SPatiotemporal ENcoding (SPEN) 3D Diffusion Tensor Imaging of *in vivo* mouse brain at ultra-high fields and ≤ 100µm isotropic resolutions

M. Yon[1], Q. Bao[1], R. Henriques[2], N. Shemesh[2] and L. Frydman[1]

[1] Department of Chemical and Biological Physics, Weizmann Institute, Rehovot, Israel
[2] Champalimaud Neuroscience Programme, Centre for the Unknown, Lisbon, Portugal

Introduction: Echo Planar Imaging (EPI) remains a key component in a wide range of applications requiring fast MRI without using a train of refocusing pulses, including functional MRI and Diffusion Weighted / Diffusion Tensor Imaging (DWI / DTI). EPI, however, faces known challenges when targeting heterogeneous tissues, when operating at high magnetic fields, or in other instances where field inhomogeneities become important. Spatiotemporal Encoding (SPEN) has been shown to be a robust alternative to deal with these challenges.[1-3]
I intend to present the features of the SPEN sequence which induce this robustness and how it can be used to perform *in vivo* 3D DTI of mice brains at 15.2T at a spatial resolution down to 75 µm isotropic. I will also show how the zooming ability of the SPEN sequence allows reaching such high resolution which has never been achieved *in vivo* with the EPI sequence.

Methods: All experiments were performed on a Bruker 15.2 Tesla preclinical MRI scanner with a surface ^{1}H quadrature transmit/receive surface coil MRI CryoProbe. The SPEN package (running on Paravision® 6 environment), is available for download.

Results and discussion: The non-b-weighted and color-coded main diffusion direction SPEN and the SE EPI images exhibit similar morphological details. SPEN images have a lower SNR than EPI due to their longer echo times and higher effective b-values induced by the SPEN imaging gradient[4]; still, the SPEN images also show reduced B0 and B1 inhomogeneities artifacts – particularly in the olfactory bulb region.

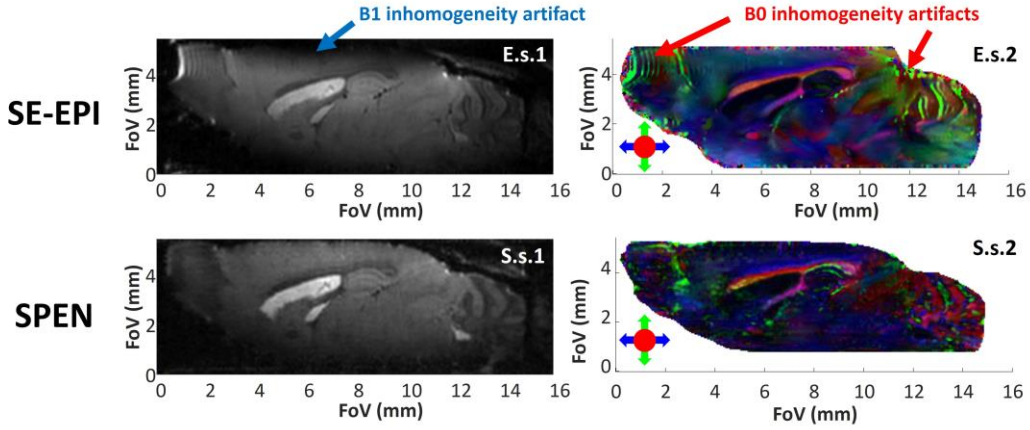

Fig. 1: Non-b-weighted and Color-coded main diffusion directions (MDDs) sagittal images extracted from 3D *in vivo* brain images obtained by interleaved SPEN and SE-EPI with double sampling in two hours exhibiting a resolution of 120 µm isotropic.

Conclusion: SPatiotemporal ENcoding is shown to be much more resilient to B0 and B1 inhomogeneities compared to SE EPI and allow preclinical micro-DTI, functional MRI, and real-time acquisitions at very high magnetic fields with high resolution and robustness.

References:

[1] Seginer, Magn. Reson. Med. (2014). [2] Schmidt, Magn. Reson. Med. (2016). [3] Bao, Proc. Intl. Soc. Mag. Res. Med. 1021 (2018). [4] Solomon, J. Magn. Reson. (2013).