

PM₁₀ from road pavement and winter tyre interaction



Mats Gustafsson

Aim of road dust research



WearTox

- Wear particles from pavement and winter tyres
 - Physical and chemical properties?
 - Factors affecting their formation?
 - Are they as dangerous to health as exhaust particles? (not further discussed here)

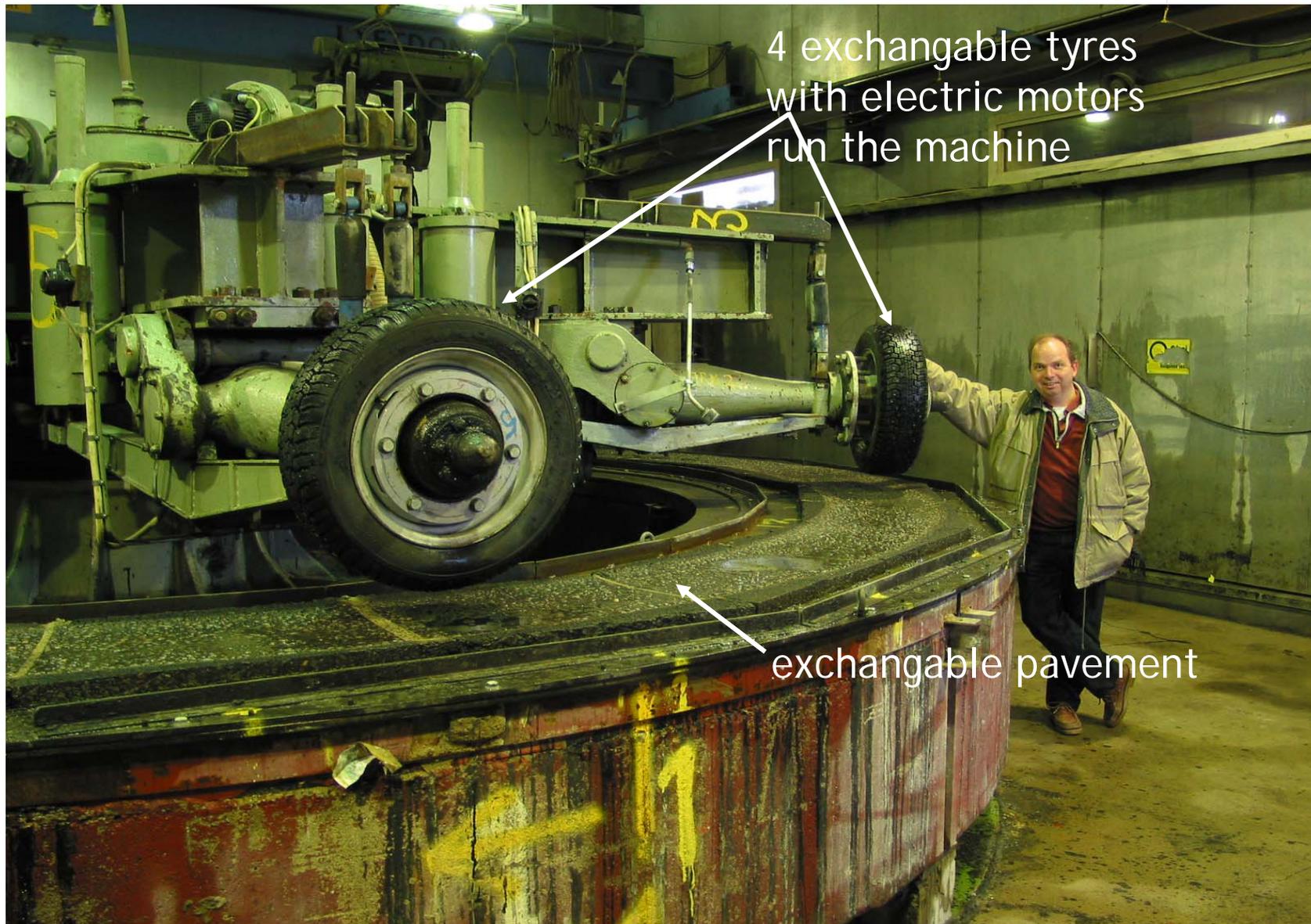


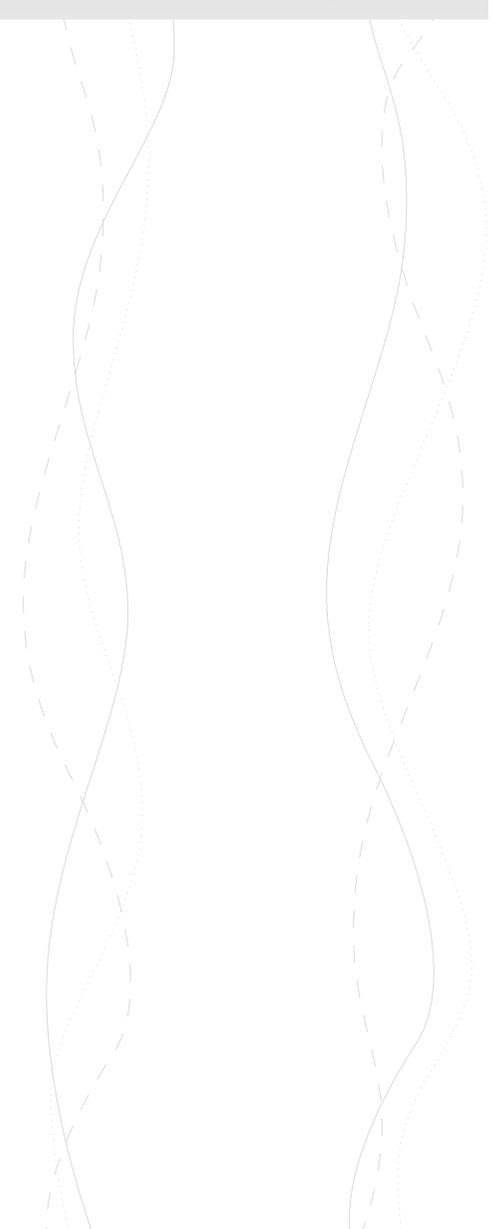
LINKÖPINGS UNIVERSITET



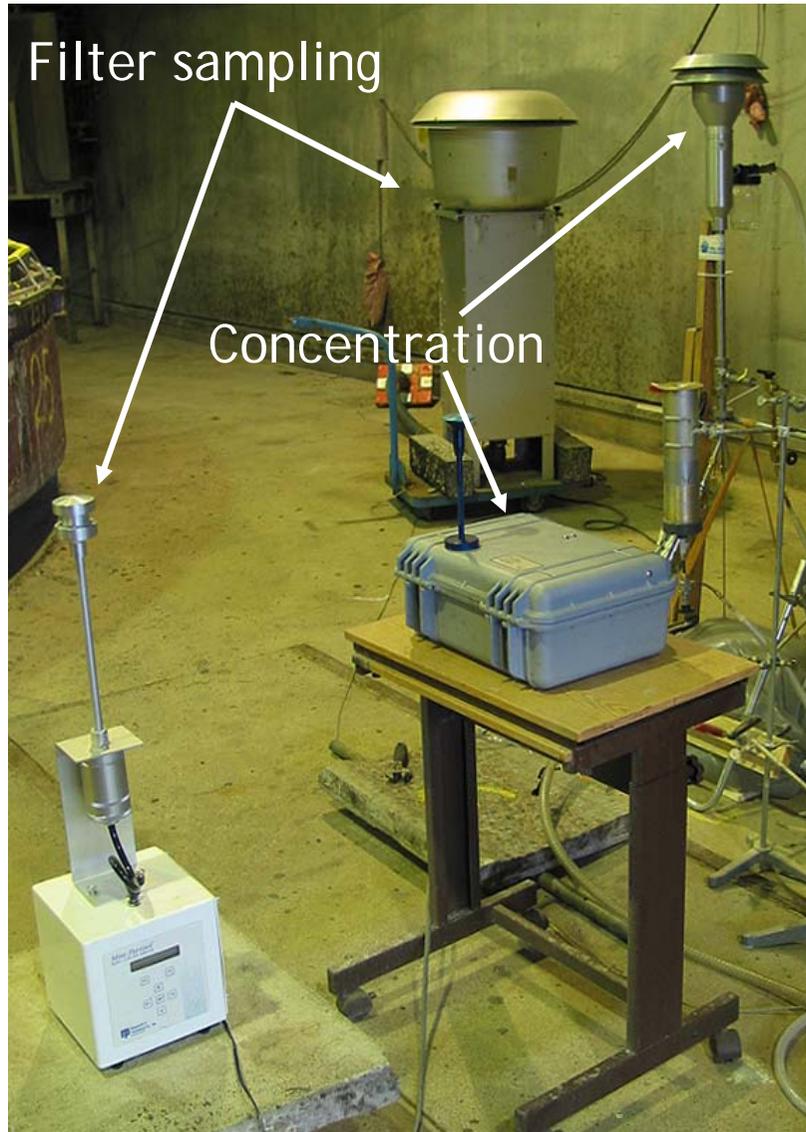
LUNDS UNIVERSITET

How do we study this?





