

A scanner to publication workflow for magnetization transfer imaging using qMRLab

Mathieu Boudreau^{1,2}, Agah Karakuzu², Nikola Stikov^{1,2}

¹Montreal Heart Institute, Montreal, Quebec, Canada

²NeuroPoly Lab, Polytechnique de Montréal, Montreal, Canada



Declaration of Financial Interests or Relationships

Speaker Name: Mathieu Boudreau

I have no financial interests or relationships to disclose with regard to the subject matter of this presentation.



[Pull requests](#) [Issues](#) [Marketplace](#) [Explore](#)

 [qMRLab / qmt_tutorial](#) Public

[Edit Pins](#) [Unwatch 3](#) [Fork 0](#) [Star 0](#)

[Code](#) [Issues](#) [Pull requests](#) [Actions](#) [Projects](#) [Wiki](#) [Security](#) [Insights](#) [Settings](#)

[main](#) [1 branch](#) [0 tags](#)

[Go to file](#) [Add file](#) [Code](#)

 [mathieuboudreau](#) Update README.md e3ee355 · now [4 commits](#)

 [README.md](#) Update README.md now

README.md

qMT Tutorial Content for the 2022 ISMRM MIT session

[ISMRM 2022 slides](#)

[Step-by-step tutorial: Google Doc](#)

[Step-by-step tutorial: Video](#)

[qMT Theory & Interactive Tutorial](#)

About

No description, website, or topics provided.

[Readme](#)

[0 stars](#)

[3 watching](#)

[0 forks](#)

Releases

No releases published

[Create a new release](#)

Packages

No packages published

[Publish your first package](#)



© 2022 GitHub, Inc.

[Terms](#)

[Privacy](#)

[Security](#)

[Status](#)

[Docs](#)

[Contact GitHub](#)

[Pricing](#)

[API](#)

[Training](#)

[Blog](#)

[About](#)

github.com/qMRLab/qmt_tutorial

Introduction



qMR

Lab

Quantitative MRI. Under one umbrella.

Major Publications

Quantitative Magnetization Transfer Imaging Made Easy with *qMTLab*: Software for Data Simulation, Analysis, and Visualization

JEAN-FRANÇOIS CABANA,¹ YE GU,² MATHIEU BOUDREAU,³ IVES R LEVESQUE,⁴ YAASEEN ATCHIA,⁵ JOHN G. SLED,^{6,7} SRIDAR NARAYANAN,³ DOUGLAS L. ARNOLD,³ G. BRUCE PIKE,^{3,8} JULIEN COHEN-ADAD,⁹ TANGUY DUVAL,⁹ MANH-TUNG VUONG,⁷ NIKOLA STIKOV^{9,10}

¹Department of Medical Physics, University of Montreal, Montreal, QC, Canada

²NeuroRX, Montreal, QC, Canada

³Montreal Neurological Institute, McGill University, Montreal, QC, Canada

⁴Department of Medical Physics, Oncology and RI-MUHC, McGill University, Montreal, QC, Canada

⁵Department of Electrical and Biomedical Engineering, University of Toronto, Toronto, ON, Canada

⁶Hospital for Sick Children, Toronto, ON, Canada

⁷Department of Medical Biophysics, University of Toronto, Toronto, ON, Canada

⁸Department of Radiology, University of Calgary, Calgary, AB, Canada

⁹Institute for Biomedical Engineering, Ecole Polytechnique, Montreal, QC, Canada

¹⁰Montreal Heart Institute, Montreal, QC, Canada



qMRLab: Quantitative MRI analysis, under one umbrella

Agah Karakuzu^{1, 4}, Mathieu Boudreau^{1, 4}, Tanguy Duval¹, Tommy Boshkovski¹, Ilana R. Leppert², Jean-François Cabana⁶, Ian Gagnon¹, Pascale Beliveau⁷, G. Bruce Pike^{2, 5}, Julien Cohen-Adad^{1, 3}, and Nikola Stikov^{1, 4}

¹NeuroPoly Lab, Institute of Biomedical Engineering, Polytechnique Montreal, Montreal, Canada ²McConnell Brain Imaging Center, Montreal Neurological Institute, McGill University, Montreal, Canada ³Functional Neuroimaging Unit, CRIUGM, University of Montreal, Montreal, Canada ⁴Montreal Heart Institute, University of Montreal, Montreal, Canada ⁵Departments of Radiology and Clinical Neuroscience, Hotchkiss Brain Institute, University of Calgary, Calgary, Canada ⁶Chaudière-Appalaches Integrated Health and Social Services Center, Sainte-Marie, Canada ⁷Department of radio-oncology, Research Center of the University of Montreal Hospital Center, Montreal, Canada

DOI: [10.21105/joss.02343](https://doi.org/10.21105/joss.02343)

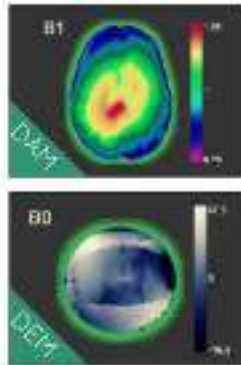
Cabana et al., (2015), *Quantitative magnetization transfer imaging made easy with qMTLab: Software for data simulation, analysis, and visualization*. Concepts Magn. Reson., 44A: 263-277. <https://doi.org/10.1002/cmr.a.21357>

Karakuzu et al., (2020), *qMRLab: Quantitative MRI analysis, under one umbrella*. Journal of Open Source Software, 5(53), 2343, <https://doi.org/10.21105/joss.02343>



<https://qmrlab.org>

qMR Lab



Quantitative MRI.
Under one umbrella.

Relaxometry

Diffusion Imaging

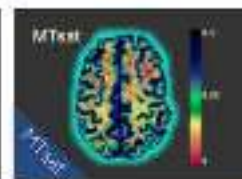
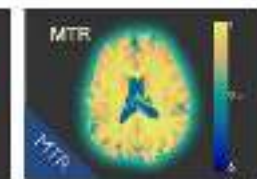
Quant. Susceptibility Mapping

Field Mapping

Quant. Magnetization Transfer



Fit. Simulate. Visualize.

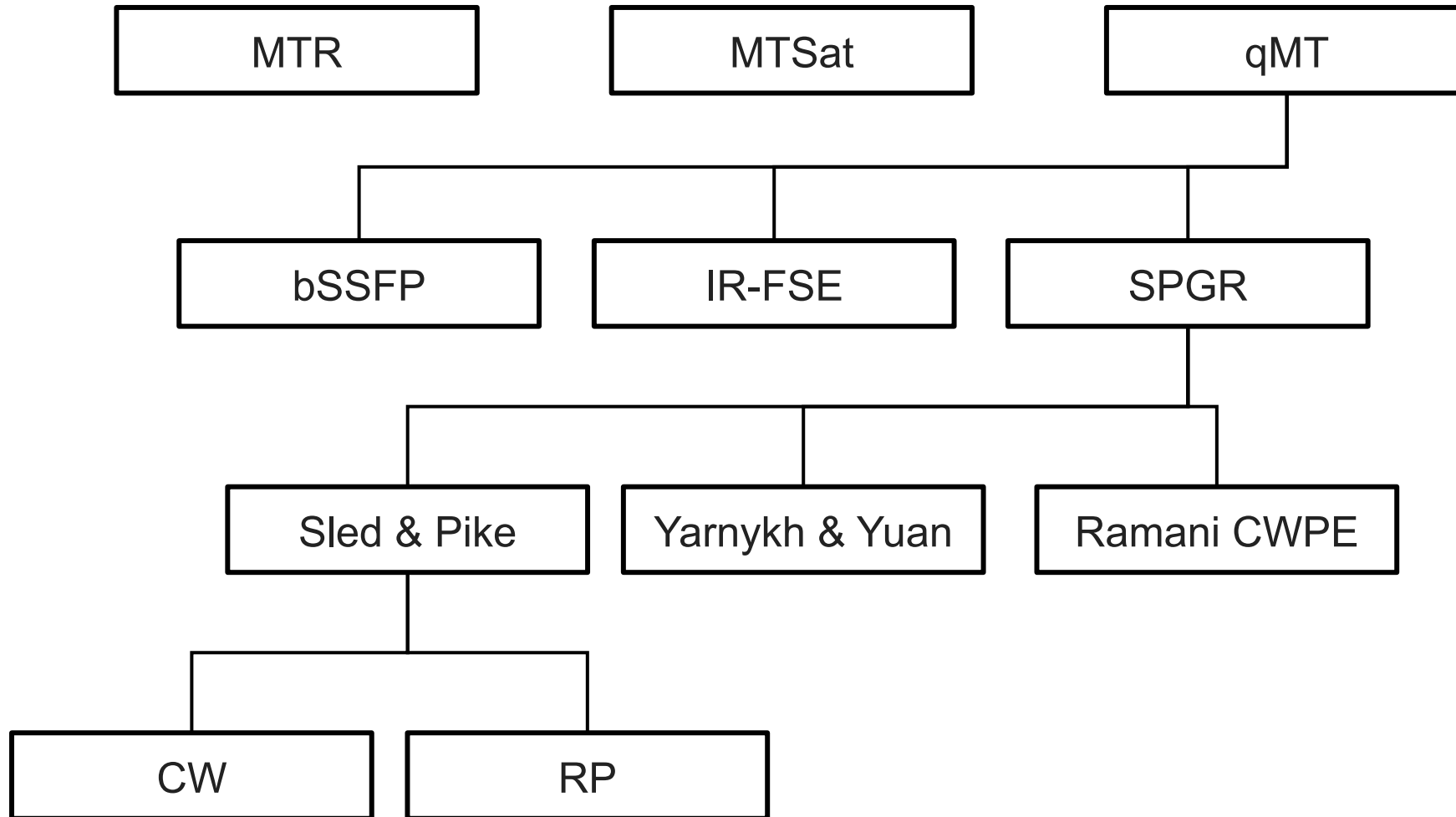


From scanner

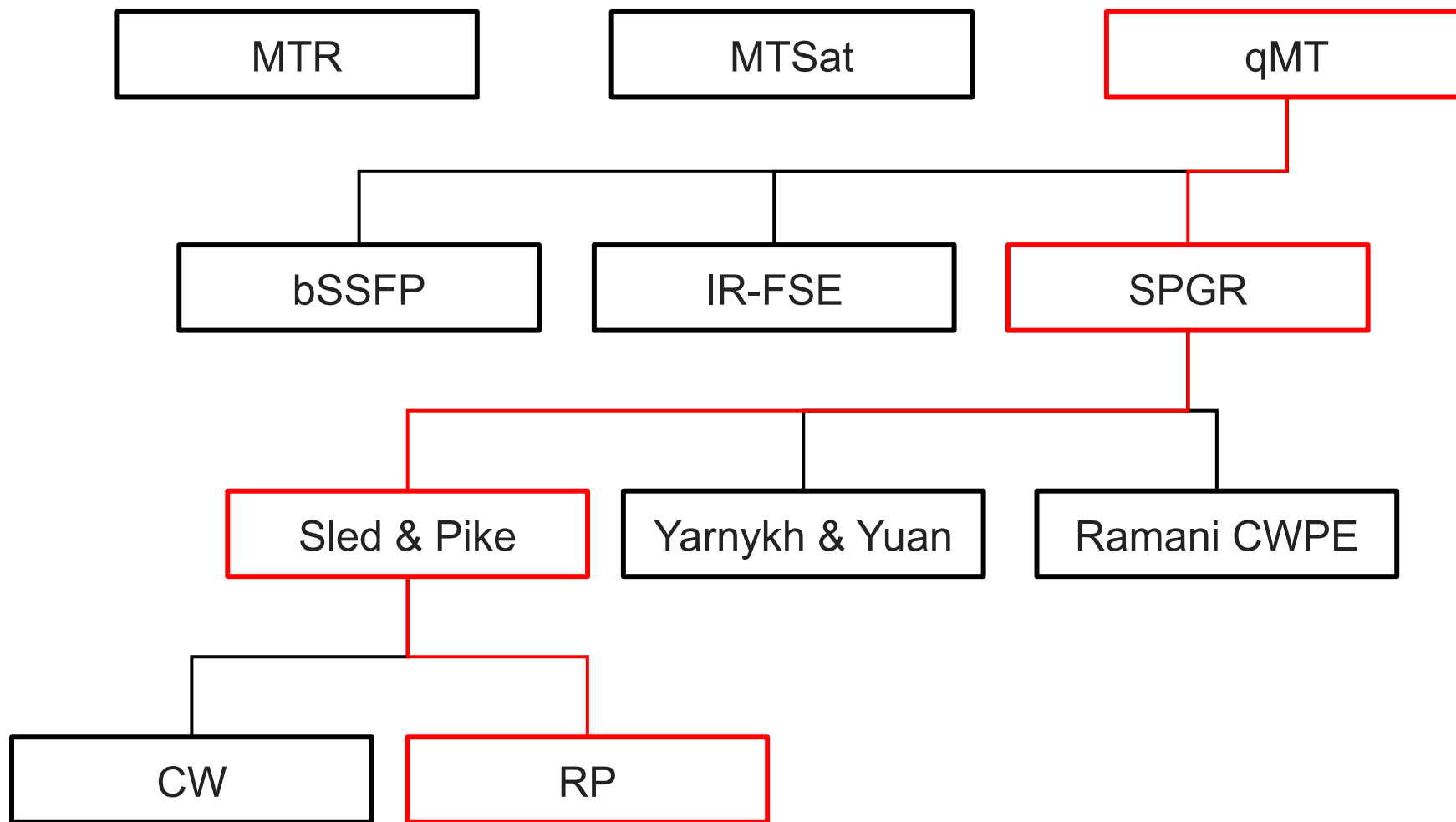
to publication



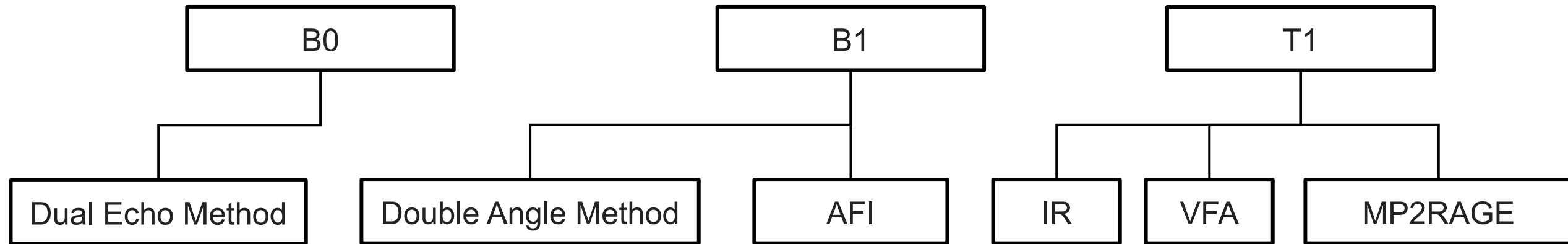
Available MT Methods in qMRLab



Available MT Methods in qMRLab



Maps required by qMT available in qMRLab



qMT Simulation and Data Analysis Tutorial

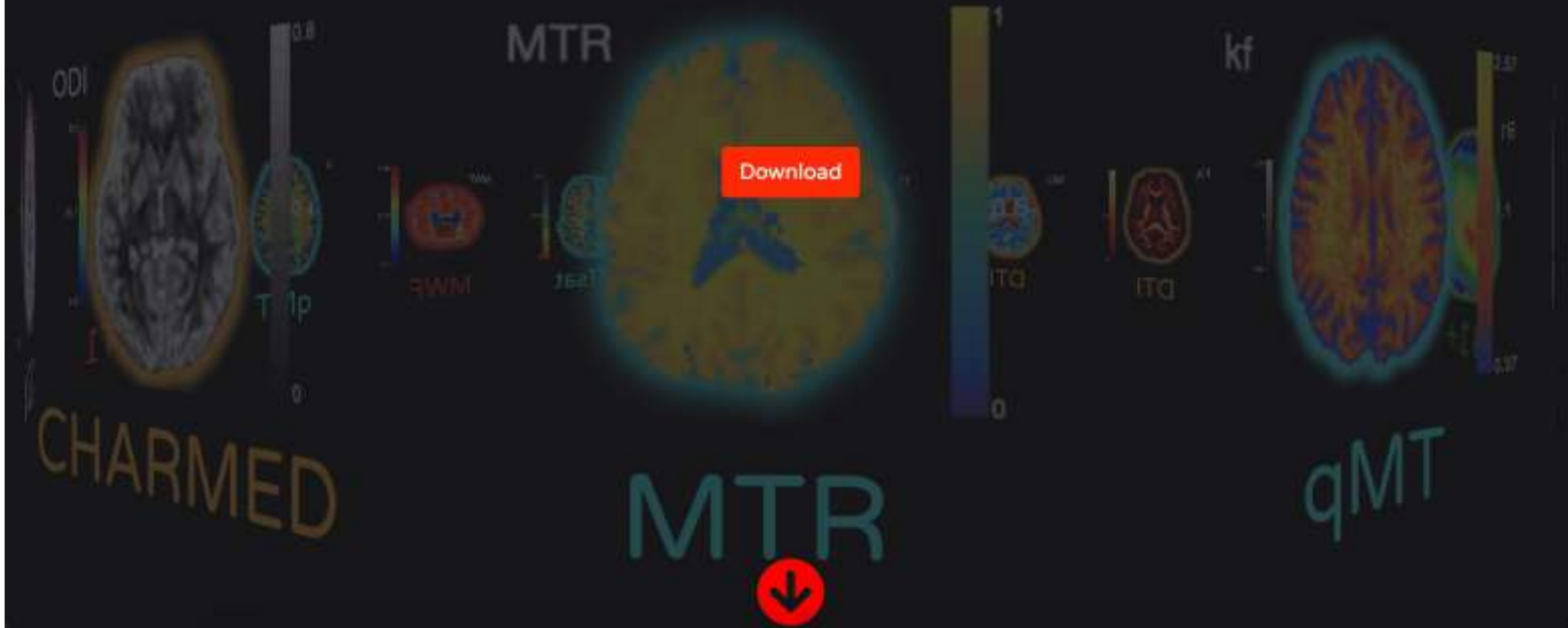


Download

the **qMRLab** software



Quantitative MRI. Under one umbrella.



<http://www.qmrlab.org>

GitHub interface showing the repository **qMRLab / qMRLab** (Public).

Navigation bar: Search or jump to... Pull requests Issues Marketplace Explore

Repository actions: Edit Pins Unwatch 22 Fork 51 Starred 100

Repository tabs: Code Issues 54 Pull requests 5 Discussions Actions Projects Wiki Security Insights Settings

Repository status: master 33 branches 18 tags Go to file Add file Code

Latest commit by mathieuboudreau: Update a few references. #5e1e62 11 hours ago 829 commits

File	Commit Message	Time
.github	Env upgrade (#431)	15 months ago
Deploy	Documentation pipeline (#434)	15 months ago
External	Remove documentation from codebase (#428)	15 months ago
Test	Remove documentation from codebase (#428)	15 months ago
src	Fix uncommented line and upgrade Azure tester Ubuntu runners (...)	7 months ago
usr	Remove report bug feature (#432)	15 months ago
.gitattributes	Added fit residuals map	6 years ago
.gitignore	Remove documentation from codebase (#428)	15 months ago
.gitmodules	Add wrappers as submodule (#430)	15 months ago
CHANGELOG.md	V2.4.1 (#405)	2 years ago
CODE_OF_CONDUCT.md	Add code of conduct (#321)	3 years ago
CONTRIBUTING.md	Add code of conduct (#321)	3 years ago
LICENSE	Move	5 years ago
PULL_REQUEST_TEMPLATE.md	Update doc (#324)	3 years ago

About

Quantitative MRI Made Easy with qMRLab: MRI software for data Simulation, analysis and visualization

qmrlab.org

analysis mapping mri data-simulation quantitative magnetic-resonance-imaging magnetization relaxometry qmri quantitative-mri

Readme MIT license Code of conduct 100 stars 22 watching 51 forks

Releases 12

Release v2.4.1 Zenodo Archive Latest on Sep 2, 2020 MATLAB_R2020b

<https://github.com/qMRLab/qMRLab>

The screenshot shows the GitHub interface for the repository **qMRLab / qMRLab**, which is public. The top navigation bar includes links for Pull requests, Issues, Marketplace, and Explore. The repository header shows 22 Unwatch, 51 Fork, and 100 Starred. Below the header, there are tabs for Code, Issues (54), Pull requests (5), Discussions, Actions, Projects, Wiki, Security, Insights, and Settings. The main content area is divided into two sections: Releases and Tags. The Tags section is active, showing a tag named **ismrm2022** created 20 days ago by **mathieuboudreau**. The tag description is "Pretty-fy graphs". Below the description, there are two assets: "Source code (zip)" and "Source code (tar.gz)". The footer of the page includes the GitHub logo, copyright notice for 2022, and various links like Terms, Privacy, Security, Status, Docs, Contact GitHub, Pricing, API, Training, Blog, and About.

Search or jump to... Pull requests Issues Marketplace Explore

qMRLab / qMRLab Public Edit Pins Unwatch 22 Fork 51 Starred 100

Code Issues 54 Pull requests 5 Discussions Actions Projects Wiki Security Insights Settings

Releases Tags Create release from tag Delete

ismrm2022 747a583 Compare

ismrm2022 mathieuboudreau tagged this 20 days ago

Pretty-fy graphs

Assets 2

- Source code (zip)
- Source code (tar.gz)

© 2022 GitHub, Inc. Terms Privacy Security Status Docs Contact GitHub Pricing API Training Blog About

<https://github.com/qMRLab/qMRLab/releases/tag/ismrm2022>





Overview

of the qMRLab **interface**

qMRLab

v2.4.2

Method:
qat_sp...

Set Default

Open Options Panel

qMR Data Fit

Fit data

Save ResultsLoad Results

qMR Simulator

Multi Voxel Distribution

Sensitivity Analysis

Single Voxel Curve

Fit qMR Data

Data

Path data:

Browse

Study ID:

Download examples

MTdata

+

-

REQUIRED Magnetization Transfer data

View

R1map

+

-

REQUIRED Longitudinal relaxation rate (MTA RECOMMENDED)

View

B1 map

+

-

Normalized transmit excitation field map (B1+). B1+ is defined as a

View

B0map

+

-

B0 field map, used for offset correction. (OPTIONAL) (-CHz if not

View

Mask

+

-

Binary mask to accelerate the fitting (OPTIONAL)

View

Cannot find required input called MTdata

Fit Results

Source:

View:

A...

3D viewer

Sanity Check

Voxel fit

ROI fit

Statistics

Histogram

Cursor

Select

S

L

R

I

(x,y) vol

Vol: 1/1Time: 1/1Slice: 1/1

Current file:

Web qmr_lab documentation

OptionsGUI

qmr_app_options

Protocol

MTData

	Angle	Offset
1	142	443
2	428	443
3	142	1008
4	428	1008
5	142	2732
6	428	2732
7	142	8262
8	428	8262
9	142	17235
10	428	17235

Add

Remove

Move up

Move down

Load

Create

TimingTable

Tmt (s)	0.0102
Ts (s)	0.0030
Tp (s)	0.0018
Tr (s)	0.0100
TR (s)	0.0250

Fit Protocol

Fitting

Var	Fix	Start	Lower	Upper
T		0.0001	0.0000	0.2000
S		30.1	0.0000	1.00
R1	☒	0.0400	0.0000	1
R1	☒	1	0.0000	1
T2		0.0200	0.0000	0.2000
T2		1.0000	0.0000	0.0000

Options

MT_Pulse

Shape:gaussian

Sinc TRFA:4

Bandwidth:200

Fermi transition (s):0.000001000

of MT pulses:500

Model:StdPikAPP

Uneshape:SuperLorentzian

fitting constraints

☒ Use R1map to constrain R11

☐ R1 R1r = R1f

☐ R1 R1PT2f

R1PT2f =:0.200

Read pulse alpha:7

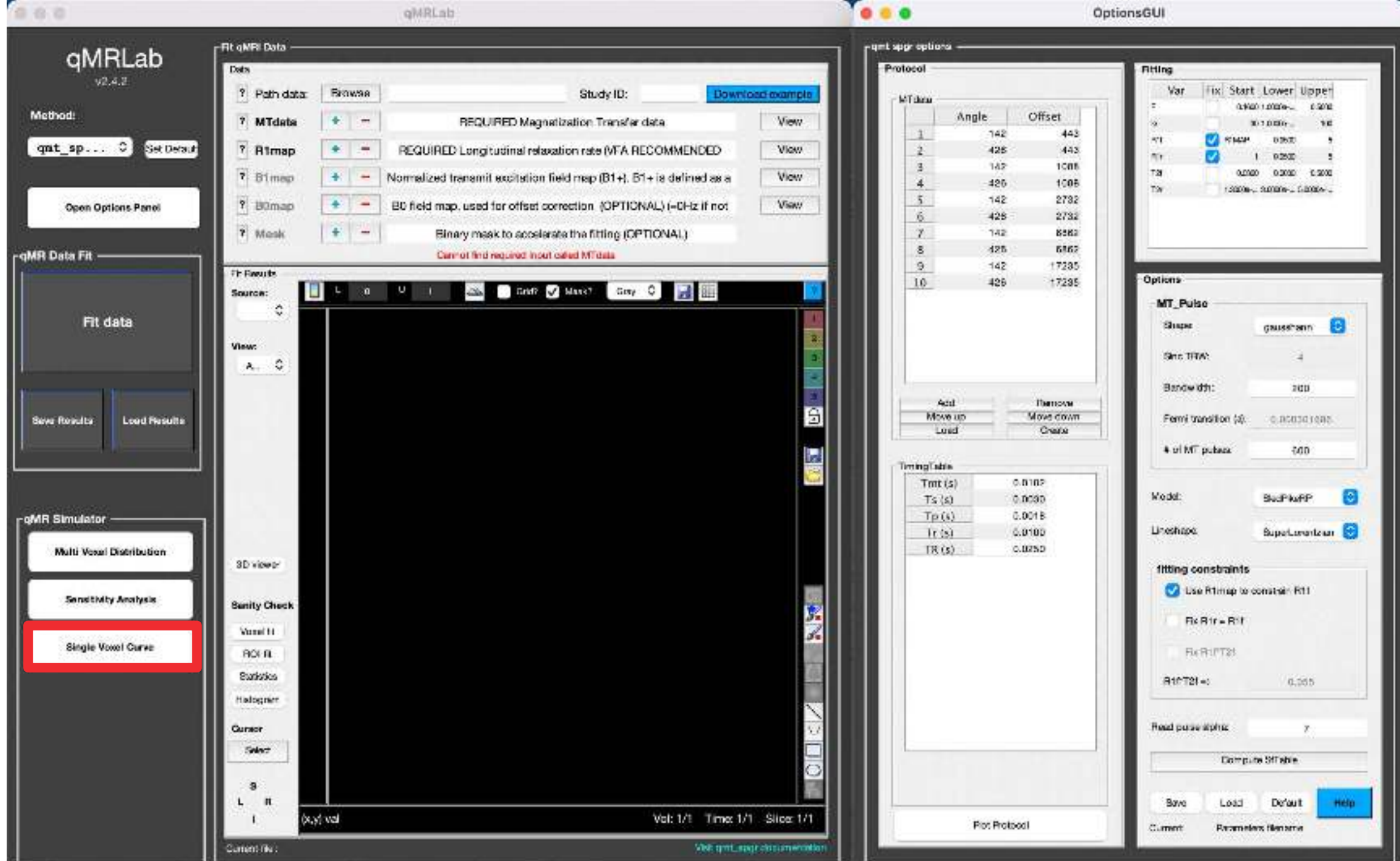
Compute Off-line

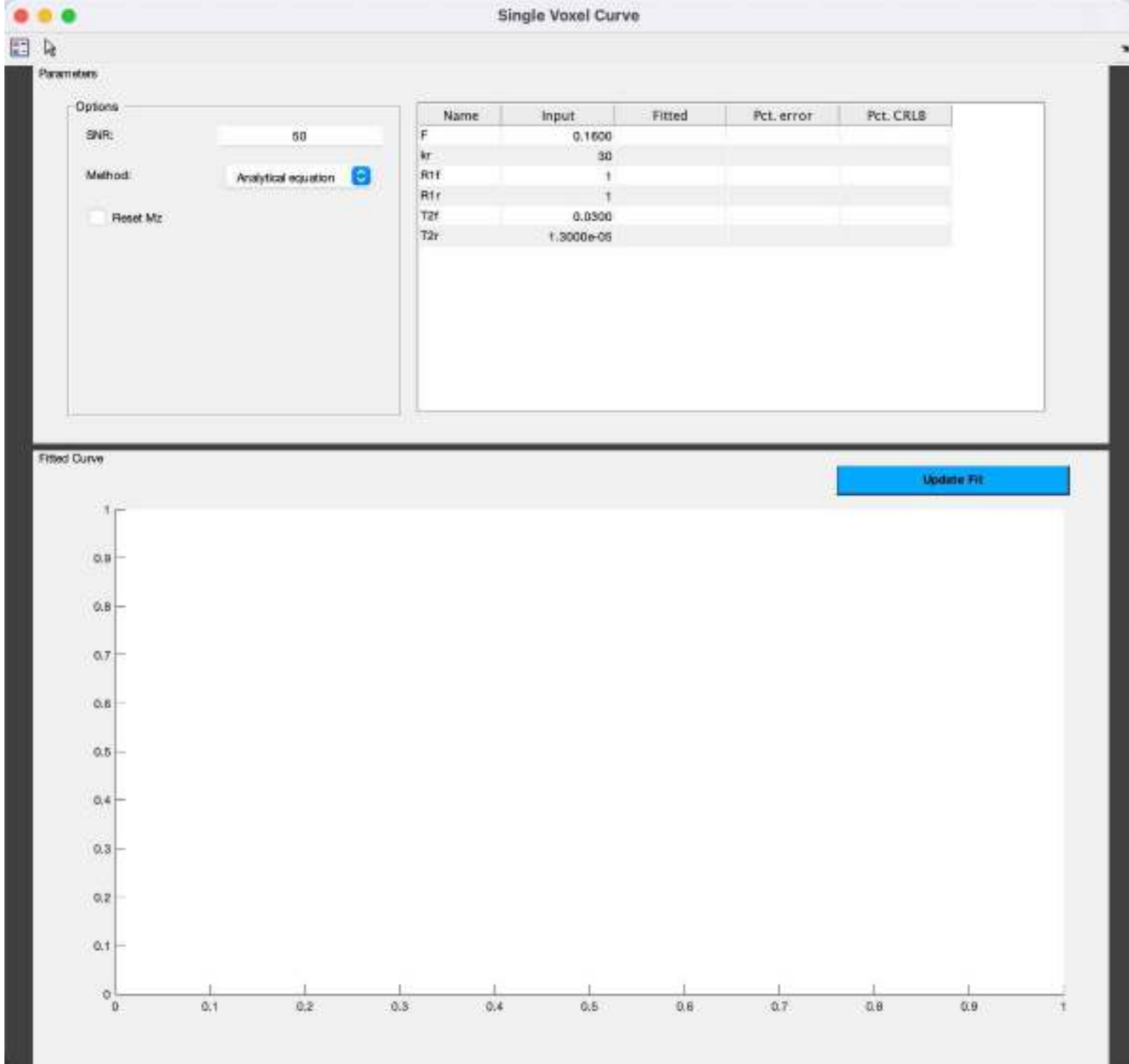
SaveLoadDefaultHelp

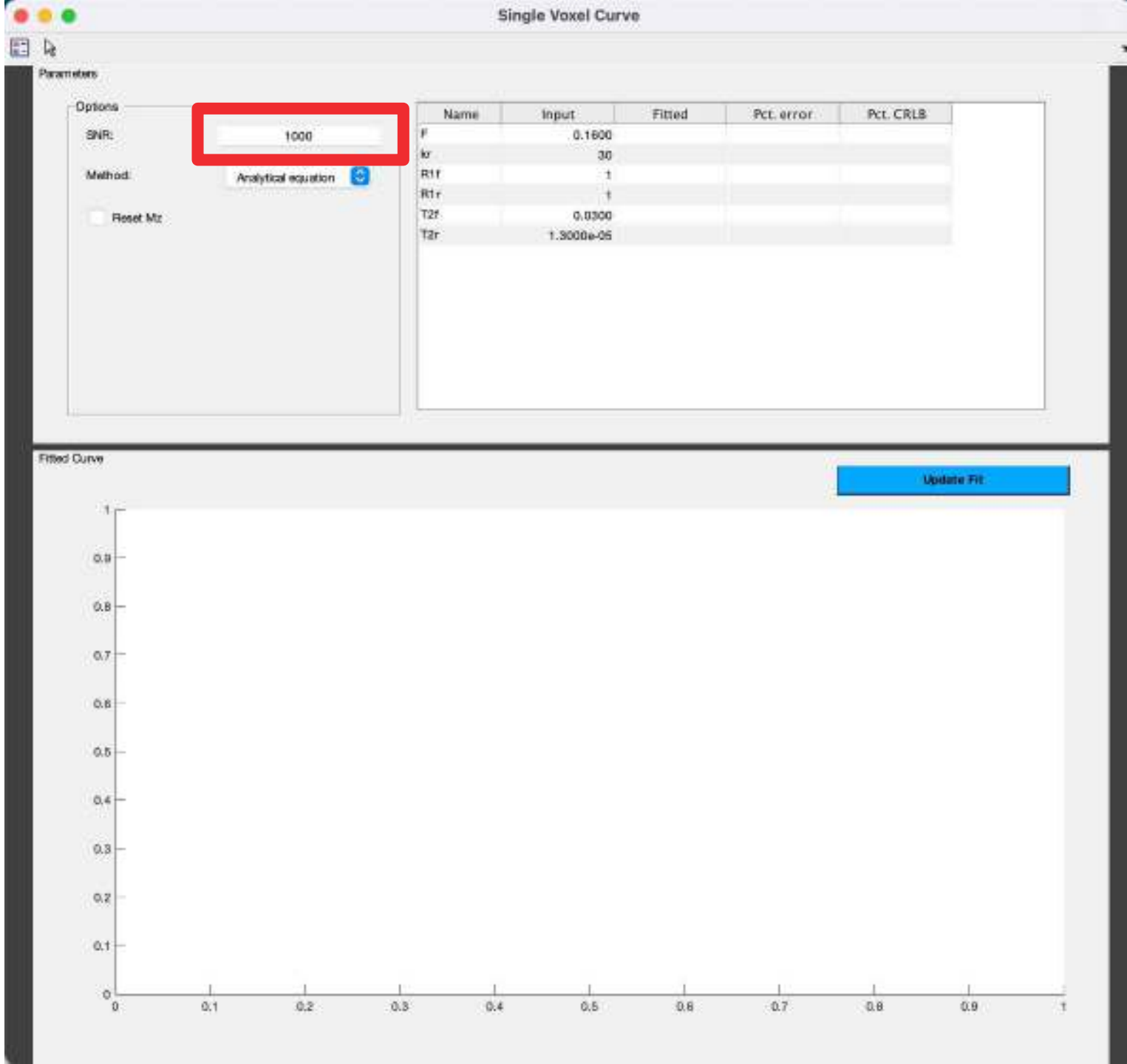
CurrentParameters filename

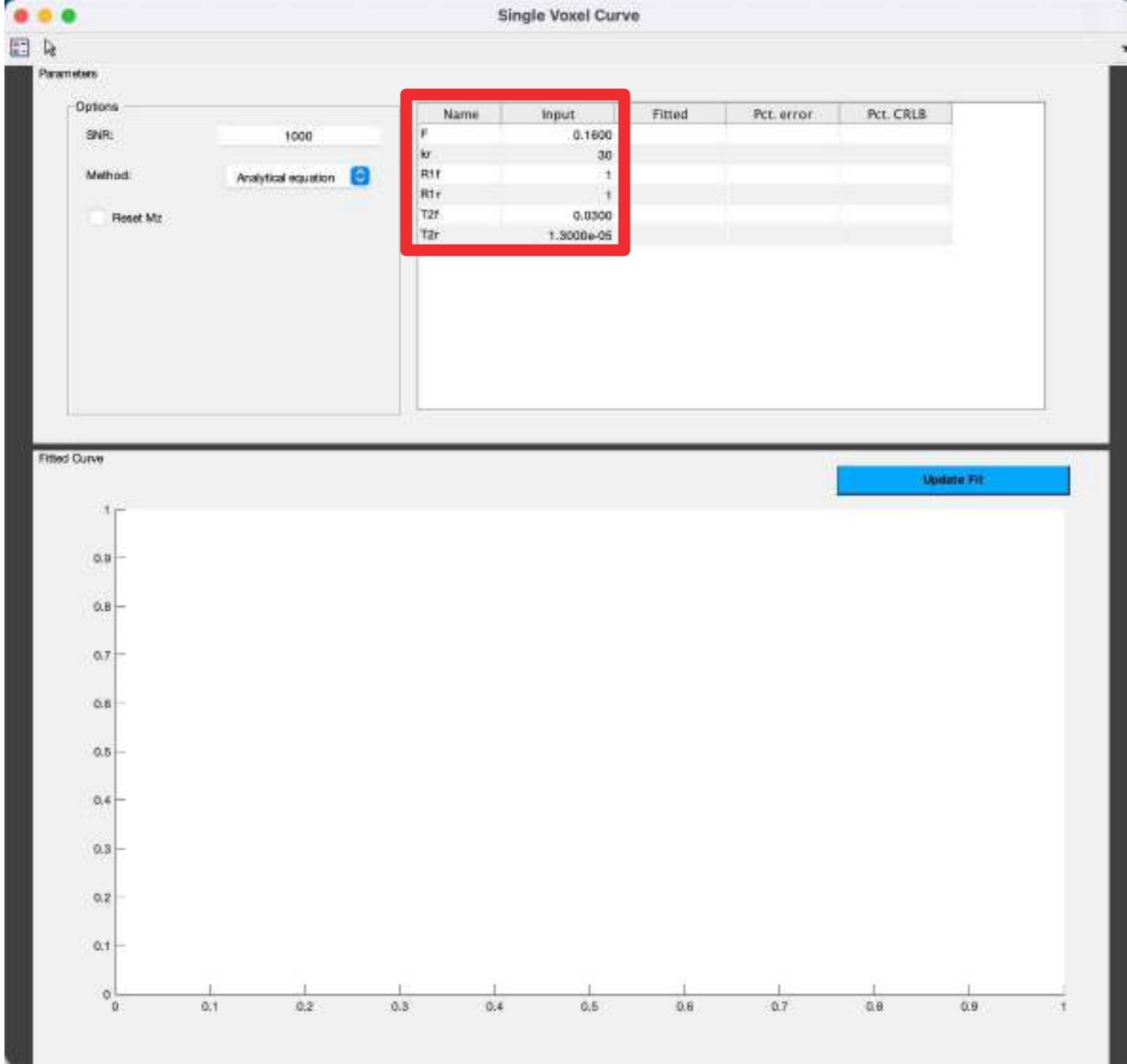
How to...

simulate and **fit**
a single “voxel” of data









OptionsGUI

qmt app options

Protocol

MTData

	Angle	Offset
1	142	443
2	425	443
3	142	1085
4	425	1085
5	142	2732
6	425	2732
7	142	6362
8	425	6362
9	142	17235
10	425	17235

Add

Remove

Move up

Move down

Load

Clear

TimingTable

Tmt (s)	0.0102
Ts (s)	0.0030
Tp (s)	0.0015
Tr (s)	0.0100
TR (s)	0.0250

Plot Protocol

Fitting

Var	Fix	Start	Lower	Upper
c	☐	0.960	1.000e-...	1.000
q	☐	30.1	0.000e-...	9.0
R1	☒	0.0424	0.000	5
R1	☒	1	0.000	5
T2	☐	0.000	0.000	1.000
T2	☐	1.000e-...	0.000e-...	0.000e-...

