IRnova

MWIR T2SL
The infrared breakthrough

T2SL material introduction

T2SL (Type II Super Lattice), sometimes also called SLS (Strained Layer Super-lattice) is an emerging technology for making the highest quality infrared photon detectors. It has numerous advantages to the preceding technologies including:

- Tailored wavelengths from 1.5 µm to 30 µm covering SWIR, MWIR, LWIR & VLWIR.
- Exceptional uniformity which reduces costs for camera design & calibration.
- Higher operating temperatures which reduces size, weight and power consumption.

Compared to other infrared detectors made of bulk material (alloys of different compounds), a superlattice detector is made of a repeating sequence of thin layers (a few nanometers) of different semiconducting materials. The result is an artificial bulk material with a cut-off wavelength (band gap) that can be tailored by the thickness and composition of the individual layers. For infrared detectors, longer cut-off wavelengths are obtained for thicker layers in the superlattice, while shorter cut-off wavelengths are obtained with thinner layers. The use of band gap engineering also create opportunities for affordable dual-color or multi band detectors.

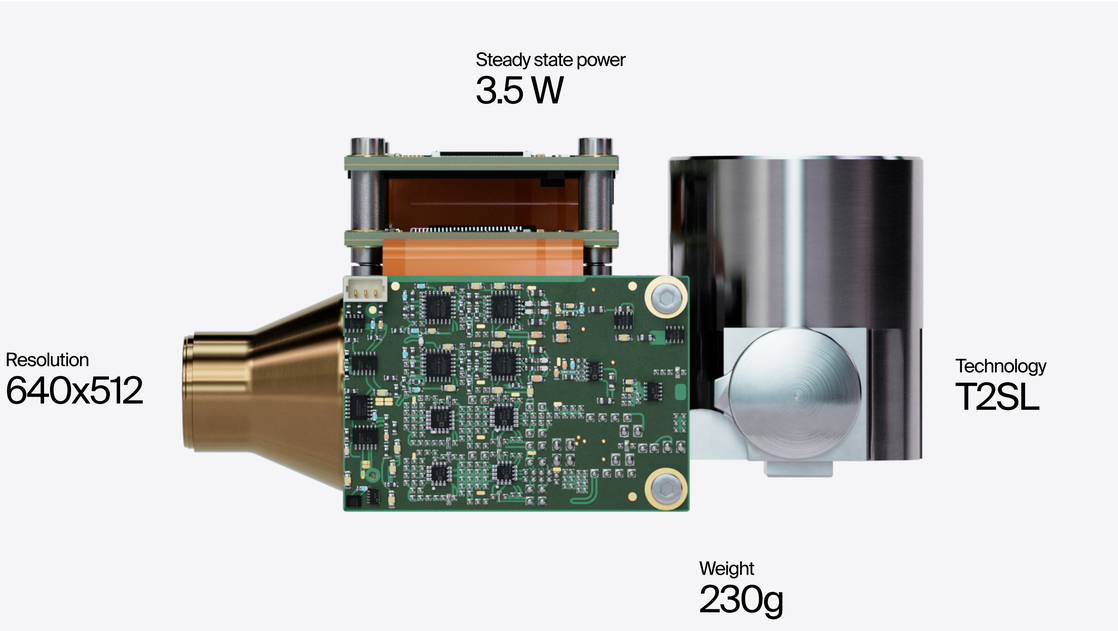
Key advantages of T2SL MWIR

When looking specifically at the MWIR wavelength, T2SL has decisive advantages over older technologies like Mercury Cadmium Telluride (MCT) or Indium Antimonide (InSb) making T2SL the obvious choice for future camera systems.

The T2SL chip is much more uniform and stable overtime than other materials, especially MCT. This incomparable uniformity allows better imagery, but most importantly reduces the design and calibration efforts at the camera level therefore its manufacturing cost. Stability of pixel response overtime reduces significantly the need for system maintenance reducing further the overall system cost of ownership.
In superlattices, the cut-off wavelength is determined by the thickness of the constituent layers. During growth of the T2SL material the layer thickness variation is very well controlled and can be less than 1 % over a whole 4″ wafer allowing incomparable repeatability especially for high resolution arrays (HD and over) and mass production technics compared to bulk materials.

IRnova' s MWIR T2SL detectors have repeatedly demonstrated lower dark current than other detectors and can therefore operate at a higher temperature. Compared to InSb, which needs to be cooled down to 80K, T2SL can operate at focal plane temperatures up to 150K (also called HOT, for High Operating Temperature) without compromises on performances, reducing the need for cooling energy thus leading to crucial system advantages of Size Weight and Power (SWaP). TS2L MWIR opens the ability to embed high performance midwave detectors into space/weight constrained or battery powered systems (UAVs, robots, handheld devices).

