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Design, Testing and Calibration of a 'Reference SEU Monitor' System.

by

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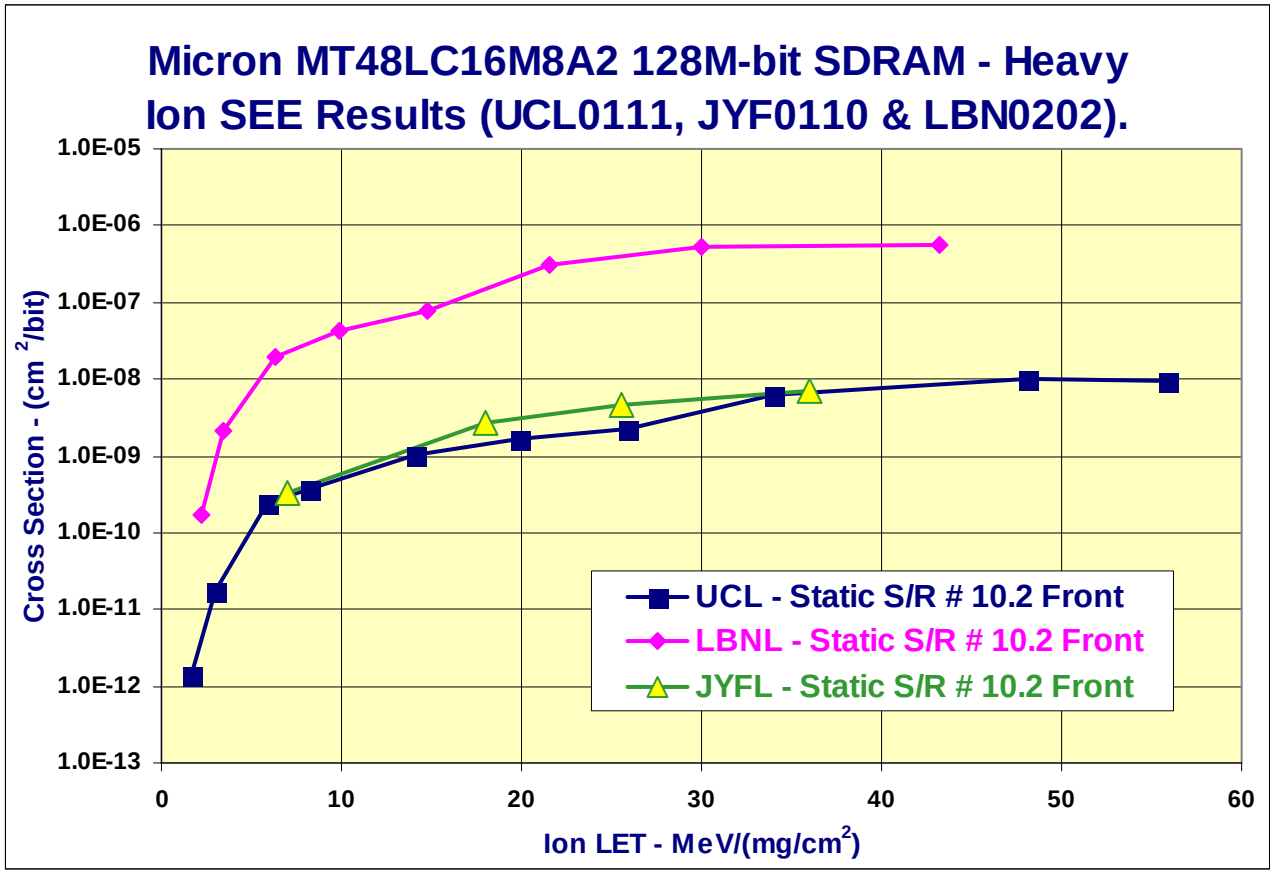
Abstract

This presentation summarises steps taken by ESA in order to construct and calibrate a 'Reference SEU Monitor' system intended for use as a reference system at accelerators. Beam characteristics can be verified by experimenters via this simple system, which uses an SRAM as the detecting element and a laptop as the controller.

Why ?


Micron MT48LC16M8A2 128M-bit SDRAM - Heavy Ion SEE Results (UCL0111, JYF0110 & LBN0202).
Cross Section - (cm 2/bit)
1.0E-05
1.0E-06
1.0E-07
1.0E-08
1.0E-09
1.0E-10
1.0E-11
1.0E-12
1.0E-13
0
10
20
30
40
50
60
Ion LET - MeV/(mg/cm2)
UCL - Static S/R # 10.2 Front
LBNL - Static S/R # 10.2 Front
JYFL - Static S/R # 10.2 Front

Introduction I.

Accelerator Single Event Effect (SEE) testing is often carried out using beams calibrated and monitored by the facility provider.

Occasionally these beam data have been incorrect due to unknown detector degradations, faulty detectors, set-up changes, misalignments or contaminated beams.

The facility user (experimenter) has no means of checking suspicious beams and often discovers data discrepancies too late, often at home base when analysing the data previously gathered on-site.

So in order to minimise test errors due to faulty beams, the user should have a simple reference system that allows beam re-checking capabilities.

Such a system, based on Single Event Upsets (SEUs) in a Static Random Access Memory (SRAM) and the use of a laptop, will be described here.

Outline:

- Basic design of the ‘Reference SEU Monitor’
- Initial testing of 4 different SRAM types
- Initial Static versus Dynamic test conditions.
- Obtained SEU data will be compared to pre calibrated SEU versus LET or energy curves.
- Beam profile and homogeneity issues will be addressed via the physical locations of SEUs
- Full SEU characterisation under heavy ions, protons and neutrons.
- 15 ‘Reference SEU Monitor’ will be produced

