Notes in operating STM2

Revised on 2025/August/25th

Ver. 1.3

Opening the preparation chamber

(1) Make sure that the gate between the preparation and stock chamber is closed.
(2) Turn off the ion pump and gauge. Wait for 30 minutes to cool down the hot filament.
(3) Make sure that the load lock is in a vacuum.
It is not necessary to be a high vacuum, but it should not be in the air.
If you don’t have the confidence, pump the load lock by turbo for 5 min.
(3) Open the gate between the preparation and load lock.
(4) Vent from load lock.

Opening the stock chamber

(1) Close the gate between the stock and the STM chamber.
(2) Turn off the ion pump and gauge (both preparation and stock chamber).
Wait for 30 minutes to cool down the hot filament.
(3) Open the gate between the preparation and the stock chamber.
(4) Make sure that the load lock is in a vacuum.
It is not necessary to be a high vacuum, but it should not be in the air.
If you don’t have the confidence, pump the load lock by turbo for 5 min.
(5) Open the gate between the preparation and load lock.
(6) Vent from load lock.

Opening the STM chamber

(1) Make sure that STM is at room temperature. Open the gate between the STM and stock chamber.
(2) Turn off the ion pump and gauge (both preparation and stock chamber).
Wait for 30 minutes to cool down the hot filament.
(3) Open the gate between the preparation and the stock chamber.
(4) Make sure that the load lock is in a vacuum.
It is not necessary to be a high vacuum, but it should not be in the air.
If you don’t have the confidence, pump the load lock by turbo for 5 min.
(5) Open the gate between the preparation and load lock.
(6) Vent from load lock.

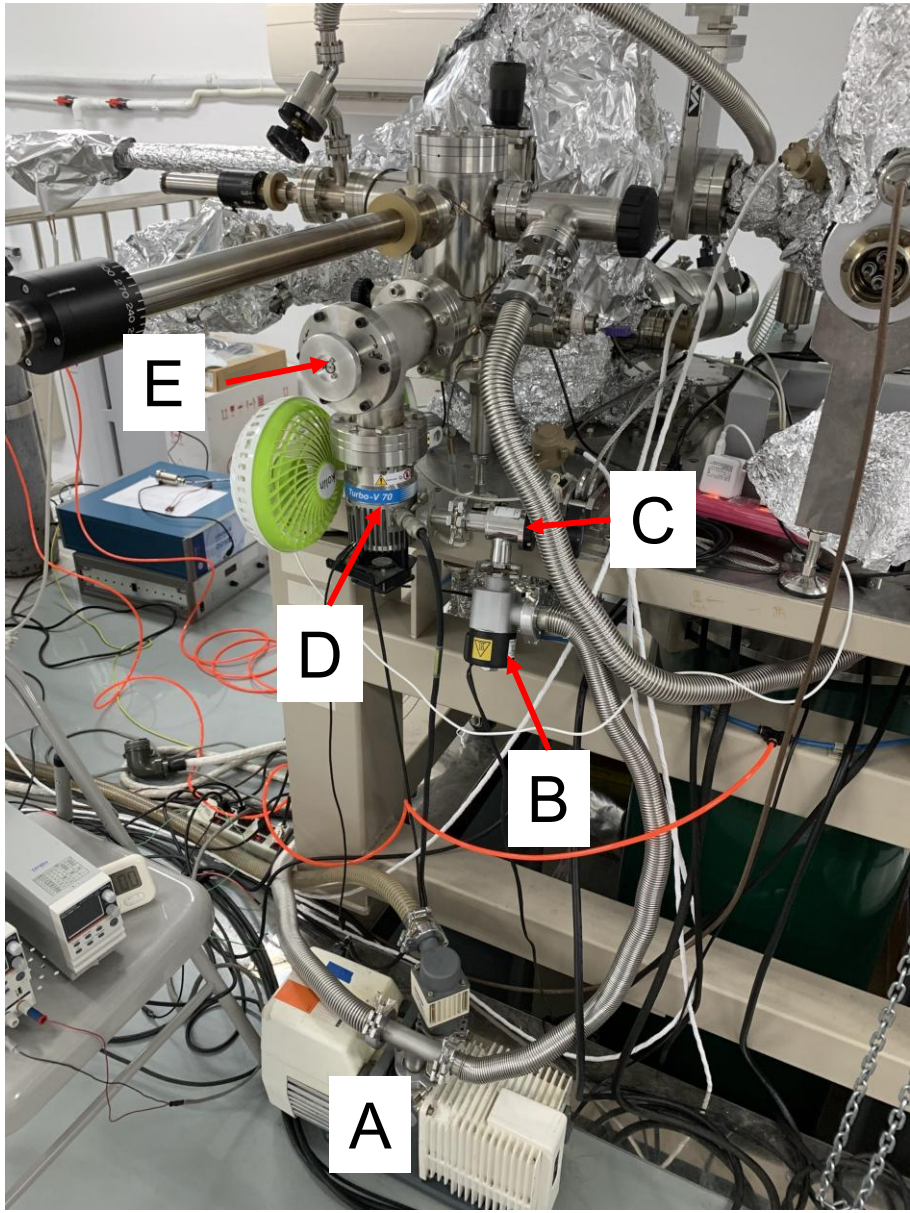
Starting pumping load lock

A: Rotary pump, B: Electric gate valve, C: Gate valve 1
D: Turbo pump, E: Gate valve 2

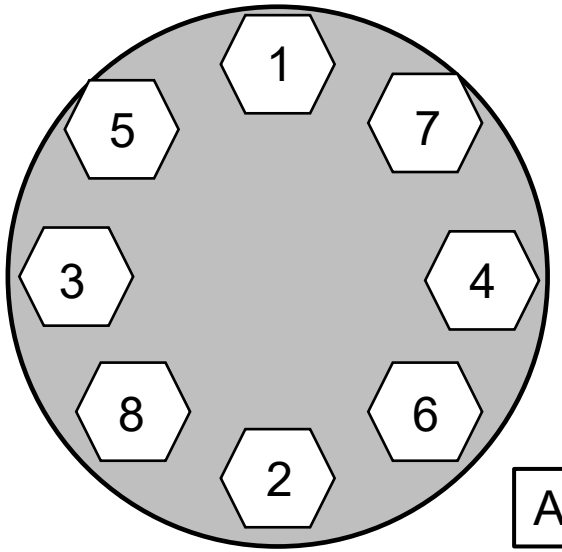
[If load lock is in vacuum]
① Turn on rotary (A).
② Open B, C.
③ Turn on turbo (D).
④ After the turbo becomes normal operation, open E.
Never open E before turbo become normal. Otherwise the oil in rotary can contaminate the chamber.

[If load lock is in air]
① Open B and E.
② Turn on rotary (A)
③ Slowly open C. The air is evacuated from the chamber.
④ Turn on turbo (D)

[If the vacuum condition is unknown]
The same as [load lock is in vacuum], but slowly open E at process ④.



Fixing screws of vacuum chamber

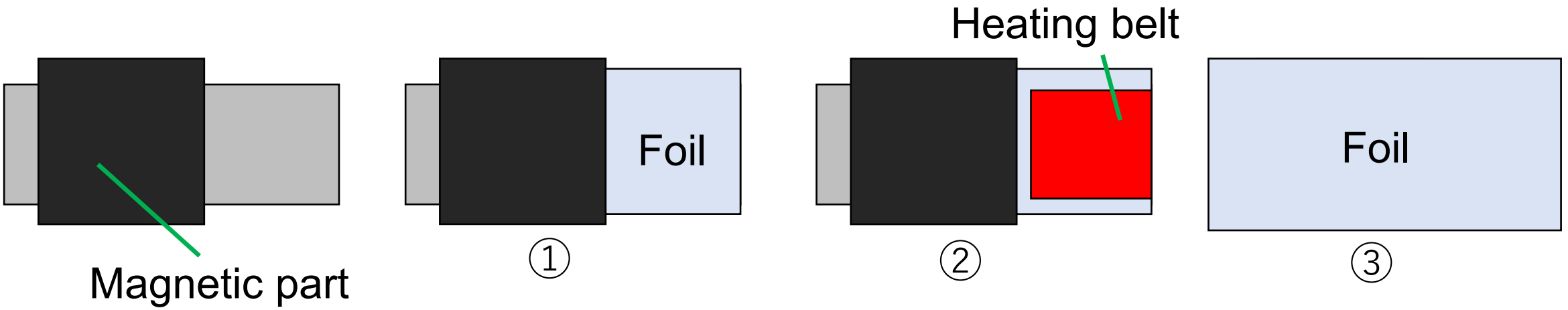


An example of the order of screw fixing

First round: 100 N/m
Second round: 115 N/m
…

The most important thing is to fix the screws in a good balance, not tight.
① Change the gasket. If the gasket are not baked, the gasket can be used for several times.
② Gently fix all the screws by hand.
③ Fix the screws a little bit tighter (such as using 110 N/m) following the order like in figure.
④ Repeat ③ with using a little bit stronger force than the previous round (such as, 115→120→125→130 N/m).

Baking ①



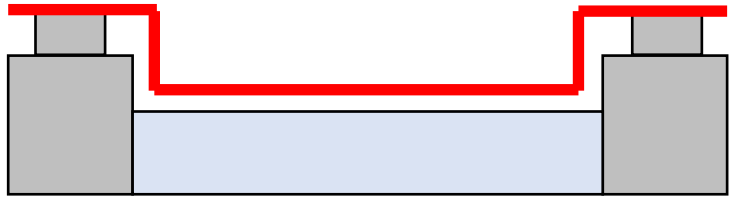
Transfer rod

① Cover the rod by foil. Heating the transfer rod directly by the heating belt may lost the smoothness of the movement.

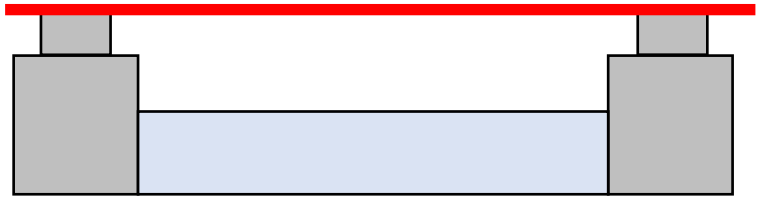
② Set heating belt along the transfer rod. The heating belt should not directly touch the magnet part.

③ Cover the whole rod by foil.

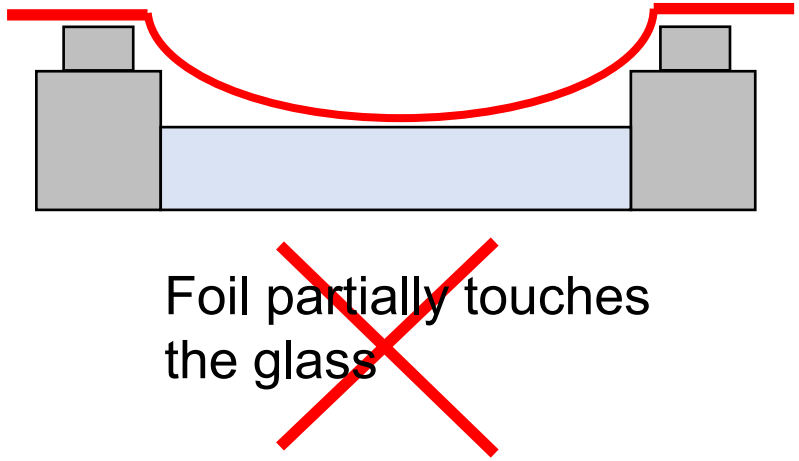
Baking ②



Foil wholly touches the glass



Foil is wholly separated from the glass



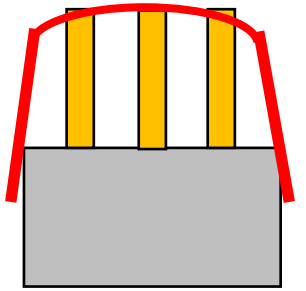
Foil partially touches the glass

View port

The glass part of the view port should be heated at equal temperature. Otherwise the glass may be broken.
The foil covering the view port should not partially floating (see figure).

Electrodes

Connect the electrode and the chamber by the foil.
Otherwise the electrodes may be charged and oxidized.



Baking ③

① Take off all the unnecessary cables, such as TSP, sample heating, and ion gun.
② Wholly cover the chamber with foils for balanced heating.
③ Wait until the pressure goes down to 10^{-7} torr range.
④ Make sure that there is nothing burnable near the chamber.
⑤ Turn on all the heating belt and heating wire.
If you have the cramp meter, check there is no leakage of current.
⑥ The pressure would increase to ~10^{-5} torr range, then start decreasing.
⑦ Check all the chamber is heated by using temperature meter.
⑧ Bake for at least 2 days. The pressure would decrease to ~2x10^{-8} torr.

Clamp meter
(A) Clamping both wires. Because the current go and back, the net current should be zero.
(B) Clamping one wire. There should be a current.

Check both (A) and (B) for all the heating wires.

Degassing after baking

① Turn off all the heating belt and wire. Wait for 10 mins to check the pressure start decrease without leak.
② Connect the cable of TSP. Degas TSP as follows:

(i) Turn on TSP. Set the current to 30. Pressure may increase and then decrease.
(ii) Wait until the pressure almost stops decreasing. Turn off TSP.
(iii) Perform (i) and (ii) for all the filaments.
(iv) Repeat (i)-(iii) with higher current than previous round (such as, 30→35→40→45).
I recommend to run TSP between the steps ③-⑦.

③ Degas gauge.

Press “Degas” of the controller. Wait until the value is back.

④ Degas ion source.

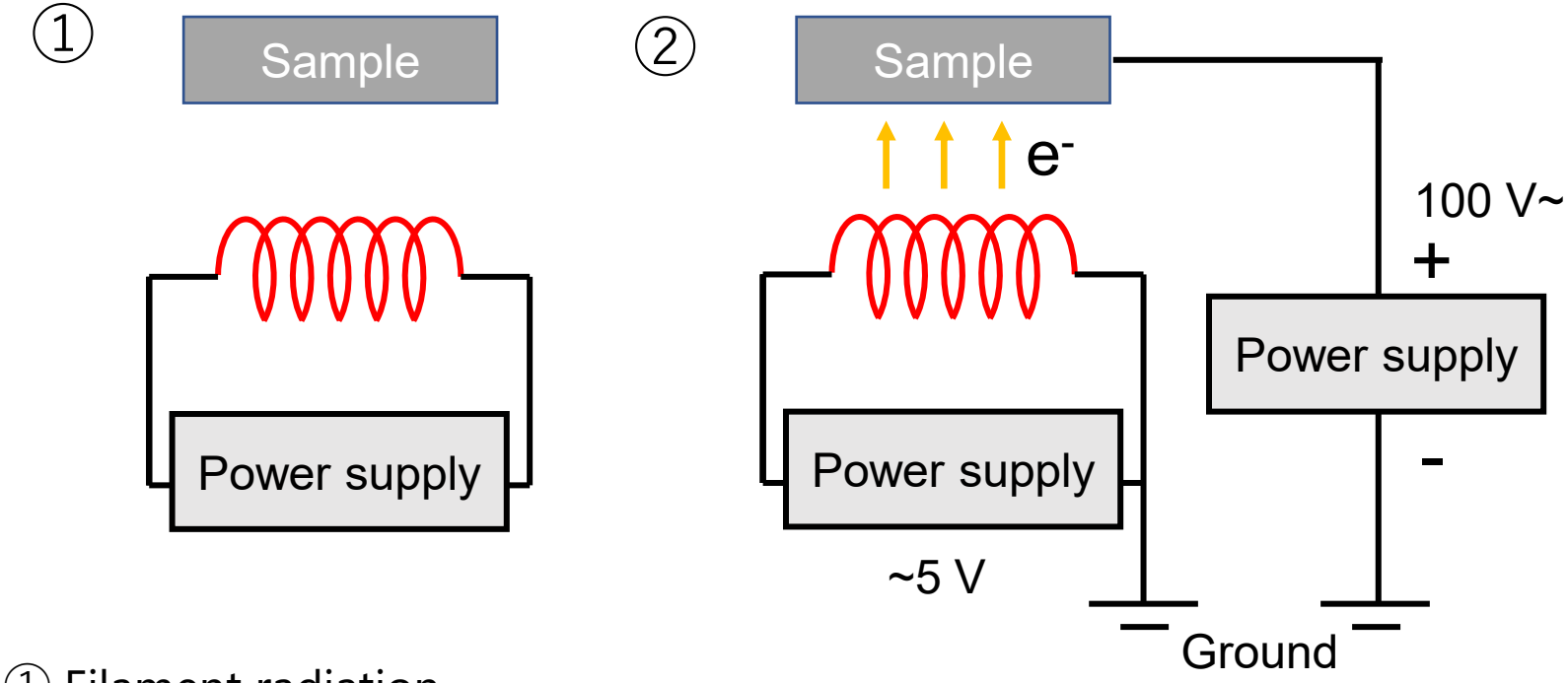
Connect the cable. Degas using degas function in software or controller.

⑤ Degas ion pump.

(i) Turn on ion pump. For the first time, the current would soon saturate and pressure increase (you may hear a sound). Then turn it off.
(ii) Wait until the pressure get low.
(iii) Repeat (i) and (ii) until the current does not saturate. If the temperature of ion pump is still high, it takes for many runs until being stable. In that case, you can wait until the temperature become low.

⑥ If necessary, degas other equipments (such as evaporator).
⑦ Remove the foils covering the chamber. Wait for the pressure reaches the UHV to confirm no leak. You can run TSP for fasten the pressure decreasing.
⑧ If the pressure reaches ~ ~10^{-10} torr range, you can turn off turbo.

