Contribution ID: **15** Type: **poster**

Characterization of the First Prototype of HEROC: An Analog Readout ASIC for Position Sensitive Helium-3 Tube Neutron Detection Applications

With the advancement of high-performance neutron sources like China Spallation Neutron Source (CSNS), neutron scattering spectrometers require reduced collisions between neutrons and air molecules to minimize background noise. This necessitates operating under vacuum conditions, which poses challenges for neutron detectors and electronics. Traditional discrete component-based PCB circuits lead to high power consumption and low event rates. This paper presents the experimental characterization of the prototype of an application-specific integrated circuit (ASIC) dedicated to position-sensitive Helium-3 tubes, addresses these issues by reducing power consumption and heat dissipation, enabling detector systems to operate efficiently in vacuum environments. The chip includes a front-end amplification, a shaping module and a readout driving buffer. The 8-channel ASIC, named HEROC (HElium-3 ReadOut Circuits), achieves an input dynamic range from 10 fC to 2 pC, with a counting rate of up to 500 kHz. The equivalent noise charge (ENC) measurement result is 1297e-@15pF, and the power consumption is less than 9.9 mW per channel. Each channel of the HEROC chip integrated a charge sensitive amplifier, a pole-zero cancellation module, a shaper circuit and an output buffer. The prototype system also includes a data aggregation board, utilizing a Xilinx ARTIX-7 series XC7A100T FPGA as the data processing chip and a multi-channel ADC chip ADS52J90 for analog-to-digital conversion. Vacuum chamber measurements were performed to assess the temperature behavior under vacuum conditions. After the prototype reached a stable operational state, the temperature of the ASIC chip increased by less than 1℃ compared to ambient air, which had minimal impact on the chip's functionality and performance. According to the test results obtained from the neutron beamline at CSNS, the first prototype of HEROC achieves a position resolution of about 6 mm after calibration and 125kHz counting rate results. The ASIC prototype has replaced the traditional front-end circuit based on discrete components, fundamentally addressing the issue of front-end power consumption and enabling the entire detector system to operate in a vacuum environment.

Workshop topics

Front-end electronics and readout

Author: JIAYI REN, 任佳义

Presenter: JIAYI REN, 任佳义