Universitätsklinikum Tübingen

MAX PLANCK INSTITUTE FOR BIOLOGICAL CYBERNETICS

FASTPTX HANDS-ON SESSION

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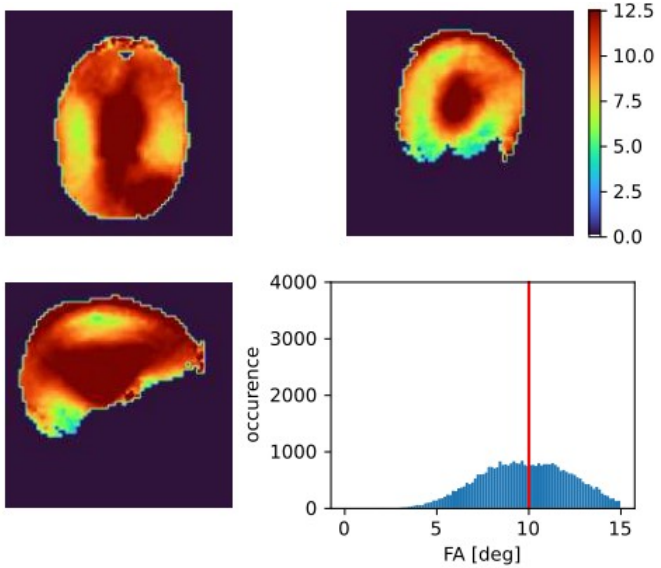
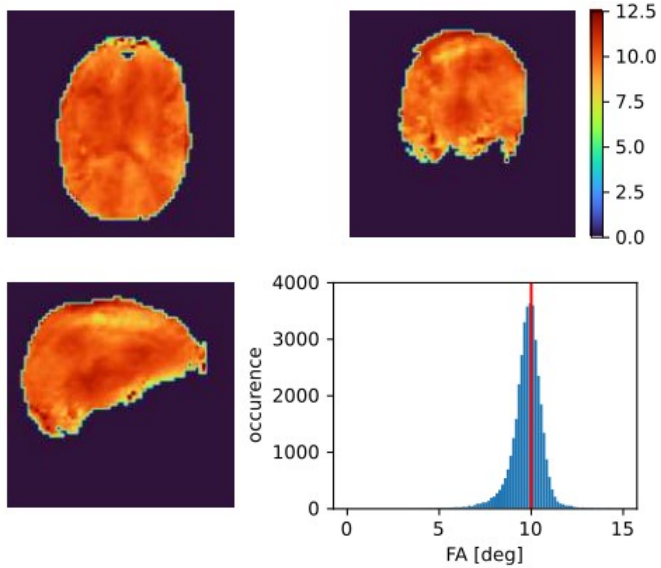
PARALLEL TRANSMISSION IN ULTRAHIGH FIELD MRI

MRI at ultrahigh fields:

- **Inhomogeneous B_1^+**
- **Highly localized tissue heating → SAR**
- **Parallel Transmit Systems: many RF (B_1^+) transmitters**



