Convegno

DALL'INQUINAMENTO URBANO AI CLIMI TERAPEUTICI DEI PICCOLO BORGHI

Poli, 30 novembre 2019

RICERCHE COMPARATIVE CHIMICO AMBIENTALI TRA ROMA E AREE DELL'APPENNINO CENTRALE. ANALISI E CONSIDERAZIONI SUL POTENZIALE CLIMATICO TERAPEUTICO DELL'APPENNINO.

PASQUALE AVINO E MARIO V. RUSSO

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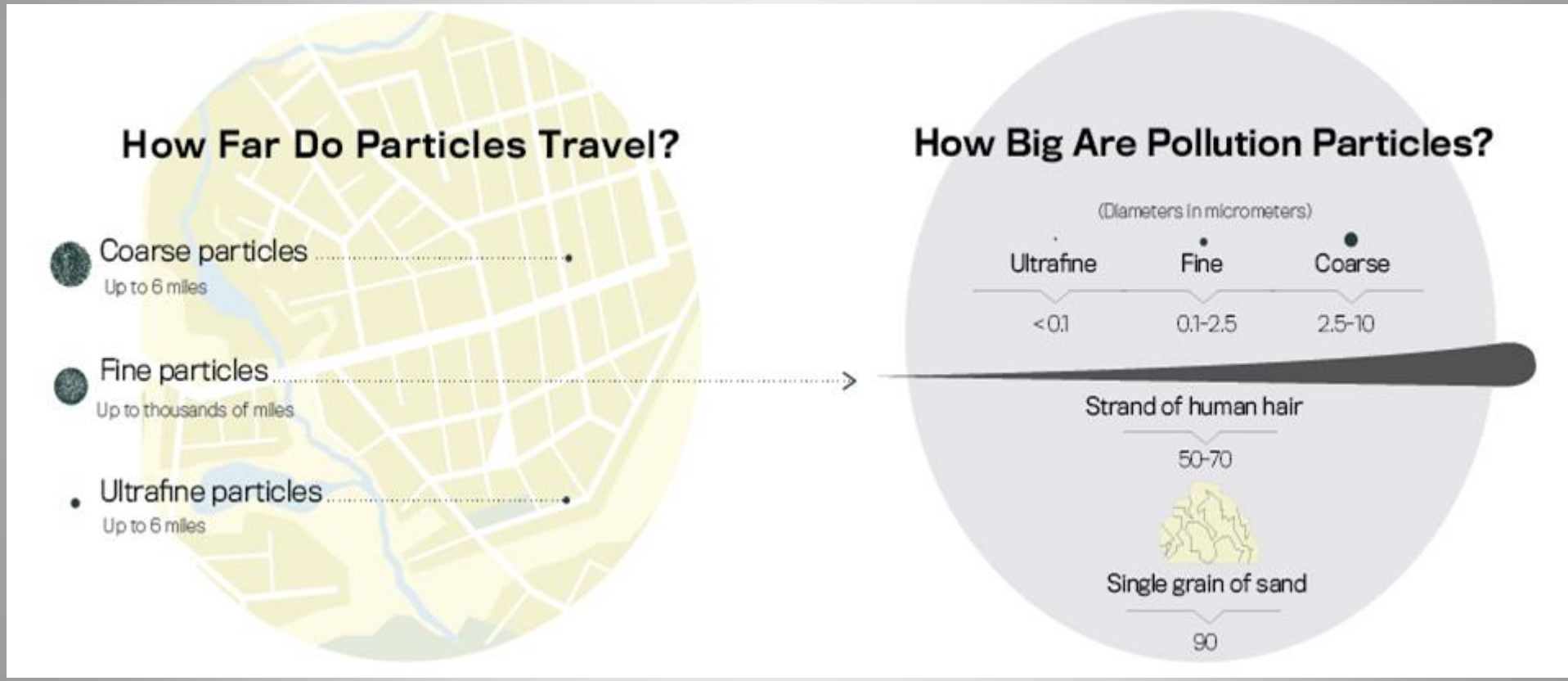
PM10 **PM2.5** **PM1**

Dimensioni


How Far Do Particles Travel?
Coarse particles
Up to 6 miles
Fine particles
Up to thousands of miles
Ultrafine particles
Up to 6 miles
How Big Are Pollution Particles?
(Diameters in micrometers)
Ultrafine
Fine
Coarse
<0.1
0.1-2.5
2.5-10
Strand of human hair
50-70
Single grain of sand
90

9,0 - 10,0 µm

490.600
Le morti premature nell'Ue causate dall'inquinamento atmosferico

72.39
da bio
di azo

402.6
da par
sottile

LE VITTI

21.600
da biossi
di azoto

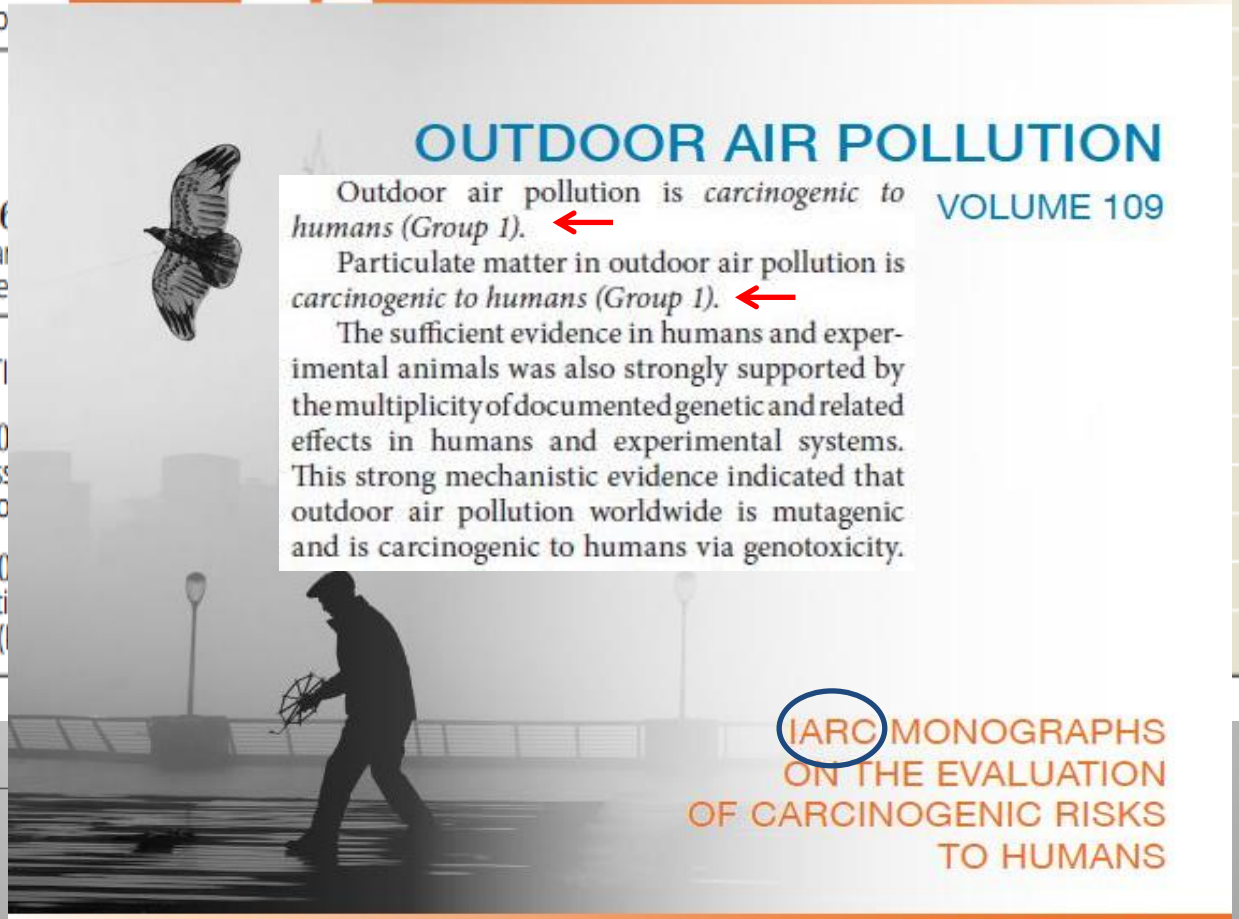
59.500
da parti
sottile (

Fonte: Agenzia europea dell'ambiente

Alveoli
0,65 - 1,1 µm
0,43 - 0,65 µm

6.190
6.010
4.820
3.870
3.060
2.380
1.960
1.950
1.830
1.230
830
650
320
220

IARC MONOGRAPHS



OUTDOOR AIR POLLUTION

VOLUME 109

Outdoor air pollution is *carcinogenic to humans (Group 1).*

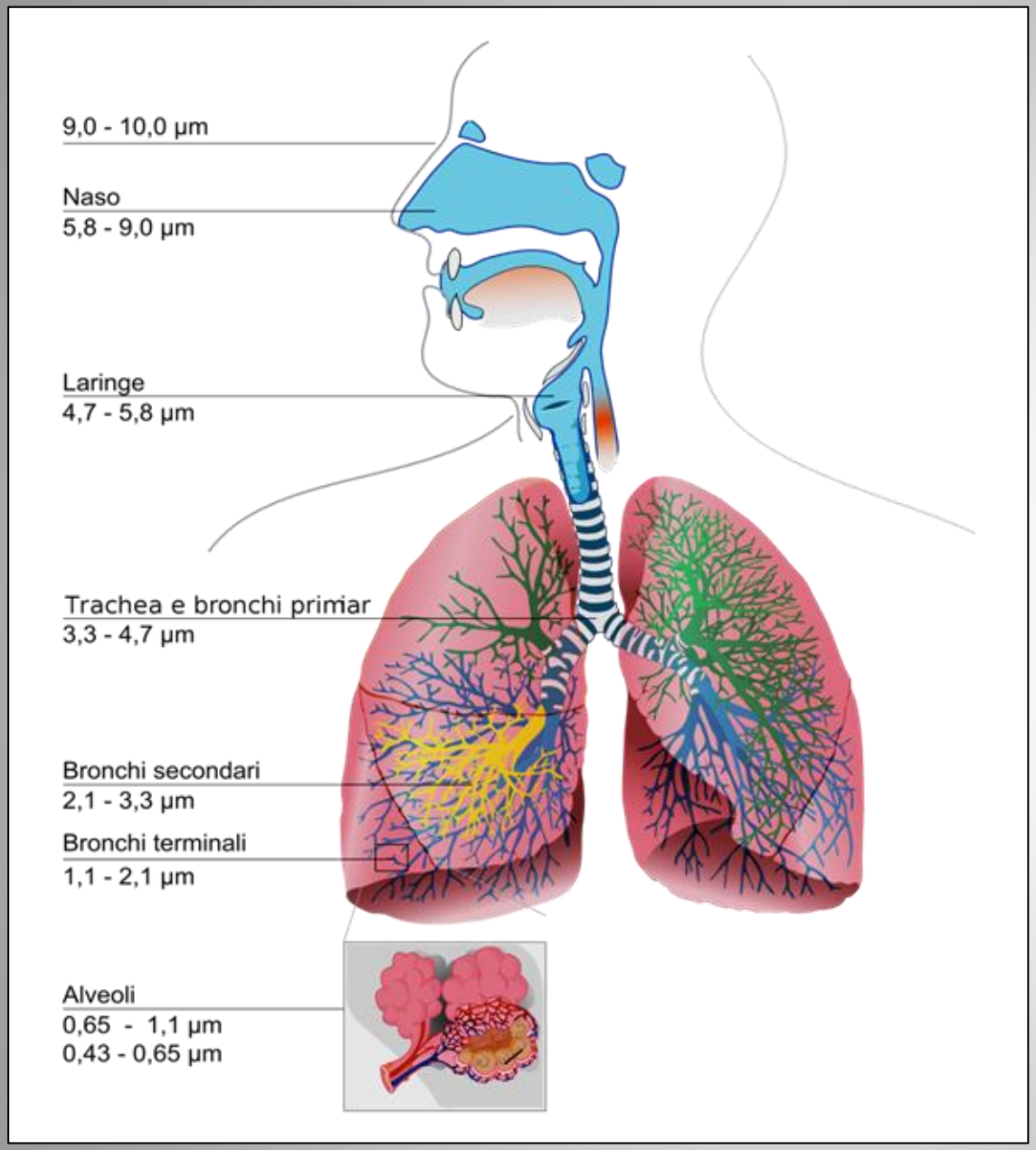
Particulate matter in outdoor air pollution is *carcinogenic to humans (Group 1).*

The sufficient evidence in humans and experimental animals was also strongly supported by the multiplicity of documented genetic and related effects in humans and experimental systems. This strong mechanistic evidence indicated that outdoor air pollution worldwide is mutagenic and is carcinogenic to humans via genotoxicity.

