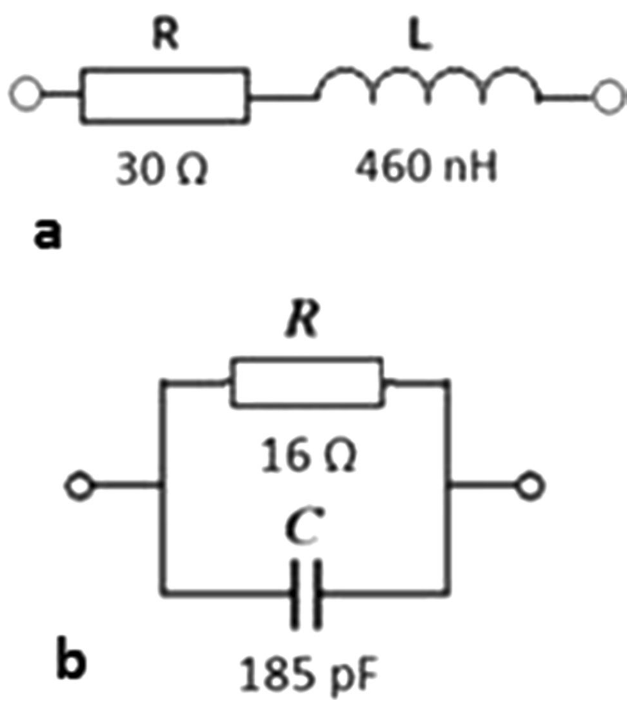

Fig. 1 Original impedances

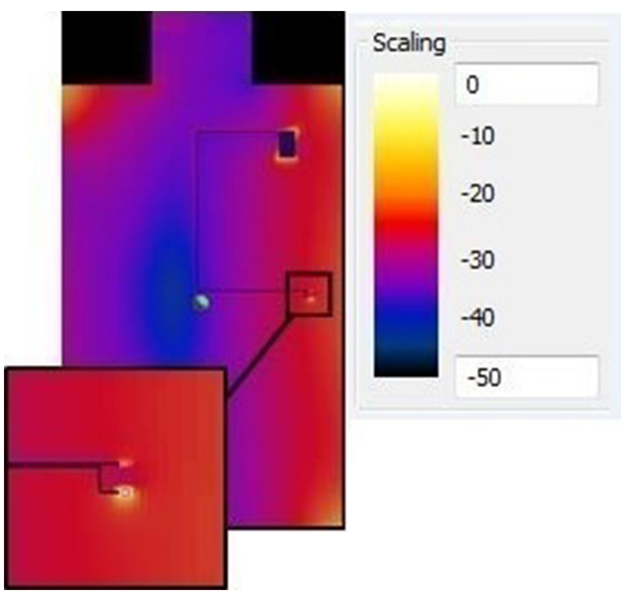

Fig. 2 10 mg averaged SAR at the *tip* of both leads (scale in dB)

Results: The results are summarized in Fig. 3. The behaviour of both leads regarding the SAR is clearly modified by the impedance of the AIMD case.

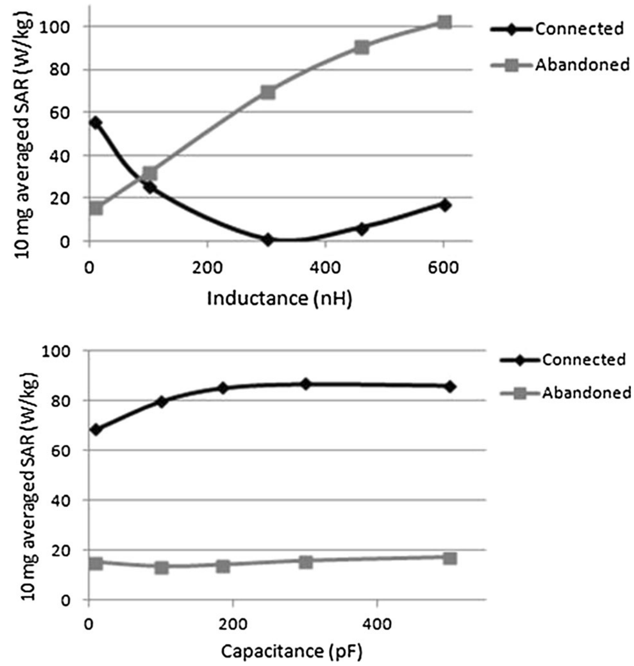

Fig. 3 Impact of inductance and capacitance on SAR at the *tip* of both leads

Discussion/Conclusion: Above and below the critical value of 100 nH, the behaviour of the leads changes dramatically. Above 100 nH, the leads seem to act accordingly to Langman et al. observations on termination conditions of leads[1], showing a higher heating at an abandoned lead's tip than at a connected one. Furthermore, a coupling between the leads appears clearly here: when the SAR decreases at the connected lead's tip, it tends to rise as much at the abandoned lead's tip. Besides, a good compromise for safety is found with this 100 nH value, since it results in a moderate SAR for both leads. Conversely, the capacitive inductance variations show a higher SAR at the connected lead's tip, for each capacitance value. This study shows that a compromise is possible regarding lead coupling, which is an essential consideration regarding a safe device design in MRI.

