

# Intro to Cypriot Industry: the Optics and Optoelectronics sections of ESA's technical directorate (TEC-MME & MMO)

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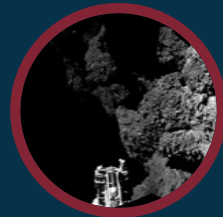
Jorge Piris

Nicosia 22/03/2022

# ESA's areas of activity



- ESA is one of the few space agencies in the world to combine responsibility in nearly all areas of space activity



space science



human spaceflight



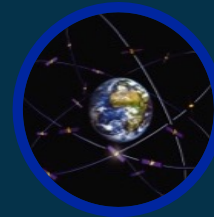
exploration



earth observation



launchers



navigation



operations



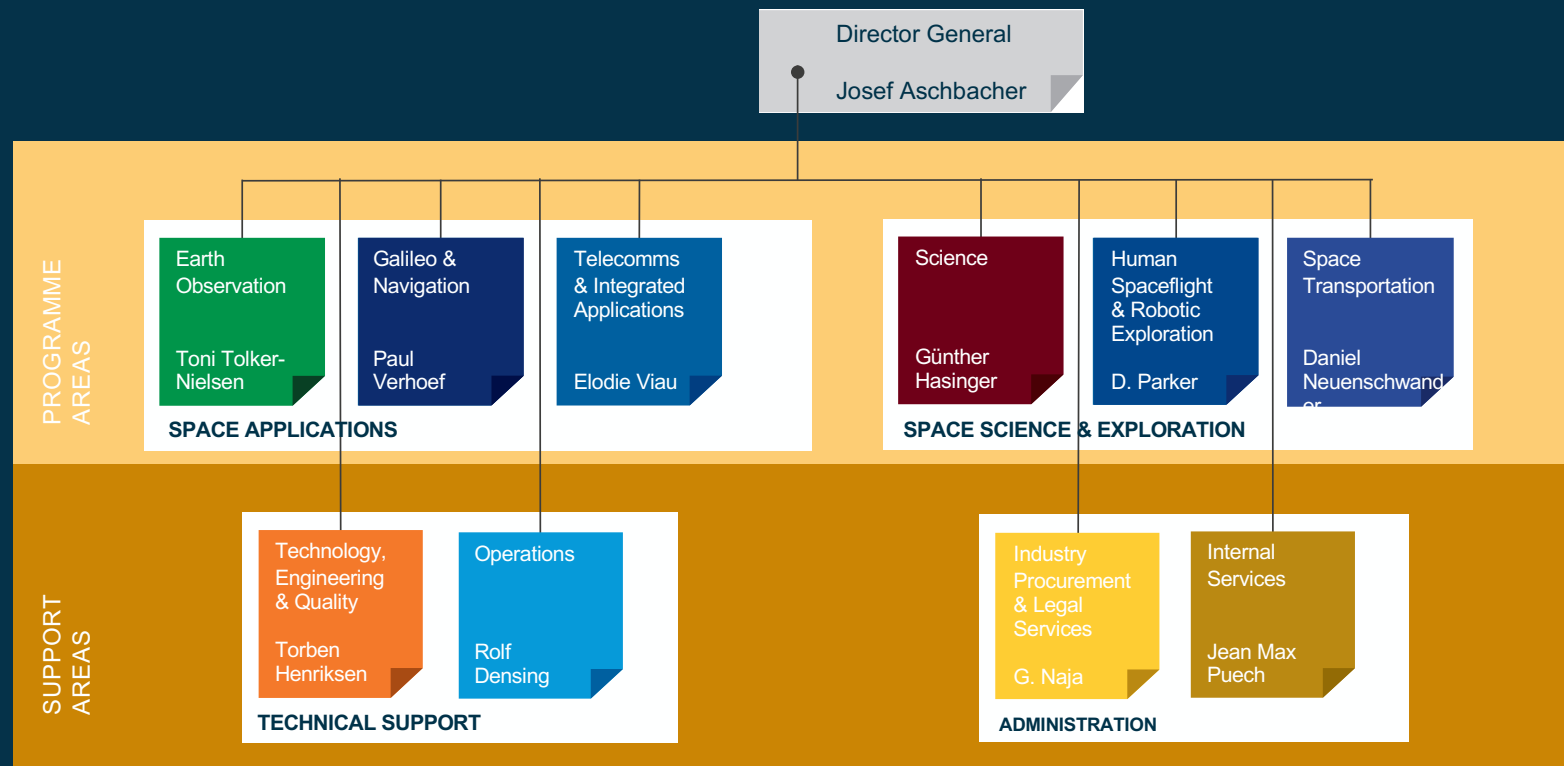
technology



telecommunications



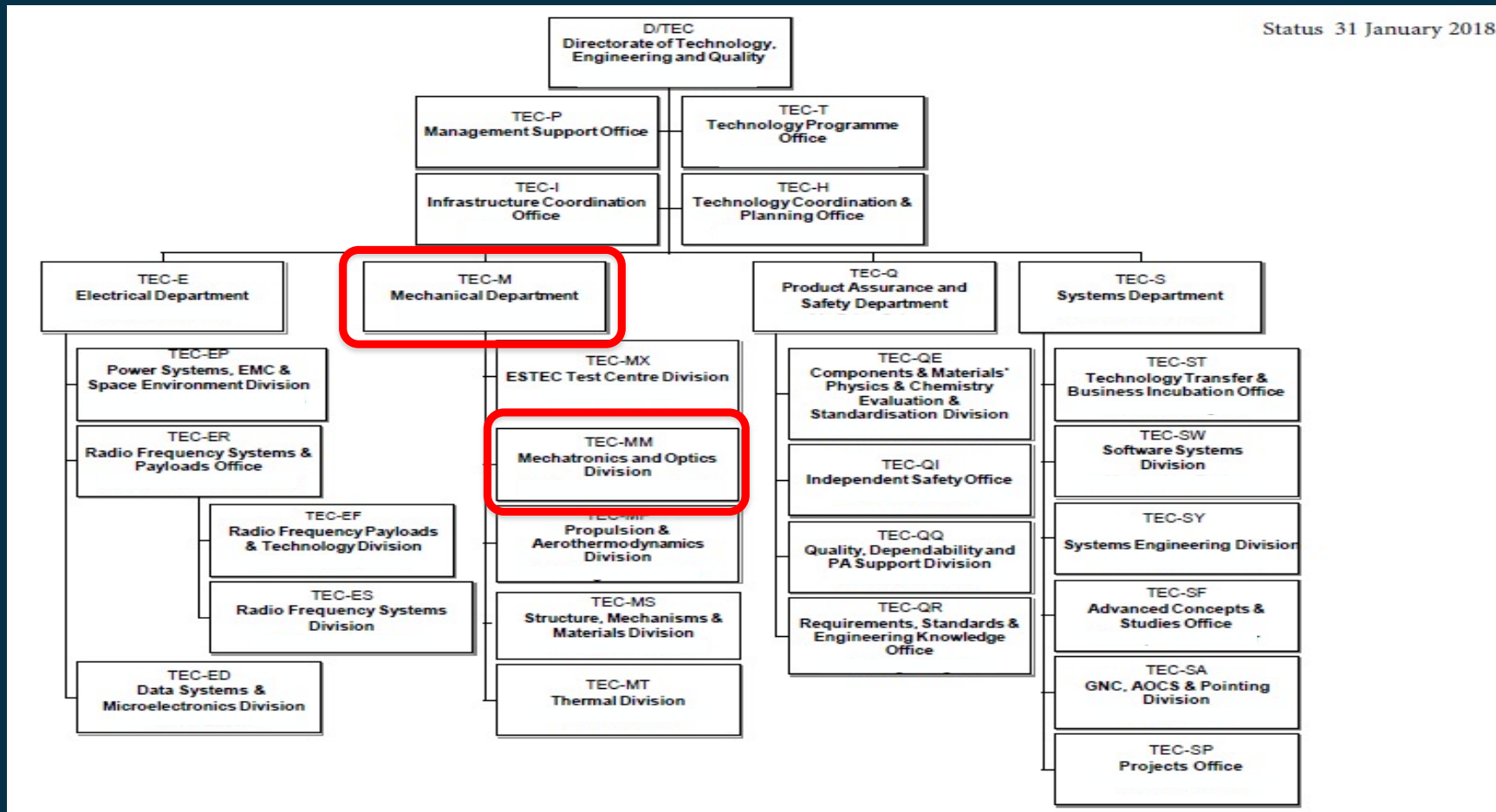
# ESA's Directorate structure



# Directorate of TEC, Mechanical department, Mechatronics and Optics Division



Status 31 January 2018





# Mechatronics and Optics Division (TEC-MM)


## Fields of competence




TEC-MM  
L. Maressi



Automation & Robotics  
(TEC-MMA)  
G. Visentin



Life Physical Science  
(TEC-MMG)  
R. Lindner



Opto-electronics  
(TEC-MME)  
K. Minoglou



Optics  
(TEC-MMO)  
V. Kirshner



- Definition of concepts for space teleoperation, automation and robotics
- Analysis, modeling and testing of robot systems
- Definition, analysis, prototyping and testing of human-robot interfaces

- Life Support, R&D and operational support
- Instrumentation for Life and Physical Sciences experiments instrumentation
- Instrumentation for Exploration
- Health related Telecommunication applications
- Planetary Protection

- Photonics (integrated optics and fiber sensors)
- Detectors
- Lasers
- Quantum Technologies
- Cold Atom Interferometry (CAI)
- Optical Atomic Clocks
- Time and Frequency Transfer
- LIDAR systems
- Optical Communication
- Optical Metrology
- Optical Pyrotechnics

- Optical system engineering: definition, design, and analysis.
- Optical Instruments: spectrometers, interferometers, radiometers, imaging systems.
