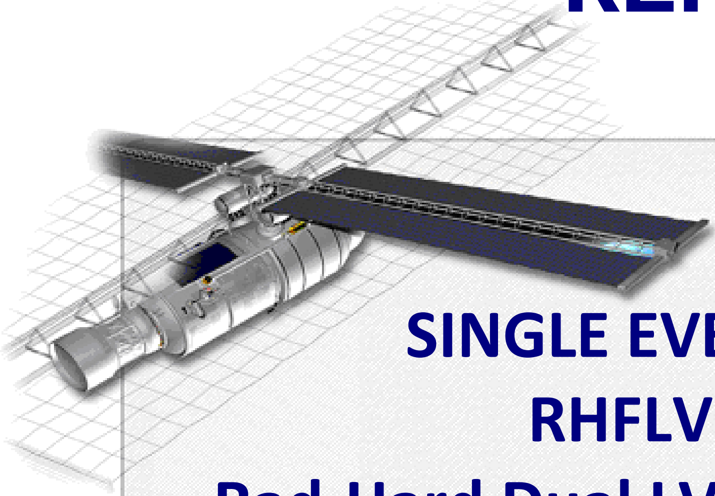
HEAVY IONS TEST REPORT



SINGLE EVENT EFFECTS
RHFLVDSR2D2
Rad-Hard Dual LVDS Driver-Receiver
From
STMicroelectronics

TRAD/TI/RHFLVDSR2D2/XXX1/STM/LS/1307		Labège, September 02nd, 2013
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Revision: 0		
To: **STMicroelectronics** **Mrs CHAUMONT Géraldine**		Project/Program: Ref:

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1. Introduction

This report includes the test results of the heavy ions Single Event Effects (SEEs) test sequence carried out on the RHFLVDSR2D2, a Rad-Hard Dual LVDS Driver-Receiver from STMicroelectronics.

This test was performed for STMicroelectronics on the RHFLVDSR2D2 susceptible to show Single Event Latch-ups (SELs) and Single Event Transients (SETs) induced by heavy ions.

2. Documents

2.1. Applicable documents

Technical Proposal: TRAD/P/STM/4xLVDS/ER/310513 Rev.1
SEE Test Plan: RNS/GC/13-141-01 ce Rev2 of 11/06/2013.
Mail from Mr Croisat, dated august 2nd, 2013, subject “RE: [SEE] RHFLVDS R2D2 - RHFLVDS228A”.
Mail from Mrs Rousseau, dated september 10th, 2013, subject “Fwd: Manip IOL semaine 35. LVDS”.

3. Organization of Activities

The relevant company has performed the following tasks during this evaluation:

1	Procurement of Test Samples	ST Microelectronics
2	Preparation of Test Samples (delidding)	ST Microelectronics
3	Preparation of Test Hardware and Test Program	TRAD
4	Samples Check out	TRAD
5	Accelerator Test	TRAD
6	Heavy Ion Test Report	TRAD

Table 1: Organization of activities

4. Parts information

4.1. Device description

The RHFLVDSR2D2 is a dual Low Voltage Differential Signaling (LVDS) Driver Receiver designed, packaged and qualified for use in aerospace environment in low power and fast transmission standard, operating at 3.3V power supply (3.6V max operating and 4.8V AMR). The LVDS-Driver operates over a controlled impedance of 100-ohm transmission media that may be printed circuit board traces, back planes or cables. The circuit features an internal Fail-safe function to ensure a known state in case of input short circuit or floating input. All pins have cold spare buffers to make them in high impedance when VCC is tied to GND.

4.2. Identification

Type:	RHFLVDSR2D2
Manufacturer:	STMicroelectronics
Function:	Rad-Hard Dual LVDS Driver-Receiver

4.3. Procurement information

Packaging:	FP-18
Sample size:	6 parts provided by STMicroelectronics.

4.4. Sample Preparation

All parts were delidded by STMicroelectronics.
A functional test sequence was performed on delidded samples and all parts provided by STMicroelectronics were functional.

4.5. Sample pictures

4.5.1. External view

No marking at the bottom of the package was observed.

Figure 1: Package marking (Top view)

4.5.2. Internal view

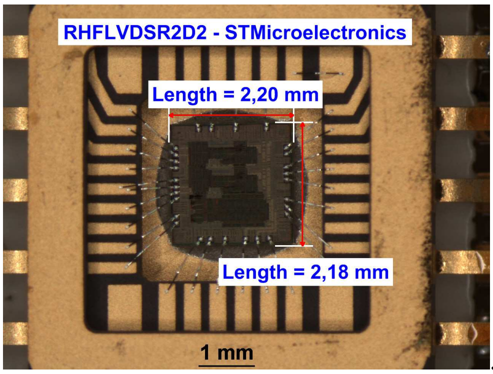


Figure 2: Internal overall view

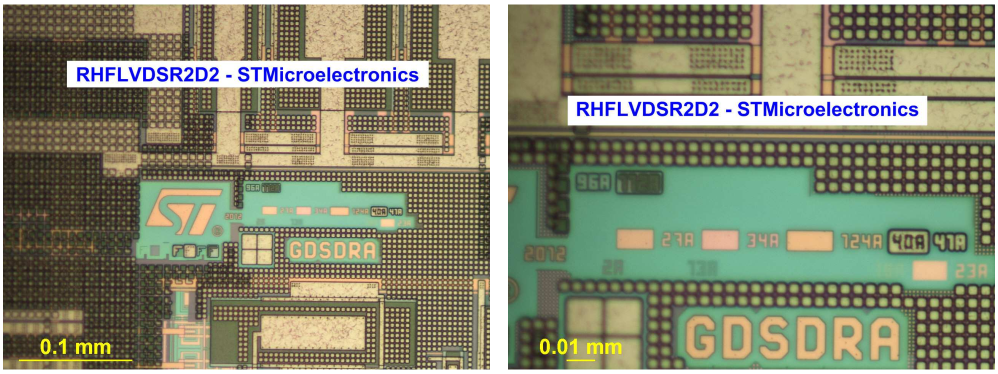


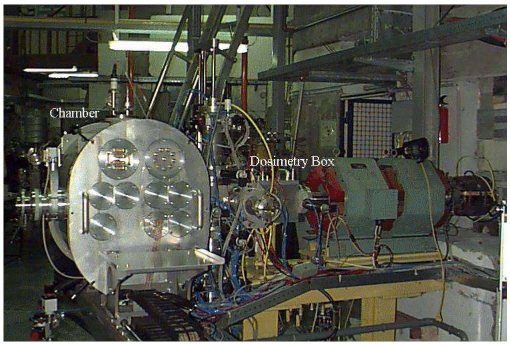
Figure 3: Die marking

5. Dosimetry and Irradiation Facilities

The test was performed at U.C.L (Université Catholique de Louvain) on August 27th, 28th and 29th, 2013 and on October 07th and 08th, 2013. 4 delidded samples were irradiated.

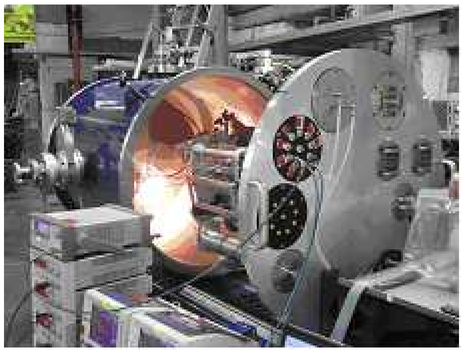
5.1. UCL Heavy Ion Test Facility (Université Catholique de Louvain - Belgique)

The CYClotron of LOuvain la NEuve (CYCLONE) is a multi-particle, variable energy, cyclotron capable of accelerating protons (up to 85 MeV), alpha particles and heavy ions.
For heavy ions, the covered LET range is between 1.2 MeV.cm².mg^{-1} and 67.7 MeV.cm².mg^{-1}. Heavy ions available are separated in two "Ion Cocktails" named M/Q=5 and M/Q=3.3.



One of the main advantages of the UCL Heavy Ion Test Facility is the fast changing of ion species. Within the same cocktail, it takes only a few minutes to change from one ion to another.

The chamber has the shape of a barrel stretched vertically; its internal dimensions are 71 cm in height, 54 cm in width and 76 cm in depth. One side flange is used to support the board frame (25 X 25 cm) and user connectors.
The chamber is equipped with a vacuum system.



5.2. Dosimetry

To control and monitor the beam parameters, a dosimetry box is placed in front of the chamber.
It contains a faraday cup, 2 Parallel Plate Avalanche Counters (PPAC).
Two additional surface barrier detectors are placed in the test chamber.
The faraday cup is used during beam preparation at high intensity.
A beam uniformity measurement is performed with a collimated surface barrier detector. This detector is placed on a X and Y movement. The final profile is drawn and the ± 10 % width is calculated. The Homogeneity is ± 10 % on a 25 mm diameter.
During the irradiation, the flux is integrated in order to give the delivered total fluence (particule.cm^{-2}) on the device.

5.3. Beam characteristics

The beam flux is variable between a few particles $s^{-1}cm^{-2}$ and $1.8 \cdot 10^4 s^{-1}cm^{-2}$ depending on the device sensitivity.

Heavy ion characteristics are listed in the following tables:

Ion	Energy (MeV)	Range (µm(Si))	LET ($MeV.cm^2.mg^{-1}$)
$^{15}N^{3+}$	60	59	3.3
$^{20}Ne^{4+}$	78	45	6.4
$^{40}Ar^{8+}$	151	40	15.9
$^{84}Kr^{17+}$	305	39	40.4
$^{124}Xe^{25+}$	420	37	67.7

Table 2 : UCL cocktail M/Q=5

Ion	Energy (MeV)	Range (µm(Si))	LET ($MeV.cm^2.mg^{-1}$)
$^{13}C^{4+}$	131	292	1.1
$^{22}Ne^{7+}$	235	216	3
$^{40}Ar^{12+}$	372	117	10.2
$^{58}Ni^{18+}$	567	100	20.4
$^{83}Kr^{25+}$	756	92	32.6

Table 3 : UCL cocktail M/Q=3.3

The highlighted ion species in the table above were used to perform this SEE test.

TRAD - Bâtiment Gallium - 907 l'Occitane 31670 LABEGE CEDEX.
Tel: (33) 5 61 00 95 60. Fax: (33) 5 61 00 95 61. EMAIL: trad@trad.fr

6. Test Procedure and Setup

6.1. Test procedure

6.1.1. Description of the test method

The test was divided in two parts, with respect to reference or applicable documents:

- Runs were performed up to a fluence of 1.10^7 cm^{-2} with only SEL monitoring. This configuration allowed us to verify the latchup sensitivity of the device.
- Runs were performed up to a fluence of 1.10^7 cm^{-2} for the SET detection. A latchup monitoring was used during these tests in order to protect the component. This configuration allowed us to verify the SET sensitivity.

The test was terminated when the maximum fluence was reached or when we got about a hundred events.

