Using Filtration and Air Cleaners for Schools

Presented by Jim Rosenthal

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Some of the things we think we know about SARS-Cov-2

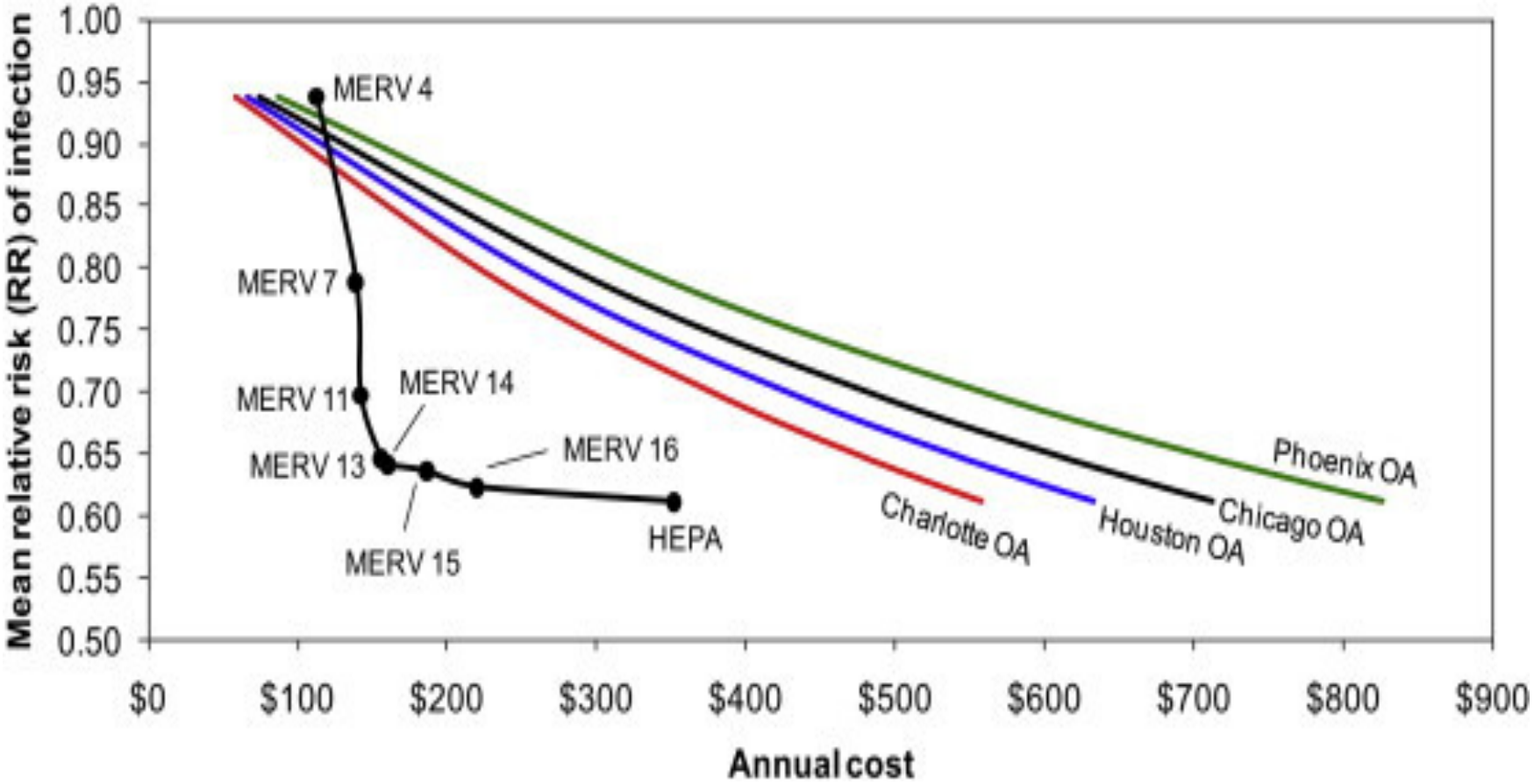
- As an unattached virus, it is approximately 0.12um
- Since it is a virus, it needs a host. Target particles of concern are in the 0.5-3um range.
- These particles can stay airborne for hours
- What they lack in size, they make up for in numbers
- Human activities like breathing, talking, laughing, singing and, of course, coughing and sneezing create SARS-Cov-2 laden particles

