Dynamic properties of exhaled e-cigarette aerosol vs. conventional cigarette smoke

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Introduction

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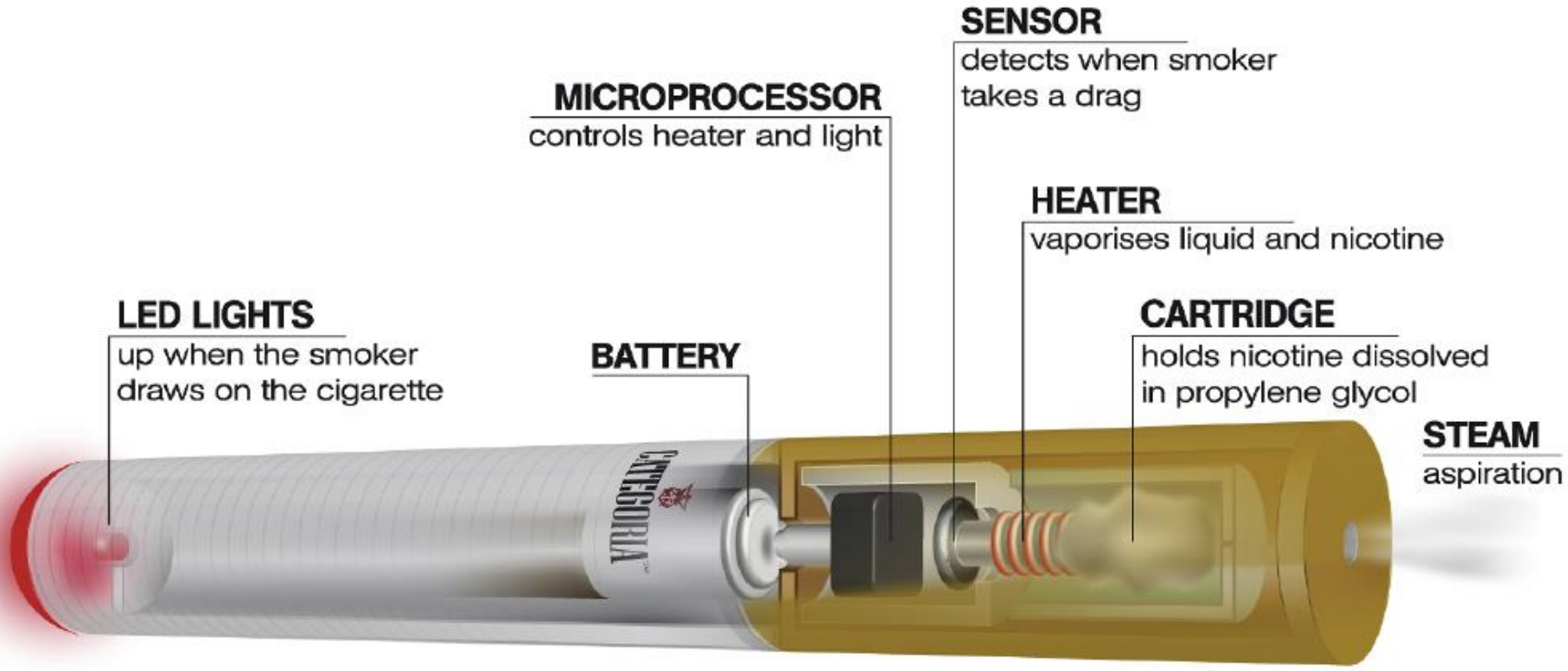
- Growing discussion amongst public health organizations and the scientific community as to whether particles exhaled following the use of e-cigarettes has potential implications for indoor air quality and bystanders.

- There is little data available on the dynamic properties of exhaled e-cigarette aerosols and how they differ to those emitted when a conventional cigarette is smoked (i.e. smoke exhaled + side-stream smoke).

Cig-a-like e-cigarette device



Caponnetto et al., Journal of Medical Case Reports, 2011, 5:585

Aim of the study

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- To investigate the spatial and temporal variations of exhaled aerosols following the use of an e-cigarette and a conventional cigarette in a room under controlled environmental conditions.

- To assess the second-hand exposure of a bystander to
  - aerosols in the exhaled air of a volunteer vaping an e-cigarette;
  - aerosols in the exhaled air of a volunteer smoking a conventional cigarette, as well as in the side-stream emissions.

Experimental setup

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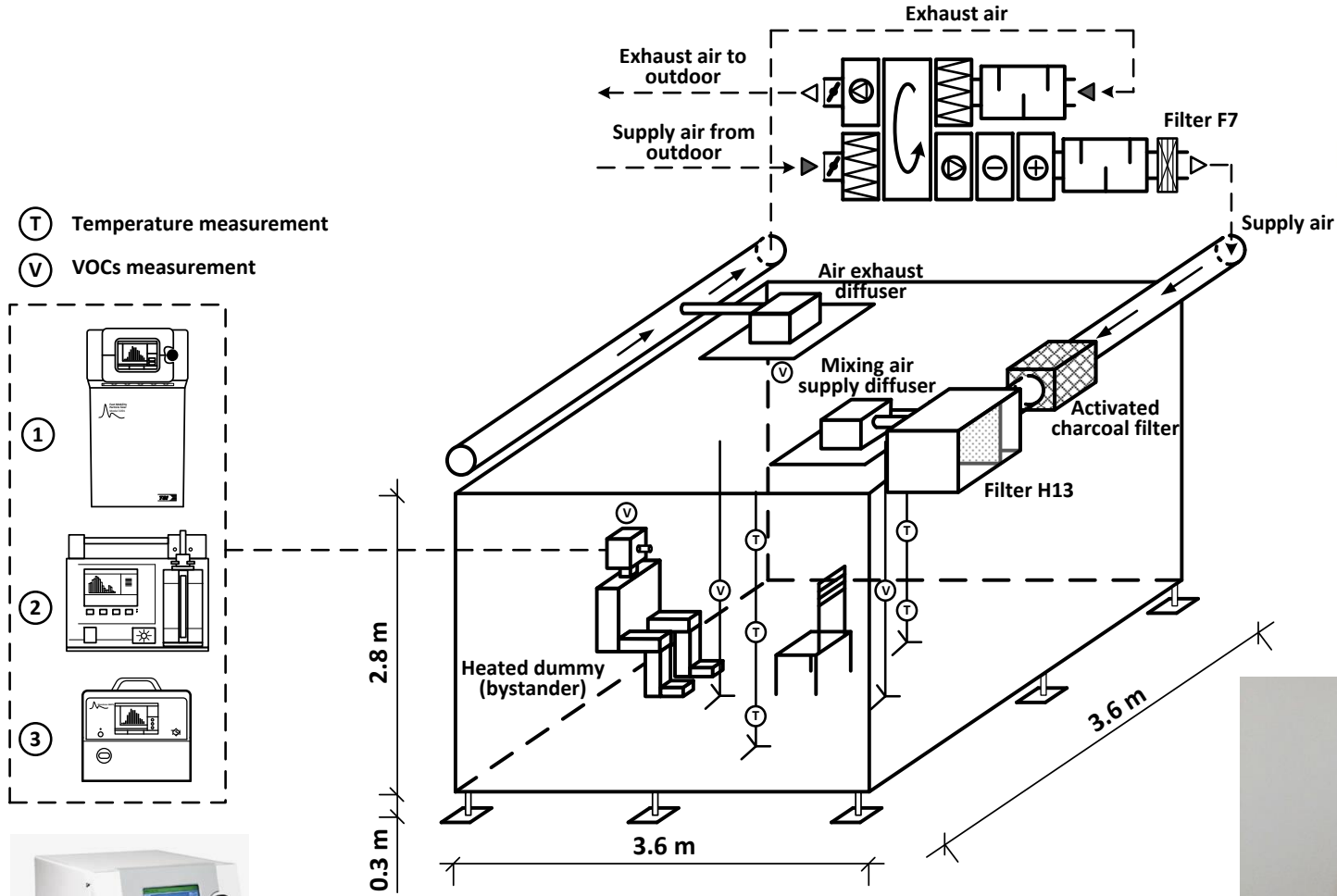

