Using Needlepoint Bipolar Ionization to Create Healthy Indoor Environments

David Schurk – Director Business Development

Global Plasma Solutions

DES., CEM., LEED-AP., CDSM., CWEP., SFP., CIAQM., HCCC.

ASHRAE Distinguished Lecturer

Welcome ASHRAE Dayton OH Chapter

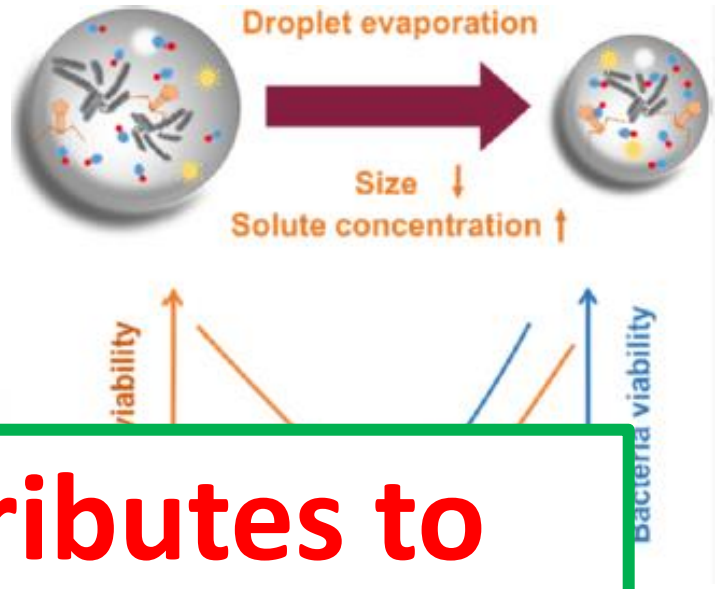
david.schurk@globalplasmasolutions.com

Background

- 38-years of HVAC Industry Experience
- Commercial Sales Engineer
- National Healthcare Strategic Account Manager
- Extensive experience in hospital environmental control and air-quality, focusing on critical care and operating room applications.
- ASHRAE Member & Distinguished Lecturer

We breathe 388-cubic feet of air each day and spend 90% of our time indoors

Filtration



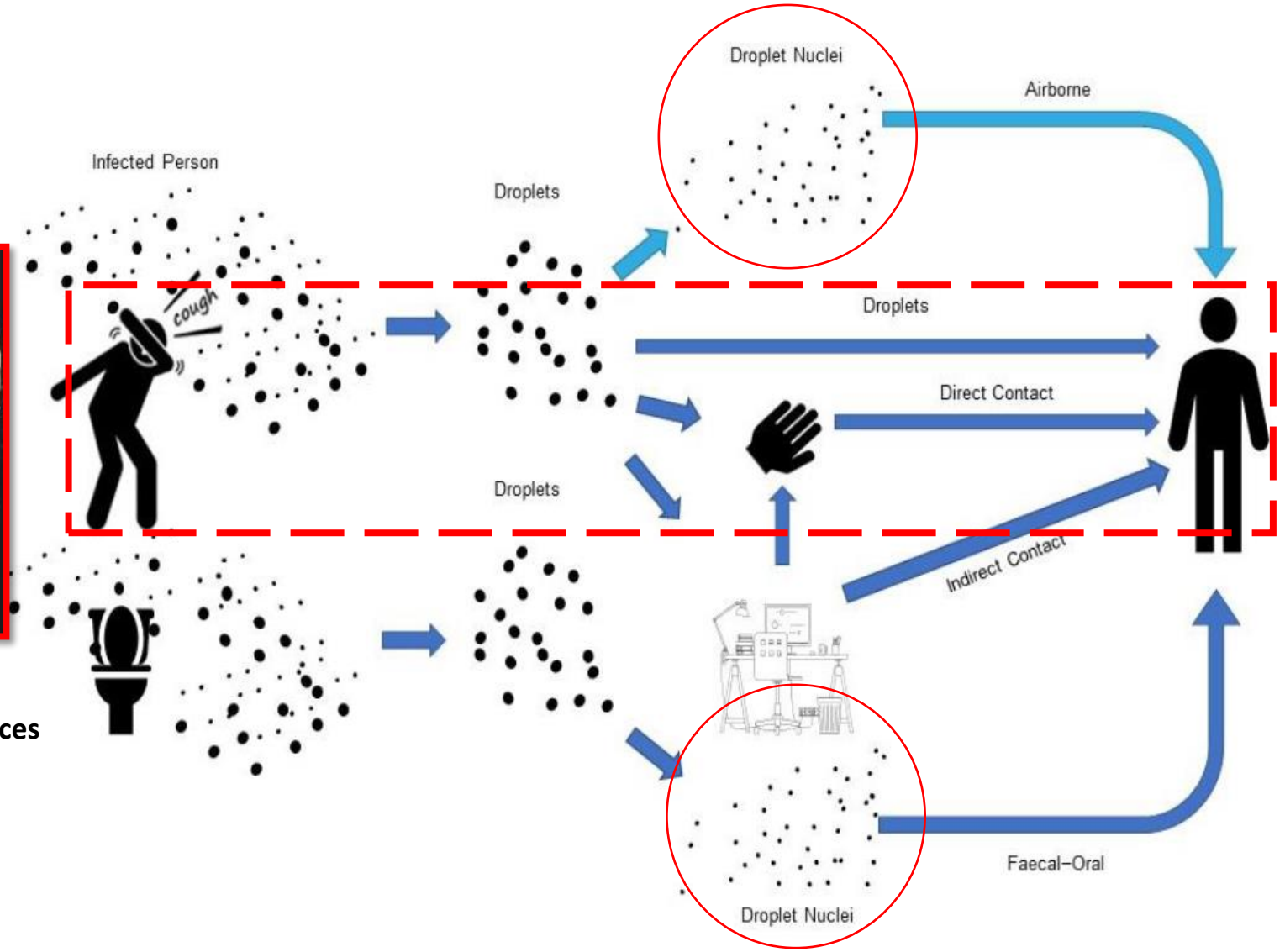
Advanced IAQ

The HVAC System Contributes to "Indoor" Social-Distancing

Airborne Viral Transmission

The SARS-CoV-2 virus can "live" hours to days in air and on surfaces

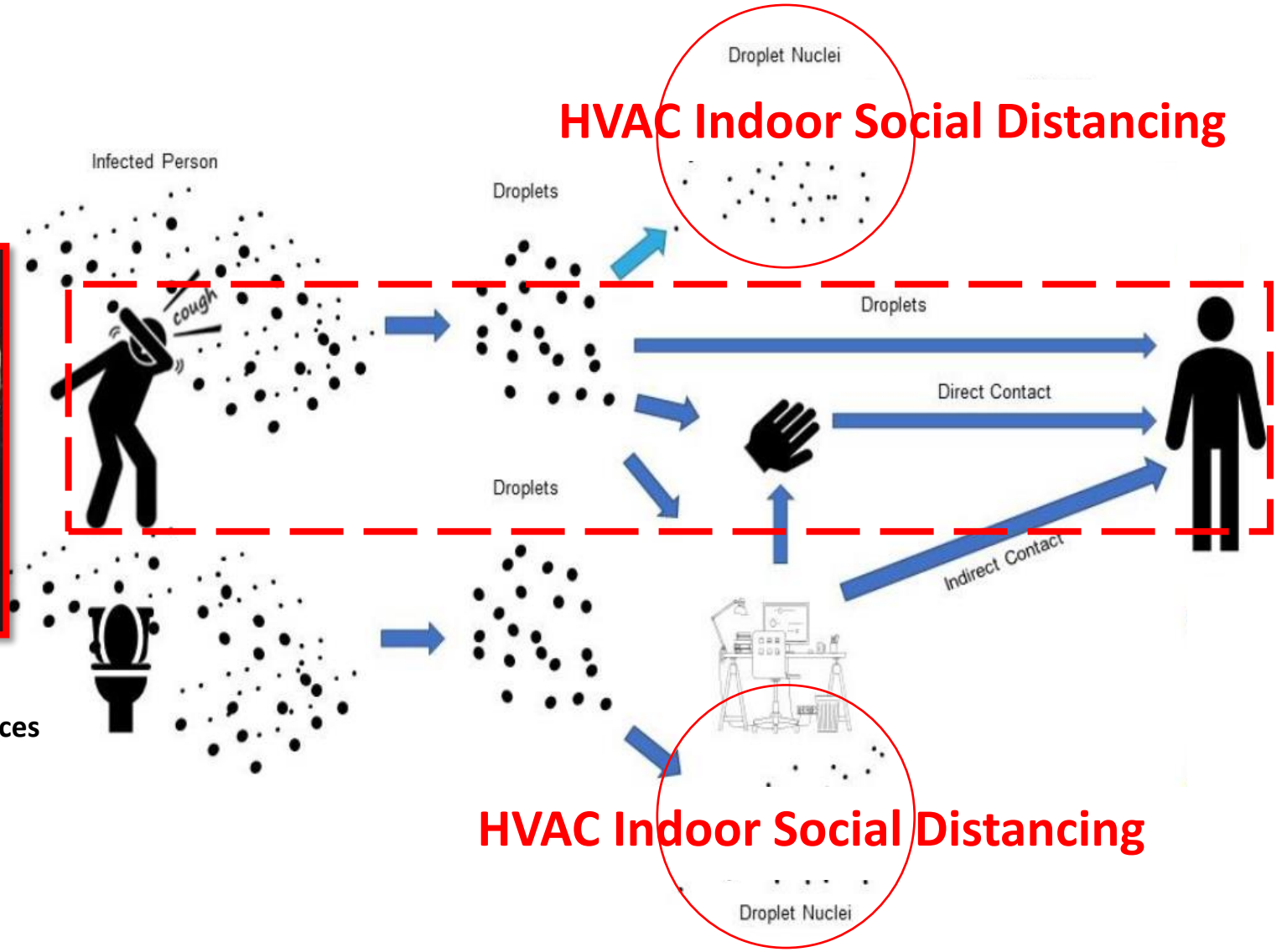
These airborne droplet nuclei can remain suspended in the environment indefinitely and be transported over great distances



