



# Addressing artefacts in *in situ* absorption measurements of black carbon aerosols

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## Why *in situ* measurements?

- Aerosol particles in the atmosphere affect health, visibility and climate
- Established absorption measurements of BC are performed *ex situ* (i.e. particles are deposited onto filters)
- These methods suffer from large systematic errors caused by the modification of particle properties upon deposition onto the filter
- In situ* absorption measurements are free of these artefacts
- Atmospheric concentrations of BC are typically sub microgram per cubic metre, so sensitive detection methods are required

## *In situ* absorption techniques

Particle  
Pump beam  
Heated particle  
Energy transfer to surrounding gas  
Pressure waves measured with a microphone (PA)  
or  
Temperature changes measured with interferometry (PTI)

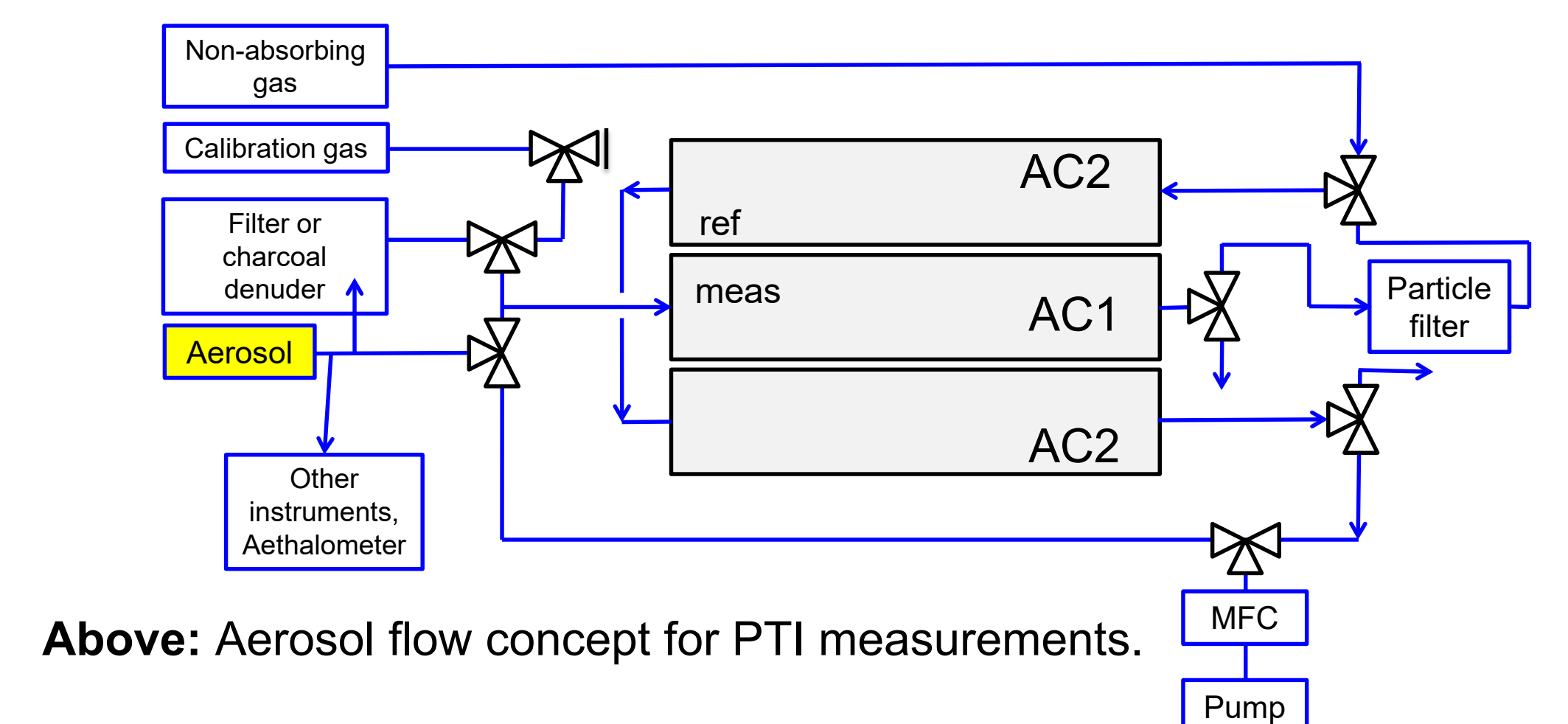
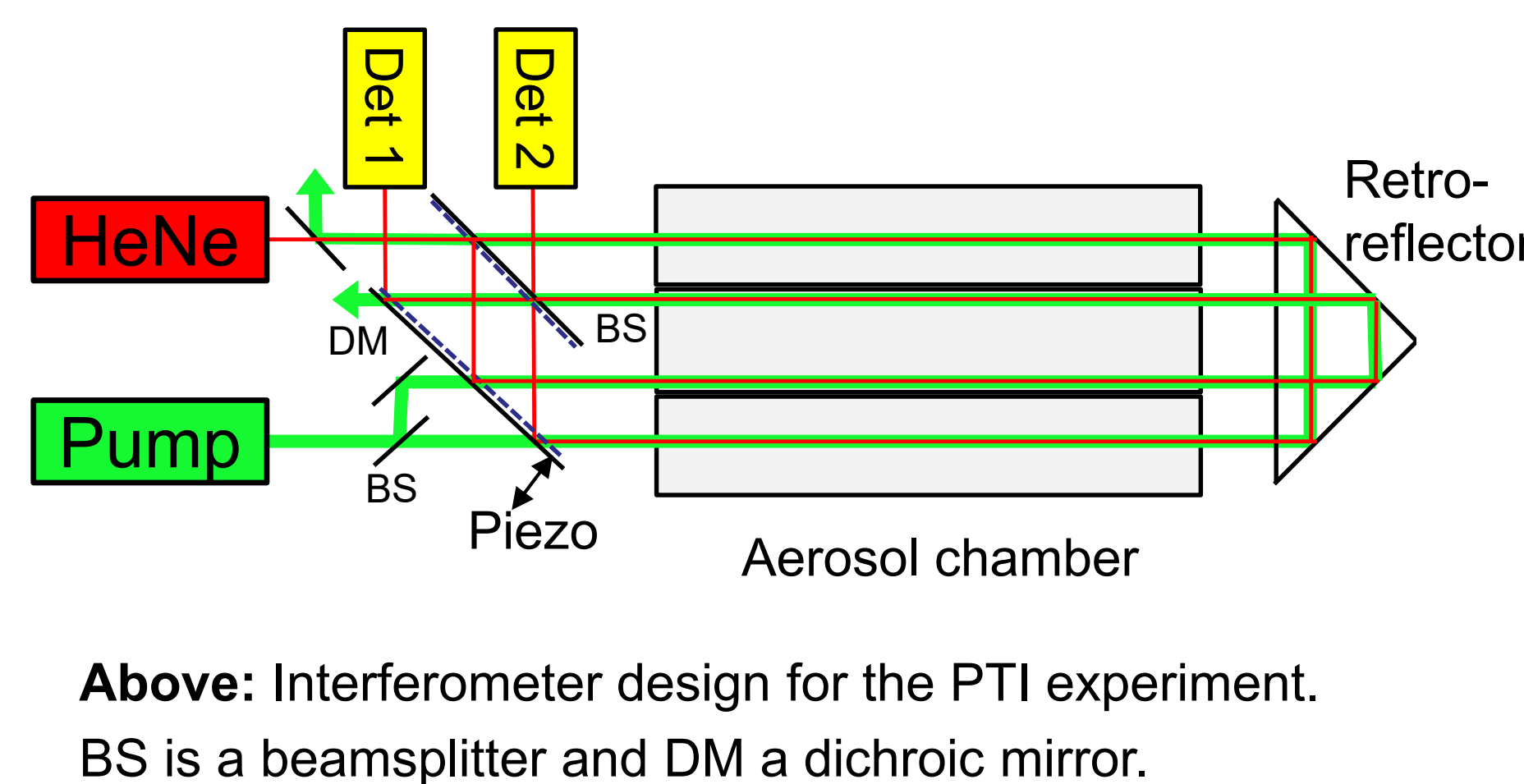
- Photoacoustic (PA) and Photothermal Interferometry (PTI) are both techniques that measure the light absorption of a sample
- PTI is a direct measurement with high temporal resolution, PA requires a resonator to amplify harmonic modes

