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Research on X-ray beam position front-end electronics based on diamond detectors

Tuesday, 10 September 2024 16:00 (1h 30m)

This project aims to collect high-frequency high-precision data from the weak current signals generated by the quadrant-type diamond detector used for high-precision beam position monitoring. The main approach is to design a current conversion amplification circuit based on the theory of high-resistance I-V weak current to achieve fast conversion and collection of the four-channel weak current with large dynamic range and multiple ranges at high frequency, with the highest precision reaching the pA level. The circuit uses the ADA4530-1 amplifier with extremely low input bias current budget to complete the front-end circuit setup. The circuit's bandwidth is simulated and analyzed, with the bandwidth limited to 159 Hz. The design uses a protection ring design, a three-axis BNC connection, and a custom shielded box to enhance the shielding performance of the measurement system. The output signal is converted to a 24-bit high-precision analog-to-digital signal by the AD7172-2, and further connected to the core control board for signal closed-loop control to achieve overall isolation of the analog and digital circuits. The final experimental test shows that the detection sensitivity of the circuit for pA-level weak currents is 9.7936 mV/pA, and the error of the circuit is 1.3% when the weak current is greater than 10 pA, which can meet the demand for beam position measurement in the stable beam system.

Footnotes

Funding Agency

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Yes

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