PTX PULSE DESIGN FOR 7T MRI

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Introduction

3 magnetic fields in 7T MRI:

(1) B_0 (2) B_1 (3) Gradient

Advantages of High Fields:

- High signal-to-noise ratio (SNR)
- High spatial/temporal resolution Novel contrast mechanisms
- SWI(susceptibility weighted imaging)
- fMRI

Challenges of High Fields:

- Inhomogeneity of B_1
- SAR effects

Solutions for Challenges:

- Parallel Transmission (pTx)

1) B_1 shimming (magnitude-pahse & phase-only)

2) kT-spoke (gradient control)

Project Objectives:

- A MATLAB app that helps researchers focus on experiments rather than coding
- An efficient, user friendly, expandable, and editable MATLAB app
- This MATLAB app includes the B_1 shimming solutions, drawing region of interest, and simulation results of the B_1 shimming solutions

Methods – Shimming solutions

B_1 without any shim schemes

$$B_1^+ = \frac{B_x + iB_y}{2}$$

Amplitude-phase shim

$$B_1^+ = \sum_{k=1}^{n} (B_1^+)_k \omega_k e^{i\theta k} \qquad \omega_k = |\omega_k| e^{i\theta k}$$

Phase-only shim

$$B_1^+ = \sum_{k=1}^{n} (B_1^+)_k e^{i\theta k}$$

kT-spoke shim

$w = argmin_w\{|||B_1^+(w,\mathrm{g})| - b||_2^2 + \lambda F(w)\}$

MLS can be used to optimise any shim schemes:

$w = argmin_w\{|||B_1^+(w)| - b||_2^2 + \lambda F(w)\}$

B1 Shimming efficiency

$$\eta = \frac{average\|B_1^+\|^2}{average\|B_{p1}^+\|^2} = \frac{w^H \Gamma w}{w_p^H \Gamma w_p}$$

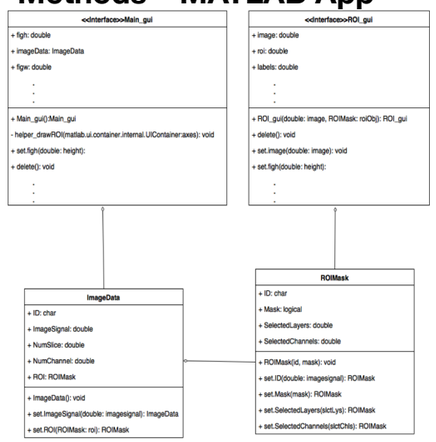
B1 inhomogeneity

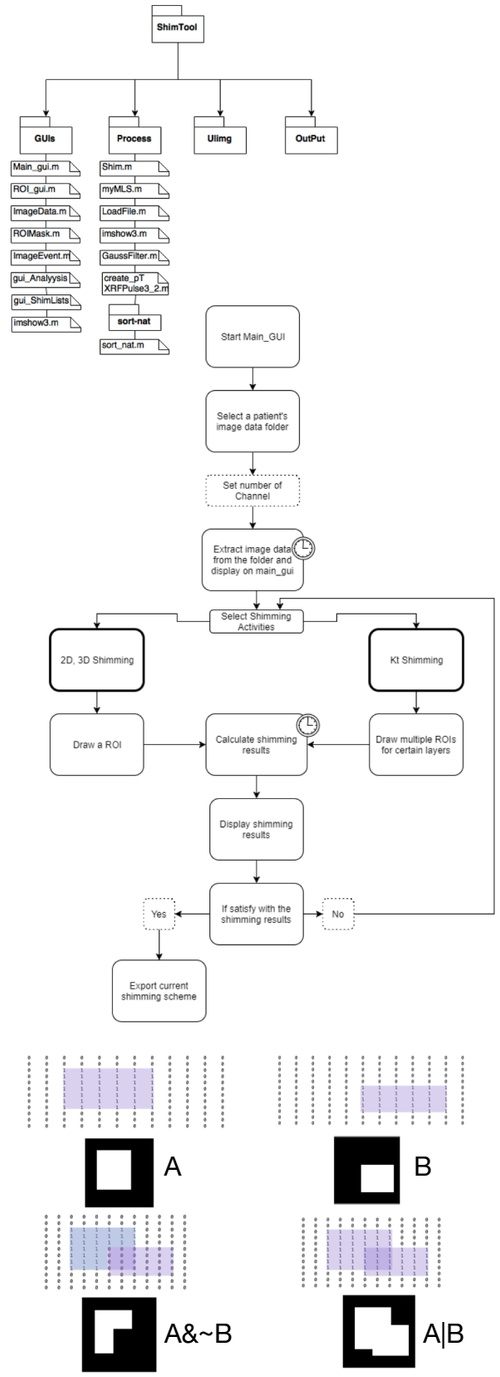
$$RMSE = \sqrt{average\Delta\|B_1^+\|^2}$$

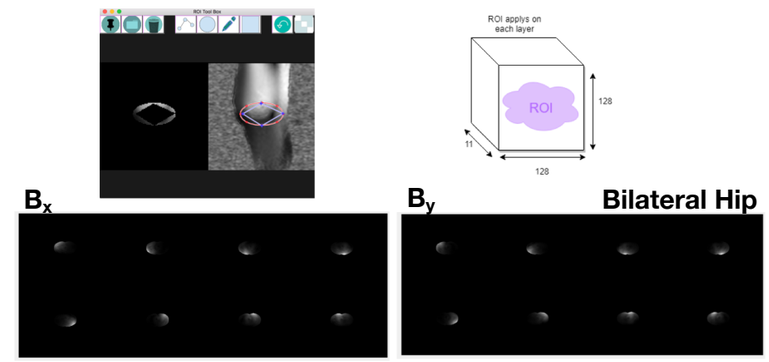
$$Inhomogeneity = \frac{RMSE}{average\|B_1^+\|}$$

B_1^+	RF field	B_{p1}^+	Phase-only filed
B_x, B_y	x, y components in RF field	Γ	correlation matrix
i	$\sqrt{-1}$	ω_k	amplitude
k	k-th channel	$e^{i\theta k}$	phase

Methods – MATLAB App



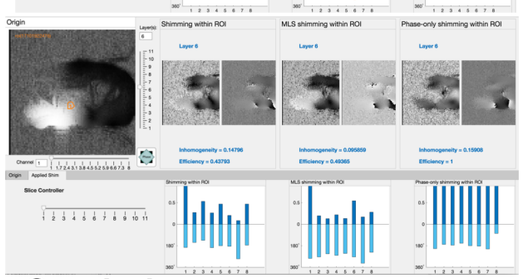




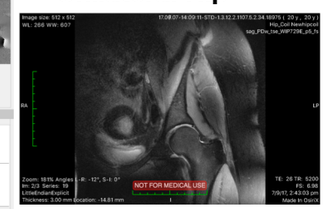
Results

Knee

Lumbar Spine



Unilateral Hip



Conclusion:

Small ROIs can achieve better efficiency, but phase-only has the best efficiency. The MLS improves the homogeneity.