HEAVY ION SINGLE EVENT EFFECTS RADIATION TEST REPORT

Part Type : SMFL2805S

28V Input DC/DC Converter

Manufacturer : Interpoint

Report Reference : ESA_QCA0403S_C

Issue : 01

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ESA Contract No 13528/99/NL/MV COO-16 dated 05/01/04

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Prepared by :	Hirex		Date :	April 5, 2004
Checked by :	F.X Guerre		Date :	April 5, 2004
Approved by :	J. F. Mounes		Date :	April 5, 2004

Heavy ion SET characterization of SMFL2805S 28V Input DC/DC Converter

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1 Abstract

Under ESA Contract No 13528/99/NL/MV COO-16 dated 05/01/04 covering "Radiation Evaluation of COTS Semiconductor Components: "Radiation evaluation of parts for the ATV project", the Interpoint SMFL2805S 28V Input DC/DC Converter was radiation assessed.

Heavy ion radiation results, focusing on Single Event Transient (SET) effects, are reported in this report.

2 INTRODUCTION

This report presents the results of a Single Event Effects (SEE) test program carried out on SMFL2805S 28V Input DC/DC Converter, from Interpoint.
Test was conducted on 2 flight lot sample delivered by the ESA ATV project.
These devices were used during heavy ion tests carried out at the European Heavy Ion Irradiation Facility (HIF) at Cyclone, Université Catholique de Louvain – March 2004.
This work was performed for ESA/ESTEC under ESA Contract No 13528/99/NL/MV COO-16 dated 05/01/04.

3 REFERENCE DOCUMENTS

RD1. SMFL2805S data sheet
RD2. ATV-RIBRE-DFX-0049-03, Astrium fax dated 14/02/03.
RD3. Single Event Effects Test method and Guidelines ESA/SCC basic specification No 25100
RD4. The Heavy Ion Irradiation Facility at CYCLONE, UCL document, Centre de Recherches du Cyclotron (IEEE NSREC'96, Workshop Record, Indian Wells, California, 1996)

4 DEVICE INFORMATION

4.1 SMFL2805S

The SMFL2805S is a switching regulator that uses a quasi-square wave, single ended forward converter with a constant switching frequency of 600kHz.
This device consists in a hybrid module inside a hermetic package.

Relevant device identification information is presented here after and photos of device with identification of the different beam areas used, are shown in Figure 1 and Figure 2.

Part type:	SMFL2805S
Manufacturer:	Interpoint
Package:	Specific hermetic (U style)
Quality Level:	Hi-Rel (ATV flight parts)
Date Code:	0347
Top marking:	see photo in Figure 1
S/Ns	0354, 0351

4.2 Sample preparation

Two samples were delivered delidded.

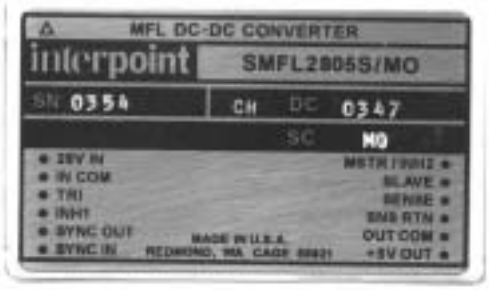


Photo 1 – Top marking

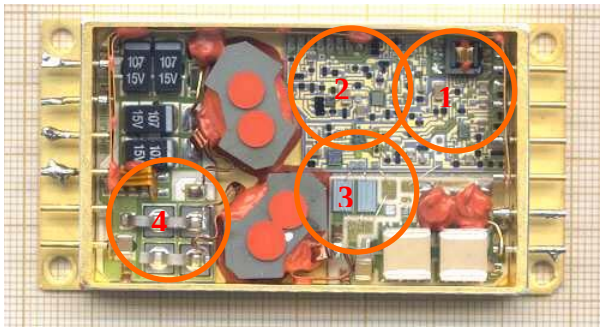


Photo 2 – Internal view

Beam area (A1 to A4) are identified with red circles (Beam diameter was set to 23mm)

Figure 1 – SMFL2805S photos, device full view

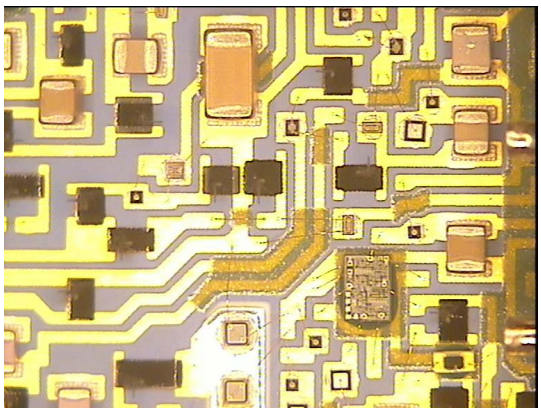


Photo 3 – Beam Area #1

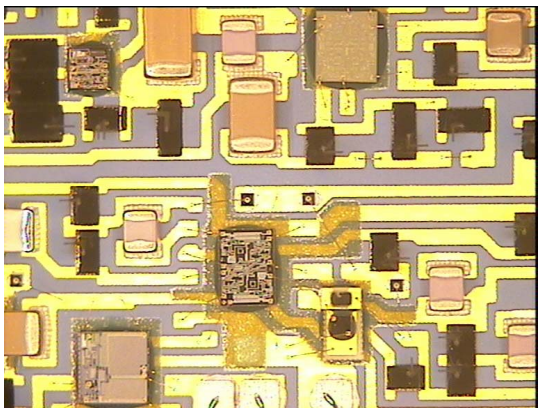


Photo 4 – Beam Area #2

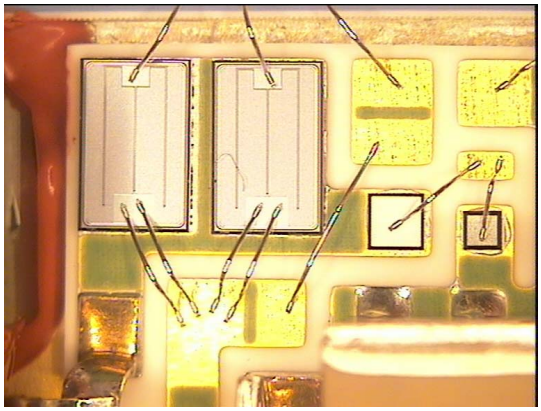


Photo 5 – Beam Area #3

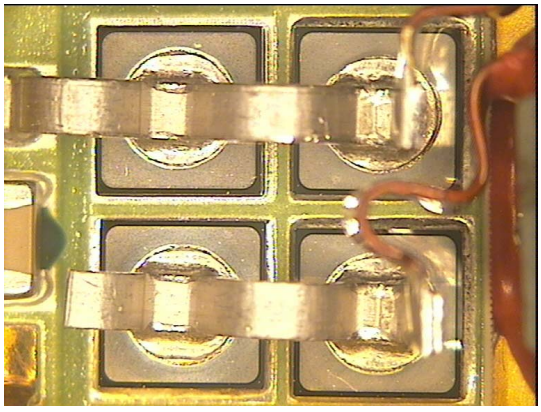


Photo 6 – Beam Area #4

Figure 2 – SMFL2805S photos, internal details

5 Test Definition

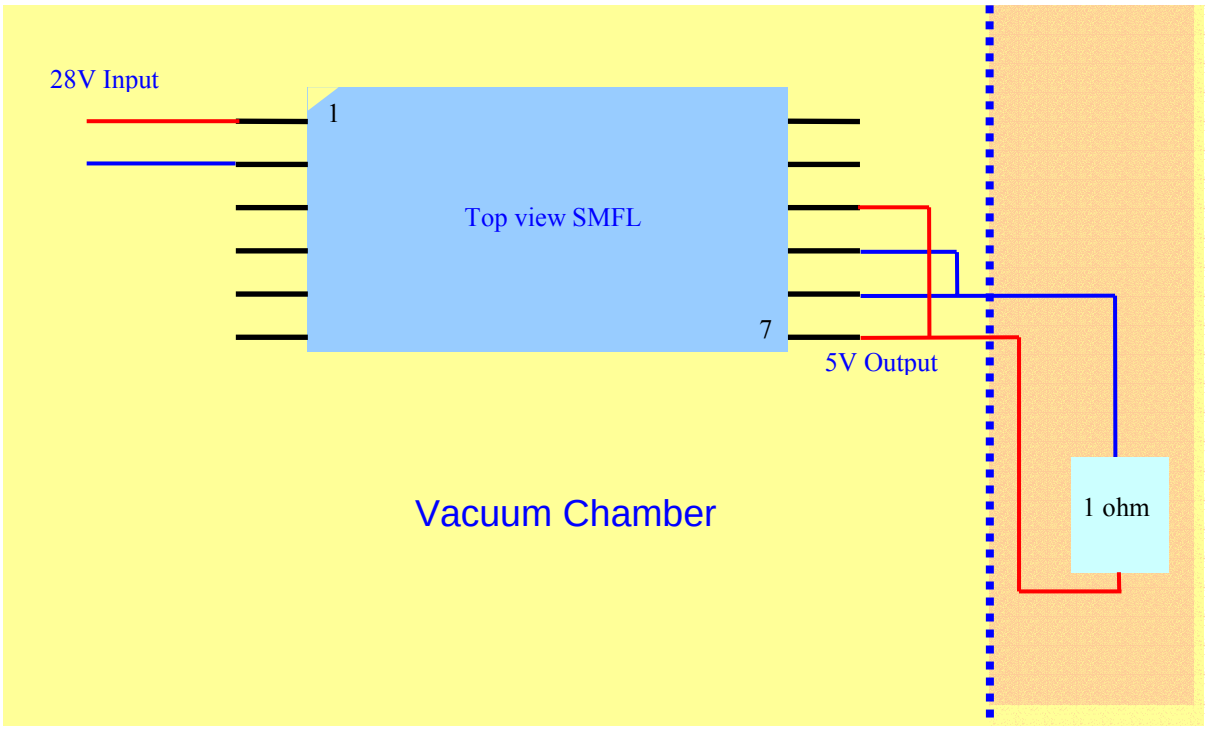
5.1 Test Set-up

The basic set-up consists in monitoring the converter output voltage with an oscilloscope and count the number of pulses (SET).

5.2 Test Configuration

(In accordance with RD2)

Input voltage range: 28 VDC ± 4 VDC
Nominal output load: 25 W



6 UCL TEST FACILITY

Test at the cyclotron accelerator was performed at Université de Louvain (UCL) in Louvain-La-Neuve (Belgium) under HIREX Engineering responsibility.

