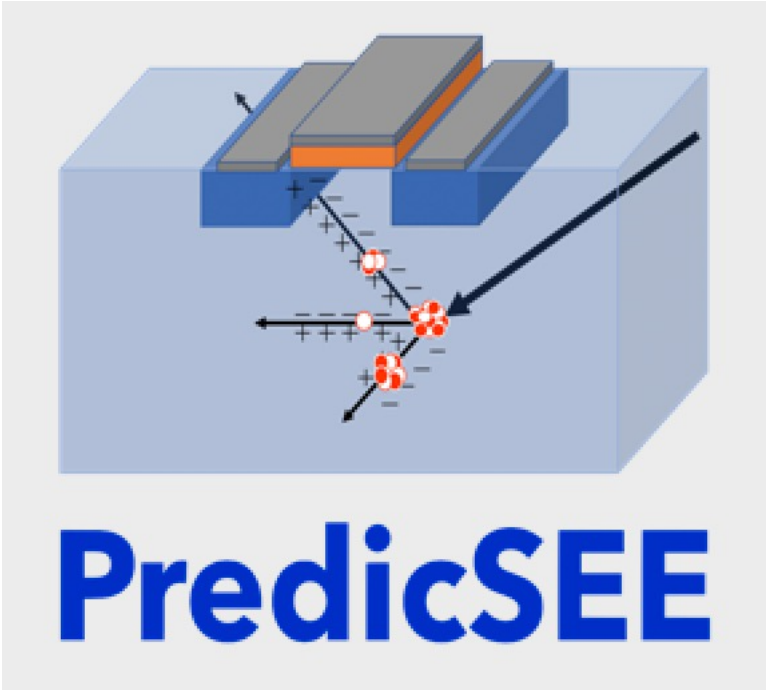
Pr. Frédéric Wrobel,
Montpellier University
frederic.wrobel@umontpellier.fr



PredicSEE:
a tool to estimate SEU and SET cross sections

Purpose of the tool**s**

- **Basic tool(s):** provide a method as simple as possible, relying on few parameters (preferably known!). Can be analytical or MC methods.

- **Research tool:** include all the physic mechanisms that are at play
  - Radiation-matter interaction
  - Semiconductor physics
  - Electrical behavior

- **End-user tool:** include physics but with simple parameters that can be available by the end-user
  - Parameters by default
  - Friendly interface
  - Acceptable time of calculation

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MC-ORACLE

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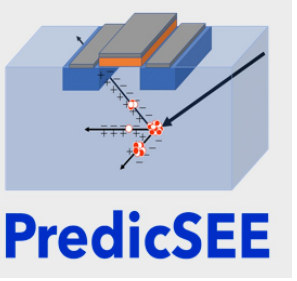
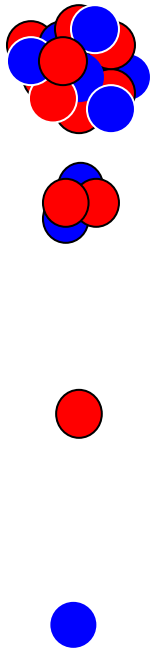
PredicSEE



Particles at play in SEE

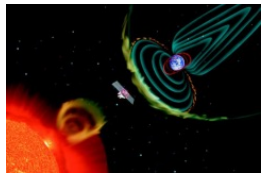
- Ions
  - from Space
  - from radioactivity (alpha particle)
- Protons
  - from Space
  - in the upper atmosphere
- Neutrons
  - In atmosphere, even at ground level!



How can we predict the effect of these particles on electronics?

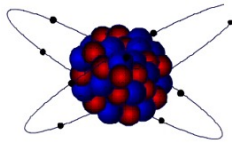
Multi-scale / Multi-physics

Radiation environment



AE8, AP8, OMERE, QARM, IEC, JEDEC…

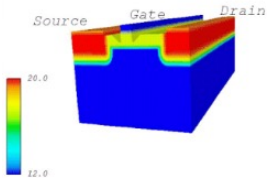
Particle-matter interaction



GEANT 4, FLUKA, MCNPX , PENELOPE, …

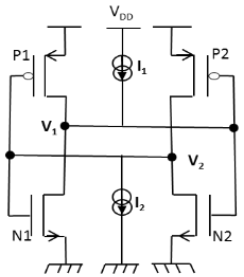
Electrons and holes transport

Transient current(s) at MOS level



Device simulation tool (transport+Poisson laws)

Effect on the cell (SET, SEU …)



Spice, Eldo, …

Effect on the system

Multi-scale / Multi-physics

Radiation environment

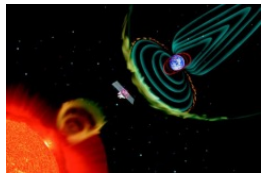
Particle-matter interaction

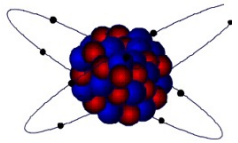
Electrons and holes transport

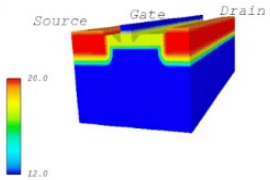
Transient current(s) at MOS level

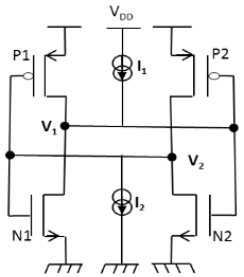
Effect on the cell (SET, SEU …)

Effect on the system









AE8, AP8, OMERE, QARM, IEC, JEDEC…

GEANT 4, FLUKA, MCNPX , PENELOPE, …

Device simulation tool (transport+Poisson laws)

