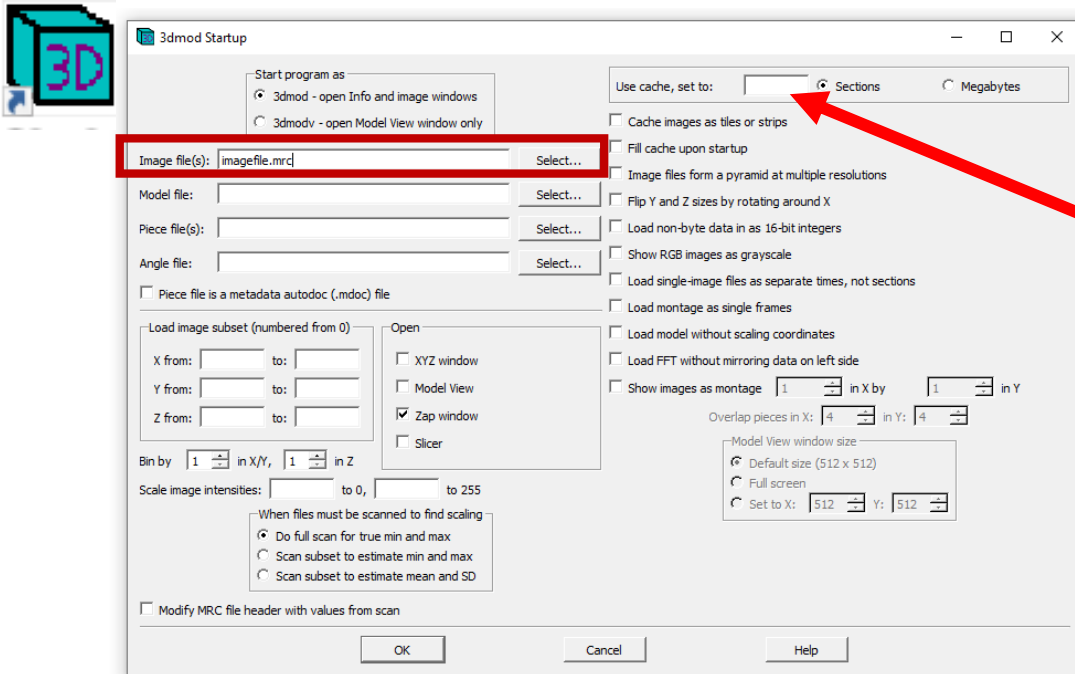


# Making 3D Models of SBFSEM / tomography data on 3dmod

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

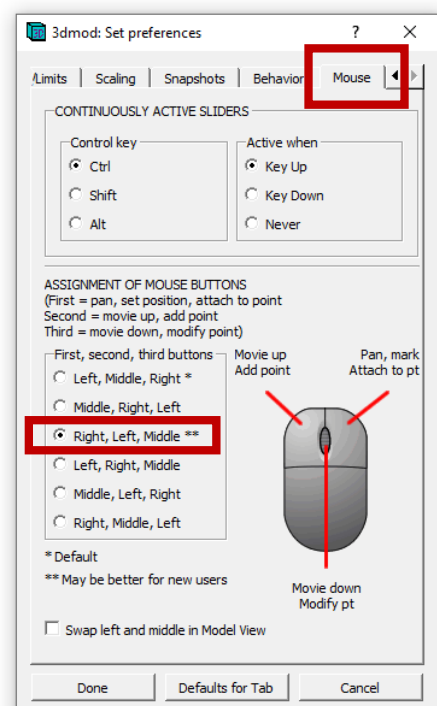
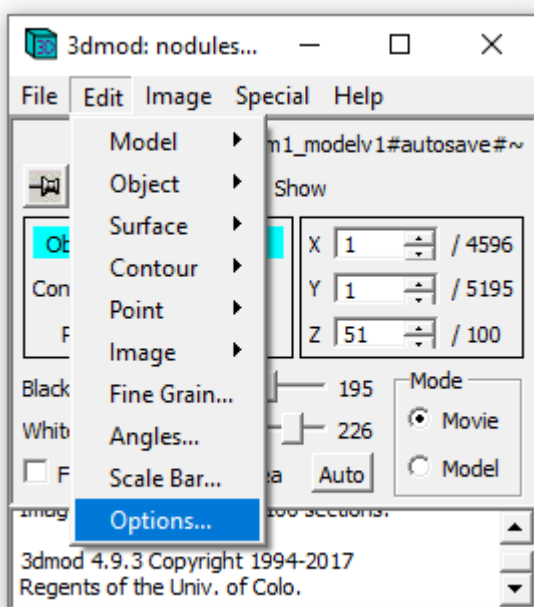
1. Open 3dmod, select your image (.mrc/.join/.rec) file and click **OK**.



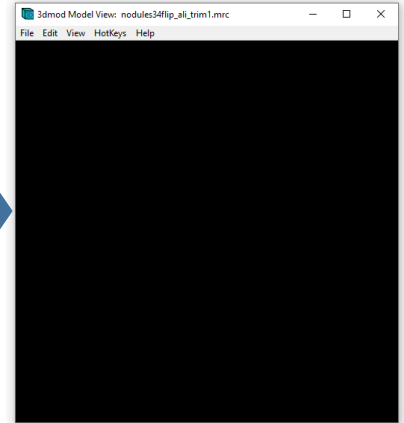
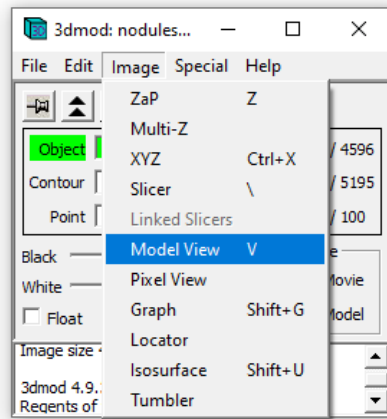
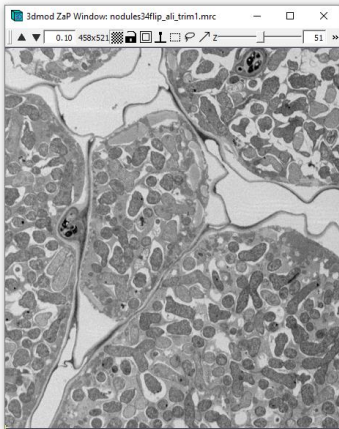
## TIP:

If you have a large data file, you can set the cache here to 1 or 2 sections. 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).

