Physics MRI Research Centre

T$_2$Mapper
VERSION 1.07

User's Guide

Last Update April 6th, 2016 by Thierry Pelletier

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Introduction

Scope

The T$_2$Mapper is designed to facilitate the process of determining T$_2$ distributions from a variety of different file types found at the MRI Center. It surrounds the Oxford Instruments WinDXP engine so that the engine can be used to process each pixel independently and automates the process so that the user is not required to process each pixel manually. Once the data has been processed, the T$_2$Mapper uses the data to create a contour or waterfall plot to represent the data.
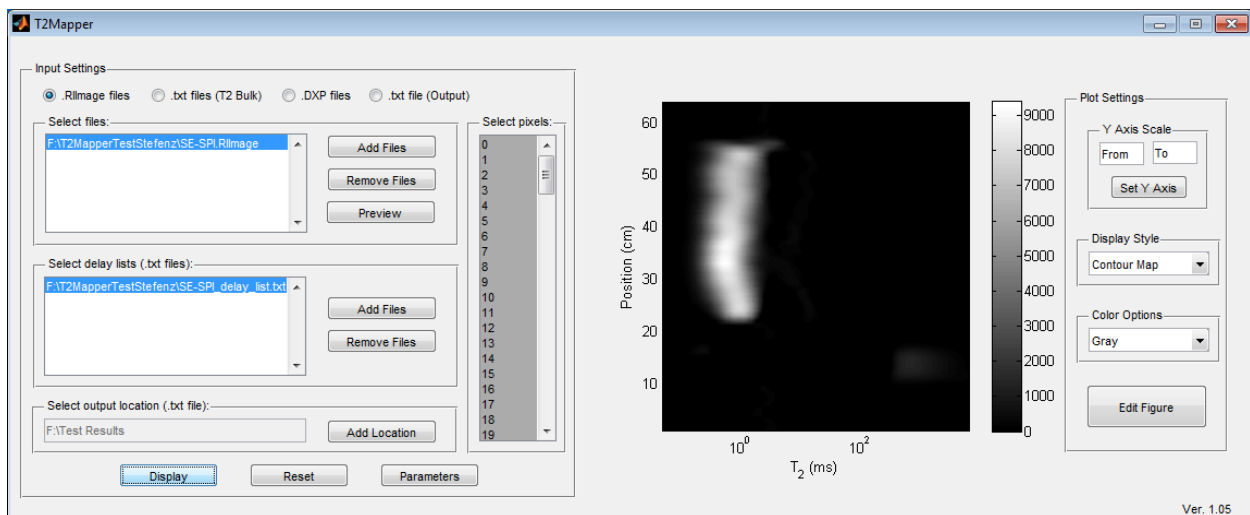
Functionality Summary

The T$_2$Mapper is currently capable of the following:

- Reading .RIImage files and processing them using WinDXP using user selected delay lists, pixels, and WinDXP parameters
- Reading T2 Bulk files (.txt files) and processing them using WinDXP using user selected delay lists, pixels, and WinDXP parameters
- Reading .DXP files, regardless of whether they were Wrapper or T2Mapper generated, and processing them
- Reading output .TXT files, regardless of whether they were DXPExtractor or T2Mapper generated, and processing them
- Displaying the processed data with a variety of display options for the user, as well as allowing for direct editing of the plot using the plot tools interface.

Note: The standalone program (.exe) works but lacks the plot tools interface functionality as it is not included in the MatLab compiler.

Running T$_2$Mapper

Requirements
In order to run the T$_2$Mapper, the computer requires the following:

- WinDXP, by Oxford Instruments, installed on the computer
- windxp.bat (included with the program) to be in the same folder as the T2Mapper program
- MatLab (for the .m version) or the MatLab Compiler (for the .exe version)

