Line measurements using 3dmod

Download IMOD (it's free!) from: https://bio3d.colorado.edu/imod/

## 1. Open 3dmod, select your image (.mrc/.join/.rec) file and click **OK**.
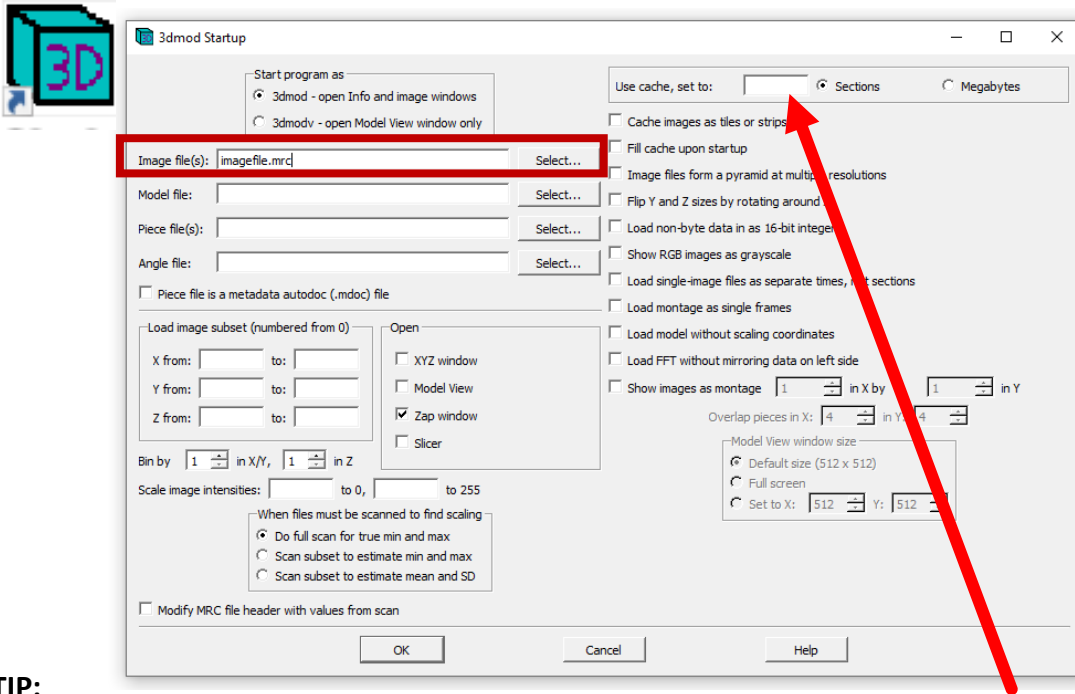
TIP:
If you have a large data file, you can set the cache here to only a few sections (1-10). **This means that even very large files will open quickly and easily in regular computers**, so you can start modelling straight away (although scrolling in z will be slower than when you open the entire file in one go).

For these instructions to work properly, set the mouse button preferences to the ones used here, by going to **Edit > Options > Mouse** and choosing the option **Right, Left, Middle**
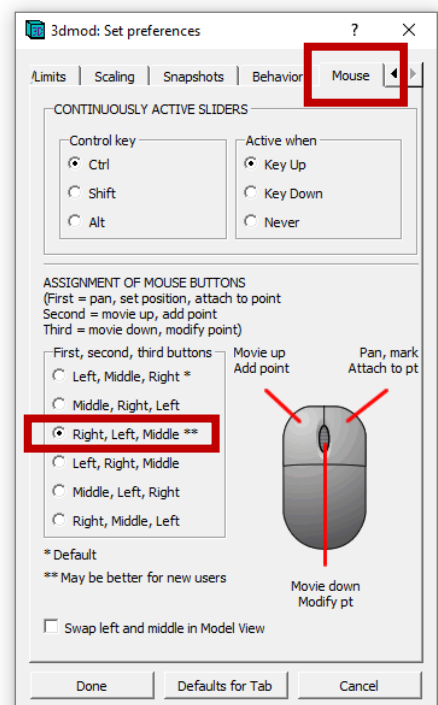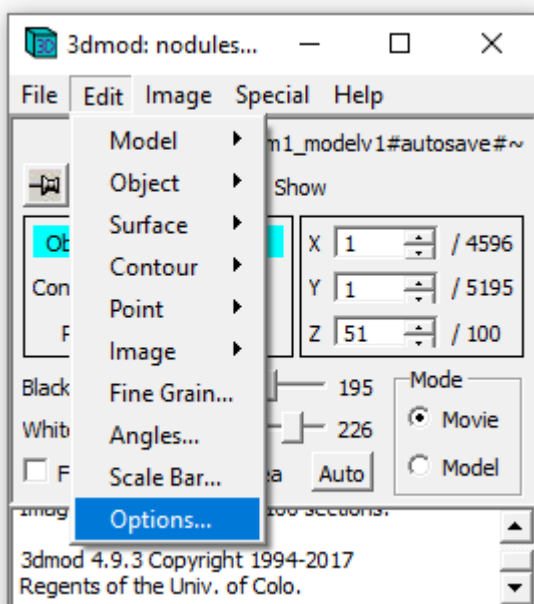
2. Your should now have a Zap window open with your data. Open a model window by going to **Image > Model View** (or just V). The model window should be just black at the moment, as you have no model.
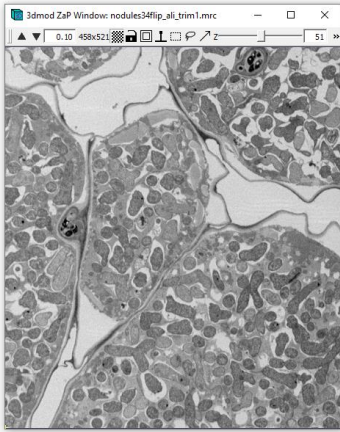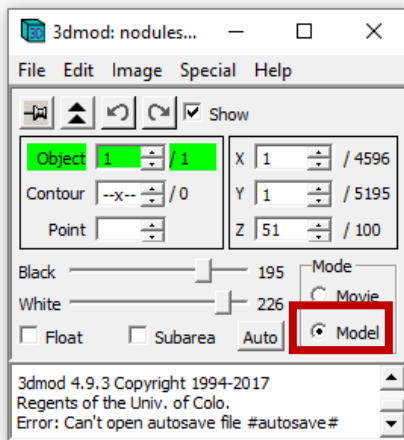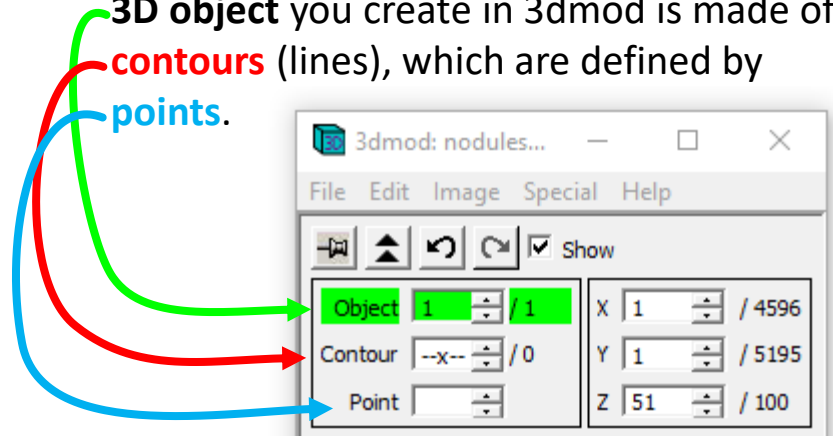

