LEONARDO
TECHNOLOGY FOR A SAFER FUTURE

Leonardo Electronics

MWGaiaDN Tech Workshop

Institute of Astronomy,
University of Cambridge

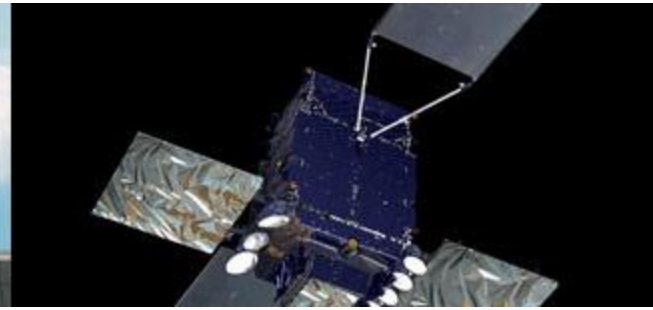
15th July 2025

Company General Use

Our group

Leonardo is a global company that develops multi-domain operational capabilities in the Aerospace, Defence and Security sector, with an integrated offer of high-technology solutions for military and civil applications.



Helicopters

- **Helicopters Division**
  PZL-Świdnik (100%)
- *Kopter (100%)*
- *Leonardo UK/Helicopters (100%)*
- *NH Industries (32%)*

Defence Electronics & Security

- **Electronics Division**
  Cyber & Security Solutions Division
  Electronics Division
- *Cyber & Security Solutions Division*
- *Leonardo DRS (80.9%)*
- *Leonardo UK/Electronics/Cyber (100%)*
- *MBDA* (25%)*
- *Hensoldt (25.1%)*
- *Elettronica (31.3%)*
- *Larimart (60%)*

Aeronautics

- **Aircraft Division**
  Aerostructures Division
- *ATR* (50%)*

Space

- *Telespazio* (67%)*
- *Thales Alenia Space* (33%)*
- *AVIO (29.6%)*

* Joint ventures % Leonardo's share

Leonardo UK - Detector Capability

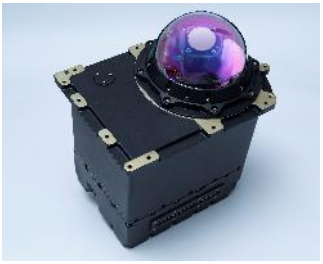
Leonardo UK Detectors based in Southampton in the UK is a growing business with a long-term commitment to the manufacture of world-class infrared sensors. Science and astronomy arrays use the same production facilities as standard thermal imaging detectors and share the same high quality, high yield process. Leonardo is therefore a reliable, long-term supplier of infrared detectors to the science community.

