

Wide-field Resonant Electro-optic Imaging Devices and Applications

The Kasevich lab has expanded on an earlier invention ([Stanford Docket 18-388: "Efficient wide-field nanosecond imaging methods using Pockels cells for low-light applications"](#)) that achieves efficient ultrafast temporal imaging on standard camera sensors. Current fast camera sensors have significant drawbacks and achieve nanosecond resolution only by sacrificing performance and sensitivity. Low-cost nanosecond camera sensors with favorable performance and form-factor are more desirable, especially for applications in LIDAR and fluorescence lifetime imaging.

The Kasevich lab has developed resonant electro-optic imaging techniques and optimized the design of electro-optic crystals to allow compact, low-cost, and wide angular field-of-view imaging. Embodiments include multi-layer structures of low-cost electro-optic crystals and polarization optics, configurations to reduce switching voltage, and integrated systems for wide-field imaging.

This technology is an advantageous approach to Pockels cell LIDAR beyond conventional "flash" imaging mode – combining high distance resolution with large depth of fields, which is not possible with traditional Pockels cell approaches. It is also compatible with mode-locked laser sources and megahertz repetition rates, and facilitates compact and low-cost nanosecond imaging and LIDAR on standard CMOS sensors.

Stage of Development - Prototype

Applications

- LIDAR with enhanced resolution at large depth of field
- Wide field ultrafast imaging

- LIDAR and time-of-flight imaging for remote sensing, mapping, autonomous cars
- 3D cameras, 3D scanners, and foreground object detection
- Fluorescence lifetime imaging microscopy (FLIM)
 - FLIM + wide-field microscopy techniques
 - Single-molecule imaging and super-resolution microscopy
 - Light sheet microscopy
 - Medical diagnostics and endoscopic imaging
- High speed optical switching

Advantages

- Compatible with standard CMOS cameras
- Reduced switching voltage and power requirements
- High photon efficiency
- Compact and inexpensive construction
- Industrially scalable
- Avoids dead-time and throughput limitations of single-photon counting detectors

Publications

- Bowman, A. J., Huang, C., Schnitzer, M. J., & Kasevich, M. A. (2023). [Wide-field fluorescence lifetime imaging of neuron spiking and subthreshold activity in vivo](#). *Science*, 380(6651), 1270-1275.
- Bowman, A., & Kasevich, M. A. (2021). *U.S. Patent Application No. [17/153,438](#)*.
- Bowman, A. J., & Kasevich, M. A. (2021). [Resonant electro-optic imaging for microscopy at nanosecond resolution](#). *ACS nano*, 15(10), 16043-16054.
- Bowman, A. J., Klopfer, B. B., Juffmann, T., & Kasevich, M. A. (2019). [Electro-optic imaging enables efficient wide-field fluorescence lifetime microscopy](#). *Nature communications*, 10(1), 4561.

Patents

- Published Application: [20210223399](#)

- Issued: [11,828,851 \(USA\)](#)

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