International Coalition of Performing Arts Aerosol Study Round 2

Study Chairs

James Weaver - NFHS Director of Performing Arts and Sports

Mark Spede – CBDNA President, Director of Bands, Clemson University

Lead Funders

NAMM Foundation®

NFHS
NATIONAL FEDERATION OF STATE HIGH SCHOOL ASSOCIATIONS

D'Addario Foundation

CBDNA College Band Directors National Association

Contributing Organizations

California Youth Symphony

ARTS ED NJ
Many Partners. One Voice.

Athletes and the Arts

Barbershop Harmony Society

The Association of Concert Bands

Association of Anglican Musicians

Alabama Music Educators Association

American School Band Directors Ass'n.

CODA College Orchestra Directors Association

CMA Foundation

Fargo-Moorhead Symphony Orchestra
Christopher Zimmerman, Music Director

Association Canadienne des Harmonies / Canadian Band Association

Florida Music Education Association

CSFI
Au service de la musique depuis 1890

GALA Choruses

Indiana Choral Directors Association

Indiana State School Music Association

Building Better Bands For Kansas

Indianapolis Children's Choir

International Double Reed Society
idrs

American Choral Directors Association

MBA

OA

Orcas Island Community Band

National Association for Music Education

National Association of Teachers of Singing, Inc. 1944

KMEA
Kentucky Music Educators Association

mpa

NCCO

National Speech & Debate Association
National Forensic League

New Horizons Music

NYSBDA
New York State Band Directors Association

New York State School Music Association

North Carolina Music Educators Association

Nova Scotia Band Association

Ohio Foundation for Music Education

OMEA

MTNA
Music Teachers National Association

C.M.P.A.
Church Music Publishers Association

LGBA
Music. Visibility. Pride.

Orchestras Canada / Orchestres Canada

PAMA
Performing Arts Medicine Association

Phi Mu Alpha Sinfonia

Quadrant

Saskatchewan Band Association

Contributing Organizations

South Dakota Music Education Association SDMEA

Sweet Adelines International

Tau Beta Sigma

TMEA Tennessee Music Education Association

TBA

Texas Music Educators Association

The College Music Society

ETC Main Street Singers Since '94

Sinfonia Educational Foundation

The Voice Foundation

VASTA Voice and Speech Trainers Association

NC Music Educators Association

BRT Bob Rogers Travel

Virginia Music Educators Association

WSMA

WBDI Women Band Directors International

WASBE World Association for Symphonic Bands and Ensembles

Young Voices of Colorado

OAKE Organization of American Kodály Educators

Music Learning Band

Conn Selmer Legendary People. Legendary Brands.

International Music Council

League of American Orchestras

National Music Council

Sigma Alpha Iota International Music Fraternity

Halifax Concert Band

SGA Songwriters Guild of America, Inc.

National Guild for Community Arts Education

Association for Body Mapping Education Teaching the Art of Movement in Music

MMEA Maine Music Educators Association

South Dakota Bandmasters Association

NCBA National Catholic Band Association

Slate Valley Singers

Mile High Denver Colorado

Choral Canada | Canada Choral

Contributing Collegiate Conference Band Associations and Universities

Collegiate Conference Band Associations:
ACC Band Directors Association
Big 12 Band Directors Association
Big 10 Band Directors Association
PAC 12 Band Directors Association
SEC Band Directors Association

Individual School Band Programs:
Clemson University Bands
Linn-Benton Community College Bands
University of California Los Angeles (UCLA) Bands
University of Utah Bands

Supporting Organizations

American School Band Directors Association (ASBDA)
American String Teachers Association (ASTA)
Arts Education in Maryland Schools (AEMS)
Association Européenne des Conservatoires/Académies de Musique et Musikhochschulen (AEC)
Buffet et Crampon
Bundesverband der deutschen Musikinstrumentenhersteller e.V
Chicago Children's Choir
Children's Chorus of Washington
Chorus America
Confederation of European Music Industries (CAFIM)
Drum Corps International (DCI)
Educational Theatre Association (EdTA)
European Choral Association - Europa Cantat
HBCU National Band Directors' Consortium
High School Directors National Association (HSBDNA)
International Conductors Guild
International Society for Music Education
Louisiana Music Educators Association (LMEA)
MidWest Clinic
Minority Band Directors National Association
Music Industries Association
Musical America Worldwide
National Dance Education Organization (NDEO)
National Flute Association (NFA)
National Guild for Community Arts Education
Percussive Arts Society (PAS)
Save the Music Foundation
United Sound
WGI Sport of the Arts

Lead Researchers

Dr. Shelly Miller
University of Colorado Boulder

Dr. Jelena Srebric
University of Maryland

Research Team

<u>University of Colorado Boulder</u>

- Professor Jean Hertzberg
- Abhishek Kumar
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- Tehya Stockman
- Professor Darin Toohey
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- Nicholas Mattise
- Sebastian Romo
- Lingzhe Wang
- Dr. Shengwei Zhu

The Importance

- Scientific studies on aerosol production in performing arts activities was lacking
- In order to get students back into the classroom, on stages, and performance venues at a lower risk, mitigations to aerosol are being tested
- Performing arts activities are essential for education and society
- Dr. Shelly Miller: “Aerosol generating activities have the potential to transmit COVID-19 as the research shows, but we have very little data on what kinds of generation happen when playing instruments. We will be studying this phenomenon in our aerosol laboratory at the University of Colorado Boulder and with this data, will be able to provide better evidence-based guidance.”