Options

MT_Pulse

Shape

gaussian

Src TRIA

-4

Bandwidth

200

Fermi transition (Å)

0.000001000

of MT pulses

500

Model

BudPikAPP

Lineshape

SuperLorentzian

fitting constraints

☒ Use R1map to constrain R11

☐ R1 R1r = R11

☐ R1 R1PT21

R1PT21 =:

0.005

Read pulse alpha:

7

Compute BFF table

Save

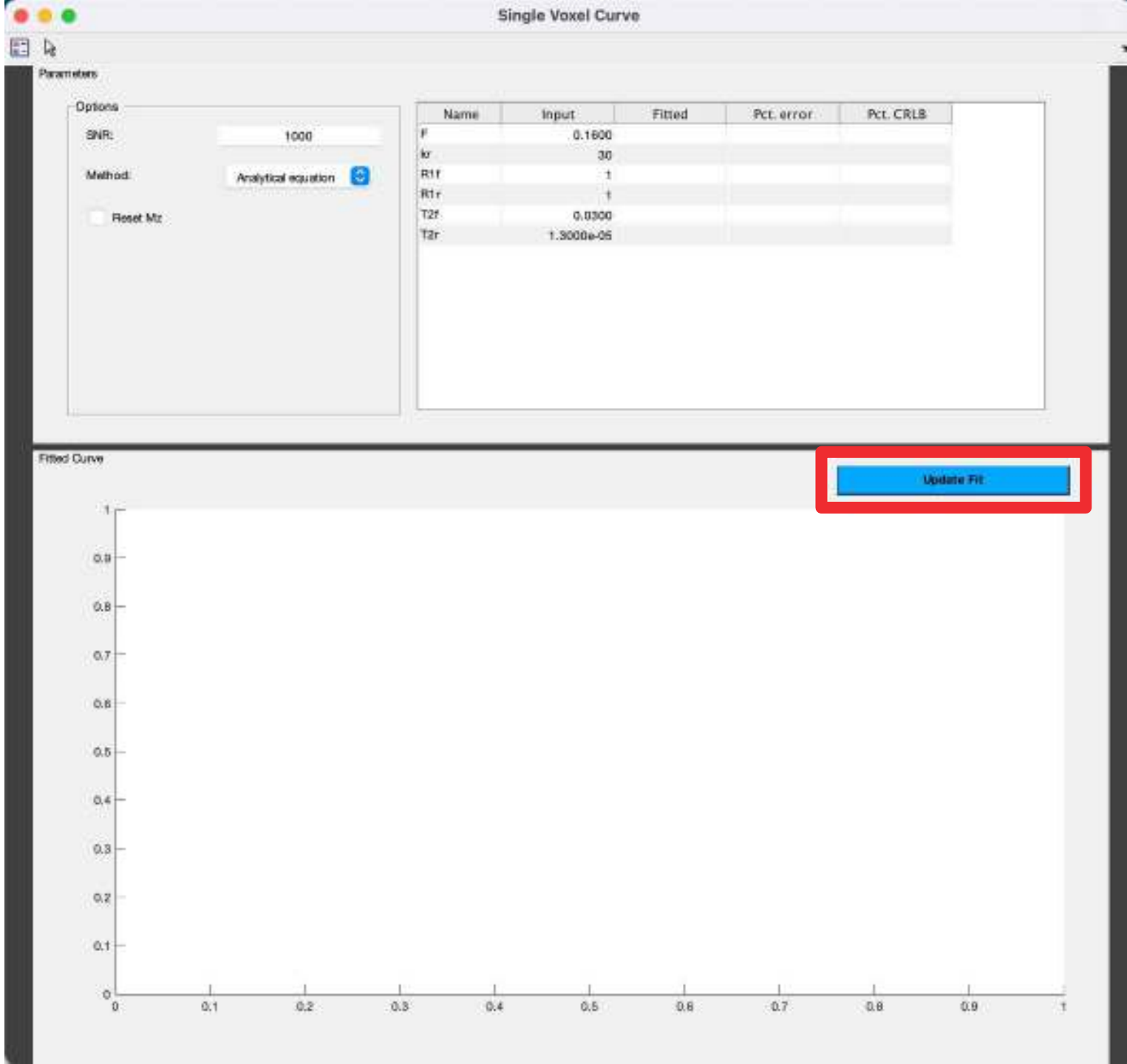
Load

Default

Help

Current

Parameters filename



Single Voxel Curve

Parameters

Options

SNR:

1000

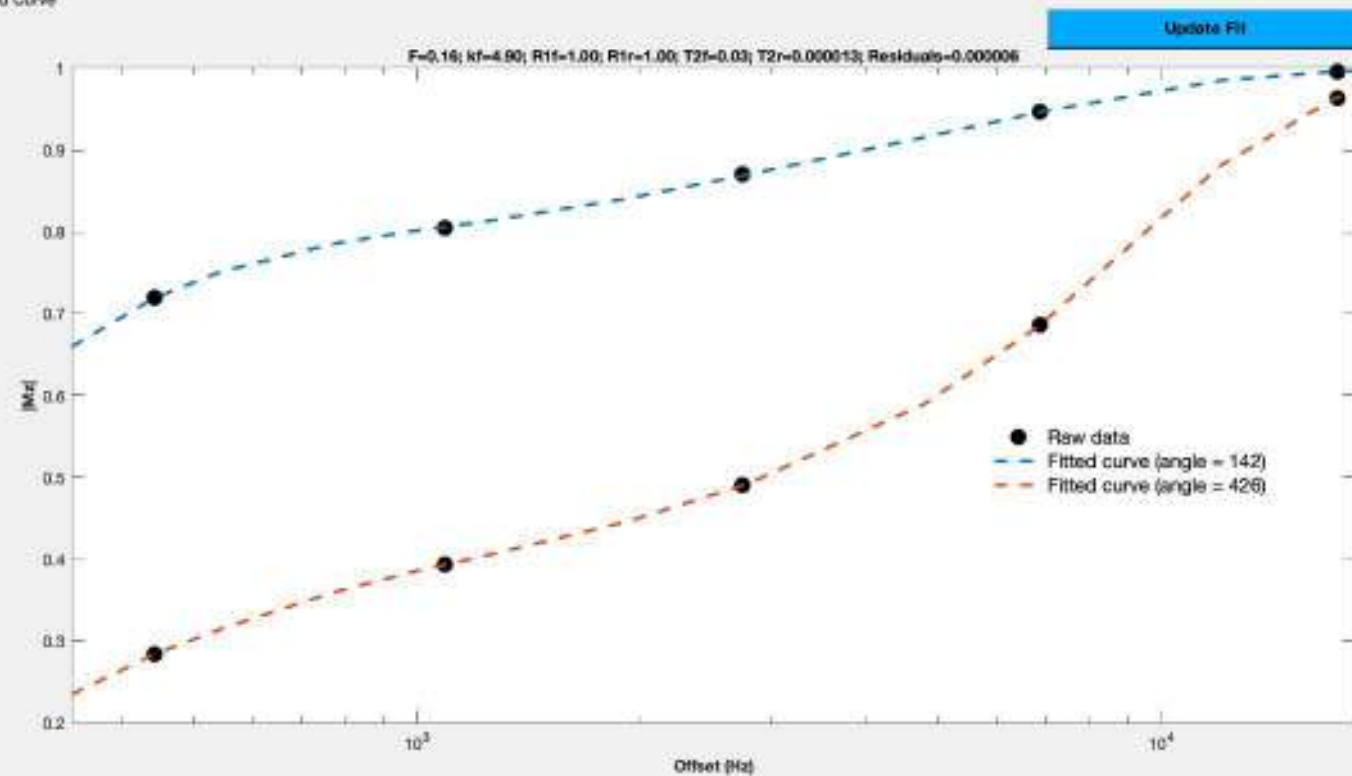
Method:

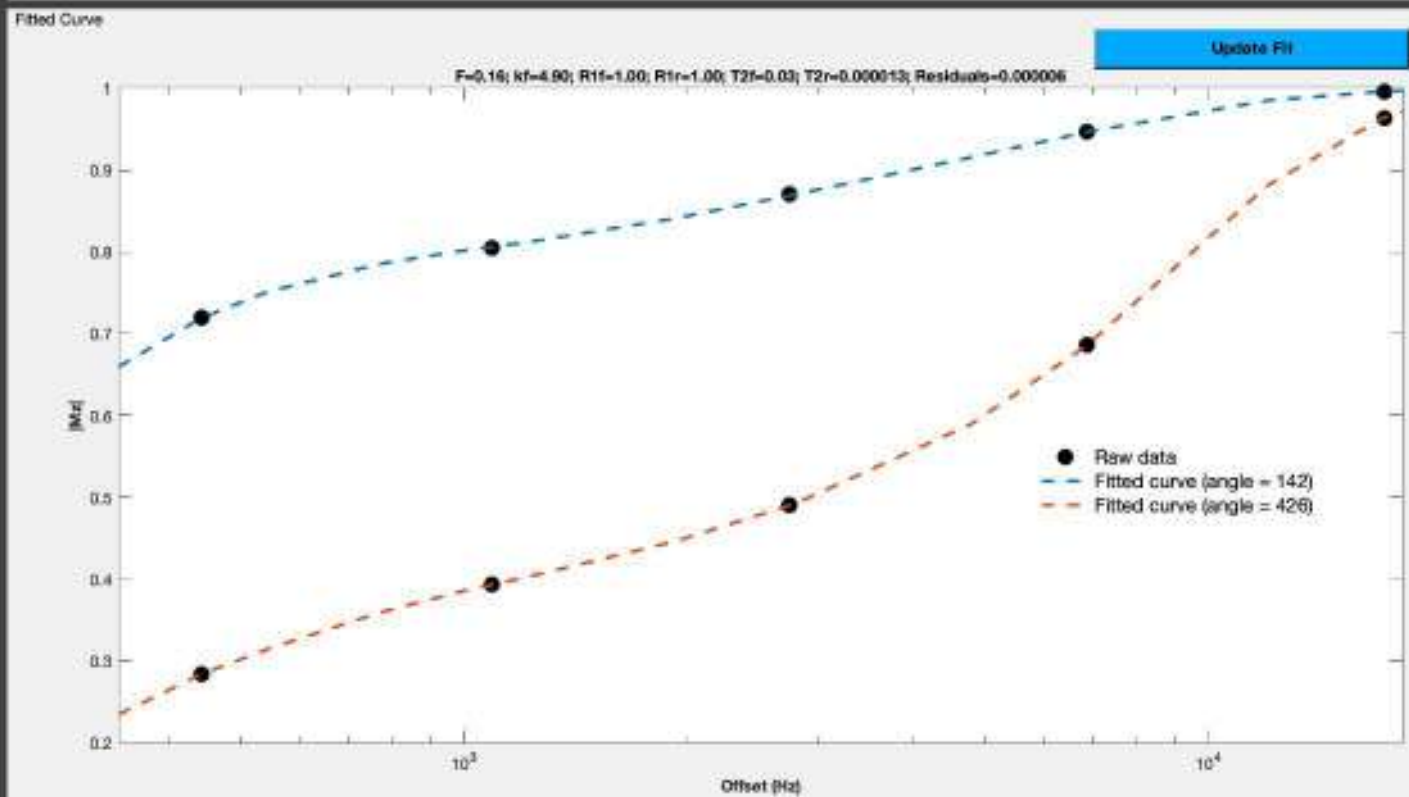
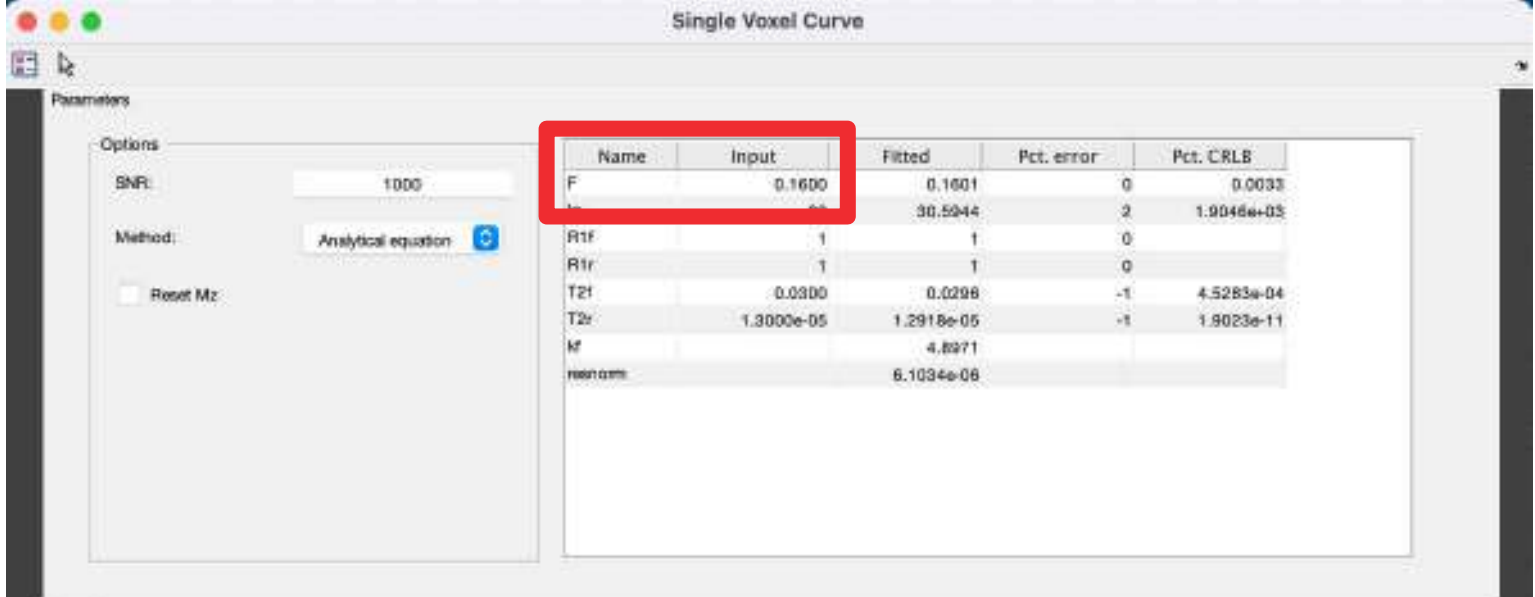
Analytical equation

☐ Reset Mz

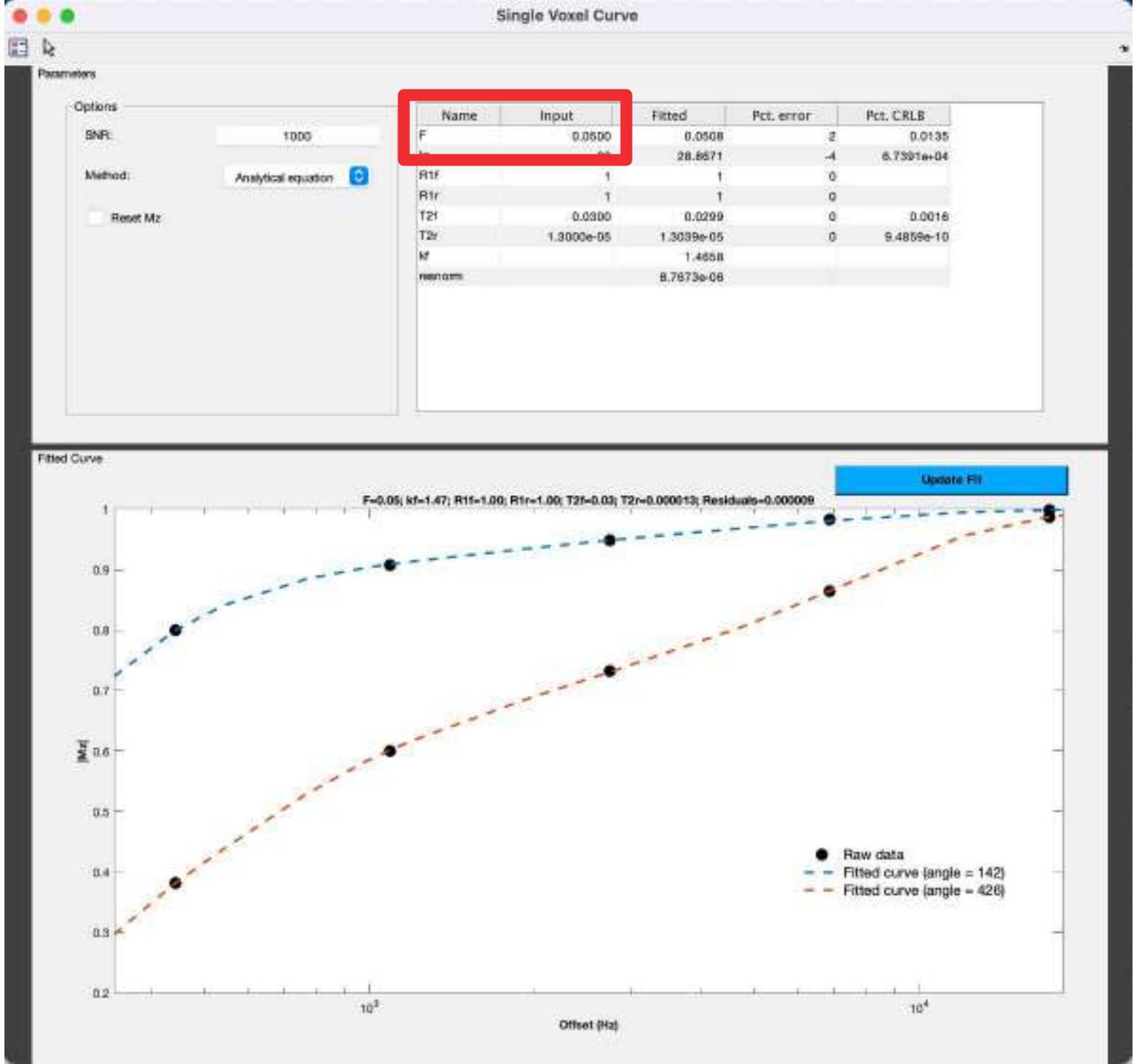
Name	Input	Fitted	Pct. error	Pct. CRLB
F	0.1600	0.1601	0	0.0033
k _r	30	30.5944	2	1.9046e+03
R1f	1	1	0	
R1r	1	1	0	
T2f	0.0300	0.0298	-1	4.5283e-04
T2r	1.3000e-05	1.2918e-05	-1	1.9023e-11
k _f		4.8971		
mean rms		6.1034e-06		

Fitted Curve

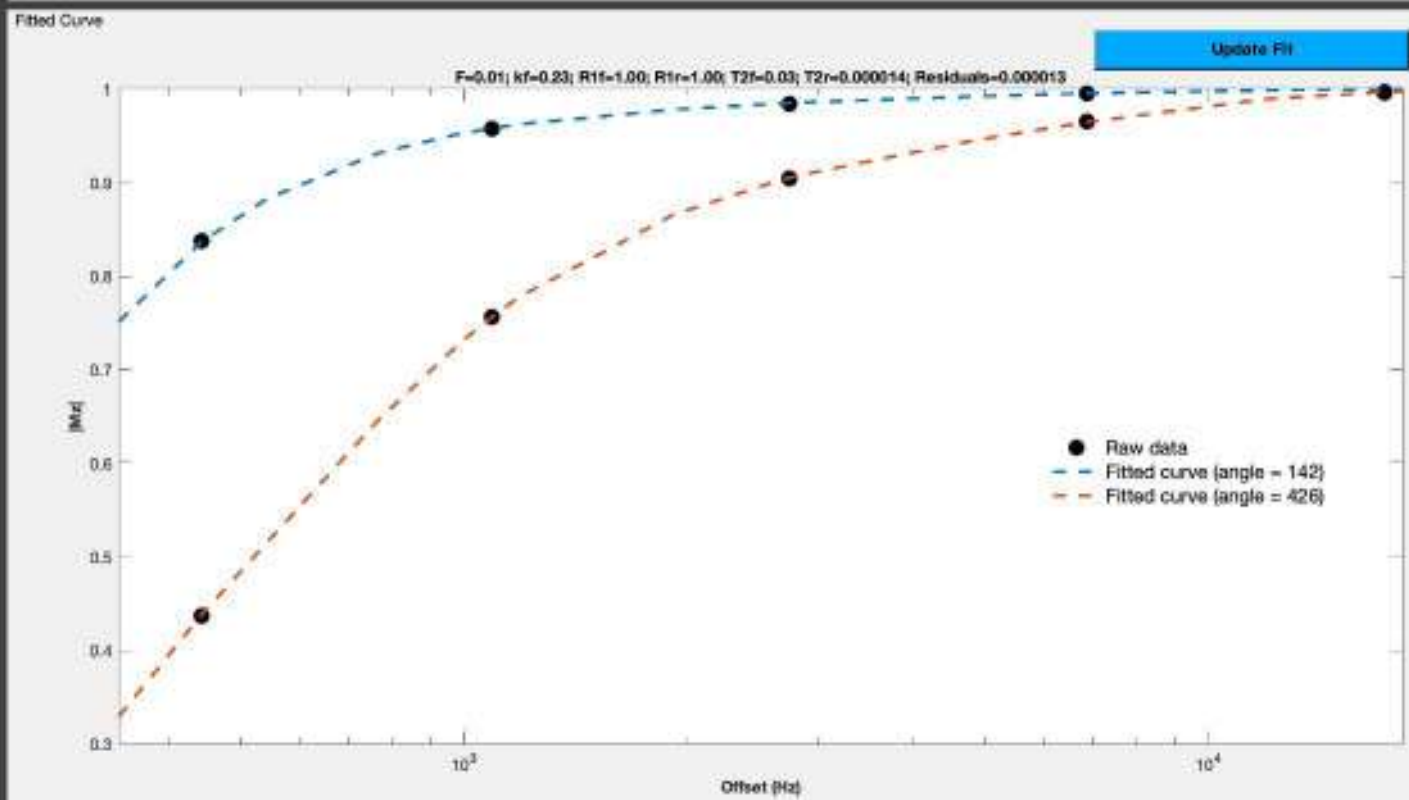
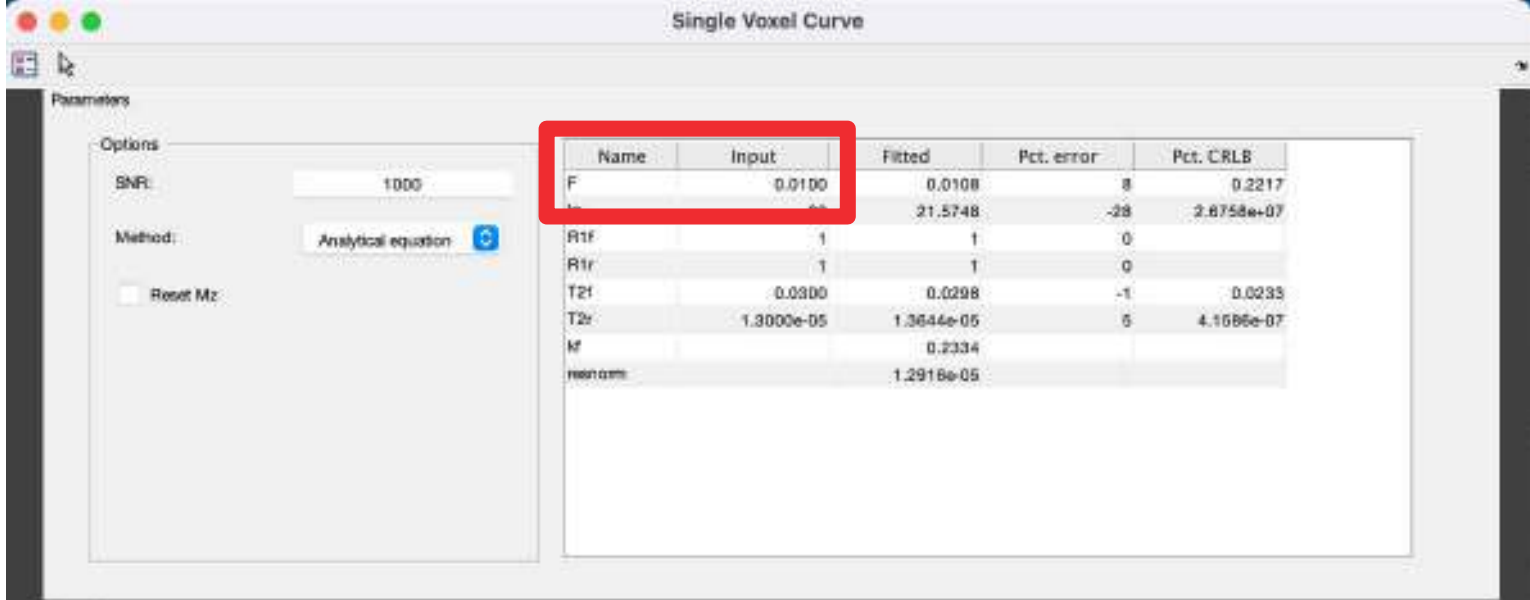




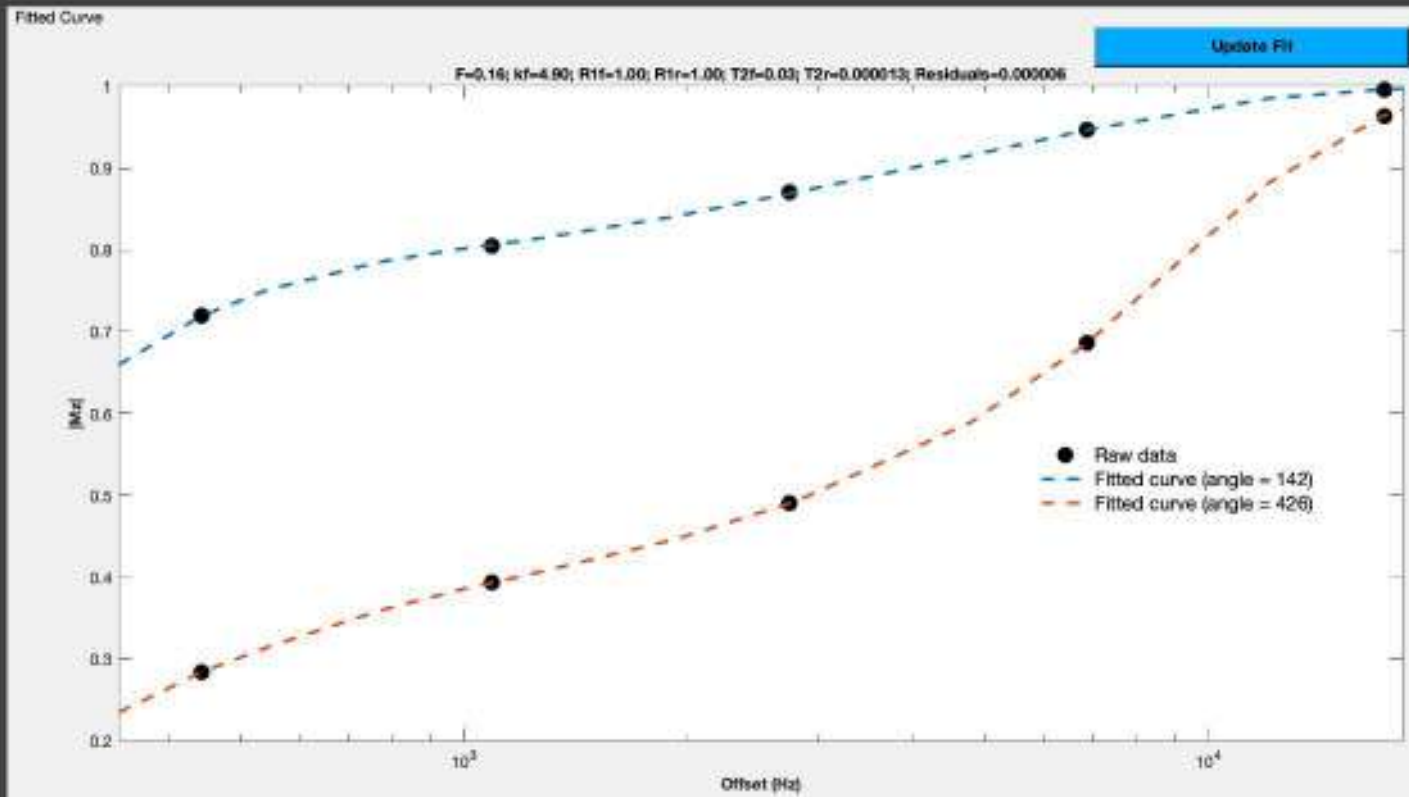
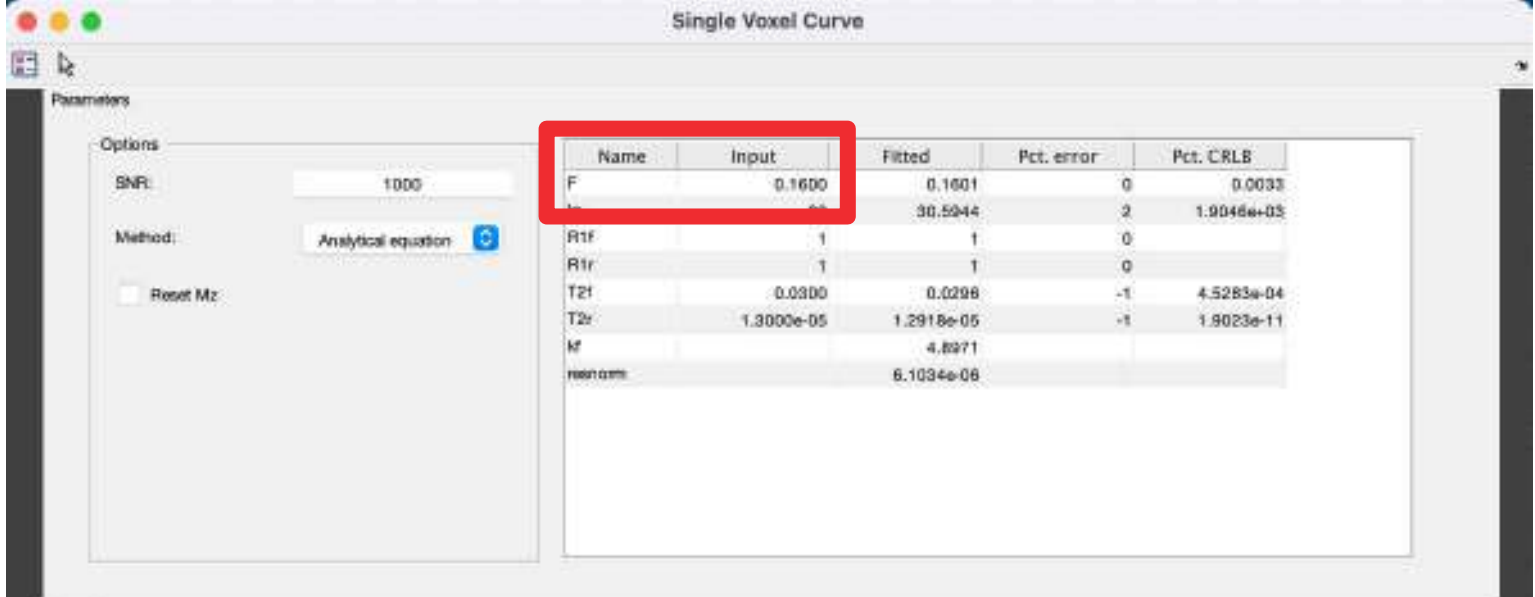
F = 0.16



