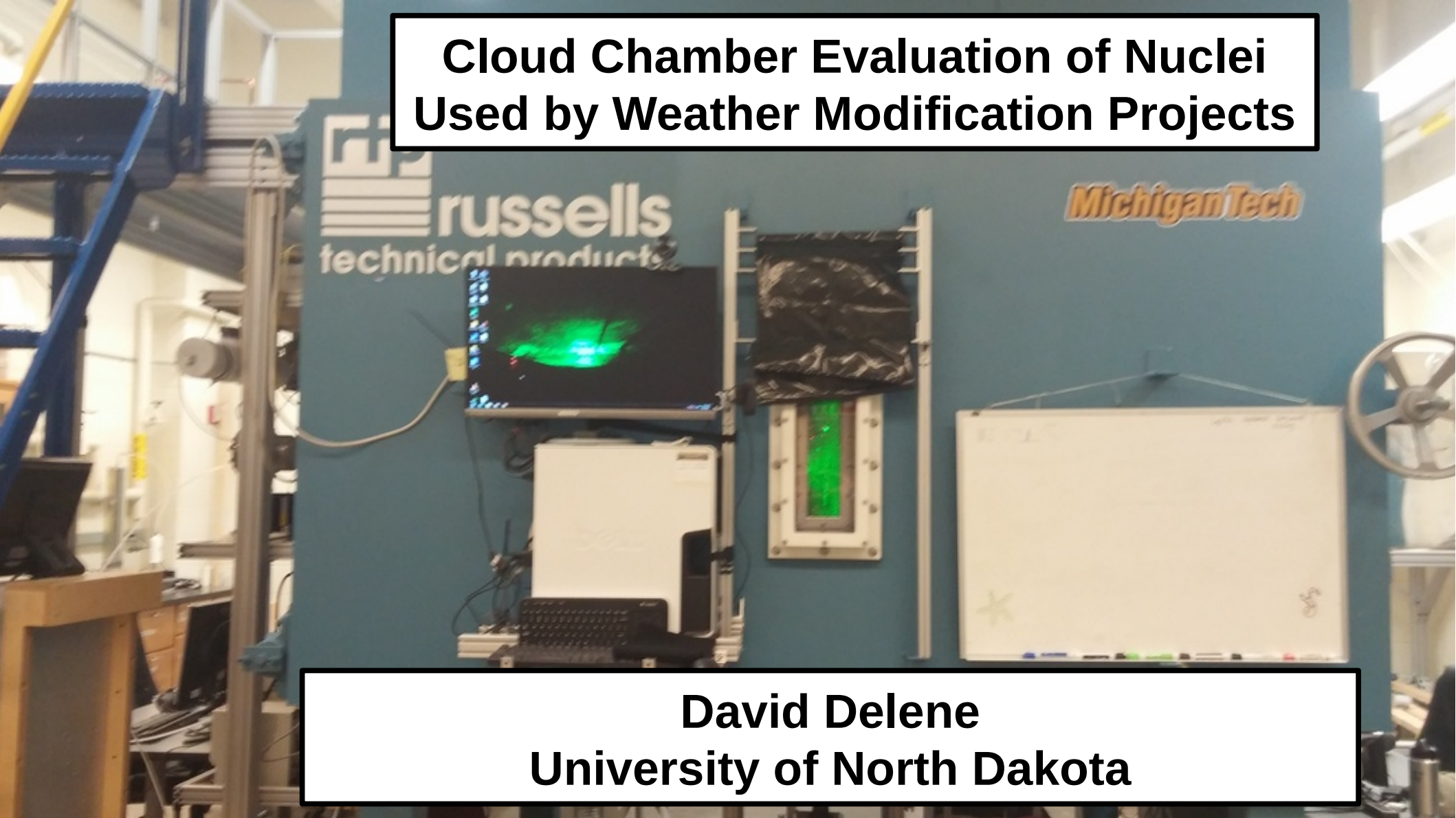
Cloud Chamber Evaluation of Nuclei Used by Weather Modification Projects

