Sixth Annual IEEE-SCV Soft Error Rate (SER) Workshop

Status of JEDEC Task Group on Revision of JESD89A

Measurement and Reporting of Alpha Particle and Terrestrial Cosmic Ray-Induced Soft Errors in Semiconductor Devices

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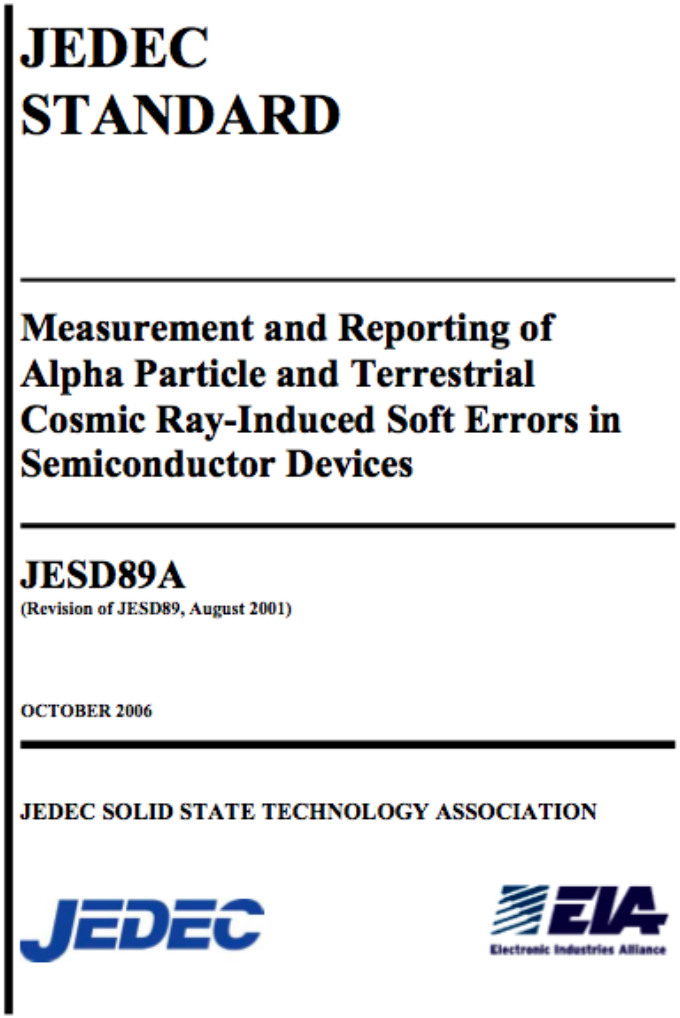
Outline

- History and Scope of JESD89
- Formation of Task Group to Address Updates Needed
- Summary of Update Areas
- Target Schedule

History of JESD89



JEDEC
STANDARD

Measurement and Reporting of Alpha Particle and Terrestrial Cosmic Ray-Induced Soft Errors in Semiconductor Devices

JESD89A
(Revision of JESD89, August 2001)

OCTOBER 2006

JEDEC SOLID STATE TECHNOLOGY ASSOCIATION

JEDEC

EIA
Electronic Industries Alliance

- First revision created August 2001
- Second revision released October 2006
- 94 page technical document

JESD89A Table of Contents

Task Group Composition

- Kick-off meeting July 17, 2014
- Composed of over 60 representatives from Europe/US/Asia
- Two bi-weekly meetings (morning PDT for US/EU and evening PDT for US/Asia)

NAME	COMPANY/INSTITUTION
Jaume Abella	BSC
Dan Alexandrescu	iROC Technologies
Hiroaki Asai	HIREC
Jean Luc Autran	Aix-Marseille Université
Robert Baumann	TI
Cyrille Beltrando	iROC Technologies
Bharat Bhuva	Vanderbilt University
Ewart Blackmore	TRIUMF
Mark Burns	IBM
Ethan Cannon	Boeing
Clark, Brett	Honeywell
Cristian Constantinescu	AMD
Mike Dion	Rockwell Collins
Anand Dixit	Oracle
Laura Dominik	Honeywell
Robert Edwards	Retired Sept 15
Adrian Evans	iROC
Veronique Ferlet-Cavrois	European Space Agency
Christopher Frost	STFC
Gilles Gasiot	ST
Dimitris Gizopoulos	University of Athens
Mike Gordon	IBM
Yi He	Intel
Eishi Ibe	Hitachi
Kazutoshi Kobayashi	Kyoto Institute of Technology
Reed Lawrence	BAE Systems
Jean-Luc Leray	French CEA
Klas Lilja	Robust Chip
Nick Lycoudes	Freescale
Nihaar Mahatme	Freescale

