EV12DS130B - VN54B - Radiation test Report

Revision date :	**June 2016**
Author :	**BONNET OLIVIER**
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SAVASTA Eric	YES	10/06/2016

Document approved by Quality Department.

1. DOCUMENT AMENDMENT RECORD

Author	Issue	Date	Reason for change
BONNET Olivier	A	June 2016	Creation

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Document approved by
Quality Department.

Document approved by Quality Department.

2. GLOSSARY

CREME Cosmic Ray Effects on Micro-Electronics
DAC Digital-to-Analog Converter
DC Direct Current
DSP Digital Signal Processor
DUT Device Under Test
HF High Frequency
HIF Heavy Ions Facility
IUCM Input Under Clocking Mode
LED Light-Emitting Diode
LET Linear Energy Transfer
MTBF Mean Time Between Failure
MUX MUltipleXer
NRTZ Narrow Return To Zero
NRZ Non Return to Zero
OCDS Output Clock Division Select Function
OMERE Outil de Modélisation de l'Environnement Radiatif Externe
PSS Phase Shift Select Function
RADEF RADiation Effects Facility (Jyväskylä University laboratory, Finland)
RF Radio Frequency
RTZ Return To Zero
SEE Single Event Effect
SEFI Single Event Functional Interrupt
SEL Single Event Latchup
SET Single Event Transient

3. INTRODUCTION

This document summarizes all radiation tests performed on EV12DS130B 12-bit 3Gsps MUX-DAC
designed on Infineon B7HF200 process.

- Total dose tests
- Heavy ion tests

4. APPLICABLE AND REFERENCE DOCUMENTS

[A1] Datasheet EV12DS130B, version 1080G-BDC-12/14

[A2] EV12DS130AGS-EB Evaluation Board – 12-bit DAC 3 Gsps with 4/2:1 MUX User Guide, version 0989-BDC-07/11

[A3] Document reference NE 31S 208187 issue C : EV12DS130A : 12-bit Gsps MUX-DAC Radiation test report Infineon B7HF200

[A4] “SEE Test Method and Guidelines”, ESA ESCC Specification 25100, Issue 1, October 2002

[A5] “Test Procedure for the Management of SEEs in Semiconductor Devices from Heavy-Ion Irradiation, JESD57, December 1996

[A6] EV12DS130B – VN54B - Total dose Report September 2015

[A7] Total Dose Steady-State Irradiation Test Method, ESA ESCC Specification 22900, Issue 3, March 2007

[A8] MIL-STD_883J – Method 1019.9

5. EXECUTIVE SUMMARY

5.1 Lot description

Reference	EV12DS130B
Package	CI-CGA255
Function	Low power 12-bit 3 Gsps digital to analog converter with 4/2:1 multiplexer
Lot No.	RU349519
Mfr. No.	EVX12DS130BGS
Mask Lot	VN54B
Manufacturer	E2V

5.2 Total dose

It was concluded that the device under test (P/N EV12DS130B) had neither functional failure nor parameter drift up to 110 Krad (Si). Static and Dynamic results are satisfactory for all parameters.

A total of ten devices were tested at 3Gsps Clock frequency.

The total irradiation test program was followed by a 24 hr. annealing process at ambient temperature followed by a 168 hr. annealing at 100℃ as per ESCC 22900.

The component is not sensitive to 110 Krad with very low dose rate (36 rad / hr).

5.3 Heavy ions

It was concluded that the devices under test (P/N EV12DS130B) have:

- **No SEL** (SEL measured at Tj=125℃ with maximum power supplies up to a LET of 80 MeVcm^2/mg with a tilt and up to 67.7 MeV-cm^2/mg without tilt)
- **No SEFI & no permanent error**
- **Low LET threshold** < 5.92 MeV.cm^2/mg

Weibull parameters are similar for DSPCLK and DACOUT, however due to the detection system, the DSPCLK errors generate some DACOUT errors.

Test Conditions			**Weibull Fit Parameters**				**SEE Rate Calculation**		
FClock (GHz)	**Output**	**Pattern**	**W (MeV.cm^2/mg)**	**S**	**LET threshold L0 (MeV.cm^2/mg)**	**Cross-Section Sat (cm^2)**	**Mission (GEO)**	**Rate/Day**	**MTBF (Days)**
2&3	DSPCLK	Dynamic	40	1.6	1.50E-2	6.7E-5	M3 15 years	3.3E-4	3030
							M8 16 Days	1.5E-1	6.7
2&3	DSPCLK+DACOUT	Dynamic	40	1.6	1.50E-2	1.51E-4	M3 15 years	8.2E-4	1220
							M8 16 Days	3.9E-1	2.6
2&3	DACOUT	Dynamic	40	1.6	1.50E-2	8.9E-5	M3 15 years	4.5E-4	2222
							M8 16 Days	2.1E-1	4.8
2	DSPCLK	Static	35	1	1.50E-2	1.9E-5	M3 15 years	6.9E-4	1450
							M8 16 Days	4E-1	2.5
2	DSPCLK+DACOUT	Static	35	1	1.50E-2	4.4E-5	M3 15 years	1.7E-3	588
							M8 16 Days	1.11	0.9
2	DACOUT	Static	40	1.6	1.50E-2	3.8E-5	M3 15 years	1.7E-4	5882
							M8 16 Days	7.6E-2	13.1

The following parameters have been calculated with *OMERE* and are given as examples of two typical missions.

Orbit	GEO (35870 km)	
Radiative Environment	CREME 86 – M3 – Cosmic Rays Solar Min	CREME 86 – M8 – Solar Eruption – Worst-Case Flux
Mission Duration	15 years	16 days
Magnetospheric Cut-Off	Without	
Shielding	1 g.cm^{-2}	
Number of Cells	12	
Cell Depth	6 µm	

6. TOTAL DOSE TESTS

The full results are available in document [A6] “EV12DS130B – VN54B - Total dose Report September 2015”.

6.1 Parts references

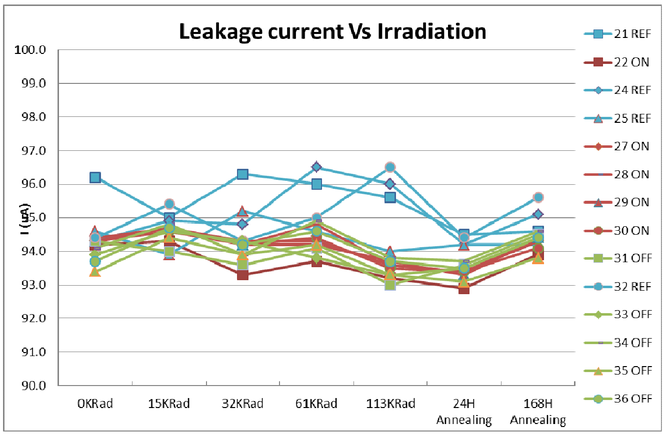
Type: EV12DS130BGS
Manufacturer: e2v Grenoble
Function: 12-bit 3Gsps 4:1 MUX-DAC
Technology: Bipolar SiGeC
Packaging: Ci-CGA 255
Date Code: 1334
Diffusion number: RU349519
Number of parts: 10 irradiated (5 biased ON and 5 OFF) + 4 Reference parts

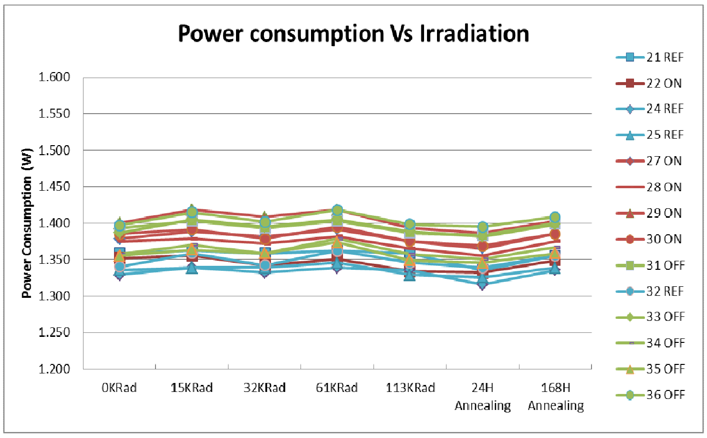
6.2 Dosimetry and irradiation facility

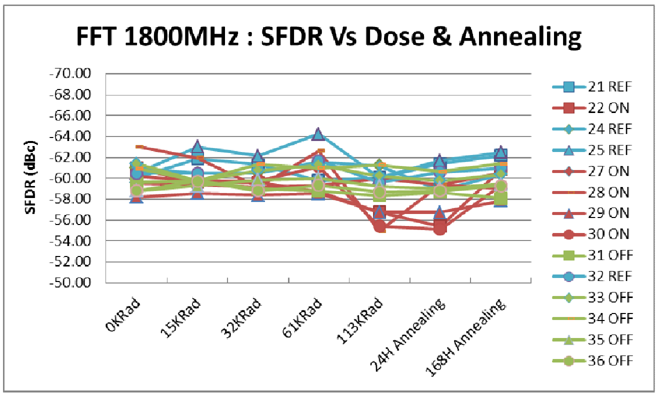
Source: 60Co (36 rad/hr)
Localization: TRAD/Toulouse (France)

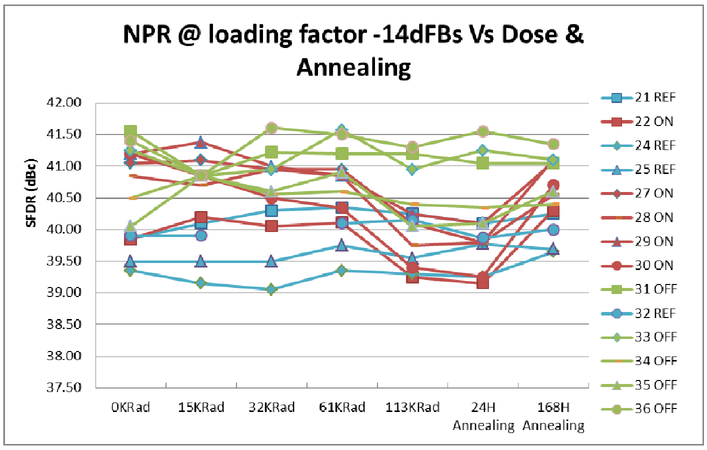
6.3 Detailed total dose test report

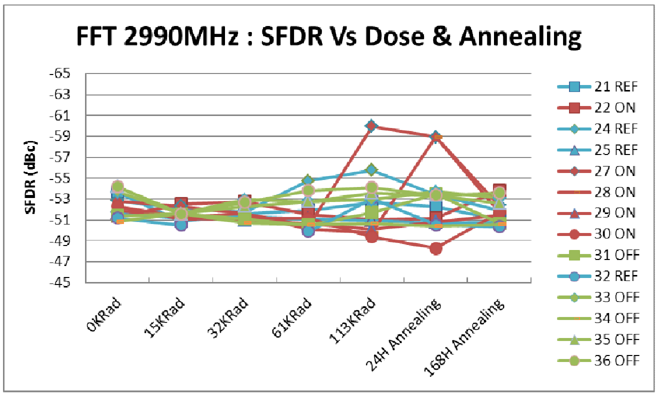
Refer to document reference NE 13S 212472.

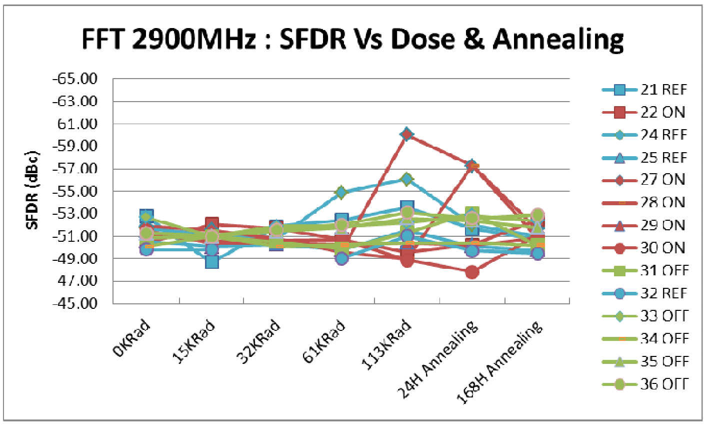












6.4 Total dose results

A total of ten devices were tested at 3Gsps Clock frequency.
The total irradiation test program was followed by a 24 hr. annealing process at ambient temperature followed by a 168 hr. annealing at 100°C as per ESCC 22900.

At the end of the total dose test, all the samples are fully functional.

Samples test under unbiased condition present no impact in their behaviour.

Samples test under biased condition present only some minor variations at 110KRad which disappeared after the annealing. As these variations remains in line with the datasheet, we don't consider that this device is dose sensitive.

It was concluded that the device under test (P/N EV12DS130B) had neither functional failure nor parameter drift up to 110 Krad (Si) with very low dose rate (36 rad / hr).

7. HEAVY IONS

7.1 Irradiation facility

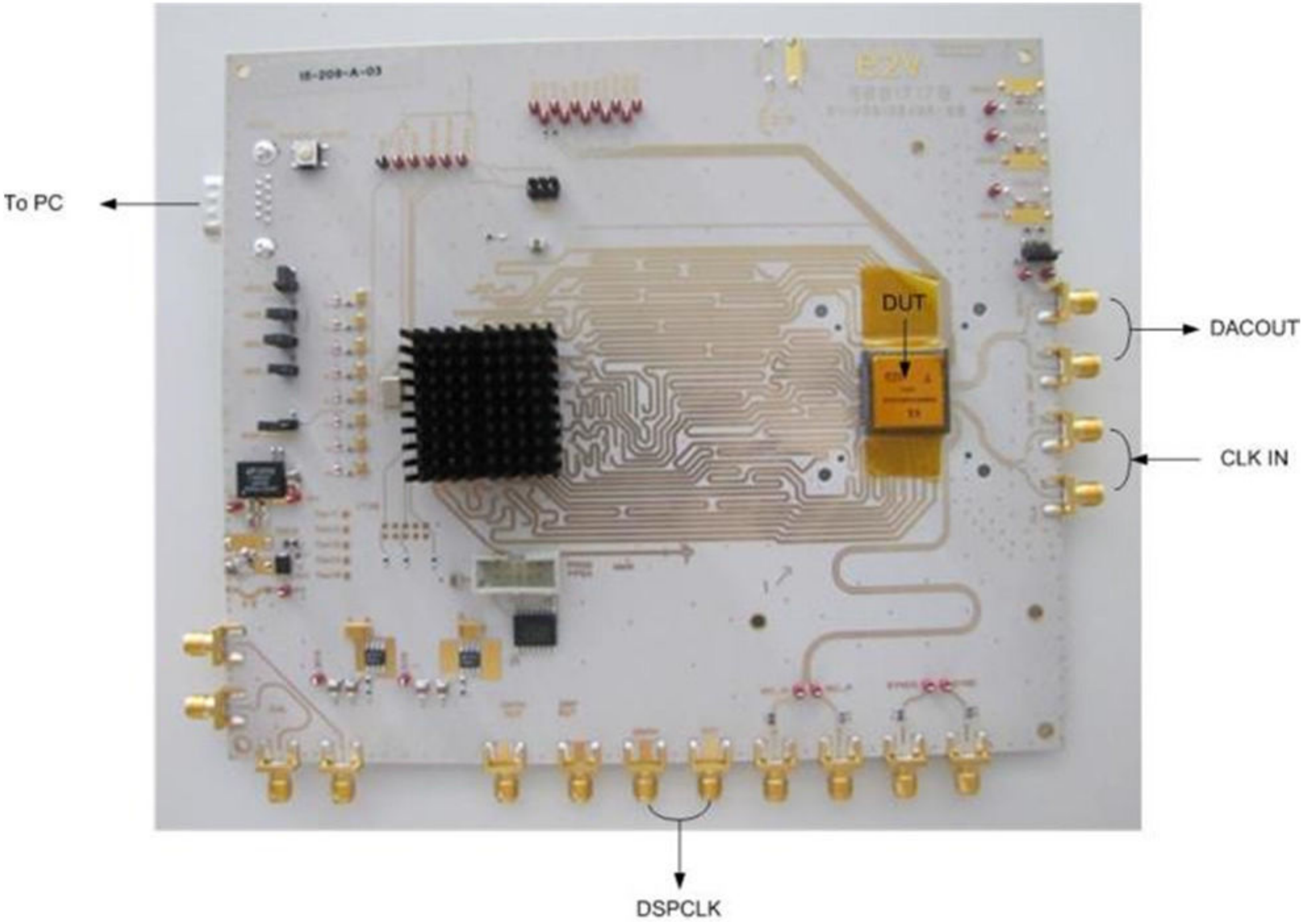
Heavy ions tests were performed at the RADEF, Jyväskylä, Finland, on the 20th to 22nd of May 2015.