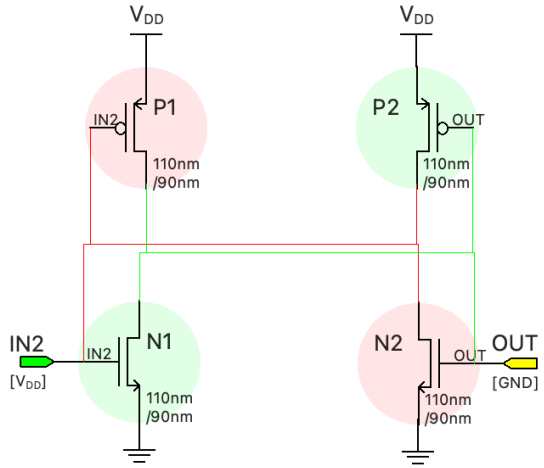
Spice, Eldo, …

CPU time consuming

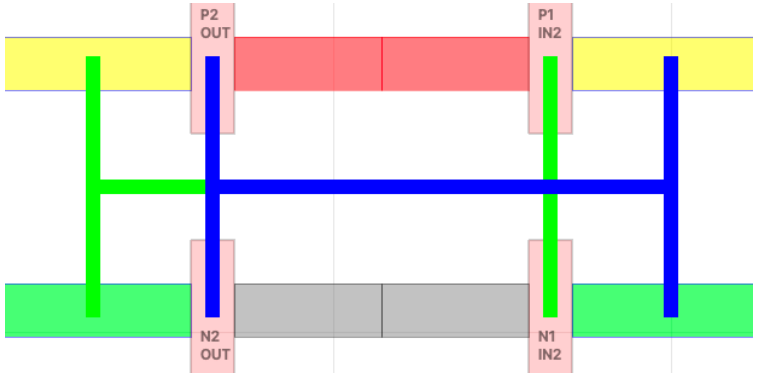
need approximations

PredicSEE at a glance!

