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SAM-APDs based on quantum-engineered semiconductors for X-ray detection

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Ultrafast, ultra-low noise X-ray detectors based on Avalanche PhotoDiodes (APDs) are crucial elements in scientific contexts such as Synchrotron Radiation facilities and Free Electron Lasers. APDs have been traditionally based on silicon, a mature and solid technology with adequate performance up to the X-ray range. However, the advent of ultimate light sources set more stringent requirements on APD detectors, which would benefit from a new choice of materials. In particular, in GaAs-based semiconductors the higher Z number of Ga and As compared to Si strongly increases quantum efficiency. Consequently, much thinner absorption regions are sufficient, resulting in improved time resolution. Furthermore, GaAs has a higher energy gap than silicon (thus a better resistance to radiation damage) and epitaxial growth of AlGaAs alloys allows exploiting quantum confinement effects through band gap engineering.

We are developing APDs with separated absorption and multiplication regions, where the latter is made of a staircase GaAs/AlGaAs multilayer, which favors well defined multiplication of electrons and suppresses multiplication of holes (lower noise of device). We will present details of the working principle and fabrication protocols, as well as of detector performance in terms of multiplication and noise, under radiation from the visible to the X-ray range.

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