MKID-based pyramid wavefront sensor, wavelength sensitivity detector for tracking optical

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Abstract

The pyramid wavefront sensor (PWFS) is widely recognized as being able to provide the best closed-loop adaptive
optics (AO) performance, with many current and future AO systems selecting the PWFS as their primary natural guide
star wavefront sensor. Existing CCD/CMOS detector technology is well suited to PWFS operation, providing near-
zero read noise detectors with frame rates of 1 - 3 kHz at either visible or near-infrared wavelengths. However, there
is little scope for significant improvement in these detector technologies to drive PWFS AO performance further. Here
we propose the use of a microwave kinetic inductance detector (MKID) array as an alternative PWFS detector
technology and describe the benefits this can bring to future AO system performance.
An MKID array is a superconducting detector with unique properties compared to CCD/CMOS detectors that give a
measure the position, time, and energy of every photon incident on the array. By sorting the photon into wavebands, it
allows us to use a multi wavelength PWFS and therefore open to possibilities in terms of the reconstruction algorithm
and bring new information to deal with PWFS limits. One of the current topic in term of limits are optical gains.
In this presentation, we will demonstrate the advantage of using the wavelength sensitivity of the detector in the
optical gain (OG) tracking. Using an MKID-based PWFS simulation developed at Durham we look at the influence
of the wavelength, the photon noise, modulation radius and Fried parameter r0 on those gains. From these different
gain curves, we can build an empirical model to track the OG changes within the multi-wavelength measures of the
wavefront and preliminary built of this model will be presented.

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