

AIDA-2020

WP11.4: Access to UCLouvain

AIDA-2020 - 2nd Annual meeting

E.Cortina

UCLouvain

April 5, 2017

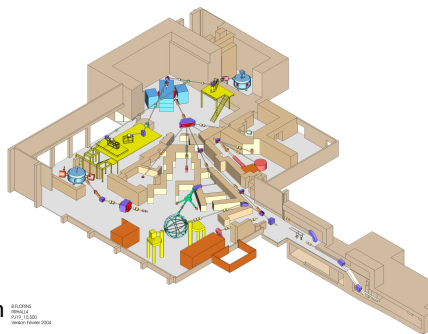
CRC facilities at Louvain-la-Neuve

Located at Louvain-la-Neuve (~ 20 km from Brussels)

Institut de Recherche en Mathématique et Physique (IRMP)
Center for Cosmology, Particle Physics and Phenomenology (CP3)
Centre de Ressources du Cyclotron (CRC)

Three irradiation facilities

- NIF: Neutron Irradiation Facility
 - ▶ Fast Neutrons (0-50 MeV)
 - ▶ Flux: $10^{11} \text{ n}/(\text{cm}^2 \text{ s})$
- LIF: Proton Irradiation Facility
 - ▶ Protons 10-60 MeV
 - ▶ Flux: $5 \times 10^8 \text{ p}/(\text{cm}^2 \text{ s})$
- HIF: Heavy-Ion Irradiation Facility
 - ▶ Heavy Ion "cocktails"
 - ▶ Electronic failures induced by radiation (Single Event Effects)



HIF: Heavy Ion Facility

Facility to measure the response of electronic components to single event effects (SEE).



How to measure SEE

$$\sigma = \frac{N_{SEE}}{\Phi}$$

← Number of SEE

← Fluence $\frac{\text{ions}}{\text{cm}^2}$

→ Φ : $1 - 10^4 \text{ ions/cm}^2 \rightarrow$ dead time

$\Phi \uparrow \rightarrow$ better statistical error
→ Total Dose effects

Weibull function

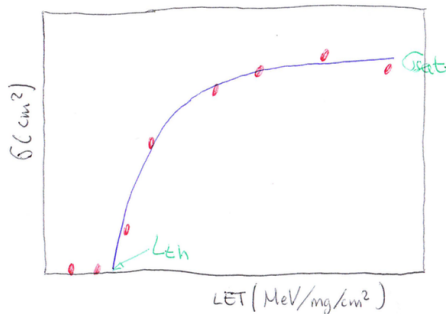
$$\sigma = \sigma_{\text{sat}} \left(1 - e^{-\left(\frac{L - L_{\text{th}}}{w}\right)^s} \right)$$

σ_{sat} : Saturation Cross-section

L_{th} : Threshold value

$L < L_{\text{th}} \rightarrow \sigma = 0$

w, s : fit parameters



HIF characteristics

- Two heavy ions "cocktails" covering a wide range of LET and ranges.
 - ▶ Fully characterisation of SEE response of electronic components.
 - ▶ Fast ion changing within the same cocktail (few minutes)
- Beam flux is variable between a few ions/s.cm² and $\sim 10^4$ ions/s.cm²
 - ▶ Can be modified from user station
 - ▶ Online monitoring → high precision in fluence delivered
- Redundant metrology
 - ▶ Fluence and energy
 - ▶ Moving frame, alignment system
 - ▶ ESA SEU monitor: 4x4 Mbit SRAM (Atmel AT60142F) arranged in a square region of 24mm x 24mm
- Beam homogeneity of 10% on a 25 mm diameter.
- Standard mechanical interface and feedthroughs
- Irradiations are done in vacuum and for most of the ions naked chips are needed.

HIF "cocktails"

		M/Q	Ion	DUT energy [MeV]	Range [$\mu\text{m Si}$]	LET [MeV/mg/cm ²]
Cocktail 1	High LET	5	¹⁵ N ³⁺	60	59	3.3
		5	²⁰ Ne ⁴⁺	78	45	6.4
		5	⁴⁰ Ar ⁸⁺	151	40	15.9
		4.94	⁸⁴ Kr ¹⁷⁺	305	39	40.4
		4.96	¹²⁴ Xe ²⁵⁺	420	37	67.7
Cocktail 2	High penetration	3.25	¹³ C ⁴⁺	131	292	1.1
		3.14	²² Ne ⁷⁺	235	216	3
		3.33	⁴⁰ Ar ¹²⁺	372	117	10.2
		3.22	⁵⁸ Ni ¹⁸⁺	567	100	20.4
		3.32	⁸³ Kr ²⁵⁺	756	92	32.6
		3.54	¹²⁴ Xe ³⁵⁺	995	73	62.5

