The Liquid Jet Characterization Pipeline at SLAC: Advancing X-Ray Laser Experiments

Dimitra Manatou [1,2] – dmanatou@slac.stanford.edu, B. Sublett [1], Y. Willard [1], W. P. Chang [1], C. Hampton [1], K.Nicolay [1], K.Karpos [2], R.Kirian [2]

1. SLAC National Accelerator Laboratory, USA 2. Department of Physics, Arizona State University, USA

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INTRODUCTION

The liquid jet characterization pipeline, originally developed at Arizona State University (ASU), was replicated at SLAC National Accelerator Laboratory during this internship. This adaptation helps in evolving the experimental tools available for sample delivery injector characterization in crystallography and solution scattering experiments. The transition not only entails the physical duplication of the setup but also incorporates the use of proven Python-based software to ensure methodological consistency and expand experimental possibilities.

At SLAC, enhancements like the integration of LEDs for improved visualization and measurement extend the utility of this pipeline. It can serve as an asset for LCLS staff, enabling them to efficiently test injectors and conduct mini-experiments. The automated data collection and image processing capabilities of this system accelerate the production of diagrams that correlate flow conditions with jet properties, optimizing jet configurations to meet precise experimental demands. This evolution not only boosts experimental efficiency but also reduces the risk of expensive failures during pivotal research phases.

SCHEMATICS

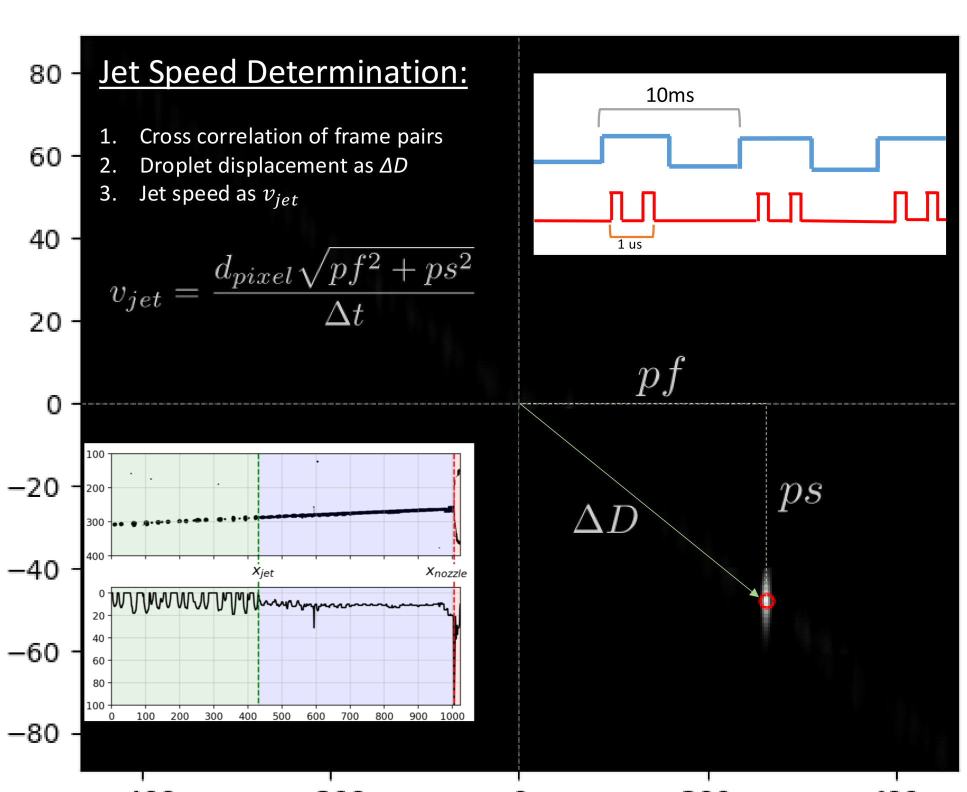

Figure 1 : (A) Dual pulse triggering scheme. LED flashes are 1us apart.