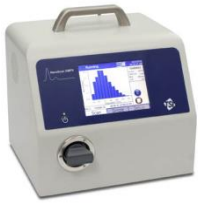

Parameters

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- **Products:** - cig-a-like e-cigarette (Puritane),
  - conventional cigarette (Marlboro Gold).
- **Volunteers:** 3.
- **Distance between volunteer and bystander:** 0.5, 1.0, 2.0 m.
- **Ventilation rate:** 0, 1, 2 ACH (air changes per hour).

- **Experiments:**
  - 1 puff every 30 sec during 3 min
  - Stay in the exposure chamber during 5 minutes after the last puff
  - Volume and puff duration, volume of inhalation during the puff up to the volunteer

Particle number concentration during vaping

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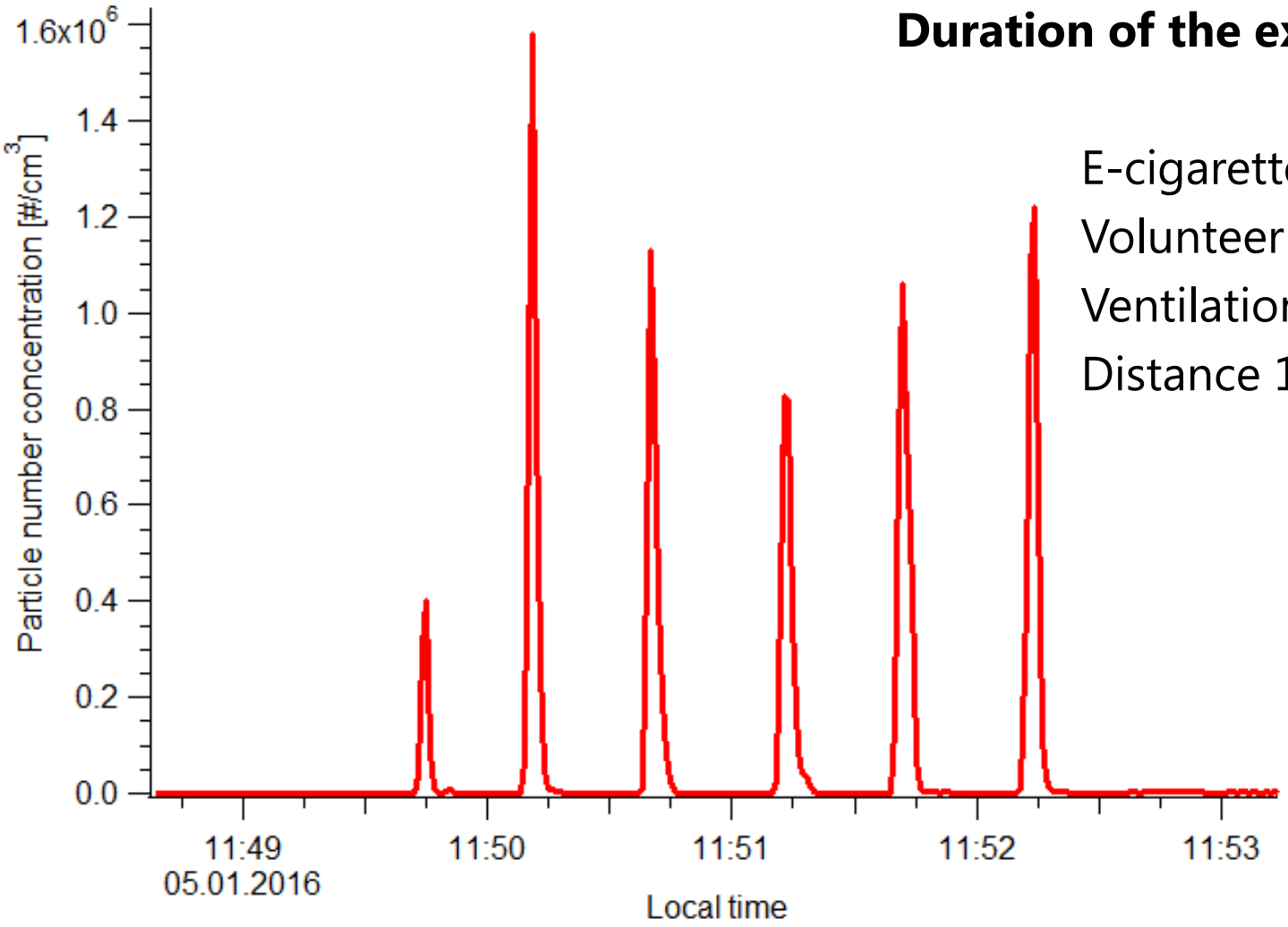
Frequency: 1 puff every 30 sec.

Duration of the experiment: 3 min.



