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Radiation test results for LM111 (CLUSTER).

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1. Scope.

The purpose of the following radiation test is to study the degradation of the electrical characteristics of the NSC LM111 bipolar voltage comparators at low dose rates under application bias conditions.

2. Test description

8 samples were received from LABEN. The samples were already serialised as 1, 2, 3, 4, 5, 7, 8 and 10. Sample number ten was chosen as the reference sample while samples 1, 3, 4, 5 and 7 were irradiated. Sample number 6 from the previous radiation run (Document ref. Ra0104) was also irradiated to investigate low dose rate effects. Irradiation performed at ESTEC Co-60 facility. All samples were biased during the entire irradiation run. The bias board was provided by LABEN and could accommodate for 6 samples. Each sample contained 4 LM111 devices. Figure1 illustrates the internal configuration of each sample. Figure2 illustrates the position of the samples on the bias board during irradiation. Figure3 illustrates the electrical circuit for irradiation (provided by LABEN).

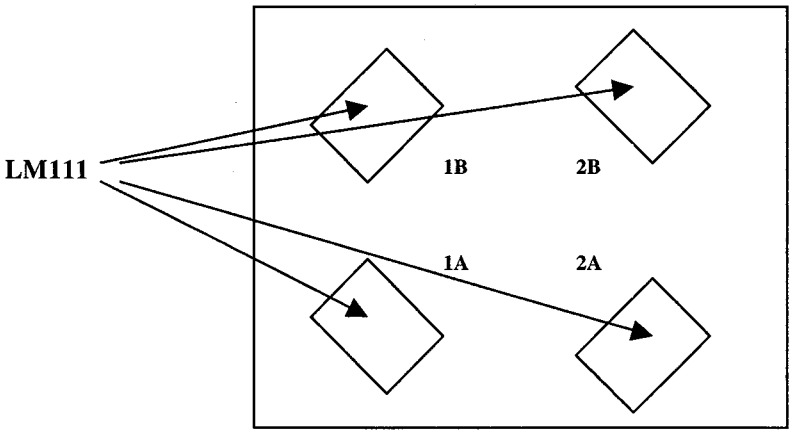

Figure 1 Sample substrate layout

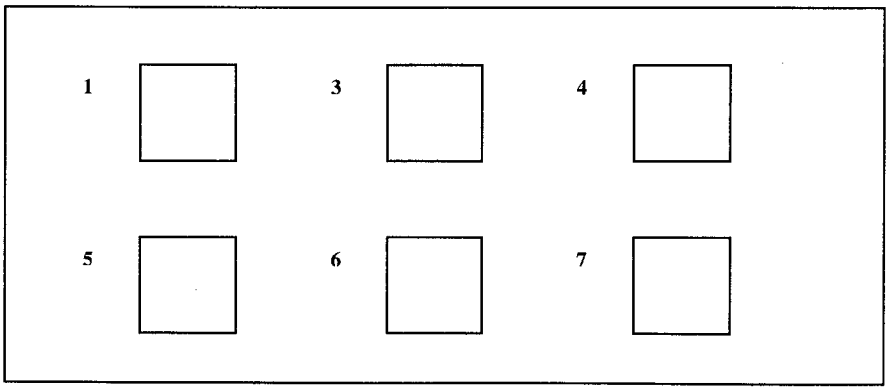

Figure 2 Sample position on the bias board

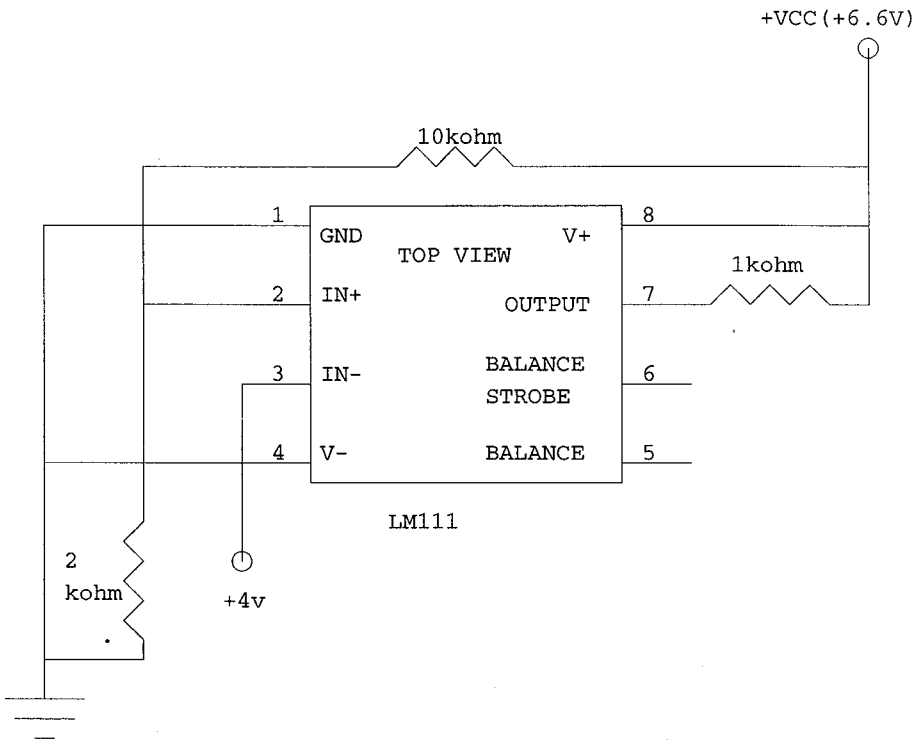

Figure 3 Electrical circuit for irradiation (provided by LABEN)

3. Test sequence

The following table illustrates the test sequence:

Description	Dose Rad(Si)	Temp. Cell [°C]	Duration [min]
Serialisation and selection of control sample. Control sample = 10.	0		
Pre irradiation measurements.	0	20 ± 2	20
First irradiation. Devices were biased.	950	19.1	
First interim electrical measurements.	0	20 ± 2	7
Second irradiation run. Devices were biased	1101	19.2	
Second interim electrical measurements.	0	20 ± 2	10
Third irradiation run. Devices were biased.	1234	19.5	
Third interim electrical measurements.	0	20 ± 2	10
Fourth irradiation run. Devices were biased.	1145	19.6	
Fourth interim electrical measurements.	0	20 ± 2	13
Fifth irradiation run. Devices were biased.	1268	19.4	
Fifth interim electrical measurements.	0	20 ± 2	10

Sixth irradiation run. Devices were biased.	2068	19.9	
Sixth interim electrical measurements.	0	20 ± 2	30
Seventh irradiation run. Devices were biased.	1088	19.2	
Seventh interim electrical measurements.	0	20 ± 2	12
Eighth irradiation run. Devices were biased.	1053	19.4	
Eighth interim electrical measurements.	0	20 ± 2	9
Room temperature anneal, devices biased	0	20 ± 2	1445
Tenth interim electrical measurements.	0	20 ± 2	10
Accelerated Ageing, 168h at 100°C, Devices biased	0	100	10080
Eleventh interim electrical measurements.	0	20 ± 2	10

4. Results

The following table illustrates the dose intervals, measurement parameters and the number of devices failed at each interval.

Param.	Pre. Rad.	0.95 krad	2.05 krad	3.29 krad	4.43 krad	5.7 krad	7.76 krad	8.85 krad	9.9 krad	Room ann.	100C ann.
Vos1	pass	pass	pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Vos2	Pass	pass	pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
+IS	Pass	pass	pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
-IS	Pass	pass	pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Ib+1	Pass	pass	pass	Pass	All Fail	All Fail	All Fail	All Fail	All Fail	All Fail	All Fail
Ib-1	Pass	pass	pass	All Fail	All Fail	All Fail	All Fail	All Fail	All Fail	All Fail	All Fail
Ib+2	Pass	pass	Pass F6	All Fail	All Fail	All Fail	All Fail	All Fail	All Fail	All Fail	All Fail
Ib-2	pass	pass	All Fail	All Fail	All Fail	All Fail	All Fail	All Fail	All Fail	All Fail	All Fail
Ios1	pass	pass	pass	pass	pass	pass	pass	Pass F1	Pass F3	Pass F1	Pass
Ios2	pass	pass	pass	pass	pass	pass	pass	pass	pass	pass	Pass
AVO	pass	pass	pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
CM RR1	Pass F1	pass	pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
CM RR2	pass	pass	pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Vol1	pass	pass	pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Vol2	pass	pass	pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass

Note: F indicates fail followed by a number indicating the number of failed devices.

The dose rate was measured to 0.86 Rad (Si)/min ±10% for all irradiation intervals. The irradiation intervals are listed below.

1) 0.95 kRad(Si)
2) 2.05 kRad(Si)
3) 3.29 kRad(Si)
4) 4.43 kRad(Si)
5) 5.7 kRad(Si)

6) 7.76 kRad(Si)
7) 8.85 kRad(Si)
8) 9.9 kRad(Si)

An irradiation test result summary follows below:

0.95 kRad (Si)

None of the devices have failed, however a sharp increase is detected in Ib+1, Ib-1, Ib+2 and Ib-2. Ib-2 has increased most followed by Ib+2, Ib-1 and Ib+1. This was the general trend for all irradiation intervals.

2.05 kRad (Si)

All devices fail Ib-2 and six devices failed IB+2. All devices passed the remaining parameters. Ib-1 for many of the devices is close to the maximum limit of 100 nA.

3.29 kRad (Si)

All devices fail Ib-1 and the remaining devices fail Ib+2. Ib+1 for many of the devices is close to the maximum limit of 100 nA. All devices passed the remaining parameters.

4.43 kRad (Si)

All devices fail Ib+1 and the remaining devices fail Ib+2 All devices passed the remaining parameters.

5.7 kRad (Si)

All Ibs are still increasing. A steady increase in Ios1 is detected. No additional devices fail.

7.76 kRad(Si)

All Ibs are still increasing. A steady increase in Ios1 is detected. No additional devices fail.

8.85 kRad (Si)

All Ibs are still increasing. One device fails Ios1. No additional devices fail.

9.9 kRad (Si)

All Ibs are still increasing. Two additional devices fail Ios1. No additional devices fail.

24 hour anneal at room temperature.

Some recovery is seen for parameters Ib+1, Ib-1, Ib+2, Ib-2. Two devices recover Ios1.

168 hour anneal at 100°C

Parameters Ib+1, Ib-1, Ib+2 and Ib-2 recover with approximately 50 to 75 nA. However, all devices still fail these parameters. The last device recovers Ios1.

8 Conclusion

The above tests were performed on LM111 devices from a lot dedicated to the Cluster project. One device (device six) from the lot dedicated to the XMM project was also included in these tests. Inclusion of device six was intended to provide dose rate dependency information for devices from the same lot. The above irradiation run was performed at a dose rate of 0.86 rad (Si)/min while the previous irradiation run (XMM project) was performed at ~2 rad (Si)/min.

Prior to the above tests it was believed that an increase in parameter degradation rate would be observed by employing a lower dose rate during irradiation. Results obtained from the above tests show that this is true only for the Ib parameters. The other critical parameters such as Vos1, Vos2 and Ios1 illustrate a different behaviour.

At 0.86 rad (Si)/min the Ib+1, Ib-1, Ib+2 and Ib-2 increase faster than what was observed at a dose rate of 2 rad (Si)/min. This increase in degradation is most obvious after a total dose of 2 krad. It has to be noted that the 168h, 100°C anneal for the above devices show a recovery of Ib+1, Ib-1, Ib+2 and Ib-2 by up to 75 nA.

Contrary to the XMM irradiation run, Vos1 and Vos2 did not fail the irradiation tests. This is also true for Ios1 where only 3 devices failed compared to 16 for the XMM irradiation run.

Sample 6 (XMM lot) illustrates a marginal deviation for some parameters compared to devices from the Cluster lot. These are Vos1, Vos2, Avo and Vol1. Sample six shows a small increase in value for Vol1. However, devices from the Cluster lot show an almost negligible change for the same parameter. The initial Vol1 value of sample six is also higher than for the other devices.

Appendix A

The following figures are graphs for the measured parameters as a function of dose.

Note: One device failed CMRR1 during pre-irradiation electrical characterisation. This is attributed to a measurement error.

Note: The graphs of Ib+1, Ib-1, Ib+2 and Ib-2 illustrate a change in value also for the reference samples after a total dose of 5.7 krad. This is due to a range change of the measurement instrument (SZ). Four different measurement boards were used during the measurements. Because of resistor tolerances on the measurement boards and the

change in the electrical measurement circuit of the SZ system due to the range change, measurements show an increased spread in the parameter values. However, this is not believed to be significant for the irradiated devices, as the trend in the parameters is still obvious.

