

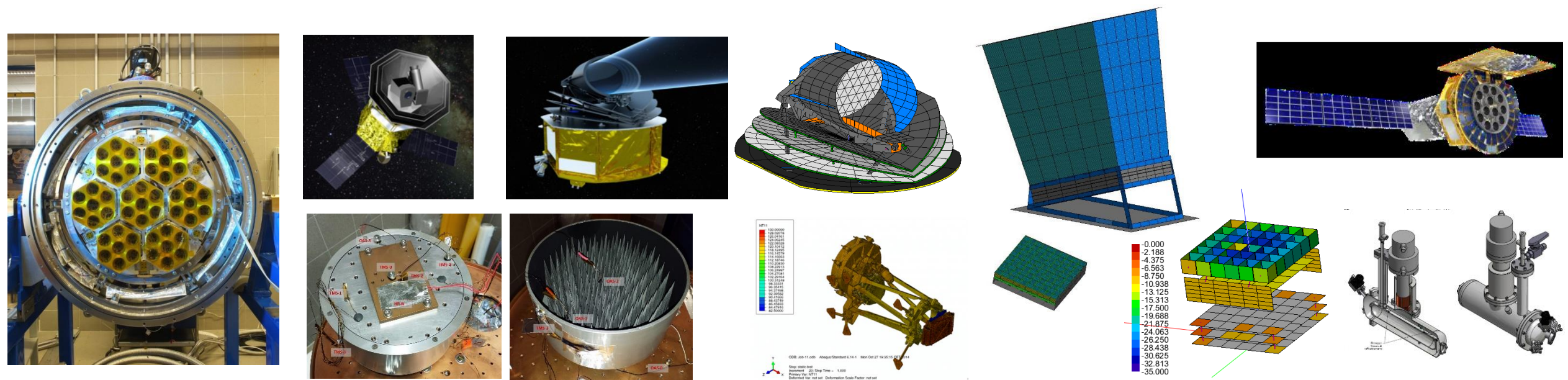
# Termomeccanica, ottica e metrologia @ OAS Bologna

# Thermal and Cryogenic Engineering for space and ground projects

- Thermal design and verification of space, balloon-borne and ground based scientific instrumentation; design, development, testing and operation of cryogenic thermal control systems and test facilities; study, characterization and analysis/removal of thermal systematic effects on scientific observations; measurement of thermo-physical properties of materials at low temperatures
- **Facilities:** presented in the dedicated session
- **Software tools:** Thermal modelling (ESATAN - TMS, SINDA/FLUINT, Systema/THERMICA), CAD Mechanical design interface (AutoDesk Inventor, SpaceClaim, ANSYS), I/F to project data analysis pipeline and instrument E2E model
- **People:** Gianluca Morgante, Luca Terenzi

# Ongoing projects

- **LSPE: Strip** Cryogenic system design and testing. Support to instrument calibration (GM, LT, F. Cuttaia, F. Villa)
- **LiteBIRD M-HFT**: Participation and support to the ESA Concurrent Design Facility (CDF) study; measurement of material RF properties at low temperatures to support optical design and characterization (GM, LT, F. Cuttaia, M. Sandri, F. Villa)
- **TMS**: 4K cold load cryogenic design and verification (LT, F. Cuttaia)
- **ARIEL**: PLM Thermal Architecture Lead, Thermal System Engineering, Telescope Assembly thermal engineering activities (GM, LT)
- **Euclid NISP**: Thermal Architecture Lead, Thermal System Engineering and AIV related activities (GM, A. De Rosa)
- **Theseus: XGIS** Thermal System Engineering activities (LT, GM)
- **HERMES**: Thermal System Engineering activities (GM, F. Fuschino)
- **FAMU**: Cryostat and laser cavity thermo-mechanical design and trade off vs optical (GM, F. Fuschino)
- **eXTP**: Thermal Engineering activities (GM)



