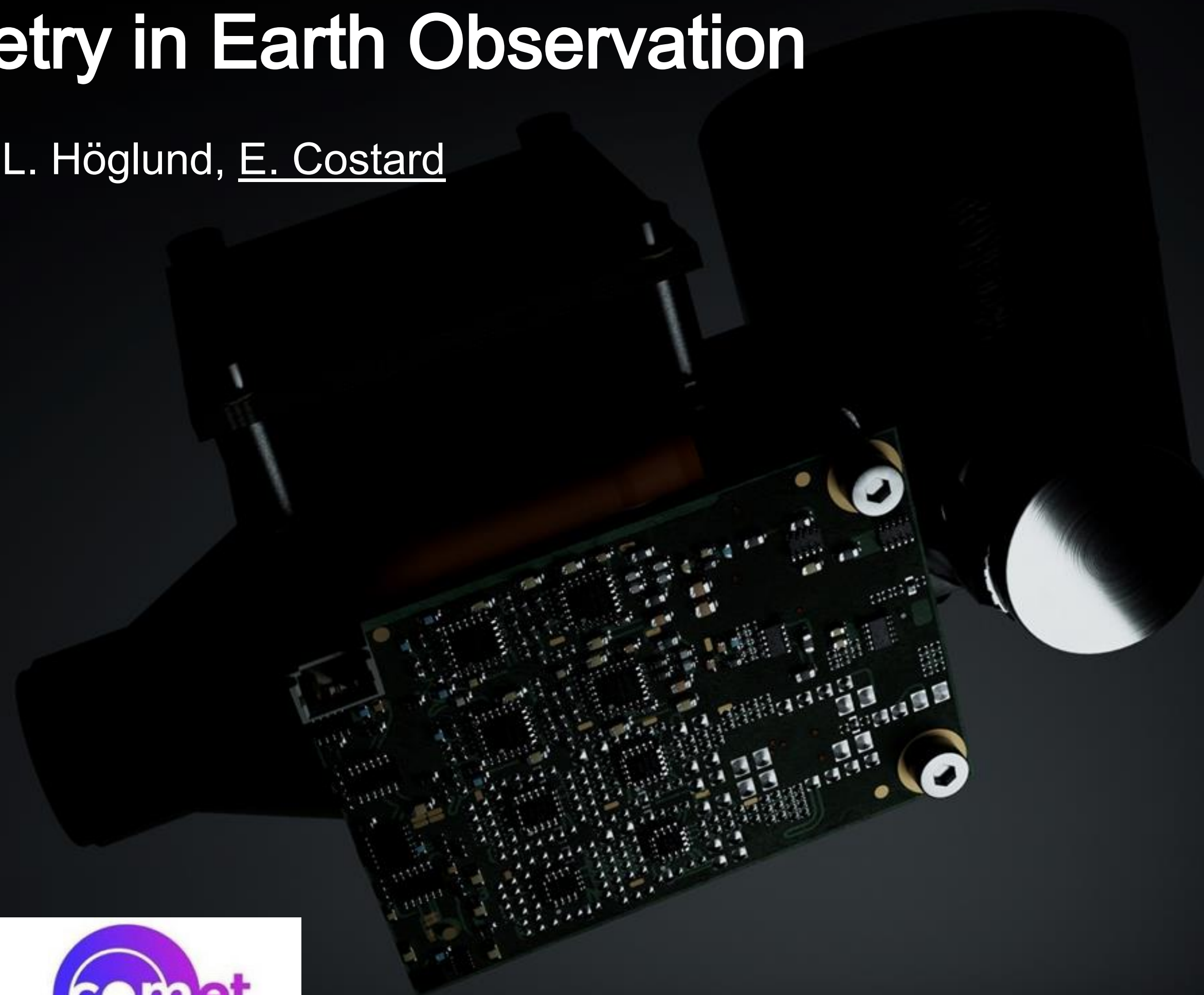
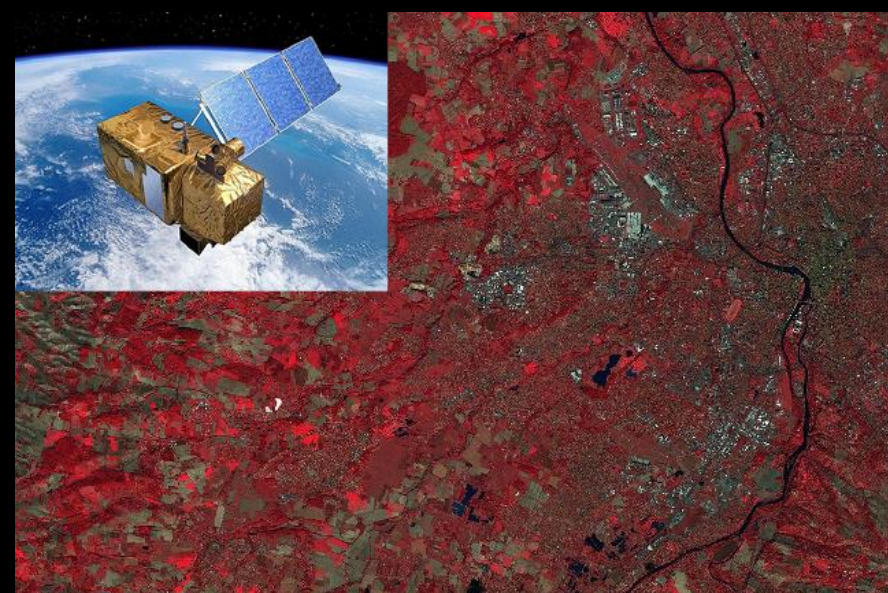


QWIP for dual-band LWIR radiometry in Earth Observation

R. Ivanov, D. Evans, D. Visser, S. Smuk, D. Rihtnesberg, L. Höglund, E. Costard



Infrared Detection for Space Applications

7th- 9th June 2023



About IRnova

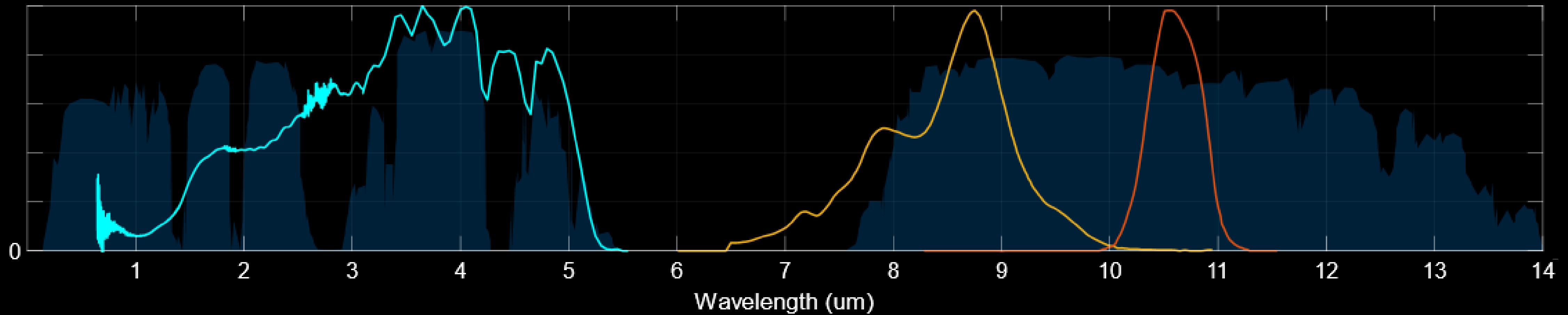
- **EU based IR detectors OEM Supplier**
 - Started in 1986 as a governmental research laboratory
 - Independent and Privately owned since 2007
- **30+ years of IR sensor R&D and Manufacturing**
 - Leading QWIP and T2SL detectors (eSWIR, MWIR, LWIR, VLWIR)
 - Several 1000's of QWIP & T2SL detectors fielded
 - Contract manufacturing for III-V material
- **Pioneers in Optical Gas Imaging**
 - MWIR and LWIR solutions for all addressable gases
 - QVGA (320x256) and VGA (640x512) solutions available
- **Strong Team and Excellent Facilities**
 - 70% staff share of PhD's and MSc's
 - 2500 m² manufacturing facilities including 1300 m² of clean room
 - ISO9001 : 2015 certified



Kista (30km from Stockholm airport)