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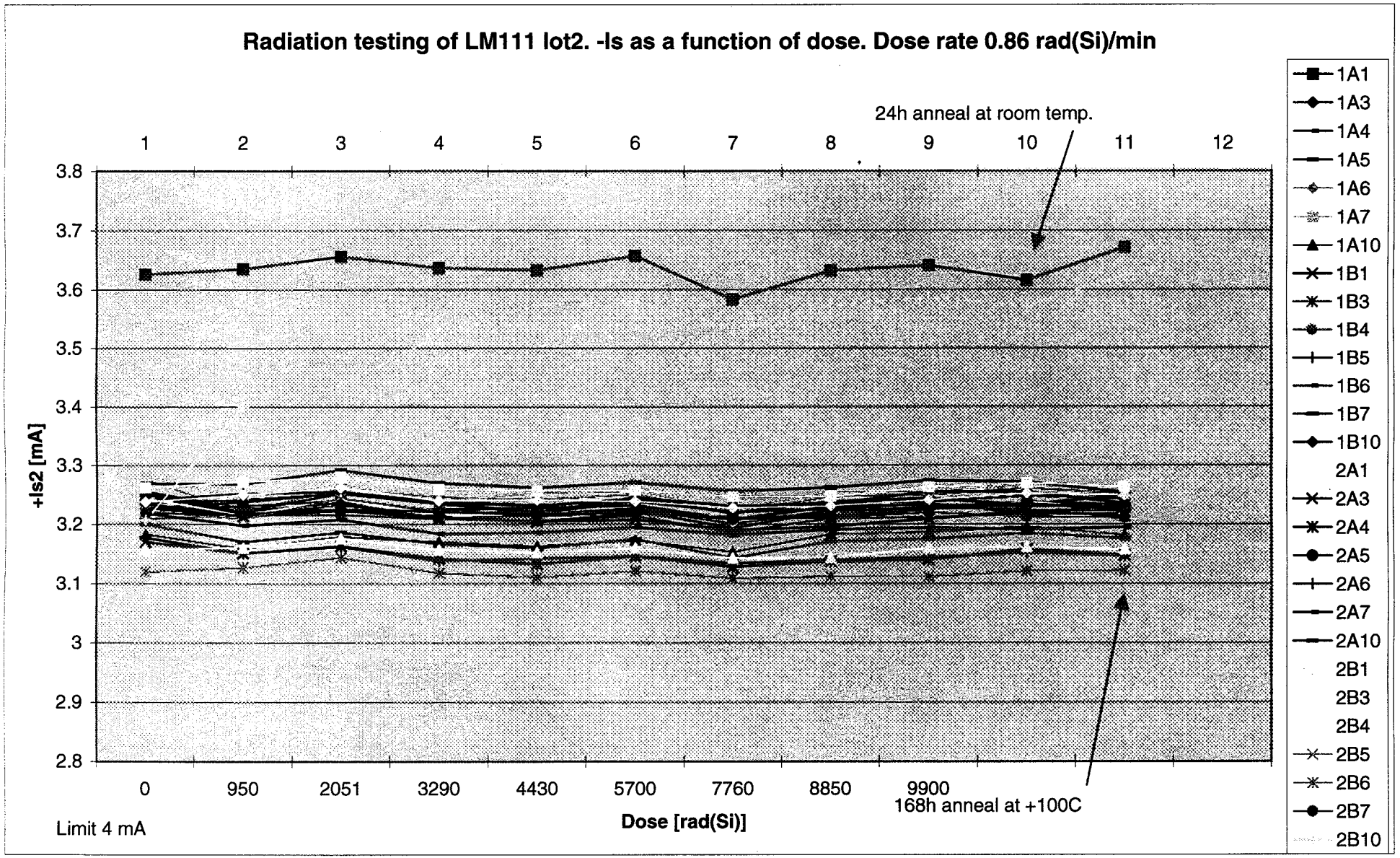
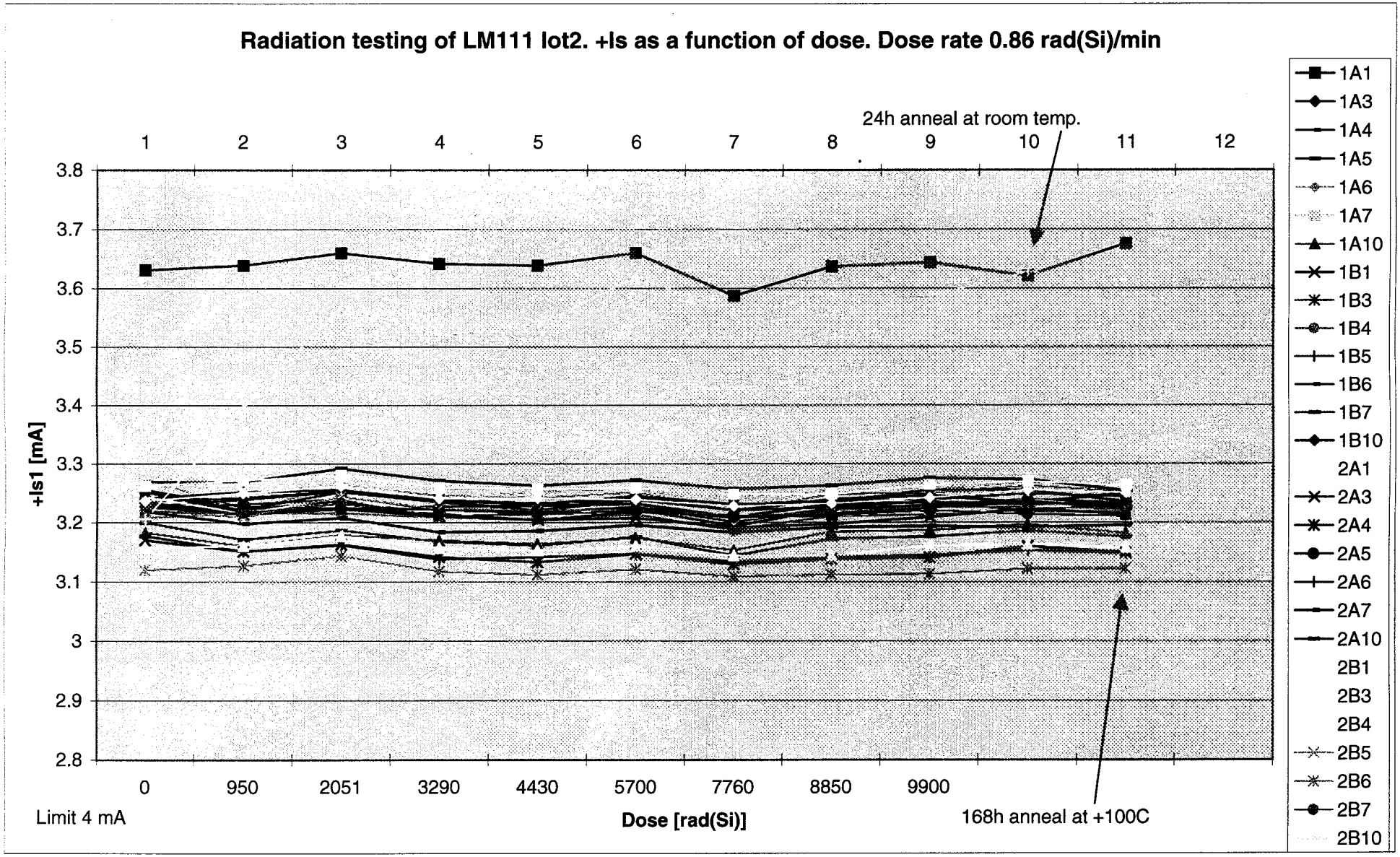

Radiation testing of LM111 lot2. -Is as a function of dose. Dose rate 0.86 rad(Si)/min
24h anneal at room temp.
168h anneal at +100C
+Is2 [mA]
Dose [rad(Si)]
Limit 4 mA
1 2 3 4 5 6 7 8 9 10 11 12
3.8 3.7 3.6 3.5 3.4 3.3 3.2 3.1 3 2.9 2.8
0 950 2051 3290 4430 5700 7760 8850 9900
1A1 1A3 1A4 1A5 1A6 1A7 1A10 1B1 1B3 1B4 1B5 1B6 1B7 1B10 2A1 2A3 2A4 2A5 2A6 2A7 2A10 2B1 2B3 2B4 2B5 2B6 2B7 2B10


Radiation testing of LM111 lot2. +Is as a function of dose. Dose rate 0.86 rad(Si)/min
24h anneal at room temp.
168h anneal at +100C
+Is1 [mA]
Dose [rad(Si)]
Limit 4 mA
1 2 3 4 5 6 7 8 9 10 11 12
3.8 3.7 3.6 3.5 3.4 3.3 3.2 3.1 3 2.9 2.8
0 950 2051 3290 4430 5700 7760 8850 9900
1A1 1A3 1A4 1A5 1A6 1A7 1A10 1B1 1B3 1B4 1B5 1B6 1B7 1B10 2A1 2A3 2A4 2A5 2A6 2A7 2A10 2B1 2B3 2B4 2B5 2B6 2B7 2B10

