

# Using an Excel Spreadsheet for T2\* Calculations:

## The DOs and DON'Ts

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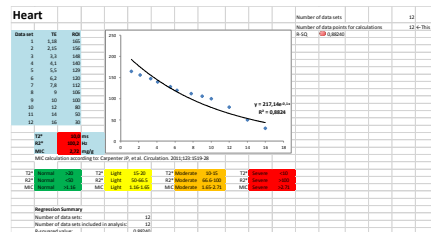
Campinas, Brazil

# What you need

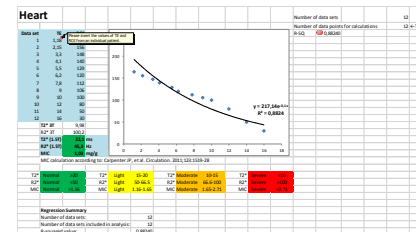
1. A spreadsheet program that supports an MS-Excel file
2. The spreadsheet model (link below – click to open)
3. A workstation or software to draw regions of interest (ROI)s in the original MRI

images

(this is standard in any MRI scanner – can be done by the technician in the scanner)



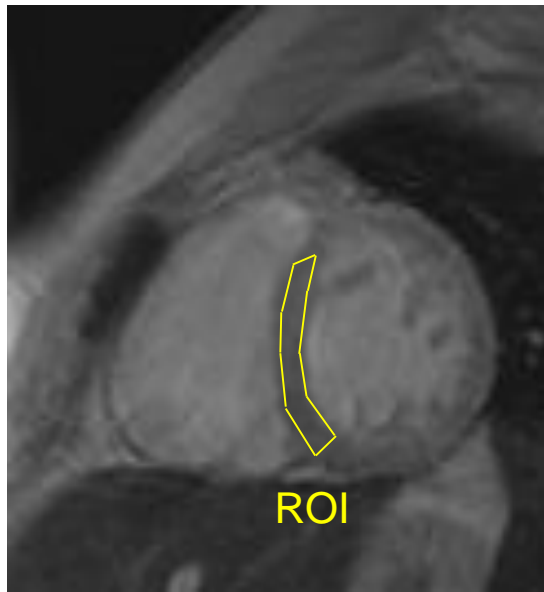
1.5T



3.0T

# Step 1

1. Acquire the images in your scanner and import them into the workstation/DICOM software for ROI drawing

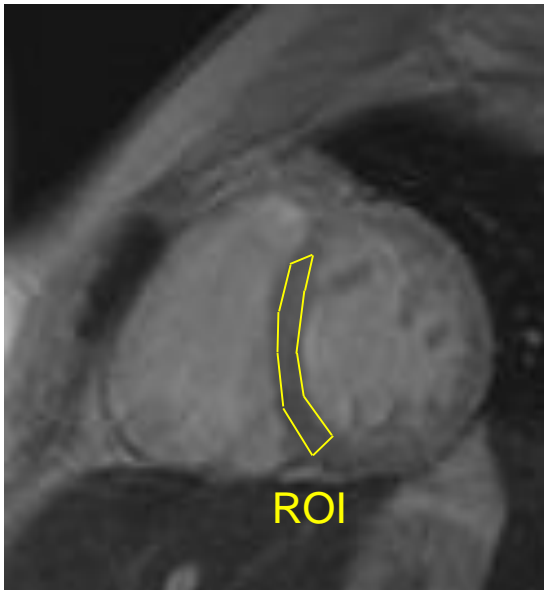


Heart



Liver

# Step 1 - pitfalls



Include the subendocardium and subepicardium layers but avoid blood signal from ventricles. Include only the septum avoiding artifacts. Adjust for respiration and copy same ROI across all images.



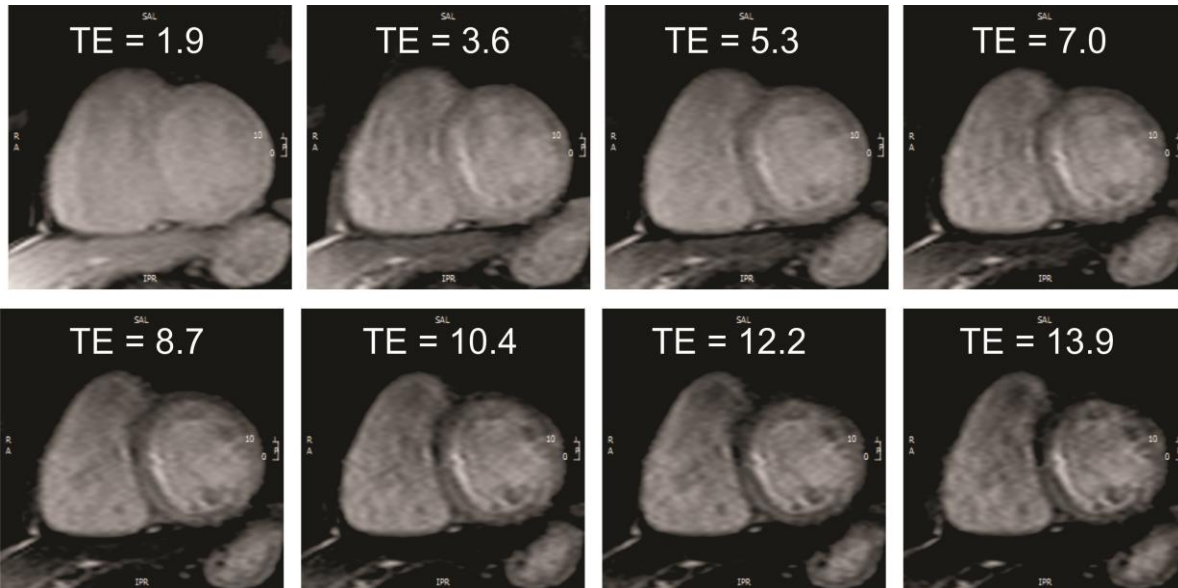
Avoid major vessels. No need to cover whole liver, but sufficient for large part of the right lobe as shown. Copy the same ROI across all images.

# Step 2 – getting the numbers from the images (TE and SI)

Each image will generate a pair of numbers: the TE and the mean signal intensity (SI) of the drawn ROIs

Write down these numbers to transfer them to the spreadsheet

TIP: the TEs will be the same for every exam – so you will only have to identify the SI and keep the same TEs for every patient after doing it for the first time.

