# MEASURING SLIPSTREAM DRAG

ME30801 Fluid Mechanics Lab, Open Lab Project

Team D1T21

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# What is Slipstreaming?

- Also known as “drafting”
- Driving technique where one vehicle closely follows another to reduce air resistance
- Commonly used in motorsports to gain efficiency [1]
- Possible (albeit dangerous) for a passenger vehicle to slipstream behind large trucks on the highway

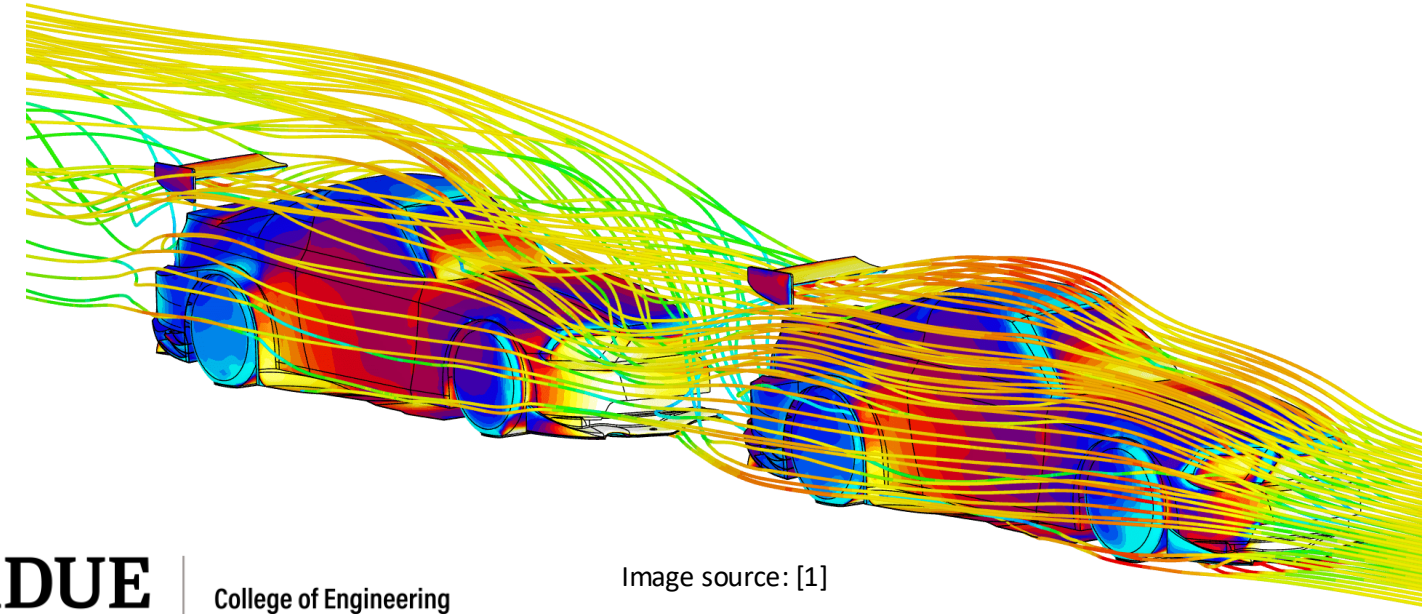
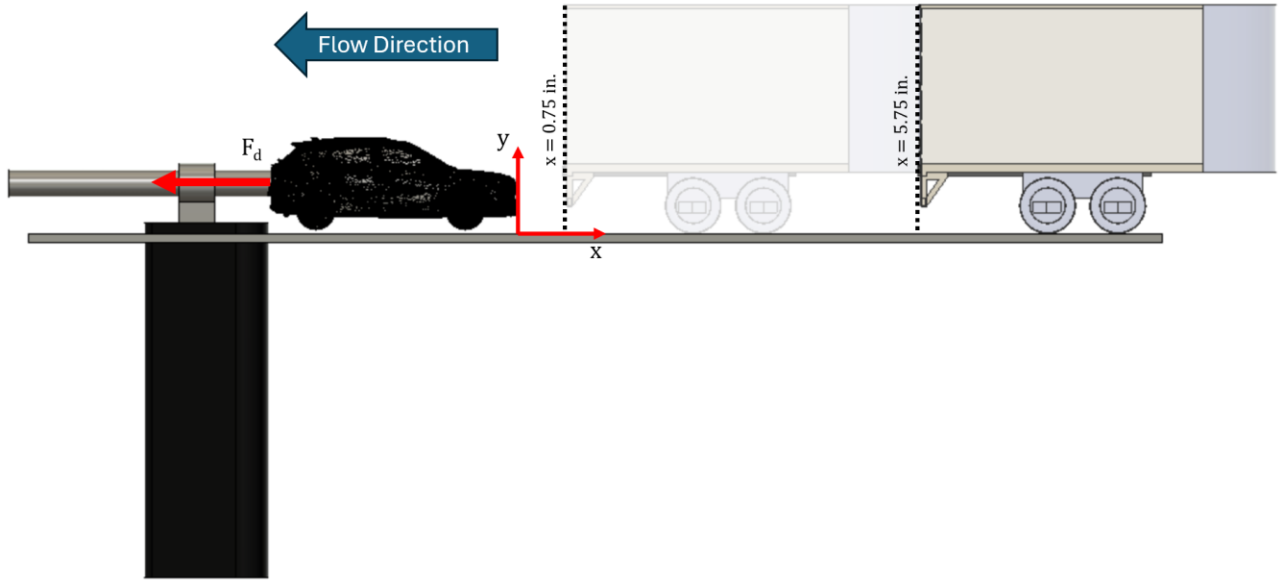


Image source: [1]

