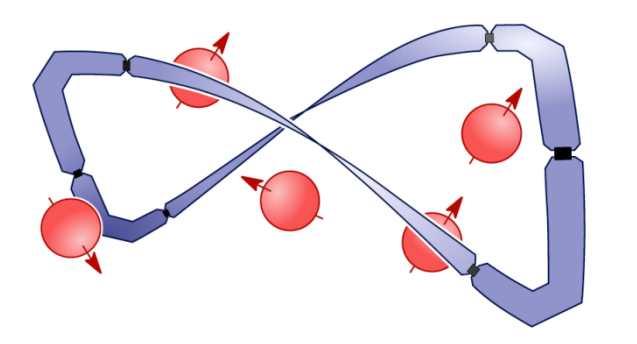


In-Magnet MRI Detection: Evaluation Platform and Applications

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Wearable MRI

Motivation

Enhancing existing and enabling new methods in magnetic resonance imaging (MRI) signal acquisition and processing for improved signal quality and patient comfort by building high-channel count in-bore receiver electronics.

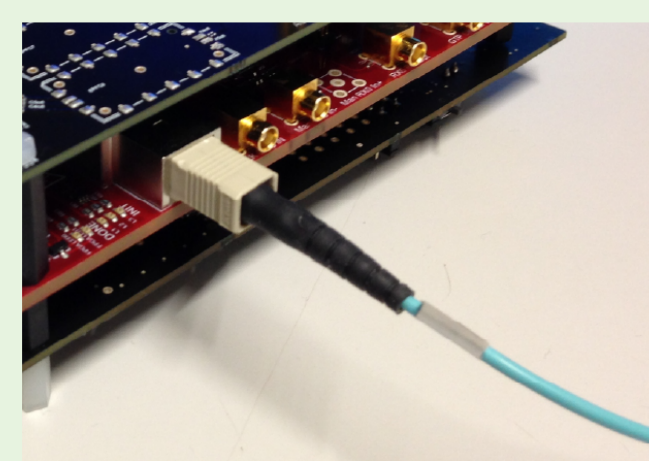
Scan acceleration

Established fast-imaging techniques (e.g., SENSE⁽¹⁾, GRAPPA⁽²⁾) rely on a high number of acquisition channels.

