10μm pitch detectors for MWIR applications

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ABSTRACT

SCD has developed over the last few years a family of digital infrared detectors for Mid-Wave Infrared (MWIR) band with 10 μm pitch, at various array formats (1920×1536, 1280×1024 and 640×512), with two type of sensing arrays (InSb and XBn-InAsSb) suitable for a large variety of electro-optical (EO) systems.

The InSb photodiode array is based on SCD's mature planar implanted *p-n* junction technology, which covers the full MWIR band, and is designed to operate at 77K. The patented XBn-InAsSb barrier detector technology covers the blue part of the MWIR band and provides electro-optical performance equivalent to planar InSb but at operating temperatures as high as 150 K. Both sensing arrays, InSb and XBn, are Flip-chip bonded to our 0.18 μm CMOS technology Read-Out Integrated Circuit (ROIC).

The FPAs are then assembled into custom designed Dewars that can withstand harsh environmental conditions while minimizing the detector heat load. A dedicated proximity electronics board provides power supplies and timing to the ROIC and enables communication and video output to the system. Together with a wide range of cryogenic coolers, a high flexibility of housing designs this family of detectors covers wide range of EO applications.

The detectors with the smaller format are especially suitable for more compact and lower cost applications such as miniature payloads, weapon sight, hand held cameras and remote weapon station. Using the XBn-InAsSb sensing material, elevates the FPA operating temperature and thus reduces the power consumption of the cooler and increases its reliability.

The large format detector allows wide Field of View (FOV) with high resolution. The InSb sensing material for the full MWIR band is an excellent solution for Missile Warning System (MWS) and spectrometry applications. The XBn-InAsSb with its high operating temperature and high reliability (long lifetime) makes it ideal solution for 24/7 Security & Surveillance applications.

In this paper we present the EO performance of the various detectors in the 10 μm pitch family emphasizing the application needs.

1. INTRODUCTION

Modern electro-optical (EO) systems are advancing in two different directions, one is towards more compact, lower power, and lower cost solutions and the other towards larger formats for large Field of View (FOV), yet with high resolution i.e. small IFOV. Although these applications seem to have contradictory requirements, both of them are gaining from the ongoing reduction in pixel size. For example, a pixel size reduction at constant Instantaneous Field of View (IFOV) enables a corresponding reduction in the size of the system optics, since the focal length is decreased. For a given Focal Plane Array (FPA) format, the detector area decreases with pixel size, reducing the Dewar dimensions and thus the required cooling power. It is therefore possible to reduce the overall Size, Weight and Power (SWaP) of the entire system. Alternatively, if the system size can stay constant the FPA format can be increased, which improves the image resolution and therefore performance metrics such as the range for target Detection, Recognition and Identification (DRI). The Blackbird family of detectors has a small pixel size of 10 μm. The smaller pixel meets the latest requirements for a wide spectrum of applications, from very high-end to very low SWaP Mid-Wave Infrared (MWIR) systems.

The blackbird family of digital infrared detectors which incorporates Readout Integrated Circuits (ROICs) with various array formats (1920×1536, 1280×1024 and 640×512)[1,2,4], and the choice of two types of sensing array (InSb and XBn-InAsSb) is a suitable solution for a large variety of EO systems. The large format array is usually used for high-end applications which need a large FOV such as Missile Warning Systems (MWS), persistence surveillance or 24/7 Security & Surveillance applications, while the smaller formats are generally used for hand held applications or small payloads. Using the XBn-InAsSb[5-7] barrier detector technology with a High operating Temperature (HOT) of up to ~150 K but with a narrow band in the blue part of the MWIR wavelength range, gives an advantage for 24/7 applications, where improved reliability and

Application	Requirements	1920×1536		1280×1024		640×512	
		XBn	InSb	XBn	InSb	XBn	InSb
Stationary situational awareness	Large format High frame rate Long MTTF	X		X			
Airborne situational awareness	Large format High frame rate Low weight Low power consumption	X		X			
Fast maneuvering airborne	Large format Short integration time		X		X		
MWS	High frame rate (and / or) Large format Full MWIR band		X		X		X
Hand held	Small-Mid format Low size and weight Low power consumption			X		X	
Long distance observation	Small-Mid format High atmospheric transmission			X		X	
Spectroscopy	Large format High frame rate Full MWIR band		X		X		

Table 1. key requirements for a variety of applications and the Blackbird detector most suitable.

long Mean Time to Failure (MTTF) are important. It is also good for low SWaP applications[8-10] where the high operating temperature allows a reduction in the power and size of the cooler. The standard implanted p-on-n InSb photodiode technology that covers the full MWIR atmospheric window and operates at 77 K is used for high dynamic scenery-small integration time applications or for missile warning systems (MWS) where information from the full band is crucial for reducing the false alarms. The ROICs allow a choice of several sub-LVDS video outputs for high frame rates at the cost of power consumption or LVCMOS video outputs for low power consumption at the expense of frame rate, depending on the system requirements.

