

Irradiation test with thermal neutrons at LNL on 18/05/99 and 3-4/06/99.

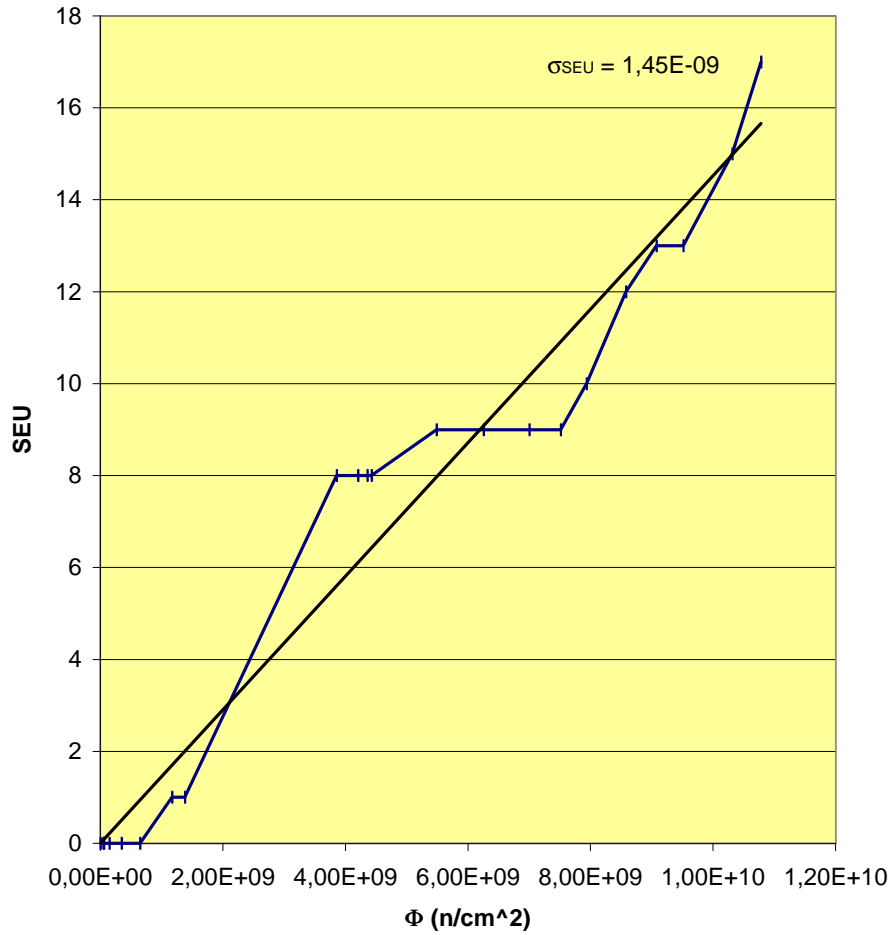
Neutron flux without DUT is $\Phi=2.3 \times 10^6$ n/cm²/μA, uniformity is better than 10%.

