

Laser systems in defence applications

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2025 key figures



85,000
employees



65 countries
A global footprint



More than **€4.5bn**
+ €1 bn
in self-funded R&D



€22.1 bn
revenues

EMPOWER CUSTOMERS TO FACE THEIR DECISIVE MOMENTS WITH CONFIDENCE



Optronics in defence application



> Long range perception of the situation.



> Collecting and gathering information to deliver at the right time.



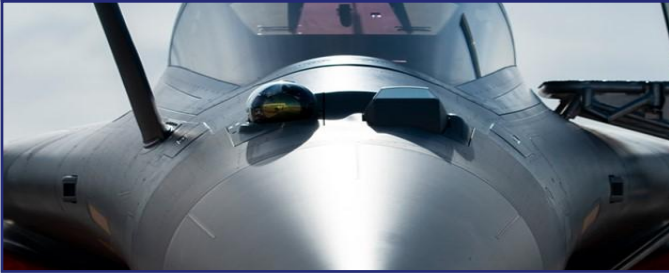
> Acting

Optronics sensors:
Collect information as early as possible, process it and transfer it

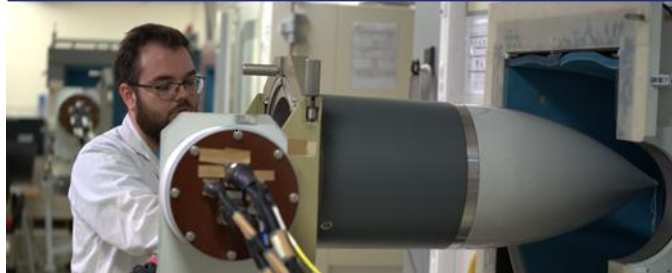
Optronics effectors:
Designate the target,
Jam or dazzle the sensors
Destroy the threat

OUR **PRODUCT LINE** PORTFOLIO

AIRBORNE OPTRONICS



SEEKERS & FUZES



VEHICLE OPTRONICS



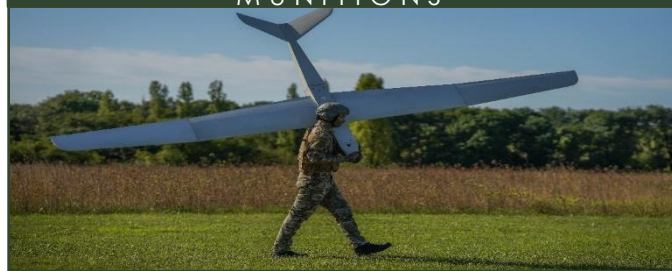
CUSTOMER SUPPORT



SOLDIER OPTRONICS



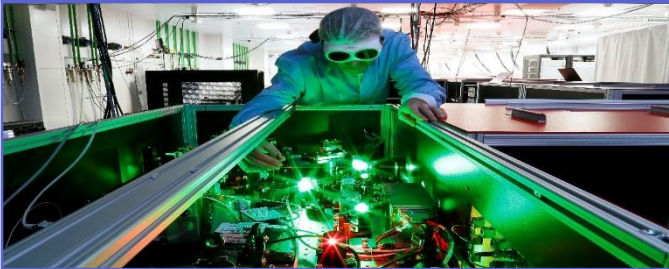
DRONE SYSTEMS & LOITERING MUNITIONS



NAVAL OPTRONICS



LASERS



CINEMA OPTICS



CRYOGENICS



Laser systems for defence

In product

> Collecting information:

- Laser range finder,

> Coordinating troops and increasing the situational awareness:

- Laser pointer,

> Acting:

- Missile guidance;
 - Beam riding,
 - Designator.



R&T

> Collecting information:

- Active imaging:
 - 3D imaging (ToF or FMCW): better situational awareness,
 - Gated imaging : night and day operation, scattering effect mitigation,

> Coordinating troops and increasing the situational awareness:

- Free space optics communication.

