ESA-QCA0069S-C

STSP

Title	Honeywell SRAM Single Event Upset Test Data				
Issue	1				
Date	20.11.91				

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BRITISH AEROSPACE SPACE SYSTEM LIMITED
COMMUNICATIONS SATELLITES DIVISION
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PAGE ISSUE RECORD

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1. INTRODUCTION

The following data has been compiled from data received from Honeywell (US) to fulfil the action AI10 of meeting ST-BAS-MN-0107. Reference should be made to Technical Note ST-BAS-TN-0001.

2. DATA APPRAISAL

This Technical Note comprises the latest SEU data results from testing performed by Brookhaven on the following devices all used on STSP programme:

- o HC6216 (2k x 8 SRAM)
- o HC6364 (8k x 8 SRAM)
- o HC6464 (64k x 1 SRAM)

The 64k x 1 and the 8k x 8 SRAM's have exactly the same memory cell array, so test results from each of these parts can be considered a single data base and thus the results are applicable to both.

The 64k x 1 "Z" level parts are screened such that they have a minimum resistor value of 690k ohms for SER and a maximum value of 1400k ohms for speed.

3. CONCLUSIONS

The data contained in this Technical Note satisfies the close out of Action AI10 of ST-BAS-MN-0107. This data should be reviewed by all Users: - BAe Bristol, Laben, and Saab. Also, this latest data should be used in any calculations of device SEU performance over orbit life time.

Honeywell

Radiation–Hardened SRAMs

Single Event Upset Test Data

November 1991

Solid State Electronics Center
12001 State Highway 55
Plymouth, Minnesota 55441

Honeywell Radiation-Hardened SRAMs

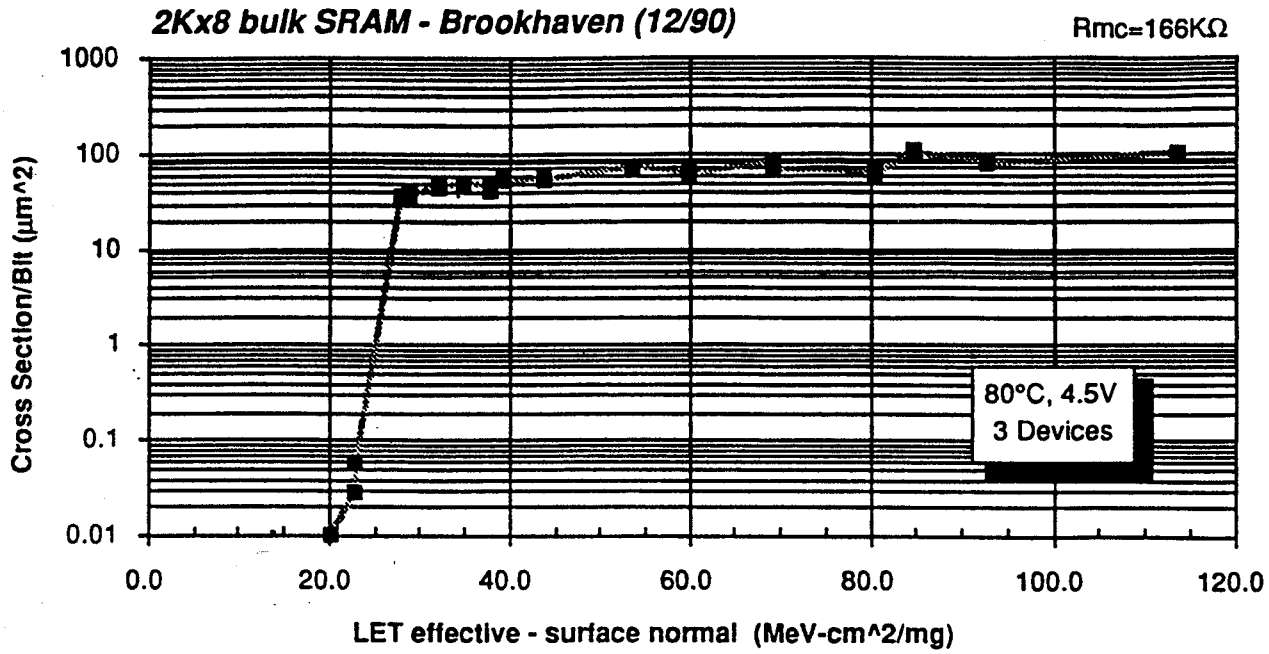
Single Event Upset Test Data

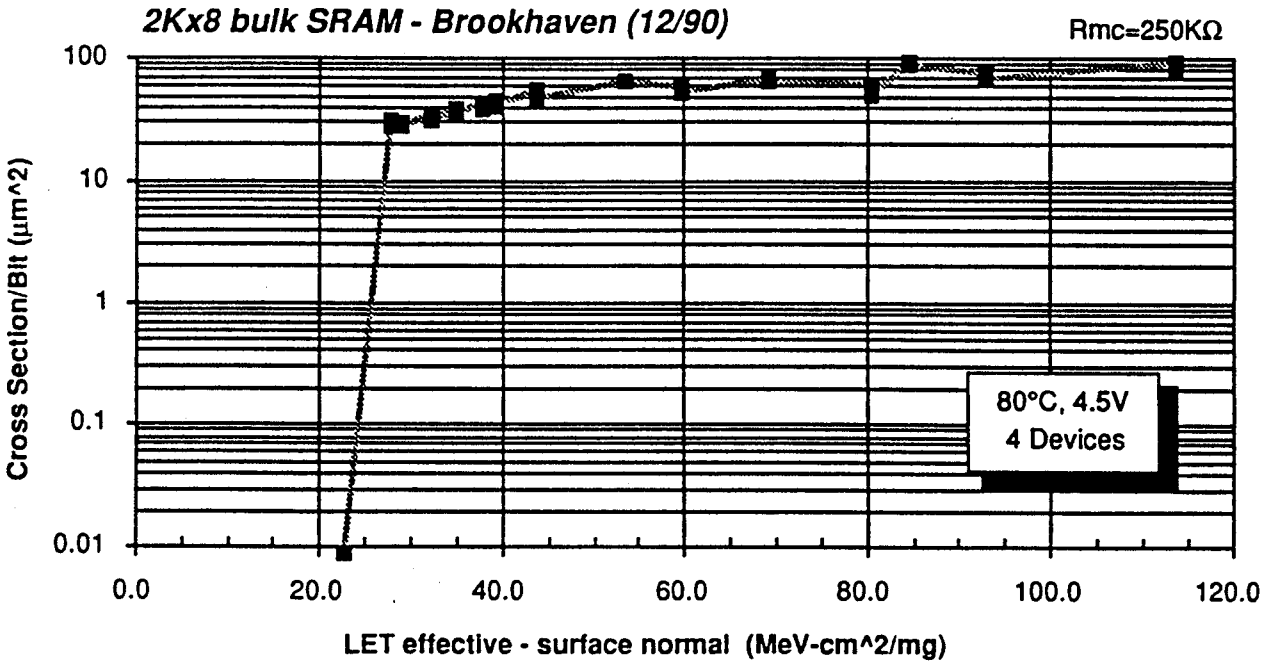
Revised November 15, 1991

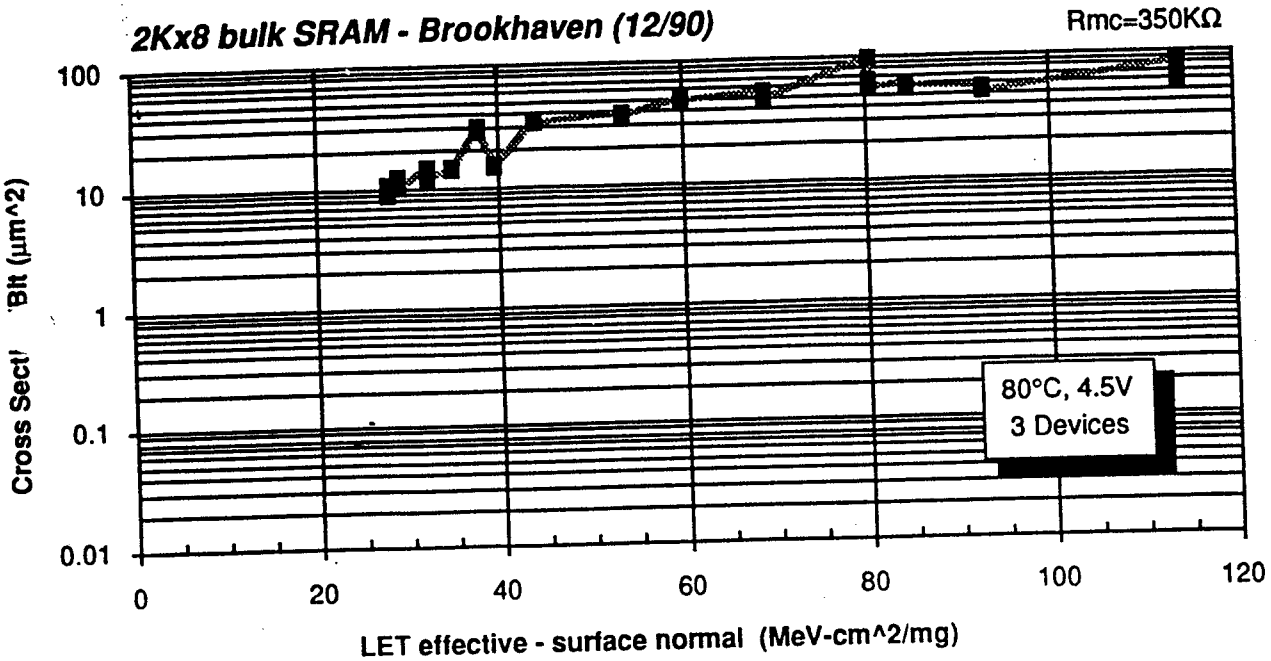
	Rmc (KΩ)	*SER (E/B-D)*	*Level*
2Kx8 SEU Data - HC6216	166	1E-6	D
	250		
	350	1E-7	C
	495		
	550	1E-8	B
	650		
	895	1E-9	A
	1000	1E-10	Z
8Kx8 SEU Data 1 - HC6364	460	1E-8	B
	520		
	610	1E-9	A
	820	1E-10	Z
8Kx8 SEU Data 2 - HC6364	444	1E-8	B
	581		
	630		
	662		
	663	1E-9	A
	695		
	821		
	1050		
	1120		
	1170		
	1400	1E-10	Z
8Kx8 SEU Data 3 - HC6364	0.7	1E-6	D
	127		
	213	1E-7	C
	374	1E-8	B
64Kx1 SEU Data - HC6464	165	1E-6	D
	224	1E-7	C
	345		
	457	1E-8	B

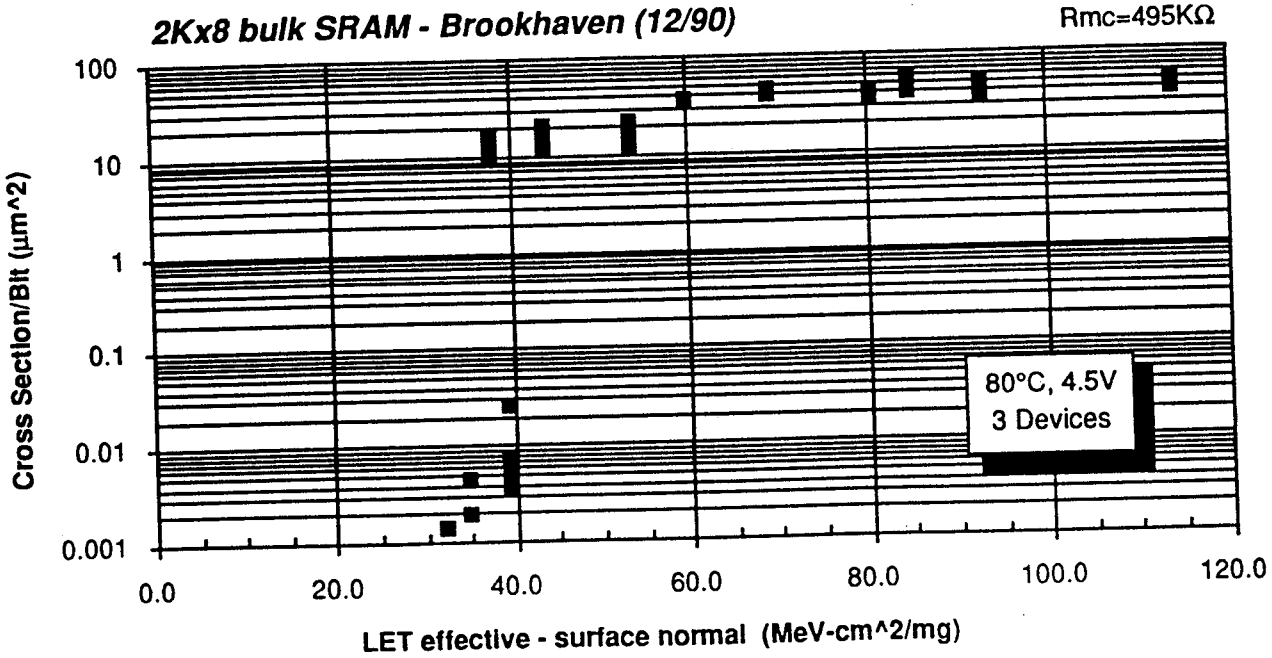
The **Sensitive Volume Depth** for these devices is: 6.0 μm worst case
7.1 μm nominal

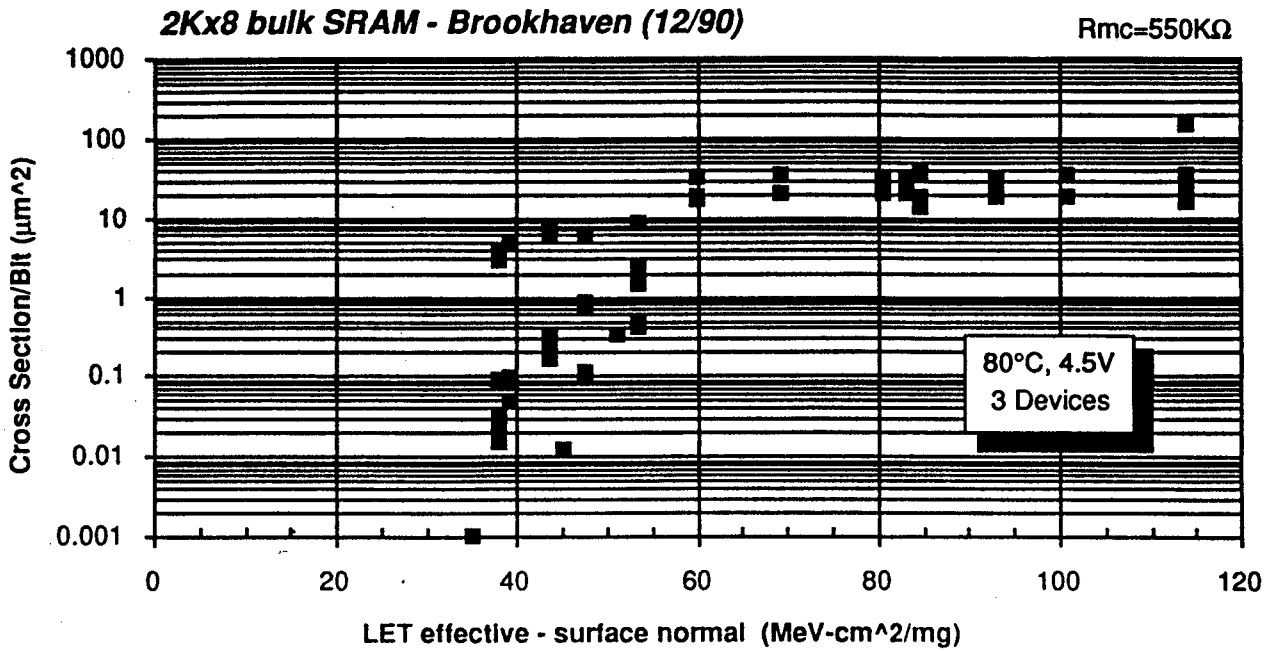
2K x 8 RADIATION-HARDENED SRAM - HC6216 SEU DATA

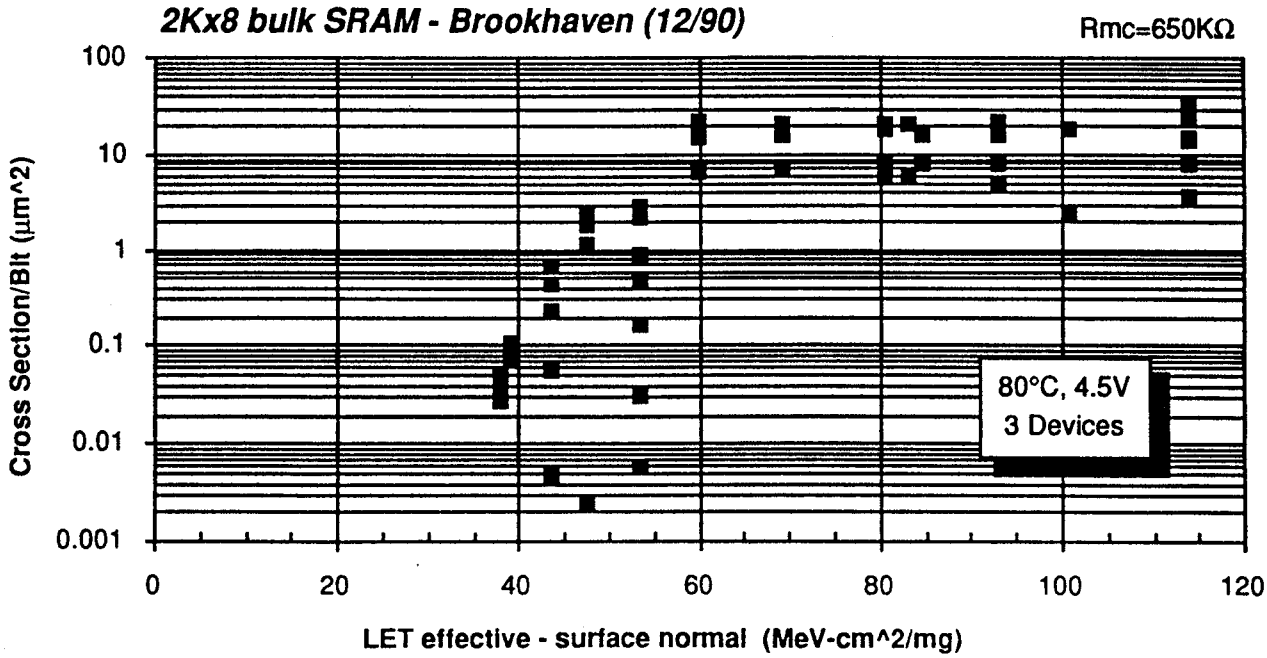





2Kx8 bulk SRAM - Brookhaven (12/90)
Rmc=350KΩ
Cross Sect' 'Bit (µm^2)
100
10
1
0.1
0.01
0
20
40
60
80
100
120
80°C, 4.5V
3 Devices
LET effective - surface normal (MeV-cm^2/mg)


2Kx8 bulk SRAM - Brookhaven (12/90)
Rmc=495KΩ
Cross Section/Bit (µm^2)
100
10
1
0.1
0.01
0.001
0.0
20.0
40.0
60.0
80.0
100.0
120.0
80°C, 4.5V
3 Devices
LET effective - surface normal (MeV-cm^2/mg)





No upsets for the memory cell resistor (Rmc) values of 895KΩ and 1,000KΩ at 80°C and 4.5V.

SEU TEST DATA

The single event upset (SEU) testing was done in the static mode where data patterns are stored before, and read out after, the ion beam irradiation exposure. After irradiation, the number of stored bit errors in the SRAM are recorded along with the exposure conditions. An effective linear energy transfer (LETeff) energy and a device cross section (Cross) are calculated.

$$LETeff = \frac{LETref}{\cos(\pi x angle/180°)} \quad MeV\text{-}cm^2/mg$$

$$Cross = \frac{No.\ of\ Upsets\ x1E8}{Fluence x 2^{14} x \cos(\pi x angle/180°)} \quad \mu m^2$$

When Honeywell estimates the soft error rate (SER), a statistical factor is applied to the upset error number. This accounts for memory cells that upset an even number of times during the heavy ion exposure that would not be counted as a memory bit error. This corrected factor has been experimentally demonstrated in a dynamic test where the bit errors are monitored continuously during exposure.

$$\text{Corrected Cross Section} = \frac{[-(2^{14}/2)x\ln(1-(2x Upsets/2^{14}))+1]x1E8}{Fluence x 2^{14} x \cos(\pi x angle/180°)}$$

The resulting corrected error count actually increases from the observed errors by about 10%. This leads to a larger calculated cross section that results in a higher (poorer) SER. The values for Cross given in the table below are the uncorrected cross section shown in the expression to the left.

In addition to correctin the cross section, all the SER calculations are from worst case test data, not nominal values - VDD=4.5V, TA=80 or 125°C and the lowest value resistor for a particular SER range. Honeywell feels that this method for SER calculation insures the most accurate number for the SRAM error rates.

Part #	Rmc KΩ	VDD V	Temp °C	Angle °	Flux #/cm^2-s	Fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross um^2
21	166	4.5	80	0	459000	3100000	Cl	208	3	16.25	16.3	0.005906628
21	166	4.5	80	0	465000	3100000	Cl	208	1	16.25	16.3	0.001968876
21	166	4.5	80	30	397000	3080000	Cl	208	1	16.25	18.8	0.002288224
22	166	4.5	80	37	386000	3100000	Cl	208	4	16.25	20.3	0.009861195
22	166	4.5	80	45	335000	307000	Cl	208	2	16.25	23.0	0.05623237
19	166	4.5	80	45	50800	301000	Cl	208	1	16.25	23.0	0.028676641
19	166	4.5	80	45	146000	1030000	Cl	208	1	16.25	23.0	0.008380261
19	166	4.5	80	45	336000	3070000	Cl	208	1	16.25	23.0	0.002811619
21	166	4.5	80	45	333000	3070000	Cl	208	1	16.25	23.0	0.002811619
21	166	4.5	80	0	24100	104000	Ni	220	612	28	28.0	35.91684195
22	166	4.5	80	0	24200	104000	Ni	220	595	28	28.0	34.91915189
19	166	4.5	80	0	24400	122000	Ni	220	693	28	28.0	34.6699699
19	166	4.5	80	15	23200	103000	Ni	220	647	28	29.0	39.69203017
21	166	4.5	80	15	23300	104000	Ni	220	608	28	29.0	36.94081705
22	166	4.5	80	15	23400	104000	Ni	220	599	28	29.0	36.39399574
21	166	4.5	80	30	20600	100000	Ni	220	670	28	32.3	47.21979756
19	166	4.5	80	30	20200	104000	Ni	220	627	28	32.3	42.4896858
22	166	4.5	80	30	20800	104000	Ni	220	626	28	32.3	42.42191916
21	166	4.5	80	37	19300	103000	Ni	220	662	28	35.1	49.11928432
22	166	4.5	80	37	19300	103000	Ni	220	650	28	35.1	48.22890455
19	166	4.5	80	37	19100	103000	Ni	220	642	28	35.1	47.63531803
21	166	4.5	80	0	12300	103000	Br	270	767	38	38.0	45.4504513
19	166	4.5	80	0	21600	104000	Br	270	748	38	38.0	43.89836238
22	166	4.5	80	0	10700	102000	Br	270	669	38	38.0	40.03188189
19	166	4.5	80	45	16600	103000	Ni	220	687	28	39.6	57.5723932
21	166	4.5	80	45	15700	103000	Ni	220	679	28	39.6	56.90197231
22	166	4.5	80	45	17000	103000	Ni	220	639	28	39.6	53.54986791
21	166	4.5	80	30	10300	102000	Br	270	817	38	43.9	56.45094323
22	166	4.5	80	30	9630	102000	Br	270	764	38	43.9	52.78888694
19	166	4.5	80	30	10600	104000	Br	270	752	38	43.9	50.96051631

