

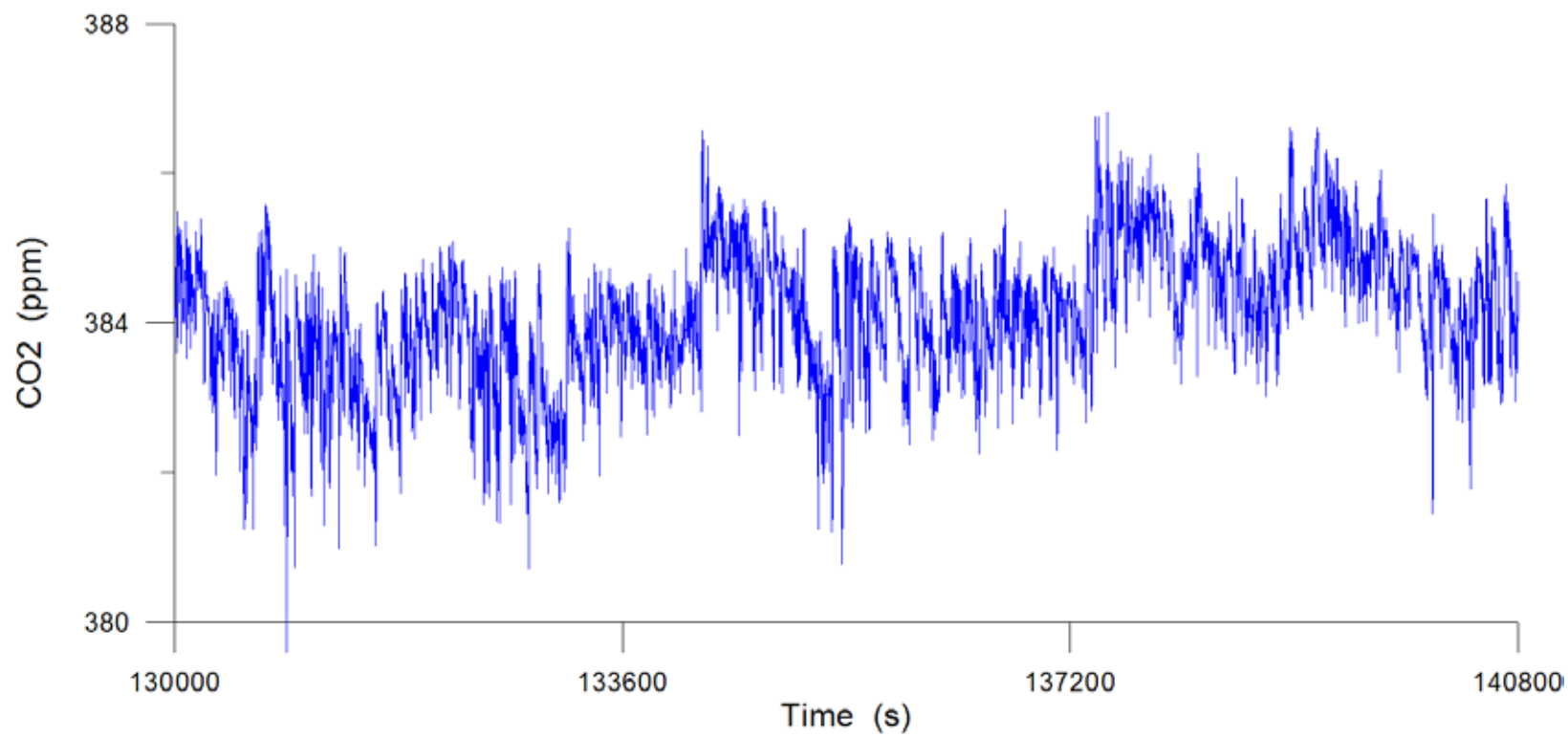
Buffer = mixing volumes

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Sweden

Norunda





1 s resolution

NOPEX



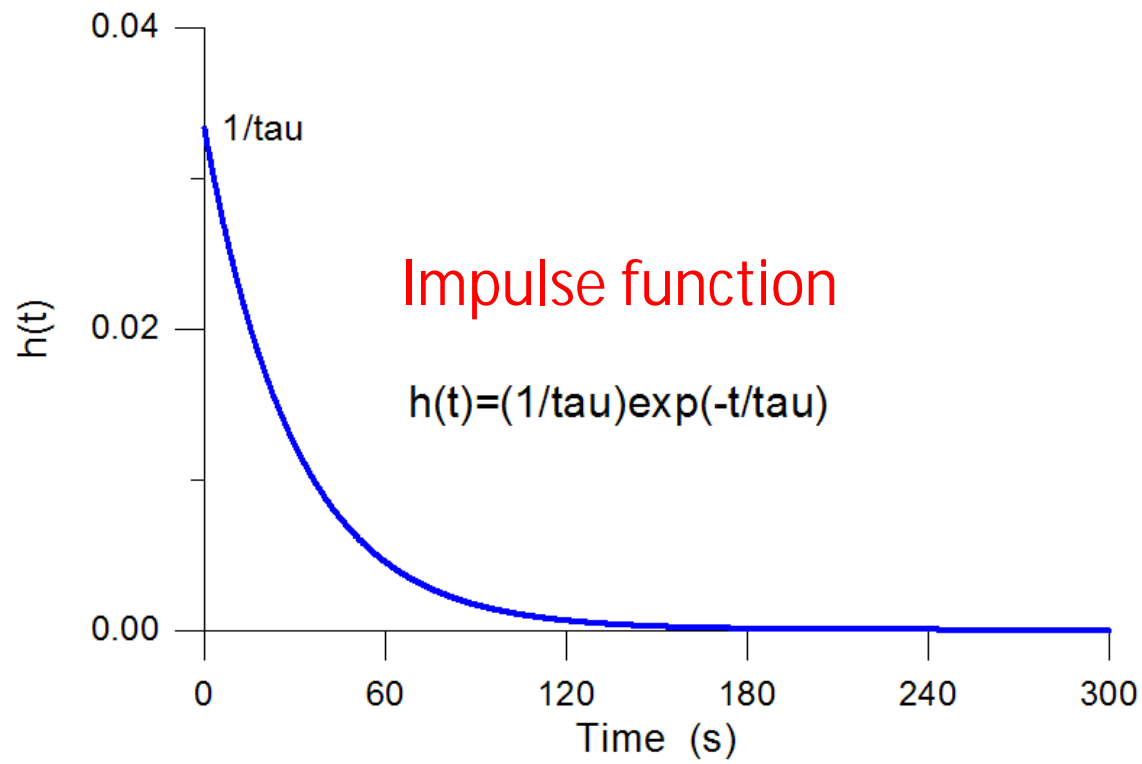
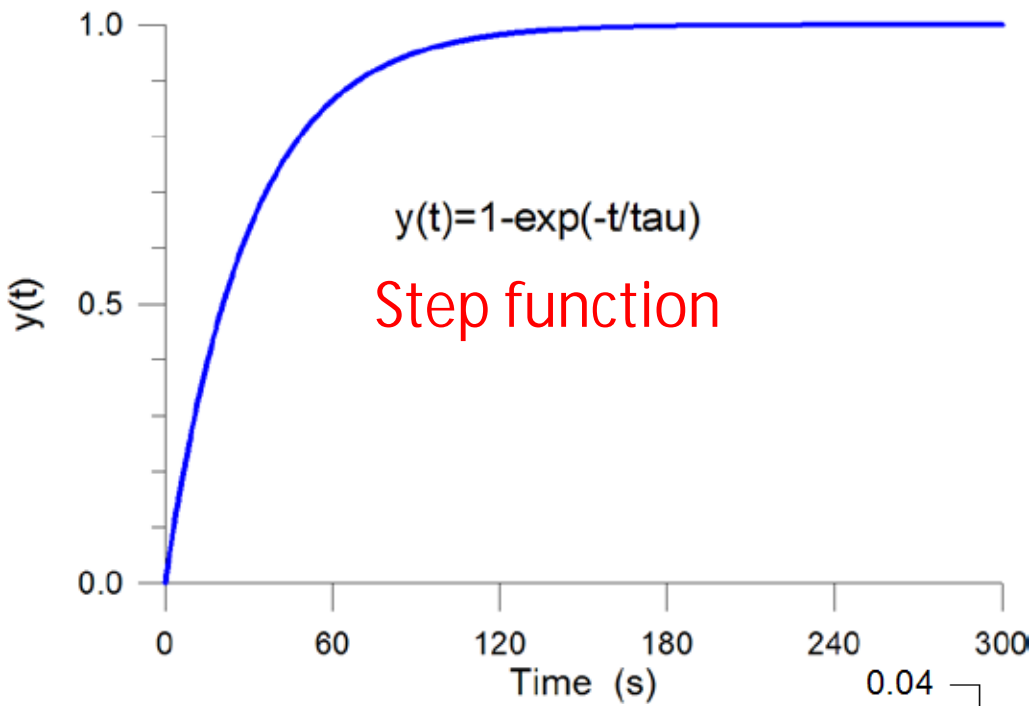
