Supplementary Material for Development and Validation of an Integrated Ambient Air Test Facility (AATF) for Multi-Instrument Aerosol Characterization

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1 Example Validation Runs

Figures S1–S3 present summed bin 10 s time averaged number and mass concentrations of three different target chemicals (tributyl phosphate, phenanthrene, and caffeine along a continuous timeline at three target concentrations with three repetitions at each concentration. Notably, data was not collected from the APS in TS 2 for caffeine. When analyzing any individual instrument, data for repetitions of the same chemical and target concentration are repeatable, resulting in similar number and mass concentrations. Comparing between instruments, the relative difference in concentrations reported by the instruments is also consistent between trials.

2 Aerosol Generator Modulation Rate

As mentioned in the main paper, some of the data show an oscillatory pattern in particle counts which is consistent between instruments. This is very obvious in the data for tributyl phosphate in Fig. S1 for example. The oscillation is primarily due to the modulation rate of the Tekceleo nebulizer. The original Human-Machine Interface (HMI) device provided with the nebulizer was only capable of whole number of seconds of modulation with the total number of seconds (on and off) for a cycle typically being 5 s for our use. For example, a 20% modulation would result in 1 s of generation followed by a 4 s pause. This results in the concentration of the target chemical varying over a small amount of time throughout a given dissemination event.

The oscillatory pattern, however, was unexpectedly present in the 100% modulation case. It was later discovered that the original HMI device had a logic error that would introduce approximately a 1 s pause between cycles, even if a cycle was specified to have 0 s off. A new HMI device with corrected firmware was purchased and the oscillatory pattern at 100% modulation was resolved. This HMI device also offers some additional finer resolution control.

Typically, the instruments would integrate for 10 s, resulting in what was planned to be two full cycles per integration period. However when the extra second from the HMI device and any latency in instruments starting a new integration period are factored in, the number of cycles was typically more than one, but slightly less than two. The exact fraction of cycles represented during a given integration varied slightly in comparison to the previous and succeeding integrations. Having so few cycles in an integration period resulted in cyclical patterns of what appeared to be higher and lower aerosol concentrations. Independent development of a control device using Pulse Width Modulation (PWM) capable of millisecond control or incorporating a customizable Programmable Logic Controller (PLC) may prove valuable if short integration times continue to be used.

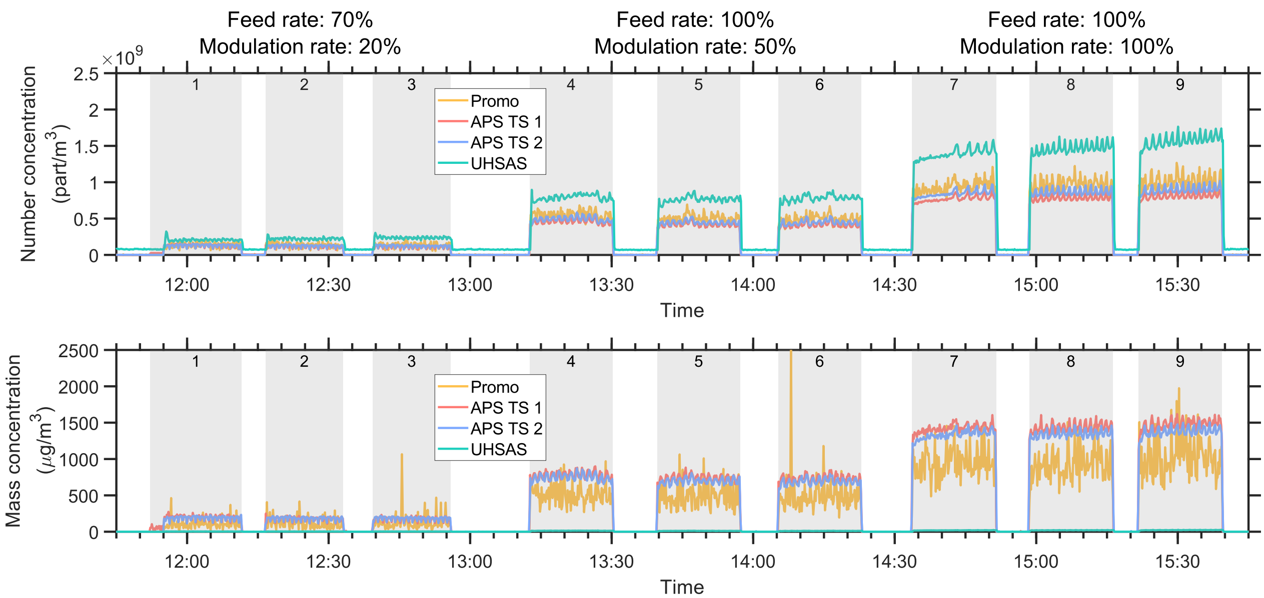

Figure S1. The number and mass concentrations for the two APSes, the Promo, and the UHSAS for 8 g/L tributyl phosphate in ethanol.