Oden MW - HOT SWAP detector operated up to 150K



Overall technology comparison table:

	InSb	MCT	T2SL
Pixel sensitivity (1)		✓	✓
Array uniformity (2)	✓		✓
Array operability (3)	✓		✓
Sensor stability (4)	✓	✓	✓
Hot Swap capability (5)			✓
Repeatability (6)			✓
Scalability (7)	✓		✓
Wavelength coverage	(MWIR only)	✓ All	✓ All

1. Pixel sensitivity: Many parameters can be considered to quantify “sensitivity” the approach here is a fair combination of commonly agreed parameters

2. Array uniformity: Quantifying variation (gain, offset) within one single array. This parameter determines how complicated the non-uniformity correction will be at the camera design level and the effect on field imagery (intra-scene dynamic range etc)

3. Array operability: Quantifying the number of defective pixels (dead, deviating, blinking, clusters sizes...)

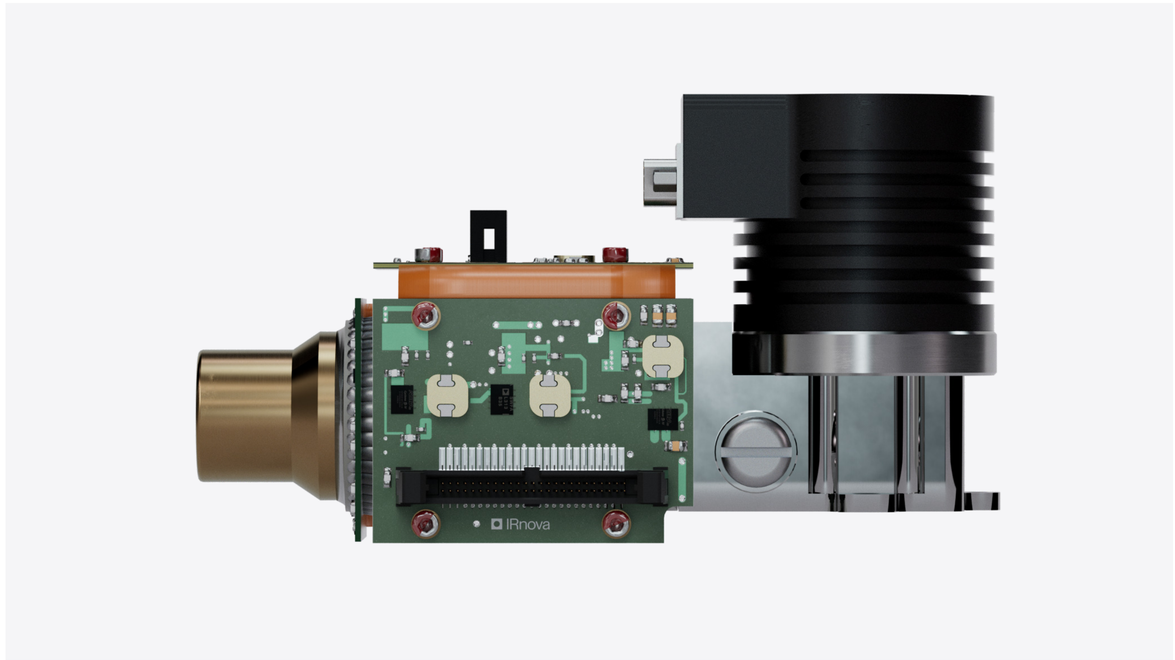
4. Sensor stability: Quantifies how each pixel and how the overall matrix response will deviate along operating conditions and lifetime. This is a crucial parameter affecting camera correction ability and lifetime maintenance/servicing cost of the system

5. HOT capability: Operating the focal plane at higher temperature is the only way foreseen to decrease the size and the power consumption of cooled detectors. This parameter not only considers the ability of the detector to operate at higher temperature but how it affects its inherent performances (sensitivity, wavelength response etc)

6. Repeatability: Quantifying the repeatability of the sensor main parameters in production. Although some applications will look for the best achievement at any detector produced, some systems will rely on good but very stable performances of all the delivered detectors ensuring a stable and proven system level qualification (video postprocessing tuning, video tracking, AI deep learning curve etc)

7. Scalability: Quantifying the ability to replicate the same performance and production cost for larger arrays and/or smaller pitch (HD, 2K,4K ...)