Airborne Viral Transmission

The SARS-CoV-2 virus can "live" hours to days in air and on surfaces

These airborne droplet nuclei can remain suspended in the environment indefinitely and be transported over great distances



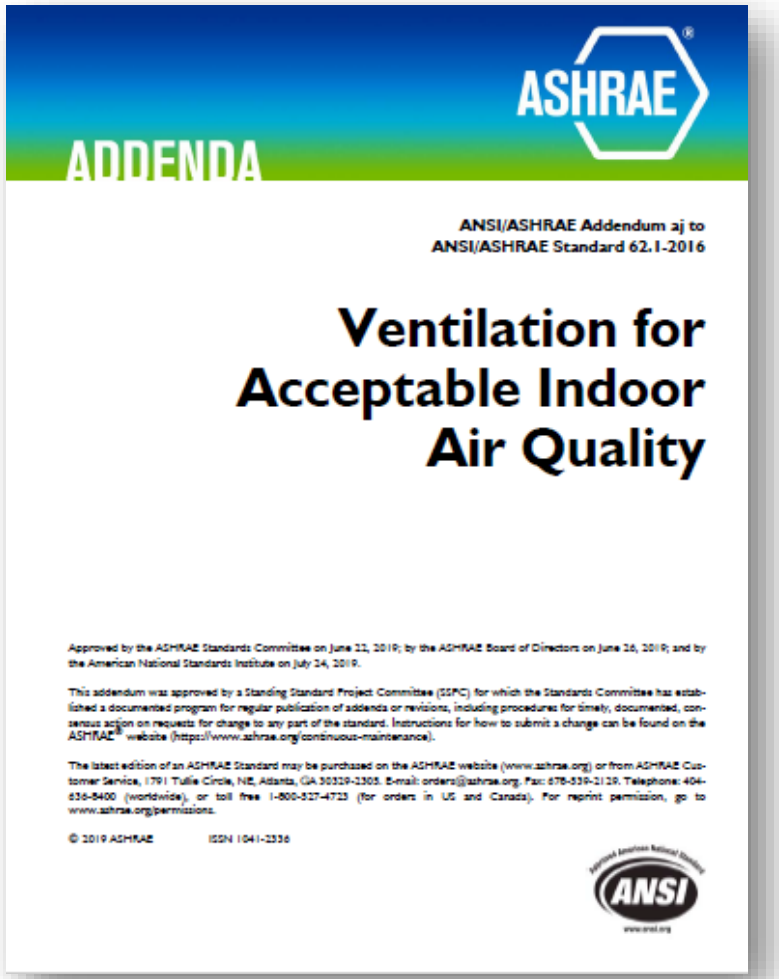
AIR CLEANING TECHNOLOGIES

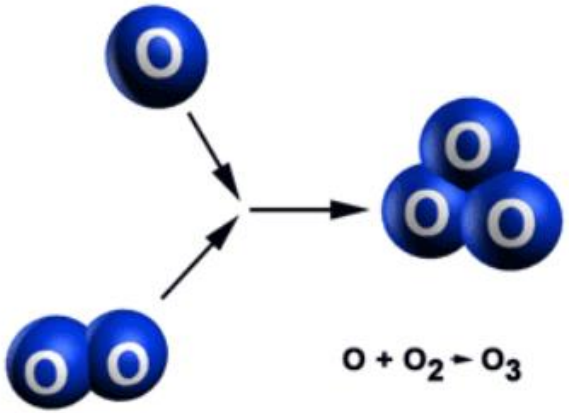
Sufficient published data shows the effectiveness of different filtration and air-cleaning technologies in removing contaminants from indoors and outdoors. In conjunction with proper mechanical (media) filtration, buildings can incorporate technology such as:

- In-Duct and Upper-Room UV Devices (UVGI)
- Needlepoint Bipolar Ionization (NPBI)
- Photocatalytic Oxidation (PCO)
- Liquid Desiccant Dehumidification (LDD)
- Polarized Media Filters
- Electrostatic Precipitators
- Negative Ion Generators
- Bipolar Ion Generators
- Electric Barrier Discharge Ion Tubes
- Corona Discharge Ion Tubes

ASHRAE notes that extreme caution is warranted when using devices in which ozone is emitted, even unintentionally, during the air-cleaning process as a byproduct.

ZERO OZONE VALIDATION IS CRITICAL





Addendum aj to Standard 62.1-2016

Add new Section 5.7 as shown. Renumber following sections as appropriate.

5.7 Ozone Generating Devices. The use of ozone generating devices shall comply with the following sections.

Exception to 5.7: Electronic devices used exclusively for the operation of HVAC equipment and controls.

Informative Note: Ozone generation is expected from ozone generators, corona discharge technology, some ultraviolet lights, electronic devices that create chemical reactions within the system, and some devices using a high voltage (>480 V). Motors and relays are examples of electronic devices that would be exempt.

5.7.1 Air Cleaning Devices. Air cleaning devices shall be listed and labeled in accordance with UL 2998.

Informative Note: The use of devices not intended for air cleaning with the potential to generate ozone should be avoided.

5.7.2 Ultraviolet Devices. Ultraviolet generating devices in supply air or spaces shall not transmit 185 nm wavelengths.

Informative Note: UV devices used in treatment of closed water systems may produce 185 nm wavelengths, which may generate ozone.

Some manufacturers try to disguise the ozone output by calling it activated oxygen, triatomic oxygen or activated plasma, to name a few. These name variations have caused confusion in the market.

Bipolar Ionization/Corona Discharge / Needlepoint Ionization and Other Ion or Reactive Oxygen Air Cleaners

Air cleaners using reactive ions and/or reactive oxygen species (ROS) have become prevalent during the COVID-19 pandemic. New devices that are not mentioned elsewhere in this guidance likely fall into this category.

Technologies utilize various methods to create reactive ions in air that react with airborne contaminants, including viruses. The design of the systems can be modified to create mixtures of reactive oxygen species (ROS), ozone, hydroxyl radicals and superoxide anions.

Systems are reported to range from ineffective to very effective in reducing airborne particulates and acute health symptoms.

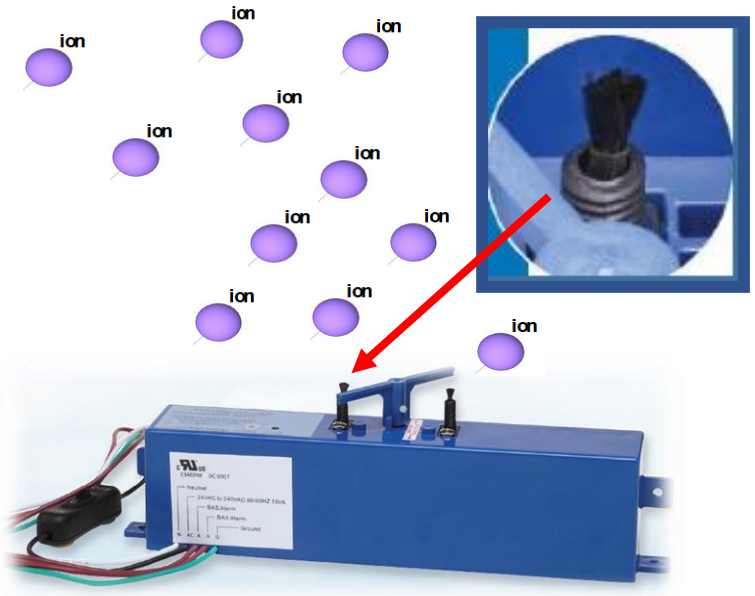
Convincing scientifically-rigorous, peer-reviewed studies do not currently exist on this emerging technology; manufacturer data should be carefully considered.

Systems may emit ozone, some at high levels. Manufacturers are likely to have ozone generation test data.

