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Koralmbahn Graz – Klagenfurt
Bahntechnische Ausstattung Koralmtunnel

SÜD STRECKE | MEHR ERFAHREN

Dust-loads in railway tunnels –

“Results from in-situ measurements and consequences for tunnel facilities and railway operation”

Helmut Steiner, ÖBB, Graz (A)
Peter Sturm, IVT, TU Graz (A)
Daniel Fruhwirt, IVT, TU Graz (A)

02.12.2020 – Graz

Koralmtunnel – KAT 2 / ÖBB (A)
20.10.2020 / Steiner

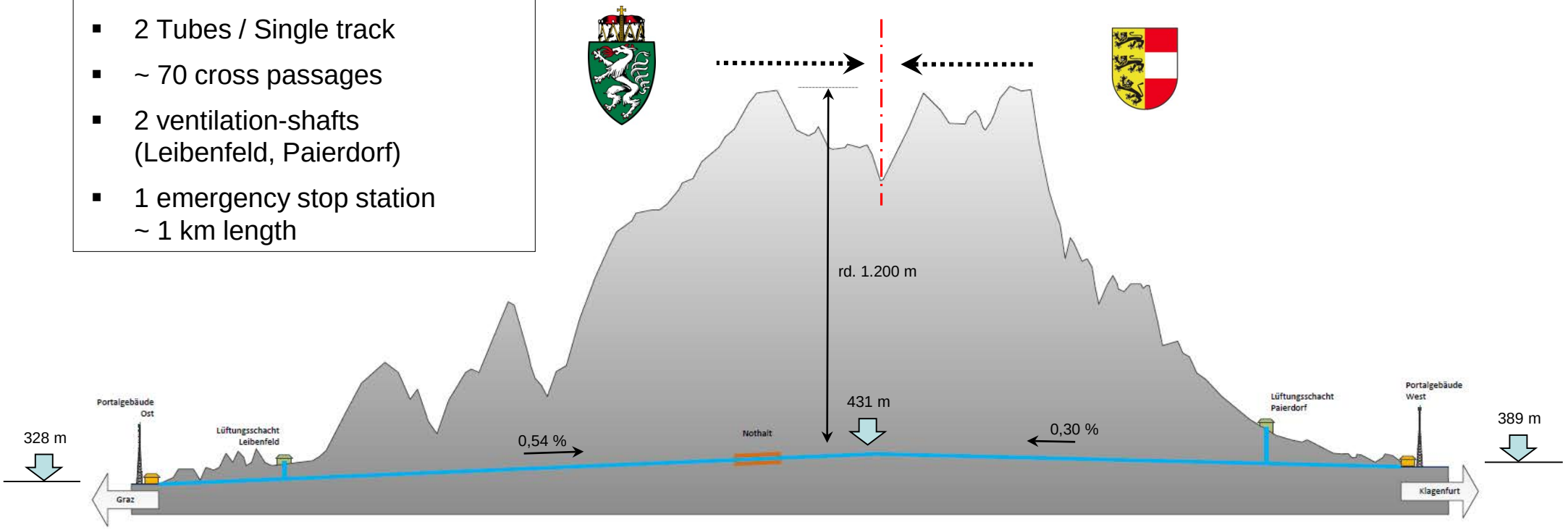
Koralmbahn / KAB – Graz - Klagenfurt

- Part of the Baltic-Adriatic TEN-T Line
- KAB / 127 km new railway line
- KAT / 32.8 km – twin tube / single track
- 2 new IC + 10 further railway stations
- 250 km/h high speed
- < 1 % track gradient
- 45 min. Graz – Klagenfurt
- 2.5 Std. Vienna – Klagenfurt

Railway station – West Styria

Koralm Tunnel / KAT – Cross section / Overview

- ~ 32.9 km - total length
- 2 Tubes / Single track
- ~ 70 cross passages
- 2 ventilation-shafts (Leibenfeld, Paierdorf)
- 1 emergency stop station ~ 1 km length



Motivation

Ceneritunnel / Camorino (CH)
01.06.2017 / Steiner

Motivation

Long rail tunnels require a lot of technical equipment for operation, which has to be installed inside the tunnel.

In order to have reliable data for planning the ÖBB commissioned detailed research in various relevant areas already at an early stage.

One of these topics is the problem of dust loads in long railway tunnels.

It is a well known fact, that high dust loads have a negative impact on the working conditions and lifetime of electrical components.

Long rail tunnels already in operation, like Wienerwald Tunnel (A), Lötschberg or Gotthard Base Tunnel (CH) report dust problems and shortened maintenance intervals for the technical equipment.

Motivation

A big part of the electrical equipment is located inside the cross passages in dedicated utility rooms or compartments.

Temperature constraints for this equipment require a temperature controlled environment. This means that either cooling by ventilation or air-conditioning is required.

Dust restricts the heat exchange at surfaces and has particularly high potential for interference or damage due to its electrical conductivity.

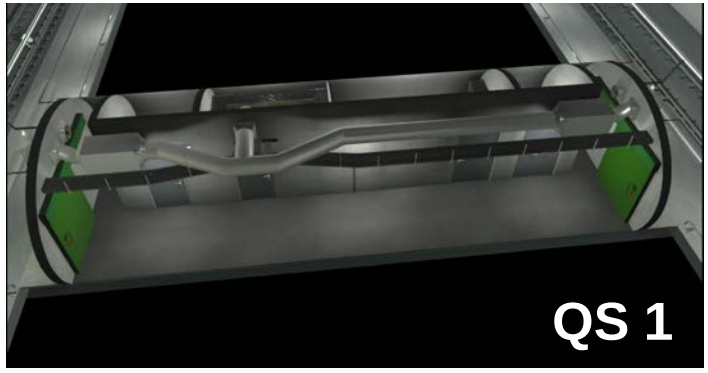
Dust sources:

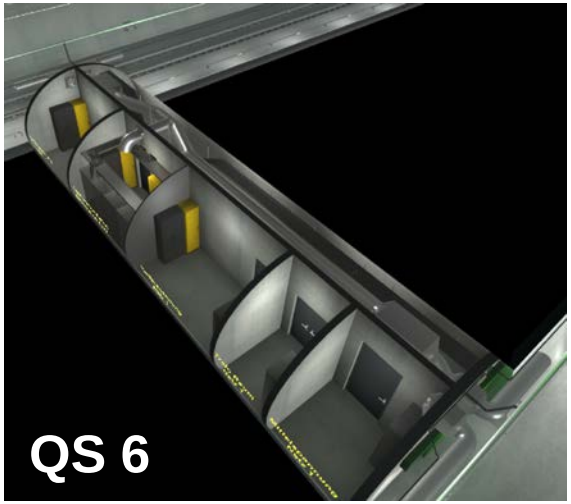
- Exhaust particles (mainly soot) from diesel powered locomotives (rather small source in A)
- Non-exhaust particles from abrasion of breaks, rails, wheels, catenary wire, pantograph as well as dust resuspension and lost goods (freight trains)

Typical components metals: Fe (rails, wheels, breaks), Cu (catenary wire, pantograph, breaks), Cr and Mn (from steel parts), Zn (breaks)

KAT – Cross passages / 3D-views

Cross passages - normaly five utility rooms (telecommunication, power supply), escape way – sluices, escape doors at both sides





