# Analysis of Terahertz Driven MeV-UED Time Tool

Timothy Do, Mohamed A. K. Othman

SLAC National Accelerator Laboratory

## ABSTRACT

This poster presents data analysis from an experiment where an electron beam intersects with a terahertz streaking pulse. This interaction encodes temporal information into the electron beam profiles, enabling improved time resolution for Mega-electronvolt (MeV) ultrafast electron diffraction (UED) cameras. Using this technique, the electron beam timing was successfully encoded, demonstrating its effectiveness for advancing MeV-UED temporal characterization.

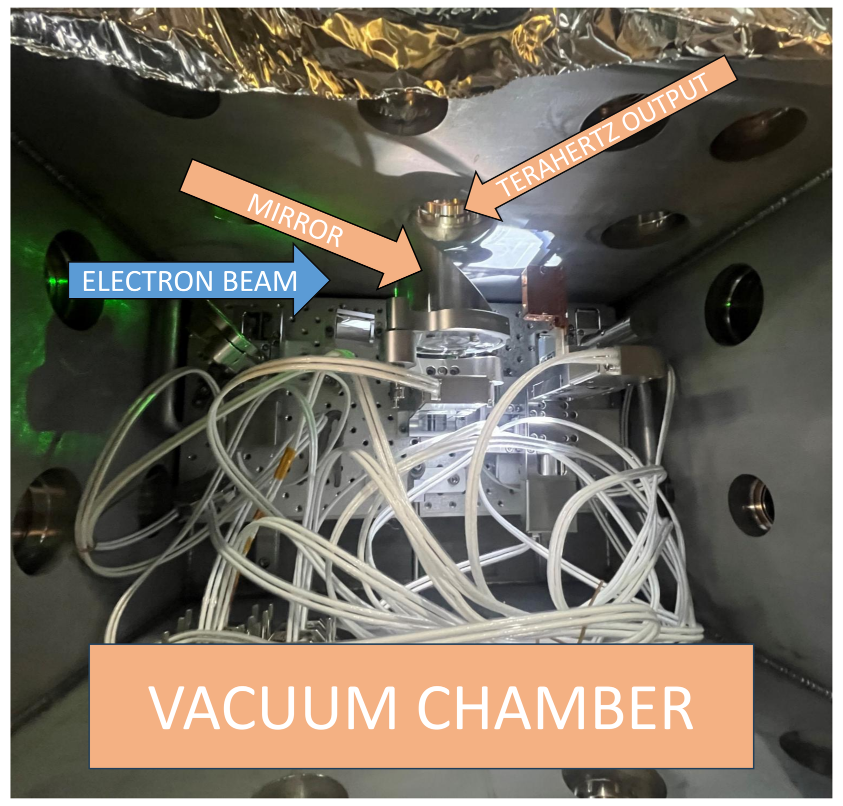
## BACKGROUND

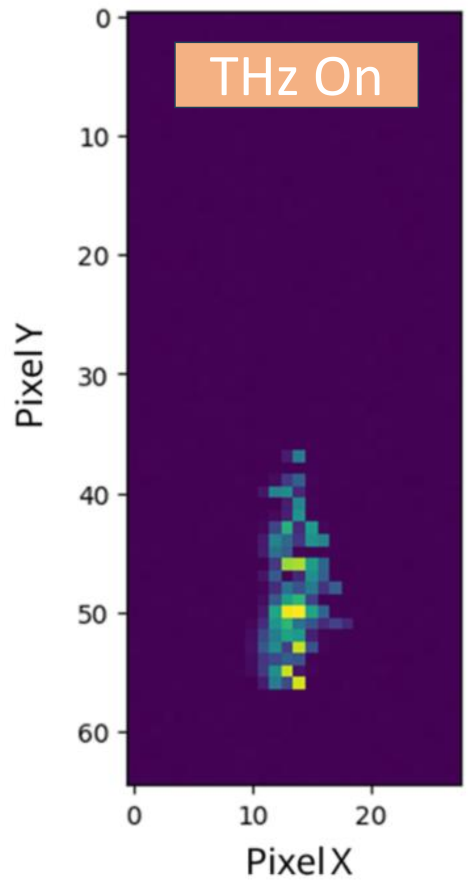
In this experiment, an electron beam intersects a terahertz (THz) streaking pulse, resulting in a deflection of the beam. The direction of this deflection depends on the instantaneous phase of the oscillating THz pulse. The optimal intersection timing is at the zero-crossing of the THz signal, where the deflection is most sensitive to phase changes. This setup enables precise temporal characterization of the electron beam relative to the THz pulse.