Part #	Rmc KΩ	VDD V	Temp °C	Angle °	Flux #/cm^2-s	Fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross um^2
22	166	4.5	80	45	7730	101000	Br	270	844	38	53.7	72.12998523
21	166	4.5	80	45	8150	102000	Br	270	851	38	53.7	72.01519794
19	166	4.5	80	45	8380	102000	Br	270	841	38	53.7	71.1689559
22	166	4.5	80	0	1640	30300	I	320	313	60	60.0	63.04951784
19	166	4.5	80	0	2040	30500	I	320	313	60	60.0	62.63607838
19	166	4.5	80	0	2030	17500	I	320	178	60	60.0	62.08147321
21	166	4.5	80	0	1930	30400	I	320	304	60	60.0	61.03515625
21	166	4.5	80	30	1600	30400	I	320	343	60	69.3	79.51880677
19	166	4.5	80	30	1750	30300	I	320	314	60	69.3	73.03589199
22	166	4.5	80	30	3110	36000	I	320	351	60	69.3	68.71537704
21	166	4.5	80	0	4880	61000	Au	320	641	80.6	80.6	64.13694288
19	166	4.5	80	0	4960	60000	Au	320	621	80.6	80.6	63.17138672
22	166	4.5	80	0	4170	60900	Au	320	588	80.6	80.6	58.93049569
21	166	4.5	80	45	1350	30200	I	320	382	60	84.9	109.1820364
19	166	4.5	80	45	1430	30200	I	320	366	60	84.9	104.6089668
22	166	4.5	80	45	2580	30400	I	320	343	60	84.9	97.39021102
21	166	4.5	80	30	4330	60800	Au	320	688	80.6	93.1	79.75064002
19	166	4.5	80	30	4010	60000	Au	320	660	80.6	93.1	77.52504076
22	166	4.5	80	30	3900	60600	Au	320	652	80.6	93.1	75.82707258
22	166	4.5	80	45	3030	60600	Au	320	707	80.6	114.0	100.7028032
21	166	4.5	80	45	3430	60500	Au	320	695	80.6	114.0	99.1571876
19	166	4.5	80	45	3230	60000	Au	320	680	80.6	114.0	97.82558029
19	166	4.5	80	0	4940	68300	Br	270	0	38	38.0	0
19	166	4.5	80	0	25600	2520000	Br	270	0	38	38.0	0
22	166	4.5	80	30	408000	3100000	Cl	208	0	16.25	18.8	0
19	166	4.5	80	0	446000	3070000	Cl	208	0	16.25	16.3	0
22	166	4.5	80	0	470000	3100000	Cl	208	0	16.25	16.3	0
21	166	4.5	125	0	4230	60900	Au	320	670	80.6	80.6	67.14869407
22	166	4.5	125	0	3900	60700	Au	320	664	80.6	80.6	66.76662891
19	166	4.5	125	0	4940	61000	Au	320	627	80.6	80.6	62.73613601
6	166	4.5	125	0	4650	80900	Au	320	750	80.6	80.6	56.58389022
21	166	4.5	125	30	3510	60600	Au	320	771	80.6	93.1	89.66667631
22	166	4.5	125	30	3440	60600	Au	320	700	80.6	93.1	81.40943375
19	166	4.5	125	30	4350	60700	Au	320	692	80.6	93.1	80.34645531
22	166	4.5	125	45	3140	60600	Au	320	798	80.6	114.0	113.6645502
21	166	4.5	125	45	2700	59500	Au	320	753	80.6	114.0	109.2377587
19	166	4.5	125	45	3490	60700	Au	320	694	80.6	114.0	98.68827316
39	250	4.5	80	0	479000	3070000	Cl	208	1	16.25	16.3	0.001988116
40	250	4.5	80	0	482000	3070000	Cl	208	1	16.25	16.3	0.001988116
37	250	4.5	80	0	485000	3070000	Cl	208	1	16.25	16.3	0.001988116
40	250	4.5	80	15	461000	3070000	Cl	208	1	16.25	16.8	0.002058249
38	250	4.5	80	30	408000	3070000	Cl	208	1	16.25	18.8	0.002295678
38	250	4.5	80	45	332000	3070000	Cl	208	3	16.25	23.0	0.008434856
40	250	4.5	80	45	341000	3070000	Cl	208	2	16.25	23.0	0.005623237
38	250	4.5	80	0	54600	260000	Ni	220	1296	28	28.0	30.42367788
39	250	4.5	80	0	52400	261000	Ni	220	1201	28	28.0	28.08552592
40	250	4.5	80	0	53600	259000	Ni	220	1182	28	28.0	27.85465432
37	250	4.5	80	0	55900	262000	Ni	220	1167	28	28.0	27.18626998
37	250	4.5	80	15	53700	259000	Ni	220	1194	28	29.0	29.13002247
39	250	4.5	80	15	50600	259000	Ni	220	1131	28	29.0	27.59301123
39	250	4.5	80	30	45000	257000	Ni	220	1268	28	32.3	34.77246257
38	250	4.5	80	30	55000	260000	Ni	220	1221	28	32.3	33.09722894
40	250	4.5	80	30	46400	258000	Ni	220	1207	28	32.3	32.97136159
37	250	4.5	80	30	48100	264000	Ni	220	1177	28	32.3	31.42113395
37	250	4.5	80	37	43400	258000	Ni	220	1253	28	35.1	37.11612518
39	250	4.5	80	37	42400	258000	Ni	220	1213	28	35.1	35.93125286
38	250	4.5	80	0	7200	101000	Br	270	695	38	38.0	41.9994392

Part #	Rmc KΩ	VDD V	Temp °C	Angle °	Flux #/cm^2-s	Fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross um^2
37	250	4.5	80	0	7880	102000	Br	270	679	38	38.0	40.63026578
40	250	4.5	80	0	9580	102000	Br	270	657	38	38.0	39.31382123
39	250	4.5	80	0	9830	102000	Br	270	648	38	38.0	38.77527574
37	250	4.5	80	0	8130	102000	Br	270	634	38	38.0	37.9375383
40	250	4.5	80	45	37200	256000	Ni	220	1323	28	39.6	44.60819487
38	250	4.5	80	45	39000	256000	Ni	220	1269	28	39.6	42.78745222
37	250	4.5	80	45	38300	256000	Ni	220	1245	28	39.6	41.97823327
39	250	4.5	80	45	37900	260000	Ni	220	1169	28	39.6	38.80931109
38	250	4.5	80	30	6370	101000	Br	270	764	38	43.9	53.31154918
37	250	4.5	80	30	6240	101000	Br	270	709	38	43.9	49.47367588
40	250	4.5	80	30	8010	101000	Br	270	680	38	43.9	47.45006996
38	250	4.5	80	45	5150	101000	Br	270	758	38	53.7	64.7802474
39	250	4.5	80	45	6580	100000	Br	270	742	38	53.7	64.04698286
40	250	4.5	80	45	7010	102000	Br	270	738	38	53.7	62.45266285
37	250	4.5	80	45	5210	101000	Br	270	723	38	53.7	61.78907503
39	250	4.5	80	0	3700	60900	I	320	573	60	60.0	57.42716672
38	250	4.5	80	0	3590	60700	I	320	569	60	60.0	57.21417447
38	250	4.5	80	0	3570	60600	I	320	528	60	60.0	53.17914604
37	250	4.5	80	0	3650	60600	I	320	523	60	60.0	52.67555564
40	250	4.5	80	0	3770	60600	I	320	513	60	60.0	51.66837485
38	250	4.5	80	30	3160	60500	I	320	586	60	69.3	68.26397278
39	250	4.5	80	30	3280	60500	I	320	572	60	69.3	66.63309289
40	250	4.5	80	30	3260	60500	I	320	565	60	69.3	65.81765294
37	250	4.5	80	30	3230	60500	I	320	546	60	69.3	63.60431594
37	250	4.5	80	0	4700	60800	Au	320	600	80.6	80.6	60.23206209
39	250	4.5	80	0	4710	81000	Au	320	793	80.6	80.6	59.75417149
38	250	4.5	80	0	4730	60900	Au	320	592	80.6	80.6	59.33138342
40	250	4.5	80	0	4640	80800	Au	320	659	80.6	80.6	49.77991085
37	250	4.5	80	45	2710	60600	I	320	634	60	84.9	90.30491832
38	250	4.5	80	45	2560	60400	I	320	611	60	84.9	87.31704746
39	250	4.5	80	45	2700	60400	I	320	601	60	84.9	85.88796321
40	250	4.5	80	45	2680	60500	I	320	594	60	84.9	84.74729415
39	250	4.5	80	30	4000	80800	Au	320	845	80.6	93.1	73.70461234
38	250	4.5	80	30	4110	60800	Au	320	620	80.6	93.1	71.86830932
37	250	4.5	80	30	4120	60800	Au	320	610	80.6	93.1	70.70914304
40	250	4.5	80	30	4010	80600	Au	320	760	80.6	93.1	66.45503156
37	250	4.5	80	45	3360	60500	Au	320	635	80.6	114.0	90.59685486
38	250	4.5	80	45	3360	60700	Au	320	612	80.6	114.0	87.0276991
40	250	4.5	80	45	3210	80600	Au	320	770	80.6	114.0	82.46135253
39	250	4.5	80	45	3110	80600	Au	320	769	80.6	114.0	82.35425986
38	250	4.5	80	0	476000	3070000	Cl	208	0	16.25	16.3	0
37	250	4.5	80	15	463000	3070000	Cl	208	0	16.25	16.8	0
40	250	4.5	80	30	414000	3070000	Cl	208	0	16.25	18.8	0
37	250	4.5	80	30	419000	3070000	Cl	208	0	16.25	18.8	0
40	250	4.5	80	37	390000	3070000	Cl	208	0	16.25	20.3	0
38	250	4.5	80	37	376000	3070000	Cl	208	0	16.25	20.3	0
38	250	4.5	80	37	194000	4040000	Cl	208	0	16.25	20.3	0
39	250	4.5	80	45	342000	3070000	Cl	208	0	16.25	23.0	0
37	250	4.5	80	45	342000	3070000	Cl	208	0	16.25	23.0	0
37	250	4.5	125	0	4680	60900	Au	320	677	80.6	80.6	67.85024759
37	250	4.5	125	0	4680	60900	Au	320	632	80.6	80.6	63.34026067
39	250	4.5	125	0	4620	81000	Au	320	783	80.6	80.6	59.00065104
37	250	4.5	125	30	4080	60900	Au	320	688	80.6	93.1	79.61968659
38	250	4.5	125	30	4160	60800	Au	320	675	80.6	93.1	78.24372386
40	250	4.5	125	30	4430	80700	Au	320	854	80.6	93.1	74.58193625
39	250	4.5	125	30	2920	81600	Au	320	830	80.6	93.1	71.68647932
38	250	4.5	125	45	3240	60400	Au	320	720	80.6	114.0	102.8940657
37	250	4.5	125	45	3350	60700	Au	320	711	80.6	114.0	101.1057093

Part #	Rmc KΩ	VDD V	Temp °C	Angle °	Flux #/cm^2-s	Fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross um^2
39	250	4.5	125	45	3170	80800	Au	320	890	80.6	114.0	95.07655044
40	250	4.5	125	45	2400	80500	Au	320	863	80.6	114.0	92.53577909
6	350	4.5	80	0	53300	261000	Ni	220	441	28	28.0	10.31283675
4	350	4.5	80	0	55200	262000	Ni	220	360	28	28.0	8.386510019
6	350	4.5	80	15	52500	258000	Ni	220	492	28	29.0	12.04985036
4	350	4.5	80	15	52400	260000	Ni	220	400	28	29.0	9.721267644
6	350	4.5	80	30	46100	256000	Ni	220	523	28	32.3	14.39829415
4	350	4.5	80	30	44100	258000	Ni	220	423	28	32.3	11.55500079
6	350	4.5	80	37	37900	587000	Ni	220	1119	28	35.1	14.56878221
6	350	4.5	80	37	17600	500000	Ni	220	949	28	35.1	14.50532533
4	350	4.5	80	37	39500	257000	Ni	220	466	28	35.1	13.85747357
6	350	4.5	80	0	10200	102000	Br	270	509	38	38.0	30.45773974
4	350	4.5	80	0	9890	102000	Br	270	460	38	38.0	27.5256587
6	350	4.5	80	45	17300	103000	Ni	220	180	28	39.6	15.08446983
4	350	4.5	80	45	38900	259000	Ni	220	422	28	39.6	14.06395465
6	350	4.5	80	30	8990	102000	Br	270	492	38	43.9	33.99493766
4	350	4.5	80	30	8510	101000	Br	270	453	38	43.9	31.61012013
4	350	4.5	80	45	6010	101000	Br	270	443	38	53.7	37.85969604
6	350	4.5	80	45	7380	101000	Br	270	434	38	53.7	37.09053743
6	350	4.5	80	45	7390	101000	Br	270	417	38	53.7	35.63768228
6	350	4.5	80	0	3610	30600	I	320	242	60	60.0	48.26963337
4	350	4.5	80	0	3790	60700	I	320	452	60	60.0	45.44957269
6	350	4.5	80	30	3080	30600	I	320	241	60	69.3	55.50663941
4	350	4.5	80	30	3220	60050	I	320	388	60	69.3	45.53737918
4	350	4.5	80	0	4990	81000	Au	320	1267	80.6	80.6	95.4710407
4	350	4.5	80	0	5190	80900	Au	320	818	80.6	80.6	61.71416293
4	350	4.5	80	0	4740	59600	Au	320	570	80.6	80.6	58.37254876
6	350	4.5	80	0	4400	80700	Au	320	711	80.6	80.6	53.77446852
6	350	4.5	80	45	2600	30400	I	320	212	60	84.9	60.19453276
4	350	4.5	80	45	2620	60500	I	320	399	60	84.9	56.92621274
6	350	4.5	80	30	3880	80700	Au	320	635	80.6	93.1	55.45612356
4	350	4.5	80	30	4300	60700	Au	320	426	80.6	93.1	49.4618352
4	350	4.5	80	45	3680	60700	Au	320	574	80.6	114.0	81.62401844
6	350	4.5	80	45	3130	80600	Au	320	617	80.6	114.0	66.07617469
4	350	4.5	80	45	3570	60600	Au	320	405	80.6	114.0	57.68689577
6	350	4.5	80	0	408000	3070000	Cl	208	0	16.25	16.3	0
4	350	4.5	80	0	480000	3070000	Cl	208	0	16.25	16.3	0
6	350	4.5	80	45	340000	3070000	Cl	208	0	16.25	23.0	0
4	350	4.5	80	45	337000	3070000	Cl	208	0	16.25	23.0	0
4	350	4.5	125	0	5010	60800	Au	320	533	80.6	80.6	53.50614849
6	350	4.5	125	30	3930	80800	Au	320	727	80.6	93.1	63.41213393
4	350	4.5	125	30	4400	60800	Au	320	558	80.6	93.1	64.68147839
6	350	4.5	125	45	3170	82300	Au	320	842	80.6	114.0	88.30941884
53	495	4.5	80	30	869000	8160000	Ni	220	1	28	32.3	0.000863693
49	495	4.5	80	30	508000	5120000	Ni	220	1	28	32.3	0.00137651
53	495	4.5	80	37	797000	8140000	Ni	220	2	28	35.1	0.001877746
49	495	4.5	80	37	533000	5120000	Ni	220	3	28	35.1	0.004477984
50	495	4.5	80	0	22700	304000	Br	270	483	38	38.0	9.697361996
53	495	4.5	80	0	28800	305000	Br	270	566	38	38.0	11.32652408
49	495	4.5	80	0	26100	353000	Br	270	901	38	38.0	15.57866169
49	495	4.5	80	45	500000	5090000	Ni	220	2	28	39.6	0.003391618
49	495	4.5	80	45	477000	5080000	Ni	220	3	28	39.6	0.005097442
53	495	4.5	80	45	7920000	8140000	Ni	220	7	28	39.6	0.007422811
49	495	4.5	80	45	229000	1040000	Ni	220	3	28	39.6	0.024899045
50	495	4.5	80	30	17900	304000	Br	270	523	38	43.9	12.12487928
53	495	4.5	80	30	23700	304000	Br	270	616	38	43.9	14.28092856

Part #	Rmc KΩ	VDD V	Temp °C	Angle °	Flux #/cm^2-s	Fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross um^2
49	495	4.5	80	30	19900	304000	Br	270	847	38	43.9	19.63627677
50	495	4.5	80	45	13500	302000	Br	270	404	38	53.7	11.54700071
50	495	4.5	80	45	14400	303000	Br	270	417	38	53.7	11.87922743
53	495	4.5	80	45	19000	304000	Br	270	595	38	53.7	16.89422028
49	495	4.5	80	45	15900	303000	Br	270	740	38	53.7	21.08064339
53	495	4.5	80	0	23600	204000	I	320	1107	60	60.0	33.12054802
50	495	4.5	80	0	25300	205000	I	320	1174	60	60.0	34.95379192
53	495	4.5	80	30	20900	205000	I	320	1134	60	69.3	38.98598502
50	495	4.5	80	30	22100	204000	I	320	1141	60	69.3	39.4189267
49	495	4.5	80	30	22100	204000	I	320	1237	60	69.3	42.73550598
50	495	4.5	80	0	4460	60700	Au	320	342	80.6	80.6	34.38883598
53	495	4.5	80	0	4380	60500	Au	320	364	80.6	80.6	36.72197831
49	495	4.5	80	0	4030	60700	Au	320	409	80.6	80.6	41.12583016
50	495	4.5	80	45	17700	203000	I	320	909	60	84.9	38.65116741
53	495	4.5	80	45	17000	203000	I	320	933	60	84.9	39.67166028
49	495	4.5	80	45	18000	204000	I	320	1257	60	84.9	53.18631247
50	495	4.5	80	30	3080	60000	Au	320	312	80.6	93.1	36.64820109
53	495	4.5	80	30	3870	60600	Au	320	343	80.6	93.1	39.89062254
49	495	4.5	80	30	3260	60500	Au	320	399	80.6	93.1	46.48007703
50	495	4.5	80	45	3110	60500	Au	320	273	80.6	114.0	38.94951398
53	495	4.5	80	45	3090	60700	Au	320	280	80.6	114.0	39.81659436
49	495	4.5	80	45	3040	60600	Au	320	358	80.6	114.0	50.99236713
49	495	4.5	80	0	629000	5090000	Ni	220	0	28	28.0	0
50	495	4.5	80	0	572000	5090000	Ni	220	0	28	28.0	0
53	495	4.5	80	0	579000	5120000	Ni	220	0	28	28.0	0
50	495	4.5	80	30	507000	5100000	Ni	220	0	28	32.3	0
50	495	4.5	80	30	524000	5110000	Ni	220	0	28	32.3	0
50	495	4.5	80	37	470000	5080000	Ni	220	0	28	35.1	0
50	495	4.5	80	45	395000	5090000	Ni	220	0	28	39.6	0
27	550	4.5	80	37	446000	7850000	Ni	220	1	28	35.1	0.000973558
27	550	4.5	80	0	516000	3100000	Br	270	1935	38	38.0	3.809775076
27	550	4.5	80	0	505000	3110000	Br	270	1885	38	38.0	3.699397734
27	550	4.5	80	0	131000	2020000	Br	270	946	38	38.0	2.8583791
26	550	4.5	80	0	480000	3100000	Br	270	44	38	38.0	0.086630544
25	550	4.5	80	0	28500	506000	Br	270	7	38	38.0	0.084435987
25	550	4.5	80	0	54000	816000	Br	270	4	38	38.0	0.029919194
25	550	4.5	80	0	336000	2060000	Br	270	7	38	38.0	0.020740102
25	550	4.5	80	0	128000	2300000	Br	270	7	38	38.0	0.018575917
25	550	4.5	80	0	54500	1010000	Br	270	3	38	38.0	0.018129254
26	550	4.5	80	0	114000	2020000	Br	270	5	38	38.0	0.015107712
27	550	4.5	80	15	124000	1200000	Br	270	838	38	39.3	4.412645405
25	550	4.5	80	15	210000	2000000	Br	270	30	38	39.3	0.09478236
26	550	4.5	80	15	468000	3070000	Br	270	39	38	39.3	0.080271705
25	550	4.5	80	15	326000	2060000	Br	270	15	38	39.3	0.046010854
27	550	4.5	80	30	110000	1020000	Br	270	978	38	43.9	6.757530291
27	550	4.5	80	30	103000	2020000	Br	270	1822	38	43.9	6.356913784
25	550	4.5	80	30	118000	2000000	Br	270	93	38	43.9	0.327719491
26	550	4.5	80	30	415000	3090000	Br	270	98	38	43.9	0.223520271
25	550	4.5	80	30	109000	2020000	Br	270	55	38	43.9	0.191893665
26	550	4.5	80	30	90600	2020000	Br	270	48	38	43.9	0.167470835
25	550	4.5	80	33	454000	3070000	Br	270	5	38	45.3	0.011852778
27	550	4.5	80	37	101000	1020000	Br	270	854	38	47.6	6.398658977
25	550	4.5	80	37	180000	2010000	Br	270	219	38	47.6	0.832682281
26	550	4.5	80	37	329000	3060000	Br	270	304	38	47.6	0.759247591
25	550	4.5	80	37	425000	3070000	Br	270	44	38	47.6	0.109533147
25	550	4.5	80	42	399000	3060000	Br	270	123	38	51.1	0.330133841
27	550	4.5	80	45	89300	1020000	Br	270	1014	38	53.7	8.580894326

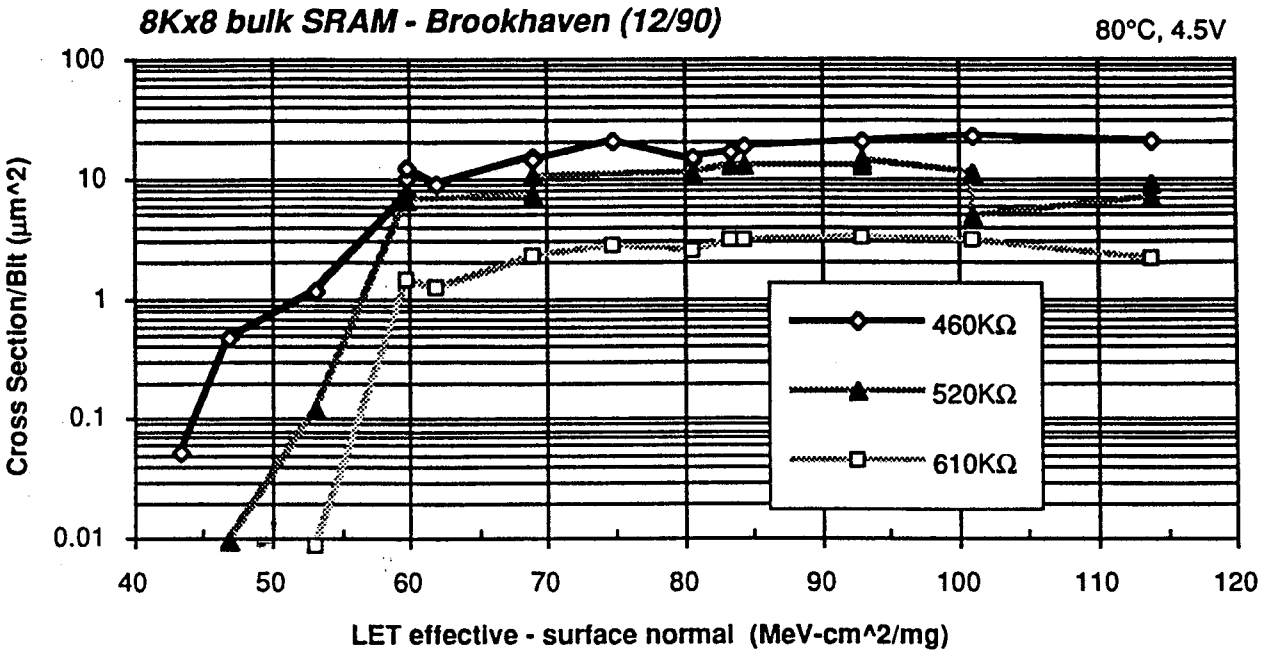
Part #	Rmc KΩ	VDD V	Temp °C	Angle °	Flux #/cm^2-s	Fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross um^2
27	550	4.5	80	45	76900	2020000	Br	270	1994	38	53.7	8.520568161
26	550	4.5	80	45	93900	2200000	Br	270	563	38	53.7	2.208922528
25	550	4.5	80	45	90700	2020000	Br	270	340	38	53.7	1.452855153
25	550	4.5	80	45	84500	2020000	Br	270	326	38	53.7	1.393031705
26	550	4.5	80	45	347000	3050000	Br	270	159	38	53.7	0.449978802
25	550	4.5	80	45	384000	3090000	Br	270	148	38	53.7	0.41342621
27	550	4.5	80	0	23800	254000	I	320	1317	60	60.0	31.64696881
26	550	4.5	80	0	23900	255000	I	320	780	60	60.0	18.66957721
25	550	4.5	80	0	24000	255000	I	320	697	60	60.0	16.68294271
27	550	4.5	80	30	20700	255000	I	320	1249	60	69.3	34.52006271
26	550	4.5	80	30	21000	254000	I	320	726	60	69.3	20.14430193
25	550	4.5	80	30	20600	253000	I	320	721	60	69.3	20.08464046
27	550	4.5	80	0	32700	307000	Au	320	1593	80.6	80.6	31.67068531
27	550	4.5	80	0	20000	123000	Au	320	616	80.6	80.6	30.5672002
26	550	4.5	80	0	20100	124000	Au	320	507	80.6	80.6	24.9555034
25	550	4.5	80	0	4220	60800	Au	320	229	80.6	80.6	22.98857036
26	550	4.5	80	0	8780	92400	Au	320	343	80.6	80.6	22.65698982
26	550	4.5	80	0	4070	60700	Au	320	220	80.6	80.6	22.12147343
26	550	4.5	80	0	39900	309000	Au	320	975	80.6	80.6	19.25866581
27	550	4.5	80	15	32000	307000	Au	320	1487	80.6	83.4	30.6061604
26	550	4.5	80	15	38400	307000	Au	320	938	80.6	83.4	19.30637421
27	550	4.5	80	45	17000	253000	I	320	1095	60	84.9	37.35840865
26	550	4.5	80	45	20000	250000	I	320	524	60	84.9	18.09197791
25	550	4.5	80	45	17100	253000	I	320	396	60	84.9	13.5104382
27	550	4.5	80	30	27800	306000	Au	320	1406	80.6	93.1	32.38271162
27	550	4.5	80	30	18200	123000	Au	320	558	80.6	93.1	31.97263322
26	550	4.5	80	30	3690	60500	Au	320	207	80.6	93.1	24.11372417
25	550	4.5	80	30	3450	60500	Au	320	200	80.6	93.1	23.29828423
26	550	4.5	80	30	17900	123000	Au	320	386	80.6	93.1	22.11726958
25	550	4.5	80	30	3770	60600	Au	320	180	80.6	93.1	20.93385439
26	550	4.5	80	30	33000	307000	Au	320	814	80.6	93.1	18.68681764
27	550	4.5	80	37	25400	305000	Au	320	1297	80.6	100.9	32.49910511
26	550	4.5	80	37	30300	305000	Au	320	701	80.6	100.9	17.56505218
26	550	4.5	80	45	2890	6070	Au	320	101	80.6	114.0	143.6241439
25	550	4.5	80	45	4000	60800	Au	320	247	80.6	114.0	35.0661547
27	550	4.5	80	45	14800	122000	Au	320	468	80.6	114.0	33.11164772
26	550	4.5	80	45	2830	60400	Au	320	151	80.6	114.0	21.57917212
26	550	4.5	80	45	14400	123000	Au	320	262	80.6	114.0	18.38615641
26	550	4.5	80	45	22900	300000	Au	320	545	80.6	114.0	15.68086508
25	550	4.5	80	0	27900	304000	Br	270	0	38	38.0	0
25	550	4.5	80	0	933000	8180000	Ni	220	0	28	28.0	0
26	550	4.5	80	0	922000	8160000	Ni	220	0	28	28.0	0
25	550	4.5	80	0	47200	700000	Br	270	0	38	38.0	0
25	550	4.5	80	0	50000	700000	Br	270	0	38	38.0	0
25	550	4.5	80	0	568000	3670000	Br	270	0	38	38.0	0
25	550	4.5	80	30	826000	8190000	Ni	220	0	28	32.3	0
26	550	4.5	80	30	817000	8160000	Ni	220	0	28	32.3	0
27	550	4.5	80	30	485000	8090000	Ni	220	0	28	32.3	0
25	550	4.5	80	30	480000	3070000	Br	270	0	38	43.9	0
25	550	4.5	80	37	770000	8140000	Ni	220	0	28	35.1	0
26	550	4.5	80	37	747000	8120000	Ni	220	0	28	35.1	0
25	550	4.5	80	45	690000	8130000	Ni	220	0	28	39.6	0
26	550	4.5	80	45	661000	8130000	Ni	220	0	28	39.6	0
27	550	4.5	80	45	654000	8090000	Ni	220	0	28	39.6	0
10	650	4.5	80	0	342000	3070000	Br	270	25	38	38.0	0.049702896
10	650	4.5	80	0	192000	3040000	Br	270	24	38	38.0	0.04818565
7	650	4.5	80	0	346000	3050000	Br	270	18	38	38.0	0.036020748

