Limitations when using a Gas Mixture and Tuning Corrector.

First, let’s note that if an *exact* calibrated measured spectrum is available for **every** gas that you will ever encounter in your experiments, then there are no errors, and also no need to perform tuning corrections.

Tuning corrections are useful when there are some gases that we can’t do a direct calibration for, because then we can take a molecule’s reference spectrum (from NIST webbook) and predict how its response is going to be in our spectrometer. This is because each spectrometer has different tuning (different sensitivity as a function of mass fragment weight).

First, let’s look at a scenario and some considerations.

1. If there are only a few gases that one does not have reference spectra for…
   1. If the *only* difference is the tuning between mass spectrometers (i.e., ours and NIST’s), then… and if *exact* patterns are available for several gases (doesn’t even need to be calibrations), MSRESOLVE can correct for the tuning.
      1. This assumes that all of the NIST spectra were collected on a single spectrometer (or sufficiently the similar spectrometers) with a single tuning.
         1. [This is probably an okay assumption.]
      2. This assumes the inherent *ionization factors* for each molecule are the same (or sufficiently similar) in the NIST spectrometer and your spectrometer, it also assumes we know what that factor is, so we can correct for it.
         1. [This is probably an okay assumption, but I worry a bit about it. Gathering more of the data on these factors is one of my longterm plans for MSRESOLVE. It is equivalent to how there are tabulated relative sensitivities for GC detectors]
      3. This assumes that the inherent molecular *fragmentation is* the same (or sufficiently similar) in the NIST spectrometer and your spectrometer.
         1. This assumption is more questionable. I know that in my spectrometer, the fragmentation pattern for alcohols and aldehydes differs from NISTS even after tuning corrections. There is currently no simple solution to this. In the future, one could use “fragmentation” corrections for classes of molecules. In practice, this is likely always going to cause quantitative inaccuracies.
   2. There are *three* ways to solve the tuning factors from a gas mixture.
      1. To resolve the gas mixture into its respective components, and *then* do the normal tuning corrector procedure.
         1. This is not viable, because it probably would require an iterative procedure and has too much risk of propagating errors unevenly.
      2. To simulate the full set of signals (using NIST references), and then do the tuning corrector on the absolute signals, and do regression to extract the tuning correction that will get this simulation to match the measured Scenario (your spectrometer)
         1. This is what I plan to do. But, it does have the risk that if either of the above two yellow-highlighted factors are imperfect, it will introduce inaccuracies in the tuning factors (and, also in the final experiments when analyzing a real experiment, with certain gases having bigger errors than others).
      3. To simulate the full set of signals, but pull out the most distinct mass fragments from individual molecules, and do a more sophisticated regression.
         1. This might be able to help to avoid the “ionization” factors inaccuracy, but this would not be easy to do.