

The highway as source of ultra-fine particles in ambient air of the City of Bolzano

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The air quality and in particular the presence of fine particulate is a topic that in recent years has assumed more and more public importance. Concerns about possible health effects related to the presence of pollutants like fine dust (PM 10 and PM 2,5) and NO_x are widely discussed. Since a few years also the presence of ultra-fine particles is under investigation of the scientific community. The presence in ambient air of anthropogenic derived ultra-fine particles, the so called “nano-particles” is considered a potential threat to human health.

The comprehensive register of emissions prepared by the province of Bolzano in 2004 identifies vehicular traffic as one of the main sources of pollution in the ambient air of the same province. The contribution of vehicular traffic for the city of Bolzano is even higher as a highway passes through its territory and the shuttle traffic of thousands of cars. The aim of this study was to investigate the relative contribution of the highway concerning ultra-fine particles in ambient air of the city of Bolzano.

We made ambient air measurements in different parts of the basin of the Bolzano city. Sampling sites, with different urban character were chosen in order to assess the possible contribution of predominant sources. One sampling site was close to the highway exit in Bolzano Sud. Other sites were in a small industrialized area and Bolzano downtown. Several samples were taken with increasing distance from the highway.

For the measurements we utilized scanning mobility particle sizers (SMPS) able to characterize the concentration of particles of different sizes from 10 to approximately 250 nm. The long term measurement results on one hand show significant correspondence of pollution related to the distance from the highway, with high concentrations found in proximity to the highway. Short term measurements on the other hand seem to be influenced by wind presence and wind direction and the results could not be correlated to the distance from the highway.

Results:

To evaluate the results of the short term measurements we compared them with the results obtained in the reference sites. The first reference site was close to the highway, on the stack of the incineration plant at 40 m above the ground level, facing the highway. The second reference site was located in the industrial zone of Bolzano. During the measurements we had some breeze. The short term measurements showed higher particle concentration in the down-wind measurement sites. Up-wind, even at a distance of a few meters, we registered considerably lower values. Up-wind at a distance of 250 m from the highway no direct influence of the highway on the ambient air levels were observed.

Also the measurements made at 40 m above the ground level at the stack showed differences of approx. 35% to the measurements made in the same place but at ground level.

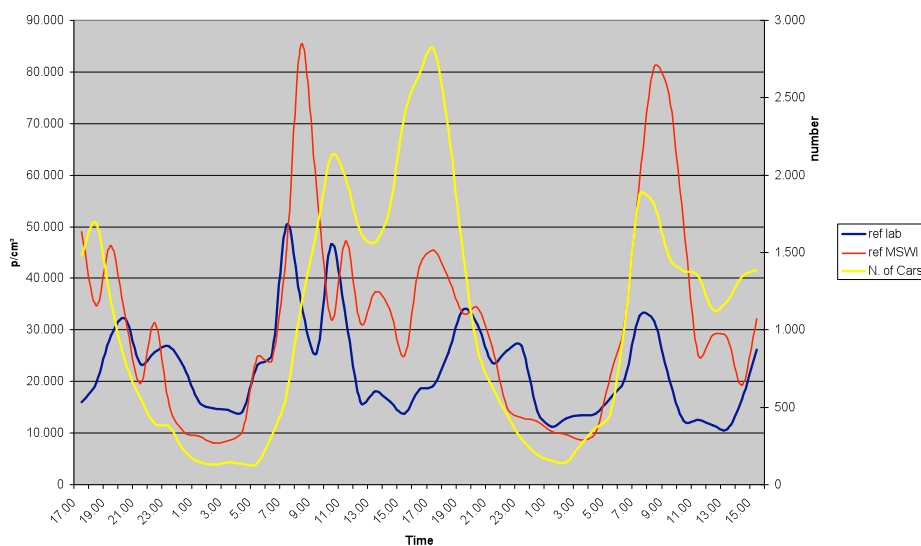
The measurement results are resumed in the following table.

Place	Time	CPC PD	Ref MSW	Ref Lab	Dist
Salewa	11.00-11.32	22.881,00	36.000,00	15.000,00	65 m
Behind salewa	11.51-12.07	14.700,00	32.000,00	17.000,00	270 m
Country	12.27-12.41	23.306,00	32.021,00	13.000,00	220 m
Highway	13.10-13.18	43.000,00	31.200,00	16.300,00	25 m

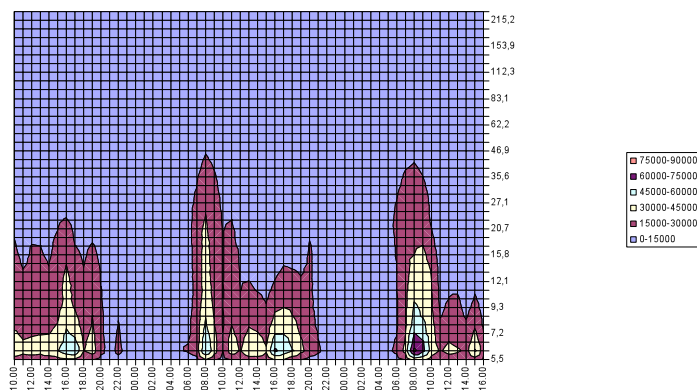
Measurement results based on a project covering several days.

The reference sites are close to the highway (incineration plant) and the industrial area of Bolzano. At both sites we registered the highest particle concentration during the rush hours. Close to the highway we have higher values of 35.000 p/cm³ compared to 22.000 p/cm³ in the industrial area. Close to the highway we observed also a relatively higher amount of nanoparticles with smaller diameters compared to the pattern we found in the industrial area of Bolzano.

The graph below resumes the time trend of the particle concentration of both reference sites and the relative traffic intensity.



In the next graph, we see the time trend and the particle distribution close to the highway



Conclusion:

The highway was found to be a major source of pollution for the city of Bolzano but with an influence which is diffuse and nearly constant, starting at a short distance of approx. 250m from the highway. Only in direct proximity of the highway, the concentrations measured were traffic dependent and generally more than an order of magnitude higher.

Close to the highway we observed a relatively higher amount of nanoparticles with smaller diameters compared to the pattern we found in the productive area.



