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Ultra Fast Silicon Detectors

We propose an ultra-fast silicon detector (UFSD) with time resolution a factor 10 better than what is possible today, which will establish a new paradigm for space-time particle tracking. Presently, precise tracking devices determine time quite poorly while good timing devices are too large for accurate position measurement. This fact is imposing severe limitations on the potential of many applications ranging from medical PET to mass spectroscopy or particle tracking. We plan to develop a single device able to concurrently measure with high precision the space (~10 μm) and time (~10 ps) coordinates of a particle.
This research is poised to open up a range of new opportunities for applications that benefit from the combination of position and timing information. For example, UFSD allows obtaining sharper PET images, 3D camera and robotic vision, monitoring more accurately the dose delivered in cancer treatment and improving particle tracking in High-Energy physics experiments.
Since UFSD are extremely thin, they will make use of the internal charge multiplication in silicon sensors; a recent very active field of investigations within the CERN based RD50 collaboration.
The core of our project is to design a thin sensor with an innovative doping profile that achieves charge multiplication without having electric breakdown. The silicon sensors will be based on the technology of Low Gain Avalanche Detectors (LGAD) developed by CNM-CSIC while the Application-Specific Integrated Circuits (ASIC) solution is the natural choice for the read-out electronics of the UFSD system. Such a solution will benefit from the performances of the most advanced technologies (based on the 65 nm node) both in terms of circuit density (for space resolution) and of circuit speed (for time resolution).

Summary

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