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CAS-ATLID (CO-ALIGNMENT SENSOR OF ATLID INSTRUMENT) THERMO-STRUCTURAL DESIGN & PERFORMANCE

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I. INTRODUCTION

This paper describes the main thermo-mechanical design features and performances of the Co-Alignment Sensor (CAS) developed by LIDAX and CRISA under ESA program with AIRBUS Defence & Space as industry prime.

The CAS can be generally described as a Focal Plane Assembly with integrated Optics, Detector, and Electronics.

The Co-Alignment Sensor (CAS) is a part of ATLID Instrument, whose mission responds to the need to provide a picture of the 3-dimensional spatial and temporal structure of the radiative flux field at the top of the Earth atmosphere, within the atmosphere and at the Earth's surface.

The CAS is located on the ATLID Optical Bench and is part of the control loop that allows identifying the pointing direction of the Laser signal return used to control the Laser co-Alignment with Optical Bench. CRISA is the final responsible of the whole CAS project design and development

II. MODELS & PROJECT STATUS

The following deliverable models are considered:

- Structural and Thermal Model (STM see Fig. 1) with the following objectives:
  - Risk minimization
  - Manufacturing & Assembly Process Check
  - Qualification Testing

- Protoflight Model (PFM)

Actually, the STM became a Qualification Model from thermo-mechanical point of view.

Currently, the STM qualification testing has been successfully completed.

III. MAIN REQUIREMENTS

Following main mechanical requirements are applicable:

<u>Mass, Structural & Thermal</u>

- Mass < 1.68kg
- Stiffness>300Hz
- Maximum Envelope: 198mm x 227mm x 130mm
- I/F loads on each interface point /fixation:
  - Forces:14-55N
  - Torques: 0.7-1.45Nm

- The unit dimensioning shall consider sine, shock and vibrations loads
- Fail-safe damage tolerance design principles
- Non-operating Thermal Environment: 50ºC/-25ºC
- Conductive coupling to its Mechanical IF (Interface) < 0.06 W/K
- MCCD temperature<Optical Bench temperature +2K
- Dissipated power< 2.0W

- Interface flatness (bipods common plane): 10 µm

<u>Stability & Alignment</u>

- MCCD stability with respect to Optics < 1µm (from mounting to flight operation all contributions)
- Overall equipment Stability (from mounting to flight operation all contributions)
  - Displacements<30 µm
  - Rotations<100 µrad
- 3 axes CAS & in-plane MCCD alignment capabilities

IV. MECHANICAL DESIGN DESCRIPTION

A. General

The CAS is shown in Fig. 1, and it is divided in three main components:

- Mechanical Bench Assembly (MBA) and main thermo-structural element developed by LIDAX
- Proximity Electronics (PE) that contains the required electronics connected to the MCCD (CFI manufactured by e2v) by means of a Flexible PCB (Printed Circuit Board) and developed by CRISA
- Optical Assembly (OA) that holds the optics (beam splitter, filter and lens) and developed by Bertin Technologies

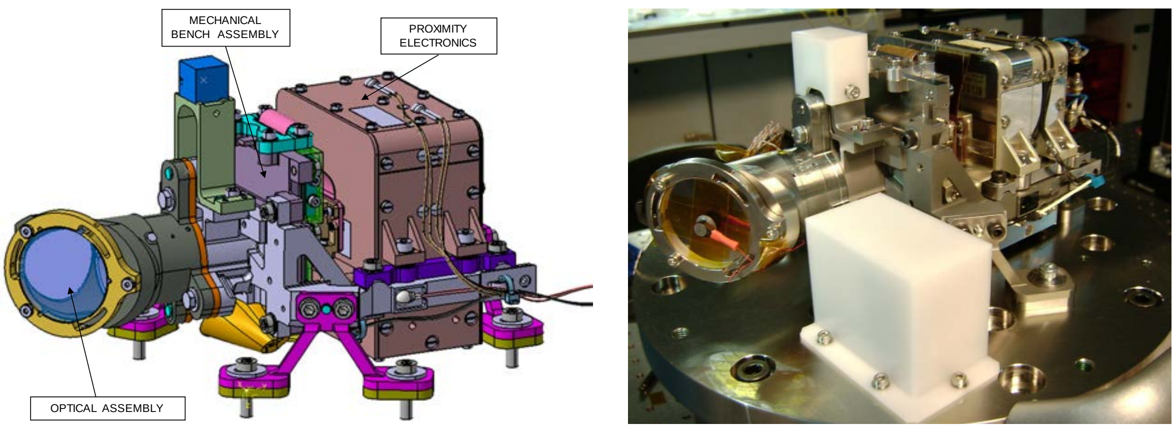

Fig. 1: CAS Main Subassemblies & STM

The whole assembly is supported by means of three bipods to get the appropriate relation between stiffness and loads induced at the interface.

