The traveling wave approach is an alternative magnetic particle imaging (MPI [1]) scanner design for a fast determination of the distribution of superparamagnetic iron-oxide nanoparticles in 3D [2]. It uses a dynamic linear gradient array (dLGA) for generating and moving a field free point (FFP) linearly along the symmetry axis (z-axis). With additional perpendicular saddle coils the FFP can be moved arbitrarily through the 3D volume (fig. 1a). One issue of the initially presented line-scanning mode (LSM) for scanning a 3D sample is the bad resolution in the x- and y-direction. To improve the resolution at least in one direction (x-direction) the slice-scanning mode (SSM) was proposed [3]. However, the resolution in the y-direction is still not optimal (fig. 1c left). To overcome this problem the scanning-slice is not moved step by step along the y-axis anymore, but is gradually rotated about the z-axis at defined angles to scan a sequence of radial slices (fig. 1b). Because of the bad resolution perpendicular to the two excitation frequencies of one scanning-slice, the received data can be seen as a projection through the 3D volume at the specific angle. For the reconstruction of the 3D volume in a first step all slices are deconvolved using Wiener filter and a suitable point spread function (PSF). In a second step the deconvolved projections are placed at their respective angle in a 3D array for calculating in a final step the whole 3D dataset using a Radon transformation.

Using the projected TWMPI approach gives the possibility to overcome the resolution issue using the slice-scanning mode in a TWMPI scanner. In figure 1c the results of the resolution improvement can be seen. Using the common slice-scanning mode the resolution in the y-axis is very bad (fig. 1c left), but using the projected SSM approach the resolution in the x- and y-direction is comparable (fig 1c right).

Fig. 1 (a) Sketch of the TWMPI scanner: (1) dynamic linear gradient array (dLGA) for generating and moving the field free point in z-direction, (2) receive coil, (3)/(4) perpendicular saddle coil system for the x- and y-deflection. (b) Schematic of radial slice-scanning. (c) Improvement of the resolution in the y-direction: on the left image the common slice-scanning mode and on the right image the radial slice-scanning mode of the same sample.