DAY	BEAM	NOTES	TIME	Δt (hh:mm)	t (s)	CHARGE (C)	Φ (n/cm ²)	SEU	
18/05/99	18nA		10.42	0	0	0,00E+00	0,00E+00	0	
			11.05	0.23	1380	1,99E-05	4,57E+07	0	
			100nA	11.07	0.02	1500	2,22E-05	5,11E+07	0
				11.10	0.03	1680	2,52E-05	5,80E+07	0
				11.15	0.05	1980	6,27E-05	1,44E+08	0
				11.26	0.11	2640	1,50E-04	3,44E+08	0
	11.43			0.17	3660	2,82E-04	6,48E+08	0	
	12.03			0.20	4860	5,08E-04	1,17E+09	1	
	250nA		12.09	0.06	5220	6,00E-04	1,38E+09	1	
			13.24	1.15	9720	1,68E-03	3,85E+09	8	
			250nA	13.35	0.11	10380	1,83E-03	4,21E+09	8
				13.50	0.15	11280	1,89E-03	4,36E+09	8
				13.54	0.04	11520	1,92E-03	4,42E+09	8
				14.23	0.29	13260	2,39E-03	5,49E+09	9
	14.43			0.20	14460	2,72E-03	6,25E+09	9	
	15.03			0.20	15660	3,04E-03	7,00E+09	9	
	03/06/99		300nA	15.18	0.15	16560	3,27E-03	7,51E+09	9
				15.30	0.12	17280	3,45E-03	7,94E+09	10
				15.48	0.18	18360	3,73E-03	8,58E+09	12
				16.02	0.14	19200	3,95E-03	9,08E+09	13
				16.16	0.14	20040	4,14E-03	9,52E+09	13
				16.40	0.24	21480	4,48E-03	1,03E+10	15
				16.54	0.14	22320	4,69E-03	1,08E+10	17
				10.36	0	0	0,00E+00	0,00E+00	0
10.48		0.12		720	2,30E-04	5,29E+08	0		
11.18		0.30		2520	8,00E-04	1,84E+09	0		
11.52		0.34		4560	1,51E-03	3,46E+09	1		
12.21		0.29		6300	2,07E-03	4,76E+09	3		
13.33	1.12	10620	3,59E-03	8,25E+09	6				
14.31	0.58	14100	4,89E-03	1,13E+10	9				
15.26	0.55	17400	5,99E-03	1,38E+10	11				
16.18	0.52	20520	7,05E-03	1,62E+10	11				
17.15	0.57	23940	8,48E-03	1,95E+10	16				
17.28	0.13	24720	8,78E-03	2,02E+10	16				
04/06/99	300nA	9.18	0.00	0	0,00E+00	0,00E+00	0		
		10.29	1.11	4260	1,54E-03	3,55E+09	1		
		10.54	0.25	5760	2,17E-03	5,00E+09	4		
		11.08	0.14	6600	2,51E-03	5,76E+09	4		
		12.07	0.59	10140	3,93E-03	9,05E+09	6		
		13.38	1.31	15600	6,15E-03	1,41E+10	9		
		14.32	0.54	18840	7,36E-03	1,69E+10	12		
		15.15	0.43	21420	8,24E-03	1,89E+10	13		
		16.06	0.51	24480	9,24E-03	2,13E+10	15		
		16.12	0.06	24840	9,33E-03	2,15E+10	15		
		16.37	0.25	26340	9,79E-03	2,25E+10	15		
		17.00	0.23	27720	1,03E-02	2,37E+10	15		
17.05	0.05	28020	1,04E-02	2,39E+10	16				
17.10	0.05	28320	1,05E-02	2,42E+10	16				
17.15	0.05	28620	1,06E-02	2,45E+10	16				

