1 Data analysis

My task in the COMPASS polarized target group was to analyze the NMR signals from the year 2003. After learning the basics of Linux operating system, a bit of C++ programming language, a bit of the program Root, and the basics of Latex, I started analyzing the signals.

The process that leads to the analysis of NMR signals has been already explained in the previous section. This analysis was carried out with the aid of some C++ programs (disp_polfxc.C, mydisp_enh1.C). These programs basically work taking the raw NMR data files for a certain period of time as the input, and producing an output file that contains the time and the polarization (in %) for each of the 10 coils in the target cells. It must be pointed out that coil number 5 does not exist. These programs include the background subtraction, baseline fit, baseline subtraction and area calculation mentioned in the previous section. Several modifications were introduced to this programs in order to improve their performance. They will be discussed in the following paragraphs.

Correction with calibration constants was introduced in order to get the correct value for the polarization. The polarization,(Pol), is obtained from the integrated area, ($Area$), of the NMR signal:

$$Pol = \frac{Area \times gain \times tepol}{au \times ff} \tag{1}$$

where $gain$ is the gain factor that accounts for the different polarization between the TE signal and the enhanced signal, $tepol = 0.0524078$ is the thermal equilibrium polarization at 1K, au is the positive field calibration constant (area unit), and ff is the field correction factor that accounts for field rotation. The values of these parameters are characteristic of each coil and are given in table 1.

coil	gain	au	ff
1	212.80	9641.5	0.963644
2	212.09	8589.3	1.057387
3	211.33	7124.8	0.944615
4	213.19	9624.3	1.031158
5	—	—	—
6	209.10	3286.8	1.005831
7	213.33	9682.1	1.004949
8	212.18	7793.2	0.997561
9	211.61	8133.2	1.008771
10	211.63	9188.7	1.00531

Table 1: Calibration constants for the calculation of the polarization value.

The program was modified so that the magnet current could be read from the input NMR data files, and corrections could be introduced to the value of the polarization in case the magnet current was found to be negative. It was checked that it is the negative magnetic field data that should be corrected with the field factor and not the positive magnetic field data.

It was also checked that the correction by the field factor should be done dividing by it, and not multiplying by it. The program was made to write a $'+'/'-'$ flag to the end of each line after calculating the polarization to distinguish between positive and negative magnetic field polarization data.

The calculation of the unix time in seconds from the input files was corrected, since writing: $date--date ='2003-4-30 23:00:00 CET'$ in the command line gives: Thu May 1 00:00:00 CEST 2003, writing: $date--date ='2003-4-30 23:00:00 CET'+\%s$ gives: 1051740000 (unix time in seconds), and writing: $date--date ='2003-5-01 00:00:00 CET'$ gives: Thu May 1 01:00:00 CEST 2003. (See program disp_polfxc.C)

The NMR signal has its resonant frequency at 16381800 Hz. The frequency window of the NMR signal is 100000 Hz (from 16330000 Hz to 16430000 Hz). The baseline is obtained by fitting a straight line to the off-resonance region of the signal. It was found that the optimum width of the off-resonance region selected for the baseline fit was from 16330000 Hz to 16341800 Hz, to the left of the resonant peak, and from 16421800 Hz to 16430000 Hz, to the right of the resonant peak. Making this selected region wider makes things worse, as it can be seen in figure 7.
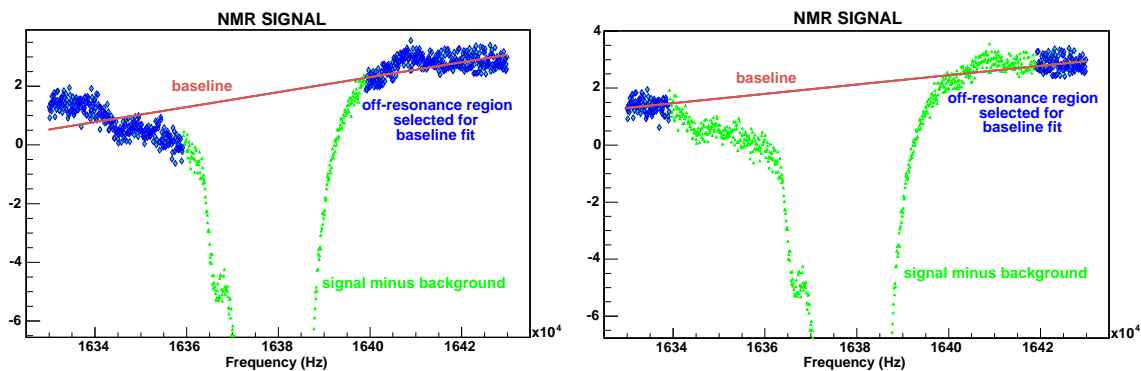

Figure 1: Baseline fits.Signal minus background is shown in green. Baseline in shown in red. Off-resonance region selected for the baseline fit is shown in blue. On the left, the region selected for the baseline fit is too wide. On the right, this region has the appropriate width.

Once the programs were ready, the data analysis started. Four cdroms containing NMR data from 2003 were provided. This NMR data was taken as the input for the programs, producing output files with the time and polarization for each coil. Some of the data points in these files had to be eliminated manually, the reason being that their value was far too high or too low, meaning that they would interfere with any fit performed on all the data points.