Using MatLab
1. Open the file T$_2$Mapper.m in MatLab
2. Select Run
3. If prompted to change folder, select "Change Folder"
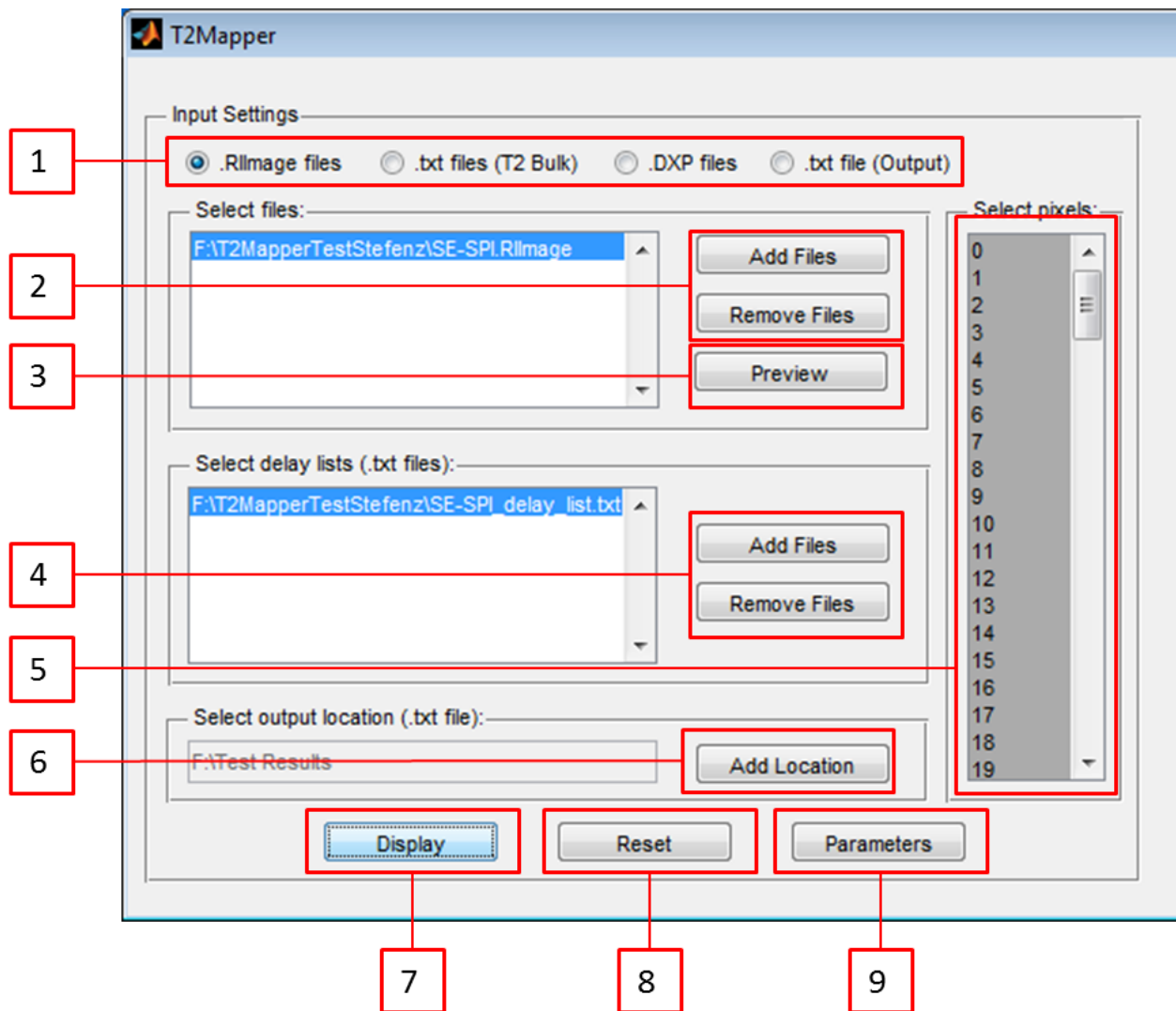
Using T2Mapper.exe
1. Open T$_2$Mapper.exe
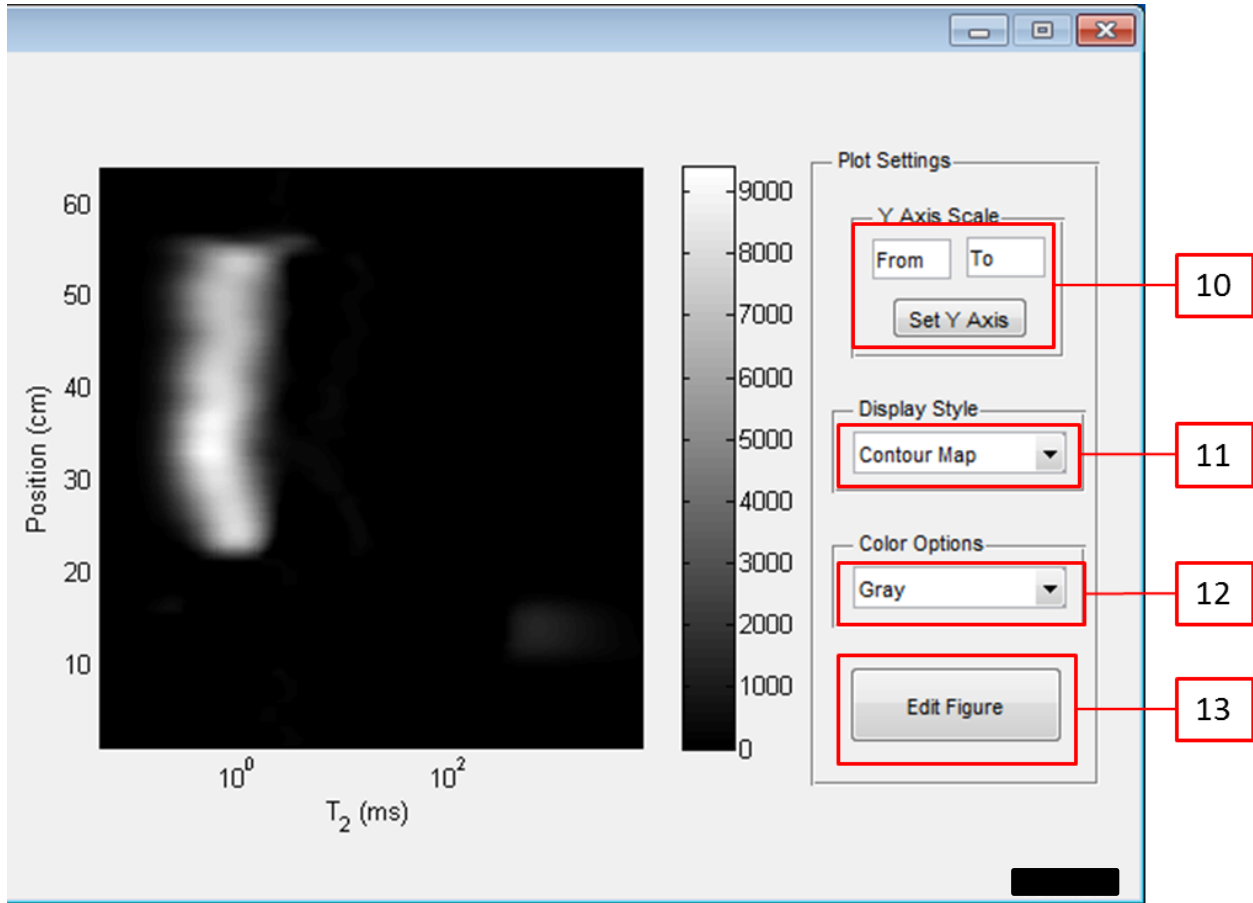
The T2Mapper Interface

