

## ESI Droplet Aspiration

- ▶ Electro spray Ionization (ESI) starts with charged droplets emitted from ESI emitter / needle
- ▶ Droplets are large and have long lifetimes using current commercial ion sources
- ▶ Charged droplets are aspirated from ESI sources into the vacuum system of mass spectrometers and are observable in mass analyzers [1,2] leading to contamination and similar adverse effects
- ▶ We investigate droplet phenomenon under actual LC conditions

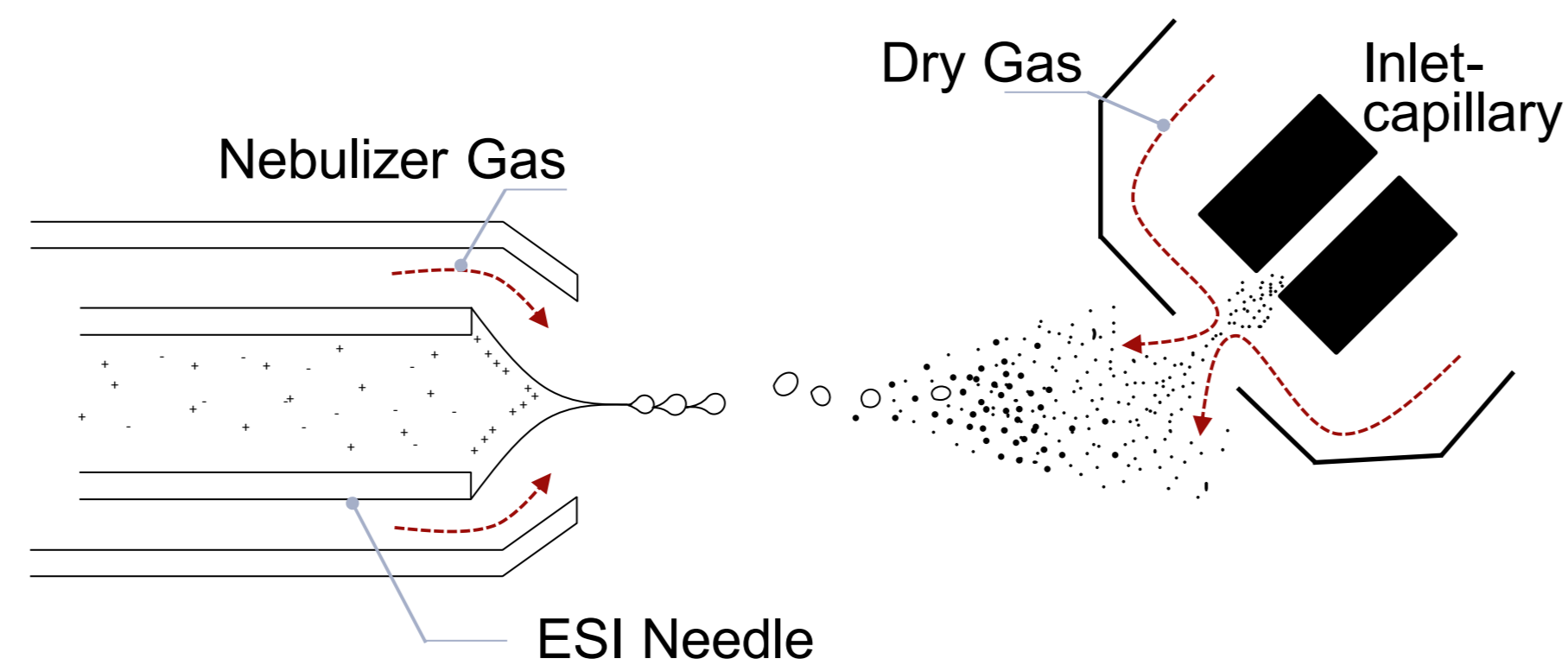
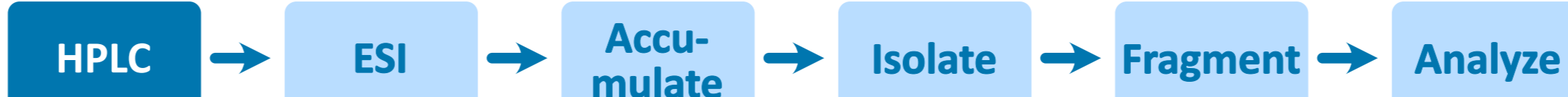