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Investigation of MRI switched gradient magnetic field-induced Heating of a heart valve implant at 2.5 kHz

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Purpose/Introduction: The gradient induced heating test has already been included as one of the MRI safety tests for active implants [1]. The rapid switching of gradient-fields generated by gradient coils of an MRI system stimulates eddy currents to electrically conductive implants which may result in significant temperature increase in the adjacent tissue. A previous study to characterize gradient induced heating of circular metallic plates has shown frequency dependent temperature increase for a frequency range of 1–5 kHz [2]. In this contribution, a gradient induced heating test for a novel heart valve implant at a frequency of 2.5 kHz is presented.

Subjects and Methods: Both, frequency-domain (FD) electromagnetic (EM) solver and thermal solver of simulation platform *CST studio suite* 2015 (Darmstadt, Germany) were employed as a preliminary step to estimate locations of significant temperature increase in the surrounding tissue of the heart valve. First, CST simulations using the FD solver were performed to model the in-house experimental setup. Then, the resulting deposit power calculated by FD solver was imported as heat source into the thermal model.

Results: Figure 2 shows the simulated temperature distribution around the heart valve (red box indicates the hot spot) for an orientation parallel to the *z*-axis. The simulation and measurement indicate a temperature increase of the heart valve implant (Fig. 1).

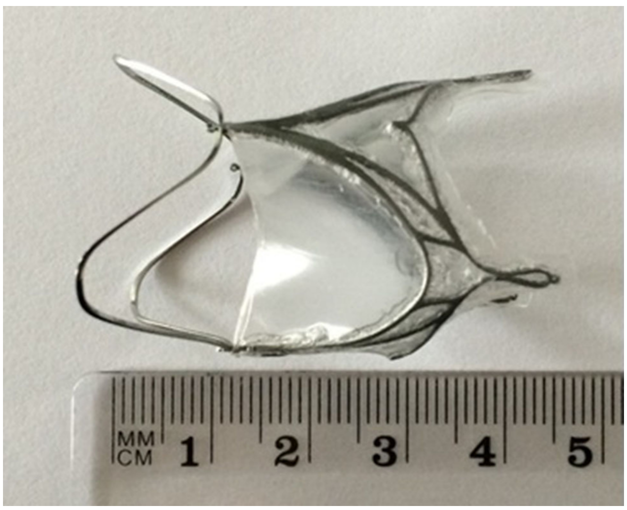

Fig. 1 Heart valve implant under test

Fig. 2 Temperature hot spot based on numerical simulation (normalized)

Discussion/Conclusion: The current setup of the heart valve implant inside the *z*-gradient coil indicates temperature increase due to induced eddy currents generated by the gradient switched magnetic field. The gradient induced heating would superimpose the RF heating, increasing the temperature in the surrounding tissue of a passive implant. Moreover, it may result in malfunction to active implants.

References:

[1] ISO/TS 10974 Ed. 1 (2012), "Assessment for the safety of magnetic resonance imaging for patients with an active implantable medical device"; *International Standards Organization Technical Specification*.

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Impact of tissue properties on radiofrequency-induced ECG cable heating: a numerical study

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Purpose/Introduction: Several cases of skin burns induced by MRI radiofrequency (RF) on an ECG cable have been reported[1, 2]. It is therefore essential to know the dielectric and geometric parameters involved by investigating a surface phantom behaviour with numerical simulations.

Subjects and Methods: Numerical FDTD simulations were performed with the SEMCAD X software (version 14.8, Speag, Switzerland) in a simulated 1.5 T MRI RF environment: a 64 MHz RF body coil (16-legs birdcage) was modeled, its accuracy previously checked by a comparison between simulated and experimental B1 maps. An ECG case connected to a cable was designed, with a commercial ECG case impedance. The cable was a Perfect Electric Conductor (PEC) wire isolated excepted at 3 mm from the end, the whole system being in contact with the surface of the phantom. The phantom was based on the ASTM norm (permittivity $\varepsilon_r = 80$, conductivity $\sigma = 0.47$ S/m, thickness = 90 mm), one parameter at a time changing: permittivity, conductivity, thickness (the range of the dielectric properties corresponding to human tissues, according to IT'IS Foundation database[3]). The averaged SAR was 1 mg, measured at the tip of the wire (Fig. 1).