The characteristics of the heavy ions used for this campaign are presented in the table below:

#	Ion	Symbol	Tilt	Energy (MeV)	Range (µm(Si))	LET (MeV/mg/cm²)
5	Xenon	Xe	30°	1217	76.9	78.2
4	Xenon	Xe	0°	1217	89	67.9
3	Krypton	Kr	0°	768	94	41.7
2	Argon	Ar	0°	372	118	18.9
1	Nitrogen	N	0°	139	202	5.92

7.2 Components implementation

E2v evaluation board was used to perform both heavy ions & proton tests. This evaluation board includes a FPGA used to generate the pattern to the MUX-DAC (DUT).



The output DSPCLK of the MUX-DAC is used as FPGA input clock. The consequence is that an event on DSPCLK can have an impact on DACOUT, so the DACOUT event number is maximize.

7.3 Implementation equipment

The implementation equipment is described in the table below

Designation	Reference	Identification	Usage *
RF signal generator	Rohde & Schwarz SMB100A	GS072	RF input clock signal
RF signal generator	Adret	AV	100 MHz synchronization signal
Power supply	Voltcraft LRP-1363	AB114	Heating system power supply
Power supply	TTI EL302R	AB106	DUT power supply
Power supply	TTI EL302R	AB107	DUT power supply
Power supply	TTI EL302R	AB122	DACOUT amplifier power supply
Power supply	Agilent E3645A	AB108	Detection boards power supply
Latchup detection board	-	CT14-03A	SEL monitoring
EV12DS130B Evaluation Board	EV12DS130XGS-EB	15-209-A-01	EV12DS130B evaluation board with DUT 1
EV12DS130B Evaluation Board	EV12DS130XGS-EB	15-209-A-02	EV12DS130B evaluation board with DUT 2
EV12DS130B Evaluation Board	EV12DS130XGS-EB	15-209-A-03	EV12DS130B evaluation board with DUT 3
SET detection board	-	DD14-16 ref BF2	SET detection
SET detection board	-	DD14-16 ref BF3	SET detection
SET detection board	-	DD14-16 ref HF2	SET detection
SET detection board	-	DD14-16 ref HF3	SET detection
Divider board	-	DD15-09	Divider board
Amplifier	ADL5611-EVALZ	AMP1	Amplifier board
Amplifier	ADL5611-EVALZ	AMP2	Amplifier board
Amplifier	ADL5611-EVALZ	AMP3	Amplifier board
Chipkit	MAX32	N°5	Control of the different configuration signals
PC	HP Probook 6570B	UC-237	Computer for chipkit configuration
PC	HP Elitebook 8540W	UC-184	Computer for communication with evaluation board

7.4 Measurement equipment

The measurement equipment is described in the table below.

Designation	Reference	Identification	Validity date
Oscilloscope	Lecroy WR640Zi	ON067	27/01/2017

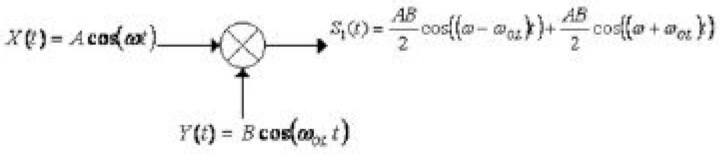
7.5 Implementation and measurement synoptic

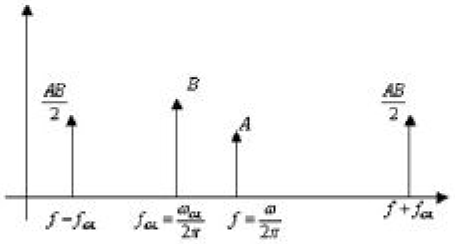
7.5.1 Principle of SEE detection

Detecting SEE on microwave periodical signals implies to remove the periodical component of the output signal,and emphasize the transient component. The resulting signal allows triggering an oscilloscope each time a SEE occurs.

In order to remove the periodical part of a signal coming out of a component under test, a mixer can be used.

This type of circuit allows frequency transposition, which transposes a signal whose frequency is centered on an initial frequency to another frequency without altering its bandwidth.



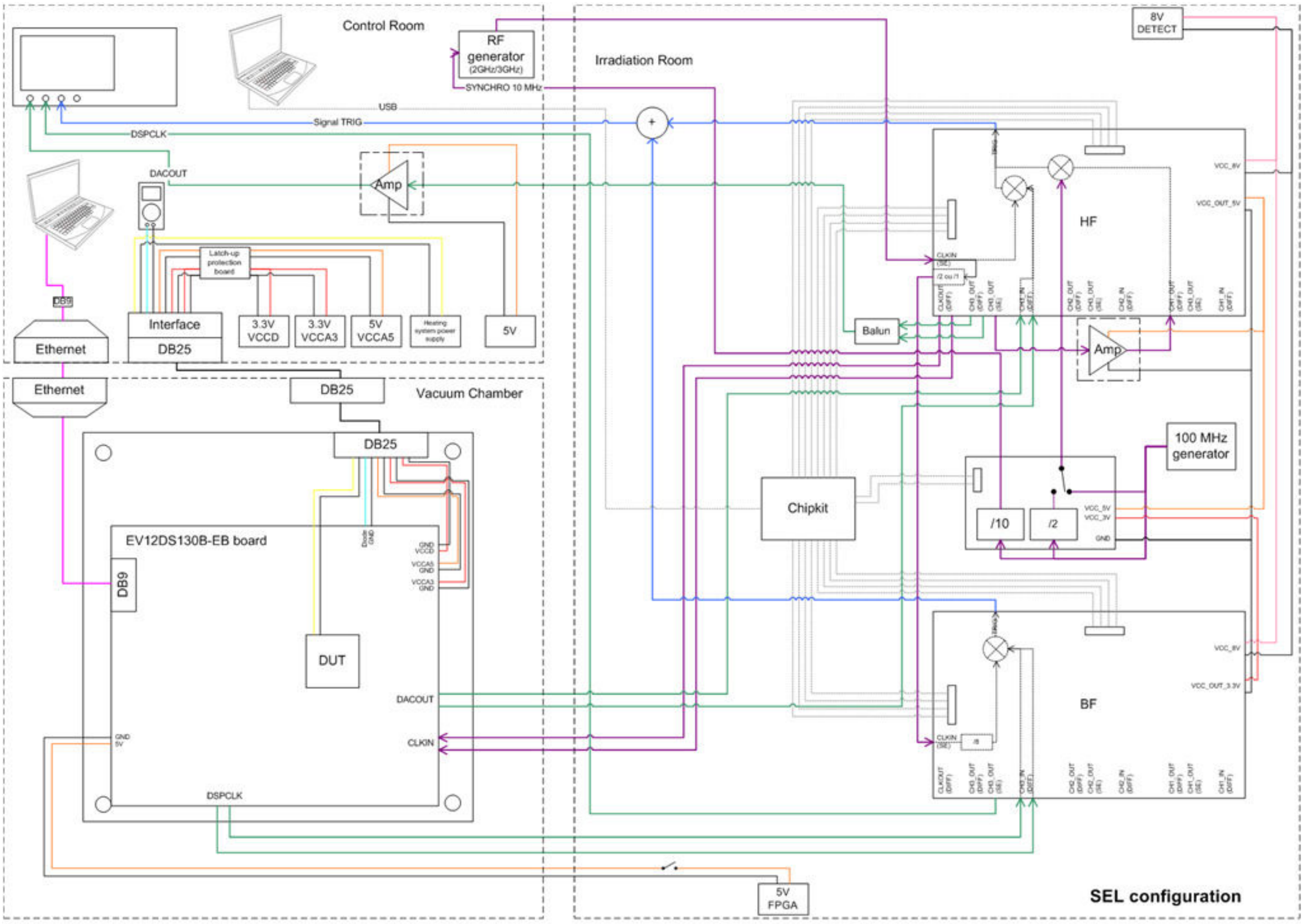


The output signal is then filtered in order to keep either its higher frequency or its lower frequency band.

In the present case, the output signal of the DUT is mixed with a signal of same spectral content, in order to get a low pass filtered signal of 0 Hz that is a DC signal. Therefore this signal is composed of all energy other than that of the input signal. In other words it only consists of the transient part, non-sinusoidal part of the signal, coming from the disturbance impacting the DUT during heavy ions experiments.

7.5.2 Setup diagram

The simplified diagram presented below shows the full setup of the experimentation.



7.6 Components configuration

Component configuration depends on several parameters, which are listed on the following paragraphs.

7.6.1 Input clock frequency

- Values: 2 GHz, 3 GHz;
- The input clock frequency is generated by the GS072 RF signal generator and fed to the EV12DS130B evaluation board through a balun soldered on the the HF detection board.

7.6.2 Input signal

- Dynamic pattern: sine wave at 100 MHz frequency;
- Static pattern.

7.6.3 Junction temperature

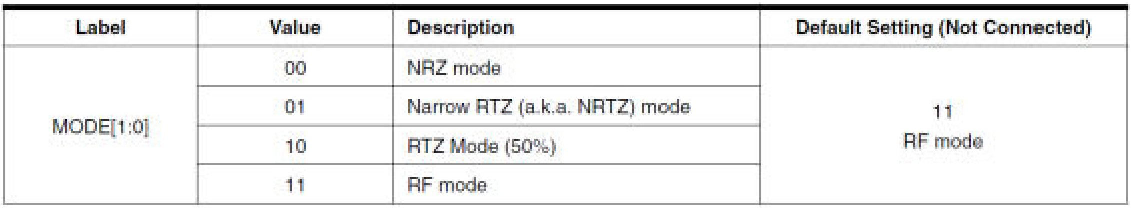
- Values: ambient temperature, 125°C;
- The component can be heated up to 125°C by using a heating system developed by Nucletudes. Junction temperature is monitored thanks to the internal diode of the component.

7.6.4 Power supply

- Values: minimum, typical, maximum for all DUT power supplies (VCCA5, VCCA3 and VCCD):
  - VCCA5 : 4.75 V / 5 V / 5.25 V;
  - VCCA3 : 3.15 V / 3.3 V / 3.45 V;
  - VCCD : 3.15 V / 3.3 V / 3.45 V;
- The power supplies of the DUT are placed in the control room. The voltage supply is adjusted for each run.

7.6.5 Mode

- Values: 00, 01, 10, 11;
-

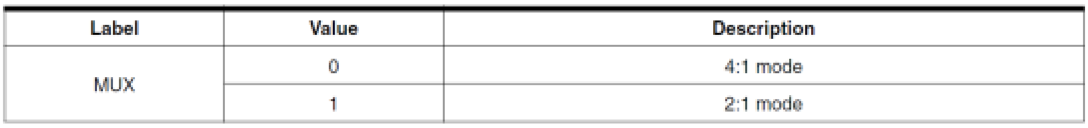


Label	Value	Description	Default Setting (Not Connected)
MODE[1:0]	00	NRZ mode	11 RF mode
	01	Narrow RTZ (a.k.a. NRTZ) mode	
	10	RTZ Mode (50%)	
	11	RF mode	

- The mode is changed using the Teoden software

7.6.6 MUX ratio

- Value: 4:1

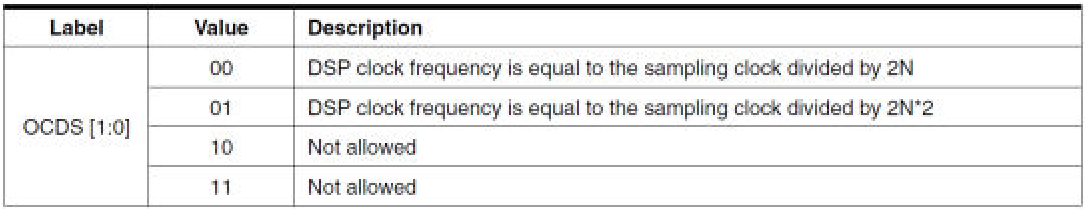


Label	Value	Description
MUX	0	4:1 mode
	1	2:1 mode

- The MUX ratio is changed using the Teoden software

7.6.7 Output Clock Division Select Function (OCDS)

- Values: 00, 01

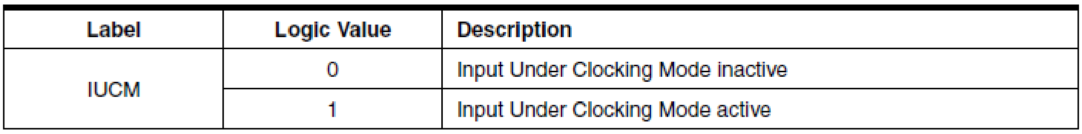


Label	Value	Description
OCDS [1:0]	00	DSP clock frequency is equal to the sampling clock divided by 2N
	01	DSP clock frequency is equal to the sampling clock divided by 2N*2
	10	Not allowed
	11	Not allowed

- The OCDS parameter is changed using the Teoden software

7.6.8 Input Under Clocking Mode (IUCM)

- Values: 0, 1

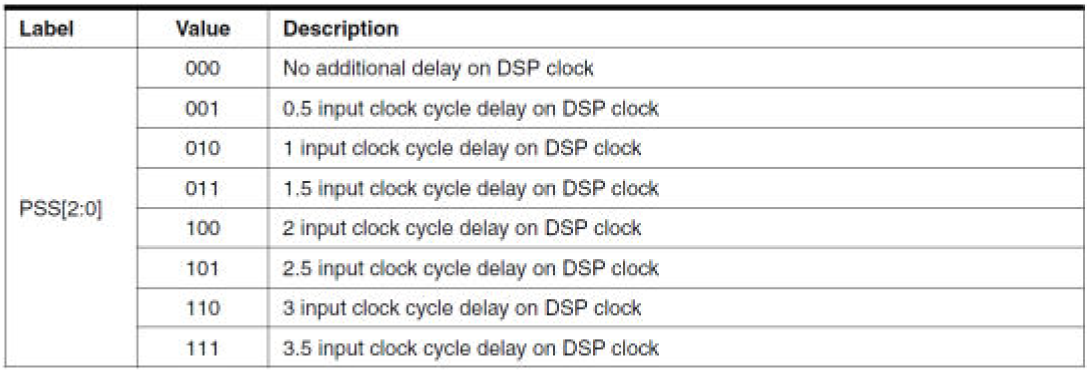


Label	Logic Value	Description
IUCM	0	Input Under Clocking Mode inactive
	1	Input Under Clocking Mode active

- The IUCM parameter is changed using the Teoden software

7.6.9 Phase Shift Select Function (PSS)

- Value: 111



Label	Value	Description
PSS[2:0]	000	No additional delay on DSP clock
	001	0.5 input clock cycle delay on DSP clock
	010	1 input clock cycle delay on DSP clock
	011	1.5 input clock cycle delay on DSP clock
	100	2 input clock cycle delay on DSP clock
	101	2.5 input clock cycle delay on DSP clock
	110	3 input clock cycle delay on DSP clock
	111	3.5 input clock cycle delay on DSP clock

- When PSS = 111, all the transistors of this function are used, which covers the other PSS configuration for the tests;
- The PSS parameter is changed using the Teoden software

7.6.10 List of configurations

Config.	Test	Supply voltage (V)	Tj (°C)	OCDS	IUCM	Frequency	Mode	Pattern
C1	SEL+SEFI	max	125 °C	1	0	3 GHz	0 (NRZ)	Dynamic
C2	SEL+SEFI	max	125 °C	1	0	3 GHz	1 (NRTZ)	Dynamic
C3	SEL+SEFI	max	125 °C	1	0	3 GHz	2 (RTZ)	Dynamic
C4	SEL+SEFI	max	125 °C	1	0	3 GHz	3 (RF)	Dynamic
C5	SET+SEFI	max	125 °C	0	1	2 GHz	0 (NRZ)	Dynamic
C6	SET+SEFI	max	125 °C	0	1	2 GHz	1 (NRTZ)	Dynamic
C7	SET+SEFI	max	125 °C	0	1	2 GHz	2 (RTZ)	Dynamic
C8	SET+SEFI	max	125 °C	0	1	2 GHz	3 (RF)	Dynamic
C9	SET+SEFI	max	125 °C	0	1	2 GHz	1 (NRTZ)	Static
C10	SET+SEFI	max	125 °C	0	1	2 GHz	2 (RTZ)	Static
C11	SET+SEFI	max	125 °C	0	1	2 GHz	3 (RF)	Static
C12	SET+SEFI	typ	Ambiant	1	0	3 GHz	0 (NRZ)	Dynamic
C13	SET+SEFI	typ	Ambiant	1	0	3 GHz	1 (NRTZ)	Dynamic
C14	SET+SEFI	typ	Ambiant	1	0	3 GHz	2 (RTZ)	Dynamic
C15	SET+SEFI	typ	Ambiant	1	0	3 GHz	3 (RF)	Dynamic
C16	SET+SEFI	typ	Ambiant	0	1	2 GHz	0 (NRZ)	Dynamic
C17	SET+SEFI	typ	Ambiant	0	1	2 GHz	1 (NRTZ)	Dynamic
C18	SET+SEFI	typ	Ambiant	0	1	2 GHz	2 (RTZ)	Dynamic
C19	SET+SEFI	typ	Ambiant	0	1	2 GHz	3 (RF)	Dynamic
C20	SET+SEFI	max	125 °C	1	0	3 GHz	3 (RF)	Dynamic
C21	SET+SEFI	typ	125 °C	1	0	3 GHz	3 (RF)	Dynamic
C22	SET+SEFI	min	Ambiant	1	0	3 GHz	3 (RF)	Dynamic
C23	SET+SEFI	max	Ambiant	1	0	3 GHz	3 (RF)	Dynamic
C24	SET+SEFI	typ	Ambiant	0	1	2 GHz	1 (NRTZ)	Static
C25	SET+SEFI	typ	Ambiant	0	1	2 GHz	2 (RTZ)	Static
C26	SET+SEFI	typ	Ambiant	0	1	2 GHz	3 (RF)	Static

Note that only two OCDS/IUCM configurations are tested (1/0 and 0/1) because it covers the other possible configurations (0/0 and 1/1).

