FTSR help files –
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Measuring the aberrations of a camera

In this exercise we will obtain an MTF/NPS measurement for a CCD camera. The Modulation transfer function (MTF) describes how effectively different spatial frequencies are transferred by the camera. The noise power spectrum (NPS) describes how the different spatial frequencies of the noise are transferred by the camera.

To estimate the MTF it is necessary to have an image of a known function containing all the spatial frequencies of interest. A step function (a sharp change from black to white) is ideal for this and can be approximated by either the beam stop or by an aperture in the back focal plane of the sample.

Data acquisition.

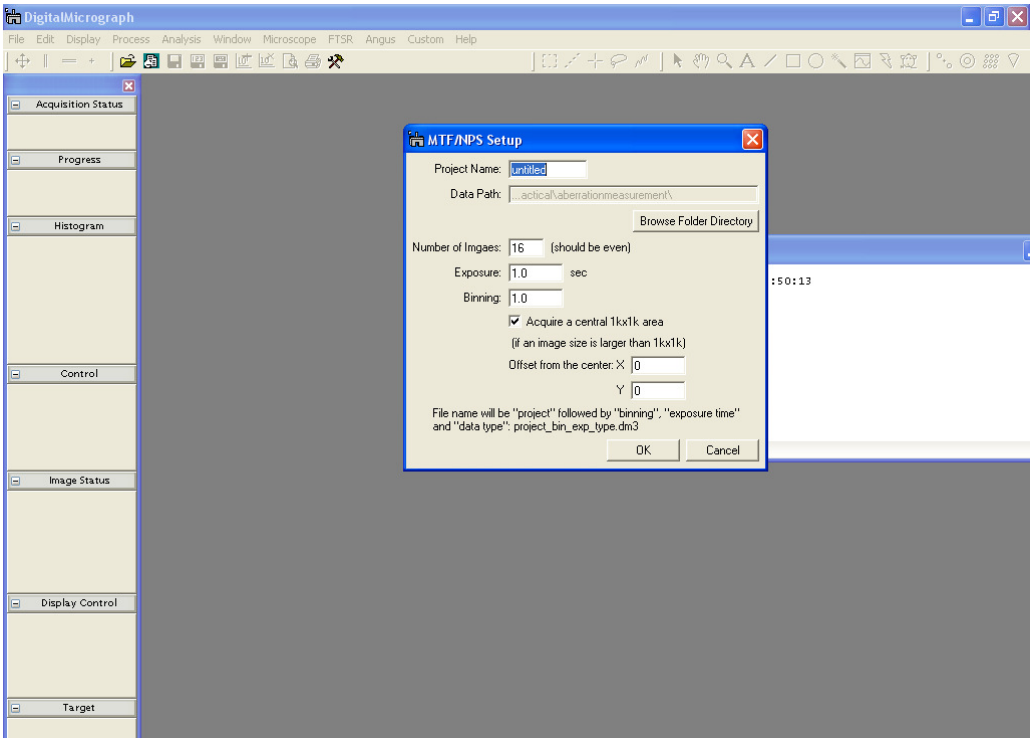
The experimental data that needs to be acquired consists of image data blocks of:

- Flat images (bright field images under uniform illumination conditions – beam spread so that it covers at least twice the area of the CCD camera)
- Dark field images (images taken with no illumination)
- Edge images (bright field images including an object approximating to a step function e.g the beam stop)

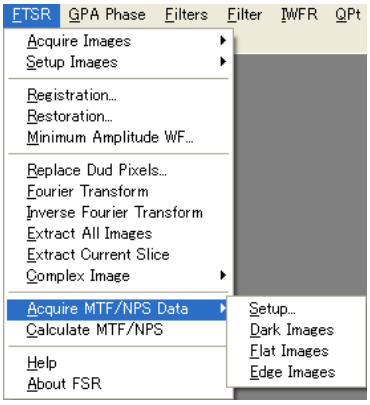
The acquisition of this data has been automated in the program FTSR.

1. Choose a low magnification (20k -40k) and find an area where there is no specimen present in the field of view.

2. From the "FTSR" menu chose "Acquire MTF/NPS data" option and "Setup". Give the project a name. Set an appropriate exposure time so that the number of counts in a bright field image corresponds to the counts in a typical experimental image (~1000 counts/pixel). Set the number of images to 16. Acquire the central 1k x 1k area.



3. Acquire the flat and dark images using the “Dark images” and “flat images” options in the “Acquire MTF/NPS data” from the “FTSR” menu.



4. Insert the beam stopper and acquire the Edge images using the appropriate option from the “Acquire MTF/NPS data” in the “FTSR” menu.

Alternatively, example data for calculating the MTF and NPS can be found in the FTSR_example_data\camera’ folder.

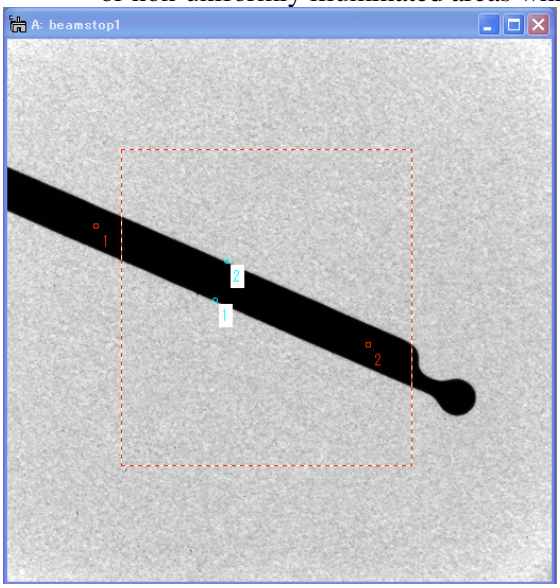
Calculating the MTF/NPS

1. Open the ‘edge’ data block showing the shadow of the beam stopper.

2. Specify the long axis of the beam stop on the ‘edge’ data block by using the ‘Mouse’ shaped controller in DigitalMicrograph. Two red squares should appear on the beam stop shadow. If you make a mistake you can delete a square by clicking on it using the ‘Mouse’ controller with the shift key held down.

