Power Distribution and Substrate Noise Coupling Investigations on the Behavioral Level for Photon Counting Imaging Readout Circuits

Jan Lundgren, Suliman Abdalla, Mattias O´Nils, Bengt Oelmann

Outline

- Funcionality – Why do we need the model?
- Model description
- Simulation procedure
- Simulating in SystemC
- Simulation examples
- Conclusions
- Future work

Funcionality – Why do we need the model?

Problem scenario

Problems with noise coupling are discovered after the chip is constructed.

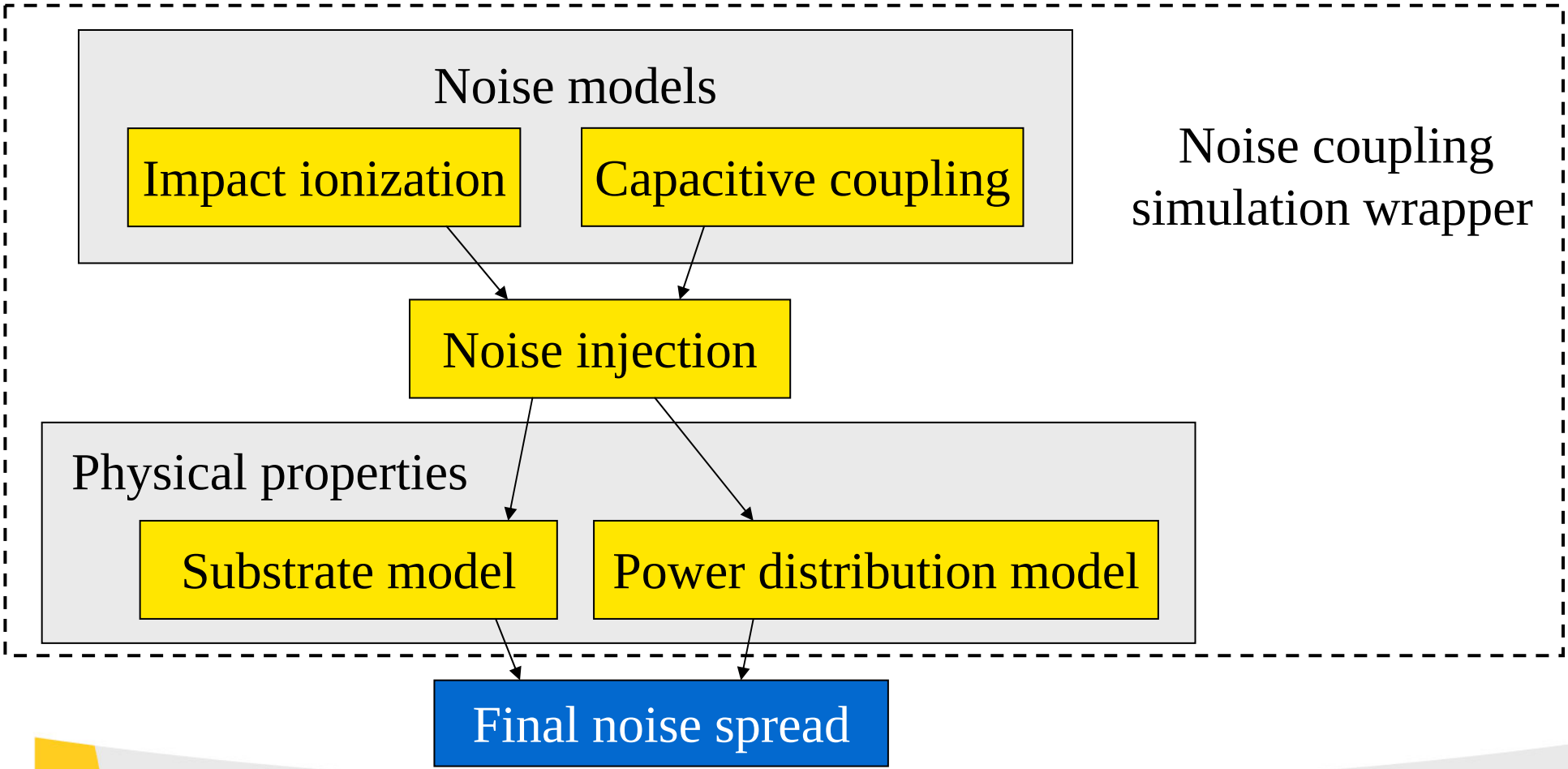
Costly design iterations follow with little guarantee that the problems have been corrected.

