

SEE Test Report V3.0
Heavy ion SEE test of SLH2812D from Interpoint
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I. Introduction

This study was undertaken to determine the single event destructive and transient susceptibility of the SLH2812D, Dual DC/DC Converters, for transient interruptions in the output signal and for destructive events induced by exposing it to a heavy ion beam for transient interruptions in the output signal and for destructive events induced by exposing it to a heavy ion beam at the Lawrence Berkeley Nuclear Laboratory (LBNL) and at the Cyclotron Institute located on the campus of Texas A&M University (TAMU). Utilizing the Berkeley Accelerator Space Effects Facility (BASEF) and the TAMU Radiation Effect Facility, this test was performed for the investigation of radiation susceptibility of transient events and destructive events for Crane Interpoint. This work was in conjunction with the NASA Electronics Parts and Packaging (NEPP) Program. NEPP is a HQ sponsored program that seeks to find new developments that will benefit NASA.

II. Devices Tested

The sample size of Device Under Test (DUT) for testing was three. Each device was exposed to the radiation beam and the results will be compared for verification. For the SLH2812D, the test samples code markings were for DUT1 SN-1415, DUT2 SN-1416, & DUT3 SN-1417 with DC-0748 on all three. The device is packaged in a 7-pin lead metal can package. The device was prepped for test by delidding. The SLH series of 28V DC/DC converters delivers 1.5 watts of output power while saving significant board area. The wide input voltage range of 16 to 40 VDC accepts the varying voltages of space, military or aerospace bus power and tightly regulates output voltages to protect downstream components.

The converters incorporate a flyback topology with a variable switching frequency. Feedback provides output voltage regulation. Output voltage is magnetically fed back to the input side of the PWM to regulate output voltage. Up to 80% of the load of the dual output models may be on one output providing that the other output carries a minimum of 20% of the total load. The dual models can be used as a single output voltage by connecting the load between positive and negative outputs, leaving the common unconnected resulting in double the output voltage.

III. Test Facility

Facility: Berkeley Accelerator Space Effects Facility, 10 & 16 MeV/u beams

Facility: Texas A&M Cyclotron Radiation Effects Facility, 15 MeV/u beams

Flux: 1.64×10^3 to 1.10×10^5 particles/cm²/s.

Fluence: For destructive events, all tests were ran to 1×10^7 p/cm² or until destructive events occurred

For non destructive events, all tests were ran to 1×10^7 p/cm² or until a sufficient (>100) number of transient events occurred.

The ions and LET values for these tests were Xe, Ta, & Au

IV. Test Conditions and Error Modes

Test Temperature: Room Temperature

Bias conditions $V_{in} = 28V$, $V_{out} = +/-12V$

See Figure 2 for detailed conditions

| | Vsupply (V) | Isupply (mA) | Vin (V) | Loading % |
|-------|------------------------|-------------------------|--------------------|----------------------|
| DUT 1 | +12/-12 | 33 | 28V | 0 |
| DUT 2 | +12/-12 | 33 | 28V | 0 |
| DUT 1 | +12/-12 | 95 | 28V | 30 |
| DUT 2 | +12/-12 | 94 | 28V | 30 |
| DUT 1 | +12/-12 | 135 | 28V | 50 |
| DUT 2 | +12/-12 | 135 | 28V | 50 |
| DUT 1 | +12/-12 | 175 | 28V | 70 |
| DUT 2 | +12/-12 | 175 | 28V | 70 |
| DUT 1 | +12/-12 | 82 | 21V | 30 |
| DUT 2 | +12/-12 | 112 | 35V | 30 |
| DUT 2 | +12/-12 | 112 | 35V | 50 |

Table 1: Test conditions

PARAMETERS OF INTEREST: Power supply currents, output voltage

SEE Conditions: SEL, SEGR, SET

V. Test Methods

The block diagram, as shown in Figure 1, for the DC-DC Converters contains a power supply for +/- input voltages, an electronic load, a DUT board for the test circuitry and devices, a computer for GPIB control of measurement equipment, and a digital scope to capture any output anomalies, and after the desired voltage input is applied, each of the two device outputs will display on the digital scope, which is set to trigger on voltages that are above or below a predetermined threshold (set to 250 mV). Each device output was tested one after each other.