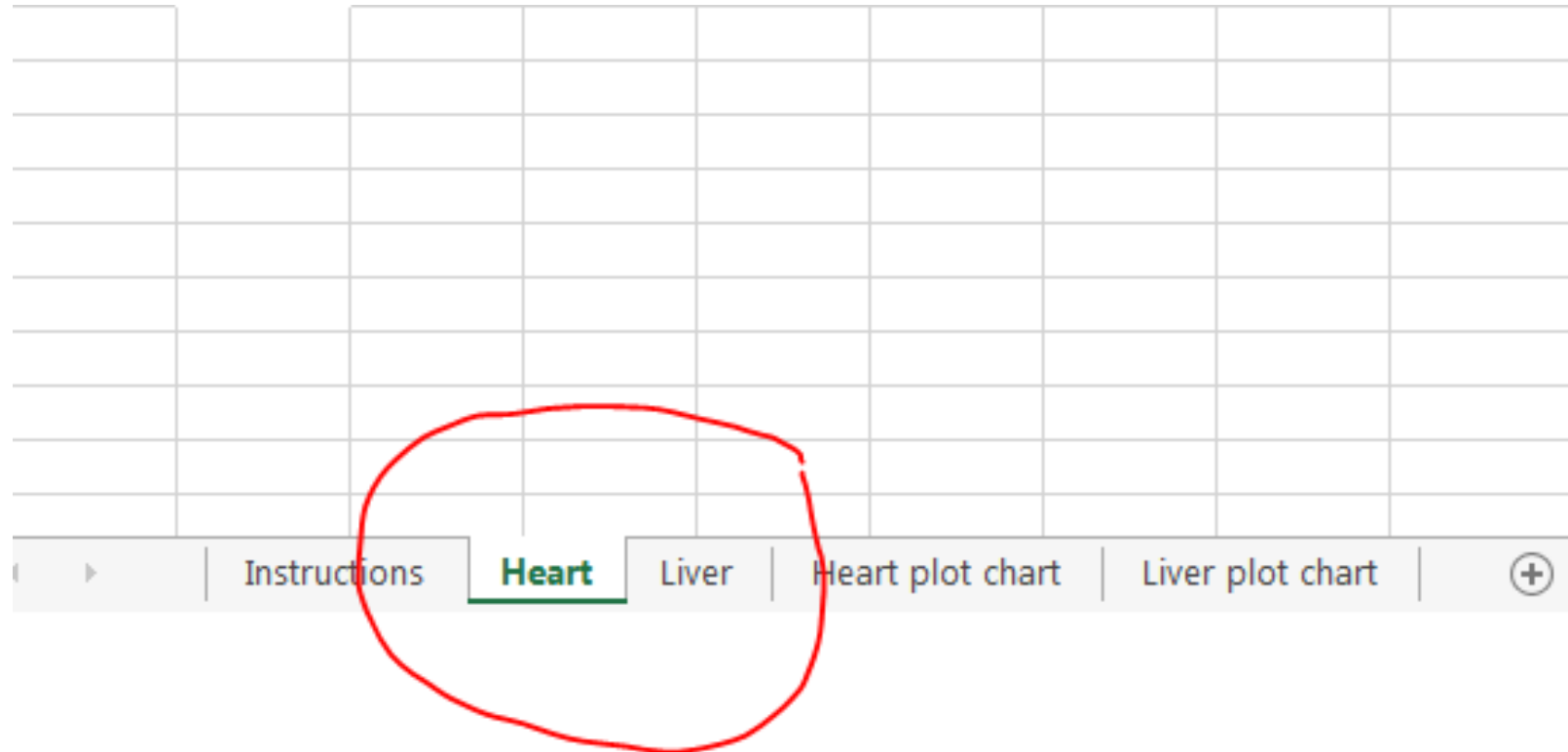


frame	TE (ms)	mean SI
0	1.9	89.5
1	3.6	83.6
2	5.3	76.8
3	7.0	70.6
4	8.7	64.5
5	10.4	59.2
6	12.2	54.9
7	13.9	50.2
8	15.6	45.8
9	17.3	42.4

# Step 3 – open the spreadsheet

The spreadsheet will have tabs on the bottom: use the heart and liver tabs for each organ respectively

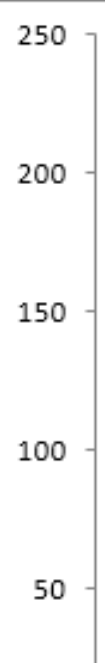
TIP: there is one spreadsheet for 1.5T and another for 3.0T – use the one appropriate to your scanner



# Step 4 – Insert the values for the heart

Insert the TEs and ROI values in the two columns identified in blue in the left of the spreadsheet in the heart tab.

