IRHC9A9x064 - SEE Test Report

Single Event Effects (SEE) Test – R9, 60V, P-channel Super-Junction MOSFET, Die Size 6

About this document

Scope and purpose

This document describes the Single Event Effects (SEE) radiation tests and results for International Rectifier HiRel Products, Inc. 60V, R9, die size 6, P-channel super-junction power MOSFET. The part numbers validated based on these tests are:

IRHNS9A97064, IRHNS9A93064, IRHMS9A97064, IRHMS9A93064.

This testing is to document the performance of a new product in wafer fabrication facility from Fab 2.

Intended audience

This document is intended for customers seeking to understand the radiation tests performed on power MOSFETs.

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1 Device Description

The IRHC9A97064 is a radhard super-junction MOSFET for space applications. The MOSFET is designed using the R9 technology platform. This super-junction power MOSFET is intended for use in applications such Point-of-Load converter, synchronous rectification, high-voltage power switching, etc. It is rated at 60V BV_{DSS} and the dimensions of bare die is approximately 6.86mm x 9.40mm. The 60V design architecture has been qualified for the given die size.

Table 1 Device Characteristics

Device	Generation	Channel	BV_{DSS}	$I_{D(max)}$ [1]	$R_{DS(on)}$ [1]	$Q_{g(max)}$ [1]	Die Size	Package
IRHNS9A97064 IRHNS9A93064	R9	P	-60V	-100 A	9.0 mΩ	221 nC	6.86 x 9.40 (mm x mm)	SupIR
IRHMS9A97064 IRHMS9A93064	R9	P	-60V	-45 A	12.5 mΩ	221nC	6.86 x 9.40 (mm x mm)	Low-Ohmic TO-254AA

1.1 Reference Documents

Datasheet: IRHNS9A97064, IRHMS9A97064
Standards: MIL-PRF-19500, MIL-STD-750
IR HiRel Test Methodology: Infineon IRHirel Radiation Test Methodolgy - Power MOSFETs

1.2 Measured Parameters

Test samples have passed on-wafer tests, notably BV_{DSS}, $V_{gs(th)}$, $R_{DS(ON)}$, I_{DSS}, I_{GSS} with their parameters within predetermined upper/lower limits. Parameter measurements have been performed on adapter-mounted devices to check that devices have not been degraded. For Post-SEE Electricals, *Pass* or *Fail* are based on electrical parameters listed on page 7.

[1]Refer to datasheet for test conditions and typical values

2 Single-Event Effects (SEE) Test Overview

2.1 Proposed Test

IRHC9A97064 was tested & spec'ed for SEE Performance at Cyclotron Institute, Texas A&M University (TAMU). The intent of this testing is to utilize previous performance data of Fab-2 9A97034 (-60V, Size 3 material) as an initial baseline for performance comparison, a summary of which is shown in Table 2 and Figure 1 below:

Table 2 Typical Single Event Effect, Safe Operating Area (TAMU)

	V_{DS} (V)		
V_{GS} (V)	LET=38.7 ± 7.5%; 325MeV ± 5%; 41µm ± 7.5%	LET=62 ± 10%; 605MeV ± 10%; 50.2µm ± 7.5%	LET=91.3 ± 5%; 1295MeV ± 7.5%; 71.6µm ± 5%;
0	-60	-60	-60
2	-60	-60	-60
5	-60	-60	
10	-60		
15			

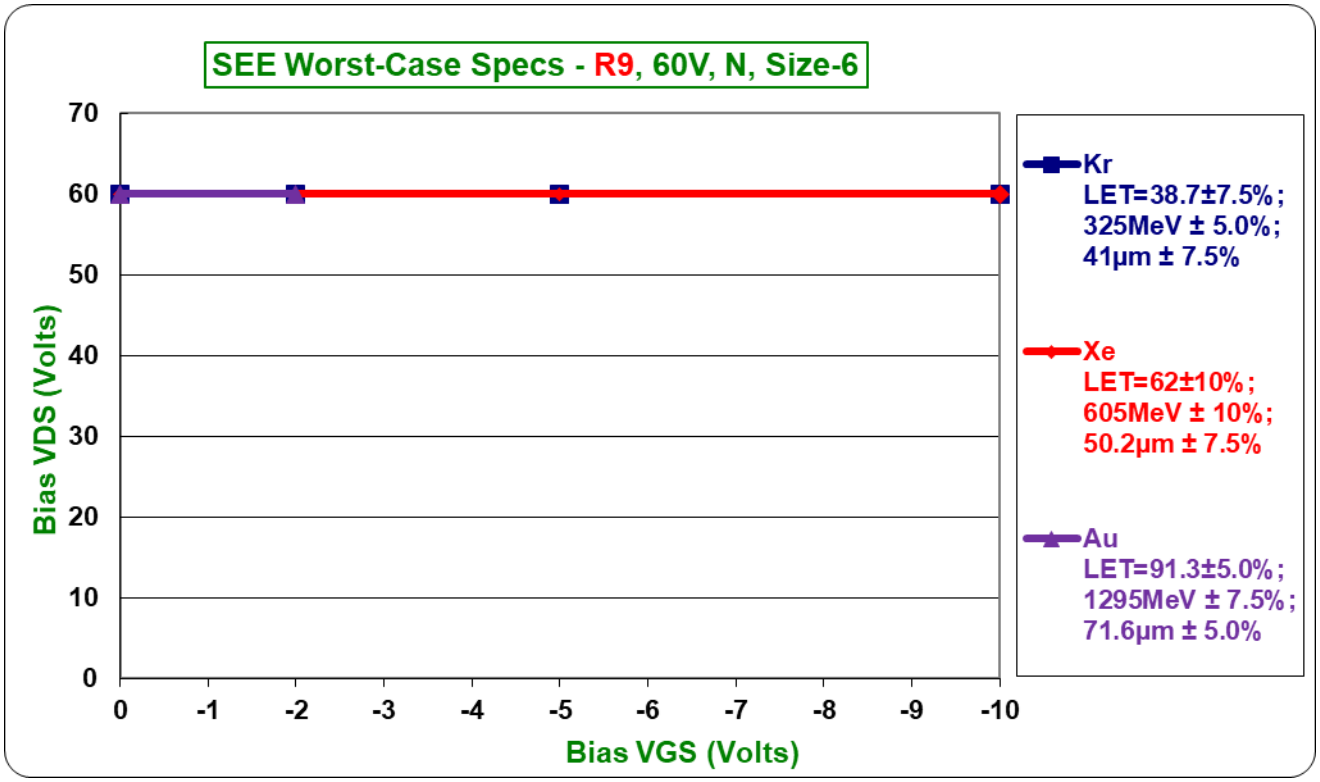


Figure 1 Typical Single Event Effect, Safe Operating Area (TAMU)

The next sections describe the radiation tests performed at TAMU on Fab-2 Qualification materials.

2.2 Test Objectives

The goal of this SEE testing is to establish that the Fab-2 IRHC9A97064 material meets or exceeds the previously published capability of Fab 2 Size-3- material. SEE capability is measured by a material's ability to withstand exposure to various heavy ions and is achieved by determining the threshold LET (minimum linear energy transfer) required to cause a single ion-induced failure under the bias conditions. Heavy-ion radiation tests for SEE characterization are performed at Cyclotron Institute, Texas A&M University using K500 Superconducting Cyclotron.

Table 3 Overview of SEE tests – Worst-Case Beam Conditions

Ion	Beam Energy [MeV]	Air-gap [cm]	LET [MeV/mg/cm^2]	Range [µm]	Run No.	Test Date	Wafer Lot _ SEE-ID
^{197}Au	1201	1.5	92.4	69.6	130 - 148 149 - 160 161 - 170	Nov. 07-10, 2021	A991882.1_15K A991898.1_16K A991906.1_17K
^{129}Xe	665	1.5	68.0	51.9	1394 – 1403 1401 – 1414 1415 - 1424	Apr. 06-10, 2022	A991882.1_15K A991898.1_16K A991906.1_17K
^{84}Kr	341	1.5	39.7	43.2	1625 – 1636 1637 – 1646 1647 - 1656	Apr. 06-10, 2022	A991882.1_15K A991898.1_16K A991906.1_17K

Table 3 highlight the test overview indicating run number, test date, wafer lot number, ion species, beam energy, LET, range in Si and air-gap between the beam and DUT. These are special beam conditions called "Worst-Case" at which the ion Bragg peak is at the Epi-Substrate Interface.

3 Test Sequence

All the tests are done at normal incidence which has been determined to be the worst case for vertical DMOS power MOSFETs. To achieve the desired energy/penetration depth, aluminium foil degraders and adjusted air distances are used. The measurements and irradiation runs are performed at 25 °C temperature with average flux and fluence of $2x10^4$ ions/cm^2/s and $3x10^5$ ions/cm^2, respectively. The test procedure is based on MIL-STD-750, Method 1080. For more detailed description on test methodology employed by IR HiRel, refer to *SEE Test Methodology* document.

3.1 Test Bias Sequence for SEB-SOA

1. V_{GS}: 0 V
2. V_{DS}: Start at -5V. Increase in steps of 5V until $V_{DS(max)}$ or FAIL occurs

3.2 Test Bias Sequence for SEGR-SOA

1. V_{DS}: Keep V_{DS} at maximum (at which PASS value was obtained for previous test bias sequence i.e. SEB)
2. V_{GS}: Start at +1V. Increase in steps of +1V until $V_{GS(max)}$ or FAIL occurs

Note that it requires 3 passes for qualification and 2 failures for characterization of each SEE-SOA test point. This is validated for samples from three different wafer lots. This sequence is repeated for the next ion species. The detailed logsheet for each run is provided in Appendix A and Appendix B. The combination of SEB-SOA and SEGR-SOA yields the SEE-SOA.

4 Test Results

4.1 Test Criterias

- Pass/Fail criteria is based on I_{DSS}, I_{GSSf} and I_{GSSr} limits (shown in Table 5)
- Required number of test samples per test case: 2 (for FAIL) / 3 (for PASS)
- Post Irradiation Gate Stress (PIGS) test: $V_{GS} = V_{GS(max)} = \pm 20V$ at $V_{DS}=0V$ is applied to verify the gate integrity

Table 4 Electrical Parameters Limits

Parameter	Test Conditions	Limit
I_{DSS}	V_{DS} = -48 V, V_{GS} = 0V	≤ -10µA
I_{GSSf}	V_{GS} = -20 V, V_{DS} = 0V	< -100nA
I_{GSSr}	V_{GS} = +20 V, V_{DS} = 0V	< +100nA
$V_{GS(th)}$	$V_{DS} = V_{GS}$, I_D = -1.0 mA	-2.0 to -4.0 V
BV_{DSS}	I_{DSS} = -1.0 mA	≥ -60 V
$R_{DS(ON)}$	V_{GS} = -12 V, I_D = -22 A	< 0.020 Ω
V_{SD}	I_S = -22 A	≤ -1.2 V

The insitu leakage current (I_{DSS}, I_{GSS}) were measured and bias voltages V_{DS}, V_{GS} were changed during the test to obtain different test data points. Under worst-case beam conditions, insitu leakage variation over time for each ion and two different (arbitrarily selected) run numbers are shown in figures below.

Heavy Ion Response for a ^{84}Kr ion:

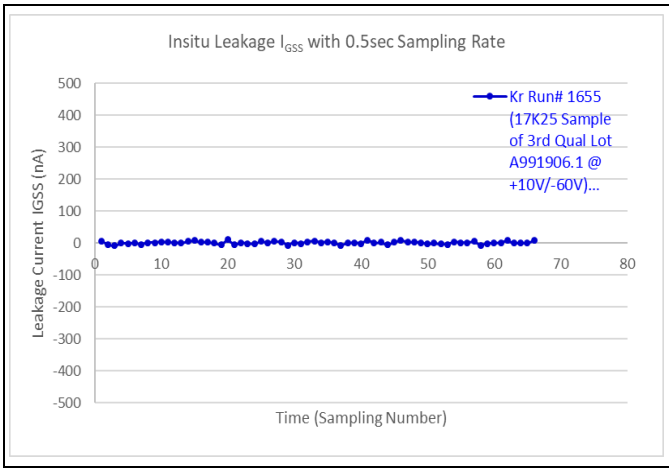


Figure 2 I_{GSS} vs. elapsed time (^{84}Kr ion)

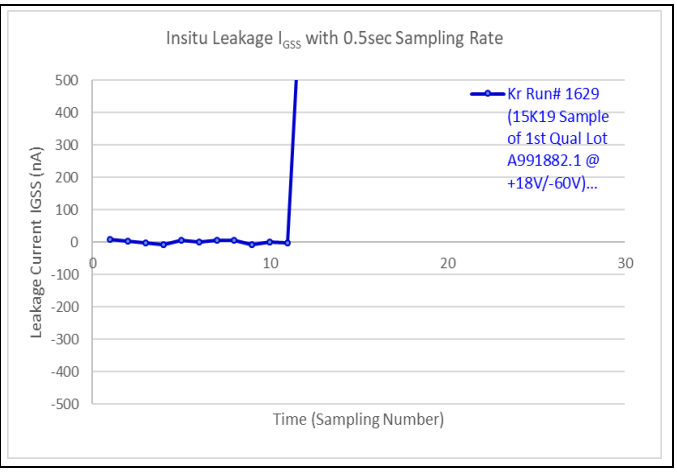


Figure 3 I_{GSS} vs. elapsed time (^{84}Kr ion)

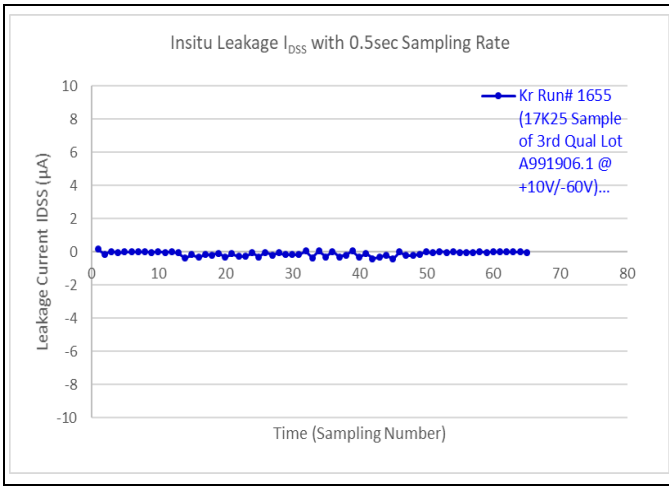


Figure 4 I_{DSS} vs. elapsed time (^{84}Kr ion)

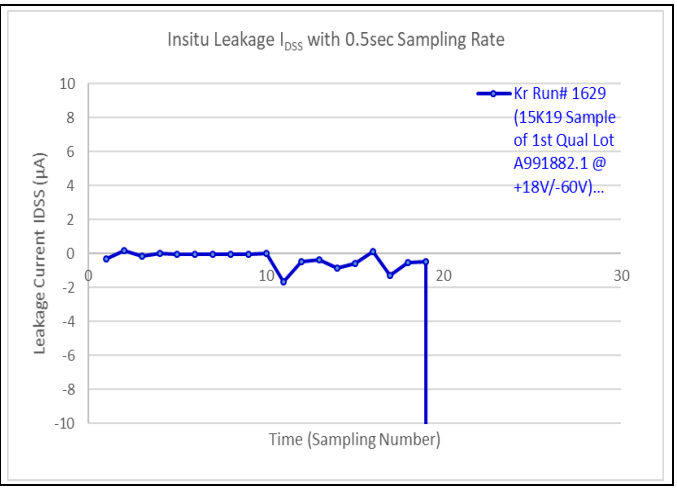


Figure 5 I_{DSS} vs. elapsed time (^{84}Kr ion)

In April 2022 TAMU Test Trip,

- During irradiation under ^{84}Kr ion in run number 1655 at V_{DS} = -60V & V_{GS} = +10V, the device 17K25 of Qual Lot #3 passed (Figure #2 & #4).
- In run number 1629 at V_{DS} = -60V & V_{GS} = +18V, the device 15K19 of Qual Lot #1 failed under ^{84}Kr ion. This is characterization-to-failure run (Figure #3 & #5).