Zap window with data
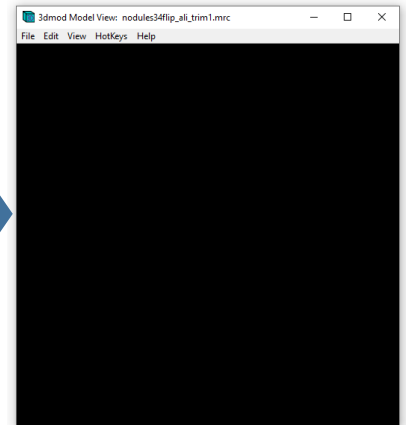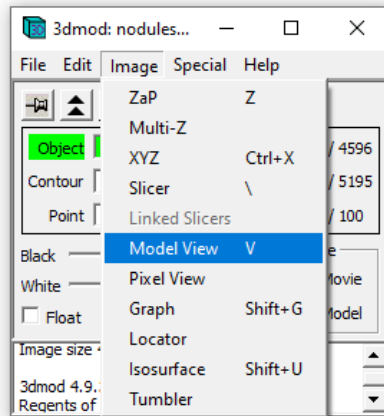
Empty Model View window

3. Change the mode to **Model** (3dmod always starts in Movie rather than Model mode).

There will be a default **Object 1** open. Each **3D object** you create in 3dmod is made of **contours** (lines), which are defined by **points**.
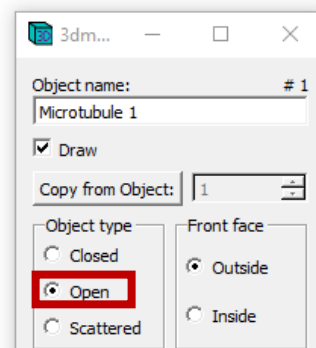

There will be no contours or points defined for this object yet, and you have not yet started to draw this object.

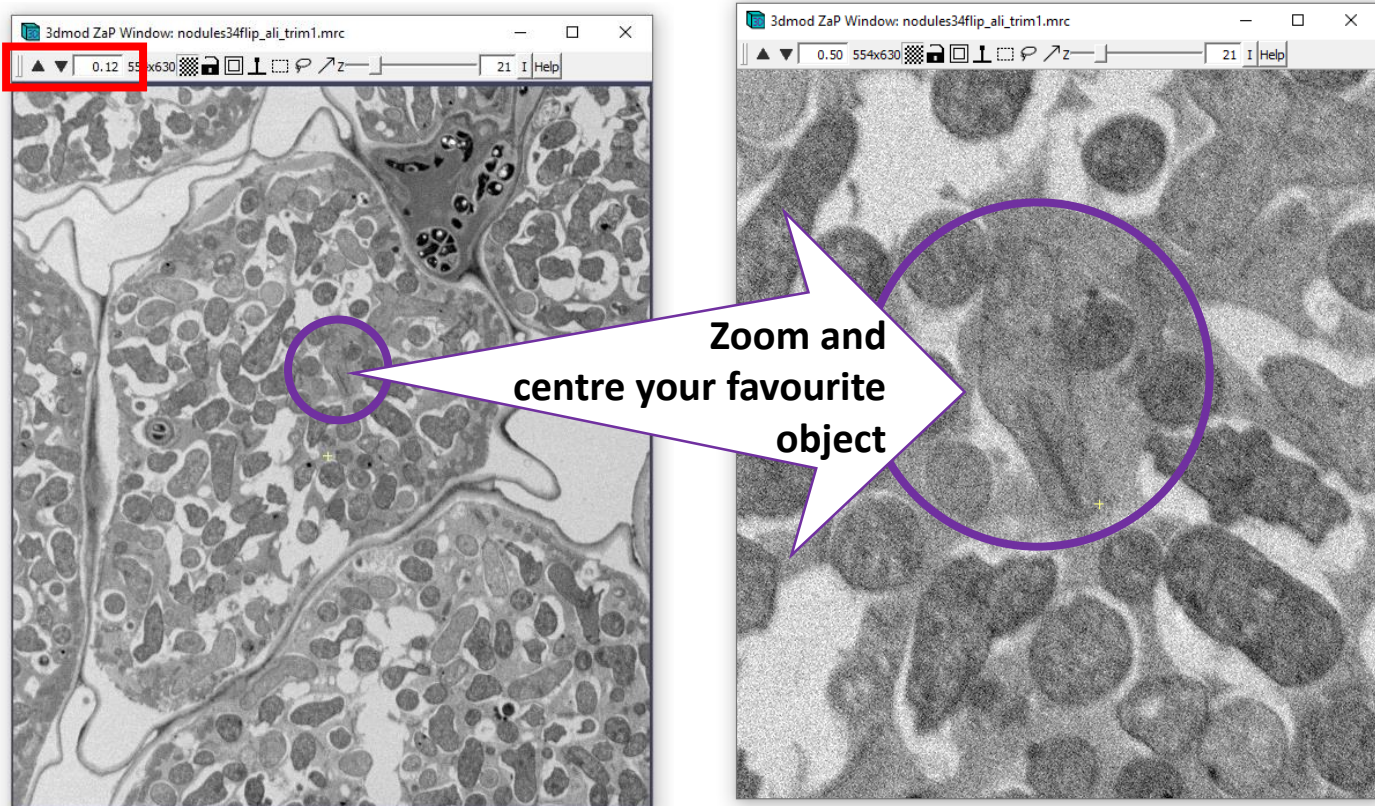4. To change the settings for Object 1, go to Edit > Object > Type
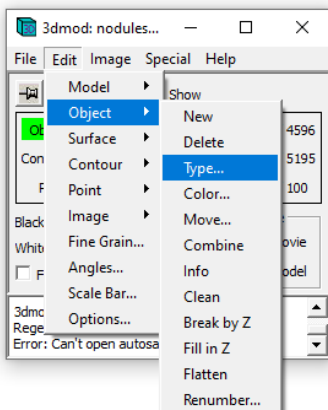
5. Define object type as **Open**, then click **Done**

6. In the Zap window, zoom in (**zoom controls** = up and down arrowheads, and the box next to it) and then centre an object of interest by holding (panning) with the ***right mouse button***.