Annealing the sample



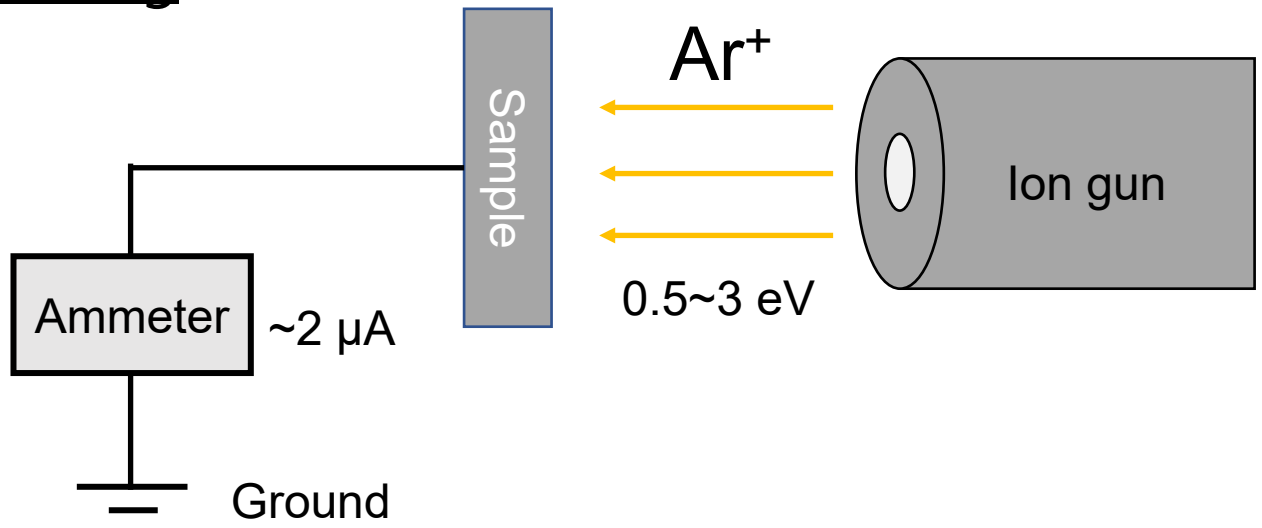
① Filament radiation

Heating the filament near the sample. The radiation from the filament heats the sample.
Advantage: Simple method.
Disadvantage: Relatively high background radiation, preventing the accurate temperature measurement.

② Electron bombardment

Applying high bias between the filament and sample. The emission electrons from the filament are acerated and hit the sample, transferring the
Advantage: High temperature and local heating.
Disadvantage: Sometimes unstable. If the insulating ceramics is polluted and becomes conductive during the heating, the temperature may change during the heating.

Sputtering



① Turn off ion pump, and check gate between preparation and STM chamber is closed.
② Open the Ar gas. The typical pressure range is 10^{-6}~10^{-5} torr.
③ Turn on the ion gun. The typical energy is 0.5~3 eV, and the time of 10~20 min.
④ Adjust the sample position. Because the charged Ar hits the sample, a current flows between the sample and ground. Find the position where the current becomes the highest. The typical current is several μA.

Cleaning process of Au(111)

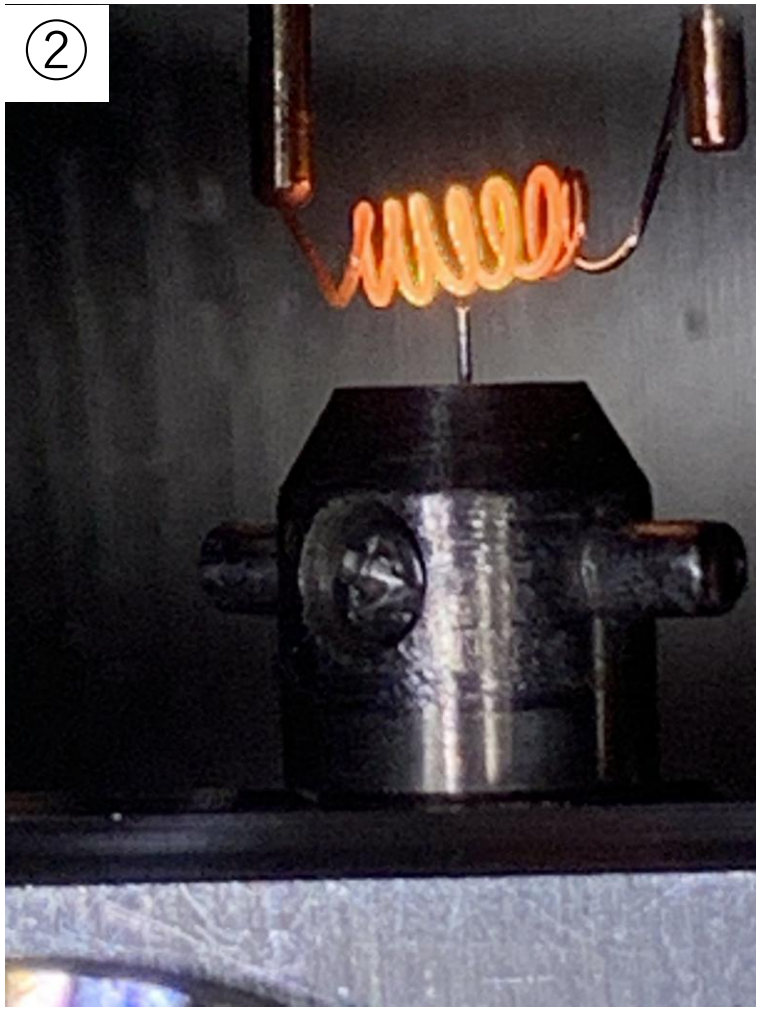
① Turn on turbo. After turn on turbo, we should wait for at least 30 min before opening the gate.
② Start annealing at ~550℃ for 15 min.
③ Turn off ion pump. The pressure would increase. After the pressure reaches ~10^{-9} torr, open the gate between preparation chamber and turbo pump. This process avoids the reverse flow of gas to the chamber.
④ Sputtering at p = 5×10^{-6}~1×10^{-5} torr, E = 1.0 keV. The current would be ~1.0 uA for 15 min.
⑤ Annealing again at ~550℃ for 15 min.
⑥ Sputtering again at E = 0.6 keV for 15 min.
⑦ Annealing again for ~550℃ for 5 min. After the final annealing, it is better to decrease the temperature slowly (~1℃/s).
⑧ Turn on ion pump. Wait for 2 min. Close the gate between preparation chamber and turbo. Turn off turbo.
⑨ Wait for 10 min after finishing annealing. Then you can transfer the sample.

※ If the sample has already cleaned and not so dirty, only one cycle would be enough.
※ If the sample is just after insulation from air, two cycles are often not enough. I recommend to perform the cleaning process for 3 cycles with the sputtering energy of 1.5, 1.2, and 1.0 keV.

Tip heating

① Heating the filament by ~2 A. The filament become a little bright.
② Approach the filament to the tip as close as possible (but don't touch).
③ Increase the filament current (~4 A). Keep for ~ 10 min.

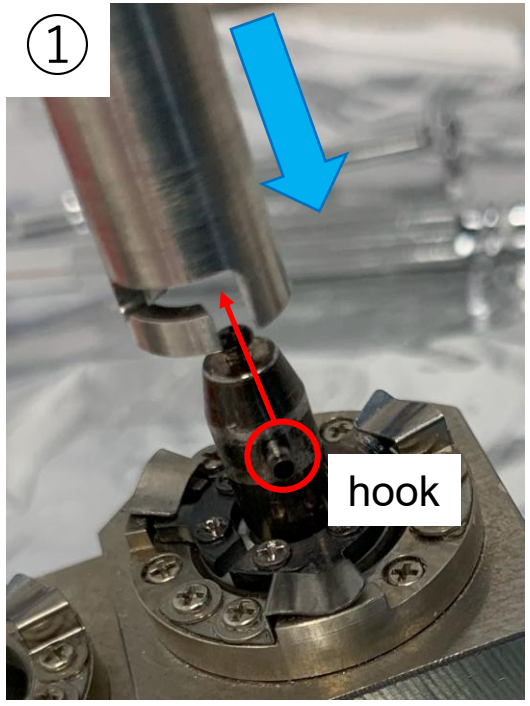
※ Actually, the tip temperature is not so high in this method and so it is not very efficient. But the adsorbates on the tip may removed by this heating method.

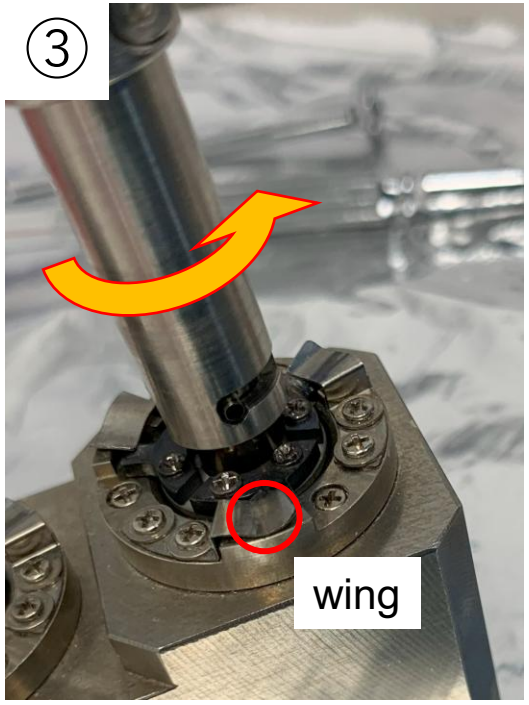


Sample transfer

① Approach the transfer rod to the sample holder. The “hook” of the holder will come into the space of the rod.
② Put the transfer rod deep enough to catch the hook. Then, rotate the rod in anticlockwise direction.
③ The hook touches the end of the space of the rod. Further rotate the rod to remove the wind of the holder from the sample stage.
④ Rotate until the wing is clearly separated from the stage. Then pull the transfer rod.
⑤ The sample is taken off from the sample stage.

Perform the process oppositely to put the sample to the stage.



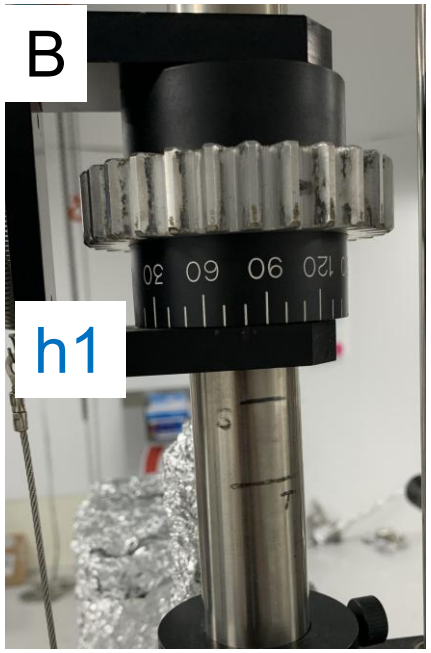


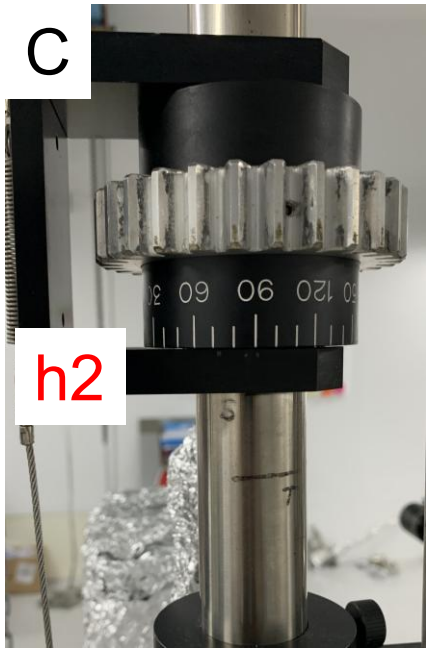
Sample transfer to STM stage

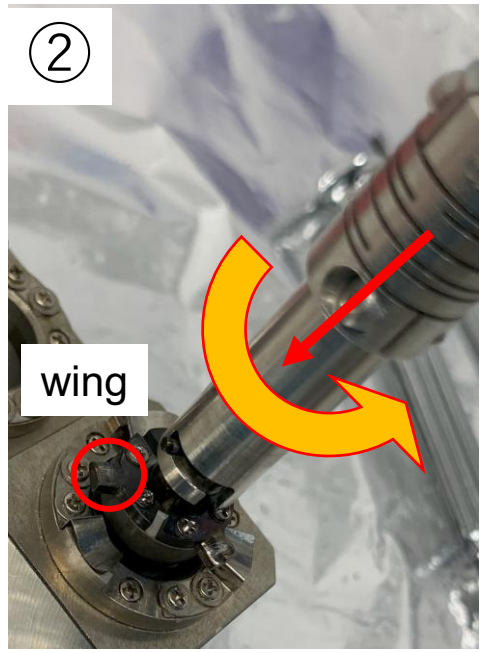
Refer to the figures in the next page.
Basically the process for transferring the sample to STM is the same. One significant difference is that we cannot see the sample during the transfer. If the sample is transferred in a wrong way, the sample may drop into the STM chamber, and we should open the chamber to take it out.

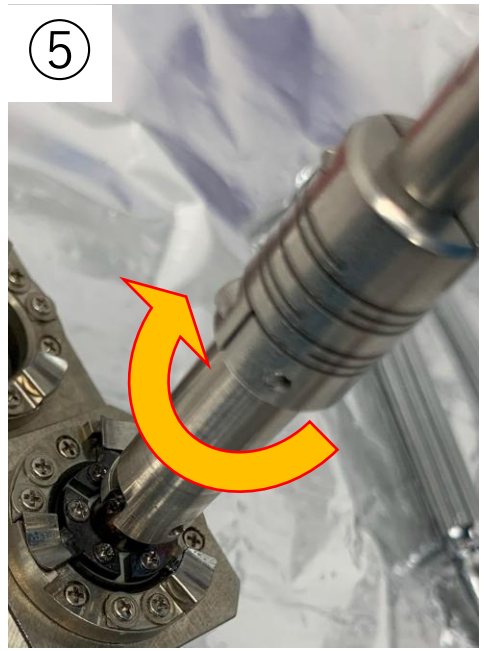
(A) Two positions are marked on the transfer rod for sample transfer, as indicated by h1 and h2.
Processes:
① Put the transfer rod with the sample toward the STM chamber.
② The sample touches the STM stage. The height of transfer rod may be h1, as shown in (B). Now the sample is touches with the sample stage, but the wings are not fit to the proper position.
※ If the rod reaches h2, skip to ⑤
Rotate the rod to anticlockwise direction with applying a little downward force.
Do not rotate in clockwise direction. The sample can drop from the rod.
③ Sometimes the sample stack and cannot rotate. In that case, lift up the rod a little and rotate a little, then lift down again.
④ When the wing matches the proper position, the rod position can be lowered to h2, as shown in (B).
⑤ Rotate the rod to clockwise direction until the limit. Now the sample is fixed at the STM stage, and rod is separated from the sample.
⑥ Carefully lift up the transfer rod.

Sample transfer to STM stage: figures







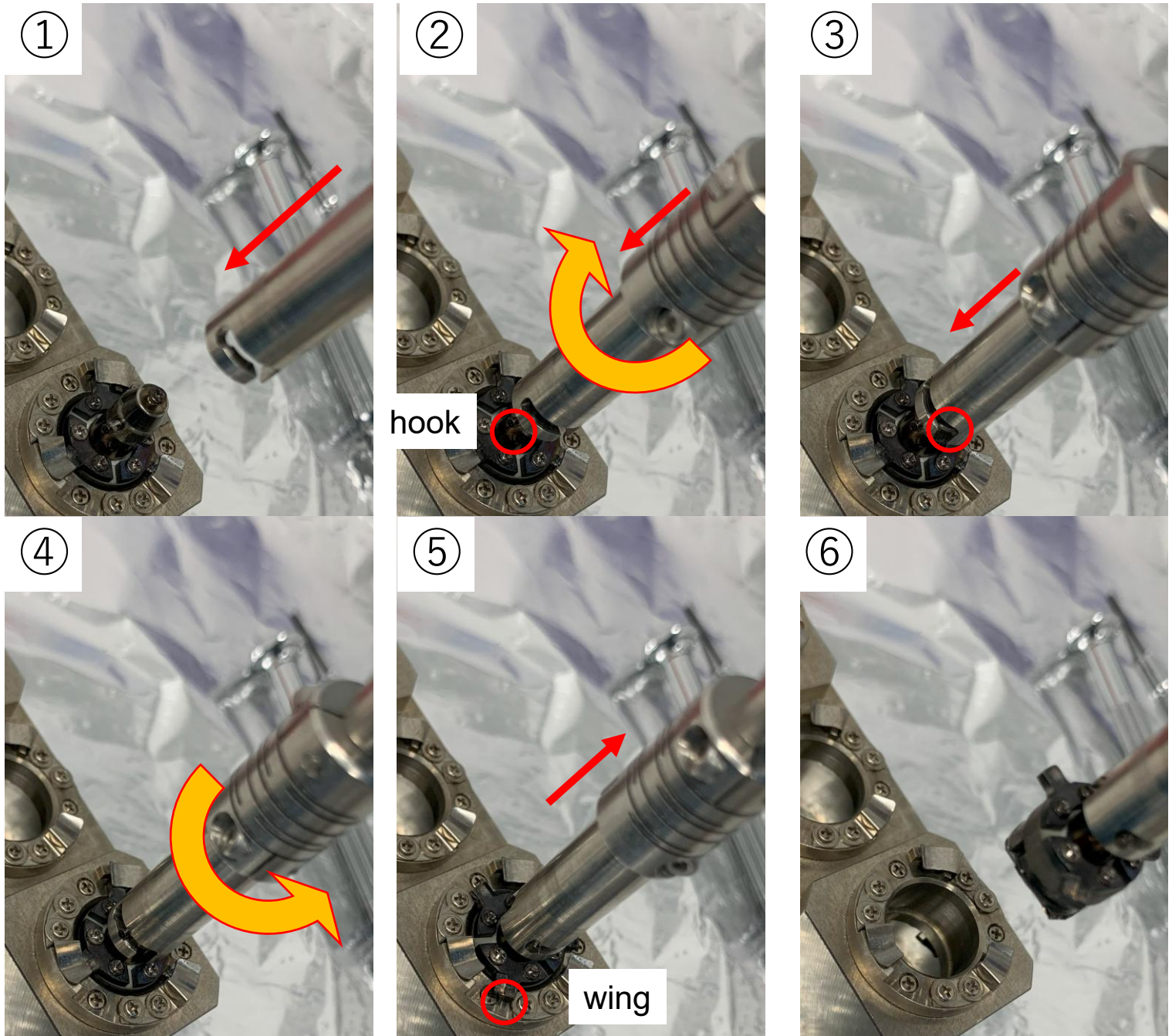


Sample transfer from the STM stage

Refer to the figures in the next page.
Now the sample is fixed at the STM stage and you want to take it out.

① Loewen the transfer rod until it touches the sample holder.
② The rod touches the sample holder. The rod height may be h1. Now the hook of the holder does not fit with the rod. Rotate the rod in **clockwise** direction with applying a small downward force.
③ When the hook fit the rod, the rod height can reach to h2.
④ Rotate the rod in anticlockwise direction until the limit.
⑤ Now the sample is totally separated from the STM stage.
⑥ Lift up the transfer rod carefully.

