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Time response of avalanche photodiode based on GaAs/AlGaAs with separated absorption and multiplication region

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In order to tackle current and future challenges in photon science it requires novel concepts of ultra fast photon counters. Especially for photon pulses with ultra-short durations at short wavelengths as delivered currently by synchrotrons and free electron lasers his leads to a demand for hard X-ray detectors providing sufficient time resolution to exploit the potential of such ultra-short pulses in time-resolved investigations.
Although silicon avalanche photodiodes and silicon photomultipliers represent the cutting edge of detection in some ultrafast experiments their main drawback is their low detection efficiency for high- energy radiation. Therefore, we have fabricated an avalanche photodiode based on GaAs/AlGaAs providing increased absorbance when compared to their silicon based counter parts due to their higher atomic number. As a consequence a much thinner absorption layer is sufficient to obtain the same or higher quantum efficiency as in silicon, resulting in an improved time resolution.
The devices presented in this work have been grown by MBE and they comprise an absorption region separated from a multiplication region by a p-doped layer of C atoms.
Here we report on the timing performances together with the signal-to-noise characterization of two devices featuring different concentrations and thicknesses of the carbon layer, a δ layer of 2.5·1012 cm -2 and a 50-nm-layer of 6·1012 cm-2 of C atoms, respectively. In particular, these devices have been tested with the 10-ps pulses delivered by a 510-nm laser with a repetition rate of 40 MHz at room temperature, achieving response rise-times as short as few tens of ps .

Authors: STEINHARTOVA, Tereza; NICHETTI, Camilla; ANTONELLI, Matias; DE ANGELIS, Dario; CAUTERO, Giuseppe; PILOTTO, Alessandro; DRIUSSI, Francesco; PALESTRI, Pierpaolo; SELMI, Luca; ARFELLI, Fulvia; BIASIOL, Giorgio; MENK, Ralf

Presenter: STEINHARTOVA, Tereza

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