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The Tynode: a new vacuum electron multiplier for ultra fast pixelised particle detectors

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By placing, in vacuum, a stack of transmission dynodes (tynodes) on top of a CMOS pixel chip, a generic, digital, single free electron detector could be made with potentially a ps time resolution. Its essential element is the tynode: an ultra thin membrane, which emits, at the impact of an energetic electron on one side, a multiple of electrons at the other side. The tynode's electron yields have been
calculated by means of GEANT-4 Monte Carlo simulations, applying special low-energy extensions. The results are in line with another simulation based on a continuous charge-diffusion model. By means of MEMS technology, tynodes and test samples have been realised. The secondary electron yield of several tynode prototypes have been measured in three different stations. Our best result so far
is a transmission secondary electron yield of 5.5, obtained with an MgO membrane made using Atomic Layer Deposition ALD technology. Several possibilities to improve the yield are presented. A prototype soft photon detector, based on a stack of tynodes placed in a Planacon (Photonis) detector, is now under construction. This new photon detector may outperform SiPMs in terms of time resolution and absence of noise. Its efficiency, however, is limited by the Quantum Efficiency (QE) of the photocathode. The QE of modern photocathodes never exceeds 50%. We propose the development of a MEMS-made active photocathode in which the absorption/conversion layer is biased with an electric field, forcing
migrating electrons towards the emission side.

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