Sample transfer from the STM stage: figures



Tip change

The tip can be transferred by the same transfer rod. A difference from the sample holder is that the tip is fixed by the screw on the tip stage.

[Take out the tip from the STM chamber]

① Make sure that sample is not set in STM chamber.
The tip in STM chamber is accessible by the transfer rod.

② Lift down the transfer rod. The rod can reach below h2, then touch the tip.
The height is little higher than the position marked by “T”, as shown in (A).
Now the rod and tip touches, but not fit.

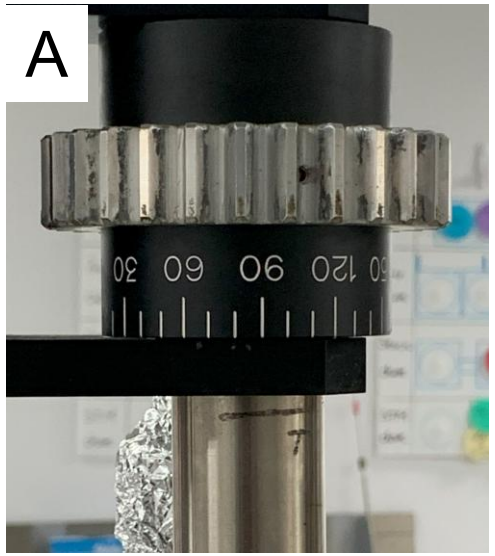
③ Rotate the rod in clockwise direction with applying small downward force.

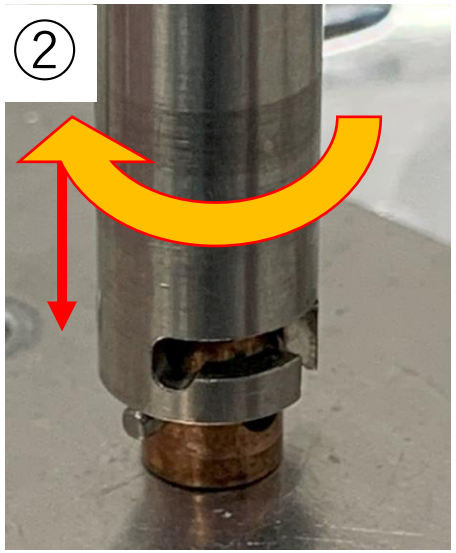
④ When the space of rod matches the hook of tip, the rod can reach the “T” line, as shown in (B)

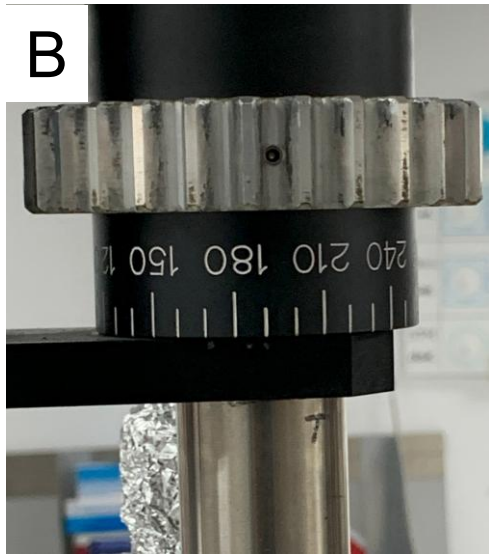
⑤ Rotate the rod in anticlockwise direction.
The rod height slightly lift up as the screw loosen. Keep rotating until the rod height does not change anymore.

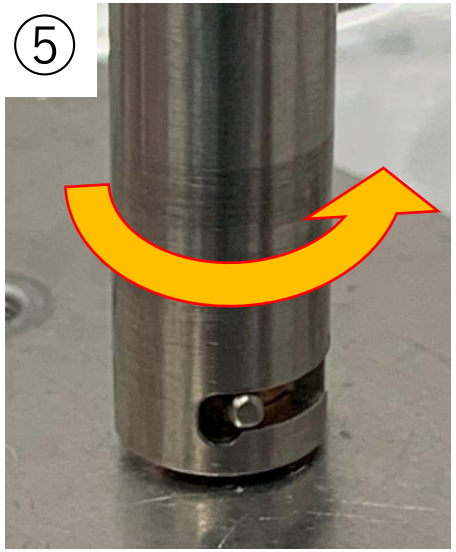
⑥ Lift up the rod.
If the screw is still in the screw hole of the tip stage, the tip stage may come out with the tip, which seriously damage the STM. Rotate the rod enough before lifting up.

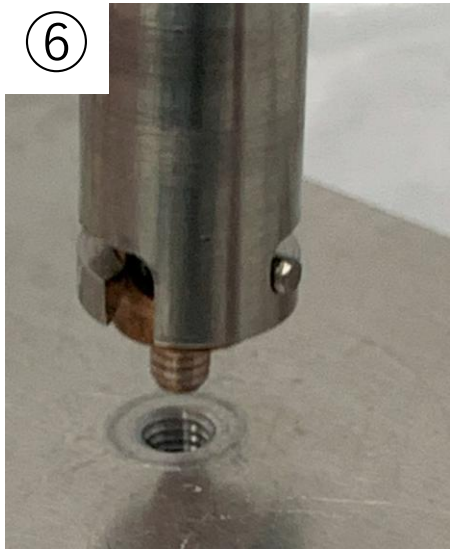
Tip change: figures





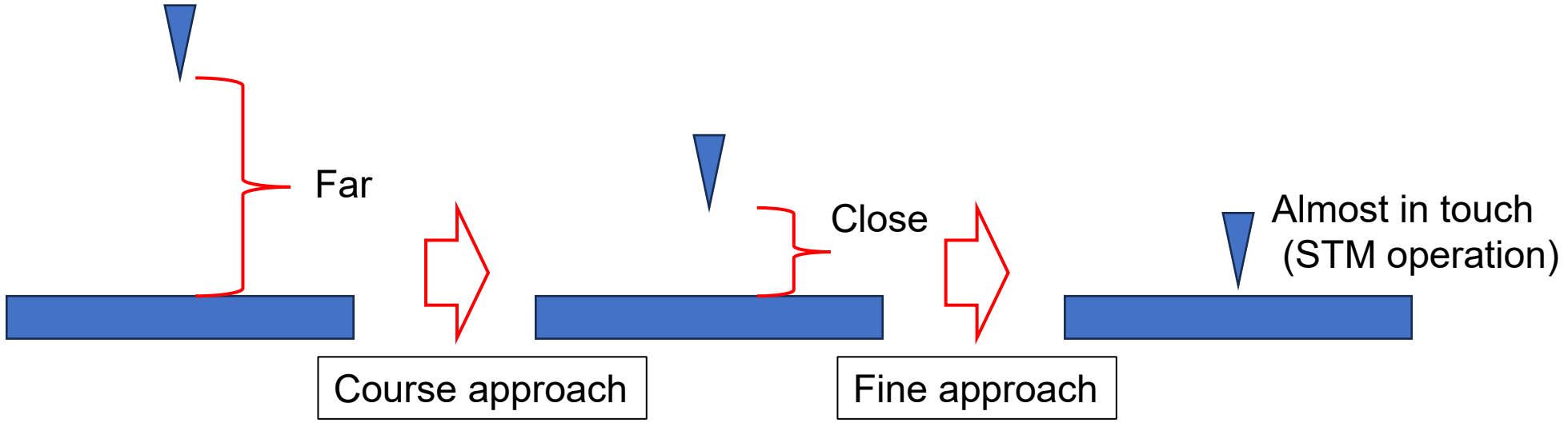


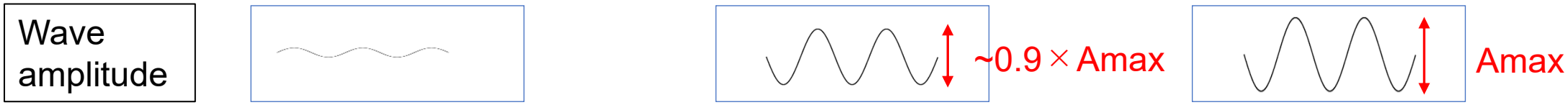




STM operation

Approaching

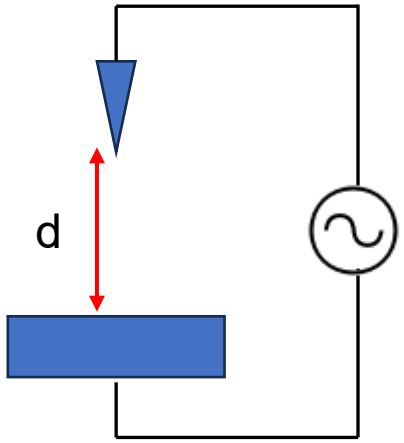




At the beginning, the distance between tip and sample is very far.
So the tip can be approached by a “Corse approach” (or Fast approach) to a closed distance.
However, the course approach is so fast that it may crash the tip to the sample.
Therefore, from a relatively close distance, a “Fine approach” (or Slow and safety approach) should be used.

The distance can be estimated from the sinusoidal wave in oscilloscope (see next page).

Approaching: Course approach



The distance can be estimated by the response to the alternative voltage.
We can regard that the tip and sample consist a capacitor with the capacitance C(d).
The current for an alternative bias $V(t) = Asin(\omega t)$ is expressed by $I = \frac{dQ}{dt} = C(d)\frac{dV}{dt} = C(d)A\omega\cos(\omega t)$.
Therefore, the amplitude of the current is proportional to the capacitance C(d).
Because the capacitance changes by the distance, we can use the amplitude of current as the indicator of the distance.

① Turn on the function generator. You may see a wave in oscilloscope.
② Approach until the amplitude reaches about 90 % of the maximum amplitude.
※ The maximum amplitude can be measured just after the STM scan, at when the distance is very close .
If the maximum amplitude is unknown (such as when using a new sample or tip), start fine approaching from safety distance.
Note that the maximum amplitude differs depending on the combination of the tip and sample.

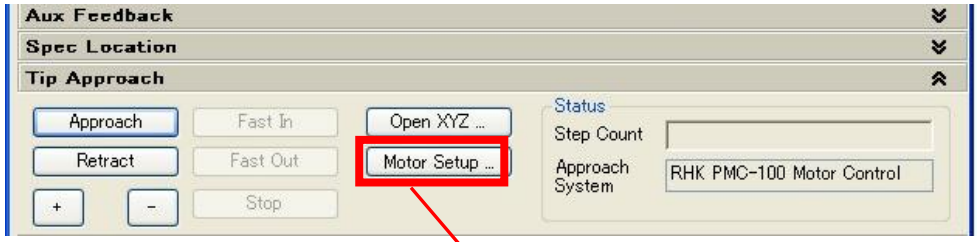
Approaching: Process

① Transfer the sample to STM. The temperature of STM raises.
② Approach by using controller (See “Course approach” page).
③ Wait until the temperature start decreasing (maybe 20~30 mins).
④ Check the controller values
(general values are setpoint 0.3, Time Constant 1.0, Gain 10, Z course and fine = 5)
⑤ Start automatic approaching.
⑥ If approaching finishes, an comment appears on window.
Rotate Z course to 0, then press the button on the window.
⑦ Rotate Z course knob slowly until tip become in range.
If tip does not become in range, repeat from ④.
⑧ Start scanning

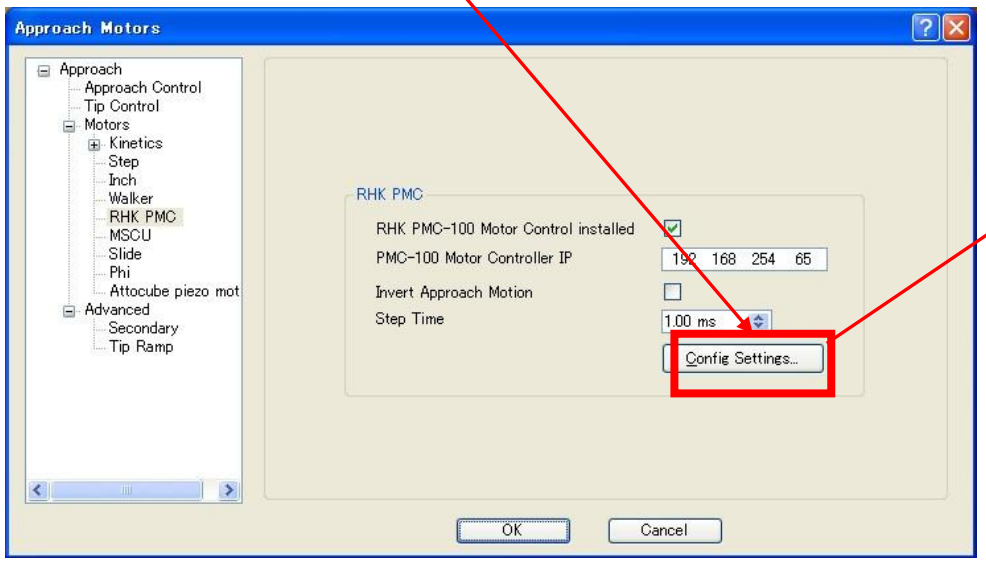
※ If approach often stops without reach in range, there is a possibility that the approach is stopped by noise signal. Try higher setpoint.
※ If the tip often crashes after approaching, the approaching drive voltage may be too high. Try lower driving bias (see “Driving bias” page).

Approach: Driving bias

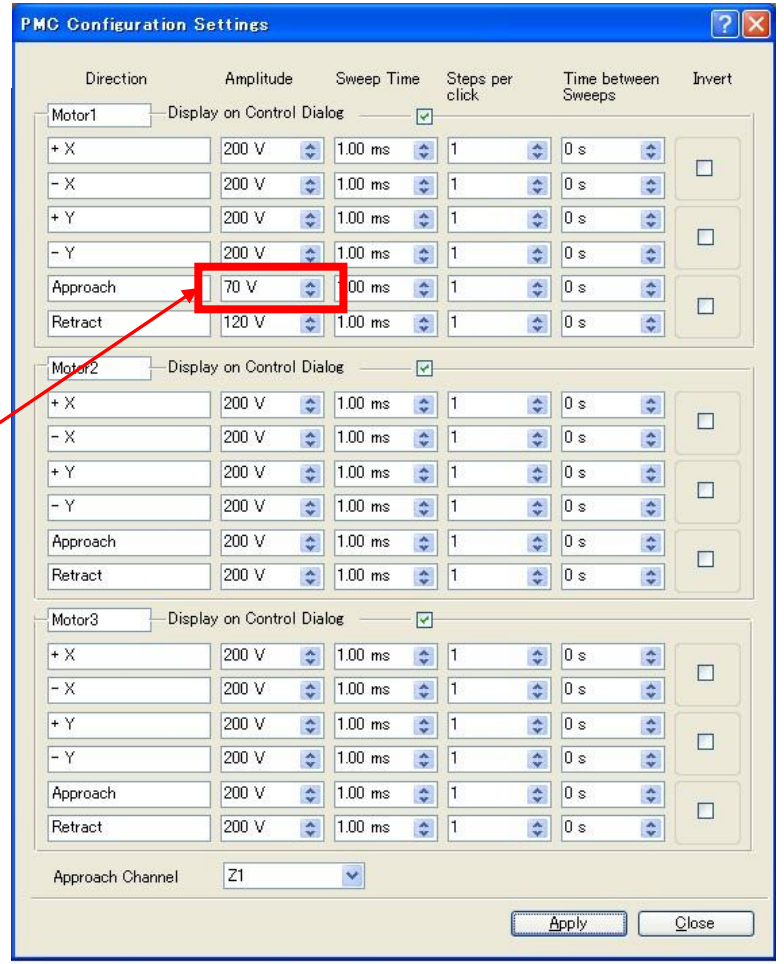
(A)



(B)



(C)



Generally, the approaching speed becomes faster at high temperature. So you may need to use smaller value at high temperature. Inversely, higher value may necessary at low temperature.

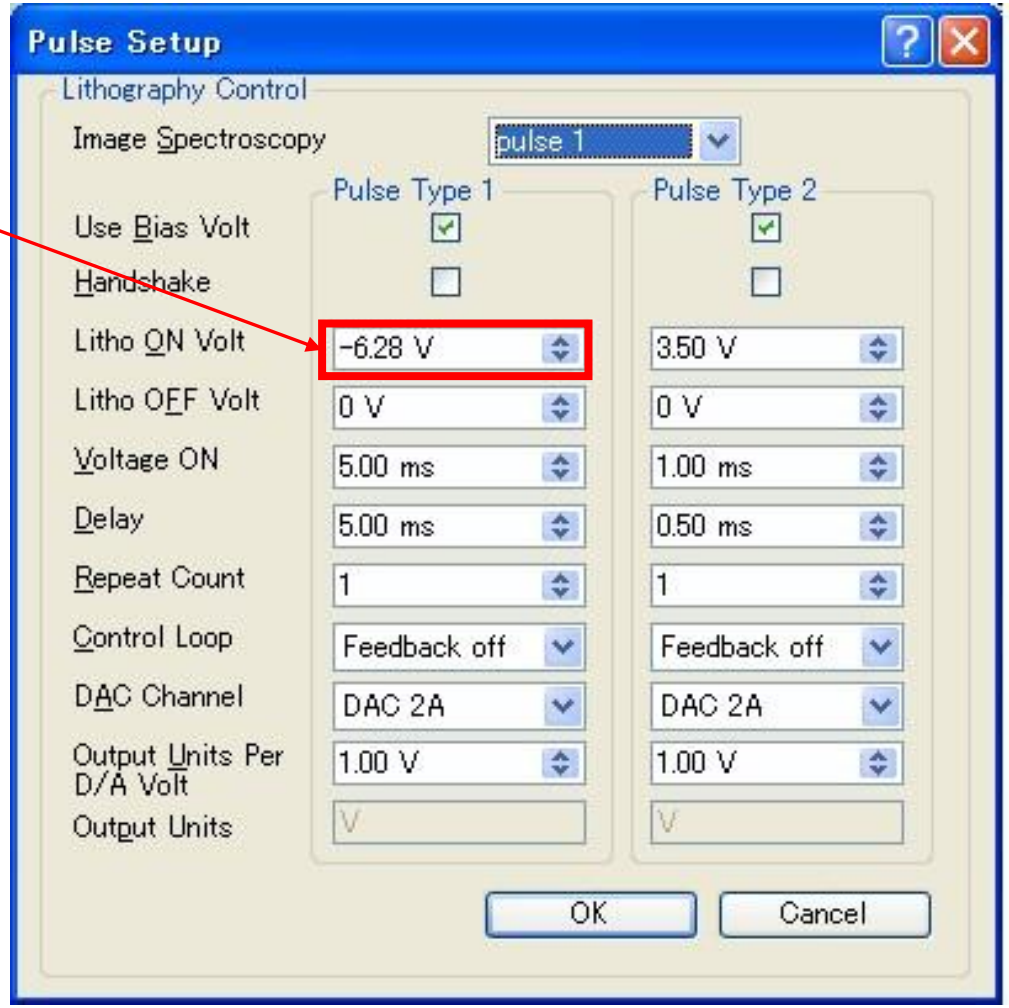
Fixing tip

Pulse

Changing the tip shape by applying a high pulse bias.
The pulse can be applied by pressing “Pulse”
The bias value can be changed at Pulse setup.
Pulse become effective using shorter tip-sample distance by increasing the setpoint or decreasing scanning bias.
[Process]
① Start scanning clean region.
② Press “Pulse”. If some change happens on STM image, change the region to the clean area.