- Distribute
- Dilute
- Remove

Current Recommendations For COVID-19

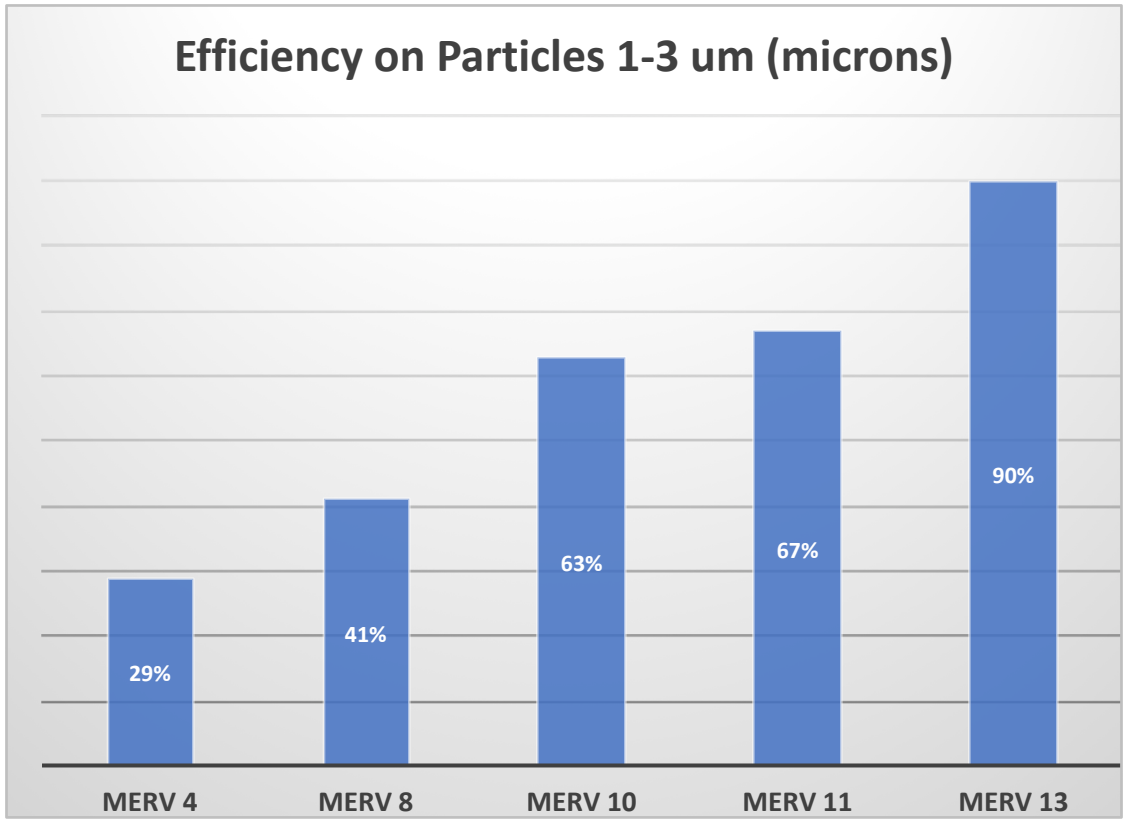
- Confirm systems provide at least the minimum outdoor air ventilation
- MERV 13 filters or higher for recirculated air
- The goal is 6 ACH
- If less, use air cleaners to supplement HVAC systems