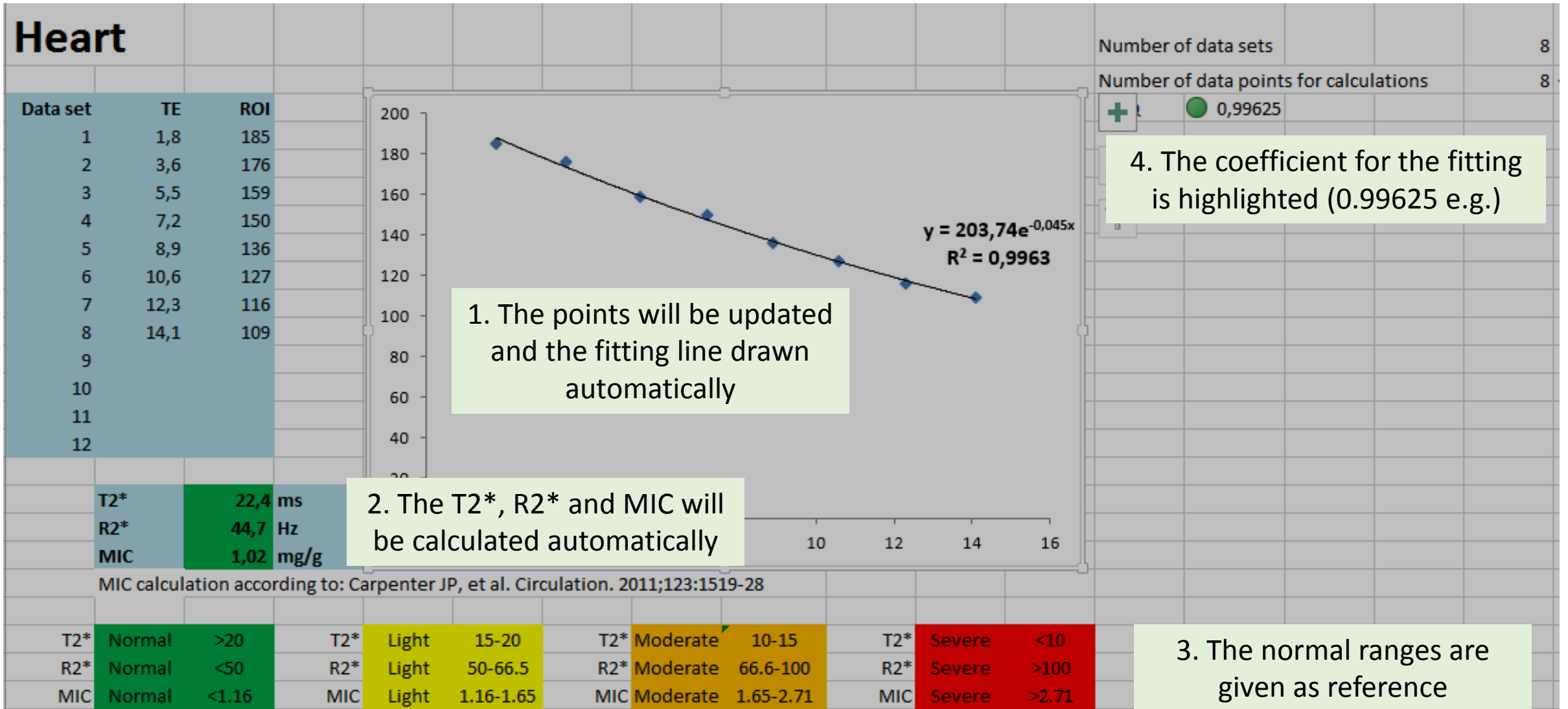
Heart		
Data set	TE	ROI
1	1,18	165
2	2,15	156
3	3,3	148
4	4,1	140
5	5,5	129
6	6,2	120
7	7,8	112
8	9	106
9	10	100
10	12	80
11	14	50
12	16	30



As you type in the numbers, you will notice that the graph and some values will change automatically as you type.

**TIP:** You can include up to 12 datasets. You will be able to delete them or use fewer number later.

# Step 5 – Observe the results reported



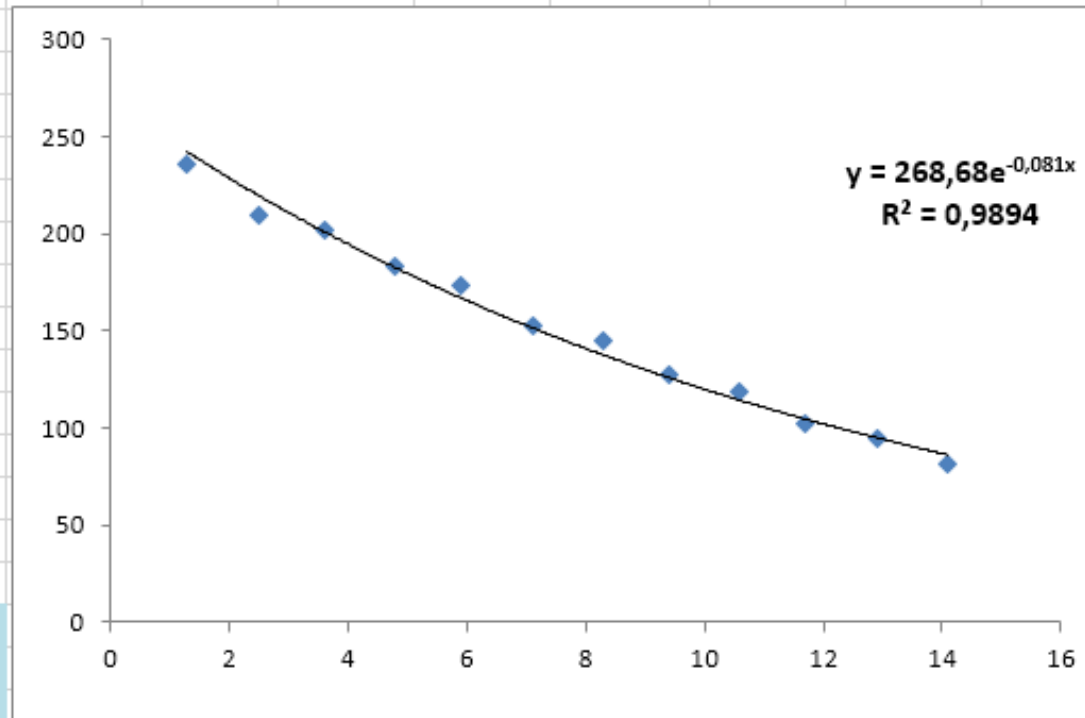


# Step 6 – Do the same for the liver (liver tab)

## LIVER

Please insert the values of TE and ROI from an individual patient.

Data set	TE	ROI
1	1,3	236
2	2,5	209
3	3,6	202
4	4,8	183
5	5,9	173
6	7,1	153
7	8,3	145
8	9,4	127
9	10,6	119
10	11,7	102
11	12,9	95
12	14,1	81



Number of data sets	12
Number of data points for calculations	12
R-SQ	0,98942

T2*	12,4 ms
R2*	80,7 Hz
LIC	1,81 mg/g

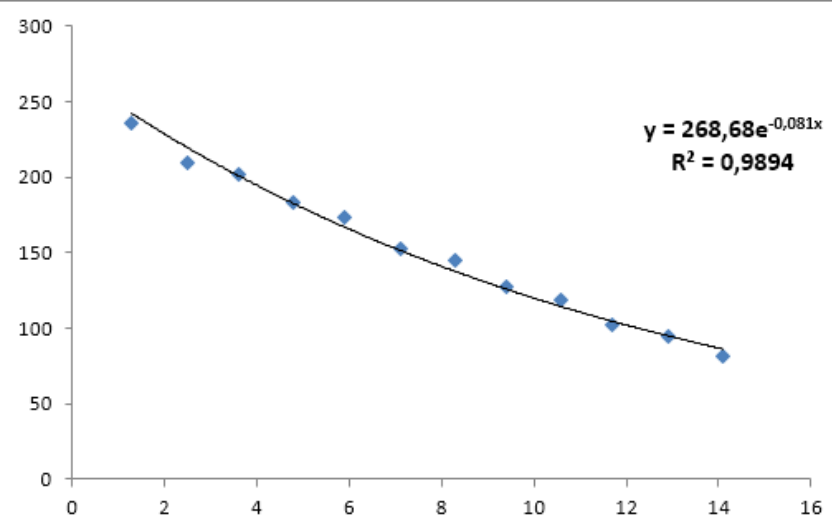
LIC calculation according to: Hankins JS, et al. Blood. 2009;113:4853-5.