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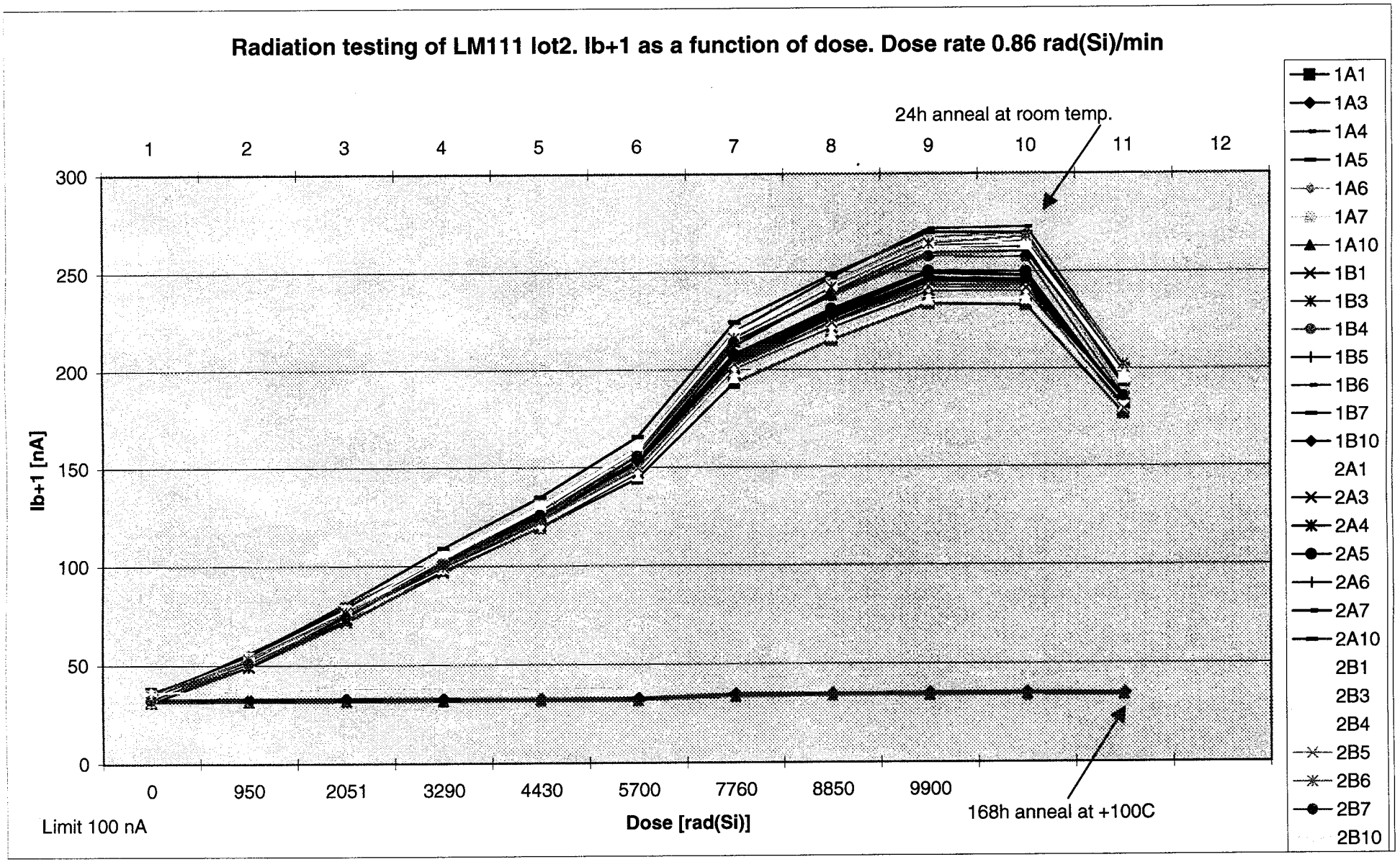
Radiation testing of LM111 lot2. Ib+1 as a function of dose. Dose rate 0.86 rad(Si)/min
24h anneal at room temp.
1
2
3
4
5
6
7
8
9
10
11
12
300
250
200
150
100
50
0
Ib+1 [nA]
0
950
2051
3290
4430
5700
7760
8850
9900
Dose [rad(Si)]
168h anneal at +100C
Limit 100 nA
1A1
1A3
1A4
1A5
1A6
1A7
1A10
1B1
1B3
1B4
1B5
1B6
1B7
1B10
2A1
2A3
2A4
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2A7
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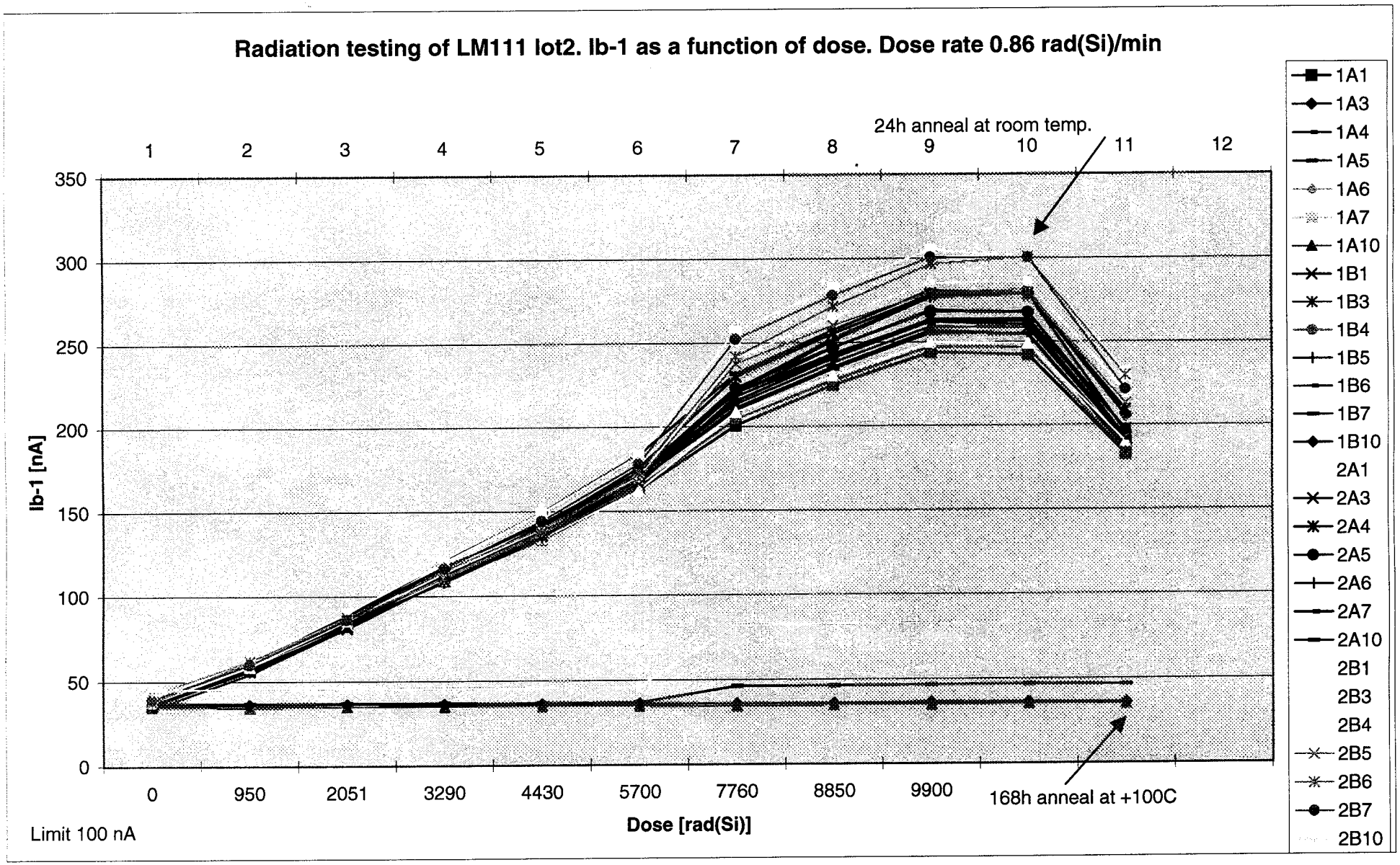
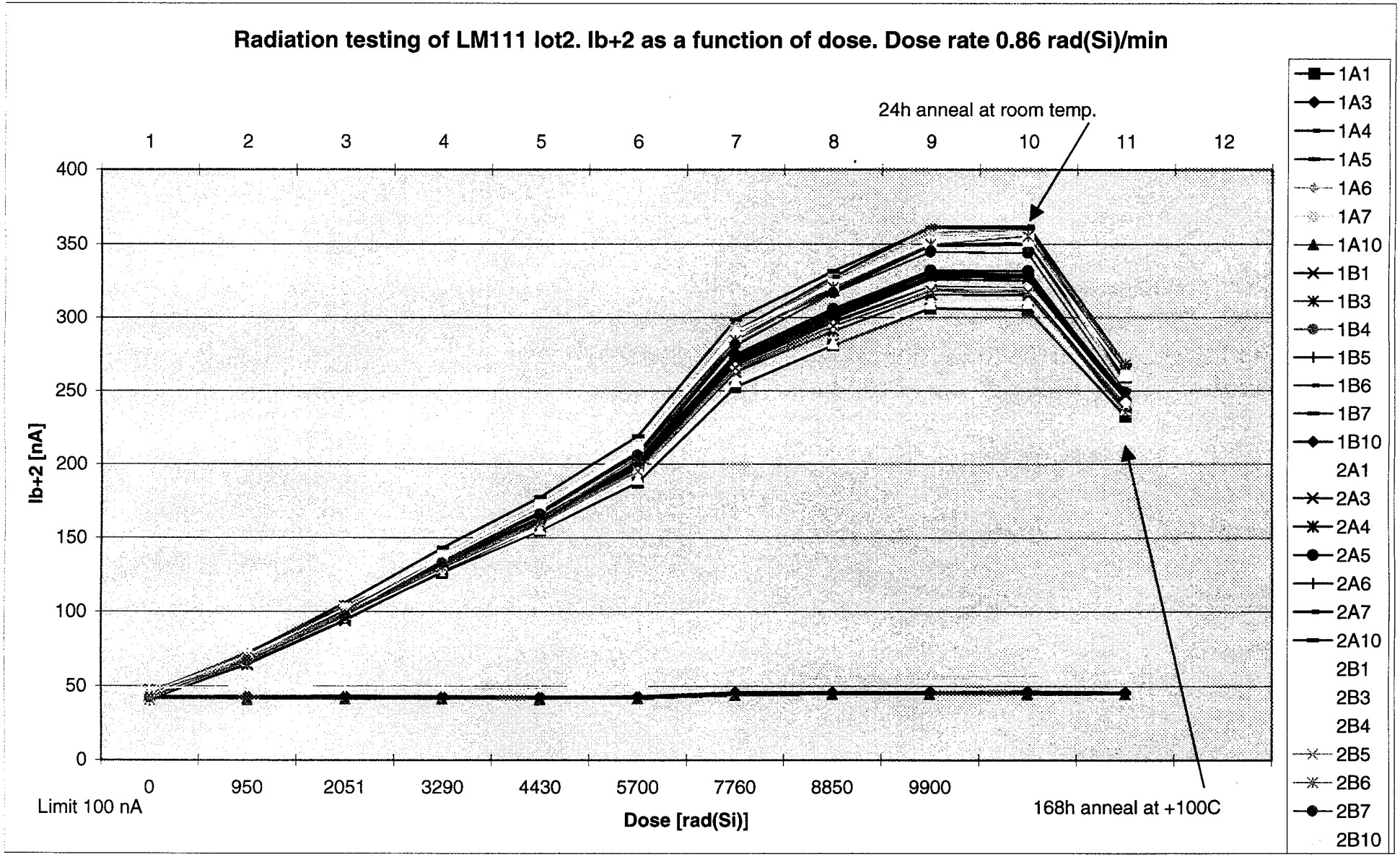
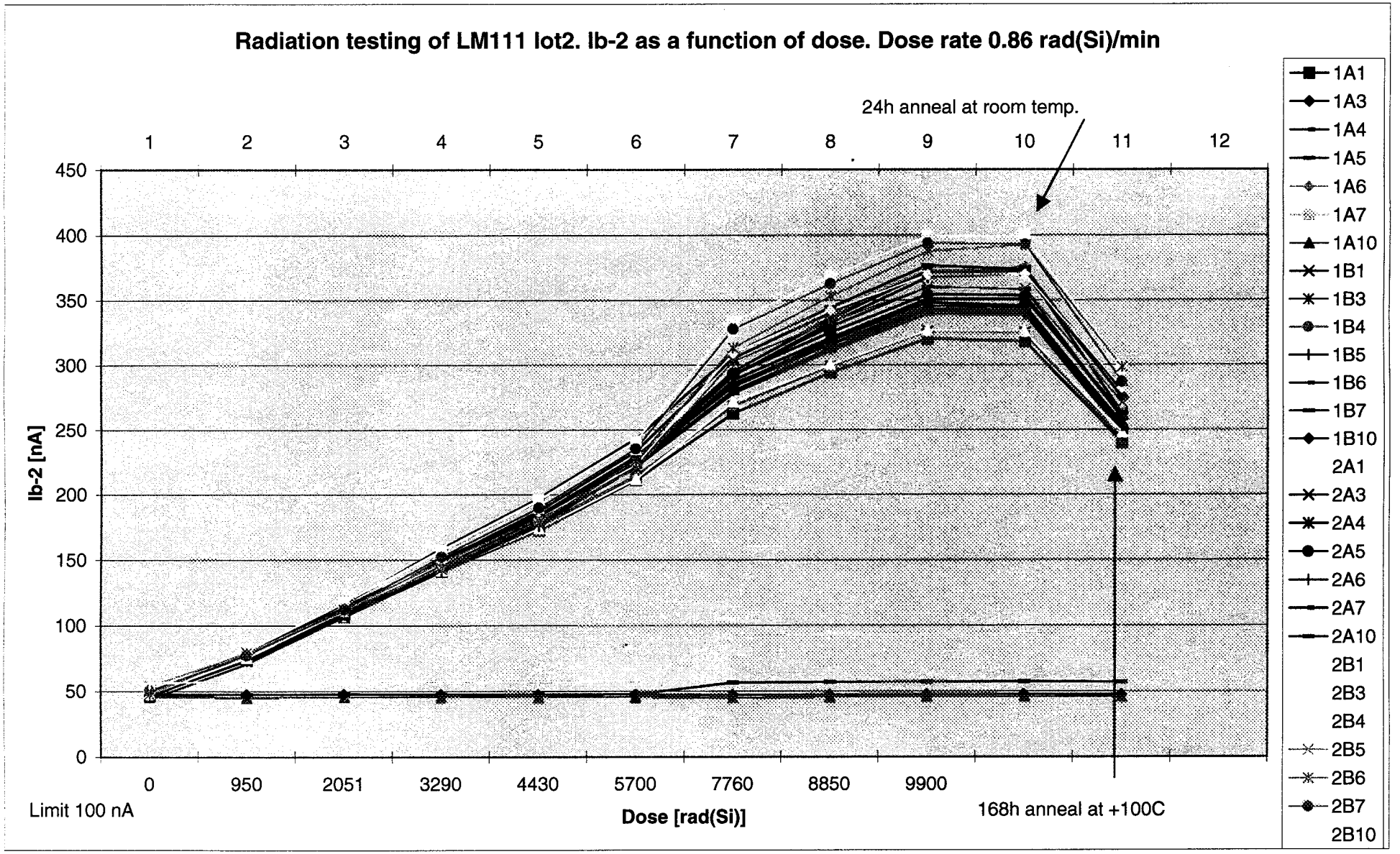
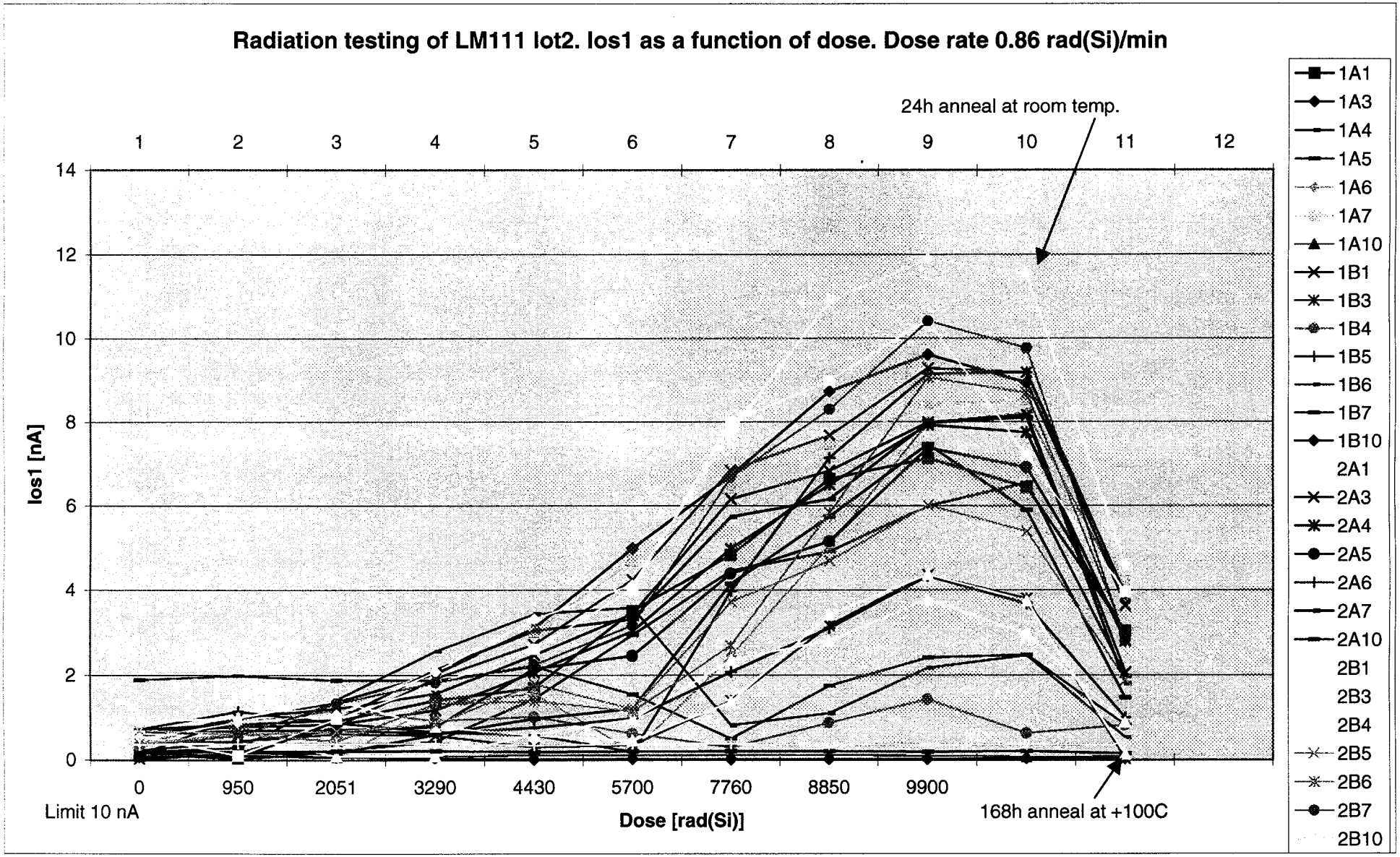
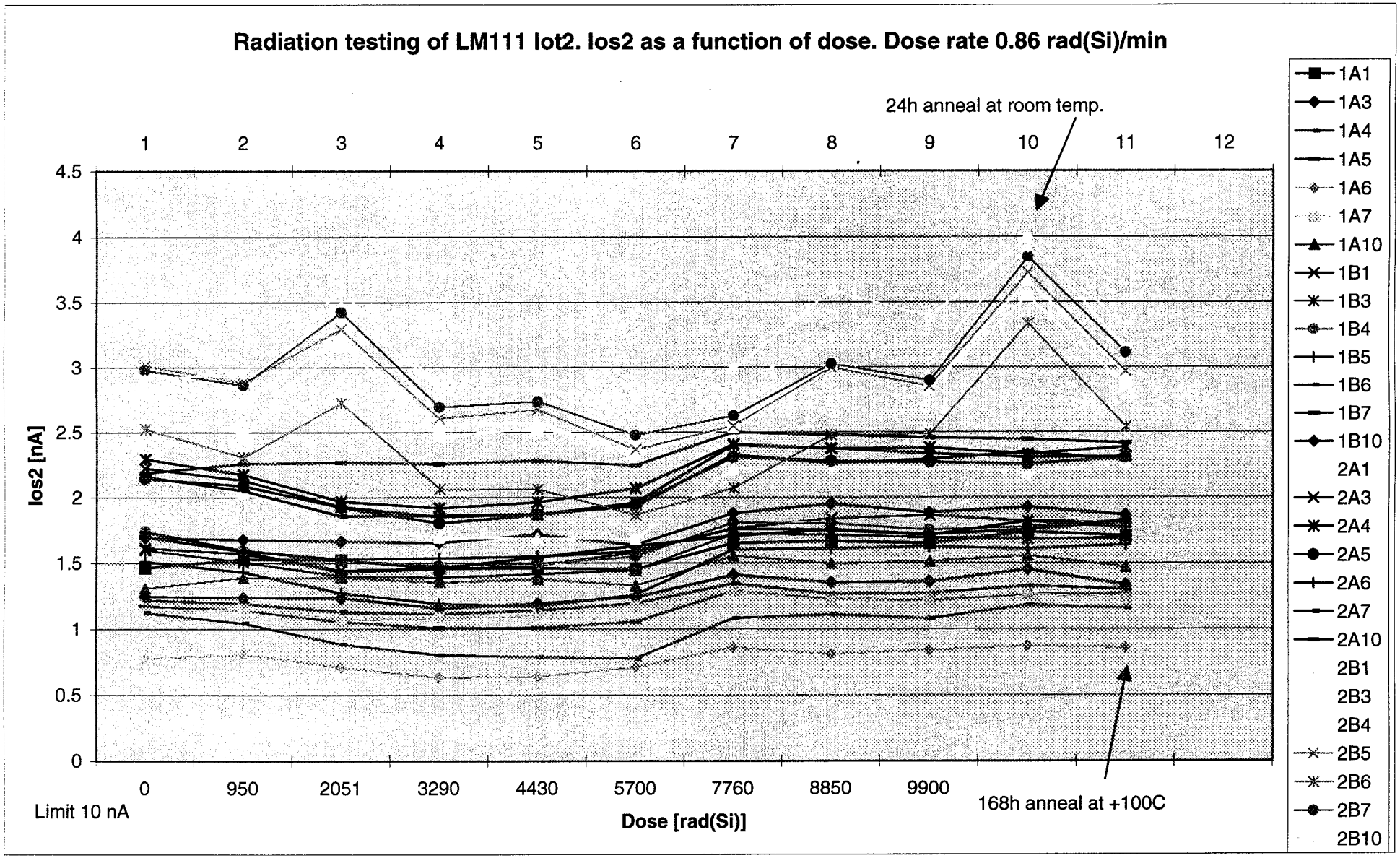
2B1
2B3
2B4
2B5
2B6
2B7
2B10


Radiation testing of LM111 lot2. Ib-1 as a function of dose. Dose rate 0.86 rad(Si)/min
24h anneal at room temp.
168h anneal at +100C
Ib-1 [nA]
Dose [rad(Si)]
Limit 100 nA
1 2 3 4 5 6 7 8 9 10 11 12
350 300 250 200 150 100 50 0
0 950 2051 3290 4430 5700 7760 8850 9900
1A1 1A3 1A4 1A5 1A6 1A7 1A10 1B1 1B3 1B4 1B5 1B6 1B7 1B10 2A1 2A3 2A4 2A5 2A6 2A7 2A10 2B1 2B3 2B4 2B5 2B6 2B7 2B10