Part #	Rmc KΩ	VDD V	Temp °C	Angle °	Flux #/cm^2-s	Fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross um^2
7	650	4.5	80	0	198000	3030000	Br	270	13	38	38.0	0.026186701
10	650	4.5	80	15	329000	3050000	Br	270	49	38	39.3	0.101515533
7	650	4.5	80	15	327000	3060000	Br	270	35	38	39.3	0.07227413
10	650	4.5	80	30	181000	3040000	Br	270	294	38	43.9	0.681589772
10	650	4.5	80	30	287000	3500000	Br	270	208	38	43.9	0.418836584
7	650	4.5	80	30	301000	3050000	Br	270	97	38	43.9	0.224140952
7	650	4.5	80	30	181000	3030000	Br	270	23	38	43.9	0.053497628
9	650	4.5	80	30	184000	3030000	Br	270	2	38	43.9	0.004651968
9	650	4.5	80	30	296000	3070000	Br	270	2	38	43.9	0.004591356
10	650	4.5	80	37	166000	3040000	Br	270	884	38	47.6	2.222337154
10	650	4.5	80	37	270000	3050000	Br	270	702	38	47.6	1.759010932
7	650	4.5	80	37	277000	3050000	Br	270	443	38	47.6	1.110031115
9	650	4.5	80	37	275000	3050000	Br	270	1	38	47.6	0.002505714
10	650	4.5	80	45	149000	3030000	Br	270	937	38	53.7	2.669265251
10	650	4.5	80	45	241000	3050000	Br	270	754	38	53.7	2.133861742
7	650	4.5	80	45	243000	3050000	Br	270	305	38	53.7	0.863166885
7	650	4.5	80	45	138000	3030000	Br	270	172	38	53.7	0.489982522
9	650	4.5	80	45	145000	2020000	Br	270	39	38	53.7	0.166651032
9	650	4.5	80	45	241000	3050000	Br	270	11	38	53.7	0.031130609
9	650	4.5	80	45	241000	3000000	Br	270	2	38	53.7	0.005754446
7	650	4.5	80	0	25800	304000	I	320	1053	60	60.0	21.14145379
10	650	4.5	80	0	24400	305000	I	320	801	60	60.0	16.02923284
10	650	4.5	80	0	24700	304000	I	320	720	60	60.0	14.4556949
9	650	4.5	80	0	25500	255000	I	320	261	60	60.0	6.247127757
7	650	4.5	80	30	21600	304000	I	320	868	60	69.3	20.12312661
10	650	4.5	80	30	21500	306000	I	320	662	60	69.3	15.24705199
9	650	4.5	80	30	20500	254000	I	320	259	60	69.3	7.18646584
10	650	4.5	80	0	35800	207000	Au	320	671	80.6	80.6	19.78482601
7	650	4.5	80	0	32000	105000	Au	320	311	80.6	80.6	18.07803199
7	650	4.5	80	0	32600	305000	Au	320	883	80.6	80.6	17.67017802
9	650	4.5	80	0	33500	306000	Au	320	420	80.6	80.6	8.377374387
9	650	4.5	80	0	41300	507000	Au	320	652	80.6	80.6	7.849097017
9	650	4.5	80	0	20400	124000	Au	320	138	80.6	80.6	6.792622228
9	650	4.5	80	0	20300	503000	Au	320	559	80.6	80.6	6.783032275
9	650	4.5	80	0	20500	204000	Au	320	199	80.6	80.6	5.953919654
7	650	4.5	80	15	28700	310000	Au	320	960	80.6	83.4	19.567971
9	650	4.5	80	15	30600	306000	Au	320	277	80.6	83.4	5.719981174
7	650	4.5	80	45	17700	303000	I	320	601	60	84.9	17.12090092
10	650	4.5	80	45	17500	303000	I	320	544	60	84.9	15.49712163
9	650	4.5	80	45	17000	253000	I	320	224	60	84.9	7.642268072
10	650	4.5	80	30	29900	206000	Au	320	628	80.6	93.1	21.4853158
7	650	4.5	80	30	32700	306000	Au	320	877	80.6	93.1	20.19888911
7	650	4.5	80	30	33200	507000	Au	320	1130	80.6	93.1	15.70796056
9	650	4.5	80	30	35600	506000	Au	320	535	80.6	93.1	7.451652319
9	650	4.5	80	30	27500	306000	Au	320	198	80.6	93.1	4.560296516
7	650	4.5	80	37	31500	305000	Au	320	696	80.6	100.9	17.4397665
9	650	4.5	80	37	25300	305000	Au	320	96	80.6	100.9	2.405485035
27	650	4.5	80	45	22700	304000	Au	320	1091	80.6	114.0	30.97746945
10	650	4.5	80	45	27100	206000	Au	320	598	80.6	114.0	25.05698044
7	650	4.5	80	45	27800	306000	Au	320	502	80.6	114.0	14.1604502
7	650	4.5	80	45	29400	506000	Au	320	821	80.6	114.0	14.00513859
9	650	4.5	80	45	29400	506000	Au	320	465	80.6	114.0	7.932264851
9	650	4.5	80	45	22600	303000	Au	320	122	80.6	114.0	3.475457424
9	650	4.5	80	0	98600	2020000	Br	270	0	38	38.0	0
9	650	4.5	80	0	200000	3510000	Br	270	0	38	38.0	0
9	650	4.5	80	0	542000	8090000	Ni	220	0	28	28.0	0
7	650	4.5	80	0	543000	8120000	Ni	220	0	28	28.0	0
10	650	4.5	80	0	531000	8090000	Ni	220	0	28	28.0	0

Part #	Rmc KΩ	VDD V	Temp °C	Angle °	Flux #/cm^2-s	Fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross um^2
9	650	4.5	80	0	343000	3070000	Br	270	0	38	38.0	0
9	650	4.5	80	15	332000	3060000	Br	270	0	38	39.3	0
9	650	4.5	80	30	477000	8100000	Ni	220	0	28	32.3	0
7	650	4.5	80	30	496000	8090000	Ni	220	0	28	32.3	0
10	650	4.5	80	30	471000	8080000	Ni	220	0	28	32.3	0
9	650	4.5	80	37	422000	8090000	Ni	220	0	28	35.1	0
7	650	4.5	80	37	458000	8080000	Ni	220	0	28	35.1	0
10	650	4.5	80	37	443000	8080000	Ni	220	0	28	35.1	0
9	650	4.5	80	45	387000	8070000	Ni	220	0	28	39.6	0
7	650	4.5	80	45	390000	8080000	Ni	220	0	28	39.6	0
10	650	4.5	80	45	389000	8060000	Ni	220	0	28	39.6	0
31	895	4.5	80	0	241000	1820000	I	320	0	60	60.0	0
31	895	4.5	80	0	246000	3050000	I	320	0	60	60.0	0
31	895	4.5	80	30	214000	3040000	I	320	0	60	69.3	0
32	895	4.5	80	30	211000	3040000	I	320	0	60	69.3	0
33	895	4.5	80	30	208000	3040000	I	320	0	60	69.3	0
34	895	4.5	80	30	211000	3040000	I	320	0	60	69.3	0
32	895	4.5	80	0	268000	850000	Au	320	0	80.6	80.6	0
31	895	4.5	80	45	190000	5130000	Au	320	0	80.6	114.0	0
32	895	4.5	80	45	196000	2040000	Au	320	0	80.6	114.0	0
33	895	4.5	80	45	206000	4040000	Au	320	0	80.6	114.0	0
34	895	4.5	80	45	207000	4030000	Au	320	0	80.6	114.0	0
31	895	4.5	125	0	254000	244000	Au	320	707	80.6	80.6	17.68518667
31	895	4.5	125	30	222000	246000	Au	320	547	80.6	93.1	15.67117417
31	895	4.5	125	45	185000	231000	Au	320	839	80.6	114.0	31.35052019
13	1000	4.5	80	30	214000	3040000	I	320	0	60	69.3	0
14	1000	4.5	80	30	211000	3040000	I	320	0	60	69.3	0
16	1000	4.5	80	30	209000	3004000	I	320	0	60	69.3	0
17	1000	4.5	80	45	208000	4040000	Au	320	0	80.6	114.0	0
14	1000	4.5	80	45	212000	4030000	Au	320	0	80.6	114.0	0
16	1000	4.5	80	45	194000	4040000	Au	320	0	80.6	114.0	0

Technical Note

8K x 8 RADIATION-HARDENED SRAM - HC6364 SEU DATA



NOTE: No upsets for the memory cell resistor (Rmc) value of 820KΩ at 80°C and 4.5V.

Rmc KΩ	VDD V	Temp °C	Angle °	Flux #/cm^2-s	Fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross µm^2
lot-wafer-die: 211-5-301, part#3894											
460	4.5	80	37	2.26E+5	3.05E+6	Ni	220	0	27.9	35	0
460	4.5	80	40	2.12E+5	3.03E+6	Ni	220	0	27.9	36	0
460	4.5	80	0	1.96E+5	3.03E+6	Br	270	4	37.5	38	0.00201
460	4.5	80	15	1.89E+5	3.03E+6	Br	270	4	37.5	39	0.00209
460	4.5	80	45	1.82E+5	3.04E+6	Ni	220	0	27.9	39	0
460	4.5	80	30	2.04E+5	3.03E+6	Br	270	89	37.5	43	0.05175
460	4.5	80	37	1.51E+4	2.97E+6	Br	270	748	37.5	47	0.48119
460	4.5	80	45	1.53E+5	3.03E+6	Br	270	1588	37.5	53	1.13095
460	4.5	80	0	2.44E+5	3.05E+6	I	320	14506	59.7	60	7.25718
460	4.5	80	0	2.35E+5	1.04E+6	I	320	6873	59.7	60	10.084
460	4.5	80	0	5.65E+4	3.10E+5	I	320	2507	59.7	60	12.3399
460	4.5	80	15	5.84E+4	6.46E+5	I	320	3736	59.7	62	9.13589
460	4.5	80	30	2.13E+5	1.04E+6	I	320	8818	59.7	69	14.9392
460	4.5	80	30	5.10E+4	4.70E+5	I	320	3763	59.7	69	14.1067
460	4.5	80	37	4.76E+4	4.10E+5	I	320	4354	59.7	75	20.2897
460	4.5	80	0	3.73E+4	3.00E+5	Au	320	2729	80.6	81	13.8804
460	4.5	80	0	1.95E+4	1.69E+5	Au	320	1666	80.6	81	15.0421
460	4.5	80	15	1.81E+4	1.53E+5	Au	320	1628	80.6	83	16.8089
460	4.5	80	45	4.57E+4	3.08E+5	I	320	2680	59.7	84	18.7767
460	4.5	80	30	1.63E+4	1.23E+5	Au	320	1392	80.6	93	19.9399
460	4.5	80	37	1.44E+4	1.23E+5	Au	320	1435	80.6	101	22.2904
460	4.5	80	45	1.27E+4	1.12E+5	Au	320	1039	80.6	114	20.0185

Rmc KΩ	VDD V	Temp °C	Angle °	Flux #/cm^2-s	Fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross µm^2
lot-wafer-die: 211-12-805, part#4035											
520	4.5	80	0	2.00E+5	1.54E+6	Br	270	0	37.5	38	0
520	4.5	80	45	1.62E+5	3.48E+6	Ni	220	0	27.9	39	0
520	4.5	80	30	1.77E+5	3.03E+6	Br	270	2	37.5	43	0.00116
520	4.5	80	37	1.65E+4	3.04E+6	Br	270	15	37.5	47	0.00943
520	4.5	80	45	1.43E+5	3.03E+6	Br	270	165	37.5	53	0.11751
520	4.5	80	0	2.37E+5	1.05E+6	I	320	4418	59.7	60	6.42032
520	4.5	80	30	1.99E+5	3.03E+6	I	320	12666	59.7	69	7.36523
520	4.5	80	30	2.01E+5	1.04E+6	I	320	6028	59.7	69	10.2124
520	4.5	80	0	4.56E+4	5.10E+5	Au	320	3643	80.6	81	10.8996
520	4.5	80	15	4.77E+4	5.09E+5	Au	320	4086	80.6	83	12.6811
520	4.5	80	45	1.69E+5	1.03E+6	I	320	6061	59.7	84	12.6982
520	4.5	80	30	3.89E+4	5.08E+5	Au	320	3725	80.6	93	12.9197
520	4.5	80	30	4.05E+4	5.08E+5	Au	320	4009	80.6	93	13.9047
520	4.5	80	37	1.33E+5	5.20E+5	Au	320	3017	80.6	101	11.0852
520	4.5	80	37	3.94E+4	5.61E+5	Au	320	1419	80.6	101	4.83271
520	4.5	80	45	1.29E+5	1.03E+6	Au	320	3359	80.6	114	7.03733
520	4.5	80	45	1.14E+5	5.24E+5	Au	320	2160	80.6	114	8.89524
lot-wafer-die: 211-10-401, part#3978											
610	4.5	80	45	1.48E+5	3.03E+6	Ni	220	0	27.9	39	0
610	4.5	80	37	1.45E+5	3.03E+6	Br	270	0	37.5	47	0
610	4.5	80	45	1.30E+5	3.02E+6	Br	270	8	37.5	53	0.00572
610	4.5	80	45	1.27E+5	3.02E+6	Br	270	12	37.5	53	0.00857
610	4.5	80	0	5.59E+4	6.09E+5	I	320	555	59.7	60	1.39058
610	4.5	80	15	5.43E+4	6.09E+5	I	320	467	59.7	62	1.21137
610	4.5	80	30	4.72E+4	6.10E+5	I	320	756	59.7	69	2.18364
610	4.5	80	37	4.51E+4	6.07E+5	I	320	882	59.7	75	2.7762
610	4.5	80	0	4.48E+4	1.01E+6	Au	320	1633	80.6	81	2.46709
610	4.5	80	15	3.90E+4	5.08E+5	Au	320	961	80.6	83	2.98838
610	4.5	80	45	3.98E+4	6.07E+5	I	320	839	59.7	84	2.98269
610	4.5	80	30	3.74E+4	5.07E+5	Au	320	902	80.6	93	3.13464
610	4.5	80	37	3.51E+4	5.08E+5	Au	320	826	80.6	101	3.10662
610	4.5	80	45	2.93E+4	5.06E+5	Au	320	503	80.6	114	2.14512
lot-wafer-die: 211-11-607, part#5391											
820	4.5	80	0	1.26E+5	3.57E+6	Br	270	0	37.5	38	0
820	4.5	80	30	1.18E+5	3.02E+6	Br	270	0	37.5	43	0
820	4.5	80	0	2.66E+4	2.66E+5	I	320	0	59.7	60	0
820	4.5	80	0	1.94E+5	1.20E+6	I	320	0	59.7	60	0
820	4.5	80	0	1.69E+5	3.03E+6	I	320	0	59.7	60	0
820	4.5	80	30	1.38E+5	3.03E+6	I	320	0	59.7	69	0
820	4.5	80	0	2.05E+4	2.26E+5	Au	320	0	80.6	81	0
820	4.5	80	45	1.45E+4	2.03E+5	Au	320	0	80.6	114	0
820	4.5	80	45	1.37E+5	3.35E+6	Au	320	0	80.6	114	0

SEU TEST DATA

The single event upset (SEU) testing was done in the static mode where data patterns are stored before, and read out after, the ion beam irradiation exposure. After irradiation, the number of stored bit errors in the SRAM are recorded along with the exposure conditions. An effective linear energy transfer (LETeff) energy and a device cross section (Cross) are calculated.

$$LETeff = \frac{LETref}{\cos(\pi * angle/180°)} \quad MeV\text{-}cm^2/mg$$

$$Cross = \frac{No.\ of\ Upsets * 1E8}{Fluence * 2^{16} * \cos(\pi * angle/180°)} \quad \mu m^2$$

When Honeywell estimates the soft error rate (SER), a statistical factor is applied to the upset error number. This accounts for memory cells that upset an even number of times during the heavy ion exposure that would not be counted as a memory bit error. This corrected factor has been experimentally demonstrated in a dynamic test where the bit errors are monitored continuously during exposure.

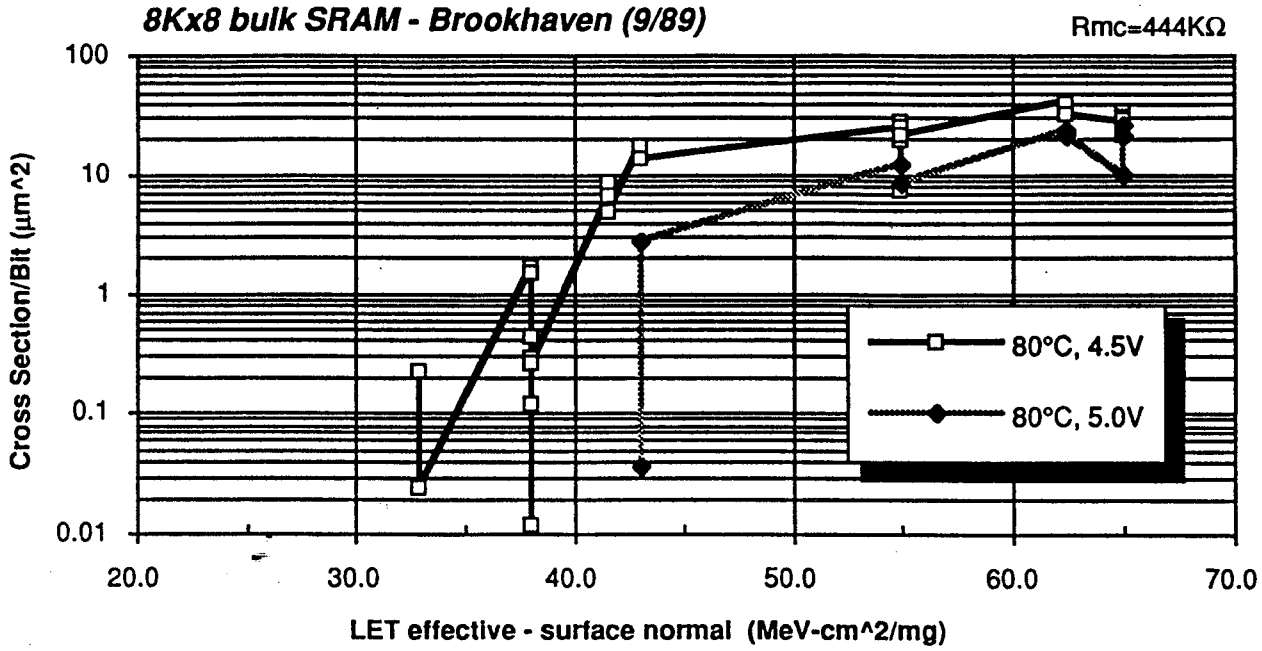
$$\text{Corrected Cross Section} = \frac{[-(2^{16}/2) * \ln(1-(2 * Upsets/2^{16}))+1] * 1E8}{Fluence * 2^{16} * \cos(\pi * angle/180°)}$$

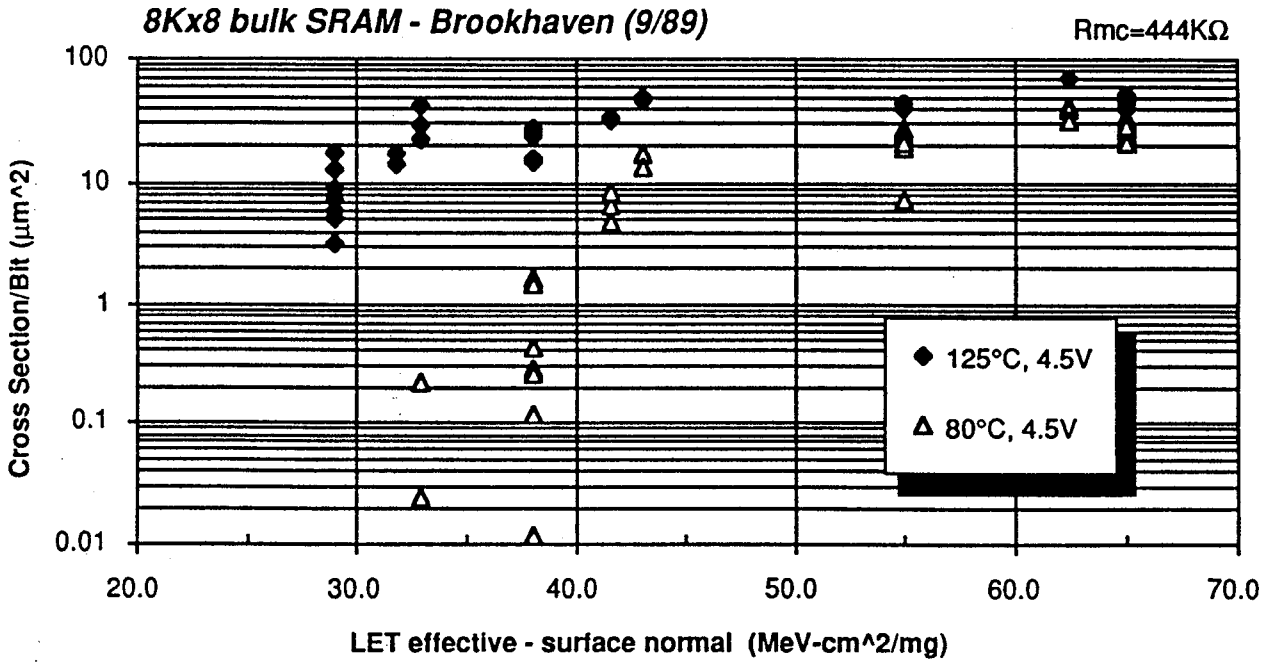
The resulting corrected error count actually increases from the observed errors by about 10%. This leads to a larger calculated cross section that results in a higher (poorer) SER. The values for Cross given in the table below are the uncorrected cross section shown in the expression to the left.

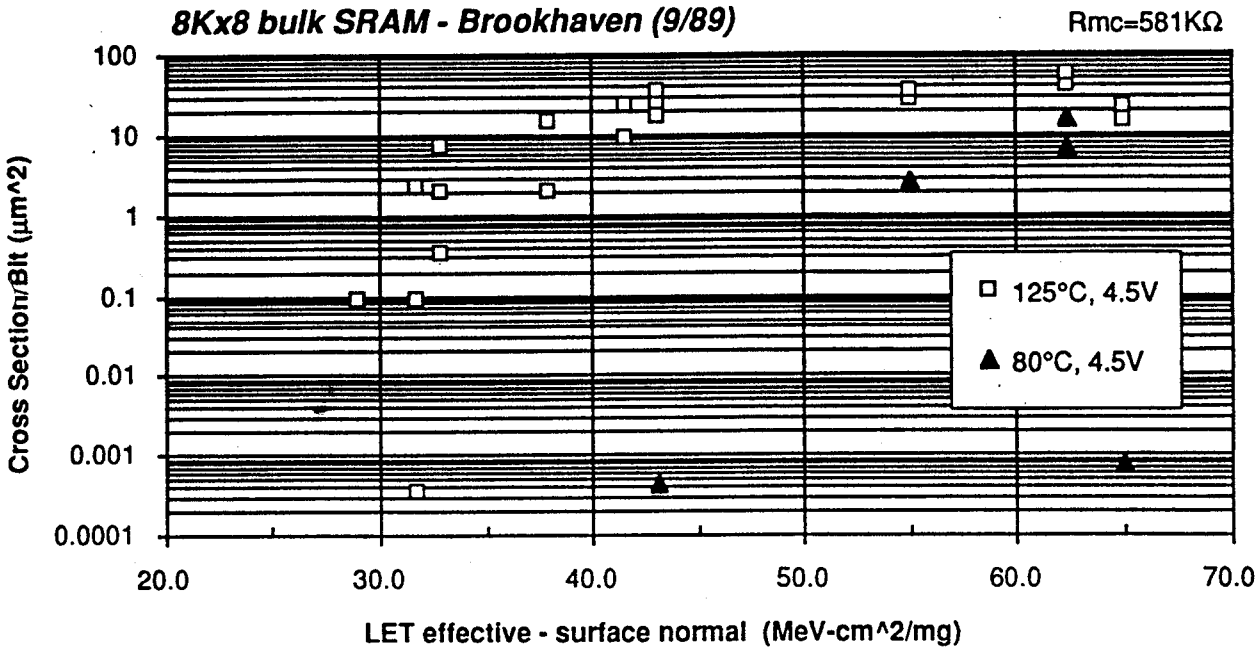
In addition to correctin the cross section, all the SER calculations are from worst case test data, not nominal values - VDD=4.5V, TA=80 or 125°C and the lowest value resistor for a particular SER range. Honeywell feels that this method for SER calculation insures the most accurate number for the SRAM error rates.