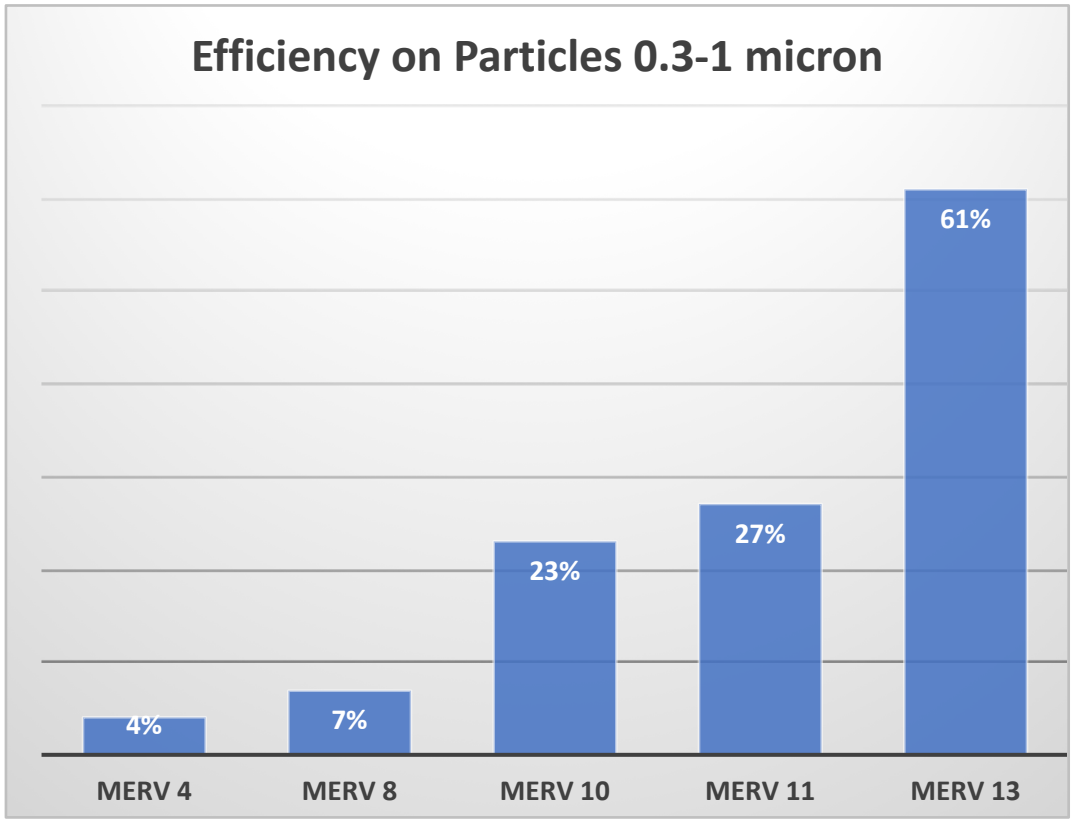
Why MERV 13?



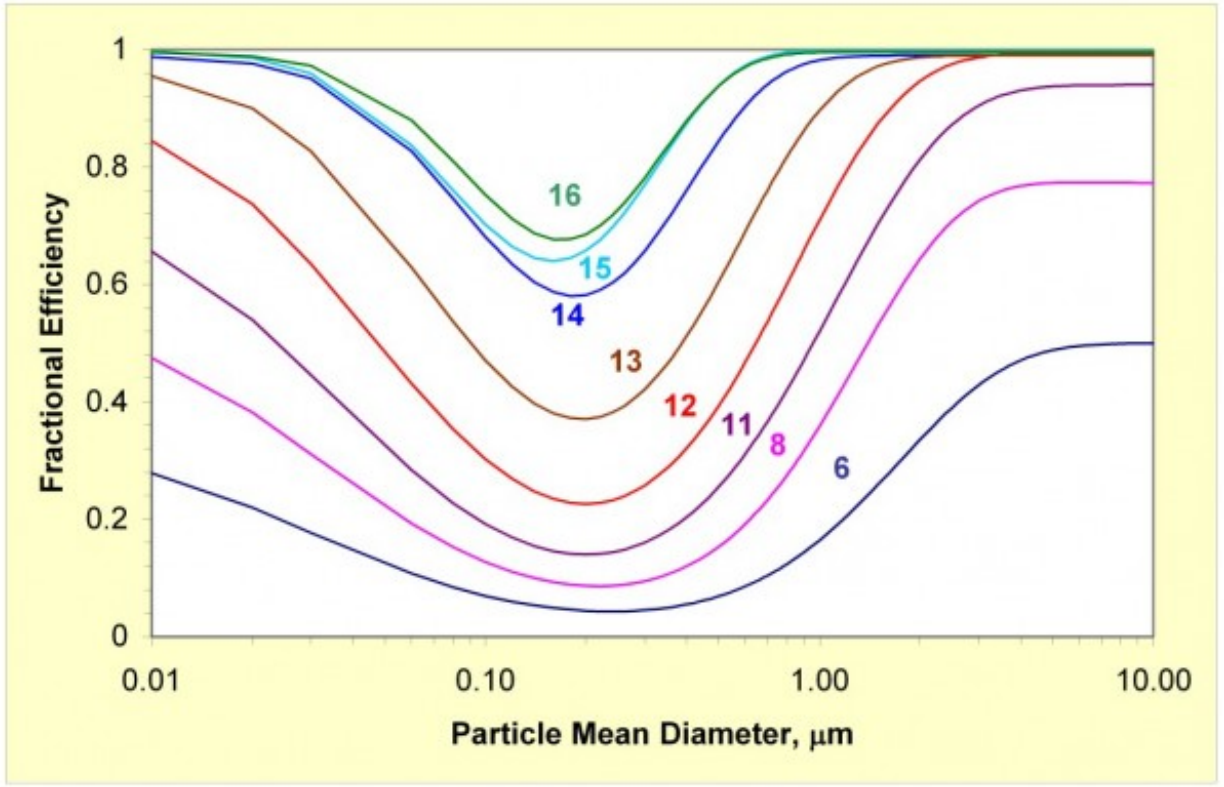
"HVAC Filtration for controlling infectious airborne disease transmission in indoor environments: Predicting risk reductions and operational costs" by Parham Azimi and Brent Stephens *Build Environ* – 2013 Dec. 70: 150-160

