# MRI Safety: Quantitative Comparison of RF-Heating on Different MR Scanners Based on the High Frequency B1-Field

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**Introduction**: The understanding of heating effects in MRI, especially in patients with medical implants, is one of the most important issues in MRI safety. Local electric fields are known as the cause of implant heating, but these are in general not accessible. The vast majority of the electric field is induced from eddy currents generated by the high frequency magnetic $B_1$-field. The local specific absorption ratio (SAR) describes the power that is transferred into heating, disregarding thermal conductance. SAR values given by the scanner software have been found to be unsuitable for a quantitative comparison of individual heating results [1]. The purpose of this work was to give a quantitative comparison of SAR maps and therefore heating results on different MRI systems and a simulation based on the knowledge of the $B_1$-field.

**Materials&Methods**: All measurements were performed at 1.5 T on a Magnetom Avanto and a Vision (Siemens, Erlangen, Germany). The Vision body coil had a length of 102 cm, the Avanto body coil 60 cm, each yielding a diameter of 60 cm. The dimensions of the phantom were chosen to fit entirely in both of the body coils (40 cm x 40 cm x 12.5 cm). The heating pulse sequence consisted of 1 ms rectangular pulses with a $B_1$-field of 11.7 µT (flip angle 180°), with a repetition time of 20 ms. Local SAR values were calculated from the temperature rise in viscous gel, measured by fluoroptic temperature probes (Luxtron, Santa Clara, USA). Global SAR values were determined by calorimetric measurements of saline solution. Additionally, local and global SAR values were calculated by a home written simulation based on the finite difference time domain method [2]. Power consumption of the transmitter and SAR values displayed by the scanner software were monitored.

**Results**: Global SAR was determined by calorimetric measurements ($B_1$ = 11.7 µT) as 0.78 W/kg for the Avanto (simulation, 60 cm coil: 0.81 W/kg) and 0.84 W/kg for the Vision (simulation, 102 cm coil: 0.83 W/kg). Power consumption and displayed SAR values showed significant differences (SAR value Avanto: 2.8 W/kg, SAR value Vision: 2.1 W/kg). Local SAR values determined by the temperature measurements in the Vision and Avanto are shown in Figure 1a and 1b, Figure 1C gives the results from the simulation.

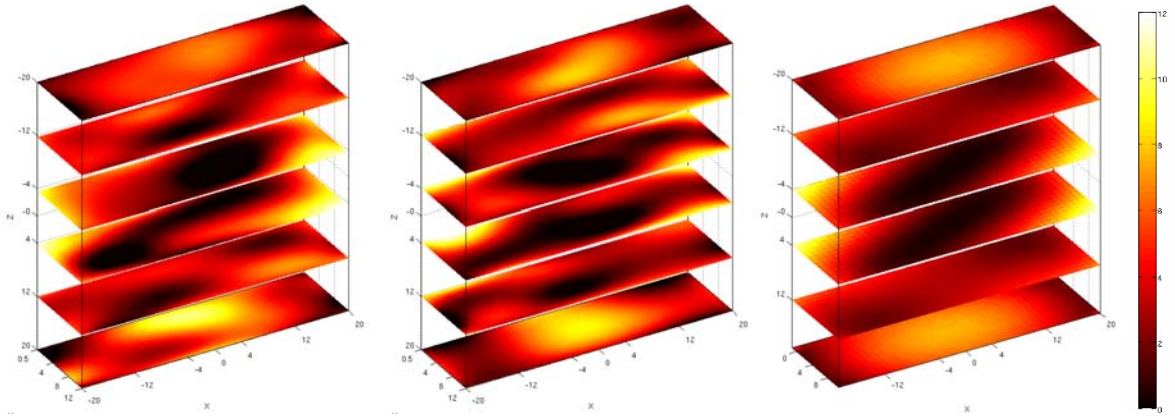

*Figure 1: Local SAR values measured (a) on the Avanto, (b) on the Vision and (c) from simulation.*

**Conclusion**: The high-frequency $B_1$-field is a suitable parameter for the comparison of heating results and MRI safety test results between different scanners and simulations in a quantitative way. The proposed sequence is an easy method to generate a reproducible $B_1$-field and therefore a predictable local SAR value.

**References:**

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