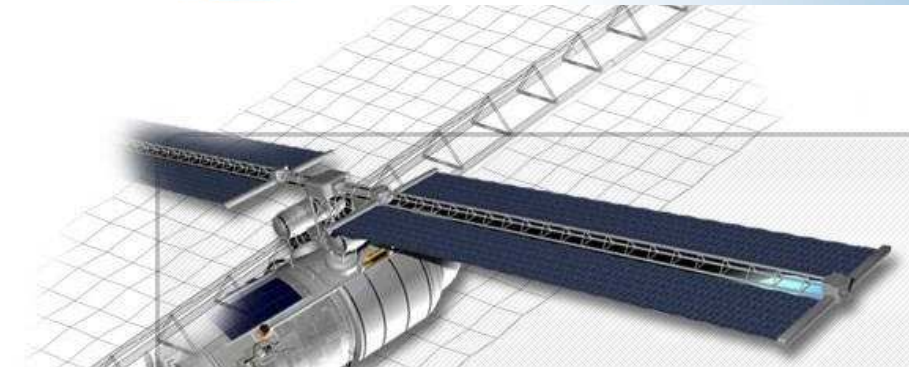


TID Influence on the SEE sensitivity of Active EEE components

Anne Samaras

Benjamin Vandevelde, Lionel Salvy, Lionel Gouyet, Athina Varotsou, Alexandre Rousset

Marc Poizat

Purpose of the study

During space application, devices are subject to TID and SEE at the same time.

But parts radiation qualification process includes both ionizing dose and SEE tests, performed independently

⇨ Synergistic effects between Dose and SEE on electronic devices ?

State of art

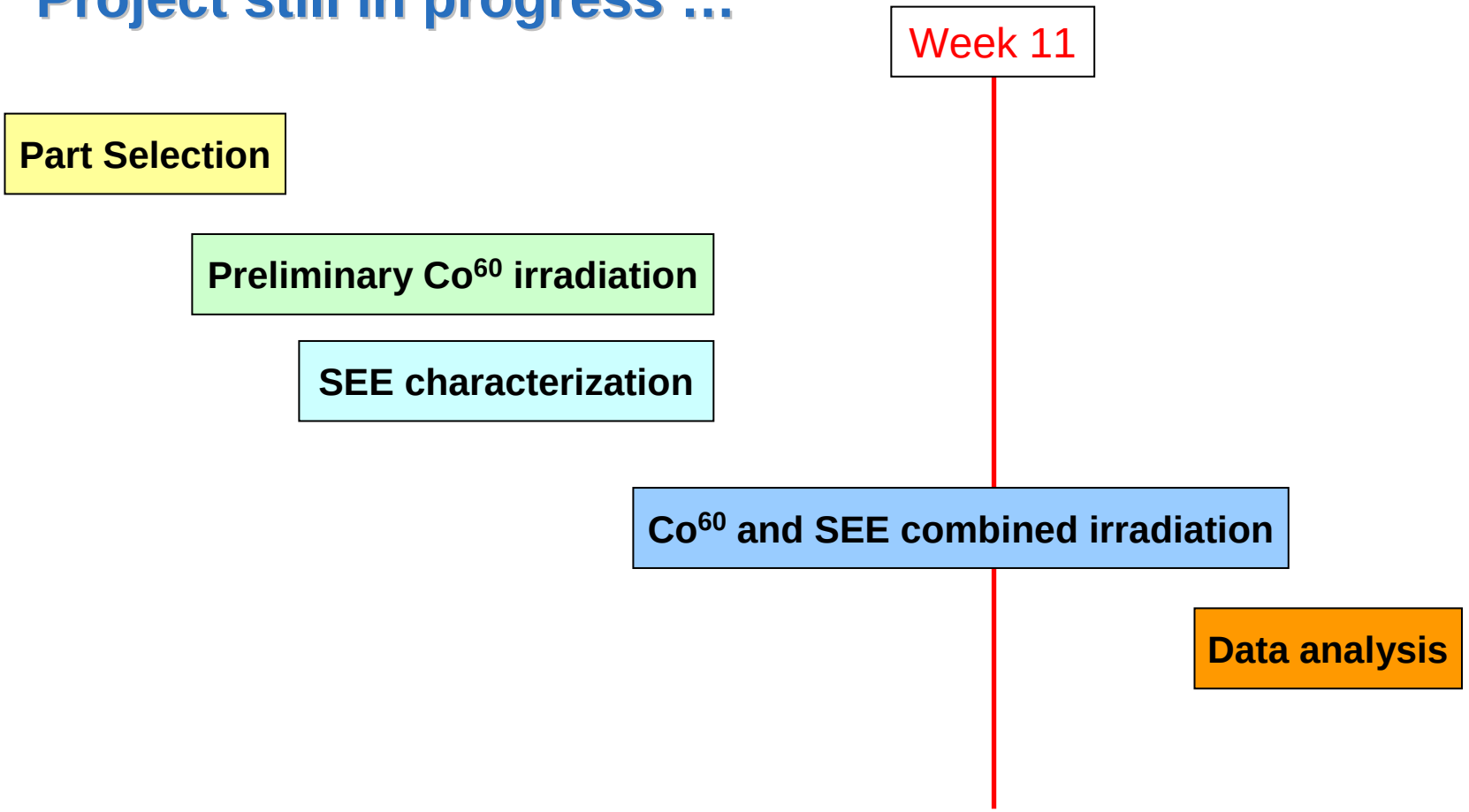
- **SRAM :**
  - An increase of soft error rate is observed when it is measured with the same pattern used during Total Dose irradiation and a decrease for the complementary pattern. *Koga 2009*

- **NAND Flash:**
  - The cross section for single bit upsets in Floating Gate cells increases if the sample has been previously exposed to even relatively low TID levels. *Bagatin 2010*

