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QWIP and T2SL infrared detectors keep all their promises

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European Space Agency
Agence spatiale européenne

EPIC Meeting on New Space at European Space Agency
(12-13 September 2019)

European Photonics Industry Consortium

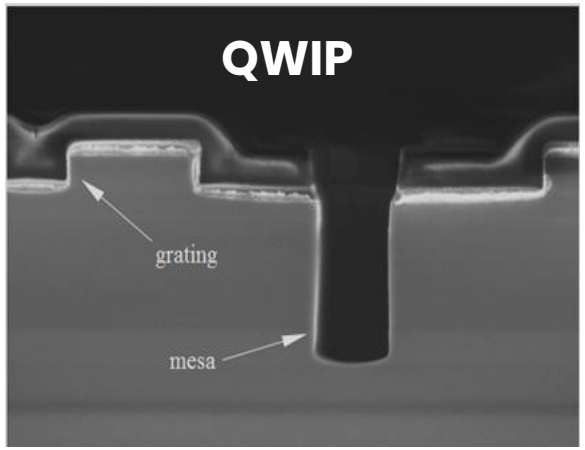
About IRnova

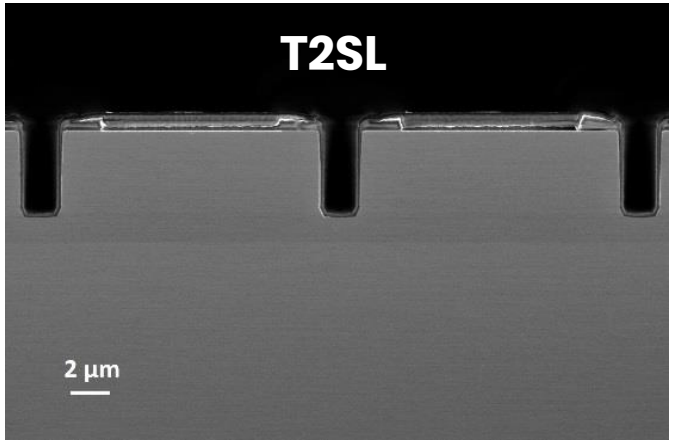
- **EU based IR detectors OEM Supplier** 🇸🇪
  - Independent and Privately owned
- **20+ years of IR sensor R&D and Manufacturing**
  - leading QWIP and T2SL detector manufacturing
  - Several 1000's of QWIP & T2SL detectors fielded
  - Contract manufacturing for III-V material and SWIR detectors
- **Pioneers 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 m^2 manufacturing facilities including 1300 m^2 of clean room

Kista (30km from Stockholm airport)

