# Reconstruction of Phase Rotation Spectroscopy Data on Partial Parallel Array MRI Systems

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**Introduction:** Phase rotation is a powerful spectroscopic technique that allows not only for the acquisition of *in vivo* ultra-short TE spectra without excessive demands on the RF pulses (1-3), but also for simultaneous acquisition of multiple coherences. With the use of partial parallel array MRI (pMRI) systems, array coils are becoming the standard for MRI systems. They improve SNR, which is a welcome addition to the world of $^{1}H$ MRS where significant effort is expended in order to improve the SNR and spectral resolution. However, current automatic techniques for combining coil signals negate the effects of the phase rotation technique in $^{1}H$-MRS. In this work, we present an expanded algorithm for combining spectroscopic phase rotation signals on pMRI systems.

**Method:** Data were collected on a Siemens TIM Trio 3.0 T using a 4-channel head coil. The spectroscopy examination included a phase rotation sequence (TR/TM/TE=3500/10/20 ms, 128 acquisitions, 2500 Hz spectral width, 2048 complex points, φ1=22.5º, φ2=67.5º, φ3=0º) and a 16-step water reference (2). Automatic phasing and averaging were turned off, and the data processed offline using IDL (Interactive Data Language, ITT Visual Information Solutions, Boulder, CO).

**Results/Discussion:** Typically, automatic processing includes phasing, coil weighting, and summation. For the 2-D phase rotation data set, a 1D-FFT along the $t_1$ axis is applied to separate the different coherences, and then, the line-of-interest (LOI) is extracted. Afterwards, the remainder of the standard automatic processing steps can be applied (Figure 1) yielding a FID/Echo similar to the standard spectroscopy exam. It is critical that any phasing is applied to the data after the first 1D-FFT but prior to the summation of the different channels in order to prevent signal loss. Acquired using a phase rotation sequence, weighted spectra from each of the 4 channels and corrected for phase are shown in Figure 2 (a-d) with the summed spectrum shown Figure 2e. Here, we applied the FFT to the FID from the LOI in order to show the spectra from the four different channels. These spectra show how each channel must be weighted with separate factors as the signal from each depends on the placement of the voxel relative to the coils. Even with the additional SNR, there is one drawback to using phase rotation with pMRI systems: the increased buffer size. Because of the increased number of coils, the buffer will be larger than the standard size by a factor of N*NEX where N is the number of channels and NEX is the number of acquisitions. Overall, pMRI systems can be easily adapted for phase rotation with these modifications: managing the size of the temporary data storage and adding two processing steps: 1D-FFT and LOI identification. With the increased SNR as a result of the array coils, the intrinsic capabilities of phase rotation to acquire multiple coherences in one acquisition and separate them makes implementing this augmented processing method necessary and worthwhile.

**References:** (1) Knight-Scott et al. Magn Reson Imaging 2005; 23(8):871-6. (2) Hennig J. J Magn Reson 1992; 96:40-49. (3) Ramadan S. Concepts Magn Reson 2007; 30A:147-53.

**Figure 1.** Flow chart of how signals from N channels ($S_1$, $S_2$, $S_3$ …$S_N$) are processed to produce one spectrum. (LOI = Line of Interest)

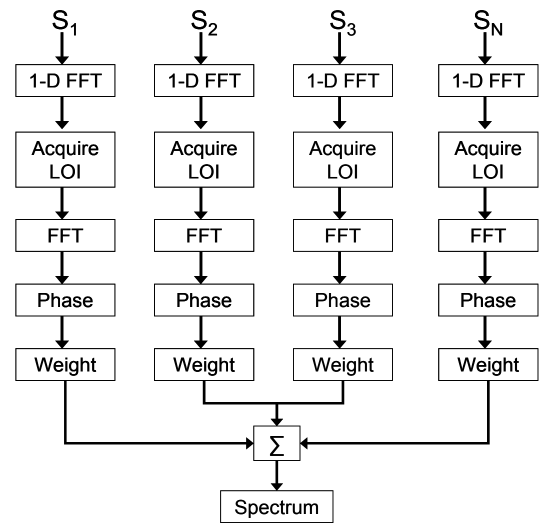


**Figure 2.** Phase corrected spectrum from each channel (a, b, c, and d) are identically scaled to the summed and phased spectrum (e).