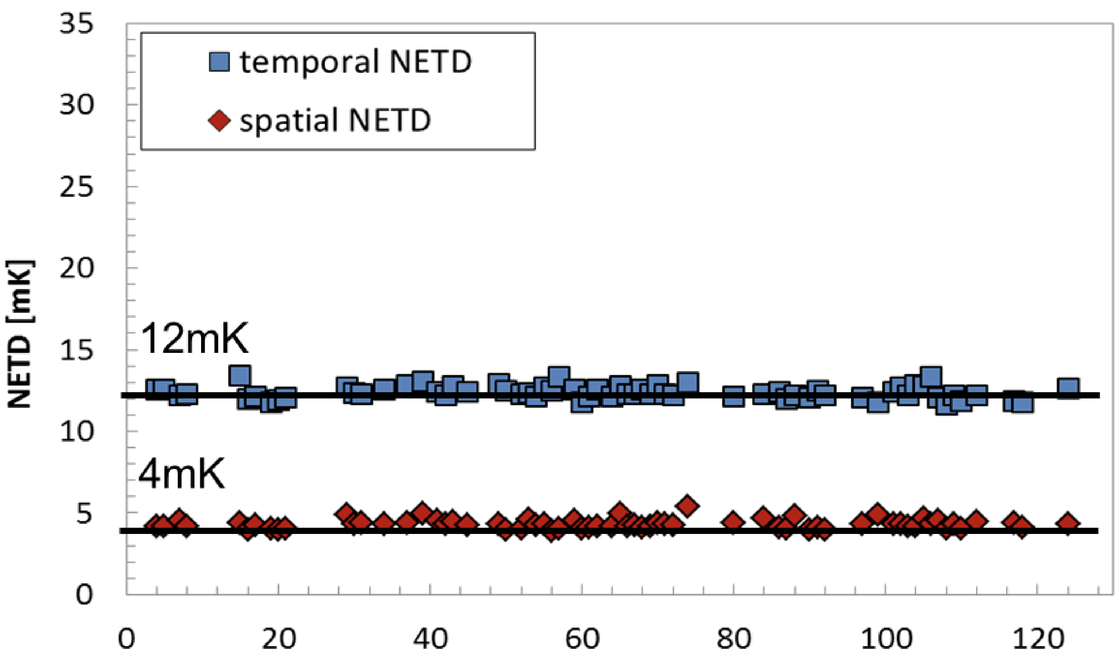
IRnova’ s T2SL at a glance: Freja 330, 390, 430, 460



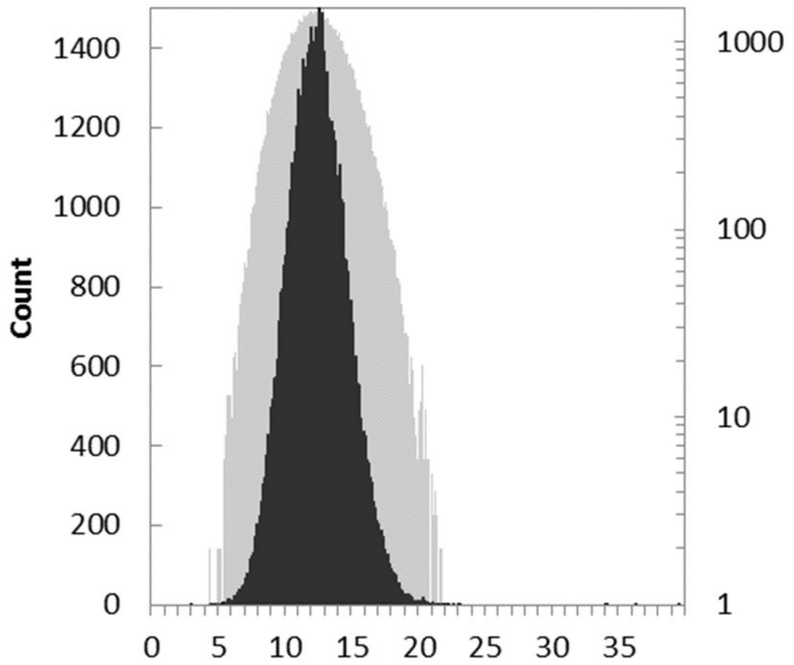
QVGA, 30um T2SL MWIR detectors for optical gas imaging

IRnova as a world leading supplier of infrared detector for optical gas imaging application (OGI) has been using its MWIR T2SL technology for this highly demanding application since 2012. Since then, the proven repeatability, uniformity, long term stability and excellent thermal sensitivity has strengthened Freja detector product line as the market reference and positioned IRnova as the most advanced and now mature pioneer for T2SL detectors.