Preliminary Results Disclaimer

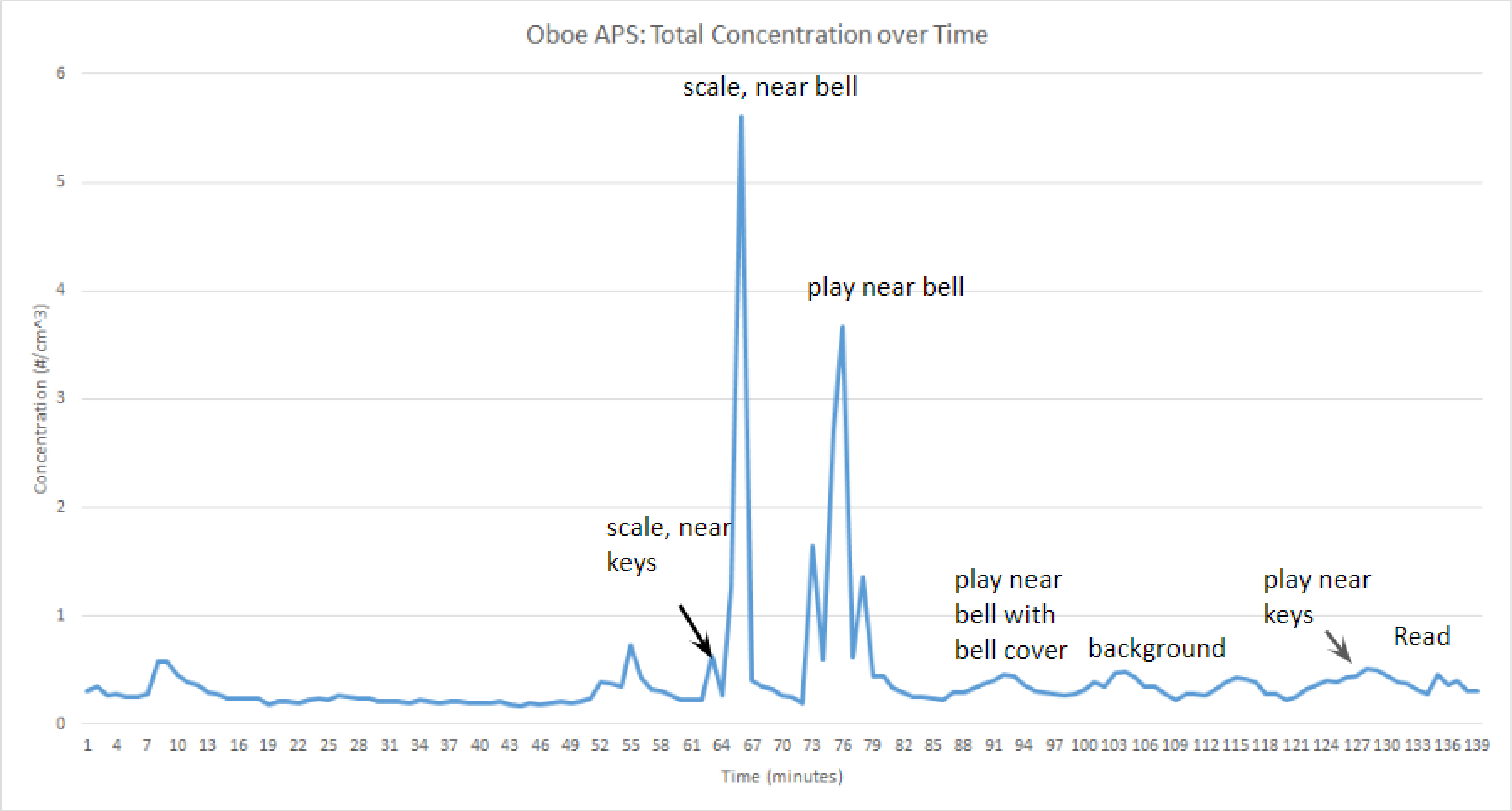
- These preliminary results are from our few weeks of exploratory testing. They will be further defined as the study continues. We are providing these preliminary results to assist in the safe return to classrooms. (Normally we do not release data until they have been quality assessed and peer reviewed).
- This study focuses strictly on the distribution of respiratory aerosols that are released while playing wind and brass instruments, singing, acting, speaking, dancing, and during a simulated aerobic activity.
- This study did not use a live virus or infected participants and therefore cannot be used to determine specific infection rates. This study was designed to (1) identify performing arts activities that generate respiratory aerosols including volume, direction, density, (2) estimate the emission rates of respiratory aerosol, (3) model the dispersion of these aerosols, and (4) investigate mitigation strategies.

Importance of Aerosol
Dr. Shelly Miller, TBA 2020

Definitions

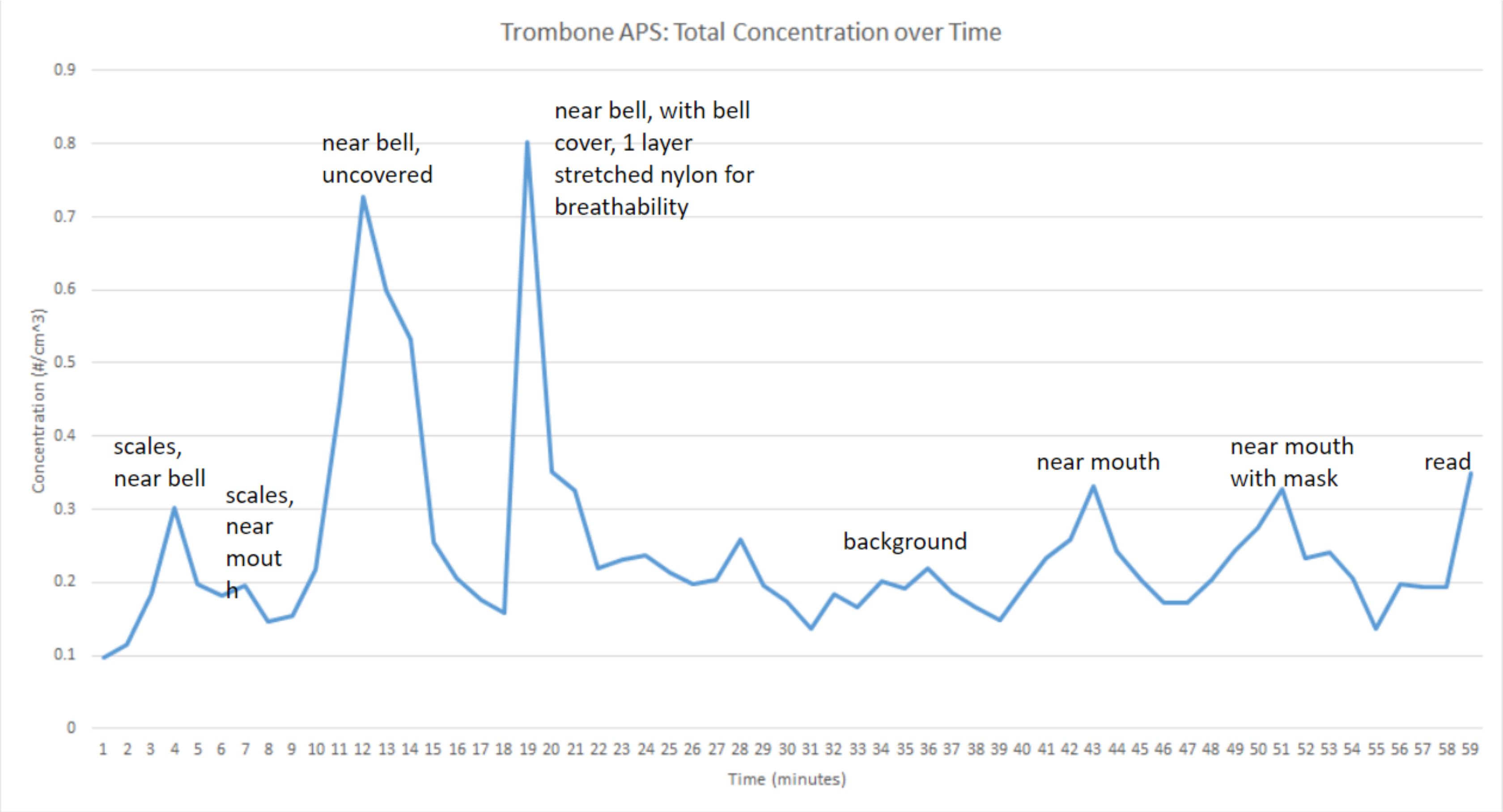
- The Aerodynamic Particle Sizer spectrometer (**APS)** is based on the acceleration of **airborne** particles immersed in an air flow through a nozzle (measures 0.5-20 μm particles).