T2*	Normal	>11.4	T2*	Light	3.8 - 11.4	T2*	Moderate	1.8-3.8	T2*	Severe	<1.8
R2*	Normal	<88	R2*	Light	88-263	R2*	Moderate	263-555	R2*	Severe	>555
LIC	Normal	<2	LIC	Light	2-7	LIC	Moderate	7-15	LIC	Severe	>15

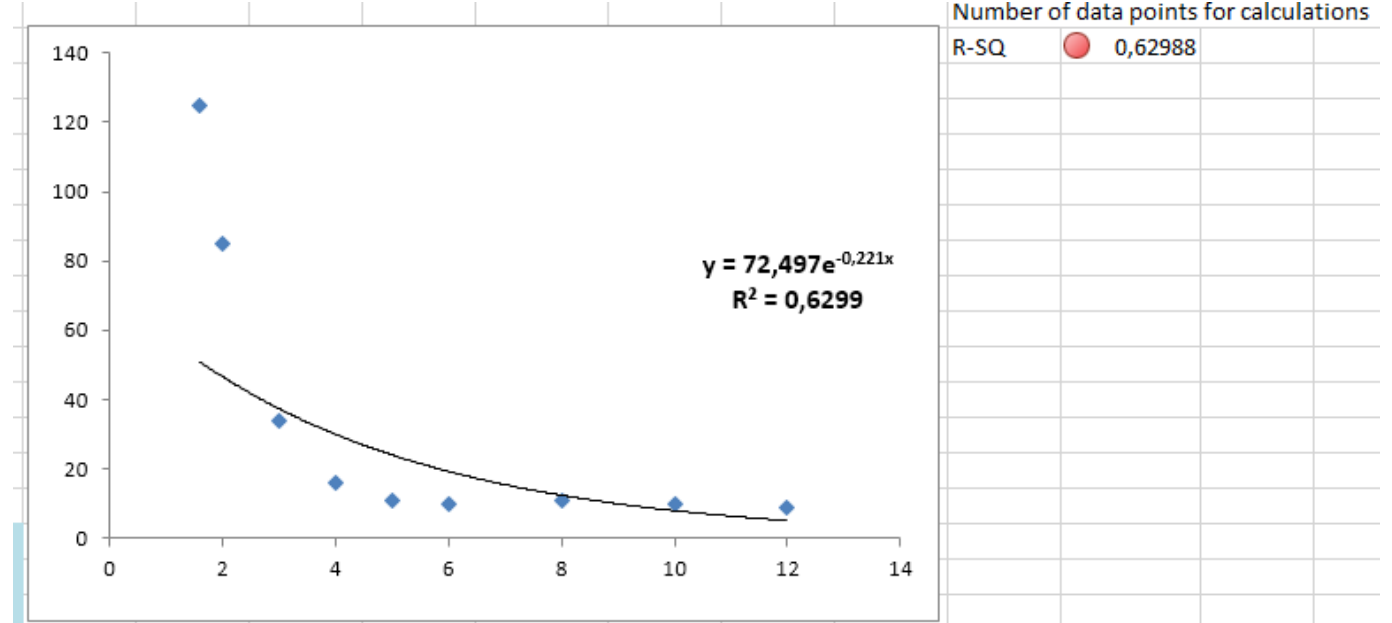
# What to look for

Make sure your correlation coefficients are  $> 0.98$  most of the times.

This assures that the fitting is very good and results should be reliable.



An example of a very good fit  
(0.9894)



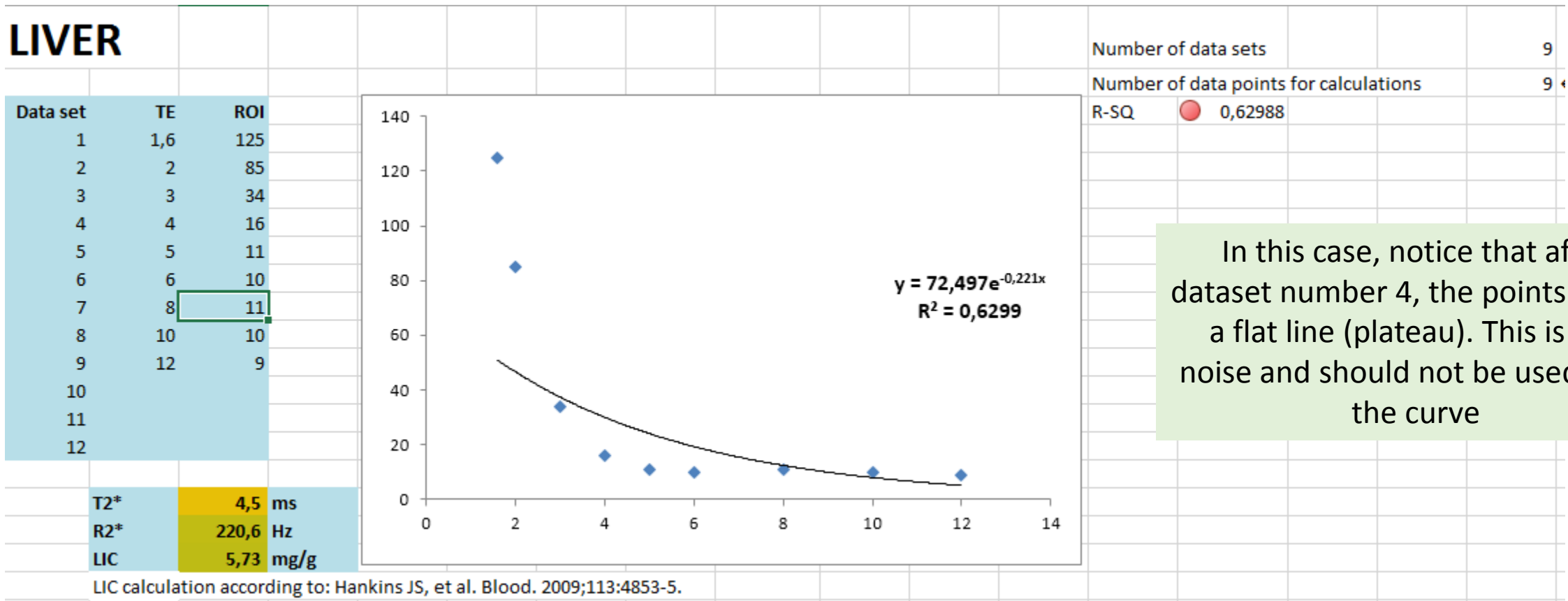
A poor fit (0.6299)

