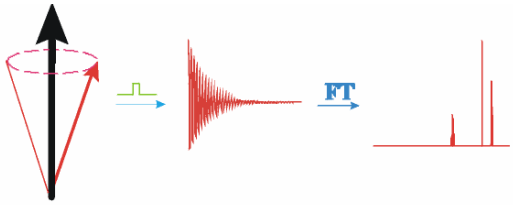


ATLANTIC REGION MAGNETIC RESONANCE CENTRE

# Filtering COSY Signals in an Automation Environment

## Announcing New Experiments Available to Users of the Bruker AVANCE 500

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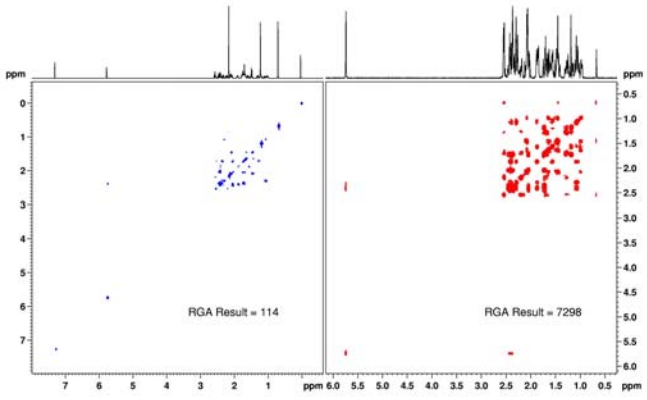
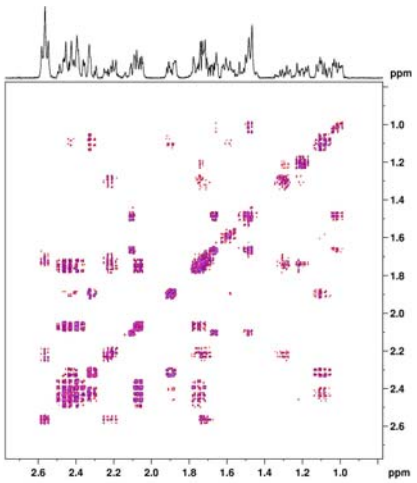
In the last bulletin published by ARMRC entitled "*Get Excited – But Be Selective*", Dr. Bob Berno told you about using shaped pulses as a type of filter in performing selective excitations, both in 1D experiments and along the F1 dimension of 2D experiments. In this bulletin, I would like to introduce another type of filter which is technically known as a multiple quantum filter (MQF). I will admit that this name sounds intimidating but in actual fact the concept is rather simple. In essence, a MQF uses a combination of rf and gradient pulses within a pulse sequence to remove certain types of signals (normally $^1$H). More explicity, whether or not a given $^1$H signal will "pass through" the MQF will depend upon the number of protons it is spin-spin (*J* ) coupled to.

As everybody reading this knows, the 2D-COSY experiment correlates protons that are *J*-coupled to one another. If any given proton does not have a coupling partner (i.e. a singlet in the 1D $^1$H spectrum), it does not give rise to a cross-peak in the 2D-COSY but its resonance signal still remains along the diagonal. In other words, singlet peaks (including solvent peaks such as residual HOD) provide no structural information in the COSY experiment but at the same time unnecessarily crowd the COSY diagonal, potentially masking the all-important cross-peaks residing close by. A double-quantum filtered (DQF) COSY filters out these signals, **leaving only protons with at least one-coupling partner**. By extension, you can now see that a DQF-COSY is a method of performing COSY with water suppression! The higher order triple-quantum filtered (TQF) COSY provides additional simplification as it filters out both singlets AND doublets, **leaving only protons which have at least two coupling partners.** Although the addition of a MQF theoretically reduces the S/N by a factor of 2 for the DQF and a factor of 4 for the TQF, this loss is at least partially compensated for in a couple different ways. One is the receiver gain (RG) setting. Because singlets are usually the most intense peaks in the spectrum, the RG setting in the conventional COSY must be set low enough to accommodate them. Since the DQF-COSY filters these out, the RG can be optimized on the less-intense coupled protons, potentially reducing the so-called digitizer noise (quantization noise) and thereby improving signal-to-noise. The other consideration is that intense singlets and certain solvent peaks are often the primary source of *t1-noise* in the conventional COSY and so this source of noise will also be attenuated in the MQF version.




Now included in your ICON-NMR experiment list are two new experiments called *2d_dqfcosy* and *2d_tqfcosy*. Both are magnitude experiments and so phasing is not required. Please note that the setup experiments for optimizing the sweep-width are not the normal 1D $^1$H but are called 1d_setdqfcosy and 1d_settqfcosy, respectively. Like the conventional COSY, the minimum phase cycle is 1, which I've set to be the default number of scans and so without changing any parameters, these experiments are calculated to take only 5m 27s each (256 $t_1$ increments). The figure on the left shows a side-by-side comparison of the conventional COSY experiment (blue contours) and the DQF-COSY (red contours) run on a ~47.5 mM sample of the hormone progesterone in $CDCl_3$ using identical parameters under the control of ICON-NMR. Identical contour levels were also used in displaying these spectra. Notice the narrower sweep width and therefore improved digital resolution in the DQF-COSY due to the fact that the $CDCl_3$ and TMS solvent signals are eliminated by the DQF. The 3 dominant peaks in the 0.5-2.5 ppm range of the spectrum are due to singlet methyl groups which, as mentioned above, dominate the signal amplitude at the receiver in the conventional COSY. Consequently, this experiment ran with an RG of 114 whereas the DQF experiment, where these singlets are heavily attenuated, ran with an RG of 7298. The figure on the right shows the TQF-COSY experimental result obtained from ICON-NMR. The spectrum represents the full sweep width, which is significantly reduced from even that of the DQF experiment due to the fact that the olefinic signal at ~5.8 ppm is a doublet and gets filtered in the TQF-COSY. Also, the experiment ran with a receiver gain of 20643, an increase over the DQF experiment by ~ a factor of 3.




In closing, it is my hope that ICON-NMR users will start to use the DQF-COSY experiment by default rather than the conventional experiment we've been using since the arrival of the 500. For those of you dealing with high molecular weight compounds in your research program, I suspect you'll particularly want to familiarize yourself with the TQF experiment. Finally, I would be remiss if I did not acknowledge Dr. Martine Monette of Bruker Biospin Canada who made me aware of these magnitude MQF-COSY experiments during a recent trip to the Bruker Application lab in Milton, Ontario.