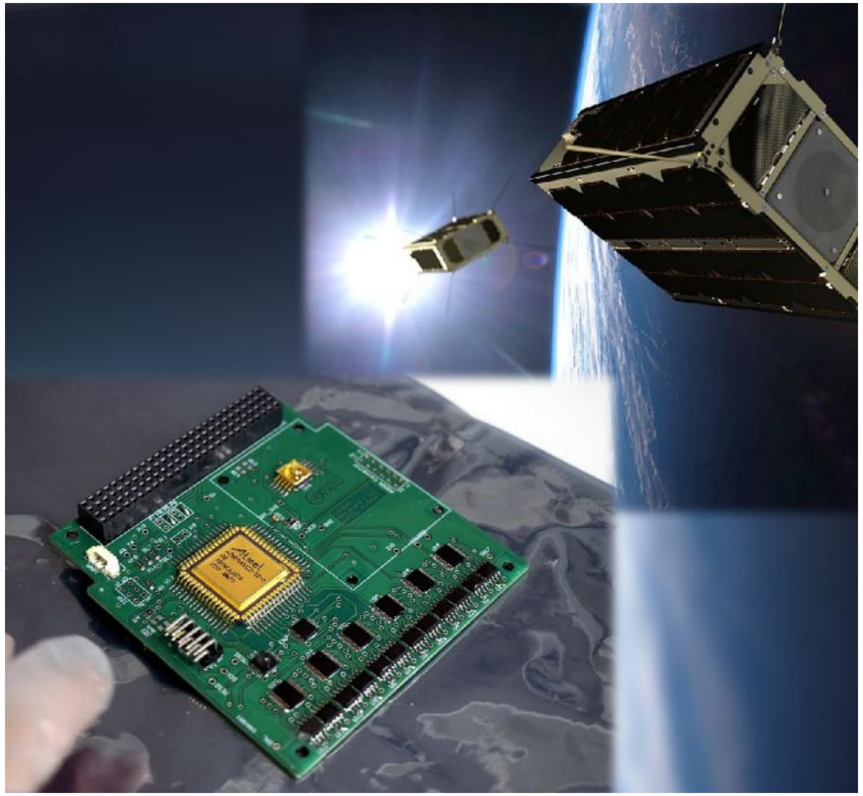
Radiation screening of COTS components and verification of COTS RHA approach (CORHA)

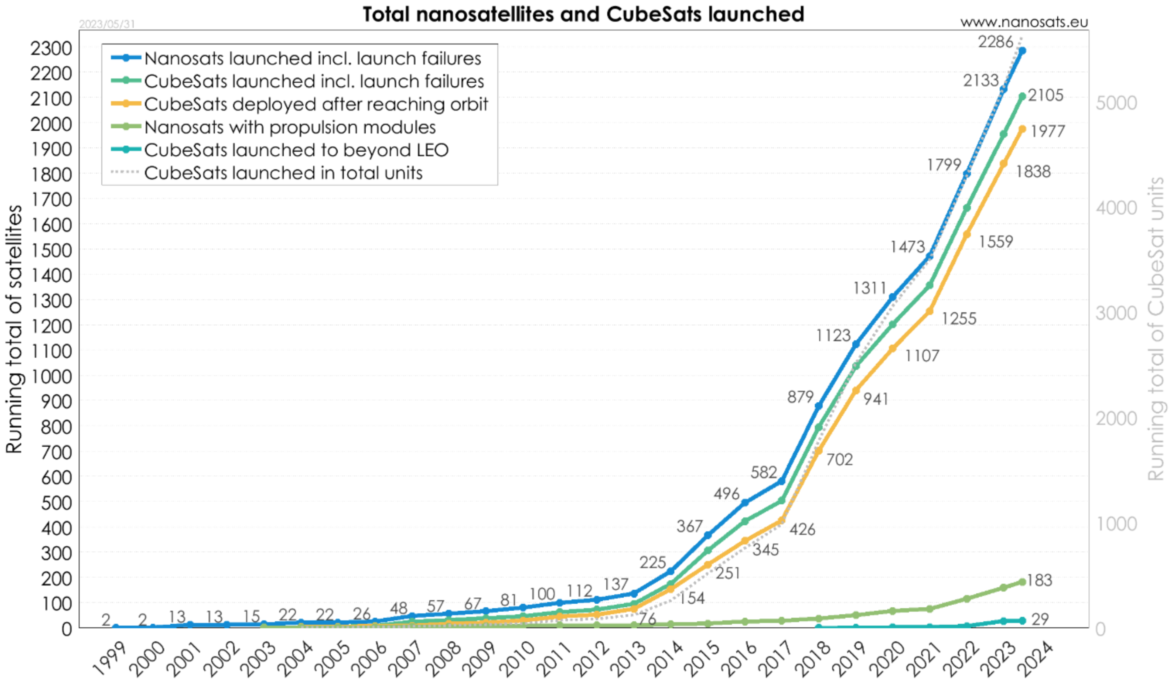
C. Tscherne[1], P. Beck[1], M. Bagatin[2], S. Gerardin[2], M. Latocha[1], A. Paccagnella[2], M. Poizat[3], M. Wind[1]