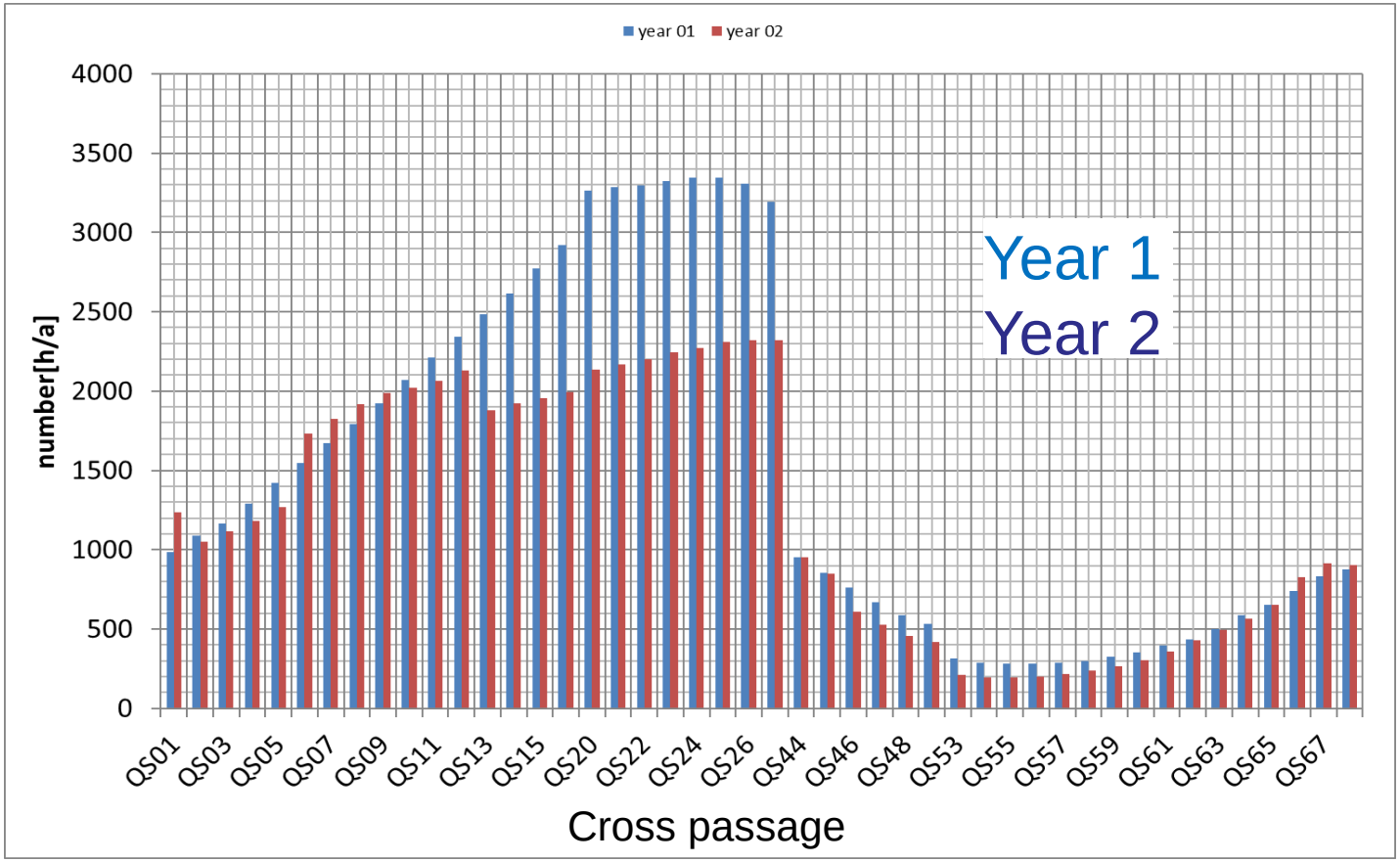
Dust-loads – Examples


Burgstallertunnel / ÖBB (A)
29.09.2020 / Steiner


Wienerwaldtunnel / ÖBB (A)
27.05.2013 / Steiner

Telecommunication rooms, exceedance of target value for air temperature

Target value for air temperature in telecommunication rooms < 22°C



→ Need for active cooling

PM Measurements

Tunnel Unterwald

Ceneritunnel / Camorino (CH)
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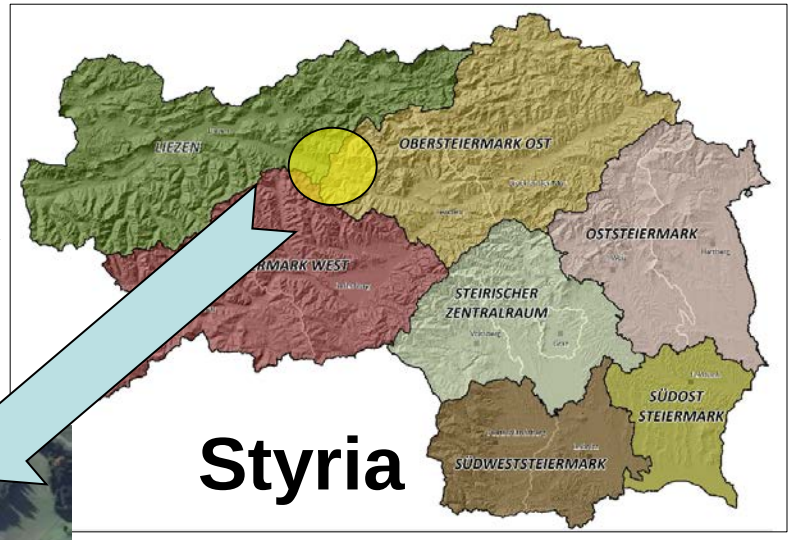
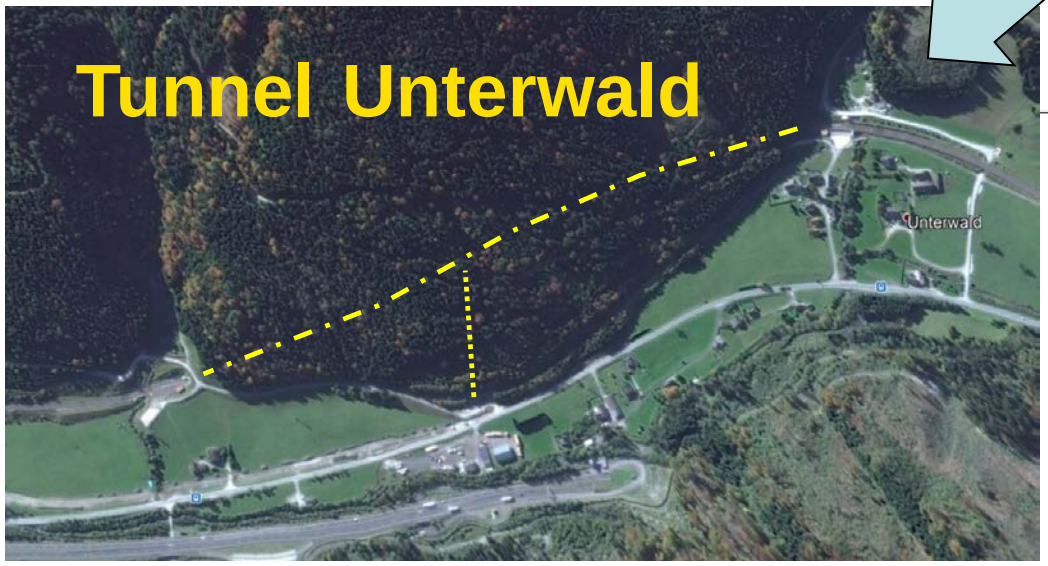
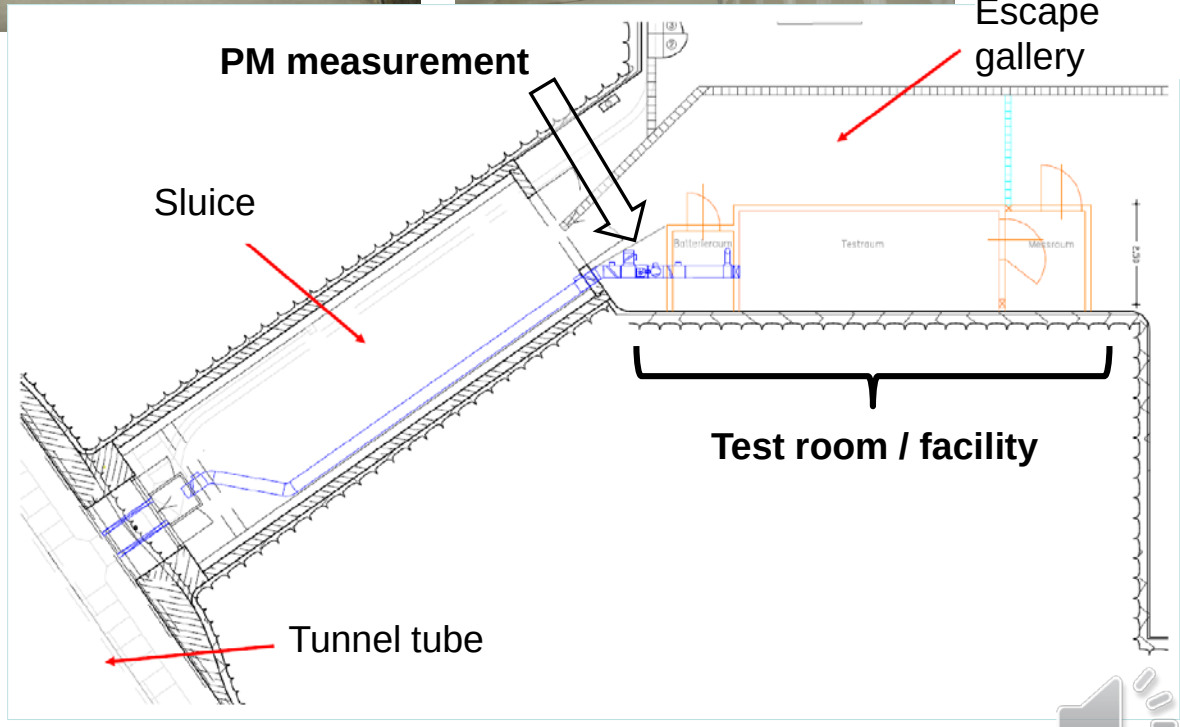
Testlocation – Tunnel Unterwald / Overview