TIP: observe the red circle indicating a poor fit on the right

# Solving a bad fit

If you correlation coefficients are  $> 0.98$ , do not do anything and accept the values generated.

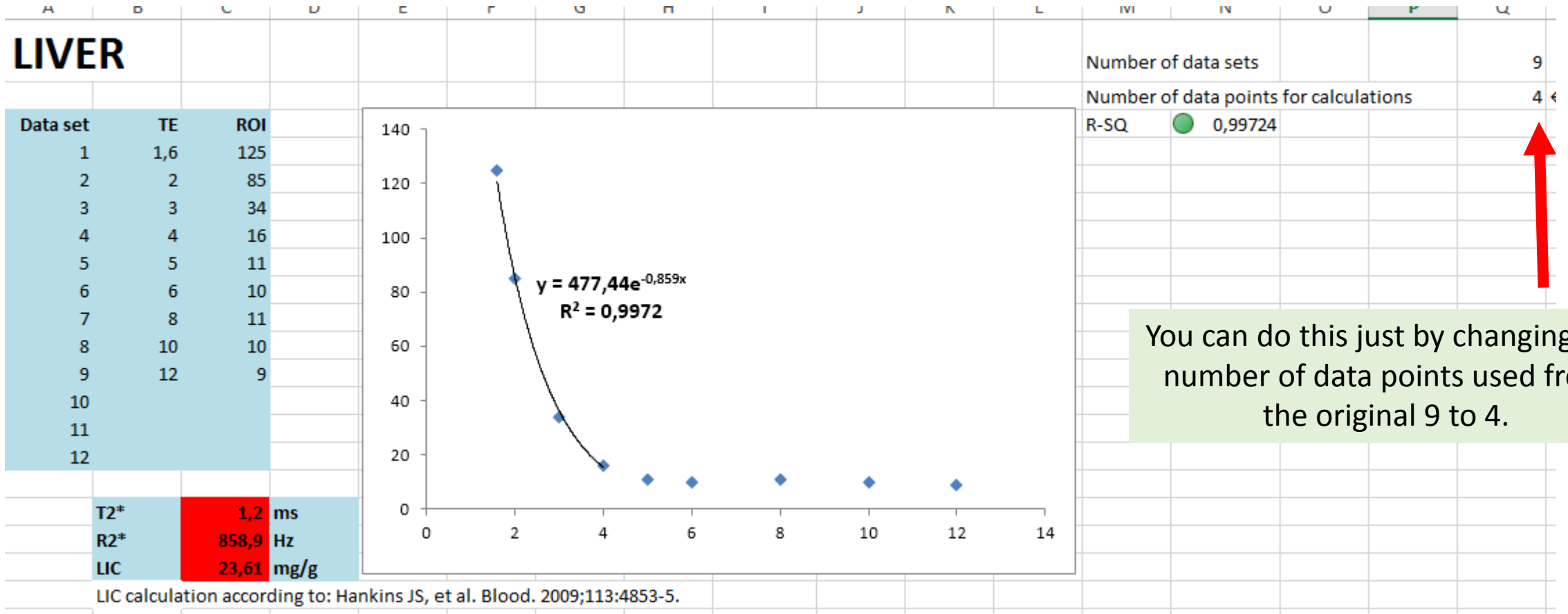
If not, most of the times the problem is related to how many points were used to fit the curve