CP-mode excitation FA



pTx excitation FA

Very expensive high-end systems

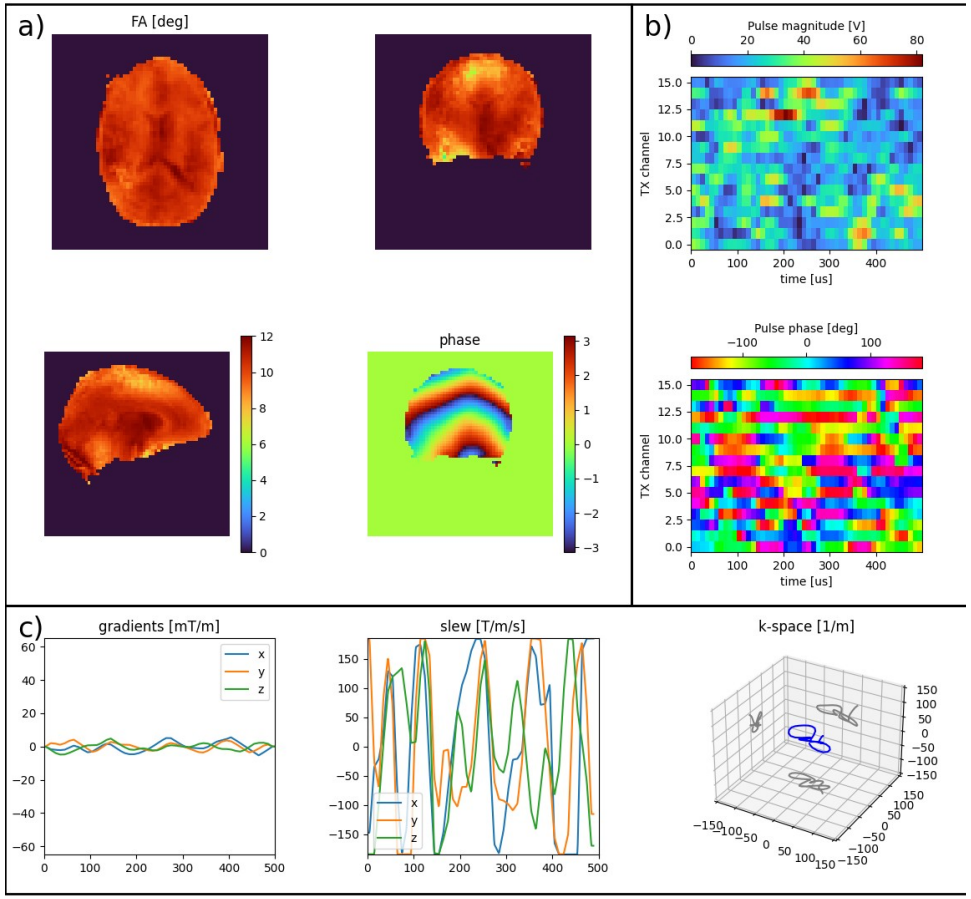
- **9.4T (400 MHz) whole-body magnet**
- **16 Tx channels**
- **Whole-body gradient coil**
- **In-house RF coil development**

THE FastPtx OPTIMIZATION TOOLBOX

- For each time point: 16 complex RF channels + 3 gradient channels = 35 parameters

- Python → PyTorch
- automatic differentiation → efficient
- Supports STA and Bloch simulations
- Can run on CPU or GPU
- Supports individual or universal pulses

Freedom to change all parameters



FastPtx

Use the Pulse in Any Sequence

Liberating pTx from Vendor Lock-in:Open-Source Cross-Vendor Parallel Transmit MRI Sequences by extending pTx-Pulseq to Siemens UHF Scanners

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Introduction

MRI Pulse Sequence source code is **vendor-specific** and **sensitive to software updates** within one generation of MRI scanners. Pulseq[1] is an approach for **vendor-agnostic open-source sequence programming**.
Parallel Transmit (**pTx**) RF-Pulses are an important technique in ultra-high field MRI and were **not supported** by Pulseq in the past, so **no open-source pTx**

Methods

Implementation

The **Pulseq v1.4.3** interpreter **for Siemens MRI** scanners was modified to handle **pTx pulses**. The waveforms of all channels are concatenated and **stored as one long waveform** (Roos et al.[2]). Modern Siemens MRI systems require the **pTx pulses in .ini** files. The interpreter **converts pulses to .ini**

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Pulseq on Philips MRI Systems: *Unlocking and Validating Open-Source Sequences*

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Synopsis

Keywords: Pulse Sequence Design, Pulse Sequence Design, Pulseq, reproducable, open, open-source, UHF, 7T, Philips

Motivation: Conventional MRI vendor-specific sequence development limits research transferability and reproducibility. Harmonized frameworks, like Pulseq, overcome these limitations - but Pulseq was not supported yet on Philips MRI scanners.

Goal(s): To develop a fully-compliant Pulseq interpreter for Philips MRI systems, facilitating the use of open-source sequences previously incompatible with these platforms.

Approach: Custom adaptation of Pulseq for the Philips R5.4 platform, followed by validation with standard imaging sequences using a field camera and phantom/in vivo scans, and comparison with native sequences.

Results: Demonstration of the first Philips-compatible Pulseq interpreter, evidenced by successful scans at 7T, marking a leap in cross-vendor research capabilities.

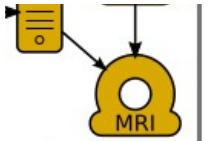
Impact: The successful adaptation of Pulseq sequences to Philips MRI system enables researchers to deploy and disseminate advanced MRI techniques universally, fostering cross-vendor collaboration and accelerating the evolution of MRI technology.

