Radiation Characterization of a 0.11 μm Modified Commercial CMOS Process

C. Poivey[1], H. Kim[1], M. Vilchis[2], J. Forney[1],
A. Phan[1], K. LaBel[3], R. Saigusa[2], R. Finlinson[2],
A. Sukharnov[2], V. Hornback[2], J.Song[2], J. Tung[2],
M. Mirabedini[2]

[1] MEI Technologies
[2] LSI Logic
[3] NASA-GSFC

To be presented by Christian Poivey at the 2006 Single Event Effects Symposium (SEESYM), April 10, 2006 to April 12, 2006 in Long Beach, CA.

Outline

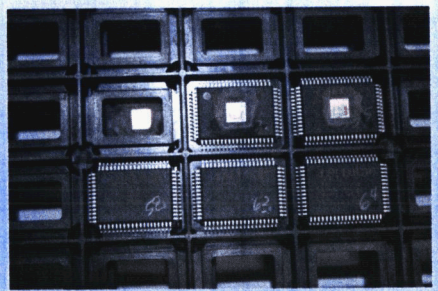
- Background – Introduction
- Test vehicles
- Test conditions
- Test results
  - SRAM
  - Logic chip
- Conclusion

Background - Introduction

- 2004:
  - Evaluation of LSI Logic 0.18 µm standard process
  - Evaluation of 0.18 µm modified process with a buried layer
    - No SEL up to a LET of 75 MeVcm²/mg
    - High SEU sensitivity
- 2005:
  - Evaluation of LSI Logic 0.11 µm standard process
    - 0.11 µm drawn bulk process with Small Trench Isolation (STI)
    - 1.2V core voltage, up to 3,3V I/O voltage
    - Up to 70 million logic gates on a chip
    - High density embedded SRAM
  - and two different versions of a modified process with buried layer

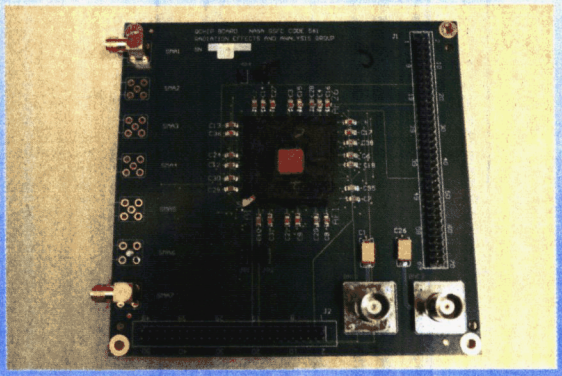
Test Vehicles

- SRAMs
  - 4 Mbit (512K*8) made with standard embedded cells
    - RAM249, high speed design
    - RAM187, high density design
    - I/O voltage = 2.5V
    - 64 PQFP



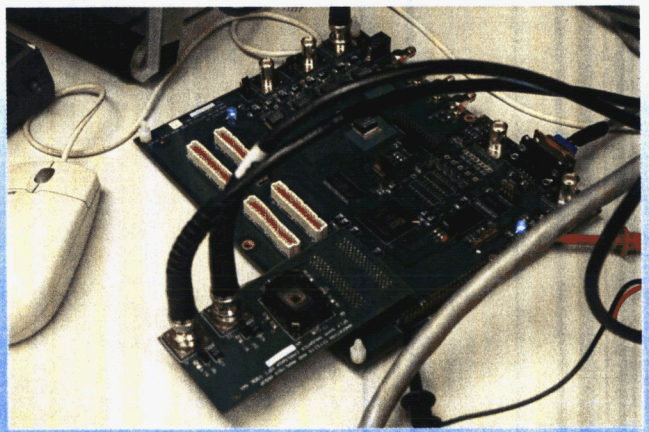
Test Vehicles

- Logic chip
  - Made of 384 64-bit ALUs with registered inputs, outputs, and function control signals
  - Scan D type flip-flop with set and clear
  - I/O voltage = 3.3V
  - 492 EPBGA

