Threshold current density for homogeneous excitation of pulsed Xenon excimer DBD

Mark Paravia
Klaus Trampert
Wolfgang Heering

Light Technology Institute
University Karlsruhe

ICOPS 2008

06/18/2008

Xenon excimer discharge

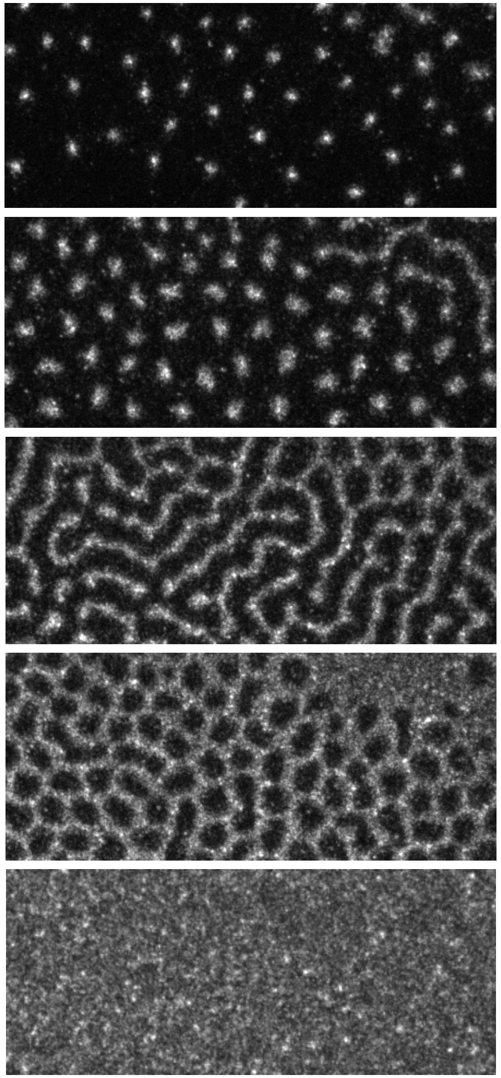
- dielectric barrier discharge
- nonequilibrium plasma
- plasma efficiency up to 65 %
- generation of VUV radiation (172 nm)
- plane gas discharge

Xenon excimer discharge

- dielectric barrier discharge
- nonequilibrium plasma
- plasma efficiency up to 65 %
- generation of VUV radiation (172 nm)
- plane gas discharge

