



Latest Developments at Leonardo in IR Detection for Earth Observation

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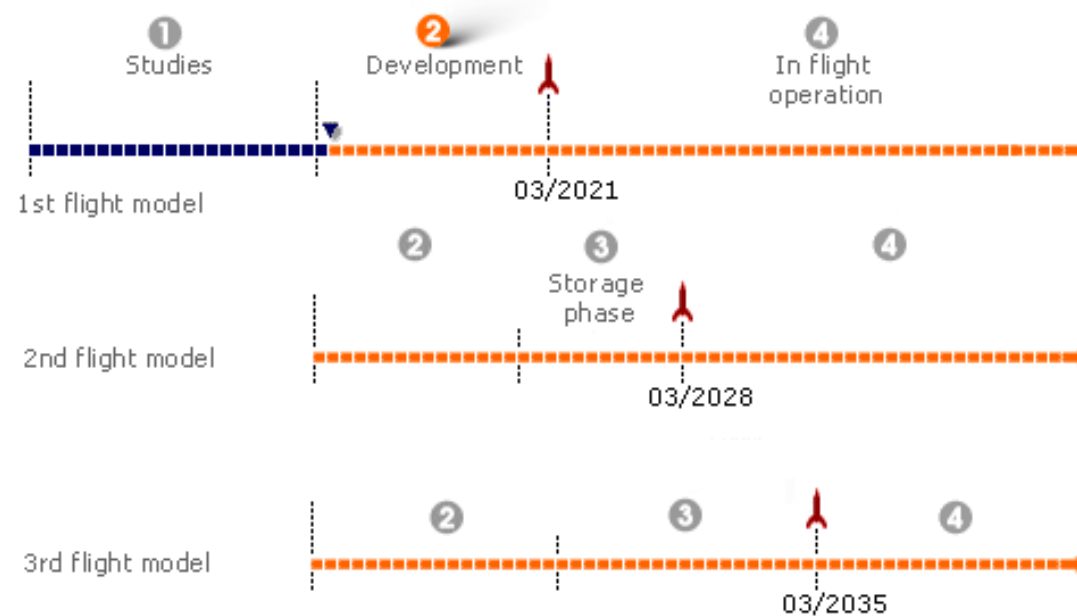
Latest Developments

- IASI-NG
- ESA {
 - SWIR 2k x 2k
 - Visible Hybrid CMOS with e2v
 - Proton and Gamma Testing of MCT APDs
- CEOI {
 - Extended SWIR spectral response
 - Proton Testing LFNIR
 - Alternative TGS crystal growth
- NSTP - 4 megapixel APD array
- DLATGS - OSIRIS-Rex, Mars Orbiter, FORUM?

IASI NG – METOP SG-A1, -A2, -A3



Airbus D&S



New Generation of Infrared Atmospheric Sounding Interferometer (IASI-NG)

Objectives to ensure continuity of the service and to provide dramatic performance improvements with respect to IASI

Operational meteorology, climate monitoring, characterization of atmospheric composition related to climate, atmospheric chemistry and environment.

IASI-NG Infrared Detector requirements

Detection units operated in temperature range 75-80K

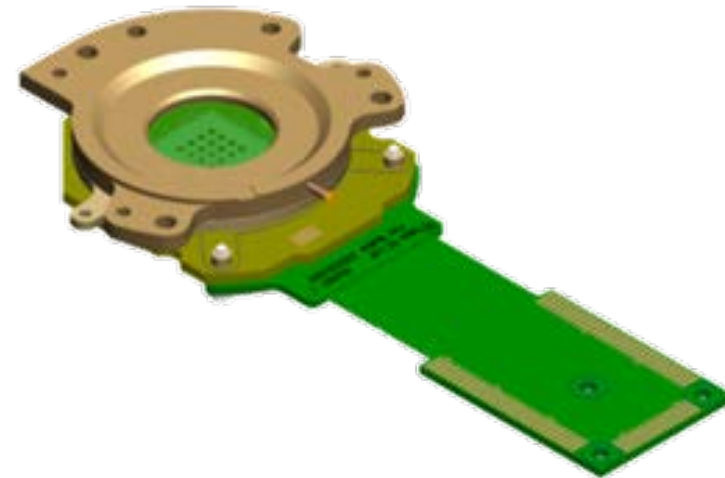
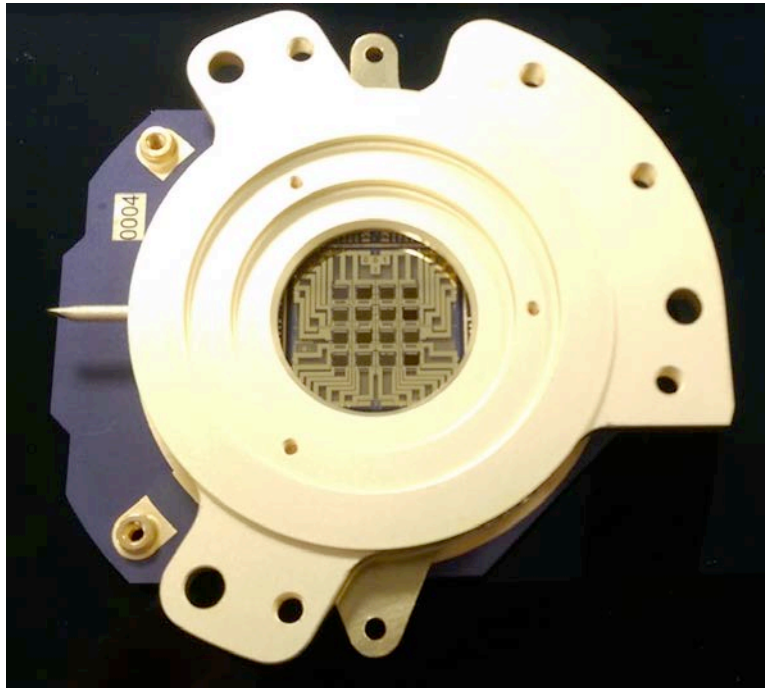
Coverage of the infrared band of 3.6 to 15.5 microns

