Building Energy and Environmental Systems Laboratory (BEESL)
Department of Mechanical and Aerospace Engineering
L.C. Smith College of Engineering and Computer Science
Syracuse University

Field Performance Evaluation of Vortex DCS for Dust/Particle Burden Reduction in Indoor Environments

By
Meng Kong, Xiao Yang, Zhenlei Liu, and Dr. Jensen Zhang

Project Objectives

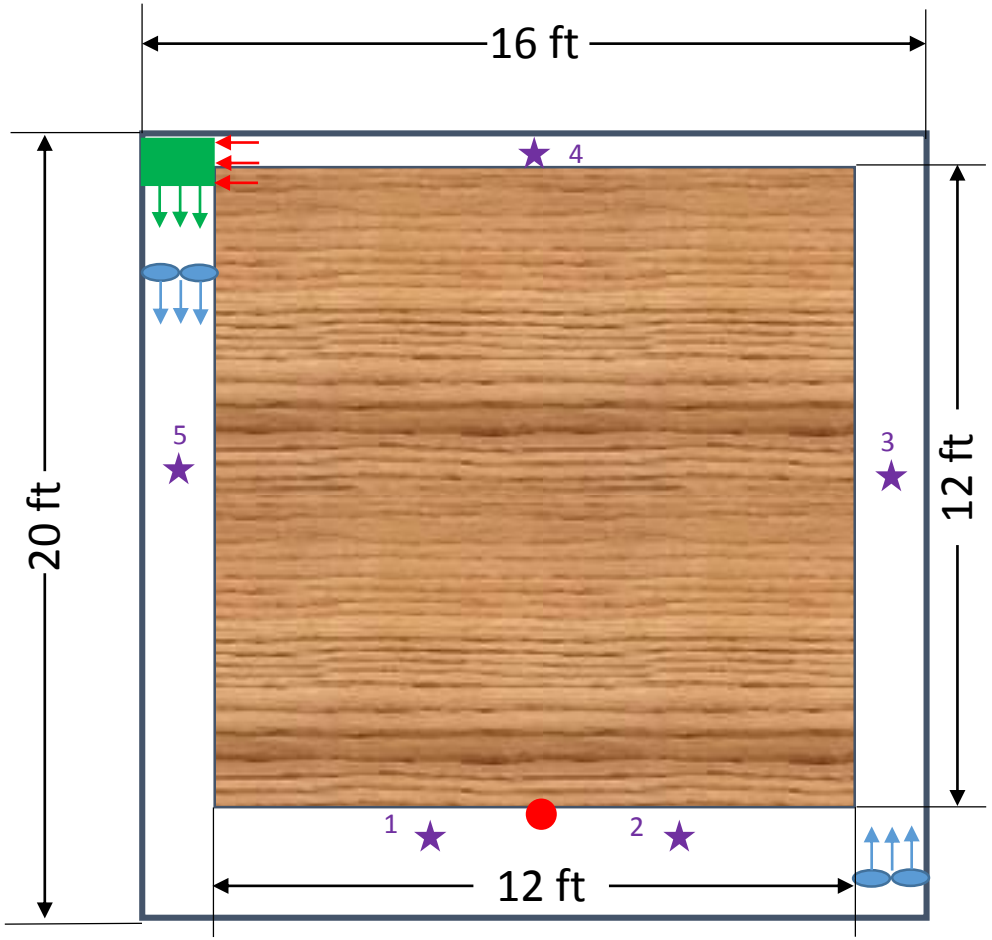
Collect reliable experimental data for demonstrating the performance of Oneida Air Systems' DCS (Dust Containment System) for dust/particle filtration, especially under realistic environmental conditions in indoor environments. The goal of the present project will be accomplished via the following objectives:

- Conduct exploratory pilot mock-up tests to determine the dust/particle removal efficiency of the Vortex DCS system with hardwood floor sanding, using a mock-up controlled room facility;
- Analyze the removal effectiveness of the Vortex DCS in the particle sizes of 0.5-20 μm, based on the dust/particle concentration measurements;
- Estimate the potential of the Vortex DCS in improving IAQ in residential environments, considering the daily allowable concentrations of occupational exposure limits.

Methods and Tasks

- Mock up a full-scale test room in the Oneida Air Systems' facility.
  - *Room Dimensions: 20 ft by 16 ft by 9 ft high;*
  - *Floor Dimensions: 12 ft by 12 ft wood floor, placed in the center of the room;*
  - *Mixing air fan: assure complete mixing of the air in the space;*
  - *Thermal condition: 73.4°F (23°C) and 50% RH;*
  - *Particle measurement location: 5 ft above the floor;*
  - *Measurement Instrument: Aerodynamic particle sizer (TSI APS 3321).*
- Perform a floor sanding with and without the Vortex DCS for two different sand paper grades (80 grit and 50 grit) for a total of four tests, each to last 1 hour for particle measurements;
- Analyze the data and report the results in $\mu g/m^3$ and against the associated exposure limits.

Test Setup

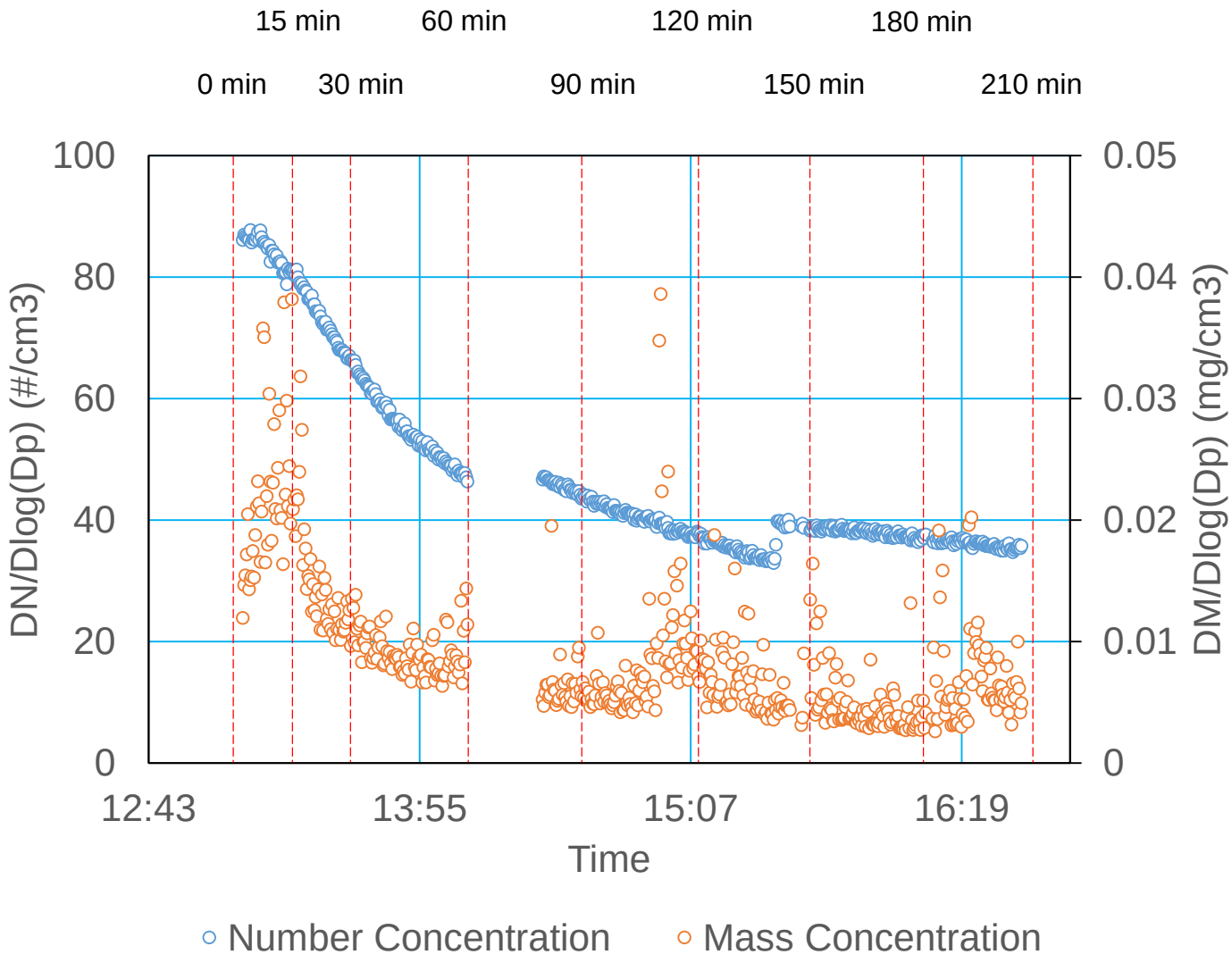


Air Conditioner
Sampling Port
Mixing Fan
Deposition Test Coupon

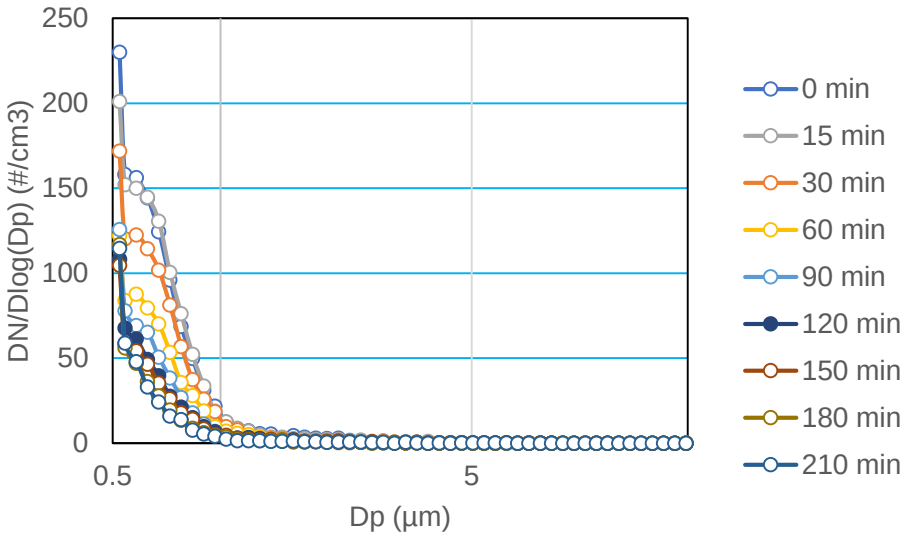
Test Procedure

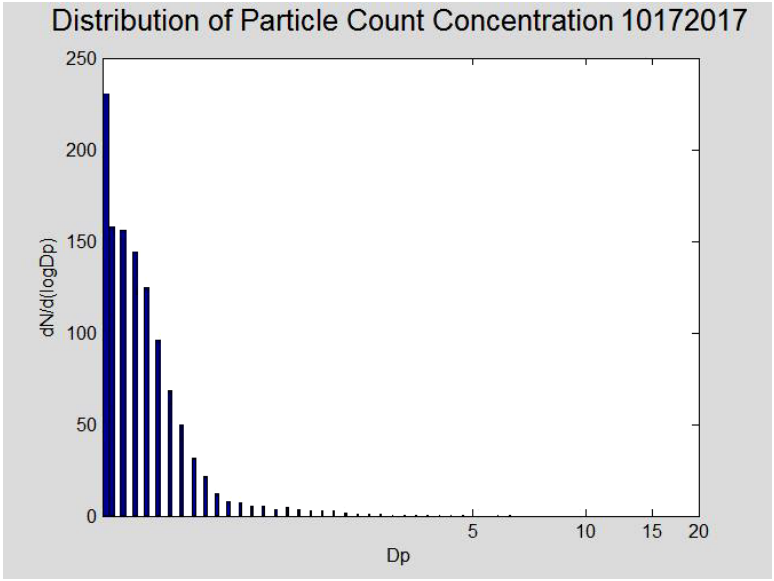
- Operating the air conditioner to condition the room to preset temperature and turn it off;
- Move the sanding machine in the room;
- Prepare the coupons for deposition test:
  - Put on a pair of nitrile gloves;
  - Clean the microscope slides to remove all the particle on it;
- Turn on the APS and start to sample;
- After the room gets to steady state (particle level), place the deposition coupons at the 5 locations. After one hour, replace them with new ones, start the sanding process, and record the time;
- Operate the sanding machine steadily for one hour;
  - Note that it will take a period of time before the particle level reaches the steady state.
- After the sampling is done, turn off the sanding machine and record the time;
- Collect the deposition coupon set right away:
  - Cover the coupon with another clean slide;
  - Make sure no air pocket exist and do not crash the particles;
  - Fix the coupon on both ends with tape;
- Analyze the data.

