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Finding opportunity in adaptation: Using existing instruments in new ways

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A flagship transmission electron microscope (TEM) with its detectors/spectrometers can cost $5M+, and would hopefully have a lifetime of up to 15-years. With such significant investment users demand the highest performance over a wide range of modes. However, longevity leaves the potential for obsolescence, and specialised performance can restrict application flexibility. In this talk, I will present some of the modular retrofittable hardware and software tools developed within the Ultramicroscopy group that can extend TEM performance, flexibility, or lifetime.

The user adjustable pole-piece (UAP) is designed to enable a single TEM objective lens to offer selectable gaps from 1.5 - 6.5mm [1]. This gap can be changed while under vacuum and without an engineer visit.

Direct detection and electron counting can deliver perfect efficiency and noise performance – but come with significant financial cost. Alternatively, adding new read-out electronics onto older photomultiplier detectors delivers a digital output for low-dose imaging without buying a new detector [2].

Even without hardware modification, scan / acquisition planning can improve STEM frame-rate, strain-precision and reduce damage. Understanding, characterising, and compensating for flyback hysteresis in post-processing saves valuable time and hence dose [3]. Scan-line interlacing [4] can double frame-rate and, when combined with multi-frame non-rigid registration [5] can improve strain precision still further.

References

[1] P. McBean et al., European Microscopy Congress proceedings (2020).
[2] T. Mullarkey et al., Microsc. Microanal., **127** 99 (2021).
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[5] L. Jones et al., *Advanced Structural and Chemical Imaging*, **1**, 1 (2015).

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