The first cdrom contained NMR data from 030624_025111.bgr to 030710_120145.sig. The listfile containing only the names of these files is 'nmrlist'. After the program disp_polfxc.C was run using 'nmrlist' as the input file, the file 'nmrlistk2' was produced containing one column with the time in unix seconds, and ten more columns with the polarization of each of the 10 NMR coils. [Data removed manually from this file were: from 1056590063 to 1056591808; 1057453986;

1057594342; from 1057821509 to 1057823484; all in unix time seconds]. The data points in the resulting file 'nmrlistk2' were plotted with the program mydisppolpm.C. This program plots both the positive and negative magnet current data. The resulting graph can be seen in figure 8.
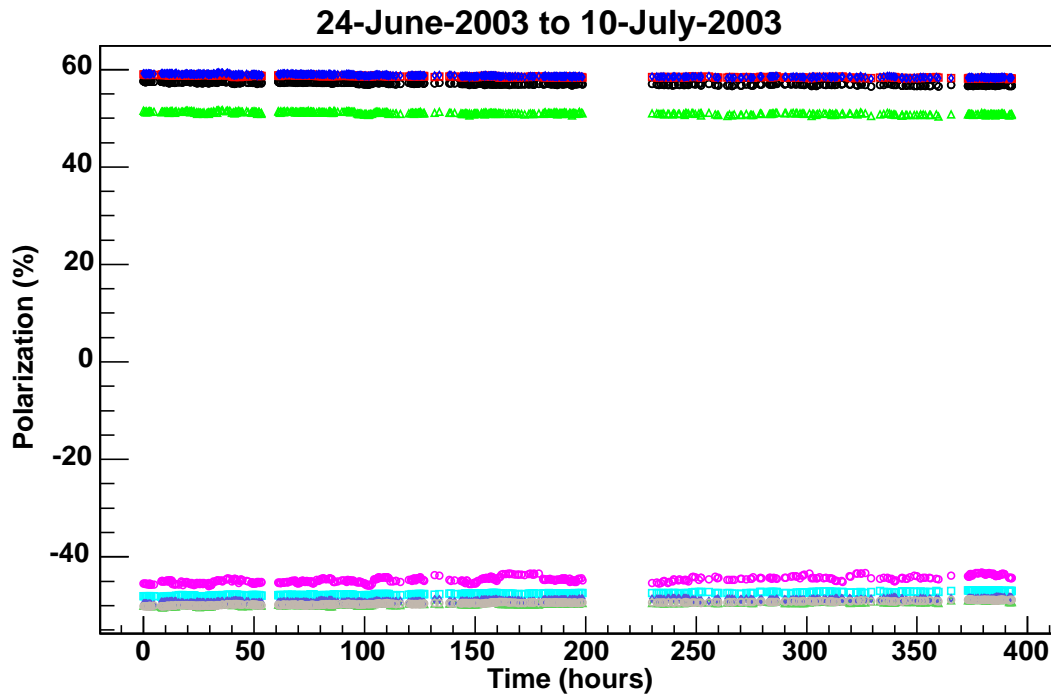

Figure 2: Polarization data from June-24-2003 to July-10-2003.

The second cdrom contained NMR data from 030513_185400.bgr to 030523_155043.sig. The listfile containing only the names of these files is 'nmrlistcd2'. After the program disp_polfxc.C was run using 'nmrlistcd2' as the input file, the produced output file giving the polarization was 'nmrlistcd2bisbis' [Files 030514_001119.sig and 030515_185418.sig were not used because they had no magnet current value written at the end of the file. Data deleted manually from this file were: the beginning and end of the file; 1053000805; 1053001526; from 1053011351 to 1053016933; 1052930495; 1052982920; 1052986227; all in Unix time seconds]. The data points in the resulting file 'nmrlistcd2bisbis' were plotted with the program mydisppolpm.C. The resulting graph can be seen in figure 9.

Exponential fits were performed on these data in order to calculate the polarization build-up time. The exponential functions were: $p2+exp(p0+p1.x)$ for coils 1 to 4, and $p2-exp(p0+p1.x)$ for coils 6 to 10. The resulting parameters p0, p1 and p2 from the fits are given in table 2. Figure 10 shows the fits graphically. The calculated polarization build-up time for May 2003 data is given in table 3.

The third cdrom contained NMR data from 030614_000003.sig to 030620_235805.sig. The listfile containing only the names of these files is 'nmrlistcd3'. The background file 030616_102828.bgr was added to the beginning of this listfile. [Data point 1056032629 in Unix time seconds was manually removed]. The program disp_polfxc.C was run entering 'nmrlistcd3' as the input file,
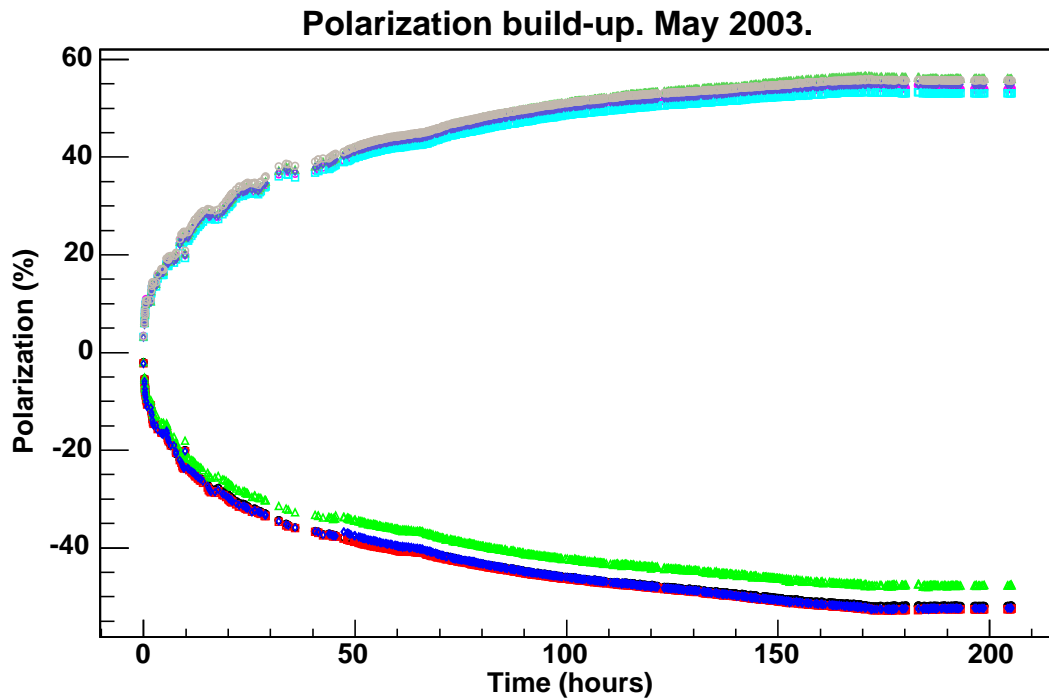
Figure 3: Polarization build-up for May 2003.

