Evaluation of the mid- and near-infrared focal plane arrays for Japanese infrared astronomical satellite ASTRO-F

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We report on the extensive tests of the infrared detector arrays for the Infrared Camera (IRC※) on board the next Japanese infrared astronomical satellite, ASTRO-F. To maximize the advantage of the cooled telescope and extremely low background radiation conditions in space, the dark current and readout noise must be minimized. We optimized the array driving clocks, the bias voltages, and the supply currents, and evaluated the temperature dependence of the performance. In addition to the standard imaging operation, we are now planning to implement the scan mode operation in order to observe the all sky with the IRC.

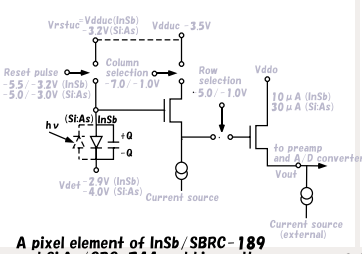
※) See 'Infrared Camera (IRC) onboard ASTRO-F (IRIS)', Wada et al. 4850-20

Array and operation

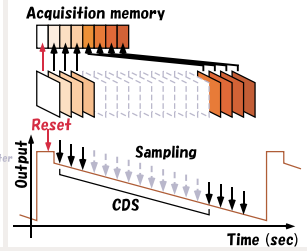
Channel	Array (Format)	Dark current ($e \cdot s^{-1}$)	Readout noise (e)	Conversion factor ($\mu V \cdot e^{-1}$)	Generation of the heat (mW)
NIR (2-5 μm)	InSb/SBRC-189※1 (512x412)	<5	~30※2	~2.8	~0.5
MIR-S (5-12 μm)	Si:As/CRC-744※1 (256x256)	<10	~40※2	~4.6	~0.8
MIR-L (12-26 μm)					

experimental value

※1) Manufactured by Raytheon, IRO.
※2) Fowler 1 sampling



A pixel element of InSb/SBRC-189 and Si:As/CRC-744 and bias voltages



Schematic diagram of the imaging operation

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Temperature dependence of array performance

InSb/SBRC-189

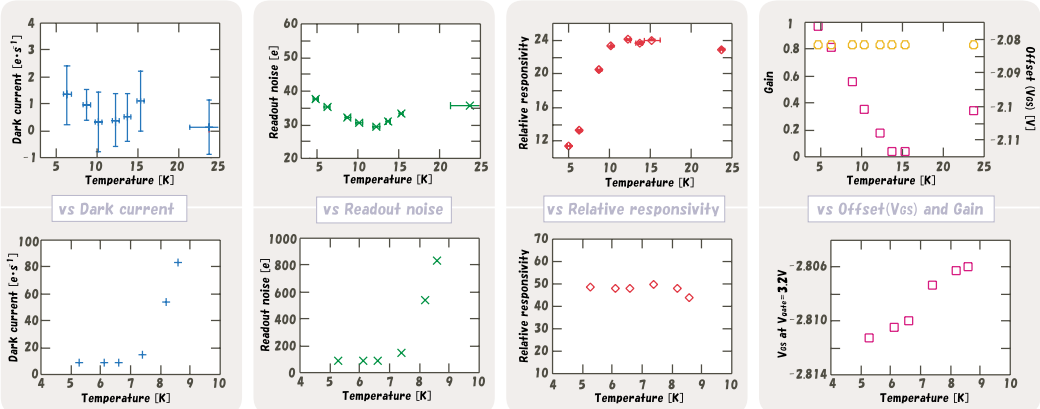
- The Vgs of the ROIC is stable around 14K but it shows a strong temperature dependence below 13K
- The relative responsivity rapidly falls below 10K

The optimum temperature : T~14K or T>10K with the stability of 20mK during each exposure.