In the past, 2D second generation IR detectors were mostly used for imaging. Nowadays, larger format detectors that combine a large Field of View (FOV) with high resolution, enable applications such as Persistent Surveillance, Situational Awareness, Infrared Search and Track, Missile Warning and numerous other EO tasks. IR detectors with a 15μm pixel such as SCD's Pelican-D and Hercules, with VGA and SXGA formats respectively, have been widely used in these systems. The Blackbird 1280×1024 (SXGA) Integrated Detector Cooler Assembly (IDCA) has similar dimensions and mechanical interfacing to Pelican-D and thus enables the retrofitting of VGA systems to XGA or SXGA formats, providing a significant improvement of resolution simply by replacing the detector and in some cases reducing the f-number of the optics. Alternatively, a reduction of the system size is possible by replacing the SXGA Hercules detector by the SXGA Blackbird detector. Another alternative is to upgrade a system based on the SXGA Hercules by the Blackbird 1920×1536 detector, which has the same dimensions and mechanical interfacing, enabling increased performance with higher resolution and high frame rate.

In this paper we present the system considerations when choosing an Infrared (IR) detector, the ROIC for the Blackbird family in three formats and the two sensing arrays. Finally, the full Detector Dewar Cooler Electronics (DDCE) assembly based on the Blackbird family of FPAs is introduced.

2. SYSTEM CONSIDERATIONS

The Blackbird detector family was designed to meet the requirements of a variety of system applications. Applications such as persistence surveillance situational awareness require staring over a large area with high resolution, enabling replacement of human observation by an automated system that does not miss events and does not get tired. Such a system needs a large format array with high sensitivity. Fast frame rate is an advantage if scanning is added to the system so as to increase the pixel count. For a system that is stationary and operates 24/7, cooler reliability dictates going to higher operating temperatures, i.e. using the XBn sensing material that operates at 150K.

For a system that is air-borne, on the other hand, going to high operating temperature reduces the weight and power of the cooler, both important for Unmanned Aerial Vehicles (UAVs). So a large / mid format high operating temperature XBn Blackbird detector with a large frame rate capability and a small pixel is a suitable solution.

However, some Situational Awareness systems are stationed on fast maneuvering air-borne platforms. In those cases a short exposure time is used in order to reduce the smearing of the image, so the relatively narrow spectral band of the XBn detector limits the performance of the detector. Thus, in applications where high dynamic changes occur and the integration time is short, using the full MWIR spectrum is important and InSb is then the natural choice over InAsSb-XBn.

If a system is designed to work at extreme low ambient temperature conditions it is possible to work with the XBn FPA and exploit its advantages by reducing the F-number to increase the signal, but it is also possible to use the InSb FPA which has wider spectral band and improve the Signal to Noise Ratio (SNR).

In order to reduce false alarms, Missile Warning Systems need very good spatial and temporal resolution and the full mid-wave infrared (MWIR) band is necessary. As a result, this application requires a large format detector so as to cover a large solid angle along with high spatial resolution and high frame rate capabilities to improve the temporal resolution. Sometimes there is need to compromise on format size to gain significant higher frame rates. Finally, the need for the full MWIR band aims towards InSb sensing material.

Hand held cameras and small payloads require small size, weight and power. To reduce these parameters the array format is kept small and in most cases VGA resolution is sufficient. A small pixel and high f-number allow for small optics and small cooler. For further reduction of the size and power of the cooler, the high operating temperature sensing material (XBn) should be used. Using XBn also reduces the spectral band of the system to the blue part of the MWIR spectrum. This gives an advantage in atmospheric transmission and improved MTF due to the shorter wavelength, both contribute to increasing the DRI range of the system.

Table 1 summarizes some key requirements of a variety of applications and suggest a suitable Blackbird detector that meets those requirements. Of course there are other parameters that need to be taken into consideration when designing the system and full system engineering is required.

3. ROIC

For many years SCD has been developing and manufacturing readout integrated circuits (ROICs) with Analog to Digital Conversion (ADC) at the focal plane, implemented using an advanced 0.18 μm mixed-signal CMOS process[4]. This feature has been incorporated into several detectors since 2001[6]. The ADCs are integrated on chip at opposite sides of the active matrix, two ADCs per each column. The pixel data of two rows are converted simultaneously to digital signal by the ADCs and then multiplexed to the chip output, using a high speed 13 bit sub-LVDS video interface developed to operate at the required data bandwidth, at reasonable pin-count. In Table 2 we show that the Blackbird ROICs work at high frame rates with relatively low power. Etch ADC channel column is based on a dedicated Dual Ramp convertor designed for low noise and low power consumption.

Figure 1 (top) presents the square of the noise measured as a function of the signal in an InSb Blackbird-1920 FPA at 77 K, for different integration times. A linear dependence is observed which indicates that the detector is shot-noise limited. These results represent a fine readout process from the ROIC pixel which does not introduce any additional noise components such as 1/f, Random Telegraph Signal (RTS), or those related to various leakage mechanisms which tend to increase at lower temperatures. The deviation from linearity of the ROIC and FPA is presented in Figure 1(bottom) and shows low non-linearity of less than 0.06% of the full Dynamic Range (DR) from 5% to 80% capacitor well-fill. The ROIC allows a wide range of controllable biasing for proper operation of the different sensing material and devices. Several conversion gain options are implemented at the pixel level to enable selection of the most suitable gain mode according to the application scenarios. At zero integration time, no photoelectrons are collected in the integration capacitors, so the readout noise is then a property of the ROIC, alone. This readout noise is then dominated by Johnson-Nyquist noise and hence is temperature dependent. Thus, the readout noise, which is presented in Table 2 for InSb working at 77K, increases by up to 30% for XBn when operated at 150K.