6.1 Beam Source

In collaboration with the European Space Agency (ESA), the needed equipment for single events studies using heavy ions was built and installed on the HIF beam line in the experimental hall of Louvain-La-Neuve cyclotron.
CYCLONE is a multi particle, variable energy, cyclotron capable of accelerating protons (up to 75 MeV), alpha particles and heavy ions. For the heavy ions, the covered energy range is between 0.6 MeV/AMU and 27.5 MeV/AMU. For these ions, the maximal energy can be determined by the formula:

$$110\ Q^2/M,$$

where Q is the ion charge state, and M is the mass in Atomic Mass Units.
The heavy ions are produced in a double stage Electron Cyclotron Resonance (ECR) source. Such a source allows producing highly charged ions and ion "cocktails". These are composed of ions with the same or very close M/Q ratios. The cocktail ions are injected in the cyclotron, accelerated at the same time and extracted separately by a fine tuning of the magnetic field or a slight changing of the RF frequency. This method is very convenient for a quick change of ion (in a few minutes) which is equivalent to a LET variation.

6.2 Dosimetry

The current UCL Cyclotron dosimetry system and procedures were used.

6.3 Used ions

The UCL ions used are listed in the table below.

Ion	Energy	LET	Range (Si)
	(MeV)	(MeV.cm²/mg)	µm
20Ne4	78	5.85	45
40Ar8	150	14.1	42
84Kr17	316	34	43

Table 1- UCL ions and features thereof

6.4 Beam set-up

The use of a tilt angle allows for additional effective LET values.
For each run, the following information is given in the detailed results tables provided in the next paragraph (paragraph 7) :

- Run Number
- Beam Area
- Ion type
- Energy
- Range
- LET
- Tilt angle
- Test Duration
- Averaged flux
- Fluence
- Equivalent dose per run
- SET
- Positive/negative triggering

7 RESULTS

The detailed results per run are presented in Table 2.

SET triggering level was set to +/- 50mV around the converter output voltage.

DC/DC output voltage was set to 5V. Depending on the different runs performed, value measured at the 1 Ohm load resistor was about 4.55 to 4.57 V. Some losses occurred mainly in the cable/connectors used.

When beam area 4 was exposed, no event could be observed at the DUT output up to an LET of 34MeV/(mg/cm²).

Both negative and positive events were detected when tested with Krypton, 34 MeV/(mg/cm²), for the three other beam areas (A1 to A3).
Negative event could be as high as 180 mV with a pulse width of 20µs (at half pulse height).
In the same conditions, positive event could be as high as 90mV with a pulse width of 50µs.

With Argon, 14.1MeV/(mg/cm²), only negative events could be detected for beam areas A1 and A2.
Lastly no event could be detected with Neon, 5.85MeV/(mg/cm²), in any beam area.

Figure 3 and Figure 4 show two typical examples of SETs, with a negative trigger respectively with a positive one.
Figure 5 to Figure 22 show for each run, an envelope of the different events recorded for each run.

Run 11

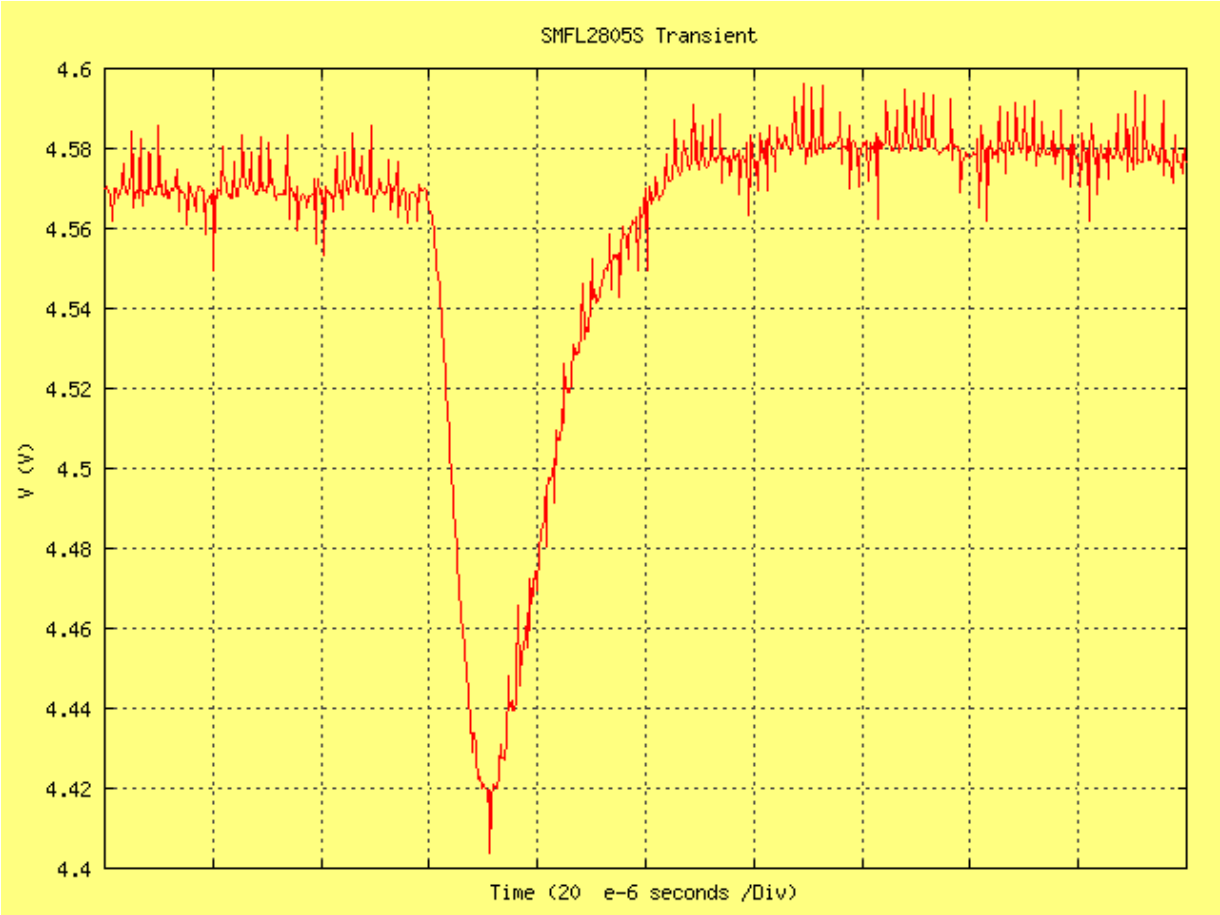


Figure 3 – Run 11, Negative trigger (50 mV), typical SET

Run 21

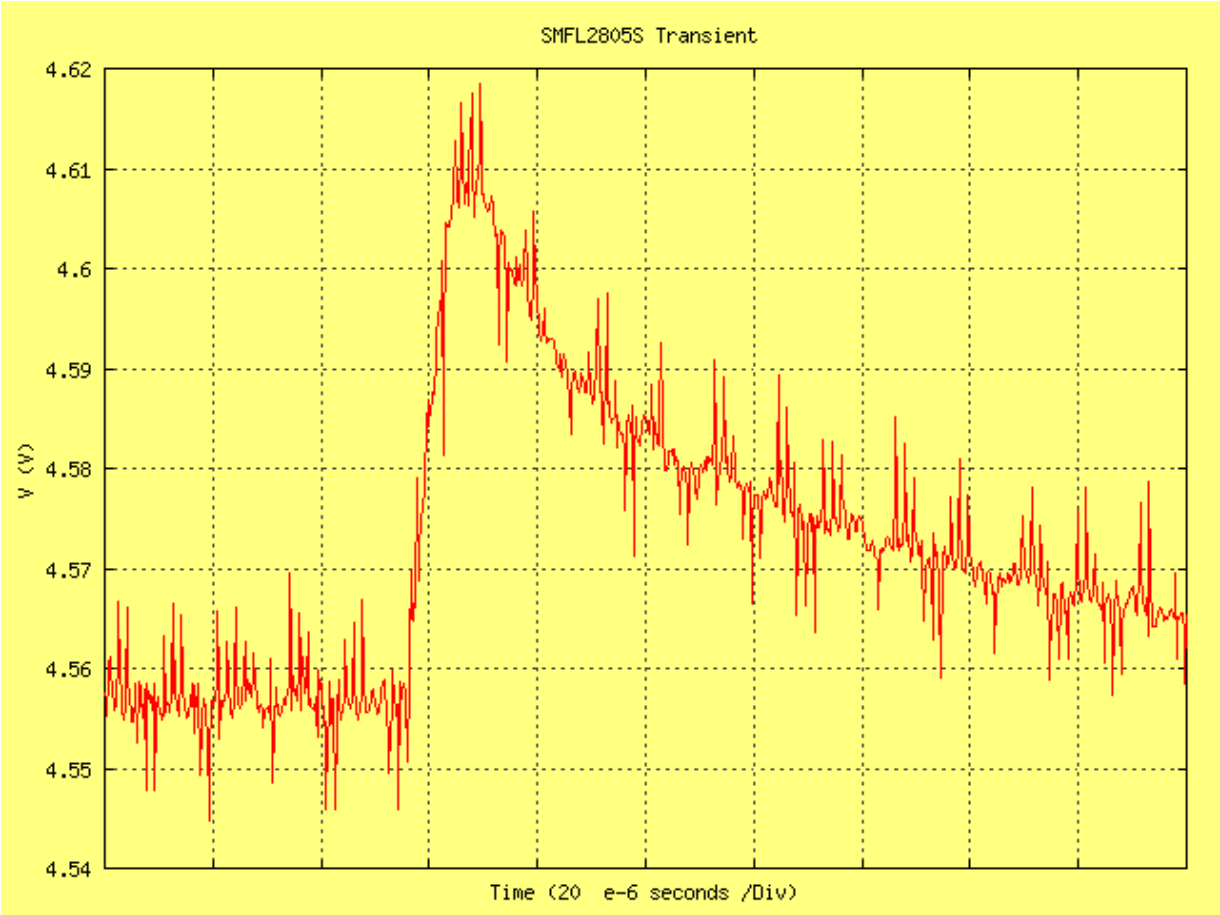
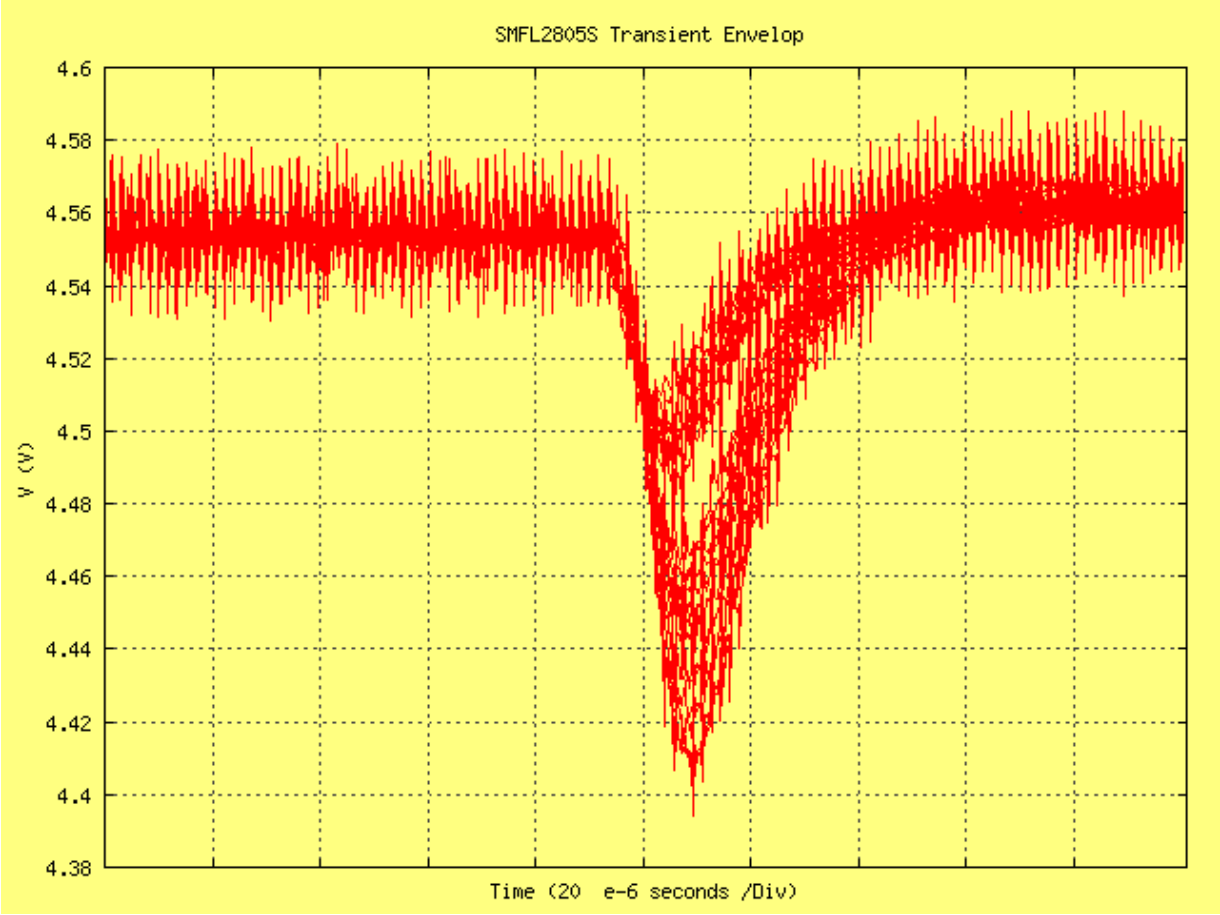