ASHRAE Recommendation – MERV 13 (or the highest possible with HVAC systems)





Air Filters are More Efficient on Larger and Smaller Particles



Factors to Consider in Schools Going to MERV 13 Filters

- Cost – More expensive. But prices of MERV 13 stable. “True cost” – filters vs. risk. Low relative cost.
- Compatibility with equipment – Concerns about increased resistance taxing older HVAC systems
- Some school districts have gone to MERV 11

Factors to Consider for Filter Effectiveness

- **Filtration**
- **Fit**
- **Flow**

What About Recirculation?

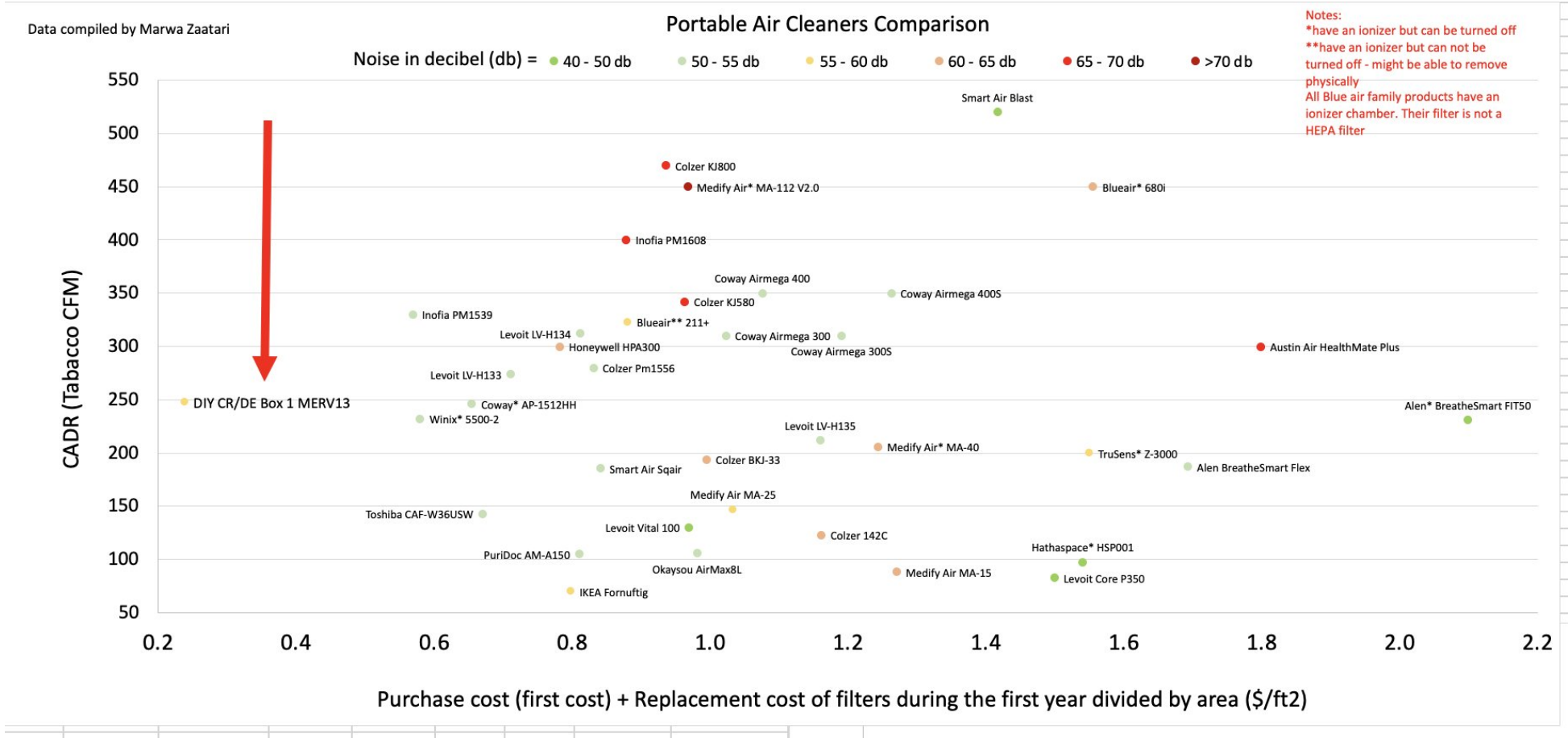
“In most systems, recirculation hasn't appeared to be a big problem because of a combination of the infectivity of the original strains of SARS-CoV-2, dilution in a much larger volume, and removal by filters. Normal office outdoor air + MERV 13 is similar in effect to 100% outside air.” Dr. Bill Bahnfleth – Chair ASHRAE Epidemic Task Force