Problem scenario

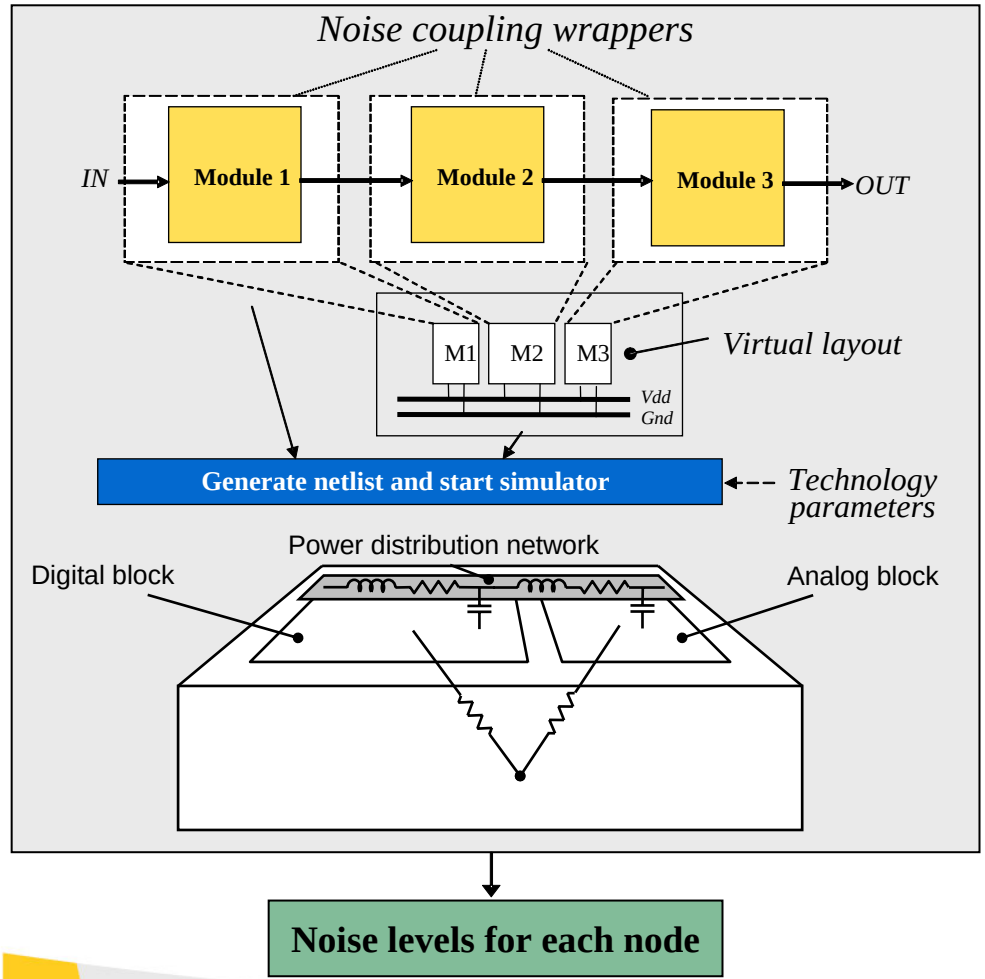
Problems with noise coupling are suspected to occur in an ongoing design.

All available design precautions are taken to make sure the problems are gone. This may introduce unnecessary processing steps.