Radiation testing of LM111 lot2. Ib+2 as a function of dose. Dose rate 0.86 rad(Si)/min
24h anneal at room temp.
1 2 3 4 5 6 7 8 9 10 11 12
400 350 300 250 200 150 100 50 0
Ib+2 [nA]
0 950 2051 3290 4430 5700 7760 8850 9900
Limit 100 nA
Dose [rad(Si)]
168h anneal at +100C
1A1 1A3 1A4 1A5 1A6 1A7 1A10 1B1 1B3 1B4 1B5 1B6 1B7 1B10 2A1 2A3 2A4 2A5 2A6 2A7 2A10 2B1 2B3 2B4 2B5 2B6 2B7 2B10


Radiation testing of LM111 lot2. Ib-2 as a function of dose. Dose rate 0.86 rad(Si)/min
24h anneal at room temp.
1 2 3 4 5 6 7 8 9 10 11 12
450 400 350 300 250 200 150 100 50 0
Ib-2 [nA]
0 950 2051 3290 4430 5700 7760 8850 9900
Dose [rad(Si)]
Limit 100 nA
168h anneal at +100C
1A1 1A3 1A4 1A5 1A6 1A7 1A10 1B1 1B3 1B4 1B5 1B6 1B7 1B10 2A1 2A3 2A4 2A5 2A6 2A7 2A10 2B1 2B3 2B4 2B5 2B6 2B7 2B10


Radiation testing of LM111 lot2. Ios1 as a function of dose. Dose rate 0.86 rad(Si)/min
24h anneal at room temp.
1 2 3 4 5 6 7 8 9 10 11 12
14 12 10 8 6 4 2 0
Ios1 [nA]
0 950 2051 3290 4430 5700 7760 8850 9900
Limit 10 nA
Dose [rad(Si)]
168h anneal at +100C
1A1 1A3 1A4 1A5 1A6 1A7 1A10 1B1 1B3 1B4 1B5 1B6 1B7 1B10 2A1 2A3 2A4 2A5 2A6 2A7 2A10 2B1 2B3 2B4 2B5 2B6 2B7 2B10


Radiation testing of LM111 lot2. Ios2 as a function of dose. Dose rate 0.86 rad(Si)/min
24h anneal at room temp.
168h anneal at +100C
Ios2 [nA]
Dose [rad(Si)]
Limit 10 nA
0
950
2051
3290
4430
5700
7760
8850
9900
1A1
1A3
1A4
1A5
1A6
1A7
1A10
1B1
1B3
1B4
1B5
1B6
1B7
1B10
2A1
2A3
2A4
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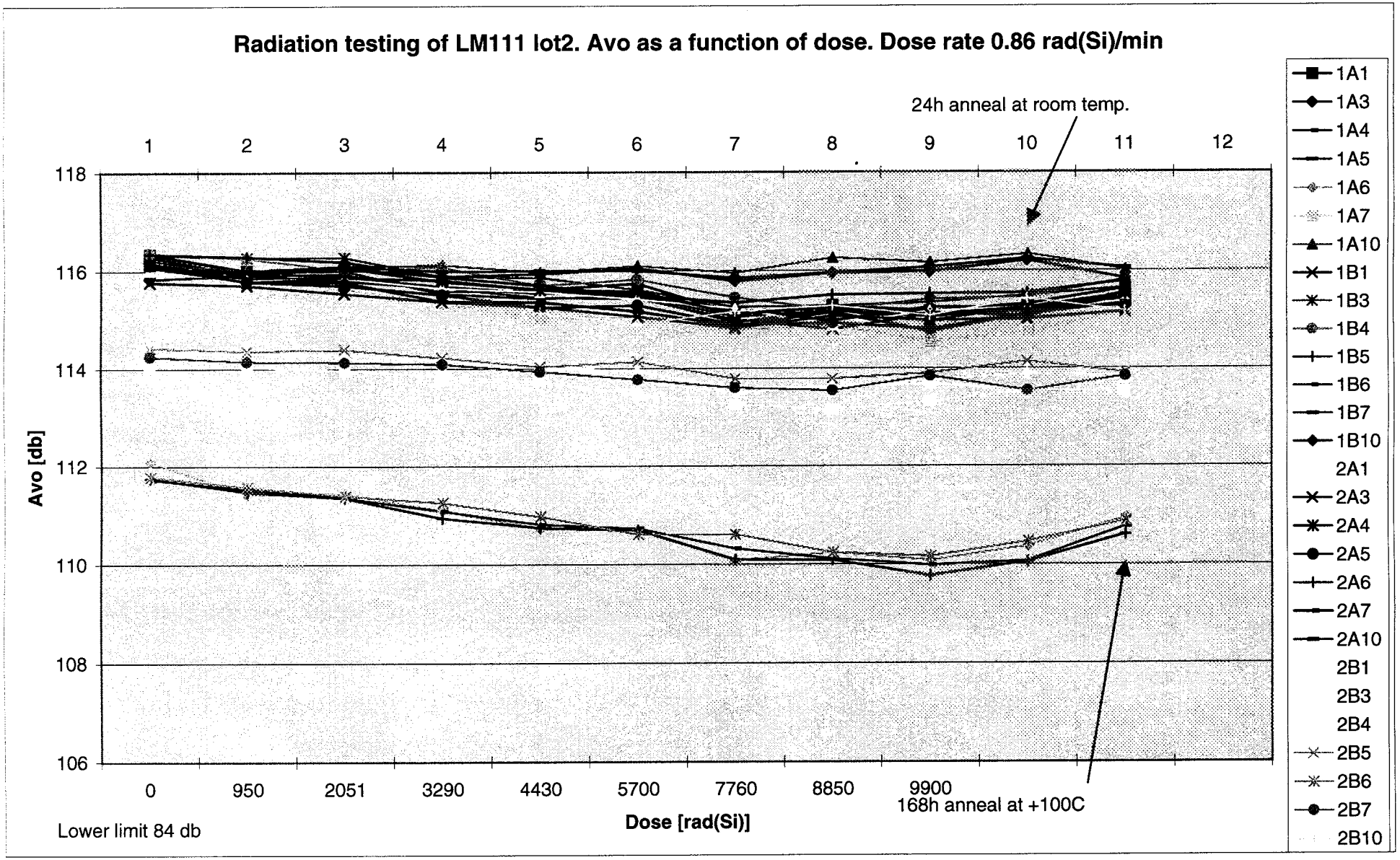
2B3
2B4
2B5
2B6
2B7
2B10


Radiation testing of LM111 lot2. Avo as a function of dose. Dose rate 0.86 rad(Si)/min
24h anneal at room temp.
1 2 3 4 5 6 7 8 9 10 11 12
118
116
114
112
110
108
106
Avo [db]
0 950 2051 3290 4430 5700 7760 8850 9900
Dose [rad(Si)]
168h anneal at +100C
Lower limit 84 db
1A1
1A3
1A4
1A5
1A6
1A7
1A10
1B1
1B3
1B4
1B5
1B6
1B7
1B10
2A1
2A3
2A4
2A5
2A6
2A7
2A10
2B1
2B3
2B4
2B5
2B6
2B7
2B10

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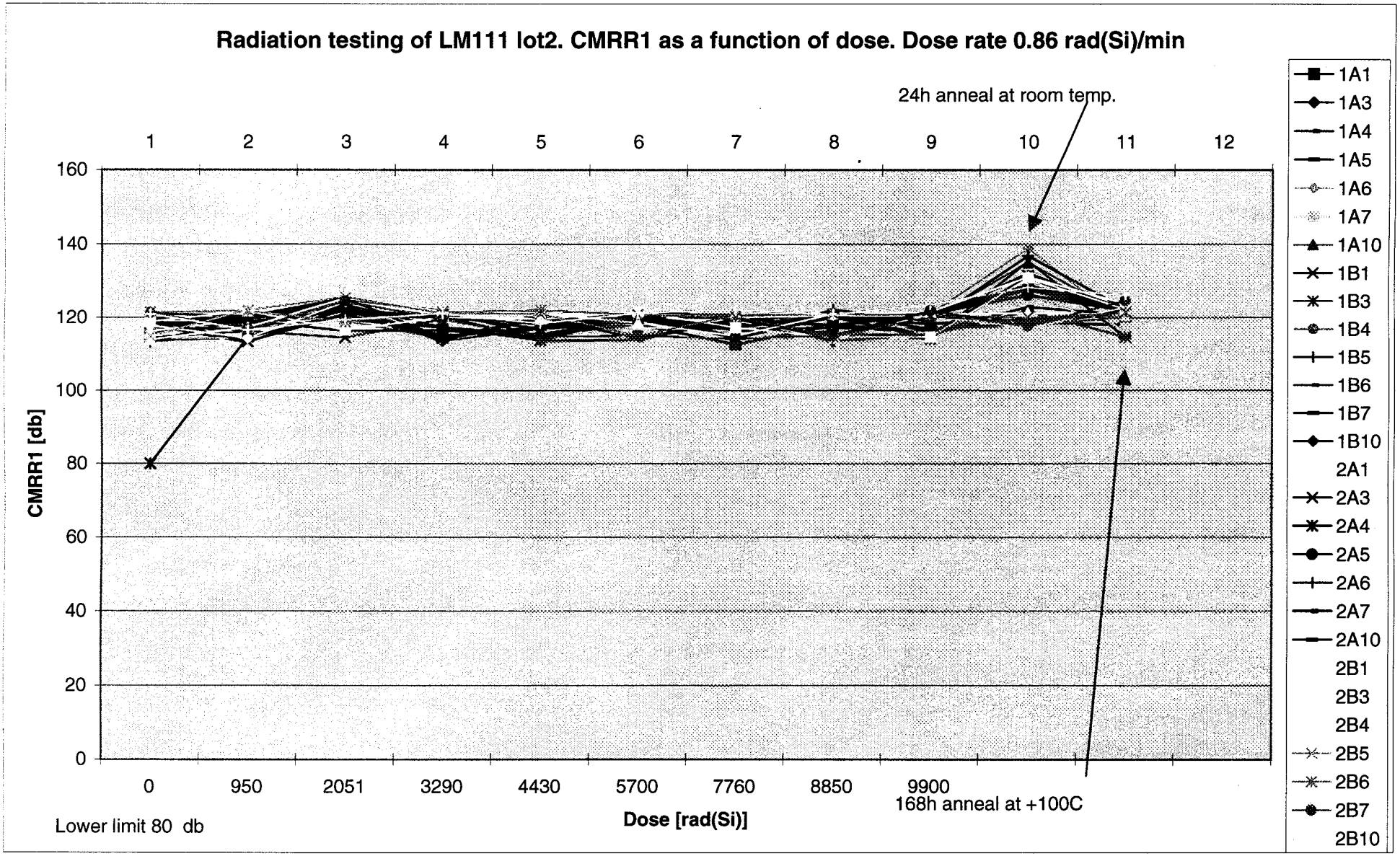
Radiation testing of LM111 lot2. CMRR1 as a function of dose. Dose rate 0.86 rad(Si)/min
24h anneal at room temp.
1
2
3
4
5
6
7
8
9
10
11
12
160
140
120
100
80
60
40
20
0
CMRR1 [db]
0
950
2051
3290
4430
5700
7760
8850
9900
Dose [rad(Si)]
168h anneal at +100C
Lower limit 80 db
1A1
1A3
1A4
1A5
1A6
1A7
1A10
1B1
1B3
1B4
1B5
1B6
1B7
1B10
2A1
2A3
2A4
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2B4
2B5
2B6
2B7
2B10

