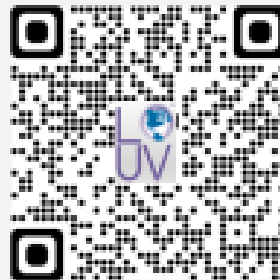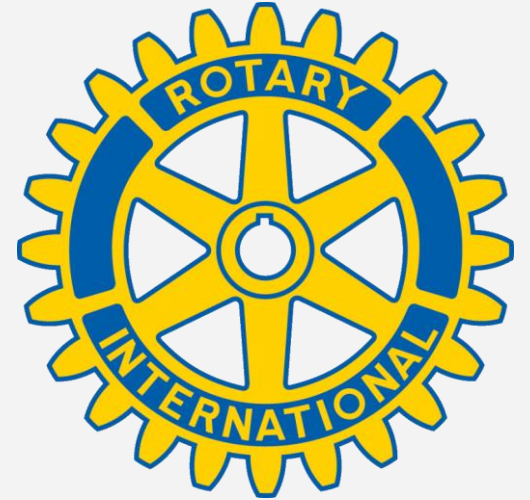# Preventing Respiratory Infections & Indoor Allergies

Presented to
Rio Hondo/Vernon Rotary Club
9 March 2023

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We are vulnerable to respiratory infections and allergens when we are indoors

Masks

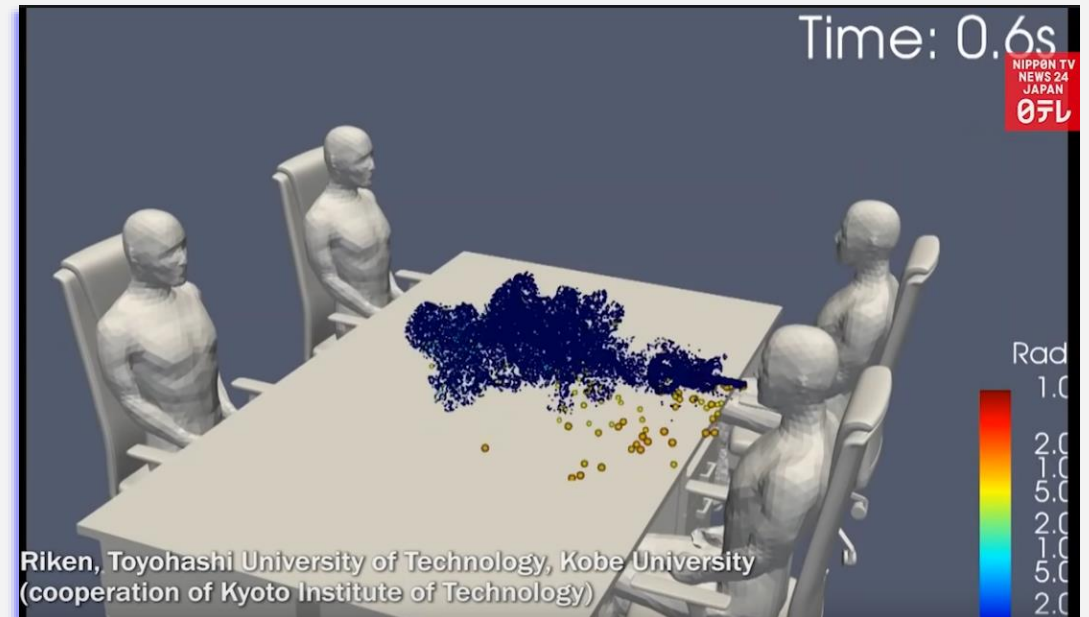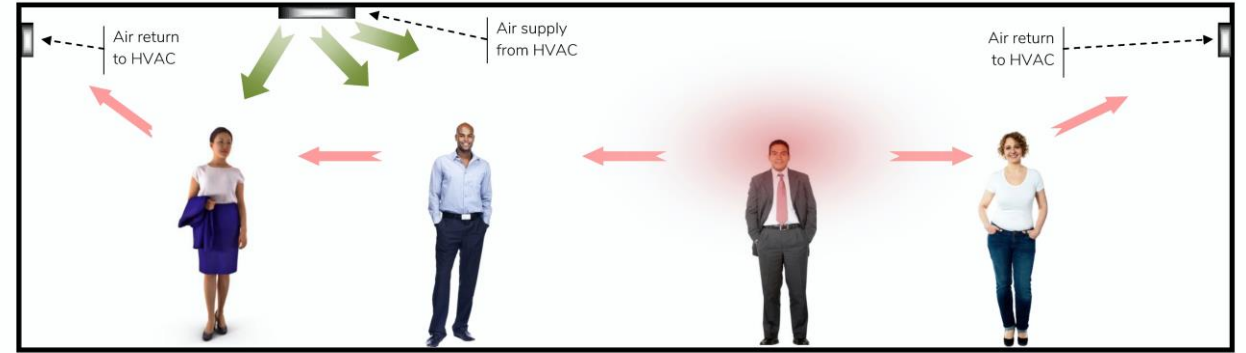Vaccines + Testing

