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Standalone Arapuca Analysis

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The X-Arapuca without Quartz window (XN) will see the sum of the three spectra, with the assumption that the three wavelengths are shifted with similar quantum efficiency.

$$\frac{dXN}{dt}(scint@128nm + 150nm + 178nm) = K\left(\frac{\tau_{TA}}{\tau_{128}}\frac{e^{-\frac{t}{\tau_{TA}}}}{\tau_{TA}} + \frac{\tau_{TA}}{\tau_{AX}}\frac{(e^{-t/\tau_{TA}} - e^{-t/\tau_{TX}})}{(\tau_{TA} - \tau_{TX})}\right)$$

The X-Arapuca with the Quartz window (XQ) will only be sensitive to the third spectrum (the one from XeXe*)

$$\frac{dXQ}{dt}(scint@178nm) = (1-\varepsilon)K\frac{\tau_{150}}{\tau_{XX} + \tau_{150}}\frac{\tau_{TA}}{\tau_{AX}}\frac{(e^{-t/\tau_{TA}} - e^{-t/\tau_{TX}})}{(\tau_{TA} - \tau_{TX})}$$

The XN and XQ spectra at the different Xe concentrations can be fitted 'simultaneously' with the $\frac{dXN}{dt}$ *and* $\frac{dXQ}{dt}$ functions to extract the common value of τ_{TA} *and* τ_{TX}.

A linear fit of $\frac{1}{\tau_{TA}}$ *and* $\frac{1}{\tau_{TX}}$ as a function of the Xenon concentration could allow to estimate estimate of τ_{AX} *and* τ_{XX} :

$$\frac{1}{\tau_{TA}} = \frac{1}{\tau_{128}} + \frac{1}{\tau_{N2}} + \frac{1}{\tau_{AX}} = (a + b\ Xe[ppm])\,\mu s^{-1}$$

