

Development of a fine steering tip/tilt mechanism for space applications

Armando Grossi - 36th Cycle

PhD Course in Science, Technologies and Measurements for Space Presentation of proposed research program - November 6th, 2020





- Industrial PhD
- Introduction
- Research Project Objectives
- The Mechanism
- The Actuators
- Methods
 - Finite Elements Analyses
 - Tests
- Work Activity
 - Main Steps
 - Gantt









• Industrial PhD







• Officina Stellare S.p.A.

an innovative SME active in the design and production of telescopes, optomechanical and aerospace instrumentation for Ground and Space based applications











Space telescopes

- Earth observation;
- Outer space observation.

Problem

Line-of-sight and image performances affected by:

- Thermal gradients;
- Misalignment due to launch vibrations;
- Platform jitter (due to reaction wheels);
- Fuel slosh;
- Ground errors (manufacturing, integration, ...)

A solution active mechanism to adjust the position/orientation of optical elements

Necessity to correct optical components position







• **Design** and **Realization** of a fine steering mechanism equipped with piezoelectric actuators;

• **Space qualification** of the fine steering mechanism;

• Acquisition of know-how in the **piezoelectric actuators** field;

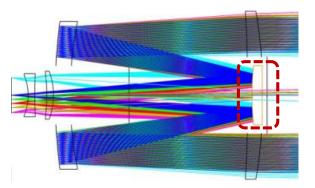
• Acquisition of experience in the **active optics** field.

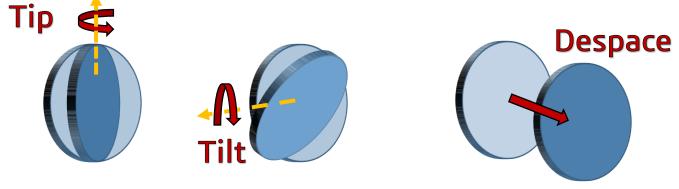






- Modify the position/orientation of a **secondary mirror**.
- 3 dof:
 - Tip/tilt;
 - Despace.







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- Movement generated by piezoelectric actuators.
- Piezoelectric **PRO**:
 - High resolutions;
 - No stick-slip;
 - No lubrifications;
 - High vacuum operations;
 - Low power consumption;
 - Low heat dissipation.
- Piezoelectric CONs:
 - Limited stroke;
 - High voltage.





[from Cedrat Technologies]

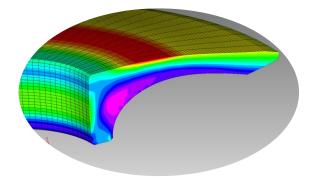


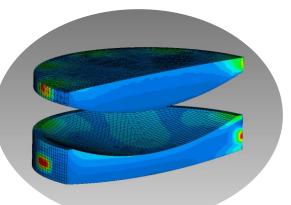


Methods - Finite Elements Analysis



- Finite Element Model in the design phase:
 - Static analyses;
 - Thermo-elastic analyses;
 - Dynamic analyses:
 - Modal;
 - Random vibrations;
 - Shock.













- Several **tests** will be performed:
 - Vibration tests;
 - Thermo-Vacuum test;
 - Functional test:
 - In vacuum;
 - In air.
- Space qualification of the mechanism.



[Officina Stellare Shaker]



[Officina Stellare TVAC]

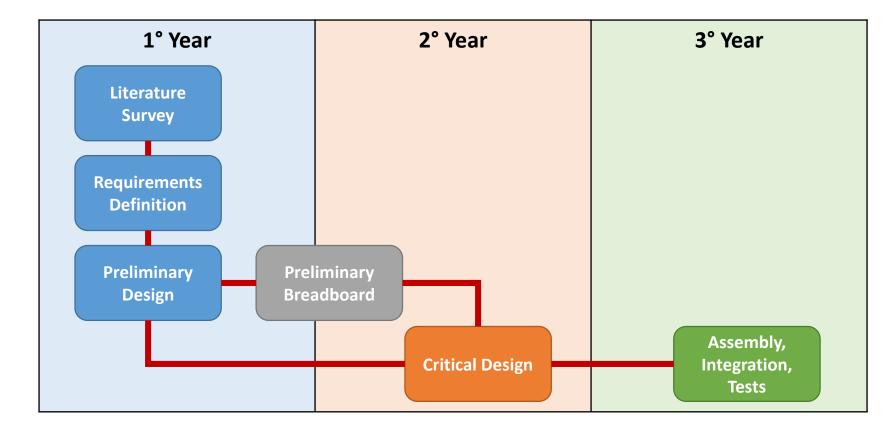




Work Activity – Main Steps



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Armando Grossi

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Work Activity - Gantt



WBS		% OF TASK	•	T1		T2		Т3		Т	4		T1		T2	Τ	ТЗ		T4	4		T1		T2	2		Т3		Τ4
NUMBER	TASK TITLE	COMPLETE	0	N D	J	FI	MA	М	J	J	A S	0	N D	J	FI	MA	A M	J	JA	S	0	N	э.	JF	м	Α	M	J.	JAS
1	Architecture Definition																												
1.1	Bibliographic review	0%																											
1.2	Architecture definition and system trade-off	0%																											
1.3	Requirement specification	0%																											
1.4	Conceptual design	0%																											
2	Preliminary Design																												
2.1	Mechanical design	0%																									T		
2.2	Functional design	0%									-																		
2.3	Thermal and structural snalysis	0%									+						-		-	-							-		
2.4	Electrical IFs and drive preliminary definition	0%									-		-						-	-							-		
2.5	Preliminary system numerical model	0%																											
3	Piezo Breadboard																												
3.1	Breadboard realizaztion	0%																											
3.2	Breadborad Testing	0%																											
4	Critical Design																												
4.1	Mechanical design	0%																											
4.2	Functional design	0%																											
4.3	Thermal and structural snalysis	0%																											
4.4	Electrical IFs and drive definition	0%																											
4.5	System numerical model	0%																											
5	Assembly, Integration and Verification																												
5.1	AIV Procedure	0%																											
5.2	Manufacturing and procurement	0%																											
5.4	Assembly	0%								-	+-												1				-		
5.5	Integration	0%																											
5.6	Testing	0%																					7						
6	PhD Thesis Development																						17						
6.1	PhD Thesis writing	0%																											
6.2	Reports on research project	0%																											
																											-		



Thanks for the attention



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