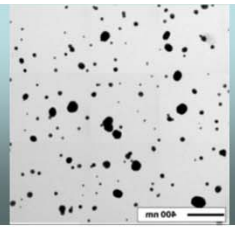
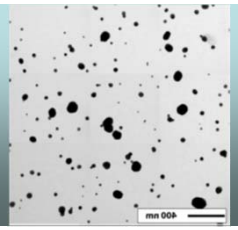
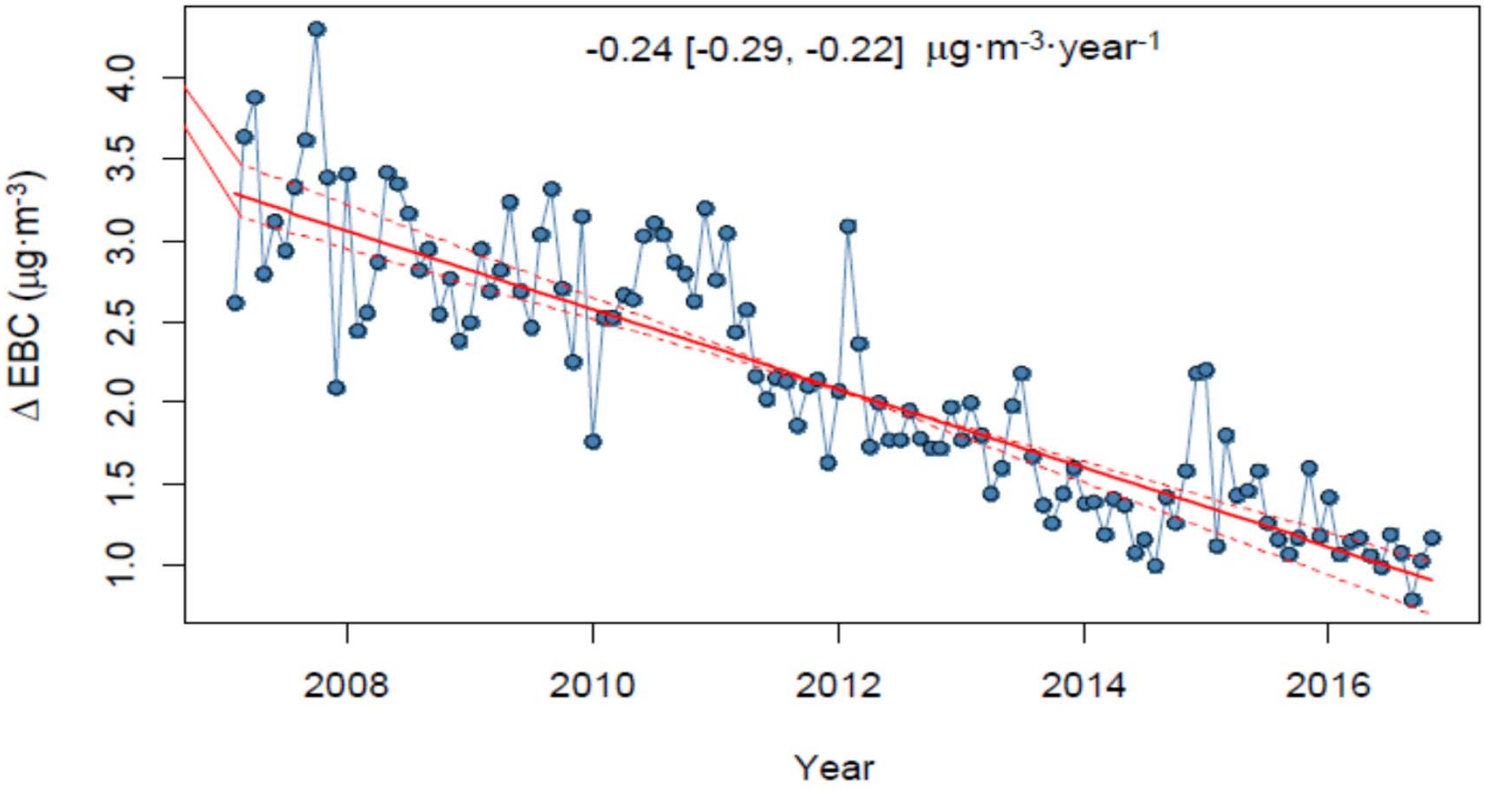


DPF-failure statistics and conclusions for Pass/Fail criteria

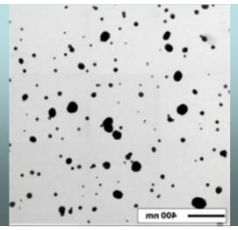
H. Burtscher
Institute for Aerosol und Sensor Technology,
Fachhochschule Nordwestschweiz

