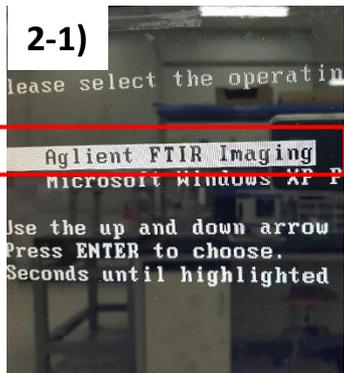


2) FPA detector(for image scan) need about 1L liquid nitrogen.



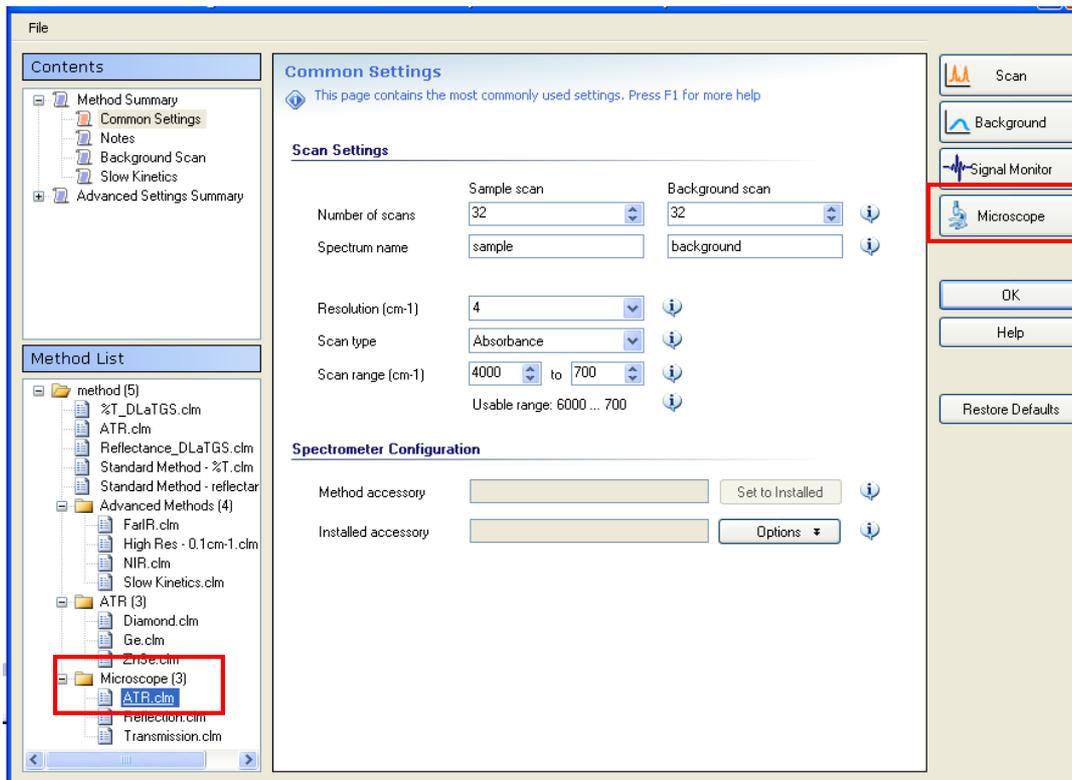
Restart the computer and Switch on the microscope part.

- 1) Select Agilent FTIR Imaging.
- 2) Click OK on Long On to Windows.
- 3) Switch on the microscope part(backside of IR microscope).
- 4) Switch on the FPA detector(only for the IR image scan).
- 5) Switch on the Joy stick for the stage control.
- 6) Open the beam line between mainbody and microscope part.

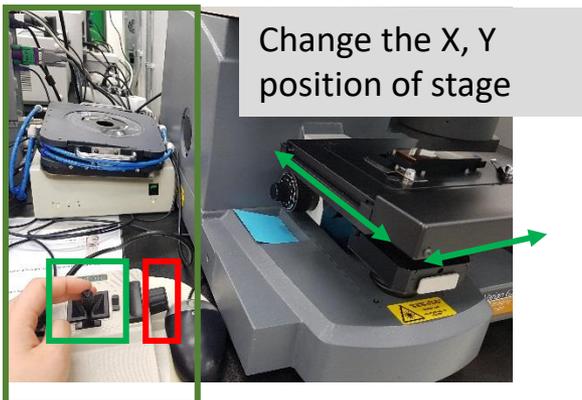
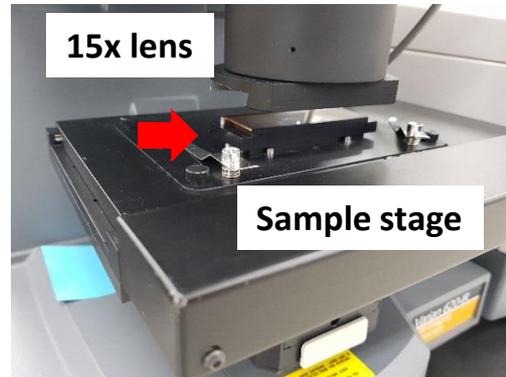


■ FT-IR Microscope_ATR

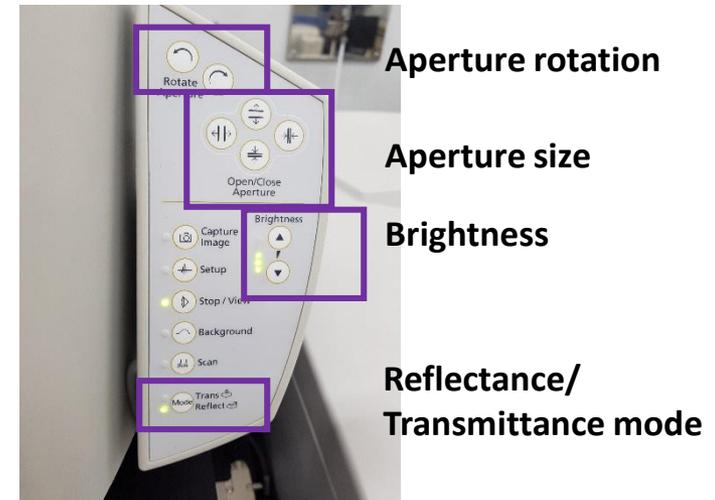
1. Open the Agilent Resolution Pro. Program.
2. Place the sample on the sample stage.
3. Method editor – Method List – Microscope.
4. Find focus and select the measurement point of sample changing the stage position.