Parameter	Blackbird 1920	Blackbird 1280	Blackbird 640
Format	1920×1536	1280×1024	640×512
Pixel Size	$10\times10\ \mu m^2$		
Output	Digital 13 bit		
Well Fill Capacity / Readout Noise at 77K *	$0.3Me^-$ / $60e^-$ $0.5Me^-$ / $90e^-$ $2.0Me^-$ / $330e^-$ ($260e^-$ ITR) $4.0Me^-$ / $800e^-$		$0.9Me^-$ / $230e^-$ $2.0Me^-$ / $440e^-$ ($330e^-$ ITR)
Integration modes	ITR, IWR		
Frame cycle control	Free running, System control		
Maximum Frame Rate	120 Hz (4 video ports) 60 Hz (2 video ports) 30 Hz (1 video port)	180 Hz (2 video ports) 90 Hz (1 video port)	350 Hz (1 LVDS video port) 180 Hz (1 LVCMOS video port)
FPA power consumption	400 mW at 120Hz 210 mW at 60 Hz 110 mW at 30 Hz	210 mW at 180Hz 110 mW at 90Hz $85/50^{cmos}$mW at 30Hz	210 mW at 350Hz 110 mW at 180Hz $85/50^{cmos}$mW at 60Hz
Maximum Frame Rate in 2×2 Binning mode	450Hz	600Hz	1000Hz
* At 150K operating temperature, the Readout Noise may increase by 30% at most.			

Table 2 Key features of the Blackbird family of ROICs

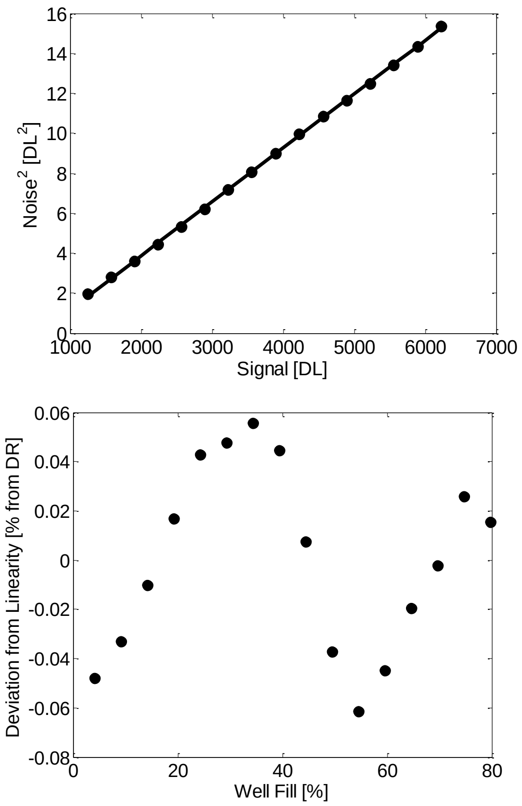


Figure 1 (top) Squared noise as a function of signal in digital levels measured for the Blackbird-1920 InSb FPA, for increasing integration times. (bottom) Deviation from linearity, where the well-fill is varied using the integration time.

The low noise characteristics of the various Blackbird ROICs together with other key parameters are summarized in Table 2.

4. INSB PHOTO-DIODE ARRAY

The Blackbird InSb sensing array of $10\times10\ \mu m^2$ pixels is based on SCD's mature InSb planar, implanted p-n diode technology, which has been in production over many years for various formats and pitches. SCD has introduced 10µm InSb pixel arrays with three different formats: 1920×1536, 1280×1024, and 640×512. These pixel arrays are integrated with the Blackbird family of ROICs using Flip-chip indium bump technology with reduced bump dimensions. The 10µm pixel in the Blackbird detector is a scale-down of the extensively used 15µm pixel. The successful scale down to a 10µm pitch was achieved in spite of the increased ratio of surface to volume that imposes new design rules necessary to maintain key parameters such as low Dark Current (Idark) and high External Quantum Efficiency (QE). The resulting FPA exhibits high performance with QE >80% and Idark<0.8 pA at 77 K. In Figure 2(top) we present a histogram of the dark current values for all InSb diodes in a single 1920×1536 Blackbird FPA. The narrow distribution (~0.2 pA) indicates a high level of dark current uniformity over the array, as can also be seen in the dark current map in Figure 2(middle). As shown in Figure 2 (bottom), the reproducibility of the 10µm InSb diode fabrication process is demonstrated through the narrow statistical spread of the average dark current values in 70 FPAs from SCD's Blackbird production line.

