NCEO CEOI Virtual conference

24th June 2020

Leonardo MW infrared detector developments

Presenter: Keith Barnes

Project Title: DARK CARB CEOI study

Lead Organisation and Partners: Leonardo and SSTL

Project Objectives

- Adapt and validate the use of high performance COTS infrared detectors for high spatial resolution (Sub 3.5m ground sample distance) imagery from LEO constellations
  - **Leonardo MW LTD** will be responsible for the detector dewar assembly and integration and test with the selected cryogenic cooler
  - **SSTL** will be responsible for electrical and mechanical aspects including integrating the sub-assemblies and conducting the environmental testing
  - **Both** will review the existing proximity electronics and collaborate on a design suitable for interfacing between the detector and front end electronics

Target Missions and Main Benefits

- SSTL and Leonardo will jointly exploit their existing capabilities with the aim of developing world-leading UK infrared EO technologies for space applications.
- The Dark CARB protoflight imager will be designed to be accommodated on the Carbonite satellite platform, moving into a demonstration mission that will follow a similar path to Carbonite 1 & 2.
- Both companies will be able to exploit the products developed, in the wider earth observation infrared imaging market
- Establishes working relationship between Leonardo and SSTL
- Knowledge sharing on design of `space ready` proximity electronics

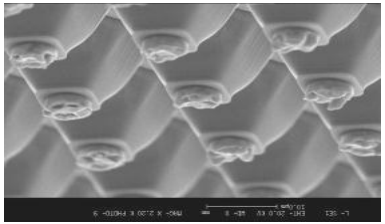
Carbonite 2 Satellite

Technology – 1

- Leonardo MW Ltd have 60 years of heritage in cooled and uncooled IR detectors at the Southampton Site, supporting markets such as
  - Infrared spectroscopy
  - Space & Astronomy instruments
  - Thermal Imaging for Land-based, Naval & Airborne systems
  - Missile Guidance

- Current MCT MOVPE process allows excellent wafer uniformity on low cost substrates. All types of IR detectors SW,MW,LW,DWB and APD are grown in these growth conditions

- Grown-in dopants mean arrays stable for >1 year at 70°C

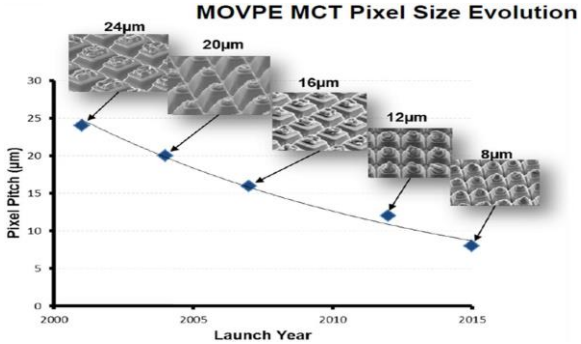


Mesa isolation provides photon confinement for high absorption efficiency and near-ideal MTF

Technology – 2

- SuperHawk is a 1280 x 1024 8µm MWIR (3.7µm-5µm) COTS IR detector
  - 110K operation
  - Typical 22mK NETD
  - Selectable Charge Handling Capacity
  - -40°C to +70°C Operating Temperature

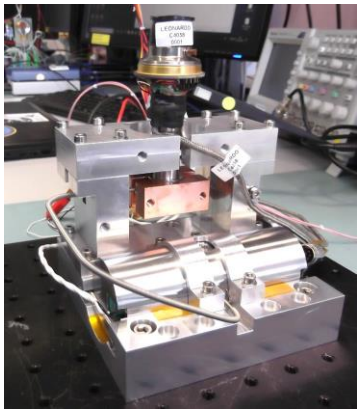
- Thales LSF9997 Cooling Engine (not pictured) that has been selected for this application is a long-life linear cooling engine, with a demonstrated MTTF of 35,000 hours



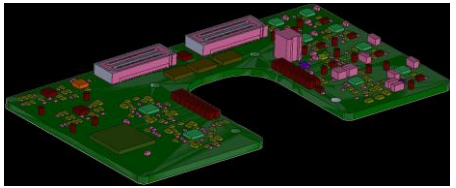
SuperHawk IDCA with RM2 rotary cooler

Achievements and Current Status

- The initial cryocooler testing has been completed. A number of Key changes to the standard SuperHawk/LSF9997 cooler have been adopted for this program
  - Increased pipe length with optimised shape to decouple cold head from compressor
  - Vibration isolation mount to protect compressor during launch
  - Additional passive balancer to dampen cold head vibrations export
- SuperHawk with rotary engine has undergone EO assessment at SSTL
- Design work on cooler control module and spaceflight approved proximity electronics is ongoing



SuperHawk model with LSF9997 engine and final pipeform



SuperHawk proximity electronics design for spaceflight approved components

Project Title: Characterisation of Leonardo MCT APD arrays in the ANU hyperspectral instrument

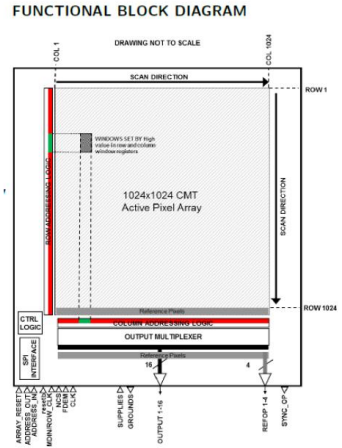
Lead Organisation and Partners: Leonardo and Australian National University

Project Objectives

- Progress the L-APD concept to 1k x 1k / 15 um pitch.
- Compatible with the requirements of SWIR hyperspectral imaging and space
- Aim for TRL7
- Collaboration with Australian National University
  - Detector control hardware
  - Detector and controller characterisation

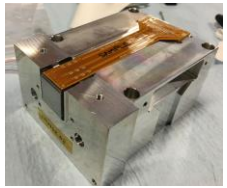
Main Benefits

- ANU and Leonardo will jointly exploit their existing capabilities with the aim of characterising our new 1kx1k APD array in a hyperspectral instrument, so that it can be used in world-leading space and astronomy applications.
- ANU's expertise with low noise cryogenic electronics will be combined with Leonardo's world leading MCT APD Short Wave Infrared arrays.
- De-risks use of Leonardo's arrays for use in space programmes in combination with radiation testing previously completed for ESA on smaller format APD array
- Supports new development of 2k x 2k APD array for ESA
- Develops relationship with ANU to support future potential missions such as bush fire `fuel` monitoring



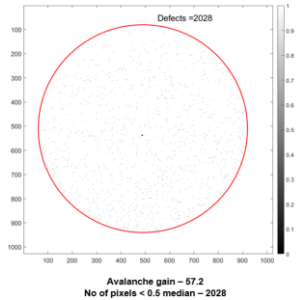
Achievements and Current Status

- The hybridisation of the first 1kx1k MCT APD material with ME1070 Si ROIC's has been successful
- Detector packaging has been delivered by ANU
- Integration of the arrays with the packages will take place over the coming weeks.
  Characterisation will commence in Q3 at ANU



Combined transit and manufacturing jig

ANU Designed Flex and array mount



LMW testing reports low defect count