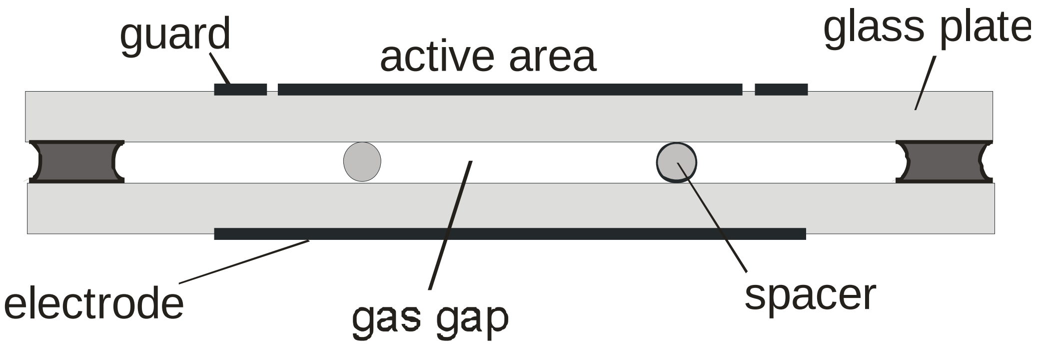
Discharge mode

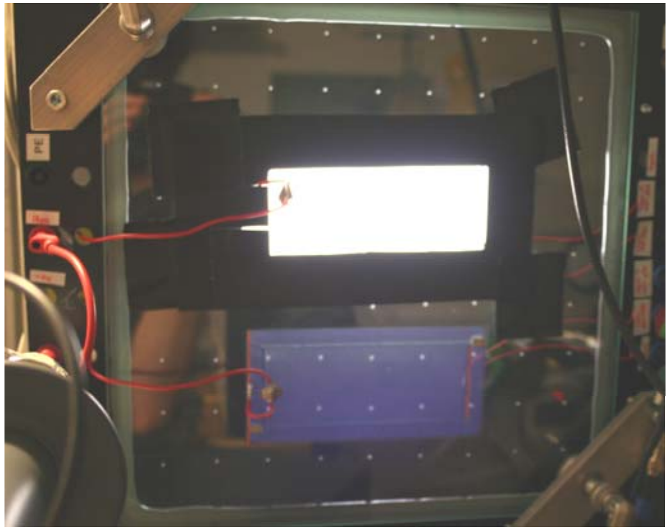
- Filamentary, patterned or homogeneous



Single pulse NIR images, t_{int} = 1µs

Experimental setup



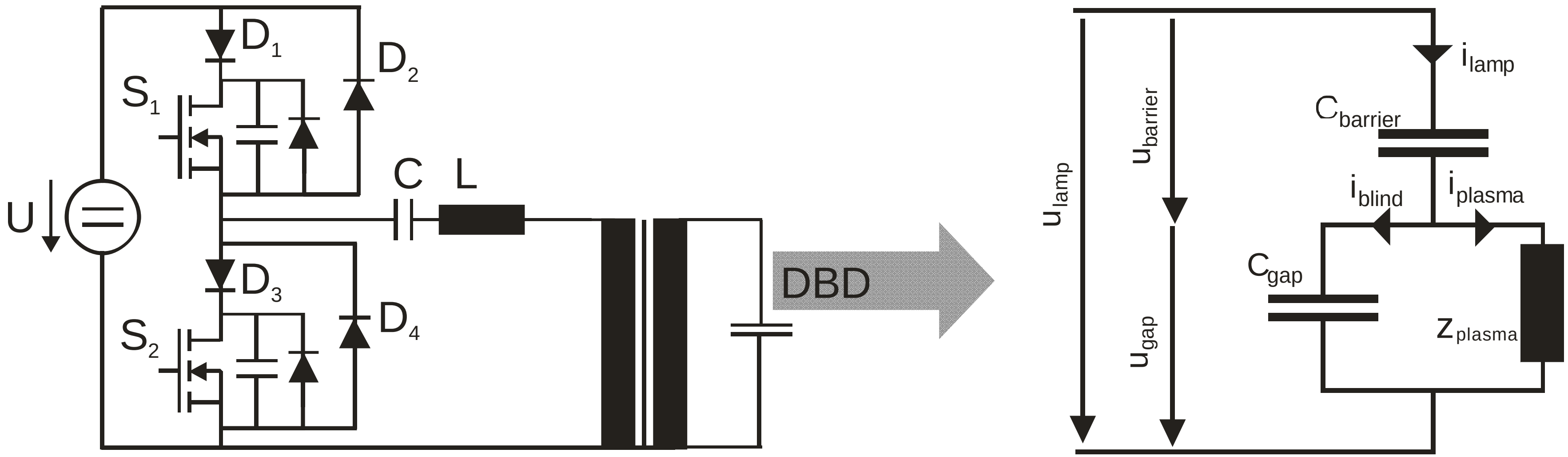


Plane DBD

- discharge with and without phosphor
- active area with electrical guard
- measurement of internal values

Xe pressure:	150 mbar
gas gap:	2 mm
active area:	54 cm^2
frequency:	40 kHz
power:	20 - 70 mW/cm^2