The Goal is to Obtain 6 ACH

- Natural ventilation
- Mechanical ventilation
- Filtration
- Supplemental Air Cleaners – HEPA and/or DIY

HEPA Air Cleaners

Portable Air Cleaner Comparison



Stick with Proven Technologies

Avoid “additive” products that claim to alter indoor air

- No Ozone
- No Hydroxyl Radicals
- No Hydrogen Peroxide
- No Bipolar Ionization
- No Cold Plasma

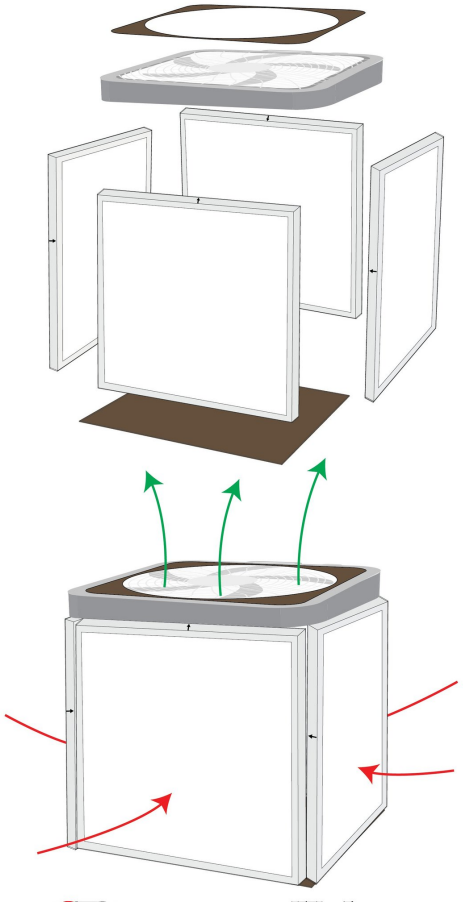
A Phone Call from a Reporter at Wired "Does the Box Fan and MERV 13 Filter Work?"

- **August 6, 2020**
- **"Could a Janky, Jury-Rigged Air Purifier Help Fight Covid-19?"**
- **"Indoor-air experts think: Sure, maybe. Why the hell not? We convinced the CEO of an air filter company to give it a try."**
- **I was the CEO.**
- **My tests showed that it was very effective with high air flow**
- **This blog post was the result:**
- How a MERV 13 Air Filter and a Box Fan Can Help Fight Covid-19 | Tex-Air Filters (texairfilters.com)

An Observation by Dr. Richard Corsi Leads to the Creation of the Corsi/Rosenthal Box

- “On a recent Zoom call, environmental engineer Richard Corsi—dean of the Maseeh College of Engineering and Computer Science at Portland State University and an indoor air quality expert—held up a Folgers Coffee box to illustrate for me how a fan at one end, and filters on three or four other sides, could reduce the “pressure drop” that can come from putting a filter in front of a fan and still move (and clean) room-sized volumes of air.”
- So I made the first Corsi/Rosenthal Box:
- A Variation on the "Box Fan with MERV 13 Filter" Air Cleaner | Tex-Air Filters (texairfilters.com)

The Corsi/Rosenthal Box
A low cost, DIY, easy-to-assemble and effective air cleaner



Advantages of the Corsi/Rosenthal Box Air Cleaner

- Supplies easy to find – 4 or 5 MERV 13 filters, a box fan and tape
- Inexpensive – less than $100
- Simple construction – If you can seal a box, you can make a CR box air cleaner
- Powerful – 580 fpm at 24” from the fan
- Efficient – 0.3 um – 58%, 0.5 um – 66%, 1 um – 81%, 2.5 um – 94%, 5 um – 95%, 10 um – 95%
- Safe – UL has studied and found within all limits for safety
- Quiet – 51 decibels at 6 feet