IARC MONOGRAPHS
ON THE EVALUATION
OF CARCINOGENIC RISKS
TO HUMANS

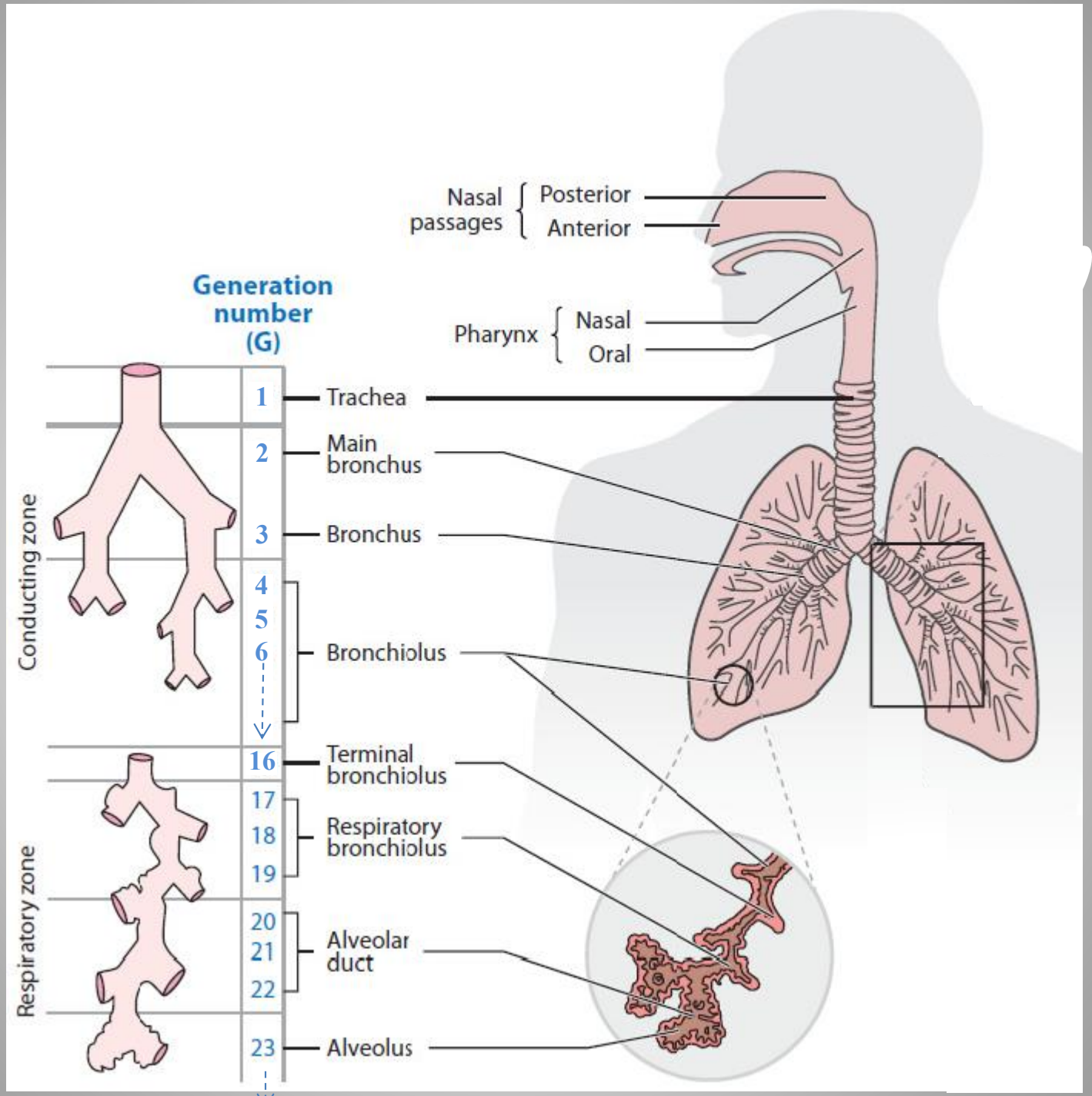
International Agency for Research on Cancer
World Health Organization

Multiple-Path Particle Dosimetry Model (MPPD)



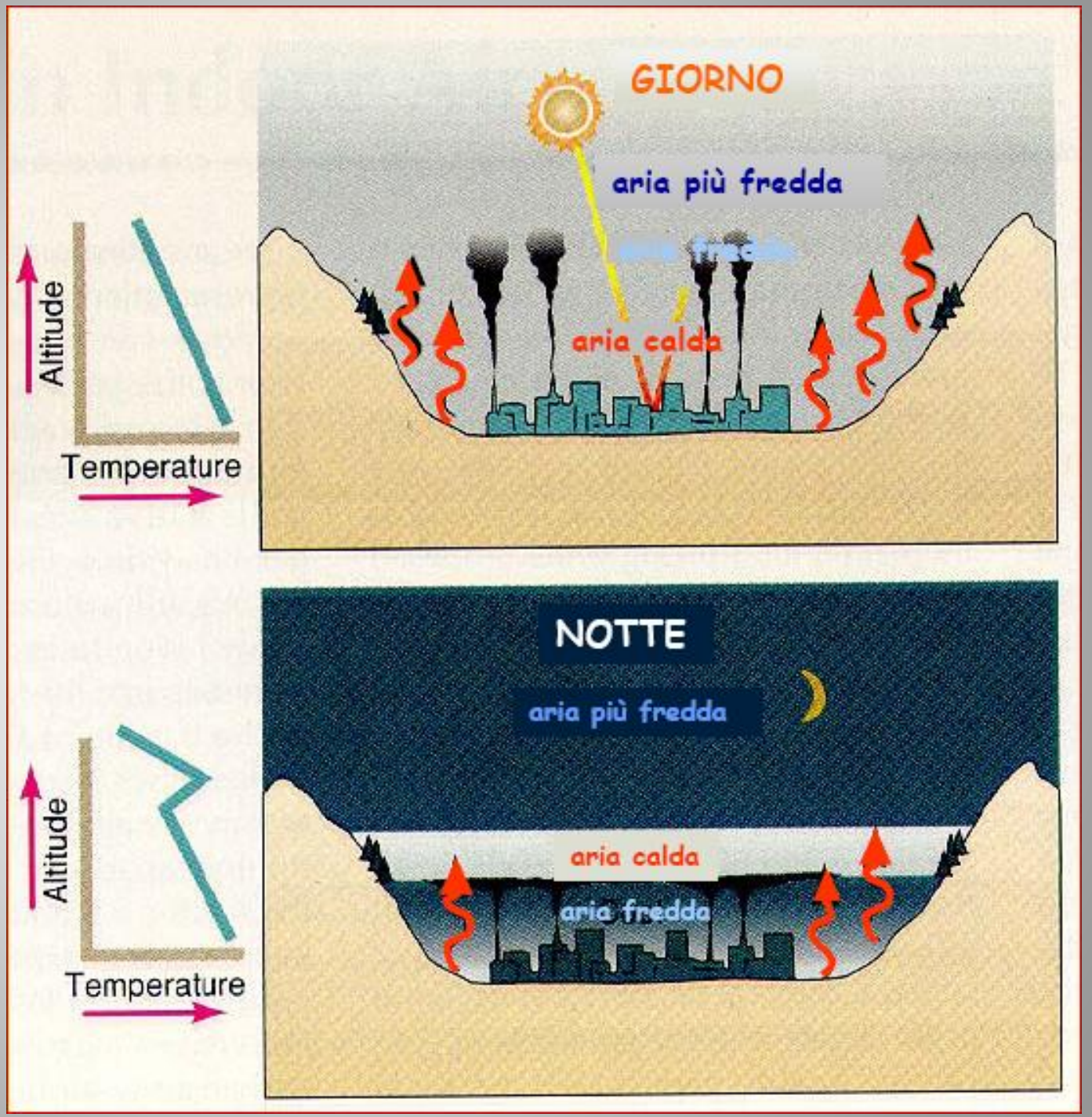
Applicando la Normativa Europea EN 481/94 e recepita con D.Lgs. 25 del Febbraio 2002 si ha la rappresentazione grafica delle tre frazioni Inalabile, Toracica e Respirabile.

Dosi depositate nell’apparato respiratorio


Nasal passages
Posterior
Anterior
Pharynx
Nasal
Oral
Generation number (G)
Conducting zone
Respiratory zone
1
Trachea
2
Main bronchus
3
Bronchus
4
5
6
Bronchiolus
16
Terminal bronchiolus
17
18
19
Respiratory bronchiolus
20
21
22
Alveolar duct
23
Alveolus

Altezza dello strato di rimescolamento

Volume disponibile per la diluizione delle specie inquinanti

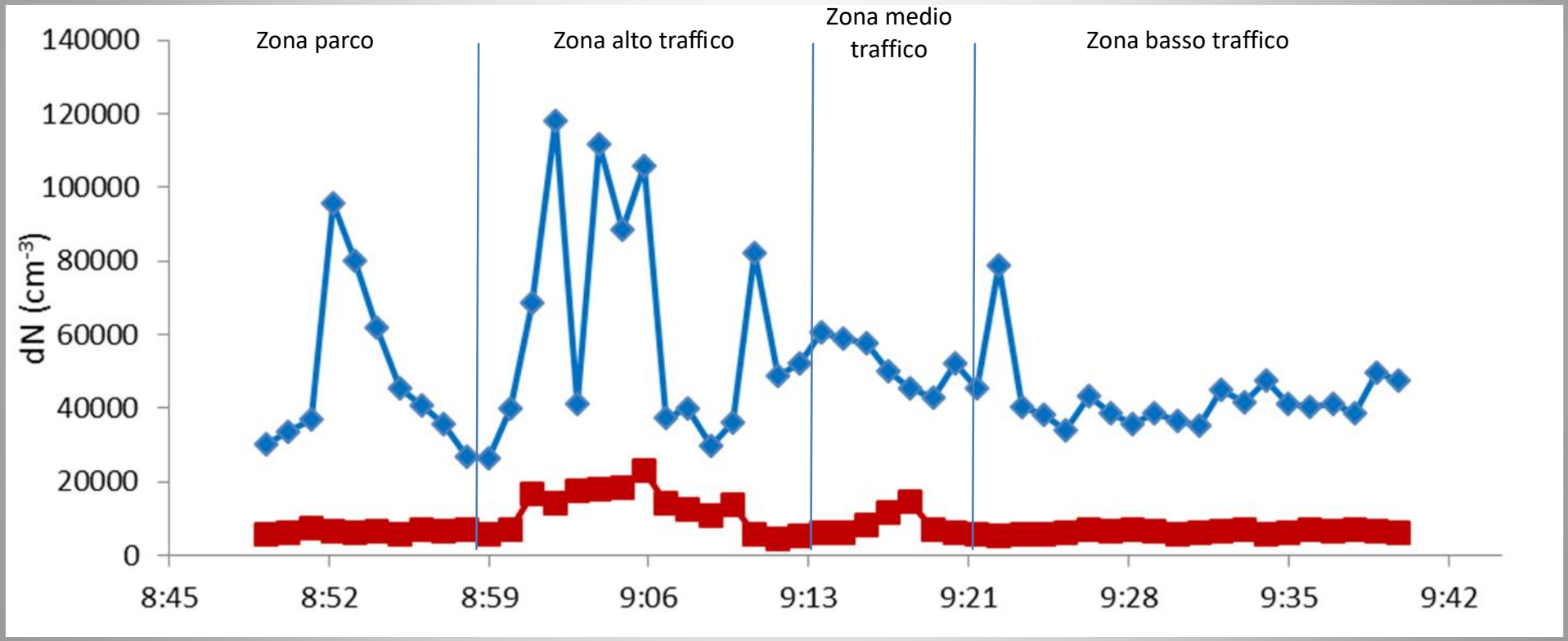


Particelle Ultrafini

- Particelle con diametro aerodinamico minore di 100 nm
- Alto numero di particelle e grande area superficiale per unità di massa in confronto con quella di particelle più grandi
- Elevata attività biologica
- Particelle Ultrafini (PUF) si depositano con elevate efficienza nei polmoni
- Le PUF sono molto piccole in relazione alle strutture cellulari

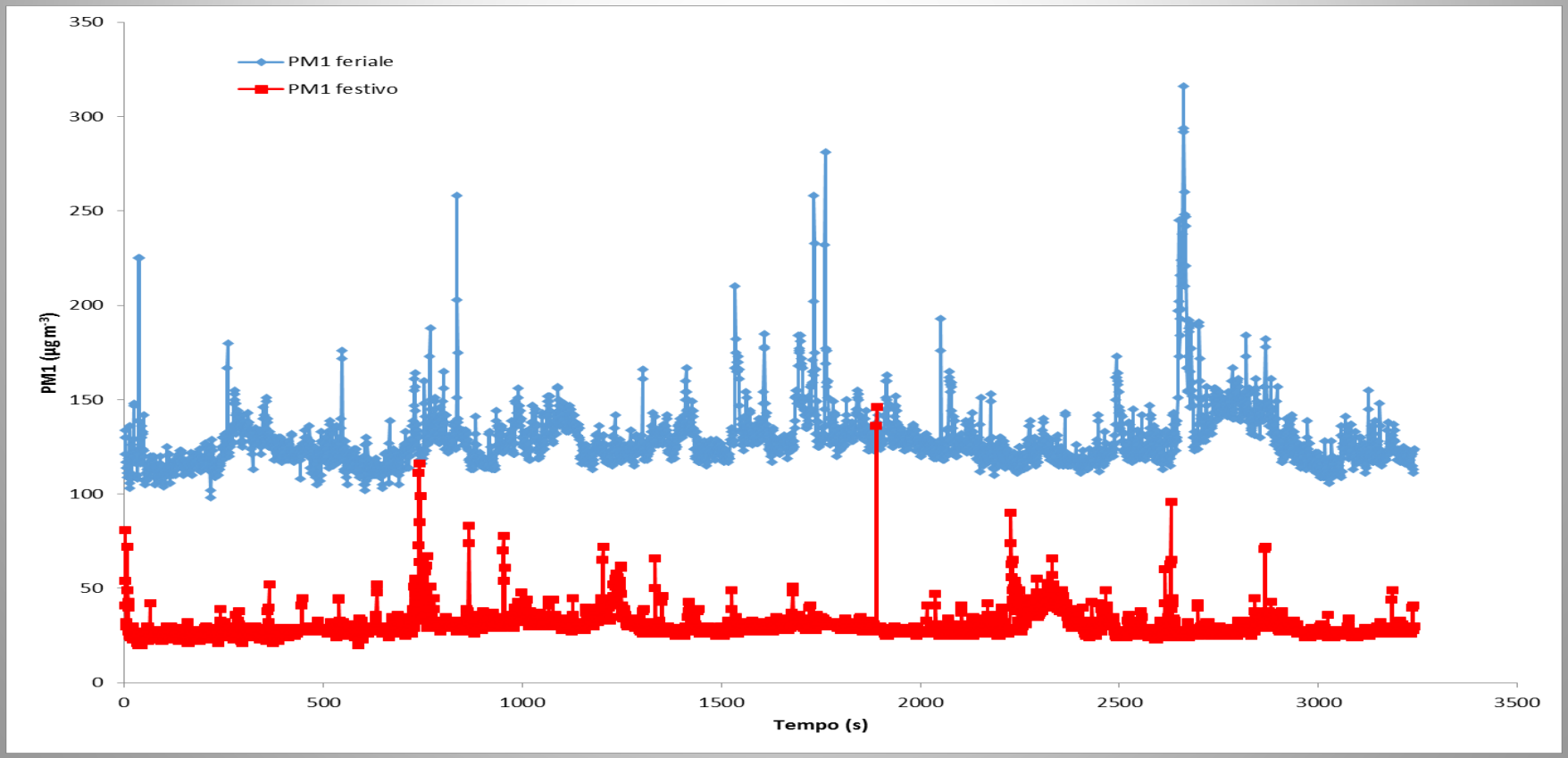
Una grande città: Roma

Percorso cittadino



	PM 1	PM 2.5	PM 4	PM 10	PM TOTALE
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
Media	129	130	131	137	155
Mediana	125	126	127	132	138
Min	98	98	99	100	100
Max	316	324	341	412	792
60%	128	129	130	135	145
80%	136	137	138	145	169
95%	154	155	157	168	239
Dev. St.	16	17	18	24	59
CV %	12	13	14	18	38