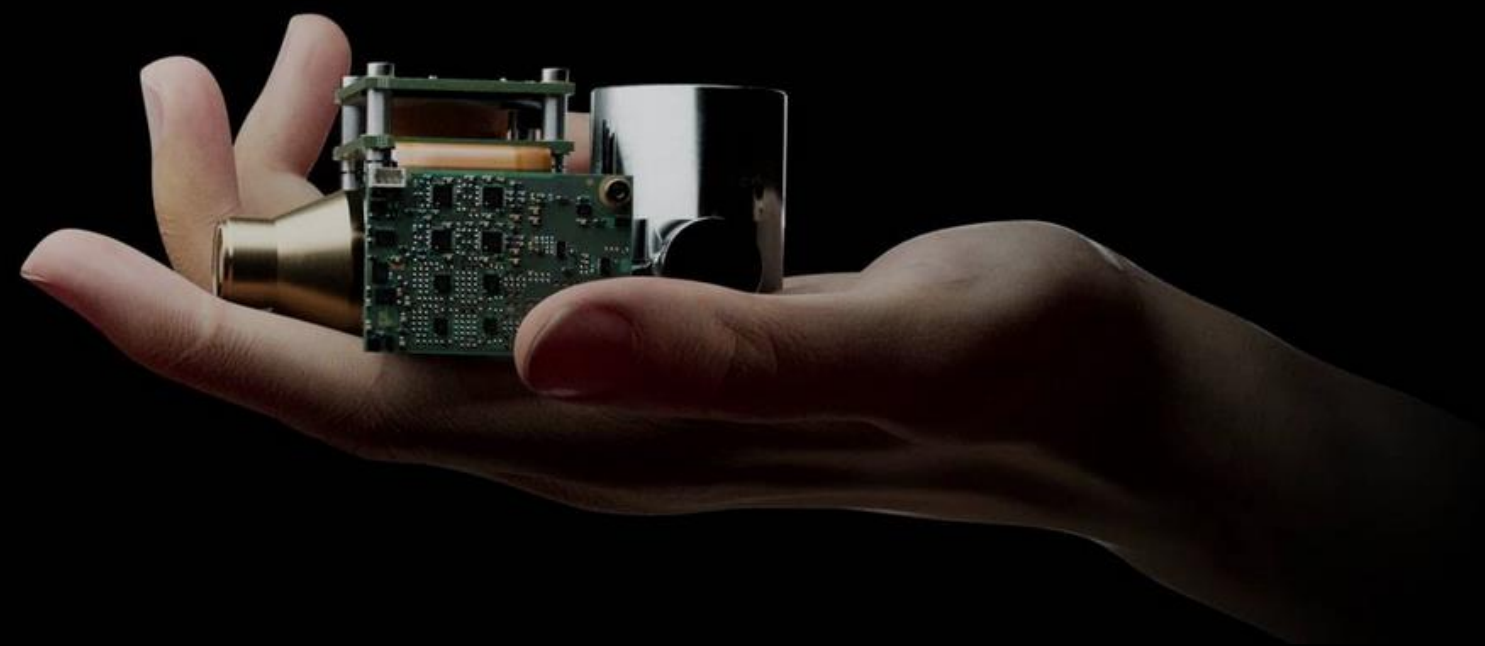


Revolutionary technologies: T2SL and small pitch QWIP



T2SL

Small pitch QWIP



State of the art II-V clean room

4" Wafers



2 Steppers



Plasma etching



bonding



FC300 Flip chip machine

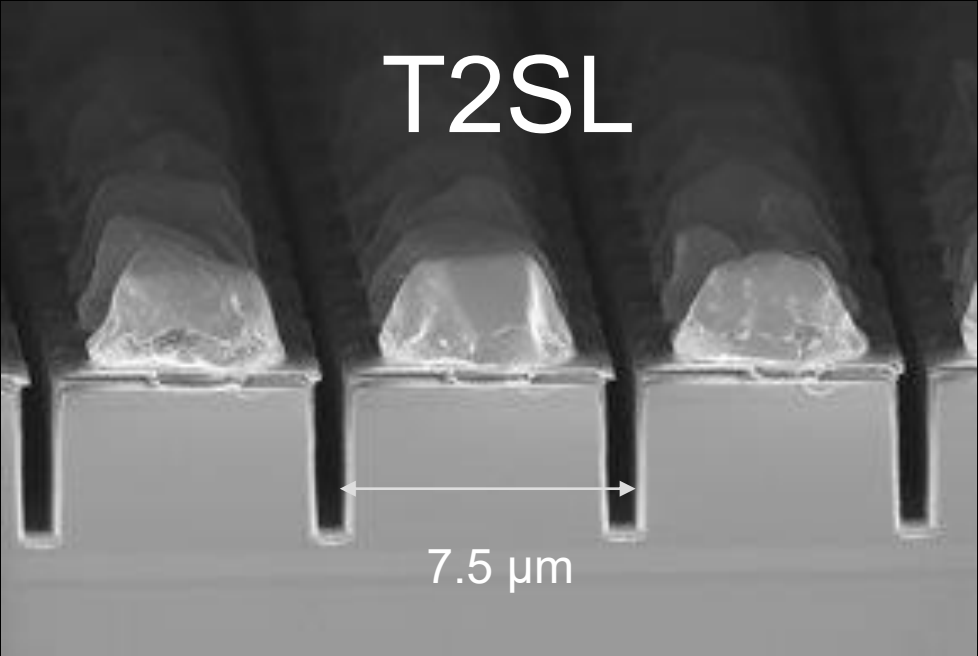
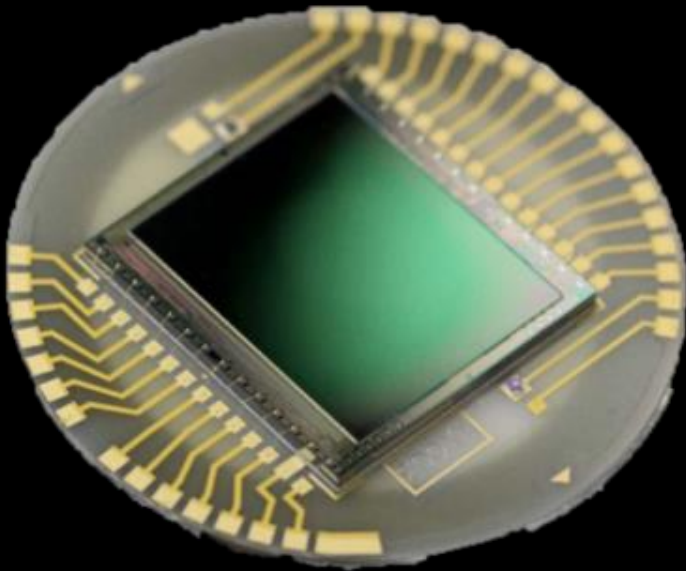
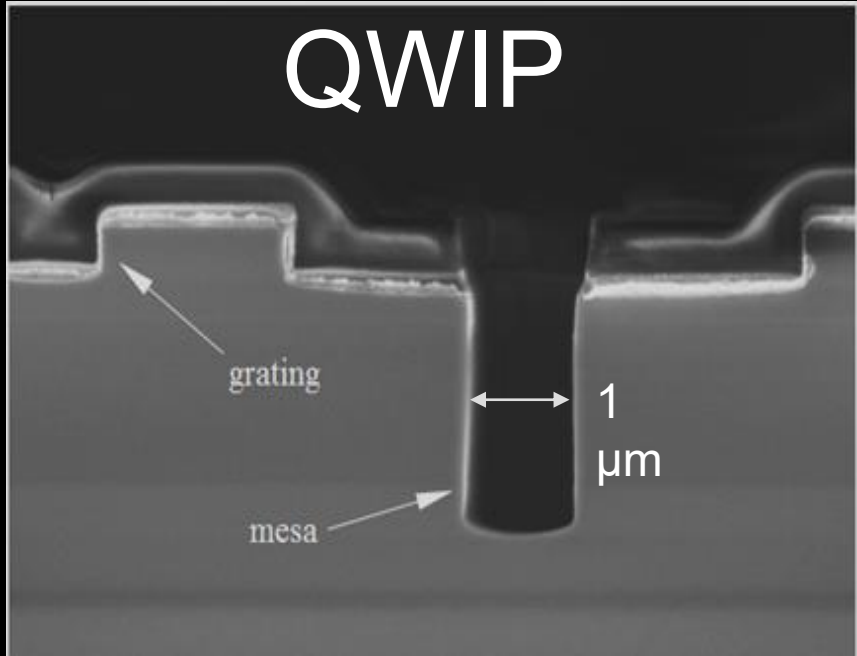


Automatic trackers



And much more (sputtering & e-beam metal deposition, ICP & RIE etching, PECVD deposition ...)

One team - one clean room



Outline

QWIPs at IRnova

QWIP manufacturability

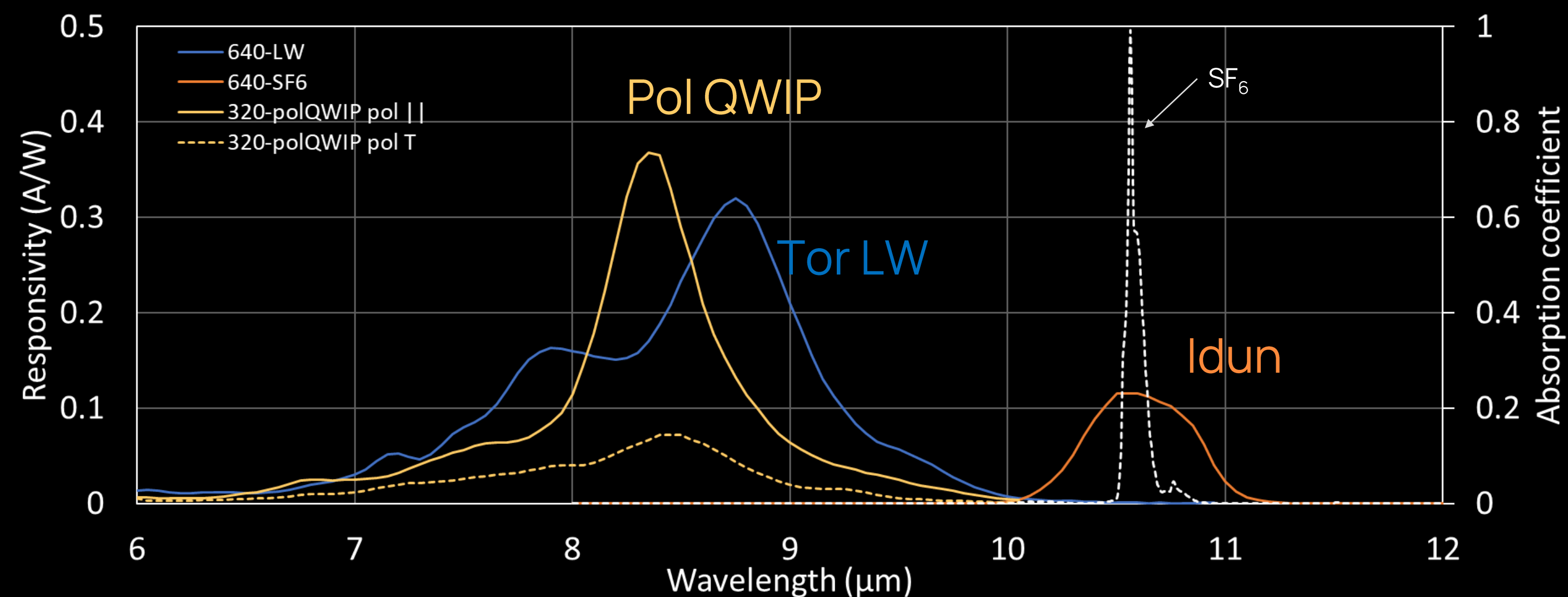
QWIP for dual-band LWIR radiometry

Conclusions



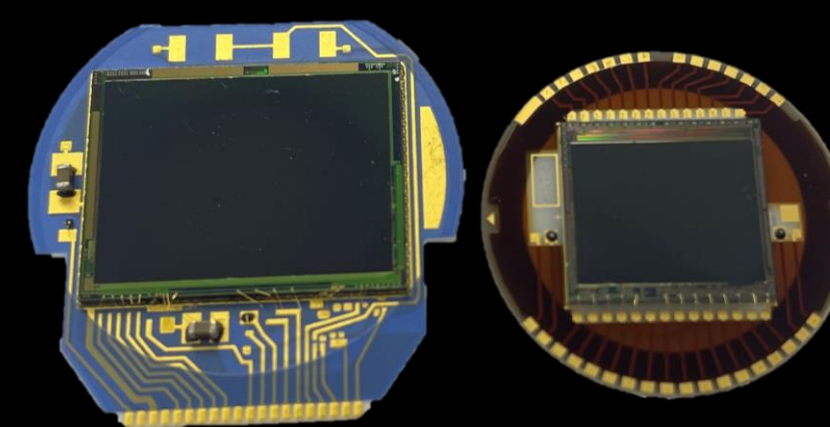
QWIPs at IRnova

QWIP at IRnova



Various detectors in the same IDCA packaging:

