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Novel imaging spectrometer for the measurement of atmospheric trace gases

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A novel, ultra-compact Static Imaging Fourier Transform Spectrometer, SIFTS, with no moving parts has been developed for the detection of atmospheric gases. The instrument has been shown to have high spectral resolution (4 cm-1) and temporal resolution (10kHz) in both the mid and near infrared and moderate spectral resolution (14cm-1) in the visible.

This instrument has been developed for both remote sensing and in-situ measurements of atmospheric gases. Due to the low mass and compact size of the instrument system, the SIFTS instrument could be deployed as a remote sensing instrument onboard Earth observation satellites, Unmanned Aerial Vehicles (UAV's), or as an in-situ sensor for the measurement of atmospheric gases.

The technique is based on a static optical configuration whereby light is split into two paths and made to recombine along a focal plane producing an interference pattern. The spectral information is returned using a detector array to digitally capture the interferogram which can then be processed into a spectrum by the application of a Fourier transform.

As there are no moving components, the speed of measurement is determined by the frame rate of the detector array. Thus, this instrument has a temporal advantage over common Michelson FTIR instruments. Using a high speed Toshiba CCD line array, sensitive over the spectral region of 400 – 1100nm, spectra have been recorded at a rate of one every 0.1 milliseconds.

Using a SELEX infrared detector array, sensitive over the spectral region of 7 to 10μm, the gases NH3, O3 and CH4 have been used to demonstrate the sensitivity of the SIFTS instrument. It has been shown that the Signal to Noise of the SIFTS(MIR)is 524 using an integration time of 77msec.

The novel optical design has reduced the optics to only 3 optical components, and the detector array, to generate and measure the interferogram. The experimental performance of the SIFTS instrument has verified the theoretical models, and it has been shown that the spectral resolution in both the Visible and MIR instruments is 4cm-1 and 14cm-1 respectively. An internal laser diode provides acts as a calibration source which is used to maintain the wavelength stability of the instrument.