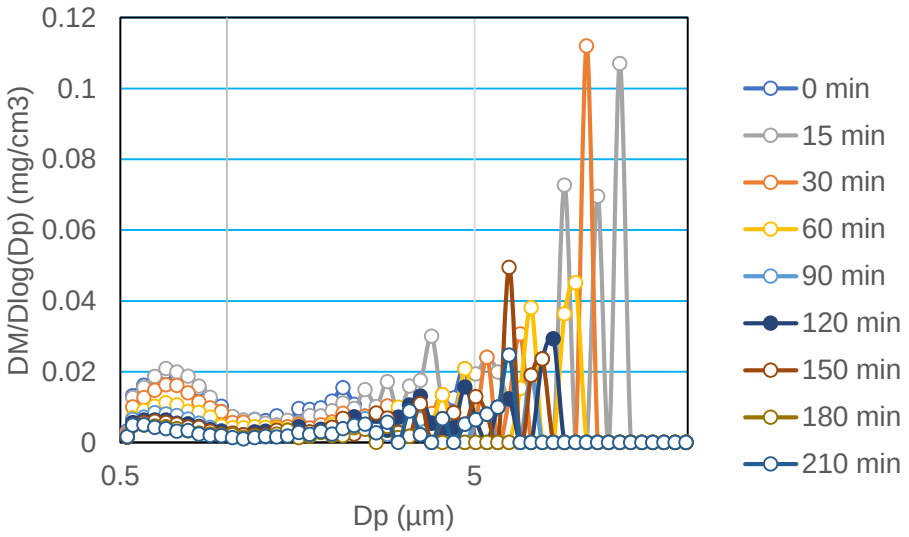
Background Test 10182017

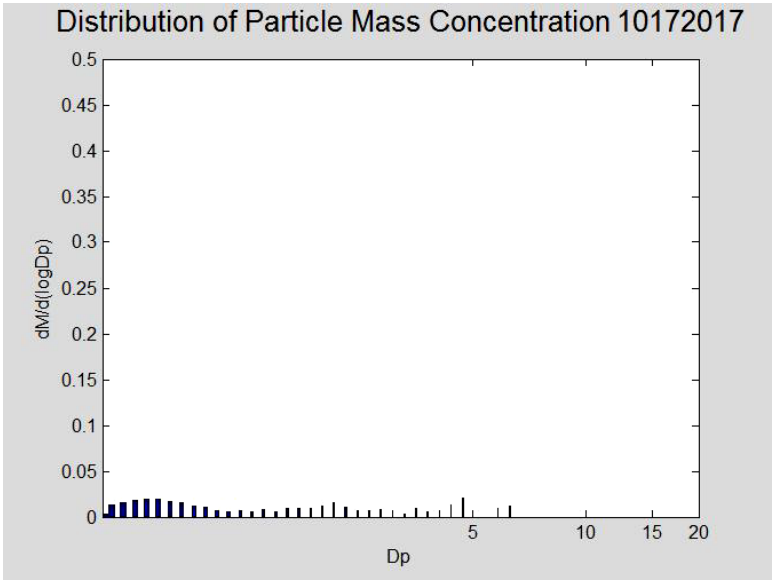


Background Test 10182017









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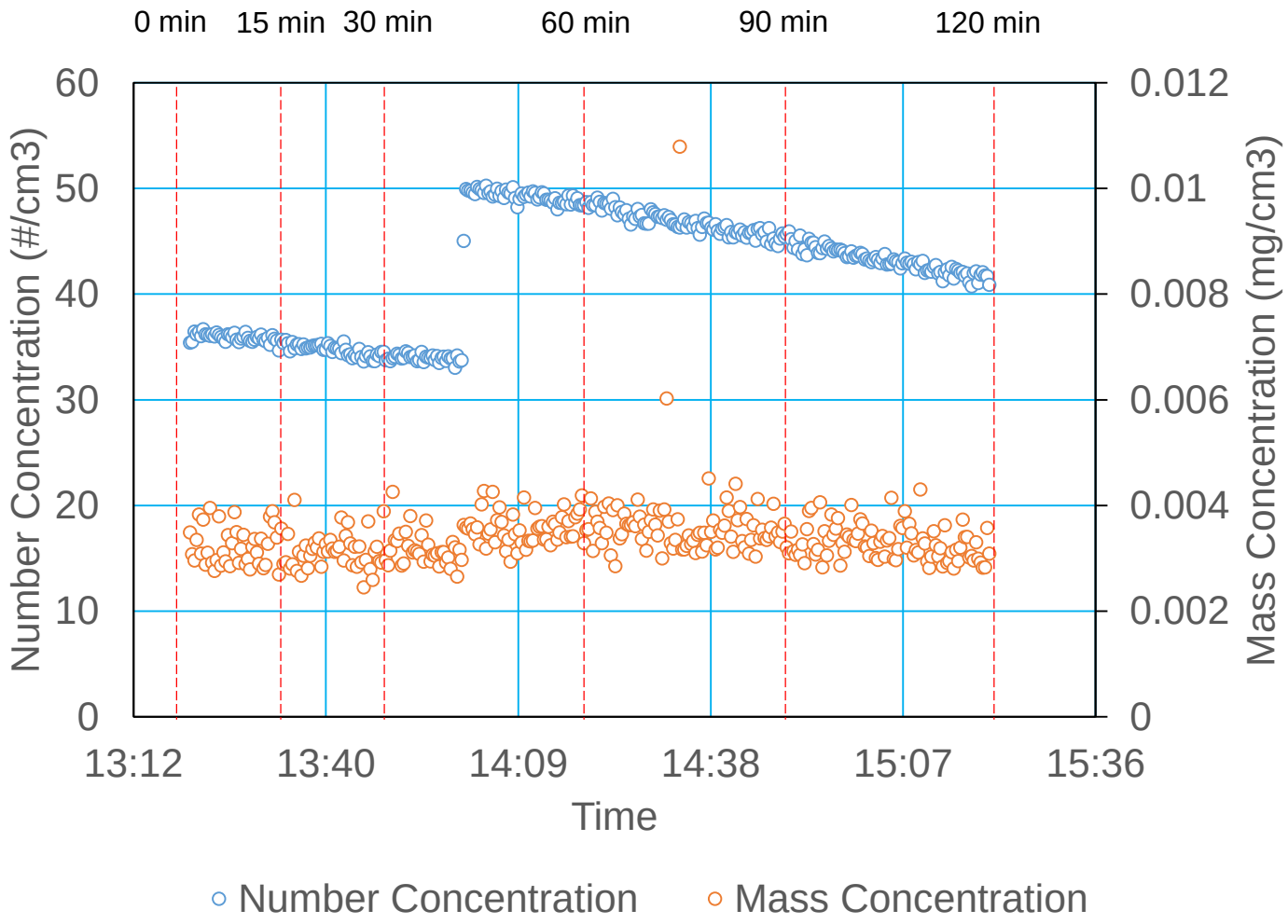

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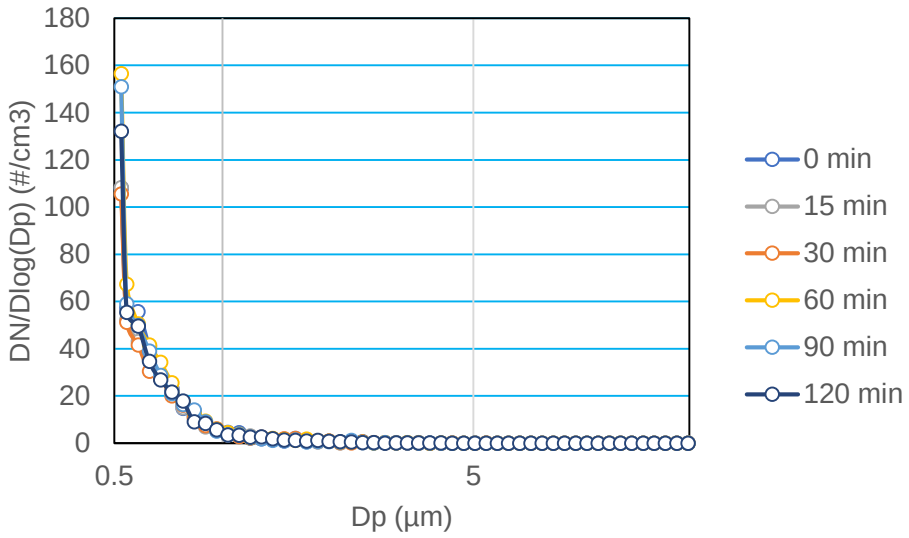

