Modeling the lateral mixing of aerosols

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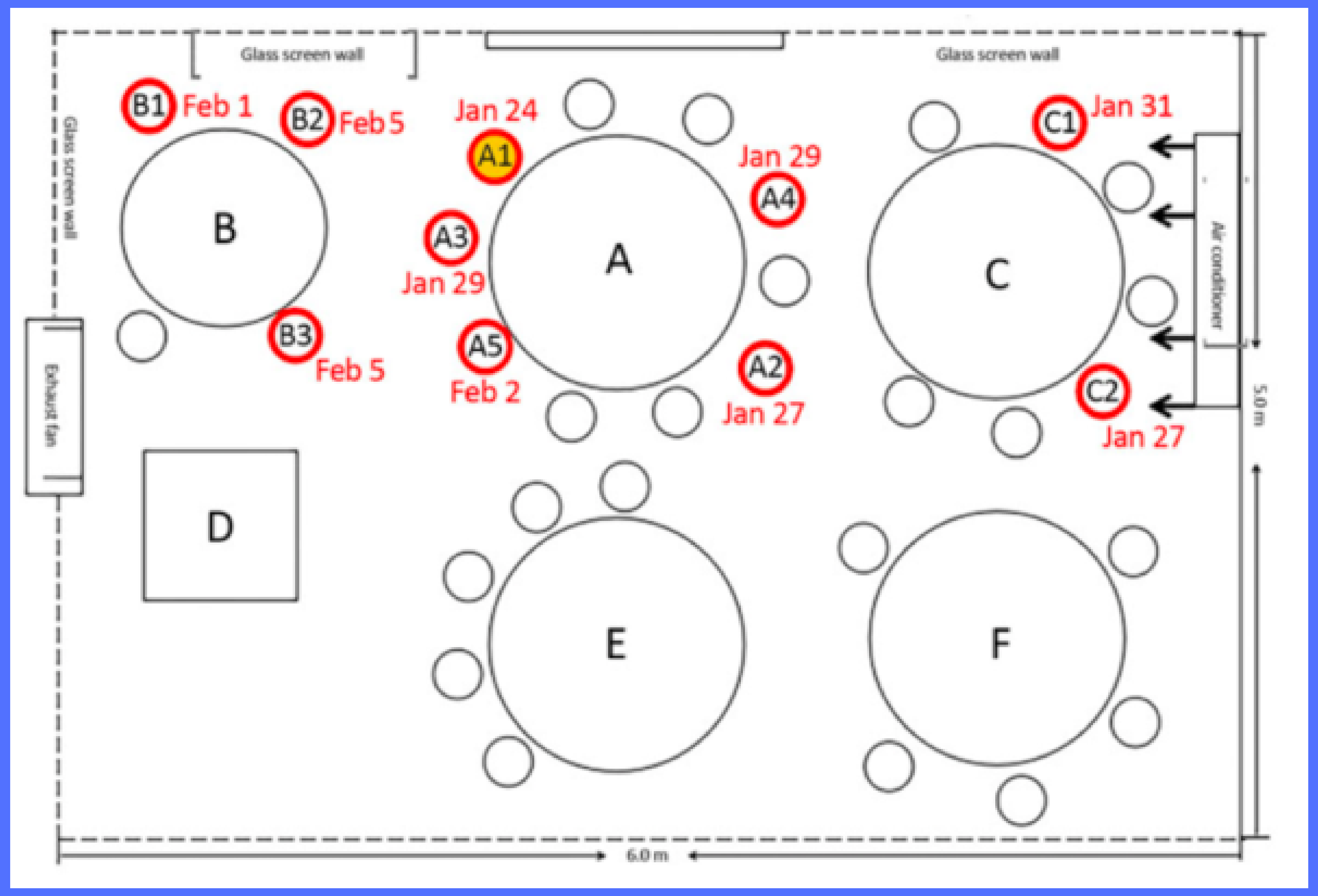
Introduction