Pulseq interpreter with pTx support

UHF

E12U-AP04 F9, VE12U-SP01, VE12U-SP01_pTx, XA60A, Dario Bosch

Edit



e used to create a .seq
converts the pTx pulse
out the pTx pulse.

Fig. 2: An open-source pTx workflow, complete from B1 mapping to image acquisition.With pTx support in Pulseq, all sequences can be open-source.

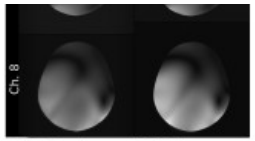


Fig. 3: Individual channel GRE images in a phantom, recorded with the Pulseq interpreter (left) and a vendor-provided sequence (right)

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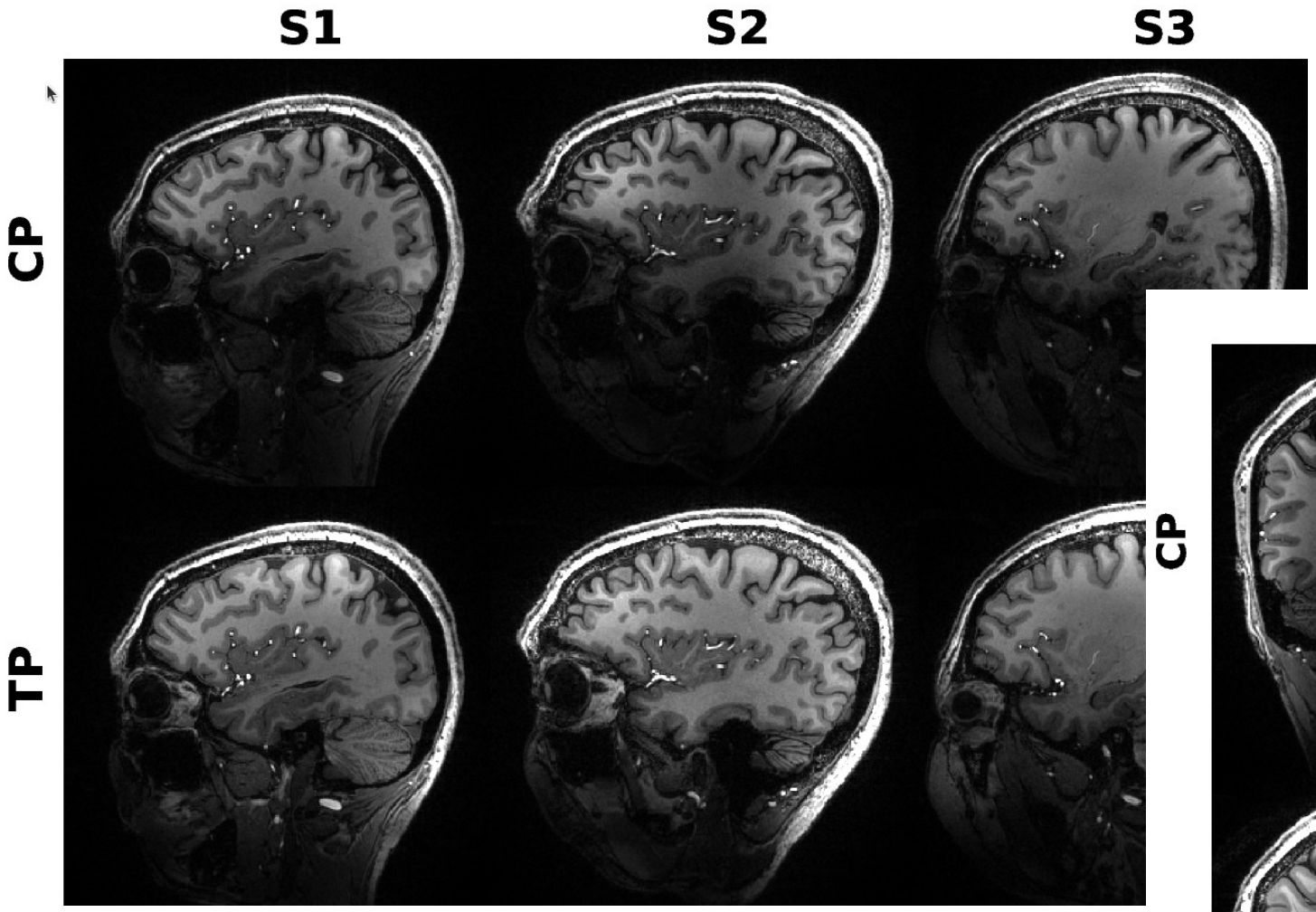