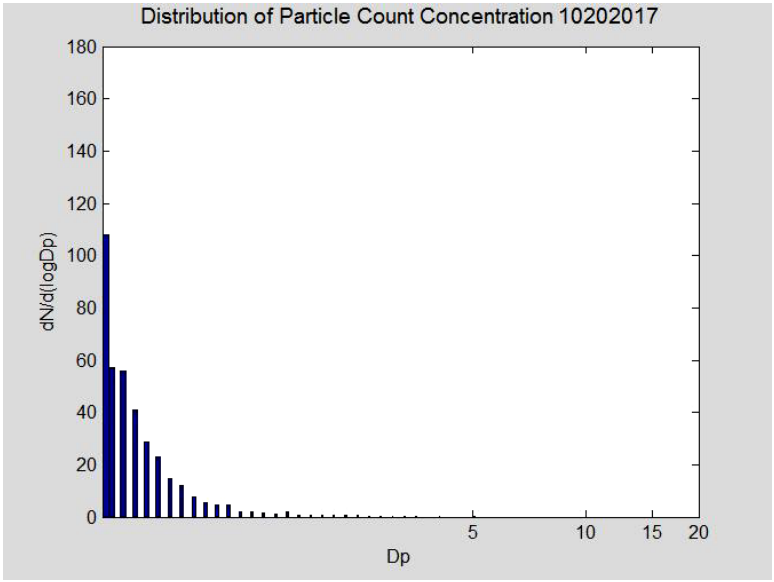

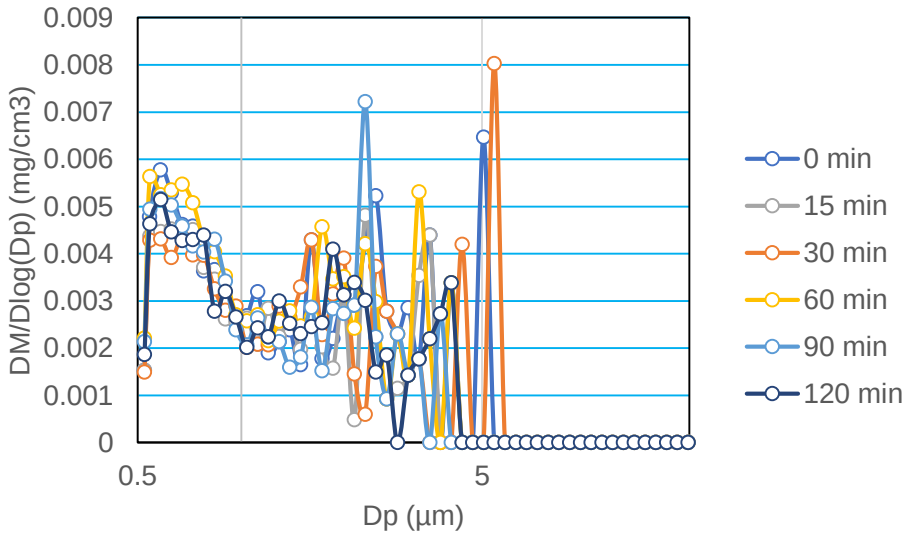

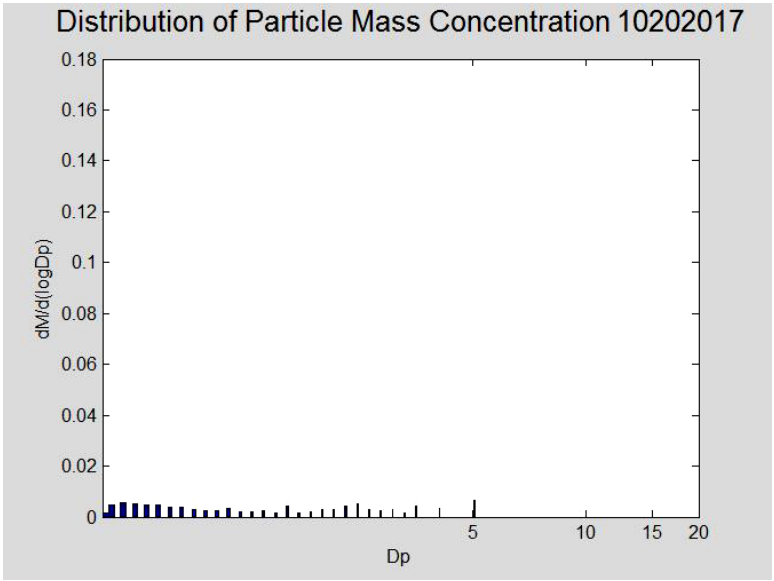

1st Test 10302017

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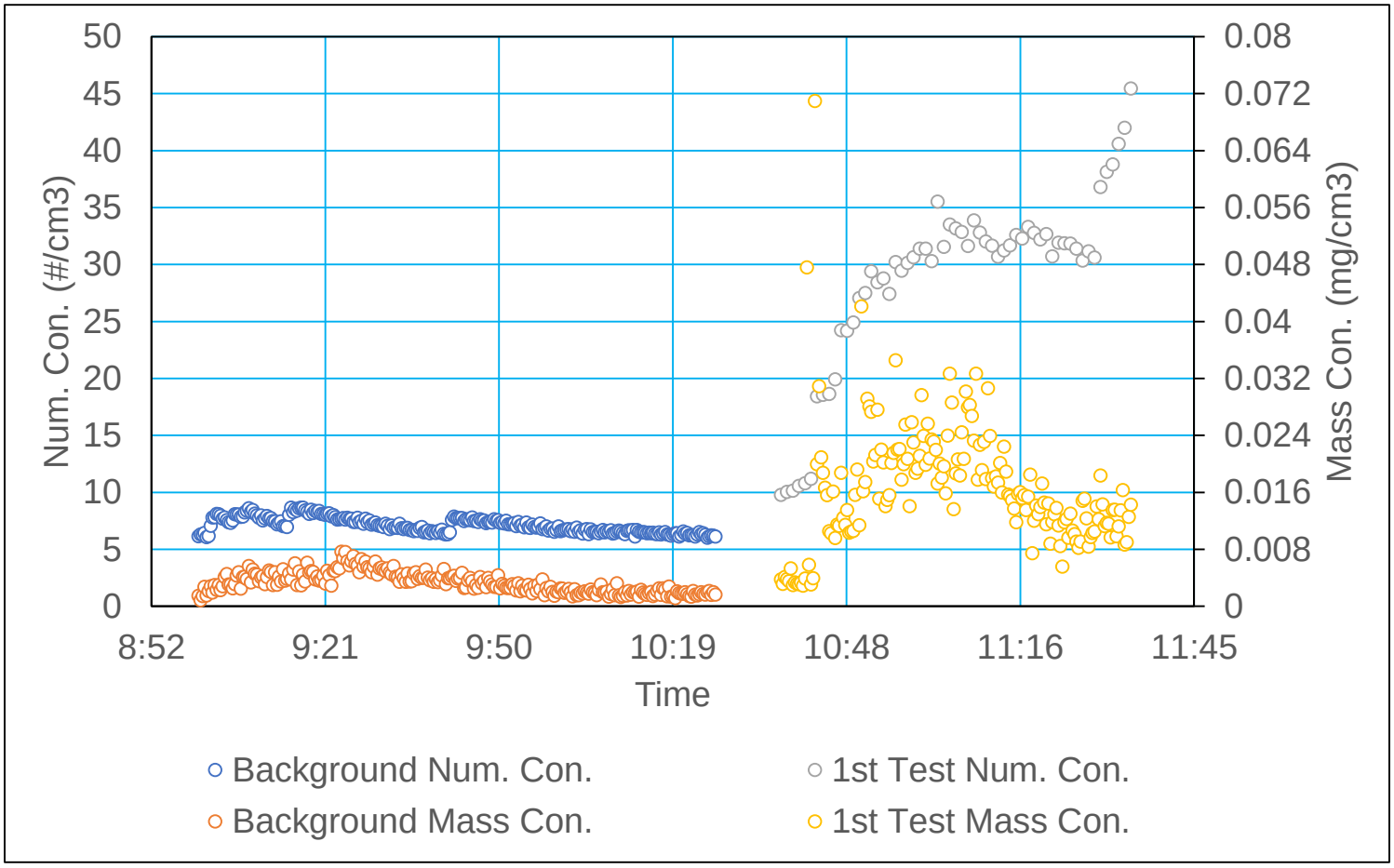

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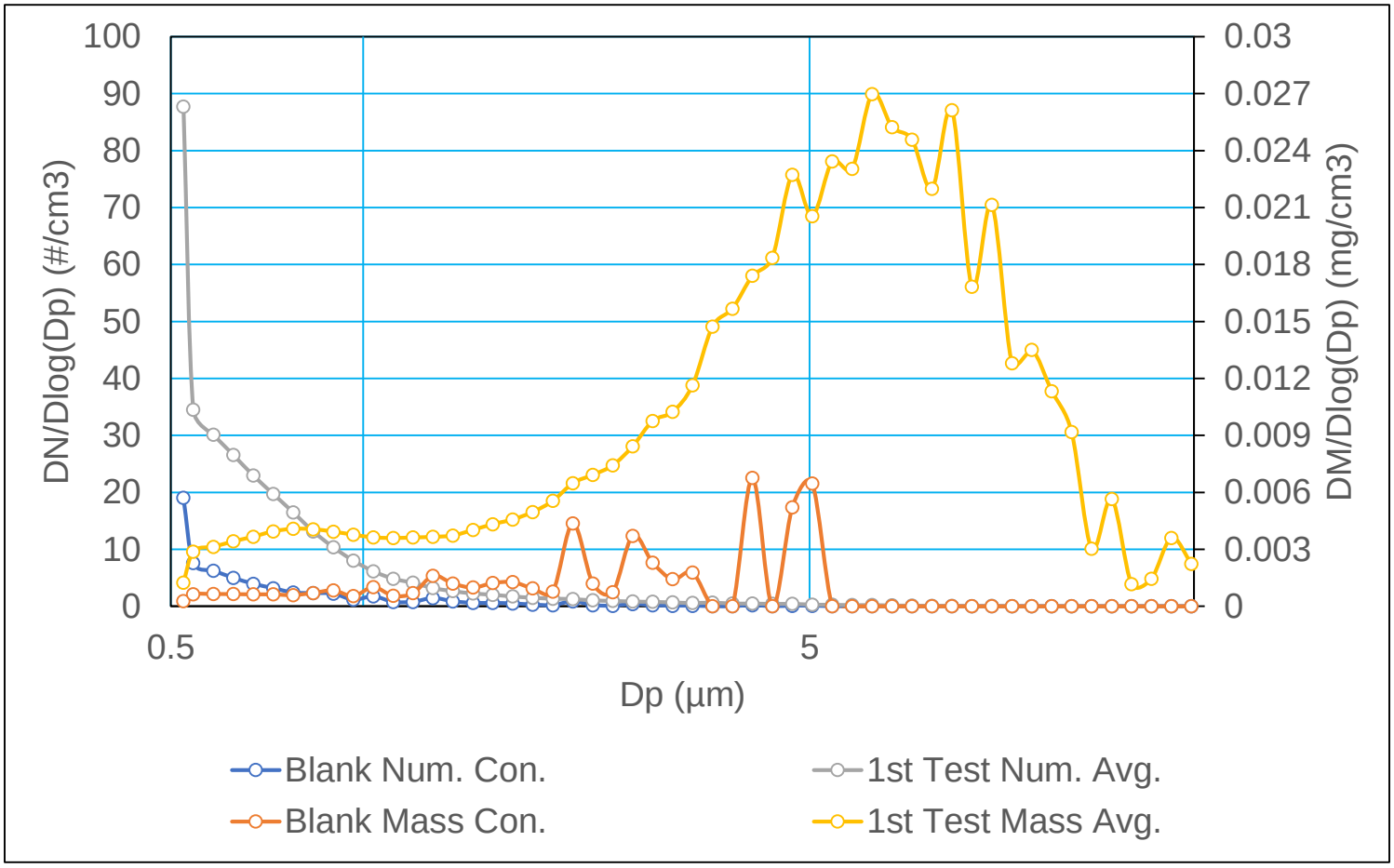

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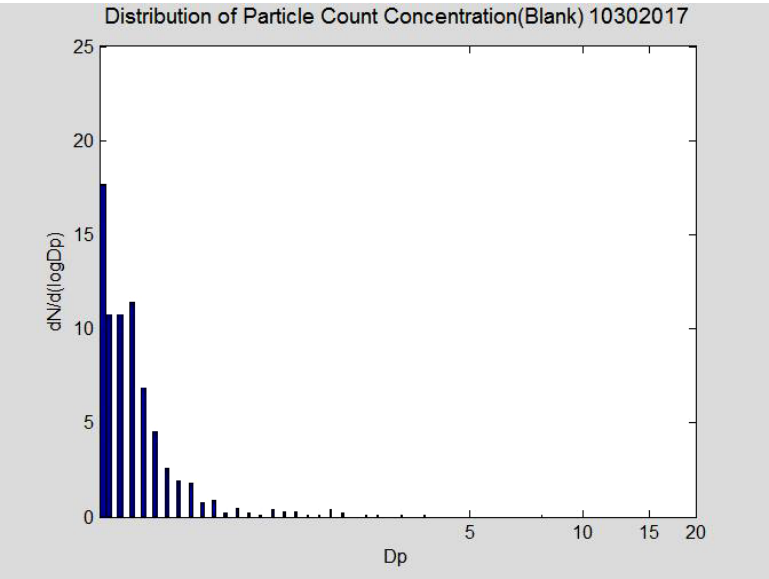