and the produced output file giving the polarization was 'nmrlistcd3bis'. A plot of these data points can be seen on figure 11.

The fourth cdrom contained data from 030621_000006.sig to 030716_235911.sig. The corresponding listfile is 'nmrlistcd4', and the polarization file that the program disp_polfxc.C outputs is 'nmrlistcd4bis'. The background file 030620_185505.bgr from the previous cdrom was added to the beginning of this listfile. [Data points manually removed were: 1056318288; from 1056348336 to 1056350159; from 1056590063 to 1056591808; from 1057821509 to 1057823484; 1056386693; 1057594342; 1058249538; all in Unix time seconds.] A plot of the polarization during this period can be seen on figure 12. Note that this period includes that on the first cdrom.

The beginning of 'nmrlistcd4bis' was put together with the end of 'nmrlistcd3bis' in order to study the polarization build-up in June 2003. Figure 12 shows this graphically.

Exponential fits were made in the same way as for the polarization build-up for May 2003 data, and the results can be seen in table 4. From the inverse of the fitting parameter p1, the polarization build-up time was calculated for each coil. Results of these calculations are shown in table 5.

Most of the polarization points in 'nmrlistcd4bis' except some at the beginning and at the end of the file were used to study the nuclear polarization decay in time. This made a period about 450 hours long, nearly 19 days long. The data corresponding to each coil were fitted to an exponential line. Exponential functions were: exp(p0+p1.x) for coils 1 to 4, and -exp(p0+p1.x) for coils 6 to 10. From the inverse of the parameter p1, the polarization decay time and its error were calculated. This calculations were first done using all polarization data points: those
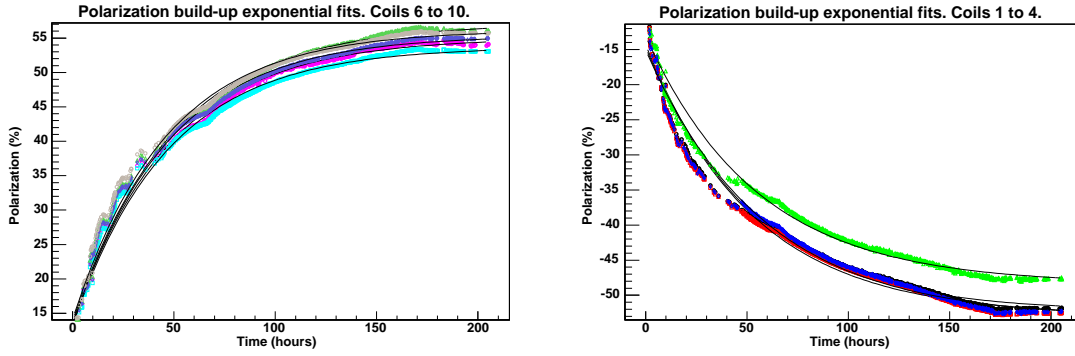
Figure 4: Exponential fits for polarization build-up calculation on May 2003 NMR data. Left figure shows coils 6 to 10. Right figure shows coils 1 to 4.

coil	p0	p1	p2
1	$3.63753 \pm 3.82008 \times 10^{-3}$	$-1.90216 \times 10^{-2} \pm 1.92210 \times 10^{-4}$	-52.2997 ±0.098069
2	$3.64477 \pm 3.78366 \times 10^{-3}$	$-1.86937 \times 10^{-2} \pm 1.89897 \times 10^{-4}$	-52.9329 ±0.100780
3	$3.56378 \pm 4.08889 \times 10^{-3}$	$-1.81209 \times 10^{-2} \pm 1.98436 \times 10^{-4}$	-48.3883 ±0.103482
4	$3.64387 \pm 3.76600 \times 10^{-3}$	$-1.73905 \times 10^{-2} \pm 1.80151 \times 10^{-4}$	-53.2771 ±0.109924
5	—	—	—
6	$3.72318 \pm 3.56992 \times 10^{-3}$	$-2.06932 \times 10^{-2} \pm 1.78610 \times 10^{-4}$	55.0213 ±0.085124
7	$3.70204 \pm 3.65858 \times 10^{-3}$	$-2.12655 \times 10^{-2} \pm 1.88932 \times 10^{-4}$	53.7157 ±0.083611
8	$3.76678 \pm 2.38972 \times 10^{-3}$	$-2.02087 \times 10^{-2} \pm 1.68746 \times 10^{-4}$	57.0940 ±0.088014
9	$3.73887 \pm 2.53142 \times 10^{-3}$	$-2.13952 \times 10^{-2} \pm 1.83219 \times 10^{-4}$	55.3763 ±0.083076
10	$3.73905 \pm 2.54560 \times 10^{-3}$	$-2.17378 \times 10^{-2} \pm 1.86345 \times 10^{-4}$	56.1515 ±0.081832

Table 2: Polarization build-up exponential fits from May 2003 data. Exponential functions are: p2+exp(p0+p1.x) for coils 1 to 4, and p2-exp(p0+p1.x) for coils 6 to 10.

corresponding to positive magnet current as well as those corresponding to negative current. Then the same fits and calculations were carried out using exclusively positive magnet current data or negative current data. The resulting parameters from these fittings are shown in table 6. Table 7 shows the results of the polarization decay time calculations.