7.7 Test setup

Before each irradiation run, the proper operation of the DUT is checked.
For each run, any detected event causes the recording of all signals listed in the table below.

7.7.1 SEL

Latchup is monitored on the DUT power supplies VCCA3, VCCD and VCCA5, with VCCA3 and VCCD tied together. Tests are done at the maximum operating temperature (125 °C) and at the maximum specified power supply (+3.45 V for VCCA3/VCCD, +5.25 V for VCCA5). Latchup detection and cut-off board is set to detect an increase of the current consumption over 2 times the nominal value. If a latchup occurs, the system switches off the power supply in less than 100 µs after the detection.

7.7.2 SET

SET detection is performed thanks to a detection board.
For this setup, two detection boards were used, one for DSPCLK event detection called BF board, the second for DACOUT event detection called RF board. The detection board is programmed by a chipkit MAX32 in order to be adapted to all configurations (frequencies of 2 GHz or 3 GHz, OCDS=0 or 1, IUCM=0 or 1). The detection board has an attenuation of 8 dB on single-ended channels, and 17.5 dB on differential channels.
Each detection level is set according to the observed trigger signal in order to be as close as possible to the trigger level.
The conversion of differential signals to single-ended signal is made with baluns, located on the detection board (for DSPCLK) and on a separate board (for DACOUT).
The minimum sensitivity of this system was defined experimentally:

Signals				
Channel 1	**Channel 2**	**Channel 3**	**Channel 4**	**Aux**
DACOUT	DSPCLK	Trigger	Trigger	Not used

7.7.3 SEFI

SEFI detection is provided by two LEDs (one for DACOUT and one for DSPCLK) or a buzzer positioned on the control desk. The LEDs turn on or the buzzer rings when a SEFI occurs. This detection remained active during all the campaign.

7.7.4 Test level

Components are exposed to the ions presented in §7.1.
For SEL research, the test is stopped when a fluency of 107 ions.cm-2 is reached, or when at least 100 events are detected. For SET research, the test is stopped when a fluency of 106 ions.cm-2 is reached, or when at least 100 events are detected.

7.7.5 Dosimetry

Dosimetry is provided by the RADEF. Fluency, irradiation times and deposited ionizing dose are provided for each run

7.7.6 Patterns

A statics pattern and a dynamic pattern (sinus) have been used.

8. HEAVY IONS TEST RESULTS

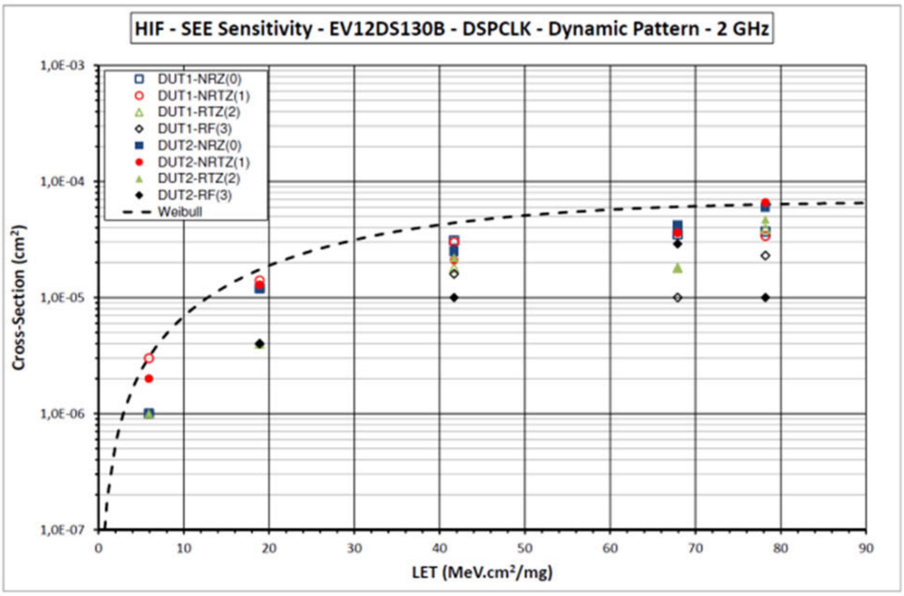
8.1 SEL

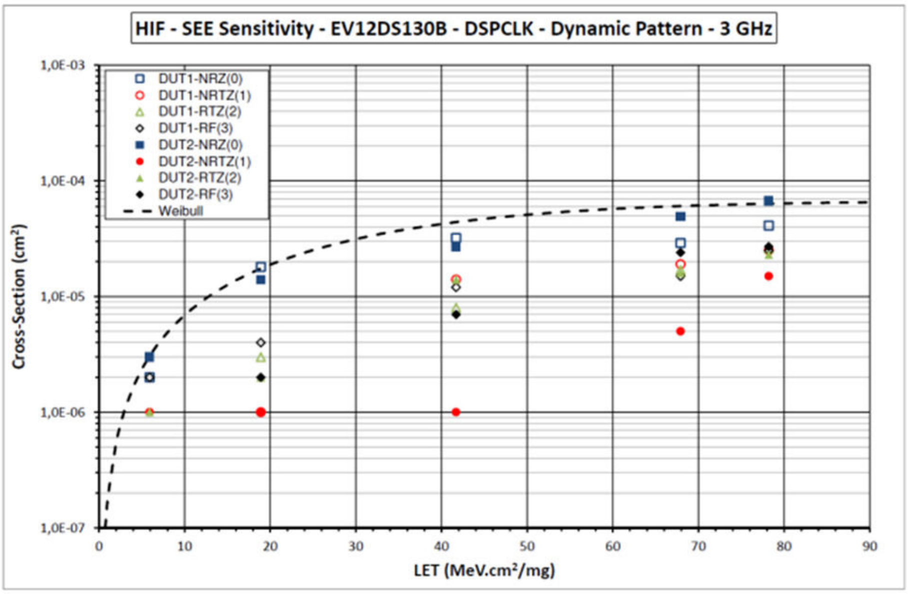
No SEL (SEL measured at Tj=125°C with maximum power supplies up to a LET of 80 MeV-cm²/mg with a tilt). The device is therefore SEL free up to at least 80MeV-cm²/mg.

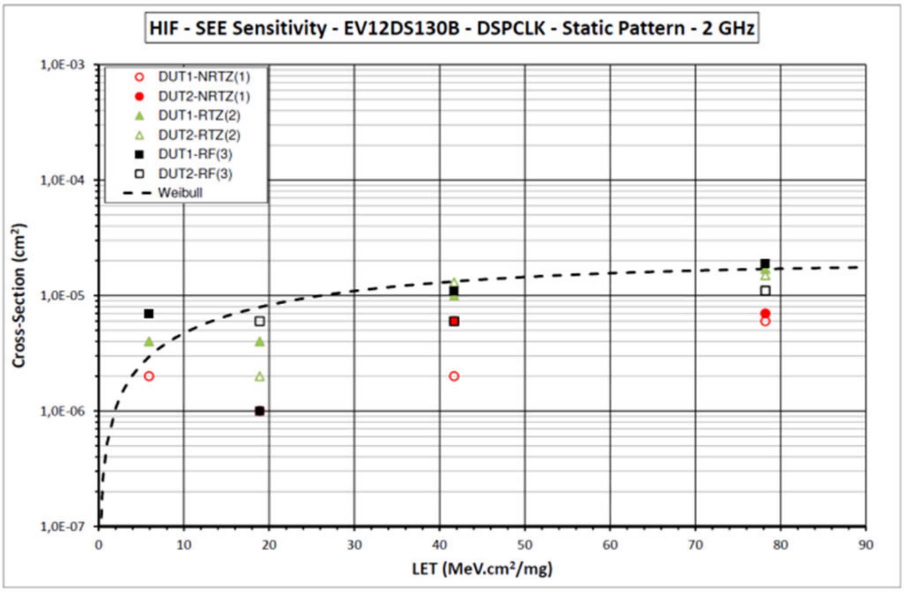
8.2 SEFI

No SEFI detected. The device is therefore SEFI free up to at least 80 MeV-cm²/mg.

8.3 SET on DSPCLK







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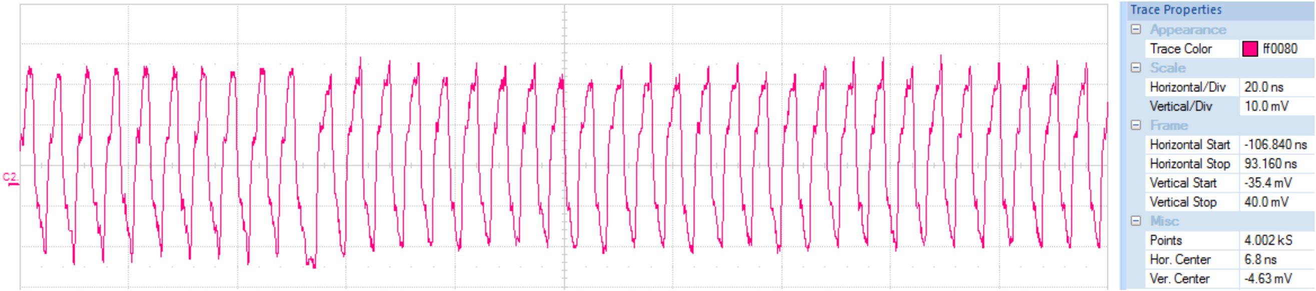
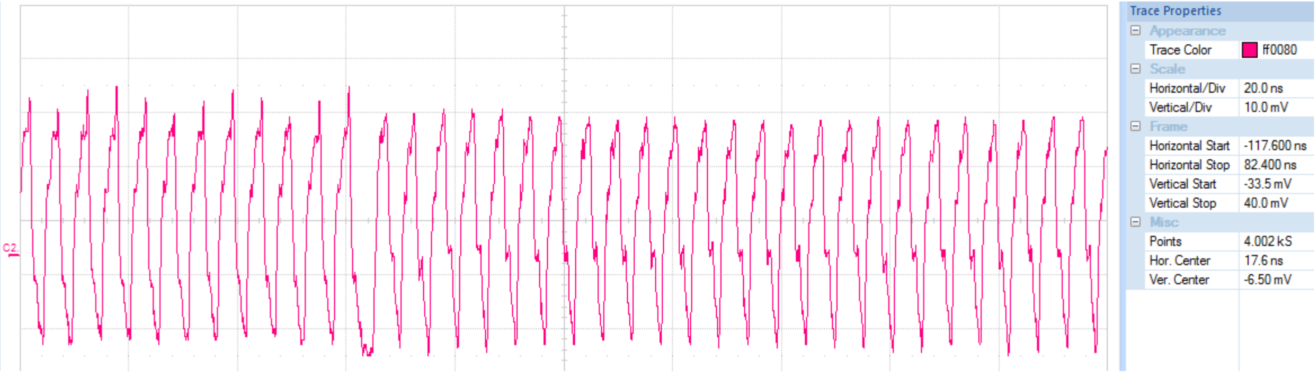
Quality Department.

8.3.1 LET 5.92(MeV/mg/cm²)



Trace Properties
Appearance
Trace Color ff0080
Scale
Horizontal/Div 20.0 ns
Vertical/Div 10.0 mV
Frame
Horizontal Start -106.840 ns
Horizontal Stop 93.160 ns
Vertical Start -35.4 mV
Vertical Stop 40.0 mV
Misc
Points 4.002 kS
Hor. Center 6.8 ns
Ver. Center -4.63 mV

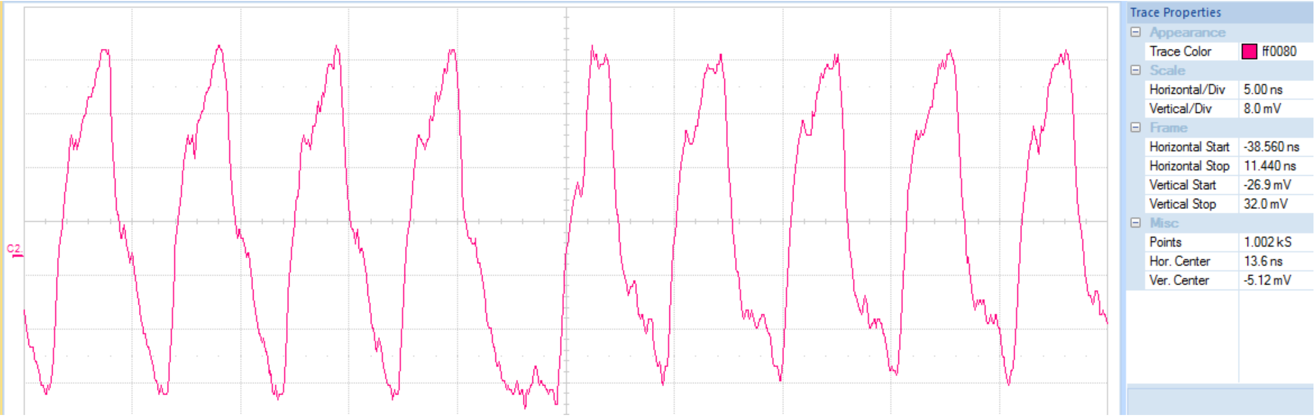
Duration 1ns



Trace Properties
Appearance
Trace Color ff0080
Scale
Horizontal/Div 20.0 ns
Vertical/Div 10.0 mV
Frame
Horizontal Start -117.600 ns
Horizontal Stop 82.400 ns
Vertical Start -33.5 mV
Vertical Stop 40.0 mV
Misc
Points 4.002 kS
Hor. Center 17.6 ns
Ver. Center -6.50 mV

