Docket #: S17-348

Multi-pass electron microscopy for enhanced imaging

Stanford researchers at the Kasevich Lab have prototyped a multi-pass electron microscope that can image nanometer scale samples including electron damage sensitive proteins and other electron dose sensitive nanostructures with low damage. The multi-pass protocol allows imaging of these objects with doses below the levels which currently damage or destroy the imaging target (?10e?/&#8491^2). This type of imaging is not possible with current electron microscopy methods since either the electron dose will damage the specimen or resolution will not be sufficient. This microscope enables order-of-magnitude improvement in dose-limited resolution, or a ten-fold reduction in sample damage at equivalent resolution. In addition, the column design reduces aberration which is a limitation for multi-pass configurations.

Related Technologies from Kasevich Group:

S15-188: Multi-pass microscopy for high sensitivity, low damage microscopy"

Patent Application: 20170261739

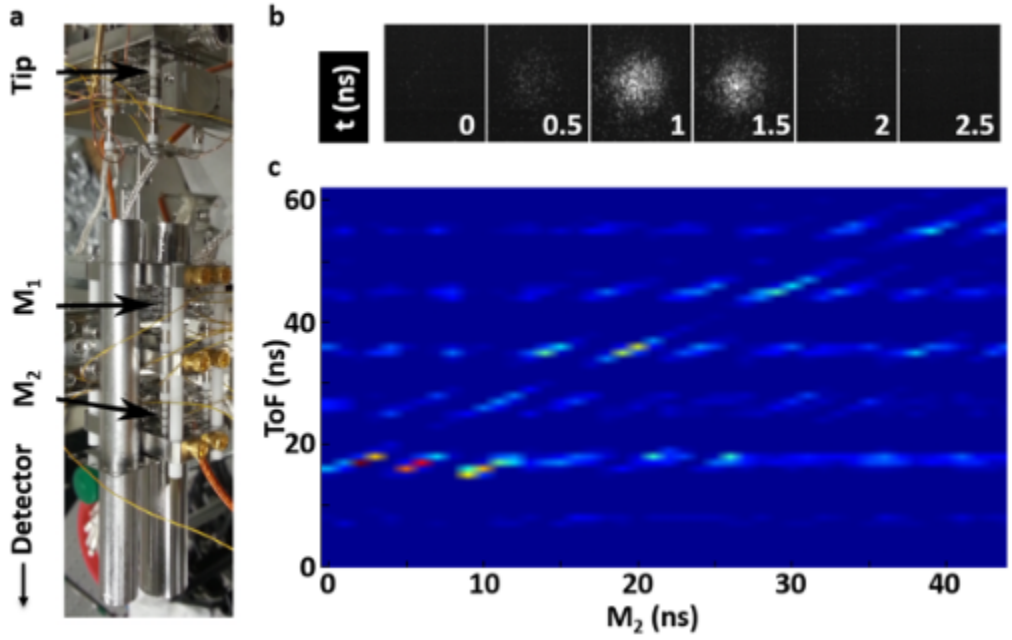

Figure description - Prototype of an electron cavity. An electron field emission tip and two mirrors (M1and M2) are gated using high voltage RF pulsers. Both mirrors achieve sub-ns gating times (b). (c) Time resolved detected electron signal as a function of the switching time of M2. The total intensity in each row was normalized to better visualize the signal detected after multiple round-trips, the origin was chosen arbitrarily.

Stage of Research

- **Proof-of-concept laboratory demonstration using prototype**

Applications

- **Imaging applications** in structural biology, material science, and pharmaceutical research
- **Low damage imaging** of nm scale proteins, DNA, nanostructures and other entities

Advantages

- **Novel** - this method enables imaging of proteins previously considered unimageable with existing electron microscopy methods
- **Low damage** - ten-fold reduction in sample damage at equivalent resolution
- **Higher resolution** - order-of-magnitude improvement in dose-limited resolution
- **Produces higher quality images** compared to standard microscopy
- **Reduces aberration** using aberration corrected gated mirrors which is an issue with multi-pass microscopy
- **Can apply various modalities** including dark-field (MP/DF), scanning (MP/STEM) and energy loss (MP/EELS)

Publications

- Thomas Juffmann, Brannon B. Klopfer, Timmo L.I. Frankort, Philipp Haslinger & Mark A. Kasevich. "Multi-pass microscopy." *Nature Communications* 7, Article number: 12858 (2016).
- Kubota, Taylor. "Stanford physicists develop a more sensitive microscope." *Stanford News* (Sept. 27, 2016)

Patents

- Published Application: 20210217578
- Issued: 11,456,148 (USA)

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