Driving innovation in high-precision optical systems

MLT at ESO EELT industry day

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Two key messages for E-ELT

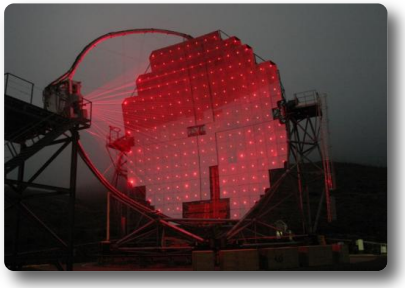
MLT has a strong and long lasting tradition of innovative high precision opto-mechanical products for scientific (and industrial) applications in partnership with **ESO, INAF, ASI, ESA, MPE,....**

MLT possesses an evolving advanced optics capabilities :

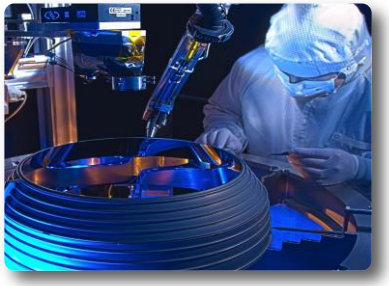
- **manufacturing** - deterministic figuring and polishing of large optics (<1.2m Ø)
- **metrology** - free-form high accuracy and comprehensive metrology
- **opto-mechanical** – lightweight athermal and thermally controlled

that can satisfy the innovation needs required by several E- ELT opto-mechanical elements

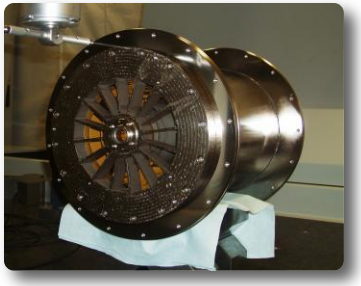
ALMA – ESO



CTA – INAF



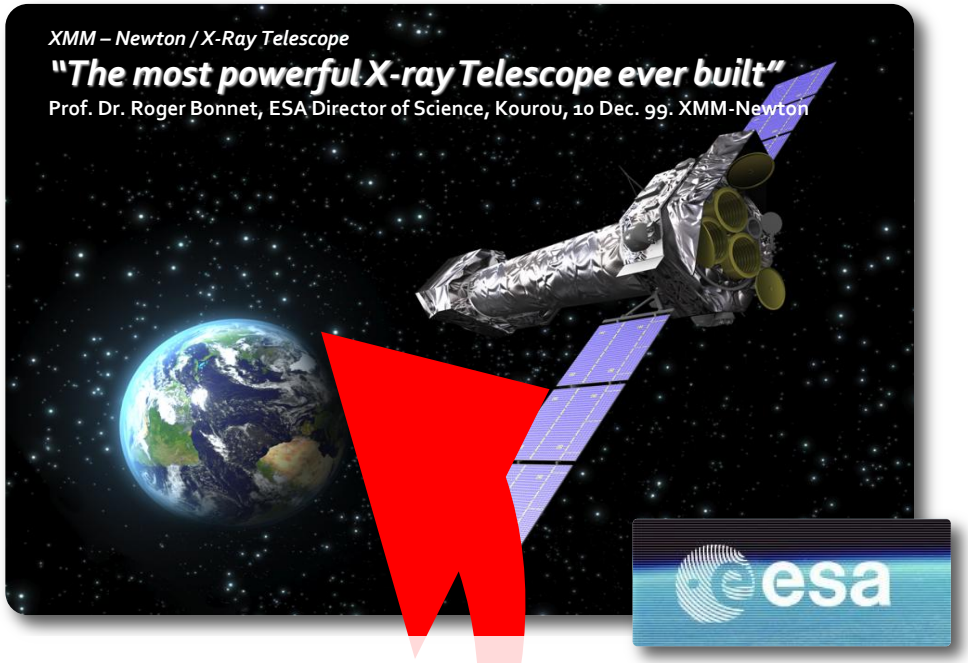
EUVL GIC - ASML



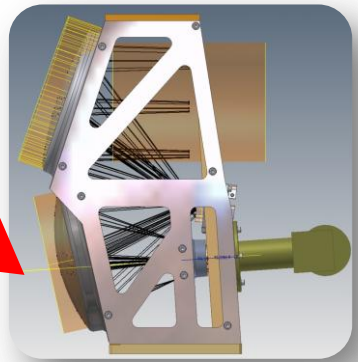
eROSITA– MPE(DLR)

