# Sodium Imaging on a Whole-Body 7T Scanner: SNR and Resolution Benefits

**Y. QIAN[1], Y-K. Hue[1], T. Zhao[2], and F. E. Boada[1]**

[1]University of Pittsburgh, Pittsburgh, PA, United States, [2]Siemens Medical Solutions USA, Pittsburgh, PA, United States

## INTRODUCTION

Due to low abundance of sodium ($^{23}$Na) in human body (~1/1000 of proton's), low signal-to-noise ratio (SNR) and low spatial resolution (~7 mm) are still major concerns on sodium MR imaging at clinical magnetic fields (1.5T/3T). Averaging, or repeating data acquisitions, is a simple way to enhance the SNR. But, it is not a favorable solution to clinical scans because long scanning time may make patients feel uncomfortable in the tight magnet space. Higher fields (e.g., 4.7T, 7T, or 9.4T) have potentials in improving SNR or resolution of sodium MR images (1-2). This study provides preliminary results obtained on our recently-installed whole-body 7T scanner and demonstrates higher-field benefits in SNR and resolution. The comparison with the images acquired on a 3T scanner was also implemented.

## METHODS AND MATERIALS

Experiments were performed on a whole-body 7T MRI scanner (Magnetom TIM 7T, Siemens Medical Solutions, Erlongen, Germany) with a volume head $^{23}$Na coil (Advanced Imaging Research, Cleveland, OH, USA). The scanner has maximum gradient amplitude of 40 mT/m and maximum slew rate of 170 mT/m/ms. Adult healthy volunteers were scanned under an IRB approved protocol using a home-developed pulse sequence AWSOS (acquisition-weighted stack of spirals) for fast three-dimensional short-$T_2$ imaging (3). The scanning parameters were a sinc RF pulse of duration=1.4ms, flip angle=$63^0$, TE/TR=0.88/100ms, FOV=220×220×150 mm$^3$, matrix size=128×128×30, in-plane spiral interleaves=36, averages=4, and readout time=15.520 ms. The total acquisition time was 7.2 min. Lower resolution data were also acquired with matrix size=64×64×30, spiral interleaves=8, averages=4, readout time=34.080 ms, and total acquisition time=1.6 min. For comparison, the experiments were repeated on a whole-body 3T MRI scanner (Magnetom Trio Tim, Siemens Medical Solutions, Erlongen, Germany) with the same acquisition parameters but a dual-tune ($^1$H-$^{23}$Na) volume head coil (Advanced Imaging Research, Cleveland, OH, USA). The images were reconstructed off-line with a Hanning window in the k-space to output different resolutions. Three in-plane nominal resolutions (1.719, 3.438, and 6.875mm) were output for the data set of size = 128x128x30 and two resolutions (3.438, and 6.875mm) for the data sets of size = 64x64x30. SNR was calculated using the mean intensity of image pixels in a region of interest and the standard deviation of noise pixels in a background region.

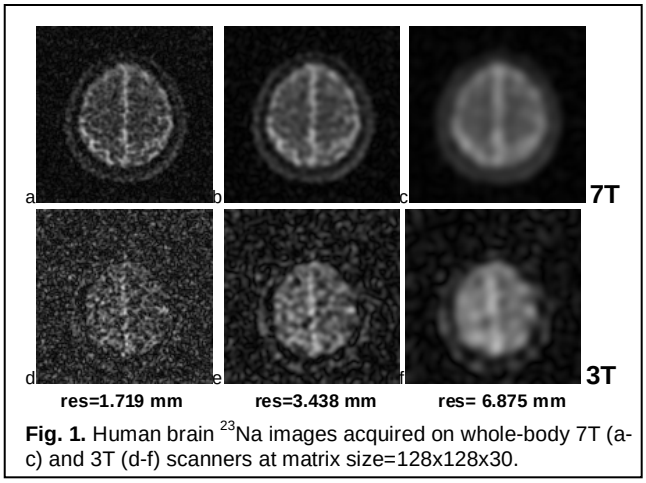


**Fig. 1.** Human brain $^{23}$Na images acquired on whole-body 7T (a-c) and 3T (d-f) scanners at matrix size=128x128x30.

## RESULTS AND DISCUSSION

Fig. 1 presents transverse images of a healthy human brain. These images were selected from the same anatomic location in the 3D images. The 7T image (Fig.1a) has much higher SNR (3.5x, as shown in Fig. 2) than the corresponding 3T image (Fig.1d). The similar SNR gain was also observed in the lower resolution images as shown in Fig 1 and Fig. 2. The gain in SNR was confirmed in the measured low images (Fig.3a, c). The increase in field strength was responsible for part of the SNR gain. Theoretically, SNR linearly increases with field strength, and the SNR at 7T should be 2.3 times high of the SNR at 3T. The extra SNR gain in our experiments was from the better shimming on the 7T than on the 3T, due to the single-tune coil with more uniform RF energy delivery. The spatial resolution of the 7T image was increased to 1.72 mm from 3.44 mm of the 3T image, with a decent SNR of 9.9. The increase in resolution was benefitted directly from the SNR improvement. In conclusion, we have shown that the 7T scanner has the potentials to improve sodium MR imaging in SNR and resolution.

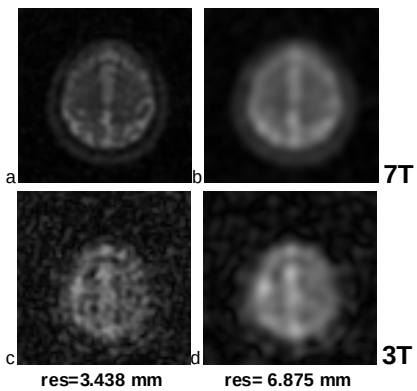


**Fig.3.** Human brain $^{23}$Na images acquired on whole-body 7T (a-b) and 3T (c-d) scanners at matrix size = 64x64x30.

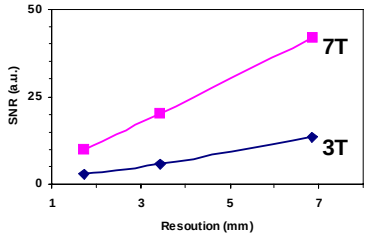


**Fig.2.** Measured SNR of the data sets of matrix size = 128x128x30.

## REFERENCES

[1] Damen F, etc. In: Proceedings of the 14th Annual Meeting of ISMRM, 2006. p3103.

[2] Nielles-Vallespin S, etc. MRM 2007; 57:74-81.

[3] Qian Y, etc. In: Proceedings of the 14th Annual Meeting of ISMRM 2006, p3031.