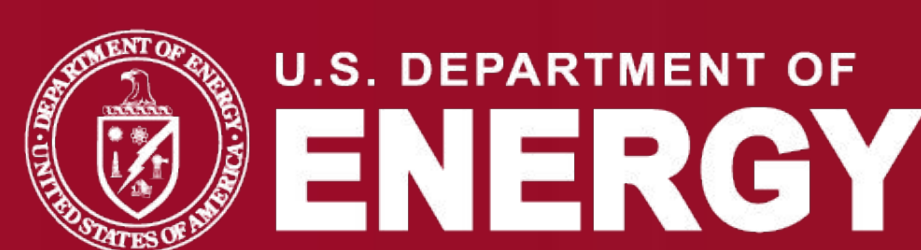


Design and Characterization of Sample Delivery to the DREAM Endstation

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Background

TMO: The Time-resolved Atomic, Molecular, and Optical (TMO) instrument at LCLS uses ultrafast X-ray free-electron laser (XFEL) pulses to investigate the structure and dynamics of atoms and molecules on their natural timescales.

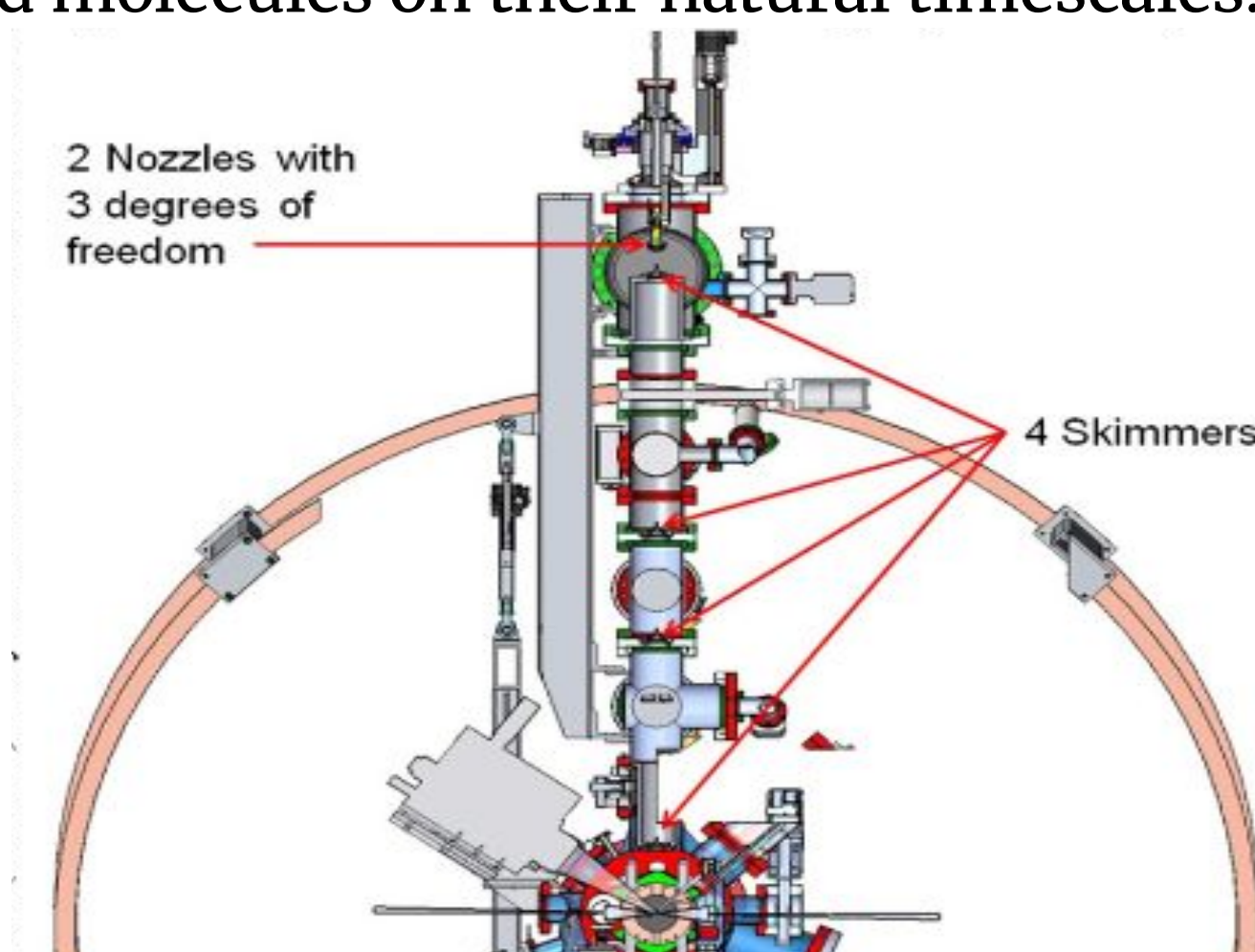
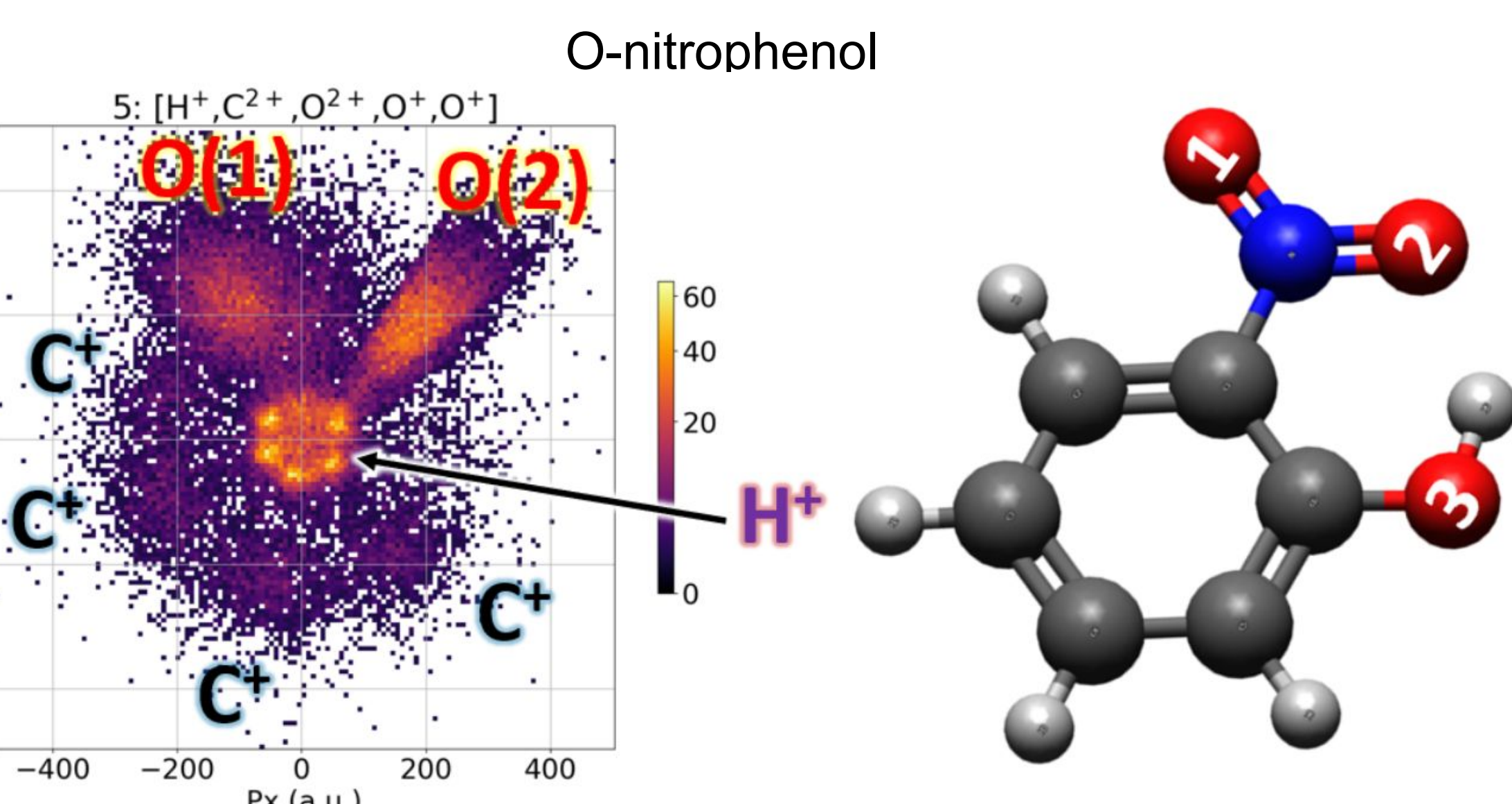


Figure 4: Cross section view of the multi-stage skimmed gas jet assembly.

DREAM: The Dynamic Reaction Microscope (DREAM) endstation measures the three-dimensional momenta of ions and electrons created during XFEL interactions with gas phase molecular targets, enabling detailed studies of molecular structure and fragmentation. Reliable, well-characterized gas jet targets are critical for delivering high-density molecular samples to the interaction region.



