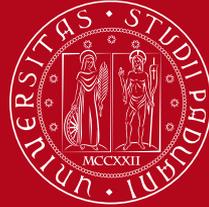


1222 · 2022  
**800**  
ANNI



UNIVERSITÀ  
DEGLI STUDI  
DI PADOVA

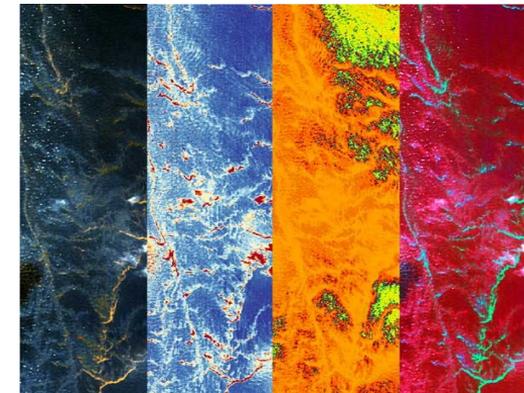
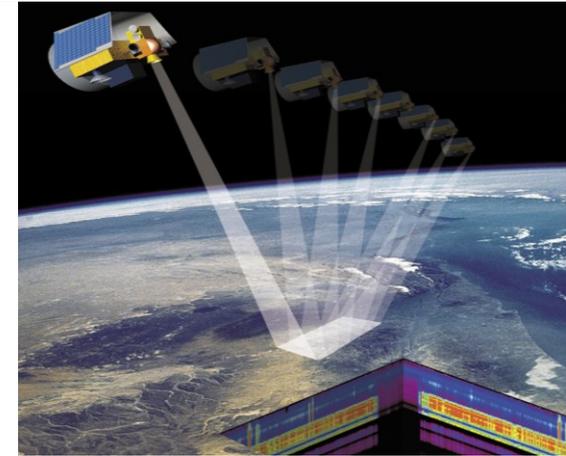
# Environmental Monitoring By Means Of Hyperspectral Cameras On Board The Cubesat

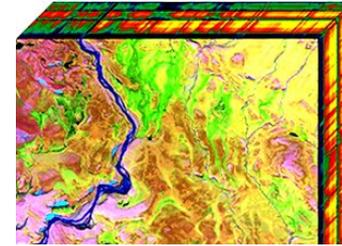
PhD Candidate: Igor Dorgnach - 37th Cycle

Supervisor: Prof./Dr. Giampiero Naletto

CISAS PhD Application – Project Work Proposal - 21/01/2022

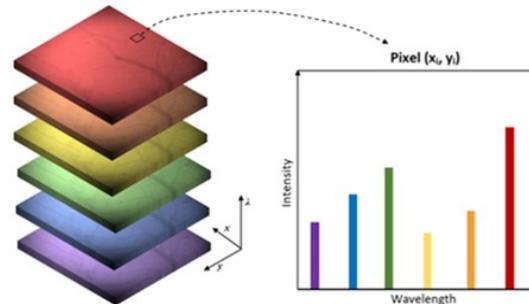
- The aim of the project is to define the design of an innovative instrument for terrestrial remote sensing, that is, for the observation of the Earth from satellite
- We will study the feasibility of an instrument of a few units of cubesat to carry out hyperspectral observations, i.e. capable of providing spectroscopic information of the observed Earth's surface
- My research proposal focuses on a new state of the art optical analysis and design methodologies applied to the cubesat missions for environmental monitoring