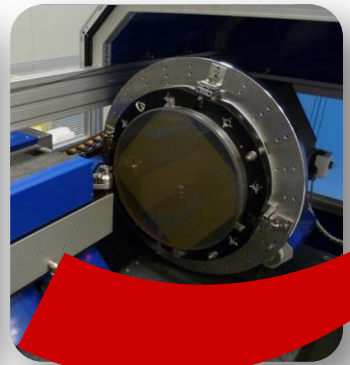
XMM - ESA

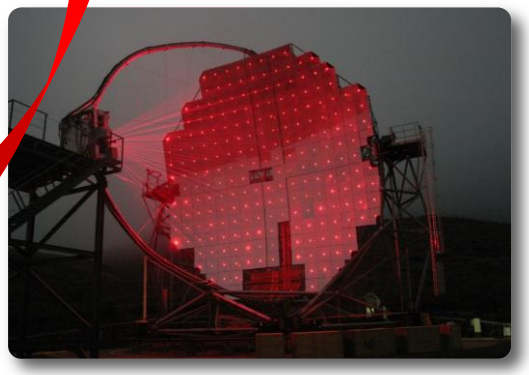
MLT is a successful example of an Italian Space Technology Spin-off, through continuous and synergistic technology evolution from Science Technologies to Industrial Applications



The Science Technology Spin-off and Spin-in







EUV LITHOGRAPHY | **IMAGING OPTICS** | **TERRESTRIAL TELESCOPES**

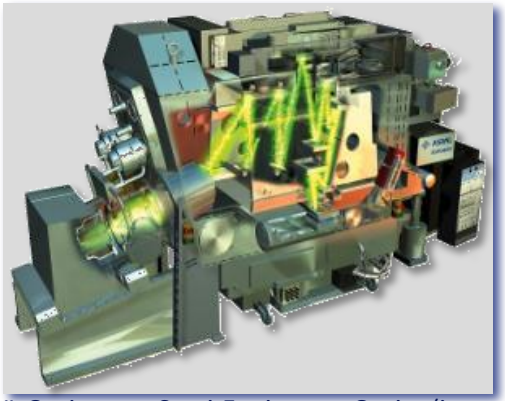
MLT's core and complementary technologies enable to serve Semi Equipment and Space & Terrestrial markets, while evolving into Imaging Optics markets

CORE TECHNOLOGIES/KNOW-HOW

- E-forming high Accuracy Replication
- Deterministic figuring & polishing
- Single & Multi-Layer Coatings

COMPLEMENTARY TECHNOLOGIES/KNOW-HOW

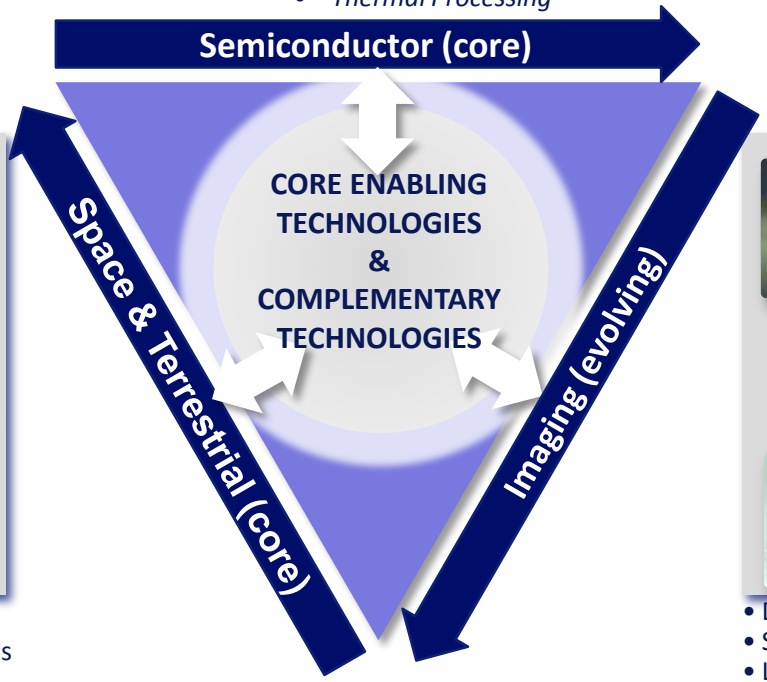
- Thermal-Mechanical & Optical Design
- Test and Integration of Opto-Mechanical systems