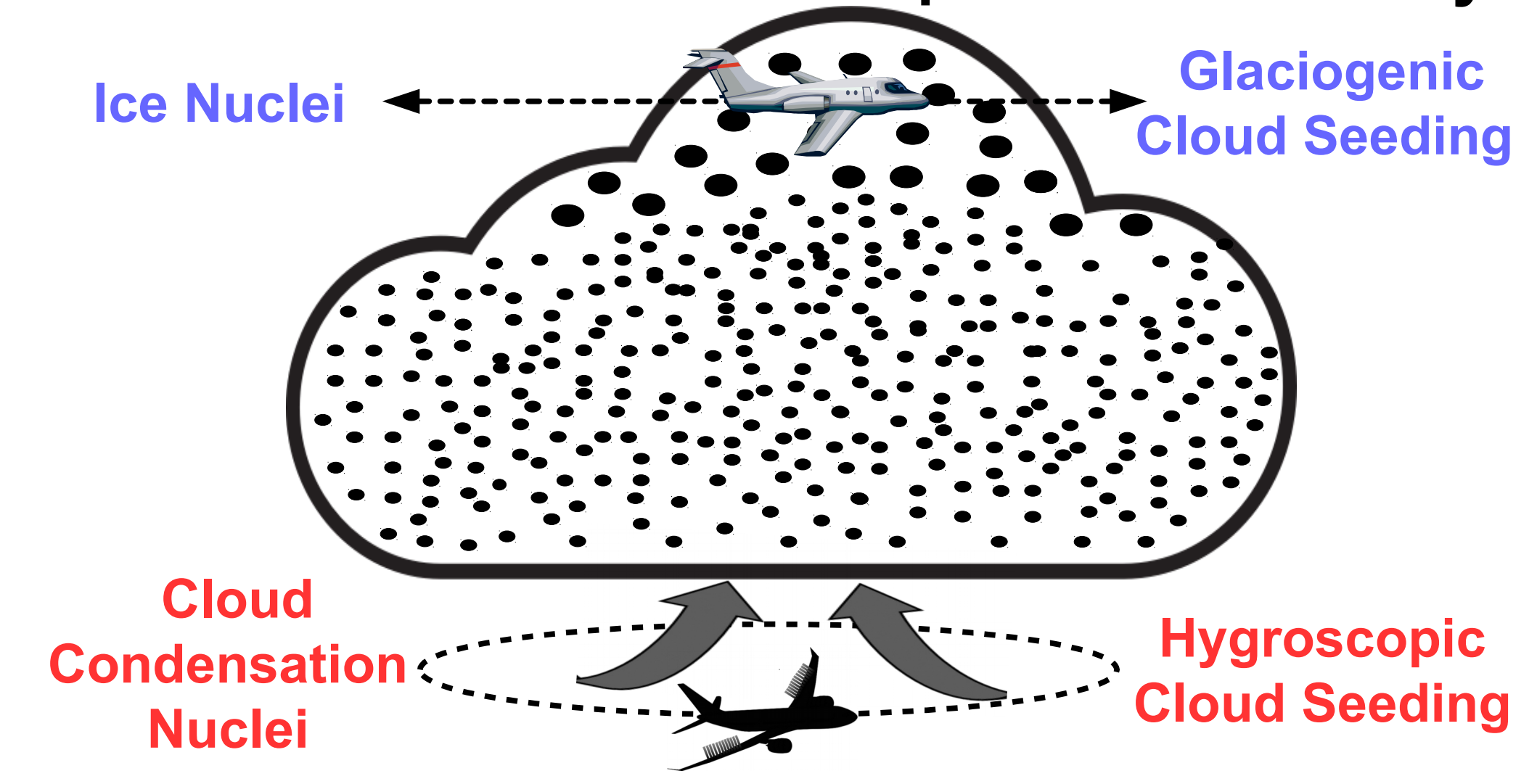


David Delene
University of North Dakota

The Need For More Precipitation

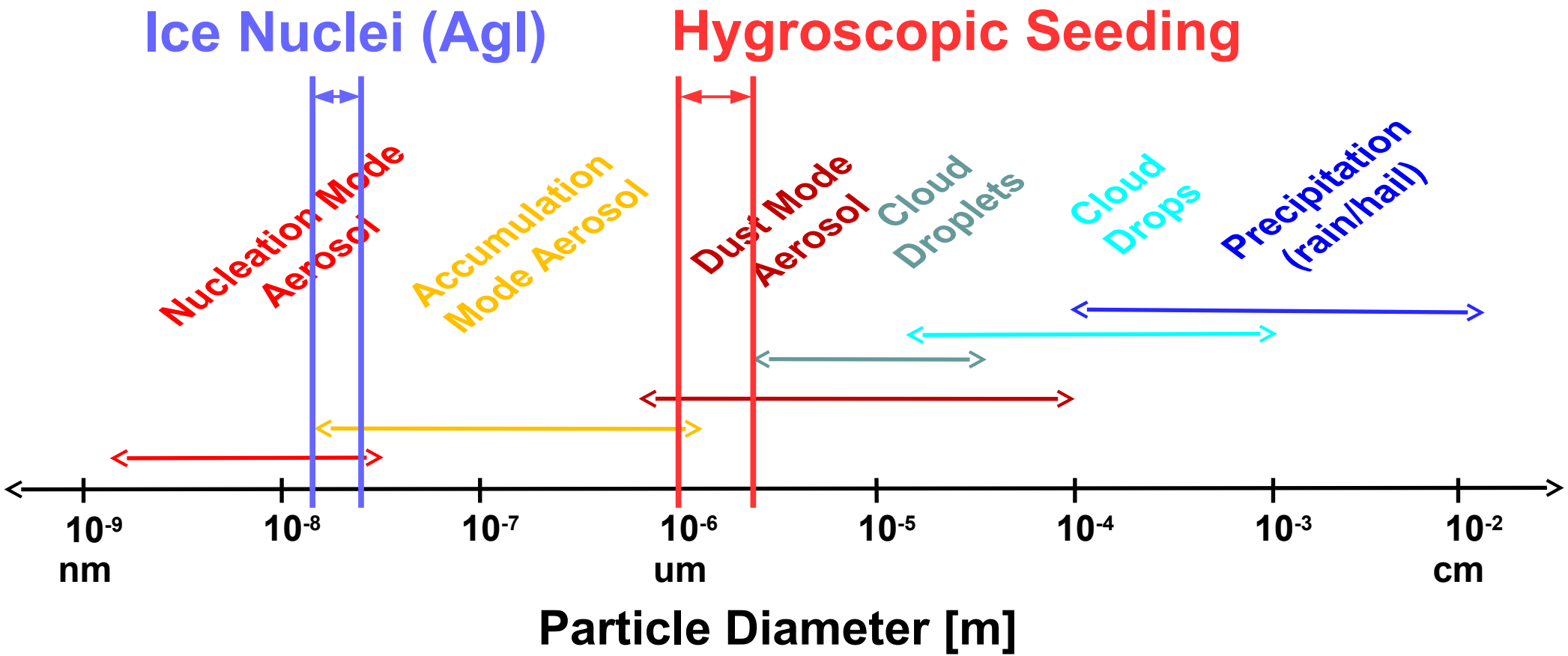
Folsom Lake, located northeast of Sacramento California, lost 80 percent of its water capacity in 2.5 years. The image on the left is from 16 January 2014, which the right image is from 20 July 2011 (Source: Daily Mail).

Nuclei Used to Increase Precipitation Efficiency



Atmospheric Particles

Suspended particles (aerosols) move with the wind; however, large particles (dust/drops/rain) have sufficient inertia to move independently.