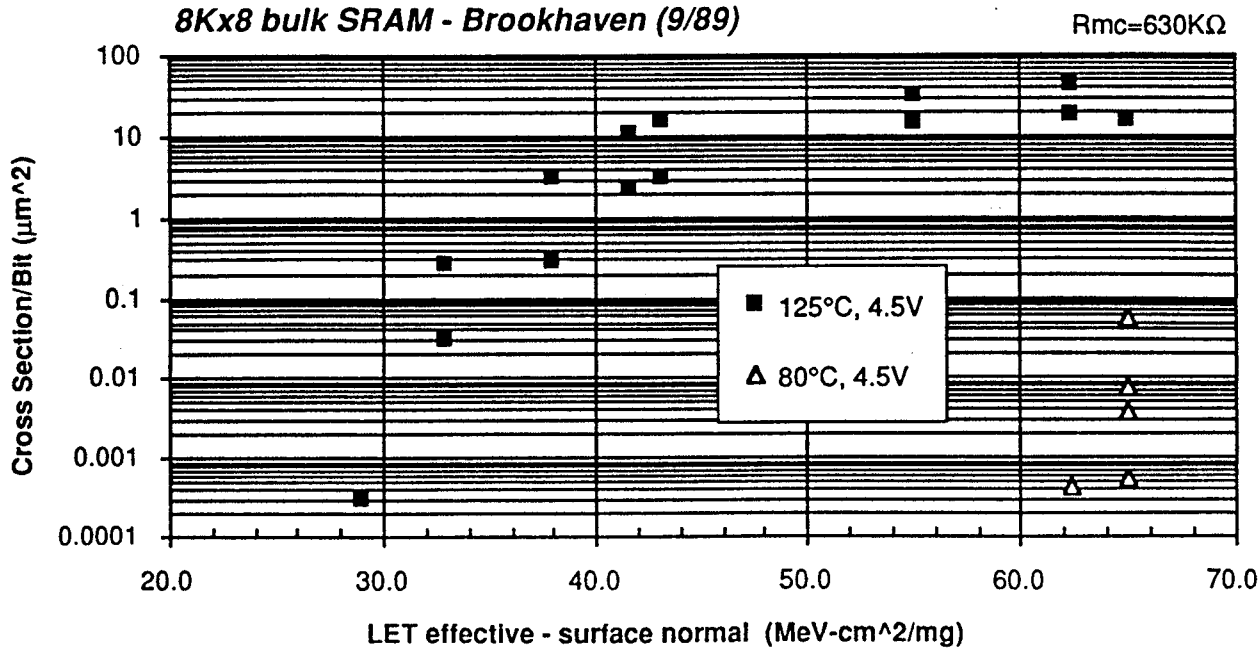
Technical Note

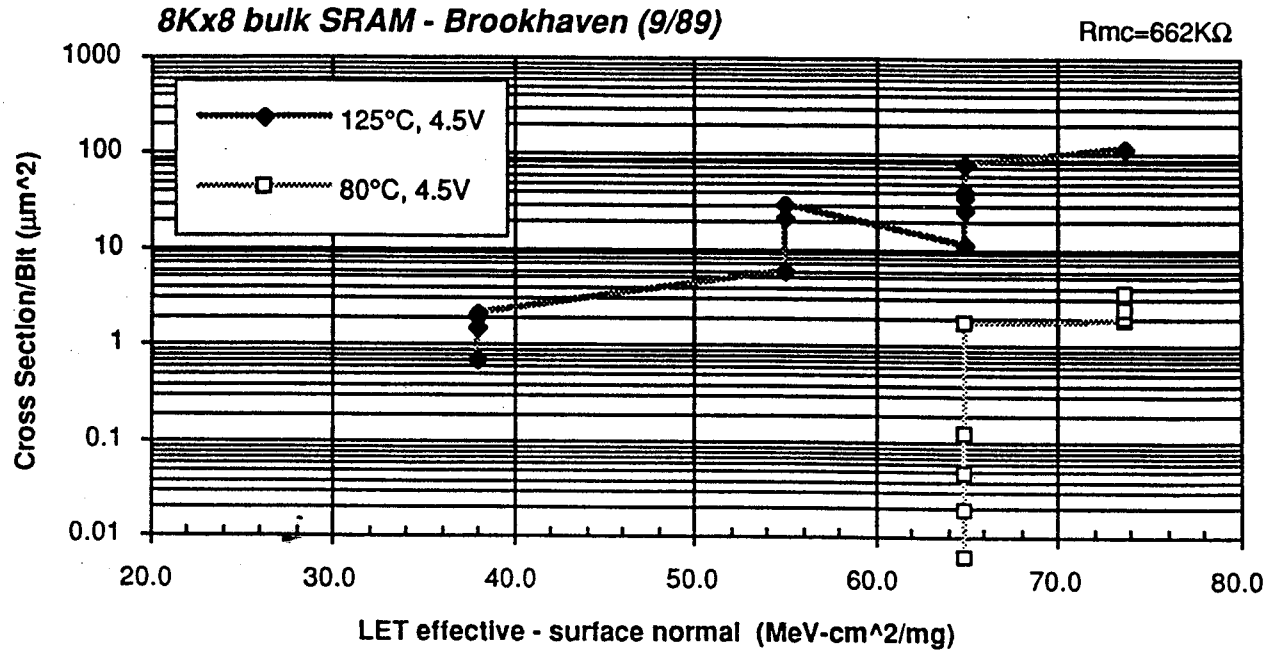
8K x 8 RADIATION-HARDENED SRAM - HC6364 SEU DATA

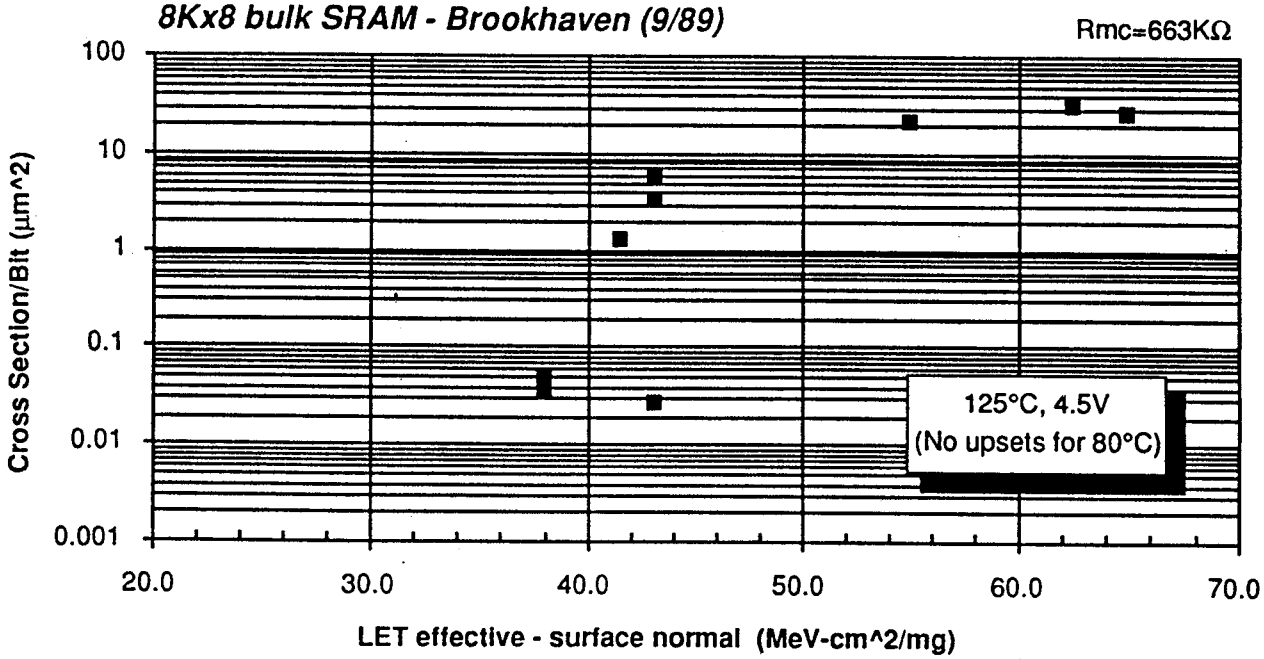


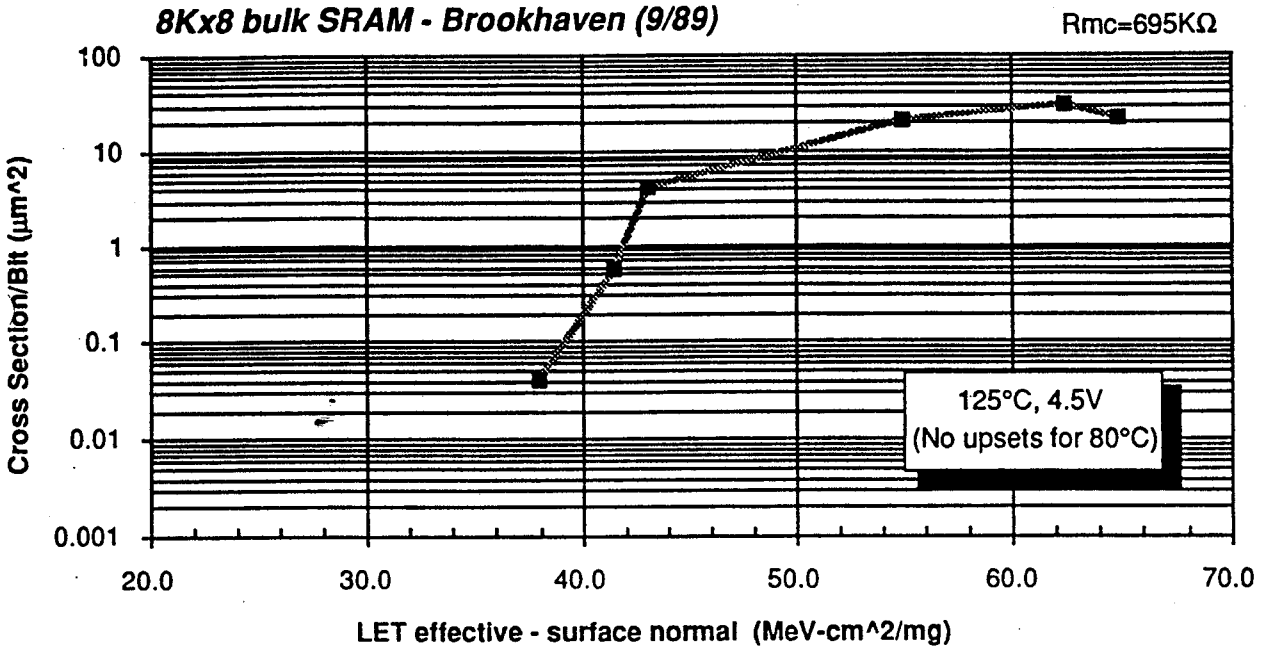



8Kx8 bulk SRAM - Brookhaven (9/89)
Rmc=581KΩ
Cross Section/Bit (µm^2)
100
10
1
0.1
0.01
0.001
0.0001
20.0
30.0
40.0
50.0
60.0
70.0
125°C, 4.5V
80°C, 4.5V
LET effective - surface normal (MeV-cm^2/mg)


8Kx8 bulk SRAM - Brookhaven (9/89)
Rmc=630KΩ
Cross Section/Bit (µm^2)
100
10
1
0.1
0.01
0.001
0.0001
20.0
30.0
40.0
50.0
60.0
70.0
125°C, 4.5V
80°C, 4.5V
LET effective - surface normal (MeV-cm^2/mg)


8Kx8 bulk SRAM - Brookhaven (9/89)
Rmc=662KΩ
125°C, 4.5V
80°C, 4.5V
Cross Section/Bit (µm^2)
1000
100
10
1
0.1
0.01
20.0
30.0
40.0
50.0
60.0
70.0
80.0
LET effective - surface normal (MeV-cm^2/mg)


8Kx8 bulk SRAM - Brookhaven (9/89)
Rmc=663KΩ
125°C, 4.5V
(No upsets for 80°C)
Cross Section/Bit (µm^2)
100
10
1
0.1
0.01
0.001
20.0
30.0
40.0
50.0
60.0
70.0
LET effective - surface normal (MeV-cm^2/mg)



SEU TEST DATA

The single event upset (SEU) testing was done in the static mode where data patterns are stored before, and read out after, the ion beam irradiation exposure. After irradiation, the number of stored bit errors in the SRAM are recorded along with the exposure conditions. An effective linear energy transfer (LETeff) energy and a device cross section (Cross) are calculated.

$$\text{LETeff} = \frac{\text{LETref}}{\cos(\pi \times \text{angle}/180°)} \quad \text{MeV-cm}^2/\text{mg}$$

$$\text{Cross} = \frac{\text{No. of Upsets x1E8}}{\text{Fluence} \times 2^{14} \times \cos(\pi \times \text{angle}/180°)} \quad \mu\text{m}^2$$

When Honeywell estimates the soft error rate (SER), a statistical factor is applied to the upset error number. This accounts for memory cells that upset an even number of times during the heavy ion exposure that would not be counted as a memory bit error. This corrected factor has been experimentally demonstrated in a dynamic test where the bit errors are monitored continuously during exposure.

$$\text{Corrected Cross Section} = \frac{[-(2^{14}/2) \times \ln(1-(2 \times \text{Upsets}/2^{14}))+1] \times 1E8}{\text{Fluence} \times 2^{14} \times \cos(\pi \times \text{angle}/180°)}$$

The resulting corrected error count actually increases from the observed errors by about 10%. This leads to a larger calculated cross section that results in a higher (poorer) SER. The values for Cross given in the table below are the uncorrected cross section shown in the expression to the left.

In addition to correctin the cross section, all the SER calculations are from worst case test data, not nominal values - VDD=4.5V, TA=80 or 125°C and the lowest value resistor for a particular SER range. Honeywell feels that this method for SER calculation insures the most accurate number for the SRAM error rates.

lot-waf-die	Rmc kΩ	VDD V	Temp °C	Angle °	flux #/cm^2-s	fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross µm^2
244-6-702	444	4.5	25	0	1.26E+5	2.04E+6	I	320	0	55	55.0	0
244-6-702	444	4.5	25	0	1.22E+5	8.03E+6	I	320	0	55	55.0	0
244-6-702	444	4.5	25	45	8.55E+5	6.02E+6	I	320	0	55	62.4	0
244-6-307	444	4.5	25	0	7.66E+4	1.02E+6	Au	332	0	65	65.0	0
244-6-307	444	4.5	25	0	2.07E+4	1.00E+7	Au	332	0	65	65.0	0
244-6-405	444	4.5	25	0	1.43E+4	3.00E+6	Au	332	0	65	65.0	0
244-6-702	444	4.5	25	60	8.55E+5	6.02E+6	I	320	0	55	67.4	0
244-6-405	444	4.5	25	45	4.81E+4	6.01E+6	Au	332	0	65	73.7	0
244-6-405	444	4.5	80	45	1.31E+5	1.34E+5	Ni	190	0	29	32.9	0
244-6-307	444	4.5	80	0	2.10E+5	5.05E+6	Ni	190	3	29	29.0	0.000906463
244-6-307	444	4.5	80	45	7.99E+4	5.04E+6	Ni	190	511	29	32.9	0.218788974
244-6-405	444	4.5	80	45	1.48E+5	5.06E+6	Ni	190	57	29	32.9	0.02430857
244-6-307	444	4.5	80	0	1.54E+5	6.52E+5	Br	270	709	38	38.0	1.660294881
244-6-405	444	4.5	80	0	1.32E+5	6.34E+5	Br	270	116	38	38.0	0.279182891
244-6-405	444	4.5	80	0	1.26E+5	1.03E+6	Br	270	79	38	38.0	0.116806622
244-6-405	444	4.5	80	0	1.25E+5	2.05E+6	Br	270	570	38	38.0	0.424268769
244-6-405	444	4.5	80	0	1.25E+5	4.04E+6	Br	270	3976	38	38.0	1.501706567
244-6-503	444	4.5	80	0	7.47E+4	5.28E+5	Br	270	4	38	38.0	0.011559689
244-6-503	444	4.5	80	0	7.29E+4	5.03E+6	Br	270	837	38	38.0	0.253908677
244-6-405	444	4.5	80	30	9.71E+4	4.03E+6	Br	270	14849	38	41.6	6.488825894
244-6-405	444	4.5	80	30	9.32E+4	1.03E+6	Br	270	4867	38	41.6	8.325561998
244-6-503	444	4.5	80	30	6.09E+4	2.02E+6	Br	270	5540	38	41.6	4.832232623
244-6-405	444	4.5	80	45	7.35E+4	8.28E+5	Br	270	6811	38	43.1	17.75070517
244-6-503	444	4.5	80	45	4.62E+4	3.10E+5	Br	270	1974	38	43.1	13.74106904
244-6-405	444	4.5	80	0	1.13E+5	3.27E+5	I	320	5509	55	55.0	25.70662659
244-6-503	444	4.5	80	0	1.09E+5	3.37E+5	I	320	6225	55	55.0	28.18574538
244-6-503	444	4.5	80	0	1.05E+4	2.26E+5	I	320	3651	55	55.0	24.65037118
244-6-702	444	4.5	80	0	1.10E+5	6.03E+6	I	320	28081	55	55.0	7.105838402
244-6-702	444	4.5	80	0	1.06E+5	6.30E+5	I	320	8057	55	55.0	19.51429579
244-6-702	444	4.5	80	0	1.03E+5	3.38E+5	I	320	4798	55	55.0	21.66025737
244-6-405	444	4.5	80	45	7.83E+4	3.17E+5	I	320	6029	55	62.4	41.04129812
244-6-503	444	4.5	80	45	6.54E+4	2.15E+5	I	320	3996	55	62.4	40.10717628
244-6-702	444	4.5	80	45	7.33E+4	3.25E+5	I	320	4927	55	62.4	32.71404664
244-6-307	444	4.5	80	0	1.70E+5	5.60E+5	Au	332	10392	65	65.0	28.31595285
244-6-307	444	4.5	80	0	1.57E+5	3.08E+5	Au	332	6287	65	65.0	31.12654343
244-6-307	444	4.5	80	0	1.53E+5	2.43E+5	Au	332	5081	65	65.0	31.90531162
244-6-405	444	4.5	80	0	1.24E+4	3.05E+5	Au	332	6809	65	65.0	34.06462122
244-6-405	444	4.5	80	0	3.03E+4	1.11E+5	Au	332	1825	65	65.0	25.20116746
244-6-503	444	4.5	80	0	1.51E+4	1.04E+5	Au	332	2112	65	65.0	30.98707933
244-6-702	444	4.5	80	0	5.11E+4	1.01E+6	Au	332	13936	65	65.0	21.05410736
244-6-702	444	4.5	80	0	4.44E+4	1.12E+5	Au	332	2025	65	65.0	27.58843558
244-6-702	444	4.5	80	0	2.16E+4	1.07E+5	Au	332	2017	65	65.0	28.76353041
244-6-307	444	4.5	125	0	2.15E+5	5.07E+6	Ni	190	24335	29	29.0	7.323917788
244-6-307	444	4.5	125	0	1.80E+5	1.50E+5	Ni	190	1704	29	29.0	17.33398438
244-6-307	444	4.5	125	0	2.78E+5	2.83E+5	Ni	190	1645	29	29.0	8.86950813
244-6-405	444	4.5	125	0	1.82E+5	3.70E+5	Ni	190	3089	29	29.0	12.73902687
244-6-405	444	4.5	125	0	2.90E+5	2.96E+5	Ni	190	971	29	29.0	5.005501412
244-6-503	444	4.5	125	0	1.83E+5	5.06E+6	Ni	190	10628	29	29.0	3.204948817
244-6-503	444	4.5	125	0	1.87E+5	2.08E+6	Ni	190	8045	29	29.0	5.901776827
244-6-503	444	4.5	125	0	1.77E+5	2.48E+5	Ni	190	986	29	29.0	6.073946716
244-6-405	444	4.5	125	30	2.51E+5	3.03E+5	Ni	190	2990	29	31.7	17.3867335
244-6-503	444	4.5	125	30	1.71E+5	2.72E+5	Ni	190	2183	29	31.7	14.14080943
244-6-307	444	4.5	125	45	1.29E+5	1.31E+5	Ni	190	1400	29	32.9	23.06172596
244-6-405	444	4.5	125	45	1.42E+5	1.03E+6	Ni	190	14113	29	32.9	29.56767555
244-6-405	444	4.5	125	45	1.28E+5	1.31E+5	Ni	190	2492	29	32.9	41.04987222
244-6-307	444	4.5	125	0	1.44E+5	6.40E+5	Br	270	10169	38	38.0	24.24857415
244-6-307	444	4.5	125	0	1.40E+5	3.00E+5	Br	270	5367	38	38.0	27.29797363

lot-waf-die	Rmc kΩ	VDD V	Temp °C	Angle °	flux #/cm^2-s	fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross µm^2
244-6-405	444	4.5	125	0	1.73E+5	2.42E+5	Br	270	4337	38	38.0	27.3460199
244-6-503	444	4.5	125	0	4.90E+4	2.16E+5	Br	270	3643	38	38.0	25.73507803
244-6-702	444	4.5	125	0	7.26E+4	3.30E+4	Br	270	546	38	38.0	25.24636009
244-6-702	444	4.5	125	0	8.01E+4	2.32E+5	Br	270	3645	38	38.0	23.9733992
244-6-702	444	4.5	125	0	2.78E+5	1.25E+5	Br	270	1234	38	38.0	15.06347656
244-6-702	444	4.5	125	0	2.78E+5	1.25E+5	Br	270	1265	38	38.0	15.44189453
244-6-405	444	4.5	125	30	1.50E+5	2.40E+5	Br	270	4702	38	41.6	34.51920784
244-6-503	444	4.5	125	30	5.50E+4	1.18E+5	Br	270	2222	38	41.6	33.17809795
244-6-405	444	4.5	125	45	6.61E+4	2.17E+5	Br	270	4833	38	43.1	48.06092537
244-6-503	444	4.5	125	45	4.30E+4	6.02E+4	Br	270	1313	38	43.1	47.06556776
244-6-405	444	4.5	125	0	6.09E+4	1.19E+5	I	320	3392	55	55.0	43.49396008
244-6-503	444	4.5	125	0	8.19E+4	1.30E+5	I	320	3853	55	55.0	45.22470328
244-6-702	444	4.5	125	0	8.40E+4	1.33E+5	I	320	3533	55	55.0	40.53330959
244-6-405	444	4.5	125	45	6.09E+4	1.19E+5	I	320	3809	55	62.4	69.07153037
244-6-503	444	4.5	125	45	6.34E+4	1.25E+5	I	320	4078	55	62.4	70.39993783
244-6-702	444	4.5	125	45	7.68E+4	1.21E+5	I	320	3896	55	62.4	69.48141352
244-6-307	444	4.5	125	0	1.28E+5	1.55E+5	Au	332	5271	65	65.0	52.05765511
244-6-307	444	4.5	125	0	3.81E+4	1.11E+5	Au	332	3714	65	65.0	51.0550834
244-6-405	444	4.5	125	0	2.79E+4	1.07E+5	Au	332	2846	65	65.0	40.50980753
244-6-405	444	4.5	125	0	3.53E+5	2.09E+5	Au	332	6275	65	65.0	45.81287147
244-6-503	444	4.5	125	0	1.32E+4	1.03E+5	Au	332	3314	65	65.0	49.09478345
244-6-702	444	4.5	125	0	1.79E+4	1.06E+5	Au	332	3051	65	65.0	43.91940135
244-6-405	444	4.5	125	45	2.24E+5	2.04E+5	Au	332	6635	65	73.7	70.18524608
244-6-307	444	5	80	0	8.30E+4	3.19E+5	Br	270	0	38	38.0	0
244-6-307	444	5	80	0	6.65E+4	4.02E+6	Br	270	0	38	38.0	0
244-6-702	444	5	80	0	1.27E+5	4.03E+6	Br	270	0	38	38.0	0
244-6-307	444	5	80	45	4.69E+4	4.01E+6	Br	270	0	38	43.1	0
244-6-405	444	5	80	0	1.52E+5	4.05E+6	Br	270	2	38	38.0	0.00075352
244-6-307	444	5	80	0	7.36E+4	5.02E+6	Br	270	6	38	38.0	0.00182376
244-6-702	444	5	80	45	8.82E+4	3.02E+6	Br	270	50	38	43.1	0.03572713
244-6-405	444	5	80	45	1.34E+5	4.03E+6	Br	270	5087	38	43.1	2.723903757
244-6-503	444	5	80	0	1.06E+5	2.36E+5	I	320	1895	55	55.0	12.25229037
244-6-702	444	5	80	0	9.78E+4	3.21E+5	I	320	1827	55	55.0	8.68467527
244-6-503	444	5	80	45	6.76E+4	2.22E+5	I	320	2472	55	62.4	24.02871571
244-6-702	444	5	80	45	6.97E+4	3.22E+5	I	320	3129	55	62.4	20.96933986
244-6-307	444	5	80	0	1.53E+5	4.06E+6	Au	332	26332	65	65.0	9.896414621
244-6-307	444	5	80	0	1.41E+4	4.37E+5	Au	332	6005	65	65.0	20.96774103
244-6-405	444	5	80	0	1.34E+4	3.05E+5	Au	332	5376	65	65.0	26.8954918
244-6-307	444	5	125	0	1.69E+5	5.06E+6	Ni	190	437	29	29.0	0.131780451
244-6-405	444	5	125	0	1.28E+5	5.05E+6	Ni	190	342	29	29.0	0.10333675
244-6-503	444	5	125	0	1.71E+5	5.05E+6	Ni	190	13	29	29.0	0.003928005
244-6-307	444	5	125	30	1.63E+5	5.06E+6	Ni	190	11068	29	31.7	3.853967707
244-6-307	444	5	125	30	1.78E+5	2.06E+6	Ni	190	3676	29	31.7	3.144109914
244-6-405	444	5	125	30	8.40E+4	5.02E+6	Ni	190	4877	29	31.7	1.711742667
244-6-503	444	5	125	30	7.00E+4	5.03E+6	Ni	190	4128	29	31.7	1.445976188
244-6-307	444	5	125	0	6.39E+4	5.13E+5	Br	270	4906	38	38.0	14.59251835
244-6-405	444	5	125	0	1.77E+4	3.05E+5	Br	270	2873	38	38.0	14.37327901
244-6-702	444	5	125	0	8.75E+4	3.20E+5	Br	270	2107	38	38.0	10.04695892
244-6-405	444	5	125	45	2.37E+4	3.07E+5	Br	270	5084	38	43.1	35.73569506
244-6-702	444	5	125	45	8.08E+4	3.26E+5	Br	270	4504	38	43.1	29.81369807
244-6-503	444	5	125	0	8.60E+4	1.20E+5	I	320	2903	55	55.0	36.91355387
244-6-702	444	5	125	0	1.06E+5	1.28E+5	I	320	3049	55	55.0	36.34691238
244-6-503	444	5	125	45	6.21E+4	1.22E+5	I	320	3329	55	62.4	58.8828784
244-6-702	444	5	125	45	7.51E+4	1.19E+5	I	320	3139	55	62.4	56.92190439
244-6-307	444	5	125	0	7.54E+4	1.20E+5	Au	332	3407	65	65.0	43.32224528
244-6-405	444	5	125	0	4.43E+4	2.12E+5	Au	332	5800	65	65.0	41.74574366