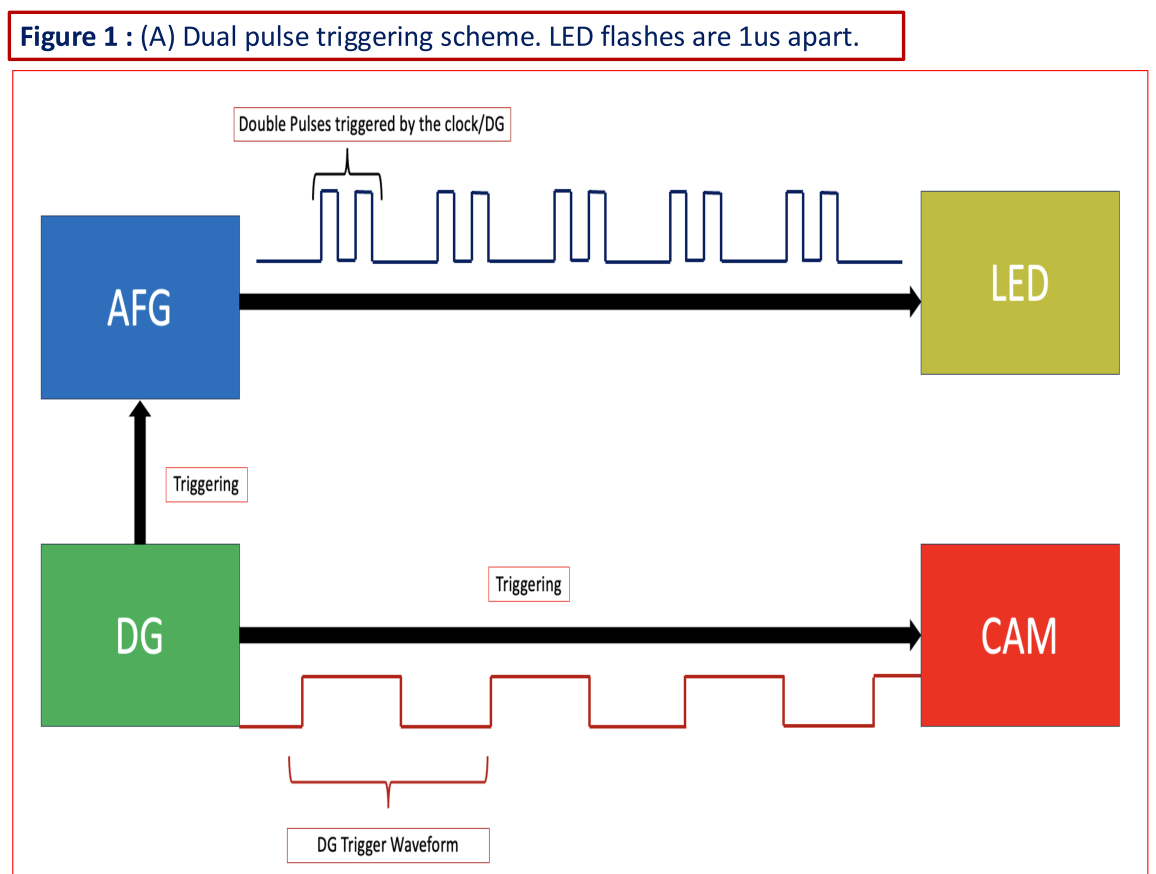

Figure 2 : Schematic of the triggering and set up of electronics and pulses.