Oboe APS

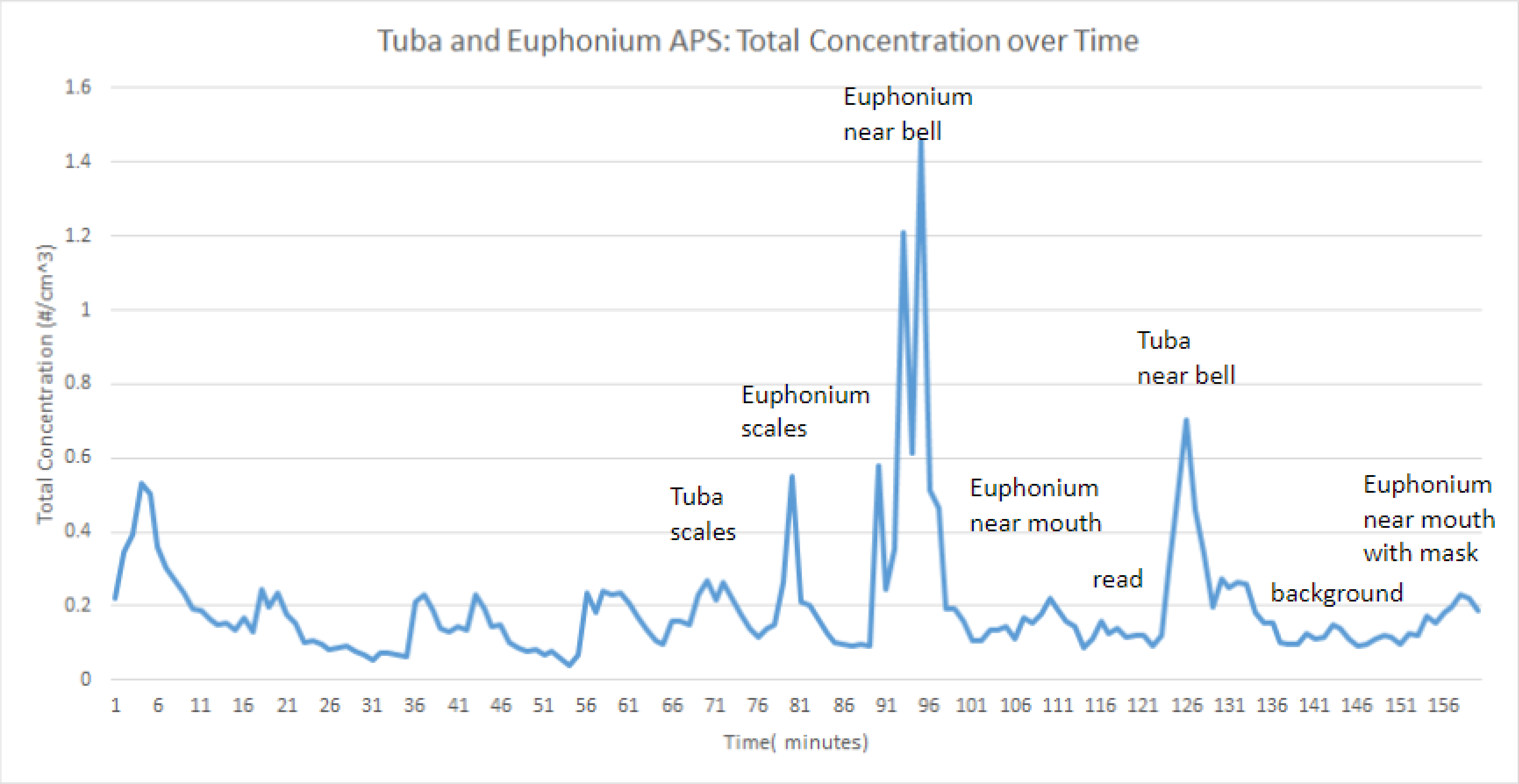


Oboe APS: Total Concentration over Time
Concentration (#/cm^3)
0
1
2
3
4
5
6
scale, near bell
play near bell
scale, near keys
play near bell with bell cover
background
play near keys
Read
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67 70 73 76 79 82 85 88 91 94 97 100 103 106 109 112 115 118 121 124 127 130 133 136 139
Time (minutes)