[1]Seibersdorf Laboratories, [2]University of Padova, [3]ESA

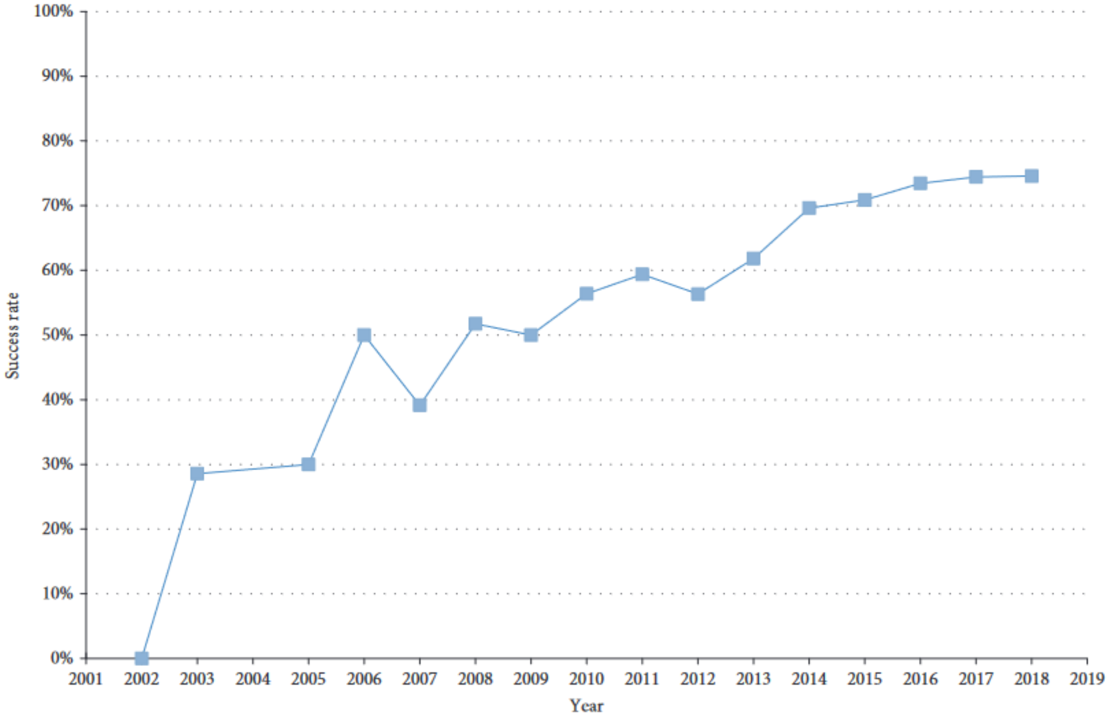
TEC-QEC Final Presentation Days
29th June 2023, ESTEC, Noordwijk, The Netherlands



Motivation



Erik Kulu, Nanosats Database, www.nanosats.eu



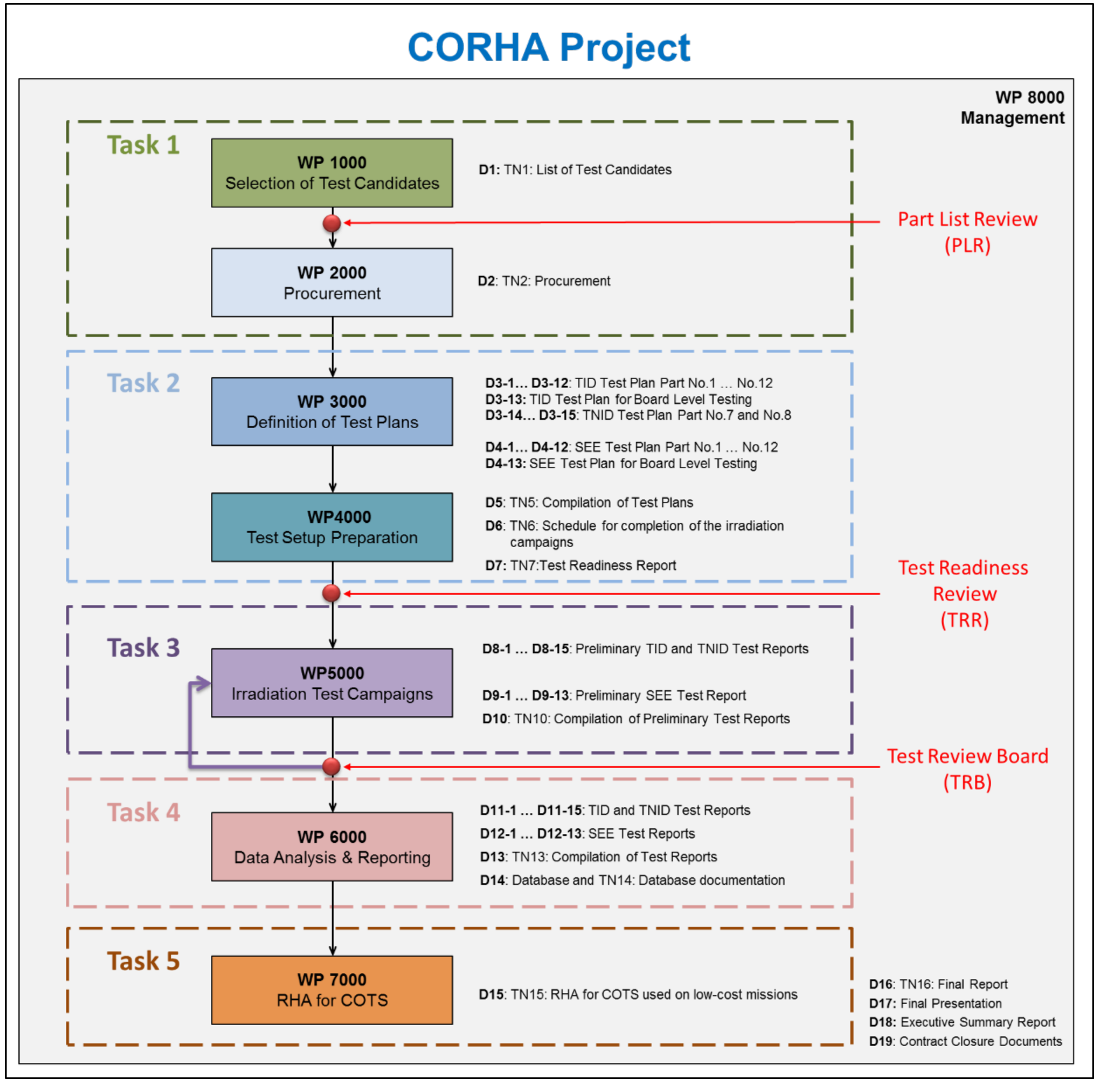
T. Villela et al., "Towards the Thousandth CubeSat: A Statistical Overview", *International Journal of Aerospace Engineering*, vol. 2019, Article ID 5063145, 13 pages, 2019. https://doi.org/10.1155/2019/5063145

CORHA Objectives

(1) **Radiation screen Commercial Off-The-Shelf (COTS)** and novel semiconductor technologies of interest to ESA, the European space industry and SmallSat applications

(2) **Define associated Radiation Hardness Assurance (RHA) processes** related to irradiation characterization of COTS components