■ FT-IR Microscope_ATR

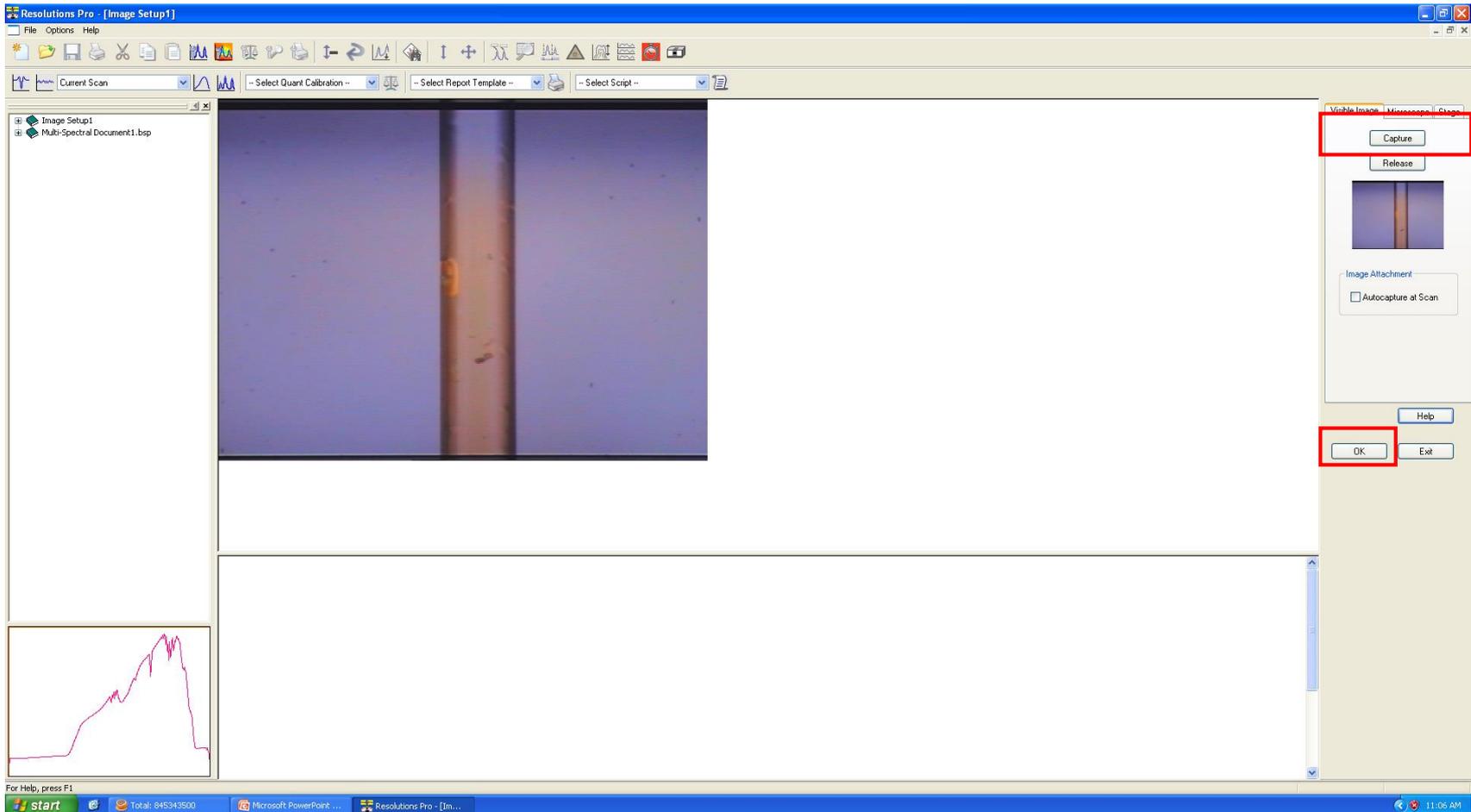


Turn **Right** – Stage **DOWN**
Turn **Left** – Stage **UP**



■ FT-IR Microscope_ATR

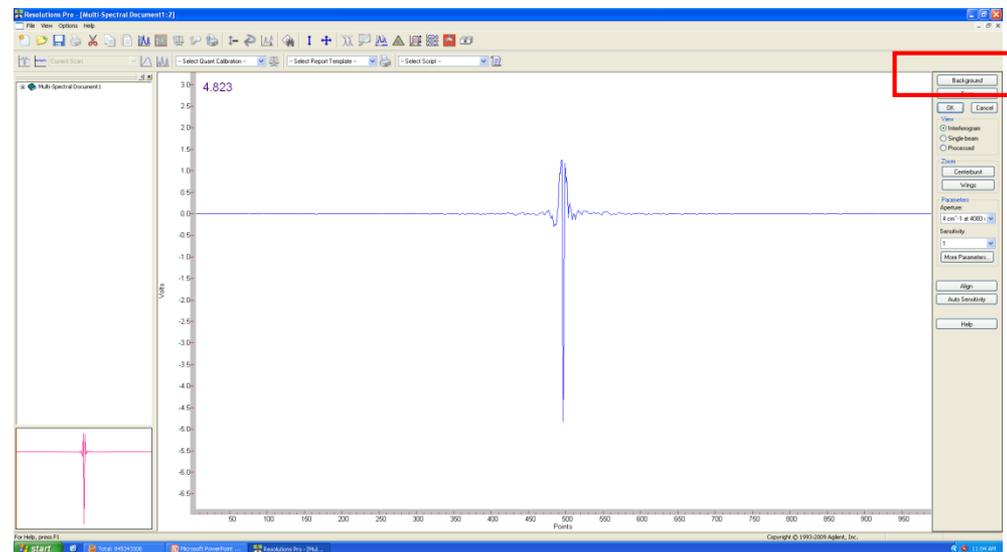
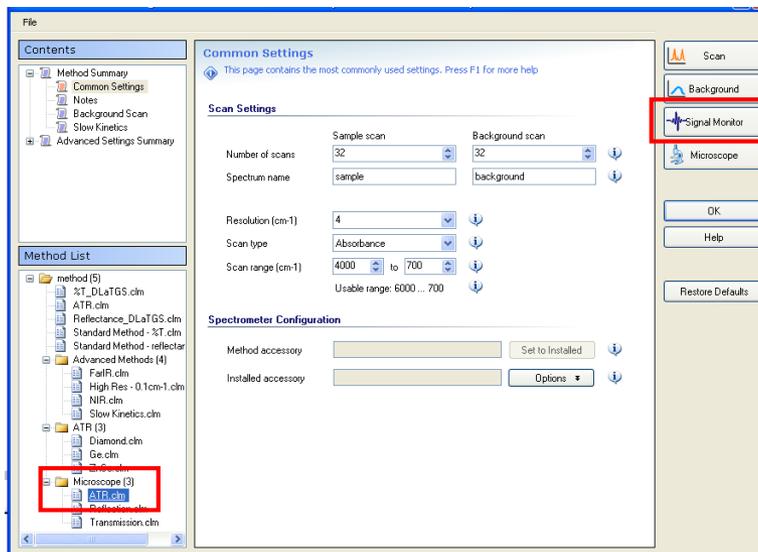
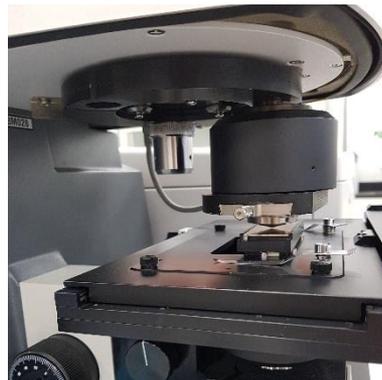
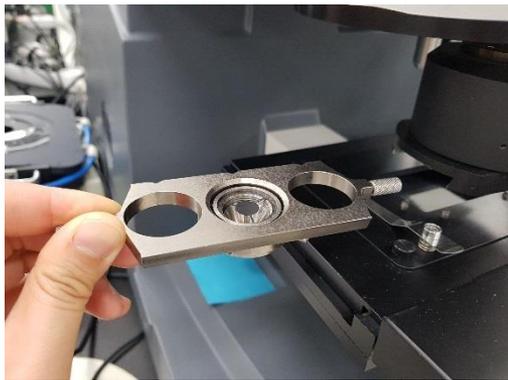
5. Click Capture.
6. Click OK.



■ FT-IR Microscope_ATR

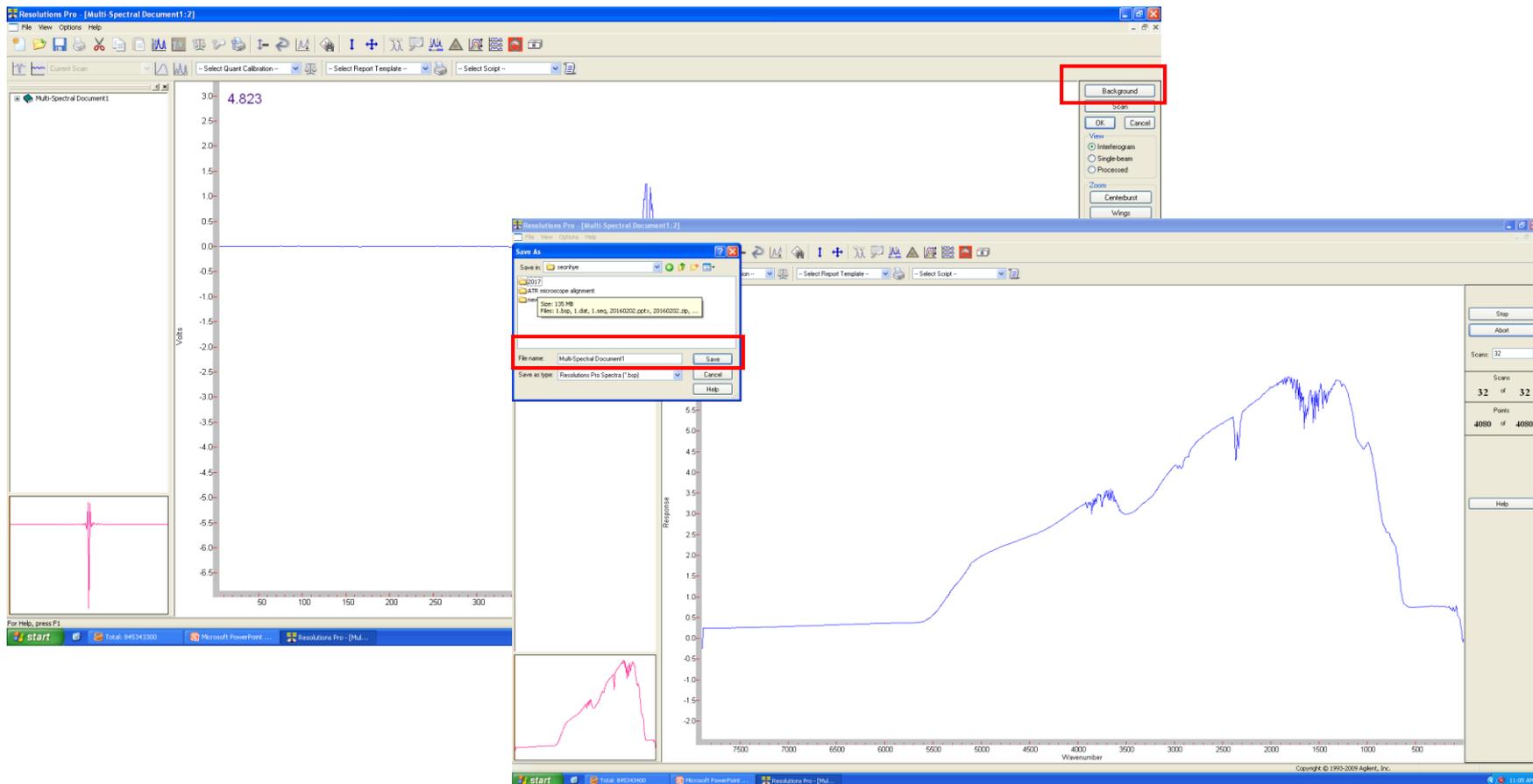
7. Put the ATR slide to the lens part.