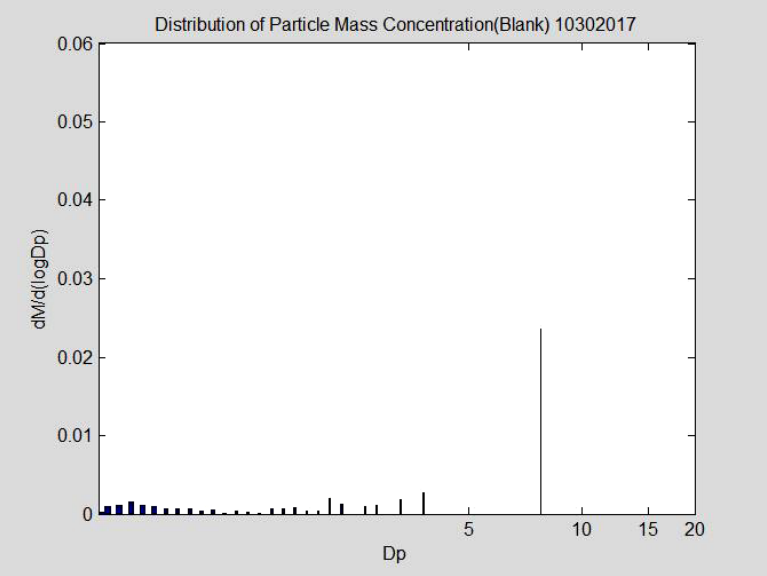

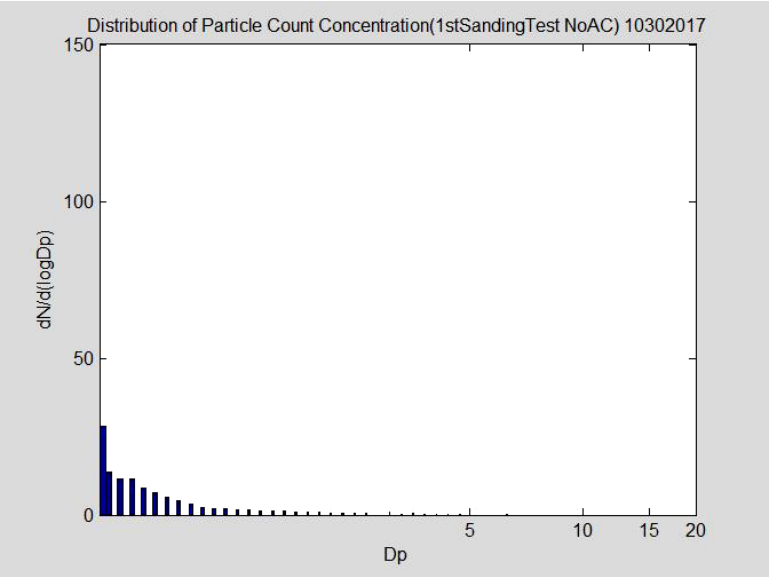

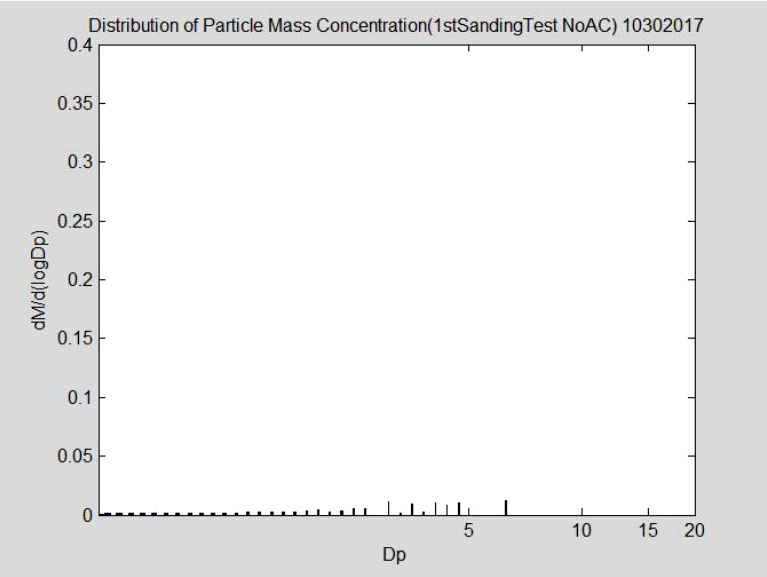

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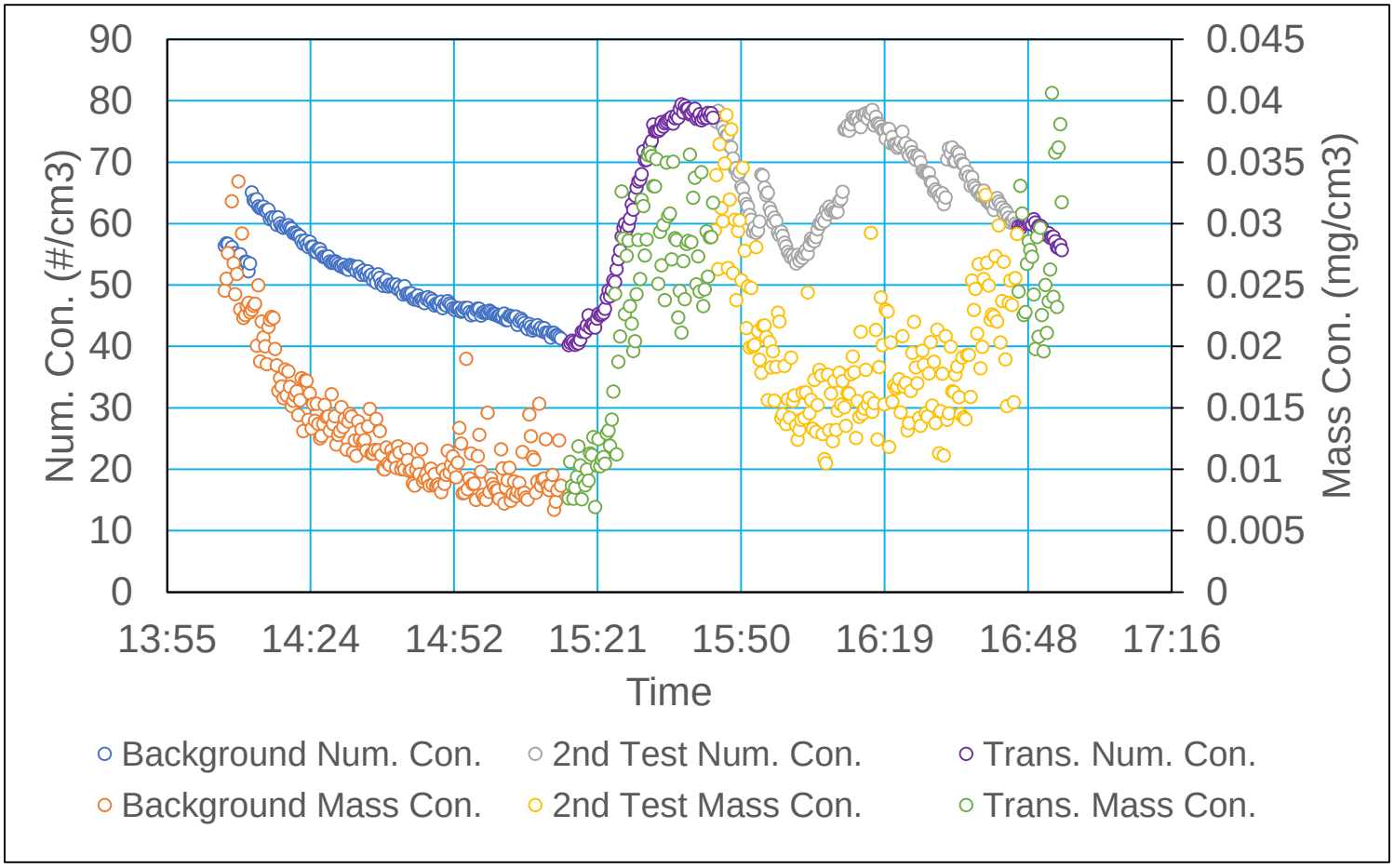

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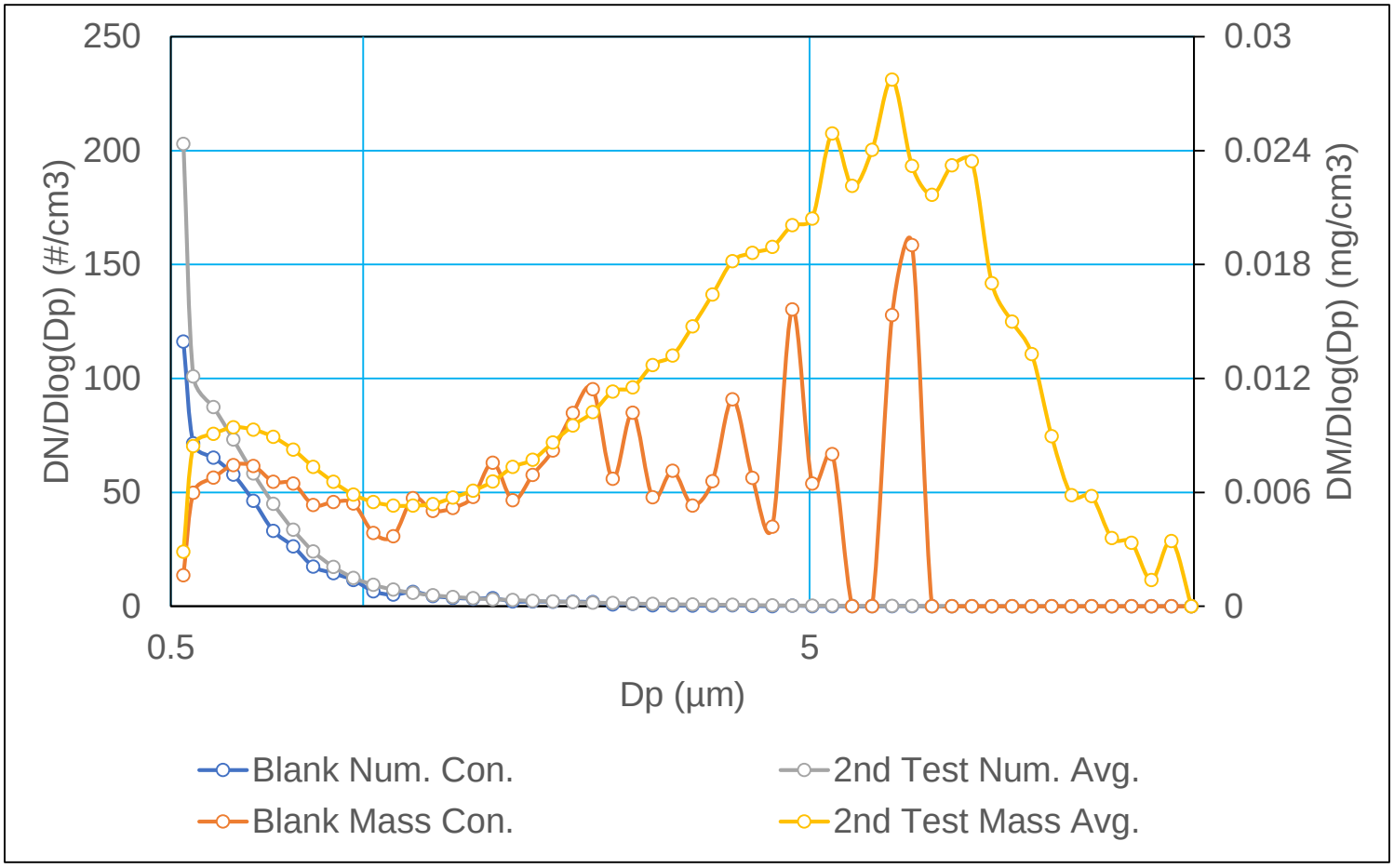

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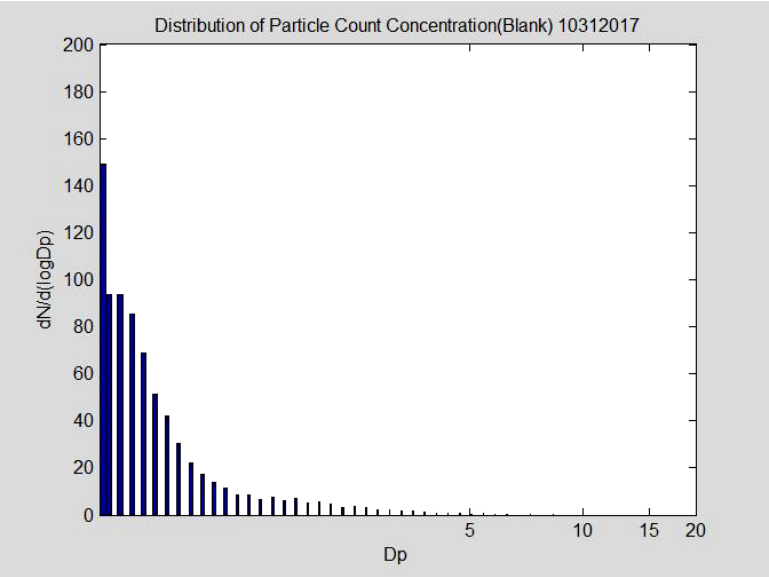
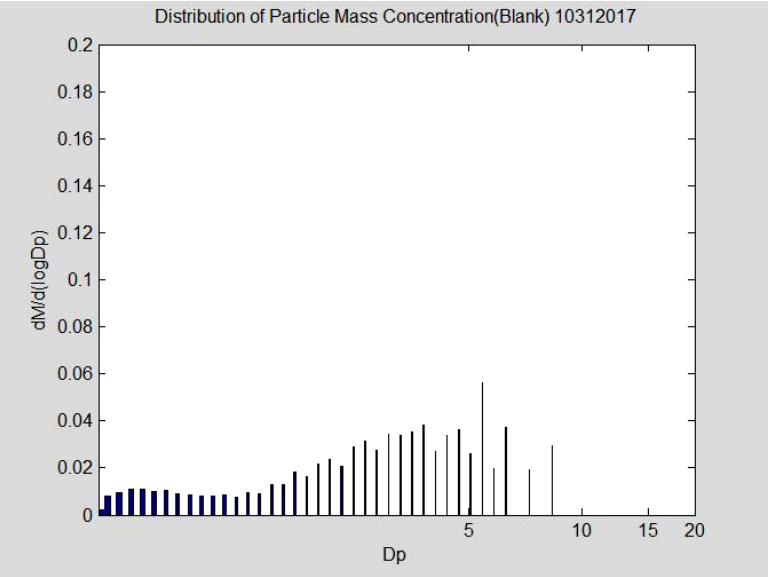
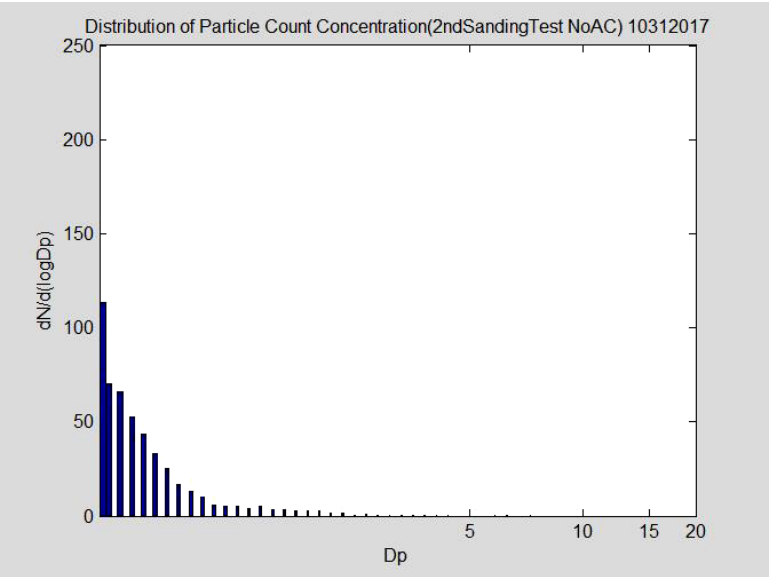
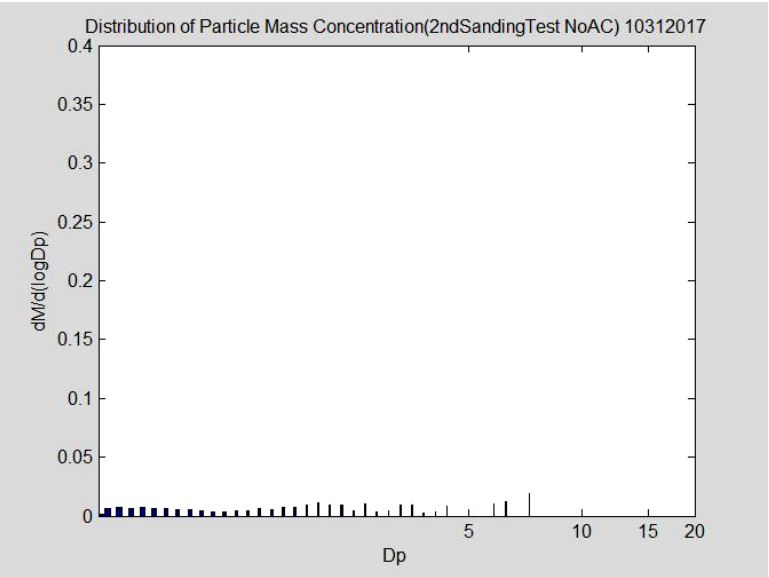