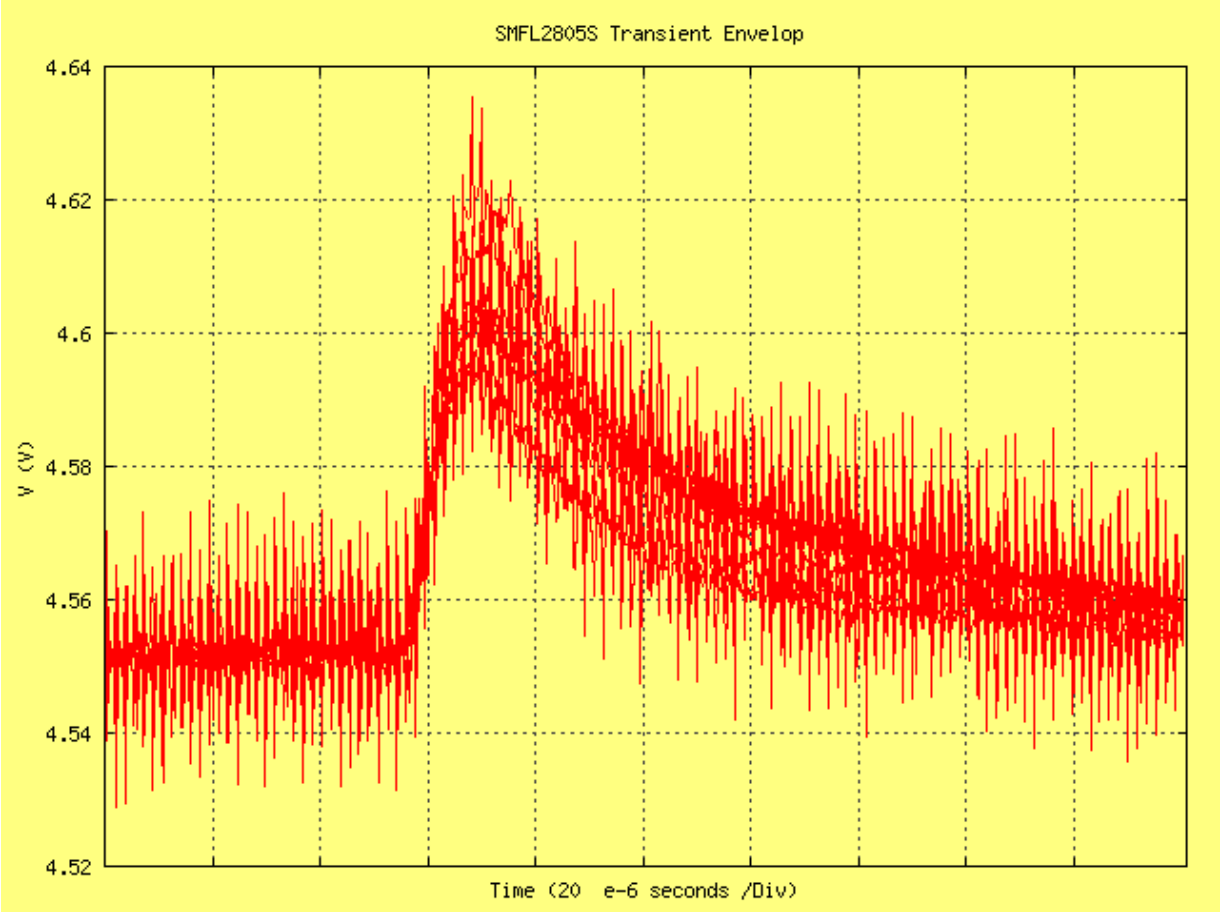
Figure 4 – Run 21, Positive trigger (50 mV), typical SET



Run 3

23 events plotted out of a total of 247.

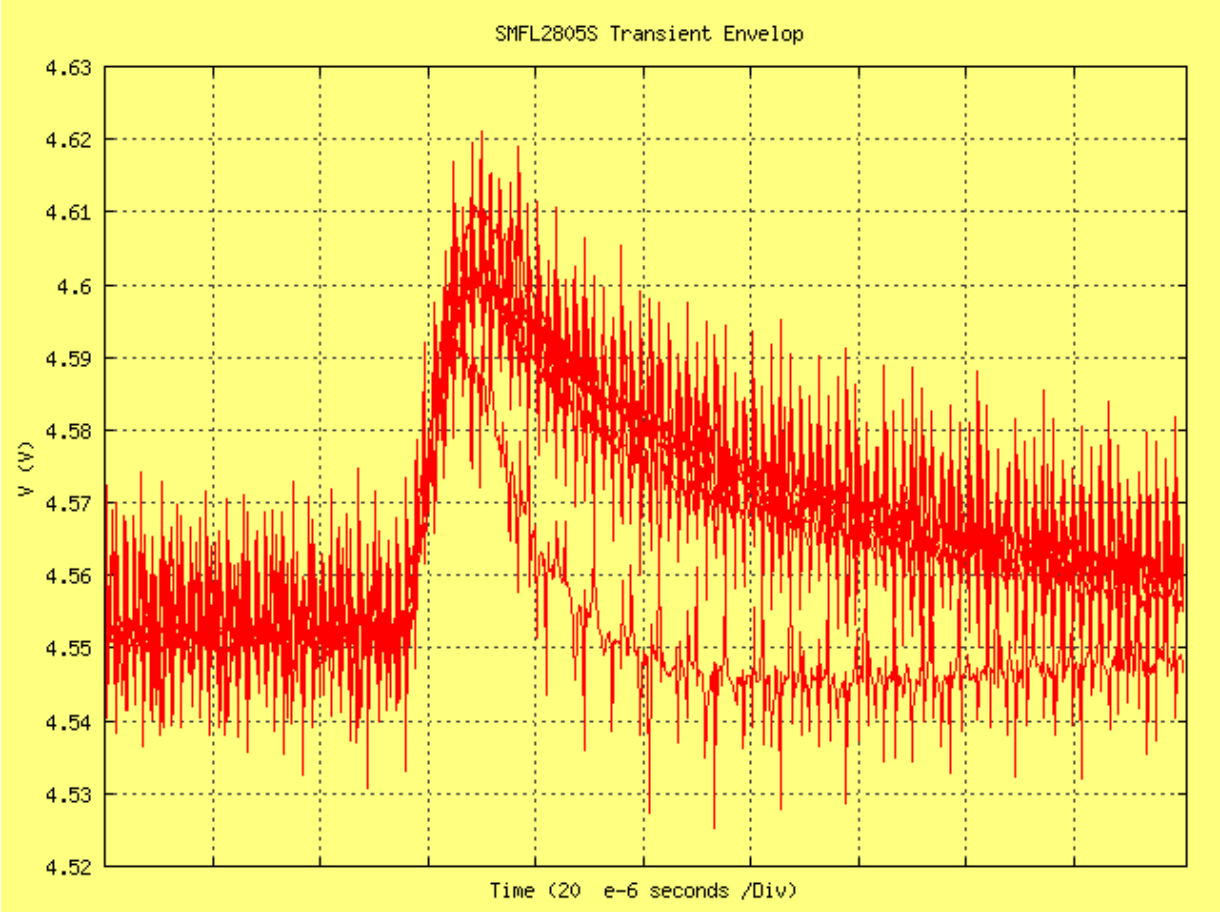
Figure 5 – Run 3, Negative trigger (50 mV)



Run 4

9 events plotted out of a total of 93.

