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## 1. Overview

T2map is a software utility and graphical user interface to reconstruct T2 maps from multi-echo spin-echo MRI acquired with an MR Solutions preclinical MRI system.

## 2. Contact

T2map and this manual are written by:

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## 3. Disclaimer

The software has been extensively tested using mouse and rat data acquired with an MR Solutions preclinical 7.0T/24cm system.

However, this does not warrant the functions contained in the program will meet your requirements or that the operation of the program will be uninterrupted or error-free.

In case of questions or issues, please contact Gustav Strijkers or Bram Coolen.

## 4. Installation notes

### Software download

Matlab source code and a Windows standalone version (using the free Matlab runtime engine) can be downloaded from github:

<https://github.com/Moby1971?tab=repositories>

### Installation of the Windows standalone version

`MyAppInstaller_web.exe`

Will install the Matlab runtime engine and the T2map program.

## 5. Running the software

### Running in Matlab 2020a

The T2map software can be started from its root directory from the command line.

```
>> T2map
```

Notes:

Additional licenses may be required.

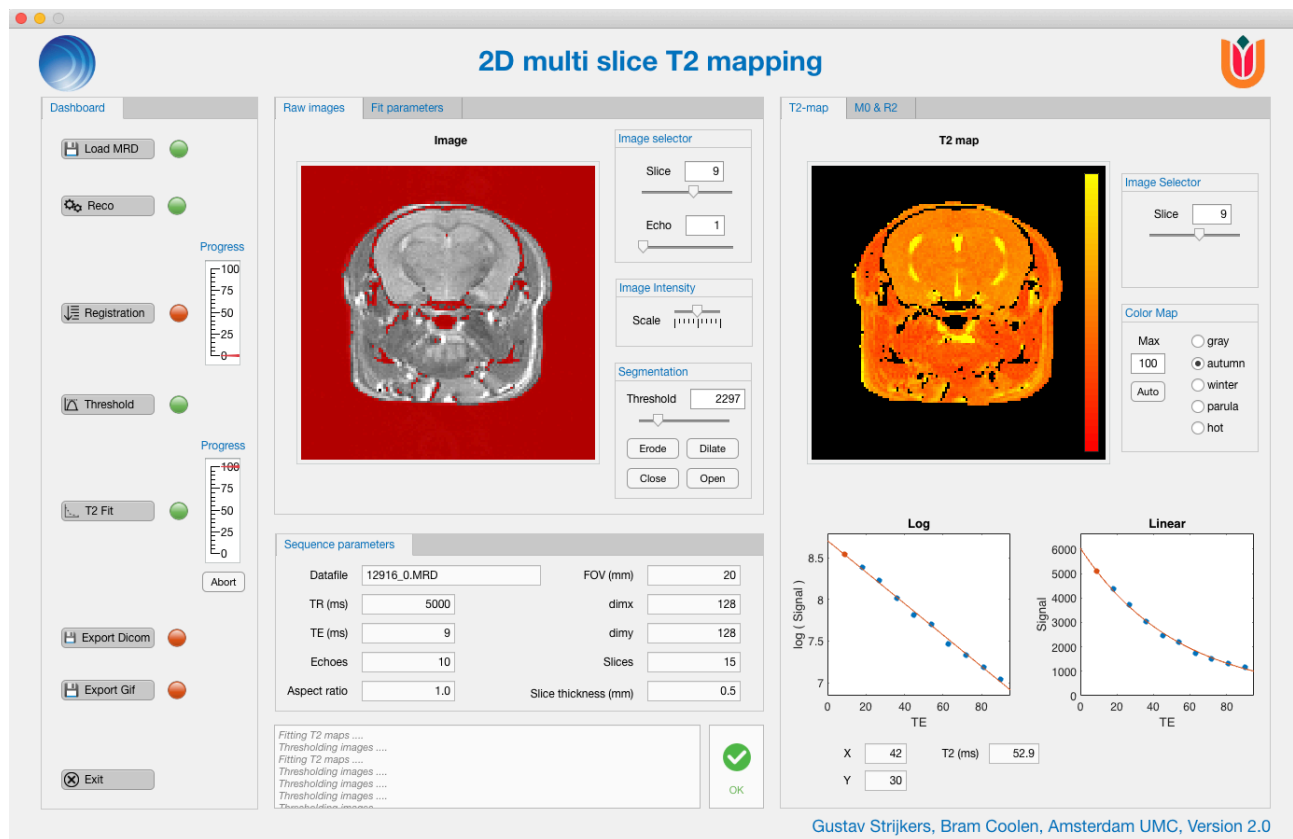
```
>> license 'inuse'
    distrib_computing_toolbox
    image_toolbox
    map_toolbox
    matlab
    signal_toolbox
```

### Running the Windows standalone

The Windows standalone version can be run from the start menu or the desktop icon.

## 6. Basic operation

The T2map program operates from a single window with 5 panels.



