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Results from the NA62 Gigatracker prototype: a lowmass and sub-ns time resolution silicon pixel detector

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The Gigatracker (GTK) is a hybrid silicon pixel detector developed for NA62, the experiment studying ultra-rare kaon decays at the CERN SPS. Three GTK stations will provide precise momentum and angular measurements on every track of the high intensity NA62 hadron beam with a time-tagging resolution of 150 ps. Multiple scattering and hadronic interactions of beam particles in the GTK has to be minimized to keep background events at acceptable levels, hence the total material budget is fixed to 0.5% X0 per station. In addition the calculated fluence for 100 days of running is 2 × 1014 1 MeV neq/cm2, comparable to the one expected for the inner trackers of LHC detectors in 10 years of operation. These requirements pose challenges for the development of an efficient and low-mass cooling system, to be operated in vacuum, and on the thinning of read-out chips to 100 μm or less.

The most challenging requirement is represented by the time resolution, which can be achieved by carefully compensating for the discriminator time-walk. For this purpose, two complementary read-out architectures have been designed and produced as small-scale prototypes: the first is based on the use of a Time-over-Threshold circuit followed by a TDC shared by a group of pixels, while the other uses a constant-fraction discriminator followed by an on-pixel TDC. The readout pixel ASICs are produced in 130 nm IBM CMOS technology and bump-bonded to 200 μm thick silicon sensors.

The Gigatracker detector system is described with particular emphasis on recent experimental results obtained from laboratory and beam tests of prototype bump-bonded assemblies, which show a time resolution of less than 200 ps for single hits.

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