Yappari tutorial : Simulate a spectrum and introduction to DRT

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Data from paper

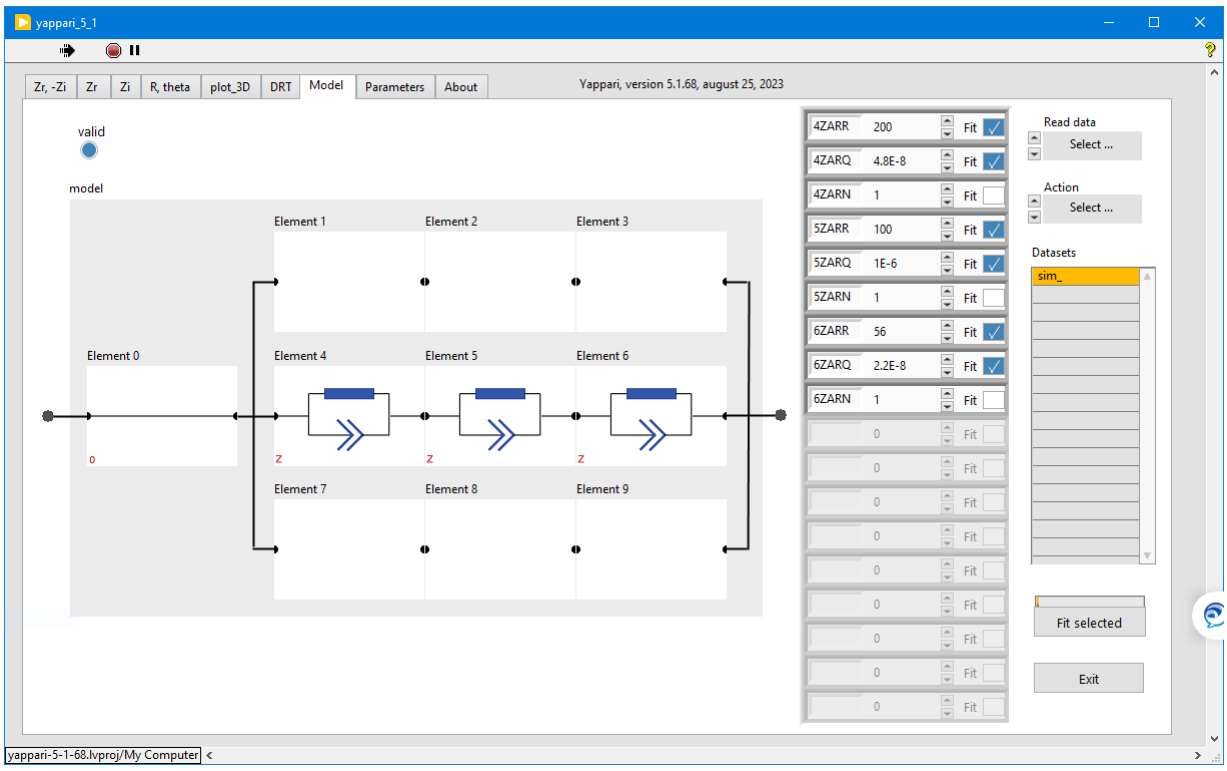
Analysis of Impedance Spectroscopy Measurements of Biological Tissue using the Distribution of Relaxation Times Method, January 2017; DOI: 10.5220/0006253902240228