Zoom and centre your favourite object

7. Using the ***left mouse button***, **click** on the edges of the element you would like to measure, to make a line.
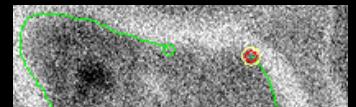

First click

Second click
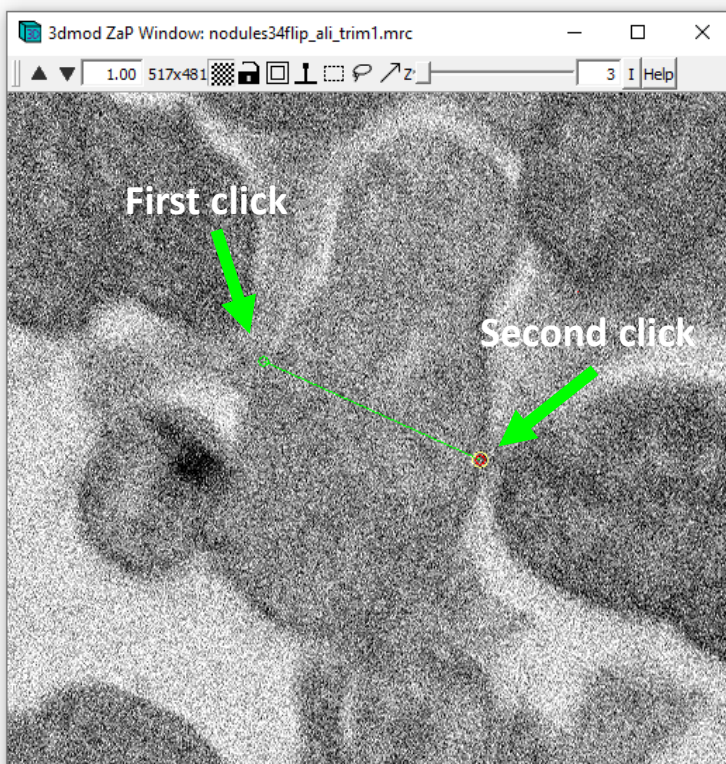
In each contour (in Zap window):
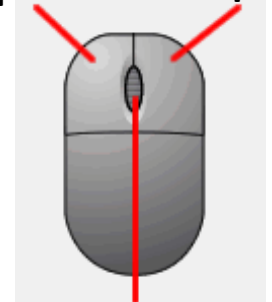**Green circle** = trailing point
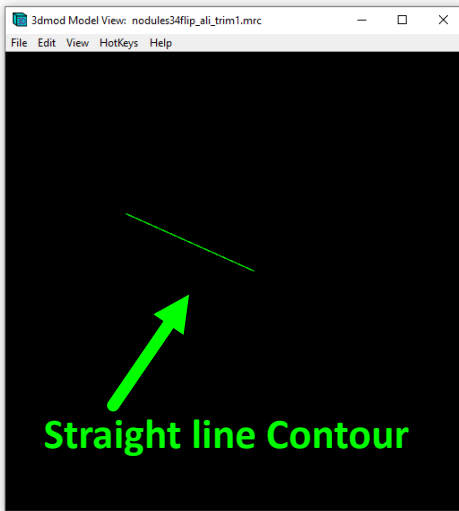**Red circle** = leading point
Yellow circle = selected point

Add point   Select point

Move selected point

8. The Model window should now start to display the contours you are drawing.

Straight line Contour

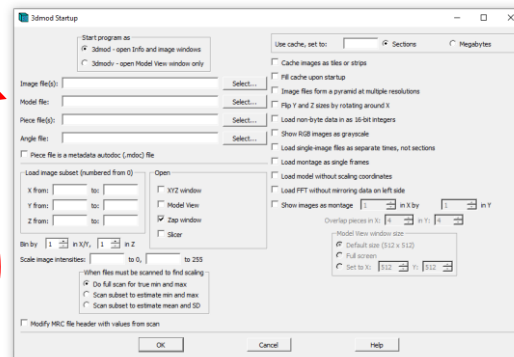**Hold** to *move* the model

Turn wheel to **zoom** in/out
**Hold** wheel to **rotate/pan**

8. In the Zap window, **scroll in Z** using: **PAGE UP / DOWN** Then draw the next contour of the same object, and *you have started to build a 3D model*!

9. **Don't forget to SAVE your model as you go along!**

Next time you open 3dmod, you can load the model *on top of the data* by selecting the model file here.
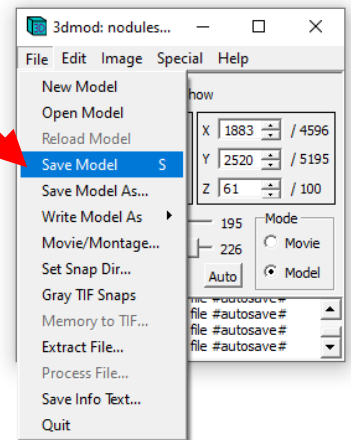
10. To Draw <u>*a different contour*</u> for the <u>*same object*</u>, in the <u>*same Z slice*</u>, **Click outside the contour with the RIGHT mouse button.** This will finish the <u>previous contour.</u> Now you can repeat step 7 to create another contour.
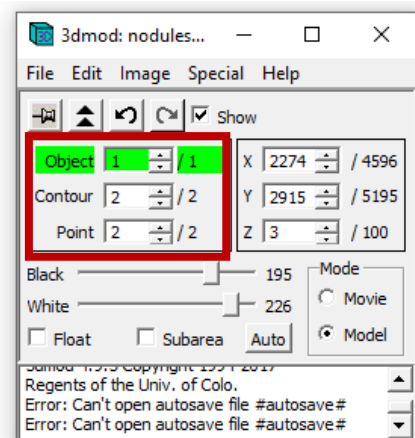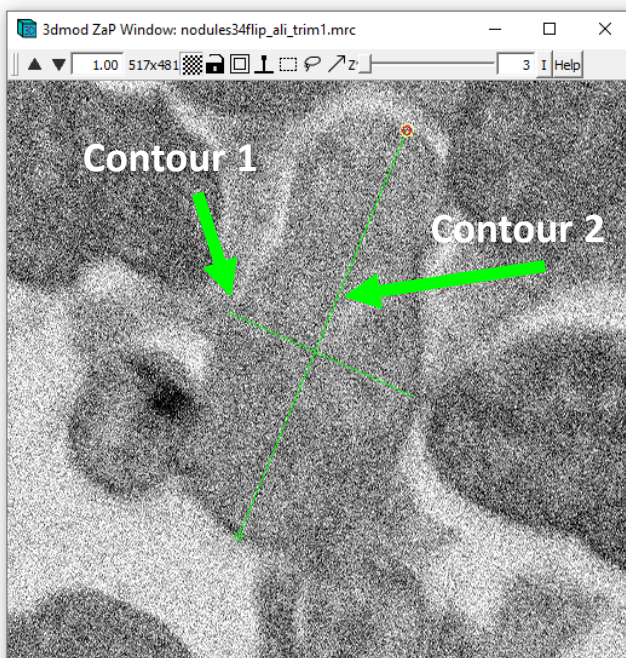
Contour 1