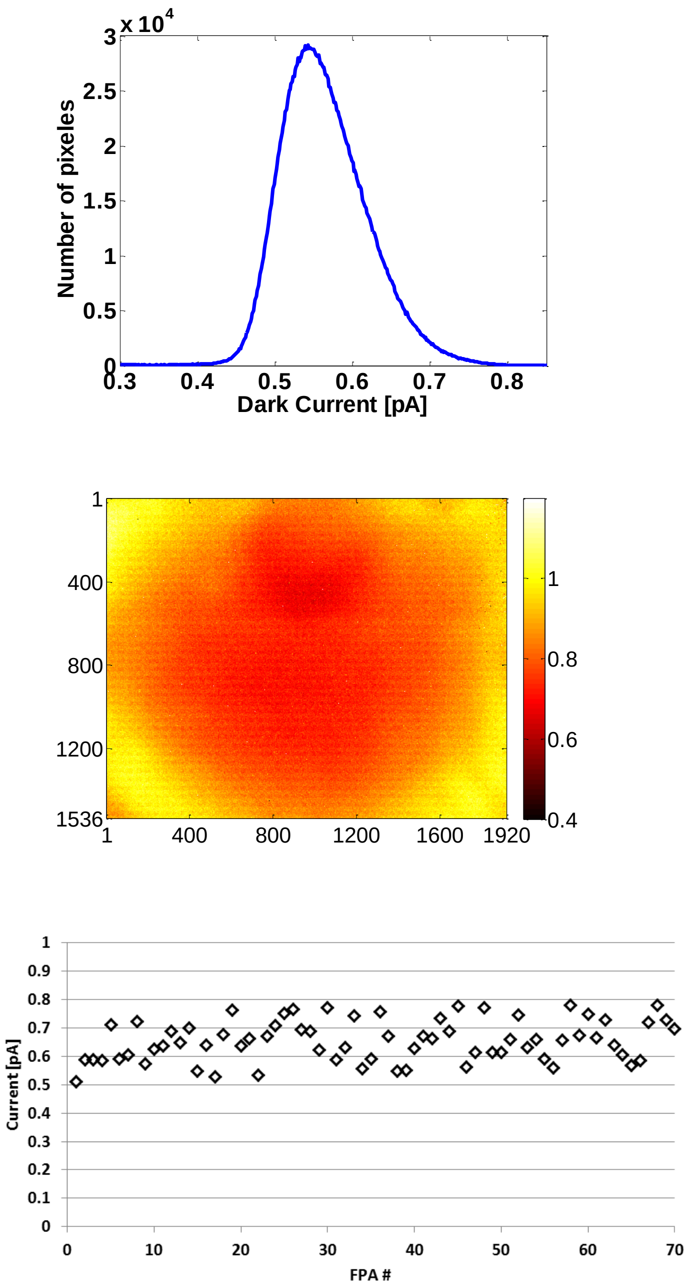


Figure 2 Dark current (in pico-Amperes) measured in an InSb Blackbird-1920 FPA at 77K and plotted as (top) pixel distribution in the array, (middle) 2D array map, (bottom) mean values of 70 FPAs from SCD's production line

Another important issue in FPA image quality is the inter-pixel cross-talk (XT). This is the fraction of the light signal falling on a given pixel that is detected by one of its neighbors. The Blackbird FPA exhibits low cross talk characteristics where 56% of the total light signal falling on the entire pixel area is detected in that pixel, 9% is detected in each of the four nearest neighbors, and 2% in each nearest–diagonal neighbor. Less than 2% of the light signal is detected at the next line of nearby pixels. The cross-talk is most conveniently quantified by the Point Spread Function (PSF), a measurement of which is presented in figure 3(top) and in the inset of figure 3(middle). The Modulation Transfer Function (MTF) is the Fourier transform of the PSF and is shown in figure 3(bottom), for different detector pitch values down to 10 µm. The MTF represents the amplitude of a spatially periodic signal detected by the FPA as a function of the spatial frequency. The PSF is measured using a gold mask with 400 square openings 2.5×2.5 µm^2 in area on the back side of the FPA, where each opening is shifted by a different distance from the pixel center. The PSF can also be measured using a knife edge technique. Both techniques give a similar value of MTF = 0.4 at half the Nyquist frequency.

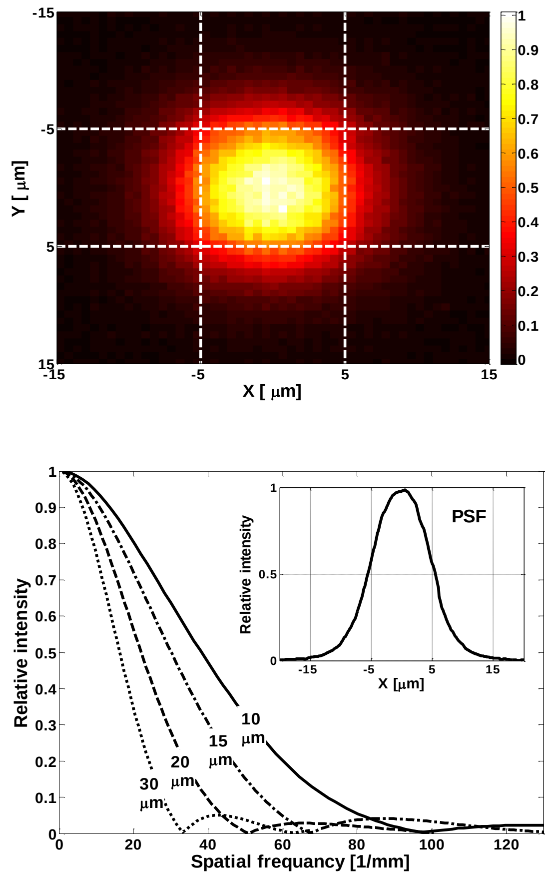


Figure 3 (top) Measured PSF image of InSb 10µm pitch detector, where the pixel borders are indicated by white dashed lines (bottom) MTF curves of InSb pixels in FPAs with four different pitches: 30, 20, 15 and 10 µm, corresponding to SCD's Blue Fairy, Sebastian, Pelican and Blackbird FPA's, respectively. Inset: Cross section of the PSF image of 10µm pitch FPA pixel.

