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Ultimate position resolution of pixel clusters with binary readout for particle tracking

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Silicon tracking detectors can record the charge in each channel (analog or digitized) or have only binary readout (hit or no hit). While there is significant literature on the position resolution obtained from interpolation of charge measurements, a comprehensive study of the resolution obtainable with binary readout is lacking. It is commonly assumed that the binary resolution is $\text{pitch}/\sqrt{12}$, but this is generally a worst case upper limit. In this paper we study, using simulation, the best achievable resolution for minimum ionizing particles in binary readout pixels. A wide range of incident angles and pixel sizes are simulated with a standalone code, using the Bichsel model for charge deposition. The results show how the resolution depends on angles and sensor geometry. Until the pixel pitch becomes so small as to be comparable to the distance between energy deposits in silicon, the resolution is always better, and in some cases much better, than $\text{pitch}/\sqrt{12}$.

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