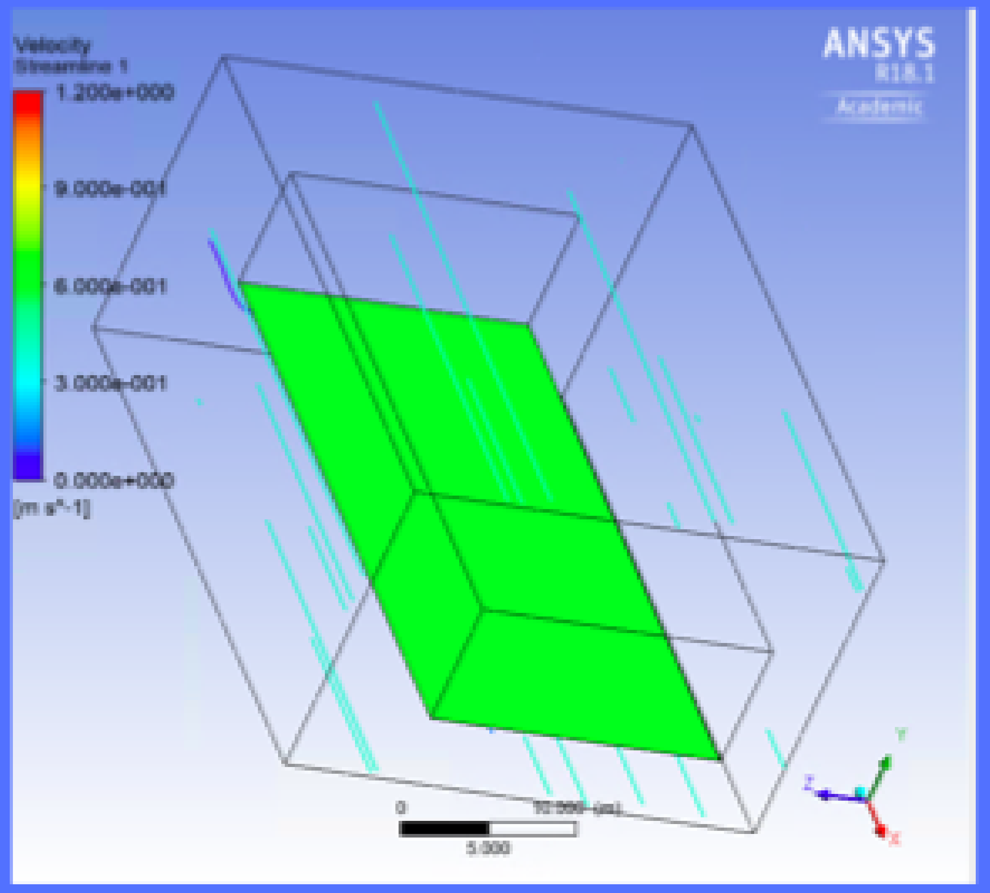
The primary transmission of the coronavirus is through droplets, resulting in at least 44% of the infections [2]. William F. Wells discovered that droplets vary in size (large and small) [1]. Large droplets fall to the floor within 6 feet while small droplets travel on air currents called aerosols [1]. The effect of aerosols can be visualized in the picture below of one of the first outbreak events to take place, in Wuhan, China.



At table A there was initially 1 infected individual and they were located at seat A1. Test subject A1's droplets were picked up by the airflow of the restaurant's mini split air conditioner and passed down to table B and then recycled into the path of individuals seated at tables A & C. The red circle around an individual indicates that they reported infection within 72 hours of leaving the restaurant [1].