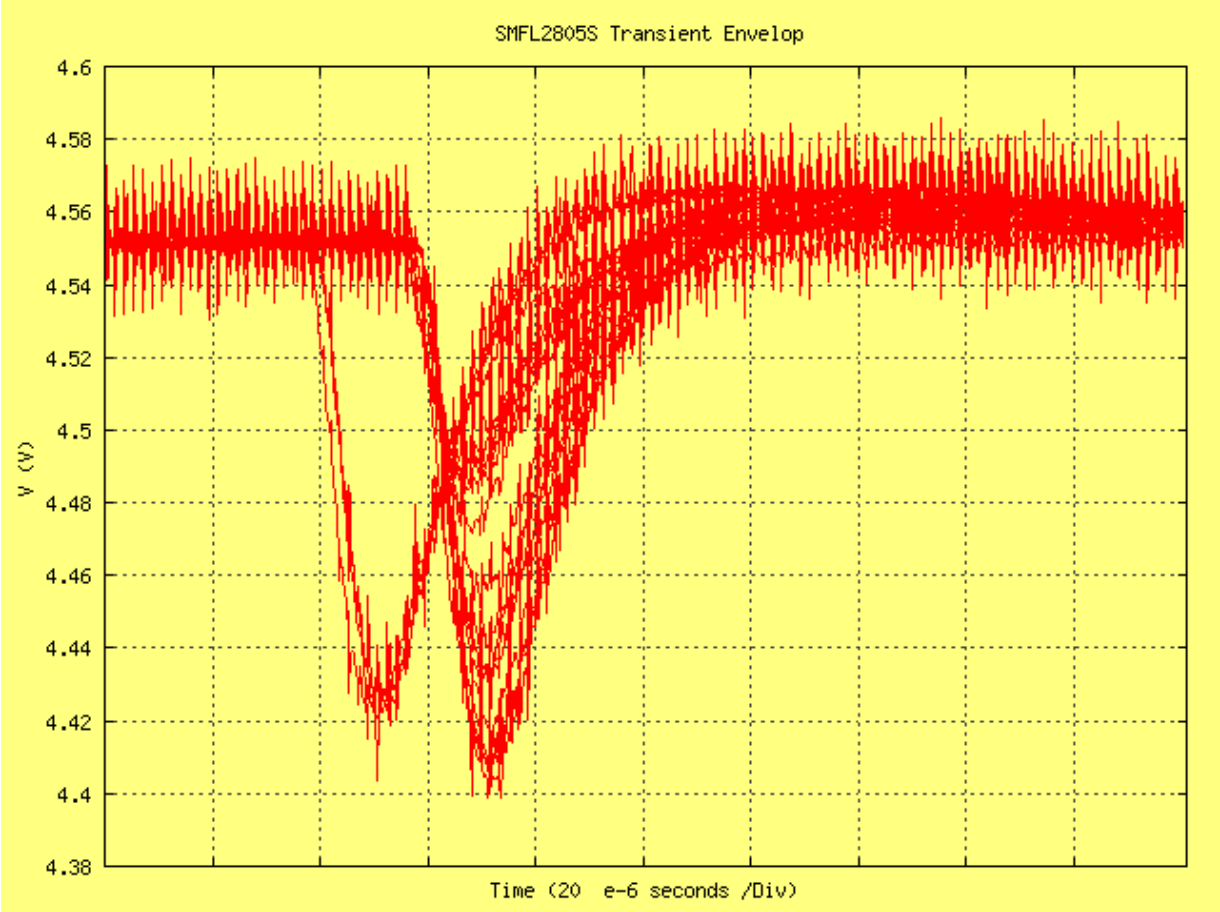
Figure 6 – Run 4, Positive trigger (50 mV)



Run 5

8 events plotted out of a total of 83.

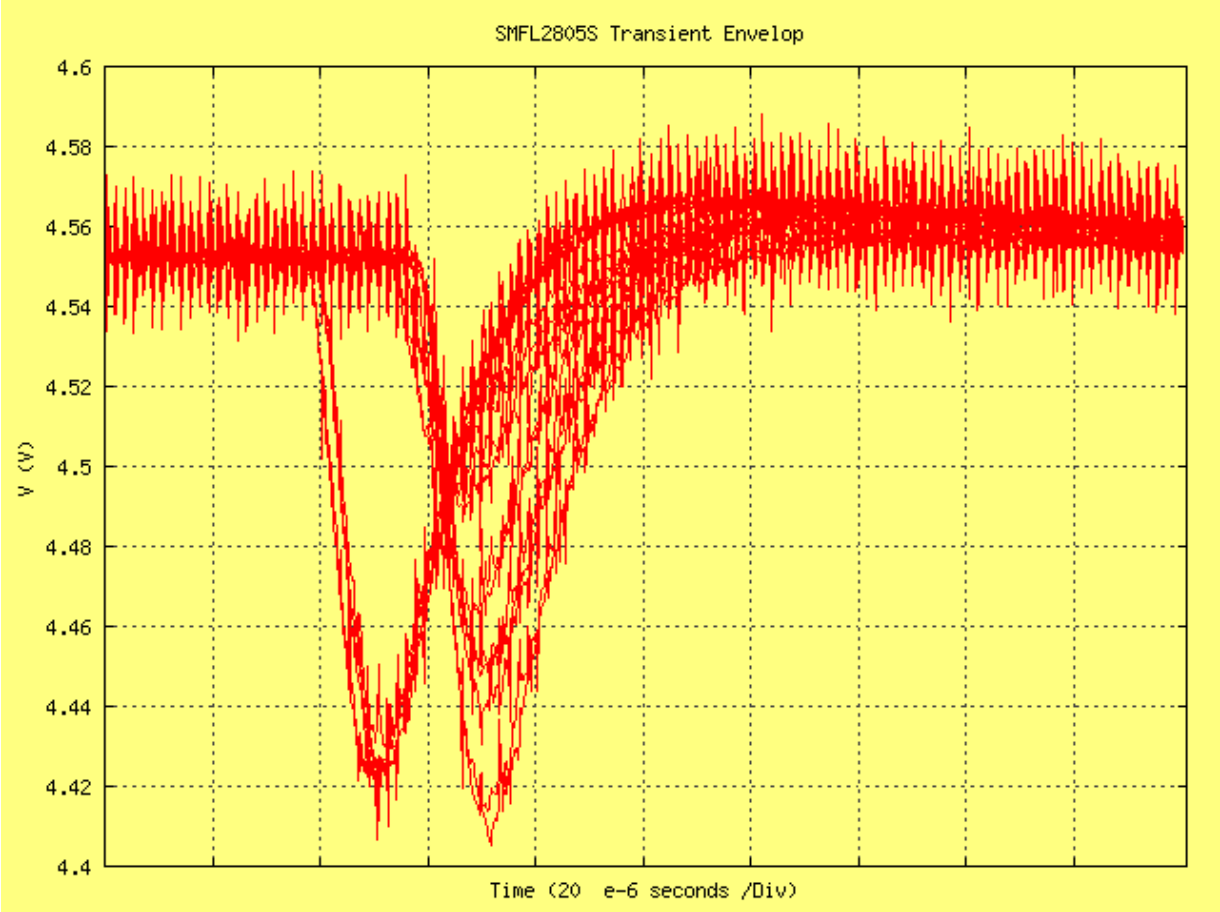
Figure 7 – Run 5, Positive trigger (50 mV)



Run 6

19 events plotted out of a total of 191.

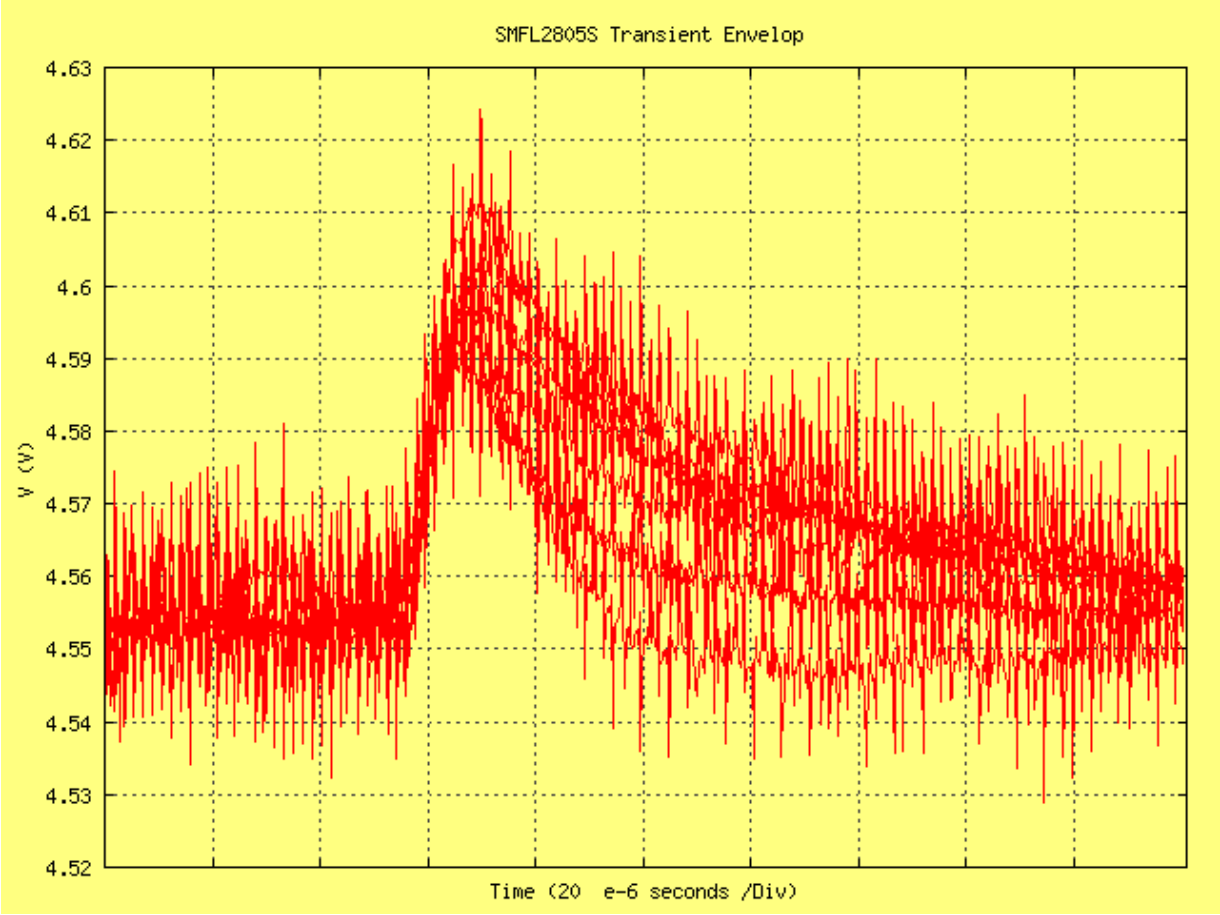
Figure 8 – Run 6, Negative trigger (50 mV)



Run 7

18 events plotted out of a total of 188.