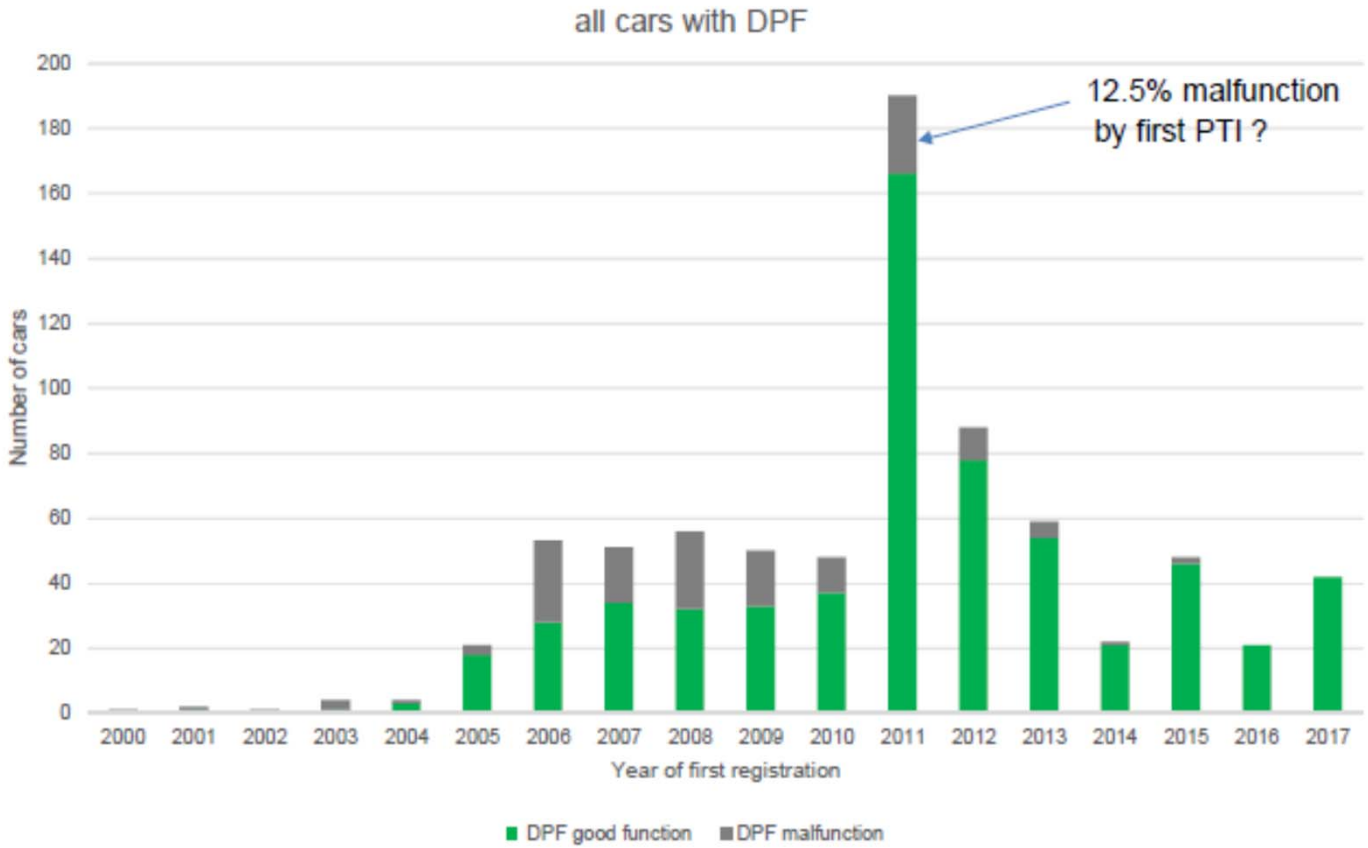


Change in black carbon concentration at the road side station Härkingen, Switzerland, from Hüglin, 2017



Kurinawan und Schmidt-Ott (2006): 5% of ‘super polluters’ are responsible for 43% of elemental carbon emissions

