THALES
Building a future we can all trust

Laser systems in defence applications

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www.thalesgroup.com

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2024 key figures

83,000

employees

68 countries

A global footprint

More than €4 bn*

* including €1,1 bn in self-funded R&D

€20.6 bn

revenues

Thales's mission

EMPOWER CUSTOMERS TO FACE THEIR DECISIVE MOMENTS WITH CONFIDENCE

Laser systems in defence application

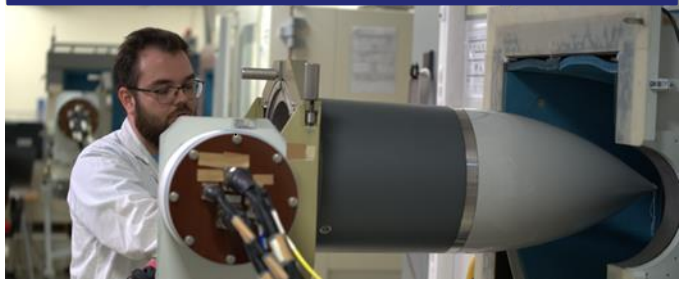
Collect information and
transfer it as early as possible

Engage:
Jam or dazzle the sensors,
Designate the target,
Destroy the threat.

OUR **PRODUCT LINE** PORTFOLIO

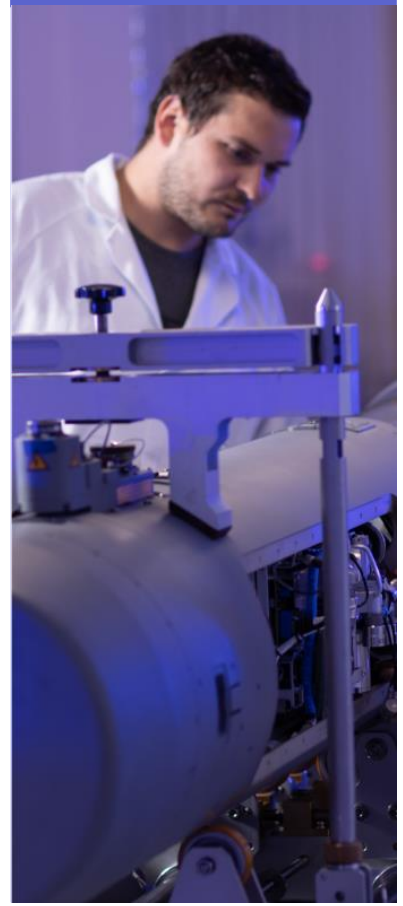
AIRBORNE OPTRONICS

SEEKERS & FUZES



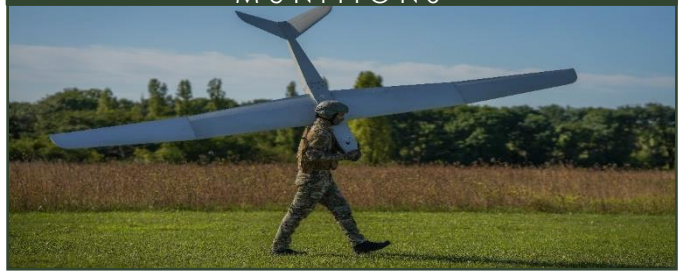
VEHICLE OPTRONICS

CUSTOMER SUPPORT



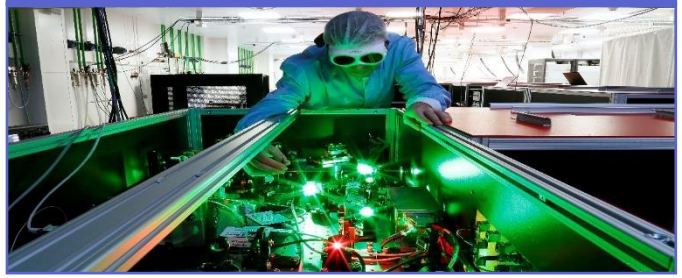
SOLDIER OPTRONICS

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 LIDAR: better situational awareness,
  - Gated imaging : night and day operation, scattering effect mitigation,

> Protecting the platform:

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

> Coordinating troops and increasing the situational awareness:

- Free space optics communication.

> Acting:

- Laser weapon.

Examples of laser systems in Thales products

Laser Range Finder (LRF)

> 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...)

> 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

Kate –LR thermal camera for land vehicles

> 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 1 mrad.