> Protecting the platform:

- Laser counter-measure (Directional Infrared Counter Measures or DIRCM),

> Acting:

- Laser weapon.

Examples of laser systems in Thales products



Laser range finder

> Principle

- Distance measurement through the time-of-flight measurement of one pulse or a train of pulses (better covertness but longer pointing time).

> Applications

- Situational awareness, Fire-control systems (artillery, armoured vehicles), Airborne systems (fighters, helicopters, UAVs), Support to munition guidance.

> Nowadays integrated in many optronics systems.

> Defence Requirements

- Long-range performance (km to tens of km),
- High accuracy (< 1 m),
- Resistance to optical countermeasures,
- Eye-safety constraints depending on platform.

> Generally in the SWIR (Short Wavelength InfraRed) for laser safety consideration.



Kate -LR thermal camera for land vehicles



The hand-held thermal imager SOPHIE Ultima



Thales Frontal Sector Optronics of the French fighter Rafale.

Laser pointer

> Laser pointer Functionality

- ▶ Laser pointers emit narrow beams used for marking targets and coordinating unit movements effectively in tactical settings.
- ▶ Tactical Applications: Laser pointers enhance situational awareness by aiding infantry coordination, rapid target indication, and supporting UAV or observer units.
- ▶ It can only be detected by specific equipment: Night Vision Goggles, cameras.

> Typical specifications: NIR wavelength lasers, power of xmW to $x00mW$, divergence less than $1mrad$.



Thales Night Vision goggles



USAF handheld laser pointer as seen under night vision, 2007



Kate -LR thermal camera for land vehicles



The hand-held thermal imager SOPHIE Ultima



Thales targeting and reconnaissance pod

Laser designator



TALIOS (Targeting Long-range Identification Optronic System)

> Laser Designators in Targeting:

- ▶ Laser designators emit pulse-repetition frequency (PRF) coded laser beam to mark targets for precision-guided munitions (bomb or missile), enhancing strike accuracy (between 1 and 5 m) and minimizing collateral damage.
- ▶ Semi-Active Laser (SAL) homing weapons detect coded laser reflections and adjust flight paths, enabling precise engagement of designated targets.

> Laser target designators play a key role in joint operations, supporting ground forces (special operation teams), naval units, and aerial platforms (fighters, UAV...).



SharpAim Laser Designator

Laser designator

> Laser designator specifications:

- They mainly operates at 1064 nm, the energy per pulse is few tens of mJ, the divergence and angular jitter are few hundreds of μrad , the duration of the pulse shall be greater than 10ns.
- PRF coding according to the NATO STANAG 3733.

> Key challenges:

- Beam stability in harsh environment (dense and compact systems with poor thermal exchange, severe vibrations...),
- Pointing (potentially a mobile target from a mobile platform).



LRF,
Pointer,
Designator.

Examples of R&T activities on laser systems

Free space optical communication

- > FSO systems transmit data via laser beams that propagates through the atmosphere.
- > This is an end-to-end communication between two terminals.
- > **Advantages over radiofrequency communications:**
 - more difficult to jam,
 - better covertness (directional end-to-end communication),
 - high data rates achievable.
- > **Some drawbacks however make FSO communication a real challenge :**
 - line-of-sight needed,
 - limited range (X0 km),
 - weather and turbulence sensitivity,
 - accurate alignment required.



Laser weapon

> Principle

- High-power lasers (kW to >100 kW) neutralise targets by heating, ablating, or damaging sensors or structures.

> The power required depends on the target type:

- Few kW for small quad-copter, few tens of kW for hard target such as mortar (from the US Army's Directed Energy Maneuver-Short Range Air Defense experience) and more power requirement for missiles...

> Applications

- Explosive ordnance neutralisation at stand-off distance,
- Drone neutralisation,
- Short-range anti-ammunition defence,
- Naval and land-based protection.

> Many countries work on demonstrators: USA, Russia, Israel, UK, Germany, France, China, India, South Korea...