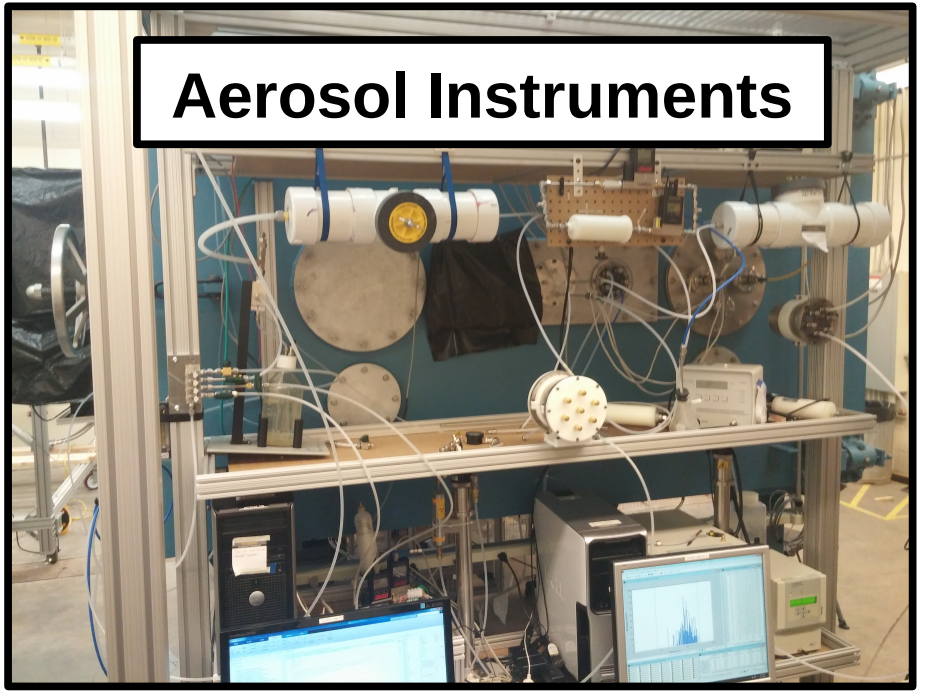


Atmospheric Clouds Seeding and Measurements

Delene, D. J., Kurt Hibert, Jamie Ekness, Dennis Afseth, Ryan Richter, World Class Platform for Weather Modification and Atmospheric Research, Poster given at the 2017 Joint Western Snow Conference / Weather Modification Association Conference, 17 April 2017, Boise, Idaho (http://aerosol.atmos.und.edu/KMA_WMA_Poster_170410.pdf)

Cloud Chamber Study: Objectives

- Develop methods to test clouds seeding flares using existing cloud chambers that are reproducible.
- Test Silver Iodide (AgI) and Hygroscopic particles with the Pi Cloud Chamber at Michigan Technological University (MTU).



MTU Pi Cloud Chamber: Modes of Operations

Expansion Cloud

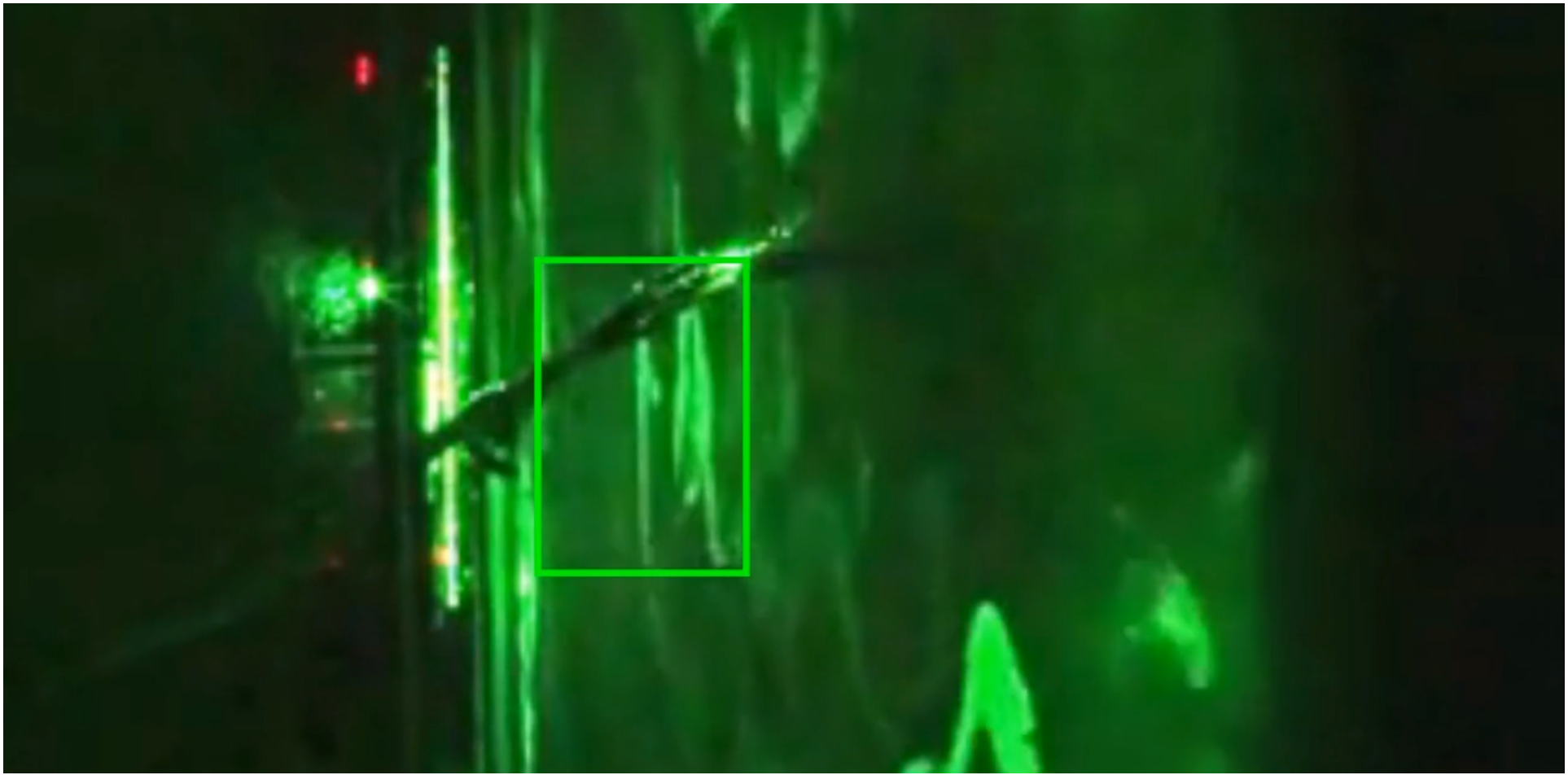
Adiabatically explanation to locally reduce the air temperature, thereby generating supersaturated conditions and inducing water vapor to form cloud droplets on any cloud condensation nuclei (CCN) present in the air.