Fig. 1: ESI Scheme: Charged droplets are generated from liquid solution and are aspirated into MS vacuum system

## Experiments: QIT-MS with HPLC



- ▶ Experiments with Quadrupole Ion Trap (QIT) (Bruker amaZon) with Agilent HPLC system
- ▶ QIT-MS allows to isolate  $m/z$  range in trap and to analyze the fragment spectrum of isolated ions
- ▶ Analytes: Reserpine and Benzylpyridinium thermometer ions
- ▶ Variation of ion source and LC conditions allows to investigate effects on observed signatures of aspirated droplets

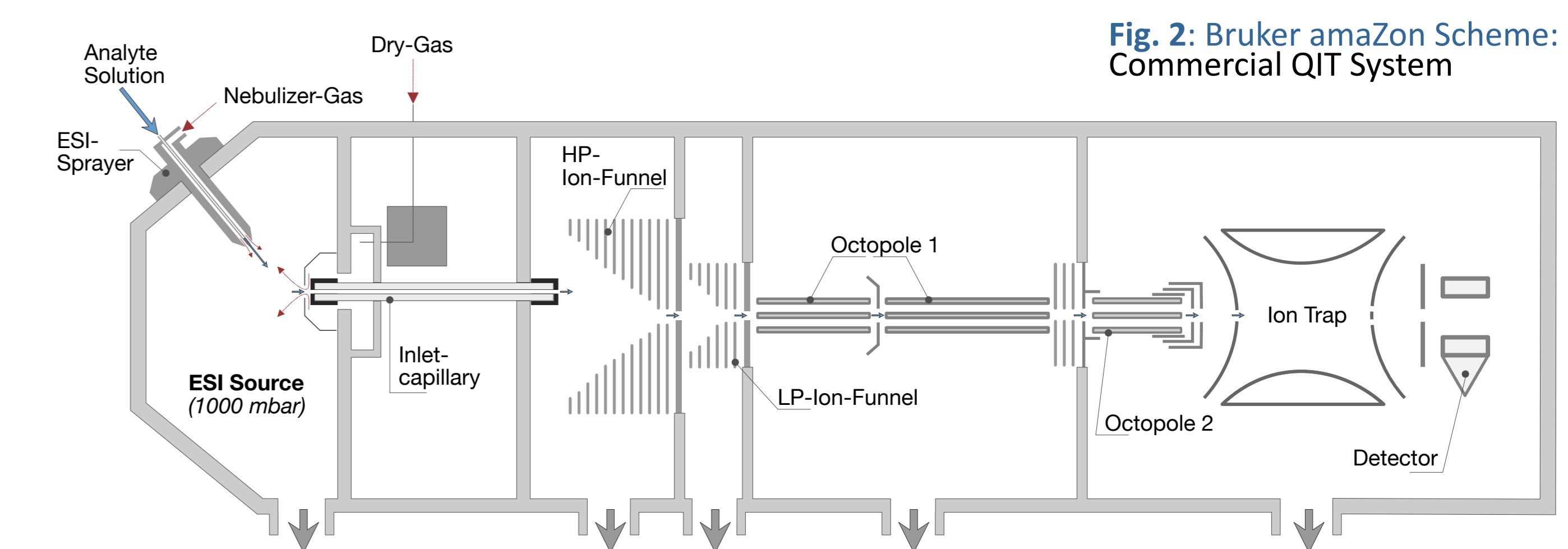
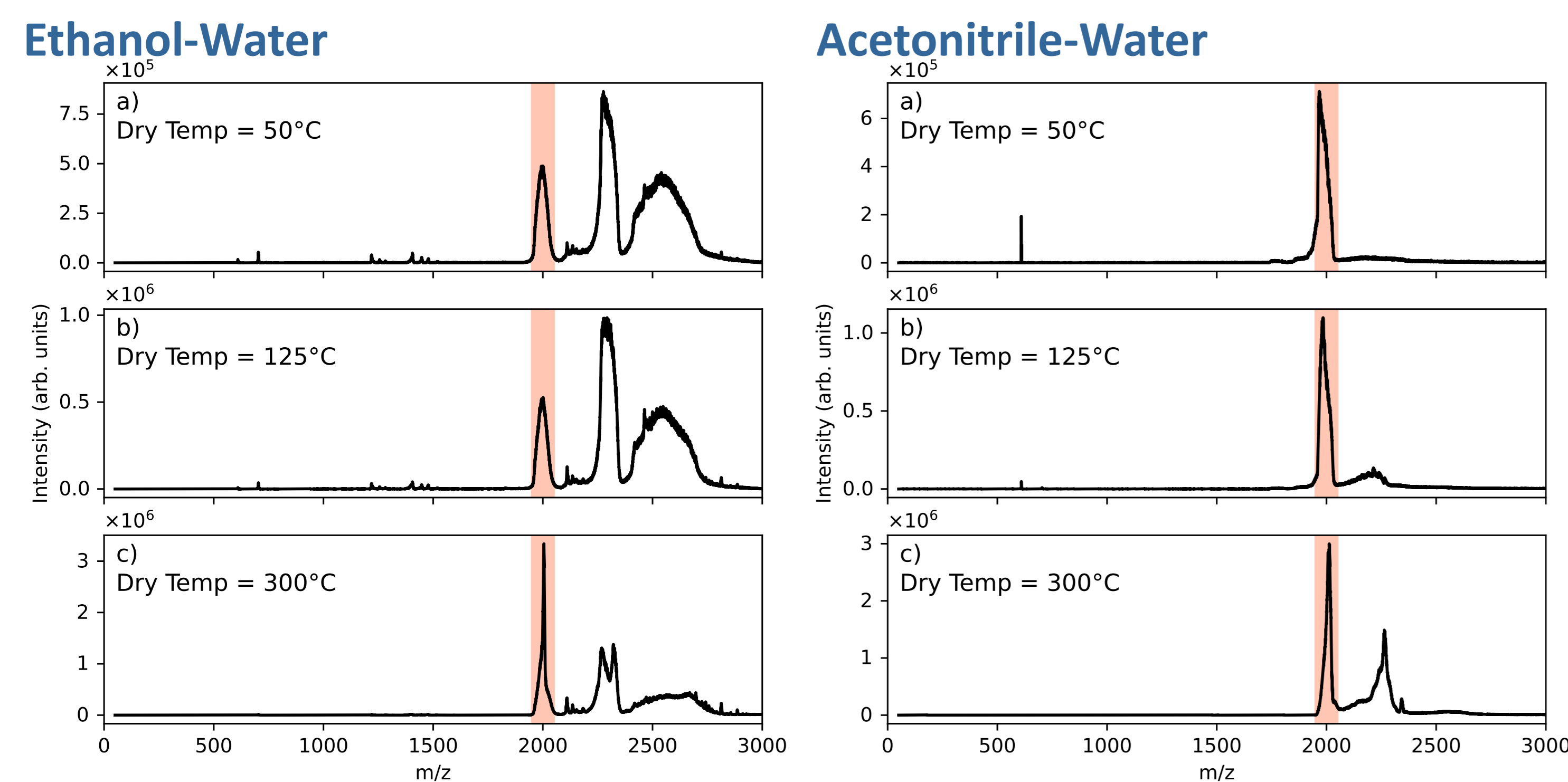


