

## MultiBand SENSE widens possibilities for fMRI and dMRI in brain

### White Paper

MRI NetForum Team • Philips Healthcare • Netherlands

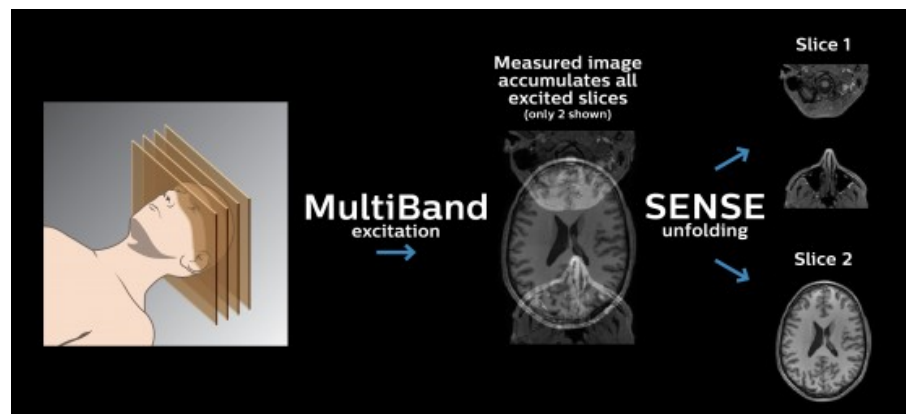
#### A response to the growing need for better and faster functional and diffusion MRI of the brain

The wealth of information from functional and diffusion MRI data has activated a large amount of neuroscience research and led to a demand for even more diffusion data and higher temporal resolution in functional MRI, with full brain coverage and in acceptable scan times.

This inspired development of a next generation of acceleration: MultiBand SENSE can now accelerate functional and diffusion imaging without compromising image quality. It uses multi-band excitation to acquire multiple slices simultaneously, and reconstruct the individual slices using sensitivity encoding.

MultiBand acceleration factors of up to 8 are possible for BOLD fMRI, which enables better spatial and temporal resolution in scans that need to be performed quickly.

#### The principle of MultiBand SENSE: simultaneous slice excitation and sensitivity reconstruction



**MultiBand SENSE:** simultaneous acquisition of multiple slices to accelerate fMRI and dMRI in the brain. A phase shift between slices is used to facilitate SENSE unfolding for obtaining the individual images.

MultiBand SENSE starts with the simultaneous excitation of two or more slices, while the acquisition readout is unchanged. So, the base resulting image is actually an accumulated image of all excited slices. However, similar to normal SENSE algorithms, the signal can be unfolded to reveal the separate images.

This unfolding can be complicated when coil sensitivity profiles are similar for the separate slices. Therefore, the MultiBand SENSE technique employs a phase shift during excitation to simplify the unfolding process, and virtually eliminate artifacts generated by residual aliasing and noise enhancement.

The result is that **MultiBand SENSE can acquire multiple slices in a time identical to that of a single slice acquisition**, which thus provides a significant acceleration. The acceleration is chosen via the MultiBand SENSE factor that indicates the number of simultaneously acquired slices, which is always an integer number.

*"We use MultiBand SENSE to double the amount of scans we acquire in a fixed amount of time"*

Dr. Gispert, BarcelonaBeta Brain Research Center, Spain.

*"Time is of the essence, most subjects cannot tolerate staying in the scanner too long for an fMRI task"*

Dr. Steinberg, VirginiaCommonwealth University, USA.

*"The high sampling rate possible with MultiBand SENSE now allows us to measure and filter out physiological noise in functional imaging data."*

Dr. Caan, Academic Medical Center Amsterdam, Netherlands.

*"We're imaging six times faster for functional fMRI. This means we can really push spatial and temporal resolution"*

Dr. Watts, University of Vermont, USA.

#### Practicalities of using MultiBand SENSE

- For BOLD fMRI, **up to 8 slices can be acquired simultaneously** with MultiBand SENSE. The distance between these slices should be kept large enough by ensuring sufficient coverage in the slice direction to prevent noise and signal leakage during unfolding.
- A further advantage is that MultiBand SENSE can be **combined with in-plane dS SENSE**, enabling high spatial and temporal resolution, respectively. At the same time there is less distortion because of the reduced EPI readout. A correctly tuned balance of dS SENSE and MultiBand SENSE is essential, since both use the same sensitivity encoding algorithm. This balancing will depend on the required spatial resolution, coverage, image quality, and temporal requirements of the acquisition.
- In addition, **multi-echo** can be used in the same MultiBand SENSE acquisition, which allows neuroscientists a more in-depth analysis. In this advanced analysis, signals can be determined to be proportional to echo time (or not), indicating whether these signals are actual functional related changes or relate to spatial B0 variations respectively.
- In **diffusion MRI**, not only the 90° excitation pulse, but also the 180° refocusing pulses are slice dependent when using MultiBand SENSE. This has two significant consequences. First, the bandwidth of these complex multislice 180° pulses limits the maximum acceleration factor to 4. And secondly, SAR is increased due to the combination of high bandwidth 90° and 180° pulses.
- Scan time reduction and increased angular resolution are desired by dMRI users. In diffusion imaging, a **shorter minimum TR** becomes possible with MultiBand SENSE, which allows using a larger anatomical coverage and a higher number of diffusion directions. For DWI and DTI, MultiBand SENSE can result in up to 73% reduction of scan time compared with normal diffusion scanning.

#### *Read more*

Neuroscientists using MultiBand SENSE in their fMRI and diffusion studies already see it can have a great impact. Read the stories of researchers from four different institutions in the

FieldStrength article: [MultiBand SENSE widens possibilities for fMRI and dMRI in brain](#)

**References**

5. Setsompop K, Cohen-Adad J, Gagoski BA, Raji T, Yendiki A, Keil B, Wedeen VJ, Wald LL. *Neuroimage*. 2012 Oct 15;63(1):569-80. doi: 10.1016/j.neuroimage.2012.06.033

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On: Jul 03, 2018

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