Turbine Aerodynamics

Active Flow Control by Plasma Actuators

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Motivation:
Active flow control methods e.g. plasma actuators may enable a further increase in cycle efficiency of modern gas turbines.

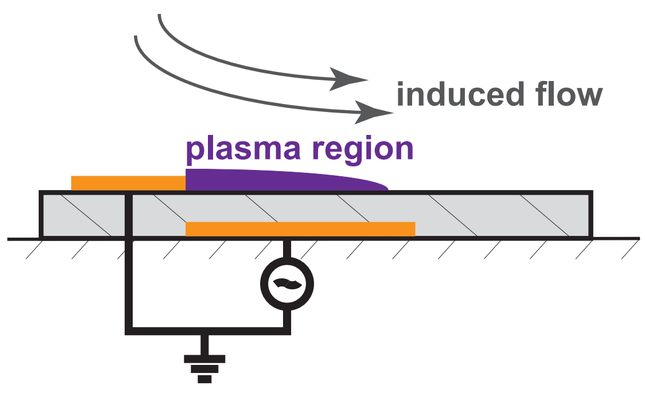
Goal:
Influencing the endwall boundary layer of the stator vane by plasma actuators to change secondary flow phenomena and turbine efficiency.

Plasma Actuators

Dielectric Barrier Discharge Actuators are high voltage devices.
The standard DBD Actuator consists of three components:

- two metallic electrodes
- an insulation material which separates the electrodes

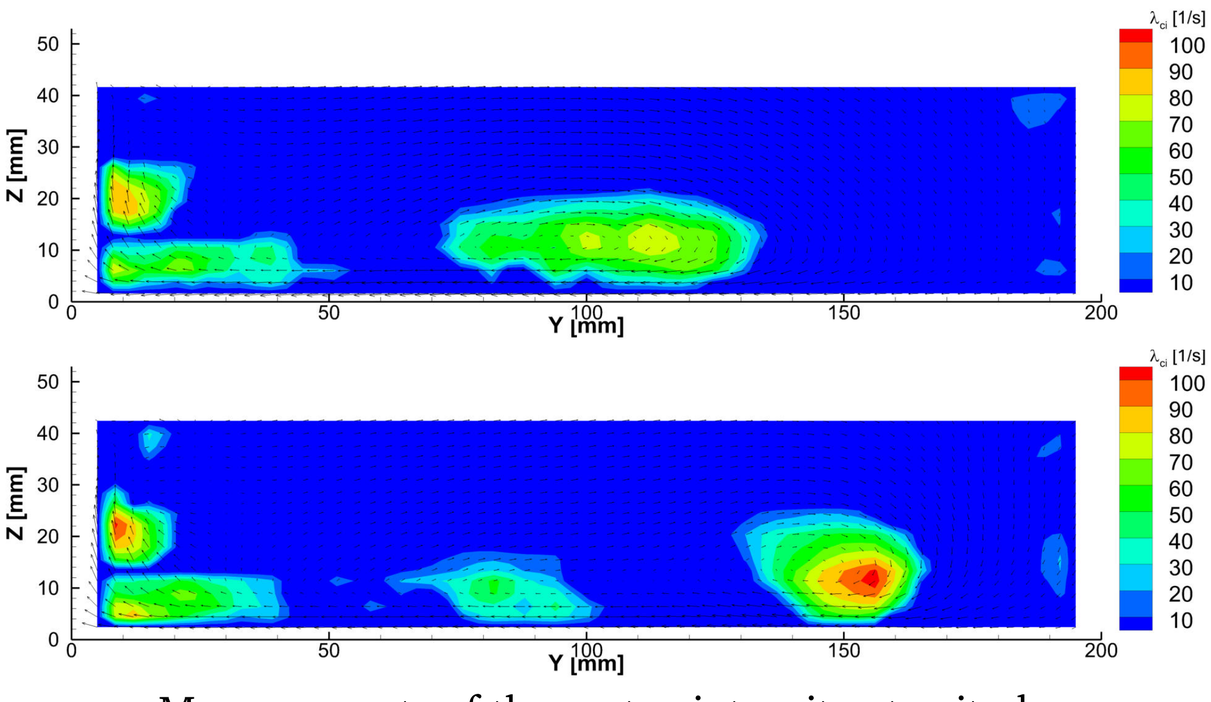
The electrodes are arranged with a parallel offset, resulting in a clear actuation direction.



By applying a radio frequency high voltage to the electrodes a weakly ionized plasma in the surrounding air is generated.
Because of the electromagnetic field the charged particles are accelerated.
They transfer the momentum to neutral air molecules by collisions. A net body force is generated in the fluid, without changing the mass flux.

Plasma Test Rig

- 76,5° bend with a constant cross section area
- transparent test sections
- Re=125 000 (based on test section height and mean inflow velocity)



Measurements of the vortex intensity at exit plane
- upper figure: without working plasma actuator
- lower figure: with working plasma actuator

Turbine Cascade

- five vanes in the test section
- transparent test section
- Re=100 000 (based on the chord length and mean inflow velocity)