TIP: this will underestimate the true LIC/MIC

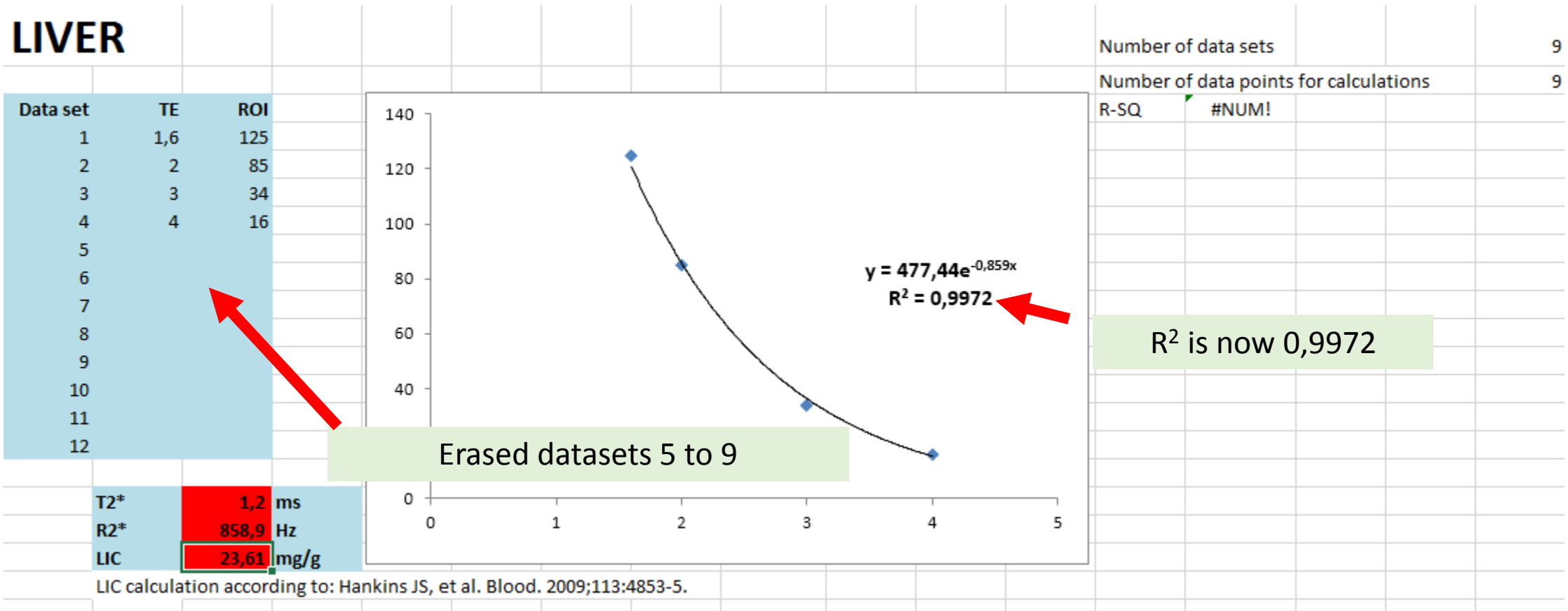
# Truncating

To correct for that, truncate (eliminate) the points that form that flat line. In this case, eliminate datasets 5, 6, 7, 8 and 9:



# Truncating

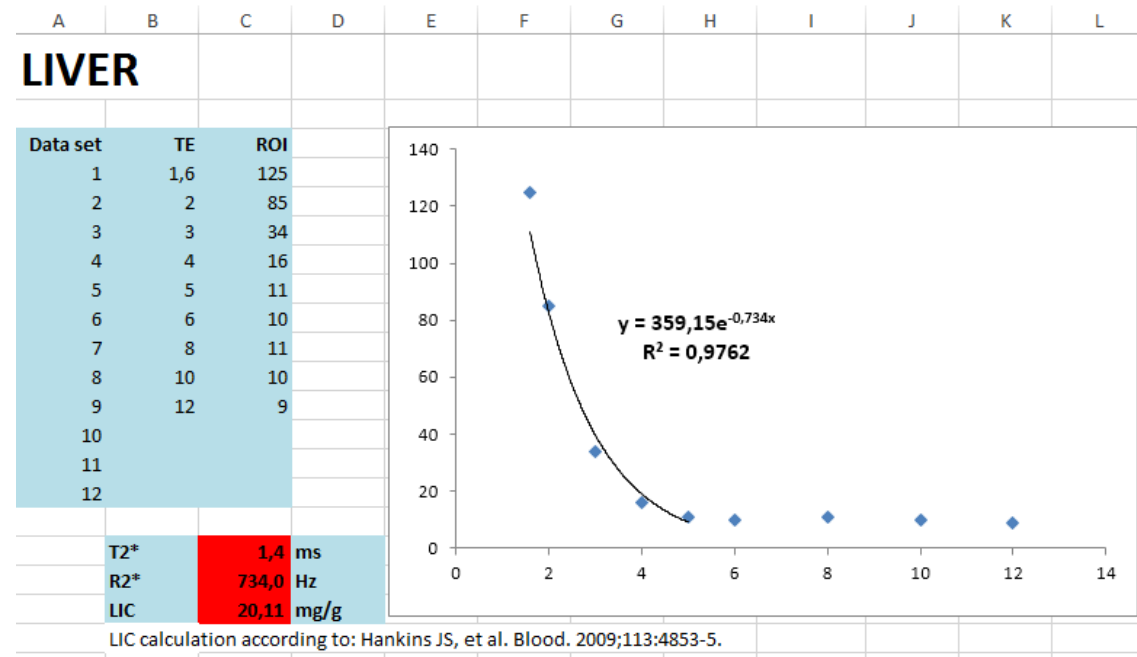
Or you can also do this by deleting the number on the left



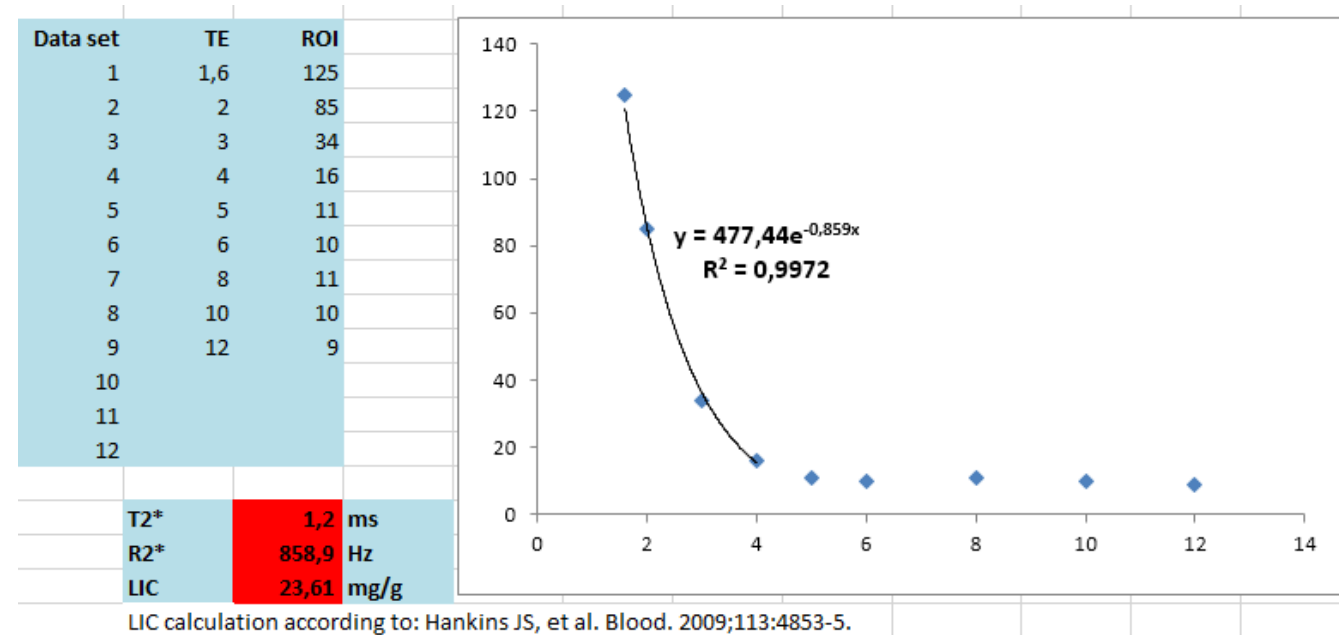
TIP: notice how the true LIC in this case is much higher than the previous one