Thermal Imaging

Handheld imagers

Airborne tracking

DIRCM



Missile Seekers

Naval IRST

Vehicle Sighting

Long Range Surveillance cameras

Infrared spectroscopy

Space and Astronomy

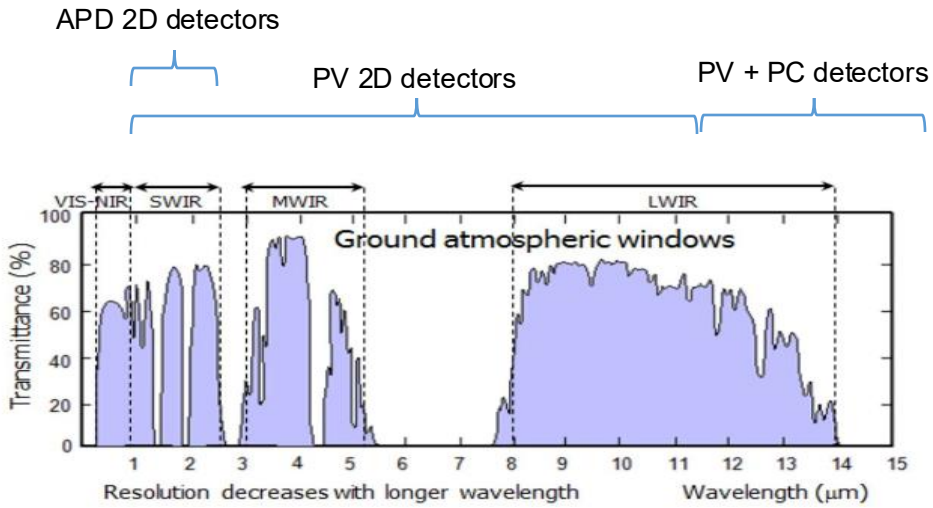
Science business area

MCT Detectors

- One technology/process covers whole IR spectral range
- Wafer scale process on 4” GaAs substrates for low cost
- Offer high performance SW (0.8 – 3), MW (3-5), LW (8-11.5µm)
- Broadband and Dual Colour
- Highest performance detector material available

Avalanche Photo-diodes (APDs) Arrays

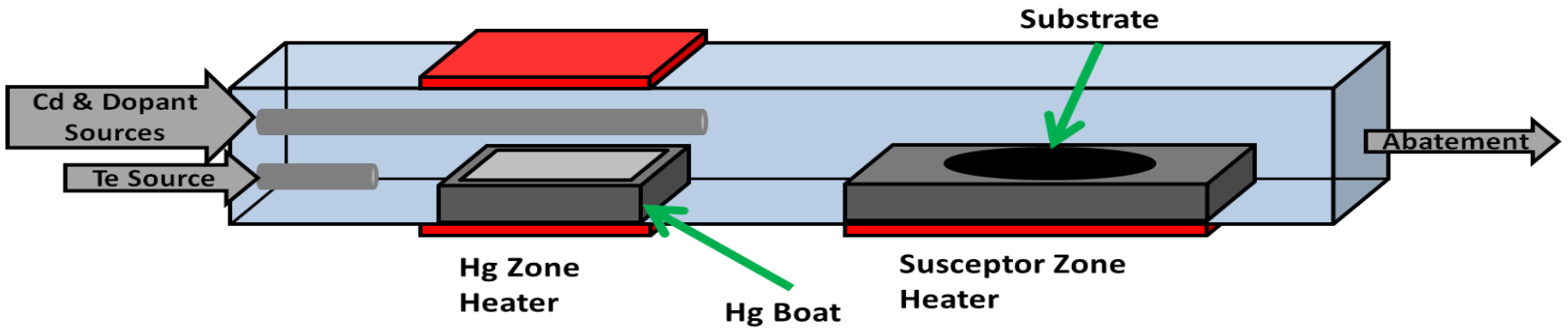
- High, noise-less gain in each pixels.
- Capable of high speed photon counting
- Spectral range 1.5-2.5um (0.4-2.5µm and MWIR on roadmap)
- Suits low flux applications - scientific, optical communication and long range LiDAR



SuperHawk MWIR imagery (1280 x 1024/8µm)

MCT MOVPE Growth Capability

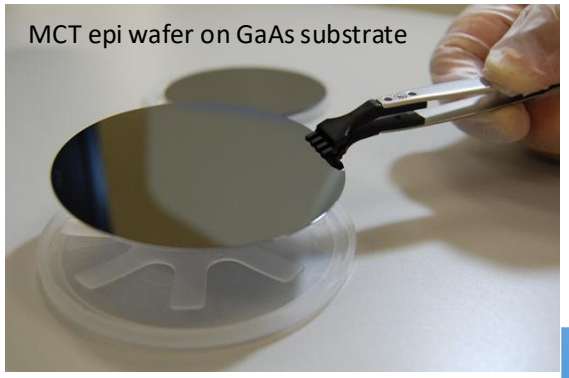
- Leonardo UK is the only detector manufacturer that uses Metal Organic Vapour-Phase Epitaxial growth on a low-cost substrate.
- Excellent uniformity, morphology
- MCT Wafer level process 4”
- Low cost GaAs substrate