<https://www.armyrecognition.com/news/navy-news/2024/uk-accelerates-dragonfire-laser-system-deployment-on-royal-navy-warships?highlight=WzlwMjRd>

Turbulence mitigation challenge

> Turbulence mitigation for Free Space Optical communication and laser weapon is a real challenge.

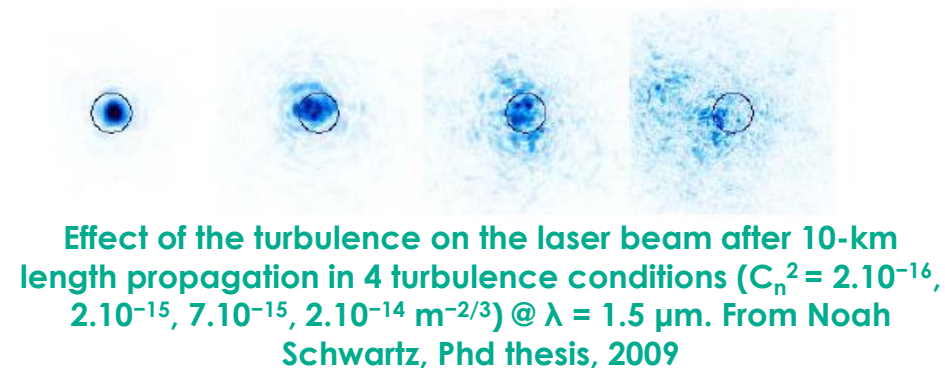
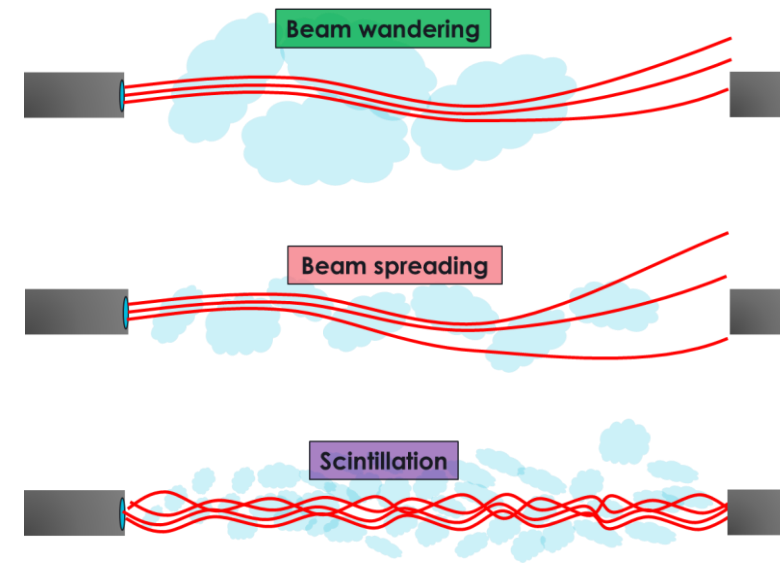
> Turbulence generates:

- Beam wandering (global deviation of the beam)
- Beam spreading (beam broadening)
- Scintillation (intensity fluctuations)

> Impact on:

- a reduction of the average power received,
- a fast and random fluctuation of the power received,
- pointing capabilities (kHz correction of the tip/tilt).

> Hardware mitigation system with low SWAP (Size, Weight and Power) are required !





Conclusions

- Thales is integrating and developing lasers and laser systems for many defence products: Laser range finders, pointers, designators.
- Products such as the TALIOS pod contains all the functionalities, which implies a complex integration constrains of all the lasers and laser functions.
- New R&T activities such as free space optical communications and laser weapons yield to new challenges for laser systems:
 - Turbulence mitigation technologies,
 - Components with a high power damage threshold and low thermo-optical sensitivity,
 - Few kW CW unitary sources,
 - Beam combining technologies.



Thank you

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