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Count rate measurements of a new single photon counting hybrid pixel detector prototype

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Matterhorn is a new single photon counting hybrid pixel detector from the PSD Detector Group at the Paul Scherrer Institute. Its design goals are ambitious, aiming to achieve 90% counting efficiency at 20Mcounts/pixel/second while covering a 250 eV –80 keV energy range and providing a 20 kHz continuous frame rate in 8 bit mode.

In this paper we present rate characterization done with synchrotron radiation on prototype chips featuring 48 x 48 pixels at 75 um pitch and four 16-bit counters per pixel. The measurements were all done using a standard 320 um thick p-on-n silicon sensor with energies from 8 to 16 keV. The measured noise ranges from 50 to 250 e- RMS depending on shaping time. With the fastest settings we measured a dead time of 49 ns utilizing the paralyzable model which predicts 90% efficiency at 17M counts/pixel/second using pileup tracking and all four counters.

The full size, not yet submitted, chip will feature 256 x 256 pixels and we foresee building 8x4cm2 modules from eight ASICs bonded to a single sensor. To cover the broad energy range, we will use sensors based on LGAD technology (<4 keV) and high Z sensors such as GaAs and CZT (>20 keV) along the normal silicon sensors.

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