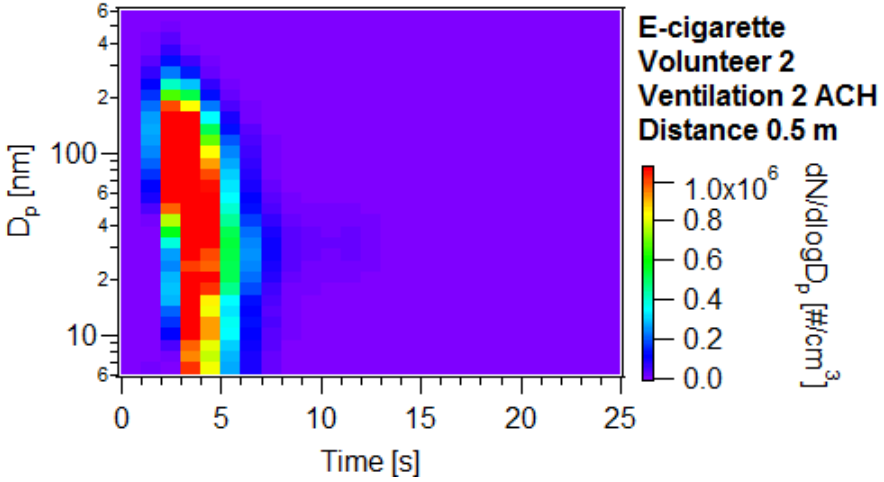
E-cigarette

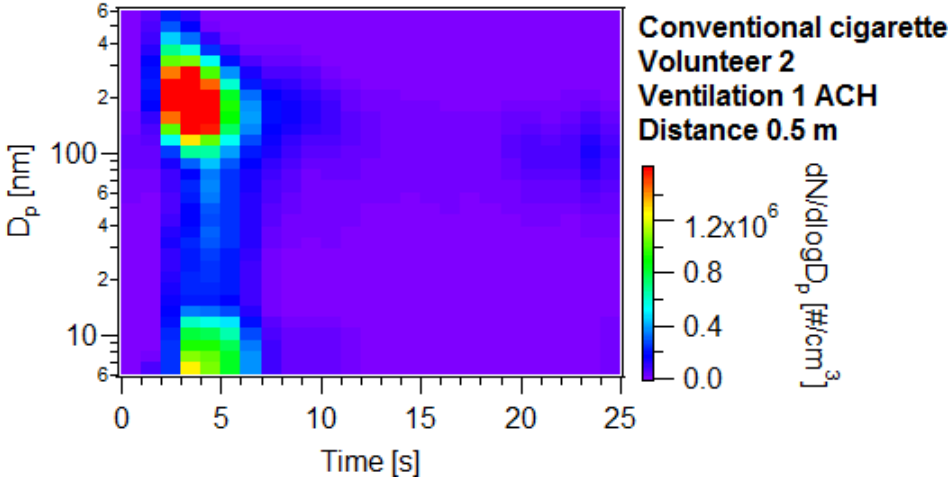
Volunteer 1

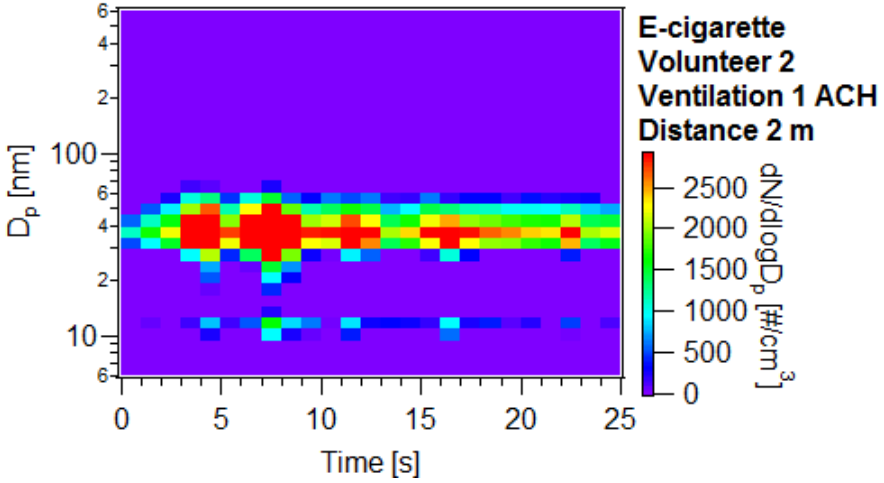
Ventilation intensity: 2 ACH

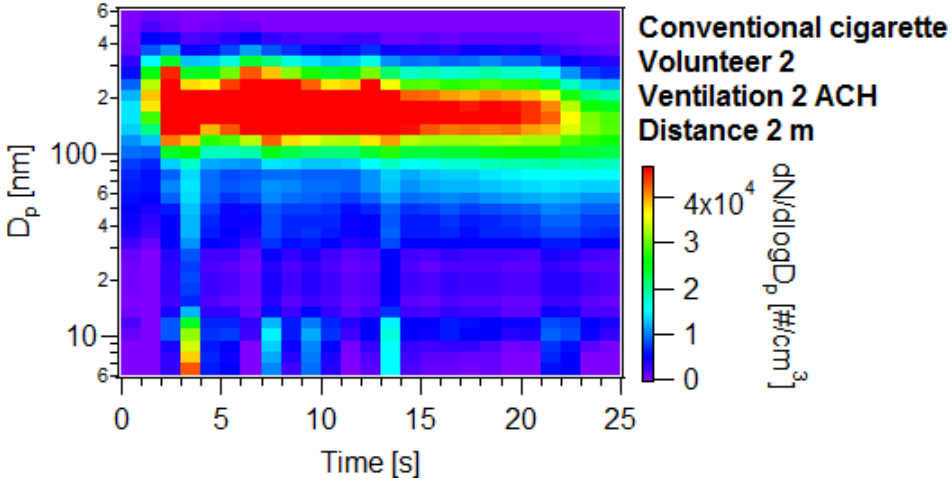
Distance 1.0 m

Contour plots of particle size distributions



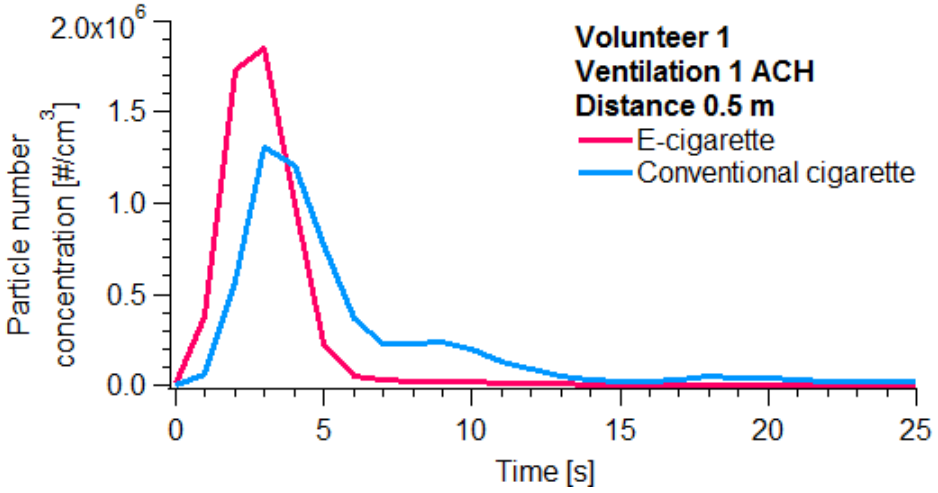


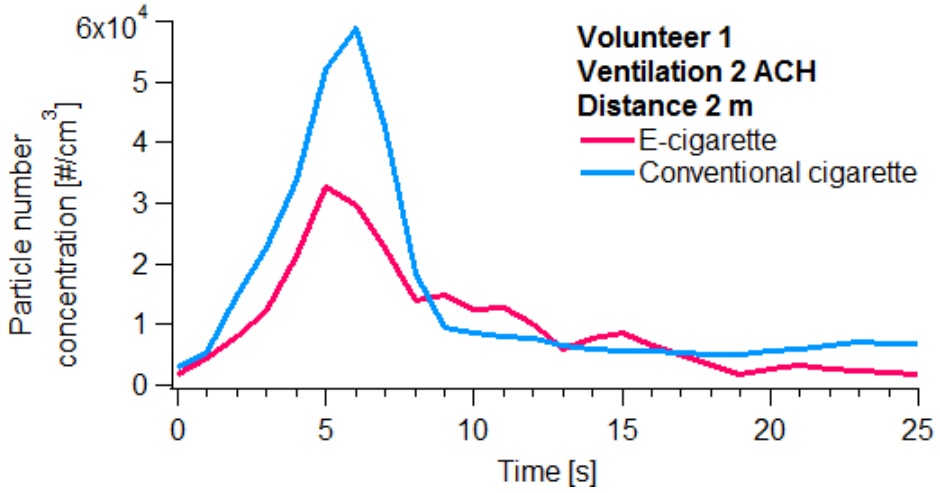