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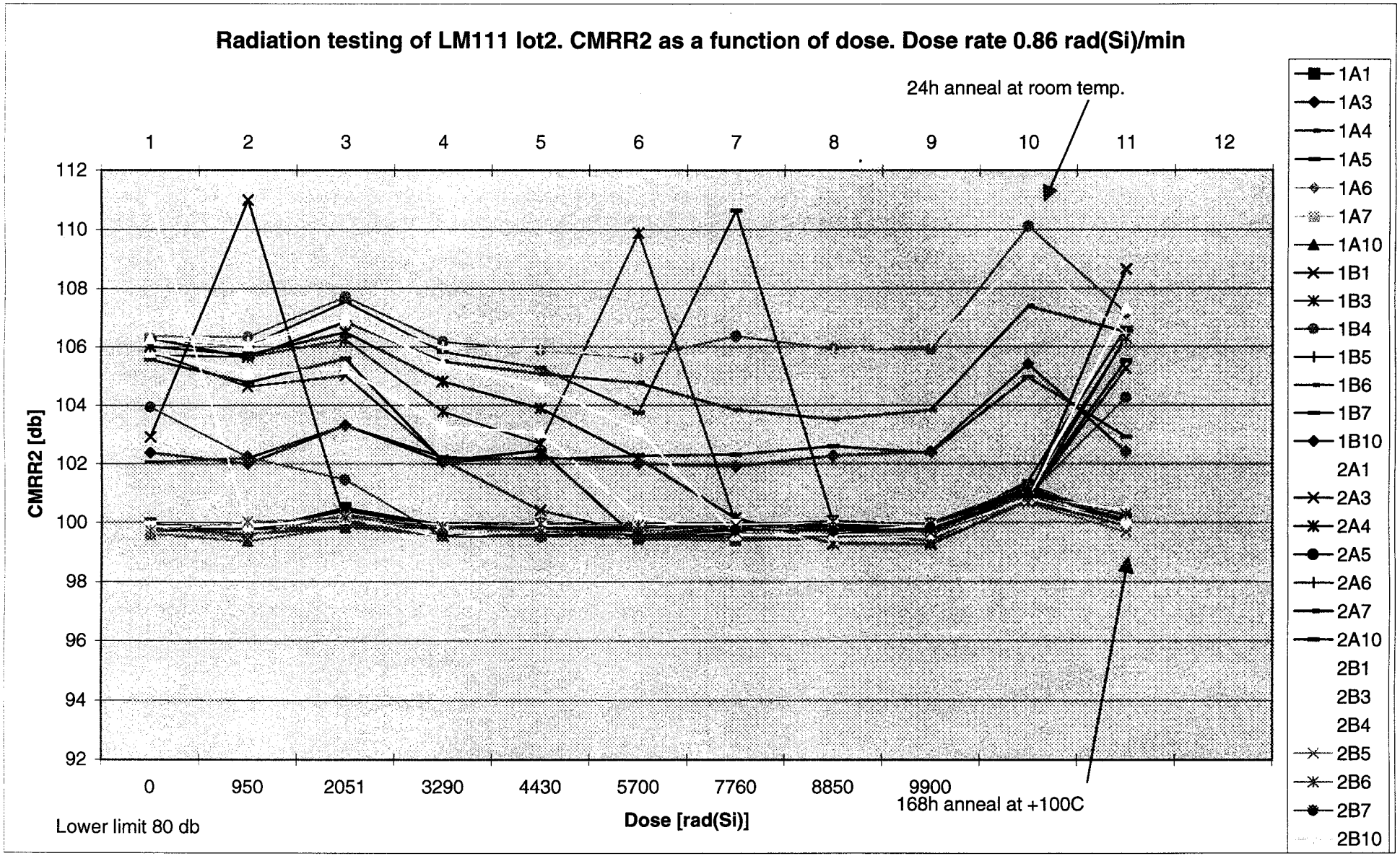
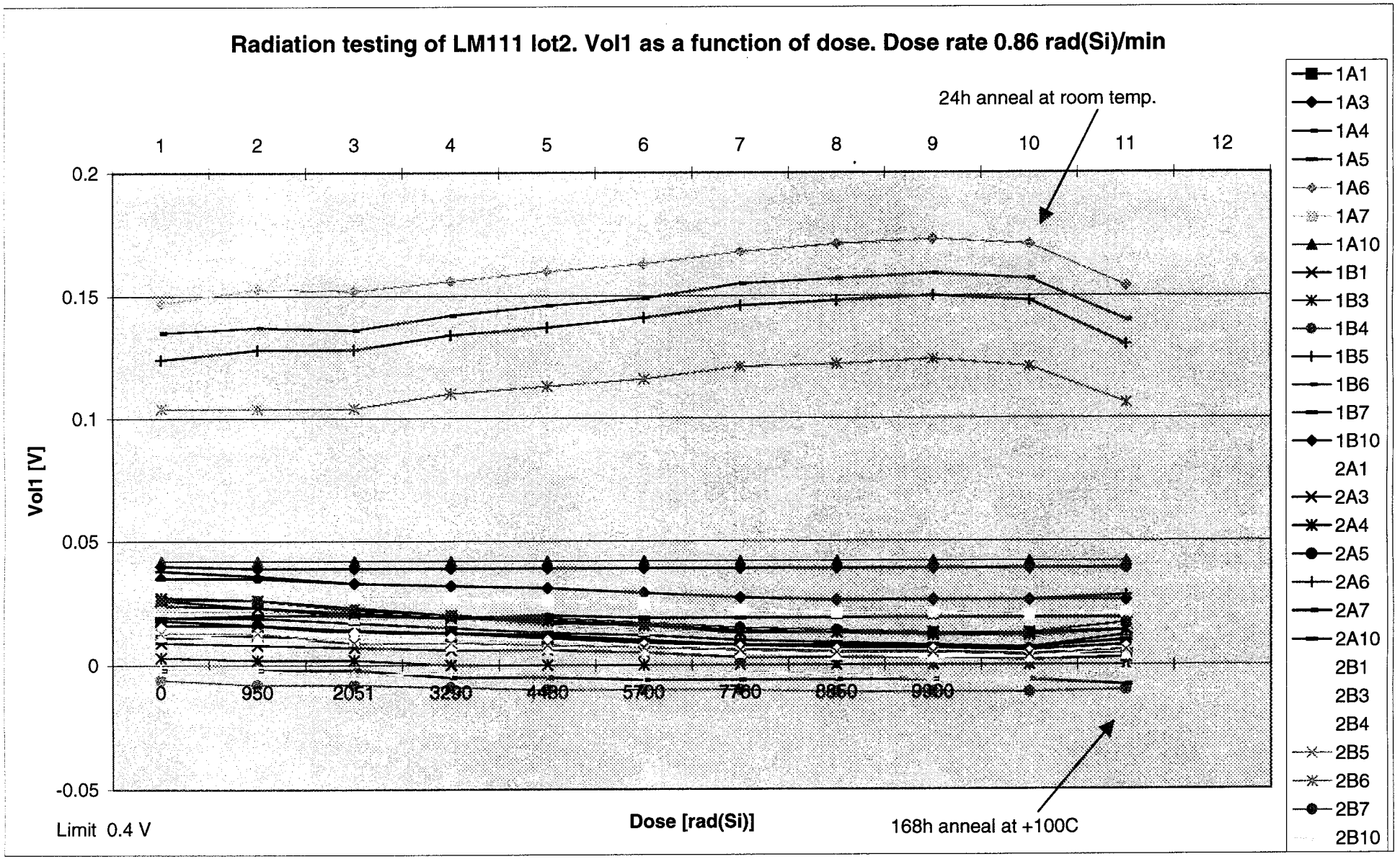

Radiation testing of LM111 lot2. CMRR2 as a function of dose. Dose rate 0.86 rad(Si)/min
24h anneal at room temp.
168h anneal at +100C
CMRR2 [db]
Dose [rad(Si)]
Lower limit 80 db
1 2 3 4 5 6 7 8 9 10 11 12
112 110 108 106 104 102 100 98 96 94 92
0 950 2051 3290 4430 5700 7760 8850 9900
1A1 1A3 1A4 1A5 1A6 1A7 1A10 1B1 1B3 1B4 1B5 1B6 1B7 1B10 2A1 2A3 2A4 2A5 2A6 2A7 2A10 2B1 2B3 2B4 2B5 2B6 2B7 2B10


Radiation testing of LM111 lot2. Vol1 as a function of dose. Dose rate 0.86 rad(Si)/min
24h anneal at room temp.
168h anneal at +100C
Vol1 [V]
Dose [rad(Si)]
Limit 0.4 V
1 2 3 4 5 6 7 8 9 10 11 12
0.2
0.15
0.1
0.05
0
-0.05
0 950 2051 3290 4480 5700 7760 8850 9900
1A1
1A3
1A4
1A5
1A6
1A7
1A10
1B1
1B3
1B4
1B5
1B6
1B7
1B10
2A1
2A3
2A4
2A5
2A6
2A7
2A10
2B1
2B3
2B4
2B5
2B6
2B7
2B10

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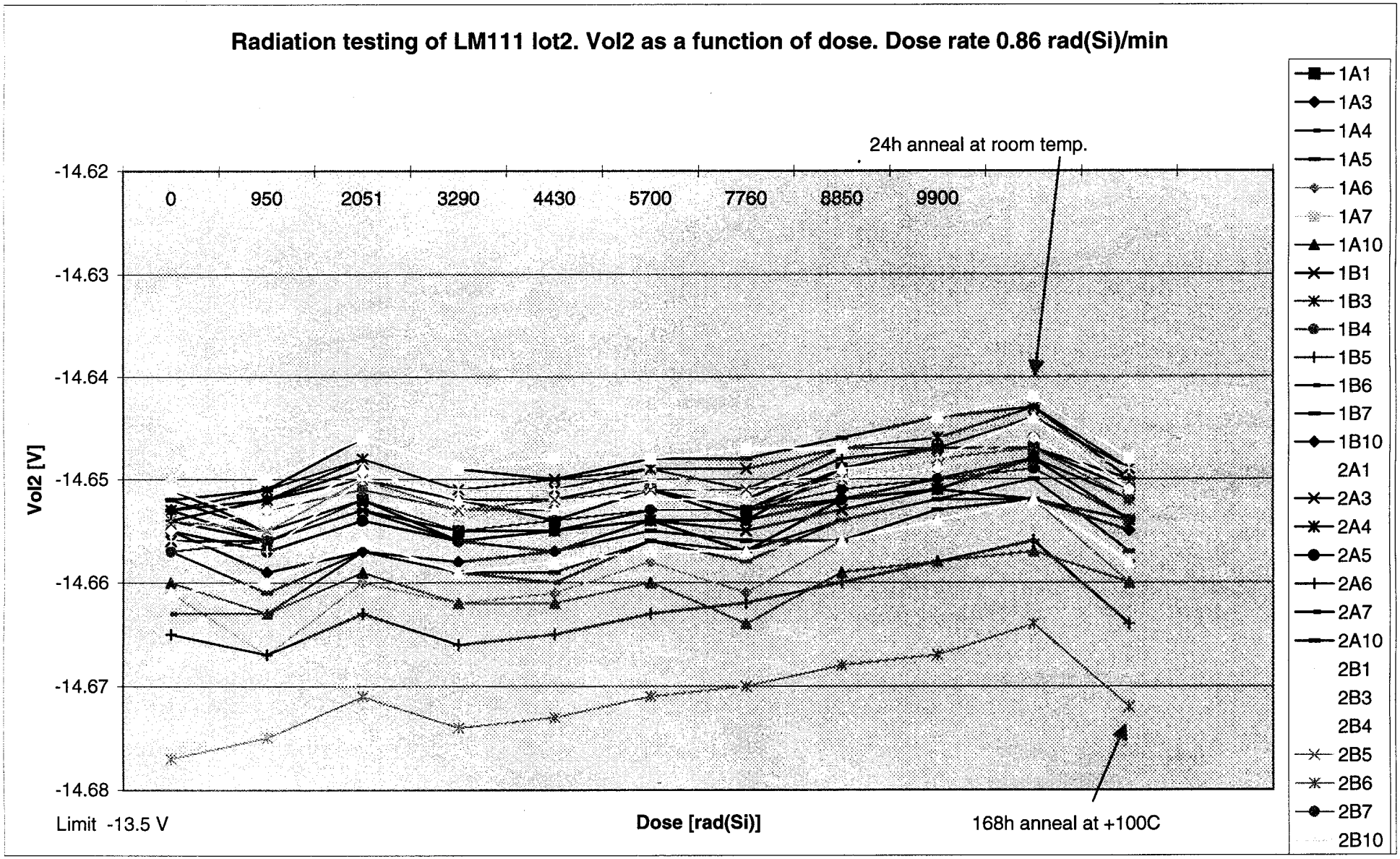
Radiation testing of LM111 lot2. Vol2 as a function of dose. Dose rate 0.86 rad(Si)/min
24h anneal at room temp.
-14.62
-14.63
-14.64
-14.65
-14.66
-14.67
-14.68
0
950
2051
3290
4430
5700
7760
8850
9900
Vol2 [V]
Limit -13.5 V
Dose [rad(Si)]
168h anneal at +100C
1A1
1A3
1A4
1A5
1A6
1A7
1A10
1B1
1B3
1B4
1B5
1B6
1B7
1B10
2A1
2A3
2A4
2A5
2A6
2A7
2A10
2B1
2B3
2B4
2B5
2B6
2B7
2B10

Vos1	Dose [Rad(Si)]	1A1	1A3	1A4	1A5	1A6	1A7	1A10	1B1	1B3	1B4	1B5	1B6	1B7	1B10
	0	-0.212	0.16	0.091	0.934	-0.017	0.529	0.341	0.78	0.798	0.522	0.754	1.283	0.832	0.737
	950	-0.34	0.082	0.001	0.857	-0.178	0.44	0.34	0.698	0.707	0.433	0.67	1.133	0.749	0.731
	2051	-0.434	0.002	-0.097	0.758	-0.34	0.351	0.343	0.61	0.62	0.34	0.57	0.963	0.66	0.727
	3290	-0.541	-0.101	-0.206	0.647	-0.543	0.243	0.341	0.503	0.52	0.226	0.468	0.76	0.547	0.73
	4430	-0.63	-0.196	-0.32	0.536	-0.716	0.139	0.336	0.404	0.427	0.129	0.366	0.572	0.448	0.738
	5700	-0.736	-0.316	-0.455	0.39	-0.937	0.008	0.335	0.291	0.318	0.014	0.249	0.351	0.313	0.728
	7760	-0.859	-0.457	-0.625	0.213	-1.213	-0.154	0.333	0.139	0.18	-0.14	0.091	0.055	0.151	0.734
	8850	-0.958	-0.552	-0.724	0.096	-1.364	-0.256	0.337	0.031	0.081	-0.228	-0.006	-0.105	0.052	0.732
	9900	-1.014	-0.625	-0.8	0.011	-1.485	-0.335	0.336	-0.043	0.012	-0.3	-0.085	-0.221	-0.034	0.723
Room temp anneal		-0.964	-0.586	-0.757	0.054	-1.421	-0.294	0.337	-0.004	0.054	-0.256	-0.047	-0.158	-0.011	0.721
168h / 100C		-0.5	-0.108	-0.21	0.62	-0.595	0.223	0.338	0.493	0.533	0.261	0.454	0.733	0.555	0.726
Vos1	Dose [Rad(Si)]	2A1	2A3	2A4	2A5	2A6	2A7	2A10	2B1	2B3	2B4	2B5	2B6	2B7	2B10
	0	1.015	0.651	0.977	0.544	0.179	0.47	0.392	0.172	0.164	1.068	0.311	0.078	0.316	0.403
	950	0.936	0.571	0.901	0.461	0.03	0.384	0.393	0.094	0.09	0.976	0.214	-0.067	0.246	0.405
	2051	0.832	0.483	0.805	0.369	-0.139	0.284	0.393	0.009	0.004	0.867	0.116	-0.225	0.162	0.406
	3290	0.733	0.377	0.703	0.262	-0.342	0.177	0.39	-0.091	-0.095	0.745	0.006	-0.427	0.059	0.402
	4430	0.637	0.274	0.6	0.164	-0.531	0.083	0.393	-0.179	-0.192	0.632	-0.101	-0.606	-0.043	0.402
	5700	0.523	0.148	0.47	0.031	-0.757	-0.029	0.391	-0.298	-0.309	0.487	-0.22	-0.827	-0.159	0.4
	7760	0.378	0.027	0.286	-0.153	-1.072	-0.201	0.394	-0.478	-0.493	0.269	-0.403	-1.145	-0.36	0.402
	8850	0.288	-0.138	0.175	-0.232	-1.204	-0.259	0.391	-0.562	-0.577	0.169	-0.482	-1.282	-0.445	0.401
	9900	0.214	-0.219	0.086	-0.309	-1.323	-0.322	0.393	-0.629	-0.653	0.066	-0.549	-1.401	-0.527	0.398
Room temp anneal		0.251	-0.173	0.127	-0.262	-1.254	-0.284	0.393	-0.581	-0.605	0.116	-0.501	-1.323	-0.483	0.399
168h / 100C		0.745	0.351	0.669	0.246	-0.362	0.205	0.39	-0.106	-0.118	0.737	0.021	-0.458	0.034	0.4