- Optical components technologies



# Opto-electronics Section TEC-MME

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# Optoelectronics section competences



	Technology Developments	Supported Programs
<b>Detectors:</b>	<ul style="list-style-type: none"> <li>• CCD and CMOS</li> <li>• InGaAs and MCT</li> <li>• Bolometers and quantum well</li> </ul>	<ul style="list-style-type: none"> <li>• Sentinel 3, 4, 5p, 5</li> <li>• EarthCare Atlid, 3MI, Flex</li> <li>• Euclid, Plato, Cheops, GAIA</li> </ul>
<b>Lasers:</b>	<ul style="list-style-type: none"> <li>• Diode, Fiber, Nd:YAG, Alexandrite</li> <li>• Optical communication systems</li> <li>• LIDAR systems</li> <li>• Metrology systems</li> </ul>	<ul style="list-style-type: none"> <li>• Meteosat TG, HYDRON</li> <li>• SILEX, Sentinel 1 &amp; 2, EDRS</li> <li>• Aeolus, EarthCare, BepiColombo</li> <li>• LISA pathfinder, LISA, NGGM</li> </ul>
<b>Photonics:</b>	<ul style="list-style-type: none"> <li>• Fiber sensors</li> <li>• Opto-pyrotechnics</li> <li>• Microwave photonics payload</li> </ul>	<ul style="list-style-type: none"> <li>• ARIANE 6</li> <li>• Future telecommunication S/C</li> </ul>
<b>Quantum:</b>	<ul style="list-style-type: none"> <li>• QKD payloads and ground stations</li> <li>• Cold Atom Interferometry</li> <li>• Atomic clocks</li> </ul>	<ul style="list-style-type: none"> <li>• SAGA, QKDSat</li> <li>• Inertial navigation</li> <li>• GNSS</li> </ul>
<b>Testing:</b>	<ul style="list-style-type: none"> <li>• LIDT and LICT test facility</li> <li>• Laser diode burn-in &amp; lifetime testing facility</li> <li>• Detector test facility</li> <li>• Mobile LIDAR facility</li> <li>• Optical Ground Station (OGS)</li> </ul>	<ul style="list-style-type: none"> <li>• Earth Observation</li> <li>• Science</li> <li>• Telecommunication</li> <li>• Space Situational Awareness</li> </ul>



