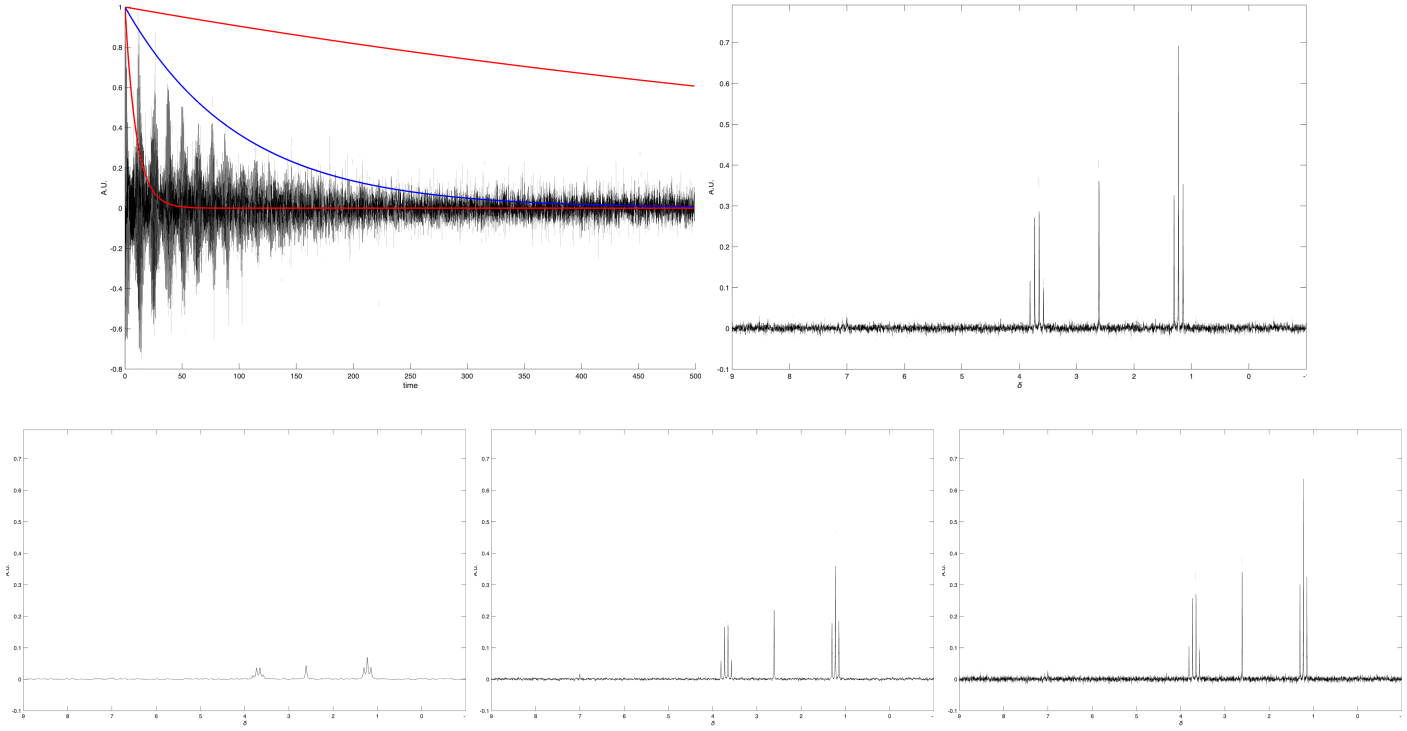
# June 2025 NMR Topic of the Month: On Filters Part I

## What is the golden rule of filters?

You never, ever gain information by applying a filter, but you can lose information by applying a filter. Filters can elucidate a signal's content, but cannot add information not already contained within the signal. Some filters do reduce the information content of a signal, which may be acceptable/desirable.

## Which Filter?

There are many types of filters, this series of topics focuses on the common data window multiplication filters found in Bruker's TopSpin. These filters are multiplied into the free induction decay (FID) or time domain signal and are convoluted into the frequency domain signal or spectrum.



## The Exponential Filter

The exponential filter is very commonly used in NMR. It has a single adjustable parameter called the line broadening (lb), which represents the strength of the filter. The pictures above are a mock ethanol proton signal with a signal-to-noise of 50 to the tallest peak. The real time domain FID (top left) has three exponential filter (em) overlaid apodization functions: a too aggressive filter (lower red), a matched filter (blue), and a too weak filter (higher red). The real Fourier transform of the FID (no apodization) is shown at the top right. The bottom figures are of the real Fourier transforms of the FID with the aggressive, matched, and weak filters shown respectively from left to right. The too aggressive filter broadens out the peaks too much and completely obliterates the contaminant at 7 ppm. The matched filter is the best option, balancing improving the signal's appearance (the peak at 7 ppm is discernible) without distorting it. The too weak filter does not improve the signal's appearance enough to warrant applying it. To set the exponential filter strength properly, set the line broadening equal to the full width at half height (FWHH) of the most narrow peak in the unfiltered spectrum.

## References


1. TopSpin: Processing Commands and Parameters User Manual Version 007 (H9776SA4_007), 57-58 (2023).
2. J.C. Hoch and A.S. Stern, *NMR Data Processing*, Section 3.10, Wiley-Liss, New York (1996).
3. R.N. McDonough and A.D. Whalen, *Detection of Signals in Noise*, 2nd ed., Academic Press, San Diego (1995).