1. Introduction

FE65-P2 chip (65nm bulk CMOS process) was fabricated twice with different isolation strategies.
A very rare opportunity to prototype and test the same complex circuit with different isolation strategies.

Double Isolation: both digital and analog are in deep n-wells

Digital Isolation: only digital is in deep n-well; analog is on substrate

2. Single pixel measurements w/o noise injection

+ If isolation is not enough, noise in digital spreads into analog
+ Noise observed in analog

\[ \sigma_{\text{ABD}} = \sqrt{\sigma_A^2 + \sigma_D^2} \]

- \( \sigma_A \): Intrinsic analog noise width
- \( \sigma_D \): Width of the noise spreads from digital to analog

\( \sigma_A \) is obtained with digital off by fitting S-curve in each pixel.

- How to measure \( \sigma_{\text{ABD}} \)? Measure 5 \( \cdot \) \( \sigma_{\text{ABD}} \) → to detect smaller \( \sigma_D \)
  + Pixel Noise OCCcupancy (NOCC): #noise observed in one pixel in 1s interval
  + Assuming that noise is Gaussian and at zero threshold the NOCC is of order 10^5

“floor” NOCC of 0.1 → critical threshold is ~5\( \sigma_A \) away from zero.

** Simulated NOCC for the power and ground rails of the FE in the double isolated chip

- Frequency dependence of the noise coupling obtained using sine waveform

\[ \delta = 5 \cdot \sigma_{\text{ABD}} - 5 \cdot \sigma_A \]

\( \sigma_D = \sqrt{\sigma_{\text{ABDI}}^2 - \sigma_A^2} \)

The digital isolation is better.

3. Pixel matrix measurements w/ noise injection

- To induce noise in digital by varying current in the pixel columns
- ** Monitoring pad

\[ f = 1 \text{MHz square wave with } I_{\text{inject}} = 4.8 \text{mA (Current limit = 23mA)} \]

5 \( \cdot \) \( \sigma_{\text{ABD}} \)

To measure the change of critical threshold

** Simulated Power Supply Rejection Ratios for the power and ground rails of the FE in the double isolated chip

- The digital noise coupling in the double isolated chip is due to noise injection from the digital power network to the FE ground, rather than through the isolated substrate.

4. Summary

The digital isolation is better than the double isolation.
Noise is coupling through the metal stack rather than through the substrate.
The double isolation has a higher impedance analog ground that is easier to shake by noise coming from the metal stack.