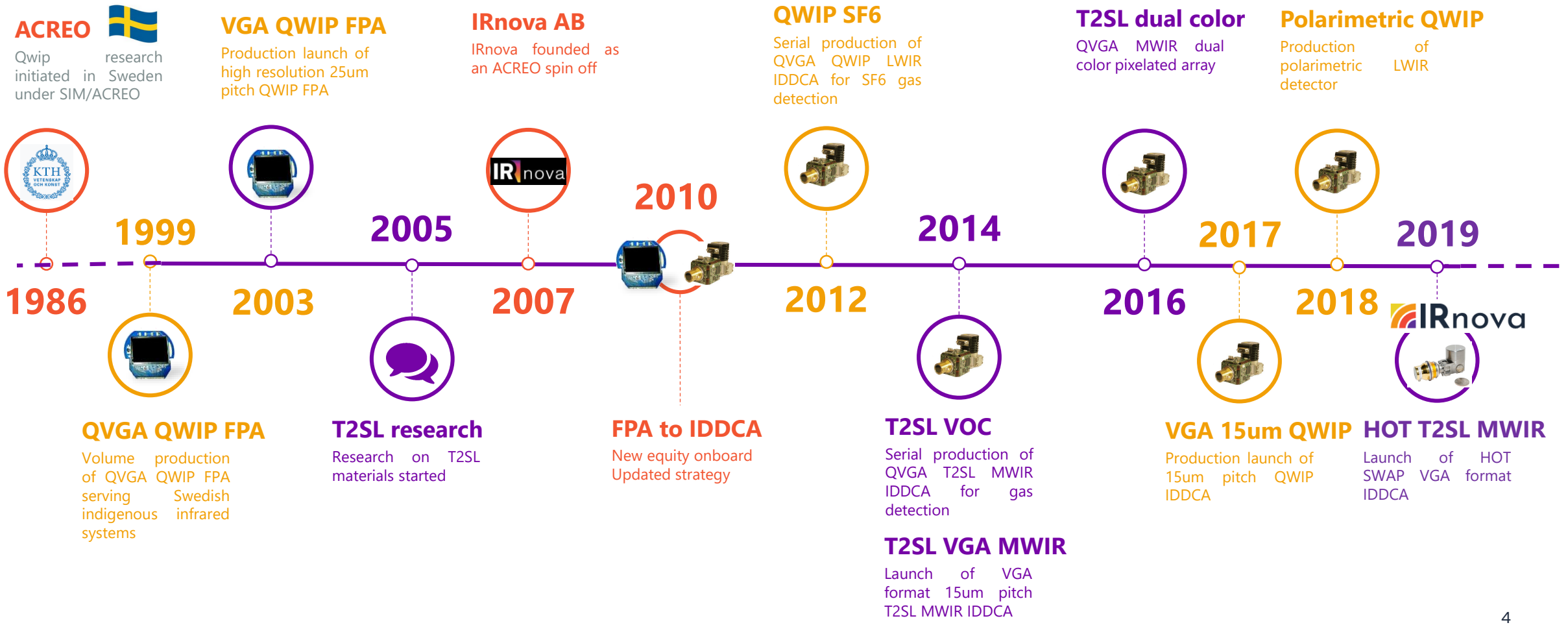
T2SL – QWIP

One team & One clean room

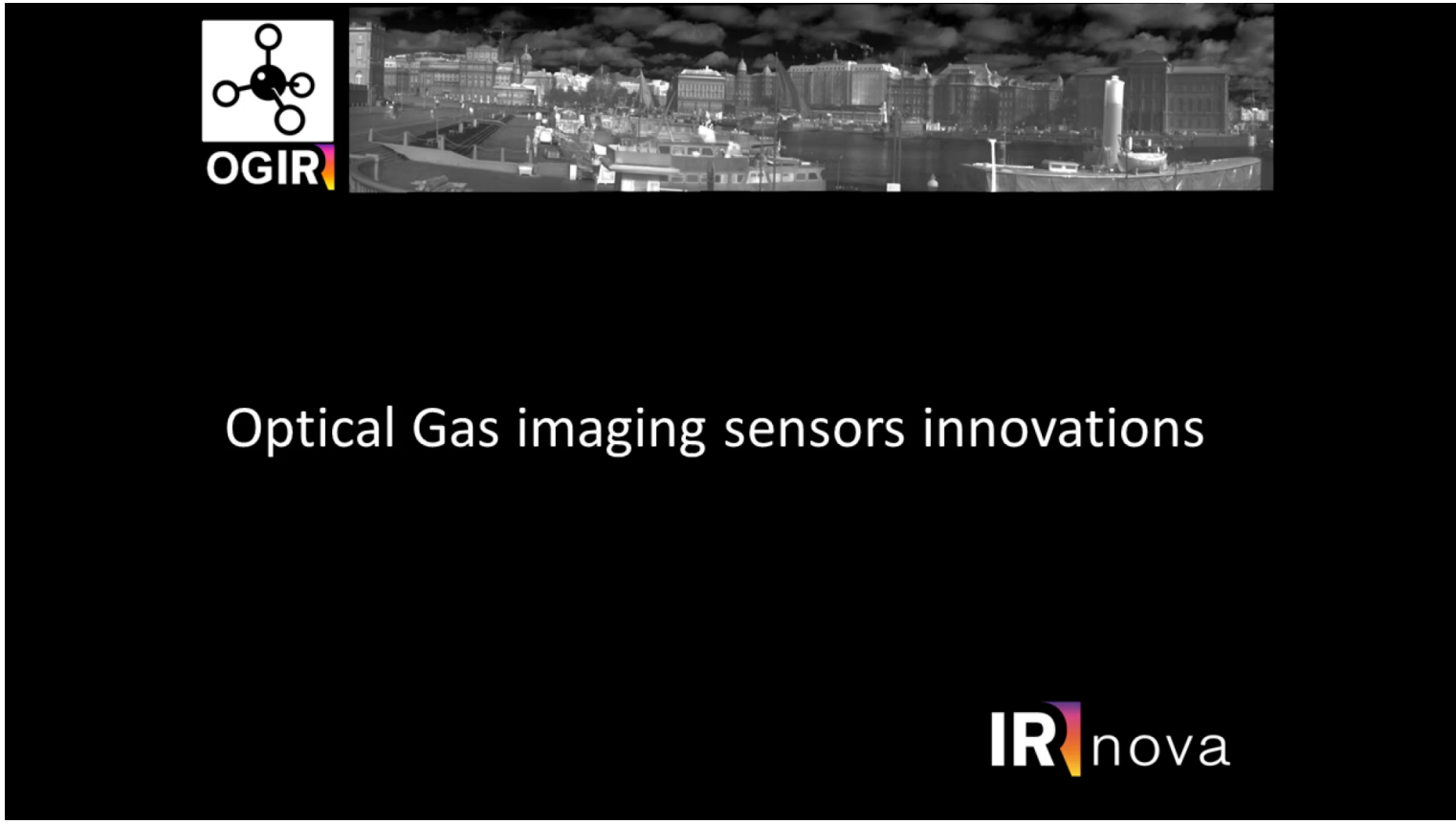




20+ years history at a glance



Already by our customers…



… In Hand Held camera, nevertheless….

