Student Research Project / Master Thesis

Impact of Fuselage Aerodynamics on the Launch of Air Launch Systems

When launching air launch systems, various aerodynamic effects can be utilized which cannot be used with vertical launch rockets due to the launch direction and structural design. One of these effects is the lift of the rocket fuselage. Depending on the angle of attack and shape of the fuselage, the ascent of the rocket can be positively supported and thus contribute to additional payload capacity of the launch vehicle. This can also be accompanied by a targeted adjustment of the target trajectory and flight maneuvers in order to make the best possible use of the positive effect.

However, as air launch systems are always transported by carrier aircraft and must fit under their wings or fuselage, the fuselage geometry of the rocket cannot be varied at will. In addition, the fuselage must provide sufficient space for all internal systems such as tanks, engines and payload. Against this background, only minor changes to the basic cylindrical design of the rocket are possible. Therefore, the aim of this thesis is to investigate the effects of the fuselage lift on the flight path and the maximum payload capacity at launch and to make recommendations for maximizing the aerodynamic quality of the rocket fuselage during the mission.

The work is divided into the following steps:

1. Literature research on the aerodynamics of rockets, flight simulations and CFD
2. Definition of ascent scenarios with the corresponding flow conditions and a reference launch system
3. CAD modeling of the geometry of the reference launch system
4. Identification of the aerodynamic properties via CFD using the ascent scenarios
5. Implementation and testing of the aerodynamic properties of the fuselage in a predefined flight simulation environment in Matlab/Simulink
6. Implementation of a trajectory optimization to maximize the payload capacity
7. Critical analysis of the aerodynamic properties, the optimized trajectory and payload capacity as well as presentation of the optimization potential of the fuselage geometry

Contact: Kai Höfner, M.Sc.
Tel. +49 (0)162 / 656-8462, E-Mail: kai.hoefner@gaia-aerospace.com
Execution only after consultation of supervising university institute