An Experimental Study of Human Exhalation during Breathing and Coughing in a Mixing Ventilated Room

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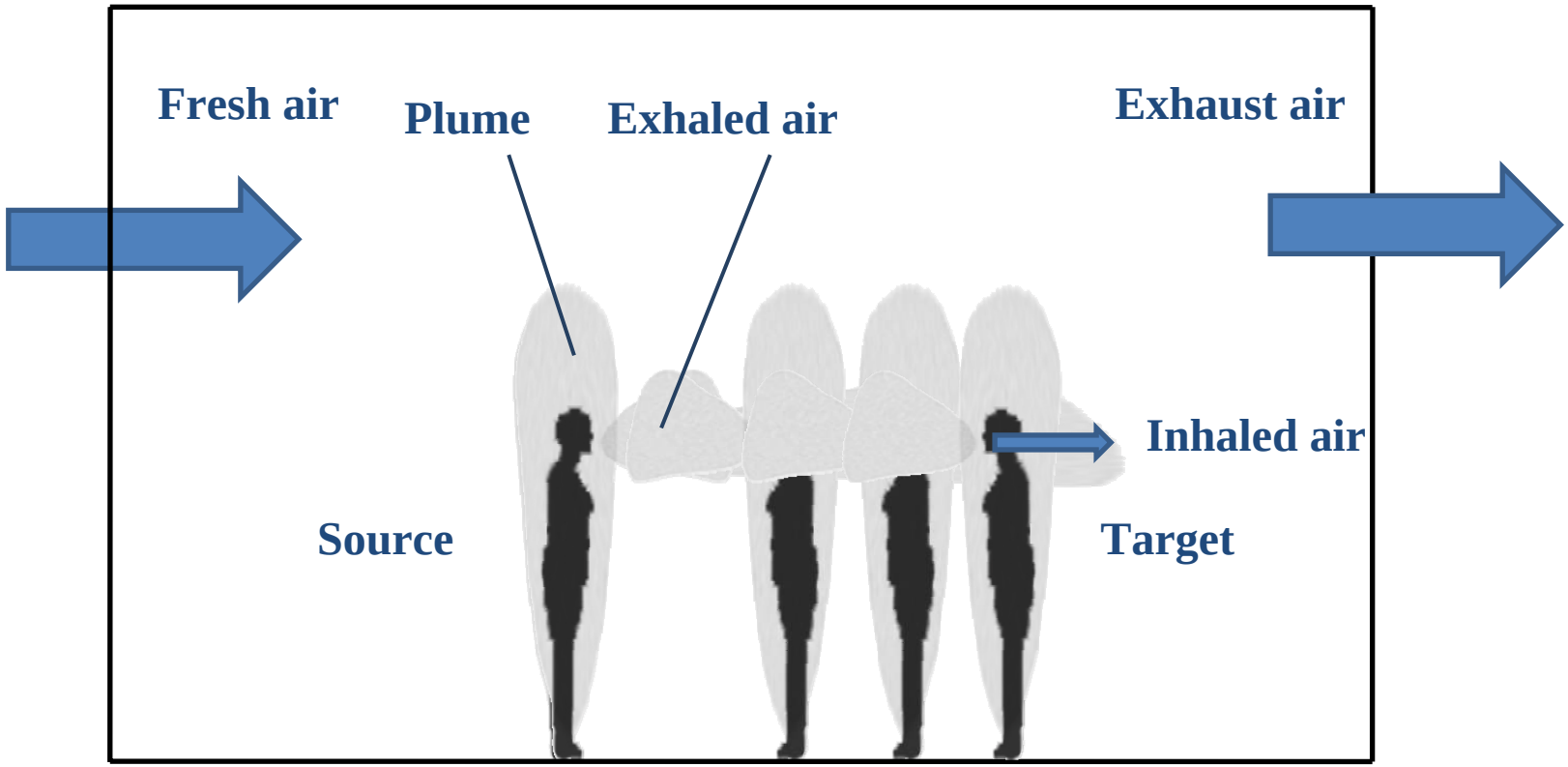
Motivation



