Measurement of aerosol from brass and woodwind instruments

playing 5 minutes in distances

from 0.5 to 4 meter.

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Background

During spring 2020 the COVID 19 pandemic has swept across the world leading to the lockdown of many activities among those cultural activities like music performance. However, in many countries the COVID 19 is now under control and gradually reopening has started with hygienic precautions.

During the last decades studies have been performed to understand the mechanism of contact and airborne spread of infectious agents, such as viruses causing respiratory syndrome epidemics. It is well established that droplets and aerosols transported by expired air result in short range airborne transmission of virus. Sneezing and coughing produces high speed airflow with high concentration of droplets and aerosols expelled up to 1.8 meter. Furthermore it has been shown that virus to some extent is spread with very fine aerosols throughout a room depending on room ventilation.

Questions have been asked whether different cultural performances are safe with respect to spread of COVID 19 infection. There is for instance concern about the spread of aerosol while playing brass and woodwind instruments. The immediate thought is that blowing in the instrument may produce airflow containing aerosols, which could contain COVID 19 virus if the musician is infected. It has been suggested that safe distance playing brass and woodwind instruments has to be 3 to 4 meters. However, this is not based on solid knowledge about airflow from the bell of the instruments. Keeping a distance of 3-4 meters will entail great challenges concerning room size for rehearsals or concerts and for the artistic expression.

However, there has been no substantial documentation based on measurements for this recommendation. But during the last months several experiments to measure airflow and spread of aerosols playing brass and woodwind instruments have been performed.

Preliminary results from The Bamberg Symphony investigating airflow from bassoon, trombone, clarinet oboe and horn revealed hardly any measurable air movements while playing the instruments.

https://www.br.de/nachrichten/bayern/bamberger-symphoniker-wissenschaftler-messen-aerosolausstoss,Ry6T6OU?fbclid=IwAR0q9LfNqv3QFBZ6EiWDlKs2vvNEnBJKb96oYhDa-PeKx6ePGu9jQqy5RrQ

In another study occupational hygienist Thomas Eiche measured expelled droplets and aerosols while playing brass and woodwind instrument, measuring aerosols (<= 5µm) and droplets (> 5µm) concentrations at 1.2-1.6 nl/m^3 and 0.1-0.8 nl/m^3 respectively, highest for clarinet. https://www.thomaseiche.ch/

https://www.svtb-astt.ch/wp-content/uploads/2020/05/200522-Schutzkonzept_COVID-19_Theater_Konzert_Veranstaltung_V2_2.pdf

Another experiment, commissioned by the Vienna Philharmonic, examined the movement of musicians' breath while performing. The study involved members of the orchestra each being fitted with an aerosol device inside their noses, which spayed a fine mist into their lungs. They were then placed in front of a black canvas and very brightly lit from the front, then photographed while playing. This made it possible to view the mist and the extent to which it travelled in the air. The results showed that for string players the maximum distance the droplets travelled was around 0.5 m while playing and being at rest. For brass and woodwind instruments, no significant amount of mist could be detected around the area of the

instruments' openings. The only exception to this was the flute, where droplets were observed up to 0.8 m from the musician. Clouds of air were observed in the area of the mouth, regardless of the breathing technique. https://wien.orf.at/stories/3049099

The Institute of Aerodynamics of the University of the Bundeswehr in Munich conducted flow experiments with 8 brass and woodwind musicians using Particle Image Velocimetry to measure air velocity and the movements of droplets emerging form the instruments. They observed airflow at 0.5 m from the bell of brass instruments. The larger the brass instrument had the lower exit velocity and air movement. Woodwind caused airflow more than 1 m. As a conclusion they recommend safety distance to be 1.5 m.
https://www.unibw.de/lrt7/video-musizieren-waehrend-der-pandemie-was-raet-die-wissenschaft
https://www.youtube.com/watch?v=BYo3wlWUDDM

Measurement aerosols from brass and woodwind instruments, Odense Symphony Orchestra

The Musician Health Clinic, Department of Occupational and Environmental Health, Odense University Hospital together with Odense Symphony Orchestra performed an experimental study on 7th, 14th and 15th May 2020 measuring airborne particles from brass and woodwind instrument, playing at distances of 0.5,1,2,3 and 4 meters. The measurements were performed in rehearsal room 1.

