



WFI 2023

Waterloo Filtration Institute

EPA's Research to Motivate Standardized Testing and Evaluate the Effectiveness of Air Cleaning Technologies

Katherine Ratliff

Office of Research and Development

U.S. Environmental Protection Agency

December 6, 2023, 10:00 – 10:10 AM EST



FOR A BETTER WORLD

Katherine Ratliff Intro



- Physical Scientist and Principal Investigator in EPA's Homeland Security Research Program
- Leads EPA's research to evaluate the effectiveness of air cleaning and treatment technologies against infectious aerosols
- Ph.D., Duke University
- B.A., Vanderbilt University



WFI 2023

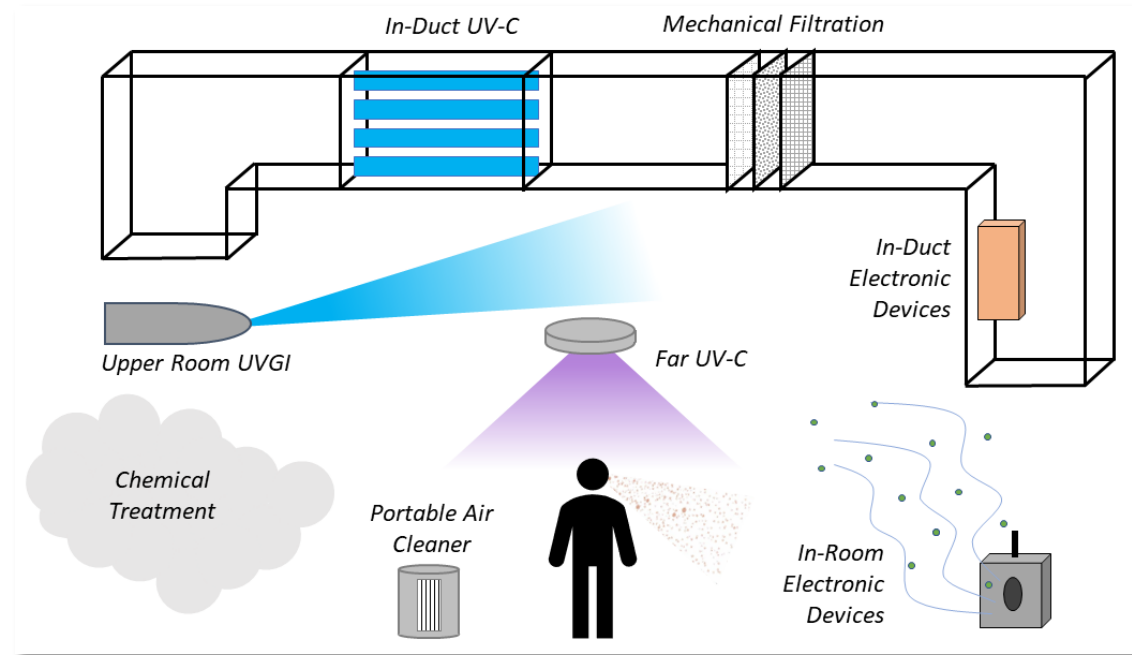
Waterloo Filtration Institute

EPA'S Research Objectives

- How effective are emerging air cleaning technologies at reducing concentrations of airborne pathogens?
- How do we compare results across technology types and manufacturers?
- How can laboratory results be used to inform predictions of real-world performance?

- Research Goals:

- Assess efficacy of aerosol treatment technologies under conditions relatable to real-world scales
- Inform development of reliable, standardizable test methods
- Develop better understanding of how laboratory results can be translated to applied settings