$$\frac{1}{\tau_{128}} + \frac{1}{\tau_{N2}} = a\ \mu s^{-1}$$

$$\frac{1}{\tau_{N2}} = (a - \frac{1}{1.6})\ \mu s^{-1}$$

$$\tau_{N2} = 1/(a - \frac{1}{1.6})\ \ \mu s$$

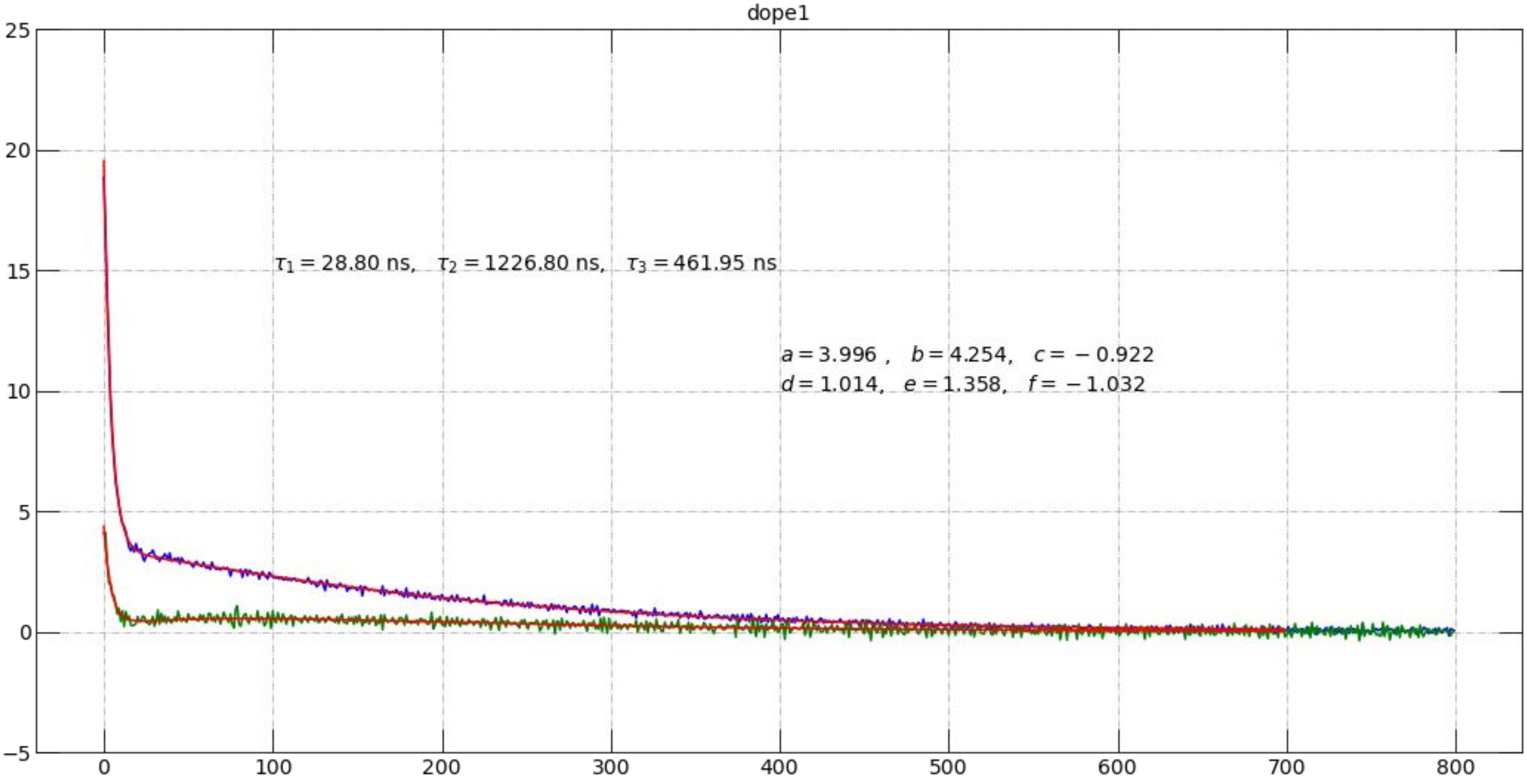
$$\frac{1}{\tau_{AX}} = b\ Xe[ppm]\ \mu s^{-1}$$

