

Effects of Co-Planar Element Shielding on Array Performance at 7T

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PURPOSE: It is generally recognized that shielding of RF coils becomes increasingly necessary at high field strengths to mitigate radiation losses¹⁻³. Shielding of the individual coils in an array can be complex, however, particularly when used in combination with overlap for geometric decoupling between elements. This abstract investigates the effects of co-planar shielding of the elements of an overlapped array at 7T with respect to achievable signal-to-noise ratio (SNR), g -factor, and RF power required for a 90 degree tip angle as indicators of efficiency.

METHODS: Design: Two five-channel receive-only arrays were constructed on a cylindrical former in an overlapped, "Olympic ring" geometry (Fig. 1). Each element was constructed out of 18 AWG wire with a diameter of 8 cm. One array included individual co-planar shields around each element (1 mm shield width spaced 2.5 mm from the coil conductor, as recommended for these coil dimensions⁴). An active trap around the match capacitor and back-to-back diodes around the tune capacitor detuned the array elements during transmit and baluns were included on each element, as shown in the insets of Fig. 1. **Imaging:** All imaging was done on a whole-body 7T scanner (Achieva, Philips Medical Systems, Cleveland, OH). A quadrature head coil was used for transmit (Nova, Wilmington, MA). The SNR maps and g -factor maps were obtained/calculated for both arrays using a 2L mineral oil phantom. g -factor maps were calculated for a SENSE reduction factor of four, accelerating 2x in both the left-to-right (L/R) and foot-to-head (F/H) directions.

RESULTS: The shielded array provided up to a 61% increase in SNR, with a 39% improvement in the mean SNR throughout the entire phantom. For the purposes of illustration, the axial view of the SNR maps for the unshielded and shielded arrays is shown in Fig. 2. In addition, as listed in Table 1, the shielded array produced a lower mean g -factor for all three views (sagittal: 12% mean g -factor improvement; coronal: 7.4%; axial: 7.3%). For the purposes of illustration, the g -factor maps for both arrays in the axial view are shown in Fig. 3. As a final remark, it is worth noting that the power from the transmit coil required to calibrate for a 90 degree tip angle was 19% lower with the shielded array in place versus the unshielded, as calculated using the Philips' driving scale.

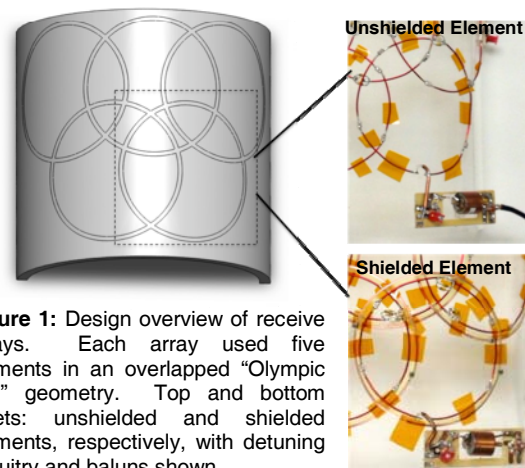


Figure 1: Design overview of receive arrays. Each array used five elements in an overlapped "Olympic ring" geometry. Top and bottom insets: unshielded and shielded elements, respectively, with detuning circuitry and baluns shown.

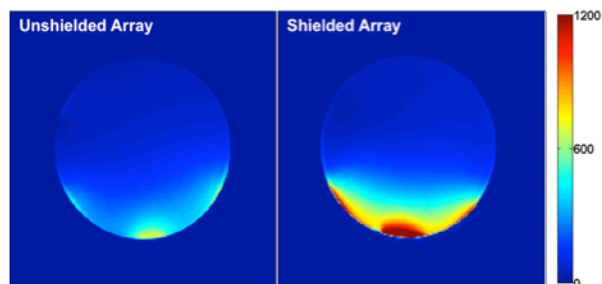


Figure 2: A comparison of the SNR maps for the unshielded and shielded array. The shielded array provided a 39% improvement in SNR throughout the phantom.

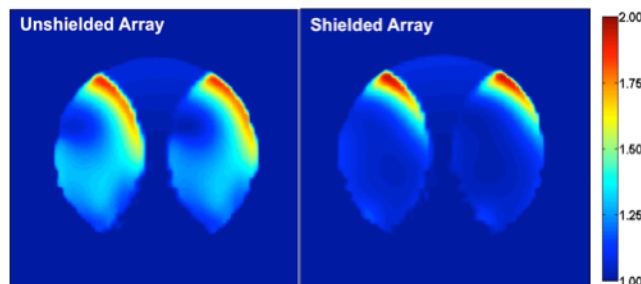


Figure 3: g -factor map for a bidirectional SENSE accelerated scan (2x2, L/R-F/H). The shielded array produced a lower mean g -factor in all three views.

Table 1: g -factor Values

	g_{mean}	g_{max}
Unshielded Array	Axial: 1.18	Axial: 1.85
	Sagittal: 1.13	Sagittal: 1.96
	Coronal: 1.30	Coronal: 2.73
Shielded Array	Axial: 1.10	Axial: 1.92
	Sagittal: 1.01	Sagittal: 1.57
	Coronal: 1.21	Coronal: 2.99

CONCLUSION: This work demonstrated the quantifiable benefits of using a co-planar shield on the elements of an overlapped array at 7T. Other practical benefits of shielding the elements were noted on the bench in terms of the stability of tuning the elements. Future work includes quantifying the same effects at varying field strengths and element sizes. Additionally, other effects of shielding could be highlighted by using higher permittivity phantoms.

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RP100625. **REFERENCES:** [1] Adriany et al., Proc. ISMRM 2000, #0563. [2] Gilbert et al., MRM, 64, 2010. [3] McDougall et al., Proc. ISMRM 2011, #1875. [4] Rispoli et al., Proc. ISMRM 2013, #2752.