NAME	COMPANY/INSTITUTION
Greg Massey	IBM
Dave Matthews	Rockwell Collins
Brendan McNally	XIA
Bradley Melnick	Freescale
Sarah Michalak	LANL
Subhasis Mitra	Stanford University
Naveen Muralimanohar	Hewlett Packard
Balaji Narasimham	Broadcom
Alexander Narr	Global Foundries
Michael Nicolaidis	TIMA Laboratory
Anthony Oates	TSMC
Ilia Polian	University of Passau
Heather Quinn	LANL
Paolo Rech	Instituto de Informatica, Brasil
Sana Rezgui	Linear Technology
Willliam H. Robinson	Vanderbilt University
Philippe Roche	ST Micro
Tatsuhiko Sato	JAEA
Frank Schlaphof	Global Foundries
Norbert Seifert	Intel
Brian Sierawski	Vanderbilt University
Vilas Sridharan	AMD
Nelson Tam	Marvell
Taiki Uemura	Fujitsu Laboratories
Nobuyuki Wakai	Toshiba
Jih-Jong Wang	Microsemi
Shi-Jie Wen	Cisco
Jeff Wilkinson	Medtronic
Rick Wong	Cicso
Stephen Wong	AMD

SCOPE

- No change
- JESD89 will remain a component test standard for soft errors in terrestrial environments
- Applicable to all semiconductor devices in general (but tends to be memory/flip-flop centric)
- Avionic, space, military and medical environments are out of scope

Alpha SER

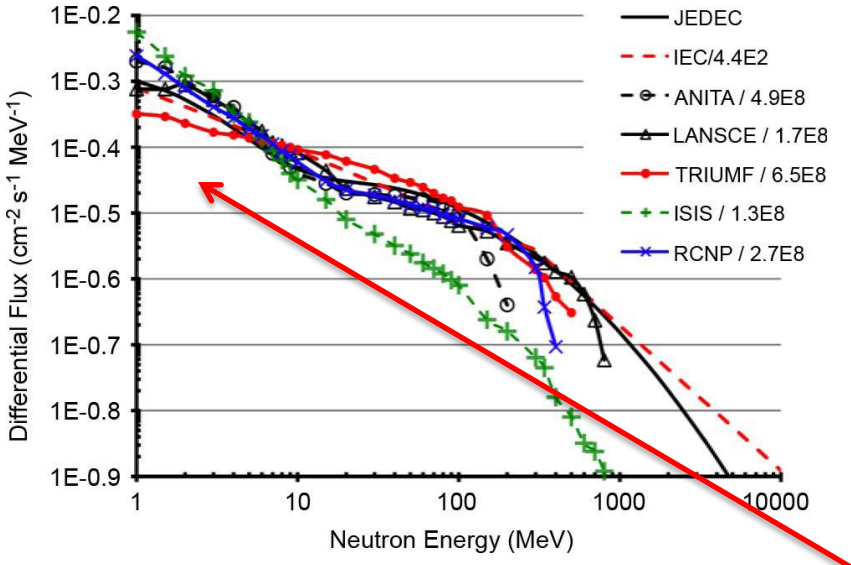
- Add details on
  - Surface emission vs bulk emission
  - Source emission uniformity and time dependent emissivity
  - Solid angle and energy loss
- Emphasize alpha particles can be an issue for any material that originates from the earth (vs synthetic)
  - Dispel myth that lead-free products are automatically low alpha

High Energy Neutron SER - General

- Update beam facility information – new beams now online or soon to be online
- Continue to support mono-energetic and quasi-monoenergetic testing

High Energy Neutron SER - E_{min}

- Cut-off energy (E_{min}) – currently 10MeV but literature indicates cross-sections can be as low as 1-2MeV



Device	Capacity (Mb)	Process Tech. (nm)	E_{min} (MeV)	Ref.
SRAM	4	350-500	2.5	[5]
SRAM	1	250	~2	[4]
SRAM	4	180	1.5	[3]
SRAM	8	180	~2	[4]
SRAM	8	180	4	[3]
SRAM	16	130	3.5	[3]
DRAM	64	250	3.5	[3]