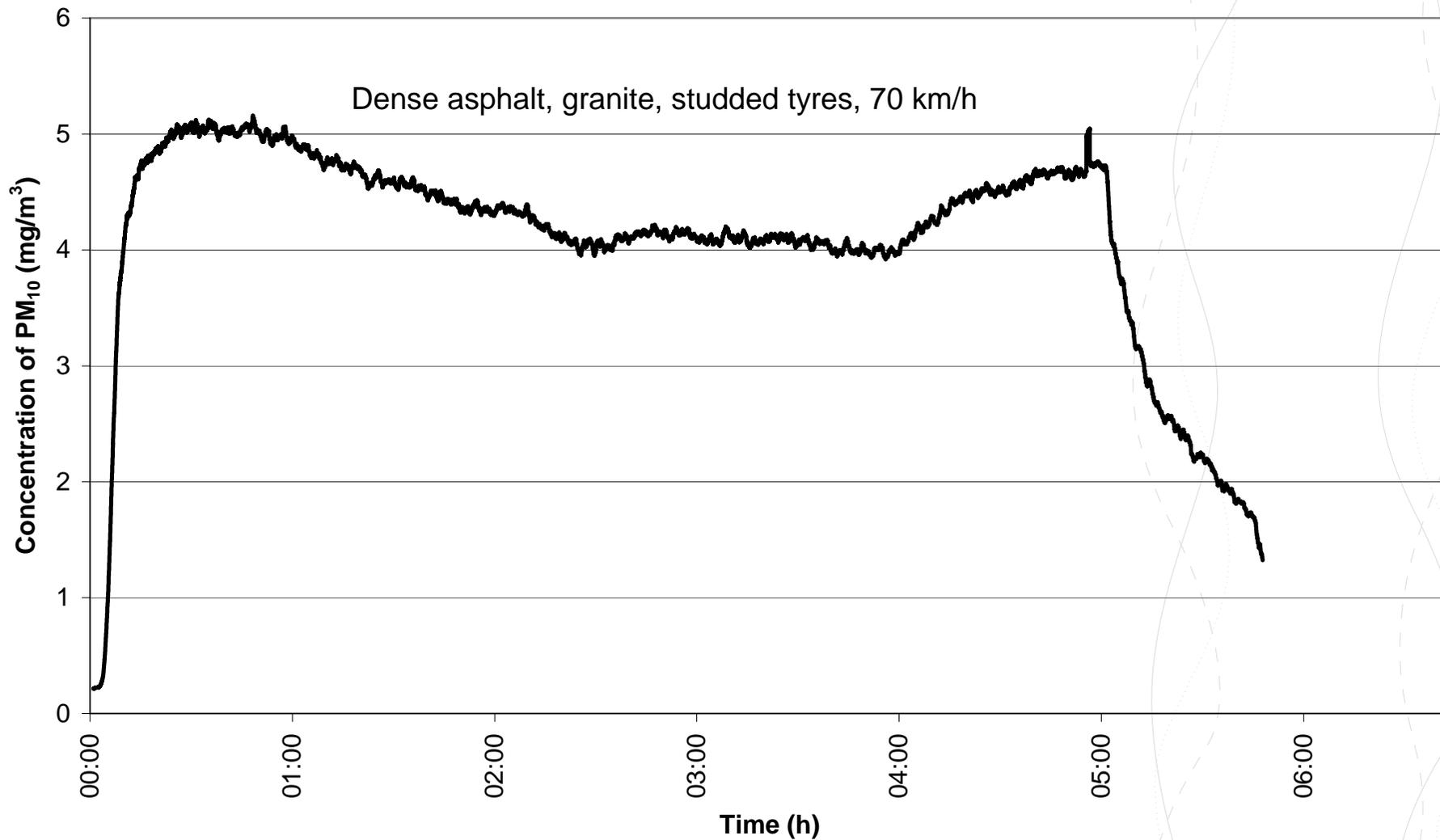
How do we study this?



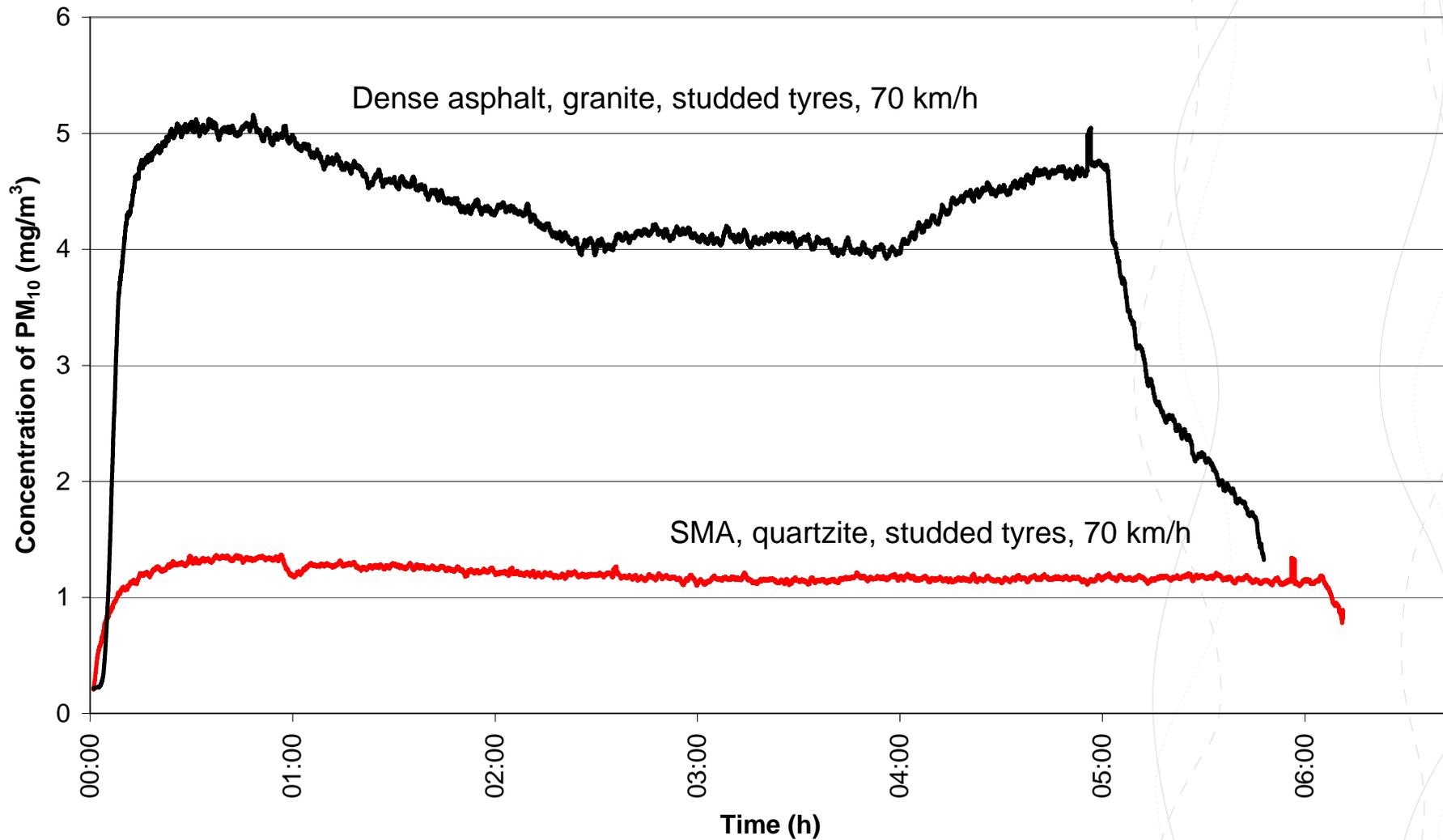
	<u>Pavement</u>	<u>Tyre</u>	<u>Friction material</u>
1.	Dense asphalt, granite	Studded	-
2.	SMA*, quartzite	Studded	-
3.	SMA, quartzite	Friction	-
4.	SMA, quartzite	Studded	Crushed stone
5.	SMA, quartzite	Friction	Crushed stone
6.	SMA, quartzite	Friction	Sand
7.	SMA, quartzite	Studded	Sand

*SMA = stone mastic asphalt (skelettasfalt)

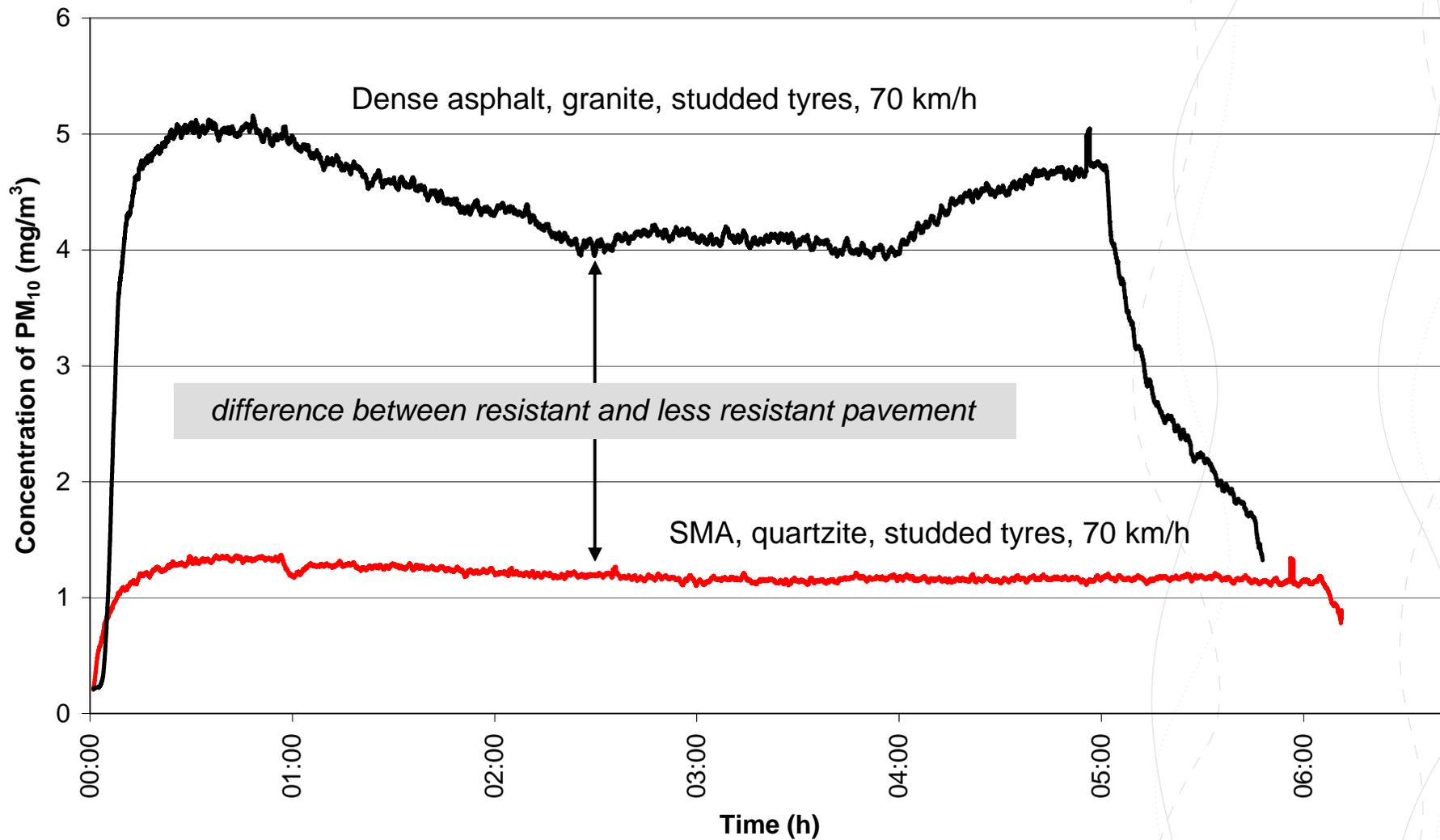
PM₁₀ concentration (tyres and pavement)



