MicroMHiDe : a Multispectral Sub-meter Resolution payload for SmallSats.

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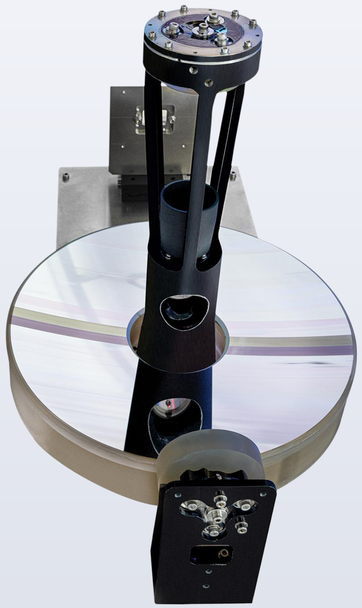
INTRODUCTION

The Earth Observation market has been going through a complete mutation during the last decade with the deployment of constellations of nano- and smallsats. These can offer shorter revisit time and capture relevant information for specific applications, and this for a significantly lower cost.

This trend is supported by the development of miniaturized and high performance avionics, that allows building microsatellite platforms with high pointing stability and accuracy. Increasing on-board processing capabilities and download capacity complete the conditions ensuring an advantageous data return for an affordable investment.

A new generation of microsatellites platform that embarks high-resolution optical systems to achieve sub-meter resolution images is being developed by a consortium led by Aerospacelab. This system will address the high resolution market, considered the largest and most profitable market for remote sensing. Physical constraints, such as diffraction limit and signal-to-noise ratio are circumvented by the innovative solutions of MicroMHiDe.

The SNR is improved by using detectors with Time Delay Integration (TDI) with a new generation of hybrid detectors, known as CCD-in-CMOS detectors, currently developed by IMEC. Sub-meter resolution is obtained thanks to an innovative low aspect ratio telescope developed by AMOS. This design minimizes the atmospheric drag when flying on a low altitude satellite. A breadboard of the telescope is being developed under an ESA contract. All parts are designed to be cost effective in view of mass production to deploy a constellation. Performances and design philosophy of the telescope are presented here.



PERFORMANCES

The work we present provides a design solution for a compact, lightweight and cost-effective system with a focal length larger than 3 meters and a 0.5° diameter Field-of-view.

The concept is based on a cutting-edge telescope design with a low cross section in the flight direction. The selected configuration allows for minimizing the atmospheric drag while achieving the required pupil diameter.

A specific attention was paid to optical distortions that are not compatible with the TDI operation. The final design has an across-track keystone distortion lower than 1 µm over the complete along track field-of-view.

The opto-mechanical design has been optimized to reduce the recurrent costs associated with manufacturing and alignment and to maximize the thermal stability in order to simplify the telescope's thermal management.

Instrument's Specifications	
Reference orbit	370 km to 450 km
Ground Sampling Distance	0,7 m to 1 m
Swath	2,5 km to 3,0 km
System SNR (TOA) @ref. radiance 110W/(m²*sr*µm)	>100 (all bands)
Spectral Range	400 - 1000 nm
Spectral bands	1 PAN + up to 6 MS
Dynamic range	8 bit
Mass	20 kg
Volume	400 x 400 x 600 mm³

DESIGN

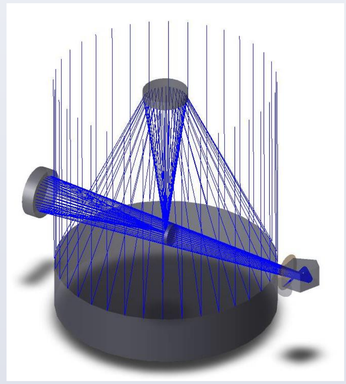
The optical requirements, the compactness and the light weight together with a high thermal stability make the design of such an instrument a great challenge. The utilization of materials like Invar and Zerodur allowed for reaching a high thermal stability while the utilization of the CFRP technology contributed to make the instrument lighter and stiffer.

The optical layout, studied by AMOS, is based on a three-mirror system (Korsh-type optical configuration). The optimized design is diffraction limited over the full FoV and reduces the keystone effect to less than 0.75 µm. Given its extreme compactness it is deemed to be the optimum configuration matching all the requirements.

INVAR - ZERODUR

CCD IN CMOS DETECTOR

TDI ROM



KORSCH SOLUTION

CFRP

MULTI-SPECTRAL

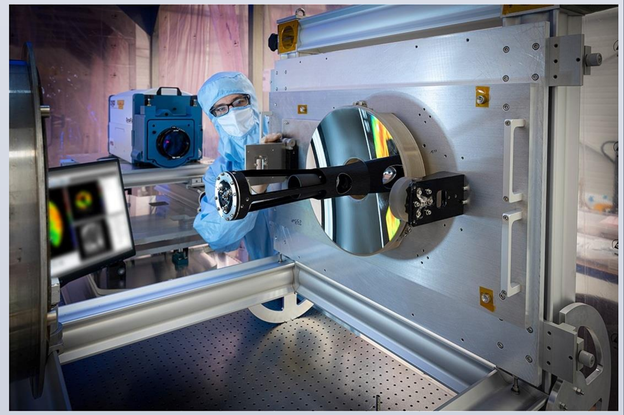
CONCLUSIONS

An extremely compact design has been developed by AMOS for a telescope able to achieve a sub-meter resolution, with a focal length larger than 3m and a flight cross section of 400mm x 400mm.

Such characteristics together with the multispectral solution and a TDI read out mode, make MicroMHiDe a very promising high definition imager for the smallsat market.

The breadboarding activity is being concluded with the telescope being assembled and aligned in AMOS' ISO-5 clean room.

Image quality and distortion test activities are currently performed on the opto-mechanical sub-system.



MICROMHIDE breadboard inside AMOS' clean room

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