These are Mercury Cadmium Telluride arrays in 4 bands:

4	3	2	1	BAND
3.6-4.4	4.4-5.1	5.1-8.7	8.7-15.5	μm
PHOTOVOLTAIC			PHOTOCONDUCTIVE	TYPE

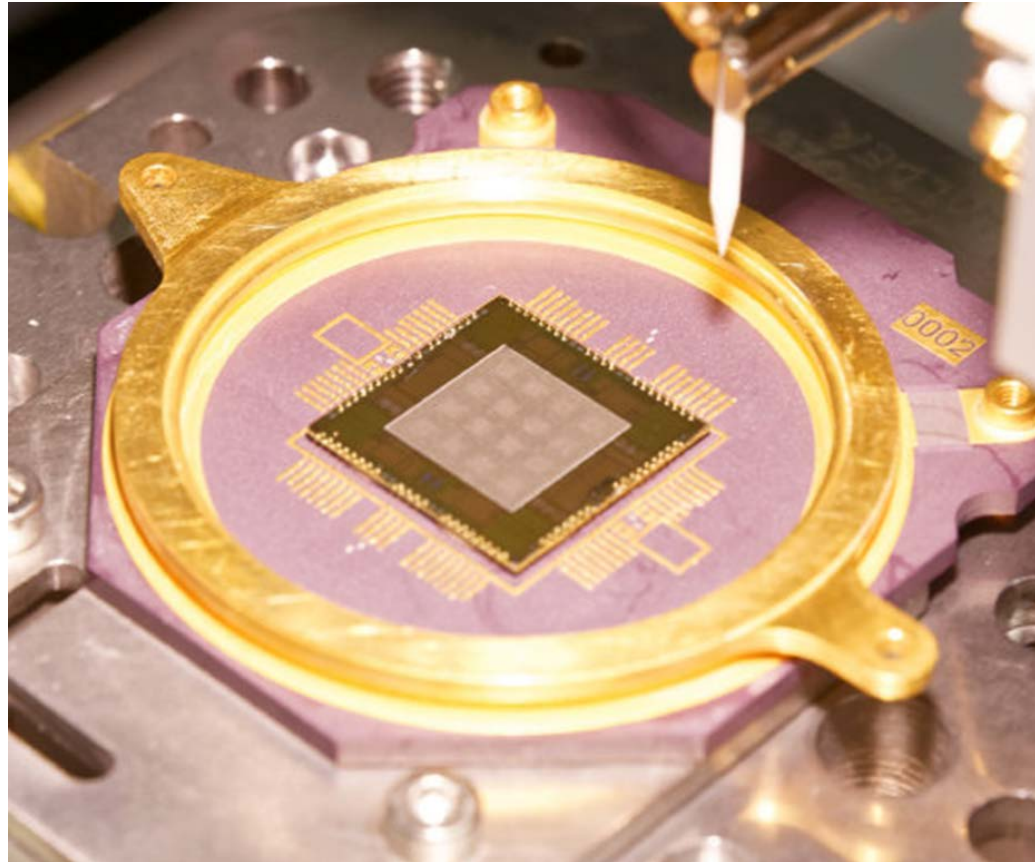
Common 4 x 4 array format of 1.3 mm square macropixels