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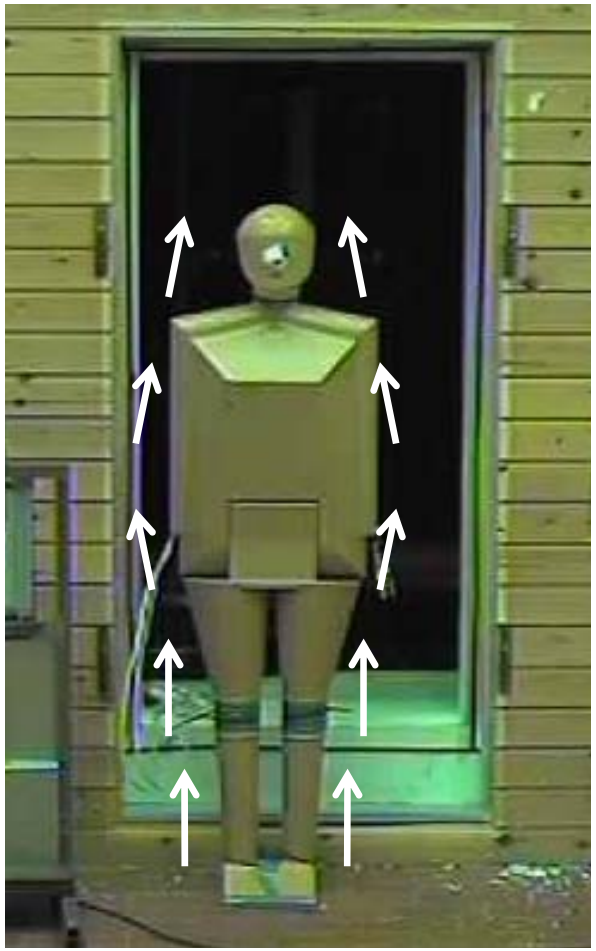
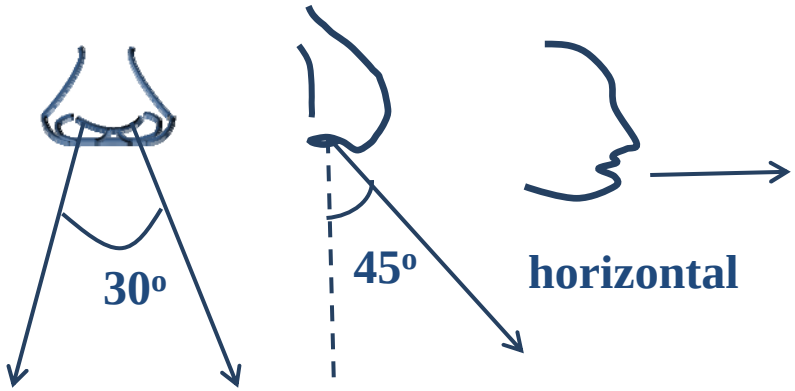
Manikin setup





Mouth	Area (mm^2)	100
	Outlet temperature (℃)	34
Nostril	Area (mm^2)	50+50
	Outlet temperature (℃)	33
Pulmonary ventilation (l/breath)		0.75
Breathing frequency (times/min)		15
Heat flux (W)		94

