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HIGH ENERGY/LET RADIATION EEE PARTS CERTIFICATION HANDBOOK

**Responsible Office:
Engineering Directorate – Avionic Systems Division**

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HIGH ENERGY/LET RADIATION EEE PARTS CERTIFICATION HANDBOOK

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Change History Log

Revision	Date	Originator	Description of Changes
Basic	March 2012	Brandon Reddell	Initial Release

1.0 SCOPE

Certifying electronic components is a very involved process. It includes pre-coordination with the radiation test facility for time, schedule and cost, as well as intimate work with designers to develop test procedures and hardware. It also involves work with radiation engineers to understand the effects of the radiation field on the test article/setup as well as the analysis and production of a test report. The technical content of traditional ionizing radiation testing protocol is in wide use and generally follows established standards (ref. Appendix C). This document is not intended to cover all these areas but to cover the methodology of using Variable Depth Bragg Peak (VDBP) to accomplish the goal of characterizing an electronic component.

The Variable Depth Bragg Peak (VDBP) test method is primarily used for deep space applications of electronics. However, it can be used on any part for any radiation environment, especially those parts where the sensitive volume cannot be reached by the radiation beam. An example of this problem would be issues that arise in de-lidding of parts or in parts with flip-chip designs, etc.

The VDBP method is ideally suited to test modern avionics designs which increasingly incorporate commercial off-the-shelf (COTS) parts and units. Johnson Space Center (JSC) developed software provides assistance to users in developing the radiation characterization data from the raw test data.

1.1 Purpose

The purpose of this document is to provide an overview of the VDBP method and to provide test procedure guidelines to the user who chooses to implement this method over traditional heavy ion methods.

1.2 Applicability

This standard is applicable to all NASA JSC organizations including Ellington Field, the Sonny Carter Training Facility, and the White Sands Test Facility.

This handbook is applicable to any projects using the VDBP to test electronics and use of the supplied software to analyze the results. This method is usable for the electronics on all deep space missions.

1.3 Conventions

The specifics of the test and analysis procedures for VDBP will be discussed along with technical aspects of the methodology.

1.4 Measurement / Verification

Technical compliance to the methods described in this handbook will be verified by the successful completion of a Test Readiness Review prior to test activity.

1.5 Cancellation / Rescission

Upon issuance of this handbook, no documents are cancelled:

2.0 REFERENCES

The latest issuances of cited documents shall apply unless specific versions are designated.

2.1 Applicable Documents

N/A

2.2 Resolving Conflicts

N/A

2.3 Reference Docs

Additional informative references are located in APPENDIX B .

3.0 ACRONYMS, TERMS, AND DEFINITIONS

Specialized terms, acronyms, and definitions used in this document are defined in APPENDIX A

4.0 SPACE RADIATION ENVIRONMENT

4.1 Overview

High energy heavy ions are required to test electronic parts for deep space environments since they will be encountered on deep space missions. Figure 4-1 shows the background galactic cosmic ray (GCR) environment computed from the Badhwar-O'Neill GCR model (reference APPENDIX B).