# Detector Developments



GAIA  
Mapping the stars

EUCLID  
Dark energy mapping

CHEOPS  
Characterizing Exoplanets

EarthCARE – ATLID  
Atmospheric LIDAR

Tropomi  
Monitoring the troposphere

Sentinel-4  
Atmospheric chemistry & air quality monitoring

Sentinel-5  
Ozone profiling & climate monitoring

Sentinel-3  
Sea and land mapping

PLATO  
Exoplanet Finder

H2RG

2x2 mosaic of H2RGs

5x7 mosaic of H2RGs (engineering model)

CCD and CMOS

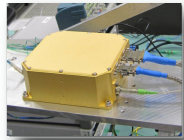
MCT



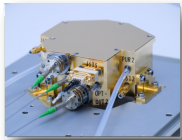


# Laser Developments (Metrology systems)

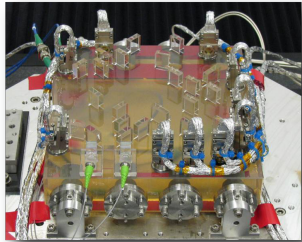
Metrology laser system developments for LISA Pathfinder, LISA and NGGM (GOCE follow on)



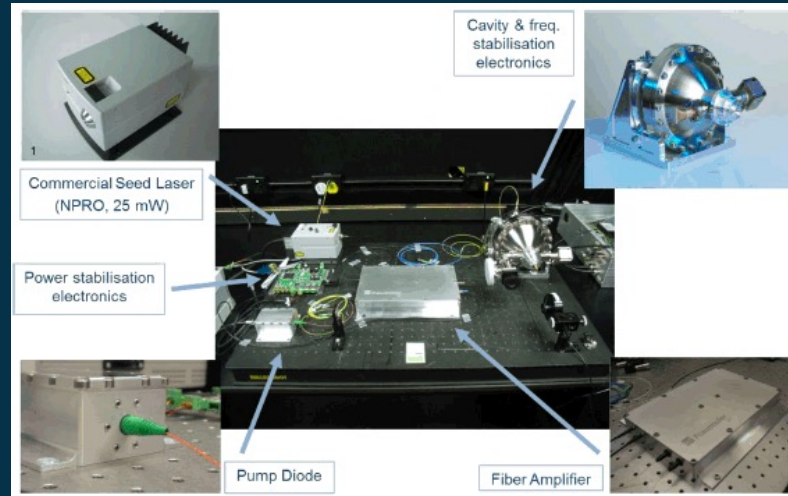
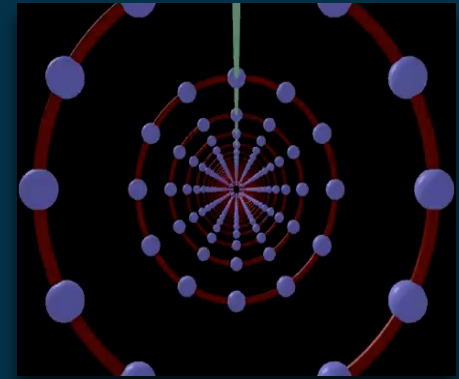
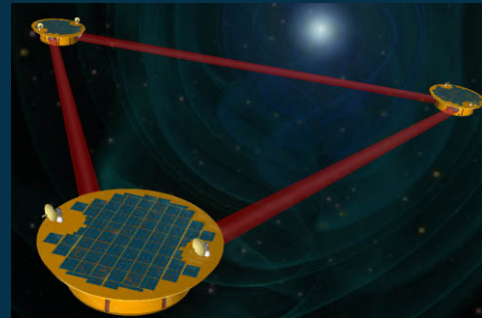
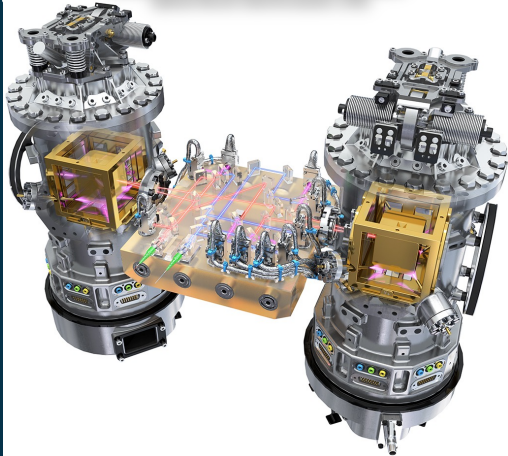
Reference Laser Unit (FM)



Laser Modulator (FM)