lot-waf-die	Rmc kΩ	VDD V	Temp °C	Angle °	flux #/cm^2-s	fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross µm^2
235-9-704	581	4.5	25	0	3.00E+5	5.09E+6	I	320	0	55	55.0	0
235-9-704	581	4.5	25	0	2.74E+5	2.79E+5	I	320	0	55	55.0	0
235-9-704	581	4.5	25	45	2.05E+5	2.08E+6	I	320	0	55	62.4	0
235-9-704	581	4.5	25	45	2.07E+5	5.05E+6	I	320	0	55	62.4	0
235-9-604	581	4.5	80	45	1.45E+5	5.04E+6	Ni	190	0	29	32.9	0
235-9-604	581	4.5	80	0	1.48E+5	5.05E+6	Br	270	0	38	38.0	0
235-9-604	581	4.5	80	0	2.34E+4	1.08E+5	Au	332	0	65	65.0	0
235-9-604	581	4.5	80	0	2.77E+4	4.11E+5	Au	332	0	65	65.0	0
235-9-604	581	4.5	80	0	2.91E+4	8.11E+5	Au	332	0	65	65.0	0
235-9-604	581	4.5	80	0	2.92E+4	1.00E+7	Au	332	0	65	65.0	0
235-9-704	581	4.5	80	45	6.52E+4	5.02E+6	Br	270	0	38	43.1	0
235-9-704	581	4.5	80	0	2.98E+5	5.11E+6	I	320	0	55	55.0	0
235-9-704	581	4.5	80	45	2.05E+5	5.05E+6	I	320	0	55	62.4	0
235-9-604	581	4.5	80	45	9.58E+4	5.02E+6	Br	270	1	38	43.1	0.000429864
235-9-604	581	4.5	80	0	7.93E+4	1.03E+6	I	320	1860	55	55.0	2.755470646
235-9-604	581	4.5	80	45	9.04E+4	2.03E+6	I	320	6144	55	62.4	6.531158693
235-9-604	581	4.5	80	45	7.03E+4	2.02E+6	I	320	14293	55	62.4	15.26887682
235-9-604	581	4.5	80	0	1.34E+4	2.01E+6	Au	332	1	65	65.0	0.000759144
235-9-604	581	4.5	125	30	2.26E+5	1.05E+6	Ni	190	0	29	31.7	0
235-9-704	581	4.5	125	0	2.38E+5	5.08E+6	Ni	190	0	29	29.0	0
235-9-604	581	4.5	125	0	2.61E+5	5.07E+6	Ni	190	300	29	29.0	0.090288693
235-9-704	581	4.5	125	30	2.11E+5	5.07E+6	Ni	190	1	29	31.7	0.000347521
235-9-604	581	4.5	125	30	2.48E+5	3.00E+5	Ni	190	15	29	31.7	0.08809666
235-9-604	581	4.5	125	30	2.32E+5	5.05E+6	Ni	190	6412	29	31.7	2.237131811
235-9-704	581	4.5	125	45	1.40E+0	5.04E+6	Ni	190	805	29	32.9	0.344667561
235-9-704	581	4.5	125	45	1.36E+5	2.05E+5	Ni	190	189	29	32.9	1.989495725
235-9-604	581	4.5	125	45	1.29E+5	2.29E+5	Ni	190	778	29	32.9	7.331269453
235-9-704	581	4.5	125	0	7.90E+4	5.30E+5	Br	270	699	38	38.0	2.012432746
235-9-604	581	4.5	125	0	1.03E+5	4.35E+5	Br	270	4206	38	38.0	14.75367053
235-9-704	581	4.5	125	30	6.86E+4	3.16E+5	Br	270	1606	38	41.6	8.95463516
235-9-604	581	4.5	125	30	9.22E+4	4.26E+5	Br	270	5486	38	41.6	22.69005987
235-9-704	581	4.5	125	45	6.17E+4	3.20E+5	Br	270	2508	38	43.1	16.91268737
235-9-604	581	4.5	125	45	8.37E+4	1.02E+6	Br	270	12237	38	43.1	25.88867691
235-9-604	581	4.5	125	45	7.88E+4	4.23E+5	Br	270	6645	38	43.1	33.89921841
235-9-704	581	4.5	125	0	1.68E+5	2.35E+5	I	320	4079	55	55.0	26.48536195
235-9-604	581	4.5	125	0	9.96E+4	2.33E+5	I	320	5194	55	55.0	34.01465682
235-9-704	581	4.5	125	45	1.58E+5	2.51E+5	I	320	4550	55	62.4	39.11764872
235-9-604	581	4.5	125	45	7.68E+4	1.03E+6	I	320	18817	55	62.4	39.42286905
235-9-604	581	4.5	125	45	7.47E+4	2.17E+5	I	320	5561	55	62.4	55.30039437
235-9-604	581	4.5	125	0	1.68E+5	1.07E+6	Au	332	10436	65	65.0	14.88231053
235-9-604	581	4.5	125	0	1.60E+5	6.49E+5	Au	332	9147	65	65.0	21.5057232
235-9-604	581	5	80	45	4.16E+4	4.01E+6	Br	270	0	38	43.1	0
235-9-604	581	5	80	0	1.31E+5	2.05E+6	I	320	0	55	55.0	0
235-9-604	581	5	80	45	6.96E+4	1.02E+6	I	320	2	55	62.4	0.004231213
235-9-604	581	5	80	45	6.84E+4	5.02E+6	I	320	3	55	62.4	0.001289593
235-9-704	581	5	80	45	1.28E+5	4.05E+6	Br	270	0	38	43.1	0
235-9-604	581	5	125	0	3.79E+4	5.12E+5	Br	270	491	38	38.0	1.463294029
235-9-604	581	5	125	30	2.98E+4	5.11E+5	Br	270	2614	38	41.6	9.013098573
235-9-604	581	5	125	45	3.18E+4	5.09E+5	Br	270	4177	38	43.1	17.70849936
235-9-604	581	5	125	0	1.01E+5	2.35E+5	I	320	3849	55	55.0	24.99194855
235-9-604	581	5	125	45	7.50E+4	5.17E+5	I	320	9230	55	62.4	38.52531737
235-9-604	581	5	125	45	7.44E+4	2.31E+5	I	320	4462	55	62.4	41.68239389
235-9-704	581	5	125	0	1.55E+5	3.05E+6	Br	270	2	38	38.0	0.001000576
235-9-704	581	5	125	30	1.35E+5	2.04E+6	Br	270	9	38	41.6	0.007773235
235-9-704	581	5	125	45	1.13E+5	4.37E+5	Br	270	188	38	43.1	0.928349439
235-9-704	581	5	125	45	9.38E+4	2.02E+6	Br	270	2666	38	43.1	2.848025299

lot-waf-die	Rmc kΩ	VDD V	Temp °C	Angle °	flux #/cm^2-s	fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross µm^2
235-2-602	595	4.5	25	0	5.71E+4	5.23E+5	Au	332	0	65	65.0	0
235-2-602	595	4.5	25	0	5.49E+4	2.01E+6	Au	332	0	65	65.0	0
235-2-602	595	4.5	80	0	1.07E+5	5.04E+6	Br	270	0	38	38.0	0
235-2-603	595	4.5	80	30	6.70E+4	5.02E+6	Br	270	2832	38	41.6	0.993983029
235-2-203	595	4.5	80	45	8.49E+4	5.03E+6	Br	270	0	38	43.1	0
235-2-204	595	4.5	80	45	2.24E+5	5.09E+6	Br	270	0	38	43.1	0
235-2-603	595	4.5	80	45	6.76E+4	5.02E+6	Br	270	4443	38	43.1	1.909886959
235-2-702	595	4.5	80	45	3.32E+4	5.01E+6	Br	270	34	38	43.1	0.014644558
235-2-203	595	4.5	80	0	2.59E+5	4.06E+6	I	320	31	55	55.0	0.0116508
235-2-204	595	4.5	80	0	8.63E+4	4.31E+5	I	320	0	55	55.0	0
235-2-204	595	4.5	80	0	8.47E+4	4.03E+6	I	320	1	55	55.0	0.00037863
235-2-602	595	4.5	80	0	1.41E+5	5.05E+6	I	320	535	55	55.0	0.161652518
235-2-603	595	4.5	80	0	1.31E+5	1.05E+6	I	320	7042	55	55.0	10.2335612
235-2-603	595	4.5	80	0	1.32E+5	5.37E+5	I	320	5593	55	55.0	15.89244082
235-2-702	595	4.5	80	0	9.93E+4	4.39E+5	I	320	2630	55	55.0	9.141370213
235-2-203	595	4.5	80	45	1.69E+5	5.03E+6	I	320	309	55	62.4	0.132563988
235-2-204	595	4.5	80	45	5.38E+4	4.01E+6	I	320	64	55	62.4	0.034440597
235-2-603	595	4.5	80	45	8.50E+4	3.27E+5	I	320	4372	55	62.4	28.85143826
235-2-702	595	4.5	80	45	6.90E+4	3.18E+5	I	320	2020	55	62.4	13.70753352
235-2-203	595	4.5	80	0	6.76E+4	5.02E+6	Au	332	30276	65	65.0	9.195364205
235-2-203	595	4.5	80	0	7.88E+4	2.29E+5	Au	332	1	65	65.0	0.006663227
235-2-203	595	4.5	80	0	7.76E+4	1.02E+6	Au	332	204	65	65.0	0.305175781
235-2-203	595	4.5	80	0	7.17E+4	1.00E+7	Au	332	2805	65	65.0	0.427154724
235-2-204	595	4.5	80	0	1.87E+4	2.07E+5	Au	332	9	65	65.0	0.066374626
235-2-204	595	4.5	80	0	8.15E+4	2.21E+5	Au	332	20	65	65.0	0.138088589
235-2-204	595	4.5	80	0	8.08E+4	2.20E+5	Au	332	159	65	65.0	1.104300164
235-2-204	595	4.5	80	0	8.14E+4	5.29E+5	Au	332	184	65	65.0	0.530840837
235-2-602	595	4.5	80	0	2.60E+4	2.08E+5	Au	332	3998	65	65.0	29.31505943
235-2-603	595	4.5	80	0	2.43E+4	2.08E+5	Au	332	3330	65	65.0	24.42873441
235-2-702	595	4.5	80	0	2.12E+4	2.06E+5	Au	332	1736	65	65.0	12.85886302
235-2-702	595	4.5	80	0	8.16E+4	2.22E+5	Au	332	2763	65	65.0	18.99956475
235-2-203	595	4.5	125	0	2.73E+5	5.09E+6	Ni	190	3	29	29.0	0.000899339
235-2-204	595	4.5	125	0	2.86E+5	5.08E+6	Ni	190	1	29	29.0	0.00030037
235-2-602	595	4.5	125	0	1.87E+5	5.04E+6	Ni	190	8	29	29.0	0.00242203
235-2-603	595	4.5	125	0	2.96E+5	5.08E+6	Ni	190	14157	29	29.0	4.252336157
235-2-603	595	4.5	125	0	2.79E+5	8.68E+5	Ni	190	3705	29	29.0	6.513112152
235-2-702	595	4.5	125	0	2.74E+5	9.05E+5	Ni	190	49	29	29.0	0.082616648
235-2-702	595	4.5	125	0	2.91E+5	2.06E+6	Ni	190	1950	29	29.0	1.444399936
235-2-203	595	4.5	125	45	2.00E+5	5.06E+6	Ni	190	6738	29	32.9	2.873528819
235-2-204	595	4.5	125	45	1.98E+5	2.05E+6	Ni	190	229	29	32.9	0.241055302
235-2-204	595	4.5	125	45	2.04E+5	2.07E+6	Ni	190	1028	29	32.9	1.071662012
235-2-603	595	4.5	125	45	1.46E+5	5.03E+6	Ni	190	24643	29	32.9	10.57208532
235-2-603	595	4.5	125	45	1.78E+5	2.49E+5	Ni	190	2207	29	32.9	19.12661224
235-2-702	595	4.5	125	45	2.03E+5	8.62E+5	Ni	190	3479	29	32.9	8.709279538
235-2-203	595	4.5	125	0	1.39E+5	6.42E+5	Br	270	1988	38	38.0	4.724995741
235-2-204	595	4.5	125	0	2.04E+5	6.72E+5	Br	270	1473	38	38.0	3.344672067
235-2-602	595	4.5	125	0	1.17E+5	3.40E+5	Br	270	2708	38	38.0	12.1531767
235-2-603	595	4.5	125	0	6.06E+4	2.02E+6	Br	270	20182	38	38.0	15.26030133
235-2-603	595	4.5	125	0	5.73E+4	3.18E+5	Br	270	4940	38	38.0	23.70390502
235-2-702	595	4.5	125	0	3.40E+5	6.11E+5	Br	270	7471	38	38.0	18.65767808
235-2-203	595	4.5	125	30	1.27E+5	4.42E+5	Br	270	3227	38	41.6	12.86370683
235-2-204	595	4.5	125	30	1.93E+5	4.52E+5	Br	270	2434	38	41.6	9.487932291
235-2-603	595	4.5	125	30	4.83E+4	1.13E+5	Br	270	2172	38	41.6	33.89653586
235-2-702	595	4.5	125	30	3.05E+5	3.69E+5	Br	270	5804	38	41.6	27.71344244
235-2-203	595	4.5	125	45	1.09E+5	2.35E+5	Br	270	2510	38	43.1	23.04840764
235-2-204	595	4.5	125	45	1.89E+5	2.64E+5	Br	270	1728	38	43.1	14.1245584
235-2-603	595	4.5	125	45	3.70E+4	6.55E+4	Br	270	1503	38	43.1	49.55464815
235-2-702	595	4.5	125	45	2.50E+5	2.08E+5	Br	270	3839	38	43.1	39.90486355

lot-waf-die	Rmc kΩ	VDD V	Temp °C	Angle °	flux #/cm^2-s	fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross µm^2
235-2-203	595	4.5	125	0	1.66E+5	1.38E+5	I	320	2749	55	55.0	30.3959501
235-2-204	595	4.5	125	0	3.37E+5	1.11E+5	I	320	2016	55	55.0	27.71326014
235-2-602	595	4.5	125	0	1.20E+5	1.45E+5	I	320	2933	55	55.0	30.86484712
235-2-603	595	4.5	125	0	1.01E+5	1.23E+5	I	320	3509	55	55.0	43.53096815
235-2-702	595	4.5	125	0	8.64E+4	1.21E+5	I	320	3219	55	55.0	40.59342313
235-2-203	595	4.5	125	45	1.32E+5	1.35E+5	I	320	2773	55	62.4	44.3252474
235-2-204	595	4.5	125	45	4.92E+4	1.16E+5	I	320	2100	55	62.4	39.06576855
235-2-603	595	4.5	125	45	7.72E+4	1.22E+5	I	320	3560	55	62.4	62.96877354
235-2-702	595	4.5	125	45	6.34E+4	1.24E+5	I	320	3752	55	62.4	65.29444154
235-2-203	595	4.5	125	0	5.24E+4	2.36E+4	Au	332	0	65	65.0	0
235-2-203	595	4.5	125	0	6.21E+4	2.15E+5	Au	332	4817	65	65.0	34.13914859
235-2-204	595	4.5	125	0	8.13E+4	2.21E+5	Au	332	5229	65	65.0	36.10326154
235-2-602	595	4.5	125	0	2.60E+4	2.07E+5	Au	332	6492	65	65.0	47.85510077
235-2-603	595	4.5	125	0	2.31E+4	2.06E+5	Au	332	6303	65	65.0	46.68745022
235-2-702	595	4.5	125	0	2.02E+4	2.08E+5	Au	332	6072	65	65.0	44.60826538
235-2-203	595	5	80	0	1.48E+5	3.05E+6	Br	270	0	38	38.0	0
235-2-203	595	5	80	45	1.03E+5	3.02E+6	Br	270	0	38	43.1	0
235-2-204	595	5	80	0	1.70E+5	3.06E+6	Br	270	0	38	38.0	0
235-2-204	595	5	80	45	1.17E+5	3.04E+6	Br	270	0	38	43.1	0
235-2-602	595	5	80	0	2.28E+5	3.05E+6	Br	270	0	38	38.0	0
235-2-603	595	5	80	0	2.07E+5	3.04E+6	Br	270	0	38	38.0	0
235-2-603	595	5	80	45	1.47E+5	3.05E+6	Br	270	3	38	43.1	0.002122543
235-2-702	595	5	80	0	1.94E+5	3.07E+6	Br	270	0	38	38.0	0
235-2-702	595	5	80	45	1.37E+5	3.03E+6	Br	270	0	38	43.1	0
235-2-203	595	5	125	0	1.36E+5	3.03E+6	Br	270	1	38	38.0	0.00050359
235-2-203	595	5	125	30	1.21E+5	3.02E+6	Br	270	68	38	41.6	0.039672668
235-2-203	595	5	125	45	9.99E+4	3.30E+5	Br	270	145	38	43.1	0.948176374
235-2-203	595	5	125	45	1.02E+4	2.03E+6	Br	270	2340	38	43.1	2.487453018
235-2-204	595	5	125	0	1.54E+5	3.04E+6	Br	270	1	38	38.0	0.000501934
235-2-204	595	5	125	30	1.31E+5	3.31E+5	Br	270	0	38	41.6	0
235-2-204	595	5	125	45	1.13E+5	3.28E+5	Br	270	316	38	43.1	2.078970401
235-2-602	595	5	125	0	2.10E+5	3.05E+6	Br	270	68	38	38.0	0.034019595
235-2-603	595	5	125	0	1.90E+5	3.73E+5	Br	270	2806	38	38.0	11.47886384
235-2-603	595	5	125	30	1.67E+5	3.60E+5	Br	270	3808	38	41.6	18.63733779
235-2-603	595	5	125	45	1.41E+5	6.53E+5	Br	270	7578	38	43.1	25.04243106
235-2-603	595	5	125	45	1.38E+5	3.51E+5	Br	270	4676	38	43.1	28.74765692
235-2-702	595	5	125	0	1.79E+5	3.50E+5	Br	270	1173	38	38.0	5.113874163
235-2-702	595	5	125	30	1.51E+5	3.54E+5	Br	270	2274	38	41.6	11.31818103
235-2-702	595	5	125	45	1.28E+5	3.48E+5	Br	270	3297	38	43.1	20.44441887
237-7-302	630	4.5	80	45	7.97E+4	5.02E+6	Br	270	0	38	43.1	0
237-7-603	630	4.5	80	45	2.62E+5	5.10E+6	Br	270	0	38	43.1	0
237-7-603	630	4.5	80	45	5.03E+5	5.03E+6	Br	270	0	38	43.1	0
237-7-302	630	4.5	80	0	3.25E+5	6.07E+6	I	320	0	55	55.0	0
237-7-603	630	4.5	80	0	1.51E+5	6.04E+6	I	320	0	55	55.0	0
237-7-302	630	4.5	80	45	2.30E+5	6.06E+6	I	320	0	55	62.4	0
237-7-603	630	4.5	80	45	1.07E+5	5.04E+6	I	320	1	55	62.4	0.000428158
237-7-302	630	4.5	80	0	5.44E+4	1.00E+7	Au	332	24	65	65.0	0.003658451
237-7-302	630	4.5	80	0	7.14E+4	5.01E+7	Au	332	18	65	65.0	0.000548658
237-7-603	630	4.5	80	0	1.08E+5	5.03E+6	Au	332	26	65	65.0	0.007887247
237-7-603	630	4.5	80	0	1.07E+5	1.00E+7	Au	332	362	65	65.0	0.055236816
237-7-603	630	4.5	125	0	2.52E+5	5.09E+6	Ni	190	1	29	29.0	0.00029978
237-7-302	630	4.5	125	45	1.42E+5	5.05E+6	Ni	190	69	29	32.9	0.029484433
237-7-603	630	4.5	125	45	1.40E+5	5.06E+6	Ni	190	614	29	32.9	0.261850207
237-7-302	630	4.5	125	0	1.42E+5	5.04E+6	Br	270	953	38	38.0	0.288524325
237-7-603	630	4.5	125	0	2.86E+5	5.64E+5	Br	270	1145	38	38.0	3.097750616
237-7-302	630	4.5	125	30	1.22E+5	5.05E+6	Br	270	6757	38	41.6	2.357501504
237-7-603	630	4.5	125	30	2.84E+5	6.11E+5	Br	270	3607	38	41.6	10.40146159

lot-waf-die	Rmc kΩ	VDD V	Temp °C	Angle °	flux #/cm^2-s	fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross µm^2
237-7-302	630	4.5	125	45	8.17E+4	5.02E+6	Br	270	7249	38	43.1	3.116086105
237-7-603	630	4.5	125	45	2.57E+5	6.05E+5	Br	270	4585	38	43.1	16.35381319
237-7-302	630	4.5	125	0	2.95E+5	3.01E+5	I	320	2998	55	55.0	15.19795668
237-7-603	630	4.5	125	0	9.90E+4	2.32E+5	I	320	4717	55	55.0	31.02401207
237-7-302	630	4.5	125	45	2.02E+5	2.56E+5	I	320	2118	55	62.4	17.85340503
237-7-603	630	4.5	125	45	7.26E+4	2.24E+5	I	320	4379	55	62.4	42.18538277
237-7-302	630	4.5	125	0	1.54E+5	4.48E+5	Au	332	4751	65	65.0	16.17819836
237-7-302	630	5	125	0	2.09E+5	4.07E+6	Br	270	0	38	38.0	0
237-7-603	630	5	125	0	2.56E+5	3.08E+6	Br	270	0	38	38.0	0
237-7-302	630	5	125	45	1.47E+5	3.03E+6	Br	270	374	38	43.1	0.266356955
237-7-603	630	5	125	45	1.77E+5	3.05E+6	Br	270	5139	38	43.1	3.635916036
237-5-502	655	4.5	80	45	1.18E+5	5.64E+5	Br	270	0	38	43.1	0
237-5-502	655	4.5	80	45	5.05E+5	5.05E+6	Br	270	0	38	43.1	0
237-5-502	655	4.5	80	0	1.22E+5	6.04E+6	I	320	0	55	55.0	0
237-5-502	655	4.5	80	45	1.05E+5	6.03E+6	I	320	11	55	62.4	0.003936502
237-5-502	655	4.5	80	0	1.05E+5	1.00E+7	Au	332	0	65	65.0	0
237-5-502	655	4.5	80	0	1.06E+5	2.00E+7	Au	332	0	65	65.0	0
237-5-502	655	4.5	125	0	2.55E+5	5.06E+6	Ni	190	0	29	29.0	0
237-5-502	655	4.5	125	0	1.99E+5	5.80E+5	Br	270	3127	38	38.0	8.226591965
237-5-502	655	4.5	125	30	1.95E+5	5.69E+5	Br	270	4171	38	41.6	12.91568252
237-5-502	655	4.5	125	45	1.68E+5	5.52E+5	Br	270	4269	38	43.1	16.68868603
237-5-502	655	4.5	125	0	1.16E+5	2.48E+5	I	320	4948	55	55.0	30.44374527
237-5-502	655	4.5	125	45	8.40E+4	2.29E+5	I	320	4799	55	62.4	45.22205926
237-5-502	655	4.5	125	0	1.03E+5	2.81E+5	Au	332	6630	65	65.0	36.00205391
237-5-502	655	4.5	125	0	9.44E+4	2.21E+5	Au	332	3063	65	65.0	21.14826737
237-5-502	655	5	125	0	2.43E+5	3.06E+6	Br	270	8	38	38.0	0.003989226
237-5-502	655	5	125	45	1.77E+5	2.07E+6	Br	270	1177	38	43.1	1.226990456
237-1-302	661	4.5	80	0	1.25E+5	5.04E+6	Ni	190	0	29	29.0	0
237-1-302	661	4.5	80	0	3.82E+5	5.11E+6	Br	270	0	38	38.0	0
237-1-302	661	4.5	80	0	1.98E+5	6.07E+6	I	320	0	55	55.0	0
237-1-302	661	4.5	80	0	1.12E+5	1.00E+7	Au	332	0	65	65.0	0
237-1-302	661	4.5	125	0	1.21E+5	5.03E+6	Ni	190	0	29	29.0	0
237-1-302	661	4.5	125	0	3.80E+5	5.08E+6	Br	270	51	38	38.0	0.015318863
237-1-302	661	4.5	125	5	1.89E+5	2.64E+5	I	320	3675	55	55.2	21.32206485
237-1-302	661	4.5	125	0	1.04E+5	2.23E+5	Au	332	4014	65	65.0	27.46582031
237-8-206	662	3.5	80	0	6.45E+4	1.15E+5	Au	332	5353	65	65.0	71.02634596
237-8-206	662	4	80	0	7.71E+4	2.24E+5	Au	332	5365	65	65.0	36.5461622
237-8-206	662	4.5	80	0	3.48E+5	1.35E+7	I	320	0	55	55.0	0
237-8-206	662	4.5	80	0	5.03E+5	5.03E+6	Br	270	0	38	38.0	0
237-8-206	662	4.5	80	0	2.28E+4	5.06E+5	Au	332	0	65	65.0	0
237-8-206	662	4.5	80	0	2.25E+4	1.01E+6	Au	332	4	65	65.0	0.006061088
237-8-206	662	4.5	80	0	2.55E+4	3.10E+5	Au	332	4	65	65.0	0.019701471
237-8-206	662	4.5	80	0	2.09E+4	3.01E+6	Au	332	91	65	65.0	0.046192608
237-8-206	662	4.5	80	0	1.92E+4	6.01E+6	Au	332	485	65	65.0	0.123136651
237-8-206	662	4.5	80	0	4.30E+4	4.02E+6	Au	332	4429	65	65.0	1.6811238
237-8-206	662	4.5	80	0	4.30E+4	4.02E+6	Au	332	4429	65	65.0	1.6811238
237-8-206	662	4.5	80	45	4.66E+4	5.16E+5	Au	332	429	65	73.7	1.794083524
237-8-206	662	4.5	80	45	4.86E+4	2.01E+6	Au	332	1887	65	73.7	2.025866906
237-8-206	662	4.5	80	45	3.60E+4	1.11E+5	Au	332	122	65	73.7	2.371766437
237-8-206	662	4.5	80	45	3.16E+4	6.20E+4	Au	332	103	65	73.7	3.58492936
237-8-206	662	4.5	125	0	2.14E+5	5.04E+6	Ni	190	0	29	29.0	0
237-8-206	662	4.5	125	0	5.03E+5	5.03E+6	Br	270	2287	38	38.0	0.693774366
237-8-206	662	4.5	125	0	2.80E+5	6.05E+5	Br	270	594	38	38.0	1.498135653
237-8-206	662	4.5	125	0	2.62E+5	1.68E+5	Br	270	211	38	38.0	1.916431245
237-8-206	662	4.5	125	0	2.46E+5	3.10E+6	Br	270	4227	38	38.0	2.080609722