Steady-state Turbulent Cloud

Forcing a negative temperature gradient between the top and bottom surfaces within the chamber, which results in warm, saturated air originating at the bottom surface to mix with cold, saturated air originating at the top surface.

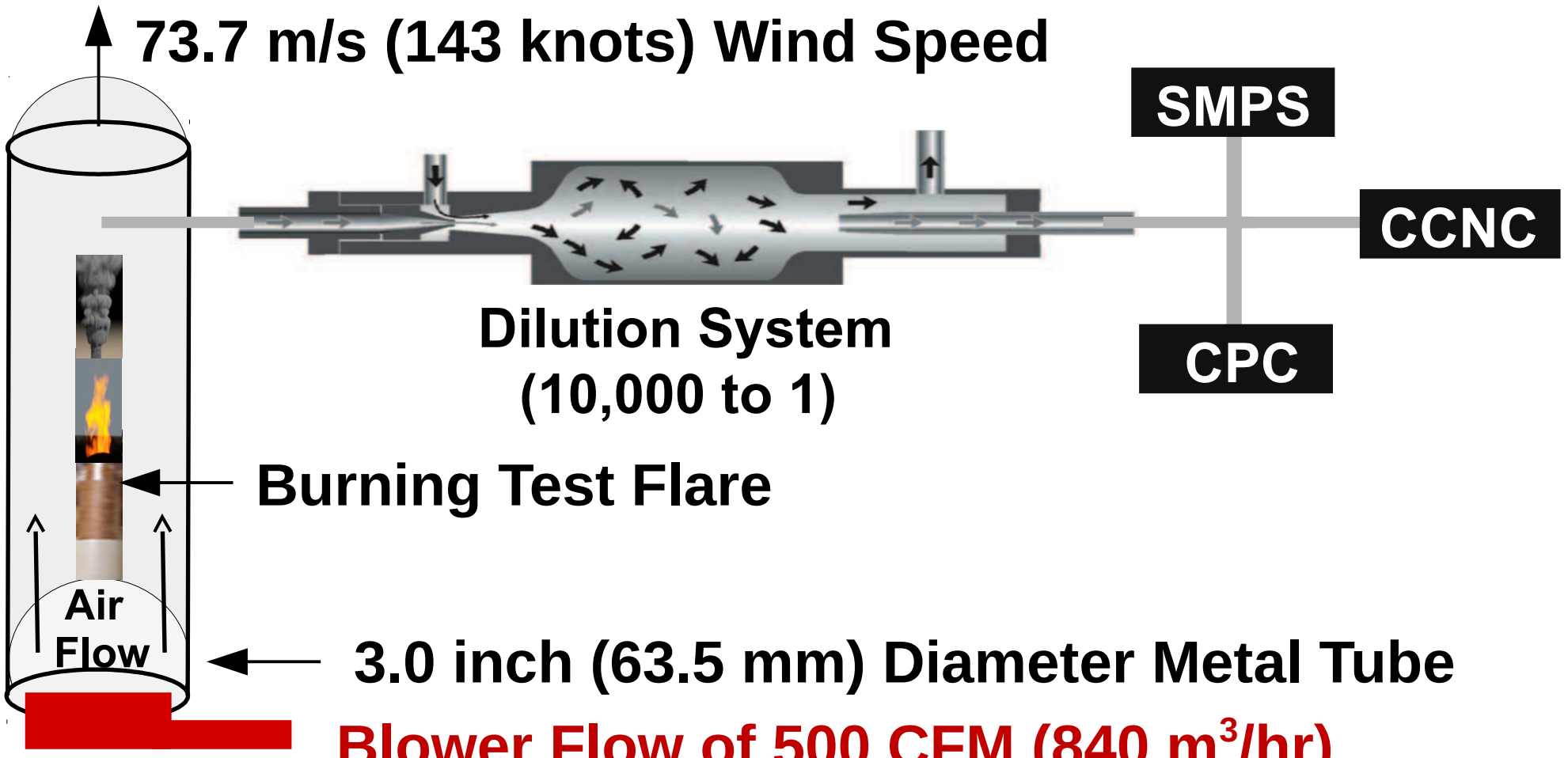
Chang, K., and Coauthors, 2016: A laboratory facility to study gas-aerosol-cloud interactions in a turbulent environment: The Π Chamber. Bull. Amer. Meteor. Soc., doi:10.1175/BAMS-D-15-00203.1. http://journals.ametsoc.org/doi/10.1175/BAMS-D-15-00203.1.

