TIMED

Thermosphere • Ionosphere • Mesosphere • Energetics and Dynamics

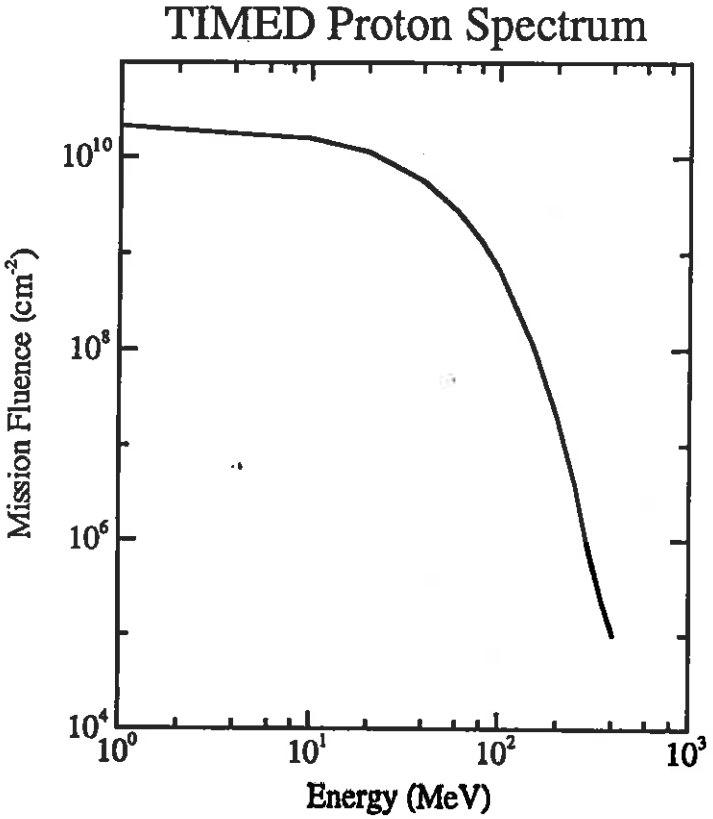
Radiation Hardness Assurance

Jim Kinnison

Outline

- Environment Estimates
- Requirements
- Testing Summary

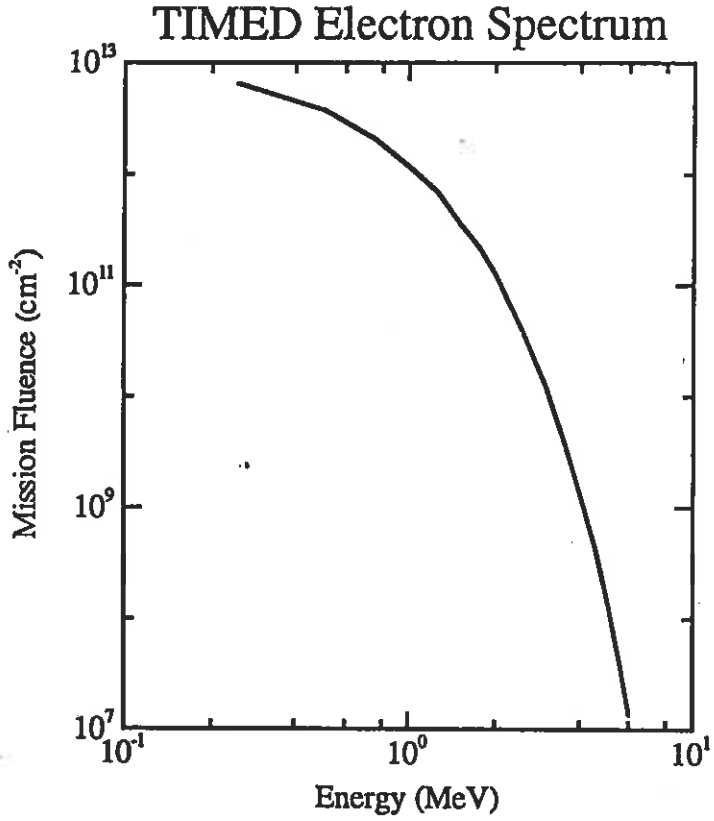
Proton Spectrum



- AP-8 Max
- Solar Maximum
- 625 km, 79 degrees
- 2 year mission life
- JPL Solar Proton Model

