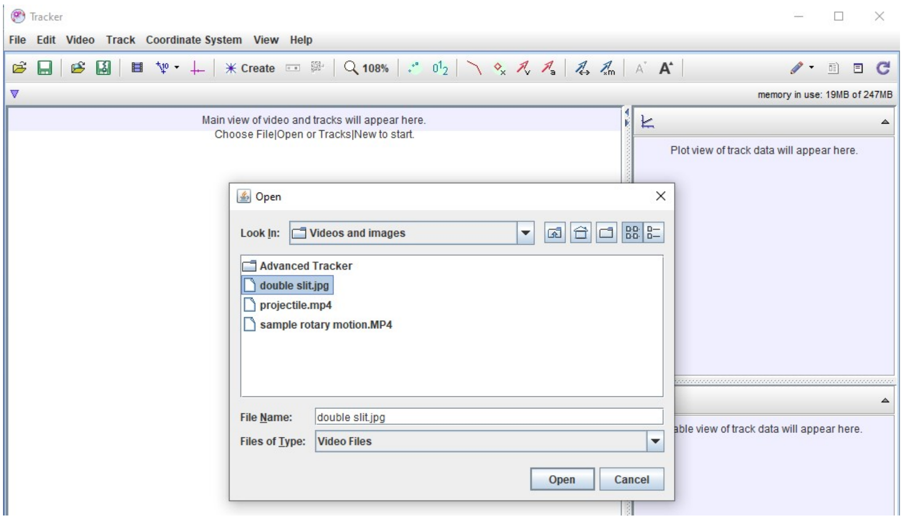
Using Tracker's Line Profile tool – Double slits example

This document assumes you have worked through *Analysing linear motion using Tracker* and can set axes, change the quantities displayed on graphs etc.

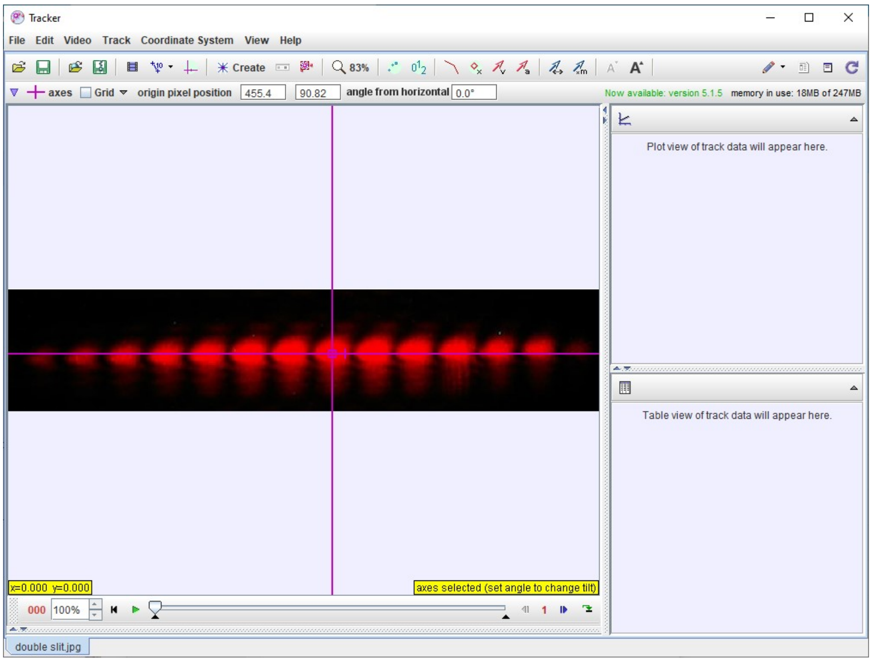
Launch Tracker. Go to **Video** and select **Import**.

Find the file **double slit.jpg**

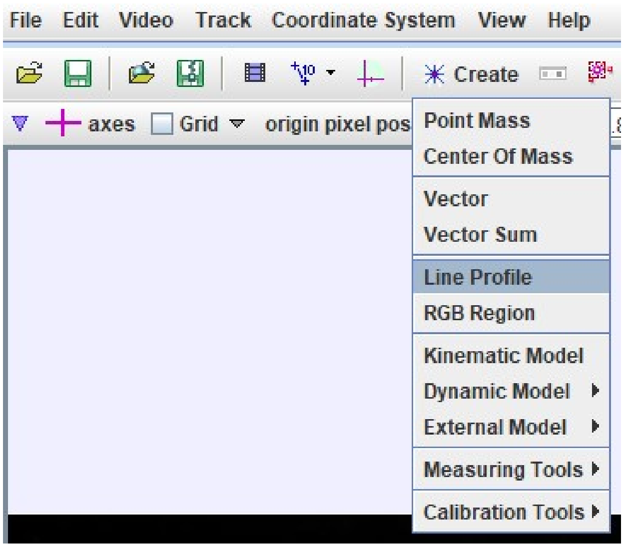
This isn't a video file but you can still import it into Tracker and analyse it.