6.1.2. SEL Test Principle

The test was performed at maximum operating voltage and temperature.
TRAD has developed a fully integrated test bench to perform Single Event Latchup tests (SEL). The GUARD system (Graphical Universal Autorange Delatcher) allows the user to easily protect his device under test and perform SEL characterization.
The power supply is applied to the device under test through the GUARD system.
The threshold current of the GUARD system is set according to the nominal current. If the nominal current exceeds the threshold current, the GUARD system is triggered and the event is counted as an SEL. Then, the GUARD system sends a trigger command to the oscilloscope, maintains the power supply during a defined 'Time hold' and cut off during a defined 'Time cut'. Then, the power supply is restarted with the nominal current expected consumption.
At the end of each run, the test program reads the oscilloscope's "Local Scope Counter" which represents the total event count and downloads the records currents waveforms to store them.

Figure 4 shows an example of the SEL detection.

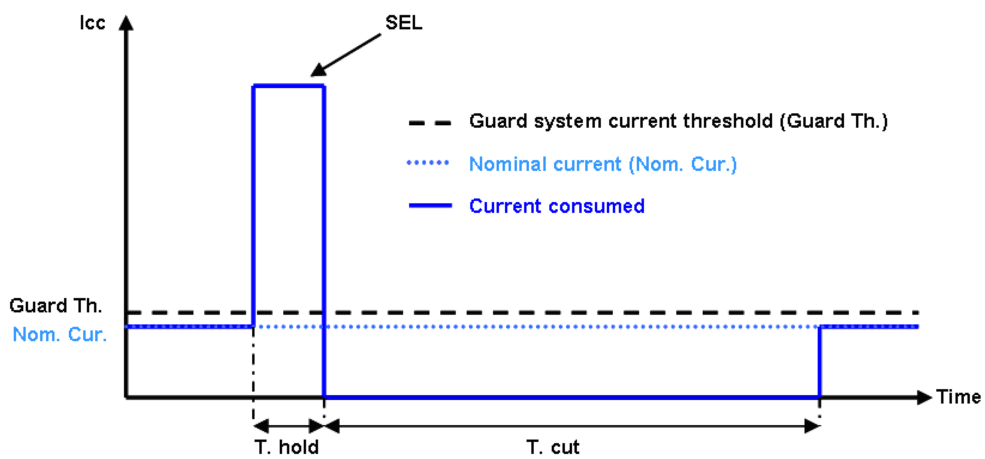


Figure 4 : Common SEL characteristic.

6.1.3. SET Test Principle

The GUARD system is always used on the component's power supply to detect SEL and to prevent the destruction of the device under test.
Single Event Transient is an event described by a voltage amplitude and a timing parameter.
To detect these events, the component's output voltage is monitored.
Two configurations were tested:

- High level out of range:

Pulse width modifications are detected. If the high level time (T_H) is not comprised between T_H min threshold and T_H max threshold, an increment of the oscilloscope internal counter occurs and the trace is stored.

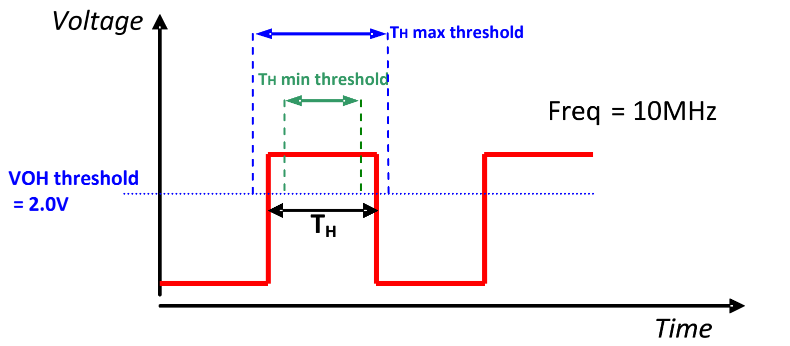


Figure 5: Output signal monitoring in High level configuration.

- Low level out of range:

Same as the High level configuration except we monitor the low level time.

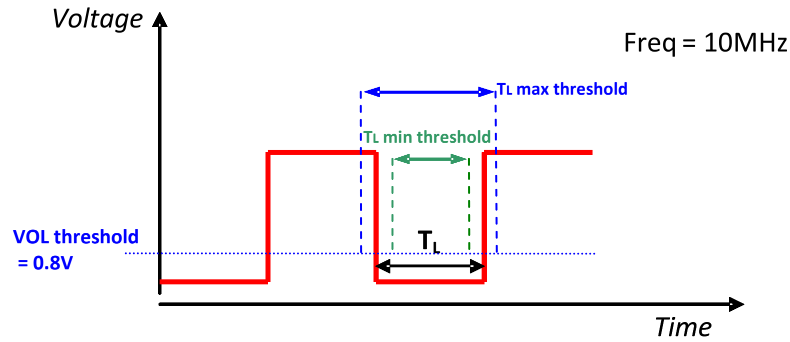


Figure 6: Output signal monitoring in Low level configuration.

At the end of each run, the test program reads the oscilloscope's "Local Scope Counter" which represents the total event count and downloads the records currents waveforms to store them.

6.2. Test bench description

6.2.1. Preparation of test hardware and program

TRAD has developed a specific test program and a specific motherboard to feed power supply to components.
The different outputs of the DUT are visualized using two oscilloscopes and curves are saved when an event occurs.
The test system is driven by a personal computer through a standard IEEE488 communication interface. All signals are delivered and monitored by this equipment and SEE curves are saved in its memory.
At the end of each test run, data is transferred to the hard disk for storage. An overall description of the test system is given in Figure 7.

6.2.2. Test equipment identification

The tests were carried out with evaluation test boards developed by TRAD.

COMPUTER	PO-TE-096
REF. TEST BOARD	TRAD/CT1/I/RHFLVDSR2D2/ZIP18/LS/1307 TRAD/CT2/I/RHFLVDSR2D2/ZIP18/LS/1307
EQUIPMENT	MI-52; MI-60; ME-44; ME-71; ME-79
TEST PROGRAM	RHFLVDSR2D2_TI_XXX1_BI_V10

6.2.3. Test Bench description

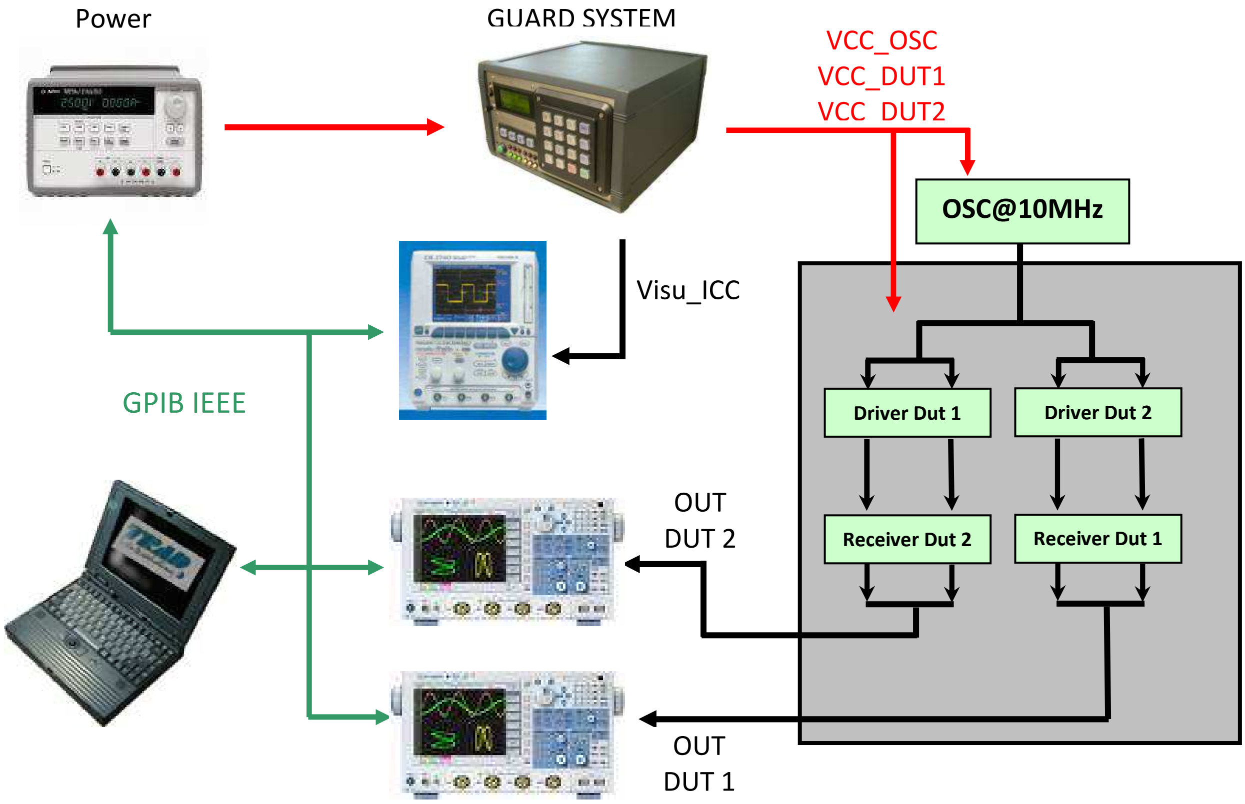


Figure 7 : test system description

6.2.4. Device setup and Test conditions

Trigger thresholds for SET test are defined in the following table:

Vcc	3.3V
VOH Threshold	2.0V
T_H max threshold	51ns
T_H min threshold	49ns
Temperature	25°C

Table 4: High level SET detection threshold

Vcc	3.3V
VOL Threshold	0.8V
T_L max threshold	51.5ns
T_L min threshold	49.5ns
Temperature	25°C

Table 5: Low level SET detection threshold

Trigger threshold for SEL test is defined in the following table:

Vcc	3.6V
$I_{nominal}$	20mA
$I_{threshold}$	40mA
T_{hold}	1ms
T_{cut}	7ms
Temperature	125°C

Table 6: SEL detection threshold

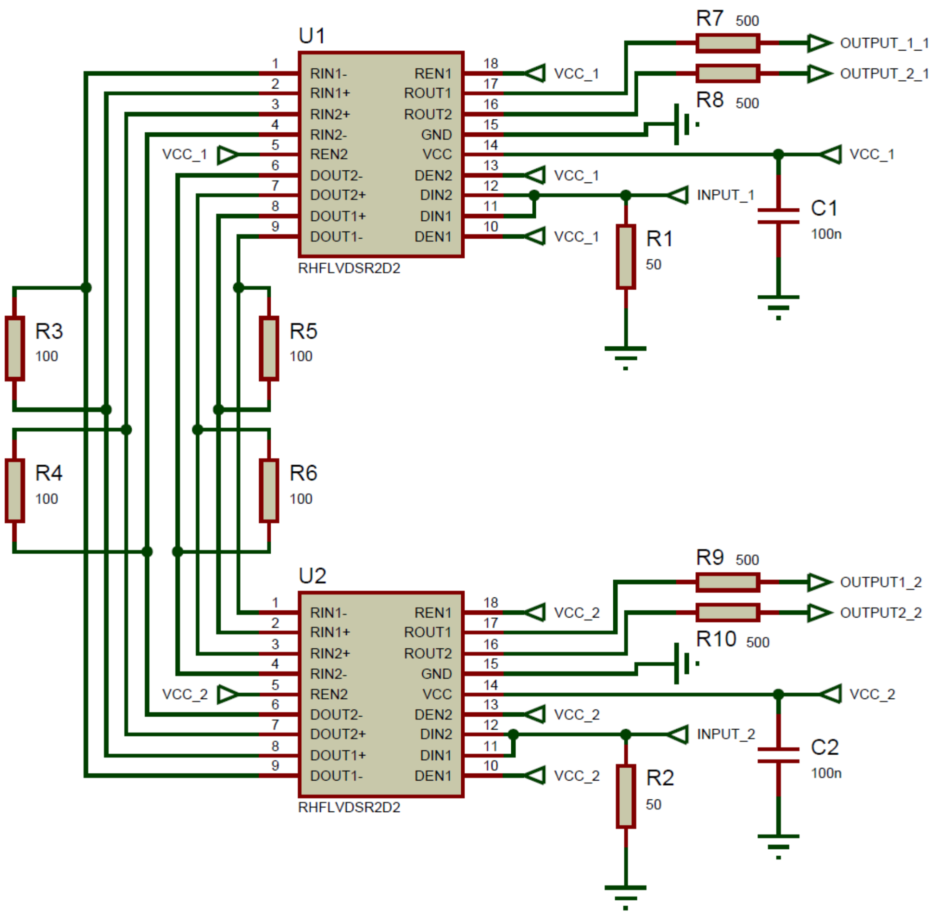


Figure 8: Test board schematic

7. Non conformance

A Non conformance NC_20131016_LS_1 was created.