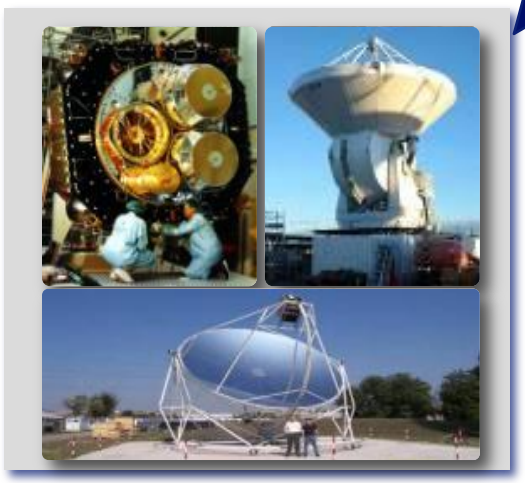


- EUVL Optics
  - Collector

Semi-Equipment Optics (intended)

- *Inspection & Metrology*
- *Illuminator*
- *Thermal Processing*



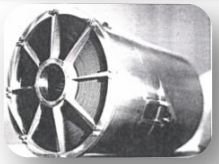


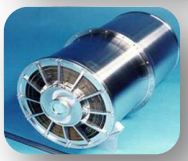
- X-ray space telescopes
- Terrestrial Radio and Cherenkov telescopes

- Defense Surveillance & Security
- Sun simulator
- Large highly aspheric optics for Visible applications

X-ray telescopes ground facilities like ALMA and CTA are MLT's legacy and innovation driver

X-ray telescope missions

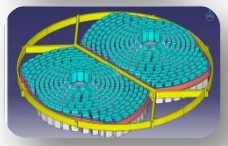
1993  Beppo SAX (**ASI**)

1995  JET-X → SWIFT (**NASA**)

1999  XMM (**ESA**), "The most powerful X-ray Telescope ever built"

2010  **ASI** sponsored technology development for NHXM

2011  EROSITA (**MPE**)

202x  ??? (**ESA**) WFI (**NASA**)

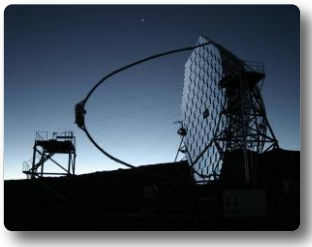
High accuracy radio telescopes

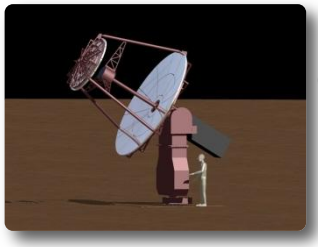
2003  IRAM PDBI

2005  LMT (**INAOE**)

2006 . . . . 2011  ALMA (**ESO**)