2 List of files and programs.

2.1 Files

The following files can be found at [pcna5802]/home/illorent:
NMR data are recorded in [pcna5802]/home/illorent/cdrom.
Listfiles containing only the names of the NMR data files in 'cdrom' are:

- **nmrlist** → Compass NMR data from 030624_025111.bgr to 030710_120145.sig.

- **nmrlistbis** → When the input file for the program disp_polfxc.C (using Jaakko's calibra-

coil	Pol. Build-up time (hours)	Pol. Build-up time (days)
1	52.57 ± 0.53	2.190 ± 0.022
2	53.49 ± 0.54	2.229 ± 0.023
3	55.18 ± 0.60	2.299 ± 0.025
4	57.50 ± 0.60	2.396 ± 0.025
5	—	—
6	48.33 ± 0.42	2.014 ± 0.017
7	47.02 ± 0.42	1.959 ± 0.017
8	49.48 ± 0.41	2.062 ± 0.017
9	46.74 ± 0.40	1.947 ± 0.017
10	46.00 ± 0.39	1.917 ± 0.016

Table 3: Polarization build-up time calculated from exponential fits on May 2003 data.

coil	p0	p1	p2
1	$3.61427 \pm 2.87313 \times 10^{-3}$	$-2.21590 \times 10^{-2} \pm 2.01749 \times 10^{-4}$	59.1618 ± 0.103194
2	$3.63385 \pm 2.76651 \times 10^{-3}$	$-2.38983 \times 10^{-2} \pm 2.05143 \times 10^{-4}$	60.3477 ± 0.0925154
3	$3.50796 \pm 3.17489 \times 10^{-3}$	$-2.26046 \times 10^{-2} \pm 2.28449 \times 10^{-4}$	52.6328 ± 0.100997
4	$3.63481 \pm 2.78138 \times 10^{-3}$	$-2.30553 \times 10^{-2} \pm 2.00738 \times 10^{-4}$	60.7239 ± 0.0971762
5	—	—	—
6	$3.35323 \pm 3.86364 \times 10^{-3}$	$-3.10843 \times 10^{-2} \pm 3.46656 \times 10^{-4}$	-45.3493 ± 0.0686781
7	$3.54722 \pm 3.01108 \times 10^{-3}$	$-2.43814 \times 10^{-2} \pm 2.22850 \times 10^{-4}$	-49.4958 ± 0.0888702
8	$3.57656 \pm 2.93550 \times 10^{-3}$	$-2.35325 \times 10^{-2} \pm 2.08760 \times 10^{-4}$	-51.8158 ± 0.0921031
9	$3.57030 \pm 2.94853 \times 10^{-3}$	$-2.38311 \times 10^{-2} \pm 2.09883 \times 10^{-4}$	-51.1158 ± 0.0899290
10	$3.58711 \pm 2.89598 \times 10^{-3}$	$-2.39440 \times 10^{-2} \pm 2.05994 \times 10^{-4}$	-51.8490 ± 0.0890584

Table 4: Polarization build-up exponential fits from June 2003 data. Exponential functions are: p2-exp(p0+p1.x) for coils 1 to 4, and p2+exp(p0+p1.x) for coils 6 to 10.

tion constants, multiplying by the field correction factors, and using baselow=16350000Hz, basehigh=16410000Hz) is nmrlist, the output file giving the polarization in time for each coil is nmrlistbis.

- **nmrlist3bis** → When the input file for the program disp_polfxc.C (using Jaakko's calibration constants, dividing by the field correction factors, and using baselow=16350000Hz, basehigh=16410000Hz) is nmrlist, the output file giving the polarization in time for each coil is nmrlist3bis.

- **nmrlistk** → When the input file for the program disp_polfxc.C (using Kaori's calibration constants, dividing by the field correction factors, and using baselow=16350000Hz, basehigh=16410000Hz) is nmrlist, the output file giving the polarization in time for each coil is nmrlistk.