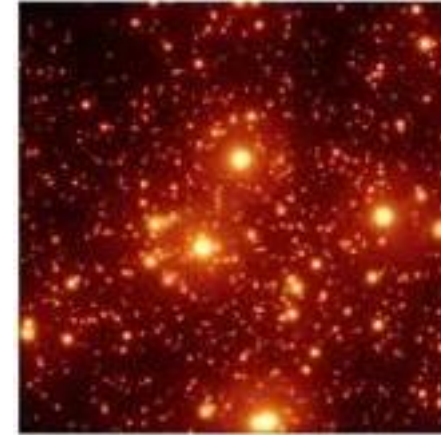
# MAORY/MORFEO Project



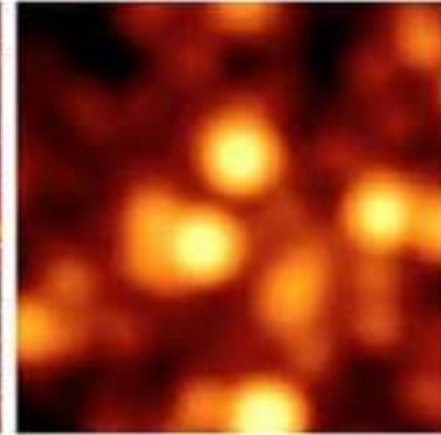
MORFEO (formerly known as MAORY) is the Adaptive Optics Module for Extreme Large Telescope (ELT, 39 m diameter)

MORFEO, as first generation ELT instrument, will help compensate for the distortion of light caused by turbulence in the Earth's atmosphere which make astronomical images blurry

MORFEO is built by a consortium of 3 institutes :  
**INAF** (7 Institutes in Italy) **IPAG** (Grenoble France) ,  
**NUIG** (Galway , Ireland). **INAF is the leader institute.**



AO Corrected



NO AO Corrected

Technological involvement at the highest levels in the fields of mechanics, optics, electronics, control software

The instrument will be integrated and tested at the Bologna Integration Hall (INAF OAS CNR Area)

Strong INAF involvement with more than 70 people involved in the project

**BOLOGNA INAF OAS** : Paolo Ciliegi (Principal Investigator) Ugo Di Giammatteo (Project Manager), Italo Foppiani (Deputy SE), Gabriele Rodeghiero (Deputy MAIV Manager), Alessandro Tacchini (Technical Team), Francesca Annibali (Project Scientist), Carlotta Gruppioni (Science Team), Elisabetta Maiorano (Science Team), Massimo Meneghetti (Science Team), Eros Vanzella (Science Team)