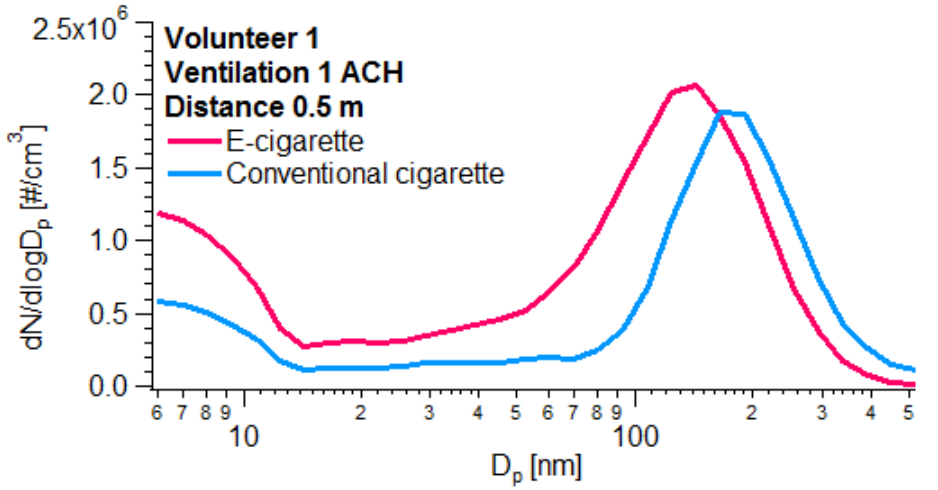


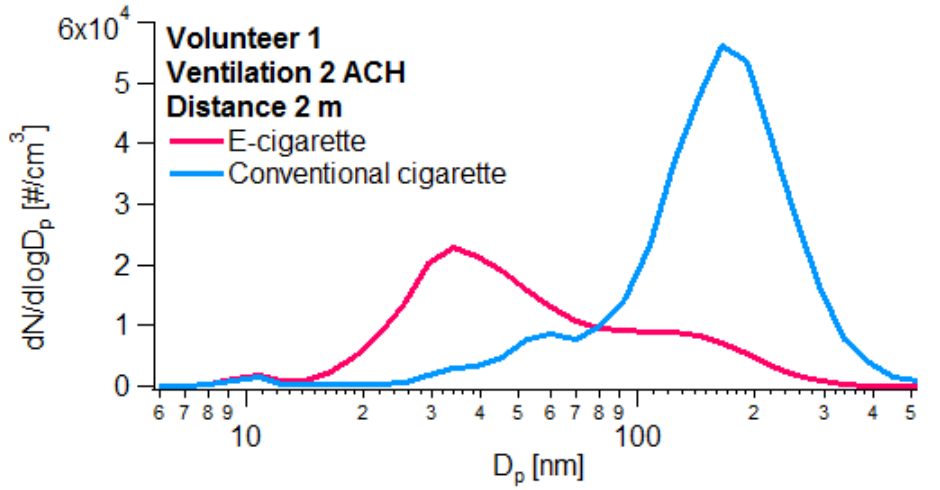
- At a short distance, the particle concentration increases and comes back to background values in < 10 sec.
- At a large distance, e-cigarette shows a smaller mode due to evaporation (size shrink), conventional cigarette has a more stable size distribution.