Significant part of neutron spectrum lies between 1 – 10MeV

High Energy Neutron SER – Weibull Fit

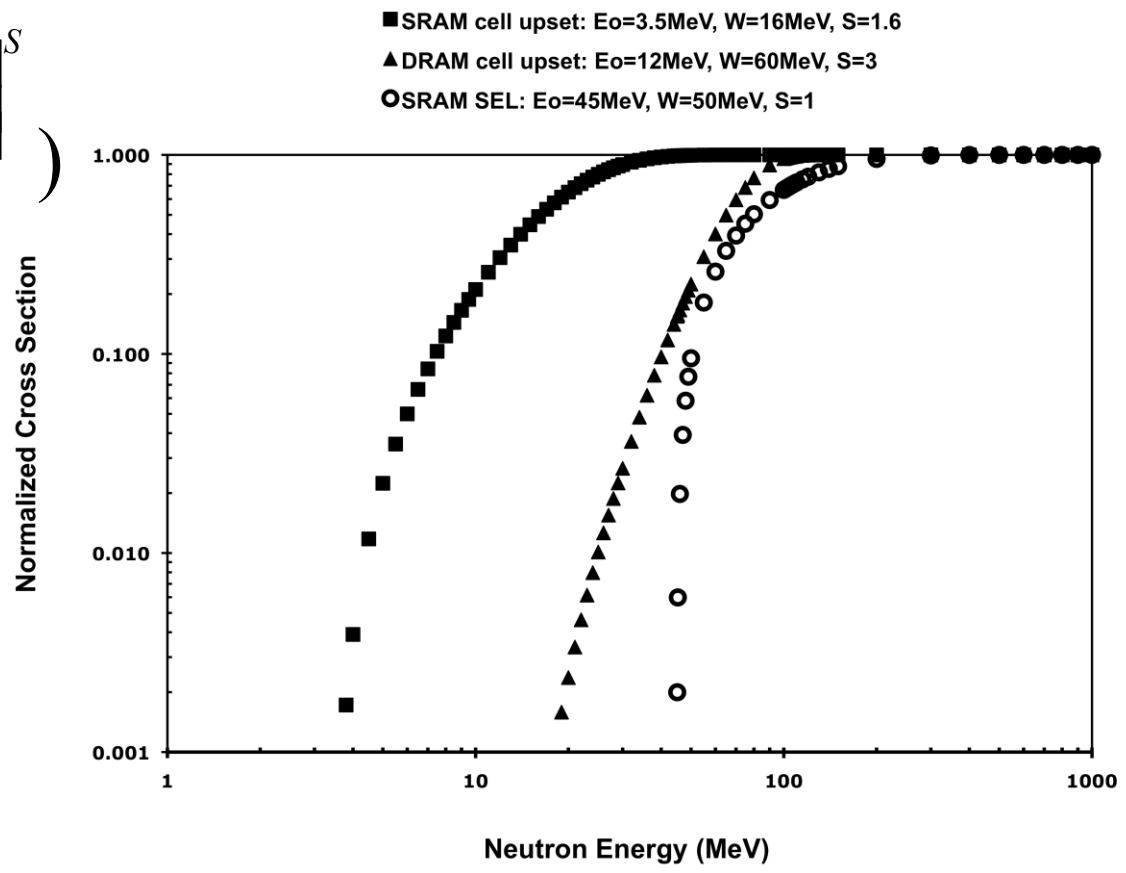
- Is four-parameter Weibull still appropriate for deep-nanometer designs?