Contour 2

The main 3dmod window will show that **Object 1** now has **2 contours**, with **2 points** in each contour.

11. If 3dmod is joining the two lines, make sure you have followed steps 4 and 10. Also, make sure the **Drawing tools** is set for **Normal**. Go to Special > Drawing Tools.
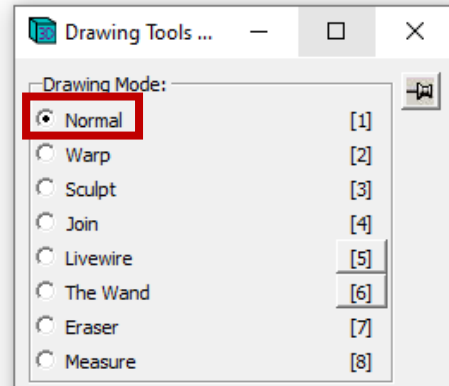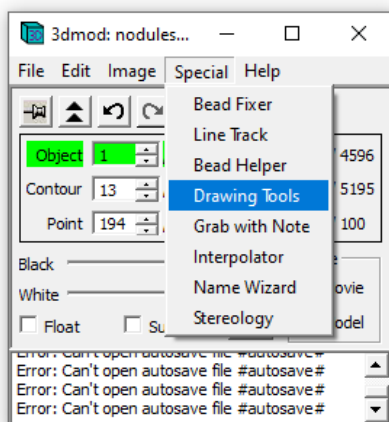
12. Measuring **option 1** - To measure the lengths of individual contours, _select a contour_

To select a contour, RIGHT click in a point within the contour. The selected contour should have circles in its leading and trailing ends.

Then go to **Edit > Contour > Info**.
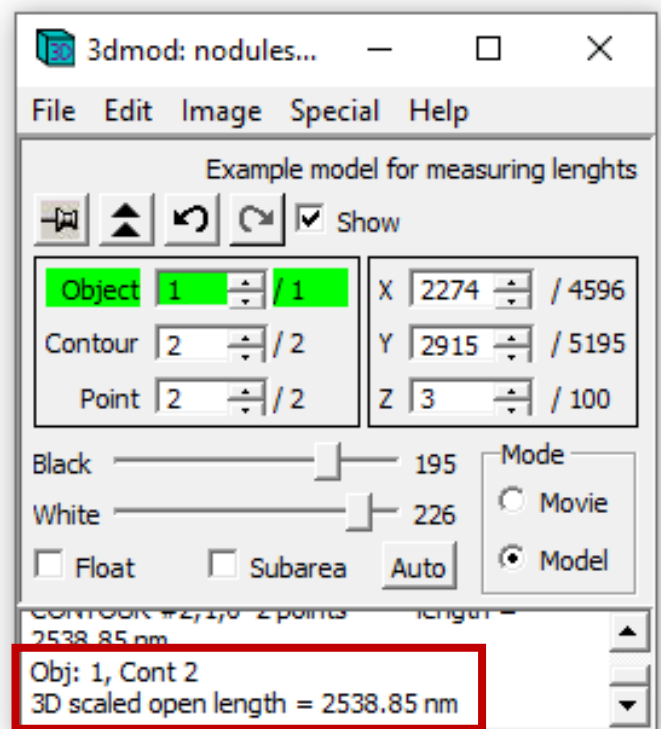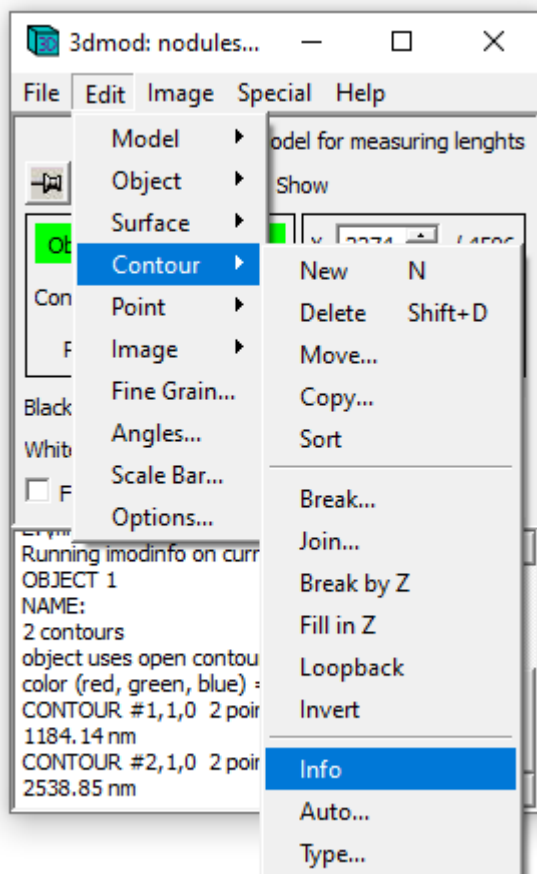
The length of the selected contour will appear in the main window of 3dmod.

