AFTU

Analog FTU Hardware Debugging System

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Abstract

What is AFTU?

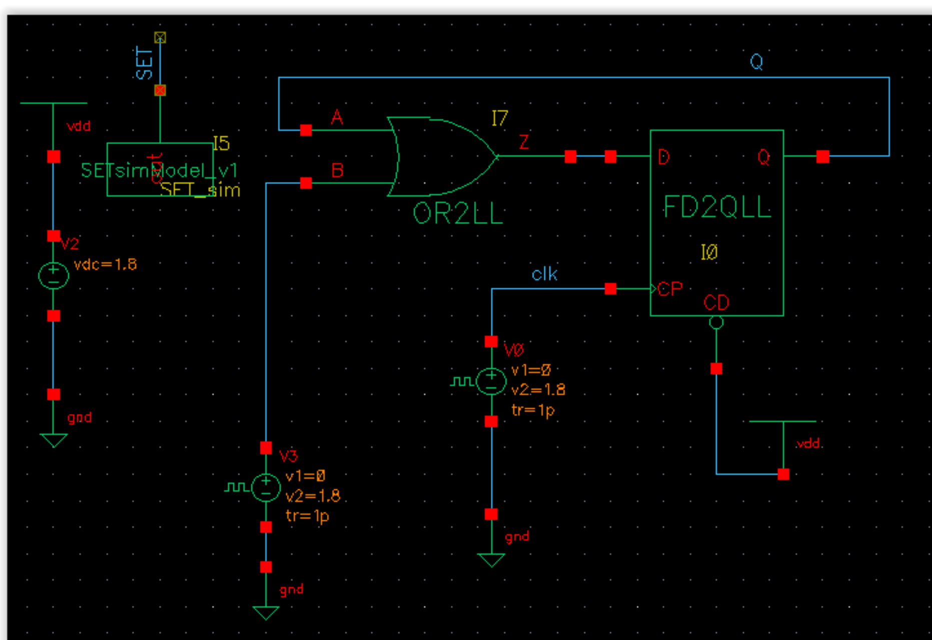
AFTU is a tool to evaluate the SEE sensitivity of analog/mixed signal circuits at transistor level

What can AFTU offer?

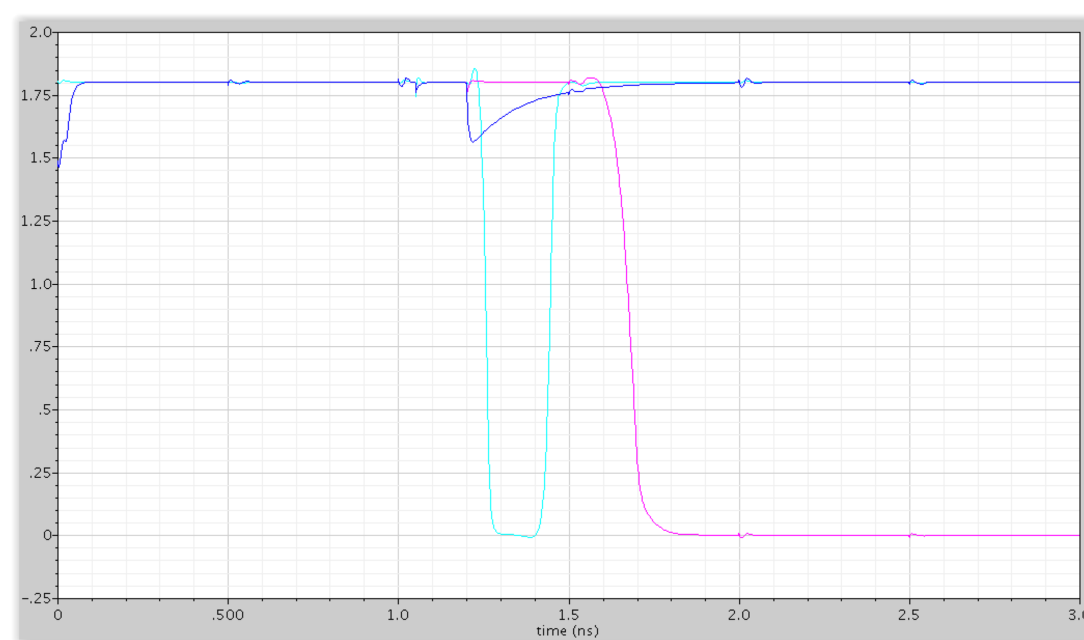
The capability of performing a rapid diagnostic over circuits for radiation-hardened systems in early stages of the design to strengthen their robustness

How Does AFTU Work?

