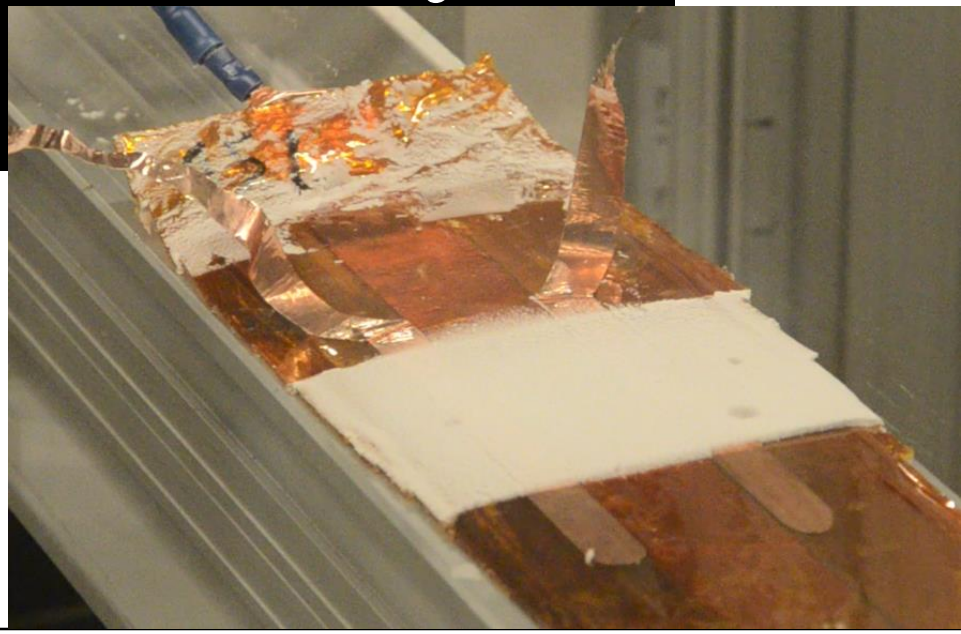
De-icing using ns-DBD plasma actuation: experimental study

Jakob Van den Broecke
Delft University of Technology



Presentation outline

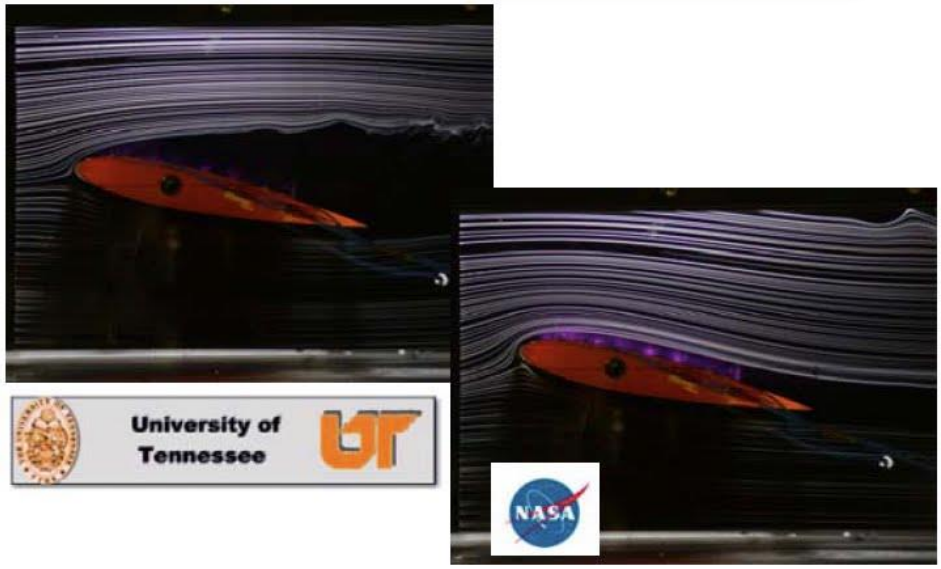
- Aerodynamic background
- ns-DBD plasma actuator
- The experiment
- Results
- Conclusion