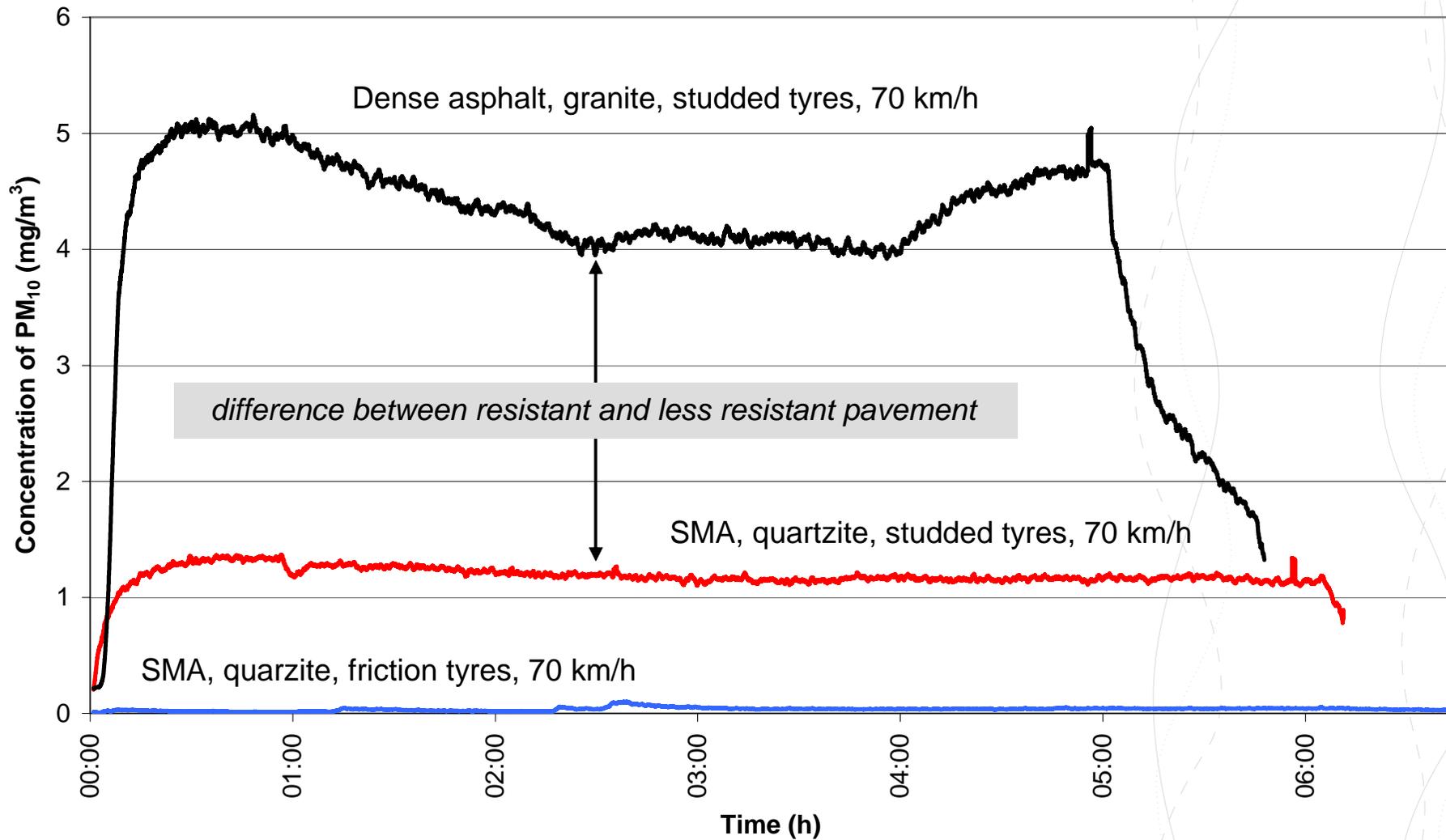
PM₁₀ concentration (tyres and pavement)



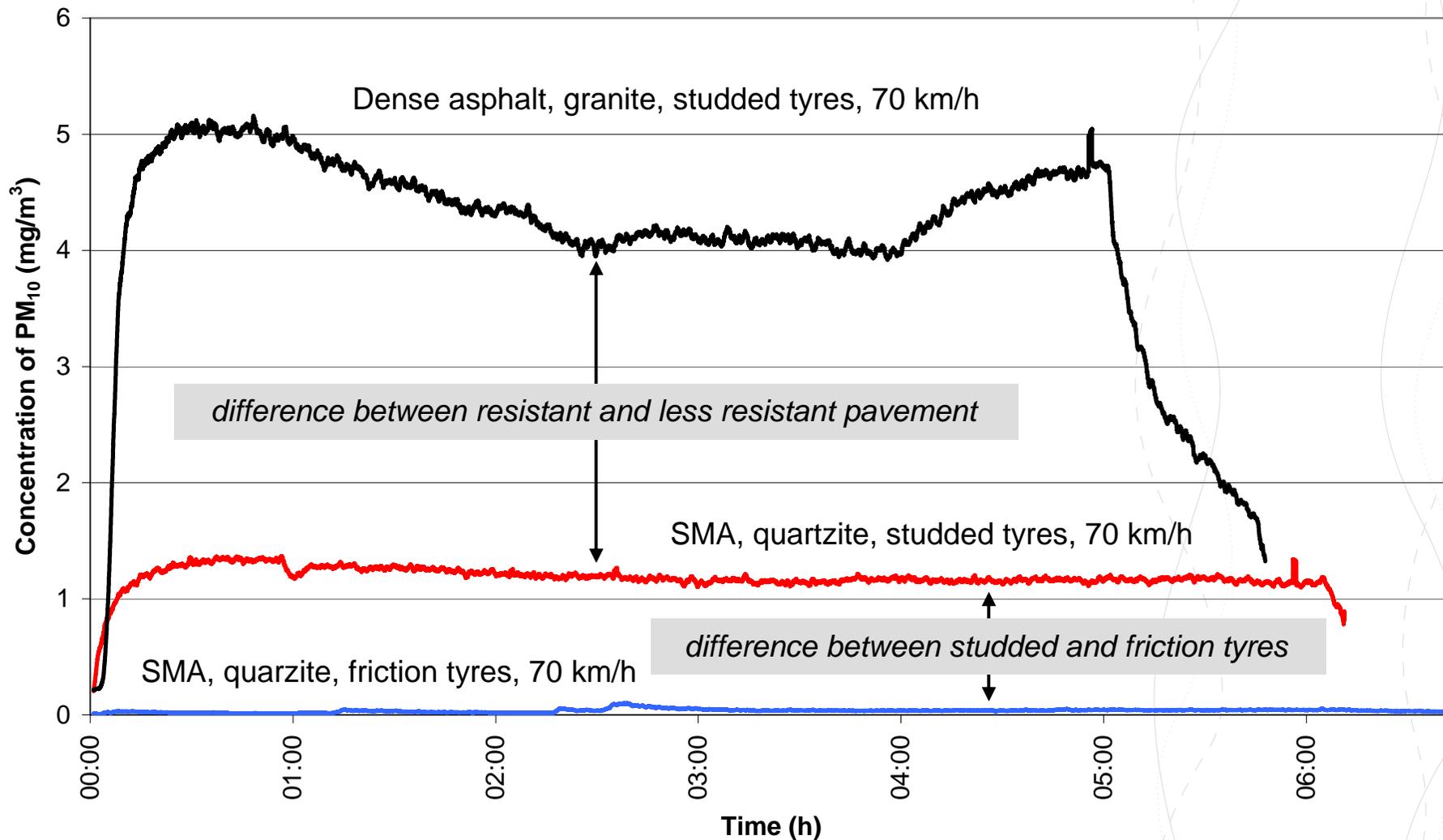
PM₁₀ concentration (tyres and pavement)



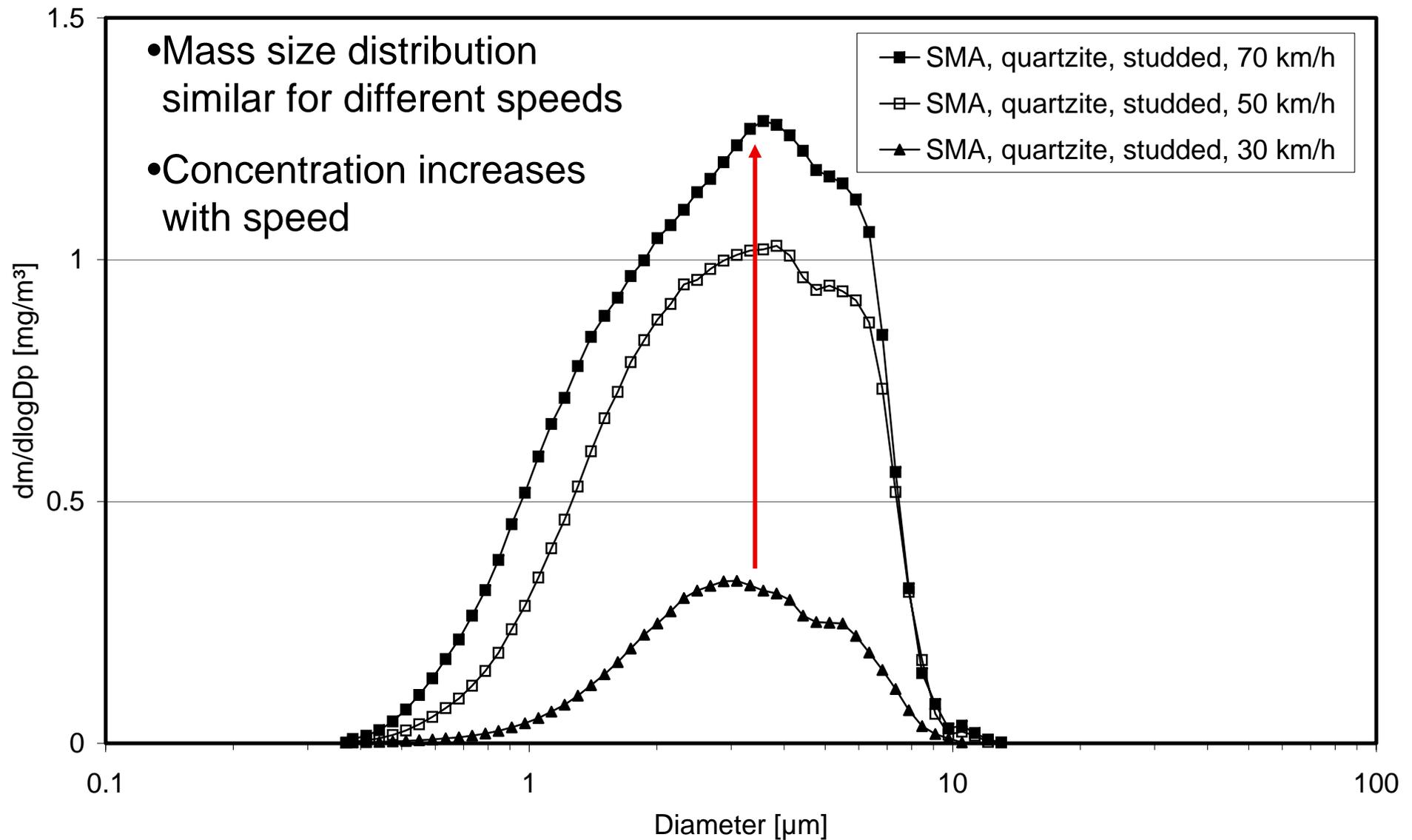
PM₁₀ concentration (tyres and pavement)