The simulated circuit discussed in this paper is

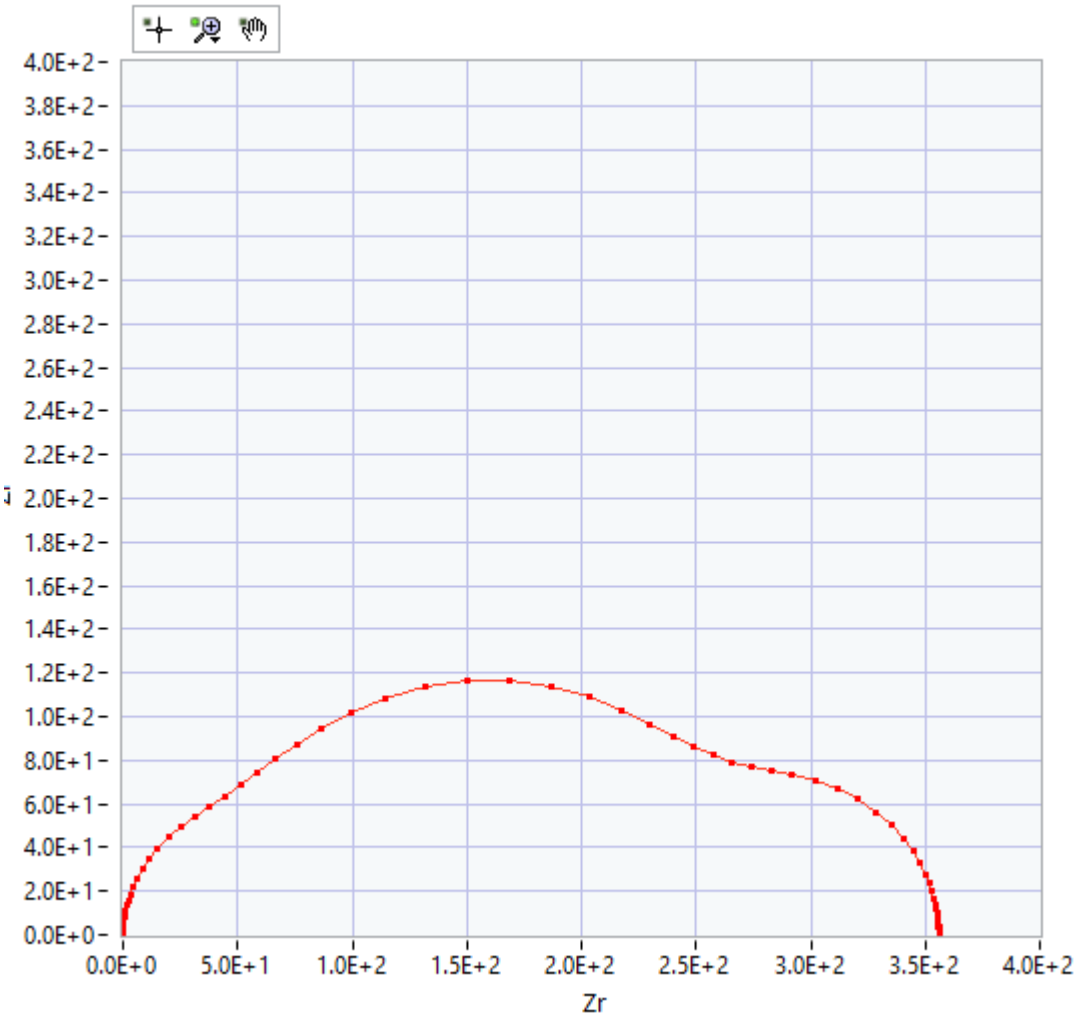
Table 1: Data for simulated RC circuits.

Circuit	R (Ω)	C (nF)	τ (µs)	f_0 (kHz)
RC_1	200.0	48.0	9.6	17.0
RC_2	100.0	1000.0	100.0	1.6
RC_3	56.0	22.0	1.2	130.0

Let's make a model ; fix n=1 so as to have a capacitor instead of Q. Fill the values as in this example then *Action*/*Simulate spectrum*