Table 1, shows the test conditions where tests were conducted for an input nominal voltage of 28V with no loading and also with 28V, 21V, and 35V with 30%, 50%, and 70% loading. Figure 2, shows the test schematic circuit of the SLH2812D and Figure 3, shows the device and test board mounted at the beam at LBNL.

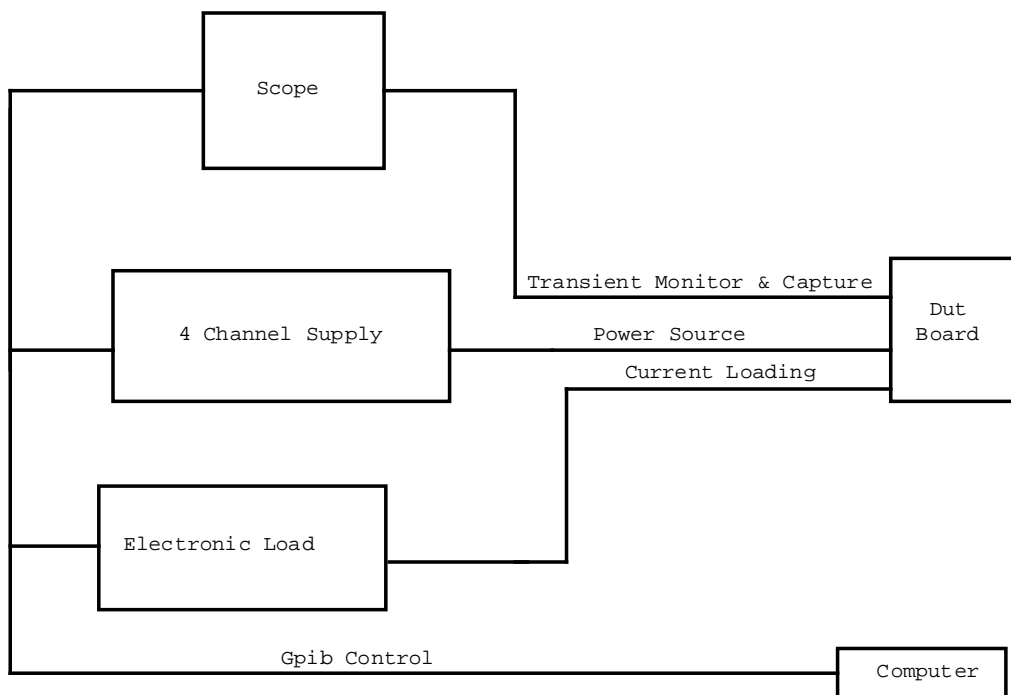


Figure 1. Overall Block Diagram for the testing of the SLH2812D

VI. Test Performance

- Destructive test at high LET ($\geq 78.2 \text{ MeVcm}^2/\text{mg}$) on 3 parts and one part at LET ($\geq 86.3 \text{ MeVcm}^2/\text{mg}$) up to a fluence of 10^7 \#/cm^2 .
- SET test on 3 parts for 1 LET value for each device output and each condition described in Table 1.