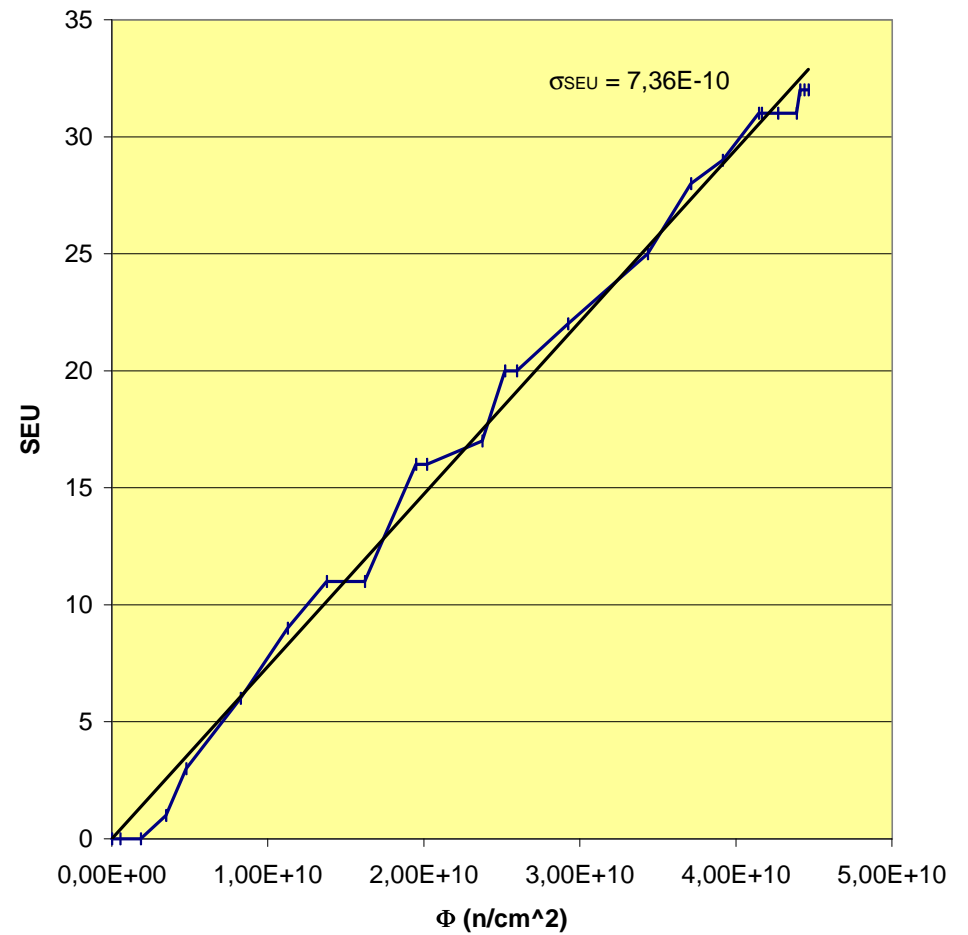
DAY	CHARGE (C)	Φ (n/cm ²)	SEU
18/05/99	0,00E+00	0,00E+00	0
	1,99E-05	4,57E+07	0
	2,22E-05	5,11E+07	0
	2,52E-05	5,80E+07	0
	6,27E-05	1,44E+08	0
	1,50E-04	3,44E+08	0
	2,82E-04	6,48E+08	0
	5,08E-04	1,17E+09	1
	6,00E-04	1,38E+09	1
	1,68E-03	3,85E+09	8
	1,83E-03	4,21E+09	8
	1,89E-03	4,36E+09	8
	1,92E-03	4,42E+09	8
	2,39E-03	5,49E+09	9
	2,72E-03	6,25E+09	9
	3,04E-03	7,00E+09	9
	3,27E-03	7,51E+09	9
	3,45E-03	7,94E+09	10
3,73E-03	8,58E+09	12	
3,95E-03	9,08E+09	13	
4,14E-03	9,52E+09	13	
4,48E-03	1,03E+10	15	
4,69E-03	1,08E+10	17	
03/06/99	4,92E-03	1,13E+10	17
	5,49E-03	1,26E+10	17
	6,19E-03	1,42E+10	18
	6,76E-03	1,55E+10	20
	8,27E-03	1,90E+10	23
	9,58E-03	2,20E+10	26
	1,07E-02	2,46E+10	28
	1,17E-02	2,70E+10	28
	1,32E-02	3,03E+10	33
	1,35E-02	3,10E+10	33
	1,50E-02	3,45E+10	34
	1,56E-02	3,60E+10	37
	1,60E-02	3,67E+10	37
	1,74E-02	4,00E+10	39
	1,96E-02	4,51E+10	42
	2,08E-02	4,79E+10	45
	2,17E-02	4,99E+10	46
	2,27E-02	5,22E+10	48
2,28E-02	5,24E+10	48	
2,33E-02	5,35E+10	48	
2,38E-02	5,47E+10	48	
2,39E-02	5,49E+10	49	
2,40E-02	5,52E+10	49	
2,41E-02	5,54E+10	49	

DAY	CHARGE (C)	Φ (n/cm ²)	SEU
03/06/99	0,00E+00	0,00E+00	0
	2,30E-04	5,29E+08	0
	8,00E-04	1,84E+09	0
	1,51E-03	3,46E+09	1
	2,07E-03	4,76E+09	3
	3,59E-03	8,25E+09	6
	4,89E-03	1,13E+10	9
	5,99E-03	1,38E+10	11
	7,05E-03	1,62E+10	11
	8,48E-03	1,95E+10	16
	8,78E-03	2,02E+10	16
	1,03E-02	2,37E+10	17
04/06/99	1,10E-02	2,52E+10	20
	1,13E-02	2,60E+10	20
	1,27E-02	2,92E+10	22
	1,49E-02	3,43E+10	25
	1,61E-02	3,71E+10	28
	1,70E-02	3,91E+10	29
	1,80E-02	4,15E+10	31
	1,81E-02	4,16E+10	31
	1,86E-02	4,27E+10	31
	1,91E-02	4,39E+10	31
	1,92E-02	4,41E+10	32
	1,93E-02	4,44E+10	32
1,94E-02	4,47E+10	32	