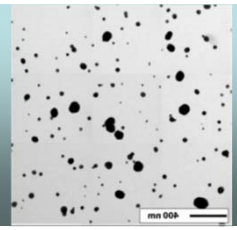


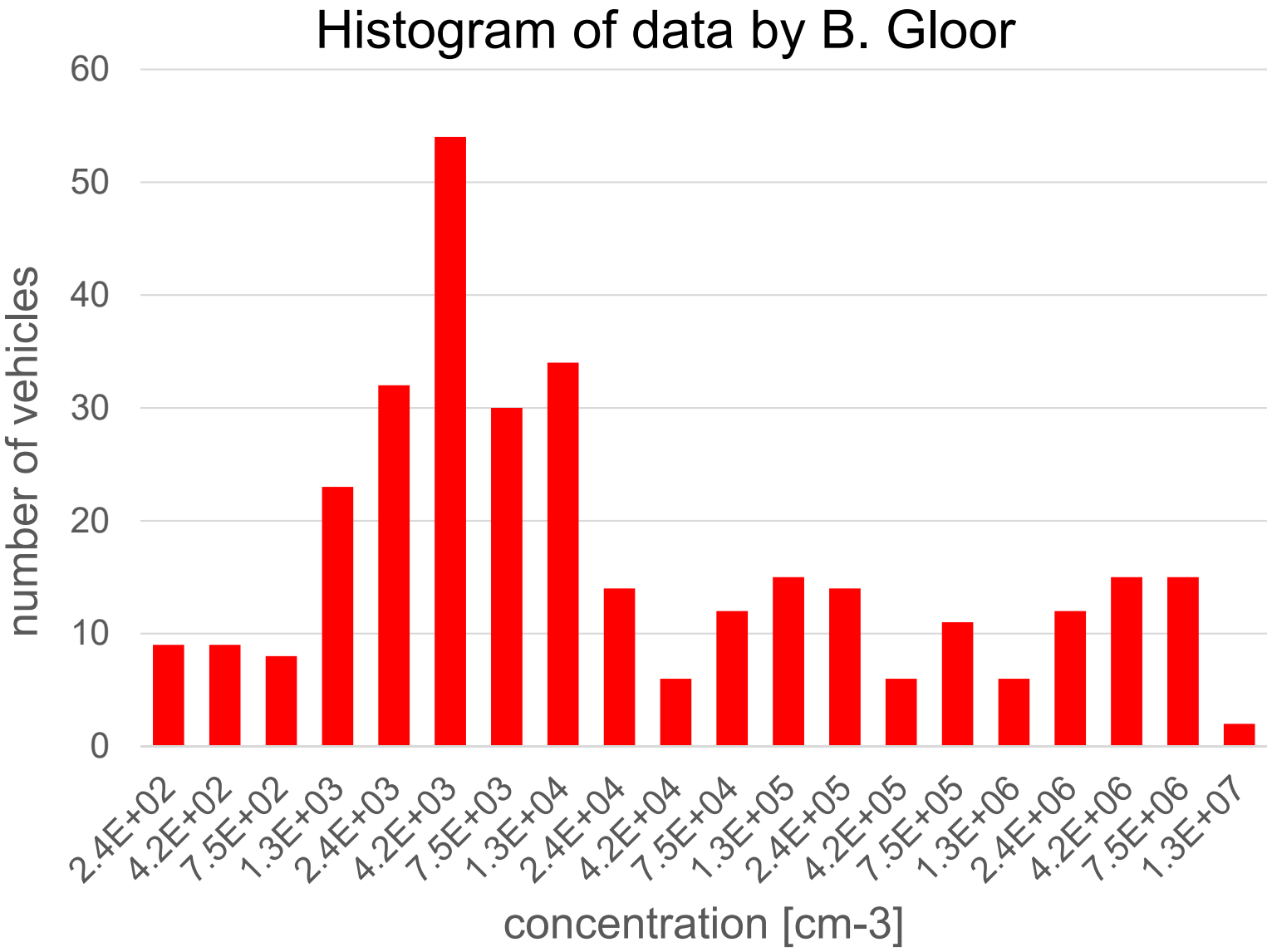


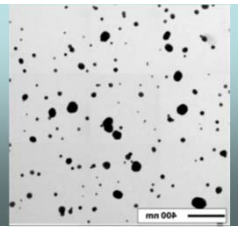
Pass/fail criteria:

100’000 cm^{-3} for cars ≥ 5b

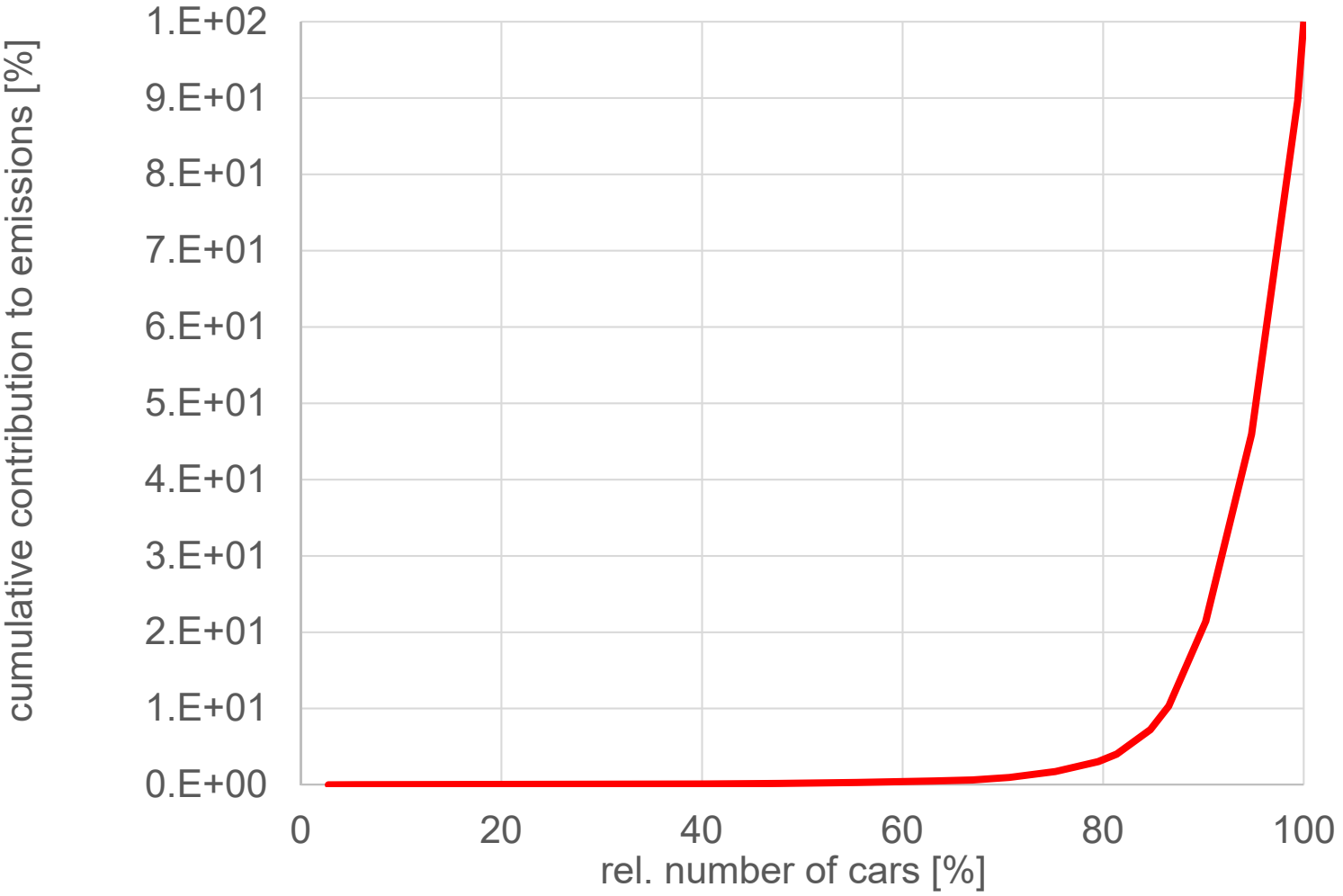
250’000cm^{-3} for cars ≤ 5a (equipped with a DPF), measured at low idle, from B. Gloor