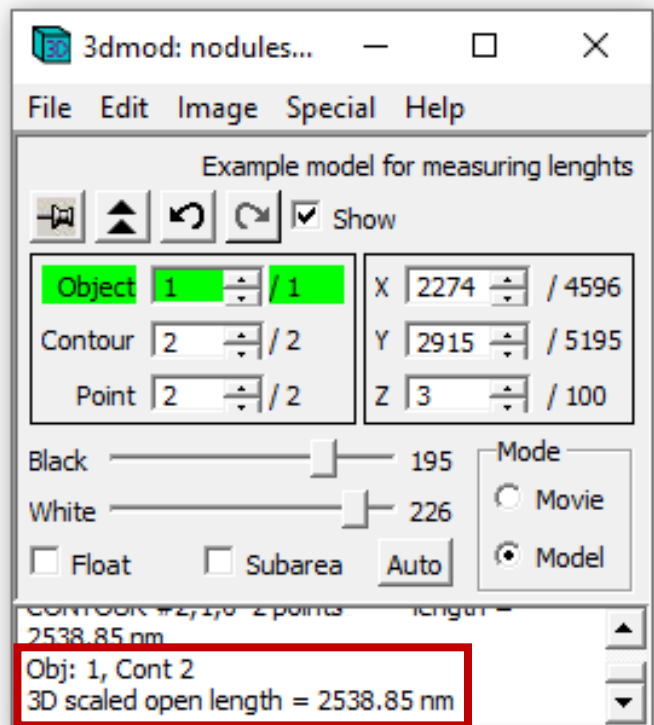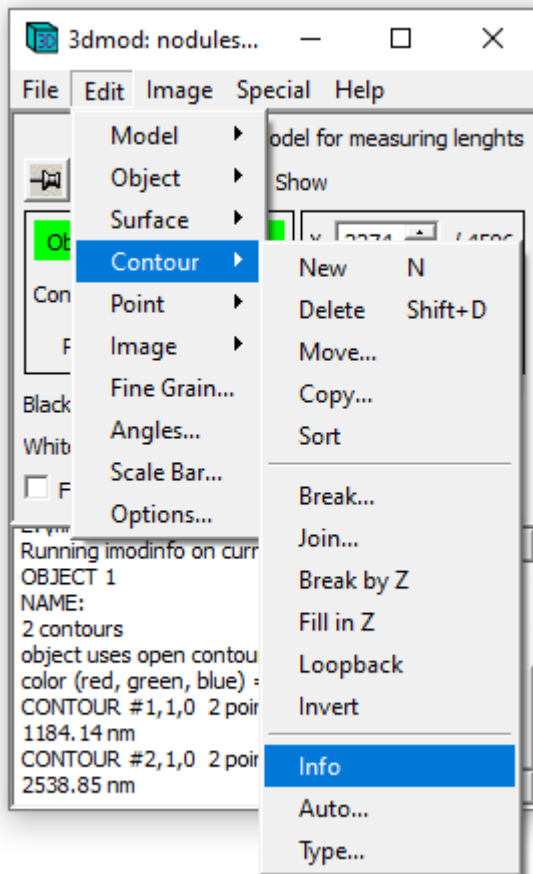12. Measuring **option 1** - To measure the lengths of individual Contours, _select the contour_ and go to Edit > Contour > Info.
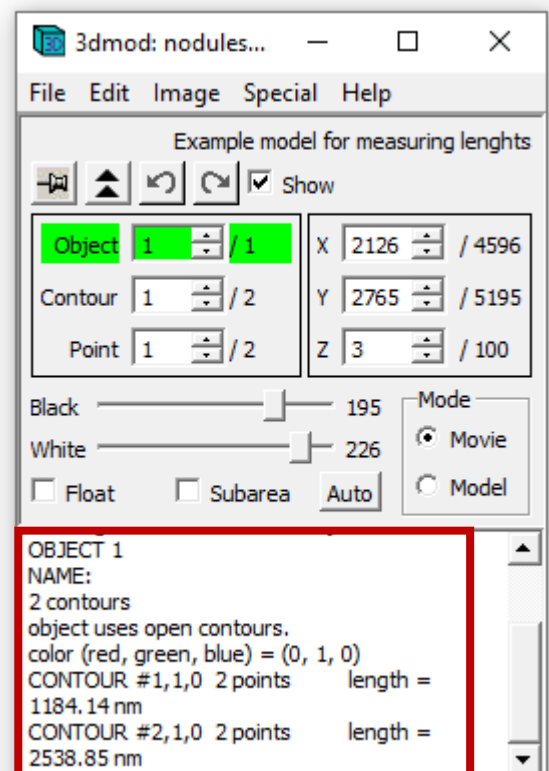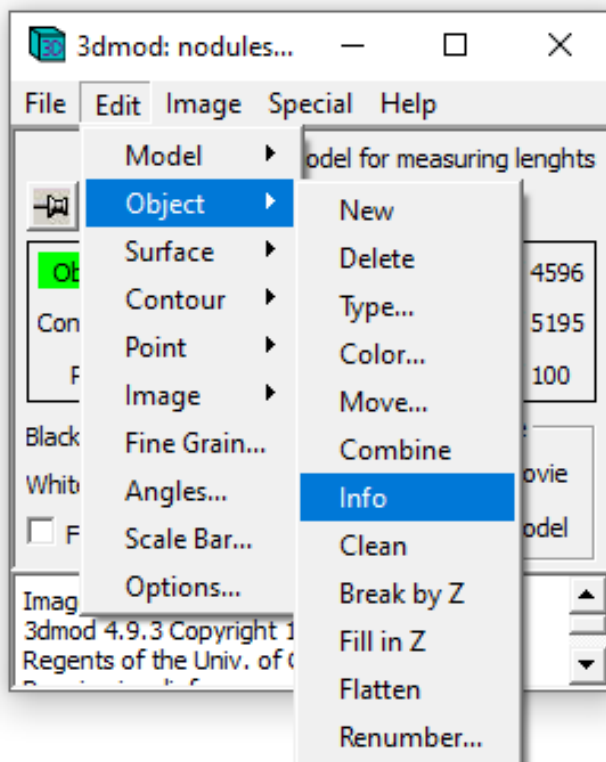

The length of the selected contour will appear in the main window of 3dmod.

13. Measuring **option 2** - To measure the lengths of all individual Contours in an object, _select a contour_ in this object and go to Edit > Object > Info.