Approach/ Methodology

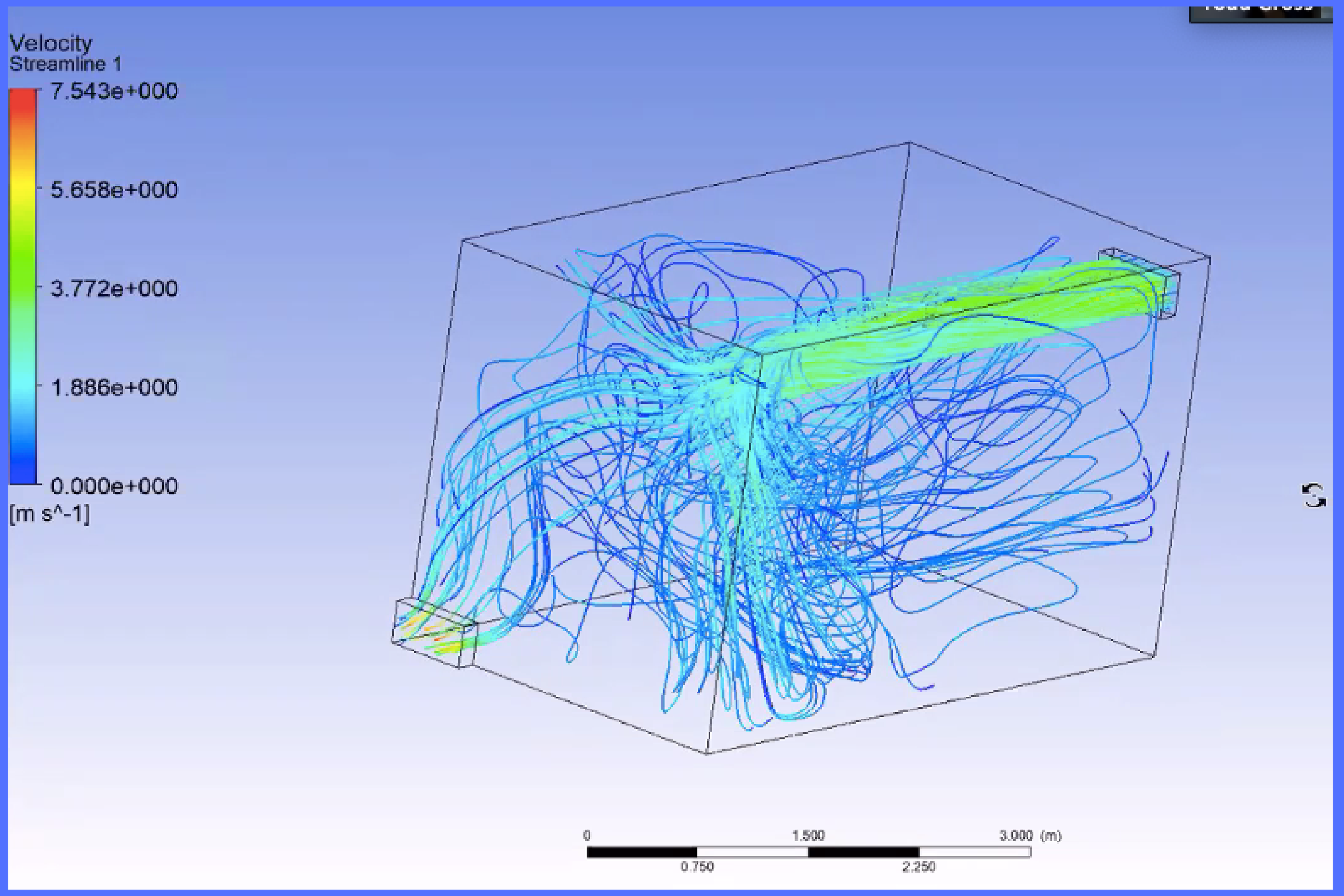
The goal of this project is to limit the lateral mixing of aerosols in an interior space. The impact of HVAC system design on aerosol transmission in interior spaces will be modeled using computational fluid dynamics software (CFD). The particular CFD software used for this project, ANSYS-Fluent, will model the airflow of the room and evaluate the concentration of droplets over time.The models will consist of several different room types and HVAC systems, as well as the effect of passive barriers on airflow.



