Zeroth Test

What We Hoped to See

(CFD verification, dead zones, and metrics comparison; amount of simulant; use of microscope during this run but with no useful results, so it was not used in the second run; fan speed):
For the Zeroth Test, Team 516 did not aim to collect or analyze any concrete data. Instead, the goal was to rehearse the procedure of the experiment. Ideally, they hoped to see if simulant buildup in predicted dead zone areas matched the CFD gradient image plots.

What We Saw

Simulant buildup occurred in the predicted areas based on the CFD.

Front Top Right:

- Experimental - Some buildup of lunar simulant

Front Middle:

- Experimental - Significant amount of lunar simulant build up relative to front top right and bottom left

Front Bottom Left:

- Experimental - build up on one piece of tape but not on other pieces, significantly less build up compared to the front middle

Back Bottom Left:

- Experimental - Decent buildup of simulant on pieces of tape, amount of simulant on tape decreases with height tape is at.

Back Middle:

- Experimental - Decent amount of lunar simulant build up like back bottom left.

Back top right:

- Experimental - Decent amount of lunar simulant build up like the back bottom left and middle

Note about zeroth run trial: tape grid system was not very systematic, so drawing qualitative conclusions regarding lunar simulant concentrations is difficult.

Challenges We Had

- Placing the fans
- Applying tape (used double-sided clear tape)
- Sealing the glovebox (gasket and yellow tape issues)
- Fan stability
- Insufficient UV lighting
- Natural light interference in the lab room

What We Learned

- Double-sided tape was not an ideal solution
- Bring cloths to block out natural light entering the lab
- The funnel used needed improvement
- More cameras are necessary for better documentation

Great Ideas We'll Take Into the Next Test

- Using tape to compare simulant buildup in predictable regions
- Running extension cords from the ceiling to avoid tripping hazards
- Moving the glovebox off the table during tape application steps for easier access

First Test

What We Hoped to See

(CFD verification, dead zones, metrics comparison, simulant amount, tape application changes, fan speed):

Team 516 hoped to observe noticeable dead zones near the top right of the front or back side of the glovebox. We theorized that low-velocity regions in the CFD would correspond to simulant accumulation.

What We Saw

Contrary to our hypothesis, images taken in low-velocity regions showed little to no simulant accumulation on the tape. This suggests that these areas lacked sufficient force to mobilize simulant particles.

(Please see Appendix A.)

Challenges We Had

- The back-bottom fan was not running for the first ~30 seconds
- Administering the increased 20g of simulant took time, leaving the glovebox unsealed for at least 3.5 minutes
- The top-middle fan fell at 3 minutes and 32 seconds
- Simulant pileup and exposure to open air persisted for most of the run

What We Learned

- A blanket can be used to cover images and reduce light interference
- A dark room is more suitable for UV-based experiments
- Contact with tape (even with gloves) leaves marks
- Consider adding doors for better access to the glovebox's bottom
- Minimize glovebox transportation
- Add clamps or latching mechanisms to stabilize the glovebox
- Explore using battery-operated CPU fans to reduce airflow interference from wires
- Document measurements electronically for optimal organization
- Create a step-by-step checklist for better time and task management

What We'll Take into the Next Test

- Assign detailed roles to each team member
- Take regular breaks to maintain clarity and focus
- Allot extra time for unexpected issues
- Document any procedural changes

Equipment and Products Used

Fans

Computer Fans by Easy Cloud

- 120mm x 120mm
- AC plug, variable speed
- Max speed: 4.25 m/s
- Max airflow: 105 CFM
- Power: 3.3 watts, 12 volts
- 2-pin connector

Singular UV Light *(For close-up imaging)*

LED UV Black Light Bar by REMINDA

- 5 ft cable, 25 watts
- Wavelength range: 395–405 nm
- Dimensions: 15.6 in x 2.2 in x 1.9 in
- Weight: 0.34 kg
- Voltage: 100V–277V

Polycarbonate Sheets

Clear Scratch-, UV-, and Impact Resistant Polycarbonate Plastic Sheets (24”x24”, 24”x36” and 32”x48”) by McMaster-Carr

- Scratch-, UV-, and impact-resistant
- Sizes: 24”x24”, 24”x36”, 32”x48”
- Thickness tolerance: ±0.013"
- Width/length tolerance: -1/4" to 5/8"
- Light transmission: 86%

Funnel

Plastic Funnel by McMaster-Carr

- Capacity: 4.5 fl. oz.
- Height: 3.25 in
- Spout opening: 0.75 in
- Material: Polypropylene

Suction Cups

Shower Mount by Glacier Bay

- Conical opening: 0.91”
- Height: 2.84”
- Base diameter: 3.13”

Gasket

High-Pressure Natural Rubber by McMaster-Carr

- Dimensions: 2" x 36", Thickness: 1/16"

Lunar Dust Simulant

SpaceResourceTech LHS-1D Regolith Simulant

- Uncompressed Bulk Density: 0.79 g/cm^3
- Mean particle size: 7 µm
- Median particle size: 10 µm
- Particle size range: <0.04 – 35 µm

- Quantity: 1000g

Fluorescent Microspheres

Fluorescent Green Polyethylene Microspheres by Cospheric

- Density: ~1.00 g/cm³
- Size Range: 10 µm to 1400 µm
- Fluorescent peak emission: 515 nm (excited at 414 nm)
- 90% of particles within specified range