- **ADC & DAC :**
  - To our knowledge these effects have not yet been published in open literature

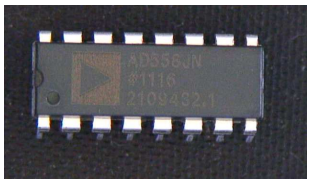
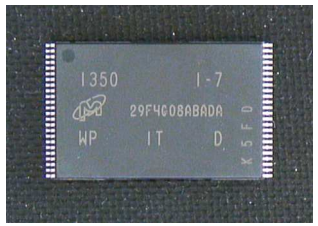
Schedule Project

Project still in progress …



Devices under test

Four different devices under test

	AD9042	AD558	MT29F4G08AAC	R1RW0416
Manufacturer	Analog Device	Analog Device	Micron	Renesas
Date code	1314	1116	1346	1350
Type	ADC 12bit	DAC 8bit	NAND flash	SRAM 16Mb 8bit
				
Effects	SEU, SET, SEL	SET, SEL	SEU, MBU, SEL, SEFI	SEU, MBU, SEL

The device has been selected in order to have different functions, manufacturers and technologies

Preliminary ^{60}Co test

Step	1	2	3	4	5	6	7	8	9	10	11
Total Dose krad(Si)	0	5	10	20	30	50	70	100	150	200	250
Dose rate rad(Si)/h	310										

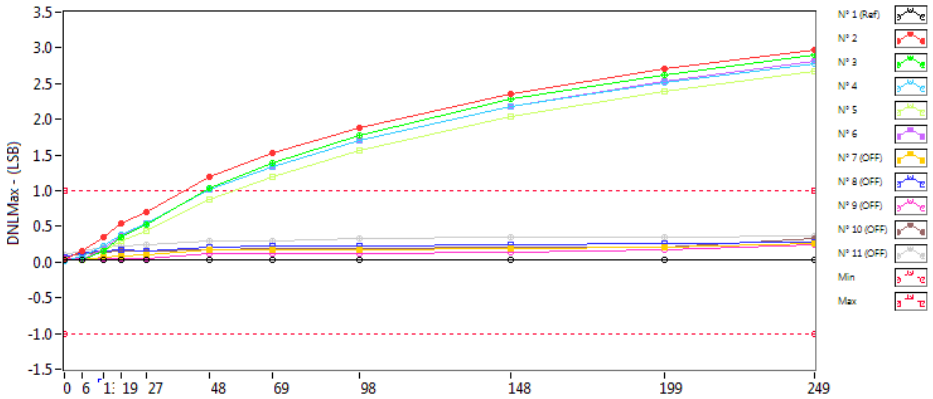
- **5 ON + 5 OFF + 1 reference sample**
- **TRAD ^{60}Co GAMRAY Facility**

⇨ **Devices behavior under total dose**

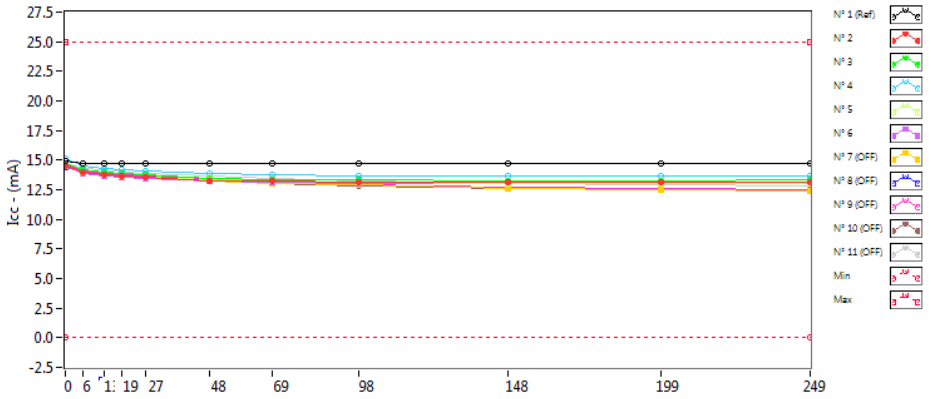
⇨ **Total dose level and dose steps for each reference for the combined ^{60}Co and SEE tests.**