TU Delft Delft University of Technology

Aerodynamic background

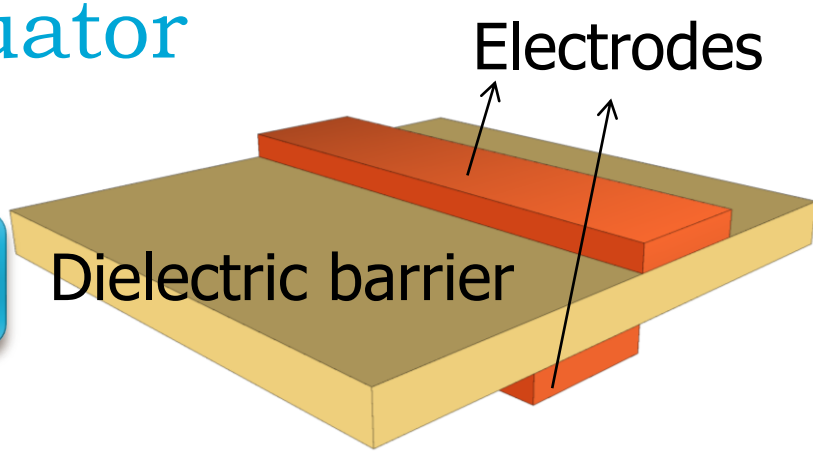
Flow Control → Postpone / prevent boundary layer separation → Increase lift Decrease drag

- Vortex generators
- BL suction/blowing
- Plasma actuators



What if this device could also de-ice?

ns-DBD plasma actuator

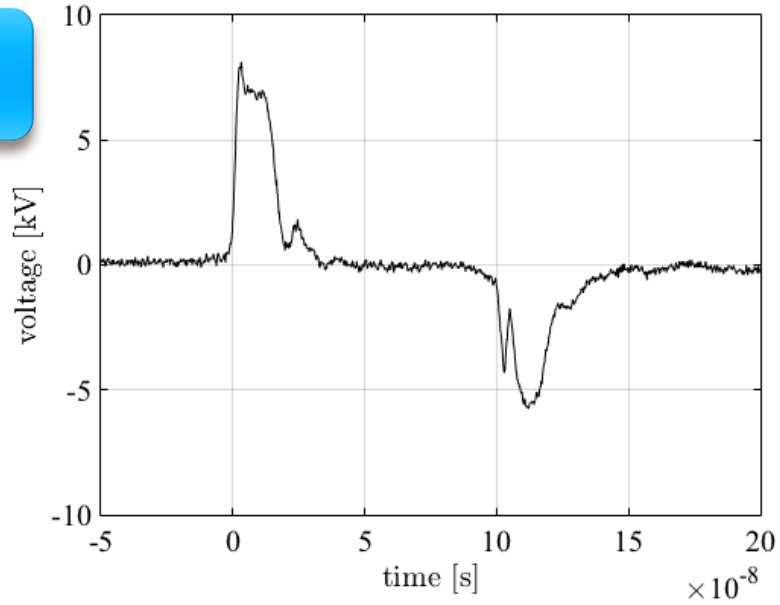


Physical

- 2 electrodes: covered/exposed
- Dielectric barrier: Kapton

Electrical

- Electrode 1: nanosecond-pulsed signal
- Electrode 2: ground
- High voltage
- High frequency