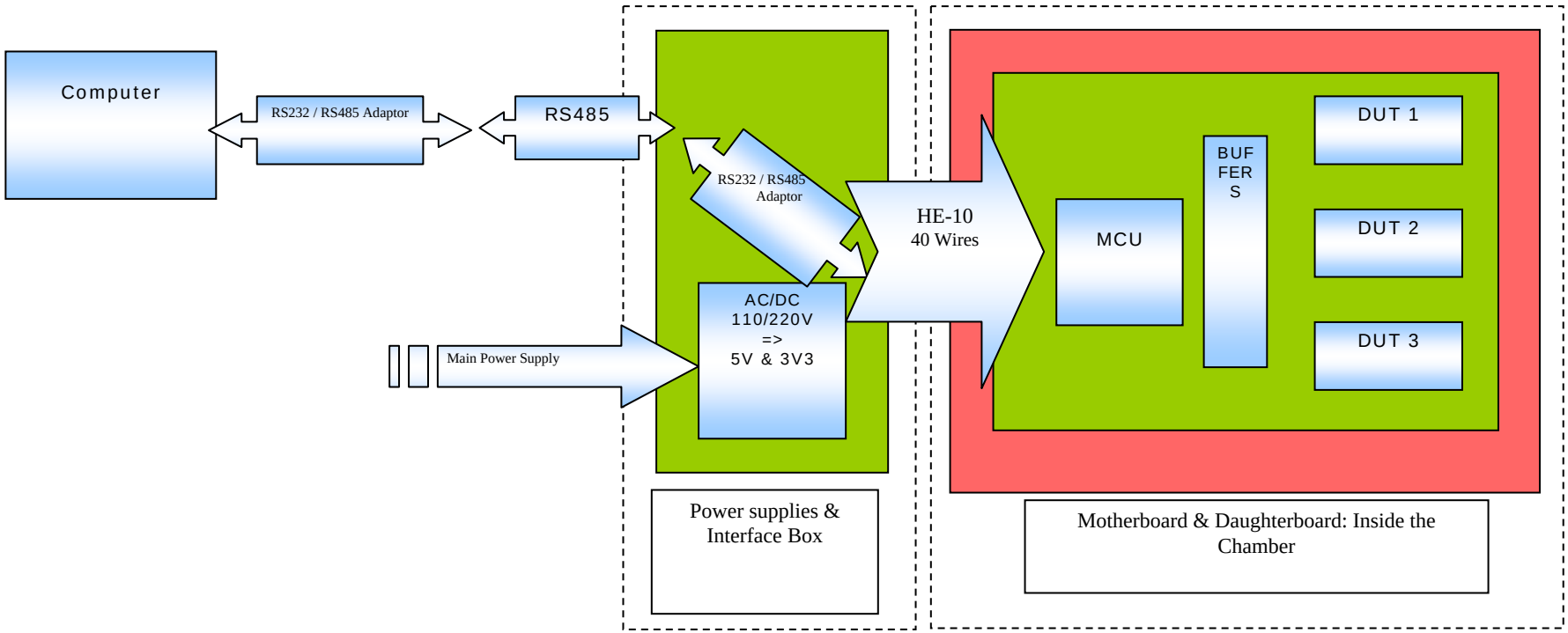
Basic ‘Test’ Design I.

Simplified design
  * One Power Supply
  * RS-232/RS-485 interface
  * Motherboard
  * DUT (Board)
  * Any computer

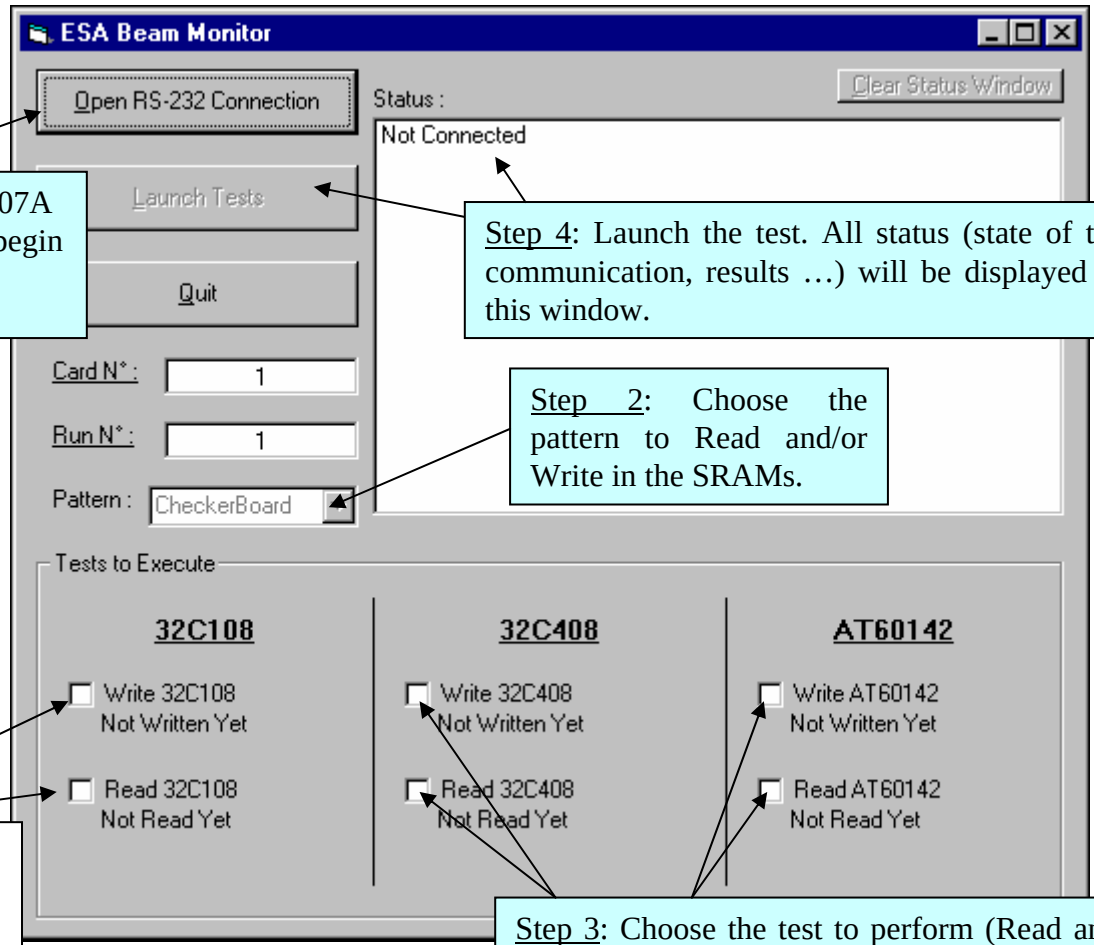
Initially design
  * 5.0 V and 3.3 V
  * Long distance
  * Microcontroller & E2PROM
  * 2 Boards (3 DUTs each)
  * Laptop/PC

Basic ‘Test’ Design II.

Initially design



Basic 'Test' Design III.



Step 1: Once the card STB007A is On, this button allows to begin the communication with the motherboard.