SOFTWARE

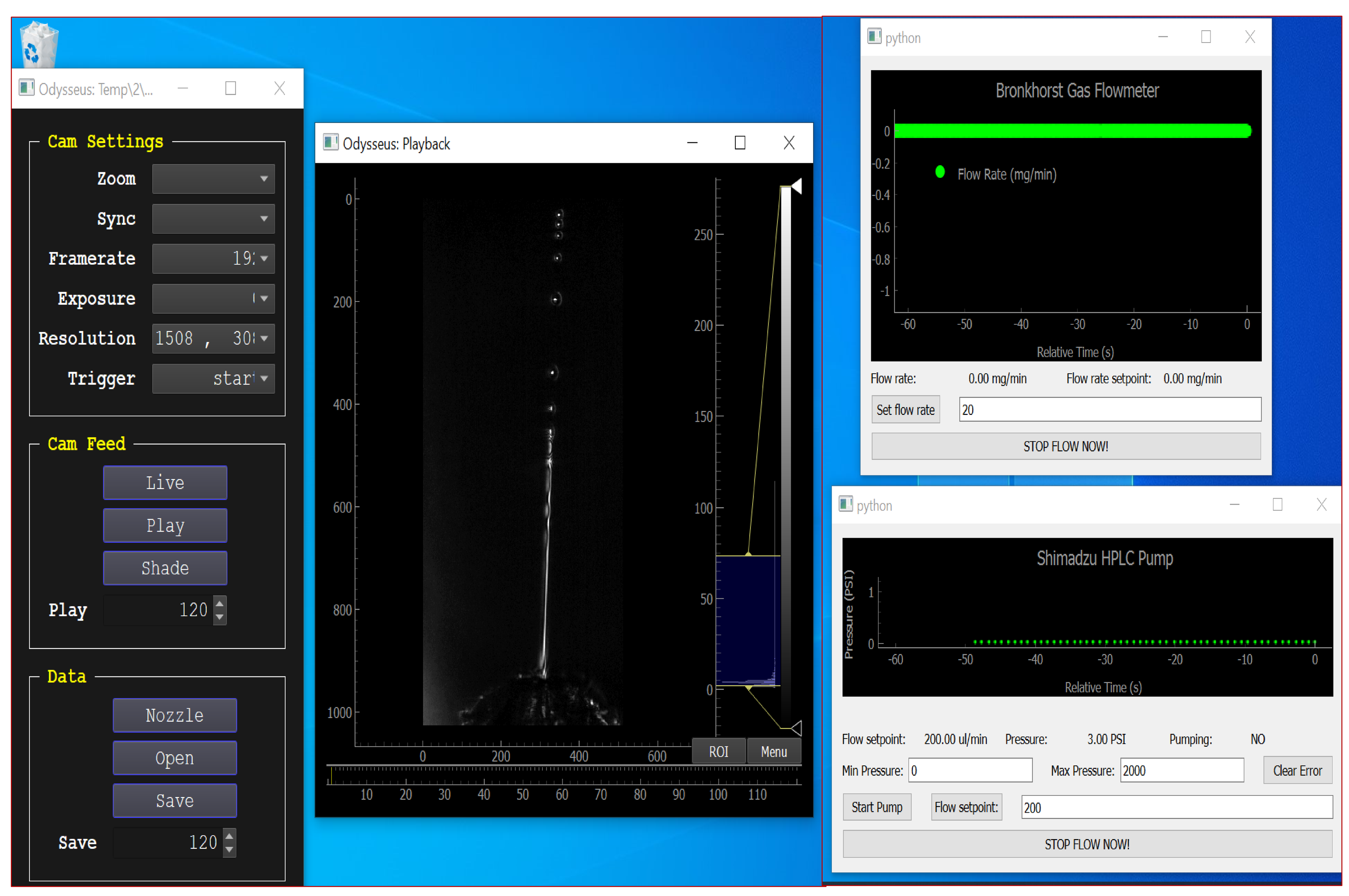

Figure 3: The Odysseus interface for controlling GDVNs and collecting stacks of jet images. Bronkhorst gas control and HPLC liquid flow control Python examples are seen below.