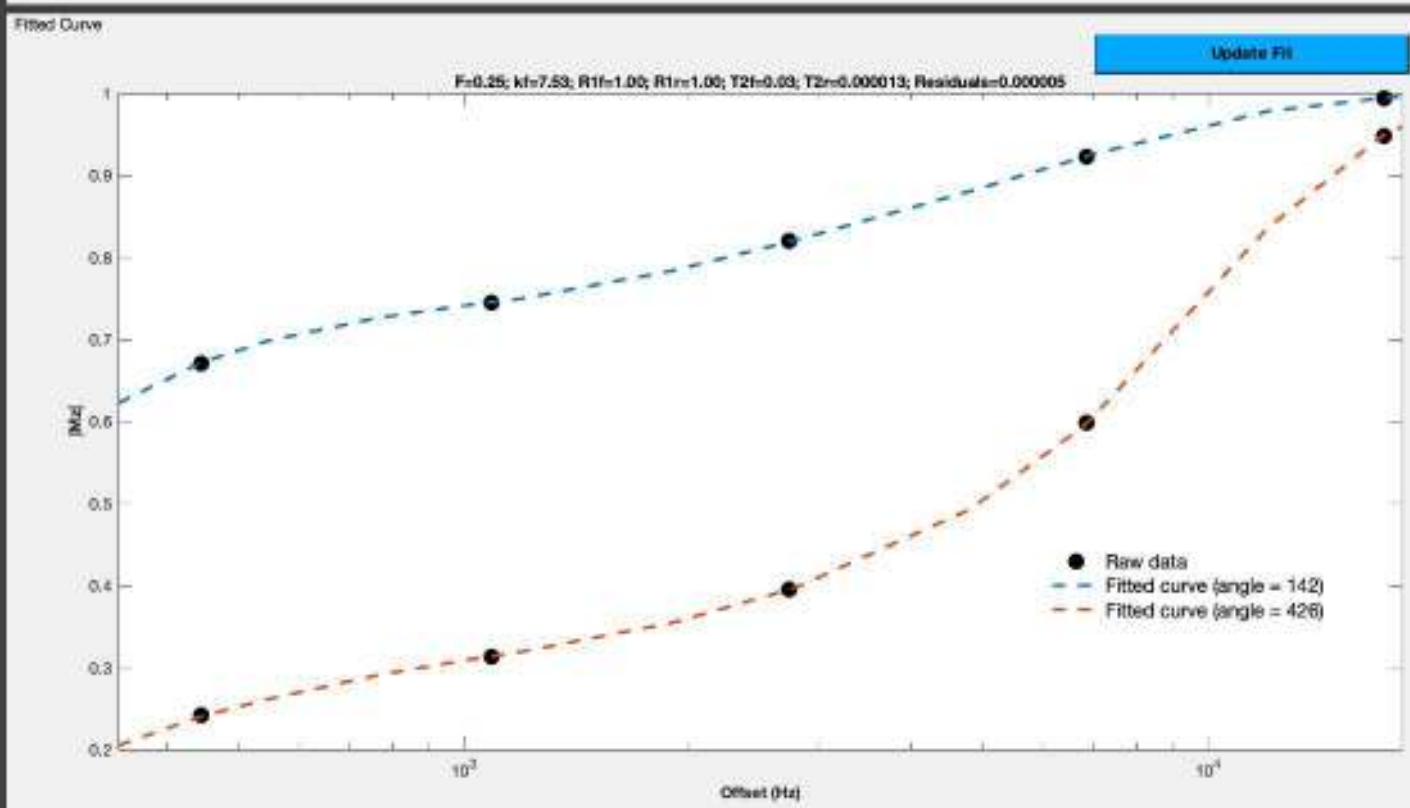
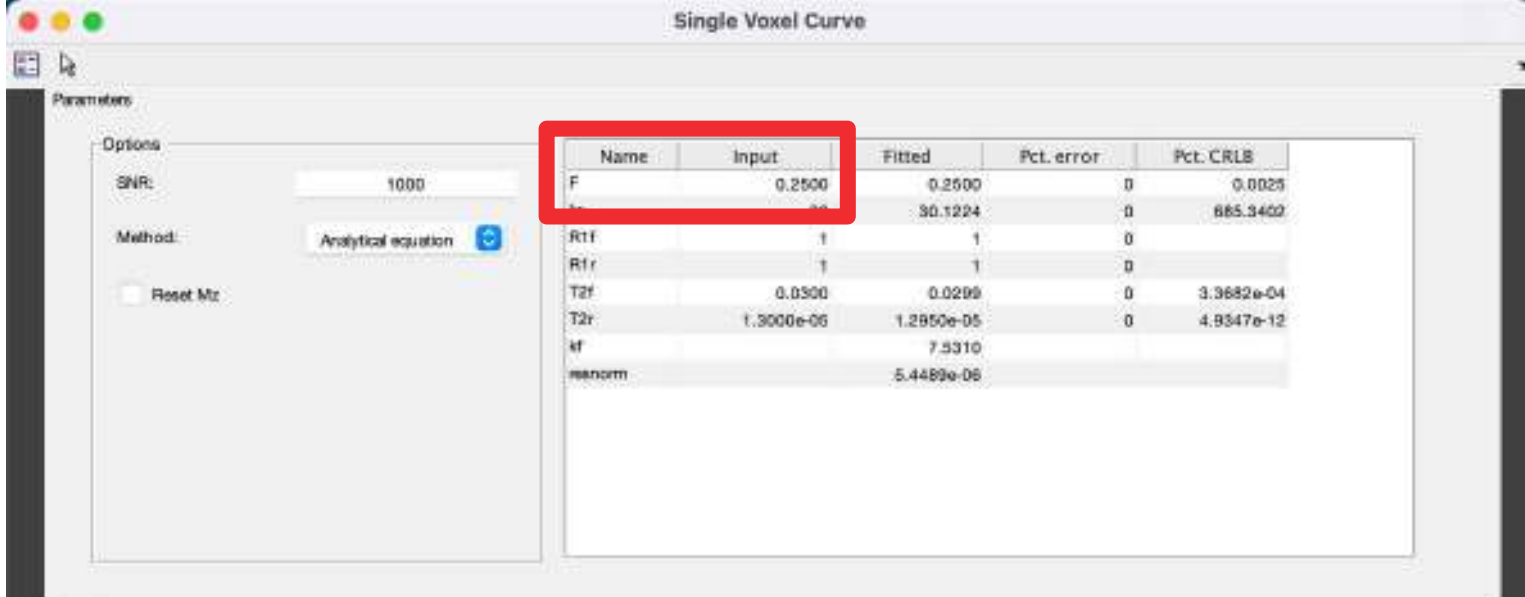
F = 0.05



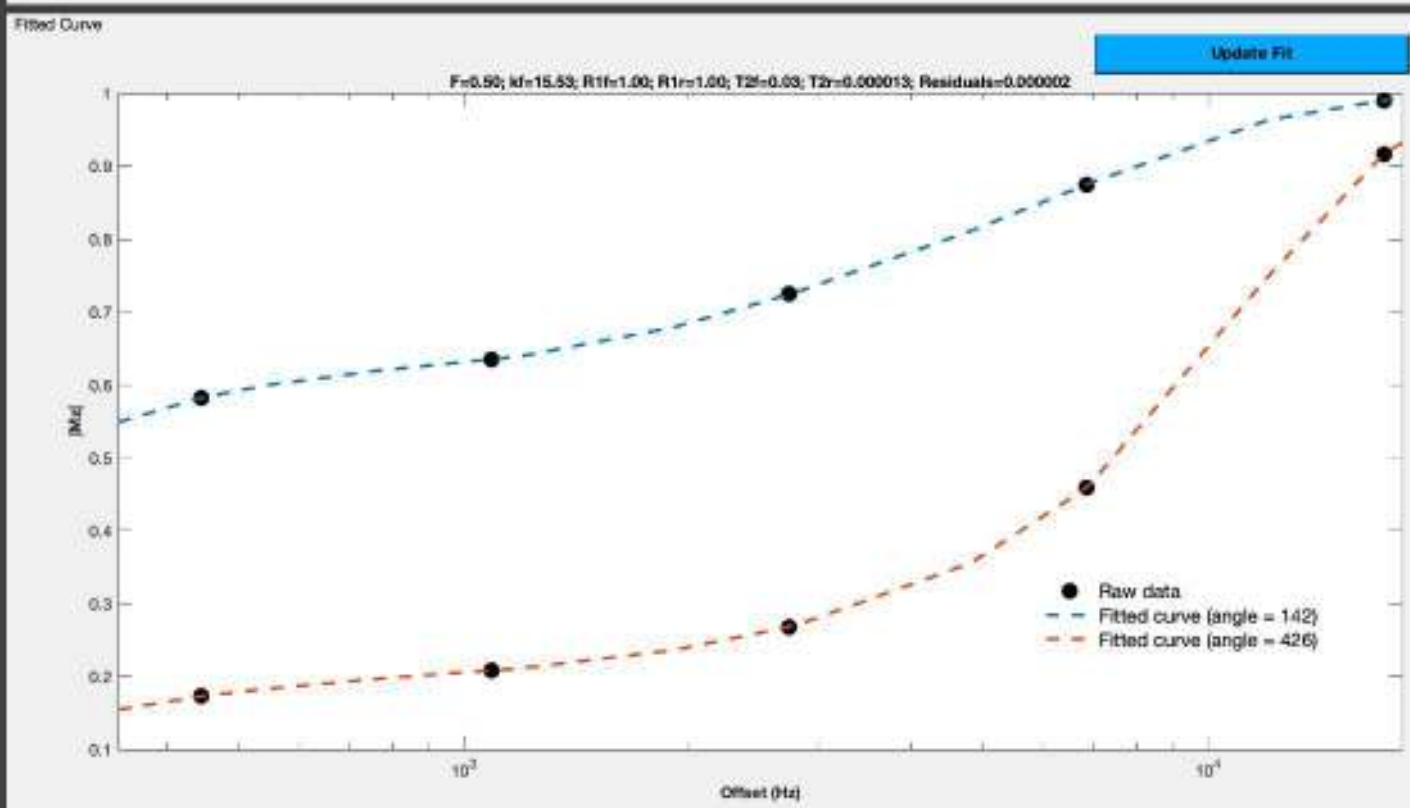
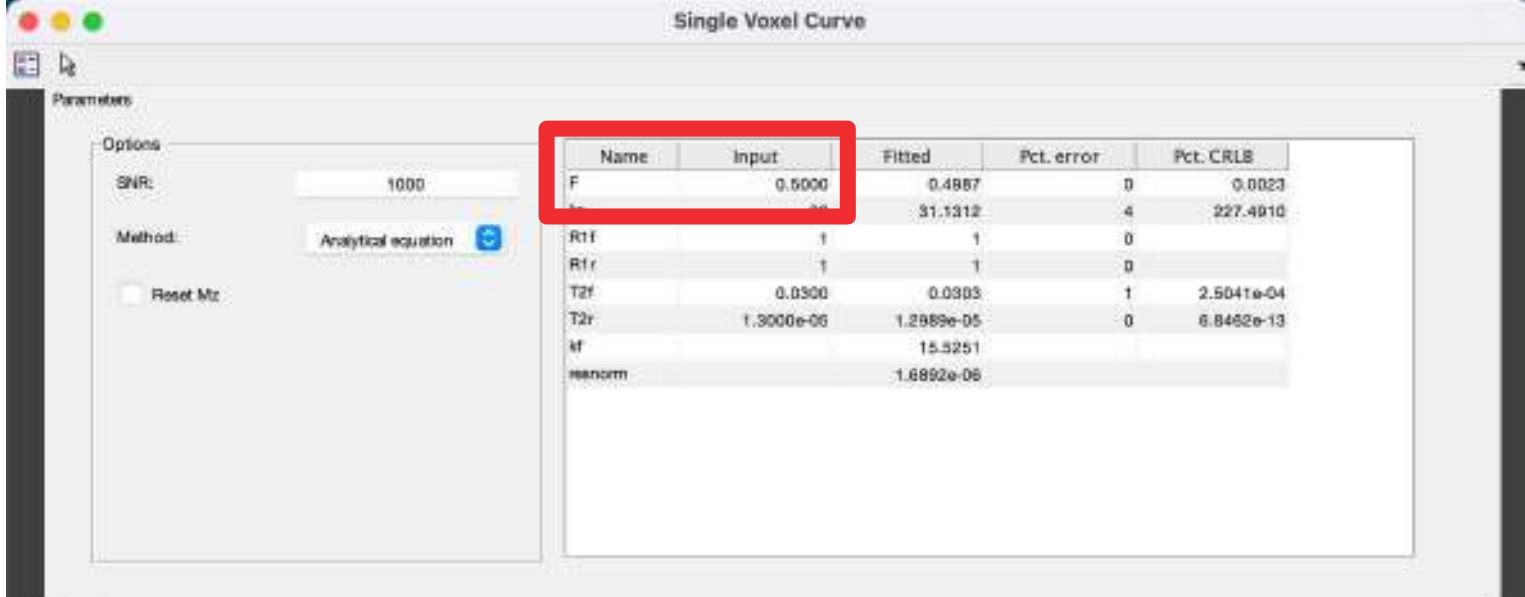
F = 0.01



F = 0.16



F = 0.25



F = 0.5

How to...

run **Bloch** simulations

Single Voxel Curve

Parameters

Options

SNR:

1000

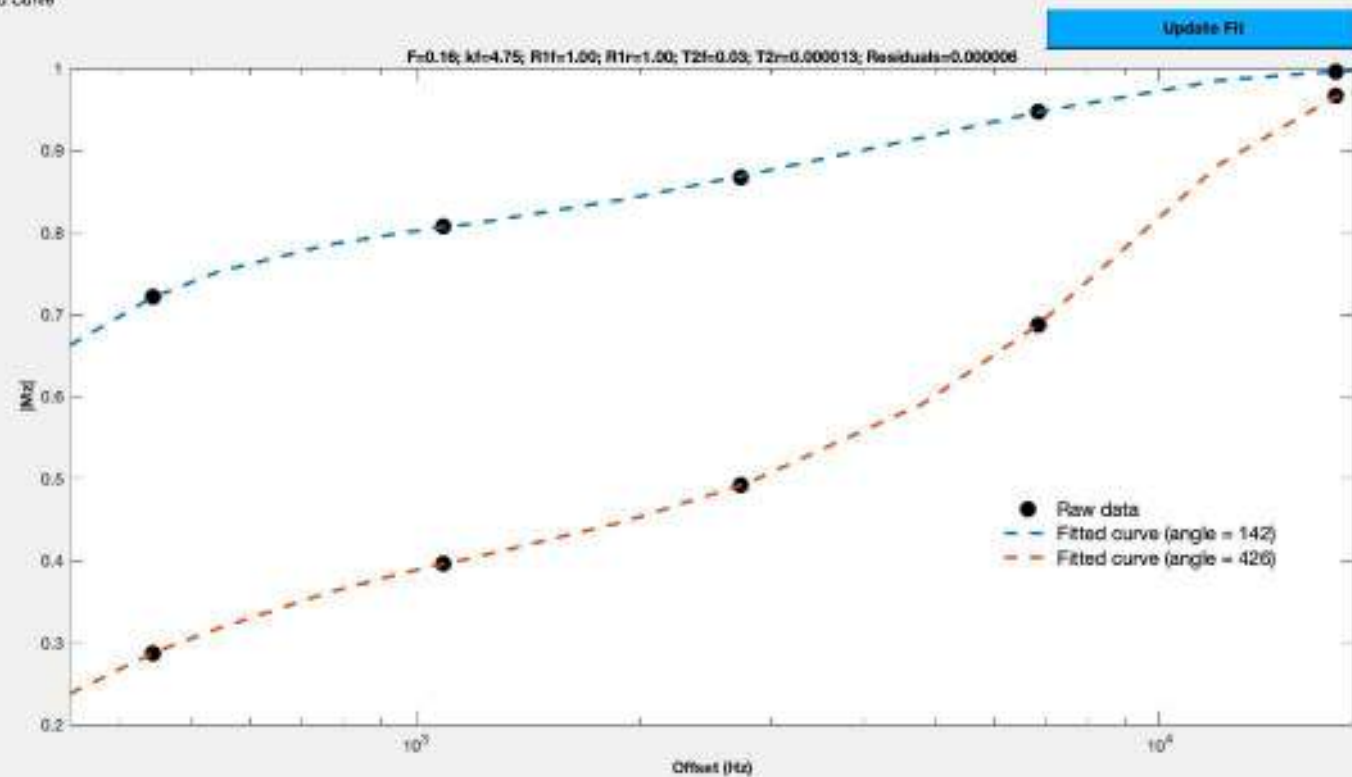
Method:

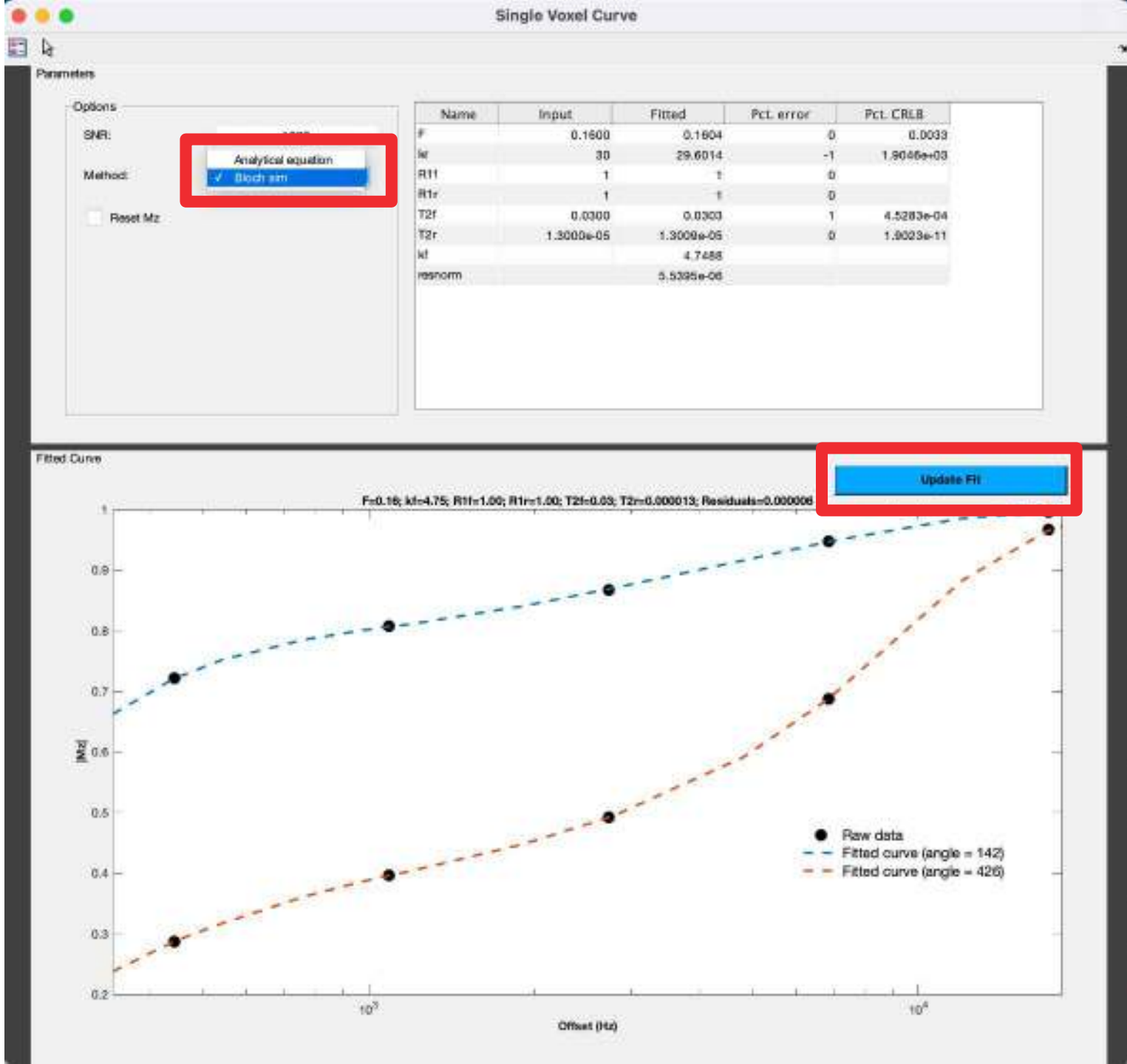
Analytical equation

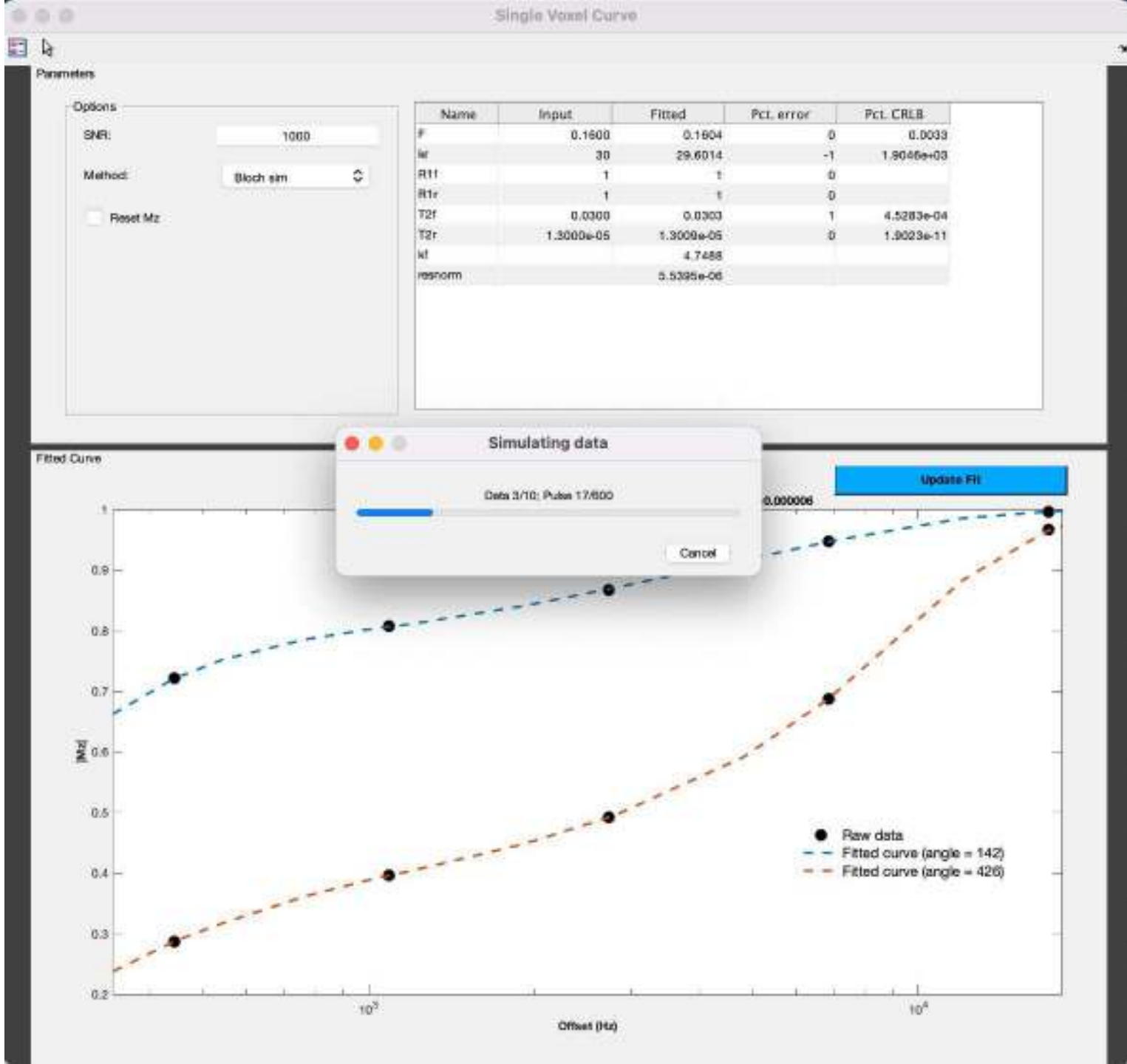
☐ Reset Mz

Name	Input	Fitted	Pct. error	Pct. CRLB
F	0.1600	0.1604	0	0.0033
kf	30	29.6014	-1	1.9046e+03
R1f	1	1	0	
R1r	1	1	0	
T2f	0.0300	0.0303	1	4.5283e-04
T2r	1.3000e-05	1.3000e-05	0	1.9023e-11
kl		4.7488		
resnorm		5.5395e-06		

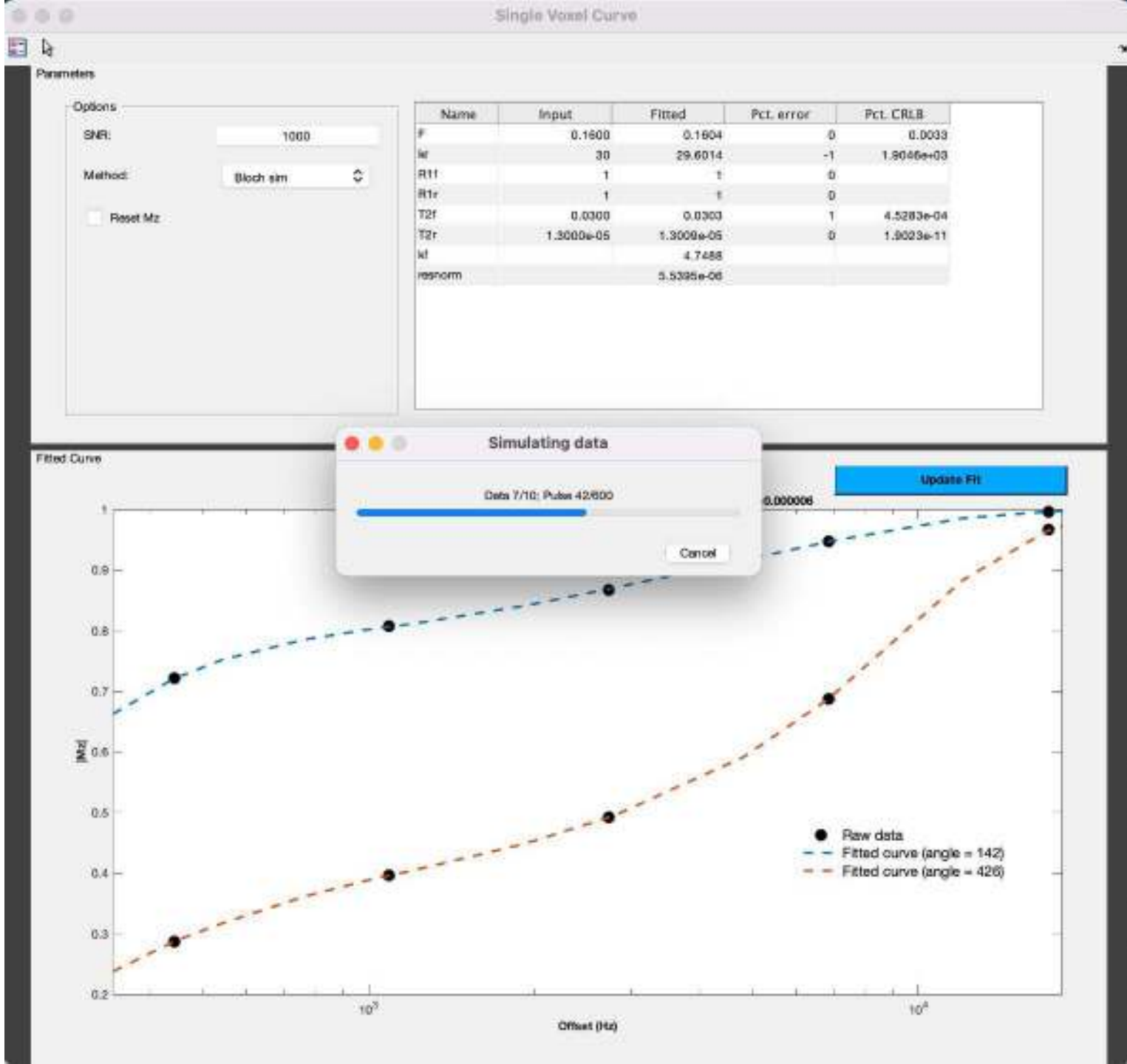
Fitted Curve



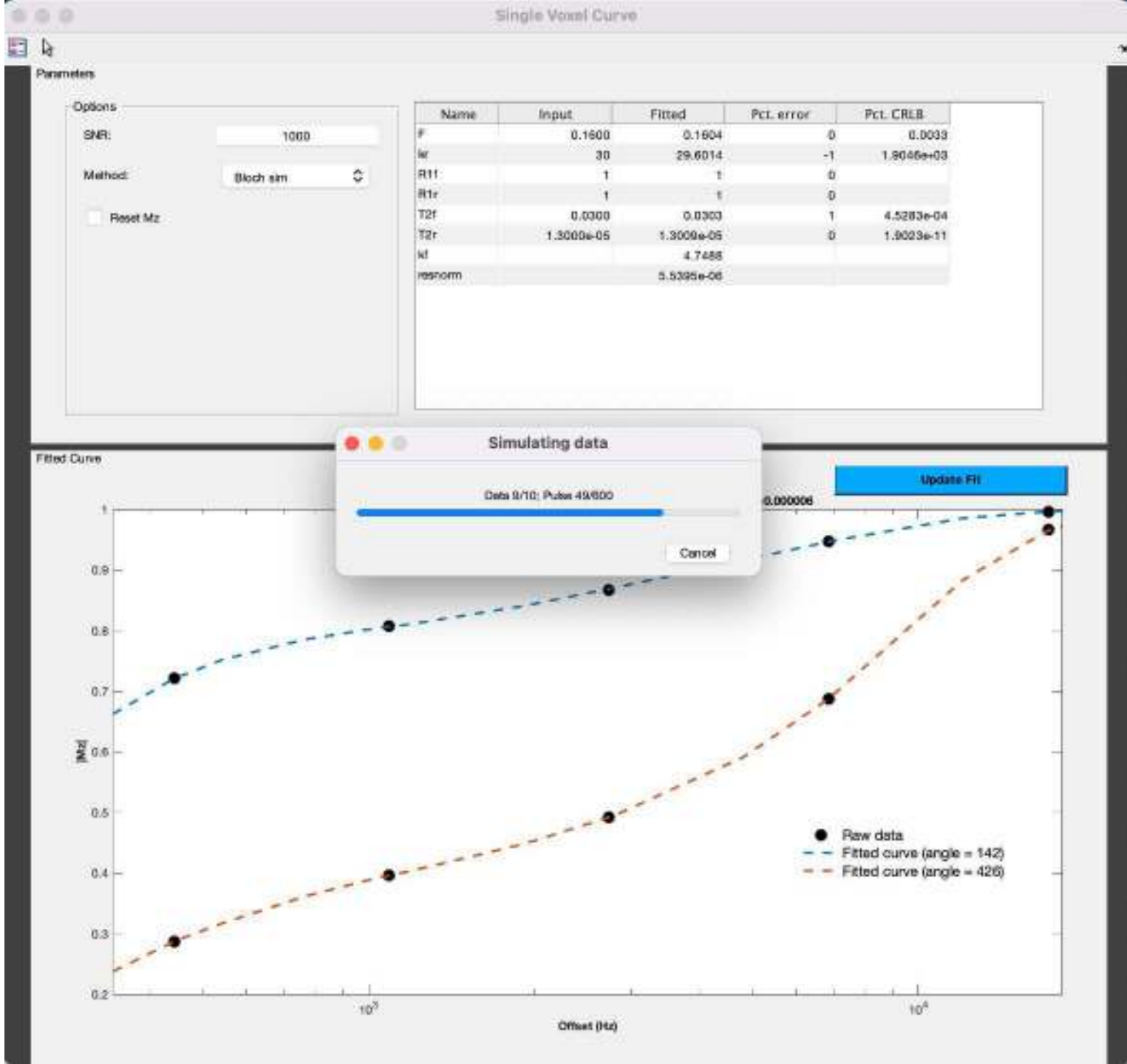




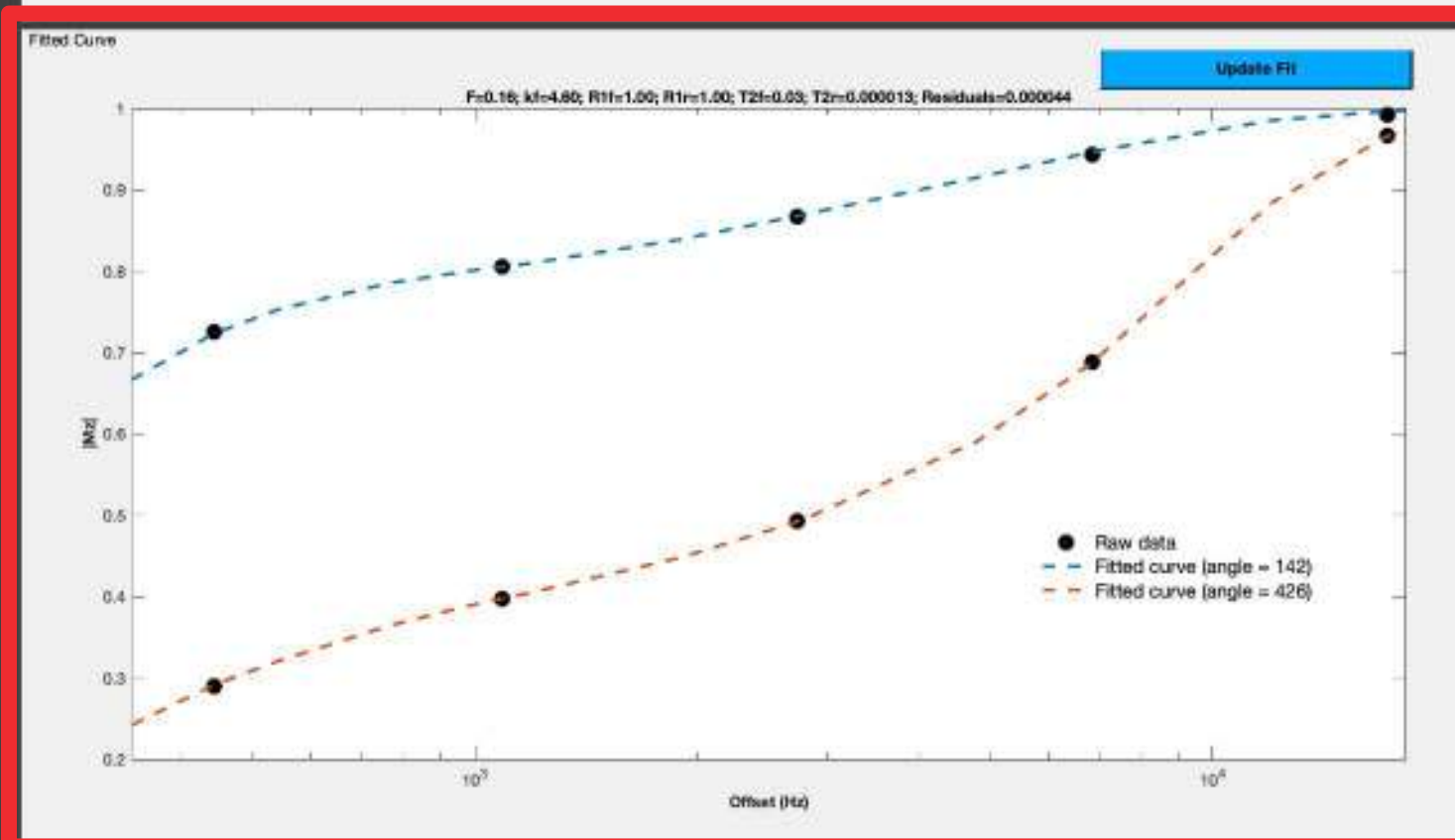
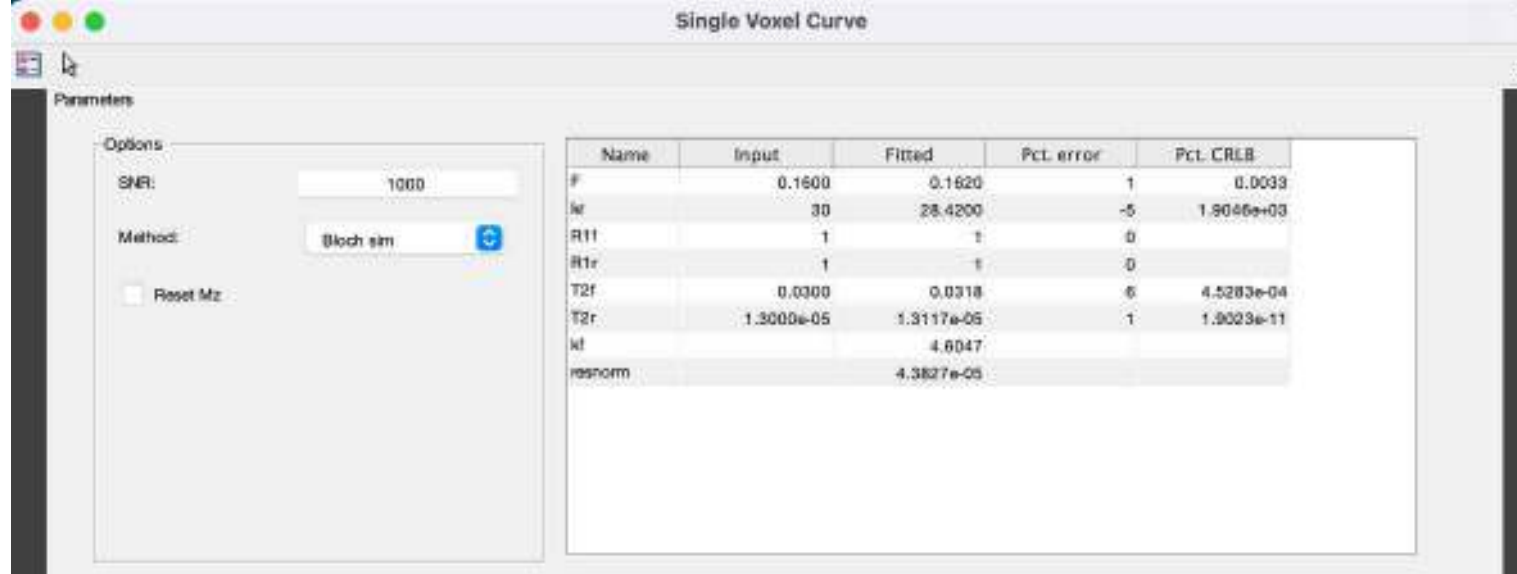
prep MT pulses: 600