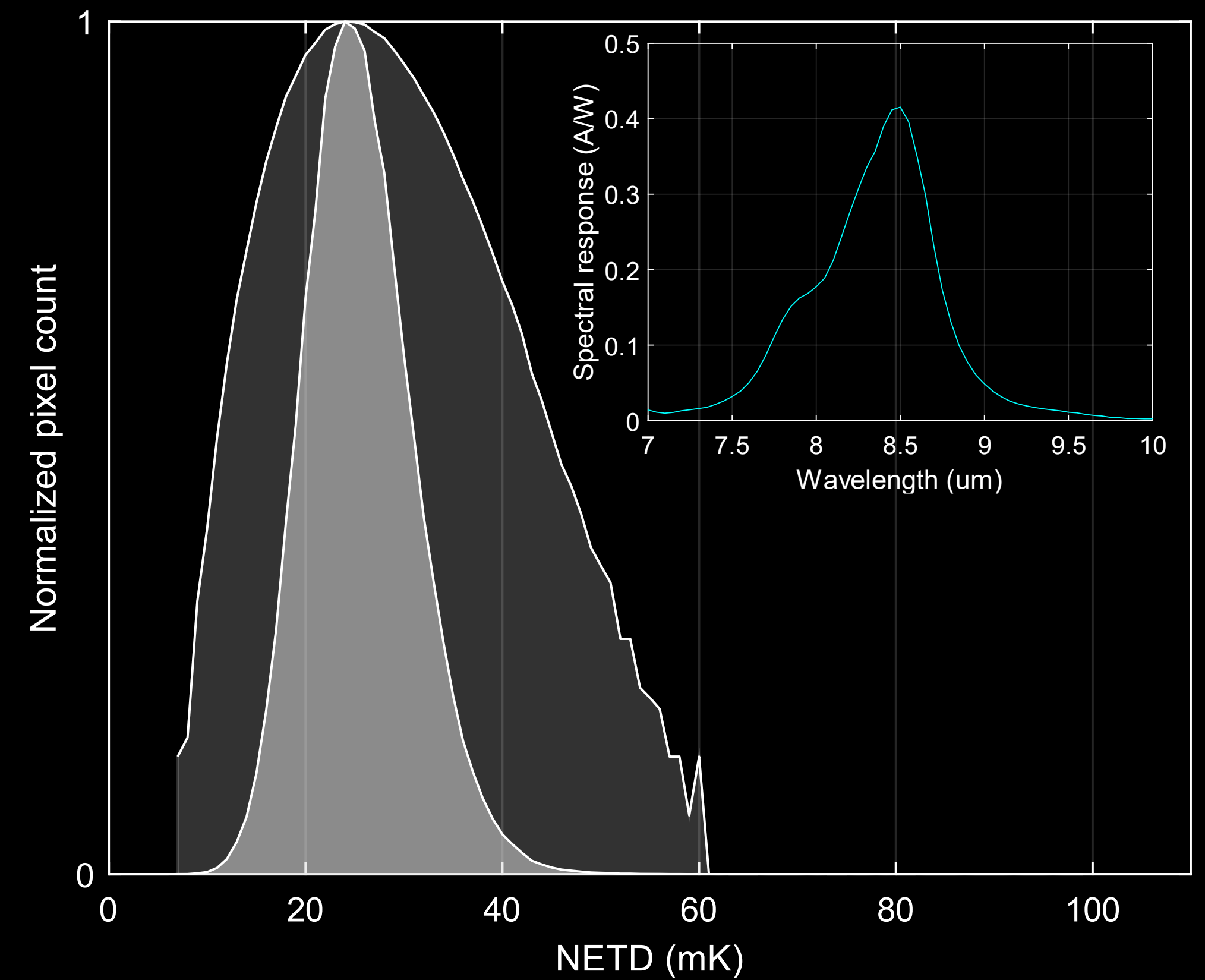
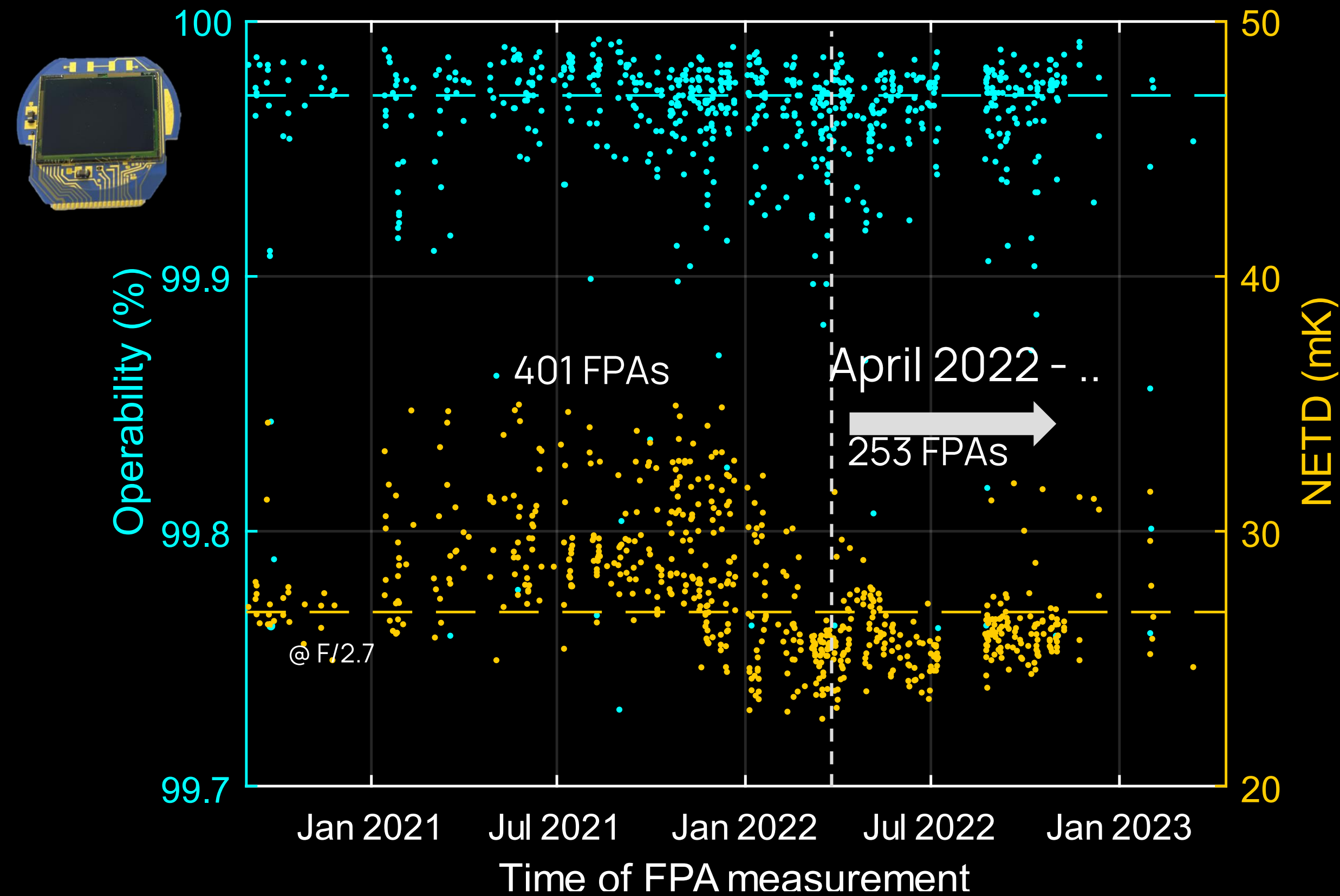
- 640- and 320- format resolution
- 15 and 30 μm pitch size
- Spectral range: 7.5 – 11 μm
- Operability > 99.8 %
- Highly stable correctability
- Integrated with 0.5 W cooler (RM3, K508)



Manufacturability of QWIP (production statistics)