### Panel 1: Dashboard

This panel contains the task buttons and parameters that control the reconstruction process. The dashboard tasks need to be completed from top to bottom. A green light next to the task indicates that the task has been completed. Red indicates not completed yet.

### Panel 2: Raw images & fit parameters

This panel has 2 tabs, raw images and fit parameters.

### Panel 3: Scan parameters

This panel displays the relevant acquisition parameters.

### Panel 4: T2-map, M0 & R2

During and after fitting is completed this panel shows the fitted T2-maps. M0-maps and R<sup>2</sup> goodness of fit maps are displayed in the second tab.

### Panel 5: Messages

Displays program status and messages.

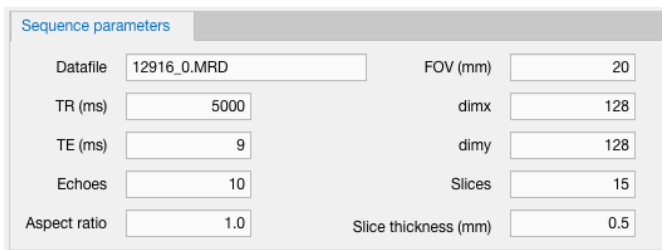
### Step 1: Loading data

Press  to import load the MRD raw data file.

T2map in principle needs multi-echo spin-echo data.

Reconstruction of multi-coil data is not supported (yet).

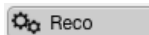
Relevant acquisition parameters will be shown in panel 3.



Sequence parameters

Datafile	12916_0.MRD	FOV (mm)	20
TR (ms)	5000	dimx	128
TE (ms)	9	dimy	128
Echoes	10	Slices	15
Aspect ratio	1.0	Slice thickness (mm)	0.5

### Step 2: Image reconstruction

Press  to perform a Fourier transform reconstruction of the multi-slice multi-echo images.

### Step 3: Image registration

Use the sliders and/or edit-fields to inspect the slices and images as function of echo-time (TE). The image scale can be adjusted with the Scale slider.



Image

Image selector

Slice

Echo

Image Intensity

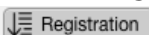
Scale

Segmentation

Threshold

Erode Dilate

Close Open

In case the images as function of TE are not perfectly registered, press  to perform an affine registration which includes translation, rotation, and scale.

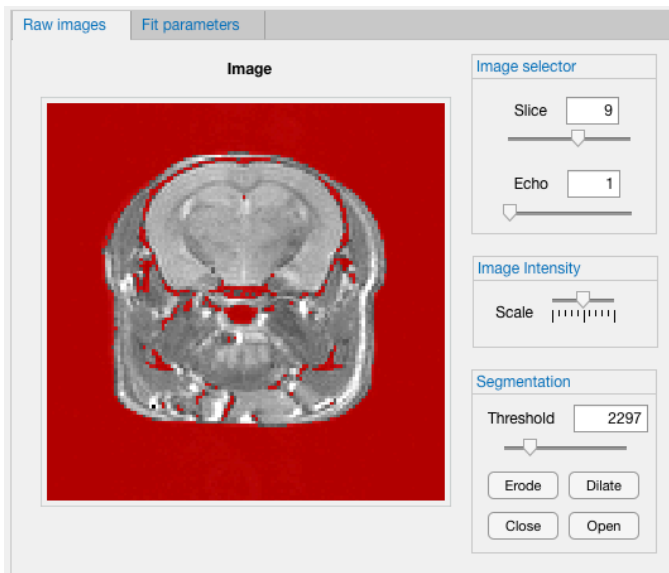
NOTE: this step usually can be omitted.

#### Step 4: Segmenting the images

To prevent unnecessary fitting of the background pixels, the images need to be segmented first.

Press  **Threshold** to perform an automatic thresholding segmentation.

The result will look something like the figure below in which the red pixels indicate the regions that will be skipped during T2 fitting.



In case automatic thresholding is not satisfying, the threshold can be manually adjusted per slice. The segmentation can be optimized by erode, dilate, close, and open morphological operations.

## Step 5: Fitting T2 maps

Press the Fit parameters tabs to inspect some fit settings.

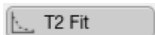
The screenshot shows the 'Fit parameters' tab in the software. It contains three main sections:

- Slice selection:** Two input fields, 'First slice' with the value '1' and 'Last slice' with the value '15'.
- Goodness of fit:** A label 'Min R-square' followed by a value of '0.80'.
- Echo selection:** A grid of 64 checkboxes arranged in 8 rows and 8 columns, numbered 1 to 64. Most checkboxes are checked, including all even-numbered echoes (2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64) and many odd-numbered echoes (9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63).

The first and last slice that will be fitted can be selected.

Min R-square is the minimally accepted  $R^2$  value that is accepted after fitting. If the result of a T2 fit in a pixel results in an  $R^2$  value less than Min R-square, then the T2 and M0 values in this pixel will be omitted and set to zero.

The bottom part of this tab shows a list of all the echo numbers. The echos that are selected will be included in the fitting process. This option can be used to exclude certain TEs, for example the first TE, the last TEs below noise level, or in some cases you may only want to fit the even or odd echo numbers.