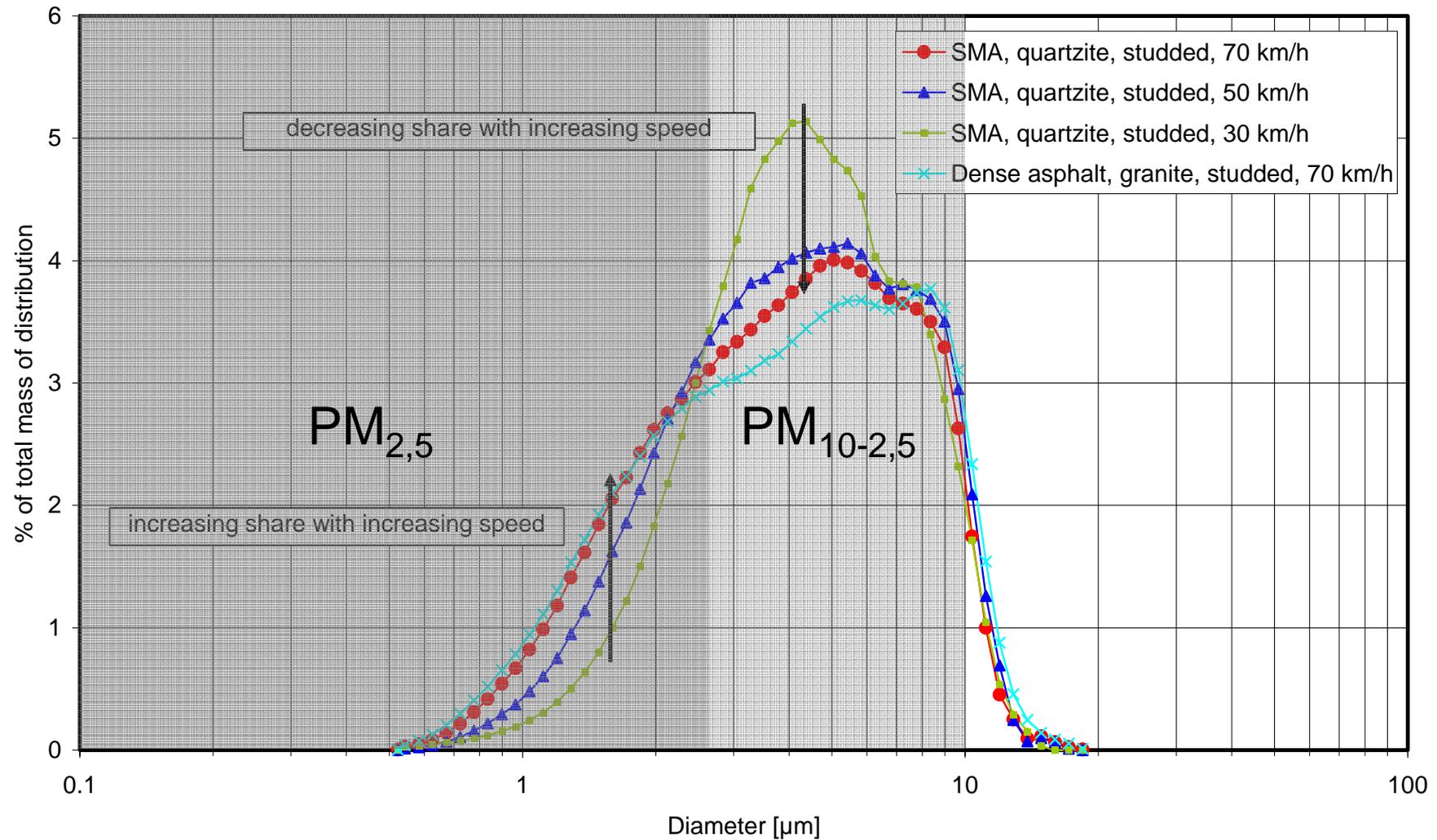
PM₁₀ concentration (tyres and pavement)