lot-waf-die	Rmc kΩ	VDD V	Temp °C	Angle °	flux #/cm^2-s	fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross µm^2
237-8-206	662	4.5	125	0	3.24E+5	8.08E+6	I	320	31336	55	55.0	5.917690768
237-8-206	662	4.5	125	0	3.08E+5	1.07E+6	I	320	15246	55	55.0	21.74163533
237-8-206	662	4.5	125	0	2.79E+5	1.08E+6	I	320	15247	55	55.0	21.54173674
237-8-206	662	4.5	125	0	2.27E+5	2.74E+5	I	320	5262	55	55.0	29.30355768
237-8-206	662	4.5	125	0	1.08E+5	4.04E+6	Au	332	30324	65	65.0	11.45315642
237-8-206	662	4.5	125	0	1.09E+5	1.04E+6	Au	332	17788	65	65.0	26.09839806
237-8-206	662	4.5	125	0	1.08E+5	4.36E+5	Au	332	9983	65	65.0	34.93772734
237-8-206	662	4.5	125	0	1.02E+5	2.38E+5	Au	332	6282	65	65.0	40.27550962
237-8-206	662	4.5	125	0	4.18E+4	1.14E+5	Au	332	5800	65	65.0	77.63243558
237-8-206	662	4.5	125	45	3.53E+4	8.92E+4	Au	332	4585	65	73.7	110.9199213
237-8-206	662	5	80	0	1.03E+5	4.03E+6	Au	332	0	65	65.0	0
237-8-206	662	5	80	0	1.03E+5	4.03E+6	Au	332	0	65	65.0	0
237-8-206	662	5	80	45	3.56E+4	3.01E+6	Au	332	2	65	73.7	0.001433833
237-8-206	662	5	125	0	2.70E+5	3.09E+6	Br	270	0	38	38.0	0
237-8-206	662	5	125	0	1.01E+4	1.02E+5	Au	332	3711	65	65.0	55.51506491
237-8-206	662	5	125	45	4.45E+4	5.13E+5	Au	332	13206	65	73.7	55.55063082
237-8-206	662	5	125	45	3.75E+4	2.15E+5	Au	332	6822	65	73.7	68.47126041
237-8-206	662	5.5	125	0	1.15E+4	2.03E+5	Au	332	4210	65	65.0	31.64507485
237-6-202	663	4.5	80	45	1.32E+5	5.36E+5	Br	270	0	38	43.1	0
237-6-202	663	4.5	80	45	5.05E+5	5.02E+6	Br	270	0	38	43.1	0
237-6-202	663	4.5	80	0	9.20E+4	6.04E+6	I	320	0	55	55.0	0
237-6-202	663	4.5	80	45	7.08E+4	6.03E+6	I	320	0	55	62.4	0
237-6-202	663	4.5	80	0	9.13E+4	2.00E+7	Au	332	0	65	65.0	0
237-6-202	663	4.5	125	0	2.43E+5	5.09E+6	Ni	190	0	29	29.0	0
237-6-202	663	5	125	0	2.37E+5	3.07E+6	Br	270	0	38	38.0	0
237-6-202	663	5	125	45	1.66E+5	2.06E+6	Br	270	25	38	43.1	0.026188333
237-6-202	663	4.5	125	0	1.54E+5	5.04E+6	Br	270	120	38	38.0	0.03633045
237-6-202	663	4.5	125	0	1.61E+5	2.03E+6	Br	270	63	38	38.0	0.047354863
237-6-202	663	4.5	125	30	1.44E+5	1.05E+6	Br	270	733	38	41.6	1.229997173
237-6-202	663	4.5	125	45	1.30E+5	5.50E+5	Br	270	840	38	43.1	3.295730292
237-6-202	663	4.5	125	45	1.55E+5	5.38E+5	Br	270	1439	38	43.1	5.771830722
237-6-202	663	4.5	125	0	8.53E+4	2.31E+5	I	320	3237	55	55.0	21.3821213
237-6-202	663	4.5	125	0	6.94E+4	2.28E+5	Au	332	4017	65	65.0	26.91899678
237-6-202	663	4.5	125	45	5.96E+4	2.18E+5	I	320	3131	55	62.4	30.99285905
237-3-301	684	4.5	80	0	1.52E+5	6.01E+6	I	320	0	55	55.0	0
237-3-301	684	4.5	80	45	8.41E+5	6.02E+6	I	320	0	55	62.4	0
237-3-301	684	4.5	80	0	1.11E+5	1.00E+7	Au	332	0	65	65.0	0
237-3-302	684	4.5	80	45	9.75E+4	5.03E+6	Ni	190	0	29	32.9	0
237-3-302	684	4.5	80	45	2.65E+5	5.10E+6	Br	270	0	38	43.1	0
237-3-302	684	4.5	80	5	2.03E+5	6.07E+6	I	320	0	55	55.2	0
237-3-302	684	4.5	80	45	1.44E+5	6.05E+6	I	320	0	55	62.4	0
237-3-302	684	4.5	80	0	9.78E+4	1.00E+7	Au	332	0	65	65.0	0
237-3-302	684	4.5	80	45	6.58E+4	1.00E+7	Au	332	0	65	73.7	0
237-3-803	684	4.5	80	45	1.18E+5	5.03E+6	Ni	190	0	29	32.9	0
237-3-803	684	4.5	80	45	1.95E+5	5.06E+6	Br	270	0	38	43.1	0
237-3-803	684	4.5	80	0	1.92E+4	5.01E+6	I	320	0	55	55.0	0
237-3-803	684	4.5	80	45	2.22E+5	6.05E+6	I	320	0	55	62.4	0
237-3-803	684	4.5	80	0	9.75E+4	1.00E+7	Au	332	0	65	65.0	0
237-3-301	684	4.5	125	0	1.78E+5	5.04E+6	Ni	190	1	29	29.0	0.000302754
237-3-301	684	4.5	125	30	1.38E+5	5.05E+6	Ni	190	13	29	31.7	0.00453567
237-3-301	684	4.5	125	30	1.46E+5	5.04E+6	Ni	190	12	29	31.7	0.004195079
237-3-301	684	4.5	125	45	1.27E+5	5.04E+6	Ni	190	4932	29	32.9	2.11167753
237-3-301	684	4.5	125	45	1.32E+5	5.05E+6	Ni	190	2118	29	32.9	0.905043899
237-3-302	684	4.5	125	45	8.94E+4	5.02E+6	Ni	190	0	29	32.9	0
237-3-803	684	4.5	125	45	1.42E+5	5.05E+6	Ni	190	0	29	32.9	0
237-3-301	684	4.5	125	0	2.97E+5	5.09E+6	Br	270	3125	38	38.0	0.936811706

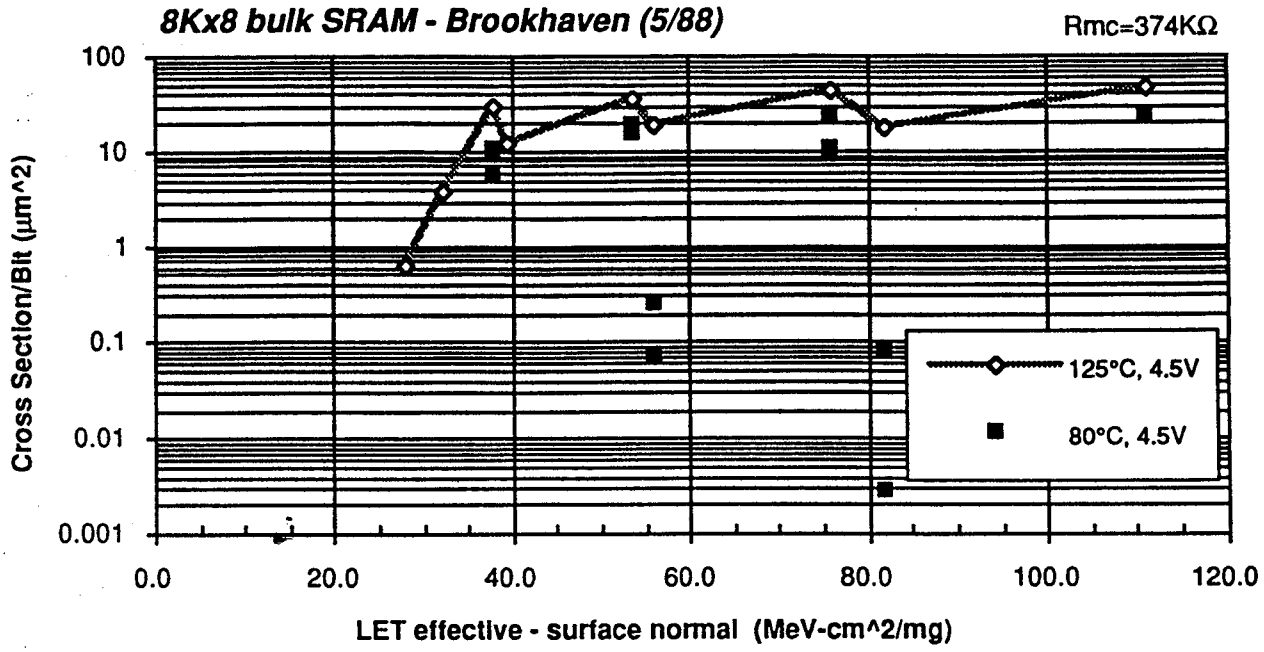
lot-waf-die	Rmc kΩ	VDD V	Temp °C	Angle °	flux #/cm^2-s	fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross µm^2
237-3-803	684	4.5	125	0	1.04E+5	5.03E+6	Br	270	177	38	38.0	0.05369395
237-3-301	684	4.5	125	30	2.77E+5	5.07E+6	Br	270	3197	38	41.6	1.111025724
237-3-803	684	4.5	125	30	1.06E+5	5.03E+6	Br	270	3528	38	41.6	1.235805231
237-3-301	684	4.5	125	45	2.53E+5	5.07E+6	Br	270	2448	38	43.1	1.041929949
237-3-302	684	4.5	125	45	2.66E+5	5.75E+5	Br	270	0	38	43.1	0
237-3-302	684	4.5	125	45	2.78E+5	3.09E+6	Br	270	27	38	43.1	0.0188556
237-3-302	684	4.5	125	45	2.83E+5	5.08E+6	Br	270	489	38	43.1	0.207720909
237-3-803	684	4.5	125	45	6.95E+4	3.02E+6	Br	270	7028	38	43.1	5.021805374
237-3-803	684	4.5	125	45	1.33E+5	5.03E+6	Br	270	3342	38	43.1	1.43375032
237-3-803	684	4.5	125	45	6.66E+4	2.02E+6	Br	270	5640	38	43.1	6.025079778
237-3-301	684	4.5	125	0	2.58E+4	3.08E+5	I	320	4169	55	55.0	20.65386091
237-3-302	684	4.5	125	0	2.29E+4	1.56E+6	I	320	3604	55	55.0	3.525171524
237-3-803	684	4.5	125	0	3.01E+5	4.18E+5	I	320	5207	55	55.0	19.00777862
237-3-301	684	4.5	125	45	5.38E+4	3.01E+6	I	320	22471	55	62.4	16.10983051
237-3-301	684	4.5	125	45	3.22E+4	5.08E+5	I	320	6846	55	62.4	29.08092723
237-3-302	684	4.5	125	45	1.39E+5	2.45E+6	I	320	0	55	62.4	0
237-3-302	684	4.5	125	45	1.45E+5	1.03E+6	I	320	46	55	62.4	0.096373066
237-3-302	684	4.5	125	45	1.50E+5	5.05E+6	I	320	3443	55	62.4	1.471230473
237-3-803	684	4.5	125	45	2.14E+5	3.80E+5	I	320	3422	55	62.4	19.43262526
237-3-301	684	4.5	125	0	1.05E+5	5.25E+5	Au	332	5629	65	65.0	16.36032831
237-3-302	684	4.5	125	0	8.61E+4	1.02E+6	Au	332	7648	65	65.0	11.44109988
237-3-302	684	4.5	125	0	8.20E+4	7.20E+5	Au	332	7778	65	65.0	16.48373074
237-3-302	684	4.5	125	0	8.29E+4	2.25E+5	Au	332	80	65	65.0	0.542534722
237-3-302	684	4.5	125	0	7.92E+4	5.30E+5	Au	332	5989	65	65.0	17.24243164
237-3-803	684	4.5	125	0	1.05E+5	5.42E+5	Au	332	5586	65	65.0	15.72612467
237-3-302	684	4.5	125	45	5.27E+4	5.13E+5	Au	332	4016	65	73.7	16.89647353
237-3-803	684	4.5	125	45	5.02E+4	5.17E+5	Au	332	5630	65	73.7	23.48556343
237-3-301	684	5	125	45	8.11E+4	4.02E+6	Br	270	0	38	43.1	0
237-3-301	684	5	125	45	8.01E+4	3.02E+6	Br	270	2	38	43.1	0.001429085
237-3-302	684	5	125	0	1.23E+5	4.04E+6	Br	270	0	38	38.0	0
237-3-302	684	5	125	45	9.39E+4	4.02E+6	Br	270	2	38	43.1	0.001073591
237-3-803	684	5	125	0	1.05E+5	3.04E+6	Br	270	0	38	38.0	0
237-3-803	684	5	125	45	7.16E+4	4.02E+6	Br	270	29	38	43.1	0.015567075
237-4-306	695	3	80	0	8.54E+4	1.35E+5	Au	332	5623	65	65.0	63.55568215
237-4-306	695	3.5	80	0	8.60E+4	5.27E+5	Au	332	8432	65	65.0	24.4140625
237-4-306	695	3.5	80	0	8.48E+4	2.27E+5	Au	332	3566	65	65.0	23.97041489
237-4-306	695	4	80	0	8.23E+4	5.20E+5	Au	332	20	65	65.0	0.05868765
237-4-306	695	4	80	0	9.28E+4	2.03E+6	Au	332	139	65	65.0	0.104481364
237-4-306	695	4.5	80	0	8.98E+4	3.03E+6	Au	332	0	65	65.0	0
237-4-306	695	4.5	80	0	7.21E+4	6.02E+6	I	320	0	55	55.0	0
237-4-306	695	4.5	80	45	4.81E+5	6.01E+6	I	320	0	55	62.4	0
237-4-306	695	4.5	80	0	1.12E+5	5.00E+7	Au	332	0	65	65.0	0
237-4-306	695	4.5	80	0	8.98E+4	3.03E+6	Au	332	0	65	65.0	0
237-4-306	695	4.5	125	0	2.39E+5	5.06E+6	Ni	190	0	29	29.0	0
237-4-306	695	4.5	125	30	2.18E+5	5.08E+6	Ni	190	0	29	31.7	0
237-4-306	695	4.5	125	45	1.75E+5	5.04E+6	Ni	190	0	29	32.9	0
237-4-306	695	4.5	125	0	5.06E+5	5.03E+6	Br	270	130	38	38.0	0.039436234
237-4-306	695	4.5	125	30	3.03E+6	3.03E+6	Br	270	949	38	41.6	0.551839803
237-4-306	695	4.5	125	45	1.03E+6	1.03E+6	Br	270	1924	38	43.1	4.030908224
237-4-306	695	4.5	125	45	1.58E+5	1.03E+6	Br	270	1940	38	43.1	4.06442929
237-4-306	695	4.5	125	0	5.25E+4	2.22E+5	I	320	2882	55	55.0	19.80893247
237-4-306	695	4.5	125	45	3.96E+4	2.12E+5	I	320	2859	55	62.4	29.10136511
237-4-306	695	4.5	125	0	1.00E+5	2.34E+5	Au	332	3271	65	65.0	21.37537431
237-4-306	695	5	80	0	8.39E+4	2.27E+5	Au	332	0	65	65.0	0
237-4-306	695	5	80	0	6.25E+4	3.02E+6	Au	332	0	65	65.0	0
237-4-306	695	5	80	0	8.39E+4	2.27E+5	Au	332	0	65	65.0	0
237-4-306	695	5	125	45	1.65E+5	3.05E+6	Br	270	0	38	43.1	0

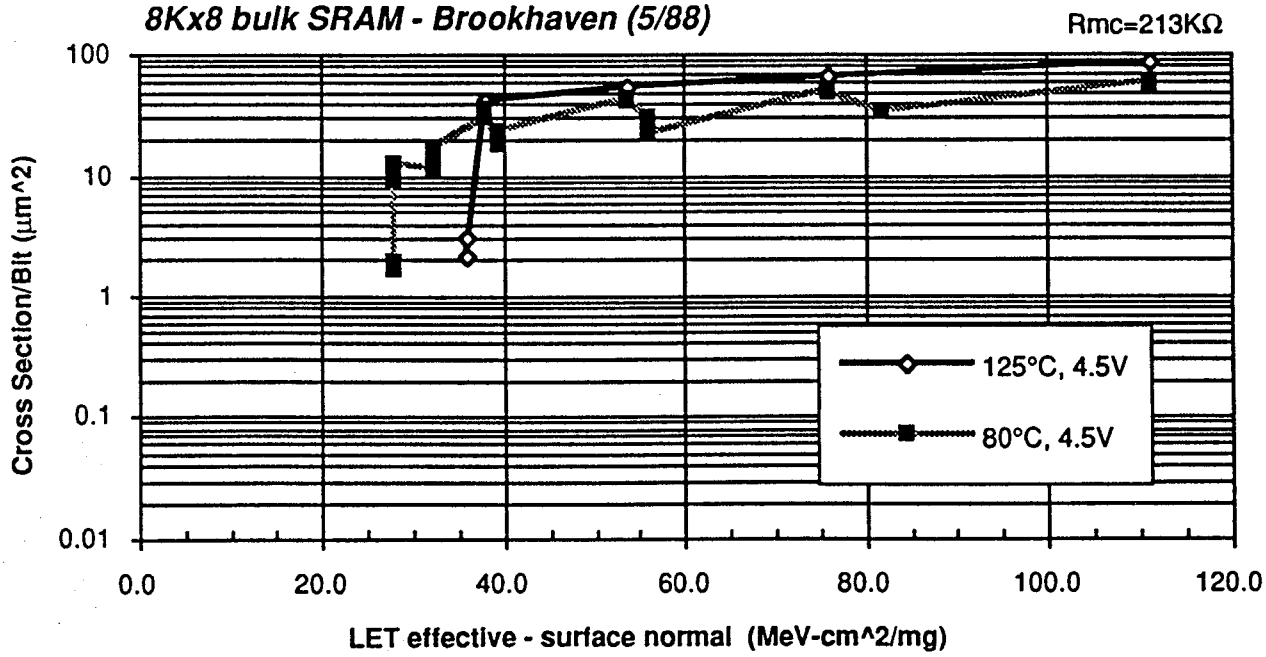
lot-waf-die	Rmc kΩ	VDD V	Temp °C	Angle °	flux #/cm^2-s	fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross µm^2
221-19-104	821	4.5	80	0	9.86E+3	1.03E+5	Au	306	1200	65	65.0	17.77722998
221-19-104	821	4.5	80	45	7.70E+3	1.03E+5	Au	306	283	65	73.7	5.929038604
221-19-404	821	4.5	80	30	1.91E+4	1.06E+5	Au	306	33	65	71.1	0.548526372
221-19-404	821	4.5	80	45	1.60E+4	1.04E+5	Au	306	0	65	73.7	0
221-19-404	821	4.5	80	45	1.51E+4	1.04E+5	Au	306	0	65	73.7	0
221-19-404	821	4.5	80	45	1.42E+4	1.01E+6	Au	306	10	65	73.7	0.021365531
221-19-104	821	4.5	125	0	2.55E+4	1.08E+5	Au	306	3185	65	65.0	44.99929923
221-19-104	821	4.5	125	30	2.25E+4	1.08E+5	Au	306	3262	65	71.1	53.21690815
221-19-104	821	4.5	125	45	2.10E+4	5.01E+6	Au	306	30697	65	73.7	13.22188196
221-19-104	821	4.5	125	45	1.95E+4	5.07E+5	Au	306	11786	65	73.7	50.16416003
221-19-104	821	4.5	125	45	1.82E+4	1.01E+5	Au	306	3138	65	73.7	67.04503667
221-19-404	821	4.5	125	0	1.60E+4	1.04E+5	Au	306	2704	65	65.0	39.67285156
221-19-404	821	4.5	125	30	1.40E+4	1.04E+5	Au	306	2775	65	71.1	47.0131213
221-19-404	821	4.5	125	45	1.20E+4	1.05E+5	Au	306	2538	65	73.7	52.15997636
221-19-404	821	5	25	0	5.81E+4	1.14E+5	Au	332	0	65	65.0	0
221-19-404	821	5	25	0	5.66E+4	5.02E+6	Au	332	0	65	65.0	0
221-19-104	821	5	125	0	2.34E+4	1.08E+5	Au	306	2409	65	65.0	34.03557671
221-19-104	821	5	125	30	2.07E+4	1.07E+5	Au	306	2647	65	71.1	43.58726323
221-19-104	821	5	125	45	1.73E+4	1.05E+5	Au	306	2470	65	73.7	50.76246714
221-19-404	821	5	125	0	1.48E+3	1.05E+5	Au	306	1969	65	65.0	28.61386254
221-19-404	821	5	125	45	9.21E+3	1.03E+5	Au	306	1832	65	73.7	38.38162093
236-2-506	1050	2	80	0	1.01E+5	1.40E+5	Au	332	6052	65	65.0	65.96156529
236-2-506	1050	2.5	80	0	1.19E+5	4.38E+5	Au	332	5449	65	65.0	18.98290904
236-2-506	1050	3	80	0	7.91E+4	3.02E+6	Au	332	62	65	65.0	0.031325991
236-2-506	1050	3.5	125	0	9.85E+4	1.38E+5	Au	332	5530	65	65.0	61.14572719
236-2-506	1050	4	125	0	9.79E+4	2.28E+5	Au	332	4010	65	65.0	26.83672989
236-2-506	1050	4.25	125	0	9.19E+4	2.33E+5	Au	332	1708	65	65.0	11.18541275
236-2-506	1050	4.5	125	0	1.18E+5	4.04E+6	Au	332	0	65	65.0	0
236-2-506	1050	4.5	125	45	8.22E+4	2.00E+7	Au	332	0	65	73.7	0
236-4-307	1120	4.5	125	0	1.26E+5	2.05E+6	Au	332	0	65	65.0	0
234-9-606	1170	2	80	0	1.39E+5	1.42E+5	Au	332	5414	65	65.0	58.17681971
234-9-606	1170	2.25	80	0	1.38E+5	2.44E+5	Au	332	7453	65	65.0	46.60809626
234-9-606	1170	2.25	80	0	1.28E+5	1.31E+5	Au	332	4702	65	65.0	54.7685696
234-9-606	1170	2.5	80	0	1.51E+5	5.56E+5	Au	332	5112	65	65.0	14.0293039
234-9-606	1170	2.75	80	0	1.47E+5	6.50E+5	Au	332	2638	65	65.0	6.192720853
234-9-606	1170	3	80	0	1.66E+5	4.05E+6	Au	332	657	65	65.0	0.247531467
234-9-606	1170	3.5	125	0	1.02E+5	1.23E+5	Au	332	4413	65	65.0	54.74555783
234-9-606	1170	3.75	125	0	9.58E+4	1.34E+5	Au	332	3389	65	65.0	38.59107174
234-9-606	1170	4	125	0	1.33E+5	5.41E+5	Au	332	7148	65	65.0	20.16078082
234-9-606	1170	4	125	0	1.23E+5	2.41E+5	Au	332	2109	65	65.0	13.35302329
234-9-606	1170	4.25	125	0	9.43E+4	3.27E+5	Au	332	1087	65	65.0	5.072264132
234-9-606	1170	4.5	80	0	1.66E+5	4.04E+6	Au	332	0	65	65.0	0
234-9-606	1170	4.5	125	0	1.53E+5	4.06E+6	Au	332	123	65	65.0	0.046227366
234-9-606	1170	4.5	125	0	9.62E+4	5.36E+5	Au	332	0	65	65.0	0
234-9-606	1170	4.5	125	0	9.61E+4	2.03E+6	Au	332	0	65	65.0	0
234-9-606	1170	4.5	125	0	9.81E+4	2.00E+7	Au	332	0	65	65.0	0
234-9-606	1170	4.5	125	0	1.53E+5	4.06E+6	Au	332	123	65	65.0	0.046227366
234-7-205	1400	2	80	0	9.24E+4	1.02E+6	Au	332	18044	65	65.0	26.99309704
234-7-205	1400	2	80	0	8.30E+4	3.20E+5	Au	332	10101	65	65.0	48.16532135
234-7-205	1400	2	80	0	6.73E+4	1.20E+5	Au	332	5036	65	65.0	64.03605143
234-7-205	1400	2.25	80	0	6.52E+4	1.16E+5	Au	332	3441	65	65.0	45.26335618
234-7-205	1400	2.5	80	0	7.73E+4	6.35E+5	Au	332	5880	65	65.0	14.12939838
234-7-205	1400	2.75	80	0	7.29E+4	6.20E+5	Au	332	1165	65	65.0	2.867175687