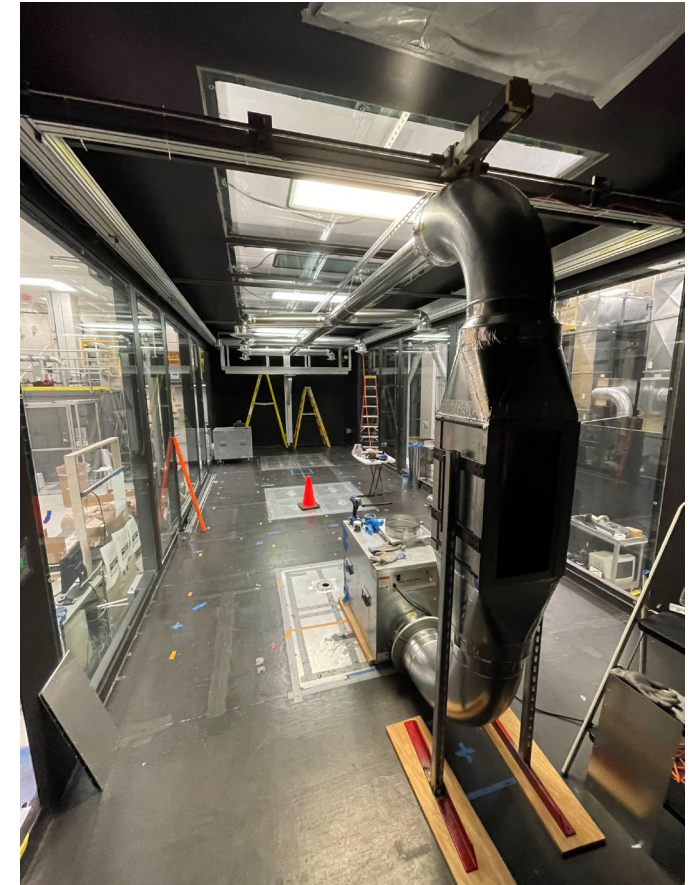


WFI 2023

Waterloo Filtration Institute

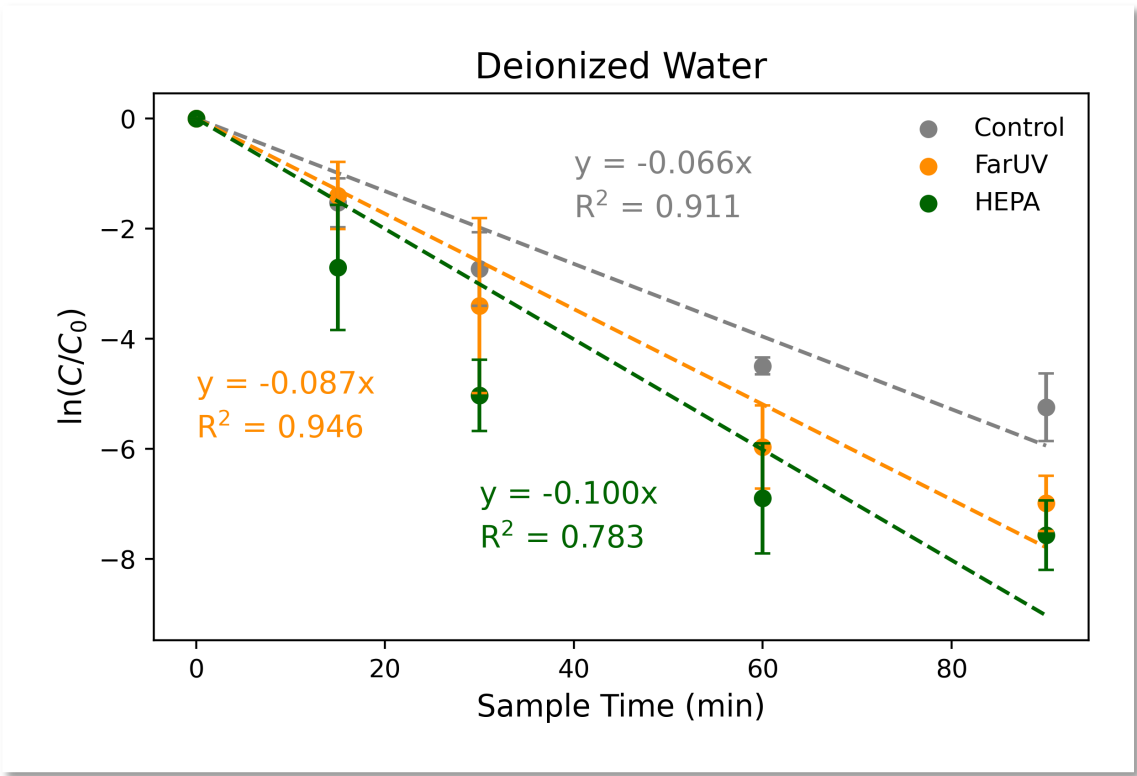
Test Methods

- Utilizing large EPA bioaerosol test chamber (25 x 12 x 10 ft; 3000 ft³ / 85 m³) with mock HVAC system and temperature/humidity control
- HVAC system and fans facilitate airflow and mixing
- Aerosolize non-pathogenic virus (MS2) prior to technology activation and take air samples from