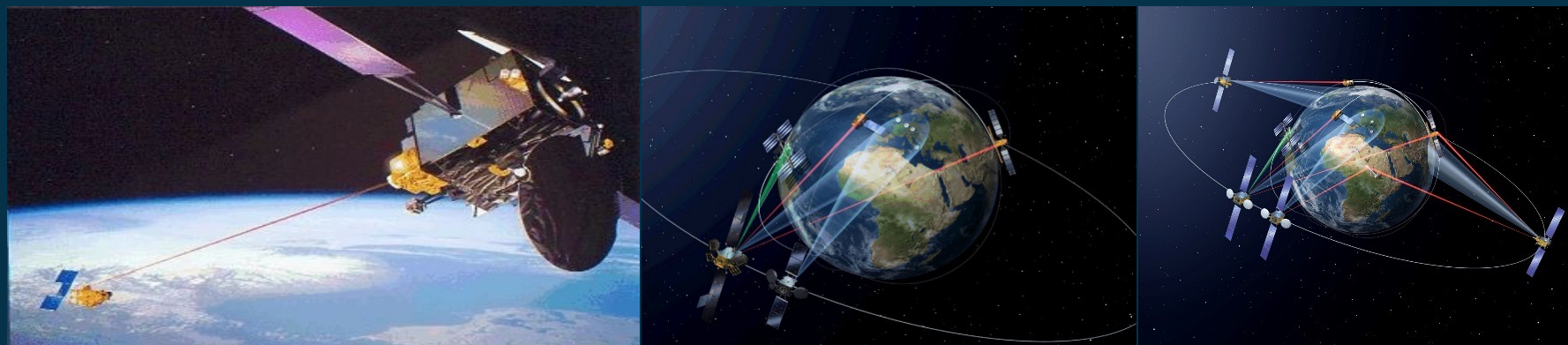


Optical Bench Interferometer (FM)





# Laser Developments (Telecommunication systems)



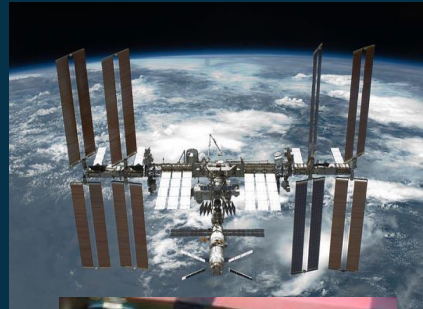
From near Earth: SILEX (the first optical data relay system) via EDRS to GlobeNet



To deep-space: LADEE (lunar optical communication) via Psyche to Space Weather mission L5.

# Photonics (Fibre optics)

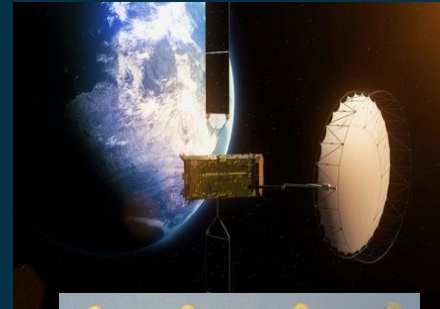
1998: ISS – Optical Comms



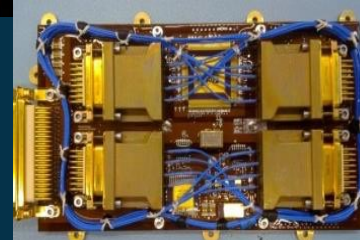
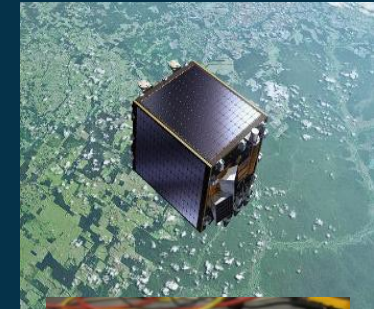
2009: SMOS – Optical Comms Data and Clock Distribution



2013: AlphaSAT - TDP 8

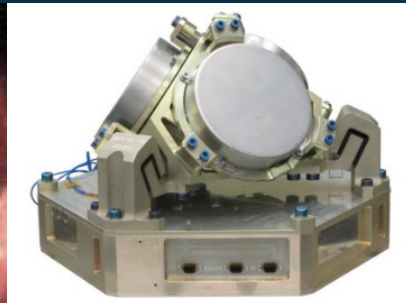
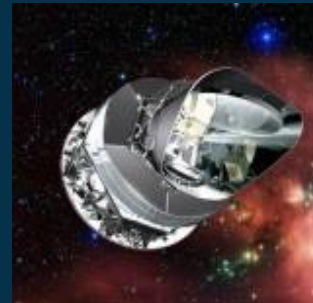


2013: PROBA V- HERMOD



2004: Demeter – Opto-pyrotechnic demonstrator

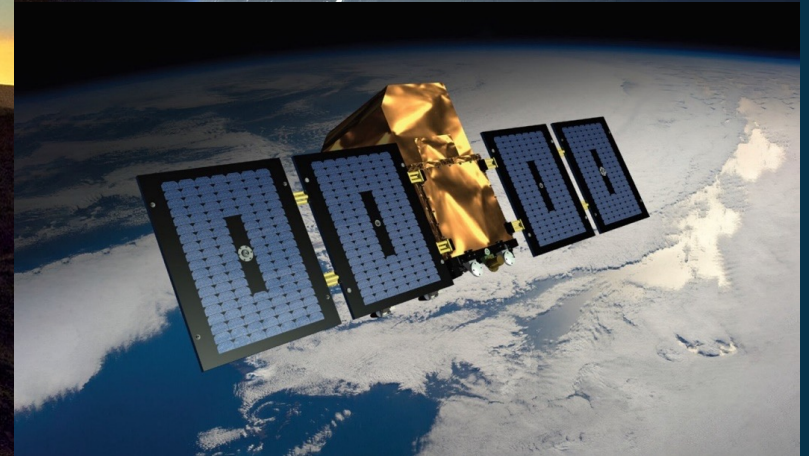
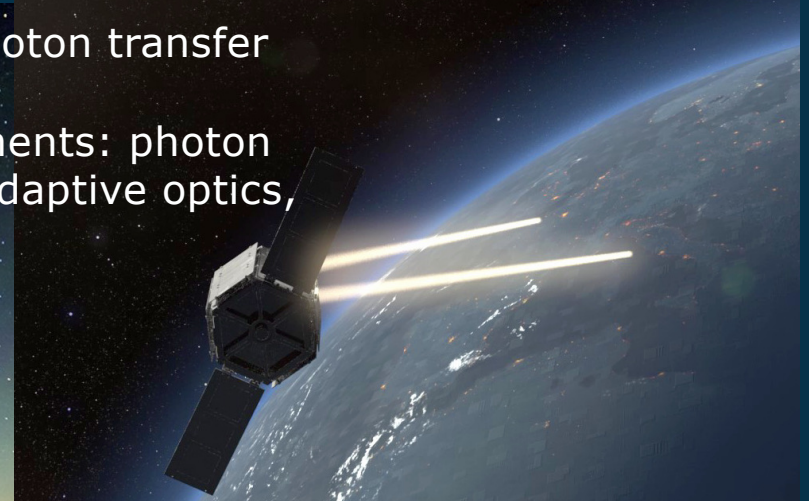
2009: Planck – Fiber optic gyro (4 axis)