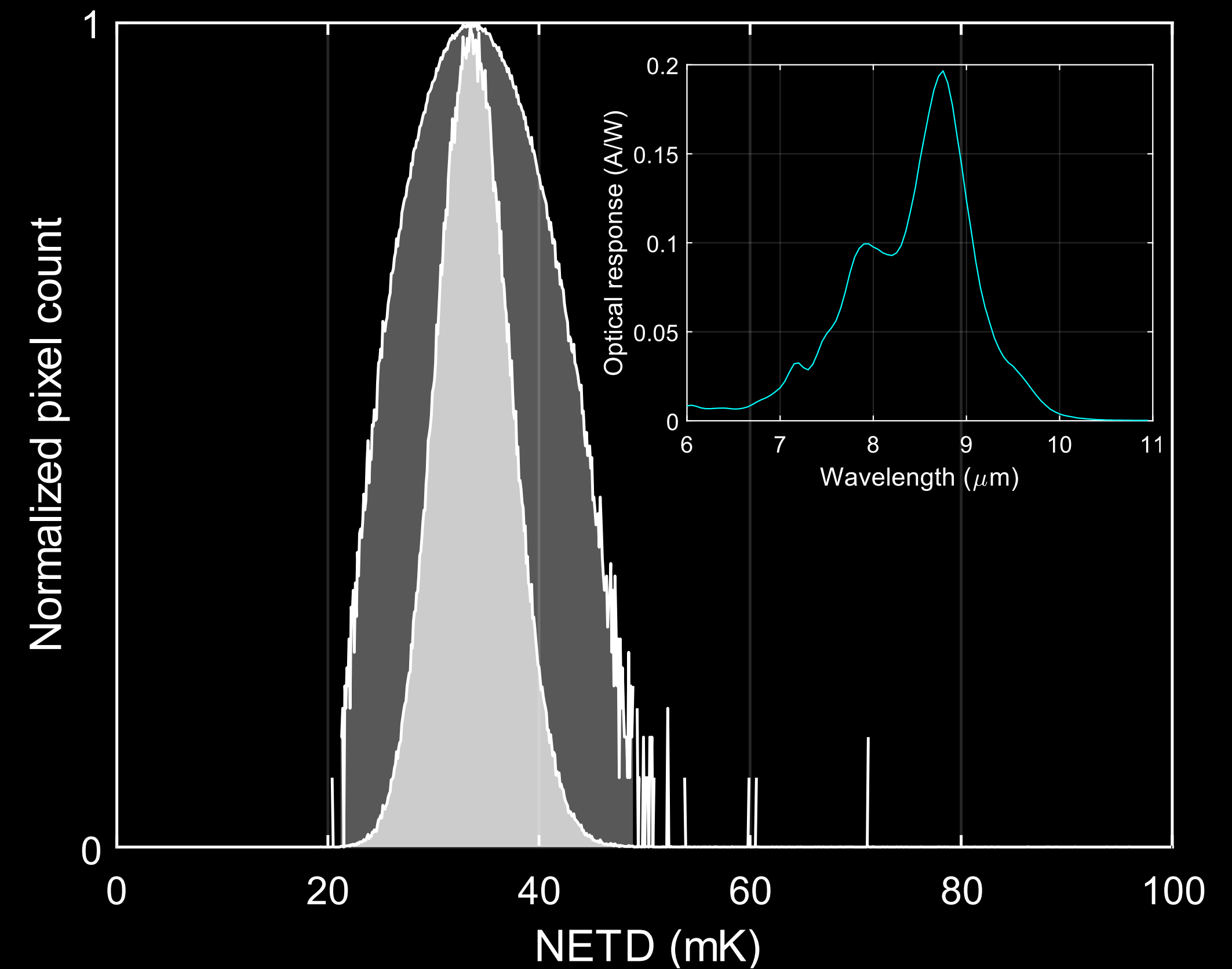
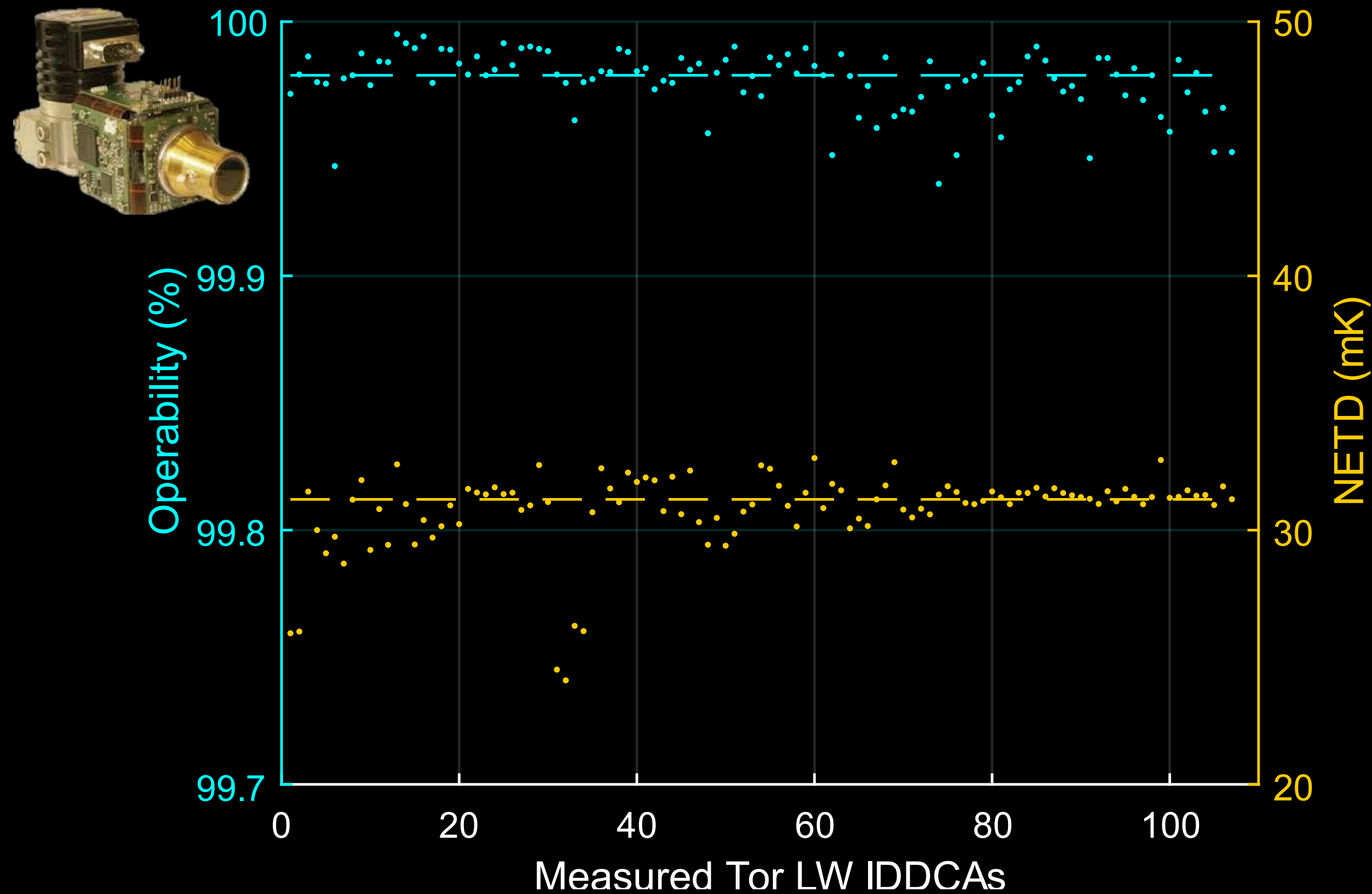
Manufacturability (#1): large-area QWIP FPAs

- LWIR (peak absorption @8.5 μm) QWIP detector on 4" wafer
- FPAs with 640×480 pixs @ 25 μm pitch: **large optical area, 16×12 mm**
- 654 delivered chips since September 2020



Manufacturability (#2-1): FPAs @ 15 μm pitch

- 640×512 pixels @ 15 μm pitch
- Tor LW IDDCA (F/2.24 / 60Hz)
- 107 delivered Tor in the past 6 months



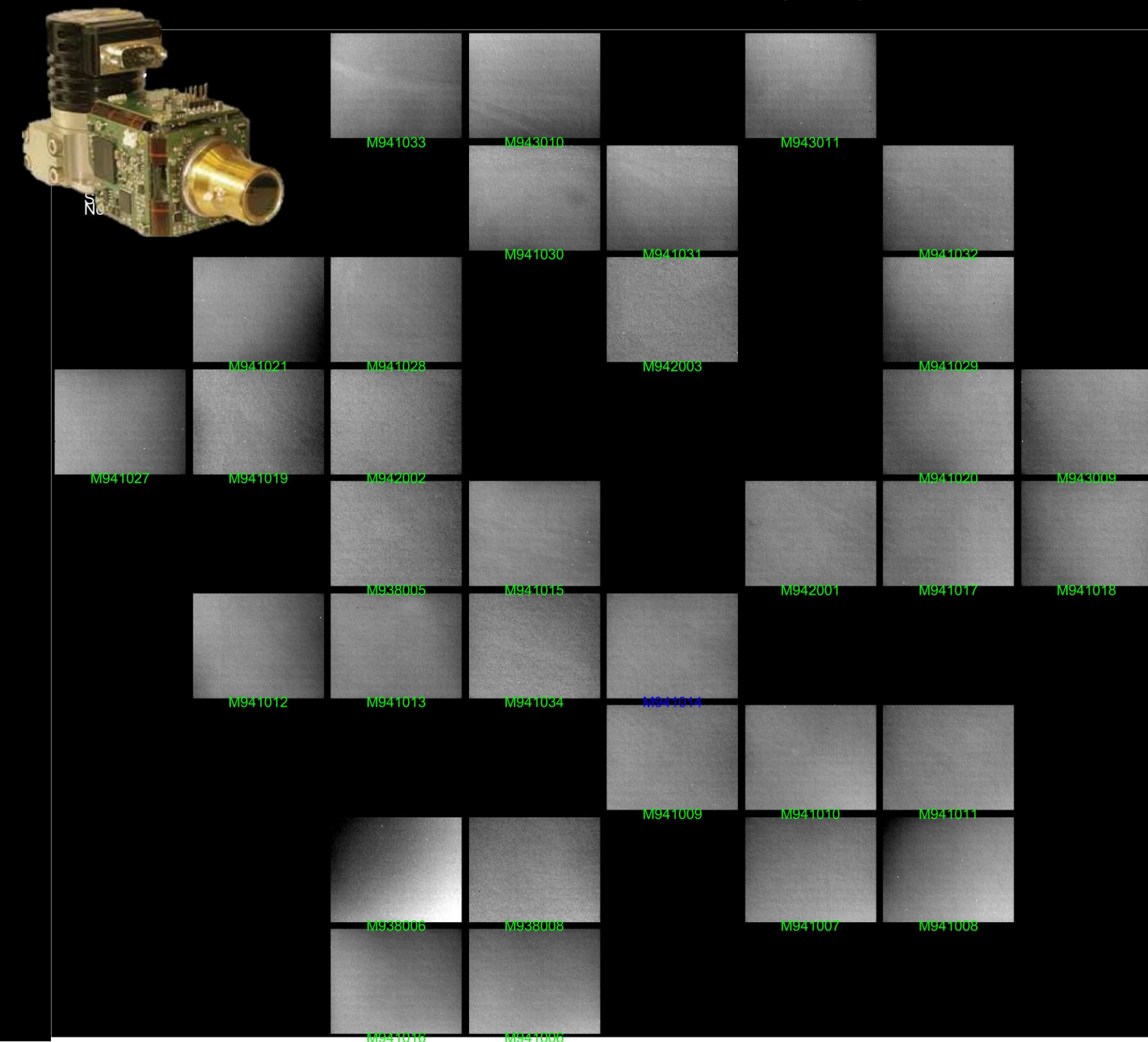
Manufacturability (#2-2): FPAs @ 15 μm pitch

- QWIP chip fabrication with uniform performance over 4" wafer
- High yield all the way to IDDCA level