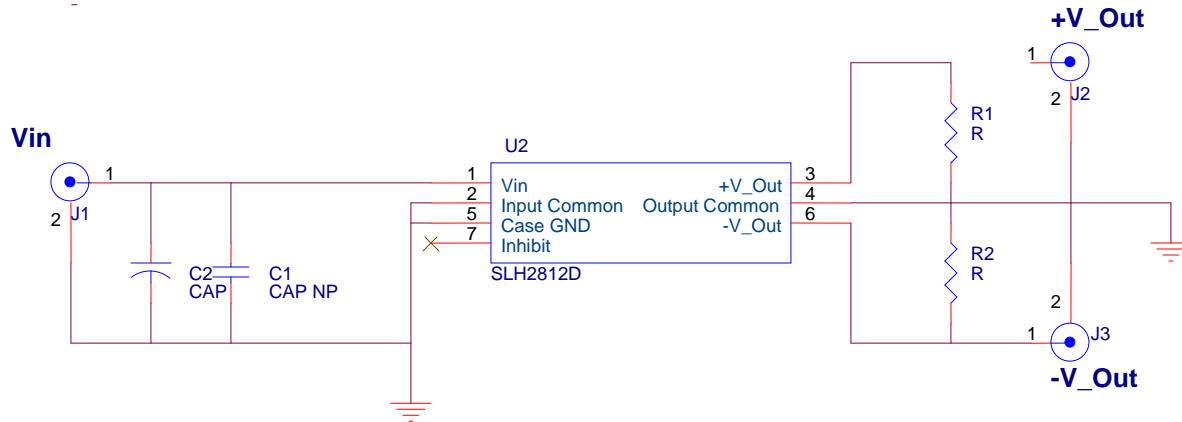


Figure 2. SLH2812D Test Schematic Circuit



Figure 3. SLH2812D cover and internal circuitry test at LBNL

VII. Test Results

Detailed test results are shown in Table 2 below. The devices were exposed from a fluence of 9.93×10^4 to 1.01×10^7 particles/cm² of the Xenon, Tantalum, and Gold ion beams. Observations for destructive and non-destructive events were for energies up to the maximum LET of 86.3 MeV-cm²/mg at normal angle of incidence. There were no destructive events observed for the SLH2812D, but the device was sensitive to SETs and did experience transient events that can be mitigated with using the appropriate LC filtering circuitry in conjunction with this DC-DC converter, with the worse case occurring <1V and <700ns. Chart 1 shows the worse case transients and Chart 2 shows the SET cross sections observed. Runs 45-80 were taken at TAMU, all others were at LBNL. The tests were run with an input of 28V, 21V, & 35V at 30%, 50%, and 70% loading conditions. In general most SETs were small; therefore this device is suitable for space applications.