The hand-held thermal imager SOPHIE Ultima

Thales Night Vision goggles

USAF handheld laser pointer as seen under night vision, 2007

Thales targeting and reconnaissance pod

Laser designator

1976 ATLIS

1985 PDL CT

1998 DAMOCLES

2018 TALIOS

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 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.
- 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.

Example 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.

Free space optical communication challenge

> Turbulence mitigation for Free Space Optical (FSO) communication is a real challenge.

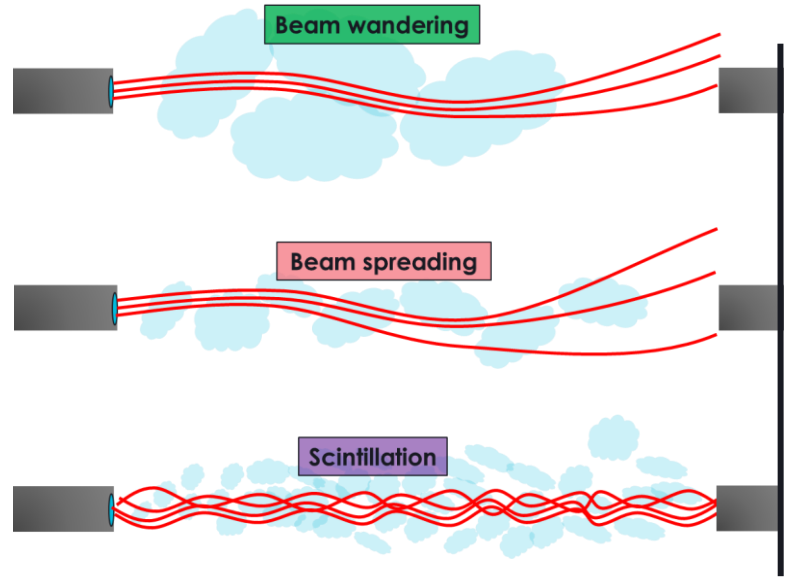
> Turbulence generates:

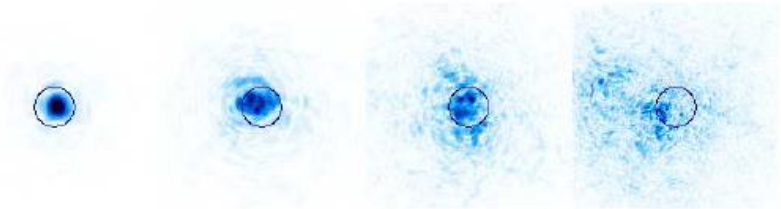
- Beam wandering (global deviation of the beam)
- Beam spreading (beam broadening)
- Scintillation (intensity fluctuations)

> Impact on:

- a reduction of the average power received,
- a fast and random fluctuation of the power received (Signal-to-noise ratio decreases), which may leads to fading (temporary signal loss),
- pointing capabilities (kHz correction of the tip/tilt).

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





Effect of the turbulence on the laser beam after 10-km length propagation in 4 turbulence conditions ($C_n^2 = 2.10^{-16}$, 2.10^{-15}, 7.10^{-15}, 2.10^{-14} $m^{-2/3}$) @ λ = 1.5 µm. From Noah Schwartz, Phd thesis, 2009

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

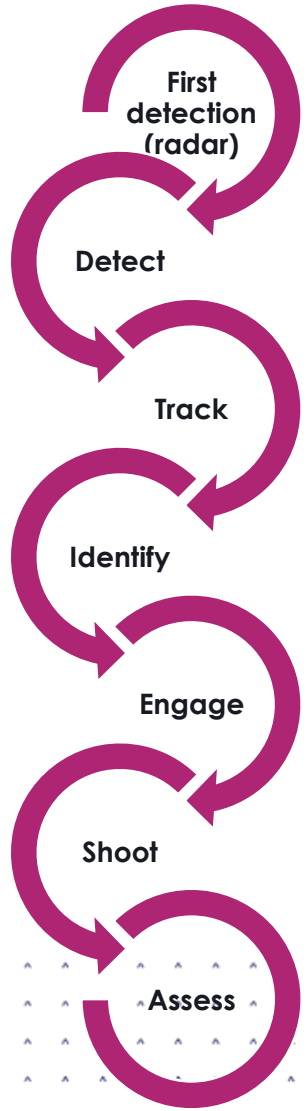
Laser weapon: a complex system

> A laser weapon is a complex system:

- Automatic Detecting, Tracking, Identifying system based on passive or active imaging,
- High energy laser beam generation,
- High energy laser beam pointing system,
- Cooling system,
- High electric power,
- Command and Control communication.

