

Liquid Upper Stage Demonstrator Engine (LUMEN): A test bed for space propulsion components

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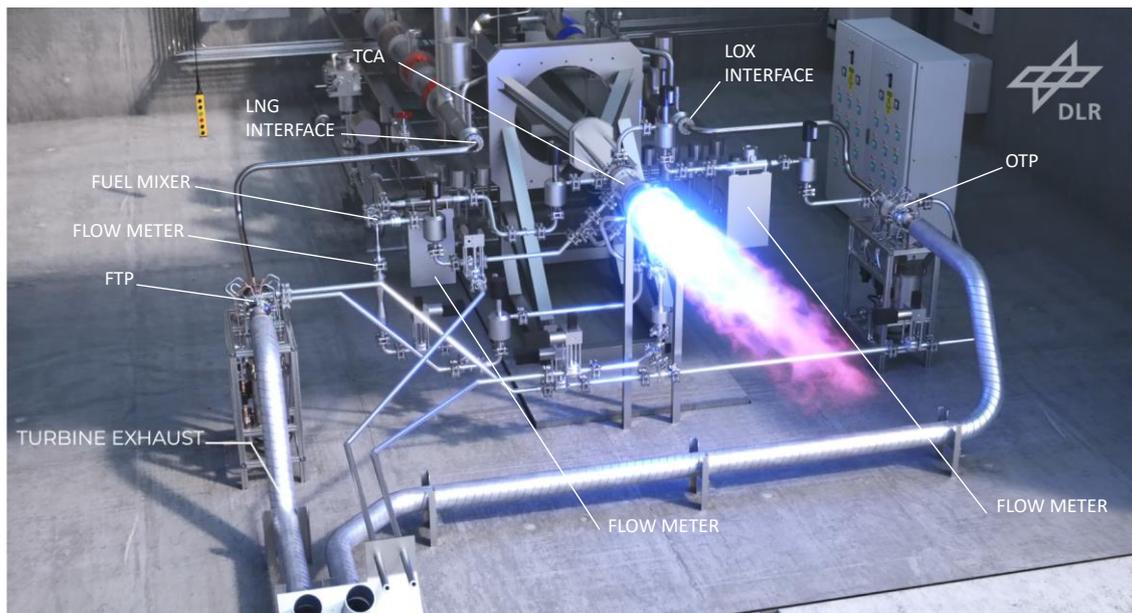
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1. ABSTRACT

With the LUMEN (Liquid upper stage demonstrator engine) project, DLR is aiming to develop, build and operate a breadboard engine based on an expander bleed cycle scheme. The propellants for LUMEN will be liquid oxygen (LOX) and liquid natural gas (LNG). LUMEN will be a modular breadboard engine to be used on DLR test benches such as the P8.3 test facility. The modular approach will make it easy to take the engine of the test bench, exchange components and go testing again. This way the demonstrator will provide a test bed for future component development. The cycle will feature two turbopumps in order to simplify the turbopump design, while on the same time allowing more freedom for an exchange of components. By this approach the DLR will create a test bed for component research on engine level, open to any industrial or institutional partner. There have been several test campaigns before final assembly can take place. The combustor tests included a calorimetric combustor to obtain the heat load distribution by the combustion of LOX and LNG which determines the cooling channel design of the thrust chamber assembly (TCA). After this campaign the newly manufactured regeneratively cooled TCA tests will take place which will determine the turbines drive power. This is a crucial step, since LUMEN is an expander bleed cycle engine and hence it relies solely on the heat pickup in the TCA cooling channels.

In parallel to the combustor tests a turbopump test campaign with the OTP was performed with water on the pump side and pressurized nitrogen on the turbine side. The campaign has been completed successfully and the operational envelope of the OTP has been confirmed. After that a cryogenic test campaign took place at the DLR test bench P8.3. The OTP was installed in the same configuration as in the engine tests of LUMEN and it was run for the first time in cryogenic fluids. The test campaign was successful proving the operation of the OTP in LOX. Especially the unconventional oil lubrication system of the LUMEN OTP worked without an issue and as expected. The thermal design of the turbopump was verified and the operation procedures in cryogenic environment were tested and refined. The next and final step in turbopump development will be cryogenic tests of the FTP.

When the combustor and turbopump tests are completed, final assembly of LUMEN will start with first tests on engine level expected to take place in 2023.



LUMEN layout at test bench P8.3