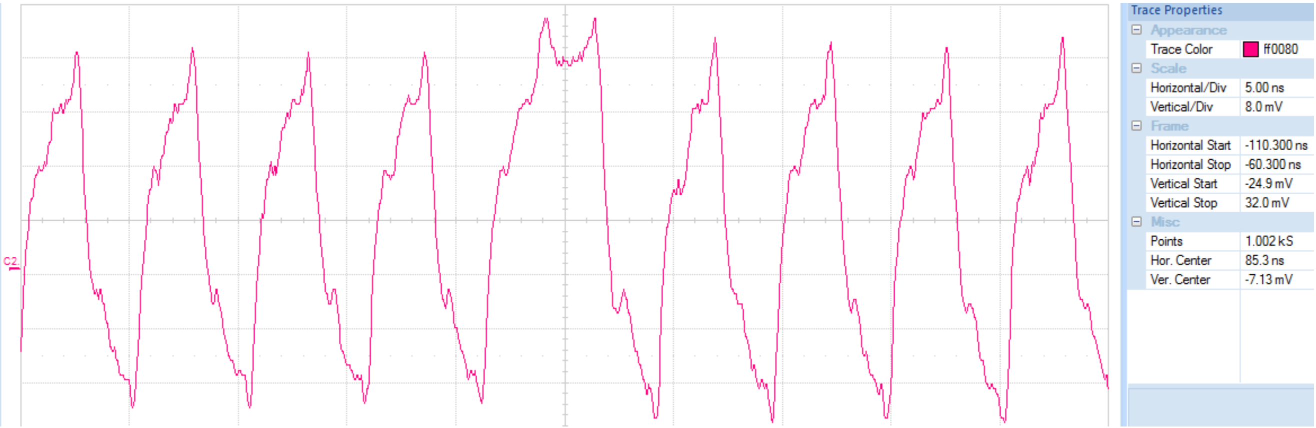
Duration 1.5ns

8.3.2 LET 18.9(MeV/mg/cm²)



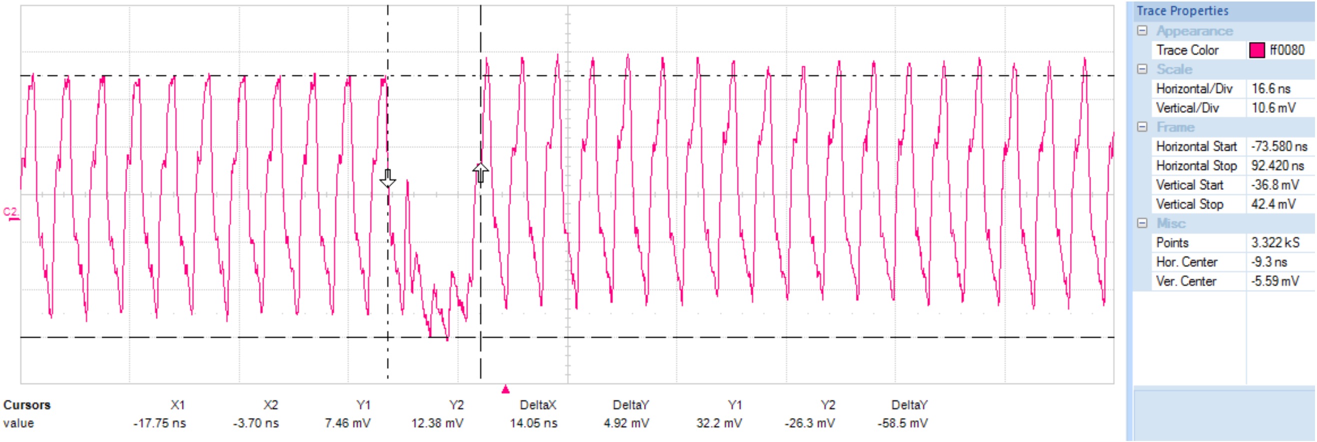
Trace Properties
Appearance
Trace Color ff0080
Scale
Horizontal/Div 5.00 ns
Vertical/Div 8.0 mV
Frame
Horizontal Start -38.560 ns
Horizontal Stop 11.440 ns
Vertical Start -26.9 mV
Vertical Stop 32.0 mV
Misc
Points 1.002 kS
Hor. Center 13.6 ns
Ver. Center -5.12 mV

Duration 2ns



Trace Properties
Appearance
Trace Color ff0080
Scale
Horizontal/Div 5.00 ns
Vertical/Div 8.0 mV
Frame
Horizontal Start -110.300 ns
Horizontal Stop -60.300 ns
Vertical Start -24.9 mV
Vertical Stop 32.0 mV
Misc
Points 1.002 kS
Hor. Center 85.3 ns
Ver. Center -7.13 mV

Duration 3ns



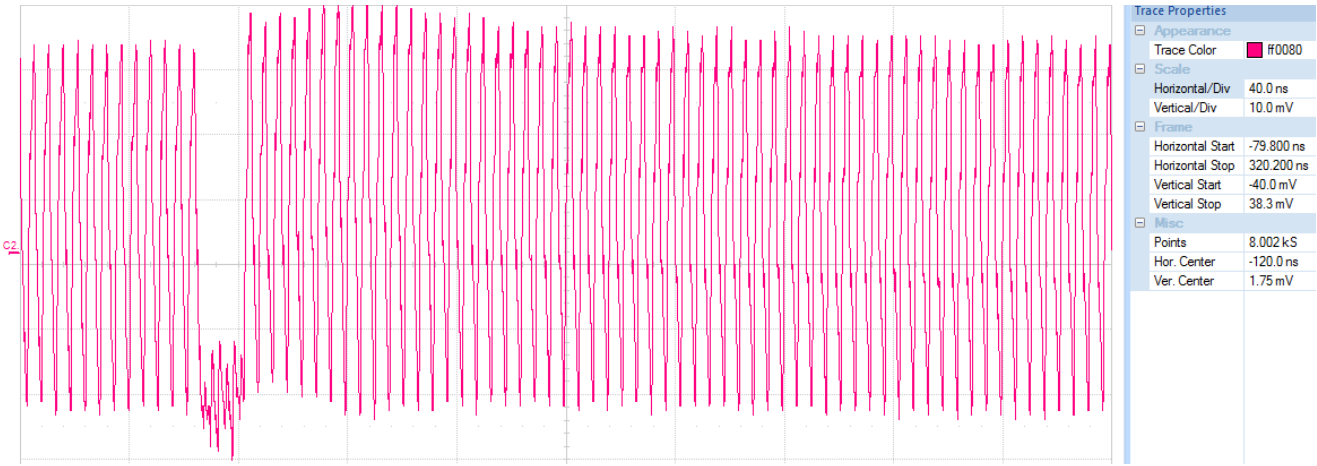
Cursors	X1	X2	Y1	Y2	DeltaX	DeltaY	Y1	Y2	DeltaY
value	-17.75 ns	-3.70 ns	7.46 mV	12.38 mV	14.05 ns	4.92 mV	32.2 mV	-26.3 mV	-58.5 mV

Trace Properties

Appearance	
Trace Color	ff0080
Scale	
Horizontal/Div	16.6 ns
Vertical/Div	10.6 mV
Frame	
Horizontal Start	-73.580 ns
Horizontal Stop	92.420 ns
Vertical Start	-36.8 mV
Vertical Stop	42.4 mV
Misc	
Points	3.322 kS
Hor. Center	-9.3 ns
Ver. Center	-5.59 mV

Duration 14.5ns

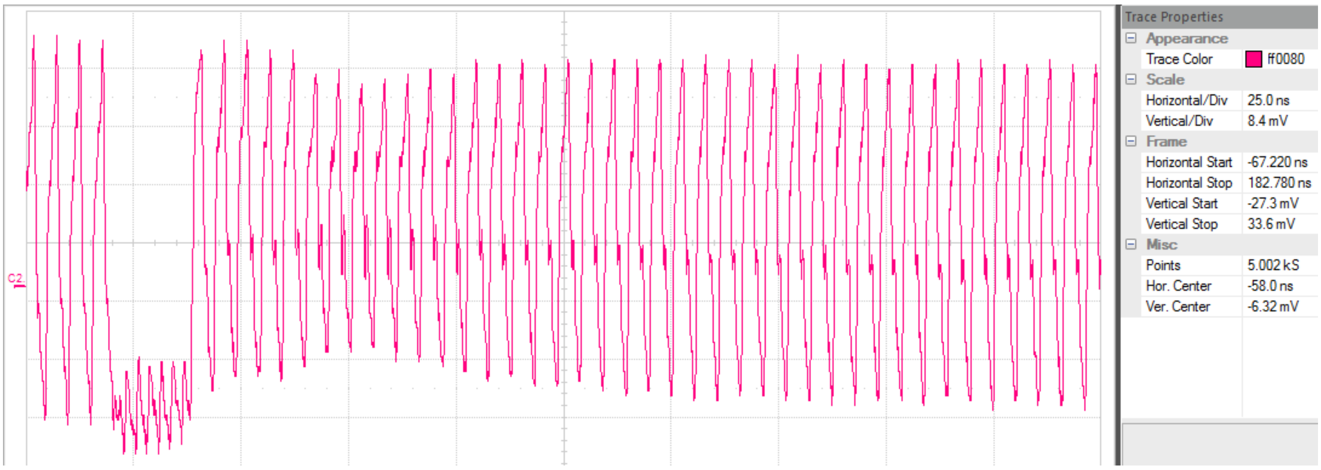
8.3.3 LET 41.7(MeV/mg/cm²)



Trace Properties

Appearance	
Trace Color	ff0080
Scale	
Horizontal/Div	40.0 ns
Vertical/Div	10.0 mV
Frame	
Horizontal Start	-79.800 ns
Horizontal Stop	320.200 ns
Vertical Start	-40.0 mV
Vertical Stop	38.3 mV
Misc	
Points	8.002 kS
Hor. Center	-120.0 ns
Ver. Center	1.75 mV

Duration 10ns



Trace Properties

Appearance	
Trace Color	ff0080
Scale	
Horizontal/Div	25.0 ns
Vertical/Div	8.4 mV
Frame	
Horizontal Start	-67.220 ns
Horizontal Stop	182.780 ns
Vertical Start	-27.3 mV
Vertical Stop	33.6 mV
Misc	
Points	5.002 kS
Hor. Center	-58.0 ns
Ver. Center	-6.32 mV

Duration 20ns

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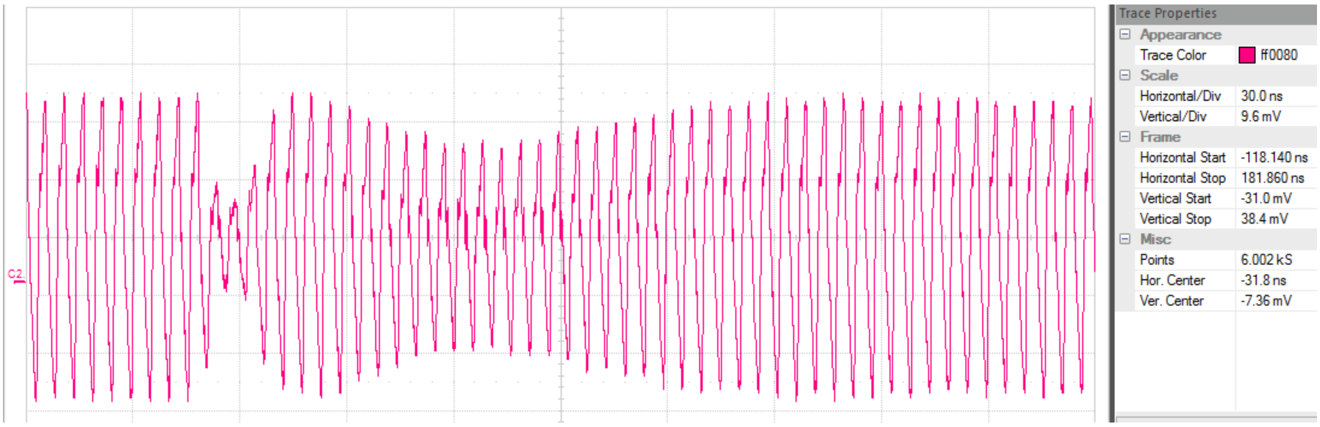
8.3.4 LET 67.9(MeV/mg/cm²)

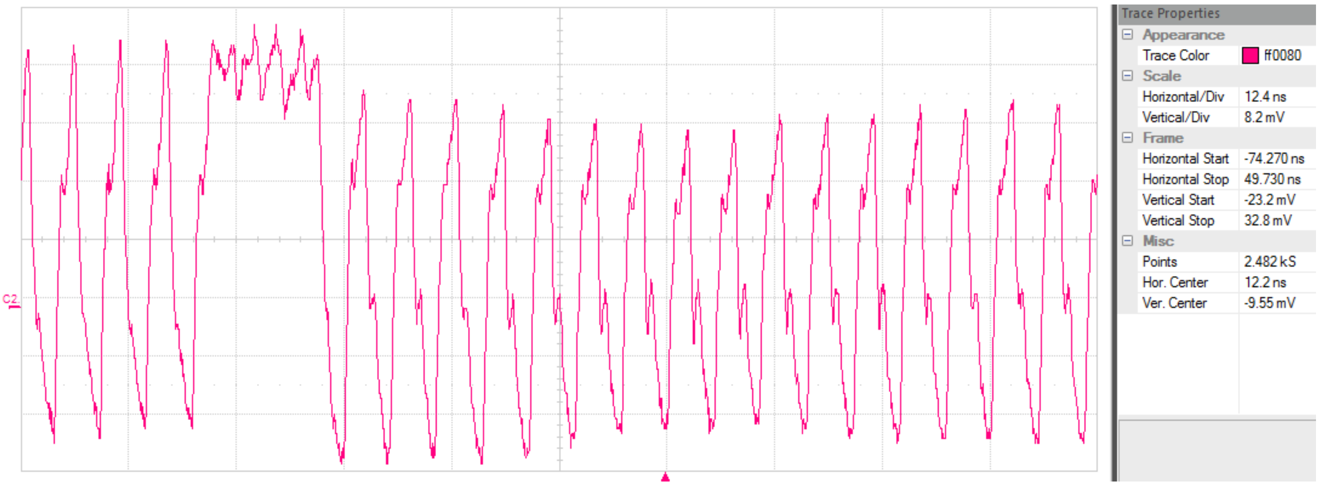


Trace Properties

Appearance	
Trace Color	ff0080
Scale	
Horizontal/Div	30.0 ns
Vertical/Div	9.6 mV
Frame	
Horizontal Start	-118.140 ns
Horizontal Stop	181.860 ns
Vertical Start	-31.0 mV
Vertical Stop	38.4 mV
Misc	
Points	6.002 kS
Hor. Center	-31.8 ns
Ver. Center	-7.36 mV

Duration 24ns

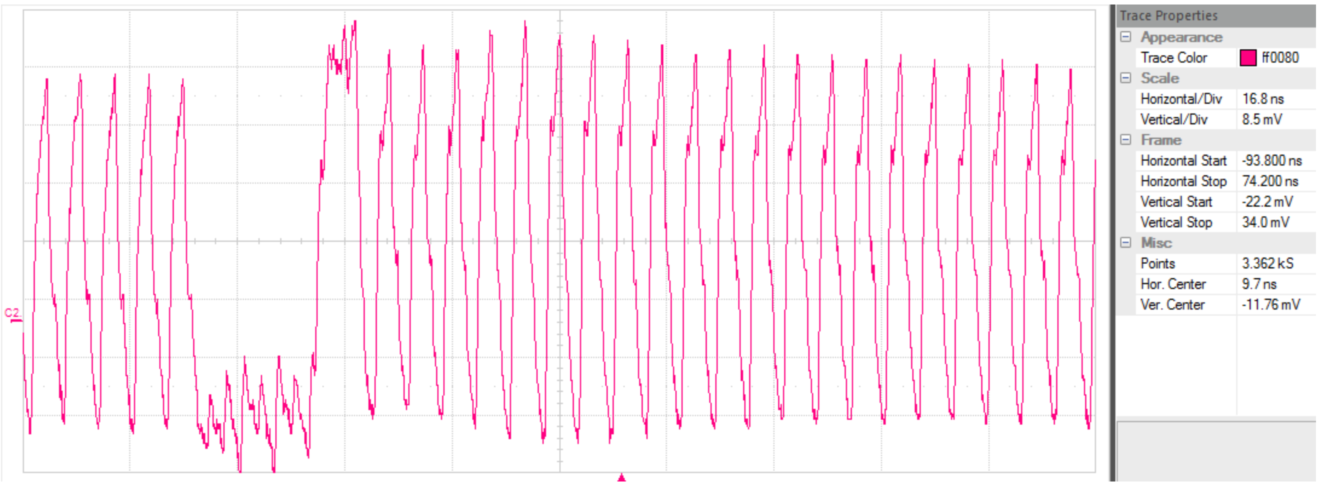
8.3.5 LET 78.2(MeV/mg/cm²)



Trace Properties

Appearance	
Trace Color	ff0080
Scale	
Horizontal/Div	12.4 ns
Vertical/Div	8.2 mV
Frame	
Horizontal Start	-74.270 ns
Horizontal Stop	49.730 ns
Vertical Start	-23.2 mV
Vertical Stop	32.8 mV
Misc	
Points	2.482 kS
Hor. Center	12.2 ns
Ver. Center	-9.55 mV

