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PVT

Reducing the Transmission of SARS-CoV-2 by reusing FFP2 Masks: Evaluation of their Filtration Efficiency after Sterilization

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Air Filtration Seminar 2020 – Frankfurt

Background and Motivation

Background

On 11 March 2020, the WHO declared the COVID-19 virus to a global pandemic

→ Shortage of breathing masks

→ Reuse of used masks

Motivation and resulting questions

To provide proof of reusability after sterilization

→ Which sterilization method is suitable

→ Volume flows during respiration

→ Efficiency after sterilisation

Wet Autoclave Sterilisation

- ZentraCERT, Series 10200
- $P_{max,abs}$ = 3210 mbar
- T_{max} = 134 °C
- T_{steril} = 18 min

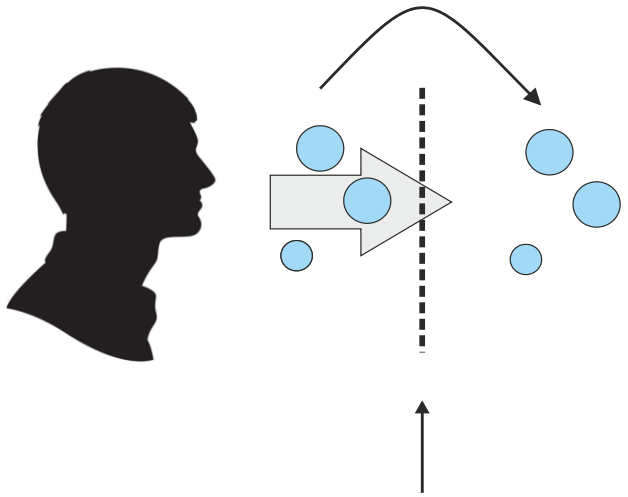
Cold Plasma Sterilisation

- Sterrad® 100NX
- Hydrogen peroxide (H_2O_2)
- Relative humidity (10-85%)
- $P_{max,abs}$ ≈ 1013 mbar
- T_{max} = 35 °C
- T_{steril} = 24 min

Main Transmission Mechanisms

droplet barrier e.g.:
- surgical masks
- FFP2 masks

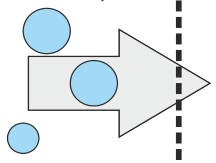
droplet emission



droplet barrier e.g.:
- surgical masks
- FFP2 masks

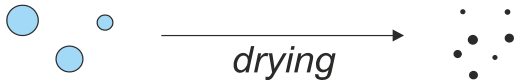
infection via droplets

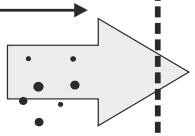
- large droplets might reach the opponent directly
- large droplets settle within <2 m distance



infection via airborne particles

- several droplets dry before settling revealing small, solid particles (airborne particles)
- can be carried over far distances