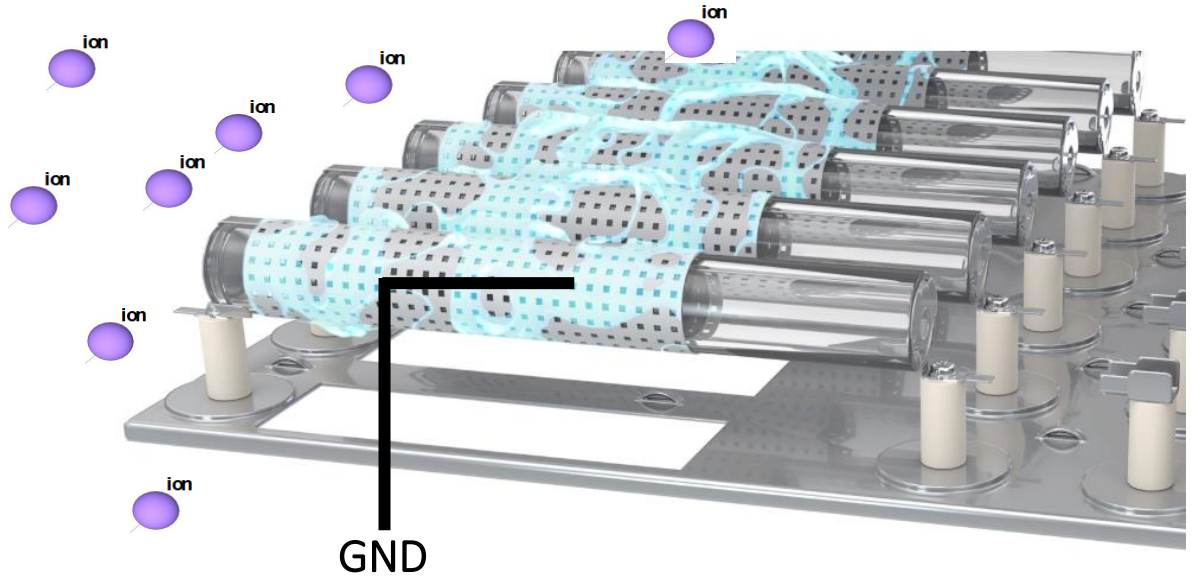
For more information, see the ASHRAE Position Document on Filtration and Air Cleaning and CDC Response to ASHRAE ETF on Bipolar Ionization

ZERO OZONE VALIDATION IS CRITICAL

Needlepoint Bipolar Ionization (NPBI):
Does not use a dielectric. The power output is controlled to less than 12.07eV to prevent the formation of ozone, aldehydes and ultra-fine particles



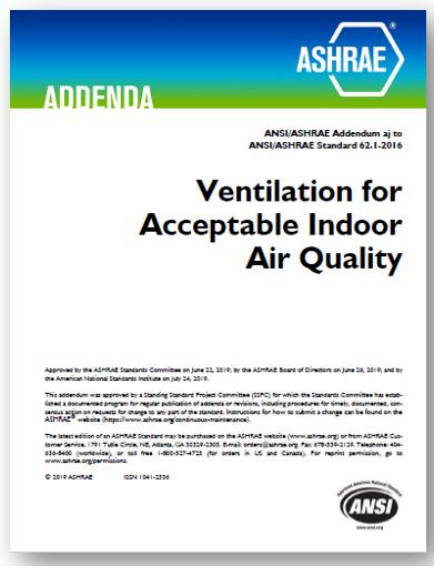
Corona Discharge Ionization:
Corona Discharge Tube (CDT), Bipolar Ionization Systems (BPI), Plasma Tube, Ionization Systems, Dielectric Barrier Discharge (DBD) Systems.



The power required to make most dielectrics break down is greater than 12.07eV (electron volts).

For a corona discharge system to operate, the voltage and current must be high enough to break down the dielectric material in order to complete the electrical path to ground. When the power output is sufficiently high and the path to ground is achieved due to the dielectric breakdown, a corona discharge is formed.

ZERO OZONE VALIDATION IS CRITICAL



Chemical Compounds Ionization Can Control

CHEMICAL	FORMULA	Electron Volt
Xylene*	C_8H_{10}	7.89
Styrene*	C_8H_8	8.46
Methyl Ethyl Ketone*	C_3H_8O	9.52
Ammonia*	NH_3	10.07
Acetaldehyde*	CH_3CHO	10.23
Ethyl Alcohol*	C_2H_5OH	10.48
Formaldehyde*	CH_2O	10.88
Oxygen	O_2	12.07

12 eV

Ionization Energy

NO OZONE

OZONE

ASHRAE

VALIDATED

- ZERO OZONE EMISSIONS - MEASURED OZONE EMISSIONS FROM GPS IMOD DURING USE PHASE DOES NOT EXCEED 0.005 PPM AS TESTED BY UL 2998

UL.COM/ECV

ASHRAE

IAQP COMPLIANT

IONS CLEAN THE AIR NATURALLY

- Air ions are electrically charged molecules or atoms in the atmosphere and are created in nature and artificially. An ion is either missing an electron (+) or has an extra electron (-). They are prevalent in the air around us.

- Natural and artificial ion generation includes the effects of radiation (radiation from the sun and cosmic radiation), the effects of the earths electric field, weather phenomena and the movement of winds (friction), plants, waterfalls and more have the effect of electrifying the atmosphere.

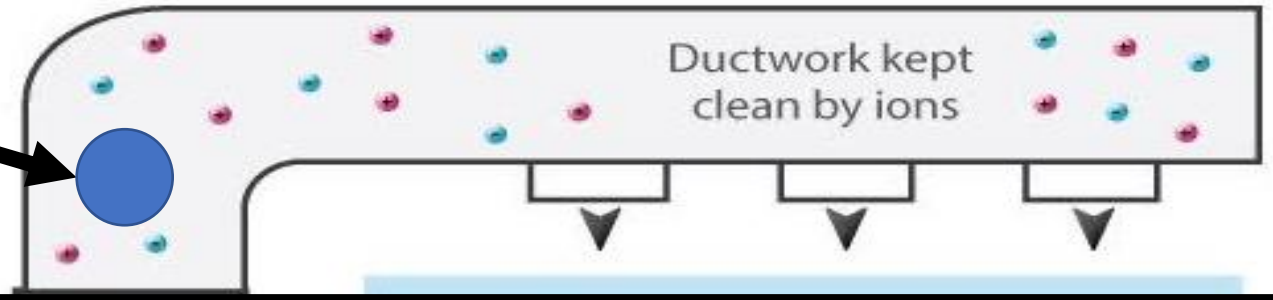
- Units of Measure = ions/cc (cubic centimeter)
  Waterfalls/High Elevation = 5,000 to 20,000 ions/cc
  City = 500 ions/cc Inside Buildings = <500 ions/cc

- There are 2.7 x 10^{19} molecules in every cubic centimeter of air

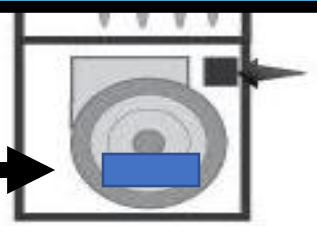
- Ions Have a Lifespan of About 60-Seconds

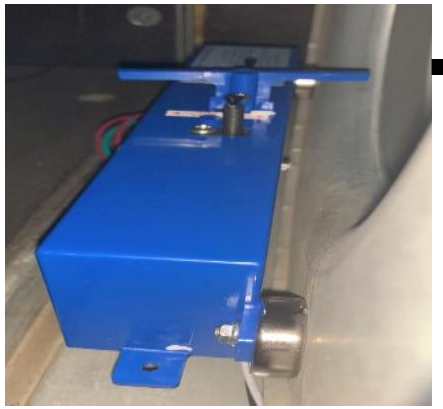
Rhine Falls - Switzerland

NPBI MOUNTS IN AHU OR DUCT



Locate NPBI Equipment AFTER (Upstream) of Filters





3. Reduce mold
4. Reduce allergens
5. Reduce dust
6. Reduce odors
7. Reduce VOCs
8. Reduce static electricity

Figure 1: Bipolar Ionization Unit

REMEMBER “POPE” NPBI BENIFITS

Particle Reduction – Technology makes particles clump together and a lower efficiency filter can capture them from the air

Odor Control – Odors, volatile organic compounds and the like are oxidized to gases already prevalent in the air such as oxygen, nitrogen, water vapor or carbon dioxide, eliminating the odors

Pathogen Control – Independent testing by CDC Affiliate Labs confirms kill rates as high as 99.9% of various pathogens and mold spores. Keeps new cooling coils clean and cleans up old coils.

Energy Savings by Outside Air Reduction, Coil Cleaning & Odor Control–

By cleaning indoor air and recirculating it – Less Outside Air is required.