BeNoC model description

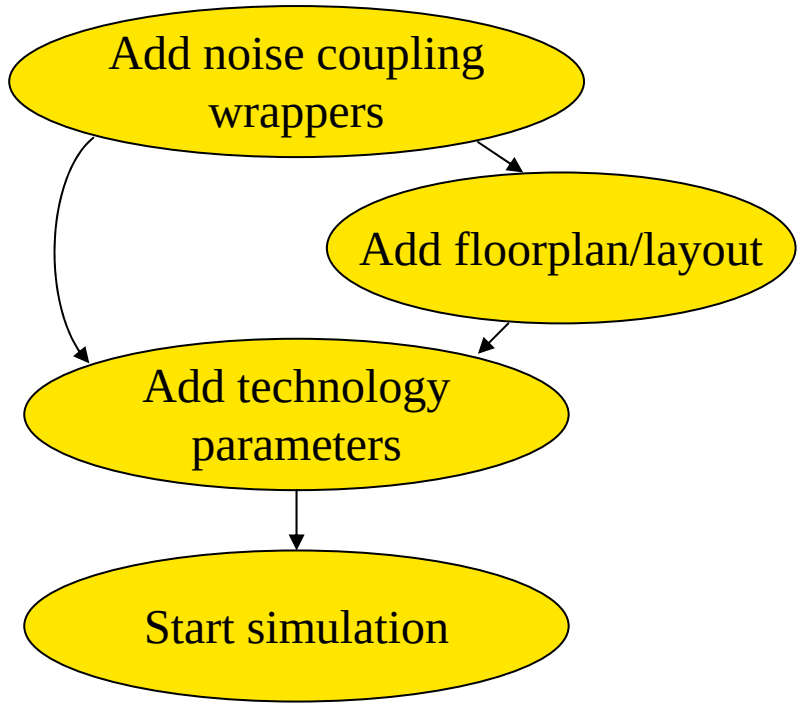


Simulation procedure

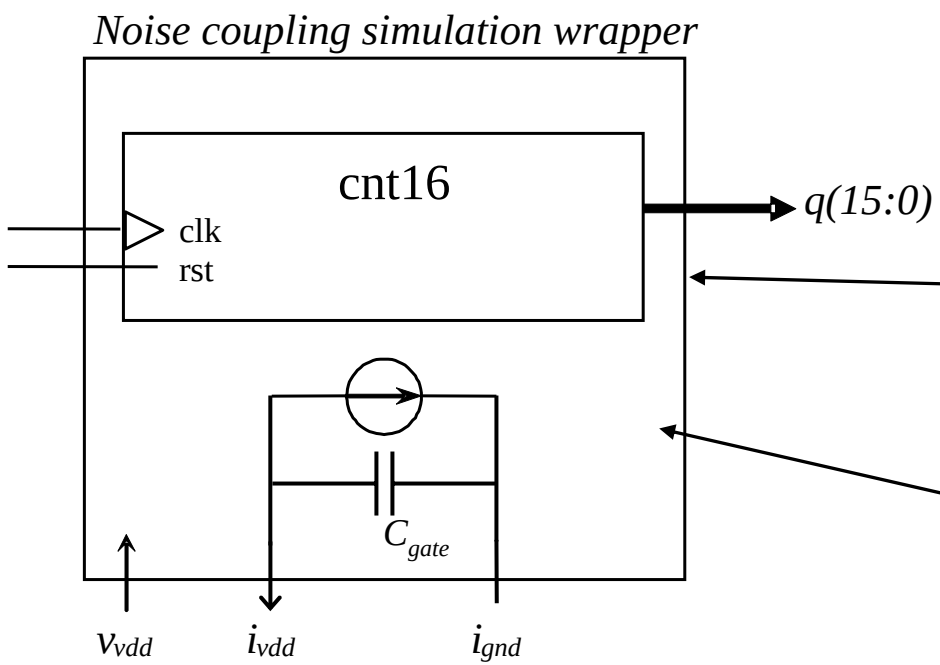


Basic simulation

Refined simulation



Simulating in SystemC

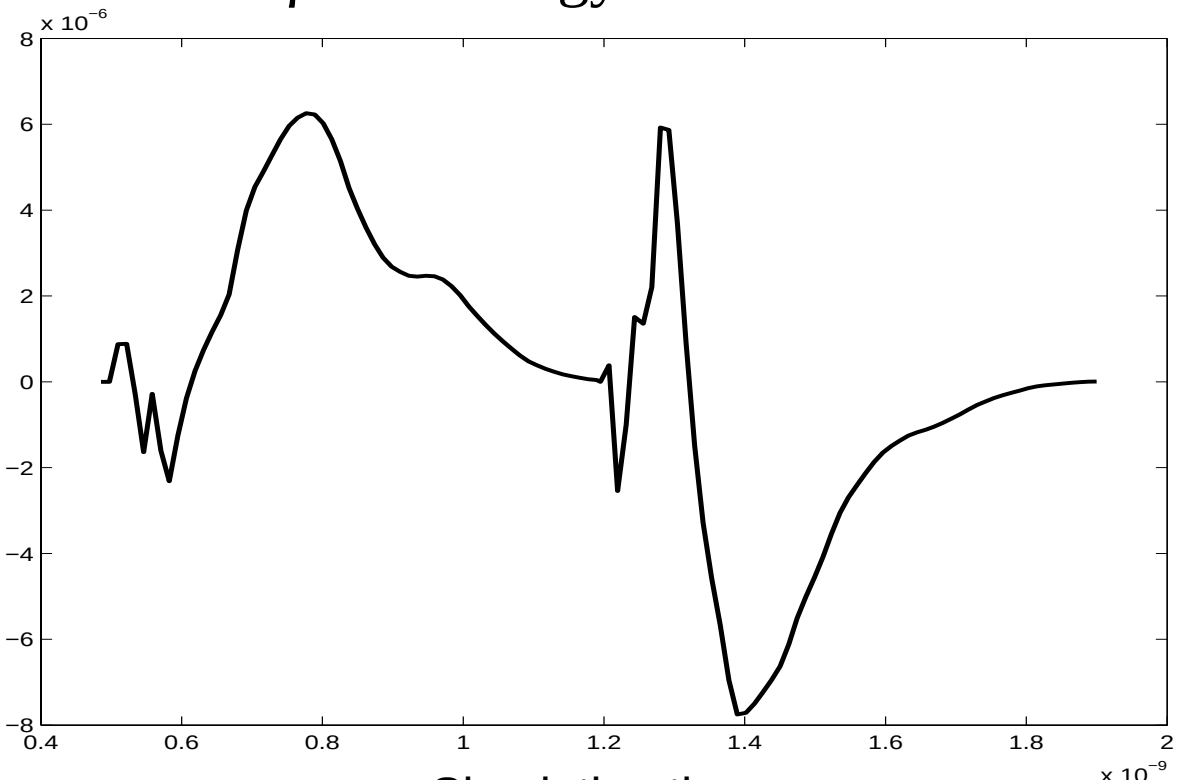



```
// cnt16.h
#include "systemc.h"
#include “benoc.h“
SC_MODULE(cnt16) {
        sc_in<sc_logic> rst;
        sc_in<bool> clock;
        sc_out<sc_lv<16> > cnt;
        sc_uint<16> temp;
        BENOC_SIM_PORTS;
        void count();
        SC_CTOR(cnt16) {
                SC_METHOD(count);
                sensitive << rst;
                sensitive_pos << clock;
                BENOC_SUBSTRATE;
                BENOC_POWER_DIST;
                sensitive << clock;
               temp = 0;
        }
};
```