Main Window
There are two sections to the main window: the left section, where input can be loaded, and the right section, where processed data is displayed.

Left Section:

Right Section:

1. File Type Selector: Allows the user to select what kind of file(s) they would like to process.
2. Add/Remove Input Files: These buttons add and remove files to be processed, respectively. For T2 Bulk measurements you need at least two input files, to be able to display Contour Map. The Waterfall graph can generated with a single input file.
3. RIImage Preview: This button displays a preview of the RIImage file, displaying each profile as well as the sum of profiles. Useful for seeing how many pixels are in the file.
4. Add/Remove Delay Lists: These buttons add and remove delay lists that go with the files to be processed, respectively. Please note: the delay lists must be in the same order as the input files (first delay list goes with first input file, and so on).
5. Pixels Selector: Allows the user to select which pixels of the RIImage they would like to process.
6. Add Output Location: Allows the user to select the output location of the files the T2Mapper will generate.
7. Display: Starts the processing of the input files by the T2Mapper program.

8. Reset: Resets the program in its entirety. Useful for when an error occurs or returning to default values.
9. Parameters: Allows the user to configure the various settings for processing data by WinDXP. Refer to the Parameters Window section for more information.
10. Y-Axis Setter: Changes the y-axis values on the plot based on the values given by the user.
11. Display Style Selector: Allows the user to display the data as a contour, checkerboard (pseudocolor), or waterfall style plots.
12. Color Palette Selector: Allows the user to change the color scheme used for the plot.
13. Edit Figure: Opens the graph with the selected display options in a separate MatLab window for further editing, which includes the plot tools interface (not available with executable version of T2Mapper). Refer to the Edit Figure Window section for more information.