Irradiations

- 5 projects finished

Acronym	Experiment	Users	Irrad	Institute
AIDA-2020-CRC-2015-01	ALICE ITS	2	11.5 h	CERN
AIDA-2020-CRC-2016-01	ATLAS calo ASIC	2	6.5 h	Columbia Univ.
AIDA-2020-CRC-2016-02	LHCB FPGA RICH	5	10.0 h	IFIN-HH
AIDA-2020-CRC-2016-03	LHCb CLARO	3	8.0 h	INFN
AIDA-2020-CRC-2016-04	LHCb calor	6	13.0 h	CNRS/Barcelona
AIDA-2020-CRC-2017-01	CMS tracker	3	12.0 h	Imperial College

- 1 project submitted but not eligible
- 21 users
 - ▶ 19 male 2 female
 - ▶ 8 institutes, 8 nationalities
- 49(61)/80h used



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Summary

- 60% of projects and 75% of Access Units allocated
 - ▶ 5(6) projects 49(61) hours
 - ▶ 18(21) user visits (2 days stay)

- 2 scientific publications so far
 - ▶ 1 project (2015-01) finalized in Dec 2015.
 - ▶ 3 projects (2016-01,02,03) irradiated on May 30, June 1, 2016.
 - ▶ 1 project (2016-04) irradiated on July 15, 2016
 - ▶ 1 project (2017-01) foreseen for Mid May (LIF)

- Direct contact with users is essential. (4-5 preparatory meetings per project)

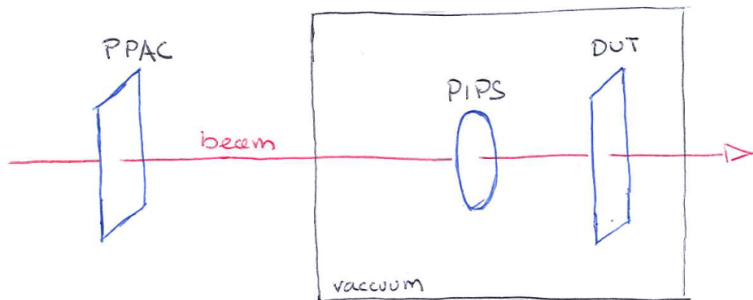
- Irradiations using other lines (NIF: fast neutrons and LIF: protons) available on special request

BACKPUP SLIDES

Quality assurance

For each run/cocktail a whole calibration and quality assurance procedure is performed.

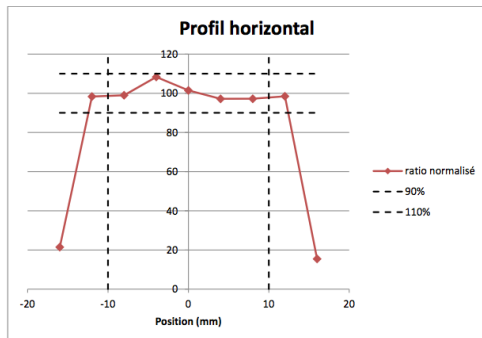
1. Fluence: PPAC+PIPS
2. Profile: PIPS+SEU monitor
3. Energy: PIPS



QA: Beam profile and beam energy

1) Horizontal profile

Reference beam :	$^{40}\text{Ar}^{8+}$ 151MeV
Horizontal homogeneity :	24 mm
Minimum X value(mm) :	-12 mm
Maximum X value (mm) :	+12 mm



<u>Cocktail</u>	<u>Particle</u>	<u>Energy DUT (MeV)</u>	<u>Measured energy (MeV)</u>
M/Q =5	$^{15}\text{N}^{3+}$	60	60
	$^{20}\text{Ne}^{4+}$	78	76
	$^{40}\text{Ar}^{8+}$	151	144
	$^{84}\text{Kr}^{17+}$	305	290
	$^{124}\text{Xe}^{25+}$	420	410

QA: SEU monitor

540	518	530	539	552	518
538	517	583	535	539	508
562	530	520	534	557	523
521	532	523	568	525	549
517	494	536	508	535	553
510	539	567	541	538	552
565	560	503	529	540	557
554	540	589	543	549	576
540	561	537	563		
539	575	606	562		
512	536	551	601		
582	523	559	568		
585	576	583	543		
554	532	529	566		
536	528	809	567		
545	585	588	614		
568	564	543	560	568	540
566	577	579	551	493	528
525	608	533	541	579	562
543	516	554	547	553	561
574	538	542	531	543	549
536	508	573	554	565	560
486	537	576	538	565	579
569	546	557	563	536	557