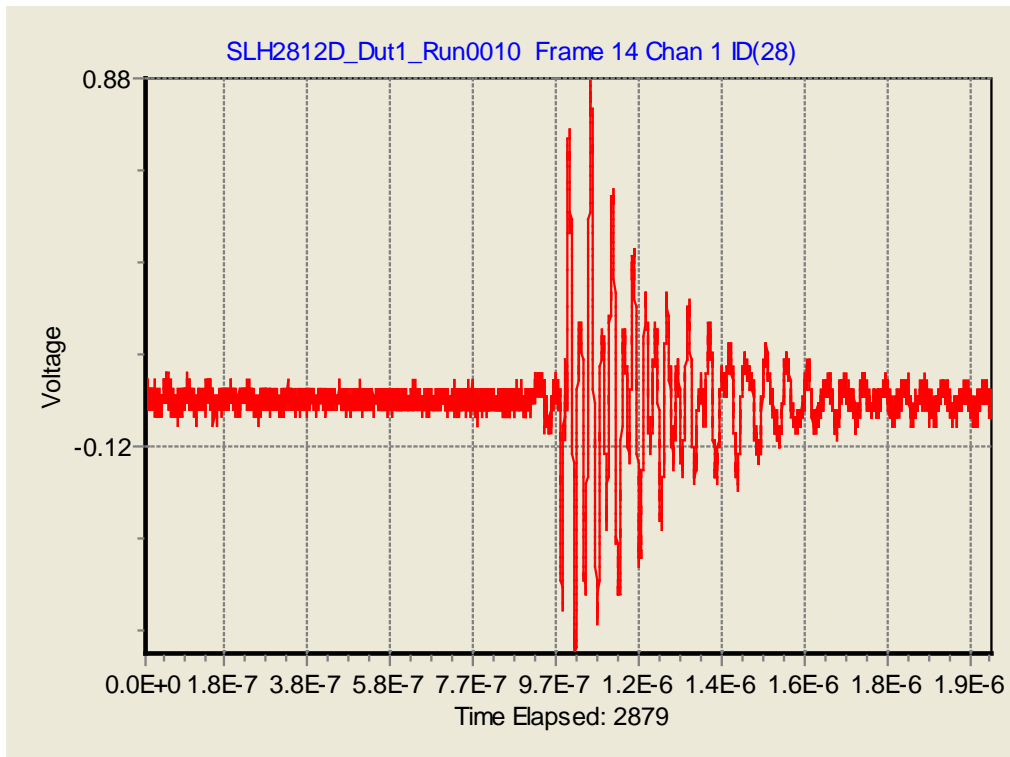


Chart 1. Typical Worst Case Transient of approx <1V and <700ns

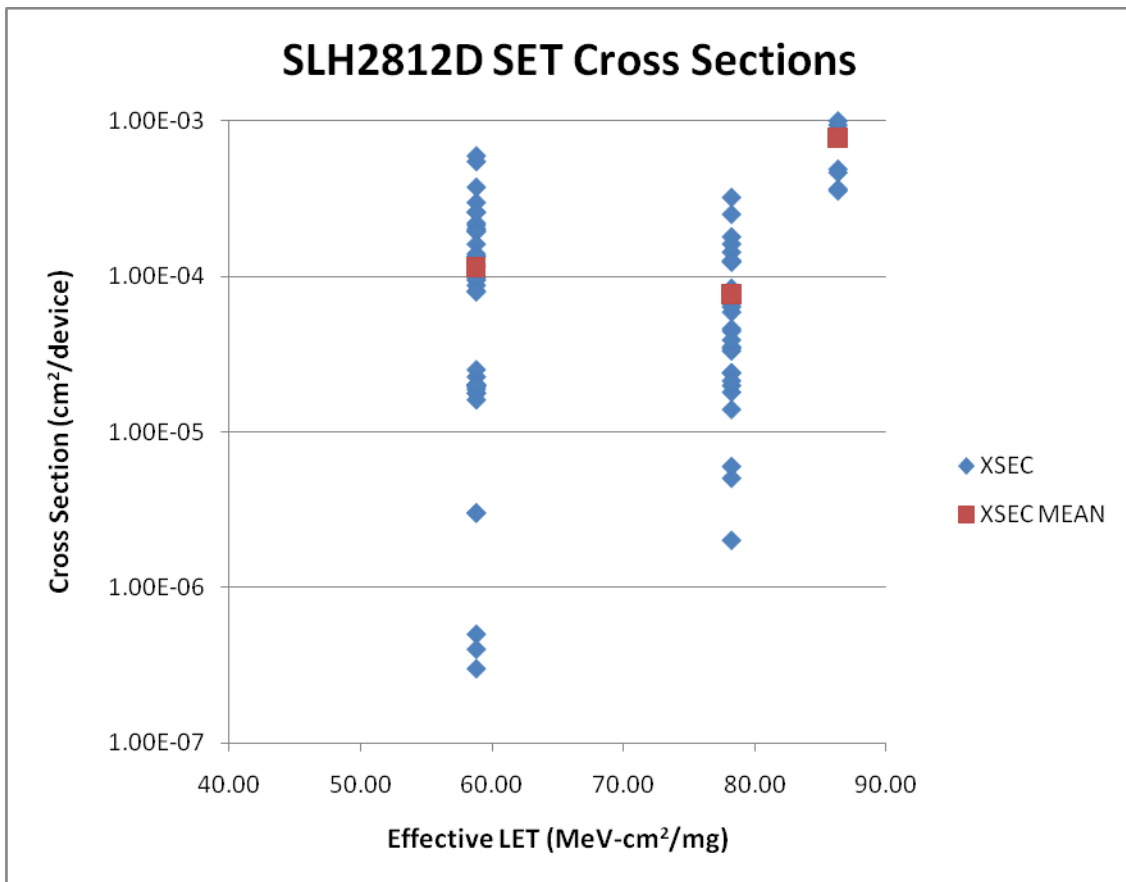


Chart 2. SLH2812D SET Cross Sections

Table 2: SLH2812D Data Collected at LBNL & TAMU

| Run# | Serial | DC | Voltage | Trig | Current(mA) | Load(A) | Ion | Energy | LET | LET(eff) | angle | Flux | Fluence _{eff} | SET | SEL | σ_{SEU} |
|------|--------|------|---------|-------|-------------|---------|-------|--------|-------|----------|-------|----------|------------------------|-----|-----|-----------------------|
| 1 | 1417 | 0748 | 28 | 11.5 | 2.8 | 0 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 9.60E+04 | 1.00E+07 | 4 | 0 | 5.00E-07 |
| 2 | 1417 | 0748 | 28 | 11.5 | 2.8 | 0 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 8.91E+04 | 1.00E+07 | 3 | 0 | 4.00E-07 |
| 3 | 1417 | 0748 | 28 | 11.5 | 18.5 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 9.05E+04 | 1.00E+07 | 2 | 0 | 3.00E-07 |
| 4 | 1417 | 0748 | 28 | 11.5 | 18.5 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 9.82E+04 | 1.00E+07 | 0 | 0 | 0.00E+00 |
| 5 | 1417 | 0748 | 28 | 11.5 | 18.5 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 1.01E+05 | 1.00E+07 | 0 | 0 | 0.00E+00 |
| 6 | 1417 | 0748 | 28 | 11.5 | 18.5 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 1.10E+05 | 8.47E+06 | 114 | 0 | 2.00E-05 |
| 7 | 1417 | 0748 | 28 | 11.5 | 18.5 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 3.04E+04 | 5.59E+06 | 104 | 0 | 1.95E-05 |
| 8 | 1417 | 0748 | 28 | 11.5 | 18.5 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 3.41E+04 | 1.02E+06 | 20 | 0 | 2.25E-05 |
| 9 | 1417 | 0748 | 28 | 11.5 | 18.5 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 3.10E+04 | 1.02E+06 | 17 | 0 | 1.76E-05 |
