# Comparison of three different microstrip transmit elements for use in multichannel Tx/Rx body coils at 7 Tesla

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**Target audience:** Coil developers at Ultra High Field

**Purpose:** In contrast to the situation at the clinical field strengths of 1.5 T and 3 T, there is no integrated body coil available in systems with field strengths of 7 T and above. Most transmit coils developed for body imaging at 7 T are arrays that are placed close to the body of the subject. Since electric dipole-like elements are quite promising[1] at ultra-high fields, three different elements are compared in this work for their suitability as single elements in a large-diameter body coil array: (i) The centrally-fed microstrip line[2] (MSL), (ii) the centrally-fed microstrip line with meanders[3], and (iii) a new design where the meanders of the aforementioned element are loaded with a dielectric to get eliminate the end capacitor.

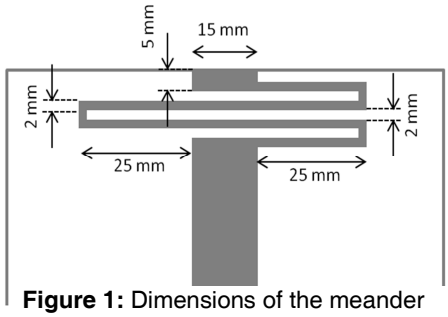


**Figure 1:** Dimensions of the meander structures.

**Material and Methods:** All elements have a length of 25 cm, a width of 10 cm and a distance of 2 cm between the front conductor and the ground plane. The PCB carrier is 0.5 mm FR-4 in all cases. All elements are fed with a λ/2 balun and a matching network as described by Brunner [2]. The meanders of elements (ii) and (iii) are as shown in Fig. 1, with a conductor width of 2 mm. In all three elements the current maxima at the target frequency of 297 MHz were 1.5 cm from the central feeding point. In (i) and (ii) this was done by using end capacitors to the ground plane with $C_{e,A}$ = 3.3 pF and $C_{e,B}$ = 1 pF, respectively, while in (iii) 2 cm by 8 cm plates of a dielectric ($\varepsilon_r$ = 9.8) with a thickness of 3 mm were glued on top and below each of the meander structures and no end capacitors were used. Numerical simulations were performed with CST Microwave Studio (CST AG, Darmstadt, Germany). For a comparison between simulation and MRI measurement, the elements were placed 18 cm above an elliptical cylindrical phantom (semi-axes: 18 cm and 28 cm) filled with tissue-simulating liquid ($\varepsilon_r$ = 45.3, σ = 0.8 $\Omega^{-1}\bullet m^{-1}$) with their respective ground planes placed against the magnet bore cover.

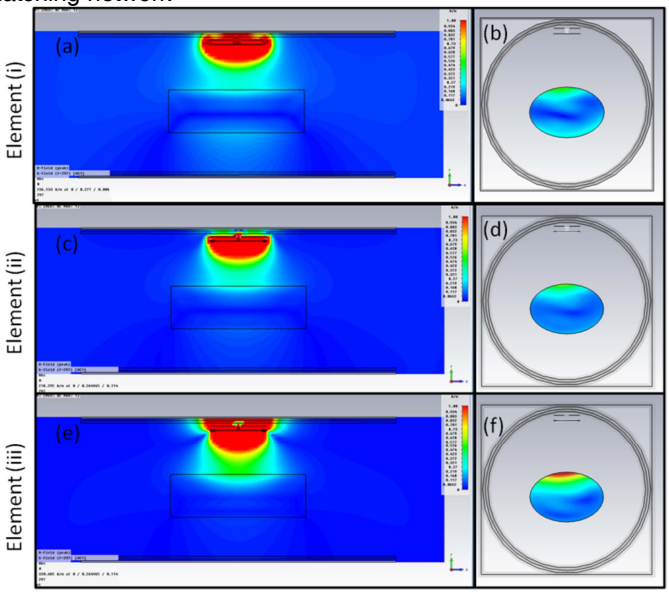


**Figure 2:** Simulated |H| fields in a mid-sagittal section (a,c,e) and $|B_1^+|$ in a mid-transversal section (b,d,f) for the three elements.

**Results and Discussion:** Figure 2a,c,e show the magnitude of the H-fields for the 3 different elements in a sagittal slice for 0.5 W input power. A notable difference can be seen at the ends of the elements where the H-field decays much faster for elements (ii) and (iii) than for (i). This leads to a more focused H-field distribution in the direction of the phantom for element (ii), which is even more pronounced for (iii), while element (i) shows a slightly broader distribution and, consequently, radiates higher fields into other parts of the bore. Figure 2b,d,f show the corresponding $|B_1^+|$ distributions, where element (i) has a significant transmit sensitivity on the far side of the phantom, while element (i) shows much less relative sensitivity on the far side and element (iii) shows a pattern that is very similar to an MSL element placed close to the surface of the phantom. Figure 3 shows good qualitative agreement between measured and simulated SNR maps.

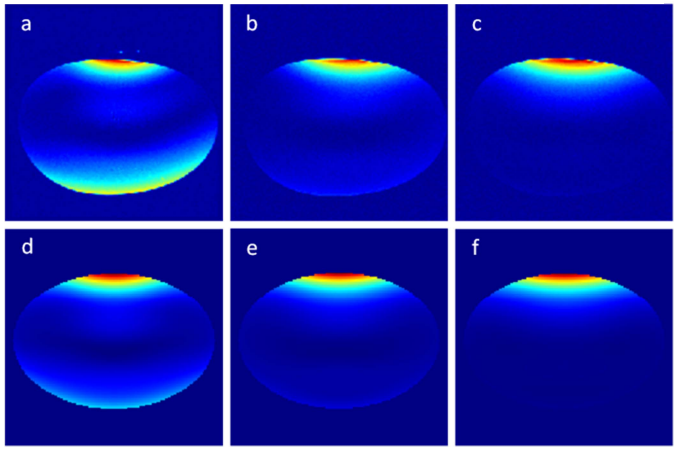


**Figure 3:** Qualitative comparison of measured (a-c) and simulated (d-e) SNR. Each map is normalized to its own maximum.

**Conclusion:** The element with dielectrically loaded meanders (iii) shows a more localized sensitivity than the MSL (i) or the meander element terminated with capacitors (ii). This may lead to better performance in parallel transmission and parallel reception as well as lower overall coupling to the other elements in the array, which will be investigated in further studies.

**References:**

1. Lattanzi R, Sodickson DK: Ideal current patterns yielding optimal signal-to-noise ratio and specific absorption rate in magnetic resonance imaging: computational methods and physical insights. Magn Reson Med. 2012 Jul;68(1):286-304.
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