Parameters Window
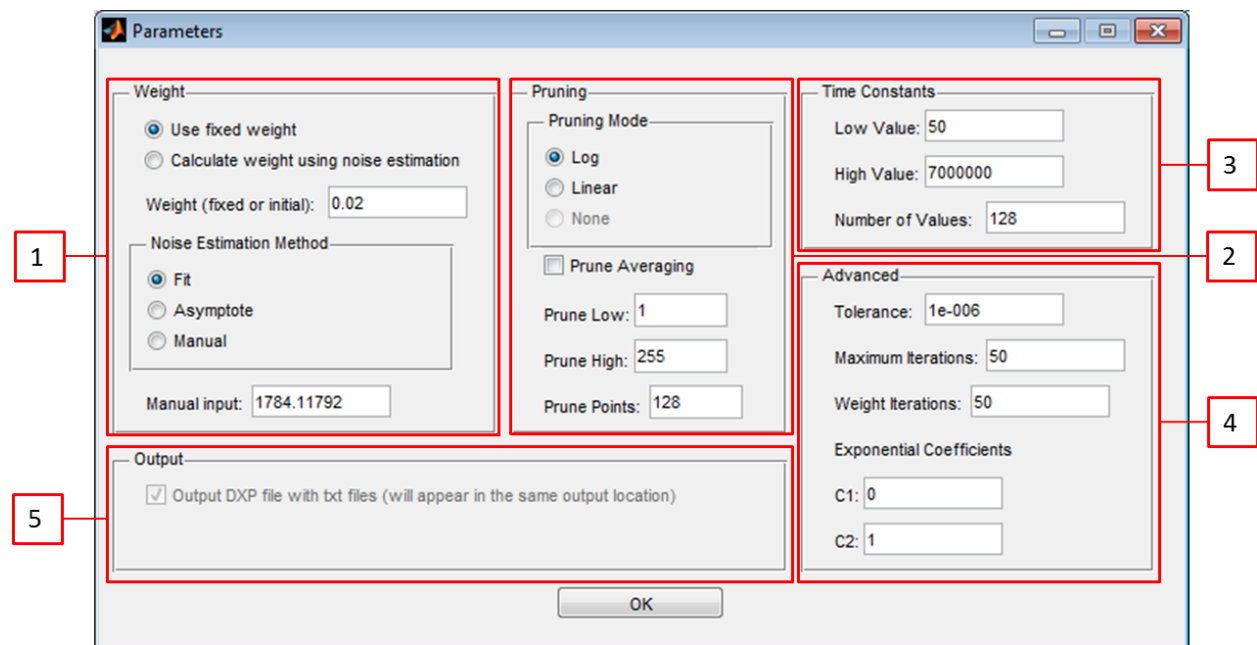
1. Weight Parameters: This area controls the weight parameter employed by the WinDXP program. The T2Mapper provides the choice between using fixed weight, which you can specify, and using WinDXP to calculate the weight using a noise estimation method. For the latter, you must specify the noise estimation method and the initial weight it will use. If "Manual" is selected for noise estimation, you must specify a signal to noise value (baseline value).
2. Pruning Parameters: The WinDXP engine uses point pruning to accelerate the processing of the distributed exponential. Unfortunately, WinDXP currently does not support using no

pruning mode to process the data through other programs, so this option has been disabled for the time being. When selecting the number of pruning points, keep in mind that the processing time is proportional to the amount of prune points. Refer to the strategy guide for further description of the pruning options.

3. Time Constants Parameters: This section provides the inputs to generate the logarithmic time scale for the distribution. Refer to the strategy guide for a better description of these parameters.

4. Advanced Parameters: These advanced options provide supporting factors that do not affect the distribution output directly. The default values match the ones from WinDXP.

