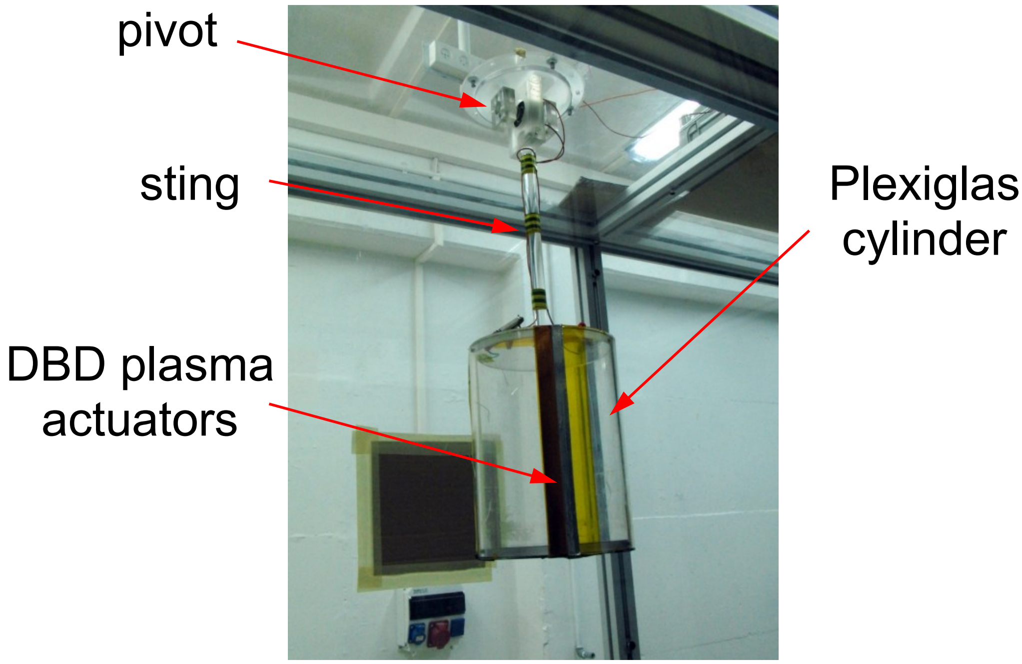
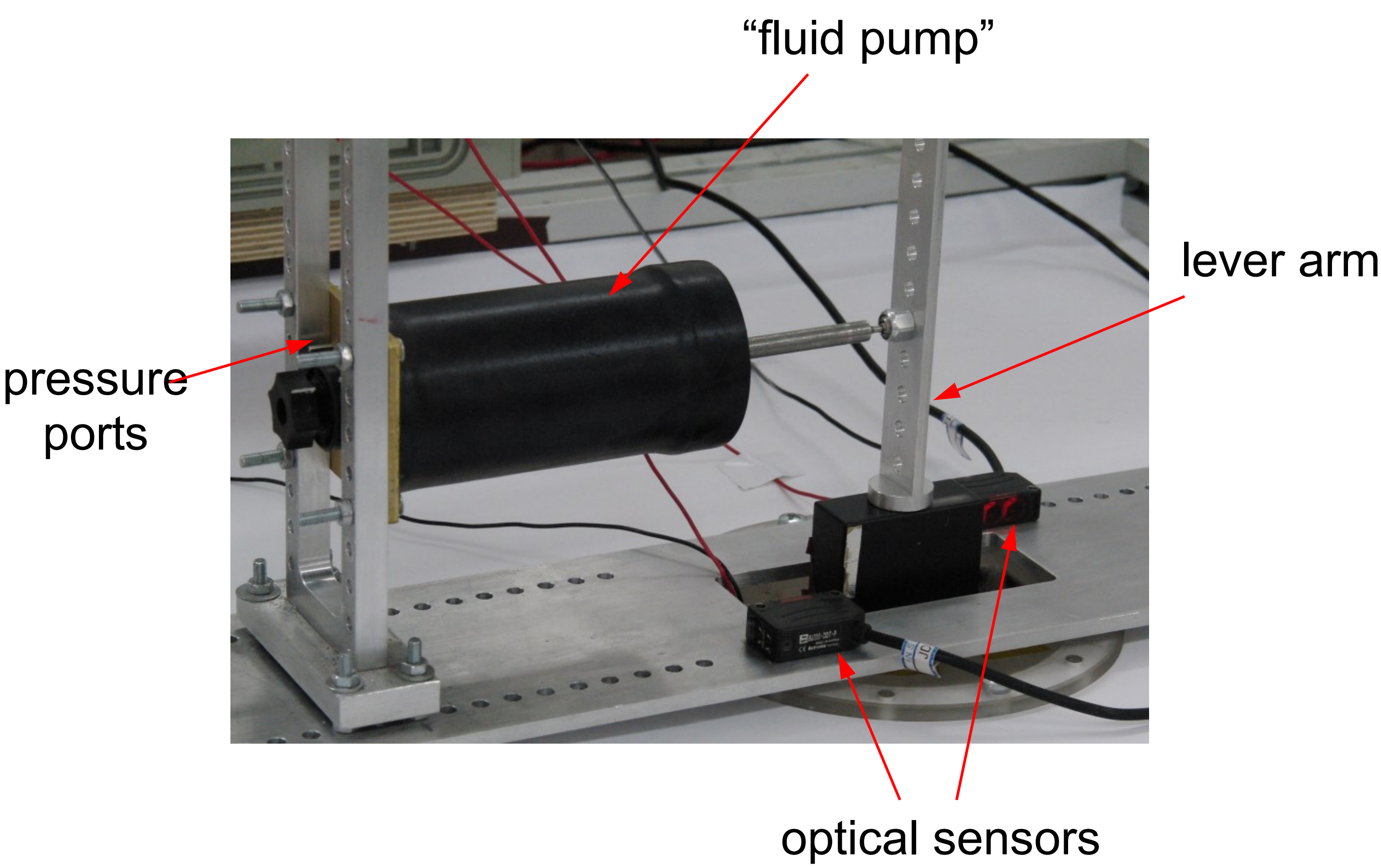
Wind-Energy Generation by Active Flow Control

We have developed a novel wind-energy generator that is driven by active flow control. To achieve this, flow-control-induced oscillations were forced by dynamic boundary layer separation and attachment using plasma actuators. Proof-of-concept wind tunnel experiments were performed on a one-degree-of-freedom sting-mounted, pivoted cylindrical body where pulsed dielectric barrier discharge plasma actuators were used to control separation. A nonlinear load, typical of a positive displacement fluid pump, was attached to the system and calibrated. Using phase-locked actuation, simultaneous pressure and angular displacement measurements were performed to determine the integrated mean system power. A system model, including non-linear load effects, aerodynamic effects and friction was developed. Peak measured power coefficients were relatively small, approximately 1%; nevertheless the power required to drive the actuators was one order of magnitude lower than the measured system power. The system model was solved using a fourth-order Runge-Kutta method and the integrated power predictions were excellent. Friction was found to play a significant role in reducing the power output of the generator. Despite these modest results, the system may be amenable to up-scaling because lateral force coefficients can be increased and the power coefficient increases with the square-root of the system dimensions.


pivot
sting
Plexiglas cylinder
DBD plasma actuators


“fluid pump”
lever arm
pressure ports
optical sensors