Reducing B1+ inhomogeneities in the brain at 7T: Pads or Parallel transmit?

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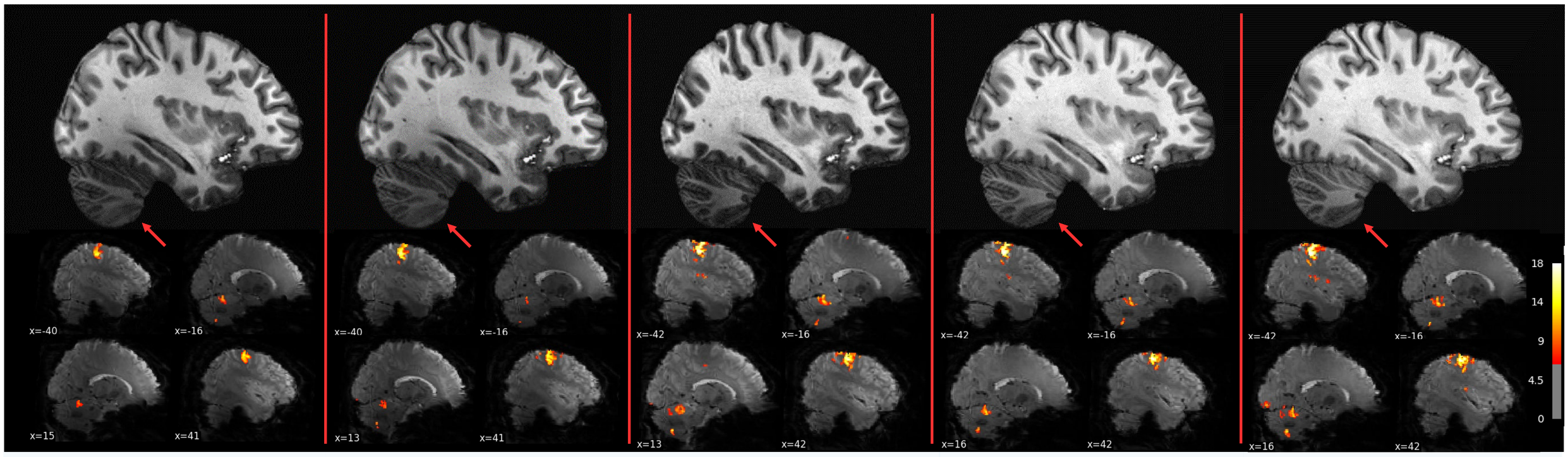
Background

At 7T the B1+ field is not homogenous. This results in varying flip angles and thus inhomogeneous contrast in anatomical scans and reduced sensitivity in functional scans. Dielectric pads offer easy improvement[1], but MultiX systems offers more control over RF. Which solution is better for anatomical and functional scans?

Conclusion

The 8Tx MultiX system offers better image homogeneity than the 2Tx Classic even with dielectric pads.
Use of a Kt-points pulse further improves the MultiX performance.
The Universal Pulse, which does not require prescans, performs similar to the individual Kt-points pulses.



2Tx 'Classic' | 2Tx dielectric pads | 8Tx 'MultiX' | 8Tx Kt-points pulse | 8Tx Universal Pulse

Methods

Systems

Philips Achieva 7T
- Classic: 2Tx32Rx Nova Medical
- MultiX: 8Tx32Rx Nova Medical

11 volunteers scanned

Acquisition

MPRAGE
- α/TR/TI/N_{av}: 7°/3s/1s/2
- 0.8 mm^3
- 8:26min acquisition

3D-EPI
- TR_{vol}/TE: 2.2s/22ms
- 2 mm3
- Topup SDC

Pulses

Kt-points[2]
- 5 sub-pulses
- Optimized both RF & gradients
- Interleaved greedy-local optimization[3]
- Online calculation as MRCodeTool plugin

Universal Pulse (Kt-point based)
- Offline calculation in Matlab
- First 6 volunteers used as reference

Task

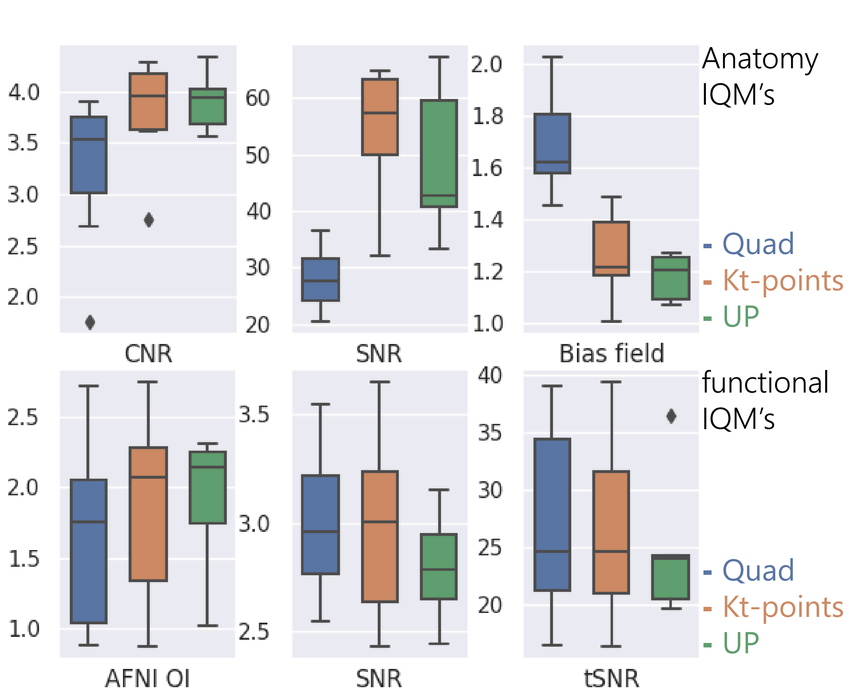
Visually cued motor task
- 18s on, 18s off, n=8