References

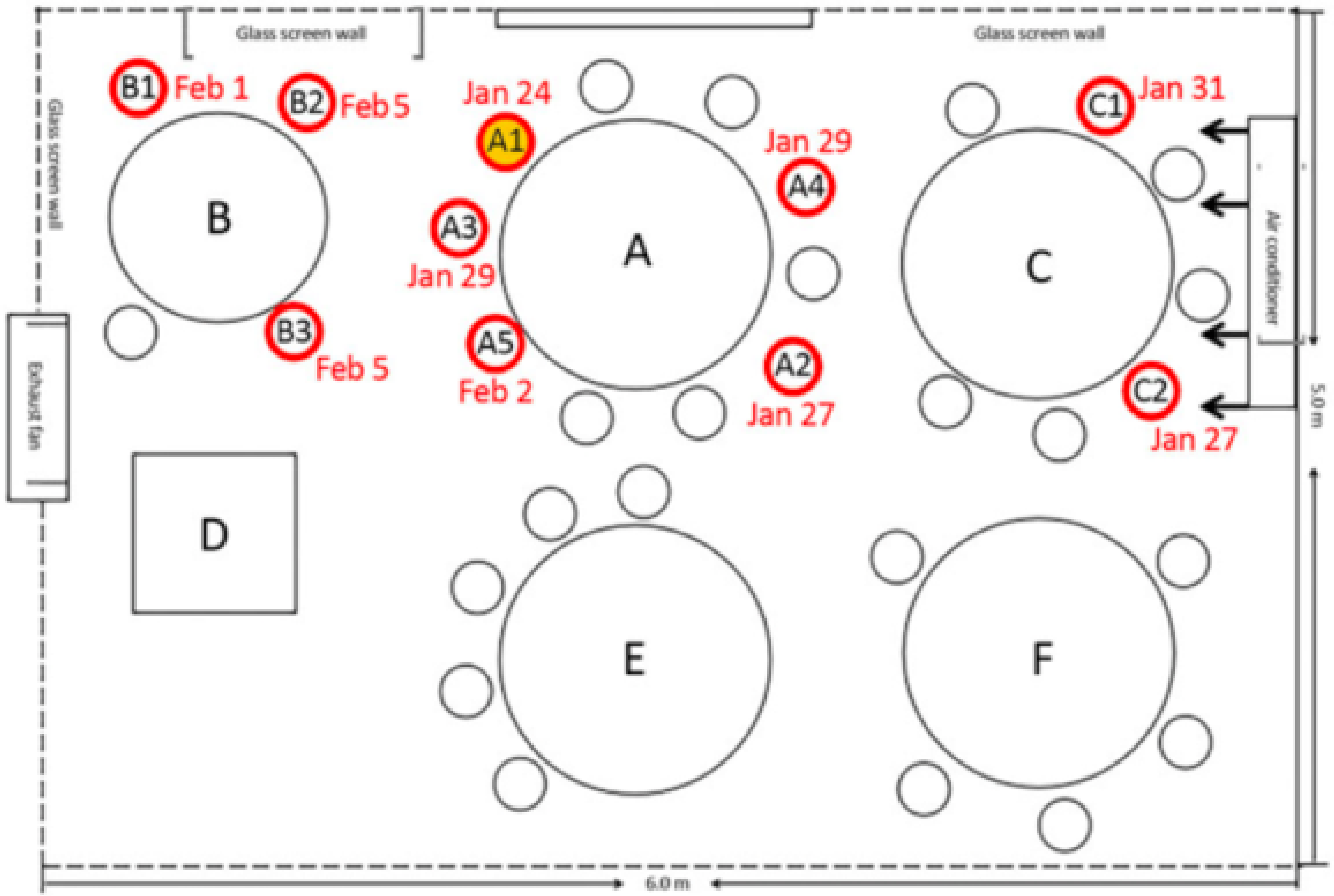
[1] Bourouiba, L. (2020). Turbulent Gas Clouds and Respiratory Pathogen Emissions. JAMA, 323(18), 1837–1838.
[2] Bromage, E. (2020). The Risks -Know Them - Avoid Them.
[3] Stewart, E. (2020). ASHRAE Position Document on Infectious Aerosols. 1791 Tullie Circle, NE • Atlanta, Georgia 30329-2305: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

