Towards Next-Gen Attosecond Science at TMO

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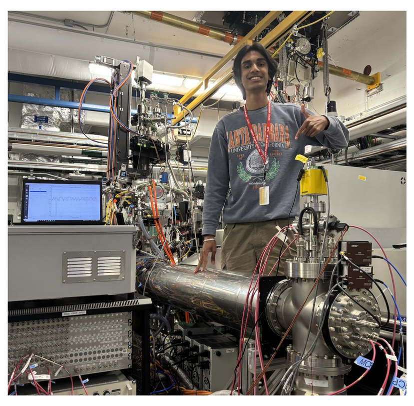
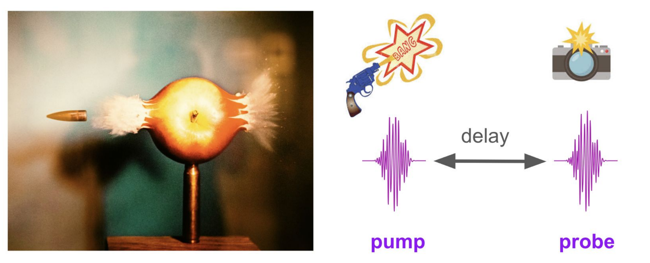
Intro to TMO

www.whatisthisamazingTMOikeephearingabout.com

- Just like how a high-speed camera captures the details a balloon popping, we can make our own high-speed camera to understand how electrons move within a molecule. To do this, we must study motion in attosecond timescales.
- This is what the TMO instrument at LCLS focuses on. TMO achieves this by shooting very short and intense x-ray pulses at molecules. The x-rays photoionize and we can study the resulting electrons to reconstruct a "movie" of the electron dynamics.





Timewalk Correction Successful

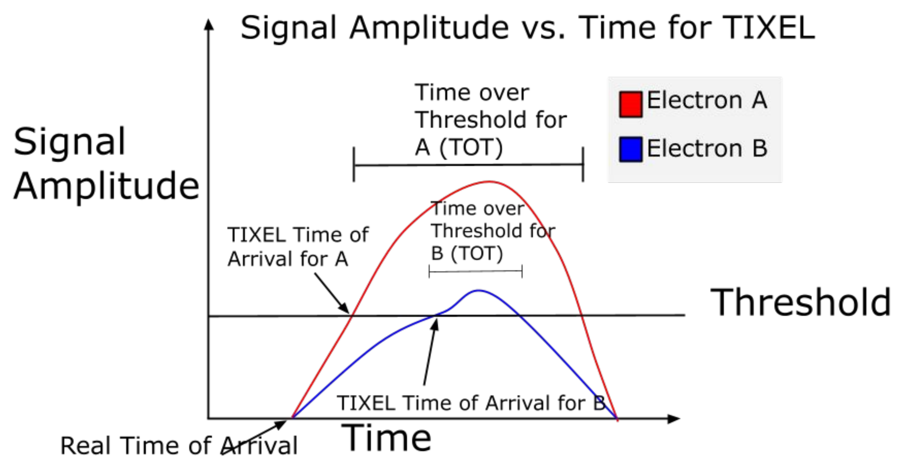
Optimal Timewalk = 32582

OK Cancel

Time-walk Correction

www.pleasefixmyTOA.io

- The TIXEL detects electrons by amplifying their signals and recording a hit when the signal crosses a threshold. Higher-energy electrons produce faster-rising signals, so they cross the threshold earlier, even if they arrive at the same time. This causes the TIXEL to record them as arriving earlier.

