Using direct-field acoustic test data for Operational Modal Analysis of the PROBA-V satellite

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During a recently organized DFAN Master Class which had as objective to gather and disseminate know-how and experience related to spacecraft direct field acoustic testing, ESA made available the Structural and Thermal Model (STM) of the PROBA-V satellite. Several acoustic and tap tests have been executed on this structure to study the influence of different test conditions on the control quality of a direct field acoustic environmental test and to identify the dynamic properties of the structure.

In this paper, the possibility is explored to apply Operational Modal Analysis (OMA) to characterize the structural dynamics of the PROBA-V using acoustic test data. During such a direct field acoustic noise (DFAN) test, very high sound pressure levels are achieved by using a large amount of professional audio speakers installed around the test specimen. Microphones are used for feedback control to achieve the desired properties of the sound field (overall sound pressure level, stability, uniformity, and coherence). In addition, also the structural vibrations of the specimen are monitored using accelerometers and strain sensors.

The purpose of the paper is to track and compare the modal parameters of the specimen during various testing phases for an enhanced understanding of the structural behaviour under acoustic loading. Classical Experimental Modal Analysis will be applied to data from a preliminary tap test and Operational Modal Analysis will be applied to data from low-level open-loop System Identification tests as well as closed-loop control tests at multiple sound pressure levels. Various acoustic tests will be performed to evaluate how the structure responds to different control parameters.
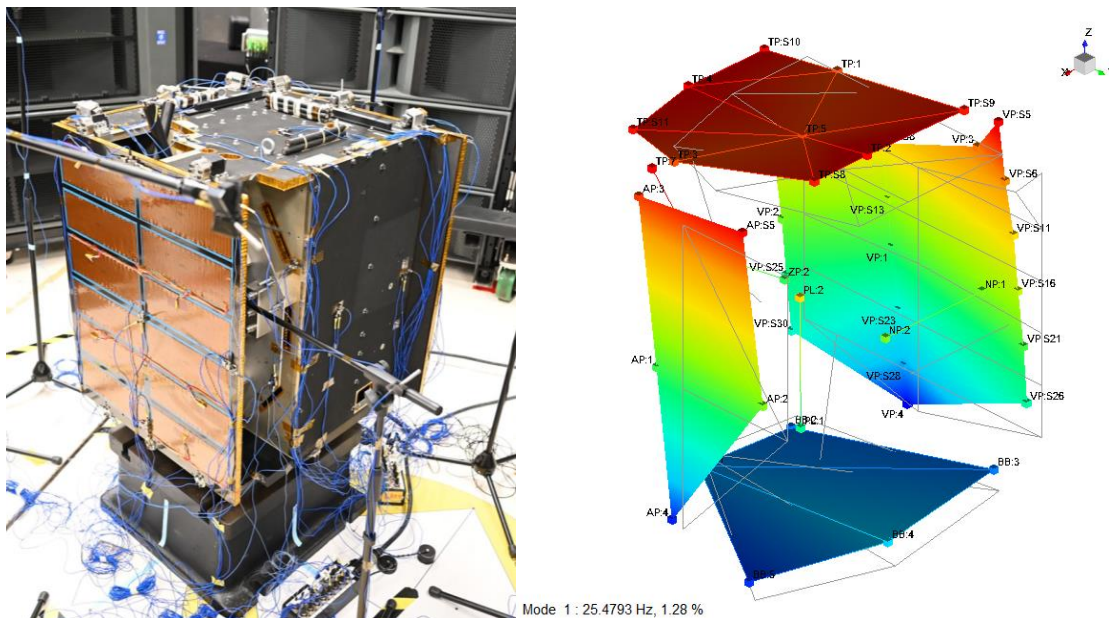

Figure 1. (Left) Proba-V DFAN test setup; (Right) mode shape identified using OMA.