- 1.1 km Tunnel length
- 1.52% Slope
- Single tube, double track
- Slap track
- One emergency exit

Test facility – Tunnel Unterwald / Emergency Exit



PM Measurements – Measurement parameters

Particulate matter

- Mass and concentrations (TEOM, SHARP, high volume sampler)
- Chemical composition (Quartz-/ Cellulose filter)

Tunnel air

- Velocity, temperature, humidity

Dust filters

- Pressure loss, PM load (TSP), ‚lifetime‘

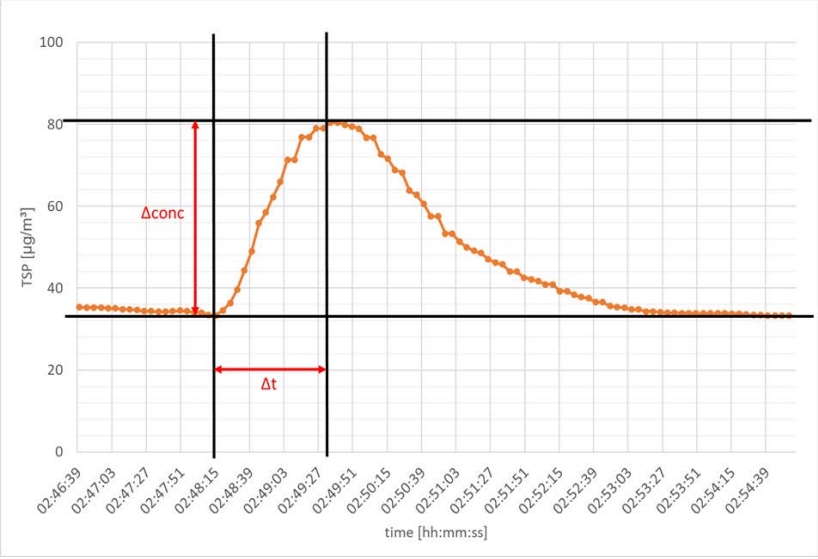
Trains

- Type of trains (video image processing), speed, direction

Outside parameters

- Temperature, precipitation

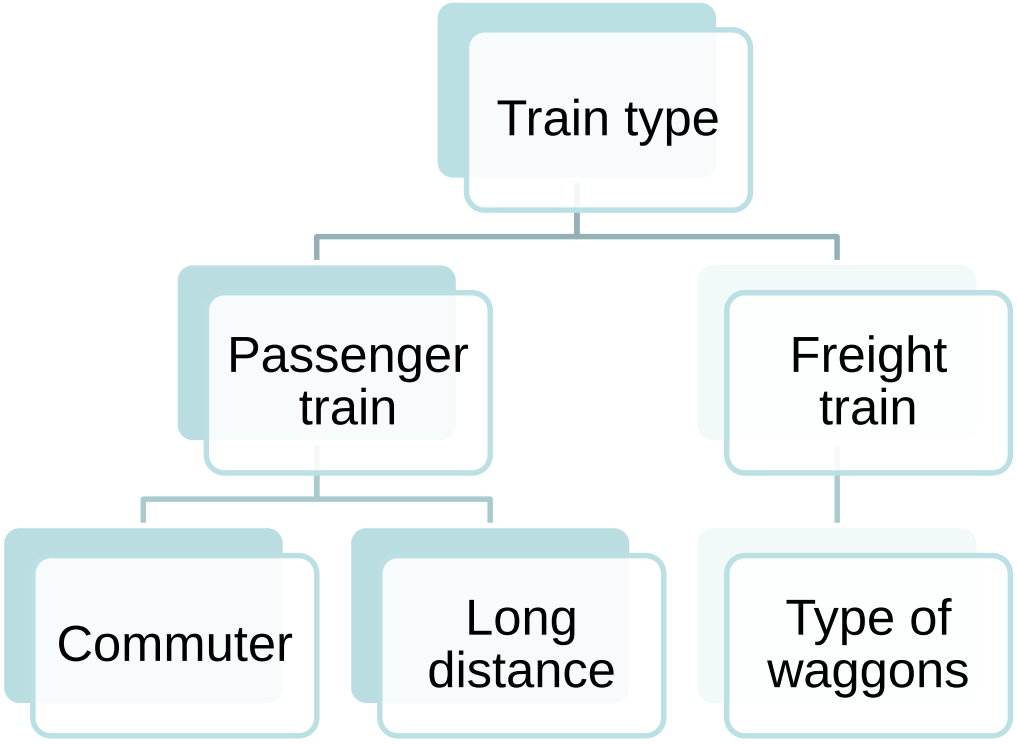
Methodology



$$EMF_{peak} = \frac{\Delta m_{conc} * A_{tunnel} * v_{tunnel\_avg} * \Delta t}{l_{char}} \Bigg]$$

EMF_{peak}	Emission factor [mass/km]
A_{tunnel}	Tunnel cross section [m²]
v_{tunnel}	Air velocity [m/s]
l_{char}	Distance between entrance portal and measurement location[m/s]