$$\tau_{AX} = \frac{1/b}{Xe[ppm]}\ \mu s$$

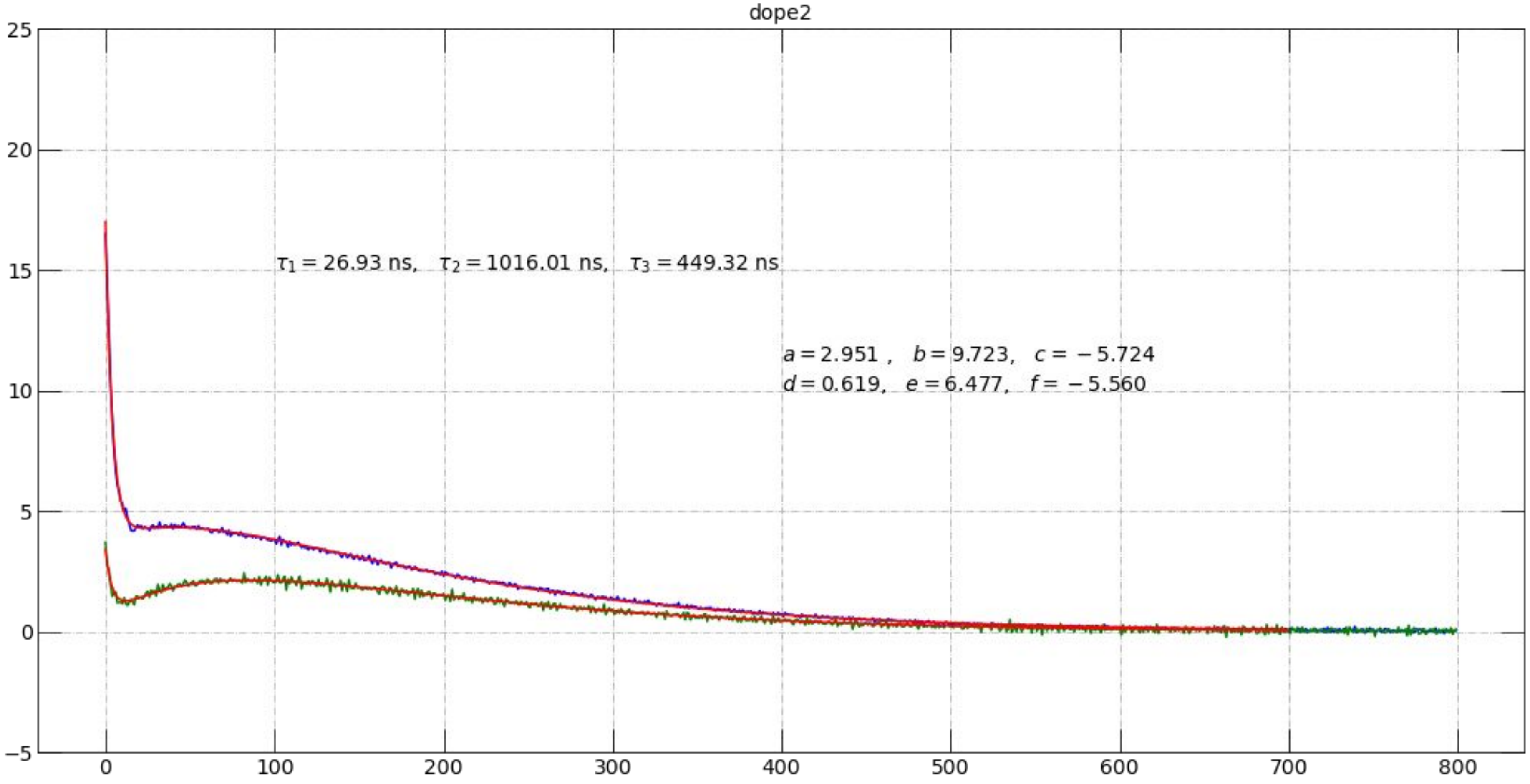
$$\frac{1}{\tau_{TX}} = \frac{1}{\tau_{150}} + \frac{1}{\tau_{XX}} = c + d\ Xe[ppm]\ \mu s^{-1}$$

