An Experiment Designed to Test Ice Nucleation of Silver Iodide Cloud Seeding Flares using the Pi Cloud Chamber

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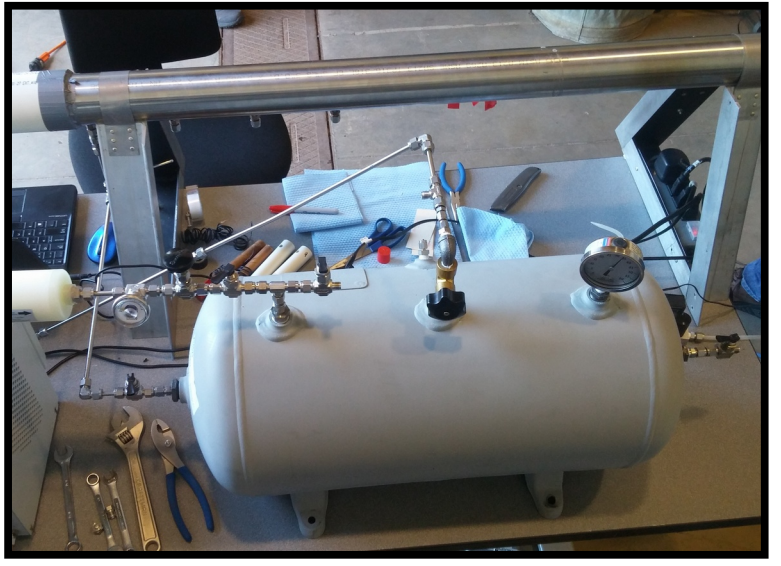
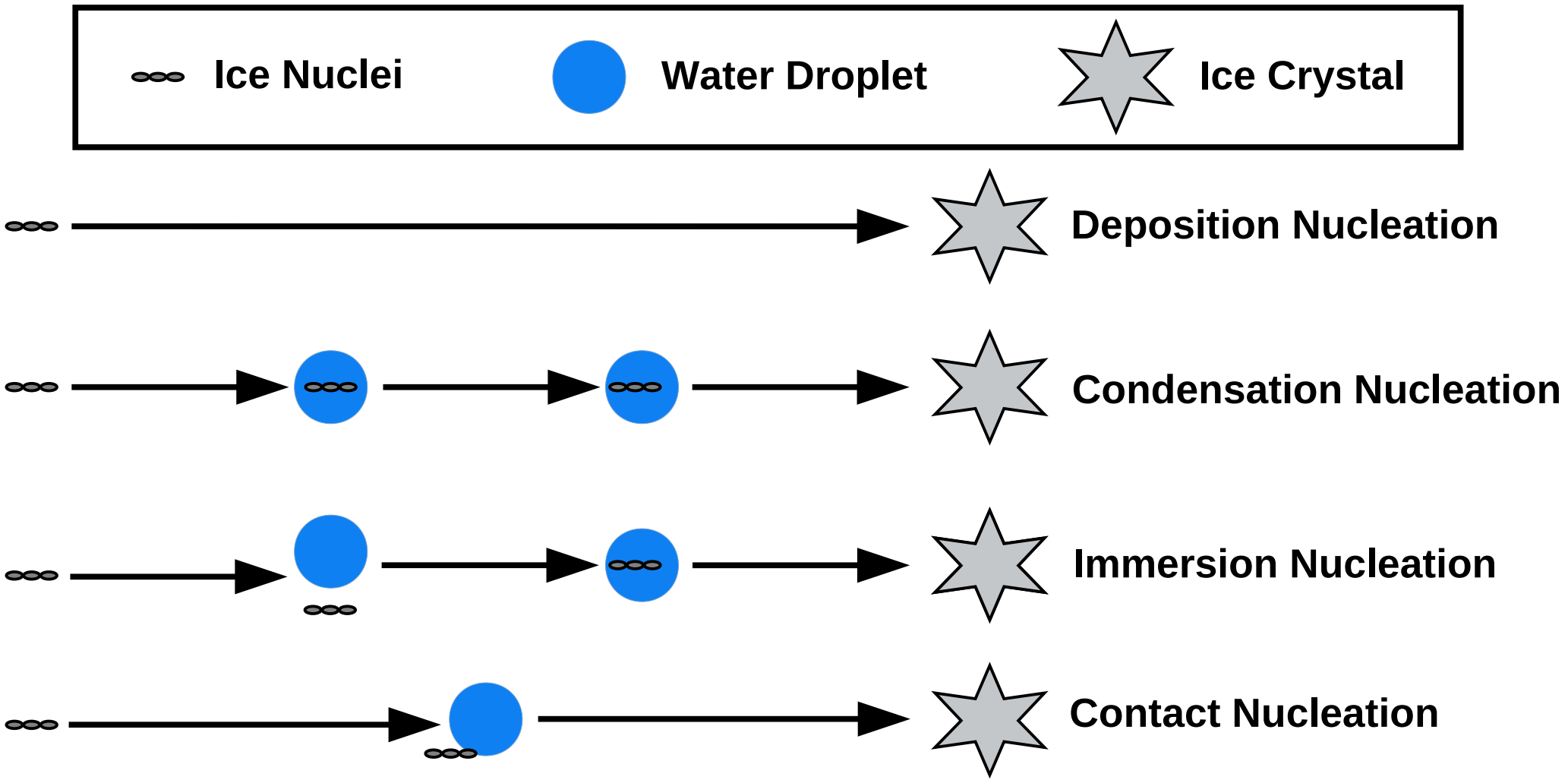
Objective and Overview

- Use the Pi Cloud Chamber at Michigan Technological University to test Silver Iodide (AgI) cloud seeding flares.