Distancing

Current approaches are *defensive*

Proactive and *permanent* solutions are urgently needed

- The problem: We share the air indoors and generally without any air disinfection

- One breath every few seconds

- We each breath ~30 pounds of air every day

- We ensure our food and water are germ-free

- No regulations for indoor air except for comfort-based standards

- Studied over 150 scientific references and academic papers

- Two components of airborne pathogen spread (well-mixed and localized hybrid):
  - Pathogen fog (buildup; long-term risk)
  - Proximal respiratory jet (short-term risk)

- Clean outside air "dilutes" the pathogen fog
  - One air change/hour (ACH) → removes 63% of pathogens in the fog
  - Surgical rooms achieve ~12 ACH
  - Energy-intensive

- Strategic, directional airflow to both break up proximal respiratory jets & eliminate pathogen fog

Air return to HVAC — Air supply from HVAC — Air return to HVAC

Time: 0.6s

Riken, Toyohashi University of Technology, Kobe University (cooperation of Kyoto Institute of Technology)

High ventilation
(Air Changes)

- Energy intensive
- Does not address proximal exposures
- May aggravate downwind channeling exposure (Taiwan restaurant study with window A/C)

Chemicals
O_3, Ionization, PCO

- May expose people and pets to hazardous chemicals/ions
- Can damage surface/materials indoors

Filters in HVAC
Charcoal, MERV/HEPA

- Does not address proximal exposures
- Performance diminishes over time
- Solid waste generation

UVC light
200 – 280 nm (germicidal)

- 254 nm Low-UVC can be shielded to protect people and pets
- Dust mites, animal- and insect-based allergens, mold, asthma
- Efficacy may be achieved with effective directional airflow
- Bulbs are recycled, low energy consumption

$$U_{INF} = (1-f_{M-I})\dot{v}_I n_B \cdot \{(1/V)(1/\beta)f_{Z-I}[\alpha t_{INF}+(N_0-(\alpha/\beta))(1-\exp(-\beta t_{INF}))]+(1-s)(1-f_{M-E})(g/V_x)t_{INF}\}$$

Quantitative IAQ risk assessment tool
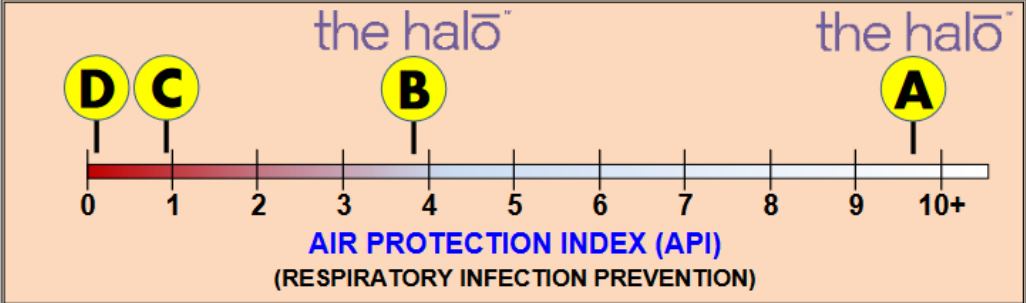- How safe is your indoor air?
- Time to infectious dose