5. Output Parameters: Provided here are options for dealing with the file outputs of the T2Mapper.

Edit Figure Window
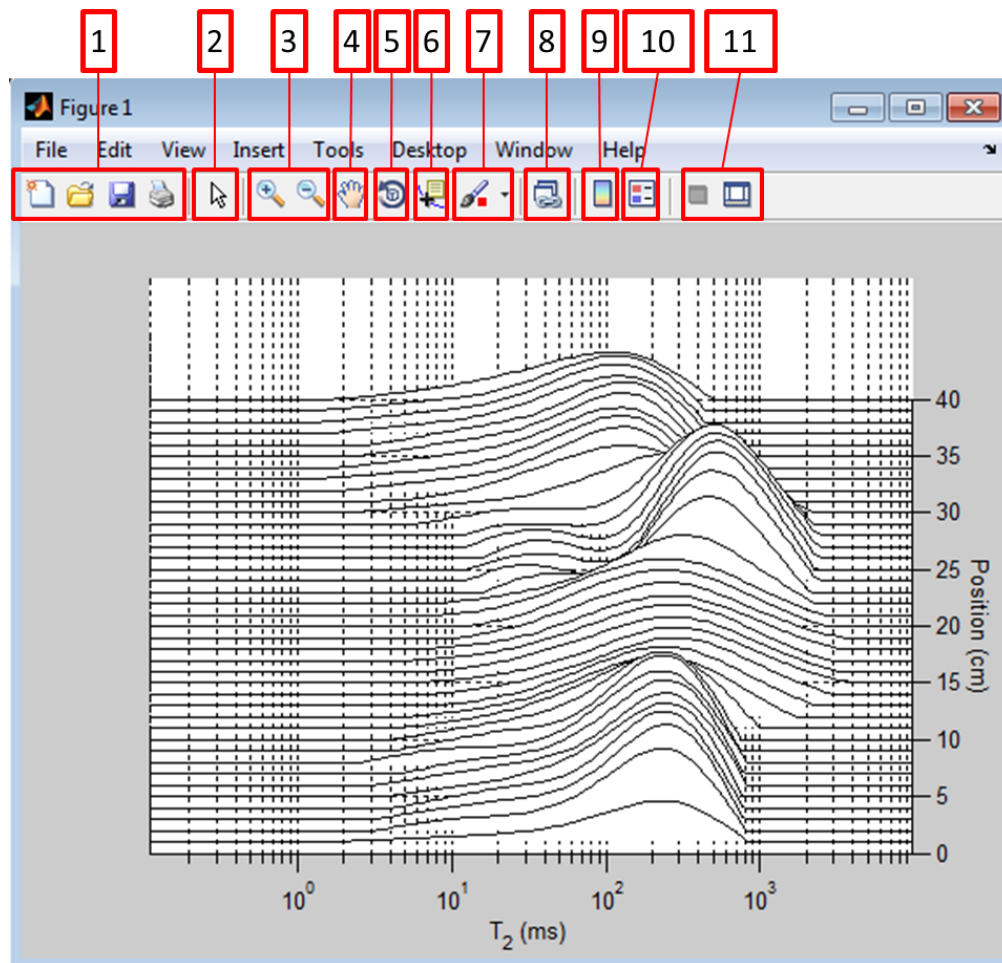
1. General Purpose Buttons:
   a. New Figure: Opens a blank, new figure.
   b. Open: Open a previously saved MatLab Figure.

      c.   Save: Saves the current figure along with all changes made so far.

      d.   Print: Prints the current figure.

2. Edit Plot: This buttons allows the user to select a specific part of the figure to edit. Double-clicking on any part of the figure with the edit plot tool selected will open the plotting tools window.

3. Zoom: Allows the user to zoom in and out of the current plot.

4. Pan: Allows the user to move the plot around the workspace.

5. Rotate: Allows the user to rotate the plot (this is especially effective on the waterfall plot).

6. Data Cursor: Clicking on a point with this tool selected will make the x, y, and z coordinates of the point appear. Using the left and right arrow keys will move the point along a specific line.

7. Brush/Select Data: Does not work with the plot styles available to the T2Mapper.

8. Link Plot: Does not work with the plot styles available to the T2Mapper.

9. Insert Color Bar: Shows or hides the color bar.

10. Insert Legend: Adds a legend.

11. Plot Tools: Closes and opens the plot tools window, respectively. For more information on using the plot tools please consult MatLab's own help files.

Note: Not all of these options will show up in the executable version of the program due to the lack of plot tools.