Step 4: Launch the test. All status (state of the communication, results …) will be displayed in this window.

Step 2: Choose the pattern to Read and/or Write in the SRAMs.

SRAMs status with respect to tests already performed.

Step 3: Choose the test to perform (Read and/or Write). Choose also if you want to perform this test on 1, 2 or 3 SRAMs.

Evaluated SRAMs I.

 # Selection criteria – Low cost

*** Potential suited**

*** Availability**

*** Ceramic Package**

Manuf.	Die	Size	Marking
Atmel	Atmel	4-Mbit	AT60142E
Maxwell	Samsung	4-Mbit	32C408B
Maxwell	Hitachi	4-Mbit	32C408R
Maxwell	Hitachi	1-Mbit	32C108RP

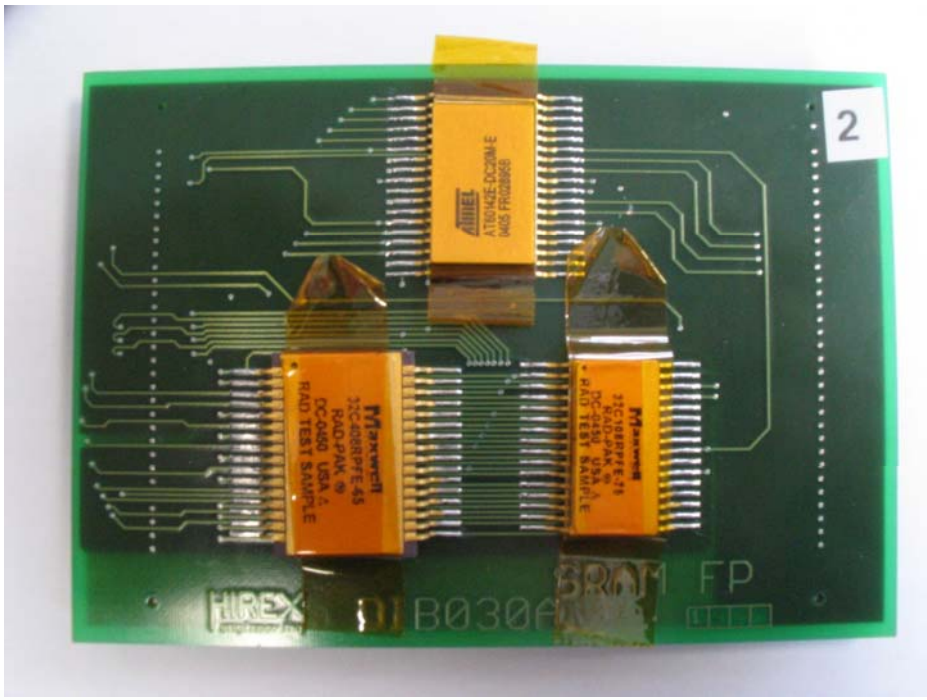
Evaluated SRAMs II.

Daughterboard – Two Types

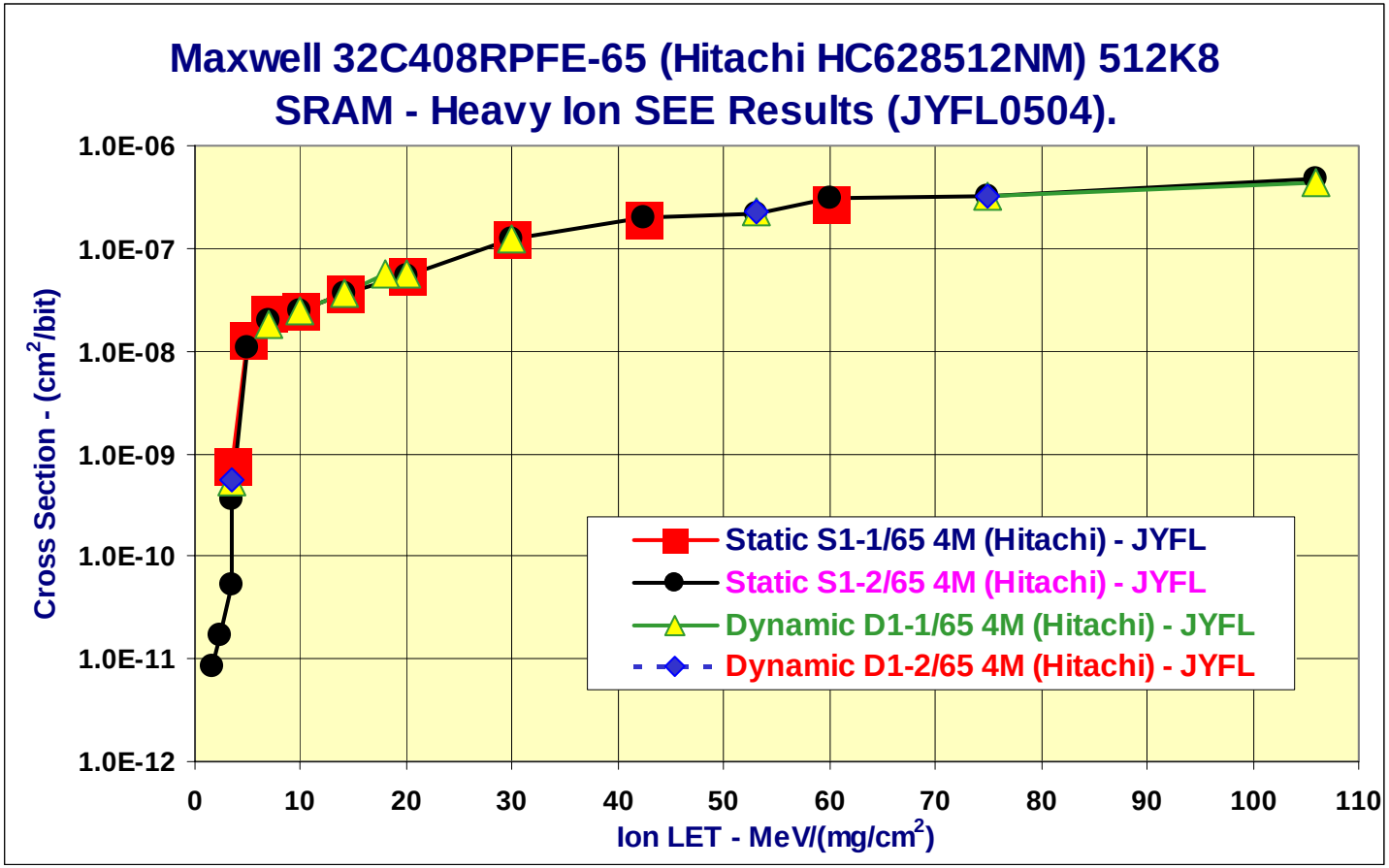
* Atmel AT60142E (3.3 V)