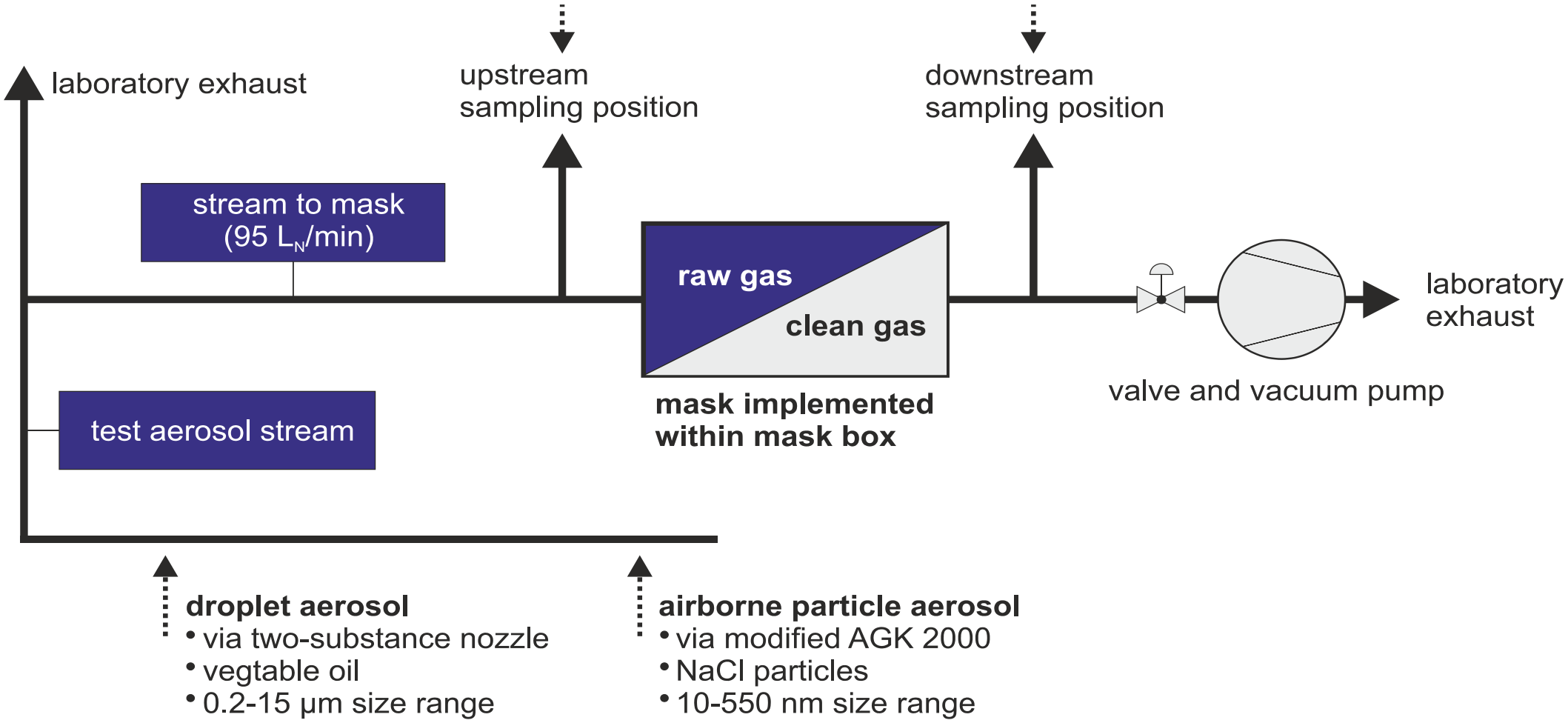




particle barrier e.g.:
- FFP2 masks

Development of the Test Rig

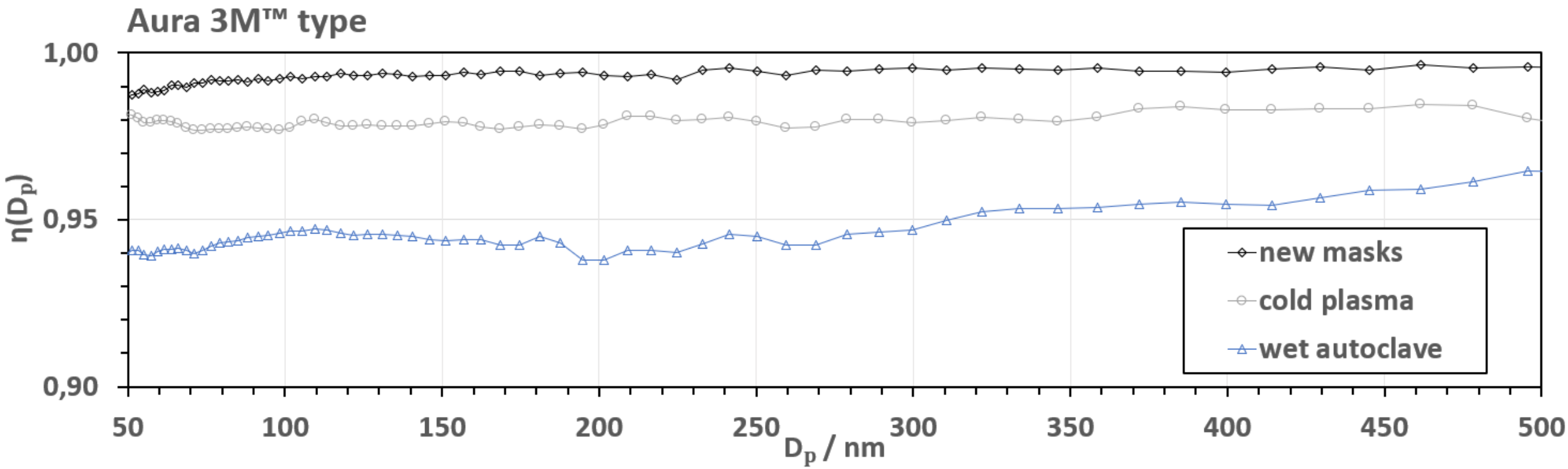
measurement principles:
- scanning mobility particle sizing (TSI, SMPS)
- light scattering spectrometry (Palas, welas)



