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Picosecond timing of high-energy heavy ions with semiconductor detectors

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Construction of new accelerating facilities for the investigation of heavy ions requires upgrading of the time-of-flight (TOF) spectrometers for on-line monitoring of the characteristics of ions delivered to experiments. The requested time resolution of the TOF system is in the range of tens of picoseconds, which will cover characterization of ions up to uranium. The TOF systems built on scintillators and microchannel photomultipliers do not satisfy this requirement and, additionally, are not enough radiation hard to withstand the expected fluence of the detected ions and harsh radiation environment outside the beam. Semiconductor detectors and, in particular, silicon detectors whose technology allows device mass-production are now considered as a real candidate for TOF heavy ion spectroscopy. The expected restriction for fast timing of heavy ions with Si detectors is the so-called "plasma"effect related to the dense ion track. This effect creates significant delay in the signal formation, which value can reach several nanoseconds for short-range particles. Obviously, this prevents reaching the picosecond time resolution. Recent results on the timing of high-energy Au ions with Si planar detectors demonstrated the time jitter which is even better than 20 ps. In this presentation the mechanism of charge collection in tracks of heavy ions is examined to explain the observed high time resolution, and the results are projected to the performance of irradiated detectors.

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