* Maxwell 32C408R (5.0 V)

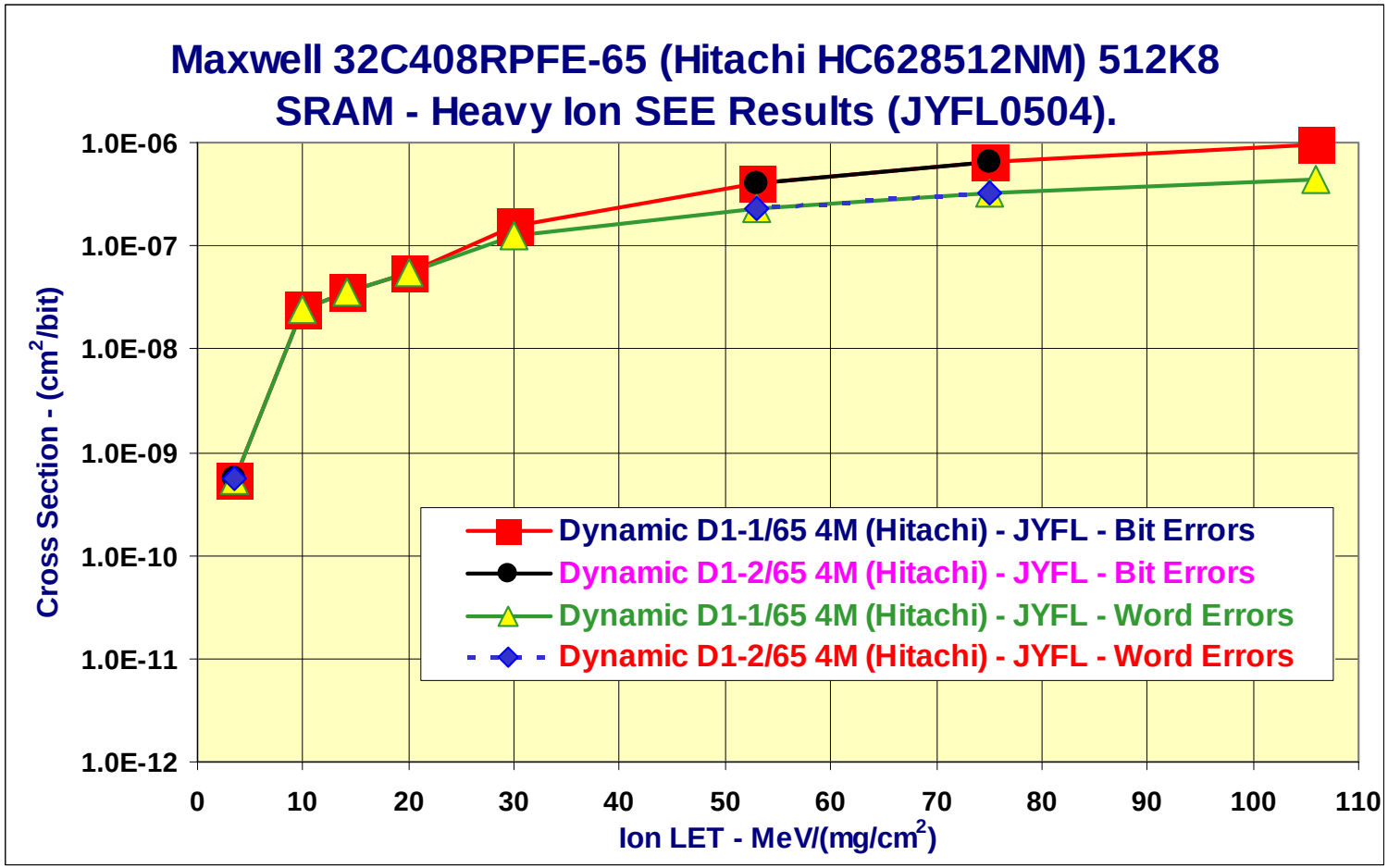
* Maxwell 32C108R (5.0 V)



Heavy Ion Test Results – Maxwell/Hitachi



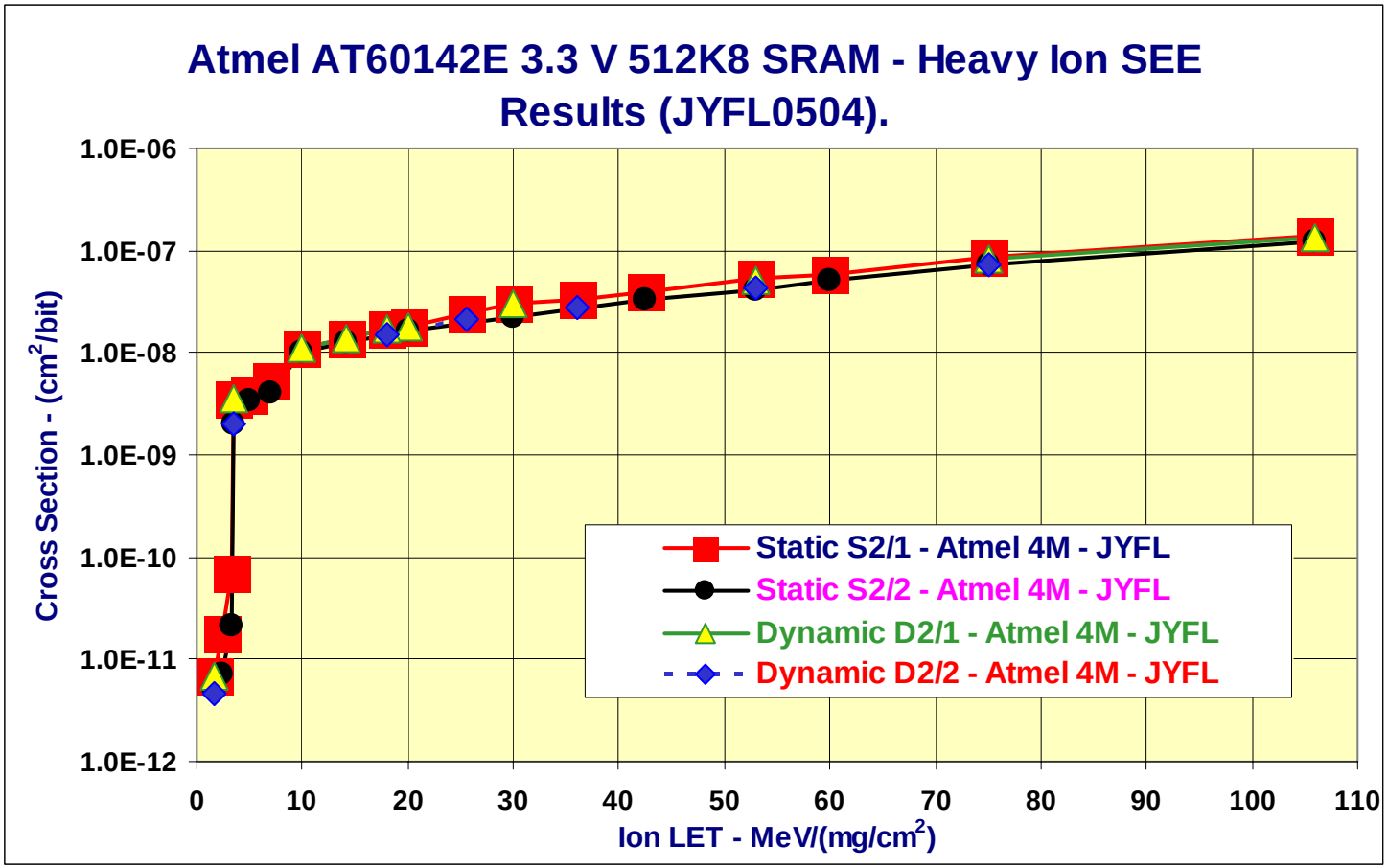
Heavy Ion Test Results – Maxwell/Hitachi