Preliminary Results

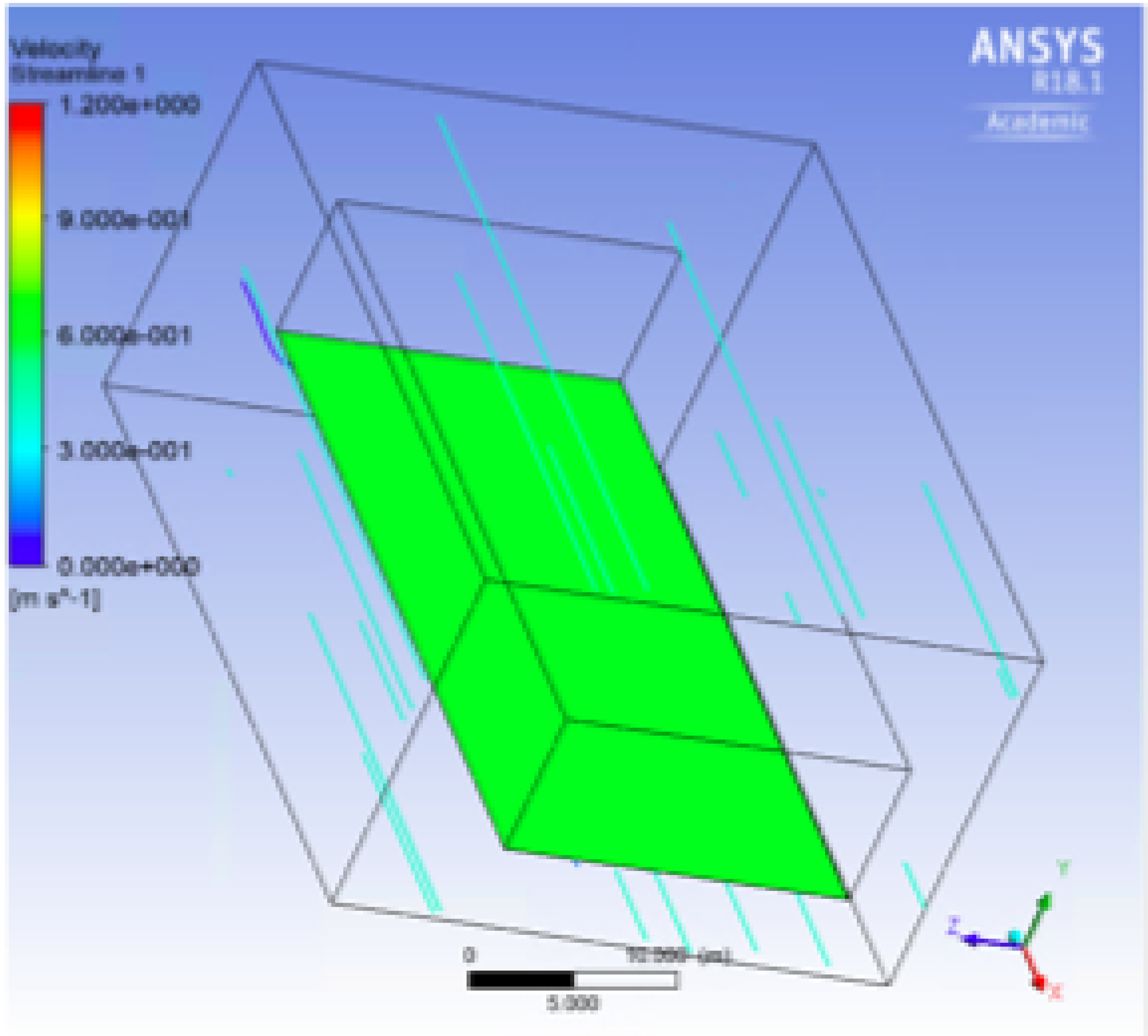


The room above has a single outlet and a single inlet vent. The dimensions of the room are 30x40x20 ft. The airflow coming out of the supply vent and into the room can be visualized by the gradient of colored streamlines. The picture shows a recently finished model that shows airflow pattern in the room. One can see that the aerosols would be expected to follow the flow lines in the picture that transport throughout the room. We plan on adjusting the velocities to the extremes of expected behaviors, as well as the position of the supply and return vents. Results from airflow models will be used to determine the most effective location to place passive barriers to limit lateral mixing of droplets on their way to the exhaust vent. The position of the supply and return vent will be adjusted to limit lateral mixing because of model and experimental results.

Introduction



Approach/Methodology



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