Simulation examples

Example of injection noise from single inverter

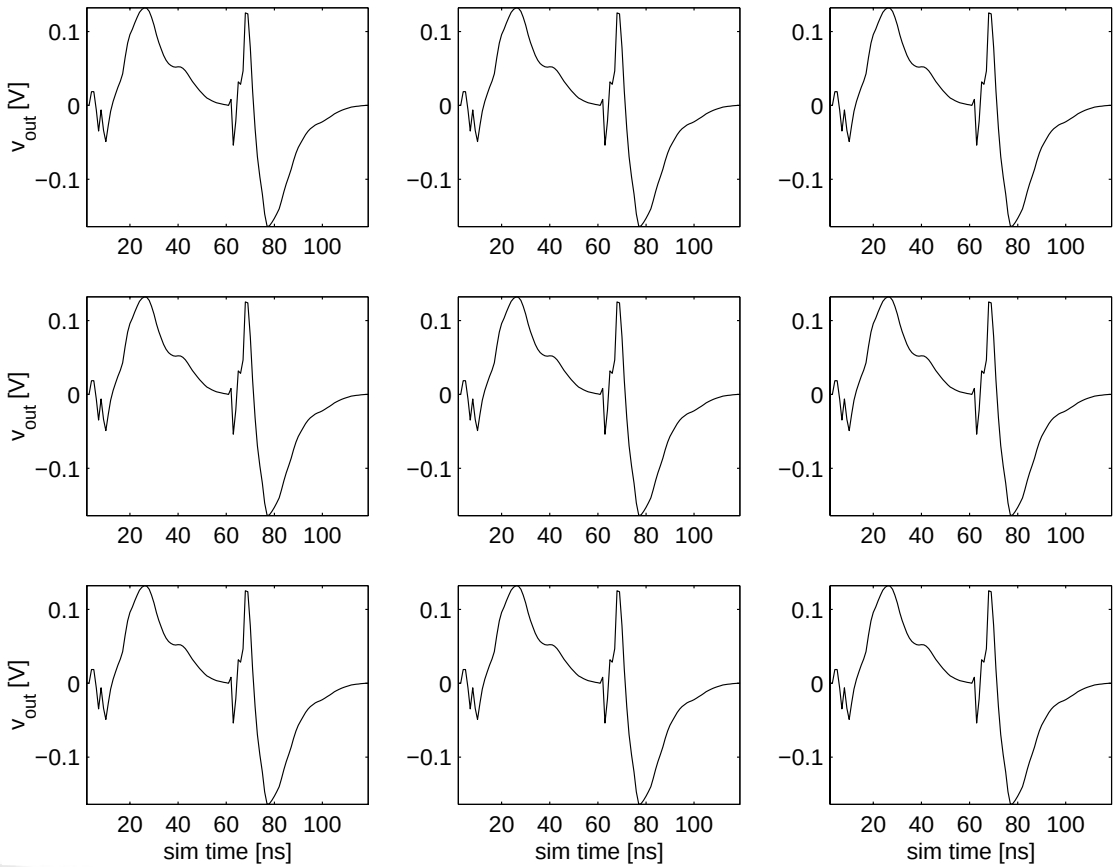
0.8µ technology with Vdd=3V



Total injection noise from capacitive coupling and impact ionization in a single inverter in the simulation.

Simulation examples

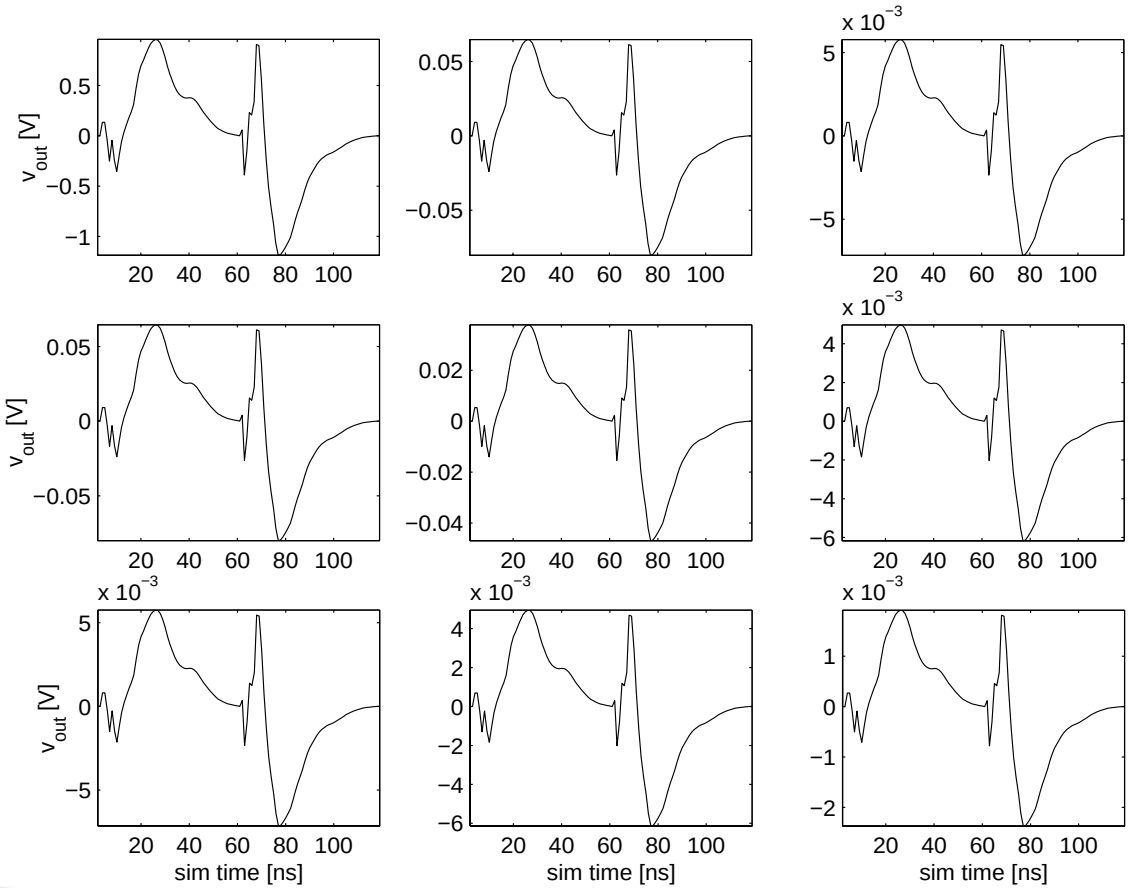
With power distribution noise coupling



Noise voltage on analog blocks in a 3x3 pixel structure.