The highway as a source of ultra-fine particles in the ambient air of the city of Bolzano

Zürich 24.6.2012

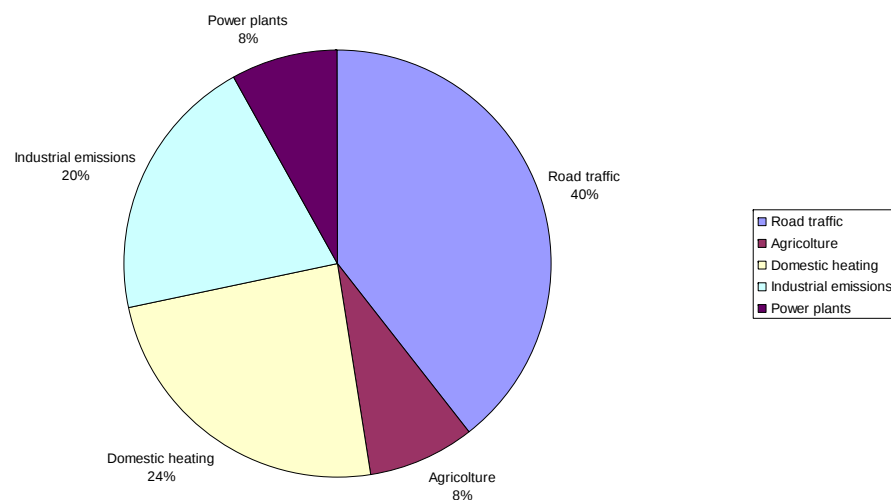
Dott. Giulio Angelucci

Dr. Werner Tirler

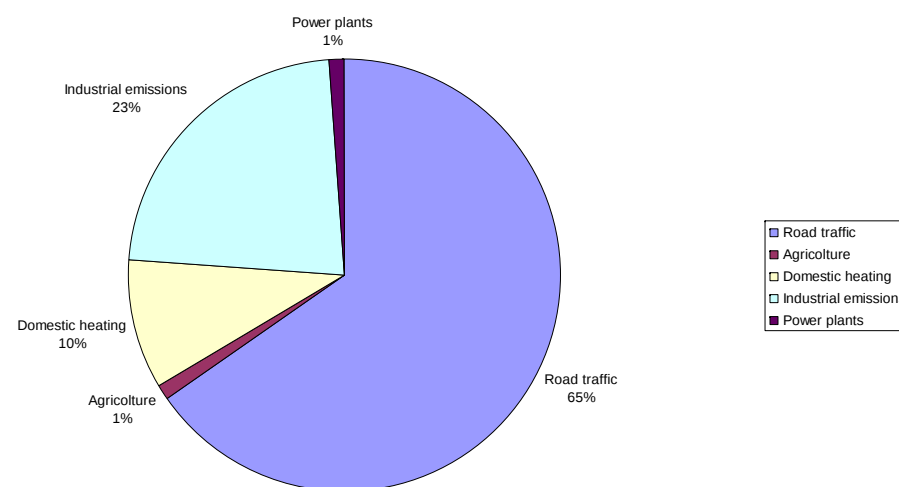


The PM 10 emissions archive of the Province of Bolzano

Province of Bolzano

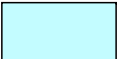


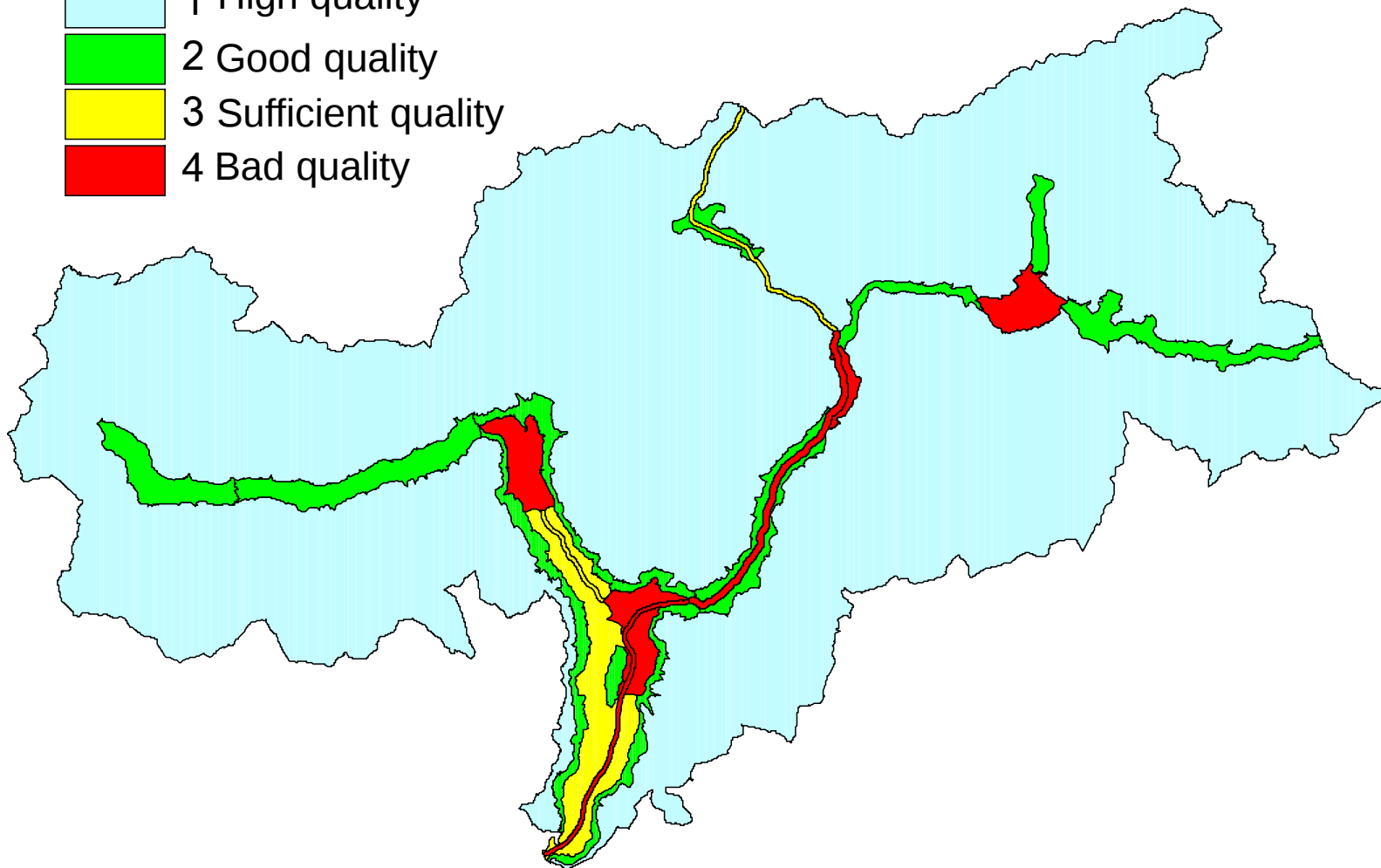
Town of Bolzano



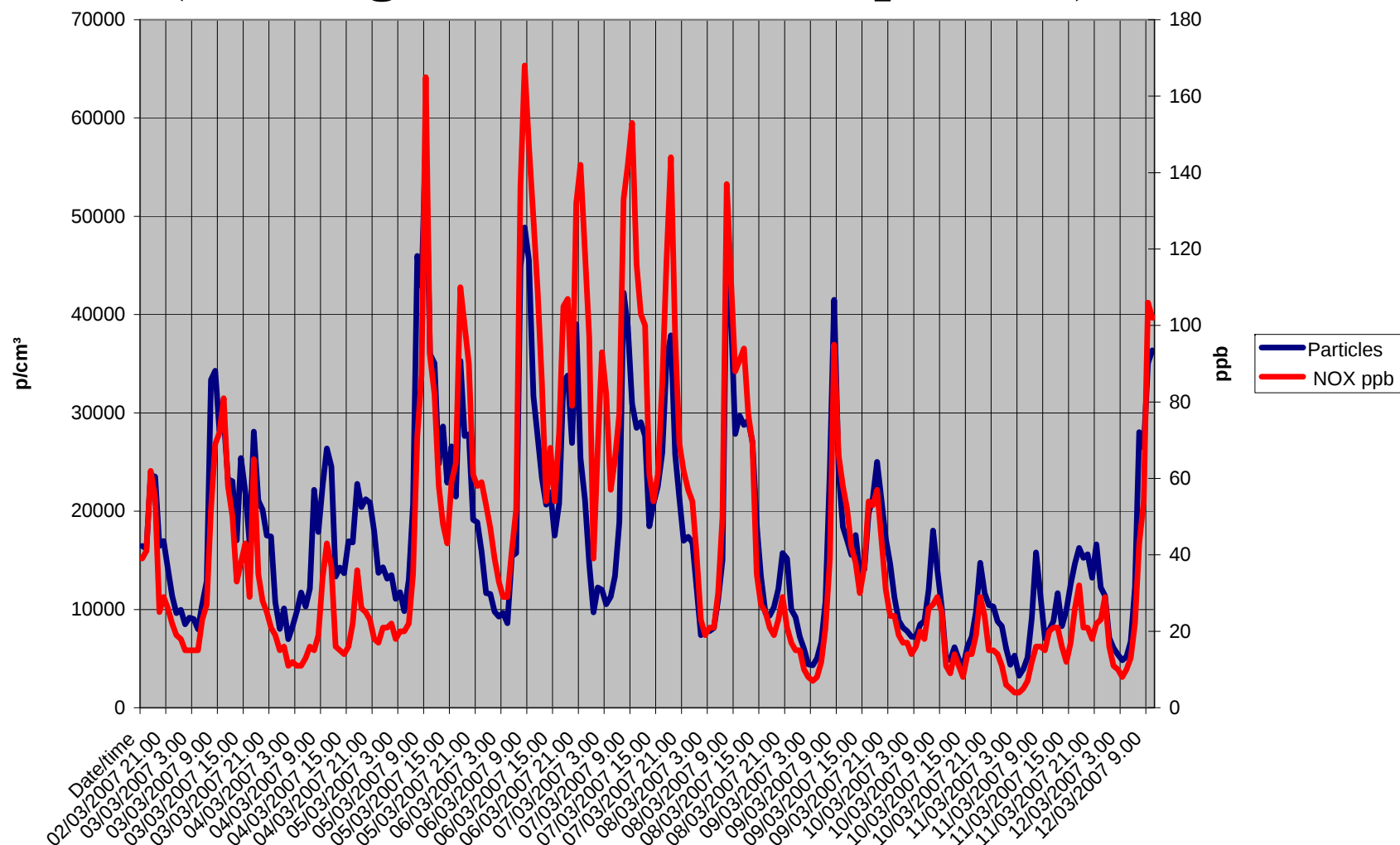
PM 2.5 (ug/m³) values

Tipo aria / Lufttyp zone classification

-  1 High quality
-  2 Good quality
-  3 Sufficient quality
-  4 Bad quality