B. Mechanical Bench Assembly

Mechanical Bench Assembly shown in Fig. 2 is the main thermo-structural component of CAS and it is composed of different thermo-mechanical components such as:

- Main Bracket
- Bipods
- MCCD and Proximity Electronics Thermal Straps

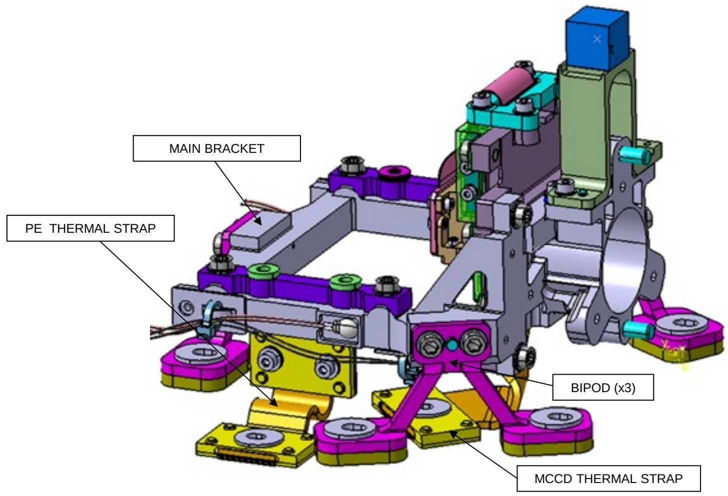

Fig. 2: Main Bench Assembly Components

Main Bracket

The Main Bracket is a Ti6Al4V bracket of complex geometry, which is the main structural element of CAS, and its complex shape provides the following functionalities:

- It provides support and mechanical tolerances for relative positioning of optical sensitive elements:
  - Bipods
  - MCCD (mounted on dedicated assembly)
  - Optical Assembly

- Stiffness and structural strength to support the above assemblies

Titanium choice (with respect to invar) is based on its lower mass density, high strength and better machining capabilities in spite of a higher thermal expansion coefficient (worst thermal performance).

Bipods

Three identical Bipods also made of Ti6Al4V supports the Main Bracket (and all elements mounted on) providing the following functionalities:

- Overall stiffness and flexibility to assure a quasi-isostatic mounting
- Structural strength to support the whole CAS
- Thermal Isolation from Interface Bench

Manufacturing

Manufacturing has become a complex issue due to the following:

- A extremely demanding overall flatness requirement (decision of avoiding any shimming process was taken early in the project)
- Complex shape of Main Bracket, needed to provide all required functionalities

Above points have driven to use Electrostatic Discharge Machining (EDM) manufacturing process for manufacturing the Main Bracket & Bipods Assembly, with the drawback of the exhaustive process controls required to assure the removal of alpha-case and hydrogen in the titanium surfaces.

A specific manufacturing process has been defined and successfully implemented for STM Model.

Thermal Straps

Thermal Straps with specific shapes due to AIV issues have been developed and submitted to qualification; they are based on piled sheets and terminals all made of golden copper.

Manufacturing process and correlation between design and measured conductance have been proven during the straps qualification campaign.

Fig. 3: MCCD & PE Thermal Straps

V. PERFORMANCES

Comparison between specified and measured performances is shown in the below table.

REQUIREMENT	SPECIFICATION	PERFORMANCE	REMARKS
Mass	< 1.68kg	1.668 kg	
Stiffness	>300Hz	360 Hz	
Maximum Envelope	198 x 227 x 130 mm	188 x 220 x 127mm	
I/F loads on each interface point /fixation	Forces: 14-55N Torques:0.7-1.45Nm	Forces<49N Torques<1.77Nm	
MCCD temperature	<OB+2K	<OB+1.8K	
Interface flatness (bipods common plane)	10 µm	25 µm	Exhaustive test campaign performed to evaluate this non-conformance resulted in compliance with the overall displacement & rotation errors due to flatness
MCCD stability with respect to Optics	< 1µm	1-3 µm	Limited by measurement accuracy
Overall equipment Stability (from mounting to flight operation)	Disp<30 µm Rot<100 µrad	Disp<17 µm Rot<65 µrad	Contributions: assembly, temperature, micro-setting & gravity release

VI. CONCLUSIONS

The following conclusions can be established:

- A CAS STM has been successfully qualified
- CAS STM is fully representative of the flight hardware from thermal and mechanical view
- Design has proved to provide response to the demanding structural and stability requirements
- Currently the PFM is under manufacturing
- Thermal Straps design and manufacturing process has been successfully qualified
- EDM manufacturing process has been proven to be suitable for flight hardware with appropriate process specification and controls

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