Inter-comparison between products



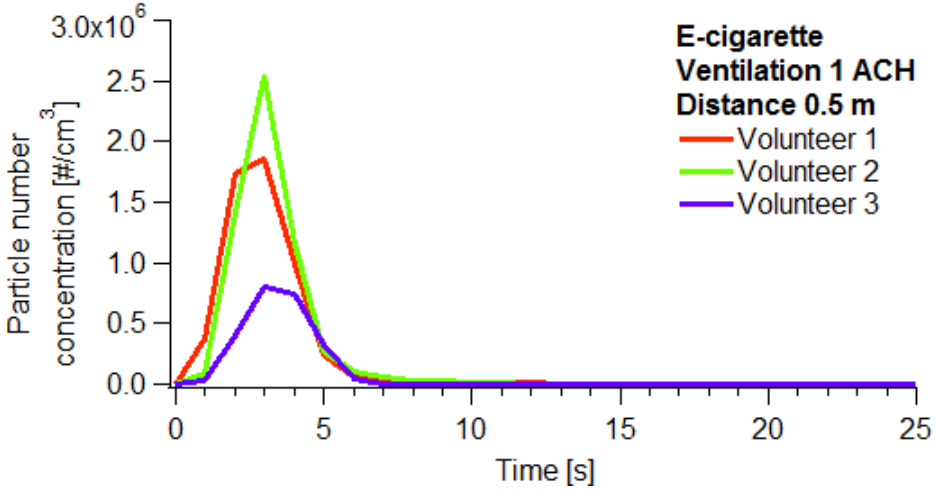


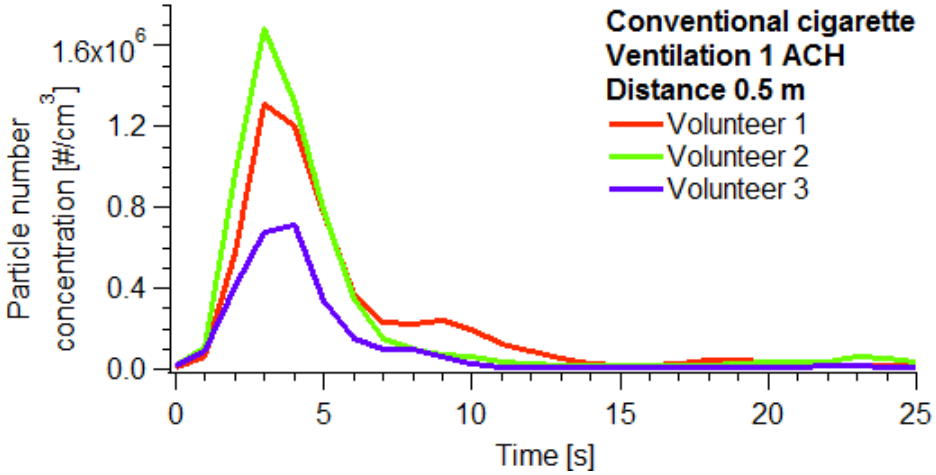


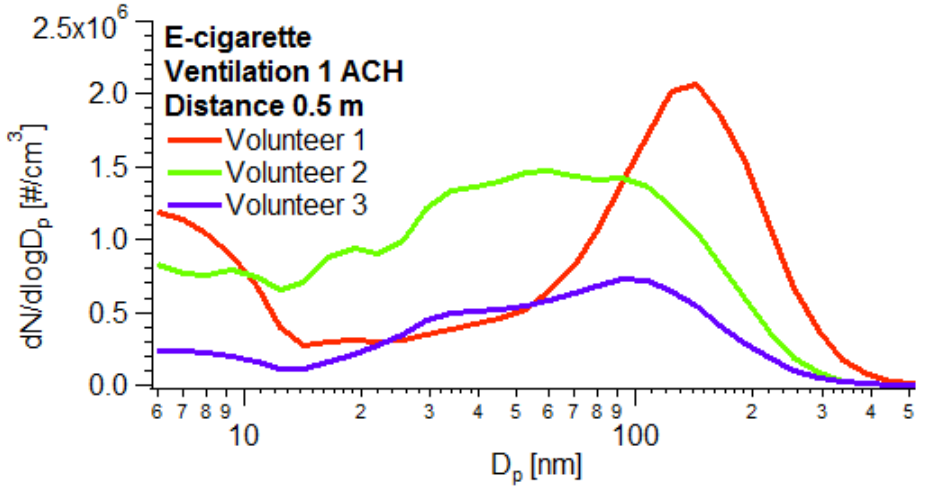


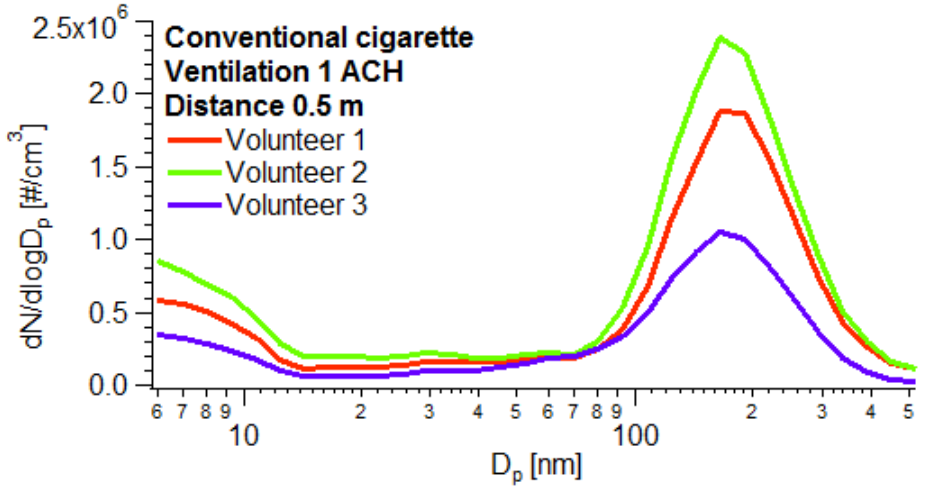
- At a short distance, no significant difference between products.
- At a large distance, the peak size of particles from e-cigarettes shrank from 150 to 30 nm due to evaporation.