Time trend for ultra-fine particles and NO_x in the ambient air of Bolzano (average value 16.900 p/cm³)



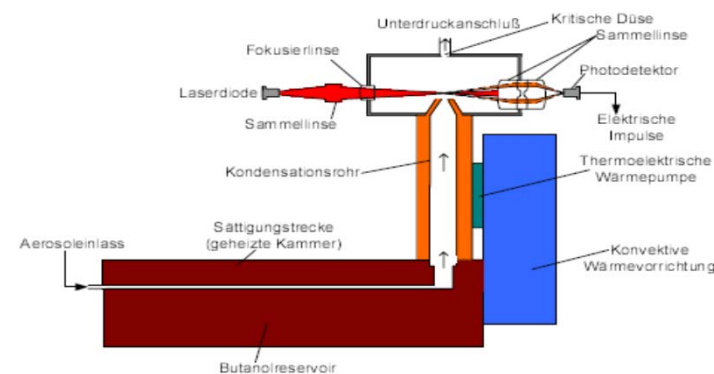
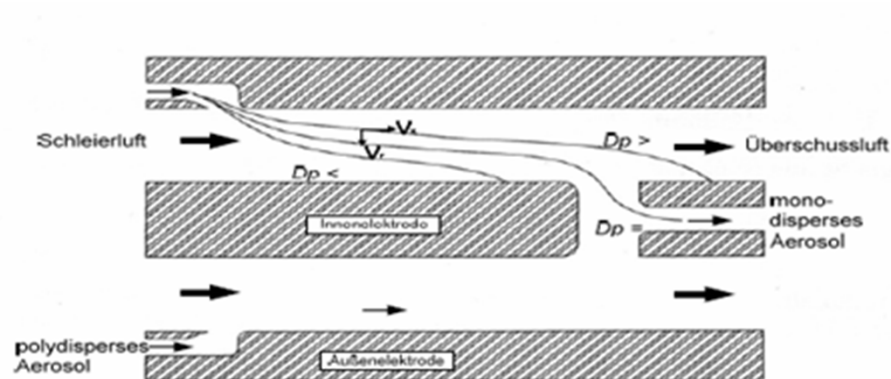
The monitoring program

- Measurements of several days were performed in two reference sites:
- One site was very close to the highway (on the stack of the incineration plant facing the highway)
- The second site was in the industrial area of Bolzano (at the Eco-Research lab)
- In parallel short time measurements at different distances from the highway were also performed



Determination of fine particle and UFPs.

