

TRADCARE[®]: a multi-physics SEE prediction software using Geant4[™] toolkit

14th Geant4 Space Users Workshop 20 – 23 oct. 2019

N. Andrianjohany, N. Chatry, L. Sarie, M. Mauguet, T. Prados, G. Augustin

24/10/2019

TRAD, Tests & Radiations



Objective (1/3)

ASIC development flow





Objective (2/3)

ASIC development flow



0

Additional step to assess SEE reliability before manufacturing and therefore, reduce manufacturing and testing costs.



Objective (3/3)

Prediction TRADCARE : SEE prediction software





24/10/2019

Multi-physics including particle-matter interaction physics based on Geant4 Monte-Carlo calculation

4



Outline

TRADCARE

- Brief history
- Simulation flow
- Implemented modules

Case study on latchup effects

- Design
- Simulation
- Experimental comparison



Outline

TRADCARE

- Brief history
- Simulation flow
- Implemented modules

Case study on latchup effects

- Design
- Simulation
- Experimental comparison



Brief history





7



Brief history







Brief history







Brief history



Need a critical charge !



Brief history







Brief history





Summary

- **3D CAD framework with GDS import** •
- Particle transportation using Geant4 •
- Charge transportation based on TCAD •
- **Electrical behaviour simulated using SPICE** ٠

Particle transportation using Geant4





Main features

Wire highlighting



Device extraction



Netlist extraction



Biasing & stimuli



Beam configuration



Post processing





Main features

24/10/2019



G4SUW, 20 – 23 oct. 19



Main features



24/10/2019

16



Main features



G4SUW, 20 - 23 oct. 19



Main features





24/10/2019



Main features

Beam configuration





Main features

Post processing





24/10/2019

Simulation software (4/5)

Simulation flow





Simulation flow

I- Circuit model



24/10/2019

Circuit biasing

II- Calculation



Beam configuration

III- Post processing



Hotspot mapping

G4SUW, 20 – 23 oct. 19



Outline

TRADCARE

- History
- Simulation flow
- Implemented modules

Case study on latchup effects

- Design
- Simulation
- Experimental comparison



Latchup effects (1/4)

Testchip development

- Design of register matrix
- Layout (PD) with cadence
- Tape-out on CMOS bulk



24/10/2019



G4SUW, 20 - 23 oct. 19





24/10/2019

Latchup effects (2/4)

Simulation on TRADCARE

Input configuration



	UCL	. Beam				
atchup cross section computation						×
Presentatio	n Analy	sis Beam Dcc	Detection Output	t		
Be	am Shape	Circle ~	Radius 1	i mm	Center	
Po	Position Direction XYZ X 0.012 Y 0.0068 Z 0.007 mm X 0 Y 0 Z -1					
Pa T	Partide Type Xe-124 V Energy 9.95e+08 eV Number 3.2e+05					
	Nº run	Particle	Energy [MeV]	Fluence [#/cm²]	Tilt [degree]	
	1	Xe-124	995	1e+07	0°	
	2	Kr-84	769	1e+07	0°	
	3	Ni-58	582	1e+07	0°	
	4	Cr-53	513	1e+07	0°	
	5	Ar-40	379	1e+07	0°	
All data filled.						



Latchup effects (3/4)

Signal monitoring on TRADCARE

Real time chronograms





Latchup effects (4/4)

Experimental comparison

- Test at UCL facility
- Dedicated testbench





24/10/2019



G4SUW, 20 - 23 oct. 19



Latchup effects (4/4)



28

G4SUW, 20 - 23 oct. 19



Conclusion

- TRADCARE : SEE prediction tool for SEL, SET, SEU, SEDR
- Based on GDS, MC, TCAD, SPICE
- Post processing
- Unique GUI

24/10/2019

SEL application case

Good correlation between simulation and experiments

Intensive validation in progress