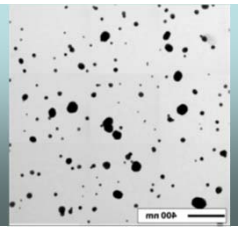



Histogram of data by B. Gloor
number of vehicles
60
50
40
30
20
10
0
2.4E+02
4.2E+02
7.5E+02
1.3E+03
2.4E+03
4.2E+03
7.5E+03
1.3E+04
2.4E+04
4.2E+04
7.5E+04
1.3E+05
2.4E+05
4.2E+05
7.5E+05
1.3E+06
2.4E+06
4.2E+06
7.5E+06
1.3E+07
concentration [cm-3]

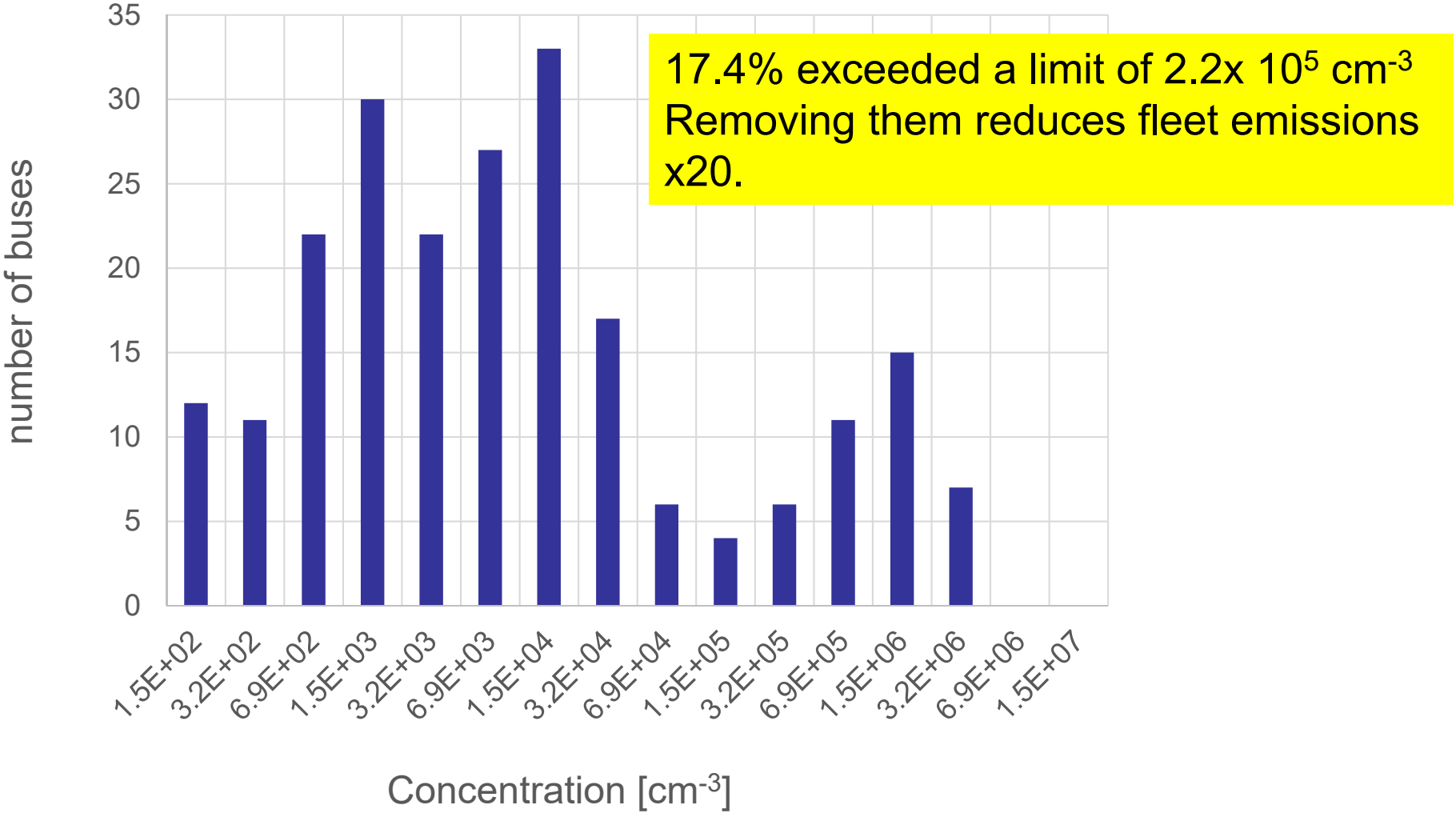