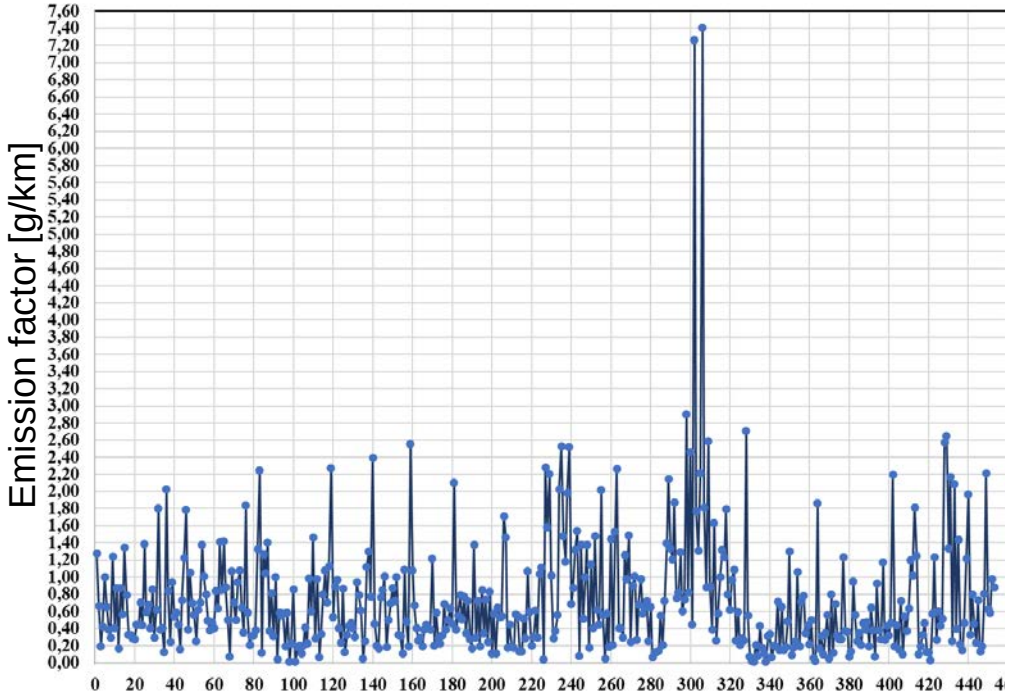
Train types

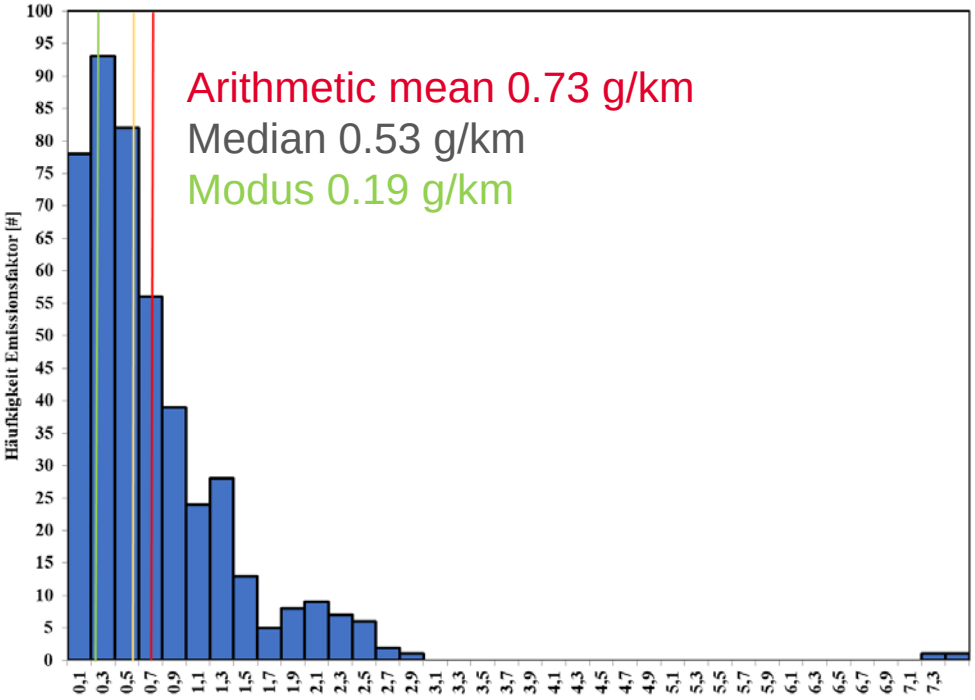

Train type
Passenger train
Freight train
Commuter
Long distance
Type of waggons


25 °C 77 °F 26/10/2019 12:19:50 0149


10 °C 50 °F 28/10/2019 10:39:05 0268

Raw data – Long distance passenger trains





Emission factors

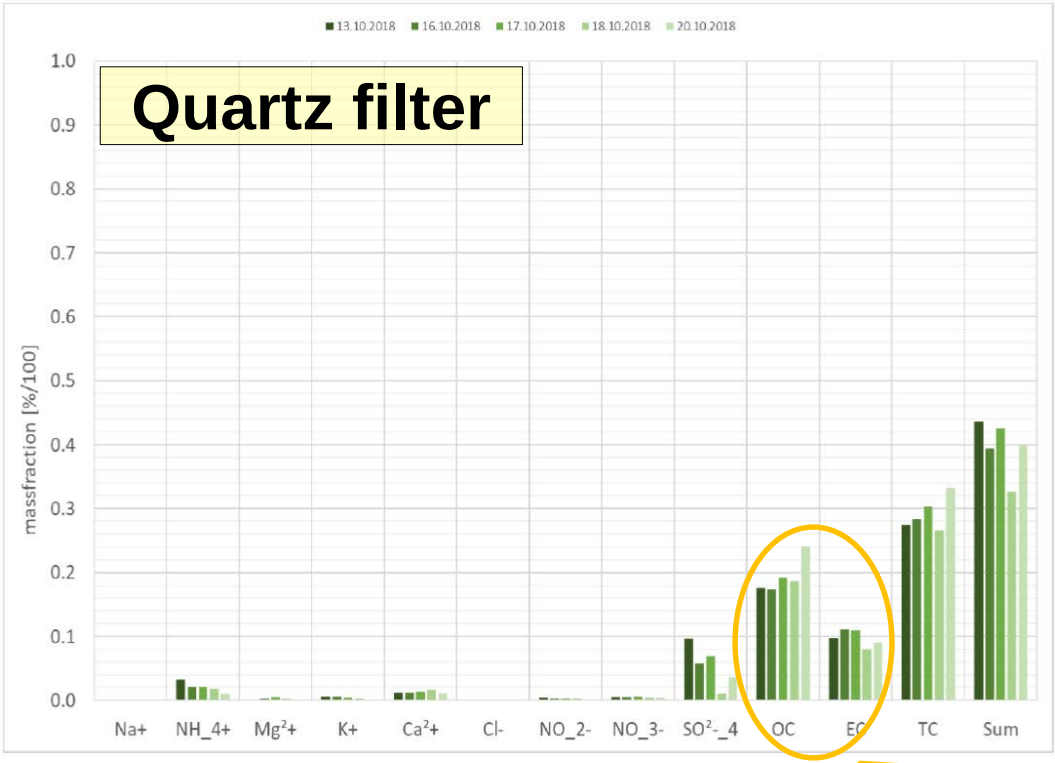
	Train-movements [#]	Emission factor [g/km] (median)	Q1/Q3		Train-movements [#]	Emission factor [g/km] (median)	Q1/Q3
Total	1576	0.48	0.162 / 1.433				
Passenger trains	803	0.26	0.103 / 0.651	Freight Trains	702	1.15	0.425 / 2.771
R	297	0.14	0.043 / 0.398	RORO	29	0.86	0.388 / 3.214
REX	48	0.27	0.099 / 0.568	Trans_ Euro	32	0.61	0.278 / 2.158
EC	160	0.35	0.166 / 0.747	Long_Dist	423	1.34	0.492 / 2.893
IC	232	0.38	0.175 / 0.871	Regional	201	1.15	0.237 / 2.152
NJ	55	0.40	0.159 / 1.109	empty	54	0.18	0.065 / 0.412