EXPERIMENTAL SETUP

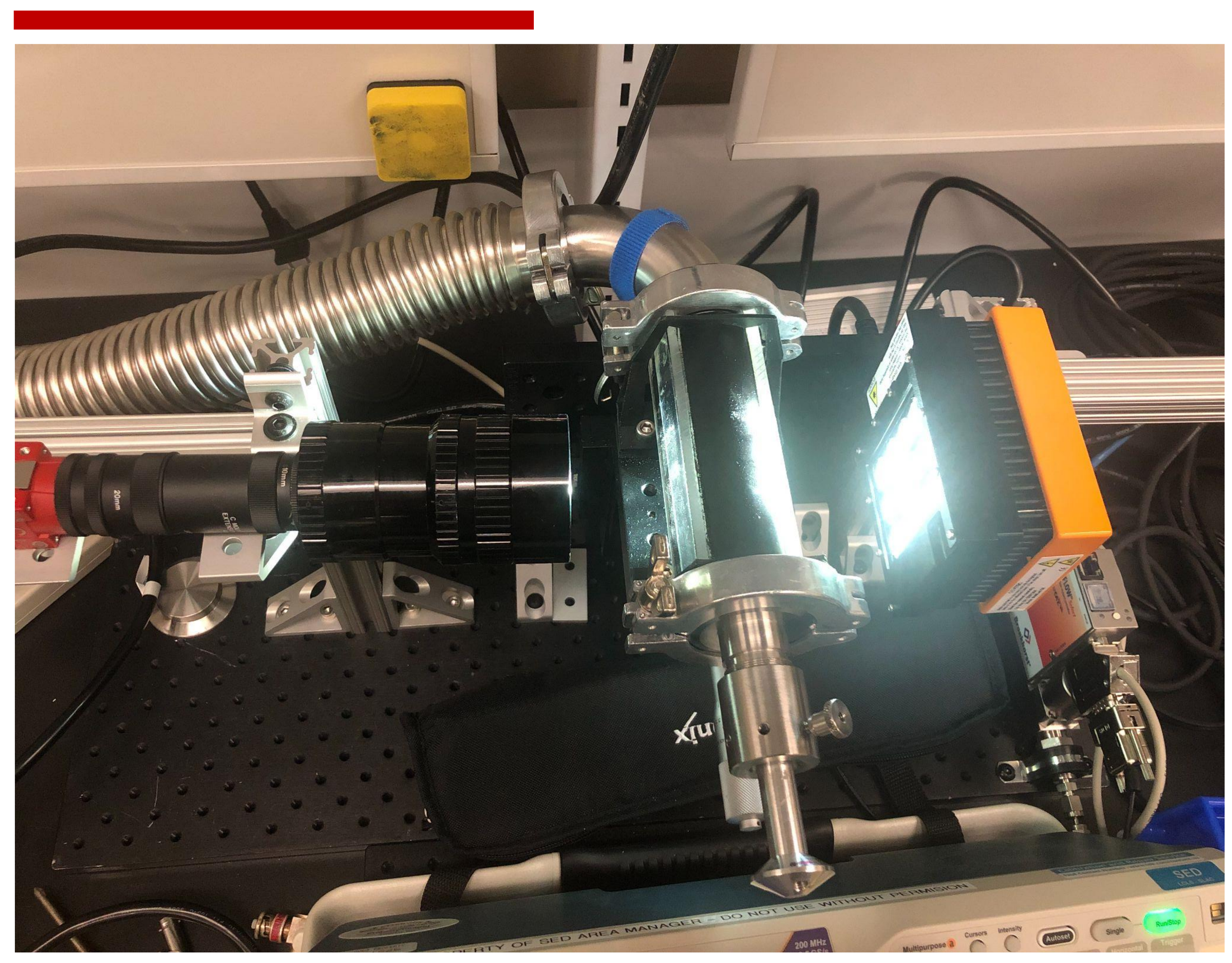

Figure 4: LED lighting up the vacuum chamber with the sample delivery injector in order to image it through the software shown above.