Intentional crash

Touch the sample with the tip to modify the tip shape.
[Process}
① Place the tip at clean area.
② Turn off feedback by pressing “Loop hold”.
③ Slightly approach the tip by “Z Fine” knob on the controller.
For the first time, rotate the knob by ~0.4. The current may be overload (showing ~120)
④ Slowly retract the tip by the knob until the current become zero.
⑤ Turn on feedback.
⑥ Check the surface. If nothing change, try again with little deeper.



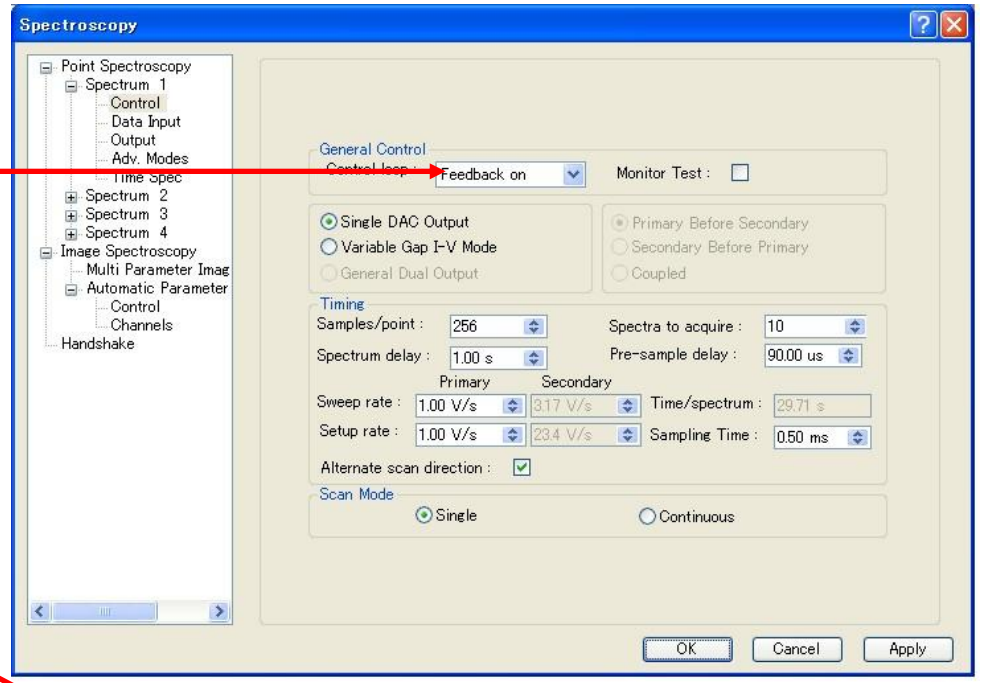
STS process

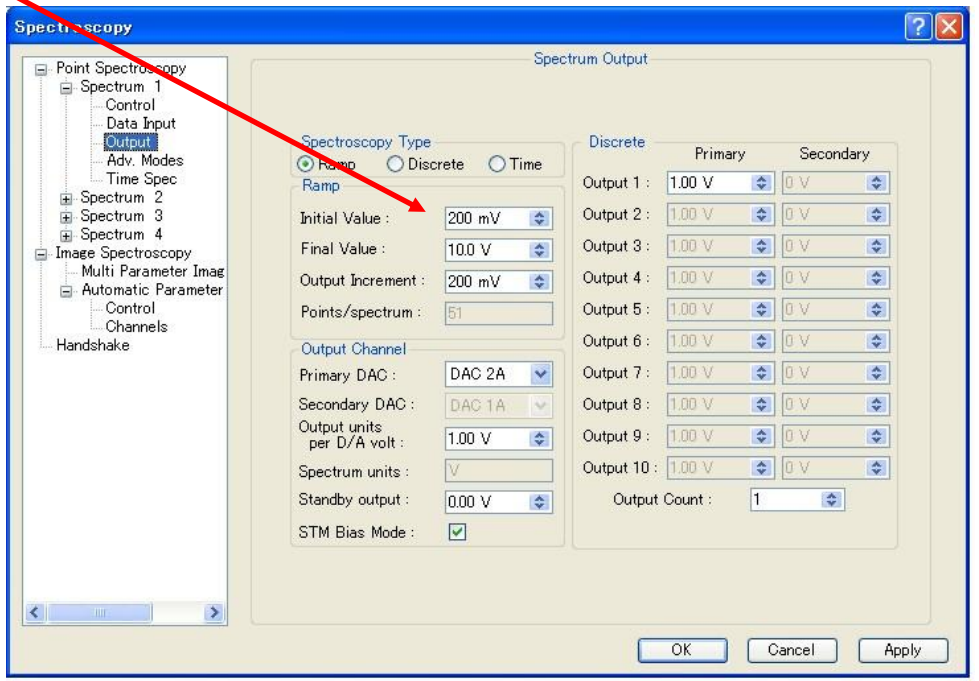
① Set the spectroscopy setting (see the following pages).
② Set the bias to the same bias as “initial bias” of spectroscopy setting.
③ Set lock in (see the following pages).
④ Place the tip onto the measurement position.
⑤ Start measurement.

STS spectroscopy setting

In Spectroscopy setting,
① Make sure that “Feedback off”.
② Set the initial bias and Final bias.

The other parameters can be changed if necessary.





Lockin: dI/dV①

For the detailed mechanism of lock in detection, see other documents.

① Make sure the connection of the cables.

Sign out→Bias#1 (controller)

Preamp monitor (controller) →signal input A/I

CH1 output → AUX CH1 (controller)

② Set parameters. Here I just introduce a typical value .

Freq: ~500 Hz, but avoid multiple of 60 Hz to avoid electric noise.

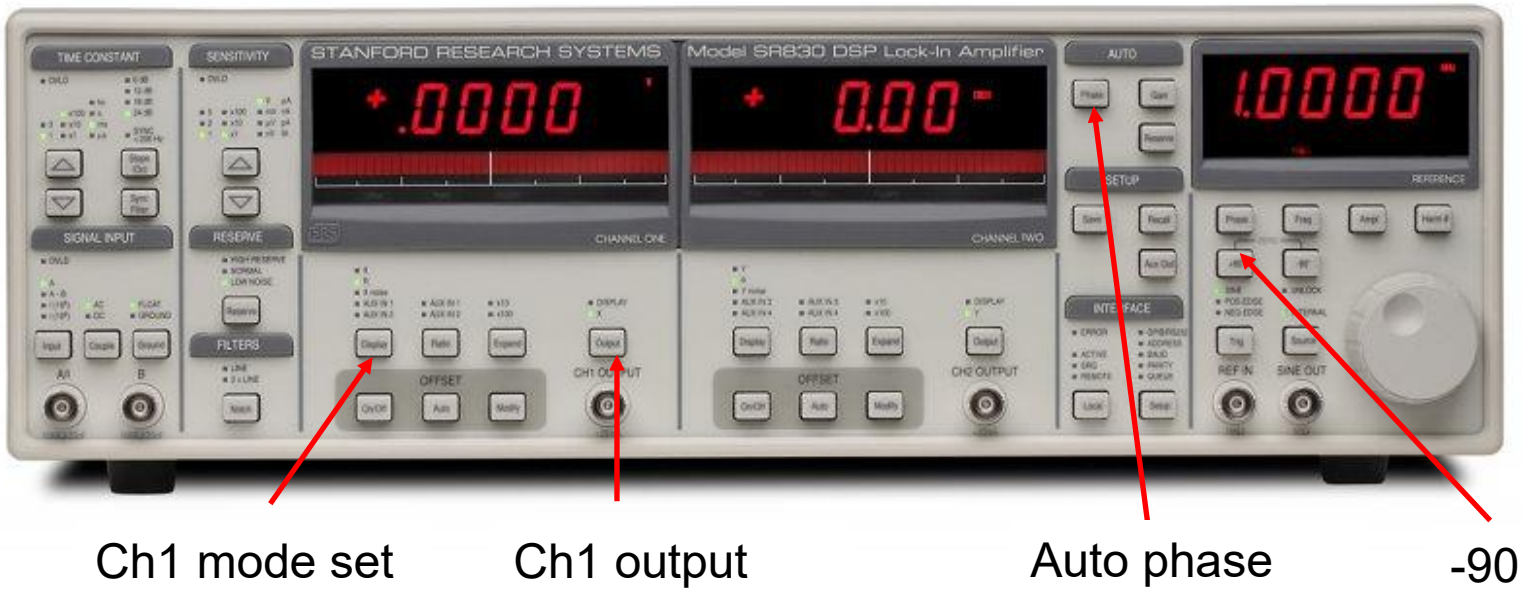
Ampl: ~10 mV

Harm: 1

Time constant: 30 ms, 18 dB

Sensitivity: 100 mV. If CH1 is overload, use larger value.

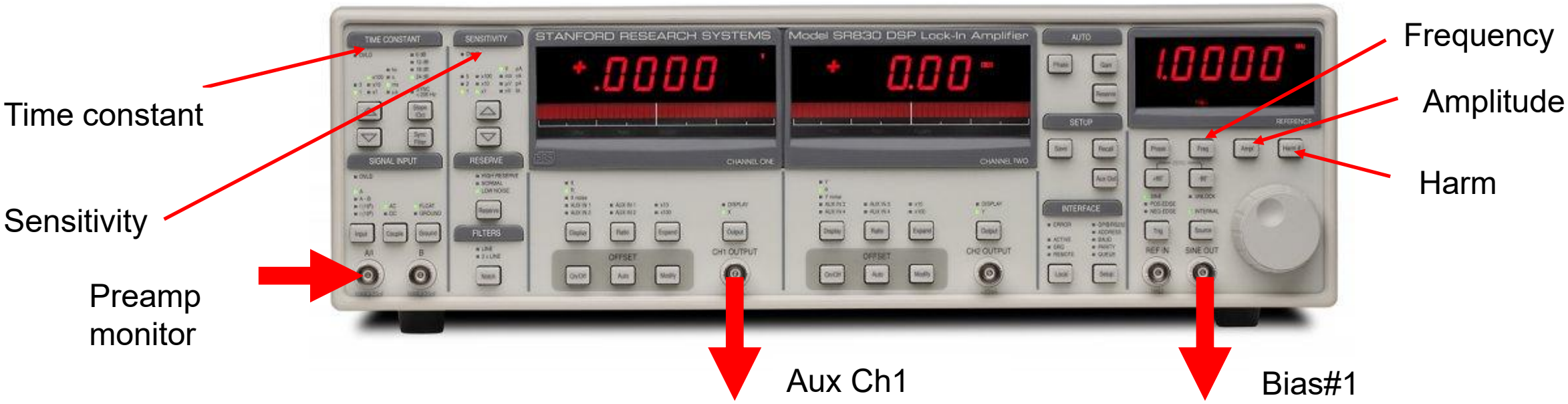
Lockin: dI/dV②



[R mode]: Easy to measure because of less setting, but output signal accompanies offset and noise.
③ Set channel 1 display “R” and Ch1 output “Display”.
④ Make sure that the tip is in range. Press “Auto phase” to confirm the successful detection of signal.
If it is fail, “bad” is displayed. If so, check connections, or tip condition may be so bad.
⑤ You can start the measurement.

[X mode]: Complicated setting, but no offset and less noise if properly operated.
③ Set channel 1 display “X” and CH1 output “Display”.
④ **Retract the tip until there is no tunneling current.** The following phase setting should be done without tunneling current.
⑤ Press “Auto phase”. If it success, press “-90”.
⑥ Approach the tip. Wait for a while until the tip position become stable.
⑦ Start measurement.
※ If “phase” is pressed or bias polarity of STM is changed, perform ④ and ⑤ again.

Lockin: d2I/dV2①



For the detailed mechanism of lock in detection, see other documents.

① Make sure the connection of the cables.

Sign out→Bias#1 (controller)

Preamp monitor (controller) →signal input A/I

CH1 output → AUX CH1 (controller)

② Set parameters. Here I just introduce a typical value. But d2I/dV2 signal is much smaller than dI/dV, further adjustment might be necessary. Find the best parameter by yourself.

Freq: ~500 Hz, but avoid multiple of 60 Hz to avoid electric noise.

Ampl: ~10 mV

Time constant: 30 ms, 18 dB

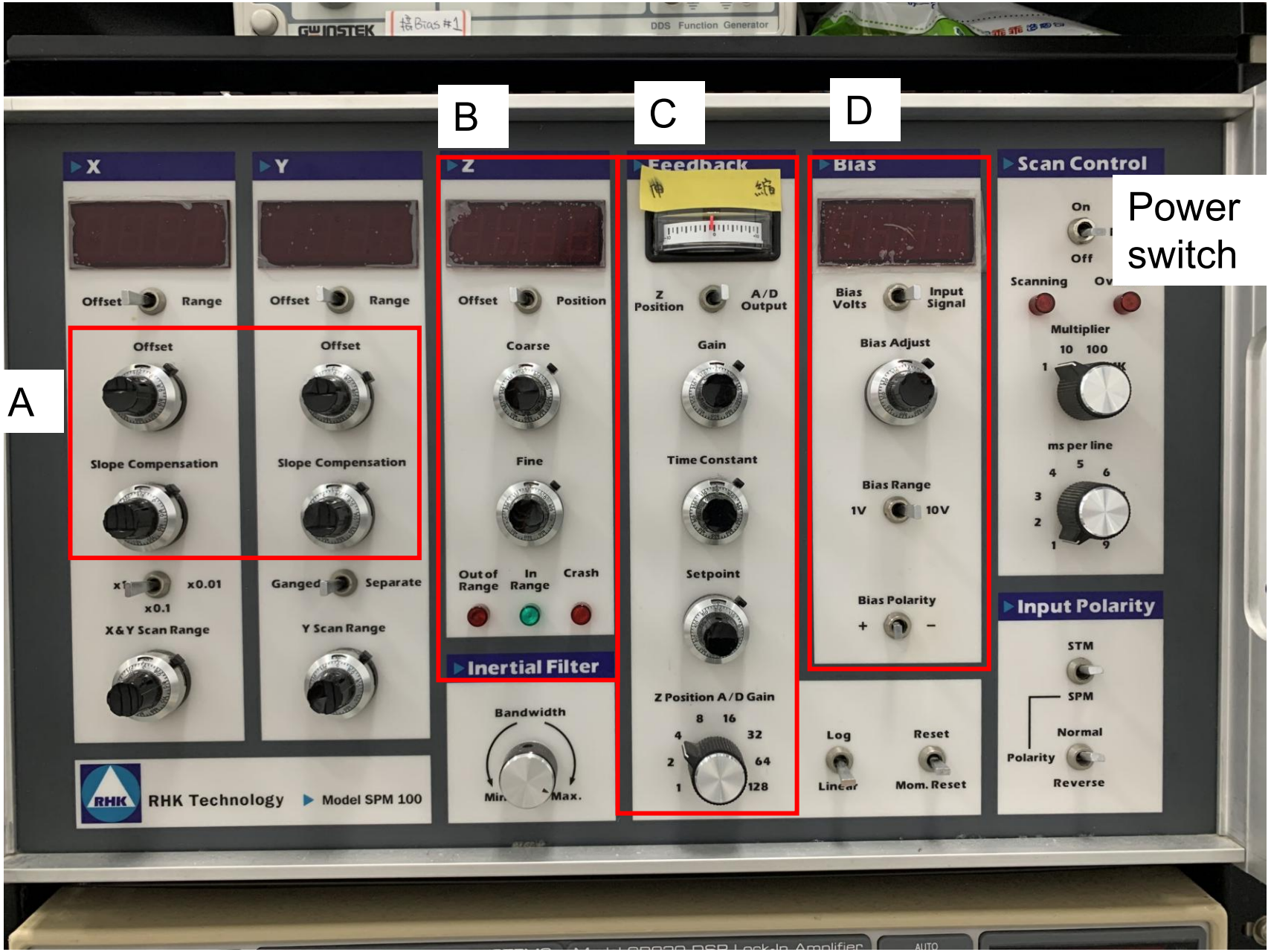
Sensitivity: 100 mV. If CH1 is overload, use larger value.

Lockin: d2I/dV2②

④ **Retract the tip until there is no tunneling current.** The following phase setting should be done without tunneling current.
⑤ Set Harm = 1. Press “Phase”. If it success, press “-90” twice.
⑥ Set Harm = 2. Set channel 1 display “X” and CH1 output “Display”.
⑦ Approach the tip. Wait for a while until the tip position become stable.
⑧ Start measurement.
※ If “phase” is pressed or bias polarity of STM is changed, perform ④ and ⑦ again.