Preliminary ^{60}Co test

DAC AD558



Differential nonlinearity MAX



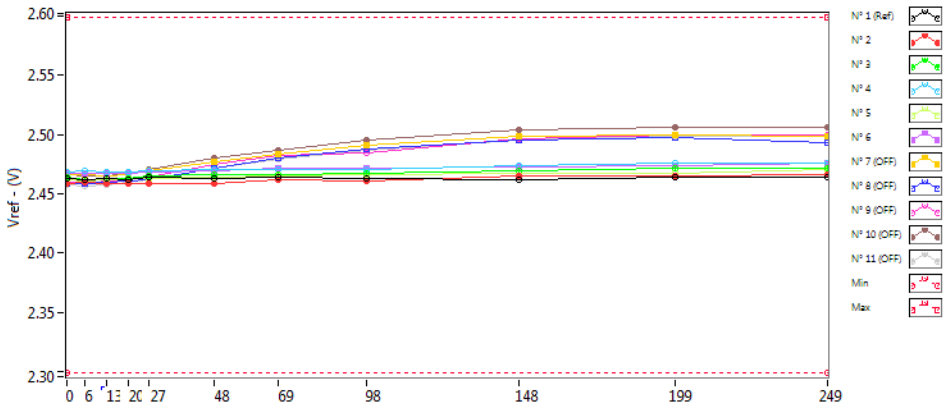
Power supply current

⇒ **Difference between ON and OFF parts**

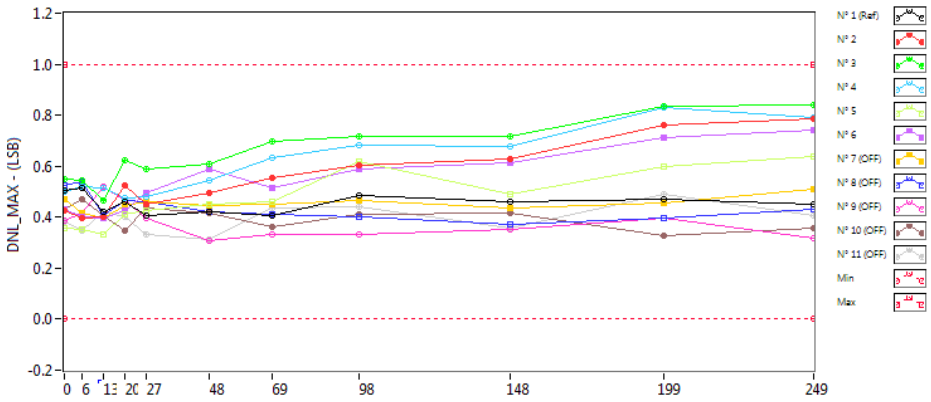
⇒ **Functional at 250krad(Si)**

Preliminary ^{60}Co test

ADC AD9042



Voltage reference



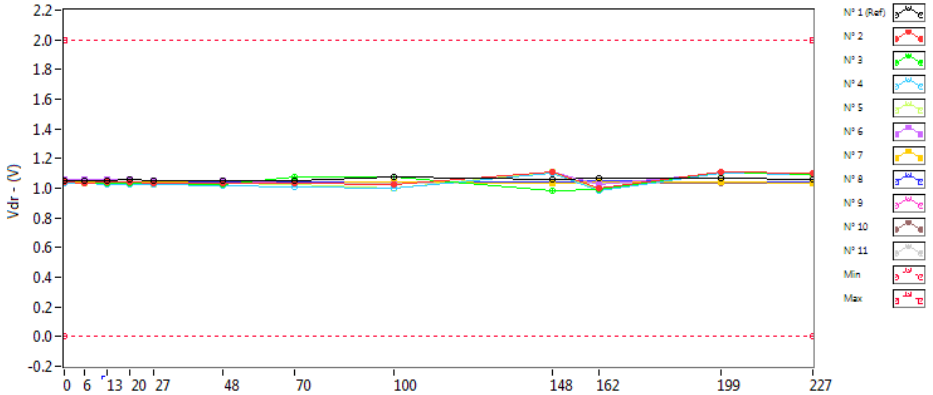
Differential non-linearity MAX

⇒ **Difference between ON and OFF parts**

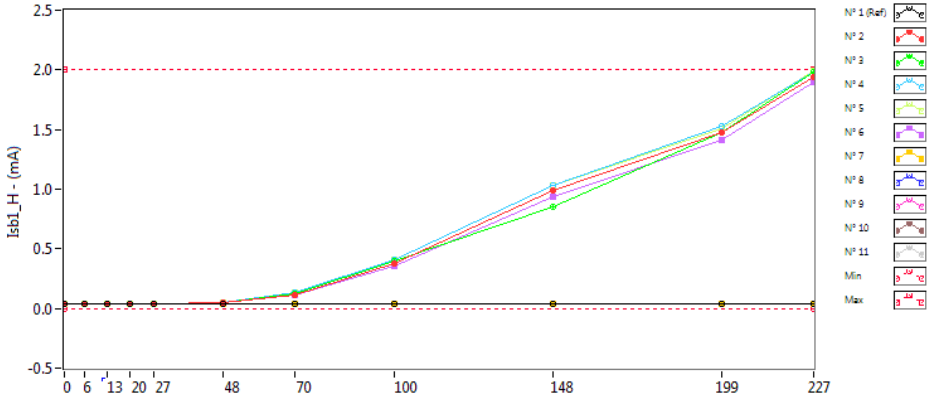
⇒ **Functional at 250krad(Si)**

Preliminary ^{60}Co test

SRAM R1RW0416



Data Retention Voltage



Standby power supply current

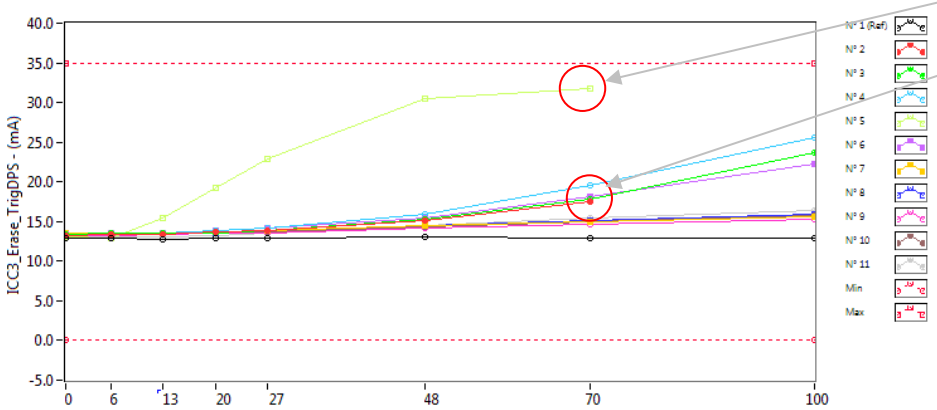
⇒ **Difference between ON and OFF parts**