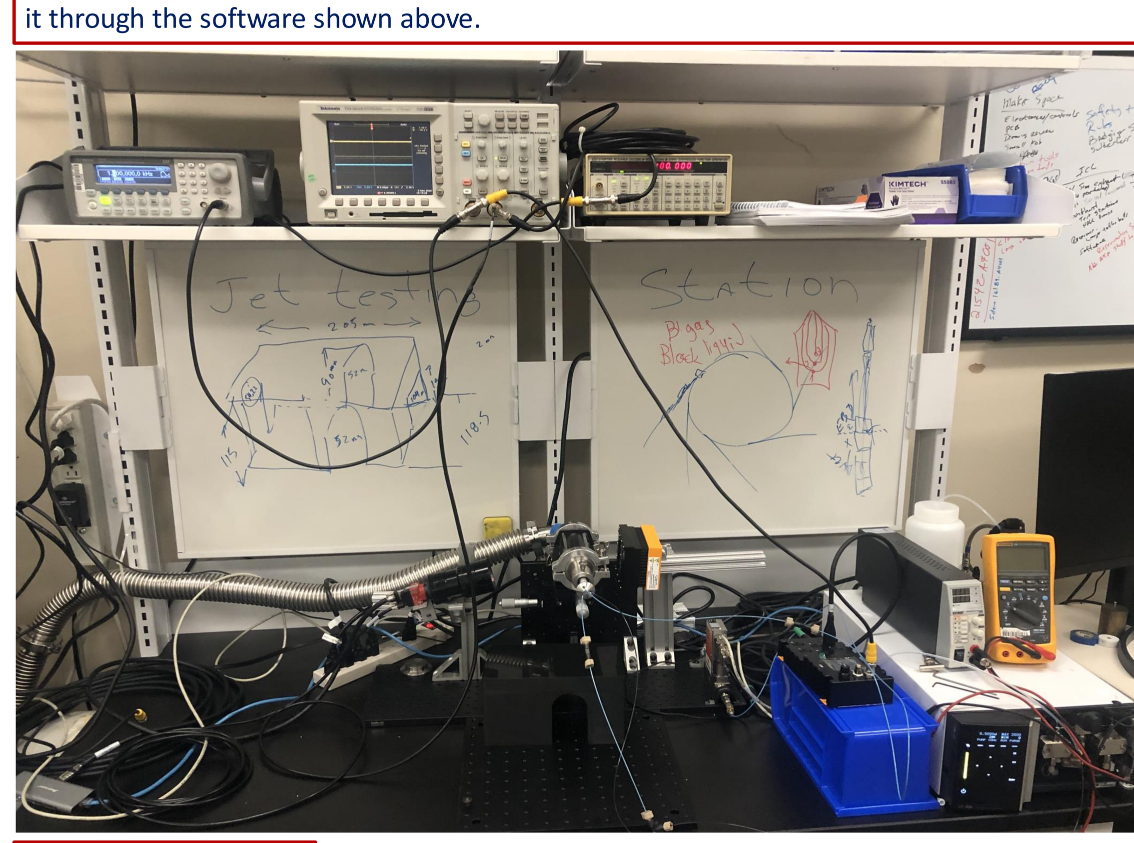

Figure 5: ICL set up

EXPECTED RESULTS

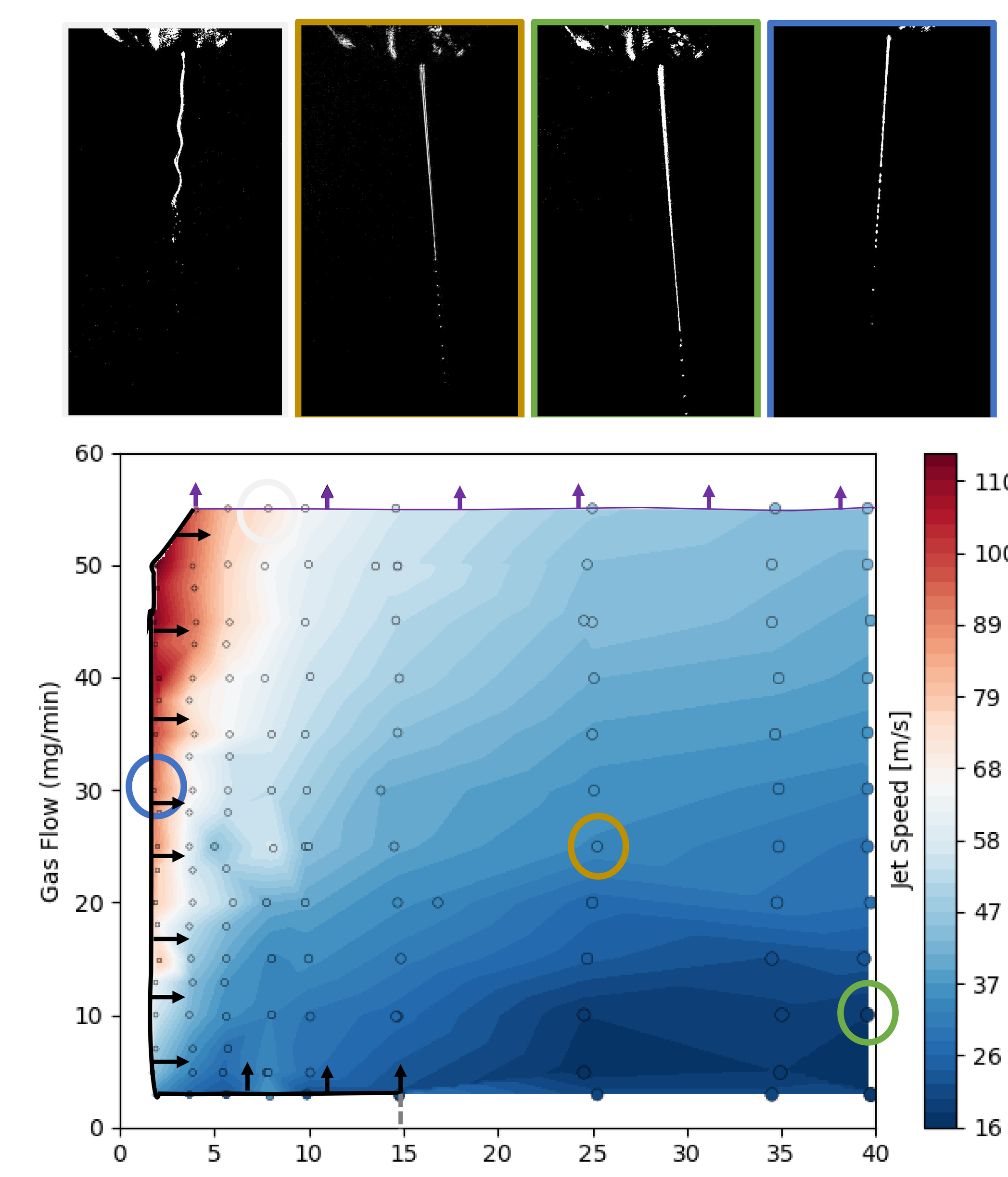

Figure 6 (above): Phase diagram indicating jet speed for each "control knob" setting (liquid volumetric flow rate and gas mass flow rate). Marker size indicates jet diameter.

FUTURE STEPS

1. Data Collection at the ICL Testing Station: The software has been adapted to efficiently collect and analyze data at the Injector Characterization Lab (ICL).