For complete test data of each SEE test run, please see refer to Appendix A.

Heavy Ion Response for ^{129}Xe ion:

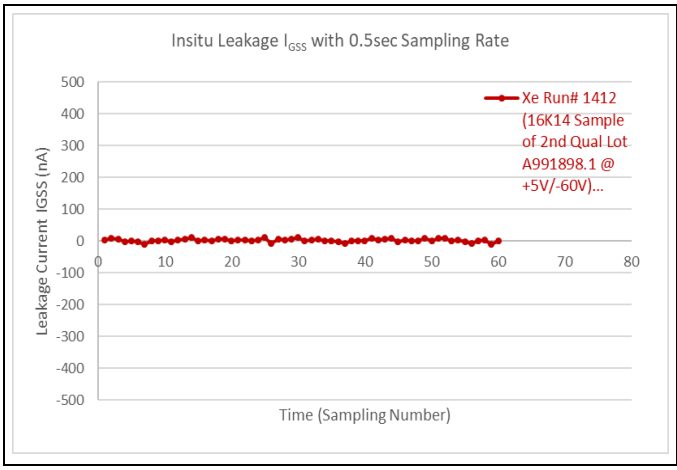


Figure 6 I_{GSS} vs. elapsed time (^{129}Xe ion)

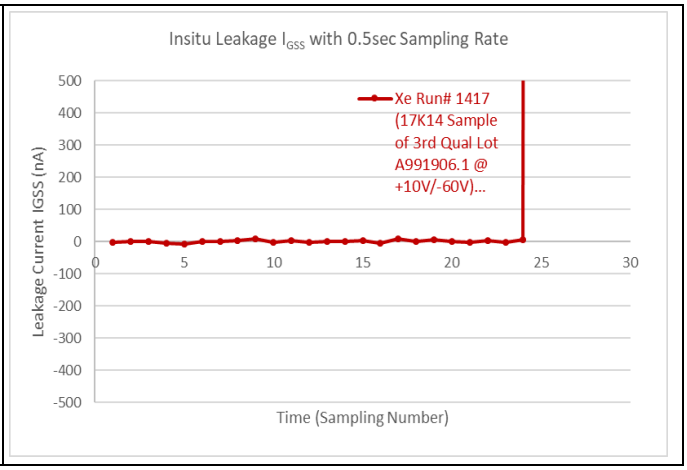


Figure 7 I_{GSS} vs. elapsed time (^{129}Xe ion)

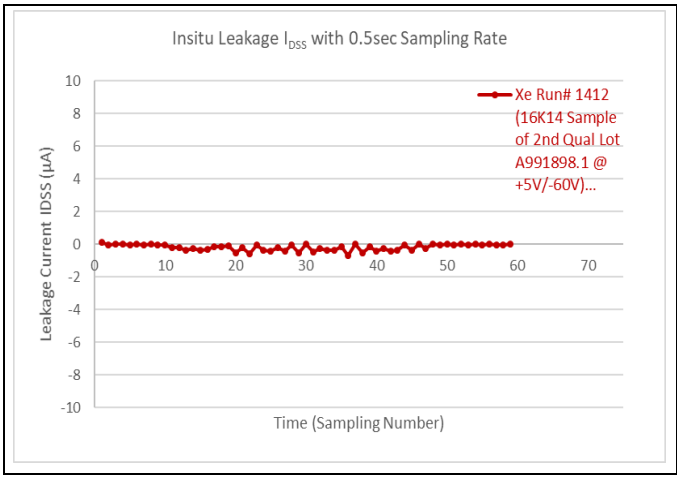


Figure 8 I_{DSS} vs. elapsed time (^{129}Xe ion)

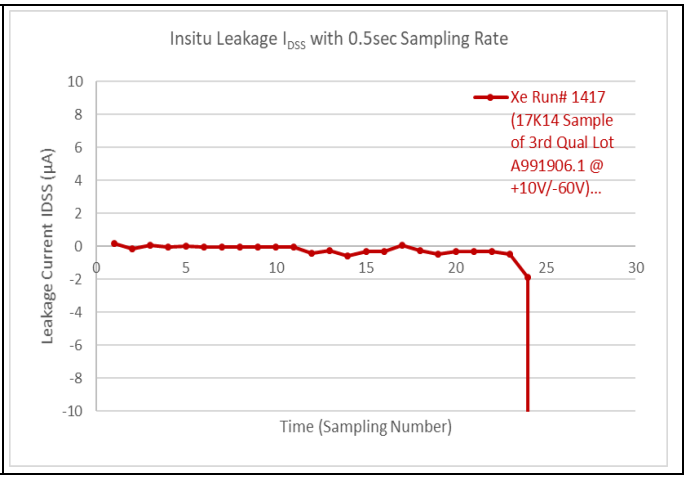


Figure 9 I_{DSS} vs. elapsed time (^{129}Xe ion)

In April 2022 TAMU Test Trip,

- During irradiation under ^{129}Xe ion in run number 1412 at V_{DS} = -60V & V_{GS} = +5V, the device 16K14 of Qual Lot #2 passed (Figure #6 & #8).
- In run number 1417 at V_{DS} = -60V & V_{GS} = +10V, the device 17K14 of Qual Lot #3 failed under ^{129}Xe ion. This is characterization-to-failure run (Figure #7 & #9).

For complete test data of each SEE test run, please see refer to Appendix A.

Heavy Ion Response for ^{197}Au ion:

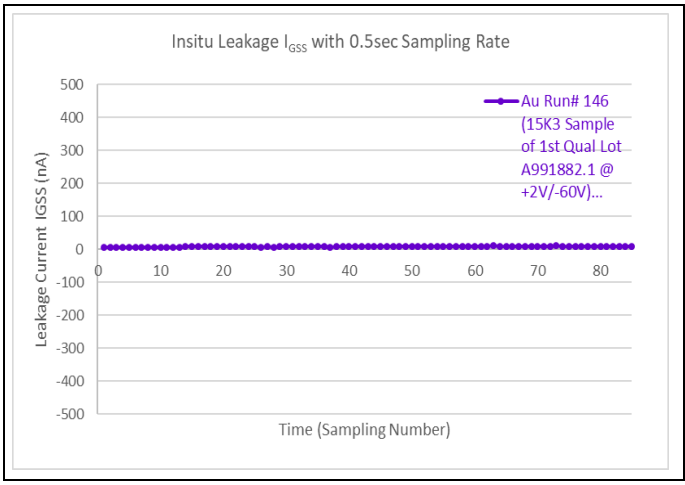


Figure 10 I_{GSS} vs. elapsed time (^{197}Au ion)

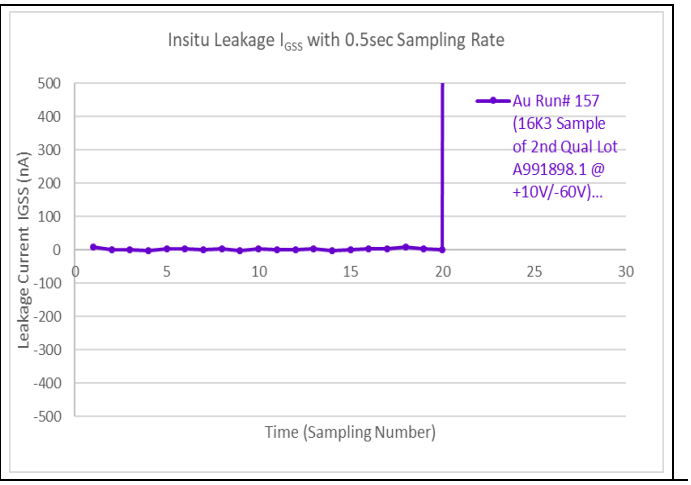


Figure 11 I_{GSS} vs. elapsed time (^{197}Au ion)

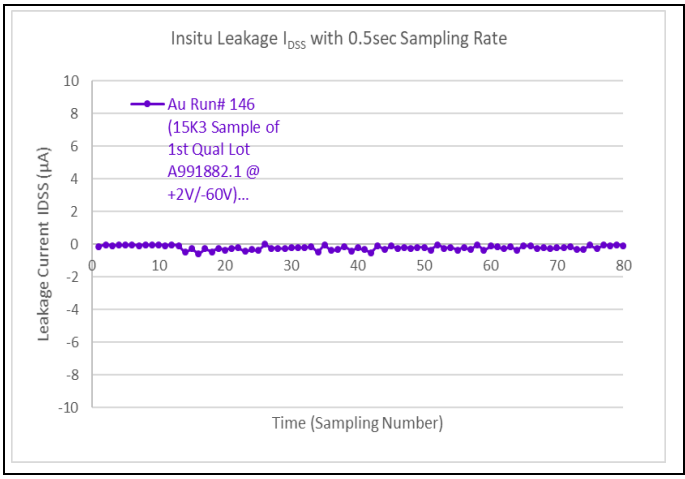


Figure 12 I_{DSS} vs. elapsed time (^{197}Au ion)

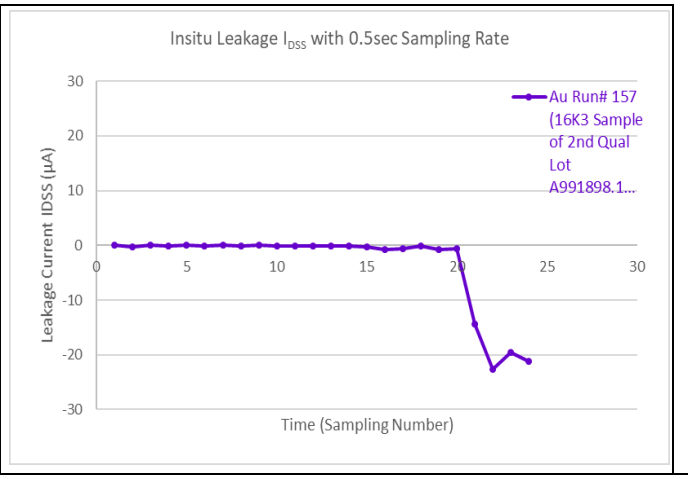


Figure 13 I_{DSS} vs. elapsed time (^{197}Au ion)

In November 2021 TAMU Test Trip,

- During irradiation under ^{197}Au ion in run number 146 at V_{DS} = -60V & V_{GS} = +2V, the device 15K3 of Qual Lot #1 passed (Figure #10 & #12).
- In run number 157 at V_{DS} = -60V & V_{GS} = +10V, the device 16K3 of Qual Lot #2 failed under ^{197}Au ion. This is characterization-to-failure run (Figure #11 & #13).

For complete test data of each SEE test run, please see refer to Appendix A.

5 Conclusion

Fab 2 Size-6 materials tested for Single Event Effects showed equivalency to the Fab 2 Size-3 materials.

Devices of type IRHC9A97064 have been tested using ion source K500 Cyclotron (TAMU) with higher energy and maximum SEE-SOA for V_{DS}/V_{GS} combinations established. Each point on the graph, or insitu bias condition, has been verified by irradiating and subsequent electrical testing of a minimum of 3 devices, with no valid failures allowed. Results based on worst-case beam conditions are shown in Table 5 and Fig. 14.