Simulation examples

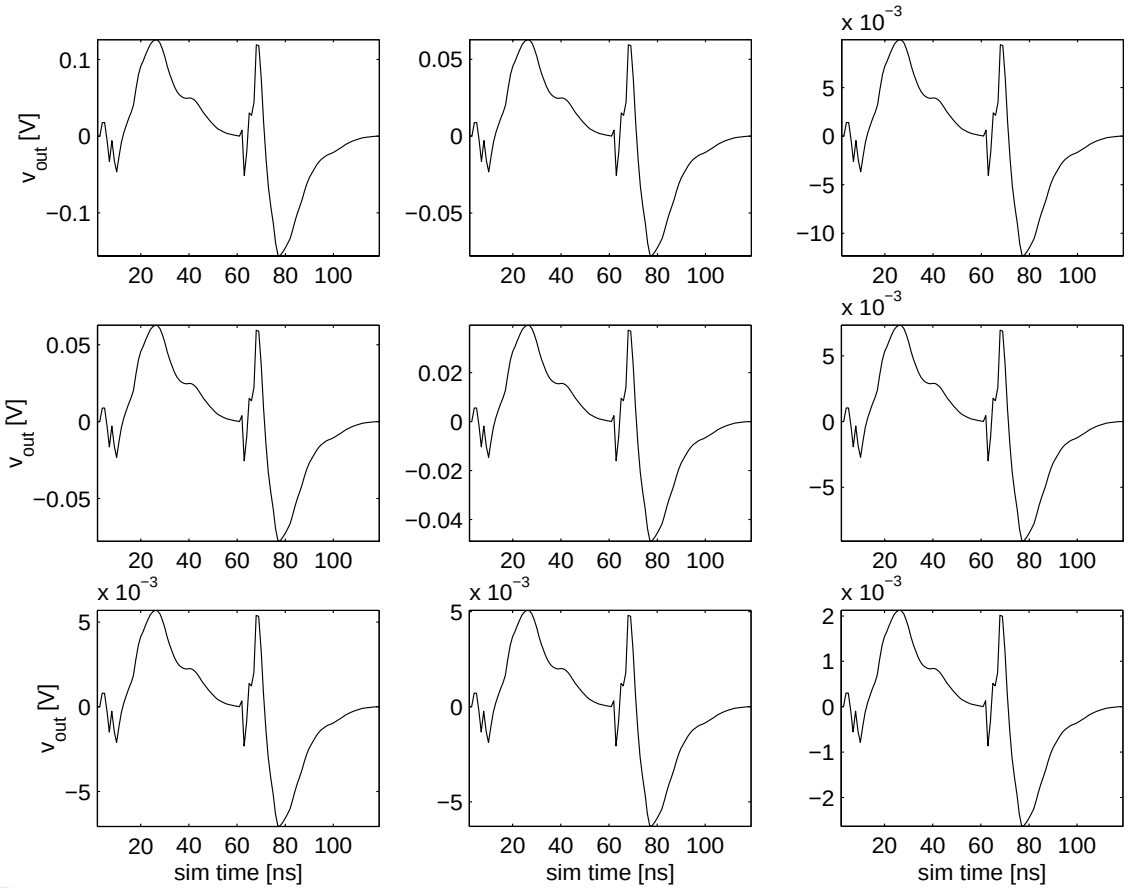
Without power distribution noise coupling



Noise voltage on digital blocks in a 3x3 pixel structure.

Simulation examples

Without power distribution noise coupling



Noise voltage on analog blocks in a 3x3 pixel structure.

Conclusions
Modelling

- The functionality and necessity of the Behavioral level Noise Coupling (BeNoC) simulation method has been discussed.

- With this new method it is possible to anticipate noise coupling problems in a mixed-signal design at an early level without significantly increasing the design time.

Future work

- Enhance the usability of the SystemC test case application, i.e. make it more user friendly.
- Increase accuracy of specific submodels, such as substrate extraction.