Experimental setup

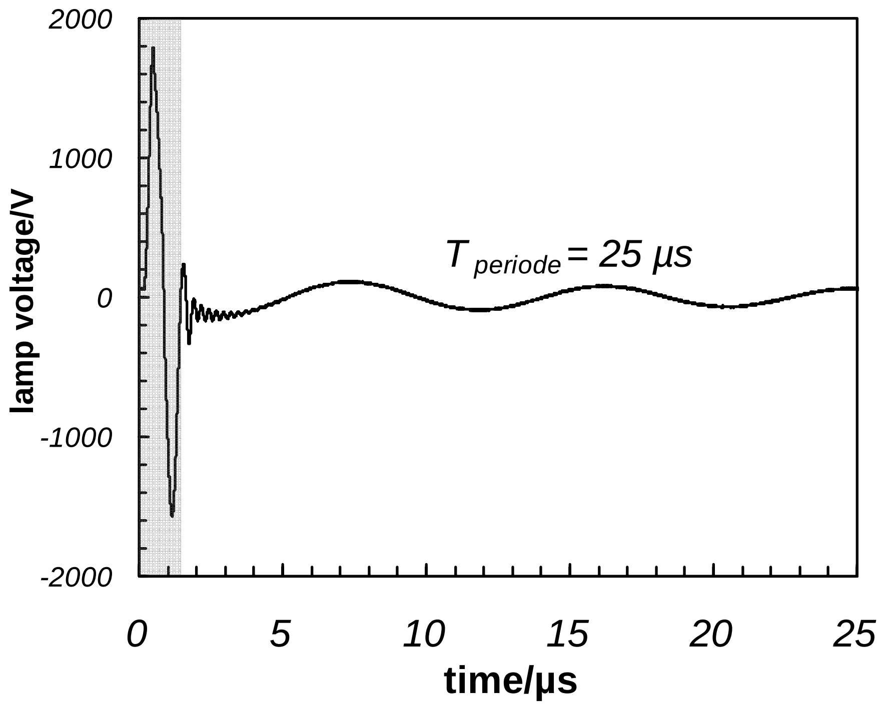


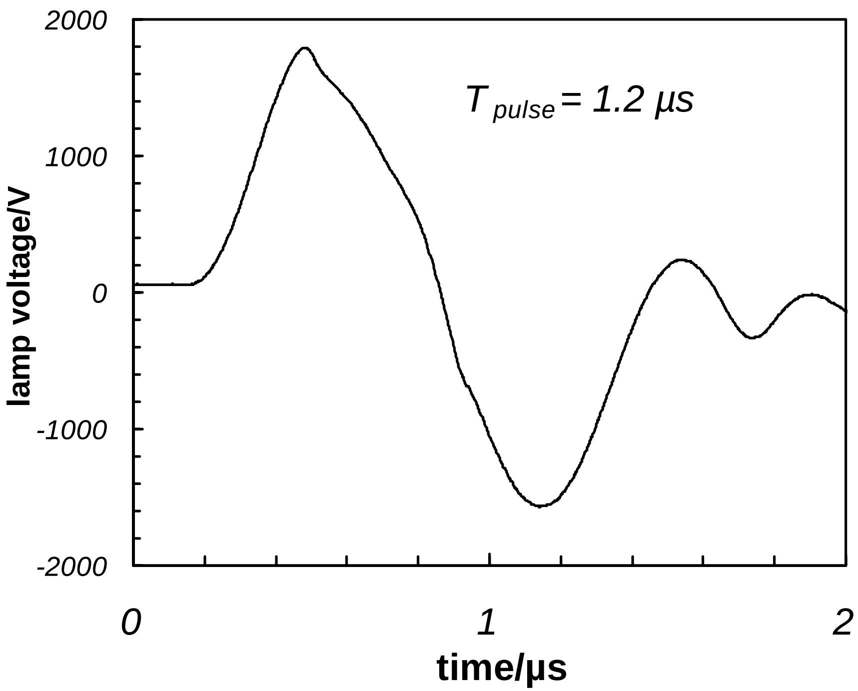
Electrical excitation and measurement

- resonant pulse ECG as current source
- measurement of plasma current i_{plasma}
- measurement of gap voltage u_{gap}

