

Tube Assembly Procedure

Qichun Xu

Physics Department
The University of Michigan
Ann Arbor, MI 48109-1120

1. Daily Routine Checking Before Working

- 1) Check power, including high-voltage and general power switch for electronics. In most cases, general power will always be on, but high-voltage power supply is off after work for safety.
- 2) Run program "UM Tube Assembly" by double-clicking on the icon. After the front page, you are required to input operators' names. Click "Continue" to next window called "Daily Calibration". At this point, there are three major steps.
- 3) Step 1-- Calibrate tension meter.
 - A. Open movable frame toward north (left) by turning red knob of valve on north plate to left. Put pulley on the backstop of movable frame on north station vacuum chuck. Adjust the position of pulley so that it is located between marks.
 - B. Cut a wire of about five feet long. Fix one end to standard weight. Put a small aluminum block in the place where there is a mark. Move standard weight on the top of it.
 - C. Pull wire through swage coil, endplug holder and tension sensor. Make sure that wire is threaded through tension sensor wheel.
 - D. Extend movable frame toward south (right) by turning red knob of valve on north plate to right. Stretch the wire. Fix the other end of wire to wire clamp at the end of tension. Remove aluminum block. Make sure there is no kinks on wire. There should be no endplug at this stage.
 - E. Check tension meter reading. It should be 390g. If it is not, try to adjust "GAIN" on front panel of tension meter. In this process, rotate the pulley either clockwise or

counterclockwise. There will be a slight difference between readings of about 6g. Adjust "GAIN" so that the average reading is 390g.

F. Cut wire and remove it. Put pulley, weight and the small aluminum block back to their places.

4) Step 2 -- Find home position of south station

Click "FindHome" button on computer screen. For this procedure, it is preferred to indicate directions that plate moves toward home. Otherwise, it will take more time. You can find home position marks on the rail under south plate. This procedure will take about half minute up to several minutes, dependent on the initial position of plate.

After computer find home position, there is a pop-up windows, which requires you to input raw tube length for home position. You can accept default value by clicking "Continue" if you do not move home position limit switch.

5) Stp3 -- Check tension meter (optional)

For this checking, the south plate should be at home position. It is the result of step 2 above. This procedure requires tensioning wire first to 350g by using calibrated tension meter and then measuring the actual tension by its resonant frequency.

A. Tension wire.

A1) Click "Tension" button. This will bring up a new window, called "Tension Wire".

A2) Cut a wire that is long enough from the end of tension actuator to the other end of south plate. Pull wire through swage coils, endplugs, endplug holders and pins, in that order at both stations. Carefully insert endplugs into its holders and rotate it until it fit into its holder. Tighten it by switch on air pressure.

A3) In south station, fix one end of wire to wire clamp. In north station, pull wire through tension sensor wheel. Tension wire manually to about 200g before fixing it on wire clamp at the end of tension actuator.

A4) In south station, push the pin into endplug and make sure there is no gap between them. Crimp the pin by turning the knob for 90 degrees. Cut wire outside and leave about 3cm.

A5) Click "START" button on the screen. Computer will automatically tension wire. The whole process will take about 1 minute. After message "Press STOP to stop measuring" and "Or press CONTINUE to next step" appeared in status windows, click "STOP" then "CONTINUE" or just "CONTINUE". This will bring you back to calibration windows.

A6) In north station, push the pin into endplug and make sure there is no gap between them. Crimp the pin by turning the knob for 90 degrees. Cut wire outside and leave about 3cm.

B. Measure frequency and calculate tension

B1) Click "Measure", which will bring up a new window, called tension measurement.

B2) Connect cables to both ends of wire. Make sure that both cable and wire will not touch plate or any other metal parts.

B3) Put magnet on the place marked in the middle range of wire.

B4) Click "START" on the screen. This measurement will take up to 10 seconds. Once the measurement is done, click "Continue" to go back to calibration windows.

B5) The frequency and tension will be shown in the screen.

6) Cut wire and discard them. Put all tools back into their places.

7) Click "CONTINUE" in the calibration windows and go to next procedure. In this window, input wire spool lot number, bare rate (BR), wire mass per 200mm(PL. WT.), tensile strength (TS) and percentage of gold plate (% PLATE). You can find all these information inside the wire spool. In most cases, you can just accept default value, unless you change wire spool. Click "CONTINUE" to next step. We are ready to assemble tube now!