ICOS Finland



ICOS Sweden

Plan

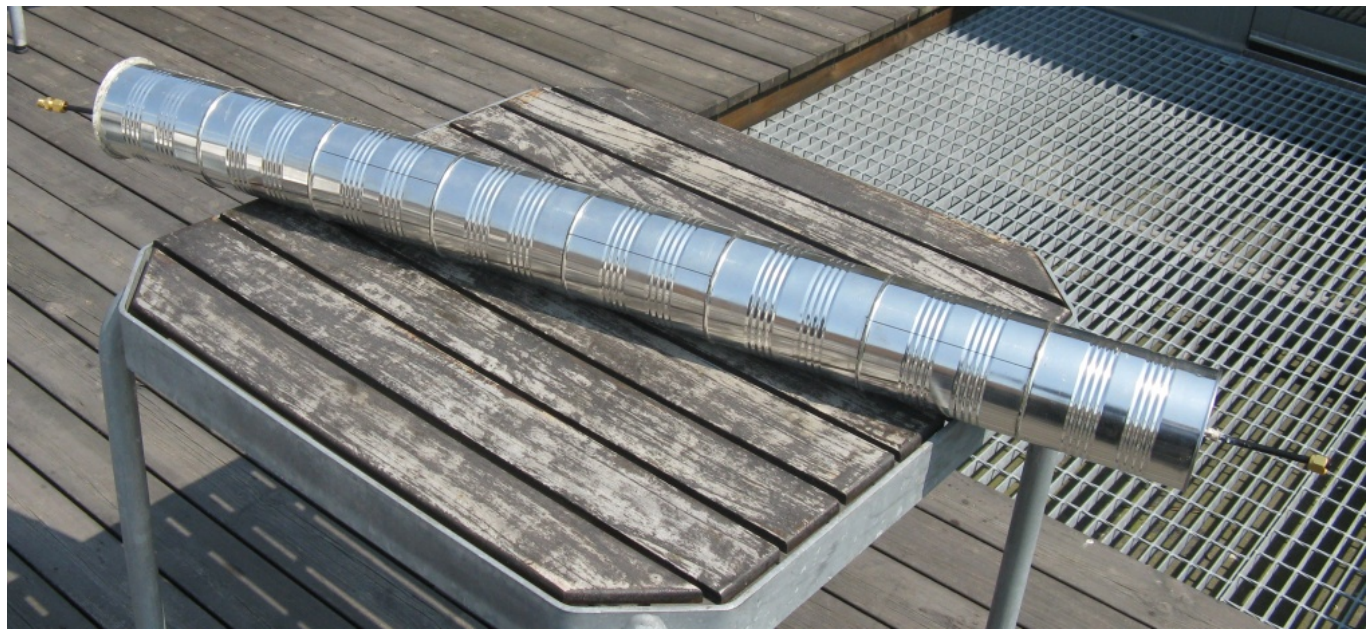
- Determine the properties of mixing volumes
- Use high frequency concentration data and filter them
- Test different filtering and sampling scenarios