Duration 15ns

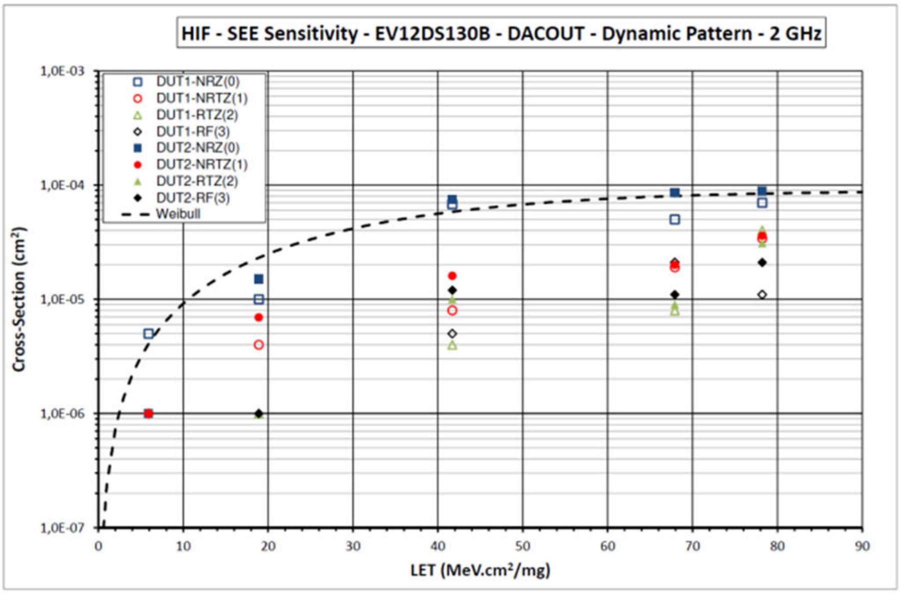


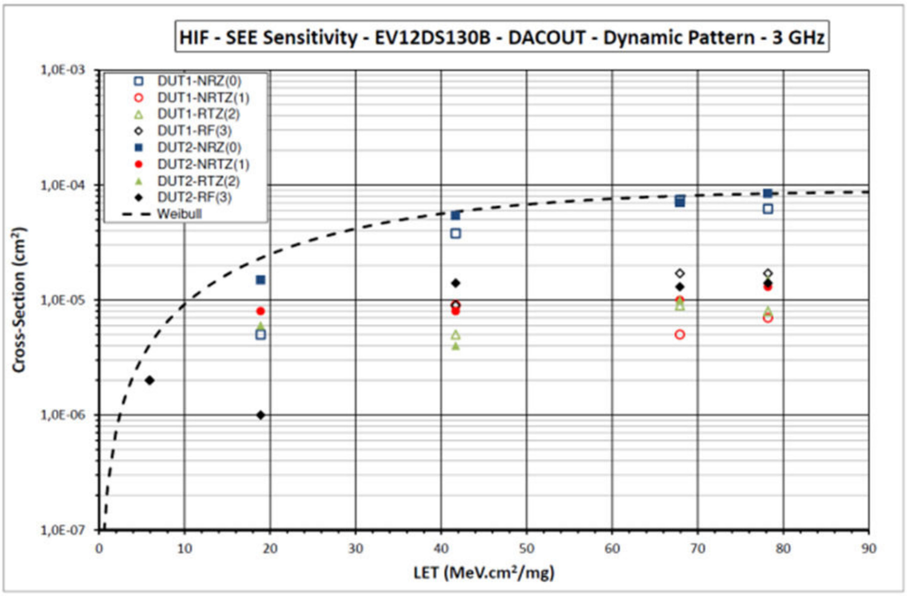
Trace Properties

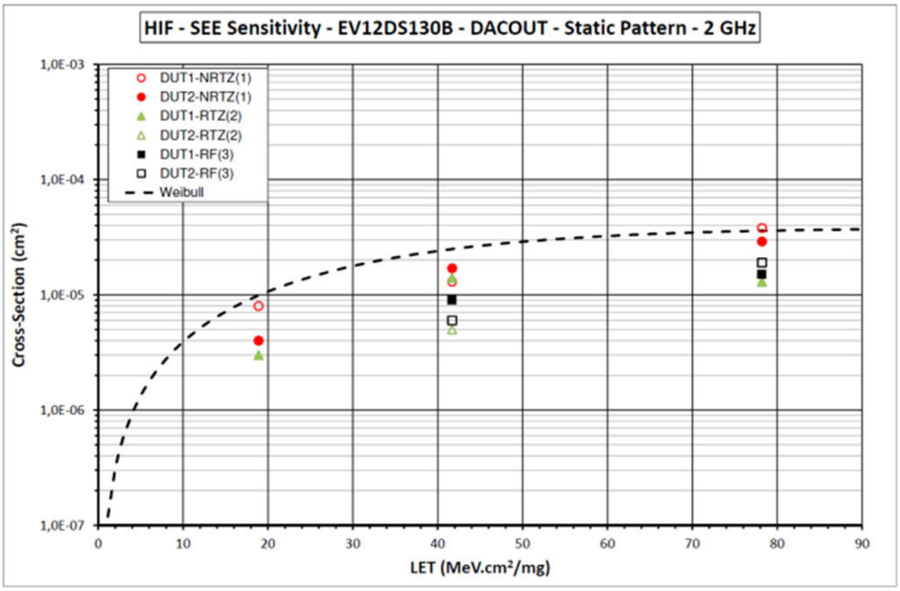
Appearance	
Trace Color	ff0080
Scale	
Horizontal/Div	16.8 ns
Vertical/Div	8.5 mV
Frame	
Horizontal Start	-93.800 ns
Horizontal Stop	74.200 ns
Vertical Start	-22.2 mV
Vertical Stop	34.0 mV
Misc	
Points	3.362 kS
Hor. Center	9.7 ns
Ver. Center	-11.76 mV

Duration 30ns

8.4 SET on DACOUT

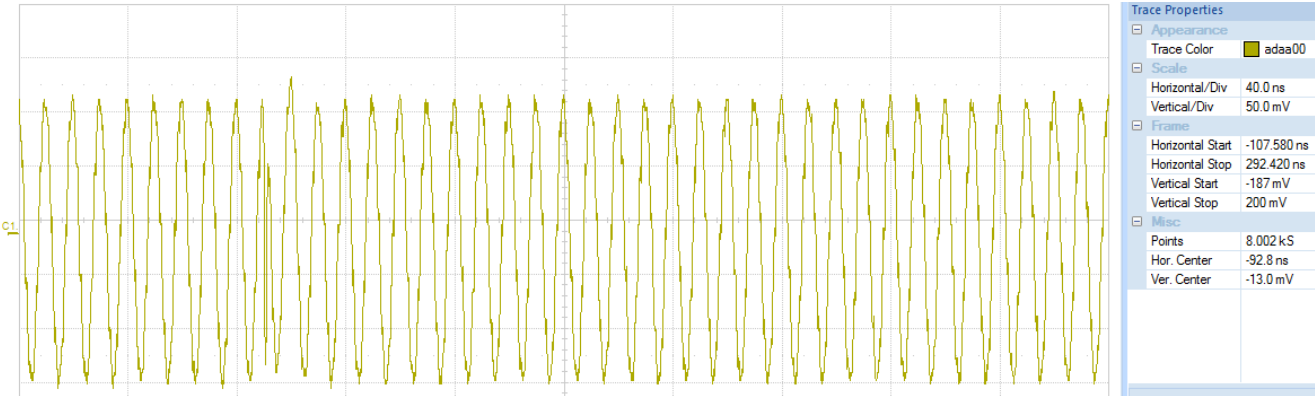






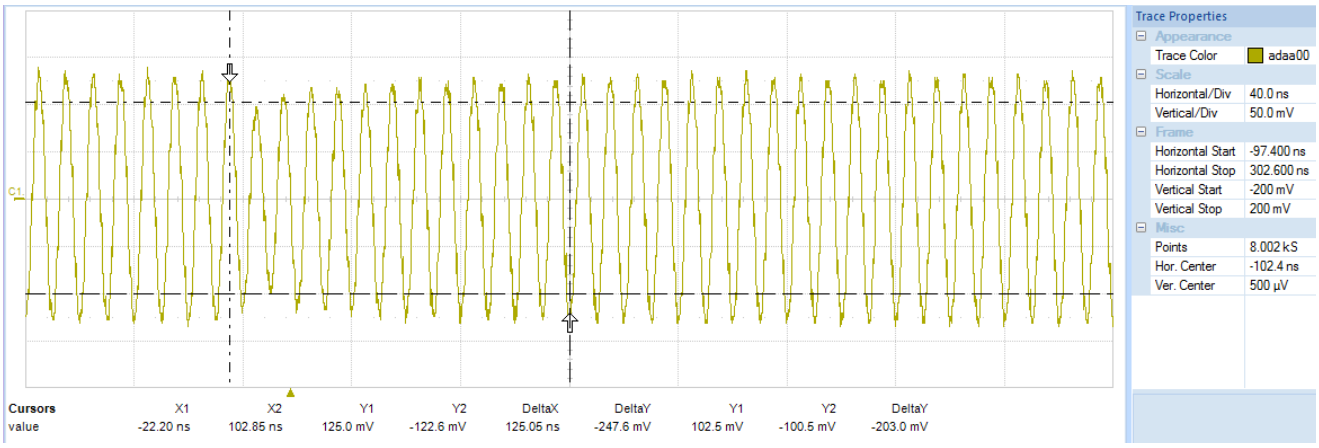
Document approved by
Quality Department.

8.4.1 LET 18.9(MeV/mg/cm²)



Trace Color	adaa00
Horizontal/Div	40.0 ns
Vertical/Div	50.0 mV
Horizontal Start	-107.580 ns
Horizontal Stop	292.420 ns
Vertical Start	-187 mV
Vertical Stop	200 mV
Points	8.002 kS
Hor. Center	-92.8 ns
Ver. Center	-13.0 mV

Duration 2ns, short duration



Trace Color	adaa00
Horizontal/Div	40.0 ns
Vertical/Div	50.0 mV
Horizontal Start	-97.400 ns
Horizontal Stop	302.600 ns
Vertical Start	-200 mV
Vertical Stop	200 mV
Points	8.002 kS
Hor. Center	-102.4 ns
Ver. Center	500 µV

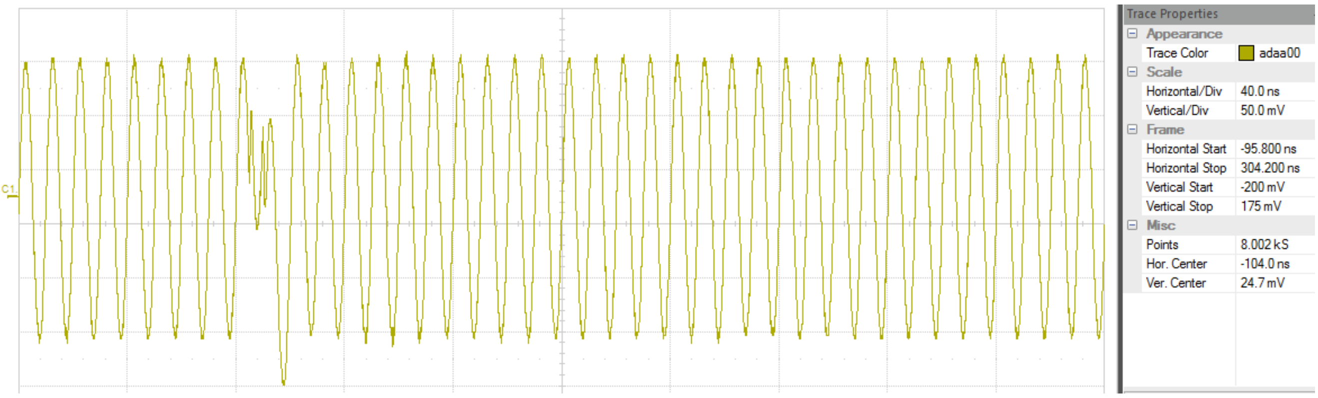
Cursors	X1	X2	Y1	Y2	DeltaX	DeltaY	Y1	Y2	DeltaY
value	-22.20 ns	102.85 ns	125.0 mV	-122.6 mV	125.05 ns	-247.6 mV	102.5 mV	-100.5 mV	-203.0 mV

Duration 125ns, long duration

8.4.2 LET 41.7(MeV/mg/cm²)

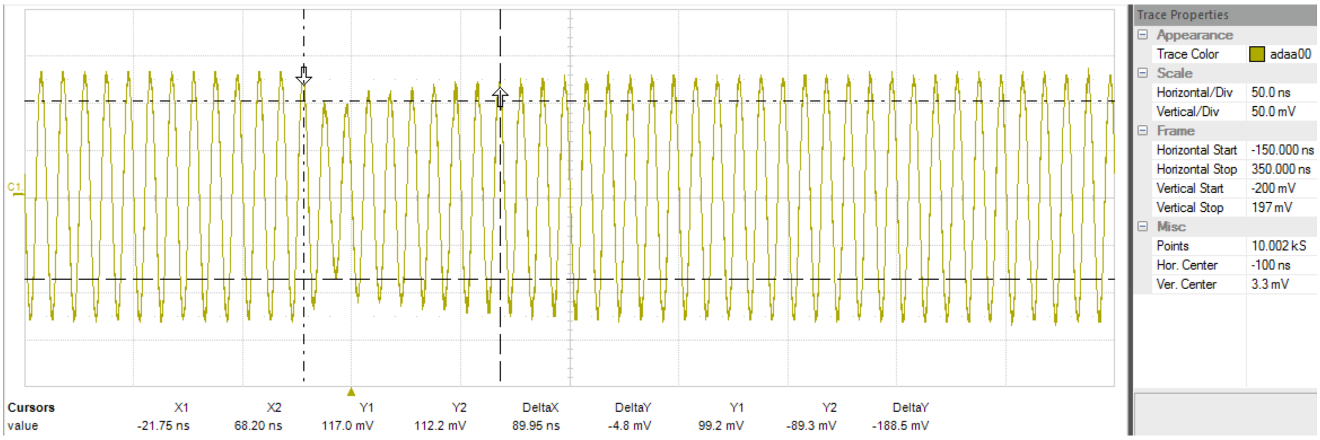
Trace Color	adaa00
Horizontal/Div	42.5 ns
Vertical/Div	59 mV
Horizontal Start	-105.780 ns
Horizontal Stop	319.220 ns
Vertical Start	-236 mV
Vertical Stop	216 mV
Points	8.502 kS
Hor. Center	-107.1 ns
Ver. Center	20.5 mV

Duration 21ns



Trace Properties
Appearance
Trace Color adaa00
Scale
Horizontal/Div 40.0 ns
Vertical/Div 50.0 mV
Frame
Horizontal Start -95.800 ns
Horizontal Stop 304.200 ns
Vertical Start -200 mV
Vertical Stop 175 mV
Misc
Points 8.002 kS
Hor. Center -104.0 ns
Ver. Center 24.7 mV

Duration 16ns

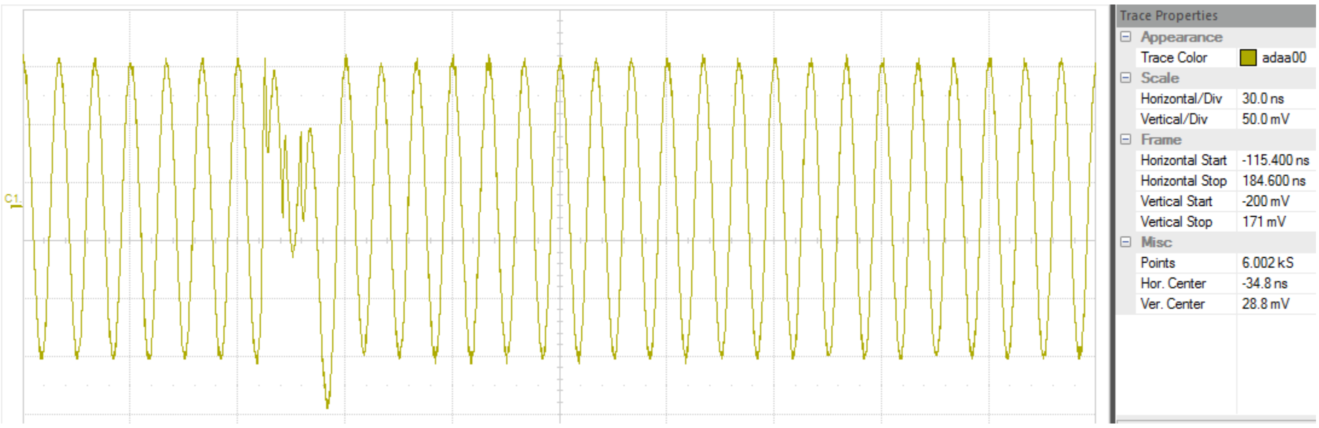


Trace Properties
Appearance
Trace Color adaa00
Scale
Horizontal/Div 50.0 ns
Vertical/Div 50.0 mV
Frame
Horizontal Start -150.000 ns
Horizontal Stop 350.000 ns
Vertical Start -200 mV
Vertical Stop 197 mV
Misc
Points 10.002 kS
Hor. Center -100 ns
Ver. Center 3.3 mV

Cursors	X1	X2	Y1	Y2	DeltaX	DeltaY	Y1	Y2	DeltaY
value	-21.75 ns	68.20 ns	117.0 mV	112.2 mV	89.95 ns	-4.8 mV	99.2 mV	-89.3 mV	-188.5 mV