- **nmrlistk2** → When the input file for the program disp_polfxc.C (using Kaori's calibration constants, dividing by the field correction factors, and using new baselow=16341800Hz,
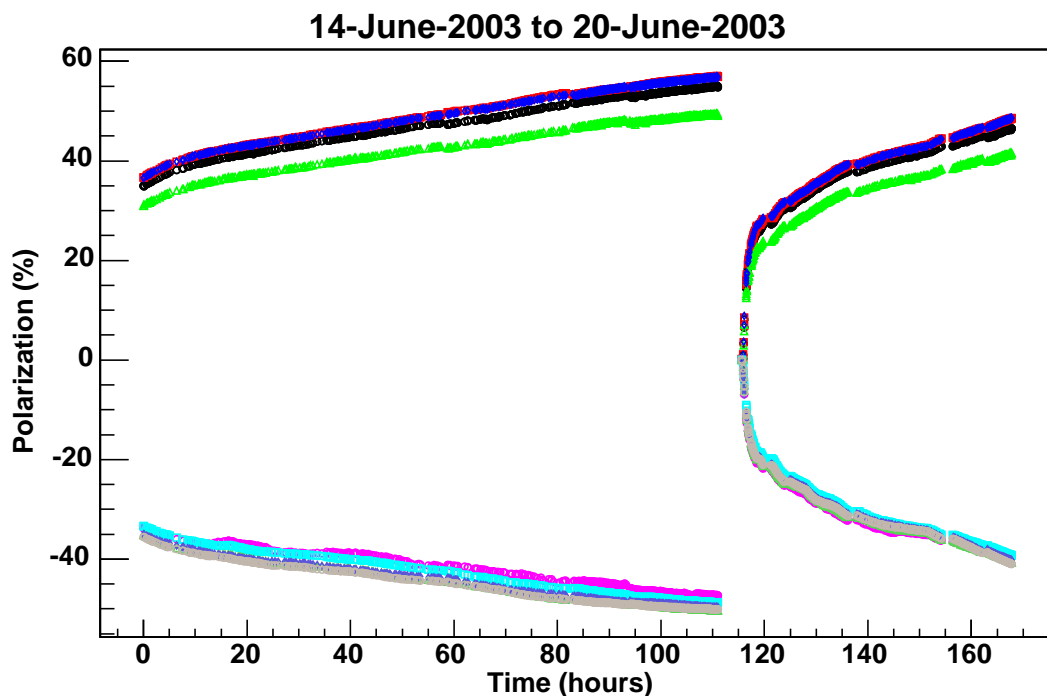
Figure 5: Polarization vs time. 14-20 June 2003. (third cdrom).

and new basehigh=16421800Hz) is nmrlist, the output file giving the polarization in time for each coil is nmrlistk2.

- **nmrlistcd2** → Compass NMR data from 030513_185400.bgr to 030523_155043.sig.

- **nmrlistcd2bisbis** → When the input file for the program disp_polfxc.C (using Kaori's calibration constants, dividing by the field correction factors, and using new baselow = 16341800 Hz, and new basehigh = 16421800 Hz) is nmrlistcd2, the output file giving the polarization in time for each coil is nmrlistcd2bisbis. This file contains all data with positive magnetic field.It contains polarization build-up that can be plotted using the program mydisppolpm.C This plot was used to perform exponential fits in order to obtain the polarization build-up time for May 2003 (See tables 2 and 3).

- **nmrlistcd3** → Compass NMR data from 030614_000003.sig to 030620_235805.sig. (Background 030616_102828.bgr was added to the beginning of the list).

- **nmrlistcd3bis** → When the input file for the program disp_polfxc.C (using Kaori's calibration constants, dividing by the field correction factors, and using new baselow = 16341800 Hz, and new basehigh = 16421800 Hz) is nmrlistcd3, the output file giving the polarization in time for each coil is nmrlistcd3bis. Part of this file contains polarization build-up data that can be used to obtain the polarization build-up time for June 2003 .

- **nmrlistcd4** → Compass NMR data from 030621_000006.sig to 030716_235911.sig. (Background 030620_185505.bgr was added to the beginning of the list).
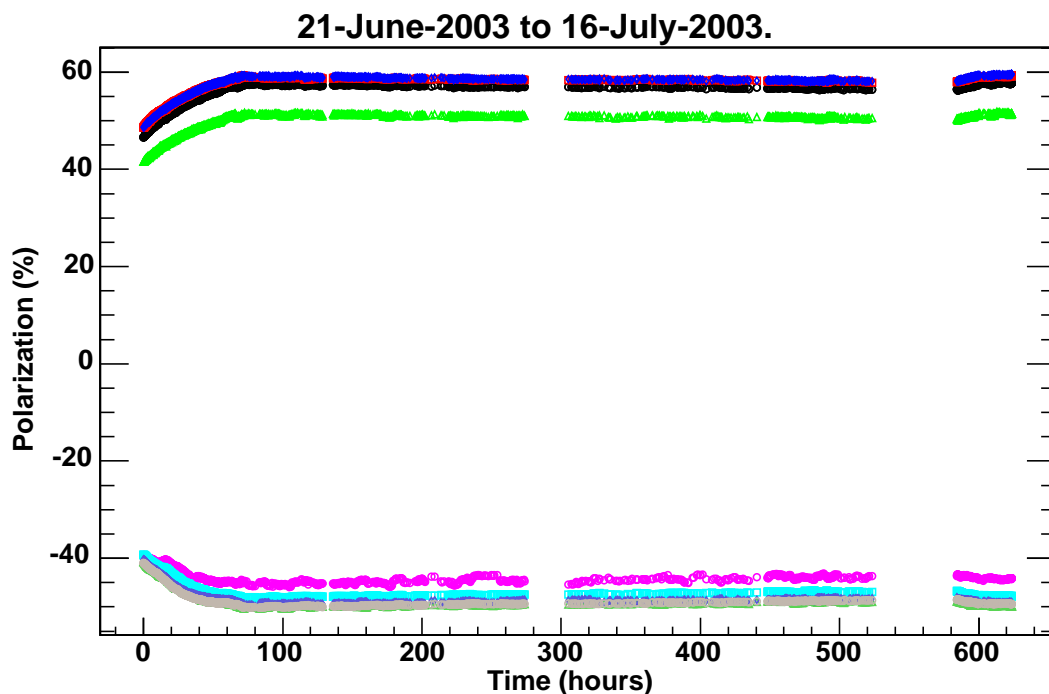
Figure 6: Polarization vs time. 14-20 June 2003. (third cdrom).