Bolts

Medium-Strength Grade 5 Steel Hex Head Screw by McMaster-Carr

- Head Type: Hex
- Drive Style: External Hex
- Thread Size: 1/4"-20
- Thread Type: UNC
- Length, 1 1/4"
- Width: 7/16"
- Height: 5/32"
- Material: Steel

Nuts

Medium-Strength Grade 5 Steel Hex Head Screw by McMaster-Carr

- Material: Zinc-Plated Steel
- Thread Size: 1/4"-20
- Width:7/16"
- Height: 7/32"

Washers

Zinc Yellow-Chromate Plated Grade 8 Steel Washer by McMaster-Carr

- For Screw Size: 1/4"
- ID: 0.281"
- OD: 0.625"
- Thickness: 0.051" to 0.080"

UV Lights (from Home Depot)

Feit Electric LED UV Spectrum Plant Grow Light

- Length: 24 in
- Power: 19 watts
- Light intensity: up to 32 PAR/PPF
- Cord: 5 ft, Voltage: 120V

Pressure Testing Valve

On/Off Laboratory Valve for Air and Gas

- Chrome-plated brass
- Dimensions: 3 7/8” x 1 ½"
- Max pressure: 125 psi
- Thread type: NPT, pipe size: 3/8”

Pivot Joints and Fan Mounts

- 3D printed using PLA
- Connected using M6 x 40mm socket head screws and M6 x 1.00 nuts
- Waterproof spray used to reduce adhesion and prevent simulant settling

Camera Settings

- Mode: Manual
- Shutter Speed: 1/100
- Aperture: f/5.6
- ISO: 800
- White Balance: Auto Ambience Priority
- Autofocus: One Shot
- Stabilizer: On
- Picture Style: Neutral
- Auto Brightness Correction: Off

Glovebox Grids Explanation

Tape Placement Reasoning

Tape grids were added to assist with alignment and spacing. Back areas were targeted to corroborate CFD zones of interest. In the Zeroth Run, grids were not used; instead, tape was placed in dead zones and in the center (non-dead zone) for comparison. This helped reference CFD simulations, which are semi-symmetrical—meaning "front" and "back" designations in ANSYS are arbitrary.

Camera Heights and Positioning

Three cameras were placed on the glovebox's backside, each ~2 inches from the surface. Heights from glovebox floor:

- 4 inches
- 10 inches
- 16 inches

Each was aligned with a key zone of interest on the glovebox's back.

Picture Comparisons and Discussion

Dead Zone vs Center Image Comparison

CFD identified two potential dead zones:

1. Bottom-left corner
2. Above the front fan near the ceiling

Photos of these were compared with the back center image (non-dead zone). Simulant buildup was higher in active regions, confirming that dead zones show minimal buildup.

Front Center vs Back Center Comparison

Both regions are non-dead zones per CFD. Experimental results showed a lack of simulant buildup, supporting the CFD assessment.

Video Recording Analysis

Inconclusive results due to poor resolution.

1st Trial – CFD vs Experimental Results

Center Front

- CFD: No dead zone; velocity ~1.187–2.37 m/s
- Experimental: Significant simulant buildup

Front Top Right (Above Front Fan)

- CFD: Dead zone
- Experimental: No simulant buildup

Bottom Left Front

- CFD: Dead zone very near wall
- Experimental: Slow buildup; overall low accumulation. Possibly due to zone being *near* wall, not directly on it (as seen in teal to light green streamlines).

Back Middle

- CFD: No dead zone
- Experimental: Moderate simulant buildup

Back Bottom Corner

- CFD: No dead zone
- Experimental: Moderate simulant buildup, similar to back middle

Note on 1st Trial

Increased simulant amount made administration difficult. Funnel remained unsealed for an extended period. Additionally, the middle fan detached mid-run, likely affecting airflow and result validity.

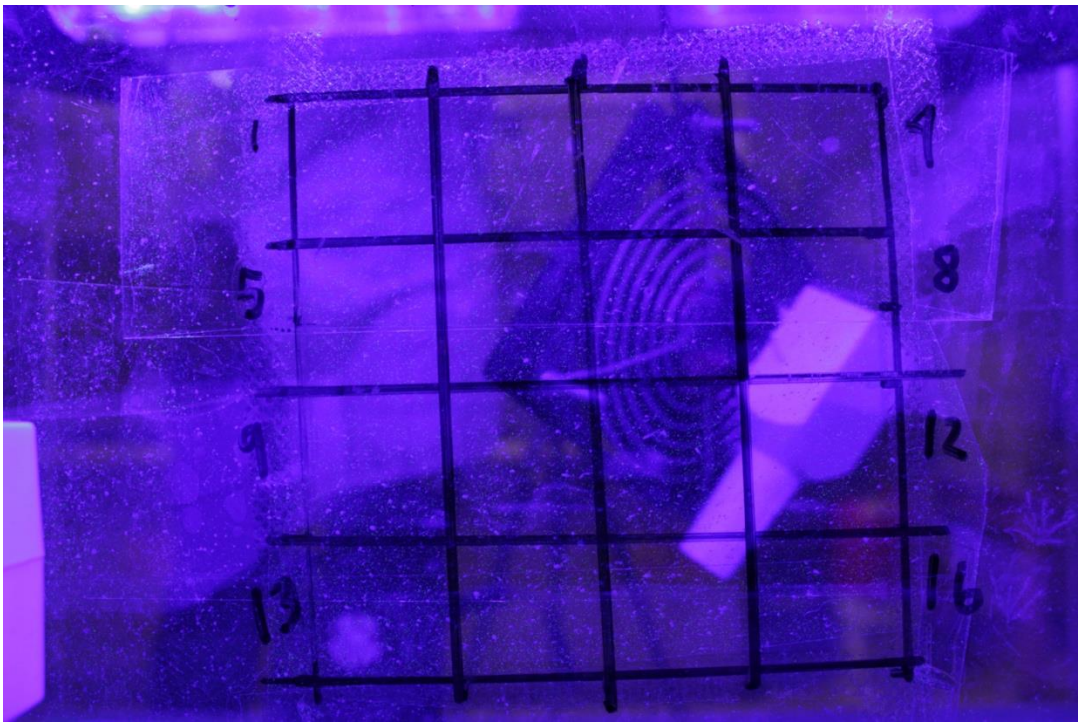
Overall back side trend: the closer to the ceiling the less simulant built up, the closer to the middle and the bottom the more simulant built up. Pieces of tape that are closer to the funnel entrance had larger amounts of simulant compared to those further from it. There are no dead zones located on the back side wall according to the CFD model, and the results regarding the lunar simulant distribution from the front side of the glove box are consistent from the middle to the bottom of the back side wall.