# Quantum (quantum key distribution)

- World record in longest distance of quantum entangled photon transfer (144 km)
- Support SAGA, EAGLE I and QKDSat technology developments: photon sources, optical terminals, receiver chain and detectors, adaptive optics, laser safety, ...etc





# Quantum (quantum key distribution)

Quantum key distribution from space – Link with Micius (CHN) satellite



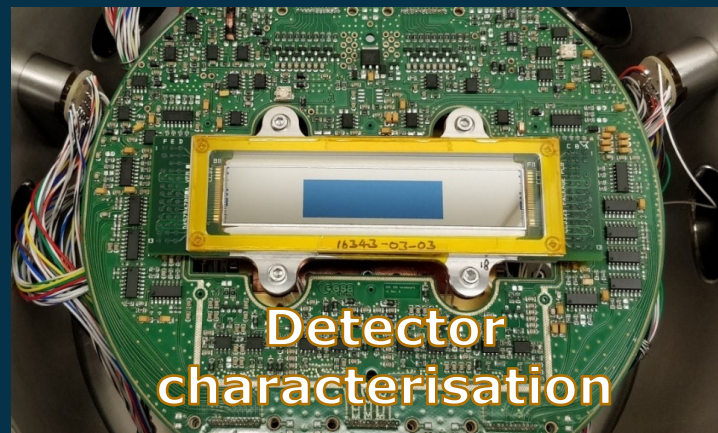
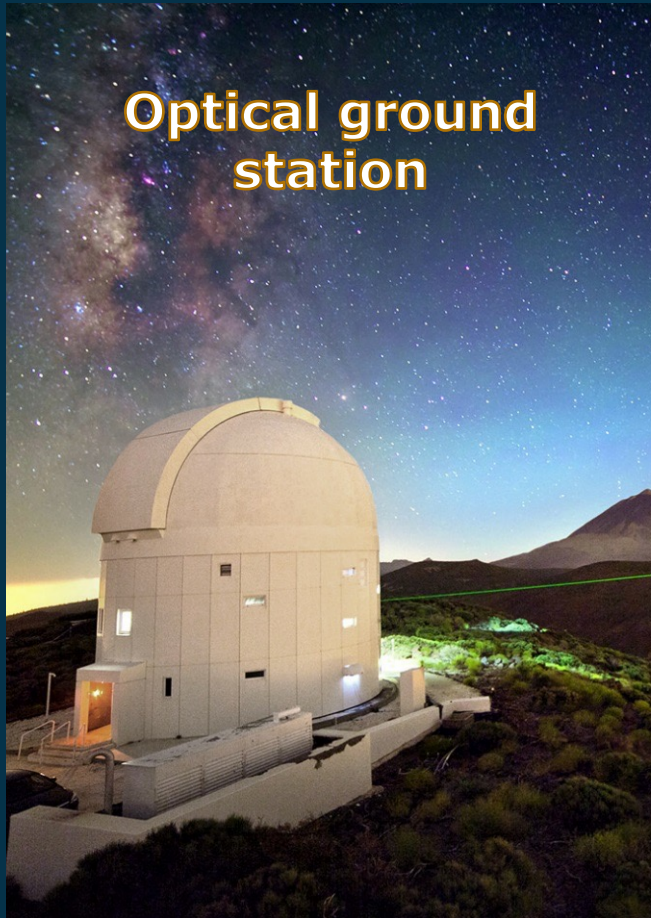
# Quantum (general)

- Optical atomic clocks
- Cold atom interferometers





# Test Facilities





# Optics Section TEC-MMO

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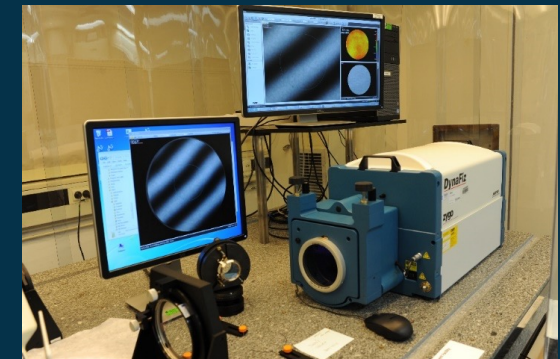
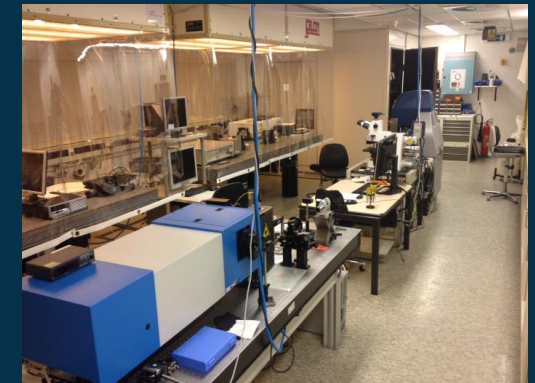
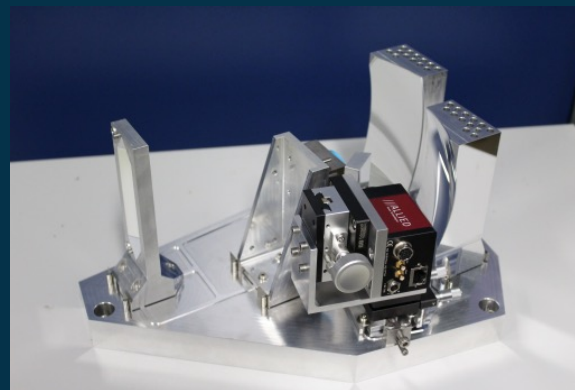
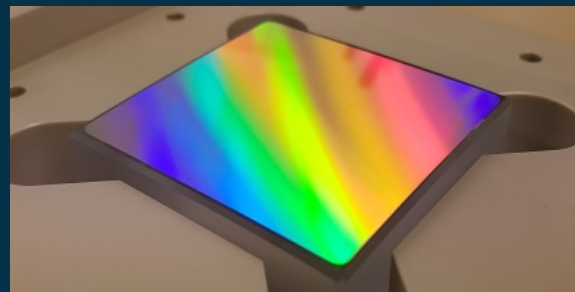
# Optical Engineering for passive systems



