ELECTRONICS DIVISION

LEONARDO

CEOI presentation
Leonardo Southampton
Space, Astronomy and Optical Communications

21/4/2021

Infrared Detectors Southampton UK

World leader in design, development and manufacture of high performance infrared detectors

- 70 year heritage in R&D and manufacture of IR Detectors
- Fully integrated capability from material growth to volume manufacture
- 200 employees including world leading scientists
- 3000m^2 clean rooms (including class 100)
- Infrared sensitive material growth specialising in 2 detector technologies
- Supplying a diverse range of markets and applications

High performance cooled Mercury Cadmium Telluride (MCT) Focal Plane Array detectors

- Thermal imaging
- Missile guidance
- Space and Astronomy

Single element Deuterated L-AlanineTriglycene Sulphate (DLATGS) pyroelectric detectors

- Infrared spectroscopy

Infrared Detector Technology

Two high performance IR sensitive material technologies

MCT

Mercury Cadmium Telluride

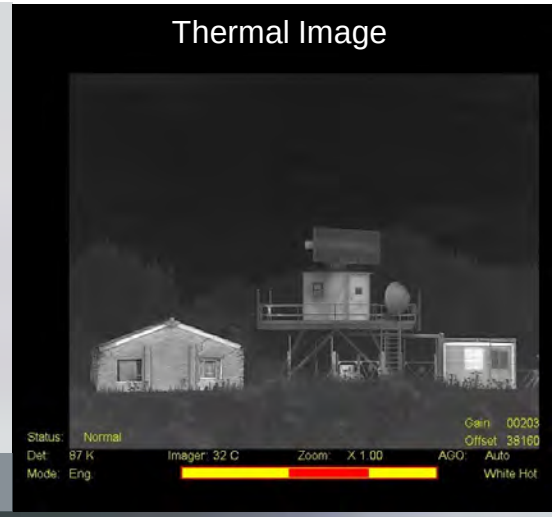
- 2-dimensional Focal Plane Array (FPA) detectors
- High performance
- Cryogenically cooled
- Tuned spectral band NIR, SWIR, MWIR, LWIR, DWIR

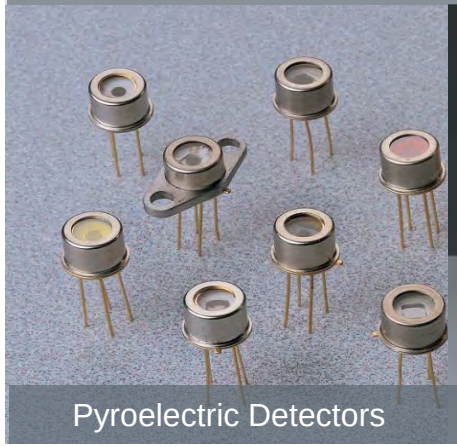
DLATGS

Deuterated L-Alanine doped Triglycene Sulphate

- High performance Pyroelectric
- Single element
- Room temperature
- Wide spectral response 1 to >1000µm
- Low cost