5. XBN BARRIER DETECTOR ARRAY

For the last few years SCD has been producing 640×512 and 1280×1024 MWIR detectors with 15 µm pitch based on the novel XBn-InAsSb barrier detector technology. This technology has outstanding electro-optical performance at operating temperatures as high as 150K, however, with a cut-off wavelength of 4.2 µm covering only the "blue" part of the MWIR spectrum (below the CO_2 absorption line). Following the trend of pixel shrinkage as for the InSb pixel, and with the availability of the Blackbird family of ROICs designed to perform also at a high operating temperature, SCD has developed three new XBn arrays with a 10 µm pitch and formats of 1920×1536, 1280×1024 and 640×512. As already mentioned, key parameters that determine the performance of the detector from the device point of view are QE and dark current. High QE and low dark current yield a better SNR, and homogeneous QE and dark current implies good signal uniformity. Usually the main contribution to the dark current originates from in III-V semiconductor photo-detector "Generation - Recombination (G-R)" that is higher than the "Diffusion process" by several orders of magnitude and has a strong dependence on the FPA temperature. XBn devices are designed to operate without depletion zone in the narrow band gap sensing material, and hence the G-R current is totally suppressed. This leaves the much smaller Diffusion current coming from the narrow bandgap photon absorbing region, as the dominant source of dark current. In this way it is possible to elevate the operating temperature to 150 K with a typical dark current of only 0.2 pA, whose distribution in a typical 640×512 XBn Blackbird FPA is shown in figure 4(top). This width of the distribution is very narrow, corresponding to a dark current that essentially varies by ~10% across all pixels. Figure 4(middle) shows the dark current map of the FPA demonstrating very good spatial uniformity. The good reproducibility of the XBn fabrication process can be seen in figure 4(bottom), where a narrow statistical spread exists around the average dark current in 63 10µm pitch FPAs from SCD's Blackbird XBn production line.

The measured QE in XBn FPA is typically 70%, and the MTF is 0.36 at half the Nyquist frequency.

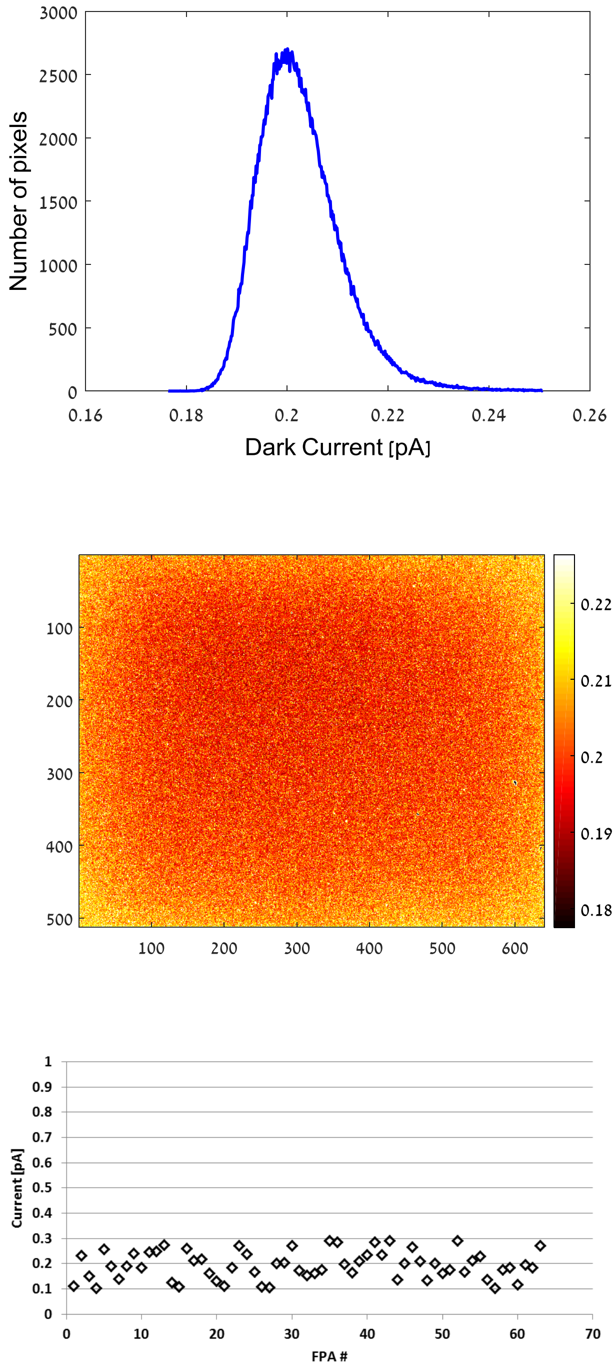


Figure 4 Dark current (in pico-Amperes) measured in an XBn-InAsSb Blackbird-640 FPA at 150 K and plotted as (top) pixel distribution in the array, (middle) 2D map, (bottom) mean values of 63 FPAs from SCD's production line

6. ELECTRO-OPTICAL PERFORMANCE

In addition to the values of the dark current and QE, as presented above, there are several other key properties that characterize the sensitivity, uniformity, and linear response of an FPA detector. Unlike the dark current, QE, or cross talk, which depend essentially on the photo-sensitive devices alone, other properties can be traced back to a combination of the sensing device and ROIC. One such property is the sensitivity of the detector, which is related to the temporal noise of a pixel, and is normally defined by the Noise Equivalent Temperature Difference (NETD).