Overall left side wall trends: the closer the pieces of tape are to the funnel entrance the more lunar simulant will build up on the tape. Since the left side wall is closer to the funnel entrance, the left side wall will have overall more simulant than the right-side wall.

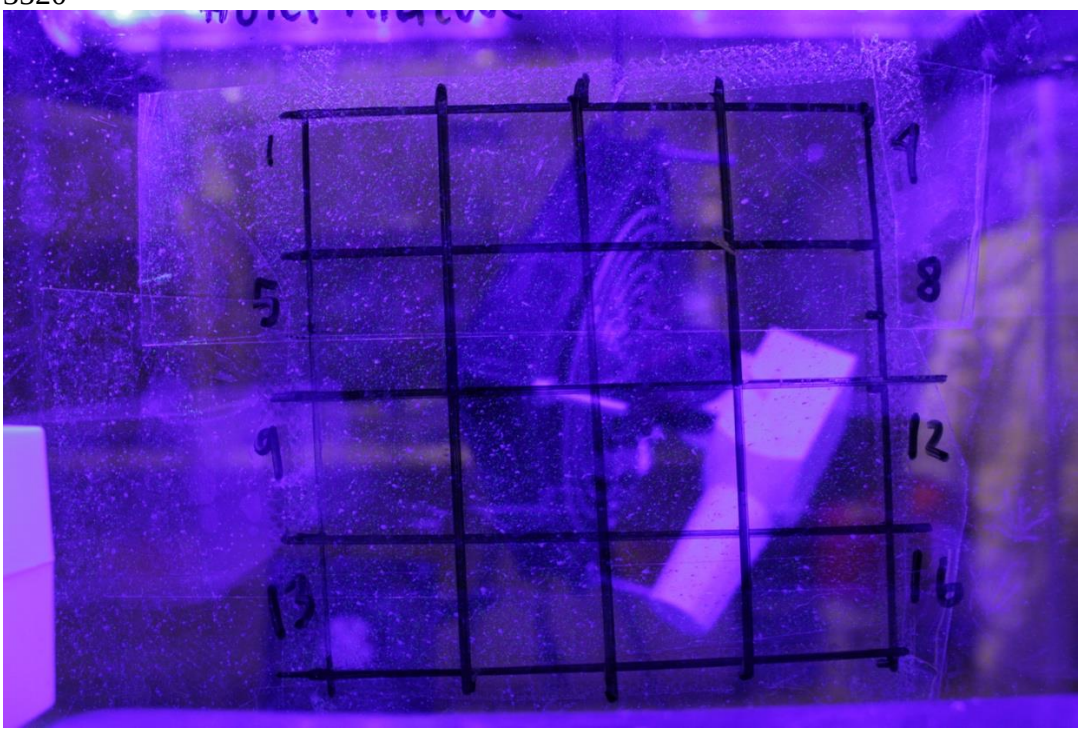
Overall right-side wall trends: More simulant built up on the left side of the right-side wall (further from the funnel enclosure), which could be due to the how the simulant was entered into the glove box with the back side fan pointing toward the front wall. The most amount of simulant seems to be built up around the middle, left side of the right-side wall of the glove box.