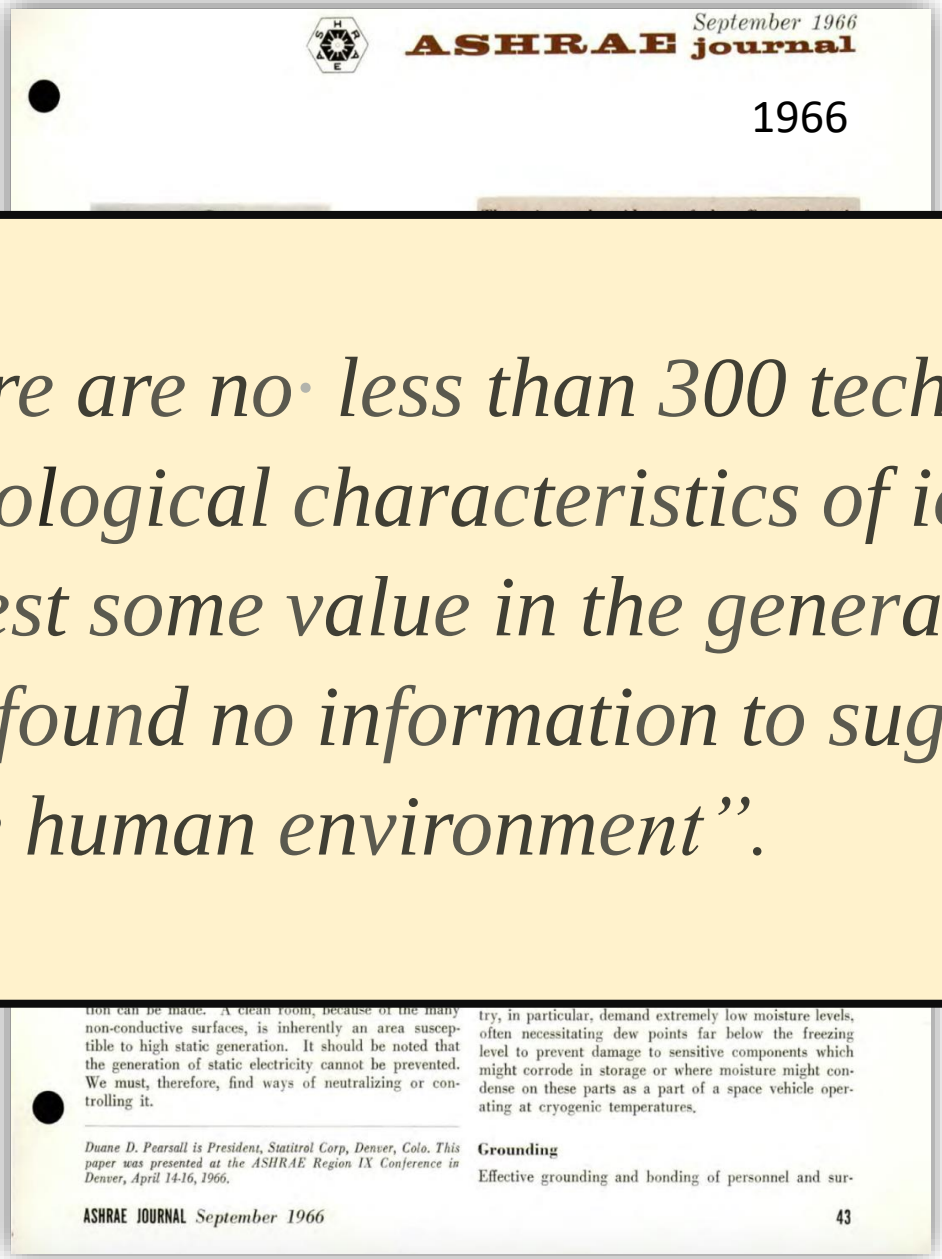
Less OA = Less Load on Cooling/Heating System – ASHRAE 62 & IMC Compliant

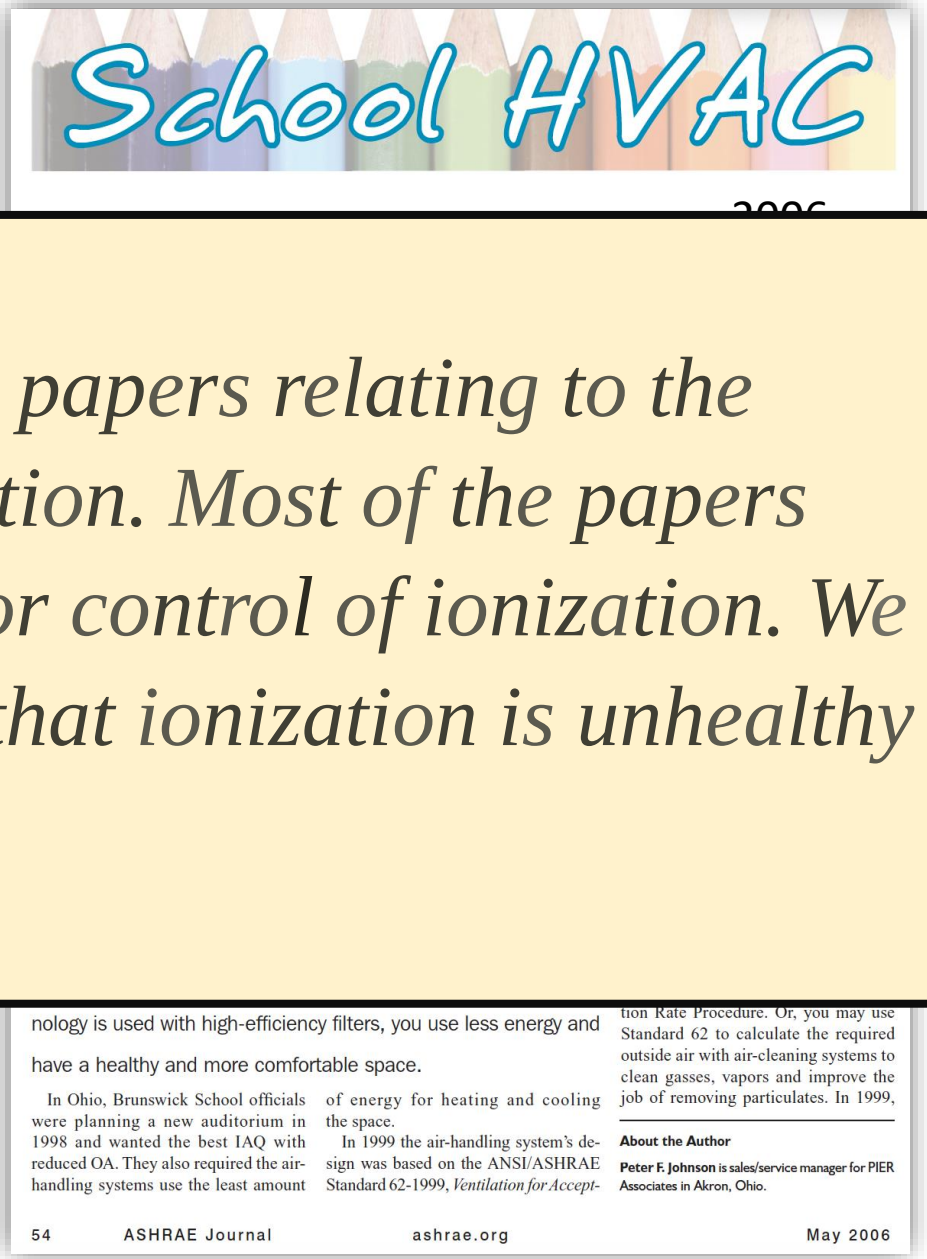
Keeping coils clean will maximize heat transfer and reduce fan/motor energy

Using NPBI in lieu of carbon will prevent the energy penalty of using carbon

ASHRAE®

ASHRAE JOURNAL ARTICLES





"There are no less than 300 technical papers relating to the physiological characteristics of ionization. Most of the papers suggest some value in the generation or control of ionization. We have found no information to suggest that ionization is unhealthy to the human environment".

ASHRAE COVID-19 GUIDENCE (UPDATE 7/17/2020

Introduction
Determining Building Readiness
- Summer Checklist for Fall Classes
- Startup Checklist for HVAC Systems Prior to Occupancy

Equipment & System Specific Checks & Verifications During Academic Year
- Cleaning & Air Flush
- Boilers
- Chilled, Hot & Condenser Water Systems
- Air Cooled Chillers
- Water Cooled Chillers
- Cooling Towers & Evaporative-Cooled Devices
- Steam Distribution Systems
- HVAC Water Distribution Systems
- Pumps
- Air Handling Units
- Roof Top Units
- Unitary & Single Zone Equipment

New/Modified Facility Design Recommendations
- Introduction
- Designer Guidelines – General School
- Nurses Office – General Requirements

Filtration Upgrades
- Introduction
- Filtration Basics
- Filtration Target Level
- Information Gathering Stage
- Data Analysis & Review
- Implementation & Considerations

Operation of Occupied Facilities
Controlling Infection Outbreak in School Facilities

Higher Education Facilities
- Student Health Facilities
- Laboratories
- Athletic Facilities
- Residence Facilities
- Large Assembly

Designer Guidelines – General School Continued

4. AHU's (SZ and VAV) and Packaged Rooftop units (PSZ, PVAV)

- During the Pandemic, increase Filtration to that recommended in the Filtration Upgrade section below.
- For existing units, an increase in filtration efficiency may reduce airflow capacity. Compensate for loss of capacity in winter with portable plug in elec. Heaters or higher discharge temps.
- Compensate for loss of capacity in summer with lower discharge temps off of AHU – recommend 52 F (this is mainly for VAV units where supply air temperature is controlled and due to additional pressure drop associated with higher efficiency filters).
- Check and fix economizer dampers and controls and maximize the economizer operation when possible (favorable outdoor conditions and outdoor air pollution).
- Check, fix and modify control sequences in VAV systems to avoid outdoor air flow /minimum OA air flow shortage.
- In VAV systems maximize the total supply air flow in each VAV terminal when the system is in full economizer mode.
- Minimize the unit air recirculation to minimize zones cross contamination thru the return air system.
- Install UV/C lights, ionization in AHU's – UV min 1500 microwatts/cm^2 when possible. UV/C lights a destructive to filter media. Ensure no UV lights shall shine on filters.
- Install Humidifiers in AHUs and Packaged rooftop units if possible.
- Install duct mounted humidifiers at classrooms as an alternate.

5. Local HVAC units (Fan Coils, WSHP, GSHP, Mini Split, VRF, Unit Ventilators, Radiators/baseboards)

- Increase Filtration to the maximum MERV suggested by the manufacturer.
- Compensate for loss of capacity in winter with portable plug in electric heaters or higher discharge temps.
- Hydronic /Electric radiators / baseboard can remain operational.
- Check unit ventilators for proper amounts of OA and operation.
- Install Portable humidifiers in each classroom for local humidity control.

6. Space Air Flow

- Ensure airflow patterns in classrooms are adjusted to minimize occupant exposure to particles.
- Recommended guidance is to provide lowest possible particulate concentration anywhere in the space.

