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The VSiPMT project: characterization of the second generation of prototypes

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VSiPMT (Vacuum Silicon PhotoMultiplier Tube) is an innovative photodetector that matches the excellent photon counting performances of SiPMs with the large sensitive surfaces of standard PMTs. In such device, the photoelectrons generated by a large surface photocathode are accelerated and driven by an electrostatic focusing system towards a small focal area covered by a SiPM.
This solution is expected to offer several important advantages with respect to standard PMTs technology (improved photon counting, faster time response, higher stability and a decreased power consumption), while keeping comparable values of gain and quantum efficiency.
The project stands on a huge preliminary phase, mainly aimed at investigating the performances of SiPMs as electron detectors. The promising results of this work provided the proof of feasibility of the device and encouraged Hamamatsu Photonics at realizing a first generation of VSiPMT prototypes, based on the combination of a circular GaAsP photocathode (3 mm diameter) and a custom SiPM without optical entrance window.

The extensive characterization of these devices provided results going far beyond the most optimistic expectations: excellent SPE resolution, easy low-voltage-based stability, very good time performances, high gain and good PDE are among the most outstanding achievements, counter-balanced by some drawbacks like a still high dark noise and lack of linearity.
The success of this phase have boosted a further design effort, which resulted in the realization of a second generation of a VSiPMT prototypes with a 1-inch photocathode surface. The outstanding performances of such device make it an attractive solution for a potentially limitless field of applications, ranging from fundamental physics research to medical applications.
In this work, the characterization of the second generation of VSiPMT prototypes will be described in detail, with a special focus on the adopted technological solutions and on the guidelines for a further engineering phase aimed at the realization of a next version of prototypes with an even larger photocathode surface.

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