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**



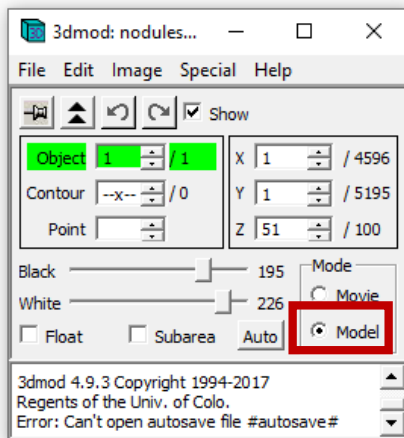
2. You should now have a Zap window open with your data. Open a model window by going to **Image > Model View** (or just V). The model window should be just black at the moment, as you have no model.



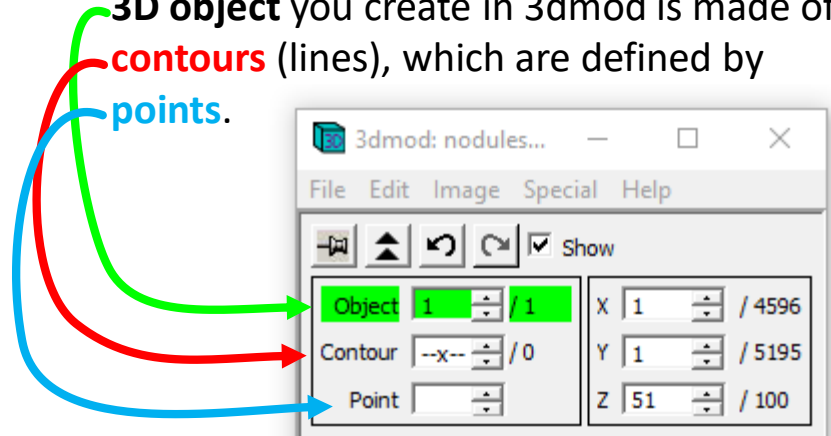
Zap window with data

Empty Model View window

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



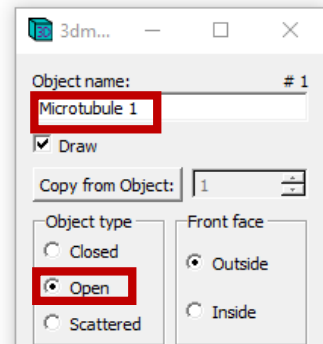
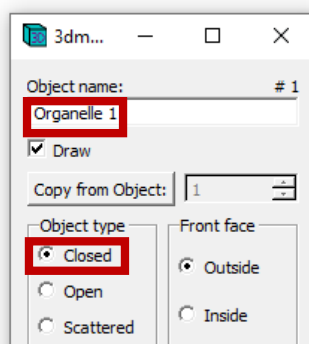
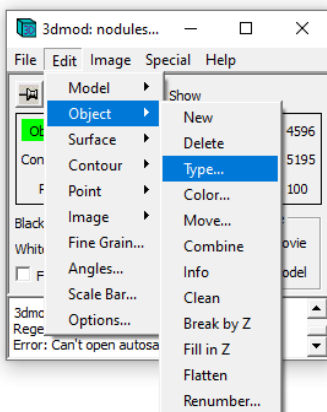
There will be a default **Object 1** open. Each **3D object** you create in 3dmod is made of **contours** (lines), which are defined by **points**.



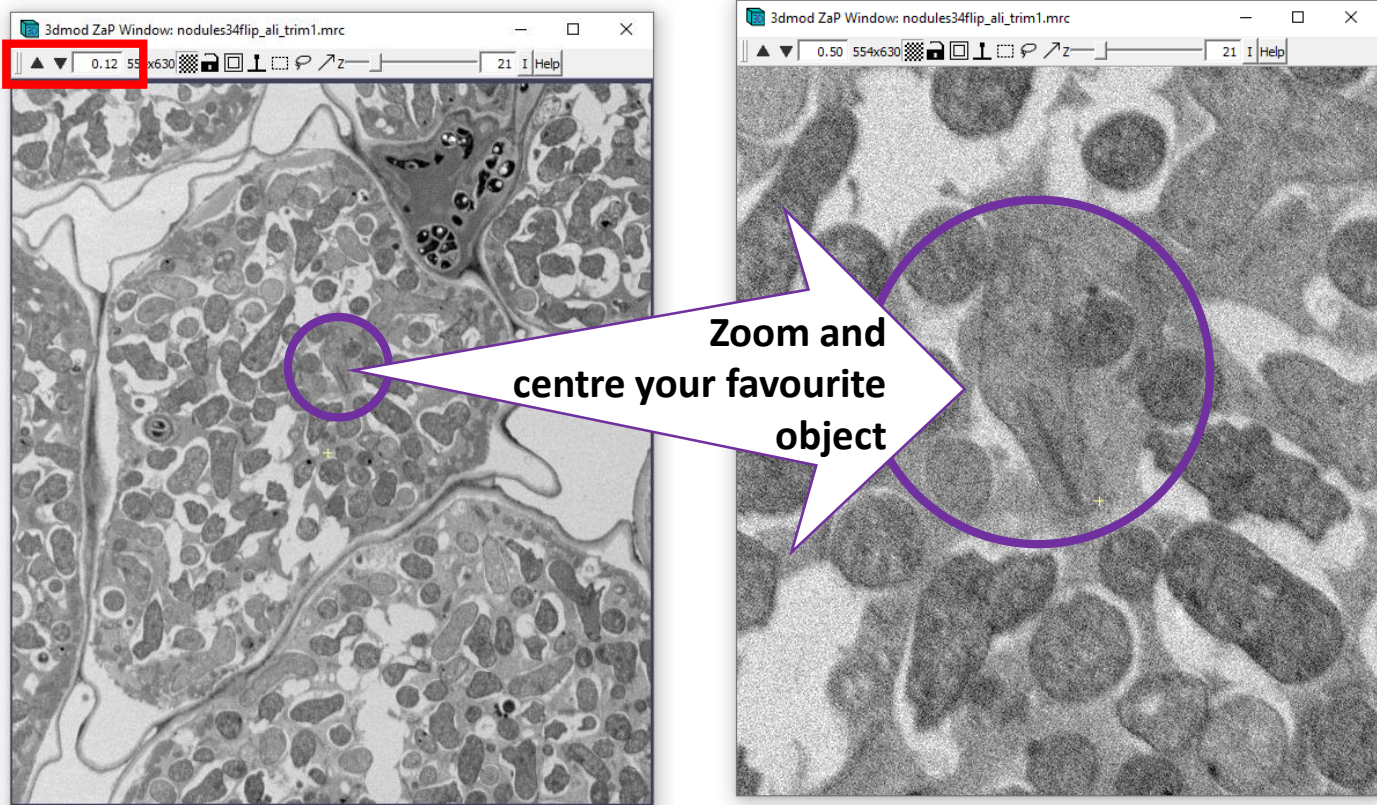
There will be no contours or points defined for this object yet, and you have not yet started to draw this object.