Thermal neutron induced SEU on CCB RAM 5/99



Thermal neutron induced SEU on CCB RAM 06/99



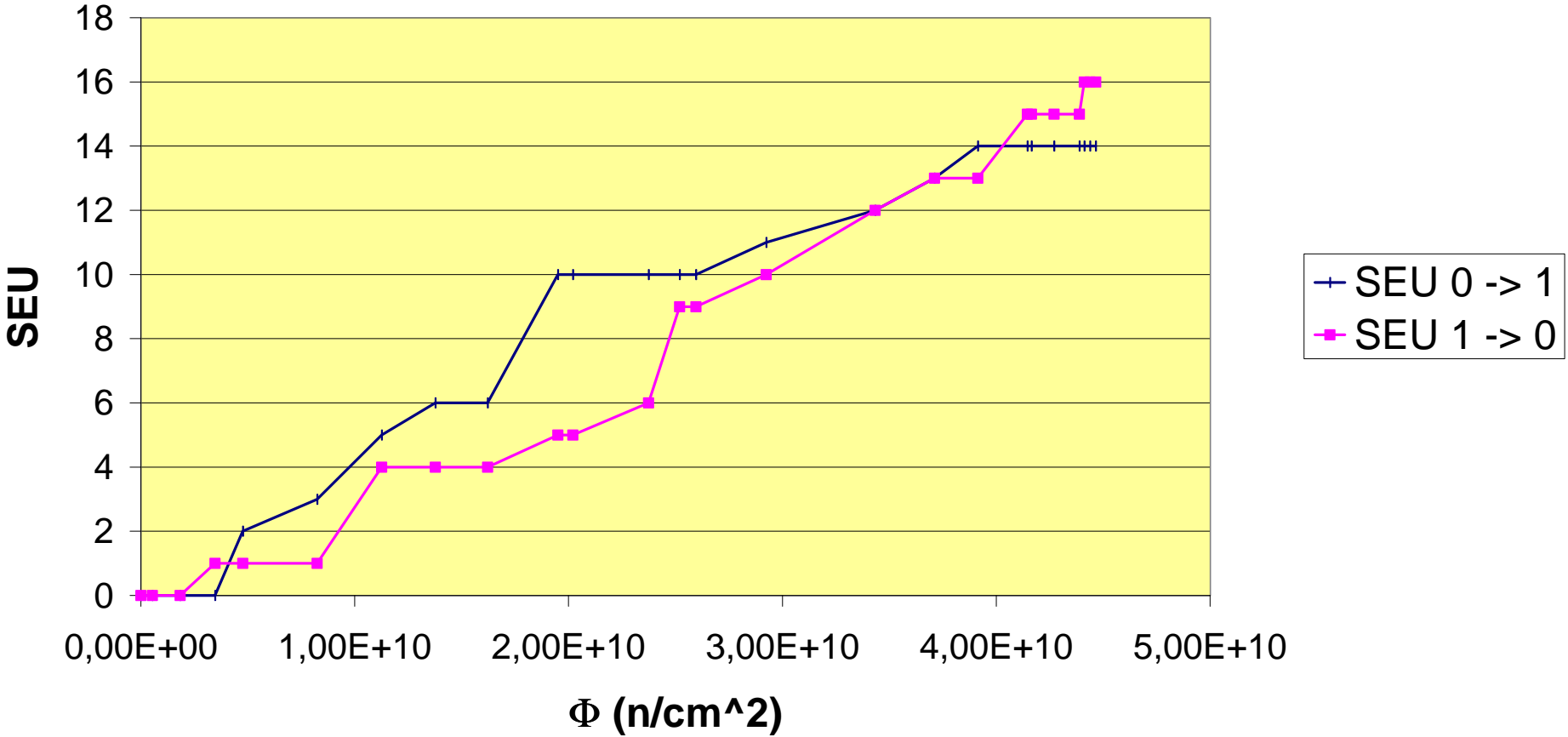
Neutron flux is calculated using the nominal yield of 2.3n/cm²/μA.

High-byte SRAM SEUs distinguishing 0-to-1 from 1-to-0 upsets.

1Mbit SRAM type SONY CXK581000AM-70LL (SN. 445J93E S) package SOIC-32

DAY	BEAM	NOTES	TIME	Δt (hh.mm)	t (s)	CHARGE (C)	Φ (n/cm ²)	SEU 0 -> 1	SEU 1 -> 0			
03/06/99	300nA	start	10.36	0	0	0,00E+00	0,00E+00	0	0			
			10.48	0.12	720	2,30E-04	5,29E+08	0	0			
			11.18	0.30	2520	8,00E-04	1,84E+09	0	0			
			11.52	0.34	4560	1,51E-03	3,46E+09	0	1			
			12.21	0.29	6300	2,07E-03	4,76E+09	2	1			
			13.33	1.12	10620	3,59E-03	8,25E+09	3	1			
			14.31	0.58	14100	4,89E-03	1,13E+10	5	4			
			15.26	0.55	17400	5,99E-03	1,38E+10	6	4			
			16.18	0.52	20520	7,05E-03	1,62E+10	6	4			
			17.15	0.57	23940	8,48E-03	1,95E+10	10	5			
			17.28	0.13	24720	8,78E-03	2,02E+10	10	5			
			04/06/99	300nA	start 9.18	10.29	1.11	28980	1,03E-02	2,37E+10	10	6
						10.54	0.25	30480	1,10E-02	2,52E+10	10	9
						11.08	0.14	31320	1,13E-02	2,60E+10	10	9
						12.07	0.59	34860	1,27E-02	2,92E+10	11	10
						13.38	1.31	40320	1,49E-02	3,43E+10	12	12
						14.32	0.54	43560	1,61E-02	3,71E+10	13	13
15.15	0.43	46140				1,70E-02	3,91E+10	14	13			
16.06	0.51	49200				1,80E-02	4,15E+10	14	15			
16.12	0.06	49560				1,81E-02	4,16E+10	14	15			
16.37	0.25	51060				1,86E-02	4,27E+10	14	15			
17.00	0.23	52440	1,91E-02	4,39E+10	14	15						
17.05	0.05	52740	1,92E-02	4,41E+10	14	16						
17.10	0.05	53040	1,93E-02	4,44E+10	14	16						
17.15	0.05	53340	1,94E-02	4,47E+10	14	16						