- Worst-case Kr with 43.2 µm ion penetration results into an SOA of VDS = -60V up to VGS = +10V
- Worst-case Xe with 51.9 µm ion penetration results into an SOA of VDS = -60V up to VGS = +5V
- Worst-case Au with 69.6 µm ion penetration results into an SOA of VDS = -60V at VGS = +2V

Table 5 Typical Single Event Effect, Safe Operating Area (Resulted Responses from TAMU)

	V_{DS} (V)		
V_{GS} (V)	WC-Kr; 1.5cm; LET=39.7; 341MeV; 43.2µm	WC-Xe; 1.5cm; LET=68; 665MeV; 51.9µm	WC-Au; 1.5cm; LET=92.4; 1201MeV; 69.6um
0	-60	-60	-60
2	-60	-60	-60
5	-60	-60	
10	-60		
15			

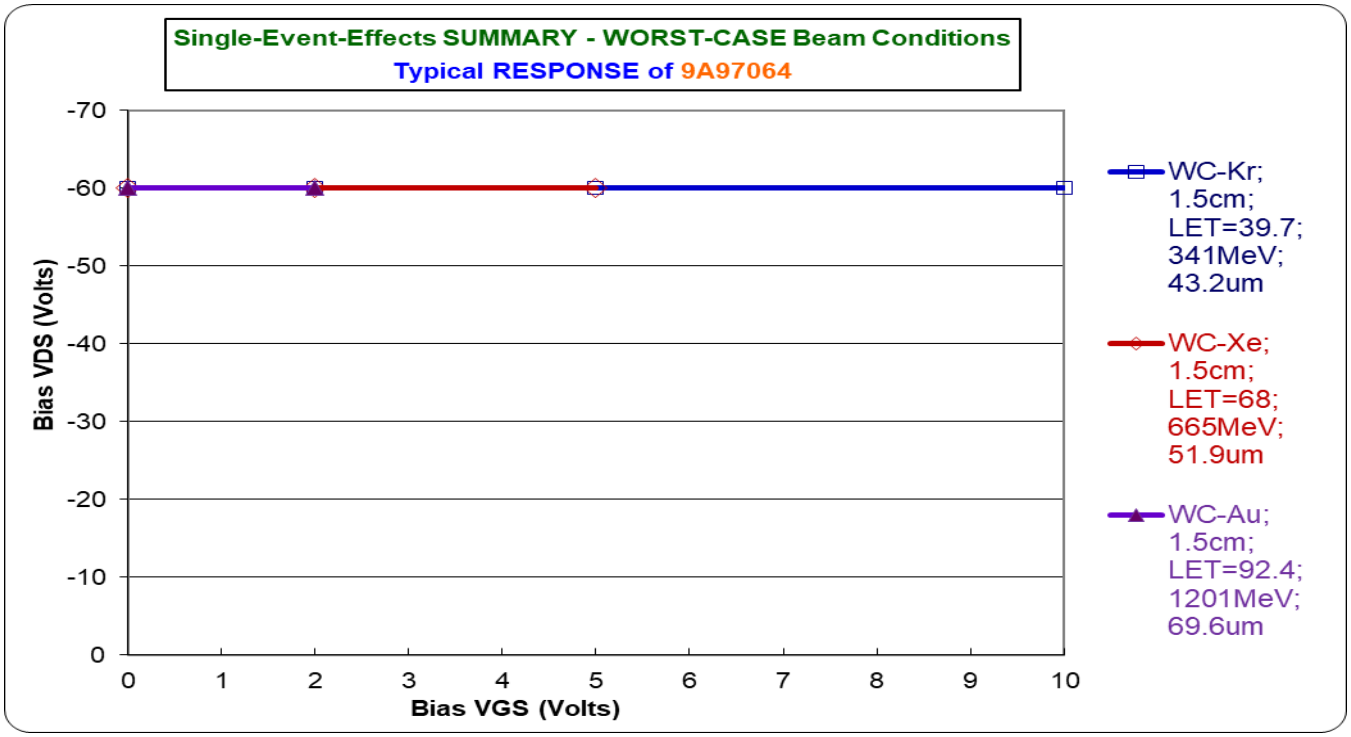


Figure 14 Typical Single Event Effect, Safe Operating Area (TAMU)

Table 6 Single-Event-Effects – Beam Data & Specs of Worst-Case Beam Conditions

Due to recent update in TAMU SEUSS Software, the testing beam conditions are slightly different from last SEE Qualification of Fab-2 Materials causing a need of Change for Beam Conditions in the original data sheet SEE-SOA. Table 6 shows the Derivation of Changed Beam Conditions and testing beam is within the tolerances of the beam conditions.

CHECKING THE TEST BEAM CONDITIONS VS. THE BEAM SPECS:

		Kr	Xe	Au	Beam Conditions to Derived Ranges	Kr	Xe	Au
LET	Nominal	38.7	62	91.3	Min LET	35.80	55.80	86.74
	Tolerance	7.5	10.0	5.0	Max LET	41.60	68.20	95.87
ENERGY	Nominal	325	605	1295	Min Energy	308.8	544.5	1197.9
	Tolerance	5.0	10.0	7.5	Max Energy	341.3	665.5	1392.1
RANGE	Nominal	41	50.2	71.6	Min Range	37.9	46.4	68.0
	Tolerance	7.5	7.5	5.0	Max Range	44.1	54.0	75.2

Minimum Data Sheet Spec	35.80	308.8	37.9	55.80	544.5	46.4	86.74	1197.9	68.0
Maximum Data Sheet Specs	41.60	341.3	44.1	68.20	665.5	54.0	95.87	1392.1	75.2

	15AMeV-Xenon Kr			15AMeV-Xenon Xe			15AMeV-Gold Au		
Worst-Case Testing Beam	LET	Energy	Range	LET	Energy	Range	LET	Energy	Range
	39.7	341	43.2	68	665	51.9	92.4	1202	69.6
Meeting Data Sheet Specs?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	TAMU April-2022			TAMU April-2022			TAMU November-2021		

Table 7 Single-Event-Effects - Worst-Case Beam Conditions (TAMU) Typical Response

	V_{DS} (V)		
V_{GS} (V)	LET=38.7 ± 7.5%; 325MeV ± 5%; 41µm ± 7.5%	LET=62 ± 10%; 605MeV ± 10%; 50.2µm ± 7.5%	LET=91.3 ± 5%; 1295MeV ± 7.5%; 71.6µm ± 5%;
0	-60	-60	-60
2	-60	-60	-60
5	-60	-60	
10	-60		
15			

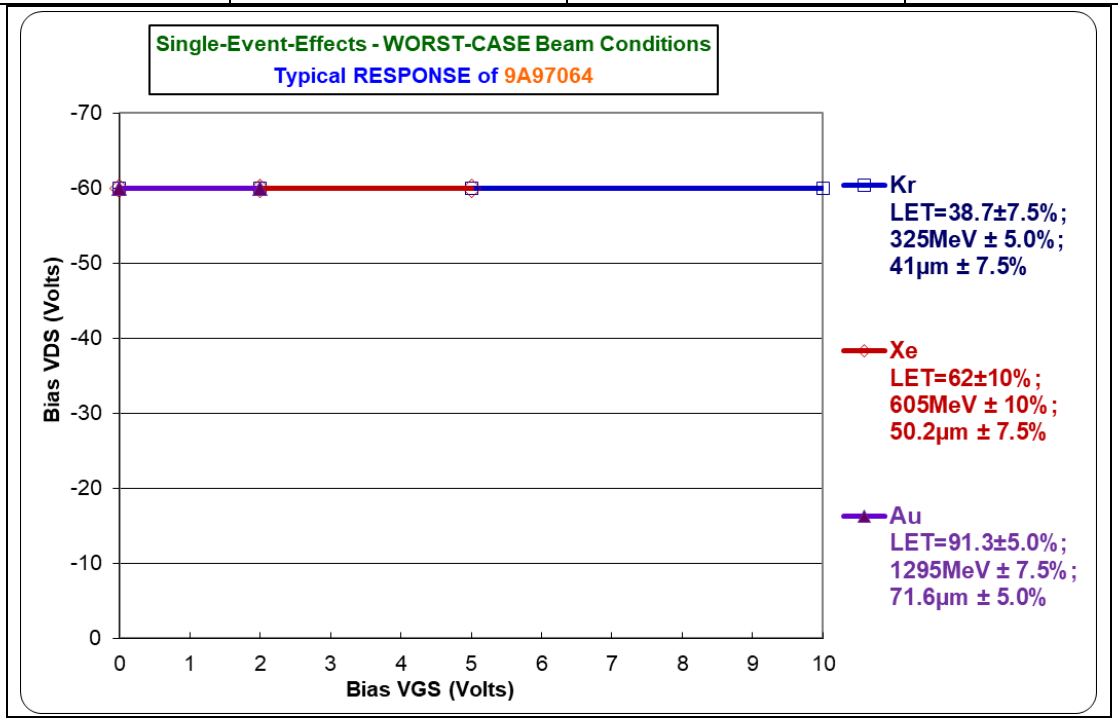


Figure 15 **Final SEE-SOA of RADhard, R6, High-voltage, 600V, N-channel MOSFET – Worst-Case Beam Conditions (TAMU)**

Appendix A – SEE Run Data

For the SEE test data of each run, please refer to the file attachements below:

Run No.	Test Date	Ion	DUT Id	Socket	WaferLot	Serial	Batch	VGS	VDS	Pass/Fail (subject to Post-SEE Electricals)
								Volts	*Volts*	*Blank=Pass*
130	11/07-10/2021		15K1	1	A991882.1	1	4	1	-60	
131	11/07-10/2021		15K1	1	A991882.1	1	4	2	-60	
132	11/07-10/2021		15K1	1	A991882.1	1	4	3	-60	
133	11/07-10/2021		15K1	1	A991882.1	1	4	4	-60	
134	11/07-10/2021		15K1	1	A991882.1	1	4	5	-60	
135	11/07-10/2021		15K1	1	A991882.1	1	4	5	-60	
136	11/07-10/2021		15K1	1	A991882.1	1	4	6	-60	
137	11/07-10/2021		15K1	1	A991882.1	1	4	7	-60	
138	11/07-10/2021		15K1	1	A991882.1	1	4	8	-60	
139	11/07-10/2021		15K1	1	A991882.1	1	4	9	-60	
140	11/07-10/2021		15K1	1	A991882.1	1	4	10	-60	
141	11/07-10/2021		15K2	2	A991882.1	2	4	2	-60	
142	11/07-10/2021		15K2	2	A991882.1	2	4	4	-60	
143	11/07-10/2021		15K2	2	A991882.1	2	4	6	-60	
144	11/07-10/2021		15K2	2	A991882.1	2	4	8	-60	
145	11/07-10/2021		15K2	2	A991882.1	2	4	10	-60	*Failed!*
146	11/07-10/2021		15K3	3	A991882.1	3	4	**2**	**-60**	←*Worst-Case Au Spec Point qualified*
147	11/07-10/2021		15K4	4	A991882.1	4	4	**2**	**-60**	←*Worst-Case Au Spec Point qualified*
148	11/07-10/2021		15K5	5	A991882.1	5	4	**2**	**-60**	←*Worst-Case Au Spec Point qualified*
		Au (15AMeV) 1.5cm AirGap LET=92.4, 1202MeV, 69.6µm (Worst-Case)								
149	11/07-10/2021		16K1	7	A991898.1	1	4	2	-60	
150	11/07-10/2021		16K1	7	A991898.1	1	4	4	-60	
151	11/07-10/2021		16K1	7	A991898.1	1	4	6	-60	
152	11/07-10/2021		16K1	7	A991898.1	1	4	8	-60	
153	11/07-10/2021		16K1	7	A991898.1	1	4	10	-60	*Failed!*
154	11/07-10/2021		16K2	8	A991898.1	2	4	4	-60	
155	11/07-10/2021		16K2	8	A991898.1	2	4	6	-60	
156	11/07-10/2021		16K2	8	A991898.1	2	4	8	-60	
157	11/07-10/2021		16K2	8	A991898.1	2	4	10	-60	*Failed!*
158	11/07-10/2021		16K3	9	A991898.1	3	4	**2**	**-60**	←*Worst-Case Au Spec Point qualified*
159	11/07-10/2021		16K4	10	A991898.1	4	4	**2**	**-60**	←*Worst-Case Au Spec Point qualified*
160	11/07-10/2021		16K5	11	A991898.1	5	4	**2**	**-60**	←*Worst-Case Au Spec Point qualified*
161	11/07-10/2021		17K1	13	A991906.1	1	4	4	-60	
162	11/07-10/2021		17K1	13	A991906.1	1	4	6	-60	
163	11/07-10/2021		17K1	13	A991906.1	1	4	8	-60	
164	11/07-10/2021		17K1	13	A991906.1	1	4	10	-60	*Failed!*
165	11/07-10/2021		17K2	14	A991906.1	2	4	6	-60	
166	11/07-10/2021		17K2	14	A991906.1	2	4	8	-60	
167	11/07-10/2021		17K2	14	A991906.1	2	4	10	-60	*Failed!*
168	11/07-10/2021		17K3	15	A991906.1	3	4	**2**	**-60**	←*Worst-Case Au Spec Point qualified*
169	11/07-10/2021		17K4	16	A991906.1	4	4	**2**	**-60**	←*Worst-Case Au Spec Point qualified*
170	11/07-10/2021		17K6	17	A991906.1	6	4	**2**	**-60**	←*Worst-Case Au Spec Point qualified*

Appendix A – SEE Run Data (continued)

For the SEE test data of each run, please refer to the file attachements below:

Run No.	Test Date	Ion	DUT Id	Socket	WaferLot	Serial	Batch	VGS	VDS	Pass/Fail (subject to Post-SEE Electricals)
								Volts	*Volts*	*Blank=Pass*
1394	04/06-10/2022	Xe (15AMeV) 1.5cm AirGap LET=68.0, 665MeV, 51.9µm (Worst-Case)	15K13	1	A991882.1	13	44	5	-60	
1395	04/06-10/2022		15K13	1	A991882.1	13	44	7	-60	
1396	04/06-10/2022		15K13	1	A991882.1	13	44	9	-60	
1397	04/06-10/2022		15K13	1	A991882.1	13	44	11	-60	*Failed!*
1398	04/06-10/2022		15K14	2	A991882.1	14	44	5	-60	
1399	04/06-10/2022		15K14	2	A991882.1	14	44	9	-60	
1400	04/06-10/2022		15K14	2	A991882.1	14	44	10	-60	*Failed!*
1401	04/06-10/2022		15K15	3	A991882.1	15	44	**5**	**-60**	***←Worst-Case Xe Spec Point qualified***
1402	04/06-10/2022		15K16	4	A991882.1	16	44	**5**	**-60**	***←Worst-Case Xe Spec Point qualified***
1403	04/06-10/2022		15K17	5	A991882.1	17	44	**5**	**-60**	***←Worst-Case Xe Spec Point qualified***
1404	04/06-10/2022		16K12	7	A991898.1	12	44	5	-60	
1405	04/06-10/2022		16K12	7	A991898.1	12	44	8	-60	
1406	04/06-10/2022		16K12	7	A991898.1	12	44	9	-60	
1407	04/06-10/2022		16K12	7	A991898.1	12	44	10	-60	*Failed!*
1408	04/06-10/2022		16K13	8	A991898.1	13	44	5	-60	
1409	04/06-10/2022		16K13	8	A991898.1	13	44	8	-60	
1410	04/06-10/2022		16K13	8	A991898.1	13	44	9	-60	
1411	04/06-10/2022		16K13	8	A991898.1	13	44	10	-60	*Failed!*
1412	04/06-10/2022		16K14	9	A991898.1	14	44	**5**	**-60**	***←Worst-Case Xe Spec Point qualified***
1413	04/06-10/2022		16K15	10	A991898.1	15	44	**5**	**-60**	***←Worst-Case Xe Spec Point qualified***
1414	04/06-10/2022		16K16	11	A991898.1	16	44	**5**	**-60**	***←Worst-Case Xe Spec Point qualified***