SuperHawk Detector IDCA





Pyroelectric Detectors

Infrared Spectrometer

Detector Capability

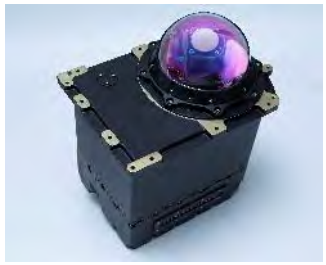
Wide ranging applications

Thermal Imaging

Handheld imagers

Airborne tracking

DIRCM



Missile Seekers

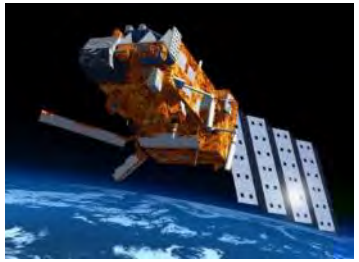
Naval IRST

Vehicle Sighting

Long Range Surveillance cameras

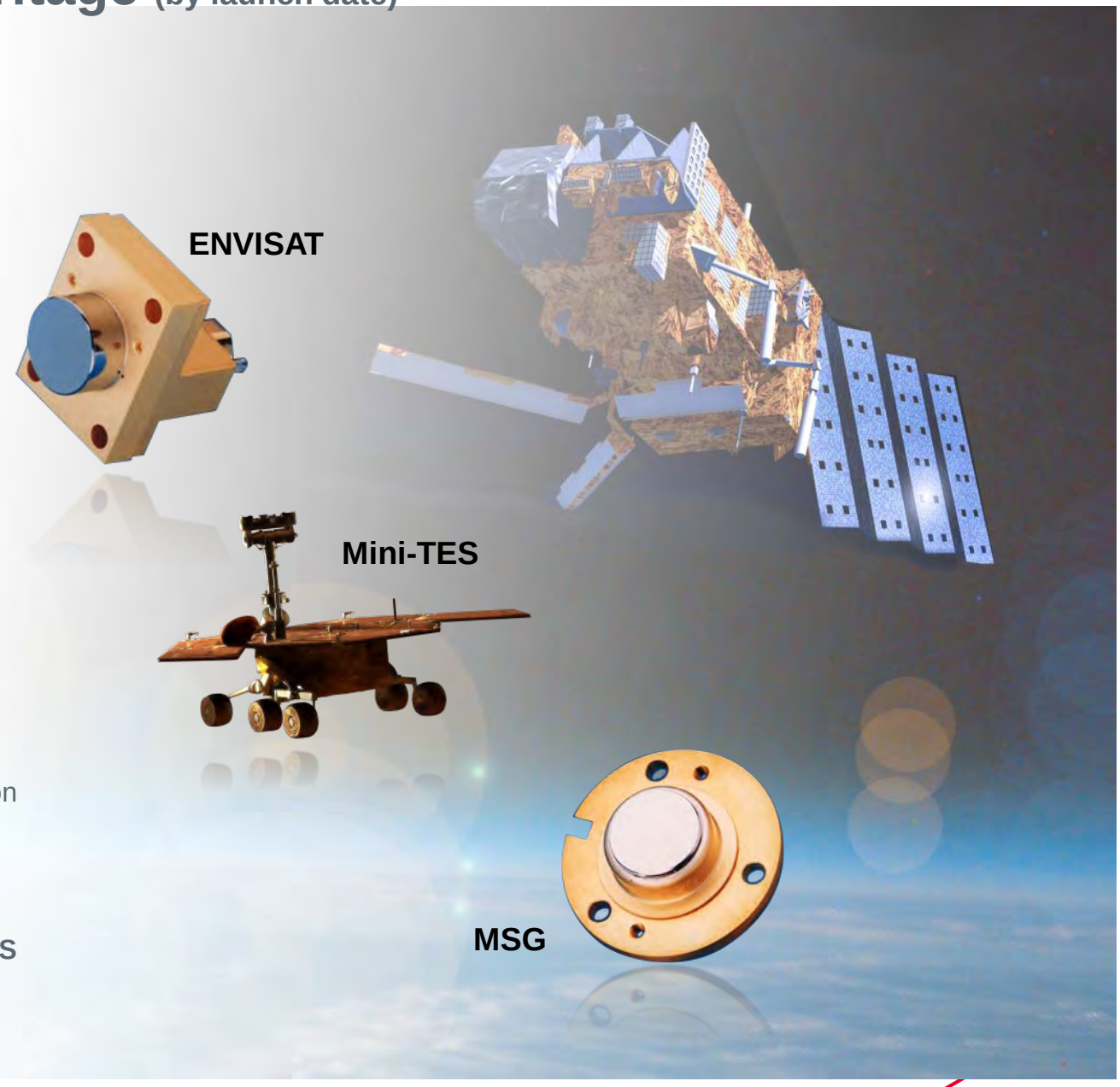
Infrared spectroscopy

Space and Astronomy



Infrared Detectors – Space Flight Heritage (by launch date)