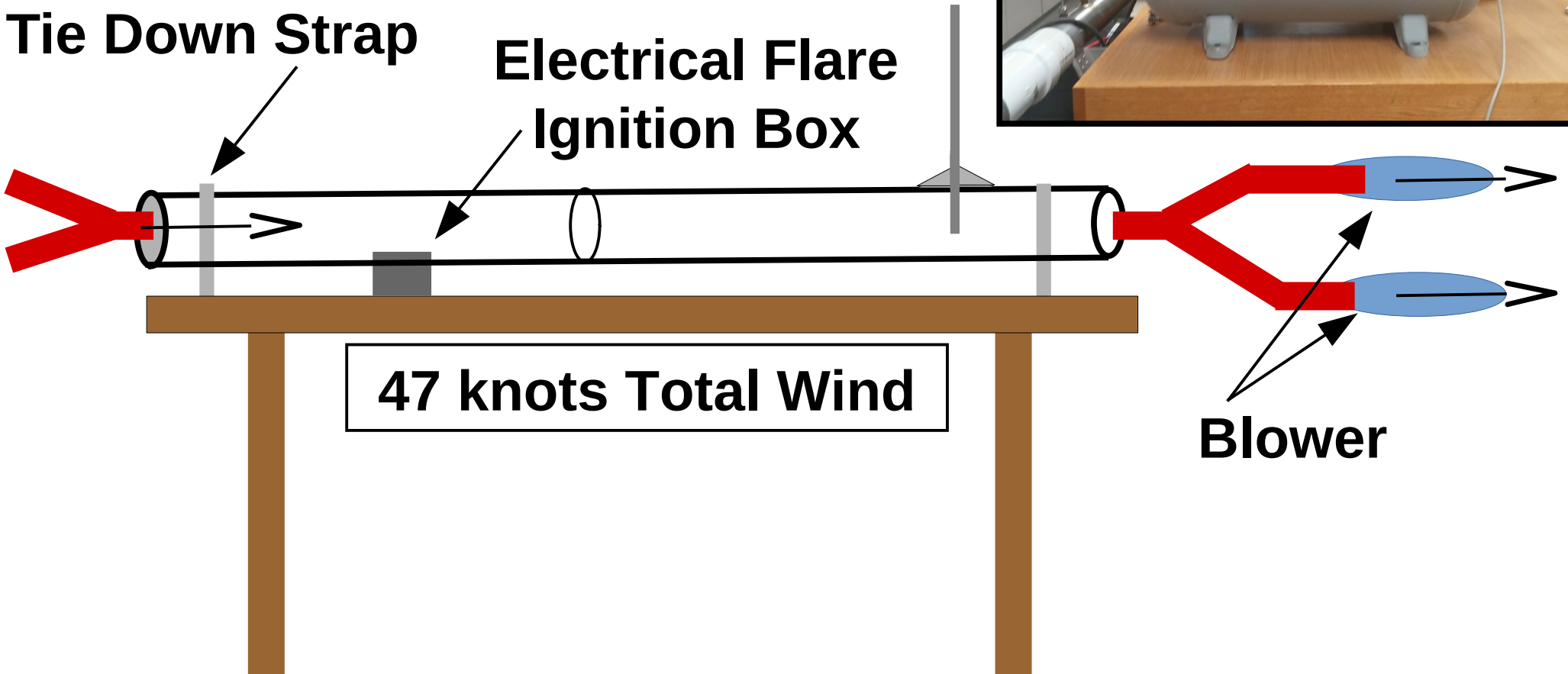
- A flare burning and dilution system is used to ensure that the Pi Cloud Chamber is not contaminated by AgI.
- The system burns flares reproducing the air flow over flares at aircraft speeds and storage in 10 gallon tank.
- Test the burning and dilution system to determine particles size and concentration.