Run No.	Test Date	DUT Id	Socket	WaferLot	Serial	Batch	VGS	VDS	Pass/Fail (subject to Post-SEE Electricals)
							Volts	*Volts*	*Blank=Pass*
1415	04/06-10/2022	17K14	13	A991906.1	14	44	5	-60	
1416	04/06-10/2022	17K14	13	A991906.1	14	44	9	-60	
1417	04/06-10/2022	17K14	13	A991906.1	14	44	10	-60	*Failed!*
1418	04/06-10/2022	17K15	14	A991906.1	15	44	5	-60	
1419	04/06-10/2022	17K15	14	A991906.1	15	44	9	-60	
1420	04/06-10/2022	17K15	14	A991906.1	15	44	10	-60	
1421	04/06-10/2022	17K15	14	A991906.1	15	44	11	-60	*Failed!*
1422	04/06-10/2022	17K16	15	A991906.1	16	44	**5**	**-60**	***←Worst-Case Xe Spec Point qualified***
1423	04/06-10/2022	17K17	16	A991906.1	17	44	**5**	**-60**	***←Worst-Case Xe Spec Point qualified***
1424	04/06-10/2022	17K18	17	A991906.1	18	44	**5**	**-60**	***←Worst-Case Xe Spec Point qualified***

Appendix A – SEE Run Data (continued)

For the SEE test data of each run, please refer to the file attachements below:

Run No.	Test Date	Ion	DUT Id	Socket	WaferLot	Serial	Batch	VGS	VDS	Pass/Fail (subject to Post-SEE Electricals)
								Volts	*Volts*	*Blank=Pass*
1625	04/06-10/2022		15K19	1	A991882.1	19	56	10	-60	
1626	04/06-10/2022		15K19	1	A991882.1	19	56	12	-60	
1627	04/06-10/2022		15K19	1	A991882.1	19	56	14	-60	
1628	04/06-10/2022		15K19	1	A991882.1	19	56	16	-60	
1629	04/06-10/2022		15K19	1	A991882.1	19	56	18	-60	*Failed!*
1630	04/06-10/2022		15K20	2	A991882.1	20	56	14	-60	
1631	04/06-10/2022		15K20	2	A991882.1	20	56	16	-60	
1632	04/06-10/2022		15K20	2	A991882.1	20	56	17	-60	
1633	04/06-10/2022		15K20	2	A991882.1	20	56	18	-60	*Failed!*
1634	04/06-10/2022		15K21	3	A991882.1	21	56	**10**	**-60**	***←Worst-Case Kr Spec Point qualified***
1635	04/06-10/2022		15K22	4	A991882.1	22	56	**10**	**-60**	***←Worst-Case Kr Spec Point qualified***
1636	04/06-10/2022		15K23	5	A991882.1	23	56	**10**	**-60**	***←Worst-Case Kr Spec Point qualified***
1637	04/06-10/2022		16K18	7	A991898.1	18	56	14	-60	
1638	04/06-10/2022		16K18	7	A991898.1	18	56	16	-60	
1639	04/06-10/2022	**Kr (15AMeV) 1.5cm AirGap LET=39.7, 341MeV, 43.2µm (Worst-Case)**	16K18	7	A991898.1	18	56	18	-60	*Failed!*
1640	04/06-10/2022		16K20	8	A991898.1	20	56	14	-60	
1641	04/06-10/2022		16K20	8	A991898.1	20	56	16	-60	
1642	04/06-10/2022		16K20	8	A991898.1	20	56	17	-60	
1643	04/06-10/2022		16K20	8	A991898.1	20	56	18	-60	*Failed!*
1644	04/06-10/2022		16K21	9	A991898.1	21	56	**10**	**-60**	***←Worst-Case Kr Spec Point qualified***
1645	04/06-10/2022		16K22	10	A991898.1	22	56	**10**	**-60**	***←Worst-Case Kr Spec Point qualified***
1646	04/06-10/2022		16K23	11	A991898.1	23	56	**10**	**-60**	***←Worst-Case Kr Spec Point qualified***
1647	04/06-10/2022		17K21	13	A991906.1	21	56	14	-60	
1648	04/06-10/2022		17K21	13	A991906.1	21	56	16	-60	
1649	04/06-10/2022		17K21	13	A991906.1	21	56	18	-60	
1650	04/06-10/2022		17K21	13	A991906.1	21	56	20	-60	*Failed!*
1651	04/06-10/2022		17K22	14	A991906.1	22	56	16	-60	
1652	04/06-10/2022		17K22	14	A991906.1	22	56	18	-60	
1653	04/06-10/2022		17K22	14	A991906.1	22	56	19	-60	*Failed!*
1654	04/06-10/2022		17K23	15	A991906.1	23	56	**10**	**-60**	***←Worst-Case Kr Spec Point qualified***
1655	04/06-10/2022		17K25	16	A991906.1	25	56	**10**	**-60**	***←Worst-Case Kr Spec Point qualified***
1656	04/06-10/2022		17K26	17	A991906.1	26	56	**10**	**-60**	***←Worst-Case Kr Spec Point qualified***

Appendix B – Post SEE Electricals Data

Fab-2 RadHard MOSFET - R9, Size-6, 60V, N-ch

Post - SEE Electricals Data

Expected Good Devices

SEE-Failed Devices

SEE-UnTested Devices

Parameter	I DSS	I GSSf	I GSSr	V GS(th)	BV DSS	R DS(on)	VSD	For Post-SEE Electricals, Pass or Failed are based on IGSSf, IGSSr & IDSS
Conditions	VDS=48V VGS=0V	VGS=20V VDS=0V	VGS=-20V VDS=0V	ID=1mA VDS=VGS	IDSS=1mA	ID=22A VGS=-12V	IS=22A	
Limits	1µA Max	100nA Max	-100nA Max	2 V to 4 V	60 V Min	< 0.020 Ohms	1.2 V Max	
Unit	nA	nA	nA	V	V	Ohms	V	

SEE Id	Log Serial	A991882.1 "15K" (TAMU 11/07-10/2021) 9A97064								Qual WL A991882.1 … to R9 60V P	
15K1	00001	17.16nA	10.28nA	1.562nA	2.903 V	72.09 V	9.338mR	1.089 V	Pass	WC Au VDS=-60V VGS-Charact.: Pass +10V & stopped	Au
15K2	00002	70.76uA	99.99uA	99.99uA	2.903 V	71.76 V	9.460mR	1.093 V	Failed	WC Au VDS=-60V VGS-Charact.: Pass +8V Failed +10V	Au
15K2	00002	55.57uA	99.99uA	99.99uA	2.903 V	71.76 V	9.460mR	1.093 V	Failed		
15K3	00003	5.277nA	10.60nA	1.607nA	2.906 V	71.76 V	9.230mR	1.082 V	Pass	WC Au Qualification: Pass +2V / -60V	Au
15K4	00004	4.726nA	10.84nA	1.586nA	2.920 V	71.95 V	9.434mR	1.078 V	Pass	WC Au Qualification: Pass +2V / -60V	Au
15K5	00005	4.841nA	10.47nA	1.620nA	2.906 V	72.18 V	9.300mR	1.076 V	Pass	WC Au Qualification: Pass +2V / -60V	Au
15K6	00006	4.500nA	10.29nA	1.529nA	2.901 V	72.06 V	9.318mR	1.084 V	Pass	Loaded but Un-Tested	Au
SEE Id	Log Serial	A991898.1 "16K" (TAMU 11/07-10/2021) 9A97064								Qual WL A991898.1 … to R9 60V P	
16K1	00001	63.70uA	99.99uA	99.99uA	2.919 V	73.38 V	9.062mR	1.075 V	Failed	WC Au VDS=-60V VGS-Charact.: Pass +8V Failed +10V	Au
16K1	00001	58.99uA	99.99uA	99.99uA	2.919 V	73.39 V	9.066mR	1.073 V	Failed		
16K2	00002	50.83uA	99.99uA	99.99uA	2.922 V	73.08 V	8.950mR	1.071 V	Failed	WC Au VDS=-60V VGS-Charact.: Pass +8V Failed +10V	Au
16K2	00002	74.73uA	99.99uA	99.99uA	2.921 V	73.08 V	8.956mR	1.071 V	Failed		
16K3	00003	4.500nA	10.38nA	1.602nA	2.920 V	73.50 V	9.166mR	1.072 V	Pass	WC Au Qualification: Pass +2V / -60V	Au
16K4	00004	4.594nA	10.53nA	1.635nA	2.907 V	74.53 V	9.205mR	1.067 V	Pass	WC Au Qualification: Pass +2V / -60V	Au
16K5	00005	4.612nA	10.77nA	1.587nA	2.900 V	73.84 V	9.217mR	1.074 V	Pass	WC Au Qualification: Pass +2V / -60V	Au
16K6	00006	4.413nA	10.72nA	1.617nA	2.921 V	73.07 V	8.872mR	1.068 V	Pass	Loaded but Un-Tested	Au
SEE Id	Log Serial	A991906.1 "17K" (TAMU 11/07-10/2021) 9A97064								Qual WL A991906.1 … to R9 60V P	
17K1	00001	78.18uA	99.99uA	99.99uA	3.020 V	74.05 V	8.852mR	1.052 V	Failed	WC Au VDS=-60V VGS-Charact.: Pass +8V Failed +10V	Au
17K1	00001	100.7uA	99.99uA	99.99uA	3.019 V	74.06 V	8.858mR	1.052 V	Failed		Au
17K2	00002	38.49uA	99.99uA	99.99uA	3.021 V	73.83 V	8.805mR	1.051 V	Failed	WC Au VDS=-60V VGS-Charact.: Pass +8V Failed +10V	Au
17K2	00002	35.69uA	99.99uA	99.99uA	3.020 V	73.84 V	8.810mR	1.050 V	Failed		Au
17K3	00003	5.059nA	10.43nA	1.611nA	3.013 V	73.78 V	8.884mR	1.055 V	Pass	WC Au Qualification: Pass +2V / -60V	Au
17K4	00004	5.128nA	10.54nA	1.576nA	3.010 V	73.75 V	8.941mR	1.058 V	Pass	WC Au Qualification: Pass +2V / -60V	Au
17K6	00006	5.299nA	10.75nA	1.522nA	3.013 V	73.95 V	8.960mR	1.057 V	Pass	WC Au Qualification: Pass +2V / -60V	Au
17K7	00007	4.669nA	10.51nA	1.586nA	3.014 V	73.93 V	8.848mR	1.052 V	Pass	Loaded but Un-Tested	Au
SEE Id	Log Serial	A991882.1 "15K" (TAMU 04/06-10/2022) 9A97064								Qual WL A991882.1 … to R9 60V P	
15K13	00013	28.40uA	99.99uA	99.99uA	2.918 V	71.65 V	9.389mR	1.077 V	Failed	WC Xe VDS=-60V VGS-Charact.: Pass +9V Failed +11V	Xe
15K13	00013	26.61uA	99.99uA	99.99uA	2.917 V	71.67 V	9.392mR	1.077 V	Failed		
15K14	00014	59.48uA	99.99uA	99.99uA	2.929 V	71.69 V	9.461mR	1.073 V	Failed	WC Xe VDS=-60V VGS-Charact.: Pass +9V Failed +10V	Xe
15K14	00014	58.79uA	99.99uA	99.99uA	2.928 V	71.69 V	9.468mR	1.074 V	Failed		
15K15	00015	4.840nA	11.82nA	1.723nA	2.918 V	71.82 V	9.628mR	1.076 V	Pass	WC Xe Qualification: Pass +5V / -60V	Xe
15K16	00016	4.753nA	11.71nA	1.645nA	2.934 V	71.88 V	9.541mR	1.072 V	Pass	WC Xe Qualification: Pass +5V / -60V	Xe
15K17	00017	4.872nA	11.97nA	1.524nA	2.913 V	72.11 V	9.320mR	1.068 V	Pass	WC Xe Qualification: Pass +5V / -60V	Xe
15K18	00018	4.125nA	12.06nA	1.737nA	2.916 V	71.73 V	9.453mR	1.074 V	Pass	Loaded but Un-Tested	Xe
15K19	00019	802.6nA	99.99uA	99.99uA	2.907 V	71.69 V	9.384mR	1.074 V	Failed	WC Kr VDS=-60V VGS-Charact.: Pass +16V Failed +18V	Kr
15K19	00019	1.426uA	99.99uA	99.99uA	2.907 V	71.69 V	9.389mR	1.073 V	Failed		
15K20	00020	8.331nA	99.99uA	99.99uA	2.904 V	72.00 V	9.358mR	1.076 V	Failed	WC Kr VDS=-60V VGS-Charact.: Pass +17V Failed +18V	Kr
15K20	00020	9.287nA	99.99uA	99.99uA	2.903 V	71.99 V	9.364mR	1.076 V	Failed		
15K21	00021	4.217nA	11.16nA	1.679nA	2.911 V	71.97 V	9.680mR	1.066 V	Pass	WC Xe Qualification: Pass +10V / -60V	Kr
15K22	00022	4.185nA	11.40nA	1.585nA	2.890 V	72.13 V	9.452mR	1.066 V	Pass	WC Xe Qualification: Pass +10V / -60V	Kr
15K23	00023	3.703nA	11.42nA	1.573nA	2.911 V	72.78 V	9.856mR	1.065 V	Pass	WC Xe Qualification: Pass +10V / -60V	Kr
15K24	00024	3.907nA	10.82nA	1.693nA	2.885 V	71.26 V	9.548mR	1.057 V	Pass	Loaded but Un-Tested	Kr

- For one qualification point, three passed samples and for characterization two failed samples are required. This is validated for samples from three different wafer lots.
- "Loaded but Un-Tested" means that the particular sample was not tested under radiation since data point was already obtained.