Inter-comparison between volunteers



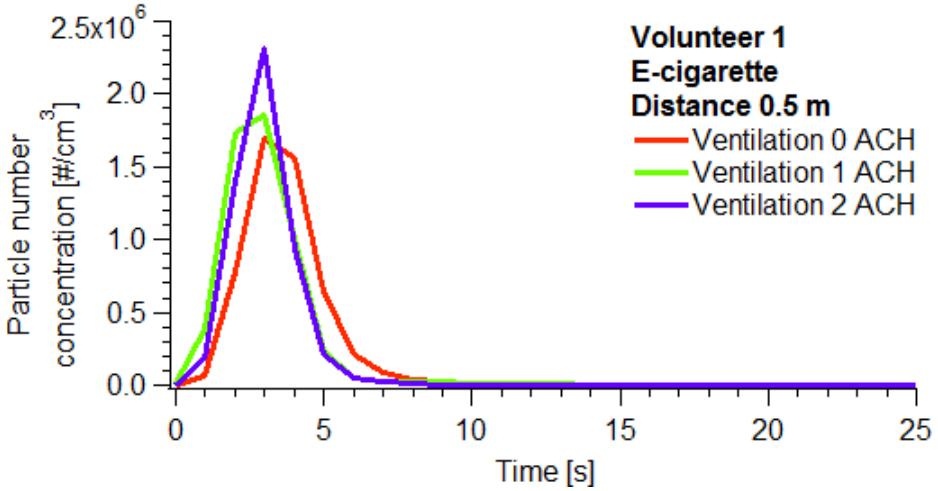


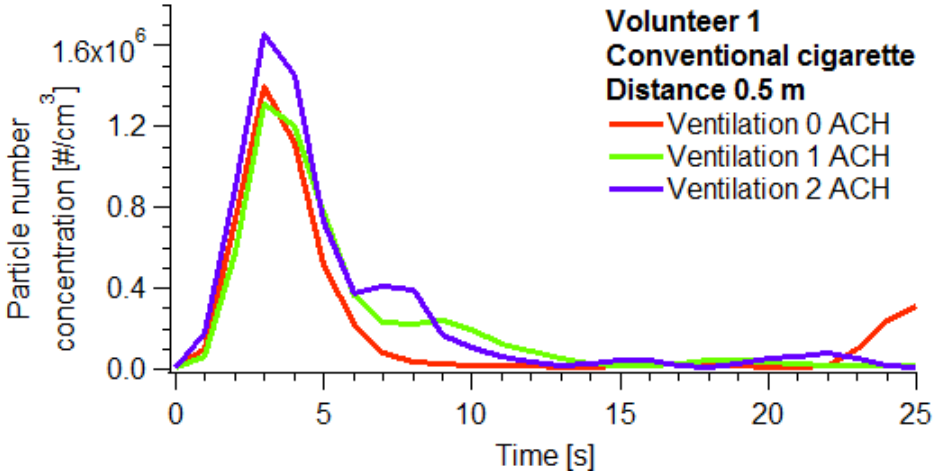


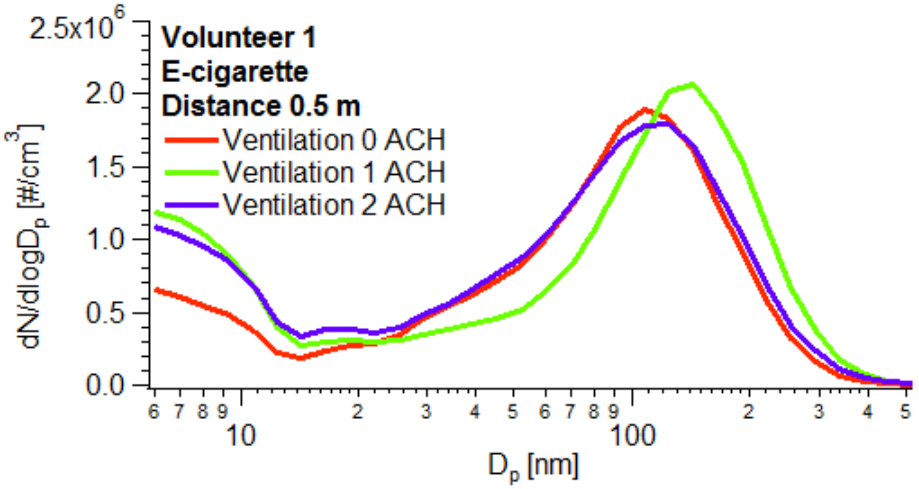


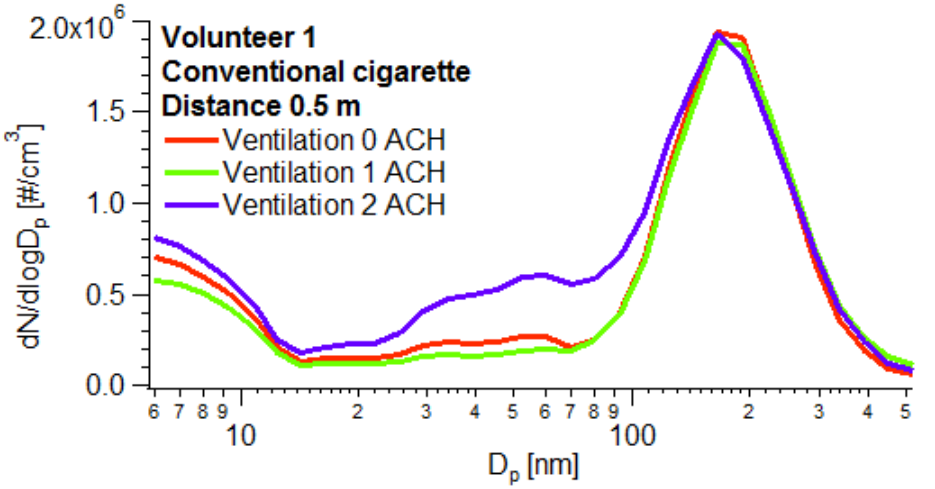
- In general, important difference among volunteers in terms of total particle concentration, sometimes also in terms of size distributions.