Implementation & Considerations Continued

If MERV 13 Filters cannot be installed consider the following:

- Increase the filtration in the unit to the maximum available
- Provide a recirculation fan filtration unit and duct into the return of units
- Provide a HEPA filtration unit which re-circulates air within the space
- Consider Air Ionization system or static charge on filters
- Consider UV treatment but review location to avoid impacts of liners and other internal components
- Refer to ASHRAE Filtration and Disinfection system section for additional information
- Consider alternate filter locations in return duct or grille but consider static pressure drop implications and relationship with outside air dampers

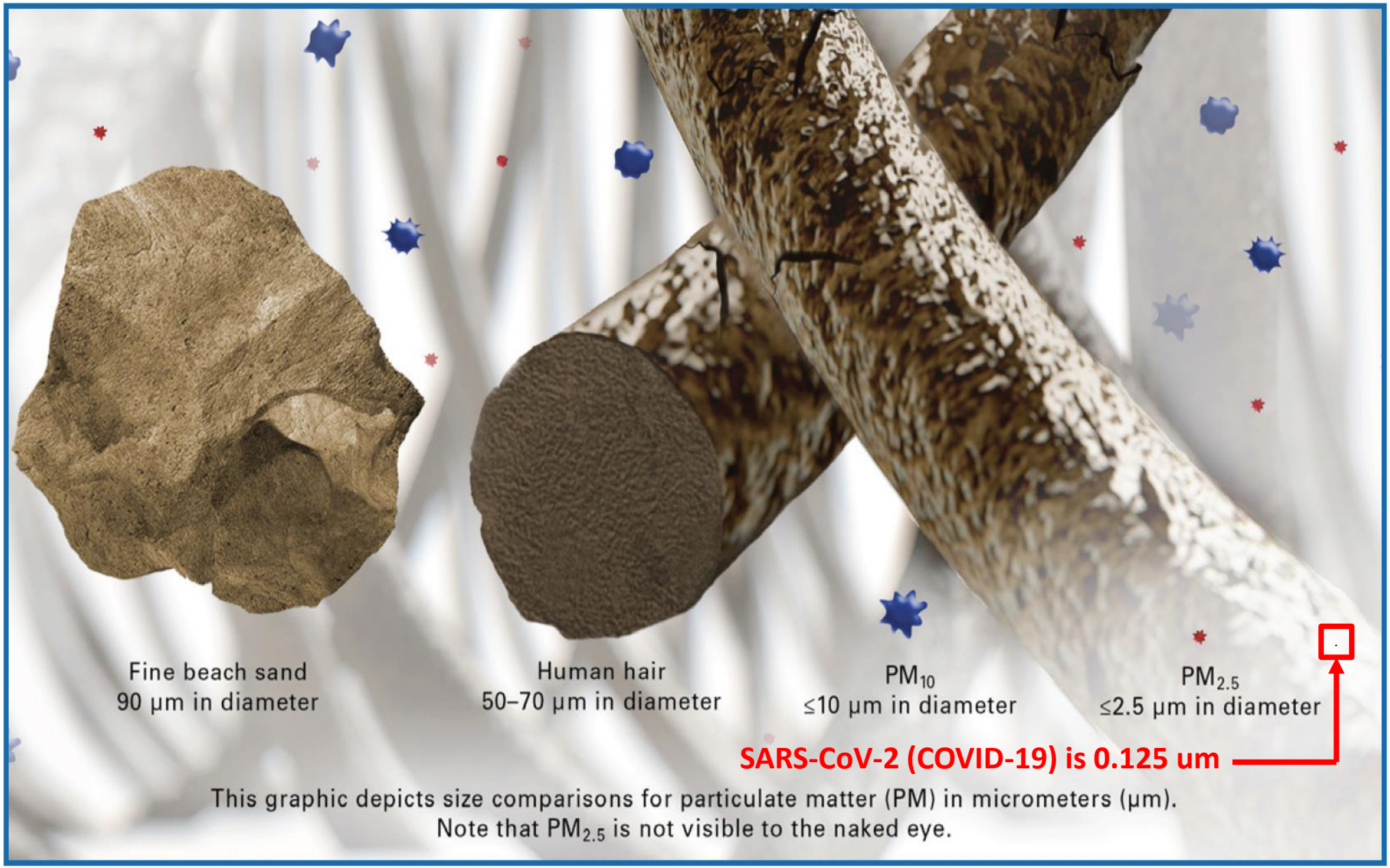
Additional Considerations:

MERV 8 + NPBI = > MERV 13 (Blue Heaven Labs)

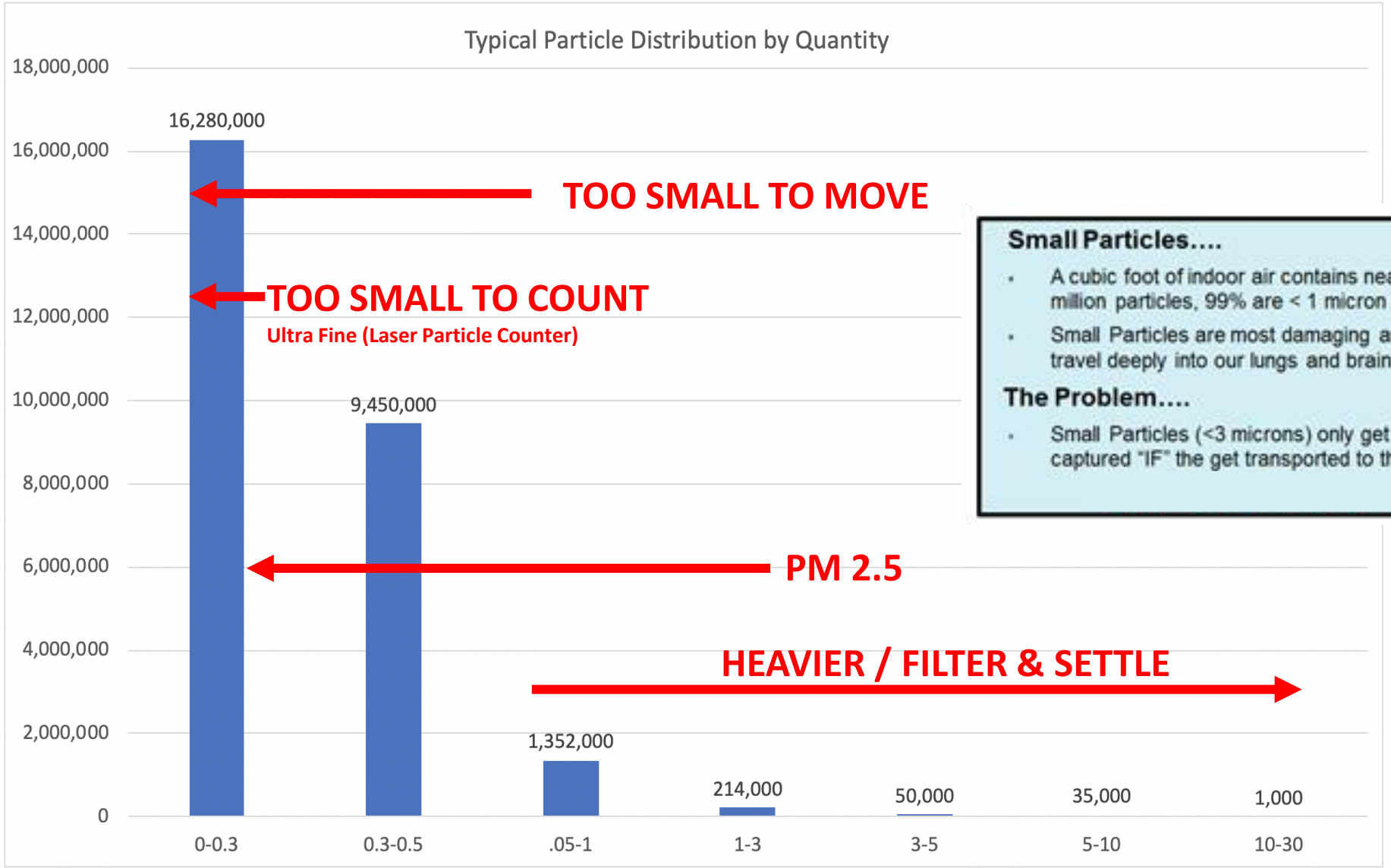
MERV 12 + NPBI => MERV 16 (NRC Canada)

Saves cost of higher MERV filter + fan energy

HOW NPBI WORKS ON PARTICLES



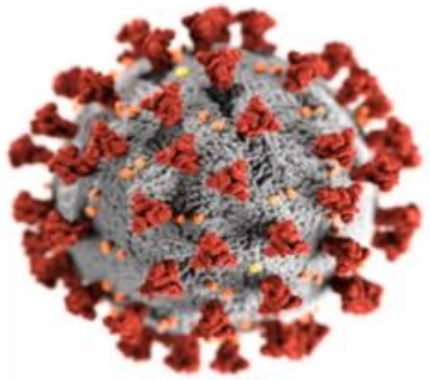
Ionization Shifts Particle Sizes



HOW NPBI WORKS ON PARTICLES

ISO 16890 classifications are based on where particles are deposited in the human lung.