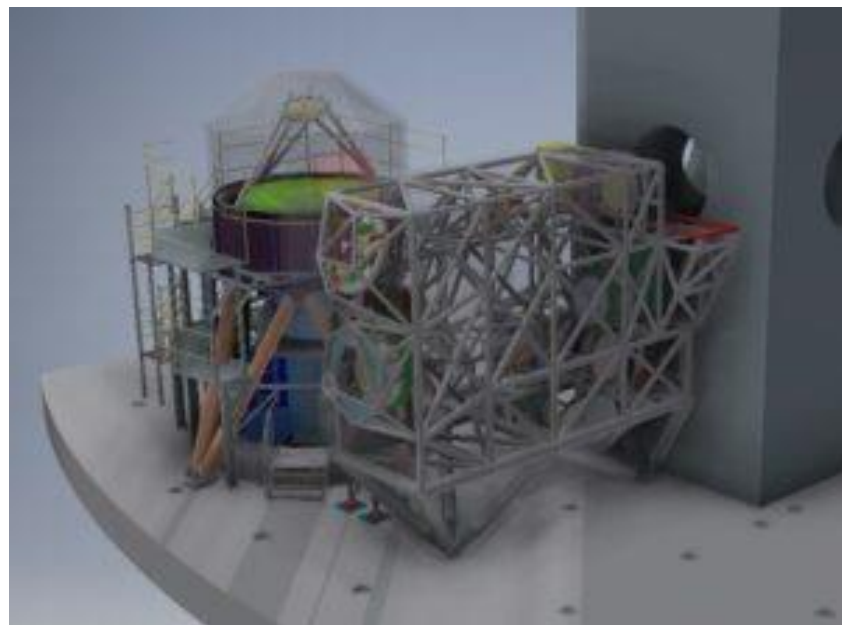


# STATUS OF THE PROJECT

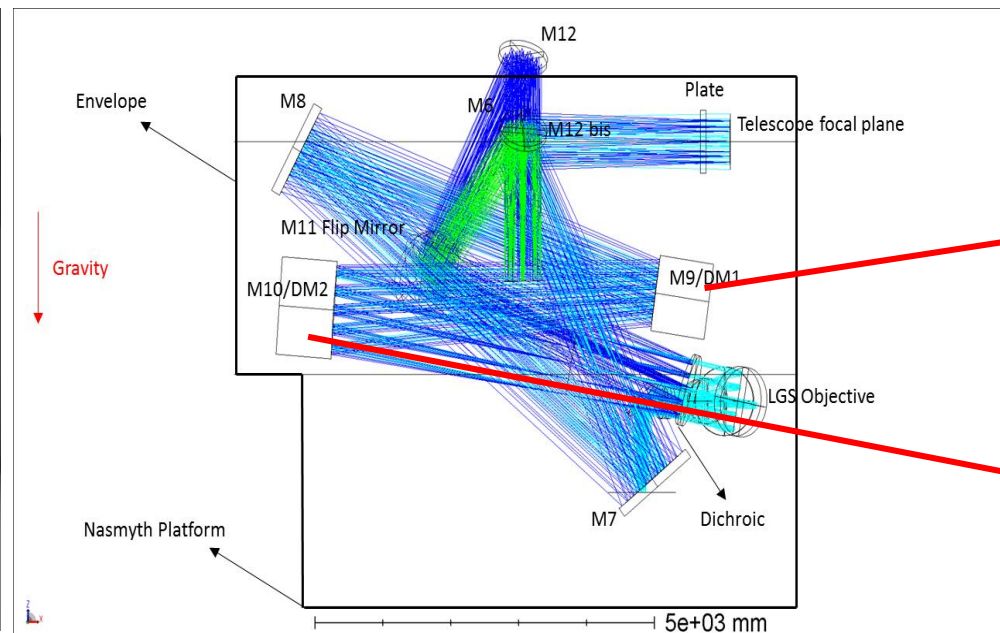
FINAL DESIGN PHASE - INTEGRATION WILL START IN BOLOGNA IN Q2 2024

THE 3 MAIN ELEMENTS WILL BE SUBJECT OF PUBLIC CALL FOR TENDER Q3/Q4 2022 (FINAL DESIGN PHASE + MANUFACTURING)

