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Silicon Photo-Multipliers: status and perspectives

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Silicon photo-multipliers (SiPM) are novel type of photo-detectors whose success is growing in various scientific fields. They are compact devices composed of a few thousands of tiny avalanche photo-diode pixels grown on a common silicon substrate. The diodes are operated in Geiger mode so that any single carrier, generated either by photons or thermally in the depletion region, might trigger a self-sustaining avalanche. Avalanche quenching is obtained either passively, by means of resistors, or actively, by means of transistors integrated in the pixel. In the former case, because all SiPM pixels work in parallel, the output signal is the sum of the signals from all fired pixels: while each pixel is an independent binary photon counter, the SiPM as a whole works as an analog detector where the signal amplitude is proportional to the number of impinging photons (analog SiPM). In the latter case, the digital signal produced by each pixel is readout yielding a measurement of the total number of photons and their arrival time information (digital SiPM).In this talk SiPMs will be introduced, showing how they combine the advantages of vacuum photomultiplier tubes and avalanche photodiodes: indeed they have high gain, exceptional charge resolution, do not require pre-amplification, are operated at low bias voltages (below 100V) and are insensitive to magnetic fields. The basic device working principles and the most relevant figures of merit will be discussed. Some emphasis will be given on the differences between the analog and the digital types of SiPM, in view of a more detailed discussion during the workshop. Few examples of application will be illustrated in order to discuss additional factors (e.g. bias voltage uniformity, temperature stability and cost) which are relevant to the performances of complete detector systems

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