Non conformance description:

At the beginning of the first test campaign one of the two SET visualization oscilloscope broke down. Without this equipment, all the required SET runs couldn't be done in time during the first test campaign.

In accordance to the mail received from Mrs E. Rousseau dated September 10, 2013, a second test campaign was scheduled in order to get the remaining SET runs. During this second campaign, test sequence, test and measurement conditions were nominal.

8. RESULTS

8.1. Runs' summary.

Hereafter you will find the Runs performed during this campaign.

RHFLVDSR2D2 SEL: VCC = 3.6V / T° = 125°C SET: VDD = 3.3V / T° = 25°C																LATCHUP		SET							
Run	Part	Config	T°	Ion	Energy (MeV)	Range (µm)	LET (MeV.cm²/mg)	Tilt (°)	Eff. LET (MeV.cm²/mg)	Eff. Range (µm Si)	Flux (φ) ($cm^{-2}.s^{-1}$)	Time (s)	Run Fluence (Φ) (cm^{-2})	Run Dose (krad)	Cumulated Dose (krad)	Vcc	Cross Section	Receiver Output 1	Cross Section	Receiver Output 2	Cross Section	Driver Output 1	Cross Section	Driver Output 2	Cross Section
High LET M/Q=5																									
1	1	SEL	125	124Xe 26+	420	37	67.7	0	67.70	37.0	9.23E+03	1086	1.00E+07	10.863	10.863	0	<1.00E-07	-	-	-	-	-	-	-	-
2	2	SEL	125	124Xe 26+	420	37	67.7	0	67.70	37.0	1.19E+04	845	1.00E+07	10.859	10.859	0	<1.00E-07	-	-	-	-	-	-	-	-
3	3	SEL	125	124Xe 26+	420	37	67.7	0	67.70	37.0	1.35E+04	740	1.00E+07	10.860	10.860	0	<1.00E-07	-	-	-	-	-	-	-	-
4	4	SEL	125	124Xe 26+	420	37	67.7	0	67.70	37.0	1.39E+04	723	1.00E+07	10.850	10.850	0	<1.00E-07	-	-	-	-	-	-	-	-
5	4	SEL	125	124Xe 26+	420	37	67.7	60	135.40	18.5	7.10E+03	1411	1.00E+07	21.689	32.539	0	<1.00E-07	-	-	-	-	-	-	-	-
6	3	SEL	125	124Xe 26+	420	37	67.7	60	135.40	18.5	7.30E+03	1371	1.00E+07	21.685	32.545	0	<1.00E-07	-	-	-	-	-	-	-	-
7	2	SEL	125	124Xe 26+	420	37	67.7	60	135.40	18.5	7.32E+03	1367	1.00E+07	21.682	32.541	0	<1.00E-07	-	-	-	-	-	-	-	-
8	1	SEL	125	124Xe 26+	420	37	67.7	60	135.40	18.5	7.57E+03	1323	1.00E+07	21.690	32.553	0	<1.00E-07	-	-	-	-	-	-	-	-
9	3	SET R1H	25	124Xe 26+	420	37	67.7	0	67.70	37.0	1.24E+04	807	1.00E+07	10.848	43.394	0	<1.00E-07	0	<1.00E-07	-	-	-	-	-	-
10	3	SET R1L	25	124Xe 26+	420	37	67.7	0	67.70	37.0	1.20E+04	834	1.00E+07	10.832	54.226	0	<1.00E-07	1	1.00E-07	-	-	-	-	-	-
11	3	SET D1H	25	124Xe 26+	420	37	67.7	0	67.70	37.0	1.39E+04	723	1.00E+07	10.852	65.078	0	<1.00E-07	-	-	-	-	0	<1.00E-07	-	-
12	3	SET D1L	25	124Xe 26+	420	37	67.7	0	67.70	37.0	1.34E+04	745	1.00E+07	10.852	75.930	0	<1.00E-07	-	-	-	-	0	<1.00E-07	-	-
13	3	SET R2H	25	124Xe 26+	420	37	67.7	0	67.70	37.0	1.41E+04	713	1.00E+07	10.853	86.783	0	<1.00E-07	-	-	2	2.00E-07	-	-	-	-
14	3	SET R2L	25	124Xe 26+	420	37	67.7	0	67.70	37.0	1.41E+04	711	1.00E+07	10.861	97.644	0	<1.00E-07	-	-	0	<1.00E-07	-	-	-	-
15	3	SET D2H	25	124Xe 26+	420	37	67.7	0	67.70	37.0	1.41E+04	708	1.00E+07	10.849	108.493	0	<1.00E-07	-	-	-	-	-	-	0	<1.00E-07
16	3	SET D2L	25	124Xe 26+	420	37	67.7	0	67.70	37.0	1.49E+04	672	1.00E+07	10.861	119.354	0	<1.00E-07	-	-	-	-	-	-	0	<1.00E-07
17	3	SET R2H	25	124Xe 26+	420	37	67.7	60	135.40	18.5	7.43E+03	1347	1.00E+07	21.683	141.037	0	<1.00E-07	-	-	3	3.00E-07	-	-	-	-
18	3	SET R2L	25	124Xe 26+	420	37	67.7	60	135.40	18.5	7.41E+03	1350	1.00E+07	21.664	162.701	0	<1.00E-07	-	-	1	1.00E-07	-	-	-	-
High Range M/Q=3.3																									
19	1	SET R1H	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	8.77E+03	1143	1.00E+07	5.226	37.779	0	<1.00E-07	0	<1.00E-07	-	-	-	-	-	-
20	1	SET R1L	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	9.91E+03	1011	1.00E+07	5.225	43.004	0	<1.00E-07	0	<1.00E-07	-	-	-	-	-	-
21	1	SET D1H	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	9.95E+03	1008	1.00E+07	5.230	48.234	0	<1.00E-07	-	-	-	-	0	<1.00E-07	-	-
22	1	SET D1L	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	1.05E+04	955	1.00E+07	5.226	53.460	0	<1.00E-07	-	-	-	-	0	<1.00E-07	-	-
23	2	SET D1H	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	1.34E+04	748	1.00E+07	5.227	37.767	0	<1.00E-07	-	-	-	-	0	<1.00E-07	-	-
24	2	SET D1L	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	1.26E+04	798	1.00E+07	5.231	42.998	0	<1.00E-07	-	-	-	-	0	<1.00E-07	-	-
25	2	SET R1H	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	1.27E+04	790	1.00E+07	5.226	48.224	0	<1.00E-07	0	<1.00E-07	-	-	-	-	-	-
26	2	SET R1L	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	1.25E+04	802	1.00E+07	5.224	53.449	0	<1.00E-07	0	<1.00E-07	-	-	-	-	-	-
27	3	SET R1H	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	1.36E+04	735	1.00E+07	5.231	167.933	0	<1.00E-07	0	<1.00E-07	-	-	-	-	-	-
28	3	SET R1L	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	1.38E+04	727	1.00E+07	5.229	173.162	0	<1.00E-07	0	<1.00E-07	-	-	-	-	-	-
29	3	SET D1H	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	1.29E+04	777	1.00E+07	5.225	178.387	0	<1.00E-07	-	-	-	-	0	<1.00E-07	-	-
30	3	SET D1L	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	1.44E+04	698	1.00E+07	5.230	183.616	0	<1.00E-07	-	-	-	-	0	<1.00E-07	-	-
31	4	SET D1H	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	1.39E+04	722	1.00E+07	5.227	37.766	0	<1.00E-07	-	-	-	-	0	<1.00E-07	-	-
32	4	SET D1L	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	1.43E+04	701	1.00E+07	5.231	42.997	0	<1.00E-07	-	-	-	-	0	<1.00E-07	-	-
33	4	SET R1H	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	1.38E+04	726	1.00E+07	5.232	48.229	0	<1.00E-07	0	<1.00E-07	-	-	-	-	-	-
34	4	SET R1L	25	83 Kr 25+	756	92	32.6	0	32.60	92.0	1.40E+04	714	1.00E+07	5.230	53.459	0	<1.00E-07	0	<1.00E-07	-	-	-	-	-	-

Table 7: RHFLVDSR2D2 first campaign test results.