Packaged detector

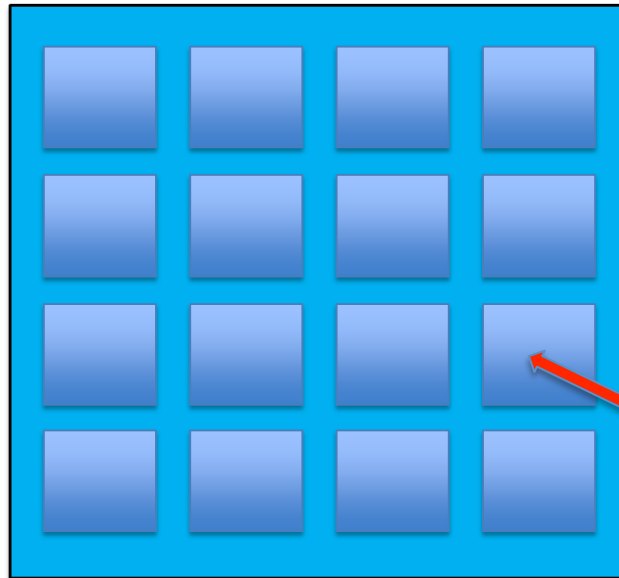


IASI-NG detector package

PV array at wire bonding

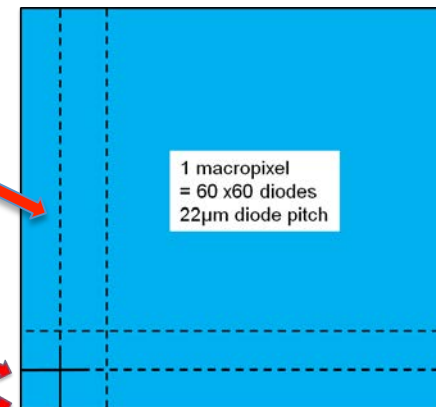


Integrated memory blocks for PV deselection



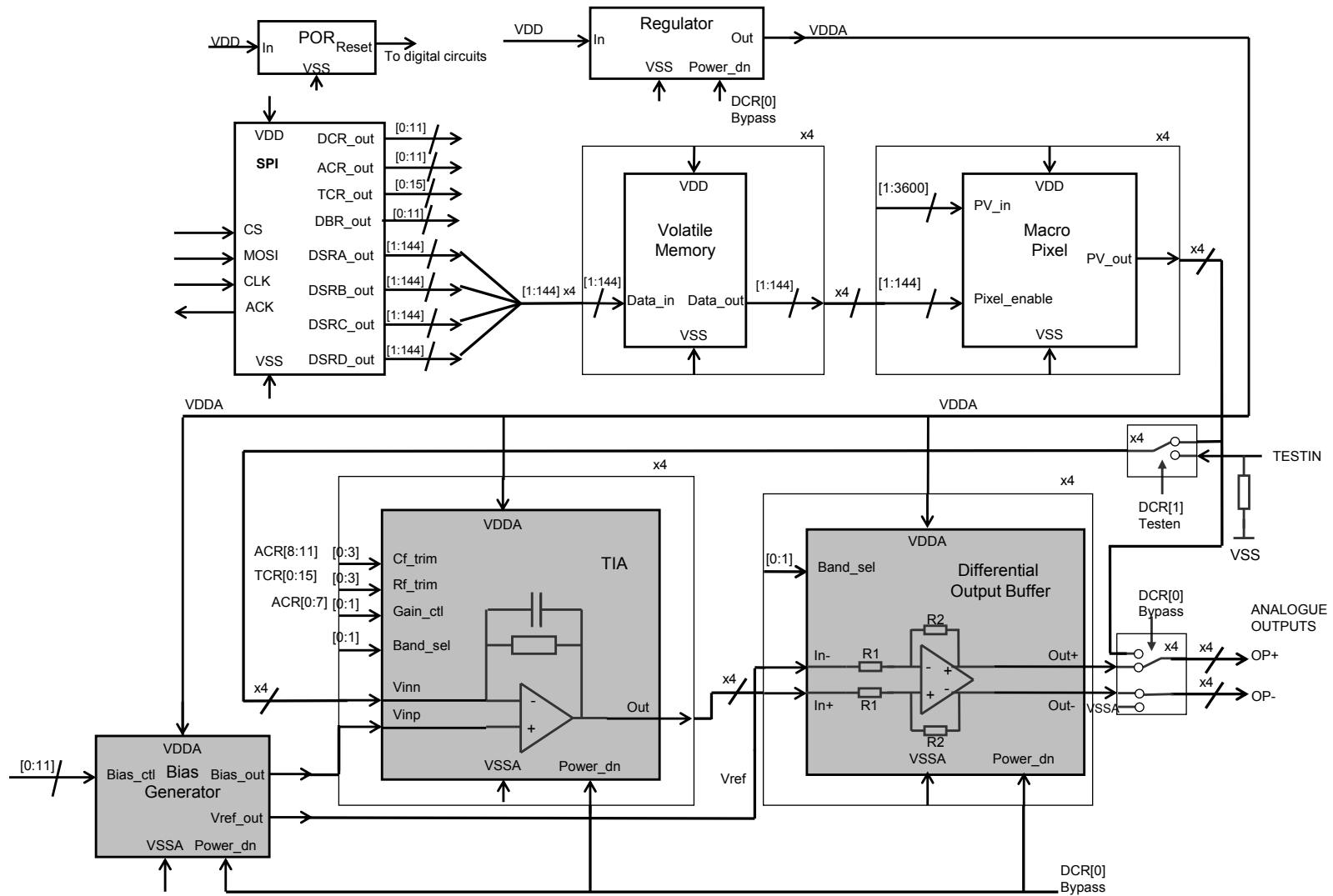
4 x 4 macropixel array, 1 TIA per macropixel
Each macropixel 1.3mm square
2.4mm pitch
4 groups with independent electrical interfaces
to limit failure propagation