STM controller

Controller SPM 100

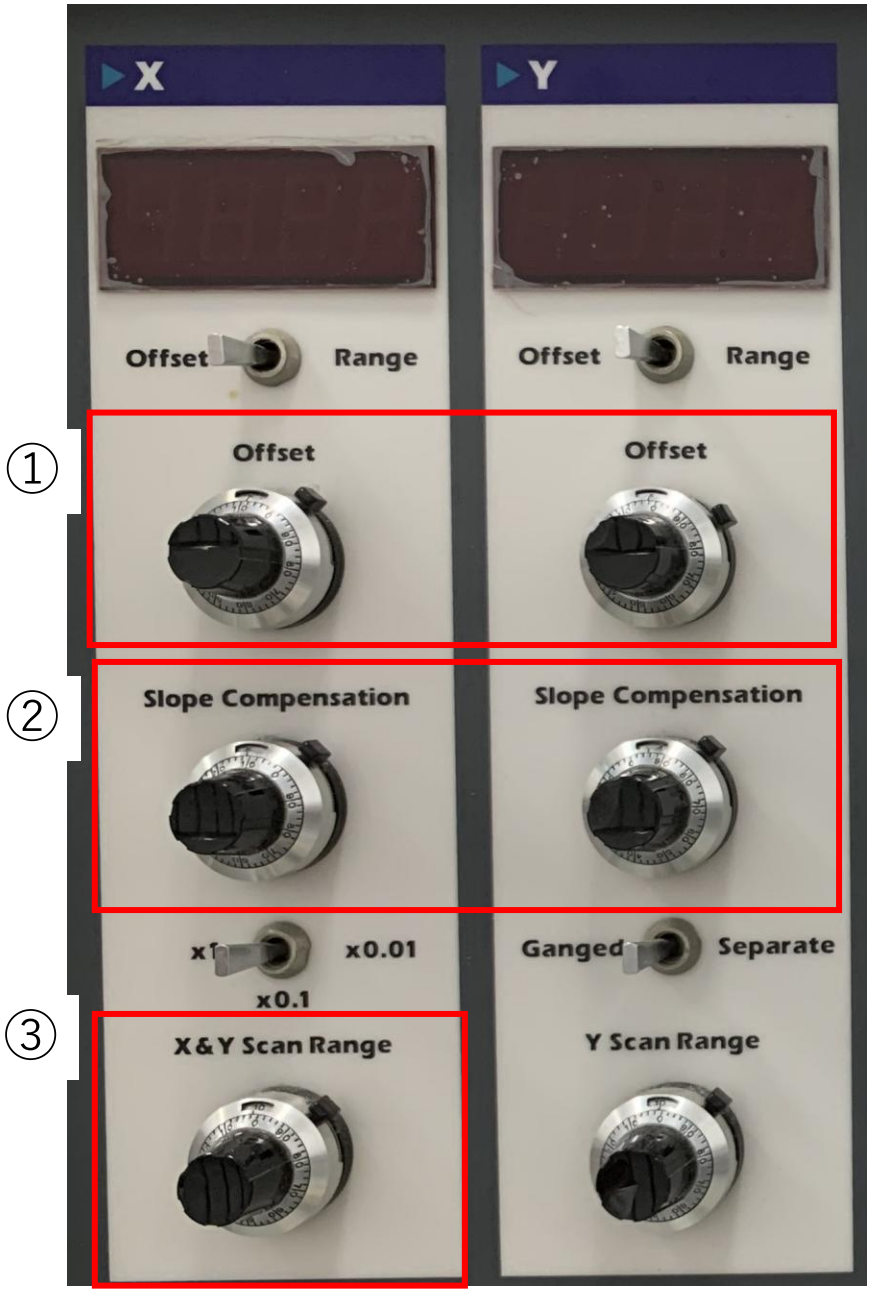


Controller: XY (A)

① Offset
Basically it is set at 5.0.
The maximum scanning range can be shifted by changing it.
Before changing this knob, press “Range” of Navigation window.

② Slope compensation
Sometimes the plane of the sample surface is not horizontal to the scanning plane.
The tilting can be compensated by this knob.

③ X and Y scan range.
The maximum scanning range can be changed.
By decreasing the maximum scanning range, the minimum scanning range also decrease, enabling the smaller scan.
Before changing this knob, press “Range” of Navigation window.

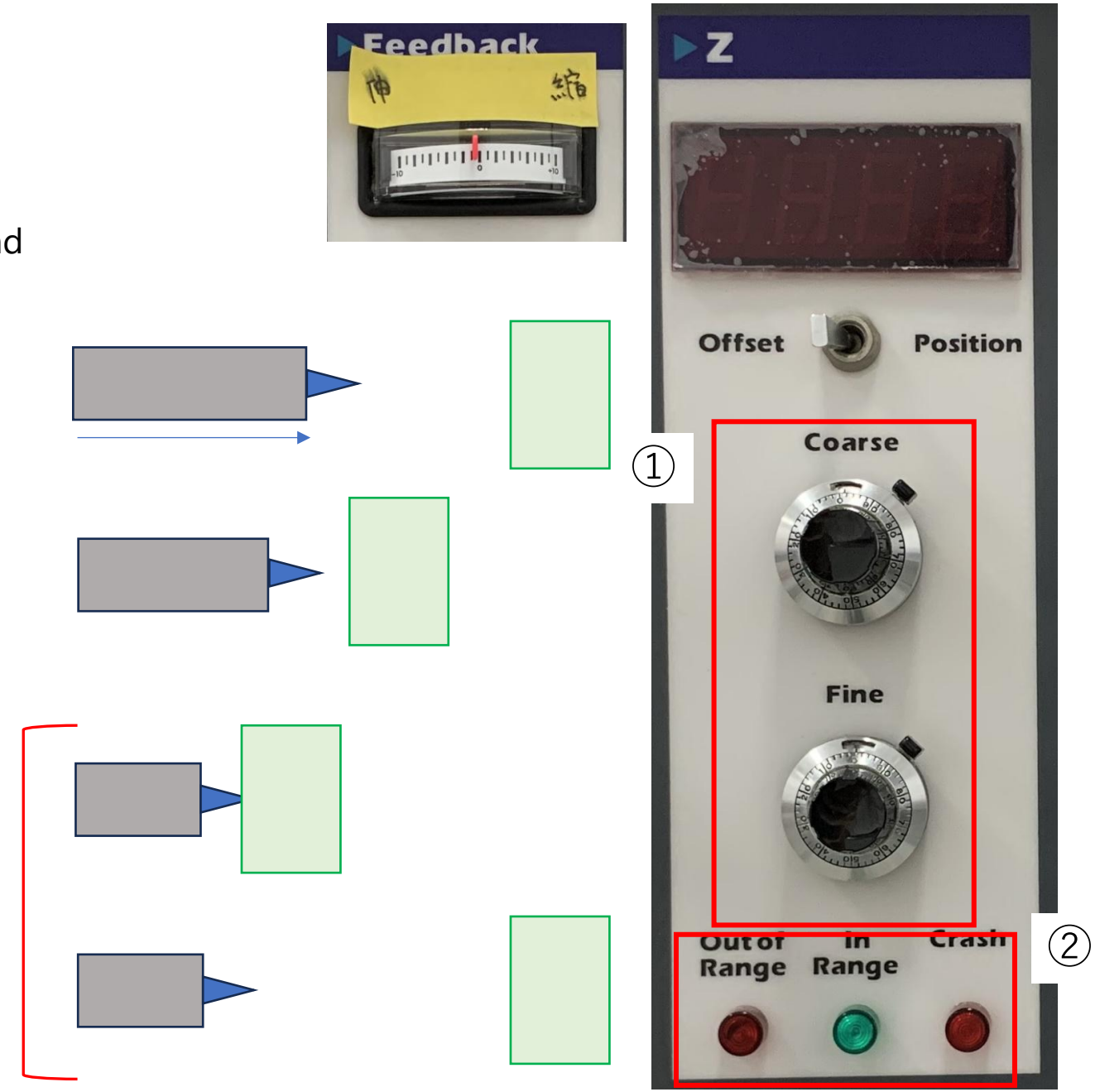


Controller: Z (B)

① Coarse and Fine
These knobs controls the offset applied on tip height.
For the full usage of feedback range, it is better to adjust offset to be the indicator in Feedback to be located at around the center.

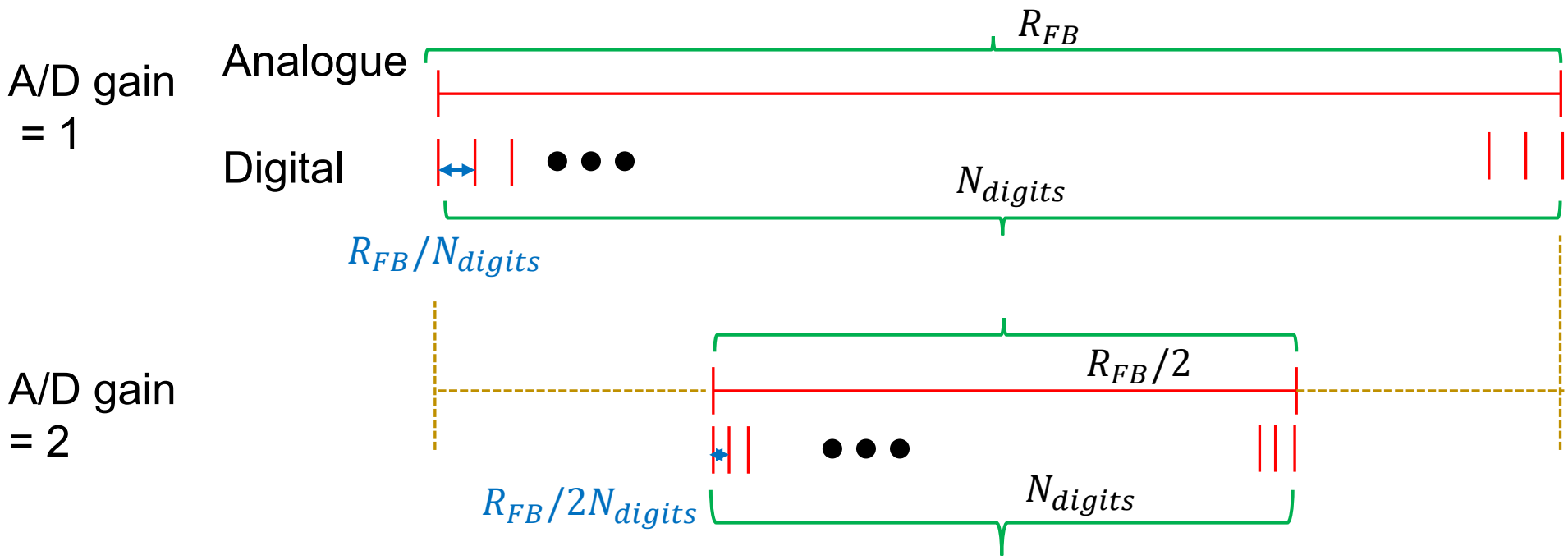
② Indicator for Z position
Out of range :
The piezo is fully expended at the feedback limit.
Sample is far and no signal detected.
In range:
Feedback is working.

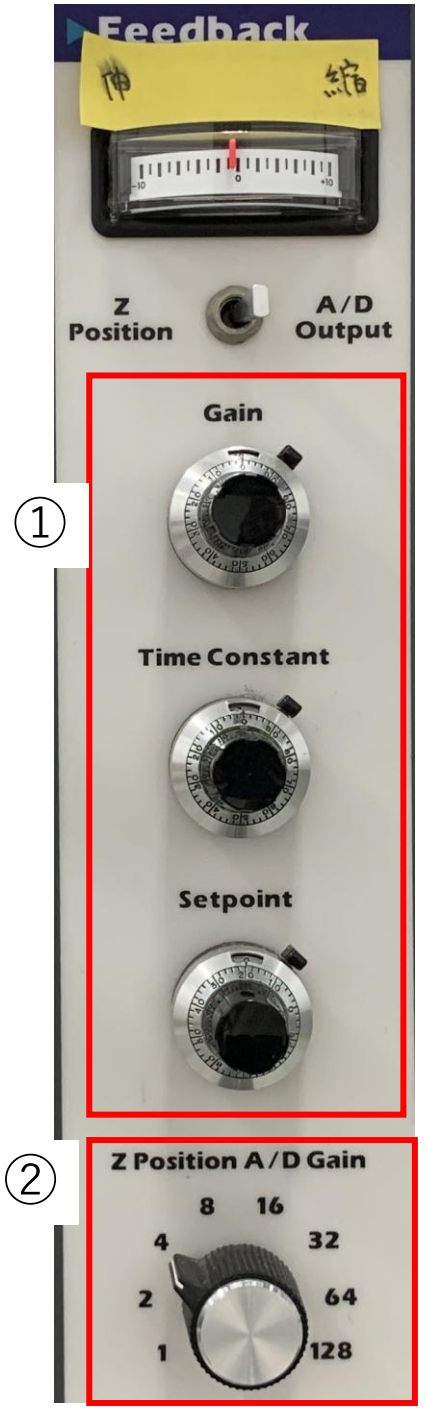
Crash: The tip is fully shrieked at the feedback limit.
Tip touch the sample, or the program shrink it for safety, such as after finish approaching or "tip retract " is pressed.



Controller: Feedback (C)

① Feedback parameters
When approaching, Gain = 10, Time constant = 1, Setpoint = 0.3 is often used.
Adjust the parameters depending on the scanning condition.
② Z position A/D gain
The analogue signal should be converted into digital signal to record in computer.
For example, we assume that the maximum feedback range is R_{FB} and it is converted to N_{digits} digital signal. The separation between neighboring digits is R_{FB}/N_{digits}.
If A/D gain is changed to 2, only the half of the feedback range is converted to digital signal, indicating smaller scanning range.
Instead, the separation between neighboring digits becomes smaller, indicating the higher resolution.





Controller: Bias (D)

① Bias/Input signal

It changes what values to display above. Input signal is the tunneling current.

② Bias adjust

For changing the bias.

③ Bias range

It can change the maximum bias. When using 10 V, 0~10 V bias can be applied, while only 0~1 V is applied when 1 V is used.
Because the bias value is much reliable in 1 V range, basically use 1 V.
If high bias is necessary, you can use 10 V range.

④ Bias polarity

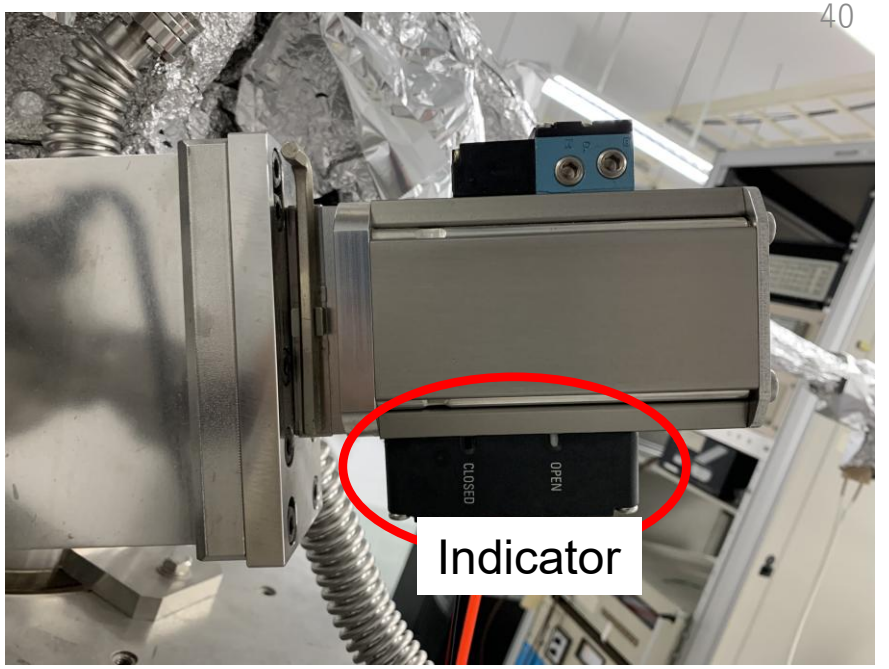
The polarity of bias can be changed.
Before changing the polarity, it is safe to retract the tip to the out of range.

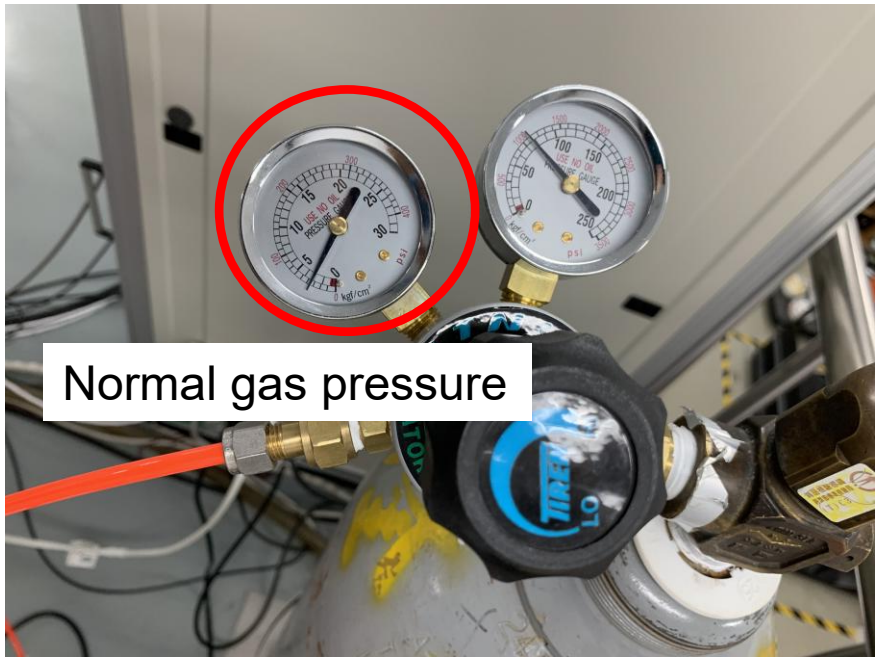
Gate between preparation and turbo

The gate between the preparation chamber and turb pump is driven by gas pressure.
If the gas pressure is not enough, the gate cannot be moved.

If you feel something strange, such as the pressure in the preparation does not decrease even after opening the gate, check if the gate is properly operated.
The gate position can be checked by a mechanical indicator on the gate.
If it does not move or stopped in the middle, there is a possibility that the gas pressure is not enough.

Then check the gas pressure of the gas tank.
If necessary, increase the gas pressure or replace the gas tank.





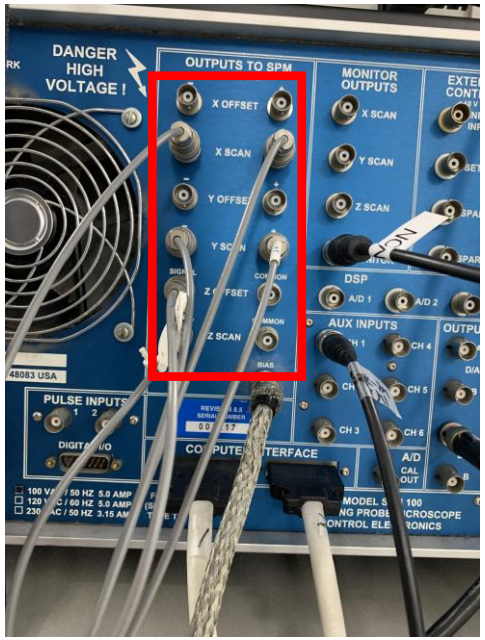
Checking piezo connection

If scanning has trouble, one of the possibility is the wire or electrode to the piezo is broken.
It can be checked by measuring the capacitance between the electrodes.

