4.7 THz local oscillator for GUSTO

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***Abstract*—** NASA has initiated a science mission (GUSTO) that will measure emissions from the interstellar medium. This data will help scientists determine the life cycle of interstellar gas in our Milky Way galaxy to understand the dynamics and gas flow in the vicinity of the center of our galaxy. In particular, GUSTO requires a local oscillator in its heterodyne receiver to detect natural Oxygen line at 4.744 THz. Considering the practical aspects, GUSTO demands a local oscillator with high power (>1 mw), tight beam pattern, and single mode of operation. Quantum Cascade Lasers (QCL) with 3rd-order distributed feedback (3rd DFB) grating on metal-metal waveguides can deliver high power and tight beam pattern. However, to achieve single mode operation at 4.744 THz, the lateral dimension of such waveguides should be much smaller than the wavelength (~20 um in the semiconductor). For such narrow lasers in metal-metal waveguides, the confinement factor gets unfavorably small and consequently decreases the output power and negatively affects the beam pattern. Lack of confinement also decreases the maximum lasing temperature and complicates the fabrication process. The second challenge is to tune the frequency of lasing and hit the target frequency within 3GHz. Fabrication fluctuation can readily produce up to ~300 GHz uncertainty in the lasing frequency. In this paper, we report a strategy to suppress higher lateral modes and still achieve high power and tight beam pattern though novel waveguide design. We also discuss a strategy to achieve exact frequency (within 3 GHz) for third order DFB's through systematic variation of laser geometry.