**5 x 5 diode memory cell
for deselection**

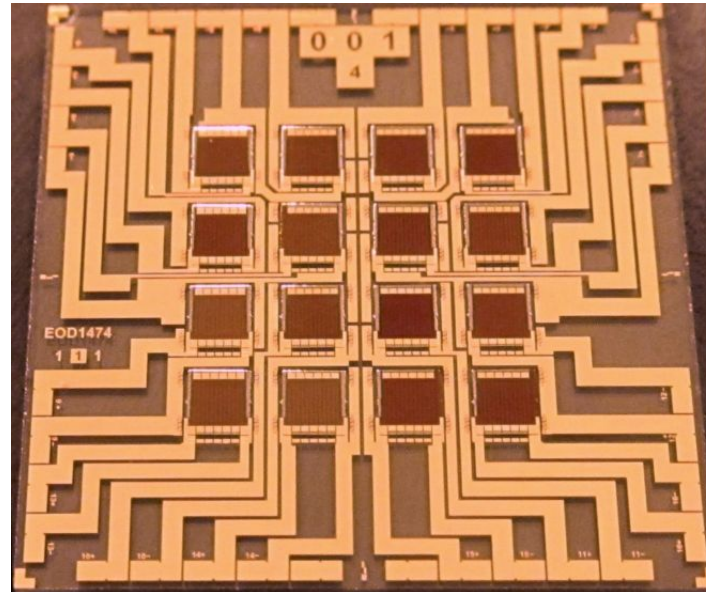


Continuous matrix of photodiodes on 22 microns pitch, including infill between macropixels
All photodiodes are bump bonded to metallization pads on the silicon chip.
Shares the heritage, reliability, and manufacturability of conventional FPAs

Integrated transimpedance amplifier at each PV macropixel



Band 1 photoconductive array



- 4 x 4 macropixel array

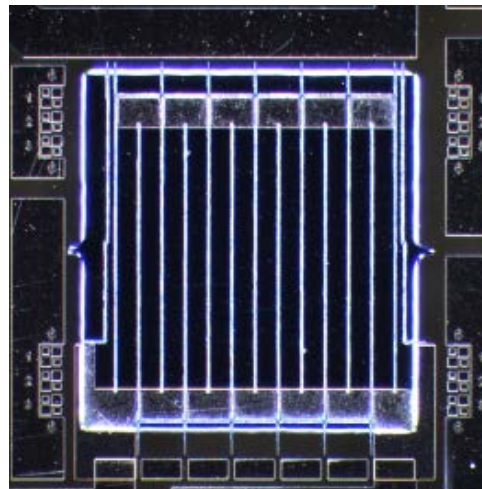
MCT Photoconductors

1st generation detectors, became mature in the 1970s

Remain ideal for very long wave detectors, up to 17 microns, where they are superior to MCT photodiodes

Heritage from other space programmes such as MSG SEVIRI instrument

12 strip labyrinth design relaxes the low noise requirements on the detection amplification chain.



Band 1 macropixel

IASI-NG – new developments

- Radiation hard readout chip design
- MOVPE heterodiode diode design for high quantum efficiency
- Multilayer antireflection coatings