  95% Confidence Level

Electron Spectrum



- AE-8 Max
- Solar Maximum
- 625 km, 79 degrees
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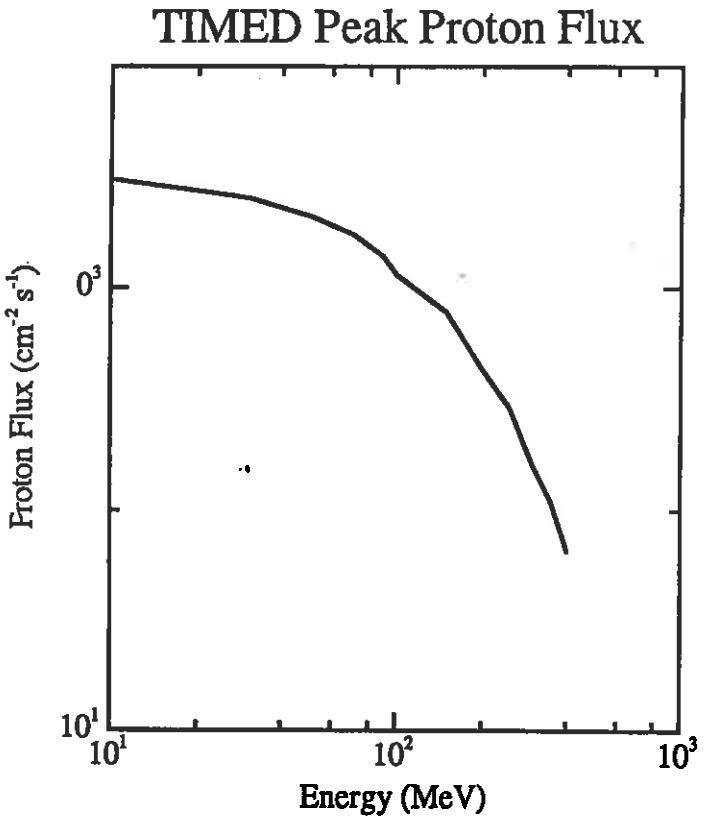
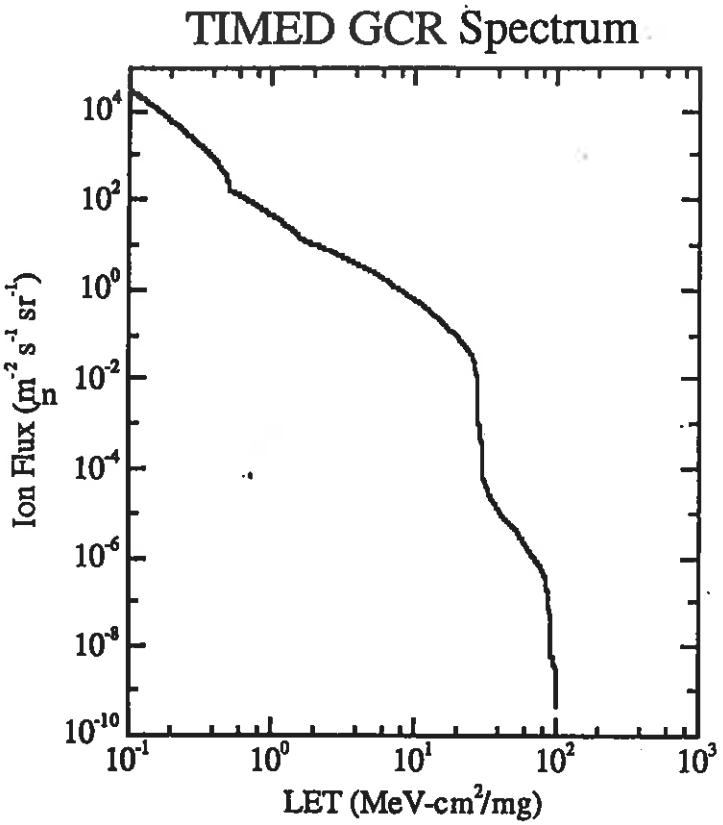
Peak Proton Flux



- South Atlantic Anomaly
- Center pass
- 15 minutes per pass
- About 8 passes per day
- Highest proton upset rate