Better image quality

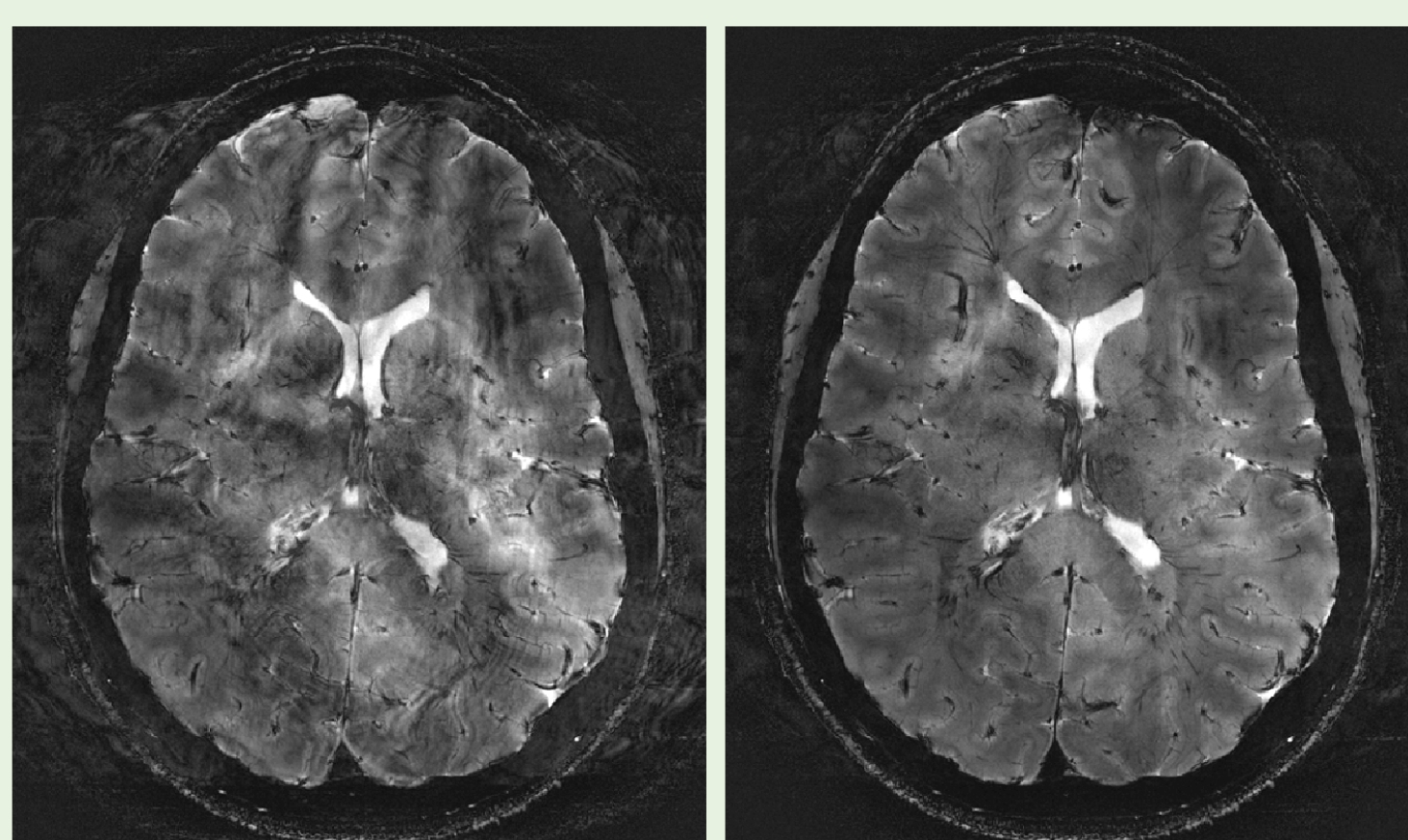
by improving signal fidelity

Replace lossy cabling by optical transmission⁽¹²⁾



by enabling field monitoring / feedback

Measuring the magnetic field and correcting (even realtime⁽⁶⁾) for artefacts induced by distortions of the main magnetic field leads to better image quality⁽³⁻⁵⁾.



No Feedback

With Feedback

by implementing motion tracking

Keeping image quality high even when patients slightly moved in the MR-scanner is possible by tracking their position⁽⁷⁾.

New Imaging Applications

Hardware processing enables unprecedented imaging possibilities as e.g., Zero Echo Time Imaging (ZTE) suitable for imaging musculoskeletal tissue^(8,9)