APPENDIX A:

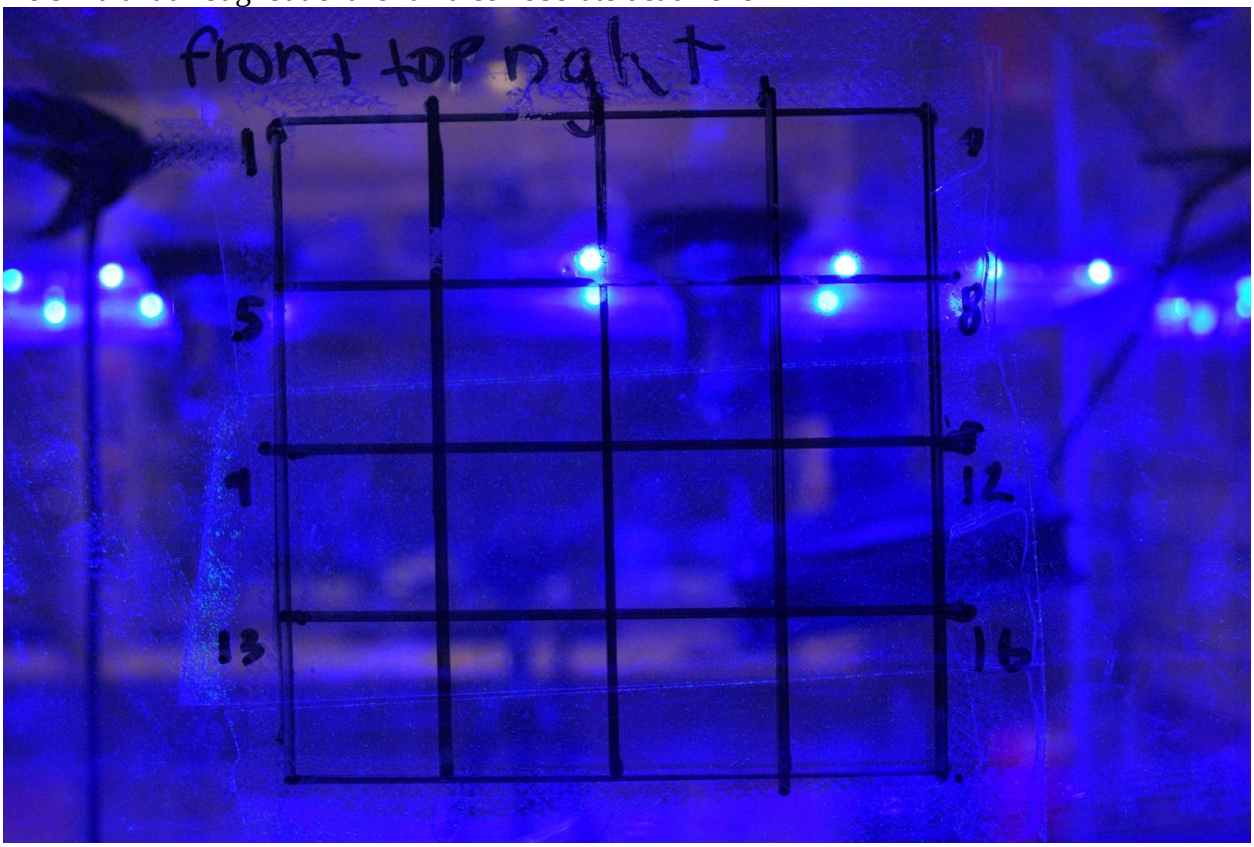
Center Front:
Most simulant in center
More than bottom or top so we can assume there is more simulant in the middle
Simulant accumulation throughout à simulant lofts
3513 – before fan fell