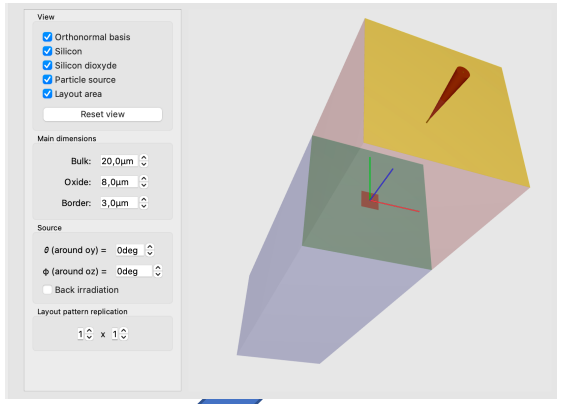
1-Circuit



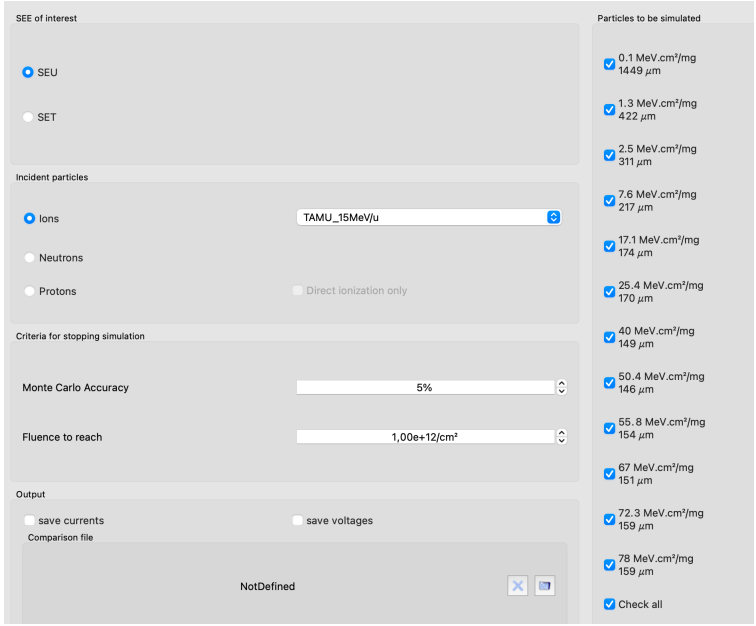
2-Layout



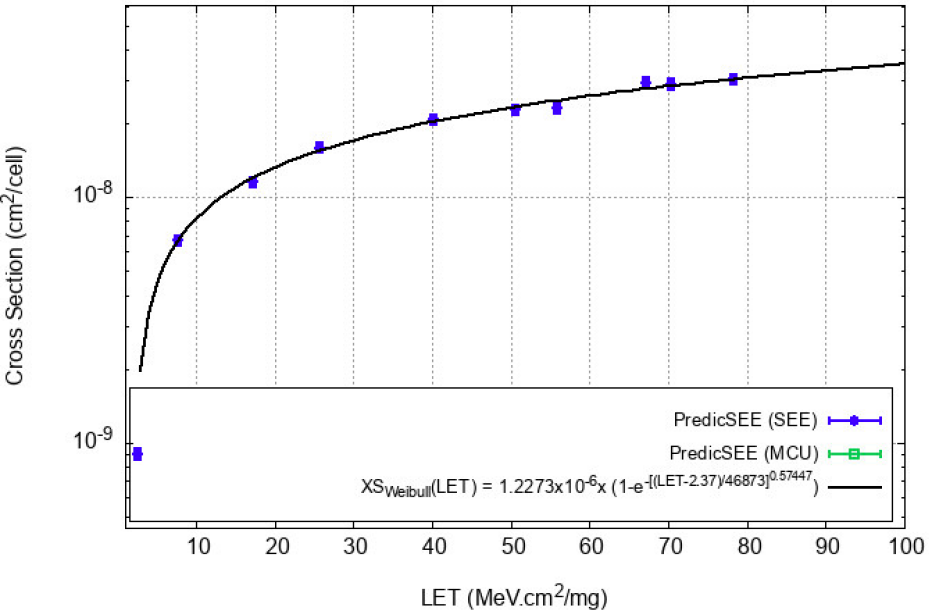
3-Geometry



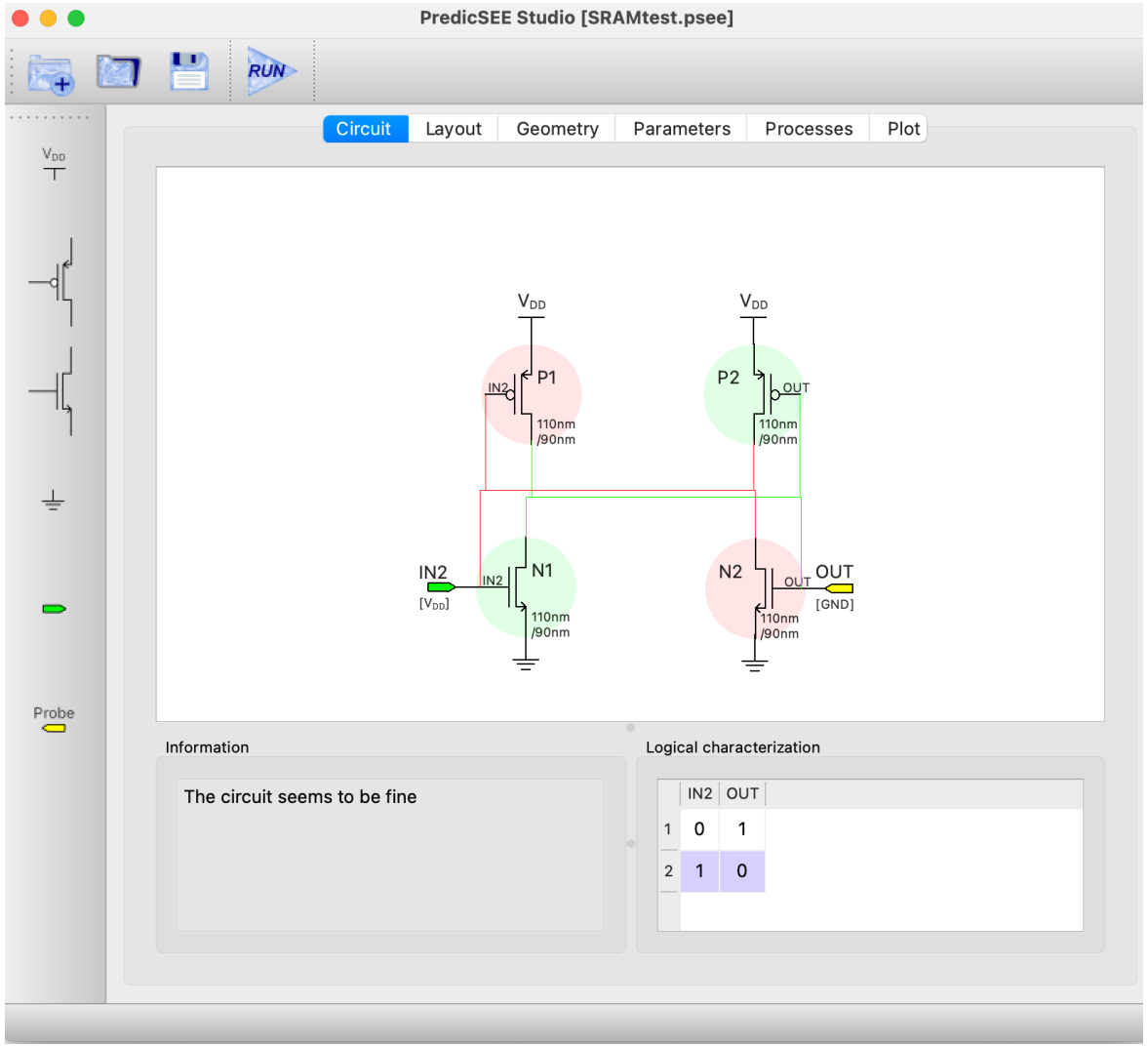
4-Parameters



5-Results



Demo!