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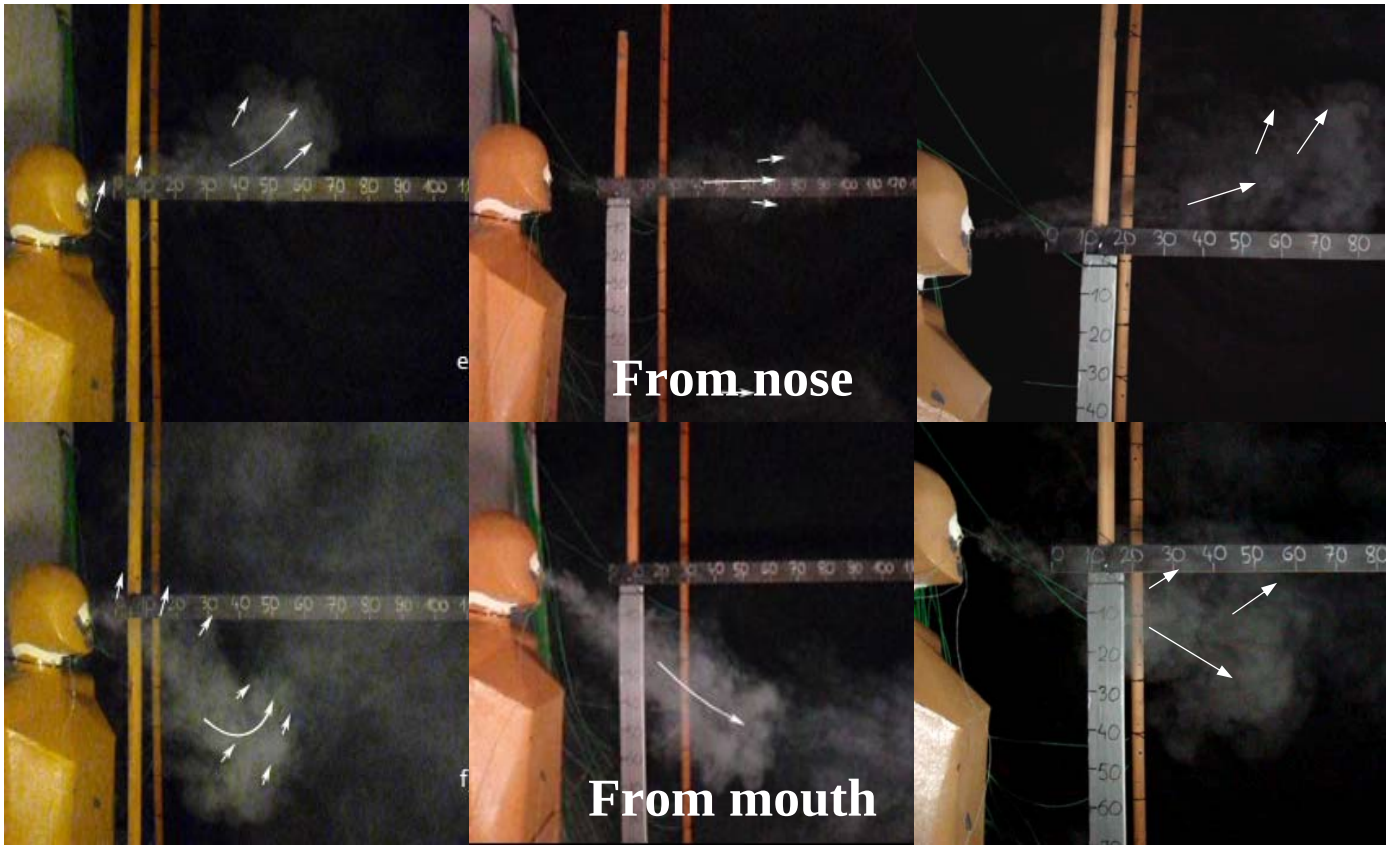
Breathing – Smoke experiment