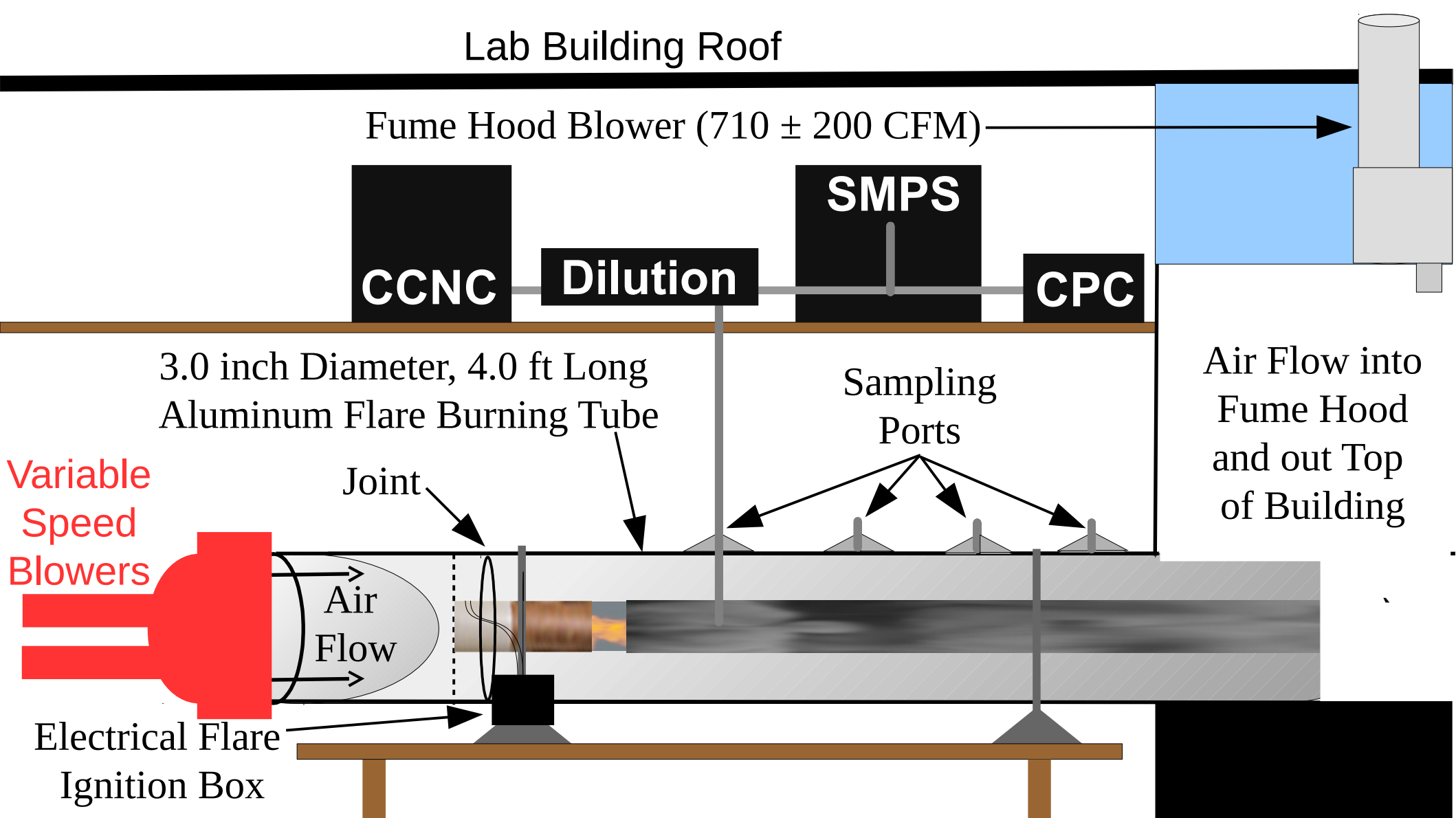
Hot and Cold Plumes Collide



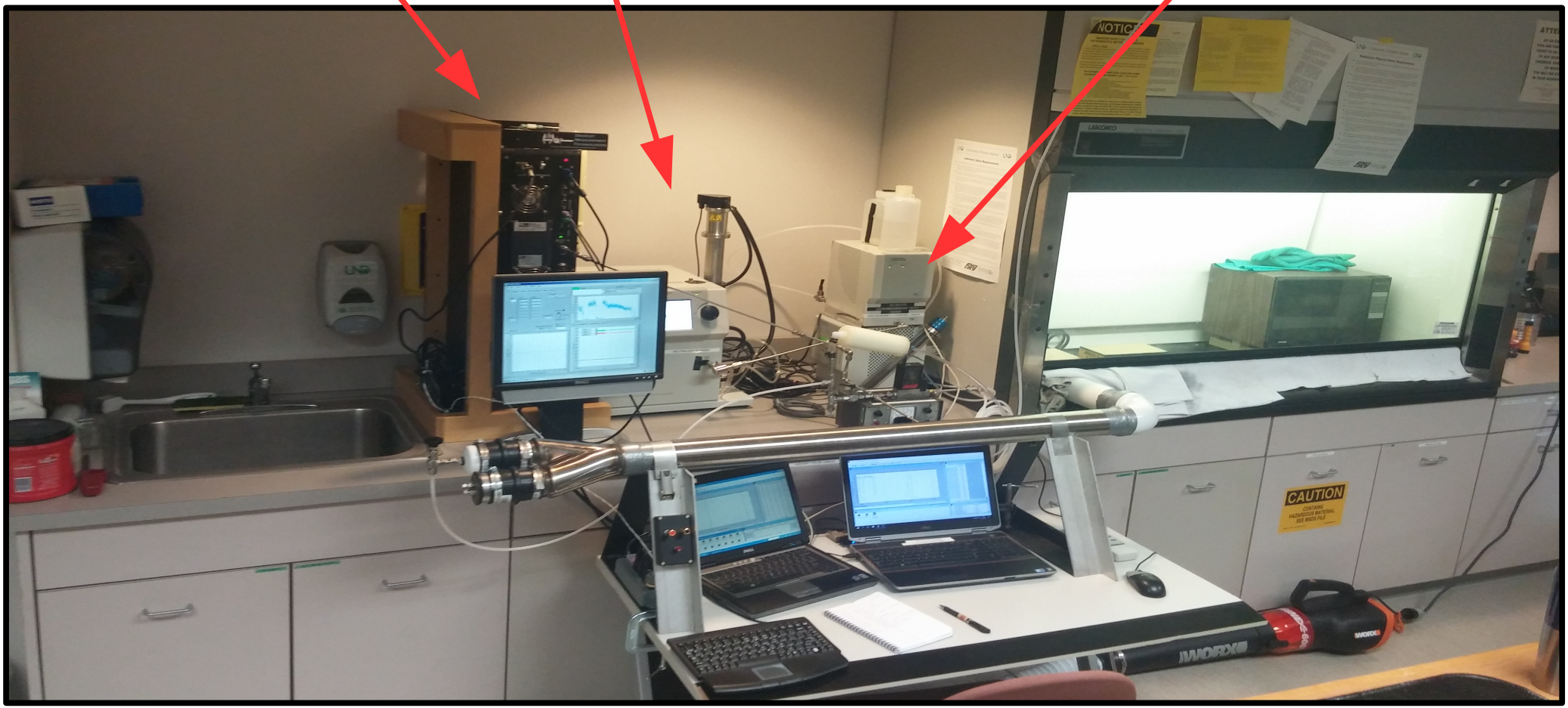
Chang, K., Chandrakar, K., Ciochetto, D., Cantrell, W., & Shaw, R. (2016). Colliding plumes in a turbulent mixing cloud. Retrieved from: http://digitalcommons.mtu.edu/physics-fp/12.