14. Measuring **option 3** – Use the imodinfo command to obtain the lengths of all contours in a model.

**https://bio3d.colorado.edu/imod/doc/man/imodinfo.html**

14.a Open the folder where your model file is, press SHIFT+CLICK with RIGHT mouse button inside the folder and select **Open PowerShell window here**.
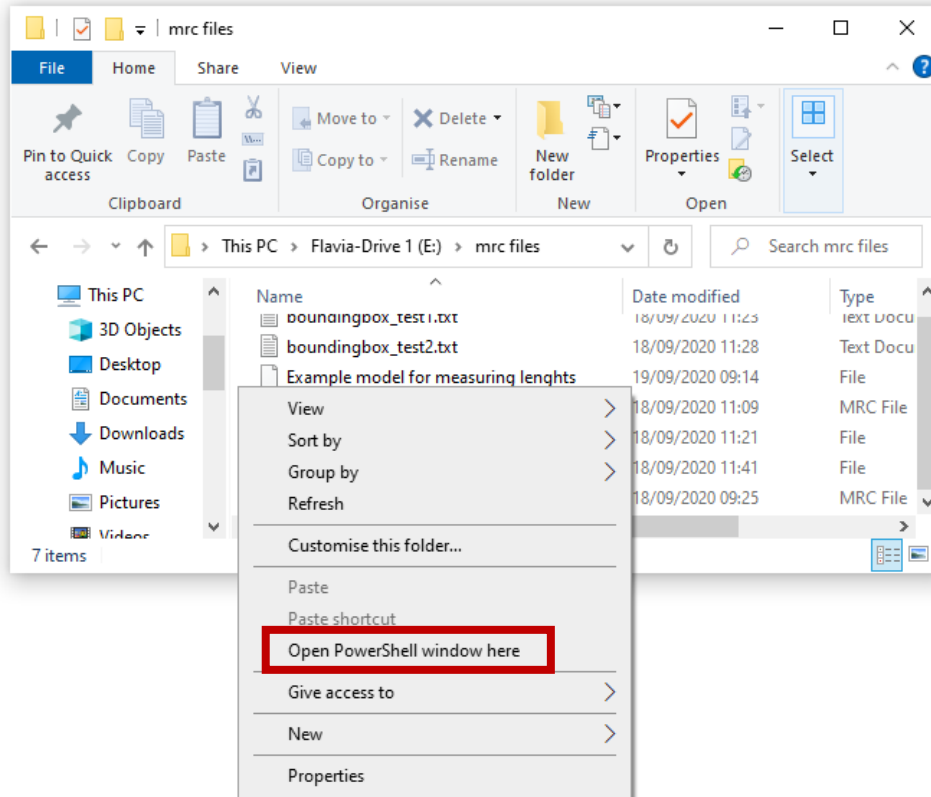
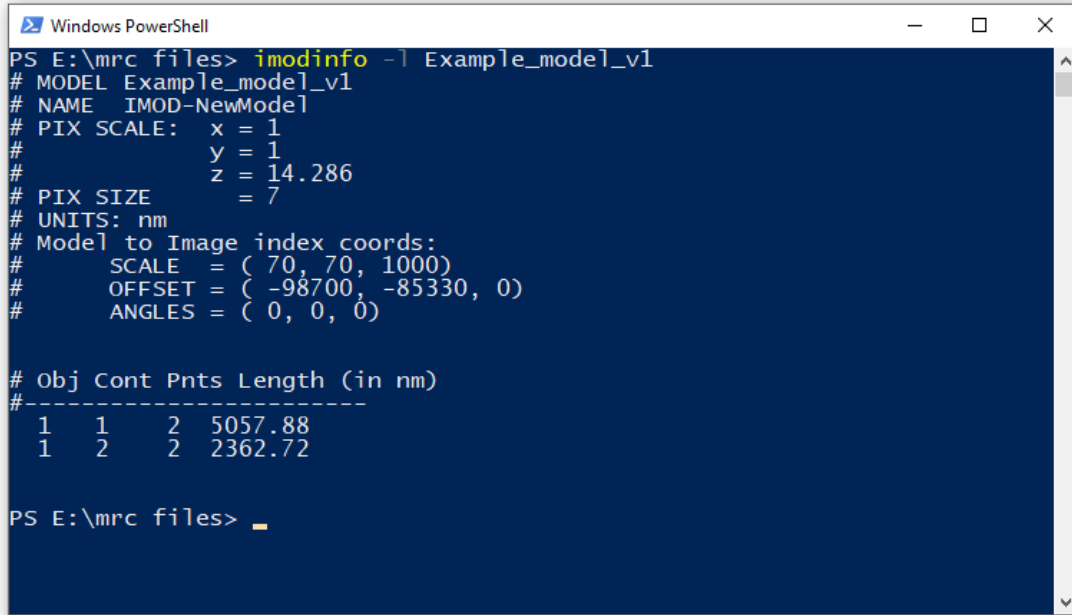14.b In this window, type **imodinfo –l ModelFileName** (where l is the lower caps letter L)
There should be a *space* between imodinfo and –l, and also a space between the –l option and the name of the model file. Do NOT add an extension to the model file name. Use the original model file name *as it appears in the folder* (i.e., use the model file as created by Save Model / Save Model As, in 3dmod).
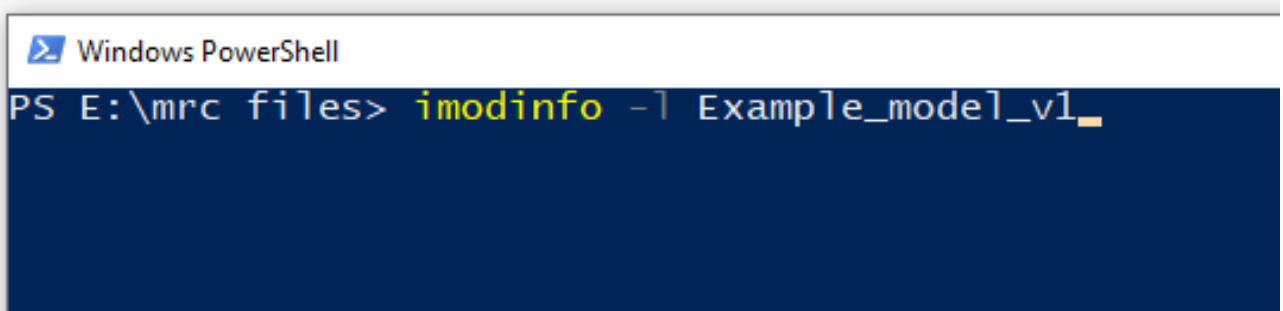
14.c Press ENTER, and the output should show the lengths of all contours in the model.

```
Windows PowerShell                                               —    □    ✕

PS E:\mrc files> imodinfo -l Example_model_v1
# MODEL Example_model_v1
# NAME   IMOD-NewModel
# PIX SCALE:   x = 1
#              y = 1
#              z = 14.286
# PIX SIZE     = 7
# UNITS: nm
# Model to Image index coords:
#      SCALE   = ( 70, 70, 1000)
#      OFFSET = ( -98700, -85330, 0)
#      ANGLES = ( 0, 0, 0)


# Obj Cont Pnts Length (in nm)
#-------------------------
   1    1     2   5057.88
   1    2     2   2362.72


PS E:\mrc files> _
```
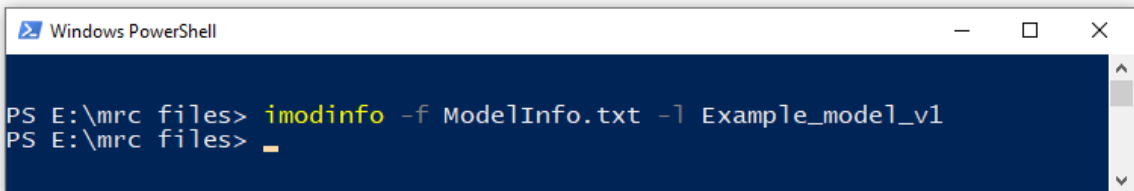
14.d To print the output to a text file, use the –f option before the –l option. Type imodinfo –f TextFileName.txt –l ModelFileName
When you press ENTER, imodinfo will create a nex text file with the lengths of all contours in the model. The PowerShell window will look like this (no output will appear in the PowerShell window)
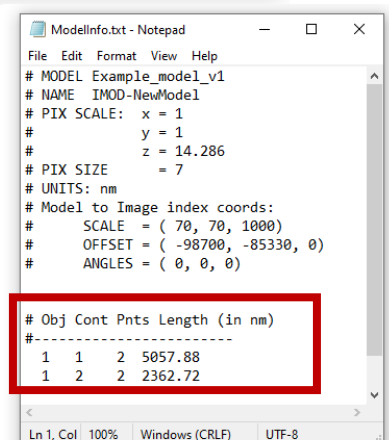
```
Windows PowerShell                                               —    □    ✕

PS E:\mrc files> imodinfo -f ModelInfo.txt -l Example_model_v1
PS E:\mrc files> _
```
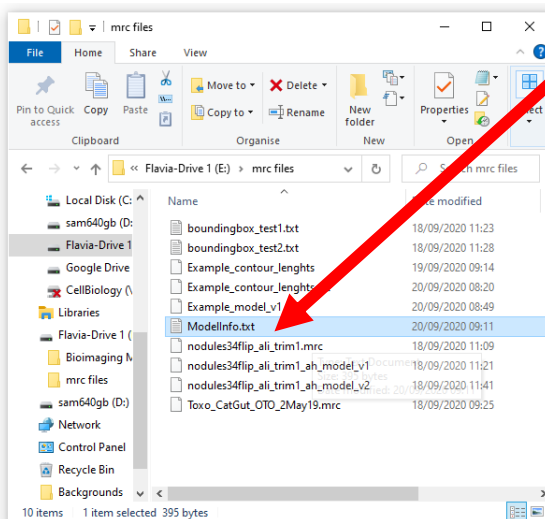
14.e Find the text file in the folder where your model file is.