TSI Dust Trak ^{tm} aerosol monitor was used to measure airborne particle concentration by measuring total particle mass in mg per m^3, and for particle mass under 1, 2.5, and 10 µm.

The aerosol monitor was placed on a music rest, and the distances were marked on the floor with tape. The musicians played one to two minute standing 0.5, 1, 2, 3 and 4 meters from the aerosol monitor. Background particle concentration in the room without any activity was measured at the start. The musicians were asked to perform a music piece and play with the same effort as under a concert. The instruments were tuba, clarinet, trombone, fagot, oboe, trumpet, horn and flute.

Results

The background mass of particles were 0.004, 0.005 and 0.006 mg/m^3 for particles less than 1, 2.5 and 10 µm respectively, and the total mass of particles was 9 mg/m^3. As seen in table 1, measured particle mass was quite similar for tuba, clarinet and trombone compared to the background measure, and a little higher for fagot, trumpet, oboe, horn and flute. In contrast, coughing at a distance of 0.5 m produced 70,000 times higher levels of particles.

Table 1.

Average particle mass expelled from brass and woodwind instruments in mg/m^3, measured during play 5 – 10 minutes in distance from 0.5 to 4 meters.

Particle size	<1 µm	<2.5 µm	<10.0 µm	total
Background	0.004	0.005	0.006	0.009
Tuba	0.004	0.005	0.007	0.009
Clarinet	0.004	0.004	0.006	0.007
Trombone	0.003	0.004	0.006	0.012
Fagot	0.011	0.012	0.016	0.024
Oboe	0.012	0.013	0.018	0.036
Trumpet	0.011	0.011	0.012	0.014
Horn	0.007	0.008	0.011	0.013
Flute	0.010	0.010	0.015	0.017
Coughing (0.5 m)	7343	7343	7590	9593

The measurements showed based on visual examination that there was no significant variation in the aerosol concentration while playing 0.5 m from the monitor or standing at a distance of 1, 2, 3 or 4 m, as seen in figure 1-8. During the time period noted on the x-axis the musician stepped progressively backward away from the monitor. The y-axis shows the size range of particles/aerosols measured. The may differ for the each instrument. The x-axis shows the time period when measurements are taken. The small fluctuation in the aerosol concentration corresponded to the small fluctuation in the background measurements (Figure 9). There are some small peaks, which not can be explained by distance from the monitor or by variation in the playing the music. The most likely explanation is dust caused by person movement in the room.

Figure 1.

