

Ultrafine Particle Concentrations Airside Center Zurich Airport



Contents

1.	Introduction and Aim of Study	3
2.	Study Setup	3
3.	Measurements and Results	6
4.	Conclusions	8

1. Introduction and Aim of Study

At an airport, local air quality is often an issue. Thus, airport operators strive to assess and understand local concentrations of air pollutants in an effort to mitigate them efficiently.

To this end, Zurich Airport has conducted a study, aiming at understanding the level of indoor air quality of a building exposed to aircraft activities and has specifically measured the concentration level of ultrafine particles in the Airside Center terminal during several days of operation. Of particular interest was to determine if the standard air filter systems are responsive to ultrafine particles.

The study does not claim to be complete in all details. It is based on a limited number of measuring sensors during a limited campaign duration.

2. Study Setup

The study setup is described in detail in table 1 and figures 1 and 2. Considering the known very high spatial and temporal variability in UFP concentrations, three devices were used simultaneously in various locations in the building, plus the reference station on the roof of Pier A (approx. 450m distance). The Airside Center building was chosen for its exposure to aircraft activities and the central use of passengers and staff.

Study Parameter	Explanation
Campaign date	8. May – 14. May 2019 (7 days)
Substances measured	Ultrafine particles: <ul style="list-style-type: none"> • Particle number • Average particle diameter • LDSA
Measurement Sensor	Partector 2 (by Naneos ¹): <ul style="list-style-type: none"> • Particle number range: 0 – 10⁶ /cm³ • Particle size range: 10 – 300 nm • Particle types: volatile and non-volatile • Measurement frequency: 1 scan/s
Number of devices used	3 (+1 reference station)

Table 1 Study Parameters

¹ www.naneos.ch



Figure 1 Situation of the Airside Center at Zurich Airport

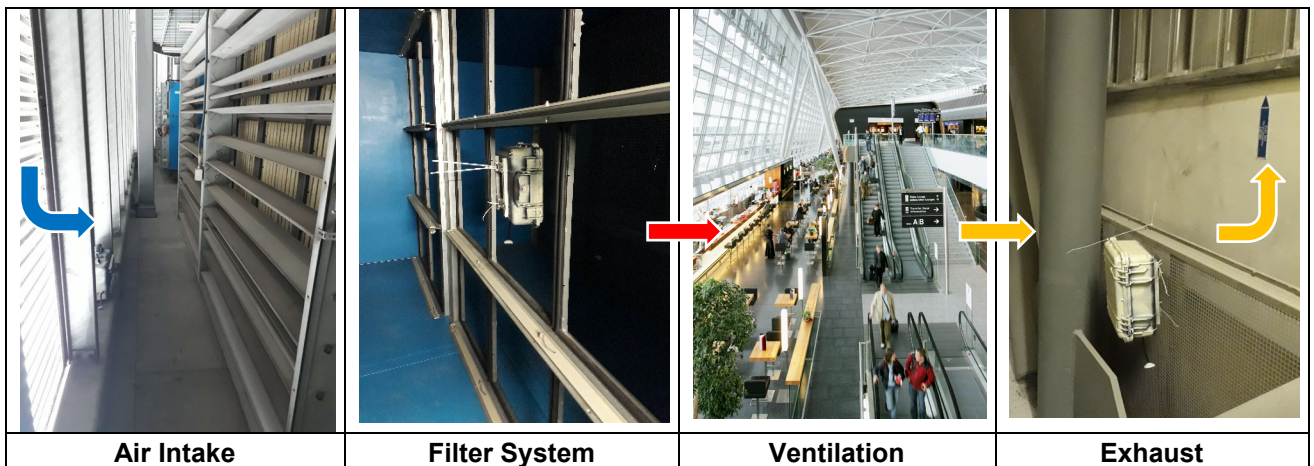


Figure 2 Detailed situation (3 monitoring sensors)

The measurements were carried out in the air supply unit "Airside Center South". Together with the unit "Airside Center North", which is identical, it supplies the Airside Center with outdoor air. Each system comprises three identical air handling units with a maximum flow rate of 33,000 m³/h each. The capacity per system is therefore around 100,000 m³/h. The entire building has a total flow rate of 200,000 m³/h. In normal operation, the systems run under partial load at around 65% of the maximum volume flow.

Each unit comprises several filter stages: Two with conventional bag filters made of glass fibres, which absorb particles and meet the ISOePM1 >50 requirement (Figure 3), and an air ionization system, which primarily eliminates odours (VACs). Heat recovery for heating and cooling is integrated. The bag filters are checked monthly for their function and are replaced annually. They meet energy efficiency class A+.



Figure 3 Glass-fibre bag filter element (symbolic picture. Source: Internet)

The reference station on roof Pier A is situated on the airport's air quality monitoring station and measures ambient conditions, in particular aircraft and aircraft handling activities on the apron.



Figure 4 Reference station roof Pier A in top of the Air Quality Station

3. Measurements and Results

The overall results are listed in table 2 for two specific operating regimes: First with the ventilation system turned on during time of occupation and activity (05:00-23:30) and second with the ventilation system turned off during night-time (00:00-04:30). For the purpose of the study, the time of interest is particularly when staff and passengers are circulating through the building (i.e. daytime).