2.5 seconds after exhaled

No ventilation	Displacement ventilation	Mixing ventilation



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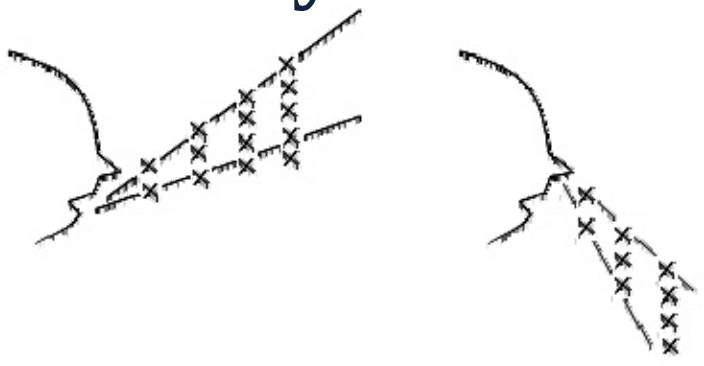
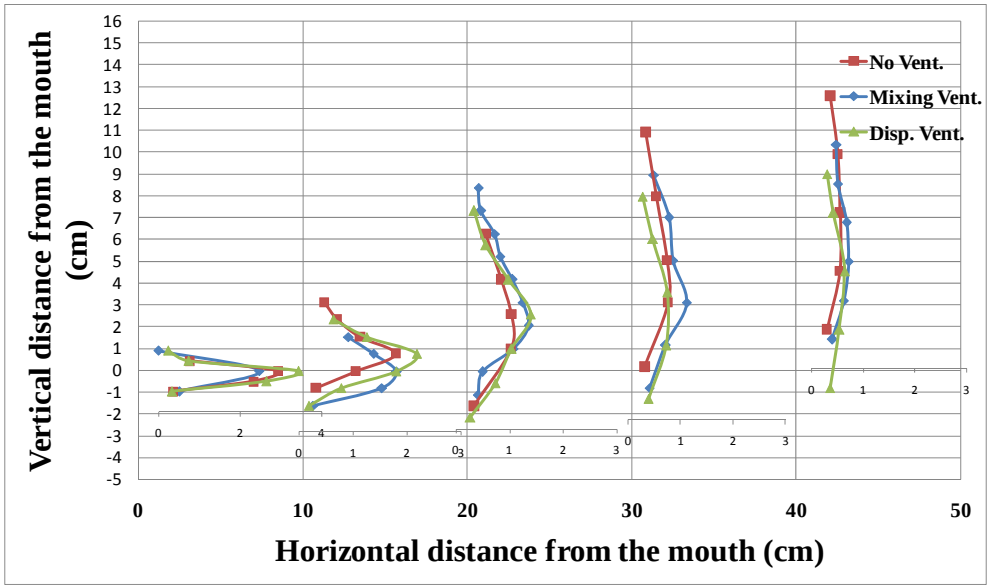
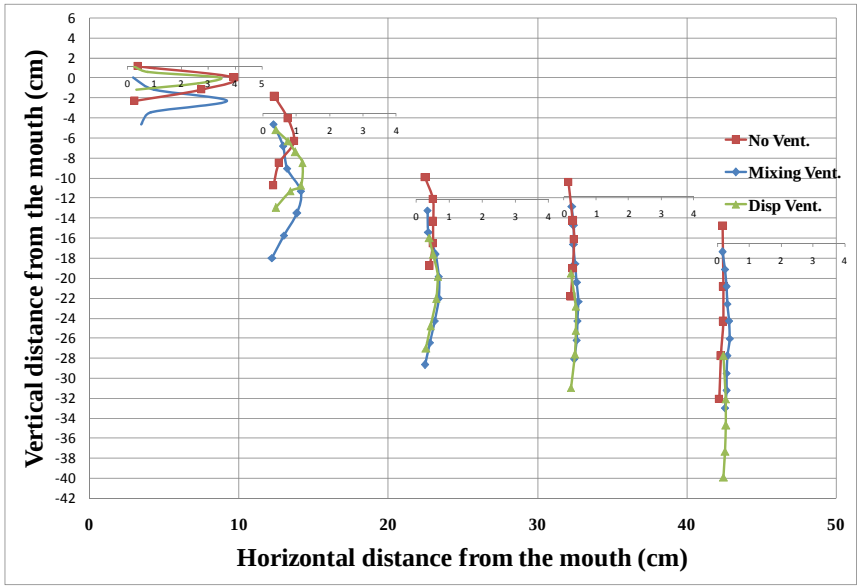
Breathing - Velocity measurements