1972 Selective chopper radiometer
Nimbus 5 for NASA in collaboration with University of Oxford
1974 Horizon sensor – X4 Miranda Earth Satellite UK/USA
1975 IR spin scan radiometer
Synchronous meteorological satellite for Hughes Corporation
1977 Meteosat 1st generation
1991 ATSR (Along track scanning radiometer) – UARS for RAL
1998 PMIRR (Pressure modulated infra red radiometer)
Mars Mariner for University of Oxford
2000 STRV2 – 2 colour PV array for DERA/BMDO
2001 BIRD (bispectral integrated detector cooler assembly) for DLR
2002 MIPAS (Michelson interferometer for passive atmospheric sounding)
Envisat for ESA
2003 Raytheon Mini TES on NASA's Mars Spirit and Opportunity Rovers
2004 SEVIRI (Spinning Enhanced Visible and InfraRed Imager)
Meteosat 2nd generation (MSG)
2016 **OSIRIS-REx thermal emission spectrometer (OTES)**
NASA asteroid sample return mission
2018 GOSAT 2 - Greenhouse Gas Observing Satellite-2 FTIR – JAXA mission
2020 UAE Planetary Science Mission – Study of climate and atmosphere
2020 ISEM (Infrared Spectrometer for ExoMars) for ESA
2021 **NASA LUCY mission to Jupiter's Trojan asteroids**
2022. IASI NG Meteorological and atmospheric science mission for CNES
2023. PACE Earth science Ocean Colour Instrument for NASA



CEOI Superhawk and ANU status

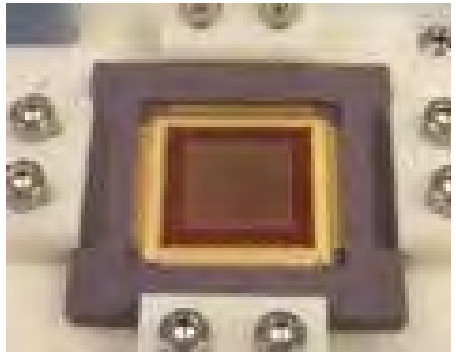
- Superhawk SSTL
- SuperHawk is a HDTV SXGA (1280 x 1024) MWIR Detector on an 8µm pitch
- Superhawk IDCA, `COTS` product comprising a hybridized array, housed in a vacuum encapsulation with an optical window and cryogenic cooler – adapted for space with a split linear cooler for low vibration export and long life to be used on Darkcarb

- Australia National University, ANU
- 1k x 1k array, custom development for University of Hawaii of both the silicon readout circuit and the APD MCT infrared sensitive material, combined to make a hybridized array being tested at ANU
- ANU designed flex and optical block
- ANU working with ESO NGC Controller

Latest developments - ESO 512 x 512 MCT APD wavefront sensing

Key Features

- 512x512 24um
- Low Glow Design
- Multiple Windows
- 64 Analogue Outputs
- Low voltage operation
- 2000Hz



Status Update

- ROIC design validated through laboratory validation and characterisation at cryogenic temperature
- ROIC hybridised with MCT APD arrays currently undergoing electro-optic performance evaluation

ROICs customised for Space & Astronomy Applications

ME1130 SWIR - ESA 2k x 2k SWIR APD array

ROIC design start in 2020, silicon expected in 2021.

Key Design features:

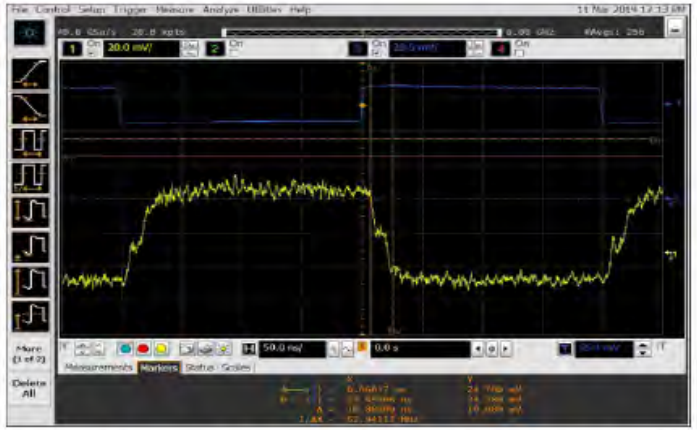
- 15µm pitch, floating gate (source follower) pixel
- Stitched reticle design
- Low-noise low-glow architecture
- Global shutter and rolling reset readout
- Reference pixels
- Programmable outputs (4, 8 or 16)
- Radiation hardened design (heritage from ME930/950)