$$\tau_{150} = \frac{1}{c}\ \mu s$$

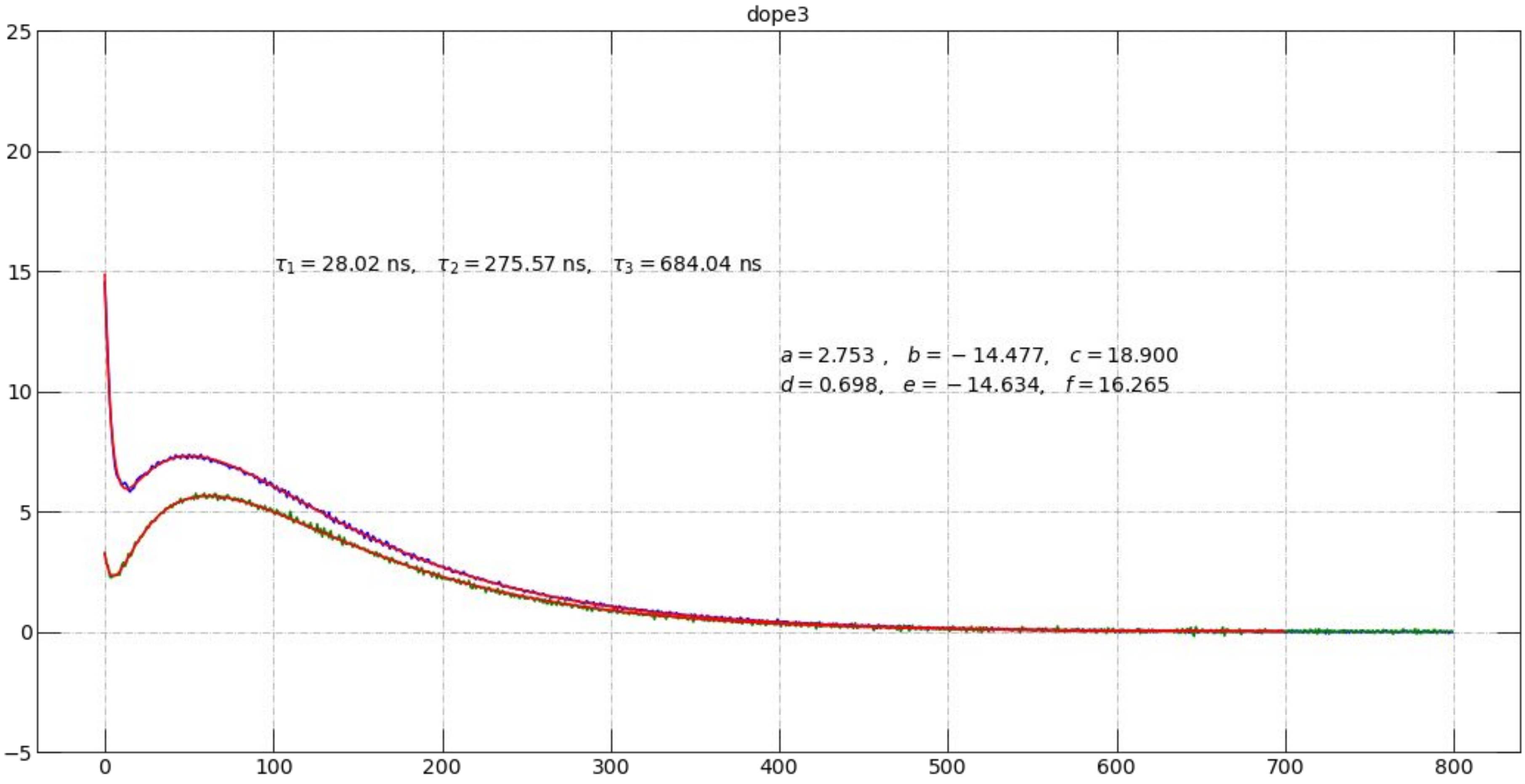
$$\tau_{XX} = \frac{\frac{1}{d}}{Xe[ppm]}\ \mu s$$