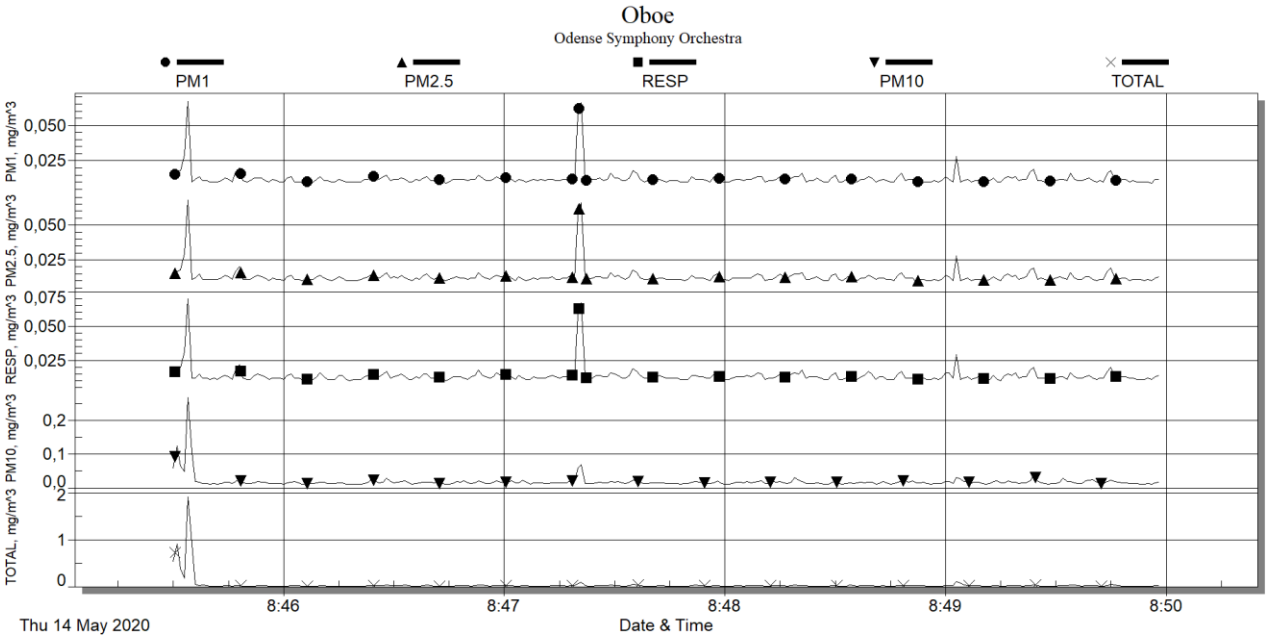


Figure 2.

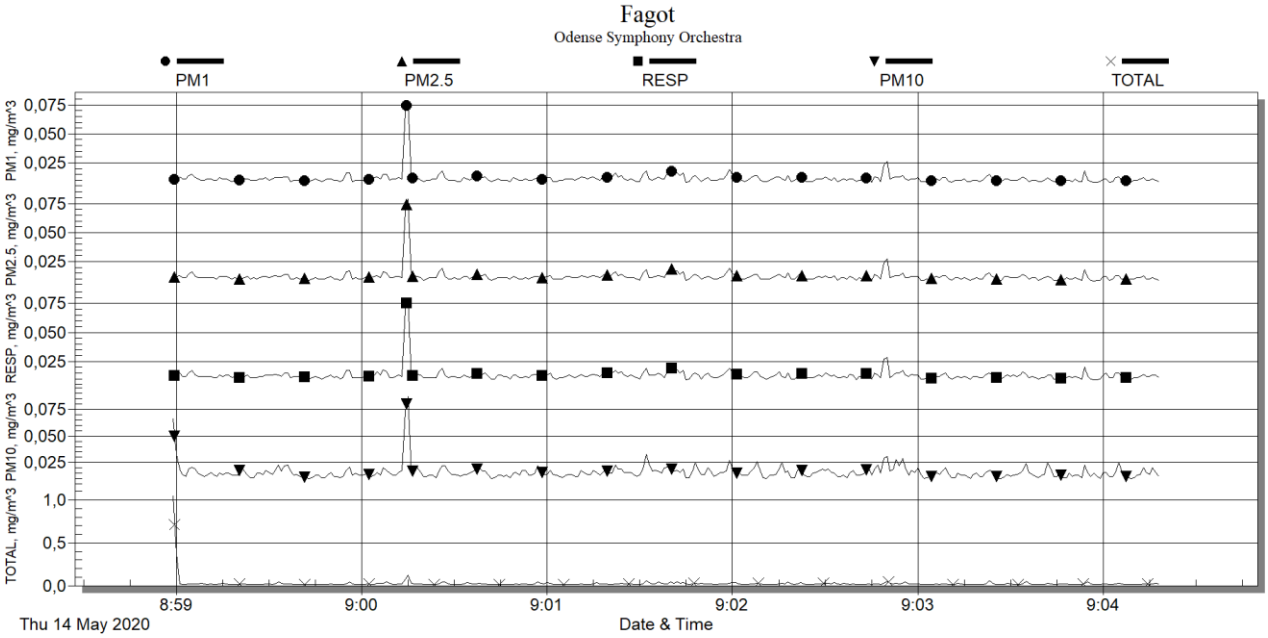


Figure 3.