Fig. 2: Bruker amaZon Scheme: Commercial QIT System

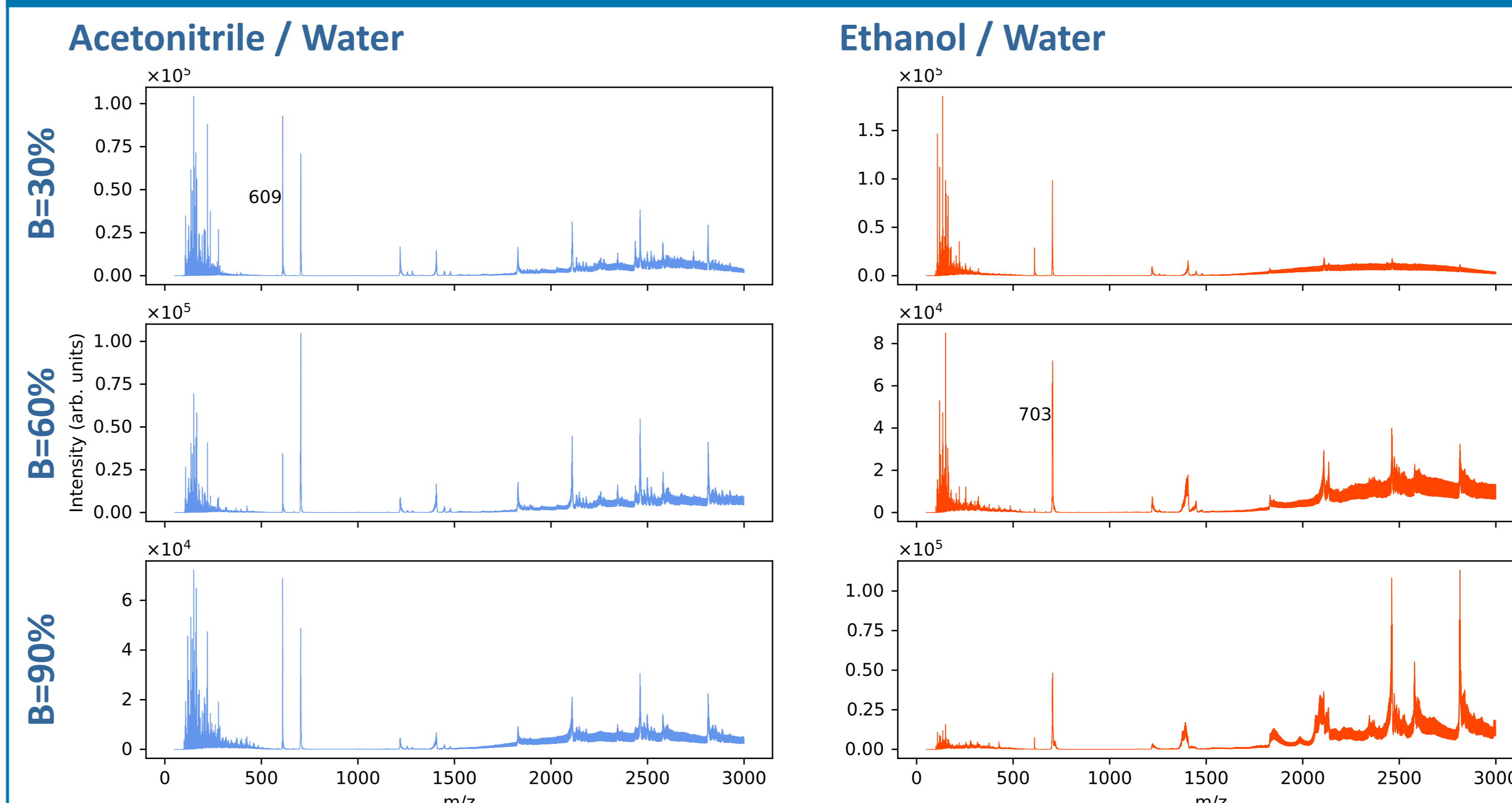
## Ion Source Parameter: Dry Gas Temperature



- ▶ Experiments with Reserpine in different solvents with varied dry gas temperature
- ▶ Ions are isolated in trap (isolation range marked orange in the spectra)
- ▶ Liberation of analyte ( $m/z=609$ ) and complex charge loss signals ( $m/z$  higher than isolation range) clearly visible
- ▶ Strong dependency of fragmentation / reaction pattern (and thus droplet species stability) on dry gas temperature and solvent.

Fig. 3: Dry gas and solvent dependent spectra: Reserpine in different solvents and with different dry gas temperatures.