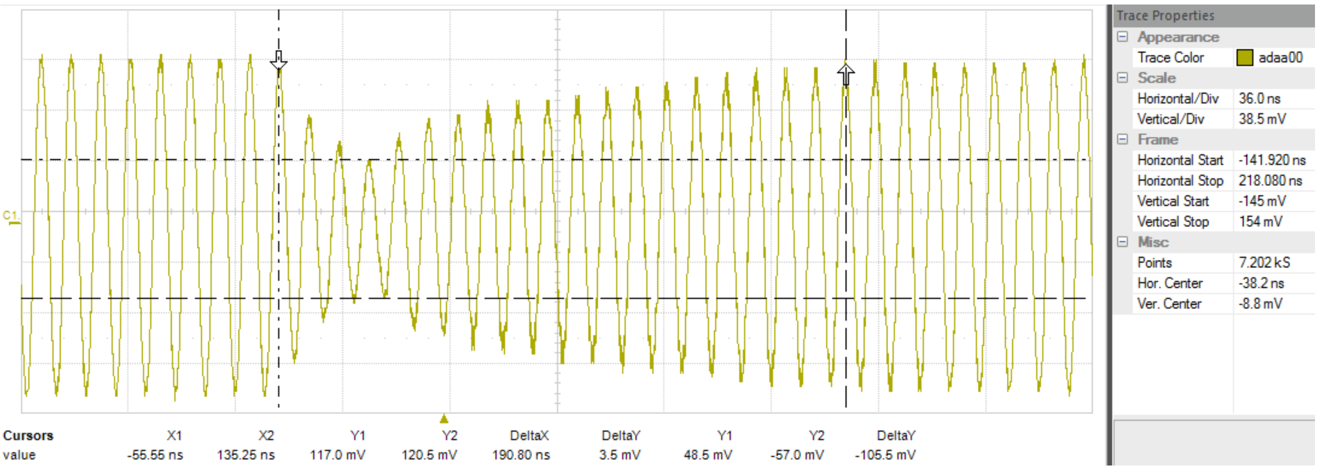
Duration 90ns

8.4.3 LET 67.9(MeV/mg/cm²)



Trace Properties
Appearance
Trace Color adaa00
Scale
Horizontal/Div 30.0 ns
Vertical/Div 50.0 mV
Frame
Horizontal Start -115.400 ns
Horizontal Stop 184.600 ns
Vertical Start -200 mV
Vertical Stop 171 mV
Misc
Points 6.002 kS
Hor. Center -34.8 ns
Ver. Center 28.8 mV

Duration 21ns



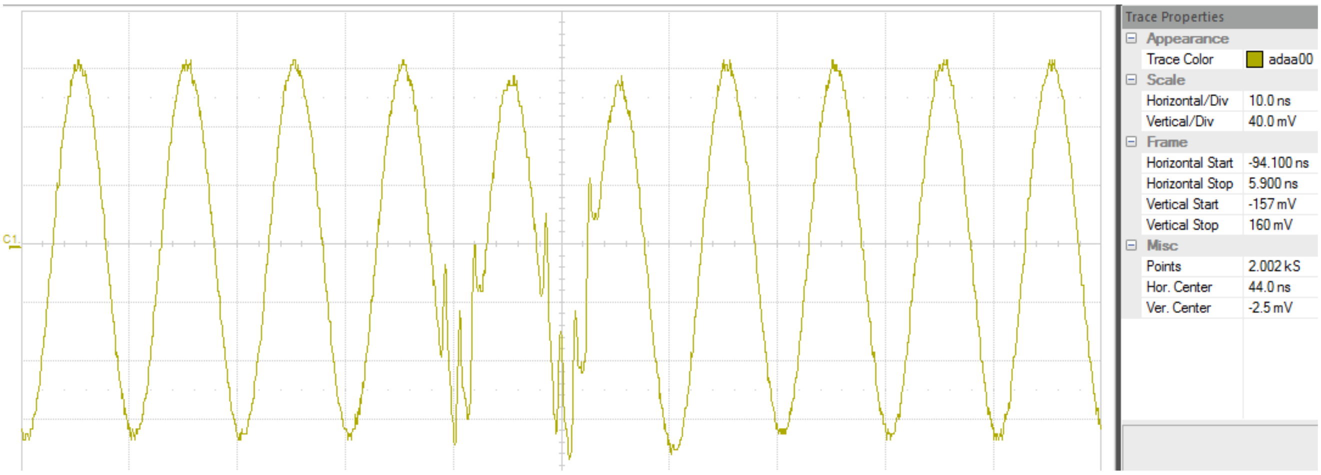
Trace Properties

Appearance	
Trace Color	🟨 adaa00
Scale	
Horizontal/Div	36.0 ns
Vertical/Div	38.5 mV
Frame	
Horizontal Start	-141.920 ns
Horizontal Stop	218.080 ns
Vertical Start	-145 mV
Vertical Stop	154 mV
Misc	
Points	7.202 kS
Hor. Center	-38.2 ns
Ver. Center	-8.8 mV

Cursors	X1	X2	Y1	Y2	DeltaX	DeltaY	Y1	Y2	DeltaY
value	-55.55 ns	135.25 ns	117.0 mV	120.5 mV	190.80 ns	3.5 mV	48.5 mV	-57.0 mV	-105.5 mV

Duration 191ns

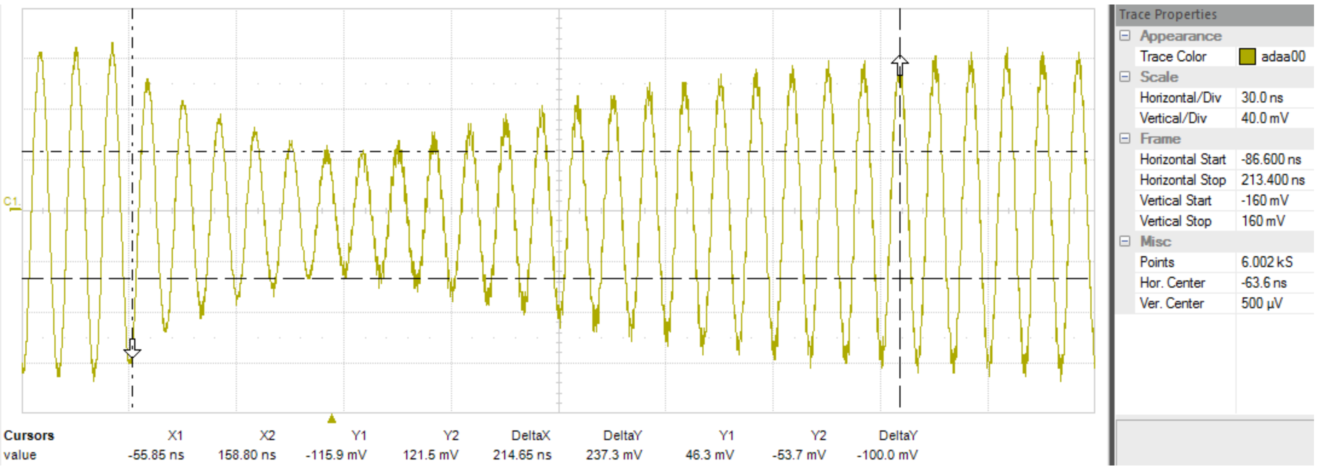
8.4.4 LET 78.2(MeV/mg/cm²)



Trace Properties

Appearance	
Trace Color	🟨 adaa00
Scale	
Horizontal/Div	10.0 ns
Vertical/Div	40.0 mV
Frame	
Horizontal Start	-94.100 ns
Horizontal Stop	5.900 ns
Vertical Start	-157 mV
Vertical Stop	160 mV
Misc	
Points	2.002 kS
Hor. Center	44.0 ns
Ver. Center	-2.5 mV

Duration 15ns



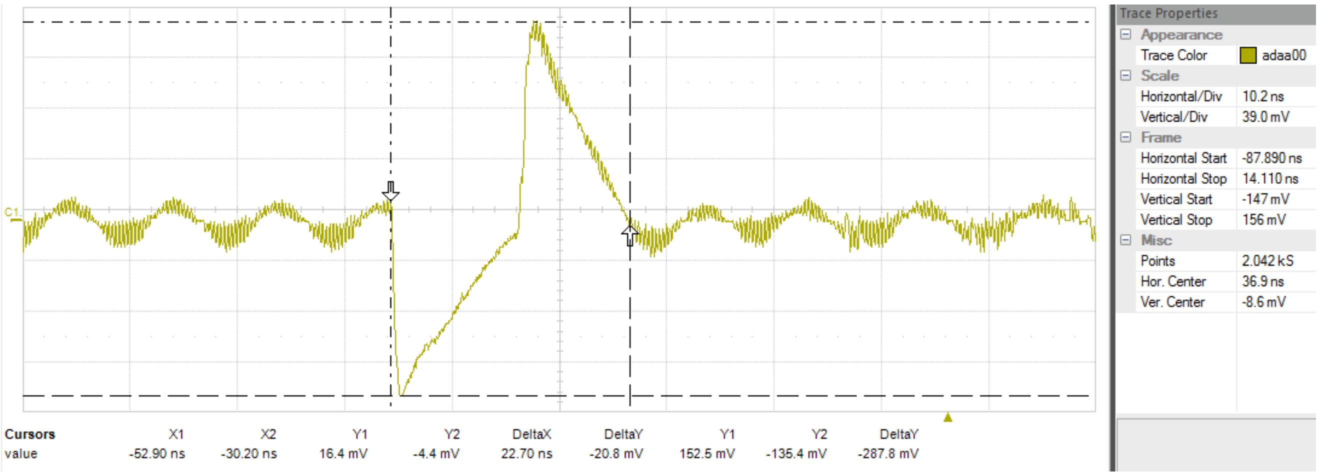
Trace Properties

Appearance	
Trace Color	🟨 adaa00
Scale	
Horizontal/Div	30.0 ns
Vertical/Div	40.0 mV
Frame	
Horizontal Start	-86.600 ns
Horizontal Stop	213.400 ns
Vertical Start	-160 mV
Vertical Stop	160 mV
Misc	
Points	6.002 kS
Hor. Center	-63.6 ns
Ver. Center	500 µV

Cursors	X1	X2	Y1	Y2	DeltaX	DeltaY	Y1	Y2	DeltaY
value	-55.85 ns	158.80 ns	-115.9 mV	121.5 mV	214.65 ns	237.3 mV	46.3 mV	-53.7 mV	-100.0 mV

Duration 215ns

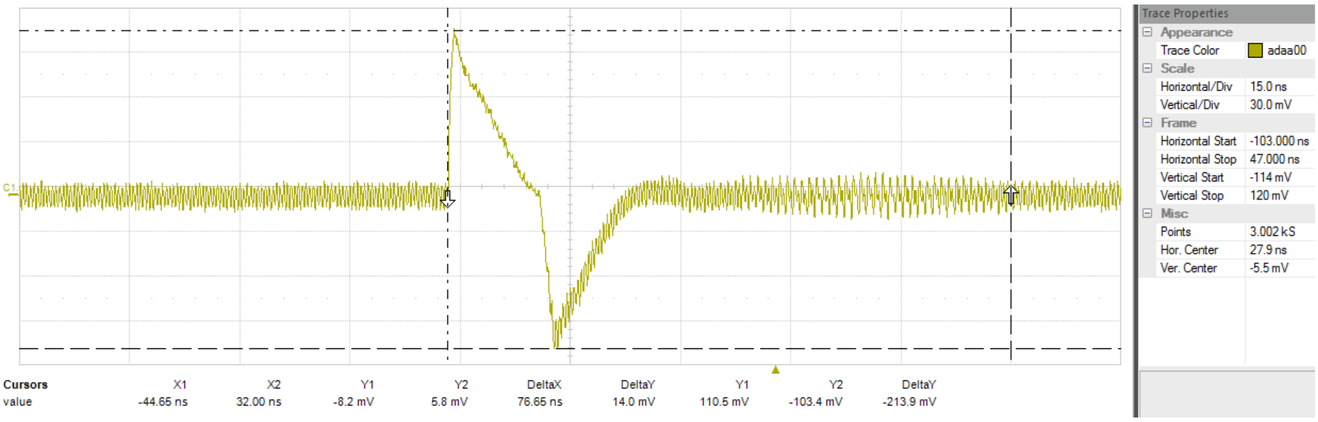
Document approved by Quality Department.



Cursors	X1	X2	Y1	Y2	DeltaX	DeltaY	Y1	Y2	DeltaY
value	-52.90 ns	-30.20 ns	16.4 mV	-4.4 mV	22.70 ns	-20.8 mV	152.5 mV	-135.4 mV	-287.8 mV

Trace Properties	
Appearance	
Trace Color	adaa00
Scale	
Horizontal/Div	10.2 ns
Vertical/Div	39.0 mV
Frame	
Horizontal Start	-87.890 ns
Horizontal Stop	14.110 ns
Vertical Start	-147 mV
Vertical Stop	156 mV
Misc	
Points	2.042 kS
Hor. Center	36.9 ns
Ver. Center	-8.6 mV

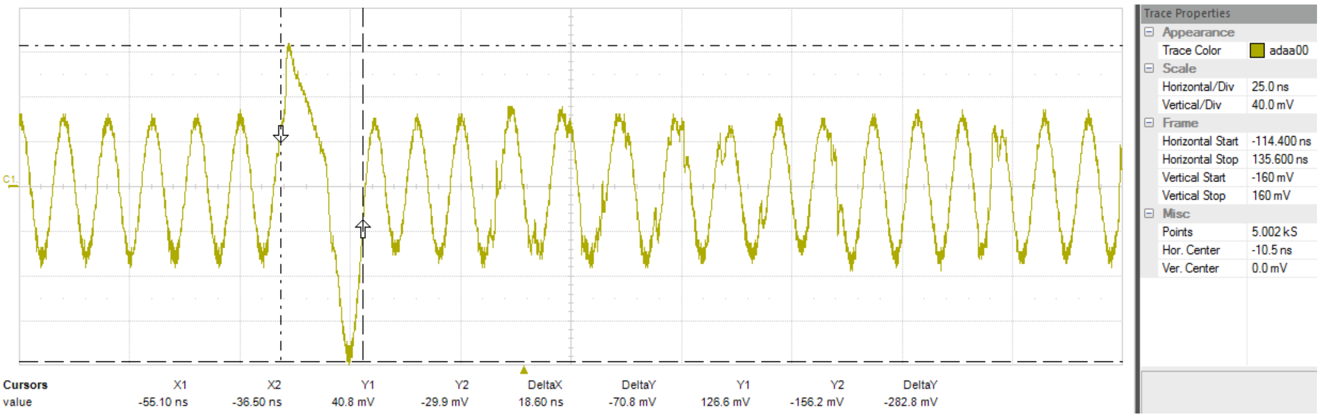
Duration 22.7ns



Cursors	X1	X2	Y1	Y2	DeltaX	DeltaY	Y1	Y2	DeltaY
value	-44.65 ns	32.00 ns	-8.2 mV	5.8 mV	76.65 ns	14.0 mV	110.5 mV	-103.4 mV	-213.9 mV

Trace Properties	
Appearance	
Trace Color	adaa00
Scale	
Horizontal/Div	15.0 ns
Vertical/Div	30.0 mV
Frame	
Horizontal Start	-103.000 ns
Horizontal Stop	47.000 ns
Vertical Start	-114 mV
Vertical Stop	120 mV
Misc	
Points	3.002 kS
Hor. Center	27.9 ns
Ver. Center	-5.5 mV

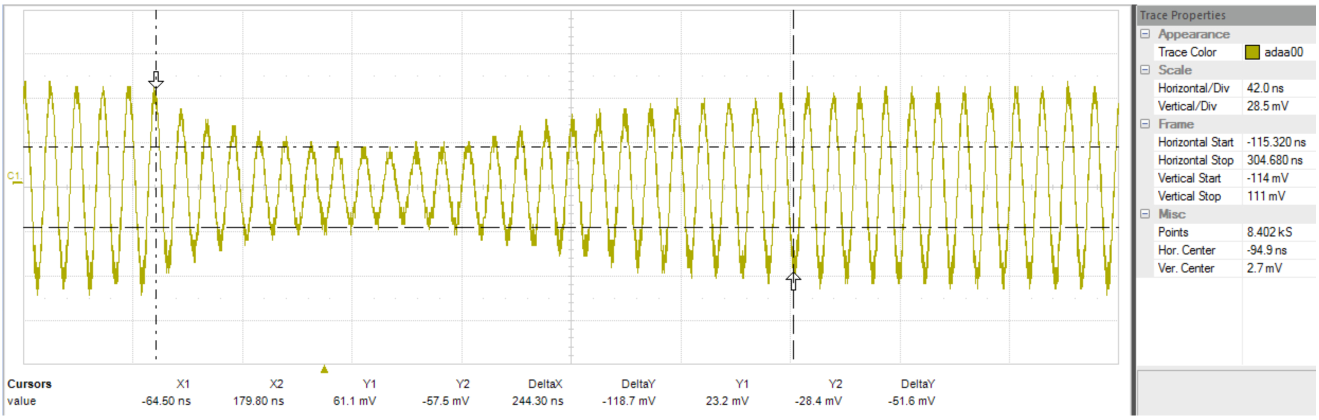
Duration 76.65ns



Cursors	X1	X2	Y1	Y2	DeltaX	DeltaY	Y1	Y2	DeltaY
value	-55.10 ns	-36.50 ns	40.8 mV	-29.9 mV	18.60 ns	-70.8 mV	126.6 mV	-156.2 mV	-282.8 mV