Different Mechanisms of Ice Nucleation



Burning and Dilution Setup



AgI Flare Particle Size Distribution

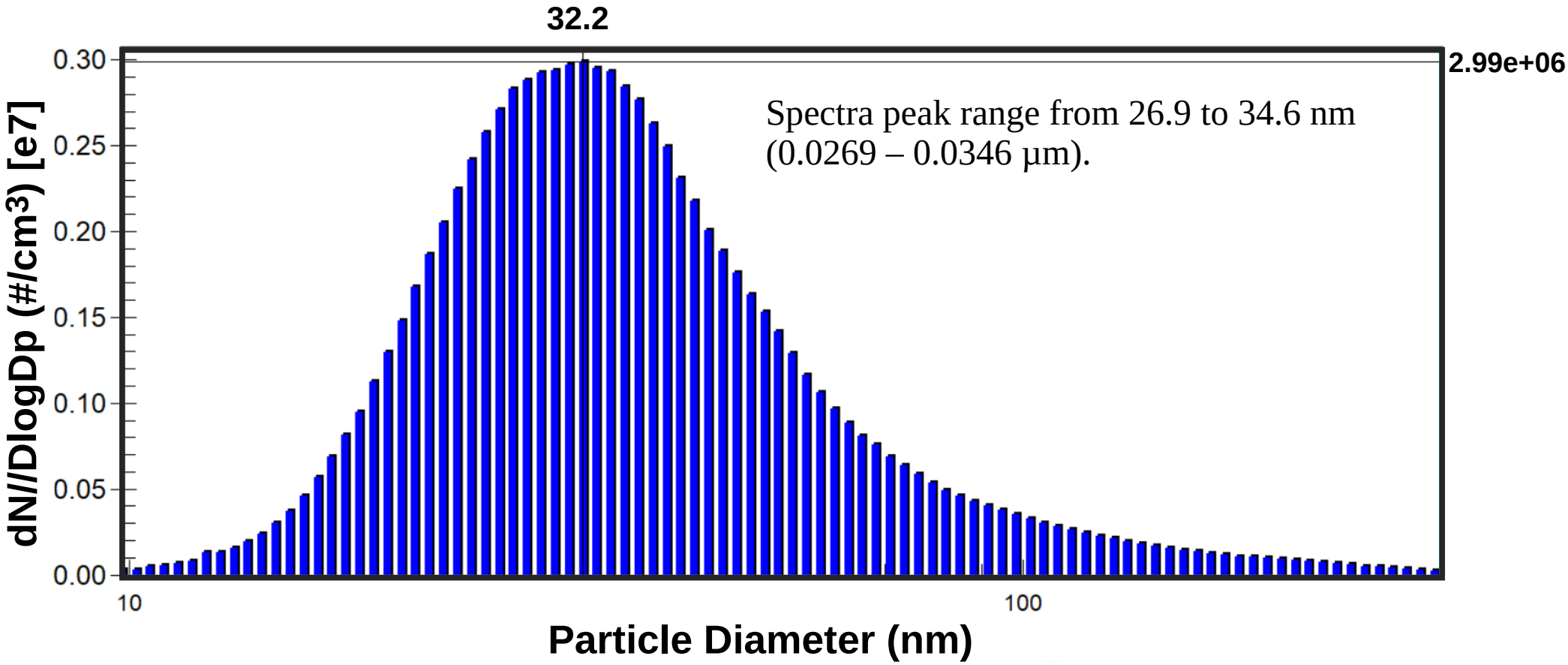
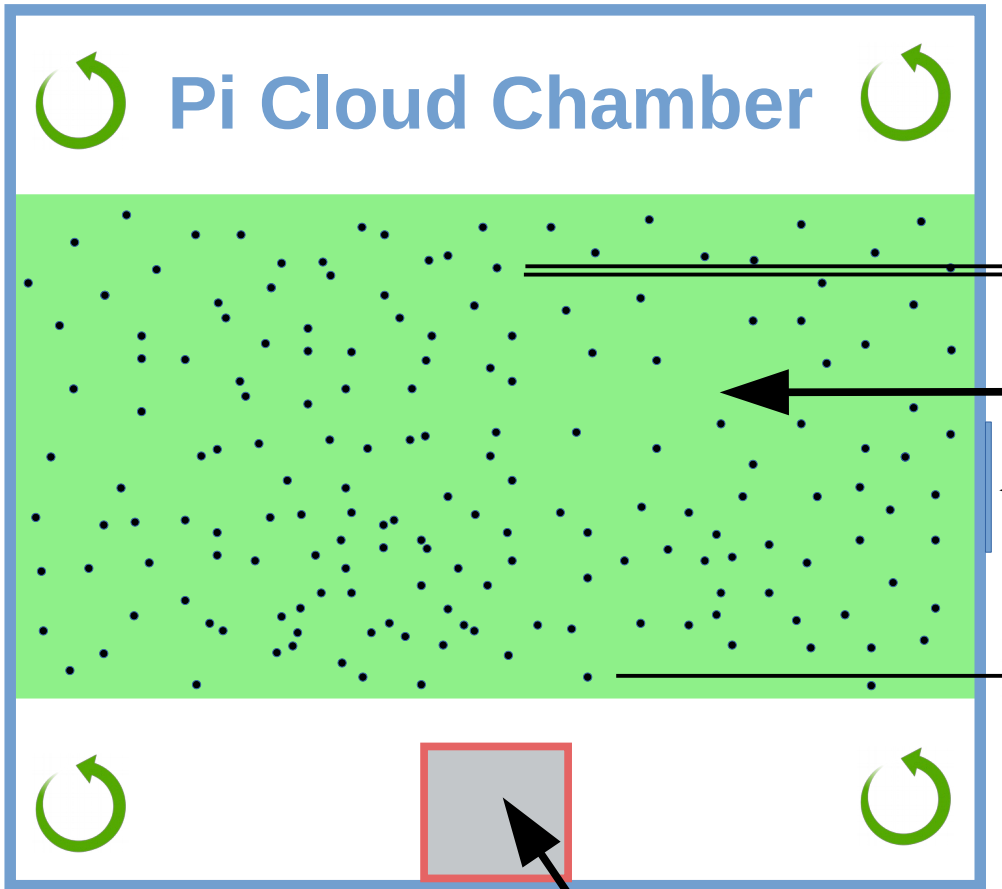


Image showing the particle size spectrum obtain from AgI flare from tank sampling using a SMPS with a 3772 CPC on 17 April 2019.