You should see a double slit interference pattern. It's not essential to do so, but you could align the origin with the central maximum using the axes tool.

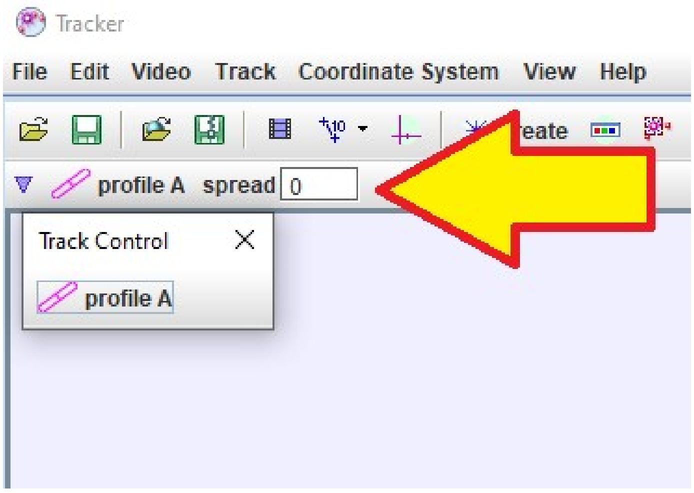


Now go to **Create**. Choose **Line Profile**.

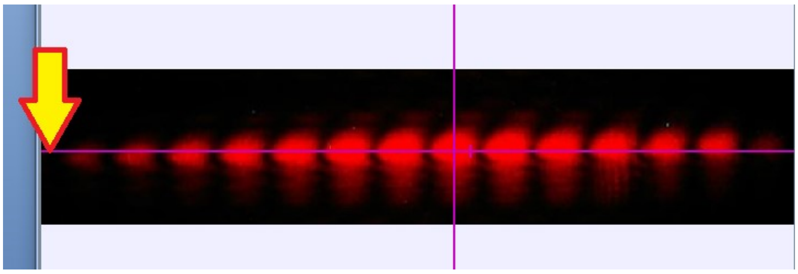


We're going to map the pixel brightness horizontally across a region of the image. Before we do so, change the **spread** value from 0 to 20.

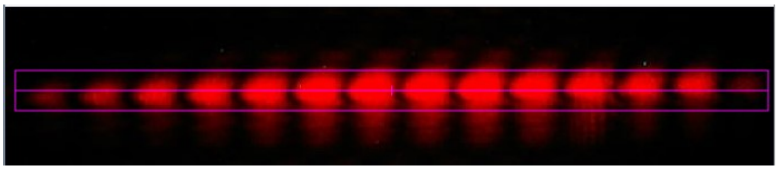
Spread is best understood by investigation – try changing its value once you have set up your first line profile.



You are instructed to **shift+click** to draw your line profile. Before doing so, place the cursor to the far left of the pattern, in the vertical centre as shown by the arrow on the picture on the right.



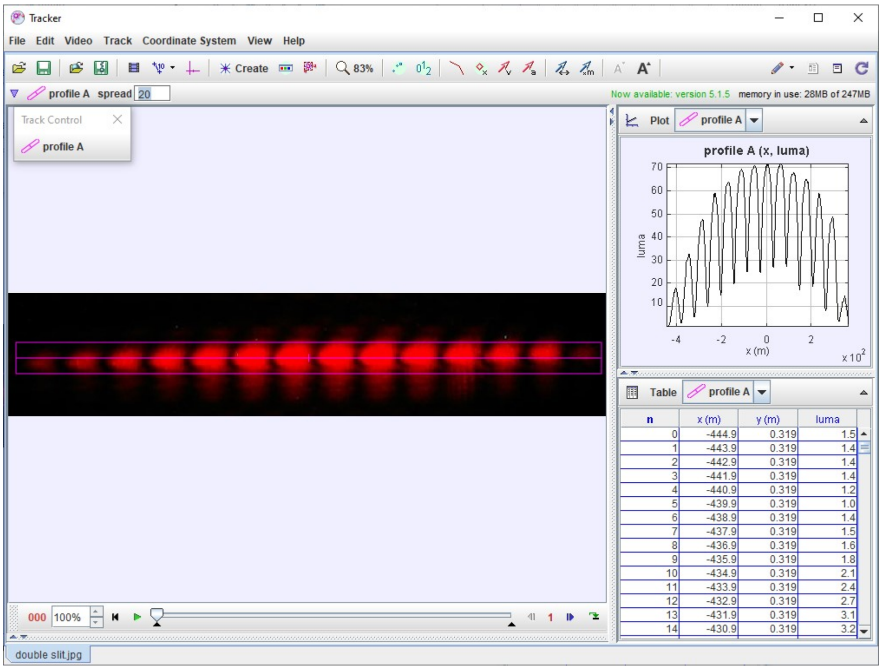
Drag right to enclose your pattern in a box as shown. **Spread** controls the 'height' of this box. You can't change that by dragging. At this point, you could experiment with different values for **spread**.