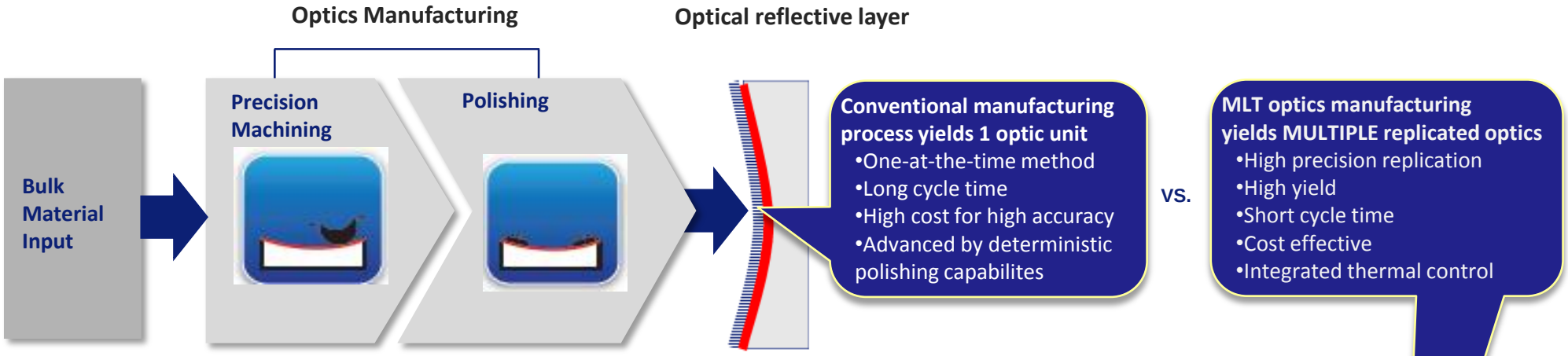
Cherenkov telescopes

2008  MAGIC 2 (**INAF-OAB**)

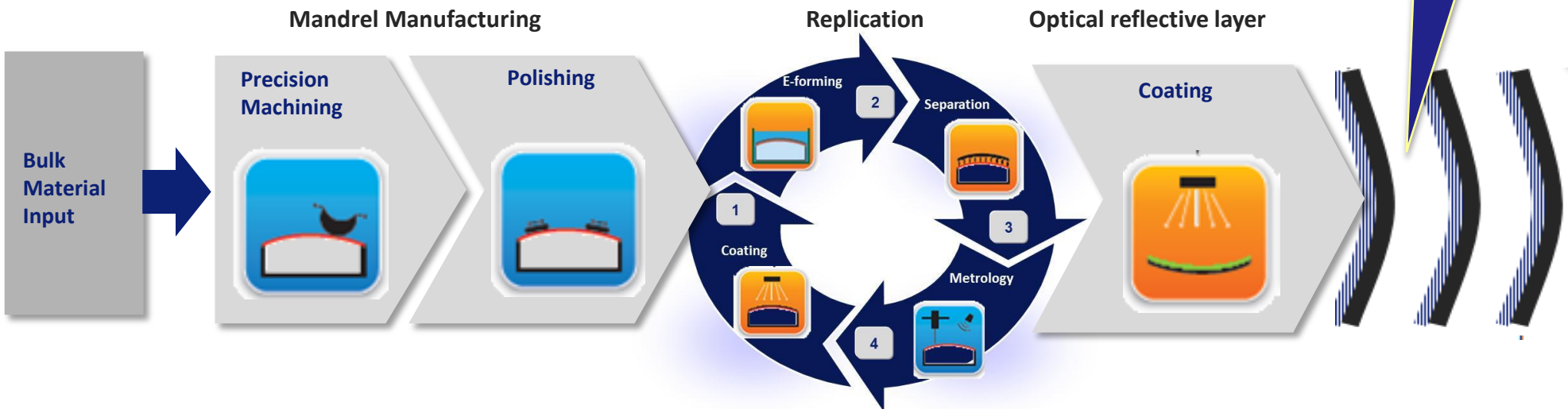
2010 . . . . 201x  CTA (**INAF-OAB**)

Evolving conventional optics mfg is complemented by MLT's disruptive "High-precision replication by electroforming" technology, which enabled our early competitive advantage