How to use T2Mapper

Basic Usage

1. Select the file type you want to work with (RIImage files, T2 Bulk text files, DXP files, or Output text files)
2. Add the files of the selected file type to the program by using the "Add Files" button in the "Select Files" section. Currently, the T2Mapper supports 1 RIImage file, multiple T2 Bulk file, multiple DXP files, and 1 Output file.
3. (If RIImage) Using the "Preview" button in the "Select Files", determine how many pixels are in the RIImage file and select the appropriate amount of pixels you want to process using the "Select Pixels" section. Note: Pixels start at 0, so if there are 64 pixels in a file and you want to select them all, select from 0 to 63.
4. (If RIImage or T2 Bulk) Add delay lists in the same manner as in instruction 2 in the "Select Delay Lists" section. Make sure that the order of the input files matches the order of the delay lists (i.e. first delay list is for the first input file and so on).
5. Using the "Add Location" button in the "Select Output Location" section, add a destination for the T2Mapper's output files.
6. If you want to modify the default parameters, use the "Parameters" button to bring up all the parameter options available. For more information, please check the T2Mapper Parameter Strategy section.
7. Hit the "Display" button to start processing. The processing takes some time, but there is a progress bar to see how far along the program is.
8. Once done processing, a plot will be displayed in the axes beside the input sections. From there, you can modify the plot or change the plot type using the "Plot Settings" section to the right of the axes.
9. You can also save the generated plot by using the "Edit Figure" button and hitting the save button in the "Edit Figure" window.
10. Double-check in the output location that all files that should be generated by the T2Mapper are there. There should be some DXP files, the number depending on how many pixels you selected or T2 Bulk files there were (or none at all if the output DXP files option was turned off), a single Output text file and a single MatLab file both named according to the date and time of processing.

T2Mapper Parameter Strategy

This section will provide some helpful information on choosing the proper values or modes for the parameters available in the T2Mapper. The successful choice of parameters is dependent on the sample data. Remember that these are general strategies and are to be considered only as an initial guide. If this information is insufficient, please refer to the Oxford Instruments WinDXP RAID manual provided with the program.

Weight Parameters Strategy

The weight parameter represents the constant required for the inverse Laplace transform's convergence. The larger the weight, the more your distribution will look like one large peak. The smaller the weight, the greater the chance your distribution will have many smaller peaks.

The default value is ~2×10^{-4}, which is considered small. Most distributions do not react very well to weight factors greater than 1. If the weight factor is too small, the data may not converge. You may consider increasing the "Maximum Iterations" parameter if you believe that the weight is appropriate. This will increase the number of iterations the engine will perform to converge the data.

An effective strategy is to begin with a large weight, which gives a broad distribution. Reduce the weight incrementally (try factors of 10) and the width of the distribution should decrease proportionally. At some point the distribution will not change with further changes in weight, while remaining free of spikes and small peaks. This value of the weight can be considered as most appropriate for your sample.

Pruning Parameters Strategy

The pruning parameter is relatively simple to use, as long as it is understood. The prune points parameter can be described in an example. If you have 2048 echoes, and choose 256 prune points using the linear pruning mode, WinDXP will use every 8th decay data point for processing. The logarithmic pruning mode will use equivalently spaced points along the logarithmic scale using the same factor of 8.

Prune averaging will average successive points (in this case 8) into 1 point. Since all the data are used, prune averaging will increase the signal to noise ratio, but may distort the distribution. It is advised to use this only when the signal to noise ratio is low.

No pruning will attempt to use every decay data point (echo peaks) up to a maximum of 512. It is not advisable to choose this option if you have more than 512 points, as it will "cut-off" at 512 and distort the distribution. Please note: This option is disabled through the T2Mapper as the dxp.exe console does not accept it as a command and will instead return files without data.

Time Constants Parameters Strategy

The time constants represent the logarithmic time scale of the distribution. The low value is the first point on the scale. The high value is the last point on the scale. The number of values represents the number of points used to create the scale. Changing the high and low values allows you to change how the distribution is displayed (field of view).

Advanced Parameters Strategy

The advance parameters include tolerance, maximum iterations, weight iterations and two exponential coefficients. The maximum iterations parameter controls the maximum number of iterations the engine will perform to achieve convergence with the inverse Laplace transform. The weight iterations parameter controls the maximum number of iterations the engine will perform while calculating the weight factor using noise estimation. The default values are typically unchanged.