Vos2	Dose [Rad(Si)]	1A1	1A3	1A4	1A5	1A6	1A7	1A10	1B1	1B3	1B4	1B5	1B6	1B7	1B10
	0	0.179	0.308	0.237	1.023	0.185	0.65	0.484	0.892	0.892	0.671	0.815	1.369	0.956	0.819
	950	0.095	0.238	0.152	0.956	0.049	0.575	0.488	0.812	0.802	0.582	0.733	1.232	0.876	0.81
	2051	0.007	0.157	0.052	0.857	-0.113	0.484	0.487	0.722	0.714	0.486	0.633	1.064	0.784	0.804
	3290	-0.086	0.058	-0.05	0.751	-0.306	0.387	0.487	0.618	0.617	0.374	0.534	0.872	0.677	0.81
	4430	-0.18	-0.039	-0.167	0.641	-0.472	0.281	0.483	0.52	0.524	0.277	0.433	0.693	0.579	0.821
	5700	-0.294	-0.158	-0.307	0.489	-0.689	0.15	0.48	0.405	0.41	0.159	0.311	0.47	0.441	0.807
	7760	-0.43	-0.294	-0.477	0.318	-0.947	0.003	0.483	0.251	0.278	0.006	0.158	0.187	0.282	0.816
	8850	-0.518	-0.398	-0.585	0.193	-1.103	-0.116	0.48	0.142	0.172	-0.092	0.053	-0.026	0.181	0.813
	9900	-0.58	-0.473	-0.663	0.105	-1.227	-0.194	0.479	0.067	0.101	-0.166	-0.028	-0.09	0.089	0.8
Room temp anneal		-0.543	-0.431	-0.619	0.148	-1.163	-0.154	0.477	0.106	0.144	-0.119	0.014	-0.02	0.137	0.798
168h / 100C		-0.061	0.056	-0.052	0.728	-0.344	0.368	0.48	0.622	0.637	0.417	0.526	0.86	0.693	0.804
Vos2	Dose [Rad(Si)]	2A1	2A3	2A4	2A5	2A6	2A7	2A10	2B1	2B3	2B4	2B5	2B6	2B7	2B10
	0	1.078	0.767	1.088	0.649	0.365	0.602	0.507	0.331	0.311	1.136	0.454	0.242	0.45	0.552
	950	1.007	0.695	1.022	0.575	0.234	0.522	0.511	0.252	0.239	1.049	0.36	0.108	0.384	0.553
	2051	0.898	0.608	0.926	0.481	0.072	0.419	0.51	0.166	0.154	0.939	0.253	-0.045	0.299	0.545
	3290	0.802	0.506	0.831	0.375	-0.117	0.318	0.509	0.07	0.061	0.822	0.145	-0.232	0.202	0.55
	4430	0.706	0.404	0.731	0.278	-0.302	0.222	0.514	-0.017	-0.033	0.711	0.038	-0.403	0.1	0.55
	5700	0.588	0.276	0.598	0.141	-0.525	0.106	0.508	-0.138	-0.15	0.562	-0.088	-0.619	0.019	0.546
	7760	0.445	0.105	0.417	-0.044	-0.83	-0.065	0.513	-0.32	-0.332	0.342	-0.273	-0.926	-0.219	0.551
	8850	0.349	-0.011	0.303	-0.127	-0.96	-0.125	0.511	-0.403	-0.418	0.241	-0.355	-1.06	-0.307	0.551
	9900	0.273	-0.096	0.21	-0.206	-1.079	-0.187	0.509	-0.474	-0.498	0.131	-0.424	-1.176	-0.394	0.544
Room temp anneal		0.309	-0.051	0.248	-0.157	-1.01	-0.148	0.507	-0.427	-0.451	0.183	-0.375	-1.099	-0.345	0.544
168h / 100C		0.814	0.481	0.801	0.362	-0.13	0.348	0.503	0.064	0.045	0.822	0.17	-0.246	0.181	0.548

+Is	Dose [Rad(Si)]	1A1	1A3	1A4	1A5	1A6	1A7	1A10	1B1	1B3	1B4	1B5	1B6	1B7	1B10
	0	3.631	3.255	3.252	3.2	3.276	3.282	3.183	3.236	3.225	3.208	3.241	3.227	3.269	3.227
	950	3.639	3.227	3.222	3.171	3.221	3.244	3.16	3.242	3.231	3.217	3.252	3.222	3.269	3.239
	2051	3.66	3.224	3.237	3.187	3.262	3.268	3.179	3.254	3.24	3.216	3.255	3.252	3.292	3.253
	3290	3.642	3.227	3.21	3.168	3.247	3.239	3.17	3.239	3.222	3.209	3.238	3.235	3.271	3.237
	4430	3.639	3.229	3.217	3.161	3.242	3.254	3.164	3.233	3.217	3.206	3.231	3.22	3.263	3.22
	5700	3.66	3.232	3.223	3.176	3.252	3.258	3.174	3.24	3.227	3.214	3.245	3.239	3.272	3.245
	7760	3.587	3.209	3.194	3.144	3.219	3.225	3.153	3.23	3.201	3.187	3.22	3.221	3.257	3.231
	8850	3.637	3.231	3.223	3.172	3.248	3.257	3.184	3.237	3.224	3.211	3.239	3.226	3.263	3.234
	9900	3.644	3.234	3.226	3.176	3.25	3.257	3.187	3.239	3.229	3.213	3.246	3.236	3.275	3.255
Room temp anneal		3.621	3.231	3.236	3.186	3.262	3.269	3.197	3.249	3.239	3.218	3.233	3.219	3.273	3.255
168h / 100C		3.676	3.235	3.233	3.176	3.253	3.262	3.182	3.244	3.233	3.218	3.25	3.233	3.254	3.235
+Is	Dose [Rad(Si)]	2A1	2A3	2A4	2A5	2A6	2A7	2A10	2B1	2B3	2B4	2B5	2B6	2B7	2B10
	0	3.244	3.227	3.17	3.252	3.177	3.219	3.235	3.237	3.262	3.158	3.222	3.12	3.218	3.206
	950	3.216	3.214	3.151	3.218	3.151	3.198	3.214	3.25	3.272	3.16	3.209	3.127	3.216	3.395
	2051	3.242	3.223	3.163	3.224	3.162	3.208	3.223	3.262	3.281	3.177	3.244	3.144	3.233	3.57
	3290	3.217	3.211	3.142	3.223	3.138	3.184	3.215	3.241	3.26	3.157	3.223	3.118	3.212	3.52
	4430	3.212	3.205	3.133	3.218	3.142	3.186	3.204	3.241	3.258	3.153	3.221	3.112	3.214	3.539
	5700	3.224	3.208	3.147	3.225	3.147	3.196	3.219	3.239	3.259	3.16	3.221	3.121	3.22	3.62
	7760	3.206	3.191	3.129	3.211	3.134	3.183	3.209	3.228	3.248	3.144	3.212	3.109	3.208	3.558
	8850	3.215	3.197	3.138	3.215	3.141	3.192	3.211	3.232	3.248	3.144	3.216	3.112	3.212	3.588
	9900	3.222	3.209	3.141	3.225	3.145	3.194	3.23	3.242	3.264	3.161	3.227	3.113	3.221	3.587
Room temp anneal		3.238	3.223	3.16	3.234	3.153	3.192	3.236	3.255	3.27	3.163	3.225	3.122	3.214	3.628
168h / 100C		3.225	3.214	3.149	3.228	3.148	3.196	3.224	3.25	3.263	3.158	3.223	3.122	3.211	3.611

-Is	Dose [Rad(Si)]	1A1	1A3	1A4	1A5	1A6	1A7	1A10	1B1	1B3	1B4	1B5	1B6	1B7	1B10
	0	3.626	3.255	3.252	3.2	3.276	3.282	3.183	3.236	3.225	3.209	3.241	3.227	3.269	3.227
	950	3.635	3.227	3.222	3.17	3.221	3.243	3.159	3.241	3.231	3.216	3.252	3.222	3.268	3.238
	2051	3.656	3.224	3.237	3.186	3.261	3.267	3.179	3.253	3.24	3.216	3.255	3.252	3.292	3.253
	3290	3.637	3.225	3.21	3.167	3.246	3.238	3.17	3.239	3.222	3.209	3.238	3.235	3.27	3.237
	4430	3.633	3.228	3.216	3.16	3.242	3.254	3.163	3.233	3.217	3.206	3.231	3.219	3.262	3.22
	5700	3.657	3.232	3.223	3.175	3.251	3.257	3.173	3.239	3.227	3.214	3.244	3.239	3.271	3.245
	7760	3.583	3.208	3.193	3.143	3.218	3.224	3.153	3.23	3.201	3.186	3.219	3.221	3.256	3.231
	8850	3.632	3.23	3.223	3.171	3.247	3.256	3.183	3.236	3.223	3.21	3.238	3.226	3.262	3.234
	9900	3.641	3.233	3.225	3.175	3.25	3.256	3.187	3.238	3.228	3.212	3.244	3.235	3.274	3.255
Room temp anneal		3.616	3.23	3.236	3.185	3.261	3.267	3.196	3.248	3.238	3.217	3.232	3.218	3.272	3.255
168h / 100C		3.671	3.235	3.233	3.176	3.252	3.262	3.182	3.243	3.233	3.218	3.25	3.232	3.254	3.235
-Is	Dose [Rad(Si)]	2A1	2A3	2A4	2A5	2A6	2A7	2A10	2B1	2B3	2B4	2B5	2B6	2B7	2B10
	0	3.244	3.228	3.17	3.251	3.177	3.219	3.235	3.238	3.262	3.158	3.223	3.12	3.219	3.207
	950	3.216	3.214	3.151	3.218	3.151	3.198	3.214	3.25	3.272	3.16	3.209	3.127	3.216	3.4
	2051	3.242	3.223	3.163	3.225	3.162	3.208	3.223	3.262	3.281	3.176	3.244	3.144	3.233	3.435
	3290	3.217	3.211	3.142	3.222	3.138	3.184	3.214	3.24	3.26	3.157	3.223	3.118	3.212	3.522
	4430	3.212	3.205	3.133	3.218	3.142	3.186	3.204	3.241	3.258	3.152	3.22	3.111	3.214	3.575
	5700	3.223	3.208	3.146	3.225	3.146	3.195	3.219	3.239	3.258	3.16	3.221	3.121	3.22	3.579
	7760	3.206	3.19	3.128	3.21	3.134	3.182	3.209	3.228	3.247	3.143	3.212	3.109	3.208	3.534
	8850	3.215	3.196	3.137	3.214	3.14	3.191	3.211	3.231	3.247	3.144	3.216	3.112	3.211	3.574
	9900	3.222	3.209	3.14	3.225	3.144	3.194	3.23	3.241	3.263	3.16	3.226	3.112	3.22	3.586
Room temp anneal		3.238	3.222	3.158	3.234	3.152	3.191	3.235	3.253	3.27	3.162	3.225	3.121	3.213	3.572
168h / 100C		3.225	3.214	3.148	3.228	3.147	3.195	3.224	3.249	3.263	3.158	3.222	3.122	3.211	3.625

Ib+1	Dose [Rad(Si)]	1A1	1A3	1A4	1A5	1A6	1A7	1A10	1B1	1B3	1B4	1B5	1B6	1B7	1B10
	0	36.146	34.028	34.236	32.317	33.788	33.966	31.576	34.71	35.896	35.6	34.01	34.189	34.889	32.741
	950	52.937	51.643	51.468	51.062	55.08	52.529	31.375	52.721	53.672	53.804	52.173	55.971	54.875	32.87
	2051	74.296	74.711	74.538	75.662	77.637	77.65	31.594	75.615	76.313	76.854	75.689	79.535	80.921	32.992
	3290	97.884	100.623	99.748	103.555	101.731	104.767	31.525	101.021	100.738	101.801	101.433	103.48	109.01	32.831
	4430	119.472	124.014	123.42	128.963	125.85	130.848	31.462	123.826	123.009	124.367	124.5	127.854	134.755	32.661
	5700	144.211	151.306	150.02	158.823	156.437	159.988	31.534	151.034	149.186	150.187	152.199	159.404	165.527	32.879
	7760	193.123	205.376	202.605	216.251	216.455	218.047	33.338	203.91	200.378	201.367	206.296	219.416	224.314	34.768
	8850	215.048	229.002	226.477	242.064	244.639	244.328	33.715	227.686	221.464	224.118	229.427	247.278	248.636	34.842
	9900	233.512	249.286	245.907	263.252	267.624	266.026	33.805	246.954	240.118	243.102	249.578	272.047	270.167	35.237
Room temp anneal		232.809	247.853	245.095	262.483	269.626	264.375	34.104	246.054	240.13	243.165	248.002	272.979	269.767	35.379
168h / 100C		176.764	183.654	182.858	190.523	198.107	187.845	33.811	184.886	181.57	182.216	181.795	201.521	191.443	34.941
Ib+1	Dose [Rad(Si)]	2A1	2A3	2A4	2A5	2A6	2A7	2A10	2B1	2B3	2B4	2B5	2B6	2B7	2B10
	0	35.672	32.344	30.957	34.869	31.229	35.494	32.389	33.596	34.764	32.025	35.071	31.845	32.503	36.044
	950	52.815	49.101	49.265	52.456	52.431	54.477	32.157	51.129	53.738	51.235	53.025	53.486	50.91	37.456
	2051	74.782	71.741	73.207	75.728	74.955	78.672	32.24	73.869	77.979	76.155	75.957	76.617	74.235	38.483
	3290	98.776	96.874	100.857	102.075	98.738	103.741	32.185	98.345	104.865	103.551	100.924	99.892	101.069	38.525
	4430	120.155	119.818	125.545	124.909	122.446	126.144	32.099	120.66	130.041	128.915	122.758	123.803	125.903	38.44
	5700	145.778	147.178	155.785	153.341	153.657	153.195	32.231	147.832	159.507	159.13	149.634	155.696	155.699	38.783
	7760	195.845	201.198	214.249	207.803	212.119	204.933	34.488	201.274	217.921	218.913	202.76	216.015	213.953	43.541
	8850	217.042	224.366	238.178	231.127	239.373	226.956	34.533	222.404	242.267	242.86	223.945	242.17	237.684	44.169
	9900	235.569	244.966	259.562	250.344	262.802	245.382	34.754	241.598	262.726	264.62	242.127	264.3	257.917	44.246
Room temp anneal		235.943	245.18	260.288	249.923	265.316	244.378	34.95	240.824	263.568	264.613	241.583	268.098	257.334	44.64
168h / 100C		180.185	184.336	195.386	182.887	197.741	180.035	34.699	182.469	194.917	196.731	178.986	202.156	185.723	44.973

Ib-1	Dose [Rad(Si)]	1A1	1A3	1A4	1A5	1A6	1A7	1A10	1B1	1B3	1B4	1B5	1B6	1B7	1B10
	0	39.579	38.086	37.564	33.754	37.498	37.805	34.919	38.179	39.042	38.747	37.962	37.838	38.33	36.07
	950	58.432	57.887	56.759	54.27	60.895	59.054	34.725	58.155	58.563	58.265	58.038	61.891	60.186	36.169
	2051	82.794	83.78	82.361	81.469	85.572	86.77	34.94	83.931	83.315	83.407	83.962	86.085	88.801	36.378
	3290	109.271	112.891	110.322	112.166	110.774	117.594	34.837	113.038	110.245	111.022	112.095	111.294	120.489	36.156
	4430	133.323	139.73	137.464	139.928	137.135	147.341	34.789	139.001	135.024	135.797	137.662	137.278	149.197	35.994
	5700	162.484	171.726	168.296	173.373	172.208	180.979	34.849	170.372	163.703	164.555	168.406	171.838	183.316	36.235
	7760	200.656	215.076	209.839	219.751	221.923	227.674	34.421	213.297	204.401	204.351	211.049	222.114	231.327	35.822
	8850	224.386	240.818	234.407	246.977	252.934	254.807	34.832	237.903	227.233	227.666	235.22	251.795	257.249	35.801
	9900	243.828	262.345	255.282	269.17	279.342	277.645	34.849	259.241	247.247	247.289	256.864	278.22	280.958	36.115
Room temp anneal		242.203	260.013	254.709	267.802	281.388	276.342	34.998	258.3	246.509	246.587	254.334	278.997	278.76	36.082
168h / 100C		182.576	190.01	187.534	192.408	204.72	194.817	34.913	190.879	183.732	183.75	185.101	205.205	195.474	35.876
Ib-1	Dose [Rad(Si)]	2A1	2A3	2A4	2A5	2A6	2A7	2A10	2B1	2B3	2B4	2B5	2B6	2B7	2B10
	0	39.71	36.834	35.845	39.7	35.557	40.818	37.09	40.799	41.016	37.777	42.718	37.876	39.494	44.824
	950	58.687	56.089	56.09	59.223	59.277	61.838	36.833	60.431	62.399	58.663	62.151	61.898	59.865	46.043
	2051	83.28	81.283	82.507	85.182	83.795	88.604	36.979	85.733	90.058	85.752	87.576	86.291	86.395	46.051
	3290	109.665	109.187	113.167	114.231	108.244	117.163	36.798	113.601	120.265	116.399	115.087	110.991	116.387	45.61
	4430	133.797	135.306	141.301	140.589	134.445	142.735	36.692	139.374	149.009	144.751	140.054	137.223	144.254	45.809
	5700	162.325	166.378	175.414	172.189	169.427	172.849	36.851	170.091	182.717	178.041	169.172	172.535	177.905	46.454
	7760	208.744	217.838	229.87	223.1	220.767	220.251	46.181	240.702	257.299	251.962	237.647	241.848	252.286	82.283
	8850	230.084	241.849	255.341	246.962	251.187	243.056	46.293	265.428	283.04	278.033	260.355	271.628	278.152	82.584
	9900	249.853	263.617	278.054	268.388	276.798	262.977	46.421	285.424	305.252	300.982	279.726	296.451	300.544	82.749
Room temp anneal		249.1	263.698	278.637	267.558	278.982	262.176	46.652	285.93	300.542	301.31	279.356	300.533	300.304	83.85
168h / 100C		190.08	197.411	209.092	197.05	206.862	191.788	46.346	220.082	231.489	229.784	212.805	229.748	221.273	83.873