RHFLVDSR2D2 SET: VDD = 3.3V / T° = 25°C																LATCHUP		SET							
Run	Part	Config	T°	Ion	Energy (MeV)	Range (µm)	LET (MeV.cm²/mg)	Tilt (°)	Eff. LET (MeV.cm²/mg)	Eff. Range (µm Si)	Flux (φ) ($cm^{-2}.s^{-1}$)	Time (s)	Run Fluence (Φ) (cm^{-2})	Run Dose (krad)	Cumulated Dose (krad)	Vcc	Cross Section	Receiver Output 1	Cross Section	Receiver Output 2	Cross Section	Driver Output 1	Cross Section	Driver Output 2	Cross Section
High LET M/Q=5																									
28	1	R2H D2L	25	124Xe 26+	420	37	67.7	0	67.70	37.0	1.20E+04	834	1.00E+07	10.857	64.317	0	<1.00E-07	-	-	1	1.00E-07	-	-	0	<1.00E-07
29	1	R2L D2H	25	124Xe 26+	420	37	67.7	0	67.70	37.0	1.38E+04	729	1.00E+07	10.864	75.181	0	<1.00E-07	-	-	2	2.00E-07	-	-	0	<1.00E-07
30	2	R2L D2H	25	124Xe 26+	420	37	67.7	0	67.70	37.0	1.35E+04	741	1.00E+07	10.850	64.299	0	<1.00E-07	-	-	0	<1.00E-07	-	-	0	<1.00E-07
31	2	R2H D2L	25	124Xe 26+	420	37	67.7	0	67.70	37.0	1.54E+04	652	1.00E+07	10.864	75.163	0	<1.00E-07	-	-	0	<1.00E-07	-	-	0	<1.00E-07
32	4	R2L D2H	25	124Xe 26+	420	37	67.7	0	67.70	37.0	1.52E+04	657	1.00E+07	10.850	64.309	0	<1.00E-07	-	-	0	<1.00E-07	-	-	0	<1.00E-07
33	4	R2H D2L	25	124Xe 26+	420	37	67.7	0	67.70	37.0	1.54E+04	652	1.00E+07	10.855	75.164	0	<1.00E-07	-	-	0	<1.00E-07	-	-	0	<1.00E-07
34	1	R2H D2L	25	124Xe 26+	420	37	67.7	60	135.40	18.5	7.47E+03	1340	1.00E+07	21.685	96.866	0	<1.00E-07	-	-	0	<1.00E-07	-	-	0	<1.00E-07
35	1	R2L D2H	25	124Xe 26+	420	37	67.7	60	135.40	18.5	7.55E+03	1326	1.00E+07	21.681	118.548	0	<1.00E-07	-	-	0	<1.00E-07	-	-	0	<1.00E-07
36	2	Cancelled	25	124Xe 26+	420	37	67.7	60	135.40	18.5	7.64E+03	1099	8.40E+06	18.189	93.352	0	<1.00E-07	-	-		-	-	-		
37	2	R2L D2H	25	124Xe 26+	420	37	67.7	60	135.40	18.5	7.75E+03	1292	1.00E+07	21.695	115.047	0	<1.00E-07	-	-	0	<1.00E-07	-	-	0	<1.00E-07
38	2	R2H D2L	25	124Xe 26+	420	37	67.7	60	135.40	18.5	7.61E+03	1316	1.00E+07	21.694	136.741	0	<1.00E-07	-	-	2	2.00E-07	-	-	0	<1.00E-07
39	3	R2H D2L	25	124Xe 26+	420	37	67.7	60	135.40	18.5	7.49E+03	1337	1.00E+07	21.693	205.309	0	<1.00E-07	-	-	2	2.00E-07	-	-	0	<1.00E-07
40	3	R2L D2H	25	124Xe 26+	420	37	67.7	60	135.40	18.5	7.67E+03	1305	1.00E+07	21.696	227.005	0	<1.00E-07	-	-	2	2.00E-07	-	-	0	<1.00E-07
41	4	R2L D2H	25	124Xe 26+	420	37	67.7	60	135.40	18.5	7.59E+03	1319	1.00E+07	21.688	96.853	0	<1.00E-07	-	-	1	1.00E-07	-	-	0	<1.00E-07
42	4	R2H D2L	25	124Xe 26+	420	37	67.7	60	135.40	18.5	7.67E+03	1306	1.00E+07	21.694	118.546	0	<1.00E-07	-	-	0	<1.00E-07	-	-	0	<1.00E-07

Table 8: RHFLVDSR2D2 second campaign test results

No SEL events were detected during this test.
SET events were detected during this test.
SET and SEL tests results are described hereafter.

8.2. SEL test results.

The SEL test was performed at 125°C.
No SEL was observed during this test under Xenon irradiation with a total fluence equal to 1E+7 cm^{-2}:
- with a particle angle of 60° (LET = 135.4 MeV.cm²/mg and range = 18.5µm).
- with a particle angle of 0° (LET = 67.7 MeV.cm²/mg and range = 37µm).

8.3. SET tests results

The SET test was performed at 25°C, two configurations were tested on the driver outputs and on the receiver outputs.

No SET was observed on the driver outputs under Xenon irradiation with a total fluence equal to 1E+7 cm^{-2}:
- with a particle angle of 60° (LET = 135.4 MeV.cm²/mg and range = 18.5µm).
- with a particle angle of 0° (LET = 67.7 MeV.cm²/mg and range = 37µm).

SETs were observed on the receiver outputs during the irradiation until the Krypton Heavy Ion (LET = 32.6 MeV.cm²/mg).

8.3.1. Receiver Output SET Cross sections.

LET Eff (MeV.cm².mg^{-1})	RHFLVDSR2D2 Receiver Output High Level SET Cross Section (cm^2)			
	N° 1	N° 2	N°3	N° 4
135.4	<1.0E-07	2.0E-07	3.0E-07	<1.0E-07
67.7	1.0E-07	<1.0E-07	2.0E-07	<1.0E-07
32.6	<1.0E-07	<1.0E-07	<1.0E-07	<1.0E-07

Table 9: SET cross section results RHFLVDSR2D2 Receiver Output High Level

LET Eff (MeV.cm².mg^{-1})	RHFLVDSR2D2 Receiver Output Low Level SET Cross Section (cm^2)			
	N° 1	N° 2	N°3	N° 4
135.4	<1.0E-07	<1.0E-07	2.0E-07	1.0E-07
67.7	2.0E-07	<1.0E-07	1.0E-07	<1.0E-07
32.6	<1.0E-07	<1.0E-07	<1.0E-07	<1.0E-07

Table 10: SET cross section results RHFLVDSR2D2 Receiver Output Low Level

The following figures present the cross section of the SET event on driver and receiver outputs on the RHFLVDSR2D2 part.
Points represented by an arrow pointing down indicate that no events were observed at the corresponding LET.
The evaluated cross section is then lower than 1.00 $10^{-7}cm^{-2}$, value corresponding to one event at maximum fluence.

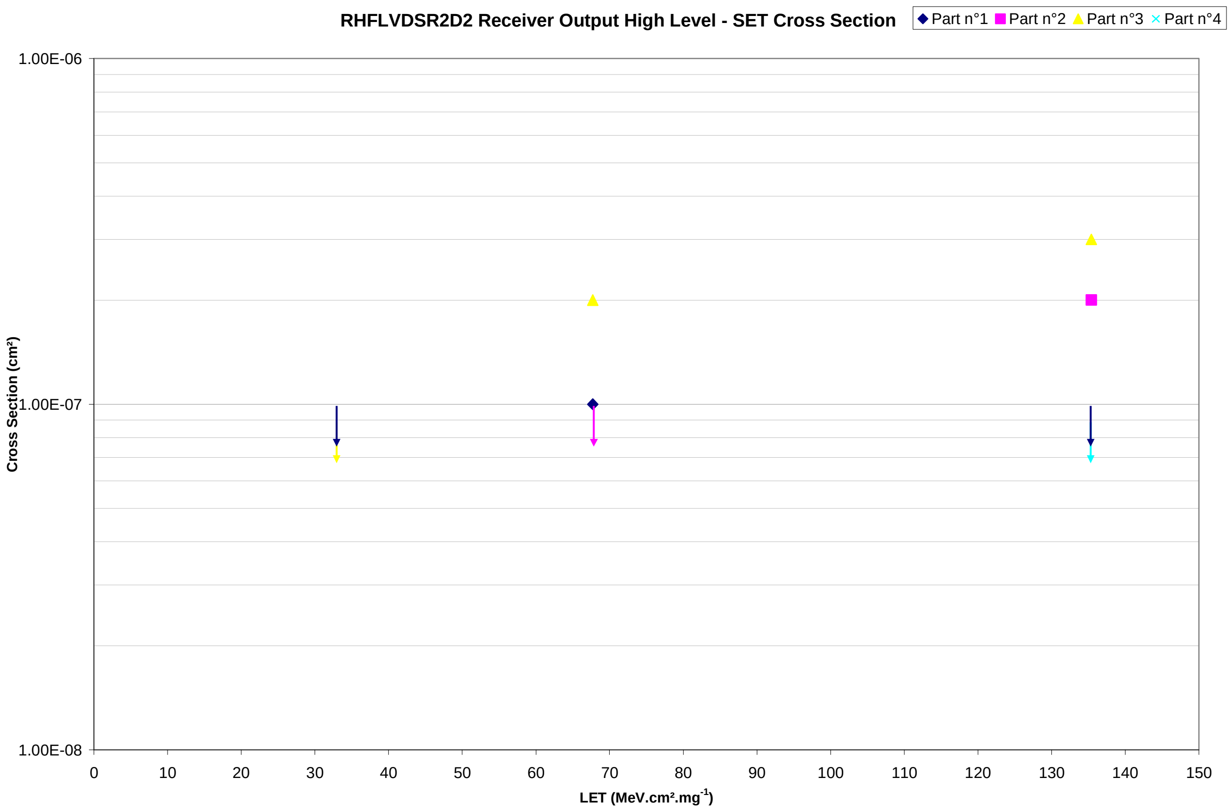


Figure9: Receiver output High Level SET cross section curve for RHFLVDSR2D2.

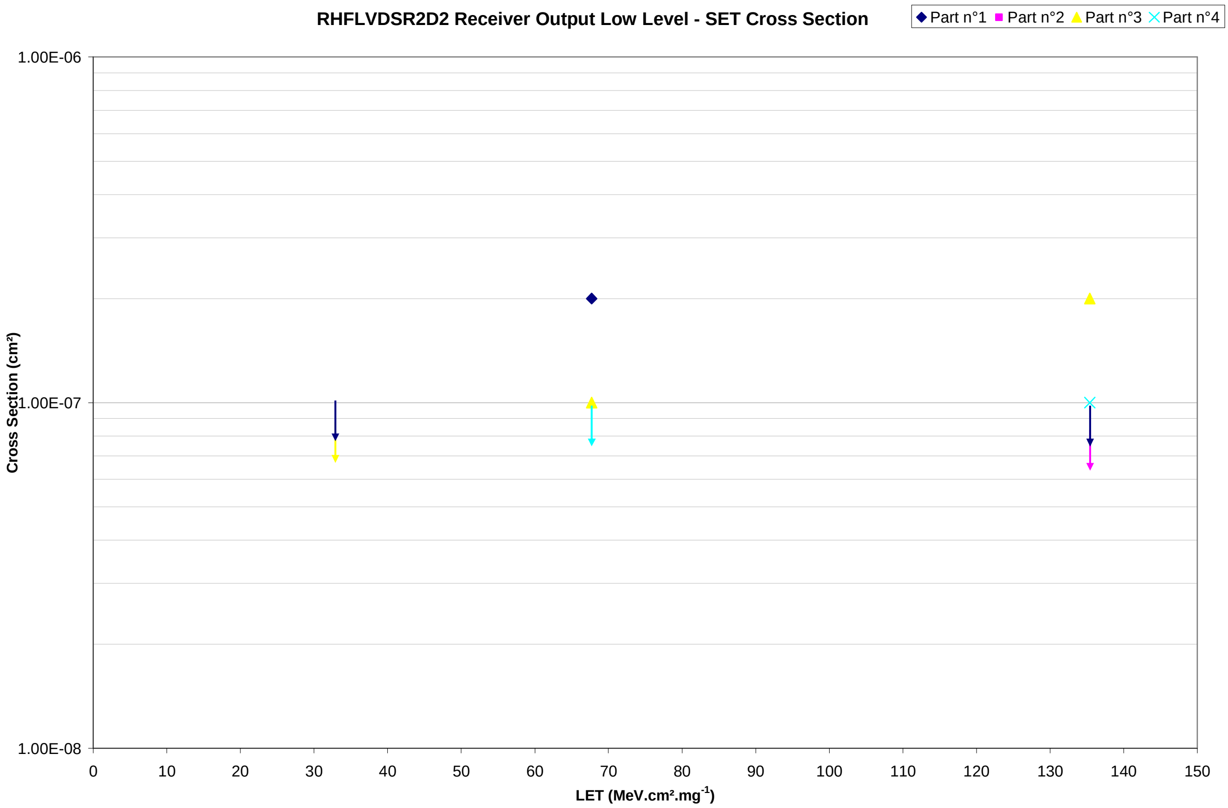


Figure10: Receiver output Low Level SET cross section curve for RHFLVDSR2D2

On these figures, we obverse that some points at LET 135.4 have a lower cross section than points at inferior LET. This phenomenon may be due to the low penetration of the tilted Xe, which is about 18.5µm. The tilted Xe runs were an express request of our customer.