⇒ **Functional at 250krad(Si)**

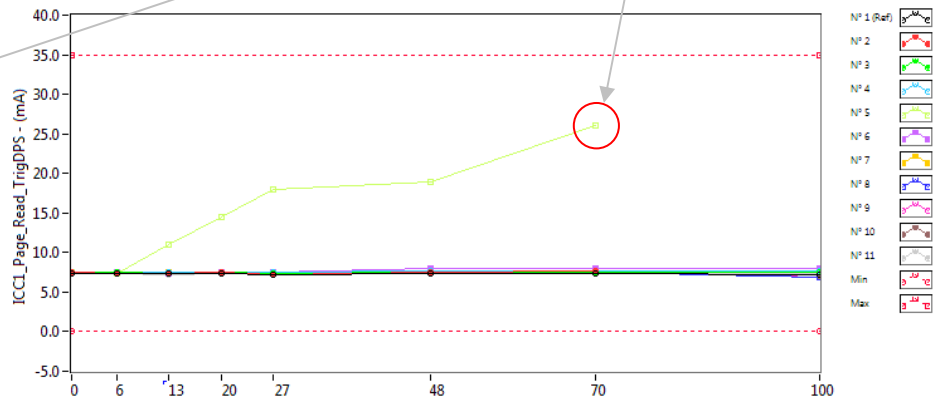
Preliminary ^{60}Co test

NAND FLASH MT29F4G08AAC

At the step of 100krad, two devices (N°2 & N°5) are not measurable



ERASE current



Sequential READ current

⇒ **Difference between ON and OFF parts**

⇒ **Not Functional at 150krad(Si)**

Combined ^{60}Co and SEE test

Preliminary dose characterization allowed to define total dose level and dose steps for each reference

AD558
AD9042
R1RW0416

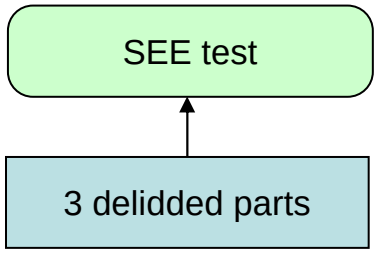
Step	1	2	3	4	5
Total Dose krad(Si)	0	37.5	75	112.5	150
Dose rate rad(Si)/h	74				

MT29F4G08AAC

Step	1	2	3	4
Total Dose krad(Si)	0	33.3	66.6	100
Dose rate rad(Si)/h	66			

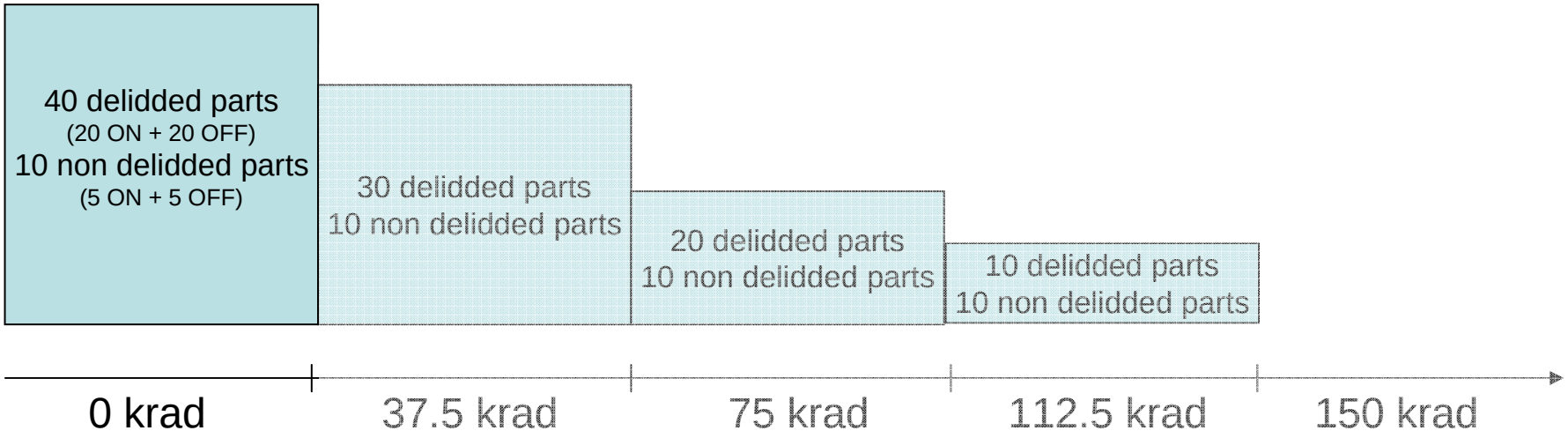
Université Catholique de Louvain (UCL) ^{60}Co Gamma Irradiation Facility (GIF)

Combined ^{60}Co and SEE test



Step 1: 0 krad(Si)