4. To change the settings for Object 1, go to **Edit > Object > Type**

5. Define object name and type (for example, **closed** for organelles, **open** for microtubules) > **Done**



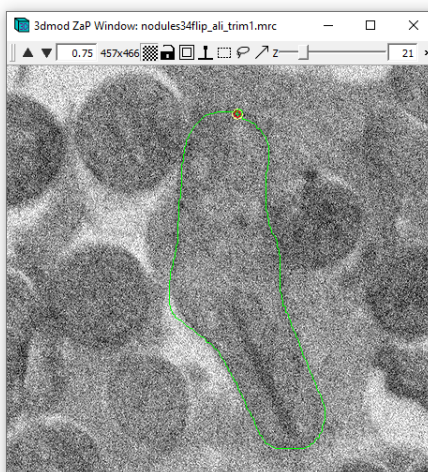
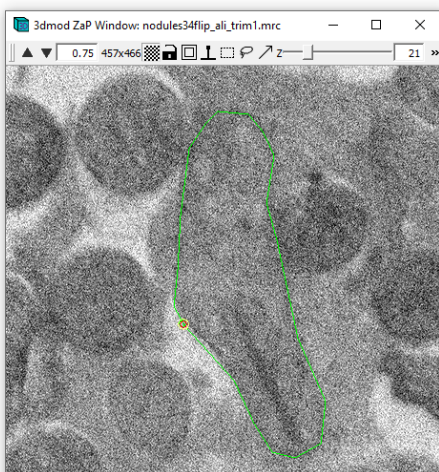
6. In the Zap window, zoom in (**zoom controls** = up and down arrowheads, and the box next to it) and then centre an object of interest by holding (panning) with the **right mouse button**.



7. Start modelling an object by *drawing a contour* around it with the **left mouse button**.

You can click around the object

OR hold/drag a line around the object

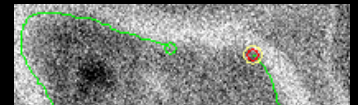


**In each contour (in Zap window):**

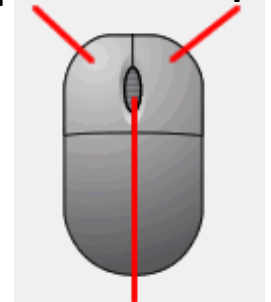
**Green circle** = trailing point

**Red circle** = leading point

**Yellow circle** = selected point



**Add point** **Select point**

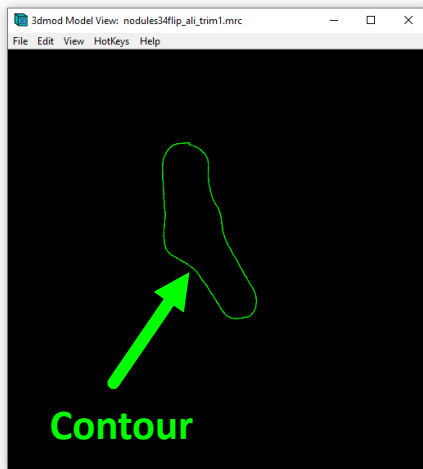


**Move selected point**

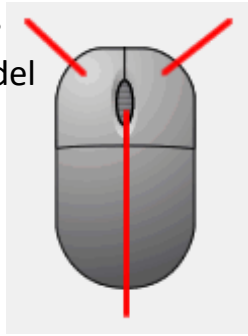
**TIP: to model MICROTUBULES, skip to PAGE 8!**



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



Hold to  
*move*  
the model

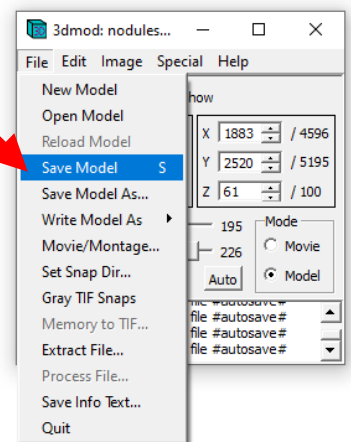
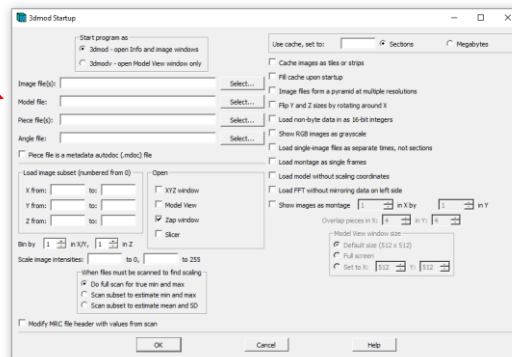