8.3.2. Receiver Output worst Cases SET Observed

The worst case on High level mode occurs on Part N°3 during run n°39 event n°1 (Xe, tilt = 60°, LET = 135.4 MeV.cm²/mg and range = 18.5µm).

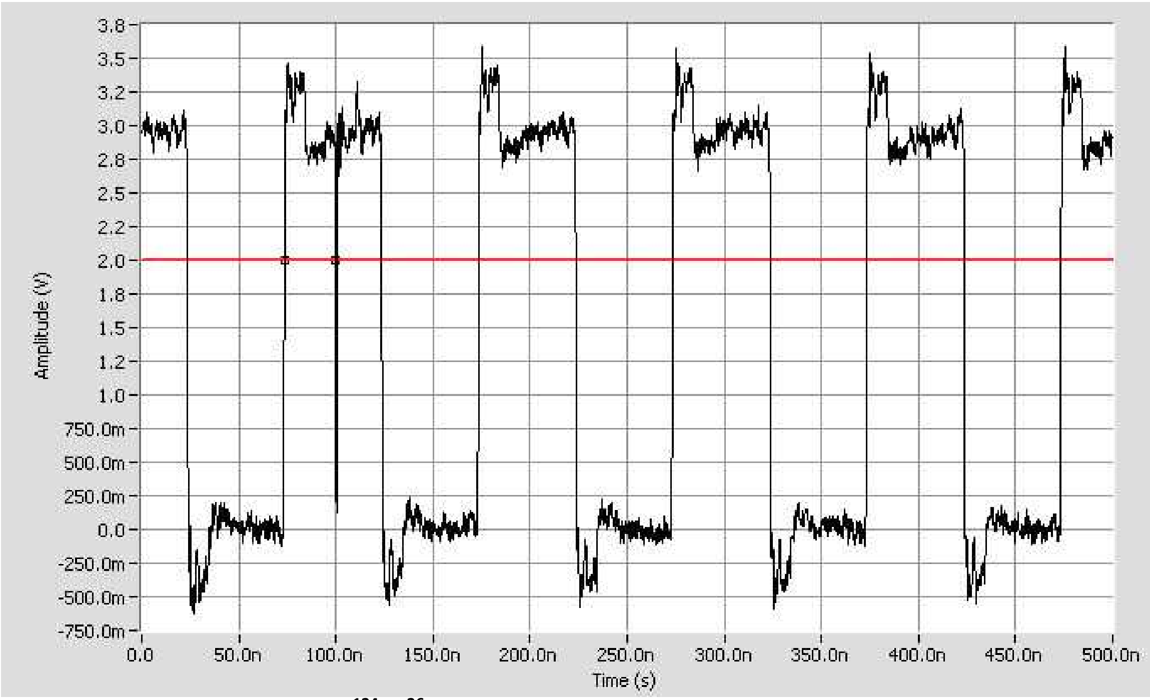


Figure 11: SET curve, Heavy Ion $^{124}Xe^{26+}$, tilt 60° (LET of 135.4 MeV. cm²/mg), Part 3, Run n°39, Event n°1.

The worst case on Low level mode occurs on Part N°1 during run n°29 event n°1 (Xe, 67.7 MeV.cm²/mg).

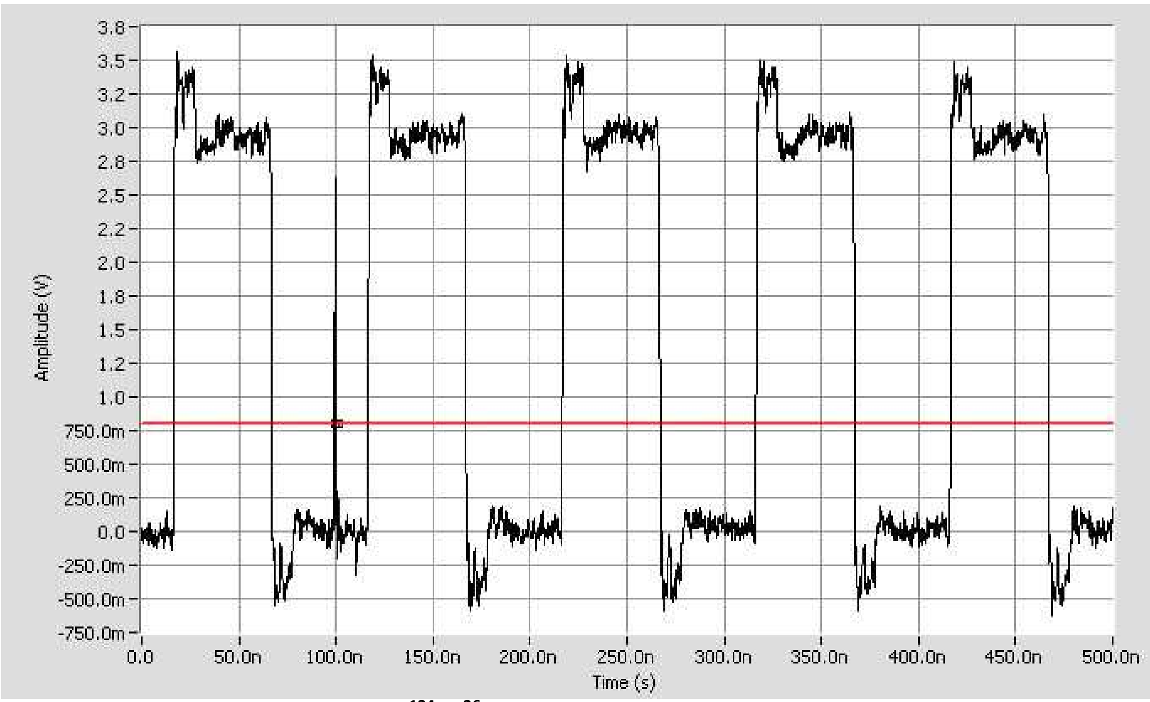


Figure 12: SET curve Heavy Ion $^{124}Xe^{26+}$(LET of 67.7MeV. cm²/mg), Part 1, Run n°29, Event n°1

9. Conclusion

Heavy ions test were performed on RHFLVDSR2D2. The aim of the test was to evaluate the sensitivity of the device versus SEL and SET.

No SELs were observed with the LET value of 67.7MeV.cm²/mg (Xenon heavy ion).

No SETs were observed on the RHFLVDSR2D2 driver outputs with the LET value of 67.7MeV.cm²/mg (Xenon heavy ion).

SETs were observed on the RHFLVDSR2D2 receiver outputs with a minimum LET of 67.7 MeV.cm²/mg. No SET was detected with a LET of 32.6 MeV.cm²/mg.

10. Appendix 1 UCL beam calibration sheets

FICHE DE CALIBRATION DU FAISCEAU HIF

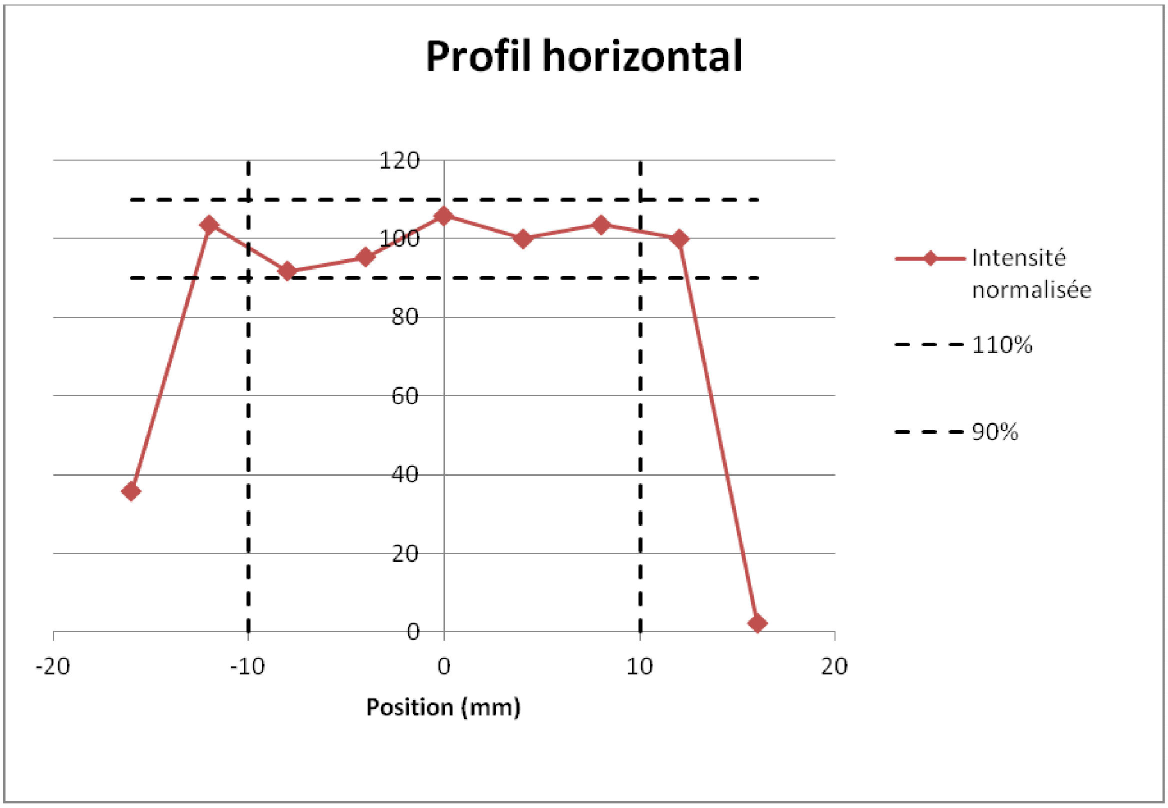
Date de calibration : 29/08/2013
Semaine : W35
Opérateur(s) responsable(s) de la calibration : ML-JVH-KS
Cocktail : ~~**M/Q = 5**~~ **-** **M/Q = 3,33**

I. Profil du faisceau

Le profil du faisceau est mesuré à l'aide d'un détecteur de type PIPS. Le détecteur est centré dans la chambre d'irradiation et réalise 9 mesures selon les axes X et Y Le faisceau doit être homogène à +/- 10% sur 20 mm aussi bien horizontalement que verticalement.