Motivation

- DREAM experiments require a dense molecular target at the X-ray interaction region to efficiently collect ion and electron coincidence data.
- Develop a dedicated test platform to characterize the supersonic expansion of vaporized samples.
- Evaluate nozzle geometry and operating conditions to determine their effects on sample delivery.
- Use a Quartz Crystal Microbalance (QCM) to quantify sample deposition within the gas jet.
- Optimize sample delivery conditions before implementation at the DREAM endstation.

Objectives

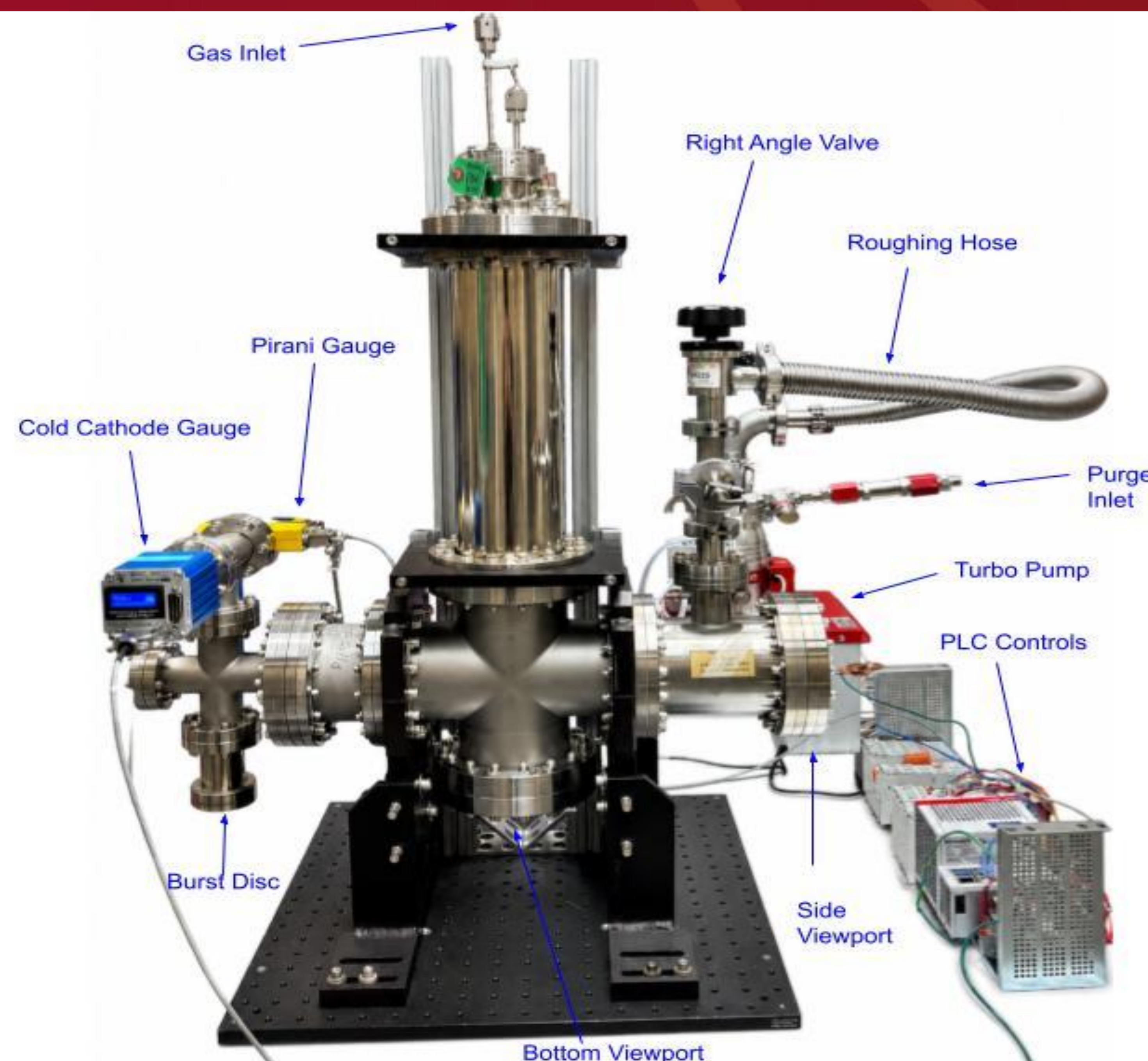
- Design a portable vacuum test stand.
- Integrate pressure instrumentation.
- Characterize the gas jet.
- Determine optimal QCM distance.
- Develop repeatable operating procedures.