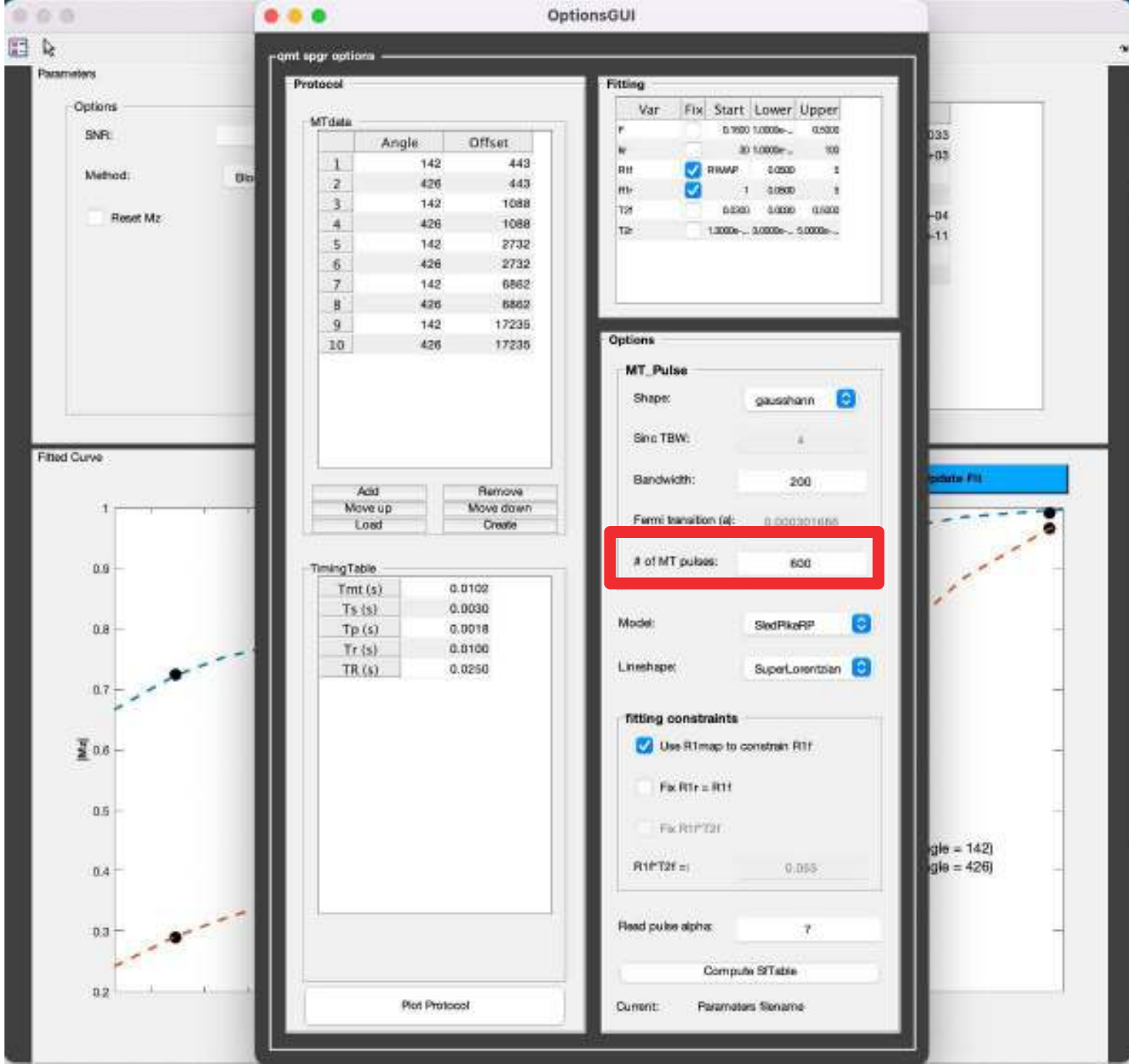
prep MT pulses: 600



prep MT pulses: 600



prep MT pulses: 600



OptionsGUI

-gmt.spr.options-

Protocol

MTdata

	Angle	Offset
1	142	443
2	426	443
3	142	1088
4	426	1088
5	142	2732
6	426	2732
7	142	6862
8	426	6862
9	142	17235
10	426	17235

Add
Move up
Load

Remove
Move down
Create

TimingTable

Tmt (s)	0.0102
Ts (s)	0.0030
Tp (s)	0.0018
Tr (s)	0.0100
TR (s)	0.0250

Plot Protocol

Fitting

Var	Fix	Start	Lower	Upper
F		0.000	1.000e-	0.500
R		30	1.000e-	100
R1f	☒	RMAP	0.000	1
R1r	☒	1	0.000	1
T2f		0.000	0.000	0.000
T2r		1.000e-	0.000e-	0.000e-

Options

MT_Pulse

Shape: gausshann

Sinc TBW: 4

Bandwidth: 200

Fermi transition (a): 0.000301698

of MT pulses: 10

Model: SledPikeRP

Linshape: SuperLorentzian

fitting constraints

☒ Use R1map to constrain R1f☐ Fix R1r = R1f☐ Fix R1f*T2f

R1f*T2f =: 0.055

Read pulse alpha: 7

Compute STable

Save Load Default Help

Current: Parameters STable

Parameters

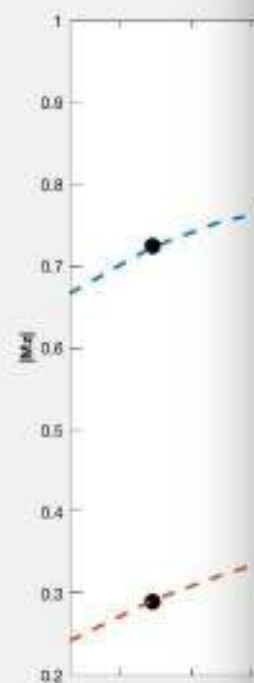
Options

SNR:

Method:

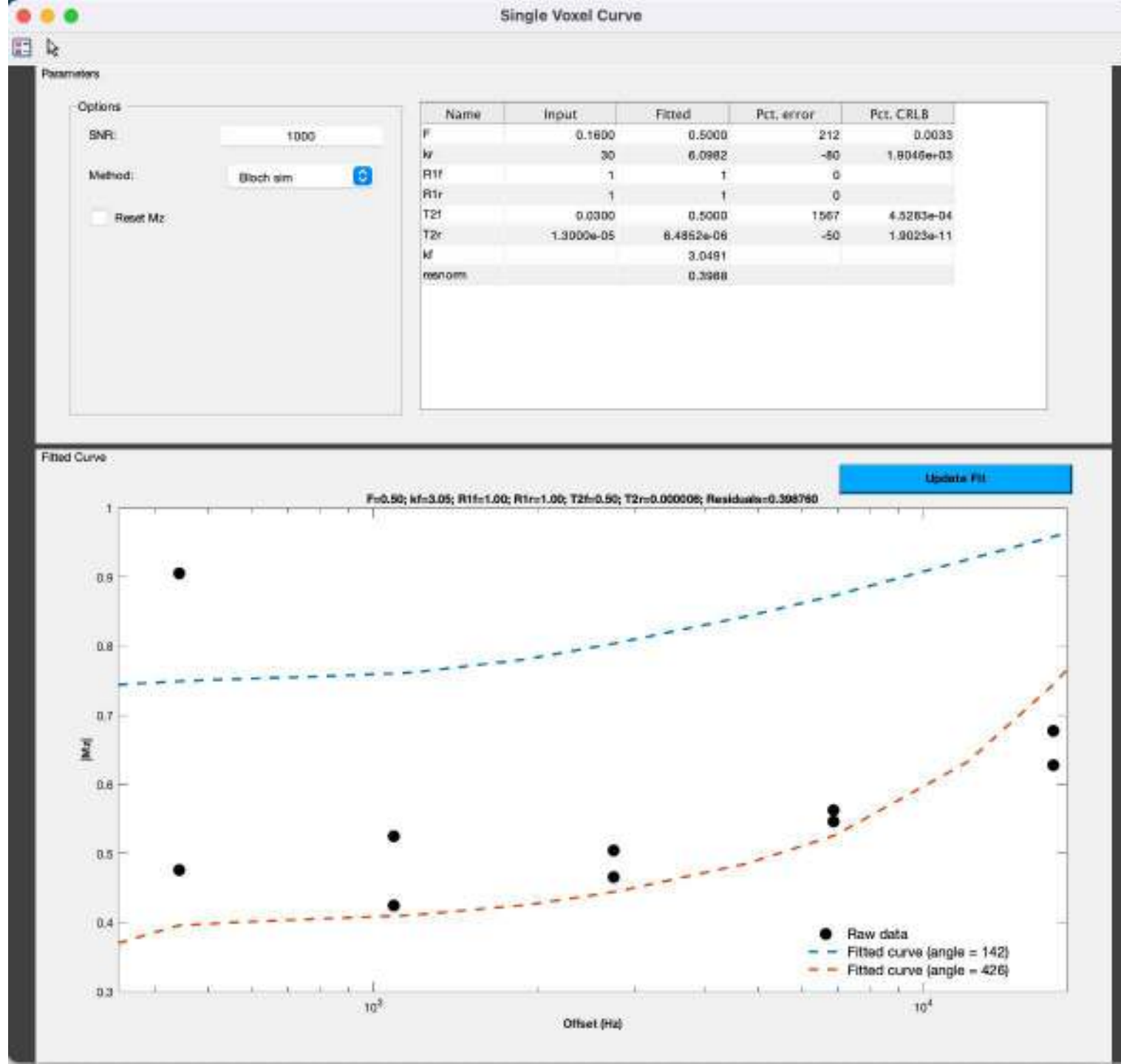
☐ Reset Mz

Fitted Curve

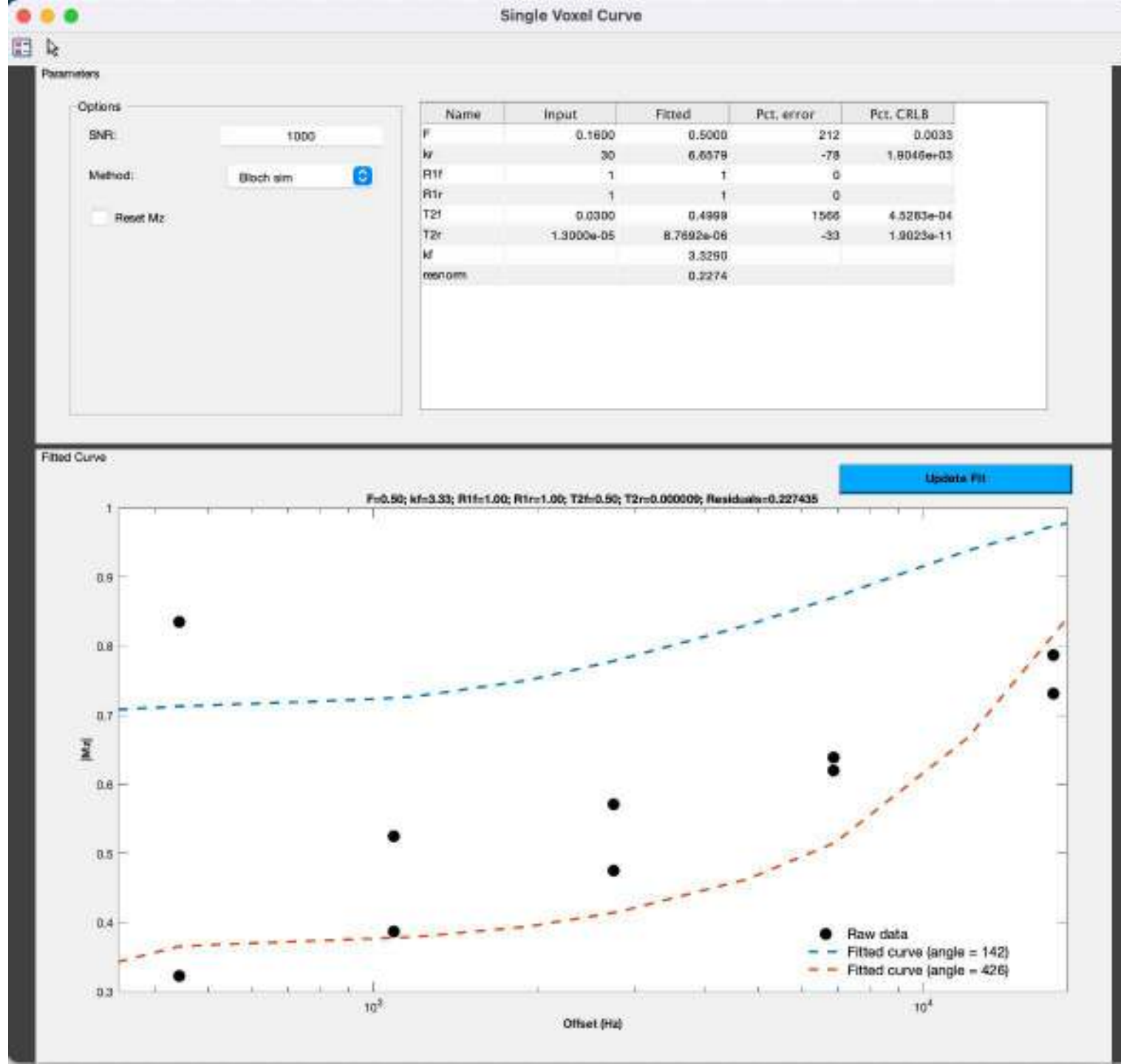


Update Fit

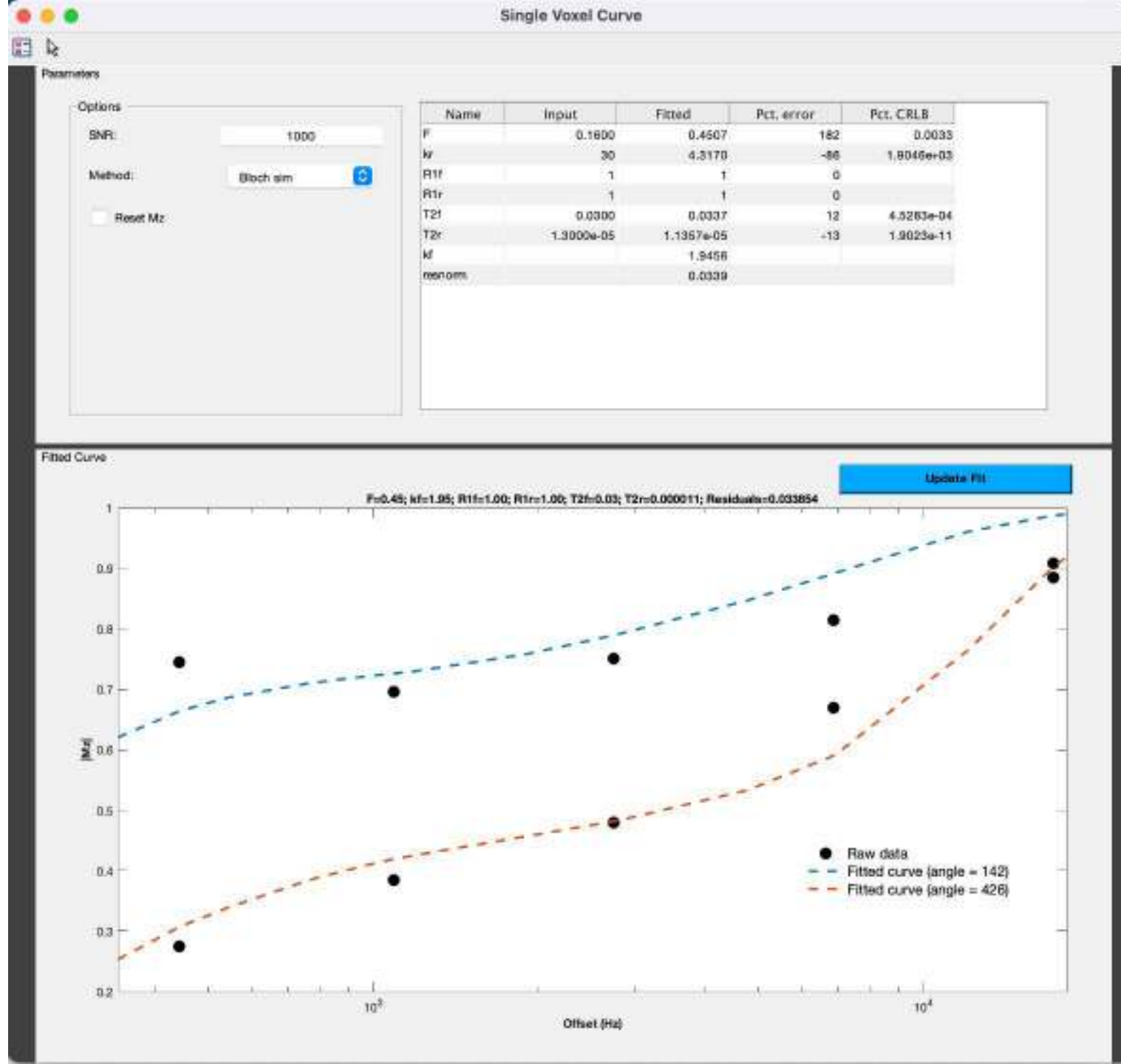
angle = 142
angle = 426



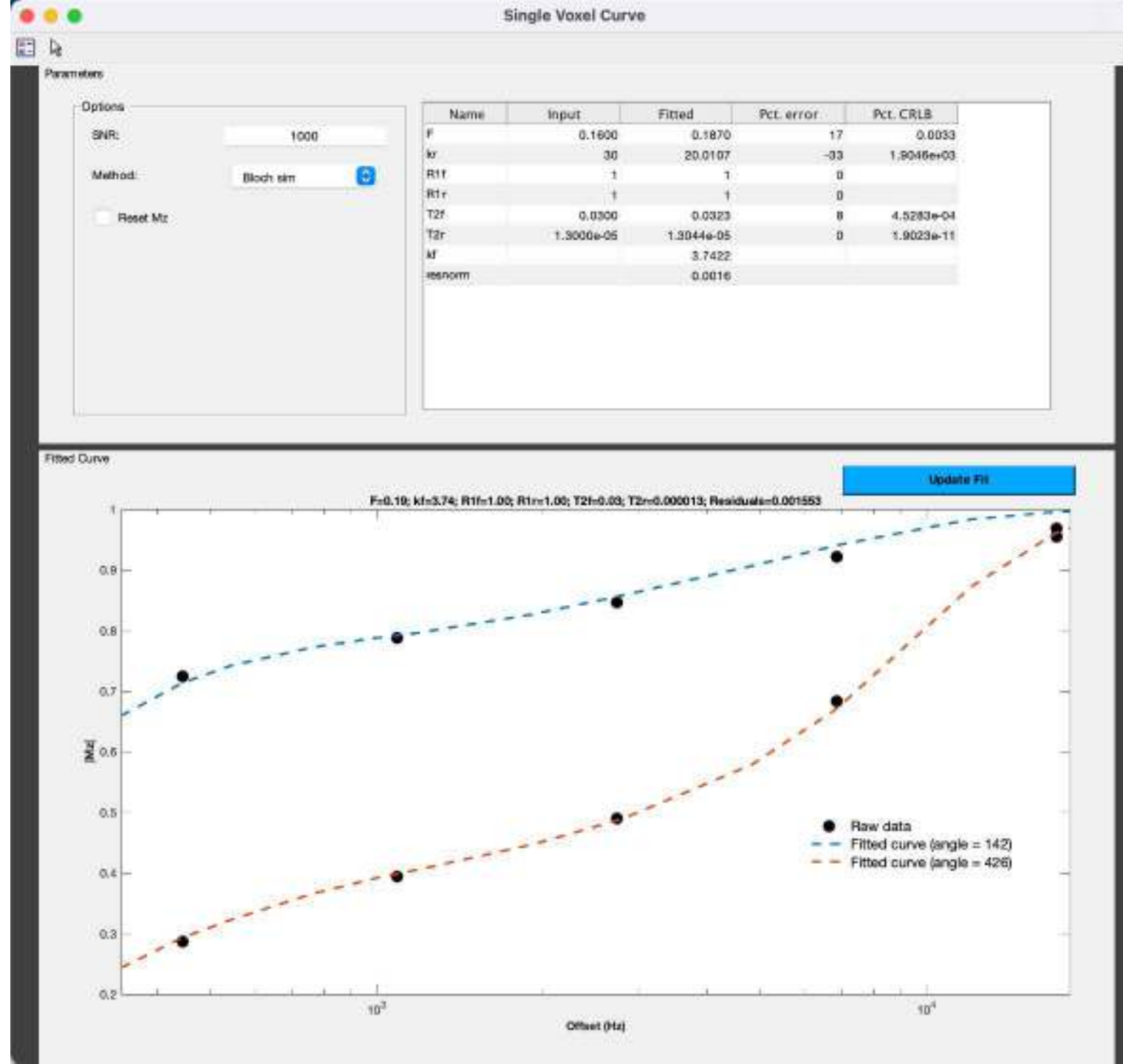
prep MT pulses: 10



prep MT pulses: 20



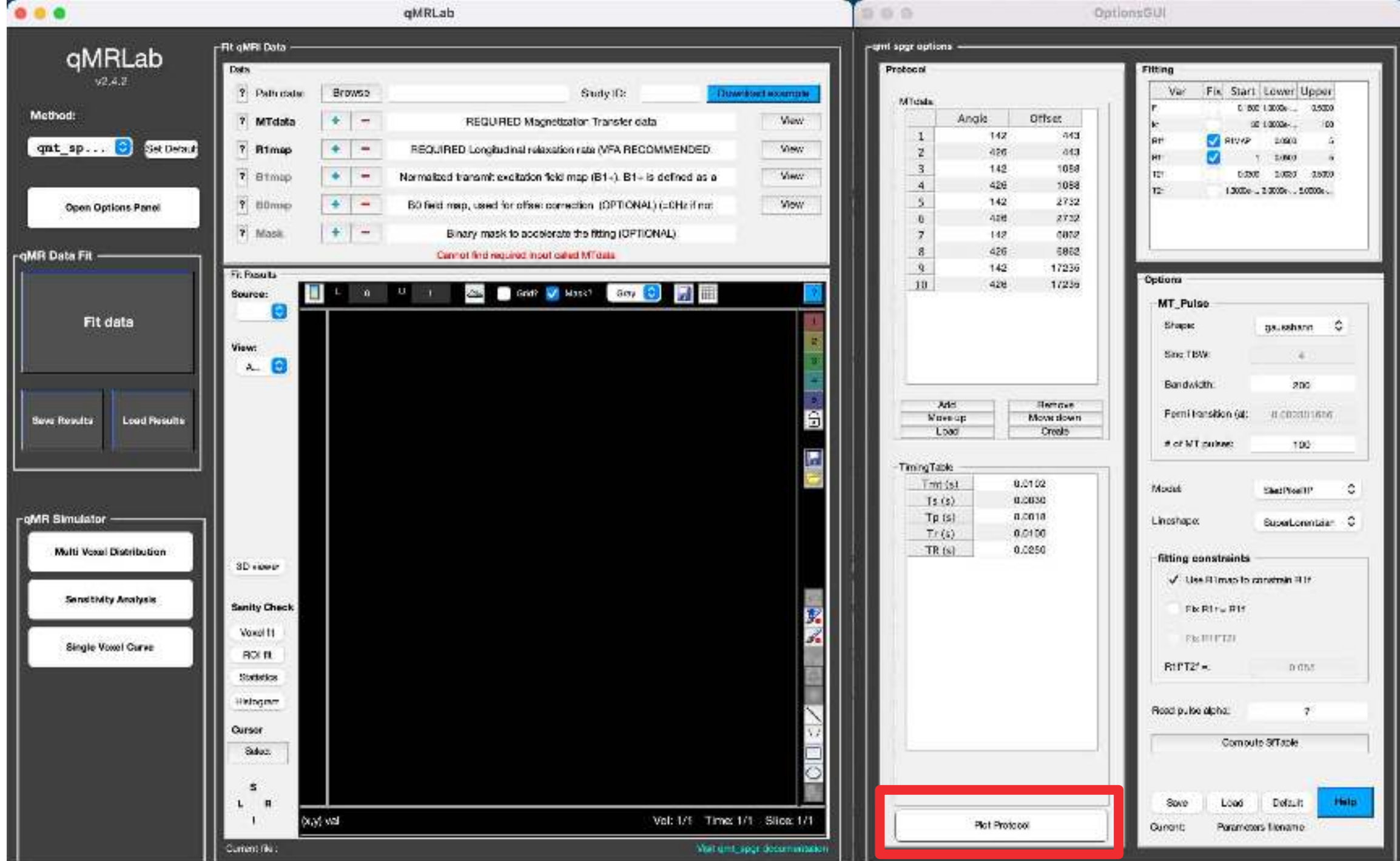
prep MT pulses: 50

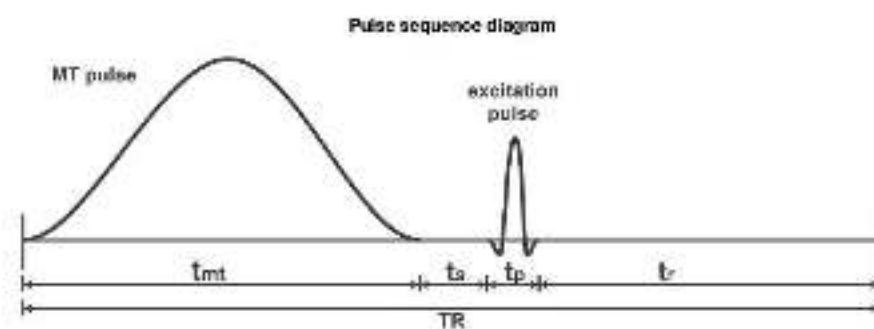
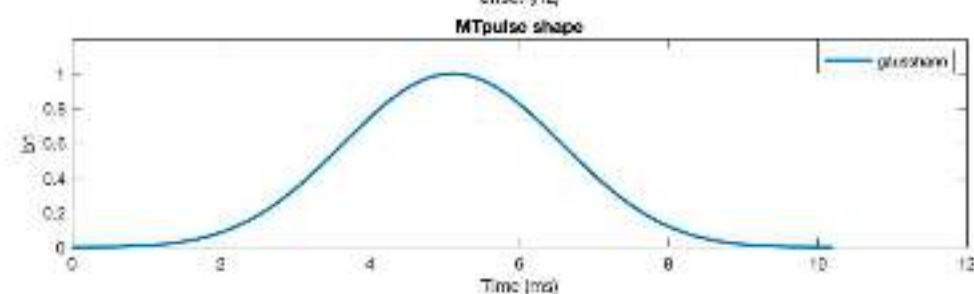
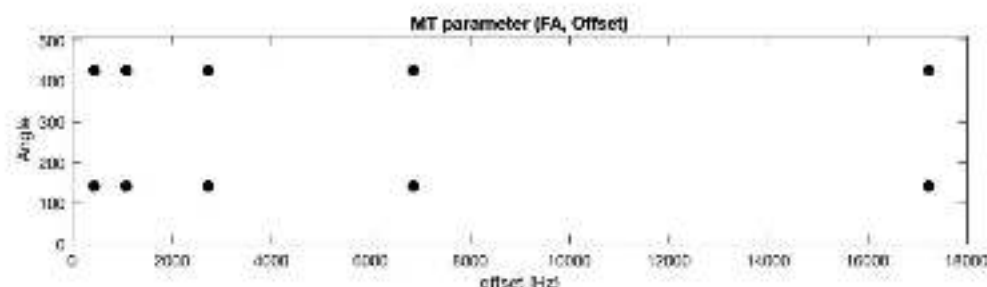


prep MT pulses: 100

Other options:

view protocol
change **lineshape**





OptionsGUI

—gmt eppr options—

Protocol

MTdata

	Angle	Offset
1	142	445
2	425	445
3	142	1085
4	425	1085
5	142	2732
6	425	2732
7	142	8382
8	425	8382
9	142	17335
10	425	17335

Add Remove
Move up Move down
Load Create

Fitting

Var	Fix	Start	Lower	Upper
F		0.0001 0.0001	0.000	0.000
H		20 1.0000	15	
R1	☒	0.0000	0.0000	0
R2	☒	1	0.0000	5
TR		0.0000 0.0000	0.0000	0.0000
T2		1.0000 0.0000	0.0000	0.0000

Options

MT_Pulse

Shape: gaussian

Sine TSW: 1

Bandwidth: 200

Fermi transition (s): 0.000001 0.000

of MT pulses: 100

Model: RedWood

Lineshape: SuperGaussian

fitting constraints

☒ Use R1 map to constrain R1

☐ Fix R1 = R1

☐ Fix R1/T2

R1/T2 = 0.015

Read pulse shape: T

Compute STable

Save Load Default Help

Current Parameters/Results

Plot Protocol

Single Voxel Curve

Parameters

Options

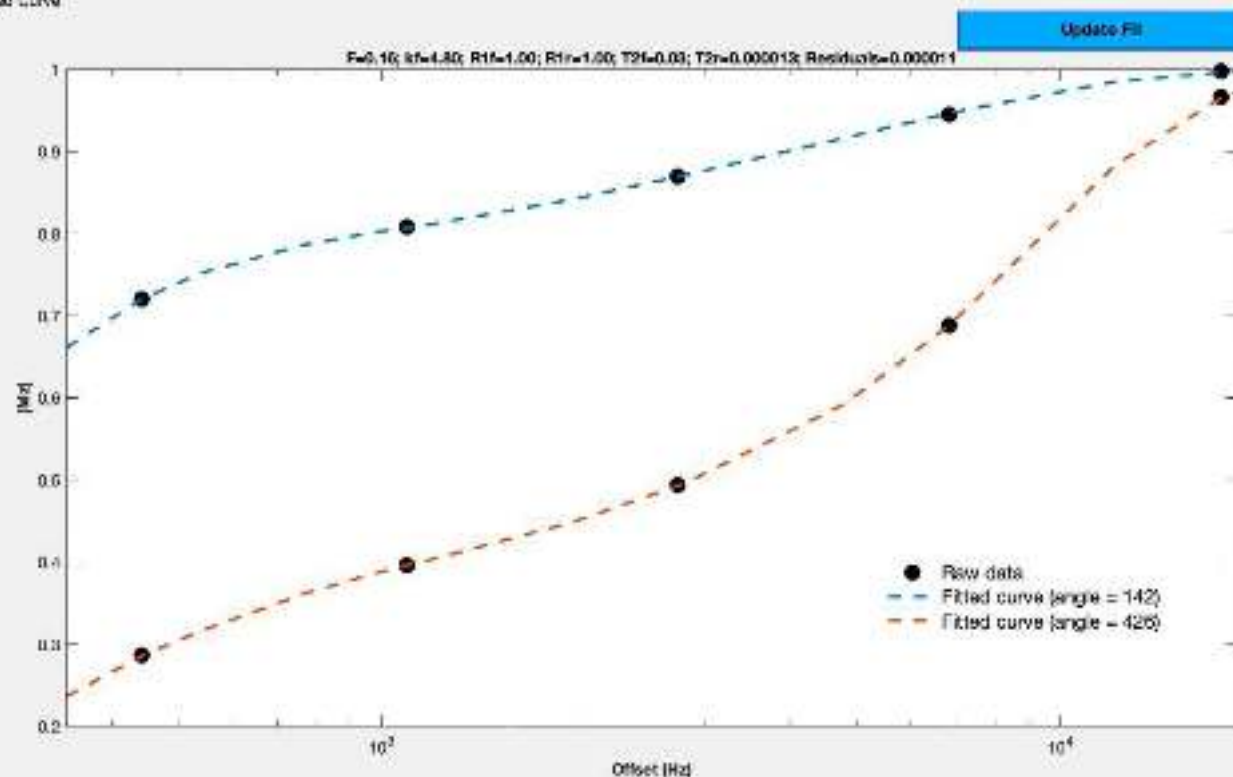
Shift 1000

Method Analytical eq. of...

☐ Fixed Mz

Name	Input	Fitted	Pct. error	Pct. CRLB
F	0.1600	0.1584	-1	0.0038
α	30	30.3167	1	1.2048e-03
R1f	1	1	0	
R1r	1	1	0	
T2f	0.0300	0.0288	-1	4.5068e-04
T2r	1.3000e-05	1.2947e-05	0	1.3023e-11
σ		4.8035		
norm		1.1252e-05		

Fitted Curve



OptionsGUI

gmit app options

Protocol

MTData

	Angle	Offset
1	142	440
2	426	440
3	142	1058
4	426	1058
5	142	2732
6	426	2732
7	142	5852
8	426	5852
9	142	17215
10	426	17215

Add
 Move up
 Load

Remove
 Move down
 Create

Timing Table

Tmt (s)	0.0100
Ts (s)	0.0050
Tp (s)	0.0018
T+ (s)	0.0100
TR (s)	0.0250

Not Protocol

Fitting

Var	Fix	Start	Lower	Upper
F		0.1600	0.0000	0.5000
α		30.0000	0.0000	100
R1f	☒	R1f/R1r	0.0000	5
R1r	☒	1	0.0000	5
T2f		0.0300	0.0000	0.0500
T2r		1.3000e-05	0.0000e-05	5.0000e-05

Options

MT_Pulse

Shape: gaussian

Sinc TBW: 3

Bandwidth: 200

Fermi transition (K): 0.00001658

of MT pulses: 100

Model: SkelTweeIT

Linshape: SuperLorentzian

fitting constraints

☒ Use R1map to constrain R1f☐ Fix R1r = R1f☐ Fix R1f/T2f

T1/T2f = 0.055

Read pulse alpha: 7

Compute SRTake

Save

Load

Default

Help

Current

Parameters filename

Single Voxel Curve

Parameters

Options

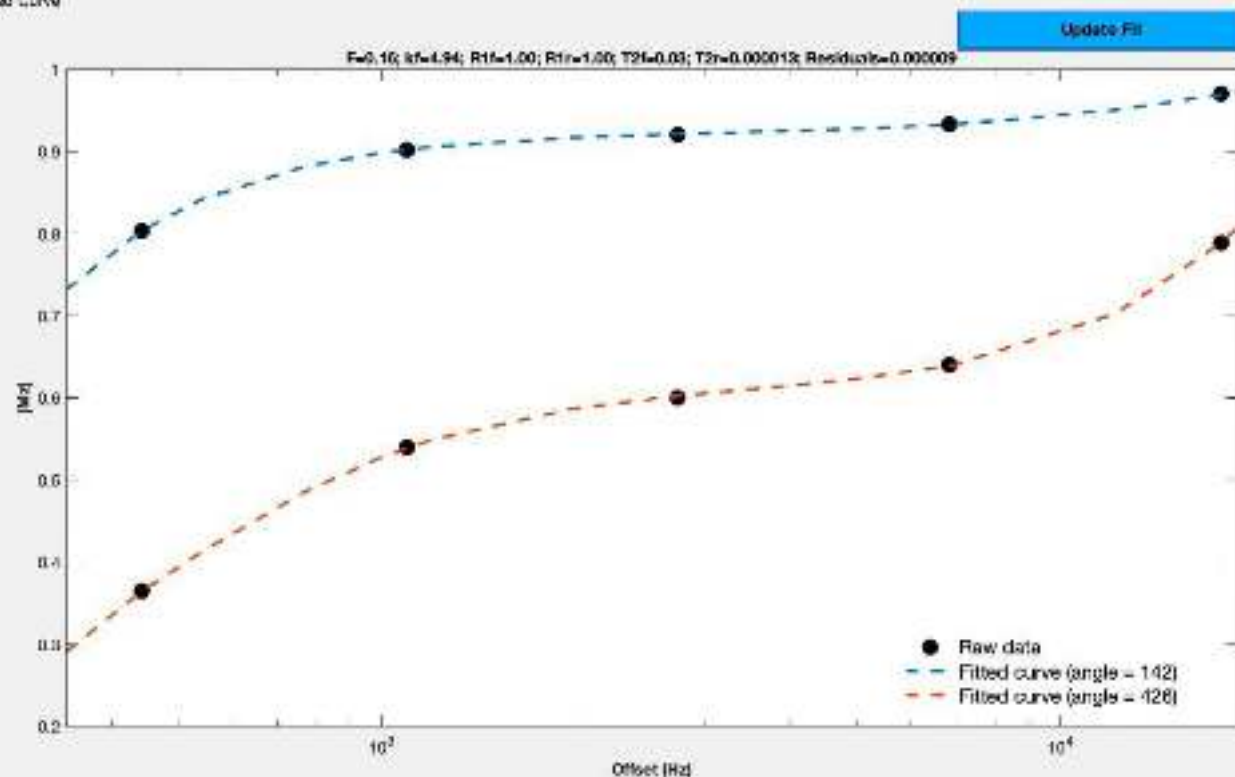
Shift 1000

Method Analytical eq. of...