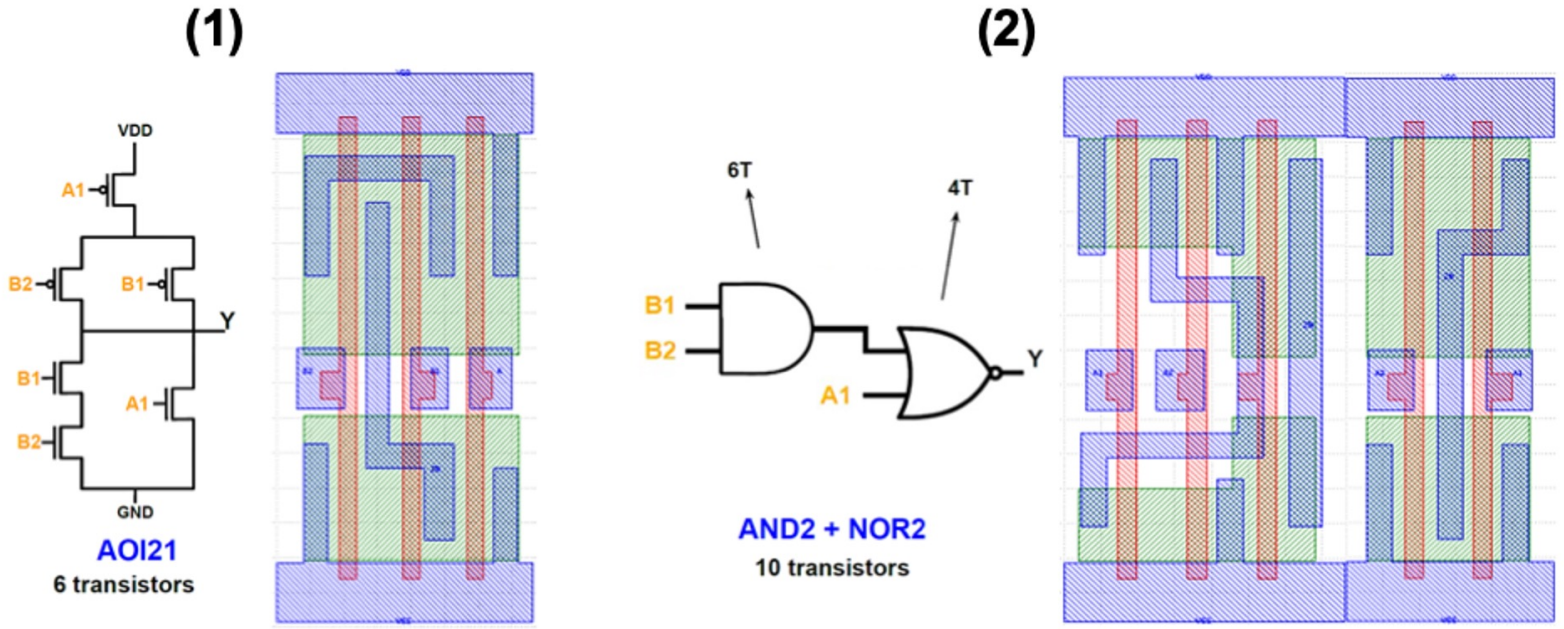


PredicSEE is developped to be crossplatform:

- Mac OS
- Windows
- Linux (not yet tested)

What can be investigated?

Example 1: AOI21



- Functions can be implemented in different ways
- AOI21 is smaller, faster and with a lower consumption
- What about SET sensitivity?

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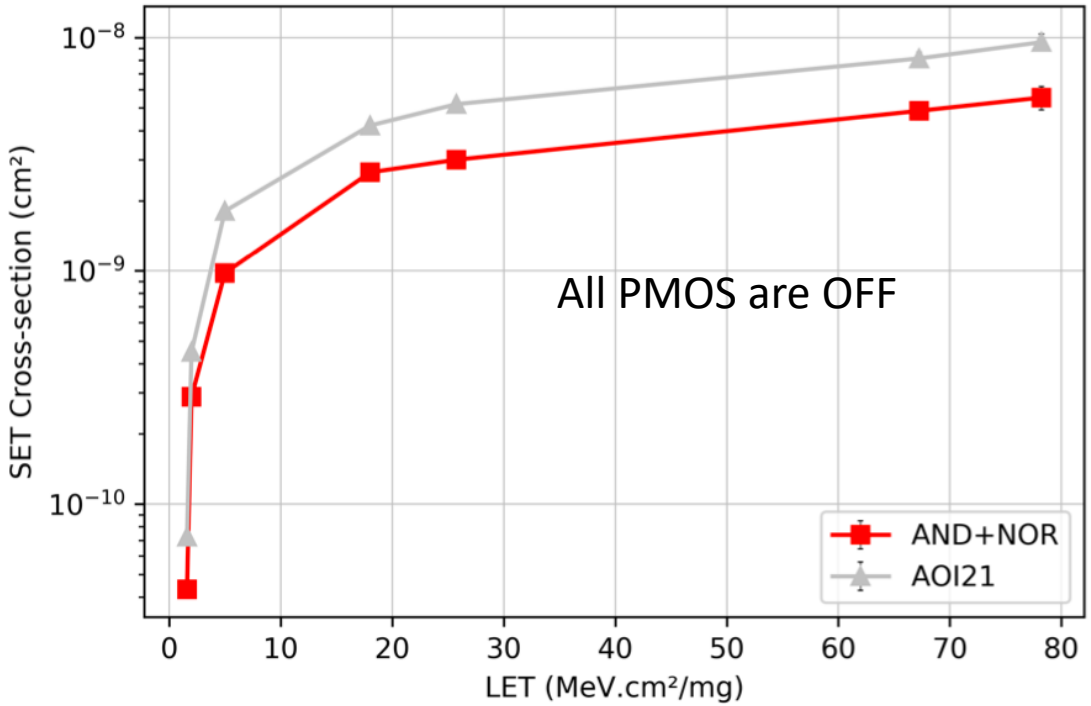
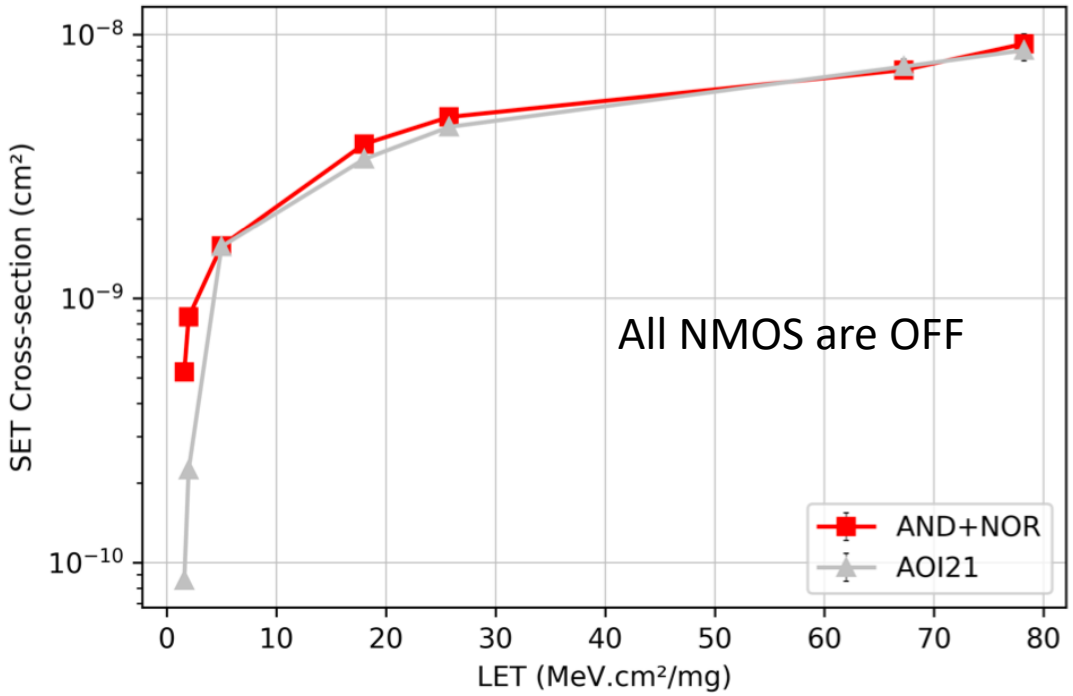
Example 1: AOI21