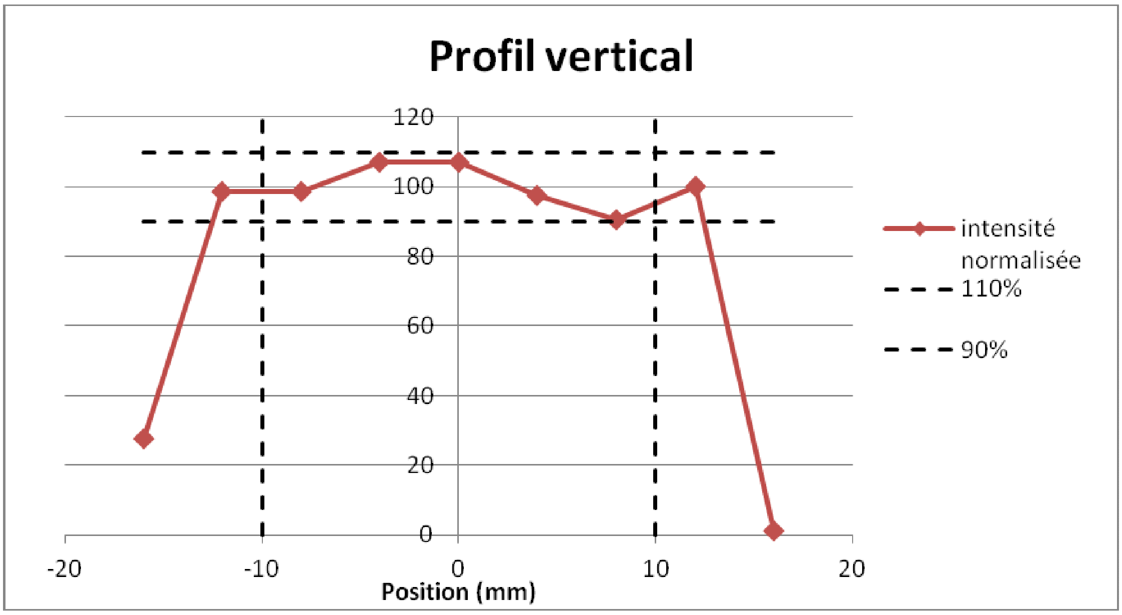
1) Profil Horizontal

Faisceau de référence :	$^{40}Ar^{12+}$ 372 MeV
Homogénéité horizontale :	24 mm
Valeur de X minimum (mm) :	-12 mm
Valeur X maximum (mm) :	+12 mm



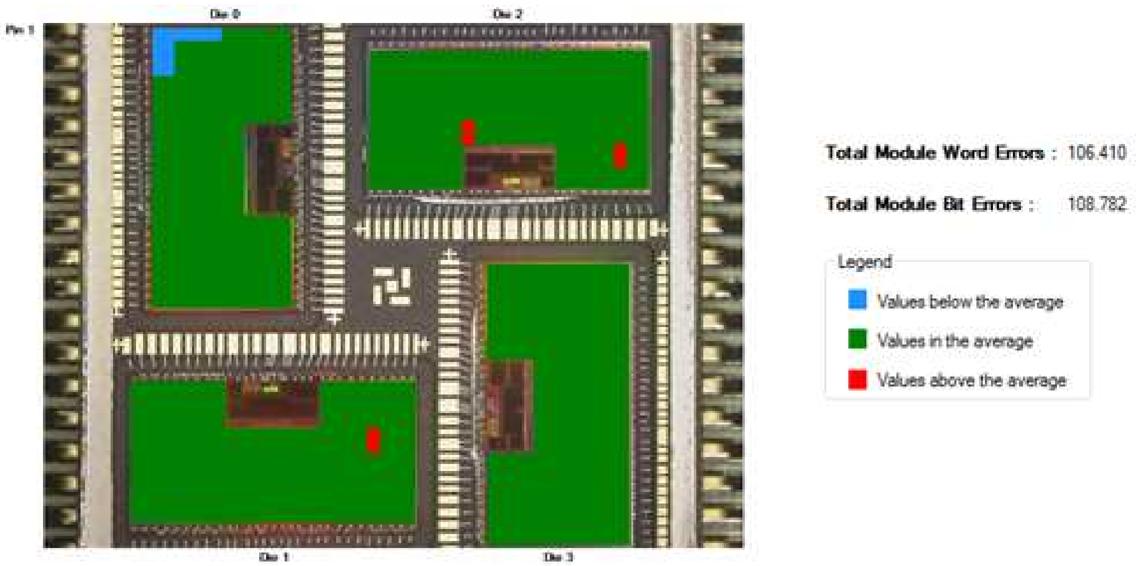
2) Scan Vertical

Faisceau de référence :	$^{40}Ar^{12+}$ 372 MeV
Homogénéité verticale :	24 mm
Valeur de Y minimum (mm) :	-12 mm
Valeur Y maximum (mm) :	+12 mm



3) Profil transverse du faisceau mesuré avec le SEU Monitor

En plus de la procédure de scan, le profil du faisceau est contrôlé à l'aide du SEU Monitor fourni par l'ESA (20mm*20 mm). Tous les faisceaux du cocktail sont contrôlés par cette méthode. Seul le profil du faisceau de référence est présenté dans ce document mais les profils des autres ions du cocktail sont disponibles sur demande de l'utilisateur.



II. Calibration en énergie du faisceau

L’énergie de chaque faisceau est contrôlée par un chaine de mesure comprenant un détecteur de type PIPS, une chaine d'amplification et un analyseur multicanal avec son logiciel associé.

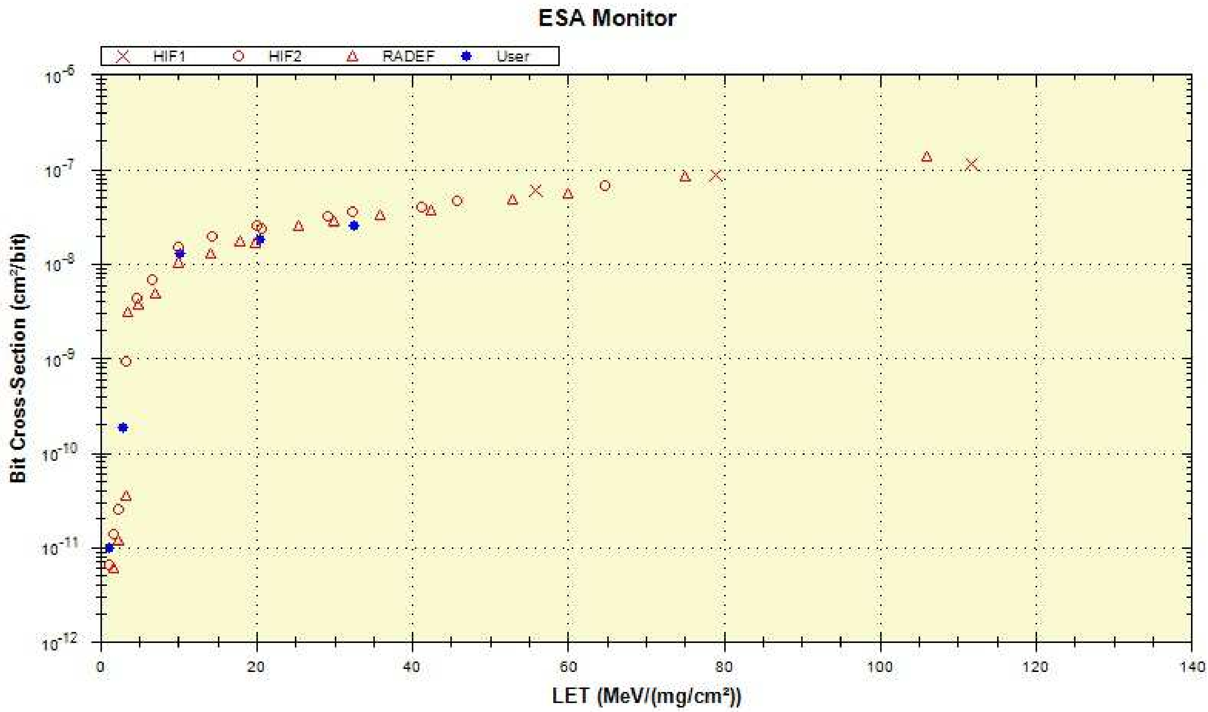
Cocktail	Particule	Energie DUT (MeV)	Energie mesurée (MeV)
M/Q = 3	$^{13}C^{4+}$	131	130
	$^{22}Ne^{7+}$	235	234
	$^{40}Ar^{12+}$	372	371
	$^{58}Ni^{18+}$	567	562*
	$^{83}Kr^{25+}$	756	749*

*Différence inhérente au détecteur PIPS "pulse height defect", liée notamment à un défaut de collection de charges pour les ions les plus lourds.

III. SEU MONITOR

Une vérification supplémentaire est réalisée à l’aide d’un SEU monitor fourni par l'ESA et servant de référence pour toutes les installations European Component Irradiation Facilities (ECIF). Celle-ci permet de vérifier la méthode de mesure dans son ensemble. Chaque ion du cocktail est mesuré à l’aide de ce composant de référence.

Courbe des sections efficace $\sigma_{(LET)}$



IV. Validation de la calibration

Remarque

Directeur du CRC

29 août 2013

M Loiselet

FICHE DE CALIBRATION DU FAISCEAU HIF

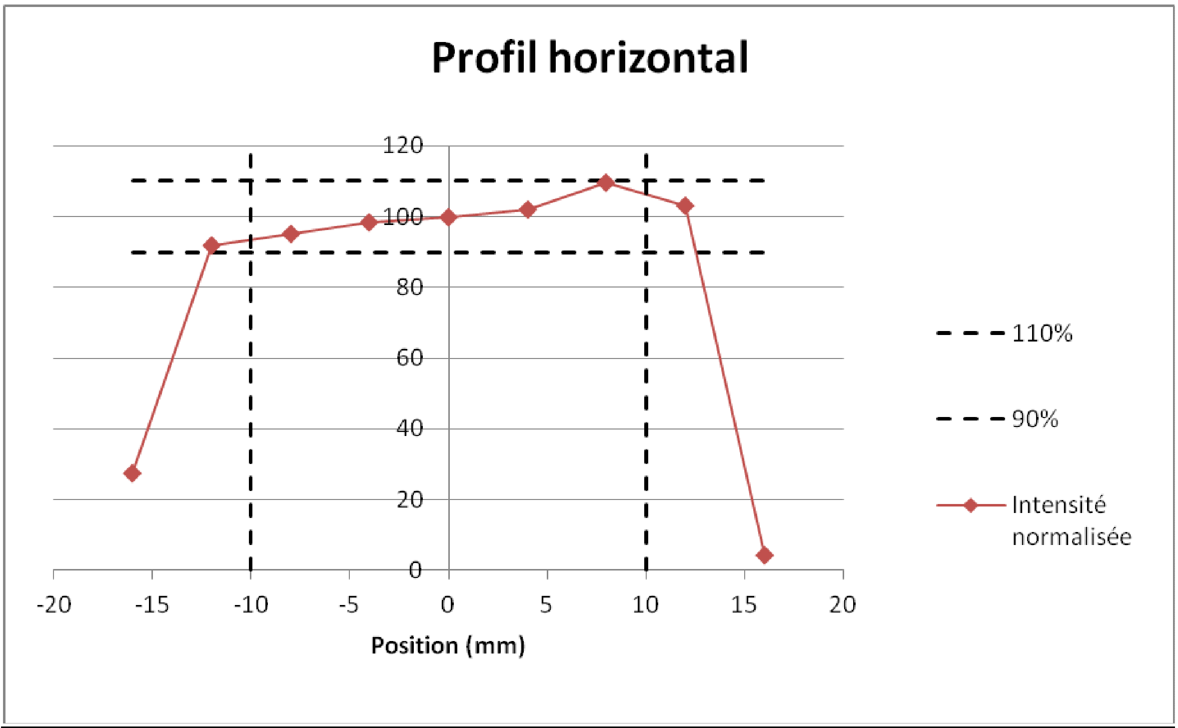
Date de calibration : 26/08/2013
Semaine : W35
Opérateur(s) responsable(s) de la calibration : ML-JVH-KS
Cocktail : **M/Q = 5** - ~~**M/Q = 3,33**~~

I. Profil du faisceau

Le profil du faisceau est mesuré à l'aide d'un détecteur de type PIPS. Le détecteur est centré dans la chambre d'irradiation et réalise 9 mesures selon les axes X et Y Le faisceau doit être homogène à +/-10% sur 20 mm aussi bien horizontalement que verticalement.