…. we'll make our customer's camera even smaller with Oden MW –

- Demonstrated at SPIE baltimore Q1 2019
- SWaP F/4 IDDCA with Thales RMs1 cooler (Weight: 230 g, Power: 3.2 W)
- No compromise on image quality and performance up to 110K
  Temporal NETD = 21 mK, Spatial NETD: 7 mK, Integration time: 10 ms
- Planned release end of 2019

Roadmap

IRnova

Has to be Done

Done

Done

HD

HOT - SWAP

HOT - SWAP

VGA LWIR QWIP

VGA MWIR T2SL

VGA HOT MWIR T2SL

RED HOT – DEEP BLUE

HD 1280 LWIR T2SL

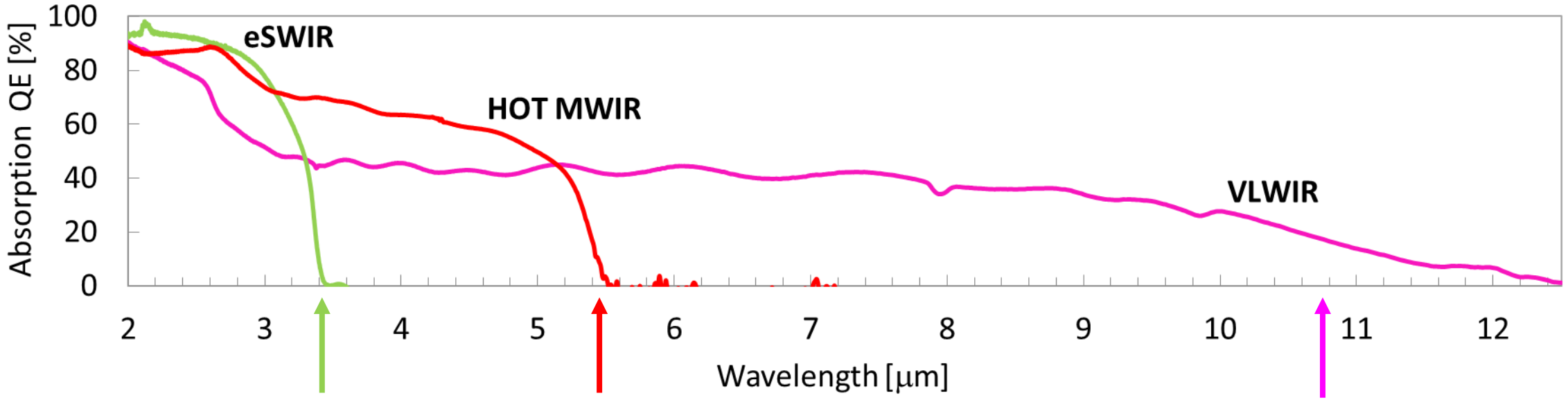
HD 1280 MWIR HOT T2SL

2018

2019

2020 ....

Ongoing R&D projects at IRnova



eSWIR (Extended SWIR imaging for space applications)

Objective: To design and fabricate a T2SL detector structure suitable for space eSWIR applications

Funding: 170 kEuro from Swedish National Space Agency

HOT MWIR (Superlattice-based HOT MWIR imaging sensors)

Objective: To optimize the passivation of the **RED HOT** detector for operating temperatures up to 130K

Funding: 190 kEuro from Vinnova = Sweden's innovation agency

VLWIR (Low dark current VLWIR T2SL infrared detectors)

Objective: To develop, fabricate and test T2SL detector arrays with 11.5 µm and 14.5 µm cut-off wavelengths