Sensitivity depends on function implementation but also on pin assignment!

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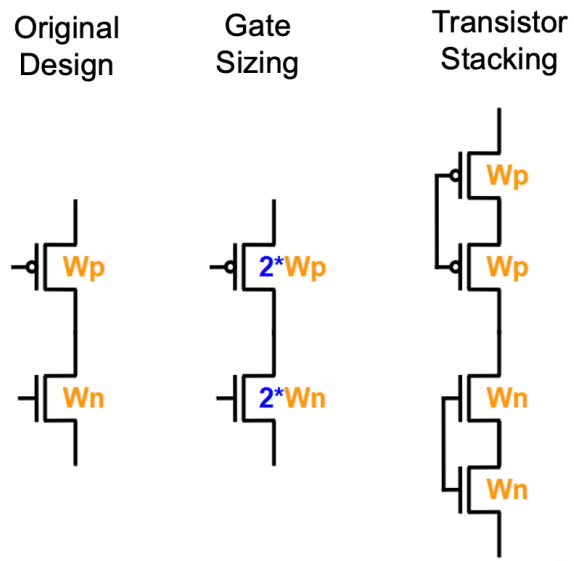
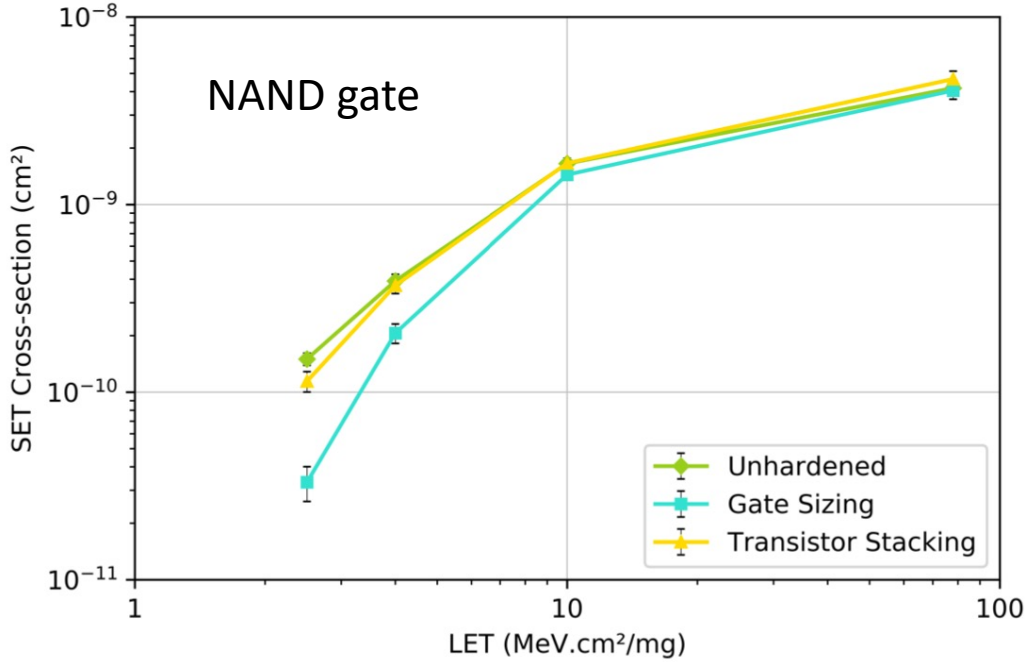
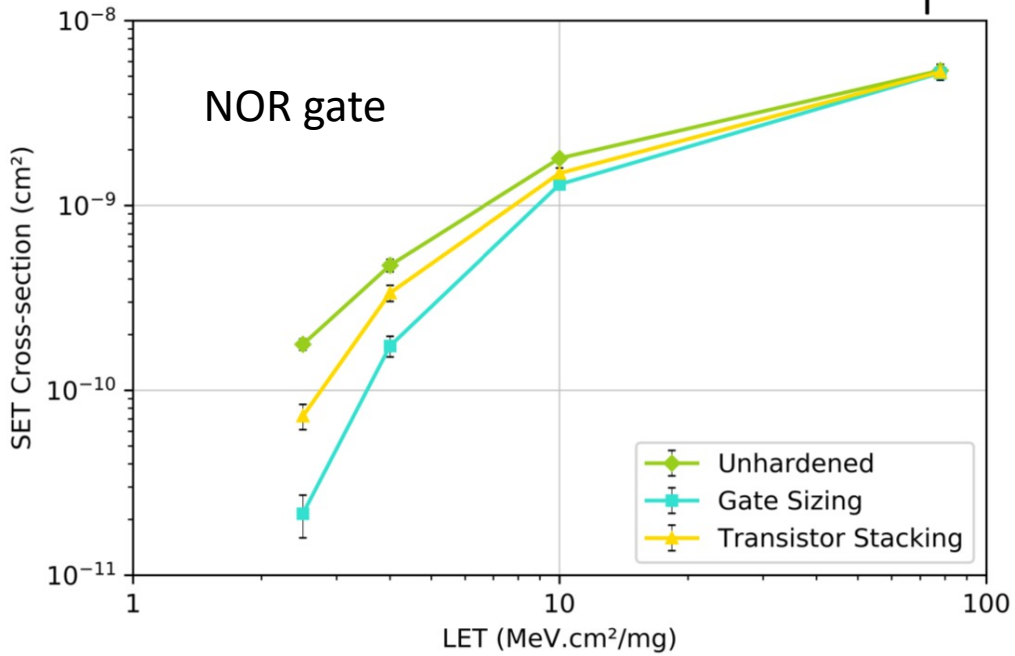
Example 2: Gate sizing & Transistor stacking