The concentration at the air intake location is only about 50% of the concentration found at the reference station roof Pier A. The high spatial variability is particularly distinct and has been analyzed in a former study.² The air is then forced through the filter system before released into the Airside Center building. The filter system absorbs approximately 95% of all particles (volatiles and non-volatiles), releasing on average less than 5,000 particles/cm³ into the building.

The activities in the building, including several restaurants, increase the average particle number by approximately a factor of 2-3 to approximately 10,000 particles/cm³.

During night-time, low ambient concentrations can be found both at the reference station and the air intake location. As the ventilation is turned off, no air is forced into the building. On the contrary, there is some back flow from the building into the ventilation unit. Particle number concentrations increase due to the various night-time activities like cleaning and maintenance that exclude the presence of a large number of staff and passengers in the building.

The average particle diameters are generally low and are in the range of ambient conditions. The filtration process and indoor activities increase the diameter, but on average, the particles don't exceed 50 nm in size.

Station	With ventilation: 05:00 - 23:30		No ventilation: 00:00 - 04:30	
	Mean particle number [# /cm ³]	Mean particle diameter [nm]	Mean particle number [# /cm ³]	Mean particle diameter [nm]
Reference	156,400	11	9,500	29
Air Intake	76,000	14	6,600	36
Ventilation	4,200	33	9,700	26
Exhaust	10,600	29	15,100	46

Table 2 Mean particle numbers and weighted average diameters at all stations

Over the course of the day, there are significant variations and figure 5 shows the hourly mean concentrations on all four stations. The reverse situation of concentrations indoors being higher than outdoors becomes very visible.

² Flughafen Zürich AG (Fleuti, Maraini, Bieri; Fierz [FHNW]): Ultrafine Particle Measurements at Zurich Airport, 2017, www.zurich-airport.com