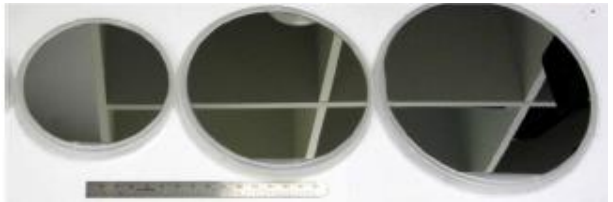
Funding: 960 kEuro from ESA End Q1 2020

T2SL activities in United States

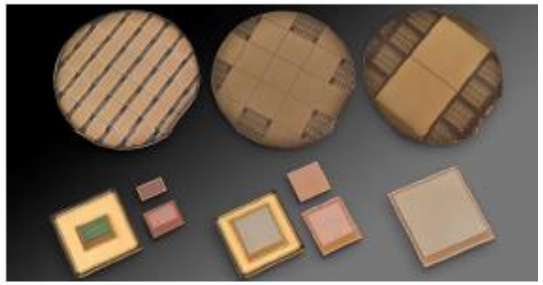
IRnova

Industry consortium

3-5” GaSb substrates



640x480 → 4kx4k FPAs



Military funded VISTA organization

T2SL detector designs: JPL, NRL

Industry consortium

Digital ROIC: MIT Lincoln Laboratory

GaSb Substrates: Galaxy/Intelliepi

Epi foundries: IQE/Intelliepi

Analog ROIC: Raytheon Vision systems

Dual band / LW Fabrication Teledyne, HRL, Raytheon

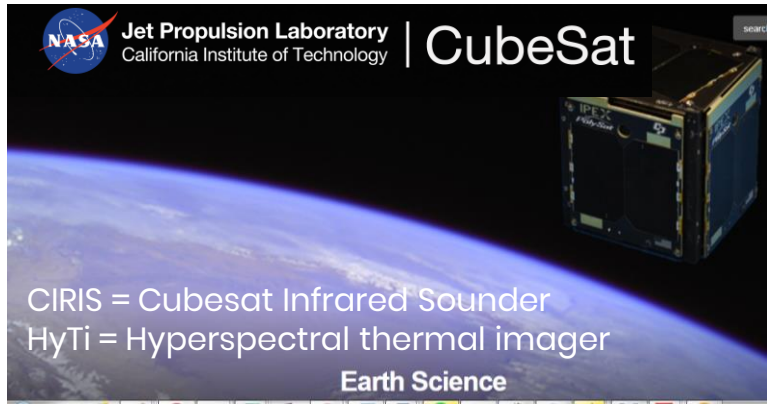
HOT MWIR Fabrication Lockheed Martin, SBF, HRL, L3, Raytheon

LW: VGA→2kx2k 20→5 µm pitch

Dual band MW/LW: VGA→720x1280 20→ 12µm pitch

HOT MWIR: VGA→4kx4k 25 → 5 µm pitch

Now included in space programs and military programs



EPIC General Assembly April 2017…. …. Still the same claim 2.5 years later

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HOWEVER….

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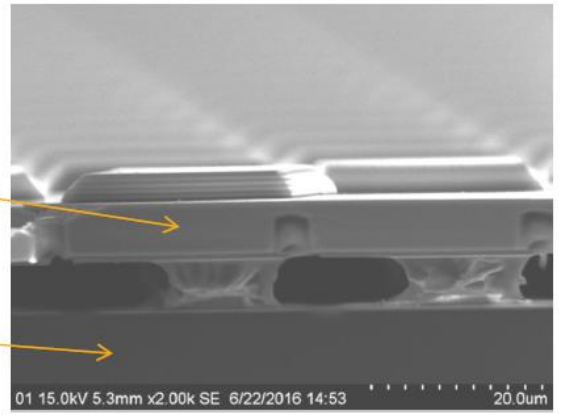
… 2 key components in our products are still not available in Europe

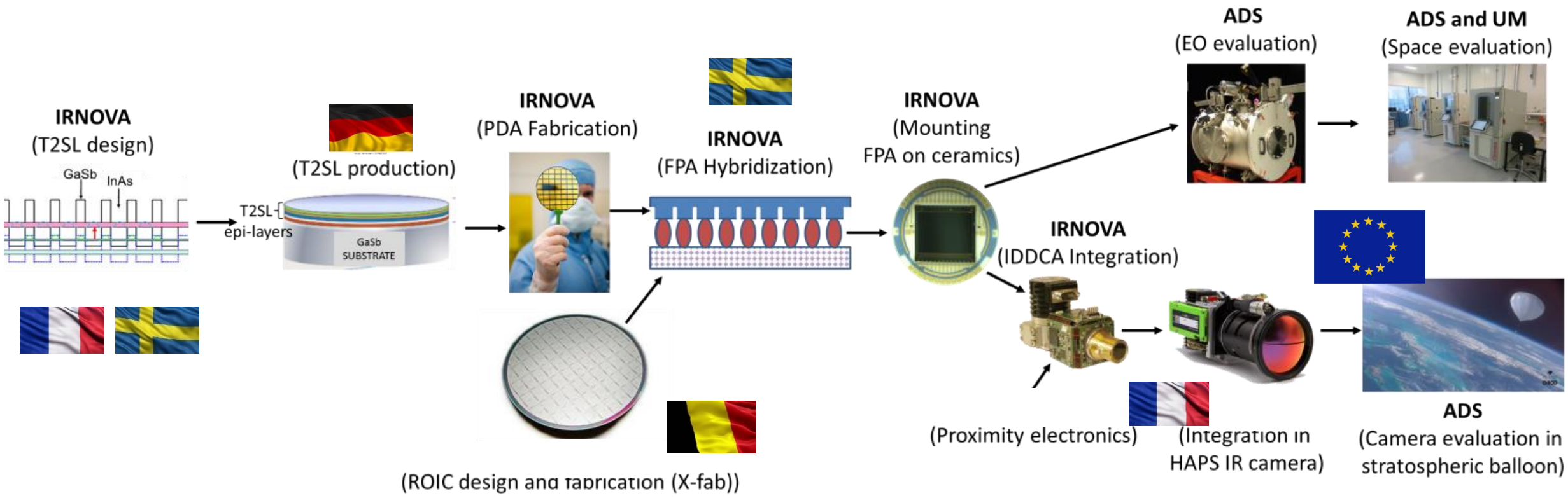
- **III-V epitaxial wafer**
- **Read Out Circuit**



We get both knowledge and know how in Europe, we just need to join our strengths in order to stay/become independent for every key technologies

