FTSR help files
Sarah Haigh, Oxford University 23/03/09

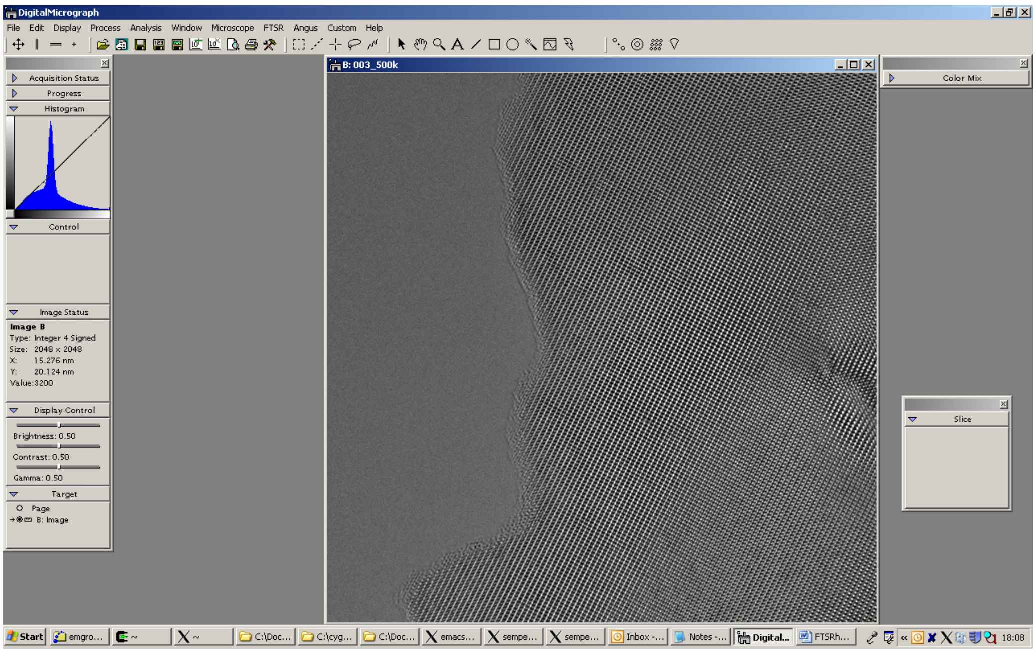
Calculating Sampling interval

The sampling interval can be calculated accurately by taking a lattice image of a sample that has an accurately known lattice spacing. Take the Fourier transform of the image and measure the distance of a Fourier spot corresponding to this known lattice distance from the central peak using the ruler tool in DigitalMicrograph. This distance will be in reciprocal pixels (if it is in reciprocal nanometers click on the small ruler shown next to the image information in the “target” pane in DigitalMicrograph to change the reading to reciprocal pixels). The sampling interval can be calculated from the measured distance as follows:

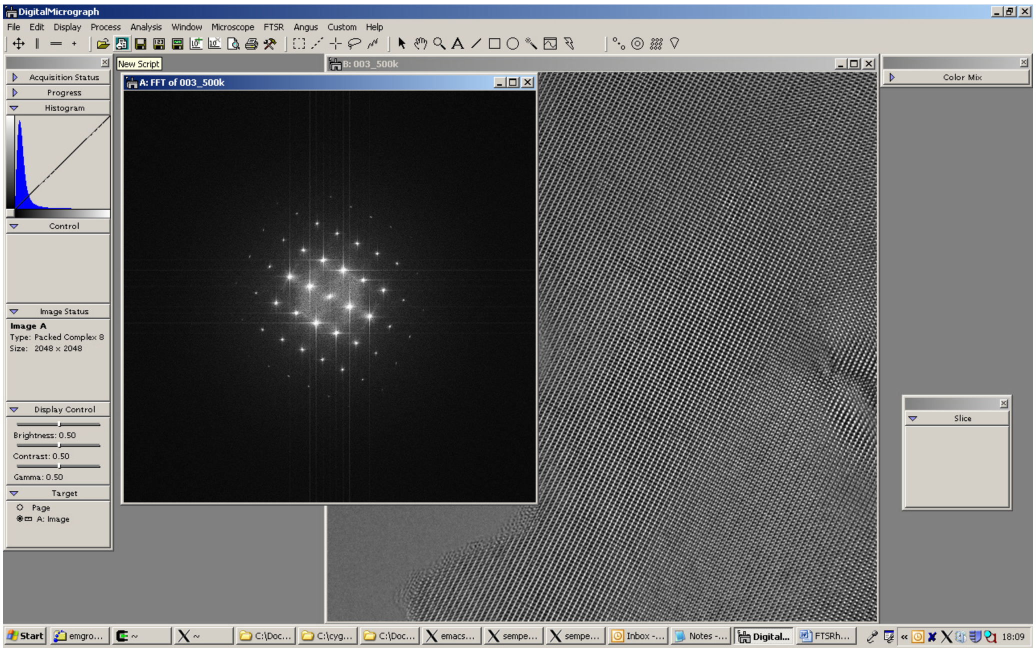
$$\text{Sampling interval (nm)} = \frac{\text{spacing in material (nm)} \times \text{distance (pixels measured in reciprocal space)}}{\text{total image size (pixels)}}$$