Optical engineering support to ESA projects hosting optical payloads

Research and Development Activities for passive optical systems

Optical Laboratory supporting ESA projects and external entities

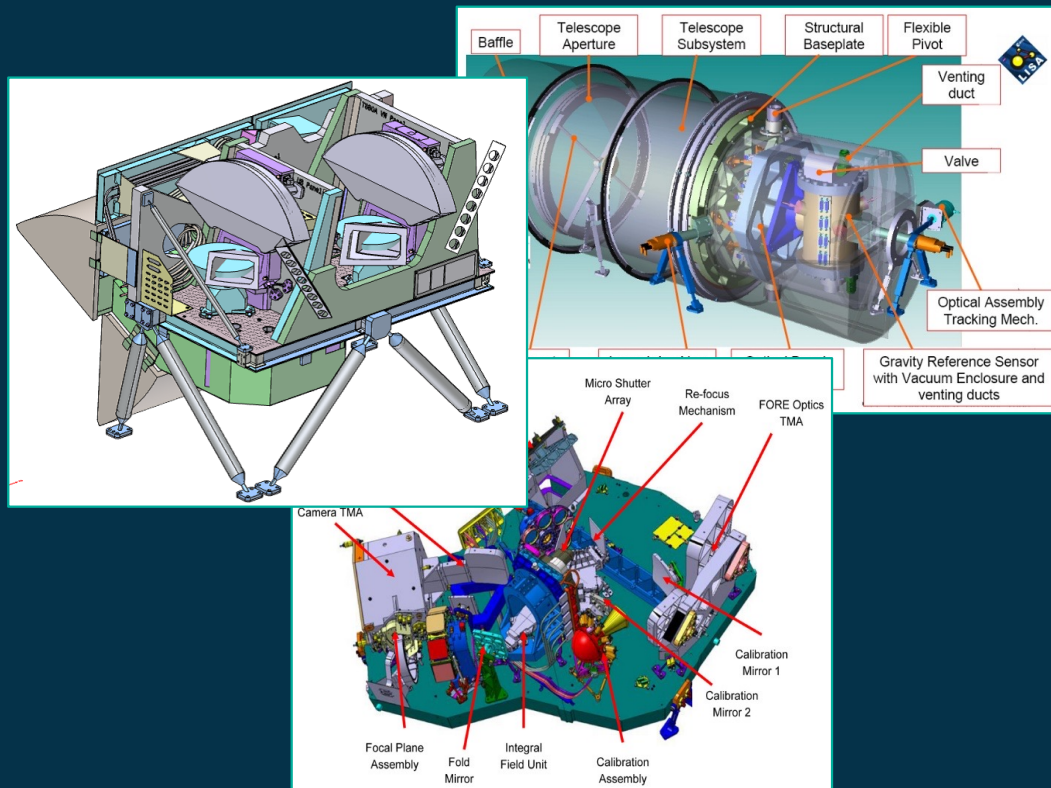




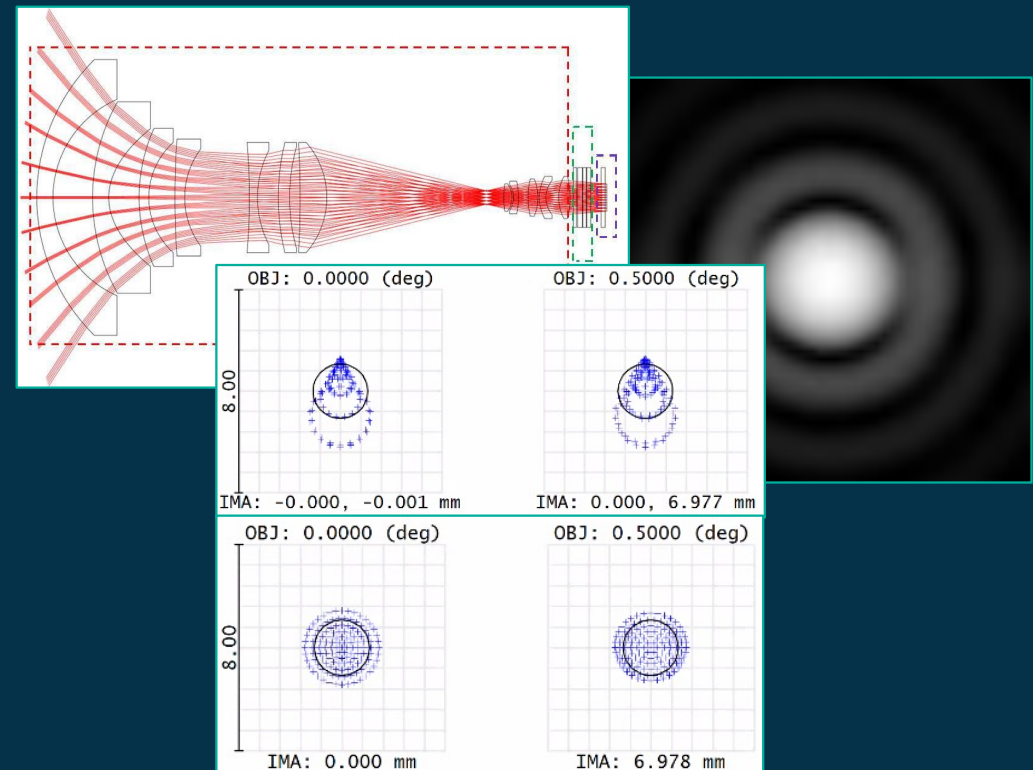
# Optical engineering support to projects (1)

