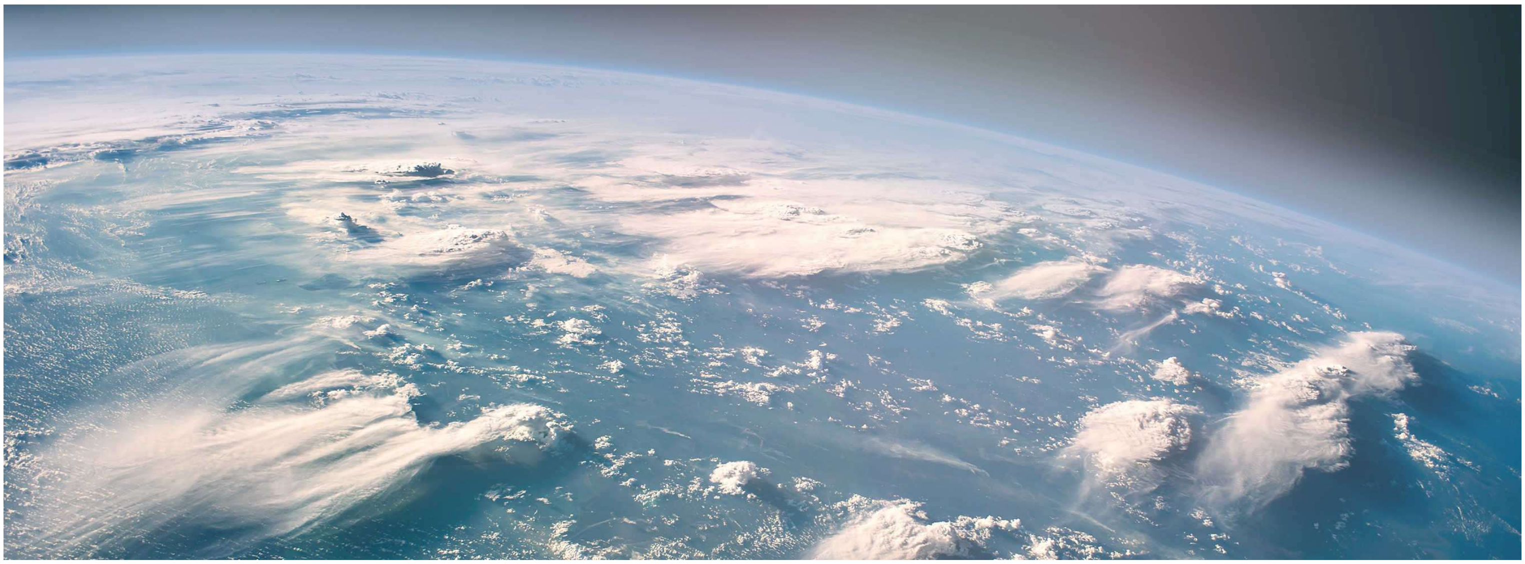
SURPRISE

SUPER-**R**ESOLVED COM**PR**ESSIVE **I**N**S**TRUMENT IN THE VISIBLE AND MEDIUM INFRARED FOR **E**ARTH OBSERVATION APPLICATIONS



SLM prototype report

[D3.1]

CSEM, with participation of IPMS

1. Summary of Deliverable content

The digital micro-mirror device (DMD) represents an essential component in the selected architecture for the SURPRISE demonstrator. By encoding random spatial patterns onto the imaged scene, the DMD allows implementing compressive sensing (CS) reconstruction algorithms based on the single-pixel CS scheme.

One aim of the SURPRISE project lies in the development of a European-based solution. Nevertheless, for the SURPRISE demonstrator, a COTS component from Texas Instruments has been selected. The use of a COTS component enables reducing the development cost and initiate the development of the demonstrator prior finalizing the custom European design.

Texas Instruments benefits from a monopolistic position on the market of commercial DMDs. Each of their DMD models contains a protective window made from glass with an anti-reflection (AR) coating designed for a specific spectral range. However, none of the models available is compatible with the required large spectral range for the SURPRISE demonstrator (VIS-NIR and MWIR). Since the micromirrors made of aluminium present an intrinsic reflectivity compatible with such a large spectral range, we investigated ways to rework the DMDs from TI by replacing the original borosilicate window with an uncoated window presenting a high transmittance over the VIS-NIR and MWIR spectrum. The reworking process must be carried out safely to protect the sensitive micromirrors from dust and water vapor all along the process, and over the whole lifetime of the reworked DMD.

Also, since the selected DMD will serve as a benchmark for testing the robustness against temperature, it is planned to place the DMD within a thermal chamber and drive it from outside the chamber. Thus, it was required to study existing electronics drivers and verify their compatibility for such tests since COTS evaluation driver boards are not designed for space qualification.

In Deliverable 3.1, we first analysed the architecture of the selected DMD (DLP7000) and its COTS evaluation boards and verified its compatibility with foreseen performances and thermal tests. Second, we investigated two ways to replace the front window of the DMD in a safe and reliable manner. The aim of this reworking process consists in producing a modified DMD that fulfils the requirements in terms of spectral transmittance range for the SURPRIRSE demonstrator. The established procedure was then detailed and followed to assemble two SLM demonstrators. One of these demonstrators will be integrated into the SURPRISE demonstrator in the next steps of the project.

The related demonstrator deliverable, namely a reworked DMD, is a key component to be integrated into the SURPRISE demonstrator.

2. Main Innovations / New knowledge

2.1 Electronics and driver

The controller solution provided by Texas Instruments is very versatile and almost any of their DMDs can be controlled through the same interface. By analysing the electronics and software schemes, we concluded that this solution is compatible with the foreseen performances and thermal testing without further modifications. In addition, the software and library will allow a smooth integration into the Master Unit software (i.e. high-level SURPRISE demonstrator controller).

2.2 DMD reworking

Similar processes to replace the protective window of DMDs have already been reported in the literature. Based on this review, two solutions were envisaged for sealing the new protective window:

- Indium wire
- Epoxy resin

The indium wire option was firstly selected and implemented through a dedicated procedure. This first realization led to the conclusion that indium sealing was inappropriate for the following reasons:

- A lack of purity in the indium wire leads to a poor adhesion.
- The process requires applying an importance force to shape the joint.
- The process is time-consuming, and its complexity hinders the development of a reliable process.

In a second step, we successfully investigated the epoxy resin option with a sapphire window. This allows realizing a high hermeticity and, facilitates the development of a reliable and repeatable process that fulfils the application requirements. The choice of sapphire for the protective window was led by the high transmittance over the given spectral range and by its high hardness. The frame was designed in Kovar to benefit from a coefficient of thermal expansion (CTE) that matches both the window and the DMD frame.

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