Radiation Hardened Design

PMOS Transistors

Surrounded by N WELL contacts to form continuous guard ring

NMOS Transistors

Enclosed Layout to prevent SE latch-up

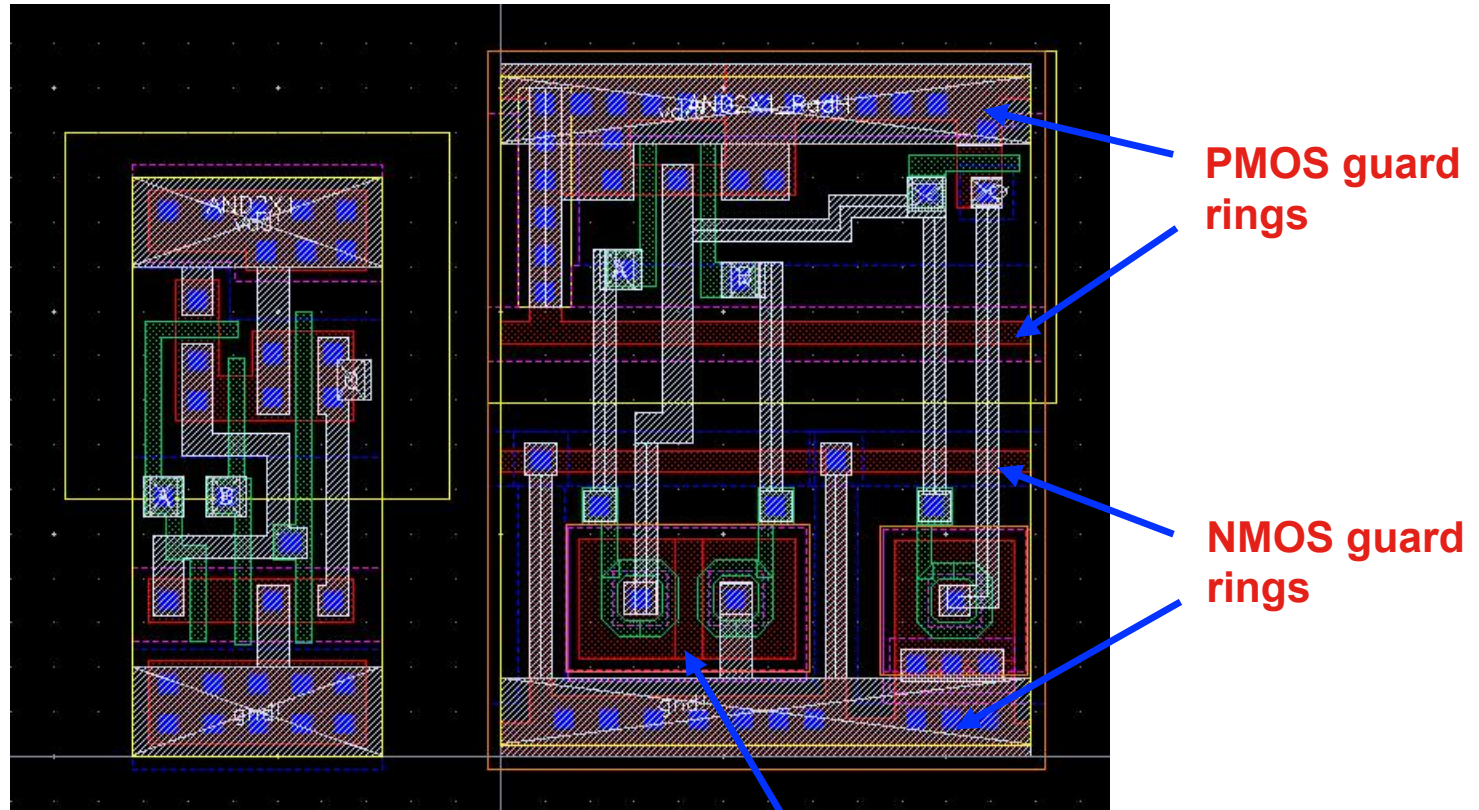
Surrounded by substrate contacts to form continuous guard ring

Triple Majority Voting

Radiation Hardened Design

Original Cell

Radiation Hardened Cell

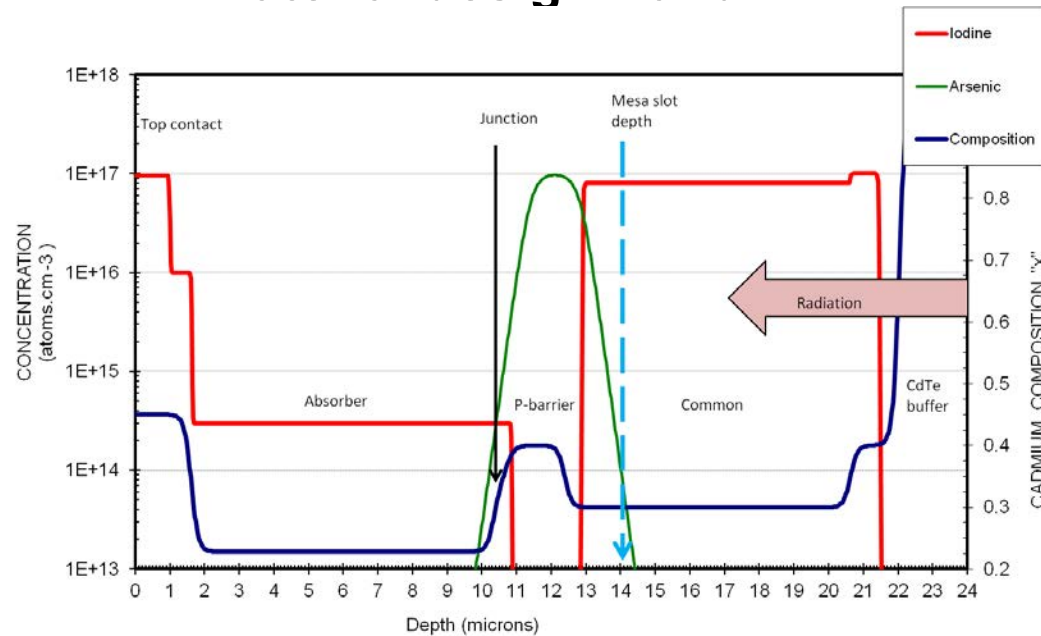


Enclosed Layout of NMOS

High Quantum Efficiency

- Required performances at worst case noise frequencies are around 80% of the theoretical photon noise limit for all three PV bands
- Drives the need for high internal quantum efficiency and multilayer coatings