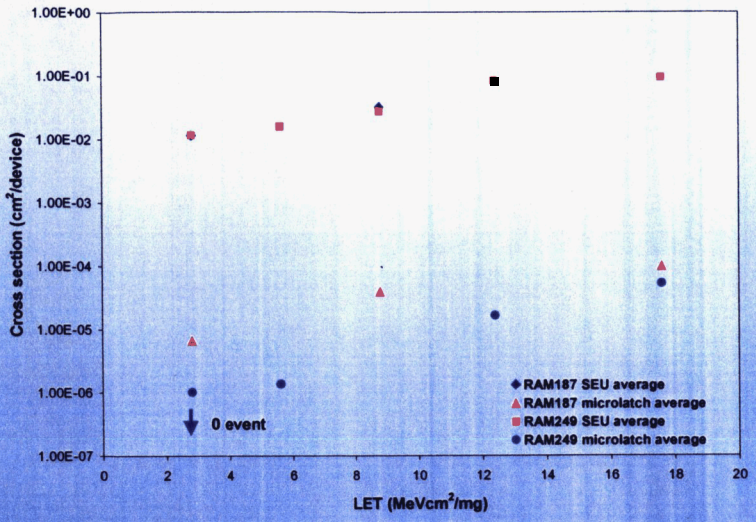


Test conditions

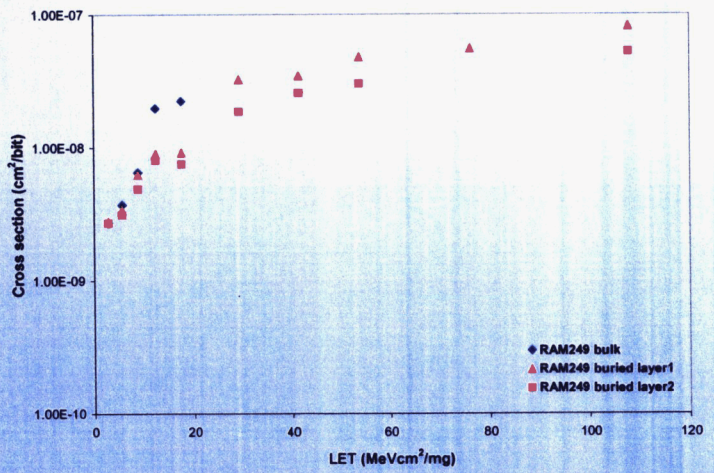
- Used NASA-GSFC low cost digital tester (LCDT)
- SRAM: static and dynamic (10MHz clock cycle)
- Logic chip: test in scan mode (6 shift register chains of 200 flip-flop each) at 2 to Mhz clock speed.



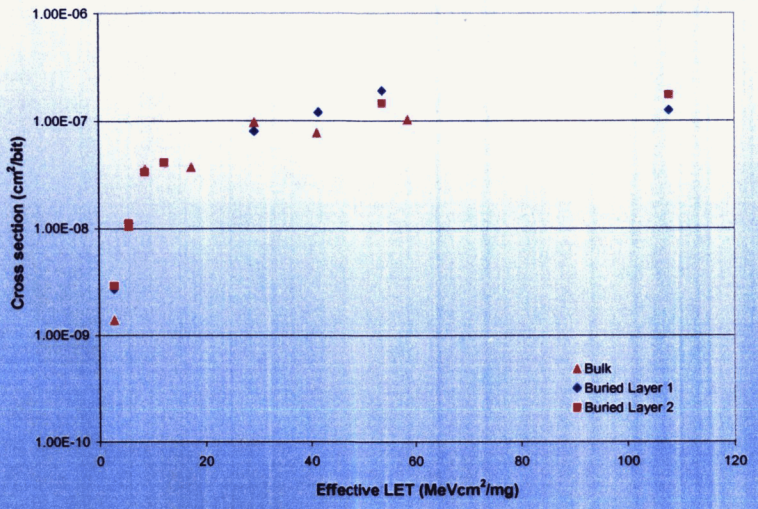
Test results – SRAM standard process



Test results
SRAM, RAM249, SEU, all processes



Test results
Logic chip, SEU



Conclusion

- 0.11 μm process with 1.2V core voltage may still be sensitive to SEU/SEL
- SRAM cells have a very low LET threshold
- Significant diffusion effect at high LET
- Significant transient sensitivity even at low speed