DIE 0

551	555	525	568	501	498
562	548	540	511	521	548
573	563	583	572	552	482
558	525	541	514	528	539
548	554	562	569	519	550
588	482	545	544	534	548
570	549	567	513	533	552
555	561	545	569	537	510
579	569	549	549	536	
527	551	556	553		
560	571	533	552		
629	533	534	573		
651	536	555	533		
624	536	481	546		
525	554	532	556		
545	585	541	537	535	513
575	607	554	537	537	499
538	547	527	542	557	487
531	516	542	529	538	522
514	560	553	498	497	479
535	530	536	522	541	544
559	524	502	552	495	496
526	497	526	484	526	524

DIE 2

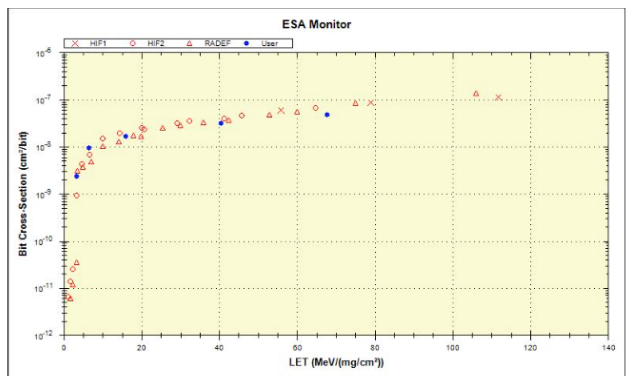
Moyenne	535
110%	589
90%	482

485	502	502	525	509	543
436	480	504	476	522	503
462	514	508	517	527	510
508	525	502	517	548	554
486	495	495	483	526	506
476	568	546	505	522	517
519	522	538	533	513	527
522	577	555	599	581	522
547	545	528	522		
527	539	534	518		
490	515	524	571		
491	518	525	551		
519	508	553	518		
521	539	540	567		
523	534	559	586		
536	506	542	495		
563	526	492	544	531	541
518	535	524	543	543	505
488	543	526	525	497	554
533	541	521	560	533	551
515	517	547	558	558	543
491	534	518	512	509	548
515	547	526	563	525	565
550	537	512	510	500	550

DIE 1

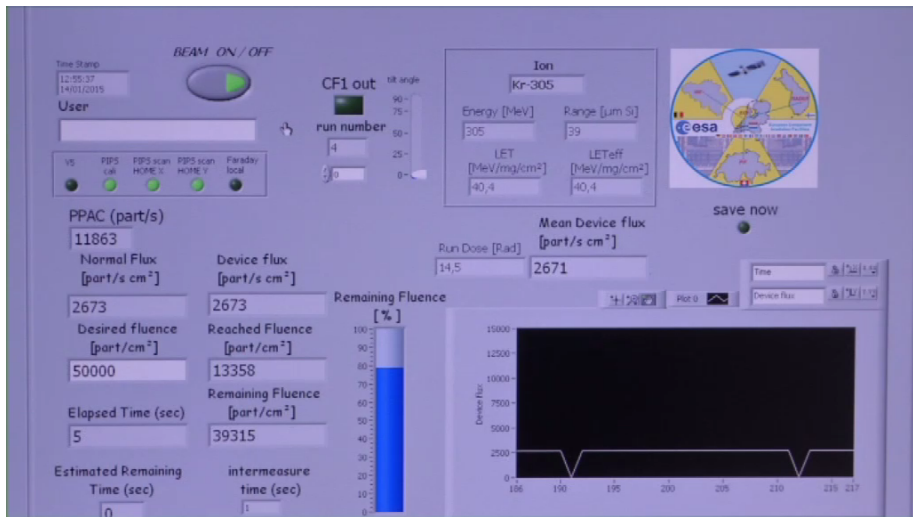
COKTAIL :	M/Q = 5
ION :	40Ar8+
ENERGIE DUT :	151 MeV
LET :	15,9 Mev/(mg/cm ²)
TOTAL WORD ERROR :	258944
TOTAL BIT ERROR :	274072
FLUENCE :	1,00E+06 Part/cm ²
CROSS SECTION :	1,633E-08 cm ² /bit

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



return

User station control panel



Single Event Effects

SEE: Effects caused by a single energetic particle. Depends on energy released (LET)

