



# Multislice Multiband Excitation with Parallel Transmission for B1 Homogenization and Power Reduction (20130170)

Technology No. 20130170

**IP Status:** Issued US Patent; **Application #:** 14/762,093

## MRI Parallel Transmission Pulse Design

A new magnetic resonance imaging (MRI) parallel transmission (pTx) pulse design targets RF homogenization in multiband (MB) excitation and refocusing and other spin manipulations while limiting the specific absorption rate (SAR). These pulses can significantly improve RF uniformity in each image slice while largely reducing global and local SAR. With full pTx hardware capable of synthesizing channel specific RF waveforms, the new approach can design band-specific pTx multi-spoke RF pulses to improve signal and contrast uniformities while complying with both technical and safety limits. In the case of limited pTx capability (for example, that using phase and gain controllers to split a single RF output from the console), the new approach also provides an effective strategy to design band-joint pTx multi-spoke pulses that outperform the traditional single transmit RF pulses. The new approach was originally validated in the human brain at 7T using a 16-channel pTx system. Most recently, its utility for rapid acquisition of high resolution whole brain imaging has been demonstrated at 7T by using a commercial multi-channel transmit RF coil (Nova Medical) and acquiring Human Connectome Project (HCP) style diffusion and functional MRI. The pulse design algorithm can be used offline or integrated into scanners and can be used with current 3T or 7T scanners that allow for pTx acquisitions and new 3T or 7T scanners entering the market that come with pTx capability.

## Lowers Specific Absorption Rate

Despite the many benefits of slice accelerated multiband methods, their optimal use at 3T and 7T is precluded by RF non-uniformity and SAR constraints. The RF non-uniformity will cause Signal-to-Noise Ratio (SNR) and image contrast to become spatially non-uniform across the brain or other organ under scan. The elevated SAR as a result of imaging acceleration has been a limiting factor that prevents higher slice acceleration factors from being utilized (especially when a spin echo type sequence is employed such as in diffusion MRI). This new technology demonstrates that when acquiring 7T HCP style diffusion and functional MRI, using pTx MB pulses can produce better image quality and contrast than the state of the art HCP protocols relying on a single transmit configuration. For diffusion MRI, because of the SAR reduction, the use of pTx MB pulses can also double the slice acceleration (MB4 vs MB2), holding great potential for reducing acquisition time or pursuing submillimeter spatial resolutions or both.

## BENEFITS AND FEATURES:

- Enables higher MB acceleration factors while improving image quality/spatial resolution
- Expands potential applications of multiband
- May allow scans previously not possible
- Add-on software or sold with new scanners

## APPLICATIONS:

- Current 3T scanners enabling pTx acquisitions
- New 3T scanners entering the market with pTx capability
- MRI applications
- Brain imaging

## PHASE OF DEVELOPMENT:

Pilot scale demonstration. The new method has been developed, implemented and demonstrated in humans. Its utility has been demonstrated by acquiring 7T Human Connectome Project (HCP) style diffusion and functional MRI using a commercial 8 transmit 32 receive RF coil and by comparing the results to those obtained with the HCP protocols. Given the observed large RF non-uniformity at 3T, the new method is also expected to have clear benefits for imaging at this more clinically relevant field strength.

## Researchers

Kamil Ugurbil, PhD

*Professor of Medicine, Department of Radiology, Center for Magnetic Resonance Research*

[External Link](http://neurosci.umn.edu) (neurosci.umn.edu)

Pierre-Francois van de Moortele, MD, PhD

*Associate Professor, Department of Radiology, Center for Magnetic Resonance Research*

[External Link](http://www.cmrr.umn.edu) (www.cmrr.umn.edu)

Xiaoping Wu, PhD

*Assistant Professor, Department of Radiology, Center for Magnetic Resonance Research*

[External Link](http://www.med.umn.edu) (www.med.umn.edu)

Sebastian Schmitter, PhD

*Assistant Professor, Department of Radiology, Center for Magnetic Resonance Research*

[External Link](http://www.med.umn.edu) (www.med.umn.edu)

Eddie Auerbach, PhD

*Assistant Professor, Department of Radiology, Center for Magnetic Resonance Research*

[External Link](http://www.med.umn.edu) (www.med.umn.edu)

## Publications

[\*Distributing coil elements in three dimensions enhances parallel transmission multiband RF performance: A simulation study in the human brain at 7 Tesla\*](#)

*Magnetic Resonance in Medicine*, Volume 75, Issue 6; June 2016; Pages 2464–2472

[\*A generalized slab-wise framework for parallel transmit multiband RF pulse design\*](#)

*Magnetic Resonance in Medicine*, Volume 75, Issue 4; April 2016; Pages 1444–1456

[\*Simultaneous multislice multiband parallel radiofrequency excitation with independent slice-specific transmit B1 homogenization\*](#)

*Magnetic Resonance in Medicine*, Volume 70, Issue 3; September 2013; Pages 630–638

<https://license.umn.edu/product/multislice-multiband-excitation-with-parallel-transmission-for-b1-homogenization-and-power-reduction>