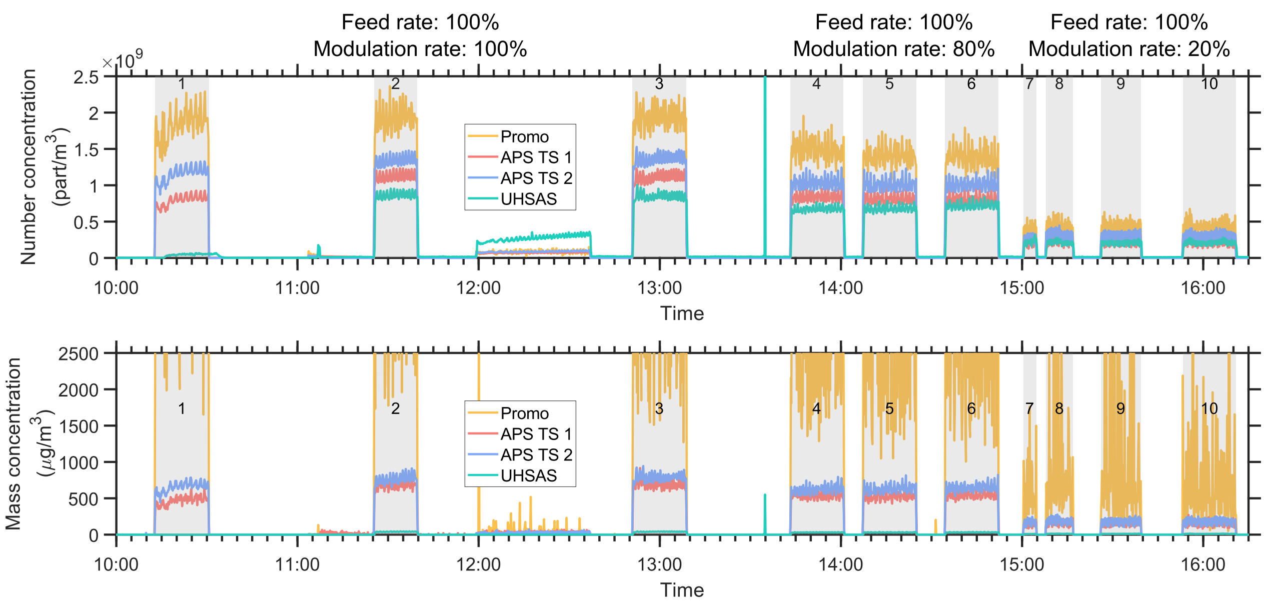

Figure S2. The number and mass concentrations for the two APSes, the Promo, and the UHSAS for 6 g/L phenanthrene in ethanol.

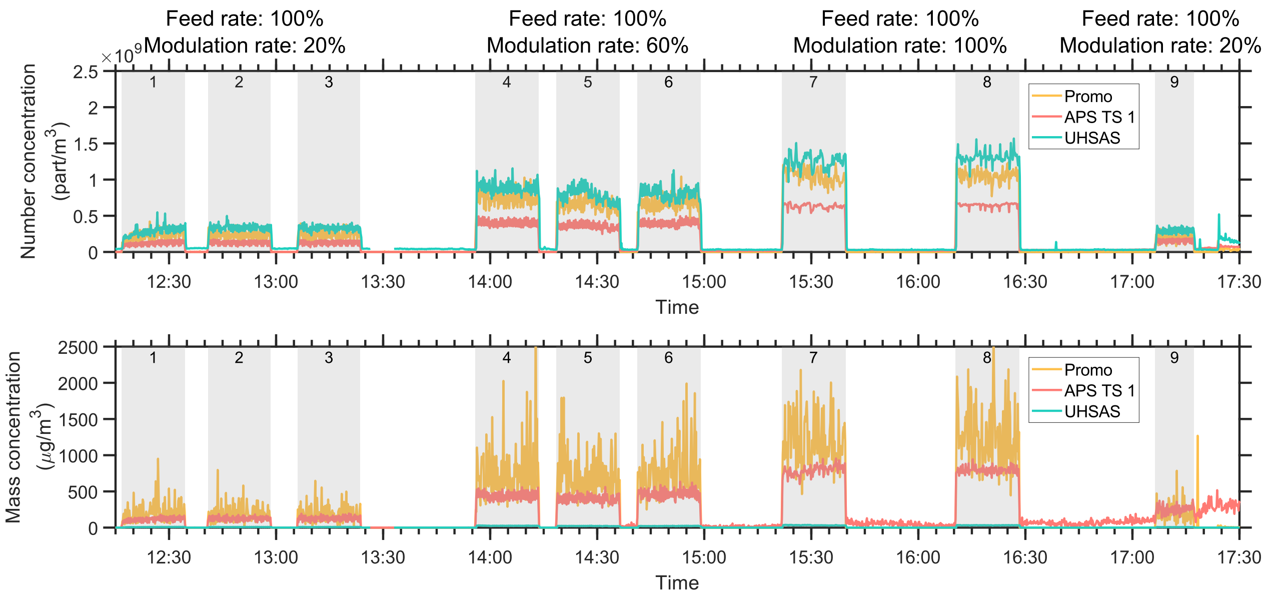

Figure S3. The number and mass concentrations for one APS, the Promo, and the UHSAS for 6 g/L caffeine in water.