Non-destructive effects (Soft errors)

SET: Single Event Transient

SEU: Single Event Upset

SBU: Single Bit Upset

MBU: Multiple Bit Upset

SEFI: Single Event Functional Interruption

SEL: Single Event Latchup

Destructive effects (Hard errors)

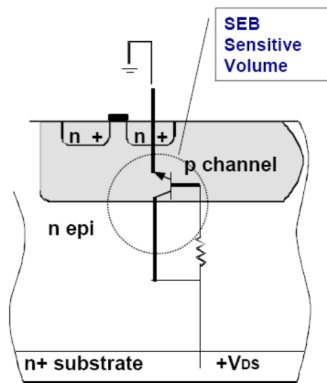
SHE: Single Hard Error (bit stuck)

SEL: Single Event Latchup

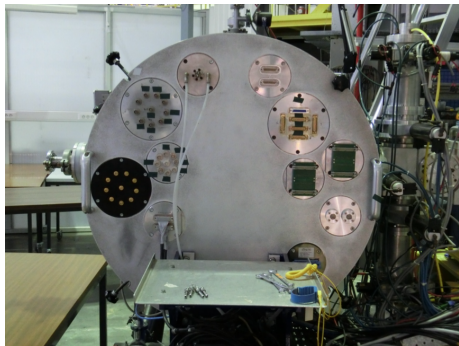
SEB: Single Event Burnout

SEGR: Single Event Gate Rupture

SEDR: Single Event Dielectric Rupture



Feedtroughs



Large Flange:

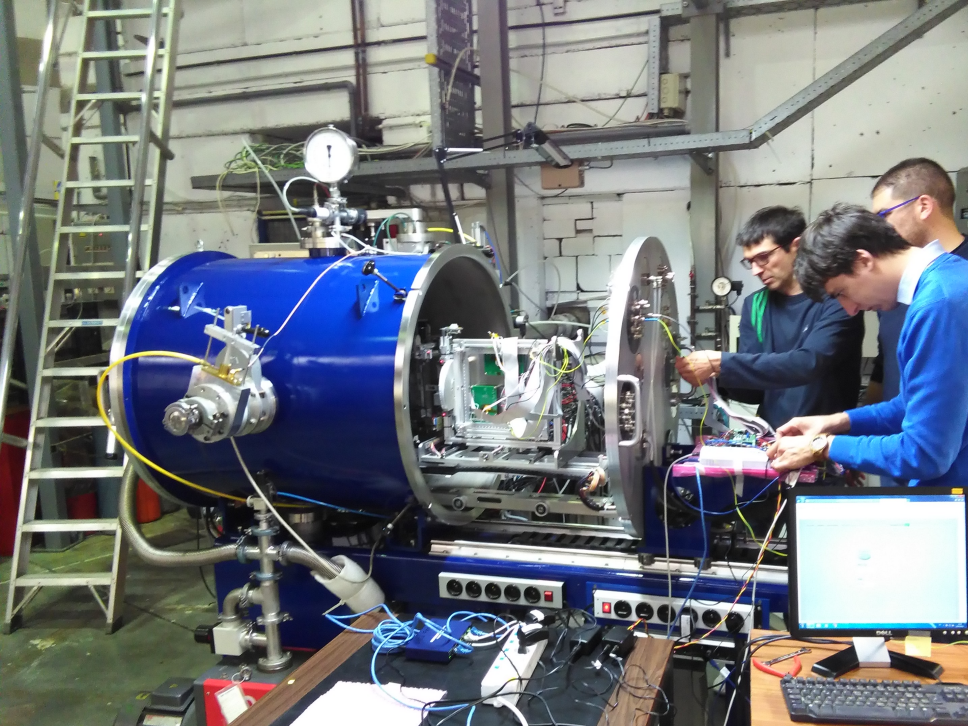
- 10x BNC (F/F)
- 10x BNC (Ground isolated) (F/F)
- 10x SMA (Ground isolated) (F/F)
- 6x Sub D 25 (Cannot be dismantled) (M outside/F inside)

Small Flange:

- 8x BNC + 2x SHV (F/F)
- 9x BNC (F/F)
- 2x USB
- 10x SMA (F/F)
- 2x Sub D 25 (M/M)
- 2x HE 10 40 pin (M/M)
- 2x H80A2CO 40 (M/M)
- Water cooling 4-6mm hose with rack connectors input/output + Thermocouple connector

Transition available on request:

- Sub-D25 transition to Ethernet (M/Eth, F/Eth)
- USB transition



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