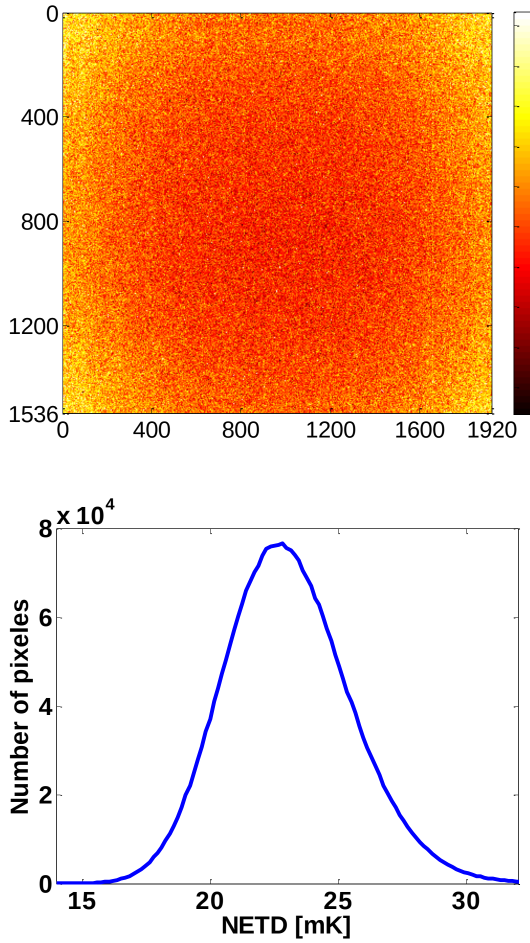


Figure 5 (top) Typical NETD (in mK) image of Blackbird-1920 with InSb diode at F/4, 77 K and 70% well-fill. NETD histogram of the same data. The average NETD and standard deviation are 22.5 mK and 2.5 mK respectively.

Another two are the uniformity and the linear response of the pixels, which both contribute to the residual spatial fixed pattern noise that remains after performing a linear Non Uniformity Correction (NUC). Their effect can be expressed by the Residual Non Uniformity (RNU), which is the standard deviation of all pixels with respect to the NUC linear calibration, at a particular well-fill. The NETD at a given frame rate and f-number is one of the critical parameters for the evaluation of an IR detector, and is therefore an important figure of merit. It is a measure of the detector's ability to register a temperature difference that creates a signal larger than the noise. Due to the low readout noise and low dark current in Blackbird FPAs, the NETD is background limited (BLIP) even at low integration capacitor well-fill (low signal).

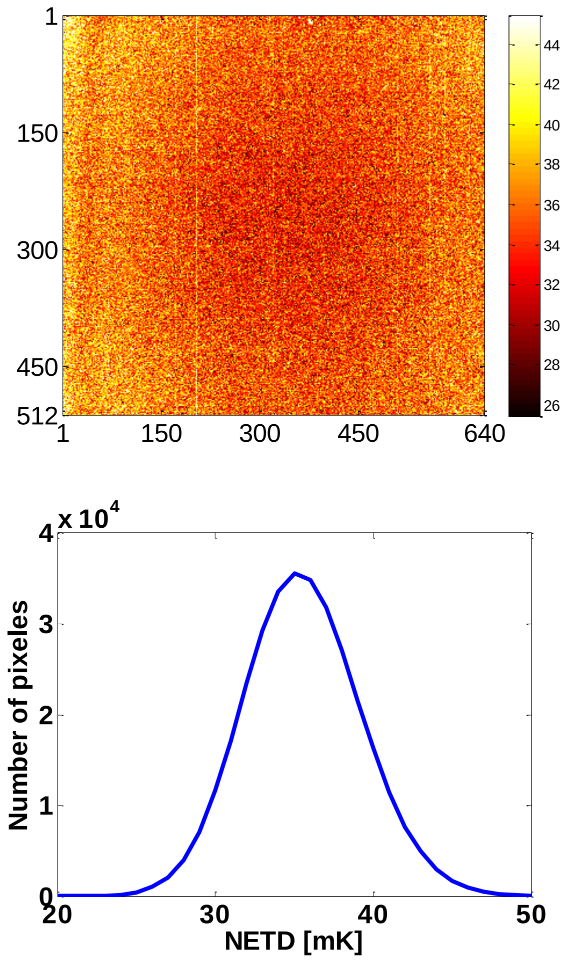


Figure 6 (top) Typical NETD image of Blackbird-640 XBn-InAsSb at F/3, 150 K and 50% well-fill. (bottom) NETD histogram of the same data. The average NETD and standard deviation are 36 mK and 4 mK, respectively.

The NETD is usually calculated at an averaged signal, corresponding to a median well fill. In Figure 5(top), a typical map of the NETD (per pixel) at 70% well-fill is presented for the 2.0Me- Blackbird integration mode in 1920×1536 InSb FPA and in Figure 5 (bottom), a typical map of the NETD at 50% well-fill is presented for the 2.0Me- Blackbird integration mode in 640×512 XBn-InAsSb FPA . As can be seen in the image, there are no spatial features in the temporal noise, indicating no additional noise mechanisms aside from shot noise. In Figures 5(bottom) and 6(bottom), a smooth Gaussian-like histogram is shown for the distribution of the NETD over all FPA pixels.