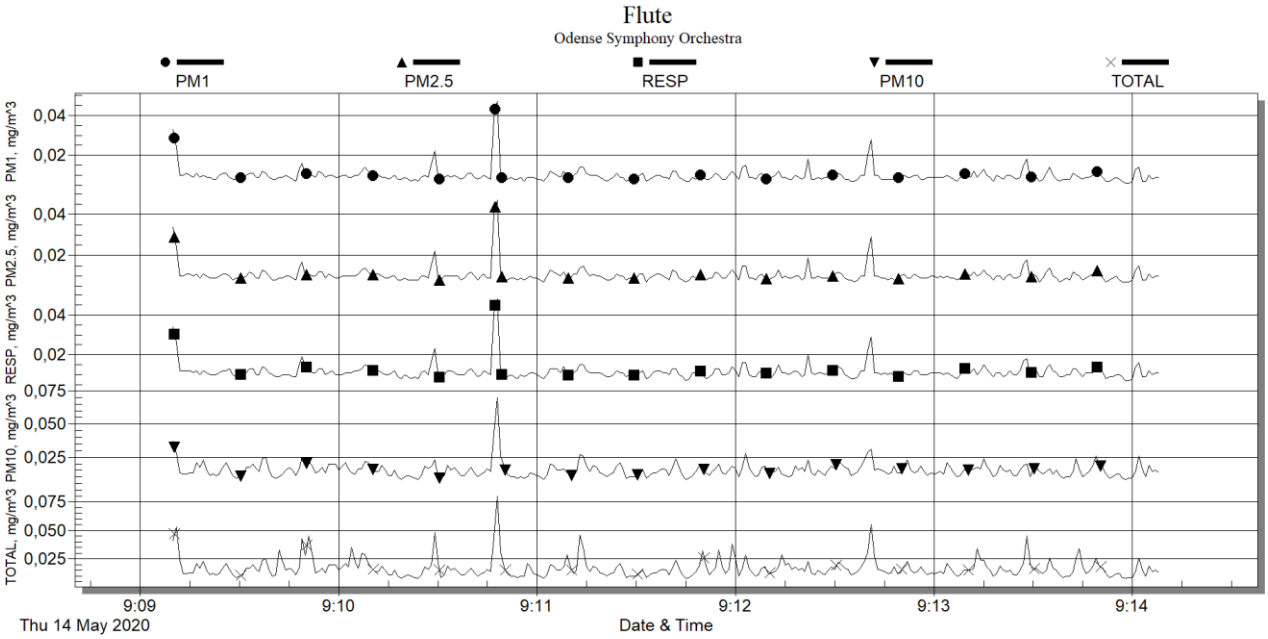


Figure 4.