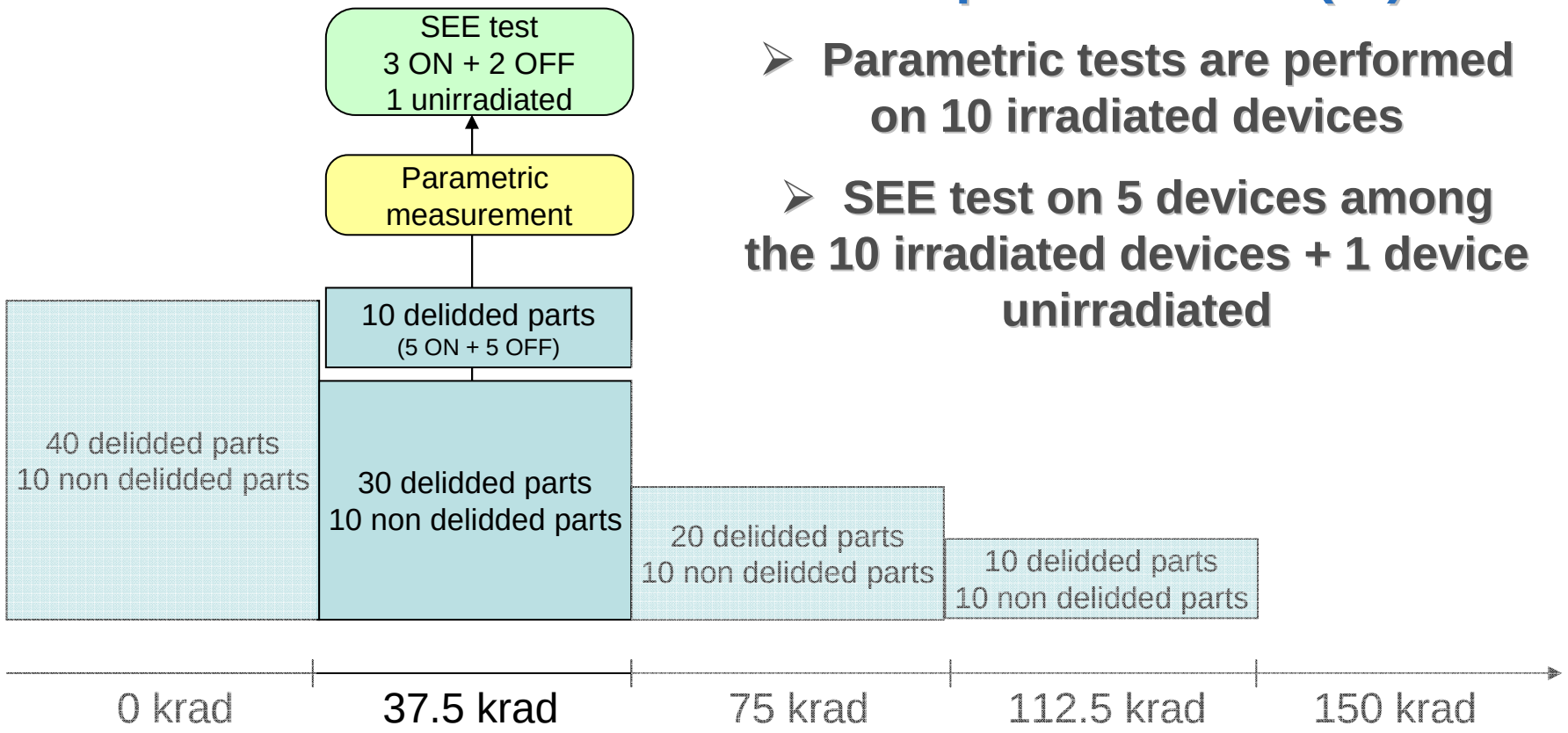
- **Parametric tests are performed on all devices before 60Co irradiation**
- **SEE test on 3 delidded devices**