Ultrafast gas heating mechanism

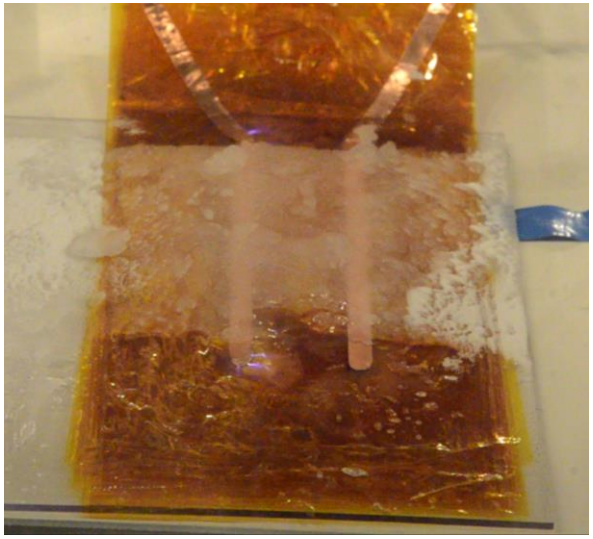
The experiment

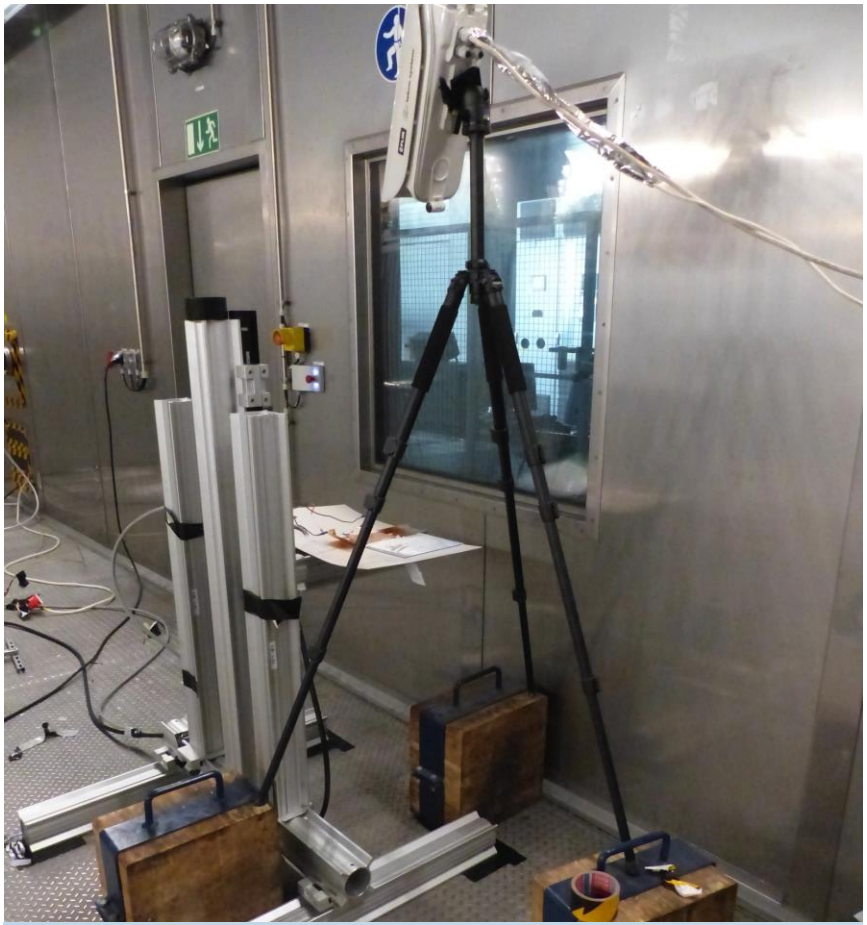
OWI-lab

- Location: Port of Antwerp, Belgium
- Temperature range: -60 to +60°C
- Lab dimensions: 10.5 x 7 x 8 m^3
- Installed power: 408 kW