8. Method editor – Method List – Microscope – Reflectance – Signal monitor



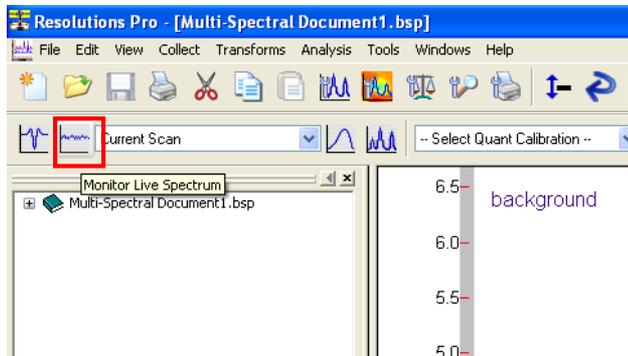
■ FT-IR Microscope_ATR

9. Background – Save



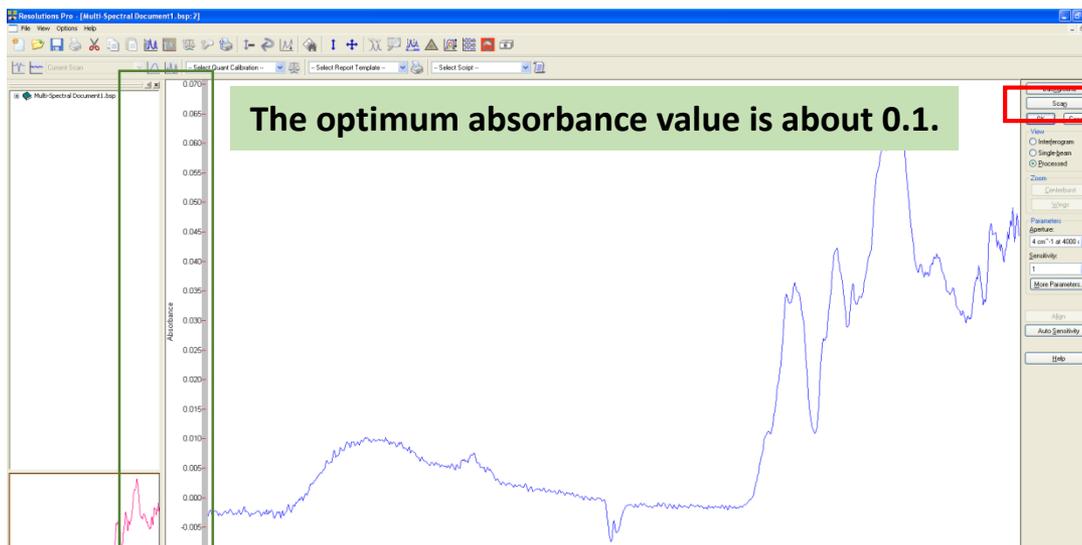
■ FT-IR Microscope_ATR

10. Monitor Live Spectrum

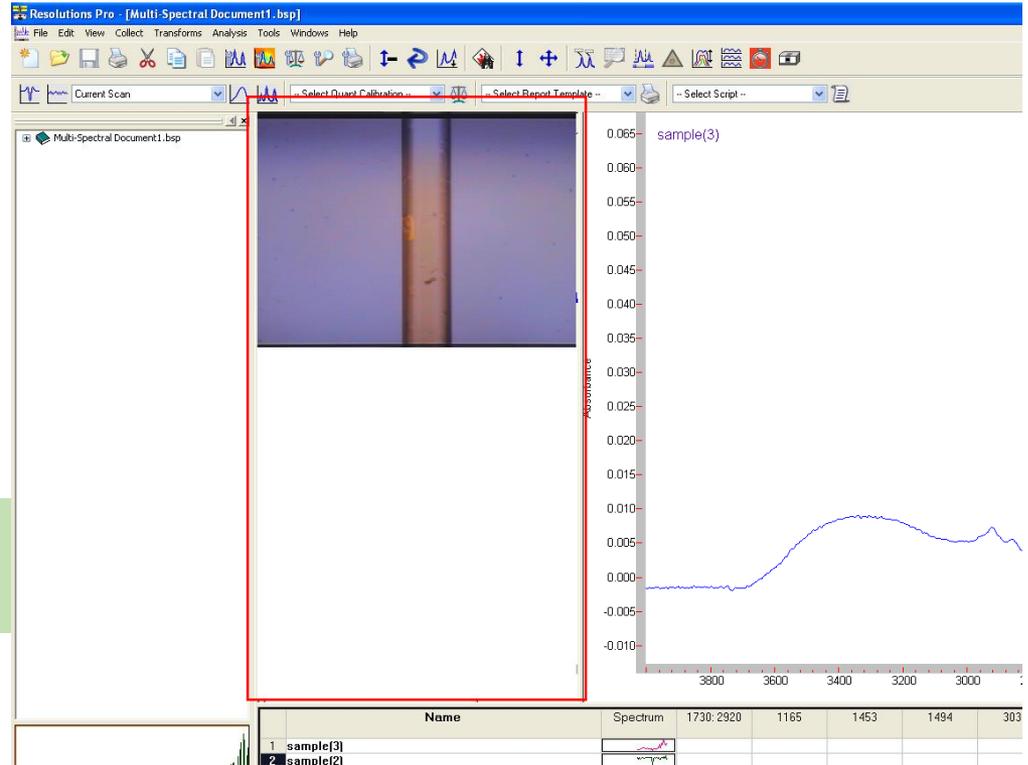
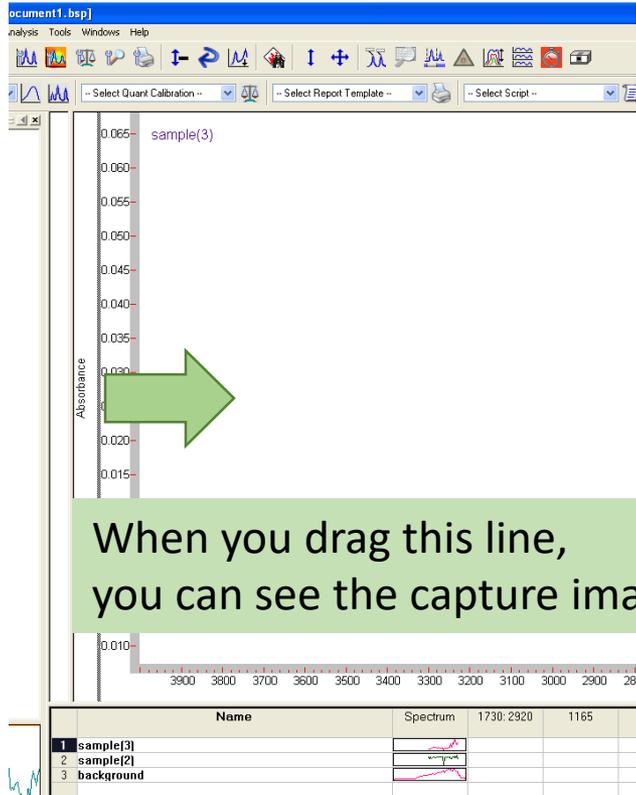


11. Move up the stage checking the IR signal through Monitor live spectrum.

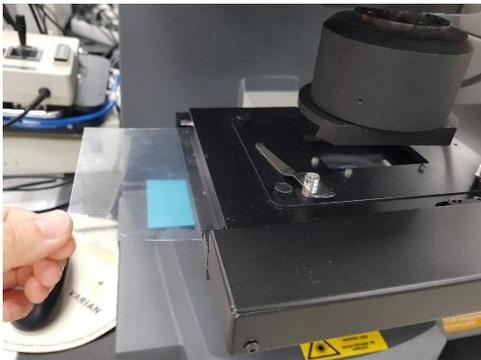
12. Scan.



■ FT-IR Microscope_ATR



■ FT-IR Microscope_Transmittance



1. Remove the protective film in the stage.
2. Place the sample on the stage and find the focus.
3. Remove the sample from the stage.
4. Method editor – Method List – Microscope – Transmittance – Signal monitor

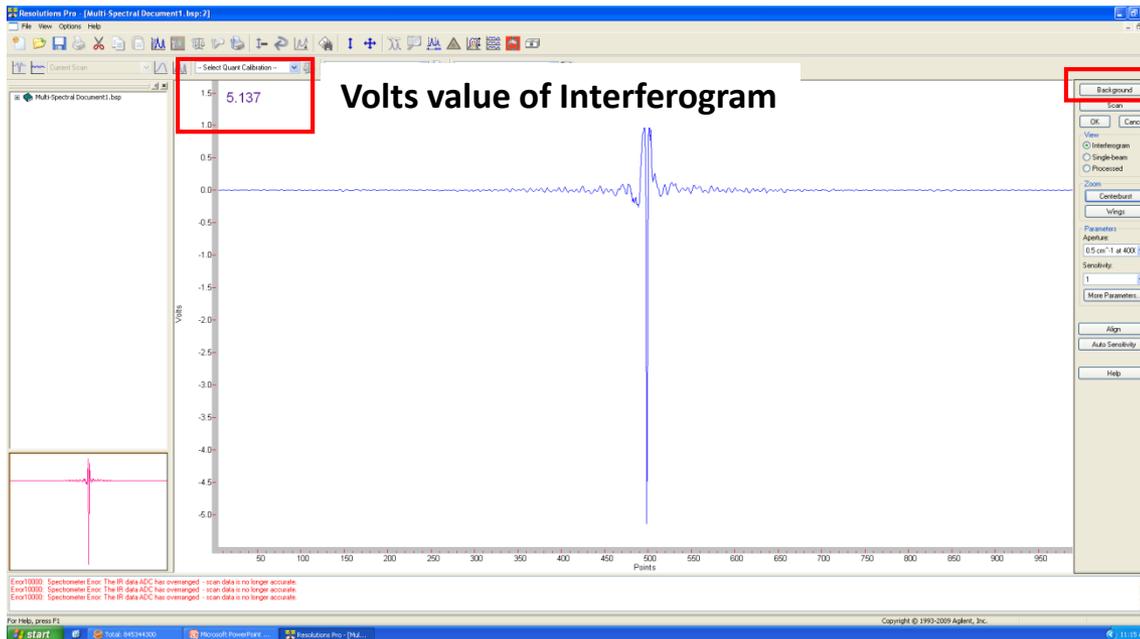
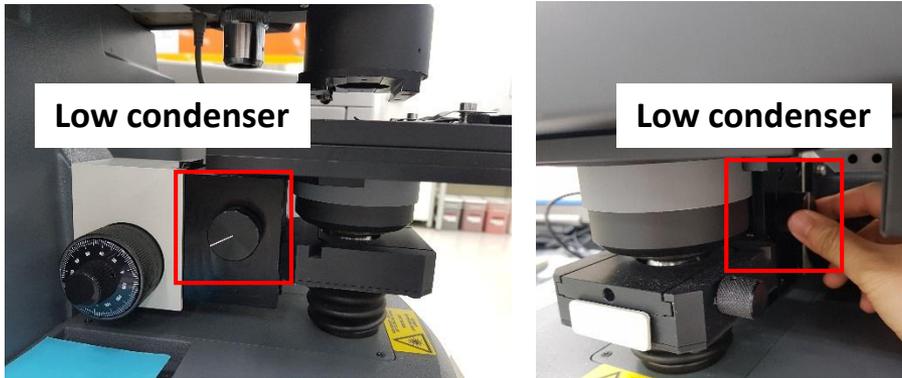
The screenshot displays the software interface for FT-IR measurements. On the left, the 'Method List' shows a tree structure with 'Transmission.clm' selected under the 'Microscope' category. The main window is titled 'Common Settings' and contains the following sections:

- Scan Settings:** Includes fields for 'Number of scans' (32), 'Spectrum name' (sample/background), 'Resolution (cm-1)' (4), 'Scan type' (Absorbance), and 'Scan range (cm-1)' (4000 to 700).
- Spectrometer Configuration:** Includes 'Method accessory' and 'Installed accessory' fields.