☐ Reset fit

Name	Input	Fitted	Pct. error	Pct. CRLB
F	0.1000	0.1588	1	0.0034
α	30	31.1531	4	1.5570e-04
R1f	1	1	0	
R1r	1	1	0	
T2f	0.0300	0.0300	0	1.7106e-04
T2r	1.3000e-05	1.2952e-06	0	1.4931e-11
σ		4.9394		
varnorm		2.1050e-06		

Fitted Curve



OptionsGUI

gmit app options

Protocol

MTData

	Angle	Offset
1	142	443
2	426	443
3	142	1058
4	426	1058
5	142	2732
6	426	2732
7	142	6852
8	426	6852
9	142	17215
10	426	17215

Add

Move up

Load

Remove

Move down

Create

Timing Table

Tmt (s)	0.0100
Ts (s)	0.0050
Tp (s)	0.0018
T+ (s)	0.0100
TR (s)	0.0250

Not Protocol

Fitting

Var	Fix	Start	Lower	Upper
F		0.100	1.000e-10	0.5000
α		30	1.000e-10	100
R1f	☒	R1f/R1r	0.000	5
R1r	☒	1	0.000	5
T2f		0.030	1.000e-10	0.5000
T2r		1.000e-10	1.000e-10	5.000e-10

Options

MT_Pulse

Shape: gaussian

Sinc TBW: 1

Bandwidth: 200

Fermi transition (K): 0.000001658

of MT pulses: 100

Model: Skel/Yeall/P

Lineshape: Gaussian

fitting constraints

☒ Use R1map to constrain R1f☐ Fix R1f = R1r☐ Fix R1f/T2f

R1f/T2f = 0.055

Read pulse alpha: 7

Compute STable

Save

Load

Default

Help

Current

Parameters filename

How to...

download a **demo** dataset



Method:

qat_sp...   Set Default[Open Options Panel](#)

qMR Data Fit

Fit data

[Save Results](#)[Load Results](#)

qMR Simulator

[Multi Voxel Distribution](#)[Sensitivity Analysis](#)[Single Voxel Curve](#)

Fit qMR Data

Path data:  Study ID: [Download example](#)

MTdata   REQUIRED Magnetization Transfer data [View](#)

R1map   REQUIRED Longitudinal relaxation rate (R1A RECOMMENDED) [View](#)

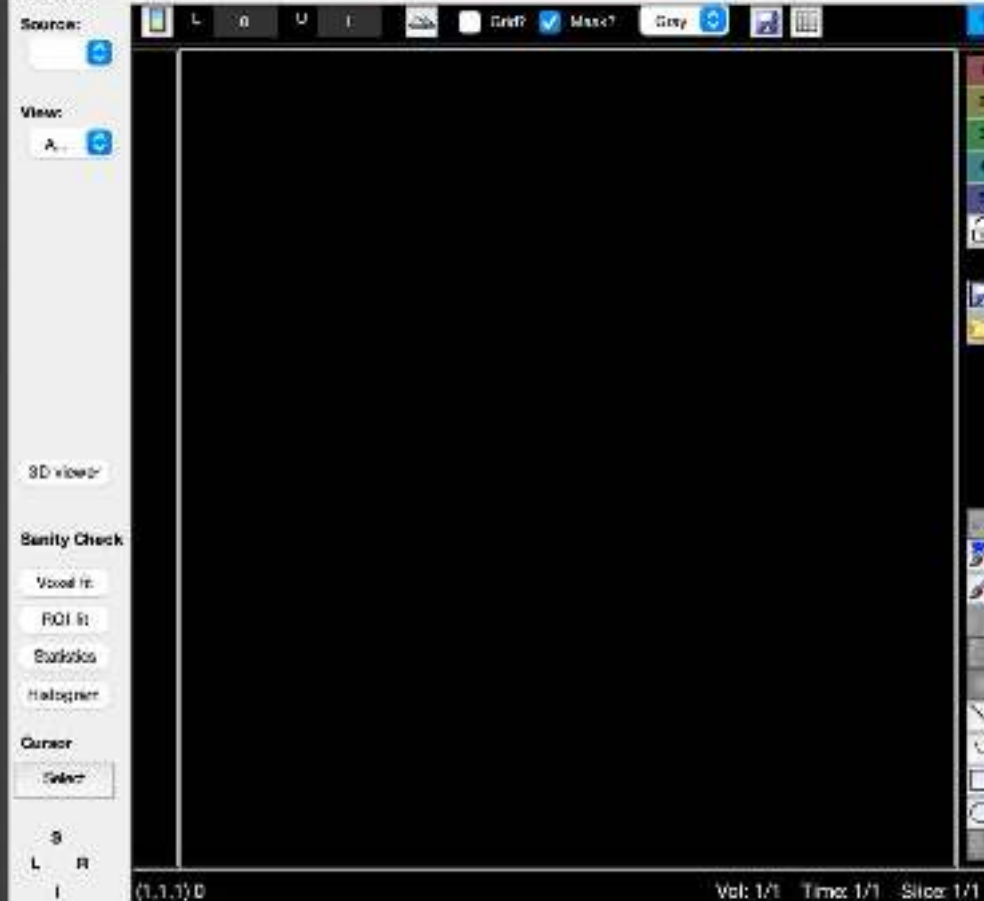
B1map   Normalized transmit excitation field map (B1+). B1+ is defined as a [View](#)

B0map   B0 field map, used for offset correction (OPTIONAL) 0-0Hz if not [View](#)

Mask   Binary mask to accelerate the fitting (OPTIONAL)

Cannot find required input called MTdata

Fit Results



Current file:

[View qMRLab documentation](#)

qMR app options

Protocol

MTdata

	Angle	Offset
1	142	443
2	425	443
3	142	1085
4	425	1085
5	142	2732
6	425	2732
7	142	6463
8	425	6463
9	142	17235
10	425	17235

[Add](#)[Move up](#)[Load](#)[Remove](#)[Move down](#)[Create](#)

TimingTable

Tmt (s)	0.0102
Ts (s)	0.0080
Tp (s)	0.0015
Tr (s)	0.0100
TR (s)	0.0250

Fit Protocol

Fitting

Var	Fix	Start	Lower	Upper
F		0.000 1.000e-		0.020
k		35 1.000e-		100
m	☒	R1MAP	0.000	5
R1	☒	1	0.000	5
T2		0.000 0.020	0.020	0.020
T2		1.000e- 1.000e-	1.000e-	1.000e-

Options

MT_Pulse

Shape:  gaussian

Sinc TRW:

Bandwidth:

Fermi transition (d):

of MT pulses:

Model:  SteadPwRP

Linehape:  Sincal envelope

Fitting constraints

☒ Use R1map to constrain R1

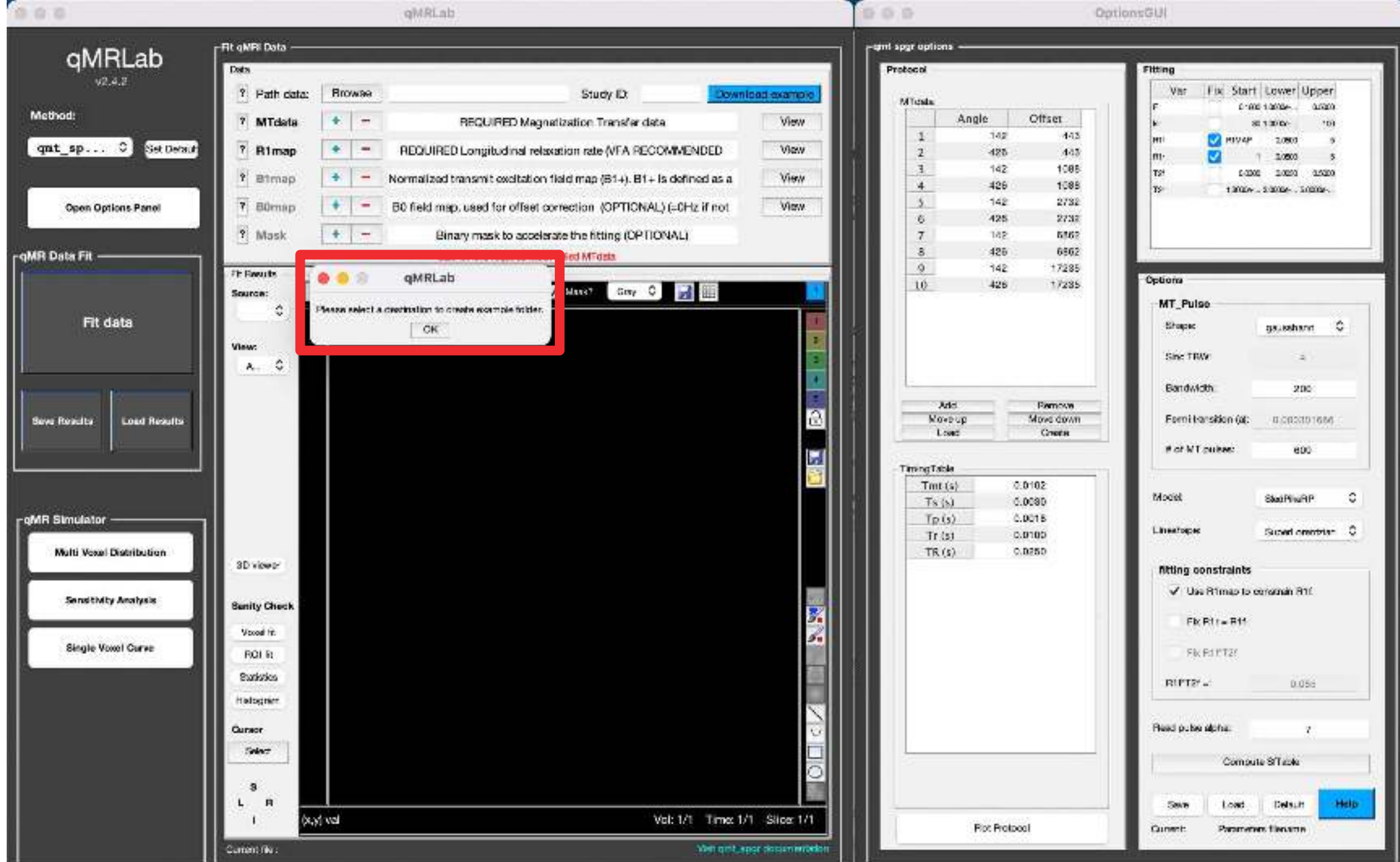
☐ Fix R1 = R11

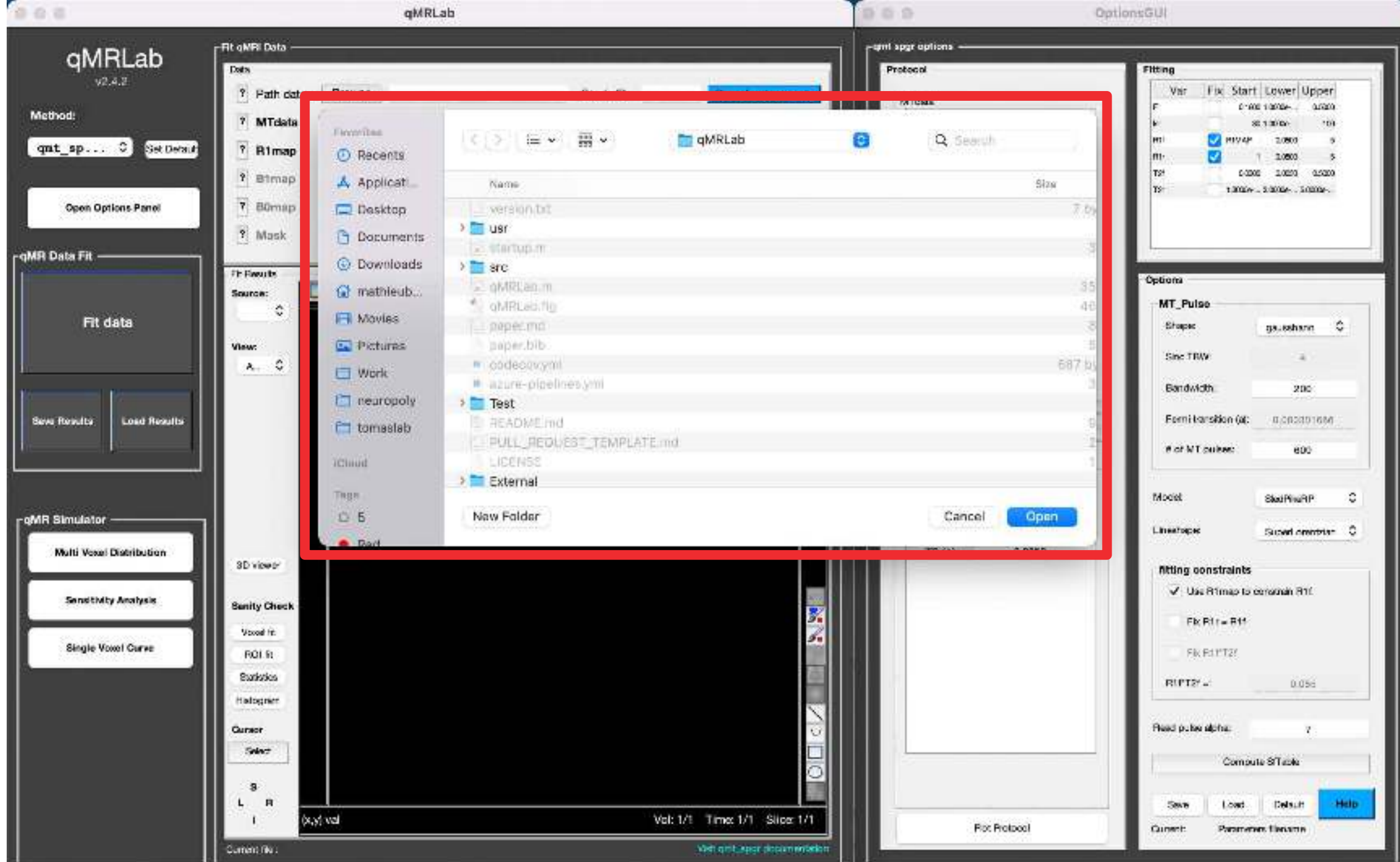
☐ Fix R1/T2

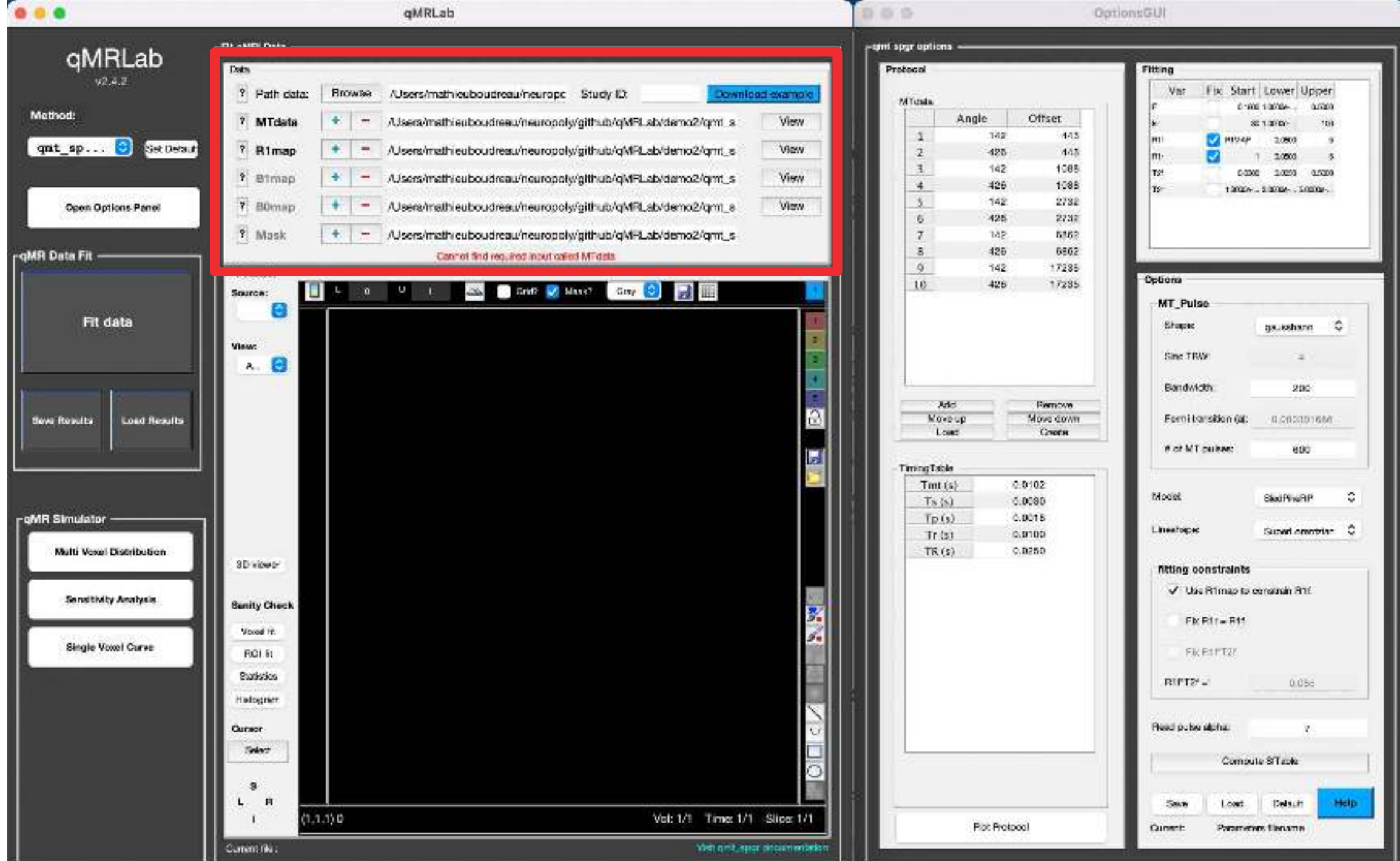
R1/T2 =

Read pulse alpha: [Compute S/Tdata](#)[Save](#) [Load](#) [Default](#) [Help](#)

Current: Parameters: Functions

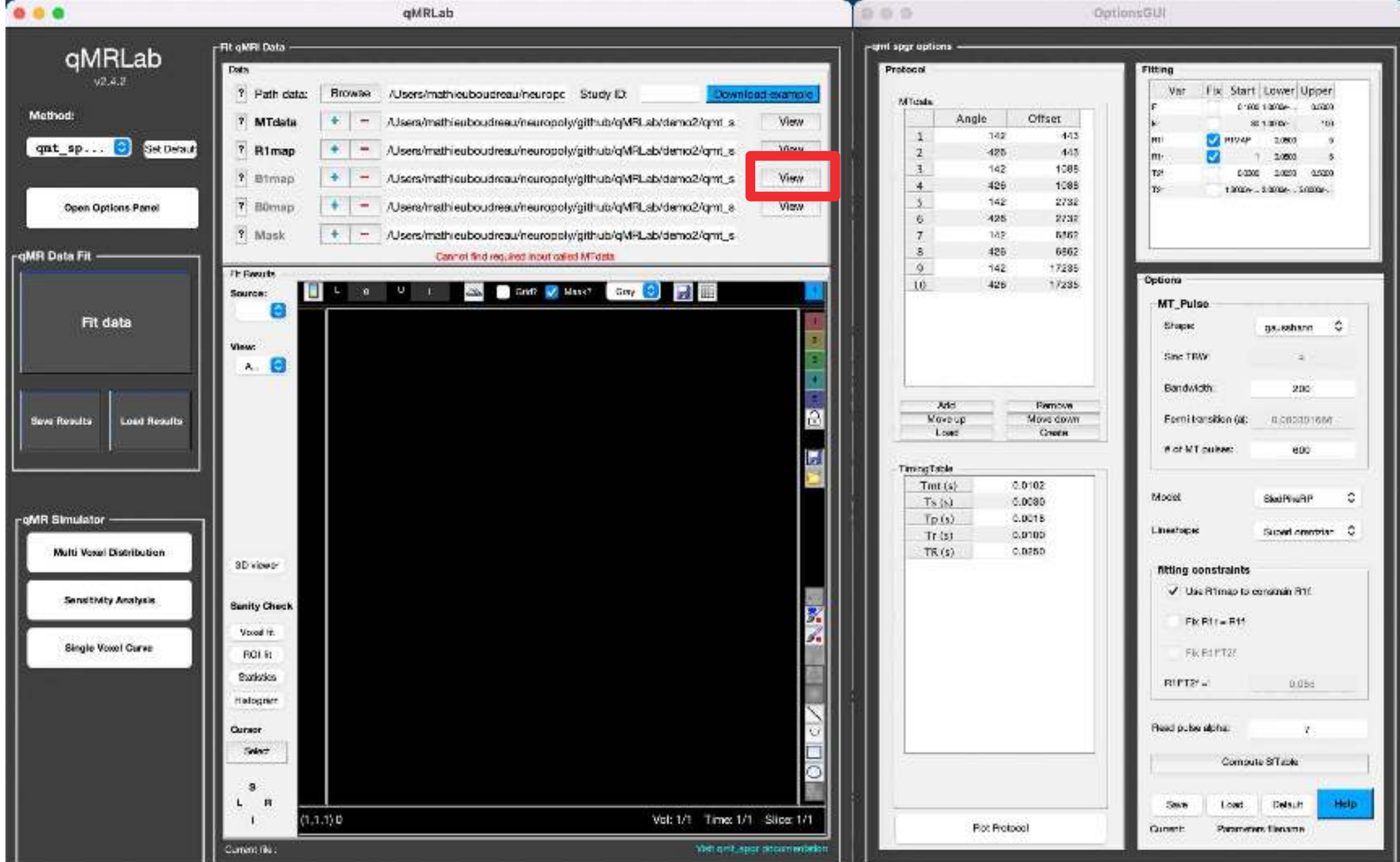






How to...

visualize loaded datasets



qMRLab
v2.4.2

Method:
qat_sp...
Open Options Panel

qMR Data Fit
Fit data
Save Results Load Results

qMR Simulator
Multi Voxel Distribution
Sensitivity Analysis
Single Voxel Curve

Fit qMR Data

Data

Path data: Browse /Users/mathieuboudreau/neuropoly/ Study ID: Download example

MTdata

+

-

/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmr_s

View

R1map

+

-

/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmr_s

View

B1map

+

-

/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmr_s

View

B0map

+

-

/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmr_s

View

Mask

+

-

/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmr_s

View

Fit Results

Source: B...

View: A...

3D viewer

Sanity Check
Voxel fit
R1 fit
Statistics
Histogram

Cursor
Select
A
L R
P

(x,y) vol

Vol: 3/4 Time: 1/1 Slice: 1/1

Current file:

Web qmr_sprg documentation

OptionsGUI

qmr sprg options

Protocol

MTData

	Angle	Offset
1	142	443
2	425	443
3	142	1085
4	425	1085
5	142	2732
6	425	2732
7	142	6262
8	425	6262
9	142	17235
10	425	17235

Add

Move up

Load

Remove

Move down

Create

Timing Table

Tmt (s)	0.0105
Ts (s)	0.0030
Tp (s)	0.0015
Tr (s)	0.0100
TR (s)	0.0250

Fit Protocol

Fitting

Var	Fix	Start	Lower	Upper
P		0.100	1.000e-	0.500
K		30	1.000e-	100
RH	☒	nrvap	0.000	5
R1	☒	1	0.000	5
T2*		0.000	0.000	0.000
T2		1.000e-	0.000e-	5.000e-

Options

MT_Pulse

Shape: gaussian

Sinc TRW: 2

Bandwidth: 200

Fermi iteration (q): 0.00301656

of MT pulses: 600

Model: SteadRP

Lineshape: SuperLorentzian

Fitting constraints

☒ Use R1map to constrain R1f

☐ Fix R1 = R1f

☐ Fix R1/T2f

R1/T2f = 0.055

Read pulse alpha: 7

Compute STable

Save Load Default Help

Current Parameters filename



Method:

qat_sp...  

Open Options Panel

qMR Data Fit

Fit data

Save Results

Load Results

qMR Simulator

Multi Voxel Distribution

Sensitivity Analysis

Single Voxel Curve

Fit qMR Data

Data

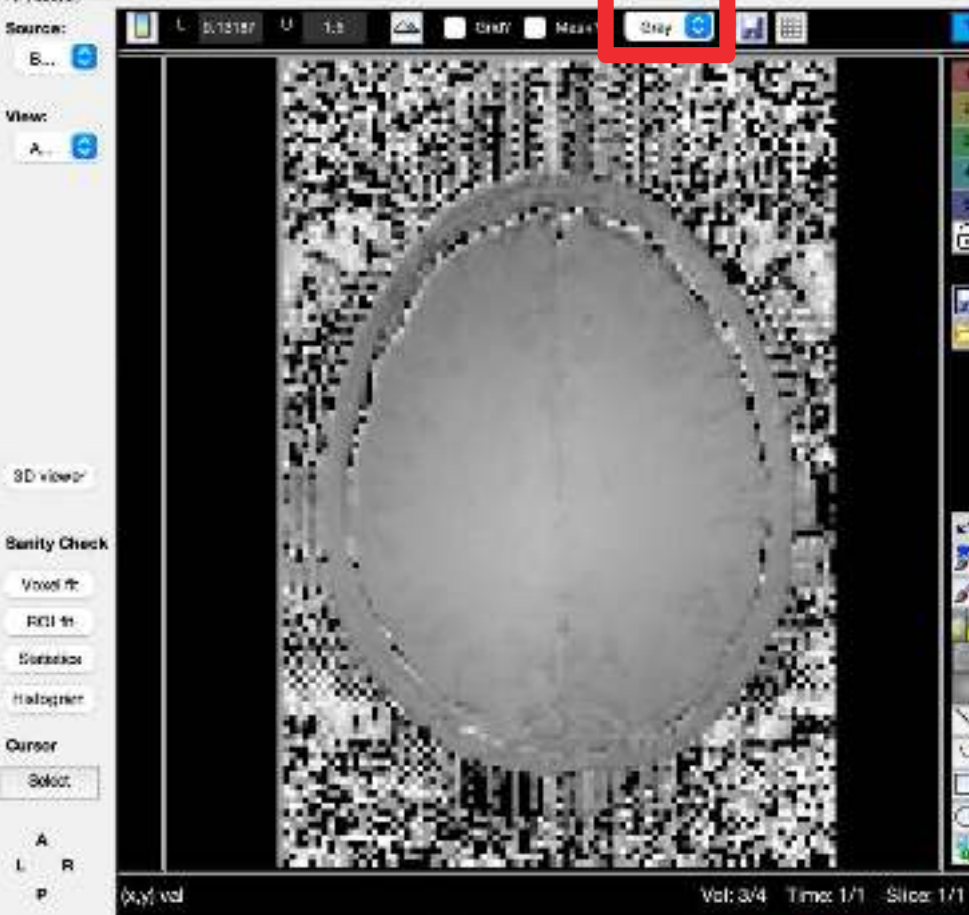
Path data:		/Users/mathieuboudreau/neuropoly	Study ID:		Download example
MTdata	 	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmr_s		View	
R1map	 	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmr_s		View	
B1map	 	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmr_s		View	
B0map	 	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmr_s		View	
Mask	 	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmr_s		View	

Fit Results

Source:

B... 

View:

A... 

3D viewer

Sanity Check

☐ Voxel fit☐ R1 fit☐ Statistics☐ Histogram

Cursor

A

L R

P

Current file:

[Web qmr_sprg documentation](#)

qmr_sprg options

Protocol

-MTData

	Angle	Offset
1	142	443
2	425	443
3	142	1085
4	425	1085
5	142	2732
6	425	2732
7	142	6262
8	425	6262
9	142	17235
10	425	17235

Timing Table

Tmt (s)	0.0105
Ts (s)	0.0030
Tp (s)	0.0015
Tr (s)	0.0100
TR (s)	0.0250

Plot Protocol

Fitting

Var	Fix	Start	Lower	Upper
P	☐	0.100	1.000e-	0.500
K	☐	30	1.000e-	100
PH	☒	nrvap	0.000	5
R1	☒	1	0.000	5
T2*	☐	0.000	0.000	0.000
T2	☐	1.000e-	0.000e-	5.000e-

Options

MT_Pulse

Shape: gaussian 

Sinc TRW: 2

Bandwidth: 200

Fermi iteration (q): 0.00301656

of MT pulses: 600

Model: SteadRP Lineshape: SuperLorentzian 

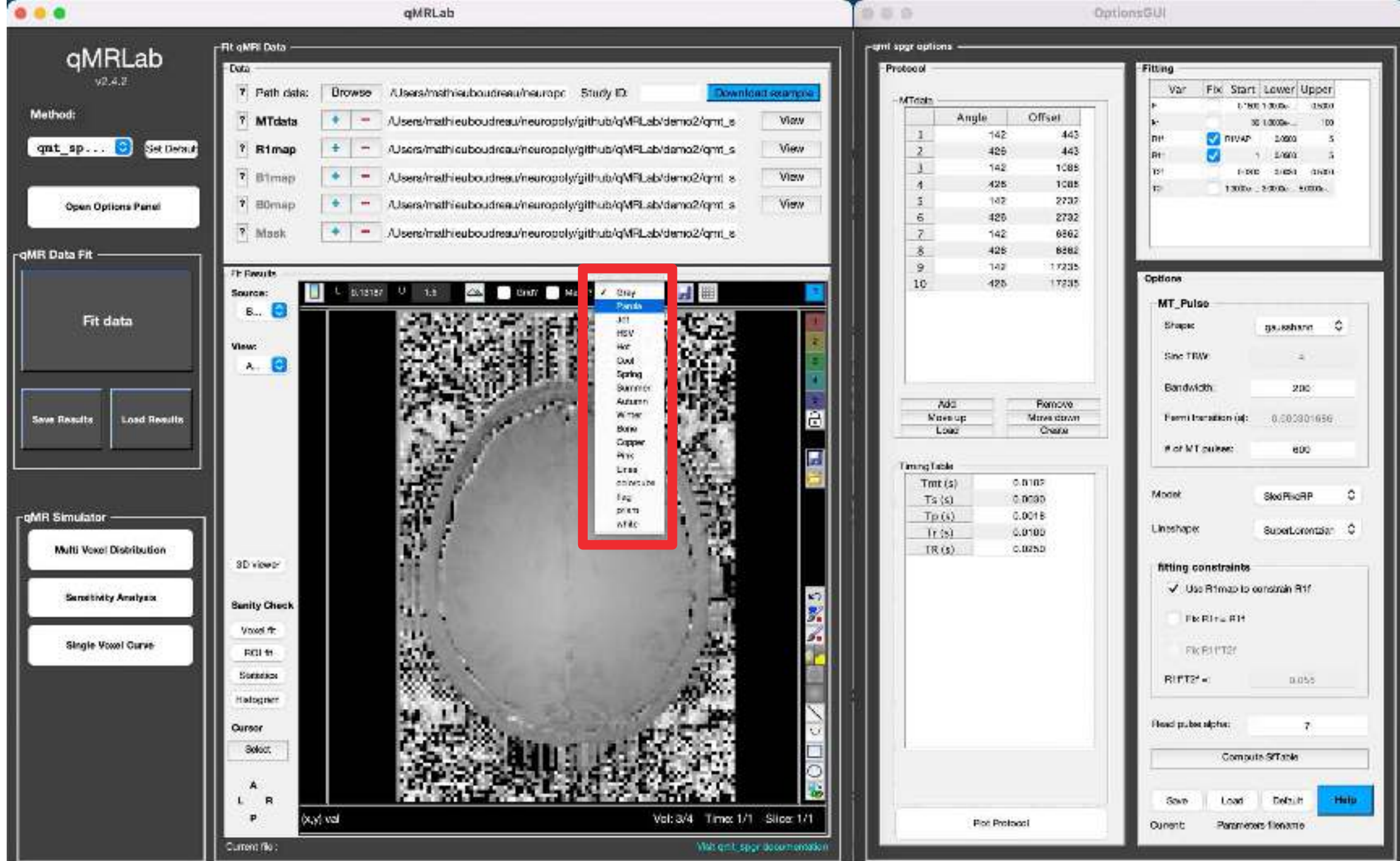
fitting constraints

☒ Use R1map to constrain R1f☐ Fix R1 = R1f☐ Fix R1/T2*

R1/T2* = 0.055

Read pulse alpha: 7

Current: Parameters filename



qMRLab

v2.4.2

Method:

qmt_sp... [Set Default](#)[Open Options Panel](#)

qMR Data Fit

Fit data

[Save Results](#)[Load Results](#)

qMR Simulator

[Multi Voxel Distribution](#)[Sensitivity Analysis](#)[Single Voxel Curve](#)

Fit qMRI Data

Data

Path data:	Browse	/Users/mathieuboudreau/neurosp/	Study ID:	Download example
MTdata	+ -	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmt_s	View	
R1map	+ -	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmt_s	View	
B1map	+ -	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmt_s	View	
B0map	+ -	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmt_s	View	
Mask	+ -	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmt_s		

Fit Results

Source:

[B...](#)

View:

[A...](#)

3D viewer

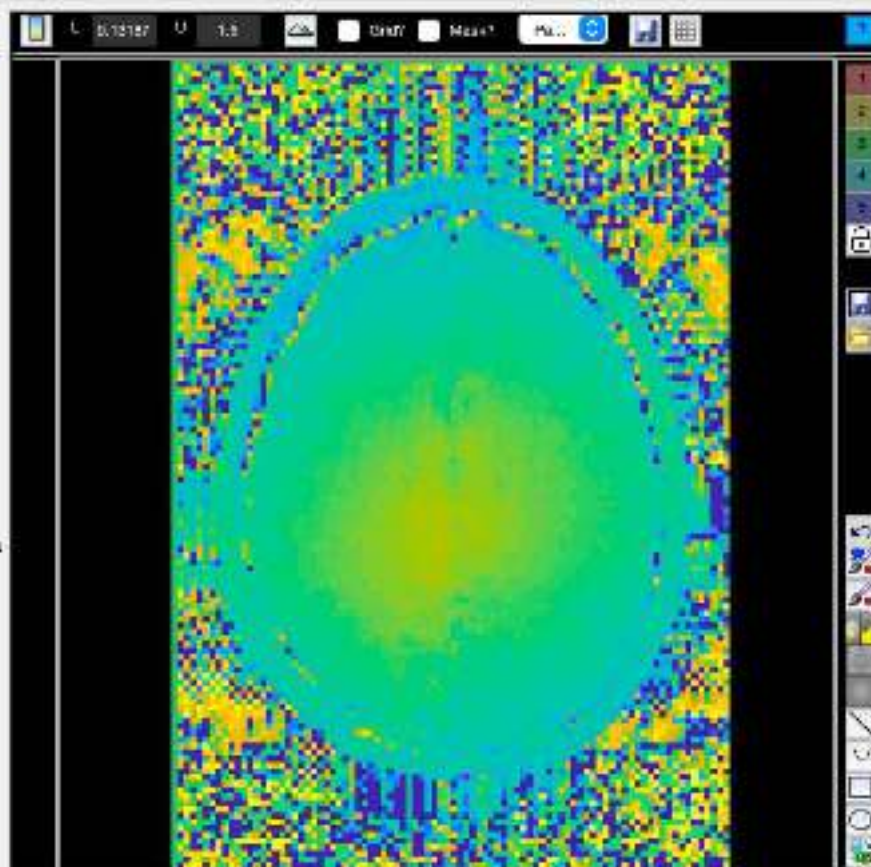
Sanity Check

[Voxel fit](#)[R1 fit](#)[Statistics](#)[Histogram](#)

Cursor

[Select](#)[A](#)
[L](#) [R](#)
[P](#)

Current file:



(x,y) val

Vol: 3/4 Time: 1/1 Slice: 1/1

[Web qmt_sprg documentation](#)

OptionsGUI

qmt sprg options

Protocol

-MTdata

	Angle	Offset
1	142	443
2	425	443
3	142	1085
4	425	1085
5	142	2732
6	425	2732
7	142	6362
8	425	6362
9	142	17235
10	425	17235

[Add](#)[Move up](#)[Load](#)[Remove](#)[Move down](#)[Create](#)

Timing Table

Tmt (s)	0.0105
Ts (s)	0.0030
Tp (s)	0.0015
Tr (s)	0.0100
TR (s)	0.0250

Plot Protocol

Fitting

Var	Fix	Start	Lower	Upper
P		0.100	1.000e-	0.500
k		00	1.000e-	100
RH	☒	nIVAP	0.000	5
R1	☒	1	0.000	5
T2*		0.000	0.000	0.000
T2		1.000e-	0.000e-	0.000e-

Options

MT_Pulse

Shape: [gaussian](#)Sinc TRW: Bandwidth: Pulse duration (s): # of MT pulses: Model: [SteinRP](#)Lineshape: [SuperLorentzian](#)

fitting constraints

☒ Use R1map to constrain R1f☐ Fix R1 to R1f☐ Fix R1/T2*R1/T2* = Read pulse alpha: [Compute S/TTable](#)[Save](#)[Load](#)[Default](#)[Help](#)

Current

Parameters filename



Method:

qmt_sp...