Roth, M., Neiger, M., 21. IDRC, Nagoya, 2001, p. 893-896

Internal values during pulsed excitation

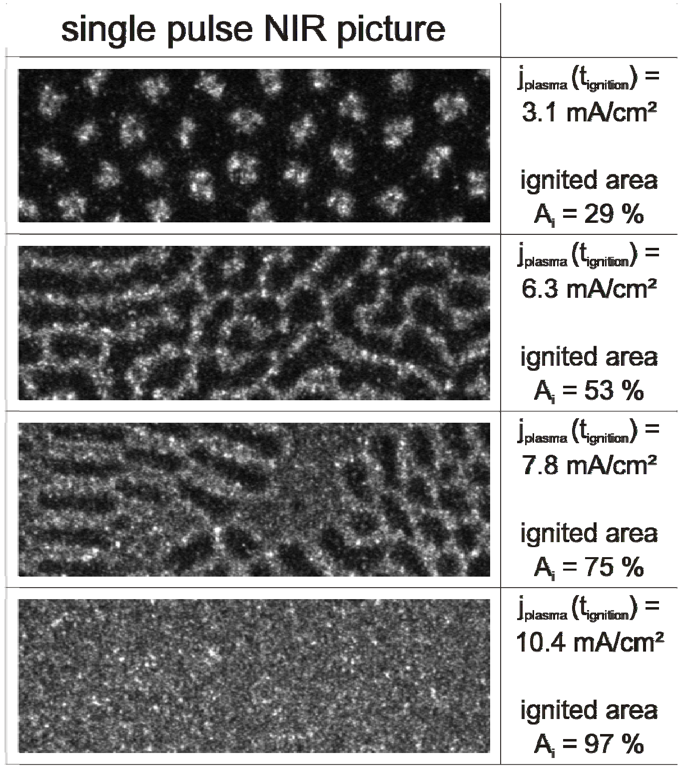


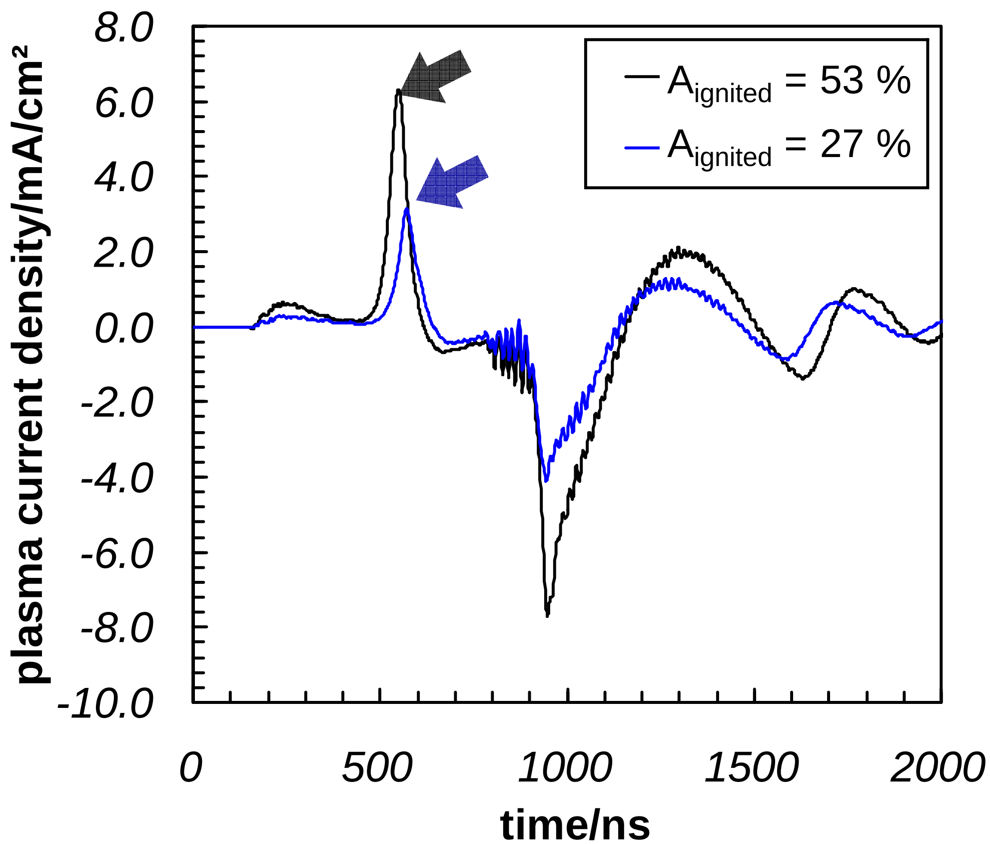


Pulsed excitation

- pulse length t_{pulse} = 1.2 µs (HF period)
- variation of current for transition from filamented to homogeneous discharge

