1. Introduction

1.1 Contact

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1.2 Solar Arrays

Solar Arrays are a vital component of satellites which function for a prolonged time in space. The primary purpose of solar panels is to provide power to satellite components, such as instrumentation, sensors, heating elements, the electronic propulsion etc.
Since the amount of space within the fairing of the rocket is limited, the solar array is integrated in stowed configuration to the satellite. Once the satellite is in orbit, the solar array mechanisms are activated in order to deploy the solar array. A Solar Array under production within Airbus Defence and Space Netherlands are the solar arrays for ESA's JUICE mission[1]. Due to the low solar intensity near Jupiter, the solar arrays need to be of exceptional size to generate sufficient power for the Spacecraft. Therefor the solar array is designed to have 5 panels; 3 panels which deploy in the main direction and 2 lateral extension panels, or LEP's.

Figure 1: Artist impression of the JUICE missions showing its characteristic solar array

During the design and development phase of such solar arrays, extensive analyses are performed on the structural mechanical and structural dynamic behavior of the wing. This is done for the deployed configuration to determine the performance when in operation, and for the stowed configuration to determine its robustness to the launch environment, that is the vibration caused by the rocket during launch. A typical result from FEM-analyses is shown in figure 2, showing an eigenmodes of the wing.

[1] http://sci.esa.int/juice/

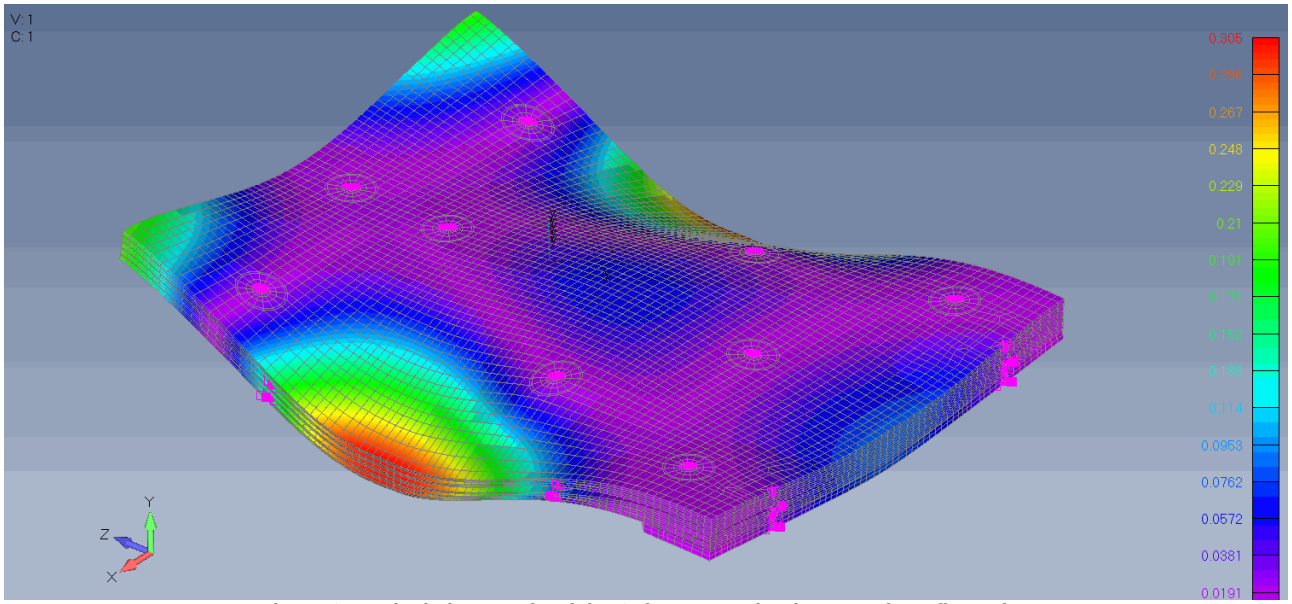

Figure 2: Typical eigenmode of the Solar Array wing in stowed configuration

1.3 Vibration test campaigns

Besides the analyses, the solar arrays are often subjected to environmental test campaigns to mimic the harsh launch conditions, to determine its functioning during and after these tests and to determine its performance as it would operate in space.

A typical environmental test is the vibration tests, where with the use of large solenoids a large table is put into a sinusoidal motion, eventually 'shaking' the wing, see figure 3. These tests are often performed by means of sine sweeps, typically from 5Hz to 100Hz with maximum input levels of around 10g's, however the wing can easily amplify up to 100 to 200g's.