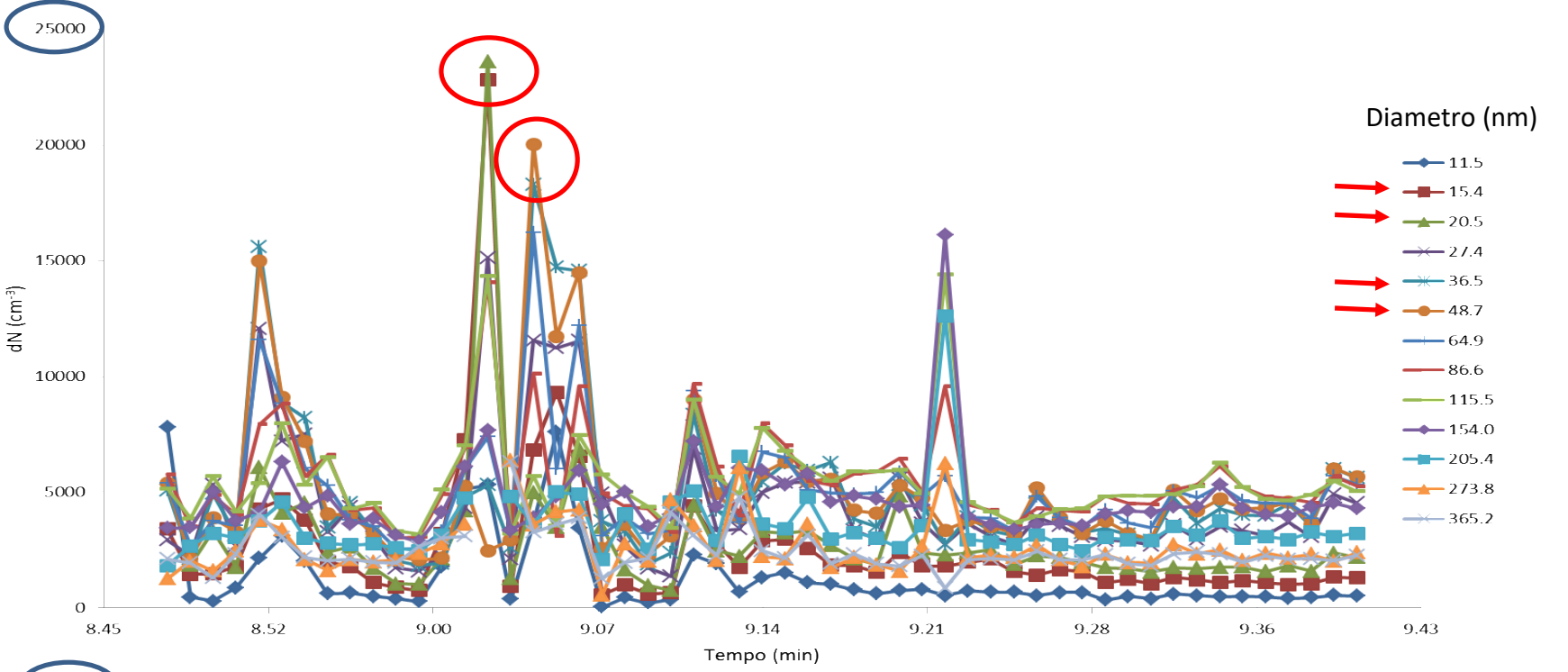
	PM 1	PM 2.5	PM 4	PM 10	PM TOTALE
	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
Media	32	32	33	35	45
Mediana	30	30	30	31	32
Min	20	20	20	20	20
Max	146	146	147	148	484
60%	31	31	32	33	34
80%	34	34	35	37	45
95%	46	46	47	53	105
Dev. St.	11	11	12	17	50
CV %	34	34	36	47	112

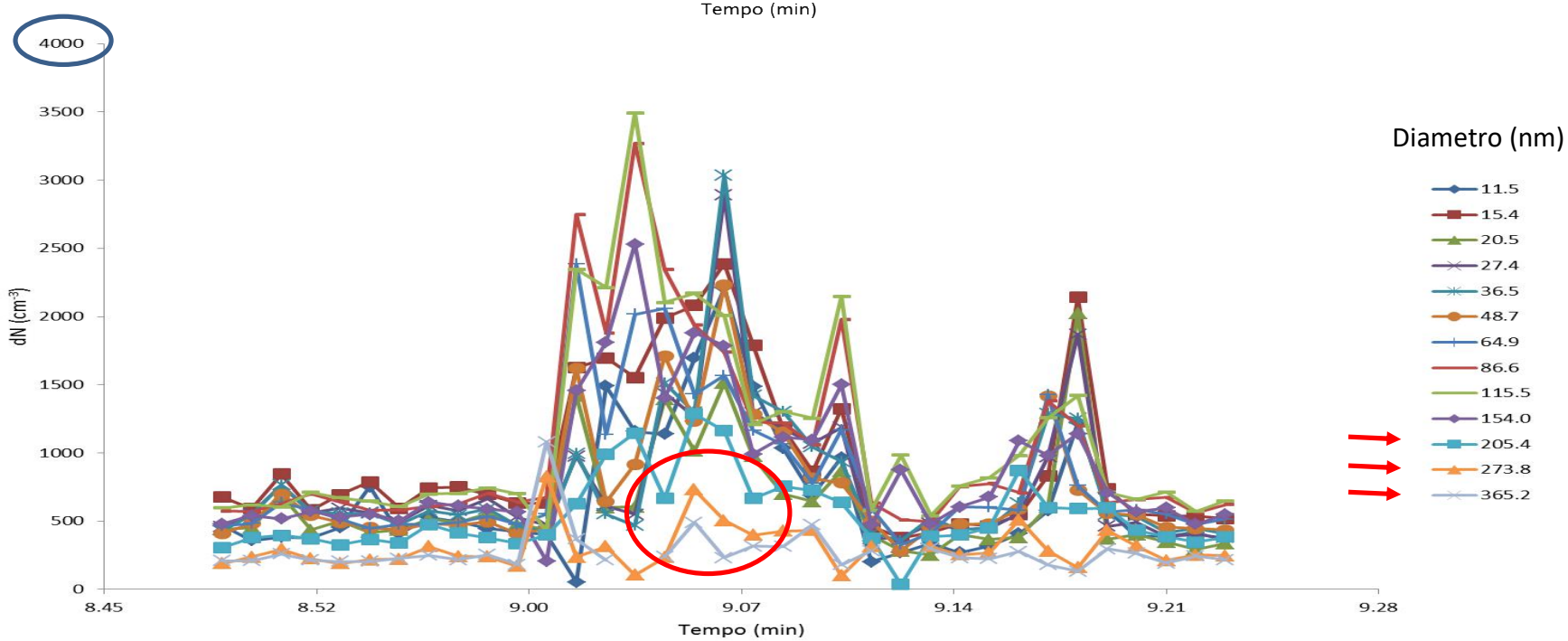


	11.5	15.4	20.5	27.4	36.5	48.7	64.9	86.6	115.5	154.0	205.4	273.8	365.2
Media	1344	2641	2958	4480	5083	5097	5172	5566	5531	4699	3538	2651	2464
Mediana	635	1655	2215	3403	3991	4090	4768	4950	5041	4329	3082	2253	2166
Min	31	567	759	1371	1829	2088	2535	3031	3187	2862	1817	568	852
Max	7818	22820	23579	15113	18271	20021	16193	14068	14399	16091	12613	6360	6302
60%	691	1816	2392	3674	4505	4593	4988	5296	5347	4388	3223	2363	2286
80%	1890	3110	3449	5422	5814	5621	5955	6543	6000	5195	3991	3510	3039
95%	5221	6998	5466	11545	14619	12827	10256	9632	8385	6650	5033	5316	4072
Dev. St.	1729	3359	3182	2915	3473	3406	2511	2121	2143	1877	1560	1183	906
CV %	129	127	108	65	68	67	49	38	39	40	44	45	37

11.5	15.4	20.5	27.4	36.5	48.7	64.9	86.6	115.5	154.0	205.4	273.8	365.2	
1	*0,707*	0,590	0,608	0,561	0,490	0,488	0,434	0,285	0,131	0,091	0,161	0,265	**11.5**
	1	*0,932*	*0,793*	0,437	0,322	0,479	*0,703*	0,598	0,283	0,233	0,310	0,355	**15.4**
		1	*0,773*	0,333	0,216	0,431	*0,751*	0,661	0,289	0,157	0,146	0,205	**20.5**
			1	*0,842*	*0,741*	*0,783*	*0,706*	0,461	0,213	0,139	0,203	0,288	**27.4**
				1	*0,976*	*0,889*	0,492	0,157	0,077	0,136	0,253	0,347	**36.5**
					1	*0,927*	0,486	0,124	0,068	0,151	0,277	0,360	**48.7**
						1	*0,761*	0,417	0,252	0,221	0,269	0,287	**64.9**
							1	*0,872*	0,596	0,424	0,228	0,040	**86.6**
								1	*0,861*	*0,717*	0,294	-0,202	**115.5**
									1	*0,909*	0,508	-0,125	**154.0**
										1	*0,806*	0,213	**205.4**
											1	*0,727*	**273.8**
												1	**365.2**

R buoni per i canali inferiori mentre peggiorano per i canali granulometrici più grandi


25000
20000
15000
10000
5000
0
dN (cm-3)
8.45
8.52
9.00
9.07
9.14
9.21
9.28
9.36
9.43
Tempo (min)
Diametro (nm)
11.5
15.4
20.5
27.4
36.5
48.7
64.9
86.6
115.5
154.0
205.4
273.8
365.2


4000
3500
3000
2500
2000
1500
1000
500
0
dN (cm-3)
8.45
8.52
9.00
9.07
9.14
9.21
9.28
Tempo (min)
Diametro (nm)
11.5
15.4
20.5
27.4
36.5
48.7
64.9
86.6
115.5
154.0
205.4
273.8
365.2

International Journal of Environmental Research and Public Health

MDPI

Article

Pedestrians in Traffic Environments: Ultrafine Particle Respiratory Doses

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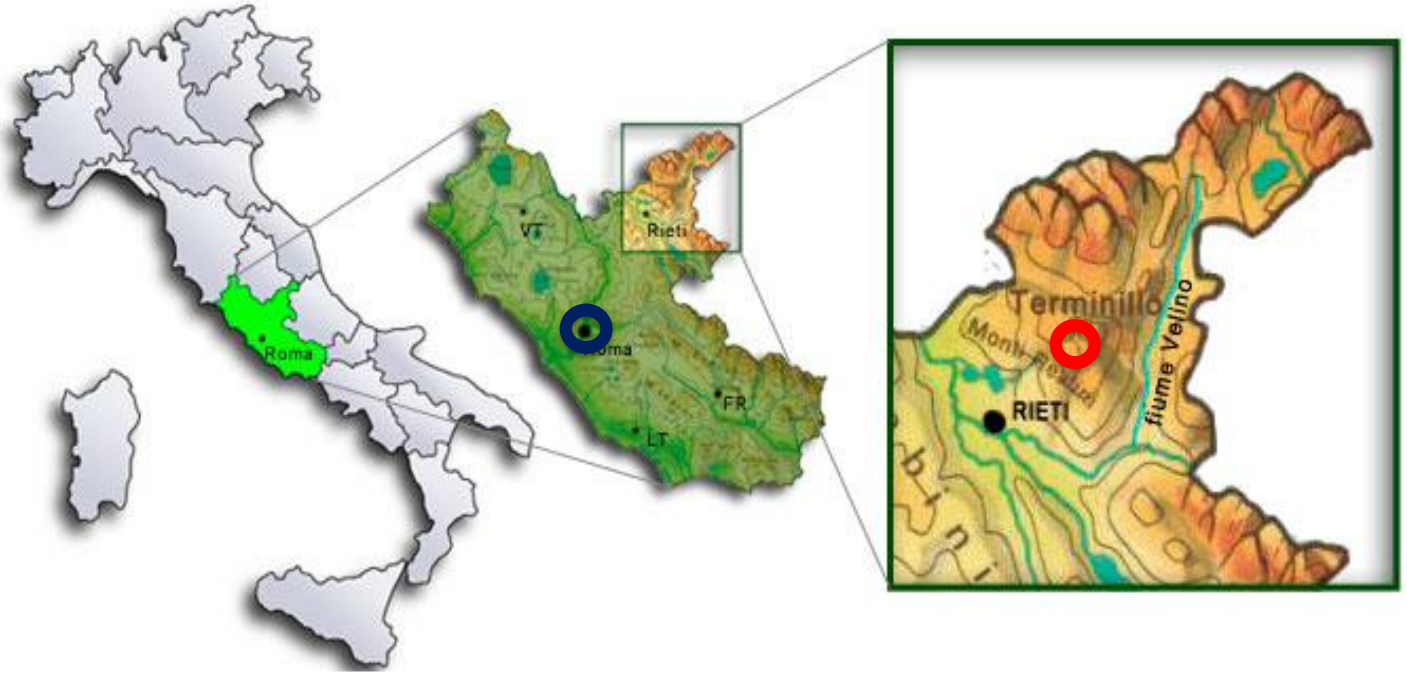
Abstract: Particulate matter has recently received more attention than other pollutants. PM_{10} and $PM_{2.5}$ have been primarily monitored, whereas scientists are focusing their studies on finer granulometric sizes due both to their high number concentration and their high penetration efficiency into the respiratory system. The purpose of this study is to investigate the population exposure to UltraFine Particles (UFP, submicrons in general) in outdoor environments. The particle number doses deposited into the respiratory system have been compared between healthy individuals and persons affected by Chronic Obstructive Pulmonary Disease (COPD). Measurements were performed by means of Dust Track and Nanoscan analyzers. Forty minute walking trails through areas with different traffic densities in downtown Rome have been considered. Furthermore, particle respiratory doses have been estimated for persons waiting at a bus stop, near a traffic light, or along a high-traffic road, as currently occurs in a big city. Large differences have been observed between workdays and weekdays: on workdays, UFP number concentrations are much higher due to the strong contribution of vehicular exhausts. COPD-affected individuals receive greater doses than healthy individuals due to their higher respiratory rate.