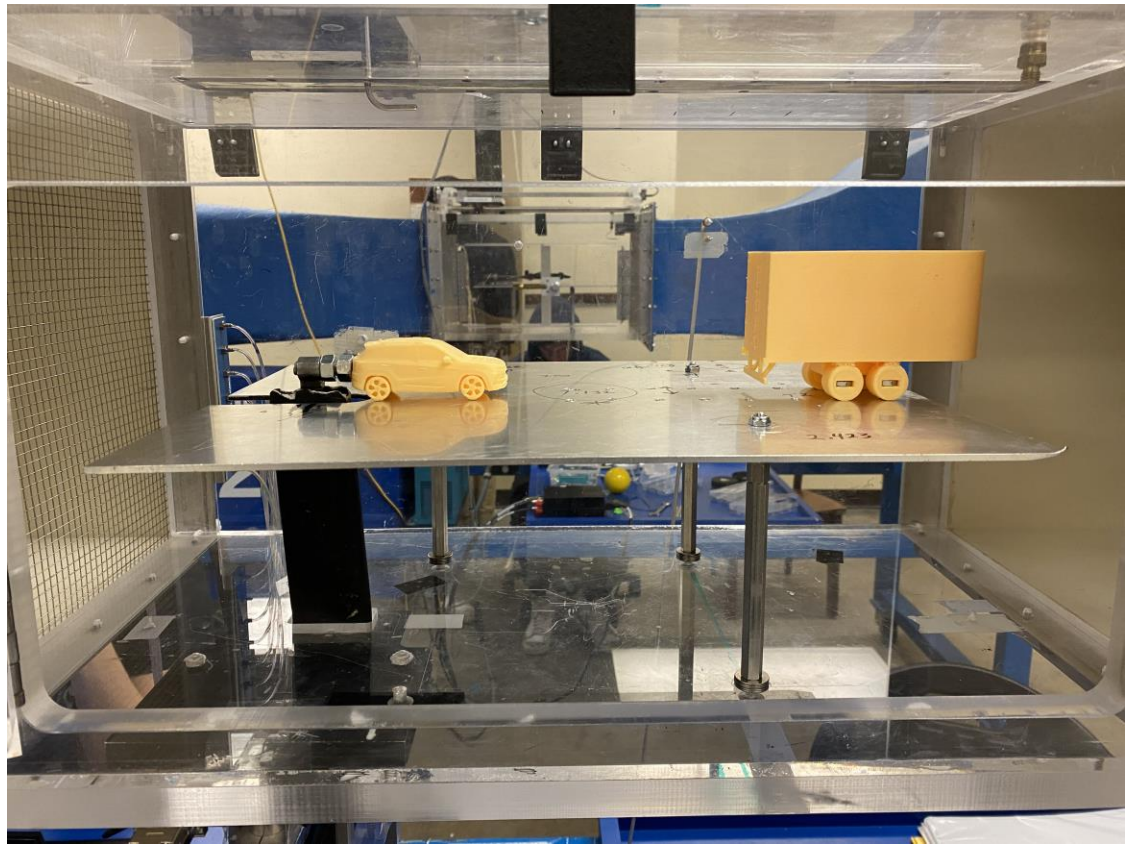
# Experiment Objectives

- Define the relationship between the drag force and the distance between a car and a semi-truck
- Determine the impact speed has on slipstreaming behind a truck
- Deduce the most efficient distance and speed to slipstream behind a semi-truck



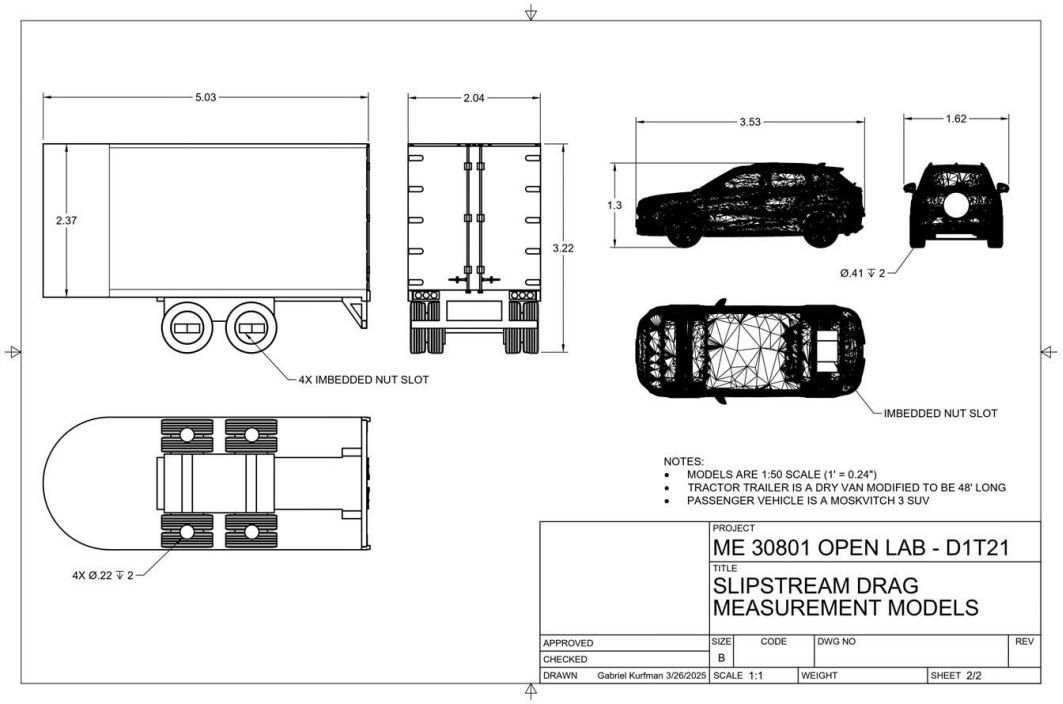
# Facility and Instruments

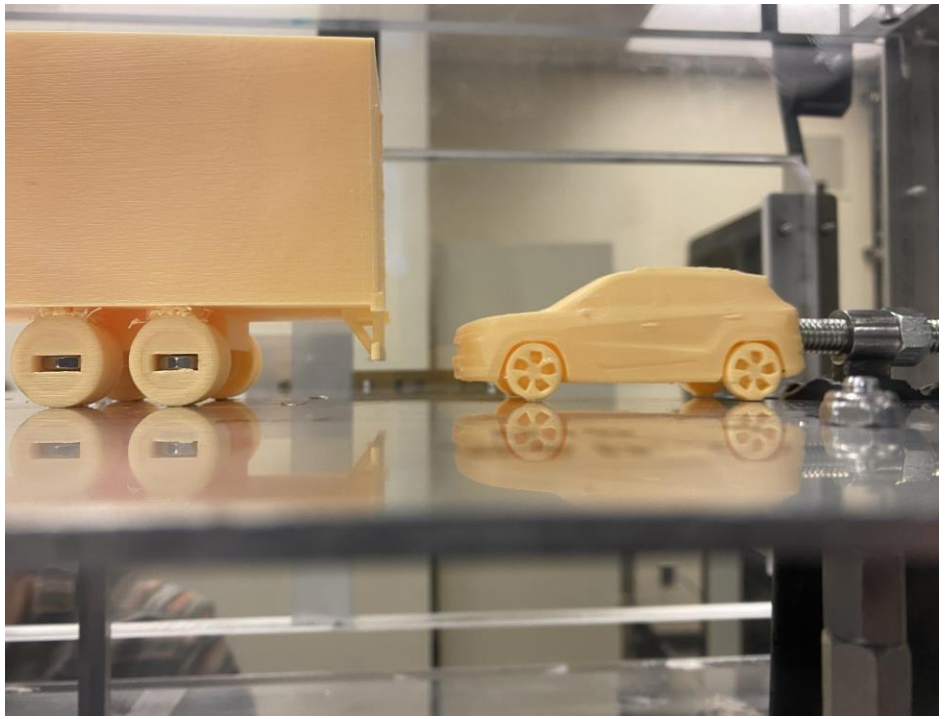
- **Wind Tunnel:** ELD 402B
  - 61×30.5×30.5 cm test section
  - 3–48 m/s wind speed
- **Force Measurement:** LVDT dynamometer
  - 0–100 N range
- **Data Acquisition:** NI USB-6341
  - Force and position readings
- **Environment Monitoring:**
  - Mercury barometer
  - Thermometer