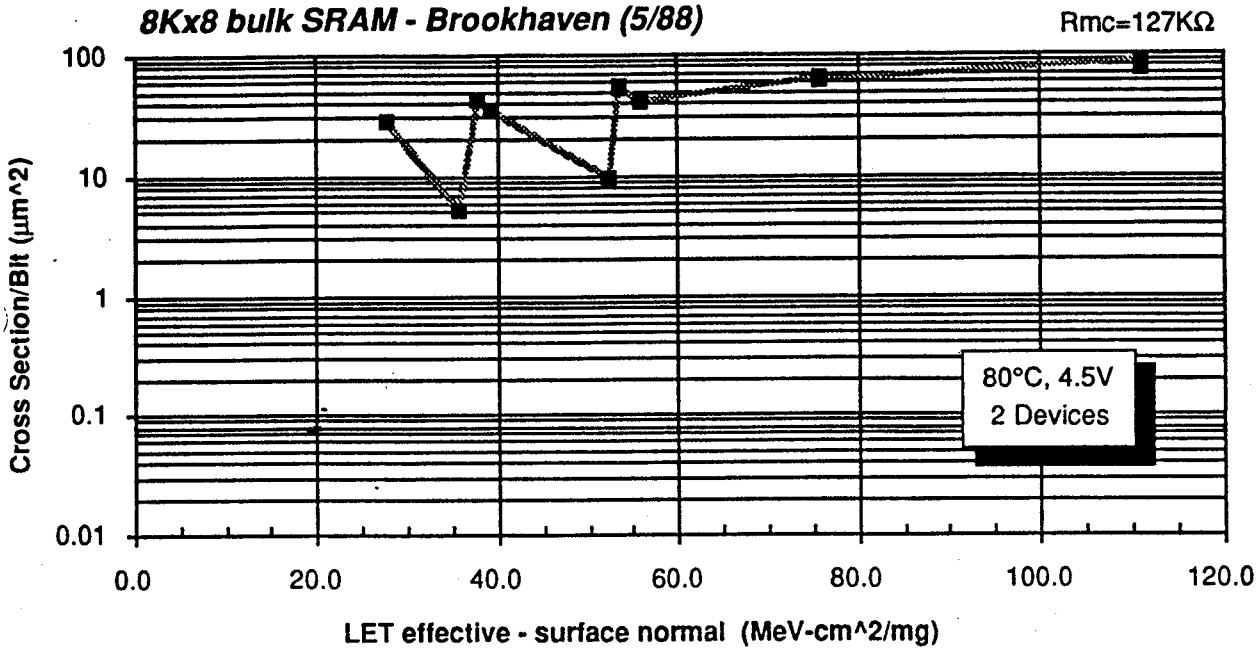
lot-waf-die	Rmc kΩ	VDD V	Temp °C	Angle °	flux #/cm^2-s	fluence #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross µm^2
234-7-205	1400	3	80	0	8.76E+4	4.03E+6	Au	332	25	65	65.0	0.00946575
234-7-205	1400	3.5	125	0	4.92E+4	1.15E+5	Au	332	4852	65	65.0	64.37882133
234-7-205	1400	4	125	0	5.52E+4	2.22E+5	Au	332	2917	65	65.0	20.04949896
234-7-205	1400	4.25	125	0	4.60E+4	3.16E+5	Au	332	2002	65	65.0	9.667118893
234-7-205	1400	4.5	80	0	8.69E+4	4.03E+6	Au	332	0	65	65.0	0
234-7-205	1400	4.5	125	0	5.50E+4	2.02E+6	Au	332	0	65	65.0	0
234-7-205	1400	4.5	125	0	6.81E+4	3.02E+6	Au	332	24	65	65.0	0.01212619

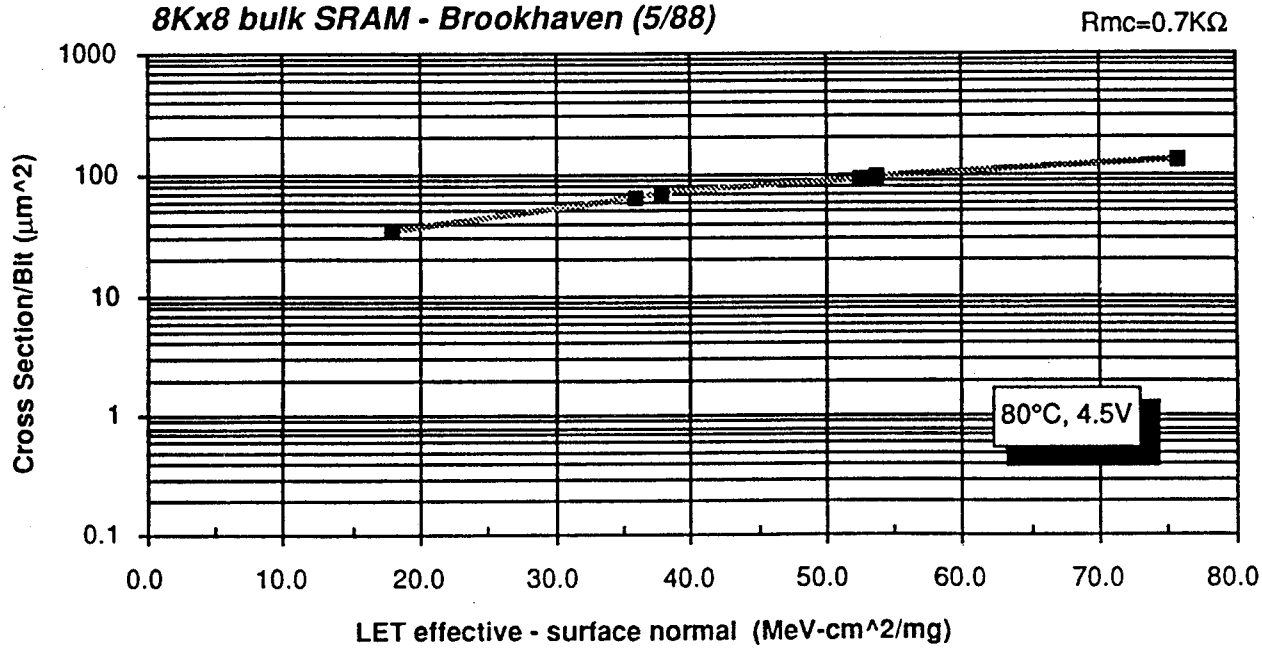
Technical Note

8K x 8 RADIATION-HARDENED SRAM - HC6364 SEU DATA






8Kx8 bulk SRAM - Brookhaven (5/88)
Rmc=127KΩ
Cross Section/Bit (μm^2)
100
10
1
0.1
0.01
0.0
20.0
40.0
60.0
80.0
100.0
120.0
80°C, 4.5V
2 Devices
LET effective - surface normal (MeV-cm^2/mg)


8Kx8 bulk SRAM - Brookhaven (5/88)
Rmc=0.7KΩ
Cross Section/Bit (μm^2)
1000
100
10
1
0.1
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
80°C, 4.5V
LET effective - surface normal (MeV-cm^2/mg)

lot-waf-die	Rmc kΩ	VDD V	Temp °C	Angle °	Fluence #/cm^2	Ion	MeV	No. of Upsets	LET eff	Cross µm^2
5-15-203	0.7	4.5	25	0	9.59E+04	Cl	105	2243	18.0	35.68870059
5-15-203	0.7	4.5	25	60	1.06E+05	Cl	105	2154	36.0	62.01402196
5-15-203	0.7	4.5	25	70	1.00E+05	Cl	105	2039	52.6	90.96736407
5-15-203	0.7	4.5	25	0	1.30E+05	Br	260	5498	38.0	64.5329402
5-15-203	0.7	4.5	25	0	1.16E+05	Br	260	4993	38.0	65.67856361
5-15-203	0.7	4.5	25	45	1.07E+05	Br	260	4531	53.7	91.3787792
5-15-203	0.7	4.5	25	60	1.16E+05	Br	260	4601	76.0	121.0442905
5-15-203	0.7	4.5	25	70	1.00E+05	Br	260	3300	111.1	147.2252582
5-15-203	0.7	4.5	80	0	1.01E+05	Cl	105	2218	18.0	33.50890509
5-15-203	0.7	4.5	80	60	1.02E+05	Cl	105	2139	36.0	63.99715648
5-15-203	0.7	4.5	80	0	1.02E+05	Br	260	4734	38.0	70.81873277
5-15-203	0.7	4.5	80	70	1.02E+05	Cl	105	2082	52.6	91.06446451
5-15-203	0.7	4.5	80	45	1.02E+05	Br	260	4505	53.7	95.30807343
5-15-203	0.7	4.5	80	60	9.80E+04	Br	260	4073	76.0	126.8347915
5-15-203	0.7	5	25	0	1.01E+05	Cl	105	2060	18.0	31.1218866
5-15-203	0.7	5	25	60	1.01E+05	Cl	105	1696	36.0	51.24535891
5-15-203	0.7	5	80	0	1.02E+05	Cl	105	1998	18.0	29.88927505
3-4-805	127	4.5	25	0	1.02E+05	Cl	105	0	18.0	0
3-4-805	127	4.5	25	60	1.02E+05	Cl	105	0	36.0	0
3-4-805	127	4.5	25	70	1.01E+05	Cl	105	0	52.6	0
3-4-805	127	4.5	25	0	2.01E+05	Fe	150	105	28.0	0.797100921
3-4-804	127	4.5	25	0	1.00E+05	Br	260	1790	38.0	27.31323242
3-4-804	127	4.5	25	45	1.01E+05	Br	260	1641	53.7	35.06083658
3-4-804	127	4.5	25	60	1.01E+05	Br	260	1390	76.0	41.9994392
3-4-804	127	4.5	25	70	1.01E+05	Br	260	1179	111.1	52.0787817
3-4-805	127	4.5	25	0	1.04E+05	Br	260	2113	38.0	31.00175124
3-4-805	127	4.5	25	45	1.06E+05	Br	260	1775	53.7	36.13495842
3-4-805	127	4.5	25	60	1.08E+05	Br	260	1296	76.0	36.62109375
3-4-805	127	4.5	25	70	1.02E+05	Br	260	917	111.1	40.10860421
3-4-805	127	4.5	80	0	1.01E+05	Cl	105	0	18.0	0
3-4-805	127	4.5	80	0	1.01E+05	Fe	150	1844	28.0	27.85862082
3-4-805	127	4.5	80	60	1.04E+05	Cl	105	171	36.0	5.017794096
3-4-804	127	4.5	80	0	9.98E+04	Br	260	2775	38.0	42.42799564
3-4-805	127	4.5	80	0	1.04E+05	Br	260	2829	38.0	41.50684063
3-4-805	127	4.5	80	45	1.00E+05	Fe	150	1589	39.6	34.28932725
3-4-805	127	4.5	80	70	1.04E+05	Cl	105	225	52.6	9.652005563
3-4-804	127	4.5	80	45	9.94E+04	Br	260	2450	53.7	53.18813559
3-4-805	127	4.5	80	45	1.02E+05	Br	260	2436	53.7	51.53617467
3-4-805	127	4.5	80	60	1.00E+05	Fe	150	1331	56.0	40.61889648
3-4-804	127	4.5	80	60	9.97E+04	Br	260	2078	76.0	63.60634638
3-4-805	127	4.5	80	60	9.10E+04	Br	260	1806	76.0	60.56565505
3-4-804	127	4.5	80	70	9.94E+04	Br	260	1909	111.1	85.6816712
3-4-805	127	4.5	80	70	1.02E+05	Br	260	1721	111.1	75.27470866
3-4-805	127	4.5	125	0	1.04E+05	Cl	105	121	18.0	1.77530142
3-4-805	127	4.5	125	60	1.05E+05	Cl	105	817	36.0	23.74558222
3-4-805	127	4.5	125	0	1.00E+05	Br	260	2919	38.0	44.54040527
3-4-805	127	4.5	125	45	1.04E+05	Br	260	2707	53.7	56.16813239
3-4-805	127	4.5	125	60	1.03E+05	Br	260	2644	76.0	78.33832676
3-4-805	127	4.5	125	70	1.03E+05	Br	260	2402	111.1	104.040915
3-4-804	127	5	25	0	1.00E+05	Br	260	841	38.0	12.8326416
3-4-804	127	5	25	45	1.01E+05	Br	260	1246	53.7	26.62145178
3-4-804	127	5	25	60	9.90E+04	Br	260	1055	76.0	32.5212575
3-4-805	127	5	80	0	1.04E+05	Cl	105	0	18.0	0
3-4-805	127	5	80	60	1.05E+05	Cl	105	0	36.0	0
3-4-804	127	5	80	0	9.98E+04	Br	260	2401	38.0	36.70977208
3-4-804	127	5	80	60	1.00E+05	Br	260	1890	76.0	57.67822266

lot-waf-die	Rmc kΩ	VDD V	Temp °C	Angle °	Fluence #/cm^2	Ion	MeV	No. of Upsets	LET eff	Cross µm^2
3-4-805	127	5	80	0	1.04E+05	Br	260	2498	38.0	36.65043758
3-4-805	127	5	80	45	1.04E+05	Br	260	2121	53.7	44.0090908
3-4-805	127	5	80	60	1.04E+05	Br	260	1809	76.0	53.08297964
3-4-805	127	5	80	70	1.02E+05	Br	260	1523	111.1	66.61439935
3-4-805	127	5	125	0	1.03E+05	Br	260	2658	38.0	39.3765644
3-4-805	127	5	125	60	1.04E+05	Br	260	2242	76.0	65.78885592

4-10-106	213	4.5	25	0	1.02E+05	Cl	105	0	18.0	0
4-10-106	213	4.5	25	70	1.02E+05	Cl	105	0	52.6	0
4-10-106	213	4.5	25	0	1.00E+05	Fe	150	0	28.0	0
4-10-504	213	4.5	25	0	1.00E+05	Fe	150	0	28.0	0
4-10-106	213	4.5	25	0	1.04E+05	Br	260	946	38.0	13.87962928
4-10-106	213	4.5	25	45	1.05E+05	Br	260	1227	53.7	25.21682072
4-10-106	213	4.5	25	60	1.04E+05	Br	260	1014	76.0	29.75463867
4-10-106	213	4.5	25	70	1.05E+05	Br	260	664	111.1	28.21286333
4-10-504	213	4.5	25	0	9.80E+04	Br	260	580	38.0	9.030711894
4-10-504	213	4.5	25	45	9.04E+04	Br	260	662	53.7	15.80245732
4-10-504	213	4.5	25	60	9.70E+04	Br	260	455	76.0	14.31494644
4-10-504	213	4.5	25	70	9.80E+04	Br	260	343	111.1	15.61480011
4-10-106	213	4.5	80	70	1.04E+05	Cl	105	65	52.6	2.788357163
4-10-106	213	4.5	80	0	1.03E+05	Cl	105	0	18.0	0
4-10-504	213	4.5	80	0	4.00E+05	Fe	150	424	28.0	1.617431641
4-10-504	213	4.5	80	0	1.01E+05	Fe	150	127	28.0	1.918679417
4-10-106	213	4.5	80	0	4.00E+05	Fe	150	2450	28.0	9.346008301
4-10-106	213	4.5	80	0	1.00E+05	Fe	150	708	28.0	10.80322266
4-10-602	213	4.5	80	0	4.00E+05	Fe	150	3386	28.0	12.91656494
4-10-504	213	4.5	80	30	4.00E+05	Fe	150	2608	32.3	11.48780443
4-10-106	213	4.5	80	30	4.00E+05	Fe	150	2984	32.3	13.14402163
4-10-602	213	4.5	80	30	4.00E+05	Fe	150	4000	32.3	17.61933195
4-10-504	213	4.5	80	0	9.90E+04	Br	260	1955	38.0	30.13225517
4-10-106	213	4.5	80	0	9.65E+04	Br	260	2158	38.0	34.12276352
4-10-602	213	4.5	80	0	9.91E+04	Br	260	2291	38.0	35.27536402
4-10-504	213	4.5	80	45	1.00E+05	Fe	150	838	39.6	18.08335823
4-10-106	213	4.5	80	45	4.00E+05	Fe	150	3334	39.6	17.9862519
4-10-106	213	4.5	80	45	1.00E+05	Fe	150	936	39.6	20.19811851
4-10-504	213	4.5	80	45	4.00E+05	Fe	150	3864	39.6	20.8454941
4-10-602	213	4.5	80	45	4.00E+05	Fe	150	4424	39.6	23.8665802
4-10-602	213	4.5	80	45	9.87E+04	Br	260	1983	53.7	43.35514357
4-10-504	213	4.5	80	45	9.89E+04	Br	260	1934	53.7	42.19832818
4-10-602	213	4.5	80	60	4.00E+05	Fe	150	4033	56.0	30.76934814
4-10-504	213	4.5	80	60	4.00E+05	Fe	150	3538	56.0	26.99279785
4-10-106	213	4.5	80	60	1.00E+05	Fe	150	821	56.0	25.05493164
4-10-504	213	4.5	80	60	1.01E+05	Fe	150	756	56.0	22.84286046
4-10-106	213	4.5	80	60	9.73E+04	Br	260	1663	76.0	52.15902613
4-10-602	213	4.5	80	60	9.95E+04	Br	260	1610	76.0	49.38020179
4-10-504	213	4.5	80	60	9.87E+04	Br	260	1588	76.0	49.10021688
4-10-602	213	4.5	80	70	3.99E+05	Fe	150	3070	81.9	34.32684306
4-10-602	213	4.5	80	70	9.98E+04	Br	260	1323	111.1	59.14222888
4-10-504	213	4.5	80	70	1.04E+05	Br	260	1235	111.1	52.97878609
4-10-504	213	4.5	80	60	1.03E+05	Cl	105	0	36.0	0
4-10-106	213	4.5	125	0	1.02E+05	Cl	105	0	18.0	0
4-10-504	213	4.5	125	0	1.02E+05	Cl	105	0	18.0	0
4-10-504	213	4.5	125	60	1.03E+05	Cl	105	104	36.0	3.081386529
4-10-106	213	4.5	125	60	1.02E+05	Cl	105	70	36.0	2.094343597
4-10-106	213	4.5	125	0	9.65E+04	Br	260	2621	38.0	41.44381983
4-10-106	213	4.5	125	45	9.71E+04	Br	260	2459	53.7	54.64801179
4-10-106	213	4.5	125	60	9.63E+04	Br	260	2110	76.0	66.86613691
4-10-106	213	4.5	125	70	9.63E+04	Br	260	1875	111.1	86.86470912

lot-waf-die	Rmc kΩ	VDD V	Temp °C	Angle °	Fluence #/cm^2	Ion	MeV	No. of Upsets	LET eff	Cross µm^2
4-10-504	213	4.5	125	45	1.02E+05	Cl	105	0	25.5	0
4-10-106	213	5	25	0	1.05E+05	Br	260	83	38.0	1.206170945
4-10-106	213	5	25	45	1.05E+05	Br	260	440	53.7	9.042706698
4-10-106	213	5	25	60	1.04E+05	Br	260	514	76.0	15.08272611
4-10-106	213	5	25	70	9.75E+04	Br	260	283	111.1	12.94941665
4-10-504	213	5	25	0	9.80E+04	Br	260	1	38.0	0.015570193
4-10-504	213	5	25	45	9.80E+04	Br	260	60	53.7	1.32117468
4-10-504	213	5	25	60	9.80E+04	Br	260	154	76.0	4.79561942
4-10-504	213	5	25	70	9.90E+04	Br	260	82	111.1	3.695277371
4-10-106	213	5	80	0	1.02E+05	Cl	105	0	18.0	0
4-10-106	213	5	80	70	1.03E+05	Cl	105	0	52.6	0
4-10-106	213	5	80	0	9.83E+04	Br	260	1702	38.0	26.41959205
4-10-106	213	5	80	45	9.84E+04	Br	260	1515	53.7	33.22405229
4-10-106	213	5	80	60	9.90E+04	Br	260	1456	76.0	44.88241793
4-10-106	213	5	80	70	9.73E+04	Br	260	1250	111.1	57.31463849
4-10-504	213	5	80	0	1.04E+05	Br	260	1545	38.0	22.66810491
4-10-504	213	5	80	60	1.03E+05	Br	260	1249	76.0	37.00626707
4-10-106	213	5	125	0	9.63E+04	Br	260	2378	38.0	37.6795435
4-10-106	213	5	125	60	9.80E+04	Br	260	1853	76.0	57.70313496
5-2-502	374	4.5	25	0	9.80E+04	Br	260	0	38.0	0
5-2-502	374	4.5	25	60	1.01E+05	Br	260	0	76.0	0
5-2-607	374	4.5	25	0	9.82E+04	Br	260	0	38.0	0
5-2-607	374	4.5	25	60	9.83E+04	Br	260	0	76.0	0
5-2-607	374	4.5	25	70	9.83E+04	Br	260	0	111.1	0
5-2-502	374	4.5	80	0	1.60E+06	Fe	150	0	28.0	0
5-2-502	374	4.5	80	30	1.60E+06	Fe	150	0	32.3	0
5-2-502	374	4.5	80	0	9.78E+04	Br	260	372	38.0	5.803956576
5-2-502	374	4.5	80	45	1.60E+06	Fe	150	0	39.6	0
5-2-502	374	4.5	80	45	9.81E+04	Br	260	843	53.7	18.54358223
5-2-502	374	4.5	80	60	1.60E+06	Fe	150	37	56.0	0.070571899
5-2-502	374	4.5	80	60	9.77E+04	Br	260	796	76.0	24.86386099
5-2-502	374	4.5	80	70	1.60E+06	Fe	150	1	81.9	0.002788357
5-2-502	374	4.5	80	70	9.77E+04	Br	260	502	111.1	22.92332112
5-2-602	374	4.5	80	0	1.60E+06	Fe	150	0	28.0	0
5-2-602	374	4.5	80	30	1.60E+06	Fe	150	0	32.3	0
5-2-602	374	4.5	80	45	1.60E+06	Fe	150	0	39.6	0
5-2-602	374	4.5	80	60	1.60E+06	Fe	150	131	56.0	0.249862671
5-2-602	374	4.5	80	70	1.60E+06	Fe	150	28.	81.9	0.078074001
5-2-607	374	4.5	80	0	9.78E+04	Br	260	678	38.0	10.57817892
5-2-607	374	4.5	80	45	9.80E+04	Br	260	690	53.7	15.19350882
5-2-607	374	4.5	80	60	9.83E+04	Br	260	348	76.0	10.80378147
5-2-607	374	4.5	80	70	9.84E+04	Br	260	497	111.1	22.53355301
5-2-705	374	4.5	80	0	1.60E+06	Fe	150	0	28.0	0
5-2-705	374	4.5	80	30	1.60E+06	Fe	150	0	32.3	0
5-2-705	374	4.5	80	45	1.60E+06	Fe	150	0	39.6	0
5-2-705	374	4.5	80	60	1.60E+06	Fe	150	0	56.0	0
5-2-705	374	4.5	80	70	1.60E+06	Fe	150	0	81.9	0
5-2-705	374	4.5	125	0	1.60E+06	Fe	150	638	28.0	0.608444214
5-2-705	374	4.5	125	30	1.60E+06	Fe	150	3365	32.3	3.70556575
5-2-607	374	4.5	125	0	9.79E+04	Br	260	1887	38.0	29.41096523
5-2-705	374	4.5	125	45	1.60E+06	Fe	150	8813	39.6	11.88608563
5-2-607	374	4.5	125	45	9.82E+04	Br	260	1690	53.7	37.13729641
5-2-705	374	4.5	125	60	1.60E+06	Fe	150	9912	56.0	18.90563965
5-2-607	374	4.5	125	60	9.80E+04	Br	260	1407	76.0	43.81452288
5-2-705	374	4.5	125	70	1.60E+06	Fe	150	6447	81.9	17.97653863
5-2-607	374	4.5	125	70	9.82E+04	Br	260	1047	111.1	47.56676088
5-2-502	374	5	80	0	9.81E+04	Br	260	9	38.0	0.13998889

lot-waf-die	Rmc kΩ	VDD V	Temp °C	Angle °	Fluence #/cm^2	Ion	MeV	No. of Upsets	LET eff	Cross µm^2
5-2-502	374	5	80	45	9.86E+04	Br	260	267	53.7	5.843451094
5-2-502	374	5	80	60	9.79E+04	Br	260	332	76.0	10.34916848
5-2-502	374	5	80	70	9.77E+04	Br	260	191	111.1	8.721821381
5-2-607	374	5	80	0	9.88E+04	Br	260	30	38.0	0.463323555
5-2-607	374	5	80	45	9.84E+04	Br	260	221	53.7	4.846544921
5-2-607	374	5	80	60	9.83E+04	Br	260	254	76.0	7.885518661
5-2-607	374	5	80	70	9.91E+04	Br	260	210	111.1	9.453965758

SEU TEST DATA

The single event upset (SEU) testing was done in the static mode where data patterns are stored before, and read out after, the ion beam irradiation exposure. After irradiation, the number of stored bit errors in the SRAM are recorded along with the exposure conditions. An effective linear energy transfer (LETeff) energy and a device cross section (Cross) are calculated.

$$LETeff = \frac{LETref}{\cos(\pi x angle/180°)} \quad MeV\text{-}cm^2/mg$$

$$Cross = \frac{No.\ of\ Upsets\ x1E8}{Fluence x 2^{14} x \cos(\pi x angle/180°)} \quad \mu m^2$$

When Honeywell estimates the soft error rate (SER), a statistical factor is applied to the upset error number. This accounts for memory cells that upset an even number of times during the heavy ion exposure that would not be counted as a memory bit error. This corrected factor has been experimentally demonstrated in a dynamic test where the bit errors are monitored continuously during exposure.