Material design Band 2

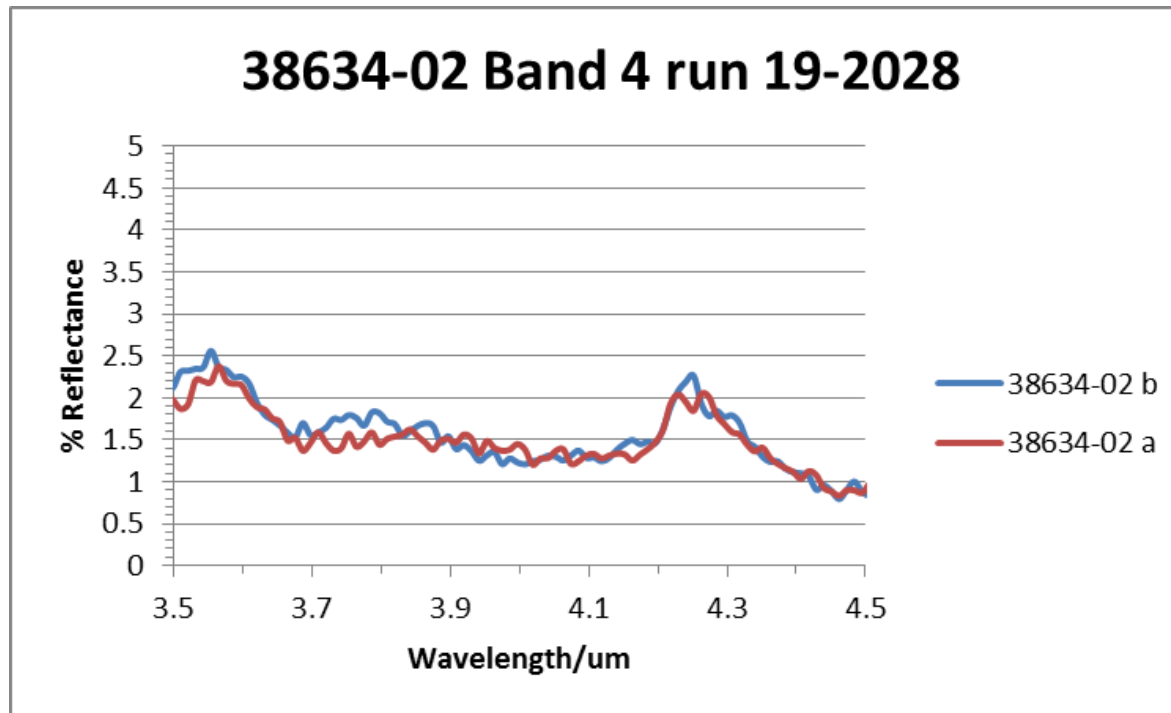


- **Absorber layer thickness increased to 8um to maximise quantum efficiency**
- **Contact layer highly doped for low contact resistance, high-x reduces surface recombination**
- **Absorber low doped for low dark current and high hole diffusion length**
- **Start of absorption coincides with p-n heterojunction**
- **Junction in x-grade reduces quantum mechanical tunnelling**
- **p-barrier to avoids electron injection from n-common**
- **n-common for low sheet resistance**

Multilayer antireflection coatings

- External coating suppliers
- Optical design for low stress to protect MCT
- Low temperature deposition to protect MCT – adhesion
- ESD protection for MCT and ROIC
- Precision jigs { handling
termination zone
- Specialised witness pieces { cryogenic reflectance
environmental testing