Key specifications:

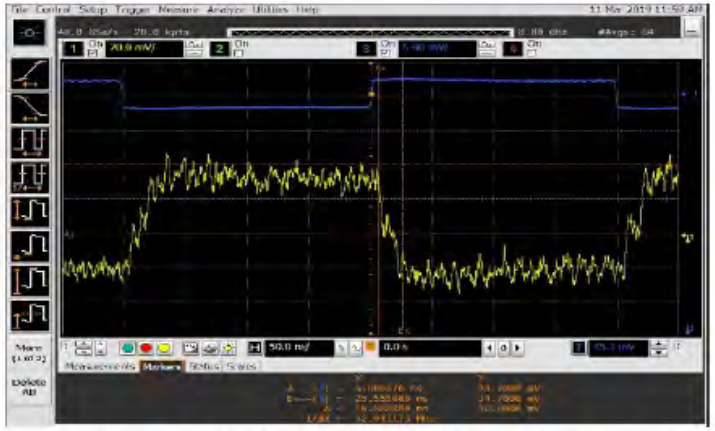
- APD MCT, cut on ≤0.8 µm cut off ≥2.5 µm
- Read noise <10 e/p/s, Dark current 3 e/p/s
- CHC >100 ke-, non-linearity <1%
- 80K operating temperature

Latest developments – MCT high speed diodes

HgCdTe APD Cell without Preamp



Output from an 8x8 pixel cell (64 diodes in parallel)



Output from a 16x16 pixel cell (256 diodes in parallel)

The pulse rise and fall times was measured to be ~2.5 ns, limited by the parasitic capacitance in the test setup, not the detector.

*The steps, or shoulders, on the pulse rise and fall times were caused by the echoes from impedance mismatch of the test setup

Latest developments – Combine 512 x 512 with high speed MCT APD diodes for optical communications > OptiTrax

- In space down-link of scientific data requires a highly sensitive, high-bandwidth optical data receiver for optical communications in a low flux regime
- There is also expected to rapidly become a growing commercial market for such a detector for constellations of miniaturized satellites in LEO with optical DTE links
- The design will take a 512x512 Imaging / tracking array and incorporate additional functionality at the centre of the array. The centre of the array can operate in imaging mode or switch to communications channel mode.

ME1150 SWIR ESA Photon-counting 2D Tracking and Communications Detector

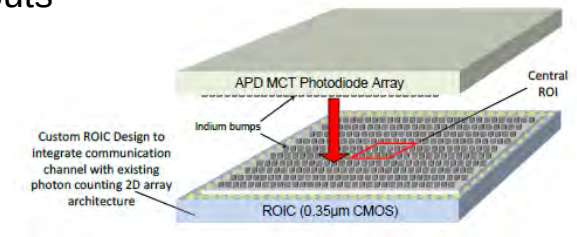
ROIC design start in 2020, silicon expected in 2021/2022.

Key Design features:

- Based on ME1120 ROIC
- 512x512, 24µm pitch, floating gate (source follower) pixel
- Central pixels with dedicated TIA for communication mode
- Low-noise low-glow
- High frame rate architecture through 64 outputs

Key specifications:

- APD MCT, 1.3 µm to 2.5 µm wavelength range
- Min signal: few photons
- Dark noise <1e- (limit)
- 80K operating temperature



Latest developments – larger format arrays

APD

Wavefront sensing (High frame rate)

- 320 x 256 Saphira
- 512 x 512 Saphira QM

APD

Imaging (Low background Imaging, low frame rate)

- 1k x 1k, 15 micron pitch Ike Pono
- 2k x 2k 15 micron pitch IBEX 4M
- Application of large format arrays

Designed for use in ground and space based astronomical imaging.

Summary

- TGS single element uncooled and MCT cooled arrays
- Standard products and custom developments
- Long space heritage, actively working on current space flight programmes and will be starting another later this year
- Overlap in requirements between space and astronomy and now optical comms
- Developments are aimed at establishing the technology, raising the TRL so that they are ready for the next flight programmes
- Company Investments in 4’’ growth and processing and increased test capabilities

THANK YOU
FOR YOUR ATTENTION

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