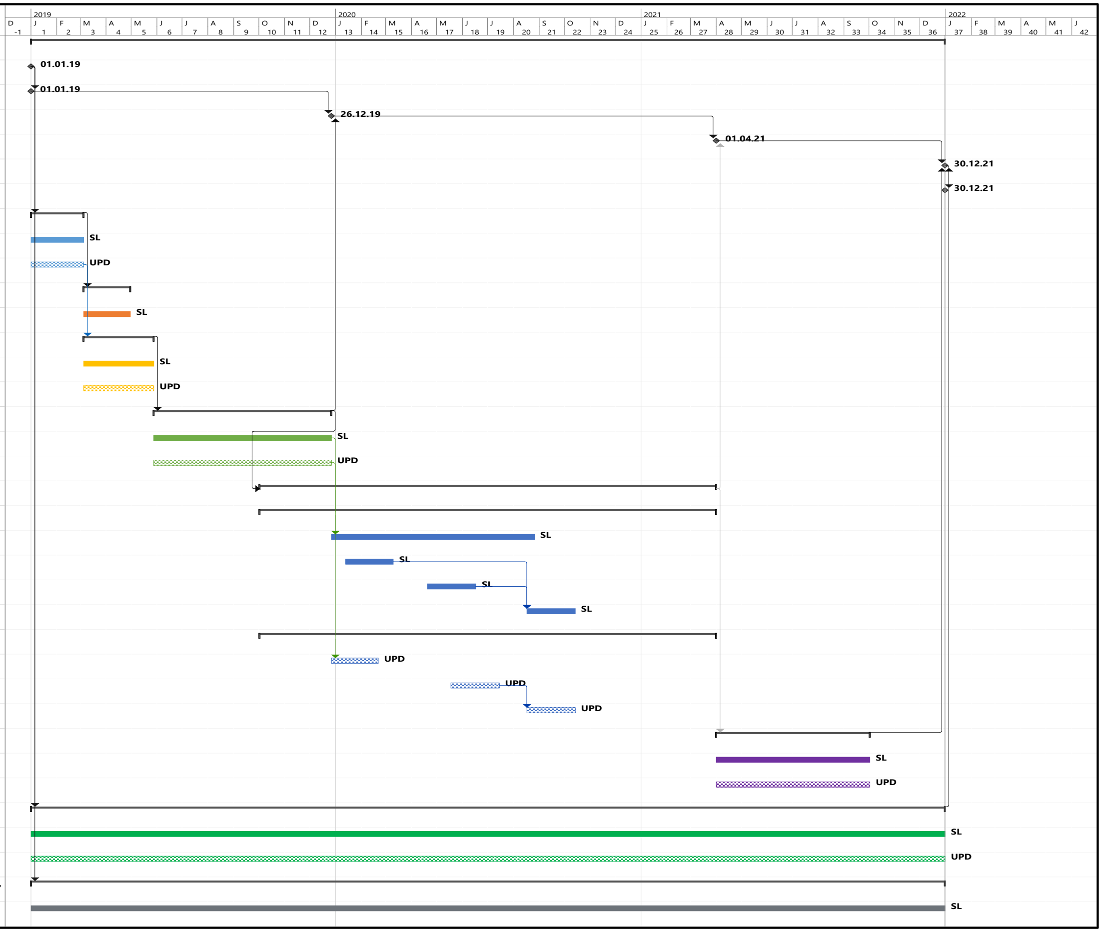
Study Logic


CORHA Project
WP 8000
Management
Task 1
WP 1000
Selection of Test Candidates
D1: TN1: List of Test Candidates
Part List Review
(PLR)
WP 2000
Procurement
D2: TN2: Procurement
Task 2
WP 3000
Definition of Test Plans
D3-1… D3-12: TID Test Plan Part No.1 … No.12
D3-13: TID Test Plan for Board Level Testing
D3-14… D3-15: TNID Test Plan Part No.7 and No.8
D4-1… D4-12: SEE Test Plan Part No.1 … No.12
D4-13: SEE Test Plan for Board Level Testing
WP4000
Test Setup Preparation
D5: TN5: Compilation of Test Plans
D6: TN6: Schedule for completion of the irradiation campaigns
D7: TN7:Test Readiness Report
Test Readiness Review
(TRR)
Task 3
WP5000
Irradiation Test Campaigns
D8-1 … D8-15: Preliminary TID and TNID Test Reports
D9-1 … D9-13: Preliminary SEE Test Report
D10: TN10: Compilation of Preliminary Test Reports
Test Review Board
(TRB)
Task 4
WP 6000
Data Analysis & Reporting
D11-1 … D11-15: TID and TNID Test Reports
D12-1 … D12-13: SEE Test Reports
D13: TN13: Compilation of Test Reports
D14: Database and TN14: Database documentation
Task 5
WP 7000
RHA for COTS
D15: TN15: RHA for COTS used on low-cost missions
D16: TN16: Final Report
D17: Final Presentation
D18: Executive Summary Report
D19: Contract Closure Documents

Project Overview and Schedule

Customer	ESA
Coordinator	Seibersdorf Labor GmbH
Partner	University Padova
Duration	2019 – 2022
Components	13
Part Types	Memories, OpAmps, MCU, MUX, Converters, ADC
Testing	TID (+ Lot-to-Lot), SEE
Innovation	RHA procedures for COTS

Nr.	WP No.	Working Package Title	Documents
1	-	**CORHA**	
2	-	MS-0: Kick-Off	KO-MoM
3	-	MS-1: PLR - Part List Review	PLR-MoM
4	-	MS-2: TRR - Test Readiness Review	TRR-MoM
5	-	MS-3: TRB - Test Review Board	TRB-MoM
6	-	MS-4: FR - Final Review	FR-MoM
7		CCD	CCD
8	**1000**	**Selection of Test Candidates**	**TN1**
9	1100	Selection Test Candidates (excl. Memories)	TN1.1
10	1200	Selection of Test Candidates (Memories)	TN1.2
11	**2000**	**Procurement**	**TN2**
12	2100	Procurement of Selected Parts	TN2
13	**3000**	**Definition of Test Plans**	**TN5**
14	3100	Definition Testplans (excl. Memories)	TN3, TN4
15	3200	Definition Testplans for Memories	TN3, TN4
16	**4000**	**Test Set-Up Preparations**	**TN6, TN7**
17	4100	Test Set-Up preparation (excl. Memories)	TN6.1, TN7.1
18	4200	Test Set-Up preparation for Memories	TN6.2, TN7.2
19	**5000**	**Irradiation Test Campaings**	**TN10**
20	5100	Irradiation Tests (excl. Memories)	**TN8, TN9**
21		T1: TID (HDR, ELDRS, Board Level)	TN8
22		T2: SEE / Heavy Ion	TN9
23		T6: SEE / Heavy Ion	TN9
24		T7: SEE, BoardLevel / Proton	TN9
25	5200	Irradiation Tests for Memories	**TN8, TN9**
26		T1: TID (HDR)	TN8
27		T4: SEE / Heavy Ion	TN9
28		T5: SEE / Proton	TN9
29	**6000**	**Data Analysis & Reporting**	**TN13, TN14**
30	6100	Analysis & Reporting (excl. Memories)	TN11, TN12, TN14
31	6200	Analysis & Reporting for Memories	TN11, TN12
32	**7000**	**RHA for COTS**	**TN15**
33	7100	Ad-Hoc RHA approach for COTS	TN15.1
34	7200	RHA approach for COTS Memories	TN15.2
35	**8000**	**Management**	**TN16, FP, ESR, CCD**
36	8100	Management	