Comprehensive dose model
- Source (α) and sink (β)
- Breathing zone and respiratory jets
- Shedding rate, infective load
- Aerosol dynamics, transport and fate
- Localized proximal/downwind effects
- Masks, social distancing, partitions
- Ventilation/windows/doors
- HVAC treatment/filtration
- Stand-alone air purifiers
- Ceiling-mounted air disinfection
- https://www.luvsystems.com/pages/pri-scientific-paper

- Comprehensive dose model provides a quantitative IAQ risk assessment <u>tool</u> to
  - Generate Airborne Pathogen Mitigation Index (APMI)
  - Guide public policy and standards for healthy indoor air
  - Inform about airborne risks in buildings
  - Compare mitigation strategies
- Results validated with
  - CDC's 15-minute close contact guideline
  - N95 masks in health-care settings
  - Documented super-spreader events

PARAMETER[1]	SCENARIO @ 3 FT DISTANCING			
	Current baseline		With the halō	
	no masks	masks	no masks	masks
	D	**C**	**B**	**A**
Inputs				
Room size, ft^2 [A]	1,167	1,167	1,167	1,167
Ceiling height, ft [H_{avg}]	11.2	11.2	11.2	11.2
Ventilation flowrate (makeup air), CFM [$\dot{V}_E$]	602	602	602	602
HVAC air flowrate, CFM [$\dot{V}_F$]^2	N/A	N/A	N/A	N/A
HVAC filtration/treatment	None	None	None	None
Lateral air velocity, ft/min [$v_{H,A}$]	49	49	10	10
Maximum occupancy, people [p]	10	10	10	10
Minimum distancing, ft [x]^3	3	3	3	3
Mask efficiency, % [f_{M-E} or f_{M-I}]	N/A	50	N/A	50
Other mitigation	None	None	the halō	the halō
Results				
Equivalent air changes per hour (ACH$_e$), hr^{-1}	3.1	3.1	29	29
Source/sink ratio, PPQ [α/β]	22,000	12,000	3,100	1,600
API, dimensionless	**<< 1**	**1**	**4**	**9.5**

the halō   the halō

D **C**   **B**   **A**

0   1   2   3   4   5   6   7   8   9   10+

AIR PROTECTION INDEX (API)
(RESPIRATORY INFECTION PREVENTION)