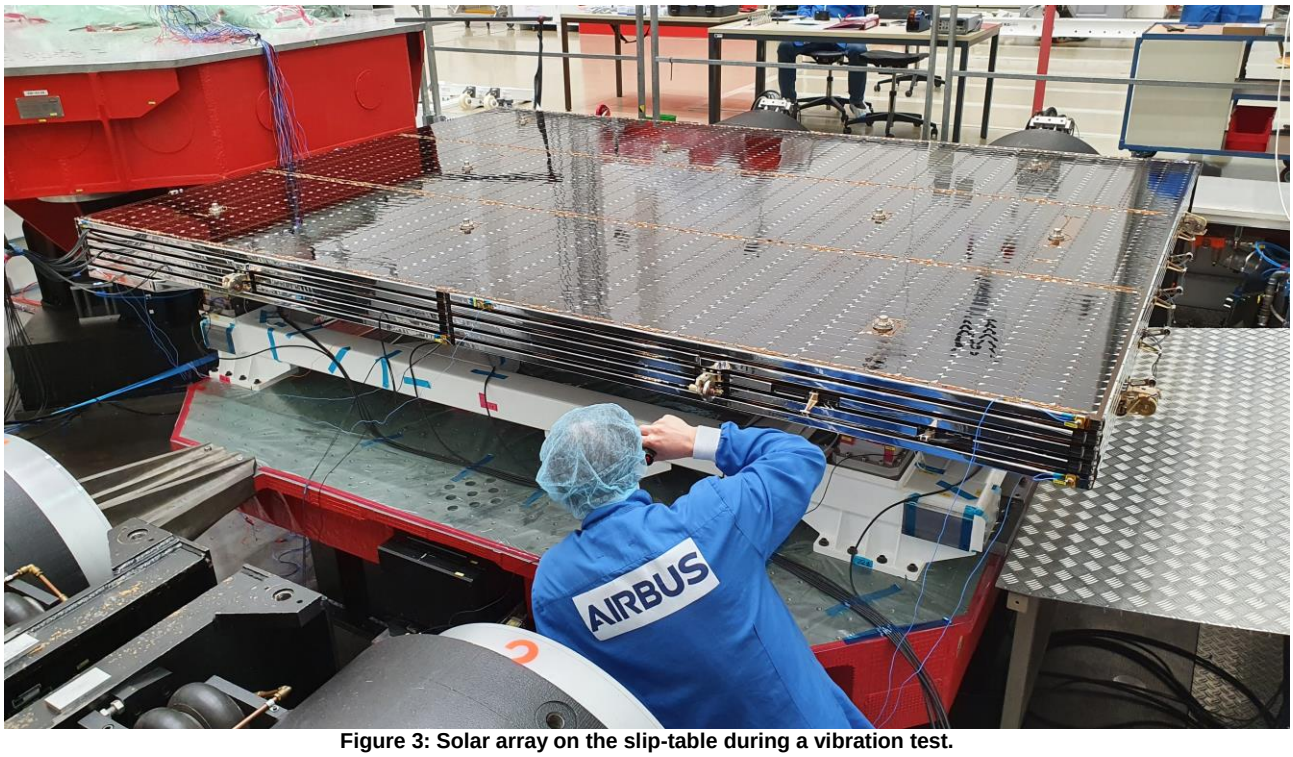

Figure 3: Solar array on the slip-table during a vibration test.

During these tests, a lot of information is acquired to measure the behavior and structural integrity of the wing. This is done by Strain gauges and accelerometers on the wing and Force load cells on the base of the solar array.

After every vibration test, this data is processed in the frequency domain an provided to the on-site engineers to do their assessments. Due to the amount of sensor on the wing, the information to be processed mentally is rather high. Application are available at Airbus to process the data in the classical 2D-graphical form as a function of the frequency, see figure 4. These applications are extremely useful and needed to do the calculations required for the vibration tests, however due to the 2D-nature of the visualization; these do not provide trivial insight in the behavior of the wing.