From mouth



From nose



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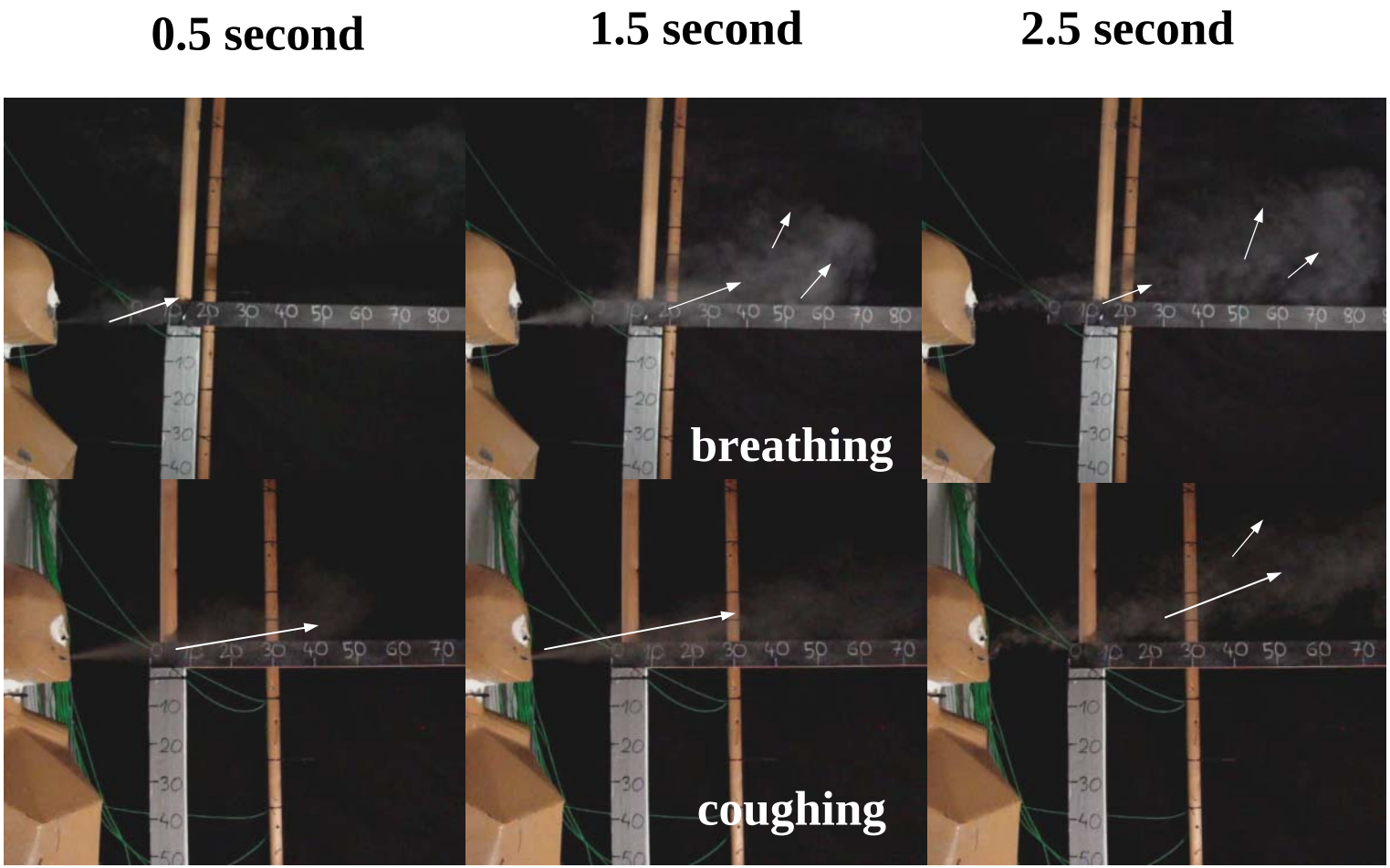
Coughing – Smoke experiment



