EDF-2021-SENS-R: Optronics and radar technologies

EDF-2021-SENS-R-IRD: Infrared detectors

Budget

The Union is considering a contribution of up to EUR 38 000 000 to support proposals addressing any of the abovementioned topics and their associated specific challenge, scope, targeted activities and functional requirements.

Several actions, addressing different topics, may be funded under this call.

The domain of Infrared (IR) detectors encompasses a variety of technologies that detect in different spectral bands for a variety of applications (land, air, naval, space, missile guidance, drones...). IR detectors are key drivers to increase DRI[1] ranges and thus improve the global efficiency of the system (situation awareness and targeting).

Europe has a strong position in advanced military IR components & systems. Yet the risks are high that the Union becomes severely dependant on suppliers established in third country for this critical defence technology in the medium/long term. This not only limits the strategic autonomy of the Member States but also generates security of supply risks.

It is key for Europe sovereignty to have a full "EU autonomous" supply chain of IR detectors. To achieve advanced performance of future IR systems in relevant platforms improved IR detectors with reduction of size, weight, power and cost is mandatory. The performance of the IR detector modules is driven not only by the IR detector itself but also by Silicon readout integrated circuits (ROIC) technology and components for cooling, if required.

Specific challenge

Access to 12'' silicon foundries is a key factor for recurrent cost optimization and because small nodes and 3D architectures will feature advanced ROIC, which are seen as key enablers not only for high-end IR detectors (all bands) but also for advanced thermal modules in the 2025-2030 timeframe. Moreover, this topic will require heavy budget allocation, which can be barely achieved at individual EU state level. Therefore the cost of access to advanced CMOS[2] node (65 nm and below) has to be shared at between the main EU players.

The proposals should mainly lead to the availability of an advanced EU ROIC supply chain compatible with various infrared detector technologies. It means:

- High resolution ROIC and compatible with 3D architecture to further enable advanced functions such as edge computing at sensor level,
- An EU open silicon foundry and affordable price (thanks to collective specifications and orders).

[1] Detection, recognition and identification
[2] Complementary Metal Oxide Semiconductor

To compete at the highest level of worldwide performance, the cooperation between the main EU infrared detectors suppliers is strictly required.

Complementarity should be ensured with past and current work funded through national programmes, the European defence agency framework, and other R&D programmes.

Scope

The proposals must address the development of the next generation of ROICs for Infrared detectors, including the EU supply chain. That next generation of ROIC will be based on an advanced Silicon technology (compatible with a 3D architecture) that can be used in various future cooled & uncooled IR detector architectures.

Targeted activities

The proposals must cover the following activities as referred in article 10.3 of the EDF Regulation:

- Activities aiming to create, underpin and improve knowledge, products and technologies, including disruptive technologies, which can achieve significant effects in the area of defence.
- Studies, such as feasibility studies to explore the feasibility of new or improved technologies, products, processes, services and solutions

These activities should be articulated as follows, without exceeding TRL4:

(1)**From system requirements to ROIC technology specifications("Improve knowledge")**: The targeted activities must in particular include, for both 2D and 3D ROICs, the collection and analysis of IR system integrators requirements; their translation into 2D and 3D building blocks, the prioritisation of these building blocks such as (and not exclusively) their coverage of future EU defence applications, an inventory of the Silicon nodes and IPs available in a selected EU foundry, and choice of the best one(s) to interface with different detector technologies (both cooled and uncooled) and be compatible with both 2D and 3D architectures.

(2)**Identification and qualification of an advanced silicon node ("Improve knowledge")** : Furthermore for conventional 2D advanced ROICs they must include activities aiming at identifying and acquiring (a) new advanced silicon node(s) for future infrared detectors' read out circuits, such as interface definition and integration constraints with sensing blocks and packaging, both for cooled and uncooled detectors; definition of performance indicators to evaluate technical solutions versus the system integrators' requirements; test chip design(s)[3] for fabrication and test of 2D advanced functional blocks; characterisation, modelling and reliability activities on test chip specific patterns.

(3)**ROICs design[4], fabrication and functional test ("Improve knowledge" and "Studies")** This will prepare for necessary activities aiming at the electronic design, fabrication and functional test (first characterisations, excluding electro-optics) of (a) first high definition, large

[3] Here, "Design » is a specific term in microelectronic to define the technological phase of building the sub-components of the ROIC to be tested. (It's therefore not to be understood as a design of a product)
[4] *Idem*

format, ultra-small pitch (≤7,5µm) 2D Read Out Circuit(s) with smart functions on this new CMOS platform(s); as well as preparatory studies to enable future ROIC functional routine tests at industrial level. When relevant some tests by system providers should be performed on the communication protocols based on the raw read out circuits.

(4) **Preparatory work of 3D technology acquisition ("Improve knowledge")** on the selected node for 3D ROICs with increased functionalities at detector and pixel level will also be covered: exploration of 3D ROIC architectures allowing implementation of add-on functionality in a second layer, such as higher scene dynamics/reduced pixel pitches, in-situ image compression for large arrays/high frame rates, combination functions of passive/active imaging, event-based computing, in situ machine learning.

The implementation of this topic is expected to target TRL 4 for 2D advanced Read Out Circuits and to minimum TRL2 (TRL3 maximum) for 3D advanced Read Out Circuits.

Functional requirements

The proposed solutions should fulfil the following main high-level optronics system requirements:

- High resolution: increase in range and field of view, which translates at focal plane arrays into reduced pixel pitch and larger array imagers in the SWIR[5], eSWIR[6], MWIR[7] and LWIR[8] range, with formats ranging from 1 megapixels to 16 megapixels. (increasing interoperability & compatibility with cooled & uncooled detectors)
- High dynamics: higher scene dynamics for simpler, more compact and more tolerant to a wide range of operating scenarios optronics systems. This translates for example into multi-gain capability at pixel level, which will be a growing challenge as pixel pitch reduces.
- High speed: increase in image frame rate, which combined with the increase of the resolution, is requested for tracking and/or targeting fast-moving and possibly stealth threats. Advanced CMOS technologies are expected to provide significant gains in terms of operating frequency and thus data rates of IR ROIC.
- On-chip processing: Towards systems-on-chip IR focal plane arrays with embedded, reconfigurable functionality depending on the application- AI. The base idea is to make pixels smarter by integrating advanced computational functions at pixel level, through 3D stacked ROIC layers. Higher scene dynamics for reduced pixel pitches, *in situ* image compression for large arrays/high frame rates, combination functions of passive/active imaging, event-based computing are some examples of advanced integrated functions.
- Significant gains in reducing power consumption for SWaP-C[9] detectors.
- Ability to support dynamic windowing and tracking providing multiple windows of interest, and associated increased frame rate.
- Fast event detection and decoding at pixel level.

[5] Short wavelength infrared
[6] Extended short wavelength infrared
[7] Medium wavelength infrared
[8] Long wavelength infrared
[9] Size, Weight, Power and Cost

Expected impact

- Driving factor for the development of tactical IR Optronics systems, reducing the time and cost development of Optronics systems
- Ensure the dominance of future EU critical air combat and ground combat systems
- Provide EU military forces with state of the art IR detectors, ensuring the dominance of future EU critical platforms and armament systems.
- Improve DRI performances of IR sensors, especially for high-end platforms
- Ease of use of smart IR modules
- Develop an EU supply chain (especially for ROIC), contributing to the strategic autonomy of the EU.