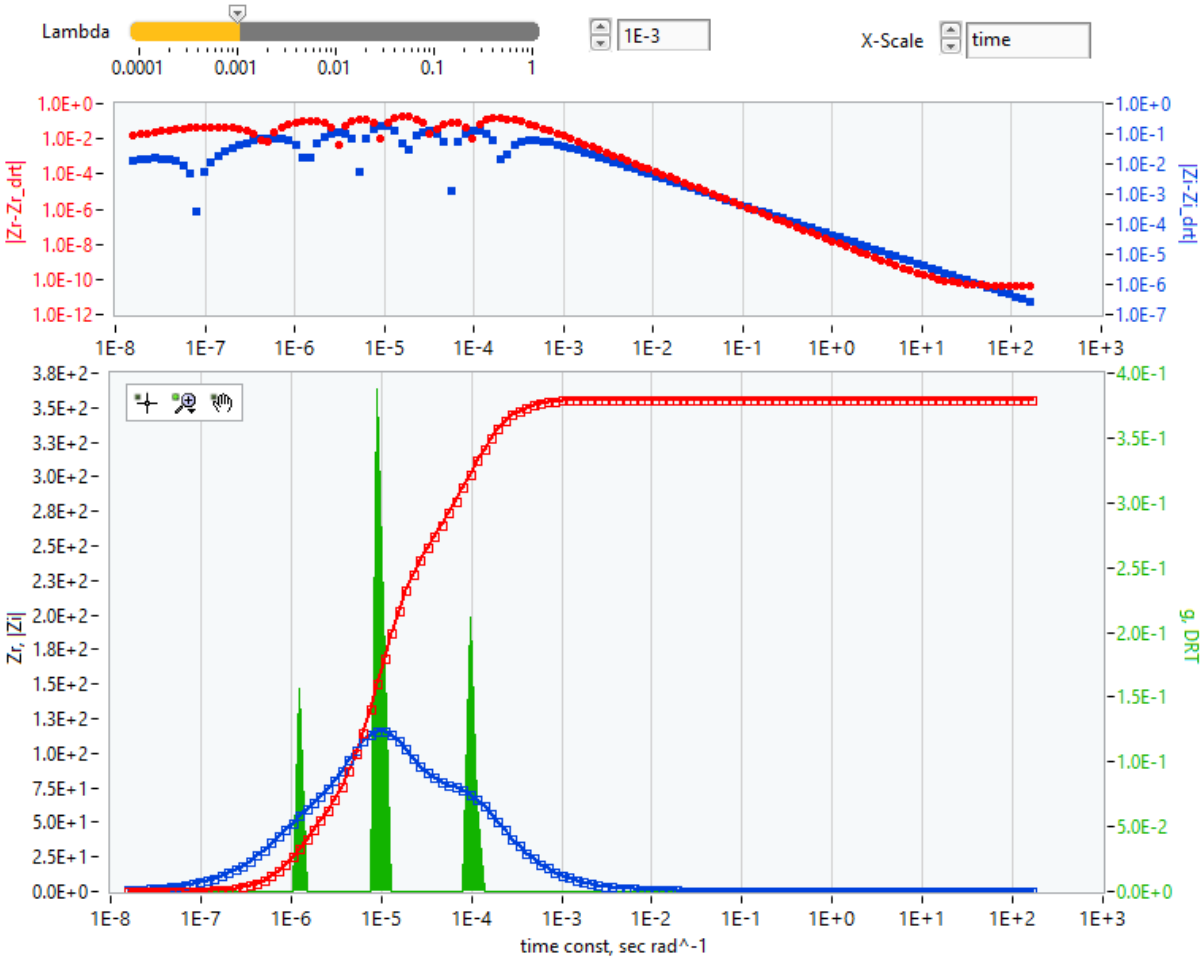


We can see then the Nyquist plot (we can see there are at least three contributions)