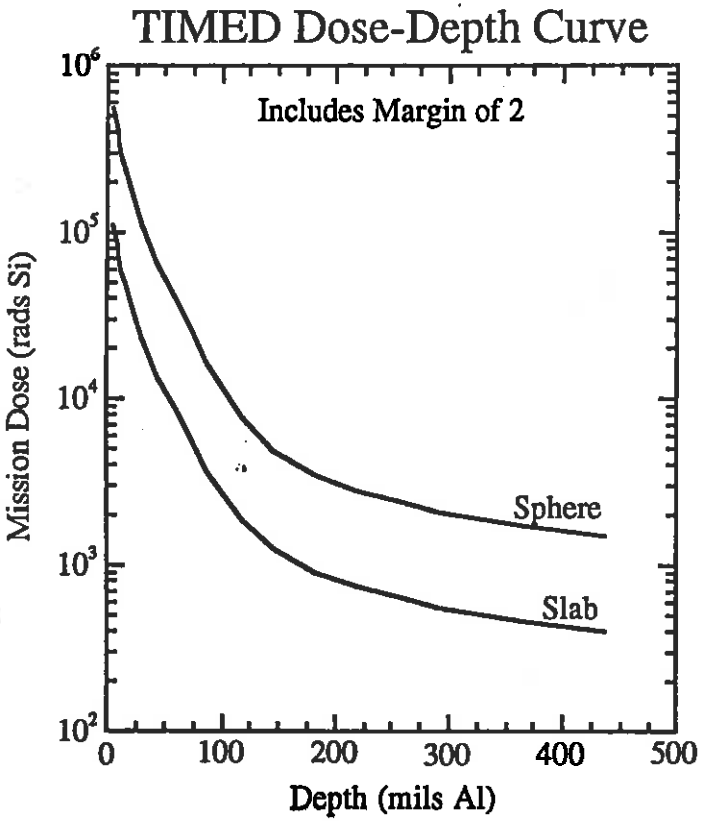
Cosmic Ray LET Spectrum



- CREME96
- Stormy Conditions
- Solar Maximum
- 625 km, 79 degrees

  Worst-case average upset rate

Dose-Depth Curve



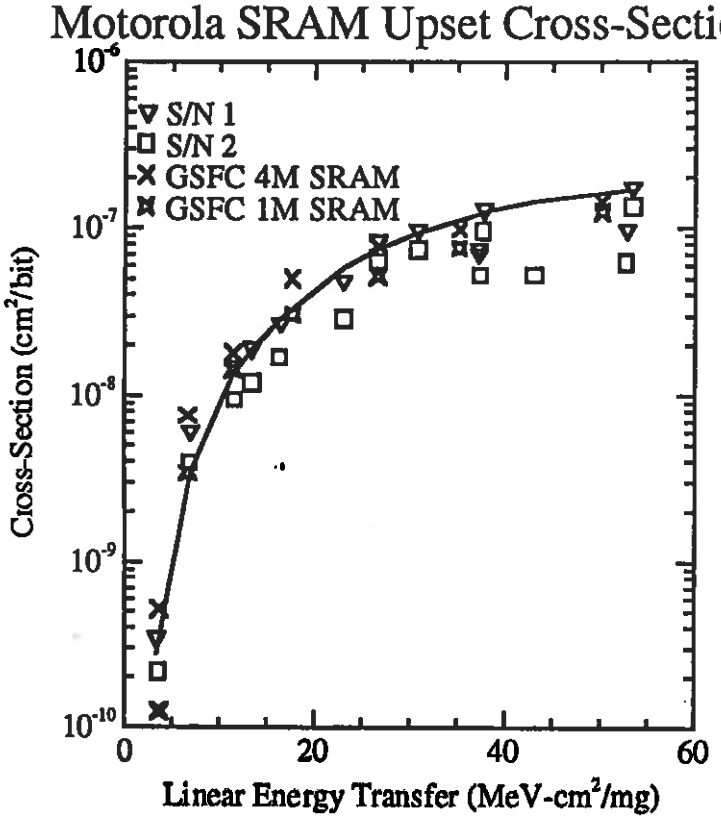
- Shieldose calculation
- Uses previous spectra
- Hollow sphere and finite slab geometries
- Use 75 mils Al as hardness requirement

  5 krads (Si)