breathing zone in test chamber during test period; use plaque assay to determine concentration of infectious virus
- Aerosolization media: here, **deionized water & simulated saliva**
- Minimum 3 replicate tests & time-matched (technology off) controls



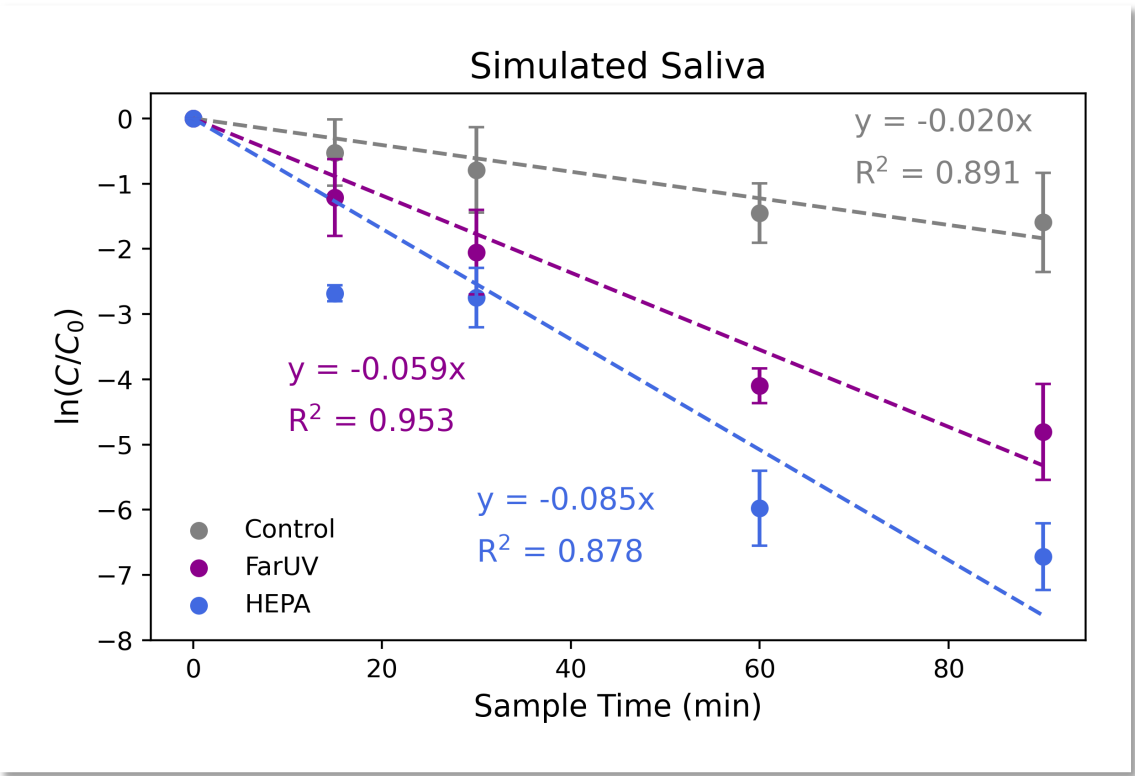
See [Ratliff et al. \(2023\) *Building and Environment*](#) for more detailed description of test methodology and instrumentation