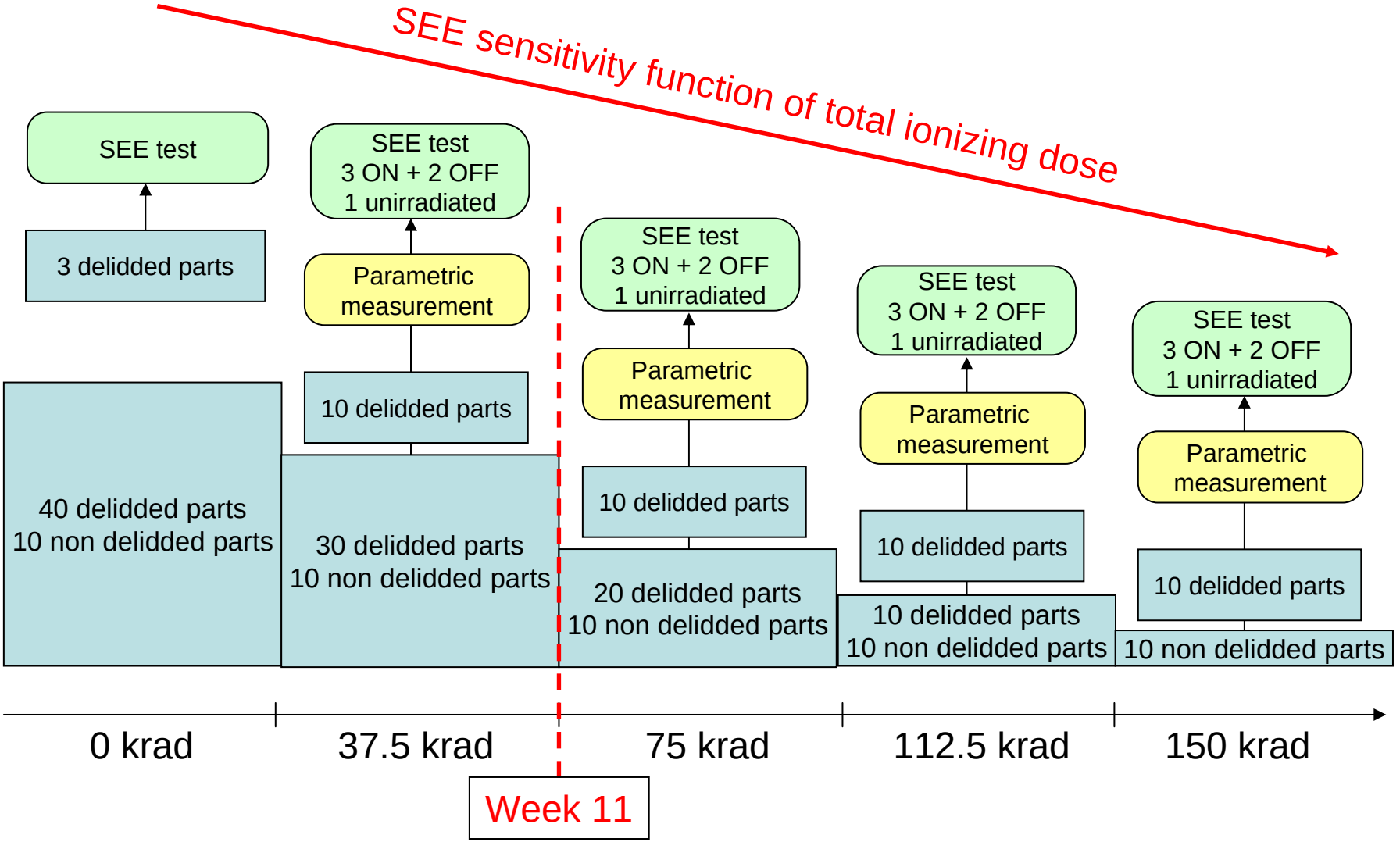
Combined ^{60}Co and SEE test

Step 2: 37.5 krad(Si)

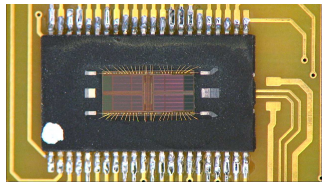
- **Parametric tests are performed on 10 irradiated devices**
- **SEE test on 5 devices among the 10 irradiated devices + 1 device unirradiated**