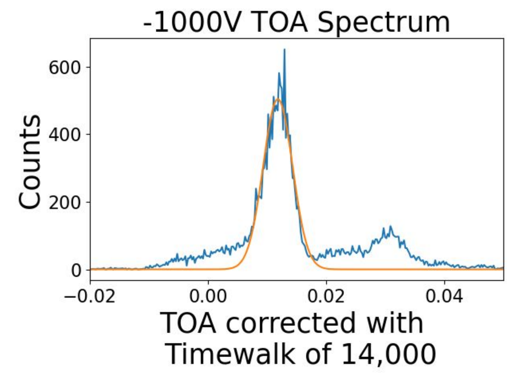


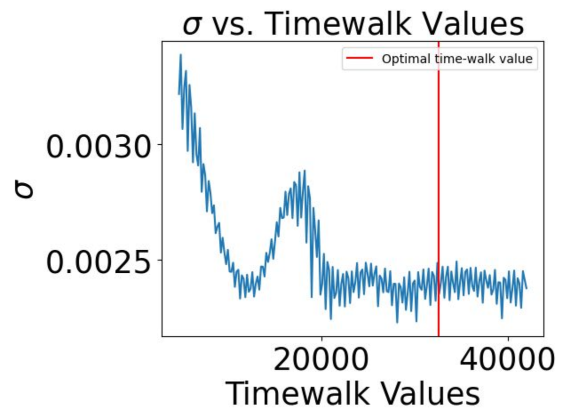
- We correct this time of arrival discrepancy using two parameters: the time that the signal spends over the threshold (TOT) and a constant called "time-walk" (TWC). Below are plots of two methods used to find the values of TWC that would best correct the time of arrival.

$$TOA_{corrected} = TOA - \frac{Timewalk}{1 + TOT}$$

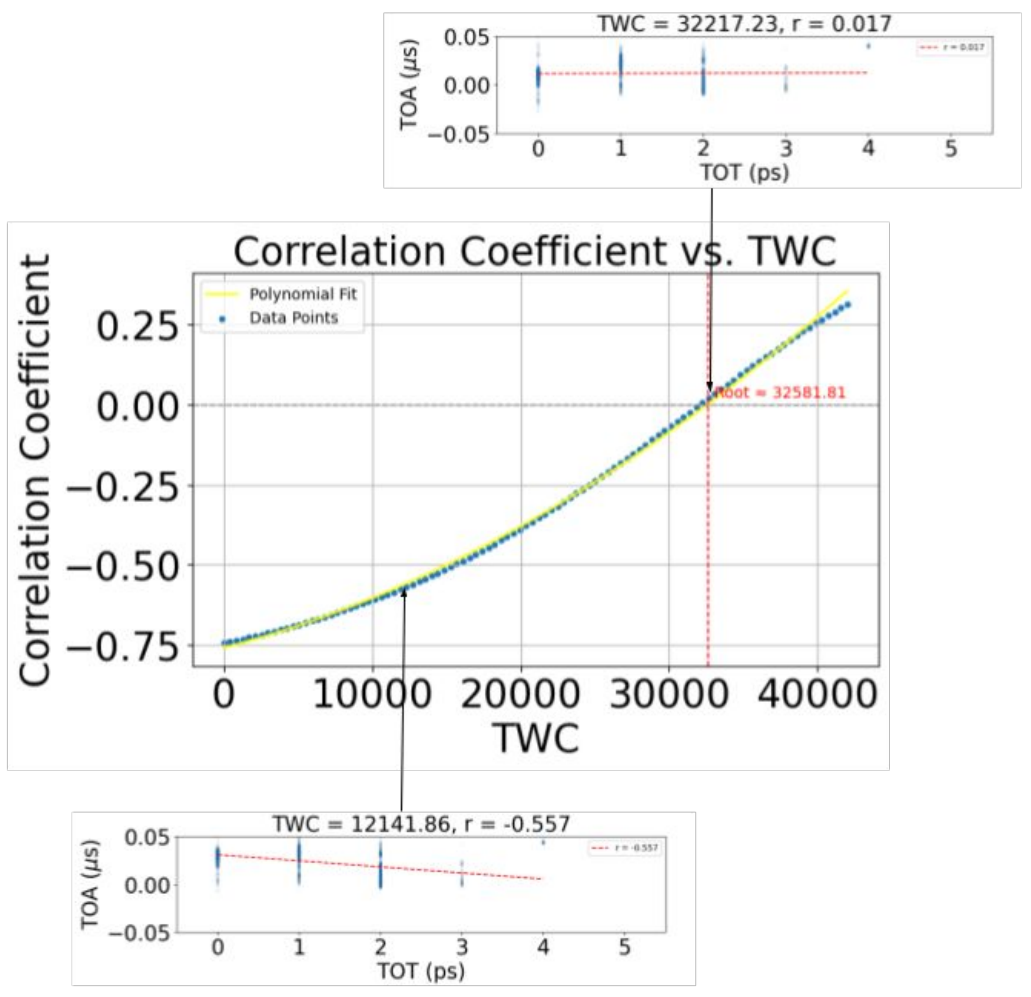
Two methods to find Timewalk:

Minimize standard deviation of TOA Histogram peaks





Minimize correlation between TOT and TOA

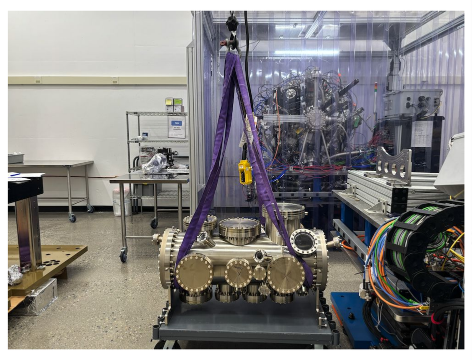


- We find that the ideal time-walk value is 32582!

Down at the Hutch

www.getyourhandsdirty/TMOedition

- I've spent a lot of time down at the hutch doing all sorts of hands-on work, such as
  - Putting together a chamber with viewports, spectrometers, and vacuum pumps
  - Putting together an 80-20 frame
  - Using control systems to remove a sample in the hutch
  - And more to come!



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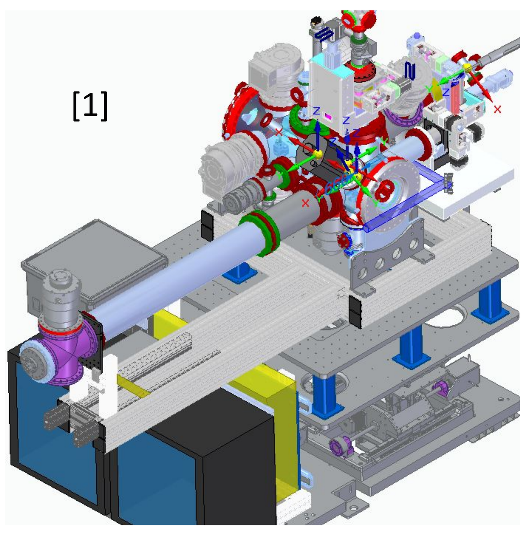
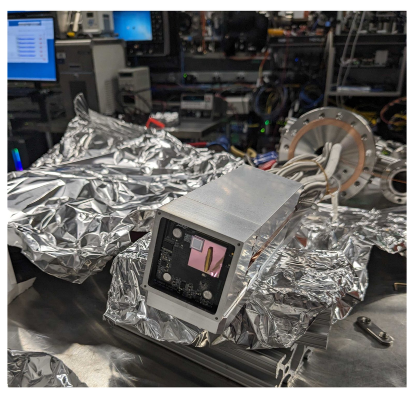
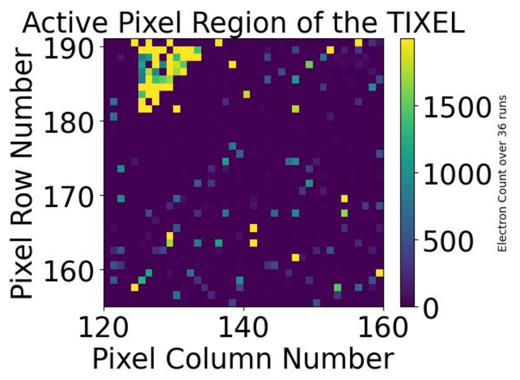


TIXEL Electron Camera

www.notyouraveragedslr.net

- While a traditional camera captures light intensity to form an image, the TIXEL measures the time-of-flight of individual electrons. This then allows us to reconstruct when and how electrons were emitted in response to an x-ray pulse.
- A series of experiments were done on a prototype of the TIXEL in the TMO hutch. Benchmarking its performance ensures future versions will support intensive science.