| 10 | 1417 | 0748 | 28 | 11.5 | 18.5 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.95E+04 | 1.02E+06 | 17 | 0 | 1.77E-05 |
| 11 | 1417 | 0748 | 28 | 11.5 | 18.5 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.49E+04 | 1.02E+06 | 19 | 0 | 1.97E-05 |
| 12 | 1417 | 0748 | 21 | 11.5 | 31.5 | 0.034 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.57E+04 | 1.01E+06 | 46 | 0 | 7.99E-05 |
| 13 | 1417 | 0748 | 21 | 11.5 | 31.5 | 0.034 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.69E+03 | 1.01E+05 | 9 | 0 | 9.86E-05 |
| 14 | 1417 | 0748 | 21 | 11.5 | 31.5 | 0.034 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.78E+03 | 1.00E+06 | 93 | 0 | 9.40E-05 |
| 15 | 1417 | 0748 | 21 | 11.5 | 31.5 | 0.034 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.80E+03 | 1.00E+06 | 114 | 0 | 1.16E-04 |
| 16 | 1417 | 0748 | 35 | 11.5 | 15 | 0.019 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.83E+03 | 7.96E+05 | 151 | 0 | 2.01E-04 |
| 17 | 1417 | 0748 | 35 | 11.5 | 15 | 0.019 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.67E+03 | 5.53E+05 | 104 | 0 | 1.95E-04 |
| 18 | 1417 | 0748 | 35 | 11.5 | 26.3 | 0.034 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.51E+03 | 5.14E+05 | 107 | 0 | 2.12E-04 |
| 19 | 1417 | 0748 | 35 | 11.5 | 18.5 | 0.034 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.56E+03 | 5.27E+05 | 107 | 0 | 2.18E-04 |
| 20 | 1417 | 0748 | 28 | 11.5 | 31.5 | 0.034 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.53E+03 | 1.00E+06 | 85 | 0 | 8.70E-05 |
| 21 | 1416 | 0748 | 28 | 11.25 | 2.85 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.00E+03 | 1.00E+06 | 24 | 0 | 2.50E-05 |