Remember to note the binning of the image (binning the image by 2 or 4 will increase the sampling interval by 2 or 4 times respectively). This process will have to be repeated (not necessarily using the same standard sample) for any magnification at which you wish to restore the exit wavefunction from images.

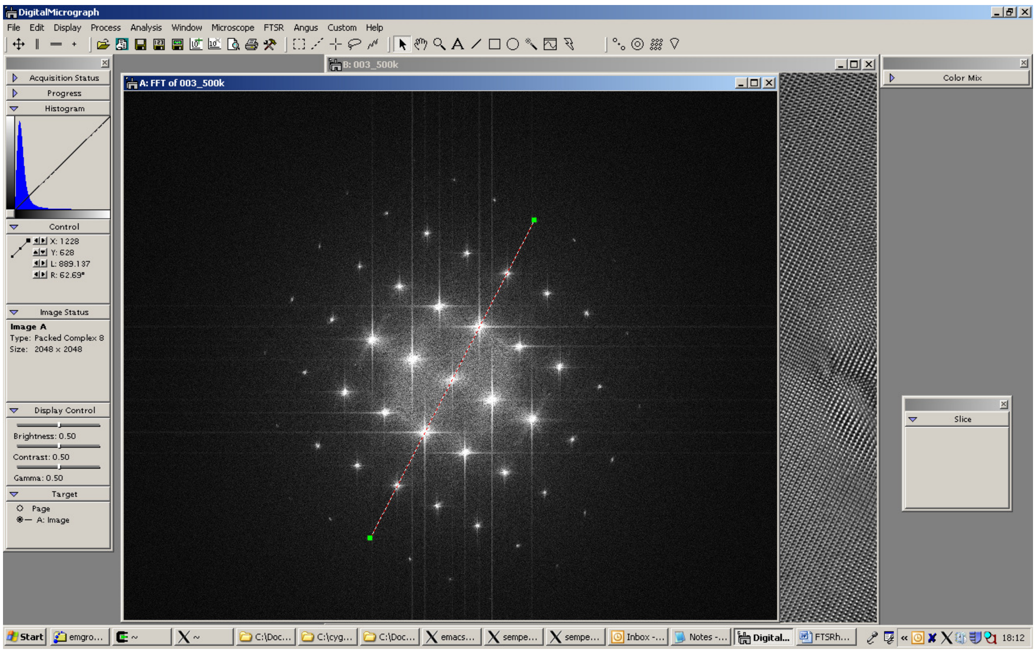
Example – Calculating Sampling interval using a lattice image of a Strontium Titanate crystal in a [011] orientation.



Take the Fourier Transform of the image and measure the number of reciprocal space pixel that separates two of the lattice reflections (make sure that you know the orientation and hence which lattice reflections these spots correspond to).



Hint: If using DigitalMicrograph to do this you can click the ruler in the Target window in order to change the 'Control' window to display the length in pixels rather than in reciprocal nm. (DigitalMicrograph converts from pixels to nanometers using an internal table of calibration factors which may or may not be sufficiently accurate, depending on how this was last calibrated for your instrument).



In the example above showing the Fourier transform of a [011] oriented $SrTiO_3$ sample the reciprocal space direction I have measured is the (0,1,-1). The distance measured for 6 of these spacings is 889.1 reciprocal pixels, thus each 0.276nm spacing is represented by (889.1)/6 = 148.18 pixels. The image has a total size of 2048x2048. Thus using the equation given previously;

$$\text{Sampling interval (nm)} = \frac{\text{spacing in material (nm)} \times \text{distance (pixels measured in reciprocal space)}}{\text{total image size (pixels)}}$$

$$\text{Sampling interval (nm)} = \frac{0.2761\,\text{(nm)} \times 148.18\,\text{(reciprocal pixels)}}{2048\,\text{(pixels)}} = 0.0200\text{nm to 3 s.f.}$$

The accuracy with which the sampling interval is determined can be improved by averaging the values found for a number of different measurements and lattice directions.