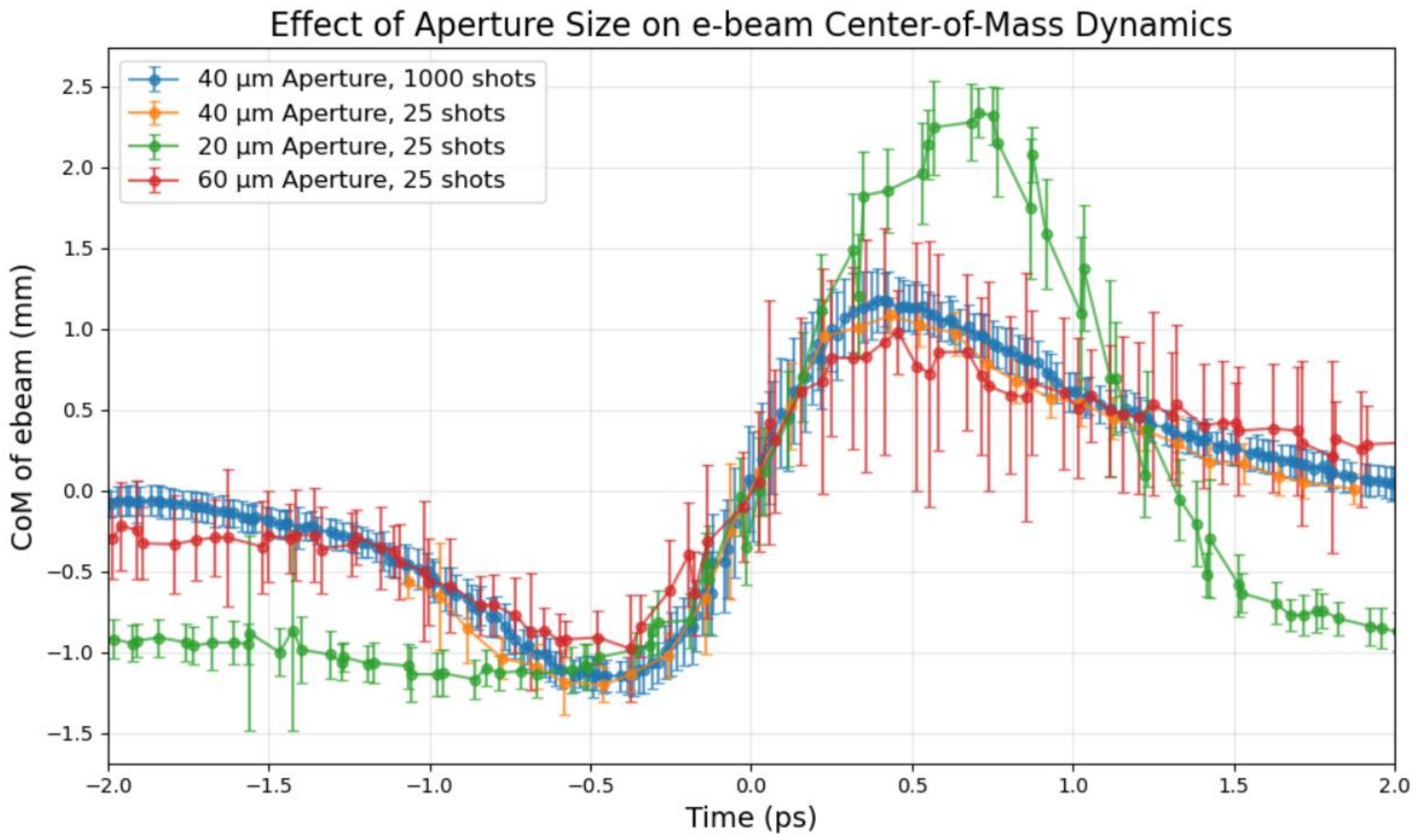
## DATA ANALYSIS WORKFLOW

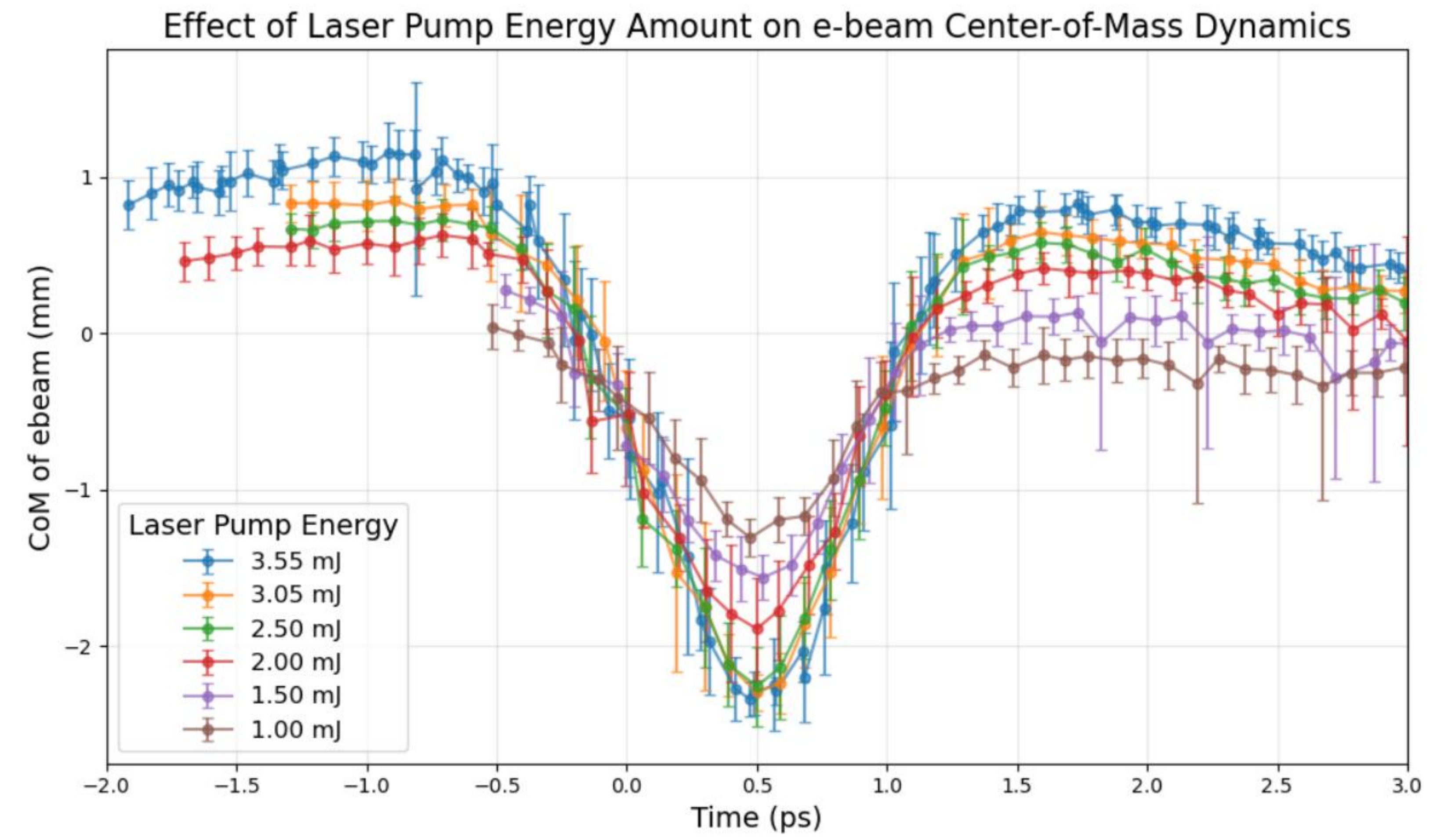
Our analysis pipeline ran on SLAC's S3DF (interactive iana queue) using Jupyter notebooks. For each experiment run, we loaded the preprocessing .h5 data, extracted the ePix image metrics, and computed the center of mass traces per shot. Scan variables were converted to physical time, using picosecond axes for plotting and femtosecond units when differentiating. We treated runs individually first, then grouped runs by matching parameters (e.g., aperture size or pump energy) and overlaid them. To compare shapes, we applied simple rigid translations to align curves (time and vertical offsets), then calculated the slope of each aligned curve to quantify the dynamic response. After designing the workflow on one representative run, we applied the identical steps to all remaining runs, modifying only the run-grouping choices.