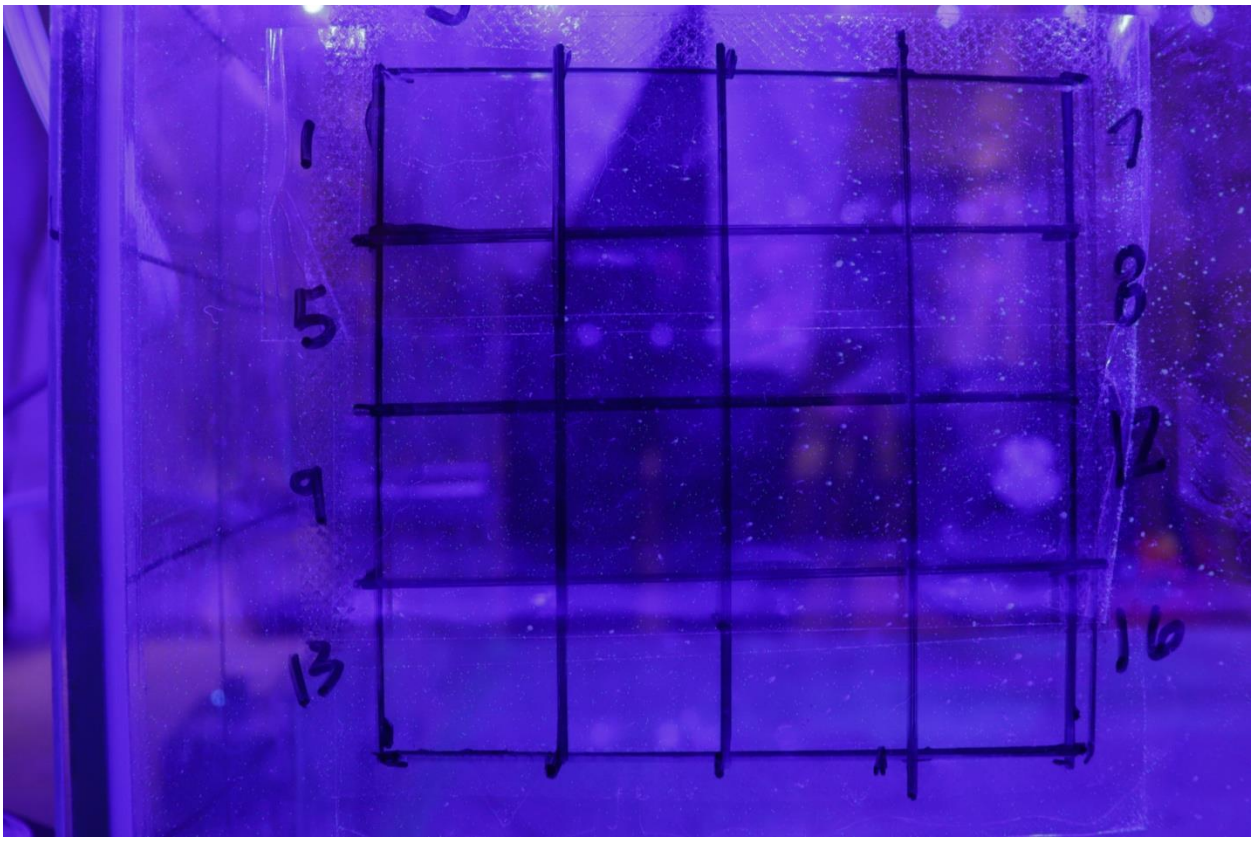
3520



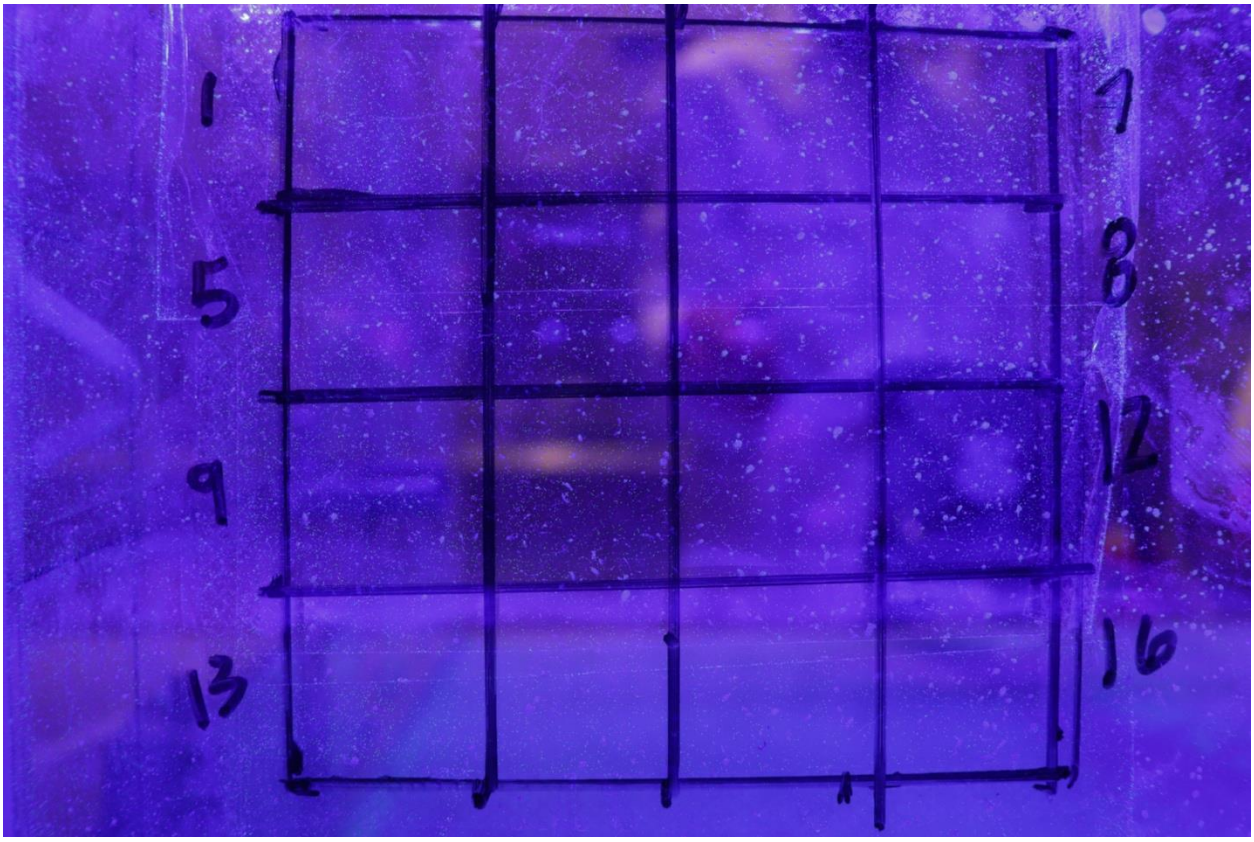
Front Top Right:
2577
No simulant throughout entire run à corroborate dead zone