[Open Options Panel](#)

qMR Data Fit

Fit data

[Save Results](#)[Load Results](#)

qMR Simulator

[Multi Voxel Distribution](#)[Sensitivity Analysis](#)[Single Voxel Curve](#)

Fit qMR Data

Data

Path data:		/Users/mathieuboudreau/neuropoly/	Study ID:	Download example
MTdata		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmt_s	View	
R1map		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmt_s	View	
B1map		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmt_s	View	
B0map		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmt_s	View	
Mask		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo2/qmt_s		

Fit Results

Source:

B...

View:

A...

3D viewer

Sanity Check

[Voxel fit](#)[R1 fit](#)[Statistics](#)[Histogram](#)

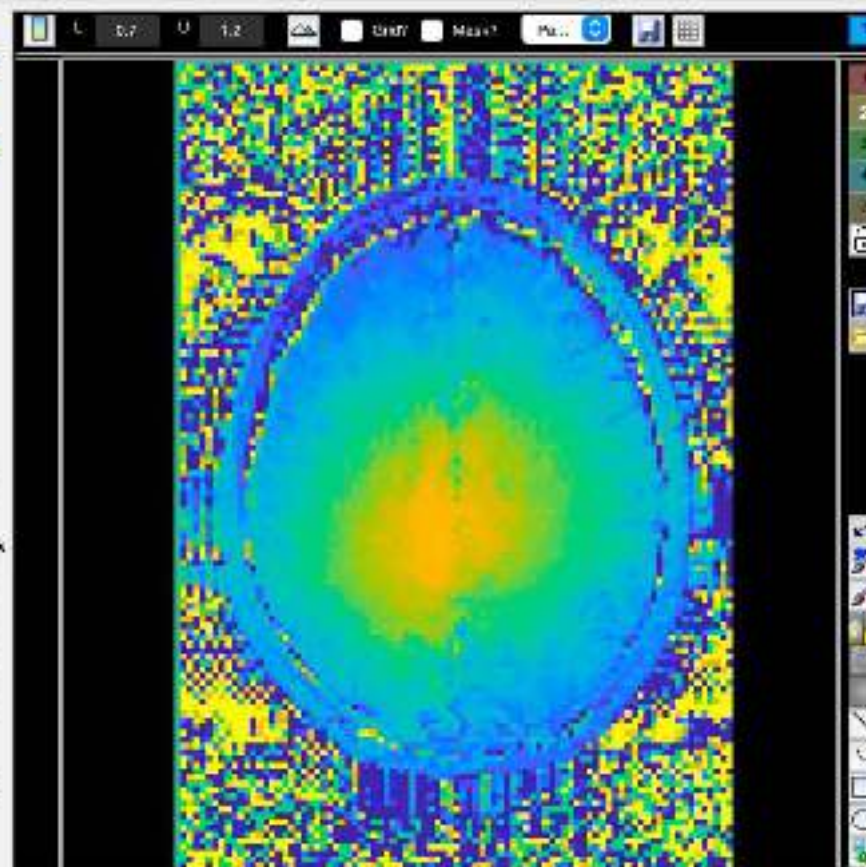
Cursor

[Select](#)

A

L R

P



(x,y) vol

Vol: 3/4 Time: 1/1 Slice: 1/1

Current file:

[View qmt_sprg documentation](#)

qmt sprg options

Protocol

-MTData

	Angle	Offset
1	142	443
2	425	443
3	142	1085
4	425	1085
5	142	2732
6	425	2732
7	142	6362
8	425	6362
9	142	17235
10	425	17235

[Add](#)[Move up](#)[Load](#)[Remove](#)[Move down](#)[Clear](#)

Timing Table

Tmt (s)	0.0102
Ts (s)	0.0030
Tp (s)	0.0015
Tt (s)	0.0100
TR (s)	0.0250

[Plot Protocol](#)

Fitting

Var	Fix	Start	Lower	Upper
P	☐	0.100	1.000e-	0.500
K	☐	0.0	1.000e-	100
RH	☒	nrvap	0.000	5
R1	☒	1	0.000	5
T2*	☐	0.000	0.000	0.000
T2	☐	1.000e-	0.000e-	0.000e-

Options

MT_Pulse

Shape: gaussian

Sinc TRW: Bandwidth: Fermi iteration (q): # of MT pulses:

Model: SteadRP

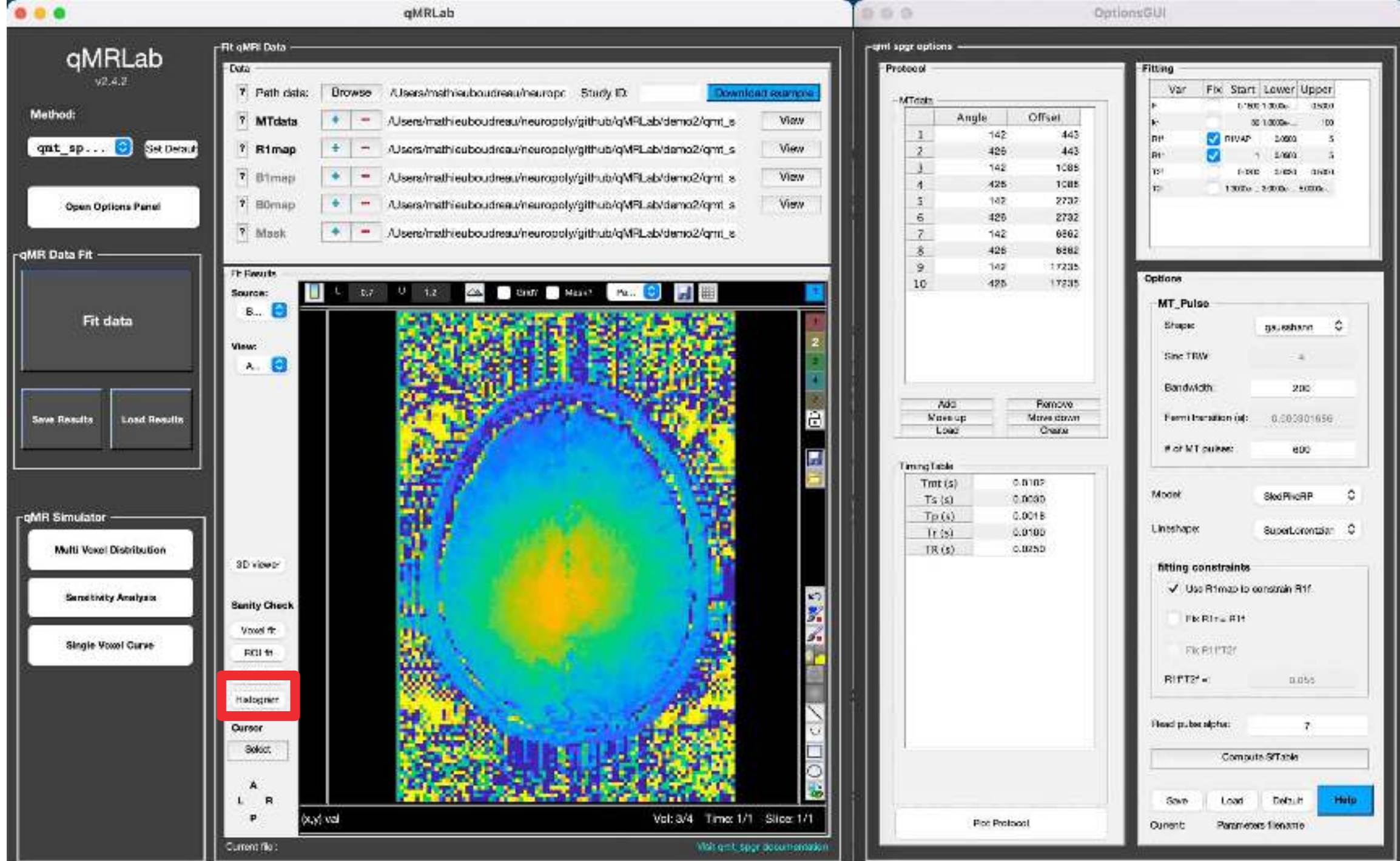
Lineshape: SuperLorentzian

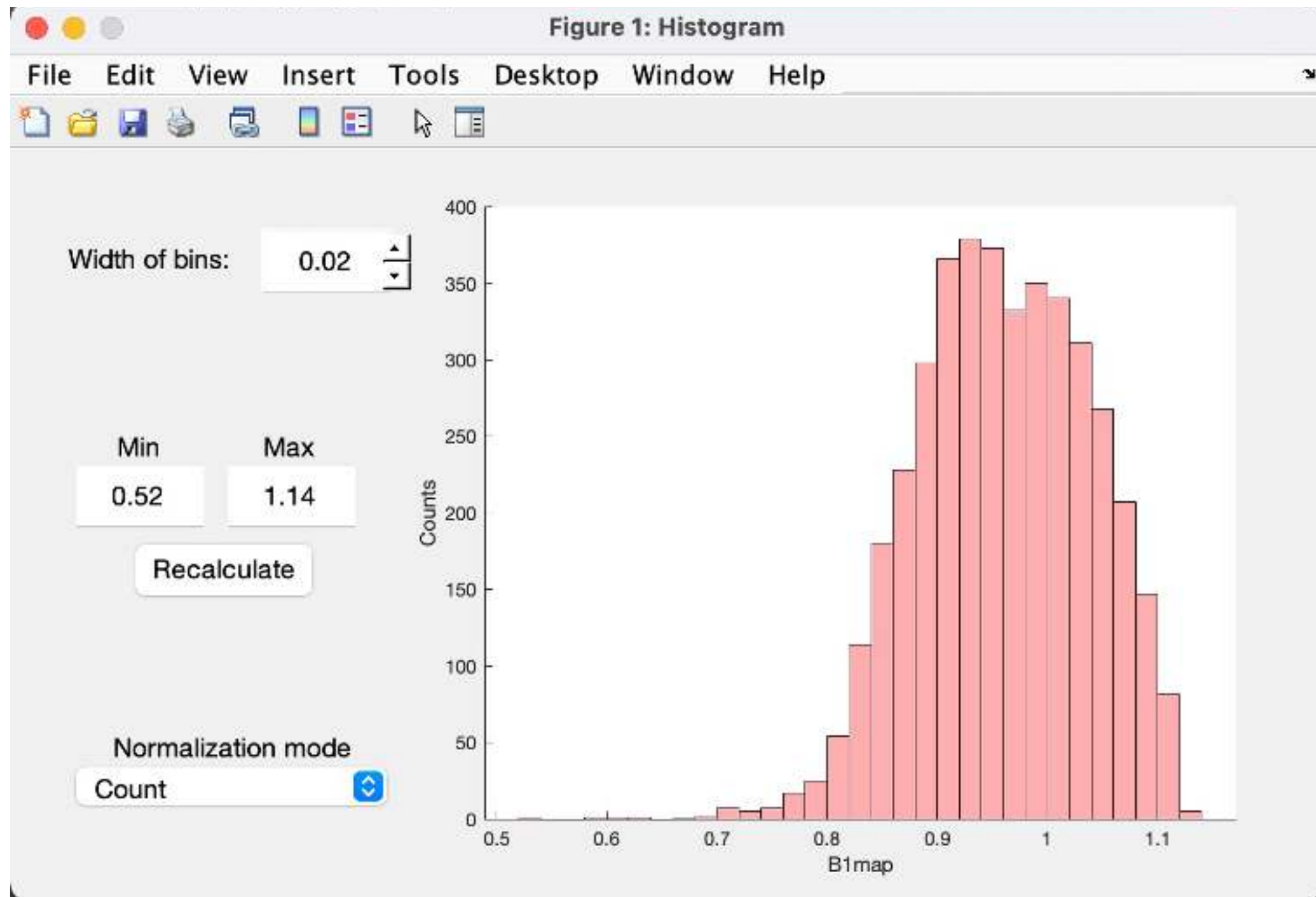
fitting constraints

☒ Use R1map to constrain R1f☐ Fix R1 to R1f☐ Fix R1/T2fR1/T2f = Head pulse alpha: [Compute STable](#)[Save](#)[Load](#)[Default](#)[Help](#)

Current

Parameters filename





qMRLab

v2.4.2

Method:
qmt_sp...
Open Options Panel

qMR Data Fit

Fit data
Save Results
Load Results

qMR Simulator

Multi Voxel Distribution
Sensitivity Analysis
Single Voxel Curve

Fit qMR Data

Data

Path data: Browse /Users/mathieuboudreau/neuropsy/ Study ID: Download example

MTdata /Users/mathieuboudreau/neuropsy/github/qMRLab/demo2/qmt_s View

R1map /Users/mathieuboudreau/neuropsy/github/qMRLab/demo2/qmt_s View

B1map /Users/mathieuboudreau/neuropsy/github/qMRLab/demo2/qmt_s View

B0map /Users/mathieuboudreau/neuropsy/github/qMRLab/demo2/qmt_s View

Mask /Users/mathieuboudreau/neuropsy/github/qMRLab/demo2/qmt_s

Fit Results

Source: B... View: A...

3D viewer

Sanity Check

Voxel fit
R1 fit
Statistics
Histogram

Cursor
Select

A
L R
P

(44,68,1) 0.99766 Vol: 3/4 Time: 1/1 Slice: 1/1

Current file: [Web qmt_sprg documentation](#)

OptionsGUI

qmt sprg options

Protocol

MTtrain

	Angle	Offset
1	142	443
2	425	443
3	142	1085
4	425	1085
5	142	2732
6	425	2732
7	142	6262
8	425	6262
9	142	17235
10	425	17235

Add
Move up
Load

Remove
Move down
Create

Timing Table

Tmt (s)	0.0105
Ts (s)	0.0030
Tp (s)	0.0015
Tt (s)	0.0100
TR (s)	0.0250

Fit Protocol

Fitting

Var	Fix	Start	Lower	Upper
P		0.100	1.000e-	0.500
k		30	1.000e-	100
RH	☒	nrvap	0.000	5
R1	☒	1	0.000	5
T2*		0.000	0.000	0.000
T2		1.000e-	0.000e-	0.000e-

Options

MT_Pulse

Shape: gaussian

Sinc TRW: 0

Bandwidth: 200

Fermi iteration (q): 0.00301656

of MT pulses: 600

Model: SteadRP

Lineshape: SuperLorentzian

Fitting constraints

☒ Use R1map to constrain R1f

☐ Fix R1 to R1f

☐ Fix R1/T2*

R1/T2* = 0.055

Read pulse alpha: 7

Compute S/Tank

Save Load Default Help

Current Parameters filename



Method:

qmt_sp...   Open Options Panel

qMR Data Fit

Fit data

Save Results

Load Results

qMR Simulator

Multi Voxel Distribution

Sensitivity Analysis

Single Voxel Curve

Fit qMR Data

Data

Path data:		/Users/mathieuboudreau/neuropr	Study ID:	
MTdata	 	/Users/mathieuboudreau/neuropr/github/qMRLab/demo2/qmt_s		View
R1map	 	/Users/mathieuboudreau/neuropr/github/qMRLab/demo2/qmt_s		View
B1map	 	/Users/mathieuboudreau/neuropr/github/qMRLab/demo2/qmt_s		View
B0map	 	/Users/mathieuboudreau/neuropr/github/qMRLab/demo2/qmt_s		View
Mask	 	/Users/mathieuboudreau/neuropr/github/qMRLab/demo2/qmt_s		View

Fit Results

Source:

B... 

View:

A... 

3D view:

Sanity Check

Voxel fit

R1 fit

Statistics

Histogram

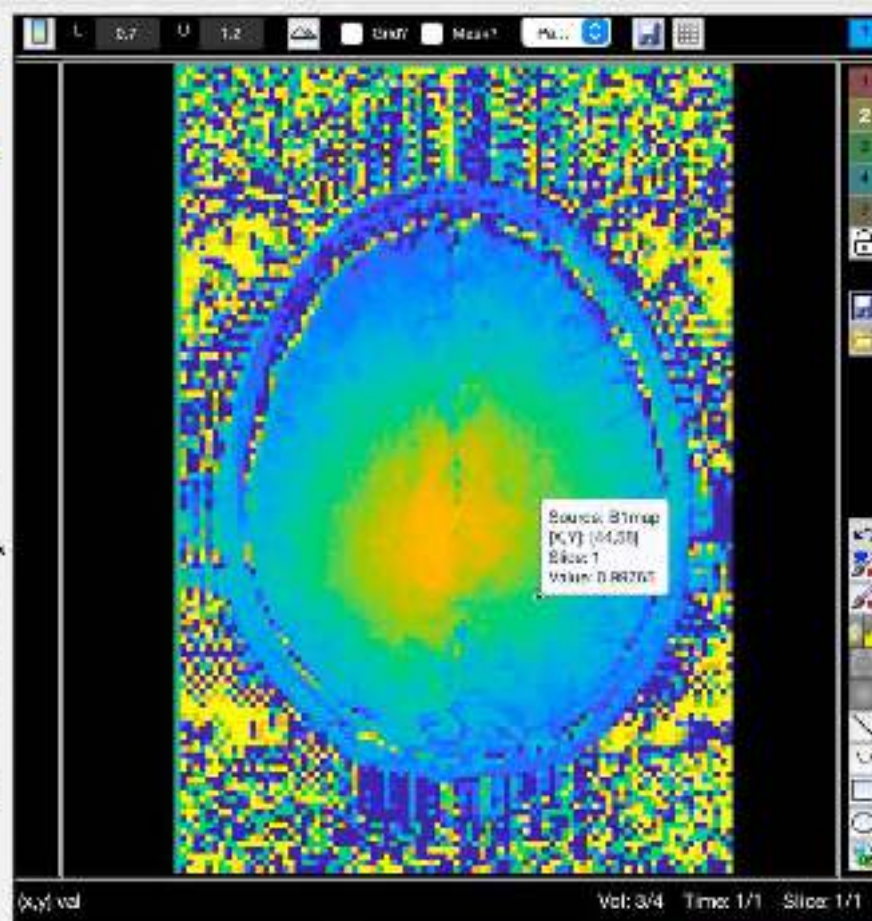
Cursor

Select

A

L R

P



Current file:

[Web qmt_spr documentation](#)

qmt_spr options

Protocol

-MTData

	Angle	Offset
1	142	443
2	425	443
3	142	1085
4	425	1085
5	142	2732
6	425	2732
7	142	6262
8	425	6262
9	142	17235
10	425	17235

Add

Move up

Load

Remove

Move down

Create

Timing Table

Tmt (s)	0.0105
Ts (s)	0.0030
Tp (s)	0.0015
Tr (s)	0.0100
TR (s)	0.0250

Plot Protocol

Fitting

Var	Fix	Start	Lower	Upper
P		0.100	1.000e-	0.500
K		00	1.000e-	100
RH	☒	nrvap	0.000	5
R1	☒	1	0.000	5
T2*		0.000	0.000	0.000
T2		1.000e-	0.000e-	0.000e-

Options

MT_Pulse

Shape: gaussian 

Sinc TRW: 0

Bandwidth: 200

Fermi iteration (q): 0.00301656

of MT pulses: 600

Model: SteadRP Lineshape: SuperLorentzian 

fitting constraints

☒ Use R1map to constrain R1f☐ Fix R1 to R1f☐ Fix R1/T2*

R1/T2* = 0.050

Read pulse alpha: 7

Compute STable

Save

Load

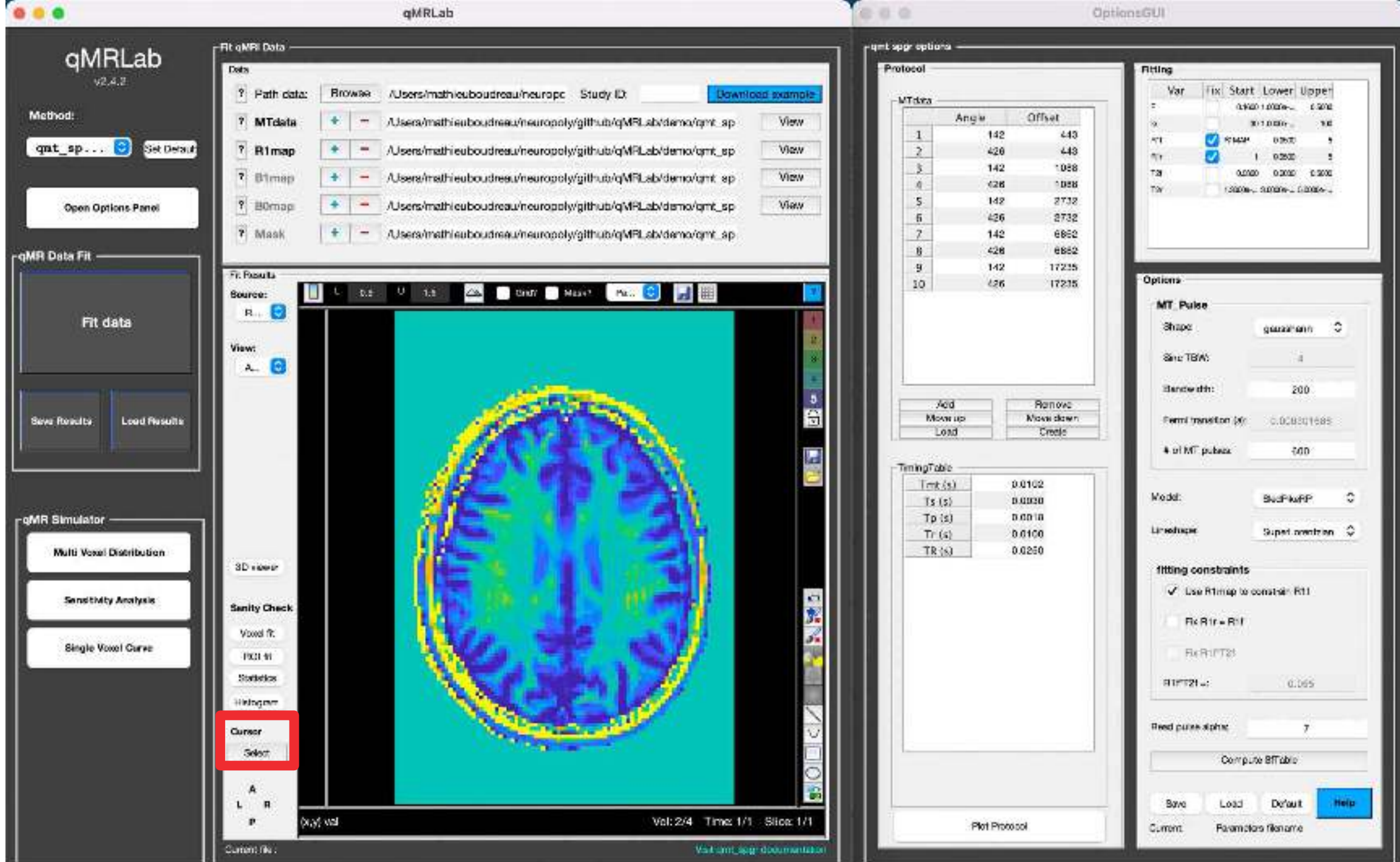
Default

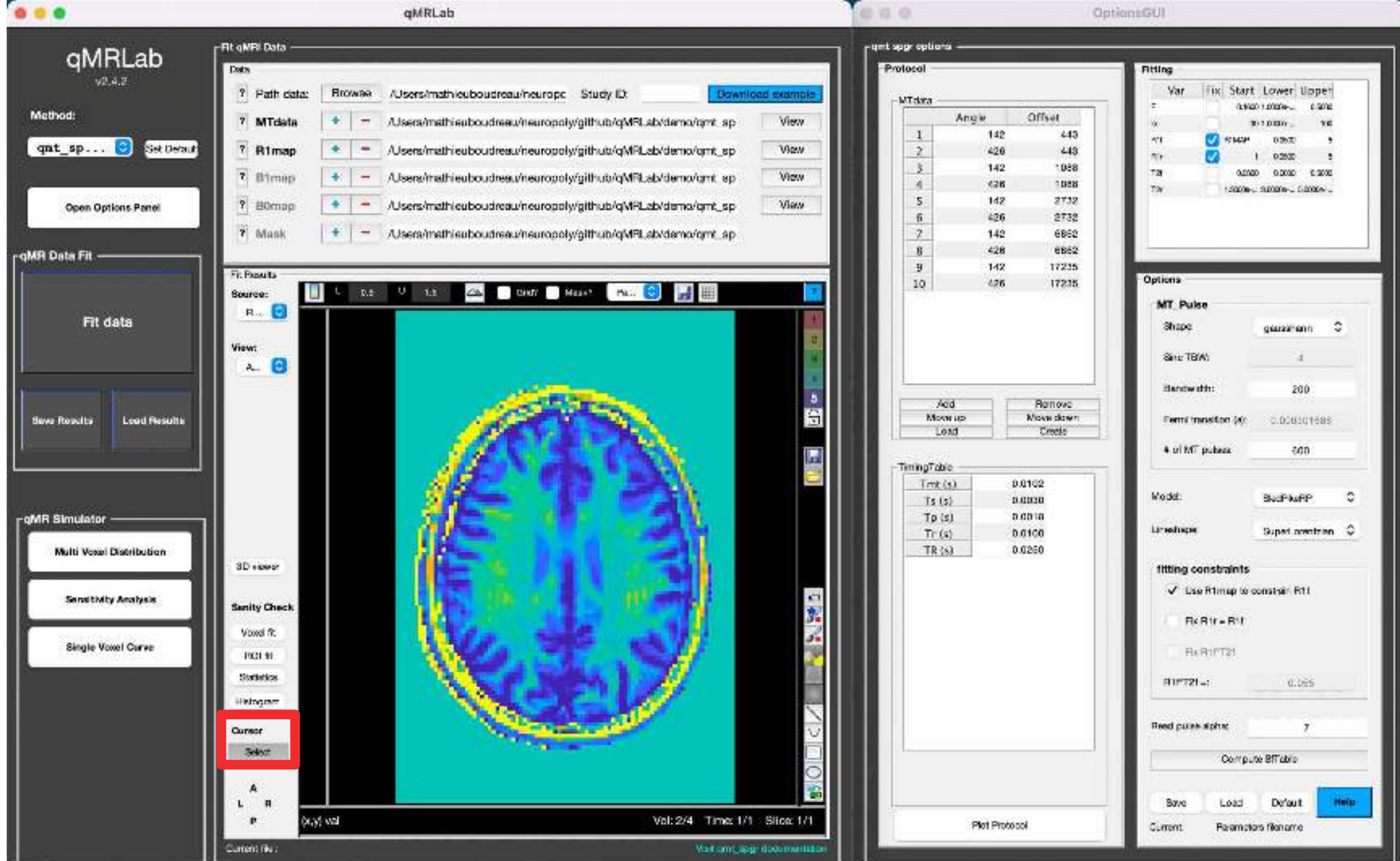
Help

Current Parameters filename

How to...

verify the fit of a single voxel







Method:

qmt_sp...

[Open Options Panel](#)

qMR Data Fit

Fit data

[Save Results](#)[Load Results](#)

qMR Simulator

[Multi Voxel Distribution](#)[Sensitivity Analysis](#)[Single Voxel Curve](#)

Fit qMR Data

Data

?	Path data:	Browse	/Users/mathieuboudreau/neuropc	Study ID:	Download example
?	MTdata	+ -	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp	View	
?	R1map	+ -	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp	View	
?	B1map	+ -	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp	View	
?	B0map	+ -	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp	View	
?	Mask	+ -	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp	View	

Fit Results

Source:

R...

View:

A...

3D viewer

Sanity Check

Voxel fit

FOI fit

Statistics

Histogram

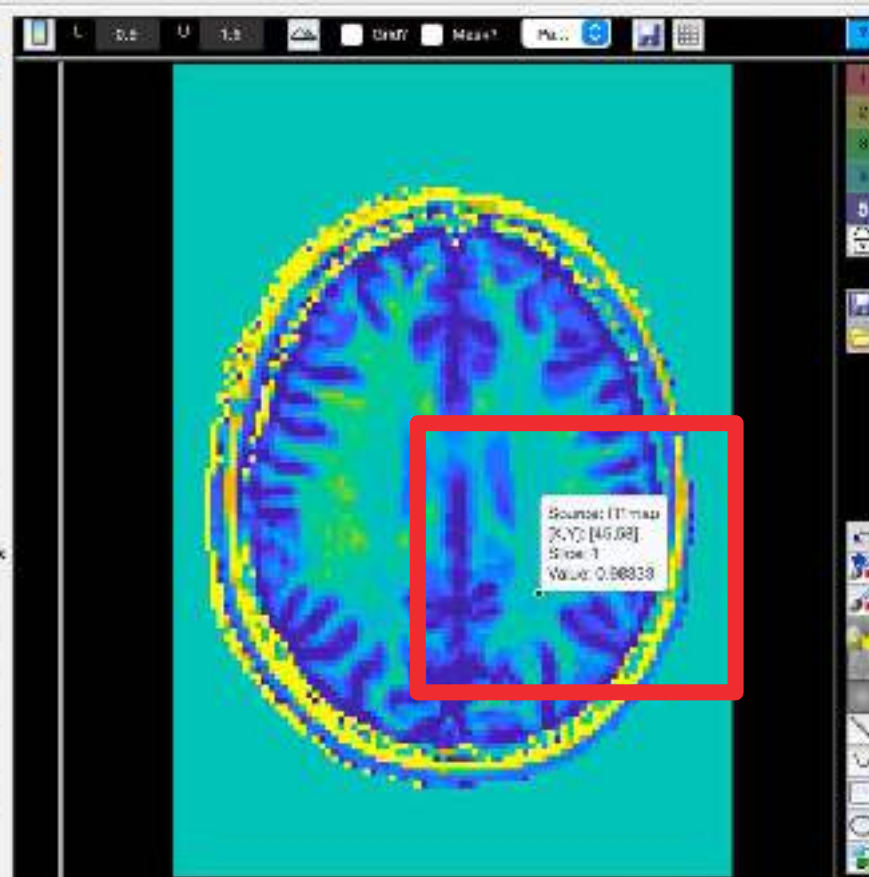
Cursor

A

L

R

P



(x,y) val

Vol: 2/4 Time: 1/1 Slice: 1/1

Current file:

[View qmt_app documentation](#)

qmt_app options

Protocol

MTData

	Angle	Offset
1	142	443
2	426	443
3	142	1088
4	426	1088
5	142	2732
6	426	2732
7	142	6882
8	426	6882
9	142	17235
10	426	17235

[Add](#)[Move up](#)[Load](#)[Remove](#)[Move down](#)[Create](#)

TimingTable

Tmt (s)	0.0102
Ts (s)	0.0020
Tp (s)	0.0010
Tr (s)	0.0100
TR (s)	0.0250

[Plot Protocol](#)

Fitting

Var	Fix	Start	Lower	Upper
T		0.0001 0.0001...	0.000	0.000
R		0.1 0.0001...	0.0	1.0
R1	☒	0.142	0.000	1
R1	☒	1	0.000	1
T2		0.000	0.000	0.000
T2		1.0000e-12 0.0000e-12	0.0000e-12	0.0000e-12

Options

MT_Pulse

Shape	gaussian
Sinc TBA	1
Bandwidth	200
Fermi transition (K)	0.0000015885
# of MT pulses	100

Model	BudFickPP
Lineshape	Super resolution

fitting constraints

☒ Use R1map to constrain R11☐ R1 R11 = R11☐ R1 R11 T21

R1 T21 = 0.065

Red pulse alpha 7

[Compute BTable](#)[Save](#) [Load](#) [Default](#) [Help](#)

Current Parameters filename



Method:

qmt_sp...

Open Options Panel

qMR Data Fit

Fit data

Save Results

Load Results

qMR Simulator

Multi Voxel Distribution

Sensitivity Analysis

Single Voxel Curve

Fit qMR Data

Data

Path data:		/Users/mathieuboudreau/neuro...	Study ID:	
MTdata		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp		
R1map		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp		
B1map		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp		
B0map		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp		
Mask		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp		

Fit Results

Source:

R...

View:

A...