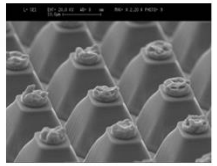


- Alternate HgTe and CdTe growth
- Same growth conditions for all compositions SW, MW,LW, DWB, APD

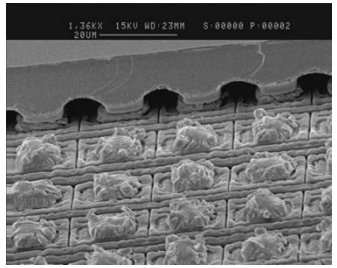
Company General Use

MCT MOVPE Wafer Scale Capability

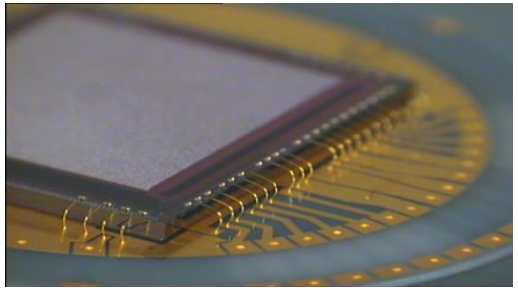


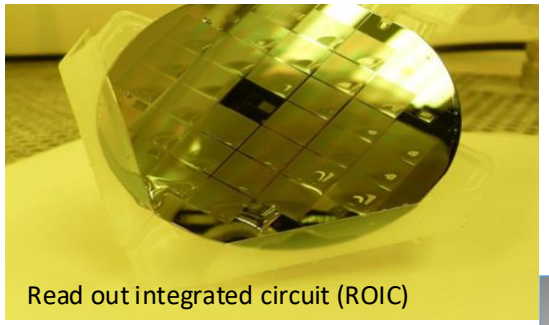


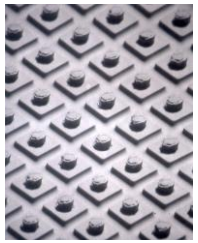
MCT mesa process



Bump bond die + substrate removal





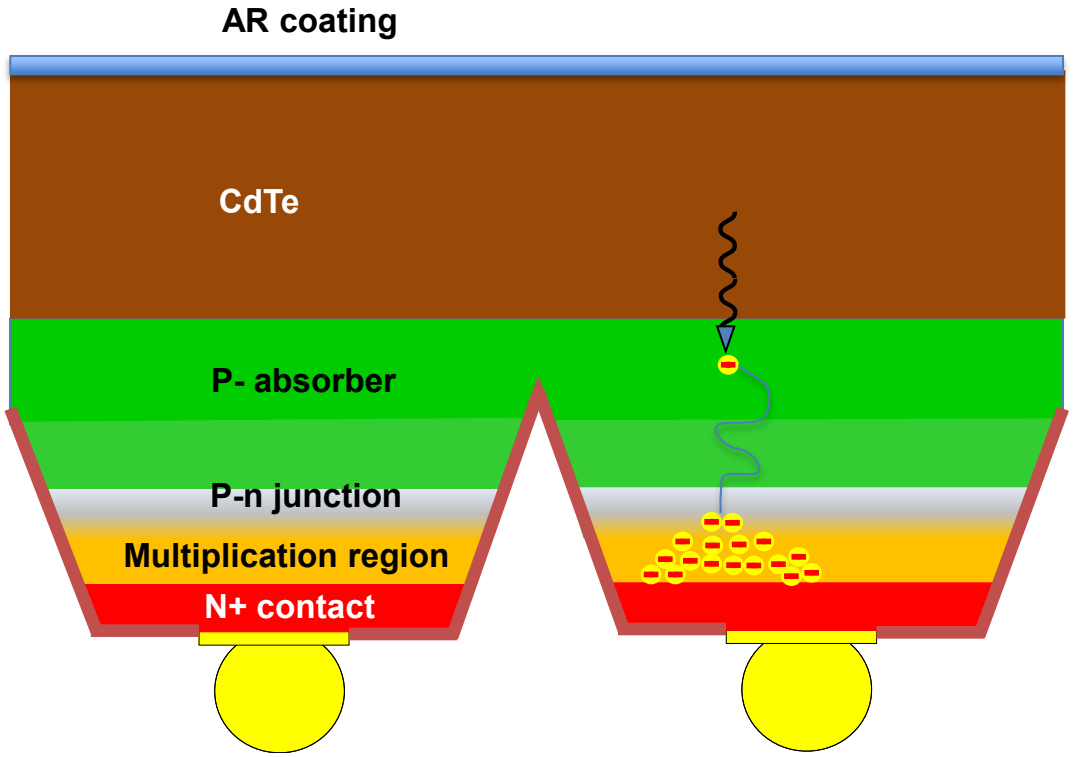


Wafer Fab

Diodes have negligible interpixel capacitance and crosstalk. The pixel has optical concentration and the minimum volume for low dark current

Leonardo e-APD solutions

1 The standard 0.8-2.5um product offers high gain
2 The high speed 1.45-2.5um product offers 100% internal QE and GHz response



Strengths:

Low p-n junction capacitance

The mesa slot structure provides for very low p-n junction and inter-pixel capacitance. Both essential for sensitivity.