Bottom Left Front:
2771- before

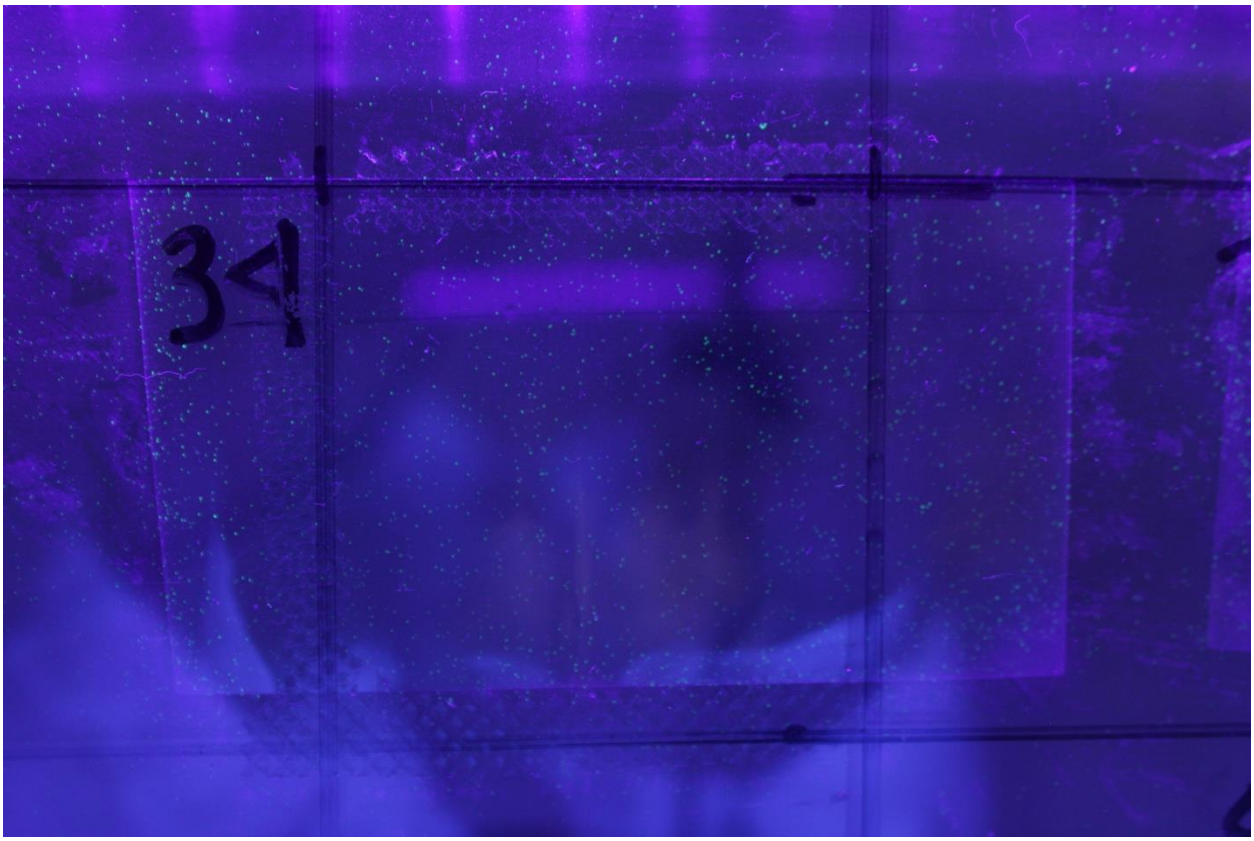


2794



Significant simulant accumulation throughout which is good because it lofted when the fans ran