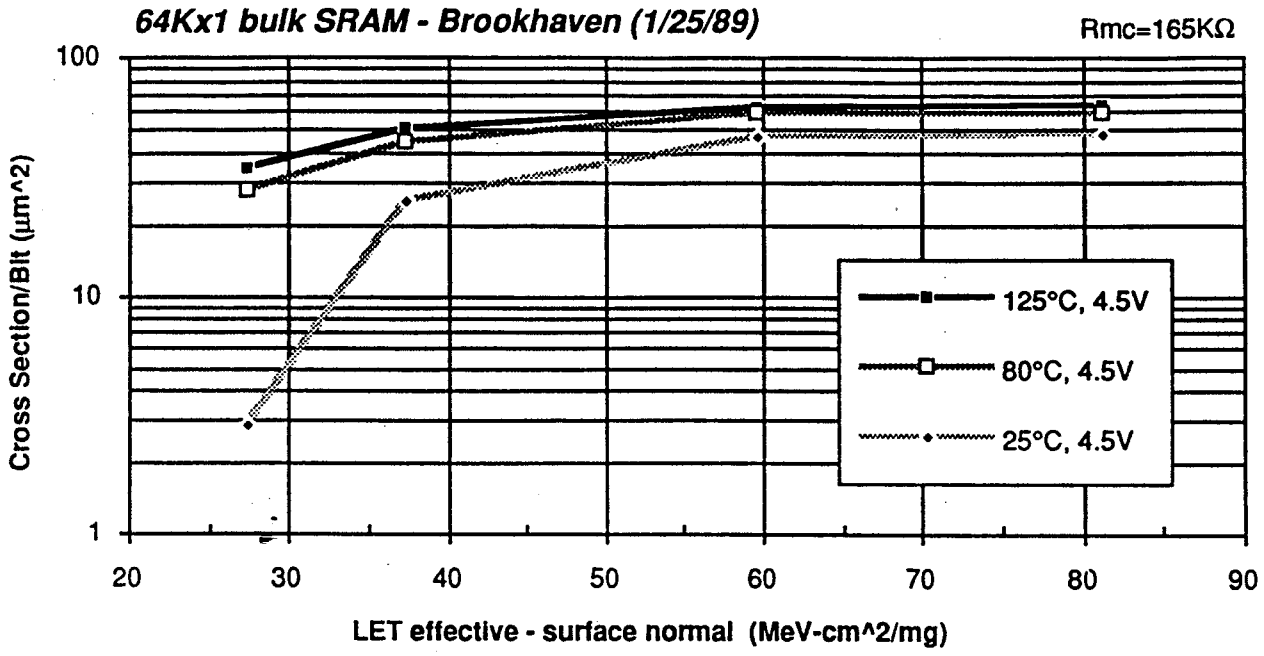
$$\text{Corrected Cross Section} = \frac{[-(2^{14}/2)x\ln(1-(2xUpsets/2^{14}))+1]x1E8}{Fluence x 2^{14} x \cos(\pi x angle/180°)}$$

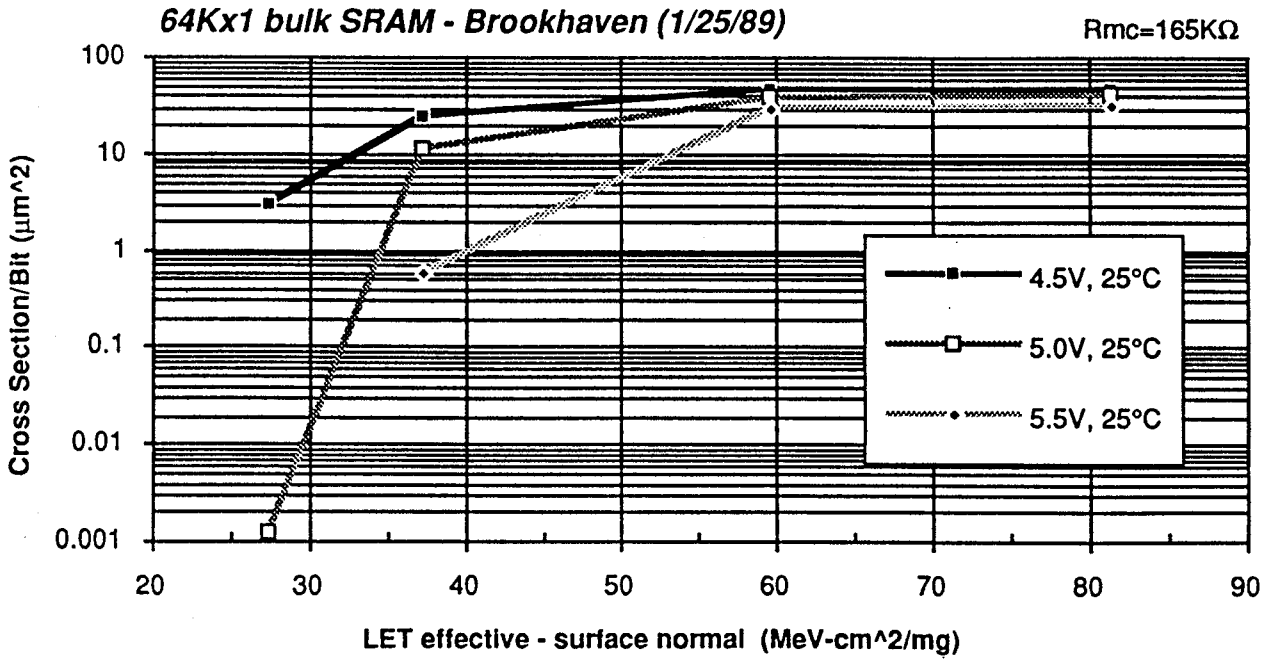
The resulting corrected error count actually increases from the observed errors by about 10%. This leads to a larger calculated cross section that results in a higher (poorer) SER. The values for Cross given in the table below are the uncorrected cross section shown in the expression to the left.

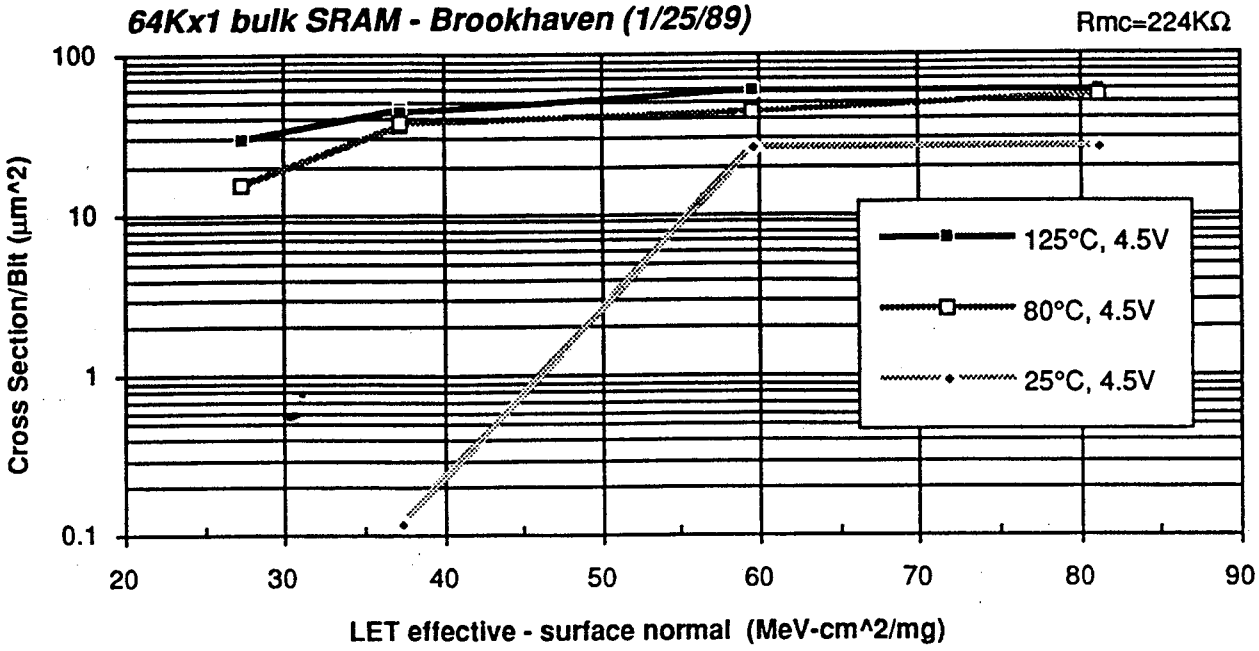
In addition to correctin the cross section, all the SER calculations are from worst case test data, not nominal values - VDD=4.5V, TA=80 or 125°C and the lowest value resistor for a particular SER range. Honeywell feels that this method for SER calculation insures the most accurate number for the SRAM error rates.

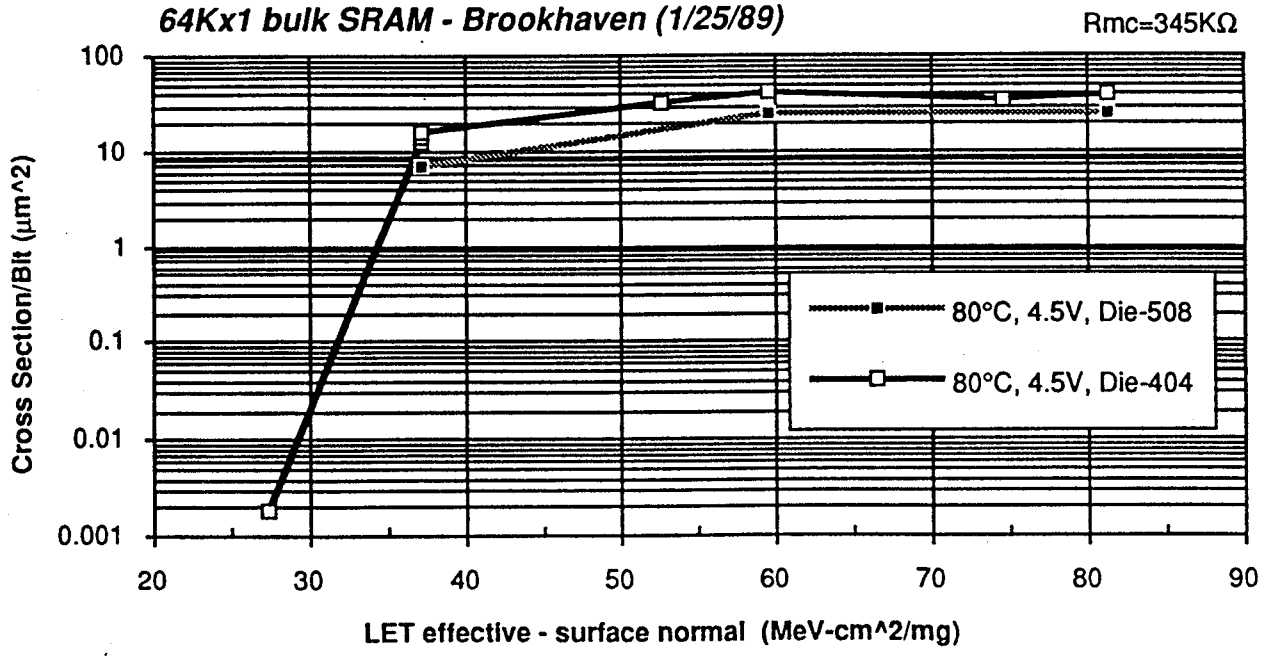
Technical Note

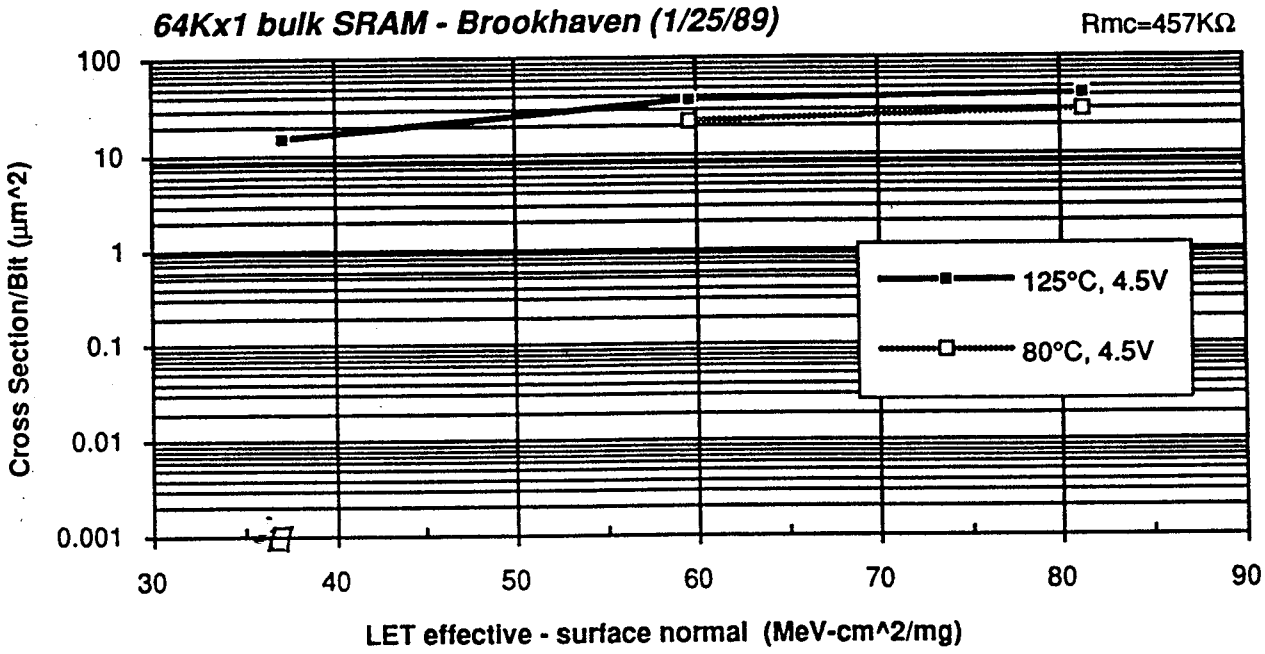
64K x 1 RADIATION-HARDENED SRAM - HC6464 SEU DATA






64Kx1 bulk SRAM - Brookhaven (1/25/89)
Rmc=224KΩ
Cross Section/Bit (µm^2)
100
10
1
0.1
20
30
40
50
60
70
80
90
LET effective - surface normal (MeV-cm^2/mg)
125°C, 4.5V
80°C, 4.5V
25°C, 4.5V


64Kx1 bulk SRAM - Brookhaven (1/25/89)
Rmc=345KΩ
Cross Section/Bit (µm^2)
100
10
1
0.1
0.01
0.001
20
30
40
50
60
70
80
90
LET effective - surface normal (MeV-cm^2/mg)
80°C, 4.5V, Die-508
80°C, 4.5V, Die-404


64Kx1 bulk SRAM - Brookhaven (1/25/89)
Rmc=457KΩ
Cross Section/Bit (µm^2)
100
10
1
0.1
0.01
0.001
30
40
50
60
70
80
90
LET effective - surface normal (MeV-cm^2/mg)
125°C, 4.5V
80°C, 4.5V

Rmc kΩ	VDD V	Temp °C	Angle °	Fluence #/cm^2	Fluence*cos #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross µm^2
lot-wafer-die: 204-2-603											
165	4.5	25	0	5.02E+5	5.02E+5	Ni-58	237	951	27.4	27.4	2.8900833
165	4.5	25	0	5.05E+5	5.05E+5	Br-79	281	8236	37.3	37.3	24.880496
165	4.5	25	0	2.04E+5	2.04E+5	I-127	320	6208	59.7	59.7	46.548679
165	4.5	25	0	2.01E+5	2.01E+5	Au-197	332	6229	81.3	81.3	47.193147
165	4.5	80	0	4.04E+5	4.04E+5	Ni-58	237	7328	27.4	27.4	27.697896
165	4.5	80	0	3.05E+5	3.05E+5	Br-79	281	8710	37.3	37.3	43.546544
165	4.5	80	0	2.03E+5	2.03E+5	I-127	320	7777	59.7	59.7	58.601285
165	4.5	80	0	2.02E+5	2.02E+5	Au-197	332	7820	81.3	81.3	59.041925
165	4.5	125	0	2.01E+5	2.01E+5	Ni-58	237	4426	27.4	27.4	33.633168
165	4.5	125	0	2.04E+5	2.04E+5	Br-79	281	6653	37.3	37.3	49.787505
165	4.5	125	0	2.03E+5	2.03E+5	I-127	320	8278	59.7	59.7	62.19215
165	4.5	125	0	2.02E+5	2.02E+5	Au-197	332	8255	81.3	81.3	62.357081
165	5	25	0	5.04E+6	5.04E+6	Ni-58	237	4	27.4	27.4	0.0012113
165	5	25	0	5.03E+5	5.03E+5	Br-79	281	3742	37.3	37.3	11.344802
165	5	25	0	2.02E+5	2.02E+5	I-127	320	5116	59.7	59.7	38.588218
165	5	25	0	2.02E+5	2.02E+5	Au-197	332	5295	81.3	81.3	40.037308
165	5.5	25	0	1.00E+6	1.00E+6	Br-79	281	397	37.3	37.3	0.603962
165	5.5	25	0	2.03E+5	2.03E+5	I-127	320	3894	59.7	59.7	29.212254
165	5.5	25	0	2.01E+5	2.01E+5	Au-197	332	4124	81.3	81.3	31.322671
lot-wafer-die: 204-18-402											
224	4.5	25	0	1.00E+7	1.00E+7	Br-79	281	763	37.3	37.3	0.1163083
224	4.5	25	0	5.04E+5	5.04E+5	I-127	320	8496	59.7	59.7	25.737279
224	4.5	25	0	2.02E+5	2.02E+5	Au-197	332	3490	81.3	81.3	26.376015
224	4.5	80	0	1.00E+6	1.00E+6	Ni-58	237	9780	27.4	27.4	14.893309
224	4.5	80	0	3.01E+5	3.01E+5	Br-79	281	6918	37.3	37.3	35.034949
224	4.5	80	0	3.02E+5	3.02E+5	Br-79	281	6939	37.3	37.3	35.106345
224	4.5	80	0	3.02E+5	3.02E+5	Br-79	281	7011	37.3	37.3	35.458857
224	4.5	80	0	3.03E+5	3.03E+5	Br-79	281	7248	37.3	37.3	36.45211
224	4.5	80	0	5.06E+5	5.06E+5	I-127	320	14376	59.7	59.7	43.386145
224	4.5	80	0	2.02E+5	2.02E+5	Au-197	332	7131	81.3	81.3	53.893227
224	4.5	125	0	3.01E+5	3.01E+5	Ni-58	237	5811	27.4	27.4	29.43852
224	4.5	125	0	2.02E+5	2.02E+5	Br-79	281	5916	37.3	37.3	44.710746
224	4.5	125	0	3.03E+5	3.03E+5	Br-79	281	8675	37.3	37.3	43.70089
224	4.5	125	0	2.03E+5	2.03E+5	I-127	320	7692	59.7	59.7	57.789564
224	4.5	125	0	2.01E+5	2.01E+5	Au-197	332	7777	81.3	81.3	58.979922
224	5	25	0	5.03E+5	5.03E+5	I-127	320	3612	59.7	59.7	10.963745
224	5	25	0	2.02E+5	2.02E+5	Au-197	332	1282	81.3	81.3	9.698447
224	5.5	25	0	1.00E+7	1.00E+7	I-127	320	1260	59.7	59.7	0.191877
224	5.5	25	0	5.00E+6	5.00E+6	Au-197	332	465	81.3	81.3	0.1417933
lot-wafer-die: 208-3-404											
345	4.5	25	0	2.00E+7	2.00E+7	I-127	320	1105	59.7	59.7	0.0842206
345	4.5	25	0	5.01E+6	5.01E+6	Au-197	332	282	81.3	81.3	0.0859564
345	4.5	80	0	1.00E+7	1.00E+7	Ni-58	237	12	27.4	27.4	0.0018292
345	4.5	80	0	1.00E+6	1.00E+6	Br-79	281	7926	37.3	37.3	12.045932
345	4.5	80	0	5.01E+5	5.01E+5	Br-79	281	4590	37.3	37.3	13.976819
345	4.5	80	0	5.01E+5	5.01E+5	Br-79	281	5078	37.3	37.3	15.456639
345	4.5	80	0	5.08E+5	5.08E+5	Br-79	281	5149	37.3	37.3	15.459958
345	4.5	80	45	4.27E+5	3.02E+5	Br-79	281	4354	37.3	52.8	31.12149
345	4.5	80	0	2.02E+5	2.02E+5	I-127	320	5588	59.7	59.7	42.148351
345	4.5	80	60	6.03E+5	3.01E+5	Br-79	281	3415	37.3	74.6	34.577813
345	4.5	80	0	2.04E+5	2.04E+5	Au-197	332	5123	81.3	81.3	38.337801
345	4.5	125	0	1.01E+6	1.01E+6	Ni-58	237	3260	27.4	27.4	4.9299953
345	4.5	125	0	5.05E+5	5.05E+5	Br-79	281	8361	37.3	37.3	25.268119
345	4.5	125	0	5.06E+5	5.06E+5	Br-79	281	9639	37.3	37.3	29.078582
345	4.5	125	45	7.13E+5	5.04E+5	Ni-58	237	5705	27.4	38.7	24.411909

Rmc kΩ	VDD V	Temp °C	Angle °	Fluence #/cm^2	Fluence*cos #/cm^2	Ion	MeV	No. of Upsets	LET ref	LET eff	Cross µm^2
345	4.5	125	60	6.09E+5	3.05E+5	Ni-58	237	4844	27.4	54.8	48.547504
345	4.5	125	0	2.02E+5	2.02E+5	I-127	320	6235	59.7	59.7	47.215161
345	4.5	125	0	2.02E+5	2.02E+5	Au-197	332	6041	81.3	81.3	45.610265
lot-wafer-die: 208-3-508											
345	4.5	25	0	2.00E+7	2.00E+7	I-127	320	8812	59.7	59.7	0.6709603
345	4.5	25	0	2.03E+5	2.03E+5	Au-197	335	36	81.3	81.3	0.270466
345	4.5	80	0	5.02E+5	5.02E+5	Br-79	281	2187	37.3	37.3	6.651579
345	4.5	80	0	4.03E+5	4.03E+5	I-127	320	6454	59.7	59.7	24.424659
345	4.5	80	0	2.01E+5	2.01E+5	Au-197	335	3232	81.3	81.3	24.511136
345	4.5	125	0	1.02E+6	1.02E+6	Ni-58	237	2070	27.4	27.4	3.0996755
345	4.5	125	0	3.02E+5	3.02E+5	Br-79	281	3806	37.3	37.3	19.262007
345	4.5	125	0	3.04E+5	3.04E+5	I-127	320	6855	59.7	59.7	34.418887
345	4.5	125	0	2.01E+5	2.01E+5	Au-197	335	4697	81.3	81.3	35.63925
lot-wafer-die: 207-6-205											
457	4.5	25	0	1.00E+7	1.00E+7	I-127	320	0	59.7	59.7	0
457	4.5	80	0	1.00E+6	1.00E+6	Br-79	281	0	37.3	37.3	0
457	4.5	80	0	5.02E+5	5.02E+5	I-127	320	7041	59.7	59.7	21.389037
457	4.5	80	0	5.03E+5	5.03E+5	Au-197	332	9250	81.3	81.3	28.05482
457	4.5	125	0	1.00E+6	1.00E+6	Br-79	281	9860	37.3	37.3	15.000166
457	4.5	125	0	2.02E+5	2.02E+5	I-127	320	4841	59.7	59.7	36.586329
457	4.5	125	0	2.04E+5	2.04E+5	Au-197	332	5367	81.3	81.3	40.163767

SEU TEST DATA

The single event upset (SEU) testing was done in the static mode where data patterns are stored before, and read out after, the ion beam irradiation exposure. After irradiation, the number of stored bit errors in the SRAM are recorded along with the exposure conditions. An effective linear energy transfer (LETeff) energy and a device cross section (Cross) are calculated.

$$\text{LETeff} = \frac{\text{LETref}}{\cos(\pi \times \text{angle}/180°)} \quad \text{MeV-cm}^2/\text{mg}$$

$$\text{Cross} = \frac{\text{No. of Upsets x1E8}}{\text{Fluence} \times 2^{14} \times \cos(\pi \times \text{angle}/180°)} \quad \mu\text{m}^2$$

When Honeywell estimates the soft error rate (SER), a statistical factor is applied to the upset error number. This accounts for memory cells that upset an even number of times during the heavy ion exposure that would not be counted as a memory bit error. This corrected factor has been experimentally demonstrated in a dynamic test wher the bit errors are monitored continuously during exposure.

$$\text{Corrected Cross Section} = \frac{[-(2^{14}/2) \times \ln(1-(2 \times \text{Upsets}/2^{14}))+1] \times 1E8}{\text{Fluence} \times 2^{14} \times \cos(\pi \times \text{angle}/180°)}$$

The resulting corrected error count actually increases fror the observed errors by about 10%. This leads to a large calculated cross section that results in a higher (poorer) SEF The values for Cross given in the table below are th uncorrected cross section shown in the expression to the lef

In addition to correctin the cross section, all the SER calcu lations are from worst case test data, not nominal values VDD=4.5V, TA=80 or 125°C and the lowest value resistor fc a particular SER range. Honeywell feels that this method fc SER calculation insures the most accurate number for th SRAM error rates.