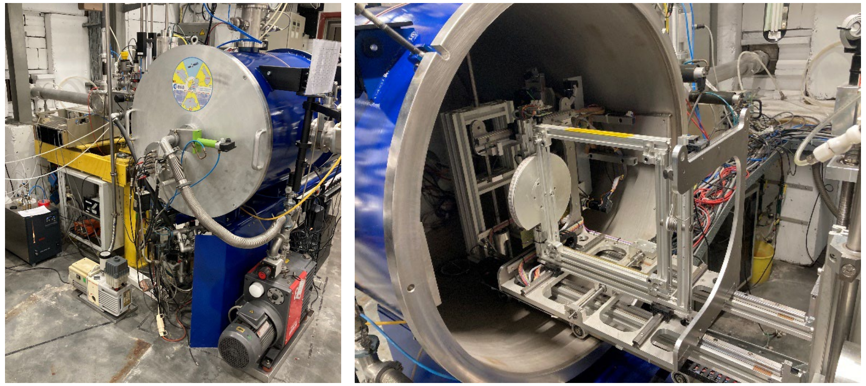


COTS Test Candidates

#	Component	Description	Manufacturer	Package	Family
1	**MT28EW128ABA**	128Mb Embedded NOR Flash Memory	Micron	TSOP 56	**Flash Memory**
2	**CY14V101PS**	1-Mbit Quad SPI nvSRAM	Cypress	16 pin SOIC	**nv-SRAM**
3	**MB85RS256TY**	256K Bit SPI FRAM	Fujitsu	8 pin SOP	**Ferroelectric RAM**
4	**CY15B102QN**	2-Mbit Serial (SPI) F-RAM	Cypress	8 pin SOIC	**Ferroelectric RAM**
5	**STM32F103**	Microcontroller	STM	LQFP100	**Microcontroller**
6	**STM32L152**	Microcontroller	STM	LQFP100	**Microcontroller**
7	**LT1499HS**	10MHz,Quad Rail-to-Rail Input and Output OpAmp	Linear Technology	14 pin SOIC	**Operational Amplifier**
8	**LTC6240**	CMOS Operational Amplifier	Linear Technology	8 pin SO	**Operational Amplifier**
9	**MAX44248ASA+**	36V, Precision, Low-Power, 90µA, Dual Op Amp	Maxim Integrated	SOIC-8	**Operational Amplifier**
10	**CD74HC4051**	Hi-Speed CMOS 8-Ch MUX	TI	16 pin SOIC	**Multiplexer**
11	**ADG5408TCPZ**	HV Latch-up proof 8 Channel MUX	Analog Devices	16 lead LFCSP	**Multiplexer**
12	**LTC3895**	Synchronous Step-Down DC/DC Controller	Linear Technology	TSSOP38	**DC / DC Converter**
13	**ADC128S102**	500 ksps to 1Msps, 12-Bit A/D Converter	TI	TSSOP-16	**AD Converter**

Radiation Testing

Source	Testing	Facility
Co-60	TID	TEC-Laboratory, Seibersdorf, AT (ISO/IEC 17025)
Heavy Ion	SEE	HIF (UCL), Louvain, BE
Proton	SEE	PSI, Villigen, CH Protonterapia Trento, IT


Heavy Ion Facility, UCL, Belgium


PSI, Switzerland

TEC Laboratory Seibersdorf, Austria

Test Overview

No.	Component	Family	Manufacturer	Package	TID (Co-60)	SEE (Heavy Ions)	SEE (Protons)
1	MT28EW128ABA	Memory – Flash	Micron	TSOP 56	Yes	Yes	N/A
2	CY14V101PS	nv-SRAM	Cypress	16 pin SOIC	Yes	Yes	Yes
3	MB85RS256TY	Ferroelectric RAM	Fujitsu	8 pin SOP	Yes	Yes	N/A
4	CY15B102QN	Ferroelectric RAM	Cypress	8 pin SOIC	Yes Lot-to-Lot	Yes	Yes
5	STM32F103RGT6	Microcontroller	STM	LQFP64	Yes Lot-to-Lot	Yes	Yes
6	STM32L152RET6	Microcontroller	STM	LQFP64	Yes	Yes	Yes
7	LT1499HS	OpAmp	Linear Technology	14 pin SOIC	Yes	Yes	Yes
8	LTC6240	OpAmp	Linear Technology	8 pin SO	Yes Lot-to-Lot	Yes	Yes
9	CD74HC4051	Multiplexer	TI	16 pin SOIC	Yes	Yes	N/A
10	ADG5408TCPZ-EP	Multiplexer	Analog Devices	16 lead LFCSP	Yes	Yes	N/A
12	ADC128S102	ADC	TI	TSSOP-16	Yes	Yes	Yes
13	MAX44248ASA+TCT-ND	OpAmp	Maxim Integrated	SOIC-8	Yes	No	No

TID Test Results Overview

Category	Device	Parametric Failure Level (krad)		Functional Failure Level (krad)		TID Pass Level (krad)		Comment
		biased	unbiased	biased	unbiased	biased	unbiased	
Non-volatile Memory	MT28EW128ABA	50	50	> 100	> 100	15	15	Standby current increases over spec.
	CY14V101PS	50	100	> 100	> 100	15	50	Supply current increases overs spec.
	MB85RS256TY	50	-	100	> 100	15	100	
	CY15B102QN	15	-	50	> 100	10	100	Standby current increases over spec, then functional failure.
Microcontroller	STM32F103RGT6	-	-	54	100	25	54	
	STM32L152RET6	-	-	54	168h, 100°C	25	24h, RT	
OpAmp	LT1499HS	10	10	> 100	> 100	2	2	
	LTC6240HVCS	10	10	> 100	> 100	2	2	
	MAX44248ASA+T	> 65	> 65	> 65	> 65	65	65	
Analog Mux	CD74HC4051M96	11	54	> 100	> 100	2	25	Truth Table Test fails after 24h, RT anneal and recovers after 168h, elevated temperature annealing
	ADG5408TCPZ-EP	2	11	> 100	> 100	0	2	Truth Table Test fails at 2 krad for the biased and at 100 krad for the unbiased device
ADC	ADC128S102CIMTX	11	11	> 100	> 100	2	2	