Appendix B – Post SEE Electricals Data (Continued)

Fab-2 RadHard MOSFET - R9, Size-6, 60V, N-ch

Post - SEE Electricals Data

Expected Good Devices

SEE-Failed Devices

SEE-UnTested Devices

Parameter	I DSS	I GSSf	I GSSr	V GS(th)	BV DSS	R DS(on)	VSD	For Post-SEE Electricals, Pass or Failed are based on IGSSf, IGSSr & IDSS	
Conditions	VDS=48V VGS=0V	VGS=20V VDS=0V	VGS=-20V VDS=0V	ID=1mA VDS=VGS	IDSS=1mA	ID=22A VGS=-12V	IS=22A		
Limits	1µA Max	100nA Max	-100nA Max	2 V to 4 V	60 V Min	< 0.020 Ohms	1.2 V Max		
Unit	nA	nA	nA	V	V	Ohms	V		

SEE Id	Log Serial										
		A991898.1 "16K" (TAMU 04/06-10/2022) 9A97064								Qual WL A991882.1 … to R9	
16K12	00012	152.0uA	99.99uA	99.99uA	2.909 V	73.35 V	9.012mR	1.065 V	Failed	WC Xe VDS=-60V VGS-Charact.: Pass +9V Failed +10V	Xe
16K12	00012	154.8uA	99.99uA	99.99uA	2.909 V	73.35 V	9.013mR	1.064 V	Failed		
16K13	00013	17.37uA	99.99uA	99.99uA	2.906 V	73.46 V	9.082mR	1.065 V	Failed	WC Xe VDS=-60V VGS-Charact.: Pass +9V Failed +10V	Xe
16K13	00013	10.25uA	99.99uA	99.99uA	2.906 V	73.45 V	9.092mR	1.065 V	Failed		
16K14	00014	5.235nA	11.61nA	1.749nA	2.916 V	73.28 V	9.086mR	1.067 V	Pass	WC Xe Qualification: Pass +5V / -60V	Xe
16K15	00015	4.638nA	11.56nA	1.718nA	2.917 V	73.39 V	9.446mR	1.073 V	Pass	WC Xe Qualification: Pass +5V / -60V	Xe
16K16	00016	5.052nA	11.74nA	1.650nA	2.919 V	73.41 V	9.053mR	1.062 V	Pass	WC Xe Qualification: Pass +5V / -60V	Xe
16K17	00017	4.272nA	11.16nA	1.532nA	2.919 V	73.37 V	9.117mR	1.067 V	Pass	Loaded but Un-Tested	Xe
16K18	00018	160.6uA	99.99uA	99.99uA	2.910 V	73.35 V	9.128mR	1.066 V	Failed	WC Kr VDS=-60V VGS-Charact.: Pass +16V Failed +18V	Kr
16K18	00018	184.2uA	99.99uA	99.99uA	2.910 V	73.36 V	9.133mR	1.066 V	Failed		
16K20	00020	6.994nA	99.99uA	99.99uA	2.903 V	73.63 V	9.286mR	1.066 V	Failed	WC Kr VDS=-60V VGS-Charact.: Pass +17V Failed +18V	Kr
16K20	00020	7.249nA	99.99uA	99.99uA	2.903 V	73.63 V	9.288mR	1.067 V	Failed		
16K21	00021	6.978nA	11.35nA	1.780nA	2.934 V	73.96 V	9.120mR	1.049 V	Pass	WC Xe Qualification: Pass +10V / -60V	Kr
16K22	00022	4.474nA	11.64nA	1.596nA	2.930 V	73.81 V	9.050mR	1.047 V	Pass	WC Xe Qualification: Pass +10V / -60V	Kr
16K23	00023	4.330nA	11.72nA	1.672nA	2.956 V	73.48 V	9.224mR	1.052 V	Pass	WC Xe Qualification: Pass +10V / -60V	Kr
16K24	00024	4.039nA	11.75nA	1.715nA	2.931 V	73.97 V	9.233mR	1.055 V	Pass	Loaded but Un-Tested	Kr
SEE Id	Log Serial										
		A991906.1 "17K" (TAMU 04/06-10/2022) 9A97064								Qual WL A991898.1 … to R9 60V P	
17K14	00014	74.04uA	99.99uA	99.99uA	3.020 V	74.16 V	9.329mR	1.066 V	Failed	WC Xe VDS=-60V VGS-Charact.: Pass +9V Failed +10V	Xe
17K14	00014	66.89uA	99.99uA	99.99uA	3.020 V	74.17 V	9.338mR	1.066 V	Failed		
17K15	00015	99.23uA	99.99uA	99.99uA	3.013 V	74.15 V	9.284mR	1.064 V	Failed	WC Xe VDS=-60V VGS-Charact.: Pass +10V Failed +11V	Xe
17K15	00015	100.3uA	99.99uA	99.99uA	3.012 V	74.16 V	9.290mR	1.063 V	Failed		
17K16	00016	4.794nA	10.94nA	1.627nA	3.011 V	73.86 V	9.269mR	1.069 V	Pass	WC Xe Qualification: Pass +5V / -60V	Xe
17K17	00017	5.098nA	11.60nA	1.742nA	3.021 V	74.20 V	9.249mR	1.065 V	Pass	WC Xe Qualification: Pass +5V / -60V	Xe
17K18	00018	4.813nA	11.46nA	1.650nA	3.008 V	73.91 V	9.350mR	1.068 V	Pass	WC Xe Qualification: Pass +5V / -60V	Xe
17K19	00019	3.995nA	11.38nA	1.719nA	2.998 V	73.08 V	9.257mR	1.062 V	Pass	Loaded but Un-Tested	Xe
17K21	00021	0.998uA	99.99uA	99.99uA	3.072 V	73.64 V	9.282mR	1.059 V	Failed	WC Kr VDS=-60V VGS-Charact.: Pass +18V Failed +20V	Kr
17K21	00021	178.0nA	99.99uA	99.99uA	3.072 V	73.65 V	9.288mR	1.059 V	Failed		
17K22	00022	10.51nA	99.99uA	99.99uA	3.096 V	74.28 V	9.350mR	1.060 V	Failed	WC Kr VDS=-60V VGS-Charact.: Pass +18V Failed +19V	Kr
17K22	00022	13.12nA	99.99uA	99.99uA	3.095 V	74.29 V	9.346mR	1.060 V	Failed		
17K23	00023	4.360nA	10.80nA	1.606nA	3.099 V	74.38 V	9.424mR	1.063 V	Pass	WC Xe Qualification: Pass +10V / -60V	Kr
17K24	00024	4.720nA	11.25nA	1.681nA	2.986 V	73.15 V	9.148mR	1.059 V	Pass	WC Xe Qualification: Pass +10V / -60V	Kr
17K25	00025	4.622nA	11.15nA	1.707nA	3.059 V	73.26 V	9.186mR	1.057 V	Pass	WC Xe Qualification: Pass +10V / -60V	Kr
17K27	00027	4.298nA	10.78nA	1.722nA	3.078 V	74.01 V	9.161mR	1.058 V	Pass	Loaded but Un-Tested	Kr

- For one qualification point, three passed samples and for characterization two failed samples are required. This is validated for samples from three different wafer lots.
- "Loaded but Un-Tested" means that the particular sample was not tested under radiation since data point was already obtained.

Appendix C – SEE Beam Data

Run #	Run FileName	Start Date	Start Time	End Time	Run Duration	Upset Events	Selected Beam	Al Thk (μm)	# of Layers (Filename)	Beam Energy (MeV/amu)	Beam Energy (MeV)	Target Material	Nominal LET (MeV.cm2/mg)	Nominal Range (μm)	Effective LET (MeV.cm2/mg)	Effective Range (μm)
130	Infineon_Nov_2021.#3l	21/11/07	19:14:28	19:14:54	00:00:26_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
131	Infineon_Nov_2021.#3m	21/11/07	19:15:07	19:15:31	00:00:24_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
132	Infineon_Nov_2021.#3n	21/11/07	19:15:48	19:16:13	00:00:25_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
133	Infineon_Nov_2021.#3o	21/11/07	19:16:25	19:16:51	00:00:26_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
134	Infineon_Nov_2021.#3p	21/11/07	19:17:06	19:19:00	00:01:54_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
135	Infineon_Nov_2021.#3q	21/11/07	19:52:48	19:53:12	00:00:24_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
136	Infineon_Nov_2021.#3r	21/11/07	19:53:41	19:53:59	00:00:18_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
137	Infineon_Nov_2021.#3s	21/11/07	19:54:14	19:54:32	00:00:18_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
138	Infineon_Nov_2021.#3t	21/11/07	19:54:40	19:54:58	00:00:18_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
139	Infineon_Nov_2021.#3u	21/11/07	19:55:09	19:55:27	00:00:18_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
140	Infineon_Nov_2021.#3v	21/11/07	19:55:42	19:56:01	00:00:19_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
141	Infineon_Nov_2021.#3w	21/11/07	19:57:10	19:57:29	00:00:19_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
142	Infineon_Nov_2021.#3x	21/11/07	19:57:47	19:58:05	00:00:18_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
143	Infineon_Nov_2021.#3y	21/11/07	19:58:18	19:58:36	00:00:18_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
144	Infineon_Nov_2021.#3z	21/11/07	19:58:48	19:59:07	00:00:19_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
145	Infineon_Nov_2021.#40	21/11/07	19:59:20	19:59:29	00:00:09_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
146	Infineon_Nov_2021.#41	21/11/07	20:00:08	20:00:33	00:00:25_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
147	Infineon_Nov_2021.#42	21/11/07	20:01:37	20:02:05	00:00:28_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
148	Infineon_Nov_2021.#43	21/11/07	20:03:07	20:03:22	00:00:15_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
149	Infineon_Nov_2021.#44	21/11/07	20:04:30	20:04:45	00:00:15_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
150	Infineon_Nov_2021.#45	21/11/07	20:04:57	20:05:12	00:00:15_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
151	Infineon_Nov_2021.#46	21/11/07	20:05:24	20:05:42	00:00:18_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
152	Infineon_Nov_2021.#47	21/11/07	20:05:56	20:06:12	00:00:16_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
153	Infineon_Nov_2021.#48	21/11/07	20:06:24	20:06:39	00:00:15_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
154	Infineon_Nov_2021.#49	21/11/07	20:07:51	20:08:06	00:00:15_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
155	Infineon_Nov_2021.#4a	21/11/07	20:08:17	20:08:31	00:00:14_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
156	Infineon_Nov_2021.#4b	21/11/07	20:08:43	20:08:56	00:00:13_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
157	Infineon_Nov_2021.#4c	21/11/07	20:09:10	20:09:16	00:00:06_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
158	Infineon_Nov_2021.#4d	21/11/07	20:09:57	20:10:12	00:00:15_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
159	Infineon_Nov_2021.#4e	21/11/07	20:11:04	20:11:19	00:00:15_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
160	Infineon_Nov_2021.#4f	21/11/07	20:12:03	20:12:17	00:00:14_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
161	Infineon_Nov_2021.#4g	21/11/07	20:13:27	20:13:41	00:00:14_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
162	Infineon_Nov_2021.#4h	21/11/07	20:13:54	20:14:08	00:00:14_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
163	Infineon_Nov_2021.#4i	21/11/07	20:14:22	20:14:38	00:00:16_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
164	Infineon_Nov_2021.#4j	21/11/07	20:14:51	20:15:05	00:00:14_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
165	Infineon_Nov_2021.#4k	21/11/07	20:15:51	20:16:06	00:00:15_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
166	Infineon_Nov_2021.#4l	21/11/07	20:16:17	20:16:31	00:00:14_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
167	Infineon_Nov_2021.#4m	21/11/07	20:16:42	20:16:53	00:00:11_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
168	Infineon_Nov_2021.#4n	21/11/07	20:17:33	20:17:50	00:00:17_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
169	Infineon_Nov_2021.#4o	21/11/07	20:18:32	20:18:52	00:00:20_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6
170	Infineon_Nov_2021.#4p	21/11/07	20:19:26	20:19:43	00:00:17_(+_0_days)	0	15.0_MeV/u_197Au_@_K500	2.109	3_(1.5_cm_AirGap)	6.1	1202	silicon	92.4	69.6	92.5	69.6