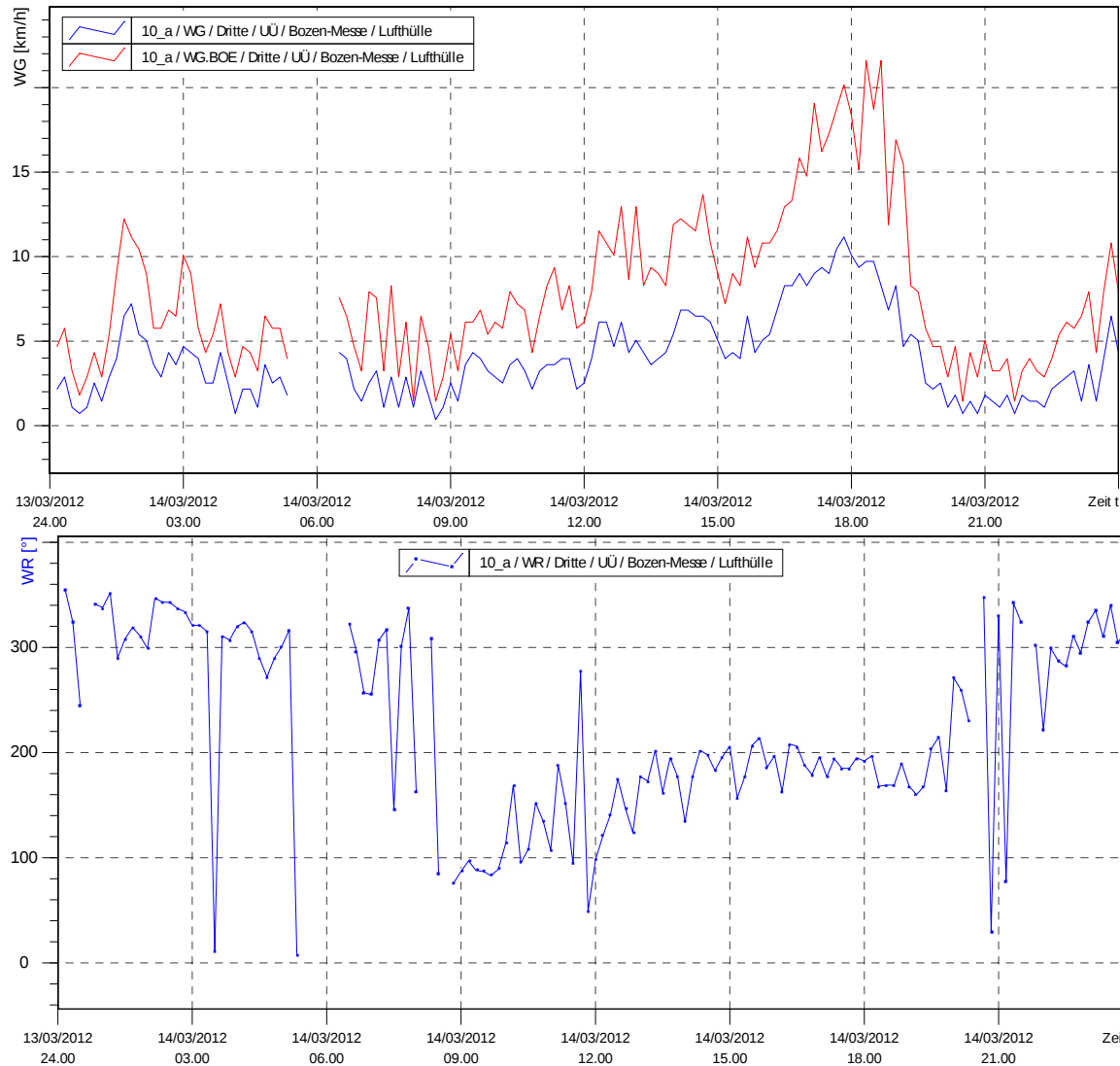
The detection of UFPs particles was done using a condensation particle counter, coupled with a Vienna-type Differential Mobility Analyser operating within a range from 5 and 250 nm.