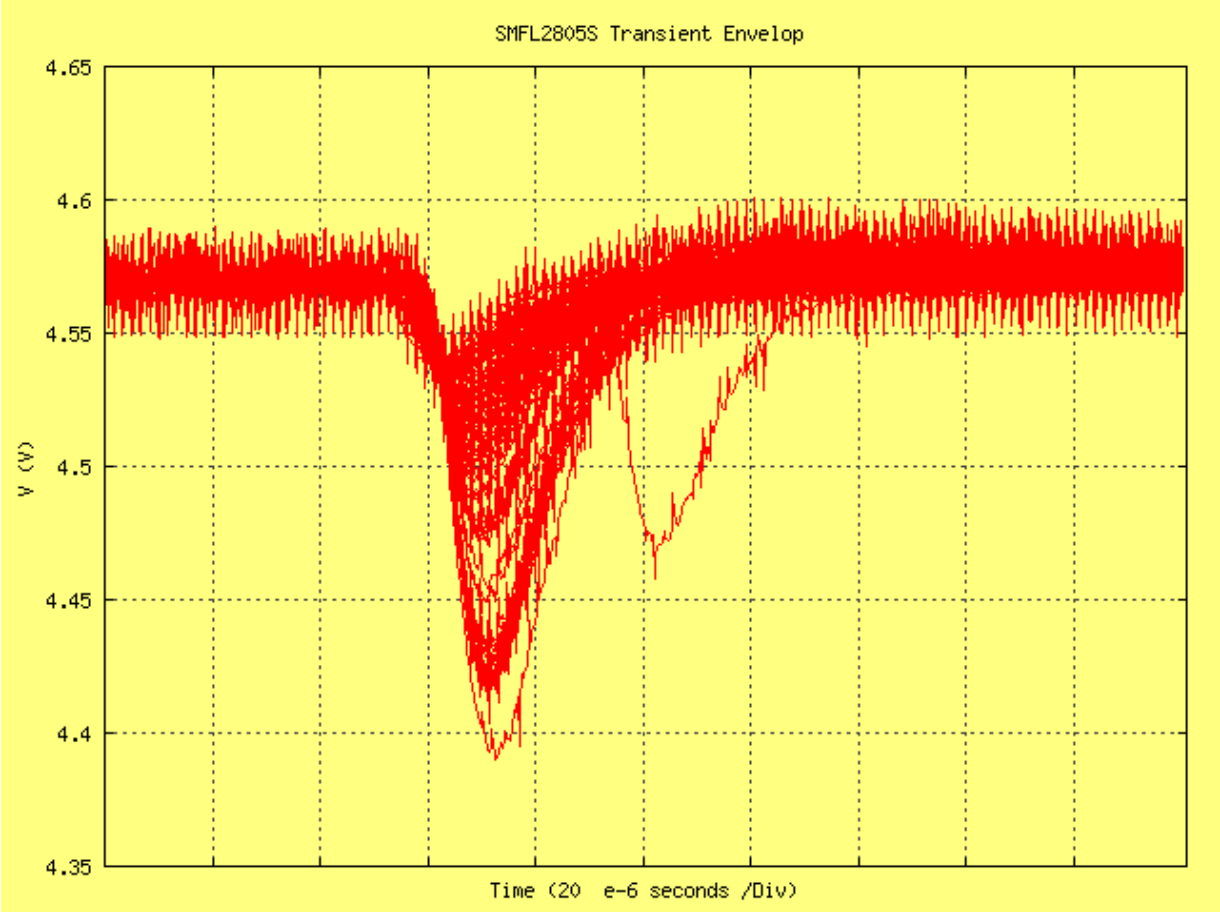
Figure 9 – Run 7, Negative trigger (50 mV)



Run 8

9 events plotted out of a total of 91.

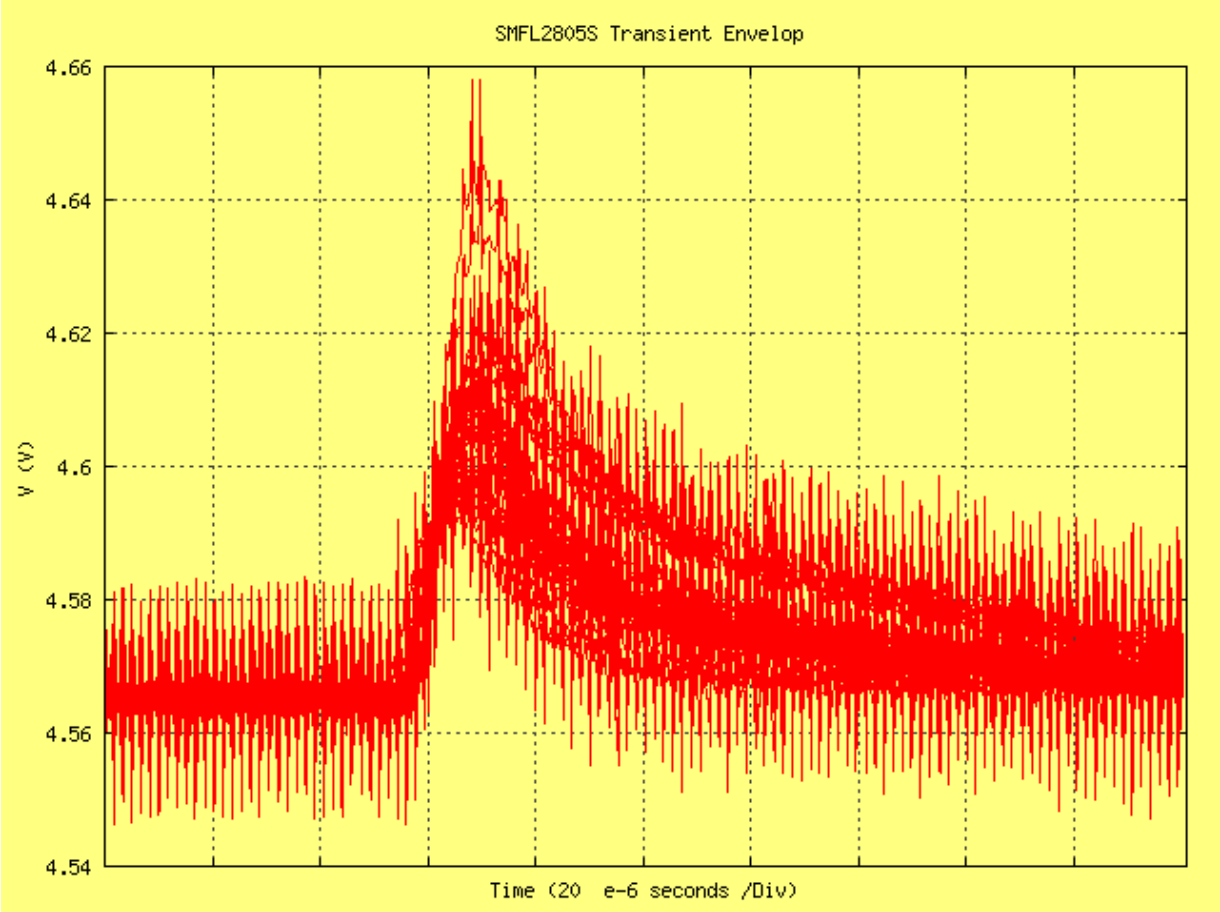
Figure 10 – Run 8, Positive trigger (50 mV)



Run 11

103 events plotted out of a total of 206.

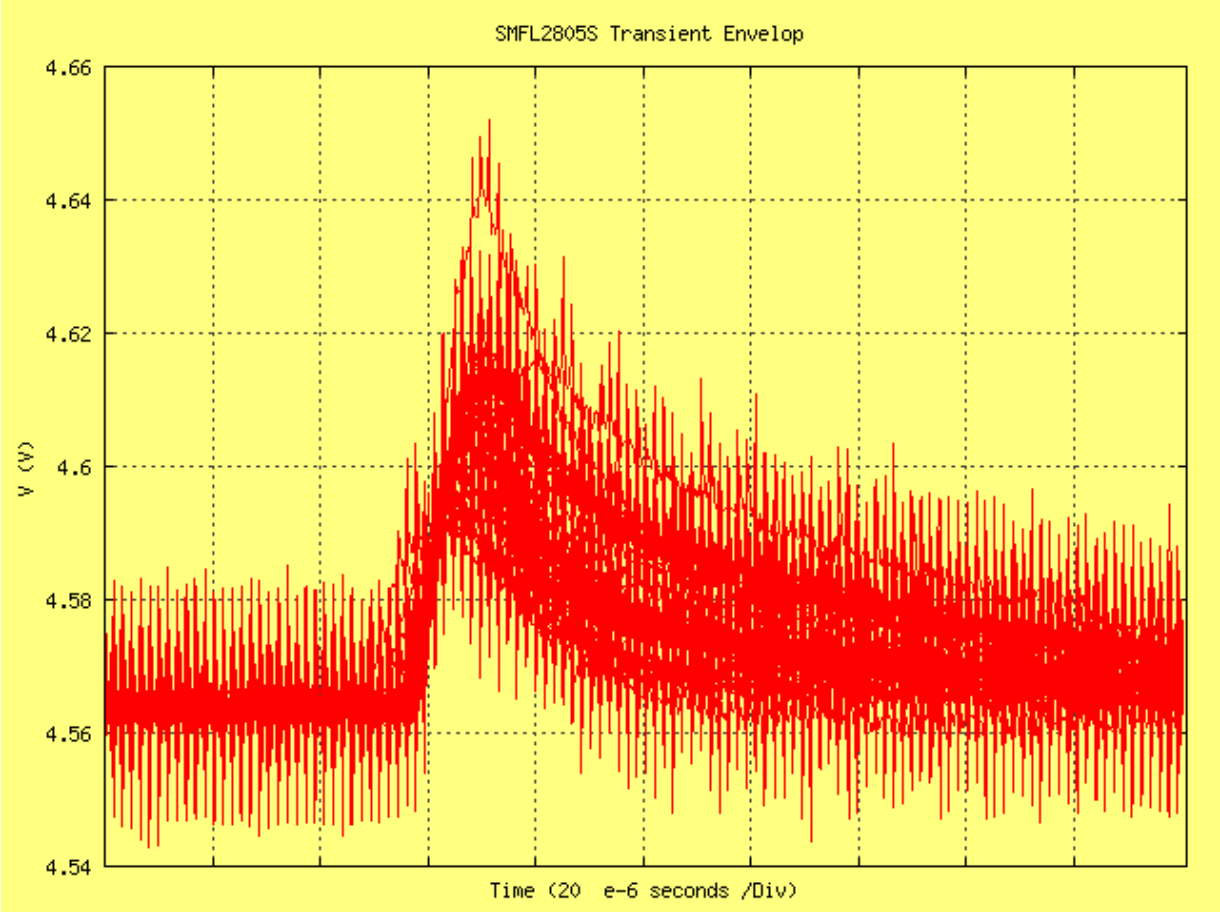
Figure 11 – Run 11, Negative trigger (50 mV)



Run 12

36 events plotted out of a total of 72.