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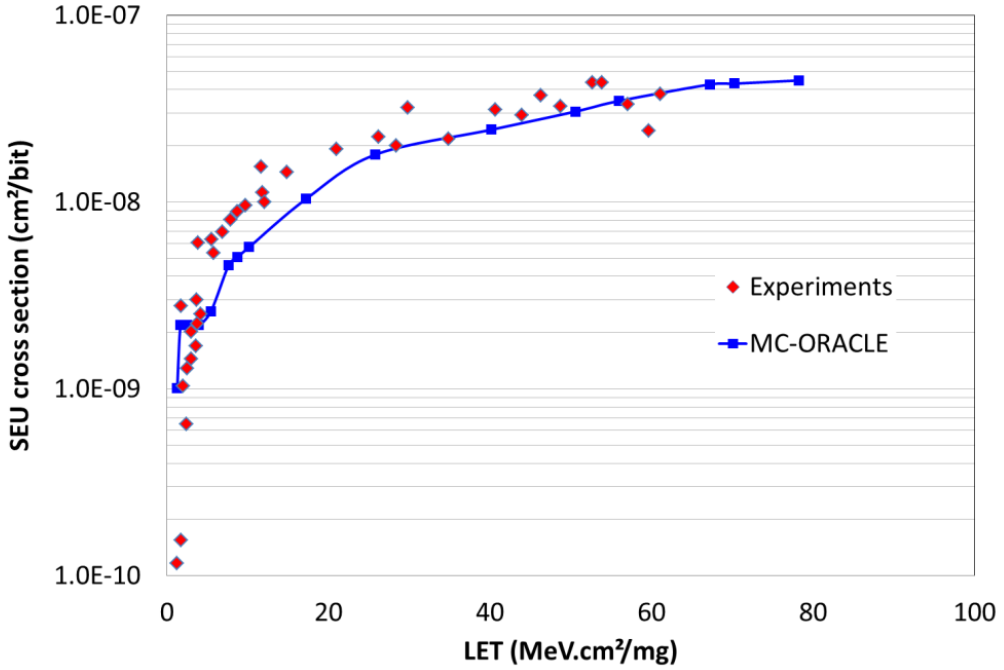
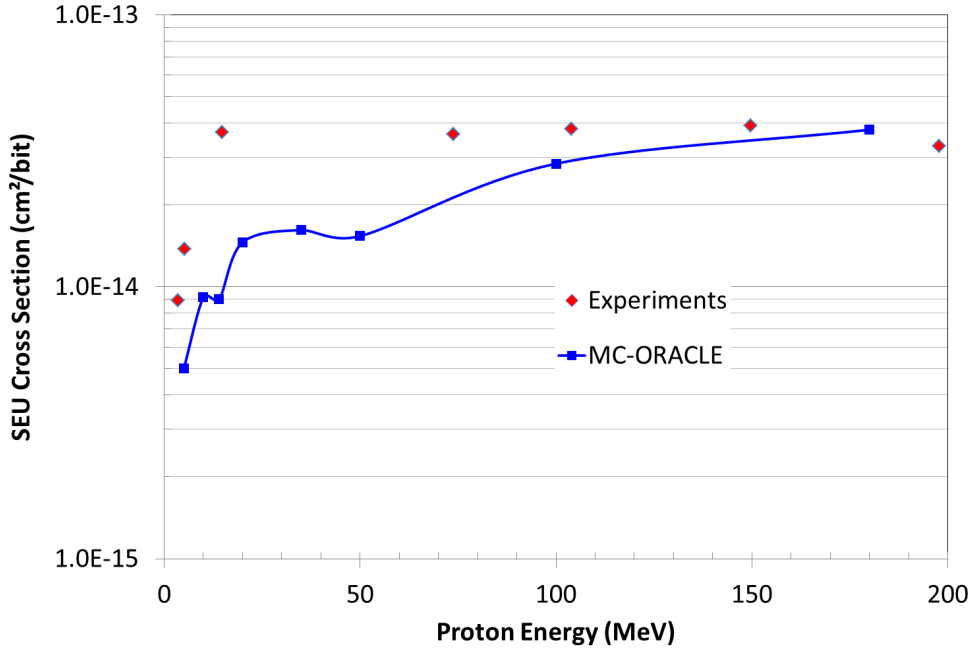
Example 3: the SRAM 150-nm