Turn wheel to **zoom in/out**  
Hold wheel to **rotate/pan**

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!***

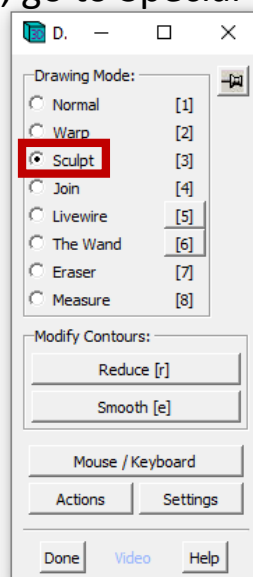
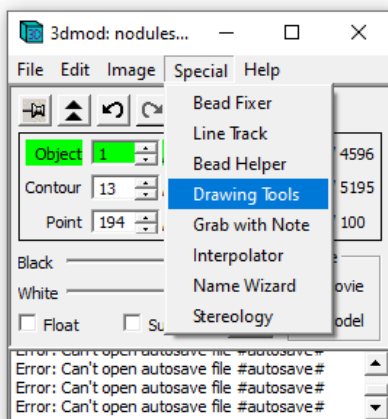
9. Don't forget to **SAVE** your model as you go along!

Next time you open  
3dmod, you can  
load the model *on*  
*top of the data* by  
selecting the model  
file here.



**TIP:** Modelling contours as shown above can be time consuming.  
The 3dmod **DRAWING TOOLS** and **INTERPOLATOR** might save you time!  
Watch these short videos on the drawing tools before you proceed:  
<https://www.youtube.com/watch?v=BsNSVLIQ-cE>  
<https://www.youtube.com/watch?v=Pe5tenT-Fok>

10. To open the **drawing tools**, go to Special > Drawing Tools.



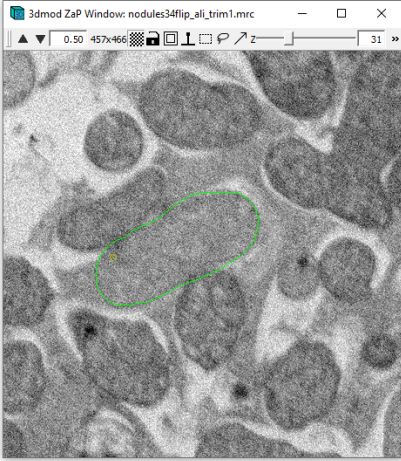
With **Sculpt**, for example,  
you can use a circle to sculpt  
the object from the inside  
and outside!

Mouse wheel = change the  
size of the circle in Sculpt

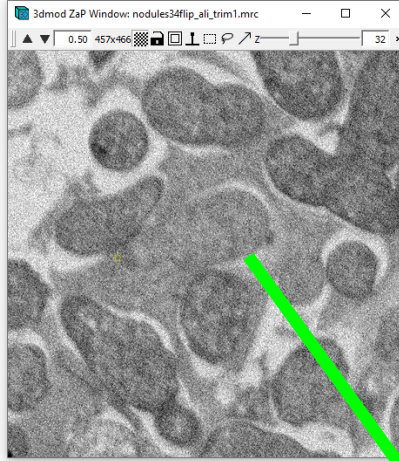
Numbers = move from one  
drawing tool to another.

11. The **interpolator** creates contours for you, between contours that you drew by hand. For example, create a contour in one z section, the *skip* a couple of z section, and draw a contour in the next z section.

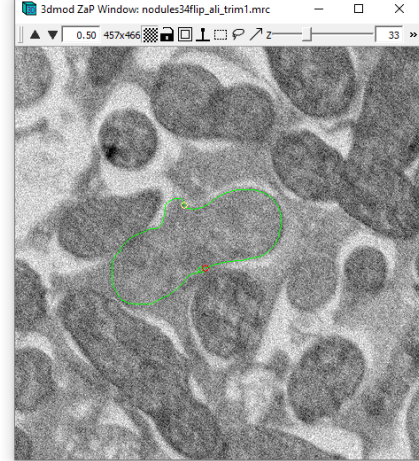
Z = 1



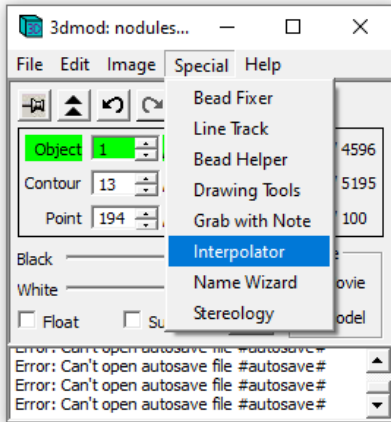
Z = 2



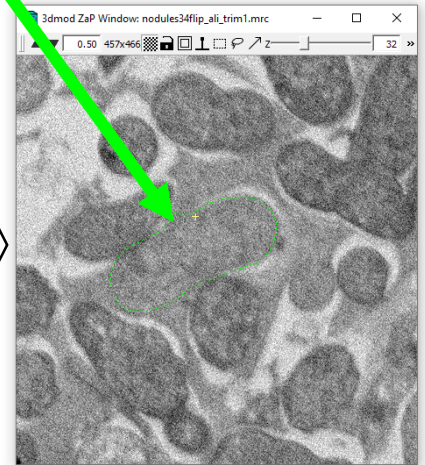
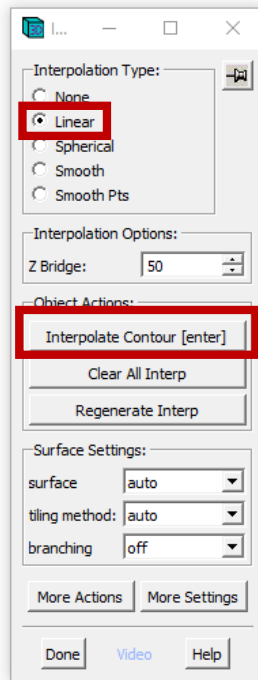
Z = 3



## 12. Open Interpolator

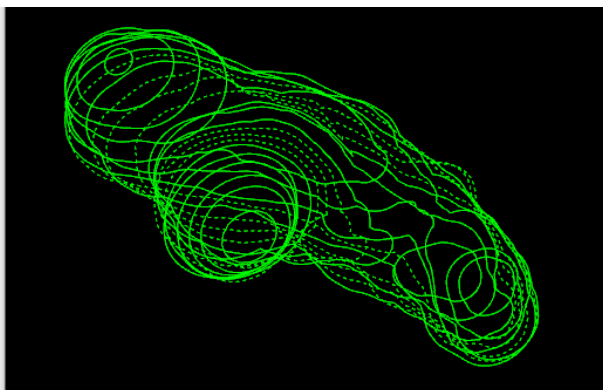


Keep the **last contour** selected  
Select **Linear**  
Press **Enter**



A **dotted** line has appeared around the object in Z=2, indicating that a contour was *interpolated* by 3dmod.