In a normal condition, the capacitance of each electrode with respect to the Z offset are summarized in the table.

Electrode	Capacitance (nF) at 80K (2023/6/27)
+-X	~1.2
+-Y	~1.2
Z scan	~2.4

If the capacitance shows strange value, there is a high possibility that the connection to the piezo have the trouble.
You may need to open the STM chamber and check the STM.



Opening STM chamber

Opening the chamber

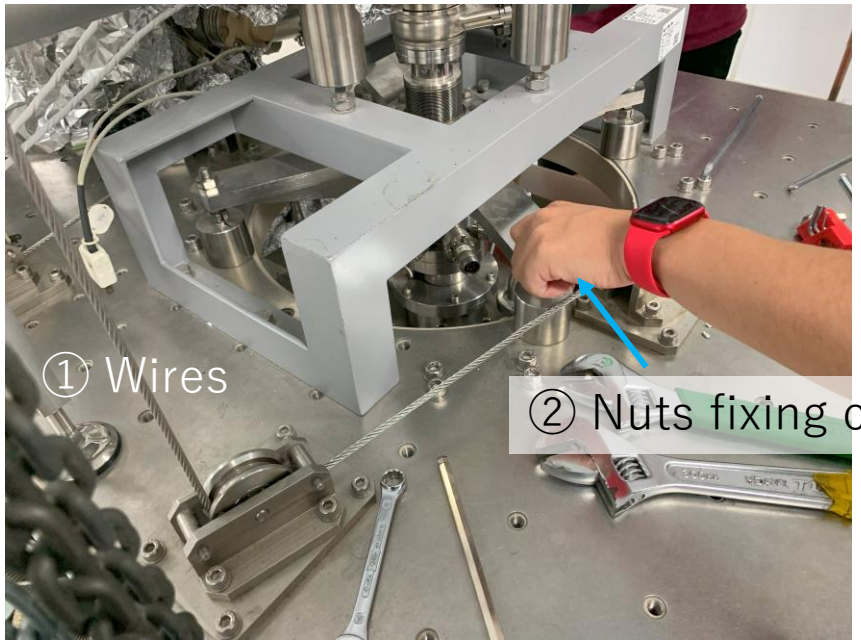
① Wait until the temperature of STM back to room temperature.
② Turn off all the equipment in the chamber (such as gauge, ion pump).
③ Open all the gates from load lock to STM chamber.
④ Vent from load lock.

Lifting down the cryostat

For accessing STM chamber, the cryostat should be taken off.

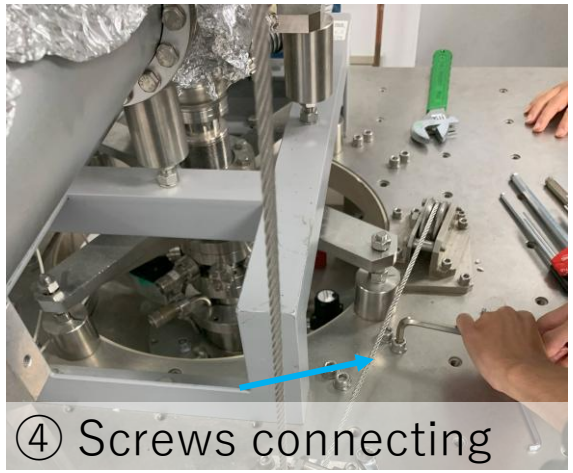
① Connecting the two wires for lifting the cryostat with the crane.
② Loosen the upper nuts fixing the chamber and table.
③ Remove the screws connecting the chamber and cryostat.
④ Remove the screws connecting the cryostat and table.
⑤ Slowly lift down the cryostat using the crane keeping it without tilt.

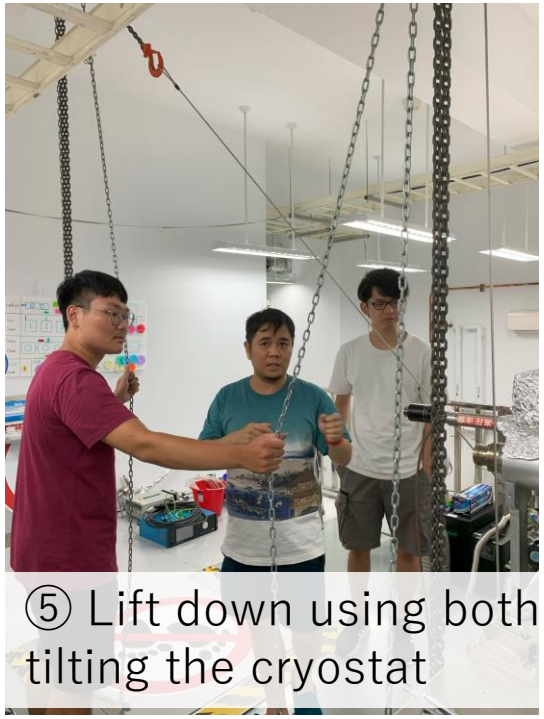

① Cranes

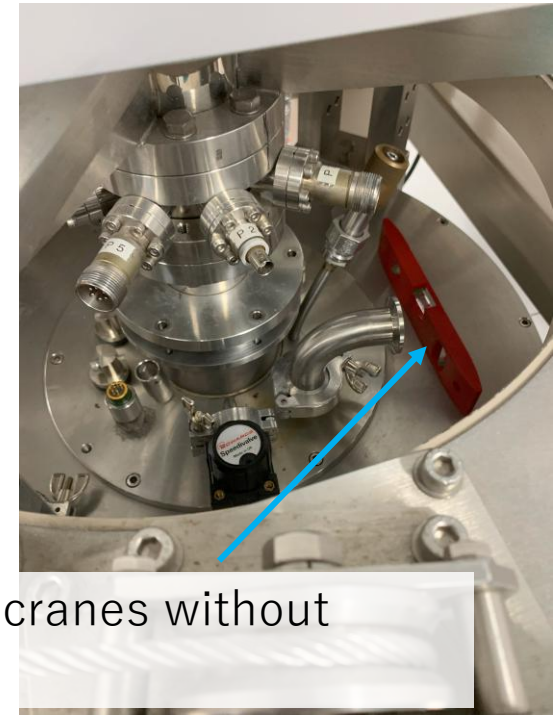

① Wires
② Nuts fixing chamber with table


② Loosen the upper nuts


③ Screws connecting chamber and cryostat


④ Screws connecting cryostat and table


⑤ Lift down using both cranes without tilting the cryostat



Lifting up the cryostat

Basically the opposite process from the lifting down process.

① Loosen the nuts connecting the STM chamber and table.
There is a space between the support and upper nuts.

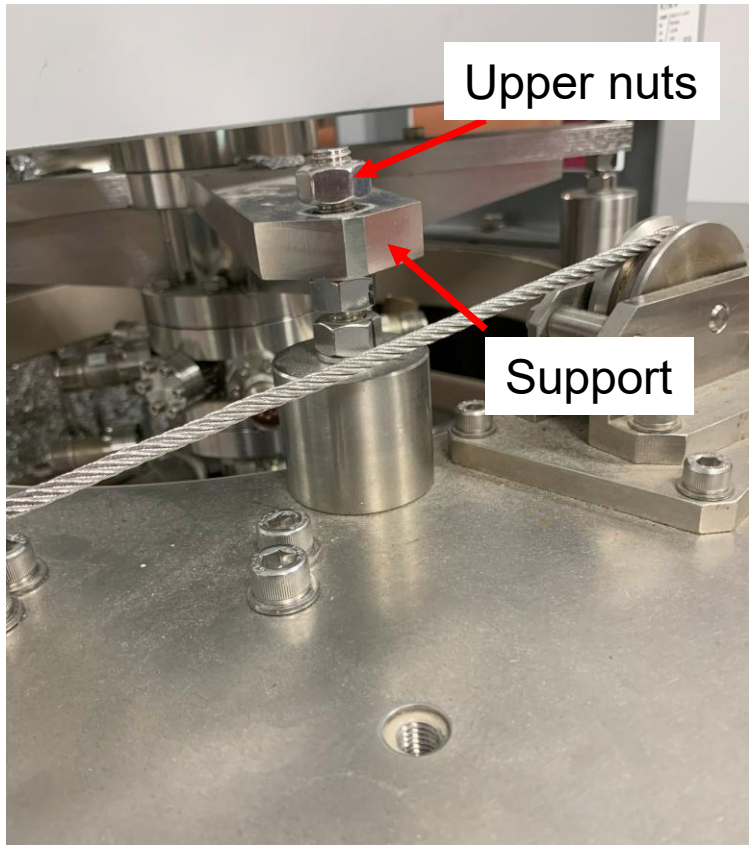
② Slowly lifting up the cryostat.

Always keep the top of the cryostat plane to the base.
When lifting up, the STM chamber may stack to the cryostat.
When it happens, the support may touch the upper nuts, lifting up the main chamber. Always make sure that the support and nuts keep a space.
If it is stacked, lift down the cryostat a little bit, and try lifting up again.

③ If the cryostat reach the table, fix the screws connecting the cryostat and table.

④ Fix screws connecting the cryostat and chamber.

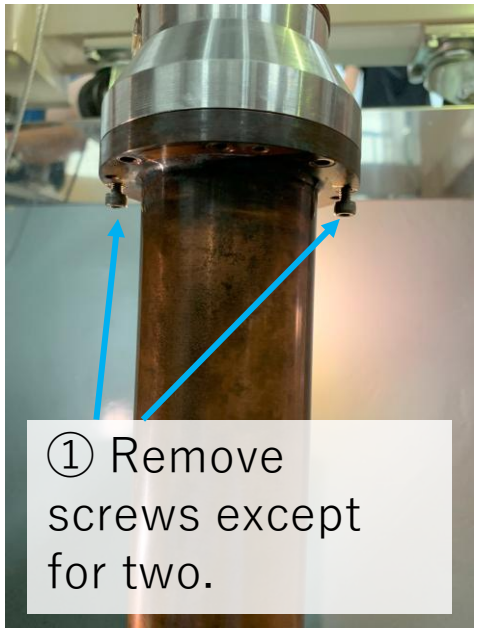
⑤ Fix the support by the nuts.

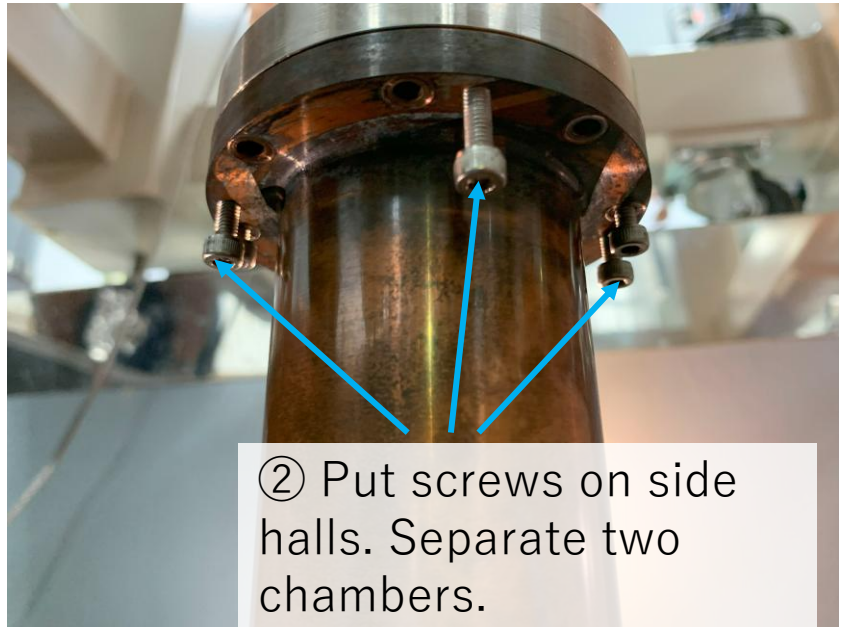


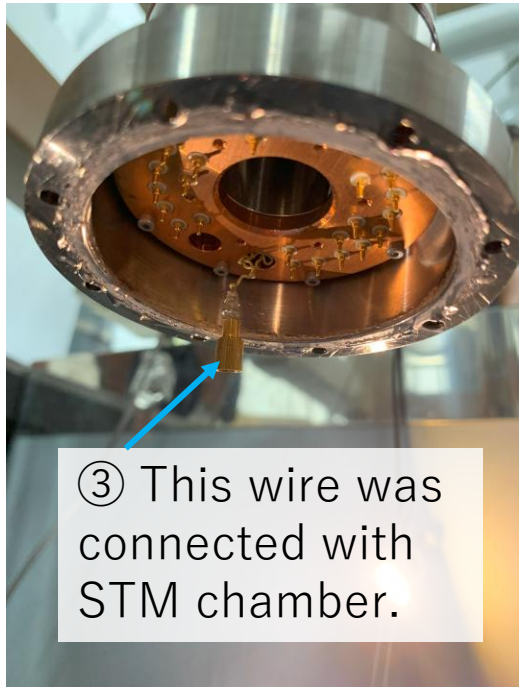
Removing the STM chamber

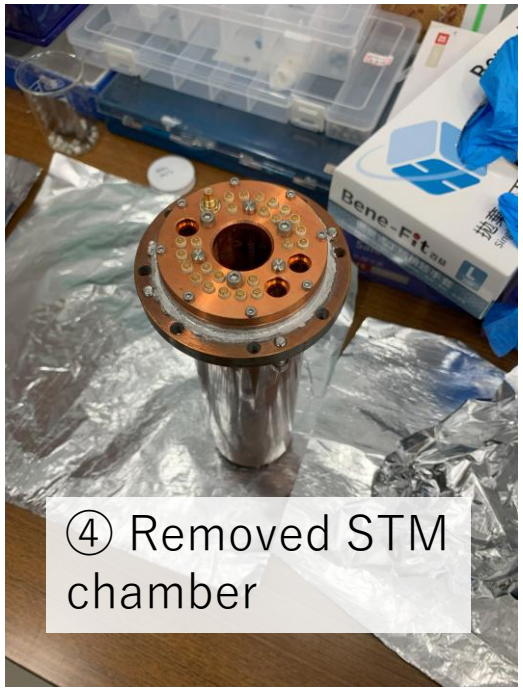
Now you can see the STM chamber.

① Remove screws except for two. Keep two screws loosen for avoiding accidental drop of STM chamber.
② Put the screws on the side holes. By tighten the screws in these side holes, the STM part is slowly taken out.
③ Remove the remaining two screws with supporting the chamber. A little down the chamber to see inside. You may see a wire connoting the top chamber and STM chamber. Remove the wire.
④ The STM chamber can be removed.

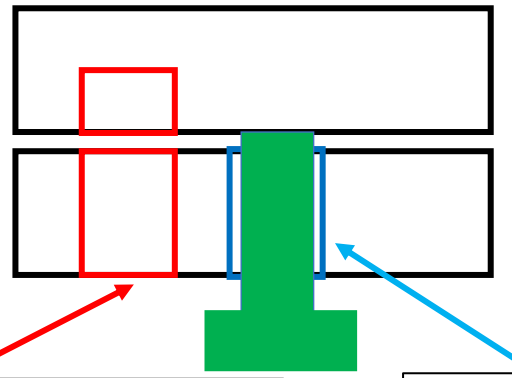








② Schematics of screw holes



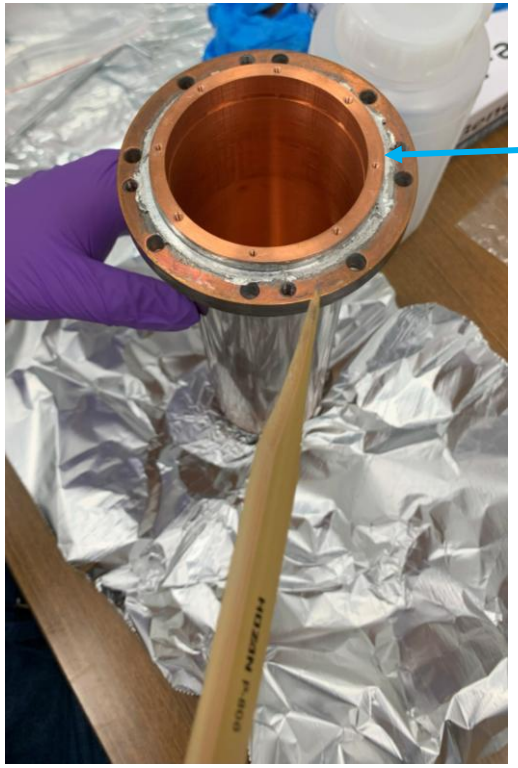
Normal screw hole, connecting top and STM chambers

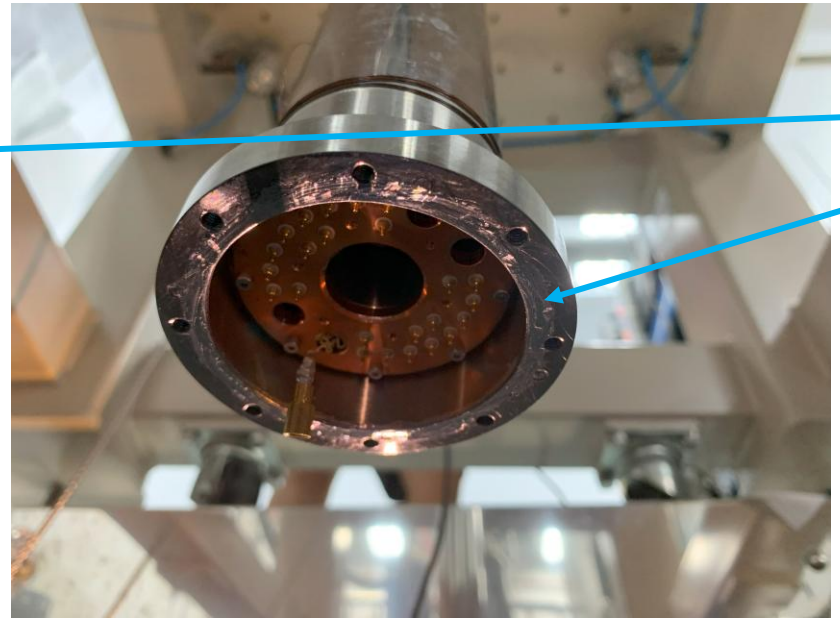
Side screw hole. No hole in top chamber side, so screws can apply a force to separate two chambers

Putting back the STM chamber

① A Indium seal is used between the STM chamber and top chamber.
Remove the Indium seal of both STM and top chamber by using a wood stick.
The wood stick is used to avoid damaging the chamber.
② Put a Indium wire around the STM chamber.
③ Fit the In wire around the STM chamber.
④ Set the STM chamber with the top chamber. Don’t forget connecting the wire.
⑤ Fix it by screws.

