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Uncooled high speed MWIR cameras applied to advanced spectrometers

G.Vergara, R. Linares, R. Gutiérrez, C. Fernández, S. de la Fuente and A. Baldasano
New Infrared Technologies, Vidrieros 30, Boadilla del Monte, 28660-Madrid. Spain

gvergara@niteurope.com

Summary:
The appearance of new and advanced instrumentation such as supercontinuum laser sources, dual comb spectrometers, virtually imaged phase arrays, powerful processors etc. is bringing the traditional scenario dominated by one channel/multichannel spectroscopy towards a new paradigm where image spectroscopy will play a key role reaching their technological and commercial maturity. Uncooled high speed infrared cameras will be an important actor in the development of affordable and reliable image spectrometers. The paper describes the state of the art in uncooled high speed infrared cameras sensitive in the MWIR. 1-5 microns, spectral range and its application in advanced spectrometers.

Keywords: High speed MWIR, imaging spectroscopy, dual comb hyperspectral imaging

Introduction

The 1-5 microns spectral range is the great interest in gas spectroscopy. Most gases have their strongest features in this region which, in practice, allow to reach good sensitivities even for compact and small spectrometer devices. However, and due to fundamental limitations, sources and sensors working in this region of the spectra have been traditionally burdened by the technological complexity associated to their processing technologies and also to the need, in most of the cases, of using expensive, power starving and bulky coolers.

The development of new materials and devices is changing the panorama in both, MWIR sources and sensors, domains. It is the case of a new family of focal plane arrays developed and processed by NIT. Based on its own technology of polycrystalline PbSe, in 2017 NIT launched the first uncooled high speed MWIR camera of the market.

The appearance of a new family of cameras, sensitive in a wide spectral range, 1 to 5 microns, with good sensitivity in uncooled operation and able to capture images to a high framerate regime will facilitate the development of a new generation of spectrometers based on disruptive concepts such as hyperspectral dual comb imaging.

Uncooled high speed MWIR camera technology

Traditionally all infrared cameras sensitive in the MWIR spectral range have needed to cool the sensor to temperatures below 100 K. As consequence, their costs and availability have precluded a wider use in industrial and environmental applications. During the last years NIT has launched the first uncooled MWIR camera of the market. The camera heart is a focal plane array of polycrystalline PbSe monolithically integrated with the Si-CMOS ROIC processed according a proprietary method developed by the company.

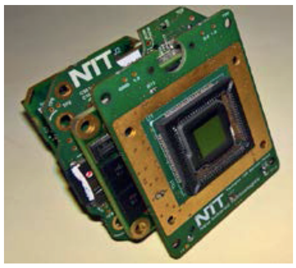

Figure 1 shows the Tachyon 16 K camera core. The picture shows the uncooled MWIR FPA developed and processed by NIT

The camera, which commercial name is Tachyon 16K, is unique. It has outstanding performances in terms of spectral band width, 1 to 4,7 microns, framerate > 2KHz @ full resolution (128x128 pixels), snapshot mode, reliability, compactness and power consumption. All these characteristics makes the camera an excellent candidate for being integrated in advanced spectrometers and active imaging spectroscopy devices.

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Tachyon 16K applied to advanced spectrometers

In the frame of the H2020-FLAIR project [1] an European consortium has developed an innovative, versatile and compact spectrometer able to acquire in one shot the concentration of specific gas species. The spectrometer was specifically designed for being integrated airborne platforms. Figure 2 shows a scheme of the FLAIR spectrometer [2].

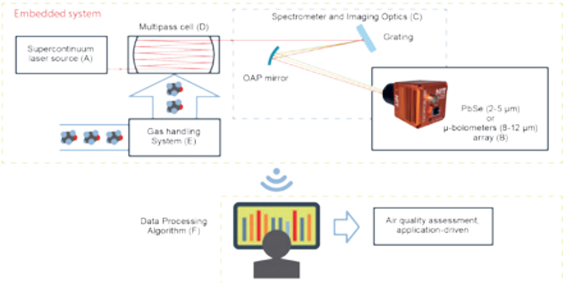

Figure 2.- Sketch shown the spectrometer developed in FLAIR project

The 16.000 pixels of the Tachyon 16K focal plane array combined with a SC laser source, a resonant cavity and different optical elements for dispersing the light allows to capture the gas spectra in one shot. Figure 3 shows the 2D absorption spectra obtained using N_2O reference cell at 1 atm. (Note: The spectra shown corresponds to set up shown in figure 2 but modified with a grating+VIPA (Virtually Imaged Phase Array) configuration.)

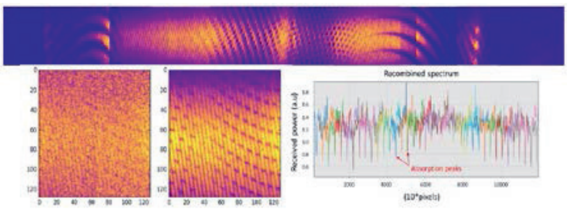

Figure 3.- 2D spectra of N_2O obtained with the first version of the FLAIR spectrometer.

Tachyon 16 K applied to dual comb hyperspectral imaging

Dual Comb Hyperspectral imaging is a novel technique with an extraordinary potential in a wide range of application fields [3]. Recent works [4] have demonstrated the advantages of using the unique performances offered by NIT cameras in terms of framerate, and spectral band sensitivity, for the application. Figure 4 shows the principle of the technique and some experimental results obtained [5] using NIT camera

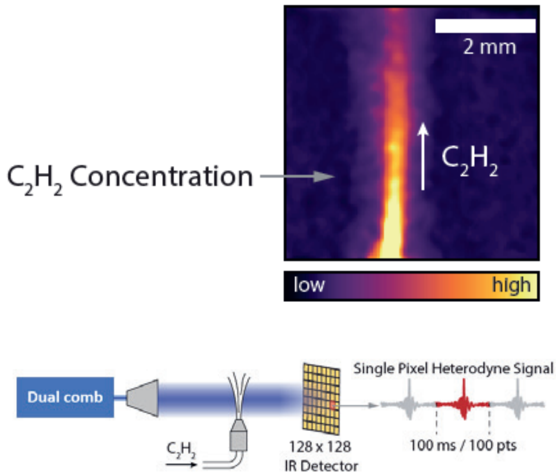

Figure 4.- Image of acetylene concentration obtained using NIT camera (courtesy [5]) and sketch describing dual comb hyperspectral imaging technique.

References

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