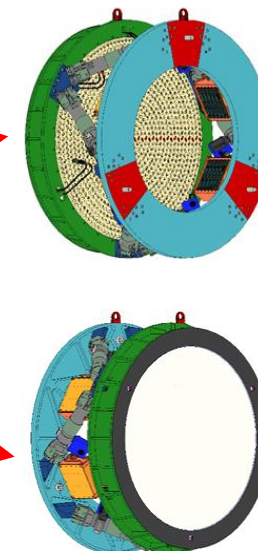
## MAIN MECHANICAL STRUCTURE



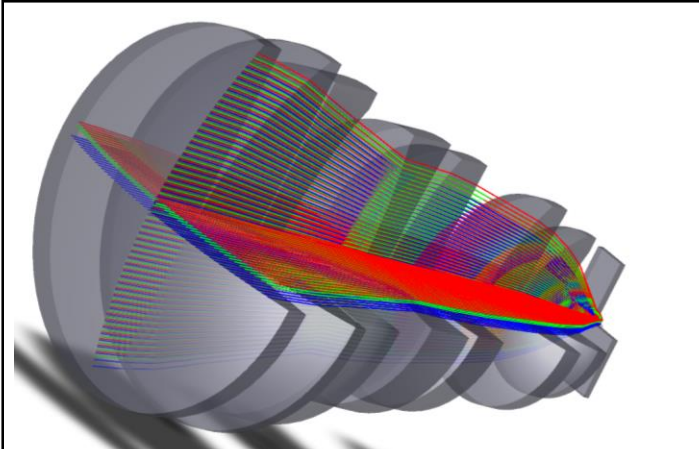
## OPTICAL ELEMENTS



## DEFORMABLE MIRRORS



# Optical design, analysis, specification, integration, alignment of optical-infrared instrumentation

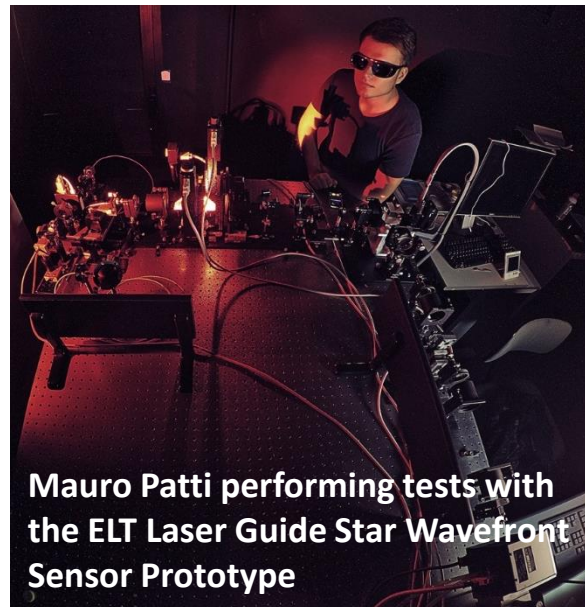
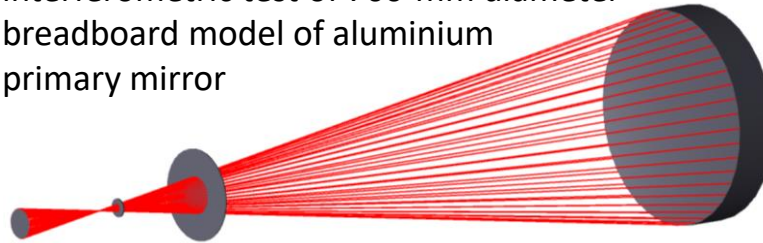


Ø130mm very fast (f/0.88) objective for LBT-NIRVANA wavefront sensor



## ESA Ariel mission – Telescope Assembly

Optical model of double-pass interferometric test of 700-mm diameter breadboard model of aluminium primary mirror



Mauro Patti performing tests with the ELT Laser Guide Star Wavefront Sensor Prototype

## Involved OAS personnel

Fausto Cortecchia

Emiliano Diolaiti

Matteo Lombini

Laura Schreiber

*Note: more people at OAS are involved in the projects shown here and in the next slide, with other functions/roles (see other talks in this meeting)*

## Main Software tools

Zemax OpticStudio®

Custom software tools

## Historic evolution of the optical design of the Multi Conjugate Adaptive Optics Relay for the Extremely Large Telescope <sup>FREE</sup>

Matteo Lombini ✉, Emiliano Diolaiti, Mauro Patti

*Monthly Notices of the Royal Astronomical Society*, Volume 486, Issue 1, June 2019, Pages 320–330, <https://doi.org/10.1093/mnras/stz810>

# Optical design, analysis, specification, integration, alignment of optical-infrared instrumentation

## Main projects<sup>(\*)</sup> in the last 20+ years

grouped by Telescope / Space Mission

(\*) projects relating to technology transfer not listed here

### Large Binocular Telescope (LBT)

- Large Binocular Camera
- Wavefront sensors for the NIRVANA adaptive optics instrument
- Infrared Test Camera
- *High-resolution visible spectrograph for SHARK-VIS (ELVIS)*

### Very Large Telescope (VLT)

- Wavefront sensor for MAD (Multi-conjugate Adaptive optics Demonstrator)
- *SAXO+ (2nd stage adaptive optics module for SPHERE)*
- *MedRes (infrared spectrograph for SPHERE)*

### Cassini Telescope @Loiano

- *1.2deg camera & spectrograph (SuperFOSC)*

### Ariel

- *Telescope Assembly AIV*

### ExoMars 2020

- *MicroMED Optical Particle Counter*

### United Kingdom InfraRed Telescope (UKIRT)

- Cambridge OH Suppressed Instrument (COHSI)

### VLT Survey Telescope (VST)

- VST telescope

### Telescopio Nazionale Galileo (TNG)

- Galileo OH Suppressed Spectrograph (GOHSS)

### European Extremely Large Telescope (ELT)

- Multi-conjugate Adaptive Optics RelaY (MAORY)
- Laser Guide Star wavefront sensor prototype