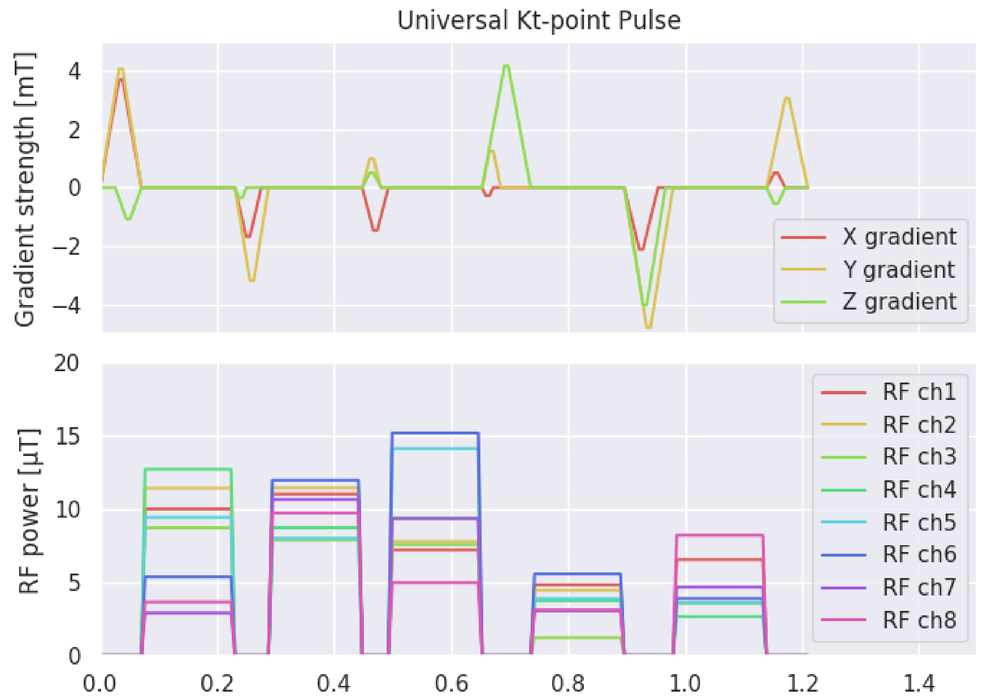
Processing & Analysis

- fMRIprep preprocessing
- MRIQC quality assessment
- GLM analysis (Nistats)

Results

- Successfully implemented Kt-points pulse
- Created Universal Pulse based on Kt-points pulse (far right)
- Exemplar volunteer (top) shows clear improvement going left-right, from Classic to UP
- Quantitative IQM analysis (right) shows improvement in both anatomical and functional scans.
- Group analysis of functional data shows more homogenous BOLD response with Kt-points and UP





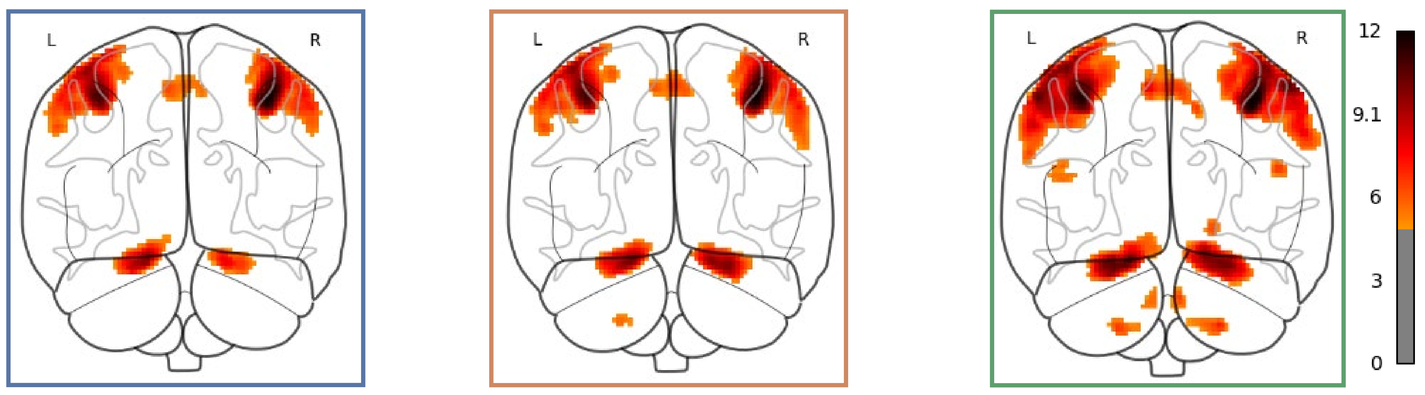
Discussion

A parallel transmit MultiX system has clear benefits, but proper utilization can be complex. However, Universal Pulses make it very accessible whilst still delivering good homogeneity.

Further work could look into combining the dielectric pads with the MultiX and Universal Pulses.

Functional group analysis

Quad -
Kt-points -
Universal Pulse -



References

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