FPAs before packaging

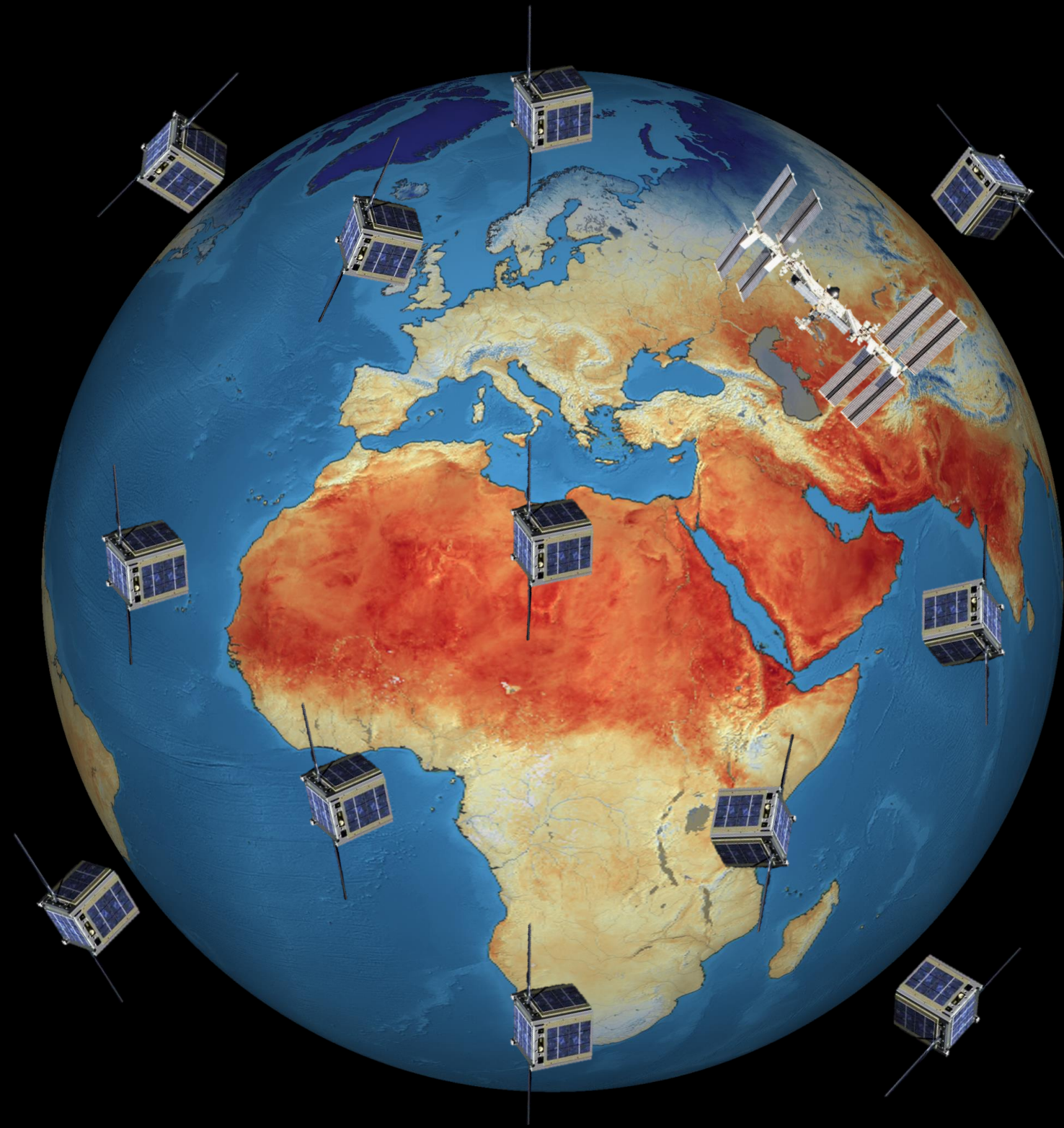


FPAs after packaging



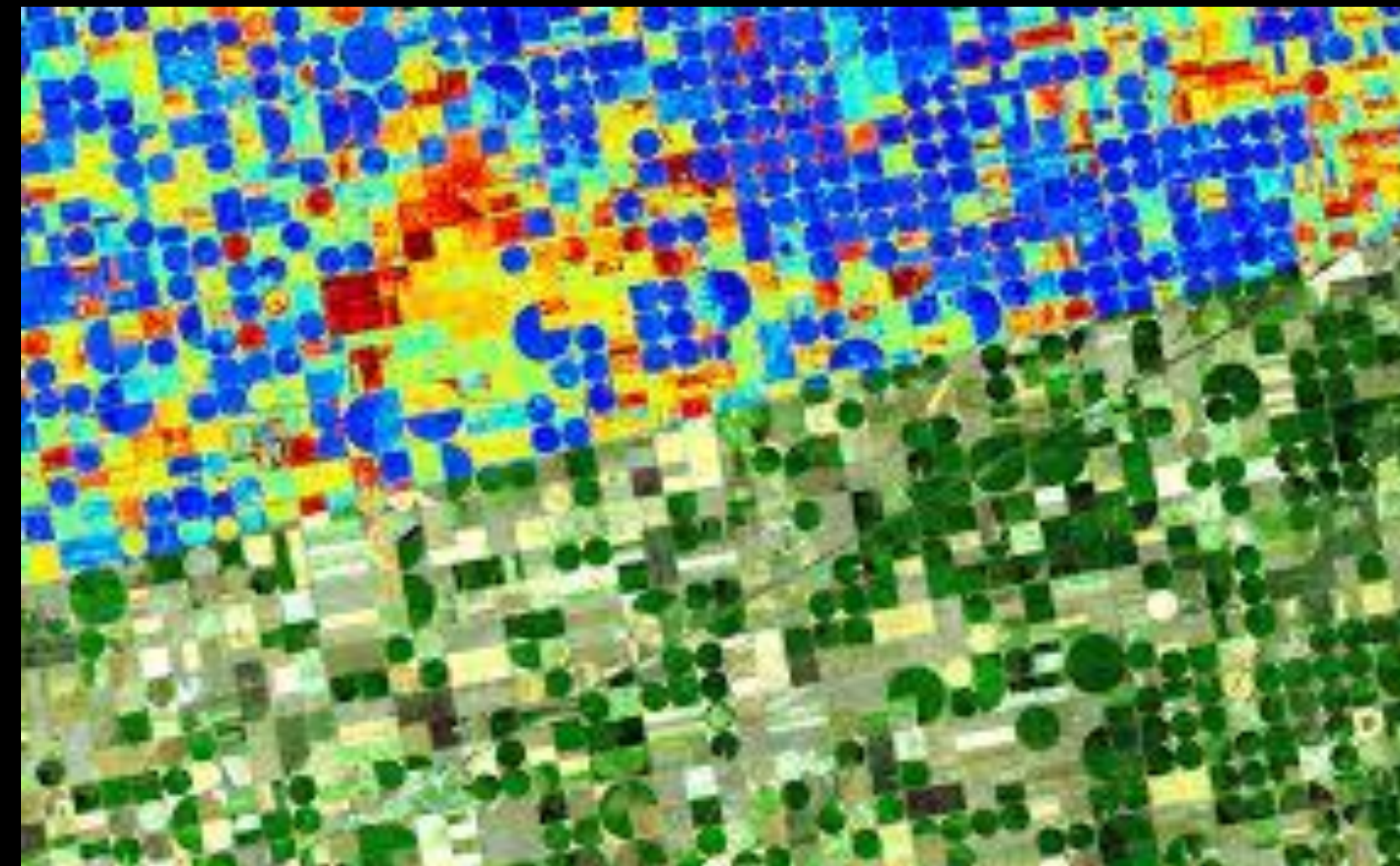
QWIP for dual-band LWIR radiometry in Earth Observation

LiSR... A first successful Space Rendez vous for IRnova



Goal: global water monitoring

- to mark water stress areas in agriculture
- Increase crop yield and optimize usage of fresh water

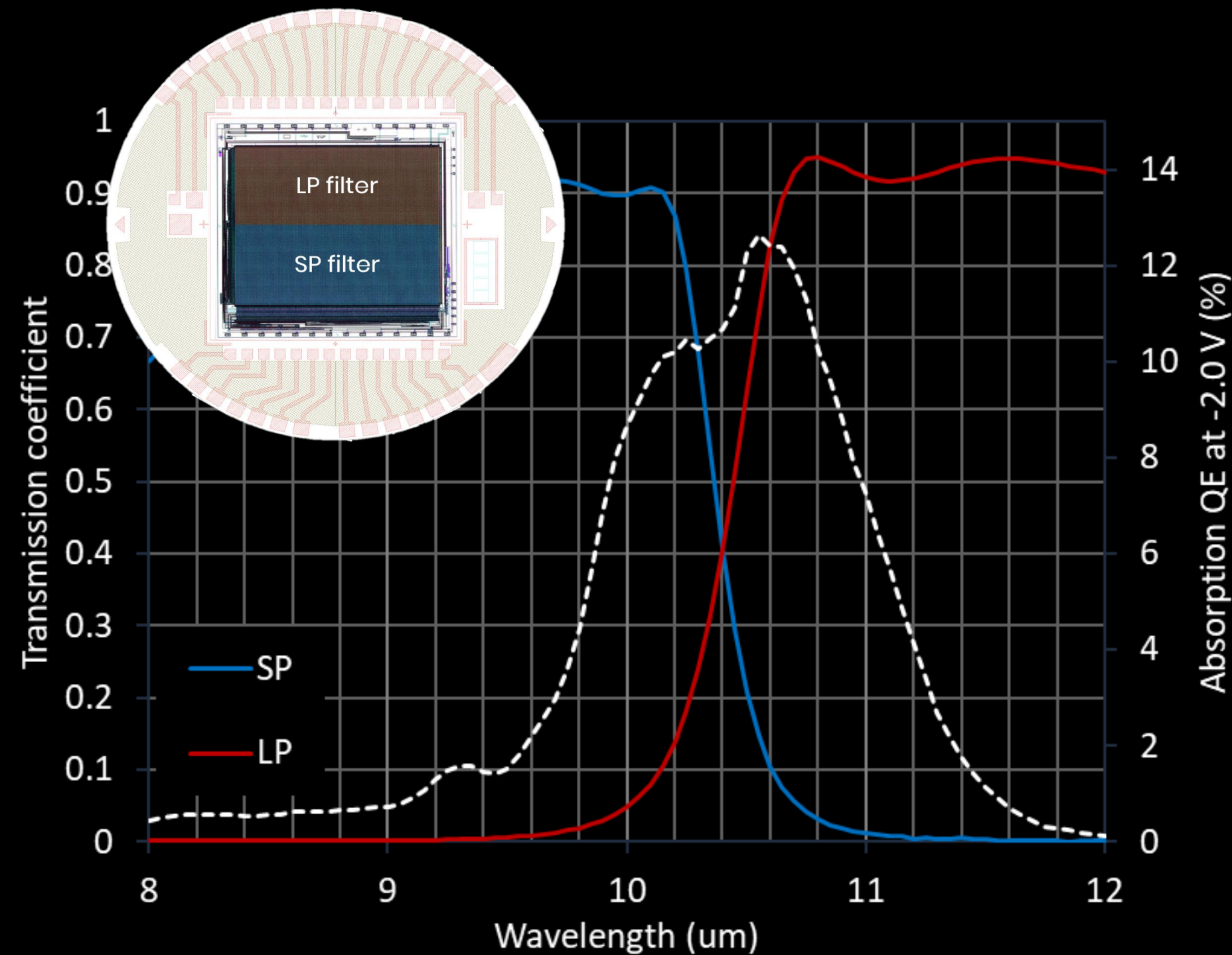


Challenge:

- Image in LWIR using dual-band mode
- Low-cost to keep affordable for constellation of CubeSats

*the image credits: [ESA](#)

AegIR: the detector solution for LiSR



- Customized using an off-the-shelf FPA
- 18 months from conception to mission launch