SCD is now manufacturing Blackbird FPAs with good reproducibility and low number of defective elements, corresponding to a pixel operability higher than 99.5%. In Figure 7 it is shown that the NETD does not vary significantly from FPA to FPA, for both 1920×1536 and 1280×1024 formats, and for InSb and XBn arrays. For comparison the NETD here is measured at 60% Well-Fill in all cases.

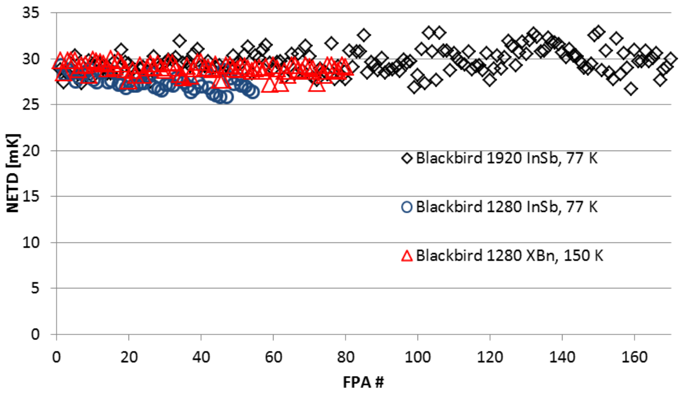


Figure 7. Averaged NETD values for FPAs from the Blackbird production line

The detector uniformity is typically evaluated from an analysis of the corrected image after NUC procedure. The RNU is the spatial standard deviation of the corrected image. Here we present the RNU measured after a standard linear 2-point NUC, with calibration points at well-fill levels of 20% and 80% from the full dynamic range. The RNU is inspected for various signal levels corresponding to a wide range of well fills that cover almost the entire DR. When calculated globally for all pixels in the array the RNU is affected by both low and high spatial pattern frequencies in the recorded image, and it is thus termed global RNU. High frequency patterns usually originate from spatial inhomogeneity across nearby FPA pixels. They are related to variations of the parameters of the individual pixels in both the ROIC and photo-sensitive device arrays. This type of non-uniformity has white noise characteristics, is local in nature, and determines the ability of the detector to distinguish targets from their close environment. It is therefore useful to discriminate the high frequency spatial patterns from the low frequency patterns. To that end, we define the local RNU as the standard deviation (STD) calculated over the 15×15 neighbors around a given pixel in the corrected image and averaged for all pixels.

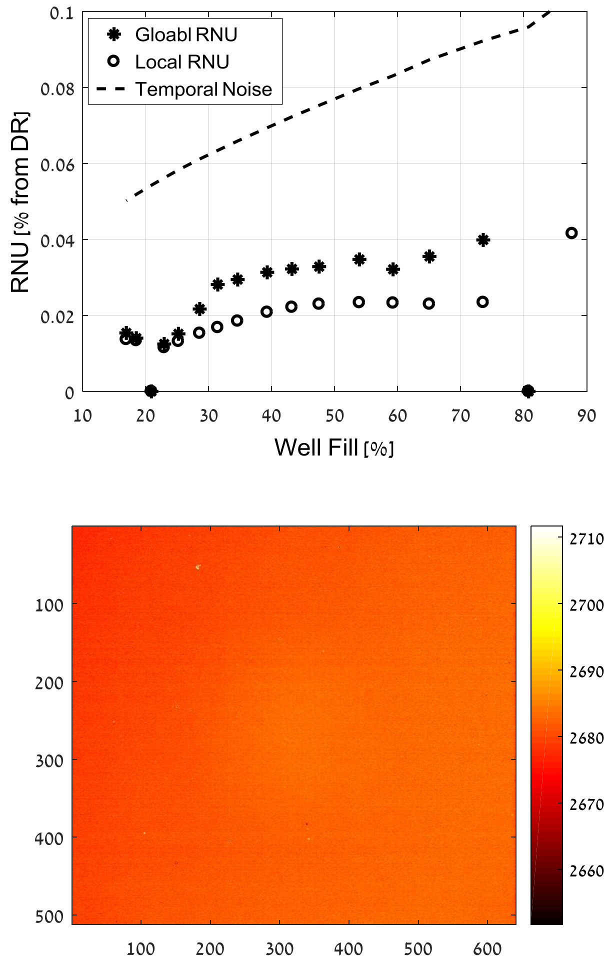
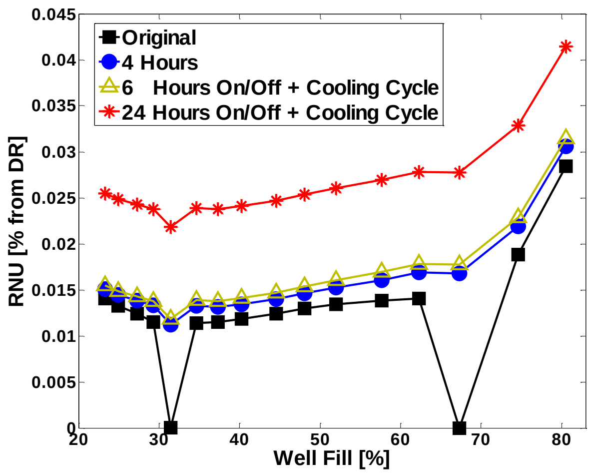