#### Key

ground-based telescope

space mission

# INAF Vs COVID – attività OAS e personale coinvolto

- Attività INAF su Ultra Violet Germicidal Irradiation UVGI a partire dalla fine di Marzo 2020 e ancora in corso
- Personale coinvolto
  - Fausto Cortecchia, Adriano De Rosa, Emiliano Diolaiti, Matteo Lombini, Giuseppe Malaguti, Filomena Schiavone, Laura Schreiber
- Ricerca:
  - Simulazioni ottiche con programmi di ray-tracing e simulazioni fluido-dinamiche per ottimizzare le prestazioni dei dispositivi
  - Moon Ultraviolet Albedo Measurement – MUAM, all'interno della proposta Earth–Moon–Mars (PI F. Esposito) nell'ambito del bando PNRR infrastrutture
  - Solar Ultraviolet Light Collector for Germicidal Irradiation on the Moon – SULCIM, all'interno dello spoke 'Habitat extraterrestri' del bando ASI in uscita
- Consulenze e progetti
  - Consulenza per Intersurgical s.p.a: "studio di un concetto di filtro per la sanificazione dell'aria mediante irraggiamento con luce Ultravioletta, da utilizzare nei caschi CPAP-AID, mediante simulazione ottica delle prestazioni e costruzione di un prototipo"
  - Consulenza per ORION s.r.l. 'Optimization of an excimer lamp for viral inactivation"
  - Collaborazione con CSMT Brescia per impianto pilota di Unità trattamento aria mediante radiazione UVC
  - Collaborazione con UNIPR per misure sperimentali efficienza dei dispositivi compatti di sanificazione aria tramite sorgenti LED UVC
  - Collaborazione con NKVDesign Milano per prototipo di dispositivo UVC con sorgenti a scarica di mercurio per sanificazione aria nelle aule scolastiche



# INAF Vs COVID – brevetti

- “Dispositivo per la disinfezione di un flusso di fluido in un condotto mediante radiazioni uv-c” , brevetto italiano n. IT102020000030899, dicembre 2020, brevetto internazionale n. PCT/IB2021/061779, dicembre 2021
- “Dispositivo per la disinfezione di un flusso di aria mediante radiazioni uv-c e sistema di respirazione assistita comprendente tale dispositivo”, brevetto italiano n. 102021000011783, maggio 2021, brevetto internazioent n. PCT/IB2022/054193, maggio 2022
- “Dispositivo e metodo di disinfezione di un volume di lavoro in un ambiente artificiale spaziale tramite radiazioni uv solari”, brevetto italiano n. 102021000014657, giugno 2021 – estensione internazionale in corso
- “Dispositivo per la sanificazione di aria mediante radiazione ultravioletta” brevetto italiano n. 02021000020087, luglio 2021

