A flexible transceiver array of monolithic transmission line resonators

Roberta Kriegl[1,2], Jean-Christophe Ginefri[1], Marie Poirier-Quinot[1], Luc Darrasse[1], Ewald Moser[2,3], and Elmar Laistler[2,3]
[1]Laboratoire d'Imagerie par Résonance Magnétique Médicale et Multi-Modalités (IR4M), Université Paris Sud, Orsay, Essonne, France, [2]Center for Medical Physics and Biomedical Engineering, Medical University of Vienna, Vienna, Vienna, Austria, [3]MR Center of Excellence, Medical University of Vienna, Vienna, Vienna, Austria

Target audience: Researchers interested in RF engineering, coil arrays, mechanically adjustable RF coils and their applications

Purpose: We present the development and performance evaluation of a form-fitting coil array for MRI at 7 T based on the concept of monolithic transmission line resonators (TLR) [1] targeting biomedical applications which require large FOV and high SNR for resolving fine anatomical structures varying strongly in size and shape from patient to patient.

Methods:
A mechanically adjustable transceiver array composed of four TLRs (40 mm diameter) fabricated on flexible 127 µm thick Teflon substrate, mutually decoupled via overlapping annexes [2], was developed. Inductive matching and fine-tuning using pick-up loops (15 mm diameter) in over-coupled mode was implemented by placing a pick-up loop coaxially above each TLR element (6.5 mm distance).
The decoupling and parallel imaging performance of the array was assessed in bench (four-port vector network analyzer, E5071C, Agilent, Santa Clara, USA) and MRI experiments (whole-body Magnetom 7T MRI, Siemens Medical Solutions, Erlangen, Germany) comparing planar and bent (4 cm bending radius) array configuration.
GRAPPA g-factor maps were computed using raw data from fully encoded transversal 2D GRE images (T_R/T_E = 500 ms/7.74 ms, 0.52 x 0.52 mm^2 in-plane resolution, 1 mm slice thickness) and noise-only acquisitions. A box-shaped (65 cm x 42 cm x 9 cm) and a cylindrical phantom (7.5 cm diameter, 17.5 cm long) filled with polyacrylic acid gel were used as load. Acceleration factors of R = 1 (no acceleration), R = 2, and R = 3, were mimicked during off-line reconstruction. Resulting g-factors were calculated for sum-of-squares combined images applying the pseudo multiple replica method [3,4]; mean and maximum g-factors were evaluated in an elliptical ROI in order to compare flat and bent configuration.
High-resolution 3D gradient echo images (T_R/T_E = 150 ms/6.56 ms, 220 x 220 µm^2 in-plane resolution, 52 slices, 1 mm slice thickness, GRAPPA with R = 2 x 2, T_{acq} = 7 min 15 sec) of a kiwano fruit (cucumis metuliferus) were acquired in bent configuration.

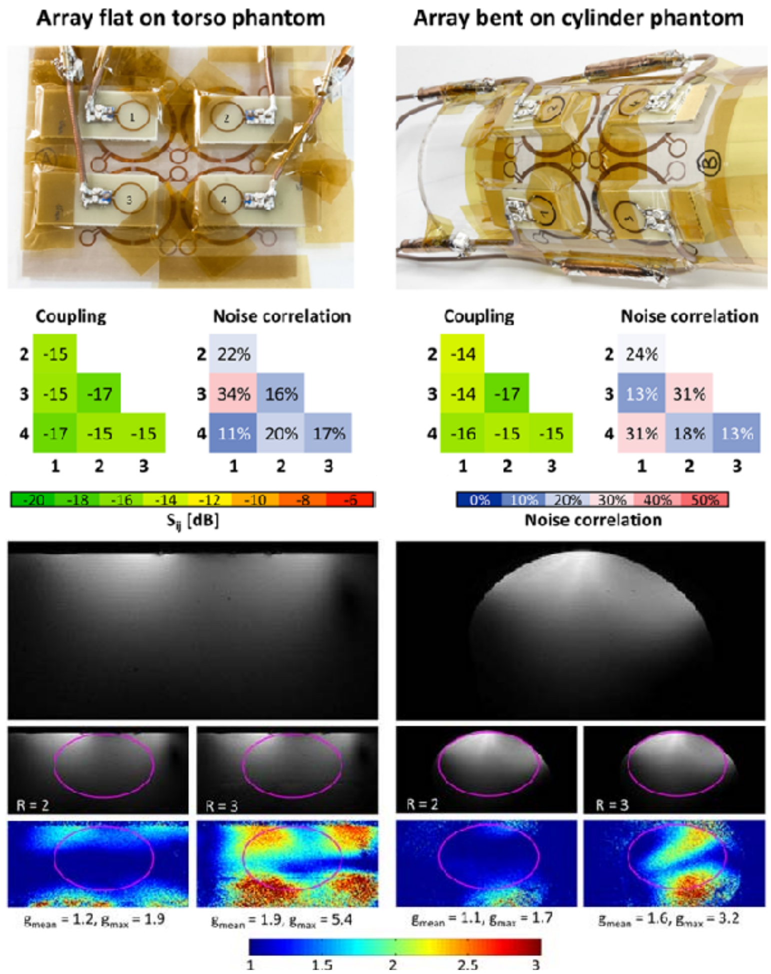

Fig.1 *Experimental set-up (top), coupling (center) and imaging performance (bottom) of the TLR array*

Results: The decoupling and parallel imaging performance of the developed array proved robust against mechanical deformation of the array and different loading conditions. Matching better than -30 dB was obtained for all coil elements. Transmission and noise correlation values are summarized in Fig. 1. Mean g-factors in the elliptical ROI were 1.16 ± 0.20 (R = 2) and 1.85 ± 0.39 (R = 3) for the flat and 1.05 ± 0.14 (R = 2) and 1.61 ± 0.44 (R = 3) for the bent configuration. In Fig. 2 a high-resolution image of the kiwano fruit is shown; the corresponding decoupling performance was comparable to that observed for the cylindrical phantom.

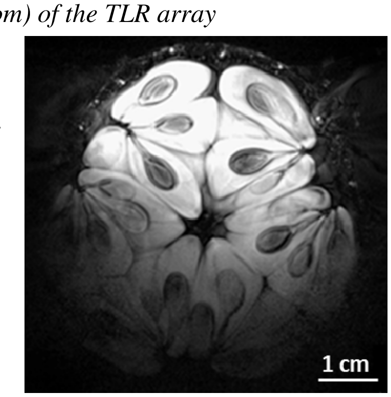

Fig.2 *Transversal GRE image of the kiwano fruit*

Conclusion: We present a novel transceiver array composed of monolithic TLRs fabricated on flexible substrate for MRI at 7 T. We show that the array may be form-fitted to non-planar samples without degrading its performance.

References: [1] Gonord P et al., Magn Reson Med 1988; 6:353–358. [2] Kriegl R et al., Proc ESMRMB 2012. #348. [3] Breuer FA et al., Magn Reson Med 2009; 62:739–46. [4] Robson PM et al., Magn Reson Med 2008; 60:895–907.