Mask Types and their Treatments

manufacturer	trademark/ type	filter fibre material	treatment	SEM/CT investigation
Valmy SAS	BTP058	polypropylene	fresh	yes
			wet autoclaved	yes
			cold plasma	no
unknown	*unknown*	polypropylene	fresh	yes
			wet autoclaved	yes
			cold plasma	no
3M Deutschland GmbH	Aura™	polypropylene	fresh	yes
			wet autoclaved	yes
			cold plasma	no

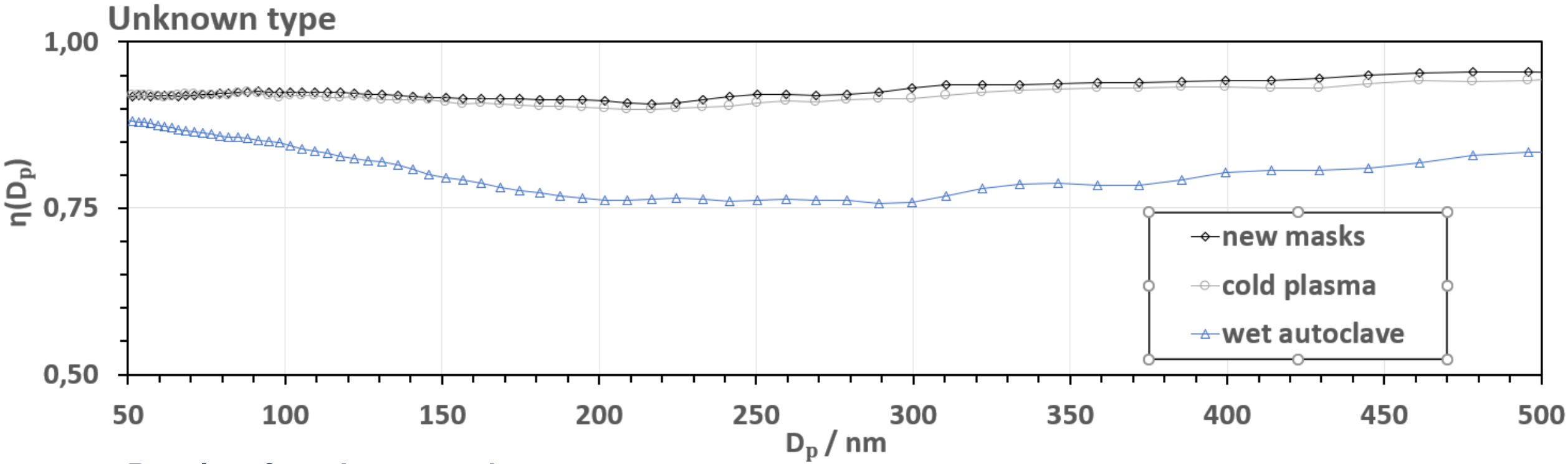
Results of the Filtration Efficency of Airborn Particles



Results of mask types Aura

- The filtration efficiency decreases during sterilization
- The filtration efficiency decreases stronger during wet autoclaving than during cold plasma sterilization