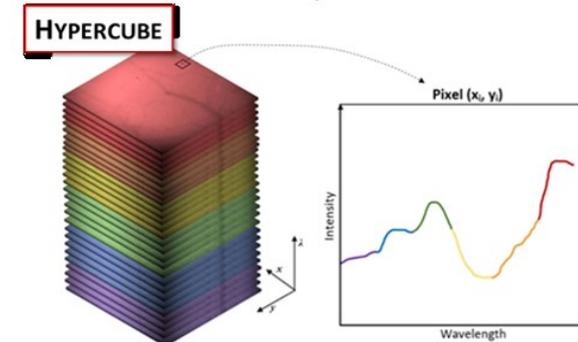
## MULTISPECTRAL IMAGING

- N separated bands



## HYPERSPECTRAL IMAGING

- Continuous spectrum

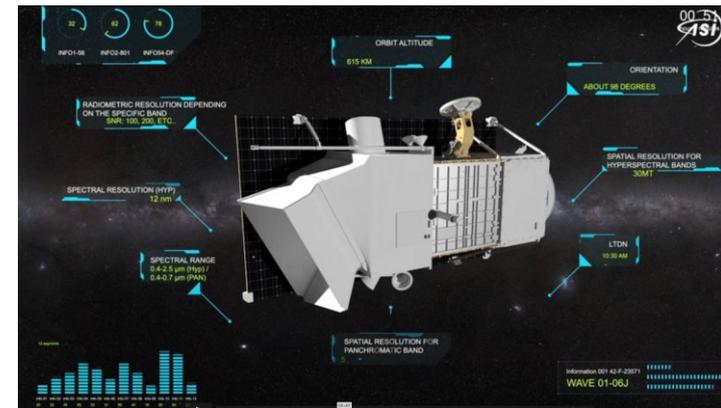


## ENABLES SPECTRAL ANALYSIS

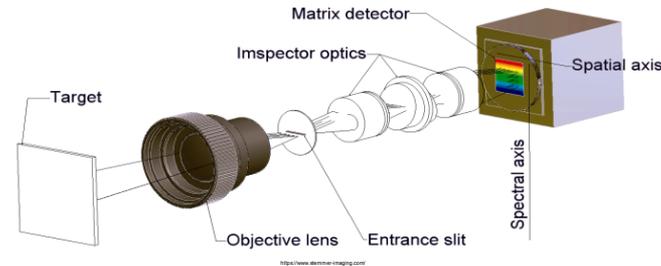
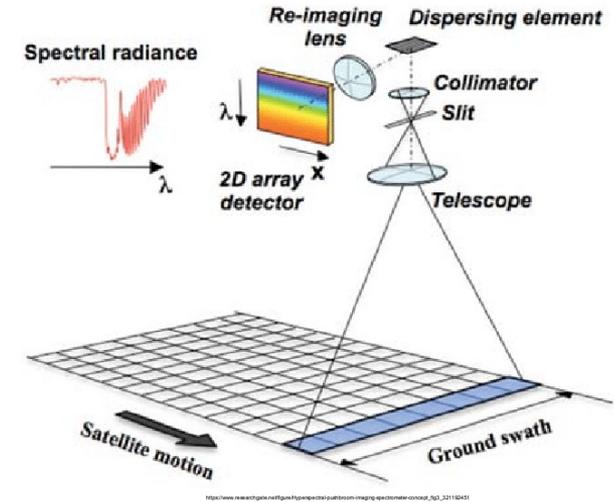
- Segmentation
- Spectral unmixing
- Evolution of spectra in time

- PRISMA - PRecursoro IperSpettrale della Missione Applicativa ( ASI – Agenzia Spaziale Italiana)
- Satellites with high spatial and spectral resolution have changed the way we consider the environment and environmental phenomena
- Technological demonstrator equipped with optical instruments for monitoring natural resources and the characteristics of the atmosphere

<https://www.asi.it/scienze-della-terra/prisma/>

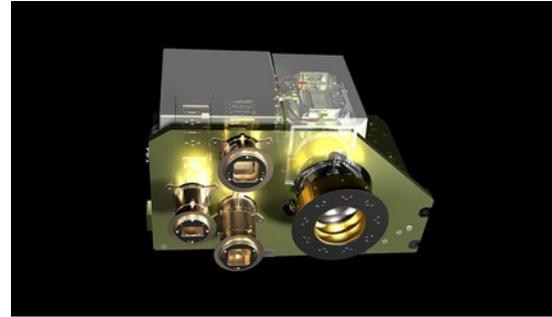


- There are some basic techniques for acquiring the three-dimensional dataset  $(x, y, \lambda)$  of a hyperspectral cube. The choice of technique depends on the specific application, as each technique has context-dependent advantages and disadvantages