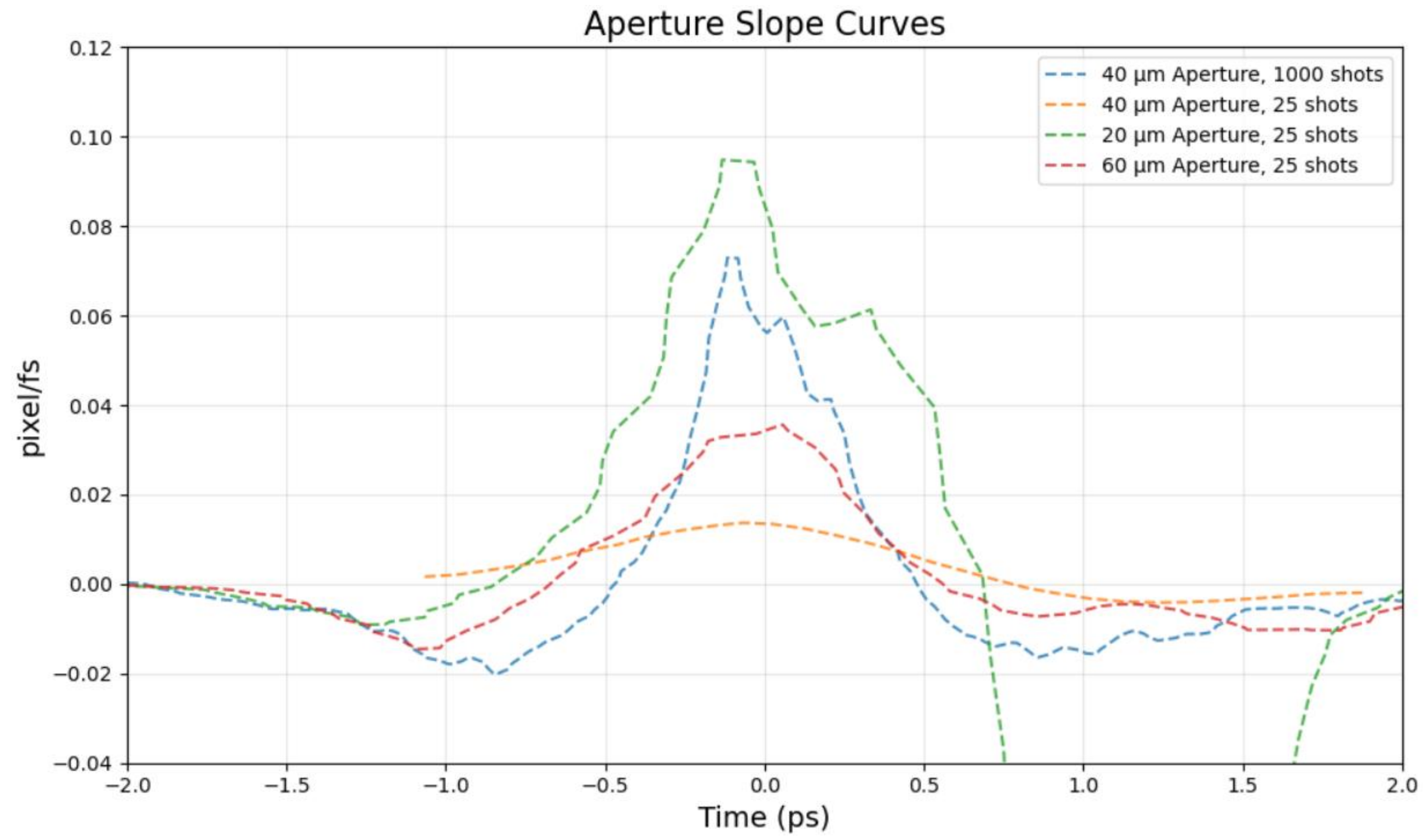
SLAC | S3DF SLAC SHARED SCIENCE DATA FACILITY




## DATA ANALYSIS

Effect of Aperture Size:

- Projects different aperture structures (20 – 60 µm)
- The 20 µm aperture produced the steepest slope, indicating the strongest e-beam deflection from the THz streaking pulse
- The 60 µm aperture resulted in the largest error bars representing the standard deviation, reflecting increased uncertainty

Effect of Laser Pump Energy:

- Depicts various amounts of laser pump energy (1 – 3.55 mJ)
- Increasing laser pump energy led to proportionally larger e-beam deflection amplitudes

Aperture Slope Curves:

- Plot showing rate of change of electron beam's position with respect to the camera pixels over a unit of time measured in femtoseconds
- The greatest slope is recorded near the zero-crossing of the signal

## ACKNOWLEDGEMENTS

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## REFERENCES

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