Run #	DUT Location	Position Name	Effective Fluence (ions/cm2)	Dose (rad)	Live Time (sec.)	Dead Time (sec.)	Average Flux (ions/(cm2s))	AvgFlux Error (%)	Overall Uniformity (%)	Overall Central Shift (%)	Calibration Factor	DUT Coordinates X (in)	Y (in)	Z (cm)	DUT Tilt Angle Degree	Aperture (inch) Width/RollAngle	Height	Al Degrader No. Step	Degrader Angle Degree	Detector Bias (V)	Comments
130	In-air	Current	3.06E+05	4.54E+02	23.4333	0	1.31E+04	0.29	79	15	1.77513	-3.876	-2.482	-9.293	1.185	-82.225	0	2	18.513	492_427_369_527_208	
131	In-air	Current	3.04E+05	4.51E+02	21.4333	0	1.42E+04	0.29	81	14	1.77513	-3.876	-2.482	-9.293	1.185	-82.225	0	2	18.513	492_427_369_527_208	
132	In-air	Current	2.99E+05	4.42E+02	21.6	0	1.38E+04	0.29	80	14	1.77513	-3.876	-2.482	-9.293	1.185	-82.225	0	2	18.513	492_427_369_527_208	
133	In-air	Current	2.97E+05	4.40E+02	22.4	0	1.33E+04	0.29	79	15	1.77513	-3.876	-2.482	-9.293	1.185	-82.225	0	2	18.513	492_427_369_527_208	
134	In-air	Current	3.01E+05	4.46E+02	110.5	0	2.73E+03	0.29	83	12	0.356787	-3.876	-2.482	-9.293	1.185	-82.225	0	2	18.513	492_427_369_527_208	
135	In-air	Current	3.03E+05	4.48E+02	14.1333	0	2.14E+04	0.29	88	9	0.909071	-3.876	-2.482	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
136	In-air	Current	2.91E+05	4.31E+02	14.1833	0	2.05E+04	0.29	84	12	0.926637	-3.876	-2.482	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
137	In-air	Current	2.95E+05	4.36E+02	13.65	0	2.16E+04	0.29	80	15	0.938952	-3.876	-2.482	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
138	In-air	Current	2.93E+05	4.34E+02	13.5667	0	2.16E+04	0.29	81	15	0.924004	-3.876	-2.482	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
139	In-air	Current	3.06E+05	4.53E+02	14.8167	0	2.06E+04	0.29	83	13	0.937117	-3.876	-2.482	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
140	In-air	Current	3.01E+05	4.45E+02	14.0667	0	2.14E+04	0.29	81	14	0.909516	-3.876	-2.482	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
141	In-air	Current	3.05E+05	4.52E+02	15.8333	0	1.93E+04	0.29	90	7	0.931324	-2.263	-2.482	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
142	In-air	Current	2.96E+05	4.38E+02	14.7667	0	2.00E+04	0.29	82	13	0.931084	-2.263	-2.482	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
143	In-air	Current	3.10E+05	4.58E+02	14.7167	0	2.10E+04	0.28	86	11	0.921613	-2.263	-2.482	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
144	In-air	Current	2.92E+05	4.33E+02	15.9833	0	1.83E+04	0.29	90	6	0.93065	-2.263	-2.482	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
145	In-air	Current	6.68E+04	9.90E+01	4.68333	0	1.43E+04	0.61	88	9	0.904144	-2.263	-2.482	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
146	In-air	Current	3.00E+05	4.44E+02	22.1333	0	1.36E+04	0.29	89	8	0.904144	-0.663	-2.482	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
147	In-air	Current	3.00E+05	4.45E+02	24.3833	0	1.23E+04	0.29	87	10	0.944998	0.924	-2.482	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
148	In-air	Current	2.93E+05	4.33E+02	11.8667	0	2.47E+04	0.29	80	16	0.939333	2.55	-2.482	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
149	In-air	Current	2.85E+05	4.22E+02	11.5333	0	2.47E+04	0.3	84	21	1.07837	-3.875	-0.062	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
150	In-air	Current	2.90E+05	4.29E+02	11.7833	0	2.46E+04	0.29	91	7	1.27094	-3.875	-0.062	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
151	In-air	Current	2.93E+05	4.34E+02	14.75	0	1.99E+04	0.29	90	7	1.25827	-3.875	-0.062	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
152	In-air	Current	3.04E+05	4.50E+02	12.8167	0	2.37E+04	0.29	90	7	1.26009	-3.875	-0.062	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
153	In-air	Current	2.47E+05	3.65E+02	11.95	0	2.07E+04	0.32	91	7	1.17001	-3.875	-0.062	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
154	In-air	Current	3.04E+05	4.50E+02	11.3333	0	2.68E+04	0.29	91	6	1.17001	-2.287	-0.062	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
155	In-air	Current	2.94E+05	4.35E+02	11.55	0	2.55E+04	0.29	91	6	1.14681	-2.287	-0.062	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
156	In-air	Current	3.16E+05	4.68E+02	9.98333	0	3.16E+04	0.28	92	6	1.24276	-2.287	-0.062	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
157	In-air	Current	8.55E+04	1.27E+02	2.73333	0	3.13E+04	0.54	94	3	1.15653	-2.287	-0.062	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
158	In-air	Current	2.85E+05	4.22E+02	12.1167	0	2.35E+04	0.3	93	5	1.12026	-0.663	-0.062	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
159	In-air	Current	3.00E+05	4.44E+02	11.5667	0	2.59E+04	0.29	93	5	1.22513	0.938	-0.062	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
160	In-air	Current	2.93E+05	4.34E+02	10.3667	0	2.83E+04	0.29	93	4	1.18902	2.55	-0.062	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
161	In-air	Current	2.87E+05	4.25E+02	10.8833	0	2.64E+04	0.3	91	6	1.20171	-3.875	2.308	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
162	In-air	Current	2.96E+05	4.38E+02	10.9	0	2.72E+04	0.29	92	6	1.21314	-3.875	2.308	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
163	In-air	Current	3.10E+05	4.60E+02	12.65	0	2.45E+04	0.28	94	4	1.20215	-3.875	2.308	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
164	In-air	Current	2.83E+05	4.18E+02	10.85	0	2.60E+04	0.3	93	5	1.21581	-3.875	2.308	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
165	In-air	Current	2.87E+05	4.25E+02	11.8833	0	2.42E+04	0.3	93	4	1.20308	-2.262	2.308	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
166	In-air	Current	2.95E+05	4.37E+02	11.35	0	2.60E+04	0.29	93	5	1.20267	-2.262	2.308	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
167	In-air	Current	2.04E+05	3.03E+02	8.35	0	2.45E+04	0.35	95	4	1.23038	-2.262	2.308	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
168	In-air	Current	2.88E+05	4.27E+02	13.4	0	2.15E+04	0.29	94	4	1.23038	-0.65	2.308	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
169	In-air	Current	3.07E+05	4.54E+02	17.6	0	1.74E+04	0.29	91	6	1.02876	0.95	2.308	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	
170	In-air	Current	2.94E+05	4.36E+02	13.85	0	2.12E+04	0.29	94	4	1.02876	2.538	2.308	-9.293	1.185	-82.225	0	2	18.513	512_427_469_527_228	

Appendix C – SEE Beam Data (Continued)

Run #	Run FileName	Start Date	Start Time	End Time	Run Duration	Upset Events	Selected Beam	Al Thk (µm)	# of Layers (Filename)	Beam Energy (MeV/amu)	Beam Energy (MeV)	Target Material	Nominal LET (MeV.cm2/mg)	Nominal Range (µm)	Effective LET (MeV.cm2/mg)	Effective Range (µm)
1394	Infineon_2__Apr_2022.#2u	22/04/09	2:18:47	2:19:04	00:00:17_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.505	3_(1.5cm_Air_Gap)	5.43	700	silicon	67.6	54.1	67.6	54.1
1395	Infineon_2__Apr_2022.#2v	22/04/09	2:19:41	2:19:58	00:00:17_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.505	3_(1.5cm_Air_Gap)	5.43	700	silicon	67.6	54.1	67.6	54.1
1396	Infineon_2__Apr_2022.#2w	22/04/09	2:26:17	2:26:33	00:00:16_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1397	Infineon_2__Apr_2022.#2x	22/04/09	2:26:47	2:27:02	00:00:15_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1398	Infineon_2__Apr_2022.#2y	22/04/09	2:27:13	2:27:29	00:00:16_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1399	Infineon_2__Apr_2022.#2z	22/04/09	2:27:44	2:27:51	00:00:07_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1400	Infineon_2__Apr_2022.#30	22/04/09	2:28:25	2:28:40	00:00:15_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1401	Infineon_2__Apr_2022.#31	22/04/09	2:28:52	2:29:07	00:00:15_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1402	Infineon_2__Apr_2022.#32	22/04/09	2:29:17	2:29:25	00:00:08_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1403	Infineon_2__Apr_2022.#33	22/04/09	2:30:00	2:30:16	00:00:16_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1404	Infineon_2__Apr_2022.#34	22/04/09	2:30:58	2:31:15	00:00:17_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1405	Infineon_2__Apr_2022.#35	22/04/09	2:31:52	2:32:07	00:00:15_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1406	Infineon_2__Apr_2022.#36	22/04/09	2:33:17	2:33:33	00:00:16_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1407	Infineon_2__Apr_2022.#37	22/04/09	2:34:08	2:34:24	00:00:16_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1408	Infineon_2__Apr_2022.#38	22/04/09	2:34:36	2:34:52	00:00:16_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1409	Infineon_2__Apr_2022.#39	22/04/09	2:35:03	2:35:15	00:00:12_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1410	Infineon_2__Apr_2022.#3a	22/04/09	2:35:53	2:36:09	00:00:16_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1411	Infineon_2__Apr_2022.#3b	22/04/09	2:36:20	2:36:37	00:00:17_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1412	Infineon_2__Apr_2022.#3c	22/04/09	2:36:49	2:37:05	00:00:16_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1413	Infineon_2__Apr_2022.#3d	22/04/09	2:37:14	2:37:30	00:00:16_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1414	Infineon_2__Apr_2022.#3e	22/04/09	2:38:09	2:38:25	00:00:16_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1415	Infineon_2__Apr_2022.#3f	22/04/09	2:39:03	2:39:18	00:00:15_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1416	Infineon_2__Apr_2022.#3g	22/04/09	2:39:55	2:40:11	00:00:16_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1417	Infineon_2__Apr_2022.#3h	22/04/09	2:41:18	2:41:33	00:00:15_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1418	Infineon_2__Apr_2022.#3i	22/04/09	2:41:44	2:42:02	00:00:18_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1419	Infineon_2__Apr_2022.#3j	22/04/09	2:42:12	2:42:23	00:00:11_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1420	Infineon_2__Apr_2022.#3k	22/04/09	2:43:09	2:43:27	00:00:18_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1421	Infineon_2__Apr_2022.#3l	22/04/09	2:43:39	2:43:53	00:00:14_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1422	Infineon_2__Apr_2022.#3m	22/04/09	2:44:03	2:44:19	00:00:16_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1423	Infineon_2__Apr_2022.#3n	22/04/09	2:44:31	2:44:39	00:00:08_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9
1424	Infineon_2__Apr_2022.#3o	22/04/09	2:45:16	2:45:31	00:00:15_(+_0_days)	0	15.0_MeV/u_129Xe_@_K500	2.581	3_(1.5cm_Air_Gap)	5.16	665	silicon	68	51.9	68	51.9

Run #	DUT Location	Position Name	Effective Fluence (ions/cm2)	Dose (rad)	Live Time (sec.)	Dead Time (sec.)	Average Flux (ions/(cm2s))	AvgFlux Error (%)	Overall Uniformity (%)	Overall Central Shift (%)	Calibration Factor	DUT Coordinates X (in)	Y (in)	Z (cm)	DUT Tilt Angle Degree	Aperture (inch) dth / RollAn	Height	Al Degrader No. Step	Degrader Angle Degree	Detector Bias (V)	Comments
1394	In-air	Current	3.03E+05	3.28E+02	14.2333	0	2.13E+04	0.29	96	2	1.13984	0.971	2.335	-9.379	-0.198	-82.225	0.1	2	37.013	472_461_460_475_410	101
1395	In-air	Current	2.89E+05	3.13E+02	12.7167	0	2.27E+04	0.29	97	2	1.14238	2.546	2.335	-9.379	-0.198	-82.225	0.1	2	37.013	472_461_460_475_410	102
1396	In-air	Current	2.94E+05	3.20E+02	12.1667	0	2.41E+04	0.29	96	2	1.1487	-3.843	-2.48	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	103
1397	In-air	Current	3.00E+05	3.26E+02	12.3667	0	2.42E+04	0.29	97	2	1.15352	-3.843	-2.48	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	104
1398	In-air	Current	2.95E+05	3.21E+02	12.8667	0	2.29E+04	0.29	97	2	1.07627	-3.843	-2.48	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	105
1399	In-air	Current	7.85E+04	8.55E+01	3.55	0	2.21E+04	0.56	97	2	1.14549	-3.843	-2.48	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	106
1400	In-air	Current	2.96E+05	3.23E+02	12.1667	0	2.43E+04	0.29	96	2	1.15262	-2.281	-2.48	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	107
1401	In-air	Current	2.98E+05	3.24E+02	12.3	0	2.42E+04	0.29	97	2	1.16991	-2.281	-2.48	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	108
1402	In-air	Current	9.33E+04	1.02E+02	4.13333	0	2.26E+04	0.52	96	3	1.17241	-2.281	-2.48	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	109
1403	In-air	Current	2.97E+05	3.24E+02	11.9167	0	2.49E+04	0.29	96	2	1.16689	-0.681	-2.48	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	110
1404	In-air	Current	3.15E+05	3.44E+02	12.4	0	2.54E+04	0.28	97	2	1.16689	0.919	-2.48	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	111
1405	In-air	Current	3.13E+05	3.41E+02	11.95	0	2.62E+04	0.28	97	2	1.14852	2.494	-2.48	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	112
1406	In-air	Current	3.00E+05	3.27E+02	13.2167	0	2.27E+04	0.29	97	1	1.08576	-3.843	-0.085	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	113
1407	In-air	Current	3.00E+05	3.27E+02	13.0667	0	2.30E+04	0.29	96	2	1.08576	-3.843	-0.085	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	114
1408	In-air	Current	3.10E+05	3.38E+02	12.6333	0	2.45E+04	0.28	97	2	1.16992	-3.843	-0.085	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	115
1409	In-air	Current	1.95E+05	2.13E+02	8.36667	0	2.33E+04	0.36	96	3	1.15042	-3.843	-0.085	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	116
1410	In-air	Current	2.94E+05	3.20E+02	12.2	0	2.41E+04	0.29	98	2	1.17017	-2.256	-0.085	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	117
1411	In-air	Current	3.11E+05	3.39E+02	13.0167	0	2.39E+04	0.28	97	2	1.16886	-2.256	-0.085	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	118
1412	In-air	Current	3.04E+05	3.31E+02	12.4167	0	2.45E+04	0.29	97	1	1.19466	-2.256	-0.085	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	119
1413	In-air	Current	3.05E+05	3.32E+02	12.2833	0	2.48E+04	0.29	98	1	1.18776	-2.256	-0.085	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	120
1414	In-air	Current	3.08E+05	3.35E+02	12.5	0	2.46E+04	0.29	97	2	1.18776	-0.68	-0.085	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	121
1415	In-air	Current	2.89E+05	3.15E+02	12.4	0	2.33E+04	0.29	97	2	1.18297	0.945	-0.085	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	122
1416	In-air	Current	2.99E+05	3.26E+02	13.05	0	2.29E+04	0.29	97	2	1.18644	2.558	-0.085	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	123
1417	In-air	Current	2.98E+05	3.25E+02	12.4	0	2.40E+04	0.29	97	2	1.17883	-3.829	2.335	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	124
1418	In-air	Current	3.00E+05	3.27E+02	12.5667	0	2.39E+04	0.29	97	1	1.1858	-3.829	2.335	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	125
1419	In-air	Current	1.89E+05	2.06E+02	8.38333	0	2.26E+04	0.36	97	2	1.18038	-3.829	2.335	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	126
1420	In-air	Current	3.06E+05	3.33E+02	13.5333	0	2.26E+04	0.29	97	2	1.08134	-2.229	2.335	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	127
1421	In-air	Current	2.89E+05	3.15E+02	11.45	0	2.53E+04	0.29	97	3	1.18398	-2.229	2.335	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	128
1422	In-air	Current	3.10E+05	3.37E+02	12.6333	0	2.45E+04	0.28	97	2	1.17653	-2.229	2.335	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	129
1423	In-air	Current	8.86E+04	9.65E+01	3.91667	0	2.26E+04	0.53	96	2	1.18679	-2.229	2.335	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	130
1424	In-air	Current	3.06E+05	3.33E+02	11.95	0	2.56E+04	0.29	97	2	1.18695	-0.654	2.335	-9.379	-0.198	-82.225	0.1	2	39.213	474_464_463_481_412	131

