Physics for Neuroscience and Medicine – Module 2
"T_1 and T_2 weighted imaging"

"First Laboratory Experience"

Objective: Determination of the time ranges for the parameters TE and TR to obtain two different MR images of the egg: T_1 and T_2 weighted**.** The images are acquired by a SE imaging sequences.

Write the report following the structure of a scientific paper:

Abstract

Introduction

Materials and Methods

Results and Discussion

Conclusions

References

Useful information to analyze the data and write the report

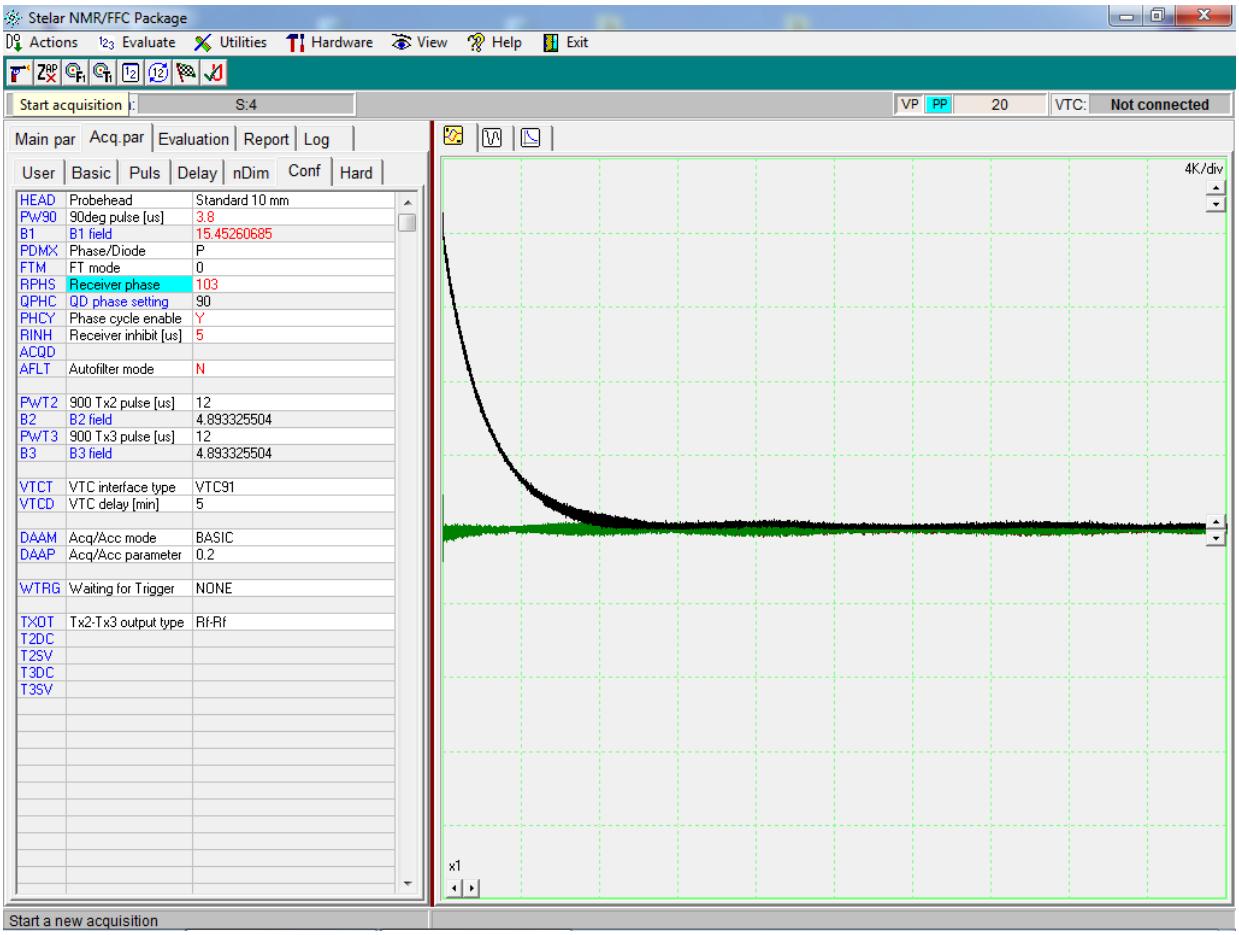
Longitudinal and transverse relaxation curves were acquired by the NMR apparatus at DIFA Department. The relaxometer is made of an electromagnet Jeol C60, controlled by a Stelar digital console that manages the realization of the NMR experiments…
The homogeneous magnetic field B_0 = … T, corresponding to a Larmor frequency … ν = … MHz for ^{1}H nuclei…
Samples of egg yolk and albumen were extracted from …
The NMR relaxation curves were acquired by sequences … (describe the sequences) …
The parameters used for the characterization of the egg components are:

YOLK	**ALBUMEN**
for CPMG:	*for CPMG:*
90° Pulse Length = xxx μs	90° Pulse Length = xxx μs
TE = xx μs	TE = xx μs
TR = xx s	TR = xx s
number of echoes = xxxxx	number of echoes = xxxxx
number of scans = xxx	number of scans = xxx
for IR:	*for IR:*
90° Pulse Length = xxx μs	90° Pulse Length = xxx μs
TR = xx s	TR = xx s
TI initial (BINI) = xxx μs	TI initial (BINI) = xxx μs
TI final (BEND) = xx s	TI final (BEND) = xx s
number of TI – LOGscale = xx	number of TI – LOGscale = xx
number of scans = xxx	number of scans = xxx

The experimental curves were inverted to obtain the relaxation times distributions. The software UPENWin computed the quasi-continuous distribution functions of the relaxation times for egg yolk and albumen.
To acquire SpinEcho MR images weighted on T_1 and T_2, the ranges of parameters TE and TR were determined by ……

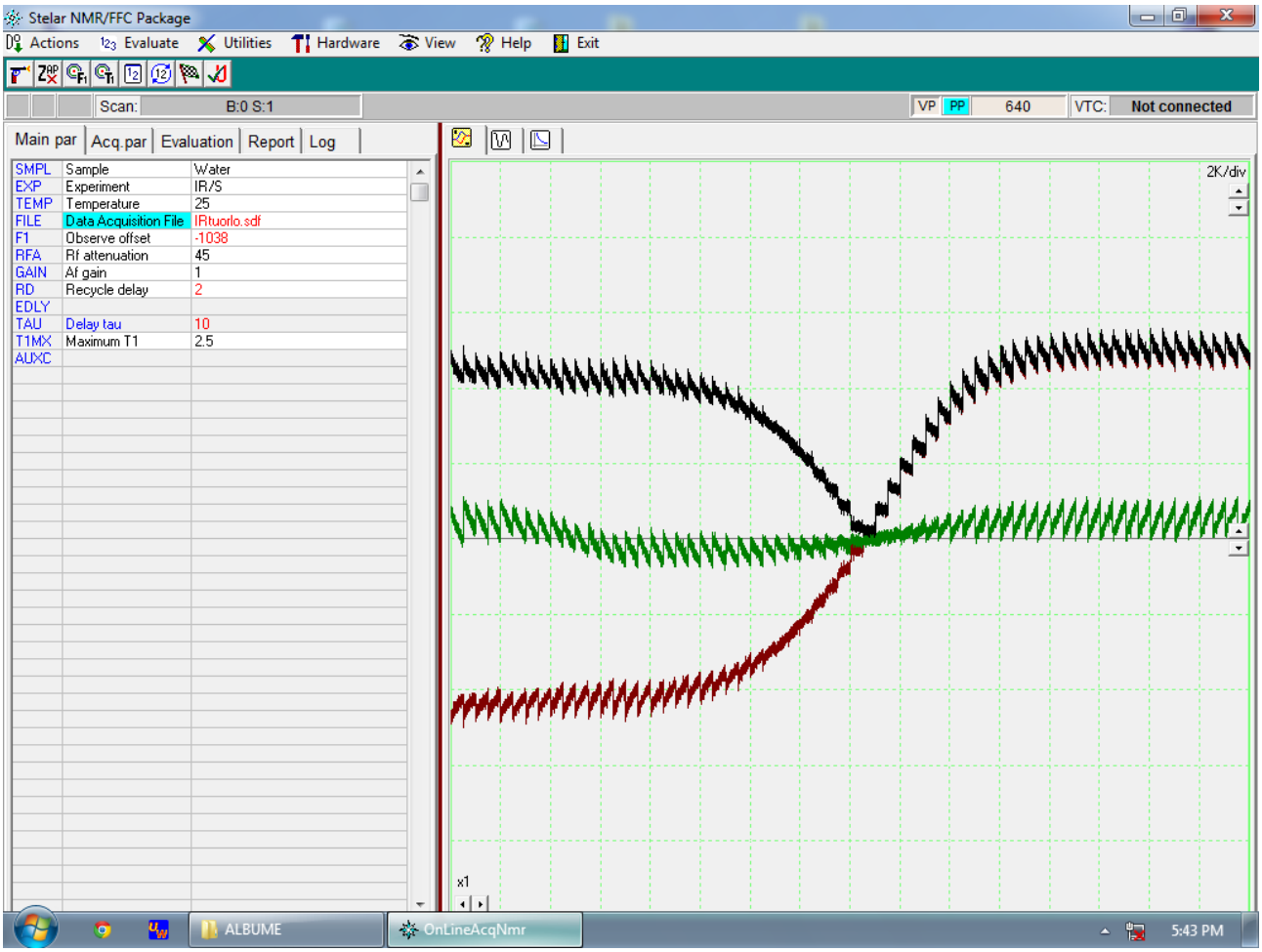
$$M_y(T_R,T_E)=M_0\left[1-e^{-T_R/T_1}\left(2e^{T_{E/2}/T_1}-1\right)\right]e^{-T_E/T_2}$$