Cumulative contribution to fleet emission

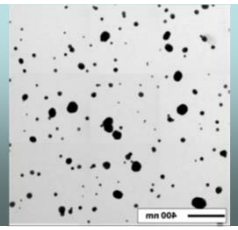




Histogram of particle concentrations for the public bus measurements in Santiago di Chile (Reinoso, 2016).

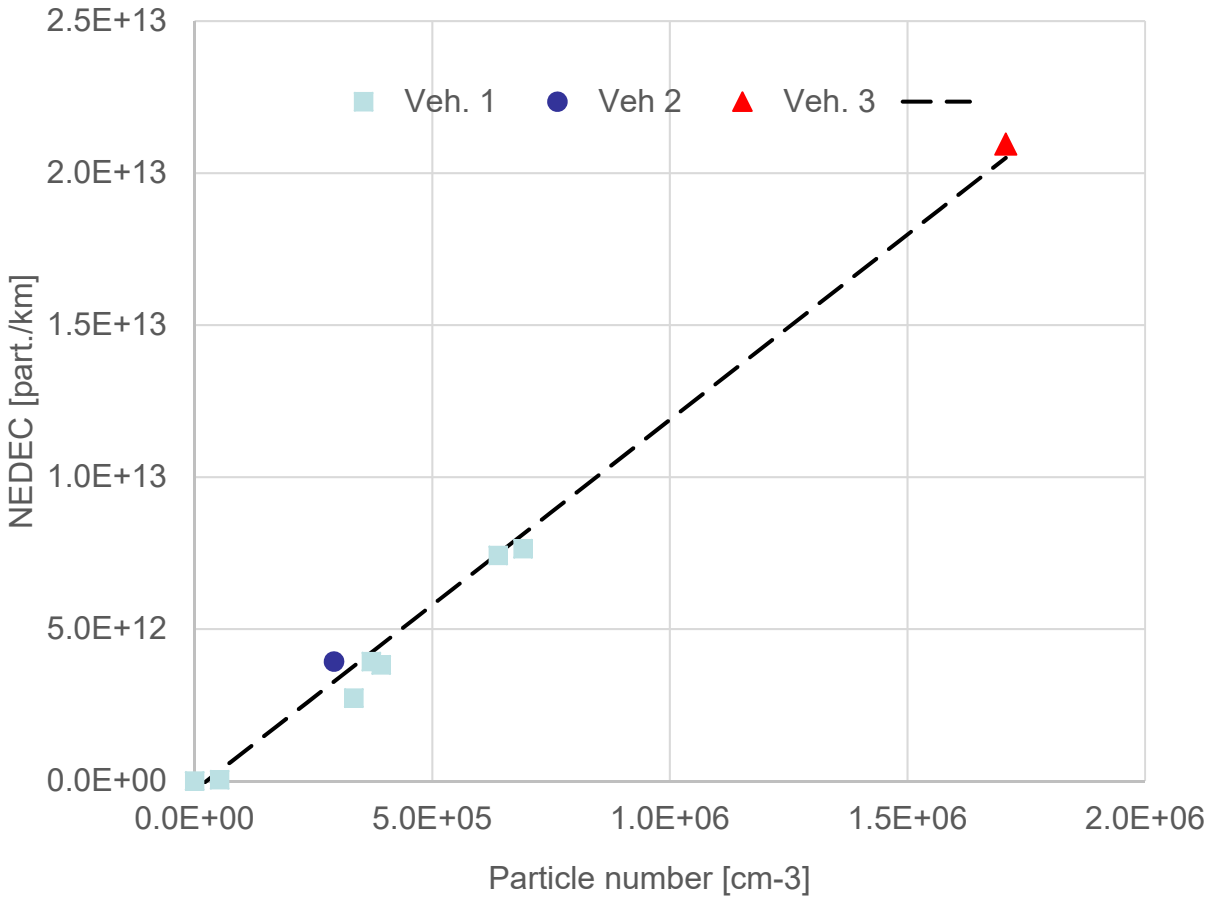


17.4% exceeded a limit of 2.2x 10^5 cm^{-3}
Removing them reduces fleet emissions x20.