Human Tooth



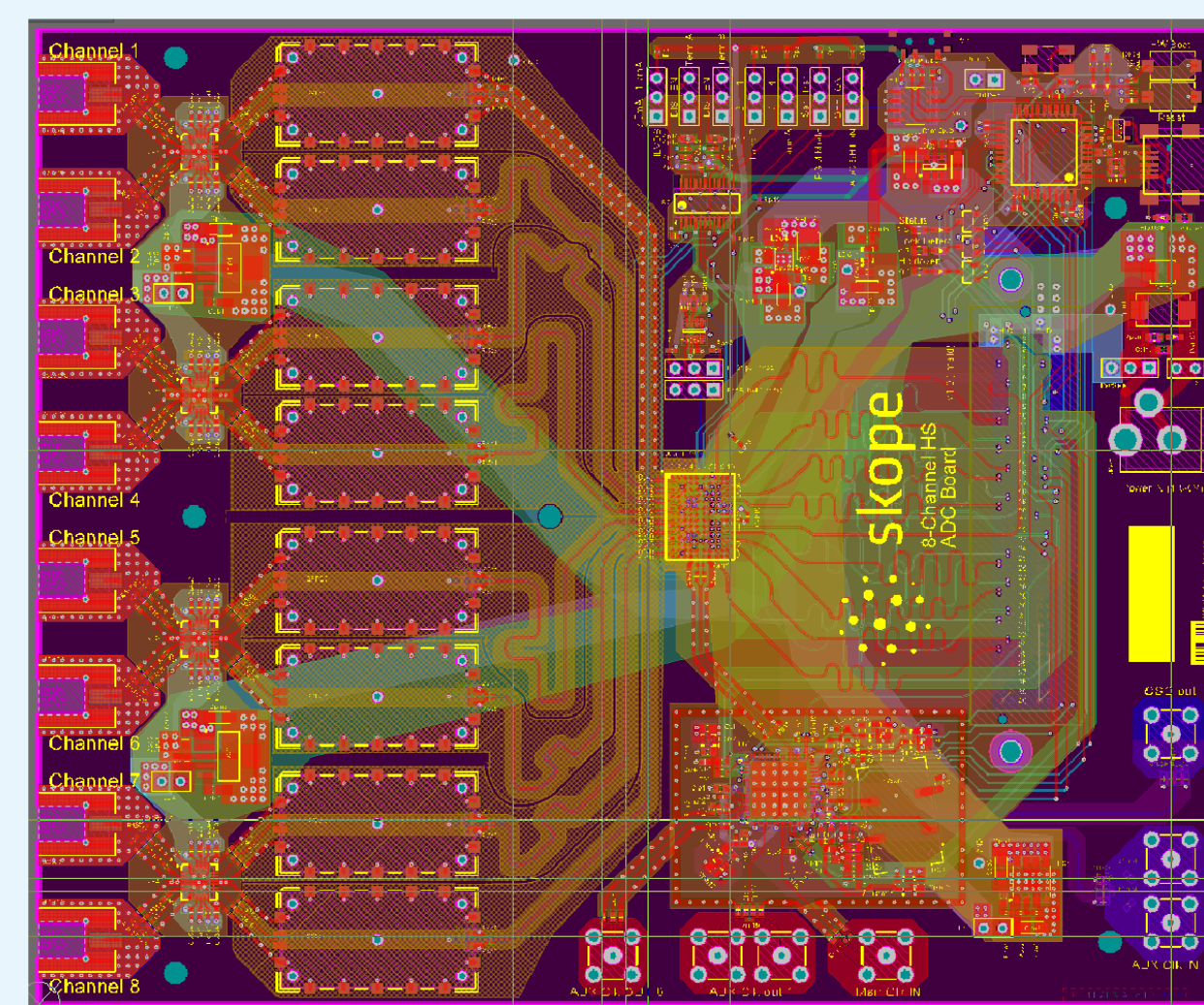
Bone Microstructure

Flexible Coils

Improve patient comfort by building flexible / wearable coils⁽¹⁰⁾.

Design Challenges

Designing electronics for use inside the MR scanner is not trivial. It is a rough environment with strong audio frequency gradient fields that induce eddy-currents and with powerful RF transmission pulses in the kW range which lead to signal corruption.



Wide dynamic range & broadband

Input signal strength greatly depends on the used receive coil size and main field strength.

Magnetic field compatibility

All electronic components have to be non-magnetic in order to not disturb the main magnetic field what otherwise would produce image artifacts.

