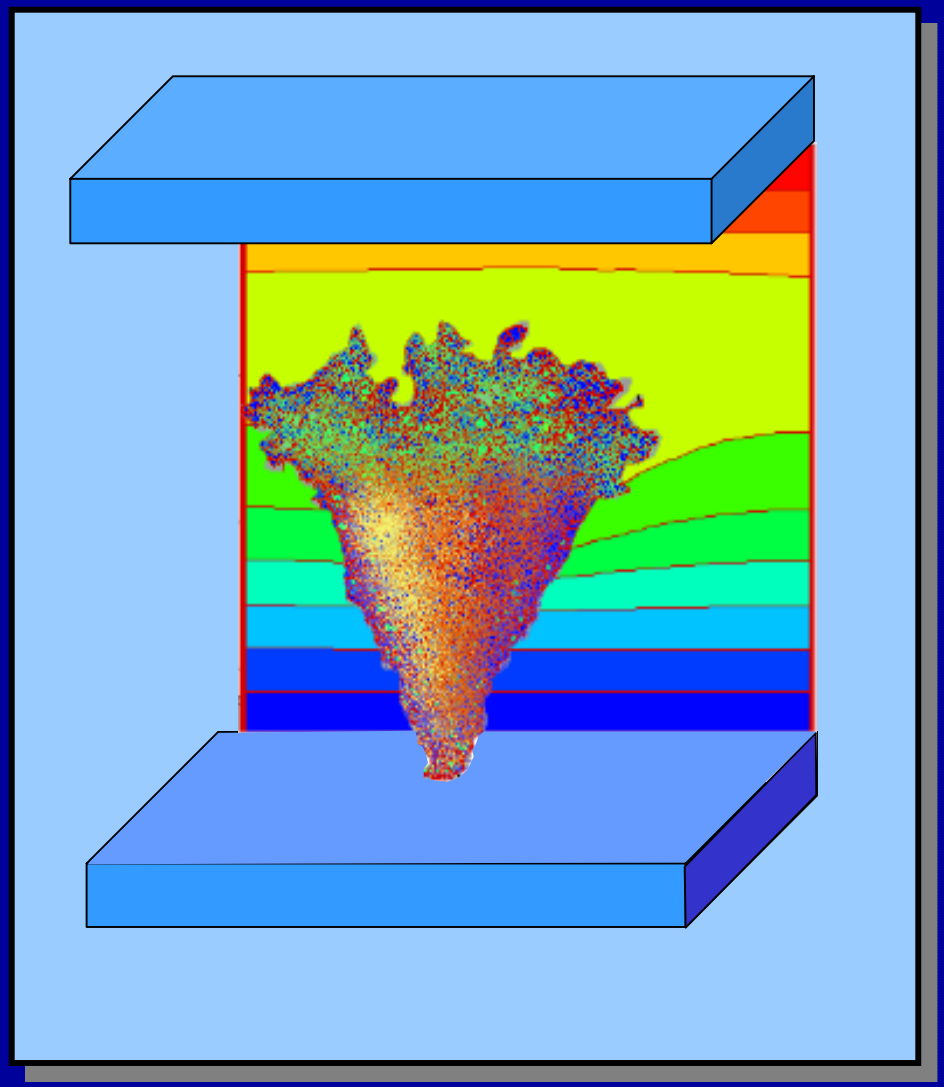
SIMULATION OF DIELECTRIC BARRIER DISCHARGES