Run	Run	Start	Start	End	Run	Upset	Selected	Al Thk	# of Layers	Beam Energy		Target	Nominal LET	Nominal Range	Effective LET	Effective Range
#	FileName	Date	Time	Time	Duration	Events	Beam	(µm)	(Filename)	(MeV/amu)	(MeV)	Material	(MeV.cm2/mg)	(µm)	(MeV.cm2/mg)	(µm)
1625	Infineon_2__Apr_2022.#99	22/04/09	6:20:05	6:20:13	00:00:08_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.883	3_(1.5cm_Air_Gap)	3.34	280	silicon	40.5	36.6	40.5	36.6
1626	Infineon_2__Apr_2022.#9a	22/04/09	6:20:48	6:21:05	00:00:17_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.883	3_(1.5cm_Air_Gap)	3.34	280	silicon	40.5	36.6	40.5	36.6
1627	Infineon_2__Apr_2022.#9b	22/04/09	6:21:51	6:22:07	00:00:16_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.883	3_(1.5cm_Air_Gap)	3.34	280	silicon	40.5	36.6	40.5	36.6
1628	Infineon_2__Apr_2022.#9c	22/04/09	6:22:46	6:23:02	00:00:16_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.883	3_(1.5cm_Air_Gap)	3.34	280	silicon	40.5	36.6	40.5	36.6
1629	Infineon_2__Apr_2022.#9d	22/04/09	6:27:35	6:27:50	00:00:15_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1630	Infineon_2__Apr_2022.#9e	22/04/09	6:28:01	6:28:16	00:00:15_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1631	Infineon_2__Apr_2022.#9f	22/04/09	6:28:26	6:28:40	00:00:14_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1632	Infineon_2__Apr_2022.#9g	22/04/09	6:28:50	6:29:05	00:00:15_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1633	Infineon_2__Apr_2022.#9h	22/04/09	6:29:13	6:29:21	00:00:08_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1634	Infineon_2__Apr_2022.#9i	22/04/09	6:29:54	6:30:09	00:00:15_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1635	Infineon_2__Apr_2022.#9j	22/04/09	6:30:17	6:30:32	00:00:15_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1636	Infineon_2__Apr_2022.#9k	22/04/09	6:30:41	6:30:55	00:00:14_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1637	Infineon_2__Apr_2022.#9l	22/04/09	6:31:06	6:31:14	00:00:08_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1638	Infineon_2__Apr_2022.#9m	22/04/09	6:31:46	6:32:00	00:00:14_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1639	Infineon_2__Apr_2022.#9n	22/04/09	6:32:32	6:32:47	00:00:15_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1640	Infineon_2__Apr_2022.#9o	22/04/09	6:33:28	6:33:43	00:00:15_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1641	Infineon_2__Apr_2022.#9p	22/04/09	6:34:50	6:35:06	00:00:16_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1642	Infineon_2__Apr_2022.#9q	22/04/09	6:35:14	6:35:30	00:00:16_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1643	Infineon_2__Apr_2022.#9r	22/04/09	6:35:40	6:35:46	00:00:06_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1644	Infineon_2__Apr_2022.#9s	22/04/09	6:36:26	6:36:42	00:00:16_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1645	Infineon_2__Apr_2022.#9t	22/04/09	6:36:52	6:37:08	00:00:16_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1646	Infineon_2__Apr_2022.#9u	22/04/09	6:37:15	6:37:31	00:00:16_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1647	Infineon_2__Apr_2022.#9v	22/04/09	6:37:42	6:37:50	00:00:08_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1648	Infineon_2__Apr_2022.#9w	22/04/09	6:38:26	6:38:42	00:00:16_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1649	Infineon_2__Apr_2022.#9x	22/04/09	6:39:15	6:39:31	00:00:16_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1650	Infineon_2__Apr_2022.#9y	22/04/09	6:40:05	6:40:20	00:00:15_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1651	Infineon_2__Apr_2022.#9z	22/04/09	6:41:28	6:41:44	00:00:16_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1652	Infineon_2__Apr_2022.#a0	22/04/09	6:41:56	6:42:32	00:00:36_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1653	Infineon_2__Apr_2022.#a1	22/04/09	6:42:38	6:42:53	00:00:15_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1654	Infineon_2__Apr_2022.#a2	22/04/09	6:43:03	6:43:16	00:00:13_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1655	Infineon_2__Apr_2022.#a3	22/04/09	6:43:53	6:44:09	00:00:16_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2
1656	Infineon_2__Apr_2022.#a4	22/04/09	6:44:19	6:44:34	00:00:15_(+_0_days)	0	15.0_MeV/u_84Kr_@_K500	3.66	3_(1.5cm_Air_Gap)	4.07	341	silicon	39.7	43.2	39.7	43.2

Run	DUT	Position	Effective Fluence	Dose	Live Time	Dead Time	Average Flux	AvgFlux Error	Overall Uniformity	Overall Central Shift	Calibration	DUT Coordinates			DUT Tilt Angle	Aperture (inch)		Al Degrader No.	Degrader Angle	Detector Bias	Comments
#	Location	Name	(ions/cm2)	(rad)	(sec.)	(sec.)	(ions/(cm2s))	(%)	(%)	(%)	Factor	X (in)	Y (in)	Z (cm)	Degree	dth / Roll	Height	Step	Degree	(V)	
1625	In-air	Current	9.96E+04	6.45E+01	4.56667	0	2.18E+04	0.5	94	4	1.18498	-2.229	2.335	-9.379	-0.198	-82.225	0.1	2	59	595_583_488_515_422	330
1626	In-air	Current	3.06E+05	1.98E+02	13.15	0	2.33E+04	0.29	95	3	1.2093	-0.654	2.335	-9.379	-0.198	-82.225	0.1	2	59	595_583_488_515_422	331
1627	In-air	Current	2.89E+05	1.88E+02	12.7	0	2.28E+04	0.29	94	3	1.18228	0.971	2.335	-9.379	-0.198	-82.225	0.1	2	59	595_583_488_515_422	332
1628	In-air	Current	2.90E+05	1.88E+02	12.5833	0	2.30E+04	0.29	94	3	1.1687	2.546	2.335	-9.379	-0.198	-82.225	0.1	2	59	595_583_488_515_422	333
1629	In-air	Current	3.08E+05	1.96E+02	12.5833	0	2.45E+04	0.28	96	3	1.17332	-3.843	-2.48	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	334
1630	In-air	Current	3.01E+05	1.91E+02	11.75	0	2.56E+04	0.29	96	3	1.19224	-3.843	-2.48	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	335
1631	In-air	Current	2.99E+05	1.90E+02	11.6833	0	2.56E+04	0.29	96	3	1.21145	-3.843	-2.48	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	336
1632	In-air	Current	3.09E+05	1.97E+02	12.3	0	2.51E+04	0.28	96	2	1.17416	-3.843	-2.48	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	337
1633	In-air	Current	1.27E+05	8.06E+01	5.05	0	2.51E+04	0.44	96	3	1.20629	-3.843	-2.48	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	338
1634	In-air	Current	3.10E+05	1.97E+02	11.8833	0	2.61E+04	0.28	95	3	1.20629	-2.281	-2.48	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	339
1635	In-air	Current	2.97E+05	1.89E+02	11.8667	0	2.50E+04	0.29	95	3	1.20799	-2.281	-2.48	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	340
1636	In-air	Current	2.93E+05	1.86E+02	10.9333	0	2.68E+04	0.29	94	4	1.21821	-2.281	-2.48	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	341
1637	In-air	Current	1.04E+05	6.61E+01	4.26667	0	2.43E+04	0.49	95	3	1.20619	-2.281	-2.48	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	342
1638	In-air	Current	2.87E+05	1.83E+02	10.8667	0	2.64E+04	0.3	94	4	1.20619	-0.681	-2.48	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	343
1639	In-air	Current	3.12E+05	1.98E+02	12.0833	0	2.58E+04	0.28	95	3	1.20619	0.919	-2.48	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	344
1640	In-air	Current	3.06E+05	1.95E+02	12.25	0	2.50E+04	0.29	95	3	1.19597	2.494	-2.48	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	345
1641	In-air	Current	2.95E+05	1.88E+02	12.4667	0	2.37E+04	0.29	95	2	1.21297	-3.843	-0.085	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	346
1642	In-air	Current	3.11E+05	1.98E+02	12.7167	0	2.45E+04	0.28	96	3	1.21297	-3.843	-0.085	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	347
1643	In-air	Current	5.70E+04	3.62E+01	2.9	0	1.96E+04	0.66	93	4	1.20282	-3.843	-0.085	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	348
1644	In-air	Current	3.09E+05	1.96E+02	13.05	0	2.37E+04	0.28	95	3	1.17558	-2.256	-0.085	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	349
1645	In-air	Current	2.96E+05	1.89E+02	12.4833	0	2.38E+04	0.29	95	2	1.20285	-2.256	-0.085	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	350
1646	In-air	Current	2.90E+05	1.84E+02	11.8167	0	2.45E+04	0.29	95	3	1.2183	-2.256	-0.085	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	351
1647	In-air	Current	9.60E+04	6.11E+01	4.46667	0	2.15E+04	0.51	94	3	1.21349	-2.256	-0.085	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	352
1648	In-air	Current	2.89E+05	1.84E+02	12.9167	0	2.24E+04	0.29	95	2	1.21349	-0.68	-0.085	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	353
1649	In-air	Current	2.97E+05	1.89E+02	12.45	0	2.39E+04	0.29	95	2	1.19158	0.945	-0.085	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	354
1650	In-air	Current	2.87E+05	1.83E+02	11.9333	0	2.41E+04	0.29	96	2	1.20583	2.558	-0.085	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	355
1651	In-air	Current	3.10E+05	1.97E+02	12.9667	0	2.39E+04	0.28	95	3	1.19031	-3.829	2.335	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	356
1652	In-air	Current	4.85E+05	3.09E+02	22.5333	0	2.15E+04	0.23	95	3	1.20413	-3.829	2.335	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	357
1653	In-air	Current	2.94E+05	1.87E+02	12.4	0	2.37E+04	0.29	95	3	1.20413	-3.829	2.335	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	358
1654	In-air	Current	6.52E+04	4.15E+01	5.75	0	1.14E+04	0.62	94	4	1.20469	-3.829	2.335	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	359
1655	In-air	Current	3.07E+05	1.95E+02	12.4167	0	2.47E+04	0.29	96	2	1.20469	-2.229	2.335	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	360
1656	In-air	Current	3.05E+05	1.94E+02	12.35	0	2.47E+04	0.29	96	2	1.22233	-2.229	2.335	-9.379	-0.198	-82.225	0.1	2	56.875	579_576_485_503_412	361

Appendix D – SEE Insitu Leakage Data

TAMU 07-10 November 2021 9A97064 Gold 130 - 170

Attached Text File:

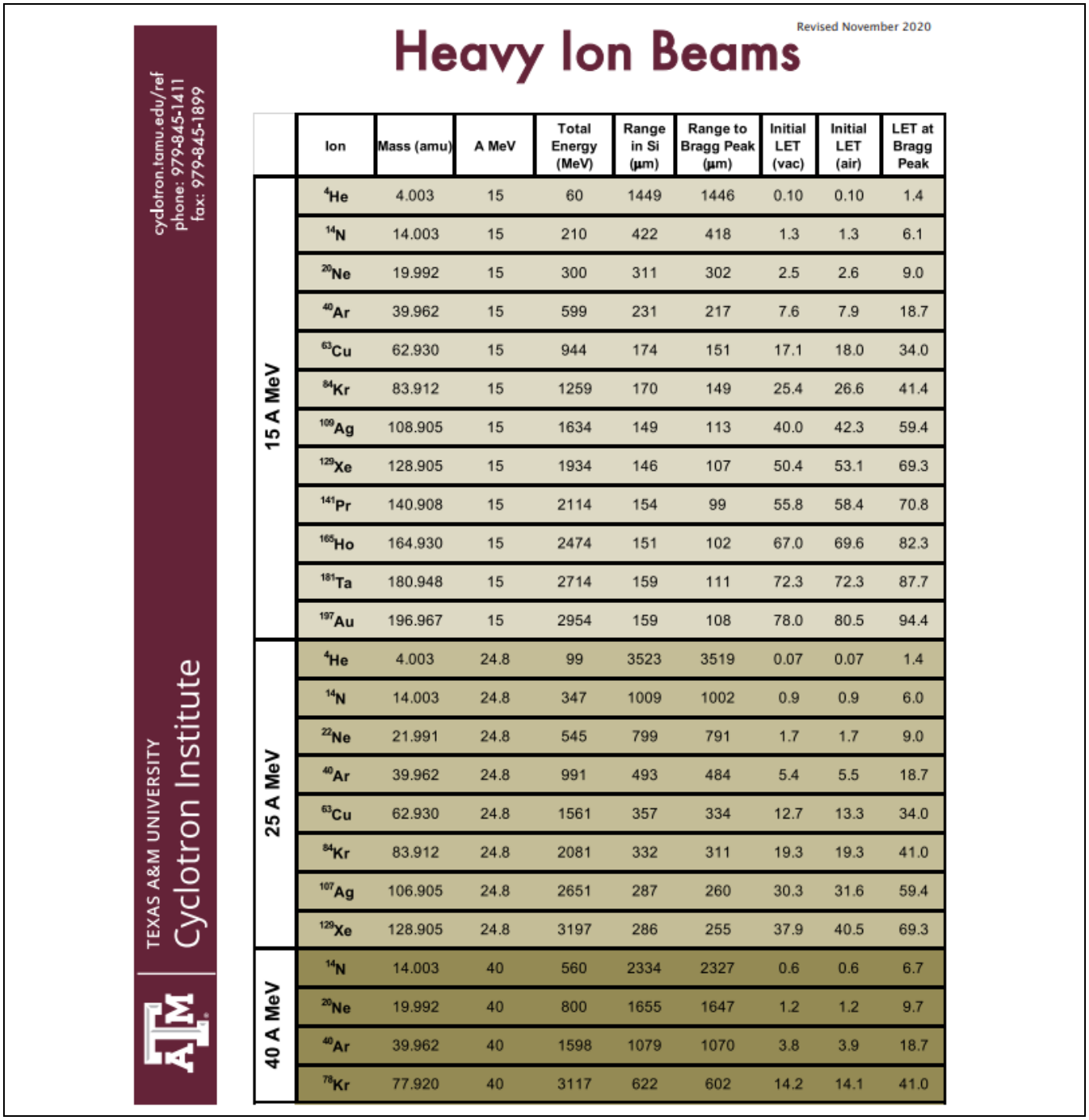
TAMU 06-10 April 2022 9A97064 Xenon 1394 - 1424