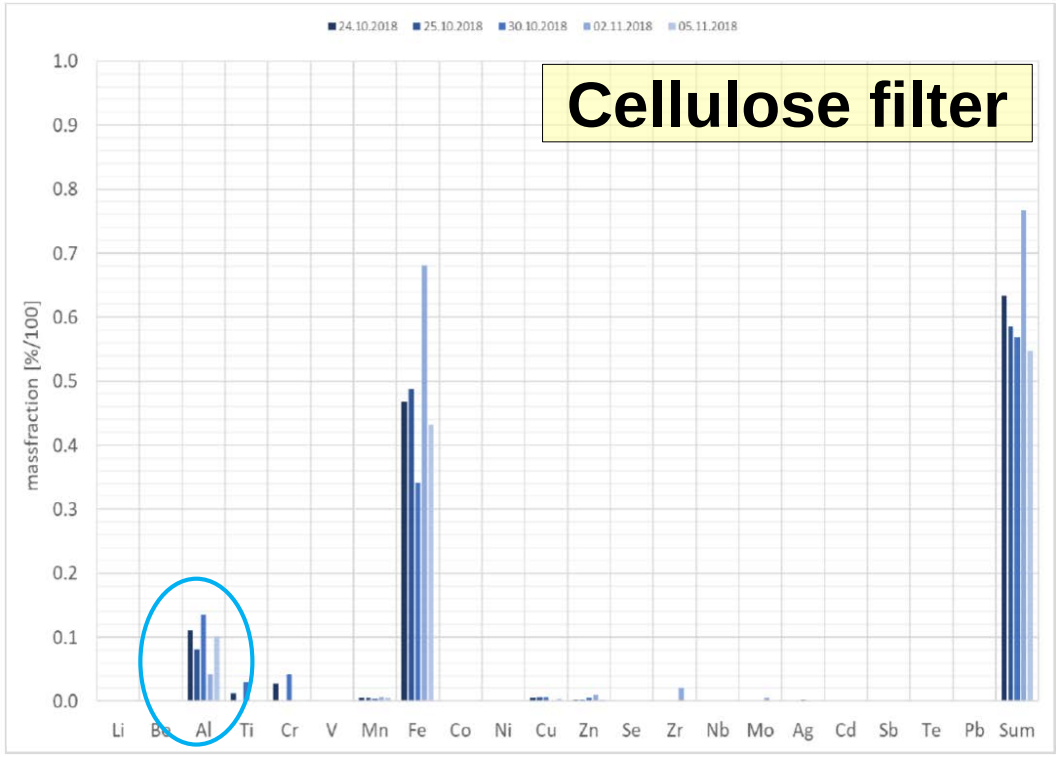
R, REX regional trains
EC, IC, NJ long distance trains

RORO rolling road

Q1 25 percentile
Q3 75 percentile

Emission factors – Chemical composition (Mass fraction)



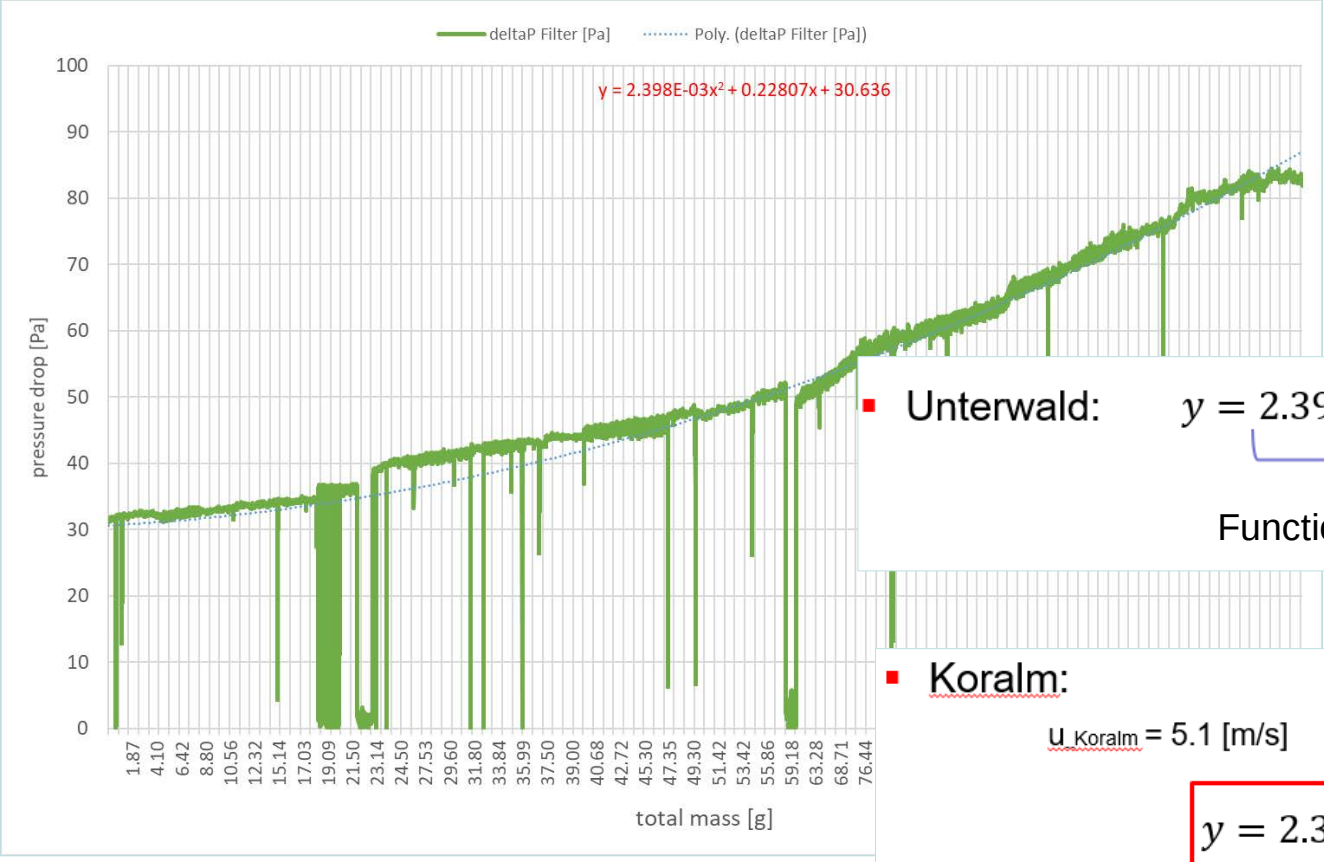


Background contribution

Dust loads on filters

Ceneritunnel / Camorino (CH)
01.06.2017 / Steiner

Filter pressure loss



- Unterwald: $y = 2.398 * 10^{-3} * x^2 + 0.22807 * x + 30.636$

Function of dust-load x in [g]