Keywords: ultraFine particles; autovehicular traffic; granulometric size; number concentration; urban air; workday; exposure; dose deposition; human respiratory tract; COPD


Roma
VT
Rieti
FR
LT
Terminillo
Monti Reatini
fiume Velino
RIETI

Strumenti utilizzati

FMPS – Fast Mobility Particle Sizer

FMPS ha il suo campo d'azione soprattutto nel settore ambientale per lo studio di fenomeni ad elevata variabilità temporale.

Le sue caratteristiche sono:

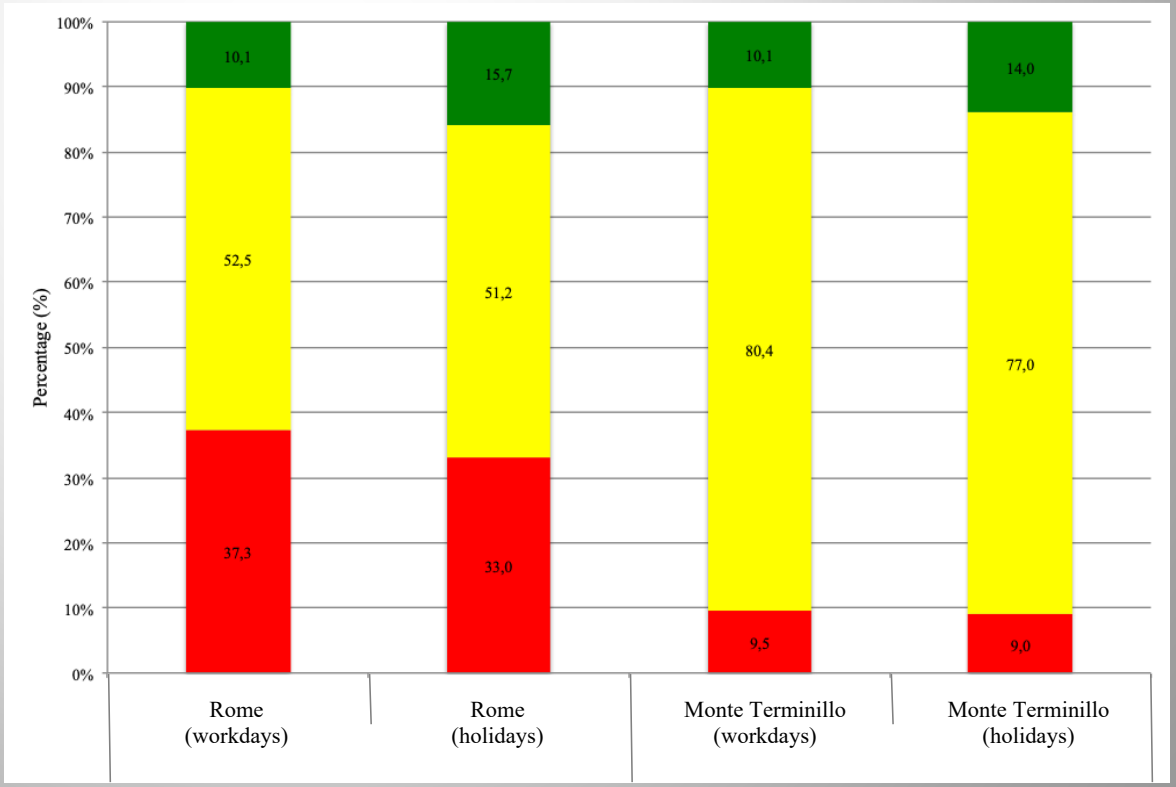
- Principio di selezione basato sulla mobilità elettrica
- Rilevamento delle particelle con elettrometri
- Classificazione dimensionale delle particelle da 5,6 a 560 nm in 32 classi
- Risoluzione temporale 1 scansione/secondo
- Semplice da usare, trasportare e impostare
- Correzione automatica della portata volumetrica e pressione barometrica
- Software con visualizzazione 3D e possibilità di playback dei dati
- Monitor integrato a colori

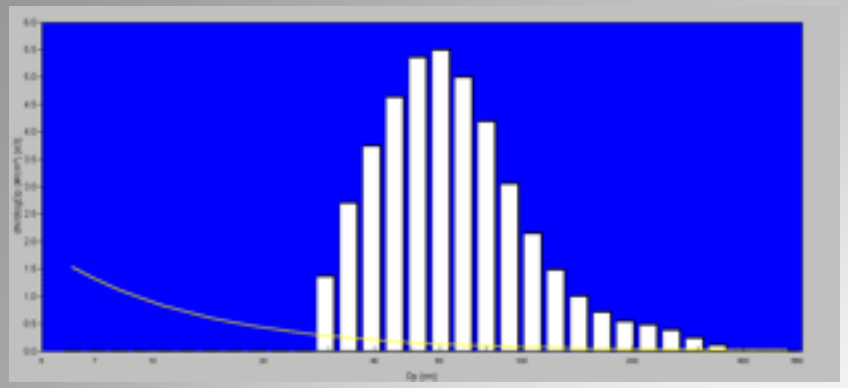
NSAM – Nanoparticle Surface Area Monitor

NSAM misura l'area superficiale delle particelle inalate e depositate in diverse aree dei polmoni.

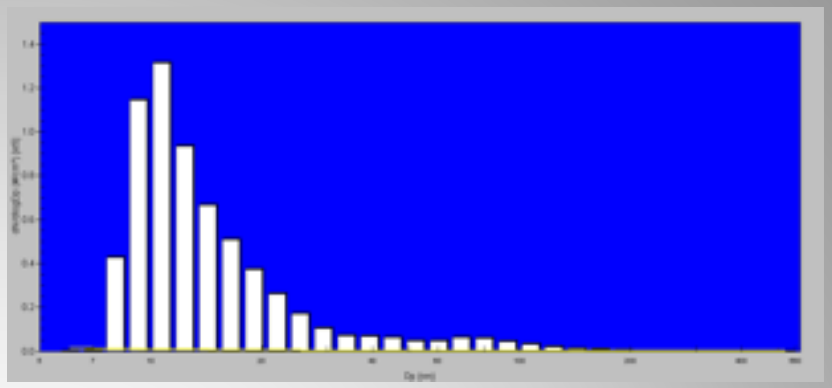
- Area superficiale depositata nelle regioni tracheo-bronchiale e alveolare
- Rilevamento delle particelle da 10 nanometri
- Concentrazioni da 0,01 a 2500 $\mu m^2\ cm^{-3}$
- Software per monitoraggio continuo con valore integrale e vari tipi di medie
- Applicazioni in tossicologia, epidemiologia, monitoraggio di ambienti di lavoro

Particles		Rome		Monte Terminillo	
		Workday	*Weekend*	*Workday*	*Weekend*
Total	average	11,905	10,006	5,695	4.072
	min-max	3,058-35,964	1,101-241,000	496-25,157	540-43,336
	st. dev.	4,318	12,373	1,696	2,837
	cv%[1]	38.3	123.7	29.8	69.7
	95 %	26,930	18,615	6,120	5,773
UFPs	average	10,183	9,299	5,271	3,492
	min-max	2,368-32,300	1,031-251,438	467-23,382	493-41,990
	st. dev.	3,810	12,137	1,740	2,550
	cv%[1]	39.9	130.5	33.0	73.0
	95 %	16,472	25,348	6,590	5,160
no-UFPs	average	1,722	707	424	580
	min-max	690-3,664	70-12,522	31-8,940	47-5,170
	st. dev.	698	712	570	600
	cv%[1]	40.5	100.7	173.0	128.2
	95 %	3,172	1,445	1,500	1,770

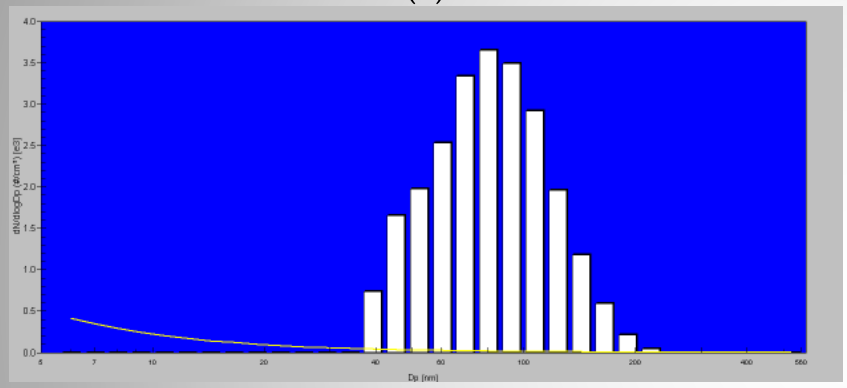




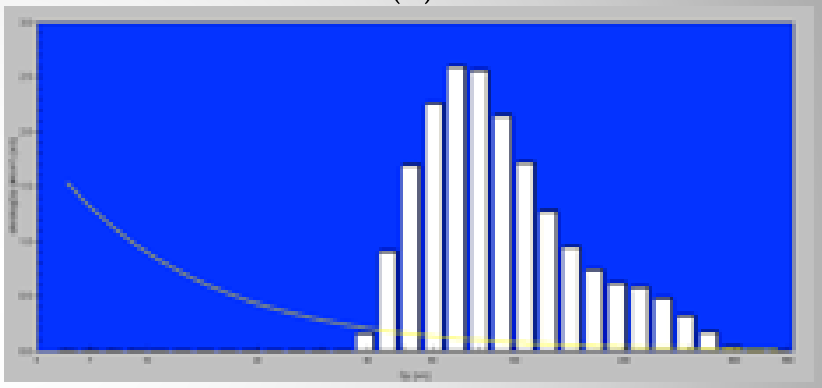
(a)



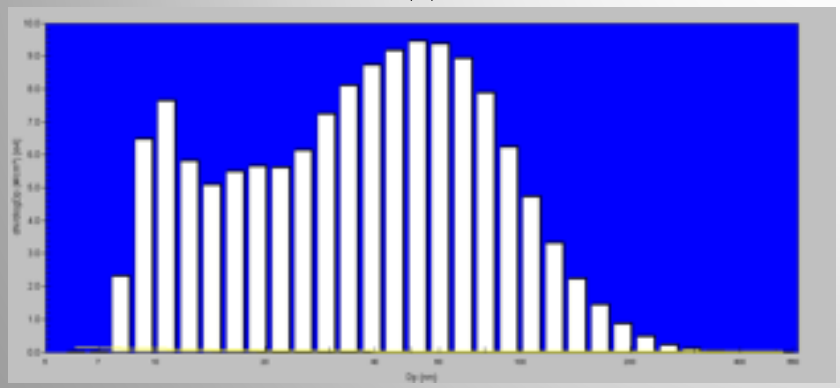
(b)



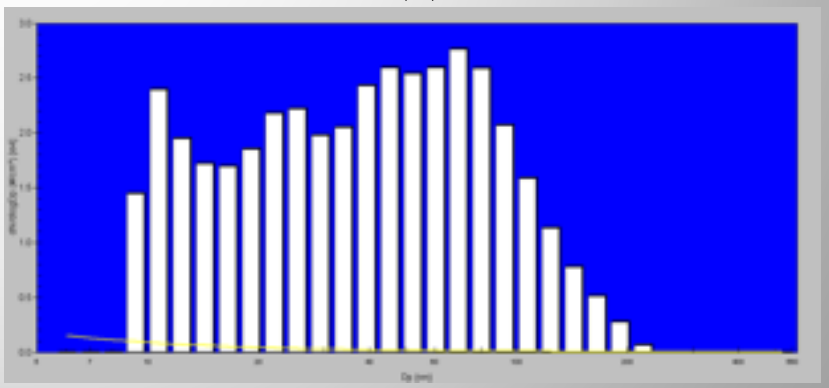
(c)



(d)



(e)



(f)

Tipici profili della distribuzione dell'aerosol (5-580 nm) al mattino (7-9 a.m.) (a,b), nelle ore centrali (5-7 p.m.) (c,d) e alla sera (8-10 p.m.) (e,f) misurati nei giorni feriali al Monte Terminillo e al centro di Roma

International Journal of
Environmental Research and Public Health

MDPI

Article

Evaluation of the Submicron Particles Distribution Between Mountain and Urban Site: Contribution of the Transportation for Defining Environmental and Human Health Issues

Maurizio Manigrasso [1], Carmela Protano [2], Stefano Martellucci [3], Vincenzo Mattei [3], Matteo Vitali [2] and Pasquale Avino [4,5,*]

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Abstract: Transportation is one of the main causes of atmospheric pollution, especially in downtown big cities. Researchers usually point their attention to gaseous and/or particulate matter pollutants. This paper investigated the role of submicron particles, particularly the fraction ranging between 5–560 nm, in aerosol chemistry for identifying the contribution of autovehicular traffic and investigating the doses deposited in the human respiratory tract. Measurements carried out by two Fast Mobility Particle Sizer (FMPS, TSI) analyzers were simultaneously performed at two different sampling sites (an urban and a mountain site) during workdays and weekends in July. The total particle number (2–2.5 times higher in the urban site), the aerosol size distribution (different modes during the day), and the ultrafine/non-ultrafine particle ratios (ranging between 2–4 times between two sites) were investigated and discussed in relationship to the high autovehicular traffic in Rome and the almost null anthropogenic emissions at the mountain site, as well as the differing contributions of both to the "fresh nucleation" and to "aged aerosol". Furthermore, the regional cumulative number doses deposited in the human respiratory tract were studied for both sites: The difference between the urban/mountain site was very high (up to 15 fold), confirming the pollutant role of transportation.