TID Lot-to-Lot Example: LTC6240

Passed	Functional Failure
Biased / Unbiased	Parametric Failure

LTC6240 (Lot-to-Lot)

Symbol	LTC6240HVCS8 Lot 1															
	Applied Dose in krad$_{(Si)}$												Annealing			
	2		10		15		25		53		100		24h R.T.		168h 65°C	
V_{OS}	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_S^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_S^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_B^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_B^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_B	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_{OS}	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
A_{VO}	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
CMRR	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
V_O^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
V_O^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_{SC}^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_{SC}^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
SR+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
SR-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
PSRR+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
PSRR-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U

Symbol	LTC6240HVCS8 Lot 2															
	Applied Dose in krad$_{(Si)}$												Annealing			
	2		10		15		25		53		100		24h R.T.		168h 65°C	
V_{OS}	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_S^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_S^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_B^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_B^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_B	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_{OS}	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
A_{VO}	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
CMRR	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
V_O^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
V_O^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_{SC}^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_{SC}^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
SR+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
SR-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
PSRR+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
PSRR-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U

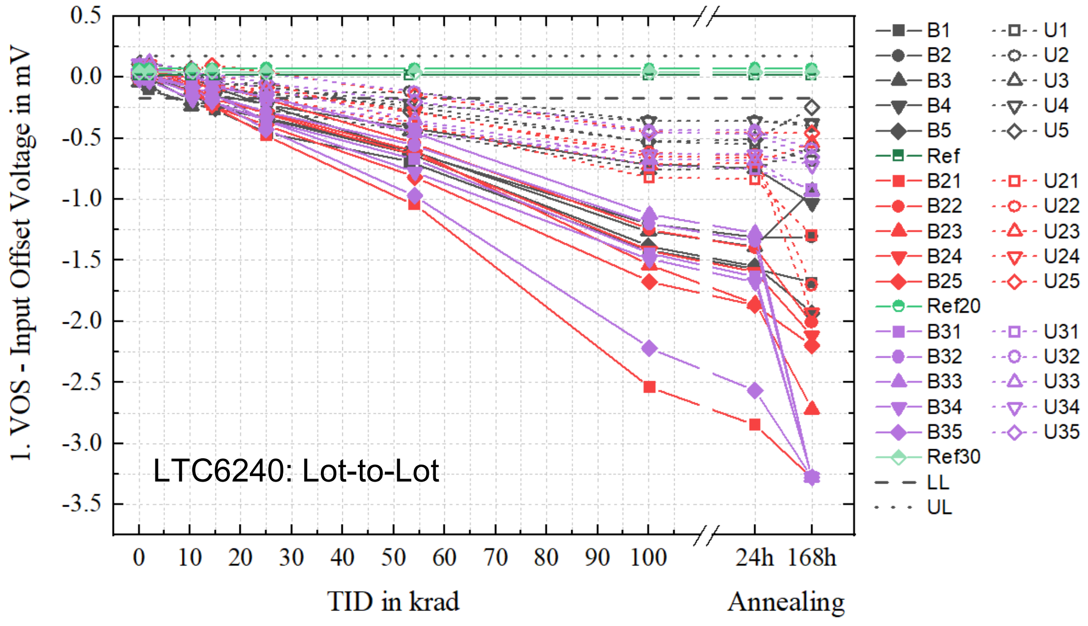
Symbol	LTC6240HVCS8 Lot 3															
	Applied Dose in krad$_{(Si)}$												Annealing			
	2		10		15		25		53		100		24h R.T.		168h 65°C	
V_{OS}	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_S^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_S^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_B^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_B^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_B	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_{OS}	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
A_{VO}	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
CMRR	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
V_O^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
V_O^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_{SC}^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_{SC}^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
SR+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
SR-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
PSRR+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
PSRR-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U

LT1499

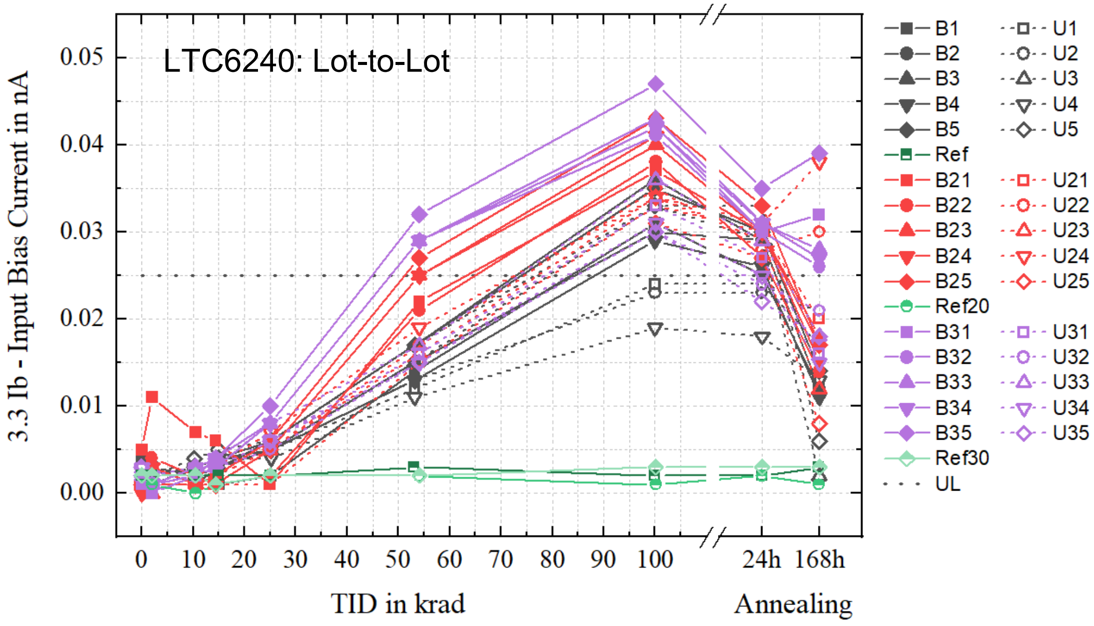
Symbol	LT1499HS															
	Applied Dose in krad$_{(Si)}$												Annealing			
	2		10		15		25		53		100		24h R.T.		168h 100°C	
V_{OS}	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_S^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_S^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_B^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_B^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_B	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_{OS}	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
A_{VO}	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
CMRR	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
V_O^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
V_O^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_{SC}^+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
I_{SC}^-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
SR+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
SR-	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
PSRR+	B	U	B	U	B	U	B	U	B	U	B	U	B	U	B	U
PSRR-																