14.f Open the text file to retrieve the contour length data.

```
ModelInfo.txt - Notepad                          —    □    ✕
File  Edit  Format  View  Help
# MODEL Example_model_v1
# NAME   IMOD-NewModel
# PIX SCALE:   x = 1
#              y = 1
#              z = 14.286
# PIX SIZE     = 7
# UNITS: nm
# Model to Image index coords:
#      SCALE   = ( 70, 70, 1000)
#      OFFSET = ( -98700, -85330, 0)
#      ANGLES = ( 0, 0, 0)

# Obj Cont Pnts Length (in nm)
#-------------------------
   1    1     2   5057.88
   1    2     2   2362.72

Ln 1, Col  100%   Windows (CRLF)    UTF-8
```

Read the imodinfo webpage for more information on other quantification options using imodinfo:
**https://bio3d.colorado.edu/imod/doc/man/imodinfo.html**

Measuring microtubule length

18. Segmenting microtubules (from tomography data) is easier with the Slicer window, rather than the Zap window. In the main 3dmod window, select Image > **Slicer**. Change the **object type** to **Open**.
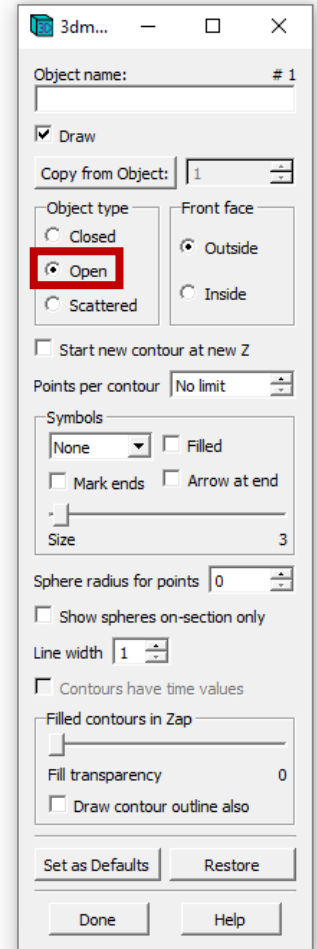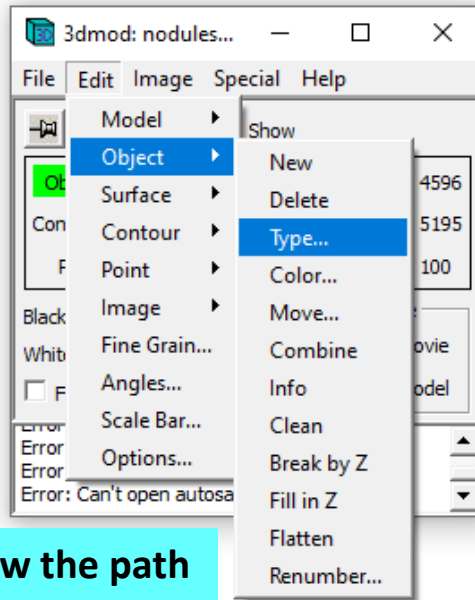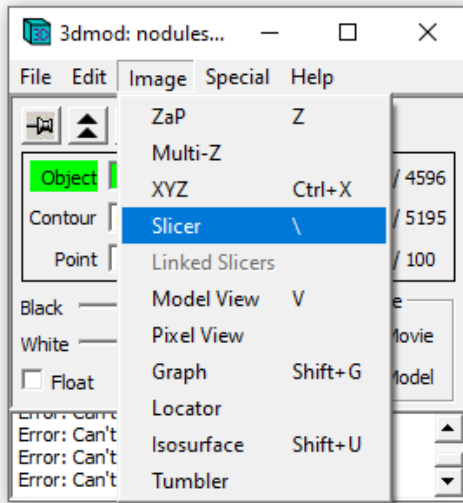
Using the **Slicer**, you can **follow the path of microtubules**, to facilitate modelling.
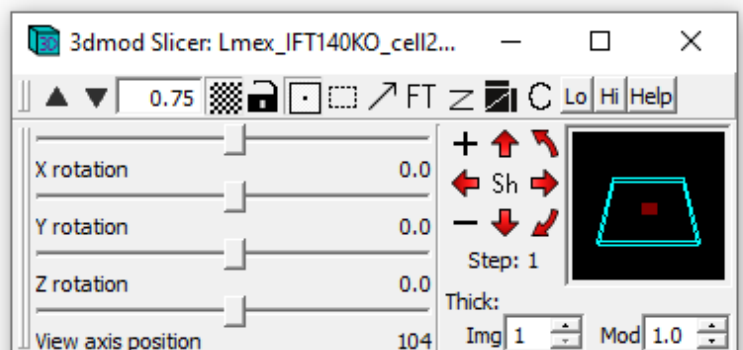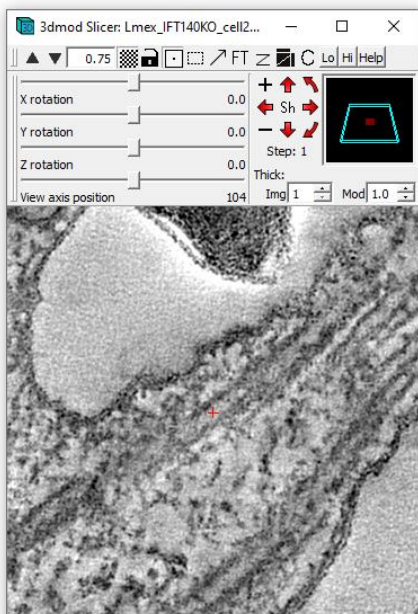
If the Drawing Tools window is open, close it or make sure "**Normal**" is selected.
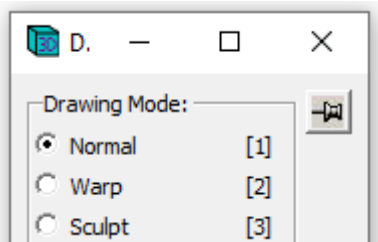
20. Click with the **right mouse button** on a microtubule of interest, to bring it to the centre, where the tiny red cross is.