Press  to start the T2 fitting.

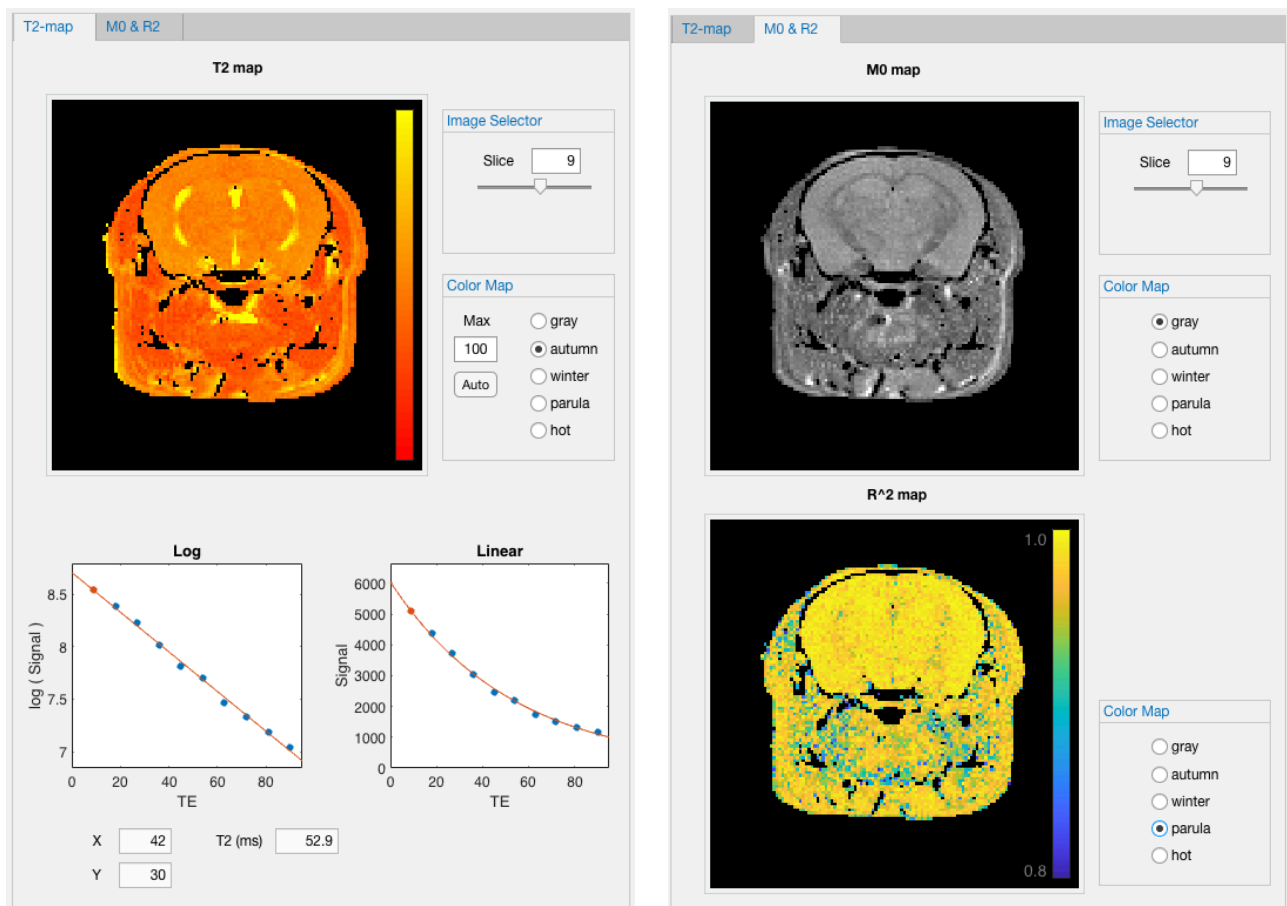
Fitting will be done using a least-squares algorithm according to the equation

$$\text{Signal} = M0 \exp(-TE/T2)$$



## Step 6: Fit results

The T2 maps will be shown in the T2-map tab. An M0 map and R<sup>2</sup> map are shown in the second tab. A different color scheme can be chosen for the different maps.



Click on the T2 map with the mouse cursor to display  $\log(\text{Signal})$  and Signal as function of TE (symbols) and the fit result (red lines). The fitted T2 in the pixel is shown below the plots. A red symbol indicates that this TE was omitted in the fitting process, according to the list in the Fit parameters tab (see step 5).

## Step 7: Exporting the T2 maps

There are two ways to export the T2, M0, and R<sup>2</sup> maps.

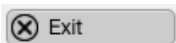
### (1) **Export Dicom**

Exports the data in Dicom format for further processing in 3rd party software. The program searches for the Dicom information. If this information is not found, tags will be generated by the program itself. In the latter case the correct image position and orientation information are lost.

### (2) **Export Gif**

Exports the data in Gif format.

## Step 8: Exit

Press  to shut down the program.