# When to stop truncating

It is a visual analysis most of the times, but a rule of thumb is to do it until you have reached the  $R^2 > 0.98$  number



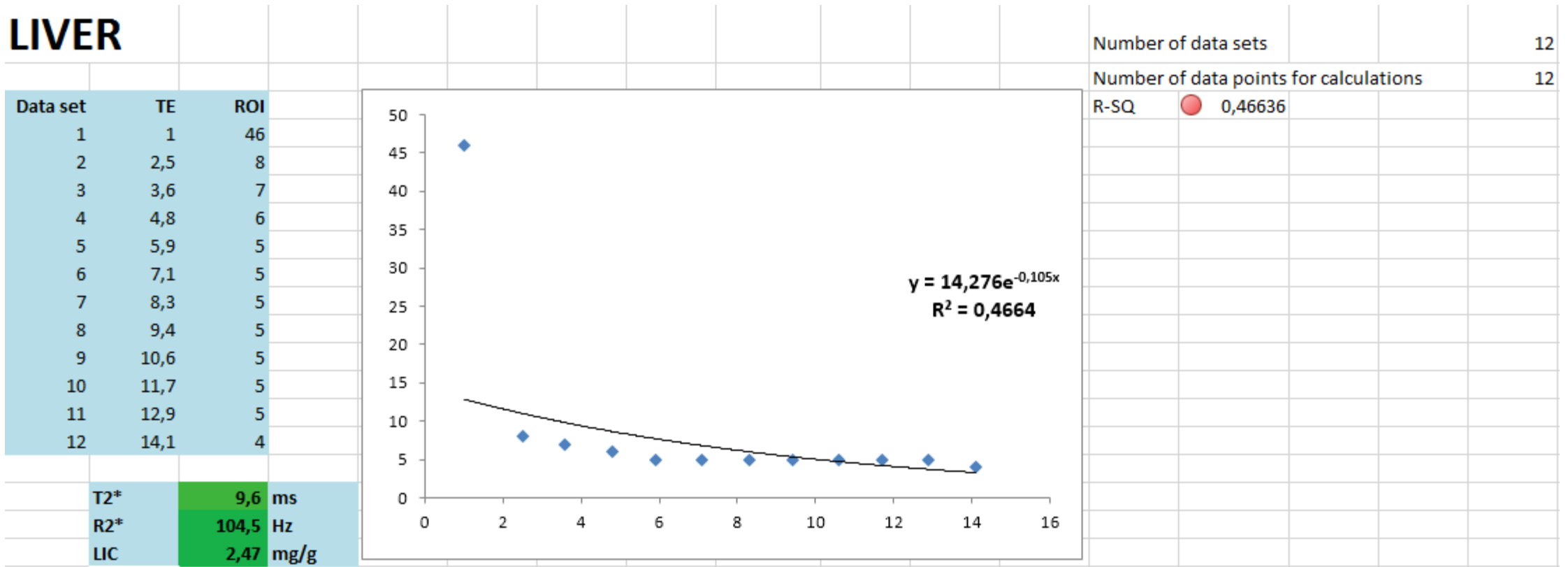
Fitting the data with 5 points  
 $R^2 = 0,9762$



Fitting the data with 4 points  
 $R^2 = 0,9972$

# Too few numbers!

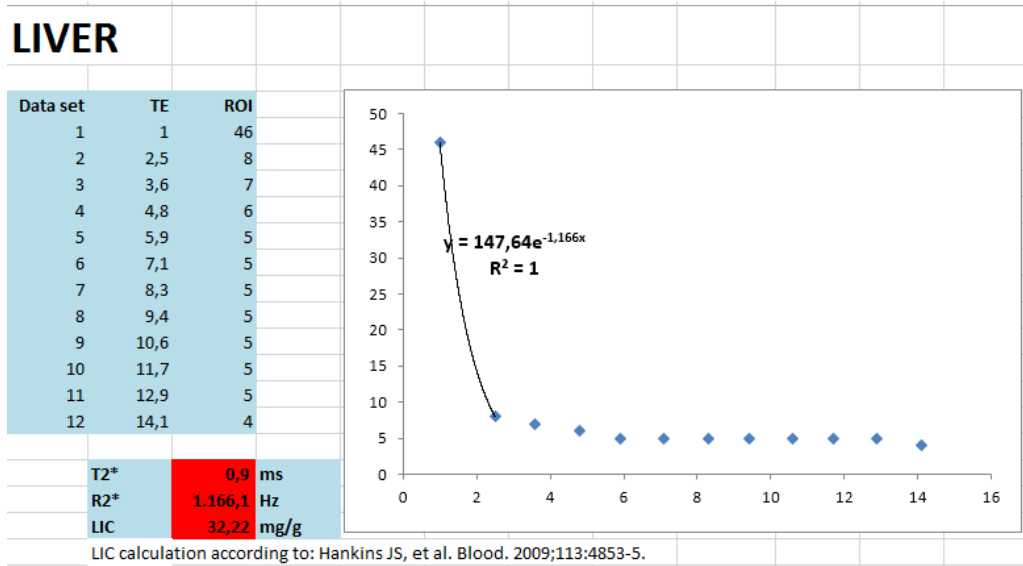
When there is too much iron in the liver (LIC >30 to 35 mg/g) you have reached the limit of the T2\* method. This will generate curves like this:



LIC very low – severely underestimated if trying to fit all points!