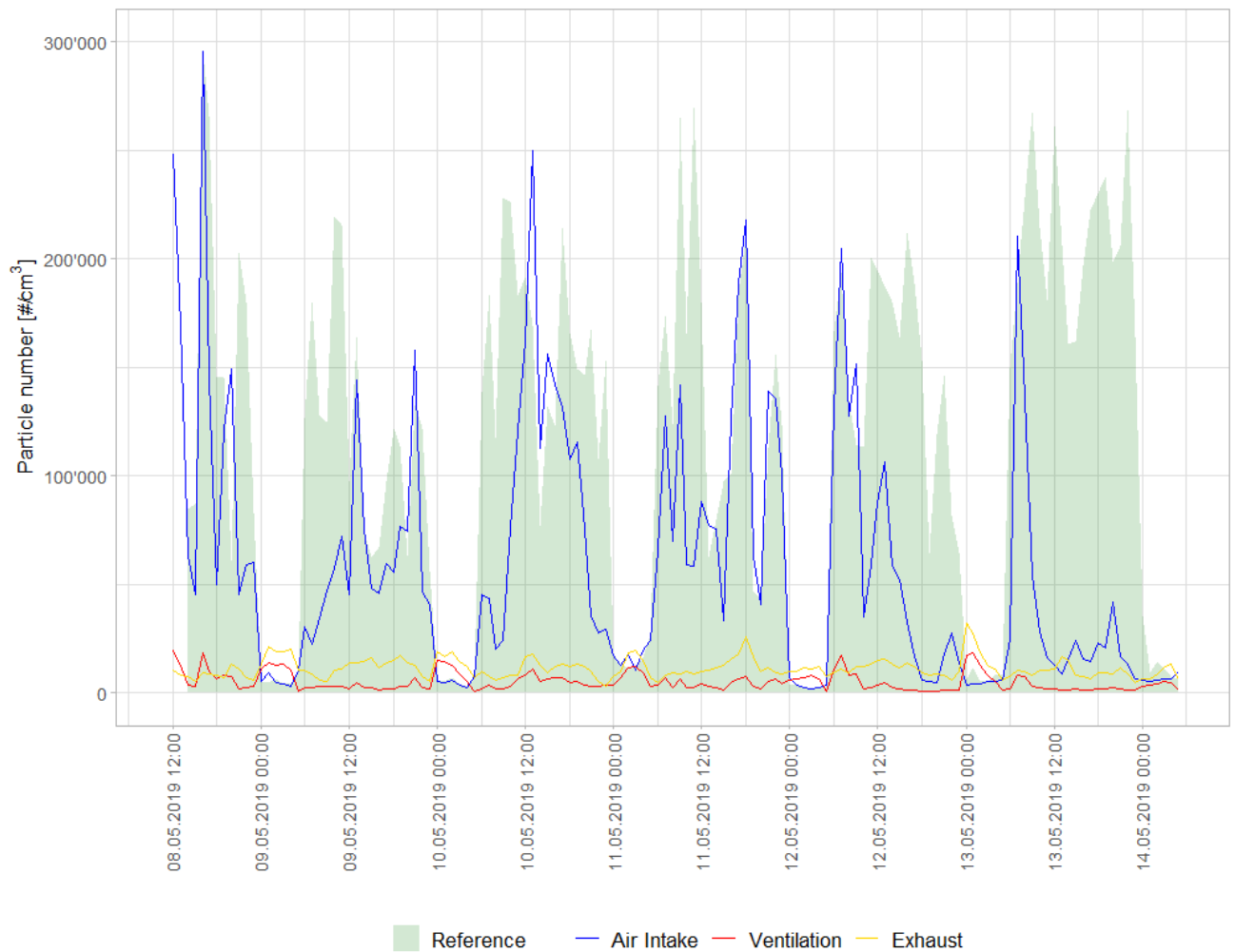


Figure 5 Hourly mean total particle number concentrations, all stations, full period

In order to gauge the level of indoor concentrations, a comparison between Zurich Airport Airside Center and other indoor premises has been done (figure 6)³.

³ ACI EUROPE: Ultrafine particles at airports. Brussels, 2018 and internet research.

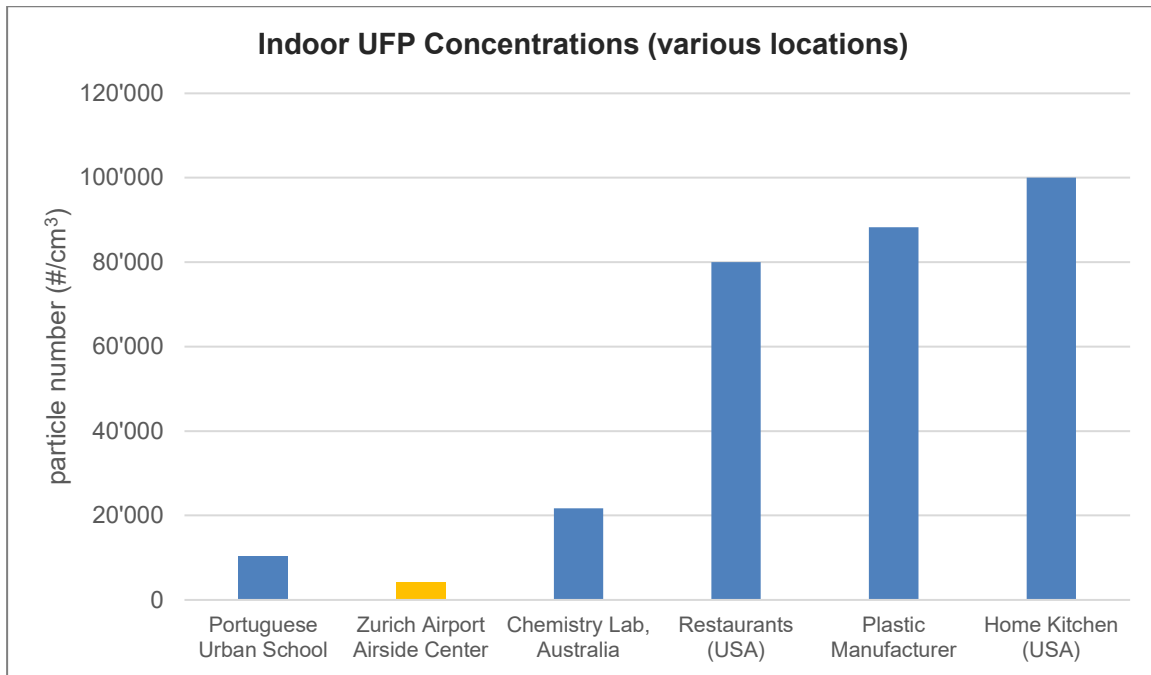


Figure 6 Indoor UFP concentrations at various locations (internet research)

4. Conclusions

The study results confirm again the distinct and high spatial variability of ultrafine particles present in the air. The high peaks disappear with increasing distance to the source and the overall concentrations are significantly lower at the intake location which is slightly shielded from the airfield activities.

The air filter unit is capable of removing more than 90% of the particles by number, irrespective of the diameter. This leads to an indoor air quality that is much better than the outside conditions.

Figures

Figure 1	Situation of the Airside Center at Zurich Airport	4
Figure 2	Detailed situation (3 monitoring sensors)	4
Figure 3	Glass-fibre bag filter element (symbolic picture. Source: Internet)	5
Figure 4	Reference station roof Pier A in top of the Air Quality Station	5
Figure 5	Hourly mean total particle number concentrations, all stations, full period	7
Figure 6	Indoor UFP concentrations at various locations (internet research)	8

Tables

Table 1	Study Parameters	3
Table 2	Mean particle numbers and weighted average diameters at all stations	6

Abbreviations

HVAC	Heating, ventilation, air-conditioning
LDSA	Lung-deposited surface area
nv	non-volatile
PN	particle numbers
UFP	Ultrafine particle
v	volatile

Version	Date	Name	Modifications
2.0	02.12.2019	Fleuti	

Authors: Emanuel Fleuti / Christian Ruf / Silvio Maraini
Division/Unit: Legal&Environment