STEP 1. CAPTURE

Lift as much air as possible, quickly & unobtrusively, up and away from the breathing zone
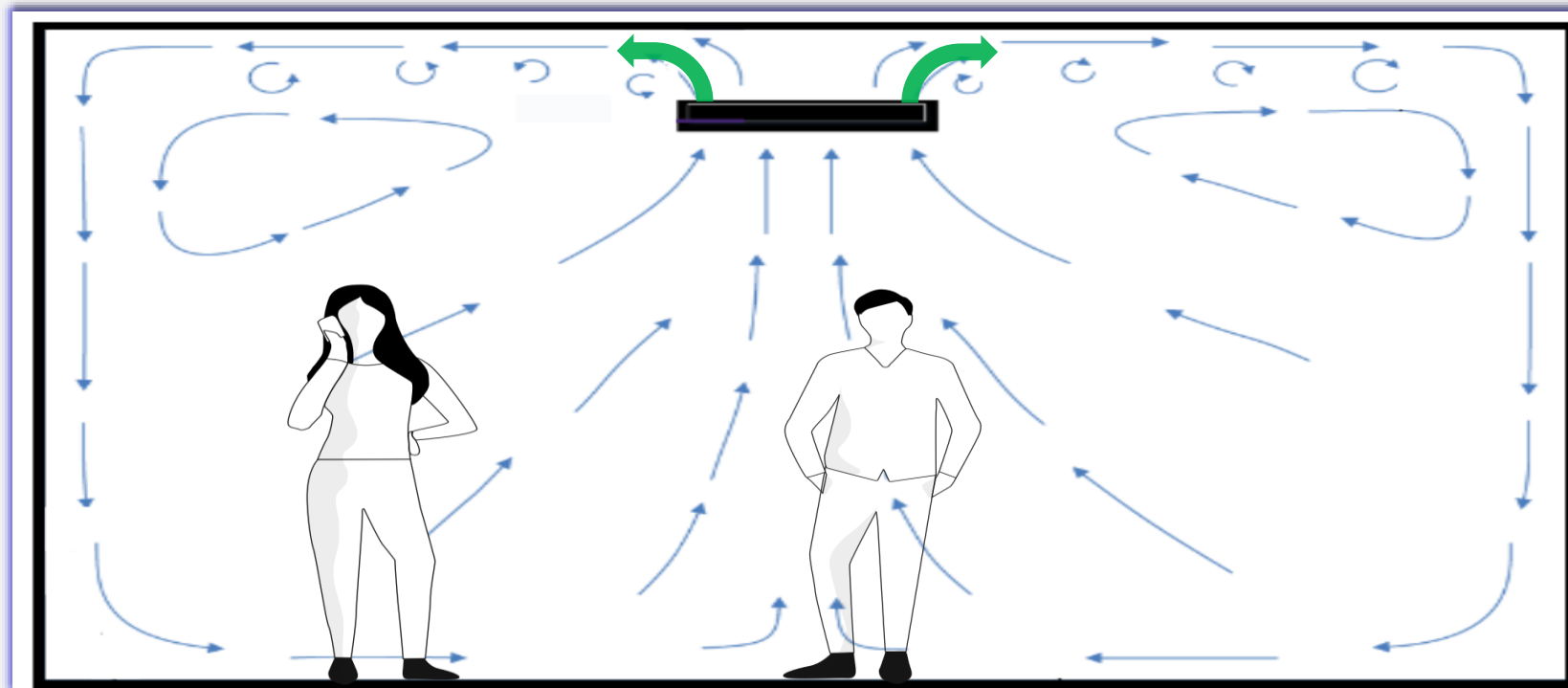