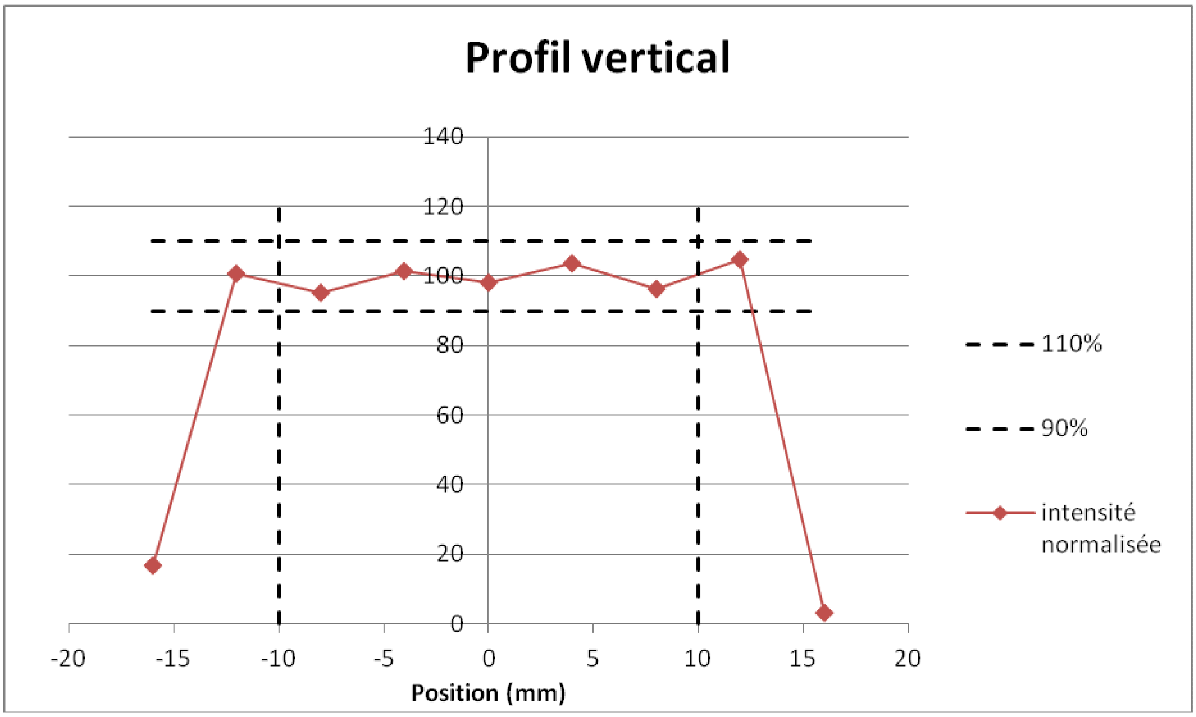
1) Profil Horizontal

Faisceau de référence :	$^{40}Ar^{8+}$ 151 MeV
Homogénéité horizontale :	24 mm
Valeur de X minimum (mm) :	-12 mm
Valeur X maximum (mm) :	+12 mm



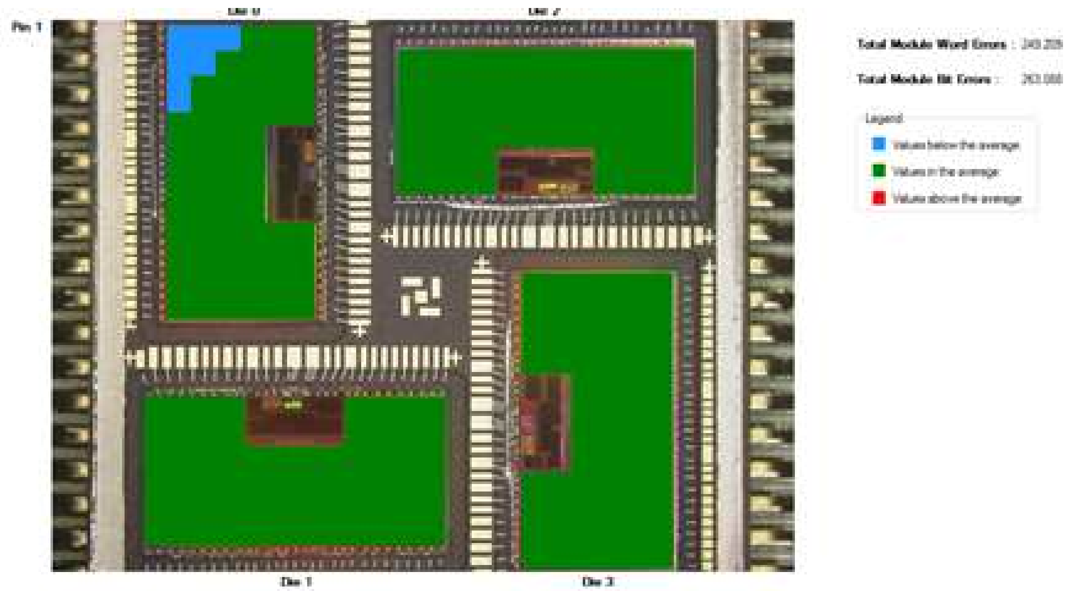
2) Scan Vertical

Faisceau de référence :	$^{40}Ar^{8+}$ 151 MeV
Homogénéité verticale :	24 mm
Valeur de Y minimum (mm) :	-12 mm
Valeur Y maximum (mm) :	+12 mm



3) Profil transverse du faisceau mesuré avec le SEU Monitor

En plus de la procédure de scan, le profil du faisceau est contrôlé à l'aide du SEU Monitor fourni par l'ESA (20mm*20 mm). Tous les faisceaux du cocktail sont contrôlés par cette méthode. Seul le profil du faisceau de référence est présenté dans ce document mais les profils des autres ions du cocktail sont disponibles sur demande de l'utilisateur.



II. Calibration en énergie du faisceau

L'énergie de chaque faisceau est contrôlée par un chaine de mesure comprenant un détecteur de type PIPS, une chaine d'amplification et un analyseur multicanal avec son logiciel associé.

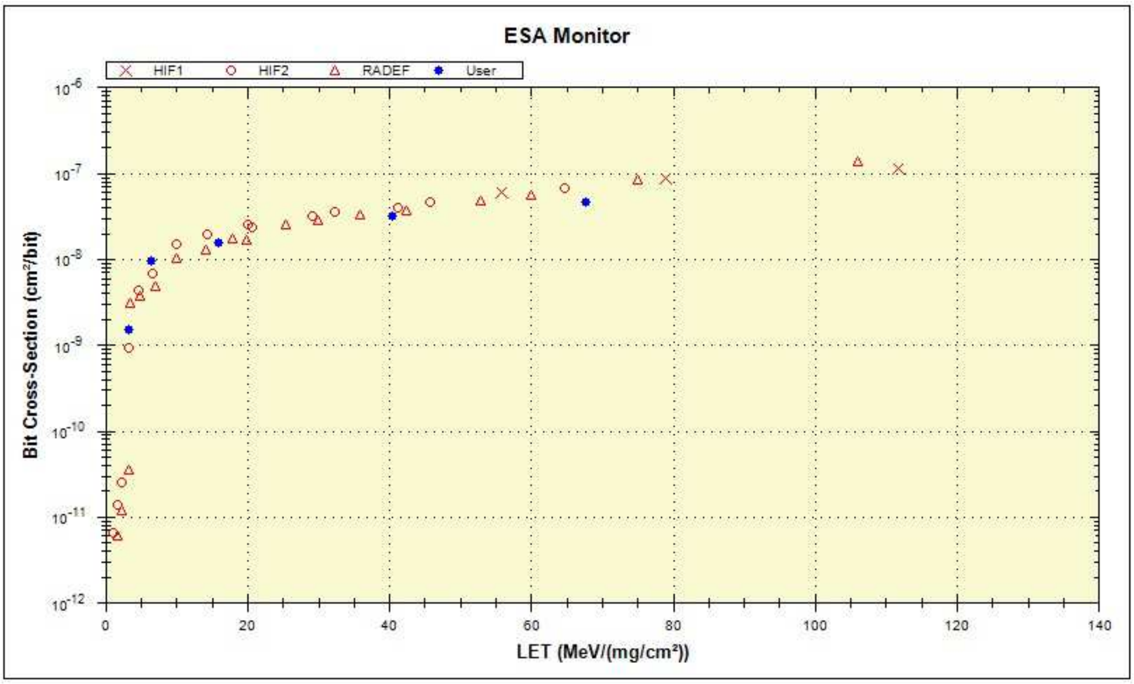
Cocktail	**Particule**	**Energie DUT (MeV)**	**Energie mesurée (MeV)**
M/Q = 5	$^{15}N^{3+}$	60	60
	$^{20}Ne^{4+}$	78	78
	$^{40}Ar^{8+}$	151	151
	$^{84}Kr^{17+}$	305	297*
	$^{124}Xe^{25+}$	420	399*

*Différence inhérente au détecteur PIPS "pulse height defect", liée notamment à un défaut de collection de charges pour les ions les plus lourds.

III. SEU MONITOR

Une vérification supplémentaire est réalisée à l'aide d'un SEU monitor fourni par l'ESA et servant de référence pour toutes les installations European Component Irradiation Facilities (ECIF). Celle-ci permet de vérifier la méthode de mesure dans son ensemble. Chaque ion du cocktail est mesuré à l'aide de ce composant de référence.