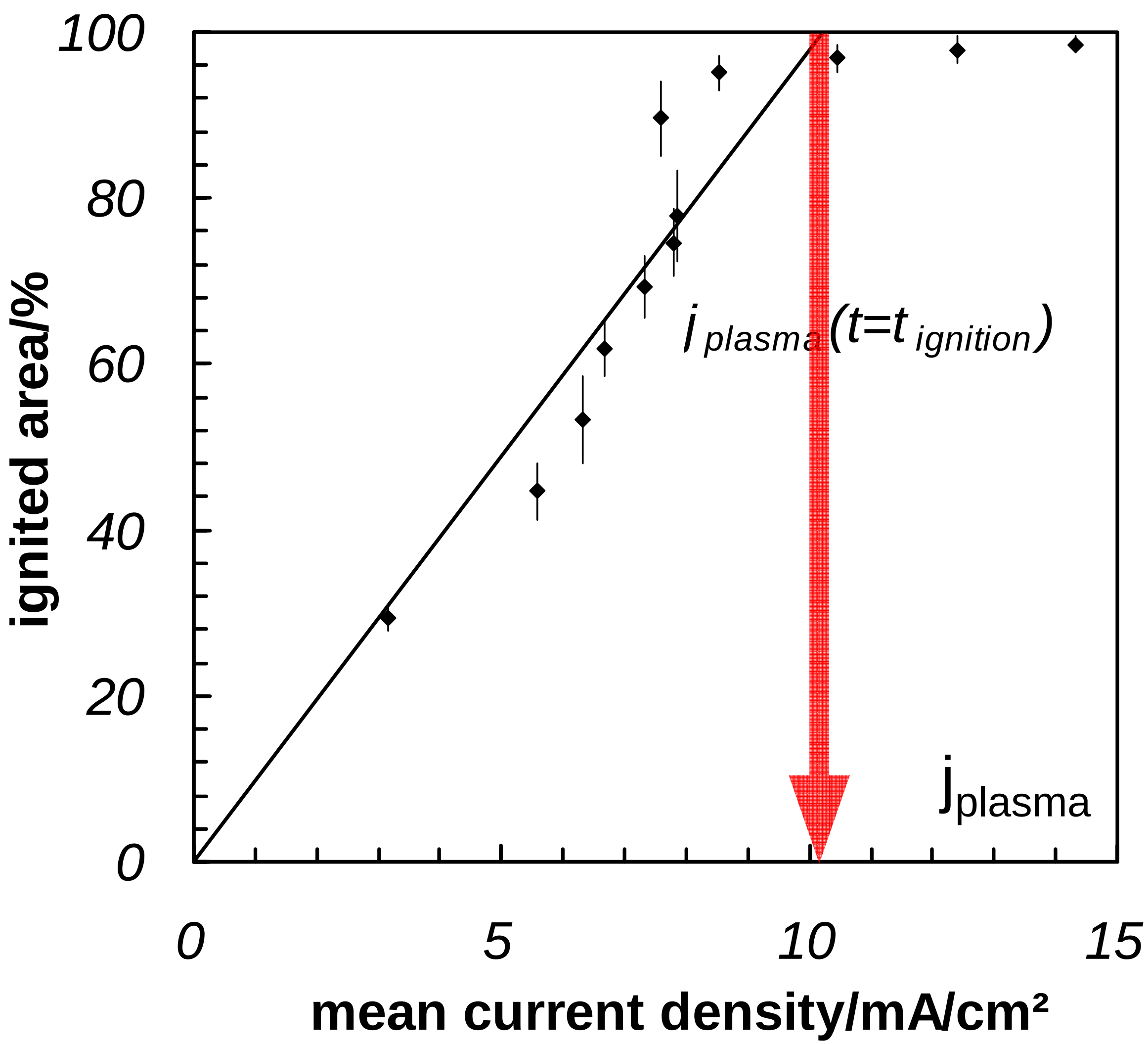
Threshold current density





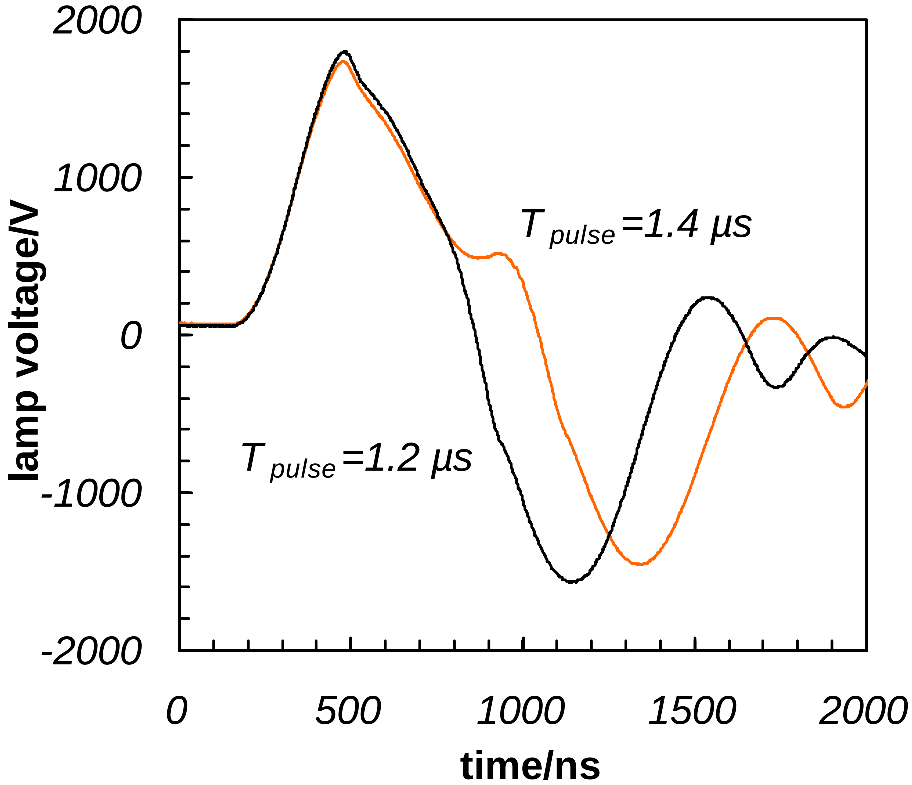
- determination of ignited area
- comparison of mean current density during ignition

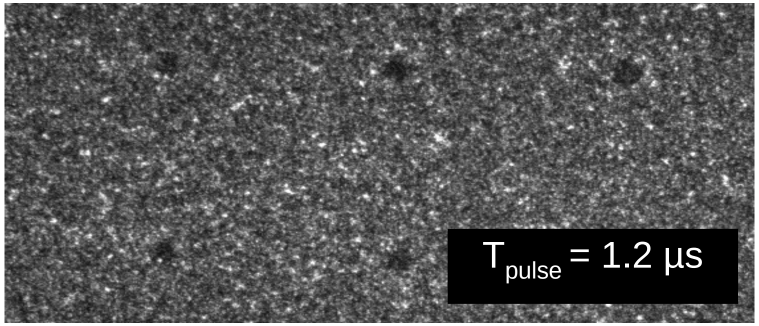
Threshold current density

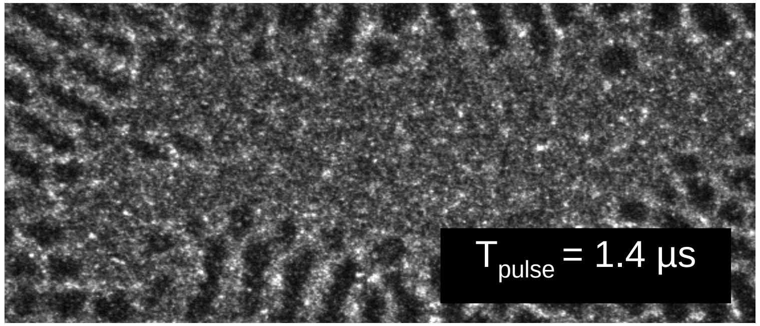


- Linear increase of ignited area up to the homogeneous discharge
- Threshold current density j_{plasma} = 10 mA/cm²
- increased current density after homogeneous discharge

