

UNIVERSITÀ  
DEGLI STUDI  
DI PADOVA

# Sviluppo di sistemi di ottica adattiva per satelliti

Lorenzo Borsoi - 39th Cycle

PhD Course in Science, Technologies and Measurements for Space  
Presentation of proposed research program - February 14th, 2024



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- Why do we need Adaptive Optics for LaserCom?



- Dynamic Optics s.r.l.

Founded by Stefano Bonora and part of the Officina Stellare group, Dynamic Optics is active in the adaptive optics sector, and supplies devices and systems with deformable optics for microscopy, ophthalmology, laser communication and astronomy worldwide.



# Research Project Objectives



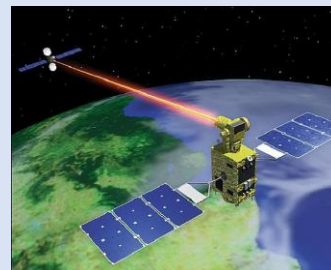
- **Designing, prototyping, and testing** a compact device (TRL5) for the pointing control of a laser beam using deformable optics (PLAN - project financed by ASI to Dynamic Optics and Stellar Project)
- **Developing** a key technology for optical band satellite transceivers made within national borders.
- Acquisition of **know-how** in the LaserCom field
- Acquisition of **experience** in adaptive optics and wavefront correction fields

# State-of-the-Art

ARTEMIS and SPOT-4 (2001)



ARTEMIS and OICETS (2005)



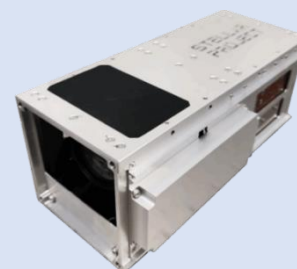
Kondor MK3 (Mynaric, DE)



CUBE LCT (Tesat, DE)

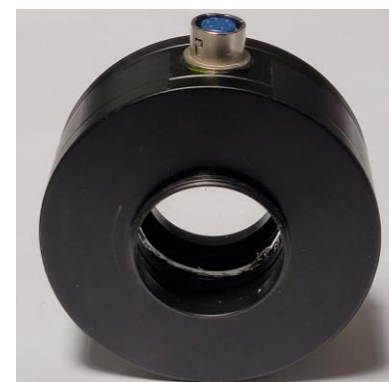
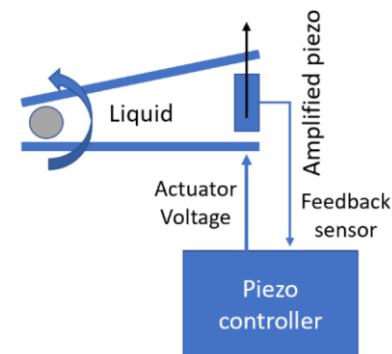


Laser Cube (Stellar Project, ITA)

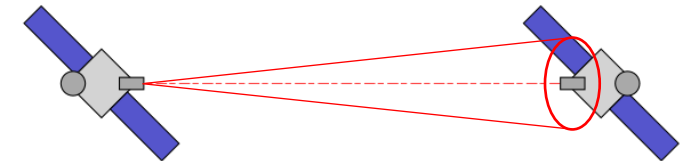


## *Dynamic Prism:*

- Composed of two glass windows that can be tilted relative to each other by a piezoelectric actuator
- Demonstration prototype of a deformable lens specific for tip/tilt



- Pointing errors → Fiber-coupling losses → BER
  - Time-constant (tracking)
  - Time-random (jitter)



- Inter-satellite optical link performance (Friis equation):

$$P_R = P_T G_T G_R \eta_T \eta_R L_{PT} L_{PJ} \left( \frac{\lambda}{4\pi Z} \right)^2$$

$G_R$ : Rx gain

$G_T$ : Tx gain

$\eta_T$ : Tx optical efficiency

$\eta_R$ : Rx optical efficiency

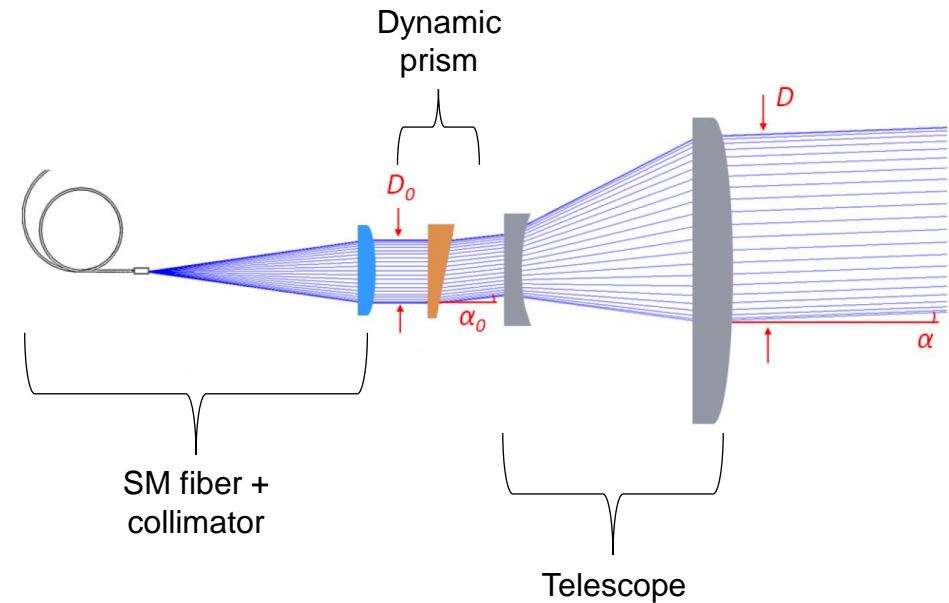
$L_{PT}$ : tracking loss

$L_{PJ}$ : jitter loss

$\lambda$ : communication wavelength

$Z$ : inter-satellite distance

- Define the overall architecture
- Optimize the optical system to maximize
  1. FoV
  2. Resolution
  3. Speed response
- Define the mechanical aspects considering
  1. Material selection
  2. Structural integrity
  3. Vibration analysis
  4. Thermal analysis





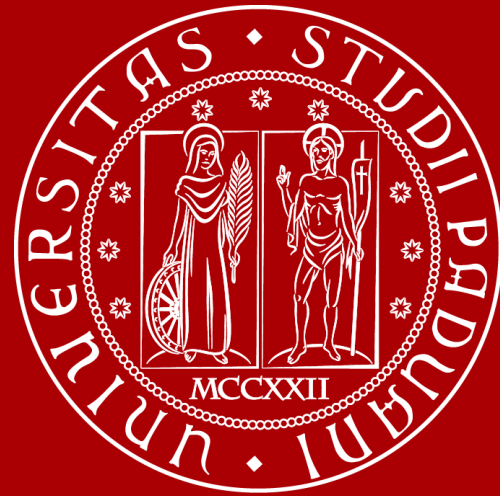
# Breadboard Testing

- The necessary optical components and other relevant materials will be identified for the experimental setup
- Data will be collected and analyzed to assess the system's pointing accuracy, speed response and overall reliability





Thanks for the attention



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