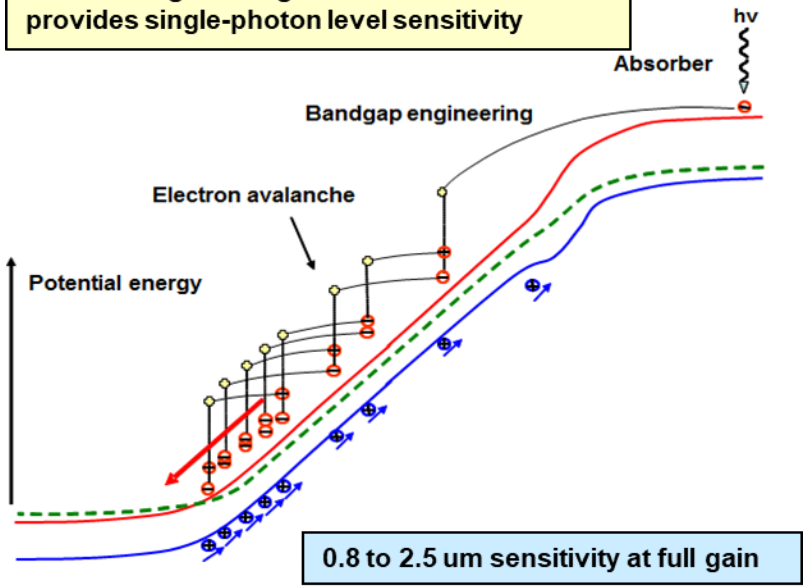
Imaging quality

The mesa structure and 100% absorption ensures that crosstalk is negligible. Unlike other device structures there is no mechanism for thermal diffusion to another pixel.

- Disruptive technology
- Gain in pixel (up to few 100)
- Enables read noise < 1e-
- Enables high speed imaging with high SNR
- New generation of detectors
  - Very low background (Hz imaging) for Astronomy
  - High speed (kHz imaging) for

  - LIDAR/3D Imaging
  - TDI Imaging
  - Photon counting
  - Optical comms

Avalanche gain in HgCdTe is noise free and provides single-photon level sensitivity



0.8 to 2.5 um sensitivity at full gain

- **Fundamentally highly stable for long-term operation**
- **Insensitive to gamma and proton irradiation**
- **High operating temperature**
- **Direct impact on the sensitivity of the camera**
- **World leading dark current (<10 electrons/hour)**

