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A Segmented Anode Vacuum Phototriode with Position Sensitivity

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Vacuum phototriodes (VPT) have been used for many years in particle physics experiments. For example, they were used in the OPAL experiment at LEP and are currently used in the endcap Electromagnetic Calorimeter of the CMS experiment, at CERN's Large Hadron Collider. Since the VPT is a fast, proximity focused device, the anode or dynode can be subdivided into several independent channels within the same overall vacuum envelope. Such a device could be useful for reading out scintillating or wavelength shifting fibres from a "SPACAL" type of calorimeter.

A prototype VPT made for us by Hamamatsu is configured with a segmented anode, followed by a fine mesh dynode. This is one of the first of its kind and the novelty of the tube allows four independent channels within a single tube sharing a common photocathode and gain stage. This is beneficial for applications with limited space, as the dead region due to the electrode structure and diameter of active photocathode is considerably minimised compared to four smaller devices; significant cost savings would also accrue. The length of the prototype VPT is 40 mm with a 23 mm diameter vacuum envelope; the anode is split into four equal quadrants with a 1mm gap between each quadrant.

This paper presents the experimental characterisation of the new segmented anode VPT as well as the predictions from a COMSOL multi-physics simulation. Measurements of the induced signal as a function of time are presented, with the effects of electrical and optical cross-talk in adjacent quadrants.

Initial experiments with a DC optical source indicate the quadrants have almost identical performance on the outputs. Results include a detailed area scan, illustrating the position sensitivity, using a blue LED focussed to a 0.5 mm spot on the photocathode. Measurements are taken of the gain using magnetic fields up-to 4T. Fast pulse characterisation is carried out using an 80 ps diode laser operating at 435 nm.

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