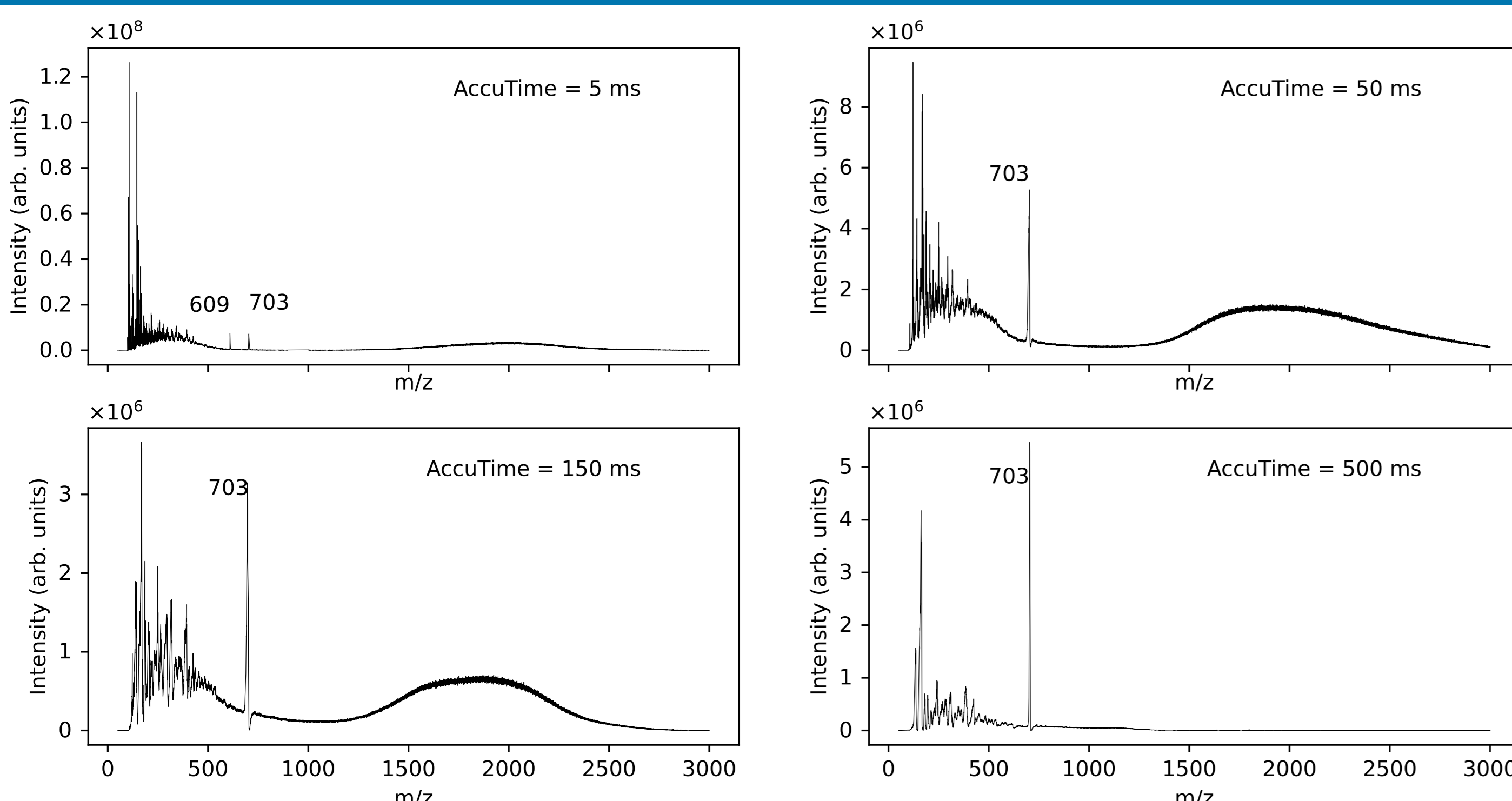
## Solvent System Dependency



- ▶ Experiments with Reserpine in different solvent systems (water / ethanol and water / acetonitrile)
- ▶ Strong dependency of observed droplet signatures (signals with  $m/z > 1800$ ) on solvent type and fraction of organic component ( $B$ )
- ▶ Analyte adduct formation and droplet signal formation particularly pronounced for Ethanol
- ▶ Distinct signal pattern in droplet signature range for both organic solvents in high concentrations

Fig. 5: Mass-spectra, with varied solvent system: Reserpine in Acetonitrile / Water and Ethanol / Water with varied organic fraction