Support to projects and associated external contractors in the various project phases with regard to

- optical design, trade-offs

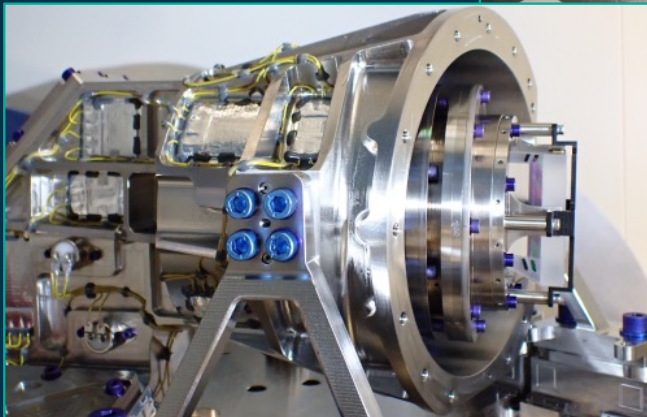
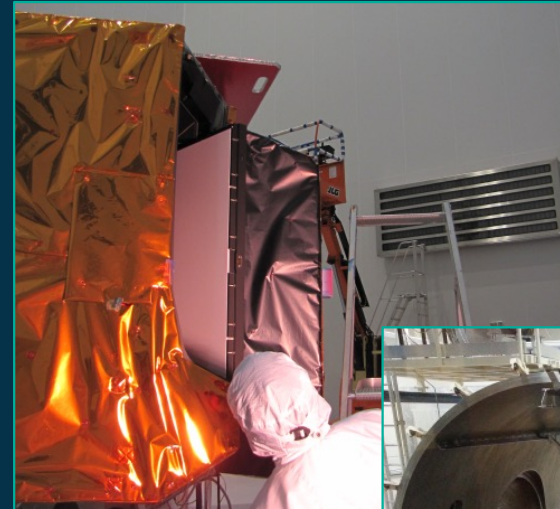
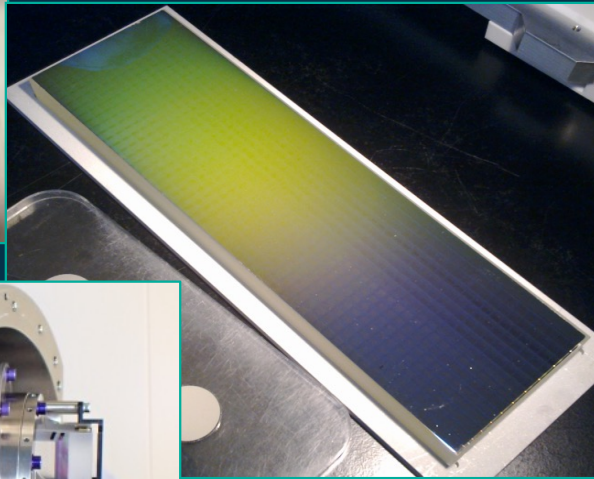
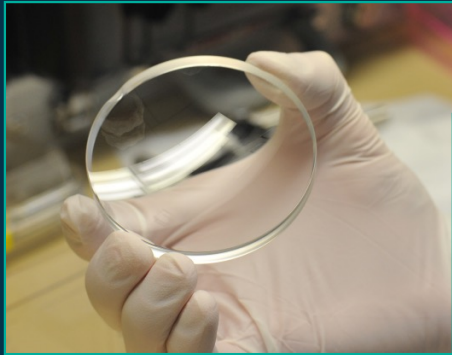


- optical performance analysis



# Optical engineering support to projects (2)

- procurement activities of components and subsystems
- alignment, integration and testing
- calibration





# R & D Activities for passive optical systems



Within the different ESA programmes (TDE, GSTP, GSP, OSIP) we explore and develop:

- optical materials
- manufacturing technology for components and optical systems
- design and development of novel optical systems and payloads
- new analysis, testing and calibration methods