In Figure XX, an example of the transverse relaxation signal of a sampleXX acquired a CPMG rf pulse sequence.



The black circles represent … **Description** ……

In Figure XX …



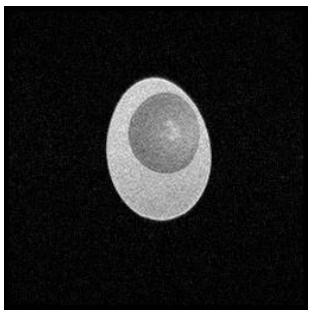
Description ……..

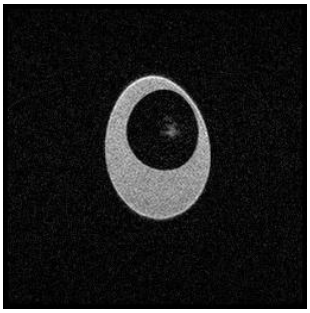
To write the “Results and discussion” report you can follow these steps:

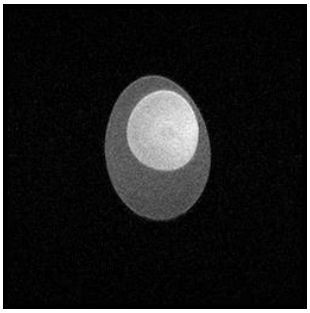
- Determining plausible T_1 and T_2 values for yolk and albumen and discuss
- Estimating the parameters TE and TR (use the eq. pag. 2) to obtain the MR images reported below *(*)*
- Assigning and determining the labels corresponding to the images below (“T_1-weighted”, “T_2-weighted” and “…”)

  (*): Hint n°1 - to evaluate the ranges of TE and TR, think about the contrast of the images, what it is? How is related to the acquired signal?
  Hint n°2 – Use a script in Python or Matlab language to compute TE and TR ranges