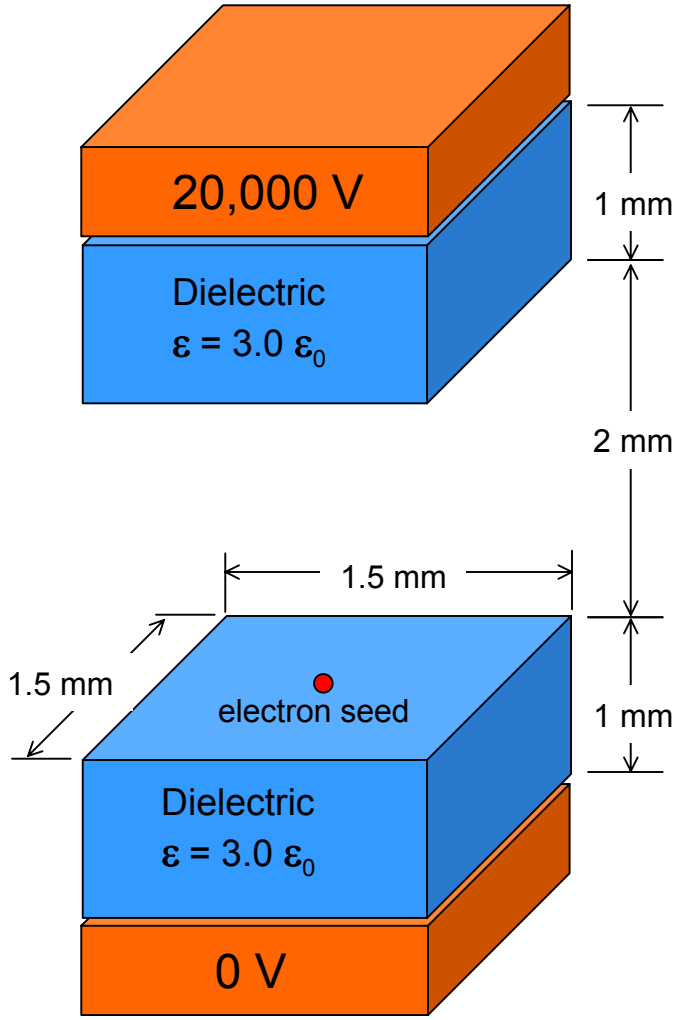
by
Gabriel I. Font
and
W. Lowell Morgan



KINEMA
Research & Software, L.L.C.

DIELECTRIC BARRIER DISCHARGE:

Computational Domain



Discharge Conditions:

Pres. = 1 atm

Gas = Nitrogen

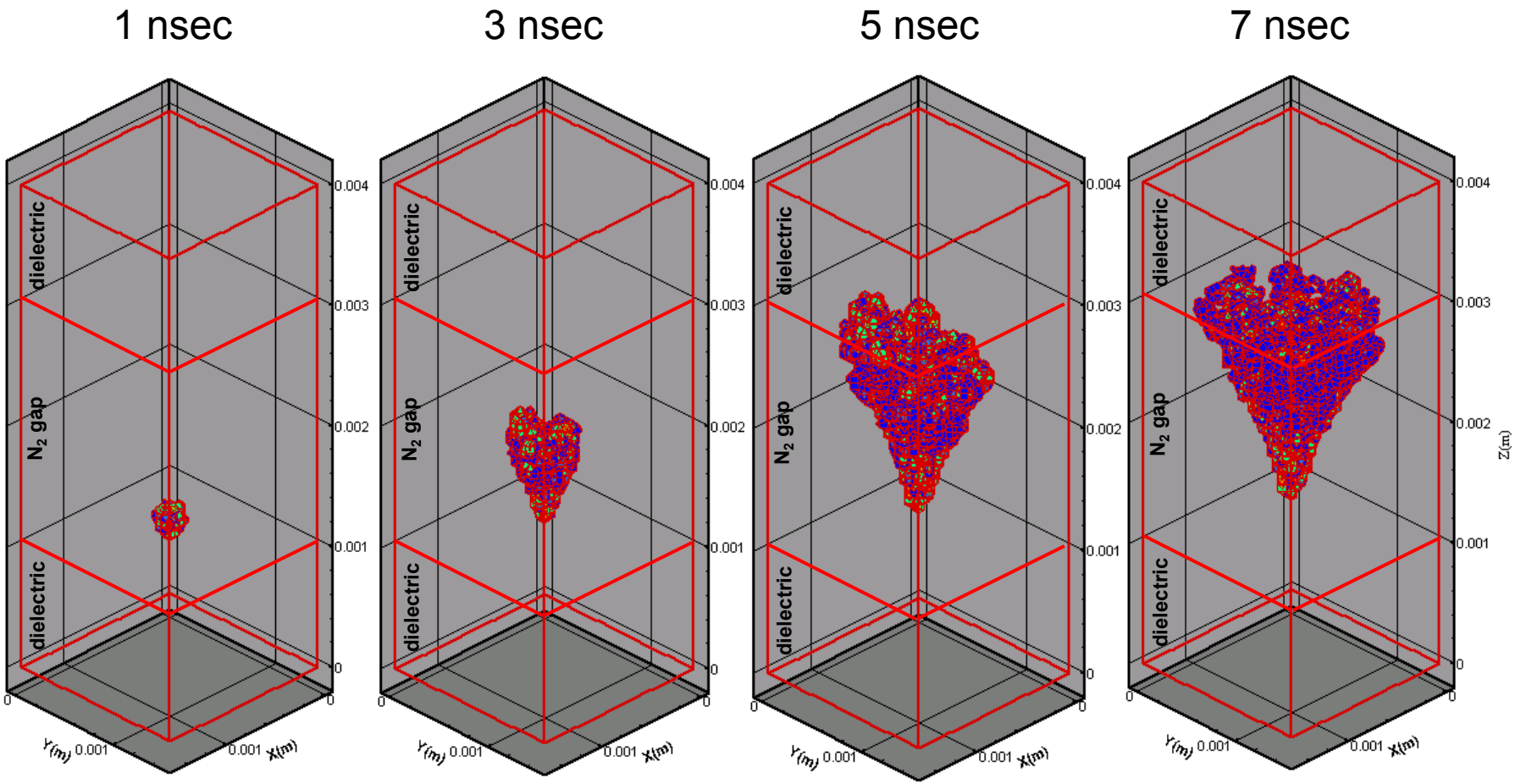
$n_{e\ (seed)} = 8 \times 10^{12}\ cm^{-3}$

$n_{e(backgrnd)} = 0\ cm^{-3}$

$R_{seed} = 50 \mu m$

DIELECTRIC BARRIER DISCHARGE:

Electron Density Evolution

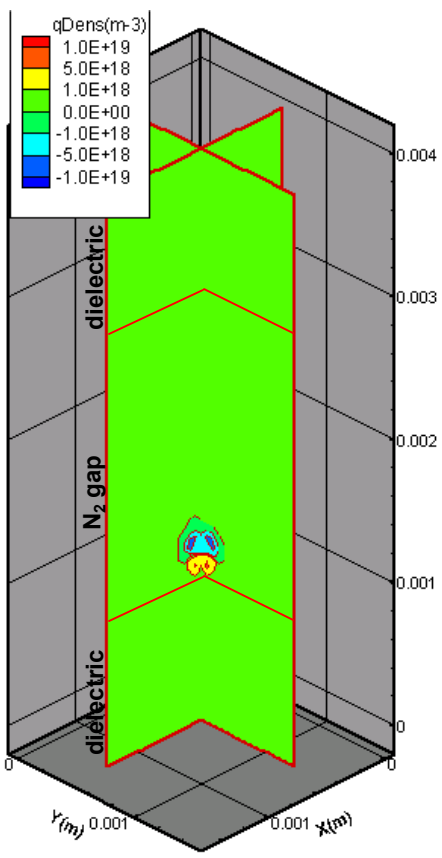


KINEMA

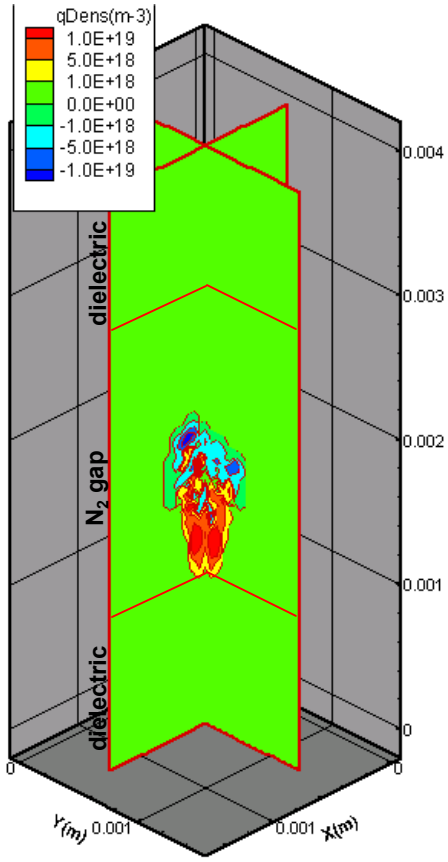
DIELECTRIC BARRIER DISCHARGE:

Plasma Density Evolution

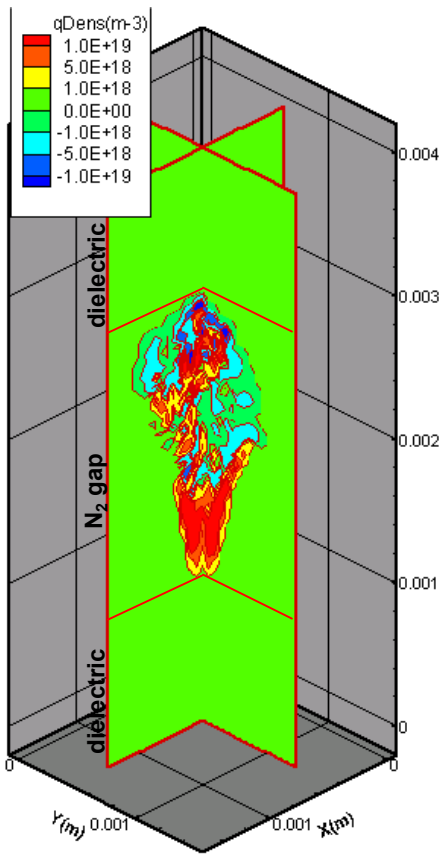
1 nsec



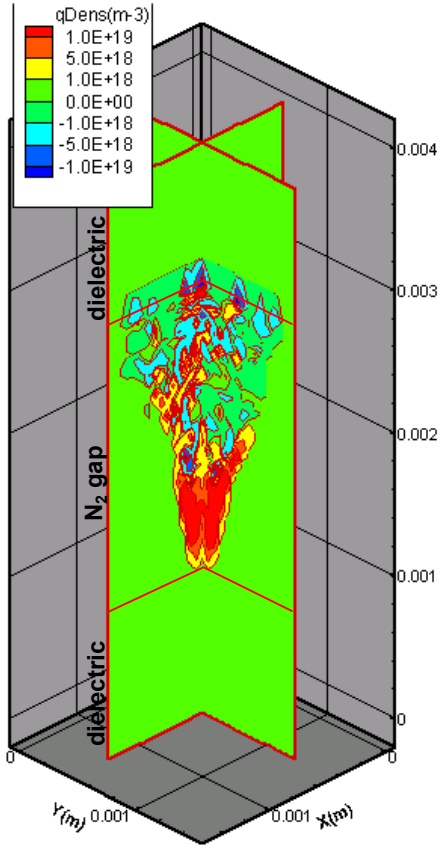
3 nsec



5 nsec



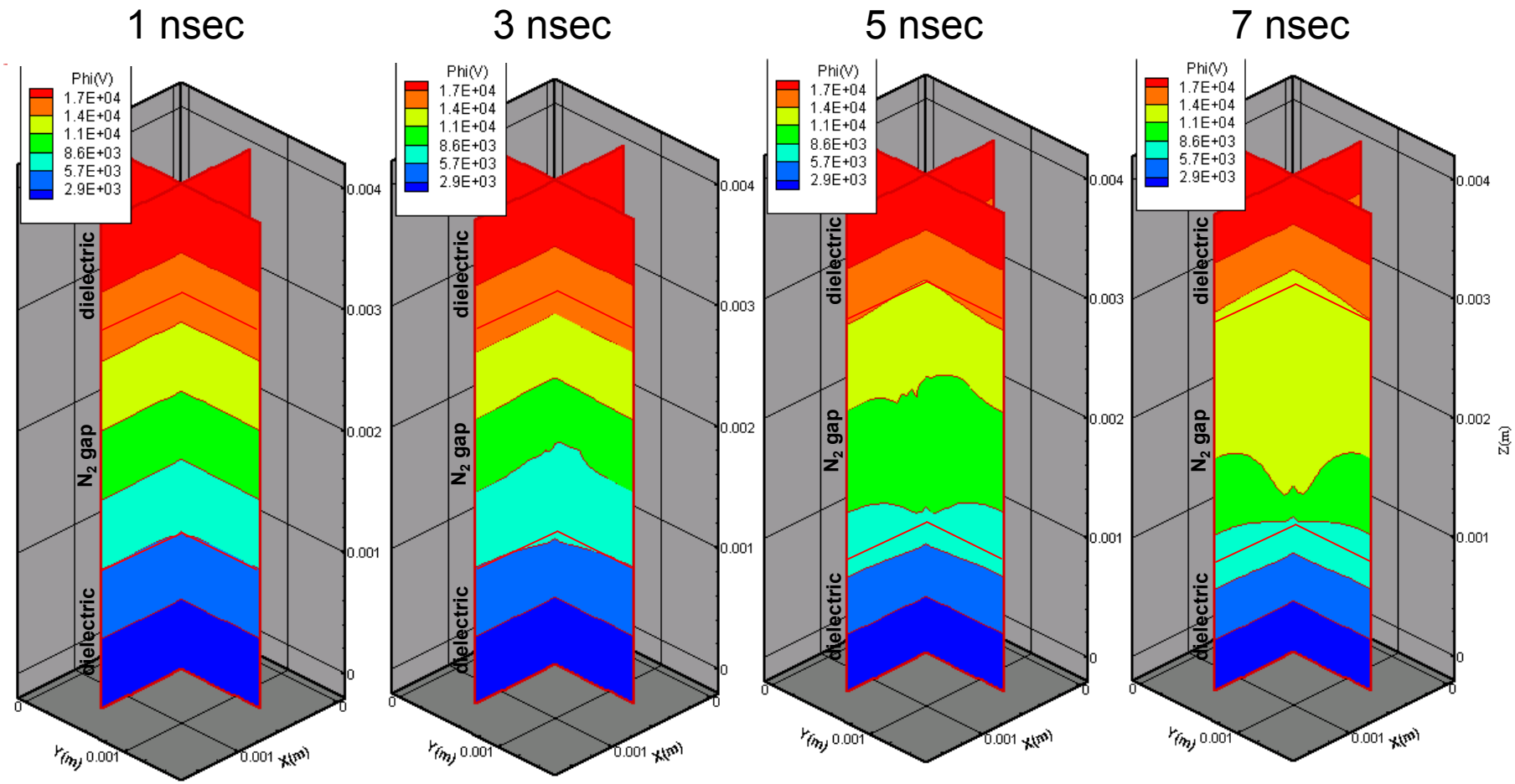
7 nsec



KINEMA

DIELECTRIC BARRIER DISCHARGE :