Initial Design of the Flare Burning System



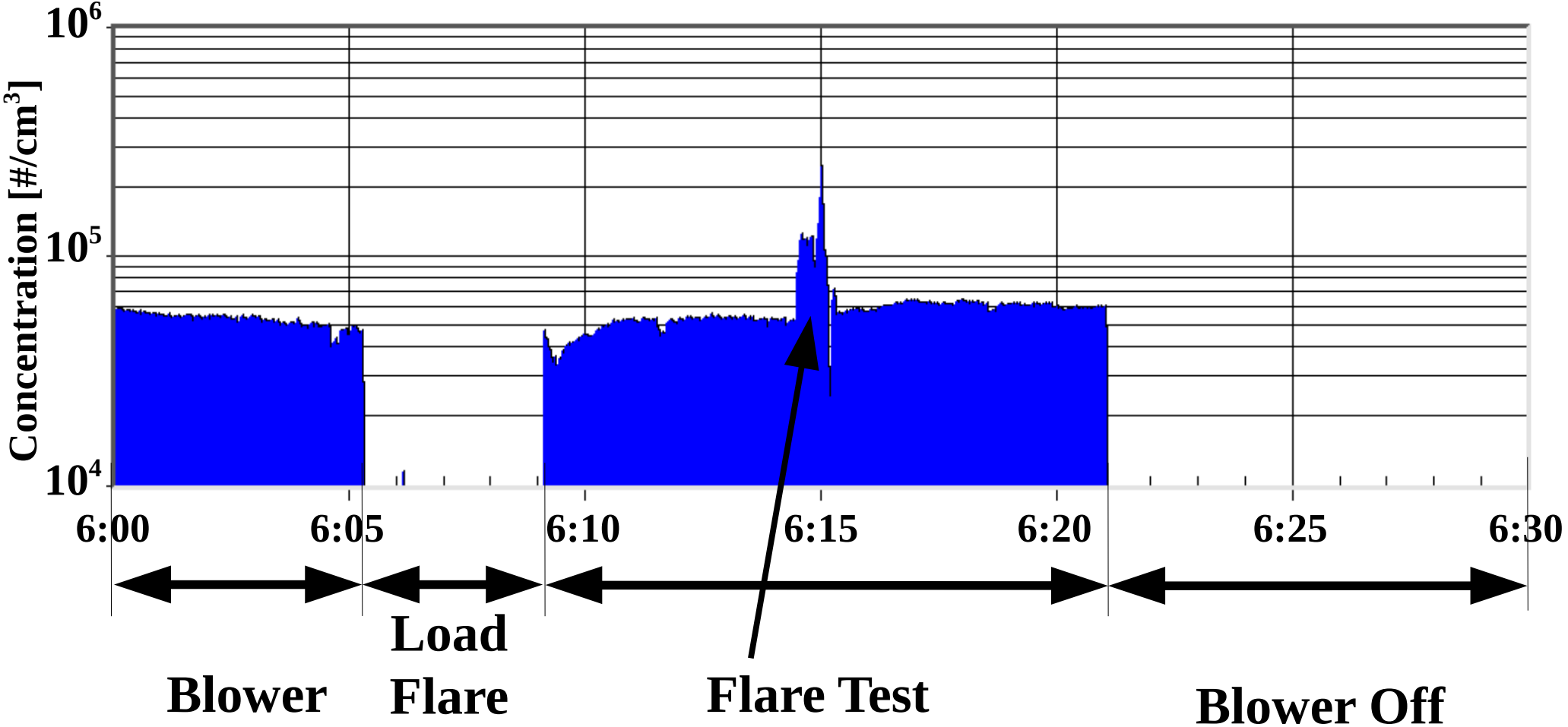

Lab Building Roof
Fume Hood Blower (710 ± 200 CFM)
CCNC
Dilution
SMPS
CPC
3.0 inch Diameter, 4.0 ft Long
Aluminum Flare Burning Tube
Sampling
Ports
Air Flow into
Fume Hood
and out Top
of Building
Variable
Speed
Blowers
Joint
Air
Flow
Electrical Flare
Ignition Box

