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Studies of uniformity of 50 um UFSD sensors at the Fermilab test beam

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We report measurements of uniformity of time resolution, signal amplitude, and charged particle detection efficiency across the sensor surface of Ultra-Fast Silicon Detectors (UFSD). Comparisons of performance of sensors with different doping concentrations, and different active thicknesses are presented, as well as their temperature dependance and radiation tolerance up to 6×10^{14}˜n/cm^2. Results were obtained during Spring 2017 campaign at the Fermilab test beam facility using 120 GeV proton beams, and a high precision pixel tracking detector. UFSD sensors based on the Low-Gain Avalanche Detector (LGAD) design were manufactured by the the Centro Nacional de Microelectr\'onica (CNM) and Hamamatsu Photonics (HPK) were tested in the experiments. The uniformity of the sensor response in pulse height, efficiency and timing resolution were found to be good pre-radiation, with time resolution around 30-40 psec depending on operating conditions. A "no-response" area between pads which exhibitwas measured to be around 70˜μm for CNM and 110μm for HPK sensors. After a neutron fluence of 6×10^{14}˜n/cm^2 the CNM sensor exhibits a large gain variation of a factor 2.5 when comparing metallized and non-metallized sensor areas. Irradiated CNM sensor achieved time resolution of 30˜psec for the metallized part, and 40˜psec for the non-metallized area, while the time resolution of the HPK sensor was measured to be 30˜psec.

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