Back:
34: 3636



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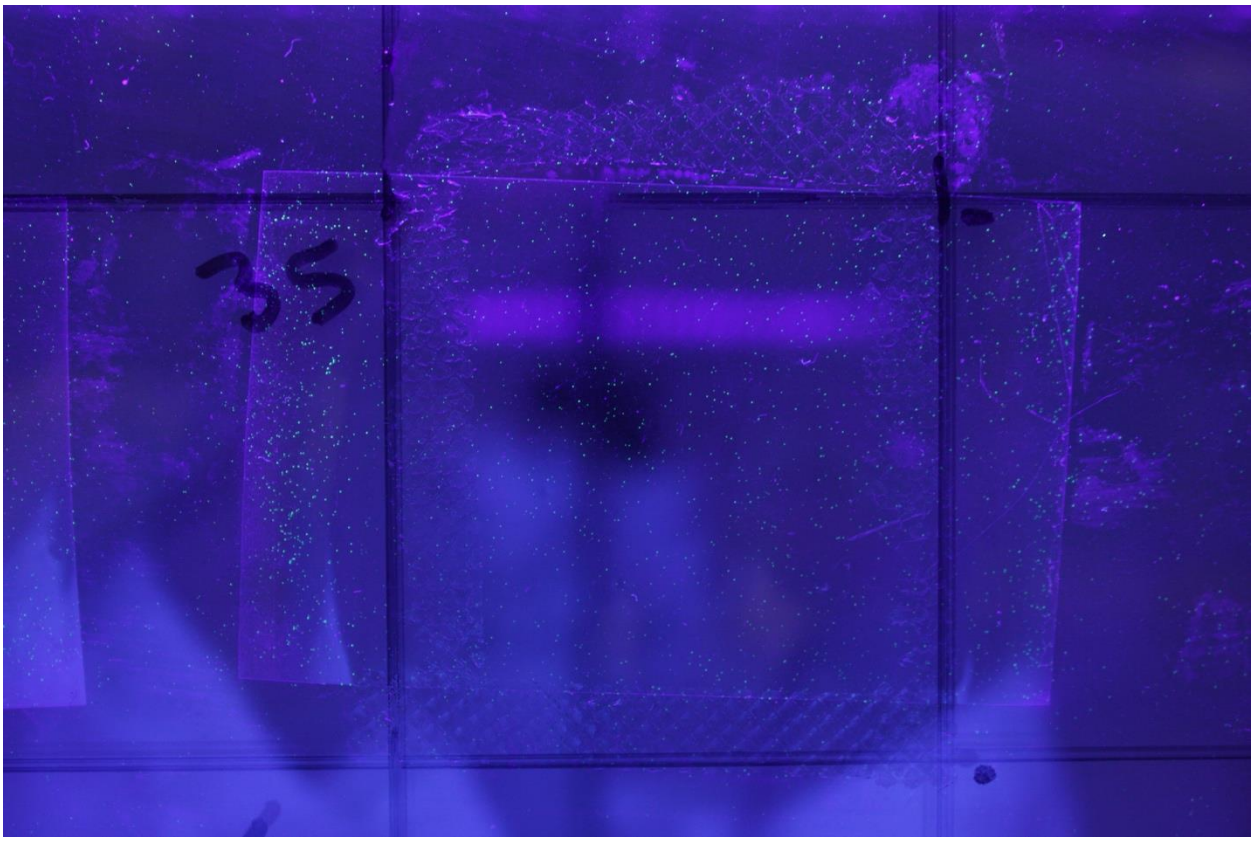
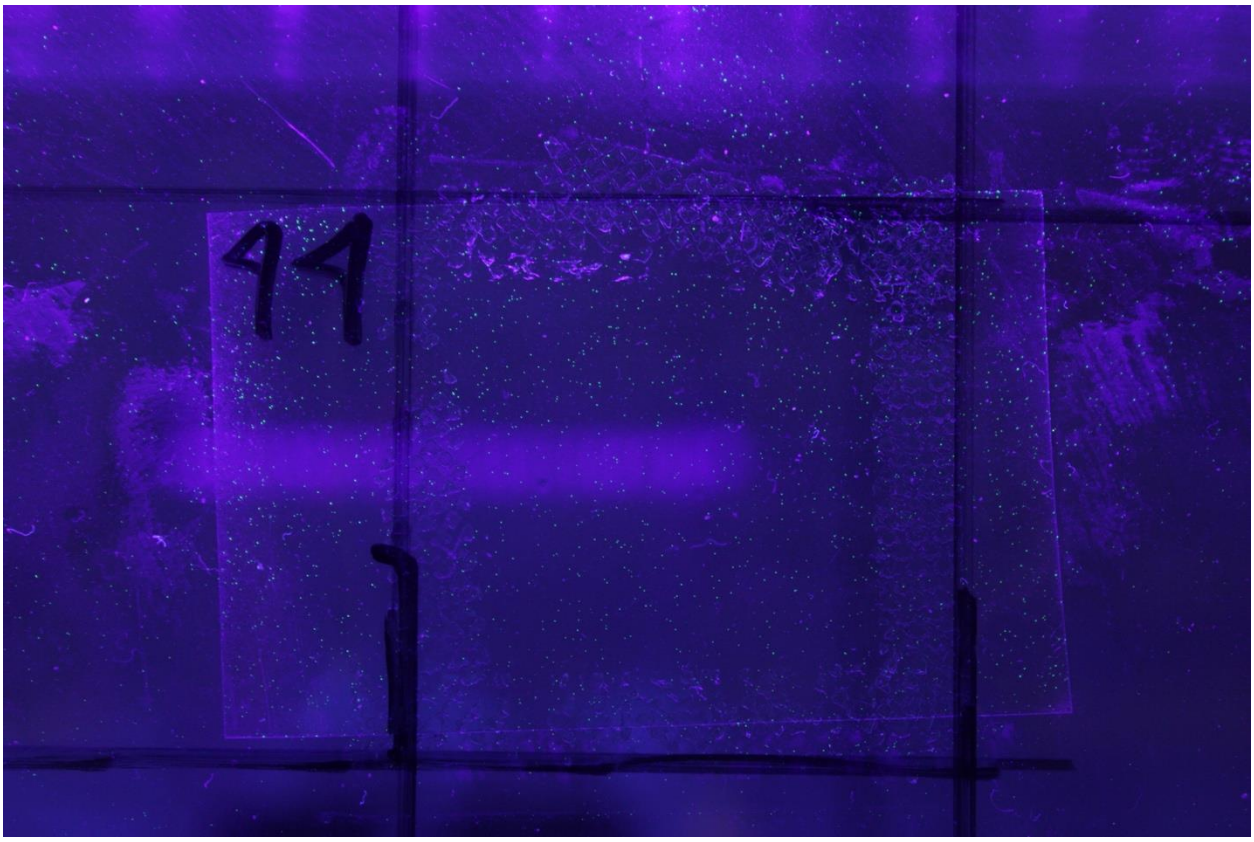
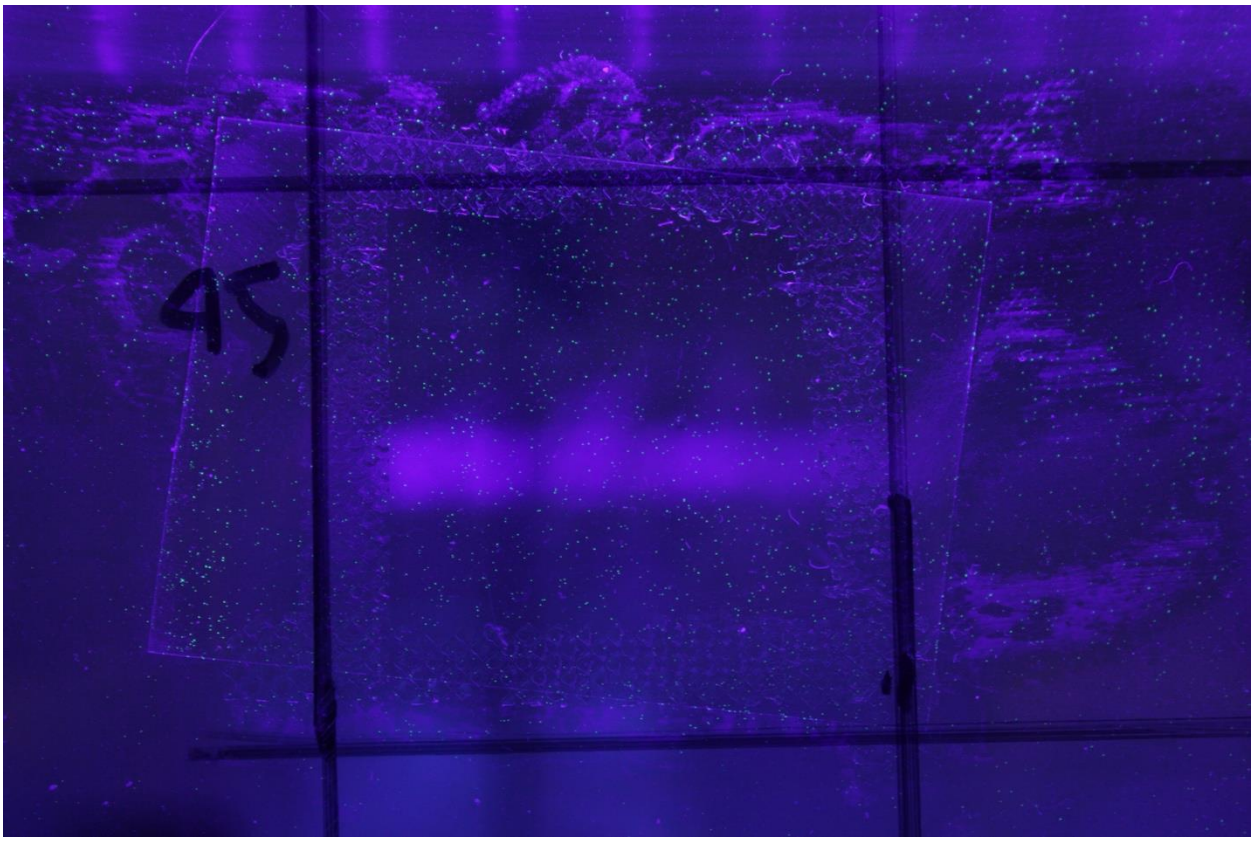