Reignition of Xe Excimer DBE

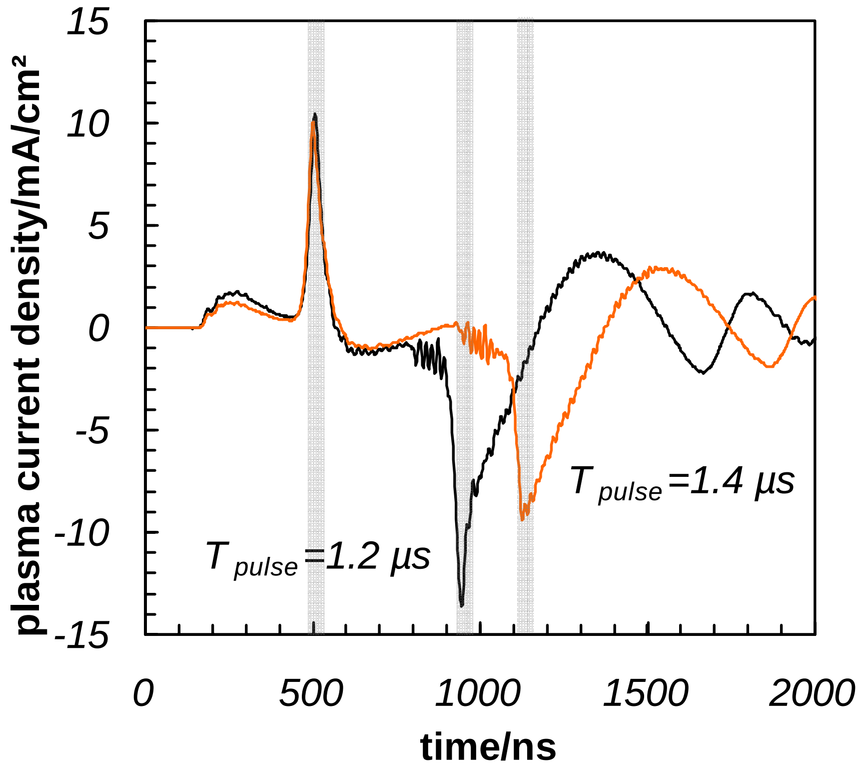


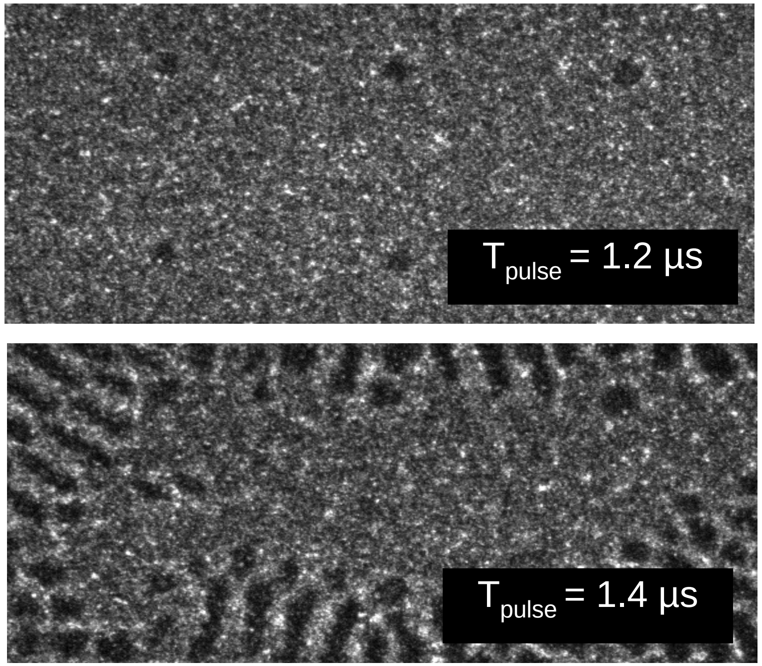




- variation of pulse length
- constant slew rate at the rising voltage edge
- discharge is not complete homogeneous for T_{pulse} = 1.4 µs