BREATHING ZONE (3-7 ft above floor)
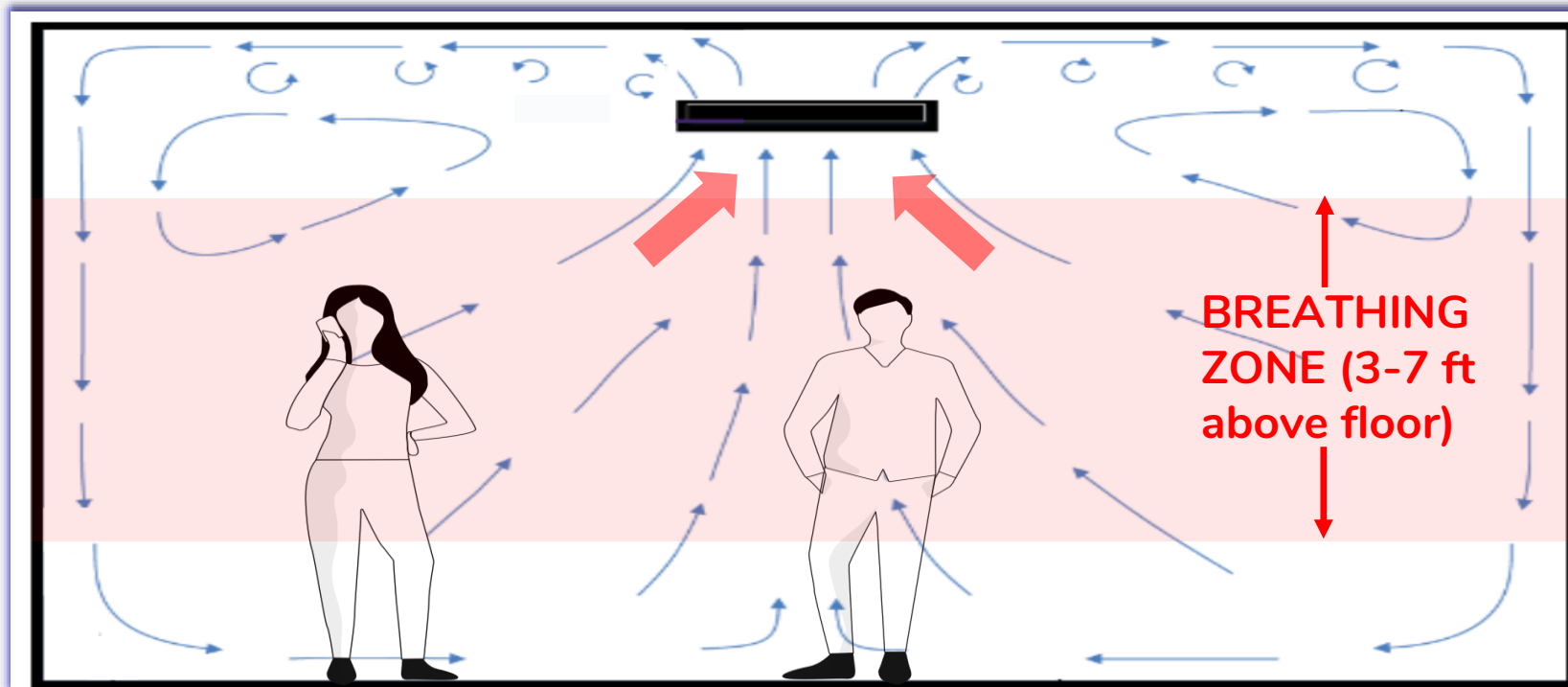
STEP 2. CONTROL