Acknowledgement

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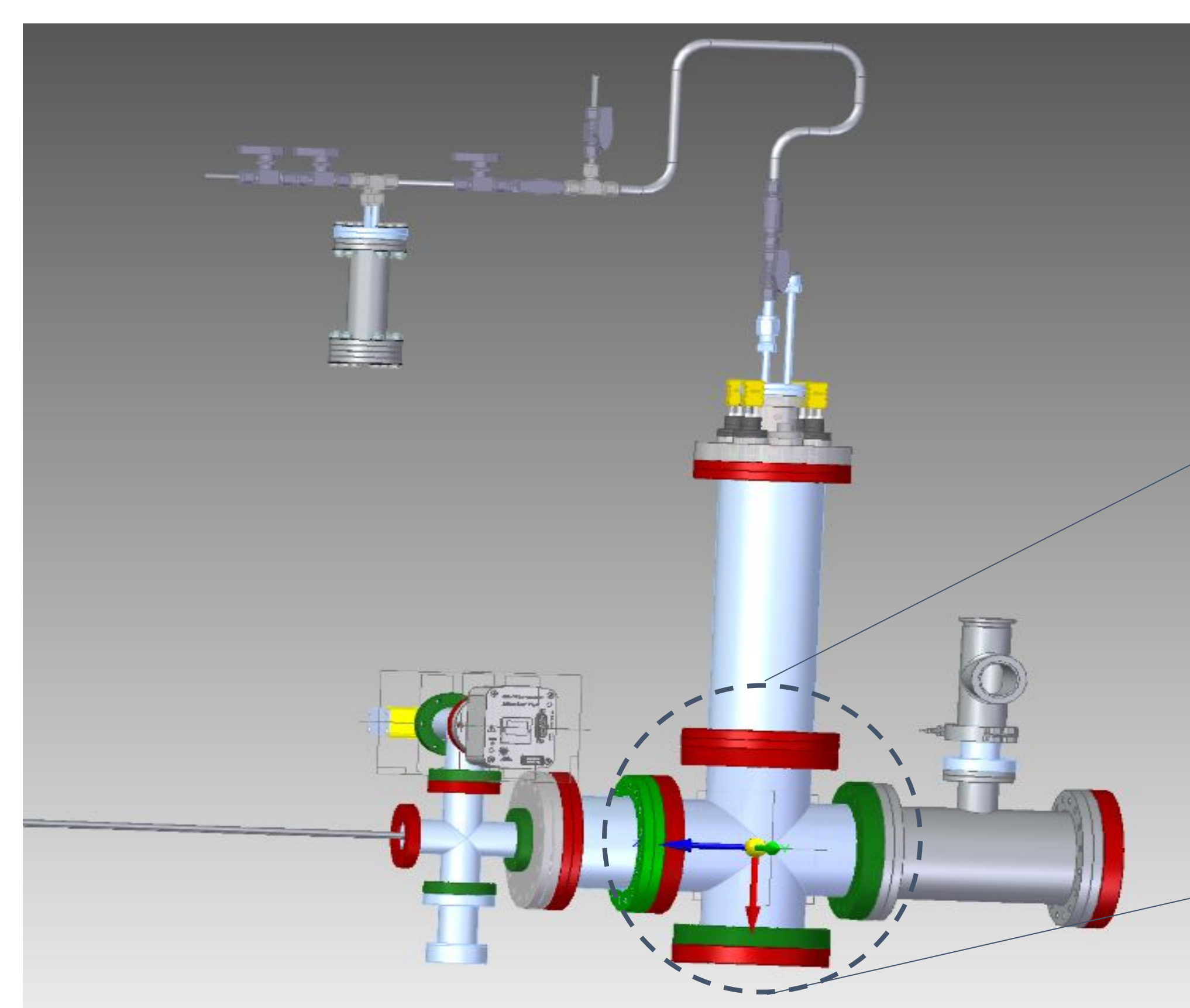
System

Solid Edge Model



Experimentation

The QCM will measure the deposition rate of the sample in vapor phase after it undergoes supersonic expansion through the gas nozzle.



Completed

- Assembled vacuum test system.
- Performed initial pump-down.
- Verified vacuum operation and instrumentation readiness.

Future Work

- Vary nozzle-to-QCM distance, D, to determine an effective collection position.
- Compare different size nozzles.
- Compare different samples.
- Integrate with DREAM.
- Operate the dual gas nozzle with varying backing pressure.
- Measure chamber pressure and sample conditions.
- Use the QCM to measure sample deposition rate.

References

Holmes, M. R.; et al. DREAM—A New Soft X-ray (Dynamic REAction Microscopy) COLTRIMS Endstation at LCLS-II. Proc. MEDSI'18 2018, 382–384.
<https://doi.org/10.18429/JACoW-MEDSI2018-THPH21>.