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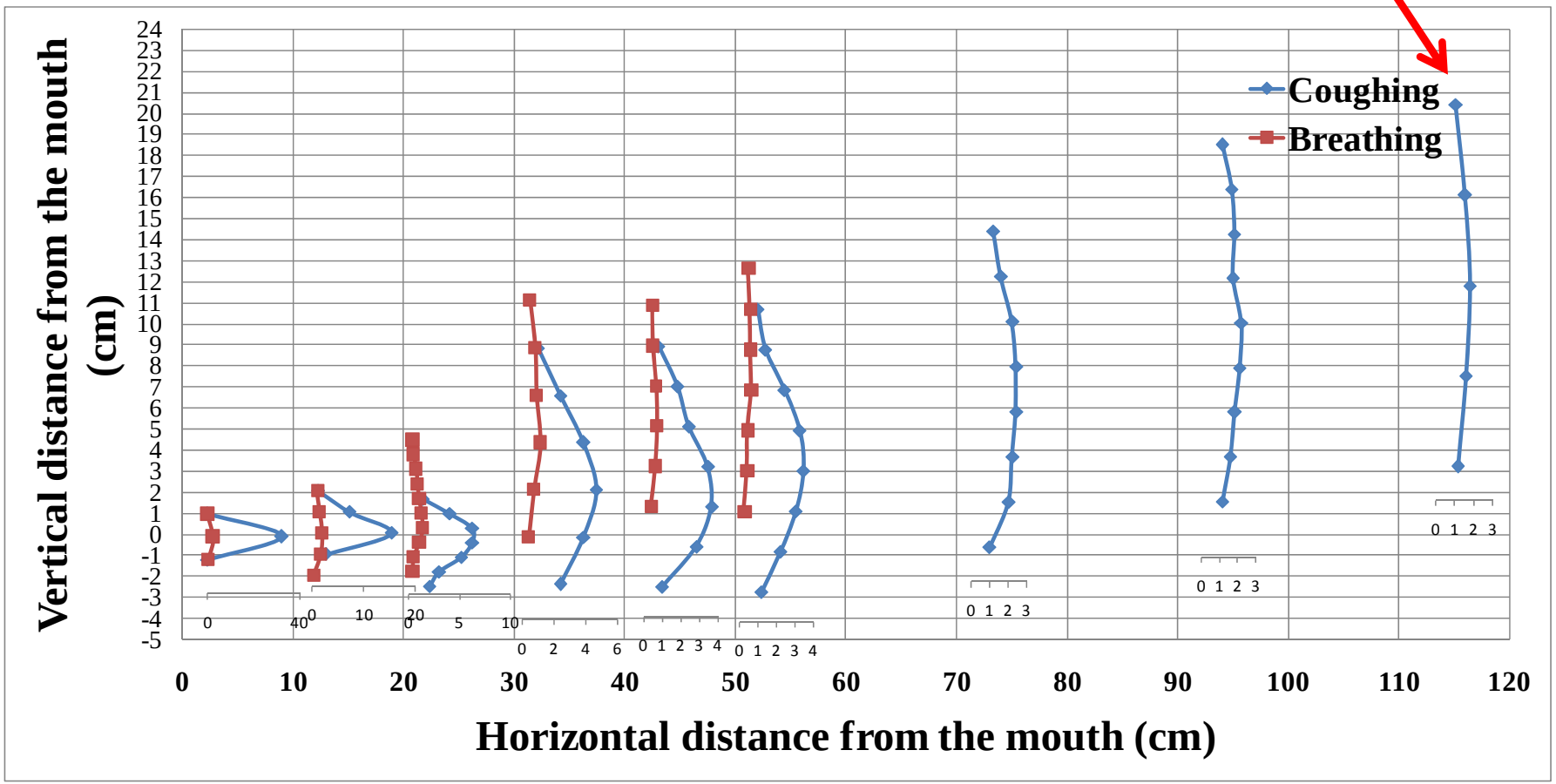
Velocity measurements for coughing jet

About **2m/s** at 1.1m



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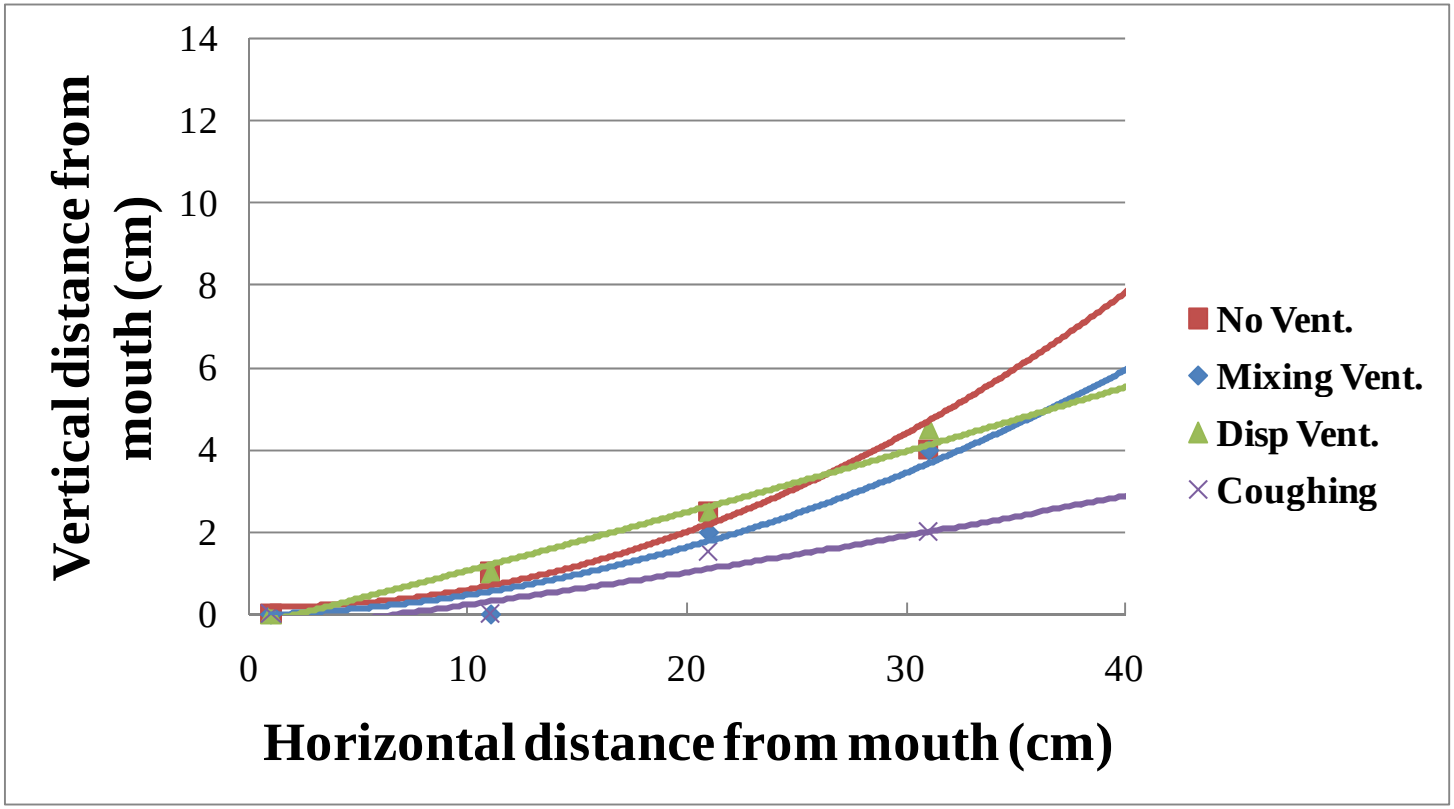
Direction of flow