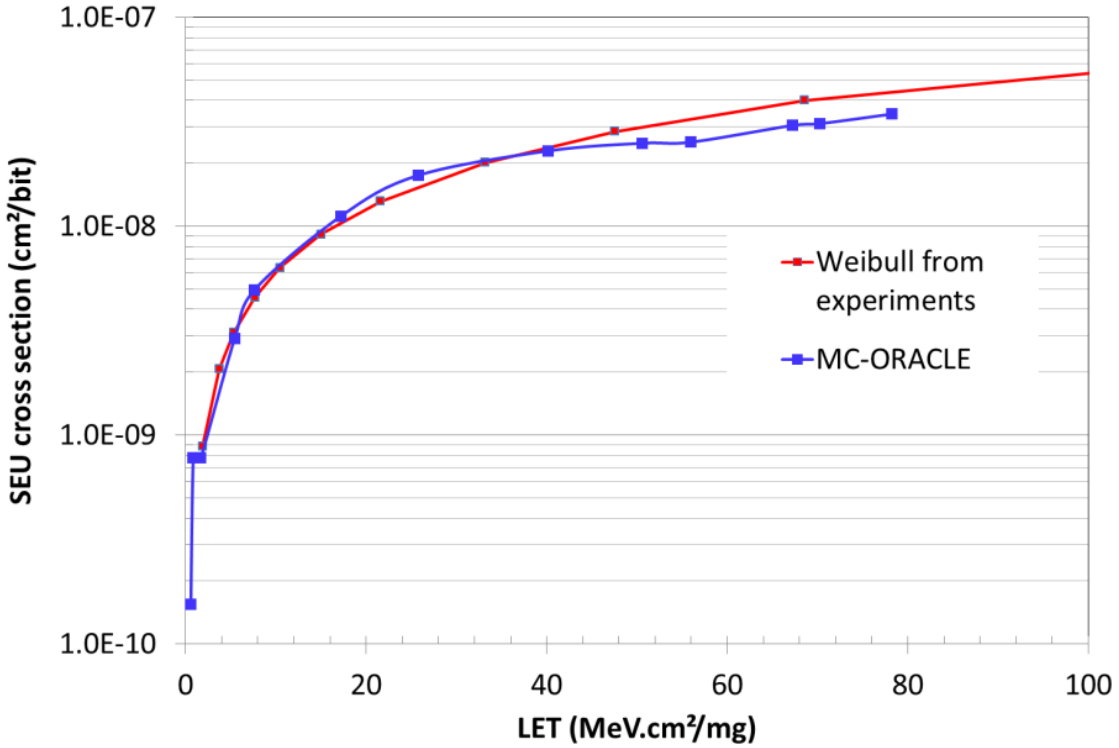


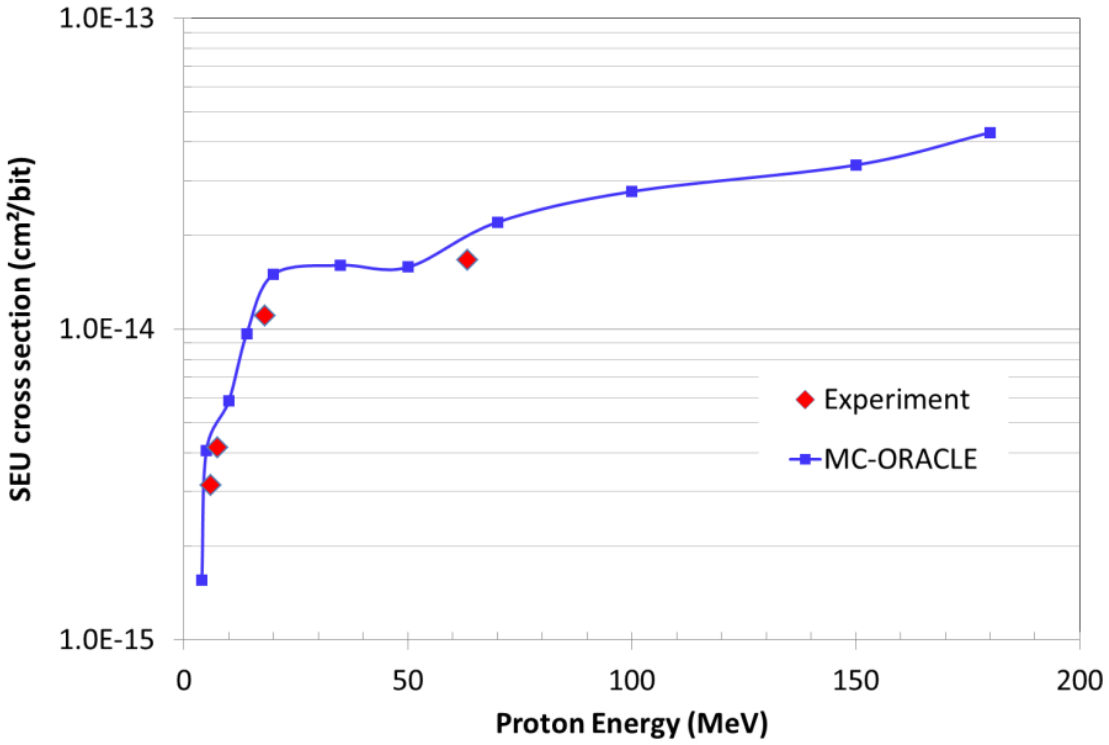


- Default parameters for the 150nm.
- No fitting parameters.

