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Design and performance of strip sensors with slim edges for HPS experiment

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The HPS experiment is searching for heavy photon particle in mass range between 30 and 200 MeV/c^2. This particle is postulated to mediate interactions with Dark Matter and is of cosmological importance. The experiment itself has a fixed target geometry. It is operated at Jefferson Lab's CEBAF electron accelerator. Electrons with energy of several GeV impinge on the thin target and can originate heavy photons in a process similar to bremsstrahlung. The photon decay into an electron-positron pair can then be detected.

HPS can use several search strategies. One of them relies on displaced vertex identification requiring a precision tracking and vertexing system. HPS was originally built with a 6-layer Silicon Vertex Tracker (SVT). For the on-going 2019 run SVT was upgraded with additional layer, called layer-zero (L0), which was placed at 5 cm distance from the target, half of the original 1st layer (L1) distance. In order to improve physics reach and avoid beam scattering, the new sensors'active region was designed to be 750 μm away from the beam. This required slim edge sensor technology with target inactive width of sensor periphery of 250 μm.

The sensors were laid out and fabricated by CNM Barcelona to HPS design. Each device has two rows of 1.5 cm long strips with 55 μm strip pitch. The relatively short strip length allowed to use 200 μm thick silicon wafers to reduce multiple scattering of individual tracks. The slim edge was implemented as a post-processing step using Scribe-Cleave-Passivate (SCP) technology. In order to improve SCP application, a wafer lattice alignment method was implemented as a pre-processing step using specifically-etched alignment marks on the bare silicon wafers. A sufficient number of sensors was produced to allow installation of the new L0. In addition, L1 modules were replaced to further enhance tracking performance.

The presentation will describe the sensor production and module building experience, as well as sensor operations during 2019 experimental run.

Submission declaration

Original and unpublished

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