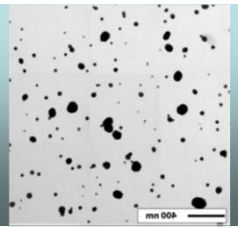


Construction engines:

Nauroy et al. (2017) measured emissions from more than 100 construction engines, equipped with particle filters. 22% exceeded the limit of 250’000#/cm^3.



Comparison of particle number, emitted during a NEDC cycle versus number concentration in low idle of 3 different diesel vehicles with cracked DPF or variable bypass (from Kadijk et al., 2017)

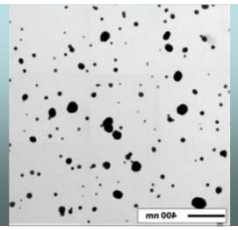


Requirements:

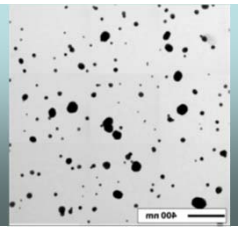
- The PTI test has case to be short (< 2 min) and simple
- applicable for road checks, in workshops and in the roadworthiness test centers.
- The NPTI working group has elaborated specifications for such a device.
  - Efficiency 100% ±25% at 55nm
  - Efficiency 50% ±25% at 23nm
  - Volatile removal inTetracontane test: removal efficiency >90% for 30nm particles with a number concentration $<10^5 cm^{-3}$

Similar, but not equal requirements exist for the Swiss regulations for construction machines and ships (see Verordnung Abgasmessmittel):

- Efficiency <50% at 23nm
- Efficiency >40% at 41nm
- Efficiency >70% and <130% at 80nm
- Efficiency <300% and 200nm
- Tetracontane test: removal efficiency >95% for 30nm particles with a number concentration $<10^5 cm^{-3}$