3D viewer

Sanity Check

Voxel fit

ROI fit

Statistics

Histogram

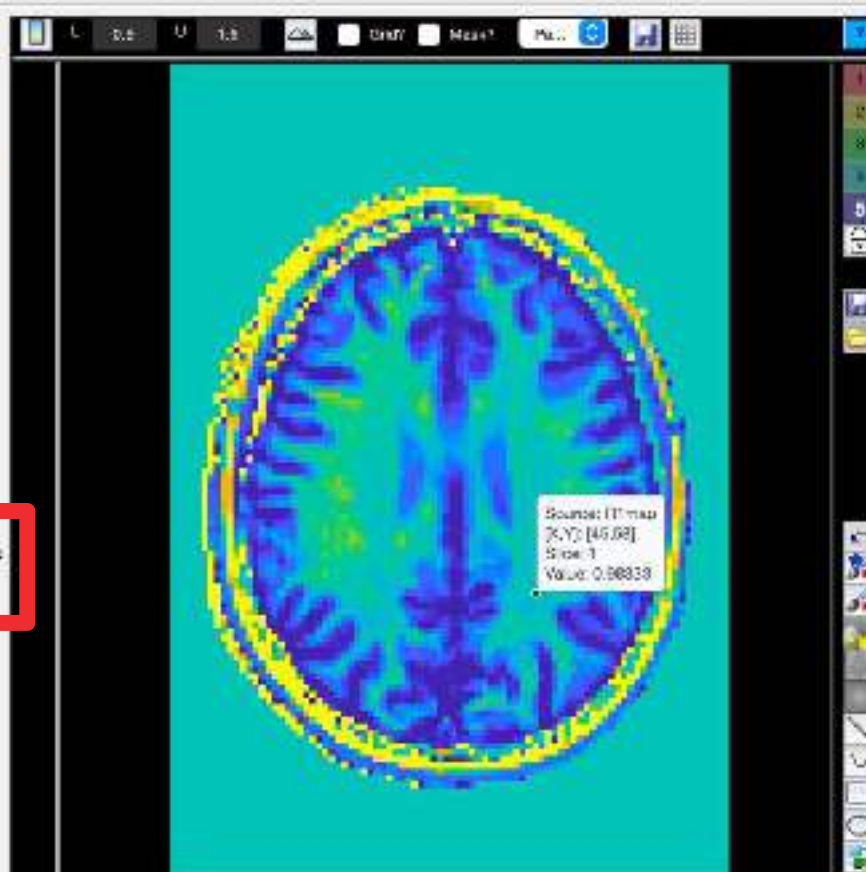
Cursor

A

L

R

P



Current file:

Vol: qmt_app_documentation

qmt app options

Protocol

MTData

	Angle	Offset
1	142	443
2	426	443
3	142	1088
4	426	1088
5	142	2732
6	426	2732
7	142	6882
8	426	6882
9	142	17235
10	426	17235

Add

Move up

Load

Remove

Move down

Create

TimingTable

Tmt (s)	0.0102
Ts (s)	0.0020
Tp (s)	0.0010
Tr (s)	0.0100
TR (s)	0.0250

Plot Protocol

Fitting

Var	Fix	Start	Lower	Upper
T		0.0001	0.0000	0.5000
q		0.1	0.0000	1.0
R1	☒	0.142	0.0000	1
R1	☒	1	0.0000	1
T2		0.0000	0.0000	0.0000
T2		1.0000	0.0000	0.0000

Options

MT_Pulse

Shape	gaussian
Sinc TBA	1
Bandwidth	200
Fermi transition (K)	0.000001588
# of MT pulses	100

Model	BudFickPP
Lineshape	Super resolution

fitting constraints

☒ Use R1map to constrain R11☐ R1 R11 = R11☐ R1 R11 T21

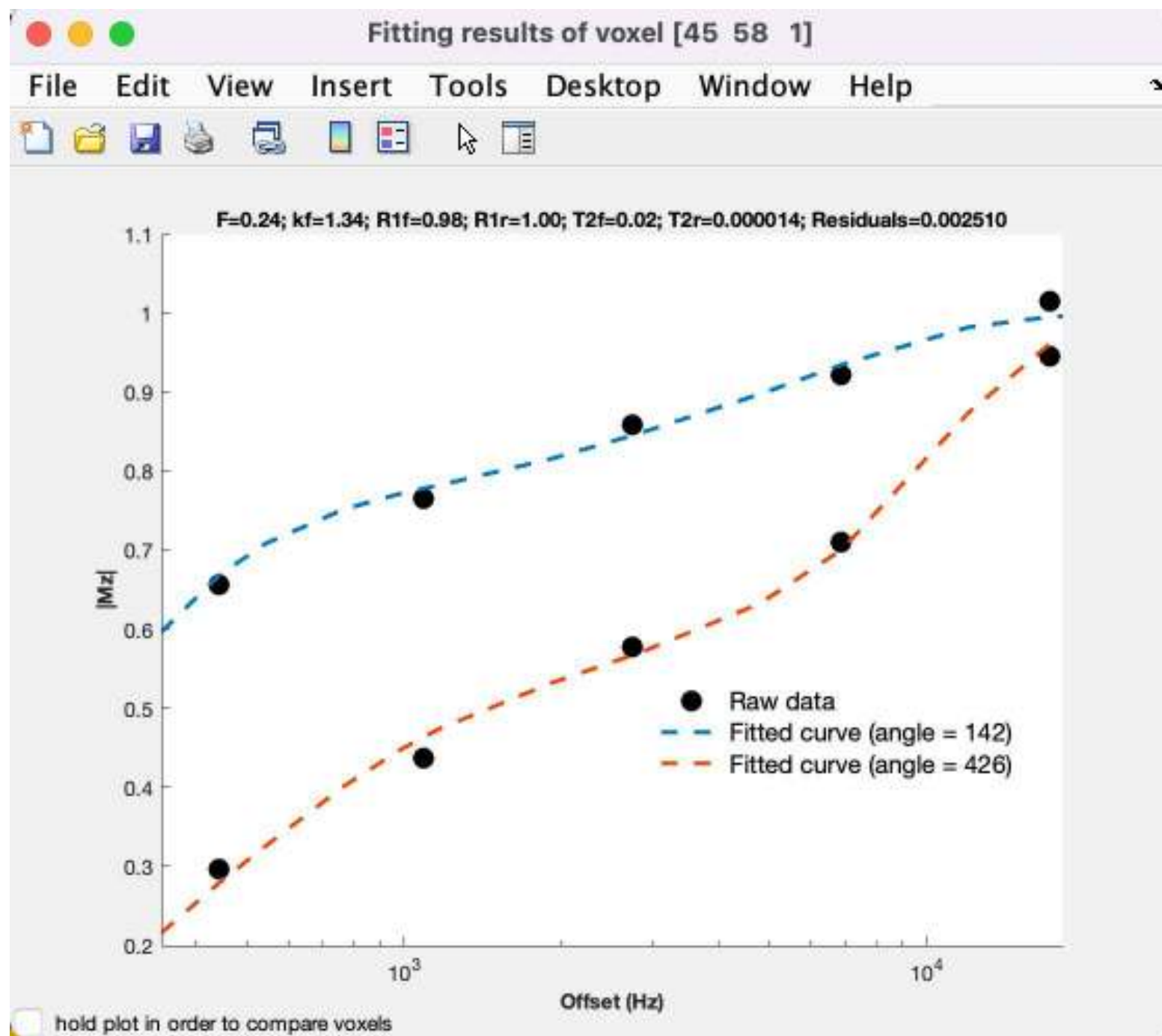
R1 T21 = 0.065

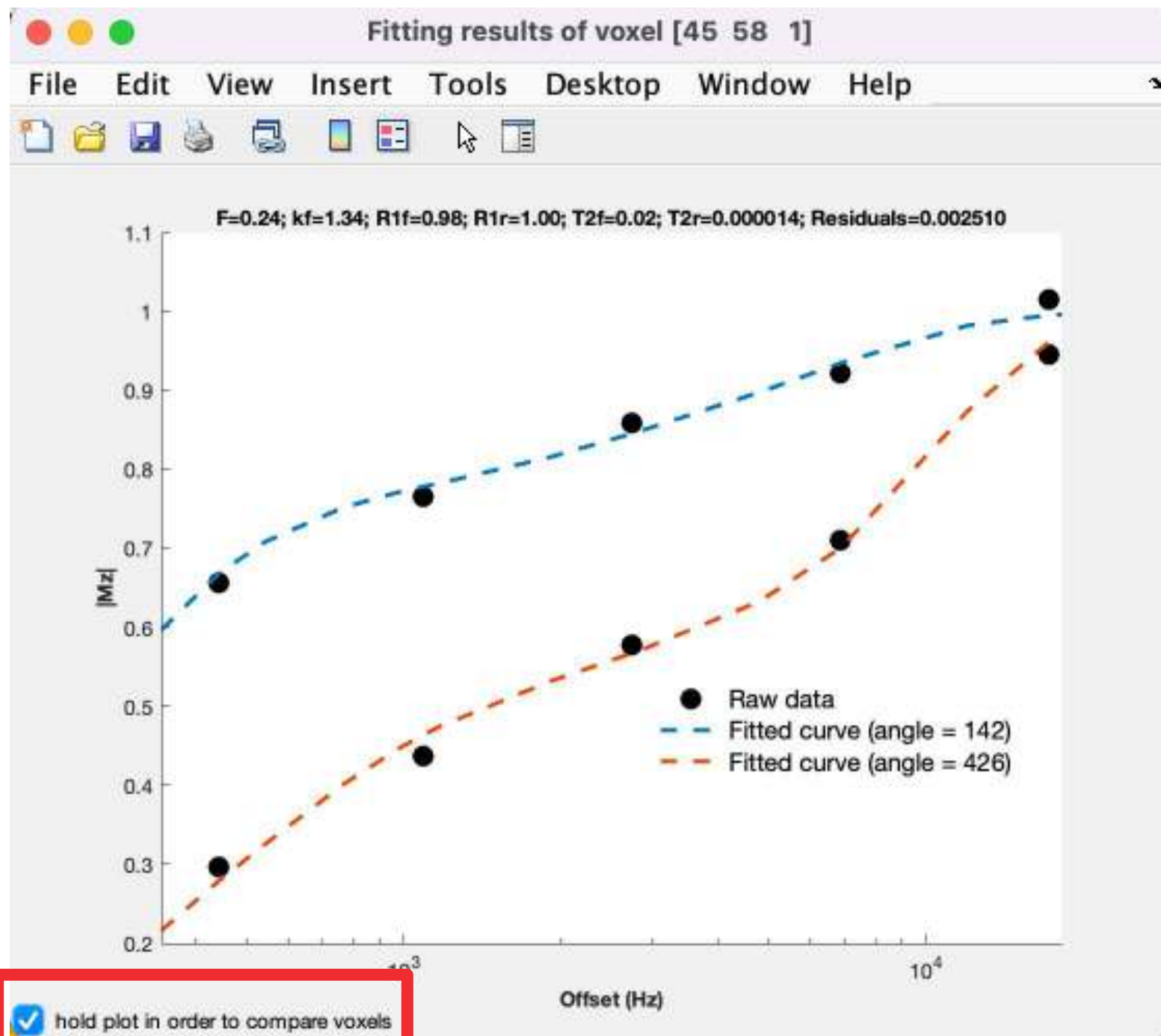
Red pulse alpha 7

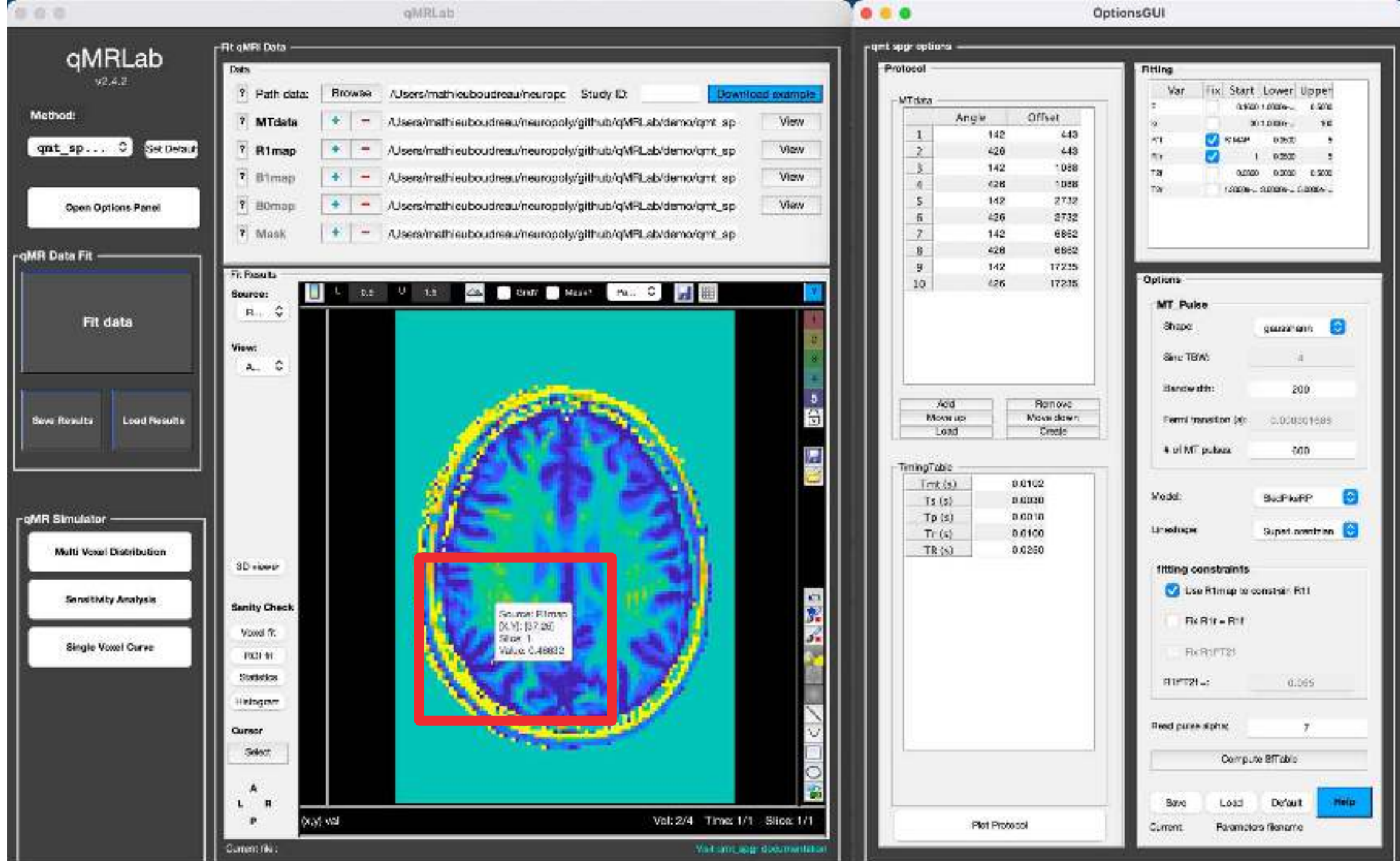
Compute BTable

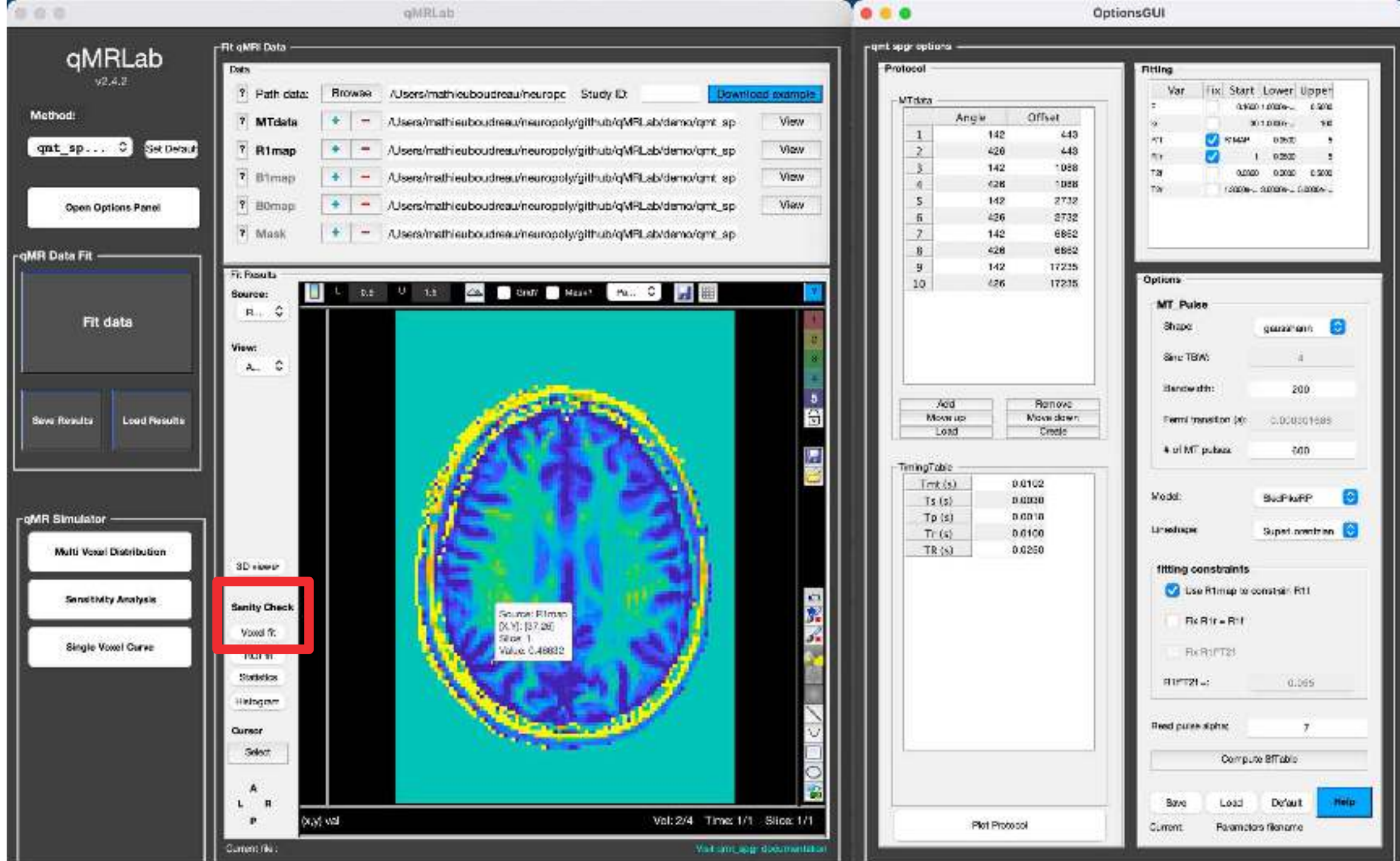
Save Load Default Help

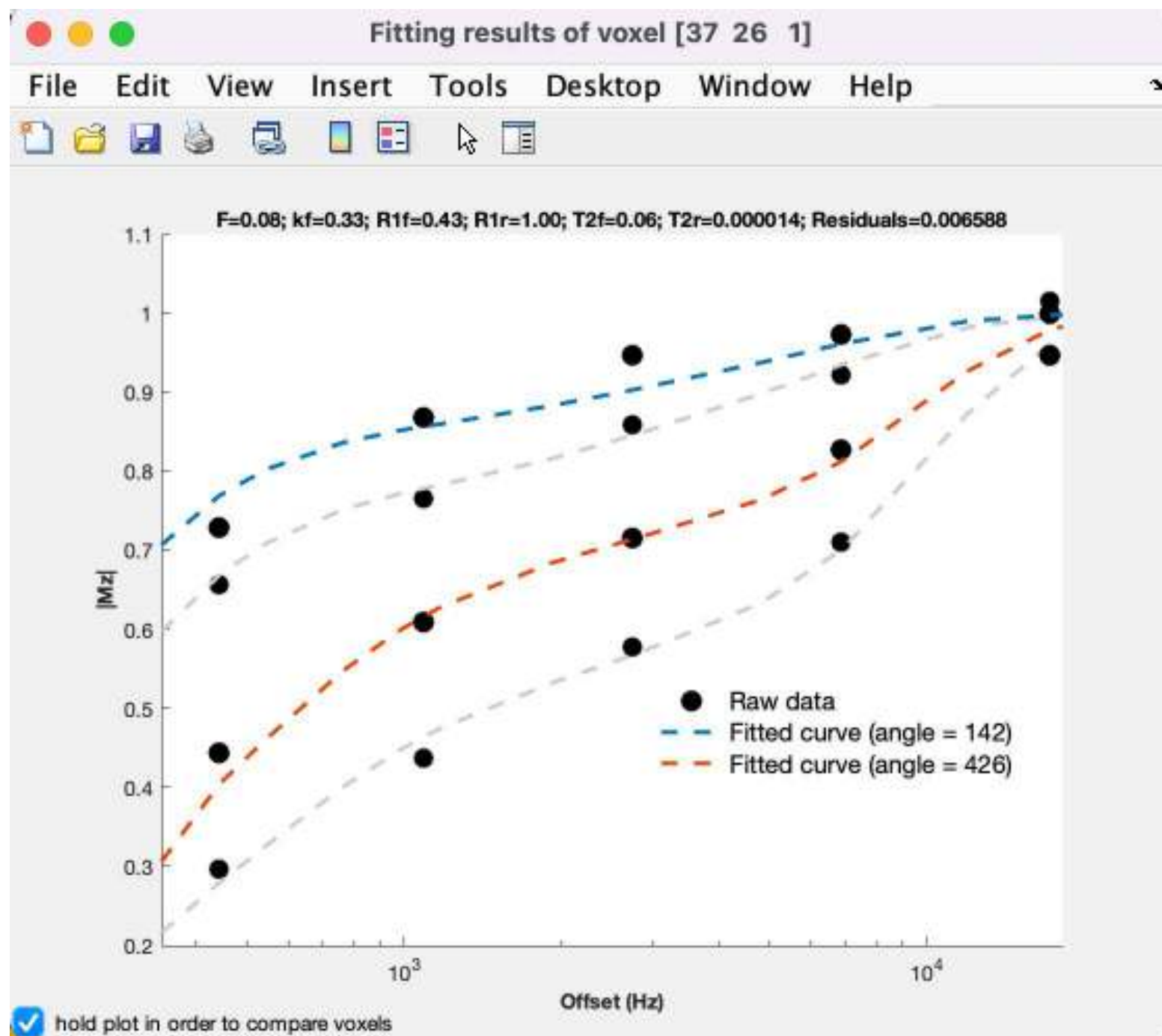
Current Parameters filename











How to...

fit an entire dataset

Method:

qmt_sp...  

Open Options Panel

qMR Data Fit

Fit data

Save Results

Load Results

qMR Simulator

Multi Voxel Distribution

Sensitivity Analysis

Single Voxel Curve

Fit qMR Data

Data

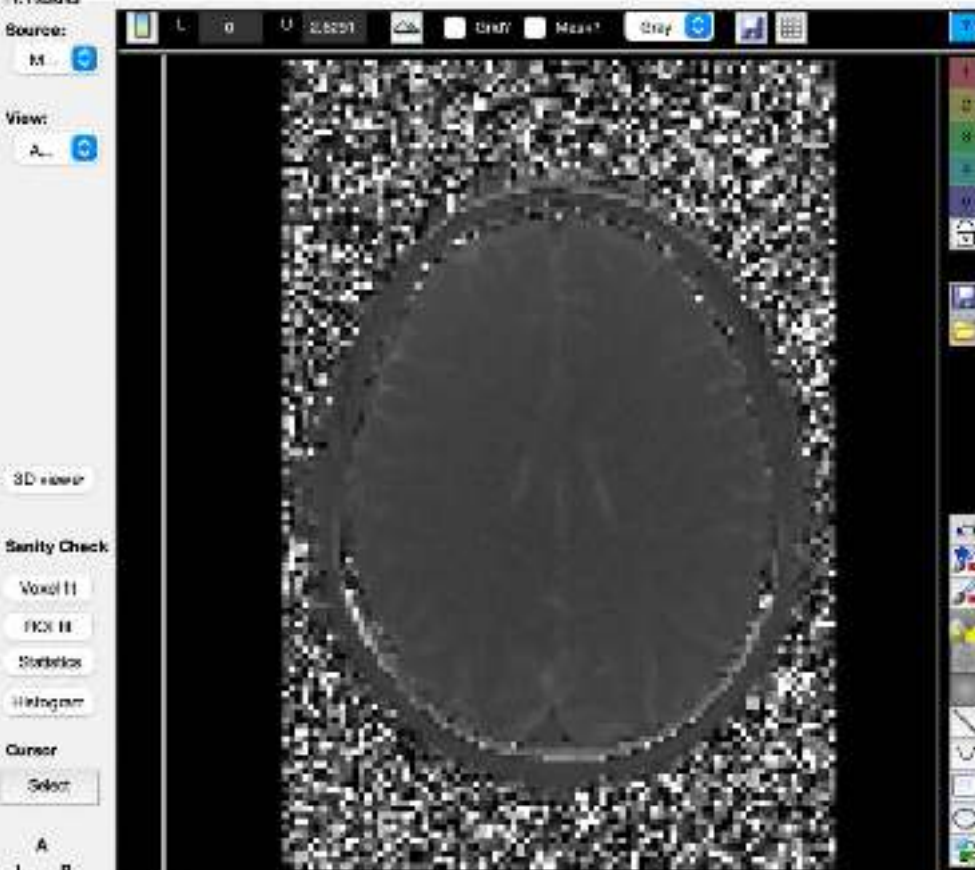
Path data:		/Users/mathieuboudreau/neuropoly	Study ID:	Download example	
MTdata	 	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp			View
R1map	 	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp			View
R1map	 	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp			View
R2map	 	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp			View
Mask	 	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp			View

Fit Results

Source:

M 

View:

A 

3D view

Sanity Check

Voxel H

ROI H

Statistics

Histogram

Cursor

Select

A

L R

P

(x,y) val

Vol: 1/4 Time: 1/10 Slice: 1/1

Current file:

[View qmt_spr documentation](#)

qmt_spr options

Protocol

-MTdata

	Angle	Offset
1	142	443
2	425	443
3	142	1085
4	425	1085
5	142	2732
6	425	2732
7	142	6262
8	425	6262
9	142	17235
10	425	17235

Add

Move up

Load

Remove

Move down

Create

Timing Table

Tint (s)	0.0102
Ts (s)	0.0090
Tp (s)	0.0015
Tr (s)	0.0100
TR (s)	0.0260

Fit Protocol

Fitting

Var	Fix	Start	Lower	Upper
F		0.000 1.000	0.000	0.000
k		80 1.000	100	100
m	☒	R1/R2	0.000	5
R1	☒	1	0.000	5
T2*		0.000 0.000	0.000	0.000
T2		1.000	0.000	1.000

Options

MT Pulse

Shape: Sinc TBW: Bandwidth: Pulse duration (s): # of MT pulses:

Model:

Line shape:

Fitting constraints

☒ Use R1map to constrain R1f☐ Fix R1 to R1f☐ Fix R1/T2*R1/T2* =

Read pulse alpha:

Compute 2T table

Save

Load

Default

Help

Current

Parameters filename

qMRLab
v2.4.2

Method:
qmt_sp... Set Default

Open Options Panel

qMR Data Fit

Fit data

Save Results Load Results

qMR Simulator

Multi Voxel Distribution

Sensitivity Analysis

Single Voxel Curves

Fit qMRI Data

Data

Path data: Browse /Users/mathieuboudreau/neuropoly Study ID: Download example

MTdata + - /Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp View

R1map + - /Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp View

R1map + - /Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp View

R2map + - /Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp View

Mask + - /Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp

Fit Parameters

Source

M

View

A

3D viewer

Sanity Check

Voxel H

ROI H

Statistics

Histogram

Cursor

Select

A

L R

P

(x,y) val

Vol: 1/4 Time: 1/10 Slice: 1/1

Current file: [View qmt_appr documentation](#)

Parallel Processing

Would you like to start a parallel pool with 8 cores?

Yes No

OptionsGUI

qmt_appr options

Protocol

MTdata

	Angle	Offset
1	142	443
2	425	443
3	142	1085
4	425	1085
5	142	2732
6	425	2732
7	142	6262
8	425	6262
9	142	17235
10	425	17235

Add

Move up

Load

Remove

Move down

Create

Timing Table

Tmt (s)	0.0102
Ts (s)	0.0090
Tp (s)	0.0018
Tr (s)	0.0100
TR (s)	0.0260

Fit Protocol

Fitting

Var	Fix	Start	Lower	Upper
F		0.000 1.000	-	0.020
k		80 1.000	-	100
m1	☒	R1/R2	0.000	5
R1	☒	1	0.000	5
T2*		0.000 0.020	0.000	0.020
T2		1.000	0.000	1.000

Options

MT_Pulse

Shape: gaussian

Sinc BW:

Bandwidth: 200

Permutation (s): 0.00001656

of MT pulses: 600

Model: SledPilot

Linehape: Scaled gaussian

Fitting constraints

☒ Use R1map to constrain R1f

☐ Fix R1 to R1f

☐ Fix R1/T2*

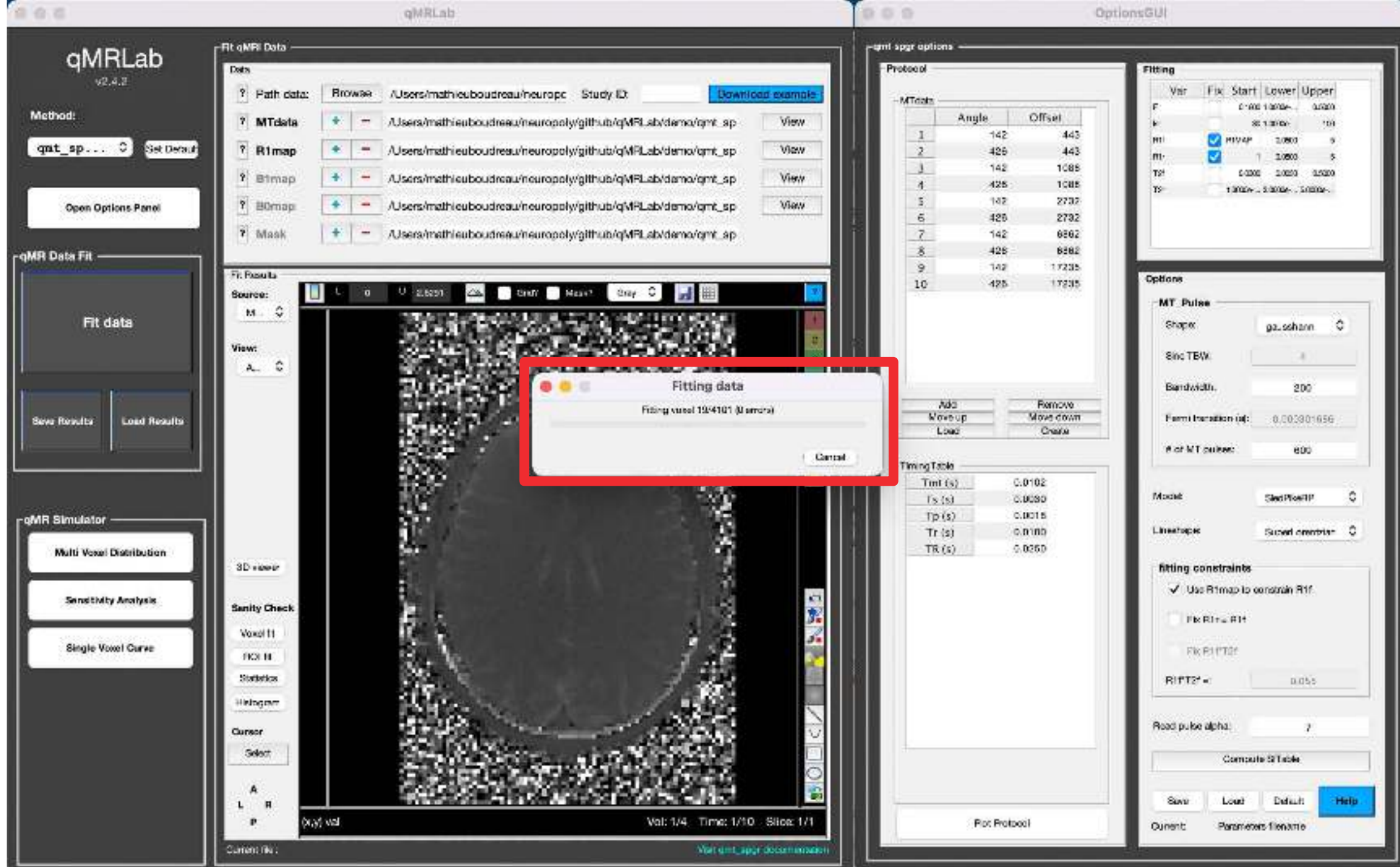
R1/T2* = 0.055

Read pulse alpha: 7

Compute QTable

Save Load Default Help

Current Parameters filename





Method:

qmt_sp...  

qMR Data Fit

Fit data

Save Results

Load Results

qMR Simulator

Multi Voxel Distribution

Sensitivity Analysis

Single Voxel Curve

Fit qMR Data

Data

Path data:		/Users/mathieuboudreau/neuropc	Study ID:	
MTdata	 	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp		
R1map	 	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp		
B1map	 	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp		
B0map	 	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp		
Mask	 	/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp		

Fit Results

Source:

F 

View:

A... 