Scalable

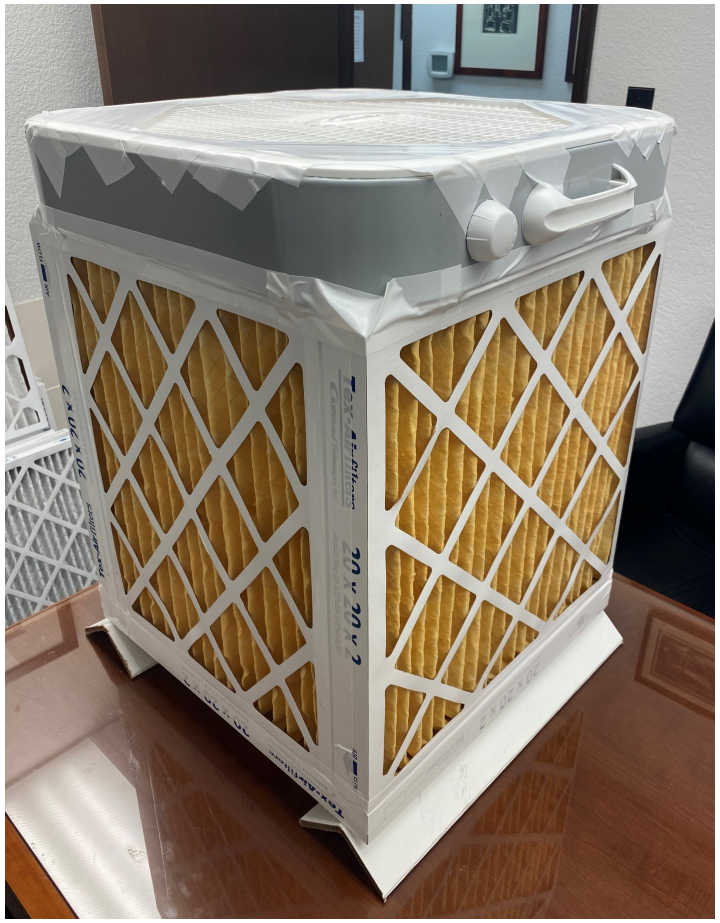
How Well Does It Work?

- Dr. Shelly Miller – University of Colorado

“The Corsi filter box reduced PM2.5 by 92% on average! Yep. It works! My student is testing a filter she made in her small apartment, challenged the air cleaner with cooking emissions.”

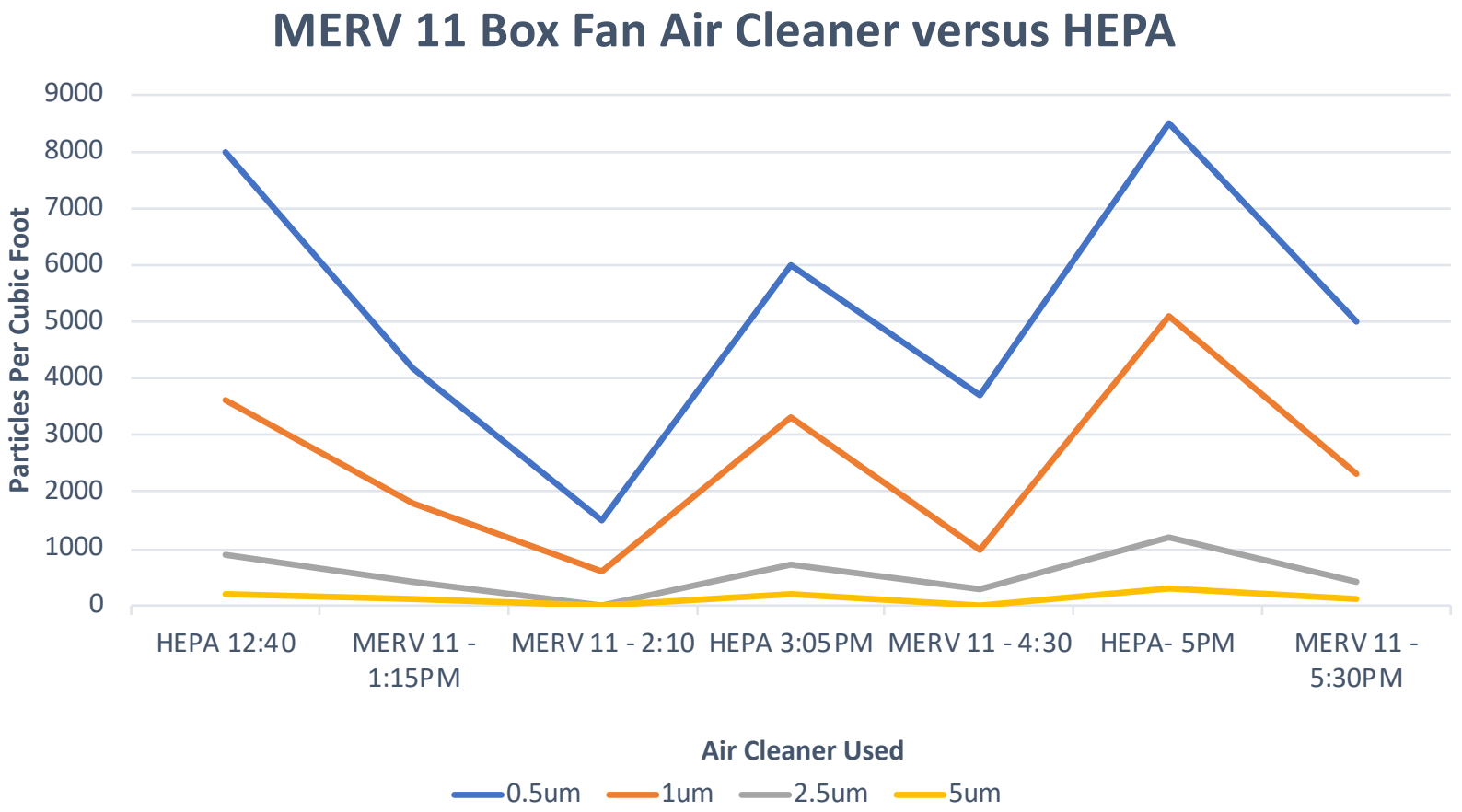
Battle of the Air Cleaners
Contestant #1 – IQ Air HEPA Air Purifier