Trombone APS

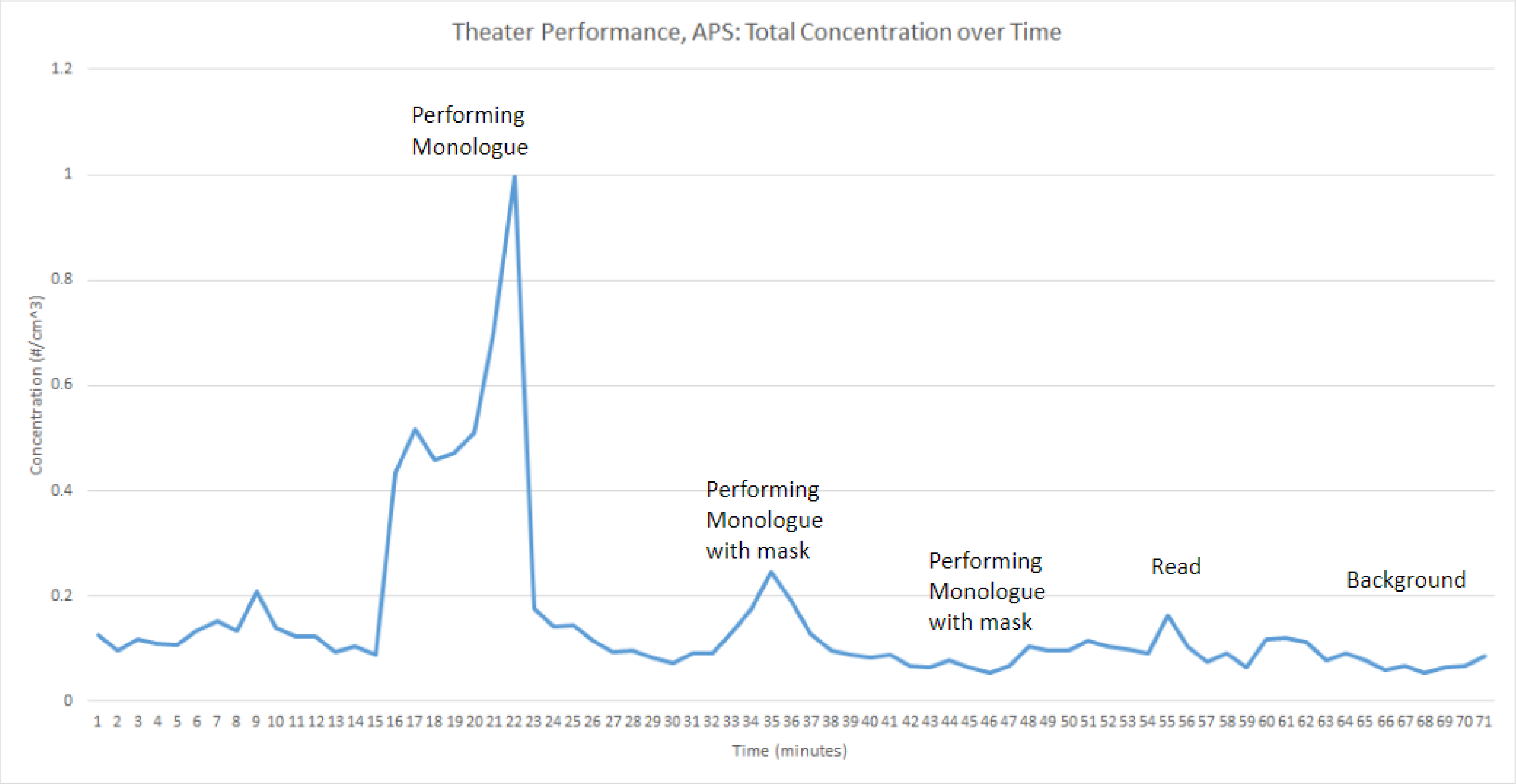


Low Brass

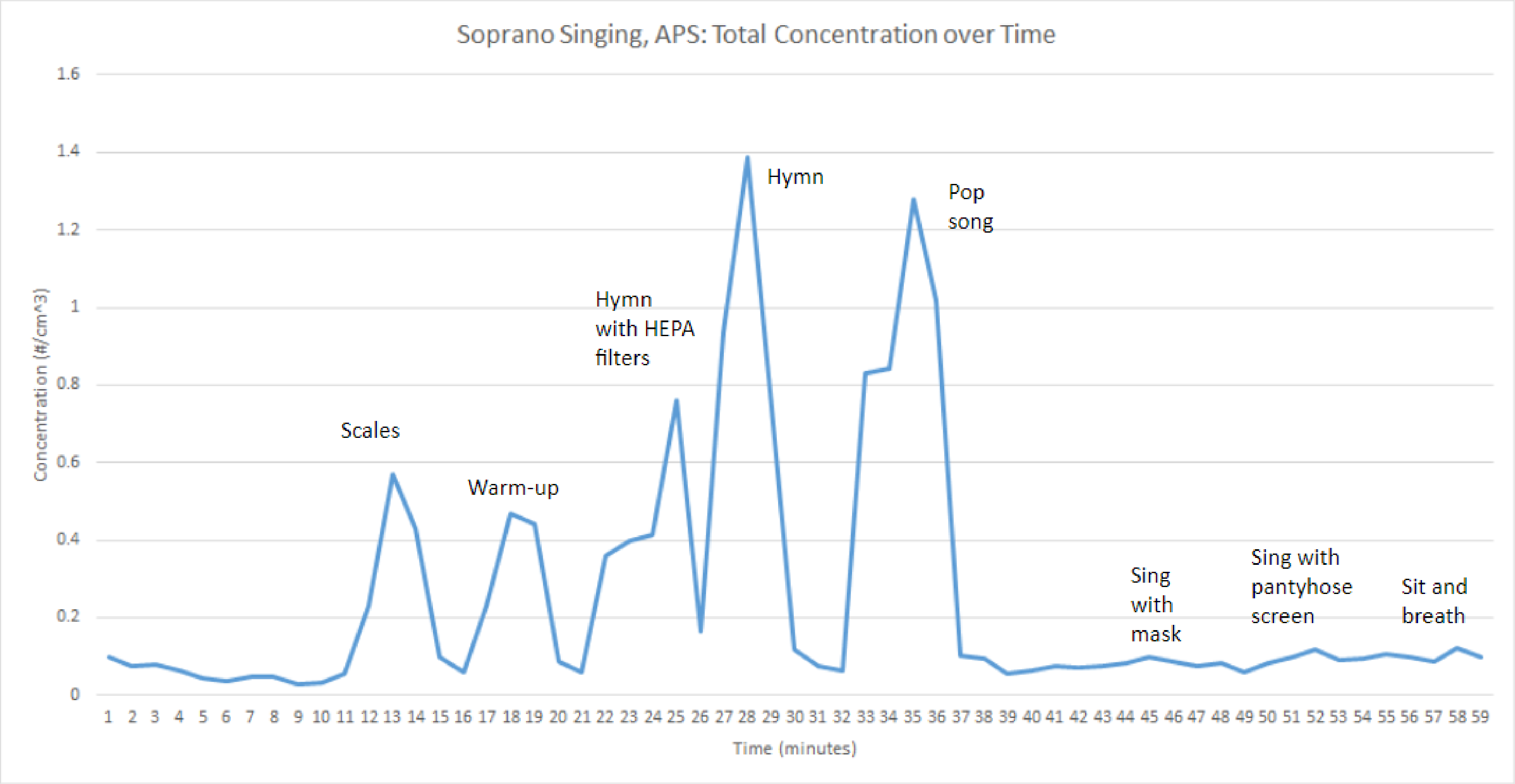


Tuba and Euphonium APS: Total Concentration over Time
Total Concentration (#/cm^3)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96 101 106 111 116 121 126 131 136 141 146 151 156
Time(minutes)
Euphonium near bell
Tuba near bell
Euphonium scales
Tuba scales
Euphonium near mouth
read
background
Euphonium near mouth with mask

