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Design and simulation of the Kinetic Inductance Detector based spectrograph (KIDSpec) demonstrator

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We present the design of the demonstrator for KIDSpec, the Kinetic Inductance Detector based medium resolution spectrograph in the optical through near-IR band. This instrument uses the intrinsic energy resolution of MKIDs to distinguish photons from multiple diffraction orders using an échelle grating as the dispersion element. KIDSpec will use this order resolving capability to replace the cross-disperser in a traditional échelle spectrograph. A technology demonstrator is being built with a monochromator based light source, a low line density optical grating and an optical fibre feed into a custom-built cryostat which will cool the MKID array down to 100 mK. The readout is based on the Reconfigurable Open Architecture Computing Hardware (ROACH) board with a Python based data analysis pipeline.

We have simulated the demonstrator in Python where we have explored the effects of the finite energy resolution ($\lambda/\Delta\lambda$) of MKIDs, choice of optical grating and size of the MKID array. The ability of the demonstrator to separate light from different orders and spectral reconstruction of various astrophysical sources is strongly dependent on the energy resolution. A low energy resolution leads to the misidentification of the order to which detected photons belong to, limits the highest order which can be identified and also affects the final spectral resolution. We will also present the effect of sky background on the signal to noise performance of the spectrograph and the potential of the instrument on current and future extremely large telescopes.

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