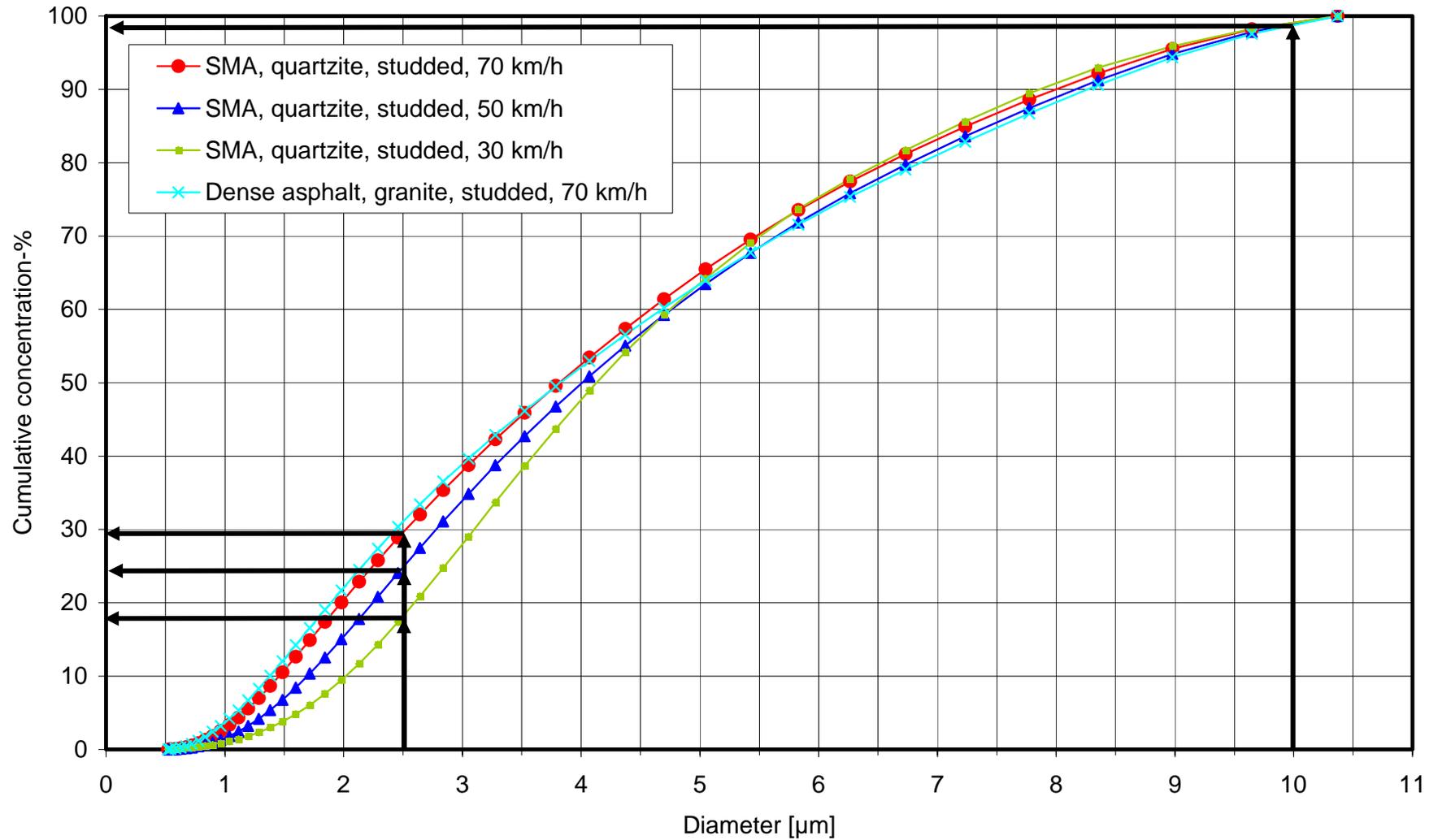
Mass size distribution, PM₁₀



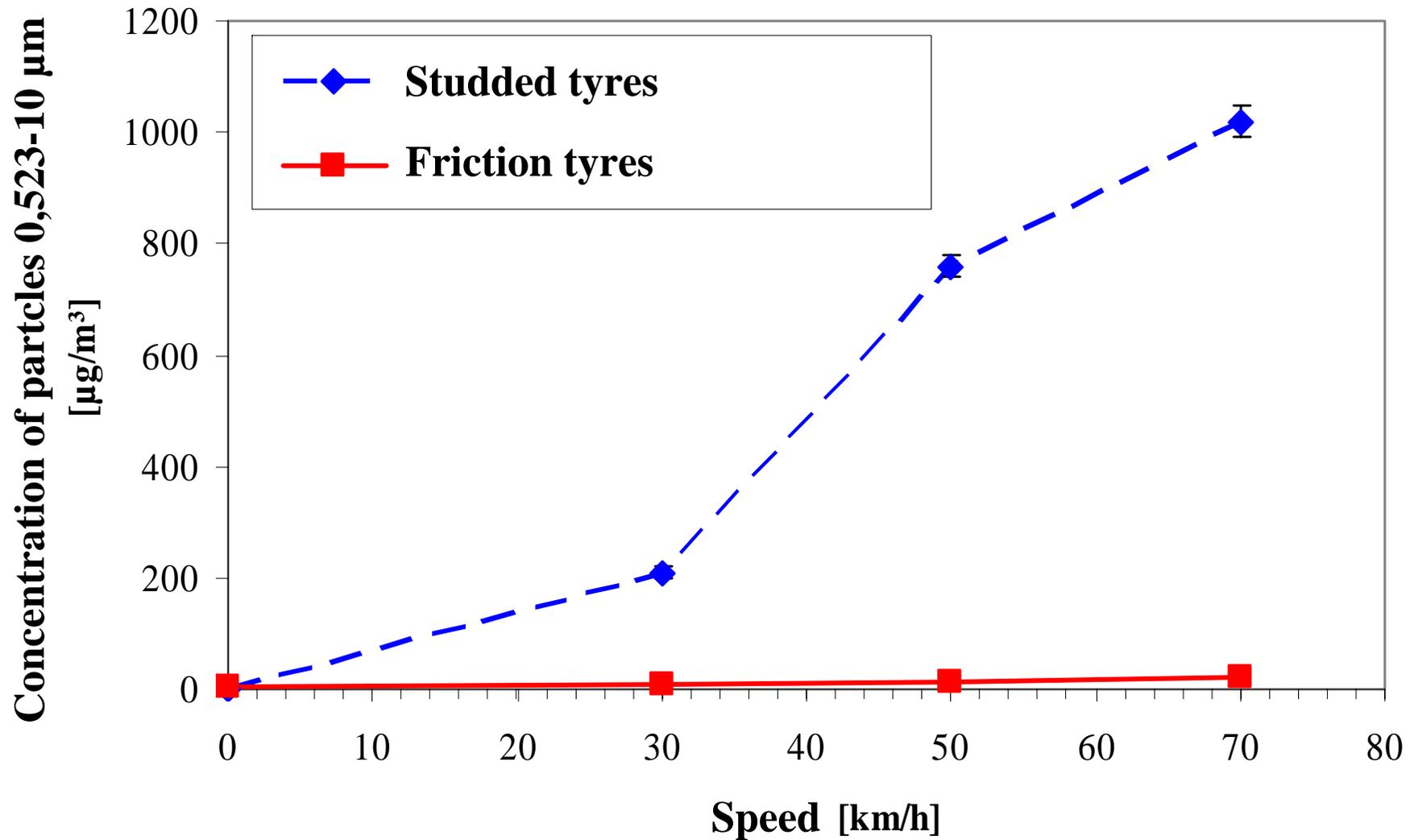
% of total mass distribution, PM₁₀



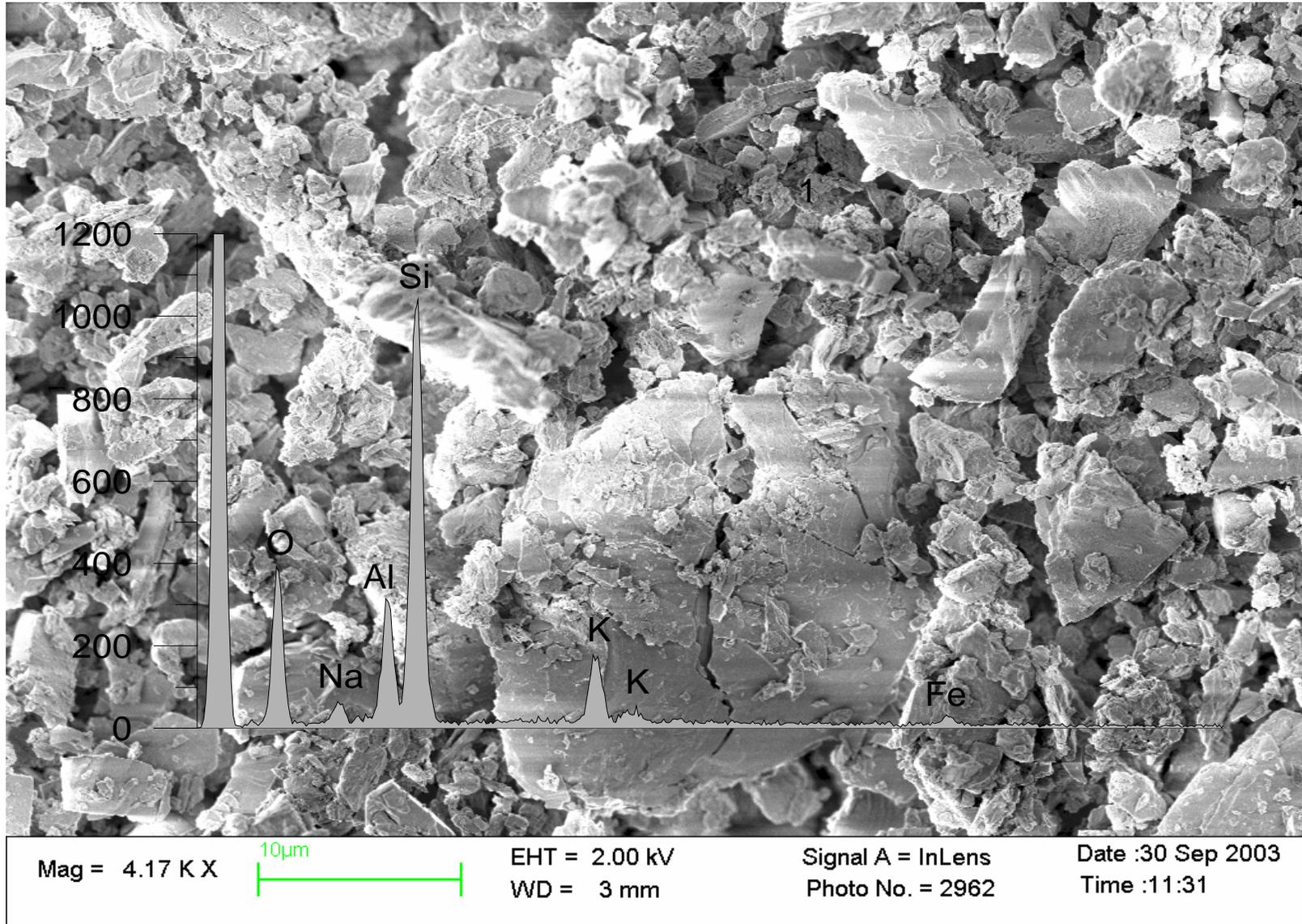
Cumulative concentration-%, PM₁₀



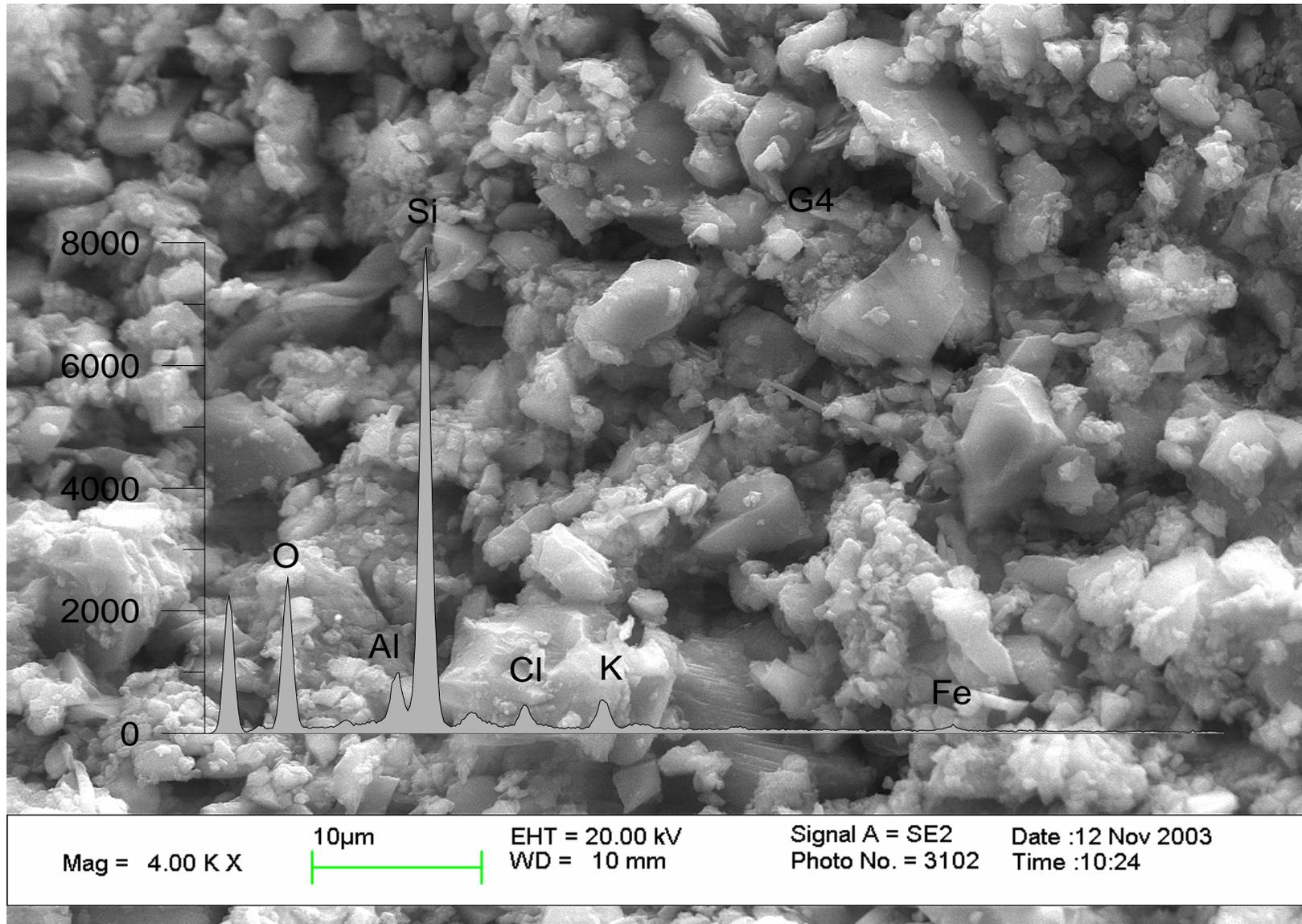
Relation to speed, particles 0,523-10 μm