The thermal sensitivity is represented by a temporal NETD (noise equivalent temperature difference), which for these detectors are on the order of 12mK. The excellent uniformity is reflected in the significantly lower spatial NETD (variation between neighbouring pixels) than temporal NETD and in the narrow noise distribution.

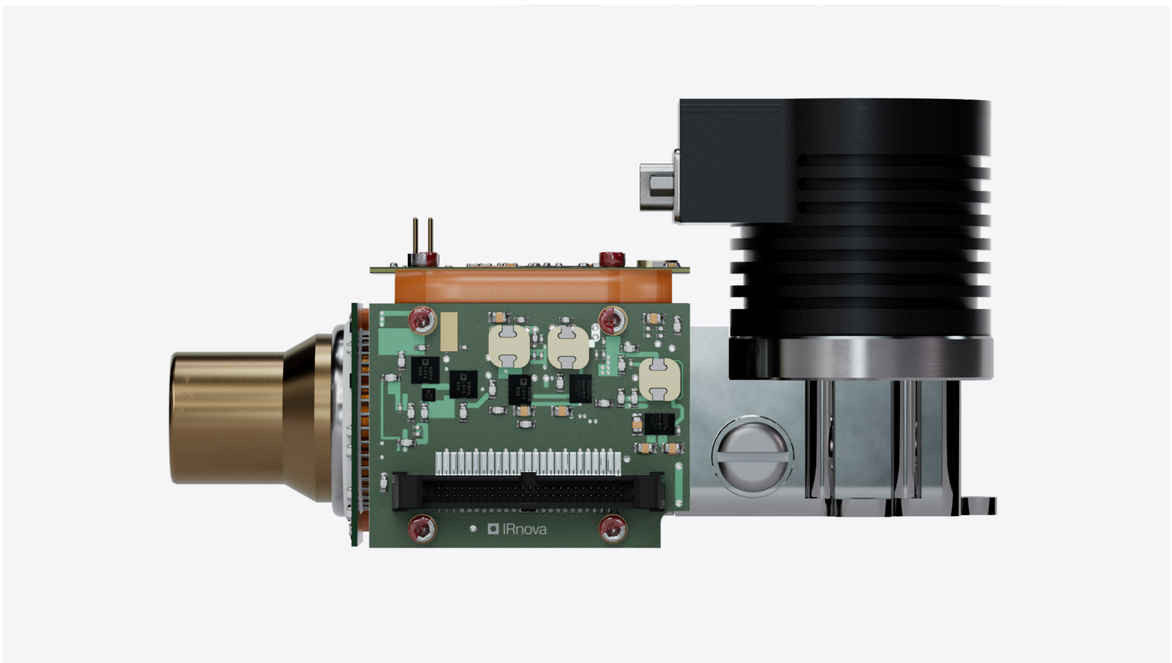


12mK temporal NETD / 4 mK
spatial NETD for hundreds of FPAs



Narrow noise distribution, no tail

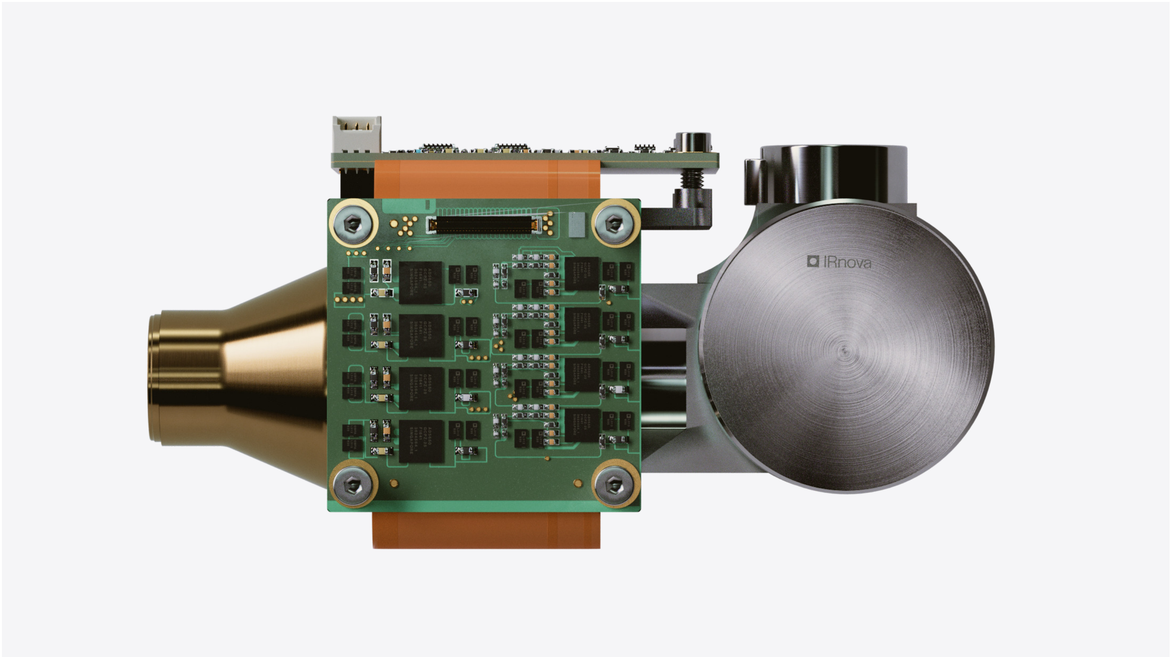
DAG MW



VGA, 15um T2SL MWIR

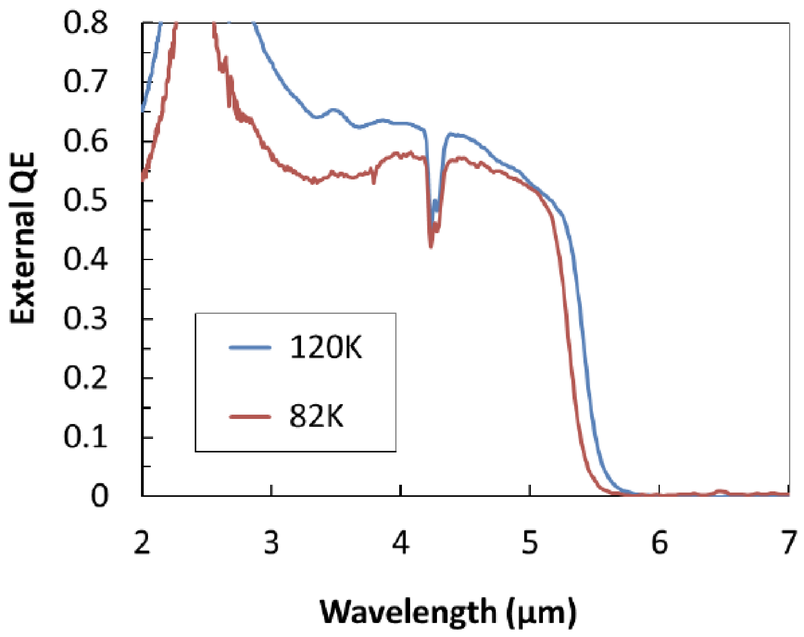
IRnova’ s general purpose T2SL detectors addresses favourably any application requiring High performance MWIR detectors, with easy integration, fast time to market and scalable delivery needs. DAG MW can compare side by side with any of its detectors, without any of their drawbacks.

ODEN MW