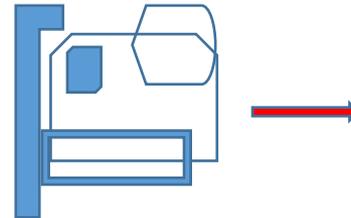
# System & Sub-Systems Integration on Cubesat. Opto-Mechanical Optimization

- The use of instrumentation installed within Cubesat is a low-cost solution aimed at achieving the "green" objectives of the project
- SIMBIO-SYS - SPECTROMETER AND IMAGERS FOR MPO BEPICOLOMBO INTEGRATED OBSERVATORY SYSTEM
- HYPSSOS - HYPerspectral Stereo Observing System. A remote sensing pushbroom instrument able to give simultaneously both 3D spatial and spectral information of the observed features
- The Novel Optomechanical Instrumentation will derive from the technical solutions used to create the equipment shown in the figure. New knowledge, skills and innovative methodologies will be articulated in reaching a new scientific and technological state of the art for this specific research project



**SIMBIO-SYS**

**VIHI**



<https://www.isepea.it/>



<https://www.ropequipment.com/>



- **Project Objectives:** The identifiable objectives are represented by the actual design and implementation of the correct optical and mechanical layout of the spectrograph that will be installed on Cubesat according to specific system requirements
- **Methodology:** The development methodology consists in obtaining, through the various phases of analysis and design, a process of continuous multivariable optimization of the system and of the related subsystems of the hyperspectral instrumentation. Trying to adopt innovative solutions that allow the housing of the instrumentation inside a Cubesat
- **Personal Objective:** To improve the set of knowledge and competencies to contribute and realize a novel type of optical instrumentation that meets the research objectives

# Gantt Chart of Activities

WBS NUMBER	TASK TITLE	% OF TASK COMPLETE	T1				T2				T3				T4					
			J	F	M	A	M	J	J	A	J	A	S	O	N	D	J	F	M	A
			M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
1	Hyperspectral instrumentation on Cubesat																			
1.1	Bibliography research. State of the Art - Study of the Hyperspectral instrumentation on Cubesat	30%																		
1.2	Methods of Analysis. General and Specific System Requirements	0%																		
1.3	Methods of Experimental Design	0%																		
2	Optics Layout characterization & Structural Support - Numerical Investigation																			
2.1	Preliminary Designs	0%																		
2.3	Sub Systems (Opto/Mech) Preliminary Design	0%																		
2.5	Optics Layout / Validation	0%																		
2.6	Mechanical Layout	0%																		
2.7	Iteration & Optimization Process Designs (Volume, Mass & Stress)	0%																		
2.8	3D CAD Model Realization	0%																		
2.9	Data Analysis	0%																		
3	Feasibility Study - Spectrograph on Cubesat																			
3.1	Interface definition	0%																		
3.2	Optimization of dimensions and masses	0%																		
3.3	Thermal analysis	0%																		
3.4	Structural analysis	0%																		
3.5	Validation	0%																		
3.6	3D CAD Model of the Spectrograph on Cubesat Final Design	0%																		
3.7	Data Analysis	0%																		
4	Validation																			
4.1	Exploitation	0%																		
4	Analysis for Space Applications	0%																		
5	PhD Thesis Development																			
5.1	Report	0%																		
5.2	PhD Thesis Writing and Documentation	0%																		

# Thanks for the attention

1222 • 2022  
**800**  
ANNI



UNIVERSITÀ  
DEGLI STUDI  
DI PADOVA