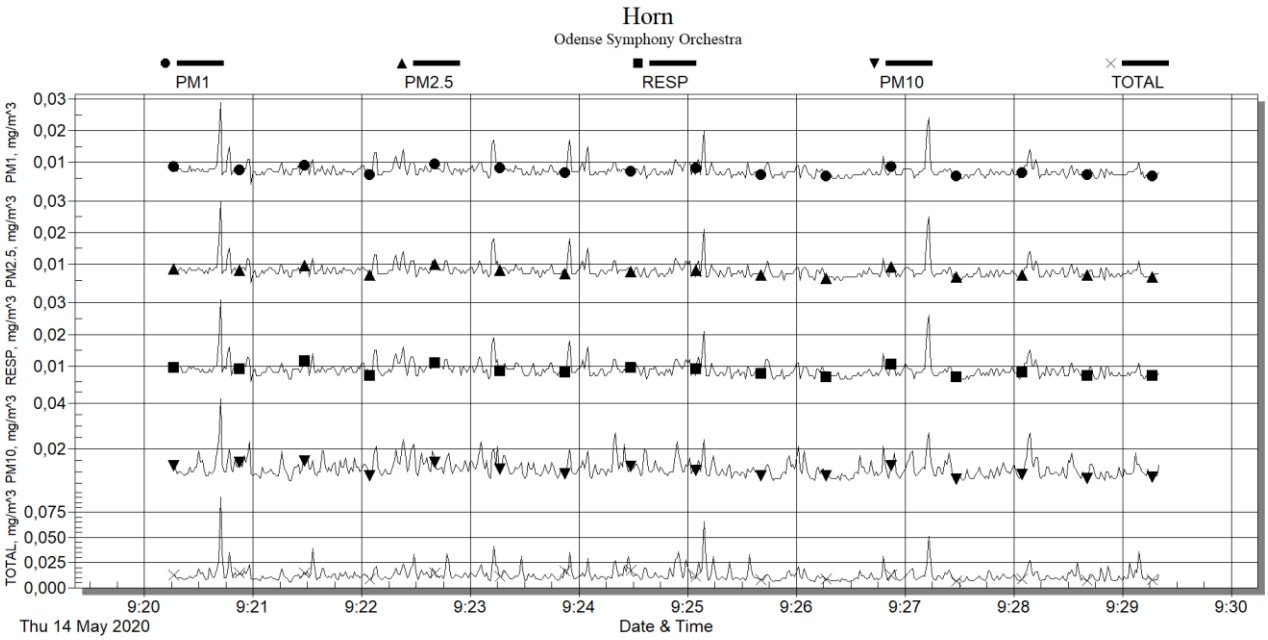


Figure 5.

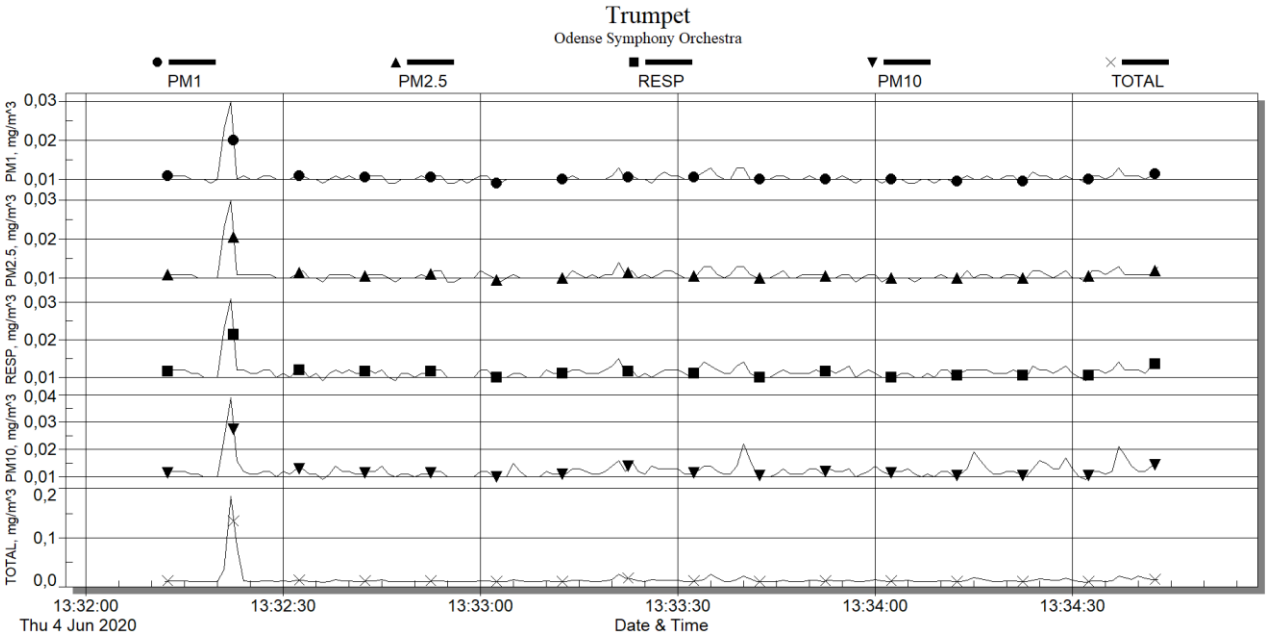


Figure 6.