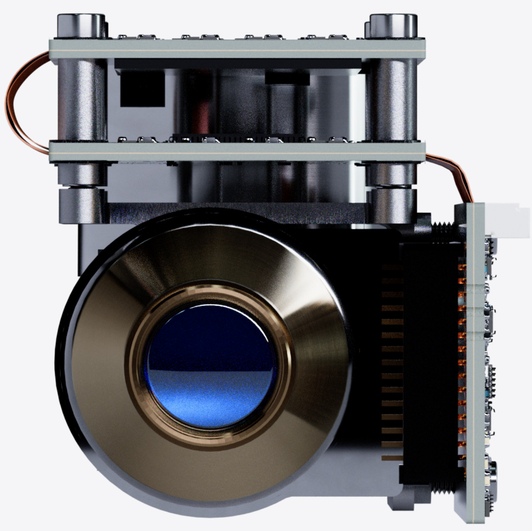


HOT SWAP VGA 15um T2SL MWIR

”IRnova demonstrated a new SWaP detector using the HOT capabilities of its T2SL material at SPIE DCS 2022. The Oden MW has a response covering the full midwave band and a high operating temperature of up to 150 K. This allows for lower power consumption, lighter and smaller detector assembly (<50% weight and 2/3 of the volume).



15um pixel pitch QE >60% in the entire MWIR range



ODEN MW
Size: 48×44×98 mm
Weight: <230 g
Power: <3.5 W

State of the art imaging quality with Oden MW. F/5.5, 60 Hz, NETD 20 mK.

T2SL next generation

Based on its T2SL expertise and demonstrated detector performances, IRnova is already planning the introduction of high definition (full HD and beyond), small pixel pitch infrared detectors serving 3-5 um (MWIR) but also 8-12 um (LWIR) wavelength, benefiting from the same superlattice material advantages.