On the right side of the interface, a vertical panel contains several buttons: 'Scan', 'Background', 'Signal Monitor' (highlighted with a red box), and 'Microscope'. Below these are 'OK', 'Help', and 'Restore Defaults' buttons.

■ FT-IR Microscope_Transmittance

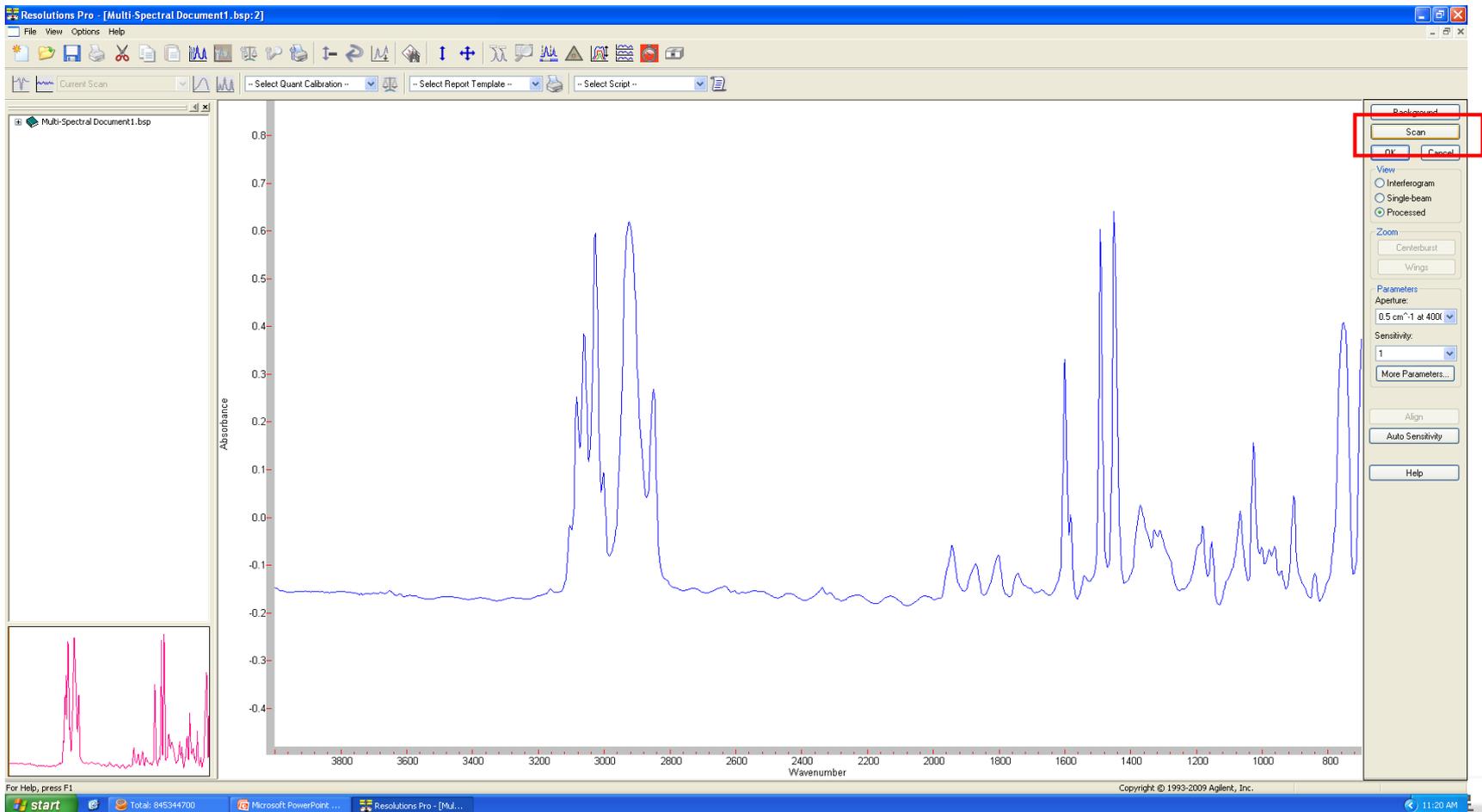
5. Adjust the maximum Interferogram volts value changing the low condenser.



6. Collect Background.
7. Save.

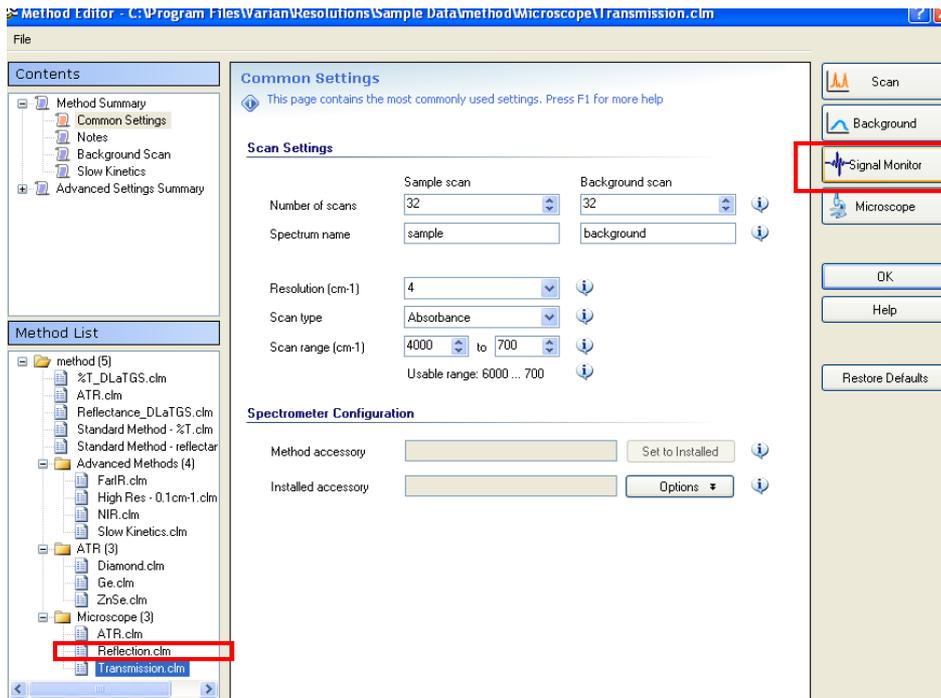
■ FT-IR Microscope_Transmittance

8. Place the sample on the stage and find the focus again.
9. Check the Monitor live spectrum.
10. Collect scan.



■ FT-IR Microscope_Reflectance

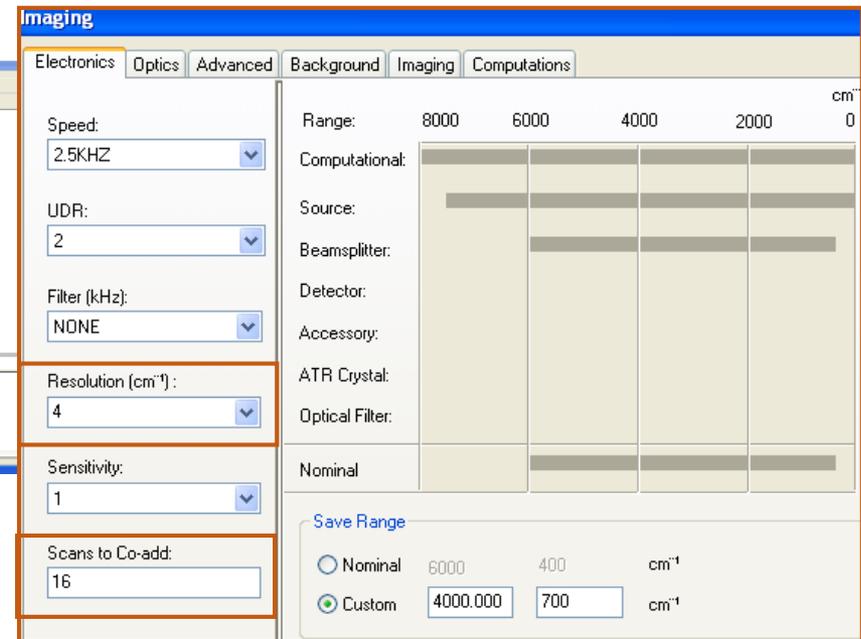
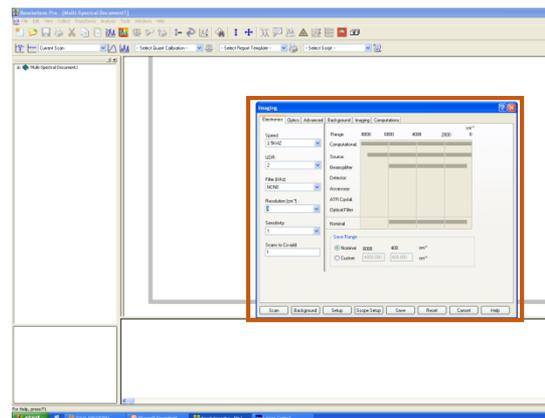
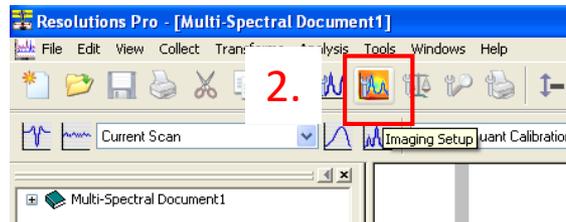
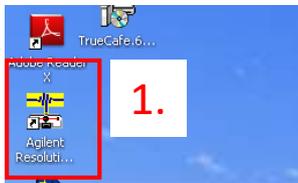
1. Place the reference gold mirror on the sample stage.
2. Find focus on surface of gold mirror.
Aperture size should be same with sample size.
3. Method editor – Method List – Microscope – Reflectance
– Signal monitor – Background – Save



4. Place the sample on the stage.
5. Find the focus and select the measurement point.
6. Check the spectrum with Monitor live spectrum.
7. Scan.

