2D compensating RF pulse with uniform image contrast in combination with an internal transceiver at 7T.
Irene Maria Louise van Kallevenet, Hugo Kroezee, Alessandro Sbrizziet, Vincent O. Boet, Reerink Onnet, Marielle E.P. Philippens, Cornelis A.T. van den Berg, Peter R. Luijten, and Dennis W.J. Klomp
1Radiology, UMC Utrecht, Utrecht, Utrecht, Netherlands

Introduction
Ultra high field MRI provides high SNR that can be used to obtain images at high resolution. However, B1 homogeneity becomes more challenging and also the B1 strength is limited, particularly within the human body. New methods are being developed to increase the B1 strength at the location of interest, while providing uniform B1 and still remain within safety guidelines (SAR). Although local RF surface coils can provide the strongest B1 per unit of SAR the flip angle is very inhomogeneous, particularly orthogonal to the coil. Nonetheless, incorporating this most dominant non-uniformity in the design of the slab selective RF pulse, we have shown that a uniform and strong flip angle can still be obtained with an external surface coil[1]. However, most surface coils provide an inhomogeneous field in more than one dimension, particularly when used as an internal transceiver, like a radiating monopole[2]. In this work we demonstrate that the radial B1 field pattern of an internal monopole antenna can still be used to provide a uniform flip angle at low SAR, thereby enabling high resolution MRI of tumors in the rectal wall.

Methods
The 2D compensating RF pulse (Fig.1) was designed[3] from the theoretical B1 profile of the antenna (Fig.2a) while incorporating the limits in B1 peak level, gradient strength and slewrate. Based on a maximum B1 level of 50μT, the excitation pulse duration for a 41 degrees flip angle is 2.1ms (Fig.2b). The 2D RF pulse was implemented on a Philips 7T whole body system. In combination with the antenna transceiver[2], the 2D RF pulse was tested with the actual flip angle (AFI[4]) method and compared to a conventional RF pulse. To illustrate the benefit of using an internal transceiver with uniform flip angle distribution, we obtained 3D FFE images from the rectum of a healthy male volunteer at 7T using the 2D compensated and conventional RF pulse.

Results
The actual flip angle map that was obtained with the 2D compensating RF pulse shows a uniform flip angle distribution when using the radiative antenna as a transceiver, particularly when compared to a conventional RF pulse (Fig.3). Consequently, in vivo images of a healthy volunteer (Fig.4) that were obtained with the compensating RF pulse shows not only improved contrast homogeneity, but also extended field of view even when compared to conventional RF pulse driven at stronger T1 contrast (shorter T2).

Conclusion and discussion
A thin antenna, applicable at 7T, enables high resolution imaging of internal structures that are accessible through cavities. When used as a transceiver, not only the high SNR of the local antenna can be used, but also the high duty cycle in flip angles provide strong contrasts. Due to the high efficiency (50μT with less than 1kW) sufficient bandwidth of the RF pulses can be maintained to enable accurate MRI in areas of strong susceptibility differences, like the rectum. Combining the antenna transceiver with a 2D compensating RF pulse restores contrast homogeneity and extends the field of view.

References