3D viewer

Sanity Check

Voxel H

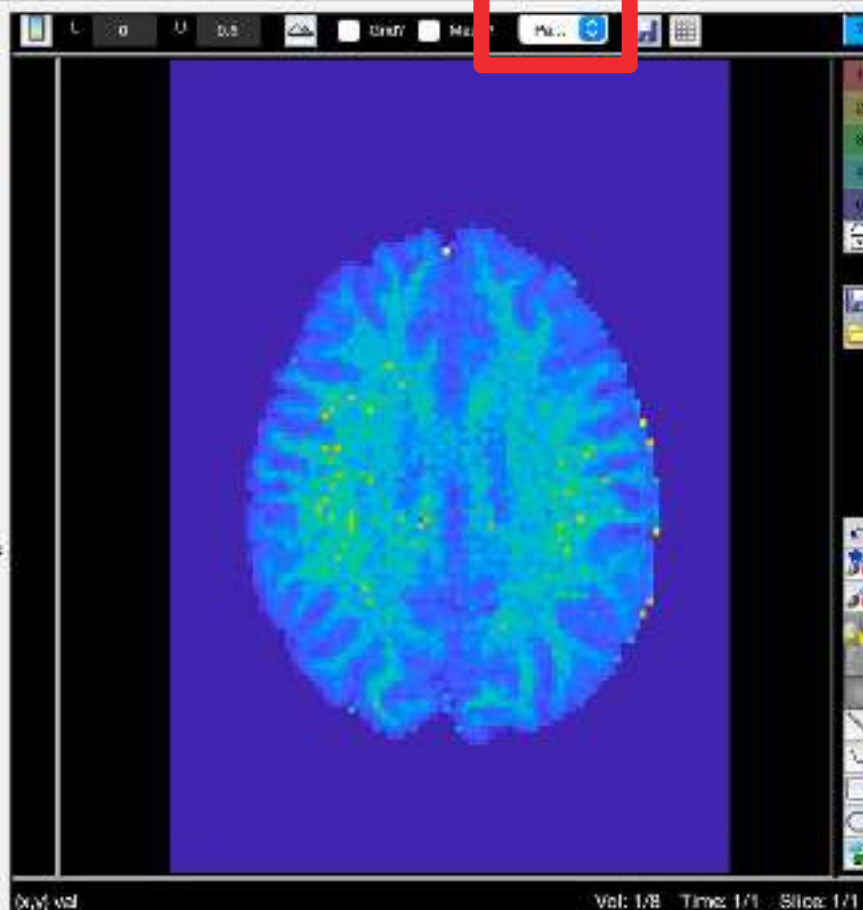
ROI H

Statistics

Histogram

Cursor

Select

A
L R
P

Current file: D:\Res..._hs.mat

[Visit qmt_appr documentation](#)

qmt_appr options

Protocol

-MTdata

	Angle	Offset
1	142	443
2	425	443
3	142	1085
4	425	1085
5	142	2732
6	425	2732
7	142	6262
8	425	6262
9	142	17235
10	425	17235

Add

Move up

Load

Remove

Move down

Create

TimingTask

Tmt (s)	0.0102	0.
Ts (s)		
Tp (s)		
Tr (s)		
TR (s)		

Plot Protocol

Fitting

Var	Fix	Start	Lower	Upper
F		0.000 1.000	-	0.020
k		80 1.000	-	100
m	☒	R1/RP	0.000	5
R1	☒	1	0.000	5
T2		0.000 0.020	0.020	0.020
T2'		1.000	0.000	5.000

Options

MT_Pulse

Shape:	gaussian
Sinc TRW:	4
Bandwidth:	200
Form factor (a):	0.00001666
# of MT pulses:	600

Model: Line shape: 

Fitting constraints

☒ Use R1map to constrain R1☐ Fix R1 = R11☐ Fix R1/T2'

R1/T2' = 0.053

Read pulse alpha: 7

Compute S/T table

Save

Load

Default

Help

Current: Parameters: Parameters



Method:

qmt_sp...

qMR Data Fit

Fit data

Save Results

Load Results

qMR Simulator

Multi Voxel Distribution

Sensitivity Analysis

Single Voxel Curve

Fit qMR Data

Data

Path data:		/Users/mathieuboudreau/neuropc	Study ID:	
MTdata		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp		
R1map		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp		
R1map		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp		
R2map		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp		
Mask		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp		

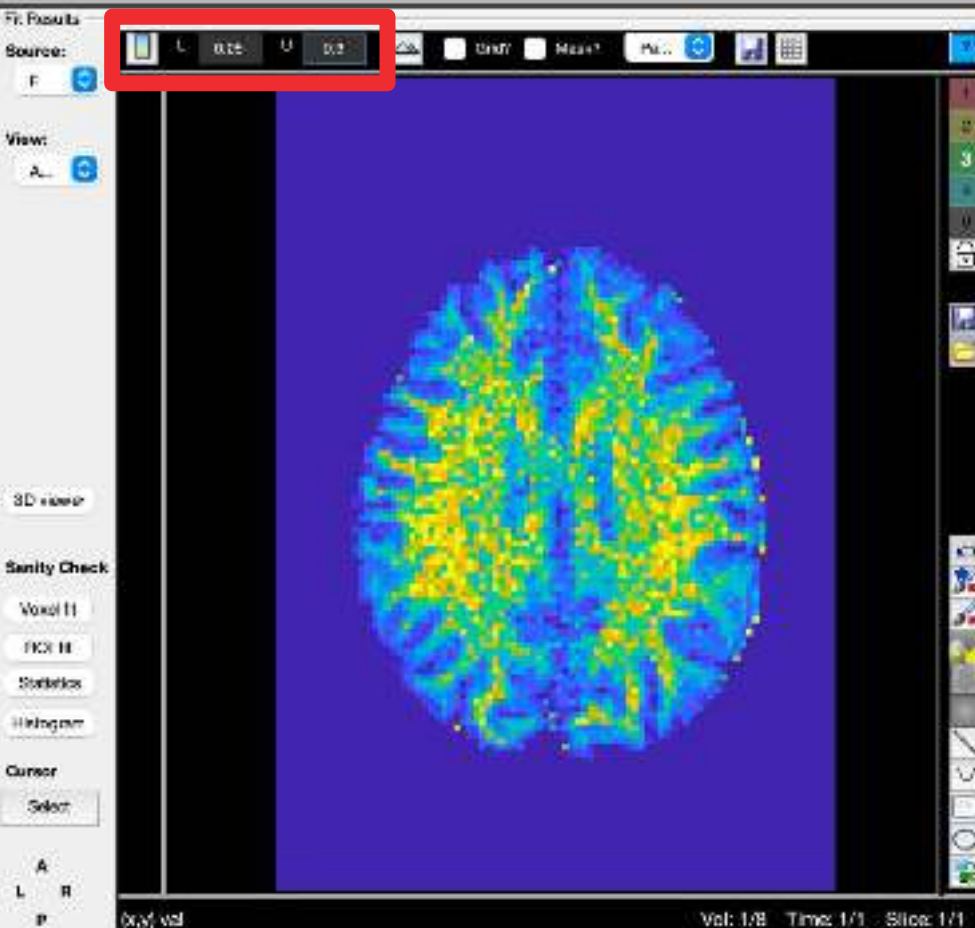
Fit Results

Source:

F

View:

A



3D view

Sanity Check

Voxel H

ROI H

Statistics

Histogram

Cursor

Select

A
L R
P

Current file: fitRes_fit.mat

[View qmt_spr documentation](#)

qmt spr options

Protocol

-MTdata

	Angle	Offset
1	142	443
2	425	443
3	142	1085
4	425	1085
5	142	2732
6	425	2732
7	142	6262
8	425	6262
9	142	17235
10	425	17235

Add

Move up

Load

Remove

Move down

Create

TimingTable

Tmt (s)	0.0102	0.
Ts (s)		
Tp (s)		
Tr (s)		
TR (s)		

Fit Protocol

Fitting

Var	Fix	Start	Lower	Upper
F		0.000 1.000		0.020
k		80 1.000		100
m	☒	R1/R2	0.000	5
R1	☒	1	0.000	5
T2		0.000 0.020	0.000	0.020
T2'		1.000	0.000	0.000

Options

MT_Pulse

Shape: gaussian

Sinc TRW: 4

Bandwidth: 200

Fermi position (a): 0.00001656

of MT pulses: 600

Model

SkatPwRP

LineShape:

SuperLorentzian

Fitting constraints

☒ Use R1map to constrain R1☐ Fix R1 = R1'☐ Fix R1/T2'

R1/T2' = 0.055

Read pulse alpha:

7

Save

Load

Default

Current: Parameters: fitParams

qMRLab
v2.4.2

Method:
qmt_sp...
Open Options Panel

qMR Data Fit
Fit data
Save Results Load Results

qMR Simulator
Multi Voxel Distribution
Sensitivity Analysis
Single Voxel Curves

Fit qMRI Data

Path data: /Users/mathieuboudreau/neuropoly/ Study ID: Download example

MTdata

R1map

R1map

R2map

Mask

View

View

View

View

Fit Results

Source:
F
kr
R1f
R1f
T2f
T2f
kr
norm

3D viewer

Sanity Check
Voxel H
ROI H
Statistics
Histogram

Cursor
Select
A
L R
P

(x,y) val

Vol: 1/8 Time: 1/1 Slice: 1/1

Current file: D:\Res...
Visit qmt_app documentation

OptionsGUI

qmt app options

Protocol

MTdata

TimingTask

Fit Protocol

Fitting

Options

Model

Fit constraints

Read pulse alpha

Compute S/T maps

Save Load Default Help

Current: Parameters: Functions

Var	Fix	Start	Lower	Upper
F		0.000	0.000	0.000
k		0.000	0.000	0.000
m	☒	0.000	0.000	0.000
R1	☒	0.000	0.000	0.000
T2		0.000	0.000	0.000
T2*		0.000	0.000	0.000

Angle	Offset
142	443
425	443
142	1085
425	1085
142	2732
425	2732
142	6362
425	6362
142	17235
425	17235

Tmt (s)	Ts (s)	Tp (s)	Tr (s)	TR (s)
0.0102	0.			

MT_Pulse

Shape: gaussian

Sinc TRW: 4

Bandwidth: 200

Fermi k (k): 0.00001656

of MT pulses: 600

Model: SkatPwRP

LineShape: SuperLorentzian

Fit constraints

☒ Use R1map to constrain R1f

☐ Fix R1 = R1f

☐ Fix R1/T2f

R1/T2f = 0.053

Read pulse alpha: 7

Compute S/T maps

Save Load Default Help

Current: Parameters: Functions



Method:

qmt_sp...

qMR Data Fit

Fit data

Save Results

Load Results

qMR Simulator

Multi Voxel Distribution

Sensitivity Analysis

Single Voxel Curve

Fit qMR Data

Data

Path data:		/Users/mathieuboudreau/neuropc	Study ID:		
MTdata		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp			
R1map		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp			
B1map		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp			
B0map		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp			
Mask		/Users/mathieuboudreau/neuropoly/github/qMRLab/demo/qmt_sp			

Fit Results

Source:

T2*

View:

A_

3D viewer

Sanity Check

Voxel H

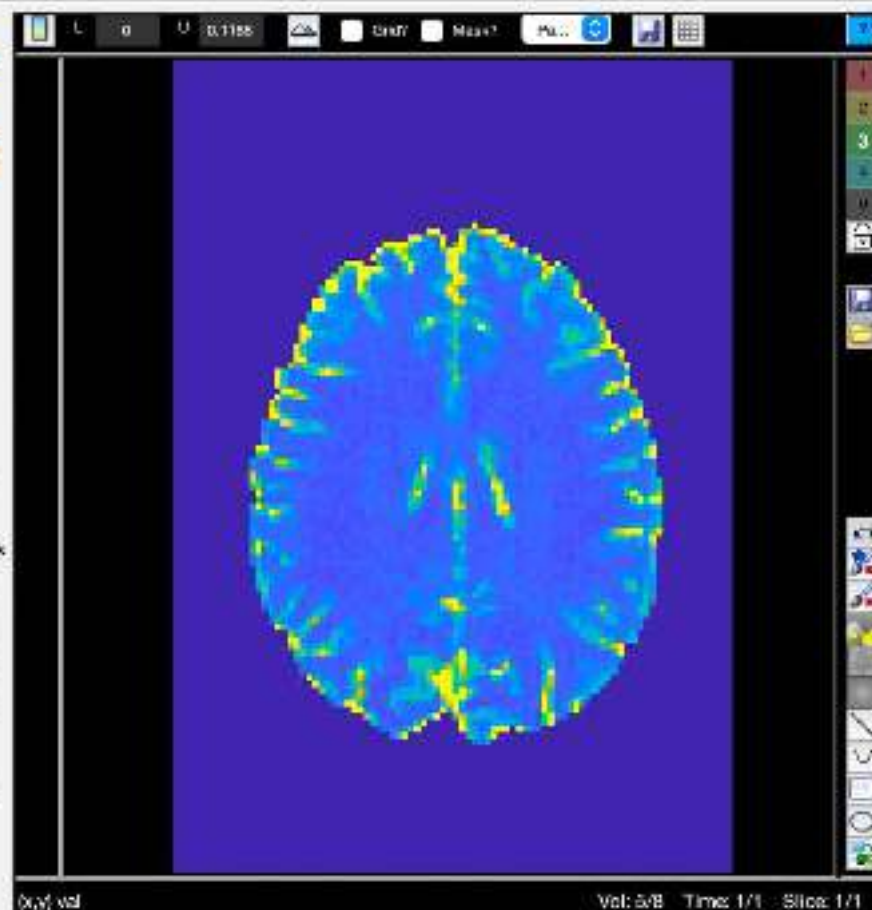
Voxel H

Statistics

Histogram

Cursor

Select

A
L R
P

Current file: fitRes_hb.mat

[View qmt_spr documentation](#)

qmt spr options

Protocol

-MTdata

	Angle	Offset
1	142	443
2	425	443
3	142	1085
4	425	1085
5	142	2732
6	425	2732
7	142	6262
8	425	6262
9	142	17235
10	425	17235

Add

Move up

Load

Remove

Move down

Create

TimingTable

Tmt (s)	0.0102	0.
Ts (s)		
Tp (s)		
Tr (s)		
TR (s)		

Fit Protocol

Fitting

Var	Fix	Start	Lower	Upper
F		0.000 1.000	-	0.000
k		80 1.000	-	100
m	☒	R1/R2	0.000	5
R1	☒	1	0.000	5
T2*		0.000 0.000	0.000	0.000
T2		1.000	0.000	0.000

Options

MT_Pulse

Shape: Sinc TRW: Bandwidth: Form factor (k): # of MT pulses: Model: Line shape:

Fitting constraints

☒ Use R1map to constrain R1☐ Fix R1 = R1f☐ Fix R1/T2*R1/T2* = Read pulse alpha:

Save

Load

Default

Help

Current: Parameters: fitRes_hb.mat

Other options:

command line interface (**CLI**)

scripting and **batch** demos

```

1 % This n-file has been automatically generated using qMRgenBatch(qmt_spgr)
2 % Command Line Interface (CLI) is well-suited for automatization
3 % purposes and Octave.
4 %
5 % Please execute this n-file section by section to get familiar with batch
6 % processing for qmt_spgr on CLI.
7 %
8 % Demo files are downloaded into qmt_spgr_data folder.
9 %
10 % Written by: Agah Karakuzu, 2017
11 % =====

```

qmt_spgr_batch.m

%% I- DESCRIPTION

```

14 qMRInfo('qmt_spgr'); % Describe the model

```

%% II- MODEL PARAMETERS

```

18 %%      a- create object

```

```

20 Model = qmt_spgr;

```

```

22 %%      b- modify options

```

```

23 %      |- This section will pop-up the options GUI. Close window to continue.

```

```

24 %      |- Octave is not GUI compatible. Modify Model.options directly.

```

```

26 Model = Custom_OptionsGUI(Model); % You need to close GUI to move on.

```

%% III- FIT EXPERIMENTAL DATASET

```

29 %%      a- set protocols via gui

```

```

30 Angle = [142.0000; 426.0000; 142.0000; 426.0000; 142.0000; 426.0000; 142.0000; 426.0000; 142.0000; 426.0000];

```

```

31 % Angle is a vector of [10X1]

```

```

32 Offset = [443.0000; 443.0000; 1088.0000; 1088.0000; 2732.0000; 2732.0000; 6862.0000; 6862.0000; 17235.0000; 17235.0000];

```

```

33 % Offset is a vector of [10X1]

```

```

34 Model.Prot.MTdata.Mat = [ Angle Offset];

```

```

35 %%

```

```

36 Tn1 = 0.8102;

```

```

37 Ts = 0.003;

```

```

38 Tp = 0.0018;

```

```

39 Tr = 0.01;

```

```

40 TR = 0.025;

```

```

41 Model.Prot.TimingTable.Mat = [ Tn1 Ts Tp Tr TR ];

```

```

42 %%

```

```

43 %%      b- load experimental data

```

```

44 %      |- qmt_spgr object needs 5 data input(s) to be assigned:

```

```

45 %      |- MTdata

```

```

46 %      |- Rmap

```

```

47 %      |- Bmap

```

```

48 %      |- B0map

```

```

49 %      |- Mask

```

```

51 data = struct();

```

Using qMRLab From Scanner to Publication

See abstract #0366



0366

Multicenter reproducibility of quantitative MRI using vendor-neutral sequences (VENUS)

Agah Karakuzu^{1,2}, Julien Cohen-Adad^{1,3}, and Nikola Stikov^{1,2}

¹NeuroPoly Lab, Polytechnique Montreal, Montreal, QC, Canada, ²Montreal Heart Institute, Montreal, QC, Canada,

³Unité de Neuroimagerie Fonctionnelle (UNF), Centre de recherche de l'Institut Universitaire de Gériatrie de Montréal (CRIUGM), Montreal, QC, Canada

Synopsis

Vendor-native implementations can lead to unaccounted variance in quantitative MRI (qMRI). The purpose of this study is to show that fully transparent qMRI workflows coupled with VEndor-NeUtral Sequences (VENUS) improve multicenter reproducibility of quantitative MRI maps across three scanners by two vendors, in phantoms and in-vivo. We developed and deployed a vendor-neutral 3D spoiled gradient-echo (SPGR) sequence on three commercial scanners and showed that vendor-neutral qMRI maps of T1, MTR and MTsat outperform their vendor-native counterparts in terms of reproducibility.

Introduction

Quantitative MRI (qMRI) has the potential to revolutionize imaging by standardizing the data that come out the scanner and assigning units to help with interpretation. However, qMRI is plagued by reproducibility problems arising from variability across scanners and vendor-native pulse sequence implementations. In-vivo, this problem recurs in nearly all fields of qMRI, from relaxometry¹ and diffusion imaging² to magnetization transfer³ (MT). Unifying pulse sequence implementations between scanners⁴ and across vendors¹ shows potential for improving reproducibility. However, what is currently missing is a vendor-neutral approach⁵⁻¹⁰ to this problem.

Figures



Figure 1 - Schematic illustration of the experimental design for multicenter data collection using vendor-native (solid lines) and vendor-neutral sequences (VENUS, dashed lines). 3 MRI scanners are located at 2 sites, where RTHawk was used to i) run open-source VENUS (https://github.com/qmrlab/mt_sat), ii) export raw and reconstructed images in BIDS and ISMRM-RD format, respectively and iii) generate T1, MTR and MTsat maps using qMRLab workflows. Vendor-native data was processed off-site.

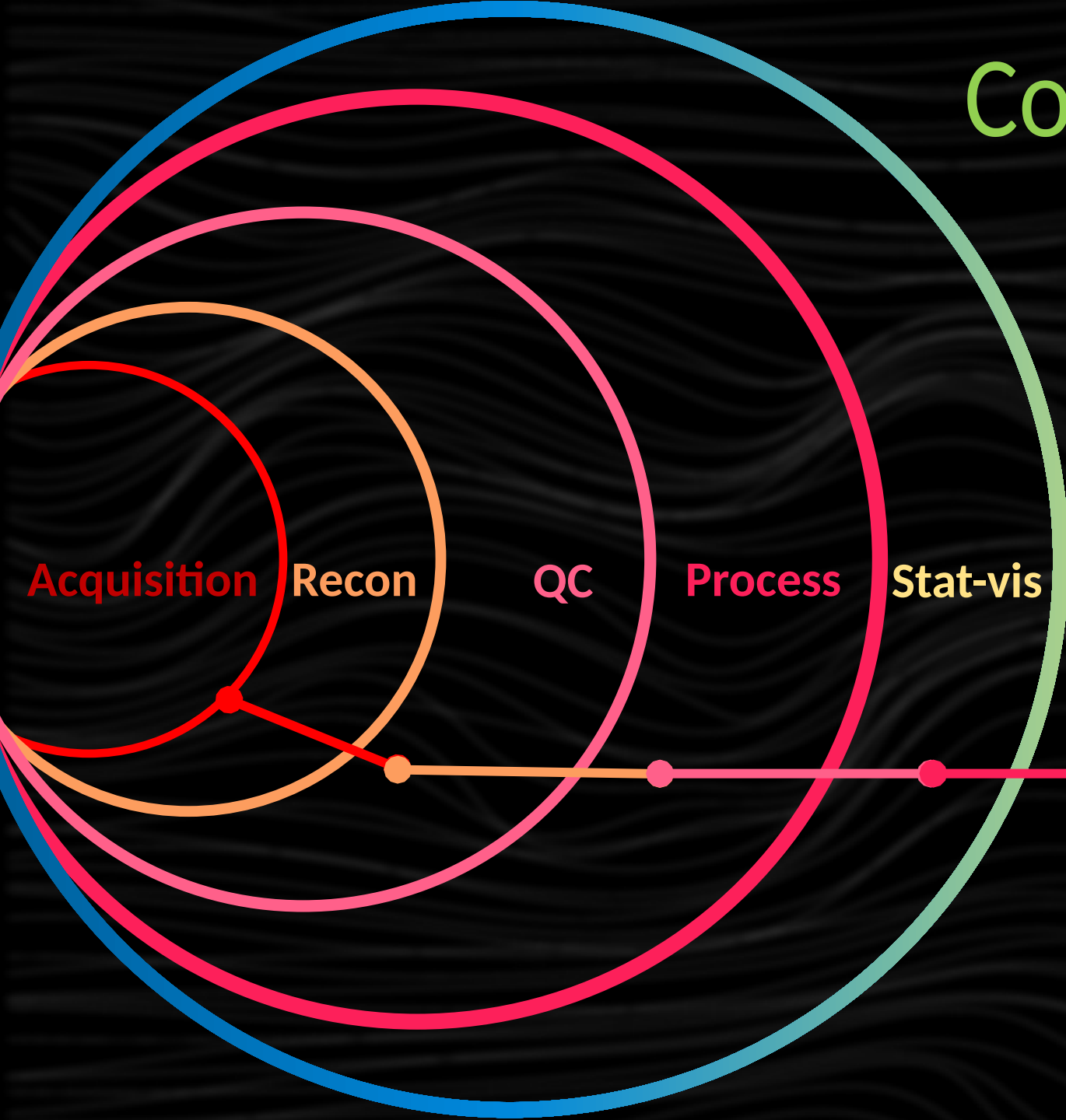
Sequence ID	01	02	03
Sequence name	3D SPGR	3D SPGR	3D SPGR
TR (ms) (S, A, R)	12, 12, 12	25, 25, 19	25, 25, 19
FA (°) (S, A, R)	8, 8, 20	8, 8, 20	8, 8, 20
TE (ms)	1	1.9	1.9
SDV (mm)	30	11.4	11.4
Acquisition matrix	128x128	128x128	128x128
Slice thickness	1	1	1
Base temperature (°C)	36.5	31.4	31.2



Agah Karakuzu

Also accepted in *Magn Res Med* (2022)

Container
mediated



Data-driven

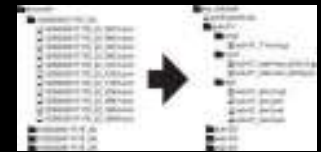
nextflow

Raw data (k-space)



ismrmrd/latest

ISMIRMRD



gadgetron/latest

Output



Input

BIDS
BRAIN IMAGING DATA STRUCTURE



elastix/latest

BIDS
BRAIN IMAGING DATA STRUCTURE



qmrlab/minimal



ISOLATE
LOGIC FROM ORCHESTRATION



MAP
ONE PROCESS TO ONE CONTAINER

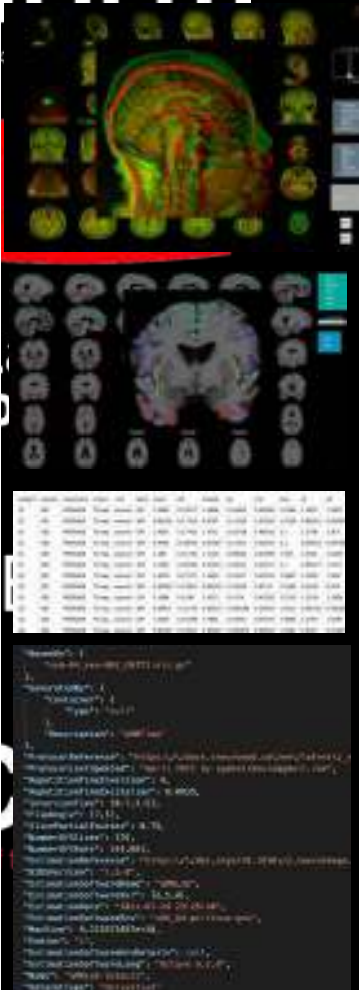
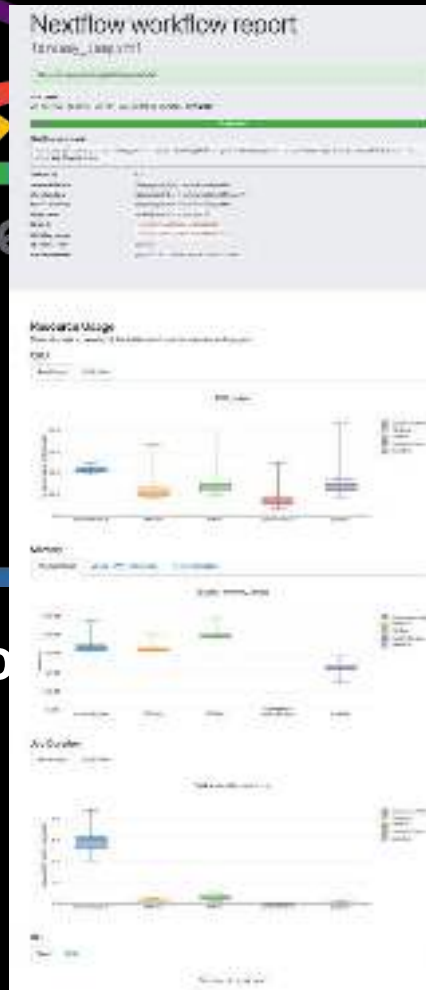


USE
COMMUNITY DATA STANDARDS

System agnostic



```
nextflow run mtsatflow_BIDS.nf --root BIDS_folder
```

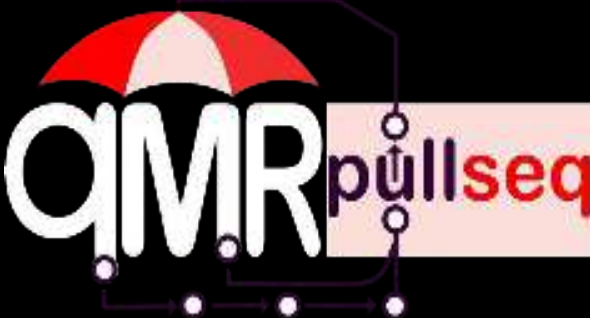


ISMRM-RD +  BIDS +  + nextflow +  qMR Lab =  qMRFlow



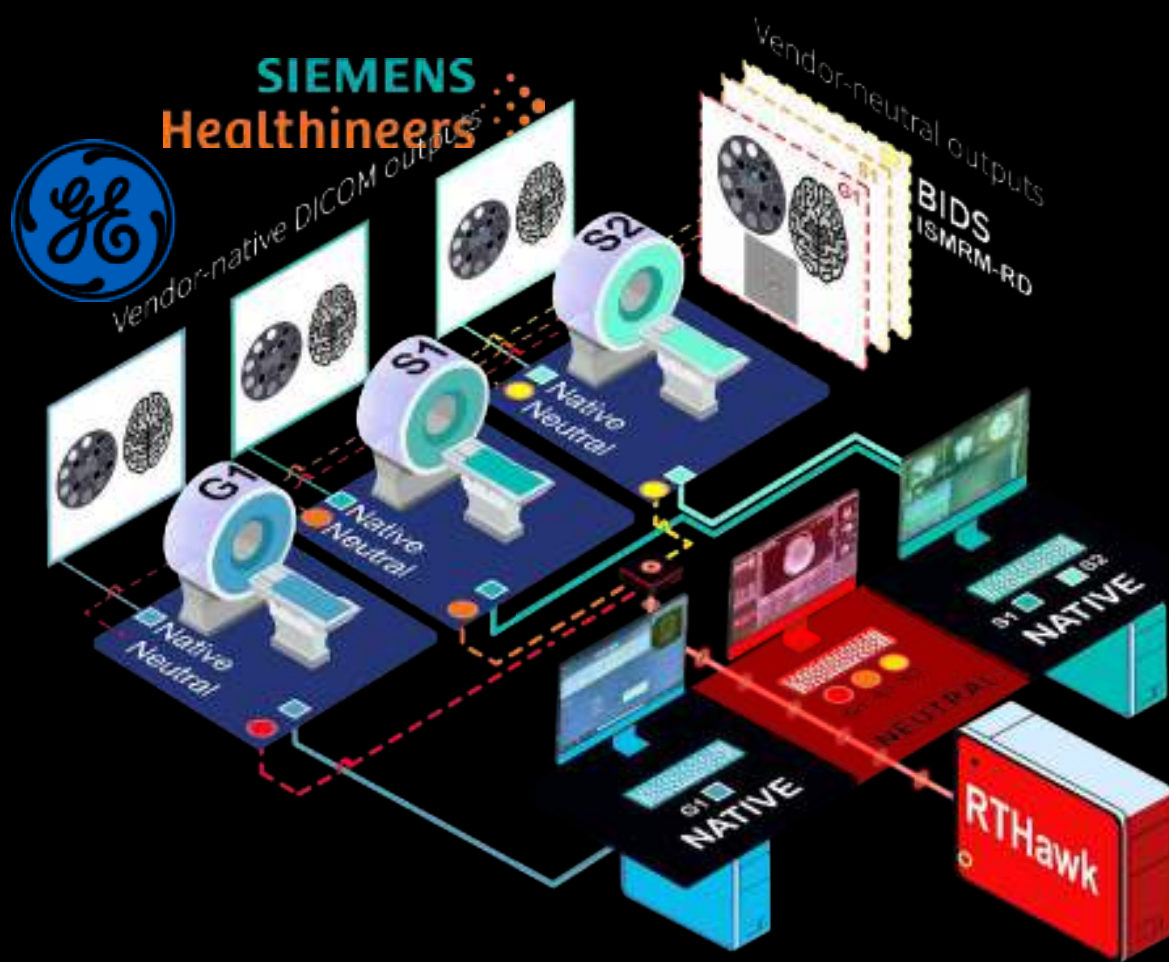
```
git clone https://github.com/qMRLab/pulse_sequences.git
```



 qMRpullseq +  qMRFlow

VENUS

VEndor **Ne**Utral **S**equences



0.1 to 1.9s (3T)



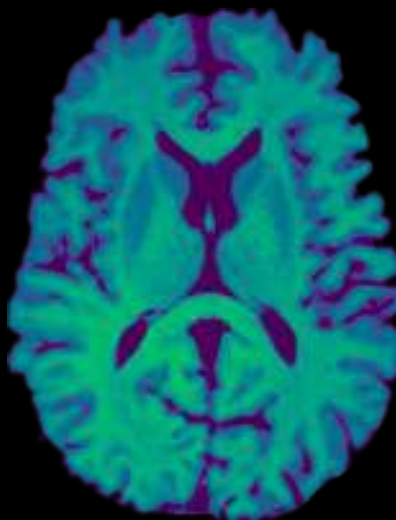
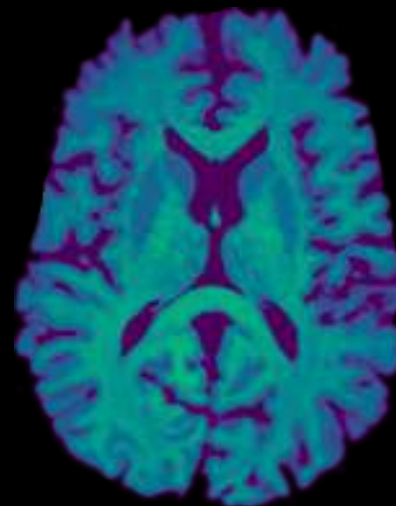
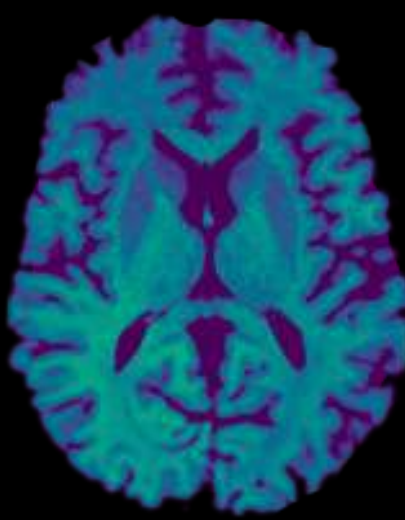
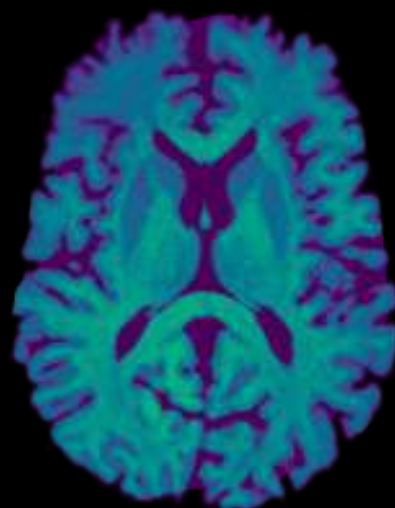
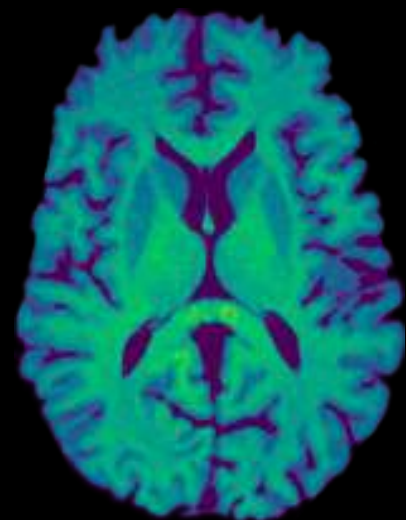
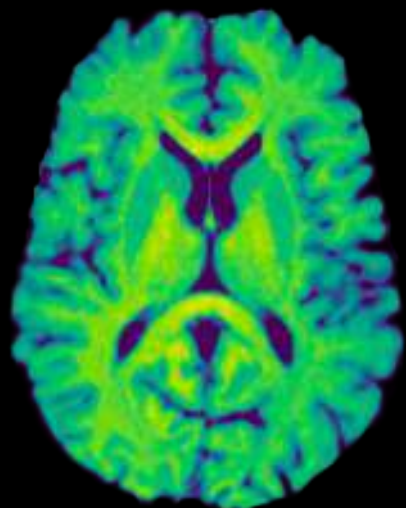
Healthy participants

	Common acquisition parameters
FA (°) PDw/MTw/T1w	6/6/20
MT PDw/MTw/T1w	off/on/off
Voxel size (mm)	1x1x3
TR (ms) PDw/MTw/T1w	32/32/18
TE (ms)	4
FOV (cm)	25.6
Readout bandwidth (kHz)	62.5
MT frequency offset (Hz)*	1200



VENUS

NATIVE



70

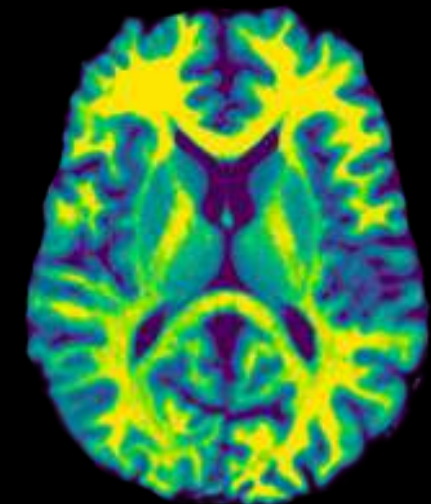
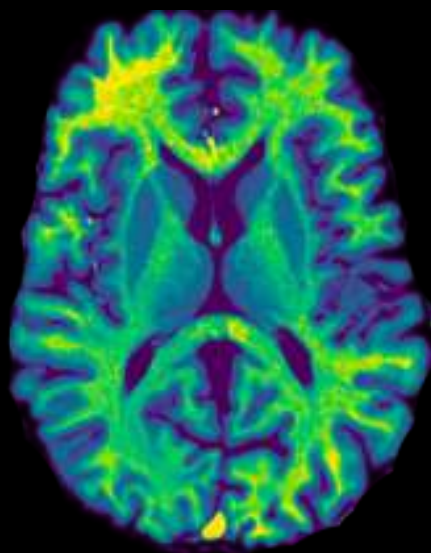
MTR(%)

35

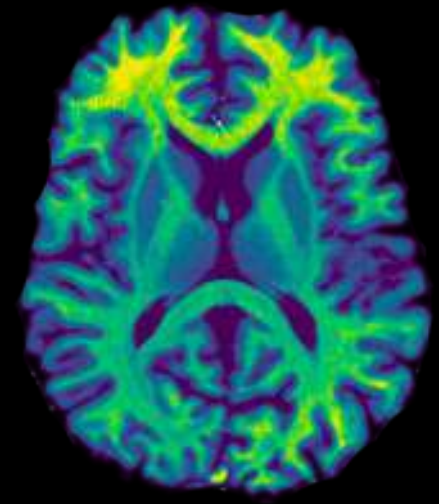
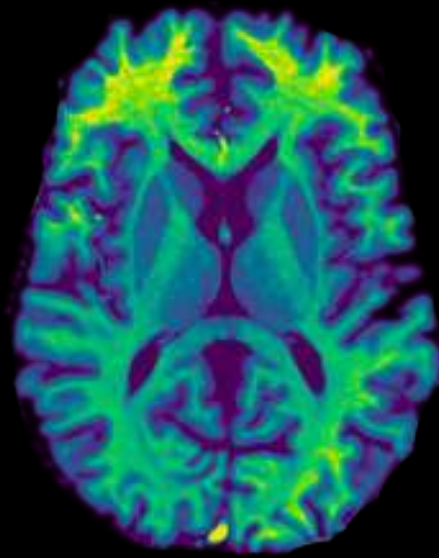


VENUS

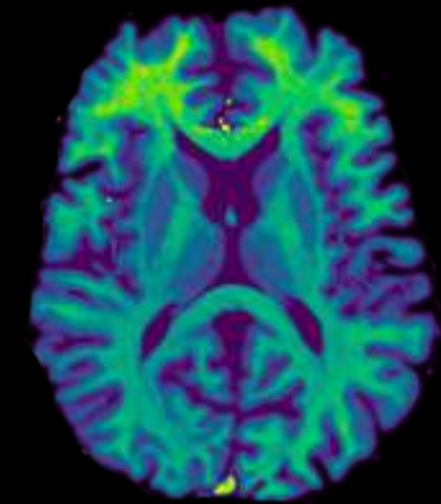
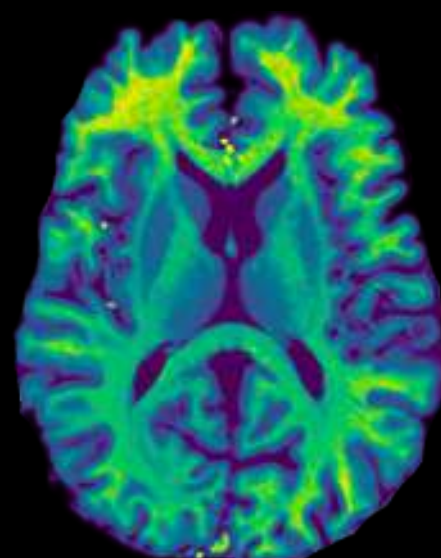
NATIVE



G1



S1



S2



5.5

MTsat
(a.u.)

1

Acknowledgements

Current & old lab members, external contributors, and users

Agah Karakuzu

Bruce Pike

Eva Alonso-Ortis

Gabriel Berestovoy

Ian Gagnon

Ilana Leppert

Ives Levesque

Harris Nami

Juan Velazquez Reyes

Jean-François Cabana

John Sled

Julien Cohen-Adad

Manh-Tung Vuong

Nikola Stikov

Pascale Beliveau

Tanguy Duval

Tommy Boshkovski

Ye Gu

Zaki Ahmed

