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Design of Nupix-A1, a MAPS with timing and energy measurement for heavy-ion physics

The vertex and tracking detectors of the heavy-ion physics experiments at the Heavy Ion Research Facility in Lanzhou (HIRFL) and the High Intensity heavy-ion Accelerator Facility (HIAF) require the development of Monolithic Active Pixel Sensor (MAPS). Hence, the Nupix-A1 has been designed in a 130nm process. It is a MAPS that can measure the particle hit's position, energy, and arrival time. It mainly consists of 128 x 64 pixels with the pitch of 30μm, thirty-two 11-bit column-parallel ADCs, the DAC array with I2C interface, and the data transmission link.

In each pixel, the charge deposited by the particle hit is collected by the charge collection diode and converted into a voltage signal, which goes into the energy and timing paths. The pixels can be tuned and characterized with a configurable DAC array consisting of four 10bit voltage DACs and seven 8bit current DACs. The analog signal from the pixels in four adjacent columns is converted into a digital signal by an 11-bit column-parallel ADC implemented in a novel cyclic structure. Finally, the digitized data is encoded and transmitted by the 5Gbps data transmission link, constituted of a 16b/20b encoder, a 20:1 serializer, and a Feed Forward Equalization (FFE) driver.

The Nupix-A1 is expected to provide a spatial resolution of ~5um, timing accuracy of ~180ps, and equivalent noise charge (ENC) of ~8e-. This paper will discuss the design and performance of this Nupix-A1.

Primary experiment

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