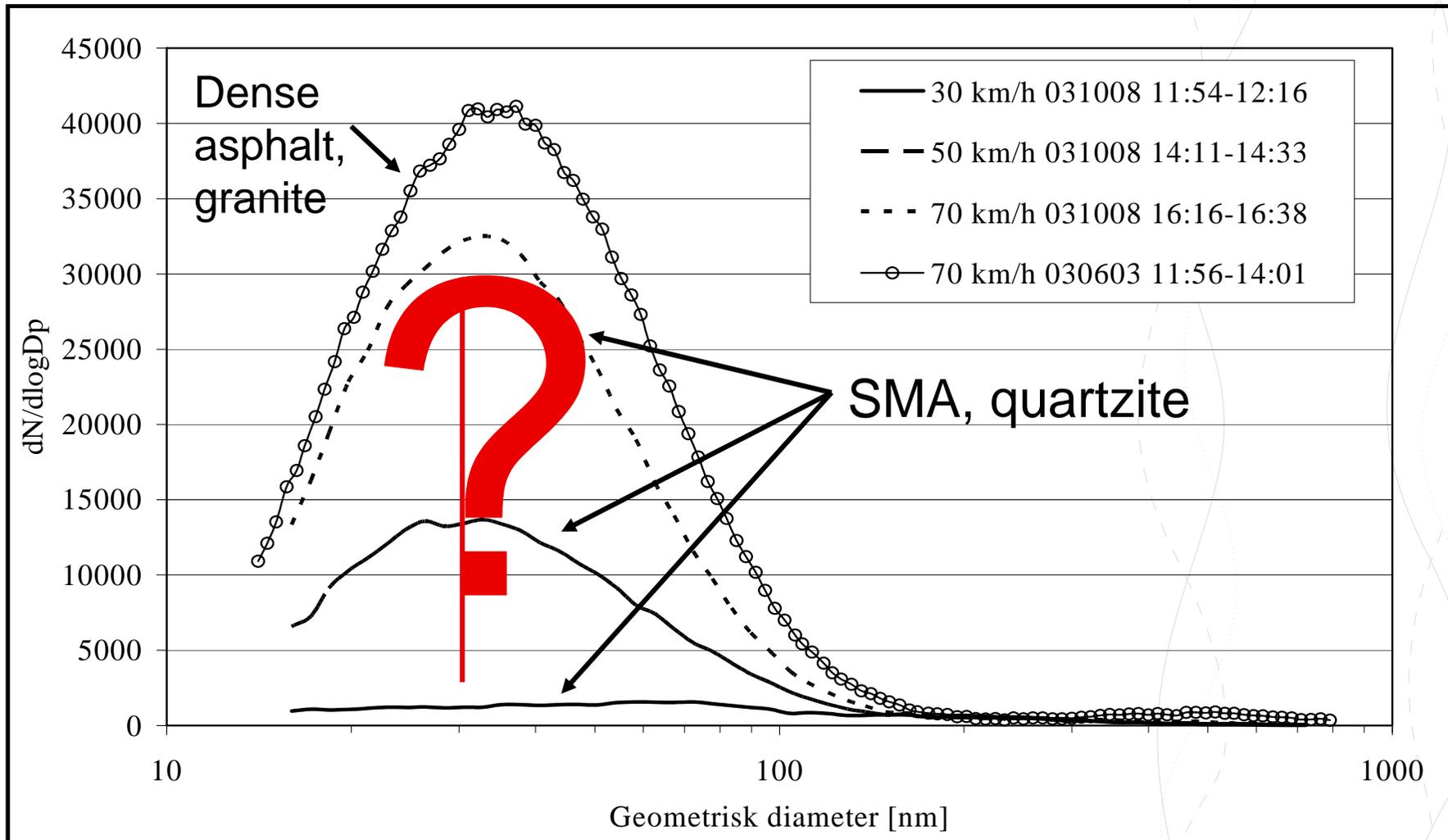
SEM, Dense asphalt, granite, studded tyres

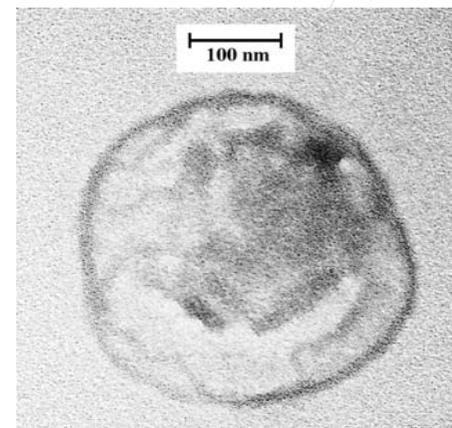
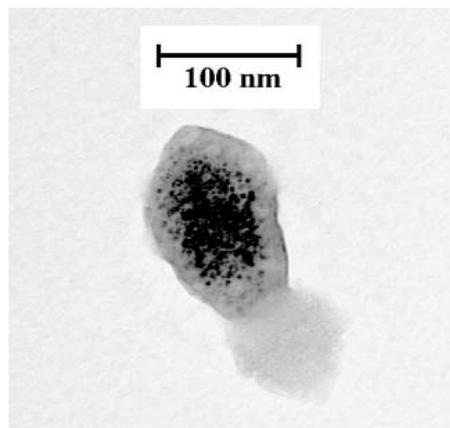
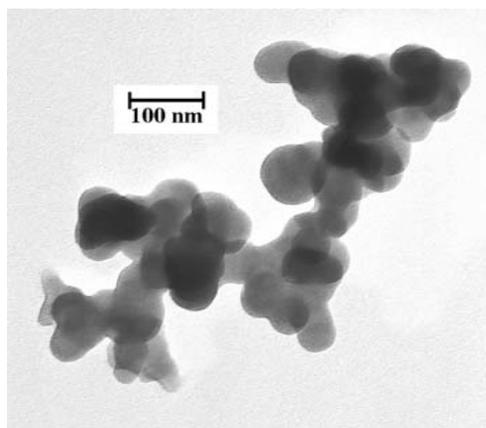