TID Lot-to-Lot Example: LTC6240

Input Offset Voltage V_{OS}



Input Bias Current I_B

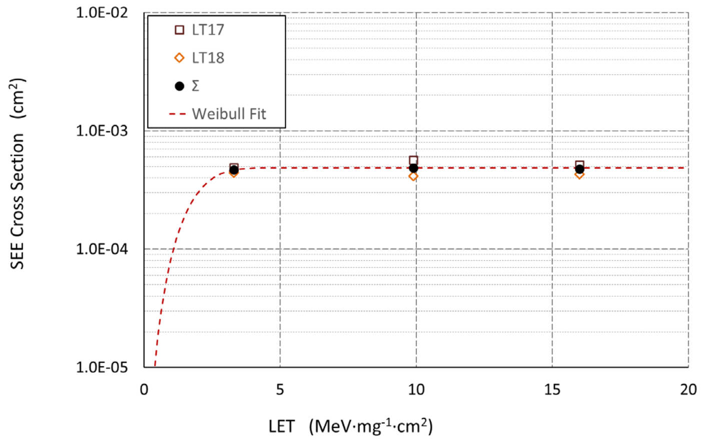


SEE Test Result Overview

Category	Device	SEL	Comments
Non-volatile Memory	MT28EW128ABA	Yes	Small probability
	CY14V101PS	Yes	At room temperature, also with protons
	MB85RS256TY	No	-
	CY15B102QN	Yes	At room temperature, also with protons
Microcontroller	STM32F103RGT6	No	-
	STM32L152RET6	Yes	Intense latching at room temperature, also with protons
OpAmp	LT1499HS#PBF-ND	No	-
	LTC6240HVCS#PBF-ND	No	-
Analog Mux	CD74HC4051M96	No	-
	ADG5408TCPZ-EP	No	A single latch up was observed at room temperature
ADC	ADC128S102CIMTX	Yes	-

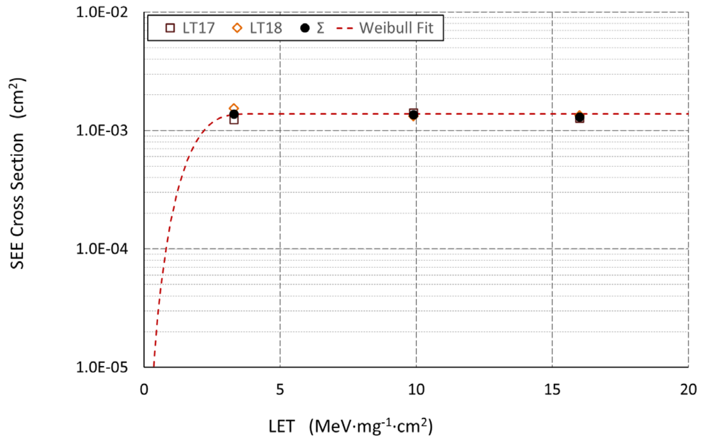
SEE Test Results Example: STM32L152RET6

Ion Species	LET (MeV·mg⁻¹·cm²)	DUT	Φ (cm⁻²)	SET	SEFI	SEL
$^{53}Cr^{16+}$	16.0	LT17	$7.4 \cdot 10^4$	-	38	94
		LT18	$6.7 \cdot 10^4$	-	29	90
$^{36}Ar^{11+}$	9.9	LT17	$7.1 \cdot 10^4$	-	40	100
		LT18	$7.5 \cdot 10^4$	-	31	99
$^{22}Ne^{7+}$	3.3	LT17	$7.3 \cdot 10^4$	-	36	91
		LT18	$6.3 \cdot 10^4$	-	28	97



SEFI cross sections for the STM32L152 when exposed to heavy ions.

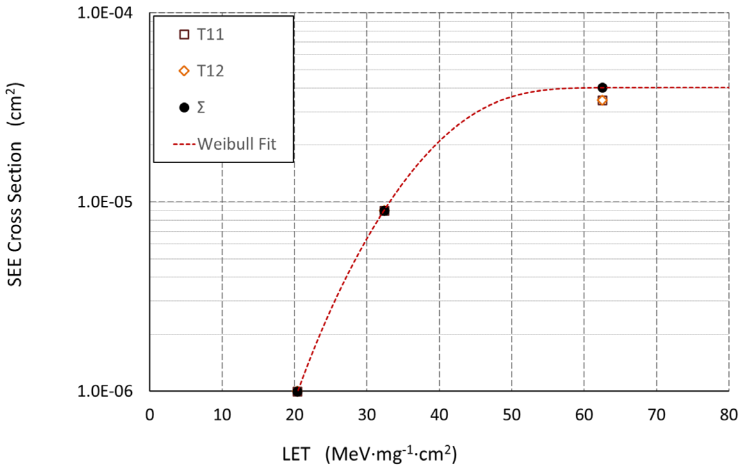
Source	Energy (MeV)	DUT	Φ (cm⁻²)	SET	SEFI	SEL
p^+	200	LP1	$1.1 \cdot 10^{10}$	-	57	104
		LP2	$1.7 \cdot 10^{10}$	-	47	100
p^+	75	LP1	$1.5 \cdot 10^{10}$	-	45	100
		LP2	$2.0 \cdot 10^{10}$	-	38	105



SEL cross sections for the STM32L152 when exposed to heavy ions

SEE Test Results Example: ADC128S102

Ion Species	LET (MeV·mg⁻¹·cm²)	DUT	Φ (cm⁻²)	SET	SEL
$^{124}Xe^{35+}$	62.5	T11	$1.0 \cdot 10^6$	-	46
		T12	$8.5 \cdot 10^5$	1	28
$^{84}Kr^{25+}$	32.4	T11	$1.0 \cdot 10^6$	2	9
		T12	$1.0 \cdot 10^6$	-	9
$^{58}Ni^{18+}$	20.4	T11	$1.0 \cdot 10^6$	1	-
		T12	$1.0 \cdot 10^6$	-	-
$^{53}Cr^{16+}$	16.0	T11	$1.0 \cdot 10^6$	-	-
		T12	$1.0 \cdot 10^6$	-	-
$^{36}Ar^{11+}$	9.9	T11	$1.0 \cdot 10^6$	1	-
		T12	$1.0 \cdot 10^6$	-	-



SEL cross sections for the ADC128S102 when exposed to heavy ions.