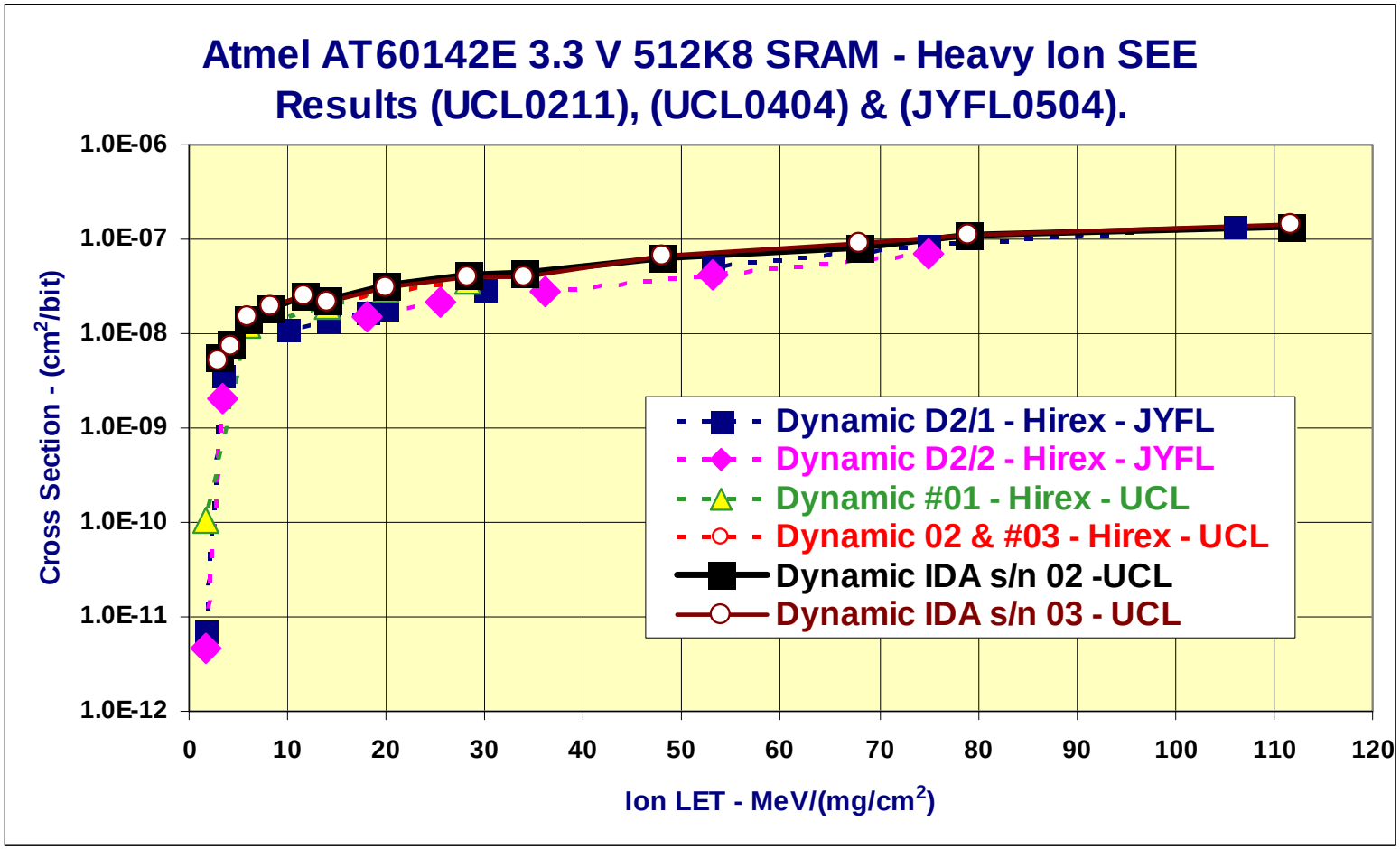
Heavy Ion Test Results – Maxwell/Hitachi

LET	1bit/word	2bit/word	3bit/word	4bit/word	5bit/word	6bit/word	7bit/word	Total words	0->1	1->0	Total bits
3.5	2220							2220	1142	1078	2220
10	35222	42						35264	17072	18234	35306
14.1	41745	80						41825	20371	21534	41905
20	58544	172						58716	28660	30228	58888
30	39187	15329	45	8				54569	34260	35752	70012
53	22999	37887	6478	98	24	1		67487	58824	59901	118725
75	16469	27708	15556	663	50	6	1	60453	60120	61378	121498
106	16621	24613	23045	3334	70	25	1	67709	73917	74908	148825