- Coronavirus related to the one that causes SARS
- RNA virus with lipid envelope
- Diameter » 120 nm (0.12 µm)
- Not determined
  - Shedding rate
  - Infectious dose
- Survival of hours in air, days on surfaces



PM 2.5

amic Diameter (µm)
les and their likely
f deposit

ISO 16890 Filter Ratings

	Nose and Pharynx	
	Trachea	
2–3 µm	Bronchia	
1–2 µm	Bronchioles	
0,1*–1 µm	Alveoli	

PM_{10}

$PM_{2,5}$

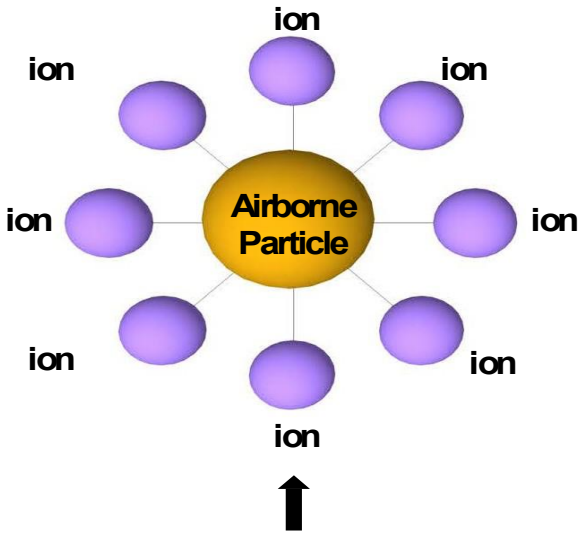
PM_1

*Efficiency on particles smaller than 0,3 micron is not defined by the ISO

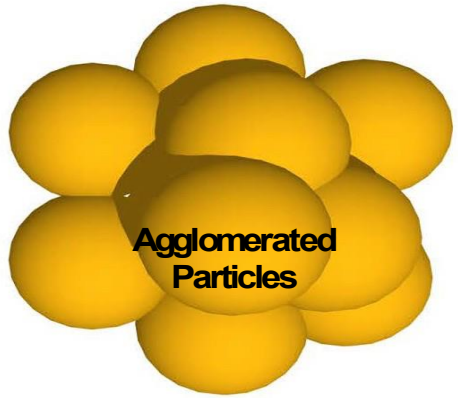
PM_1 – The Smaller the More Dangerous!

A variety of studies are focusing on the health effects of PM1 particles:

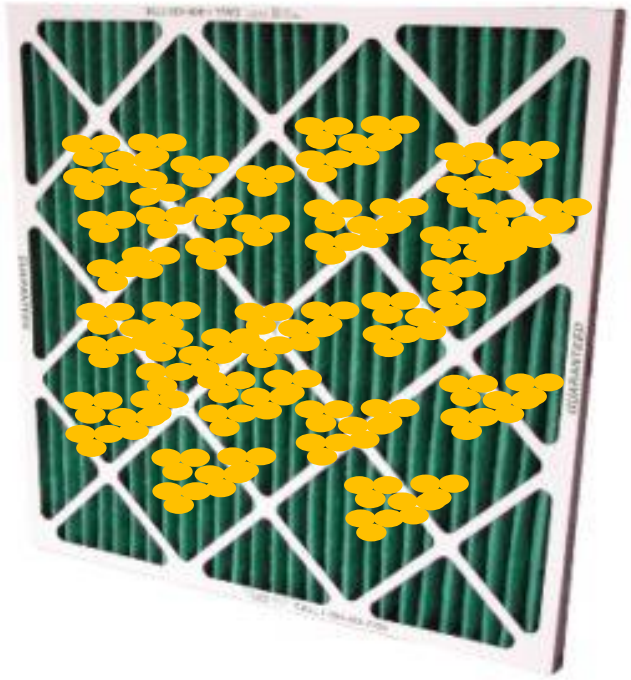
HOW NPBI WORKS ON PARTICLES



Charged atoms or molecules



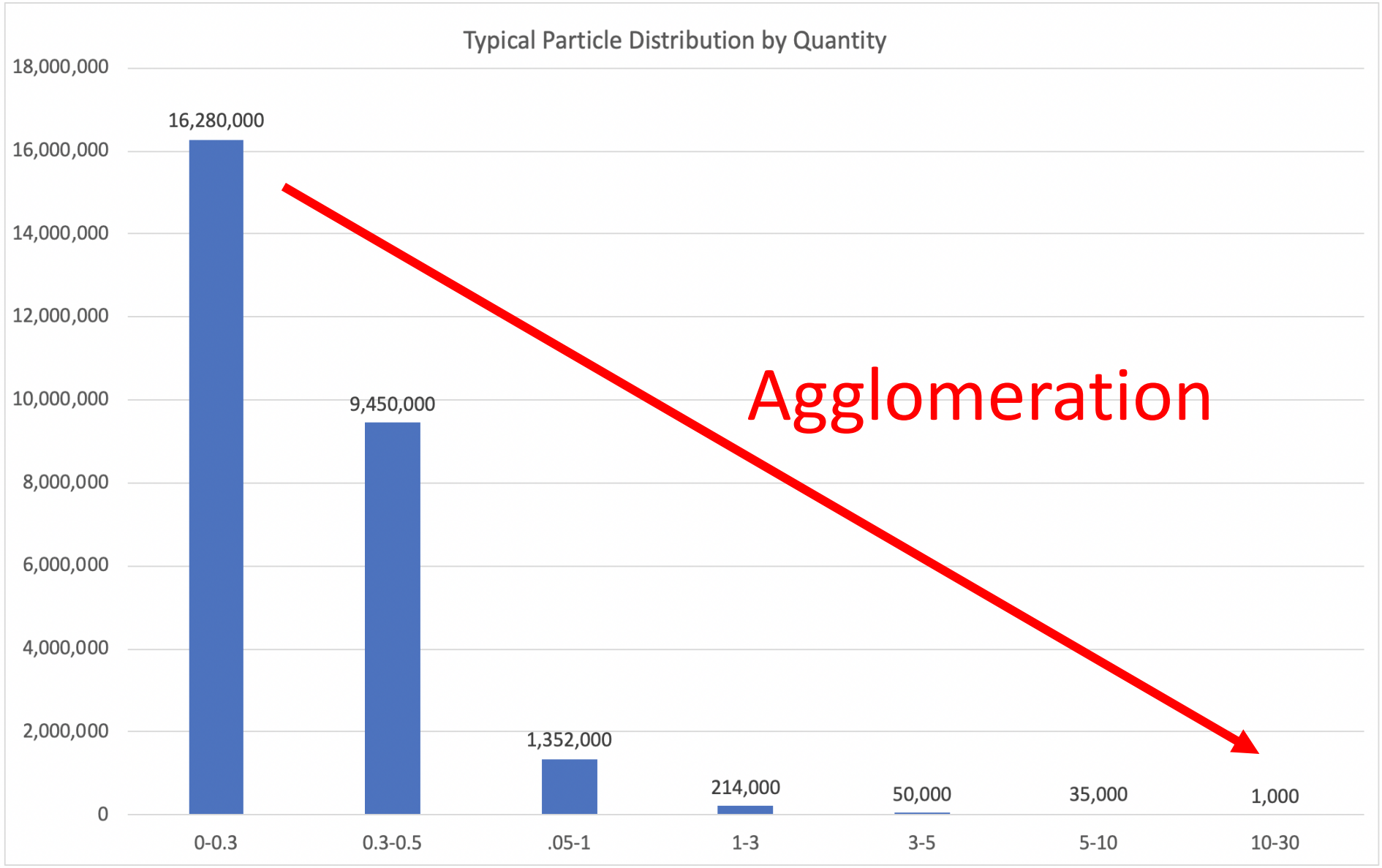
Once the ions attach to the particle, the particle grows larger by attracting nearby particles of the opposite polarity, thereby increasing the filtration effectiveness.