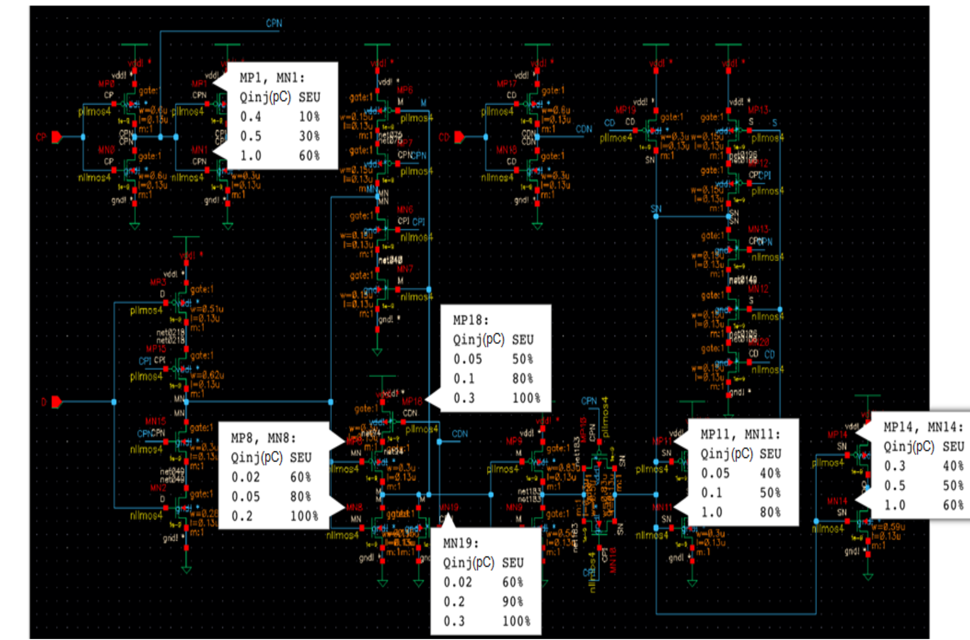
AFTU takes a Spectre design



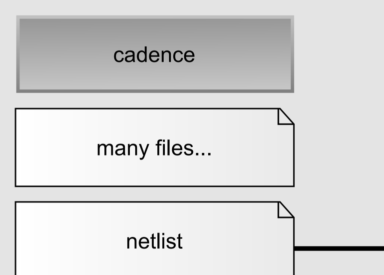
Emulates radiation conditions

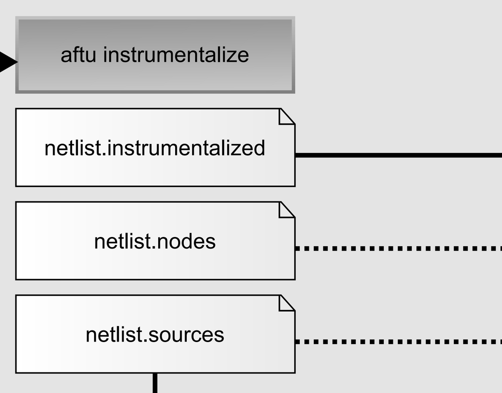


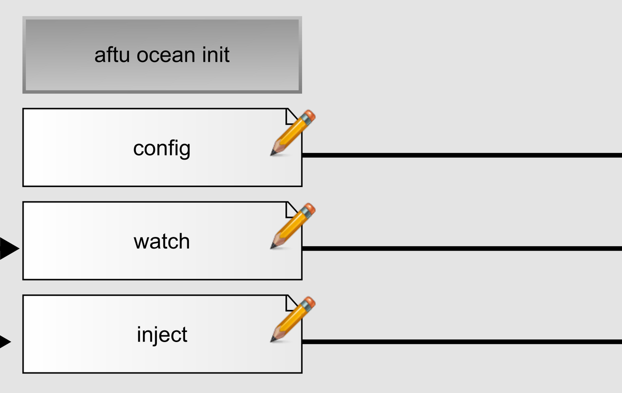
And evaluates SEE sensitivities

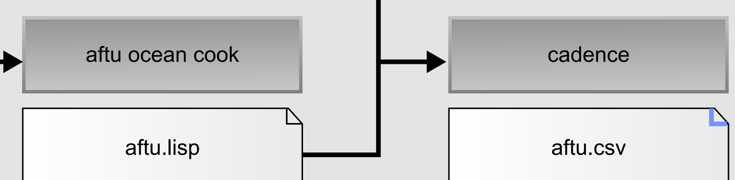


AFTU Toolchain









Before using AFTU

The user designs a circuit with Cadence as usual

The design is simulated through a testbench

Of all files generated by Cadence, we pick the netlist

The instrumentalizer implements a parser for the SPECTRE language

Replaces the netlist with a functionally identical one allowing radiation emulation

netlist.nodes
lists all observable circuit nodes

netlist.sources
lists all transistors where an impact can be emulated

AFTU projects are flexible and give the user many options for analysis

config
contains paths, times, heuristics, initial values...

watch
defines all elements in the circuit to be observed during simulation

inject
defines where, when and how much charge we inject (radiation emulation)