Ib+2	Dose [Rad(Si)]	1A1	1A3	1A4	1A5	1A6	1A7	1A10	1B1	1B3	1B4	1B5	1B6	1B7	1B10
	0	46.563	44.108	44.46	42.099	43.727	44.498	41.253	45.186	46.255	45.896	44.059	43.936	45.467	42.916
	950	68.256	67.055	67.006	66.68	71.666	69.112	40.991	68.722	69.25	69.437	67.797	72.408	71.806	43.07
	2051	95.867	97.32	97.197	98.976	101.503	102.283	41.269	98.752	98.651	99.254	98.564	103.307	105.953	43.232
	3290	126.564	131.359	130.38	135.944	133.546	138.473	41.171	132.284	130.543	131.762	132.412	135.163	143.235	43.013
	4430	154.754	162.271	161.65	169.698	165.699	173.391	41.066	162.57	159.761	161.393	163.008	167.508	177.577	42.821
	5700	187.393	198.615	197.174	209.629	206.659	212.631	41.184	198.806	194.334	195.57	199.872	209.62	218.983	43.069
	7760	252.378	271.218	267.942	287.405	287.849	291.696	43.714	270.113	262.781	263.958	272.454	290.549	298.754	45.676
	8850	281.355	302.932	299.478	322.009	325.935	327.088	44.258	301.789	290.784	294.045	303.634	327.562	331.582	45.731
	9900	306.163	330.542	326.326	351.056	357.514	357.013	44.306	328.198	315.632	319.417	330.755	361.862	361.044	46.089
Room temp anneal		304.946	328.607	325.063	349.784	359.71	354.917	44.626	326.953	315.383	318.974	329.094	362.098	360.658	46.274
168h / 100C		232.246	243.764	243.07	254.97	264.389	253.206	44.309	246.061	239.062	239.75	241.545	267.869	256.592	45.859
Ib+2	Dose [Rad(Si)]	2A1	2A3	2A4	2A5	2A6	2A7	2A10	2B1	2B3	2B4	2B5	2B6	2B7	2B10
	0	45.894	42.296	40.67	45.158	40.168	45.612	42.289	43.533	45.442	41.669	45.337	40.903	42.445	48.403
	950	68.146	64.329	64.82	68.206	67.813	69.971	42.033	66.422	70.236	66.73	68.363	69.051	66.564	49.385
	2051	96.505	94.214	96.487	98.68	97.485	101.204	42.117	96.254	102.161	99.371	98.109	99.348	97.423	49.21
	3290	127.887	127.587	133.387	133.302	128.977	133.833	42.021	128.541	137.954	135.677	130.809	130.22	133.036	49.094
	4430	155.84	158.123	166.616	163.406	160.382	163.02	41.947	158.102	171.624	169.454	159.493	161.799	166.162	49.022
	5700	189.695	195.082	207.298	201.462	201.993	198.986	42.082	194.324	211.213	210.056	195.137	204.314	206.279	49.905
	7760	256.279	268.287	287.249	274.583	280.982	267.553	44.964	265.98	286.944	290.526	265.563	284.377	281.499	55.732
	8850	282.327	299.466	318.641	305.934	317.274	297.004	45.052	294.599	322.624	321.773	294.194	320.617	316.981	55.898
	9900	309.395	328.398	348.811	331.942	348.949	321.122	45.377	320.417	350.801	351.969	318.3	349.812	344.657	55.887
Room temp anneal		309.844	328.464	349.643	331.591	352.177	319.969	45.352	319.844	352.261	351.905	317.311	355.197	343.742	55.999
168h / 100C		237.042	247.223	263.509	243.337	262.836	236.702	45.34	241.946	260.322	261.918	235.13	267.825	249.047	56.911

Ib-2	Dose [Rad(Si)]	1A1	1A3	1A4	1A5	1A6	1A7	1A10	1B1	1B3	1B4	1B5	1B6	1B7	1B10
	0	51.009	49.407	48.787	43.957	48.453	49.632	45.592	49.738	50.38	49.987	49.426	48.872	50.085	47.253
	950	75.32	75.234	73.965	70.964	79.306	77.76	45.341	75.878	75.705	75.195	75.716	80.424	78.876	47.371
	2051	106.844	109.07	107.439	106.779	111.768	114.538	45.609	109.738	107.876	107.754	109.583	112.415	116.573	47.637
	3290	141.339	147.431	144.382	147.455	145.463	155.709	45.477	148.119	143.153	143.932	146.882	146.003	158.574	47.377
	4430	172.6	182.884	180.218	184.497	180.695	195.557	45.423	182.651	175.69	176.42	180.787	180.575	196.965	47.183
	5700	211.186	225.564	221.326	229.46	227.549	240.903	45.514	224.597	213.715	214.48	221.96	226.826	242.984	47.464
	7760	262.418	284.115	278.011	292.791	295.258	305.056	45.019	283.15	268.322	268.02	279.932	295.049	308.835	47.088
	8850	294.001	318.714	310.846	329.344	337.118	342.377	45.487	316.202	298.911	298.943	312.572	335.303	344.198	47.035
	9900	320.164	348.187	339.238	360.186	372.79	374.259	45.585	345.597	325.949	325.591	342.149	371.29	376.573	47.316
Room temp anneal		317.759	345.378	338.492	358.433	375.522	372.036	45.682	344.27	324.863	324.612	339.038	372.151	373.486	47.353
168h / 100C		239.696	252.765	249.521	258.19	273.977	263.092	45.565	254.68	242.611	241.894	247.042	274.327	262.698	47.141
Ib-2	Dose [Rad(Si)]	2A1	2A3	2A4	2A5	2A6	2A7	2A10	2B1	2B3	2B4	2B5	2B6	2B7	2B10
	0	50.899	47.808	46.68	51.081	45.554	52.169	47.933	51.828	52.471	48.147	54.123	47.983	50.469	56.299
	950	75.588	73.203	73.568	76.756	76.563	79.239	47.652	77.501	80.719	75.714	79.318	79.248	77.426	57.702
	2051	107.451	106.475	108.651	110.777	108.859	113.789	47.836	110.744	117.151	111.452	112.287	111.297	112.542	57.591
	3290	141.992	143.725	149.524	148.995	141.437	150.998	47.623	147.464	157.454	152.213	148.442	144.167	152.575	57.911
	4430	173.85	178.558	187.301	183.944	176.079	184.516	47.48	181.708	195.923	189.985	181.336	179.026	189.858	57.233
	5700	211.598	220.384	233.24	226.205	222.738	224.218	47.677	222.711	241.135	234.852	219.942	225.958	235.243	57.994
	7760	271.436	288.239	305.245	292.789	291.657	285.634	56.586	308.985	333.271	326.313	302.9	313.29	327.629	93.6
	8850	300.151	320.697	340.142	324.958	332.215	315.754	56.879	342.129	368.489	361.669	333.311	353.114	362.537	93.989
	9900	326.69	350.754	371.873	354.462	367.489	343.034	57.015	369.636	399.246	393.492	359.821	387.539	393.753	93.974
Room temp anneal		325.846	350.974	372.556	353.508	370.283	341.838	57.224	369.907	399.362	393.463	358.68	392.354	392.834	94.994
168h / 100C		247.864	261.841	279.247	259.421	274.783	250.05	56.843	281.835	299.451	296.992	270.508	298.334	286.705	95.899

Ios1	Dose [Rad(Si)]	1A1	1A3	1A4	1A5	1A6	1A7	1A10	1B1	1B3	1B4	1B5	1B6	1B7	1B10
	0	0.222	0.568	0.167	1.887	0.222	0.394	0.096	0.027	0.428	0.394	0.591	0.192	0.003	0.064
	950	0.046	0.97	0.012	1.986	0.153	1.118	0.1	0.169	0.439	0.877	0.693	0.286	0.171	0.096
	2051	0.918	1.36	0.207	1.875	0.027	1.213	0.065	0.784	0.609	1.179	0.692	1.417	0.149	0.059
	3290	1.403	2.03	0.437	1.873	1.31	2.095	0.08	1.921	0.573	0.928	0.626	2.553	0.594	0.039
	4430	1.698	3.108	1.439	2.2	1.575	3.032	0.109	2.717	0.295	1.018	0.757	3.441	0.97	0.007
	5700	3.51	4.988	2.955	1.546	0.201	4.708	0.102	4.251	0.35	0.625	0.981	3.587	1.208	0.019
	7760	4.832	6.711	4.459	0.503	2.451	6.419	0.103	6.844	1.397	0.297	2.075	0.821	4.148	0.004
	8850	6.626	8.723	4.912	1.745	5.062	7.446	0.108	7.672	3.171	0.871	3.105	1.104	5.737	0.013
	9900	7.122	9.61	5.992	2.408	7.976	8.411	0.092	9.282	4.365	1.433	4.334	2.165	7.455	0.017
Room temp anneal		6.44	8.932	6.539	2.476	8.206	8.518	0.069	9.179	3.801	0.627	3.674	2.46	5.891	0.031
168h / 100C		3.039	3.745	1.986	0.83	3.832	4.198	0.079	3.636	0.024	0.819	0.997	0.531	1.47	0.032
Ios1	Dose [Rad(Si)]	2A1	2A3	2A4	2A5	2A6	2A7	2A10	2B1	2B3	2B4	2B5	2B6	2B7	2B10
	0	0.623	0.125	0.661	0.222	0.723	0.719	0.175	0.497	0.572	0.898	0.692	0.388	0.339	0.363
	950	0.545	1.004	0.786	0.431	1.149	0.842	0.201	0.89	0.098	0.999	0.622	0.621	0.576	0.381
	2051	0.087	1.205	0.834	0.704	0.872	0.947	0.203	1.071	0.974	1.404	0.669	0.436	1.335	0.384
	3290	0.088	1.559	1.176	0.781	0.655	2.124	0.207	2.077	1.779	0.782	0.839	1.319	1.821	0.387
	4430	0.598	2.469	2.071	2.151	0.586	3.049	0.185	3.321	2.609	0.574	1.789	1.397	2.24	0.341
	5700	0.962	3.448	3.034	2.451	0.187	3.319	0.196	4.126	4.021	0.454	1.205	1.15	3.179	0.374
	7760	2.361	6.157	4.982	4.394	3.982	5.74	0.201	7.753	8.004	1.373	3.724	2.691	6.666	0.378
	8850	2.816	6.825	6.5	5.155	7.135	6.154	0.202	10.894	8.99	3.424	4.696	5.838	8.295	0.35
	9900	3.79	7.984	7.923	7.371	9.146	7.965	0.188	11.9	10.445	4.372	6.013	9.061	10.415	0.37
Room temp anneal		2.974	8.155	7.743	6.905	9.177	8.105	0.203	11.569	7.192	3.741	5.387	8.689	9.764	0.353
168h / 100C		0.89	2.066	2.808	3.012	3.904	1.8	0.15	4.613	3.961	0.133	1.891	2.924	2.821	0.372

Ios2	Dose [Rad(Si)]	1A1	1A3	1A4	1A5	1A6	1A7	1A10	1B1	1B3	1B4	1B5	1B6	1B7	1B10
	0	1.464	1.246	1.217	1.172	0.779	1.121	1.308	1.614	1.601	1.742	1.737	1.123	1.701	1.69
	950	1.531	1.236	1.191	1.144	0.808	1.153	1.392	1.57	1.508	1.597	1.595	1.045	1.588	1.677
	2051	1.524	1.234	1.129	1.054	0.71	1.073	1.392	1.446	1.4	1.522	1.529	0.884	1.434	1.665
	3290	1.46	1.156	1.114	1.007	0.634	1.088	1.355	1.463	1.391	1.477	1.538	0.802	1.46	1.654
	4430	1.464	1.191	1.141	1.01	0.642	1.103	1.382	1.485	1.418	1.494	1.551	0.787	1.545	1.717
	5700	1.453	1.241	1.194	1.056	0.711	1.173	1.331	1.582	1.446	1.549	1.588	0.775	1.63	1.638
	7760	1.652	1.411	1.344	1.286	0.86	1.284	1.555	1.762	1.724	1.807	1.761	1.083	1.706	1.878
	8850	1.666	1.353	1.265	1.224	0.807	1.212	1.495	1.84	1.713	1.801	1.75	1.11	1.754	1.95
	9900	1.65	1.36	1.27	1.214	0.839	1.226	1.513	1.862	1.692	1.752	1.712	1.08	1.717	1.883
Room temp anneal		1.737	1.452	1.327	1.262	0.873	1.268	1.557	1.818	1.683	1.774	1.819	1.179	1.753	1.923
168h / 100C		1.706	1.337	1.302	1.265	0.858	1.226	1.47	1.81	1.69	1.825	1.77	1.158	1.813	1.866
Ios2	Dose [Rad(Si)]	2A1	2A3	2A4	2A5	2A6	2A7	2A10	2B1	2B3	2B4	2B5	2B6	2B7	2B10
	0	2.151	2.223	2.294	2.145	1.511	2.159	2.187	3.408	2.804	2.962	3.015	2.524	2.979	2.906
	950	2.04	2.13	2.175	2.088	1.432	2.051	2.259	2.876	2.479	2.734	2.882	2.306	2.862	2.957
	2051	1.796	1.929	1.97	1.926	1.272	1.859	2.268	3.464	3.188	3.23	3.295	2.724	3.425	3.587
	3290	1.694	1.854	1.92	1.804	1.19	1.862	2.257	2.851	2.469	2.552	2.607	2.065	2.693	2.866
	4430	1.691	1.871	1.964	1.87	1.17	1.875	2.282	2.82	2.528	2.577	2.673	2.064	2.737	2.943
	5700	1.682	1.96	2.069	1.946	1.26	1.933	2.245	2.773	2.398	2.329	2.365	1.868	2.477	2.778
	7760	2.22	2.398	2.404	2.308	1.602	2.323	2.497	2.986	2.534	2.545	2.546	2.07	2.623	2.849
	8850	2.233	2.372	2.37	2.277	1.609	2.258	2.477	3.59	3.023	3.032	2.998	2.474	3.024	3.23
	9900	2.233	2.333	2.379	2.267	1.624	2.288	2.456	3.389	2.846	2.835	2.851	2.486	2.896	3.046
Room temp anneal		2.187	2.305	2.329	2.251	1.607	2.346	2.441	3.99	3.547	3.666	3.726	3.334	3.845	3.919
168h / 100C		2.269	2.312	2.383	2.305	1.64	2.284	2.415	3.144	2.861	2.948	2.967	2.537	3.111	3.335