Keywords: submicron particles; mountain and urban site; transportation; human health

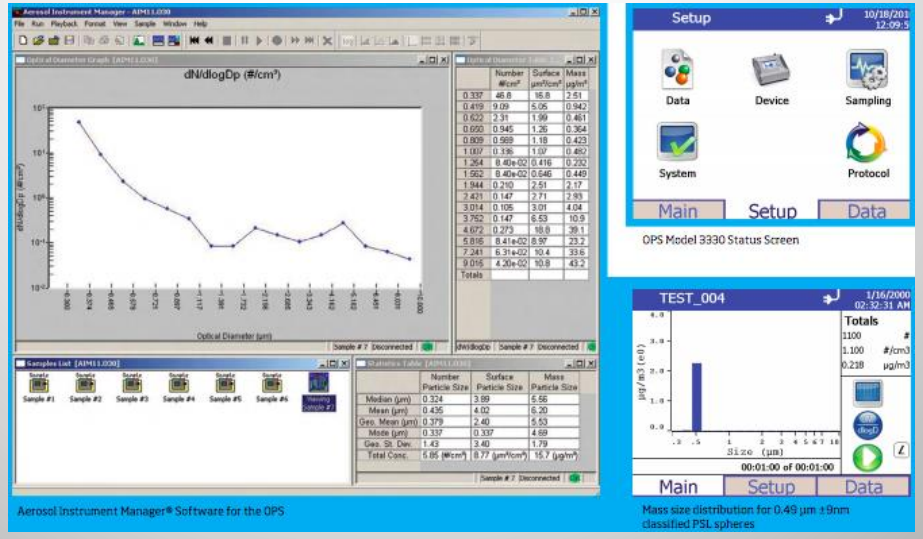
Regione Molise

DustTrack (PM10, PM4, PM2.5, PM1)

DustTrack (PM10, PM4, PM2.5, PM1)

Nanoscan (10-365 nm)

Optical Particle Sizer (0,3-10 μm)

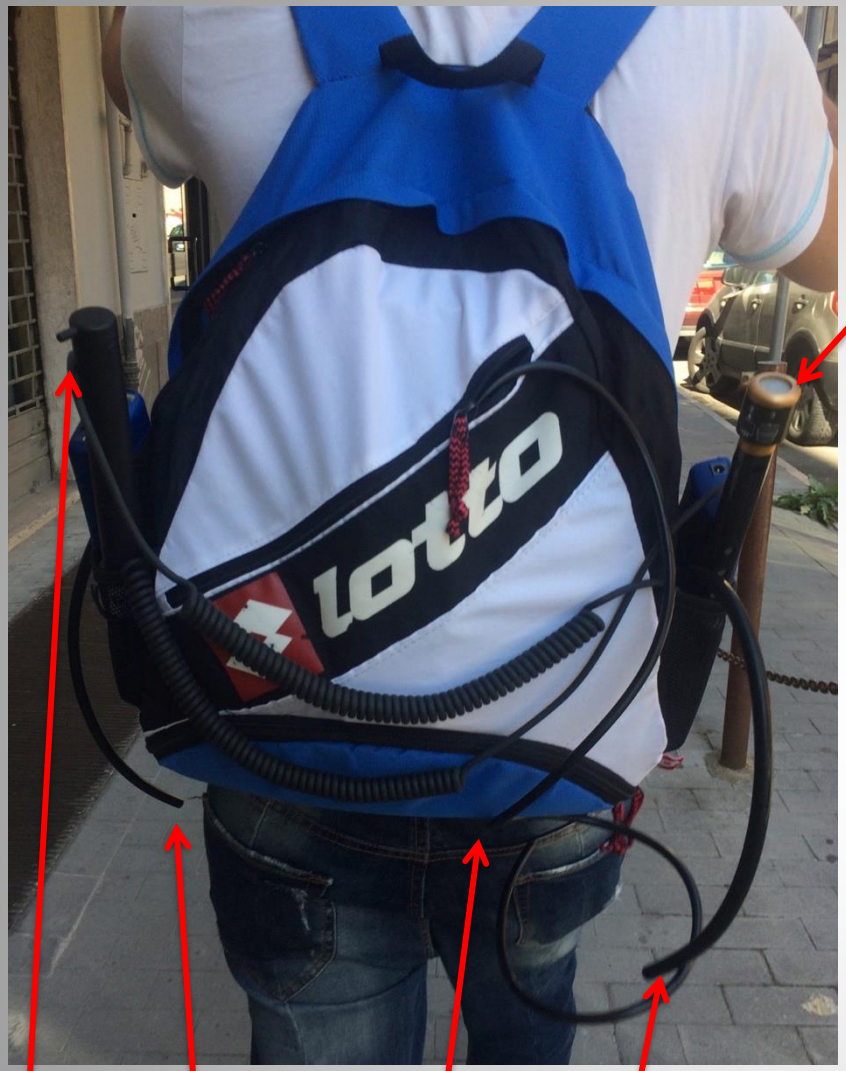


Aerosol Instrument Manager® Software

Analizzatore di CO_2 e CO

Analizzatore di COV

Analizzatore di *Black Carbon*



COV,
Temp,
RH

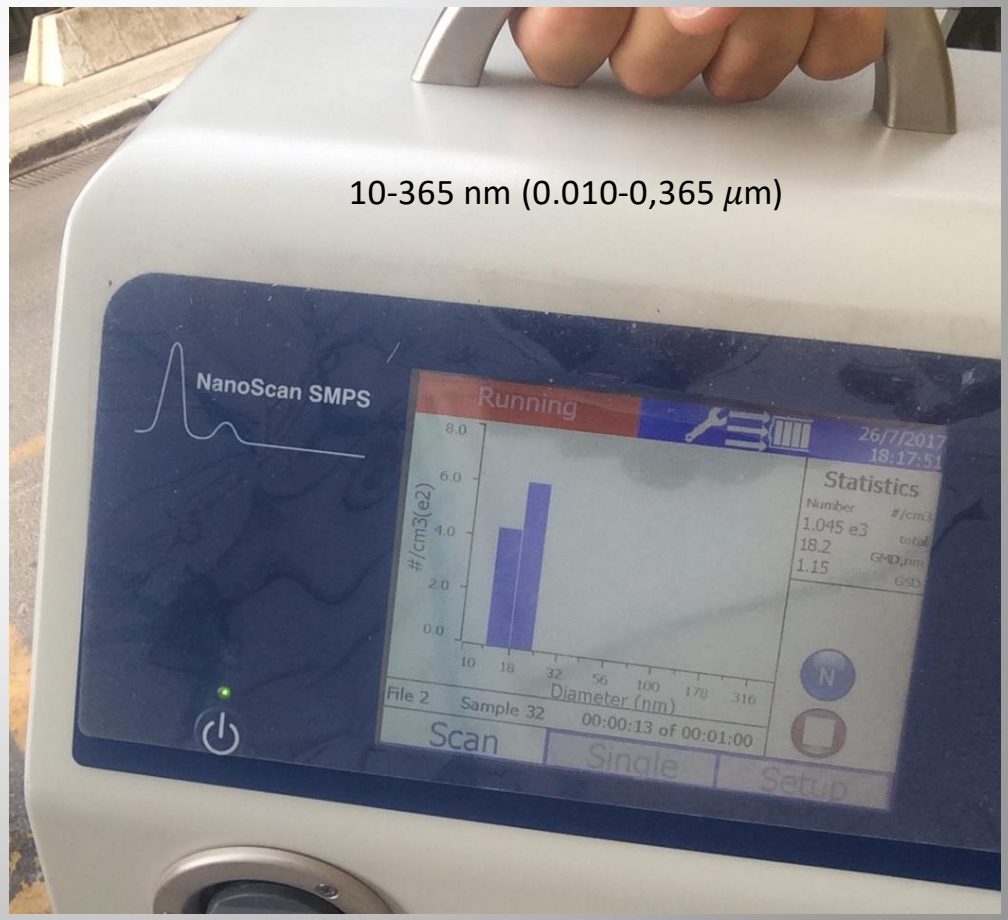
CO_2, CO,
Temp,
RH

0,3-10 μm

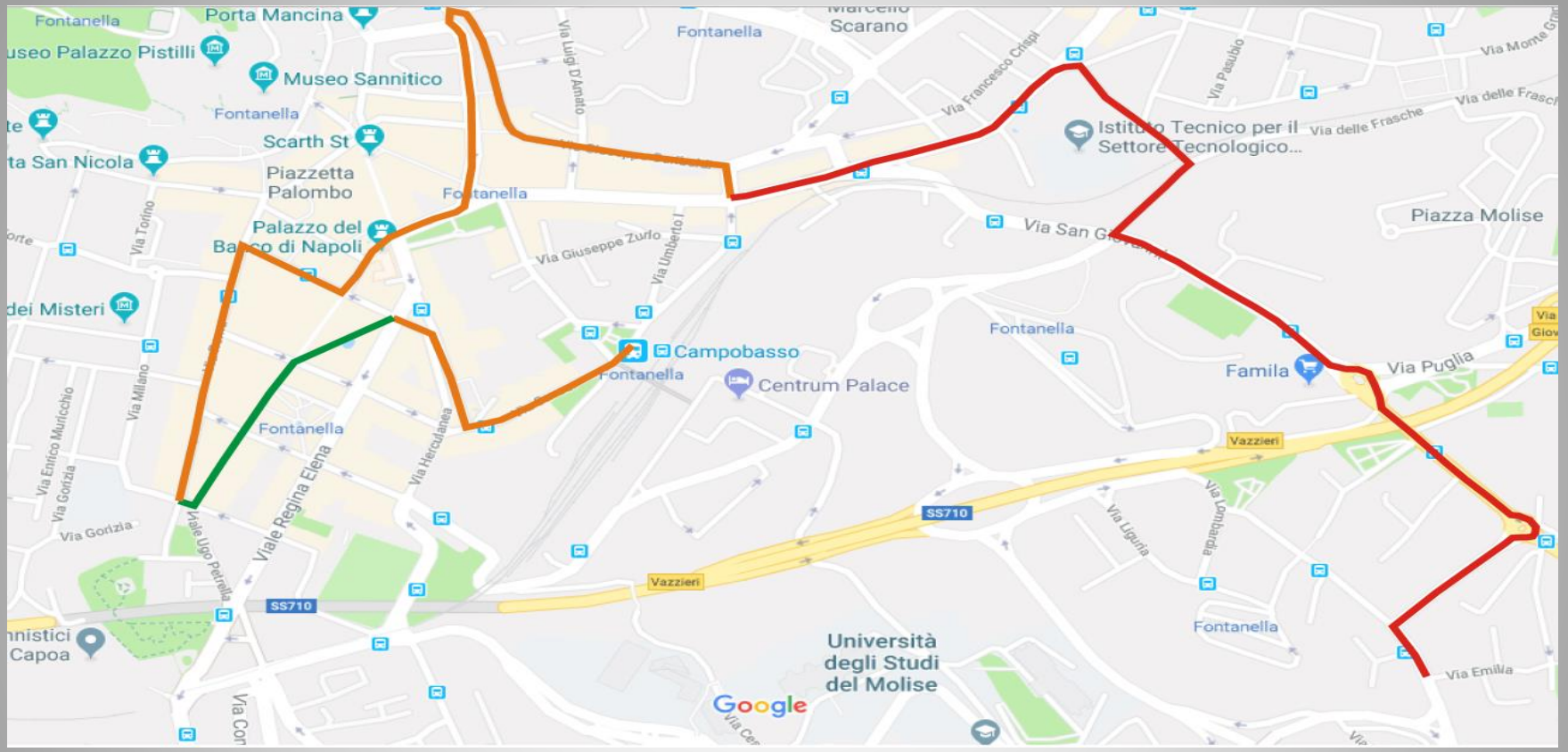
Black Carbon

PM_{10}, PM_4
$PM_{2.5}$, PM_1

10-365 nm (0.010-0,365 μm)



Campobasso



	T (°C)	Pressione (mmHg)	CO (ppm)	CO_2 (ppm)	COV (ppm)	BC ($\mu g\ m^{-3}$)
Estate	26 / 25	694 / 695	2.0 / 0.4	383 / 378	0.2 / 0.3	4 / 5
Inverno	12 / 9	700 / 699	0.1 / 0.2	371 / 367	0.05/0.09	9 / 5

Particolato ($\mu g\ m^{-3}$)

Estate

Mattina

	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	7	7	8	9
max	8	8	9	11
95%	8	8	9	11
media	7	7	8	11
max	17	19	25	46
95%	10	10	13	20
media	6	7	8	9
max	9	10	12	17
95%	8	9	11	15

Pomeriggio

	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	7	8	8	10
max	401	403	410	521
95%	24	24	25	29
media	10	10	11	12
max	198	198	199	203
95%	25	26	27	30
media	6	6	6	7
max	19	19	20	23
95%	9	10	11	14

