rzero

**Study Report**

# Air Disinfection Technology Reduced SARS-CoV-2 in School Classrooms

## Using R-Zero Upper Room UVGI in Schools Reduced SARS-CoV-2 Levels by 53% in Wastewater

One of the groups most affected by the COVID-19 pandemic have been K-12 students. Schools across the US closed for long periods to contain the spread of the SARS-CoV-2 virus and, **according to a McKinsey and Co report**, students tested in 2021 were on average ten points behind in math and nine points behind in reading compared with matched students in previous years, **with students in high-poverty districts affected most**.

The pandemic's effects extend beyond academics, with more than **35% of parents** very concerned about their children's mental health and loss of social-emotional skills typically developed in school.


> "Air disinfection is critical to stemming this pandemic and vital to keeping our students, teachers and the general public safe. While continued studies and monitoring are important, the early results of this study are promising in showing that upper room germicidal air disinfection may reduce transmission in schools as reflected by wastewater monitoring."
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> **- Dr. Edward Nardell, professor at Harvard Medical School and Harvard T.H. Chan School of Public Health and Principal Investigator for the Study**

Education leaders understand the importance of school attendance and are looking for science-backed, sustainable, and easy-to-implement solutions that keep students and staff in school. Schools have long contended with winter waves of cold, influenza, and norovirus – and the surge in RSV has only reinforced that the challenge of creating healthy education spaces will extend far beyond SARS-CoV-2.

## Ensuring safety and learning

The participating school district is one of the top 10 largest in the US, with over 300,000 students.

This district was one of the first in the U.S. to bring students back to school in person and had to meet very strict disinfection standards to do so. Like other districts, they had investigated many different approaches to mitigating the spread of SARS-CoV-2. Any disinfection solution considered had to take into account increasing janitorial labor costs, staffing shortages, and the recurrent cost associated with chemical disinfection that the district was facing.

The district was interested in autonomous disinfection that could continuously reduce exposure in real-time while students and staff were using communal spaces, ideally without requiring additional labor. Leaders wanted to show that an added, continuous disinfection layer could improve on the already significant investments they had made in disinfection, so they commissioned a pilot study of the **R-Zero Beam**.

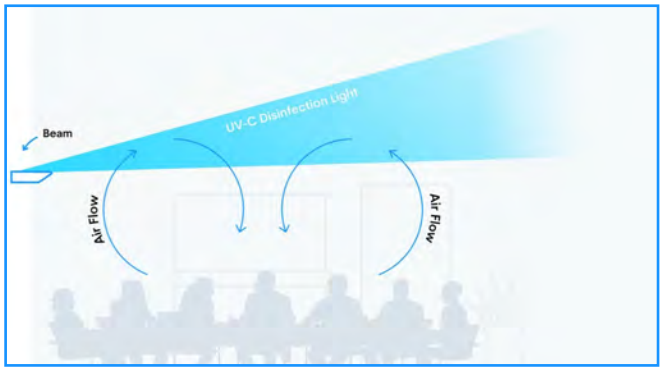
## The Technology

**R-Zero Beam** is an upper room ultraviolet germicidal irradiation (UR-UVGI) system. It continuously emits a band of UV-C light across the upper part of a room that inactivates harmful microorganisms as they come in contact with the UV-C light.

When occupants breathe, cough, sneeze, or speak, the warmer air expelled rises to meet the disinfecting zone of **R-Zero Beam**, aided by natural convection currents and any mechanical air changes delivered by a building's existing HVAC system. Natural and HVAC airflow recirculates the disinfected air back into the occupied breathing zone. While this technology is unfamiliar to many, it has actually been used for decades to control the spread of TB and is recommended by the CDC as part of a layered approach to reducing the spread of SARS-CoV-2.

The efficacy of ventilation interventions like R-Zero Beam is measured by how quickly they are able to replace contaminated air with disinfected air, commonly called equivalent air changes per hour (eACH). HVAC systems in schools typically provide 2-3 ACH (air changes per hour) via mechanical ventilation, which means the total air in a room is only changed every 20-30 minutes.