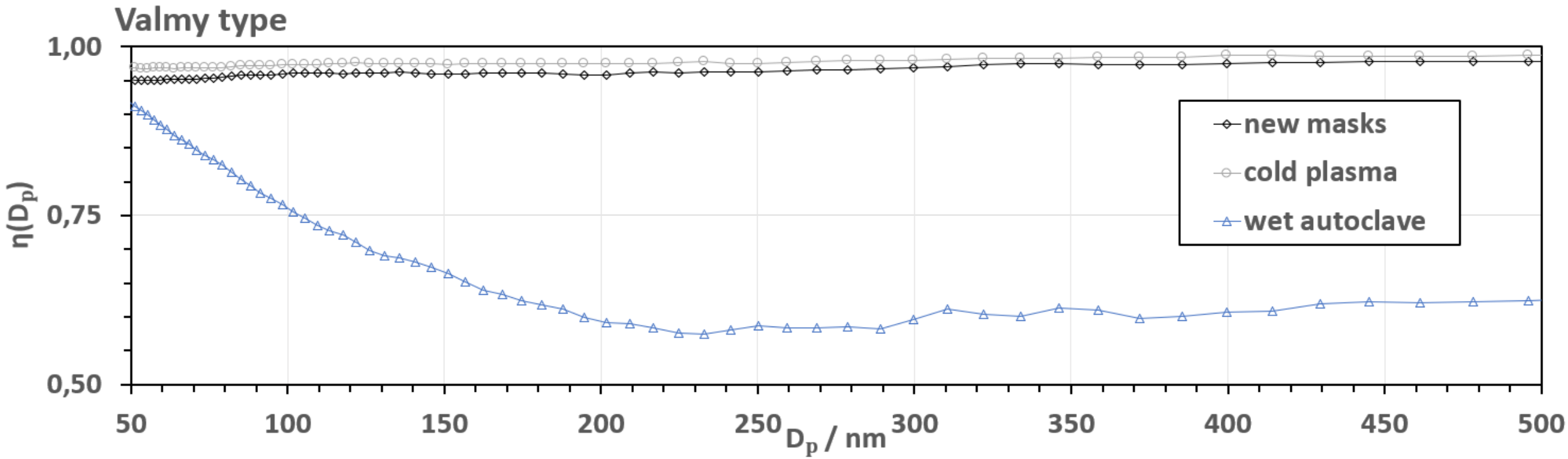
Results of the Filtration Efficency of Airborn Particles



Results of mask types unknown

- The filtration efficiency during the cold plasma sterilization is unchanged
- The filtration efficiency of this mask type is generally lower compared to the Aura type
- During wet autoclaving, the filtration efficiency of this mask type decreases stronger compared to the mask type Aura

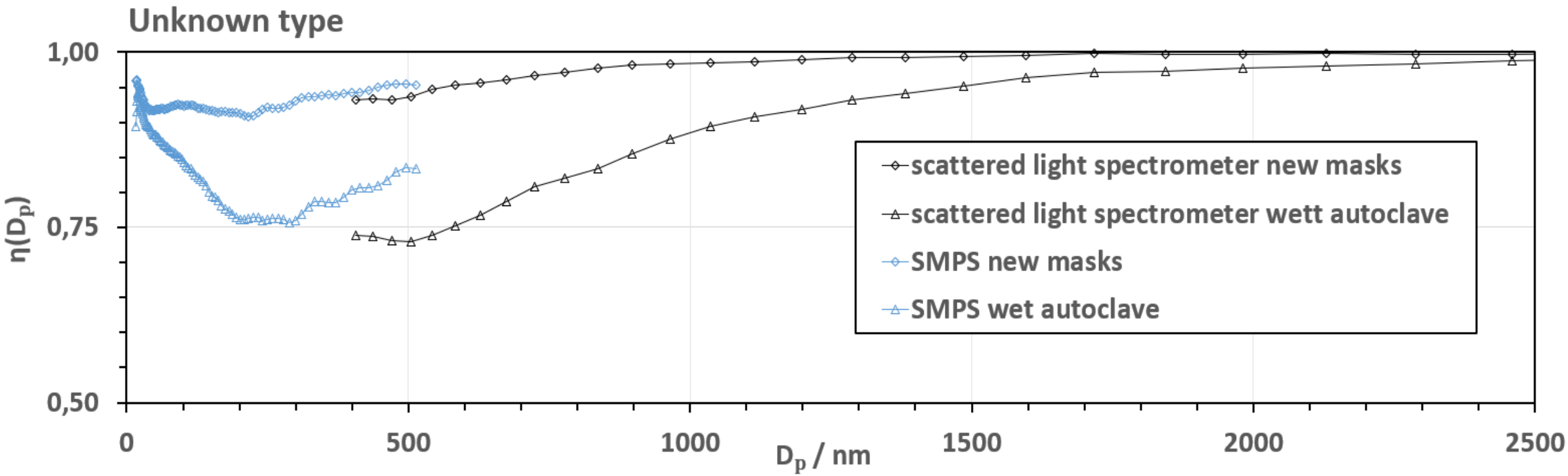
Results of the Filtration Efficency of Airborn Particles



