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MR image corrections for PET-system-induced gradient distortions

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Combining positron emission tomography (PET) and magnetic resonance imaging (MRI) can be realized by placing a PET insert in a clinical MRI scanner. When designing the PET insert, mutual influences of both imaging modalities need to be minimized. The gradient magnetic fields induce eddy currents in all conductive components of the PET insert. Eddy currents produce superimposing magnetic fields distorting the gradient magnetic field. However, the gradient magnetic fields determine how the MRI data is acquired in the k-space. A distorted gradient shape produces a distorted k-space trajectory which then results in a distorted image. The dynamic performance of the gradient system can be characterized by measuring its gradient impulse response function (GIRF). Furthermore, knowledge of the GIRF enables to correct the k-space trajectory and thereby reduce image distortions.

In this work, we characterized the influence of the preclinical PET insert, i.e. the Hyperion IID, on the gradient performance of a 3 T MRI scanner. A GIRF of up to the second order spherical harmonics was determined by measuring frequency-swept gradient pulses with an NMR probe. We used the GIRF to correct the k-space trajectory of a single-shot spiral sequence.

The low-pass characteristic of the gradient system slightly increased for a measurement with the PET insert. A slight difference of the k-space trajectory of the single-shot spiral sequence with and without PET insert was predicted. We showed an improved image quality by correcting the k-space trajectory using the measured GIRF.

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