Source	Energy (MeV)	DUT	Φ (cm⁻²)	SET	SEL
p^+	200	P1	$1.0 \cdot 10^{11}$	-	-
		P2	$1.0 \cdot 10^{11}$	-	-

Radiation Testing Database

Objective and Scope

- To analyze existing databases and gain insights
- To design database structure based on lessons learned
- To outline of the first implementation of the design

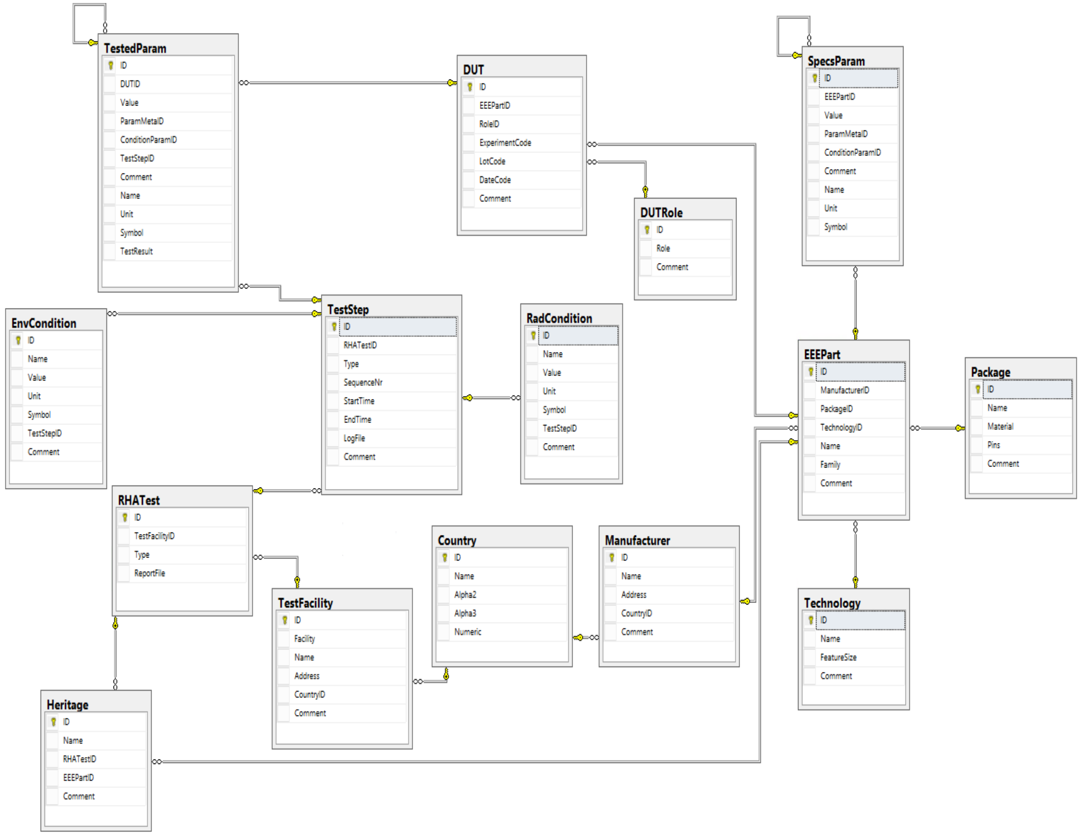
Analysis of existing databases

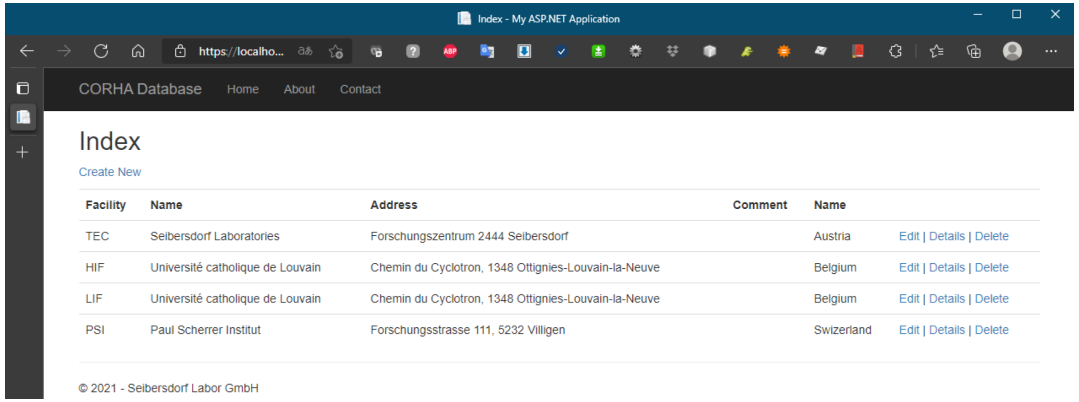
Database	Part-Description	Manufacturer	Part Type Date Code	Source / User	Date	Device Function	Test Type	Dose Rate	Dose Level	Link to Report
ESA Radiation Test Database	✓	✓	✓	✓	✓	x	x	x	x	✓
GSFC	✓	✓	✓	x	✓	✓	x	x	x	✓
JPL	✓	✓	✓	x	✓	✓	✓	x	x	✓
CERN Radiation Test Database	✓	✓	✓	x	✓	✓	✓	✓	✓	N/A

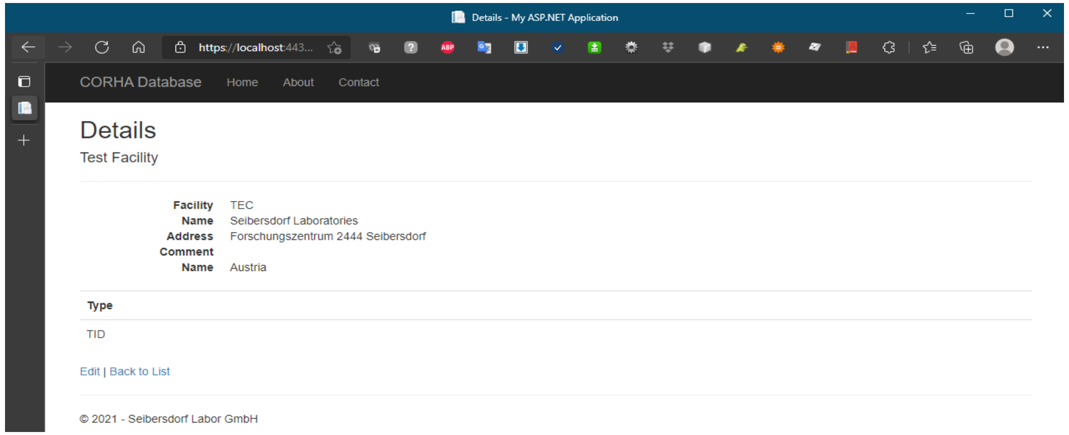
Lessons Learned

- User friendliness crucial
- Powerful front-end website
- Navigate comfortably
- Quickly find relevant data
- Search for specific test conditions
  - TID levels,
  - applied dose rates
  - investigated SEE effects
  - applied LET, …
- Availability of test reports

