

Stay on the beat with tensor-valued encoding: time-dependent diffusion and cell size estimation in ex vivo heart

Samo Lasič^{1,2*}, Nadira Yuldasheva³, Filip Szczepankiewicz^{4,5,6}, Markus Nilsson⁴, Matthew Budde⁷, Erica Dall'Armellina³, Jürgen E. Schneider³, Irvin Teh^{3†} and Henrik Lundell^{1†}

1. Danish Research Centre for Magnetic Resonance, Centre for Functional and Diagnostic Imaging and Research, Copenhagen University Hospital Amager and Hvidovre, Copenhagen, Denmark
2. Random Walk Imaging, Lund, Sweden
3. Leeds Institute of Cardiovascular and Metabolic Medicine, University of Leeds, Leeds, United Kingdom
4. Clinical Sciences, Lund University, Lund, Sweden 5. Harvard Medical School, Boston, MA, United States
5. Brigham and Women's Hospital, Boston, MA, United States
6. Department of Neurosurgery, Medical College of Wisconsin, Milwaukee, WI, USA

†These authors have contributed equally to this work and share last authorship

*Corresponding Author:

Samo Lasič, PhD
Research Fellow
DRCMR, MR-forskning, Afs. 714
Copenhagen University Hospital
Amager and Hvidovre
Kettegard Allé 30
DK-2650 Hvidovre
Email: samol@drcmr.dk

Reference

Lasič et al. Stay on the Beat With Tensor-Valued Encoding: Time-Dependent Diffusion and Cell Size Estimation in ex vivo Heart, *Front Phys* 2022; 10:1–19.
<https://doi.org/10.3389/fphy.2022.812115>

Additional resources

[FWF sequence GIT repository](#) and the [GIT repository](#) for Lasič et al. *NMR in Biomedicine*, 2020;33:e4213. doi: <https://doi.org/10.1002/nbm.4213>.

Overview

Matlab code used for the publication:

[Lasič et al. Stay on the Beat With Tensor-Valued Encoding: Time-Dependent Diffusion and Cell Size Estimation in ex vivo Heart, Front Phys 2022; 10:1–19.](#)

Code written by Samo Lasič. Datasets produced by Irvin Teh.

- `wfm_analyze.m`
Analyze and plot b-tensor waveforms (time and frequency domain, b-tensor shape and q-trajectory).
Makes the `*_info.mat` files in the *waveform* folders.
- `extract_spectral_trace.m`
Extract spectral traces (saved in the waveform folders), which are used by `make_lookup_table_DvsR_mouse.m` and `differential_sensitivity.m`
- `differential_sensitivity.m`
Plot differential sensitivity vs. R_{ω} .
Uses `spectral_traces.mat`.
- `DvsR_substrates.m`
Calculate ADCs for various waveforms and substrates (with varying compartment size and shape).
Makes `DvsR_*.mat` files in the *model* folders.

- `signal_MD_vsb_vsR_cylinder.m`
Plot $S(b,R)$ and $MD(\bar{b},R)$ for cylinders.
Makes `*_signal_fig_data.mat` file in the *model* folder.
- `noise_simulation_cylinder.m`
Perform noise simulations, calculate signal error as a function of f_R and SNR and generate figures for cylinders.
Makes `*_noise_fig_data.mat` files in the *model* folder.
- `noise_simulation_asymmetric_cylinder.m`
Perform noise simulations, calculate signal error as a function of f_R and SNR and generate figures for asymmetric cylinders.
Makes `*_noise_fig_data.mat` files in the *model* folder.
- `noise_simulation_spheroid.m`
Perform noise simulations, calculate signal error as a function of f_R and SNR and generate figures for spheroids.
Makes `*_noise_fig_data.mat` files in the *model* folder.
- `make_lookup_table_DvsR_pig.m` and `make_lookup_table_DvsR_mouse.m`
Calculate lookup tables: MD vs cylinder R vs waveform.
The tables are used for fitting and are saved in the *data* folders.
- `fit_MDvsWaveform_pig.m` and `fit_MDvsWaveform_mouse.m`
Fit and plot mouse and pig heart data with the hindered-restricted model using lookup tables. Saves fitting results in the *data* subfolders.
- `test_background_cross_terms_wfm.m`
Calculate normalized encoding spectra by including the effects of background gradients.
Saves results in `wfms_background_info.mat` in the *waveform* folder.
- `test_background_cross_terms_attenuation.m`
Calculate attenuation terms for various waveforms and background gradients (cylindrical geometry)
Uses `wfms_background_info.mat` and makes `attenuation_cylinder.mat` file in the *model* folder.
- `test_background_cross_terms_signal_cylinder.m`
Calculate and plot signals due to background gradients for cylinder powders as a function of b , G_b and direction.
Uses `attenuation_cylinder.mat` file in the *model* folder.
- `test_background_cross_terms_signal_IVIM.m`
Calculate and plot signals due to background gradients for IVIM as a function of b , G_b and direction.