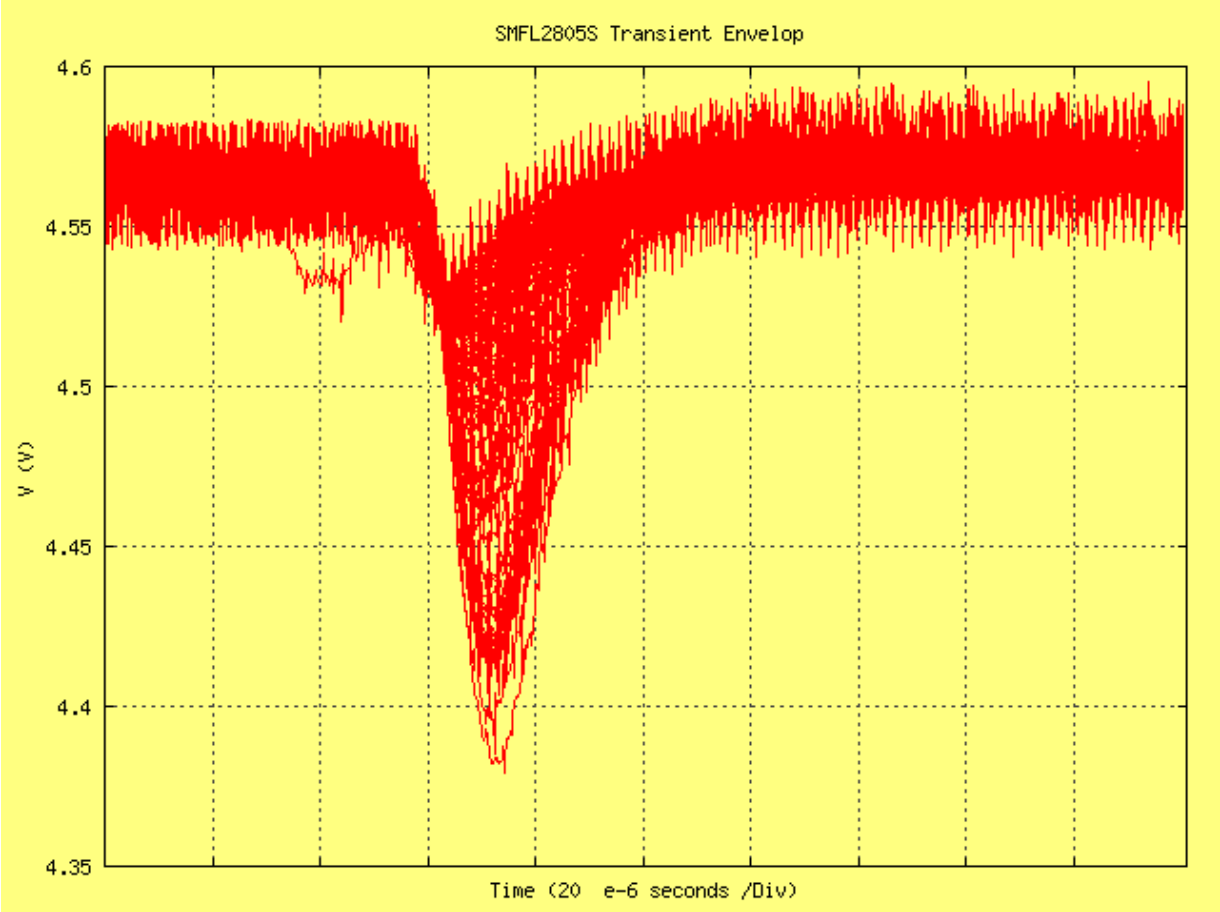
Figure 12 – Run 12, Positive trigger (50 mV)



Run 13

45 events plotted out of a total of 89.

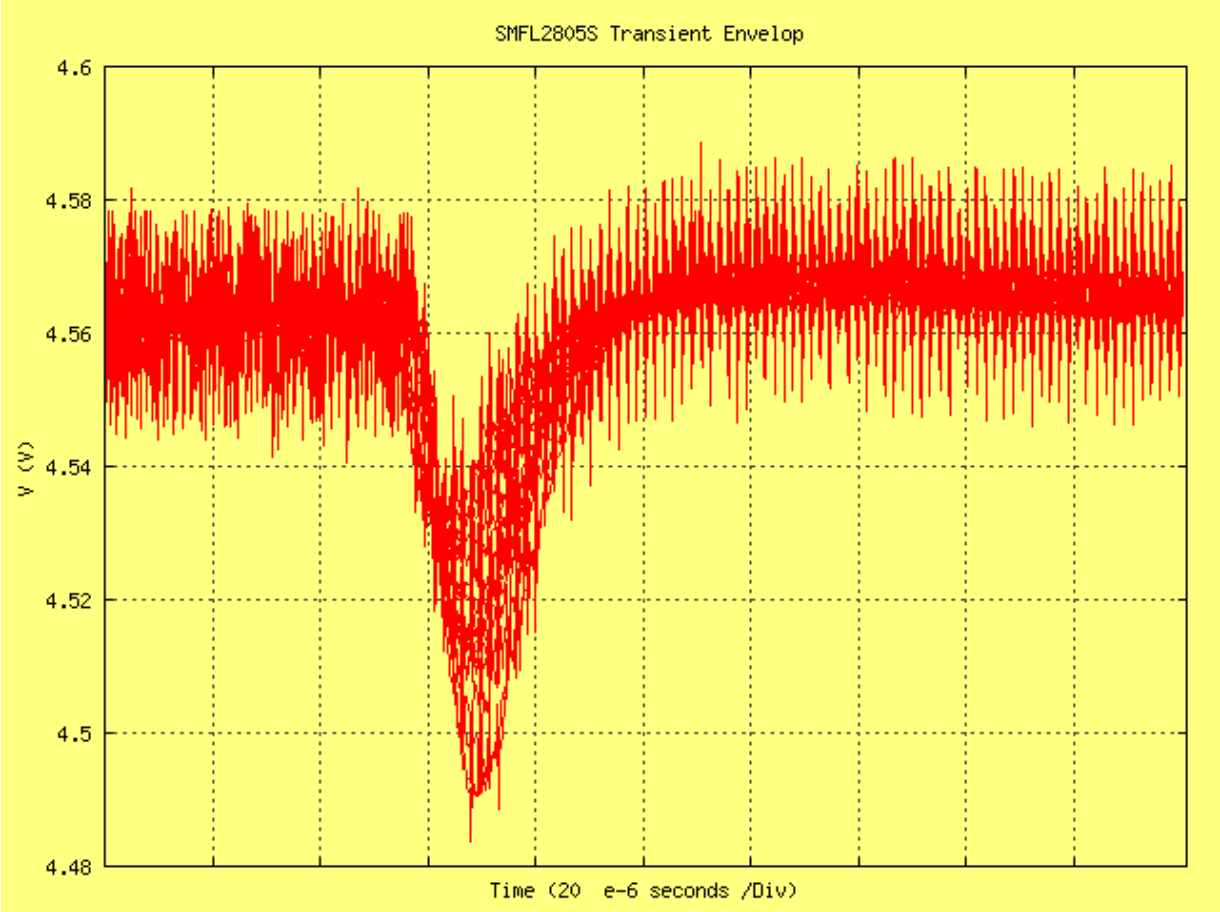
Figure 13 – Run 13, Positive trigger (50 mV)



Run 14

117 events plotted out of a total of 234.

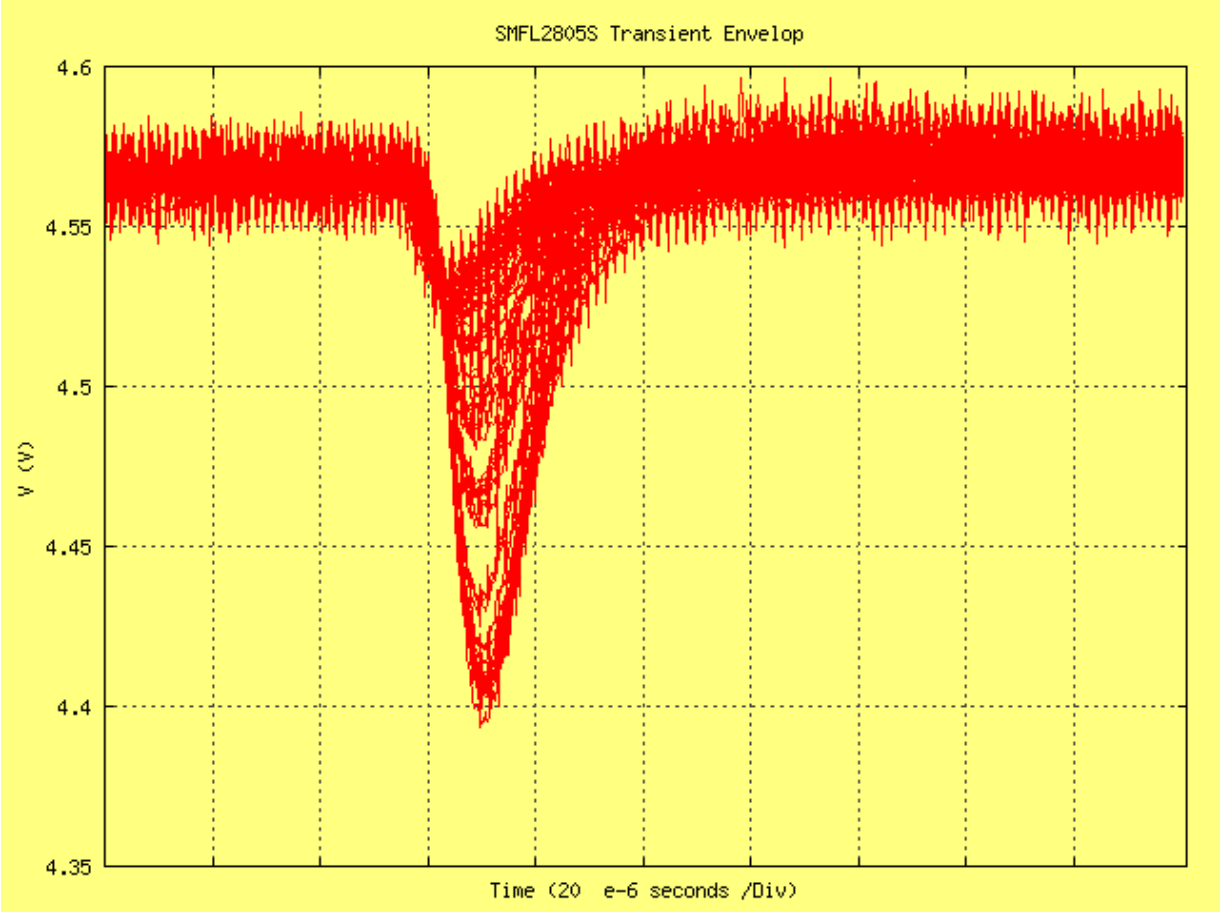
Figure 14 – Run 14, Negative trigger (50 mV)



Run 15

20 events plotted out of a total of 39.