Attached Text File:

TAMU 06-10 April 2022 9A97064 Krypton 1625 - 1656

Attached Text File:

Appendix E – TAMU SEE Beam Specifications



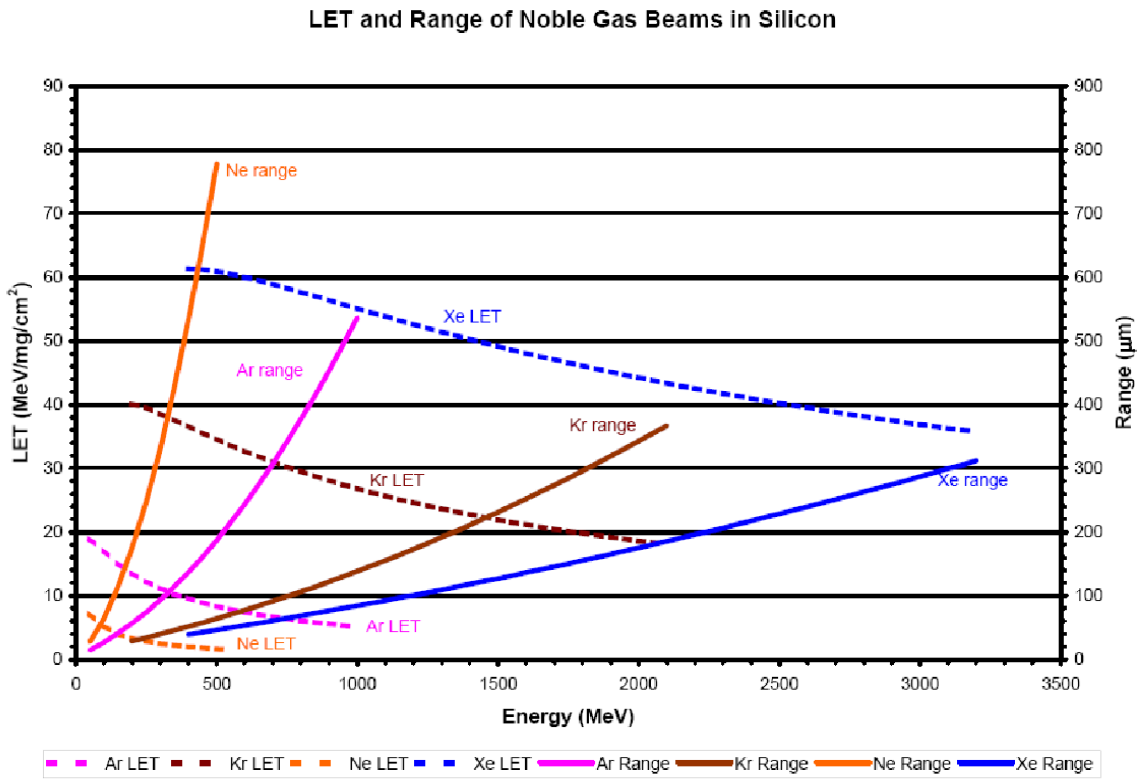
TEXAS A&M UNIVERSITY Cyclotron Institute
cyclotron.tamu.edu/ref
phone: 979-845-1411
fax: 979-845-1899

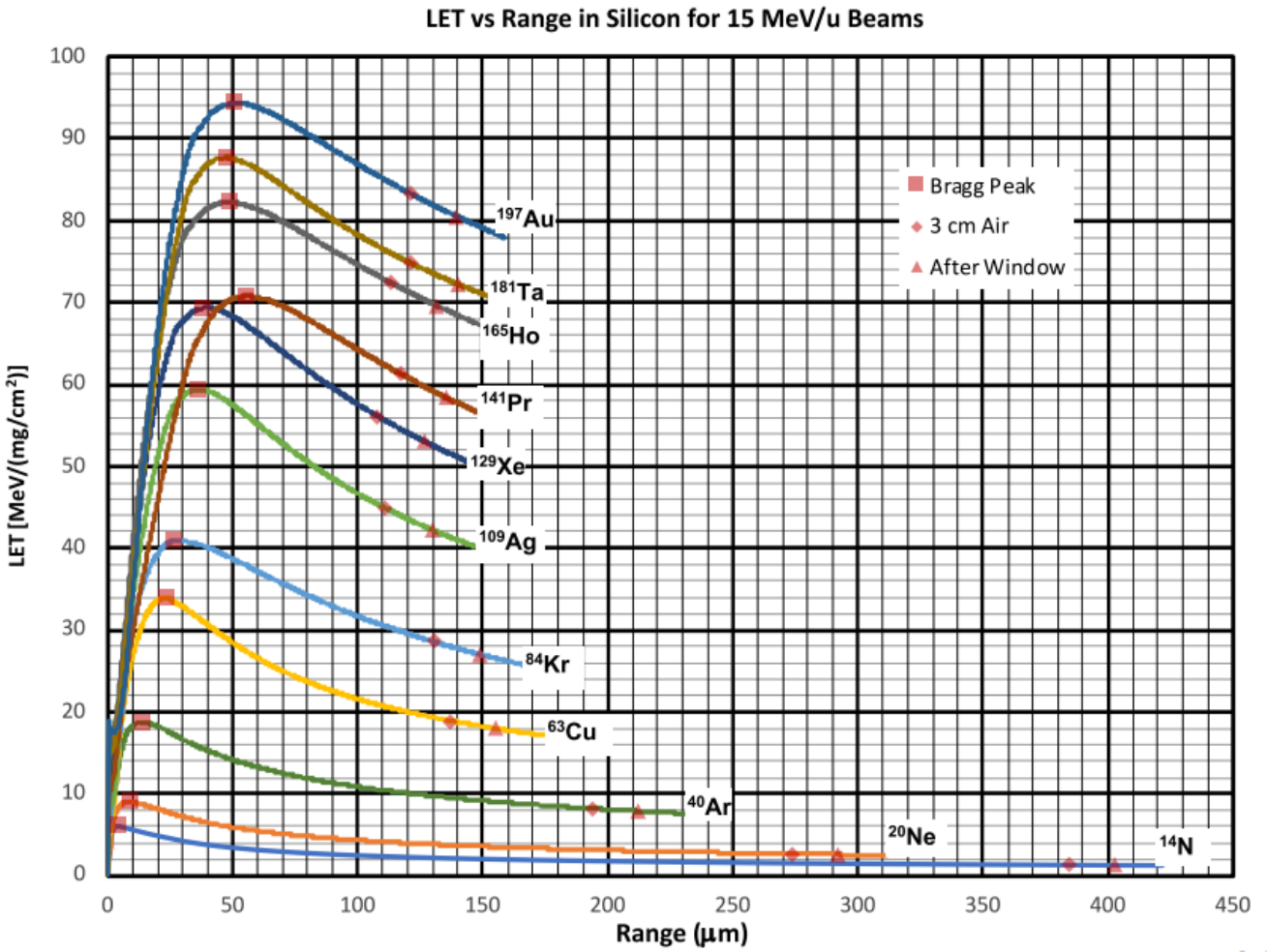
Revised November 2020

Heavy Ion Beams

	Ion	Mass (amu)	A MeV	Total Energy (MeV)	Range in Si (µm)	Range to Bragg Peak (µm)	Initial LET (vac)	Initial LET (air)	LET at Bragg Peak
15 A MeV	^{4}He	4.003	15	60	1449	1446	0.10	0.10	1.4
	^{14}N	14.003	15	210	422	418	1.3	1.3	6.1
	^{20}Ne	19.992	15	300	311	302	2.5	2.6	9.0
	^{40}Ar	39.962	15	599	231	217	7.6	7.9	18.7
	^{63}Cu	62.930	15	944	174	151	17.1	18.0	34.0
	^{84}Kr	83.912	15	1259	170	149	25.4	26.6	41.4
	^{109}Ag	108.905	15	1634	149	113	40.0	42.3	59.4
	^{129}Xe	128.905	15	1934	146	107	50.4	53.1	69.3
	^{141}Pr	140.908	15	2114	154	99	55.8	58.4	70.8
	^{165}Ho	164.930	15	2474	151	102	67.0	69.6	82.3
	^{181}Ta	180.948	15	2714	159	111	72.3	72.3	87.7
	^{197}Au	196.967	15	2954	159	108	78.0	80.5	94.4
25 A MeV	^{4}He	4.003	24.8	99	3523	3519	0.07	0.07	1.4
	^{14}N	14.003	24.8	347	1009	1002	0.9	0.9	6.0
	^{22}Ne	21.991	24.8	545	799	791	1.7	1.7	9.0
	^{40}Ar	39.962	24.8	991	493	484	5.4	5.5	18.7
	^{63}Cu	62.930	24.8	1561	357	334	12.7	13.3	34.0
	^{84}Kr	83.912	24.8	2081	332	311	19.3	19.3	41.0
	^{107}Ag	106.905	24.8	2651	287	260	30.3	31.6	59.4
	^{129}Xe	128.905	24.8	3197	286	255	37.9	40.5	69.3
40 A MeV	^{14}N	14.003	40	560	2334	2327	0.6	0.6	6.7
	^{20}Ne	19.992	40	800	1655	1647	1.2	1.2	9.7
	^{40}Ar	39.962	40	1598	1079	1070	3.8	3.9	18.7
	^{78}Kr	77.920	40	3117	622	602	14.2	14.1	41.0

Figure 16 Heavy Ions Beam List – Ion Species, LET, Range to Bragg Peak


LET and Range of Noble Gas Beams in Silicon
LET (MeV/mg/cm²)
Range (µm)
Energy (MeV)
Ne range
Xe LET
Ar range
Kr range
Kr LET
Xe range
Ar LET
Ne LET
Ar LET
Kr LET
Ne LET
Xe LET
Ar Range
Kr Range
Ne Range
Xe Range


LET vs Range in Silicon for 15 MeV/u Beams
LET [MeV/(mg/cm²)]
Range (µm)
Bragg Peak
3 cm Air
After Window
197Au
181Ta
165Ho
141Pr
129Xe
109Ag
84Kr
63Cu
40Ar
20Ne
14N

Beam Energy, LET and Range in Si at Various Air Gaps From Rear Foil for 15 MeV/u Beams

Air Gap Distance from Rear Foil (cm)

Beam	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
Ne	299	287	285	283	281	279	278	276	274	272	270	268	266
	2.6 | 314	2.6 | 294	2.6 | 291	2.7 | 288	2.7 | 285	2.7 | 282	2.7 | 279	2.7 | 276	2.7 | 273	2.7 | 270	2.8 | 267	2.8 | 264	2.8 | 262
Ar	596	559	554	548	543	537	531	525	519	514	508	502	496
	7.7 | 227	8.1 | 207	8.1 | 204	8.2 | 201	8.2 | 198	8.3 | 195	8.3 | 192	8.4 | 189	8.4 | 186	8.5 | 183	8.6 | 180	8.6 | 177	8.7 | 174
Cu	936	851	838	825	812	798	785	771	757	743	729	715	701
	17.9 | 170	18.8 | 150	19.0 | 147	19.1 | 144	19.3 | 141	19.4 | 138	19.6 | 135	19.8 | 132	19.9 | 129	20.1 | 126	20.3 | 123	20.5 | 120	20.7 | 117
Kr	1248	1126	1108	1089	1070	1051	1032	1012	993	973	953	933	912
	25.5 | 169	26.8 | 149	27.0 | 146	27.2 | 143	27.4 | 140	27.6 | 137	27.8 | 134	28.1 | 313	28.3 | 128	28.5 | 125	28.8 | 122	29.1 | 119	29.3 | 116
Ag	1617	1433	1405	1376	1348	1319	1289	1260	1230	1200	1170	1139	1109
	38.7 | 154	40.6 | 134	40.9 | 131	41.2 | 128	41.5 | 125	41.8 | 122	42.2 | 119	42.5 | 116	42.8 | 113	43.2 | 110	43.6 | 107	43.9 | 104	44.3 | 101
Xe	1913	1688	1653	1618	1583	1547	1512	1476	1439	1403	1366	1329	1291
	47.5 | 155	49.7 | 135	50.0 | 132	50.4 | 129	50.8 | 126	51.1 | 123	51.5 | 120	51.9 | 117	52.3 | 114	52.7 | 111	53.1 | 108	53.5 | 105	53.9 | 102
Pr	2090	1834	1795	1755	1716	1675	1635	1594	1553	1512	1470	1428	1385
	54.0 | 153	56.4 | 132	56.7 | 130	57.1 | 127	57.5 | 124	57.9 | 121	58.3 | 118	58.7 | 115	59.2 | 112	59.6 | 108	60.0 | 105	60.4 | 102	60.5 | 99
Ho	2447	2142	2095	2048	2001	1953	1905	1857	1808	1759	1710	1660	1610
	64.5 | 155	67.2 | 135	67.5 | 132	67.9 | 129	68.3 | 126	68.7 | 123	69.1 | 120	69.6 | 117	70.0 | 114	70.4 | 111	70.8 | 107	71.3 | 104	71.3 | 101
Ta	2684	2341	2289	2236	2183	2130	2076	2022	1967	1913	1858	1802	1745
	72.5 | 154	75.2 | 134	75.6 | 131	76.0 | 128	76.4 | 125	76.9 | 122	77.7 | 116	78.2 | 113	78.2 | 113	78.6 | 110	79 | 107	79 | 104	79.4 | 101
Au	2920	2540	2482	2424	2365	2306	2247	2187	2127	2067	2006	1945	1883
	80.5 | 153	83.3 | 133	83.7 | 130	84.1 | 127	84.6 | 124	85 | 121	85.4 | 118	85.8 | 115	86.3 | 112	86.7 | 109	87.1 | 106	87 | 103	87.4 | 100

BLACK = Beam Energy (MeV) RED = LET in Si (MeV/(mg/cm^2)) Blue = Range in Si and is given in microns

Revision history

Document version	Date of release	Description of changes
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