■ FT-IR Microscope_ATR image scan(mapping)

1. Open the Agilent Resolution Pro. Program.
 2. Click the Image Setup.
- You can change the Resolution, Sensitivity and Scan number.



■ FT-IR Microscope_ATR image scan(mapping)

3. Find the beam line from the mainbody.

1) Select the Optics.

- Beam_Internal

- Detector_Mainbody detector(DLaTGS, TE Cooled or MCT, Lin Broadband 1.0)

2) Click Set up.

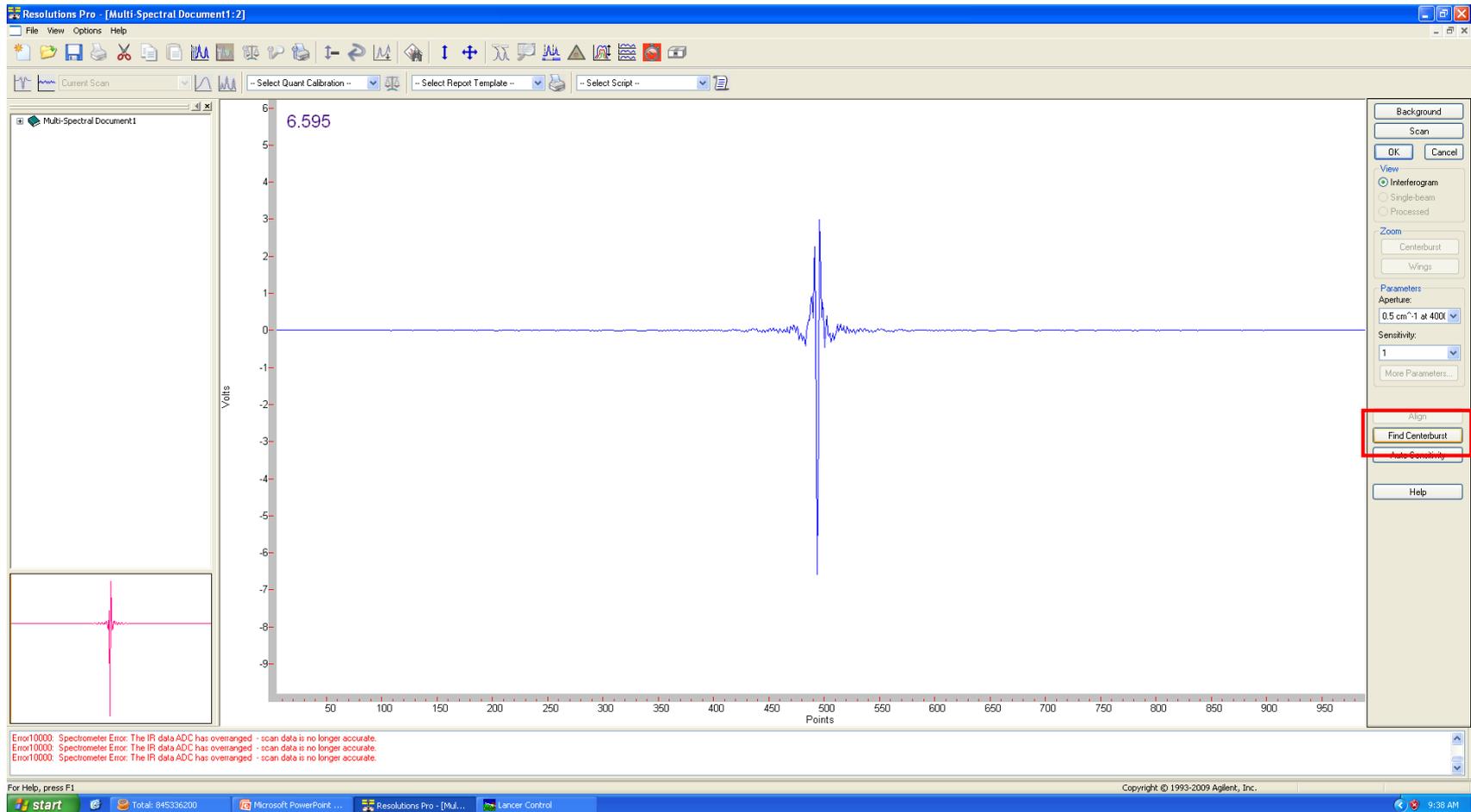
The screenshot displays the 'Imaging' dialog box in the software. The 'Optics' tab is active, showing the following settings:

- IR Source:** MIR Source (selected), NIR Source, Off, External.
- Source Power:** Boost, Normal (selected), Off.
- Beam:** Internal (selected), Left, Right, Not Installed.
- Detector:** DLaTGS, TE Cooled, MCT, Lin Broadband 1.0 (selected), Not Installed, MCT, High Sensivity 25l, Not Installed, Ground.
- Hardware:** Beamsplitter: KBr, Accessory: None, ATR Crystal: None, Optical Filter: None.
- Aperture:** Source (selected), Open.
- Beam Attenuator Throughput:** 100%.
- Microscope:** Pass Through (checked), Side Port: Not in use, Detector: Left (selected), Optics mode: Reflectance (selected).

The 'Setup' button at the bottom is highlighted with a red box.

■ FT-IR Microscope_ATR image scan(mapping)

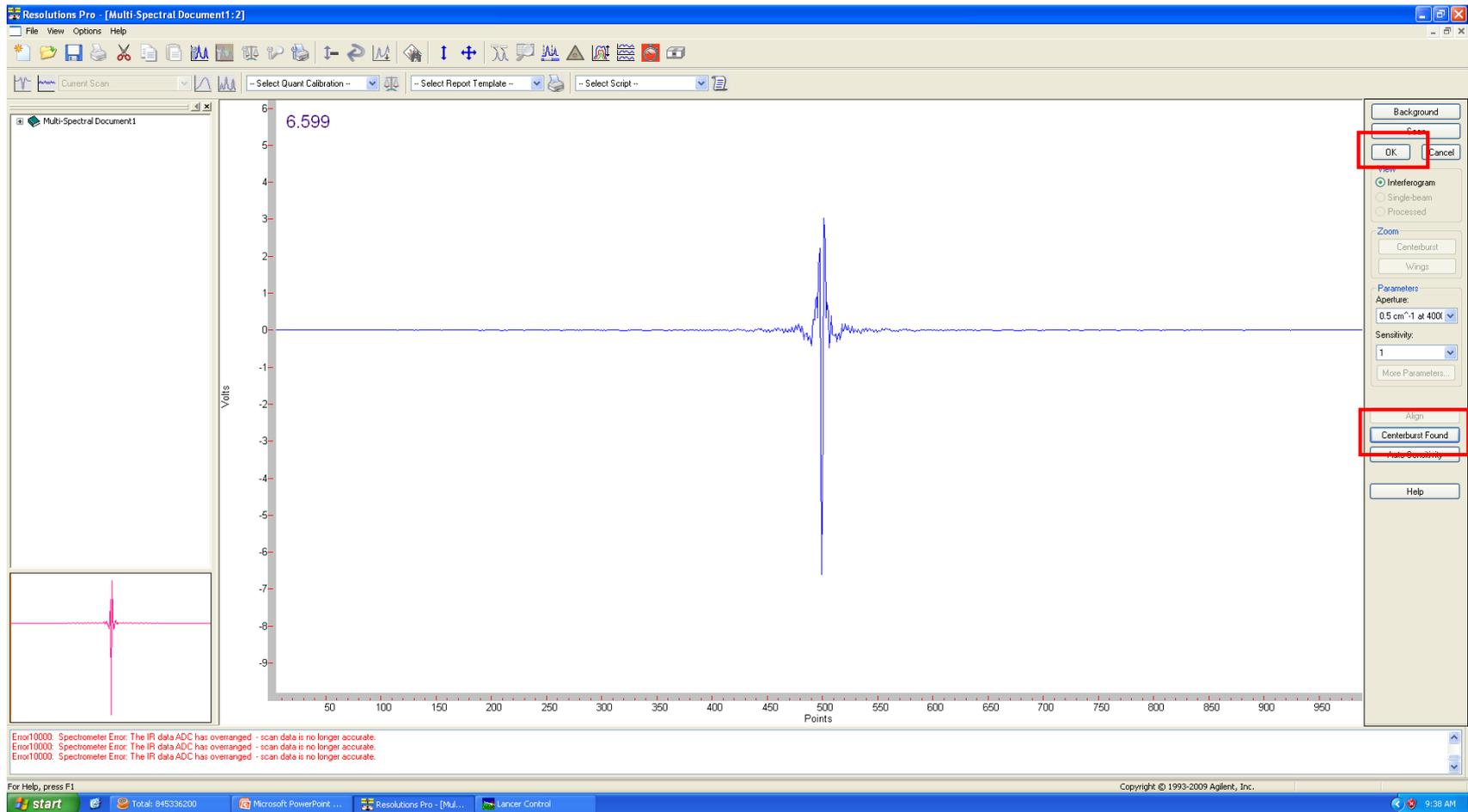
3) Click Find Centerburst.



■ FT-IR Microscope_ATR image scan(mapping)

4) Check Centerburst Found.