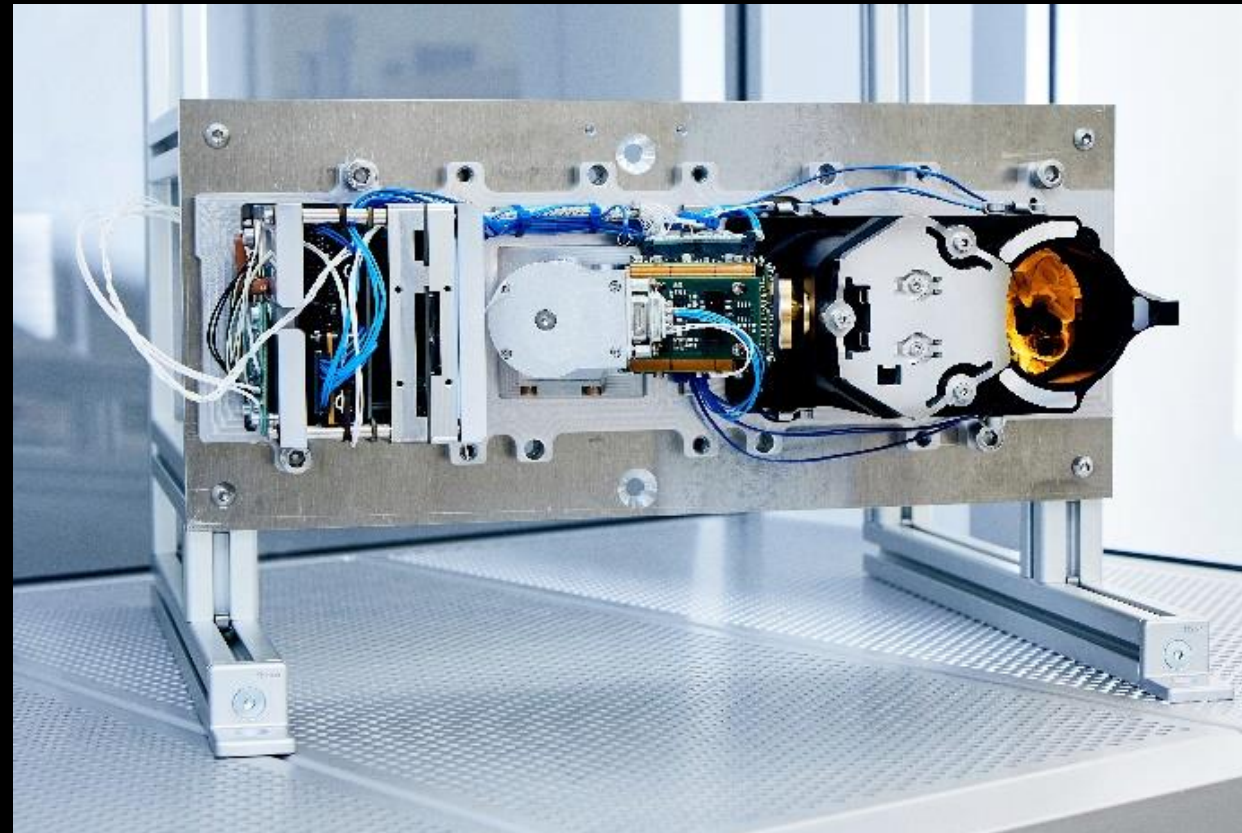
- Monolithically integrated bandpass filters
- 320x256 @ 30um pitch
- Spectral crosstalk = 10 %
- Operability: 99.79 % in LP band, and 99.65 % - in SP band
- NETD @ F/1.2 & 2 ms int. time: < 25 mK (for 18 °C BB)

In partnership with:

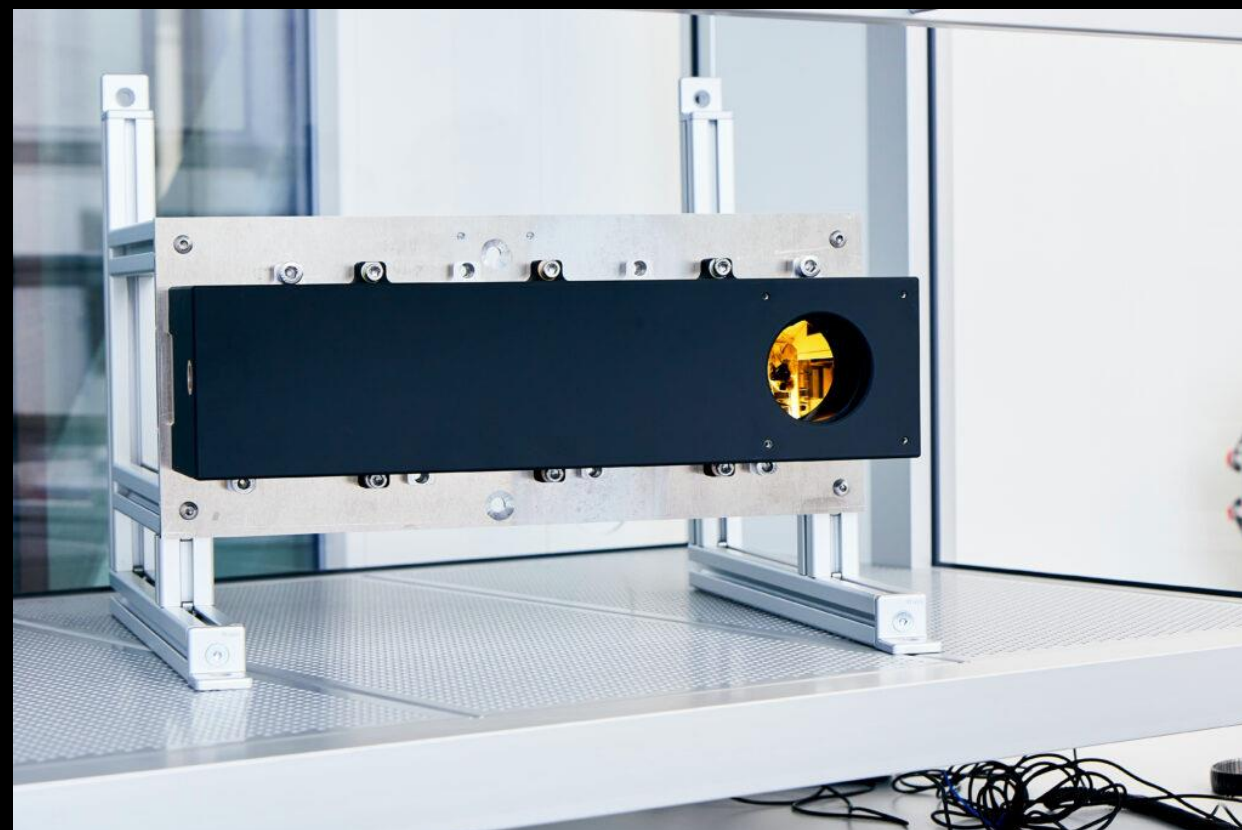
SPECTROGON

<https://www.spectrogon.com/>

19 months after PO signature – Aegir reached the ISS

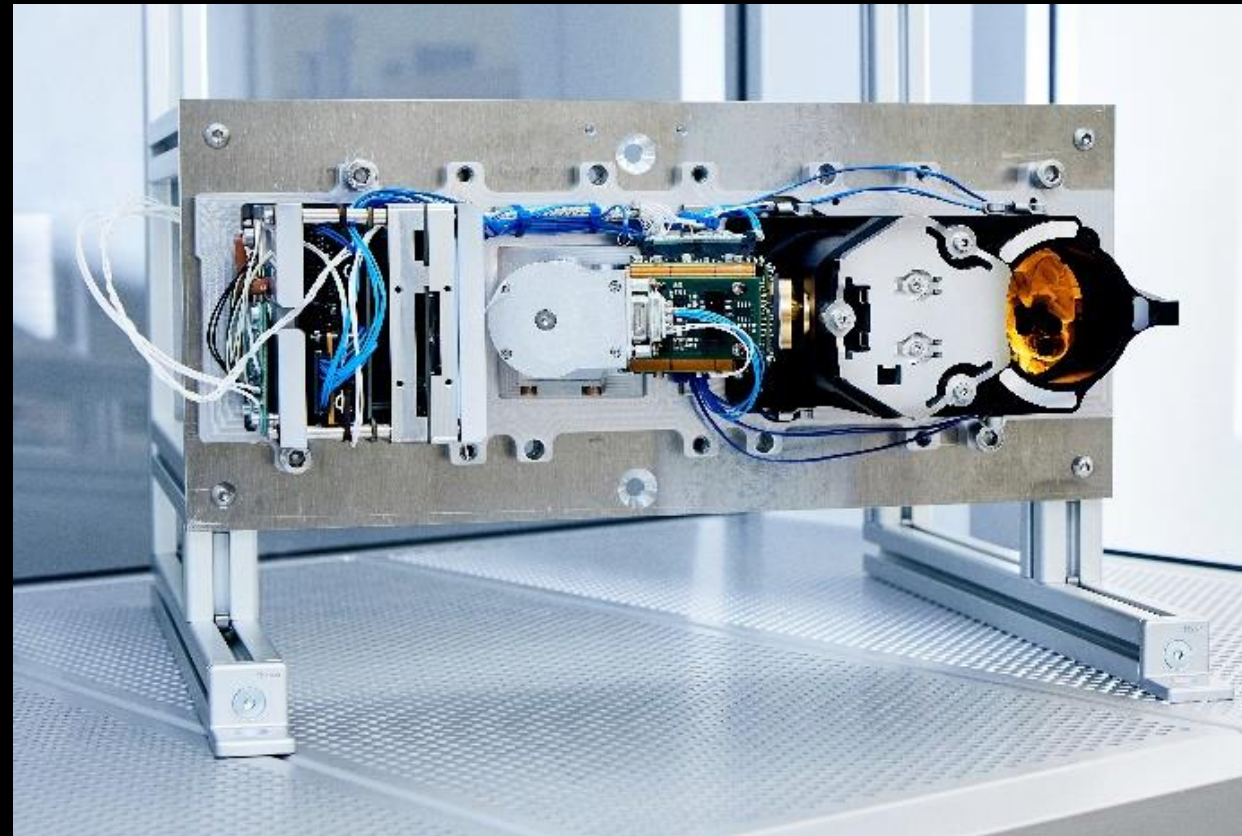


40×10×10 cm, 6 kg

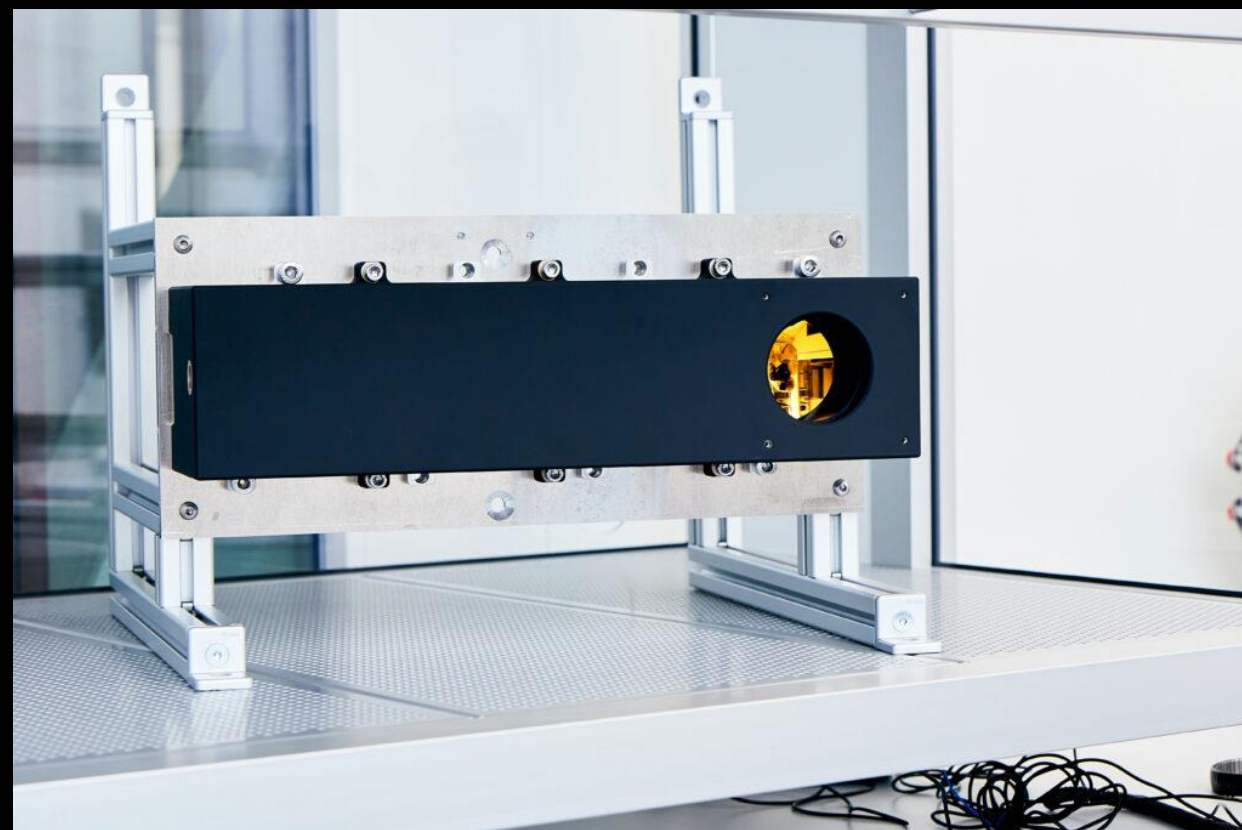


(Reached the ISS as part of Cygnus NG-17 resupply mission in March 2022)