Inverno

Mattina

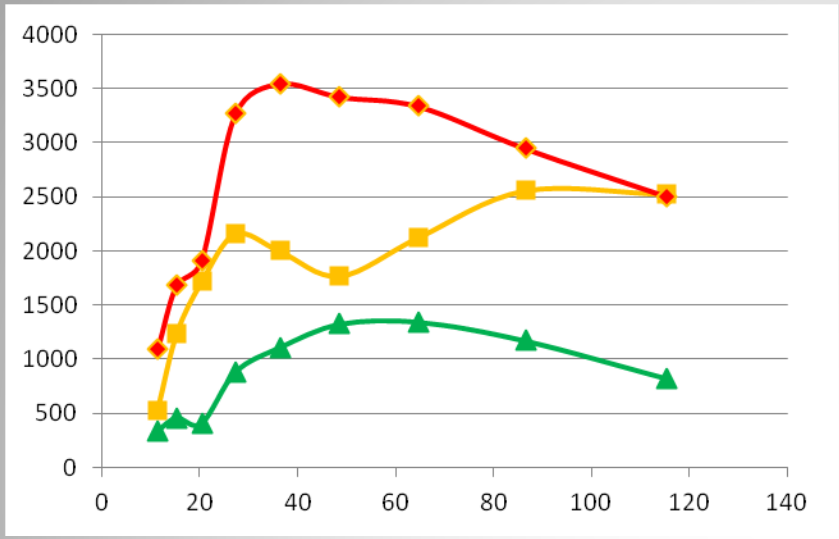
	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	11	20	23	28
max	49	57	61	63
95%	16	25	30	35
media	9	14	16	20
max	33	41	44	51
95%	28	35	39	45
media	3	7	8	10
max	5	8	9	11
95%	4	8	9	11

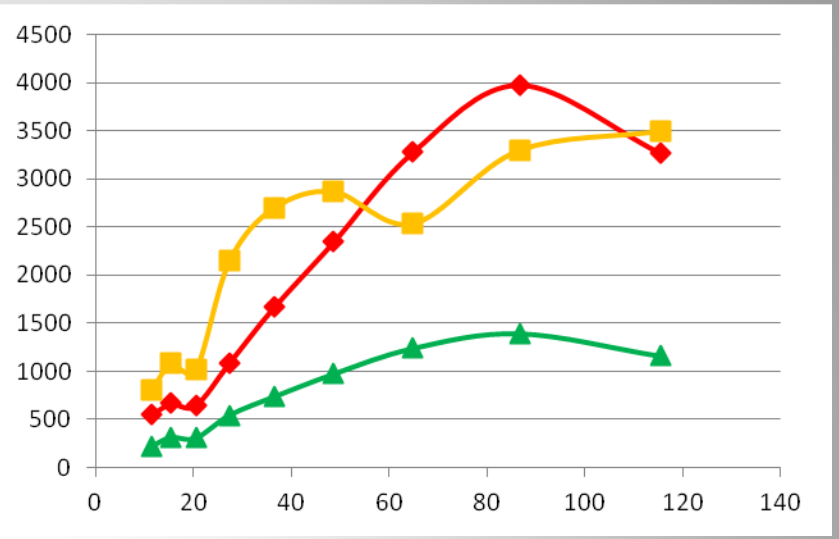
Pomeriggio

	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	9	13	16	24
max	15	23	31	52
95%	14	20	24	37
media	10	15	18	28
max	22	28	38	84
95%	19	27	32	56
media	6	9	11	15
max	7	11	14	20
95%	7	11	13	19

Particelle Ultrafini (# cm^{-3})

Estate

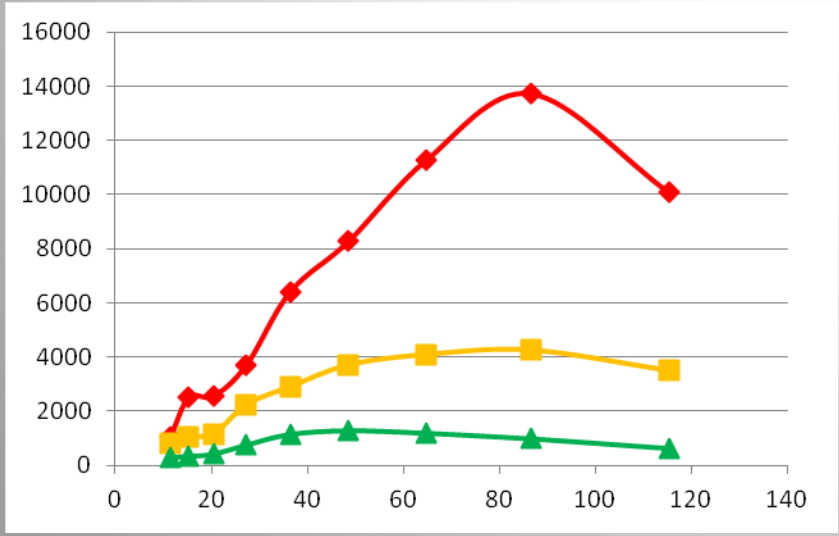


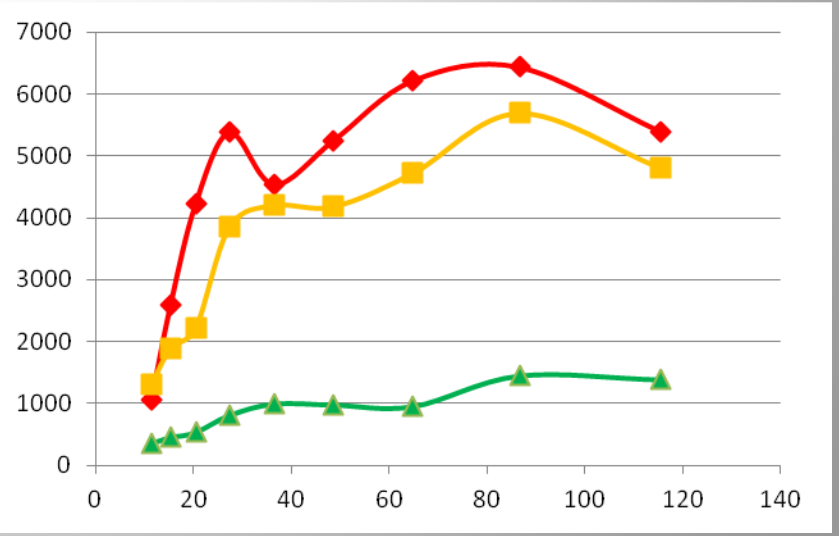


Mattina

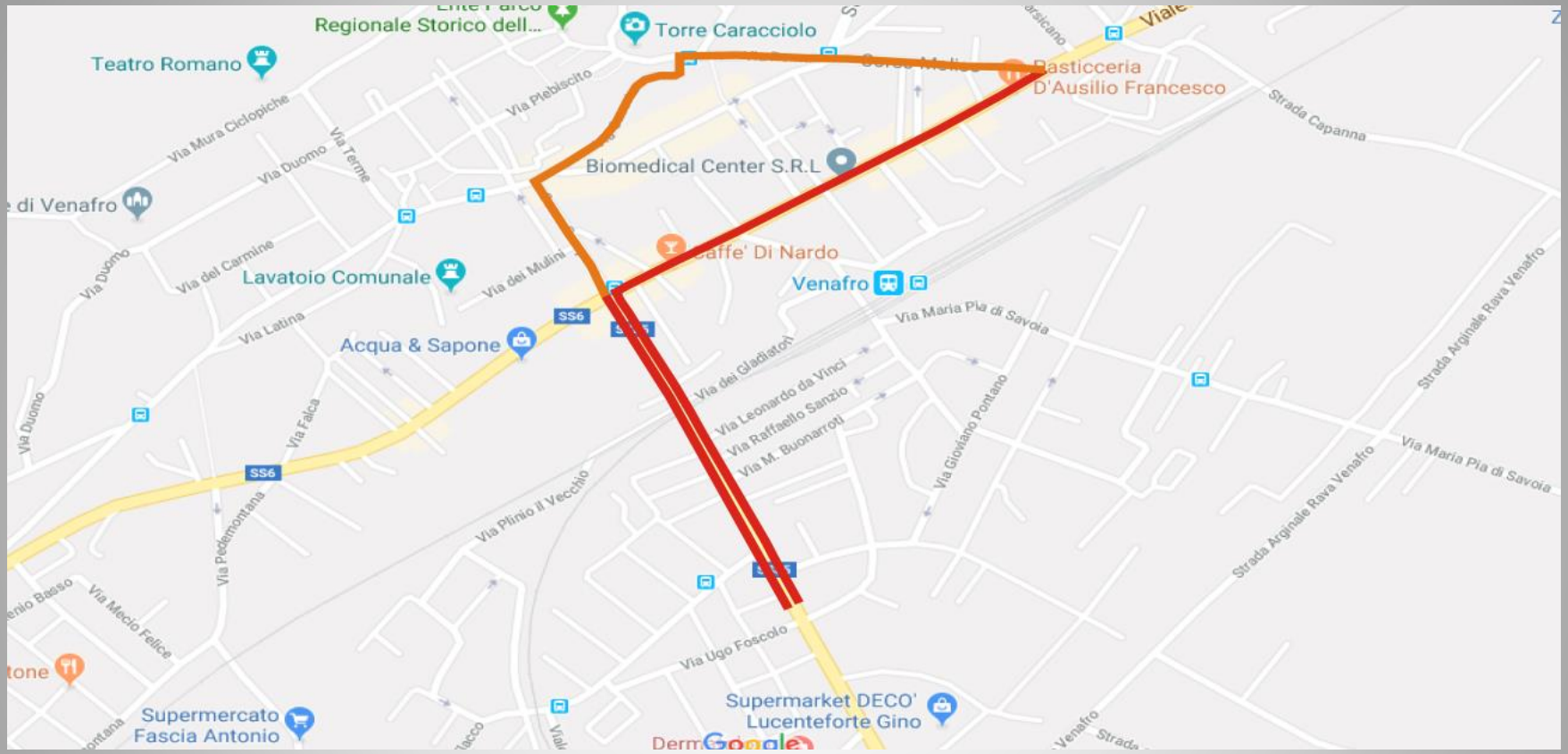
Pomeriggio

Inverno





Venafro



	T (°C)	Pressione (mmHg)	CO (ppm)	CO_2 (ppm)	COV (ppm)	BC ($\mu g\ m^{-3}$)
Estate	30 / 32	743 / 742	0.4 / 2.0	401 / 399	0.3 / 0.4	5 / 3
Inverno	11 / 12	742 / 741	0.4 / -	440 / -	0.05 / 0.2	9 / 8

Particolato ($\mu g\ m^{-3}$)

Estate

	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	22	23	24	28
max	109	110	113	172
95%	37	38	41	49
media	26	26	27	29
max	153	154	155	156
95%	51	51	52	57

Mattina

	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	14	15	15	18
max	108	109	113	143
95%	27	28	29	33
media	11	12	13	15
max	101	101	101	211
95%	22	22	24	30

Pomeriggio

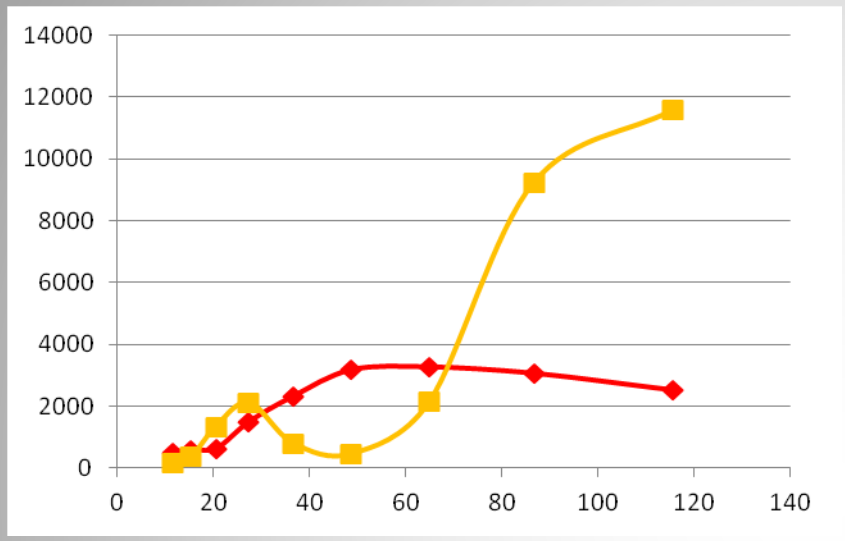
Inverno

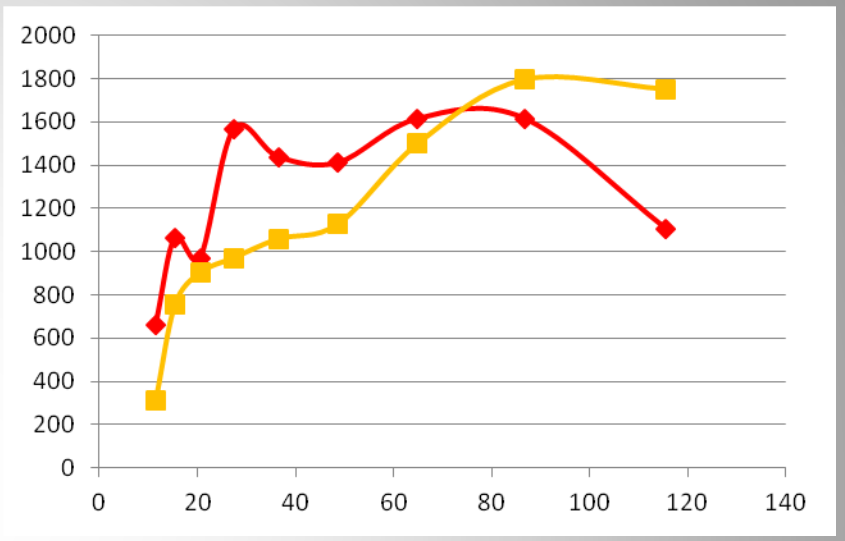
	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	34	46	51	60
max	135	147	150	216
95%	52	64	74	131
media	37	49	52	56
max	76	90	94	101
95%	60	74	77	82