CONVENTIONAL OPTICS MANUFACTURING PROCESS



REPLICATION BY ELECTROFORMING OPTICS MANUFACTURING PROCESS



MLT free-form deterministic figuring & polishing capabilities developed for our high accuracy mandrel technology…

The free-form Deterministic Figuring & Polishing Process

MLT Equipment and machinery

Bulk Material

Precision Machining

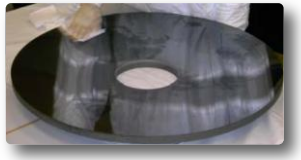
Shape Metrology

Deterministic Figuring & Polishing

Reflective Coating

Final Metrology

Reflective and refractive optical components



- Al, SS, NiP, TiN, S-PFL, SUPRAMAX, BK7, Glass ceramic
- Qualified MLT supply chain
- Customized profile metrology with 50 nm precision
- λ/40 interferometer
- CNC polishing process driven by metrology output
- 1.2 m diameter
- In-house and outsourced capability
- ∅800 mm PVD sputtering system
- ∅1 m ebeam evaporation coating systems
- Product specific optical benches for final verification
- ∅ 1200 mm
- Highly aspheric
- Non rotationally symmetric

…enables the manufacturing of high precision aspherical/free-form imaging components

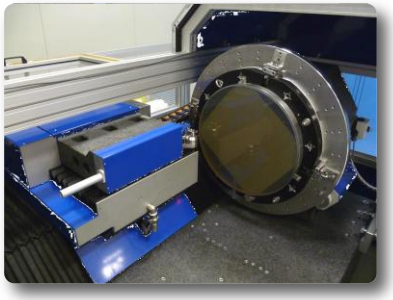
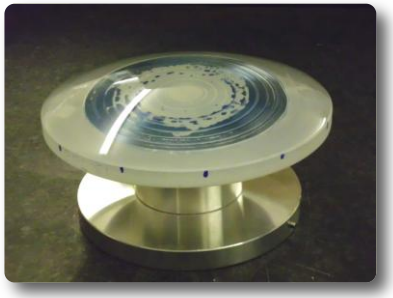
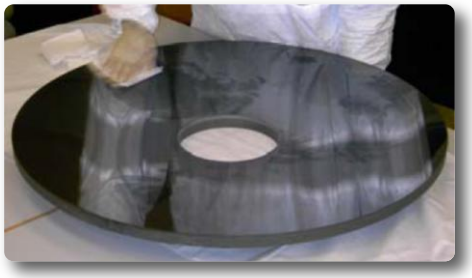
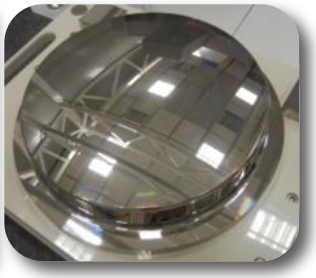
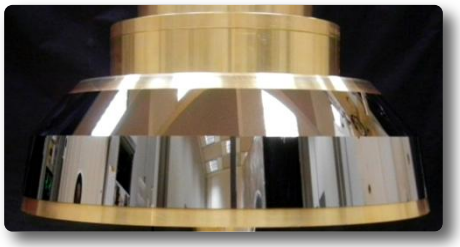
Capabilities and performances

Parameters	Description
Surface shape	Spherical, Elliptical, Aspheric, Free-form
Applications Wavelengths	XRay, EUV, VIS, IR
Materials	Al, SS, NiP, TiN, S-PFL, SUPRAMAX, BK7 (SiO_2, ULE, ZD)
Coatings	Au, Al, SiO_2, Cr, Ru, Pd, Pt, Ag, Rh, a-periodic W/Si and Pt/C

Parameters	Unit	Values
Optics diameter	[mm]	< 1200
RMS figure error*	[λ = 632 nm]	<λ/30
RMS slope error*	[µrad]	<4
HSFR (200 µm - 2 µm) *	[nm]	<0.2
HSFR (1 µm - 20 nm) *	[nm]	<0.2
MSFR (2mm - 50µm) *	[nm]	<0.3

