SILA Project: Side Loads and Acoustics at DLR Lampoldshausen test facilities

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ABSTRACT

The institute of space propulsion of the German Aerospace Center (DLR) is located in Lampoldshausen. The site offers a wide range of testing capability for the experimental investigation of rocket engines, from cold flow sub-scale conditions up to full scale qualification tests. The test specimen features two interfaces with the facility in which it is tested. The first interface is mechanical and features the fixation of the specimen on the test rig and the feeding lines. The second one corresponds to the exhaust gases coming in contact with the engine environment into the test cell.

In an effort to better understand and operate the facilities, the project SILA (SIde Loads and Acoustics in rocket engines test benches) has been started 2016 between the three departments operating, developing and utilizing the facilities. The project focuses on two topics: the generation of side loads and the qualification of a reduction device, and the jet acoustic and the interaction with its environment.

During transient start-up of a rocket engine, the flow inside the supersonic part of the nozzle separates until the engine reaches its design operation point. The flow separation causes side loads that affect the structural integrity of the engine and are a dimensioning factor for engine and test position. A side load reduction device (SLRD) has been proposed in the framework of research activities. Preliminary tests on various configurations have shown the high potential for amplitude limitation. The activities in SILA will follow two aspects, first the optimization of the SLRD concept under cold flow conditions and then the verification and application to hot flow conditions. As the SLRD requires only little modifications of the bench, most investigations can be conducted as passenger in other test campaigns with a wide range of conditions in propellants, nozzle geometries, combustion chamber conditions, test sequences for validation for the concept.

Engine jet noise interacts with the test bench or launch pad, and reflection and coupling with the nozzles and facility structure can happen. During engine tests, noise limitation techniques are imposed by safety and legal constraint. Various solutions are available to limit the overall noise level. The objective of the acoustic investigation within SILA is to reach a better understanding in the noise emission mechanisms, the spatial distribution and the resonance frequencies. Therefore, new acoustic measurement system and protocol are being developed and tested at a cold flow facility. The method will be implemented at the various test facilities and will provide comparable data for different test configurations. These insights will be then used for improved noise limitation measures.

The final paper will detail the activities planned within the framework of the project SILA and present the first results in the side load and acoustics work packages.