Radiation Testing Database



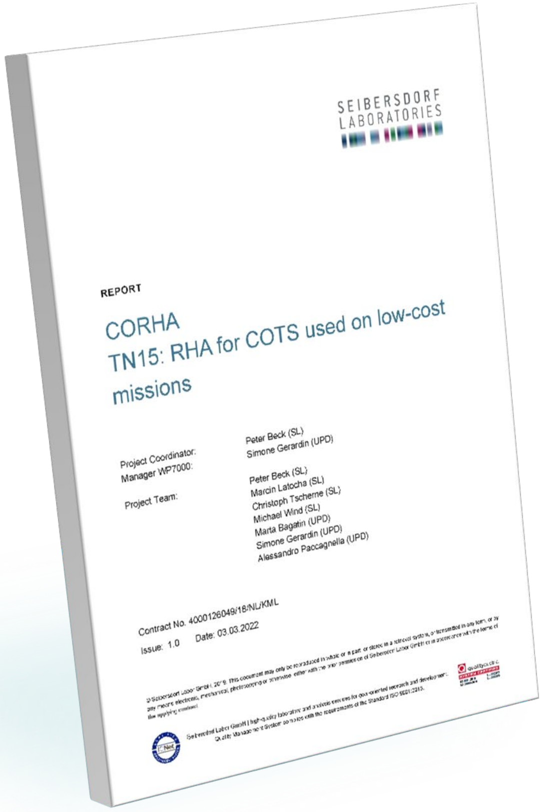




SEIBERSDORF LABORATORIES

RHA Approach & Guidelines for COTS

- ✓ **Part criticality analysis**
- ✓ **Evaluation of radiation performance of selected parts**
  - Use of existing data
  - Use of information on manufacturing technology
- ✓ **Radiation testing**
  - Reduction of tested parts and radiation sources
  - Radiation testing at board and system level
  - TID and SEE testing recommendations
- ✓ **Part suitability assessment**
  - Recommended radiation design margins


SEIBERSDORF LABORATORIES

REPORT

CORHA
TN15: RHA for COTS used on low-cost missions

Project Coordinator: Peter Beck (SL)
Manager WP7000: Simone Gerardin (UPD)

Project Team: Peter Beck (SL)
Marcin Latocha (SL)
Christoph Tscherne (SL)
Michael Wind (SL)
Marta Bagatin (UPD)
Simone Gerardin (UPD)
Alessandro Paccagnella (UPD)

Contract No. 4000126049/18/NL/KML
Issue: 1.0 Date: 03.03.2022

Summary & Conclusion

- **COTS-RHA Study**: Coordinator: **Seibersdorf Laboratories**, Partner: **University Padova**
- **Radiation testing** (TID incl. lot-to-lot, SEE, board level) of **13 COTS** components allowed to evaluate different types and technologies in terms of TID and SEE susceptibility
- **Test Results:** Some COTS devices show very high TID susceptibility, with parametric failures at TID levels as low as **2 krad**$_{(Si)}$ and **SEL** already at low LET
- **Final Presentation** was successfully held at ESA/ESTEC in April 2022
- The CORHA study concludes with **RHA for COTS used on low-cost space missions**

CORHA Publications

- Peter Beck, Marta Bagatin, Simone Gerardin, Marcin Latocha, Alessandro Paccagnella, Christoph Tscherne, Michael Wind, Marc Poizat, **CORHA - Radiation Screening of COTS Components and Verification of COTS RHA Approach**, in *ACCEDE COTS 2019*, Seville, Spain, 2019.
- Peter Beck, Marta Bagatin, Simone Gerardin, Marcin Latocha, Alessandro Paccagnella, Christoph Tscherne, Michael Wind, Marc Poizat, **ESA Study on Radiation Testing of COTS Components to Verify a COTS RHA Approach**, in *5th RADHARD Symposium*, Seibersdorf, Austria, 2020.
- Christoph Tscherne, Michael Wind, Marta Bagatin, Simone Gerardin, Marcin Latocha, Alessandro Paccagnella, Marc Poizat, Peter Beck, **Testing of COTS Operational Amplifier in the Framework of the ESA CORHA Study**, Radiation Effects on Components and Systems Conference, RADECS 2020, Oct-Nov 2020, to be published
- M. Wind, C. Tscherne, M. Bagatin, S. Gerardin, L. Huber, M. Latocha, A. Paccagnella, M. Poizat, P. Beck, **Testing of COTS Multiplexer in the Framework of the ESA CORHA Study**, Radiation Effects on Components and Systems Conference, RADECS 2021, Vienna, Austria, September 2021, to be published
- Peter Beck, Marta Bagatin, Simone Gerardin, Marcin Latocha, Alessandro Paccagnella, Christoph Tscherne, Michael Wind, Marc Poizat, **Radiation Testing on COTS Components in the Frame of the CORHA ESA Study**, in *7th RADHARD Symposium*, Seibersdorf, Austria, 2022.
- M. Wind, C. Tscherne, M. Bagatin, S. Gerardin, L. Huber, M. Latocha, A. Paccagnella, M. Poizat, P. Beck, **SEE Testing of COTS Microcontroller and Operation Amplifier in the Framework of the ESA CORHA Study**, Radiation Effects on Components and Systems Conference, RADECS 2022, Venice, Italy, October 2022, to be published
- Peter Beck, Marta Bagatin, Simone Gerardin, Marcin Latocha, Alessandro Paccagnella, Christoph Tscherne, Michael Wind, Marc Poizat, **Radiation Testing of COTS Components and Lessons from the ESA Study CORHA**, in *ACCEDE COTS 2022*, Seville, Spain, 2022.

Thank you for your attention!

SEIBERSDORF LABORATORIES
RHA | Space Weather
Mag. DI Christoph Tscherne

Seibersdorf Labor GmbH, 2444 Seibersdorf, Austria
T +43 (0) 50 550-2537, F +43 (0) 50 550-2502
christoph.tscherne@seibersdorf-laboratories.at
www.seibersdorf-laboratories.at