After setting, check if STM is working or not by observing a sample such as HOPG.

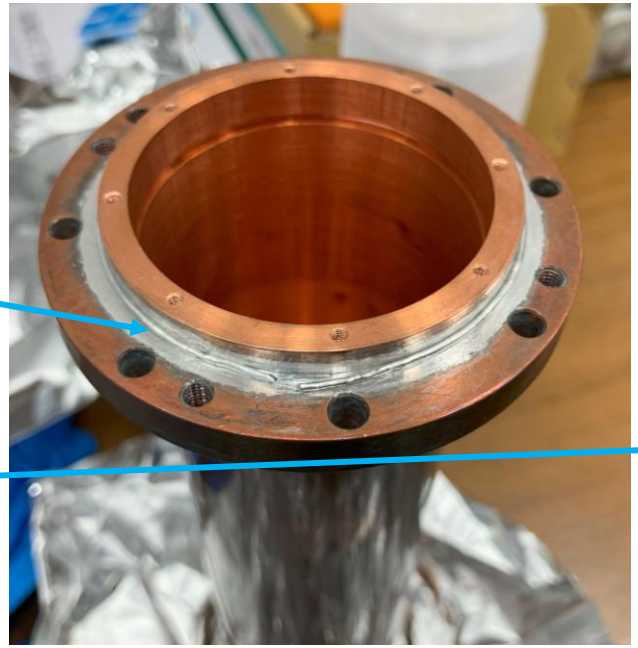


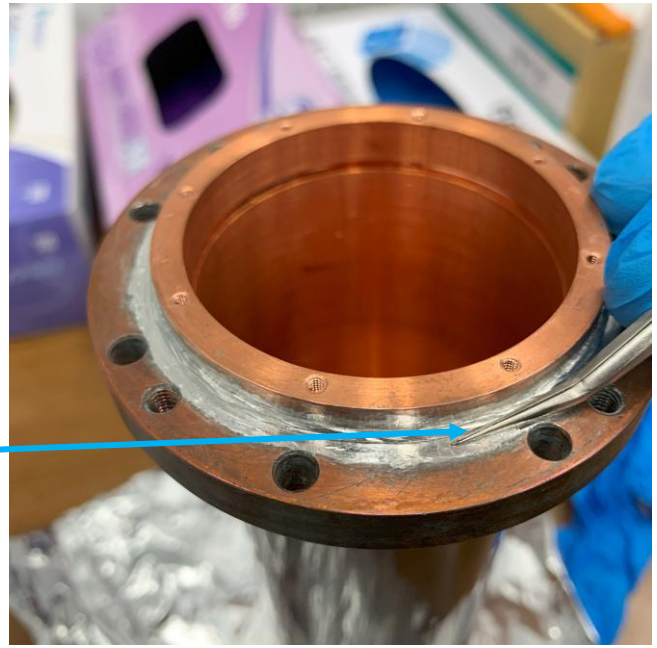


① Remove old indium wire at the interface between two chambers as much as you can.

② Put In wire around the STM chamber.

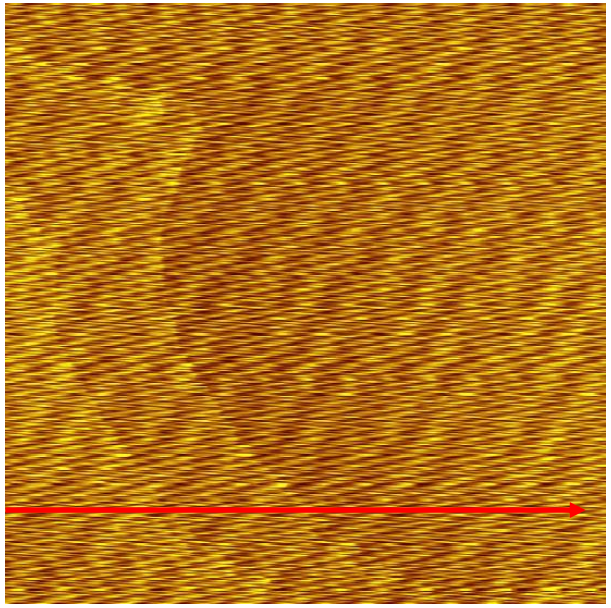
③ Press In wire to well fit with the STM chamber.

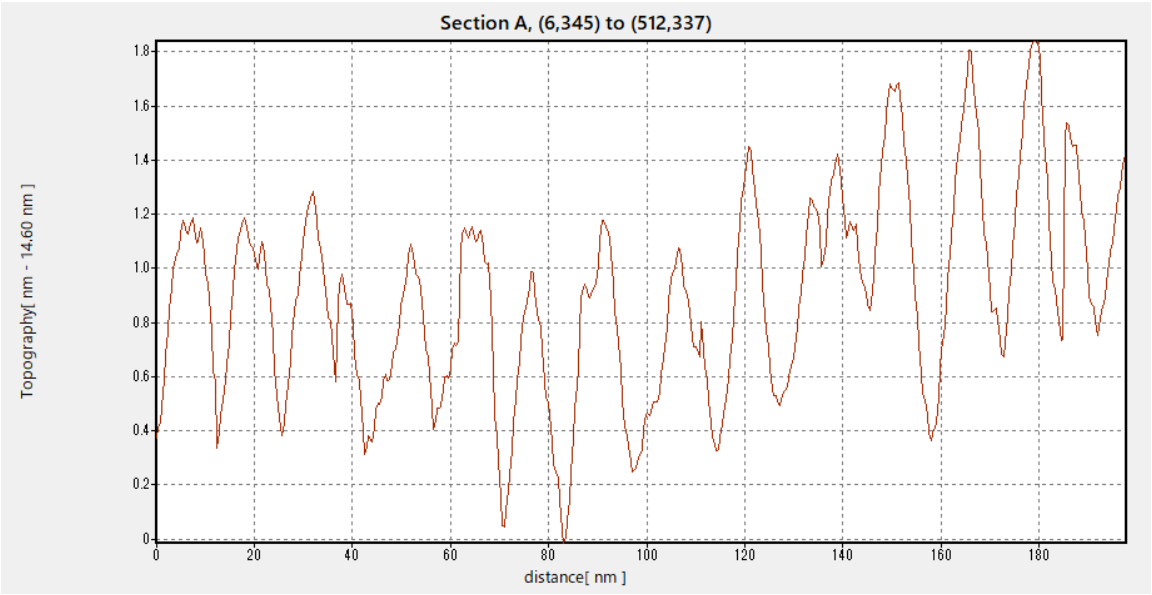




Other topics

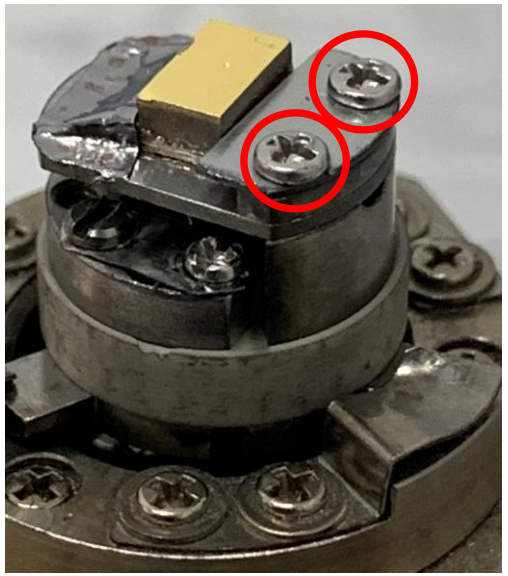
May 2nd /2023 Large noise on Au(111)

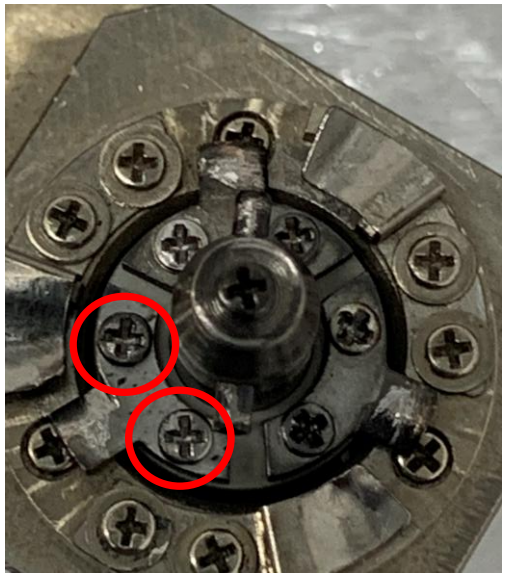




Huge noise with ~1 nm height appeared on Au(111).
The herring bone is completely absent, and the step is very faint.

The problem was the screw on the sample holder.
The screw was loosen, which might cause vibrational noise in scanning.





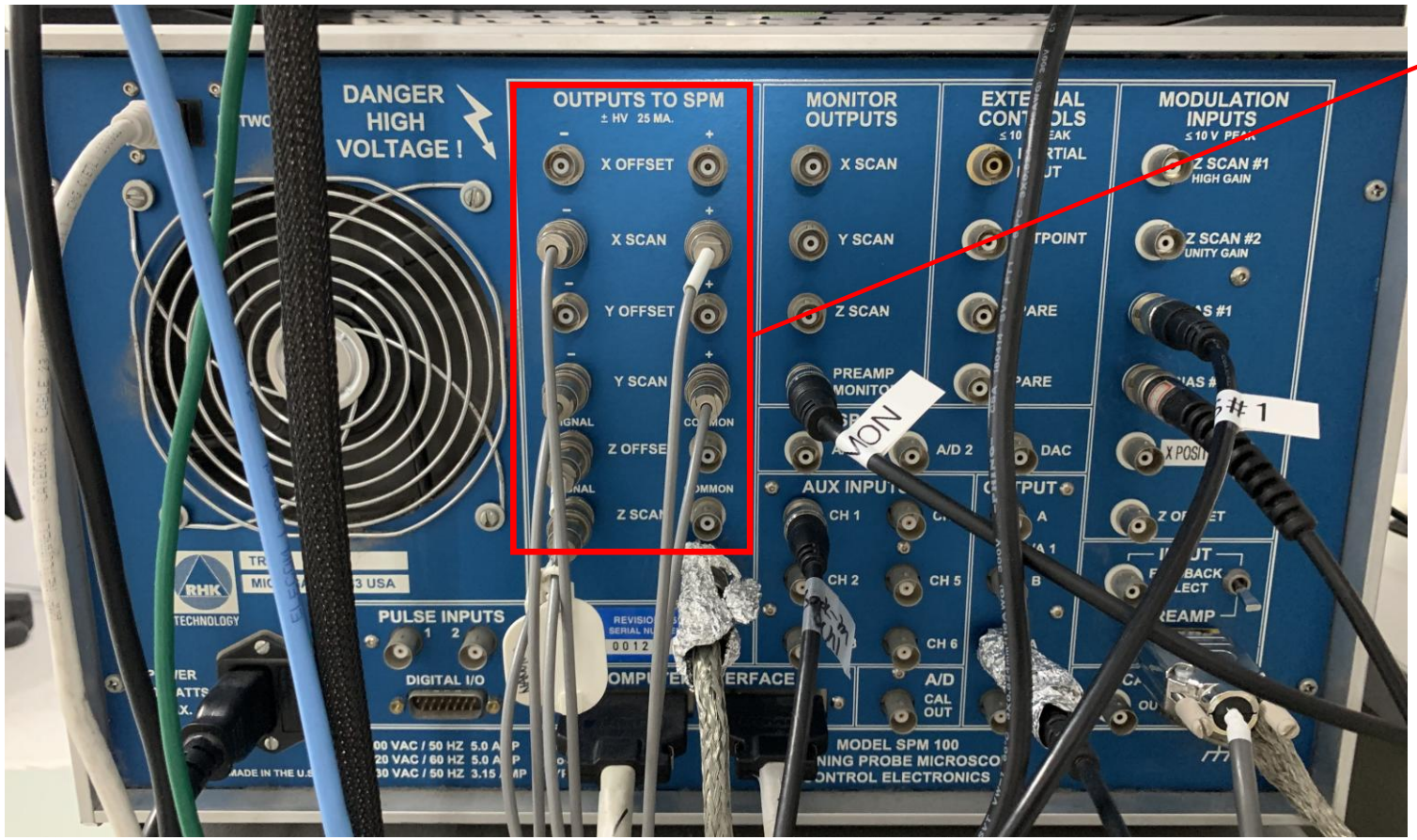
Jun. 9 th 2023 Controller trouble ①

Original trouble: Tip does not go in range after finish approaching.
Possible problem:

(1) Z offset or Z scan from the controller is not outputted.

(2) The Z signals does not reach the scanner because of the broken wire.

We firstly checked the output signal from the controller, and find that the all the high bias output is not working.



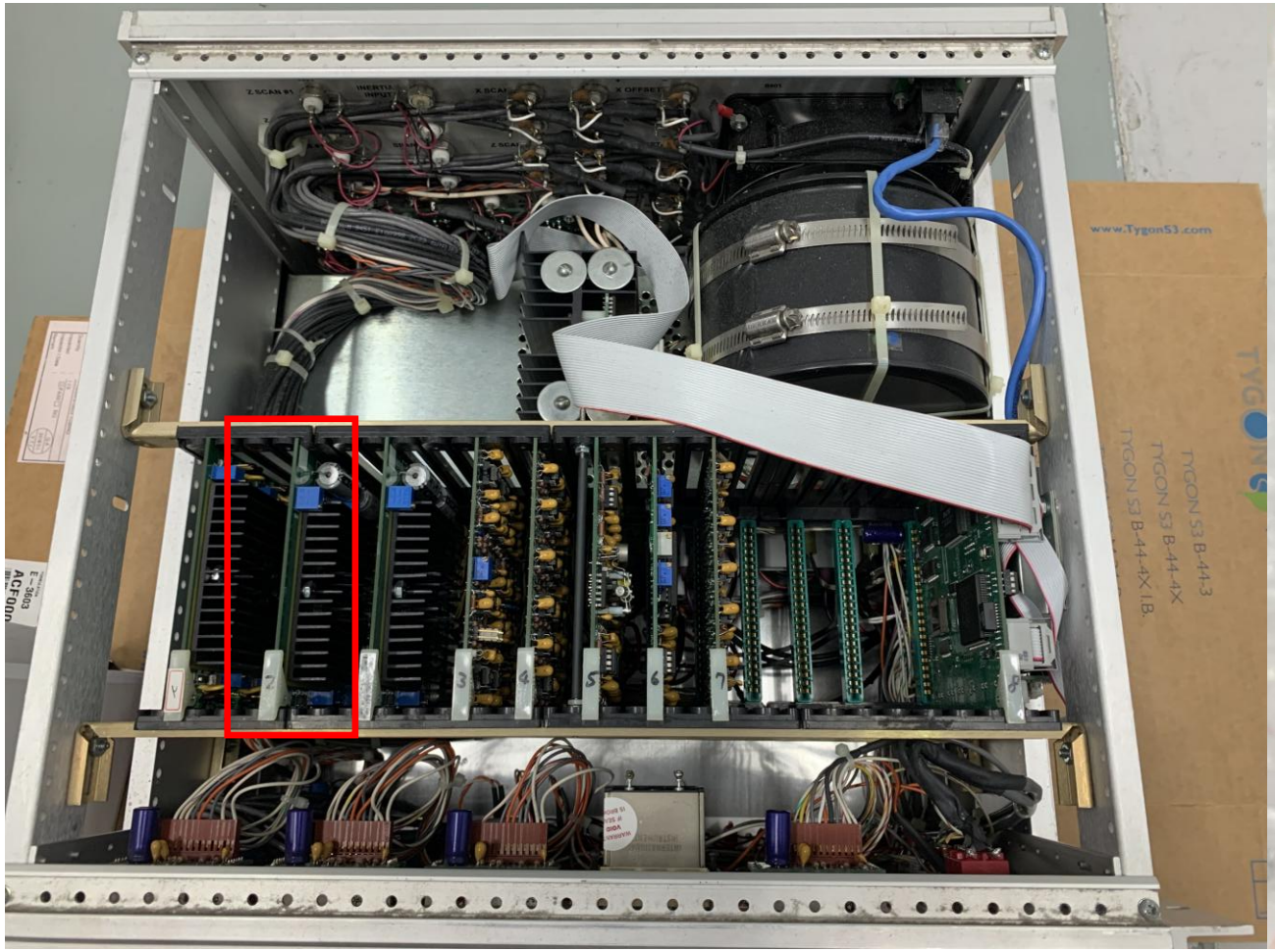
High bias output to scanner.
All the channel fluctuate, unstable