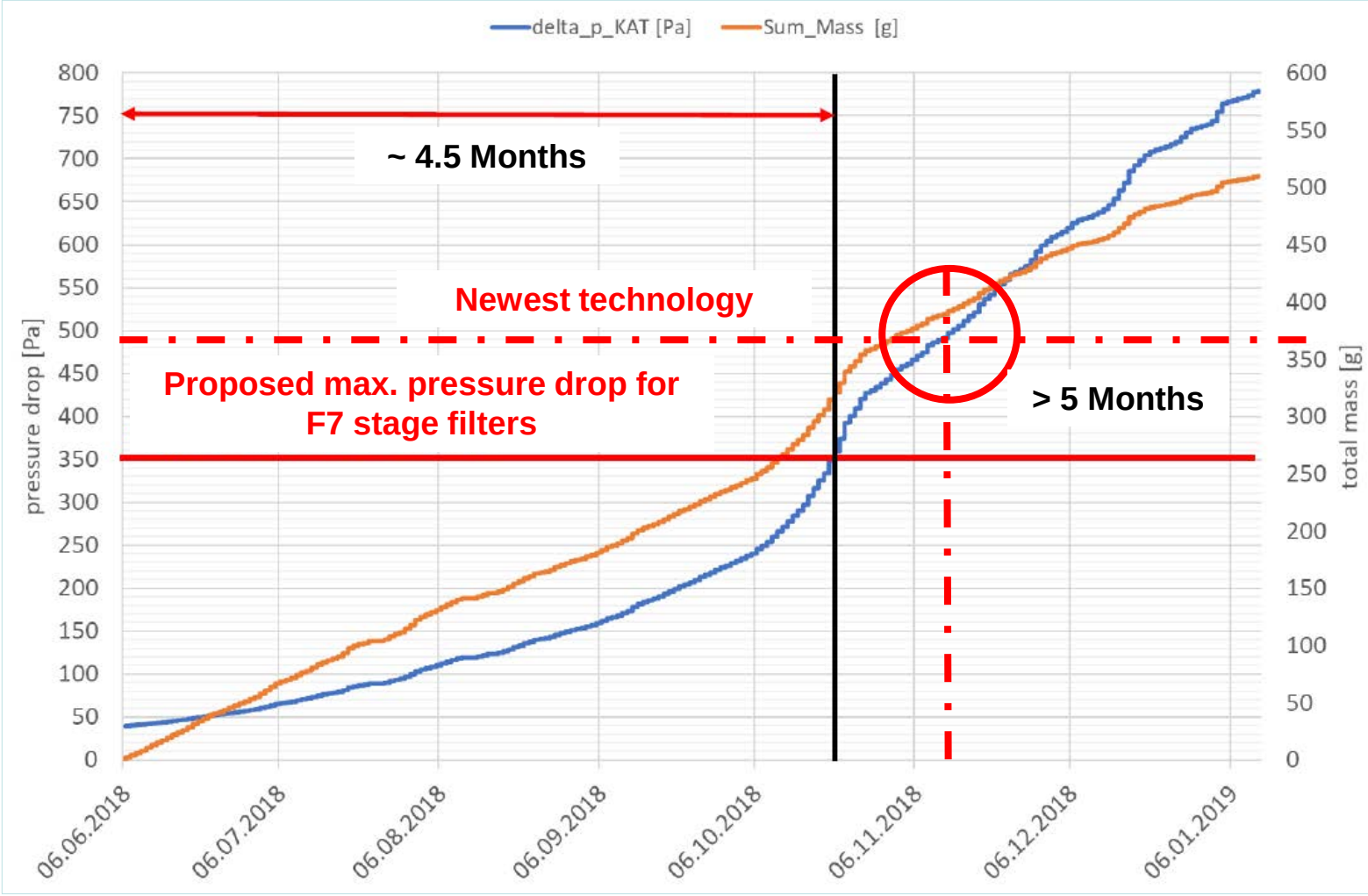
Δp_{Filter} - function of air velocity [m/s]

- Koralm:

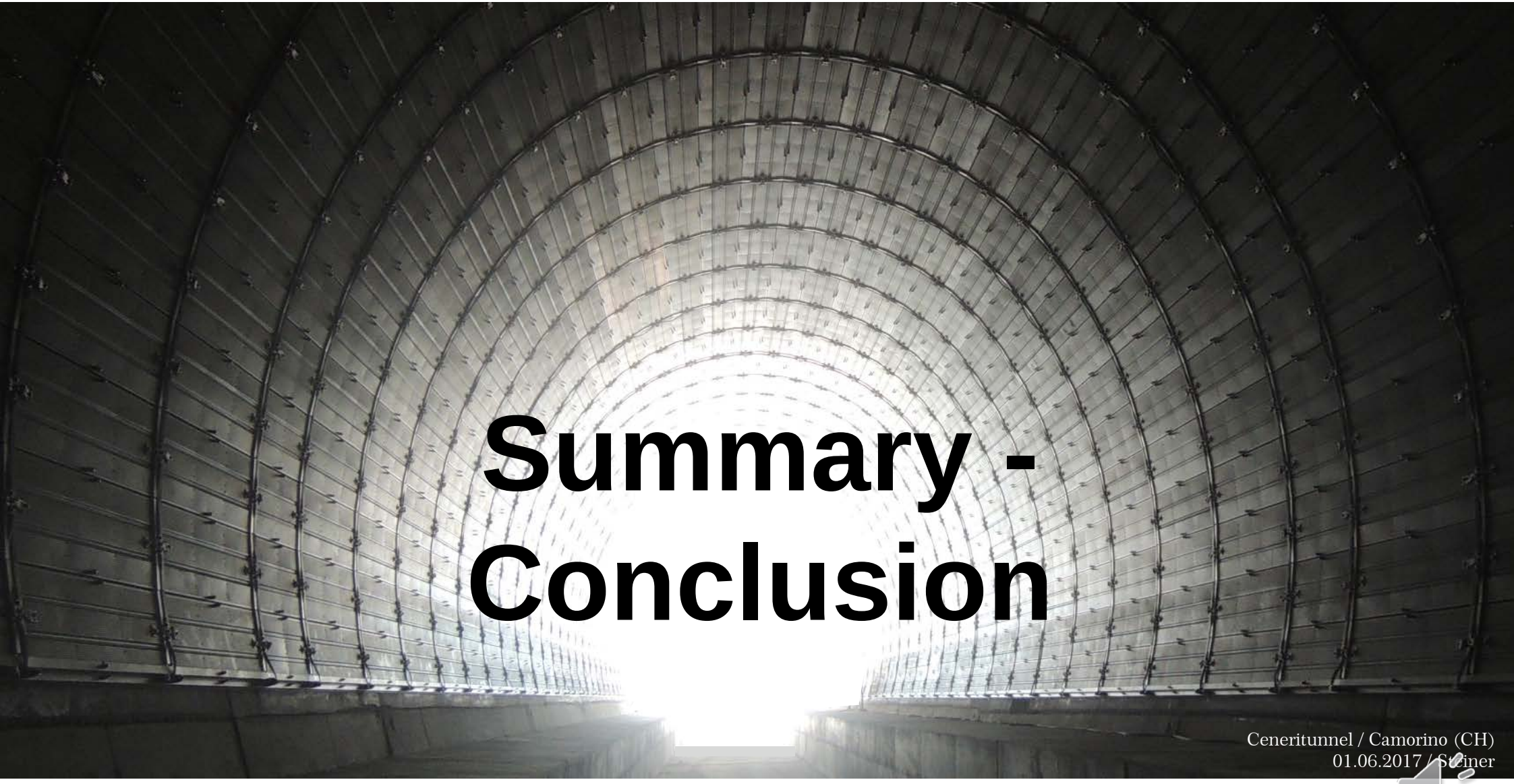
$u_{Koralm} = 5.1$ [m/s] → $\Delta p_{Filter} = 2.515 * \frac{1.2}{2} * 5.1^2 = 39.25$ [Pa]

$$y = 2.398 * 10^{-3} * x^2 + 0.22807 * x + 39.25$$

Filter lifetime



Summary - Conclusion



Ceneritunnel / Camorino (CH)
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Summary / Conclusion

- Some 2000 train movements were analysed and emission factors for PM derived
- Averaged emission factor for passenger trains 0.26 g/km and 1.15 g/km for freight trains
- Bulk freight transport in open cars entails highest emissions.
- Due to the large variation of trains and the pilot character of the project the factors are subject to a large degree of uncertainty
- Exposure to dusty tunnel air is a key factor behind equipment durability
- For protection purposes equipment is either located in utility rooms or closed cabinets → cooling and air filtration is required
- Depending on the air flow rate for cooling, the lifetime of F7 stage filters is estimated between 5 and 20 months