- The locations of peak velocities



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Velocity decay along the jet

- The exhalation flow is partly a vortex ring and partly an instantaneous turbulent jet.
- $$\frac{u_x}{u_o} = K_{exh} \cdot \frac{\sqrt{a_o}}{x}$$

K_{exh}	No ventilation	Mixing ventilation	Displacement ventilation
Breathing from nose	5.0	6.3	5.0
Breathing from mouth	7.8	7.6	13.9
coughing		7.4	

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Summary

- The breathing jet is influenced by the temperature difference with ambient air, ventilation systems and body plume.
- The exhalation jet of coughing is much stronger than breathing jet. The peak velocity remains about 2 m/s one meter away from the mouth.
- An expression for describing the decay of peak velocity along the exhalation jet may be useful.

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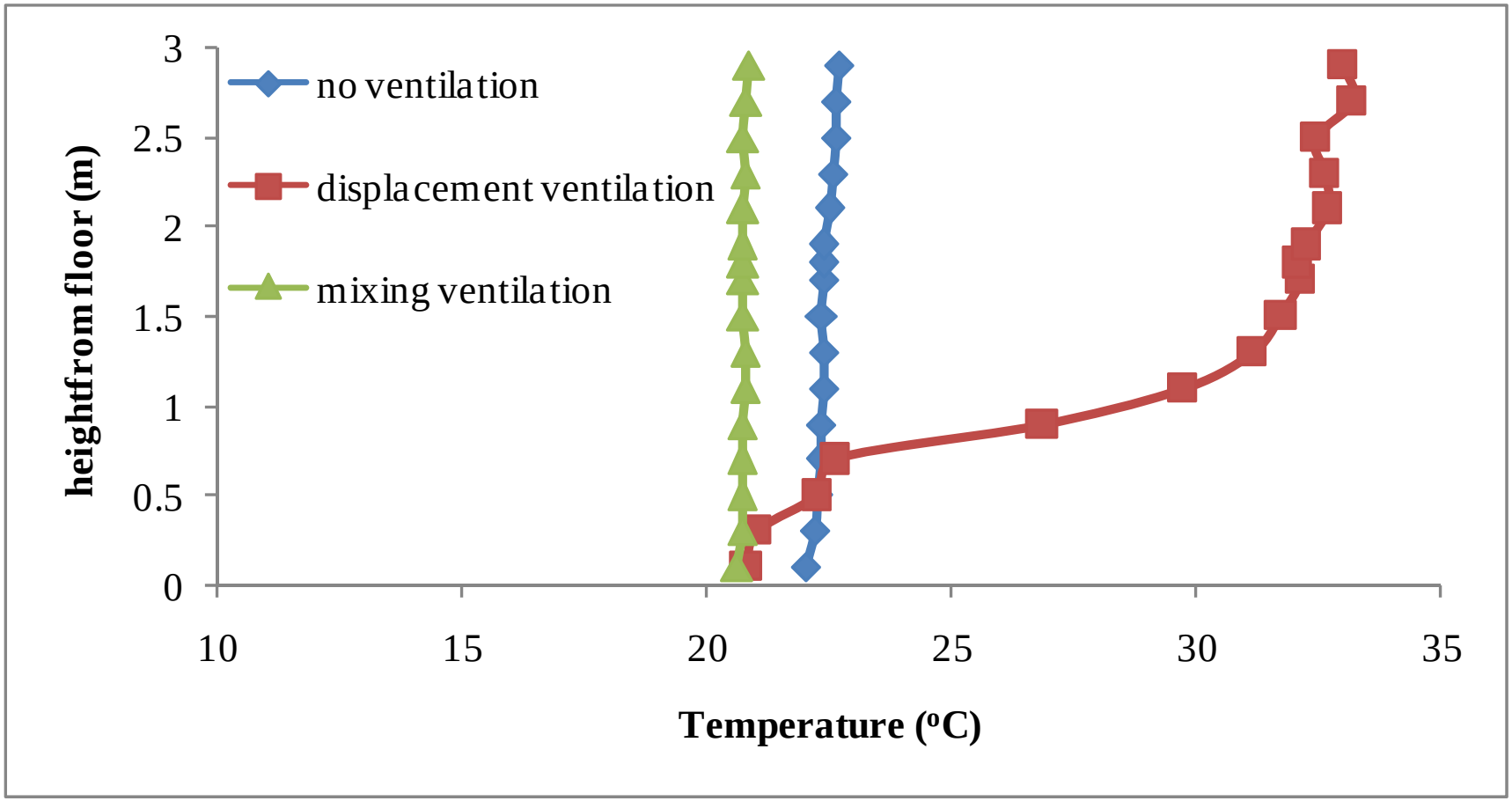

