# Active Separation Flow Control Experiments in Weakly Ionized Air

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Topic: A and H

## Abstract

High voltage electrostatic gas discharges from a spanwise corona wire placed 2.5 cm in front of the conducting leading edge of a dielectric wing with 50 cm span width are applied to control the separation in low Reynolds number air flows [3]. Additional discharge electrodes are placed on the upper surface of the rectangular wing to energize the boundary layer through ionic winds. Plexi glas end discs are used to maintain a two-dimensional flow for visualization and measurement of aerodynamic forces with a two component balance. The chord Reynolds number range is from 6,500-130,000 which equals a velocity range from 0.5 - 11 m/s (0,5 - 6,6 and 6,6 - 11 m/s) typical for micro-vehicle [2]. The average electrical power expenditure is 8 Watt per 50 cm corona wire positively charged with 16 – 17 kV with a maximum current limited by the high voltage power supply to 0.5 mA.

The influence of unipolar space charges on boundary-layer separation is visualized with continous smoke generated from a hot wire placed in front of the wing leading edge but perpendicular to the span width to provide a cross-sectional view of the flow field. Laser light sheet techniques were used to illuminate the fine paraffin oil smoke.

The flow visualizations at different velocities illustrate the results of the lift diagrams showing dramatic separation delays and resulting lift enhancement by applying electrostatic forces for a very modest expenditure of energy. A video presentation will show the strong and reproducible flow modifications around the airfoil at high angles of attack up to 30 degrees. The separated boundary-layer on the airfoil is completely corrected after switch-on of the electrostatic field leading to weakly ionized air flow [3].

Currently the research focus is cylinder wake flow control by means of electric field actuation. The goal is to investigate the *Electroaerodynamic Coanda Effect (ECE)* by steady and pulsed ionic wind blowing from flat array phased plasma actuators [1]. First results show that pulsating excitation is more efficient than steady blowing.

## References

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[3] B. Göksel, I. Rechenberg, R. Bannasch (2003) Experimentelle Untersuchungen zur aktiven Beeinflussung von laminaren Strömungsablösungen. 11. STAB-Workshop, Göttingen.

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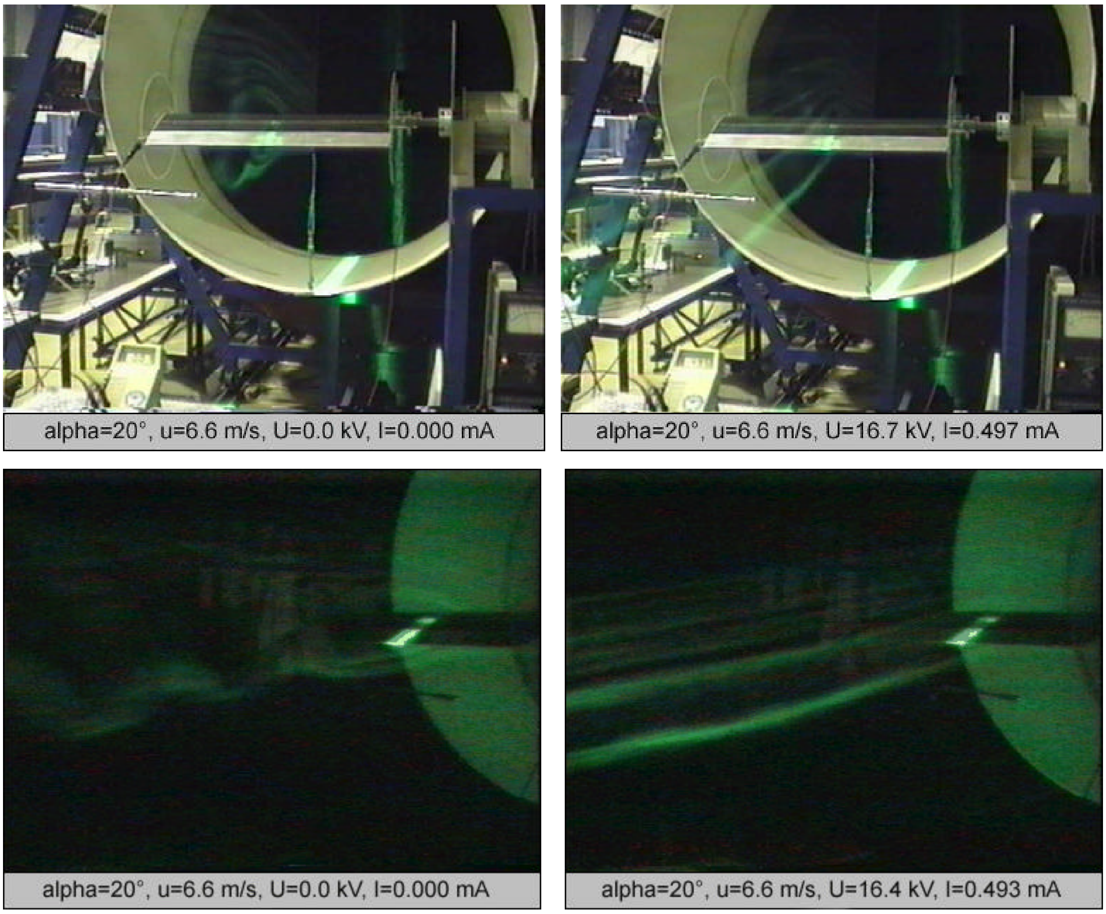