Theatre APS

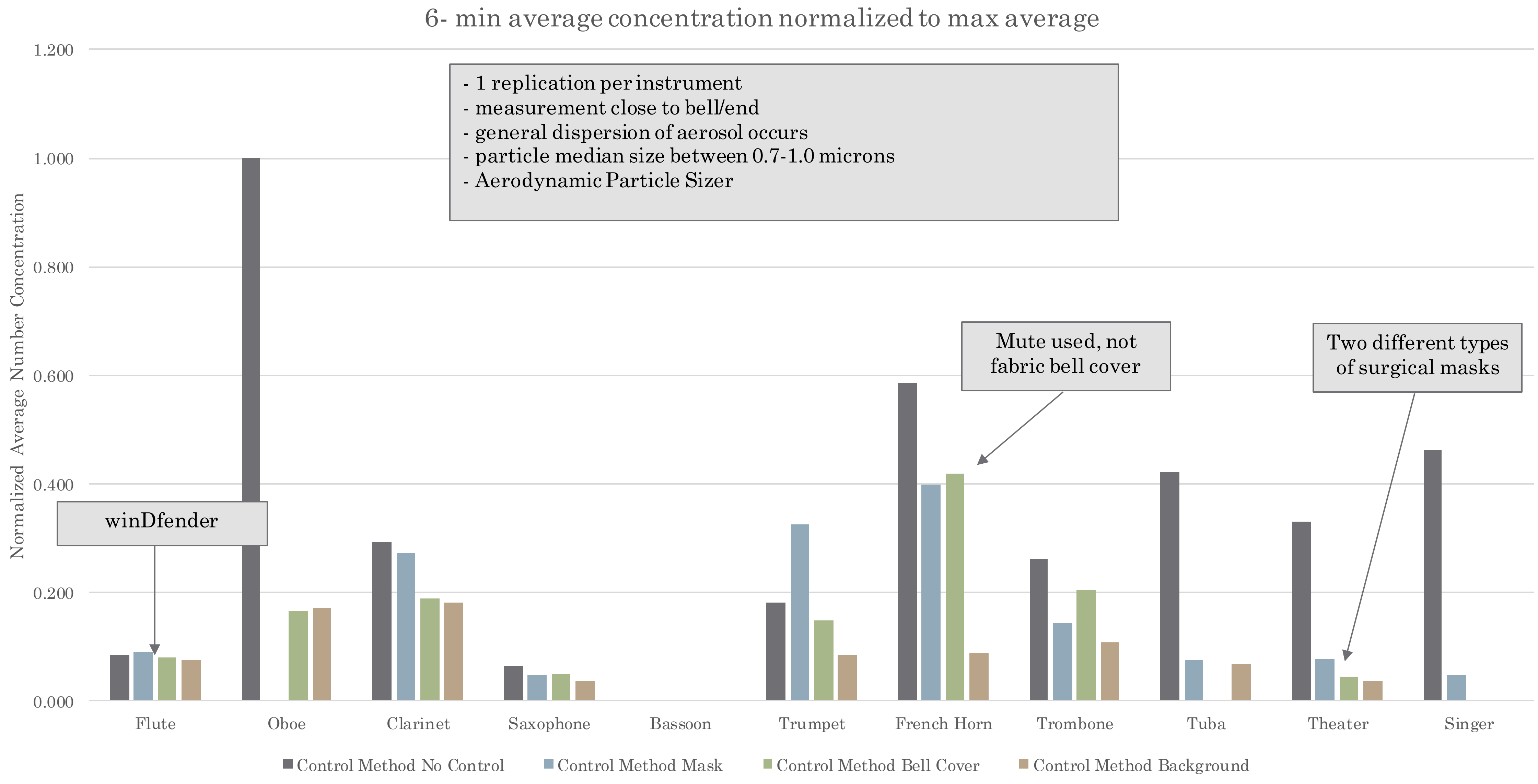

Theater Performance, APS: Total Concentration over Time
Performing Monologue
Performing Monologue with mask
Performing Monologue with mask
Read
Background
Concentration (#/cm^3)
Time (minutes)
1.2
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71

Singing APS



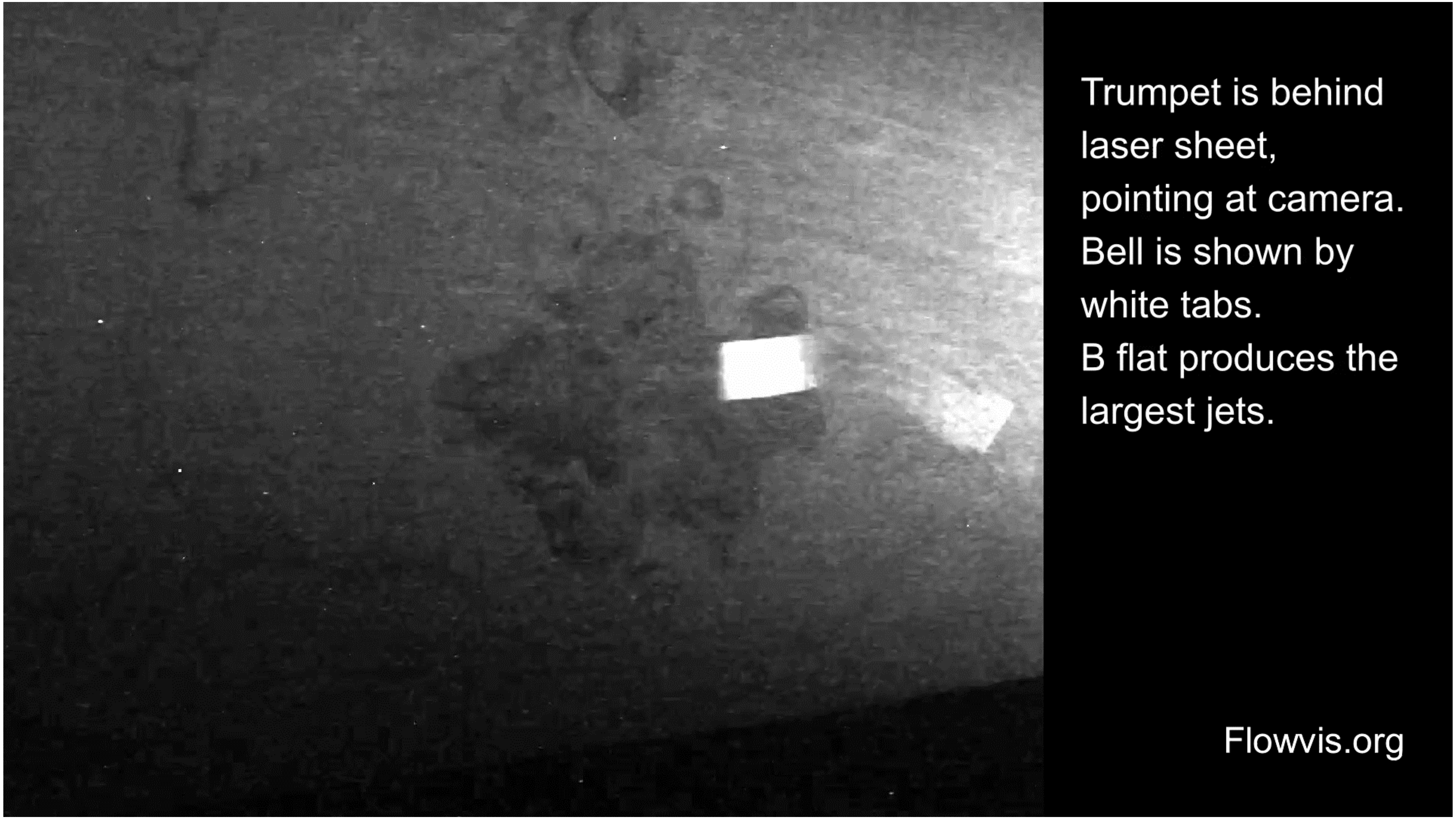
Soprano Singing, APS: Total Concentration over Time
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Concentration (#/cm^3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59
Time (minutes)
Scales
Warm-up
Hymn with HEPA filters
Hymn
Pop song
Sing with mask
Sing with pantyhose screen
Sit and breath