Requirements

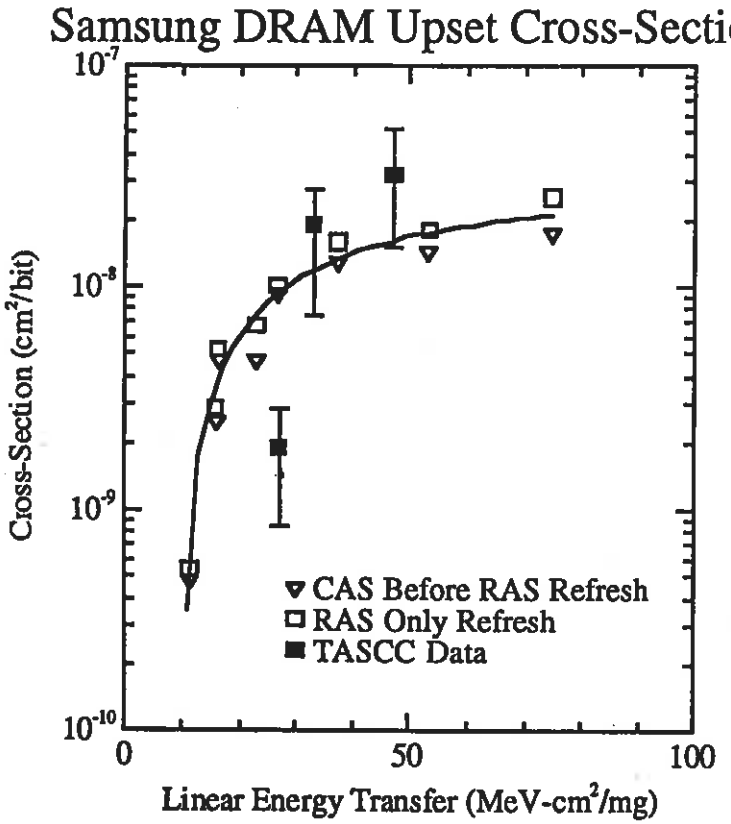
- Total Dose
  - w 5 krads (Si)
  - w Includes Margin of 2
- No Latchup
- SEU must not impact system performance
  - w Mitigation is allowed

SRAM SEU Results



- 4 Mbit Motorola SRAM
- Packaged by Austin
- Peak heavy ion rate
  - w 35 errors/dev-day
- Peak proton rate
  - w 1860 errors/dev/day

DRAM SEU Results

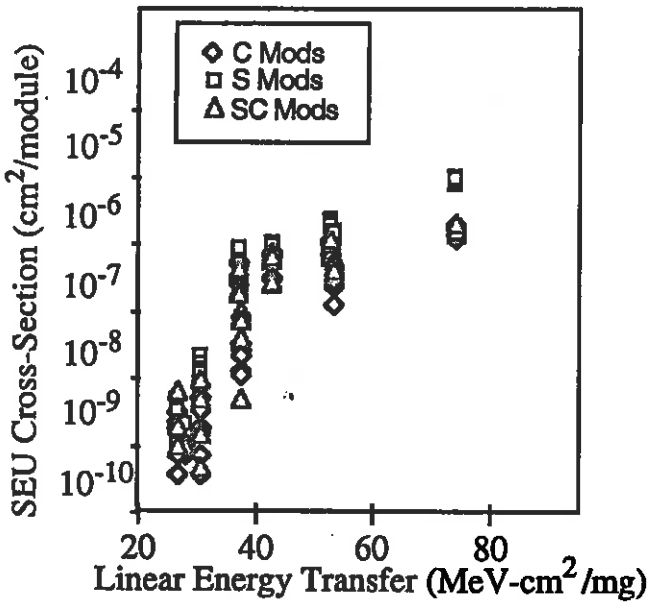


- 64 Mbit Samsung DRAM
- Peak heavy ion rate
  - w 30 errors/dev-day
- Peak proton rate
  - w 2000 errors/dev-day

DC/DC Converter SEU Results

- Some devices can show drop-outs that are not self-correcting or are long-term
- Tested Interpoint and Lambda
- Lambda preferred for engineering reasons
- Depending on which PWM is used, some show long-term drop-outs
- Performance is acceptable with correct PWM

A1280 SEU Results



- Similar to previous Actel 1280s
  - Except S-mods
- Not susceptible to protons
- C-mods and SC-mods usable
- Recommend TRM for critical registers/latches
- Error rate
  - 6.2 x 10-9 err/mod-day

Flash Memory

- Cells do not upset
- State machine can upset
  - w Correctable with reset command
  - w Low probability of occurance
  - w Mitigation in place to correct effect

Total Dose Summary

- About 20 lots tested
- Low requirement
- Can use transfers from any APL program
- Concentrating on MOS technology
  - w Analog parts
  - w Actel arrays
- No unacceptable parts yet