Testing of Flare Burning System at UND



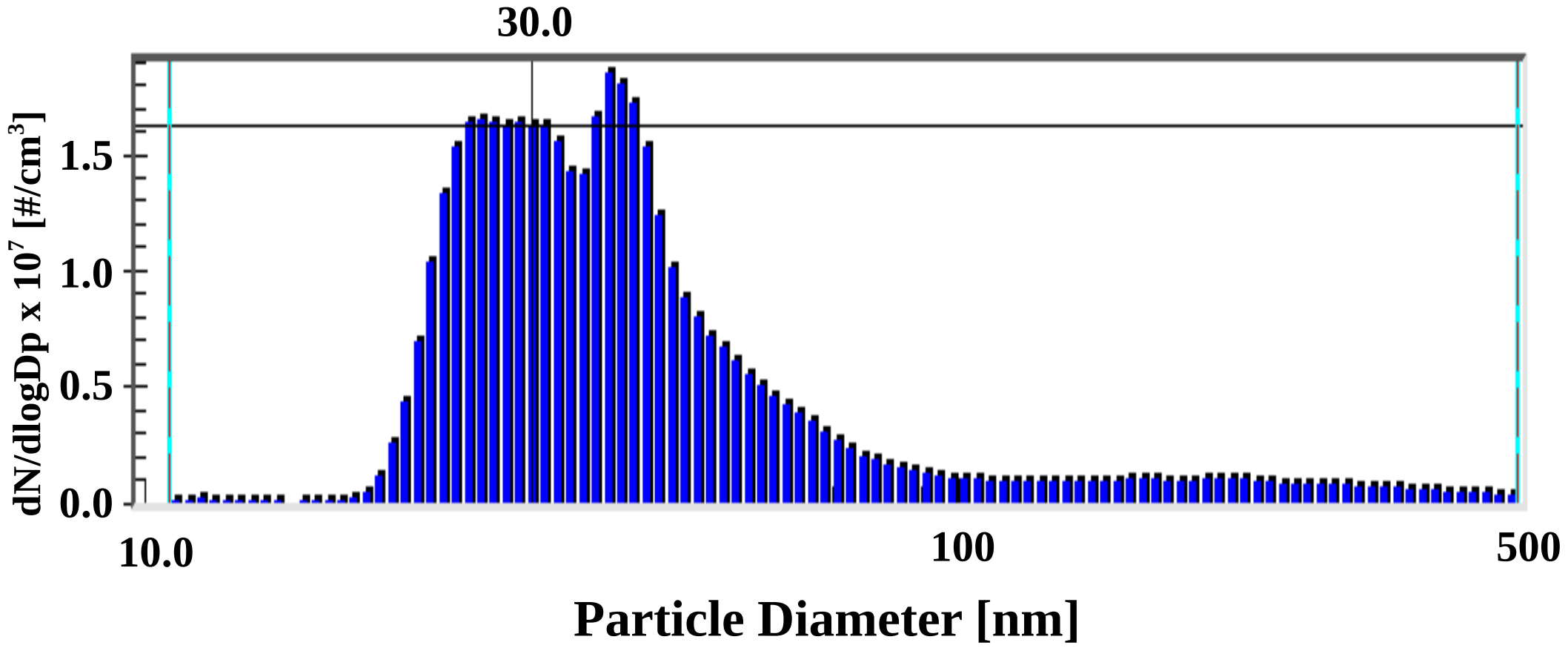
UND Lab Sampling on 10 April 2017

Aerosol (> 10 nm) Time Series (UTC)