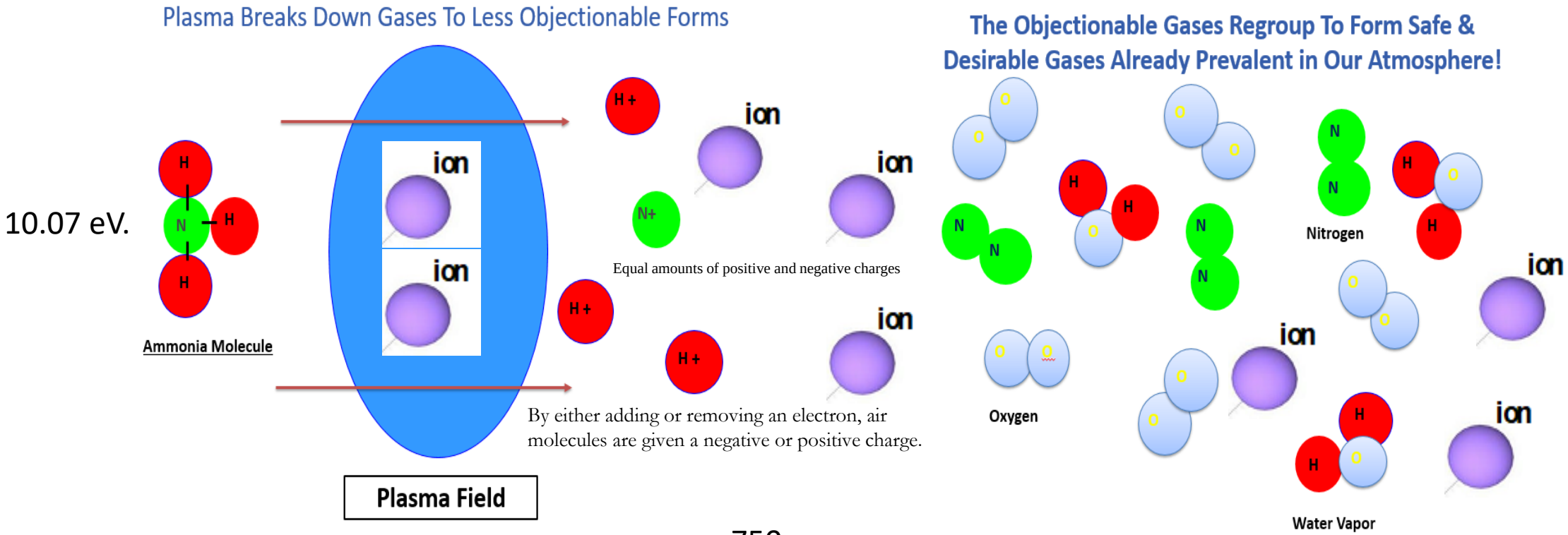
Agglomeration by Attraction

HOW NPBI WORKS ON PARTICLES

Ionization Shifts Particle Sizes



HOW NPBI WORKS ON VOCs



750

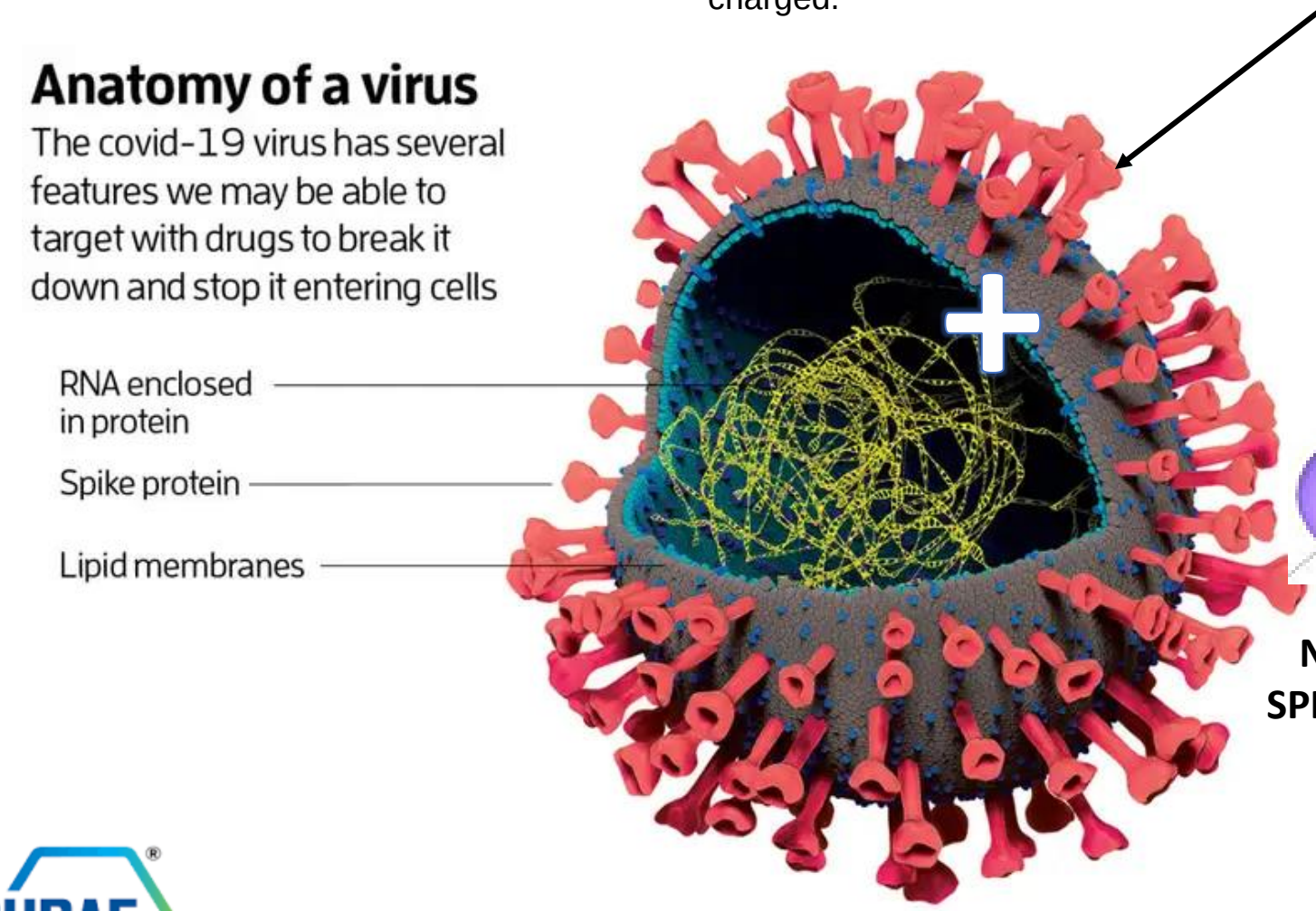
Chemical	Formula	Electron Volt (eV)
Xylene	C_8H_{10}	7.89eV
Styrene	C_8H_8	8.46eV
Methyl Ethyl Ketone	C_3H_8O	9.52eV
Ammonia (common from human activity)	NH_3	10.07eV
Acetaldehyde	CH_3CHO	10.23eV
Ethyl Alcohol	C_2H_5OH	10.48eV
Formaldehyde (common in new construction)	CH_2O	10.88eV
Oxygen	O_2	12.07eV*

Breaks down molecules (VOCs) by developing a molecular potential that is greater than the bond that holds molecules together.

Also provides static electricity control

HOW NPBI WORKS ON A VIRUS (SARS-CoV-2)

The spike protein contains the virus' binding site, which adheres to host cells and enables the virus to enter and infect the body. The human cell receptors are negatively charged.



NEGATIVE ION ATTRACTED TO VIRUS MEMBRANE

NEGATIVE IONS BREAK DOWN PROTEIN IN SPIKES & MEMBRANE, DISRUPT RNA LEAVING VIRUS INCAPABLE OF INFECTIVITITY

VIRUS MEMBRANE HAS A NET (+) CHARGE

HOW NPBI WORKS ON A VIRUS

Pathogen	Time Exposed	Kill/Inactivation Rate	Ion Concentration
E.coli	15 minutes	99.68%	1,500 ions/cc
C.diff	30 minutes	86.50%	1,500 ions/cc
Noro Virus	30 minutes	93.50%	1,500 ions/cc
MRSA	30 minutes	96.24%	1,500 ions/cc
Human Cor. 229E	60 minutes	90.00%	1,500 ions/cc
COVID-19 - CoV-2	***30 minutes***	***99.95%***	***27,000 ions/cc***

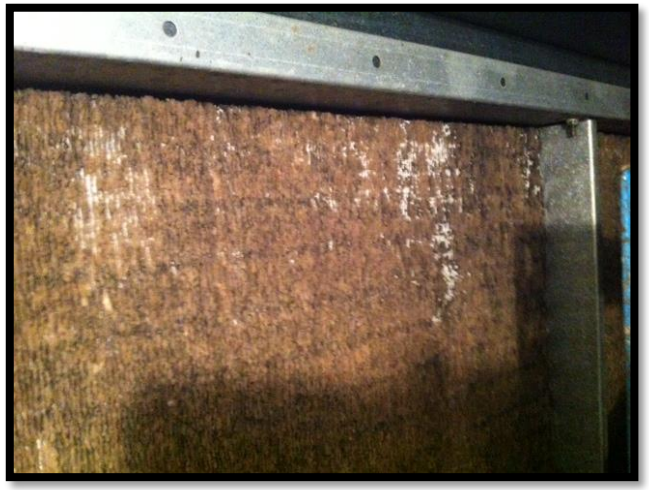
SARS-CoV-2 (COVID-19)