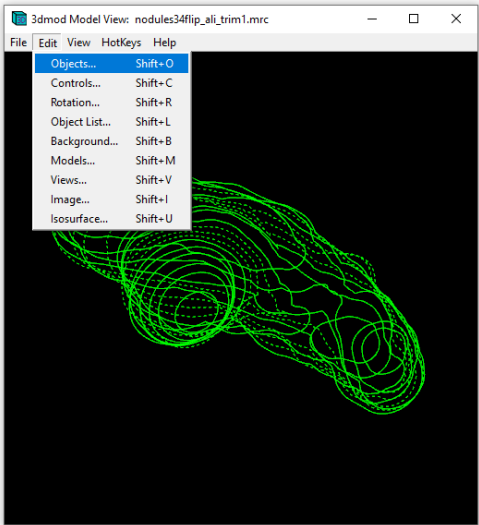
The Model View window shows hand **drawn** and **interpolated** contours as **solid** or **dotted** lines, respectively.



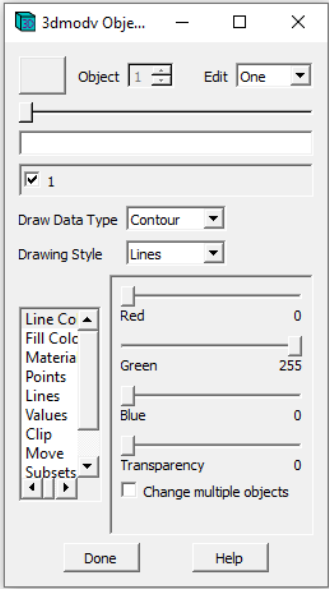
You can edit interpolated contours using **Sculpt**.



12. Once you have created several contours for an object, go to Edit > Objects



This menu allows you to change many properties on your object.



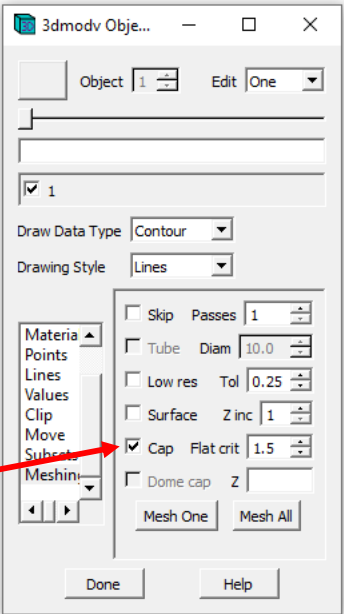
Beware of the following:

The **tick** indicates this objects is being displayed, **NOT** edited!

These two boxes indicate ***the objects being edited***

13. To “mesh” (put a skin) on an object, scroll to the bottom of the list on the left of the Objects window and select **Meshing**. Then click **Mesh One**.

Tick to put a **cap** on closed objects before meshing.