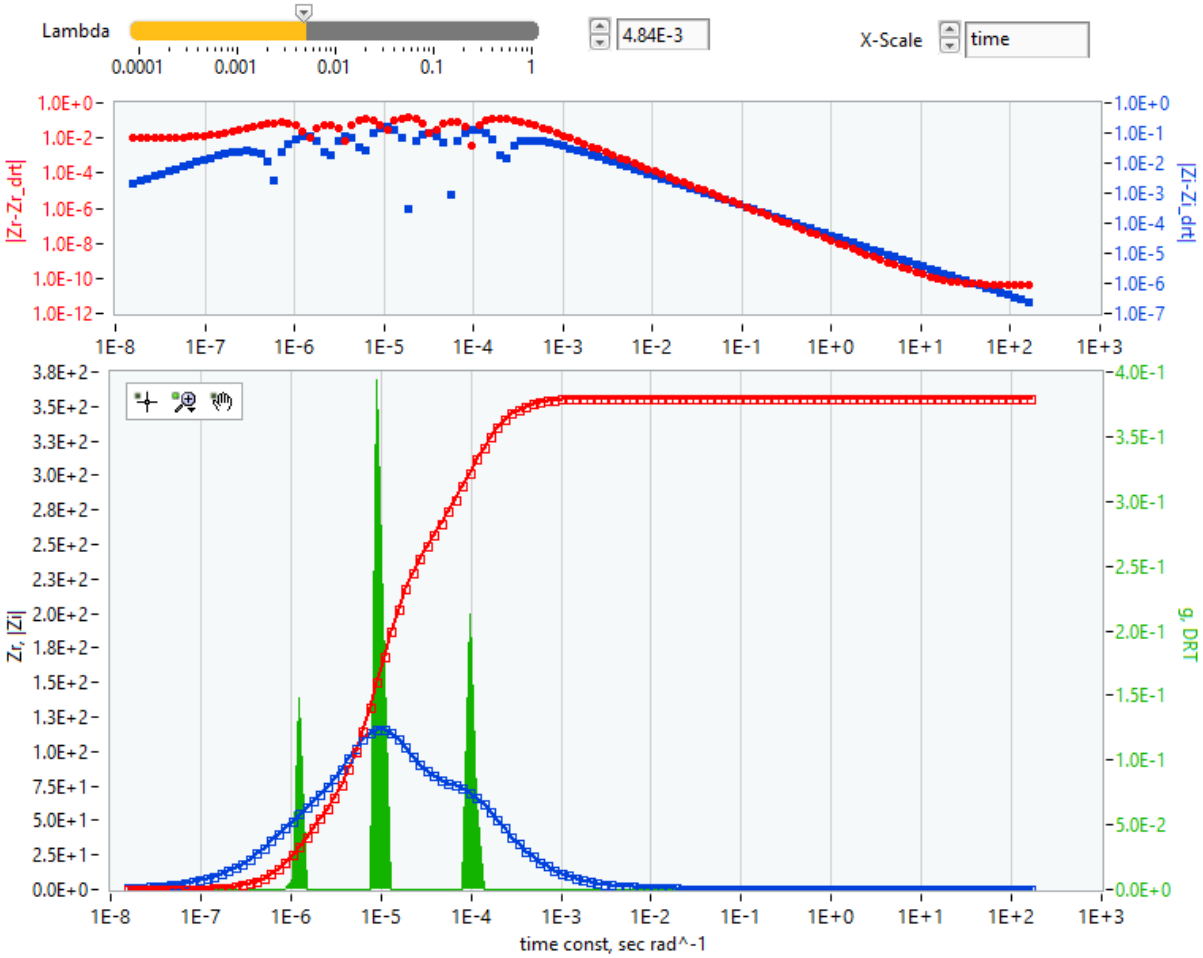
We can perform a simple DRT calculation, with default parameters : *Action*/*DRT active datasets*

Then we can see this nice result :



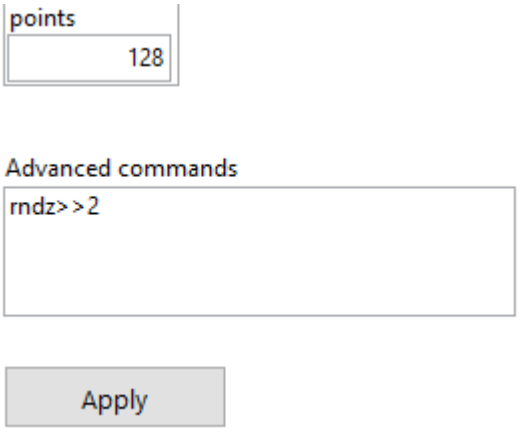
Three contributions, the time constants are in agreement with simulation.

Let's try to improve this, if possible, by searching an optimal Tikhonov parameter : do *Action*/*Search Lambda*

