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In-pixel conversion with a 10 bit SAR ADC for next generation X-ray FELs

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This work presents the design of an interleaved SAR ADC, part of the readout channel of an X-ray imager for application at the next generation free electron laser facilities. The front-end channel, designed in a 65 nm CMOS technology in the framework of the PixFEL project, has to be capable of processing signals in a very large dynamic range (1 to 10000 photons) with single photon resolution at small number of photons. Each channel is equipped with an ADC. This makes the system more robust as compared to the case of conversion at the chip periphery or off chip transmission of analog samples. The choice of the SAR architecture is justified by the need for a good tradeoff between power dissipation, area occupation and conversion speed. While an 8-bit ADC may ensure single photon resolution at small energies and Poisson limited performance for signals towards the high energy range, a 10-bit resolution may be exploited to improve robustness against parameter dispersion and noise. After schematic simulation at the maximum sample rate of 5 MHz, a maximum DNL = 0.125 LSB and a maximum INL = 0.138 LSB were obtained. None of them exceeds 0.5 LSB after post layout simulations. The SNR is 56.6 dB, implying an ENOB = 9.6. The power consumption is 85 uW. The layouts designed for different test chip occupy an area that spans from (97 x 74) um to (97 x 58) um, compatible with the target pitch of the pixel of 100 um. Experimental data are expected for the time of the conference.

Collaboration

On behalf of the PixFEL Collaboration. The PixFEL project is funded by INFN. The members of the PixFEL Collaboration are affiliated with Università di Bergamo, Università di Pavia, Università di Pisa, Università di Trento and INFN, Italy.

Primary author: LODOLA, Luca (PV)

Presenter: LODOLA, Luca (PV)

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