Improvement and Evaluation in PET Performance of 16-Channel Receive Anterior Array Coils for 3T Simultaneous PET/MR Scanner

Yun-Jeong Stickle[1], Jianhua Yu[2], Tae-Young Yang[1], Sahil Bhatia[1], and Dmitriy V Londarskiy[1]
[1]*GE Healthcare, Aurora, OH, United States,* [2]*GE Healthcare, Waukesha, WI, United States*

Target Audience: Researchers and RF engineers working in the new field of PET/MR hybrid imaging.

Purpose: The simultaneous positron emission tomography (PET) / magnetic resonance imaging (MR) scanner is a powerful tool for clinical diagnosis and investigation. Among the challenges of developing the hybrid scanner is surface coil design. MR imaging procedures commonly use radio-frequency (RF) receive coils that are placed as close to the patient as possible to maximize signal-to noise ratio. The attenuation of these coils impacts PET image quality (IQ) [1]. The purpose of this study was to develop and evaluate novel coil designs with new materials adopted to reduce the coil impact on PET IQ. We developed a new plastic-free 3T 16-channel flexible anterior array (AA) RF coil (improved prototype AA2) for torso and cardiac imaging and validated the PET performances for 16-CH GE conventional AA coil, 16-CH PET/MR prototype AA1 coil and 16-CH improved PET/MR prototype AA2 coil.

Methods: The PET-compatible 3T 16-CH anterior array coil (PET/MR prototype AA1) was designed and built by GE Healthcare Coils (Aurora, OH) [2]. The PET/MR prototype AA1 coil was optimized by arranging the coil components to avoid attenuating material on opposite sides of the patient space, designing PET transparent components (cable, cable balun, decoupling and feed boards) and reducing the thickness of the coil covers, which was made by Lexan 940 (Fig. 1 middle). In this study we developed and validated a novel plastic-free foam anterior coil with V0 flammability rating and biocompatibility (Fig.1 right). This new PET/MR prototype AA2 coil was tuned to 127.73MHz and matched to 50 ohms. The phased array elements show good isolation. The Q ratio of unloaded and loaded was ~5. The MR performance on this improved prototype AA2 coil is comparable with conventional AA coil and prototype AA1 coil. The PET performance was evaluated and compared on the three 16-CH anterior array RF coils (Fig. 1). PET performance was measured by calculating sensitivity loss and quantitative mean error over the 26 cm region corresponding to the PET FOV in PET/MR scanner that covered the highest density coil components. PET/CT scans were performed for a Ge-68 cylindrical phantom (20cm diameter X 26cm length, 3.0mCi) with and without being covered by the coils using GE Discovery 690 PET/CT scanner. During the 4 PET scans, a rib-cage supporter was used to guarantee no touch and movement on the phantom while switching the coils (Fig. 2). The PET scan covered 26cm axial FOV with 2 bed positions and 20min total scan time and PET images were reconstructed using OSEM iterative algorithm with attenuation correction (AC). AC only included patient table, the phantom and the rib cage; the coils were not corrected. The total prompt counts of each scans were recorded to calculate the sensitivity loss. The mean intensities of PET images with AC were measured to calculate the mean error due to the presence of coils. Furthermore, the mean error per PET slice and the difference image with and without coil were plotted to illustrate the comparison among 3 anterior array coils.

Fig. 1: 16-CH conventional AA coil (left), 16-CH PET/MR prototype AA1 coil (middle) and 16-CH improved PET/MR prototype AA2 coil

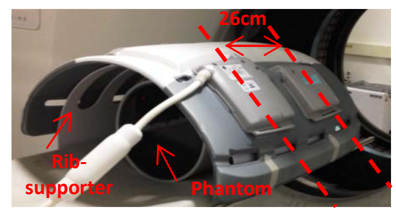

Fig. 2: Ge-68 cylindrical phantom was used for experiments. Anterior coil was placed on phantom and rib-cage supporter.

Results & Discussion: The average SNR on phantom for PET/MR improved prototype AA2 coil is ~2.5% better than GE conventional anterior array coil. Table 1 shows sensitivity loss and mean error on three anterior array coils for the worst area in PET FOV. We observed a 48% and a 79% average sensitivity loss improvement on PET/MR prototype AA1 coil and improved PET/MR prototype AA2 coil, respectively, from the GE conventional AA coil. The mean error plots (%) for three coils are shown in Fig. 3 (left). The error map on the improved PET/MR prototype AA2 coil is more evenly distributed than GE conventional AA coil and PET/MR prototype AA1 coil.

Scan Objects	**Phantom Only (No Coil)**	**Phantom w/ Conventional AA Coil**	**Phantom w/ Prototype AA 1 Coil**	**Phantom w/ Prototype AA 2 Coil**
Total Counts	8.97E+07	8.37E+07	8.66E+07	8.85E+07
Sensitivity Loss	-	**-6.65%**	**-3.46%**	**-1.34%**
Mean Error	-	**-7.06%**	**-4.62%**	**-2.06%**

Table 1: Sensitivity loss and mean error comparison on the 16-CH conventional AA coil, 16-CH PET/MR prototype AA1 coil and improved 16-CH PET/MR prototype AA2 coil

Conclusion: The 3T 16-CH PET/MR prototype AA1 coil and prototype AA2 coil show significant improvements in sensitivity loss and mean error with good MR performance. Future work will include scanning human volunteers to qualify the improvements.

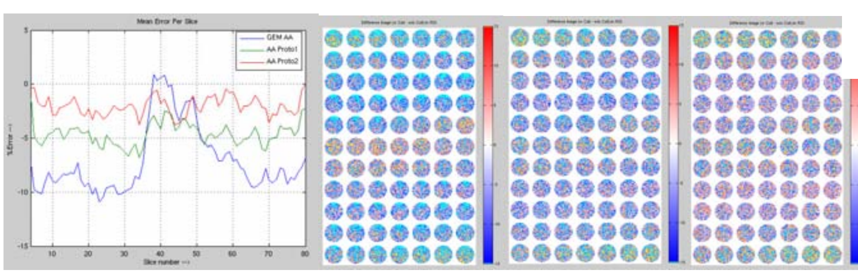

Fig. 3: Mean error plots (blue: 16-CH conventional AA coil, green: 16-CH PET/MR prototype AA1 coil and red: improved 16-CH PET/MR prototype AA2 coil) and PET difference image on 16-CH GE conventional AA coil (left), PET/MR prototype AA1 coil (middle) and improved PET/MR prototype AA2 (right)

References:
[1] G Delso et al. 2010 *Phys. Med. Biol.* 55, 4361-4374
[2] Proc. Intl. Soc. Mag. Reson. Med. 21 (2013), p. 825