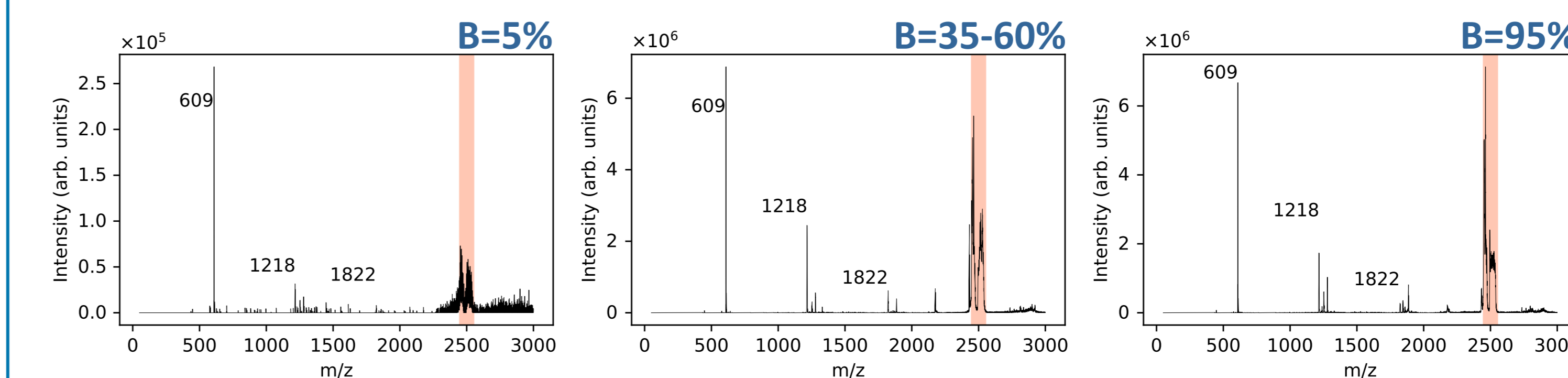
## Ion Trap Parameter: Accumulation Time



- ▶ Surprisingly, a very pronounced dependency of the observed mass spectra on the trap accumulation time is observable
- ▶ Observed analyte adduct signal ( $m/z=703$ ) relative to other signals in the spectrum is strongly dependent on accumulation time
- ▶ Remarkably, wide droplet fragment signal ( $m/z < 1200$ ) vanishes with very long accumulation time
- ▶ Strong effect of accumulation time hints towards complex dynamics of trapping process and in-trap reactions of charged droplet fragments
- ▶ Further investigation will require advanced modeling of ion dynamics in QIT

Fig. 4: Accumulation Time Variation: Accumulation time variation with Reserpine in Ethanol/Water (1:1), 100 $\mu$ l/min liquid flow

## Isolation Experiments with Acetonitrile / Water



- ▶ Isolated spectra during an LC gradient: Bare analyte (Reserpine) is generated from trapped droplet fragment species with all investigated organic solvent fractions

Fig. 6: Isolated spectra, varied organic fraction: Reserpine in Acetonitrile / Water

## Conclusions

- ▶ Droplet signature observation with analytical LC conditions
- ▶ Strong effects of ion source and LC parameters observed
- ▶ Solvent system and dynamics in liquid droplets is crucial factor for droplet aspiration and thus all related phenomena
- ▶ Droplet aspiration changes significantly during an LC gradient
- ▶ Further investigation requires more experiments but also sophisticated modeling

## References

- [1] Kang, Y.; Schneider, B. B.; Covey, T. R. On the Nature of Mass Spectrometer Analyzer Contamination. *J. Am. Soc. Mass Spectrom.* 2017, 28 (11), 2384–2392. <https://doi.org/10.1007/s13361-017-1747-3>.
- [2] Markert, C.; Thinius, M.; Lehmann, L.; Heintz, C.; Stappert, F.; Wissdorf, W.; Kersten, H.; Benter, T.; Schneider, B. B.; Covey, T. R. Observation of Charged Droplets from Electro spray Ionization (ESI) Plumes in API Mass Spectrometers. *Anal Bioanal Chem* 2021. <https://doi.org/10.1007/s00216-021-03452-y>.