Aerosolization Media Impacts Efficacy



Far UV CADR = 62 ft³/min
HEPA CADR = 103 ft³/min

***Calculated CADR values for
combined effect of 2 of each devices***



Far UV CADR = 116 ft³/min
HEPA CADR = 193 ft³/min

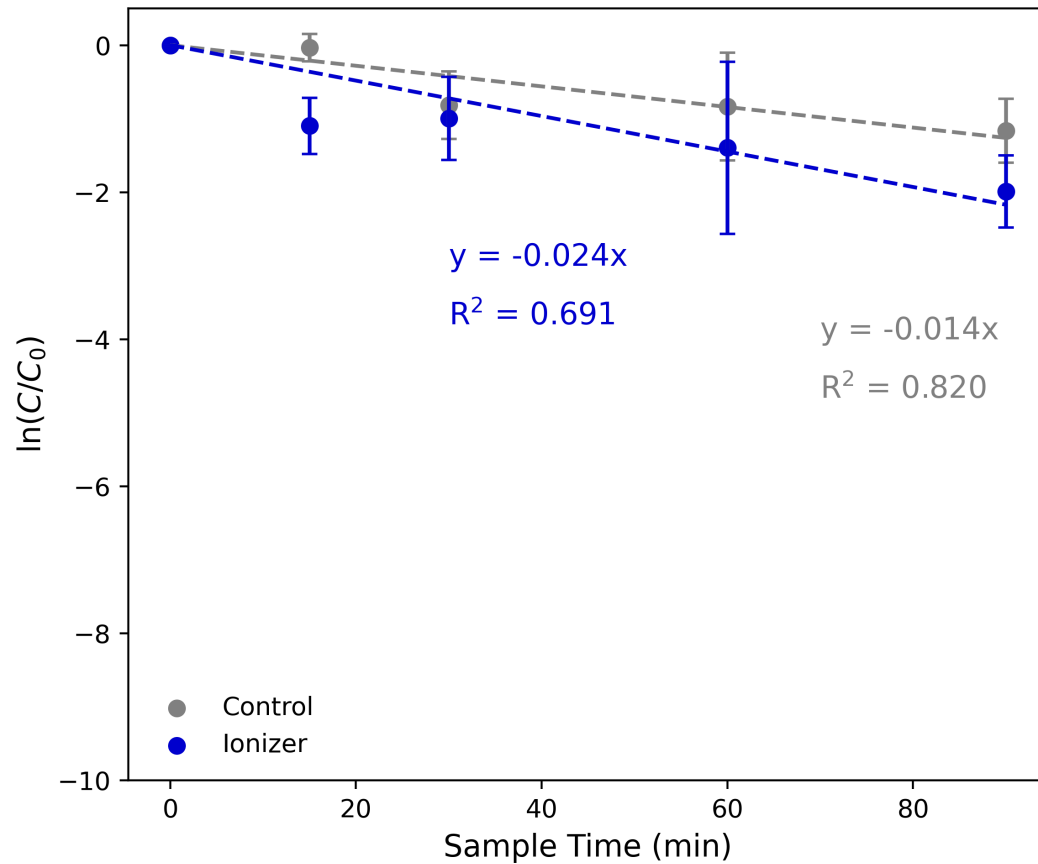
$$\text{Clean Air Delivery Rate (CADR)} = V (L_{\text{on}} - L_{\text{off}})$$

V = volume of test chamber; L_{on} and L_{off} are first-order loss rates for technology on/off conditions (Stephens et al. [2022] "Interpreting Air Cleaner Performance Data" *ASHRAE Journal*)

