CLEAR-SWI: Susceptibility Weighted Imaging at 7T using bipolar multi-echo acquisition and optimized processing of phase and magnitude

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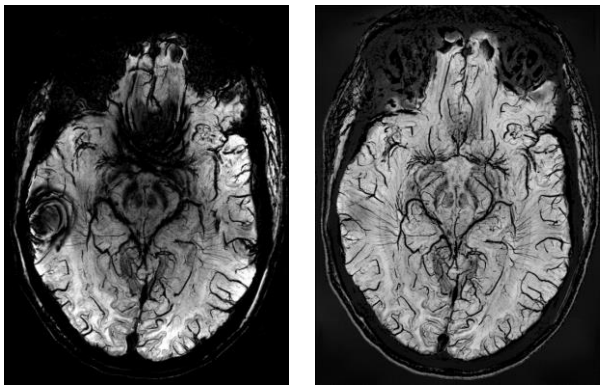
Standard SWI **CLEAR-SWI**



- reduced signal dropouts
- no phase wrap artefacts
- improved contrast
- improved homogeneity

CLEAR-SWI is a method for susceptibility-weighted imaging at ultra-high field.

The contact authors here are Korbinian Eckstein and myself.

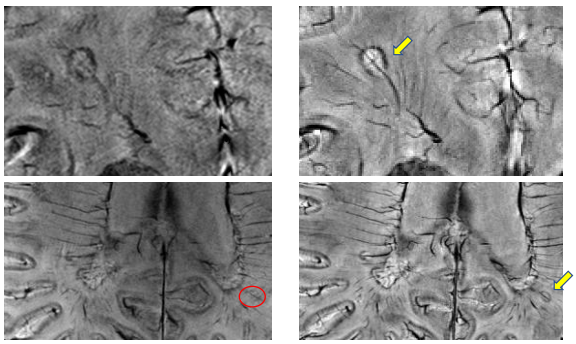
CLEAR-SWI has been developed with a view to online implementation, and uses both existing and new solutions to the problems of SWI at ultra-high field.

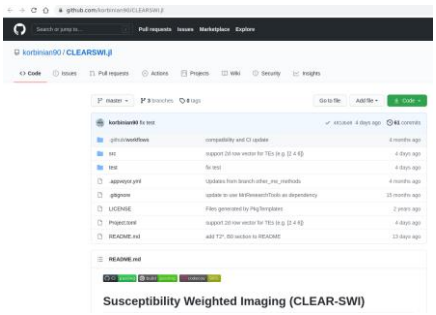
- It uses optimized weighting of phase and magnitude in multi-echo acquisition to reduce signal dropouts in regions of high field gradients in standard, single-echo SWI which you can see here, whilst retaining optimized phase contrast between tissues of interest*
- Inhomogeneity in the magnitude is removed using a simple homogeneity correction which I won't go into here
- Coil combination is performed using ASPIRE rather than Homodyne Filtering and
- The phase artefacts that we are used to in regions of high field gradients in standard SWI using Homodyne Filtering are avoided using unwrapping + high-pass filtering
- Phase noise is reduced and a more natural contrast using a tanh phase filter

- Flexible adjustment of phase contrast is offered using a softplus weighting function

CLEAR-SWI

Standard SWI **CLEAR-SWI**





Eckstein K, Bachrata B, Hangel G, Widhalm G, Enzinger C, Barth M, Trattnig S, Robinson SD. Improved susceptibility weighted imaging at ultra-high field using bipolar multi-echo acquisition and optimized image processing: CLEAR-SWI. Neuroimage. 2021 May 15;237:118175.

Links:
https://github.com/korbinian90/CLEARSWI.jl
Harvard Dataverse. https://doi.org/10.7910/DVN/4ZUFTH
https://www.sciencedirect.com/science/article/pii/S1053811921004523

Here‘s an example in a patient with multiple sclerosis, where this lesion with an enhaning rim and central vein is more clearly visible on CLEAR-SWI and this small lesion only visible on CLEAR-SWI.

CLEAR-SWI appeared in NeuroImage in May and is available free and open source in Julia on github.
It requires channel-combined phase and magnitude images (either single-echo or multi-echo as input).
Korbinian is working on implementing this in Siemens image reconstruction environment and bundling this with ASPIRE