2. Normal tube assembly procedure

1) Input tube identification and move the plate

First input tube ID, tube length, manufacturer ID1 and manufacture ID2. You find these informations on tube wall. The computer will calculate the distance that plate needs to move according to its current position.

Since there are 48 tubes with same length, computer will only move plate for the first tube of the day. In this case, when you hit the "CONTINUE" button, computer will remind you how much the plate will move. Otherwise, just go to next step if length difference is less than 0.5 mm, since even the same length tubes in nominal are actually slightly different in length.

For training and test purpose, you can input an arbitrary negative tube ID. In this situation, computer will not move plate, but directly go to next step. However, the input tube length is still used to calculate the tension.

2) Hold the tube

At south and north stations, open moveable frame by turning red knobs to outsides.

Put tube on aluminum vacuum chuck and put on two semi-cylinders at both ends of the tube. Adjust tube position so that cylinders will be just against chucks at both ends. If there are small gaps less than 0.75mm, make them evenly split at both ends. Otherwise, you need check if you have the right tube. Turn on the high vacuum to hold the tube. The switch is under table of south station with sign on it.

Move coils back over tube at both stations.

3) Pull through wire

At south station, insert the end of wire into center hole of black plastic cylinder and push in small white pin. Carefully put the cylinder into tube and lower down the pulley. Make sure wire will be threaded in pulley.

Then at north, turn on low vacuum switch, which is under north station with sign on it. Insert the black sucker into the other end of tube. Under air pressure, the black cylinder will pull wire through the tube. When you hear a slight clatter, turn off low vacuum and take out sucker. Pull wire out and leave enough wire at both ends. Cut off wire.

4) Assemble endplug

Insert wire through endplug, which has twist in it. This is a painstaking job and needs careful attention. If it is really difficult, try to use the air-blow.

Once wire goes through endplug, carefully insert it into endplug holder and rotate it until it totally fit into holder and can not turn it anymore. Pull up air pressure switch to squeeze endplug. Close moveable frame by turning red knobs to the other direction. In this process, be careful not to twist wire.

Insert wire through pin at both ends.

At south station, fix the wire on wire clamp. At north station, pull wire through tension sensor wheel. Manually tension wire to about 200g and fix on wire clamp, which is located at the end of tension actuator.

5) Crimp pin at south station

Turn knob under endplug holder for 90 degrees. Cut outside remaining wire and leave about 1mm.

6) Tension wire

On computer screen, hit "CONTINUE" button and a window called "Tension Wire" will appear. In most cases, you do not change all settings on the screen. Click "START", which will tension wire automatically. The whole procession will take about one minute. After that, just click "STOP" and "CONTINUE", or just "CONTINUE".

7) Swage tube

Check high-voltage setting. The most important setting is “TRIP VOLTAGE”. It should be 11.5KV. Press the “START” button on the top of control box. Keep people away from high-voltage equipment. After you hear clatter from both ends, it is finished.

8) Crimp pin at south station

At north station, push pin along wire into endplug. Make sure there is no space between them. This is very important. Otherwise, wire tension will change. Turn knob under endplug holder for 90 degrees. Cut outside remaining wire and leave about 1mm.

9) Move tube

Turn off high vacuum and push down air pressure switch to release endplug. Open moveable frame at both ends. Put on end caps for endplugs.

Move tube from assembly plate into V-channel. Fit south end into brass cylinder and push against it. Connect cable for the other end.

10) Frequency measurement

On screen, hit “Continue” and goes to the windows of “Tension Measurement”. Click “START” to start measurement. In most cases, you can just accept all default settings. For these settings, this process will take about 10 seconds. If necessary, you can repeat measurement. Click “CONTINUE” to next step.

11) Length measurement

At north station, move small brass plate with meter on top of it against the end of tube. The length of tube will appear in LCD of meter. You can try for several times. Once you think that reading is stable, click “ReadLength” on screen. Verify if the reading on screen is the same as in the meter. Click “CONTINUE”.

12) Results

There is a result window. All measurement results of this tube will be shown here. Check all listing. You can choose either “CONTINUE” or “QUIT”. In the former case, repeat from step 1.