Playing wind instruments, singing, and theatrical voice releases airborne particles (aerosol). These particles are of the size range that may transmit the COVID-19 virus. Performing with mask and bell cover reduces emissions.



Flow Visualization Explanation

Laser sheet visualization - Trumpet



Laser sheet visualization - Oboe

Oboe aimed
at camera.
No bell cover.

Videos Links

- Laser sheet visualization: https://vimeo.com/443506508

Initial CFD Results for Well-Fitted Mask Impacts on Aerosol Spread

Shengwei Zhu and Jelena Srebric

Center for Sustainability in the Built Environment (***City@UMD***)

University of Maryland

July 31, 2020

CFD (Computational Fluid Dynamics) Modeling

Using computational fluid dynamics and the Wells-Riley equation, the City@UMD team has analyzed the concentration of airborne COVID-19 particles in **outdoor and indoor case studies with a human body wearing a surgical mask with a 64% efficiency to capture aerosols of < 5 µm.**

The **outdoor study included a canopy tent of 3 m × 3 m (10 ft × 10 ft).** A person wearing the mask stands in a light wind field of 1m/s (2.2 mph) at 10 m (33ft) above ground, being roughly 0.2 m/s (0.5 mph) at a person's height. The person is at the center of the open space covered by the tent.

The **indoor case study** represent a typical small rehearsal hall with a human body wearing the mask and standing at the center of the well-ventilated room.

The simulated results are compared to those of cases with person not wearing the mask, which were reported on 07/11/2020.

Animations of difference cases are being posted at: **https://city.umd.edu/covid-19**

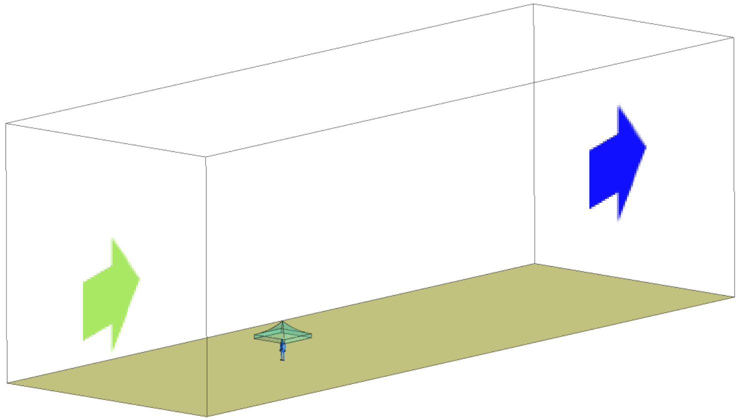
CFD Case Study Setups

Outdoor Case (20 m × 60 m × 20 m)

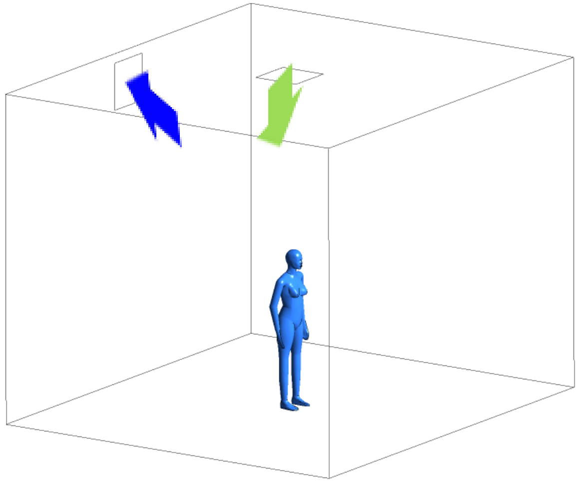
Inlet (green arrow):
Vel.: 2.2 mph at elevation of 10 m
Temp.: 22°C at elevation of 1.5 m

Indoor Cases (4.5 m × 4.0 m × 3.5 m)

Inlet (green arrow):
Size: 0.5 m × 0.5 m
Vel: 0.21 m/s (3 ACH)
Temp.: 22°C



Outdoor Case



Indoor Case

Human Body: Area of 1.47 m^2 and Heat flux of 23 W/m^2

Mask: Area of 107.7 cm^2, Velocity of 0.02 m/s (mass flow rate same as the exhaled air of the singer), and Temp. of 32°C

