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% Optimization for DMI using ME-SSFP and CSI-SSFP

% (TE increment/dwell time choice, maximization of NSA)

% Release version - August 2023

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For additional information regarding this tool, kindly reach out to the authors at:

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* <https://www.weizmann.ac.il/chembiophys/Frydman_group/software>

**Optimization for DMI using ME-SSFP and CSI-SSFP when B0 is known:**

Peters DC, Markovic S, Bao Q, Preise D, Sasson K, Agemy L, Scherz A, Frydman L. Improving deuterium metabolic imaging (DMI) signal-to-noise ratio by spectroscopic multi-echo bSSFP: A pancreatic cancer investigation. Magn Reson Med. 2021 Nov;86(5):2604-2617. doi: 10.1002/mrm.28906. Epub 2021 Jun 30. PMID: 34196041.

Reeder SB, Wen Z, Yu H, Pineda AR, Gold GE, Markl M, Pelc NJ. Multicoil Dixon chemical species separation with an iterative least-squares estimation method. Magn Reson Med. 2004 Jan;51(1):35-45. doi: 10.1002/mrm.10675. PMID: 14705043.

**For a complete discussion with B0 is also unknown:**

Pineda AR, Reeder SB, Wen Z, Pelc NJ. Cramér-Rao bounds for three-point decomposition of water and fat. Magn Reson Med. 2005 Sep;54(3):625-35. doi: 10.1002/mrm.20623. PMID: 16092102.

**More about ME-SSFP sequence:**

Leupold J, Månsson S, Petersson JS, Hennig J, Wieben O. Fast multiecho balanced SSFP metabolite mapping of (1)H and hyperpolarized (13)C compounds. MAGMA. 2009 Aug;22(4):251-6. doi: 10.1007/s10334-009-0169-z. Epub 2009 Apr 15. PMID: 19367422.

**CRB\_reeder\_DMI.m**

B0=15.2; LarFreq=6.5357; %B0(T), Larmor's frequency (MHz/T)

flipPulse1=pi\*(60/180); %Flip Angle

TR=0.0115; %TR to plot

ppmoff=2.0; %carrier frequency (ppm)

algoParams.species(1).name = 'water';

algoParams.species(1).frequency = 4.7 - ppmoff; % frequency (in ppm)

algoParams.species(1).relAmps = 1; % relative amplitudes

algoParams.species(1).T1 = 0.3; % T1 (s)

algoParams.species(1).T2 = 0.02; % T2 (s)

algoParams.species(2).name = 'glucose';

algoParams.species(2).frequency = 3.6 - ppmoff; % frequencies in ppm

algoParams.species(2).relAmps = 1; % relative amplitudes

algoParams.species(2).T1 = 0.06; % T1 (s)

algoParams.species(2).T2 = 0.03; % T2 (s)

algoParams.species(3).name = 'lactate';

algoParams.species(3).frequency = 1.2 - ppmoff; % frequencies in ppm

algoParams.species(3).relAmps = 1; % relative amplitudes

algoParams.species(3).T1 = 0.03; % T1 (s)

algoParams.species(3).T2 = 0.06; % T2 (s)

NTEs=5; %N echoes

t=linspace(0,10000,100)/10^6;

**TE increment choice, maximization of NSA:**



Maximum NSA around is 2.2 ms.

TR will be 5 x 2.2 = 11 ms.

**After the TR choice, you need to choose the carrier frequency that avoids the stop bands for all species**:

*Leupold J, Månsson S, Petersson JS, Hennig J, Wieben O. Fast multiecho balanced SSFP metabolite mapping of (1)H and hyperpolarized (13)C compounds. MAGMA. 2009 Aug;22(4):251-6. doi: 10.1007/s10334-009-0169-z. Epub 2009 Apr 15. PMID: 19367422.*

*Peters DC, Markovic S, Bao Q, Preise D, Sasson K, Agemy L, Scherz A, Frydman L. Improving deuterium metabolic imaging (DMI) signal-to-noise ratio by spectroscopic multi-echo bSSFP: A pancreatic cancer investigation. Magn Reson Med. 2021 Nov;86(5):2604-2617. doi: 10.1002/mrm.28906. Epub 2021 Jun 30. PMID: 34196041.*