BSL 3 Testing Lab

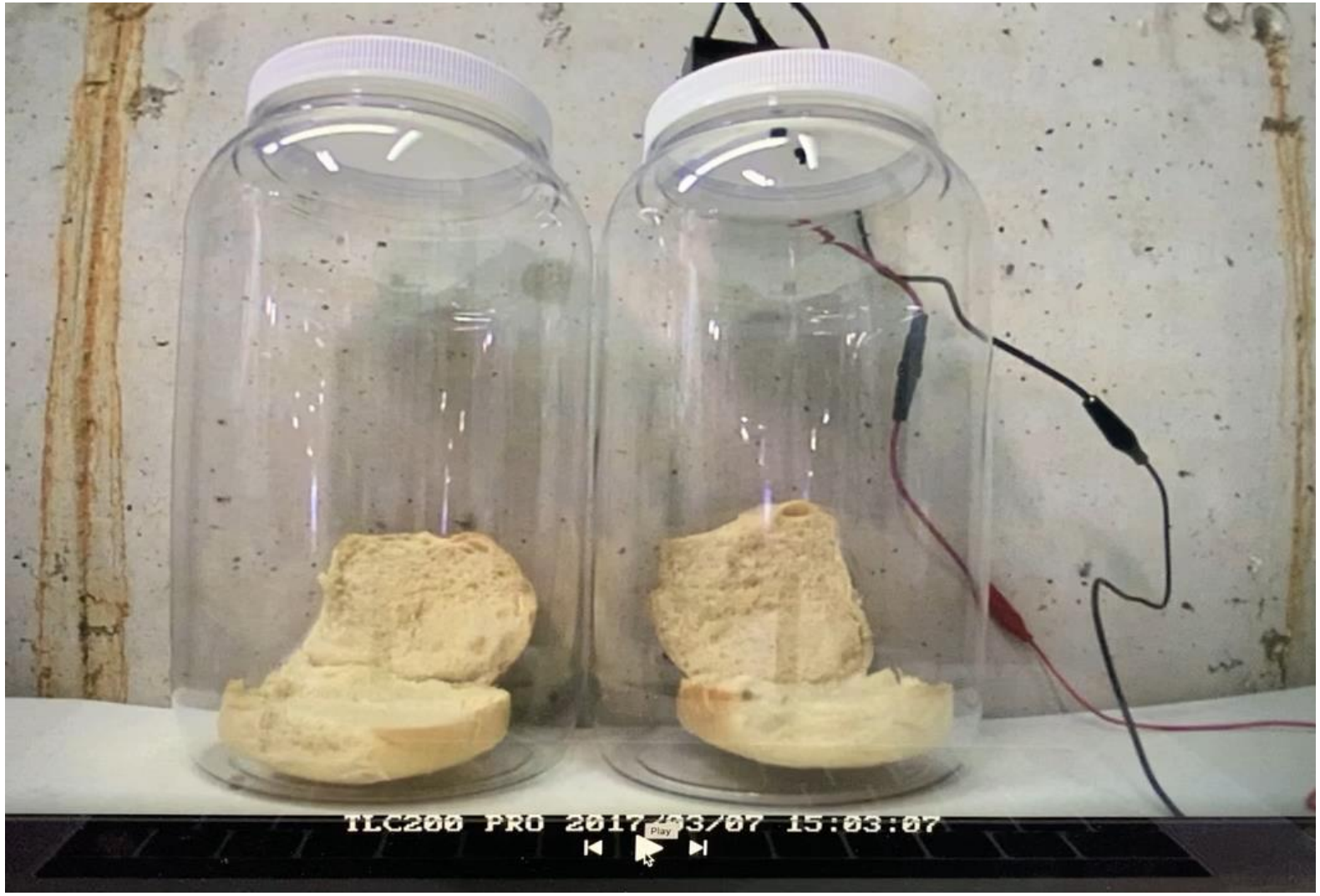
Dose X Time = Effectiveness

Independent Testing by EMSL, ALG, & Innovative Bioanalysis

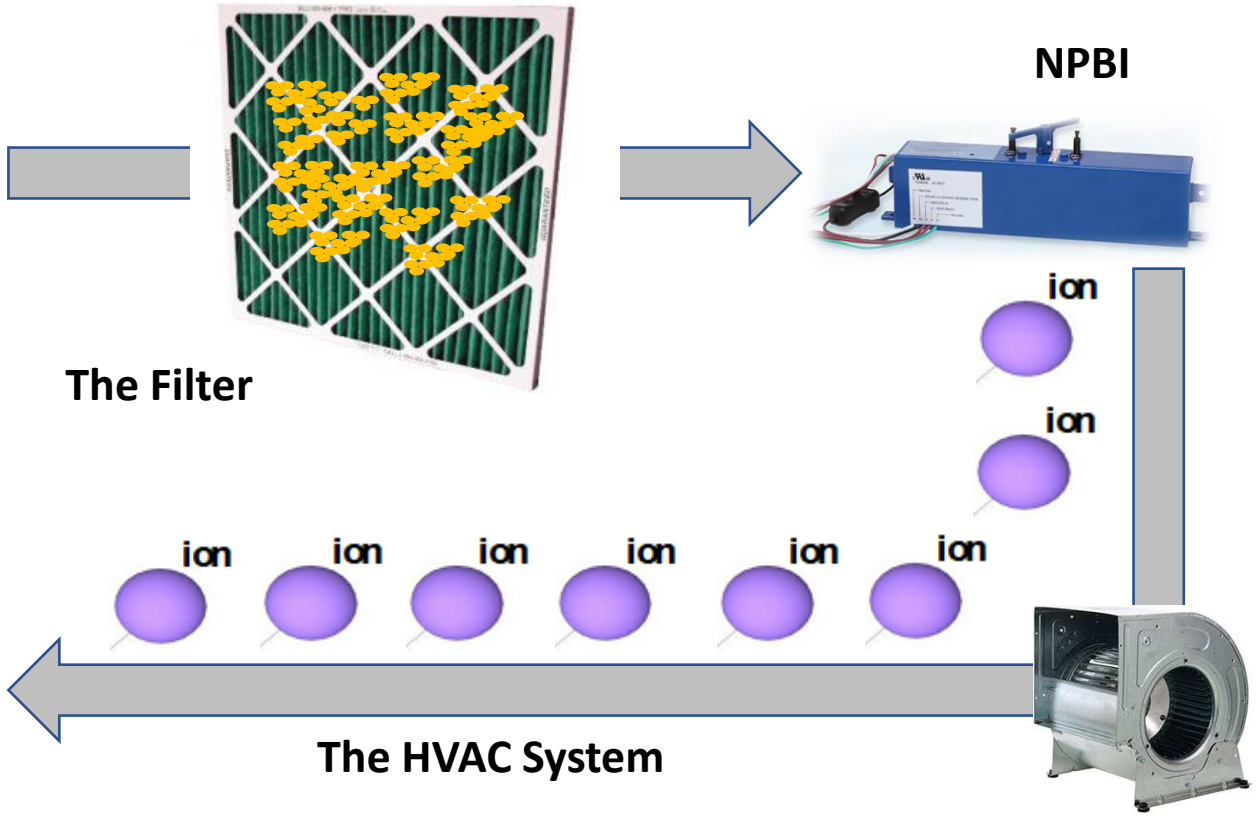
HOW NPBI WORKS ON A PATHOGEN



Time Lapse of Bread/Mold Ion Test



"Actively" Treating Air & Surfaces Continuously



HOW NPBI SAVES ENERGY

the Indoor Air Quality Procedure provides a directed approach by reducing and controlling the concentrations of selected air contaminants of concern through both dilution and enhanced air cleaning.

Utilizing the **ASHRAE 62 Indoor Air Quality Procedure** combined with GPS' NPBI technology, outside air may be reduced by **up to 75%** in non-healthcare applications, subject to building pressure. NPBI has been installed in over 1,000 projects with the ventilation rates reduced to 5 CFM per person or less.

ASHRAE

Energy Savings

ASHRAE
IAQP COMPLIANT

HOW TO DETECT AND MEASURE ION CONCENTRATION

Devices

- You can test the ion concentration in your indoor environment before and after employing NPBI technology with **third-party** air ion counters, available for purchase through AlphaLab Inc .
- Ion counters may be set to measure + and – ions separately or combined. GPS represents ionization levels as the combined total of + and – ions.

How to Use

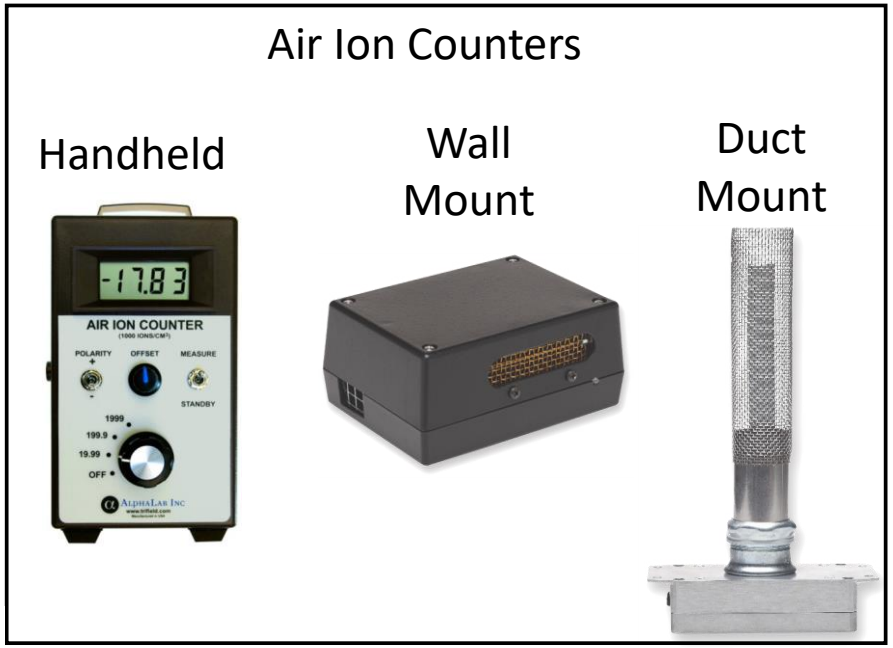
- To measure, position the handheld air ion counter approximately 2” from the register, directly within the air stream, while the HVAC system is active.
- Ensuring the grounding wire is plugged-in, hold for at least 30 seconds to determine the range of ions per cc. Measurements will continuously fluctuate.

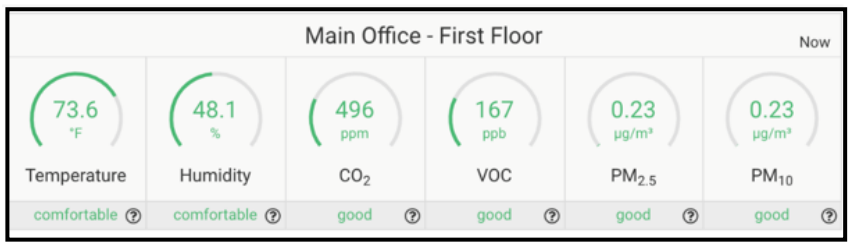
Model: AIC2
Accurate within 20%

Model: AIC
Accurate within 25%

Building Automation System integration and Sensors

- Unit operating (on/off)
- Ion meters
- Particle/VOC meters
- Sense of smell
- Lab results (EMSL and ATS)





QUESTIONS

THANK YOU