Results of mask types Valmy

- The filtration efficiency decreases during wet autoclaving
- The filtration efficiency of this mask type is generally lower compared to the Aura type
- During wet autoclaving, the filtration efficiency of this mask type decreases more compared to other two mask type

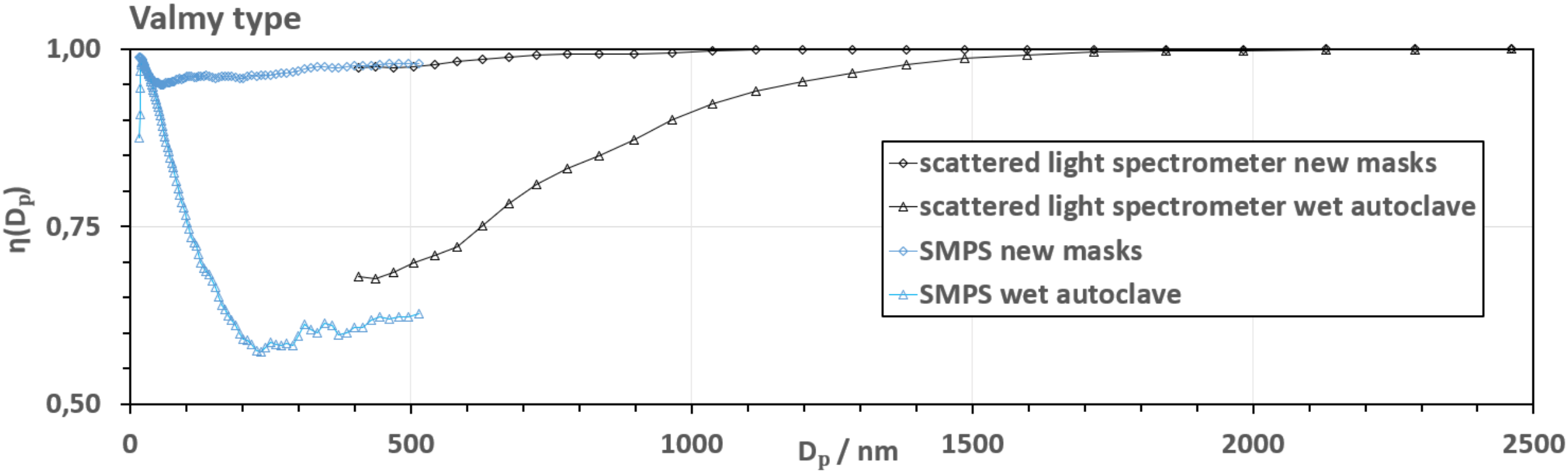
Results of the Filtration Efficency of Droplets