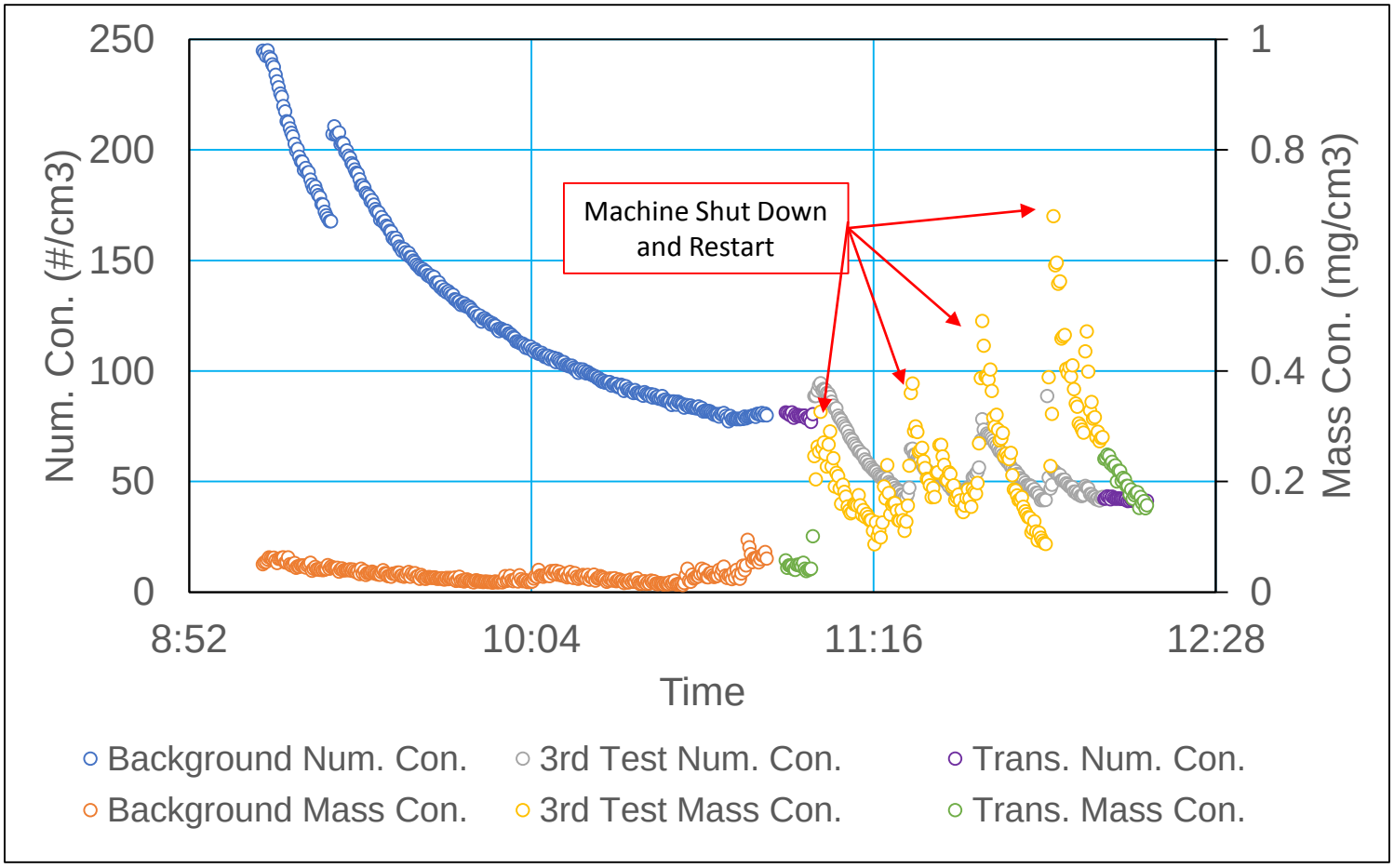




3rd Test 11022017

3rd & 4th Test

3rd Test 11022017



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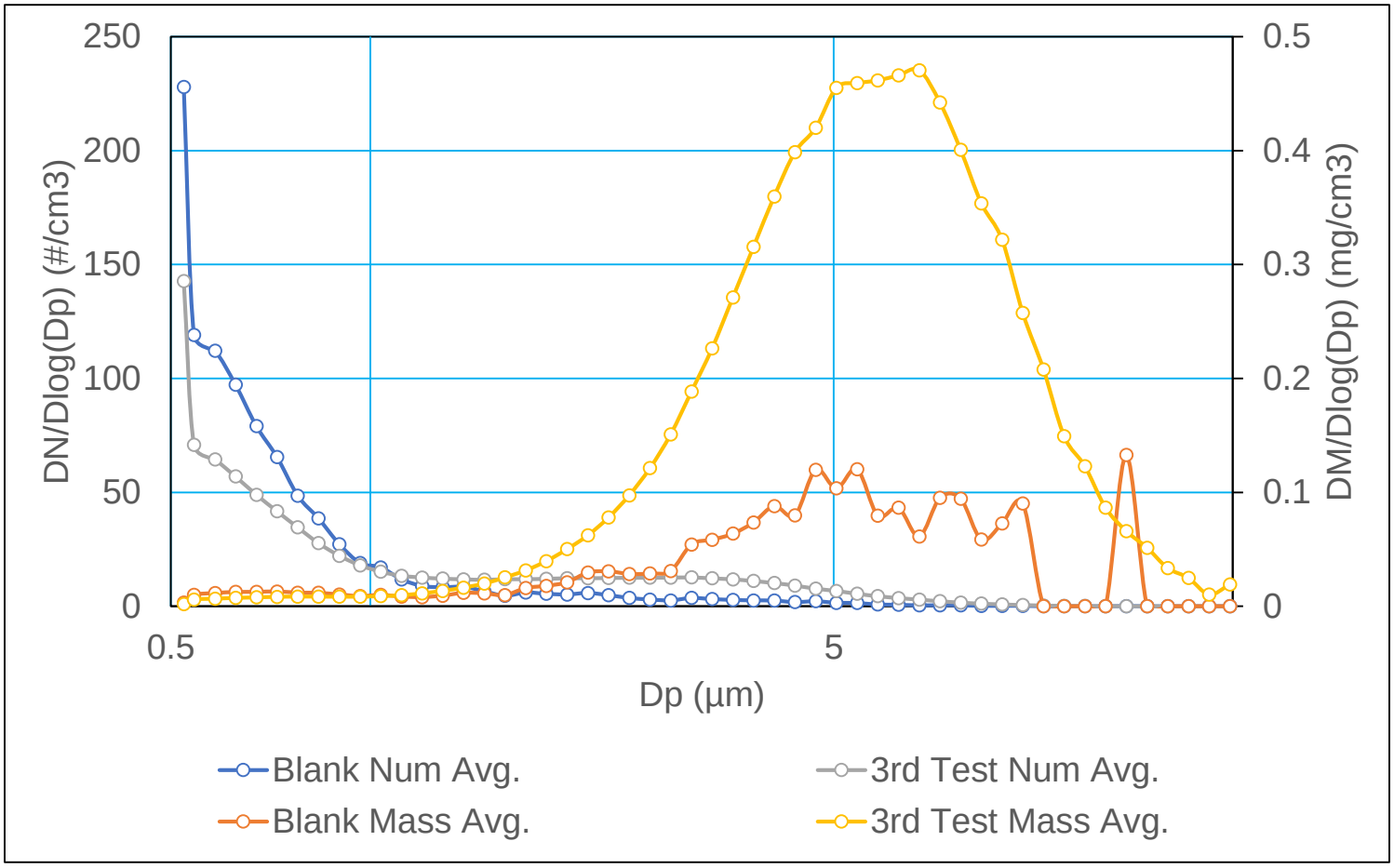

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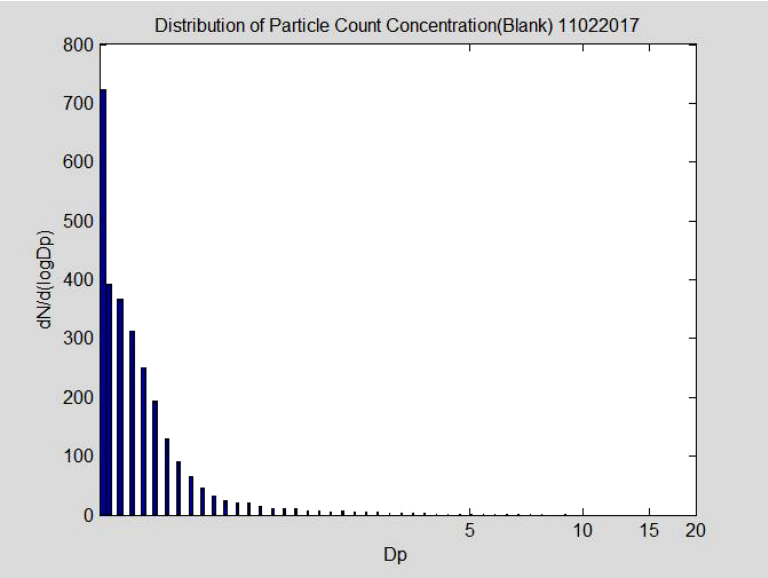

