



GAIA NETWORK

Student Research Project / Master Thesis **Behavior of Air Launch Systems in the** **Asymmetric Downwash under Carrier Aircraft Wings**

The GAIA Network is currently investigating the launch procedure of various air launch systems. During the launch procedure of an air launch system, the launcher falls back slightly after release because the propulsion system has not yet been ignited and thus shifts in the direction of the rear fuselage segment under the carrier aircraft. In this area, a downwash is formed due to the finite wings of the carrier aircraft. This can lead to a negative angle of attack on the launcher's fins and result in an uncontrolled pitching of the launcher. If the launcher pitches up too much, additional lift can affect the launcher, which in the worst case can lead to a collision of the rocket with the tail unit of the carrier aircraft.

Depending on the wing geometry of the carrier aircraft and the positioning of the launcher under the carrier aircraft, the downwash effect can have a different influence on the launch of an air launch system. When launching from the underside of one of the two wings, there is an asymmetrical downwash field, which can induce an additional rolling moment on the launcher. For this reason, this thesis examines in more detail how an air launch system would behave when launched from the underside of the wing of a Boeing 747-400 and what potential danger exists for the launcher and the carrier aircraft.

For this purpose, the work is divided into the following steps:

1. Literature research on air launch systems, the Boeing 747-400, downwash and wake vortices, flight mechanics and aerodynamics of aircraft and launcher
2. Definition of launch scenarios for a predefined air launch system
3. Definition of a mathematical downwash model for the carrier aircraft using CFD
4. Implementation of the carrier aircraft and downwash model in a predefined flight simulation of the air launch system in a Matlab/Simulink environment
5. Performance of launch simulations using the previously defined launch scenarios
6. Critical analysis of the flight mechanical behavior of the air launch system and the probability of collision with the carrier aircraft
7. Summary of the results and presentation of possible approaches for collision avoidance

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