Influence of the ventilation rate



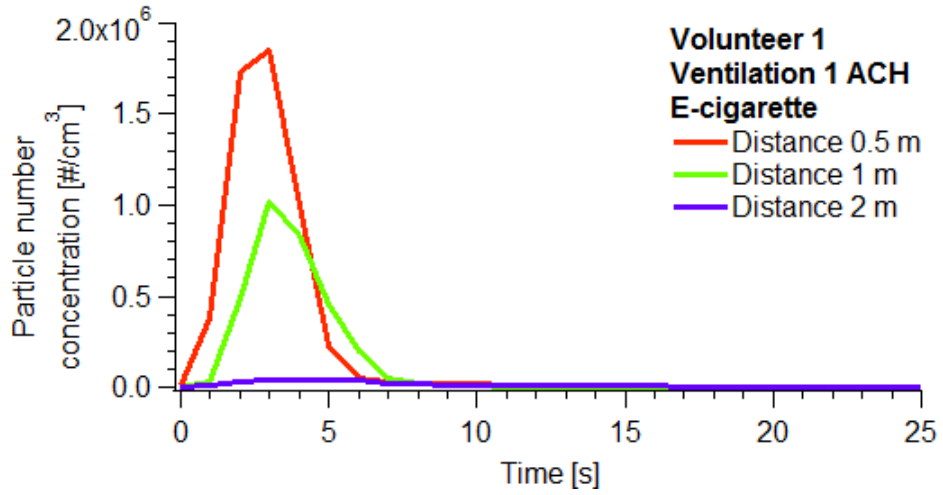


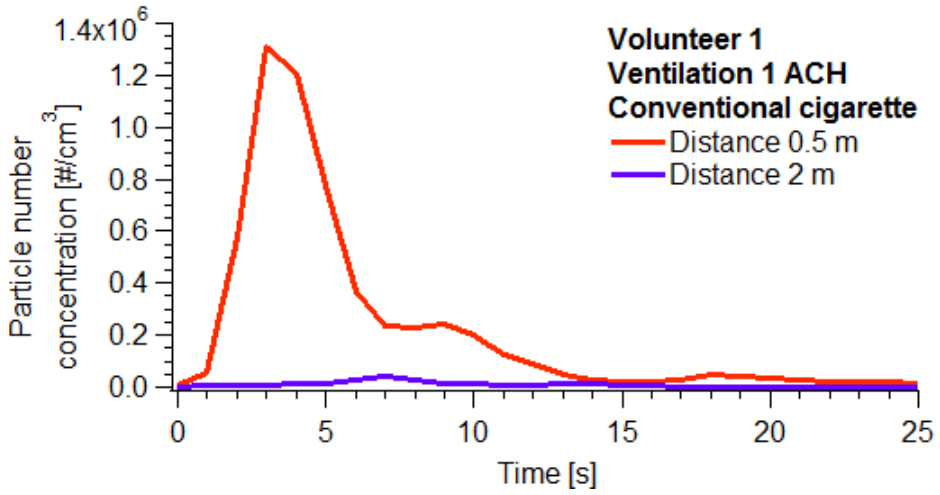


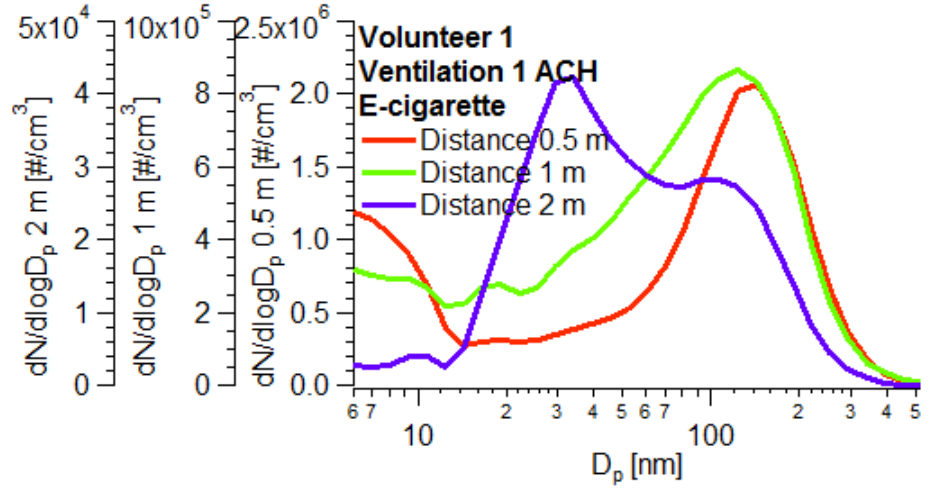


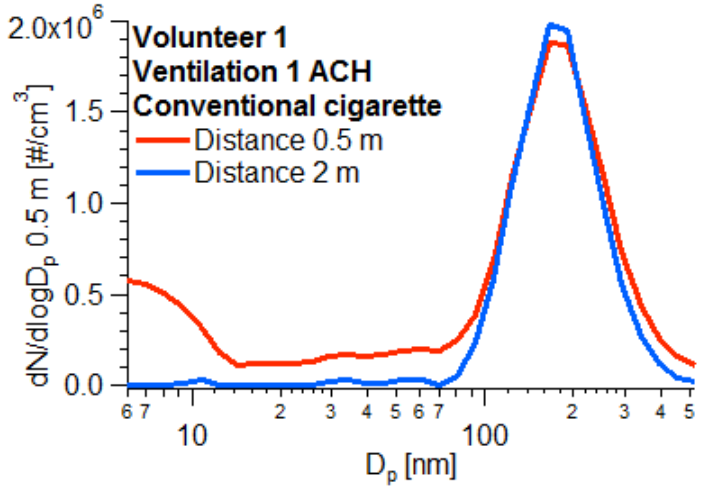
- No significant impact of ventilation rate on particle concentration and size distribution during puffs.

Influence of the distance between the volunteer and the bystander









- Important decrease of the particle concentration with the distance.
- For e-cigarette, shrink of the particle size (evaporation) at large distance.

  For conventional cigarette, size distribution stable with distance.