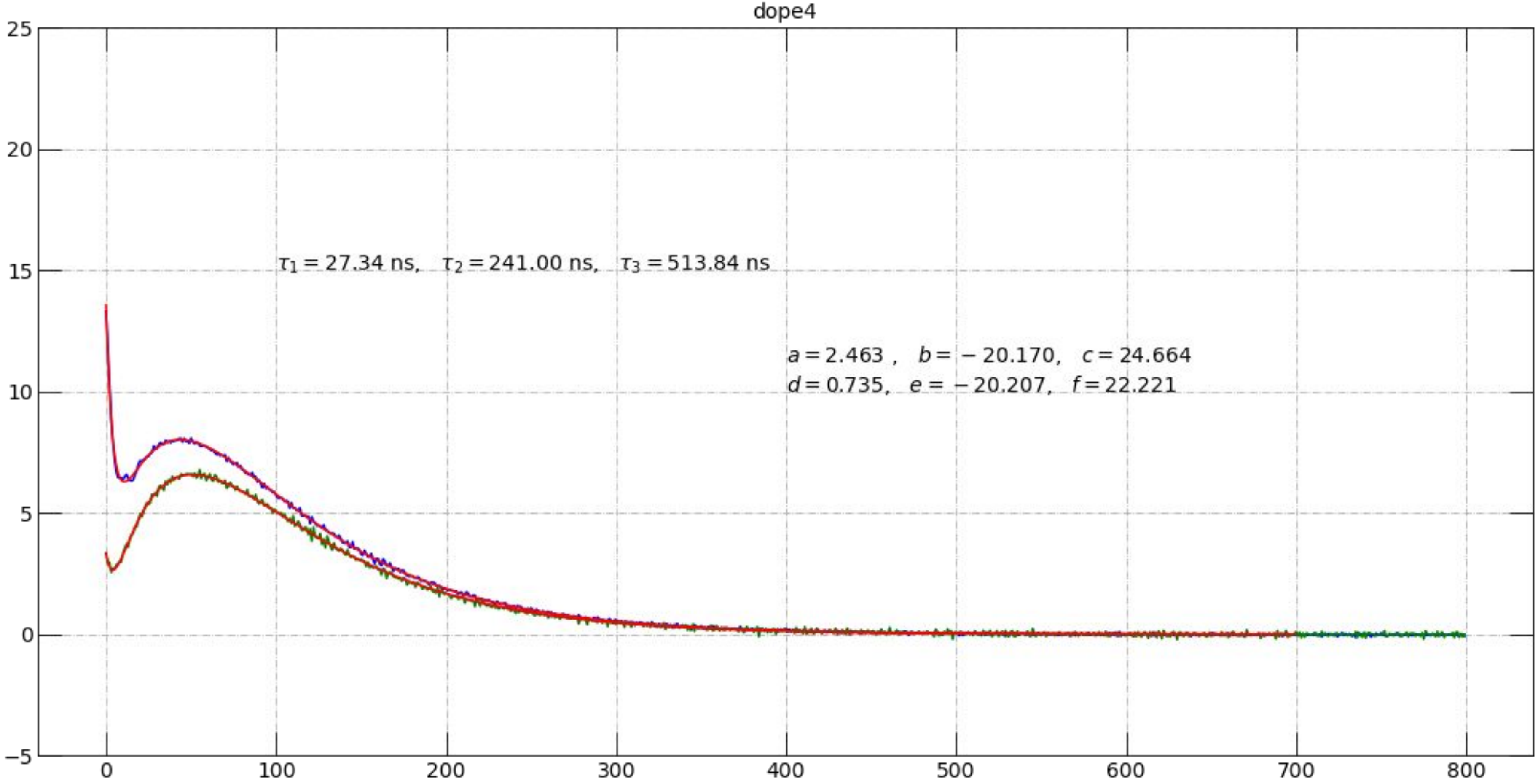
dope1
$\tau_1 = 28.80$ ns, $\tau_2 = 1226.80$ ns, $\tau_3 = 461.95$ ns
$a = 3.996$, $b = 4.254$, $c = -0.922$
$d = 1.014$, $e = 1.358$, $f = -1.032$
25
20
15
10
5
0
−5
0
100
200
300
400
500
600
700
800