Beam significantly reduces exposure by adding at least 12 eACH (equivalent air changes per hour), air disinfection equivalent to replacing the air in a room 12 times per hour with disinfected air. Notably, this technology helps facilities, especially older buildings with poorer ventilation, meet and even surpass CDC and ASHRAE recommended 6-12 equivalent air changes per hour for healthy indoor air, and at approximately 95% less in energy costs and greenhouse gas emissions compared to delivering additional clean air with HVAC systems alone. R-Zero's Beam strictly adheres to official exposure thresholds and safety standards for UV-C. Beam is also uniquely equipped with heat and motion sensors making accidental exposure virtually impossible.




## The Study

Seven schools with more than 4,500 students and staff were chosen to participate in the randomized experiment. In each intervention school, **R-Zero Beam** was installed in classrooms, cafeterias, and other large shared spaces. Beams were continuously active during school hours during Spring Semester 2022 (January - May), while the Omicron wave was widely prevalent in the community.

Researchers measured the effectiveness of **R-Zero Beam** by closely monitoring wastewater from the schools for the presence of SARS-CoV-2. Wastewater surveillance is widely considered by epidemiologists to be one of the most reliable indicators of SARS-CoV-2 and provided a direct and objective test of whether the **R-Zero Beam** was creating healthier spaces for students and staff.

## The Results

Schools with **R-Zero Beam** reported fewer occurrences of SARS-CoV-2 detection and much lower levels of SARS-CoV-2 when it was detected in wastewater.

Based on the marked reduction in SARS-CoV-2 detection after R-Zero Beam implementation, the data suggests that Beams helped reduce the spread of SARS-CoV-2 over the study period and during the Omicron surge.

**UV-C** treated schools had consistently fewer SARS-CoV-2 positive wastewater samples than non-treated schools.

**53%** fewer samples contained SARS-CoV-2 in intervention schools compared to non-intervention schools.

**0** Safely deployed with 0 incidents or complaints reported.

## Conclusions

The reduction in the SARS-CoV-2 viral load in test schools suggests that the likelihood of contracting COVID in schools with Beams is lower than in schools without Beams. The results are particularly notable considering students and faculty may also have been exposed to the virus during off-campus hours while mitigation was only happening at school.

While the study only evaluated the presence and concentration of SARS-CoV-2 in schools' wastewater, UV-C has demonstrated efficacy against a wide range of microorganisms, including influenza, RSV, coronaviruses, and rhinoviruses, which are consistently a leading cause of school absences. R-Zero's Beam has been validated by independent labs against an array of microorganisms in addition to SARS-CoV-2.

This was all accomplished safely and silently directly in the classroom, without the requirement of frequent maintenance, technical expertise or special training, or the need to contend with hazardous waste and non-recyclable materials.

**R Zero's Beam** is already recognized as an industry-leader, receiving the Red Dot Design Award in 2022 and for being the first LED-enabled UR-UVGI system. Utilizing tunable LEDs enables the device to calibrate the UVC emitted to the most germicidal output, affording greatest efficacy.

In this era of increasing public health crises and impossibly stretched K–12 education budgets, **R-Zero's Beam** technology combines broad spectrum efficacy with ease of use, and lower energy costs and deployment costs. Looking ahead, this technology offers the opportunity to provide safer and healthier spaces to work, learn, and live.

## More on the Research

The research will be presented at the American Thoracic Society International Conference on May 19-24, 2023 in Washington, DC. Dr. Edward Nardell, professor of global health and social medicine at Harvard Medical School, served as the principal investigator for the study; Dr. Edwin Oh, associate professor, Kirk Kerkorian School of Medicine and Laboratory of Neurogenetics and Precision Medicine, University of Nevada, Las Vegas, led the team overseeing wastewater analysis; and Dr. Megan Murray, professor, Department of Global Health and Social Medicine at the Harvard Medical School, served as a consultant in infectious disease epidemiology. The University of Nevada Las Vegas independently analyzed wastewater results.