# Test Models

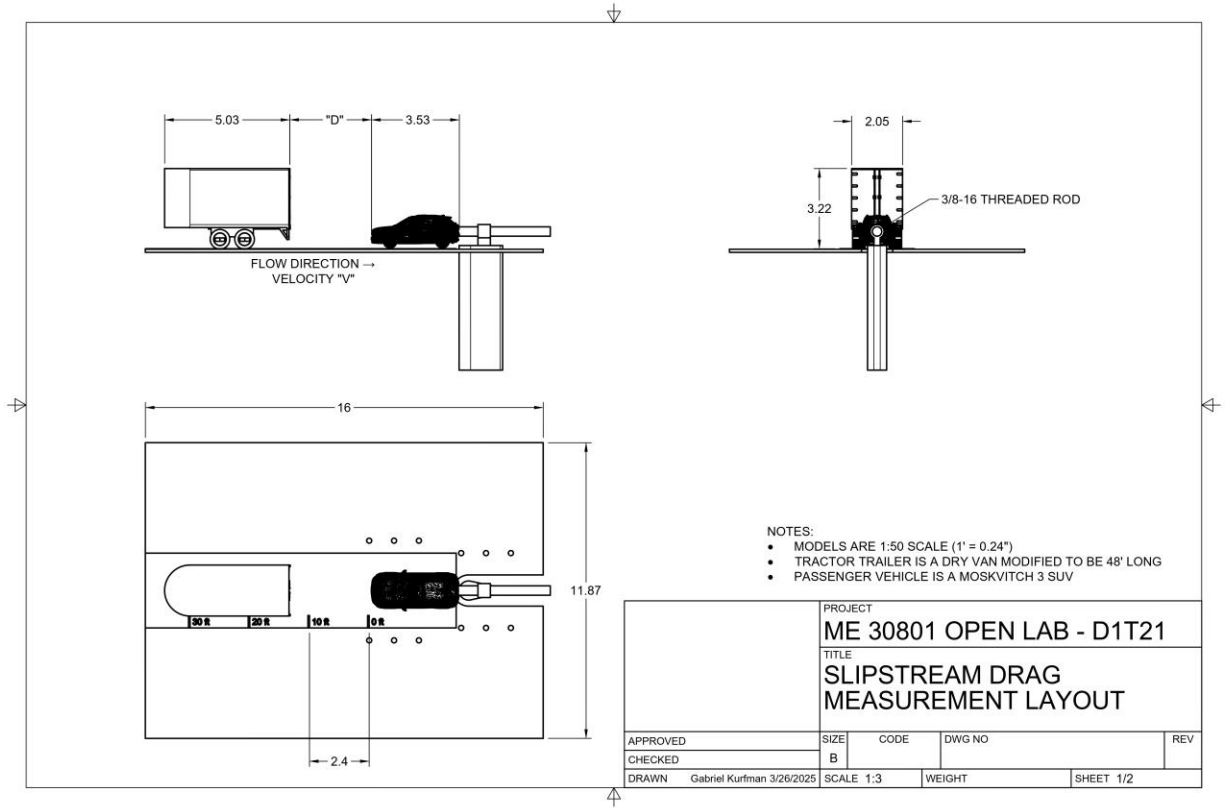
- Models are 1:50 scale (1′=0.24″)
- 3D printed PLA
- Tractor trailer is dry van with a modified curved nose
- Passenger vehicle is a Moskvitch 3 SUV

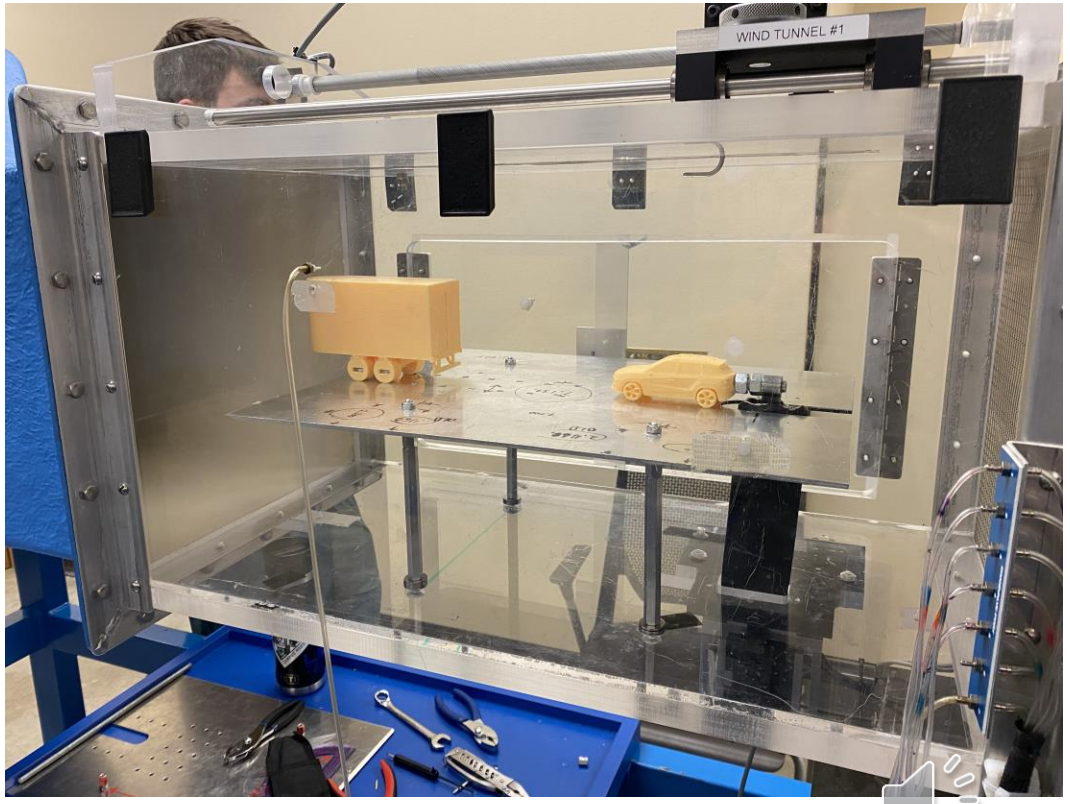


# Test Plan

- A ground plate was mounted to the wind tunnel.