Methodology



Cloud Condensation Nuclei Counter

Condensation Particle Counter

Green Laser Sheet

Observation Window

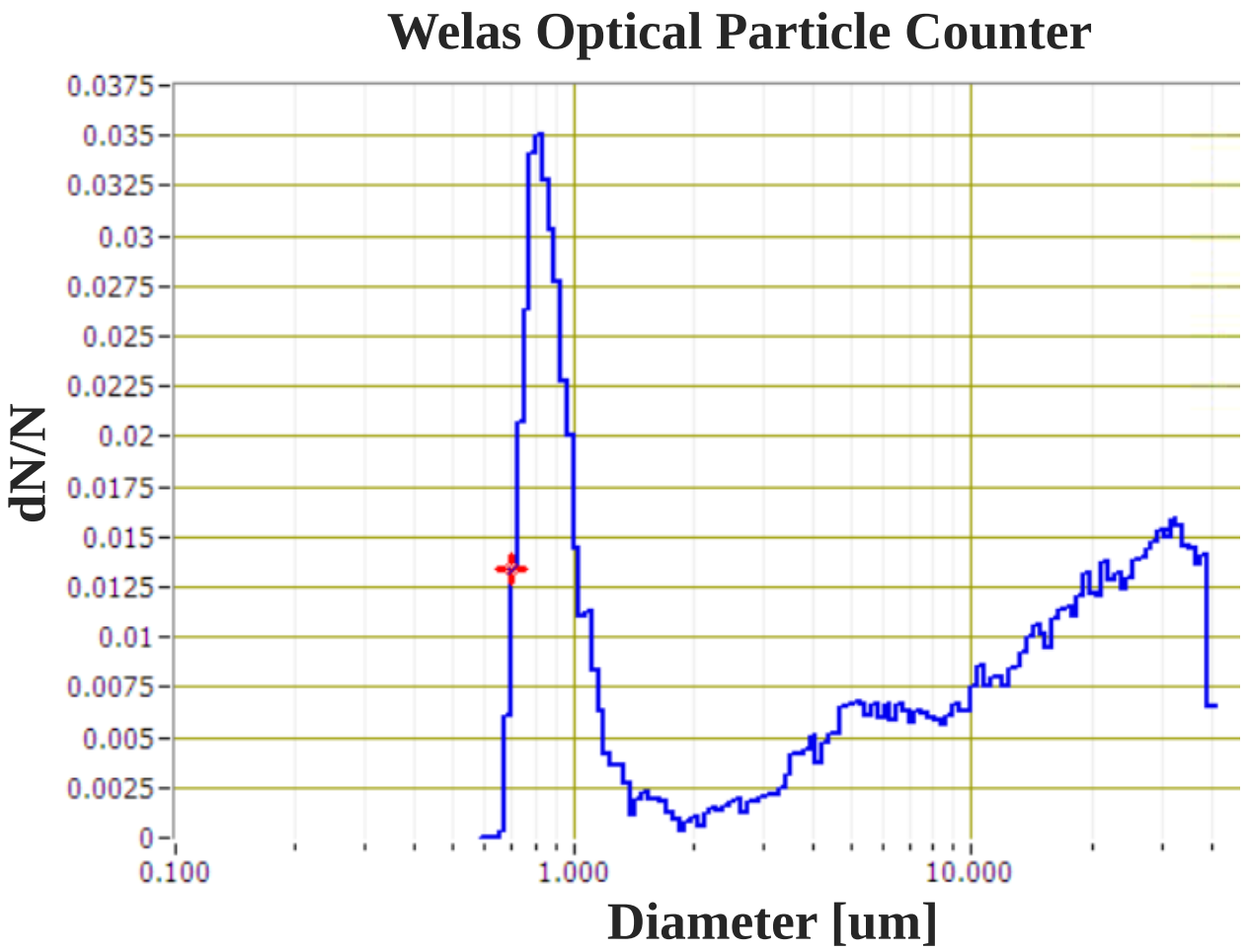
Exit

Tank

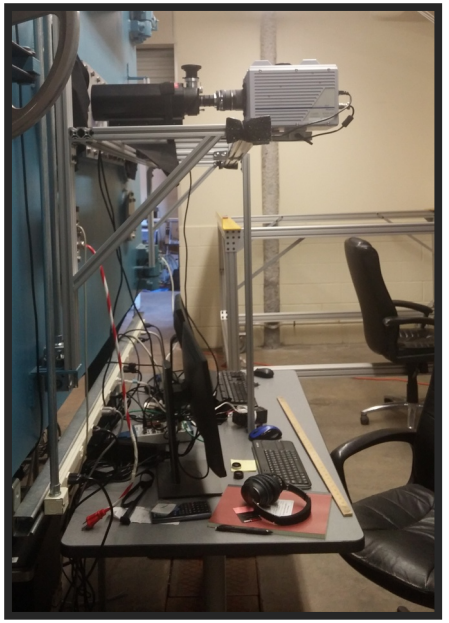