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THANK YOU VERY MUCH FOR YOUR ATTENTION

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„GLÜCK AUF“

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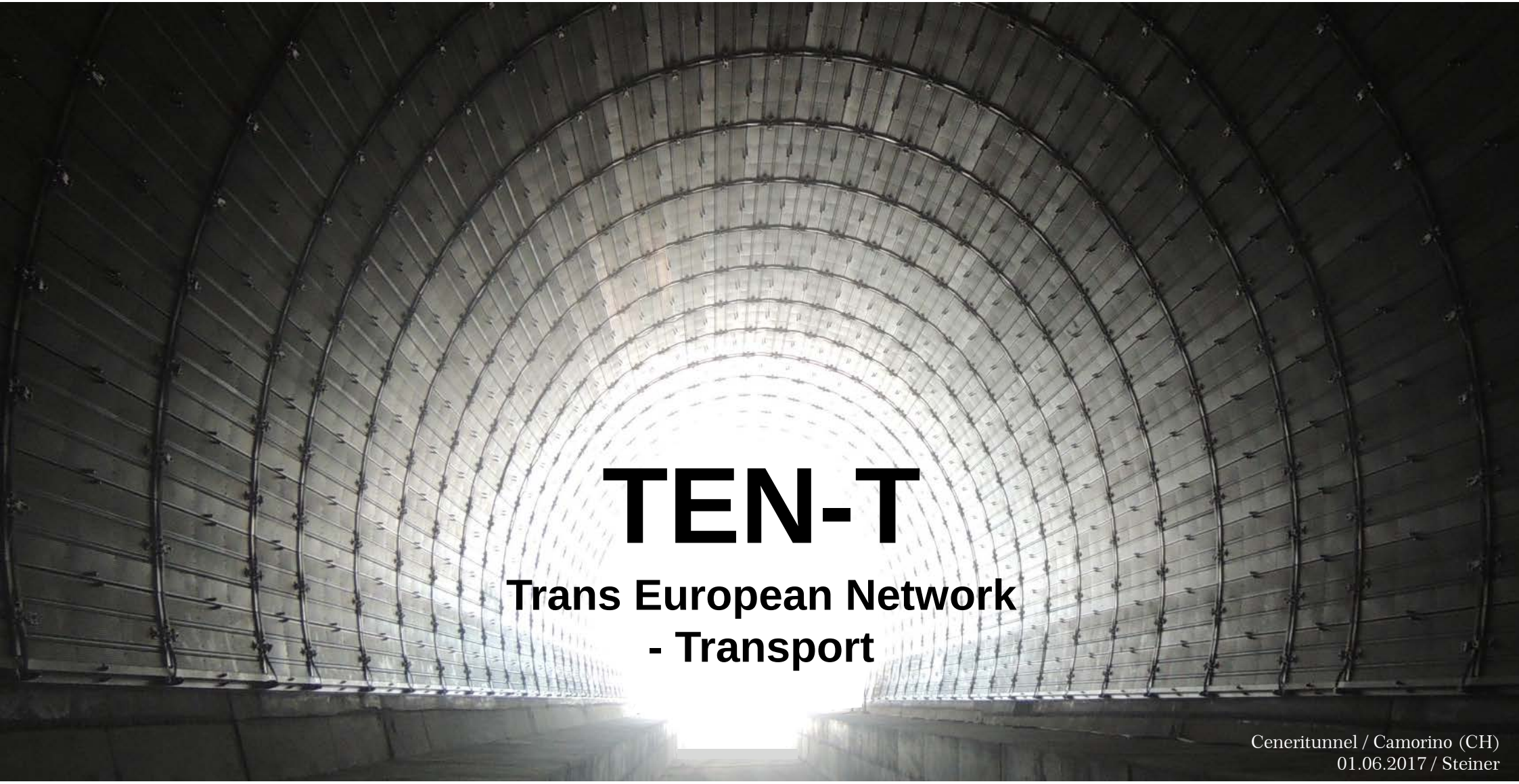

TEN-T

Trans European Network - Transport

Ceneritunnel / Camorino (CH)
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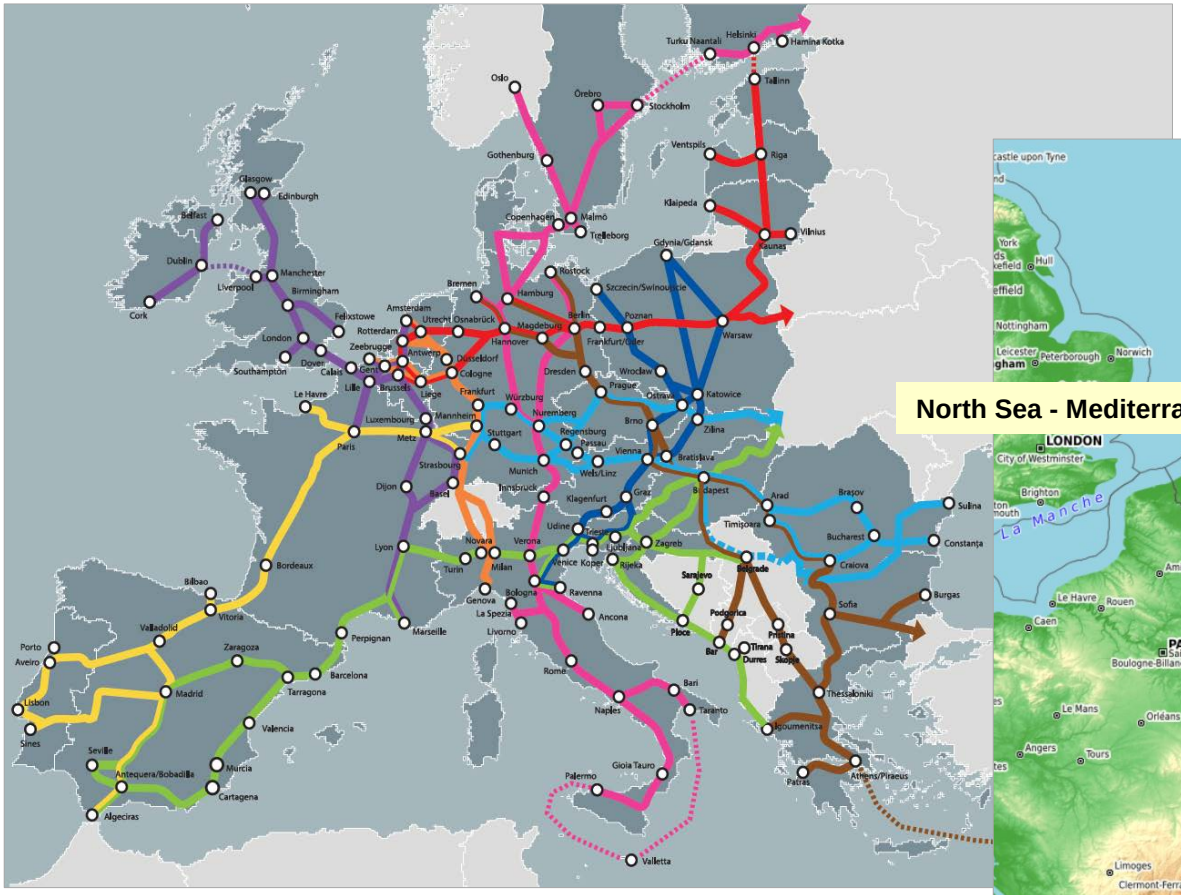
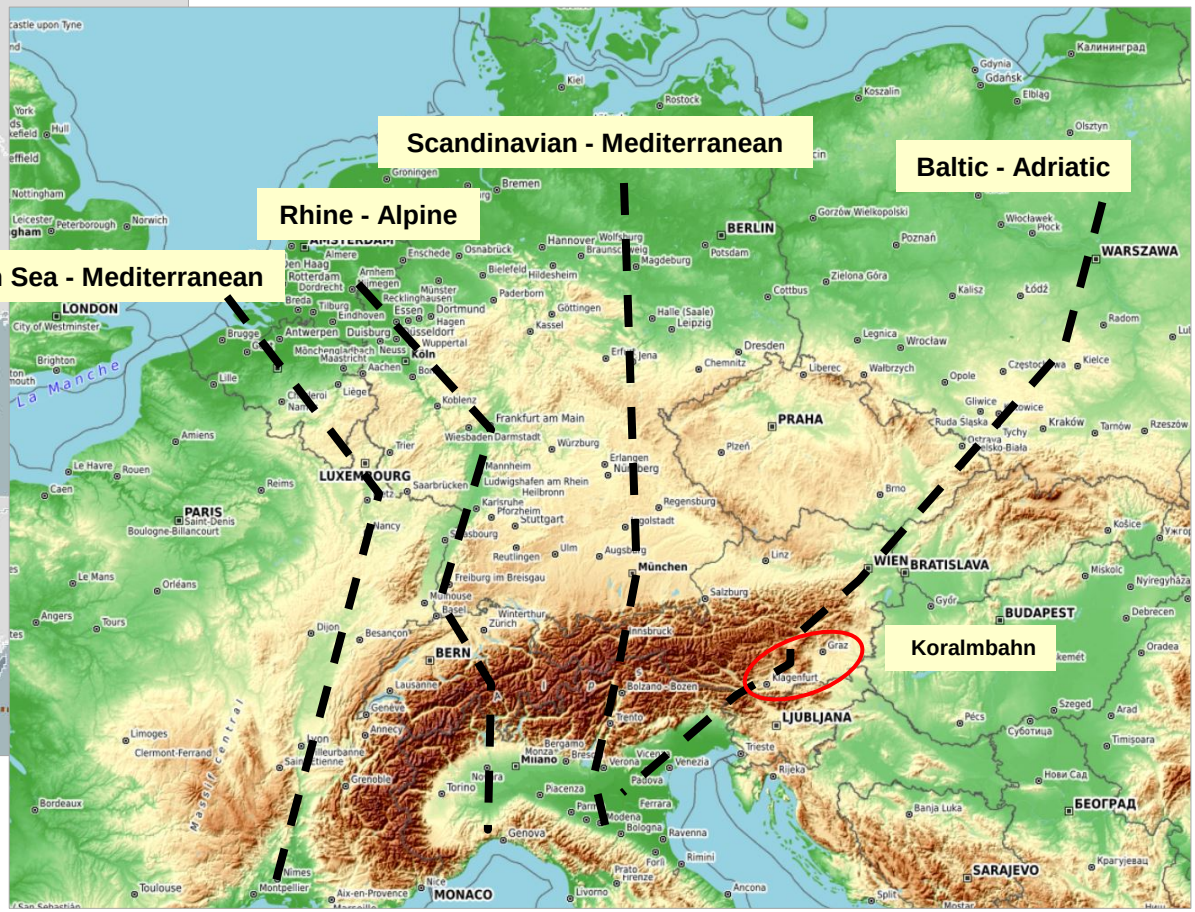
TEN-T / Central Europa