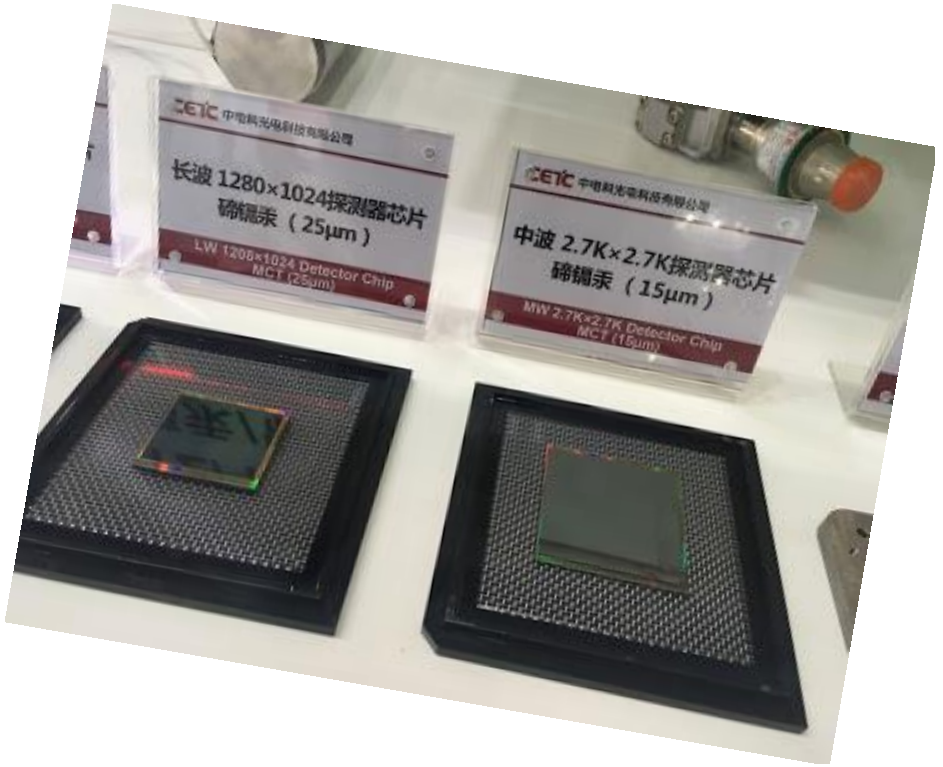
EPIC European Photonics Industry Consortium **is a fantastic tool for reaching our independence**

Trying to build a T2SL supply chain …
with H2020 funding through a HD detector goal for Space need



rejected twice… in 2018 and in 2019 … 2.5 years have passed….
and during this time….

… Even China is growing up…



…. up…. up…… !

Summary

- T2SL is the solution for SWaP, we have it

- RED HOT SWaP IDDCA
  - 20 mK NETD @ F/4
  - High performance up to 120K
  - Oden Release December 2019

- DEEP BLUE SWaP IDDCA
  - 160 K, F/4, 20 mK
  - First prototype December 2019

Any interest for New Space ?


IRnova
INFRARED DETECTORS

ESA funding for VLWIR T2SL …

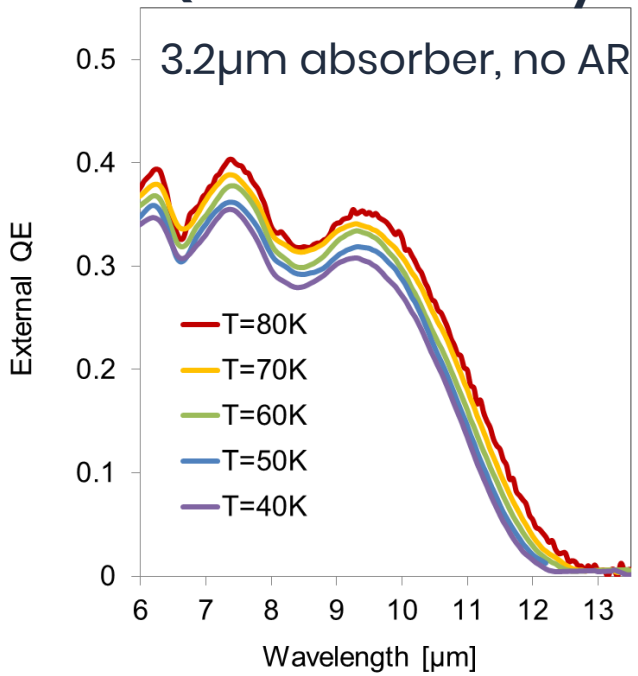
- IRnova – **Design, fabrication, photodiode and FPA characterization**
- ies l'institut d'électronique – **MBE growth development, material characterization**
- AIRBUS DEFENCE & SPACE – **Extensive electro-optical FPA characterization**

State of the art performance:

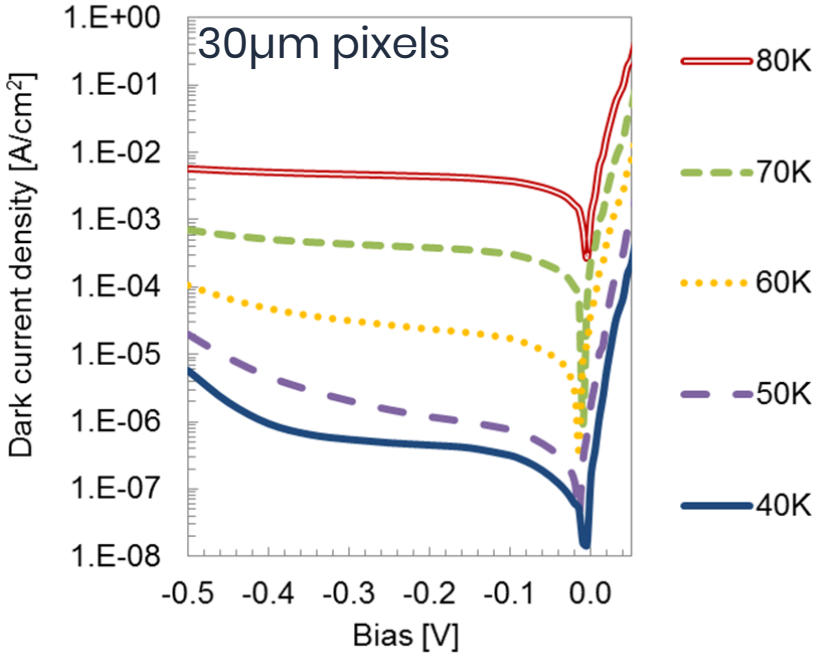
- QE up to 60% (with AR)
- Low dark current
- pixel to pixel uniformity

R&D FPA format: 320x256 pitch 30um

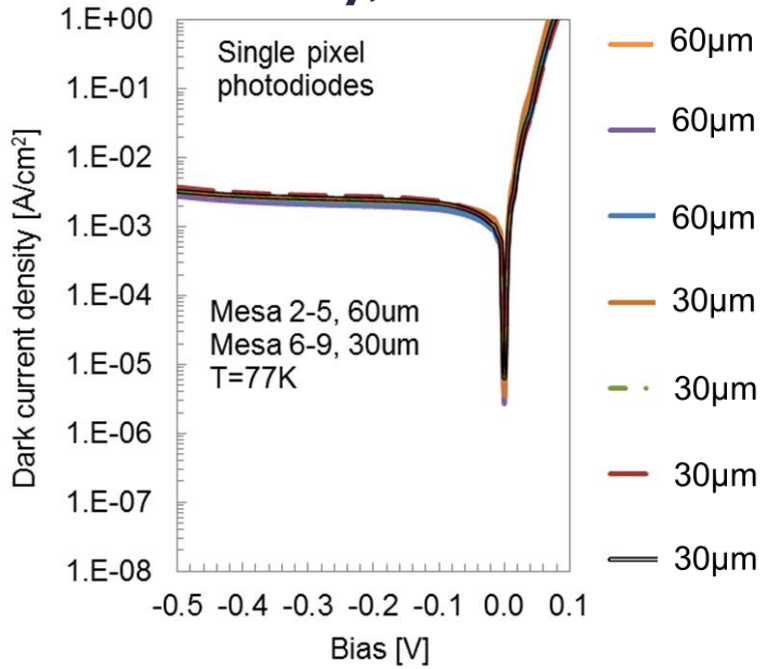
Quantum efficiency:



Dark current density:



Uniformity, dark current:



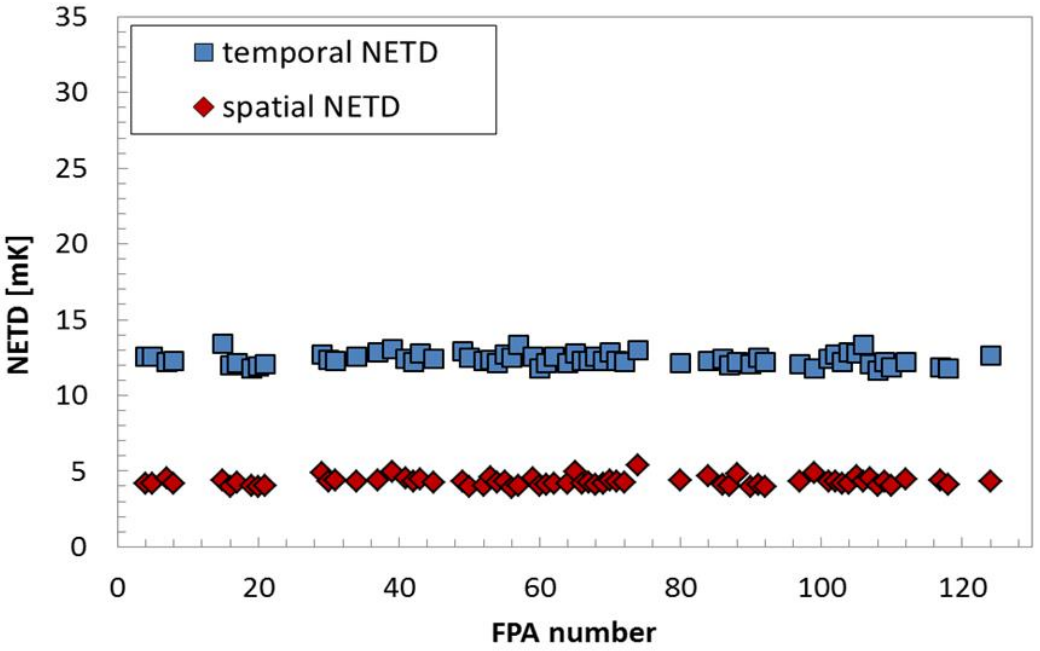
General Purpose IDDCAs

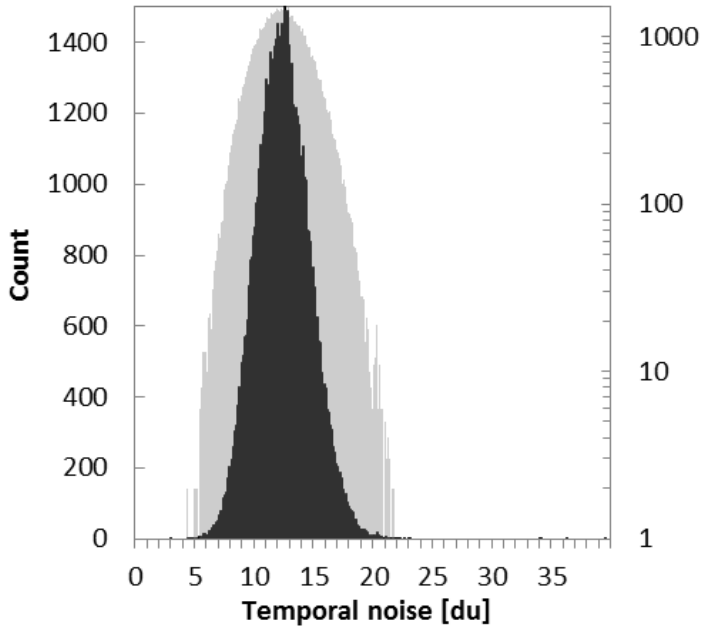
	**Brage LW** *QWIP*	**Tor LW** *QWIP*	**Heimdall MW** *T2SL*	**Dag MW** *T2SL*	HOT - SWAP  **Oden MW** *T2SL*	
λ (µm)	7.7<>9.1	7.7<>9.1	3.7<>5.1	3.7<>5.1	3.7<>5.1 Red Hot 110K	3.7<>4.2 Deep blue 150K
Array	320x256 30µm	640x512 15µm	320x256 30µm	640x512 15µm	640x512 15µm	
NETD	20 mK	25 mK	15 mK	20 mK	20 mK	
F/#	F/2 F/1.2	F/2 F/1.2 F/2.24	F/4 F/2 F/1.2	F/4 F/2 F/1.2	F/4 F/2 F/1.2 F/5.5*	

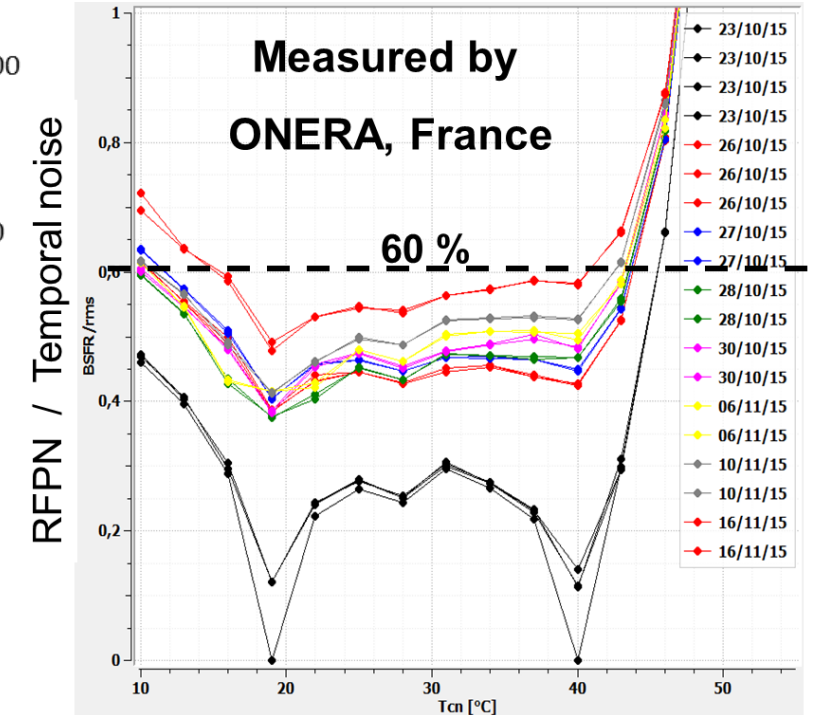
T2SL – high performance, reproducibility and reliability

IRnova has been manufacturing QVGA MWIR T2SL FPAs since 2012 and have experienced:

- Good manufacturability
- Low noise, narrow noise histograms
- Great long term stability