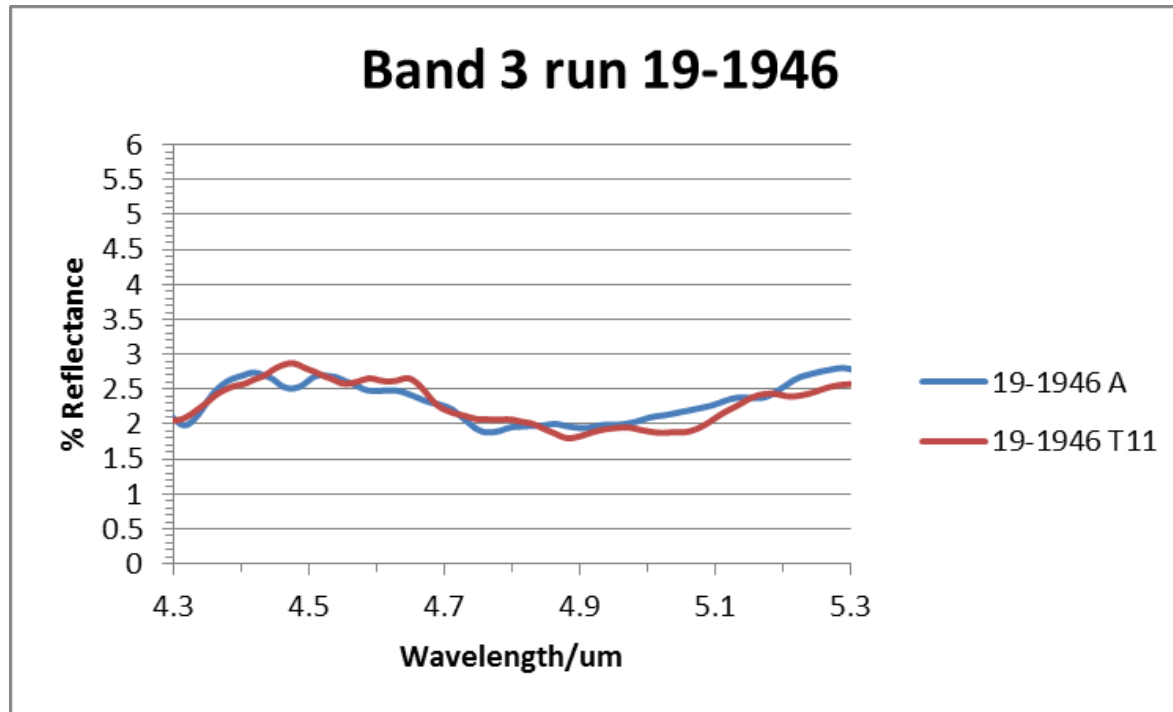
Reflectance of Band 4 photodiode at 80K



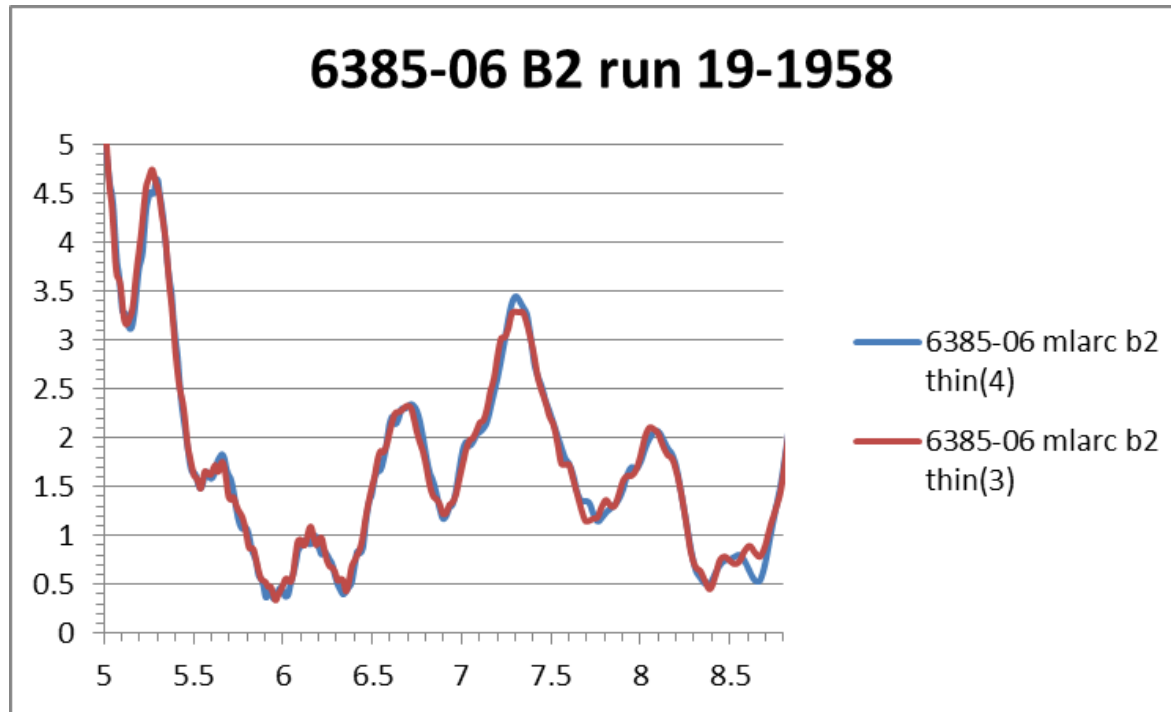
Digilab FTS3500 FTIR spectrometer UMA600 microscope attachment

