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The problem of digital and analog circuits working together.
Outline

- Motivation
- The error scenario
- Simulation models
- Simulation results
- Conclusions
- Future work
Motivation

Photon counting pixel detector

Digital

Analog

Digital

Analog

2005-07-06
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The error scenario

Self-generated noise within a pixel

Noise between adjacent pixels

Example of a dental X-ray image
Simulation models
Photon counting pixel detector

pre-amplifier  pulse shaper  window discriminator

Analog Circuits

detector

Digital Circuits

counter

out logic

clock generator

comparator
Simulation models

**Noise injection modeling**

\[ i_{\text{inj, cap}}(t) = f\left(i(t), T, A\right) \]

\[ i_{\text{inj, cap}}(t) = C_j \left( \frac{\partial u_{sn}(t)}{\partial t} + \frac{\partial u_{sp}(t)}{\partial t} \right) + \left( C_{ox} + C_{ch} \right) \left( \frac{\partial u_{gn}(t)}{\partial t} + \frac{\partial u_{gp}(t)}{\partial t} \right) \]
Simulation models

Substrate modeling

The 3D single substrate node model with a resistive network ready for simulation.

In this case, with an epi-layer model.
Simulation results

Effect from one bit (20um away)

![Graph showing simulation results for current versus voltage with peaks at specified intervals.]
Simulation results

Effect from 12 bits in 12 bit counter (20um)

Output current from preamplifier

Output current from pulse shaper
Simulation results

Noise from 16 bits in 16 bit counter (20um)

Output current from preamplifier

Output current from pulse shaper
Conclusions

• Substrate coupling needs to be considered in future readout electronics where components are more tightly integrated.

• The problems with substrate noise coupling can be avoided with smart floorplanning.
Future work

- Implementation of remaining parts into Behavioral level Noise Coupling (BeNoC) simulation.
- Behavioral level Noise Coupling (BeNoC) evaluation of photon counting pixel detector.
- Survey and design of RFID sensor interface.