- De-icing @ -20°C

The experiment



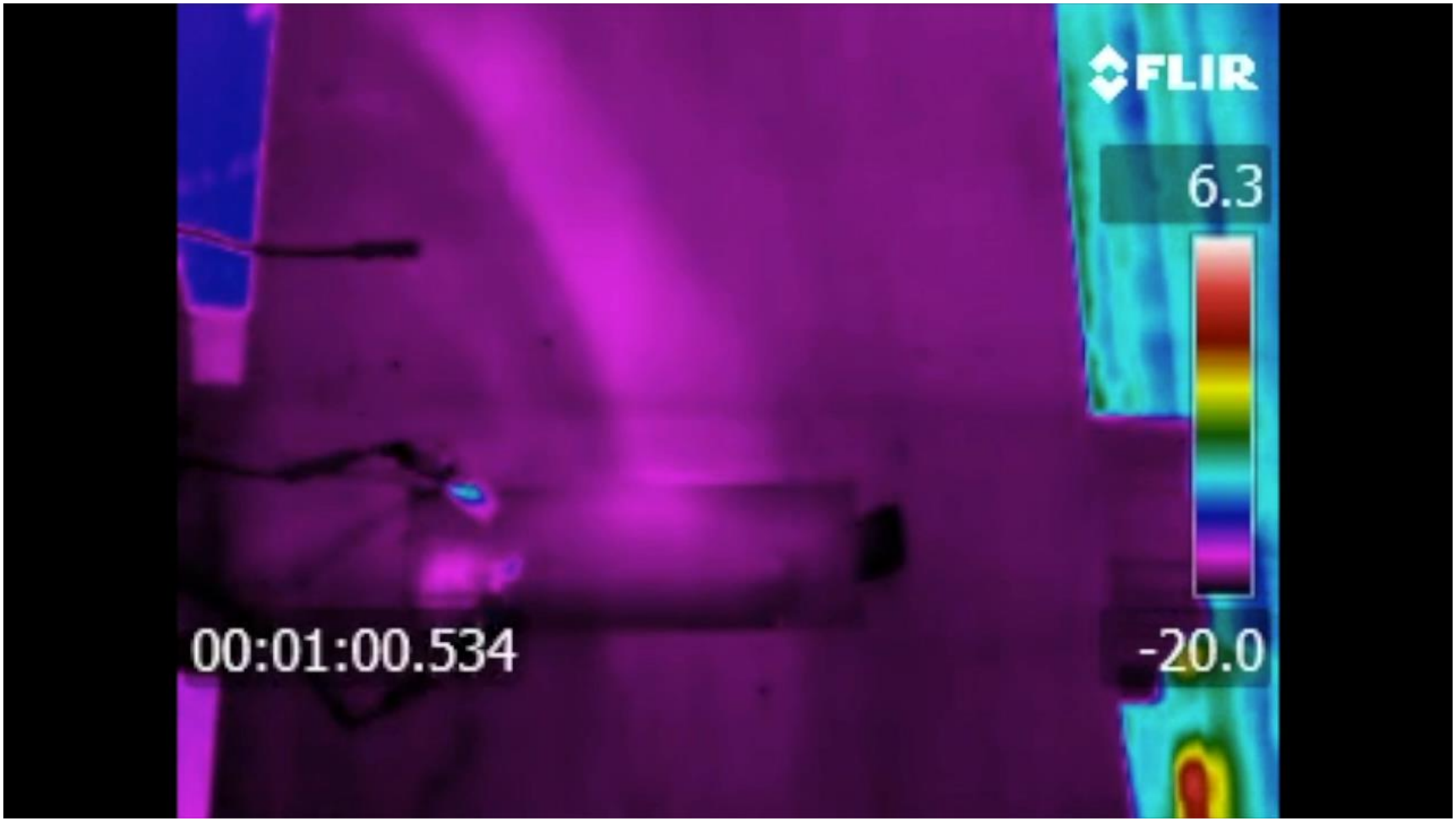


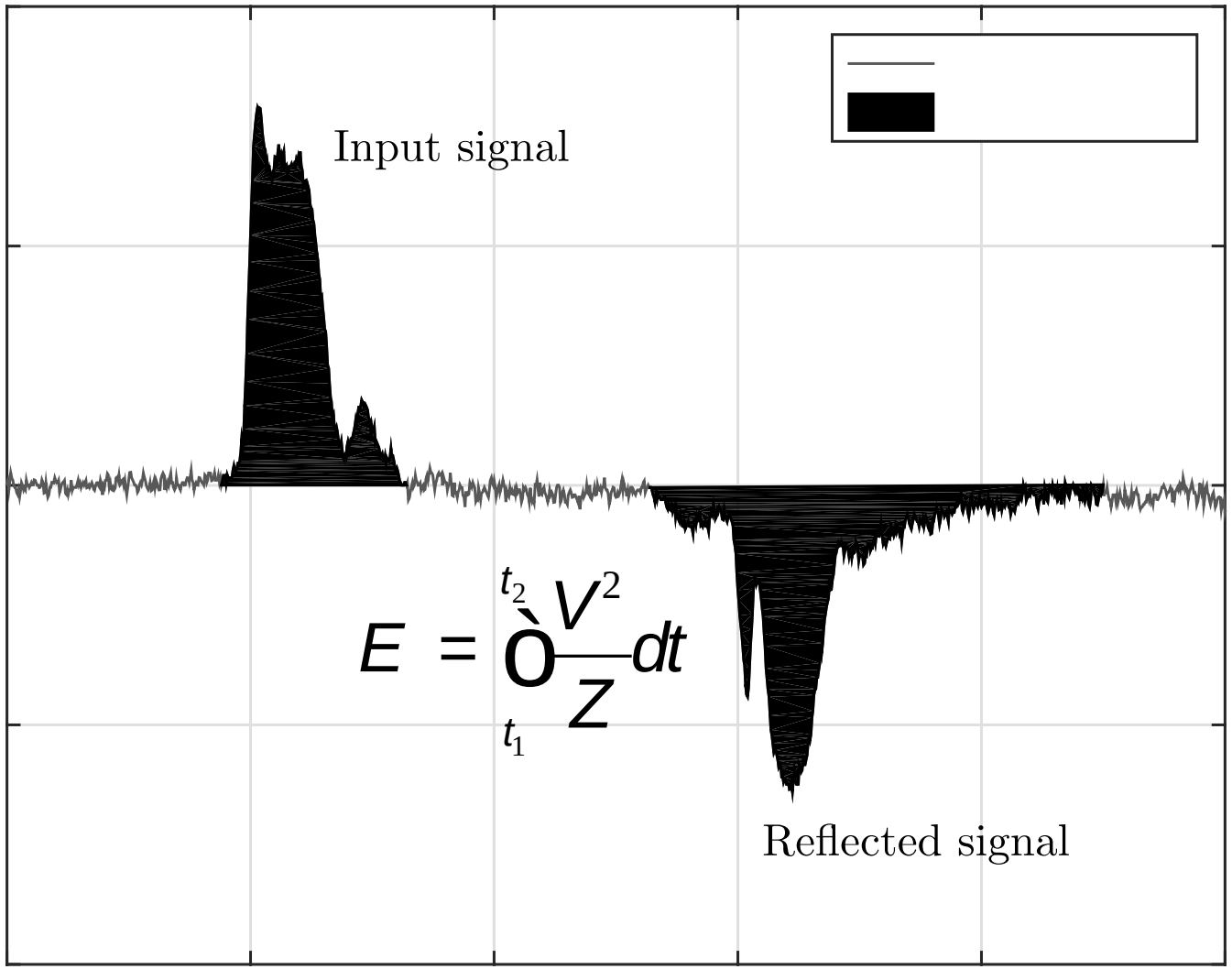
OWI application lab
For efficient and reliable offshore wind energy

Qualitative analysis

Qualitative analysis

IR results




Input signal
Reflected signal
$E = \int_{t_1}^{t_2} \frac{V^2}{Z} dt$
V [kV]
t [s]

Results

- Measurement uncertainties
- Ice parameter uncertainties
- Ice refreezing during test

Conclusion on using ns-DBD plasma actuation for de-icing

Flow control device	• Decrease drag and increase lift • Or: increase drag for aerodynamic braking • De-icing capabilities with same device
Speed	• Ultrafast gas heating mechanism • Produces heat where it is needed
Retrofit possible	• Film/electrode combination on LE of rotor blade • Hydrophobic material as dielectric barrier
Cons	• Electromagnetic noise production • New technology, needs accurate adjustment

De-icing using ns-DBD plasma actuation: experimental study

Jakob Van den Broecke
Delft University of Technology