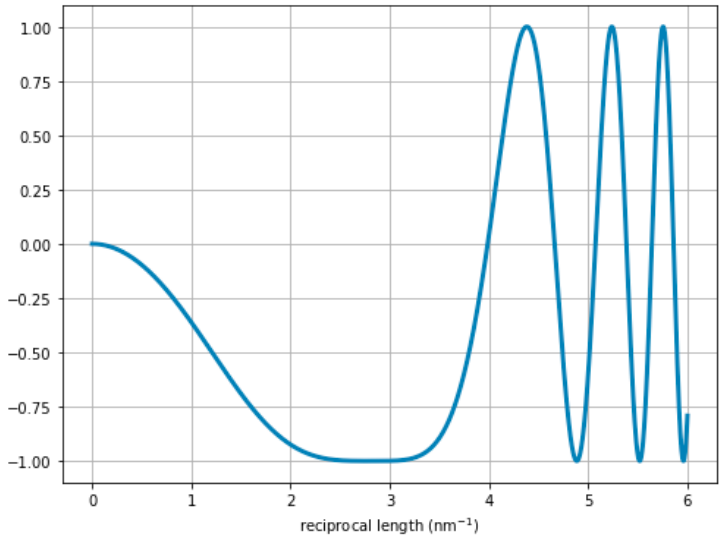
Assignment Module 7 Phase contrast (1) – Corrections

Prompt 1:

Here is the component sin(chi(u)) of the phase contrast transfer function of a given (non Cs corrected) microscope under certain operation conditions and with an acceleration voltage of 200 kV.



Can you use this microscope under those conditions to provide a high resolution image of a crystal with lattice spacing of 2.5 angstrom ? Explain why.

Answer:

No, because 2.5 angstrom corresponds to a spatial frequency of 4 (1/nm), and this is not transmitted as the function is 0 for this value of u.

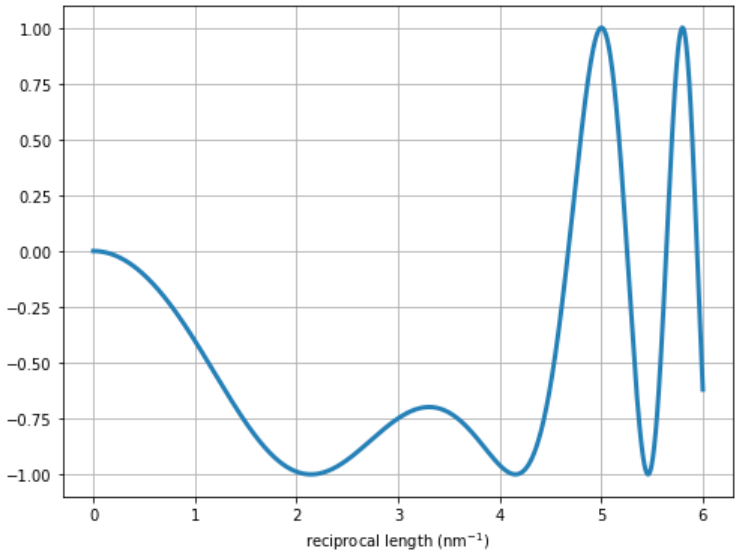
Prompt 2:

We use the same function sin(chi(u)) as in question 1. Which parameter would you change on the microscope to be able to image lattice planes with a spatial frequency of 4 (1/nm)?

The easiest parameter to change is the defocus.

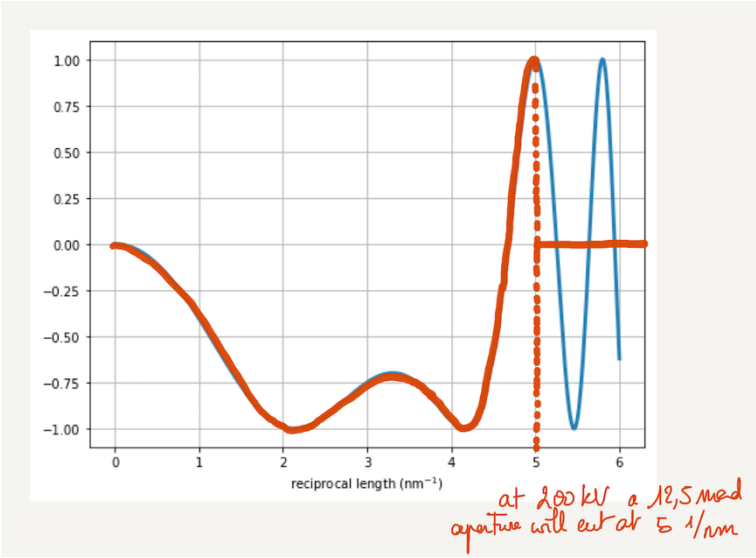
Prompt 3:

Here is the component sin(chi(u)) of the phase contrast transfer function of a given (non Cs corrected) microscope under certain operation conditions. The accelerating voltage is 200kV.