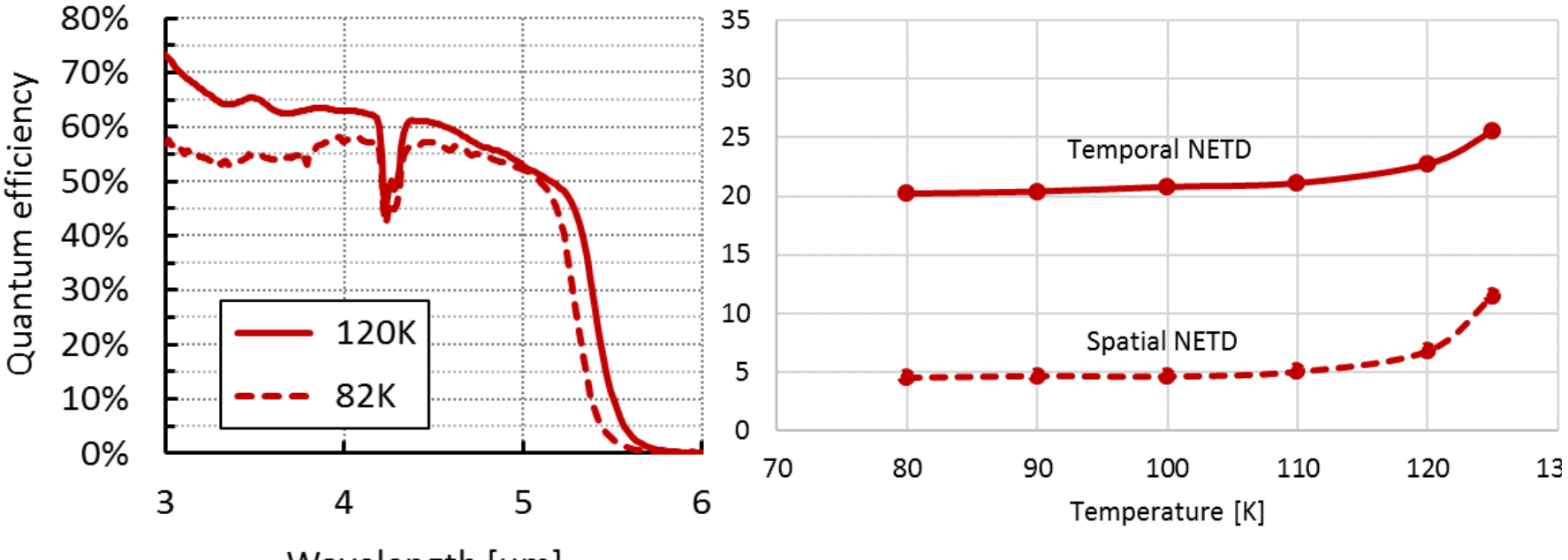


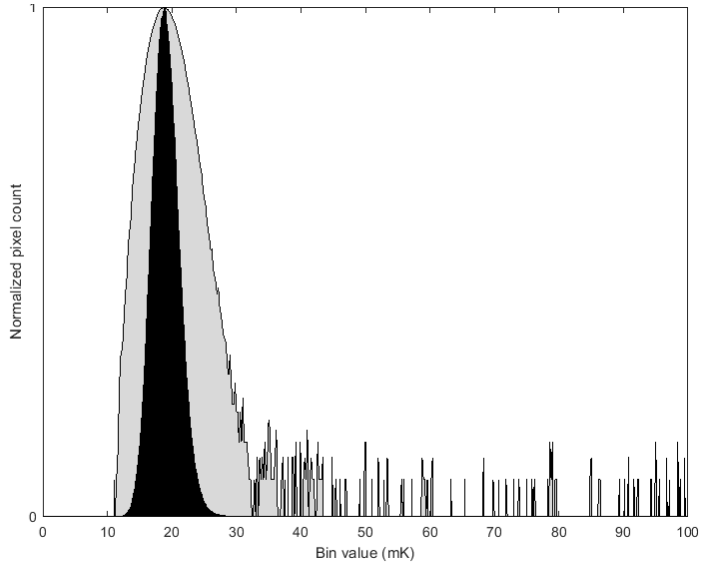


T2SL activities at IRnova

Main focus is on VGA format with SWaP capability

- New design has enabled **high QE** (60% single pass)
- SWaP capability with:
  - Size: **48×44×98 mm**
  - Weight: **230 g**, Power: **3.2 W**
- Low NETD: **21 mK at F/4, 110 K, 10 ms** integration time
- Narrow noise histogram





Gas and pollution detection

One IDDCA, multiple configurations

	Integrated proxy board
Power	<7W (12VDC)
Cooler	Stirling Rotary
Cool down	< 6 min
Video Interface	LVDS Camlink*
Control interface	I2C
Frame rate	Proxy Max 60Hz

	Embla 1055 *QWIP*	Idun 1055 *QWIP*	Freja xxx *T2SL*
Detection	**SF6**	**SF6**	**VOCs**
λ (µm)	10.55	10.55	On demand
Array	320x256 30µm	640x512 15µm	320x256 30µm
NETD	25 mk	25 mK	15 mK
F/#	F/2	F/1.2	F/2 F/1.2

This presentation was presented at EPIC Meeting on New Space 2019

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