Contribution ID: **203** Type: **Poster**

P1.45: Spectroscopic effects of distributed-line phenomena in integrated feedback resistors for charge-sensitive pre-amplifiers

Monday, 26 June 2023 14:53 (1 minute)

Charge-sensitive pre-amplifiers for semiconductor radiation detectors require a feedback discharge device to ensure proper functionality and avoid saturation. This can be a continuous-time device, like a simple resistor or trans-conductor, or an active structure that provides pulsed reset. Traditionally in the field of gamma spectroscopy such device is a discrete resistor of high value (1GΩ or more). This because the noise produced by this device is one of the key elements that concur in defining the total equivalent input noise of the pre-amplifier. For the same reason this device can be operated at liquid nitrogen temperature for noise minimization. The state-of-the-art spectroscopic filtering techniques require also this device to be exceptionally linear in order to produce exponential-shaped signals at the pre-amplifier output to ensure best energy resolution. Unfortunately such surface-mount devices are realized on ceramic substrates that are not radio-pure and this can be an issue if radio-purity is required, like in underground laboratories where rare-decay studies are carried out. Such devices are also bulky and may be an issue while pursuing maximum system integration in high-channel-number applications. Since active trans-conductors generally have a higher noise respect to passive resistors, integrated high-resistivity polysilicon resistors seem a viable solution to combine integration, low noise and radio-purity. In fact, silicon dies are naturally radio-pure due to their technological production process.
One factor that should not be underestimated is the capacitive coupling to bulk that characterize such integrated polysilicon resistors. Such capacitance turn integrated polysilicon resistors into distributed-line devices. The interaction of the resistor thermal noise with such distributed capacitance shapes the white power spectral density of noise that such resistor produces when connected as feedback device of charge-sensitive pre-amplifier. Interestingly, the net effect is the appearance of a current noise component with power spectral density proportional to the square root of frequency. When conventional spectroscopy shaping techniques are applied to the signals from charge-sensitive amplifiers equipped with such resistor, an equivalent noise charge component arises that is proportional to the square root of the shaping time (see Figure 1). Closed form calculations and experimental data are presented that explain the origins of this interesting phenomenon and the practical consequences in typical experimental contexts.

[1] Capra, S., IEEE Trans Nucl Sci, 67 (4) (2020), 722-731.
[2] Capra, S., Secci, G., Pullia, A., IEEE Trans Nucl Sci, 10.1109/TNS.2023.3259143, in press.

Primary author: Dr CAPRA, Stefano

Co-authors: SECCI, Giacomo (University of Milan and INFN of Milan); PULLIA, Alberto (University of Milan and INFN of Milan)

Presenter: Dr CAPRA, Stefano

Session Classification: Poster (incl. coffee)