# Test Plan

- 7 varying separation distances “D”
- 3 varying wind speeds “V”
- 22 total data points

| Full Scale Distance (ft.) | Test (in.) |
|---|---|
| 3.125 | 0.75 |
| 7.292 | 1.75 |
| 11.458 | 2.75 |
| 15.625 | 3.75 |
| 19.792 | 4.75 |
| 23.958 | 5.75 |
| ∞ (control, no truck) | ∞ |

Separation distances

| VFD Frequency (Hz) | Wind Velocity (m/s) | MPH |
|---|---|---|
| 0.0 (calibration) | 0.0 | 0 |
| 24.6 | 17.9 | 40 |
| 35.2 | 26.8 | 60 |
| 45.8 | 35.8 | 80 |

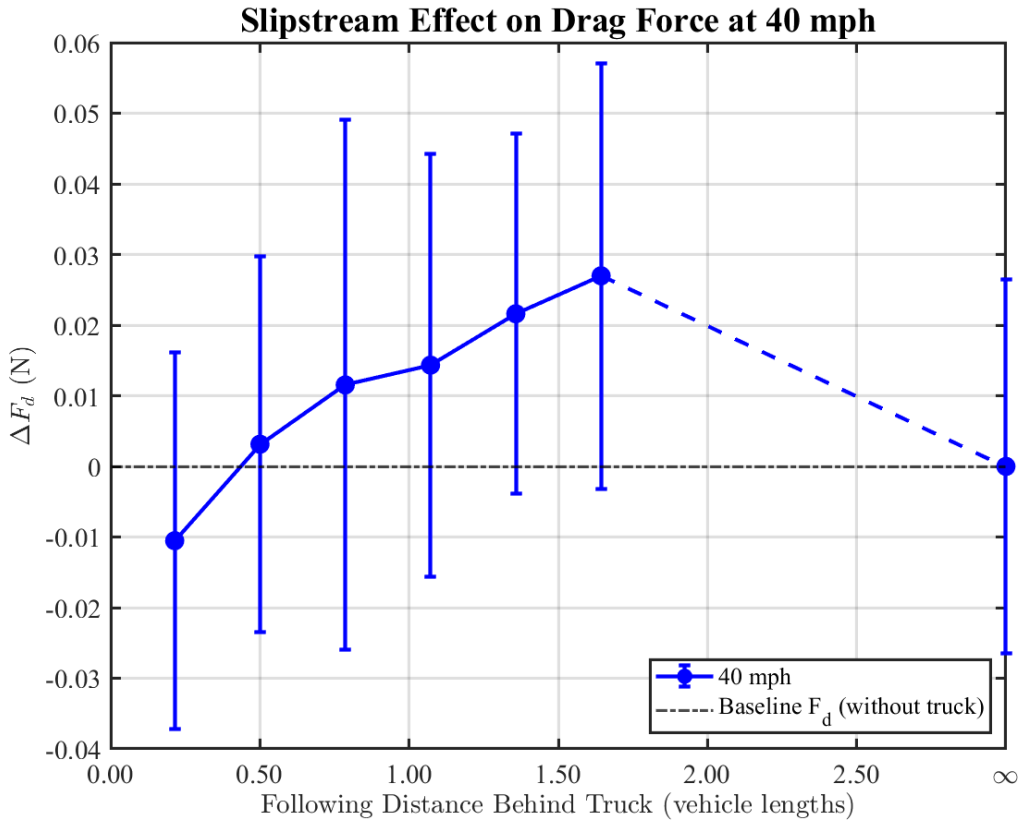
Wind speeds

| Date | Temp | Hg Height | Pressure | Density ρ |
|---|---|---|---|---|
| 4/16/25 | 21.3°C | 747.5 mm | 99.66 kPa | 1.18 $\frac{kg}{m^3}$ |

Experimental conditions

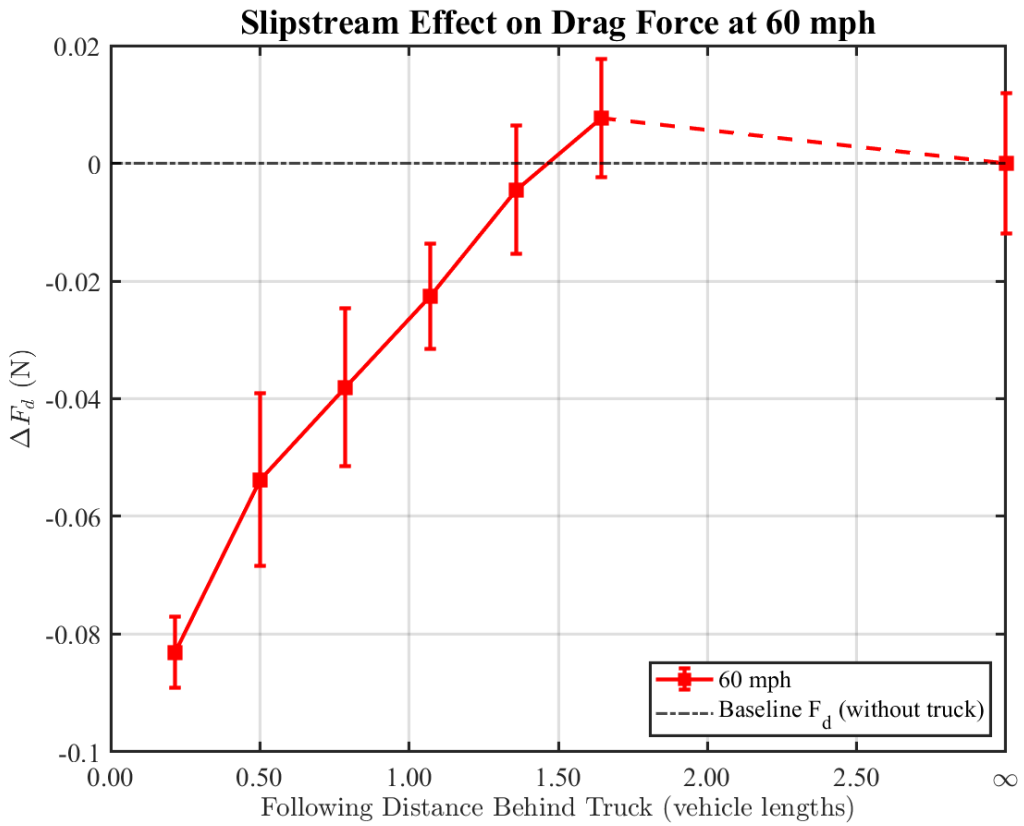
# Results

- Measured drag force at distances
- Slowest speed, largest standard deviation (error bars)