TE = 10ms
TR = 1000ms

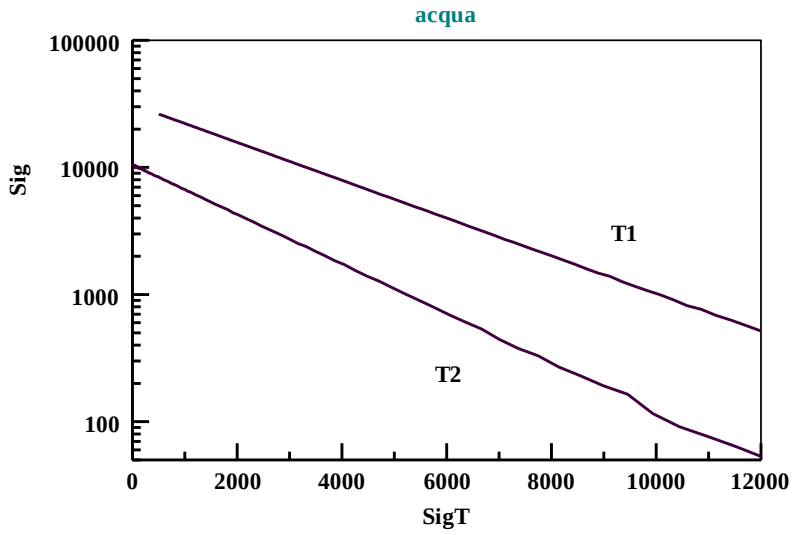




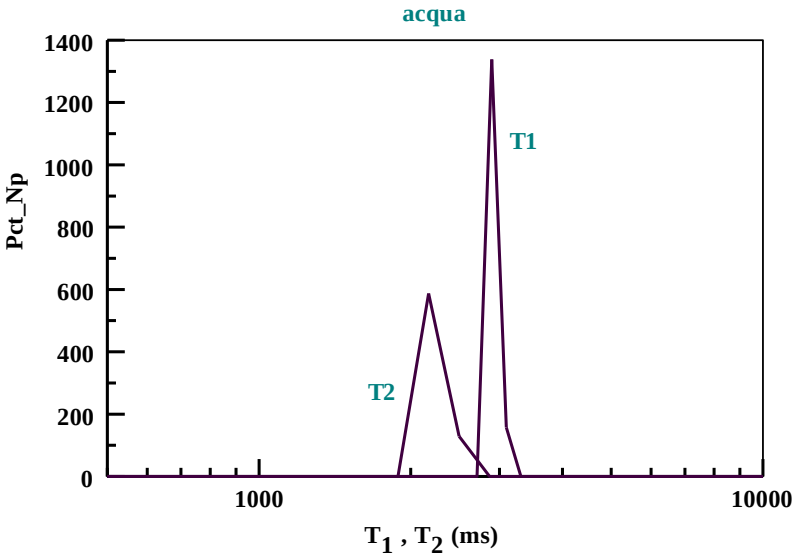


Example of data computed by UpenWin:

The acquired data of a sample of bulk water were computed by UPENwin that produced the following outputs:



Sig indicates the intensity of the signal in arbitrary units. SigT represents the time t in ms. The intercept to the y-axis (SigT = 0) indicates the total NMR signal, proportional to the water amount in the glass tube. In the semi-logarithmic scale, the linear trend of the curves suggests a mono-exponential decay, expected for a sample in which all the ^{1}H nuclei are affected by the same chemical-physical environment.



The relaxation times are plotted on the x-axis in log-scale. On the y-axis the percentual value of the normalized signal density (signal normalization, the areas of the curve are the same) is represented. (Using the Sig_Np, the area of the curve indicates the absolute acquired signal).

The narrower the distribution more similar are the conditions (chemical-physical environment, confinement, ...) in which the spins are measured.