$$y(t) = \int_0^{\infty} h(u)x(t - u)du$$

$$H(f) = \int_{-\infty}^{\infty} h(t)\exp(-i2\pi ft)dt$$

NOPEX



ICOS 2x



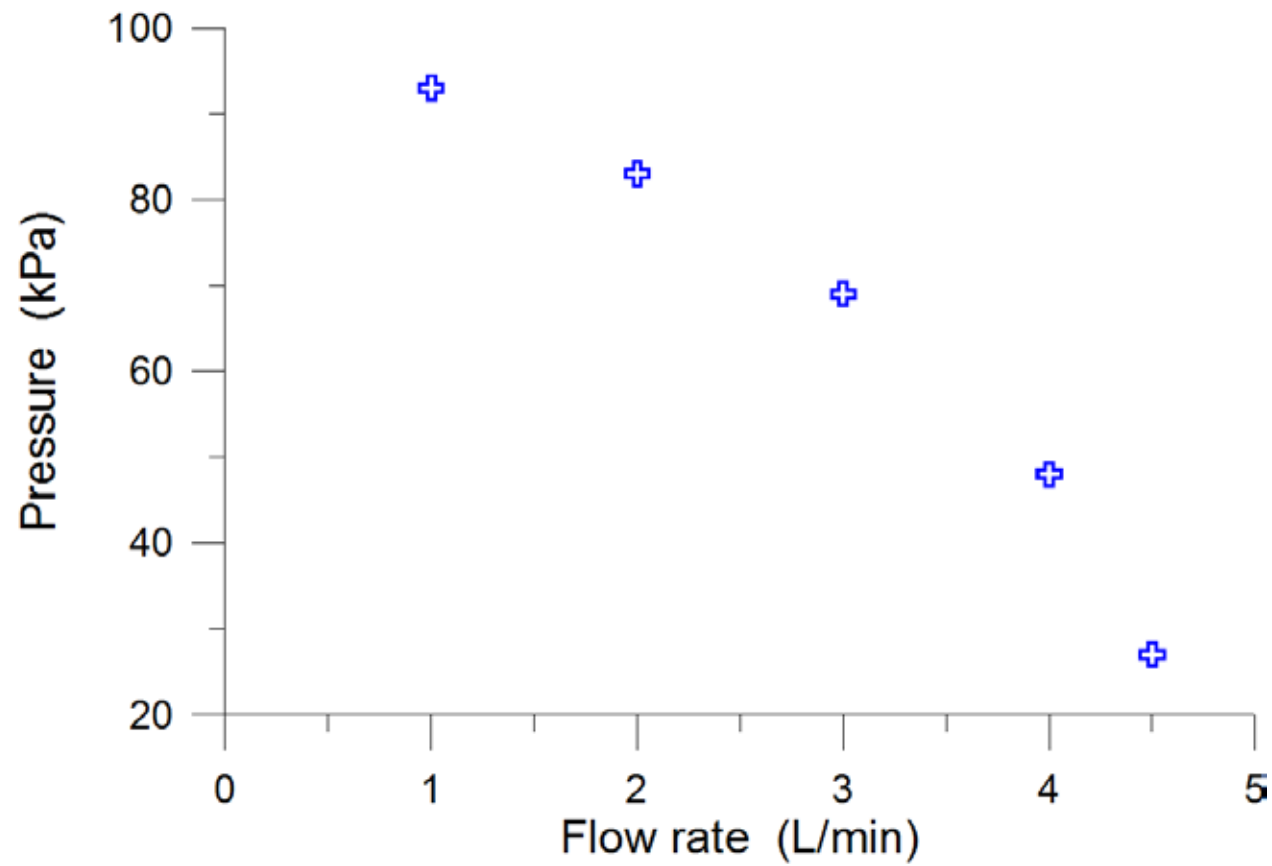
JENA

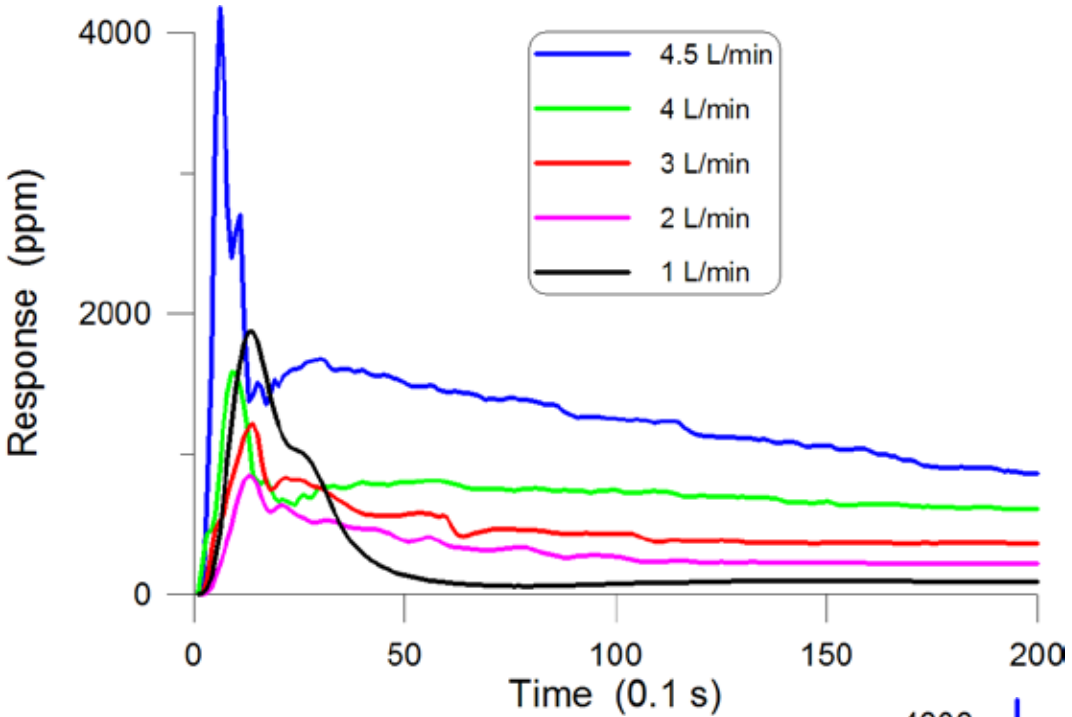