| 22 | 1416 | 0748 | 28 | 11.5 | 18.5 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.02E+03 | 1.00E+06 | 15 | 0 | 1.60E-05 |
| 23 | 1416 | 0748 | 28 | 11.5 | 18.5 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.01E+03 | 6.94E+05 | 12 | 0 | 1.87E-05 |
| 24 | 1416 | 0748 | 28 | 11.5 | 31.7 | 0.038 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 1.94E+03 | 2.60E+05 | 45 | 0 | 1.92E-04 |
| 25 | 1416 | 0748 | 28 | 11.5 | 31.7 | 0.038 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 1.91E+03 | 1.00E+05 | 15 | 0 | 1.60E-04 |
| 26 | 1416 | 0748 | 21 | 11.5 | 42.3 | 0.038 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.07E+03 | 1.01E+05 | 46 | 0 | 5.42E-04 |
| 27 | 1416 | 0748 | 21 | 11.5 | 42.3 | 0.038 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.02E+03 | 1.02E+05 | 46 | 0 | 5.91E-04 |
| 28 | 1416 | 0748 | 35 | 11.5 | 25.6 | 0.038 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 1.99E+03 | 1.01E+05 | 26 | 0 | 2.96E-04 |
| 29 | 1416 | 0748 | 35 | 11.5 | 25.6 | 0.038 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 1.95E+03 | 1.01E+05 | 25 | 0 | 2.56E-04 |
| 30 | 1416 | 0748 | 35 | 11.5 | 14.9 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.03E+03 | 1.01E+05 | 13 | 0 | 1.38E-04 |
| 31 | 1416 | 0748 | 21 | 11.5 | 24.6 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.09E+03 | 1.01E+05 | 0 | 0 | 0.00E+00 |
| 32 | 1416 | 0748 | 21 | 11.5 | 24.6 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.05E+03 | 1.01E+05 | 0 | 0 | 0.00E+00 |
| 33 | 1416 | 0748 | 21 | 11.5 | 24.6 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.05E+03 | 1.00E+06 | 2 | 0 | 3.00E-06 |
| 34 | 1415 | 0748 | 28 | 11.5 | 18.8 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 1.93E+04 | 7.07E+05 | 41 | 0 | 9.62E-05 |