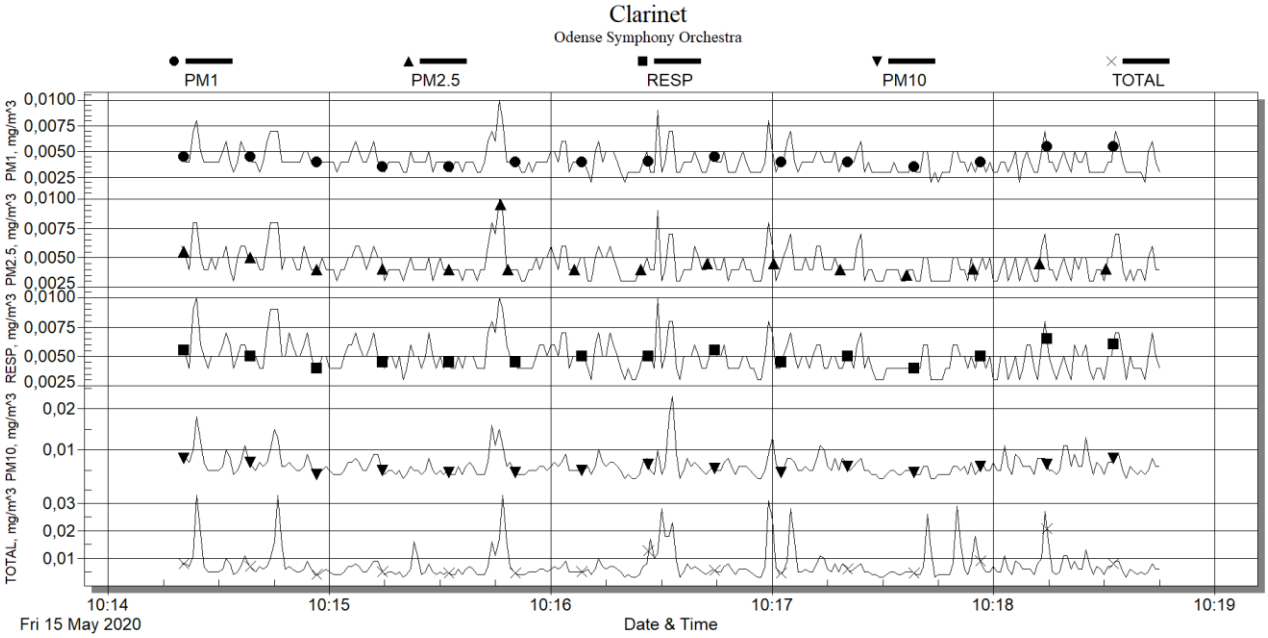


Figure 7.