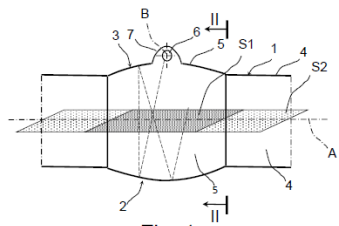


Fig. 1

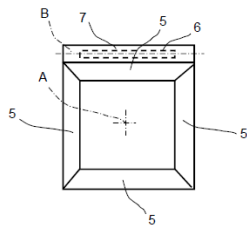


Fig. 2

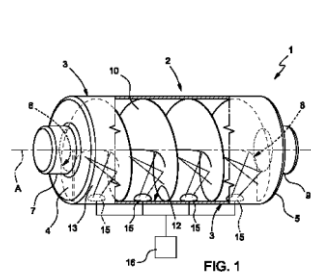


FIG. 1

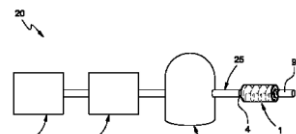


FIG. 2

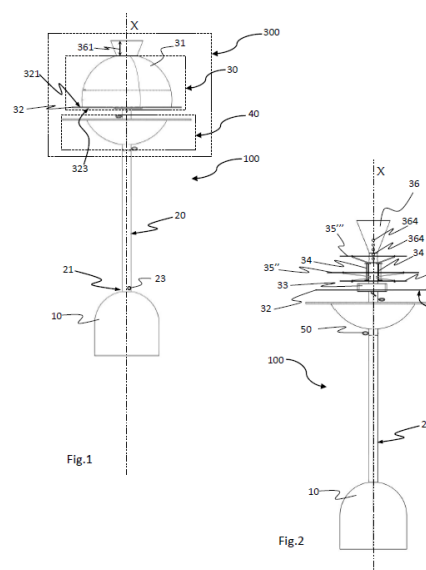


Fig.1

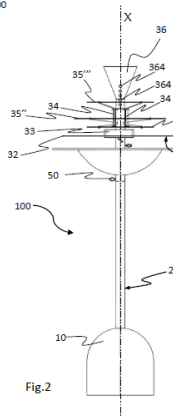


Fig.2

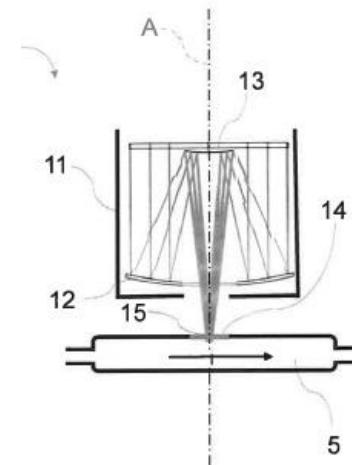


FIG. 3a

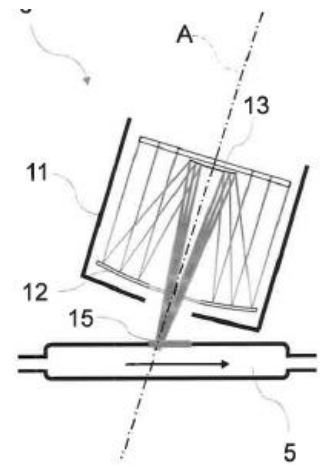
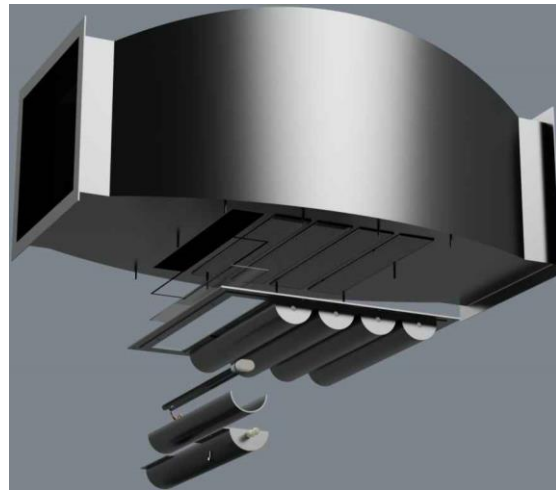