Welas Optical Particle Counter

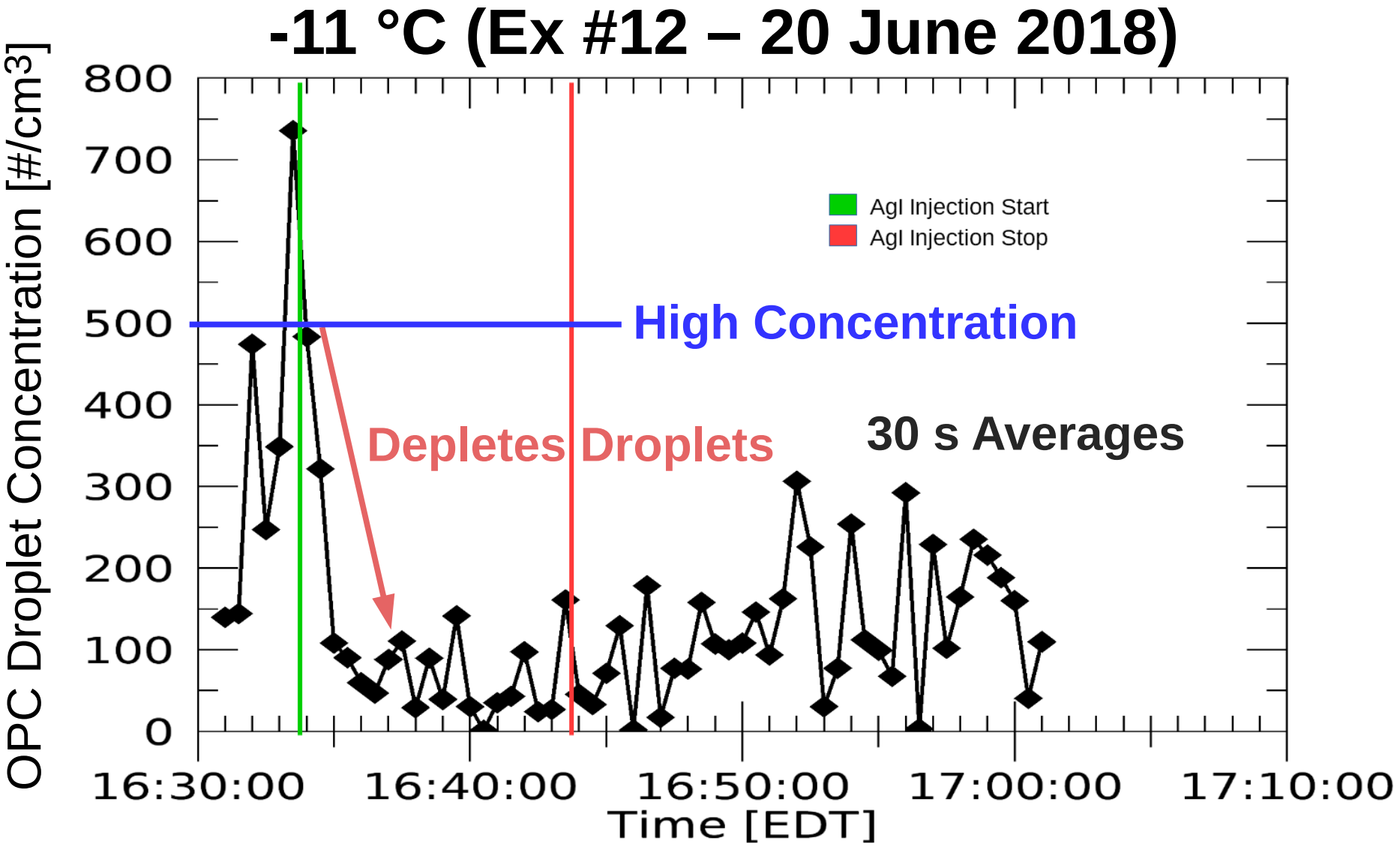
- Chamber Temperatures:
  -11 ˚C, -5.8 ˚C, and -3.2 ˚C
  - High Droplet Concentration (500 #/cm^3)
  - Low Droplet Concentration (80 #/cm^3)