Linkam FTIR600 module cryostage

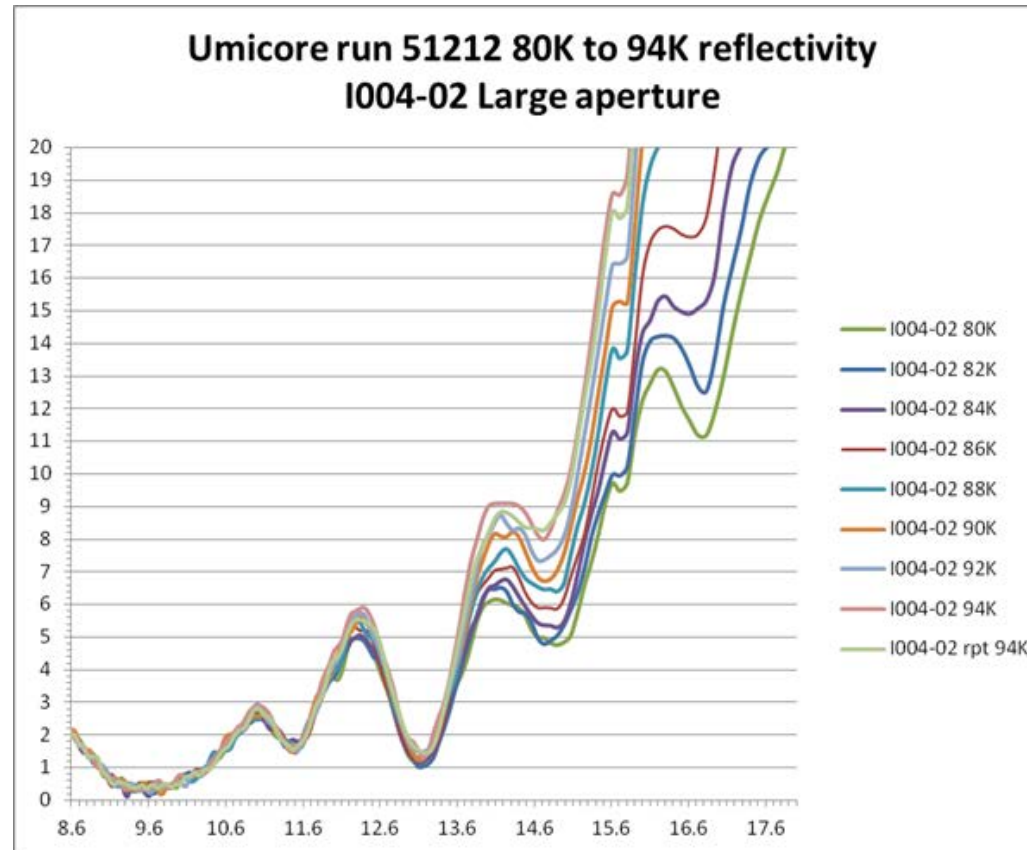
Reflectance of Band 3 photodiode at 80K



Reflectance of Band 2 photodiode at 80K

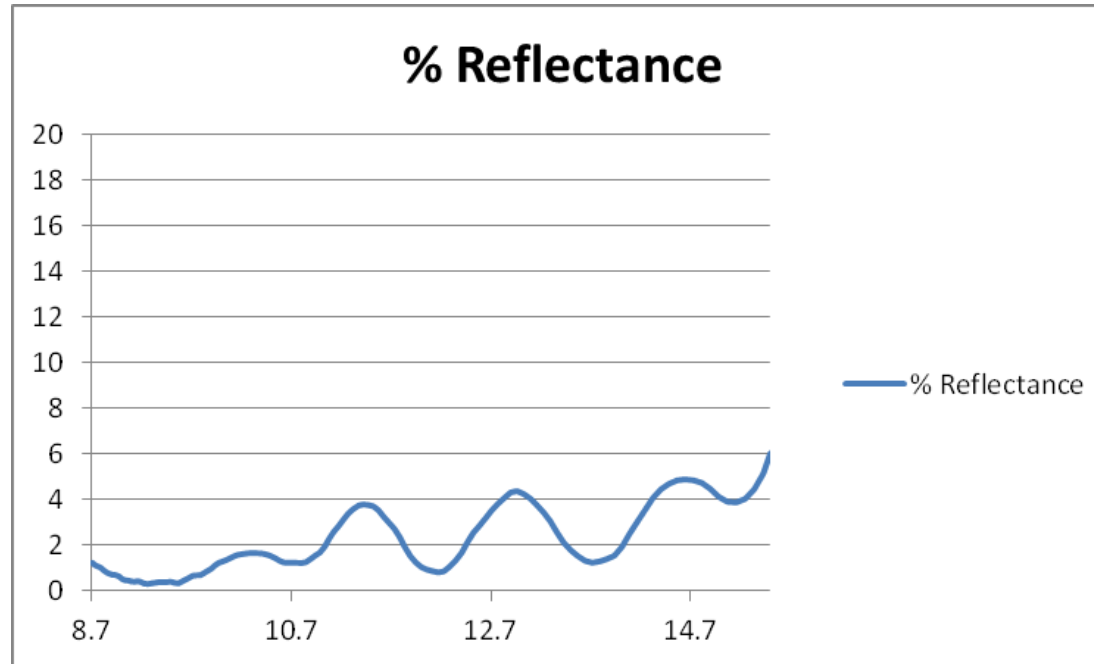


Reflectance of Band 1 photoconductor 80-94K



Partial transparency of very long wave MCT below the cut-off allows reflections from the MCT back surface

Reflectance of Band 1 photoconductor at 80K



Optimization of the MCT thickness and cut-off wavelength minimizes back surface reflections .

SPACE DETECTOR ASSEMBLY AND TEST



Space Assembly Clean Room



Space Test Clean Room

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in IR Detection for Earth Observation

THANK **YOU** FOR YOUR ATTENTION