**Above:** Principle behind PA and PTI techniques.

**Left:** Simulation of the first azimuthal mode in a cylindrical resonator showing the pressure gradient

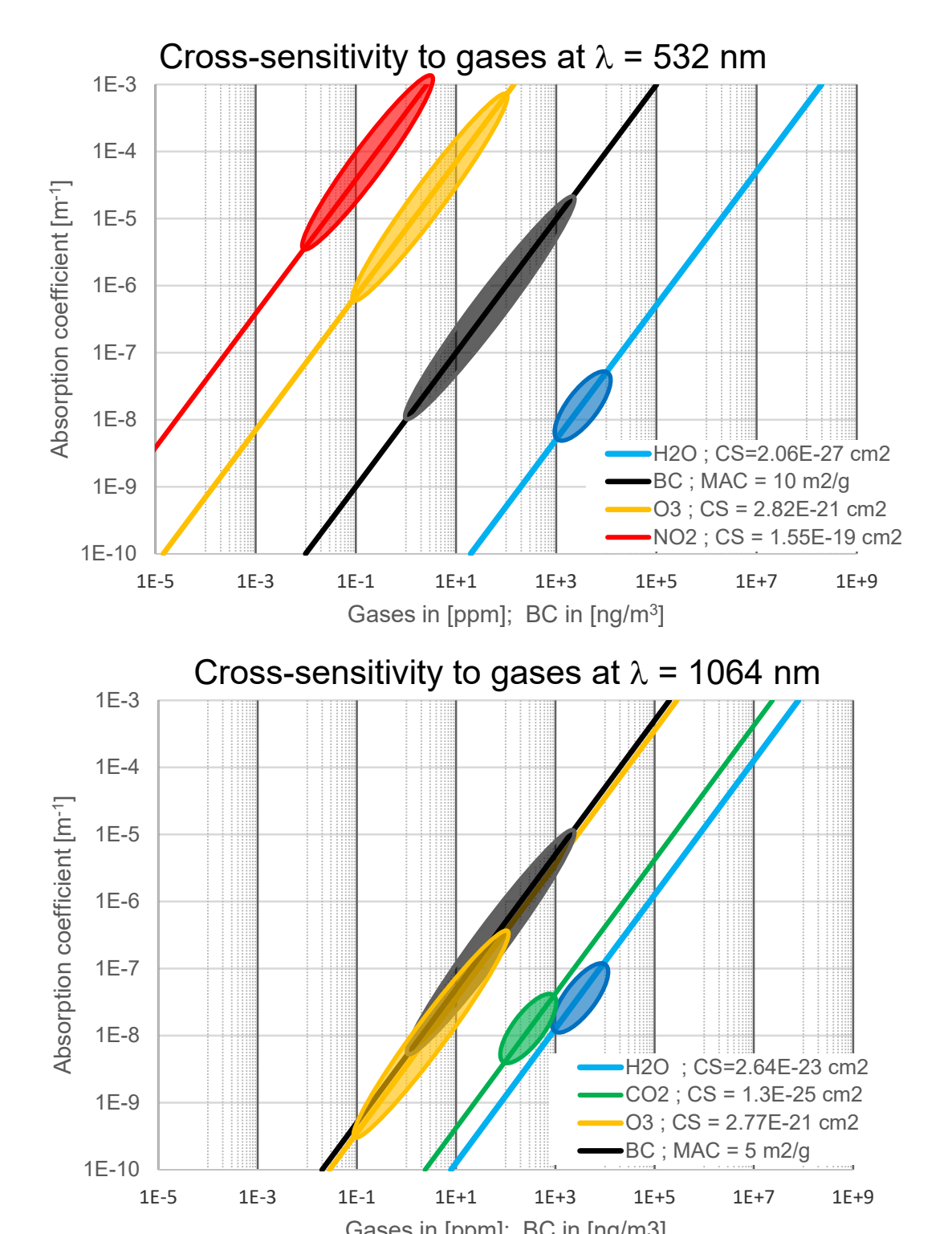
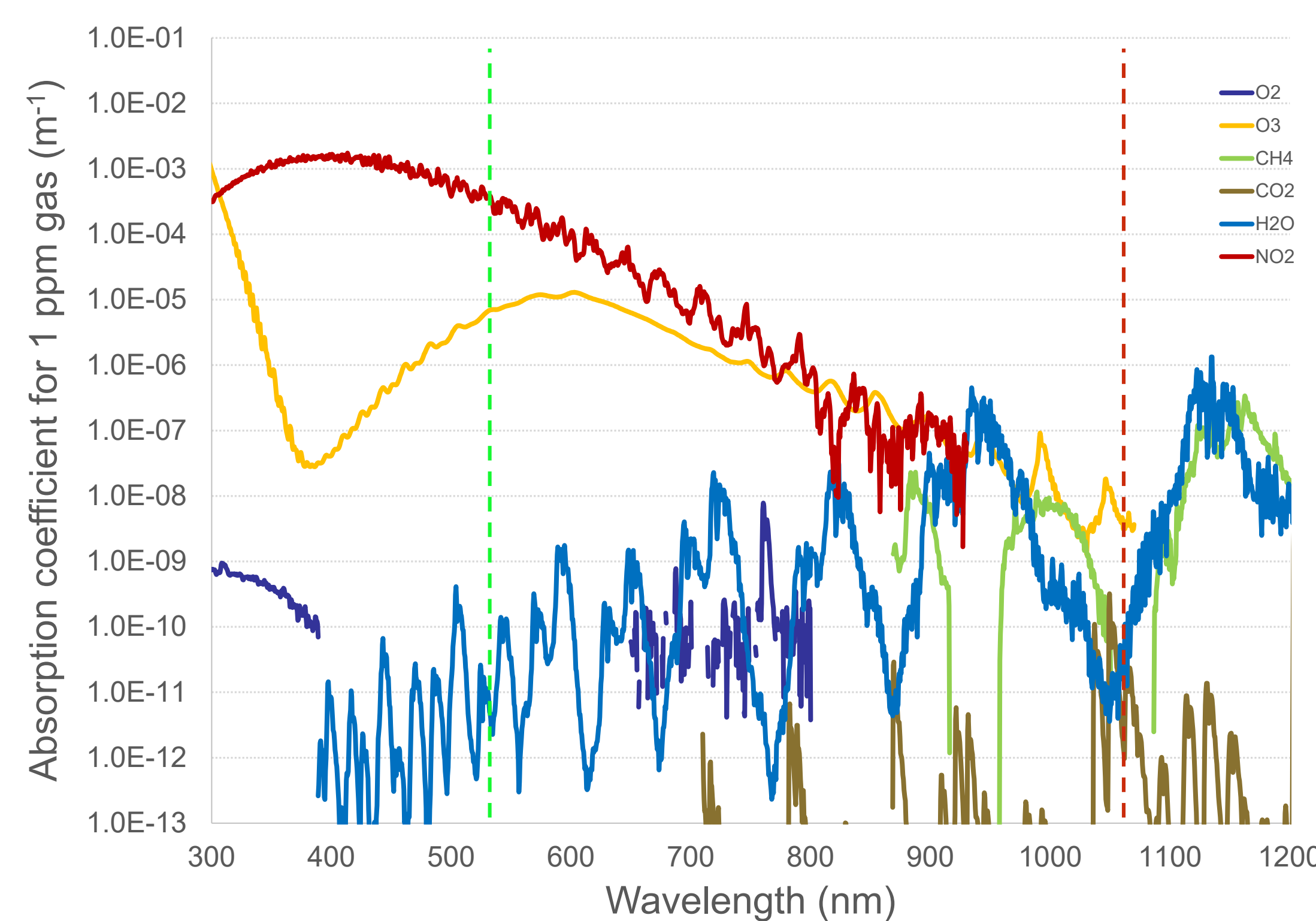
## Experiment