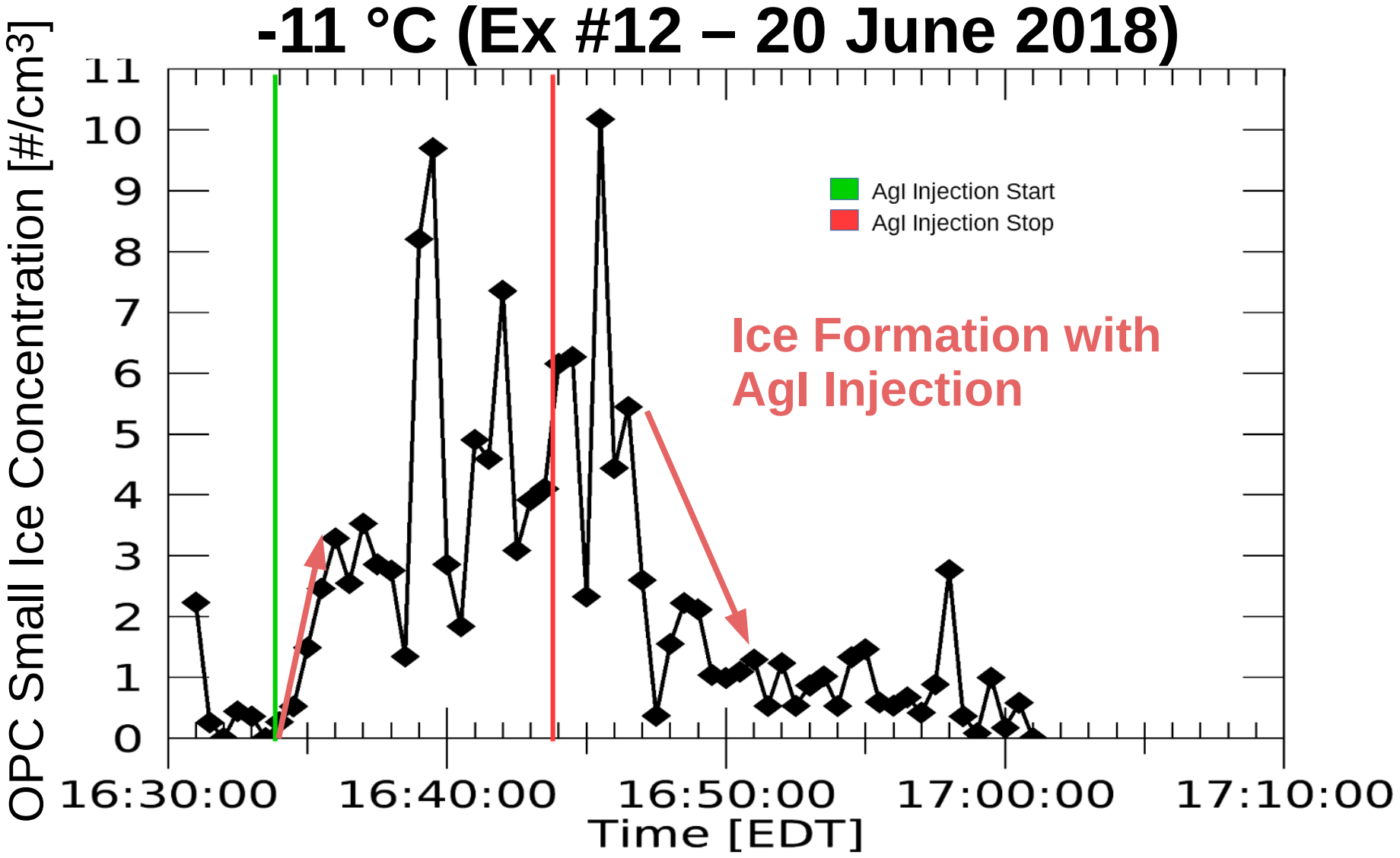
Droplet Measurement Methodology

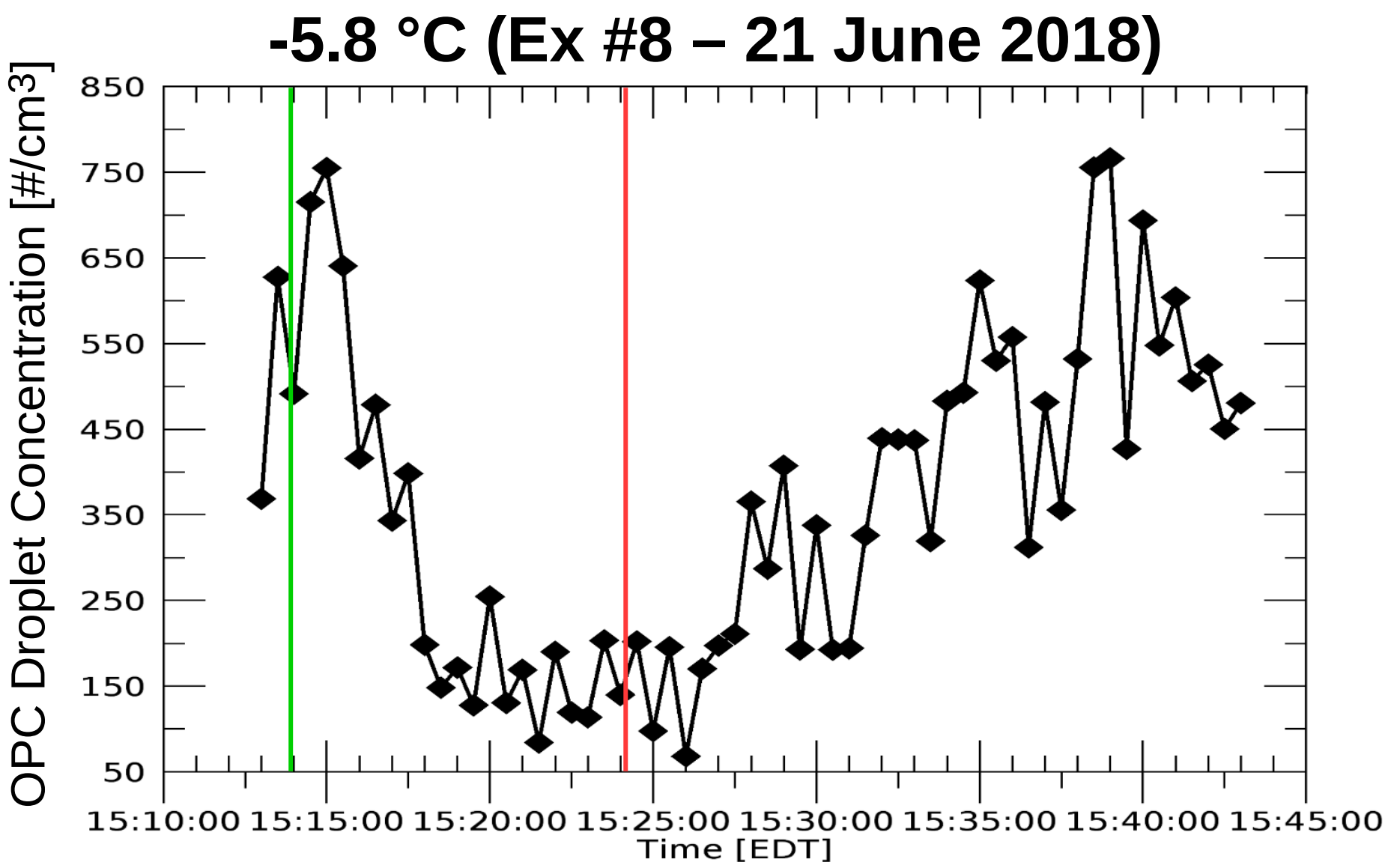


Water Drops
2 – 10 μm
Ice Particles
20 – 105 μm

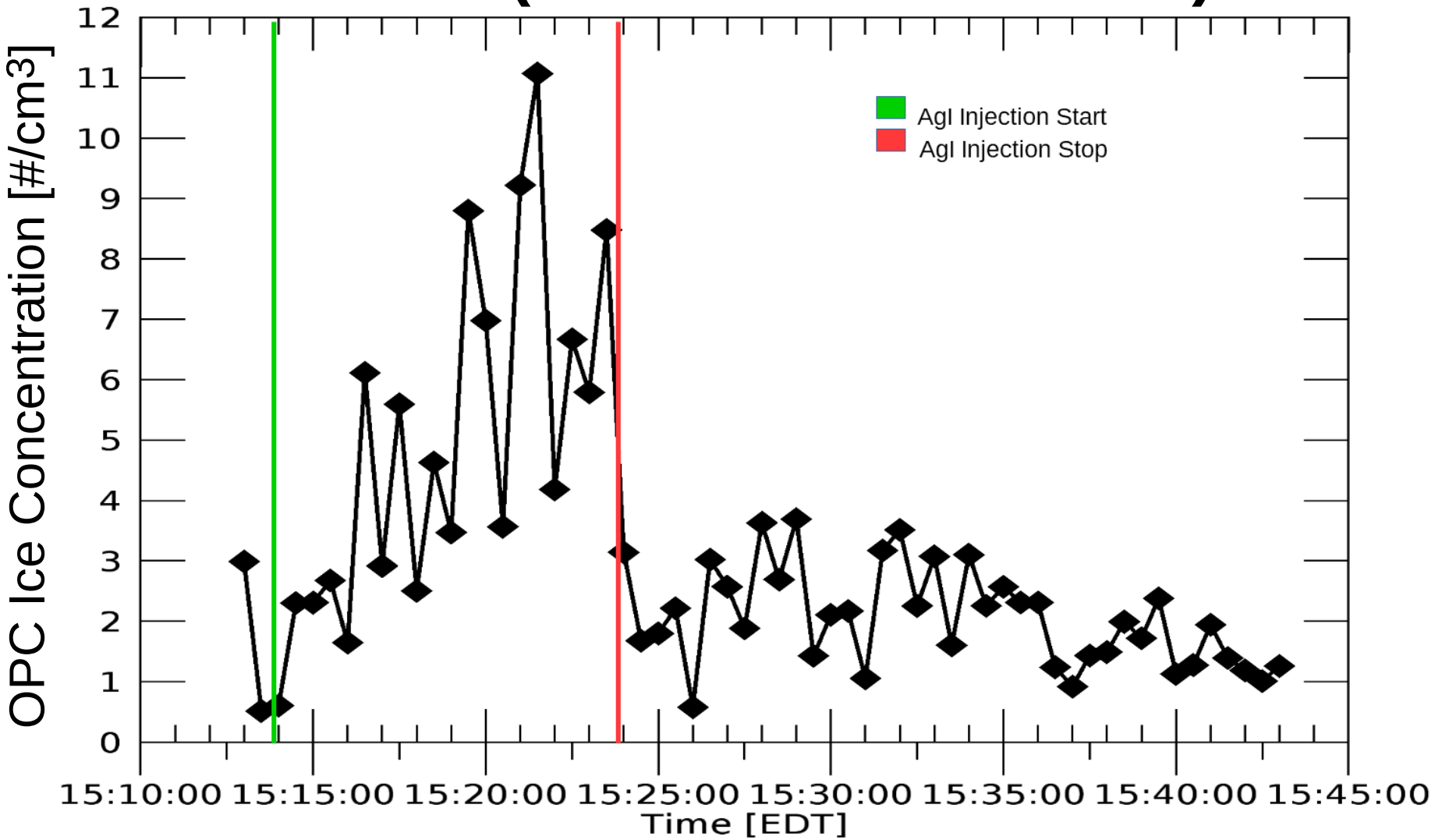



-11 °C (Ex #12 – 20 June 2018)
OPC Droplet Concentration [#/cm³]
800
700
600
500
400
300
200
100
0
AgI Injection Start
AgI Injection Stop
High Concentration
Depletes Droplets
30 s Averages
16:30:00
16:40:00
16:50:00
17:00:00
17:10:00
Time [EDT]

