Flow, Chemical Shift, and Phase-based B1 Mapping

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Introduction: Accurate B1 assessment allows optimum set up of a scan and accurate determination of transverse magnetization after scanning.

The Bloch Siegert phase shifts allow B1 mapping [1]. Irradiating transverse magnetization above resonance lowers its Larmor frequency and vice versa such that a phase difference image between above and below resonance effects determines B1. In radian measure

\[ \Omega_1^2 = (\varphi_{\text{below}} - \varphi_{\text{above}}) \omega_{\text{off}} / T_{BS} \]

with \( T_{BS} \) the effective Bloch Siegert pulse length. These phases are independent of TR so the method can be faster than amplitude methods such as dual flip angle [2,3] and less (if at all) T1 dependent. Comparing Bloch Siegert to dual flip, 6 minute, dual flip B1 maps show residual T1 dependence but 30 second, Bloch Siegert maps did not.

While influences on amplitude, such as T1 or receiver coil coupling, do not affect phase based B1 mapping, influences on phase may. Here we examine the affect flow and chemical shift.

Methods: Images were made in the standard head coil of a 3 Tesla Signa (GE Healthcare, Milwaukee WI). Bloch Siegert pulses were 4 kHz off resonance, 8 ms long. Low amplitude pixels were masked. For flow studies, 6 mm ID Tygon tube was wrapped around a static gel phantom. A peristaltic pump gave tap water in the tube steady laminar flow at a mean speed of 0.47 m/s, Reynolds number 2800. Chemical shift studies imaged a static phantom with regions of water and of Wesson oil.

Results & Discussion: Turning the pump on changes pixel phases ~120° (fig 1) but has much less effect on B1 measurements than does position in the head coil (fig 2). The oil water boundary is imperceptible in B1 maps made with several different TE. Fig 3 shows a case with oil and water in phase and another with them out of phase. These results suggest Bloch Siegert B1 maps are robust.


Support: This research was supported by NIH grant 5R01EB005307-02