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Non-linearity Reduction in Electronic Image Readouts

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Simulation of detector operation can be a valuable tool in optimizing design before recourse to cutting metal, and if successful, can significantly reduce the requirement for design iteration. This paper describes this process as applied to the reduction of spatial non-linearities in electronic charge division readout devices.

Several theoretical analyses of the non-linearities expected such devices in have been previously undertaken, however all suffer from the inability to analyze the perimeter pattern areas where the electrode geometry does not bear simple analytical description. We present a technique whereby an arbitrary radial charge footprint may convolved with any electrode structure which can be defined as a closed polygon, to calculate total charge deposited on the electrode. This technique can be used for electronic charge division image readouts to accurately determine the effect of arbitrary electrode perimeter designs; the major cause of non-linearity in these devices.

We present measurements of readout non-linearity both from pattern simulations and from manufactured readout patterns used in an operational microchannel plate detector, and use comparison to demonstrate the validity of this convolution technique. We describe a computer procedure whereby the linearity measurements from real image data may be obtained automatically by looking for correlation between a predefined kernel obtained from the image, and representing repetitive elements within the image data.

We demonstrate how the design of the electrode perimeter is crucial in the mitigation of readout non-linearity and present results from designs optimized using this simulation technique. We discuss the degree of improvement gained using this method and suggest areas where simulation prior to manufacture may be used to good effect.

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