Experimental data from:
R. Koga, J. George, G. Swift, C. Yui, L. Edmonds, C. Carmichael, T. Langley, P. Murray, K. Lanes and M. Napier,
"Comparison of Xilinx Virtex-II FPGA SEE sensitivities to protons and heavy ions," IEEE Trans. Nucl. Sci., vol 51, NO 5, pp. 2825-2833, Oct 2004.

Example 4: SRAM 90-nm

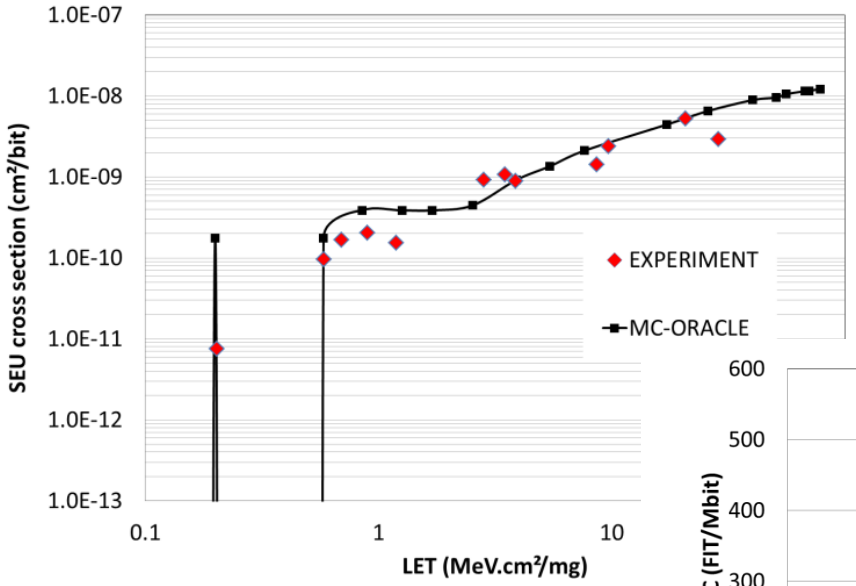


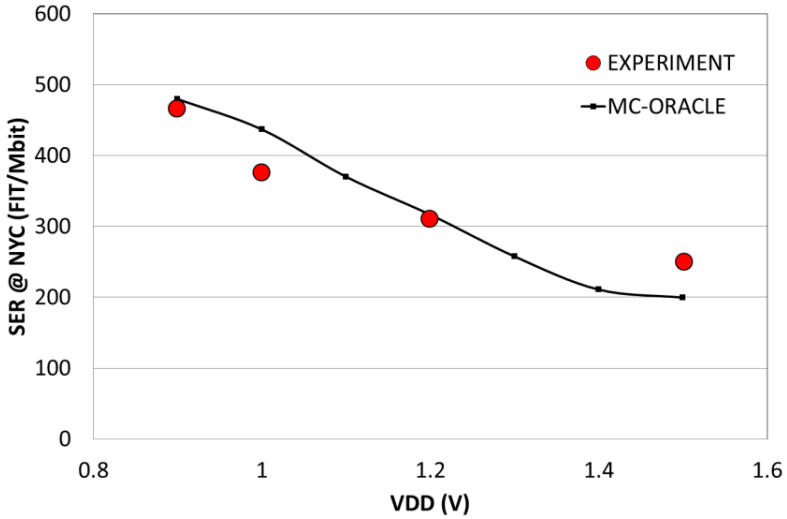


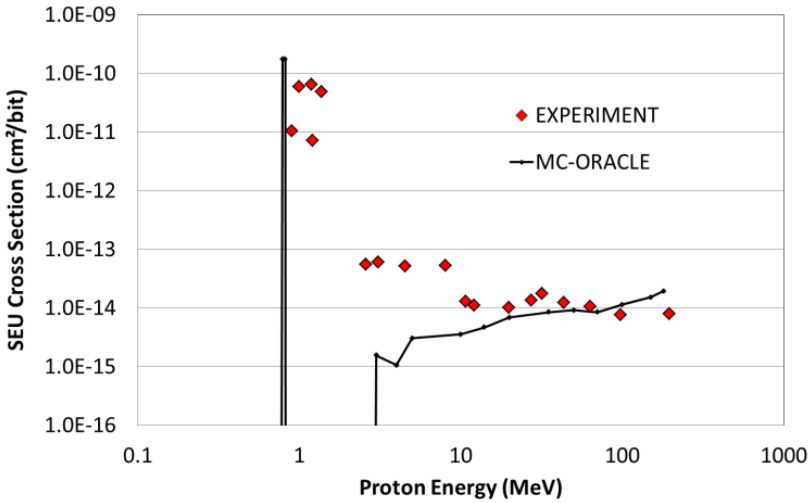
- Default parameters for the 90nm.
- No fitting parameters.

Experimental data from:
Swift, G.M.; Allen, G.R.; Chen Wei Tseng; Carmichael, C.; Miller, G.; George, J.S.;
"Static Upset Characteristics of the 90nm Virtex-4QV FPGAs," Radiation Effects Data Workshop, 2008 IEEE , vol., no., pp.98-105, 14-18 July 2008.

Example 5: SRAM 65-nm







- Default parameters for the 65nm.
- No fitting parameters.

Experimental data from:
B.D. Sierawski, K. M. Warren, R. A. Reed, R. A. Weller, M. M. Mendenhall, R. D. Schrimpf, R. C. Baumann, and V. Zhu,
"Contribution of low-energy (<10MeV) neutrons to upset rate in a 65 nm SRAM," IRPS 2010, IEEE International, pp. 395-399, 2010.

Thank you!

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