Combined ^{60}Co and SEE test

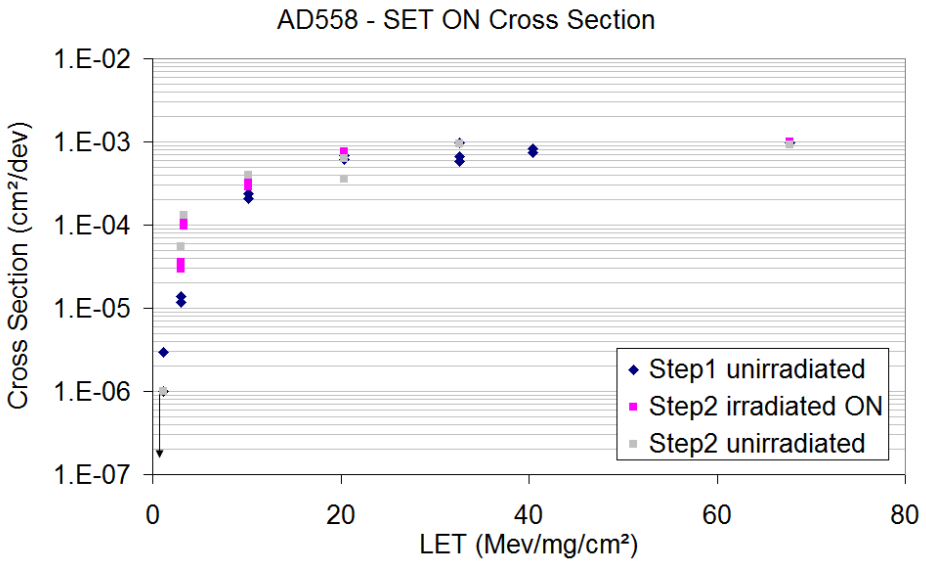


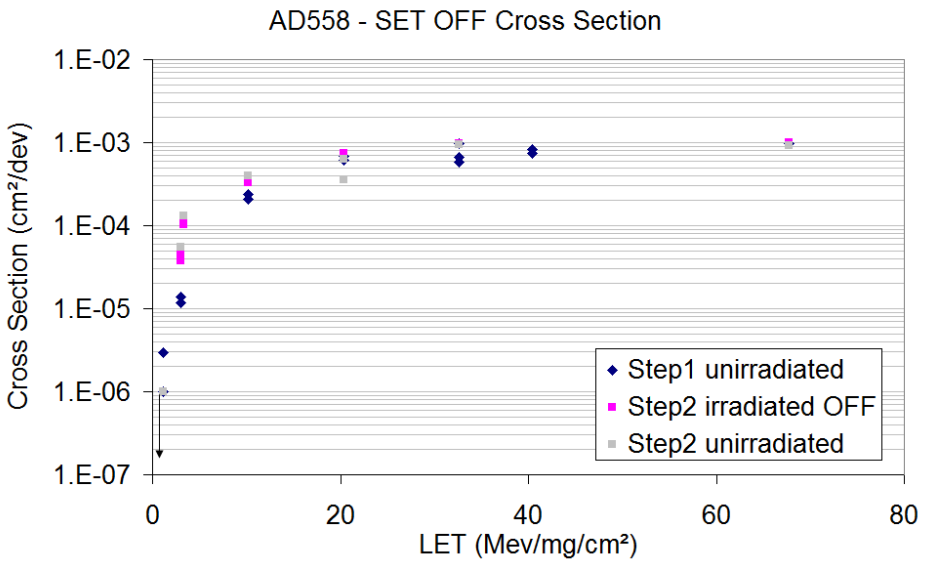
Combined ^{60}Co and SEE test



Combined ^{60}Co and SEE test

DAC AD558 : Step2 = 37.5krad



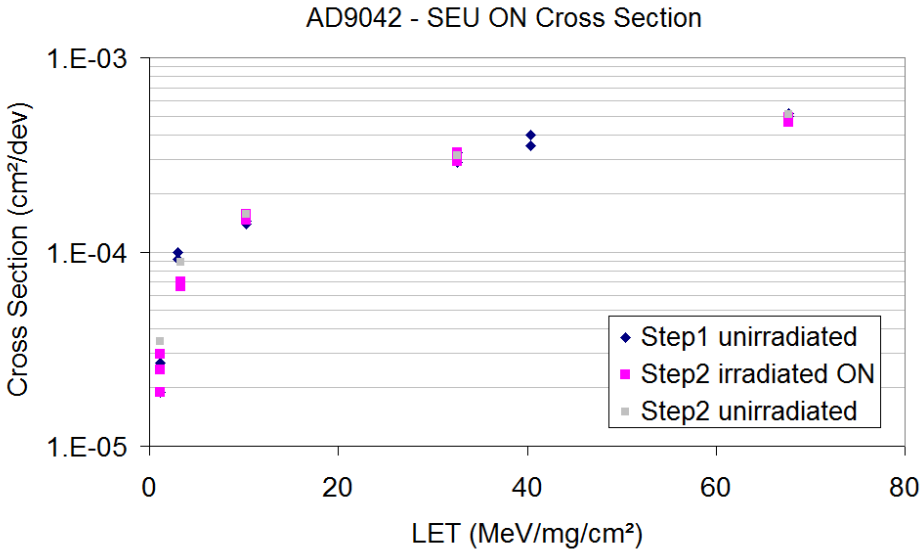


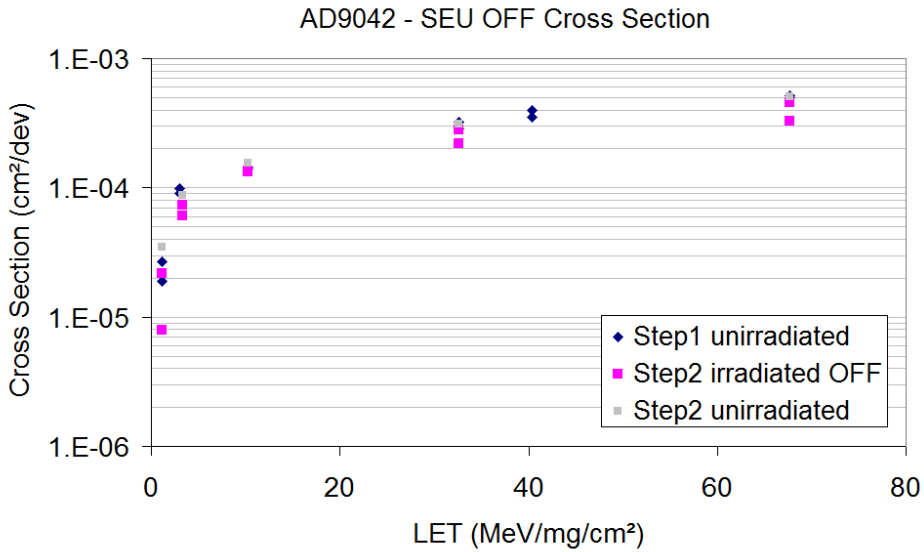
⇒ **No difference between ON and OFF parts**

⇒ **No Synergy effect at 37krad(Si)**

Combined ^{60}Co and SEE test

ADC AD9042 : Step2 = 37.5 krad



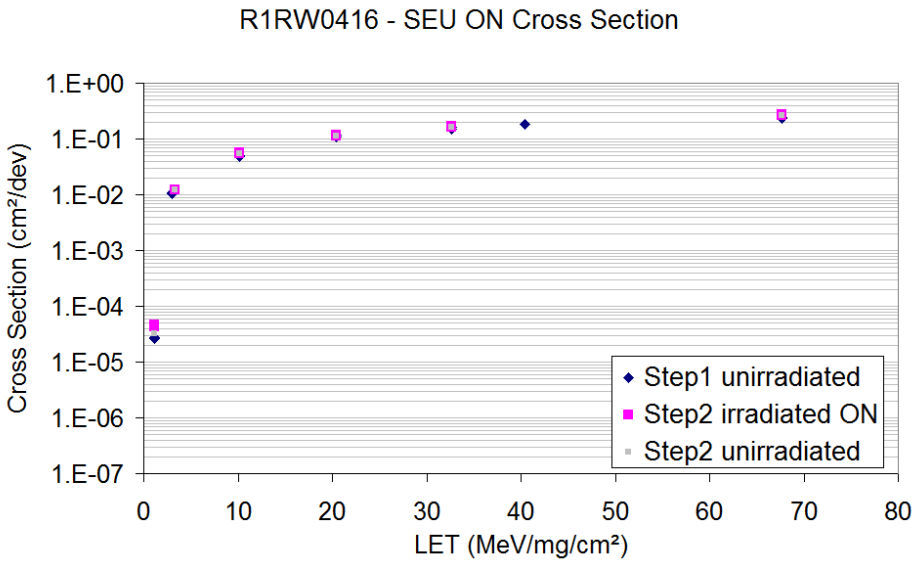


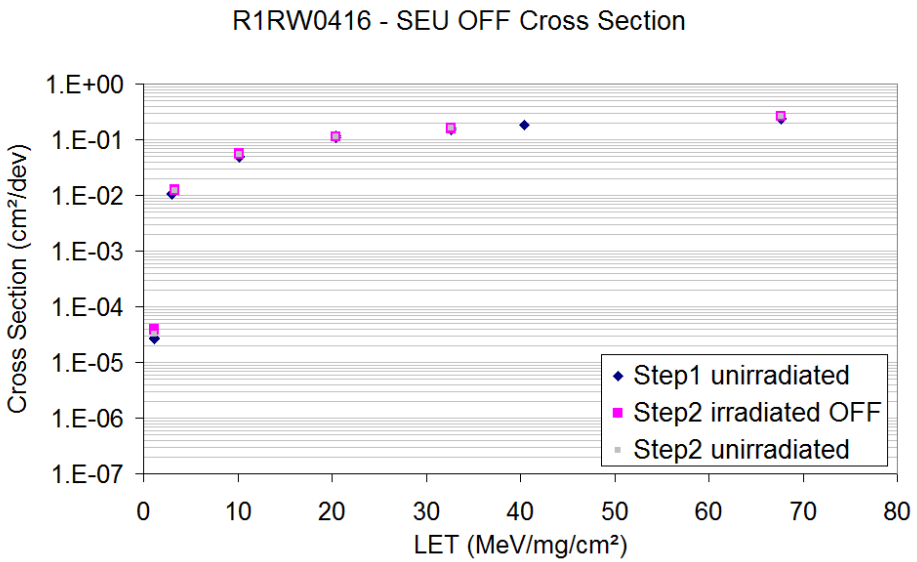
⇒ **No difference between ON and OFF parts**