MOVPE MCT is ideal material for APD

Leonardo APD focal plane arrays for low background flux applications

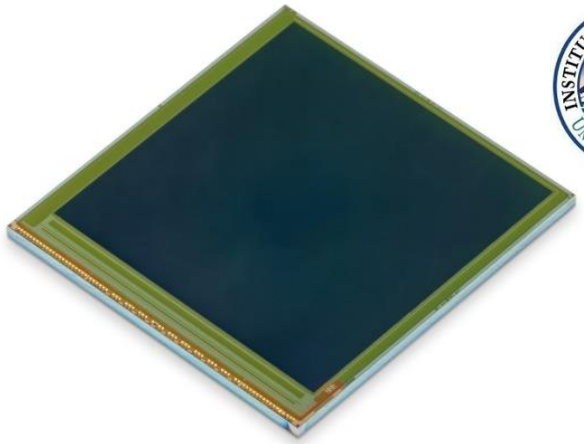
- Initial development in collaboration with University of Hawai'i, Institute of Astronomy under NASA ROSES project.

- Initial development and low-background flux APD assessment on 'Ike Pono'

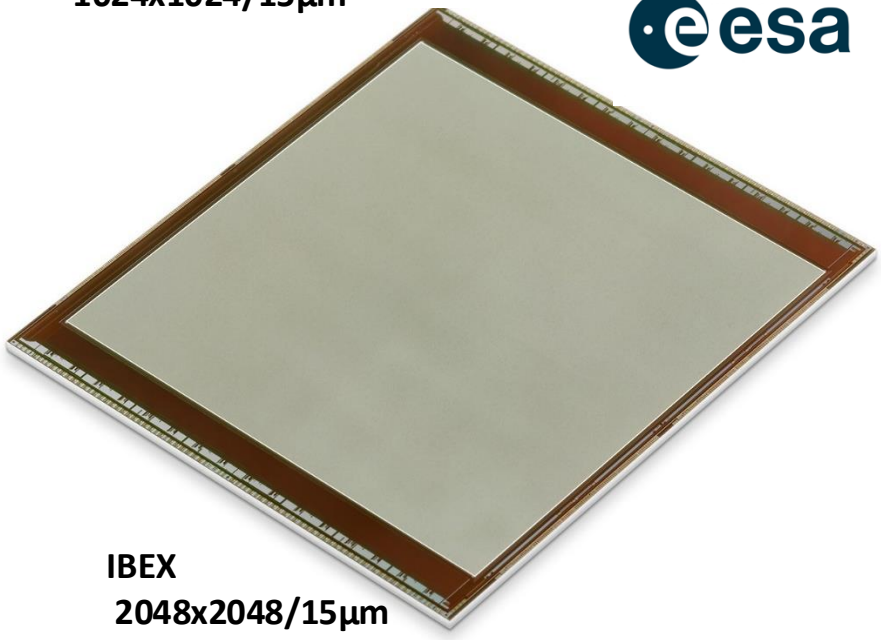
  Named by the late Don Hall – Hawaiian for 'far seeing'

- 2kx2k FPA funded by European Space Agency – called 'IBEX'

- Further funding for 2kx2k development from UoH and ESA to refine performance under low flux conditions