- **nmrlistcd4bis** → When the input file for the program disp_polfxc.C (using Kaori's calibration constants, dividing by the field correction factors, and using new baselow = 16341800 Hz, and new basehigh = 16421800 Hz) is nmrlistcd4, the output file giving the polarization in time for each coil is nmrlistcd4bis. This file contains both parts of polarization build-up and of polarization decay.

- **nmrlistbiscinco** → Putting together the last part of nmrlistcd3bis and the first part of nmrlistcd4bis, we get this file that can be plotted using program mydisppolpm.C in order to see polarization build-up for June 2003. Exponential fits can be performed on this plot in order to find the polarization build-up time for each coil (See tables 4 and 5).

- **nmrlistbisseis** → Using most of nmrlistcd4bis polarization points except those at the beginning and at the end of the file, we get this file giving the polarization decay during about 450 hours, ie. nearly 19 days. This can be plotted using mydisppolpm.C or disppolpm.C, and exponential fits can be done in order to obtain the polarization decay time for each coil (See tables 6 and 7).

2.2   Programs

- **monday4.C** → This program can be used to obtain graphs of the different stages of the process of NMR signal analysis (eg. background plot, signal minus background plot, baseline subtraction, etc).

- **disp_polfxc.C** → This program calculates the polarization from the NMR data and

coil	Pol. Build-up time (hours)	Pol. Build-up time (days)
1	45.13 ± 0.41	1.880 ± 0.017
2	45.84 ± 0.36	1.743 ± 0.015
3	44.24 ± 0.45	1.843 ± 0.019
4	43.37 ± 0.38	1.807 ± 0.016
5	—	—
6	32.17 ± 0.36	1.340 ± 0.015
7	41.01 ± 0.37	1.709 ± 0.016
8	42.49 ± 0.38	1.771 ± 0.016
9	41.96 ± 0.37	1.748 ± 0.015
10	41.76 ± 0.36	1.740 ± 0.015

Table 5: Polarization build-up time calculated from exponential fits on June 2003 data.

writes a $'+'/'-'$ flag to the end of each line, depending on whether the magnet current is positive/negative.

- **disppolpm.C** $\rightarrow$ This program can plot data only with a certain magnet current sign, $'+'or'-'$, so that analysis can be done using only positive or negative magnetic field data.

- **mydisppolpm.C** $\rightarrow$ Plots all data together, with both $'+'and'-'$ flag, independently of the input sign entered through the keyboard.

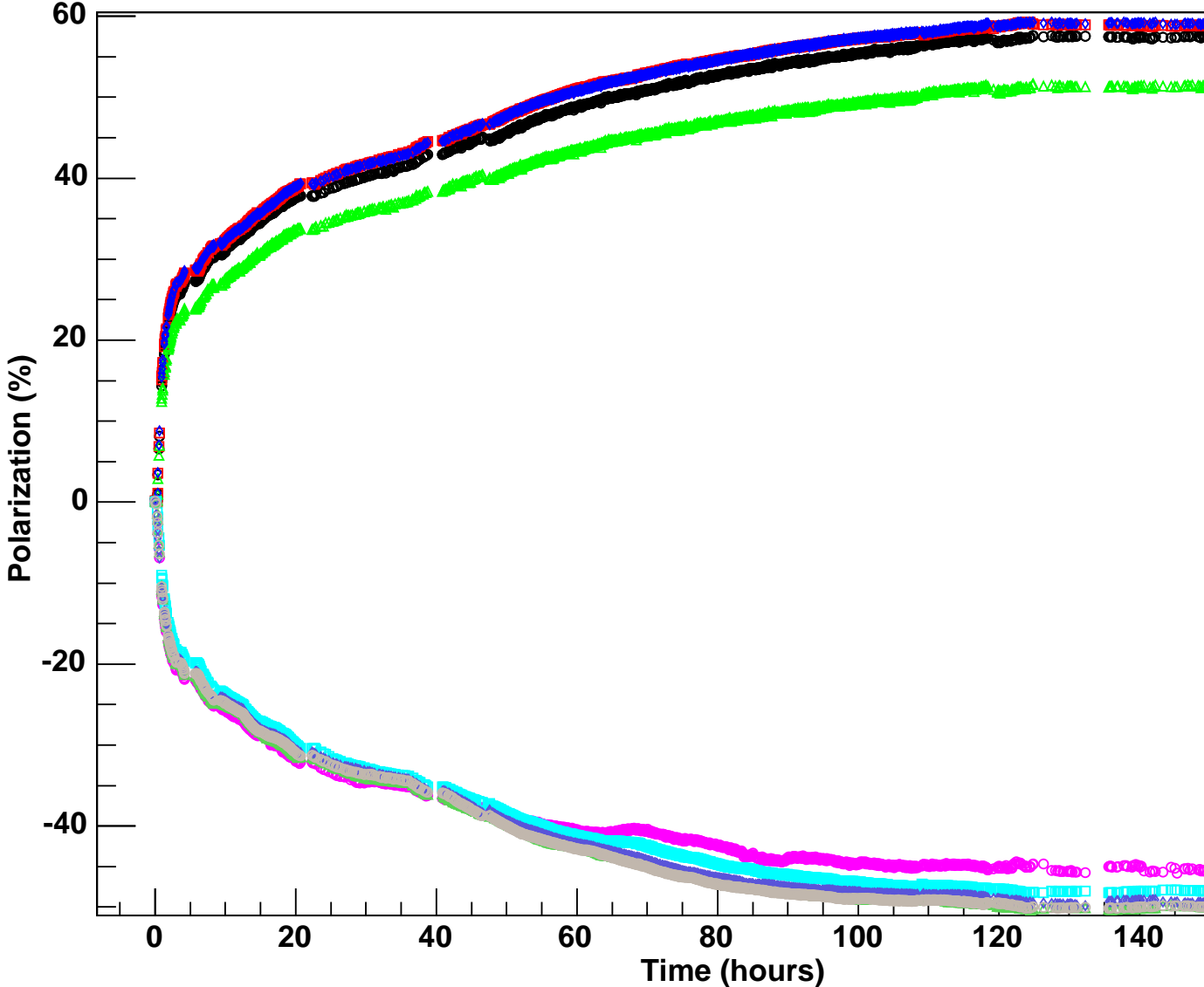Figure 7: Polarization build-up in time from June 2003 data.