2. Implementation in ASC Wet Labs: To support cryo-electron microscopy (cryoEM) experiments, the software was integrated into the ASC wet labs.
3. Potential Integration into Experimental Hutches: Plans are underway to integrate the software into one of the experimental hutches. This integration is envisioned as a method for continuous monitoring and control of the sample delivery systems, ensuring optimal operation during critical experimental runs.

Figure 7: ASC set up

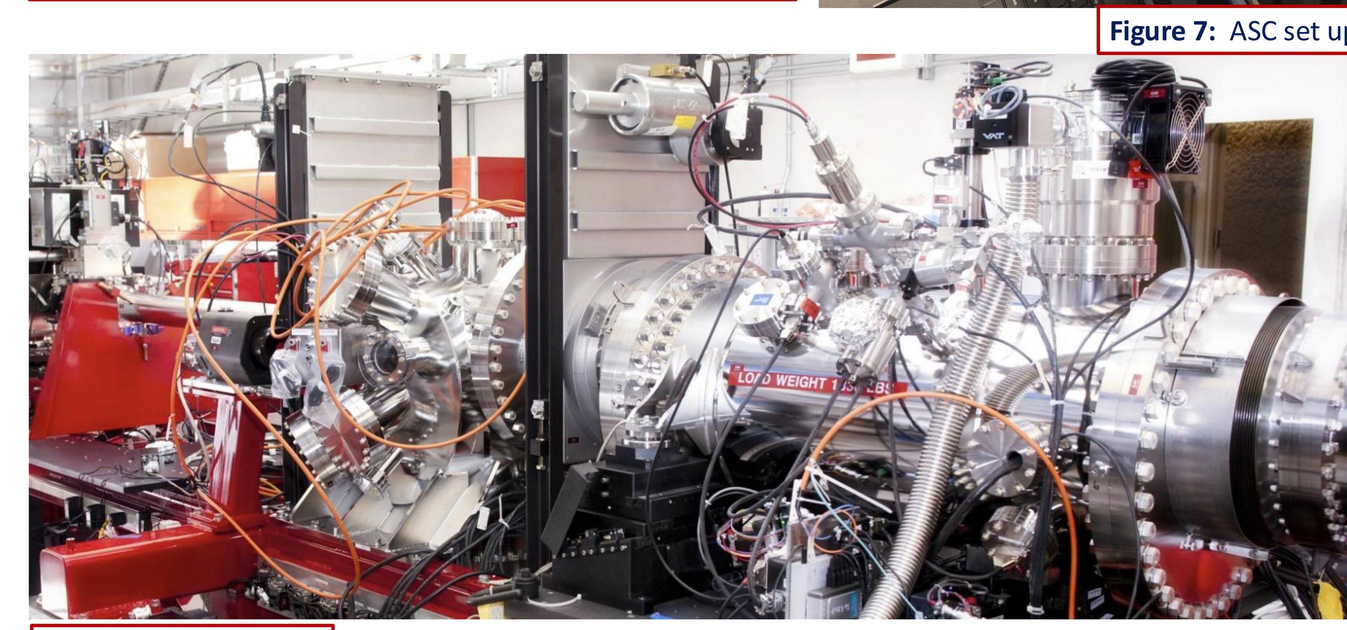

Figure 7: CXI hutch.

ACKNOWLEDGEMENTS

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