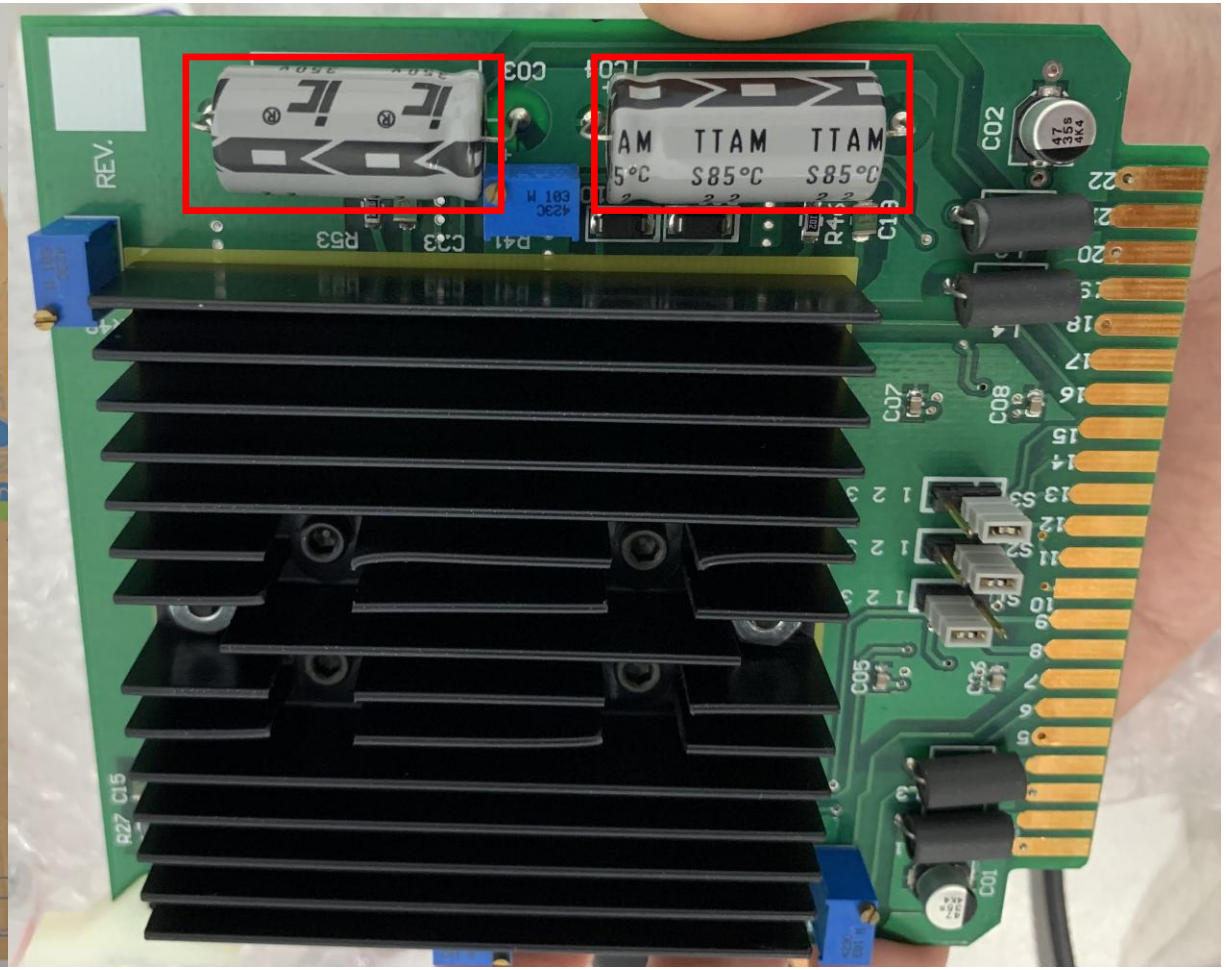
In normal situation, these channels output a stable signal of -130~+130 V.

X (Y) scan changes depending on the tip position.
Z offset depends on the Course and Fine Z of controller knob.
Z scan depends on the feedback.

Jun. 9 th 2023 Controller trouble ②

We found that a capacitor in board 2 is broken.
Board 2 is the output for X and Y offset, but these outputs are not used in our system.
Thus, we removed board 2, them the controller works normally.





Des. 23 th, 2023 IP mismatch

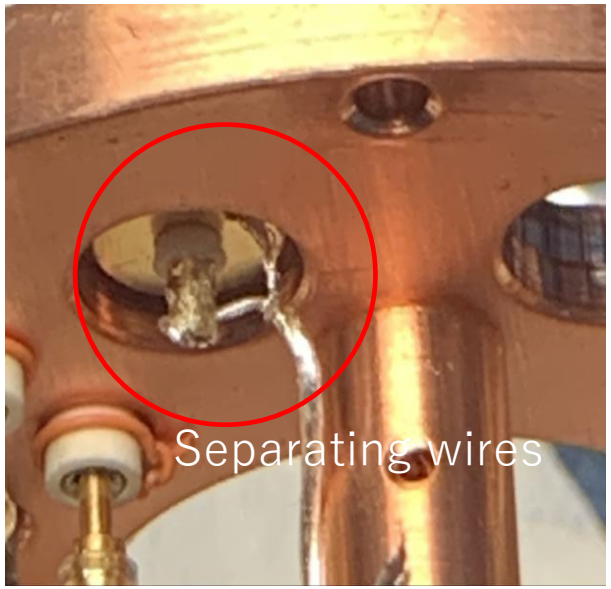
When opening XPM pro, “IP mismatch” is shown and no response from the controller.
We solved it by changing the setting of the computer.
※The default language of the computer is Japanese, and I cannot change it to English. So I put the Japanese name as the reference.

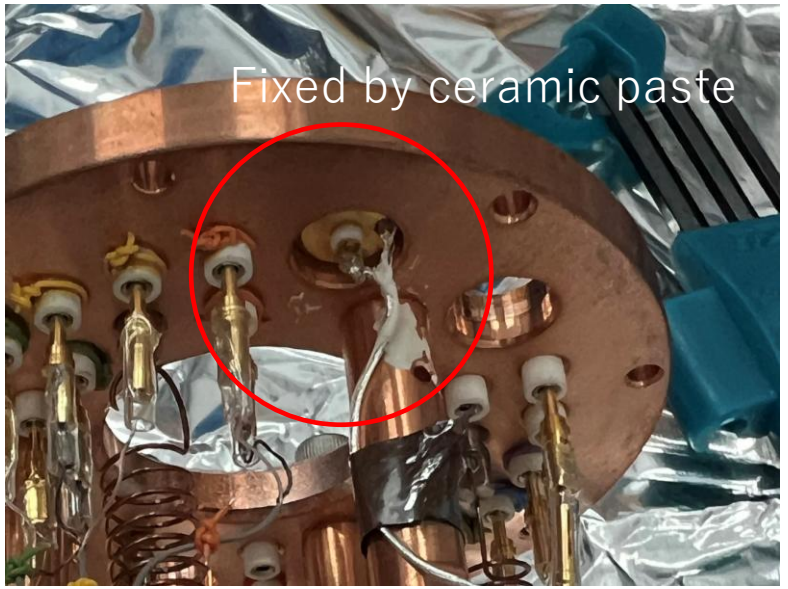
Solution:
(i) Open “My network (マイネットワーク)”
(ii) Click “Show network connection (ネットワーク接続を表示する)”. It is listed in the left side.
(iii) Right click “Local area connection (ローカルエリア接続)” and choose “Property (プロパティ(R))”
(iv) Select “Internet protocol (インターネットプロトコル(TCP/IP))”.
(v) Select “Use this address (次のIPアドレスを使う(S))”, and set IP address to “192.168.254.143”. Then press “OK”.
A message will appear. Press “OK”.
Close all the windows by pressing “OK”.
(vi) Restart computer.

Jan. 9 th, 2024 Short circuit in tunneling wire

The wire for tunneling current and shielding wire touch in the chamber, resulting in the huge offset current.
The resistance between the wires was ~70 Ω, which should be overload in normal condition.

We opened the chamber and found that the wires are almost touching.
So we carefully separated two wires by using tweezers and then fixed them by ceramic paste.

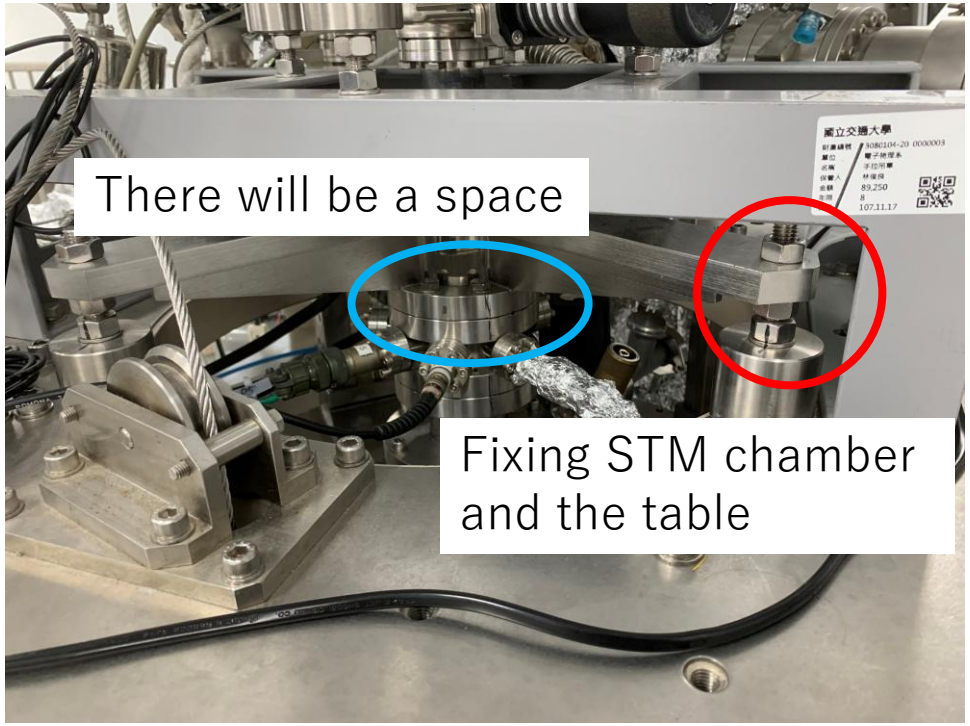




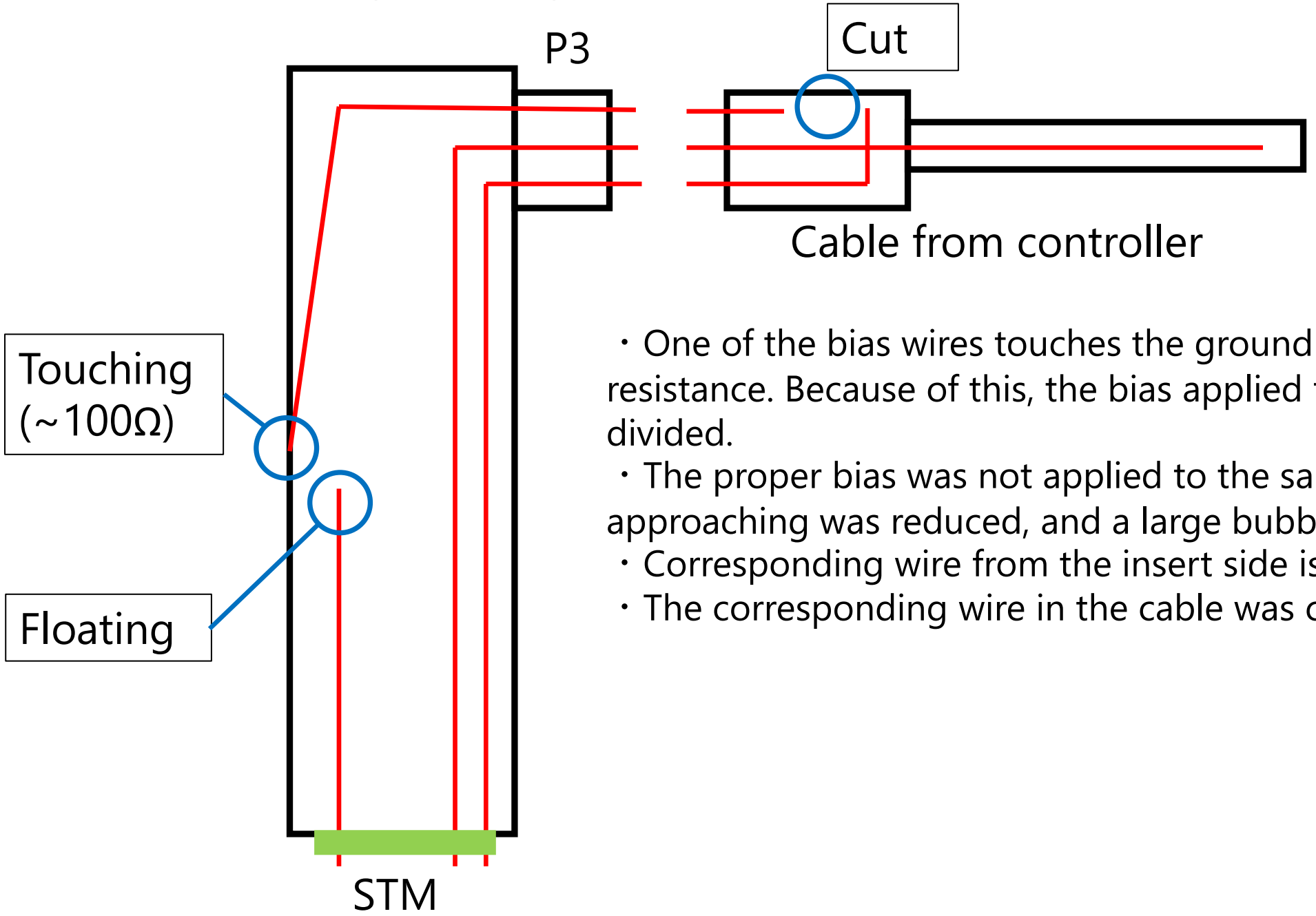
Feb. 2024 Leak after setting cryostat

The final step to set the cryostat is to fix the STM chamber and the table.
At this time, if the support is fixed with applying a upper force, there will be a small space at the blue circled part, resulting in a leak.

Therefore, when fixing the STM chamber and the table, fix the screws from the upper side.



Jul. 2024 Bias cable grounding



・One of the bias wires touches the ground with ~100 Ω resistance. Because of this, the bias applied to the sample was divided.

・The proper bias was not applied to the sample, the Vp-p when approaching was reduced, and a large bubbling noise appeared.

・Corresponding wire from the insert side is floating

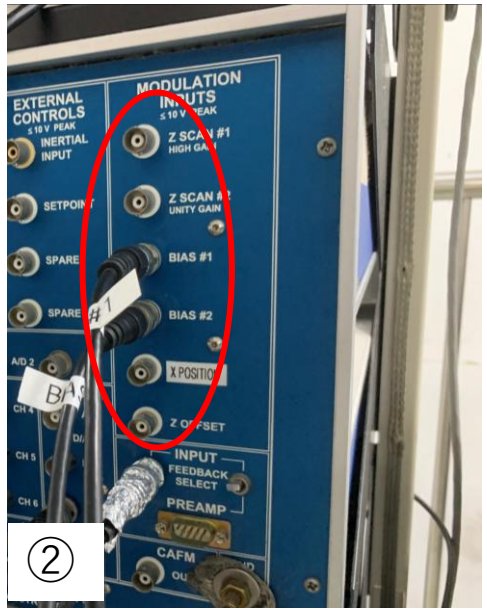
・The corresponding wire in the cable was cut to avoid dividing.

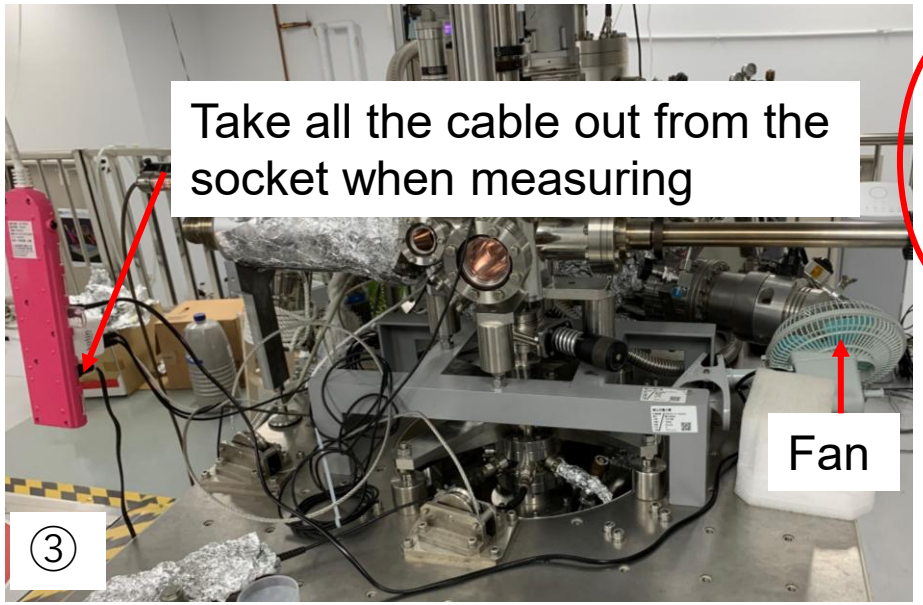
July. 2025 Lock-in amplifier error

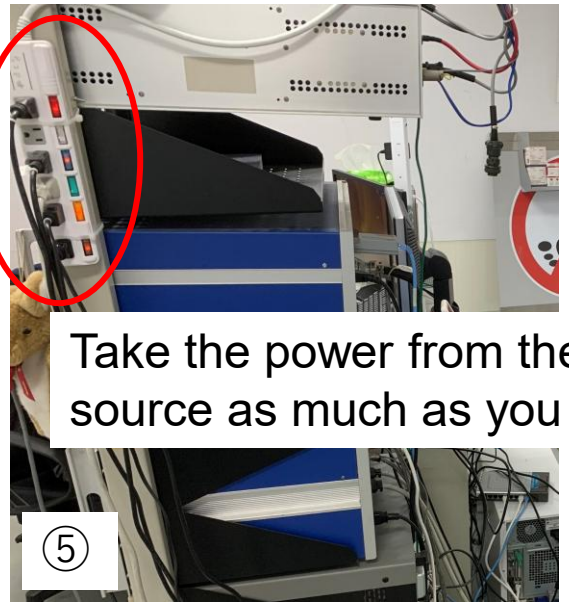
It showed “Calc err” after turning on, and cannot be operated.
For solving:
① Turn off
② Turn on by pressing “set up”.
③ The whole setting in the lock-in is initialized, and it successfully works.

Noise reduction

Here I note several possible noise source in STM2.
① The screws in sample holder, which should be fixed tight.
② Modulation inputs in the controller. A noisy signal would added to the bias. I recommend to remove he cables when these are not used.
③ Some of sockets. For example, the fan for cooling down the turbo pump cause some noise (even when it is switched off!). So, take it off from the socket.
④ Grounding cables. Generally, the system should be grounded. However, if there are several path to the ground, it can cause some noise. Try to take off grounding cables.
⑤ Power source. It is better to get the power of STM equipment from the same source. Now the power cables for STM measurements is summarized in a extension cord.
⑥ The horizontality of the table.







Take the power from the same source as much as you can.