> The main technological challenges identified are:

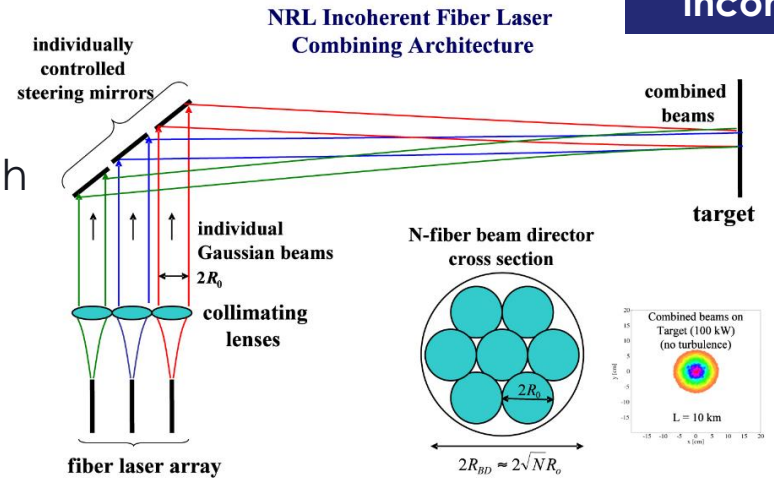
- Thermo-optical effects and damage of the components,
- Laser sources:
  - Unitary sources (CW optical fibre laser of few kW power),
  - Combining unitary laser beams.
- Atmospheric effect mitigation for fine pointing,
- Thermal management and cooling system,
- Energy management (batteries and platform power).



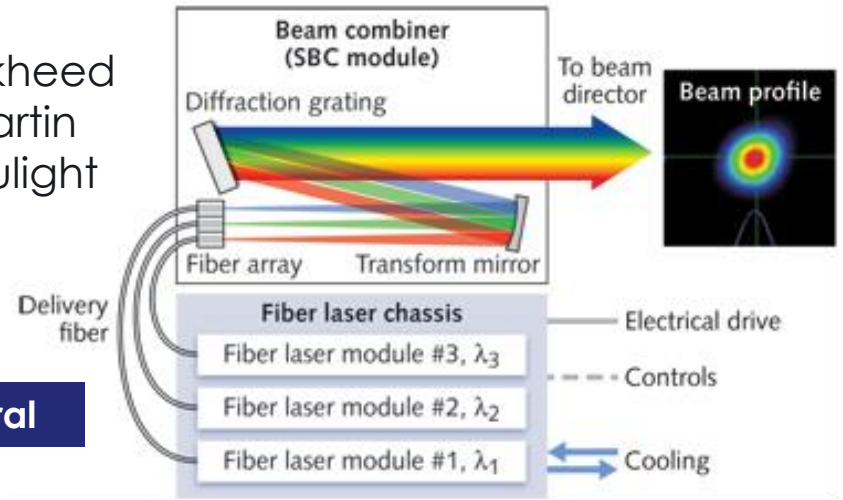
Beam combining

Incoherent

Naval Research Lab.

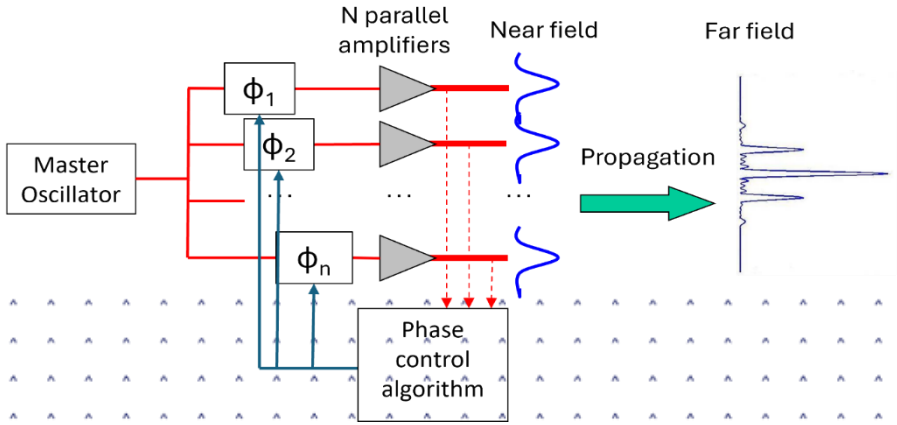


Lockheed Martin Aculight



Spectral

Coherent by tiled aperture



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.

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Thank you

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