Trace Properties	
Appearance	
Trace Color	adaa00
Scale	
Horizontal/Div	25.0 ns
Vertical/Div	40.0 mV
Frame	
Horizontal Start	-114.400 ns
Horizontal Stop	135.600 ns
Vertical Start	-160 mV
Vertical Stop	160 mV
Misc	
Points	5.002 kS
Hor. Center	-10.5 ns
Ver. Center	0.0 mV

Duration 18.6ns



Cursors	X1	X2	Y1	Y2	DeltaX	DeltaY	Y1	Y2	DeltaY
value	-64.50 ns	179.80 ns	61.1 mV	-57.5 mV	244.30 ns	-118.7 mV	23.2 mV	-28.4 mV	-51.6 mV

Trace Properties	
Appearance	
Trace Color	adaa00
Scale	
Horizontal/Div	42.0 ns
Vertical/Div	28.5 mV
Frame	
Horizontal Start	-115.320 ns
Horizontal Stop	304.680 ns
Vertical Start	-114 mV
Vertical Stop	111 mV
Misc	
Points	8.402 kS
Hor. Center	-94.9 ns
Ver. Center	2.7 mV

Duration 244.3ns

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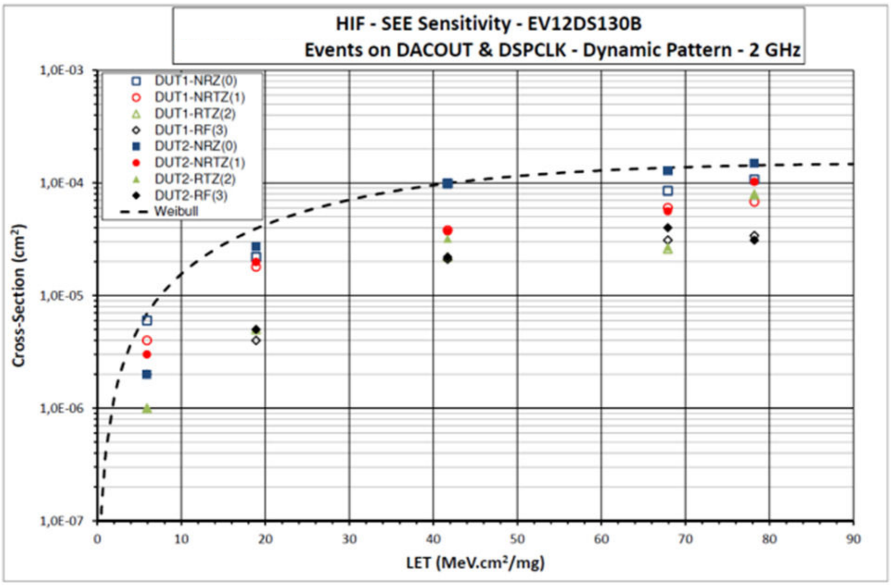
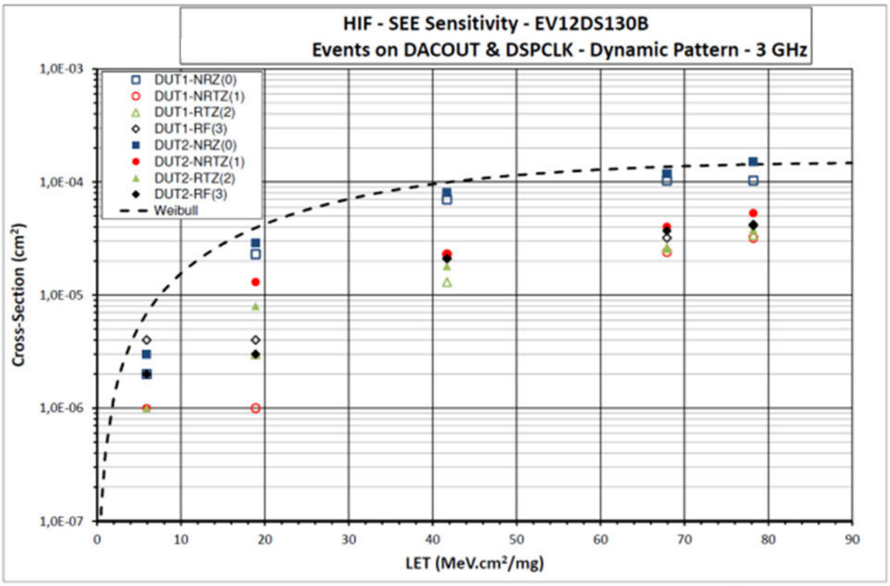
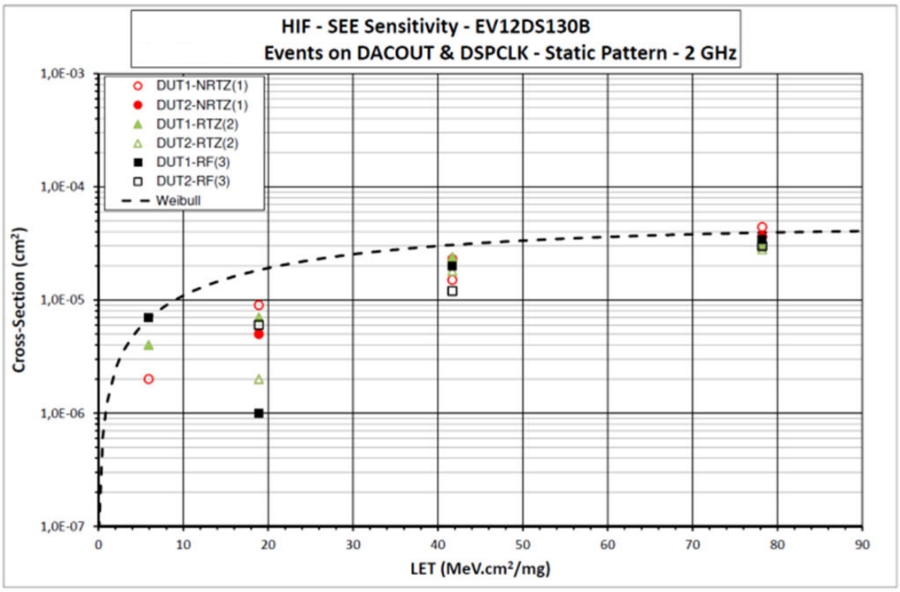
Quality Department.

8.5 SET on DSPCLK&DACOUT







8.6 Conclusion

Digital to analog converter EV12DS130B from E2V was tested to four heavy ions with five different LET and ranges. Test configurations were chosen in order to obtain significant results about the component behavior under heavy ions exposure. These results also permit to calculate MTBF for a geostationary orbit, with CREME 3 and CREME 8.

The results obtained allow assuming that, in the conditions and configurations applied during the campaign:

- No SEL nor SEFI have been detected;
- There is no significant gap between SET cross sections obtained at 2 GHz and 3 GHz;
- There is no significant gap between SET cross sections obtained at ambient and 125°C;
- There is no significant gap between SET cross sections obtained at the minimum, typical and maximum voltages;

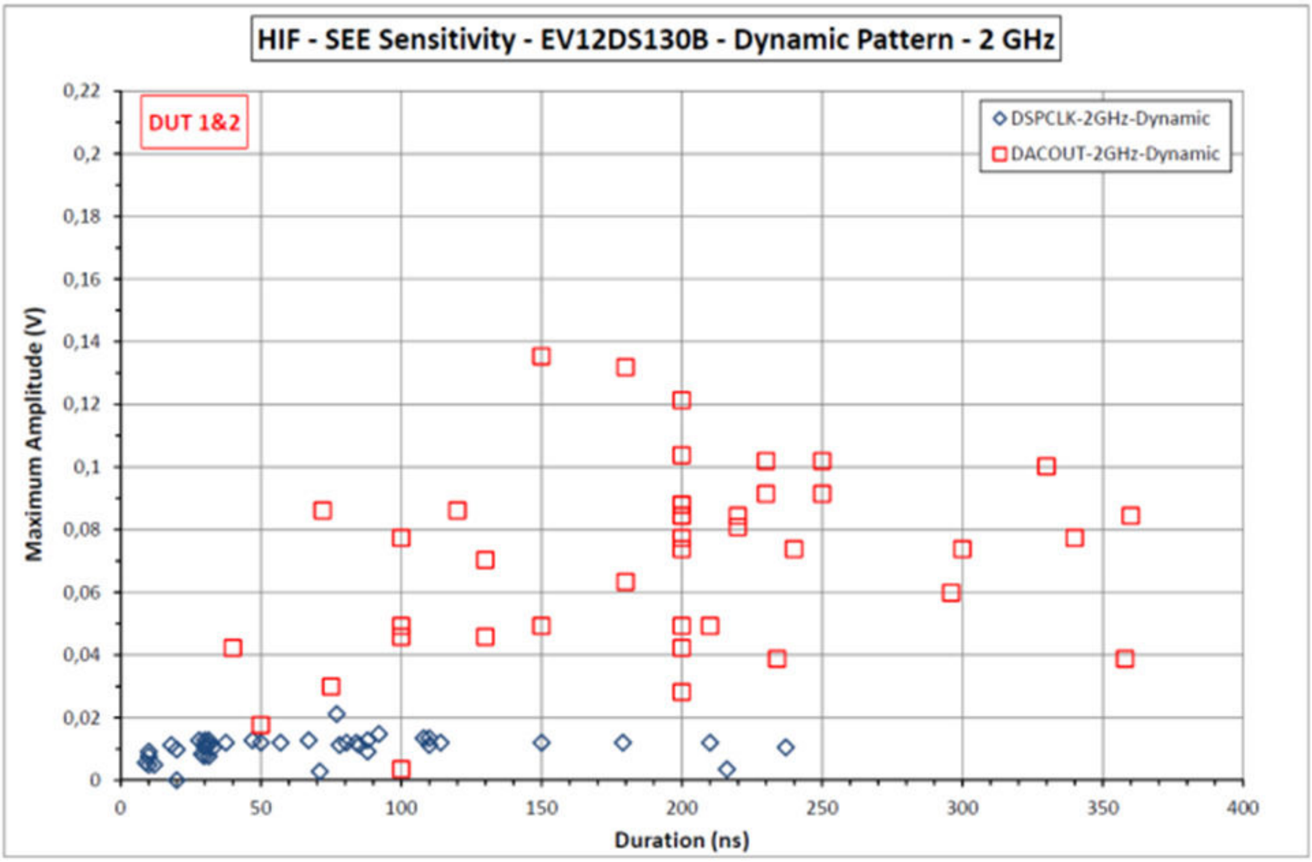
The table below summarizes the worst case Weibull fit parameters for DACOUT and DSPCLK, for both dynamic and static pattern. The LET threshold value is extracted from previous proton measures done on EV12DS130A. Both SEE rate and MTBF calculations were performed with OMERE software from parameters detailed in the following table.

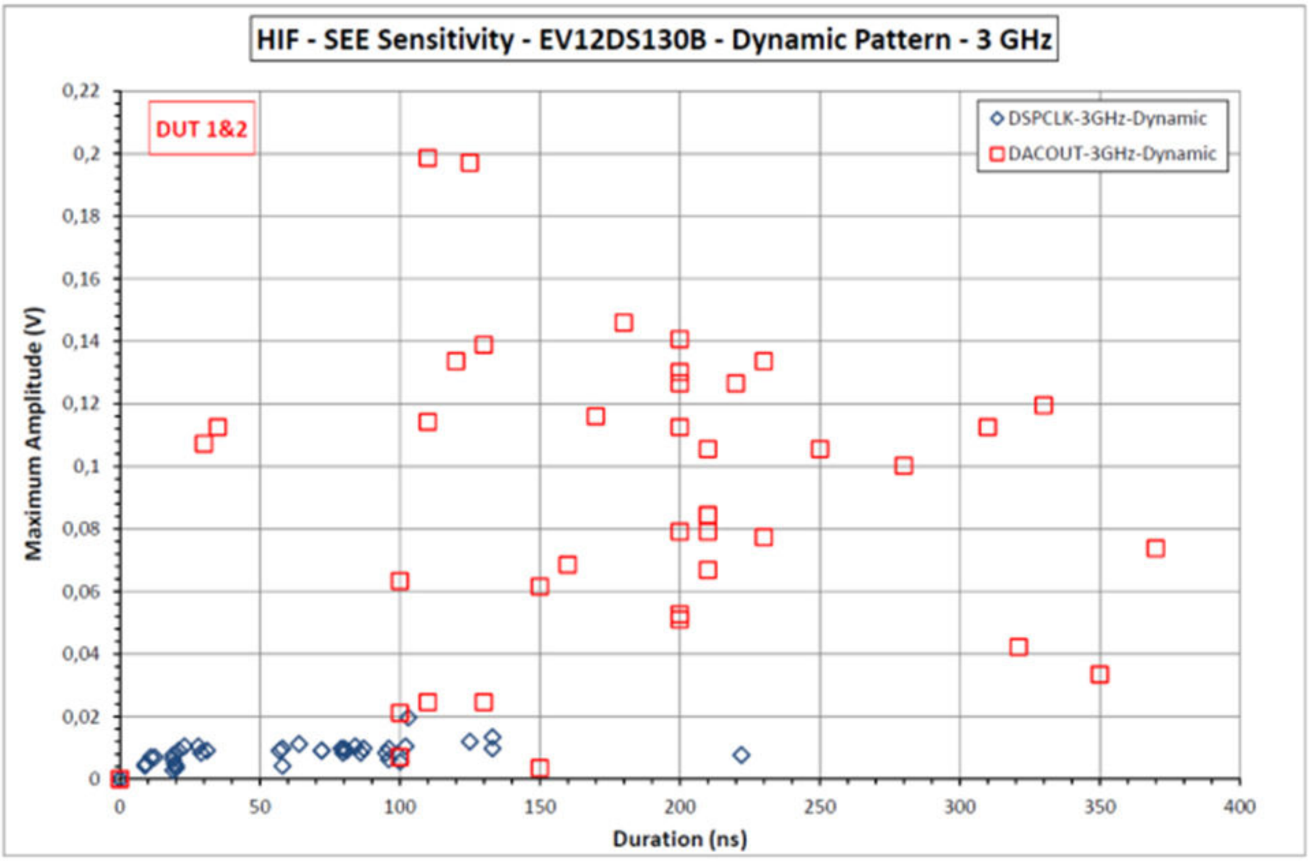
Test Conditions			**Weibull Fit Parameters**				**SEE Rate Calculation**		
FClock (GHz)	**Output**	**Pattern**	**W (MeV.cm^2/mg)**	**S**	**LET threshold L0 (MeV.cm^2/mg)**	**Cross-Section Sat (cm^2)**	**Mission (GEO)**	**Rate/Day**	**MTBF (Days)**
2&3	DSPCLK	Dynamic	40	1.6	1.50E-2	6.7E-5	M3 15 years	3.3E-4	3030
							M8 16 Days	1.5E-1	6.7
2&3	DSPCLK+DACOUT	Dynamic	40	1.6	1.50E-2	1.51E-4	M3 15 years	8.2E-4	1220
							M8 16 Days	3.9E-1	2.6
2&3	DACOUT	Dynamic	40	1.6	1.50E-2	8.9E-5	M3 15 years	4.5E-4	2222
							M8 16 Days	2.1E-1	4.8
2	DSPCLK	Static	35	1	1.50E-2	1.9E-5	M3 15 years	6.9E-4	1450
							M8 16 Days	4E-1	2.5
2	DSPCLK+DACOUT	Static	35	1	1.50E-2	4.4E-5	M3 15 years	1.7E-3	588
							M8 16 Days	1.11	0.9
2	DACOUT	Static	40	1.6	1.50E-2	3.8E-5	M3 15 years	1.7E-4	5882
							M8 16 Days	7.6E-2	13.1