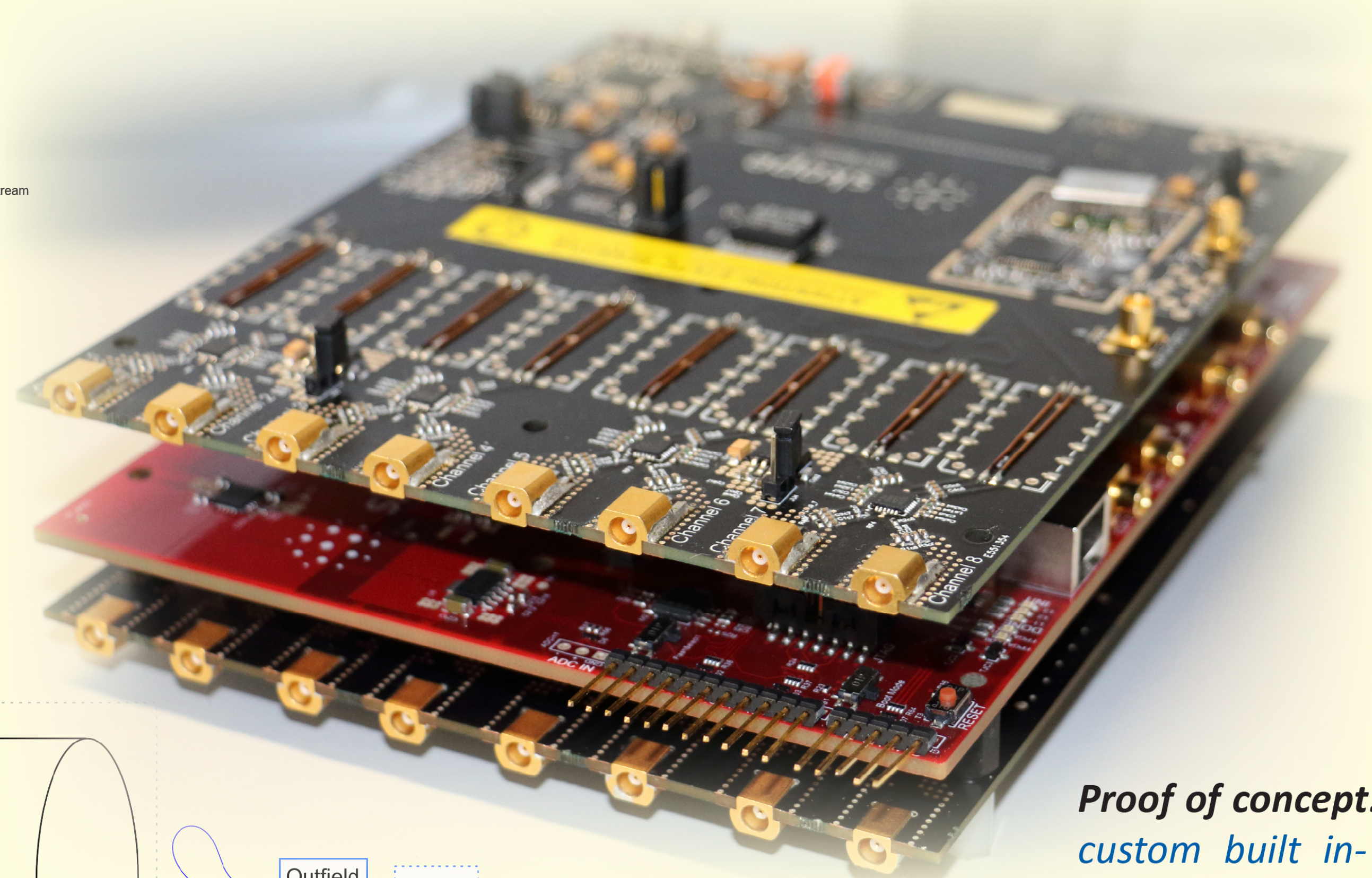
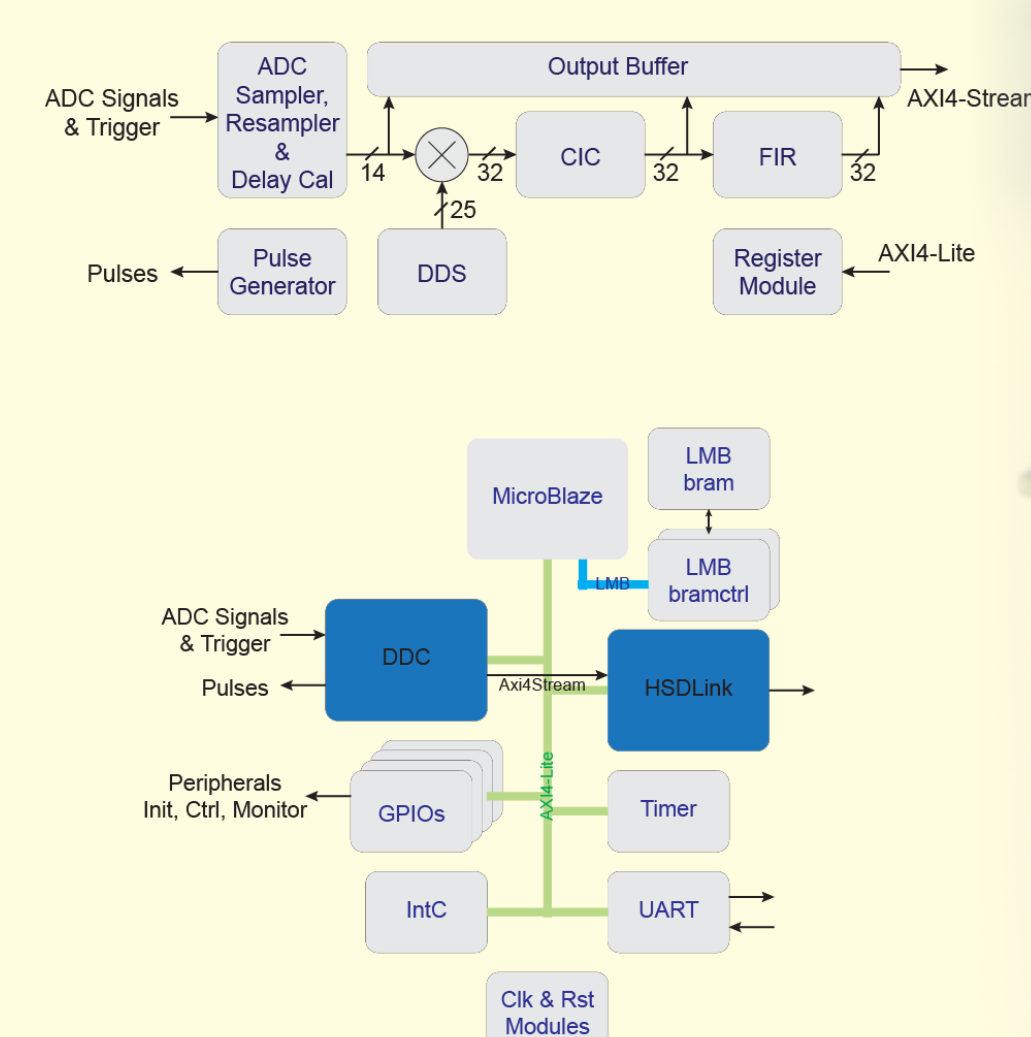
FPGA Power consumption & heat