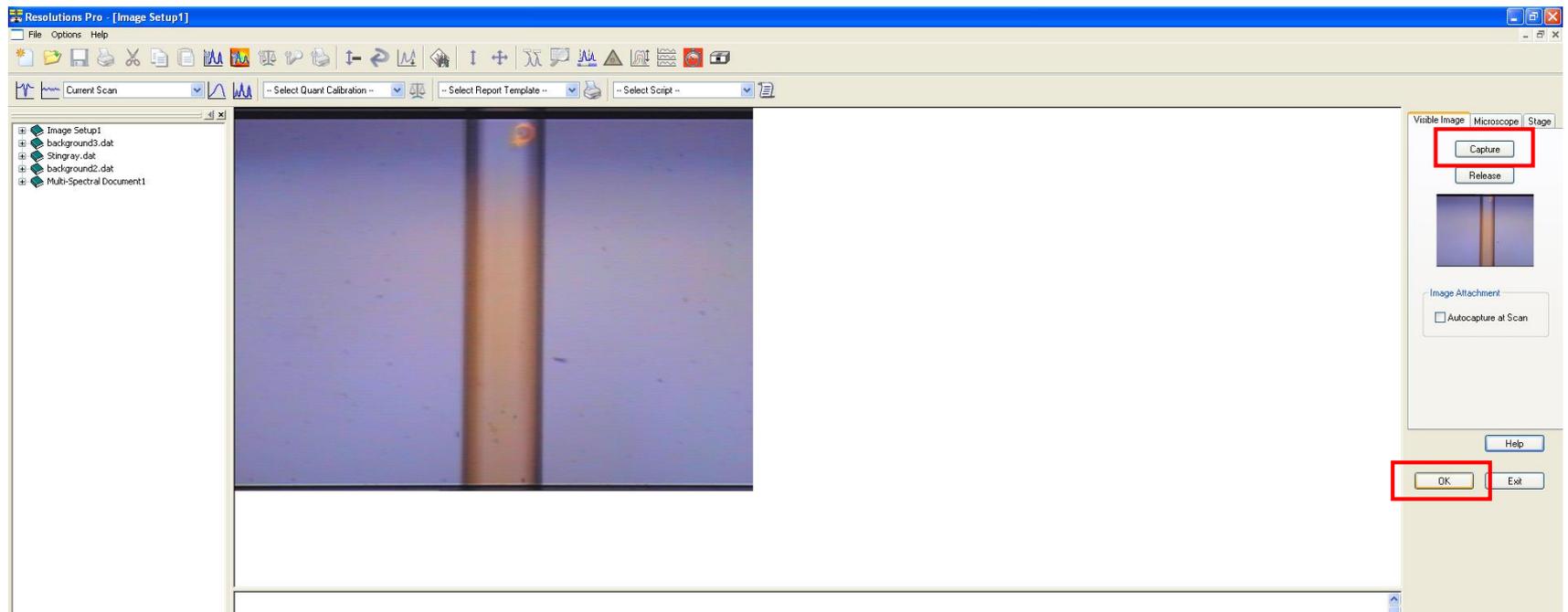
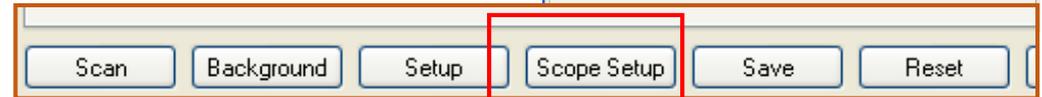
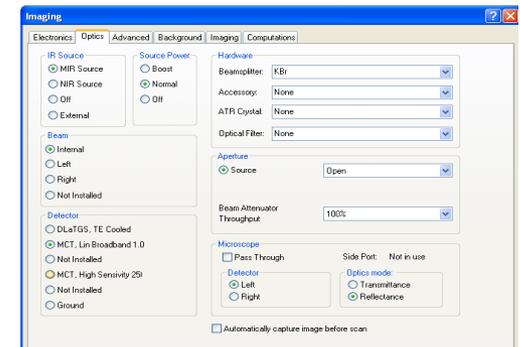
5) Click OK.



■ FT-IR Microscope_ATR image scan(mapping)

4. Imaging – Scope Setup

- 1) Find the focus of measurement point.
- 2) Change the aperture size and rotation of lens.
- 3) Click capture.
- 4) Click OK.

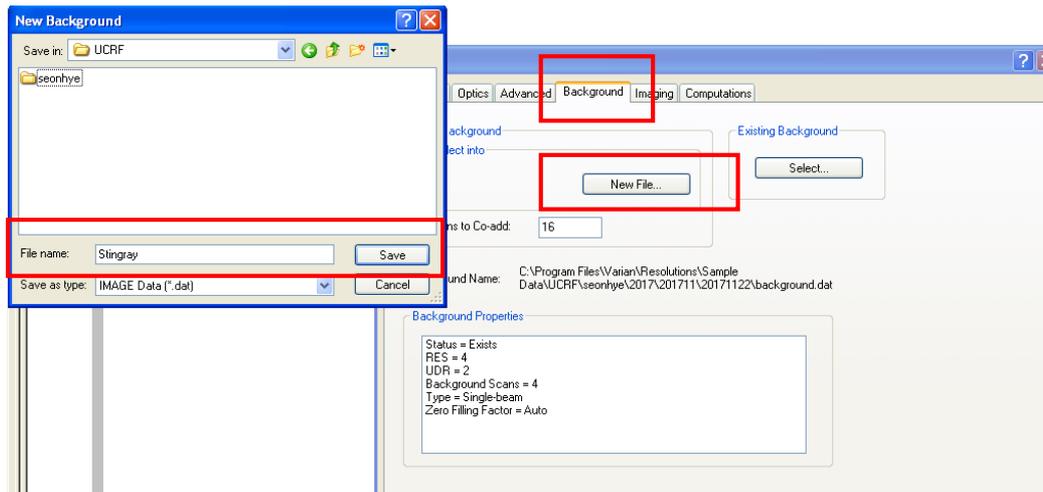


■ FT-IR Microscope_ATR image scan(mapping)

5. Put the ATR slide to the lens part.



6. Set the background file name and save condition.
Imaging – Background – New File - Save



■ FT-IR Microscope_ATR image scan(mapping)

7. Imaging set up again.

1) Select the Optics.

- Beam_Left

- Detector_Ground

2) Click Set up.

The screenshot displays the 'Imaging' configuration window of the FT-IR Microscope software. The 'Optics' tab is active, showing various settings for the imaging setup. The 'IR Source' is set to 'MIR Source'. The 'Source Power' is set to 'Normal'. The 'Hardware' section includes 'Beamsplitter: KBr', 'Accessory: None', 'ATR Crystal: None', and 'Optical Filter: None'. The 'Aperture' is set to 'Source' with a value of '0.5 cm⁻¹ at 4000 cm⁻¹'. The 'Beam Attenuator Throughput' is set to '100%'. The 'Microscope' section has 'Pass Through' checked and 'Side Port: Not in use'. The 'Detector' section has 'Left' selected. The 'Optics mode' is set to 'Reflectance'. The 'Beam' section has 'Left' selected. The 'Detector' section has 'Ground' selected. The 'Setup' button is highlighted with a red box.

■ FT-IR Microscope_ATR image scan(mapping)

8. Lancer Control

Lancer Control

Live Display

min Warmth max

min Contrast max

Calibration

Show Raw Data Show Calibrated Data

Expand IR Field of View

Calibrate Setup Stage

Signal Intensity

High Range

Frame Rate (Hz): 3773.58

Frame Period (ms): 0.26

Integration Time (ms): 0.055

Average Intensity: 10348

Info

64 x 64 Lancer MCT

Serial Number: 07-2907

Detector Temperature: 75K

< Calibration >

- Click show Raw Data
- Change Warmth and Contrast checking right image.

< Control Signal Intensity >

- Check the shape of mountain.
- Make the baseline one-third of box.

< FPA detector information >

You have to check the temperature.

When you see the red warning mark, please close the program and fill the liquid nitrogen again.

■ FT-IR Microscope_ATR image scan(mapping)

9. Click Calibrate – OK – Check the calibration Results – OK

The image displays two side-by-side screenshots of the 'Lancer Control' software interface. The left screenshot shows the 'Calibrate' button highlighted in red, with a dialog box titled '1st NonUniformity Correction Flux ...' overlaid. The right screenshot shows the 'Calibration Results' dialog box with the following data: OOR Pixels = 117 (2.856 %), LowFlux = 5539 counts, HighFlux = 10466 counts, and LowFluxNoise = 2.44 counts.