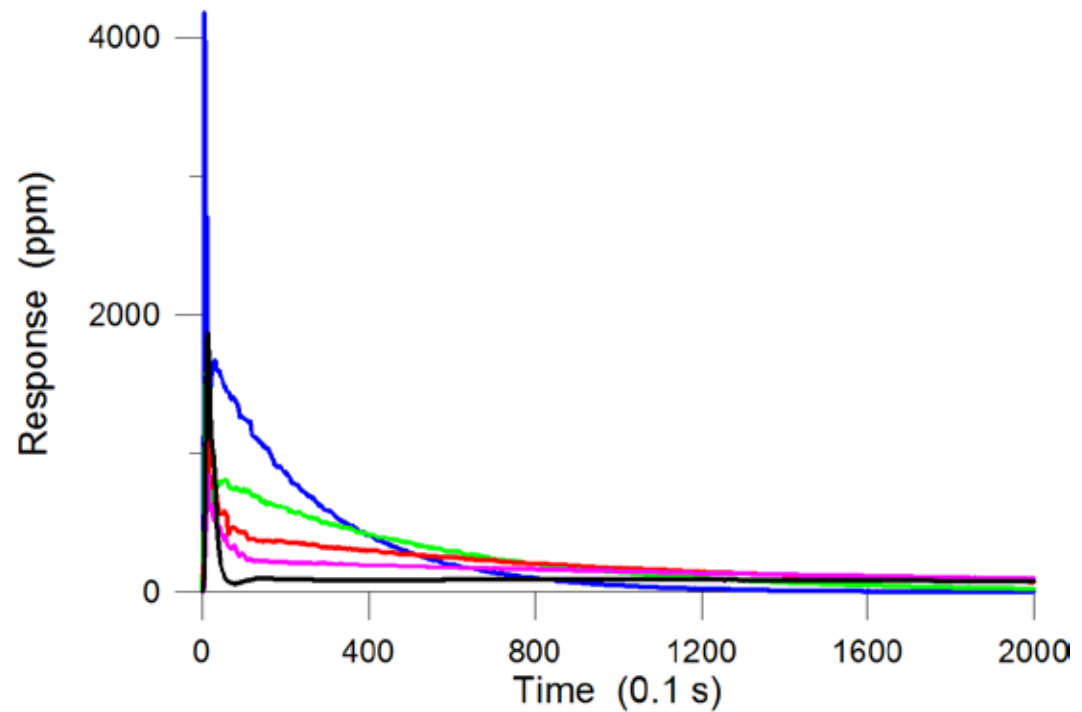
TUBE

150 m long, 4 mm inner diameter

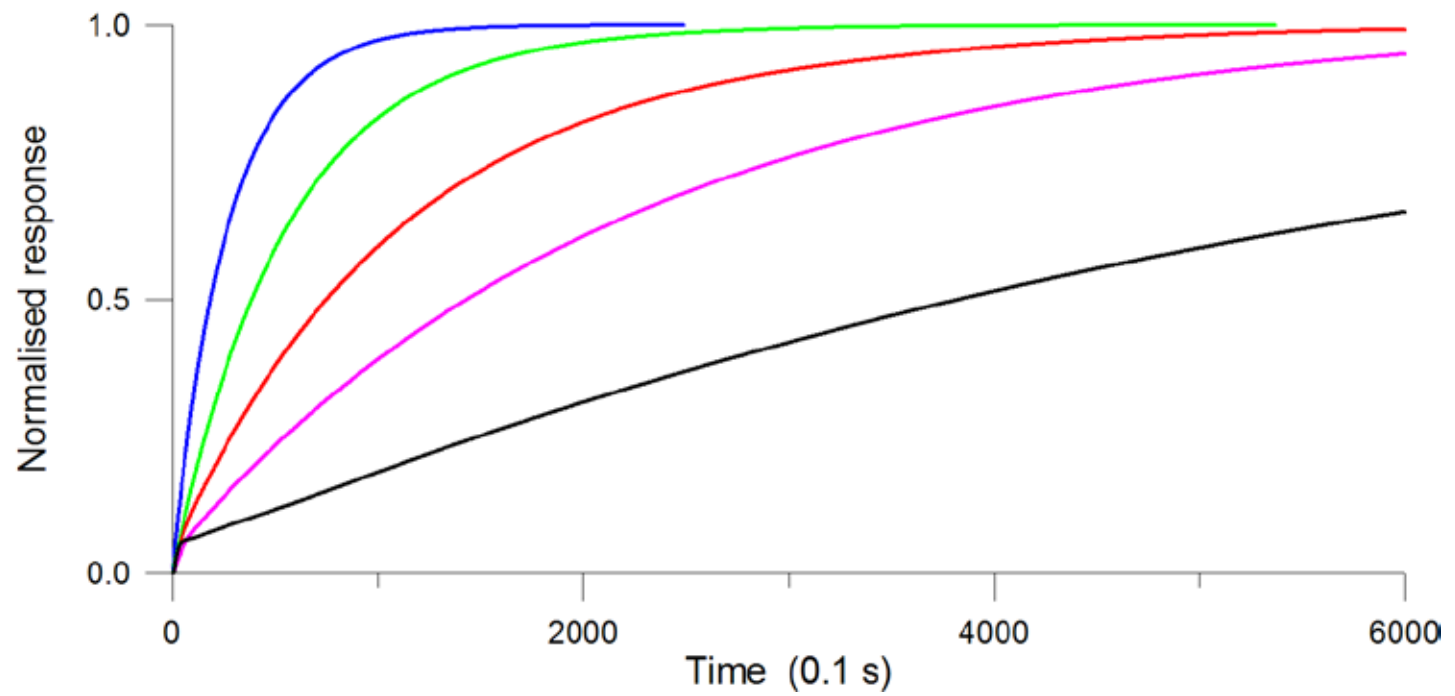




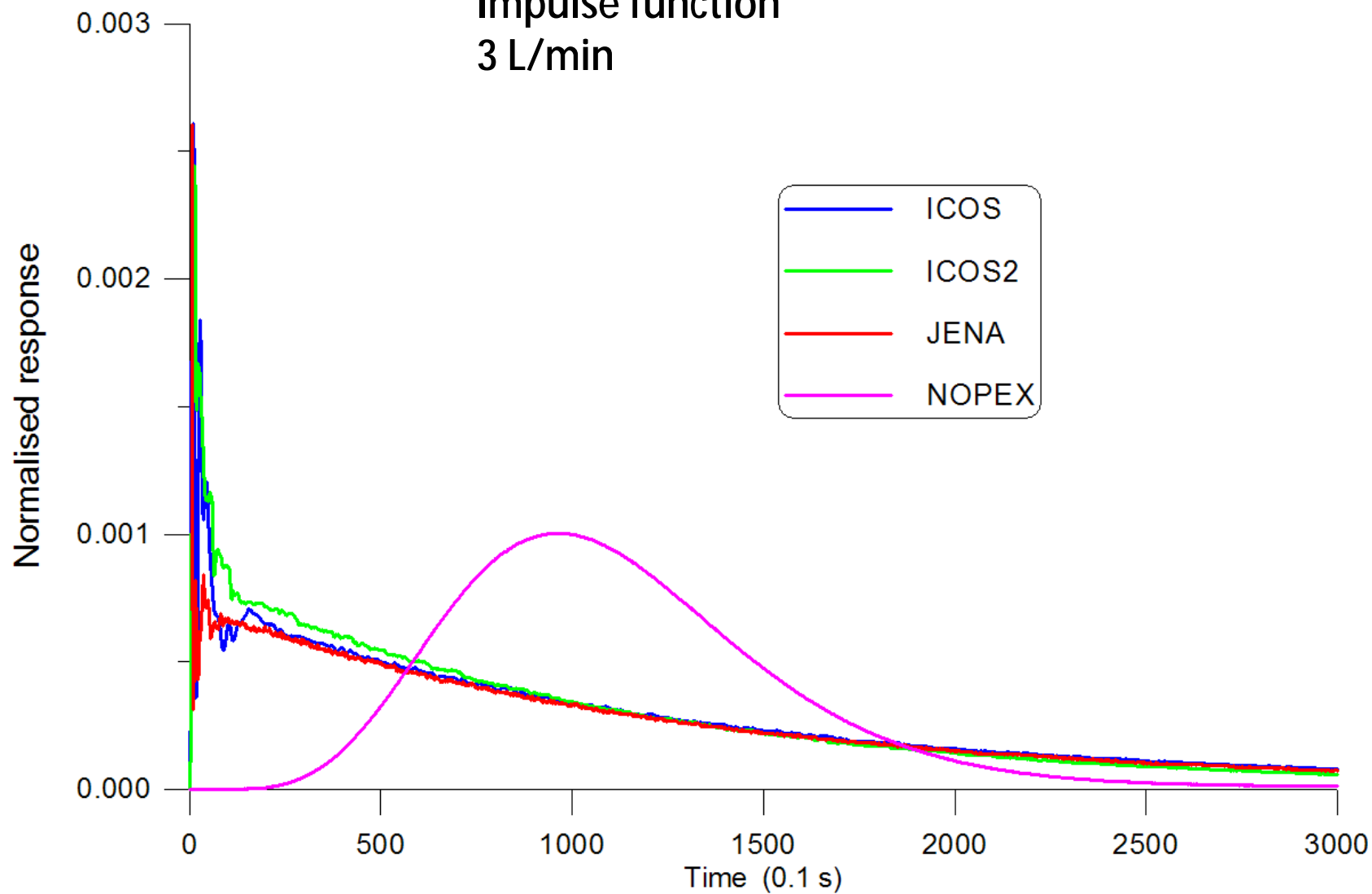
Impulse function



