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P1.071 SINGLE: single photon sensitive cryogenic light detectors

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Thermal particle detectors are used as calorimeters in rare events physics (neutrino-less double beta decay, direct dark matter detection, rare nuclear processes, coherent neutrino interactions), where the excellent energy resolution and the wide choice of materials are important features. The simultaneous detection of the energy deposited in the target material and the amount of emitted light is a powerful tool to identify and reject background events in modern and future detectors, but the amount of light to be detected can be as small as few optical photons for some materials and setups. Moreover, in order to measure the small temperature variation induced by a particle interaction, thermal detector are operated at cryogenic temperature, in the tens of mK range, where standard light detectors with single photon sensitivity aren't a viable solution.

SINGLE is an INFN founded R&D project. Its primary goal is the development of large area (up to 10000 mm^2), single optical photon sensitive light detectors that can operate at 10mK as thermal detectors and can be easily integrated in next-generation ton-scale cryogenic experiments. The single photon sensitivity will be achieved by exploiting the Neganov-Luke effect in a novel way: a strongly non-uniform electric field applied to a silicon substrate induces a large thermal signal by drifting the electron-hole pairs generated by photons absorption. Depending on the magnitude of the applied bias, secondary charges can be produced by impact ionisation inducing an avalanche effect and further increasing the signal-to-noise ratio.

We present the results of the phased approach with prototypes up to 5 x 5 cm^2, as well as the near-future plans for the upscaling to full-size devices.