19 months after PO signature – Aegir reached the ISS



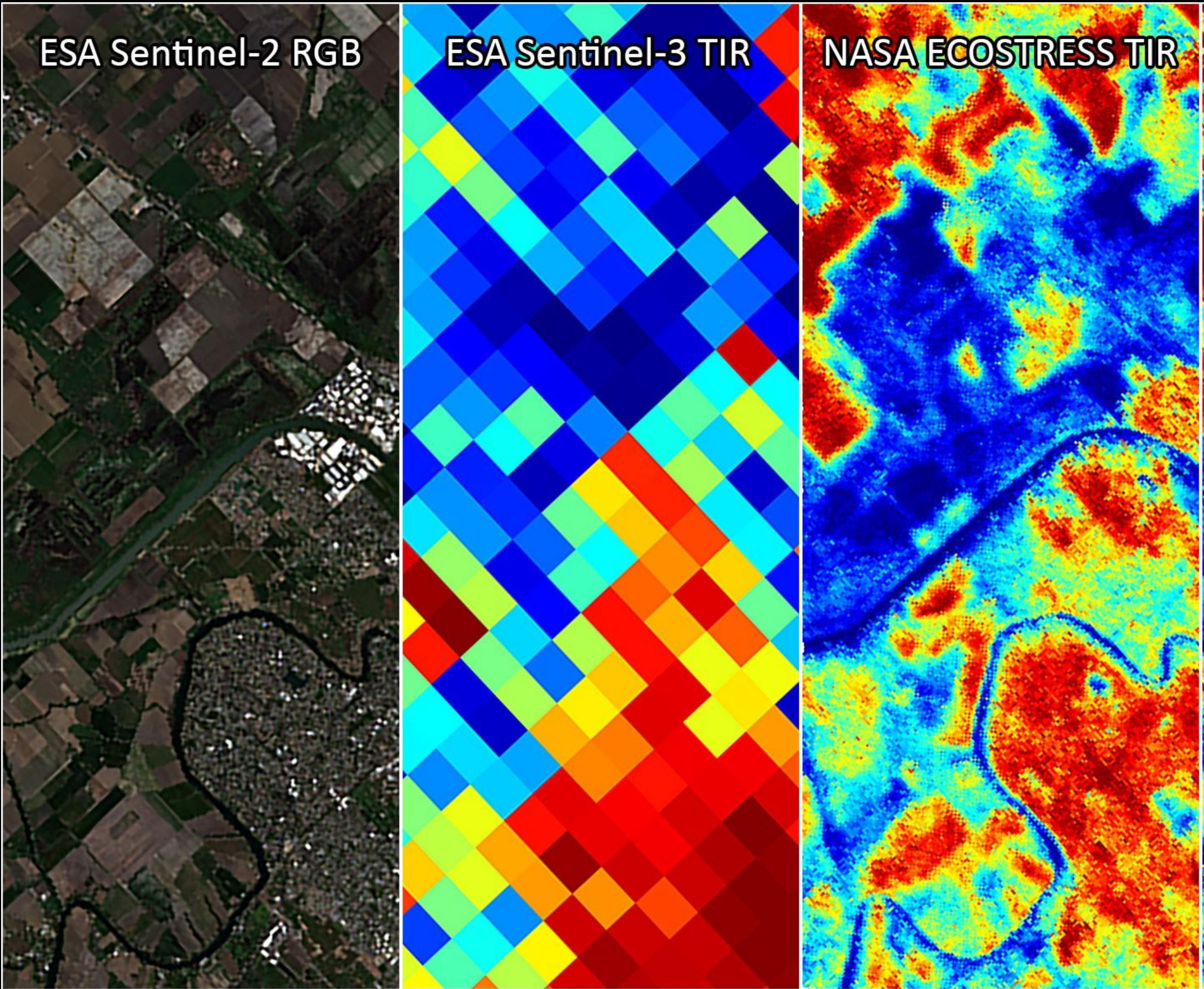
40×10×10 cm, 6 kg



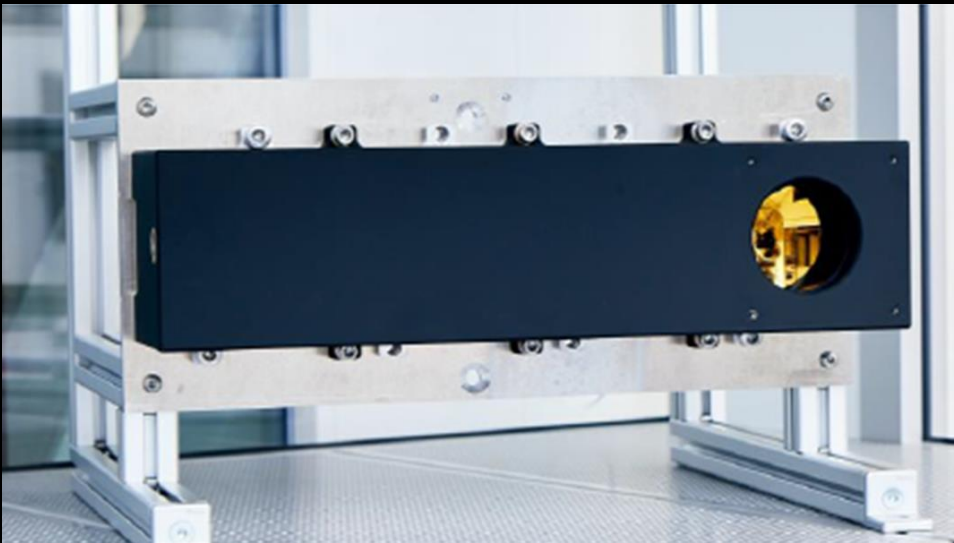
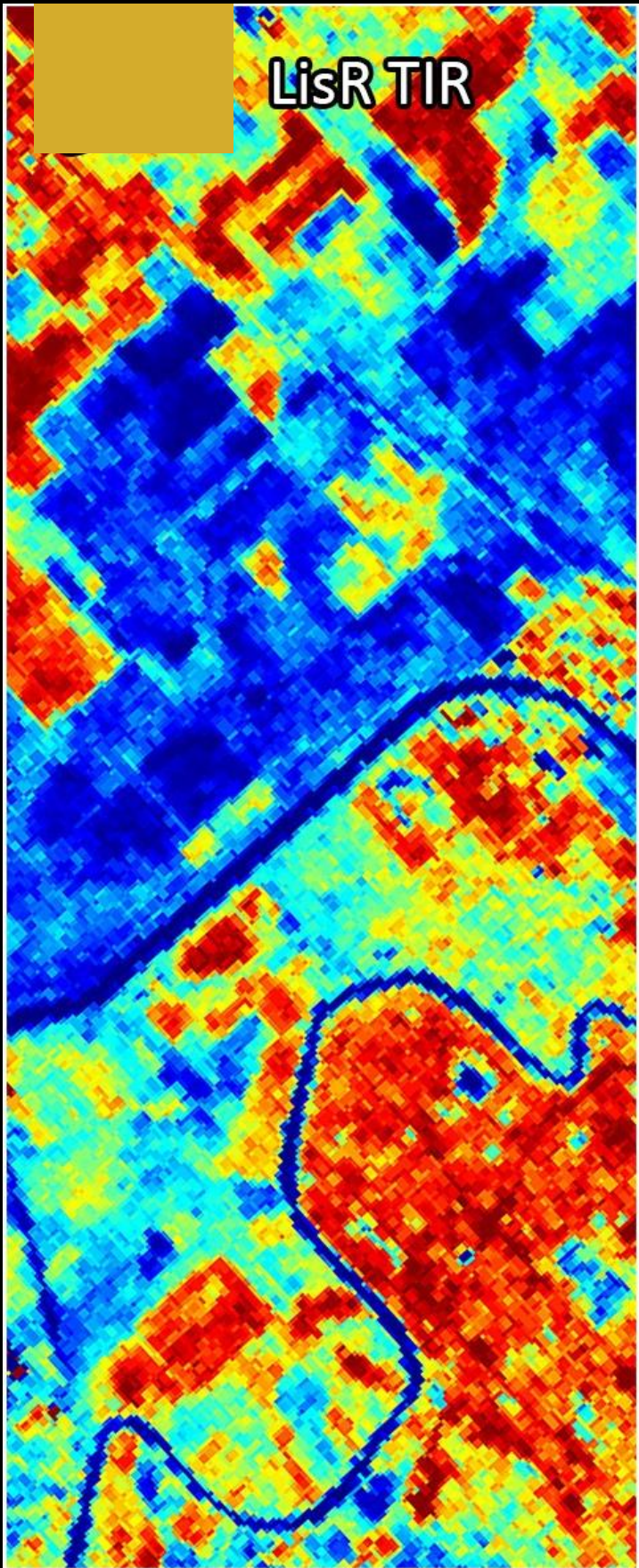
(Reached the ISS as part of Cygnus NG-17 resupply mission in March 2022)