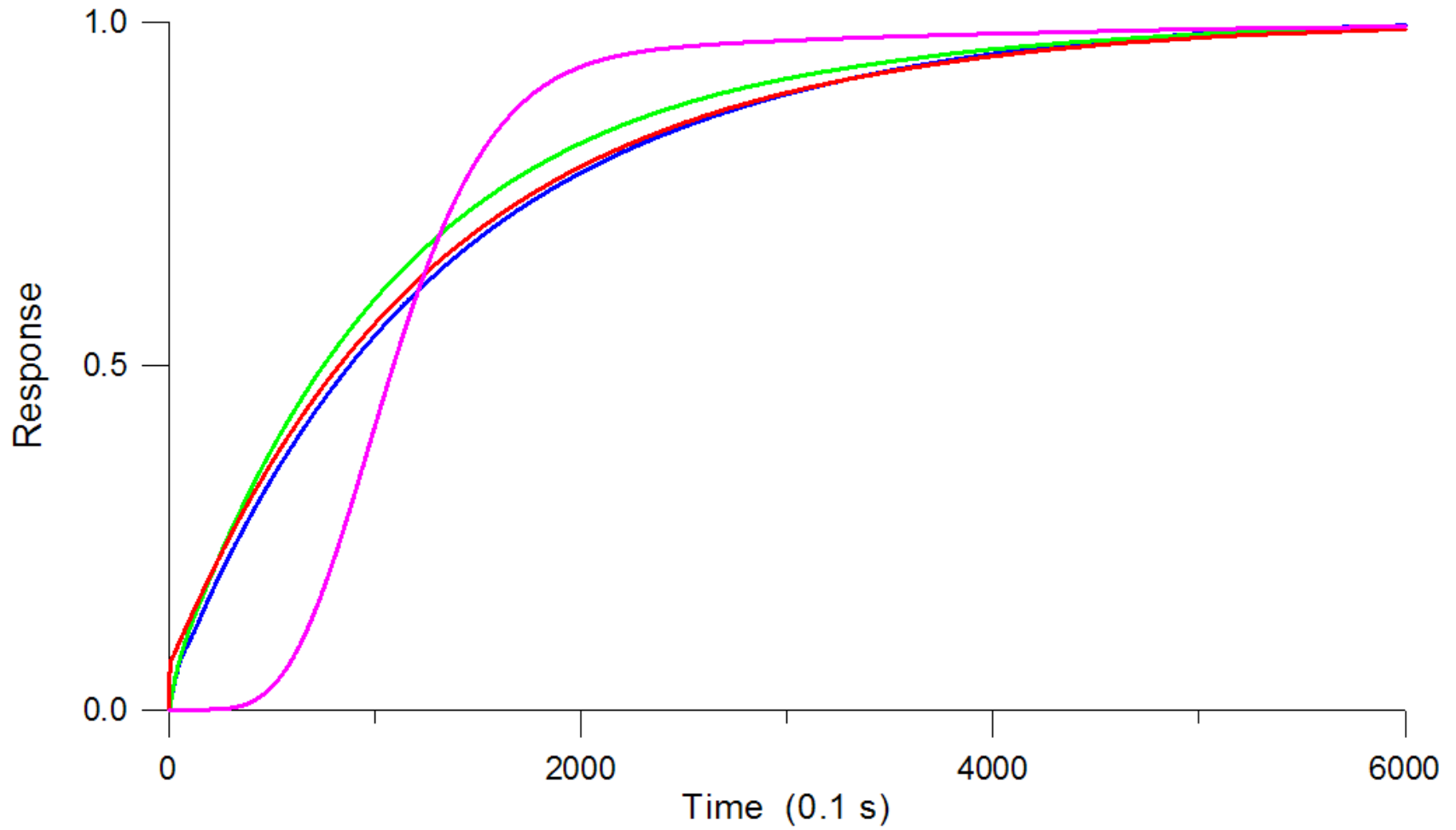
Step function



Impulse function 3 L/min



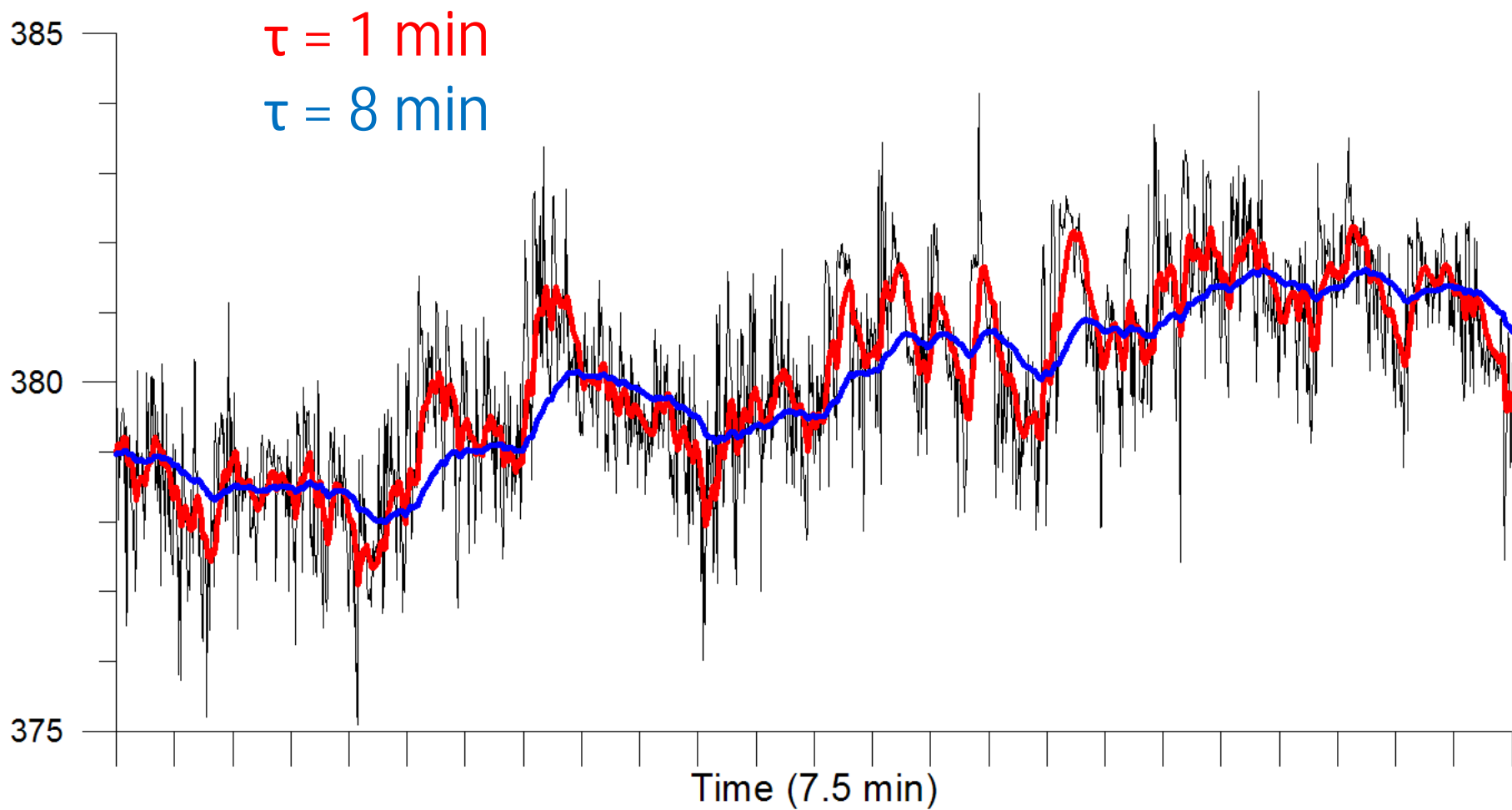
Step function
3 L/min



Recursive filter

$$y(I) = a \times y(I - 1) + (1 - a) \times x(I)$$