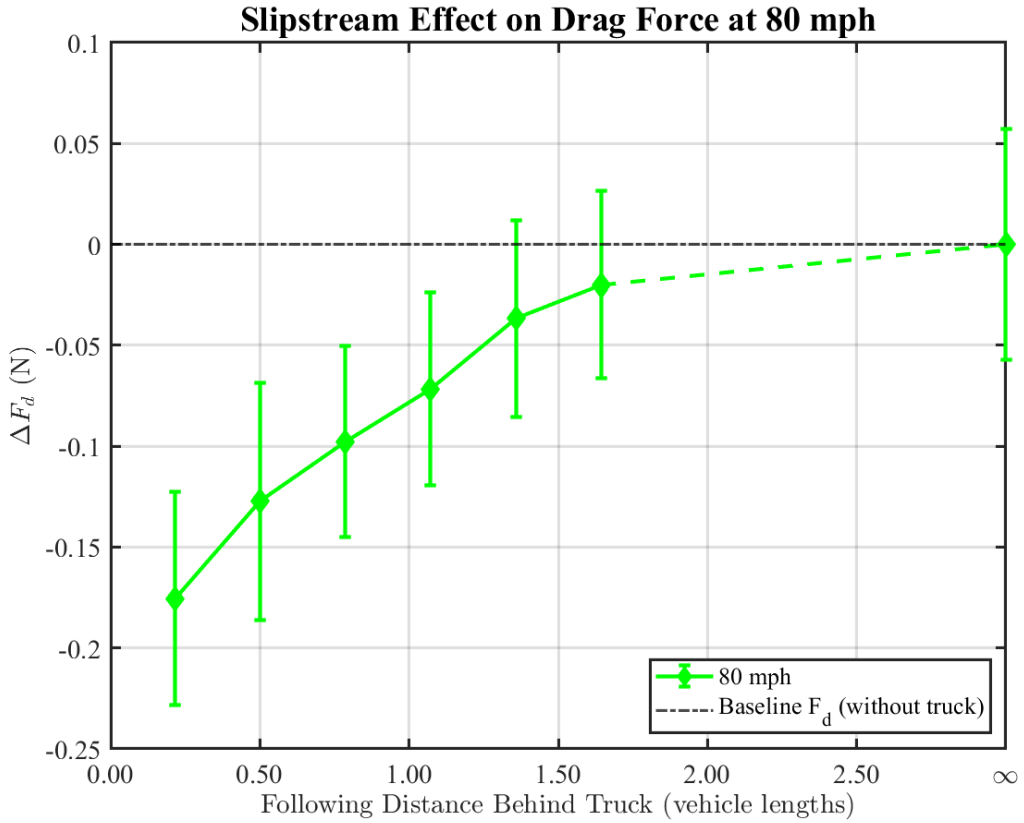
# Results

- Clearer trend at 60 mph



# Results

- No upward motion at all
- Lower coefficient the closer the truck is



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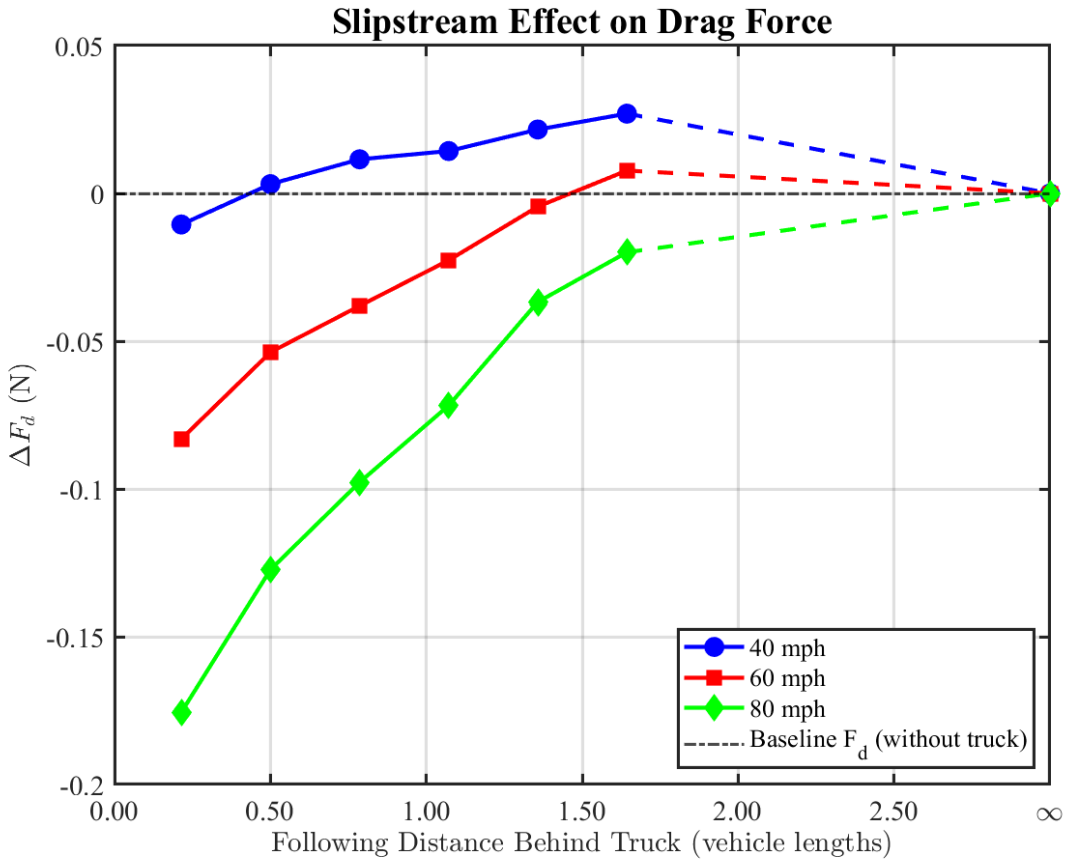
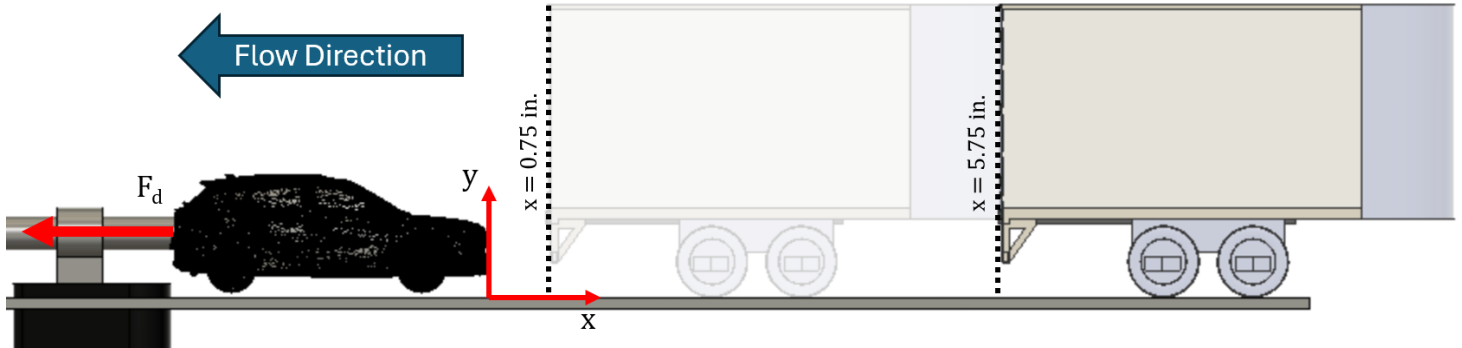
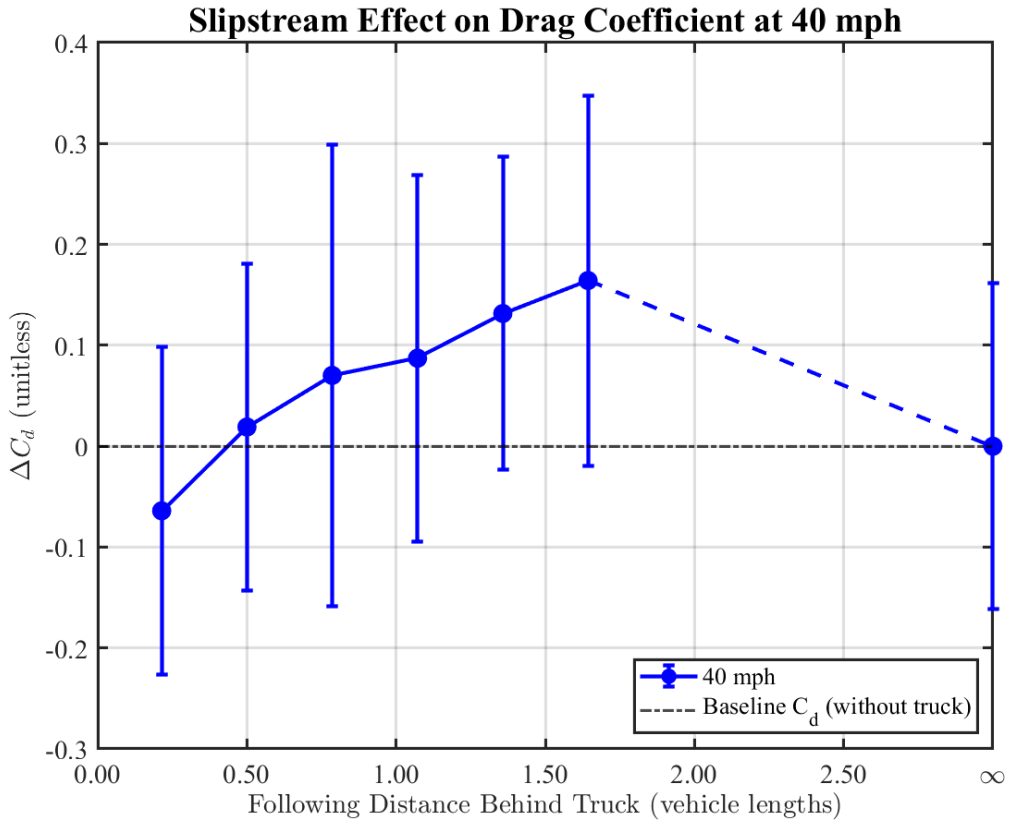

Slipstream Effect on Drag Force
0.05
0
-0.05