LisR (with AeglR core): Imaging quality

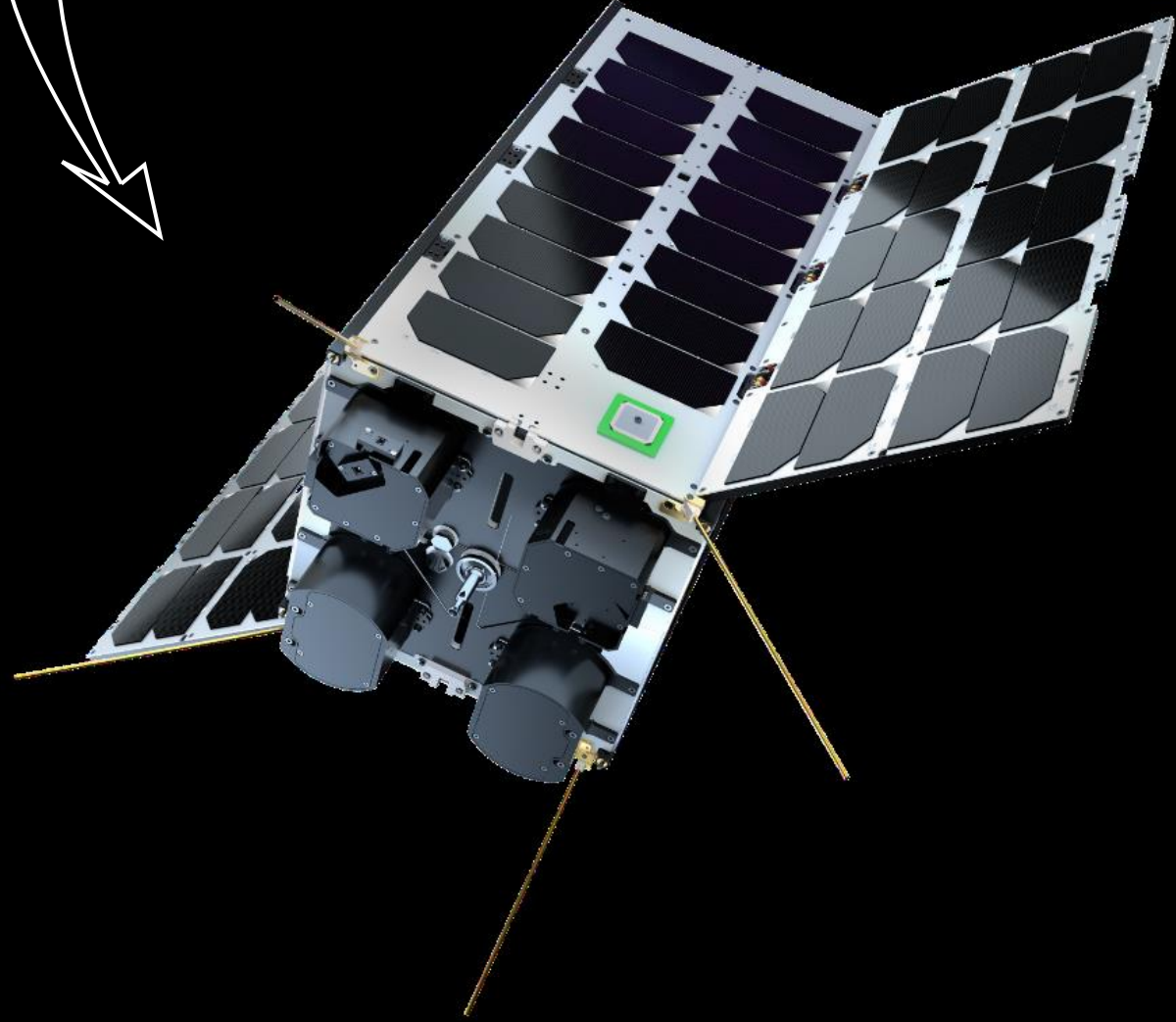
*Reference: previous missions



LisR with AeglR core



40×10×10 cm, 6 kg



*the image credits: Our customer

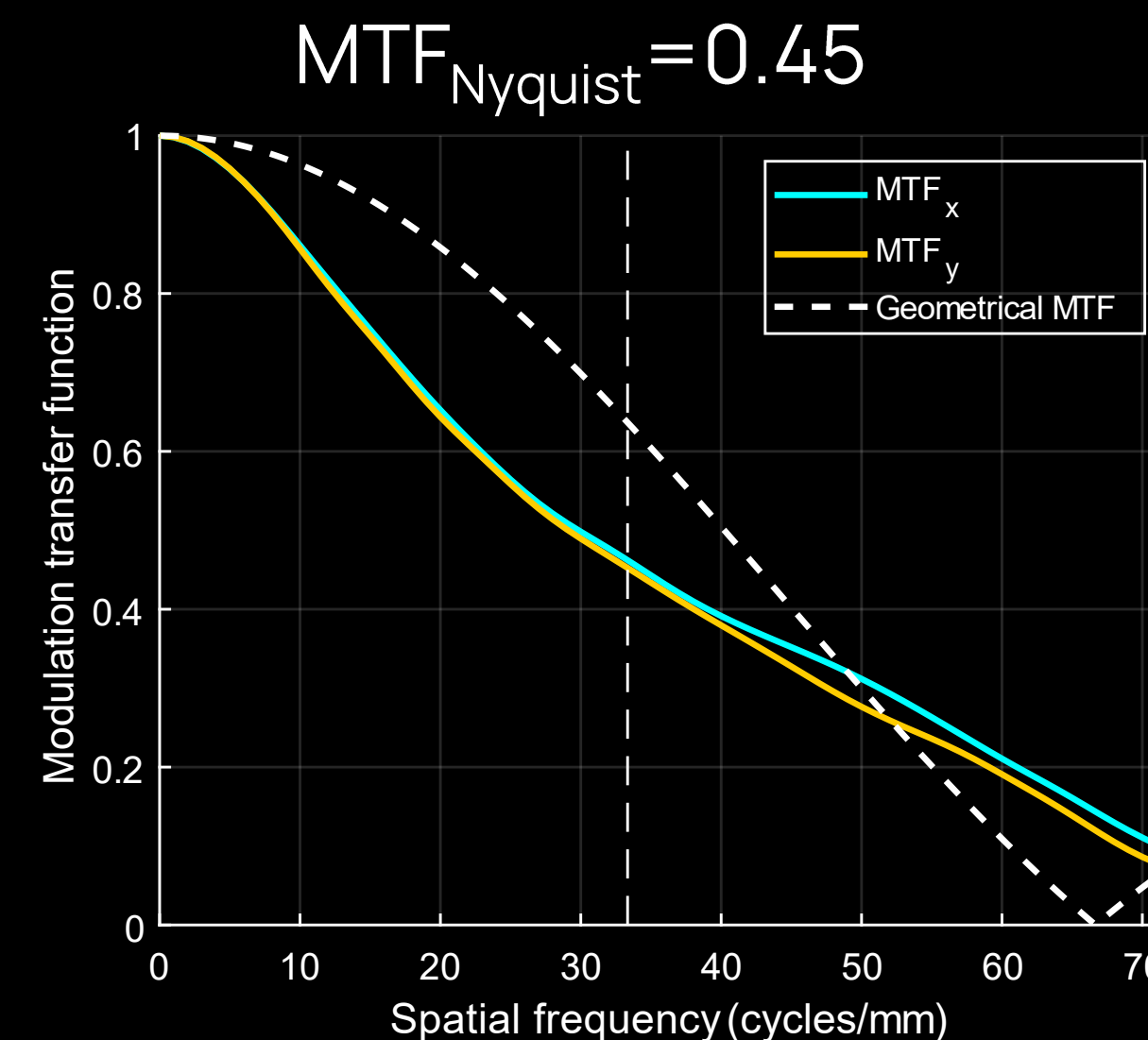
IRnova reached Space in 2022 And will be back up there with both T2SL and QWIP!



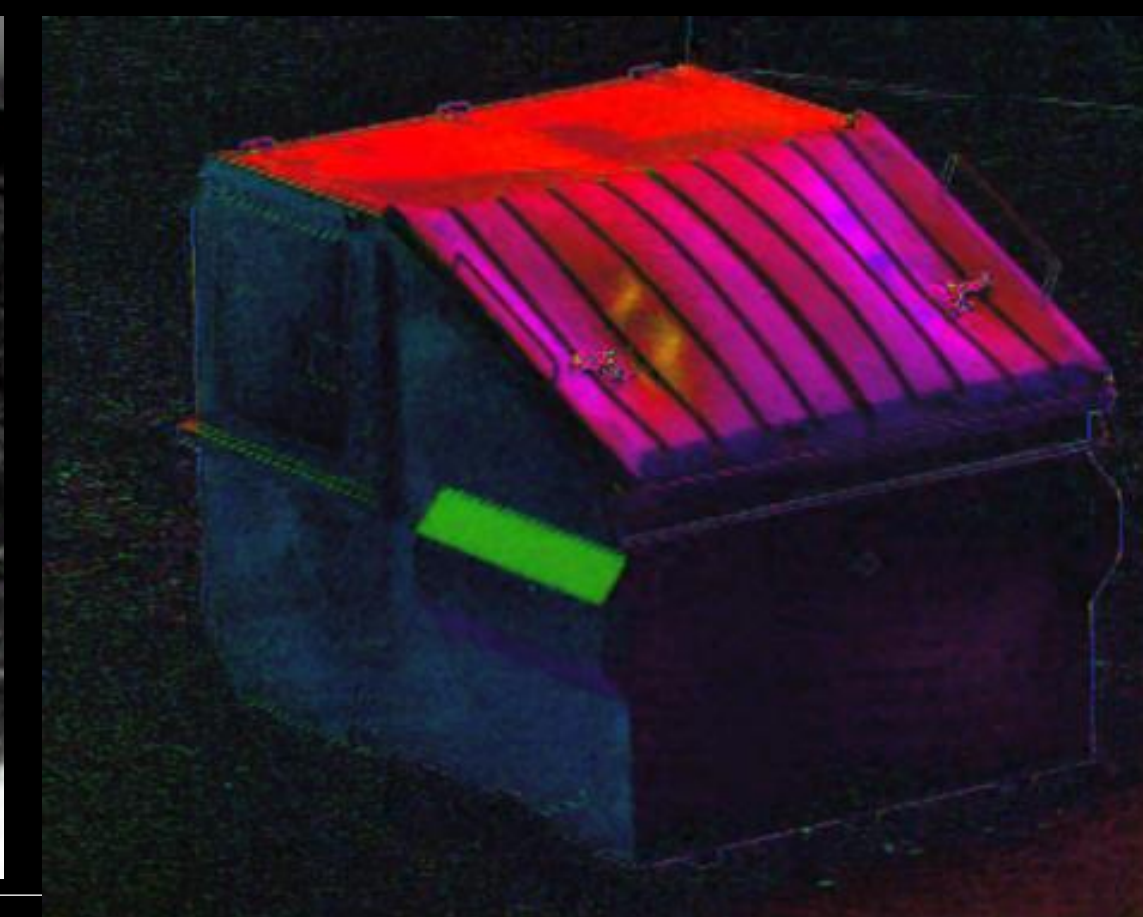
Aegir@IRnova Reached the ISS as part of Cygnus NG-17 resupply mission in March 2022

Conclusions

- High-volume production (VGA QWIP LWIR)
- Mastery of QWIP on 15 μm pitch
 - High-end thermal imaging ($\text{MTF}_{\text{Nyquist}} = 0.45$)
 - Advanced detection schemes (polarimetric)
- Dual band In Space, from PO to ISS... 19 months
- Ready for HD format
 - Pitch @ 10 μm , NETD ≈ 30 mK at F/2



640×512 LWIR polarimeter





IRnova