**Fig. 1-4:** Laser light sheet smoke visualizations with electric field switched off/on.

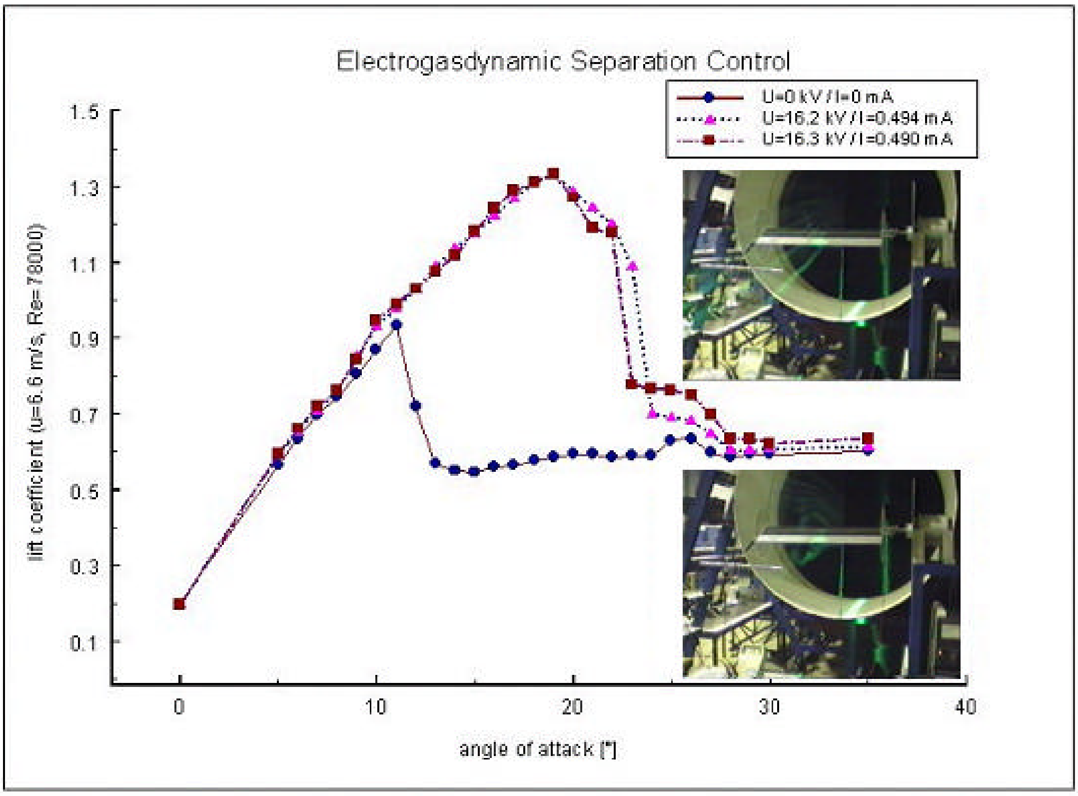


**Diagram 1:** Lift diagram for air velocity u=6.6 m/s.