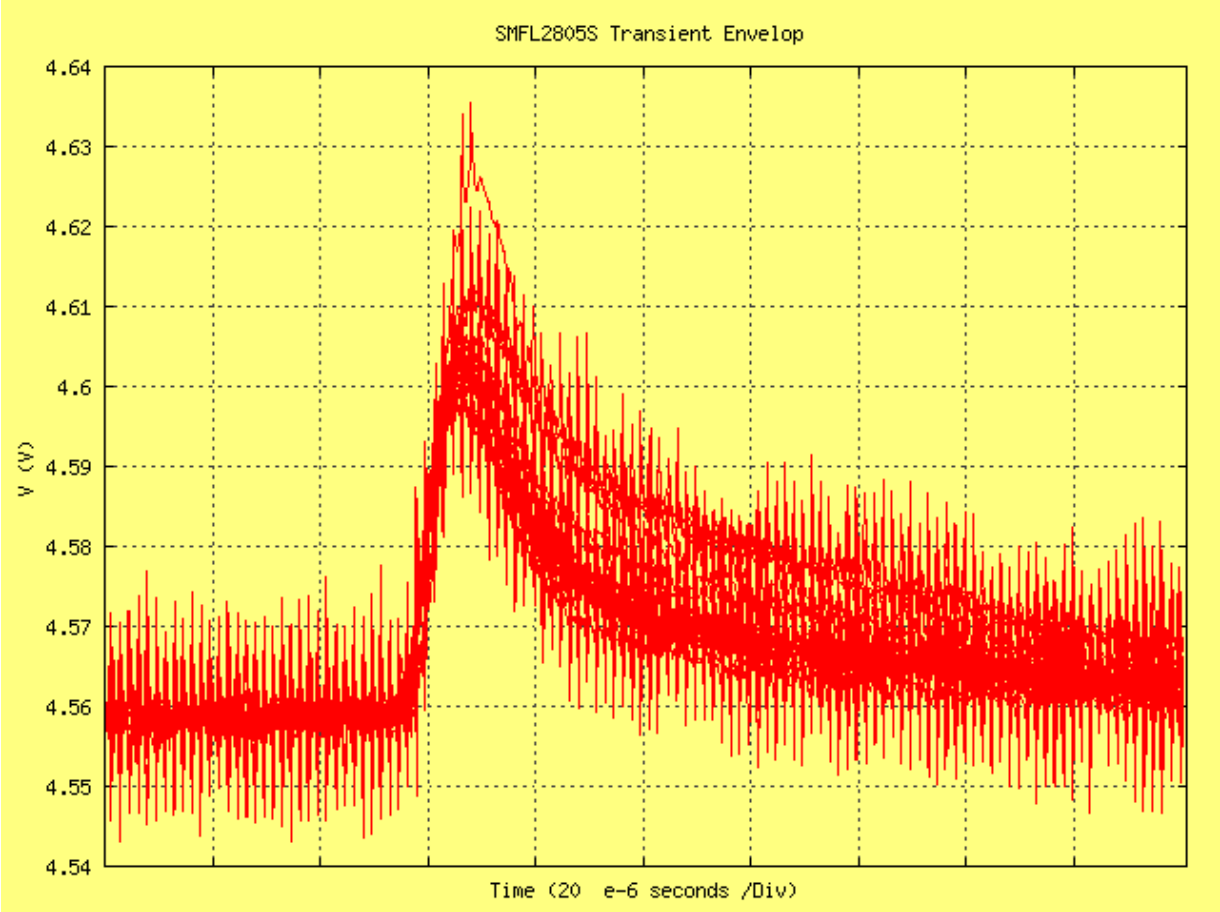
Figure 15 – Run 15, Negative trigger (50 mV)



Run 19

86 events plotted out of a total of 172.

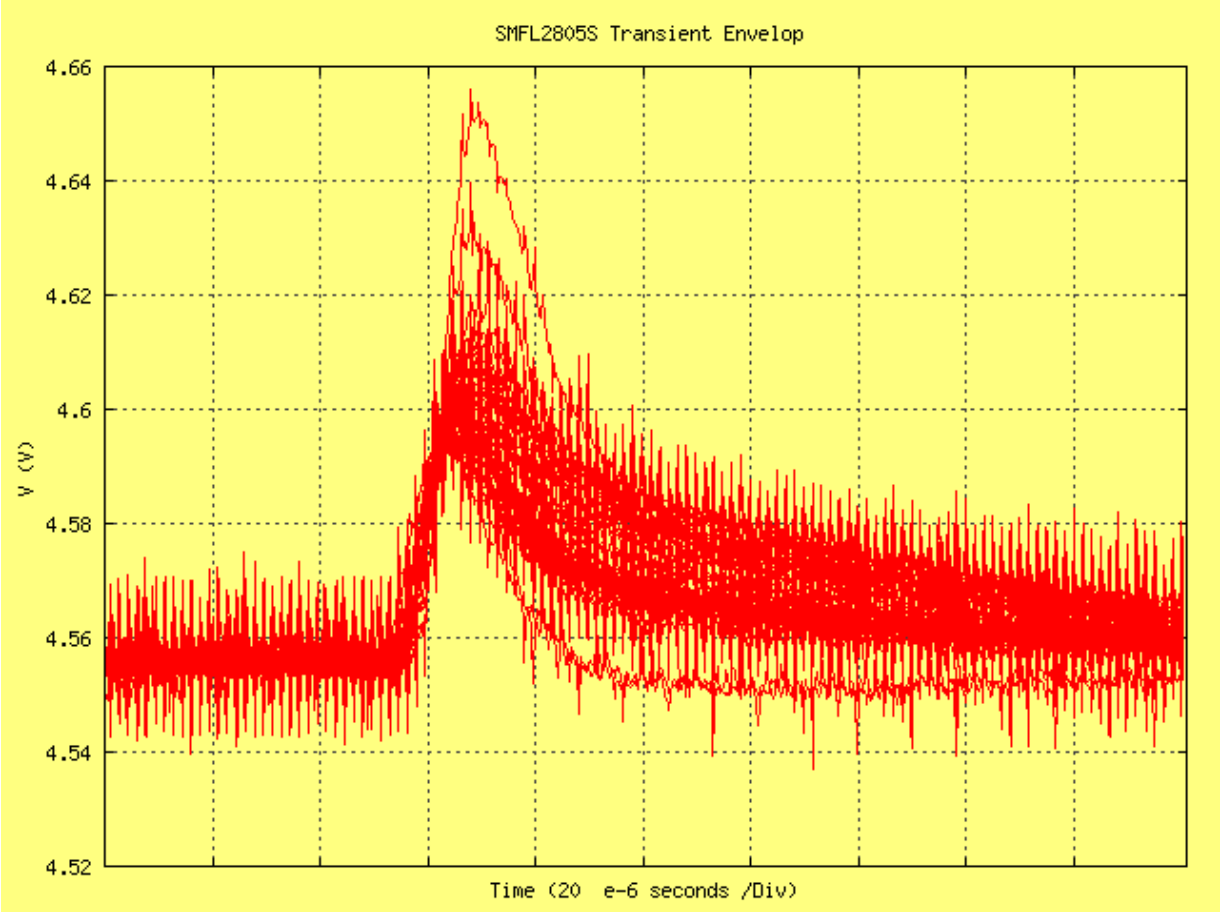
Figure 16 – Run 19, Negative trigger (50 mV)



Run 20

27 events plotted out of a total of 53.

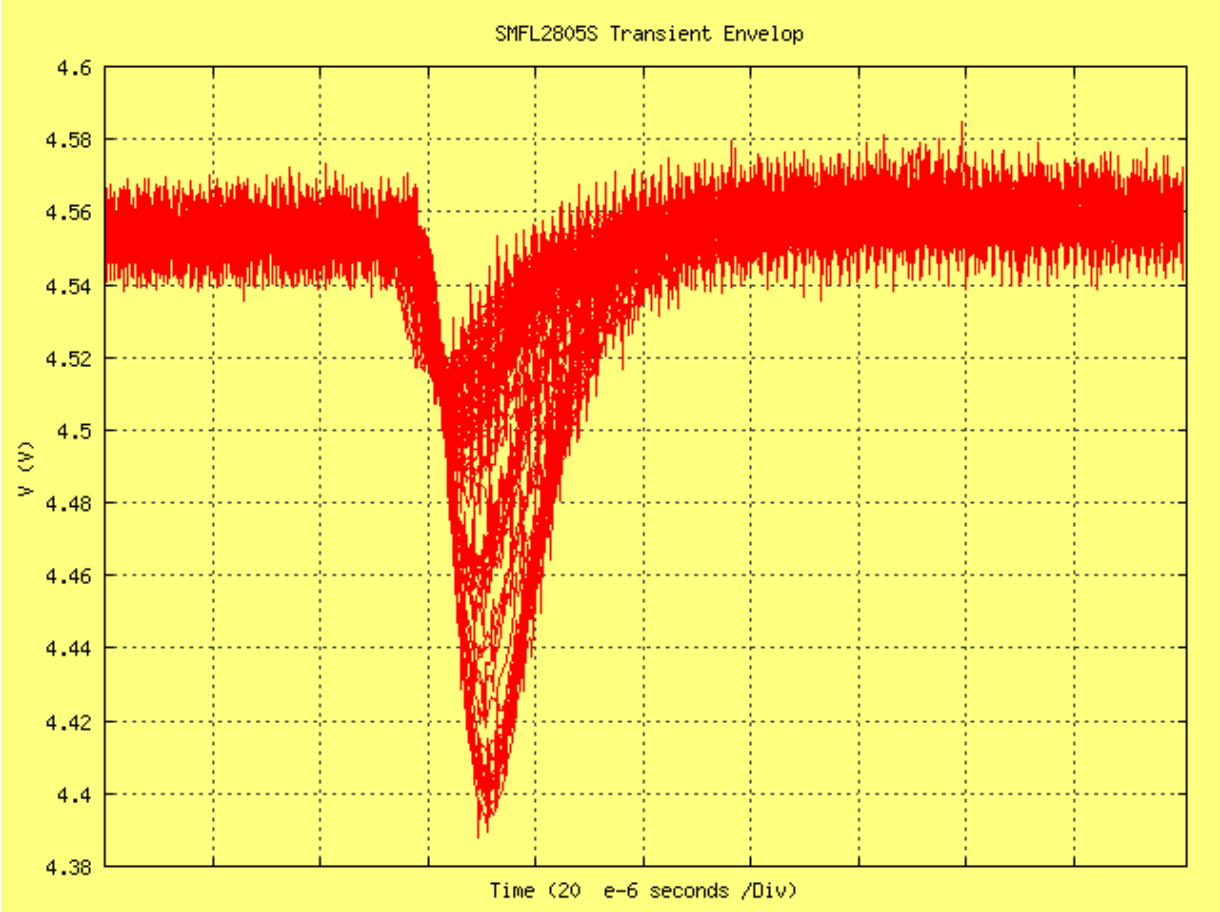
Figure 17 – Run 20, Positive trigger (50 mV)



Run 21

45 events plotted out of a total of 89.