$$\sigma(E) = \sigma_0\left(1 - e^{-\left[\frac{E-E_0}{W}\right]^S}\right)$$

E_0 is the cut-off energy

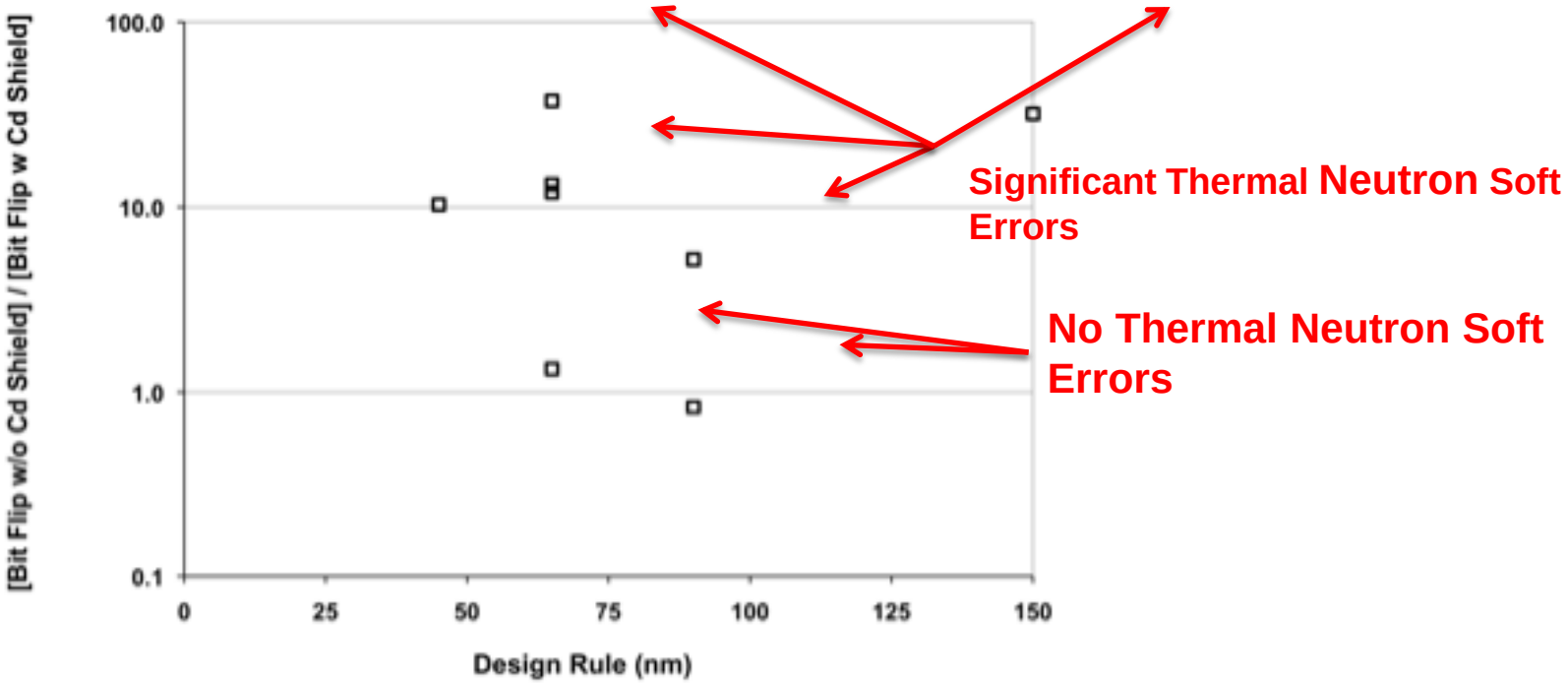
σ_0 is the saturated cross section

S and W are width and shape fitting parameters



Thermal Neutron SER

- Address misconception that thermal neutron SER is only a BPSG issue



S.J. Wen et.al., "Thermal Neutron Soft Error Rate for SRAMs in the 90nm-45nm Technology Range", *Proc. of the IEEE 48th Int. Rel. Physics Symp.*, May 2010, Anaheim, CA.

Muon SER

- Muons (anti-muon) are negatively (positively) charged particles with 200x mass of electrons
- TBD if muon cross-sections are significant enough to warrant adding a new section
- Decision will be made before submitting for electronic ballot

MISC

- Create reporting format/template to make reports more consistent across all suppliers
  - Guidance on correlation of different methods (real time SER vs accelerated SER)
- Make different types of soft errors more explicit – single cell, multi-cell, SEFI, latch-up, etc
- Expand on SER testing of non-memory type devices (power devices, analog, etc.)

SUMMARY

- Many new discoveries have been made in soft error effects since the Oct. 2006 release of JESD89A
- Task group has started working on revisions for JESD89B
- Target schedule
  - Final draft ready for ballot late-2014
  - Response and closure with ballot comments
  - Final version mid-2015

THANK YOU!