The temperature has to be kept at a room temperature level to not influence the magnetic field or the patients.

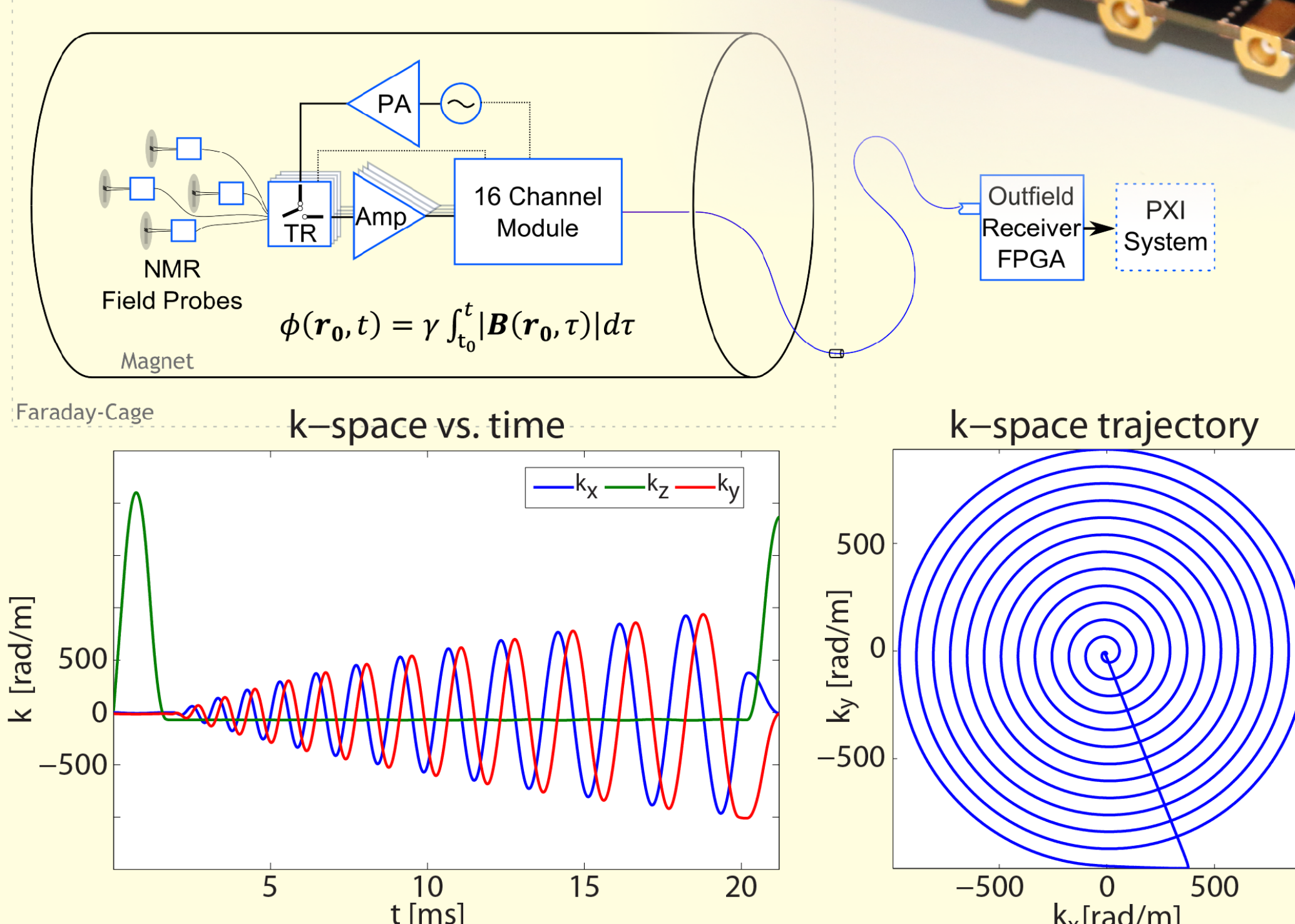
Clocking of the acquisition system

With high sampling rates and high input frequencies clock jitter becomes the determinant factor for signal quality.