Short time measurements



Wind speed and wind direction



AUTONOME PROVINZ BOZEN - SÜDTIROL

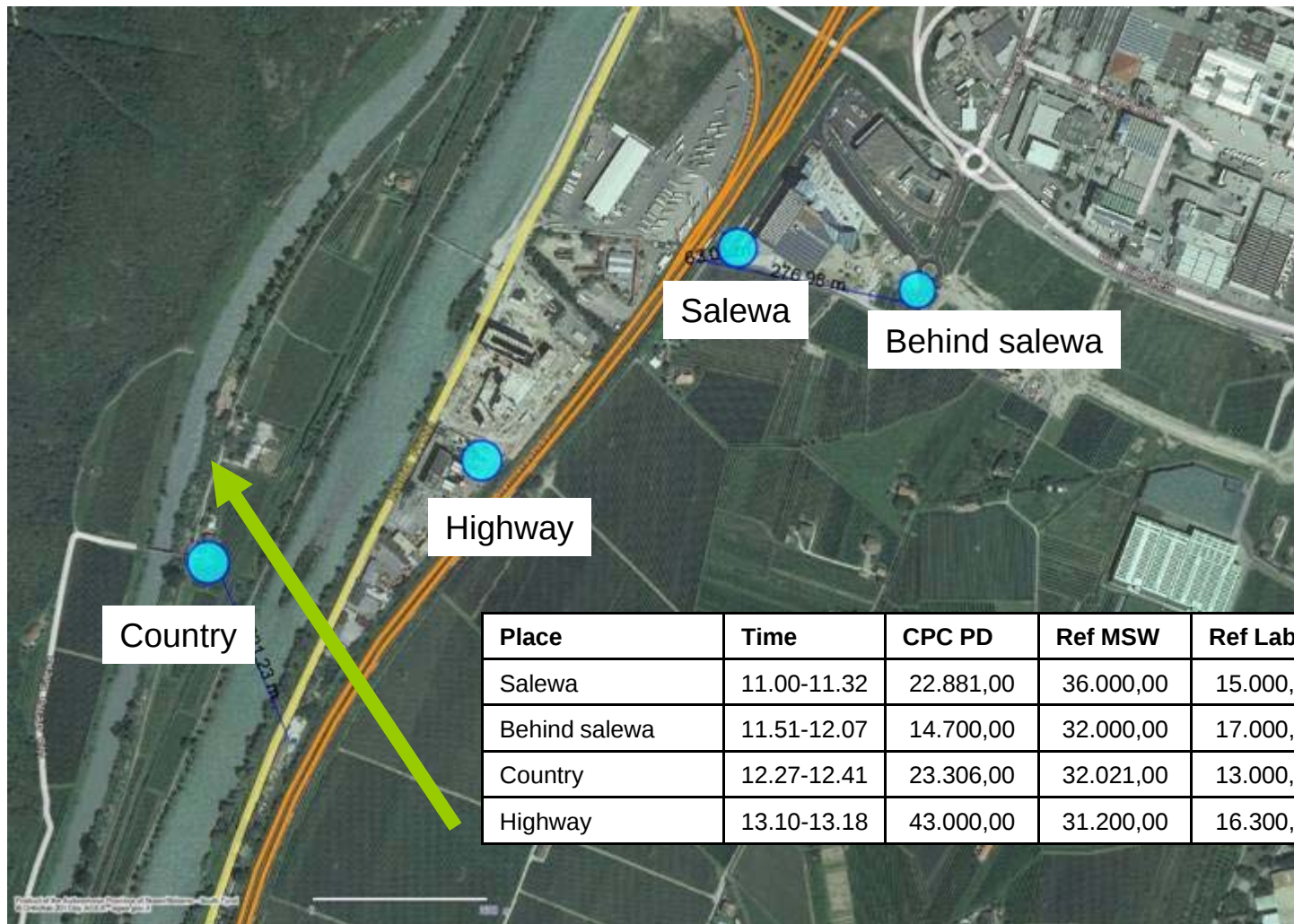
Dott. Giulio Angelucci



PROVINCIA AUTONOMA DI BOLZANO - ALTO ADIGE

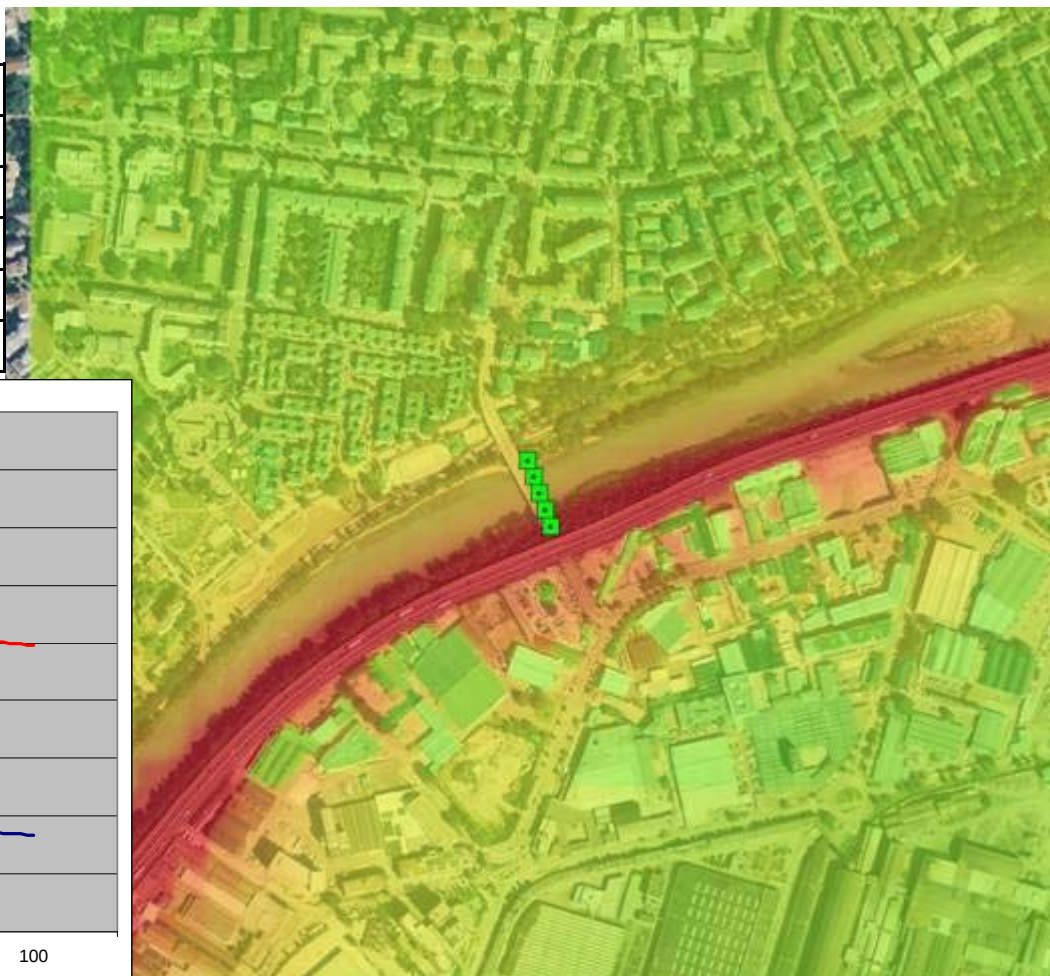
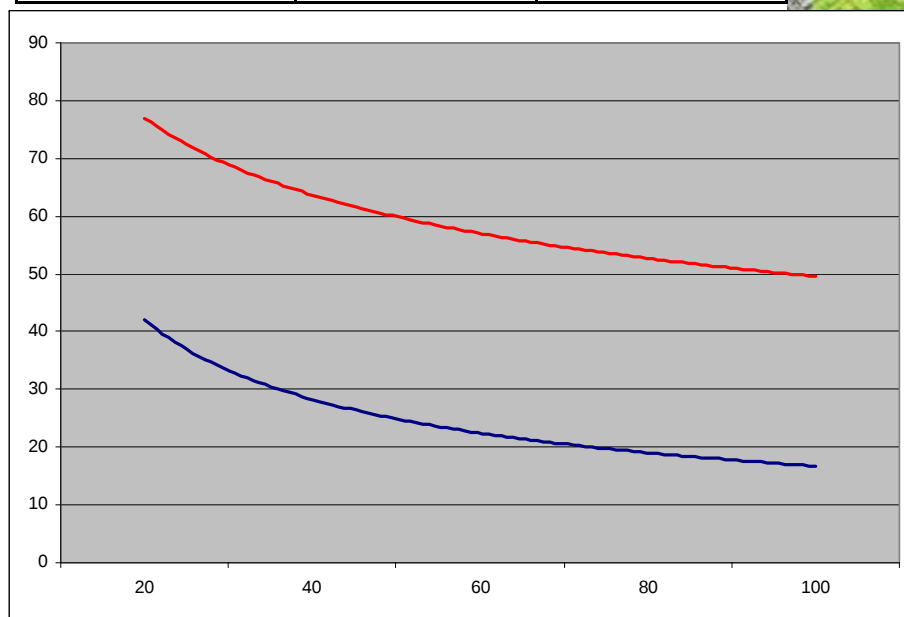
Dott. Giulio Angelucci