Heavy Ion Test Results – Atmel AT60142E



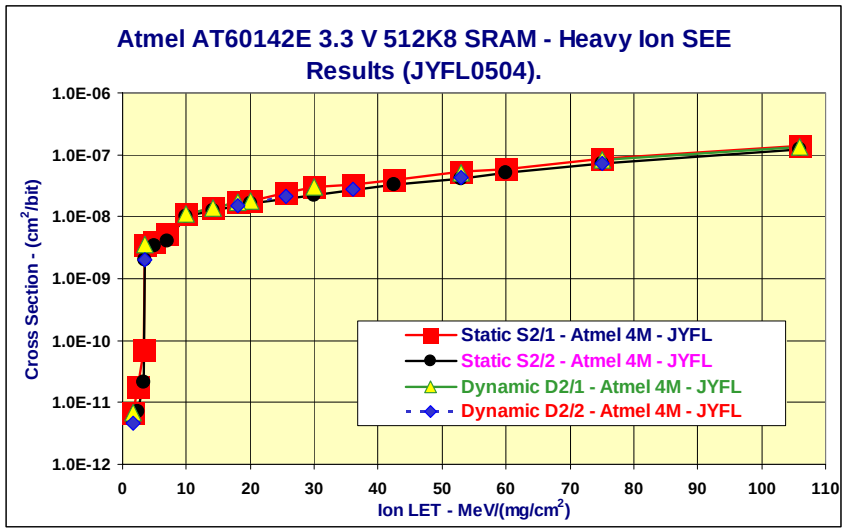
Heavy Ion Test Results – Atmel AT60142E

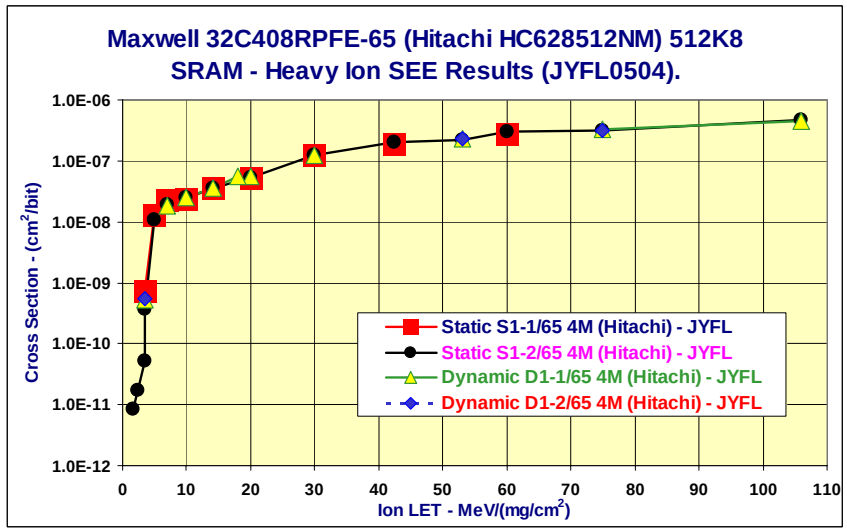


Heavy Ion Test Results – Atmel

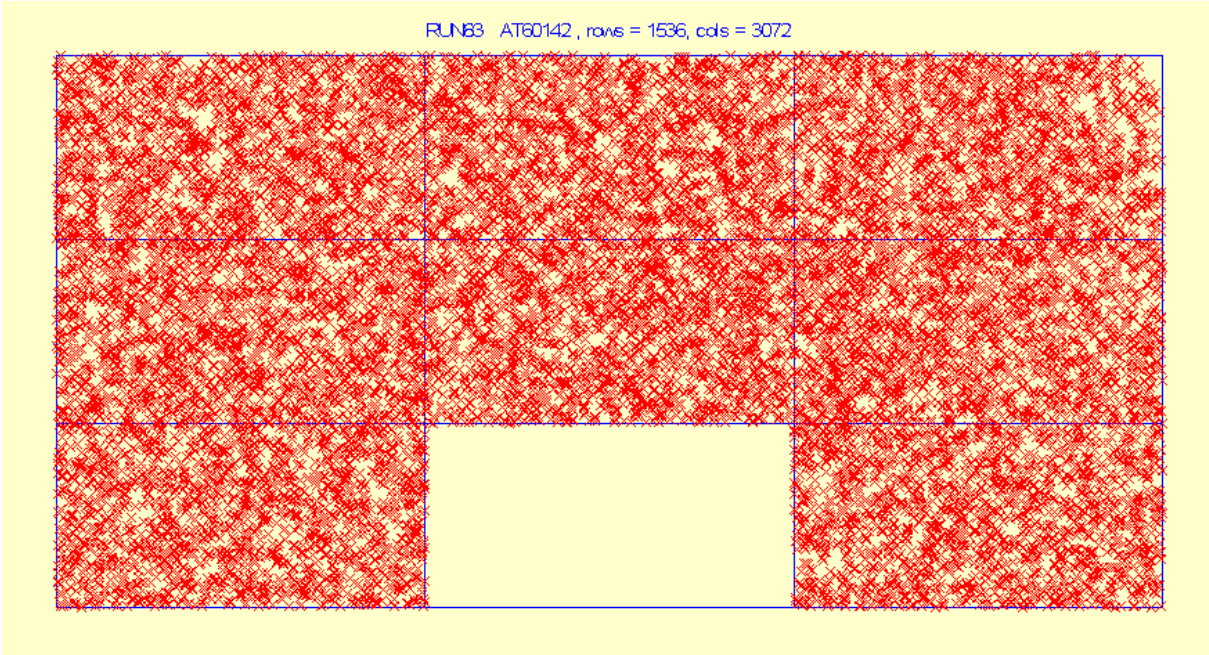
LET	1bit/word	2bit/word	3bit/word	4bit/word	5bit/word	6bit/word	7bit/word	Total words	0->1	1->0	Total bits
3.5	8910	1						8911	4715	4197	8912
10	19628	8						19636	9890	9754	19644
14.1	19552	4						19556	9980	9580	19560
30	13809	11						13820	7215	6616	13831
53	24648	33						24681	13428	11286	24714
75	26403	35						26438	14690	11783	26473
106	25614	27						25641	14484	11184	25668