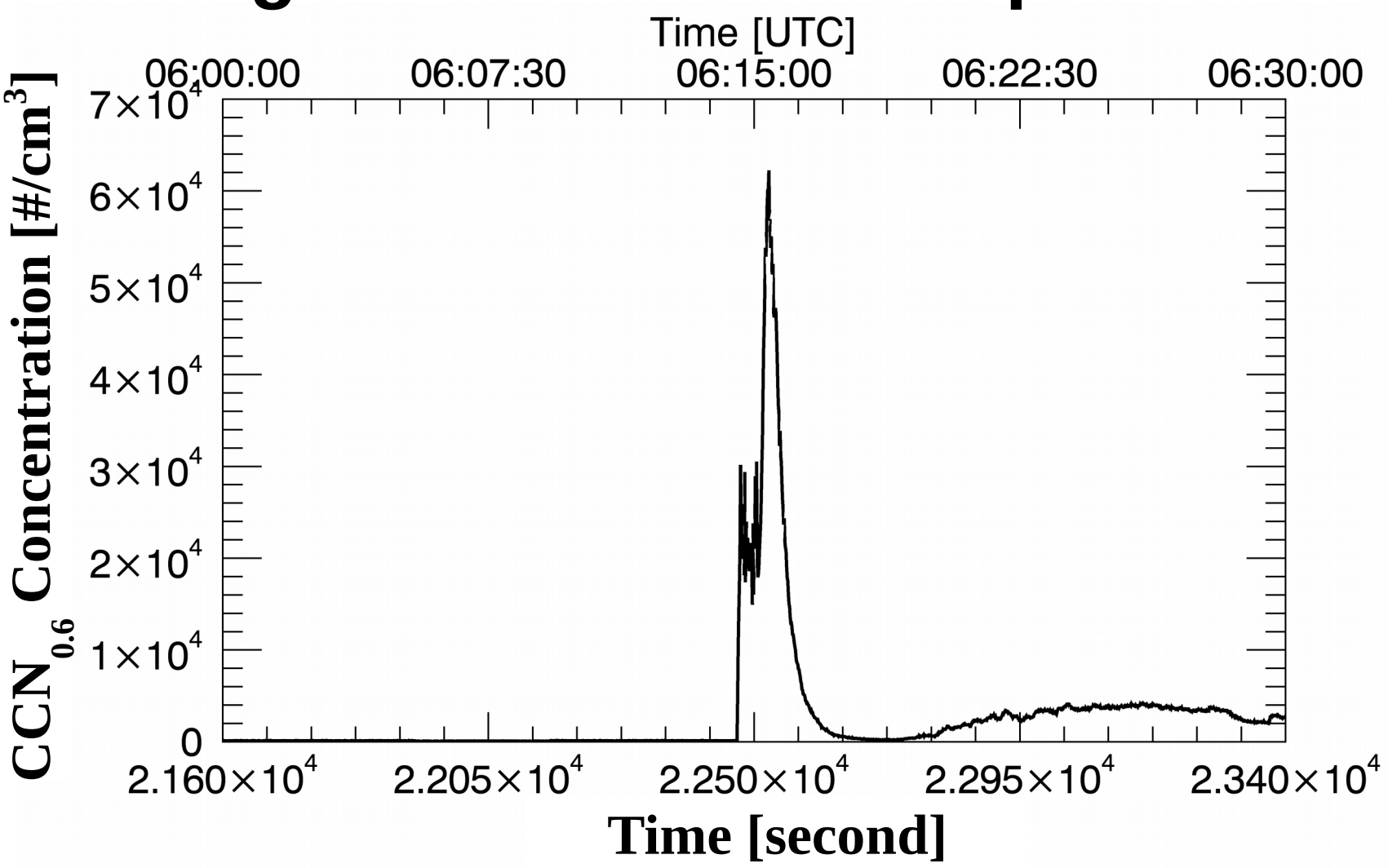


AgI Flare Burning with 100 knot Wind

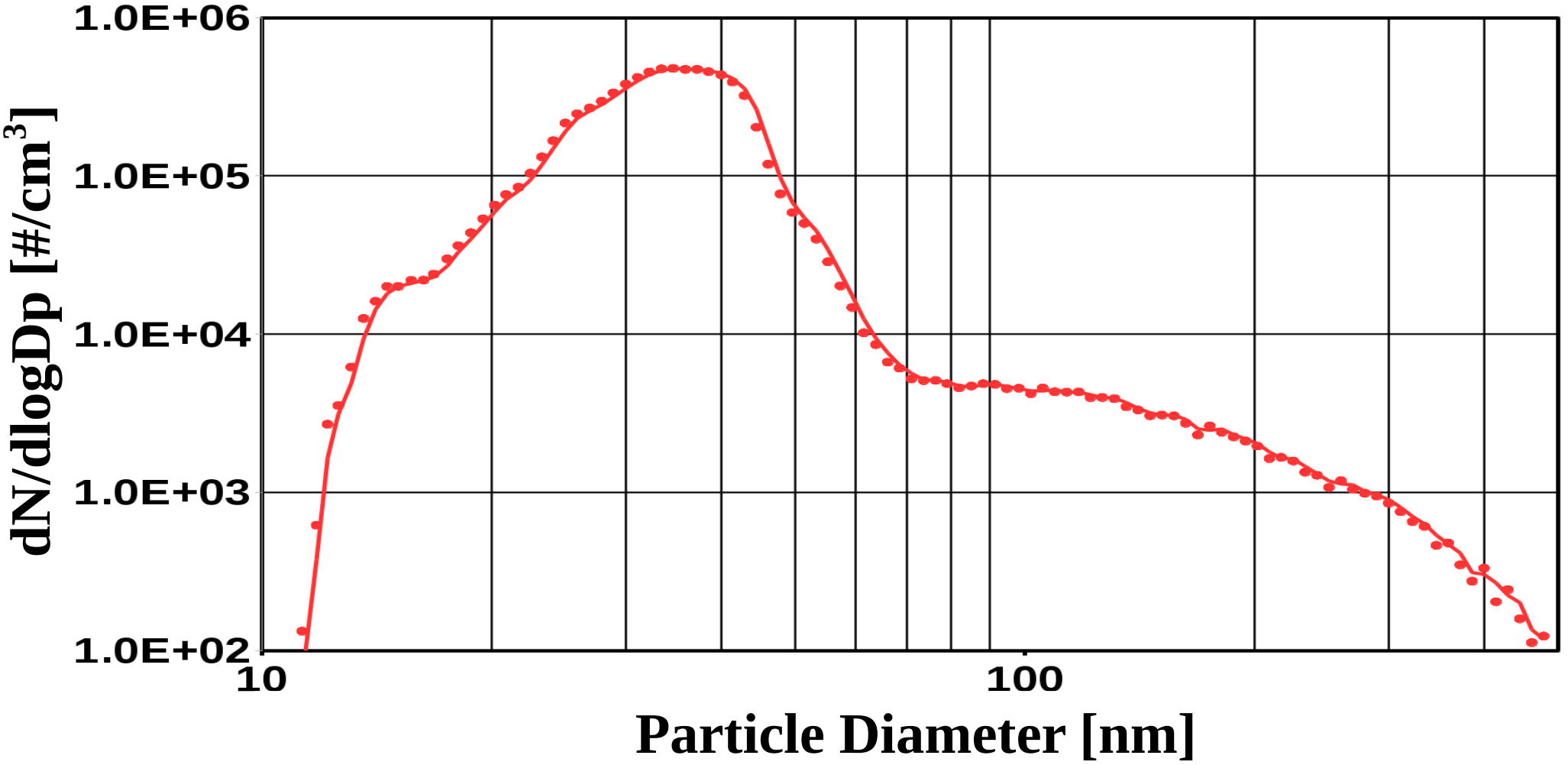
10 April 2017, 06:14 UTC, Sample 99



AgI Flare Test on 10 April 2017

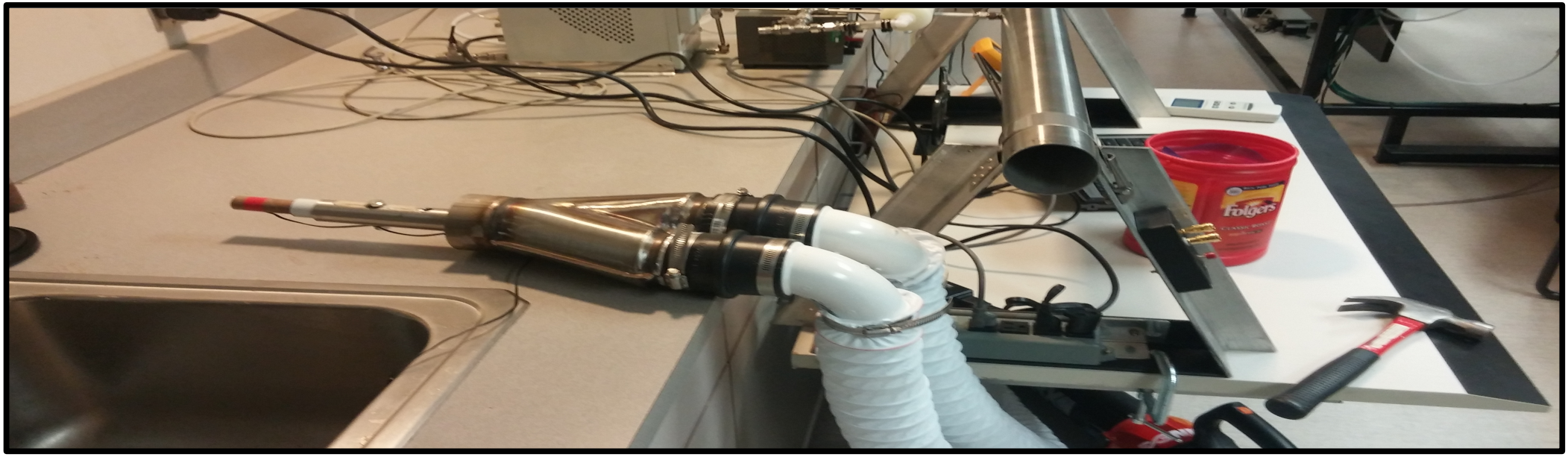


AgI Flare (*Delene and Bow, WMA 2016*)
(4 November 2015, 16:48:48 – 16:51:05 CST)



Conclusion

- AgI flares can be safely sampled in the lab.
- Need an air filter and longer flare burn time.
- AgI are ~25 – 40 nm diameter particles.
- AgI activate as CCN at 0.6 % supersaturation.



Future Work

- Eliminated blower produced particles and conduct additional lab experiments with dilution system.
- Conduct first series of chamber tests.
- Develop standard evaluation method.

UND Aerosol Chamber

MTU Cloud Chamber