COIL NO.	p0	p1
1	$4.05037 \pm 1.15455 \times 10^{-3}$	$-3.15341 \times 10^{-5} \pm 4.30006 \times 10^{-6}$
	$4.05151 \pm 1.53277 \times 10^{-3}$	$-3.24151 \times 10^{-5} \pm 5.35159 \times 10^{-6}$
	$4.04931 \pm 1.77228 \times 10^{-3}$	$-3.29775 \times 10^{-5} \pm 7.41075 \times 10^{-6}$
2	$4.07533 \pm 1.12578 \times 10^{-3}$	$-2.90111 \times 10^{-5} \pm 4.19127 \times 10^{-6}$
	$4.07610 \pm 1.49505 \times 10^{-3}$	$-2.97891 \times 10^{-5} \pm 5.21778 \times 10^{-6}$
	$4.07455 \pm 1.72774 \times 10^{-3}$	$-2.95662 \times 10^{-5} \pm 7.22161 \times 10^{-6}$
3	$3.93789 \pm 1.29168 \times 10^{-3}$	$-2.96252 \times 10^{-5} \pm 4.80932 \times 10^{-6}$
	$3.93903 \pm 1.71490 \times 10^{-3}$	$-3.07095 \times 10^{-5} \pm 5.98605 \times 10^{-6}$
	$3.93680 \pm 1.98264 \times 10^{-3}$	$-3.05063 \times 10^{-5} \pm 8.28721 \times 10^{-6}$
4	$4.07902 \pm 1.12222 \times 10^{-3}$	$-3.36501 \times 10^{-5} \pm 4.18113 \times 10^{-6}$
	$4.07967 \pm 1.49029 \times 10^{-3}$	$-3.34201 \times 10^{-5} \pm 5.20415 \times 10^{-6}$
	$4.07852 \pm 1.72246 \times 10^{-3}$	$-3.65010 \times 10^{-5} \pm 7.20689 \times 10^{-6}$
5	—	—
6	$3.81249 \pm 1.47077 \times 10^{-3}$	$-7.56358 \times 10^{-5} \pm 5.51365 \times 10^{-6}$
	$3.81269 \pm 1.95372 \times 10^{-3}$	$-7.76763 \times 10^{-5} \pm 6.86803 \times 10^{-6}$
	$3.81176 \pm 2.25469 \times 10^{-3}$	$-7.15673 \times 10^{-5} \pm 9.48478 \times 10^{-6}$
7	$3.87261 \pm 1.38253 \times 10^{-3}$	$-5.87064 \times 10^{-5} \pm 5.16953 \times 10^{-6}$
	$3.87153 \pm 1.83876 \times 10^{-3}$	$-5.90048 \times 10^{-5} \pm 6.44514 \times 10^{-6}$
	$3.87319 \pm 2.11899 \times 10^{-3}$	$-5.52213 \times 10^{-5} \pm 8.88842 \times 10^{-6}$
8	$3.91371 \pm 1.32662 \times 10^{-3}$	$-5.74322 \times 10^{-5} \pm 4.95943 \times 10^{-6}$
	$3.91119 \pm 1.76681 \times 10^{-3}$	$-5.60867 \times 10^{-5} \pm 6.19021 \times 10^{-6}$
	$3.91567 \pm 2.03073 \times 10^{-3}$	$-5.39270 \times 10^{-5} \pm 8.51694 \times 10^{-6}$
9	$3.90080 \pm 1.34338 \times 10^{-3}$	$-5.28130 \times 10^{-5} \pm 5.01883 \times 10^{-6}$
	$3.90245 \pm 1.78232 \times 10^{-3}$	$-5.59833 \times 10^{-5} \pm 6.24445 \times 10^{-6}$
	$3.89885 \pm 2.06362 \times 10^{-3}$	$-4.99223 \times 10^{-5} \pm 8.64879 \times 10^{-6}$
10	$3.91261 \pm 1.32867 \times 10^{-3}$	$-6.14218 \times 10^{-5} \pm 4.97012 \times 10^{-6}$
	$3.91253 \pm 1.76517 \times 10^{-3}$	$-6.17522 \times 10^{-5} \pm 6.18954 \times 10^{-6}$
	$3.91247 \pm 2.03841 \times 10^{-3}$	$-6.08571 \times 10^{-5} \pm 8.55678 \times 10^{-6}$

Table 6: Polarization decay exponential fits. Exponential functions are: exp(p0+p1.x) for coils 1 to 4, and -exp(p0+p1.x) for coils 6 to 10. First fit for each coil is made from both positive and negative magnetic field data. Second and third fits are made only from positive or negative field data respectively.

