Design of a 10keV Multi-pass Microscope

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Multi-pass microscopy has recently been introduced as a method for contrast enhancement in imaging using photons [1] or electrons [2] as probe particles. Crucially, for thin samples, this contrast enhancement can lead to an improved signal-to-noise ratio per electron-specimen interaction. This might allow for imaging the folding conformation of single proteins [2].

Here we present the design for a proof of concept multi-pass transmission electron microscope (MPTEM) operating at 10 keV [3]. The microscope is designed to validate the multi-passing concept for ultra-thin specimens (few atomic layers). We will discuss how an electron beam can be coupled into, and out of, the multi-passing cavity, and how aberrations affect the expected performance. Ray tracing simulations of the electron optical design yield a spatial resolution of 5 nm for 10 electron-specimen interactions. The instrument is currently being manufactured.

References:

[1] T.Juffmann, B.B.Klopfer, T.L.Frankort, P.Haslinger & M.A.Kasevich, Nature Communications 7, 12858 (2016).
[2] T.Juffmann, S.A.Koppell, B.B.Klopfer, C.Ophus, R.M.Glaeser & M.A.Kasevich, Scientific Reports 7, 1699 (2017).
[3] Stewart A. Koppell, Marian Mankos, Adam J. Bowman, Yonatan Israel, Thomas Juffmann, Brannon B. Klopfer, Mark A. Kasevich, arXiv:1904.11064 (2019).