< Calibration Results >

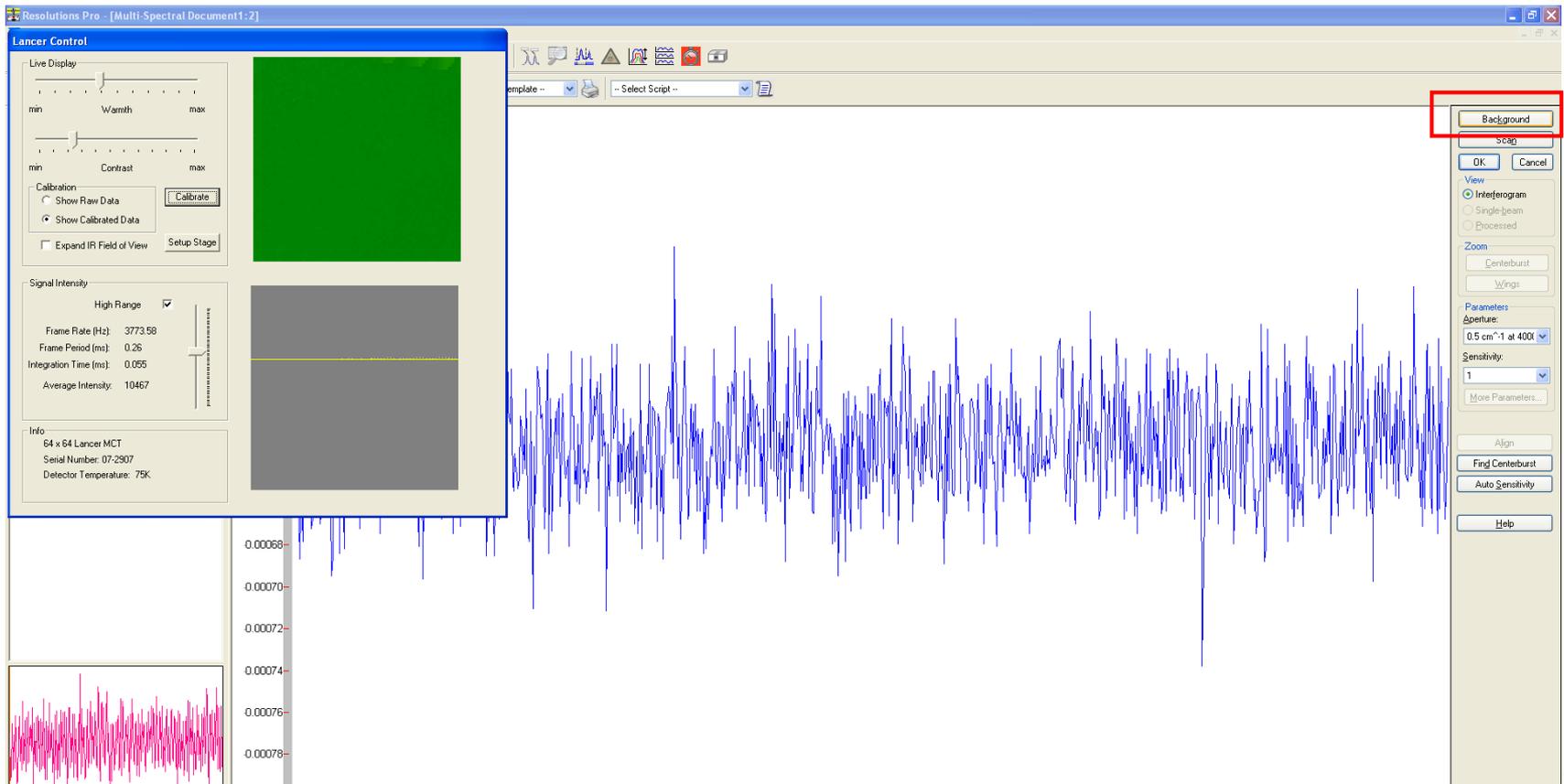
- **OOR Pixels** have to be below than **7%**.
- The difference value between **LowFlux** and **HighFlux** is about **3000**.
- ✓ Value > 3000, Calibration again after decrease Average Intensity .
- ✓ Value < 3000, Calibration again after increase Average Intensity.
- **LowFluxNoise** have to be below than **5**.

■ FT-IR Microscope_ATR image scan(mapping)

10. After calibration,

you can see the green color window at upper box and yellow line at lower box.
(uncalibrated data would be in white)

11. Click background.



■ FT-IR Microscope_ATR image scan(mapping)

12. Save the data

The screenshot displays the Resolutions Pro software interface. A 'Save As' dialog box is open, showing the file name 'background' and the save type 'Resolutions Pro Spectra (*.bsp)'. The 'Save' button is highlighted with a red rectangle. The main interface shows a 2D ATR image scan (mapping) with a color scale from blue to red. Below the image is a 1D IR spectrum plot showing Response versus Wavenumber (cm⁻¹). The spectrum shows a broad absorption band around 3400 cm⁻¹ and a sharp peak around 1700 cm⁻¹. The plot is labeled 'Row = 38 Col = 40'. The software interface includes a menu bar, a toolbar, and a sidebar with a file list.

■ FT-IR Microscope_ATR image scan(mapping)

13. Place the sample on the stage and find the focus of measurement point.

14. Open Imaging Setup.

15. Click Setup.

The screenshot displays the Resolutions Pro software interface. The main window shows a 2D image scan of a sample, with a color scale ranging from 0 to 60. The X and Y axes are labeled in pixels, ranging from 0 to 30. Below the image is a plot of Absorbance versus Wavenumber (cm⁻¹), showing a series of sharp peaks. The Wavenumber axis ranges from 5800 to 400 cm⁻¹. The Absorbance axis ranges from 0 to 8. The 'Imaging' dialog box is open, showing various settings for the scan. The 'Setup' button is highlighted with a red box. The dialog box includes tabs for Electronics, Optics, Advanced, Background, Imaging, and Computations. The 'Imaging' tab is active, showing parameters such as Speed (2.5KHZ), UDR (2), Filter (NONE), Resolution (4 cm⁻¹), Sensitivity (1), and Scans to Co-add (16). The 'Background' section shows a range of 8000 to 0 cm⁻¹. The 'Computations' section shows a range of 6000 to 400 cm⁻¹. The 'Save Range' section shows 'Nominal' selected with a range of 6000 to 400 cm⁻¹. The 'Setup' button is highlighted with a red box.

Resolutions Pro - [Stingray.dat]

File Edit View Collect Transforms Analysis Tools Windows Help

Current Scan

Select Quant Calibration

Select Report Template

Select Script

Stingray.dat
background2.dat
Multi-Spectral Document1

Y Pixel

X Pixel

Imaging

Electronics Optics Advanced Background Imaging Computations

Speed: 2.5KHZ

UDR: 2

Filter (kHz): NONE

Resolution (cm⁻¹): 4

Sensitivity: 1

Scans to Co-add: 16

Range: 8000 6000 4000 2000 0 cm⁻¹

Computational:

Source:

Beamsplitter:

Detector:

Accessory:

ATR Crystal:

Optical Filter:

Nominal

Save Range

Nominal 6000 400 cm⁻¹

Custom 4000.000 400.000 cm⁻¹

Scan Background Setup Scope Setup Save Reset Cancel Help

Aborbance

Wavenumber

Extract at

Row: 31

Feature Image

Col: 29

Image View

Frequency Slice

Feature:

Apply

Animate Slice Show

Start: 399.195

Stop: 6001.430

Step: 1.928

Play

Axis Unit Options

Pixel

Micros

Millimetres

Draw Mode

Wireframe Color Bleed

Solid Contours

Colors

Always Autoscale

Upper Intensity: 8.0000

Lower Intensity: -1.7605

Palette

Monochrome Background

Color 1 Black

Color 2 White

Zoom

Nearer Farther

Y Scale

Taller Shorter

3D

Flat View Default Angle

Pitch

18

Bottom Side Top

Rotation

18

DW Front

For Help, press F1

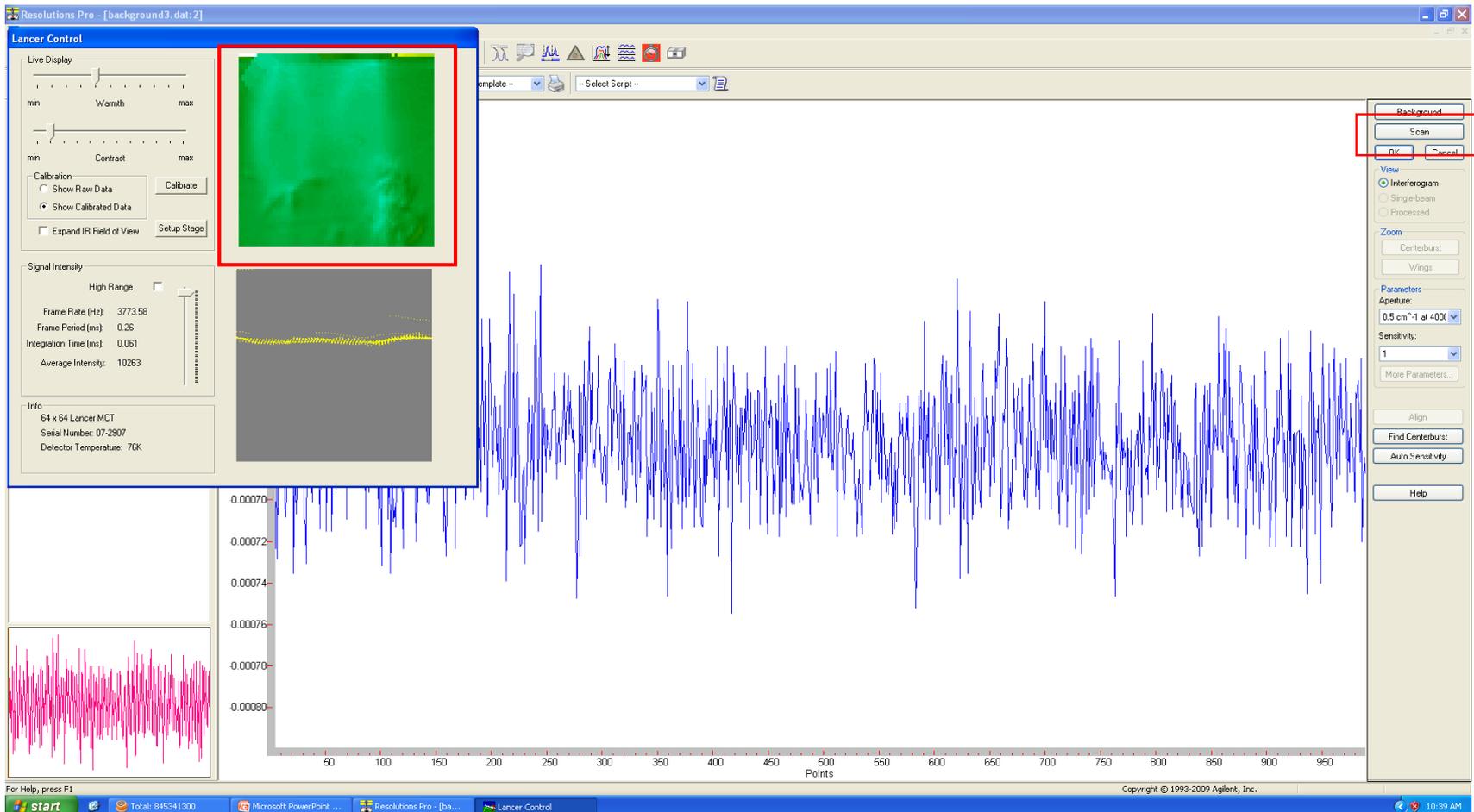
Copyright © 1993-2009 Agilent, Inc.

start Total: 845340800 Microsoft PowerPoint... Resolutions Pro - [St... Lancer Control

10:34 AM

■ FT-IR Microscope_ATR image scan(mapping)

16. Move up the stage and check the Display image(green box) on Lancer Control.
17. Click **Scan** when you see the shape of sample surface.