FIG. 3b

# INAF Vs COVID – pubblicazioni

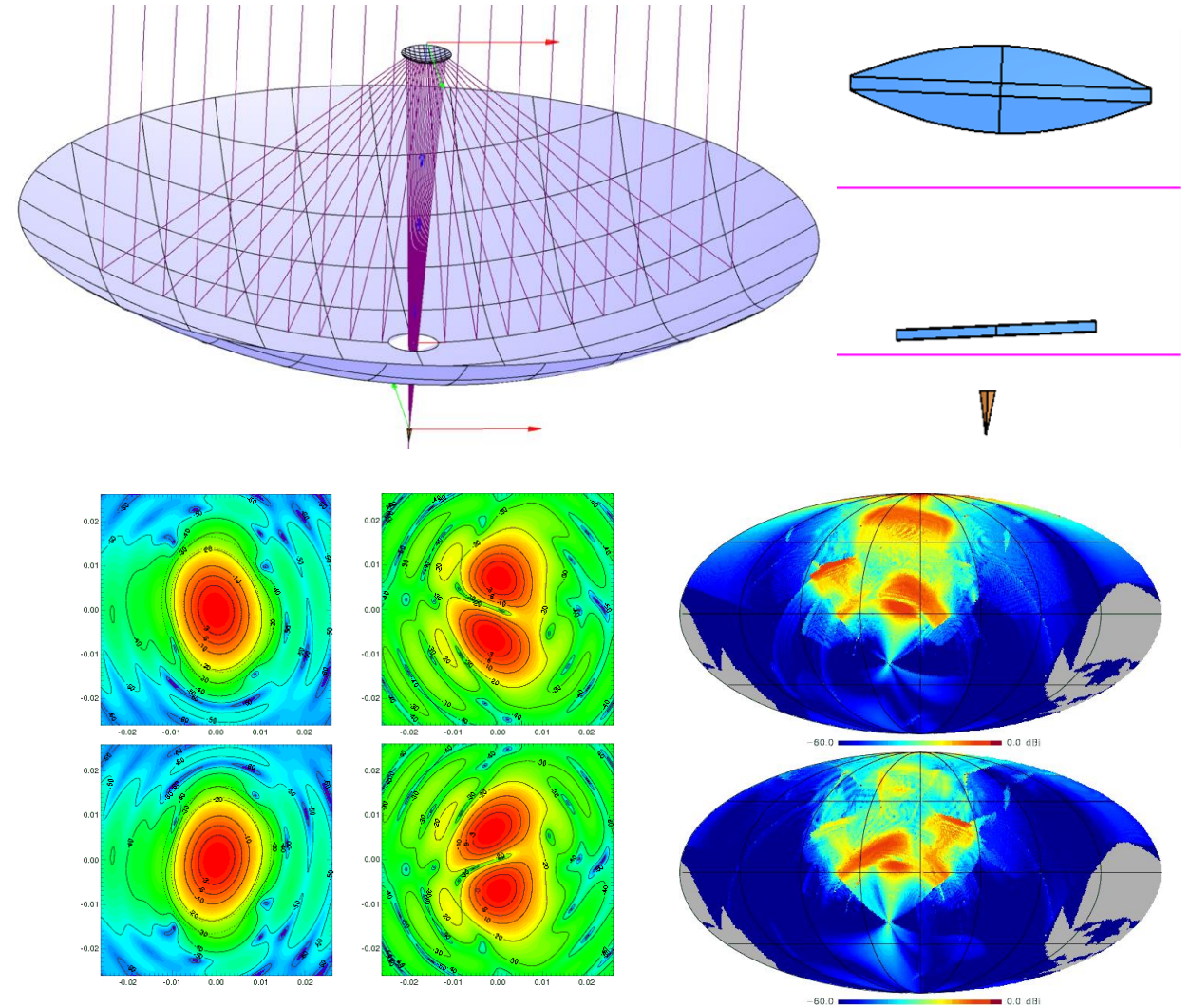
- Lombini, M., et al. *“Effective pathogens inactivation in air ducts through UVC light”*, in pubblicazione @ Memsait
- Macchi A., et al. *“UV-C Light, an Example of Application for Air Sanification”* , in pubblicazione @ Memsait
- Lombini, M., Diolaiti, E., De Rosa, A., Lessio, L., Pareschi, G., Bianco, A., Cortecchia, F., Fiorini, M., Fiorini, G., Malaguti, G., Zanutta, A. *“Design of optical cavity for air sanification through ultraviolet germicidal irradiation “*, (2021) Optics Express, 29 (12), pp. 18688-18704
- Lombini, M., Diolaiti, E., De Rosa, A., Lessio, L., Pareschi, G., Bianco, A., Cortecchia, F., Fiorini, M., Fiorini, G., Malaguti, G., Zanutta, A. *“ Optical design applied to an effective inactivation of airborne pathogens “*, (2021) Proceedings of SPIE, 11876, art. no. 118760D



# Simulazioni ottiche alle microonde e onde mm

## 1/2 Attività ed Expertise

- Progettazione, Ottimizzazione e caratterizzazione completa di sistemi ottici. Principalmente antenne di piano focale (horn) e a riflettore e loro accoppiamento
- Utilizzo di software di simulazione elettromagnetica allo stato dell'arte (es. GRASP, HFSS)
- Expertise riconosciuta a livello mondiale grazie agli studi sul telescopio e piano focale del satellite Planck (progettazione, sviluppo, osservazioni ed analisi dati)
- Competenze uniche grazie ad un approccio sistemico, fondamentale in tutte le fasi di sviluppo di esperimenti e per la valutazione degli effetti sistemici.



# Simulazioni ottiche alle microonde e onde mm

## 2/2 Principali progetti e Personale Coinvolto

passato

- ESA / Planck (cosmologia CMB)
- Consulenze per SRT, LiteBIRD (JAXA)

presente

- ASI-INFN / LSPE-Strip (cosmologia CMB)

- ALMA Banda 2

- SOLARIS (Space Weather)

- ALMA upgrades (TBD)

- ...

- Personale OAS

- F. Cuttaia, M. Sandri, F. Villa