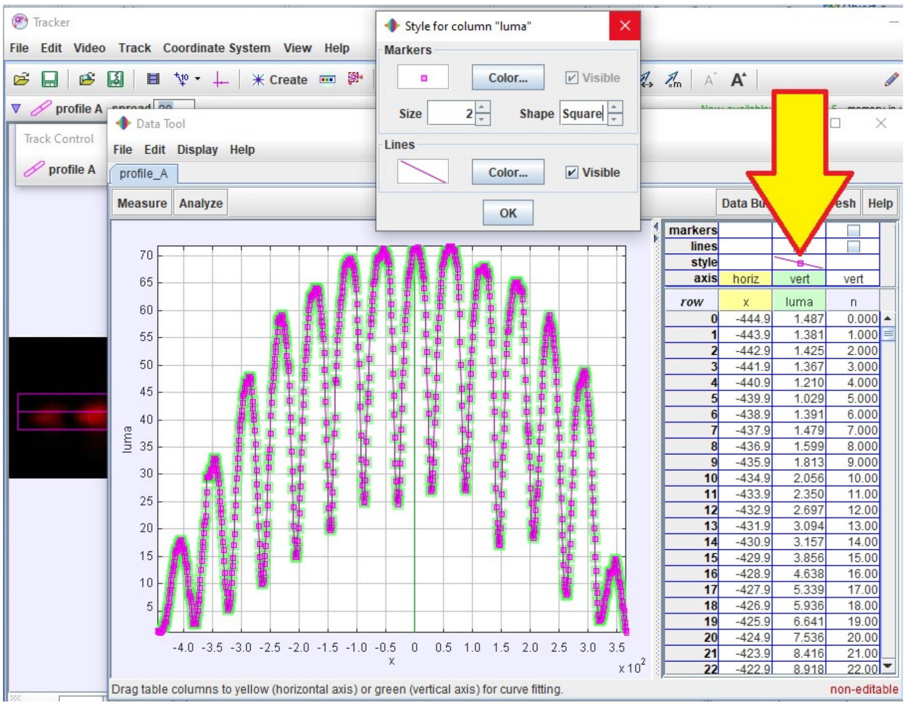
If you don't quite get the box in the right place, you can drag it around until you do.

It's a good idea to right click on the graph and select **Autoscale**.

Note the unit – **Luma**. We'll not go into it here, but you might be interested to research what it actually represents.



As before, double clicking the graph produces a larger graph. By clicking in the **style** cell as indicated by the arrow, you can change the size, shape and colours of the markers on the graph. This is a case where (gasp!) joining the dots on a graph is probably the right thing to do.



Interpreting the line profile.

Here we assume a bit of knowledge of interference and diffraction. If you aren't familiar with the theory but would like to know more, please get in touch. As we'd expect with an interference pattern, we have a series of bright and dark bands – maxima and minima. The separation of the maxima and minima are related to the distance between the slits.

The maxima are not the same brightness – the 'envelope' that modulates the brightness is the shape of the diffraction pattern you would get from a single slit.

Quantum physics

The y-axis value can be thought of as relating to the probability of a photon being found at the corresponding location on the pattern. A high value means a high probability.

Taking the photo

We used a laser and slits from a Photonics Explorer kit which is found in many schools. Our experiment was qualitative but we could have made it quantitative by putting an object of known size – a strip of graph paper, for example, below the interference pattern before photographing it. We would then calibrate the image the way we used a metre stick to calibrate the image in our projectiles example.

If we know the distance between the slits and pattern and the wavelength of the laser light, we can calculate:

- Slit separation, if we know the separation between maxima.
- Slit width, if we know the width of the diffraction envelope, between the points where brightness drops to zero (at about +3.75 and -3.75 in the uncalibrated image above).

We used a digital SLR camera with manual exposure control to get the best image we could. We were then rather taken aback to find that a shot with a smartphone camera gave reasonable results too.