$$a = \exp(- D t / t)$$

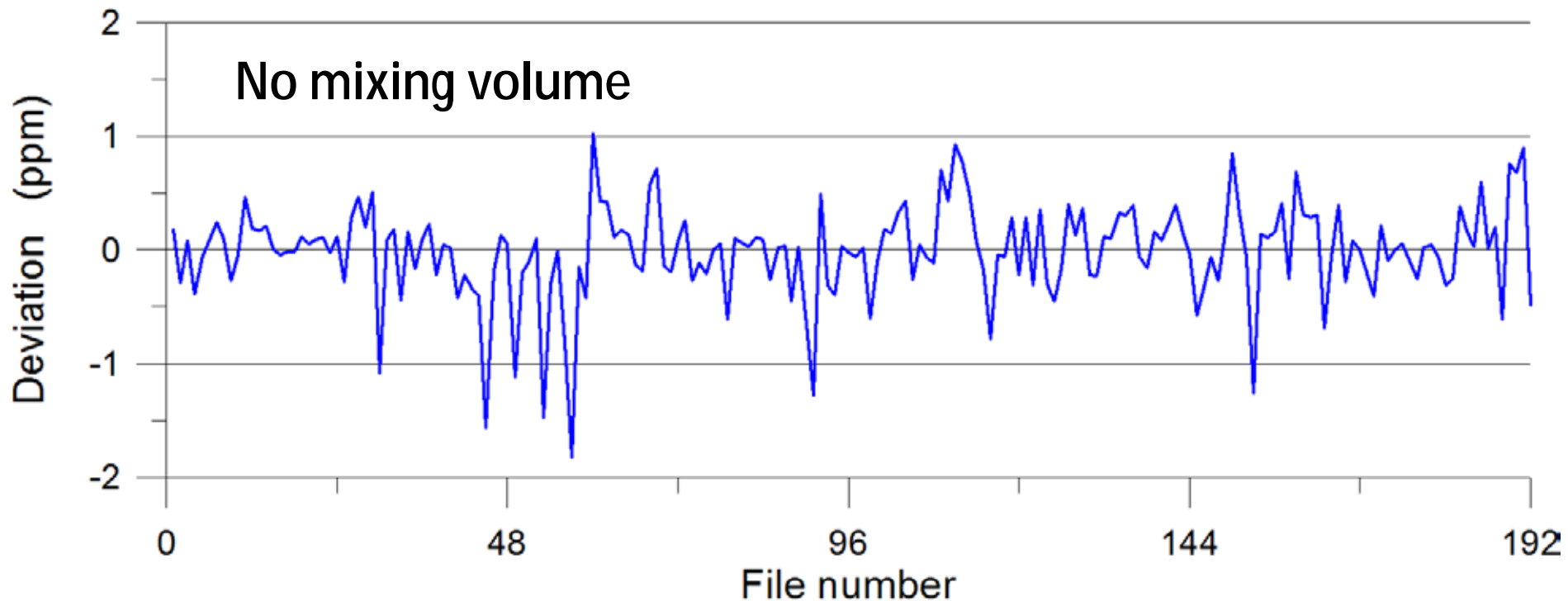


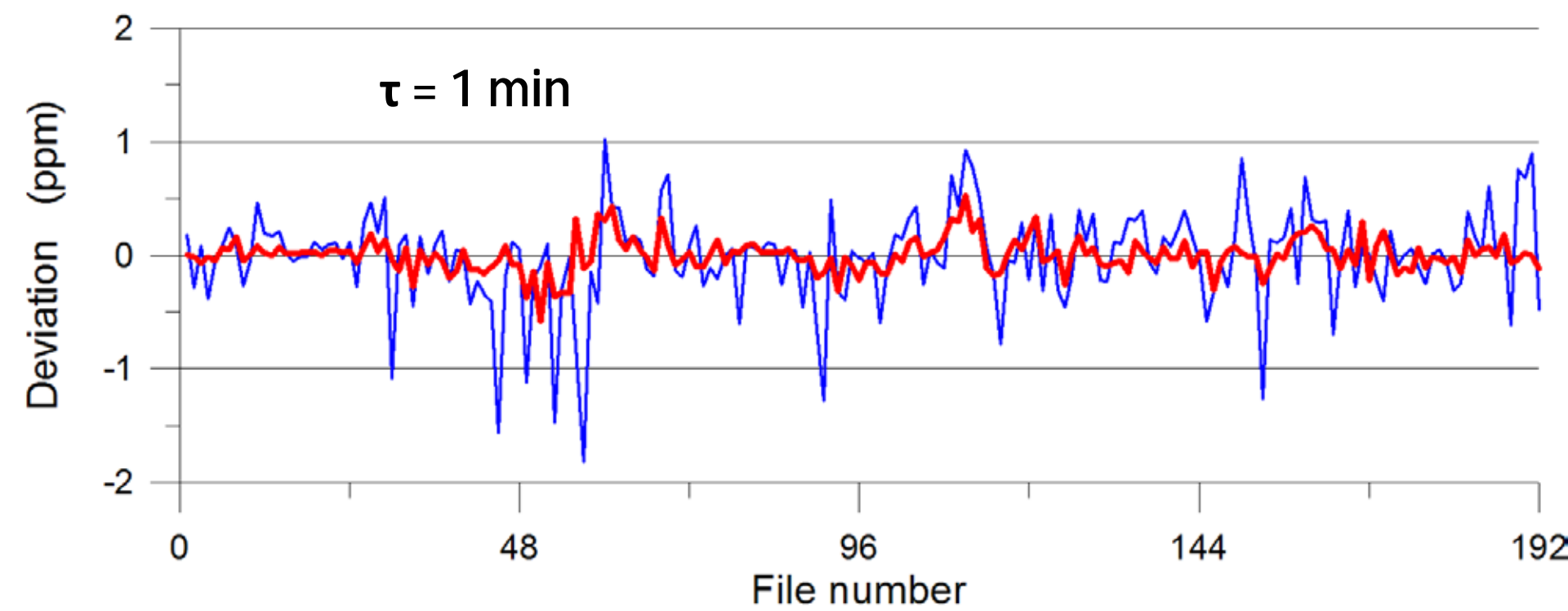
Scenario

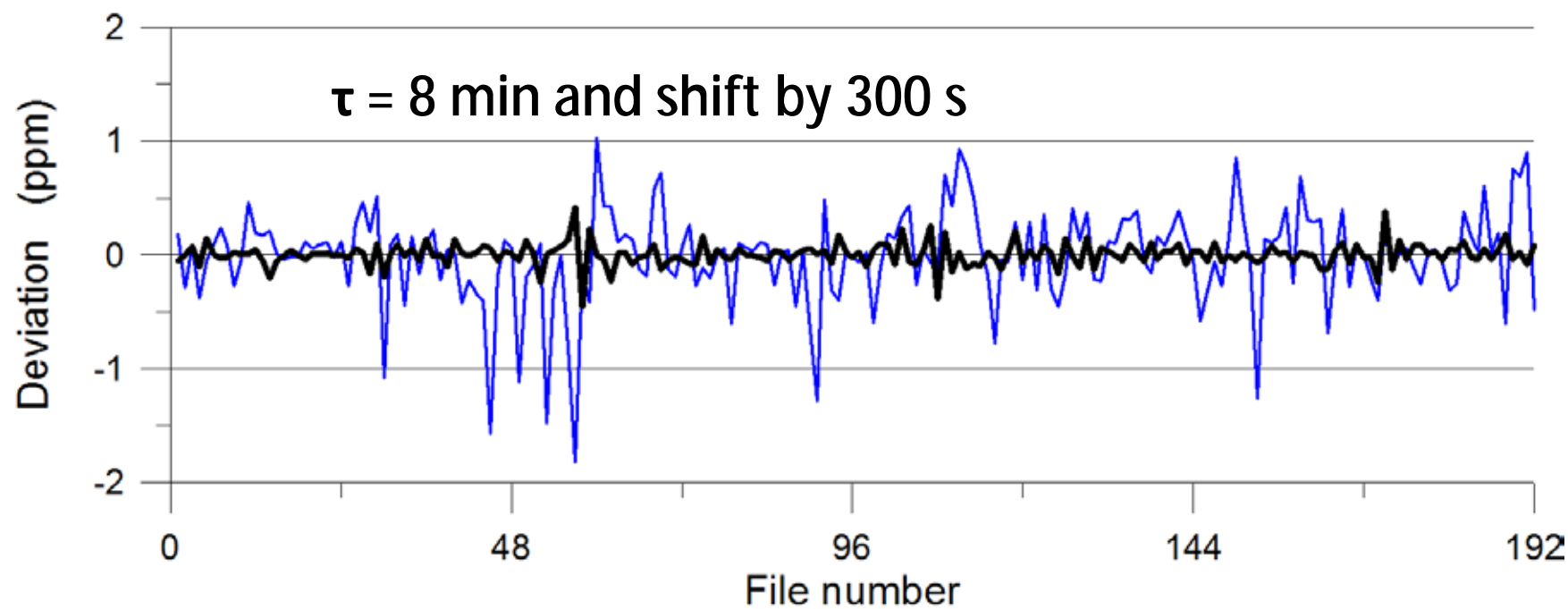
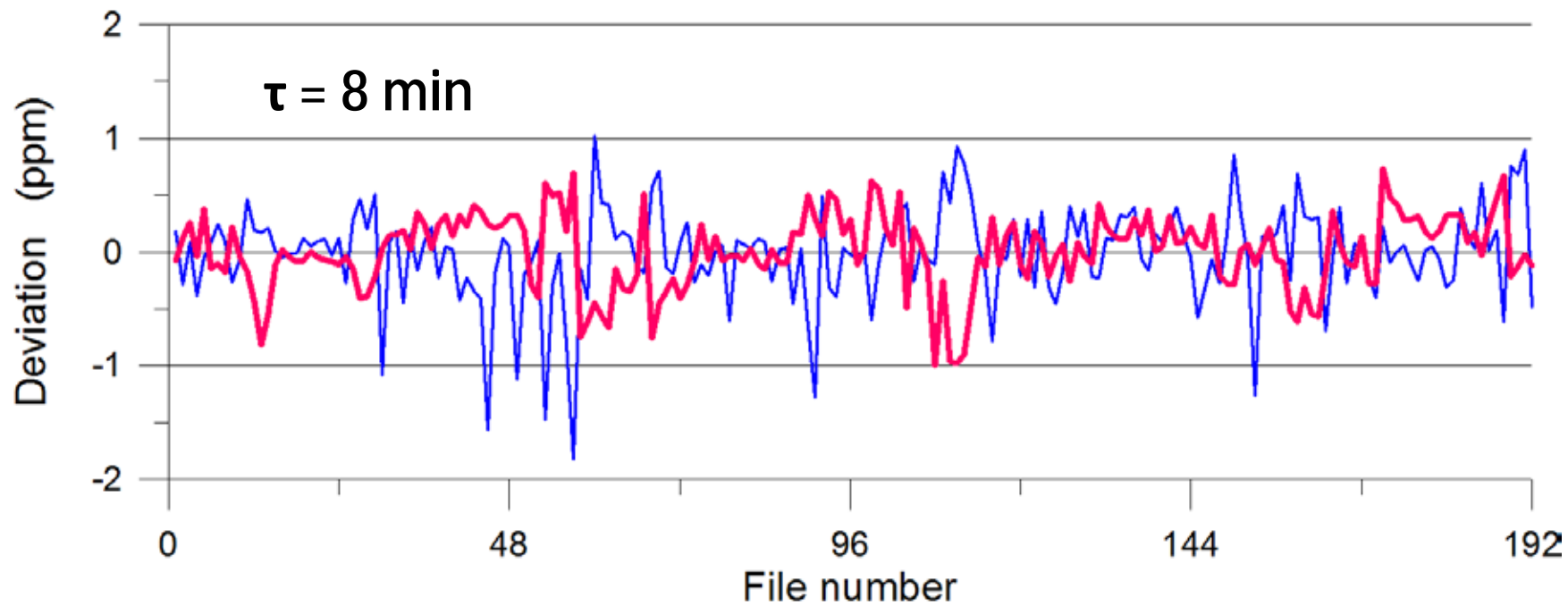
15 levels switched in 20 s steps

The same level is measured every 300 s

30 min averages







Conclusions

- * Design matters
- * Direct flow should be avoided
- * Higher pressure and lower flow rate give better mixing
- * If sampling frequency low,
then mixing volumes improve the accuracy of averages
- * Too effective mixing might introduce time shift
that should be taken into account

Thank you!