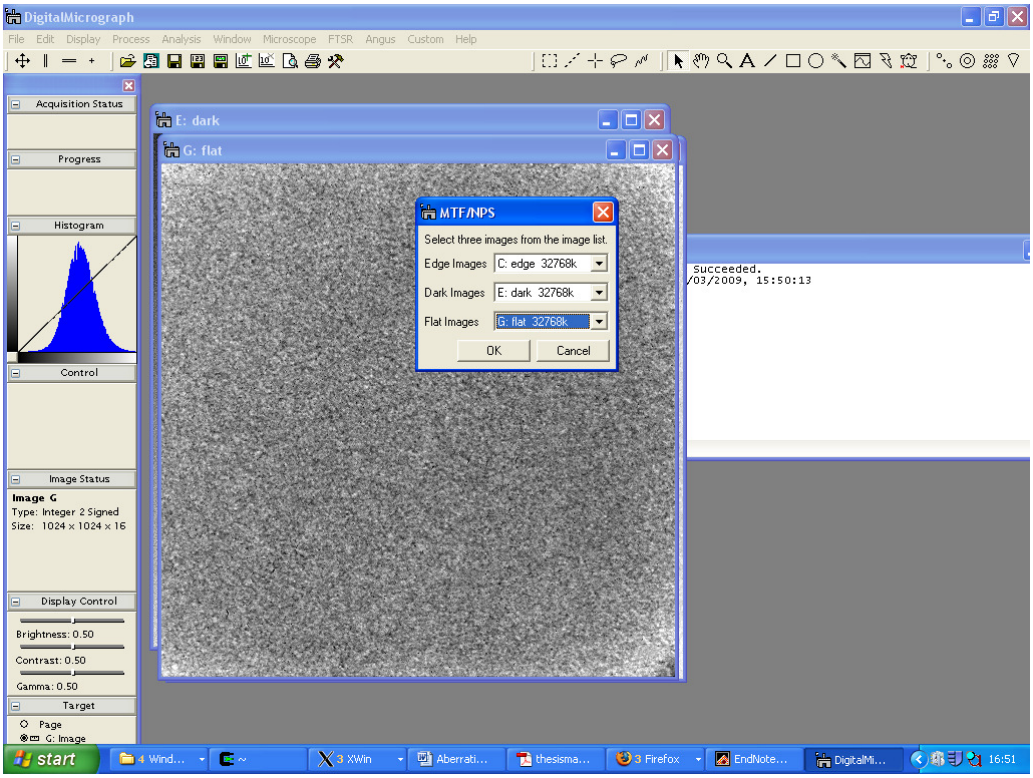
3. Specify the beam stop width on the ‘edge’ data block by using the ‘Mouse’ shaped controller in DigitalMicrograph with the alt key held down. Two blue circles should appear. If you make a mistake you can delete a circle by clicking on it using the ‘Mouse’ controller with the shift and the alt key held down.

4. Specify the image area to be used for NPS estimation can be specified by using the rectangular ROI tool on the edge image. Avoid including damaged areas of the CCD or non-uniformly illuminated areas which are close to the edge (see example).



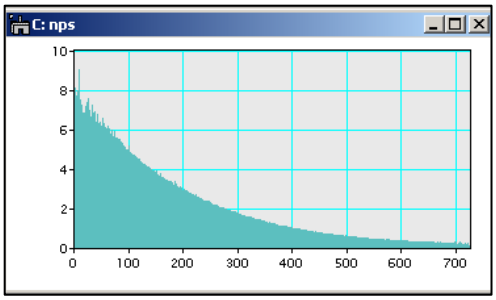
5. Open the dark data block and the flat data block.

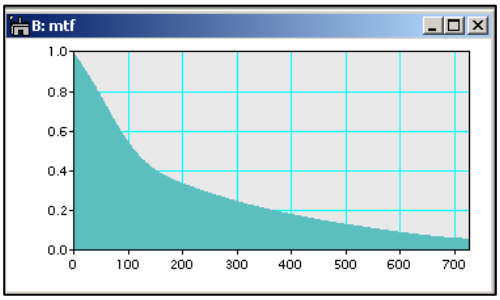
6. Choose the “Calculate MTF/NPS” command from the “FTSR” menu. Select the appropriate data blocks for the edge, dark and flat images from the open image list, then click OK.



The MTF and NPS will then be estimated within a few minutes. In both the MTF and NPS the horizontal scale represents pixels in reciprocal space. This data is normalized and for any camera size the data is 725,1 – representing the total distance from the centre to the corner for a camera size of 1024.

The mtf and nps you calculate should look like this:





If there is time repeat the exercise for data acquired with a different level of binning. Compare the results. Binning the images should give a better mtf and nps but this is at the expense of a smaller field of view for the same sampling interval.