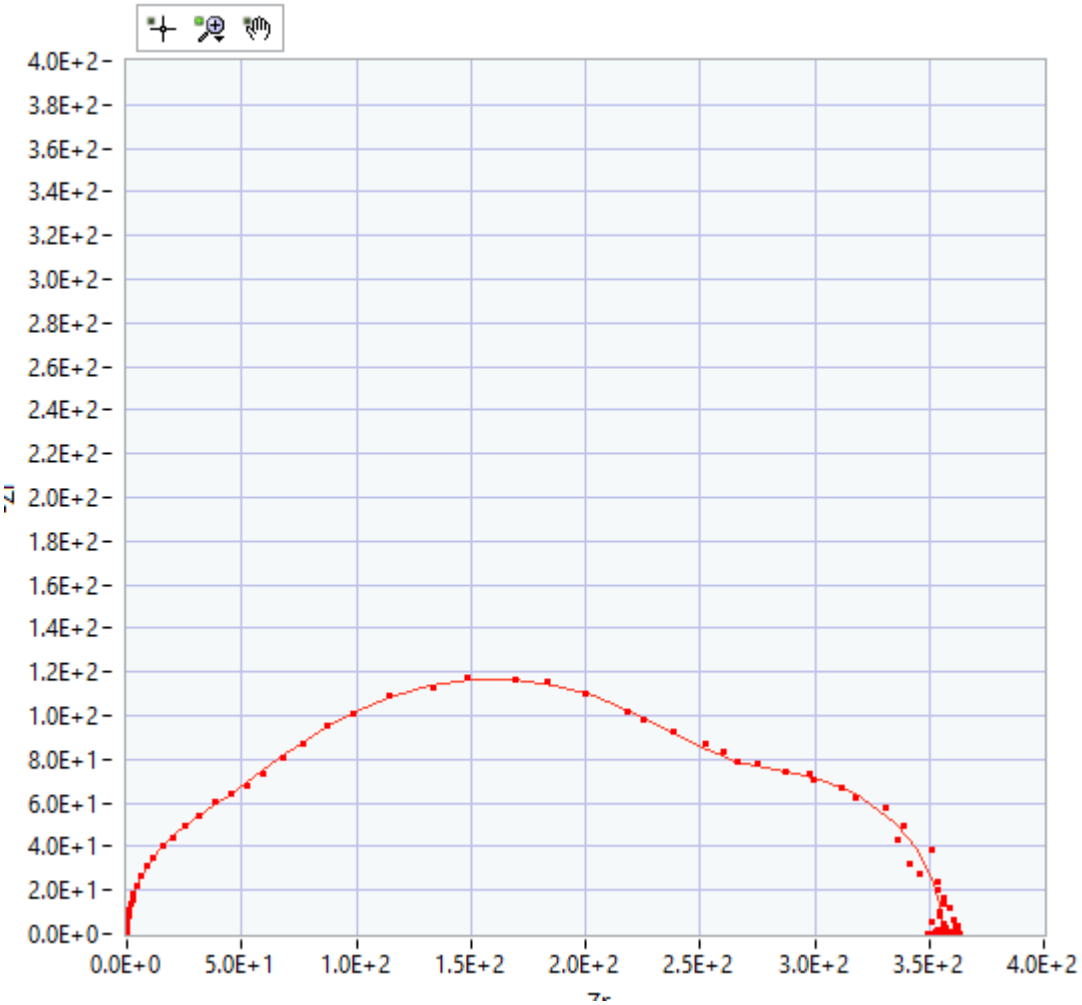


The error is a little bit smaller but not essential.

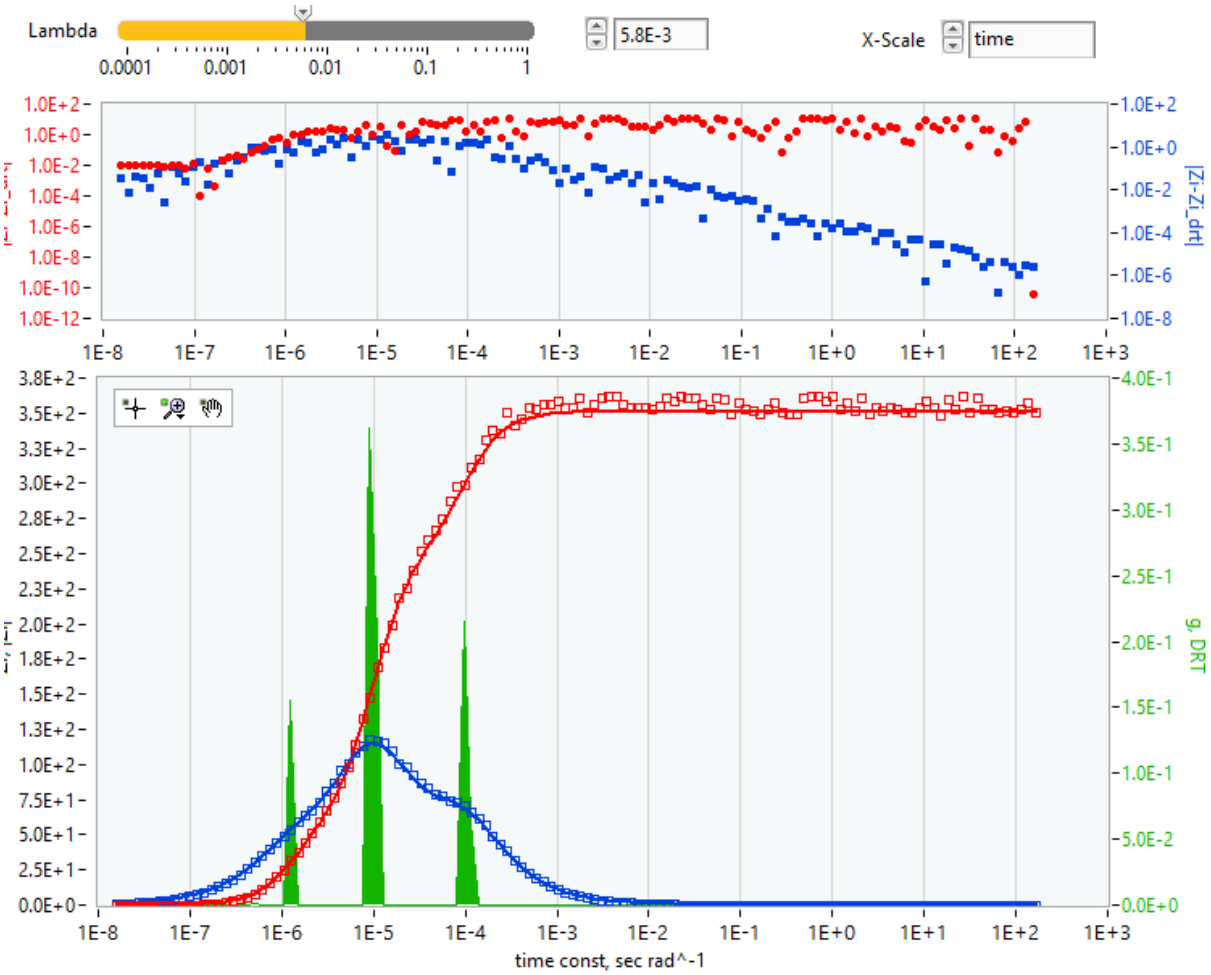
Of course, on simulated data is easy. Let's add some with noise, up to + or - 2% of value of Z. The command to do this is rndz>>2. See Parameters panel, Advanced commands.