SEM, SMA, quartzite, studded tyres

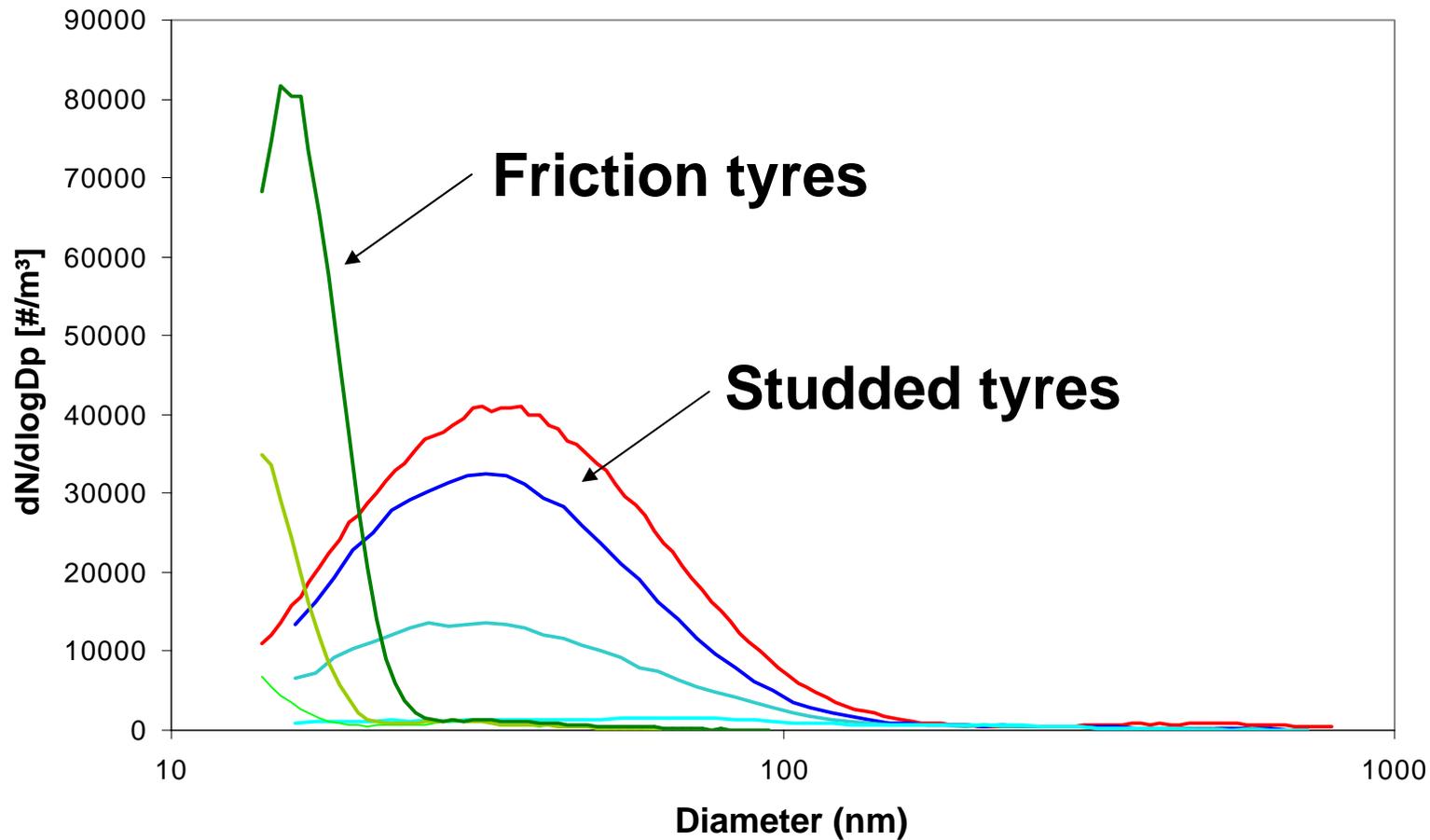


Number size distribution, sub-micron particles



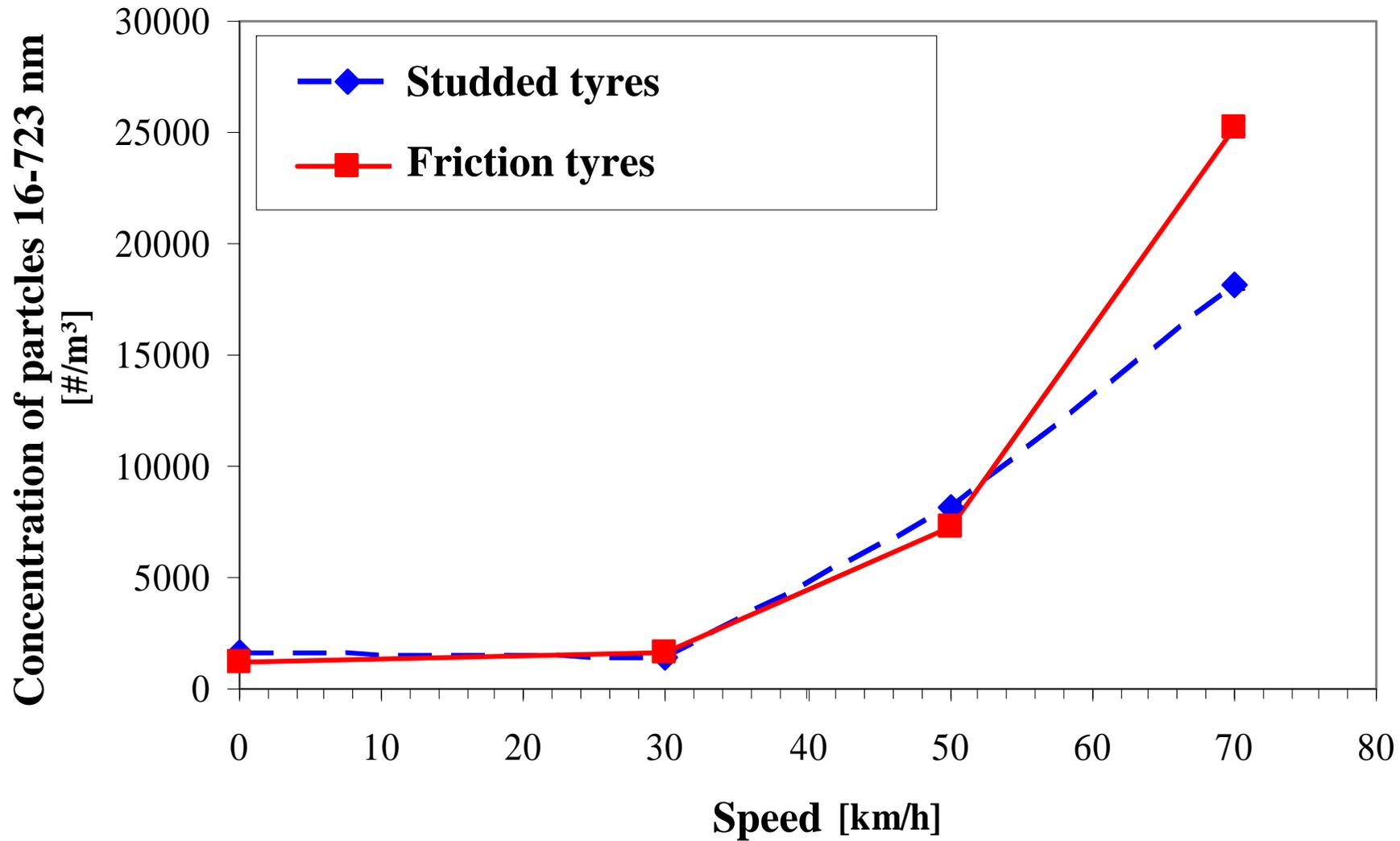


Source?



Tyre particles?

Relation to speed, particles 16-723 nm



Emission factors for sub-micron particles



Tire	Road surface	Speed (km h ⁻¹)	Number of measurements	Emission factor (particles vehicle ⁻¹ km ⁻¹)
Non studded tires	Rubber	50	1	3.7•10 ¹¹
Non studded tires	Rubber	70	1	1.1•10 ¹²
Non studded tires	Quartzite, ABS (stone mastic asphalt)	50	1	3.8•10 ¹¹
Studded tires	Quartzite, ABS (stone mastic asphalt)	70	1	1.9•10 ¹²
Studded tires	Quartzite, ABS (stone mastic asphalt)	50	1	6.1•10 ¹¹
Studded tires	Granite, ABT (asphalt concrete)	70	2	3.1•10 ¹²

From Dahl, A. et al., 2005 (submitted to Atmospheric Environment)

Comparison: $2.7 \pm 1.1 \cdot 10^{14}$ particles vehicle⁻¹ km⁻¹ in road tunnel with 95% gasoline powered LDV, 5% diesel powered LDV with an average speed of 70 km h⁻¹ (Kristensson et al., 2004).