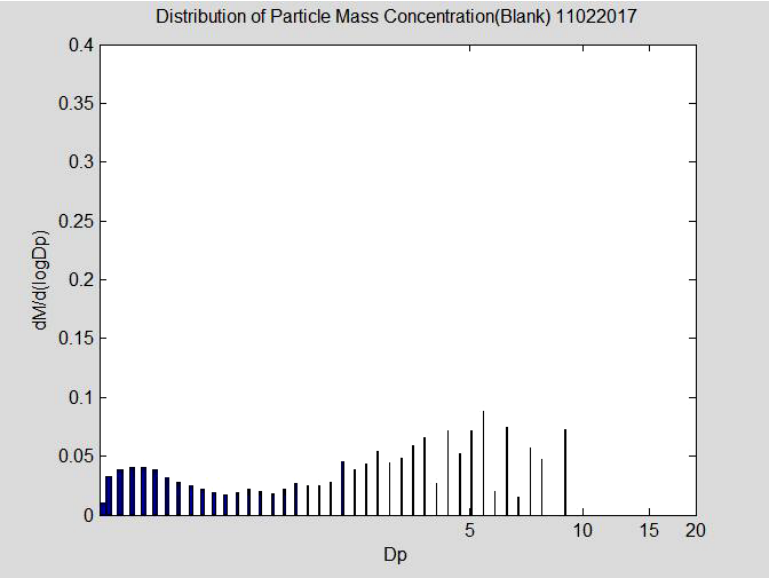

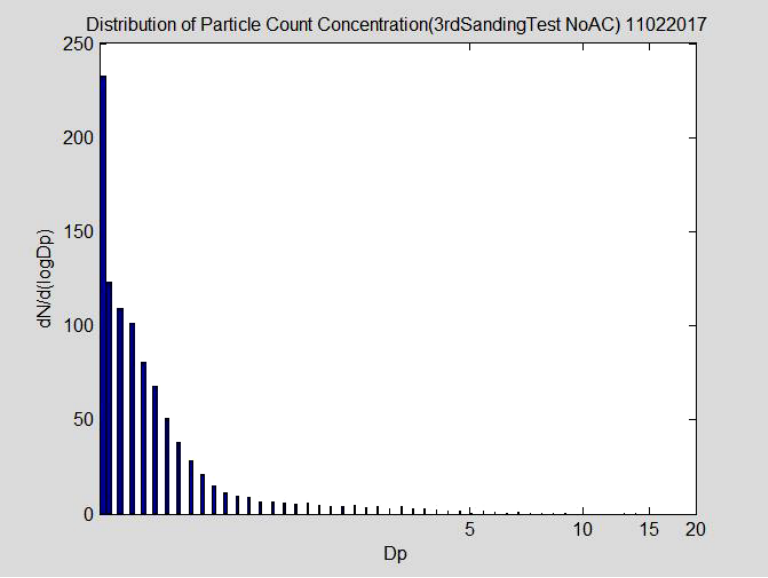

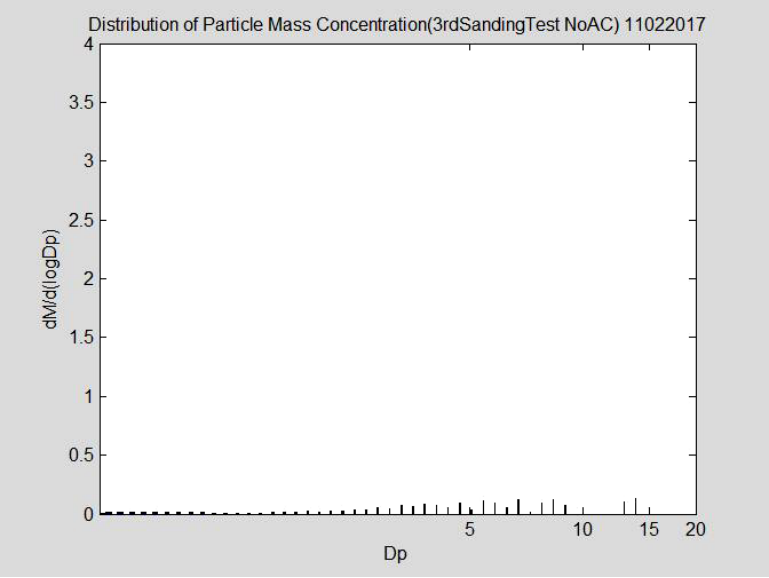

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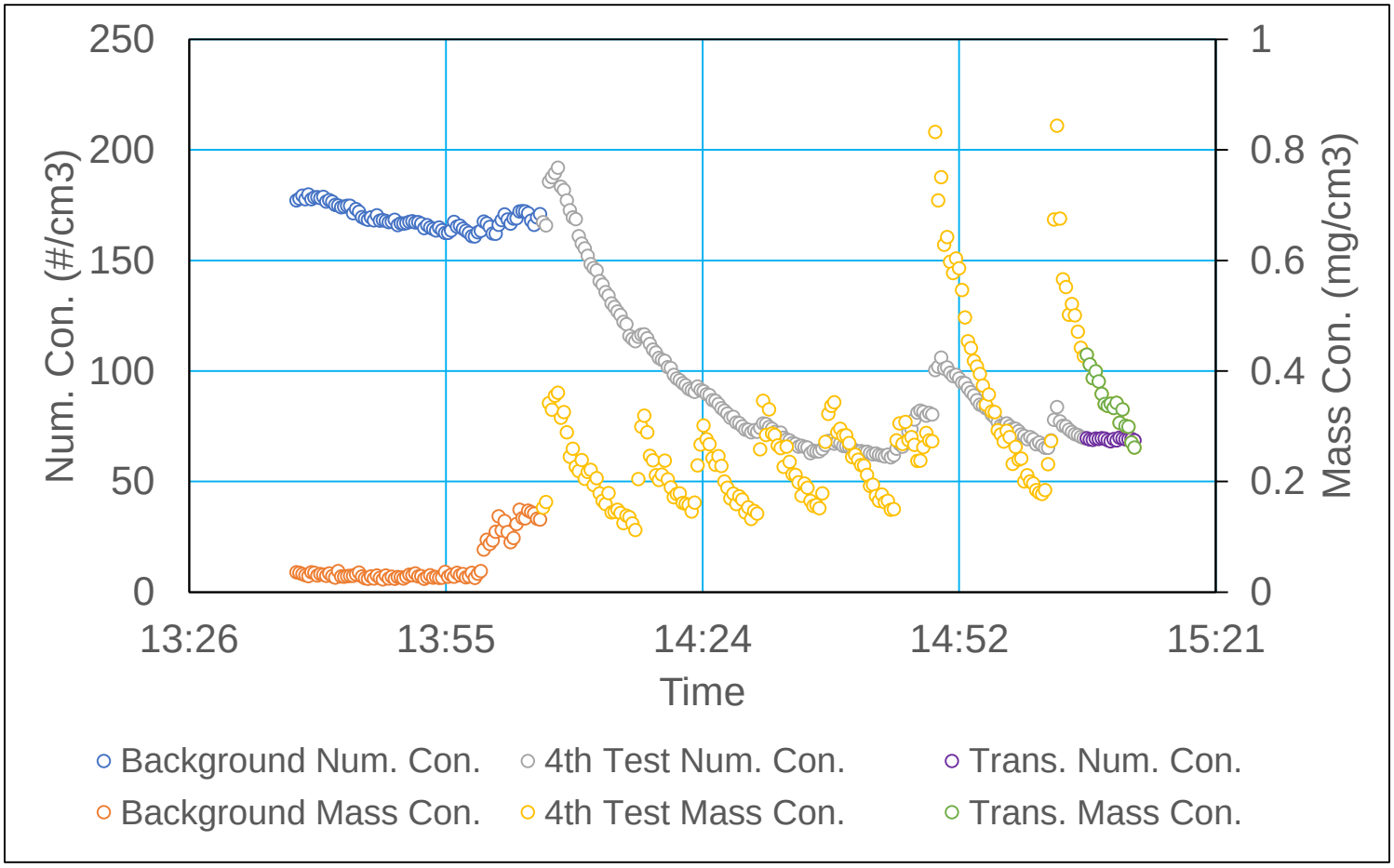

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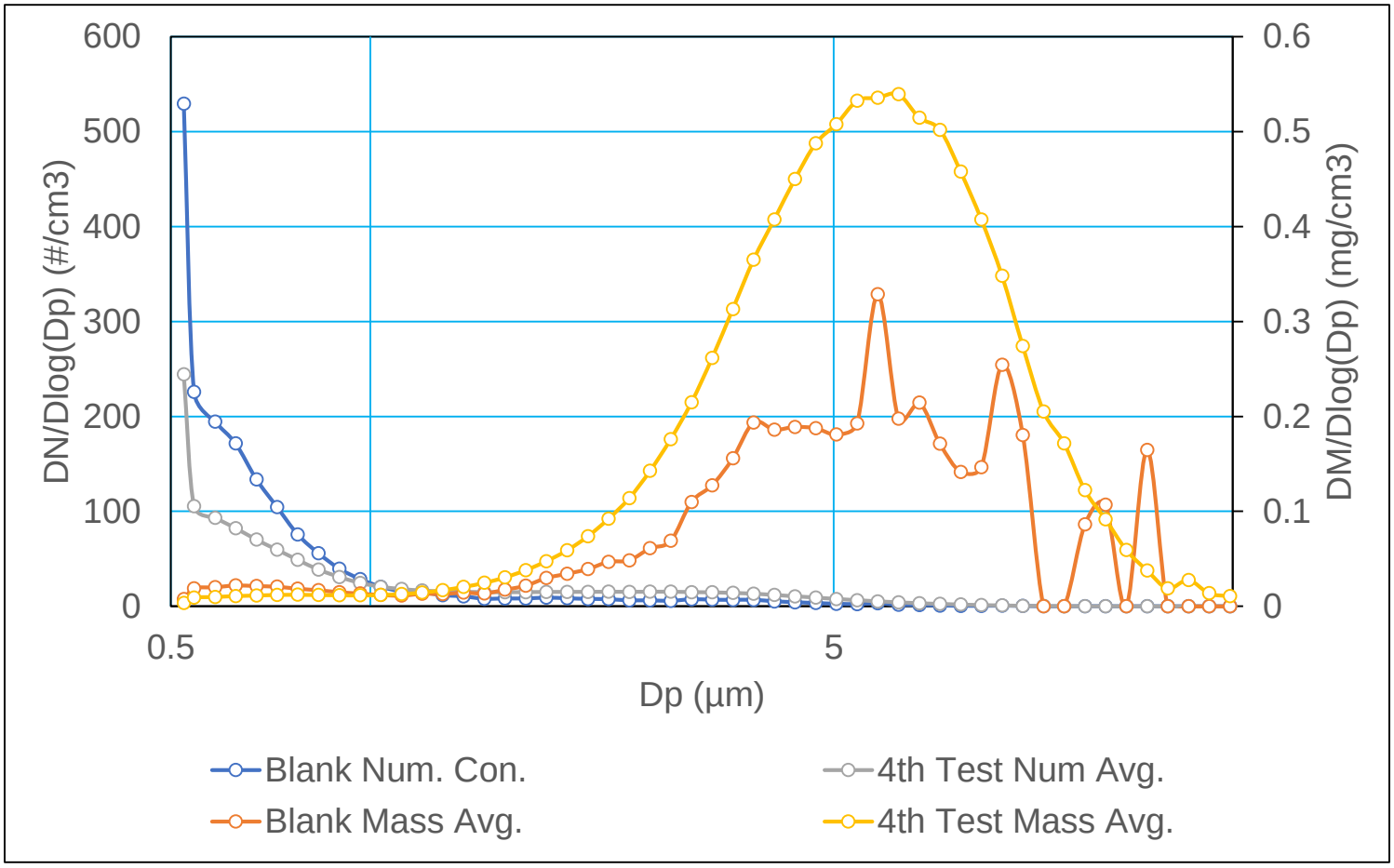

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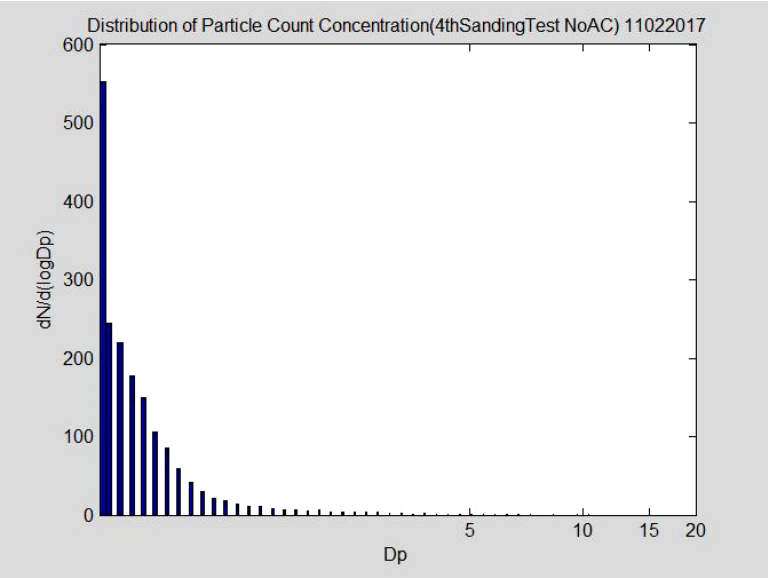
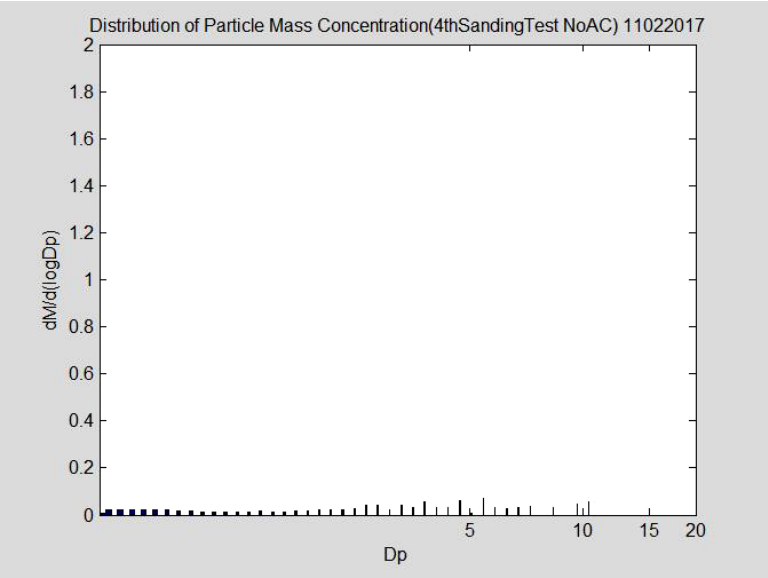
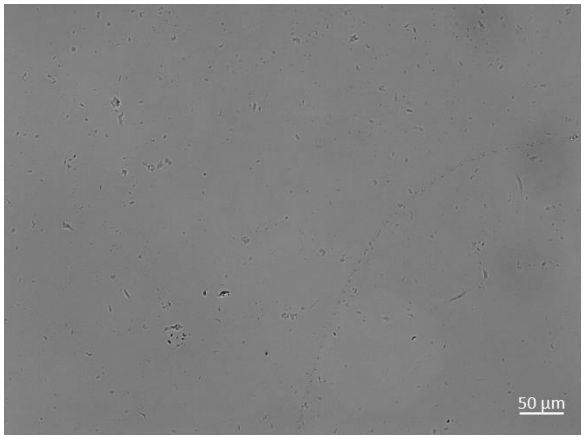