Results of mask types unknown

- The filtration efficiency increases with increasing particle size

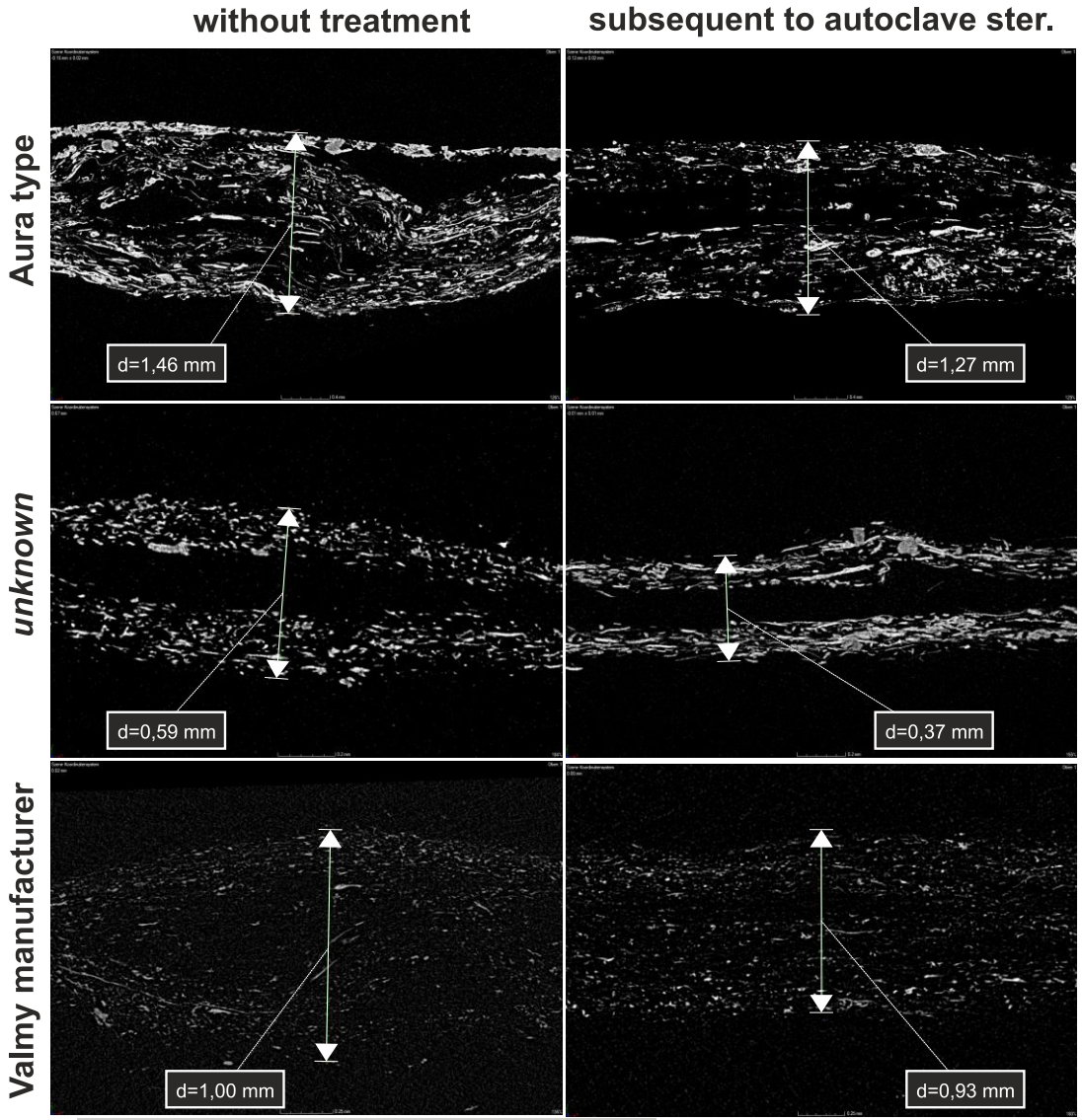
Results of the Filtration Efficency of Droplets



Results of mask types Valmy

- The filtration efficiency increases with increasing particle size
- During wet autoclaving, the filtration efficiency of this mask type decreases more compared to the other two mask type

Results of the Computer Tomography



Results of CT investigation

- no structural change of fibre (SEM)
- the thickness of the filter layer is reduced
- the thickness of the filter layer is reduced more after wet autoclave sterilization than after cold plasma sterilization
  - → Lower porosity
  - → Higher flow velocity
  - → Higher particle velocity

Summary and Prospects

Summary

- FFP2 masks differ in their filtration efficiency when new
- Cold plasma sterilization is more careful than wet autoclave sterilization
- The resistance of the masks to the sterilization process varies considerably
- The filtration efficiency increases with increasing particle size
- The measured subsides cannot be explained by the CT/SEM measurements

Prospects

- The material properties need further investigation (Charge, structure, ...)
- Further masks are to be examined (same type, other types)
- Further sterilization methods will be investigated

Questions and feedback

Thank you for your attention!