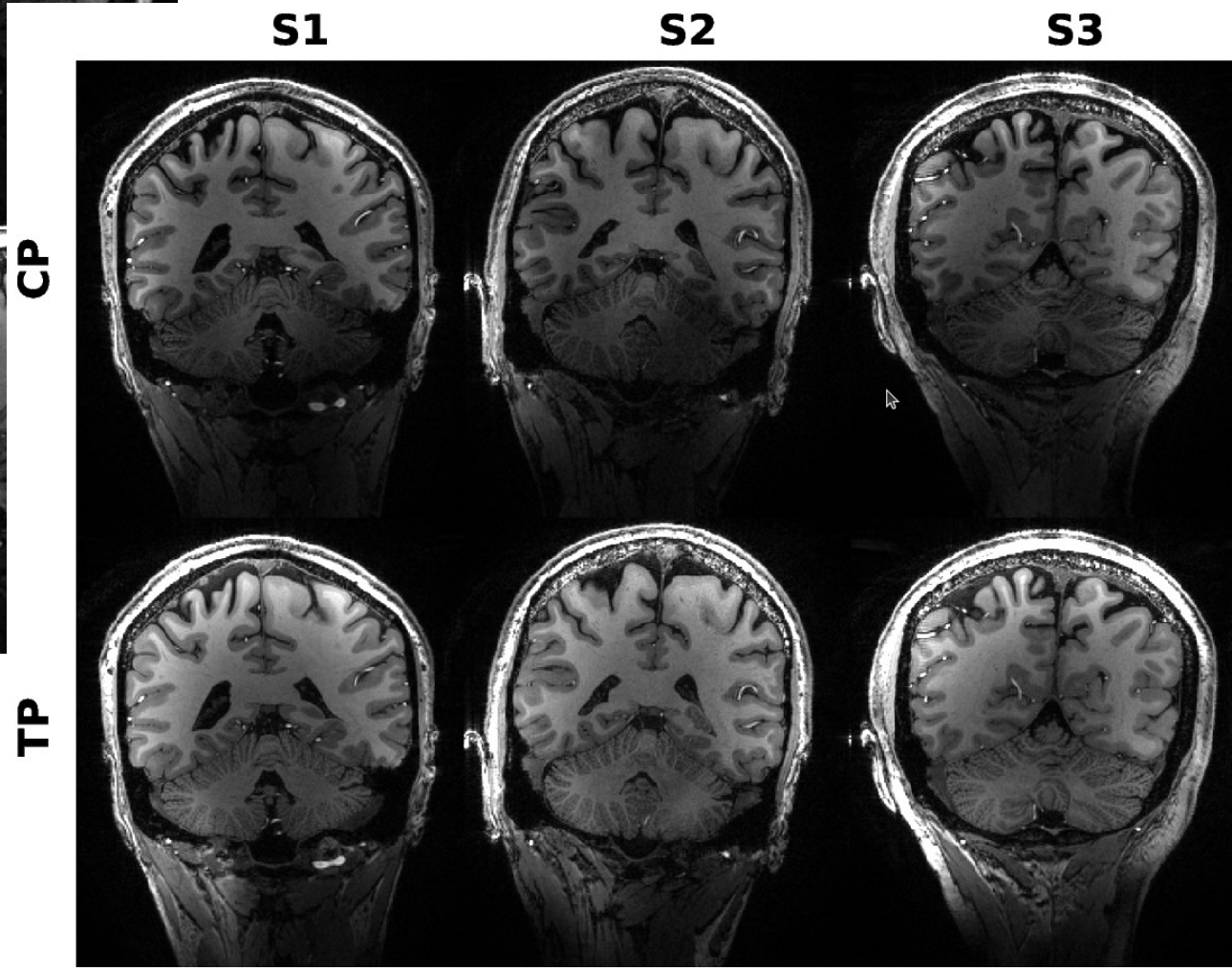

- Toolbox and example data publicly available
- Bosch & Scheffler Magn Reson Mater Phy 2024. https://doi.org/10.1007/s10334-023-01134-7
- github.com/dabosch/FastPtx

https://colab.research.google.com/github/dabosch/FastPtx/blob/main/Colab_Demo.ipynb