Heavy Ion Test Results – Atmel AT60142E/Maxwell-Hitachi

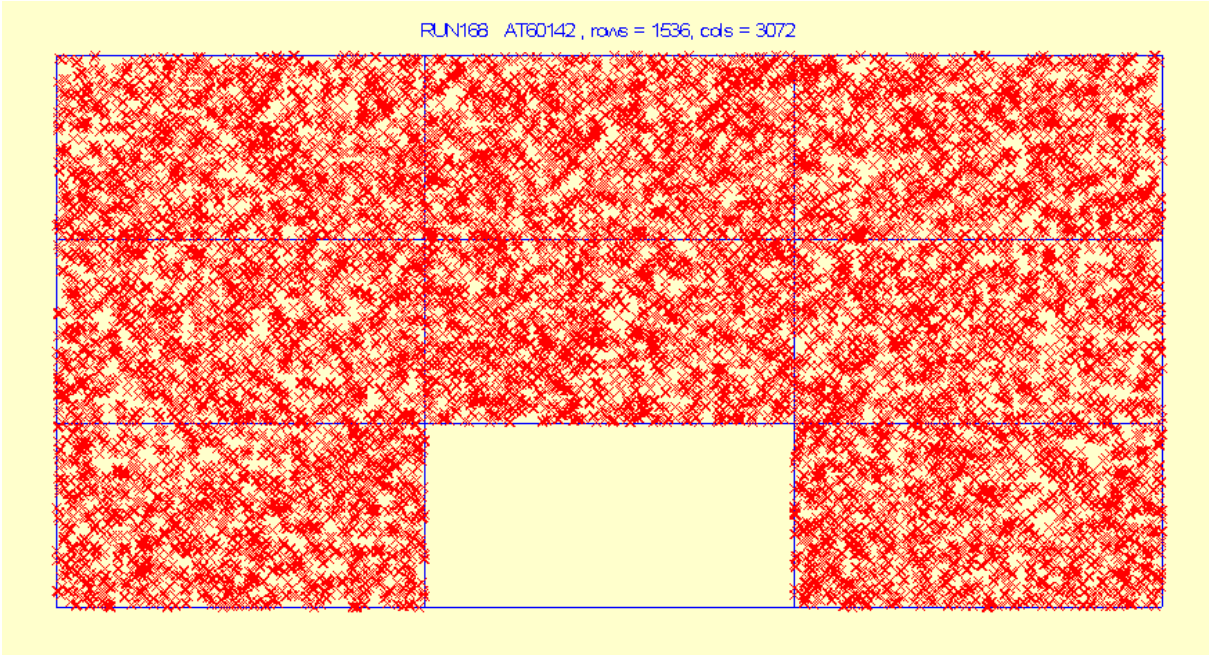




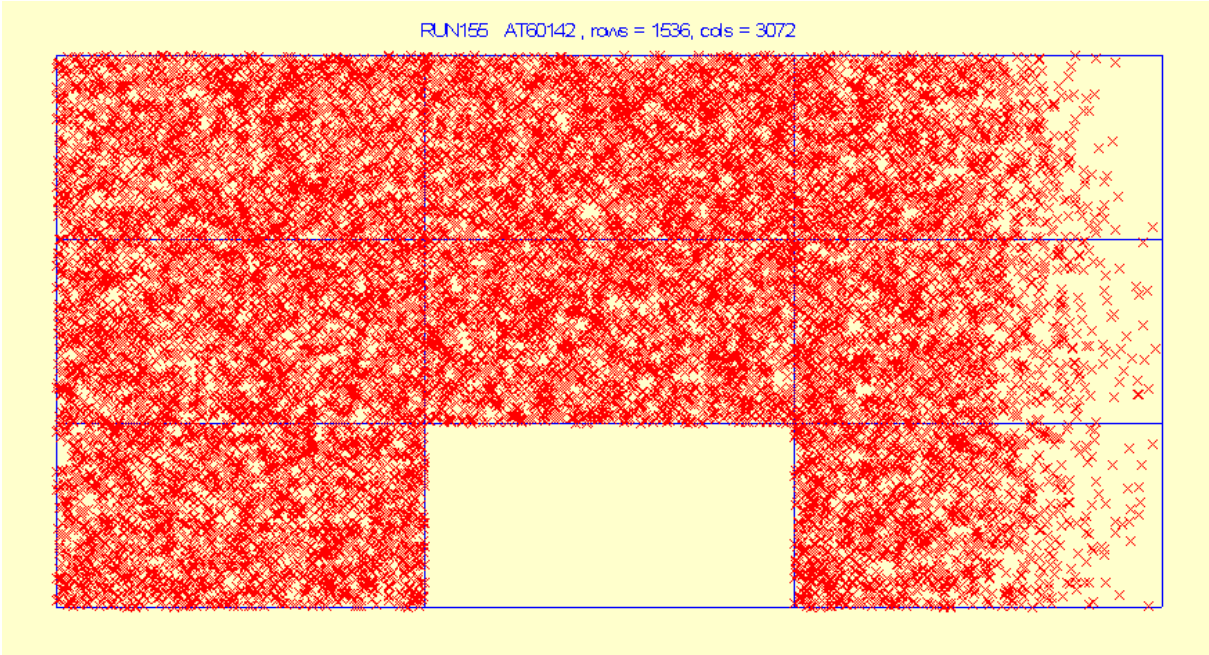
Atmel AT60142E – SEU Results: $^{20}Ne^{6+}$ 186 MeV, 0 Deg.
LET = 3.5 MeV/(mg/cm2) – Beam area 20x20 mm, 15328 Errors.