From all this data, a simulation script is produced

including
all paths and required data

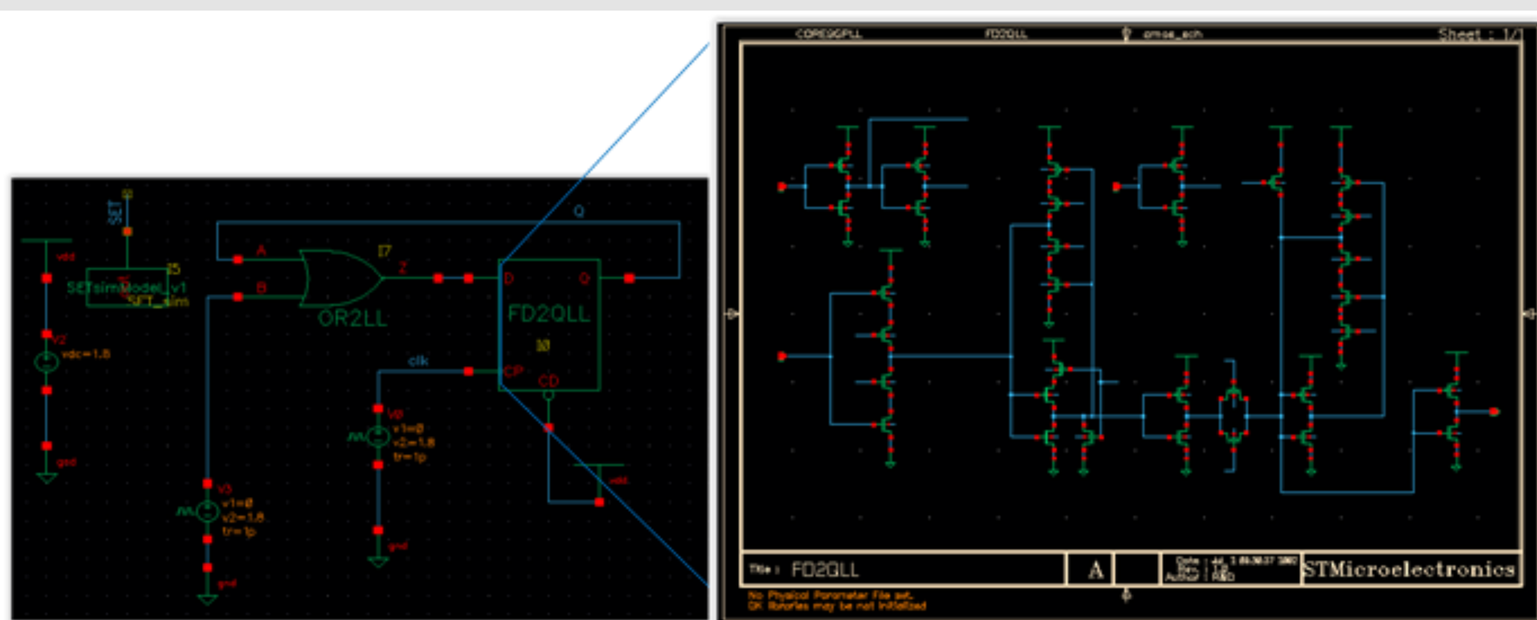
describing
the way to perform the user defined test campaign

defining
how to analyze the results of the campaign

The provided script is ran by Cadence, generating a CSV file with the desired statistics

This uncovers radiation vulnerabilities in the circuit

Example



Determine the critical charge that generates a Single Event Upset in a latch for a ST 130nm CMOS technology

Inject

```
inject I0_MP19:
    Q = .025p, .05p, 0.1p, .2p, .5p,
.75p, 1p;
    t = 1.0n : 1.9n : 0.1n;
inject I0_MN19:
    Q = .025p, .05p, 0.1p, .2p, .5p,
.75p, 1p;
    t = 1.0n : 1.9n : 0.1n;
inject I0_MP18:
    Q = .025p, .05p, 0.1p, .2p, .5p,
.75p, 1p;
    t = 1.0n : 1.9n : 0.1n;
```

Watch

```
watch Q = /Q :
    threshold = 0.975 ;
```

Results

Output	ImpactNode	Qinj	Timp	Trec/1ns	Vmax
V_Q	I0_MN11	2.5e-14	1e-09	0.000000	0.006827
V_Q	I0_MN11	2.5e-14	1.9e-09	0.000000	0.016568
V_Q	I0_MN11	5e-14	1e-09	0.000000	0.017084
…					
V_Q	I0_MN11	5e-14	1.3e-09	0.000000	0.005371
V_Q	I0_MN11	5e-14	1.4e-09	1.610000	1.806680
V_Q	I0_MN11	5e-14	1.5e-09	1.500000	1.806814
V_Q	I0_MN11	5e-14	1.6e-09	1.400000	1.805740
V_Q	I0_MN11	5e-14	1.7e-09	1.300000	1.802925
V_Q	I0_MN11	5e-14	1.8e-09	0.240000	1.404223

Conclusions

A tool for automatic analysis of SEE sensitiviy in analog/mixed signal circuits has been developed

Allows impact emulation, based in current injection models, in every transistor of a given design by means of configuration files (config, inject, watch)

Implements different heuristics for results classification and allows the analysis of every node of the circuit or composed signals defined by the user

Several technologies (ST Microelectronics 130n CMOS, IHP 250 SIGE BiCMOS, UMC 180nm CMOS) are supported

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