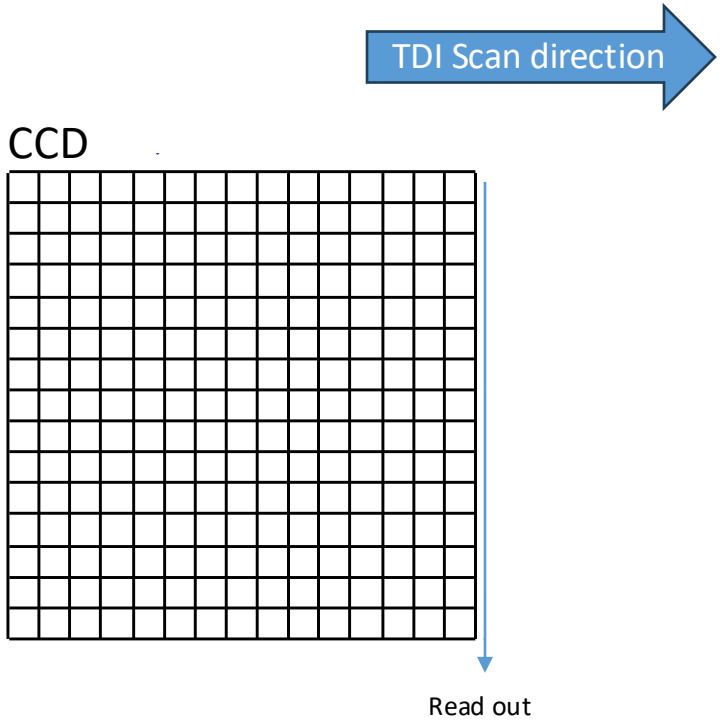


Ike Pono
1024x1024/15µm



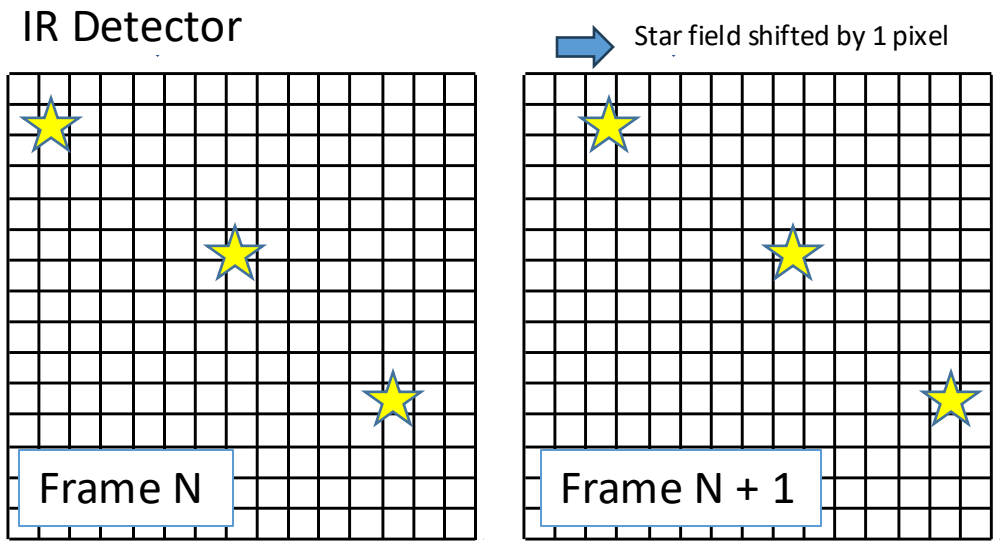
IBEX
2048x2048/15µm

GAIA detector considerations



Integration time up to few sec
Readout 1 column per frame

Challenges
- Flux range – mag. 6 down to mag. 20 (5E5 range)
- Variable TDI length
- Radiation charge trapping



Integration time up to few msec
Readout whole frame
Pseudo TDI by off chip processing