Battle of the Air Cleaners
Contestant #2 – “Corsi/Rosenthal” Box with MERV 11 Filters



E1 - (0.3-1um) – 27%
E2 – (1-3um) – 67%
E3 – (3-10um) – 85%

It’s the airflow!



University of California – Davis Tested the Corsi/Rosenthal DIY Box

Table 1 - DIY box fan filter test results. Best value highlighted in green.

Fan	Fan Intake	Speed	Power (W)	Airflow (CFM)	CADR	Noise (dB)	Face Velocity (fpm)	Energy Efficiency (CADR/ Watt)	Cost ($)	Cost ($) per unit of CADR
Lasko (A) + Shroud	4 Filter	1	70	306	165	53	34	2.19	$74.48	$0.24
Lasko (A) + Shroud	4 Filter	2	88	407	220	58	45	2.31	$74.48	$0.18
Lasko (A) + Shroud	4 Filter	3	102	443	239	61	49	2.17	$74.48	$0.17
Lasko (A) + Shroud	1 Filter	1	70	85	46	53	38	0.61	$41.12	$0.48
Lasko (A) + Shroud	1 Filter	2	89	120	65	58	53	0.67	$41.12	$0.34
Lasko (A) + Shroud	1 Filter	3	102	142	77	61	63	0.70	$41.12	$0.29
Lasko (B) + Shroud	4 Filter	1	71	301	163	52	33	2.12	$104.48	$0.35
Lasko (B) + Shroud	4 Filter	2	90	422	228	57	47	2.34	$104.48	$0.25
Lasko (B) + Shroud	4 Filter	3	103	500	270	60	56	2.43	$104.48	$0.21
Lasko (B) + Shroud	1 Filter	1	71	91	49	52	40	0.64	$69.12	$0.76
Lasko (B) + Shroud	1 Filter	2	89	135	73	57	60	0.76	$69.12	$0.51
Lasko (B) + Shroud	1 Filter	3	103	154	83	60	68	0.75	$69.12	$0.45

[1] *Considerations for Use and Selection of Portable Air Cleaners for Classrooms: bit.ly/pacClassrooms*

[2] *ENERGY STAR® Program Requirements for Room Air Cleaners: bit.ly/energystarRequirements*

UC Davis Developed and Presented a Two Day IAQ Class for Junior High Students: Concluded with Students Building 30 CR Boxes for Their School (9/20/2021)

Illinois Institute of Technology
Built Environment Research Group

- We tested a version of a Corsi-Rosenthal box with MERV 13 filters: https://built-envi.com/wp-content/uploads/IIT-CADR-Testing-C-R-Box-September-2021.pdf…
- CADR intuitively increased with particle size:

  166 CFM for 0.09-1 µm (CADR Smoke)

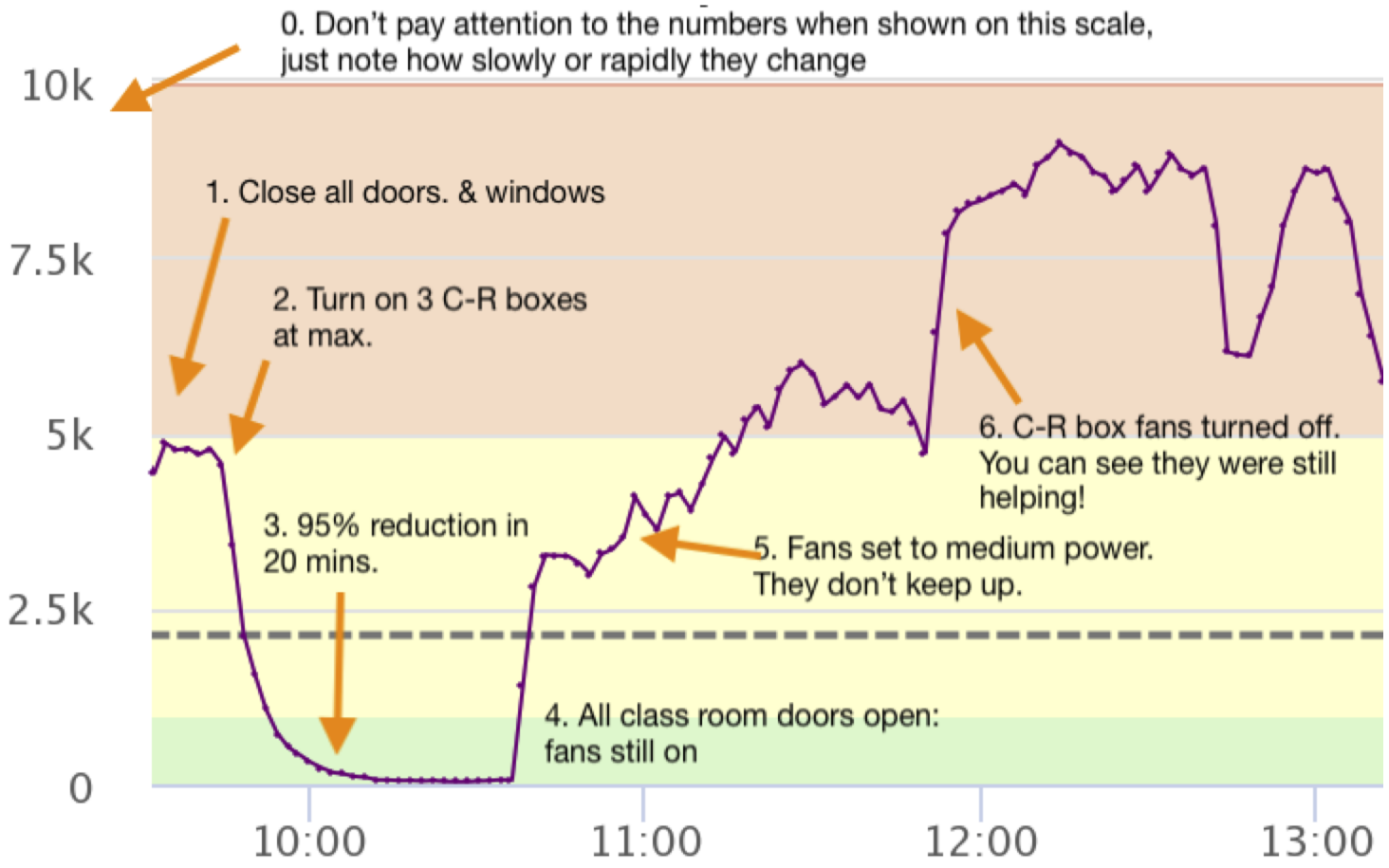
  321 CFM for 0.5-3 µm (CADR Dust)

  464 CFM for 5-11 µm (CADR pollen)

More Examples of Corsi/Rosenthal DIY Box Fan Filters

www.cleanaircrew.org

Dr. Josh Apte (UC Berkeley) - "Every air quality researcher I know has played around with these because they are so satisfying and simple and fun, and they work."



“140 Corsi/Rosenthal (Elfstrom) Box Materials Being Unloaded at 6th Grade Partner Classrooms” – UC Berkeley

UC – San Diego Builds 250 CR Boxes

It works!

We are not helpless!