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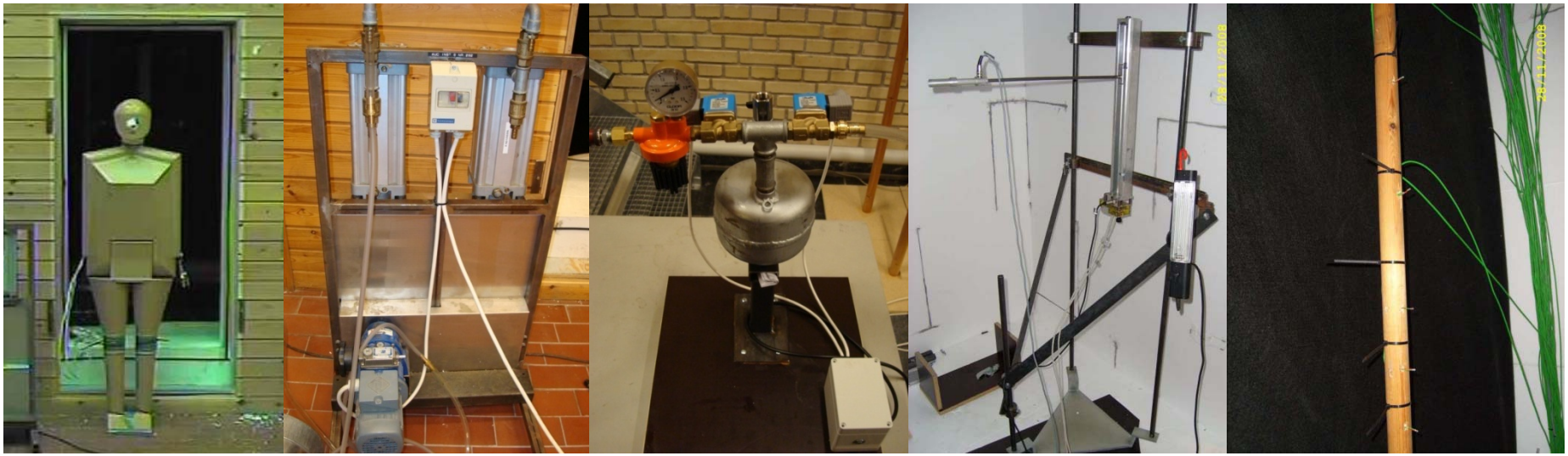

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