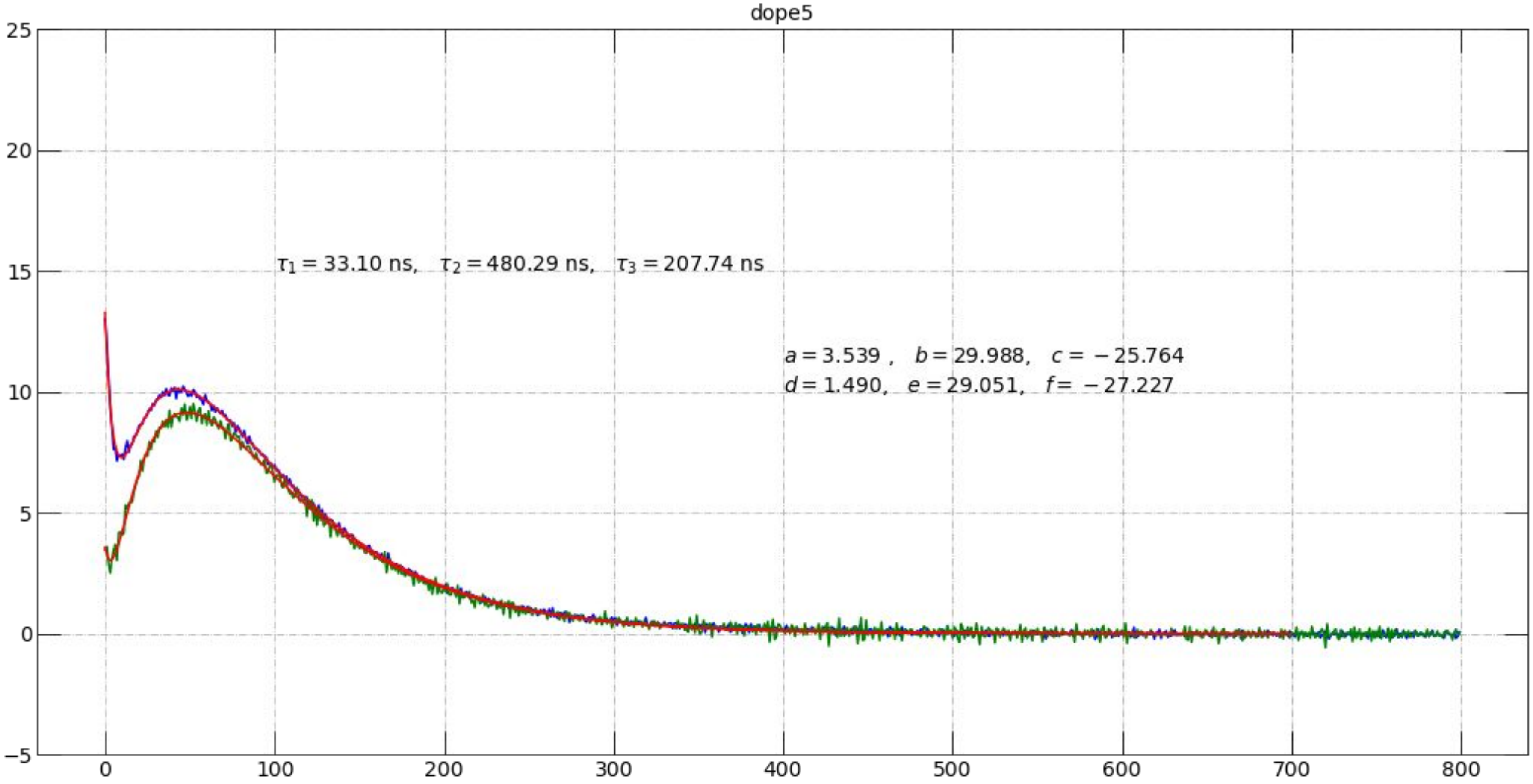


dope2
$\tau_1 = 26.93$ ns, $\tau_2 = 1016.01$ ns, $\tau_3 = 449.32$ ns
$a = 2.951$, $b = 9.723$, $c = -5.724$
$d = 0.619$, $e = 6.477$, $f = -5.560$
25
20
15
10
5
0
−5
0
100
200
300
400
500
600
700
800