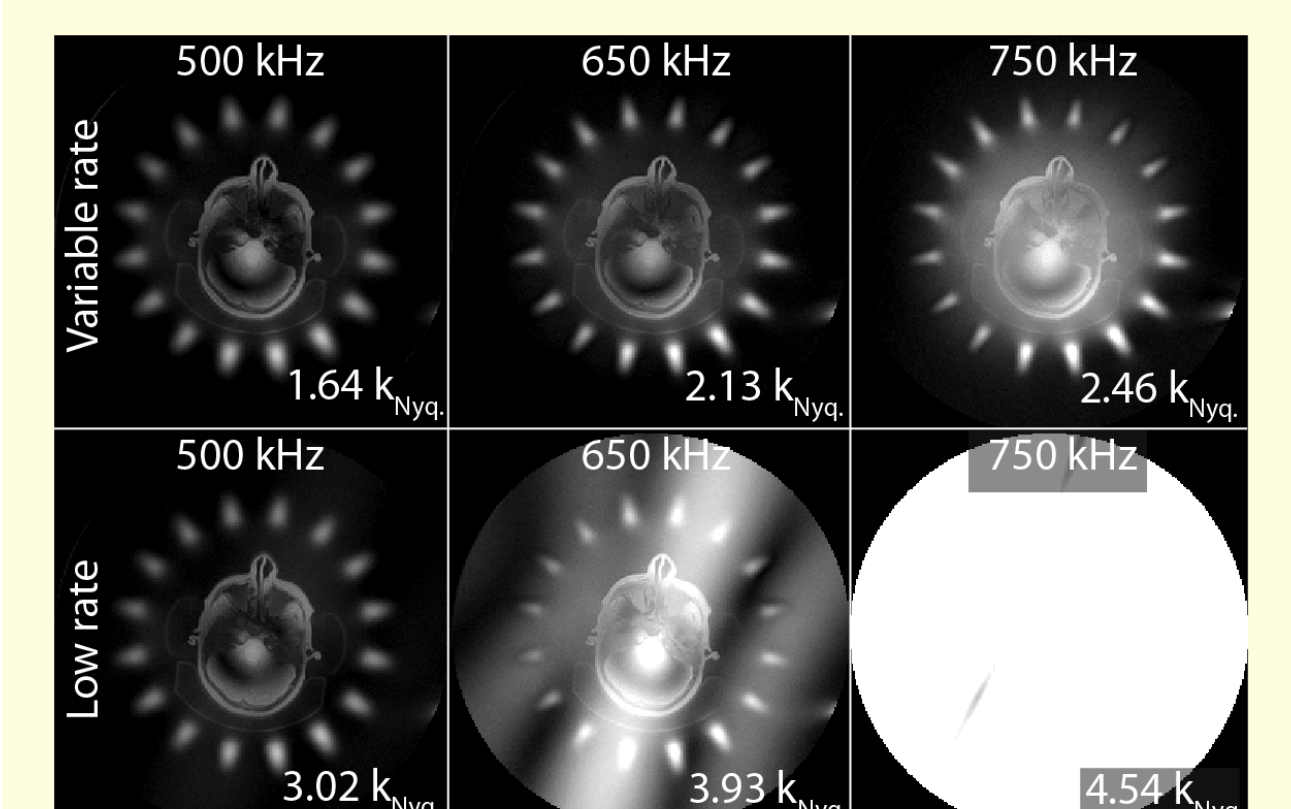
Results



Proof of concept:
custom built in-bore receiver⁽¹²⁾



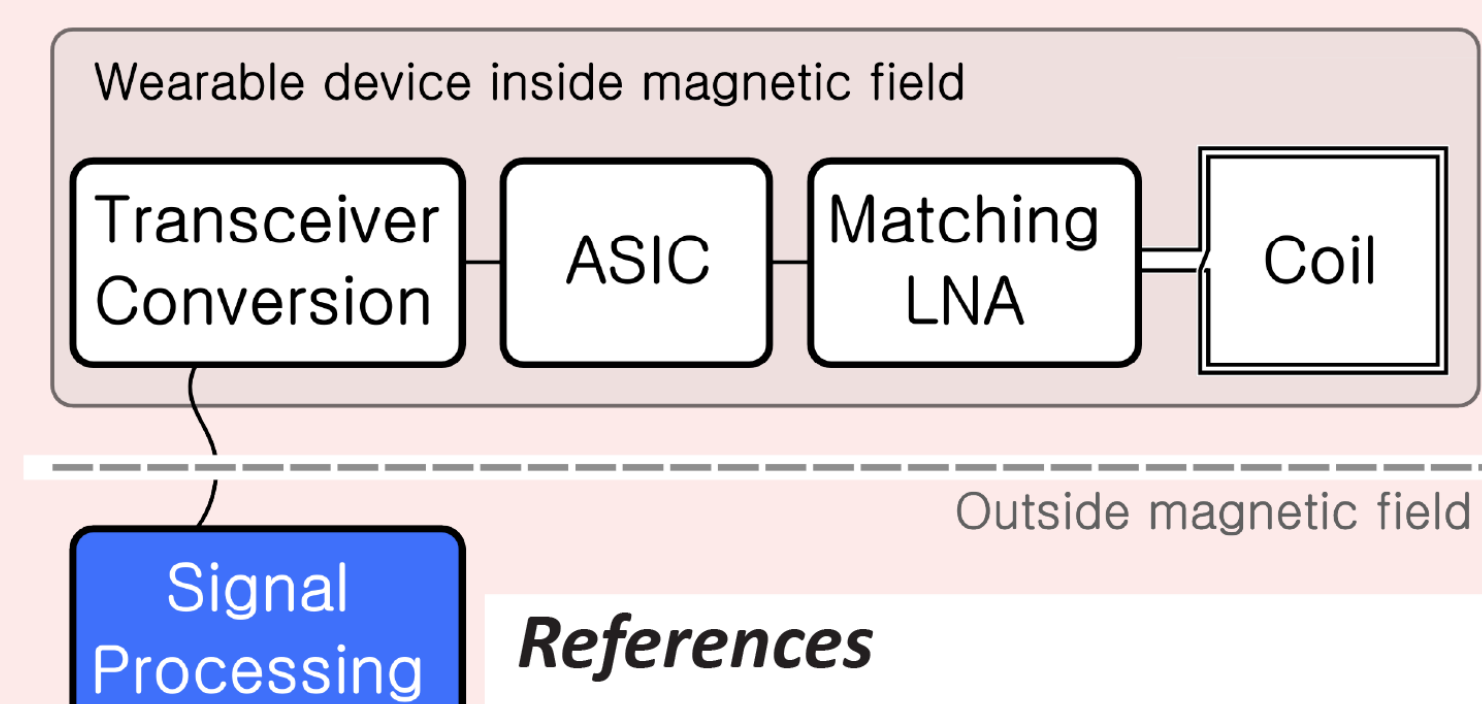
Monitoring Experiment: An example of using NMR field probes and our receiver system, for magnetic field monitoring. The position encoding (done by magnetic field gradients) can be monitored. This information is then used for a more accurate image reconstruction⁽⁵⁾.



ZTE Variable Rate Imaging⁽¹¹⁾: The custom FPGA board and implementation enables the data processing at variable rates and allows to improve the image reconstruction for ZTE imaging.

Outlook

The WearableMRI project replaces the current in-bore receiver by a miniaturized version with dedicated ASIC, to build a powerful, light weight and wearable MR receiver. Together with high-speed, broadband processing this forms a next generation MR platform.



Project scope:
signal reception & processing

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