

A high-speed low-noise front-end ASIC prototype for high-intensity ionization chamber

A novel ionization chamber measures the position and arrival time of each ion for the high intensity beam detection. The biggest challenge of the ionization chamber is to design a high-speed low-noise charge readout chip in which the charge collection electrodes and the readout electronics are integrated into a same silicon chip in a standard CMOS process.

A high-speed low-noise front-end readout ASIC prototype is presented in this paper. The ASIC prototype is composed of a charge collection electrode, a Charge Sensitive Amplifier (CSA), a discriminator and buffers. The charge collection electrode is an exposed top-most metal with a size of $996\ \mu\text{m} \times 85\ \mu\text{m}$, named Topmetal, and surrounded by the same metal layer, named Guardring. The Guardring is to form focusing electronic field to improve the charge collection efficiency in the normal operating mode and to inject the signal in test operating mode. The Topmetal is directly coupled to the CSA. The CSA can be set in different gain modes through three-bit switches to change the value of the feedback capacitor. The output of the CSA is split into two branches. One is connected to a two-stage source follower to transmit the analog signal off-chip. The other is AC coupled to the discriminator. The threshold of the discriminator can be adjusted off-chip and the output signal can be transmitted off-chip by a buffer. The ASIC prototype has been manufactured in a 180 nm process and come back to the lab.

The test results show that the charge conversion gains of different modes are 324.8 mV/fC, 98.63 mV/fC and 40.58 mV/fC. The input equivalent charge noise is about 30 e⁻. The linear input charge range is about 9.6 fC with a linearity of less than 3.4%. The shaping time of the CSA can be less than 1 μs .

Submission declaration

Original and unpublished

Authors: QIAO, Yuxin; GAO, Chaosong; FENG, wanhan (central china normal university)

Presenter: QIAO, Yuxin

Track Classification: ASICs