Pass/Fail Criteria

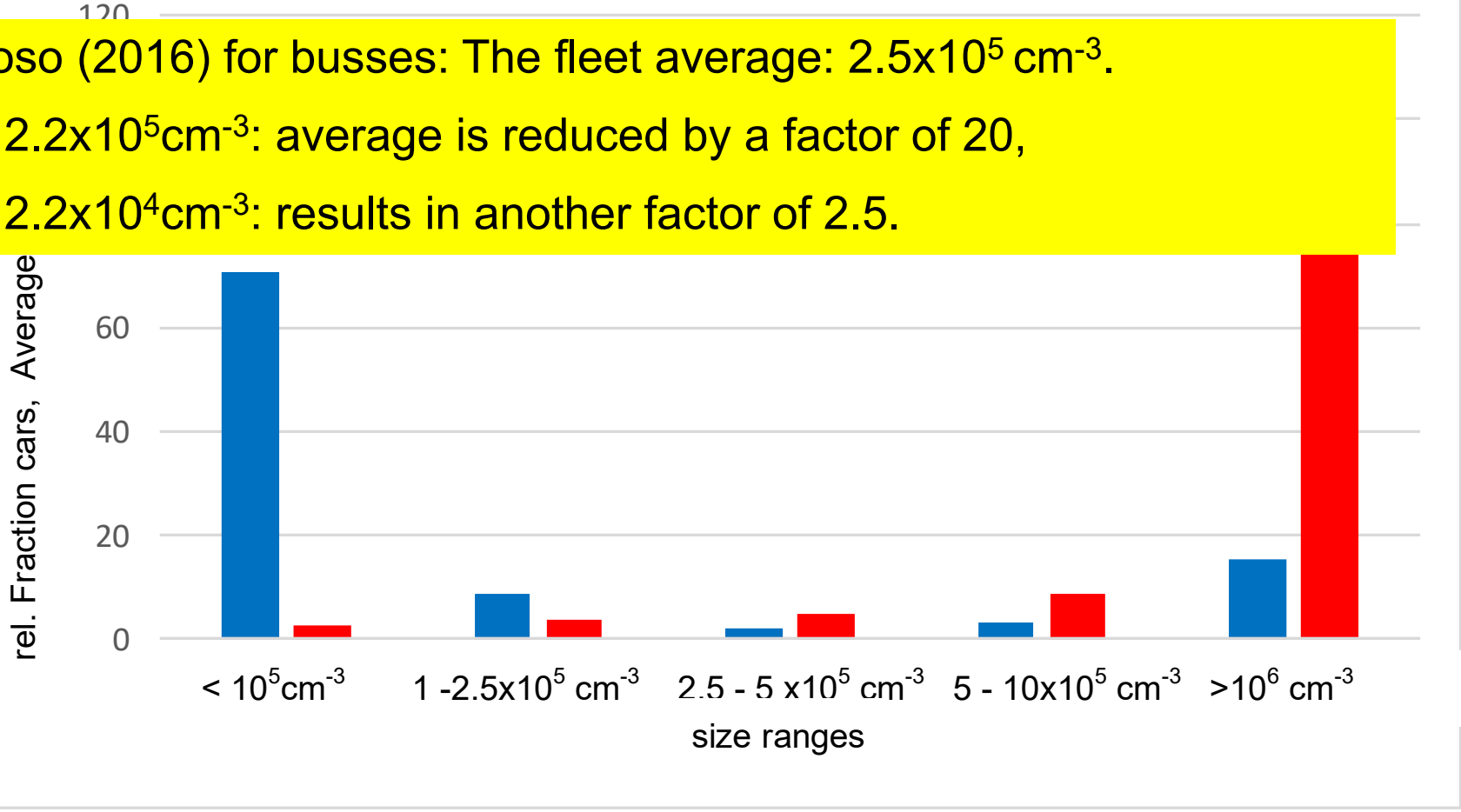


rel. fraction of cars in a particle emission range (blue) and cumulated average fleet emissions of cars (red). Calculated from data by Gloor, 2018.

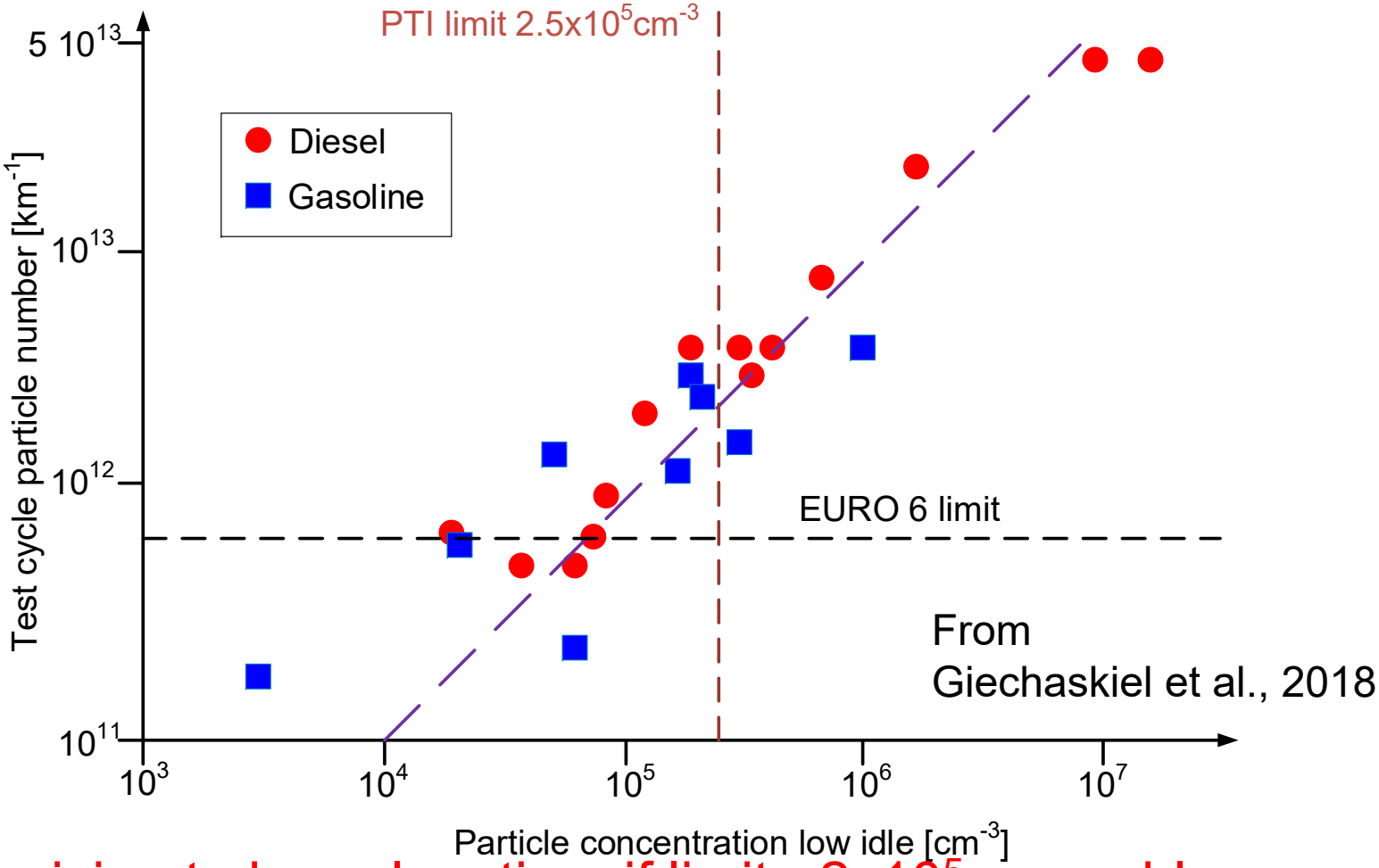
Reinoso (2016) for busses: The fleet average: 2.5×10^5 cm^{-3}.