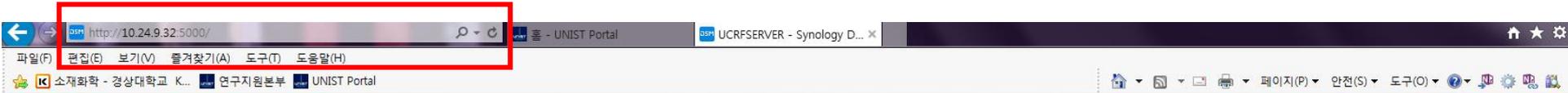
■ FT-IR Microscope_ATR image scan(mapping)

18. Save.

The image displays a software interface for FT-IR microscopy. A 'Save As' dialog box is open in the top-left corner, showing a file list with 'background2.bsp', 'background3.bsp', 'background.bsp', and 'stingray.bsp'. The 'File name' field contains 'sample1' and the 'Save as type' is 'Resolutions Pro Spectra (*.bsp)'. The 'Save' button is highlighted with a red box. The main window, titled 'Resolutions Pro - [sample.dat]', features a toolbar, a menu bar, and a central plot area. The plot area shows a 2D spectral mapping (heatmap) with X and Y axes ranging from 0 to 60 pixels. Below the heatmap is a 1D spectral plot showing Absorbance vs. Wavenumber (5000 to 1000 cm⁻¹). The 1D plot is labeled 'Row = 25 Col = 27'. The right side of the interface contains a 'Draw Mode' panel with options for Wireframe, Solid, Color Bleed, and Contours, along with 'Colors' and 'Palette' settings. The bottom of the window has a control panel for 'Extract at' and 'Image View'.

Data translation

2)



- 1) Connect to the Internet
- 2) Type the IP address

UCRF PC
100.100.100.30

When you access from outside,
10.24.9.32

- 3) Sign in
ID(Professor name)/PW



6. FAQ

- Reservation control information
- Request for self user
- Reservation, cancel and input result
- Guideline for the Operation of the UCRF
- Penalty Points and Sanction Criteria

Reservation control information

Reservation time unit	Daily maximum reservation time	Cancelable timing	Fee (ATR)	
			Client	21,000/hr
30 min.	3.0 hr	2.0 hr	Self-user	15,000/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

Welcome 손선혜 LOGOUT My Page Edit profile KOR ENG

Equipment Status Data Room Participation Space

My Page
UNIST Central Research Facilities

Request for Self-user

Status of analysis request

Status of settlements

Status of education application

Status of tour application

Status of access permissions application

Status of penalty

MY PAGE > Status of analysis request

Status of analysis request

Equipment	Status	Application date	Result of analysis
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Request for Self-user

4-1 Materials Characterization Lab

4-2 Surface Analysis

4-3 Confocal Raman

4-4 Apply

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].

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

Equipment Reservation

Detailed Navigation

- Equipment Reservation
- Equipment Reservation List
- Equipment Status

Favorite

Equipment reservation

Search condition

Inquiry

Reservation date: 2015.01.01 ~ 2015.08.26

Reservation Input result Completed All

1st classification: [] 2nd classification: [] Equipment name: []

Equipment booking list

Application Reservation cancel Input result

Select	Status	Sortation	Equipment name	Chief of research	Reservation date	Reservation time	Fee	1st classification	2nd classification name	Application date	Free_Test	Free_Longterm	Memo
<input type="checkbox"/>	Reservation	Admin	Confocal Raman	김영기	2015.08.17	13:00~16:30	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.04 18:44	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Admin	AFM-Raman	김영기	2015.08.17	13:00~16:30	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.10 16:27	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Admin	Confocal Raman	김영기	2015.08.17	09:00~11:30	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.04 18:44	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Admin	AFM-Raman	김영기	2015.08.17	09:00~11:30	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.10 16:27	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Admin	FT-IR	김영기	2015.08.13	15:00~18:00	0.00	UMAL - 기기분석실	Spectroscopic Analys	2015.08.07 10:53	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Admin	FT-IR	김영기	2015.08.13	13:30~15:00	0.00	UMAL - 기기분석실	Spectroscopic Analys	2015.08.07 10:52	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Admin	FT-IR	김영기	2015.08.13	09:00~12:00	0.00	UMAL - 기기분석실	Spectroscopic Analys	2015.08.07 08:57	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Admin	Confocal Raman	김영기	2015.08.12	15:30~17:00	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.07 17:15	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Admin	FT-IR	김영기	2015.08.12	10:30~11:00	0.00	UMAL - 기기분석실	Spectroscopic Analys	2015.08.07 14:57	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Admin	Confocal Raman	김영기	2015.08.12	09:00~10:30	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.06 13:21	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Admin	FT-IR	김영기	2015.08.11	14:30~18:00	0.00	UMAL - 기기분석실	Spectroscopic Analys	2015.08.07 08:57	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Admin	Confocal Raman	김영기	2015.08.11	13:30~14:30	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.05 11:42	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Admin	Confocal Raman	김영기	2015.08.11	09:00~10:00	0.00	UMAL - 기기분석실	Surface Analysis	2015.08.10 13:04	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Admin	FT-IR	김영기	2015.08.11	09:00~12:00	0.00	UMAL - 기기분석실	Spectroscopic Analys	2015.08.07 10:56	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Admin	FT-IR	김영기	2015.07.29	09:30~10:30	0.00	UMAL - 기기분석실	Spectroscopic Analys	2015.07.28 13:26	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Admin	FT-IR	김영기	2015.07.17	16:00~17:00	0.00	UMAL - 기기분석실	Spectroscopic Analys	2015.07.17 18:00	<input type="checkbox"/>	<input type="checkbox"/>	

Equipment reservation help

Search condition **Inquiry**

Reservation date: 2015.01.01 ~ 2015.08.04

Reservation
 Input result
 Completed
 All

1st classification: [dropdown]
 2nd classification: [dropdown]
 Equipment name: [dropdown]

Equipment booking list **Application**

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

3

1

2

Application

Select equipment

Client ID: shson35@unist.ackr 30678 / 손선재 Subscriber: 30678 손선재

1st classification: UMAL - 기기분석실
 2nd classification: Surface Analysis
 3rd classification: Confocal Raman

project information

Chief of research	Chief of research	Detail project number	detailed item	Executable amount
20032	김영기			0

Reservation control information

Reservation time unit	daily maximum reservation time	Reservation open timing	Cancelable timing	Fee
30 분	3.0 시간	5 일전	2 시간전	0.5 Hour 12,500 원

유의사항01 Laser power on/off
 유의사항02 Keep clean lens to avoid contamination

Time/date	07/20(M)	07/21(T)	07/22(W)	07/23(T)	07/24(F)	07/25(S)	07/26(S)	07/27(M)	07/28(T)	07/29(W)	07/30(T)	07/31(F)	08/01(S)	08/02(S)
09:00-09:30	✓	✓												
09:30-10:00	✓	✓												
10:00-10:30	✓	✓												
10:30-11:00	✓	✓												
11:00-11:30	✓	✓												
11:30-12:00	✓	✓												
12:00-12:30	✓	✓												
12:30-13:00	✓	✓												
13:00-13:30	✓	✓	✓											
13:30-14:00	✓	✓	✓											
14:00-14:30		✓	✓		✓									
14:30-15:00		✓	✓		✓									
15:00-15:30		✓	✓		✓									
15:30-16:00		✓	✓		✓									
16:00-16:30	✓	✓	✓		✓									
16:30-17:00	✓	✓	✓		✓									

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

Equipment reservation

Search condition

Reservation date: 2015.01.01 ~ 2015.08.04

Reservation Input result Completed All

1st classification: UMAL - 기기분석실

2nd classification: Surface Analysis

Equipment name: Confocal Raman

Equipr **Reservation cancel**

Select	Status	Sortation	Equipment name	Chief of research	Researvation date	Reservation time	Fee	1st classification	2nd classification name
<input checked="" type="checkbox"/>	Reservation	Self	Confocal Raman	김영기	2015.07.24	14:00~15:00	0.00	UMAL - 기기분석실	Surface Analysis
<input type="checkbox"/>	Reservation	Self	Confocal Raman	김영기	2015.07.22	13:00~14:00	0.00	UMAL - 기기분석실	Surface Analysis

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

Input result

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

Equipment reservation

Search condition

Inquiry

Reservation date: 2015.01.01 ~ 2015.08.04

1st classification: UMAL - 기기분석실 2nd classification: Surface Analysis Equipment name: Confocal Raman

Equipment booking list

Input result

Application Reservation cancel **Input result**

Select	Status	Sortation	Equipment name	Chief of research	Reservation date	Reservation time	Fee	1st classification	2nd classification name	Application date	Free_Test	Free_Longterm	Memo
<input checked="" type="checkbox"/>	Reservation	Self	Confocal Raman	김영기	2015.07.24	14:00~15:00	0.00	UMAL - 기기분석실	Surface Analysis	2015.07.17 11:07	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Reservation	Self	Confocal Raman	김영기	2015.07.22	13:00~14:00	0.00	UMAL - 기기분석실	Surface Analysis	2015.07.20 11:20	<input type="checkbox"/>	<input type="checkbox"/>	

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

Reservation information

Reservation number: 2015001217 Reservation date: 2015.07.24 Client authorization: Self shson35@unist.ac.kr

Application date: 2015.07.17 Reservation time: 14:00~15:00 Rate: 50 Equipment name: Confocal Raman

Project information

Chief of research	Chief of research	Detail project number	detailed item	Executable amount		
20032	김영기			0	0	0

Fee

Cost	Unit quantity	Unit	unit amount	discount applying	Option applying	Amount	Fee	Rate	Amount
기본공정료	0.5	H	12,500	<input checked="" type="checkbox"/>		1.0	25,000	50	12,500
합계							25,000		12,500

Process condition

equipment status (problem and repair) **Mode** **ATR**

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.

• 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 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	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

- 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.