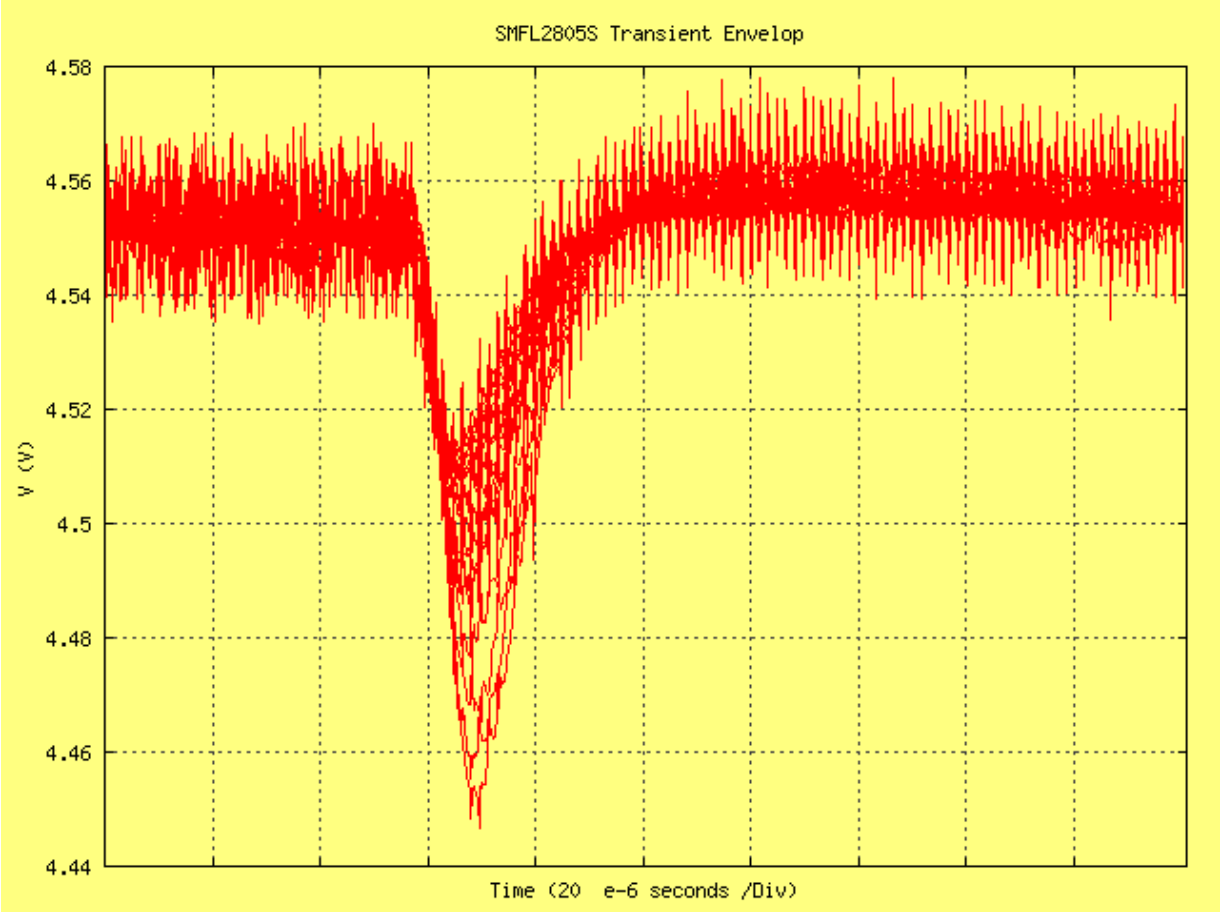
Figure 18 – Run 21, Positive trigger (50 mV)



Run 22

104 events plotted out of a total of 207.

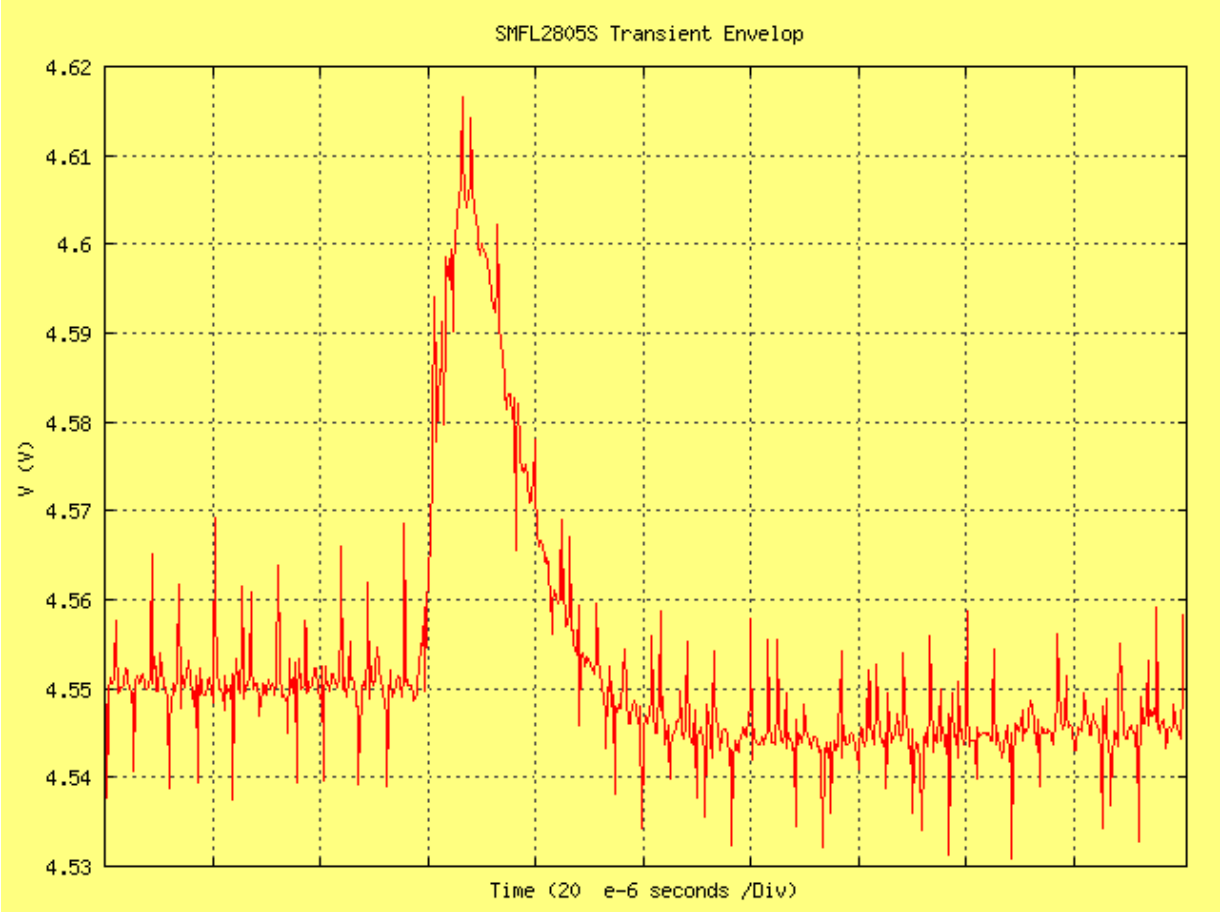
Figure 19 – Run 22, Negative trigger (50 mV)



Run 23

21 events plotted out of a total of 41.

Figure 20 – Run 23, Negative trigger (50 mV)



Run 24

1 events plotted out of a total of 4.

Figure 21 – Run 24, Positive trigger (50 mV)

Run 30

9 events plotted out of a total of 18.

Figure 22 – Run 30, Negative trigger (50 mV)

Run	S/N	Area	Ion	Energy MeV	LET MeV/(mg/cm²)	Range µm	Tilt Deg.	Eff LET MeV/(mg/cm²)	Test Time s	Flux #/(cm².s)	Fluence #/cm²	Dose Rad(Si)	SETs	50mV Trigger up/down
Run 3	354	A1	84Kr17	316	34	43	0	34	186	5.38E+03	1.00E+06	544	247	↓
Run 4	354	A1	84Kr17	316	34	43	0	34	238	4.20E+03	1.00E+06	544	93	↑
Run 5	354	A2	84Kr17	316	34	43	0	34	264	3.79E+03	1.00E+06	544	83	↑
Run 6	354	A2	84Kr17	316	34	43	0	34	207	4.83E+03	1.00E+06	544	191	↓
Run 7	354	A3	84Kr17	316	34	43	0	34	149	6.71E+03	1.00E+06	544	188	↓
Run 8	354	A3	84Kr17	316	34	43	0	34	129	7.75E+03	1.00E+06	544	91	↑
Run 9	354	A4	84Kr17	316	34	43	0	34	231	4.33E+03	1.00E+06	544	0	↑
Run 10	354	A4	84Kr17	316	34	43	0	34	277	3.61E+03	1.00E+06	544	0	↓
Run 11	354	A1	84Kr17	316	34	43	0	34	419	1.19E+03	5.00E+05	272	206	↑
Run 12	354	A1	84Kr17	316	34	43	0	34	217	2.30E+03	5.00E+05	272	72	↑
Run 13	354	A2	84Kr17	316	34	43	0	34	160	3.13E+03	5.00E+05	272	89	↑
Run 14	354	A2	84Kr17	316	34	43	0	34	174	2.87E+03	5.00E+05	272	234	↓
Run 15	354	A3	84Kr17	316	34	43	0	34	150	3.33E+03	5.00E+05	272	39	↓
Run 16	354	A3	84Kr17	316	34	43	0	34	159	3.14E+03	5.00E+05	272	2	↑
Run 17	354	A4	84Kr17	316	34	43	0	34	154	3.25E+03	5.00E+05	272	0	↑
Run 18	354	A4	84Kr17	316	34	43	0	34	166	3.01E+03	5.00E+05	272	0	↓
Run 19	351	A1	84Kr17	316	34	43	0	34	215	2.33E+03	5.00E+05	272	172	↓
Run 20	351	A1	84Kr17	316	34	43	0	34	186	2.69E+03	5.00E+05	272	53	↑
Run 21	351	A2	84Kr17	316	34	43	0	34	212	2.36E+03	5.00E+05	272	89	↑
Run 22	351	A2	84Kr17	316	34	43	0	34	243	2.06E+03	5.00E+05	272	207	↓
Run 23	351	A3	84Kr17	316	34	43	0	34	233	2.15E+03	5.00E+05	272	41	↓
Run 24	351	A3	84Kr17	316	34	43	0	34	236	2.12E+03	5.00E+05	272	4	↑
Run 25	351	A4	84Kr17	316	34	43	0	34	135	3.70E+03	5.00E+05	272	0	↑
Run 26	351	A4	84Kr17	316	34	43	0	34	182	2.75E+03	5.00E+05	272	0	↓
Run 27	351	A1	40Ar8	150	14.1	42	0	14.1	94	5.32E+03	5.00E+05	113	25	↓
Run 28	351	A1	40Ar8	150	14.1	42	0	14.1	74	6.76E+03	5.00E+05	113	0	↑
Run 29	351	A2	40Ar8	150	14.1	42	0	14.1	109	4.59E+03	5.00E+05	113	0	↓
Run 30	351	A2	40Ar8	150	14.1	42	0	14.1	113	4.42E+03	5.00E+05	113	18	↓
Run 31	351	A3	40Ar8	150	14.1	42	0	14.1	98	5.10E+03	5.00E+05	113	0	↑
Run 32	351	A3	40Ar8	150	14.1	42	0	14.1	85	5.88E+03	5.00E+05	113	0	↓
Run 33	351	A1	20Ne4	78	5.85	45	0	5.85	86	5.81E+03	5.00E+05	47	0	↓
Run 34	351	A2	20Ne4	78	5.85	45	0	5.85	84	5.95E+03	5.00E+05	47	0	↓

Table 2 – Detailed results per run

8 CONCLUSION

Heavy ion tests were conducted on 2 flight lot parts for the ATV project, SMFL2805S 28V Input DC/DC Converter from Interpoint, using the heavy ions available at the European Heavy Ion Irradiation Facility (HIF) at Cyclone, Université Catholique de Louvain, Belgium.

Different beam spot (23mm diameter) locations (A1 to A4, see Figure 2) have been defined, considering the hybrid topography, and three locations were found to be sensitive to heavy ions at an LET of 34MeV/(mg/cm²).

Both negative (up to 180 mV/20 us) and positive (up to 90 mV/50 us) events were detected.

With Argon, LET of 14.1MeV/(mg/cm²), two locations, A1 and A2, were found to be sensitive and only negative events were detected.

With Neon, LET of 5.85MeV/(mg/cm²), no event could be detected in any area.