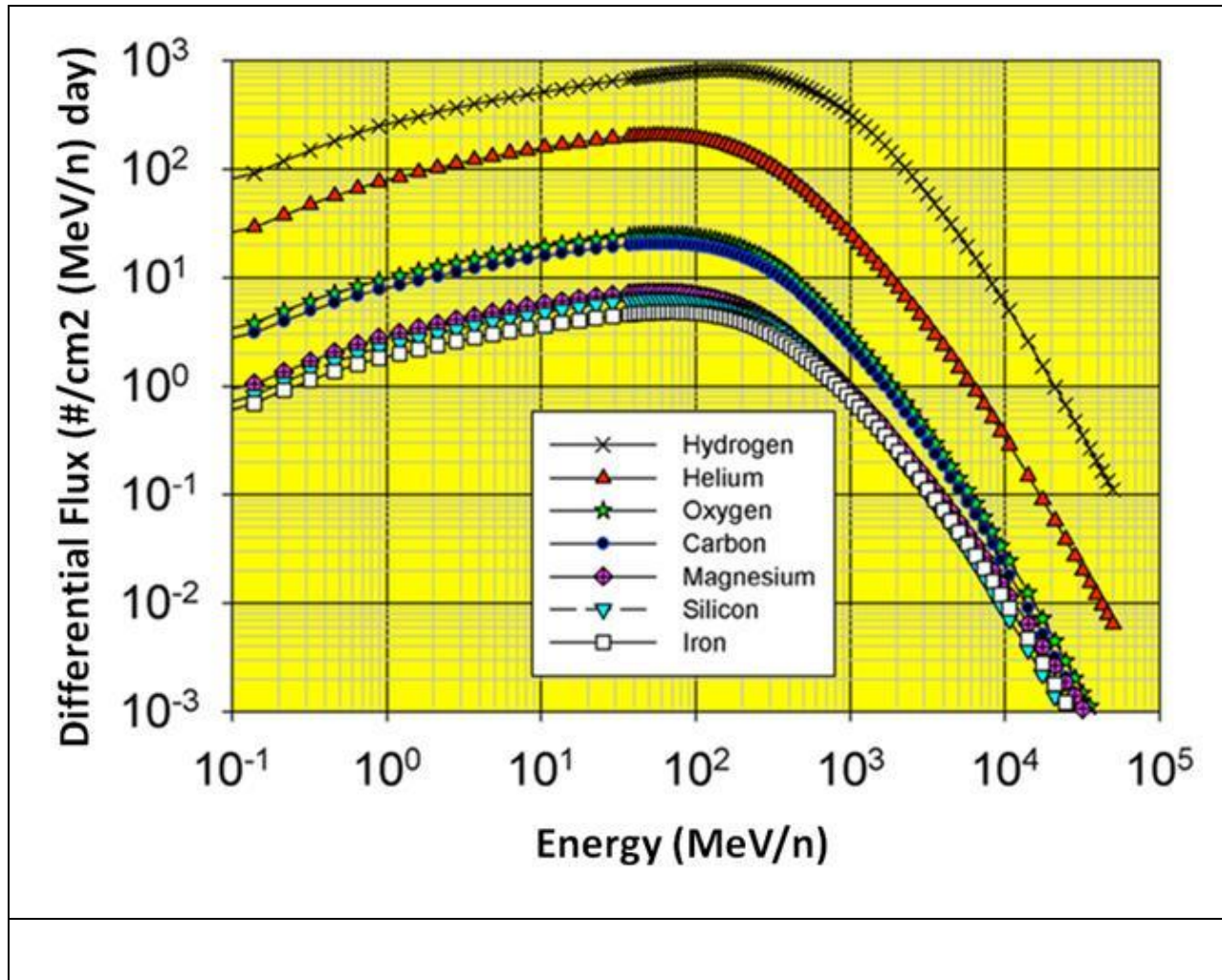


Figure 4-1 The Most Abundant Elements in the Galactic Cosmic Ray Environment

As can be seen from Figure 4-1, the range of energies of the particle extends over seven orders of magnitude. The fluxes peak around 100-200 MeV/n, however a significant flux of higher energies exist and can easily penetrate typical spacecraft shielding. These particles pose the greatest threat to active electronics.

Figure 4-2 shows the full GCR differential spectrum as a function of Linear Energy Transfer (LET). All observed elements in the natural spectrum (up to Iron) and extrapolated up to Uranium are included in the plot. Also shown is the modified GCR behind 1 inch of aluminum shielding. The

shielding attenuates the spectrum only slightly showing that shielding doesn't have much effect in shielding GCRs. The NASA Space Radiation Laboratory (NSRL) gold beam can simulate most of the LET spectrum, ranging from approximately 24-86 MeV-cm²/mg.

