Mid-infrared multi-beam local oscillator source based on a fiber coupled quantum cascade laser

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High resolution spectroscopy has been proven to be a powerful tool in atmospheric and astronomical research, ranging from millimeter wavelength to mid-infrared wavelength range. As demonstrated at millimeter/sub-millimeter wavelength region, multi-beam heterodyne array receivers play a vital role, not only due to its improved mapping speed but also with the enhanced sensitivity in the continuum observation mode. However, at mid-infrared wavelengths, multi-beam heterodyne array receiver has not been reported yet, which is largely due to the complexity of efficiently demultiplexing the local oscillator (LO) source.

We have developed a fiber coupled demultiplexed local oscillator source for cryogenic application based on a distributed feedback quantum cascade laser (QCL) at an operating wavelength of 10.6 μm. Reflection phase grating generating 2×2 beams has been achieved with a total power efficiency of 64% based on gold covered etched silicon pattern. The diffraction beam has been readily coupled into a 2 meter long polycrystalline fiber with a core diameter of 240 μm, with 49% coupling efficiency achieved using an aspheric lens. Despite the 48% transmission coefficient for the polycrystalline fiber, Gaussian-like beam with a FWHM of 200 μm has been delivered at the fiber output. By aligning the fiber core position to the center of a superconducting hot electron bolometer mixer placed at 4 K in a closed-cycle cryostat, we demonstrate the application of fiber coupled demultiplexed QCL source for pumping the superconducting mixer with adequate LO power.

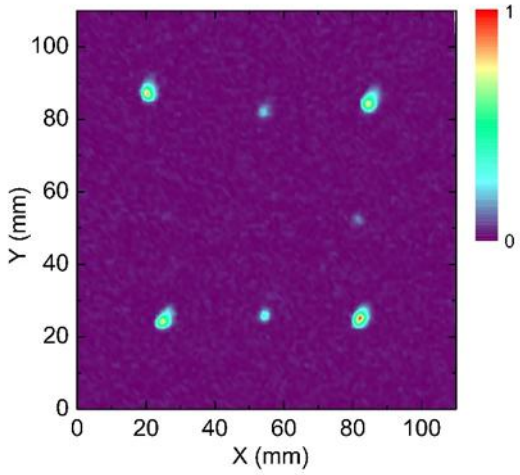

Fig. 1. Experimental result of diffraction pattern at 10.6 μm for the step phase grating.

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