⇒ **No Synergy effect at 37krad(Si)**

Combined ^{60}Co and SEE test

SRAM R1RW0614 : Step2 = 37.5 krad



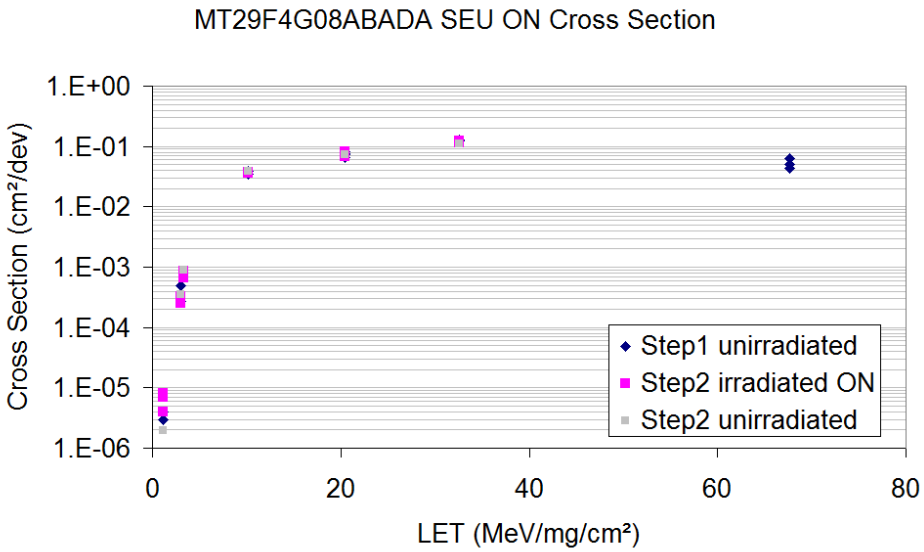


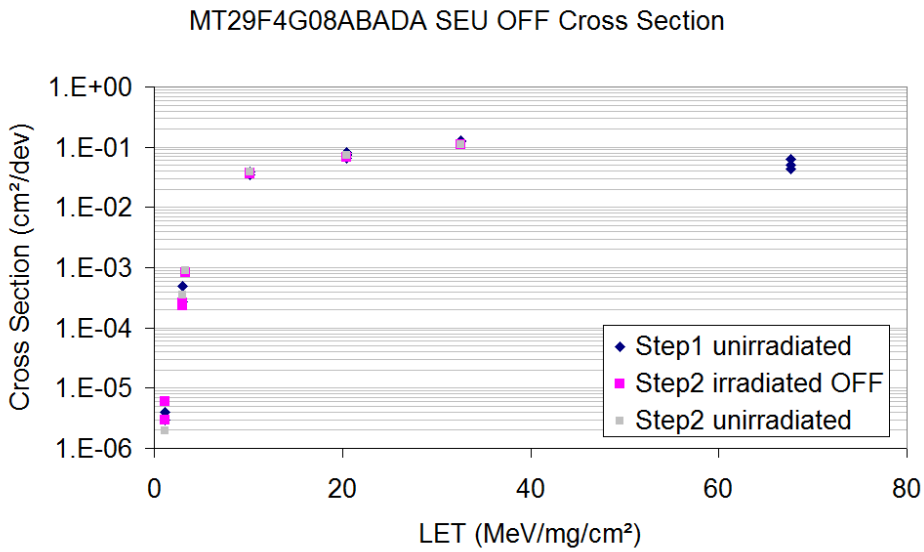
⇒ **No difference between ON and OFF parts**

⇒ **No Synergy effect at 37krad(Si)**

Combined ^{60}Co and SEE test

NAND FLASH MT29F4G08AAC : Step2 = 33.3 krad

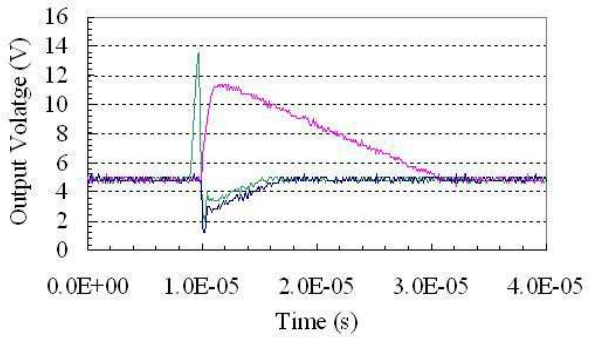




⇒ **No difference between ON and OFF parts**

⇒ **No Synergy effect at 37krad(Si)**

Perspectives



- **Impact of TID on SET shape**
- **Imprint effect on SRAM**
  - During the ^{60}Co total dose irradiation AA pattern is written at all addresses
  - the SEU test pattern is AA in half of the memory array, and the complementary pattern 55 in the other half
- **Impact of TID on SEFI signature …**
- **Impact of TID on SEL sensitivity**

Conclusion

Up to now, no impact of TID on SEE sensitivity,

But …

The project is still in progress

TID Influence on the SEE sensitivity of Active EEE components

QUESTIONS