| 35 | 1415 | 0748 | 28 | 11.5 | 18.8 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 1.88E+03 | 3.14E+05 | 40 | 0 | 1.34E-04 |
| 36 | 1415 | 0748 | 28 | 11.5 | 32 | 0.038 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 1.98E+03 | 1.01E+05 | 7 | 0 | 7.91E-05 |
| 37 | 1415 | 0748 | 28 | 11.5 | 32 | 0.038 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 1.83E+03 | 3.38E+05 | 44 | 0 | 1.33E-04 |
| 38 | 1415 | 0748 | 35 | 11.5 | 25.5 | 0.038 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 1.74E+03 | 1.70E+05 | 58 | 0 | 3.71E-04 |
| 39 | 1415 | 0748 | 21 | 11.5 | 42.7 | 0.038 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 1.70E+03 | 1.01E+05 | 24 | 0 | 2.57E-04 |
| 40 | 1415 | 0748 | 21 | 11.5 | 24.5 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 1.75E+03 | 1.00E+05 | 1 | 0 | 2.00E-05 |
| 41 | 1415 | 0748 | 21 | 11.5 | 24.5 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 1.64E+03 | 2.51E+05 | 4 | 0 | 1.99E-05 |
| 42 | 1417 | 0748 | 21 | 11.5 | 24.6 | 0.021 | Xe-10 | 1232 | 58.78 | 58.8 | 0 | 2.26E+03 | 1.00E+06 | 2 | 0 | 3.00E-06 |
| 45 | 1415 | 0748 | 28 | 11.5 | 19.7 | 0.021 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.37E+05 | 3.08E+06 | 42 | 0 | 2.37E-05 |
| 46 | 1415 | 0748 | 28 | 11.5 | 19.7 | 0.021 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.29E+05 | 8.22E+06 | 125 | 0 | 3.50E-05 |
| 47 | 1415 | 0748 | 28 | 11.5 | 19.7 | 0.021 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.01E+04 | 1.38E+06 | 58 | 0 | 4.42E-05 |
| 48 | 1415 | 0748 | 28 | 11.5 | 19.7 | 0.021 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.16E+04 | 1.00E+06 | 32 | 0 | 3.30E-05 |
| 49 | 1415 | 0748 | 21 | 11.5 | 26 | 0.021 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.04E+04 | 9.97E+05 | 4 | 0 | 5.02E-06 |