Coil no.	Pol. Decay time (hours)	Pol. Decay time (years)
1	$3.17 \times 10^4 \pm 0.43 \times 10^4$	3.62 ± 0.49
	$3.08 \times 10^4 \pm 0.51 \times 10^4$	3.52 ± 0.58
	$3.03 \times 10^4 \pm 0.68 \times 10^4$	3.46 ± 0.78
2	$3.45 \times 10^4 \pm 0.50 \times 10^4$	3.93 ± 0.57
	$3.36 \times 10^4 \pm 0.59 \times 10^4$	3.83 ± 0.67
	$3.38 \times 10^4 \pm 0.83 \times 10^4$	3.86 ± 0.94
3	$3.38 \times 10^4 \pm 0.55 \times 10^4$	3.85 ± 0.63
	$3.26 \times 10^4 \pm 0.63 \times 10^4$	3.71 ± 0.72
	$3.28 \times 10^4 \pm 0.89 \times 10^4$	3.74 ± 0.99
4	$2.97 \times 10^4 \pm 0.37 \times 10^4$	3.39 ± 0.42
	$2.99 \times 10^4 \pm 0.47 \times 10^4$	3.41 ± 0.53
	$2.74 \times 10^4 \pm 0.54 \times 10^4$	3.12 ± 0.62
5	—	—
6	$1.32 \times 10^4 \pm 0.10 \times 10^4$	1.50 ± 0.11
	$1.29 \times 10^4 \pm 0.11 \times 10^4$	1.47 ± 0.13
	$1.40 \times 10^4 \pm 0.19 \times 10^4$	1.59 ± 0.21
7	$1.70 \times 10^4 \pm 0.15 \times 10^4$	1.94 ± 0.17
	$1.69 \times 10^4 \pm 0.19 \times 10^4$	1.93 ± 0.21
	$1.81 \times 10^4 \pm 0.29 \times 10^4$	2.06 ± 0.33
8	$1.74 \times 10^4 \pm 0.15 \times 10^4$	1.98 ± 0.17
	$1.78 \times 10^4 \pm 0.20 \times 10^4$	2.03 ± 0.22
	$1.85 \times 10^4 \pm 0.29 \times 10^4$	2.11 ± 0.33
9	$1.89 \times 10^4 \pm 0.18 \times 10^4$	2.16 ± 0.21
	$1.79 \times 10^4 \pm 0.20 \times 10^4$	2.03 ± 0.23
	$2.00 \times 10^4 \pm 0.35 \times 10^4$	2.28 ± 0.40
10	$1.63 \times 10^4 \pm 0.13 \times 10^4$	1.85 ± 0.15
	$1.62 \times 10^4 \pm 0.16 \times 10^4$	1.84 ± 0.19
	$1.64 \times 10^4 \pm 0.23 \times 10^4$	1.87 ± 0.26

Table 7: Polarization decay time. First value for each coil refers to calculation from both positive and negative magnetic field data. Second and third values for each coil refer to calculation only from positive or negative field data respectively.
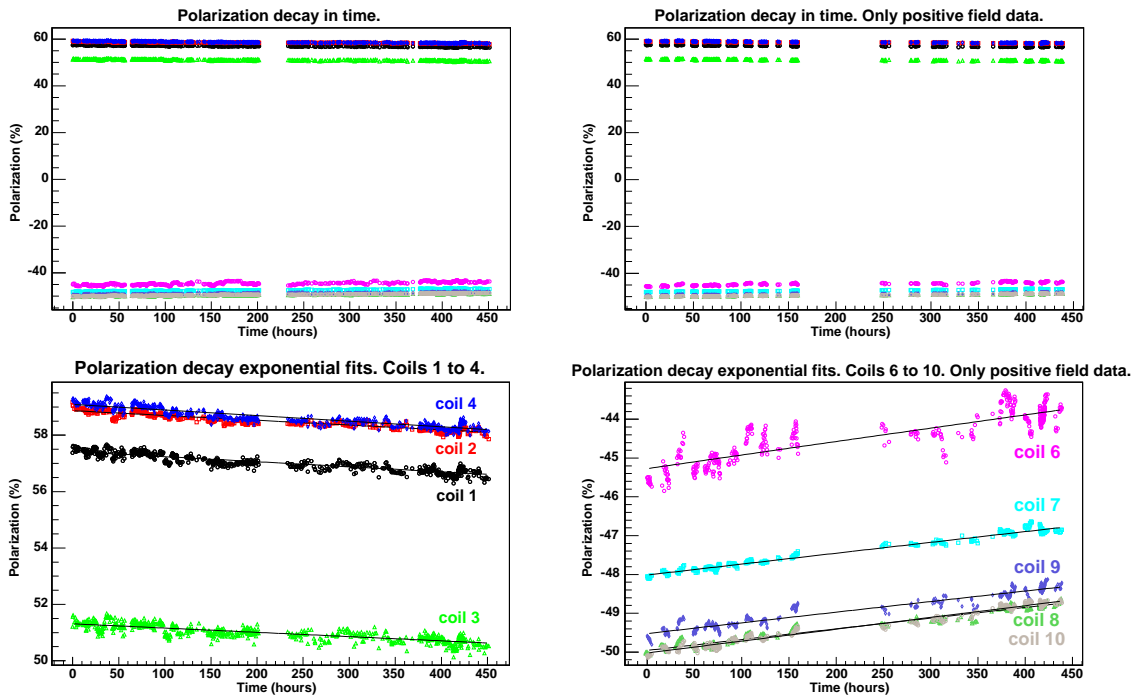
Figure 8: From top to bottom and from left to right: Polarization decay for both positive and negative magnetic field data; Polarization decay for only positive magnet current data; Exponential fits for coils 1 to 4, with both positive and negative field data; Exponential fits for coils 6 to 10 for only positive field data.