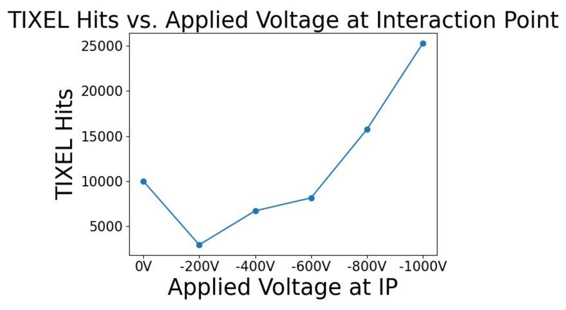




Simulations and More

www.SLACker.com

- The TIXEL prototype was more sensitive to electrons with higher energies, so a voltage was applied around the interaction point to speed them up.



- I used a SIMION environment which replicates the chamber to find voltages at the interaction point

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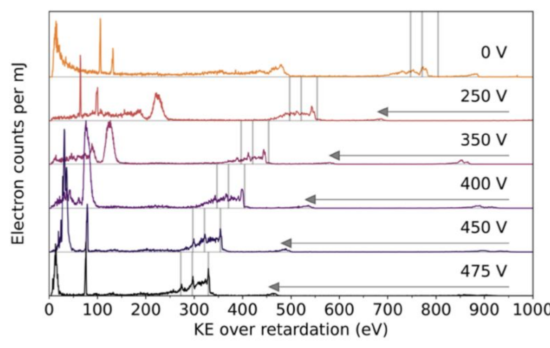

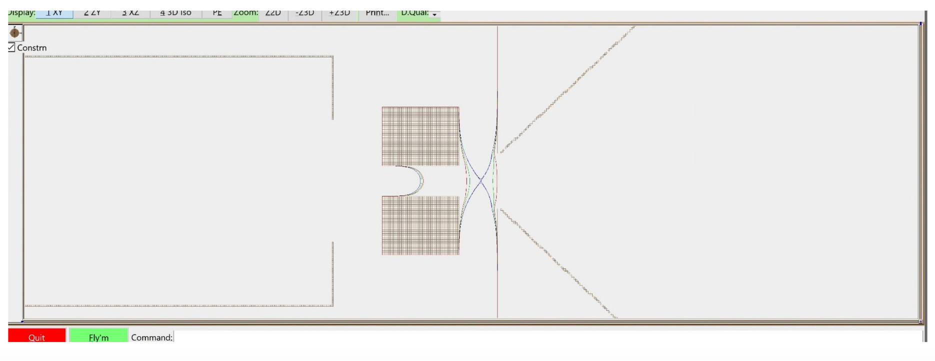

Acknowledgements

I would like to express my gratitude to everyone in the ATO and TMO groups, especially my mentors Taran and James, in granting me guidance and academic freedom to pursue ventures I found interesting. I would also like to thank Arturo, Hillary, and everyone else who made this summer possible!

References

[1] K. Borne, J. T. O'Neal, J. Wang, E. Isele, R. Obaid, N. Berrah *et al.* (2024). Design and performance of a magnetic bottle electron spectrometer for high-energy photoelectron spectroscopy. *Rev. Sci. Instrum.* 95, 125110.

Shut Down Windows

Hope you enjoyed this Windows 95 theme! Did you know that in 1995 a paper detailing the potential scientific contribution of building a free-electron laser at SLAC! How far we've come! Paper: Arthur, J., Bostedt, C., Brachmann, A., et al. (1995). *The LCLS: A fourth-generation light source using the SLAC linac*. **Review of Scientific Instruments**, 66(2), 1987. https://doi.org/10.1063/1.1146074

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Portions of this work was supported by the U.S. Department of Energy (DOE), Office of Science, Office of Basic Energy Sciences (BES), Chemical Sciences, Geosciences, and Biosciences Division (CSGB). Use of the Linac Coherent Light Source (LCLS), SLAC National Accelerator Laboratory, is supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences under Contract No. DE-AC02-76SF00515.