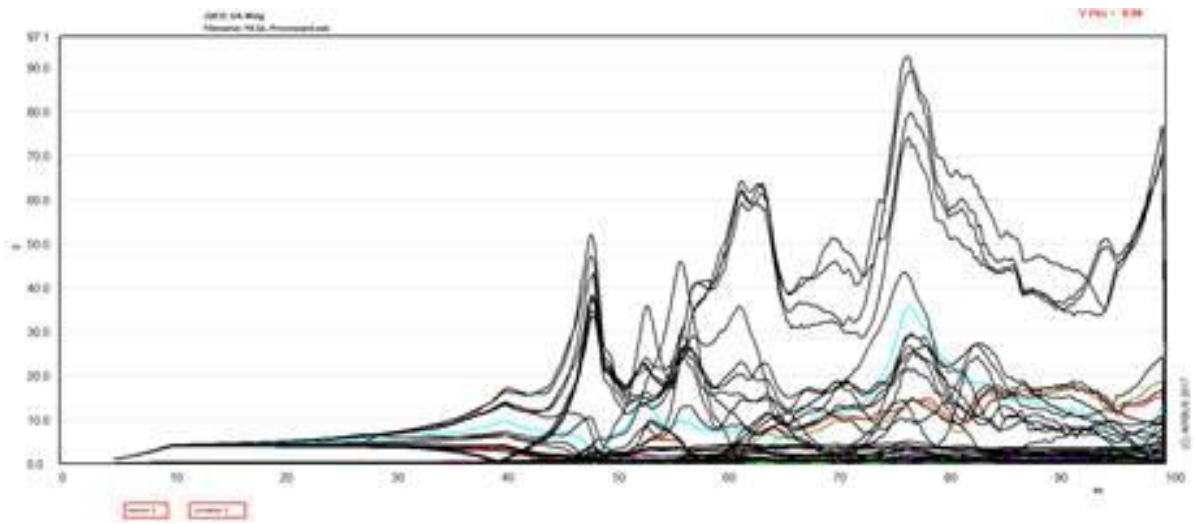

Figure 4: Snap-shot of the in-house program VAPA

With the increasing complexity of the wings, Airbus is looking for an application which is capable of directly visualizing the behavior of the solar array wing based instrumentation data provided by the vibration facility data in combination with a pre-prepared configuration datafile. This application should be able to insightfully visualize the responses of the wing based on the measurements. An indicative visualization of how this could look like is depicted in figure 5

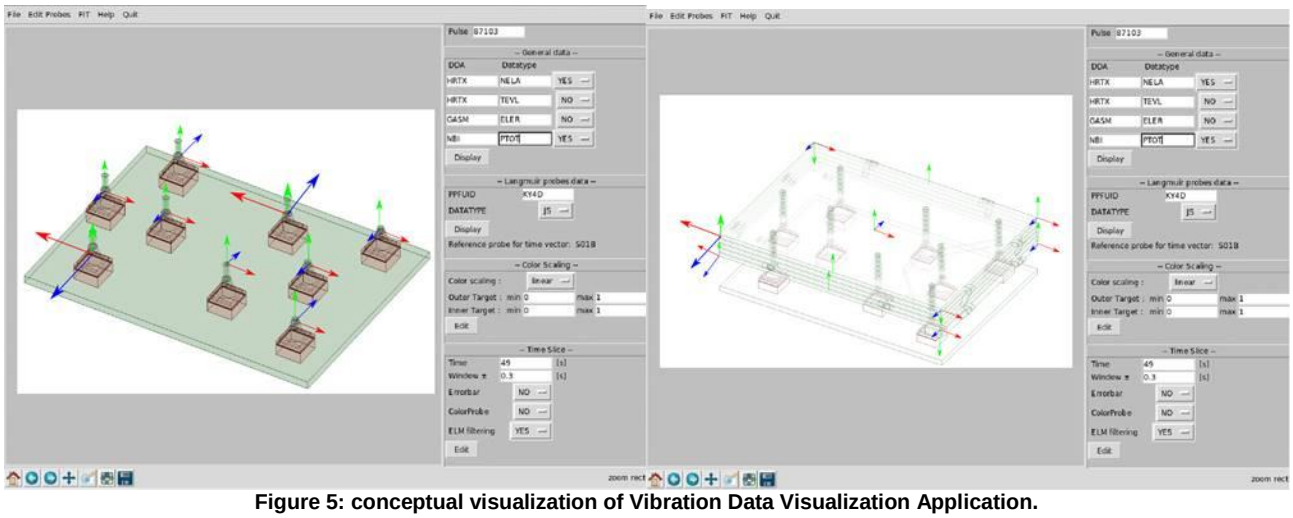

Figure 5: conceptual visualization of Vibration Data Visualization Application.

2. Assignment description

The goal of this assignment is to develop an application which is capable of identifying the qualitative behavior of the solar array resulting from the vibration test facility data. The application shall be capable of giving full insides in the interface loads, accelerations, modes shapes, etc. and is capable of making a comparisons between test runs and between test and analyses. In order to perform this development, the following sub-assignments are applicable:

The goals of the assignment are to:

- Acquire available knowledge on the Solar arrays mechanical design
  - Acquire knowledge on mechanical design,
  - Acquire knowledge on structural dynamic behavior.

- Acquire available knowledge on the process of the vibration testing
  - Acquire knowledge on test approach, sequence and types of instrumentation
  - Acquire knowledge on available data during vibration tests and understand it's formats

- Develop an application capable of visualizing the wing responses as measured during the vibration tests, which:
  - Can generate a schematic visualization of the wing based on a provided input file
  - Can visualize the instrumentation responses as measured during the test, with possibilities to change the visualization for any frequency and phase.
  - Can provide an indicative visualization of the wing modeshapes.

- Perform a correlation of the results based on available test data from earlier performed tests.

2.1 Assignment constraints

Due to the nature of this project, the following preferences are applicable

- Preferred studies are: Mechanical Engineering, Aerospace engineering etc.
- The duration of the assignment is preferably 5 months as an internship assignment, however longer durations are possible.
- Preferred starting date is May 2021, however other starting dates might be acceptable.
- The student must have basic knowledge of programming (python) and CAD-applications.
- Due to the COVID-19 situation, this assignment might be supervised fully off-site. Physical presence on-site at Airbus Leiden might not be possible. This assignment is deemed as highly possible to be performed of-site.