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Tracking with the ultra fast pixelised Tipsy single photon detector

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Tipsy is an assembly of a pixel chip and a stack of transmission dynodes “tynodes”, placed in the vacuum under a classical window+photocathode. A tynode is an array of thin membranes: an electron impinging the upper surface causes the emission of (now) 5.5 secondary electrons at the bottom side. A stack of 5 tynodes causes a cloud of 5.5**5 = 5 k electrons to enter the pixel input pad, sufficient to activate the pixel circuitry. Due to the small geometry of the stack and the uniform straight electron paths between the tynodes, the time jitter of electrons entering the pixel is less than a ps.

A tynode with a transmission secondary electron yield of 5.5 has been realised. A prototype Tipsy is now under construction in the form of a modified Planacon (Photonis).
New concepts for TimePix chips are being proposed, with a TDC-per-pixel with time resolution better than 10 ps.

Future low-cost, mass produced Tipsy’s may have the following specifications:

- Thin (4 mm), planar, light, square geometry
- 10 ps time resolution and 10 um 2D spatial resolution per single soft photon
- amplification stack free of dark noise
- absence of ion feedback
- operates in strong B-fields
- hit-pixel data rates up to 5 Gb/s

Tipsy could be well-applied in PET scanners. Instead of a scintillator, a lead glass or saffire cube could be readout at all six sides, recording (prompt) Cherenkov photons originating from the 511 keV gamma interaction point. By means of GPS algorithms, this point can be reconstructed in 4D with high precision.

The tracking of MIPs could be done by replacing the photo cathode by an ‘e-brane’: a foil having a high probability to emit at least one electron at the surface crossing point of the track of the MIP. Another method would be to create Cherenkov photons in thin transparent (mylar) foils. A future inner tracker of a collider experiment would then take the form of a vacuum tank around the interaction point in which foils are stretched in a cylinder geometry, at several radii. The detectors of Cherenkov photons could be placed at the inner side of the vacuum cylinder wall, meters away from the interaction point.

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