Covid-19 generation rate: 17.28 quant/hr with a 64% particle removal efficiency

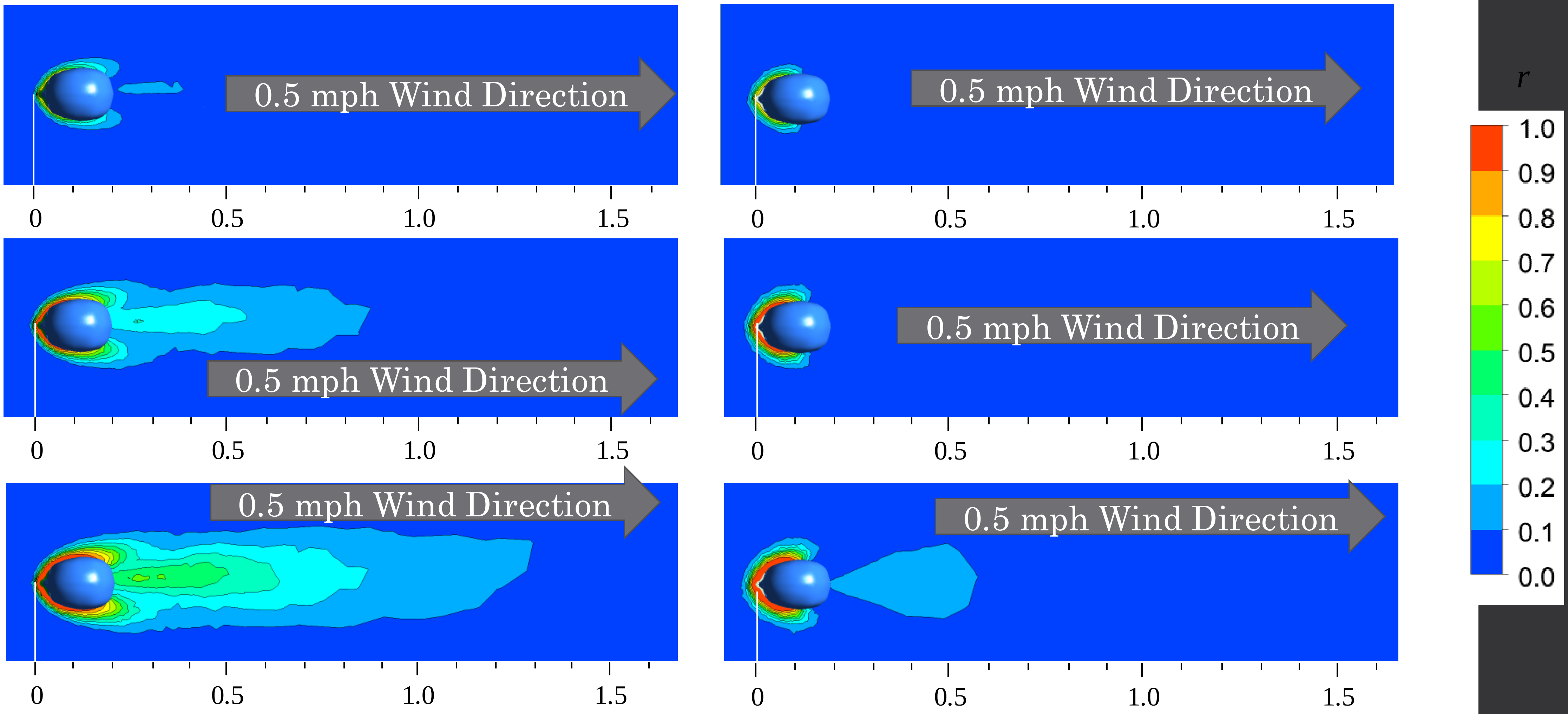
Outdoor Case: Impact of Tent/Masks on Infection Risk

Infection risk *r* by Wells-Riley equation at the height of mouth opening, with breathing rate of 8 L/min. Including 2.2 mph headwind at 10 meters, 0.5 mph at average head level.

t = 10 min
Distance in meters

t = 30 min

t = 60 min



Without Mask

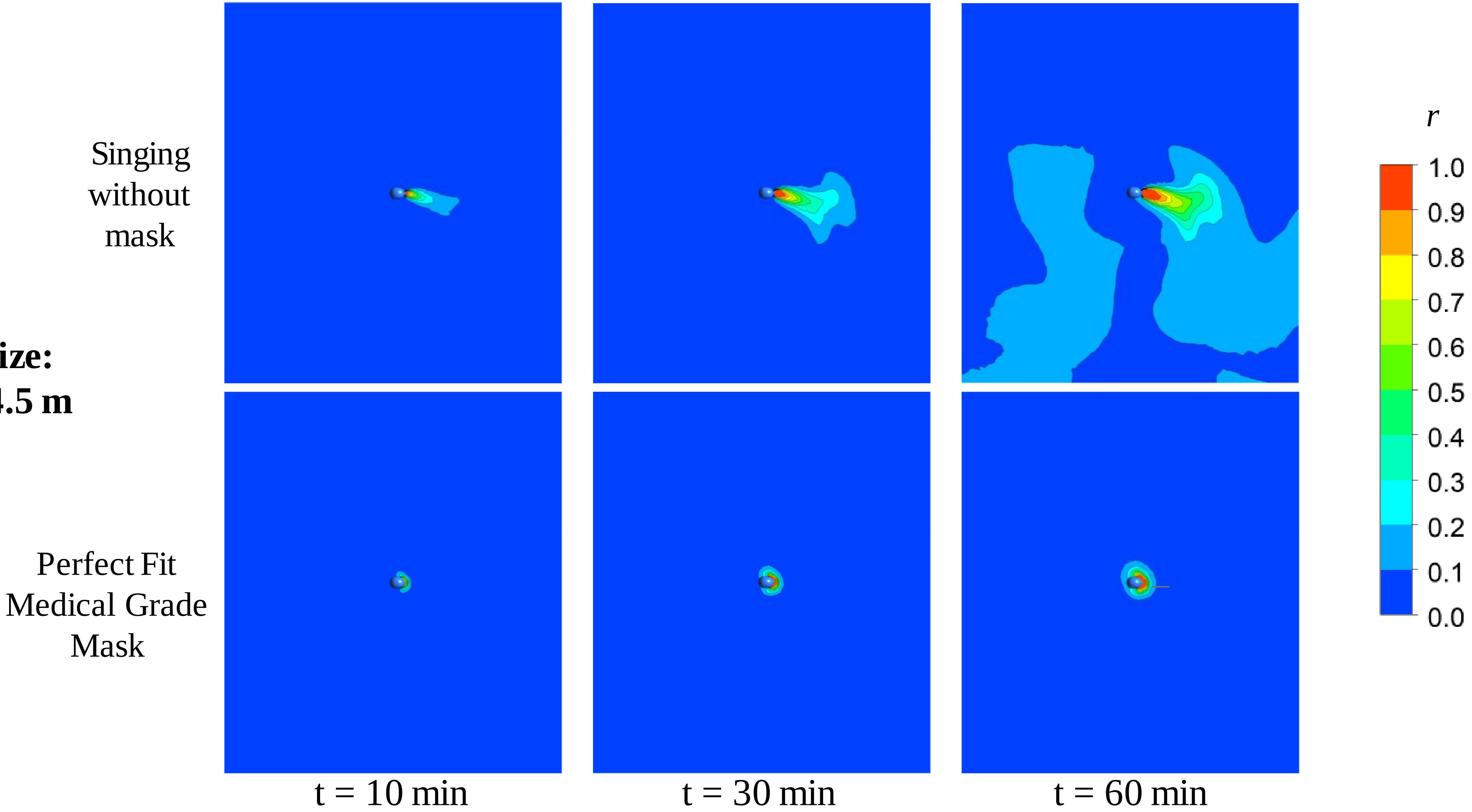
Perfect Fit Medical Grade Mask in a Canopy Tent