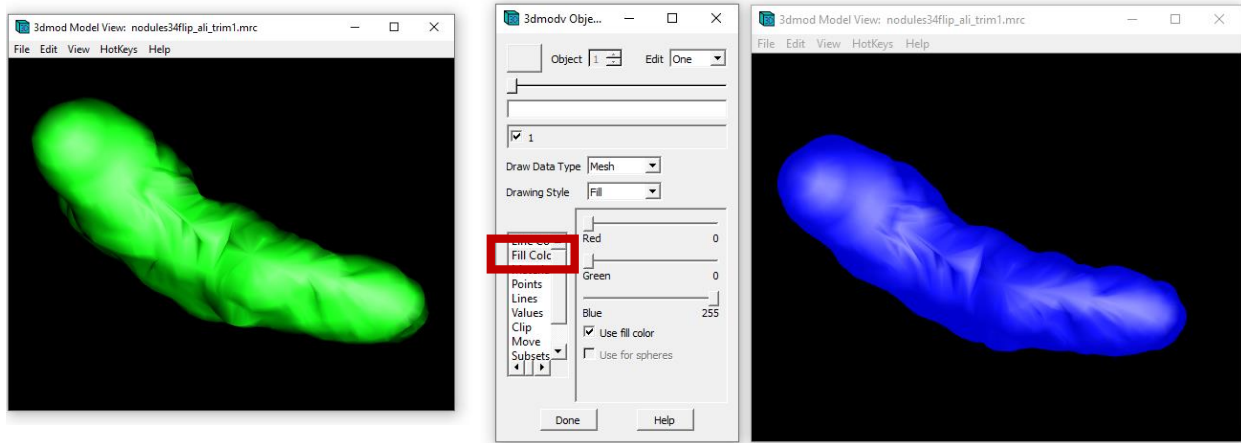


Meshed closed object



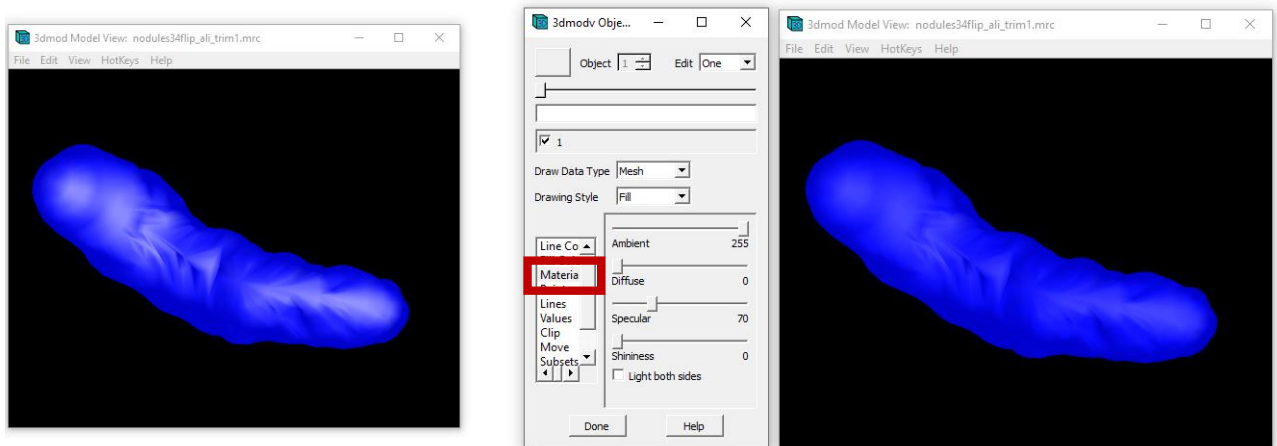
You have to mesh again after adding contours to an object.

14. Choose a colour for the meshed object in the **Fill Colour** menu.

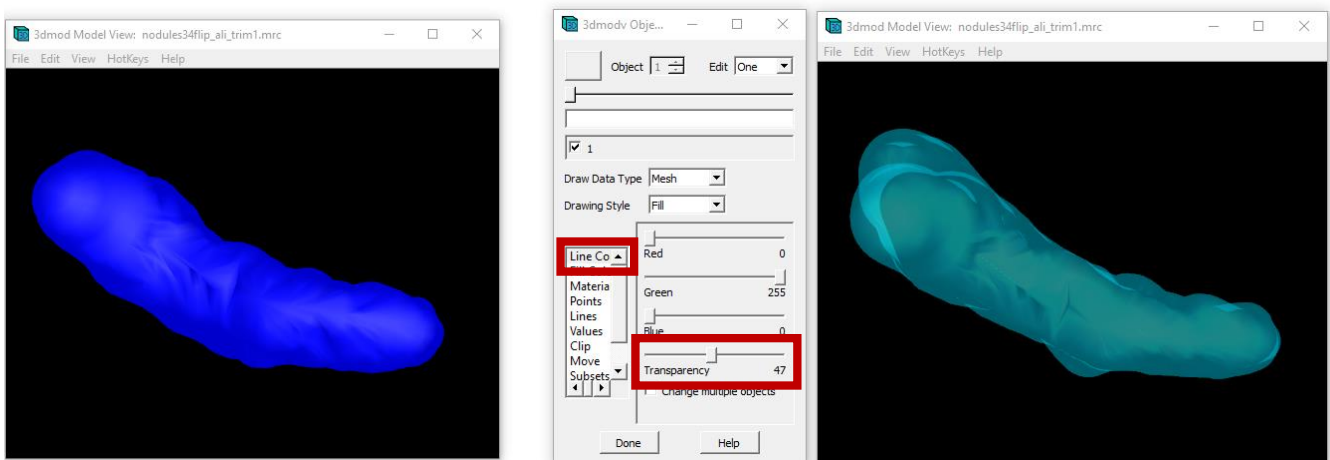


**TIP:** Although you should draw individual objects of the same type as separate objects (i.e., draw each mitochondrion in the same cell as a separate object), you may want to match the fill colour of objects of the same type by **making them have the exact same RGB in the Fill Colour menu.**

15. Change the appearance of the object surface using the **Materials** menu.



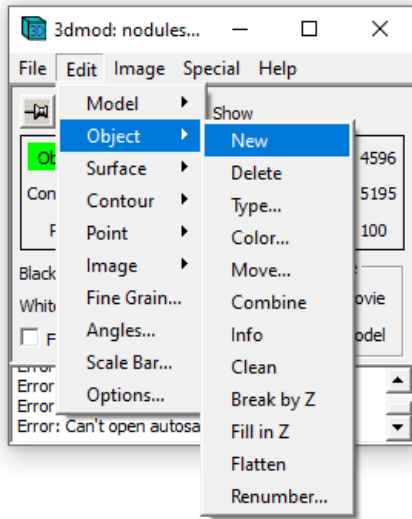
16. You can also change object transparency in the **Line Colour** menu.





17. To create another object, go to **Edit > Object > New**

then repeat steps 4-17.