1Mbit SRAM SEU



Neutron flux is calculated using the nominal yield of 2.3n/cm²/μA.

DAY	BEAM	NOTES	TIME	Δt (hh.mm)	t (s)	CHARGE (C)	Φ (n/cm ²)	MAD Ch1	MAD Ch2	CHARGE (C)	Φ (n/cm ²)	MAD Ch1	MAD Ch2			
03/06/99	300nA	Illegal Instruction -> Reboot System crash	10.36	0	0	0,00E+00	0,00E+00	0	0	0,00E+00	0,00E+00	0	0			
			10.48	0.12	720	2,30E-04	5,29E+08	0	0	2,30E-04	5,29E+08	0	0			
			11.18	0.30	2520	8,00E-04	1,84E+09	0	0	8,00E-04	1,84E+09	0	0			
			11.52	0.34	4560	1,51E-03	3,46E+09	60	27	1,51E-03	3,46E+09	60	27			
			12.21	0.29	6300	2,07E-03	4,76E+09	92	36	2,07E-03	4,76E+09	92	36			
			13.33	1.12	10620	3,59E-03	8,25E+09	155	54	3,59E-03	8,25E+09	155	54			
			14.31	0.58	14100	4,89E-03	1,13E+10	223	70	4,89E-03	1,13E+10	223	70			
			15.26	0.55	17400	5,99E-03	1,38E+10	265	80	5,99E-03	1,38E+10	265	80			
			16.18	0.52	20520	7,05E-03	1,62E+10	303	101	7,05E-03	1,62E+10	303	101			
			17.15	0.57	23940	8,48E-03	1,95E+10	365	120	8,48E-03	1,95E+10	365	120			
			17.28	0.13	24720	8,78E-03	2,02E+10	378	126	8,78E-03	2,02E+10	378	126			
			04/06/99	300nA	Execution Error -> Reboot	9.18	0.00	0	0,00E+00	0,00E+00	0	0	1,03E-02	2,37E+10	443	146
						10.29	1.11	4260	1,54E-03	3,55E+09	65	20	1,10E-02	2,52E+10	443	146
						10.54	0.25	5760	2,17E-03	5,00E+09	65	20	1,13E-02	2,60E+10	480	157
11.08	0.14	6600				2,51E-03	5,76E+09	102	31	1,27E-02	2,92E+10	562	178			
12.07	0.59	10140				3,93E-03	9,05E+09	184	52	1,49E-02	3,43E+10	664	199			
13.38	1.31	15600				6,15E-03	1,41E+10	286	73	1,61E-02	3,71E+10	713	214			
14.32	0.54	18840				7,36E-03	1,69E+10	335	88	1,70E-02	3,91E+10	750	225			
15.15	0.43	21420				8,24E-03	1,89E+10	372	99	1,80E-02	4,15E+10	750	225			
16.06	0.51	24480				9,24E-03	2,13E+10	372	99	1,81E-02	4,16E+10	811	236			
16.12	0.06	24840				9,33E-03	2,15E+10	433	110	1,86E-02	4,27E+10	836	243			
16.37	0.25	26340				9,79E-03	2,25E+10	458	117	1,91E-02	4,39E+10	855	248			
17.00	0.23	27720				1,03E-02	2,37E+10	477	122	1,92E-02	4,41E+10	860	249			
17.05	0.05	28020				1,04E-02	2,39E+10	482	123	1,93E-02	4,44E+10	869	250			
17.10	0.05	28320				1,05E-02	2,42E+10	491	124	1,94E-02	4,47E+10	872	251			
17.15	0.05	28620	1,06E-02	2,45E+10	494	125										

Thermal neutron induced SEU on MAD