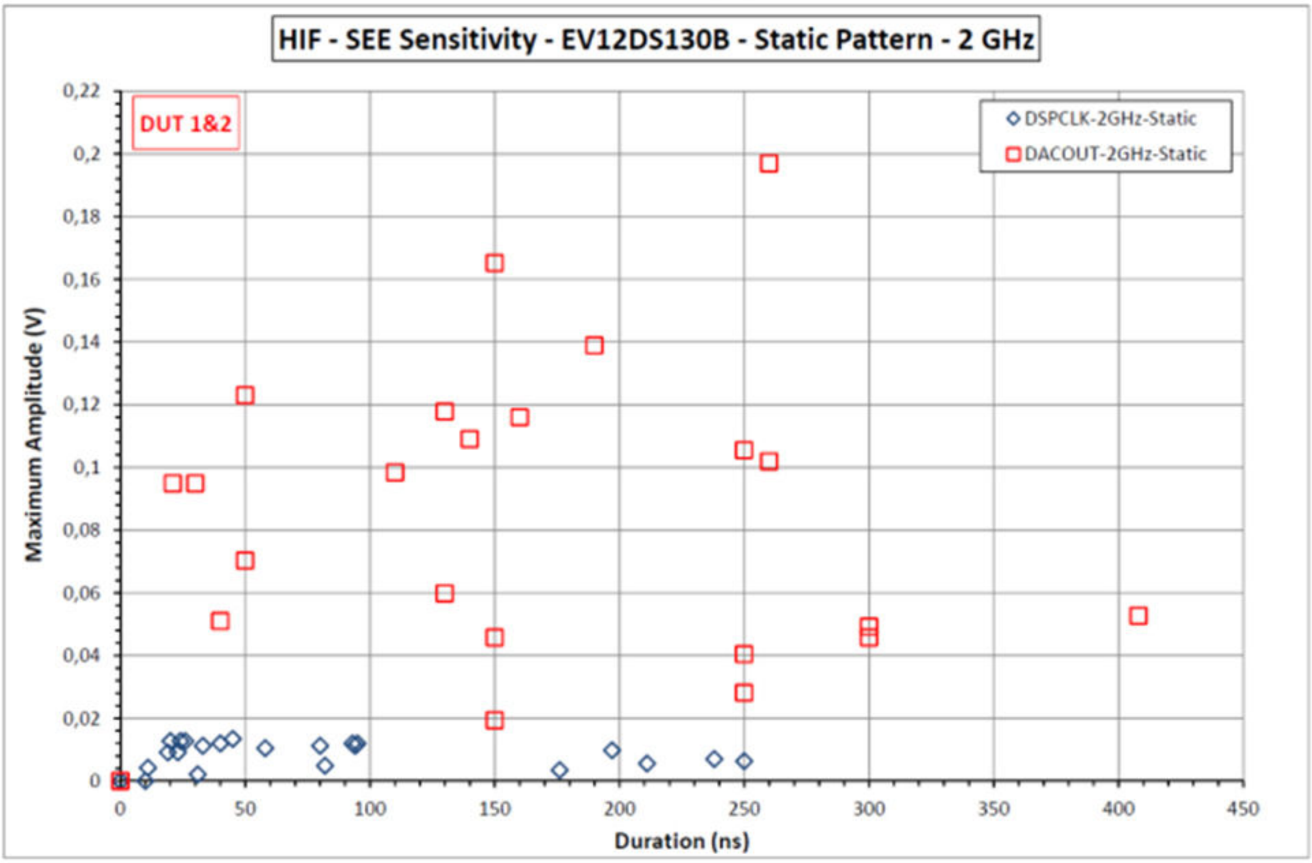
The following parameters have been calculated with *OMERE* and are given as examples of two typical missions.

Orbit	GEO (35870 km)	
Radiative Environment	CREME 86 – M3 – Cosmic Rays Solar Min	CREME 86 – M8 – Solar Eruption – Worst-Case Flux
Mission Duration	15 years	16 days
Magnetospheric Cut-Off	Without	
Shielding	1 g.cm^{-2}	
Number of Cells	12	
Cell Depth	6 µm	

The following graphs plot the events depending on their amplitude and duration. Events causing lower signal amplitude than the nominal one are not displayed in these graphs.

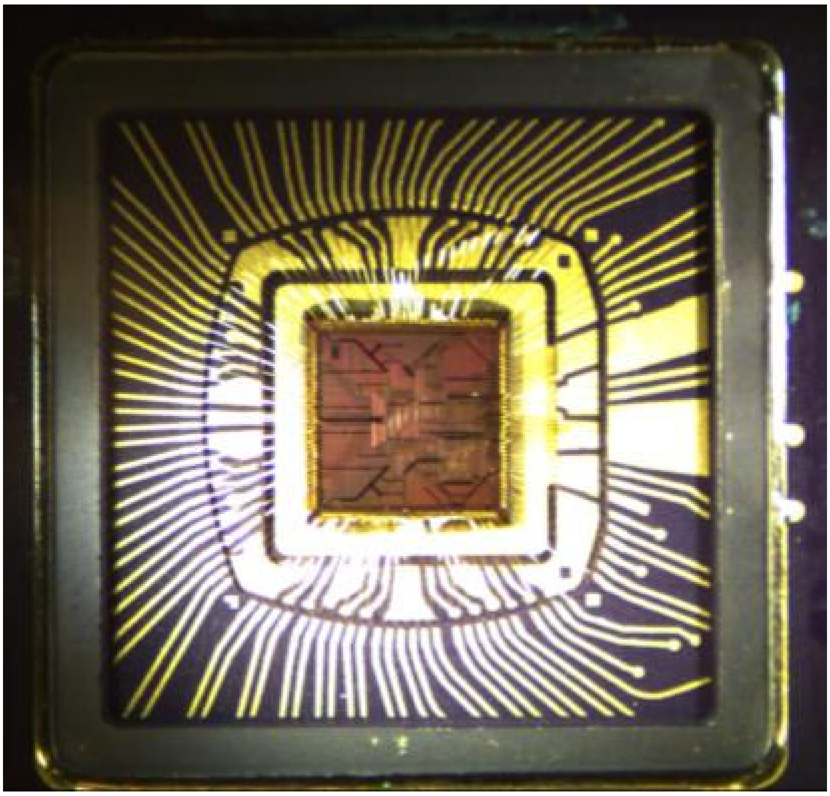






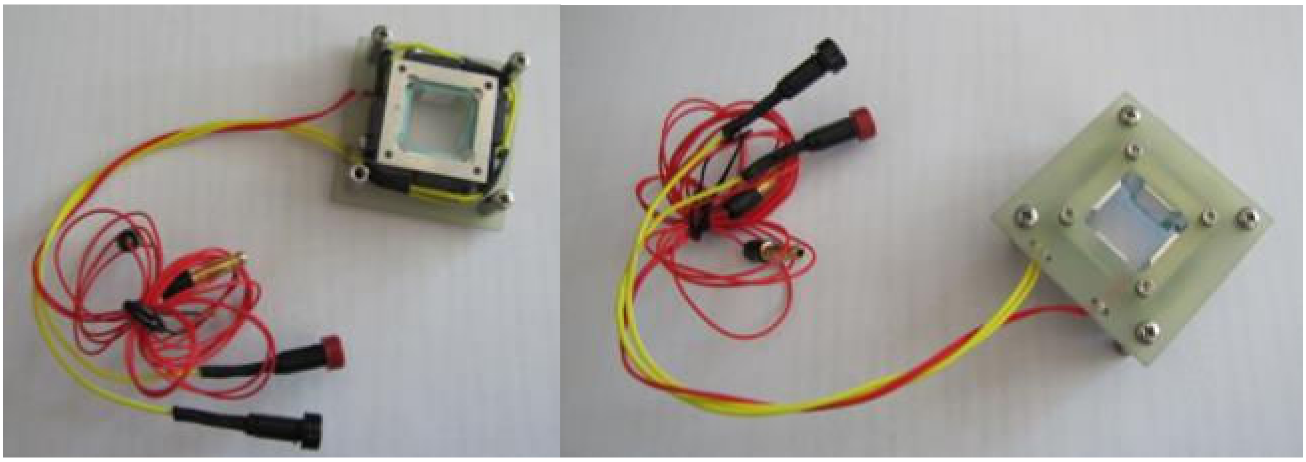
These graphs show that for the configurations tested during this campaign, results obtained at 2 GHz are similar to the results obtained at 3 GHz.

9. PICTURES

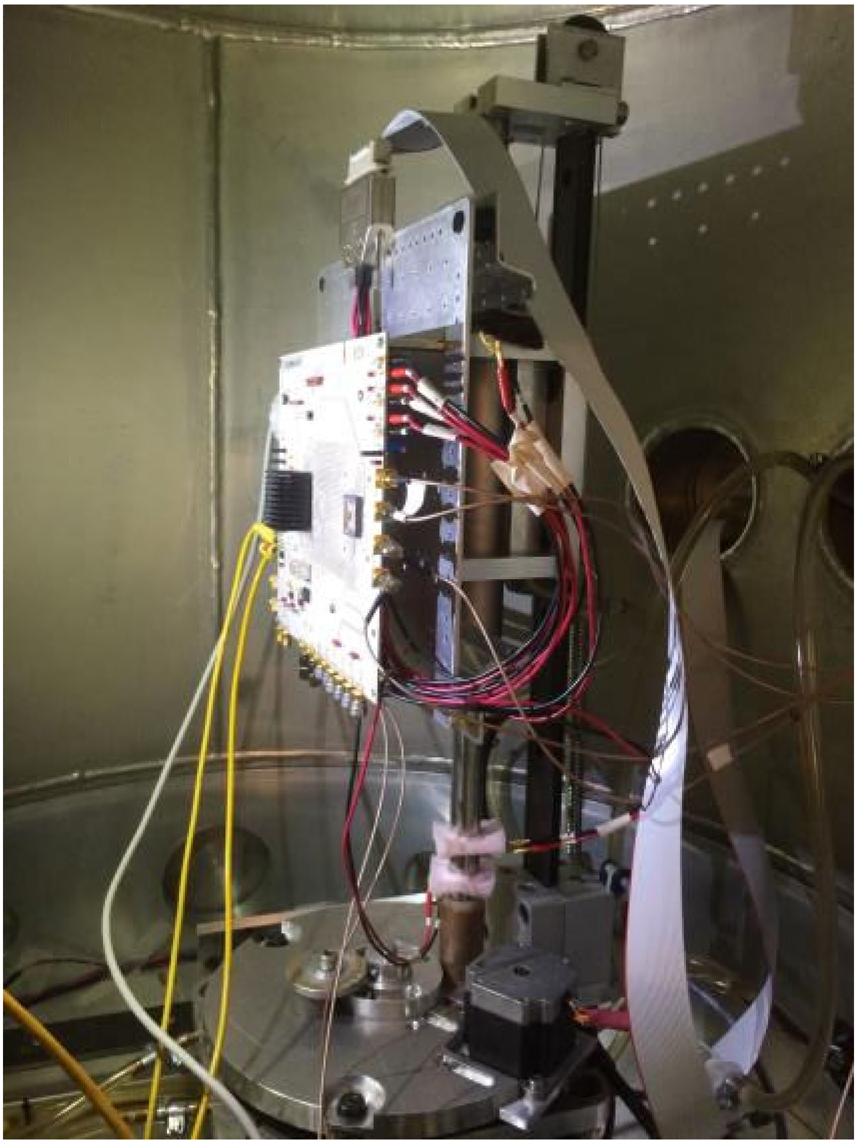


EVX12DS130BG die.

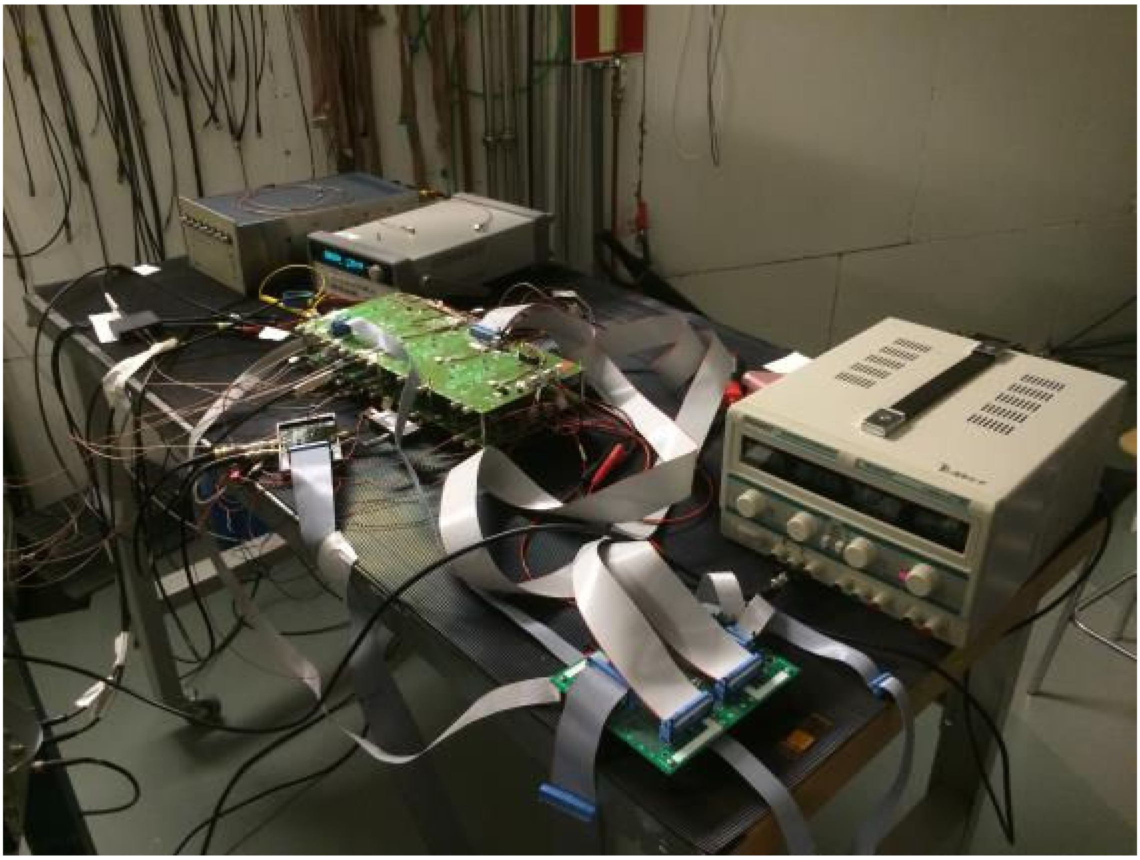
Die marking.



Heating system.

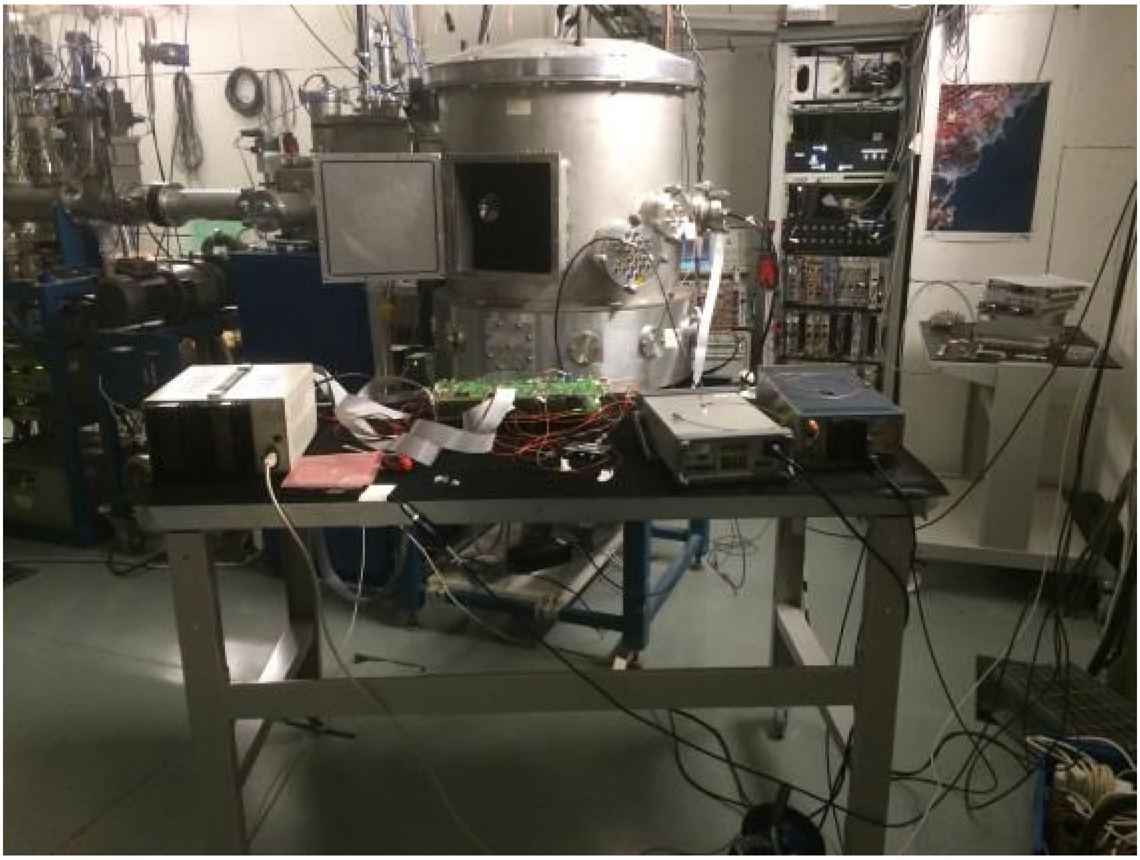


DAC evaluation board in the vacuum chamber.



SET detection system.

Setup in data room.



Setup in irradiation room.