-0.1
-0.15
-0.2
$\Delta F_d$ (N)
0.00
0.50
1.00
1.50
2.00
2.50
∞
Following Distance Behind Truck (vehicle lengths)
40 mph
60 mph
80 mph
Baseline F_d (without truck)


Flow Direction
F_d
y
x
x = 0.75 in.
x = 5.75 in.

# Results

- Slowest speed, largest standard deviation (error bars)



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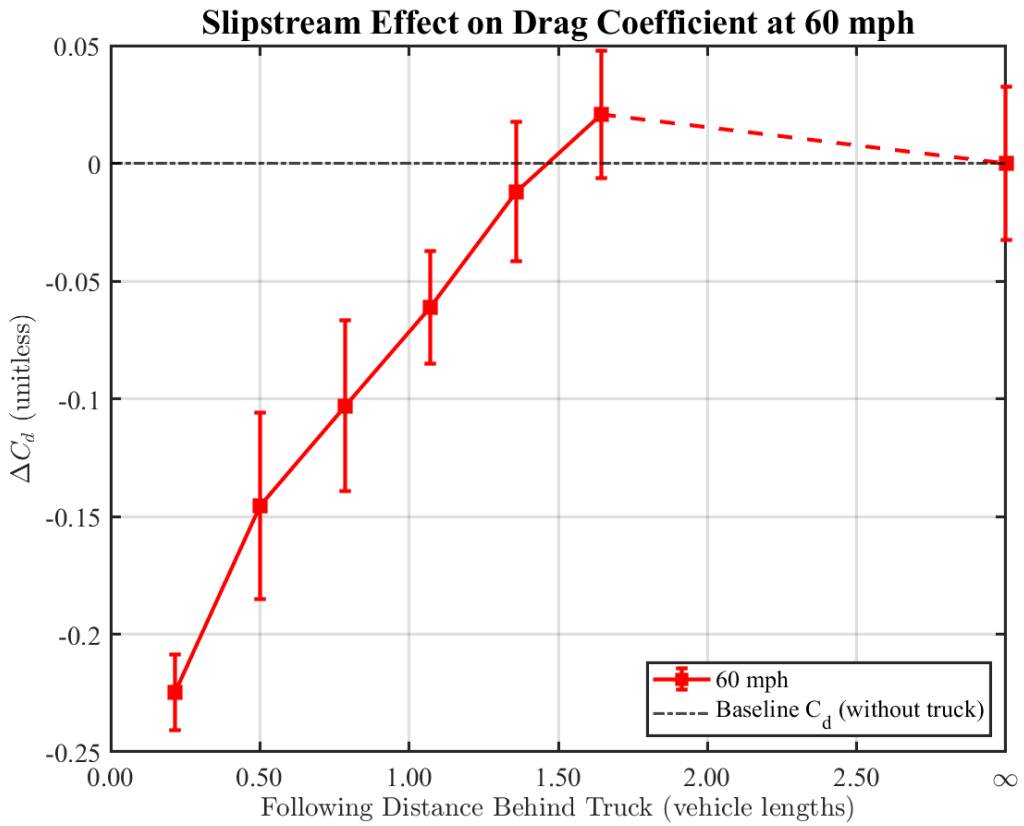