	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	35	42	45	47
max	155	165	168	171
95%	57	65	68	71
media	28	35	38	41
max	45	51	53	56
95%	42	50	52	55

Particelle Ultrafini (# cm^{-3})

Estate

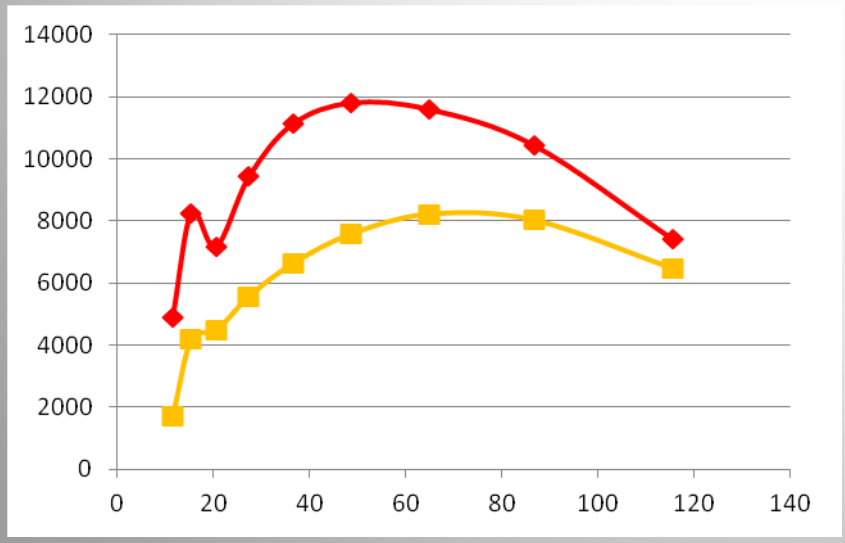


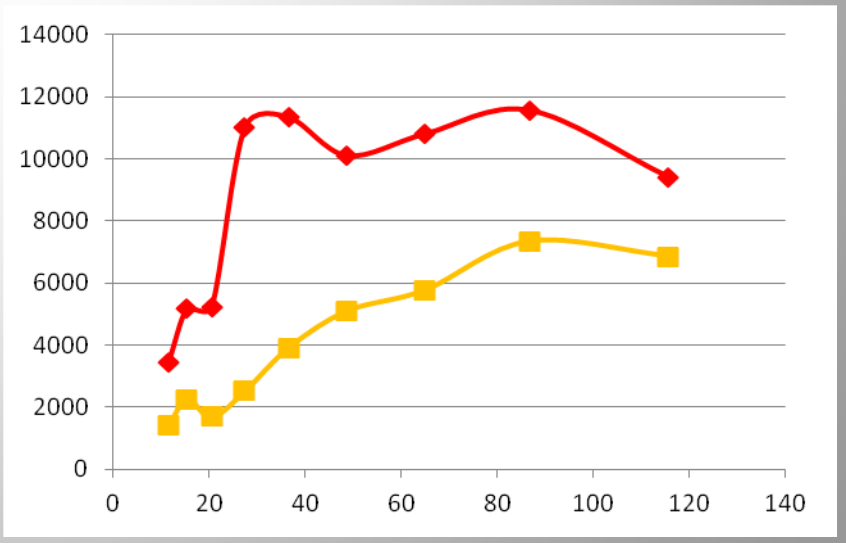


Mattina

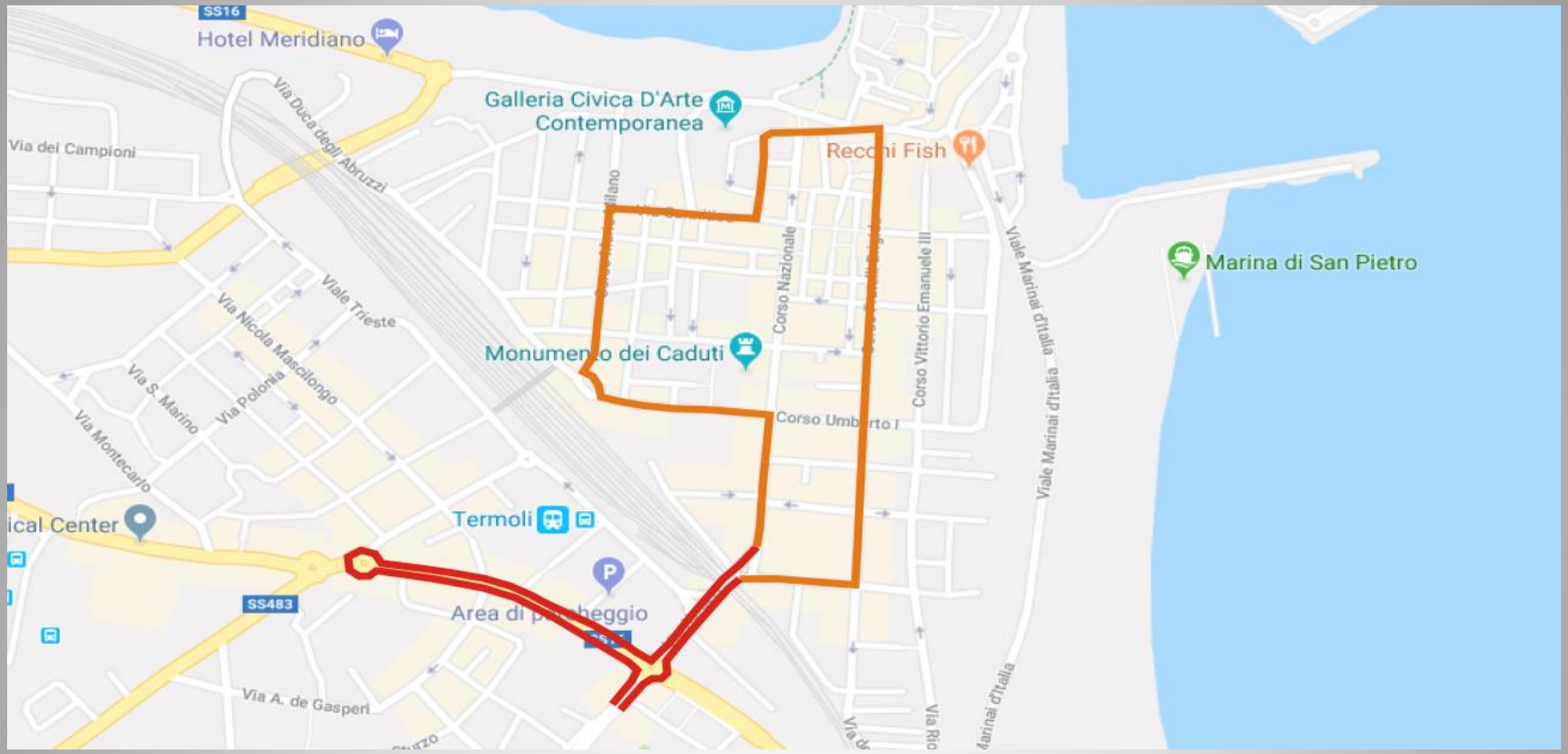
Pomeriggio

Inverno





Termoli



	T (°C)	Pressione (mmHg)	CO (ppm)	CO_2 (ppm)	VOC (ppm)	BC ($\mu g\ m^{-3}$)
Estate	29 / 29	752 / 752	1.3 / 1.3	418 / 420	0.2 / 0.2	3 / 4
Inverno	22 / 20	754 / 754	0.03 / 0.1	395 / 416	0.03/0.03	2 / 7

Particolato ($\mu g\ m^{-3}$)

Estate

	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	14	15	16	18
max	122	135	169	276
95%	24	25	27	31
media	16	16	17	19
max	87	88	90	99
95%	28	29	30	34

Mattina

	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	10	11	11	13
max	155	155	156	184
95%	24	24	25	29
media	13	13	14	16
max	164	165	166	170
95%	30	31	33	36

Pomeriggio

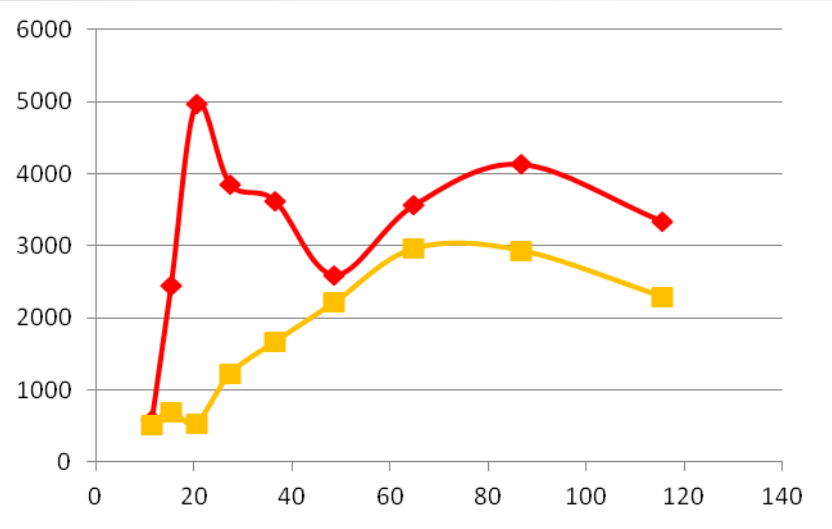
Inverno

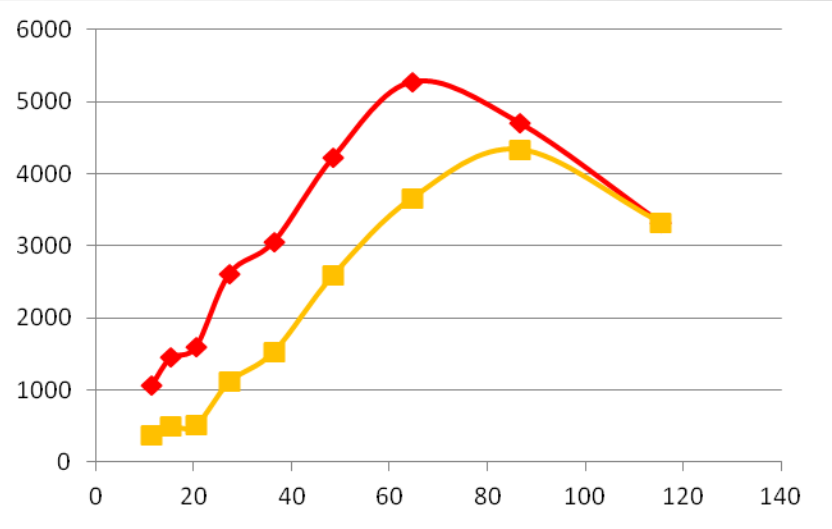
	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	9	18	24	37
max	23	32	38	56
95%	13	22	27	52
media	9	19	24	42
max	12	21	30	59
95%	11	21	29	51

	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	17	34	44	61
max	21	38	48	76
95%	19	37	48	67
media	20	37	46	67
max	27	50	64	102
95%	25	43	57	91

Particelle Ultrafini (# cm^{-3})