### **Important TIP:**

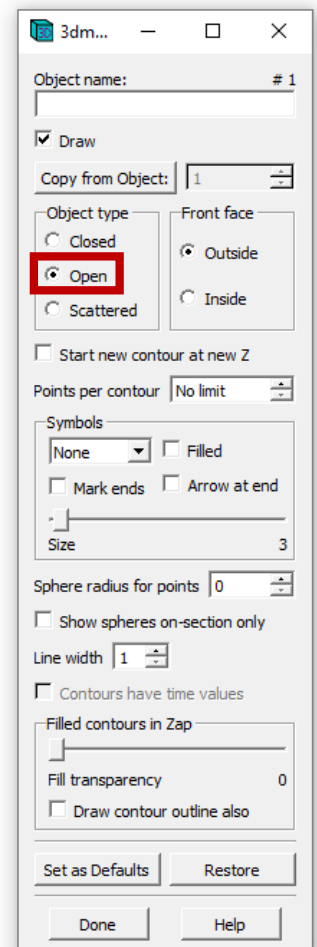
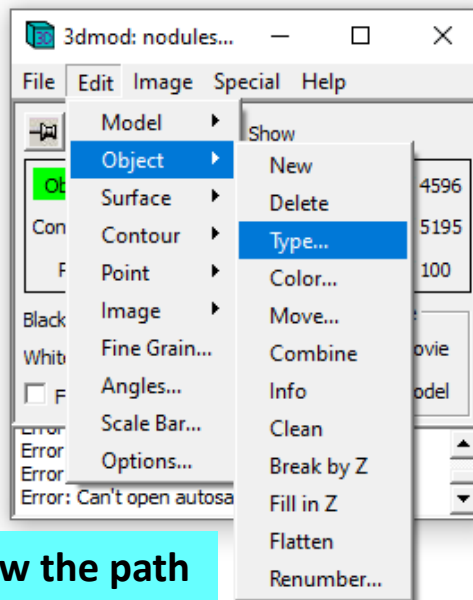
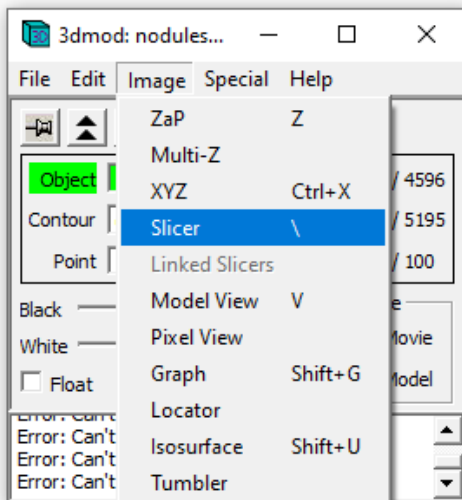
**Define *unconnected* objects as *separate* objects.** For example, each mitochondrion in the same cell should be defined *as a separate object* (NOT as a single object for mitochondria).

*This avoids confusion when “meshing” the objects.*

To make movies of your model, refer to the presentation/PDF below:  
**“Making Movies of 3D Model using IMOD”**

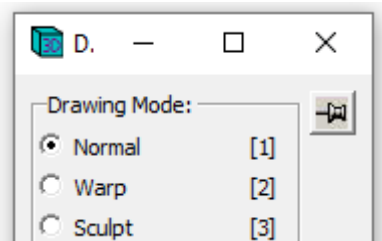
## **Segmenting Microtubules**

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**.



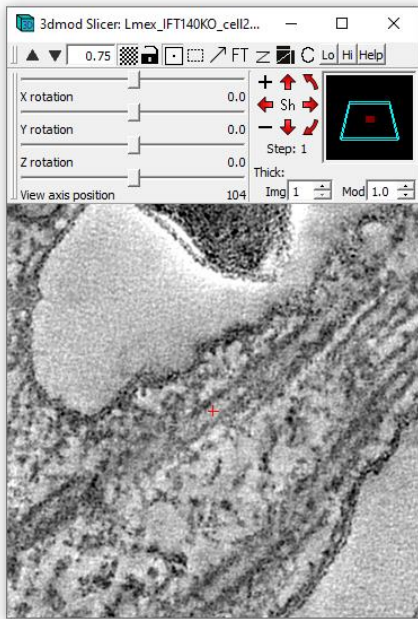
Using the **Slicer**, you can **follow the path of microtubules**, to facilitate modelling.

If the Drawing Tools window is open, close it or make sure **“Normal”** is selected.



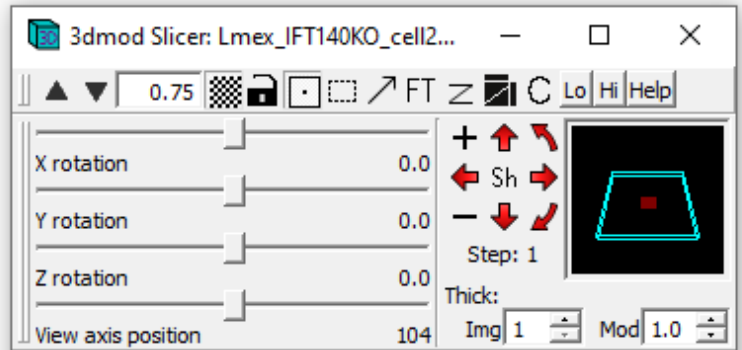


20. Click with the **right mouse button** on a microtubule of interest, to bring it to the centre, where the tiny **red cross** is.

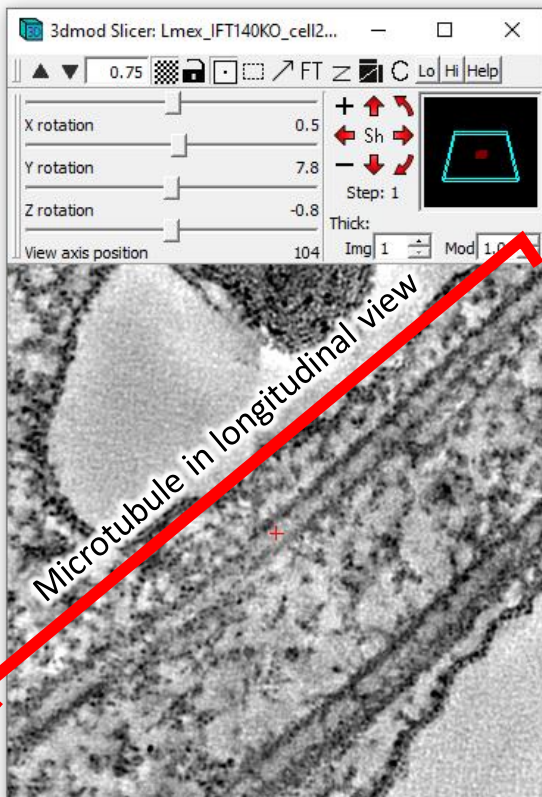


21. Hold **Shift + left mouse button** to rotate the microtubule of interest in X, Y, Z

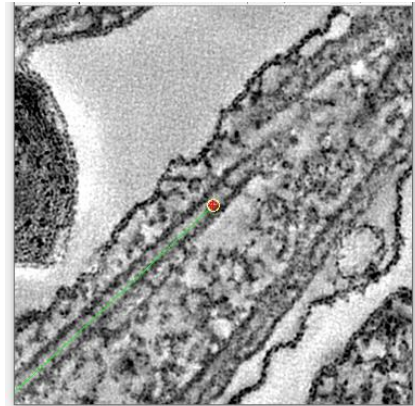
You can also use the controls at the top of the Slicer window to select rotation steps:



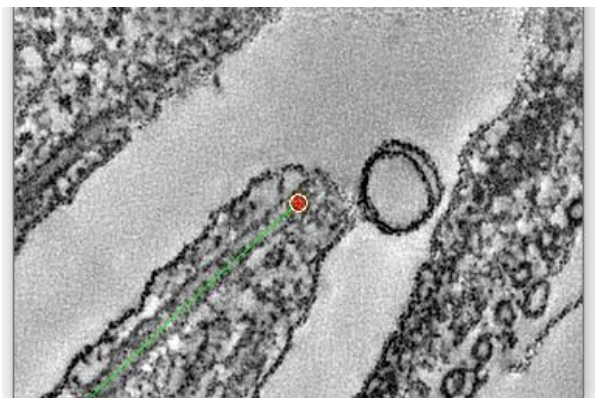
With the microtubule in the middle, you should be able to rotate it into longitudinal view, by holding **Shift + left mouse button**.



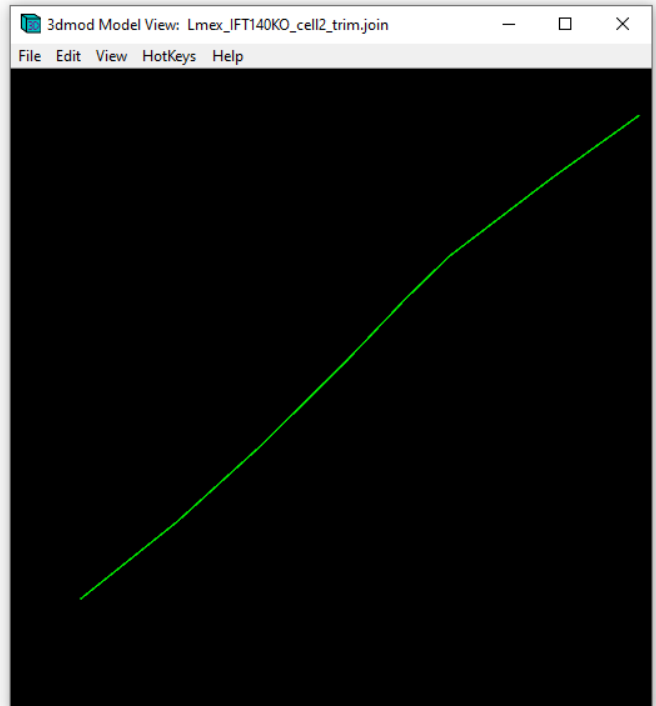
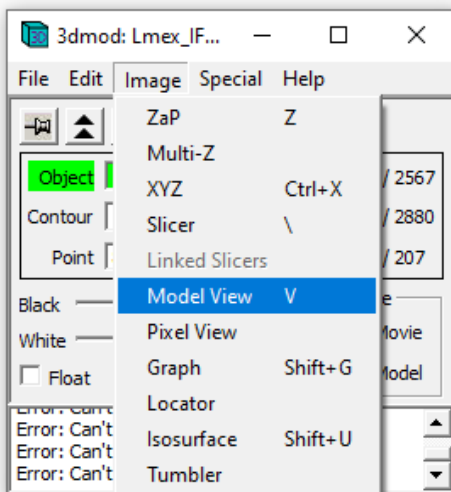
22. In model mode, **click** along the microtubule with the **left mouse button** to draw its path.



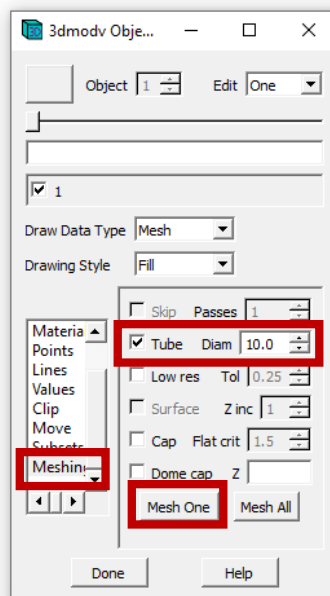
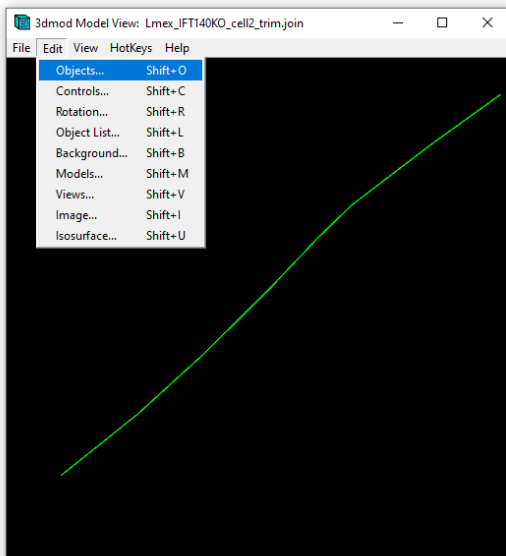
23. Keep “straightening” the microtubule by holding **Shift + left mouse button** as you draw its path to the end with the left button.



23. The Model view window will show the microtubule's path as a line (make sure you selected object type as open – step 18).



23. Open the Object window and scroll down the options on the left to find **Meshing**. Tick **Tube**, select tube **diameter**, and click on **Mesh One**.

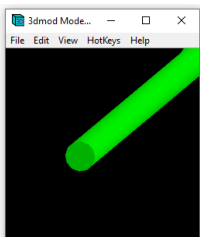


Microtubule meshed as a tube.

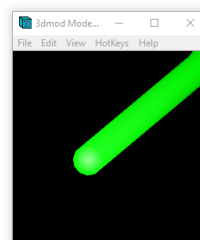


You can choose to mesh the microtubule as an open or capped tube.

Open tube  
Cap unticked



Capped tube  
Cap ticked



Now go to page 7  
to change colour,  
material and  
transparency!