Tunnel Unterwald - 50Hz-Pilotprojekt

NS-Umschalteinrichtungen, USV-Anlagen, Brandmeldeeinrichtungen

PM Measurements - Installation

PM Measurements – Test equipment

Tunnel
- Temperature
- Humidity
- Airspeed

Escape tunnel
- Dust
- Temperature
- Humidity

Test room
- Dust
- Temperature
- Humidity
- Airspeed

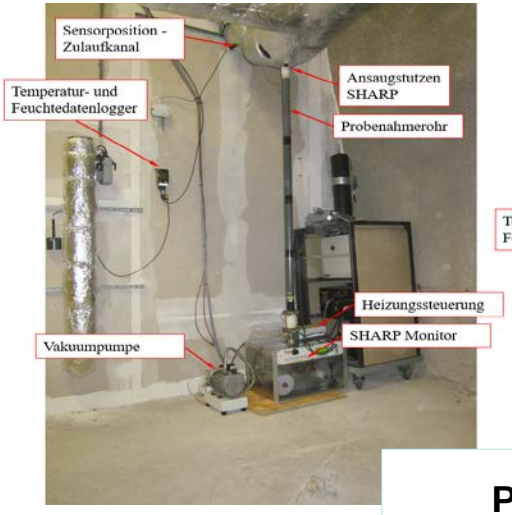
Escape tunnel
- Temperature
- Humidity
- Airspeed

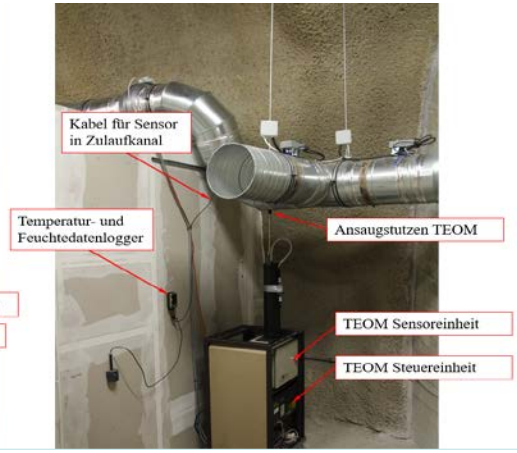
Portal
- Dust
- Meteorologie

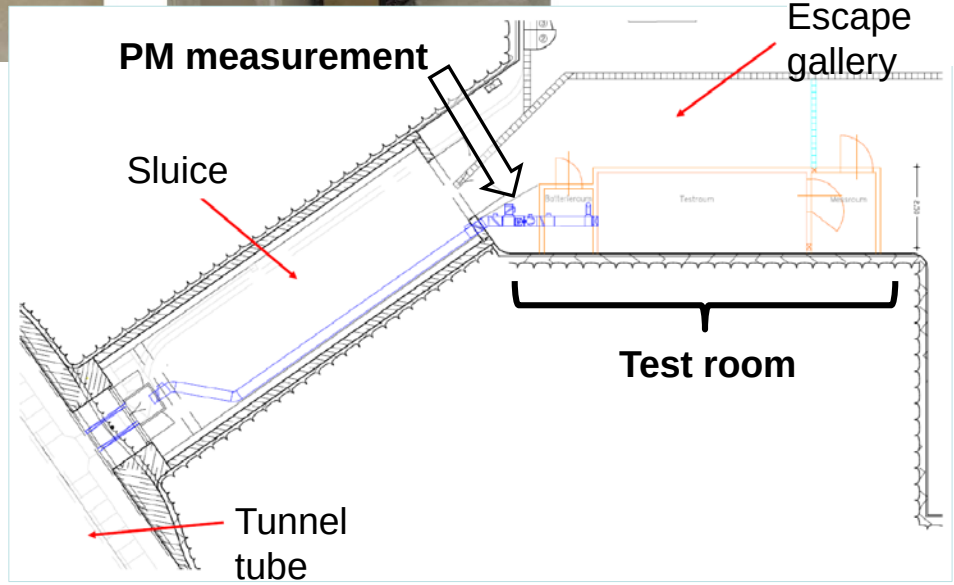
Testequipment

Parameters

- PM concentration
- PM chemical comp.
- Temperature
- Humidity







Summary / Conclusion

Consequences of high dust load on electrical equipment

- All of the 70 cross passages of the Koralmtunnel needs to be cooled in order not to exceed the target temperature for the most critical components.
- Regardless, if the technical rooms are ventilated or air conditioned filtering of the air is necessary.
- Based on the results from the tests an average timespan of 4 to 6 months is estimated for the filter boxes.