Safely & uniformly treat captured air with the needed UV-C dose
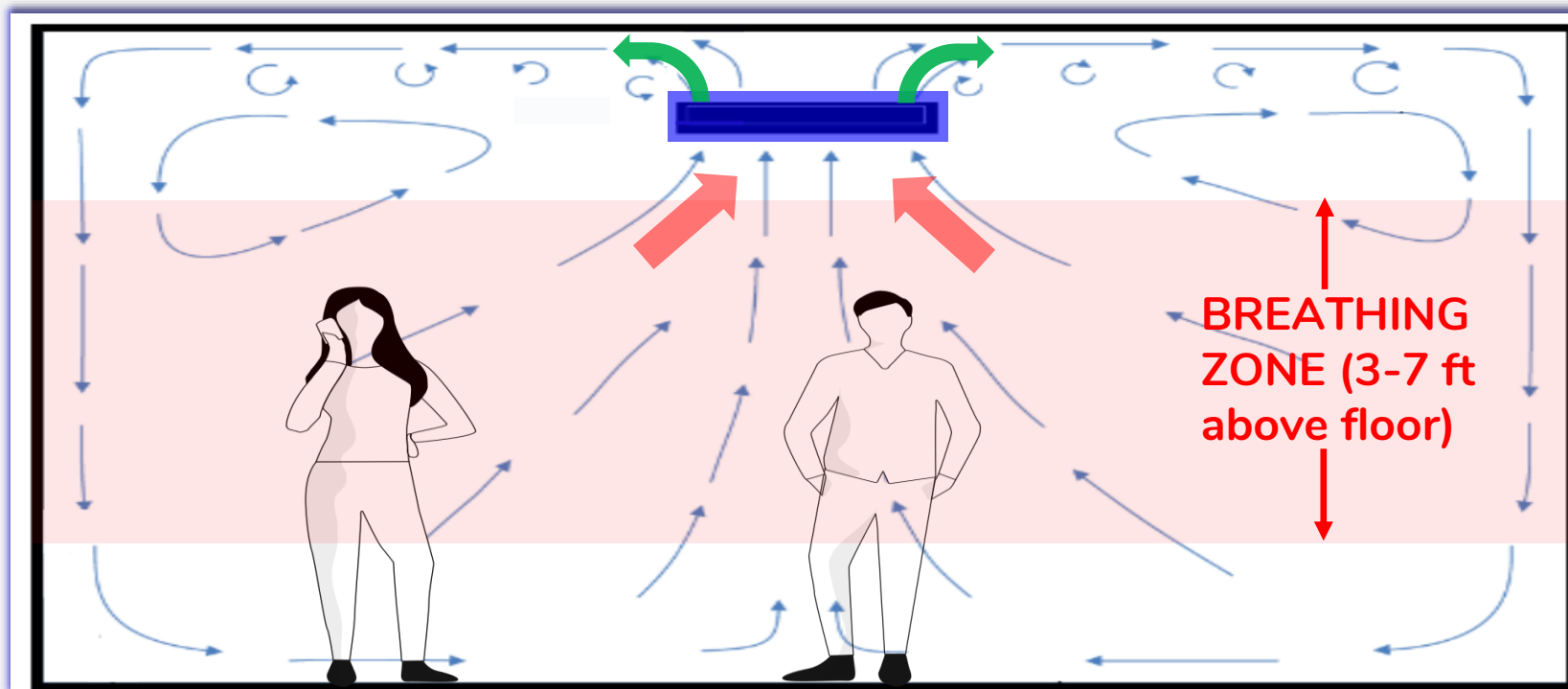for 