*depending on substrate dimension and material

Imaging components examples

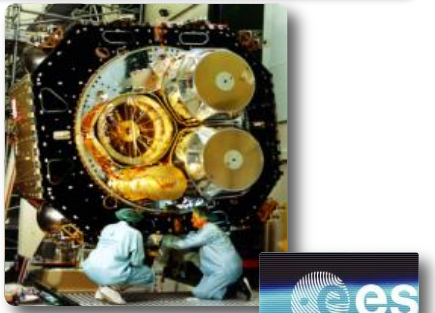







MLT deterministic polishing machines, associated with our free-form metrology capabilities, enable the manufacturing of large highly aspheric optics for visible applications

MLT's two deterministic polishing machines

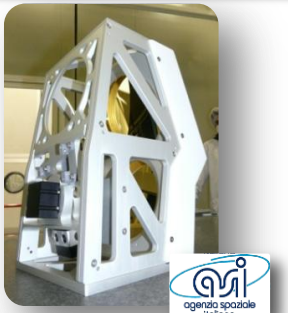
We combine strong opto-mechanical design & MAIT competencies, enabling advanced optical systems in a wide range of applications, in cooperation with our key partners

XMM Xray Telescopes



MPE - eROSITA Xray Telescope

Defense Multispectral VIS-LWIR



courtesy of

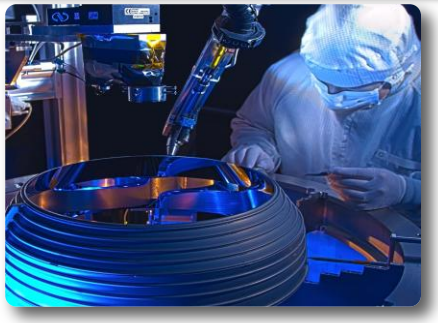
EUV Collector

ASML

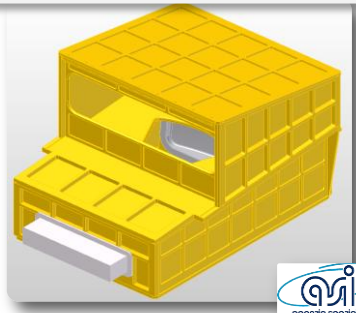
Nikon

Canon

EUV Collector



Space Multispectral VIS-LWIR

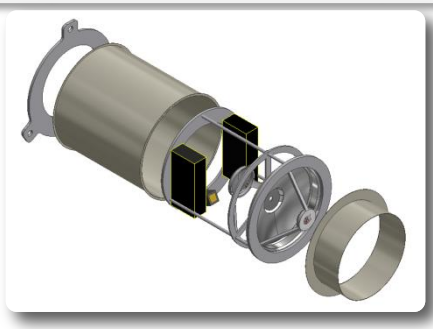


courtesy of

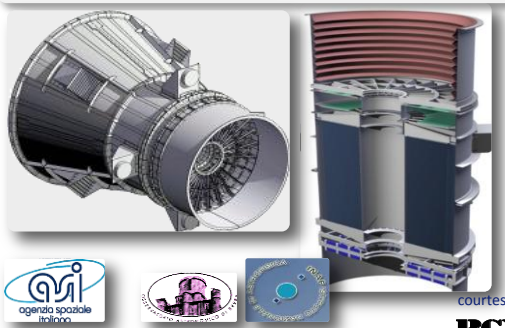
eder

www.e-der.de

High Res Visible Telescopes



SIMBOL-X Xray Telescope



courtesy of

BCV progetti s.r.l.

IXO Xray Mirror Module

courtesy of

BCV progetti s.r.l.

Summary

MLT has the capability and know-how to partner with scientific Institutions and Industries in order to provide E-ELT with innovative high precision opto-mechanical products

Manufacturing – Deterministic figuring and polishing of large optics (∅1.2m)

Metrology – Freeform high accuracy and comprehensive metrology

Opto-mechanical assembly – Lightweight athermal and thermally controlled systems