Investigation of the Effects of BLI Engine Integration on Aircraft Thrust Requirement

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Due to the increasing focus by the aerospace industry to reduce the adverse impact of aviation on the environment, new aircraft configurations are increasingly being investigated with the aim of improving the overall aircraft efficiency. Focusing on engine integration, one of the concepts examined is boundary layer ingestion (BLI). BLI engine integration places the engine near the rear section of the fuselage, enabling it to ingest and energize the boundary layer air (see Figure 1b).

For UHBR engines one possible BLI configuration is to position the engine along the upper side of the tail of the aircraft where the core engine is shielded by the fuselage (see Figure 1a). In order to estimate the fuel saving potential of this configuration, a parameter study was carried out, in which the degree of embedding was varied. This allows for the evaluation of the BLI effect on the overall aircraft performance. The engine was integrated using four different embedding depths. For this investigation the DLR TuLam aircraft was used [1].

A thrust-drag balance was carried out, in which the engine settings were adjusted in such a way that the total thrust equals the total drag. Furthermore, a fixed lift coefficient was maintained for all configurations in order to accurately compare the respective efficiency and performance metrics. It could be shown that greater engine integration leads to a slimmer design of the aircraft, reducing frontal drag area, which increases its overall aerodynamic efficiency.

In order to use computing power efficiently, this study was carried out with the actuator disk model [2]. This permitted a comparative calculation with a conventional underwing configuration, which represented the baseline. From the required shaft power of the engine, conclusions can be drawn about the thrust required to propel the aircraft. This renders possible a first estimate of the fuel saving potential of a BLI aircraft compared to a conventional underwing configuration.

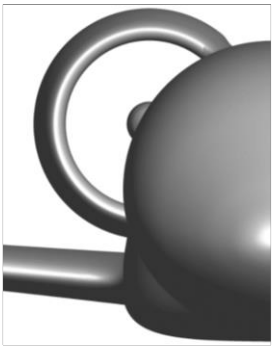

Figure 1a: BLI aircraft

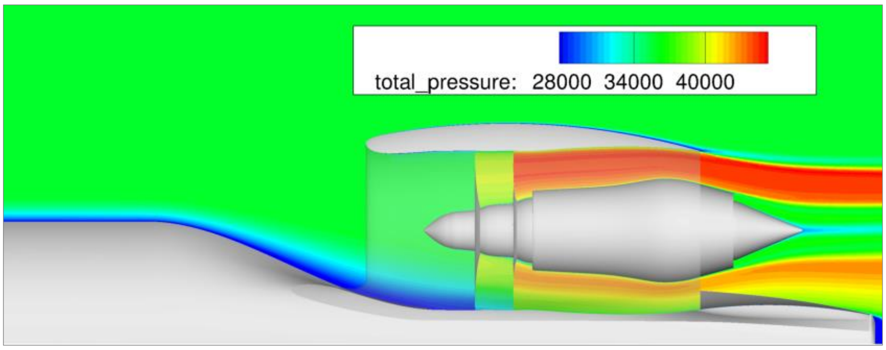

Figure 1b: Total Pressure Flow through BLI Engine featuring an Actuator Disk (AD)

[1] Seitz, A., Hübner A., Risse K., The DLR TuLam project: design of a short and medium range transport aircraft with forward swept NLF wing, CEAS Aeronautical Journal, 2019.

[2] Raichle, A., Flusskonservative Diskretisierung des Wirkscheibenmodells als Unstetigkeitsfläche, Forschungsbericht 2017-62, 2017