99.9% pathogen inactivation
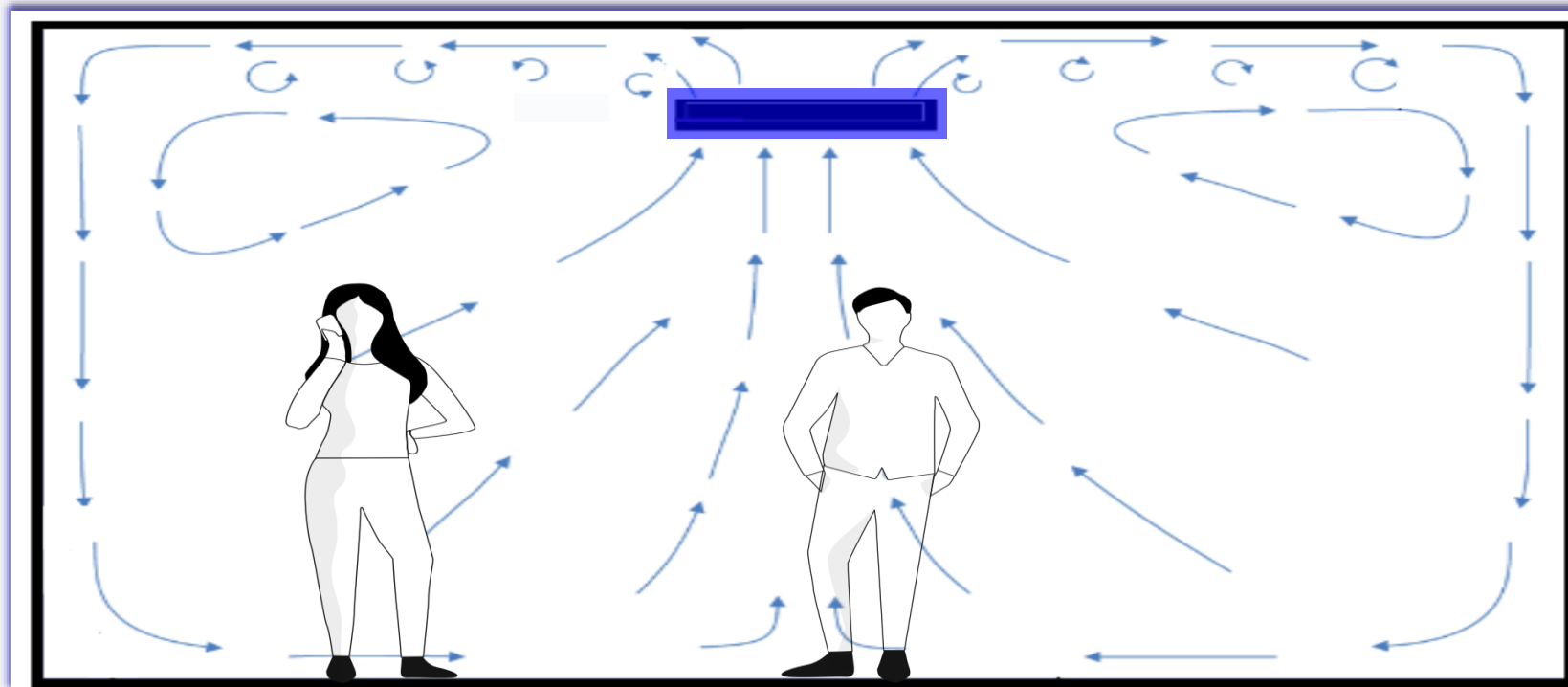
STEP 3. RETURN