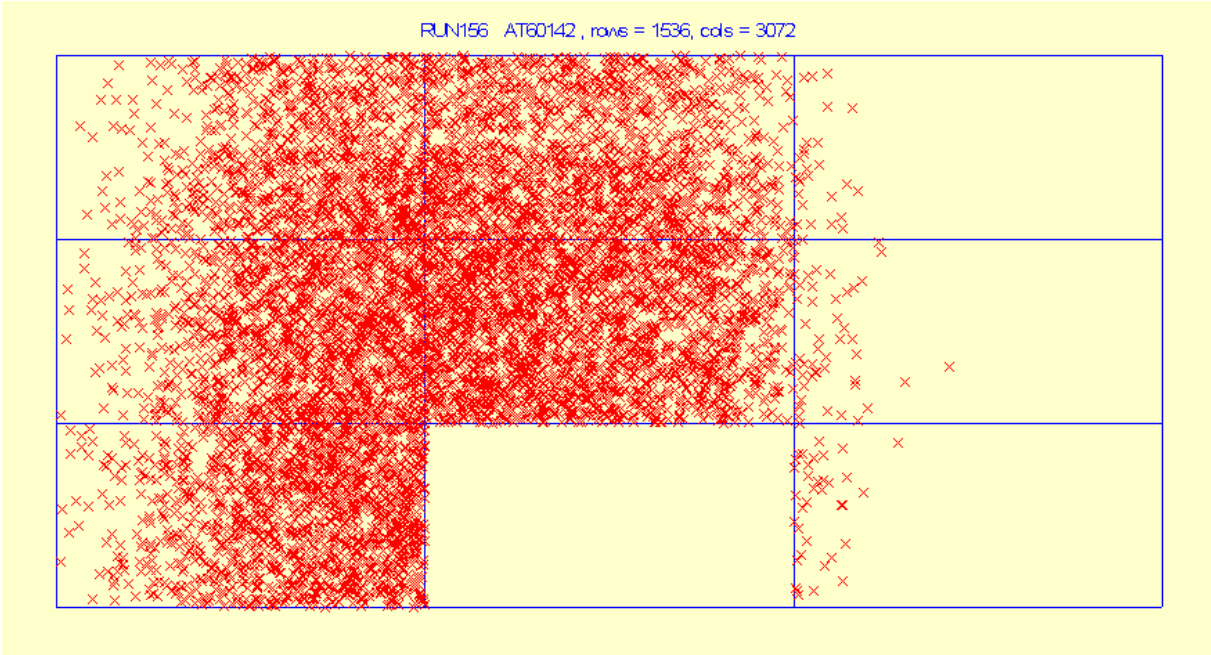
Atmel AT60142E – SEU Results: $^{131}Xe^{35+}$ 1217 MeV, 60 Deg. LET = 106 MeV/(mg/cm2) – Beam area 20x20 mm, 25641 Errors.



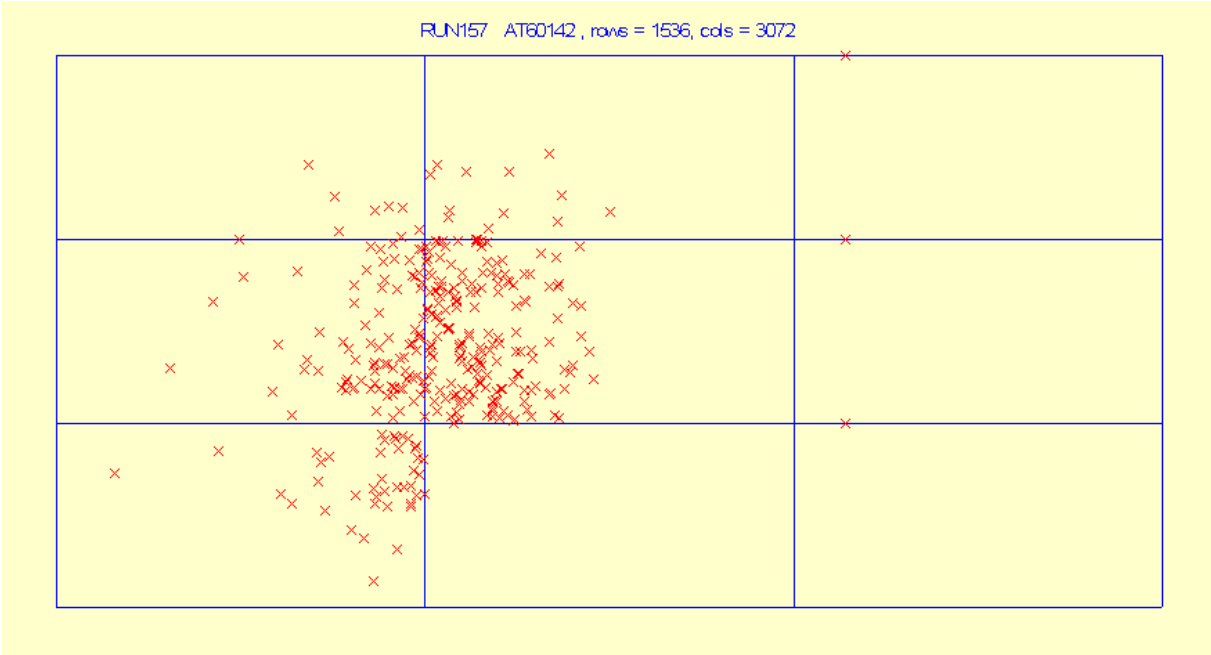
Atmel AT60142E – SEU Results: $^{56}Fe^{15+}$ 523 MeV, 0 Deg.
LET = 18 MeV/(mg/cm2) – Beam area 10x10 mm, 16992 Errors.



Atmel AT60142E – SEU Results: $^{56}Fe^{15+}$ 523 MeV, 0 Deg. LET = 18 MeV/(mg/cm2) – Beam area 5x5 mm, 8181 Errors.



Atmel AT60142E – SEU Results: $^{56}Fe^{15+}$ 523 MeV, 0 Deg. LET = 18 MeV/(mg/cm2) – Beam area 1x1 mm, 365 Errors.



Test Results – New Data:

Not yet analysed

* JYFL, Jyvaskyla, Finland - Proton data April 2005
* TSL, Uppsala, Sweden - Proton data April 2005
* TSL, Uppsala, Sweden - Neutron data April 2005

New updated design to be evaluated at

* UCL, Louvain-la-Neuve, Belgium – June 2005
* PSI, Villigen, Switzerland – August 2005

Preliminary Conclusions:

Detector element to be Atmel

Further devices and technical support also to be provided by Atmel

New updated design with Atmel SRAM to be further evaluated

Initially 15 ‘Reference SEU Monitor’ systems will be produced and distributed – fee of charge – to interested European SEE test sites

Acknowledgment:

Atmel, France for providing 12 pc AT60142E, Ceramic Package 4M-bit SRAMs with the package lid taped on.

Maxwell, USA for providing 12 pc 32C108RP, Ceramic Package 1M-bit SRAMs with the package lid taped on.

Maxwell, USA for providing 12 pc 32C408R, Ceramic Package 4M-bit SRAMs with the package lid taped on.

Maxwell, USA for providing 12 pc 32C408B, Ceramic Package 4M-bit SRAMs with the package lid taped on.