# Diffusion Exchange Weighted (DEW) Imaging

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**Introduction:** The correlation of different molecular properties in two dimensional techniques used in high resolution NMR spectroscopy encouraged us to apply the imaging version on a whole body MR imager. Morris et al [1] used a technique (DOSY) where they were able to correlate different molecular diffusion coefficients in a mixture with their corresponding chemical shifts. Callaghan et al [2,3] also correlated molecular diffusion with molecular exchange in poly-domain liquid crystal. Since water protons are an easily exchangeable source of MR signal, the exchange of protons from one compartment to another, marked with different ADCs, gives an insight into exchanging protons especially at tissue-tissue border, e.g. proton exchange between tumour and healthy brain tissue. Thus, the detected ADCs will be weighted by proton rate of exchange between different compartments/entities. Studies demonstrate that chemical exchange can cause serious signal distortions that can lead to severe sensitivity loss and misinterpretation of diffusion experiments. The choice of parameters in a diffusion-weighted imaging procedure critically influences the ability to observe the effect of chemical species involved in exchange [4]. Diffusion-exchange weighted (DEW) imaging, can serve as a potential imaging contrast mechanism for *invivo* imaging, and will be described in this abstract.

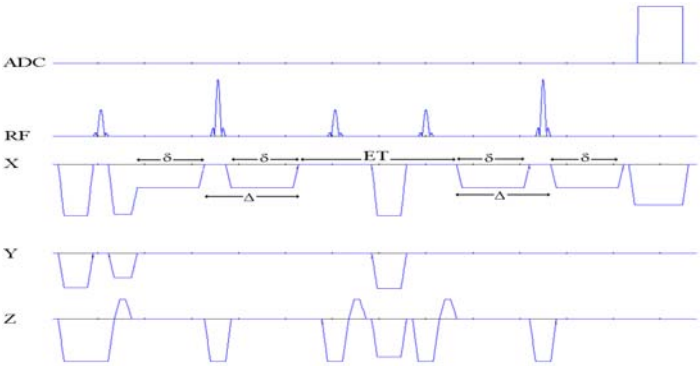


**Figure 1**: DEW imaging pulse sequence with diffusion gradients oriented in the X direction, but can also be oriented along Y or Z directions. The initial phases of 90, 180 rf pulses and receiver are 90°, 0° and 0°, respectively. Symbols in figure are: δ is duration in ms of DSG (diffusion sensitising gradients) from leading edge to end of plateau, Δ is delay in ms from leading edge of DSG to leading edge of next DSG and ET is exchange time in ms.

**Materials and Methods:** MR images were obtained with a superconducting 3T MR imaging unit (Magnetom Trio; Siemens, Erlangen, Germany) using an 8-channel head coil as a transceiver. A series of DEW images were acquired using the following parameters: 350/50 (TR/TE msec), 5-mm section thickness, 144 x 256 matrix, 267 x 285-mm FOV, BW=130 Hz/pixel, acquisition=7680 μs, gradient rise time=1ms, δ=16.50 ms, Δ=21.06 ms, ET=8 or 100 ms. Fat/OVS suppression was inserted before the sequence (Figure 1). A pair of DSGs (diffusion sensitizing gradients) were applied along x, y or z direction. Data was obtained from water in a spherical phantom and from the brains in six apparently healthy volunteers (4 males, 2 females, mean age=46.3±16.6 years).

**Results:** ADC's of water in a spherical phantom were found to be independent of the ET and equal to $1.80 \times 10^{-3}$ $mm^2/s$ in x, y and z directions. ADC was measured with ET set to 8 and 100 ms. In contrast; ADC's of water in the brain (prefrontal) was also measured and found to be dependent on ET. Data from the prefrontal region of the brain were examined. ADC was measured at two values of ET; 8 and 100 ms, and the mean ratio of the ADCs at different ET ($ADC_{100}/ADC_8$) was found to be 0.74± 0.04.

**Discussion and Conclusions:** The observed ADC is the result of exchange-weighted average of two diffusion phenomena: fast extra-cellular diffusion represented by $ADC_e$ and slow intracellular represented by $ADC_i$. The observed ADC will also be effected by the relative relaxation times of the intra- and extra- cellular environments, as well as the unknown absolute exchange rate of protons between the two environments. The difference between brain water ADC at different ET values is evidence that exchange takes place between extra cellular fluid and brain tissue when time allows on the experimental time scale. Since the majority of signal in the image comes from extra cellular fluid, then ADC is expected to decrease after protons are exchanged with neurons. The DEW imaging technique can also add more contrast to the image based on the exchange property, which is a function of various cell properties.

**References:**

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