Results

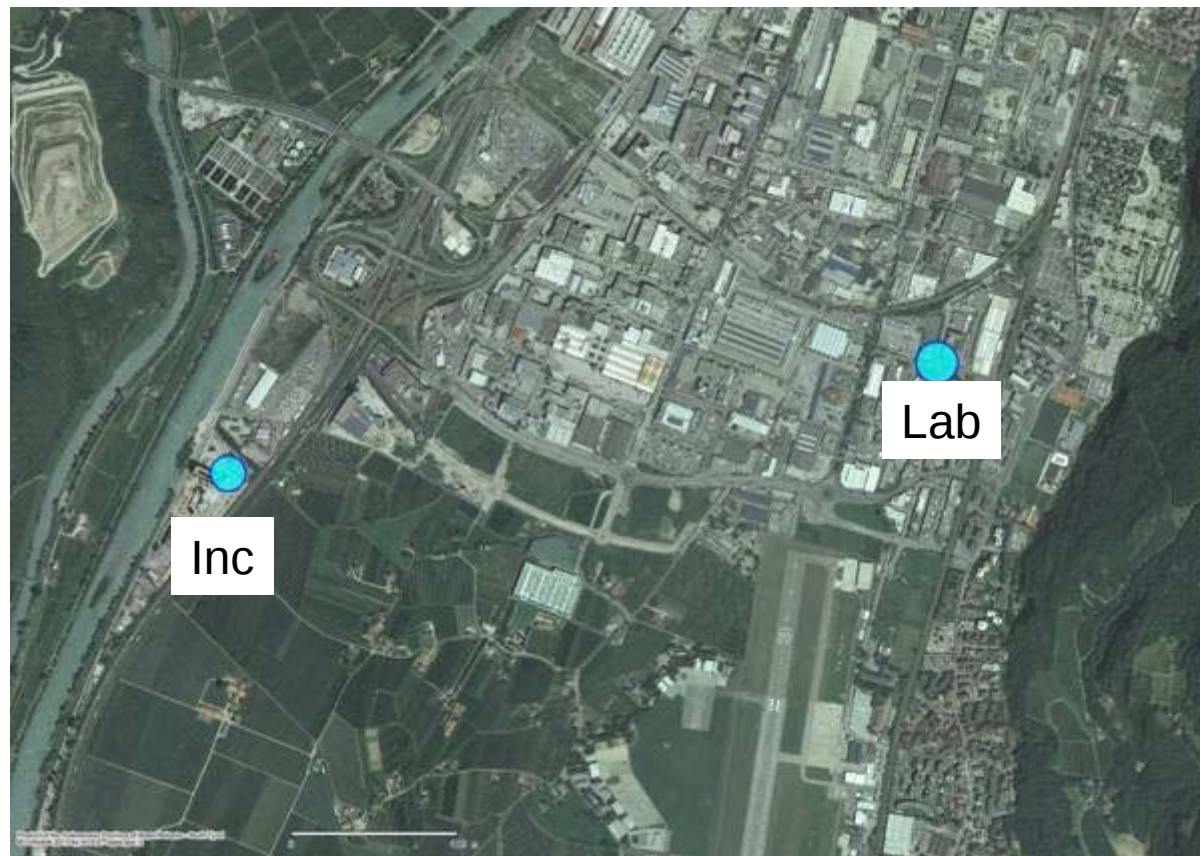


High way and NOx levels

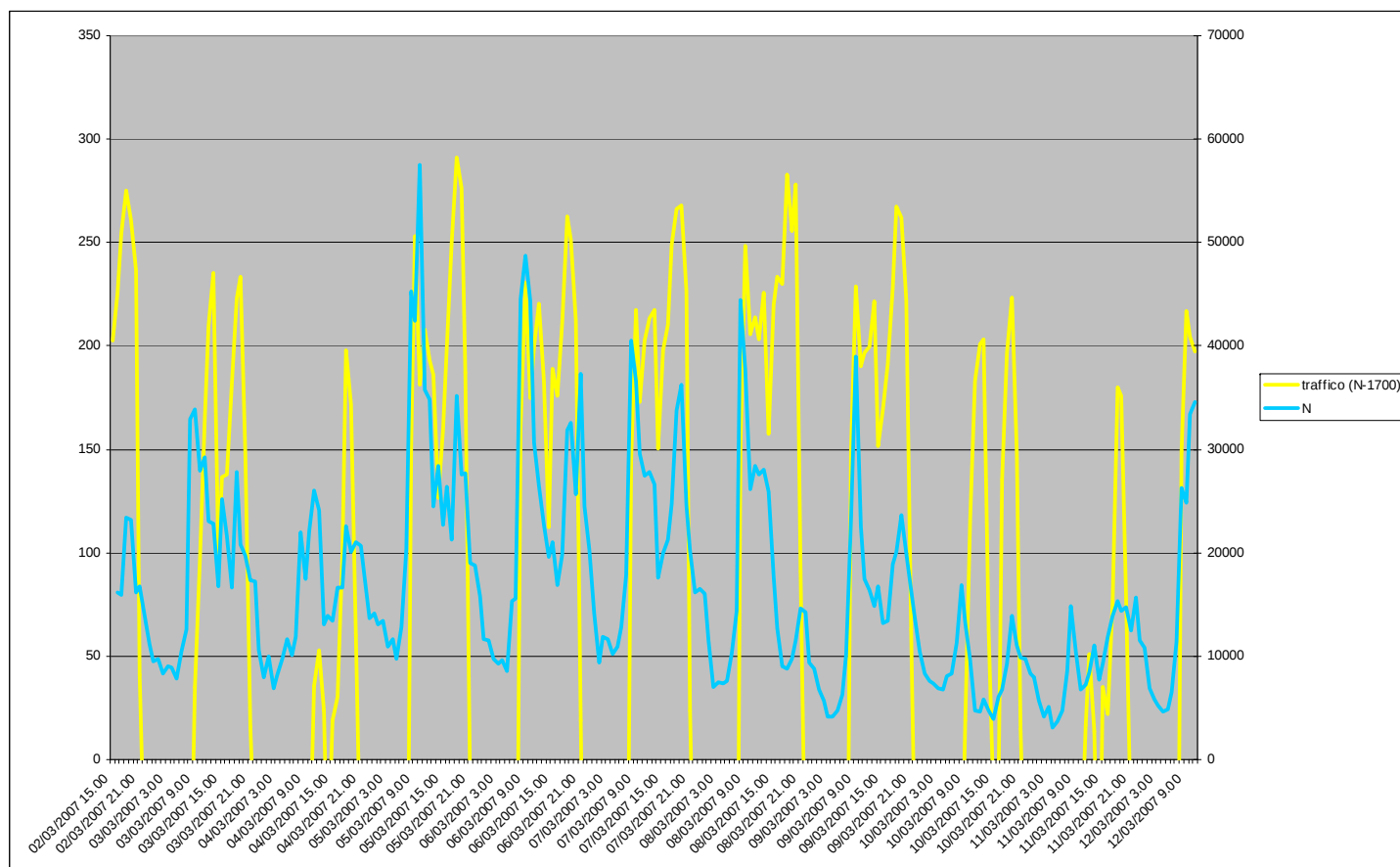
Distance to the A22	2009 tot [$\mu\text{g}/\text{m}^3$]	solo A22 [$\mu\text{g}/\text{m}^3$]
20	78,7	43,8
40	61,2	26,3
60	57,3	22,4
80	52,4	19,1
100	50,5	17,3