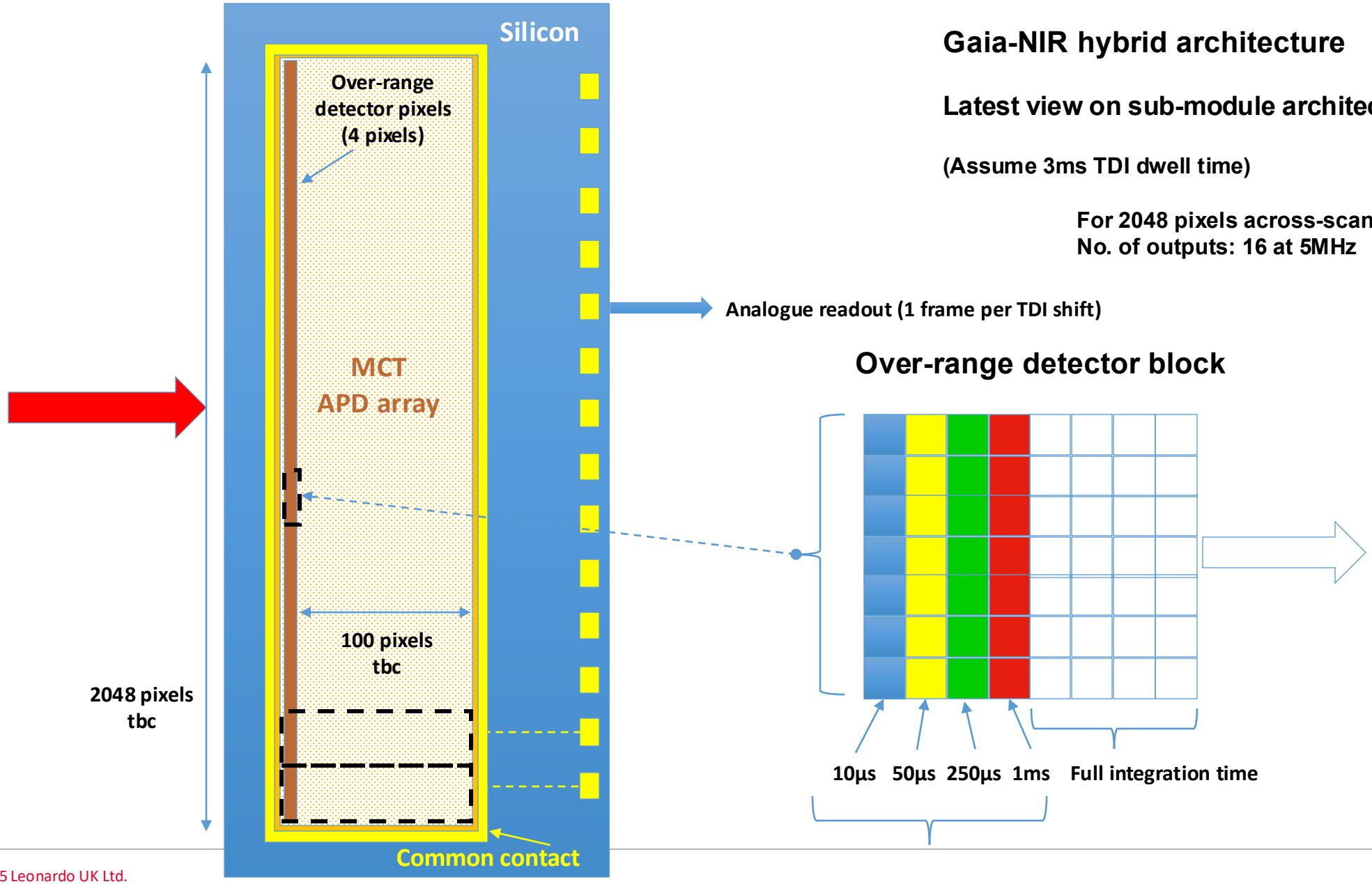
Challenges
- Flux range – mag 6 down to mag 20 or lower
- Variable integration time
- Signal to noise for few msec integration time
- Need to detect signal photons

Gaia-NIR hybrid architecture

Latest view on sub-module architecture

(Assume 3ms TDI dwell time)

For 2048 pixels across-scan
No. of outputs: 16 at 5MHz



Leonardo Detector Considerations

Technical Challenges

- Photon level sensitivity required
- APD gain >200
- Suppressed APD noise sources

Manufacturability Challenges

- Gaia is potentially a huge project depending on architecture selected
- Yield challenges of larger arrays
- Needs to fit into commercial business alongside other contracts

Conclusions

- An attractive but challenging programme
- Further de-risking activities to develop full photon level detection
- Trade-off sensitivity with array size/TDI length

Thank you
for your attention

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Company General Use