21. Hold **Shift + left mouse button** to rotate the microtubule of interest in X, Y, Z

You can also use the controls at the top of the Slicer window to select rotation steps:

With the microtubule in the middle, you should be able to rotate it into longitudinal view, by holding **Shift + left mouse button**.


Microtubule in longitudinal view
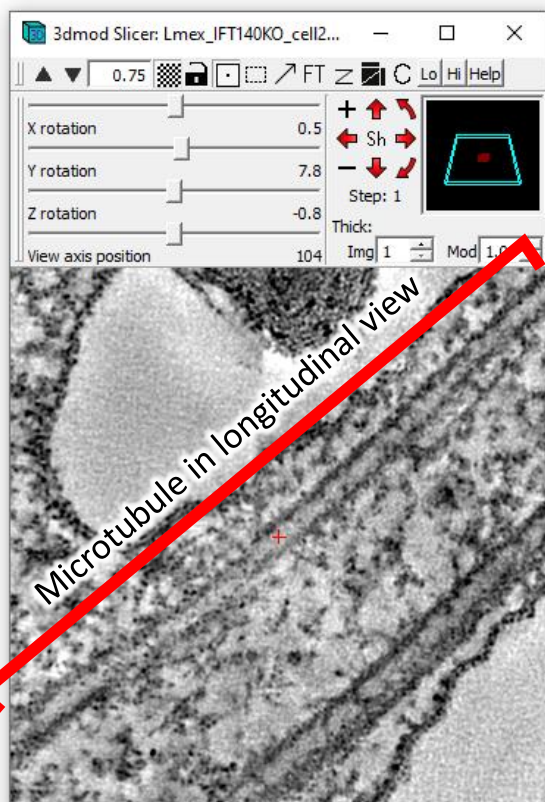
22. In model mode, **click** along the microtubule with the **left mouse button** to draw its path.
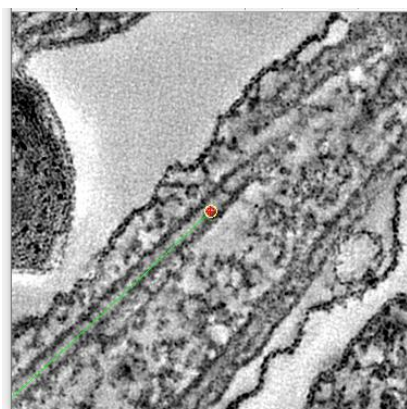
23. Keep "straightening" the microtubule by holding **Shift + left mouse button** as you draw its path to the end with the left button.
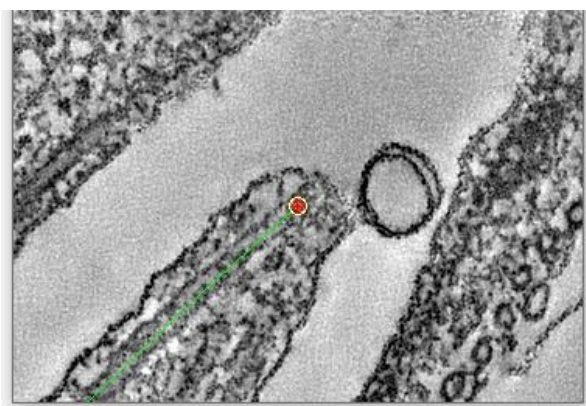
23. The Model view window will show the microtubule's path as a continuous line (make sure you selected object type as open).
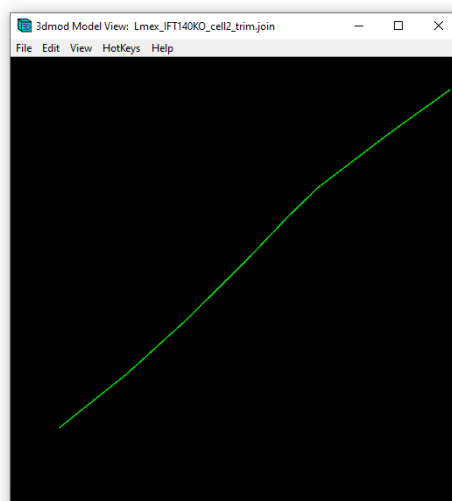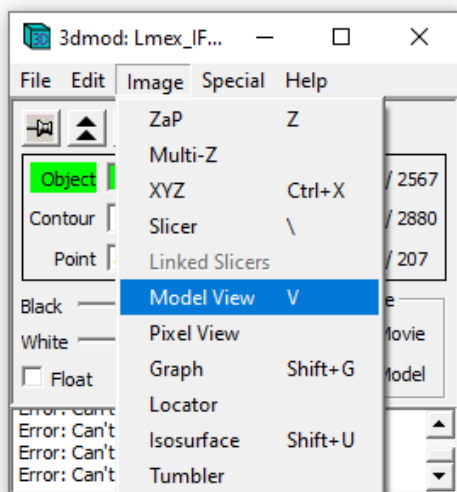
24. Now use one of the _length measuring options_ **(steps 12 to 14)** to determine the length of the microtubule contour.