Estate

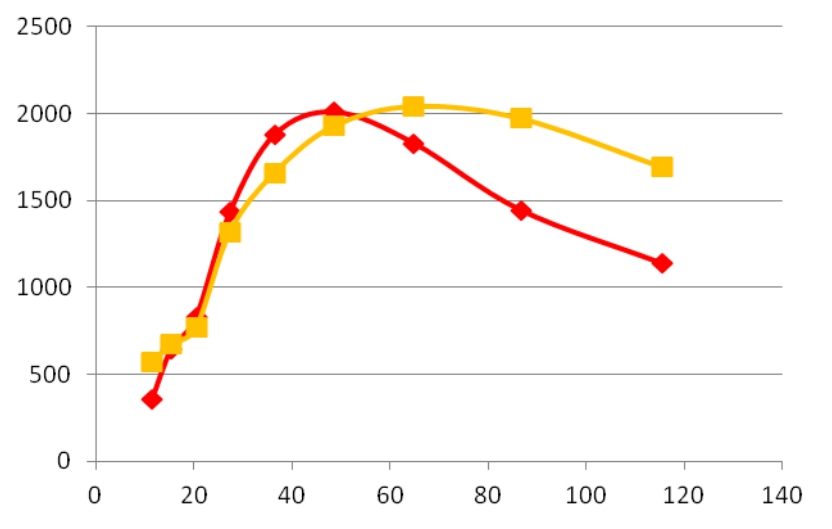


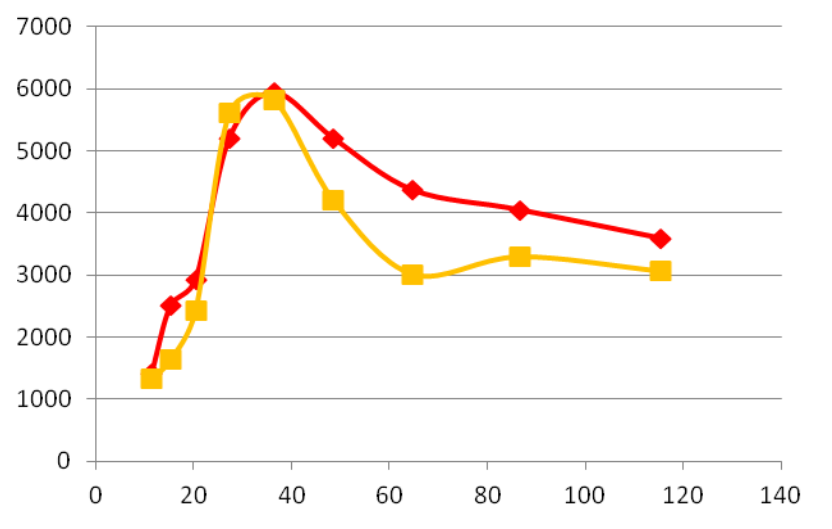


Mattina

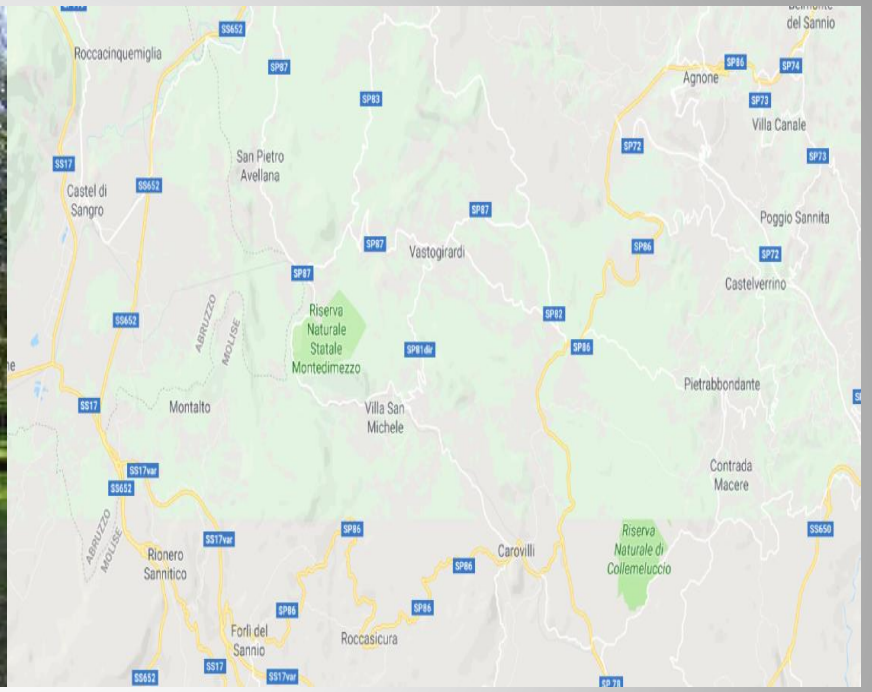
Pomeriggio

Inverno





Montedimezzo

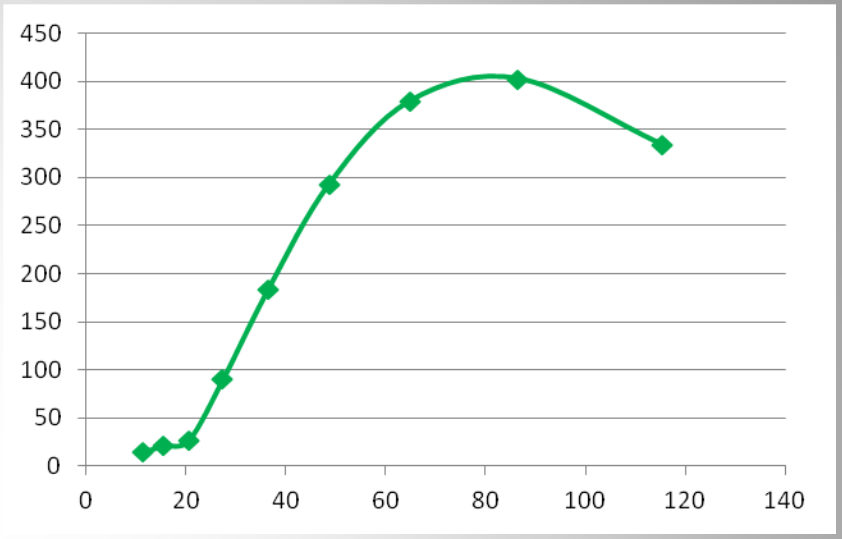


	T (°C)	Pressione (mmHg)	CO (ppm)	CO_2 (ppm)	VOC (ppm)	BC ($\mu g\ m^{-3}$)
Estate	25	678	0.06	349	0.1	0.7
Inverno	10	675	/	/	0.4	0.4

Particolato e Particelle Ultrafini

Estate

	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	8	11	12	16
max	9	13	14	22
95%	9	12	14	20

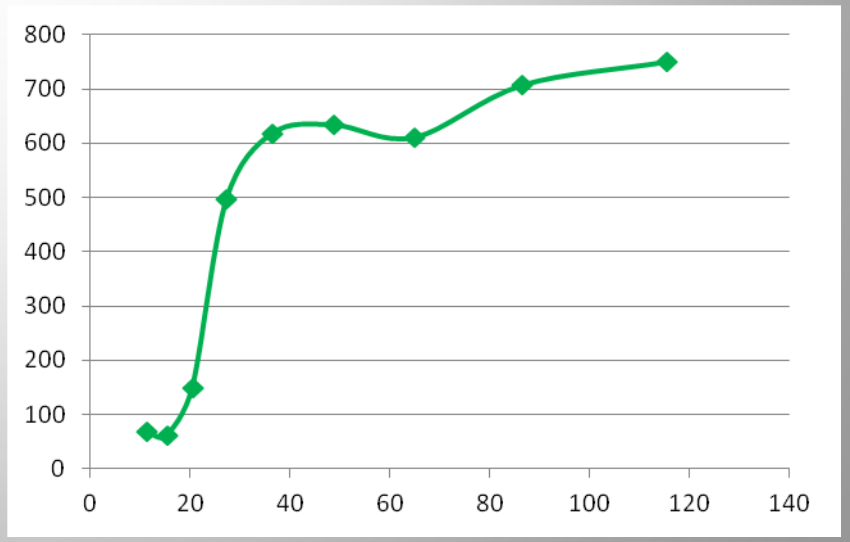


Particolato

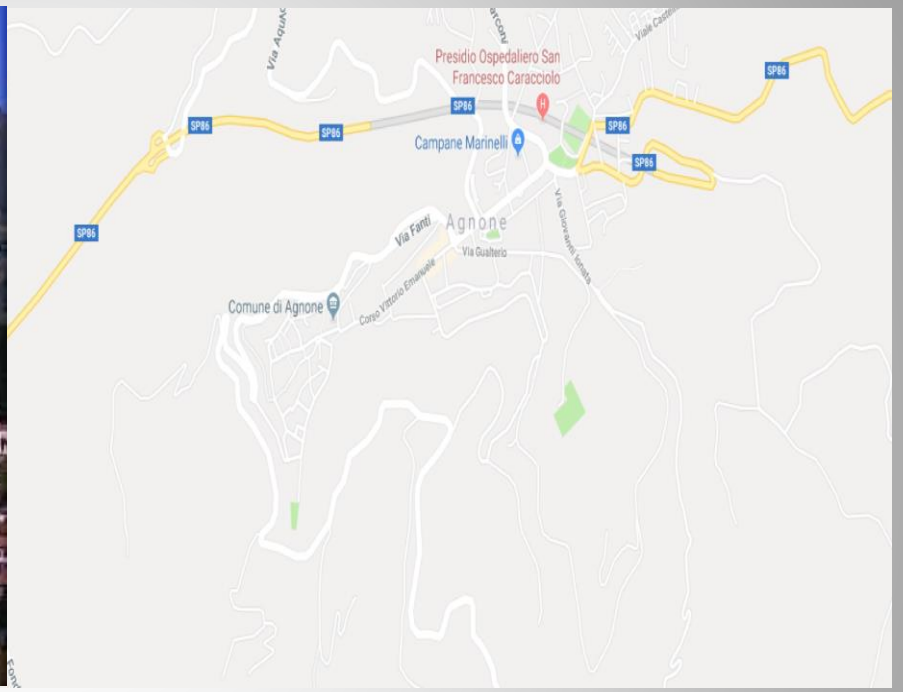
Particelle Ultrafini

Inverno

	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	9	9	9	10
max	154	139	135	124
95%	29	29	30	30



Agnone



	T (°C)	Pressione (mmHg)	CO (ppm)	CO_2 (ppm)	VOC (ppm)	BC ($\mu g\ m^{-3}$)
Estate	31	689	0.07	348	0,2	10
Inverno	9	685	/	/	0.4	2

Particolato e Particelle Ultrafini

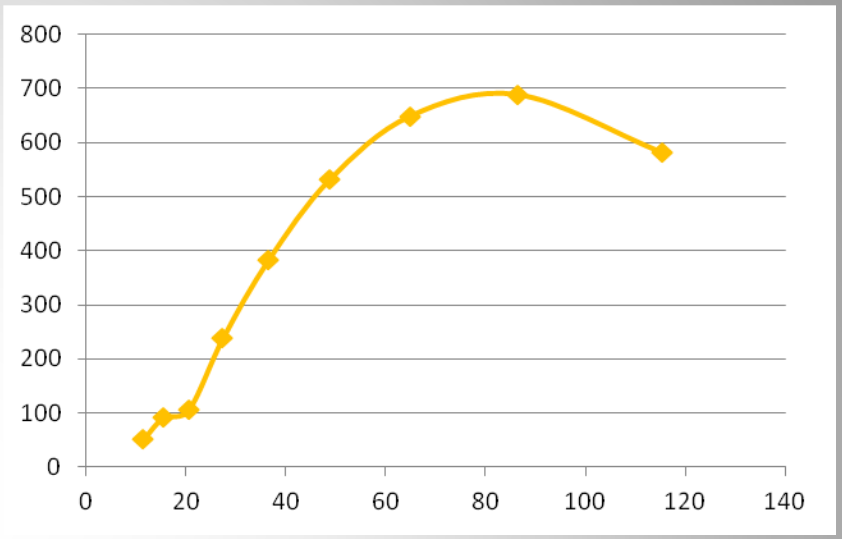
Estate

	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	7	7	8	10
max	8	22	25	29
95%	8	15	16	17

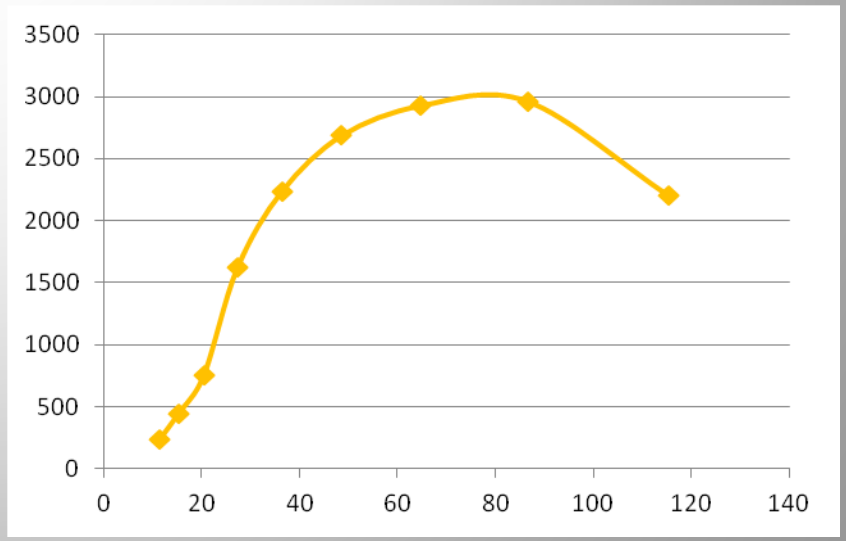
Inverno

	PM_1	$PM_{2.5}$	PM_4	PM_{10}
media	19	20	21	22
max	76	78	79	79
95%	47	49	50	52

Particolato

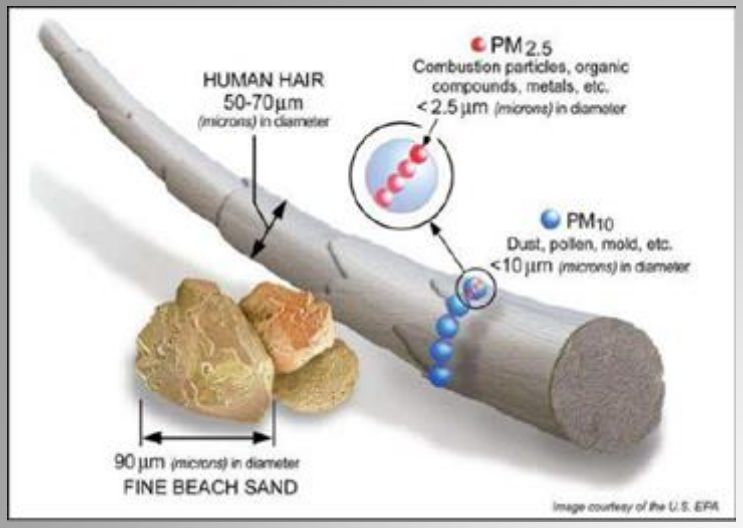


Particelle Ultrafini



Spirale antizanzare	$8.9*10^5$
incenso	$1.7*10^5$
Candela alla citronella	$8.6*10^4$
Deodorante per ambienti	$4.9*10^4$
Sigaretta elettronica con nicotina	$4.09*10^9$
Sigaretta elettronica senza nicotina	$5.28*10^9$
Griglia aspirata	$2.0*10^6$
Griglia non aspirata	$4.1*10^7$
Phon 1000W	$2.5*10^5$
Phon 2000W	$5.3*10^4$
Piastra per capelli	$9.0*10^5$
MIcroambienti	
Pista aereoporto	$1.14*10^8$
Canyon piccolo	$6.55*10^7$
Grigliate all'aperto	$7.82*10^8$
Carrazzeria	1.0410^6

Conc. (ng/m3)	Pellet	Charcoal	Wood
Fluorantene	2680±375	1372±343	12063±41
Pirene	2980±447	1560±421	21369±53
benzo(a)antracene	601±54	308±49	5302±10
crisene	949±161	485±92	9769±23
benzo(b)fluorantene	464±32	237±49	10345 ±35
benzo(k)fluorantene	146±18	119±25	3232±77
benzo(e)pirene	169±17	91±6	2393±64
benzo(a)pirene	**475**±85	**221**±51	**5895**±14
Perilene	90±16	59±8	1299±33
indeno(1,2,3,c,d)pirene	205±41	99±18	4781±17
dibenzo(a,h)antracene	82±7	36±9	189±59
benzo(g,h,i)perilene	222±53	104±12	4412±39
Somma	**9063**	**4691**	**81049**



Grazie per la gentile attenzione