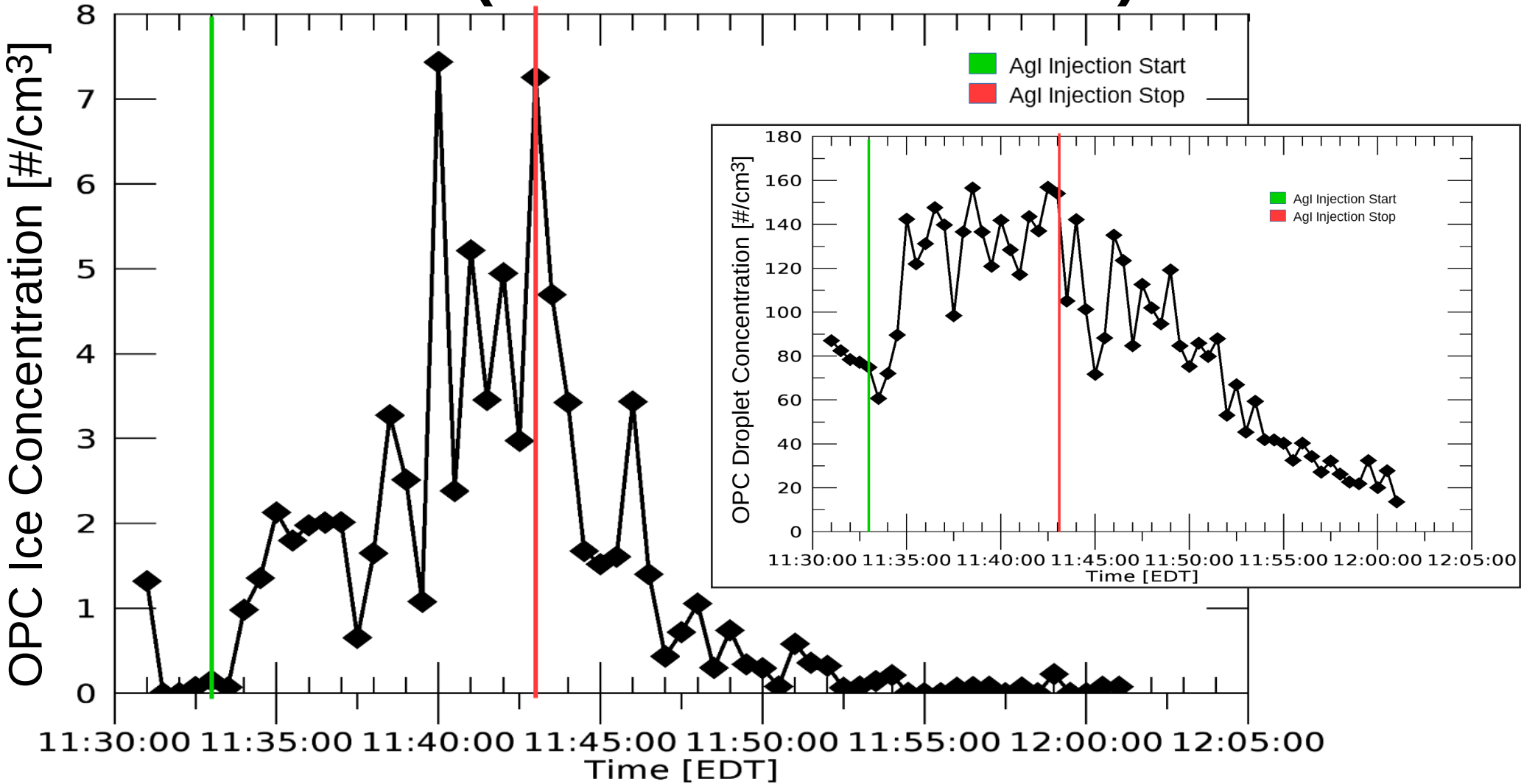

-11 °C (Ex #12 – 20 June 2018)
OPC Small Ice Concentration [#/cm³]
11
10
9
8
7
6
5
4
3
2
1
0
AgI Injection Start
AgI Injection Stop
Ice Formation with AgI Injection
16:30:00
16:40:00
16:50:00
17:00:00
17:10:00
Time [EDT]


-5.8 °C (Ex #8 – 21 June 2018)
OPC Droplet Concentration [#/cm³]
850
750
650
550
450
350
250
150
50
15:10:00
15:15:00
15:20:00
15:25:00
15:30:00
15:35:00
15:40:00
15:45:00
Time [EDT]

-5.8 °C (Ex #8 – 21 June 2018)



-5.8 °C (Ex #1 – 21 June 2018)



Summary and Conclusions

- High Cloud Droplet Concentration
  - Quick Rise in Ice Concentration
  - Drop in droplet concentration
- Low cloud droplet concentration cases
  - Slower Ice Production
  - No Decrease in Droplet Concentration with AgI Injection.
- Contact Nucleation Important Nucleation Mechanism
    - Demot 1983 - Colorado States Expansion Cloud Chamber found that Contact Nucleation is the Dominate Mode for AgI Nuclei (>-16 ˚C)

Chamber Observational Window Videos

http://aerosol.atmos.und.edu/CloudChamberVideos_2018.html

June 21, 2018 – **3:14**

0:23 - Injection starts.

1:14 - Start to see some ice.

2:16 - More turbulent eddies.

2:33 - Ice is becoming more prevalent.

3:52 - In the upper right corner, a large dark area.

5:22 - Ice continue to increase.

7:00 - Water drops depleting as more dark spots apparent

8:37 - Very little super cooled drops left.

9:06 – Lot of the ice particles apparent.

9:33 - Water drops increasing.

10:15 - Chamber mainly ice particles.