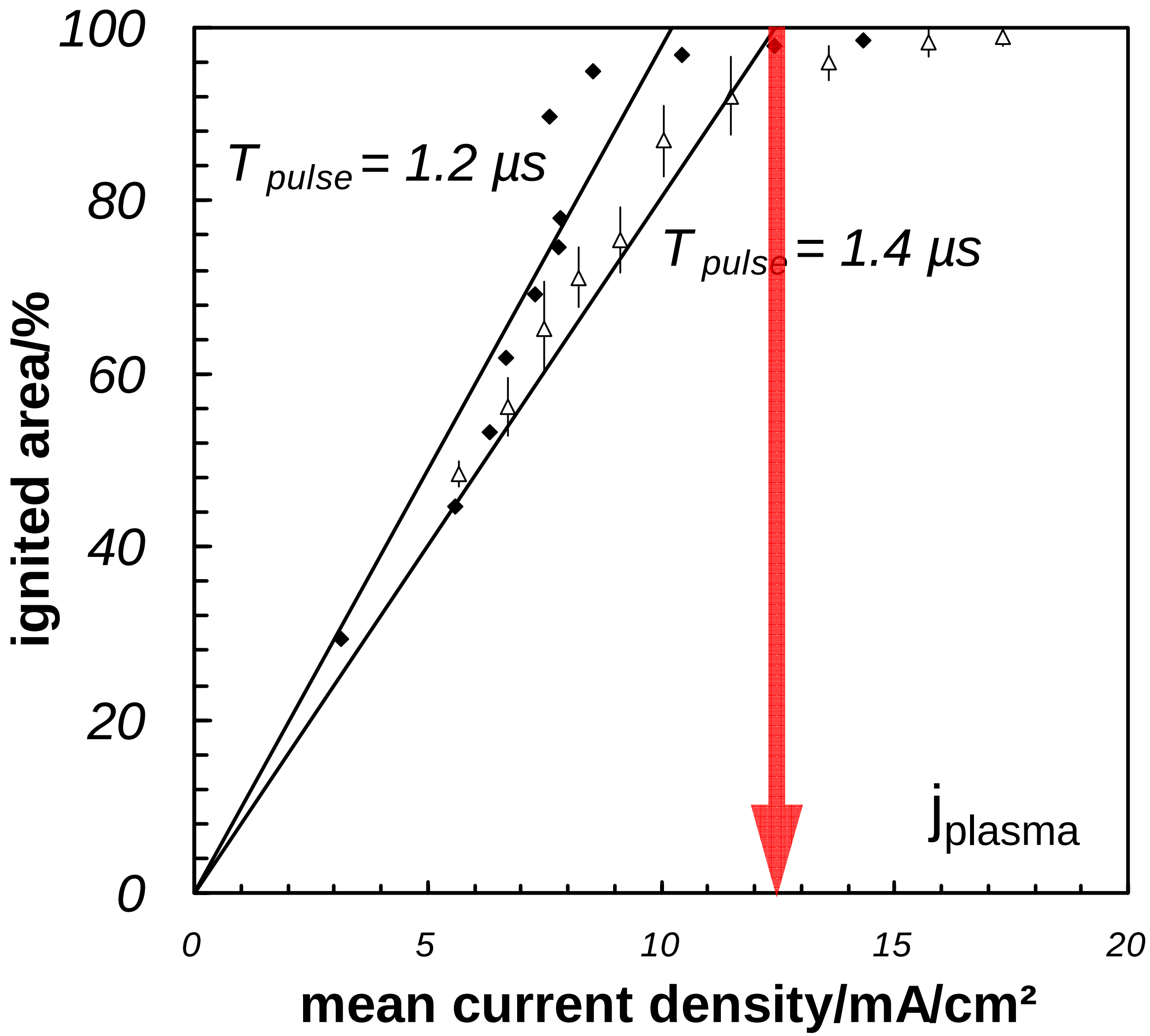
Reignition of Xe Excimer DBE





- Same current density of first ignition
- Shift second ignition to 600 ns after first ignition

Reignition of Xe Excimer DBE



- Higher threshold current density j_{plasma} = 12.5mA/cm²
- Pulse shape influences the threshold current density

Summary

- current density determines discharge mode
- linear increase of ignited area with mean current density
- homogeneous discharge above threshold current density
- reignition influences threshold current density

Thank you for your attention.