The **French-German Research Institute of Saint-Louis (ISL)** situated in the border triangle of Germany, France and Switzerland is an internationally renowned research institute belonging to a global industrial and economic network.
The spectrum of our core activities comprises a variety of topics: aerodynamics, energetic and advanced materials, lasers and electromagnetic technologies, protection, security and situational awareness. Our activities are related to both basic and applied research.

ISL is offering a **PhD Position**

Research field: Flight techniques for projectiles

Modelling of the aerodynamic effects of projectiles flying at high angles of attack

Projectiles fired at high angles of elevation can reach high angles of attack of more than 20 degrees at transonic speeds in the apogee of their trajectory. The flight dynamics of projectiles with high angles of attack and transonic velocities in the apogee are not yet fully understood. The aerodynamic coefficients show substantial variations for projectiles in the transonic speed regime. Changes in the flow field around the projectile, occurring close to the apogee of the flight trajectory, can therefore significantly alter the accuracy of a projectile. In order to enhance precision it is necessary to elucidate the aerodynamic effects occurring for projectiles flying at high angles of attack in the transonic regime on the flight dynamics in the apogee.

Description of the tasks of the study and objectives: A reliable description of the flight dynamics of a projectile at high angle of attacks in the apogee of its trajectory is necessary to predict the accuracy of large caliber projectiles. The tasks of the proposed thesis addressing the need of a reliable description of uncertainties responsible for unpredictable flight behavior close to the apogee includes:

1) Literature survey to scope the existing knowledge on aerodynamic coefficients of projectiles at high angle of attack in the transonic regime.
2) Validating the capabilities of existing CFD methods to predict aerodynamic coefficients of projectiles at high angles of attack in the transonic regime.
3) Determination of the most crucial parameters regarding uncertainties in the flight dynamics near the apogee of projectiles with high angle of attack using a 6-Degree-of-Freedom (6-DOF) trajectory algorithm.
4) Optional: Measurements of the beforehand determined, crucial aerodynamic coefficients in the wind tunnel or free flight experiments (according to availability of wind tunnel and test range facilities)
5) Development of an aerodynamic model including the crucial parameters to determine uncertainties responsible for the flight behavior of projectiles at high angles of attack.

Expected results

The eventual goal is to determine the most crucial aerodynamic parameters affecting the accuracy of projectiles with a high angle of attack in the apogee of their trajectory and to develop an aerodynamic model describing the uncertainties caused in the flight behavior. This involves also a critical discussion of the accuracy of measurement results published in the literature, determination of random effects on a flight trajectory like cross-winds, and the limits of applicability of numerical simulations for unsteady, transonic, highly separated flow field of a projectile flying at high angle of attacks.

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