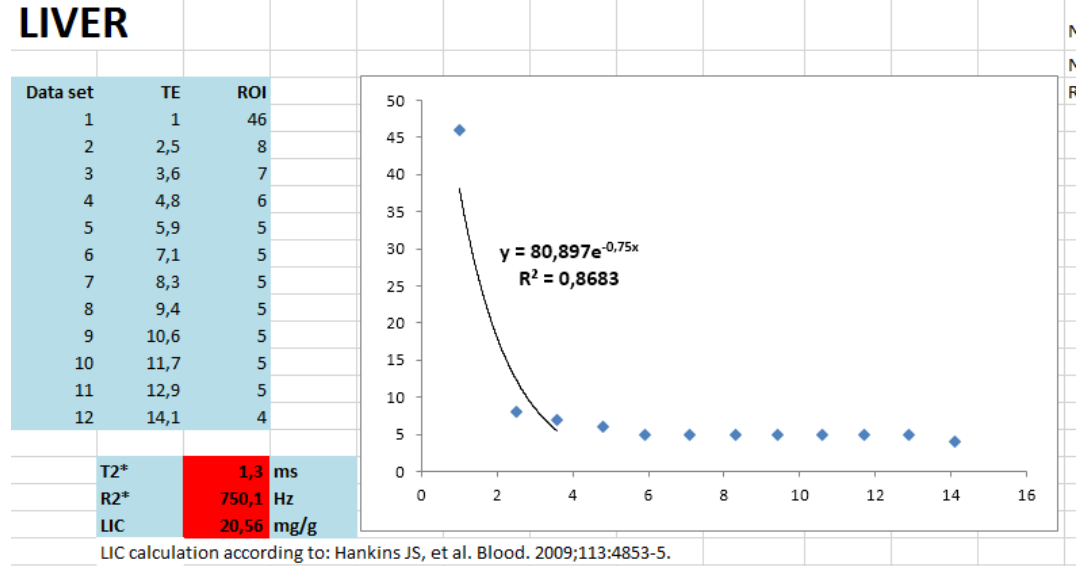
# Too few numbers – how to correct

- Reacquire the images with the lowest TE possible (the lower the better)
- If already very low TE (as in this case TE1 = 1.0ms), use just two or three points. This will overfit your data and give you a less accurate number. Some centers just report LIC above 30mg/g threshold for example.



2 points only – overfit, but more accurate result

Report: LIC > 30mg/g (above upper limit of the method)



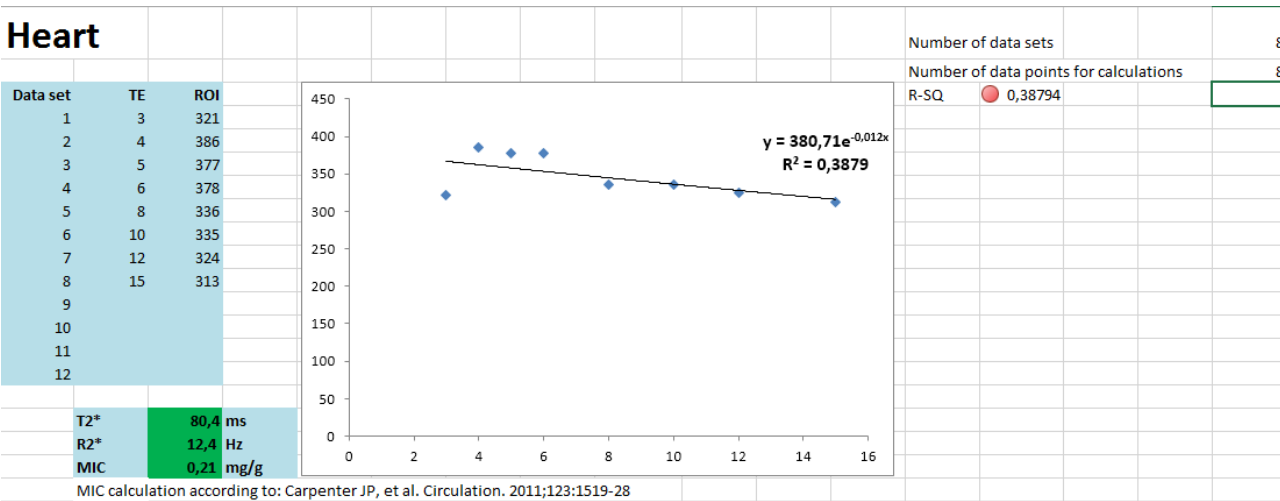
3 points – still poor fit, with R<sup>2</sup> = 0,87 only



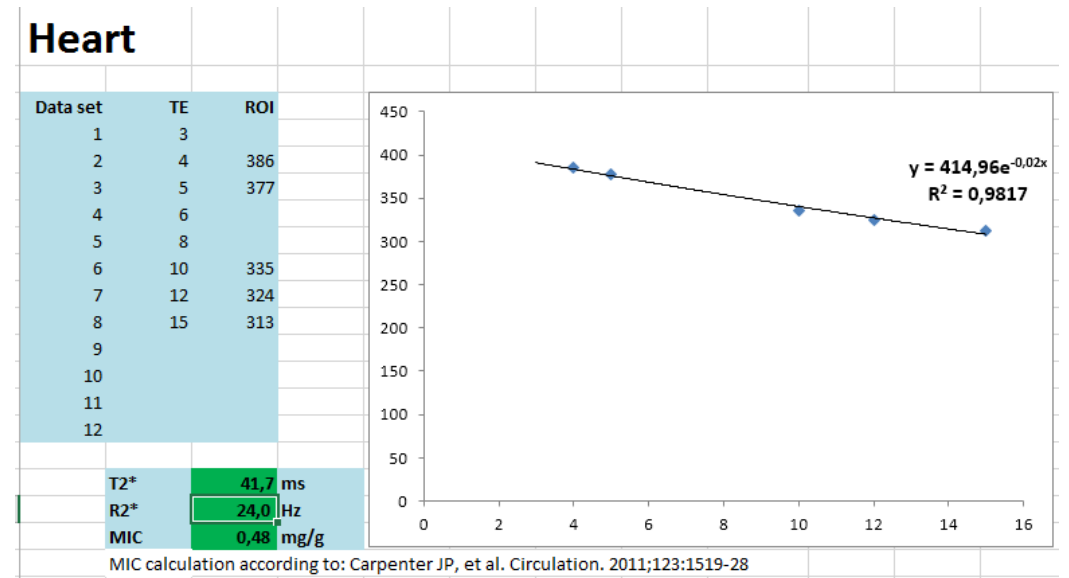
# Bad images

This case generated very noisy/moving images of the heart. Ideally this should be rescanned.

If not possible, delete points which look out of line. Nevertheless, signal drop very slow, so certainly classified as > 20msec.



Very high T2\* - uncommon. Very poor fitting.



Manual exclusion of points 3 – 6 – 8. Better fitting. T2\* normal.

# Further information

Principles explained here apply for all T2\* analysis software, not only the spreadsheet

For further information, please contact me:

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