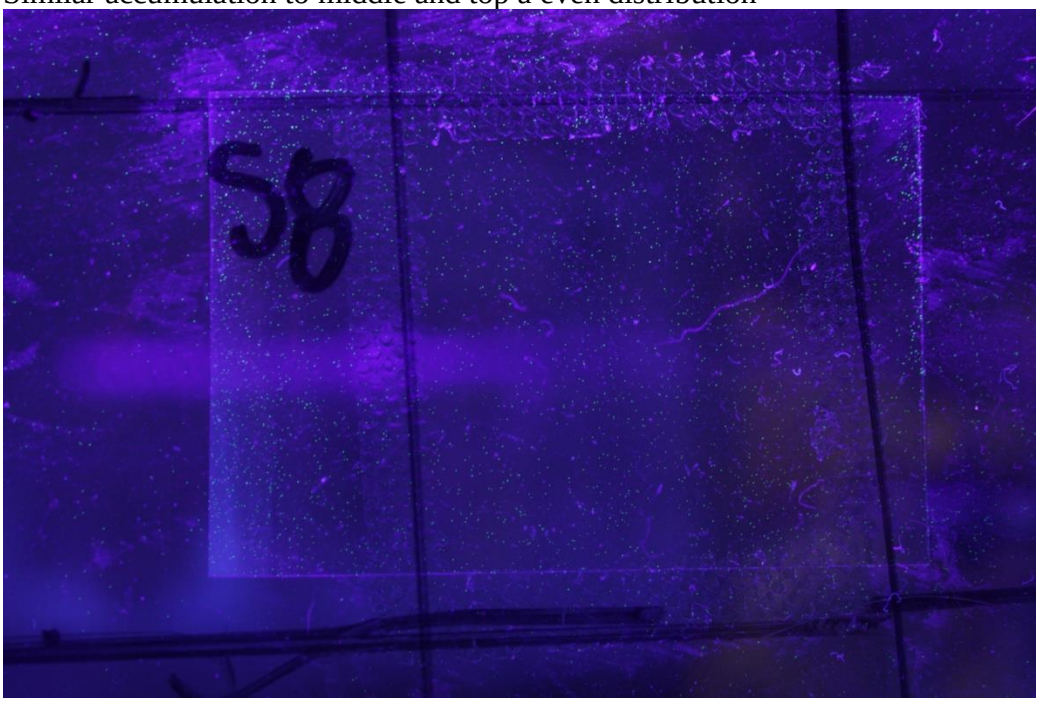
44: 3662



45: 3665



Back bottom corner: 3684 and 3687
Similar accumulation to middle and top à even distribution

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