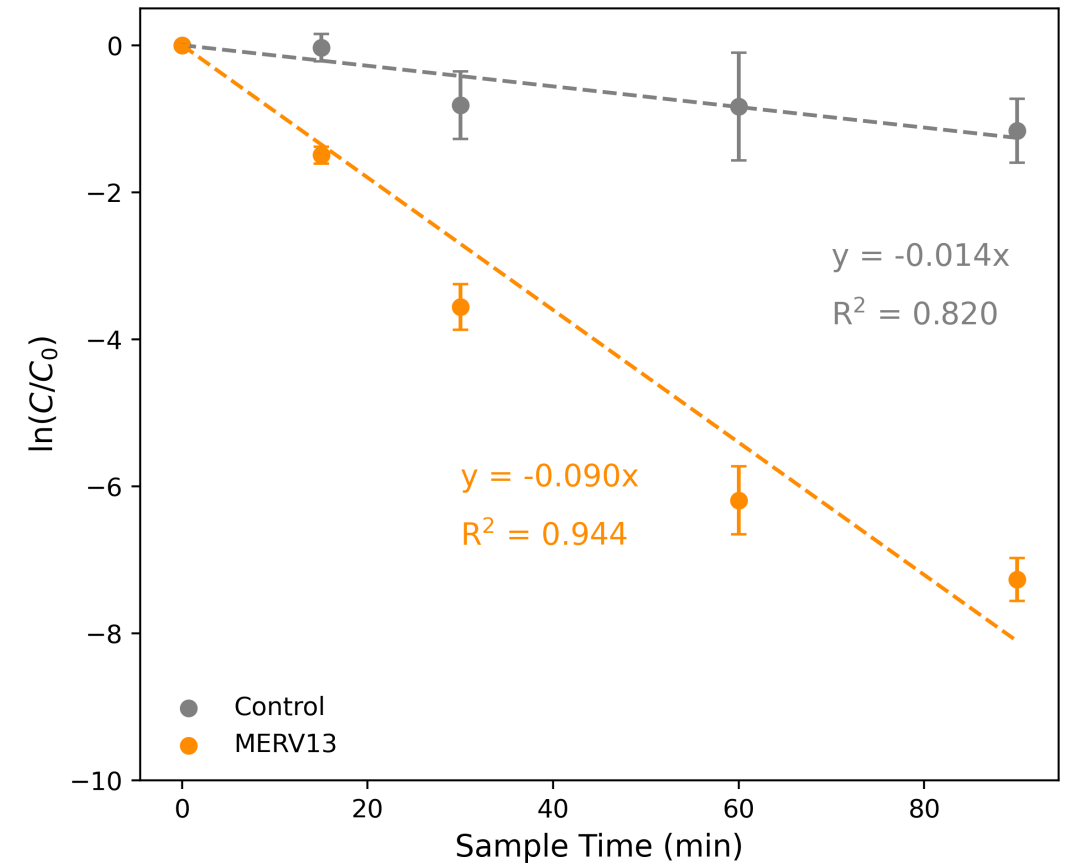


WFI 2023
Waterloo Filtration Institute

Combining Technologies Impacts Efficacy



Ionizer CADR = 30 CFM



MERV13 CADR = 228 CFM

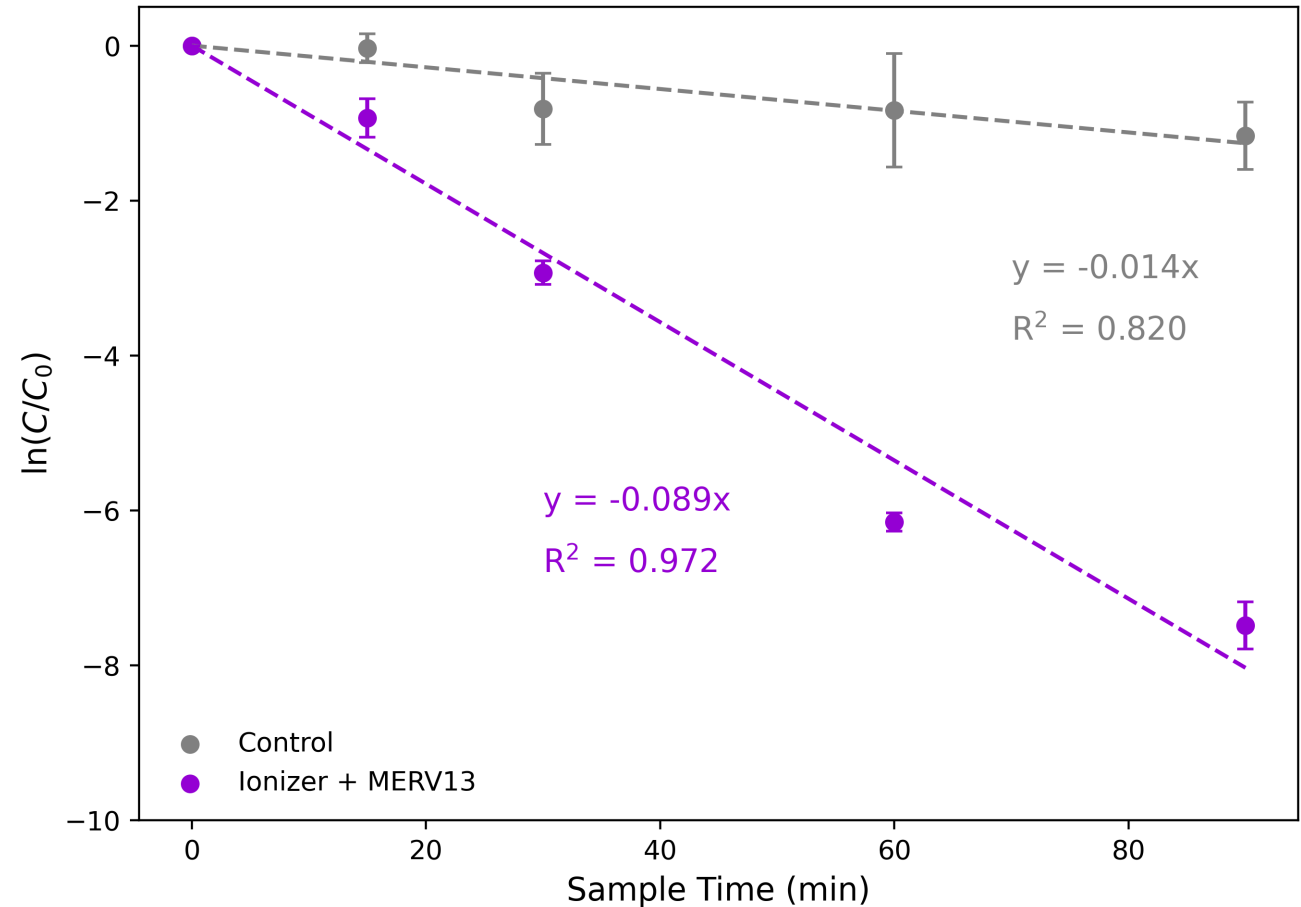
Combining Technologies Impacts Efficacy

Ionizer CADR = 30 CFM

MERV13 CADR = 228 CFM

Ionizer + MERV13 CADR = 226 CFM

Marginal benefit from ionizer alone, but no additional benefit from bipolar ionization when combined with MERV13 filtration.



Conclusions and Implications

- Seemingly simple changes to test methodology can have significant impact on calculated efficacy (here, ~2-fold difference in CADR values)
- Combining air cleaning and treatment technologies does not necessarily mean additive efficacy
- Important to keep in mind as new standards and targets emerge (e.g., ASHRAE 241 - *Control of Infectious Aerosols*, CDC's new 5 eACH ventilation recommendation for occupied spaces)
- How can we improve predictions of real-world performance?

Katherine Ratliff

Ratliff.Katherine@epa.gov

DISCLAIMER: The United States Environmental Protection Agency (EPA), through its Office of Research and Development, funded and managed the research described. This presentation was peer and administratively reviewed and has been approved for presentation as an Environmental Protection Agency document. It does not necessarily reflect the views of the Environmental Protection Agency. No official endorsement should be inferred. This presentation includes photographs of commercially-available products. The photographs are included for purposes of illustration only and are not intended to imply that EPA approves or endorses the product or its manufacturer. EPA does not endorse the purchase or sale of any commercial products or services.

Data presented herein did not undergo a formal quality assurance review as outlined in “U.S. EPA Office of Research and Development’s Quality Management Plan for Scientific Research”. If these data are included in future EPA reports or other publications, they will be subjected to this review.



FOR A BETTER WORLD

Thank You for Your Attention

<https://www.wfinstitute.com/>

© All the rights reserved



FOR A BETTER WORLD