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Wavelength shifters for optically read out MPGDs

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Optical readout of MPGDs achieves high spatial resolution with state-of-the-art pixellated imaging sensors for applications ranging from optical Time Projection Chambers (TPCs) to imaging and detector characterisation. Gas mixtures containing CF4 are the most popular choice for optically read out MPGDs due to their strong visible light yield. This presents challenges due to decreasing availability of CF4 and its classification as greenhouse gas and limits the usability of optical readout. Alternative approaches include the use of UV-sensitive imaging sensors or the use of wavelength shifting to convert light to a wavelength range compatible with the sensitivity of readout devices.

We present studies of solid wavelength shifters including Tetra-Phenyl-Butadiene (TPB) and PolyEthylene Naphthalate (PEN) layers which were used to convert secondary scintillation light in the (V)UV range to visible light. The re-emission of both materials is compatible with conventional imaging sensors. In comparison, TPB achieves higher conversion efficiency, while PEN is readily available and may be advantageous for integration into detectors due to its higher robustness.

Spectroscopic measurements are performed to confirm re-emission from wavelength shifting layers. The achievable spatial resolution of GEM and Micromegas detectors combined with semi-transparent wavelength shifting layers deposited on right substrates to enable optical readout is studied. X-ray radiography is used to quantify the effect of the separation of amplification stage and wavelength shifter spatial resolution. The deposition of a wavelength shifting layer on the anode in a bulk glass Micromegas detector minimises blurring and yielded the best results with spatial resolution comparable to the case of direct readout of CF4-based gas mixtures.

Operation in pure noble gases with wavelength shifters coupled to (M-)THGEM detectors is studied which extends the versatility of the optical readout approach for TPCs and reduces limitations on gas mixture composition.

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