Return treated air with directed airflow, <u>without mixing it with untreated air</u> rising into the fan

STEP 4. OPTIMIZE

Complete Steps 1-3 in a safe, effective, inclusive, and sustainable manner <u>in compliance with benchmark ESG principles</u>

BREATHING ZONE (3-7 ft above floor)

- ✓ > 2,000 ft^3/min from breathing zone
- ✓ Cowling encircles fan and contains low-UVC
- ✓ Clean, disinfected air exits the cowling
- ✓ Over 20 ACH$_e$ (hospital-grade air) for up to 4,500 ft^2
- ✓ Electricity cost under US $1.00/shift (US $0.20/kWh)
- ✓ Improves year-round HVAC energy efficiency
- ✓ Whisper-quiet and almost imperceptible breeze
- ✓ Operating continuously in our office since 4 Nov 2021; 2,500+ visitors with zero cases of cross-transmission

SUN VALLEY STARBUCKS & VISITOR CENTER
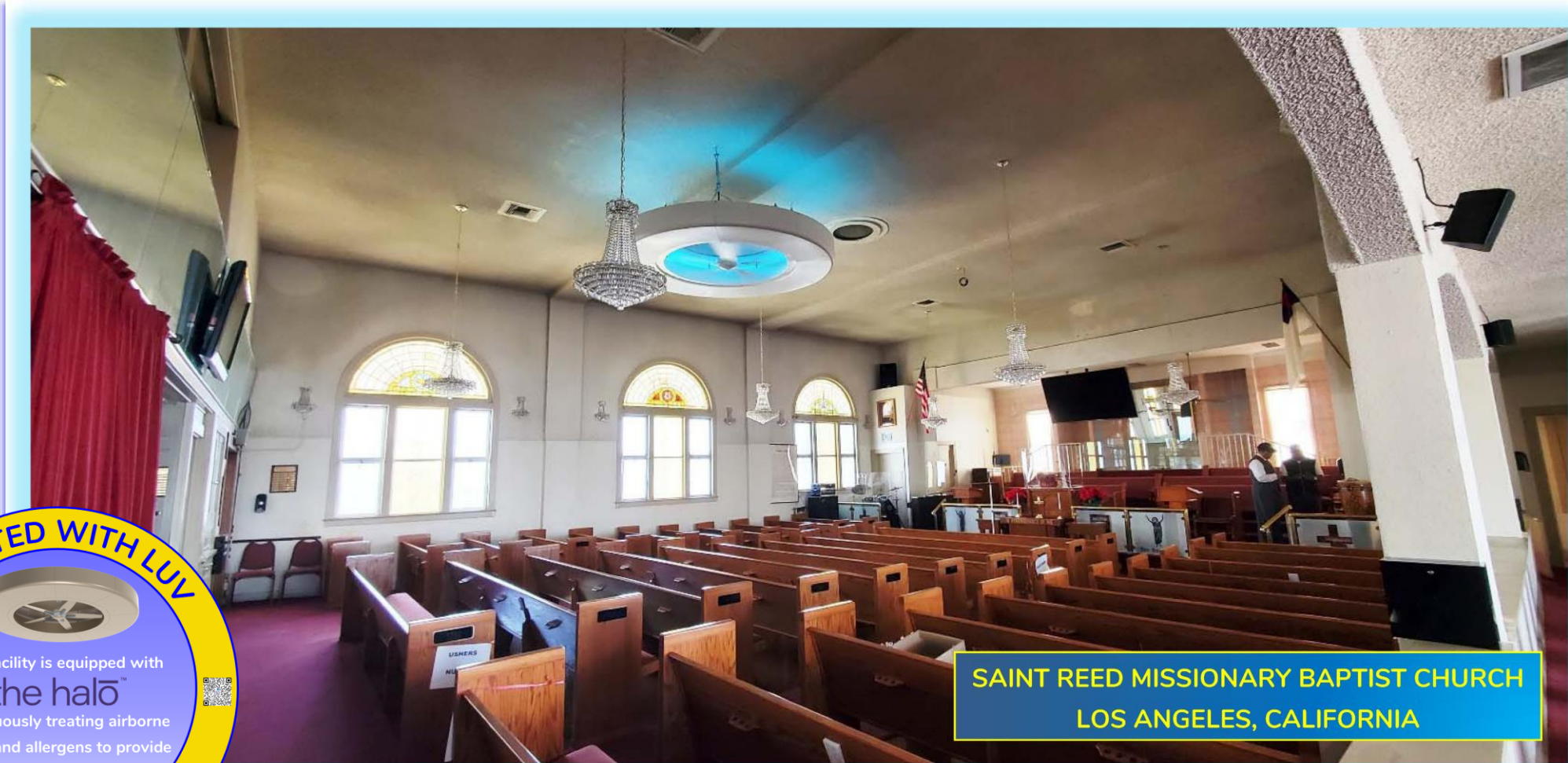KETCHUM, IDAHO

TREATED WITH LUV

This facility is equipped with
the halō™
Continuously treating airborne germs and allergens to provide you healthy indoor air
www.luvsystems.com

BREATHE FREE!

HOMEBOY INDUSTRIES (FIRST STREET)
LOS ANGELES, CALIFORNIA

TREATED WITH LUV

This facility is equipped with
the halō™
Continuously treating airborne germs and allergens to provide you healthy indoor air
www.luvsystems.com

BREATHE FREE!

SAINT REED MISSIONARY BAPTIST CHURCH
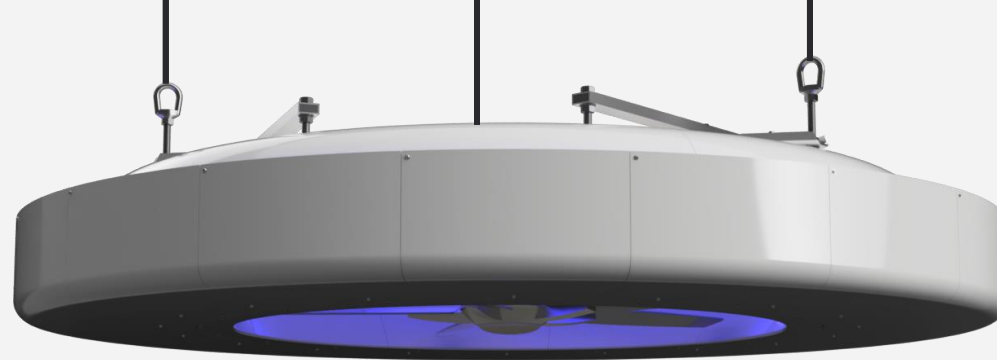LOS ANGELES, CALIFORNIA

TREATED WITH LUV

This facility is equipped with
the halō™
Continuously treating airborne
germs and allergens to provide
you healthy indoor air
www.luvsystems.com

BREATHE FREE!

Thank You!

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