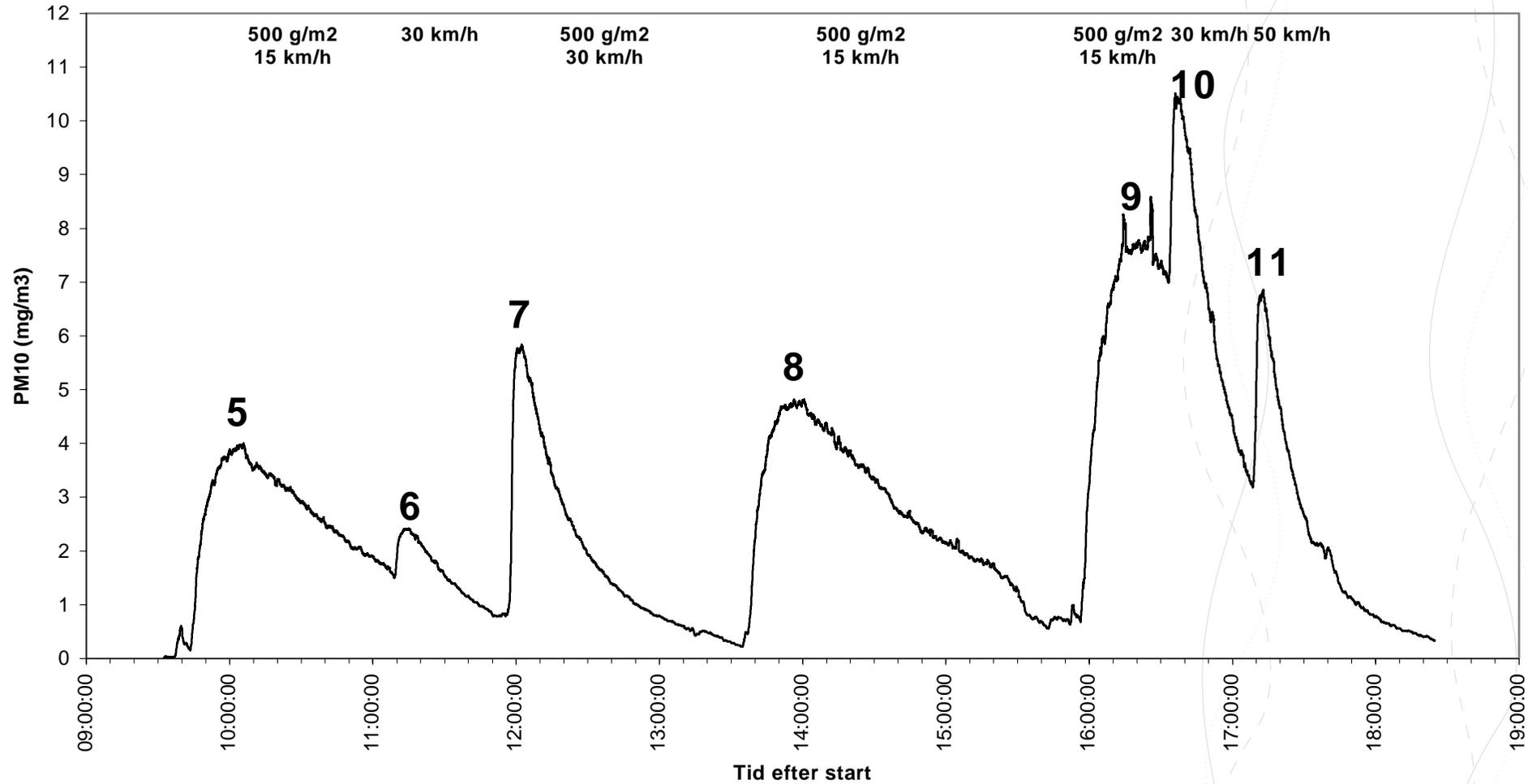
Friction material in the road simulator

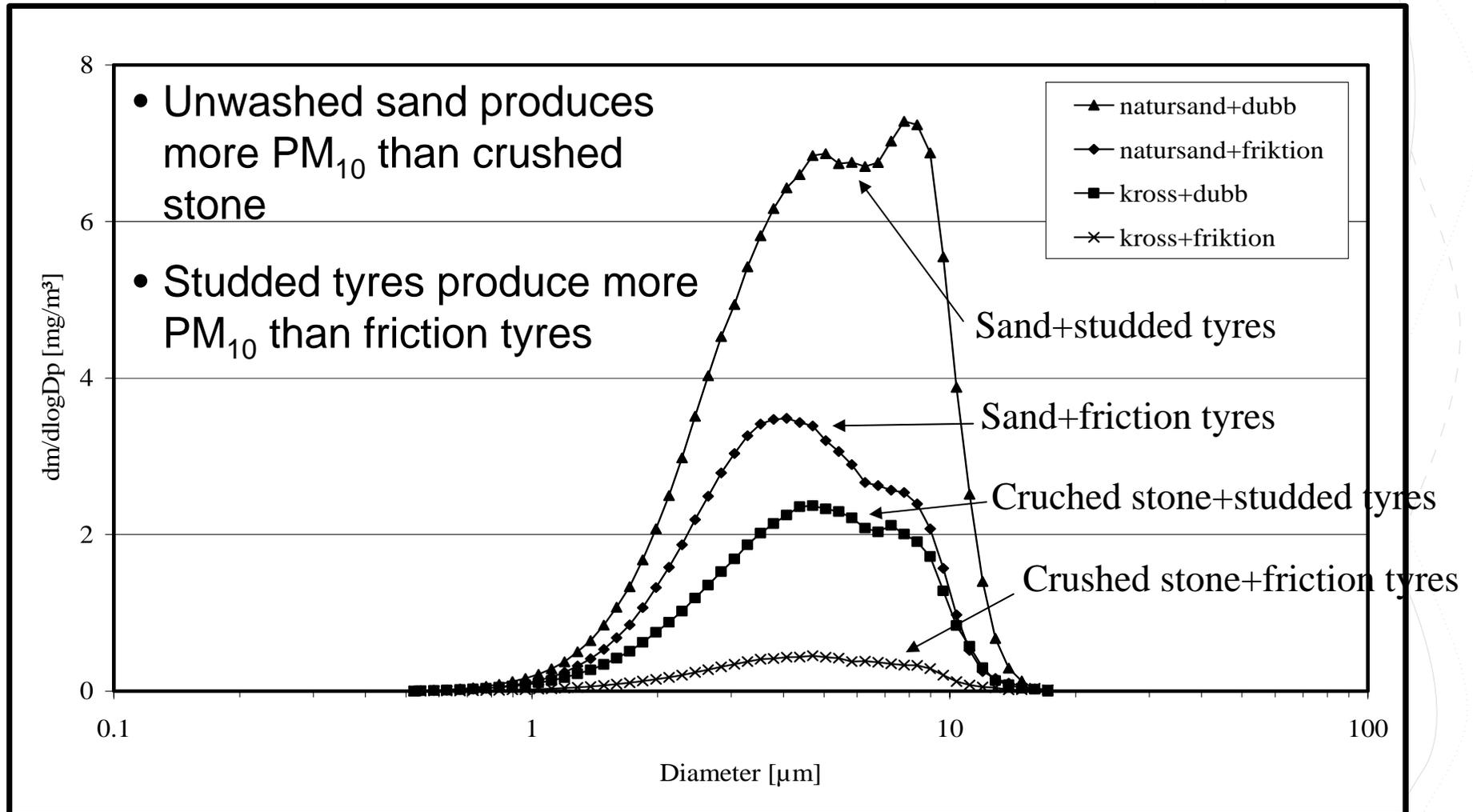


Concentration of PM₁₀ using crushed stone

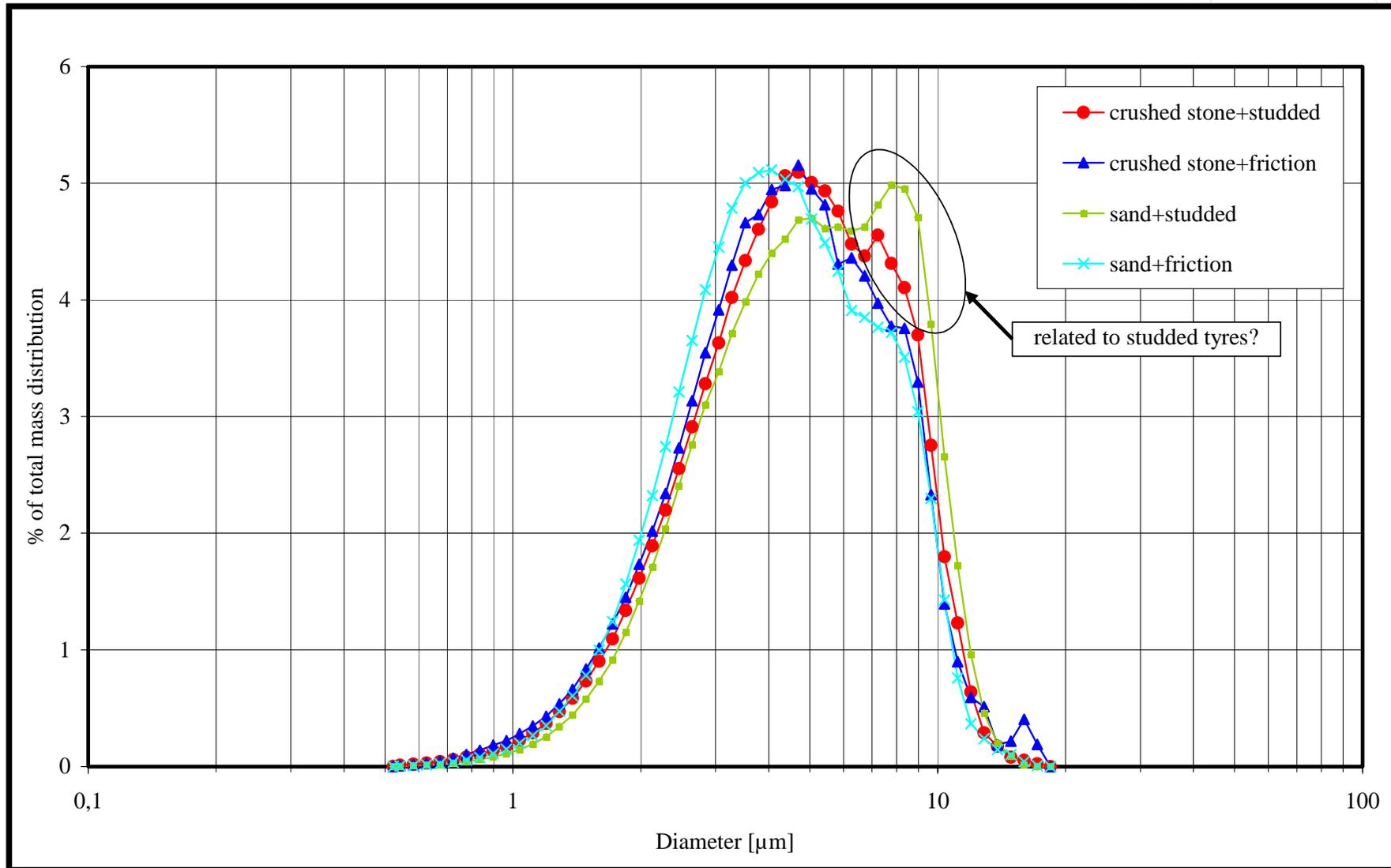


2004-02-11





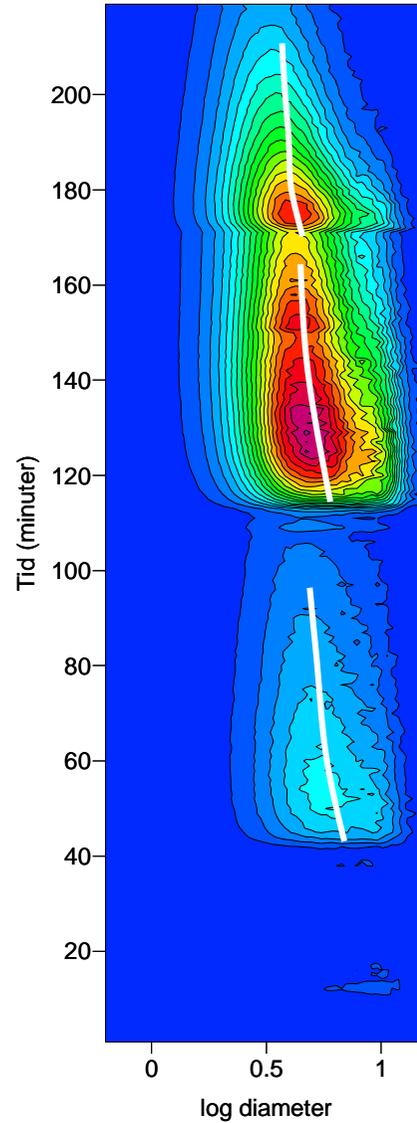
% of total mass distribution, PM₁₀



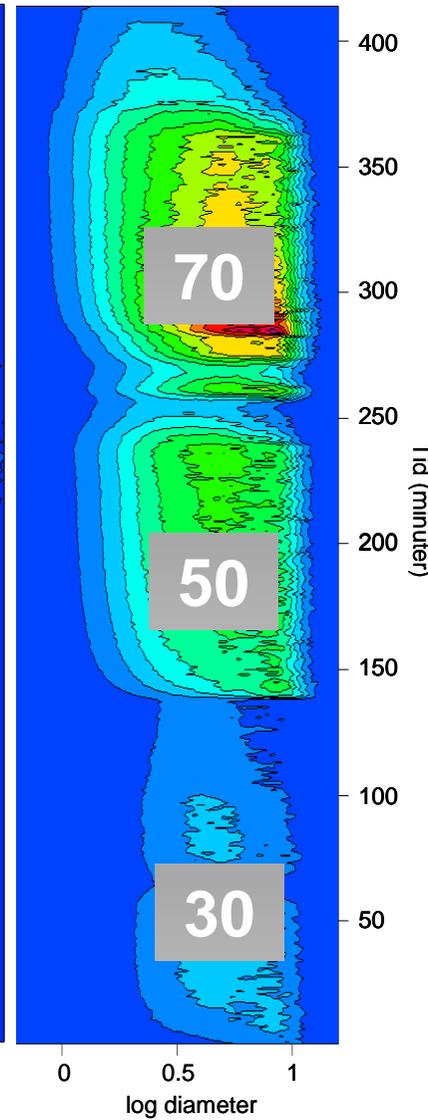
Mass size distribution, PM₁₀



With
friction material



Without
friction material



Some important conclusions...



- Studded tyres generates 40 - 50 times higher concentrations of PM₁₀ than friction tyres on the same pavement.
- A dense asphalt with granite generates several times higher PM₁₀ concentrations than an SMA with quartzite.
- Higher speed causes higher PM₁₀ concentrations and a higher share of finer particles (PM_{2.5}).
- Sub-micron particles are formed during wear between tyres and pavement. Tyres are a potential source.
- Washed crushed stone generates less PM₁₀ than unwashed sand, irrespective of tyre type.
- The particles are strongly dominated by mineral particles. Tyre and bitumen have not been identified in the SEM studies.

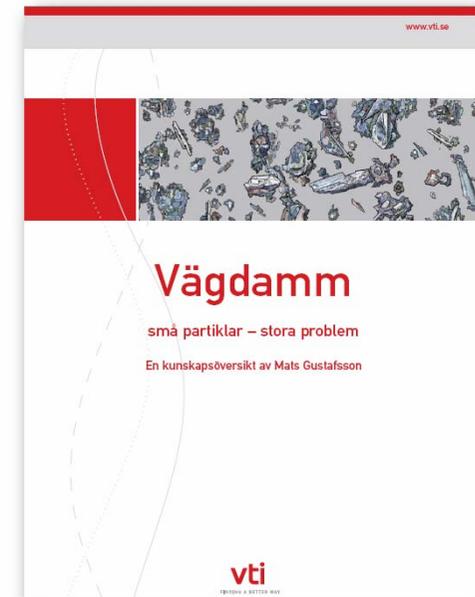
- Studded tyre effect
- Pavement properties
- Speed
- Effect of winter sanding (material properties, size distribution)

- Reduce concentrations and effects of road dust PM₁₀ through:
 - reducing the use of studded tyres
 - using pavements producing less and also less inflammatory particles
 - reducing speed
 - Using washed friction material for winter sanding



VTI-rapport 520 and 521

Booklet about road dust



VTI research related to road dust



Ongoing projects

- PM₁₀ in railway environments, 2004-2005
- Dust minimized operation, 2004-2006
- NanoWear - Nano particles from wear of tyres and road pavement?, 2005-2007
- WearEm - Emissions of wear particles, 2005-2008
- Dusting from pavements and traction materials, 2005-2007

Thanks for listening!