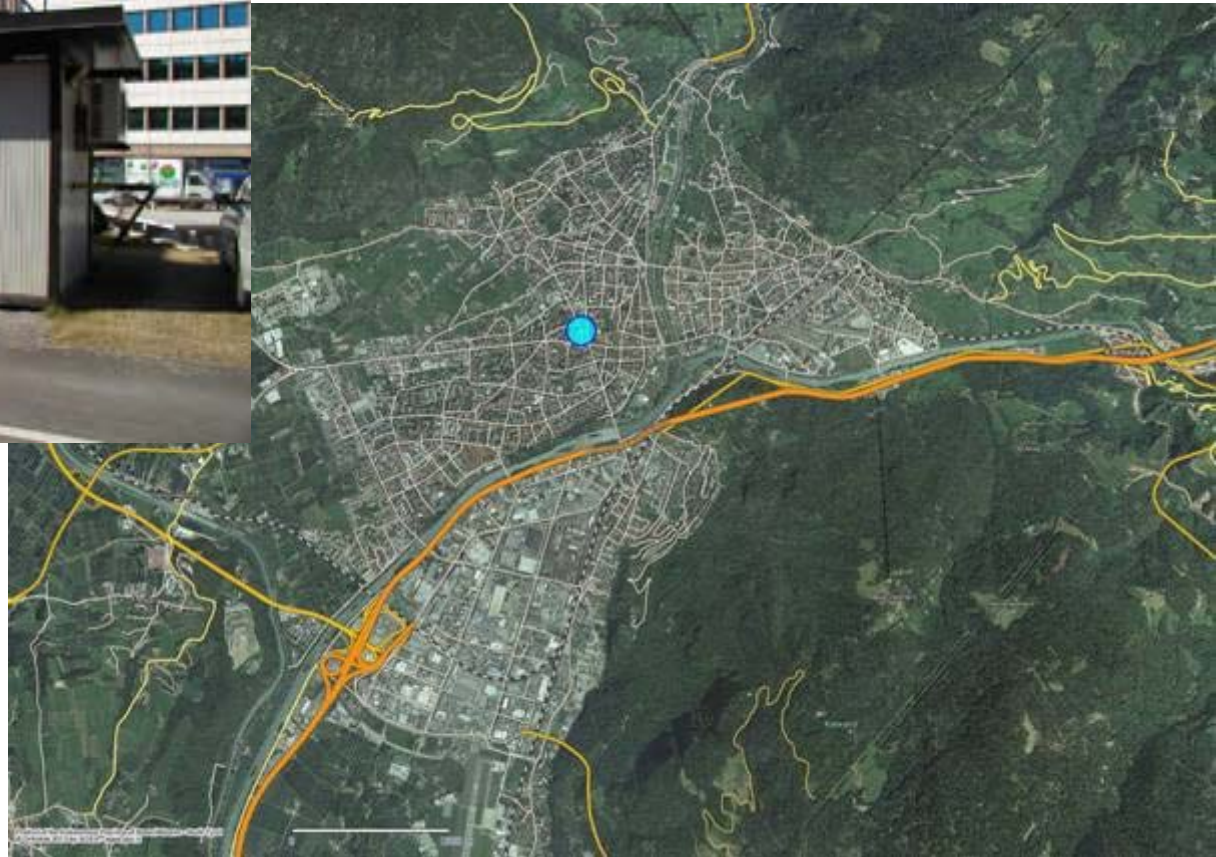
Measurements at reference sites



Relationship between traffic and UFP 2007



The air quality station in Bolzano



AUTONOME PROVINZ BOZEN - SÜDTIROL

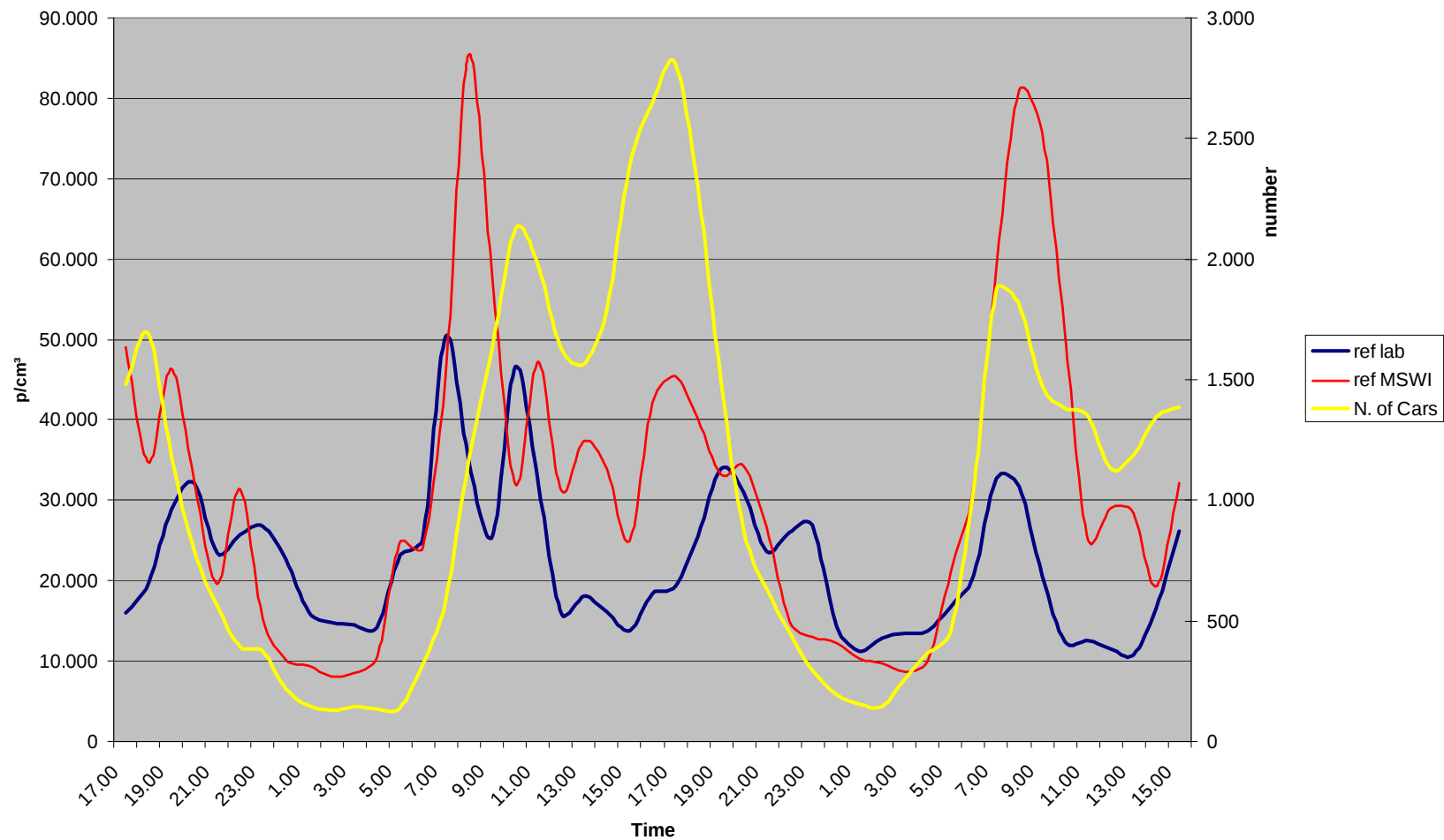
Dott. Giulio Angelucci



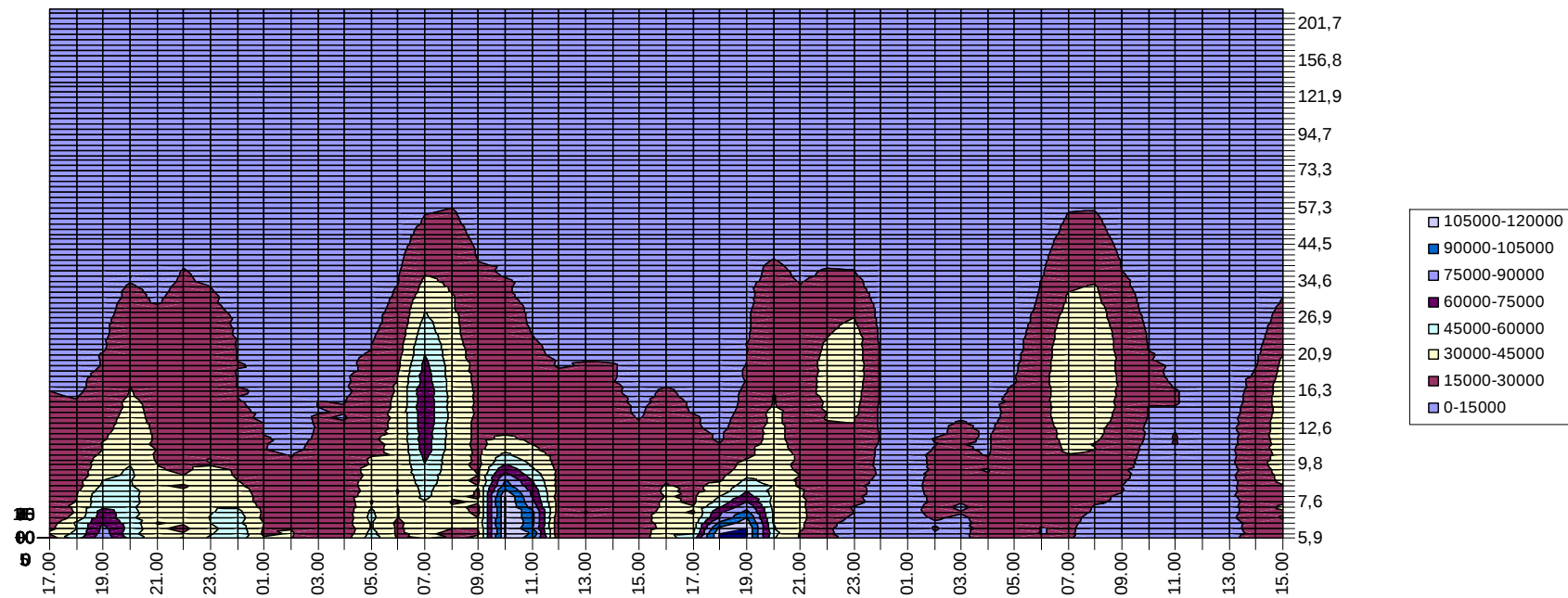
PROVINCIA AUTONOMA DI BOLZANO - ALTO ADIGE

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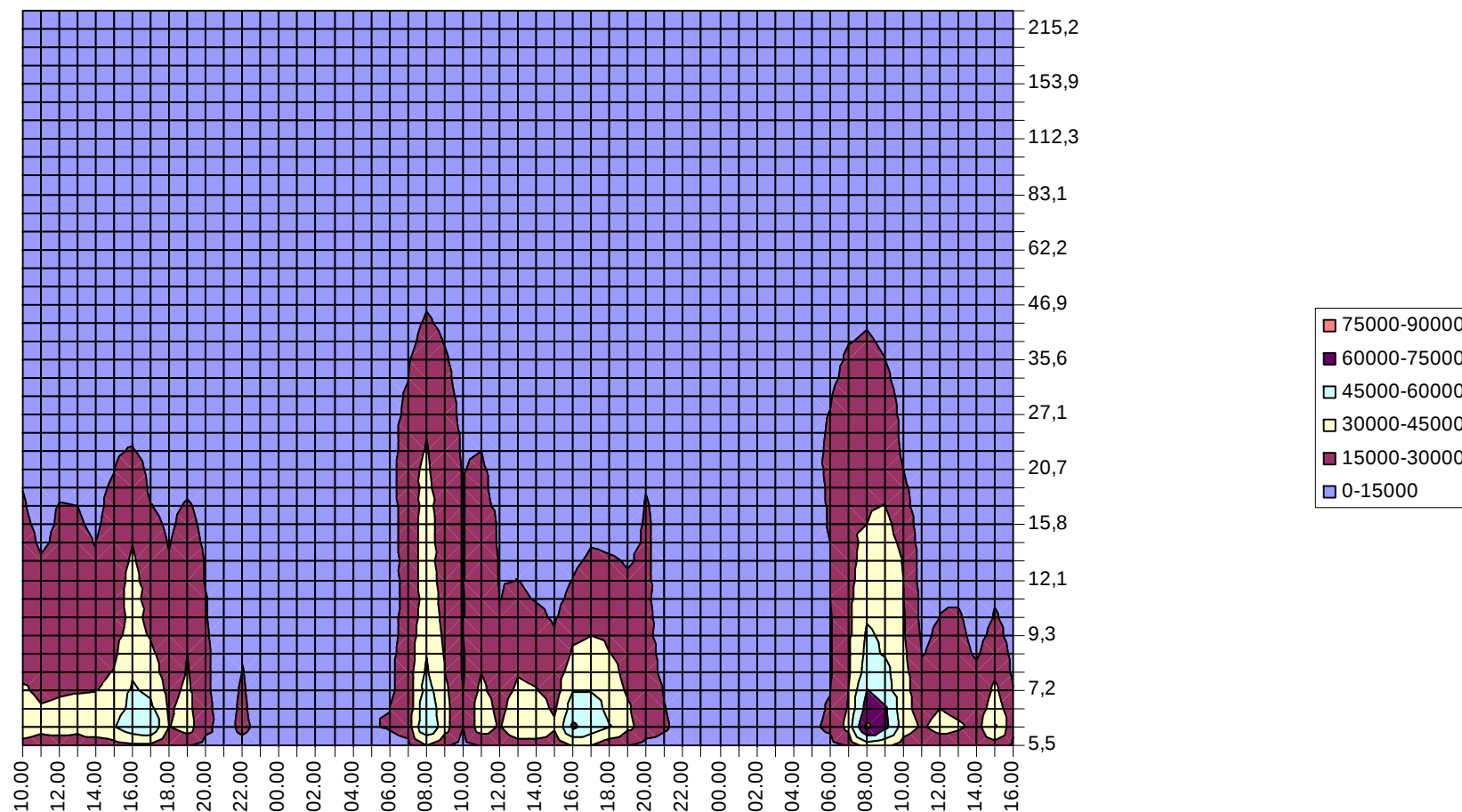
Number of UFP



Distribution of ambient UFPs in the Lab site



Distribution of ambient UFPs close to the highway



Conclusion

- The highway is a very important source of ambient air nanoparticles .
- The levels decline rapidly within a short distance to the highway
- Close to the highway, we observed a relatively higher amount of nanoparticles with smaller diameters compared to the pattern we found in the industrial area



Thank you for your attention