Sketch the new phase contrast transfer function if one takes into account the insertion of an objective aperture with collection semi-angle 12.5 mrad.

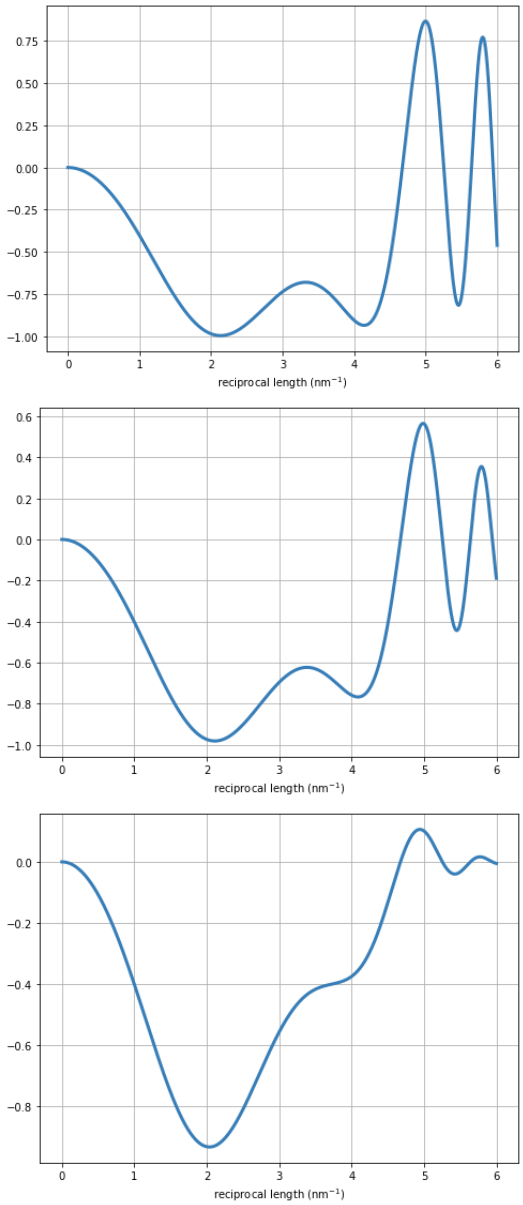
This is the correct sketch:



There are two important components in the answer:
1) The 12.5 mrad aperture gives a reciprocal length of 5 (1/nm) at 200 kV
2) the aperture will multiply by a step function, 1 before the cutting aperture, zero after

Prompt 4:

Here are the phase contrast transfer functions of 3 microscopes with exactly the same aberrations (Cs, Cc, etc.), at the same defocus and same high tension.
1) Which contribution to the PCTF can explain the differences?
2) What constituent of the microscope can be at their origin?

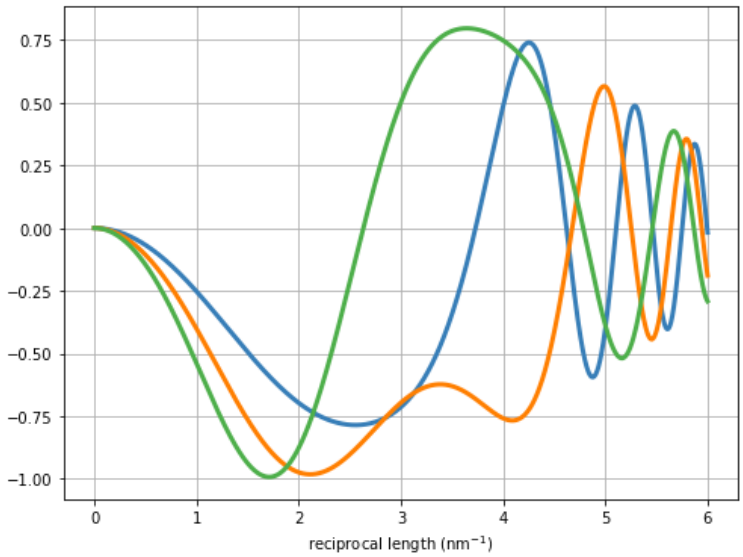


The correct answer is:

- *The difference between the three curves is caused by an envelope function (also correct: damping function).*
- *The constituent of the microscope at the origin is most probably the electron gun. This is due to the different coherence.*
- *The most probable is that we have one FEG microscope, one with LaB_6 source and one with tungsten source. This would affect the spatial and temporal coherence.*
- *We can also note that a change of coherence can be due to instabilities in the electronics of the lenses.*

Prompt 5:

Here are the PCTF of the same microscope (same Cc, Cs, high tension) where the user changed one parameter during operation. Which is this parameter and what brings you to this conclusion?



The correct answer is:

- *The parameter changed by the operator is the defocus.*
- *On sees that on those 3 curves, the envelope function remains the same and no aperture was inserted, but the position and numbers of zero-crossings of the PCTF changed, This can be attained by changing the defocus.*