

## **PRESTO-CAN for Three-Dimensional Functional MRI**

### **Project Name**

PRESTO-CAN for three-dimensional functional MRI

### **Project Leader**

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### **Main Project Participants**

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### **Grants**

Swedish Research Council (VR), Cancerfonden, Knowledge foundation.

### **Key publications**

Magnusson M, Dahlqvist Leinhard O, Brynolfsson P, Thyr P, Lundberg P. 3D Magnetic Resonance Imaging of the Human Brain — Novel Radial Sampling, Filtering and Reconstruction. In: Proceedings of the 12th IASTED International Conference on Signal and Image Processing, Acta Press, 2010.

Magnusson M, Dahlqvist Leinhard O, Brynolfsson P, Lundberg P. A 3D-plus-time radial-Cartesian hybrid sampling of k-space with high temporal resolution and maintained image quality for MRI and fMRI. In: Proceedings of the 19th Scientific Meeting & Exhibition of ISMRM, Montréal, Québec, Canada, 2011.

Magnusson M, Dahlqvist Leinhard O, van Ettinger-Veenstra, H, Lundberg P. fMRI Using 3D PRESTO-CAN - A Novel Method Based on Golden Angle Hybrid Radial-Cartesian Sampling of K-Space In: Proceedings of the 20th Scientific Meeting & Exhibition of ISMRM, Melbourne, Australia, Montréal, 2012.

## **Summary**

**The magnetic resonance** images (MRI) are not produced directly by the MRI scanner. Instead raw data from the scanner is temporary stored in the so called k-space. The raw data comes in to k-space as sinus waves of different frequencies. These frequencies can then be transformed into images by a mathematical operation. This is called reconstruction. Normally, the frequency measurements are performed in thin 2D slices of the body which are reconstructed and combined in a stack to form an image volume. Occasionally, k-space is measured directly in 3D with a square pattern called Cartesian sampling pattern (figure 1, left).

In contrast to the 3D Cartesian geometry, our method PRESTO-CAN samples k-space using a hybrid between a radial geometry and a Cartesian geometry (figure 1, right). The large steps in the angular direction gives a fast recording of the important information located in the center of k-space.

As seen to the right in figure 1, there are more densely sampled data in the inner part of k-space. It has been shown that by removing parts of the inner over-sampled k-space at certain time points, the temporal resolution can be further increased. However, this gives a more complicated sampling pattern and a non-trivial reconstruction. PRESTO-CAN has shown to provide excellent temporal resolution and satisfactory image quality.

The method was developed having functional MRI (fMRI) applications in mind. In fMRI, MRI-volumes are recorded during a time period when a person/patient performs a particular task. By analyzing the MRI time sequence, it is possible to detect brain activity. Accordingly, it is desirable with a high time resolution.

A major advantage of the PRESTO-CAN sequence is that it allows for whole brain coverage. We are currently performing a comparative fMRI study between PRESTO-CAN and conventional techniques, like EPI. Figure 2 shows left and right fingers fMRI-activation computed from MRI-data based on PRESTO-CAN.

The rather simple geometry of PRESTO-CAN makes it easy to include standard procedures for speeding up the data acquisition further, such as parallel imaging which can be combined with unique 3D motion correction schemes. These possibilities will be investigated further.

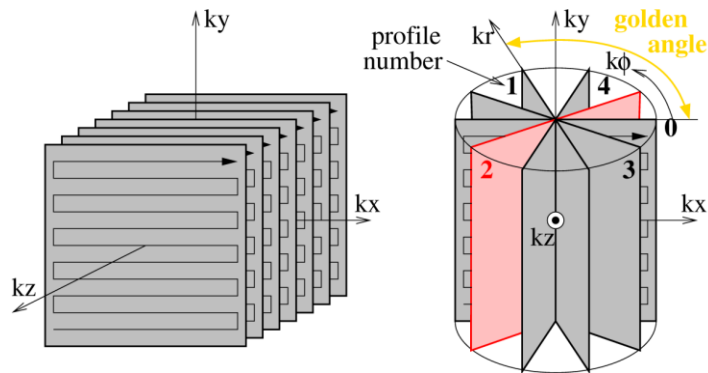


Figure 1 Left: 3D Cartesian sampling of k-space. Right: PRESTO-CAN sampling of k-space.

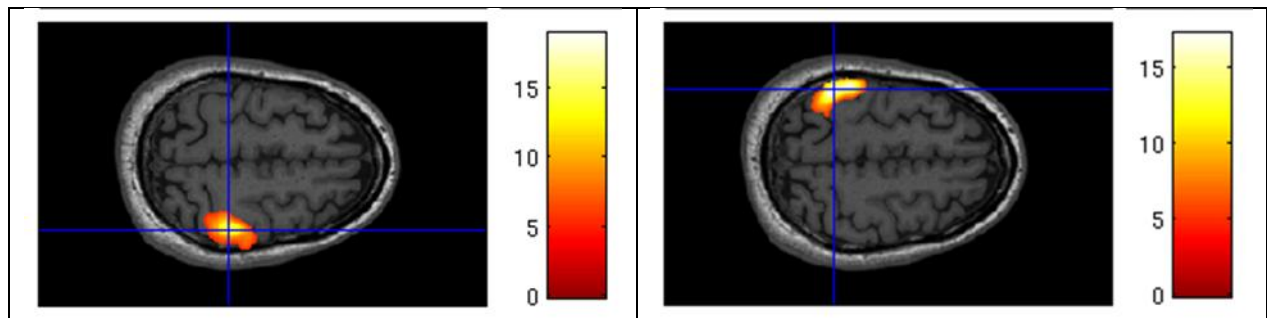


Figure 2 fMRI-activation computed from MRI-data based on PRESTO-CAN. Left: activation in left fingers motor cortex. Right: activation in right fingers motor cortex.