Background Deposition Test



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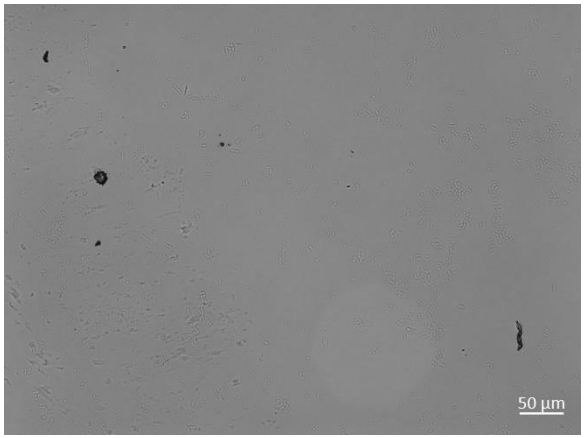

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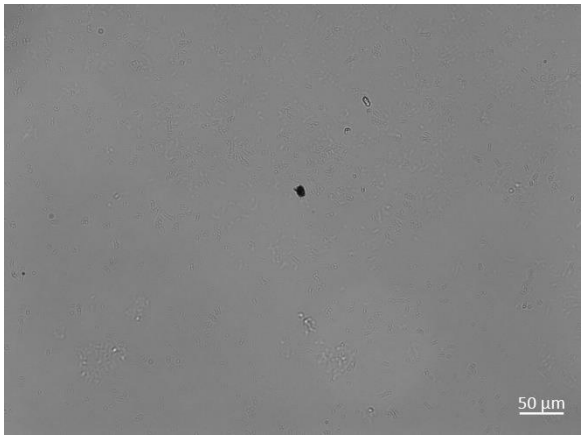

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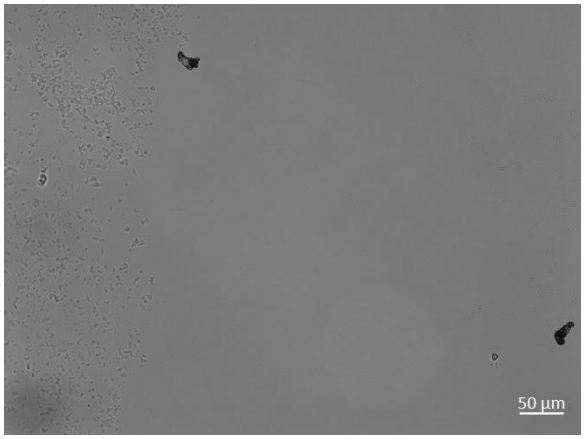
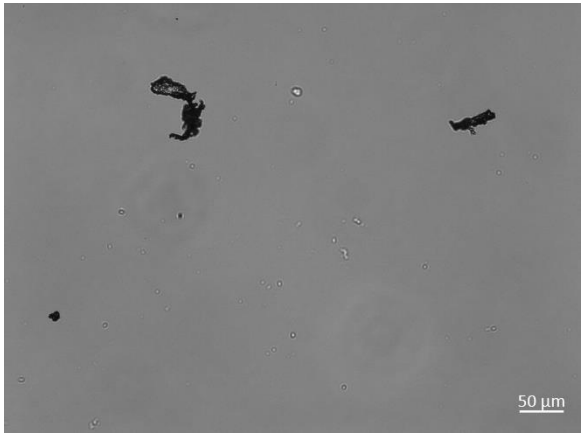
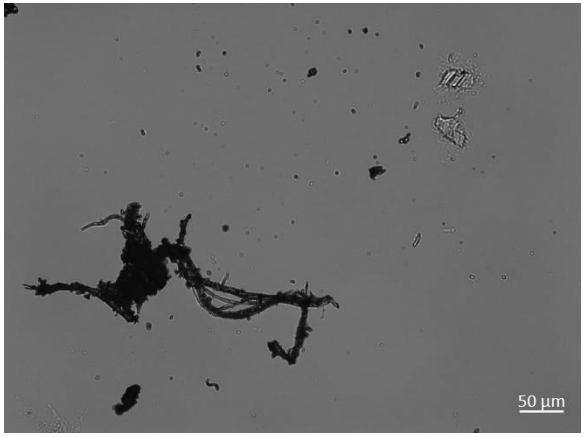


Slide #5

1st Deposition Test



Slide #1



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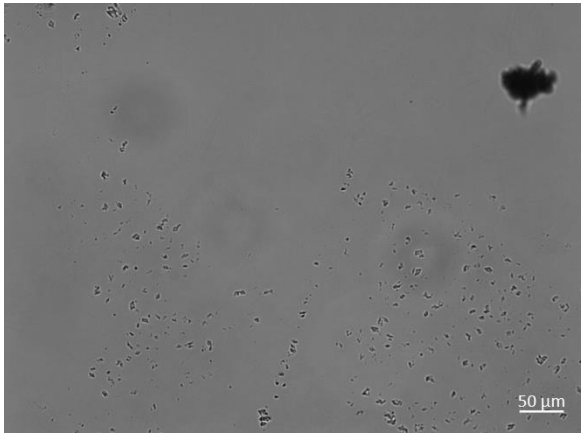

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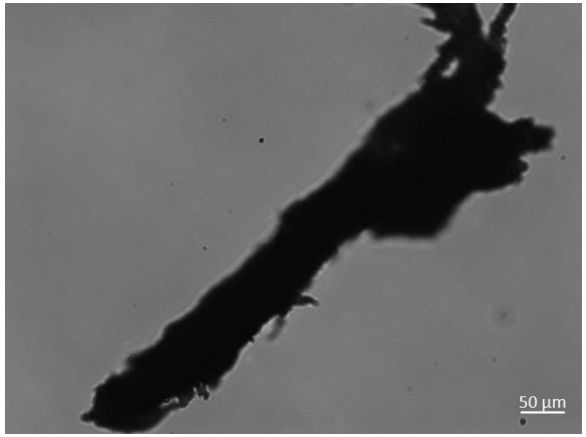

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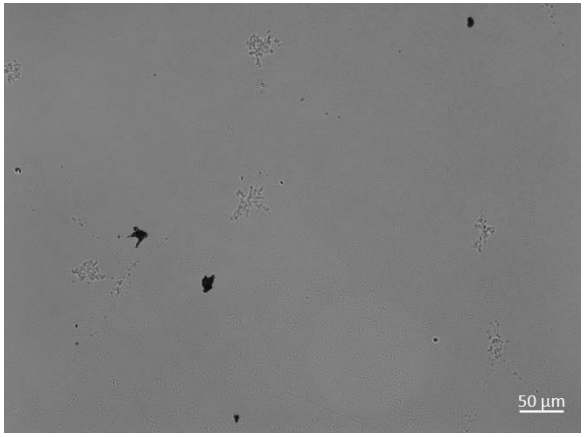
Slide #5

2nd Deposition Test



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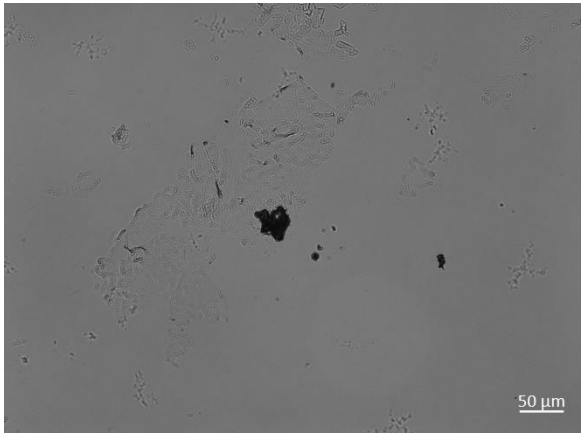

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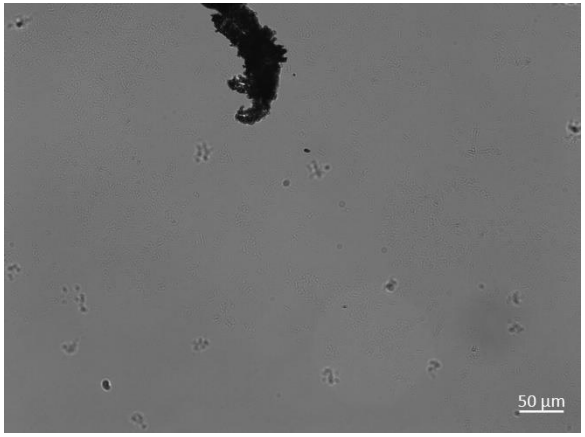

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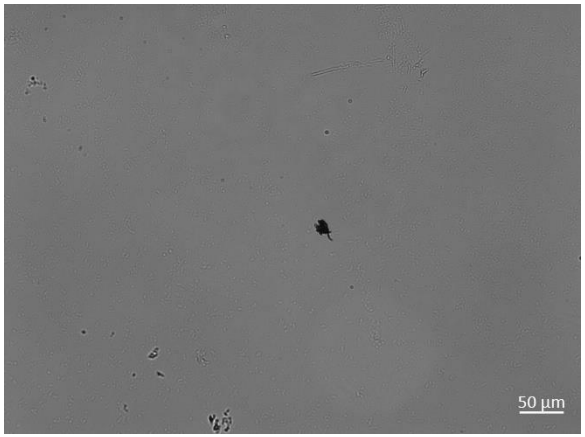

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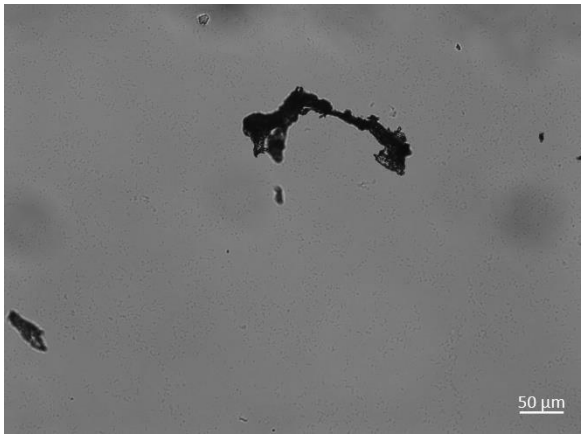

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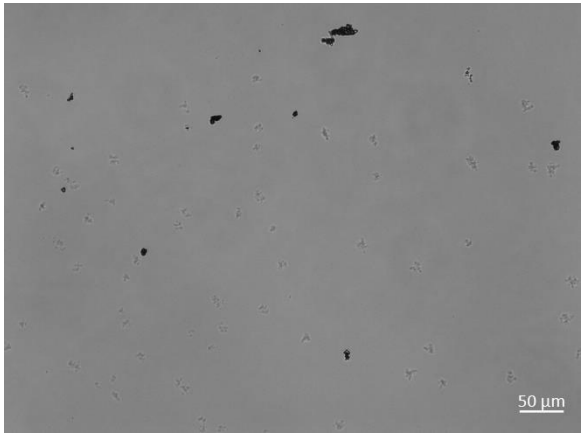
3rd Deposition Test