Si:As/CRC-744

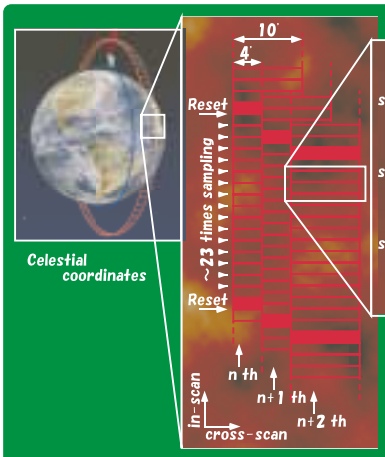
- The dark current increases rapidly above 7.5K
- The Vgs of the ROIC shows a strong temperature dependence in 4~9K

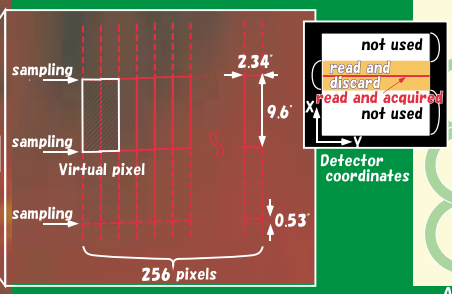
The optimum temperature : T>7.5K with the stability of 30mK during each exposure.



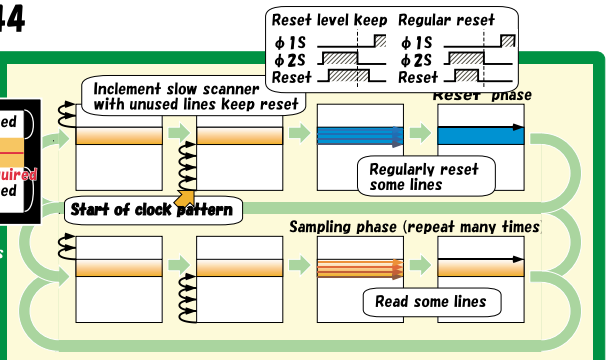
温度依存性

Development of scanning operation with Si:As/CRC-744





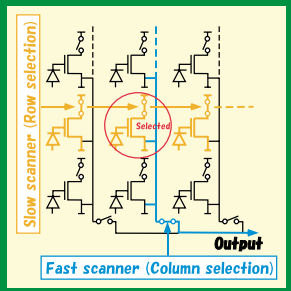
All sky survey observation with the scan operation of detector array



Array driving clock pattern for scanning operation with Si:As/CRC-744

Possibility of Y-scanning operation

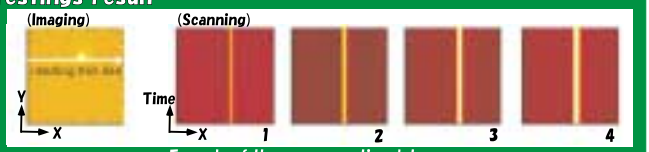
Example of the normal imaging operation (left) and the operation of the slow scanner fast and the fast scanner slow (right). The effect of the hot pixel is small enough.



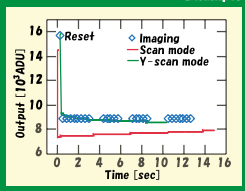
Schematic diagram of the ROIC of InSb/SBRC-189 and Si:As/CRC-744

The slow scanner (Y-direction) supplies the power to all pixels in the selected row, while the fast scanner (X-direction) connects the selected column to the output.

Testings result



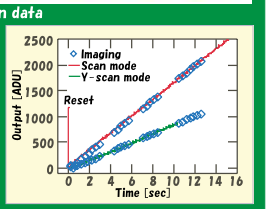
Example of the scan operation data



Output vs time in the dark configuration

Readout noise [e]	
Imaging	42
X-scanning	47
Y-scanning	43

Readout noise (CDS) of each operation mode



Output vs time in the lighted configration

The readout noise and the linearity in the scanning operation are sufficiently good for actual observations.

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