Figure 8. (top) Typical RNU from Blackbird-640 XBn FPA at F/4, 150 K as a function of well-fill. The signal is varied by changing the black-body target temperature at constant integration time. (bottom) An image of a uniform target at 50% well-fill after 2-point NUC. The color scale is in digital levels

As can be seen in Figure 8 (top) for Blackbird-640 XBn FPA, the local RNU is lower than the global RNU since low frequency patterns are filtered out. The global (local) RNU of the Blackbird FPA is less than 0.04% (0.02%) STD/DR for a wide range of signal well fills. A comparison of the spatial noise (RNU) and the temporal noise (related to NETD and plotted as a dashed line) indicates the high uniformity of the array. For a good BLIP detector, the spatial noise should always be significantly lower than the temporal noise, as indeed occurs in Figure 8(top). Figure 8(bottom) shows a corrected image of a uniform target at 50% well-fill registered in the same expriment. The color scale is in digital levels, and shows excellent uniformity at the individual bit-level, consistent with the very low values of RNU in Figure 8(top). Figure 8(bottom) also demonstrates the very high pixel operability of the FPA, since no Bad Pixel Replacement (BPR) routine was applied.



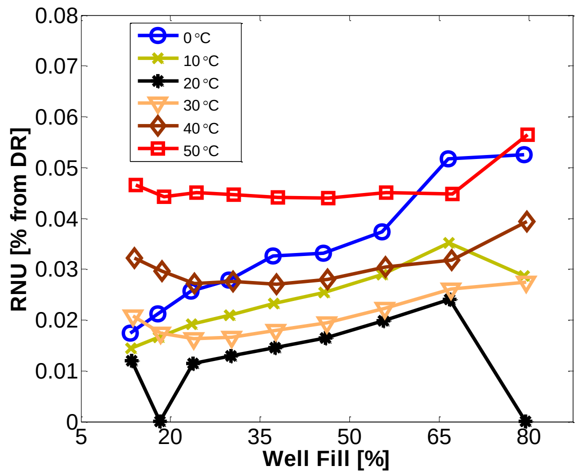


Figure 9 Stability of NUC for a Blackbird-1280 InSb IDCA at F/3 with a cut-off wavelength filter of 4.2µm. The RNU is plotted as a function of well-fill. (top) Local RNU at different operation times but corrected with the same initial tables of NUC coefficients. (bottom) Global RNU measured at different ambient temperatures after performance of NUC at 20ºC

Another important parameter of image quality is related to the stability of the RNU (and so the validity of the NUC tables) over time, from one operation to another and when the ambient temperature is changed. In order to test the RNU stability over time and operation cycles, we have used a standard F/3 Blackbird InSb Integrated Detector Cooler Assembly (IDCA) to obtain a few sets of measurements. The second set was measured four hours after the first while the detector remained cooled and powered, while the third set was measured two hours later, in this case after the ROIC power supply had been turned off and then on again. The last set was measured one day later during which time the FPA reached room temperature, before being cooled back down to 77K prior to the measurement. The Local RNU of all the data sets is calculated as described above from the Gain and Offset tables of the "original" first set. The results are presented in Figure 9(top) for a Blackbird 1280 InSb detector although Blackbird XBn detectors show similar results. Similarly the Global RNU stability for various ambient temperatures is tested in an environmental chamber. Here the "original" gain and offset are measured at 20°C and the detector remains cooled and powered during the whole set of measurements which are presented in Figure 9(bottom). It is evident that the RNU is very stable during an operation cycle (constant temperature and power) and after an On/Off procedure, while it degrades moderately after a cooling cycle. It is also relatively insensitive to environmental conditions, in this case between 0 - 50°C.

7. IDCA

The FPA is packaged in a Dewar which is integrated with a cryo-cooler and an electronics proximity board suitable to its format. An image of Blackbird-1280 IDCA and Image from the Blackbird-640 XBn detector with 250 mm lens from approximately 5 km away, are shown in Figures 10 and 11, respectively. SCD has adapted its well established rigid Dewar technology from Blackbird's predecessors to fit the current set of detectors.

Figure 10. The Blackbird-1280 IDCA.

Figure 11. Image from the Blackbird-640 XBn detector with 250 mm lens from approximately 5 km away.

The rugged Dewar envelope has supporting strings which are connected to the cold finger. The structure and the geometry were optimized to give a high natural frequency to the structure. This results in a sub pixel lateral movement of the FPA when the complete IDCA is subjected to rough vibrations in the frequency range 5-2000Hz. The IDCA makes a compact MWIR detector that can withstand harsh environmental conditions such as high ambient temperatures of up to 71 ºC. The design and fabrication of the Dewar minimizes the heat load and stray light on the FPA. The proximity electronics board has a single power supply and a standard video output and communication that enable a fast and easy integration of the detector into the system. The Blackbird family is designed to easily replace the previous generation of SCD IDCAs (Hercules and Pelican-D) with compatible electronics and mechanical interfacing, including the cryo-coolers.

8. SUMMARY

In conclusion, Blackbird is a diverse family of MWIR detectors with a range of formats based on both cooled InSb and HOT XBn technologies. The Blackbird detectors exhibit high electro-optical performance and feature many qualities beneficial to the system, making them good candidates for a wide spectrum of modern IR system applications. Moreover, the detector's standard mechanical and electrical interface allows easy and fast integration into existing systems, to improve performance and to reduce both system Size, Weight, and Power and also system Cost.

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