Courbe des sections efficace $\sigma_{(LET)}$



IV. Validation de la calibration

Remarque

Directeur du CRC

26 août 2013

M Loiselet

FICHE DE CALIBRATION DU FAISCEAU HIF

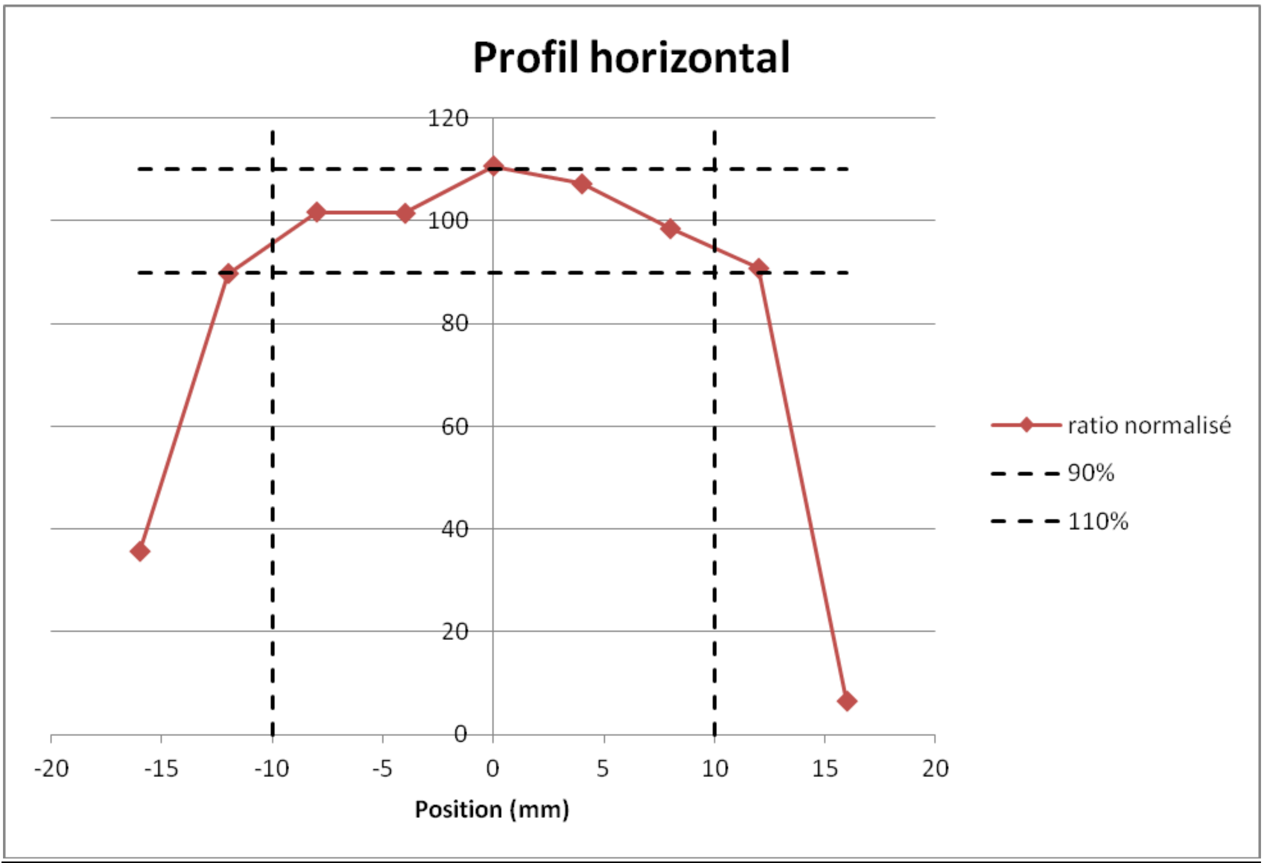
Date de calibration : 7/10/2013
Semaine : W41
Opérateur(s) responsable(s) de la calibration : KS-GU-LS-PJ-JVH
Cocktail : **M/Q = 5** - ~~**M/Q = 3,33**~~

I. Profil du faisceau

Le profil du faisceau est mesuré à l'aide d'un détecteur de type PIPS. Le détecteur est centré dans la chambre d'irradiation et réalise 9 mesures selon les axes X et Y Le faisceau doit être homogène à +/- 10% sur 20 mm aussi bien horizontalement que verticalement.

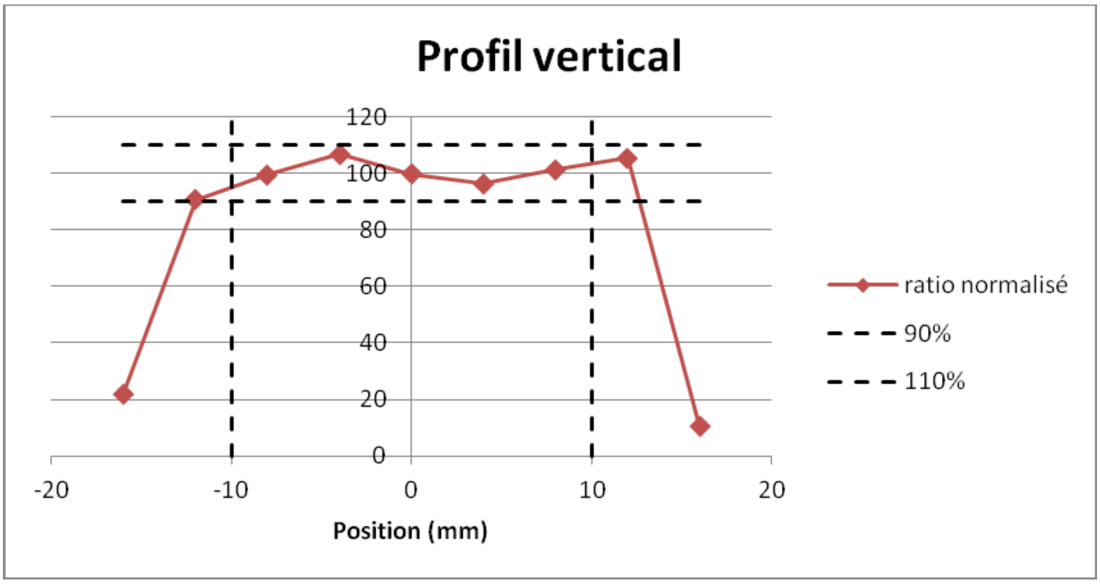
1) Profil Horizontal

Faisceau de référence :	$^{40}Ar^{8+}$ 151 MeV
Homogénéité horizontale :	24 mm
Valeur de X minimum (mm) :	-12 mm
Valeur X maximum (mm) :	+12 mm



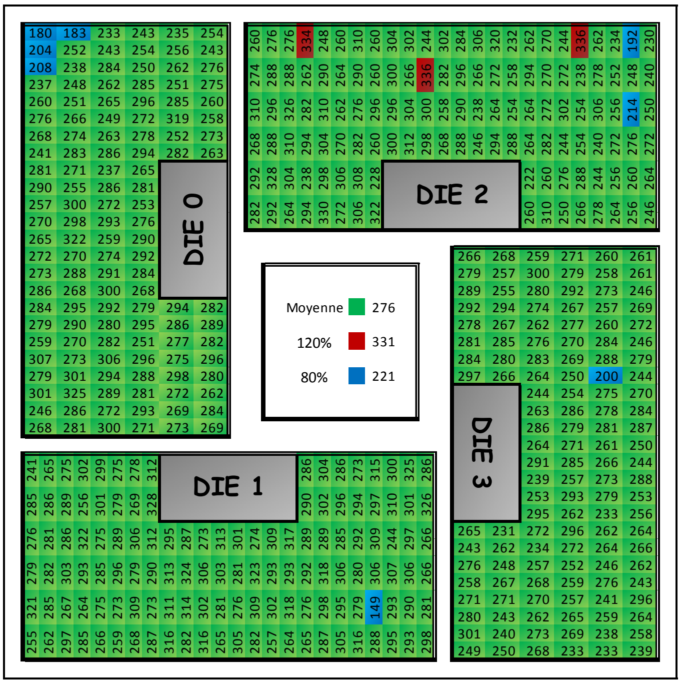
2) Scan Vertical

Faisceau de référence :	$^{40}Ar^{8+}$ 151 MeV
Homogénéité verticale :	24 mm
Valeur de Y minimum (mm) :	-12 mm
Valeur Y maximum (mm) :	+12 mm



3) Profil transverse du faisceau mesuré avec le SEU Monitor

En plus de la procédure de scan, le profil du faisceau est contrôlé à l'aide du SEU Monitor fourni par l'ESA (20mm*20 mm). Tous les faisceaux du cocktail sont contrôlés par cette méthode. Seul le profil du faisceau de référence est présenté dans ce document mais les profils des autres ions du cocktail sont disponibles sur demande de l'utilisateur.



COKTAIL :	M/Q = 5	
ION :	40Ar8+	
ENERGIE DUT :	151	MeV
LET :	20,2	Mev/(mg/cm²)
TOTAL WORD ERROR :	137337	
TOTAL BIT ERROR :	141346	
FLUENCE :	5,00E+05	Part/cm²
CROSS SECTION :	1,685E-08	cm²/bit

II. Calibration en énergie du faisceau

L'énergie de chaque faisceau est contrôlée par un chaine de mesure comprenant un détecteur de type PIPS, une chaine d'amplification et un analyseur multicanal avec son logiciel associé.

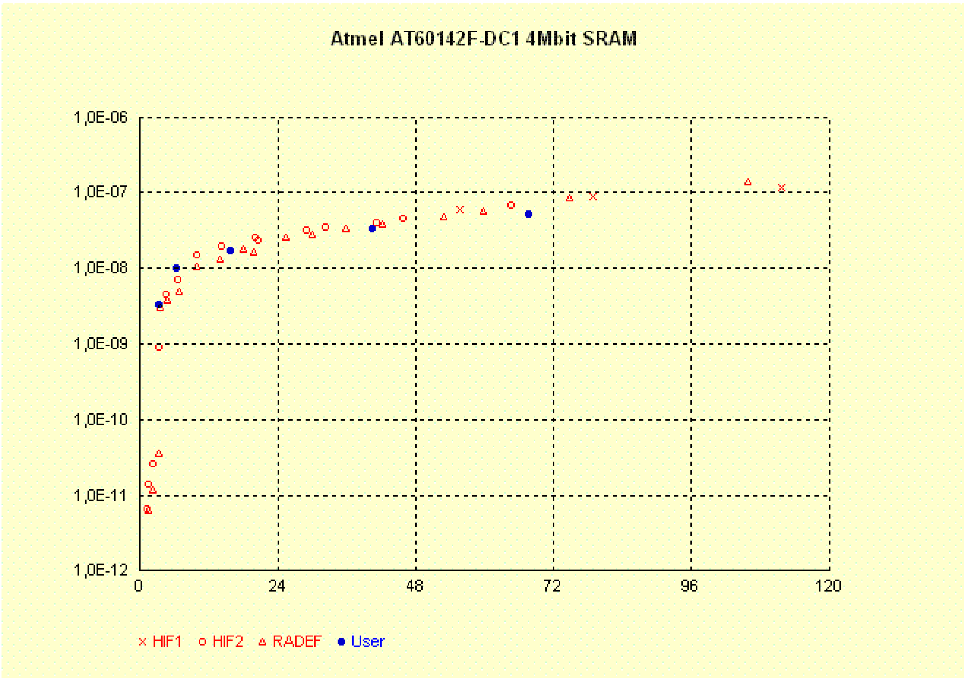
Cocktail	Particule	Energie DUT (MeV)	Energie mesurée (MeV)
M/Q = 5	$^{15}N^{3+}$	60	61
	$^{20}Ne^{4+}$	78	77
	$^{40}Ar^{8+}$	151	144*
	$^{84}Kr^{17+}$	305	276*
	$^{124}Xe^{25+}$	420	371*

*Différence inhérente au détecteur PIPS "pulse height defect", liée notamment à un défaut de collection de charges pour les ions les plus lourds.

III. SEU MONITOR

Une vérification supplémentaire est réalisée à l'aide d'un SEU monitor fourni par l'ESA et servant de référence pour toutes les installations European Component Irradiation Facilities (ECIF). Celle-ci permet de vérifier la méthode de mesure dans son ensemble. Chaque ion du cocktail est mesuré à l'aide de ce composant de référence.

Courbe des sections efficace $\sigma_{(LET)}$



IV. Validation de la calibration

Remarque

La courbe des sections efficaces a été obtenue avec l'ancien SEU monitor fourni par l'ESA.

Directeur du CRC

9 septembre 2013

M Loiselet