Particle concentration after successive puffs

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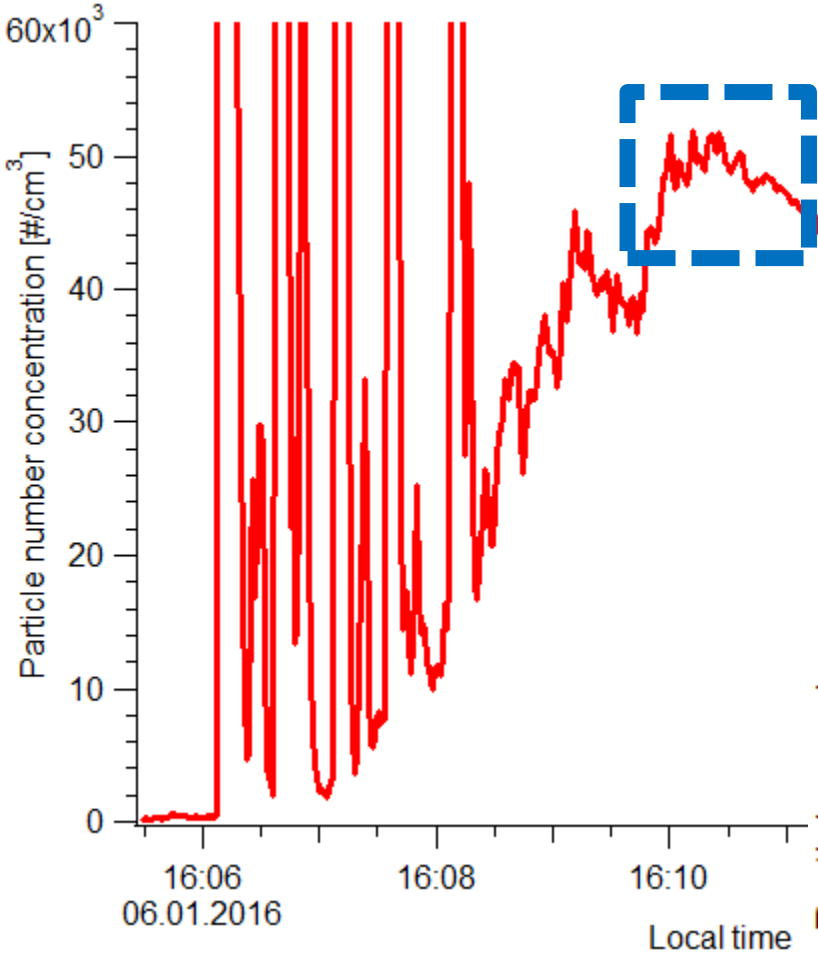
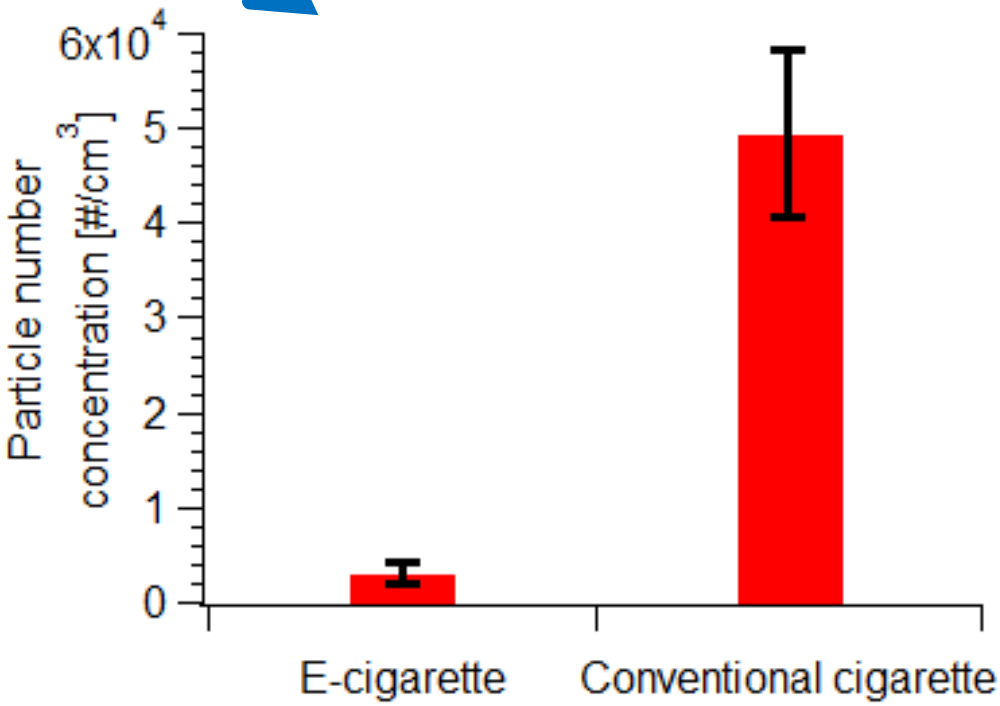
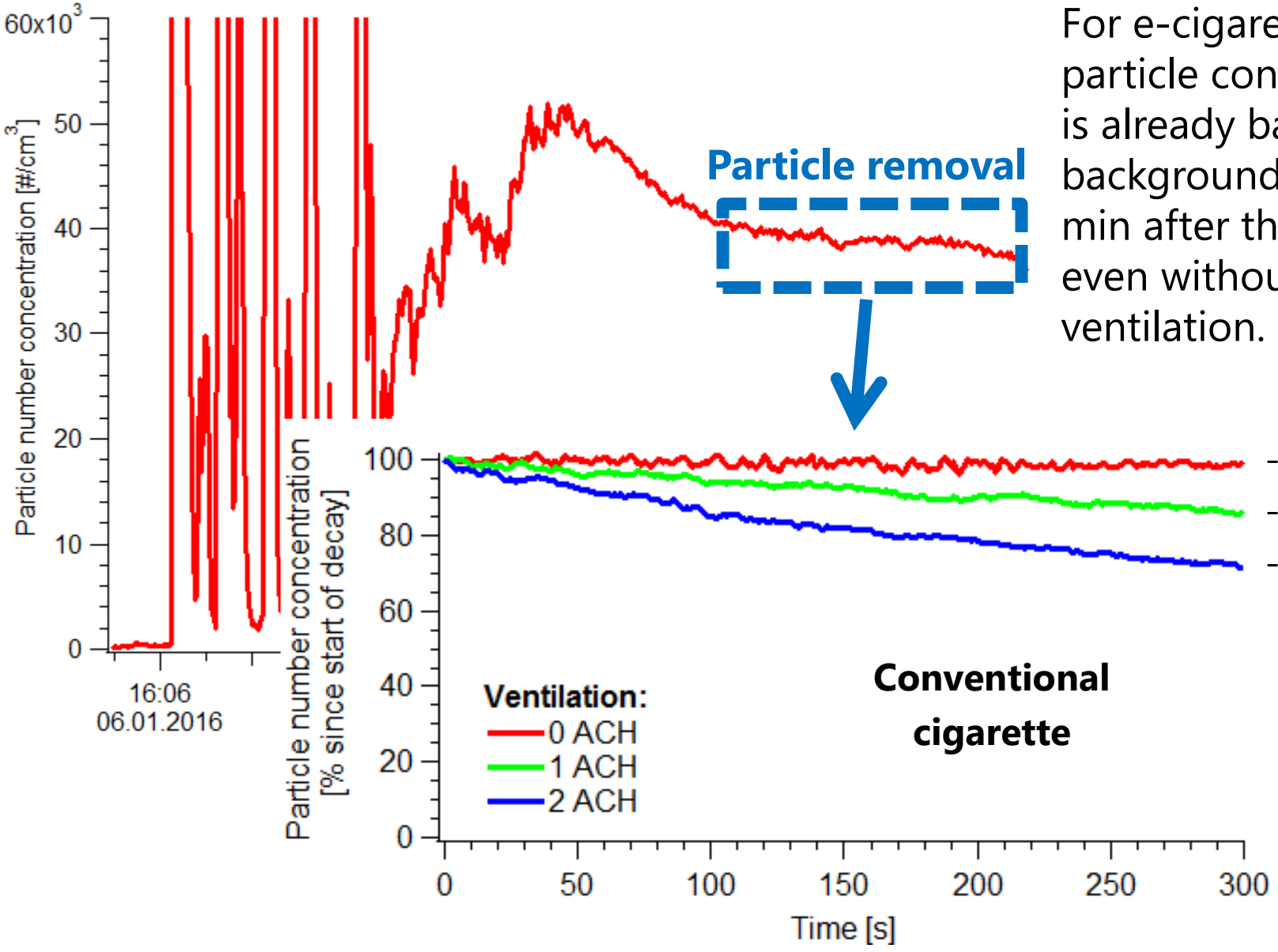


Average particle concentration 2-3 minutes after the last puff



Decay rates



For e-cigarette, the particle concentration is already back to background levels <1 min after the last puff, even without ventilation.

- 0.3% per min
- 2.9% per min
- 5.6% per min

Conclusion

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- Very fast variation of the particle concentration during the use of e-cigarettes and conventional cigarettes.
- Particles exhaled after the use of e-cigarettes were in the range 100-150 nm, shrank rapidly down to 30-40 nm due to evaporation of volatile compounds, and disappeared 10-15 seconds after the puff, transferring into the gas phase.
- Conventional cigarette particles were larger (150-200 nm) and much more stable than those from e-cigarettes. The removal of these particles was much longer, and depended on the ventilation rate in the room.

Thanks for your attention!

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