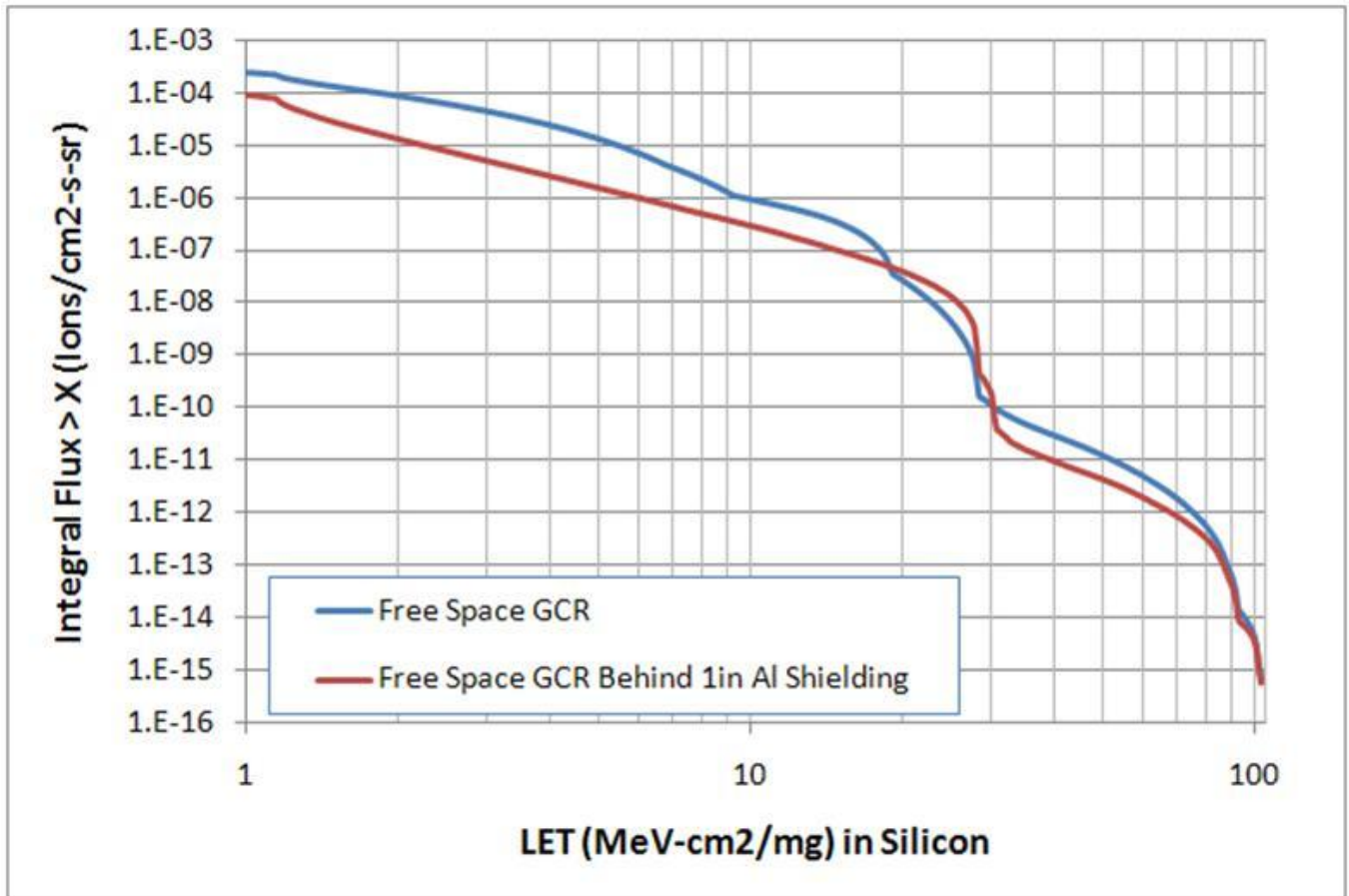


Figure 4-2 Differential Galactic Cosmic Ray Spectrum in Free Space and Behind 1 Inch of Aluminum Shielding

4.2 Induced Ionizing Radiation Environments

To date, traditional test facilities in the U.S., such as the Texas A&M Cyclotron Facility and the Lawrence Berkeley National Laboratory, only offer low energy heavy ion beams with energies in the range of 10-40 MeV/n. NSRL offers beams more much higher energy beams, 100-300 MeV/n, closer to what is expected in space. These energies are at or near the peak flux occurring in space. NSRL also provides the user with the ability to degrade the beams down (in energy/velocity) in order to position the Bragg Peak on sensitive areas in EEE parts.