AVO	Dose [Rad(Si)]	1A1	1A3	1A4	1A5	1A6	1A7	1A10	1B1	1B3	1B4	1B5	1B6	1B7	1B10
	0	116.348	116.289	116.336	116.226	112.087	115.861	116.141	116.008	116.335	116.361	116.35	111.732	116.164	115.84
	950	116.015	115.924	115.996	115.91	111.435	115.488	116.027	115.967	116.275	116.261	116.292	111.531	115.849	115.92
	2051	116.078	115.8	116.011	115.939	111.45	115.623	116.1	115.921	116.28	116.027	116.189	111.36	115.884	116.058
	3290	115.787	115.667	115.538	115.58	111.096	115.347	116.124	115.664	115.888	116.081	115.879	111.088	115.683	115.888
	4430	115.626	115.549	115.44	115.616	110.732	115.036	115.973	115.452	115.867	115.702	115.701	110.81	115.562	115.939
	5700	115.738	115.551	115.487	115.48	110.676	115.074	116.099	115.438	115.611	115.824	115.503	110.727	115.475	116.051
	7760	115.129	115.164	115.062	114.94	110.081	114.804	115.959	115.001	115.258	115.454	115.348	110.32	115.215	115.784
	8850	115.286	115.222	115.179	115.193	110.241	114.88	116.263	114.798	115.283	115.193	115.507	110.114	114.974	115.951
	9900	115.167	115.13	115.054	114.966	110.083	114.546	116.166	115.103	115.348	115.413	115.528	109.981	115.25	115.979
Room temp anneal		115.308	115.071	115.178	115.244	110.369	114.743	116.333	115.235	115.49	115.459	115.544	110.067	115.243	116.205
168h / 100C		115.638	115.468	115.445	115.41	110.945	115.184	116.014	115.458	115.648	115.813	115.78	110.763	115.277	115.84
AVO	Dose [Rad(Si)]	2A1	2A3	2A4	2A5	2A6	2A7	2A10	2B1	2B3	2B4	2B5	2B6	2B7	2B10
	0	116.019	115.77	116.143	116.123	111.754	116.094	116.059	114.288	114.066	114.286	114.428	111.784	114.253	114.513
	950	115.825	115.713	115.785	115.793	111.479	115.796	115.999	114.447	114.036	114.326	114.368	111.582	114.152	114.794
	2051	115.852	115.543	115.87	115.708	111.353	115.775	116.099	114.225	113.966	114.292	114.396	111.398	114.136	115.131
	3290	115.655	115.374	115.814	115.521	110.943	115.379	115.999	114.037	113.854	114.182	114.227	111.256	114.094	114.797
	4430	115.577	115.267	115.615	115.247	110.746	115.363	116	114.159	113.742	114.016	114.038	110.97	113.937	115.157
	5700	115.42	115.061	115.579	115.294	110.696	115.169	116.004	113.756	113.474	113.949	114.138	110.604	113.776	114.907
	7760	115.223	114.829	115.111	114.896	110.096	114.867	115.854	113.496	113.254	113.585	113.787	110.609	113.6	115.167
	8850	114.884	115.07	115.237	114.93	110.085	115.15	115.961	113.609	113.156	113.627	113.79	110.24	113.543	115.279
	9900	115.172	114.98	115.1	114.797	109.771	114.752	116.069	113.757	113.317	113.682	113.901	110.159	113.838	115.079
Room temp anneal		115.242	115.007	115.237	115.107	110.055	115.107	116.238	113.886	113.537	113.55	114.14	110.459	113.537	115.426
168h / 100C		115.507	115.154	115.515	115.547	110.599	115.322	116.054	113.842	113.53	113.791	113.907	110.883	113.833	115.175

CMRR1	Dose [Rad(Si)]	1A1	1A3	1A4	1A5	1A6	1A7	1A10	1B1	1B3	1B4	1B5	1B6	1B7	1B10
	0	117.469	113.717	117.823	113.574	114.243	118.941	117.694	114.466	117.232	115.379	113.216	117.372	118.493	115.485
	950	116.653	114.486	113.115	114.499	114.23	113.658	118.262	116.19	116.4	119.877	119.708	119.333	117.377	119.871
	2051	119.414	122.127	122.809	123.448	123.872	124.339	121.893	114.528	123.513	119.046	123.123	124.995	122.392	124.187
	3290	117.277	113.622	119.242	113.339	113.844	119.756	115.168	119.525	117.327	114.256	113.909	121.901	114.823	120.418
	4430	115.271	117.018	119.702	119.768	117.576	114.881	115.537	120.031	113.705	120.068	119.963	114.806	117.464	118.121
	5700	118.212	118.217	118.369	118.247	118.062	117.359	119.732	119.696	120.425	119.631	119.583	121.263	119.431	120.309
	7760	112.611	118.237	116.553	118.201	119.786	116.331	118.097	117.866	116.47	119.208	114.675	120.609	119.822	119.732
	8850	117.823	119.744	117.29	115.21	117.46	121.299	120.062	120.817	115.985	120.405	120.1	119.988	117.818	113.577
	9900	116.636	118.293	116.138	115.365	120.94	115.434	119.798	120.642	114.057	120.912	114.532	119.242	121.1	115.412
Room temp anneal		118.624	119.572	122.861	121.764	138.865	126.058	134.954	127.53	135.343	117.534	130.884	132.166	117.837	131.171
168h / 100C		117.958	120.947	120.763	114.695	118.328	116.892	120.412	121.569	114.555	120.328	121.451	121.94	121.771	122.4
CMRR1	Dose [Rad(Si)]	2A1	2A3	2A4	2A5	2A6	2A7	2A10	2B1	2B3	2B4	2B5	2B6	2B7	2B10
	0	116.119	119.397	80	119.613	121.072	118.446	119.368	117.746	118.784	113.878	114.813	121.576	121.227	120.892
	950	119.391	113.408	114.638	119.208	120.328	118.827	120.1	114.304	121.756	117.313	122.041	121.809	116.827	116.54
	2051	117.01	120.933	120.878	116.315	125.32	121.947	123.257	124.288	116.582	125.388	125.598	118.822	124.514	119.42
	3290	119.988	120.49	114.46	116.499	114.378	120.412	113.711	120.756	120.037	121.703	121.227	121.422	119.437	121.142
	4430	119.696	116.909	119.804	114.496	119.501	113.607	120.162	120.906	119.566	121.178	120.974	121.971	114.701	118.354
	5700	119.865	120.181	119.835	120.213	121.429	113.814	114.25	121.002	121.621	118.587	114.995	120.837	115.097	121.249
	7760	119.186	117.45	117.272	114.388	114.615	119.607	119.316	119.994	117.232	114.947	120.622	120.27	114.151	122.199
	8850	114.285	120.689	120.602	120.219	122.127	114.542	121.037	120.569	114.552	120.988	121.03	114.715	115.107	120.858
	9900	120.919	121.002	120.556	120.968	118.996	121.539	116.87	120.431	114.675	121.473	120.642	120.194	121.863	123.606
Room temp anneal		121.22	128.235	131.398	126.108	136.797	128.796	118.151	117.156	130.82	131.104	120.037	118.838	117.684	128.251
168h / 100C		120.81	121.847	121.688	121.886	122.392	122.607	121.994	122.724	122.247	123.719	121.199	121.393	124.629	126.12

CMRR2	Dose [Rad(Si)]	1A1	1A3	1A4	1A5	1A6	1A7	1A10	1B1	1B3	1B4	1B5	1B6	1B7	1B10
	0	99.961	99.895	99.939	106.281	99.944	99.582	99.597	105.844	105.714	106.361	99.928	99.873	105.565	102.373
	950	99.71	99.758	99.742	106.021	99.862	99.726	99.367	104.634	105.65	106.338	99.807	99.769	104.778	101.994
	2051	100.504	100.405	100.208	107.538	100.09	100.197	99.851	105.022	106.246	107.712	100.191	100.214	105.597	103.307
	3290	99.928	99.889	99.95	105.833	99.818	99.769	99.56	102.128	103.776	106.167	99.835	99.856	102.093	102.064
	4430	99.956	99.933	99.889	105.274	100.028	99.911	99.608	100.41	102.679	105.888	99.769	99.856	102.448	102.221
	5700	99.895	99.523	99.699	103.75	99.84	99.818	99.439	99.635	109.883	105.618	99.967	99.818	99.434	102.001
	7760	99.791	99.917	99.911	110.645	99.867	99.895	99.398	99.471	99.967	106.361	99.867	99.944	99.619	101.91
	8850	100.048	99.911	100.045	100	99.856	99.9	99.471	99.534	99.699	105.921	99.753	99.851	99.534	102.264
	9900	99.944	99.956	99.884	99.694	100.011	99.884	99.592	99.613	99.382	105.91	99.956	99.961	99.726	102.403
Room temp anneal		101.179	100.946	101.275	101.399	101.237	100.878	100.707	100.78	101.052	110.112	101.09	101.065	100.841	105.408
168h / 100C		100.056	100.271	100.033	106.644	100.118	99.867	99.889	105.264	106.281	107.161	100.011	100.073	105.533	102.403
CMRR2	Dose [Rad(Si)]	2A1	2A3	2A4	2A5	2A6	2A7	2A10	2B1	2B3	2B4	2B5	2B6	2B7	2B10
	0	105.812	102.909	106.007	99.802	99.704	106.292	102.05	110.954	99.873	106.281	99.571	99.721	103.932	106.525
	950	105.132	110.993	105.725	99.597	99.786	105.629	102.185	99.873	99.851	106.043	99.529	100.028	102.221	106.133
	2051	105.264	100	106.501	99.845	99.851	106.85	103.299	100.18	100.135	106.948	100.294	100.174	101.464	107.048
	3290	103.259	99.55	104.816	99.823	99.873	105.502	102.221	99.513	99.933	105.439	99.818	99.873	99.534	105.987
	4430	103.074	99.56	103.889	99.786	99.688	105.082	102.15	99.731	99.889	104.653	99.694	99.956	99.508	105.91
	5700	100.191	99.635	102.178	99.544	99.9	104.758	102.264	99.651	99.922	103.154	99.71	99.917	99.597	105.682
	7760	99.624	99.944	100.152	99.742	99.851	103.836	102.308	99.884	99.939	99.582	99.884	99.688	99.748	105.661
	8850	99.45	99.64	99.294	99.917	99.802	103.522	102.596	99.651	99.994	99.582	99.791	100.045	99.715	105.833
	9900	99.534	99.748	99.269	99.967	99.972	103.828	102.366	99.95	99.9	99.629	99.651	99.944	99.813	106.155
Room temp anneal		100.719	100.78	100.732	100.872	100.713	107.393	104.953	100.86	100.835	100.811	100.665	100.897	100.909	109.103
168h / 100C		106.304	108.654	106.315	99.917	100.078	106.501	102.917	100.446	99.956	107.328	99.683	100.294	104.262	106.443

Vol1	Dose [Rad(Si)]	1A1	1A3	1A4	1A5	1A6	1A7	1A10	1B1	1B3	1B4	1B5	1B6	1B7	1B10
	0	0.011	0.035	0.024	0.019	0.147	0.022	0.042	0.009	0.003	-0.006	0.038	0.135	0.018	0.04
	950	0.012	0.035	0.023	0.019	0.153	0.022	0.042	0.008	0.002	-0.008	0.036	0.137	0.016	0.039
	2051	0.009	0.033	0.02	0.017	0.152	0.019	0.042	0.007	0.002	-0.008	0.033	0.136	0.014	0.039
	3290	0.009	0.032	0.019	0.015	0.156	0.019	0.042	0.006	0	-0.009	0.032	0.142	0.013	0.039
	4430	0.008	0.031	0.017	0.013	0.16	0.016	0.042	0.006	0	-0.01	0.031	0.146	0.012	0.039
	5700	0.007	0.029	0.016	0.012	0.163	0.014	0.042	0.005	0	-0.01	0.029	0.149	0.01	0.039
	7760	0.006	0.027	0.014	0.01	0.168	0.013	0.042	0.003	0	-0.01	0.027	0.155	0.008	0.039
	8850	0.006	0.026	0.013	0.009	0.171	0.013	0.042	0.003	0	-0.011	0.026	0.157	0.008	0.039
	9900	0.005	0.026	0.013	0.008	0.173	0.012	0.042	0.003	0	-0.011	0.026	0.159	0.007	0.039
Room temp anneal		0.005	0.026	0.013	0.007	0.171	0.011	0.042	0.002	0	-0.011	0.026	0.157	0.007	0.039
168h / 100C		0.004	0.026	0.014	0.012	0.154	0.014	0.042	0.003	0	-0.01	0.028	0.14	0.01	0.039
Vol1	Dose [Rad(Si)]	2A1	2A3	2A4	2A5	2A6	2A7	2A10	2B1	2B3	2B4	2B5	2B6	2B7	2B10
	0	0.012	0.026	0.027	0.016	0.124	-0.002	0.019	0.015	0.032	0.015	0.013	0.104	0.026	-0.002
	950	0.011	0.023	0.026	0.016	0.128	-0.002	0.02	0.013	0.031	0.013	0.013	0.104	0.026	-0.002
	2051	0.01	0.021	0.023	0.013	0.128	-0.002	0.02	0.013	0.027	0.012	0.009	0.104	0.022	-0.004
	3290	0.008	0.019	0.02	0.013	0.134	-0.005	0.019	0.011	0.027	0.009	0.009	0.11	0.02	-0.003
	4430	0.007	0.018	0.018	0.011	0.137	-0.005	0.02	0.01	0.026	0.008	0.008	0.113	0.019	-0.003
	5700	0.006	0.016	0.016	0.009	0.141	-0.006	0.019	0.008	0.025	0.006	0.007	0.116	0.017	-0.005
	7760	0.005	0.013	0.013	0.008	0.146	-0.006	0.019	0.007	0.022	0.005	0.006	0.121	0.015	-0.003
	8850	0.004	0.013	0.013	0.007	0.148	-0.006	0.019	0.006	0.021	0.004	0.005	0.122	0.014	-0.004
	9900	0.004	0.013	0.012	0.006	0.15	-0.006	0.019	0.006	0.021	0.003	0.005	0.124	0.013	-0.006
Room temp anneal		0.003	0.013	0.012	0.006	0.148	-0.006	0.019	0.005	0.02	0.003	0.004	0.121	0.013	-0.006
168h / 100C		0.004	0.014	0.014	0.008	0.13	-0.008	0.019	0.007	0.021	0.006	0.006	0.106	0.017	-0.002