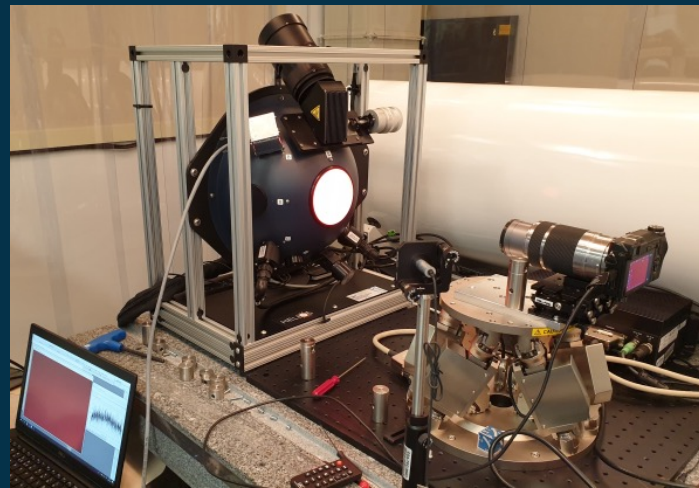
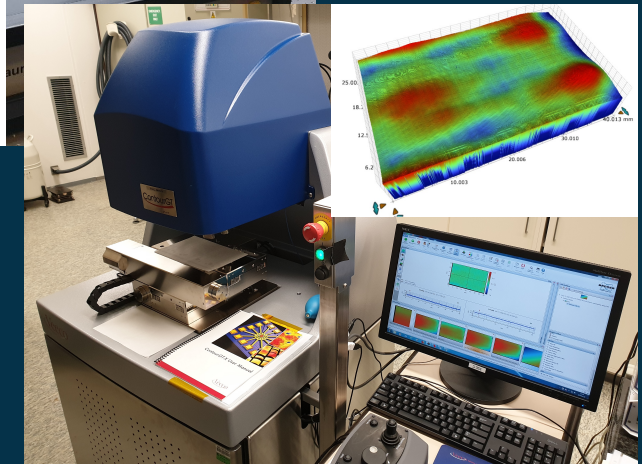
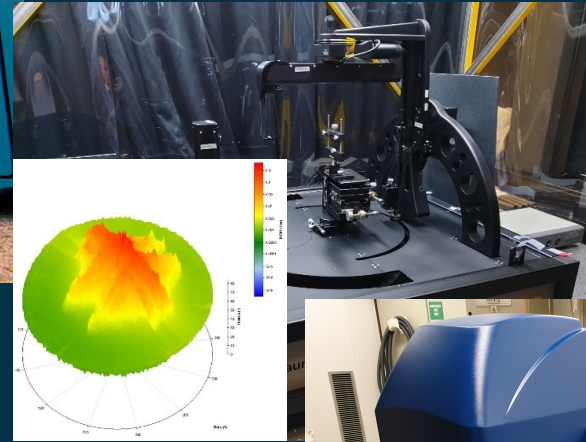
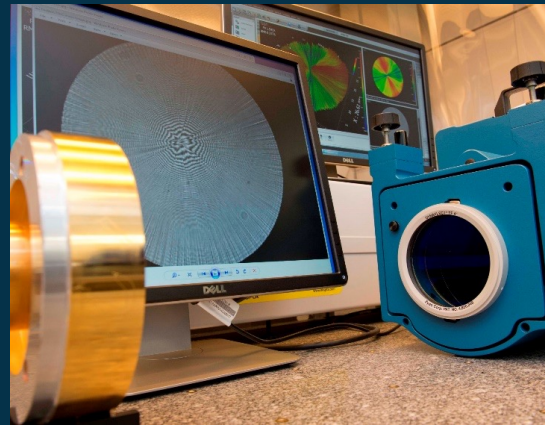
Some examples to the right:

Prog	Reference	Title
TRP	CZTF_1904;	Calomel Material Evaluation - Polishing Process Optimization
TRP	T716-702MM;	Alternative materials for mirror manufacturing
GSTP	GT11-015MM;	IAPETHOS 2: Infrared Advanced Polarizer for Space and Other Applications
TRP	T716-503MM;	Infra Red lens polishing for high performance applications
GSTP	G61A-032MM;	Development of low areal density Aluminium alloy mirrors using Additive Manufacturing
GSTP6	GT17-045MM;	Optomechanical mounts for large lenses
TRP	T116-401MM;	Wide band and high efficiency reflective grating
TRP	T116-701MM;	Dielectric broad-band mirror coatings
TRP	T116-705MM;	Large monolithic mirrors with ultra-lightweighted honeycomb structure
TRP	T716-602MM;	Manufacturing of ultralight mirrors by replication
TRP	T116-601MM;	Low stray light diffraction grating
TRP	T216-112MM;	Design and testing of Far and Medium Ultraviolet coatings
TRP	T216-111MM;	Joining process for manufacturing of large Aluminium-based optical mirrors
GSTP	GT17-410SW;	Solar Polarimeter - Critical Technology Development
GSTP	GT17-409MM;	Free form optical telescopes
TAS	TSS-MM-2020-172;	Ultrafine Guiding Sensor
TRP	T816-701MM;	Space Weather Magnetograph
TRP	T116-702MM;	Design and breadboarding of a wide field-of-view telescope for the next generation Copernicus Sentinel-2
TRP	A02017133;	High Throughput Waveguide Imaging Spectrometer
TRP	T116-703MM;	EBB of a Fourier Transform system for in-flight calibration of the Instrument Spectral Response Function.
GSTP	GT37-008MM;	High Quality MultiSpectral Imager payload for the Multispectral Companion Constellation
TRP	T116-503MM;	Efficient straylight characterisation and verification techniques for Earth Observation instruments
GSTP	GT17-179MM;	Software for System-Level Analysis of Space Optical Instruments
GSTP6	GT27-009MM;	MICA Optical characterization of high-precision mirror.
GSTP6	G617-234MM;	Radiation testing of optical coatings for space
TRP	T716-502MM;	Metrology for optical free-form surfaces
TRP	T116-501MM;	Characterisation of contamination induced straylight
TRP	T208-022MM;	Straylight LIDAR OGSE verification tool, hardware pre-development.
TRP	T716-703MM;	Optimisation tool for freeform mirrors using NURBS
TRP	T116-602MM;	Large area flat high-performance on-board Black-Bodies



# Optical Laboratory

- characterisation/testing of optical components (e. g. WFE, stray light, surface quality and inspection)
- testing of small optical payloads (imaging quality, radiometric calibration, stray light rejection)



# Take away



- **What do we do a TEC-MME and MMO?**  
provide technical support to programs and missions for the development of systems and payloads containing optics and opto-electronics.
- **What can we do for you?**  
guide you to the relevant areas of application and development programs, put you in contact with relevant developers. Once in a program, we will follow the technical development and assist on the particularities of space development.
- **What can you do for us?**  
let us know about the awesome things you do.

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