Limit $2.2 \times 10^5 cm^{-3}$: average is reduced by a factor of 20,

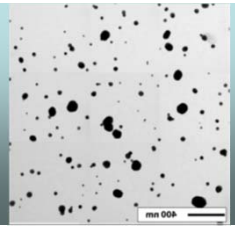
Limit $2.2 \times 10^4 cm^{-3}$: results in another factor of 2.5.



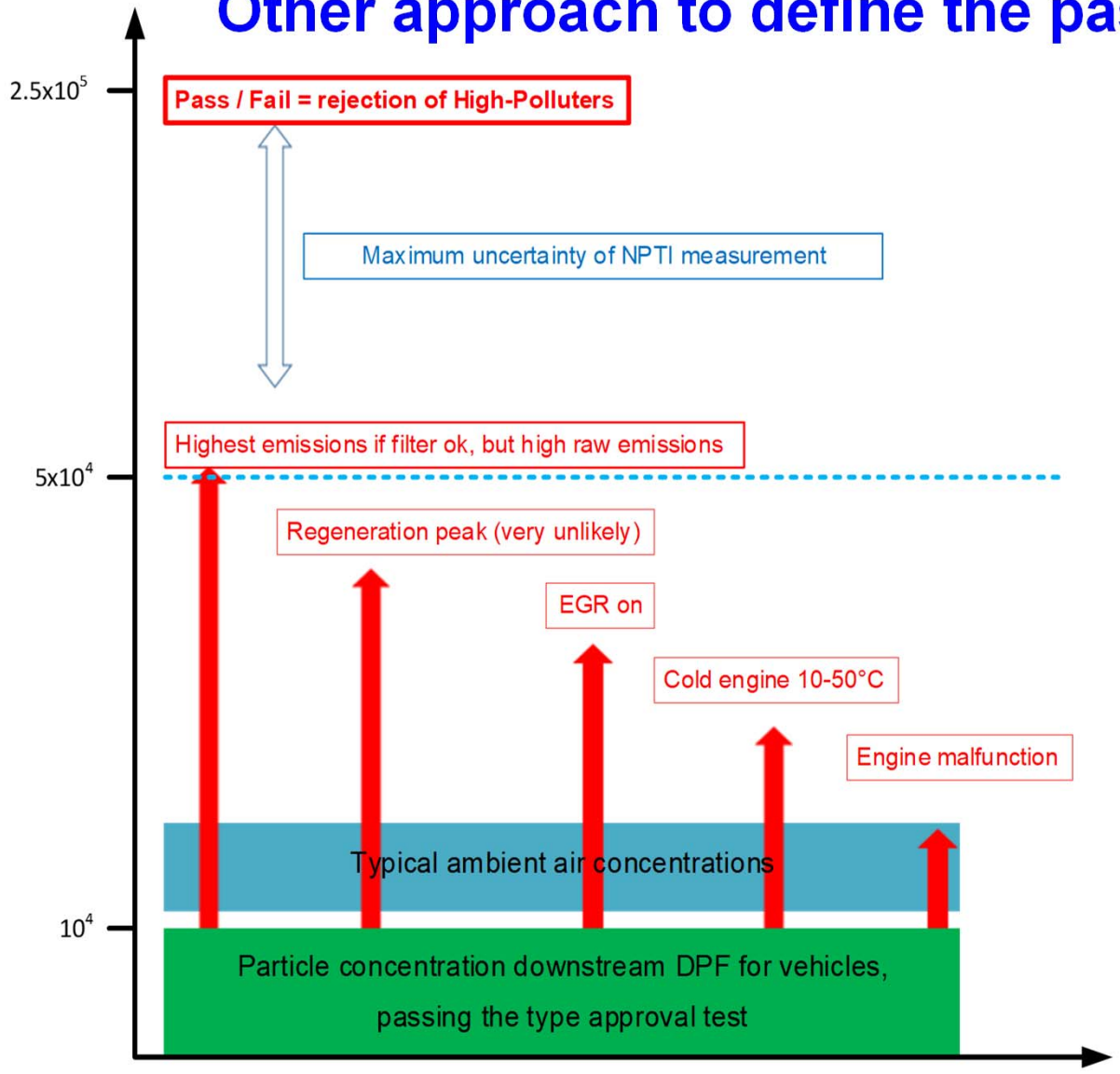
results from cycle test as done for type approval and low idle measurements.

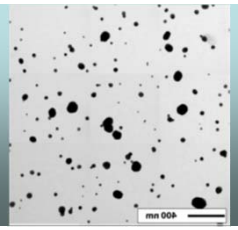


Comparision to homologation: if limit >2x10^5 no problem



Other approach to define the pass/fail criteria:





Conclusions

- Fleet emissions are dominated by few high polluters
- Introducing PTI again is important
- Measuring at low idle is possible, allow a very fast and low cost test
- The limit should be in the range of 1 to 5 x$10^{5}$$cm^{-3}$