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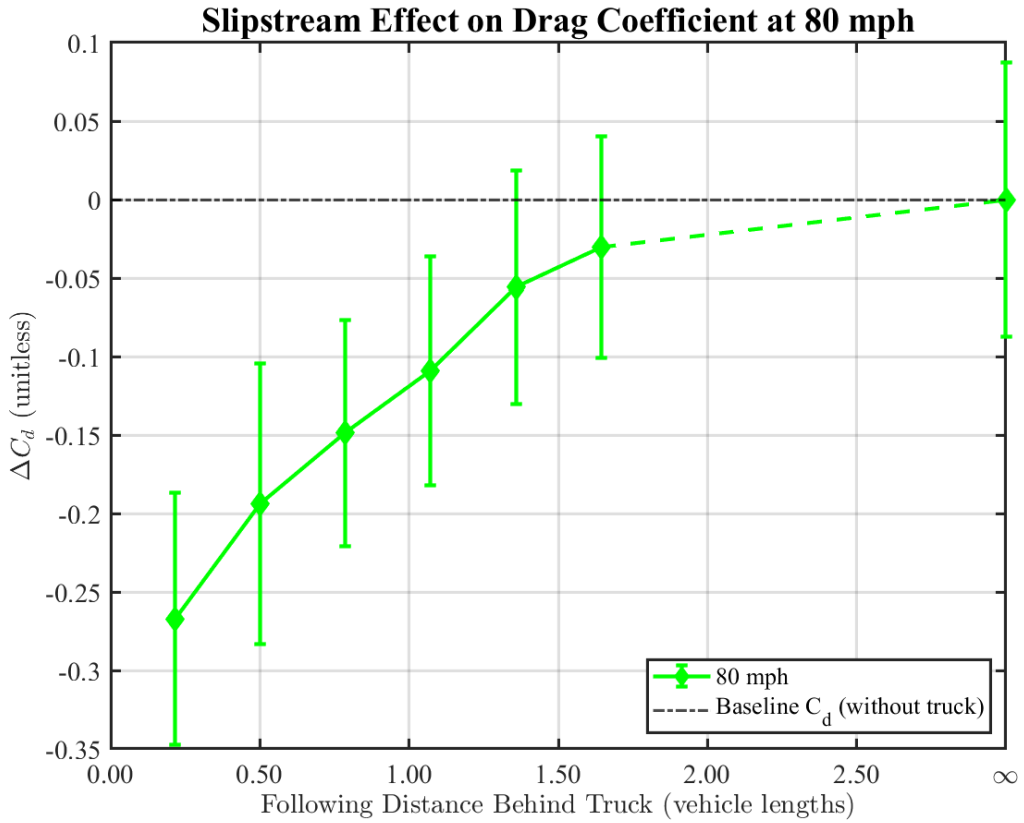

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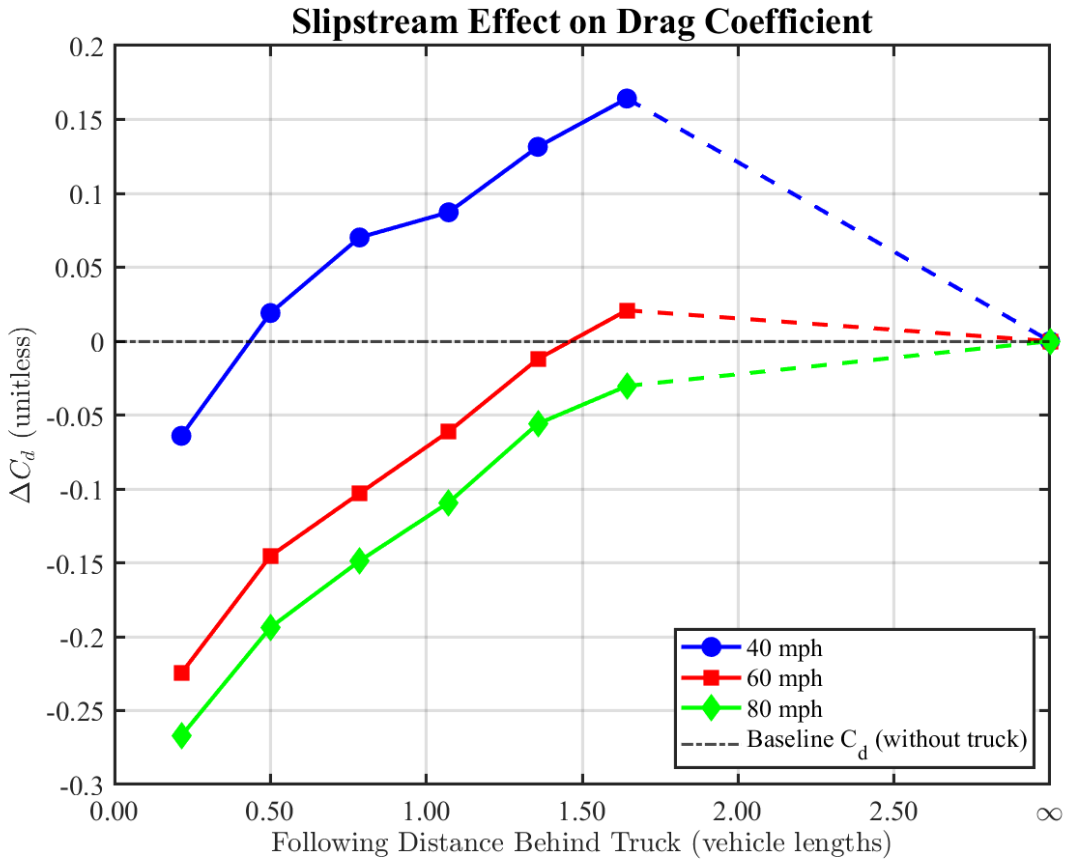
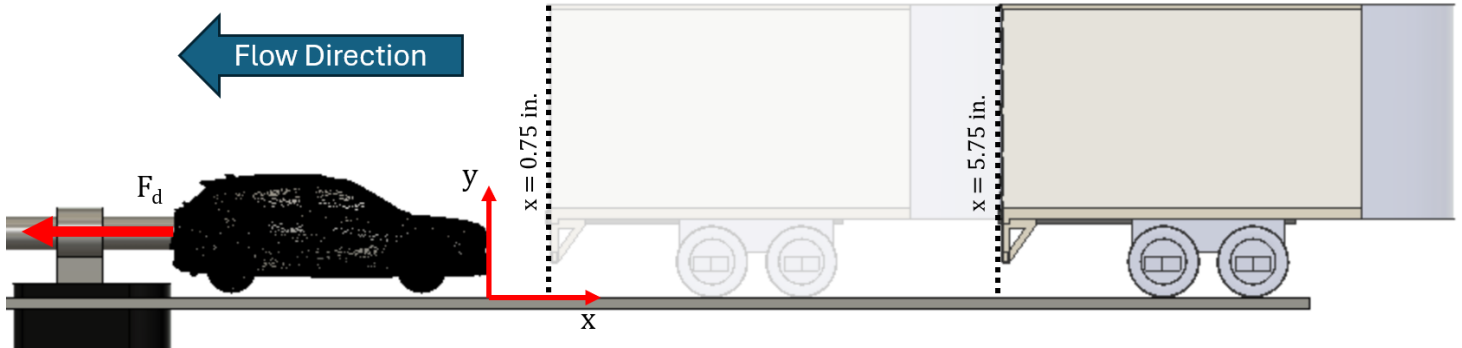