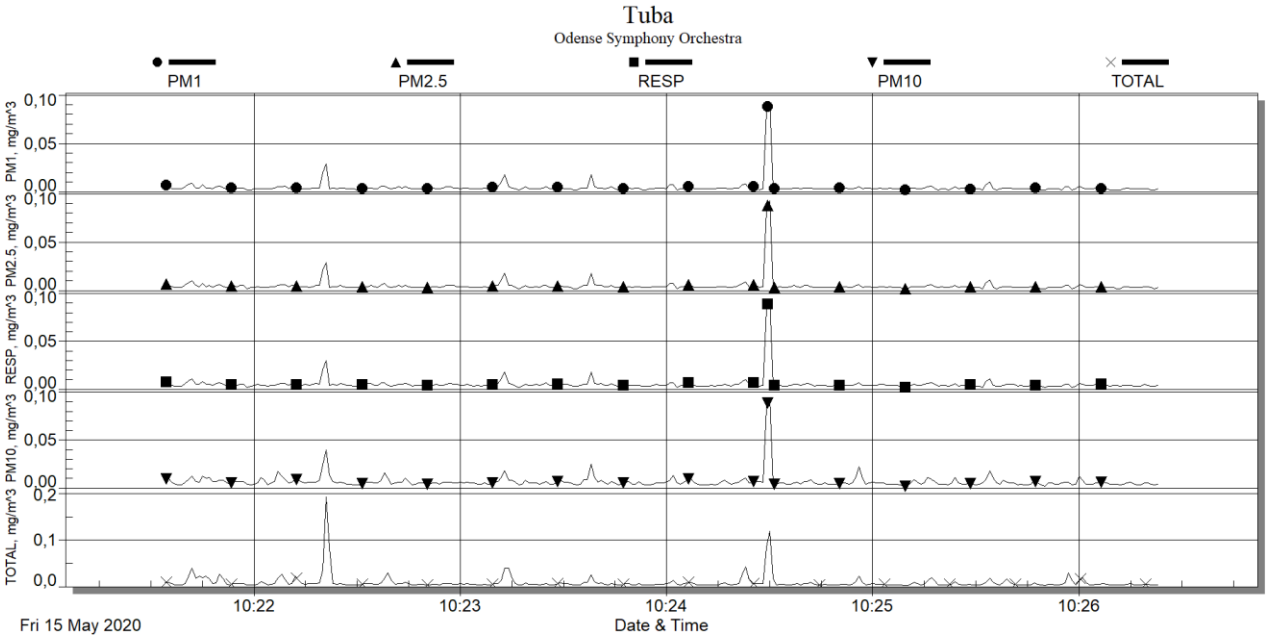


Figure 8.