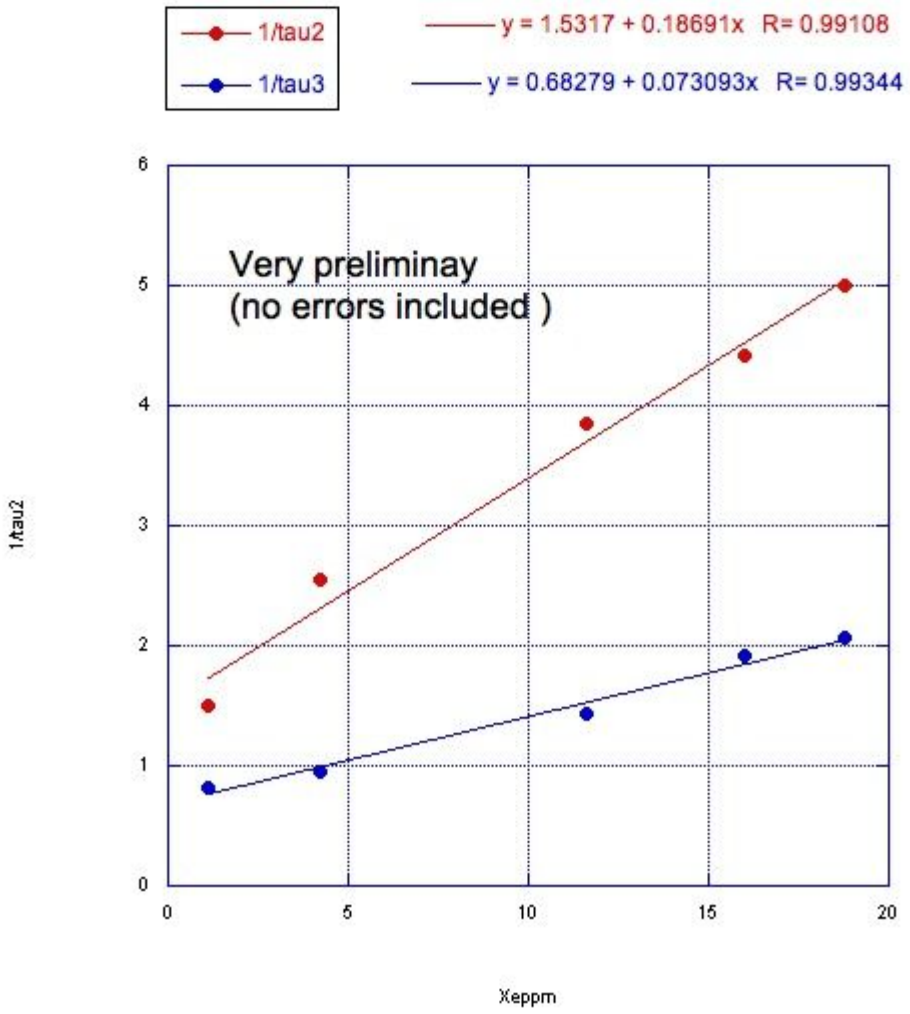


dope3
$\tau_1 = 28.02$ ns, $\tau_2 = 275.57$ ns, $\tau_3 = 684.04$ ns
$a = 2.753$, $b = -14.477$, $c = 18.900$
$d = 0.698$, $e = -14.634$, $f = 16.265$
25
20
15
10
5
0
−5
0
100
200
300
400
500
600
700
800


dope4
$\tau_1 = 27.34$ ns, $\tau_2 = 241.00$ ns, $\tau_3 = 513.84$ ns
$a = 2.463$, $b = -20.170$, $c = 24.664$
$d = 0.735$, $e = -20.207$, $f = 22.221$
25
20
15
10
5
0
−5
0
100
200
300
400
500
600
700
800



dope5
$\tau_1 = 33.10$ ns, $\tau_2 = 480.29$ ns, $\tau_3 = 207.74$ ns
$a = 3.539$, $b = 29.988$, $c = -25.764$
$d = 1.490$, $e = 29.051$, $f = -27.227$
25
20
15
10
5
0
−5
0
100
200
300
400
500
600
700
800



1/tau2
1/tau3
y = 1.5317 + 0.18691x R= 0.99108
y = 0.68279 + 0.073093x R= 0.99344
Very preliminay
(no errors included)
6
5
4
3
2
1
0
0
5
10
15
20
1/tau2
Xeppm