Slipstream Effect on Drag Coefficient
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
$\Delta C_d$ (unitless)
0.00
0.50
1.00
1.50
2.00
2.50
∞
Following Distance Behind Truck (vehicle lengths)
40 mph
60 mph
80 mph
Baseline C_d (without truck)


Flow Direction
F_d
y
x
x = 0.75 in.
x = 5.75 in.

# Conclusion

**Key Discoveries:**

- While slipstreaming, drag force is reduced as separation distance decreases
- The slip stream effect is more prevalent at higher speeds

**Suggestion for Future Results:**

- Repeat the testing in a larger wind tunnel
  - Allow for Reynolds numbers to be matched
  - Allow for larger forces within the precision of the drag measurements

# Disclaimer

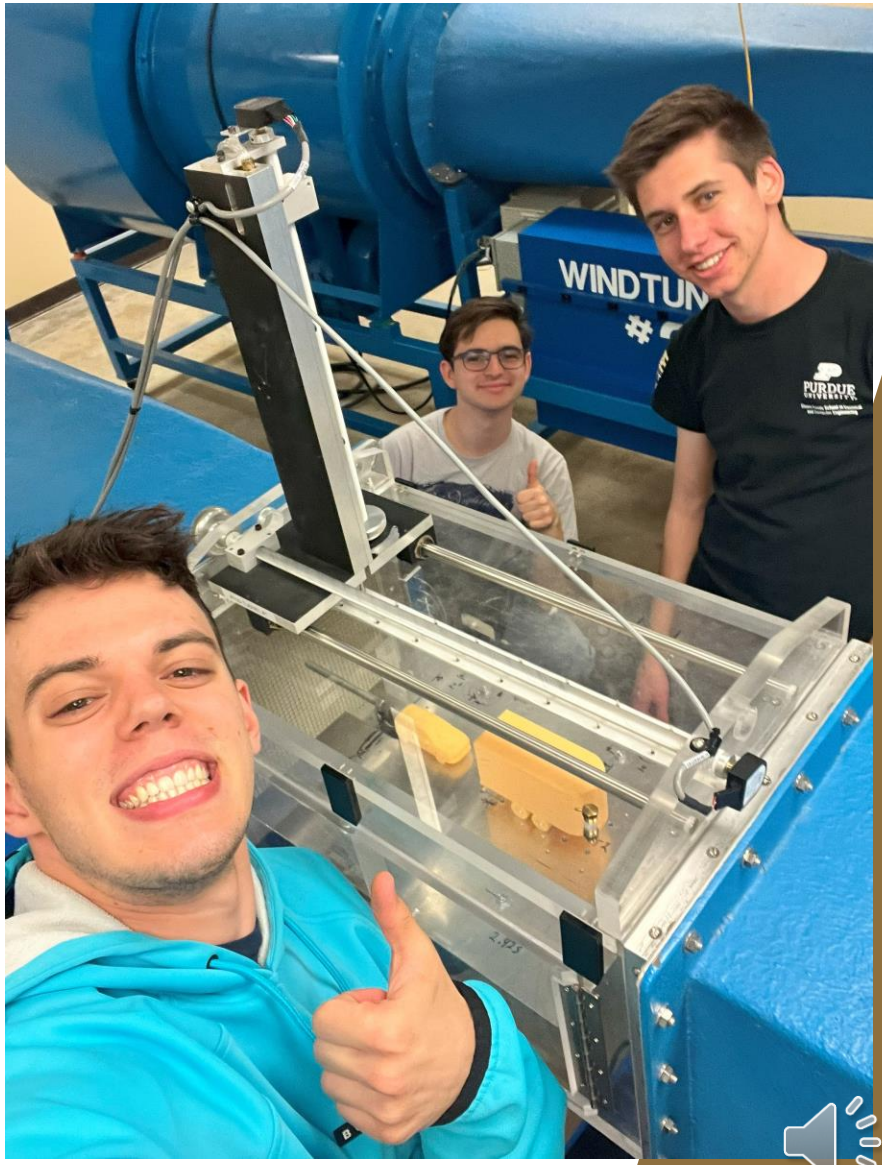
- While slipstreaming behind a semi-truck can improve fuel efficiency, the associated safety risks are beyond the scope of this experiment
- We do not endorse this technique in real-world driving scenarios


Image source: [2]

# References

[1] Halliday, N. (2023, November 28). Aerodynamic drafting (slipstreaming) in racing. SimScale. https://www.simscale.com/blog/drafting-slipstreaming-in-racing/
[2] RoadsterCovingtonIll. (2024, October 4). Chevrolet Malibu into a Hyundai Trailer IIHS Underrail crash test [Video]. YouTube. https://www.youtube.com/watch?v=FmKAQOOWbBY

# THANK YOU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