Tenting

Indoor Case Study: Mask Impact on Infection Risk

Infection risk *r* by Wells-Riley equation at the height of mouth opening, with breathing rate of 8 L/min.

Floor size:
4 m × 4.5 m



Mask Fitting Importance

Poor fitting mask

- Gaps on the sides
- Nose not covered
- Loose around the edges
- All of the above are poor fitting in their own right

Better fitting mask

- No gaps on the sides
- Nose covered
- A fairly good fit around the edges

Well fitting mask

- No gaps
- Nose covered
- Tight around the edges
- Should leave a mask outline once removed

In an outdoor space covered by the **canopy tent with fully open sides**, infection risk is significantly reduced by using a well fitted surgical mask. A tent with side panels would behave like any other indoor space and there would be no benefits in risk reduction by outdoor airflow in that enclosure.

In a well-ventilated indoor environment, the area (at the height level of mouth) with an infection risk of > 10% is limited around the person in a radius of roughly 1m/3ft after 60-minute exposure.

The CFD findings confirm that wearing a surgical mask with 64% particle removal efficiency can effectively reduce the spread of viral bioaerosols.

These numerical findings need to be compared to **actual experimental data** as numerical simulations cannot replace experiments when studying new transport phenomena, especially the ones that threaten human life.

General Considerations

Performing arts activities have been found to create aerosol that is less than coughing, but more than talking. The following considerations are effective for music, speech, theatre and debate activities.

The median particle size range for singing is 1.3 microns, and clarinet is 0.9 micron as general examples of particle sizing for this study. The Coronavirus has been measured at 0.1 micron.

More particle emissions near bell of wind instruments.

Bell covers should be used in multi-layer with filtering materials.

Particle emissions are comparable between all wind instruments, singing and acting except for oboe.

From the theater performance, projecting voice produces many more particles than regular talking. Looked like an instrument and singing.

5 Principal Takeaways

Masks
- Student
- Instruments
- Materials

Distance
- 6-foot CDC guidance
- Applies indoors and outdoors
- 9x6 for trombone

Time
- 30-minute rehearsal
- Clear room for minimum 1 air change before next rehearsal period

Air Flow
- Outdoors is best
- HEPA Filtration
- ACH Rates

Hygiene
- Spit Valves
- Handwashing
- Storage Areas

Masking – Fit Matters

- Wash your hands before putting on your mask
- Place it over your nose and mouth and secure it under your chin
- Try to fit it snugly against the sides of your face
- Make sure you can breathe easily
- Wear a mask correctly for maximum protection
- **Woodwinds and Brass** should use a mask while playing which includes a small straight slit in a surgical style mask
- Do not use the woodwind/brass mask outside of rehearsal

Masking for Wind Instruments

Mask the Person, Mask the Instrument

Person – Well Fitting

- Multi-layer
- Surgical Style Mask
- Washable or Disposable

Instrument – Multi-layers

- MERV 13 type material
- Surgical mask type material
- Something is better than nothing
- Non-stretchy material

Masking Continued

Masks should be worn by all students and staff prior to entering the performing arts room. Masks should continue to be worn at all times.

Teachers should consider using a portable amplifier to keep their voices at a low conversational volume. Students should also ask questions in a low conversational volume with a mask.

Teachers are assumed to talk the most and as a result should wear the most efficient mask possible that is readily available, which are surgical masks. (N95s are not recommended at this time due to supply chain issues.)

No talking should occur in the room without a mask being properly worn.

Distance – It Matters

- CDC Guidance currently is 6-foot distancing
- Indoors
  - 6x6 area
  - 9x6 for trombone
- Outdoors
  - 6x6 area
  - Masks strongly recommended
  - Instrument bell covers should still be used

Time

- 30-minute rehearsal times
  - **Indoor**
    - Allow a minimum of 1 air change prior to next use of the room, 3 would be better.
  - **Outdoor**
    - Playing should cease for approximately five minutes to allow the aerosol to disperse.
- More study is needed prior to any recommendations of time changes

Air Flow

Outdoor is best

- Open air
- Tenting from elements

Indoor air filtration

- HEPA – Size of Room
- Filtration Certification
  - CADR - Clean Air Delivery Rate
  - AHAM Certification - Association of Home Appliance Manufacturers

Air Change Rate Per Hour (ACH)

- 3 ACH is the standard used for the modeling presented
- Increased ACH recommended if possible

ASHRAE Guidelines - American Society of Heating, Refrigerating and Air-Conditioning Engineers

Hygiene

Spit Valves

- Empty away from others
- Have an absorbent disposable material to catch the condensation (Puppy Pad)

Handwashing

- Hand sanitizer should be readily available
- Soap and Warm water should be available.
- Hands should be washed after contact with surfaces and others

Common Areas

- Should be managed to limit the number of students at a time in the room.
- Anyone who enters the room should bring a 70% alcohol wipe to wipe all surfaces before and after touching.
- The wipe should be discarded properly upon leaving the storage area.

Resources

- Main Coalition Page
- FAQ Page
- Submit a question
- The University of Colorado Boulder has developed a risk assessment tool: https://tinyurl.com/covid-estimator
- Harvard-UC Boulder Portable Air Cleaner Calculator for Schools.v1.1
- ASHRAE
- Next round of information
  - Improving chamber performance
  - Developing specialized emissions estimation capability
  - Testing a recorder
  - Narrowing the types of instruments we will study next and increasing study on mitigation

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Thank you