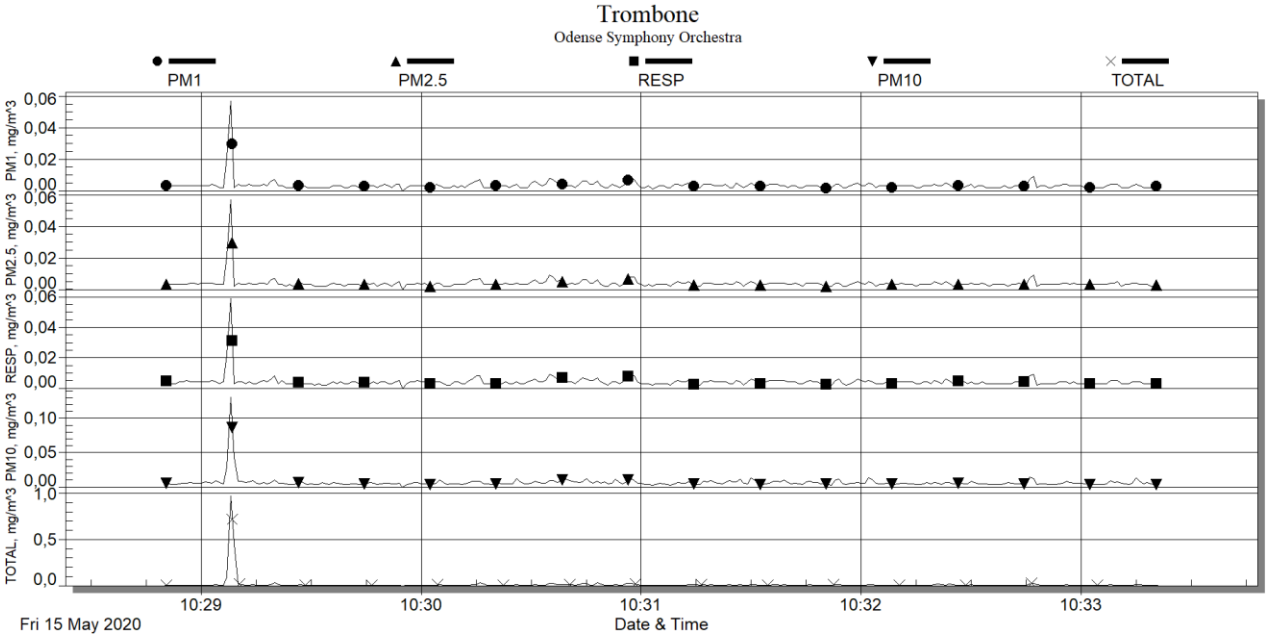
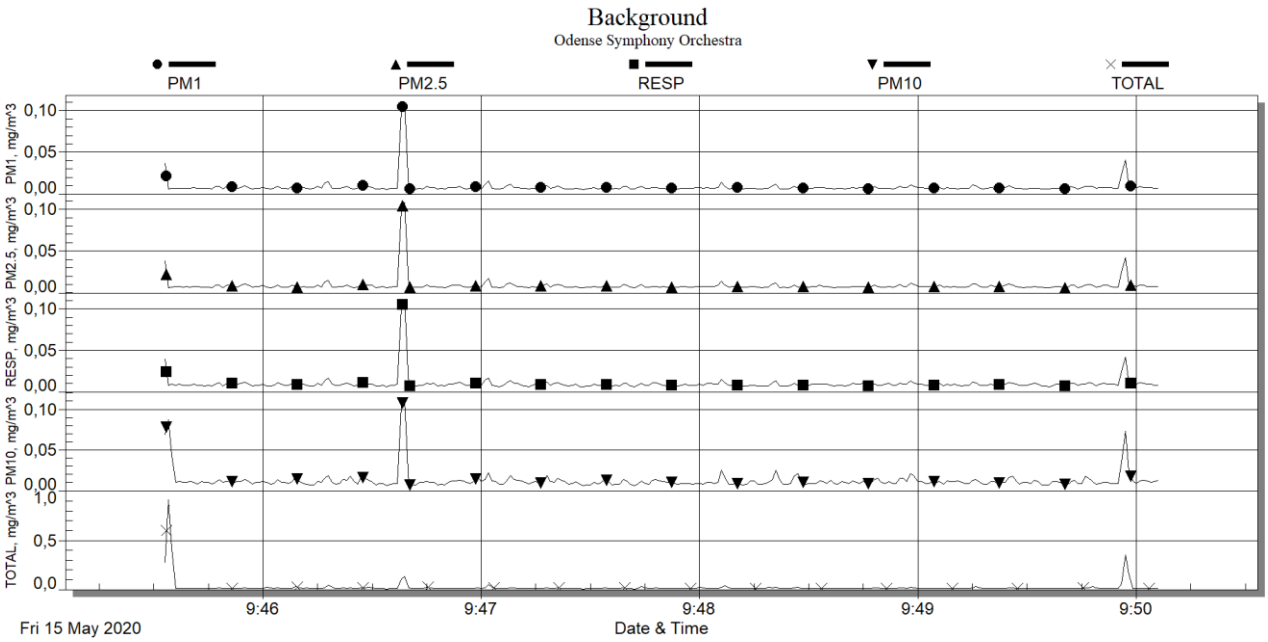


Figure 9.



Conclusion

The emission of aerosol measured from brass and wood wind instruments was very low, and almost at the same level as background concentrations. Other experiments have shown very little airflow and verysmall aerosol concentrations at short distances from brass and woodwind instruments. Based on the actual measurements and the other studies mentioned 1 meter distance playing brass and woodwind instruments seems to be safe with respect to the risk of spreading aerosol from the instruments. This assumes that musician blow towards the back of fellow musicians.

Acknowledgement

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