- We are currently working on a PTI instrument for the measurement of ambient BC aerosols
- Using the PTI technique allows the correction of measurement artefacts



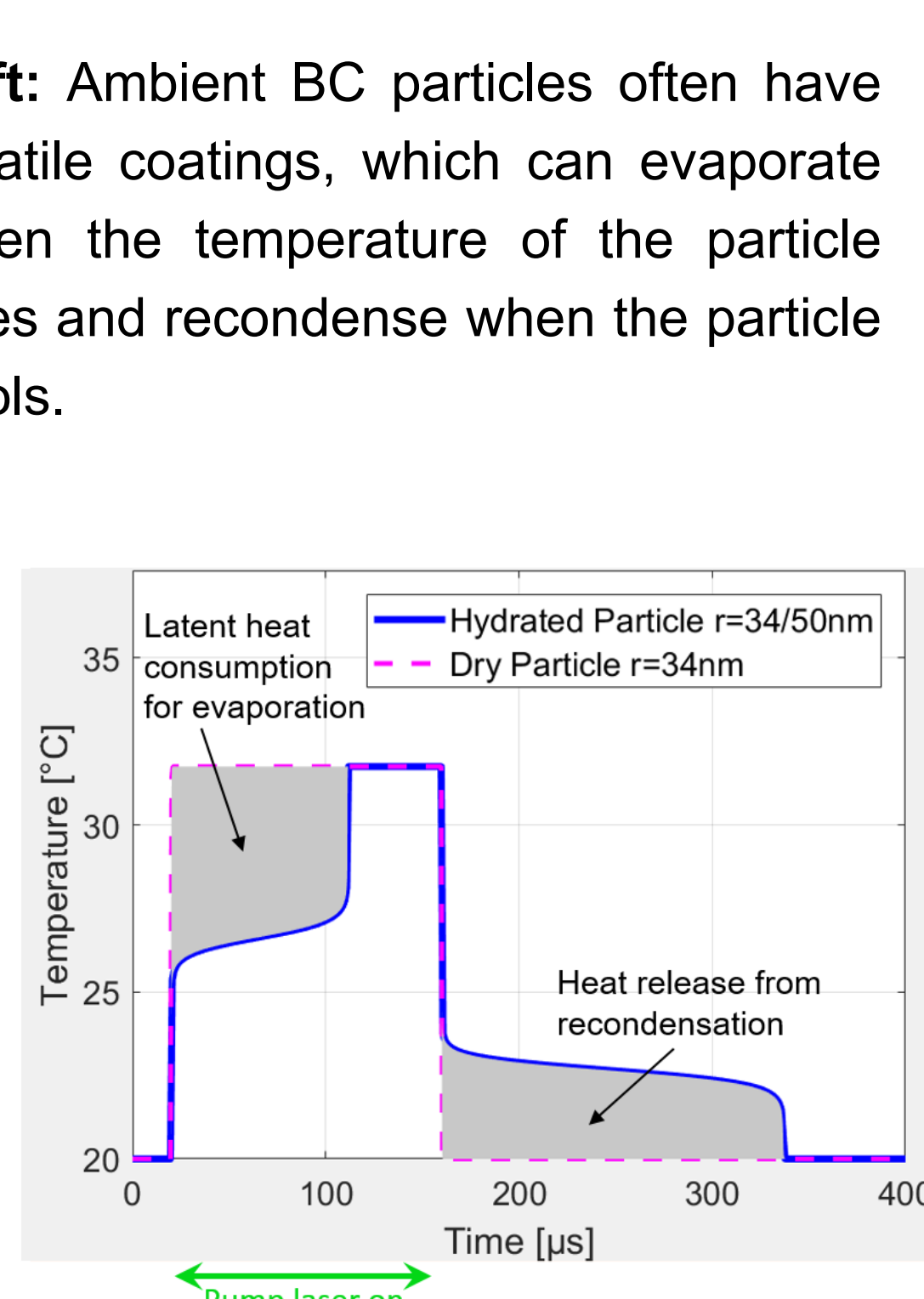
## Background gas absorption

- In addition to aerosol particles, naturally occurring gases can contribute significantly to light absorption measurements
- Either the gases need to be separated before the measurement or the light absorption of the gas measured without aerosol particles
- With an appropriate experimental set-up absorbing gases can be used to calibrate the instrument response
- Absorption features of gases are very specific
- Which gases contribute to the measured absorption is wavelength dependent



## Volatiles and latent heat

- Ambient BC particles often have volatile coatings, which can evaporate when the temperature of the particle rises and recondense when the particle cools.
- The evaporation and condensation cycle changes the phase of the energy release of the aerosol to the surrounding gas. This effect significantly affects the strength of a PA signal, but could possibly be measured and corrected for in PTI measurements.



## Conclusions

- In situ* absorption measurements of ambient BC aerosols are complicated by artefacts arising from light absorption by gases and evaporation of volatiles
- These issues can be mitigated by careful experimental design
- PTI has the potential to determine the influence of volatile coatings in *in situ* absorption measurements

## References

HITRANonline database, www.hitran.org, accessed 29.06.2017;  
J. A. Davidson *et al.*, JGR, 93, D6, 7105 (1988);  
J. B. Burkholder and R. K. Talukdar, Geophys. Res. Lett., 21, 7, 581 (1994)

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