If we look at the Nyquist spectrum it is a bit noisy, particularly at low frequency. This looks more like experimental data than the nice simulated spectrum before.

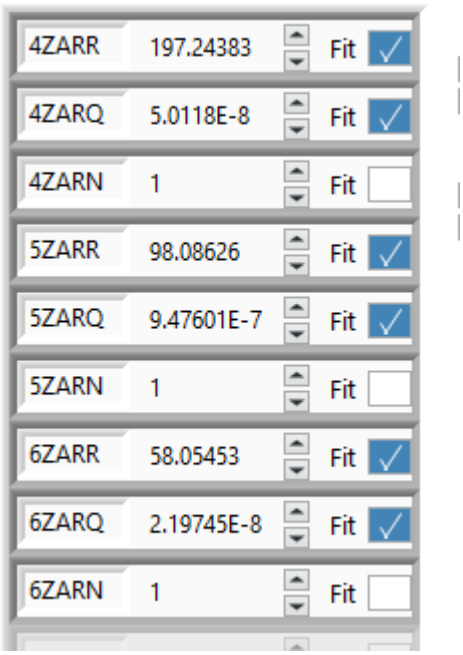


Performing DRT on this data we obtain :



Errors are much larger, it is to be expected, yet we see three contributions at the relaxation times we should.

Let’s perform a classical fit with 3 zarcs, the fit is very good, and the Parameters panel shows the results (close to the simulated values).



And if you want also the error bars use *Report* or *Save parameters*.

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All parameters :
4ZARR: 1.97244E+2, 4ZARQ: 5.01180E-8, 4ZARN: 1.00000E+0, 5ZARR: 9.80863E+1, 5ZARQ:
9.47601E-7, 5ZARN: 1.00000E+0, 6ZARR: 5.80545E+1, 6ZARQ: 2.19745E-8, 6ZARN:
1.00000E+0,
Dataset name : sim_
Fitted parameters and calculated standard error :
4ZARR 1.972E+2 +/- 5.91E+0
4ZARQ 5.012E-8 +/- 3.59E-9
5ZARR 9.809E+1 +/- 0.00E+0
5ZARQ 9.476E-7 +/- 5.13E+0
6ZARR 5.805E+1 +/- 1.12E-7
6ZARQ 2.197E-8 +/- 0.00E+0

R square: 9.984960E-1
Chi square: 1.541100E-1
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