| | | | | | | | | | | | | | | | | |
|----|------|------|----|------|------|-------|-------|------|------|------|---|----------|----------|-----|---|----------|
| 50 | 1415 | 0748 | 21 | 11.5 | 26 | 0.021 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.07E+04 | 1.01E+06 | 5 | 0 | 5.97E-06 |
| 51 | 1415 | 0748 | 35 | 11.5 | 16.3 | 0.021 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.05E+04 | 9.96E+05 | 74 | 0 | 8.33E-05 |
| 52 | 1415 | 0748 | 35 | 11.5 | 16.3 | 0.021 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.34E+04 | 1.00E+06 | 61 | 0 | 6.60E-05 |
| 53 | 1415 | 0748 | 28 | 11.5 | 33.5 | 0.038 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.36E+04 | 1.01E+06 | 56 | 0 | 5.86E-05 |
| 54 | 1415 | 0748 | 28 | 11.5 | 33.5 | 0.038 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.32E+04 | 9.96E+05 | 60 | 0 | 6.32E-05 |
| 55 | 1415 | 0748 | 21 | 11.5 | 44.2 | 0.038 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.76E+04 | 1.01E+06 | 13 | 0 | 1.39E-05 |
| 56 | 1415 | 0748 | 21 | 11.5 | 44.2 | 0.038 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.36E+04 | 1.00E+06 | 23 | 0 | 2.39E-05 |
| 57 | 1415 | 0748 | 35 | 11.5 | 27.3 | 0.038 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.73E+04 | 6.34E+05 | 63 | 0 | 1.78E-04 |
| 58 | 1415 | 0748 | 35 | 11.5 | 27.3 | 0.038 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 2.02E+04 | 6.61E+05 | 62 | 0 | 1.60E-04 |
| 59 | 1416 | 0748 | 28 | 11.5 | 19.8 | 0.021 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 2.23E+04 | 1.01E+06 | 17 | 0 | 1.79E-05 |
| 60 | 1416 | 0748 | 21 | 11.5 | 26.1 | 0.021 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 2.19E+04 | 1.01E+06 | 42 | 0 | 4.58E-05 |
| 61 | 1416 | 0748 | 35 | 11.5 | 16.6 | 0.021 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 2.00E+04 | 9.98E+05 | 81 | 0 | 1.23E-04 |
| 62 | 1416 | 0748 | 28 | 11.5 | 33.7 | 0.038 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 2.15E+04 | 8.44E+05 | 68 | 0 | 1.42E-04 |
| 63 | 1416 | 0748 | 28 | 11.5 | 33.7 | 0.038 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 4.42E+03 | 7.82E+05 | 97 | 0 | 1.25E-04 |
| 64 | 1416 | 0748 | 21 | 11.5 | 44.3 | 0.038 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 4.41E+03 | 3.89E+05 | 109 | 0 | 3.19E-04 |
| 65 | 1416 | 0748 | 35 | 11.5 | 27.3 | 0.038 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 4.23E+03 | 4.18E+05 | 98 | 0 | 2.49E-04 |
| 66 | 1417 | 0748 | 28 | 11.5 | 19.7 | 0.021 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 4.06E+03 | 4.05E+05 | 7 | 0 | 1.97E-05 |
| 67 | 1417 | 0748 | 28 | 11.5 | 19.7 | 0.021 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 4.32E+03 | 9.06E+05 | 30 | 0 | 3.42E-05 |
| 68 | 1417 | 0748 | 35 | 11.5 | 16.5 | 0.021 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 4.30E+03 | 4.50E+05 | 36 | 0 | 8.22E-05 |
| 69 | 1417 | 0748 | 21 | 11.5 | 25.9 | 0.021 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.79E+04 | 9.98E+05 | 1 | 0 | 2.00E-06 |
| 70 | 1417 | 0748 | 28 | 11.5 | 33.4 | 0.038 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.85E+04 | 1.01E+06 | 38 | 0 | 3.87E-05 |
| 71 | 1417 | 0748 | 21 | 11.5 | 43.9 | 0.038 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.93E+04 | 9.92E+05 | 20 | 0 | 2.12E-05 |
| 72 | 1417 | 0748 | 35 | 11.5 | 27.2 | 0.038 | Ta-15 | 1967 | 78.2 | 78.2 | 0 | 1.00E+00 | 8.79E+05 | 75 | 0 | 1.23E-04 |
| 73 | 1415 | 0748 | 28 | 11.5 | 19.7 | 0.021 | Au-15 | 2127 | 86.3 | 86.3 | 0 | 1.03E+04 | 1.42E+05 | 20 | 0 | 9.31E-04 |
| 74 | 1415 | 0748 | 28 | 11.5 | 19.7 | 0.021 | Au-15 | 2127 | 86.3 | 86.3 | 0 | 1.03E+04 | 2.21E+05 | 20 | 0 | 3.62E-04 |
| 75 | 1415 | 0748 | 28 | 11.5 | 19.7 | 0.021 | Au-15 | 2127 | 86.3 | 86.3 | 0 | 5.10E+03 | 1.77E+05 | 46 | 0 | 4.85E-04 |
| 76 | 1415 | 0748 | 21 | 11.5 | 25.8 | 0.021 | Au-15 | 2127 | 86.3 | 86.3 | 0 | 5.04E+03 | 2.67E+05 | 60 | 0 | 3.52E-04 |
| 77 | 1415 | 0748 | 35 | 11.5 | 16.9 | 0.021 | Au-15 | 2127 | 86.3 | 86.3 | 0 | 1.14E+03 | 9.98E+04 | 29 | 0 | 4.61E-04 |
| 78 | 1415 | 0748 | 35 | 11.5 | 27.9 | 0.038 | Au-15 | 2127 | 86.3 | 86.3 | 0 | 1.12E+03 | 1.00E+05 | 77 | 0 | 8.80E-04 |
| 79 | 1415 | 0748 | 28 | 11.5 | 33.5 | 0.038 | Au-15 | 2127 | 86.3 | 86.3 | 0 | 1.16E+03 | 1.00E+05 | 80 | 0 | 9.90E-04 |
| 80 | 1415 | 0748 | 21 | 11.5 | 44.2 | 0.038 | Au-15 | 2127 | 86.3 | 86.3 | 0 | 1.14E+03 | 9.93E+04 | 110 | 0 | 1.76E-03 |