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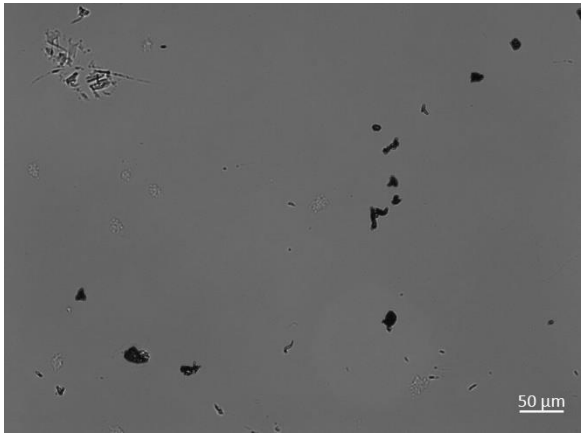
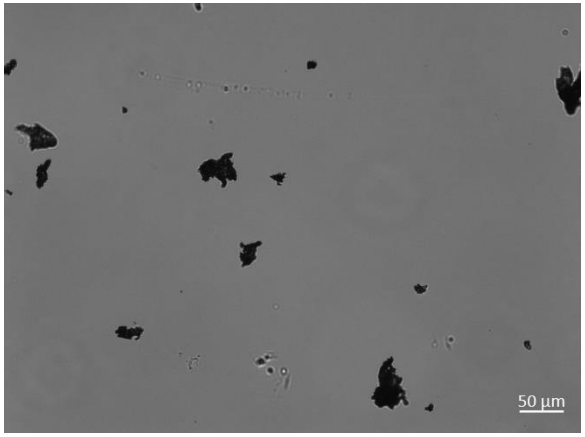


Slide #2

Slide #3

Slide #4

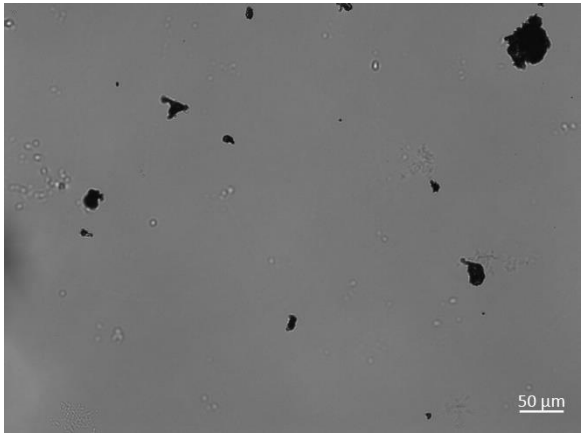


Slide #5

4th Deposition Test

Slide #1

Slide #2



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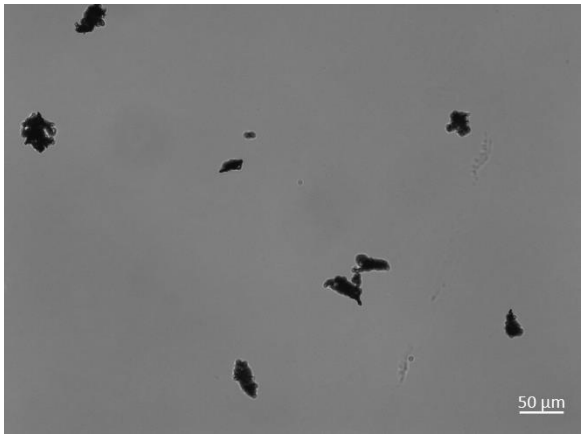

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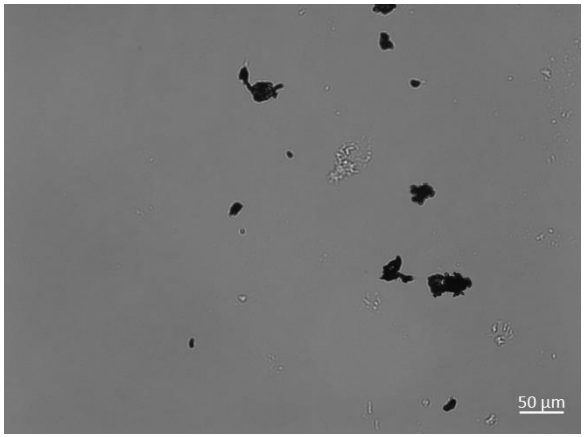

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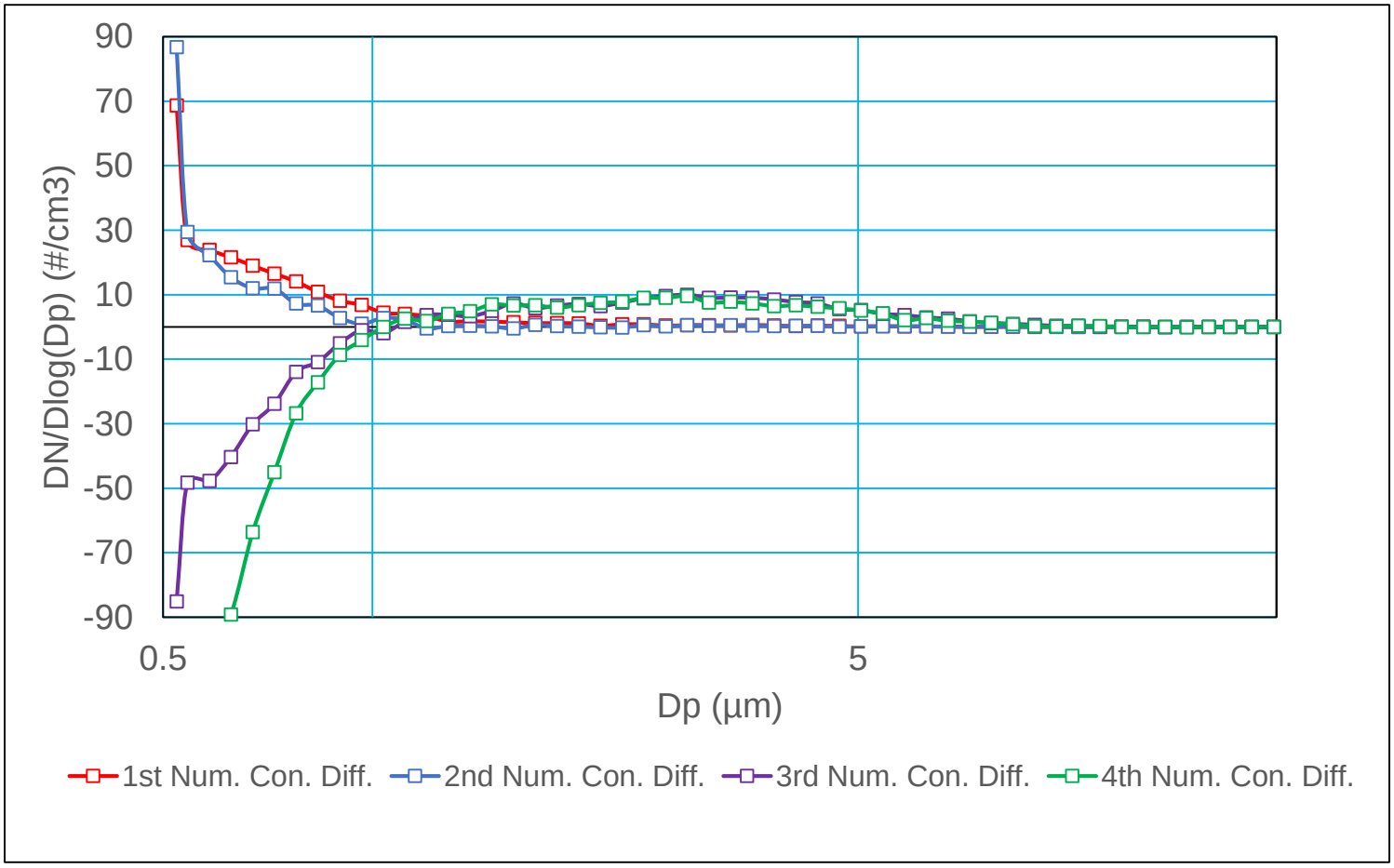
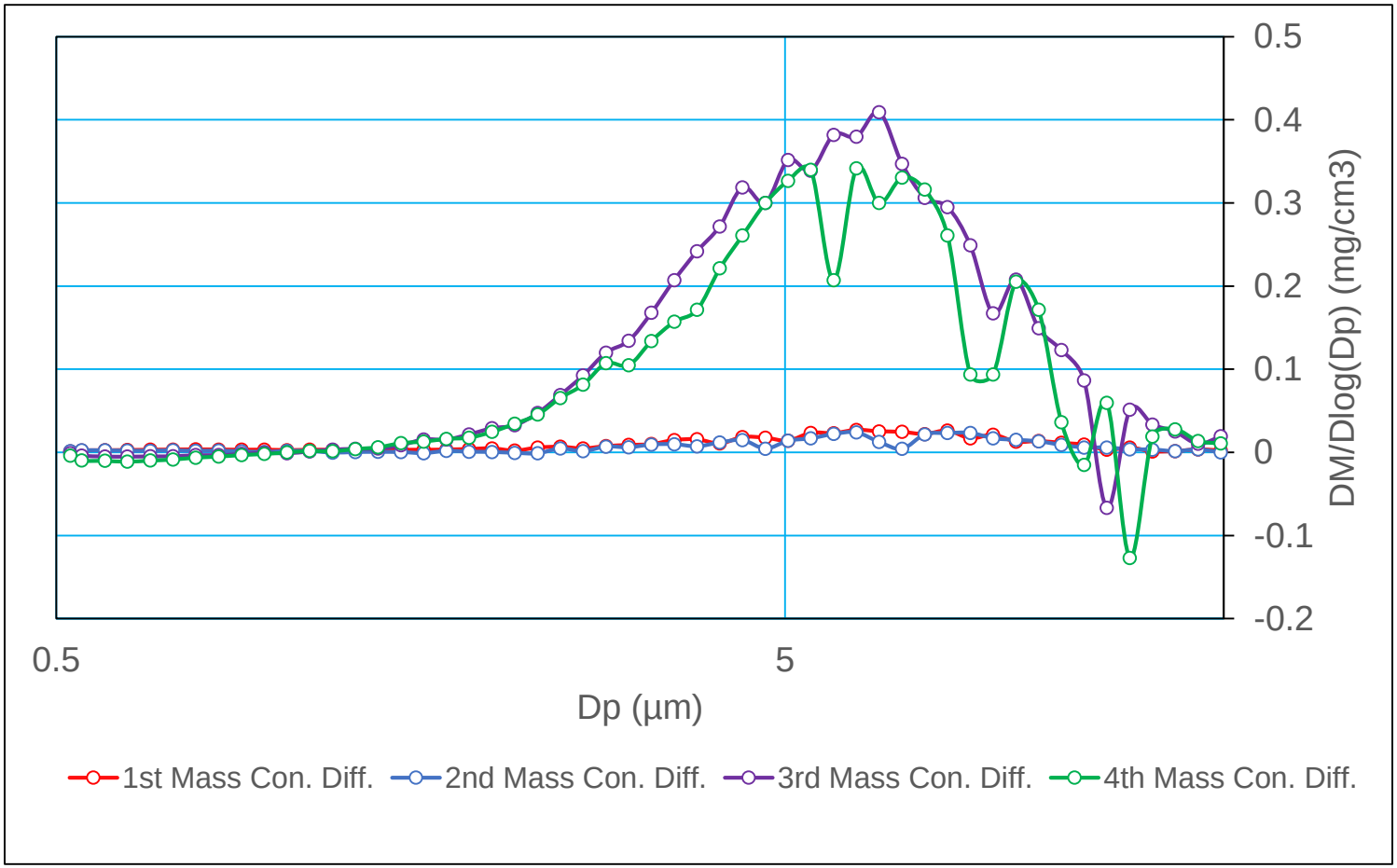
Number Concentration Difference



Mass Concentration Difference



Summary

	1st Test (Coarse, DCS)		2nd Test (Fine, DCS)		3rd Test (Coarse, Bag)		4th Test (Fine, Bag)	
	Num. (#/cm3)	Mass (mg/cm 3)	Num. (#/cm3)	Mass (mg/cm 3)	Num. (#/cm3)	Mass (mg/cm 3)	Num. (#/cm3)	Mass (mg/cm 3)
Backgr ound Con.	6.13	0.0033	41.29	0.0087	79.92	0.0604	170.95	0.1309
Avg. Con.	28.87	0.0165	66.73	0.0195	56.89	0.2457	89.75	0.2776
Increas ed Con.	22.74	0.0149	25.43	0.0108	-23.02	0.1852	-81.19	0.1467
Improve ment	-45.76	**0.1703**	-106.62	**0.1359**	N/A		N/A	
Improve ment %	199	**92**	132	**93**				

Note:

- Improvement= (Num. or Mass Con. Of Bag Test) – (Num. or Mass Con. Of DCS Test);
- Improvement %=Improvement/ (Num. or Mass Con. Of Bag Test) × 100%

Conclusions

- Most of the fine particles come from the background environment;
- The sanding process generates larger particles (Dp > 1 μm);
- The Vortex DCS is able to reduce the total particle mass concentration level by 92~93% in the particle sizes of 0.5-20 μm;
- The Vortex DCS is very effective in reducing the concentration of the larger particles (Dp > 1 μm).