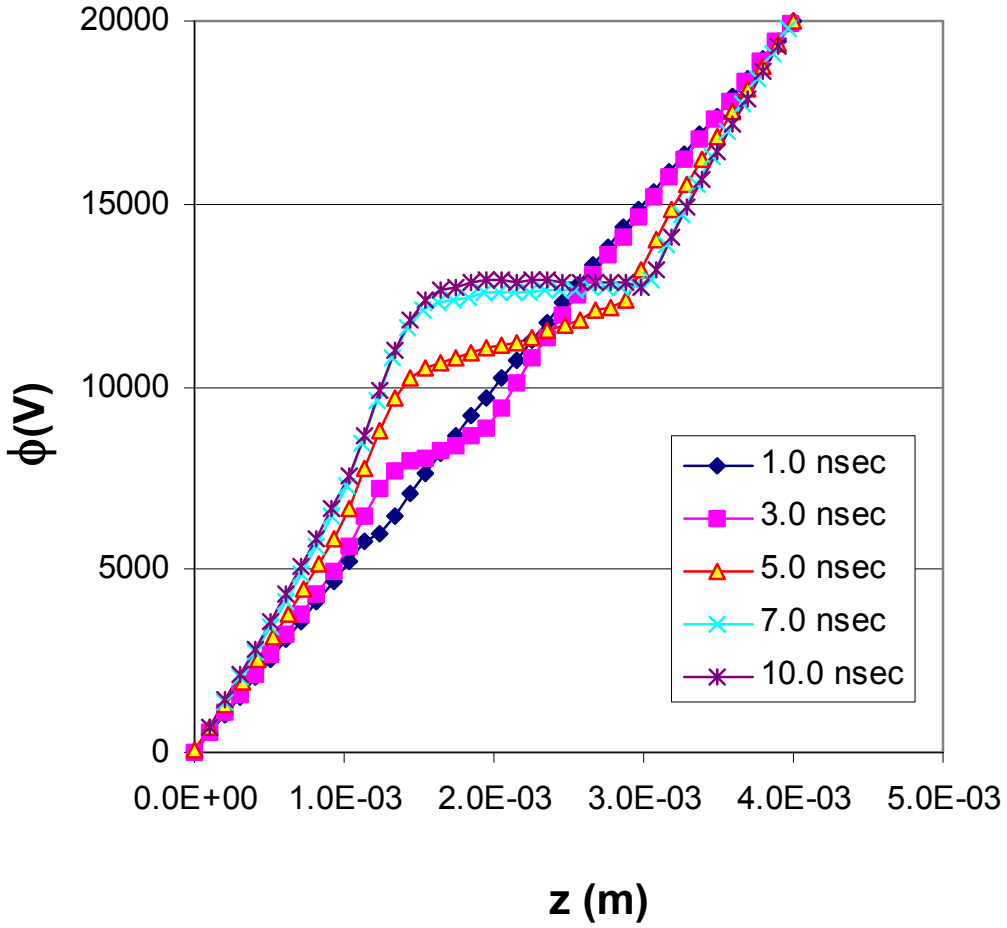
Plasma Electric Potential Evolution



KINEMA

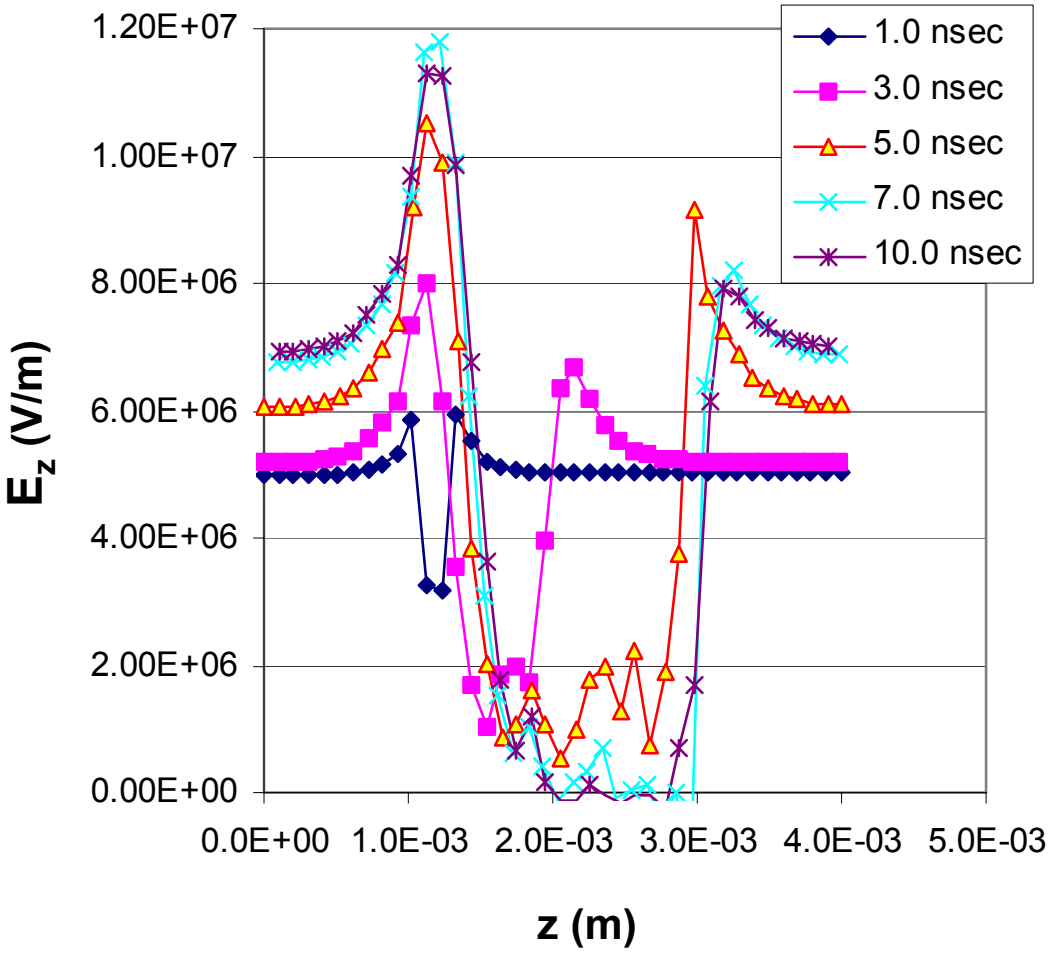
DIELECTRIC BARRIER DISCHARGE:

Streamer Core Potential Evolution



DIELECTRIC BARRIER DISCHARGE:

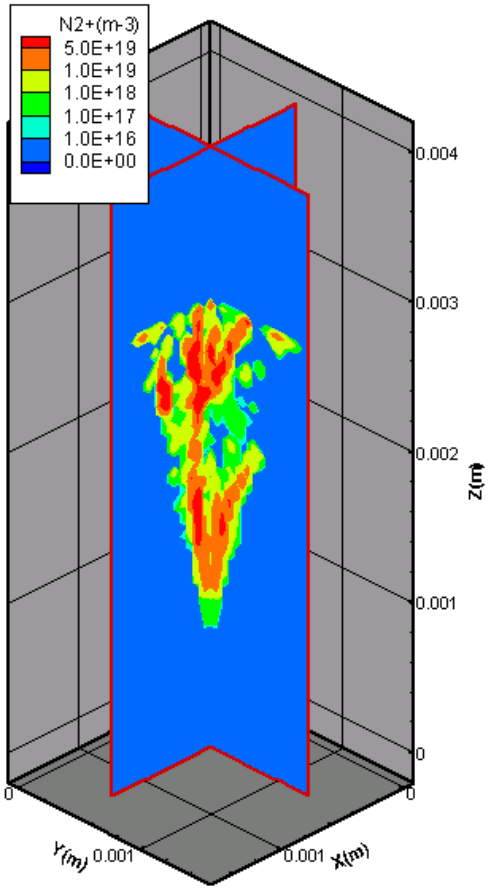
Streamer Core Electric Field Evolution



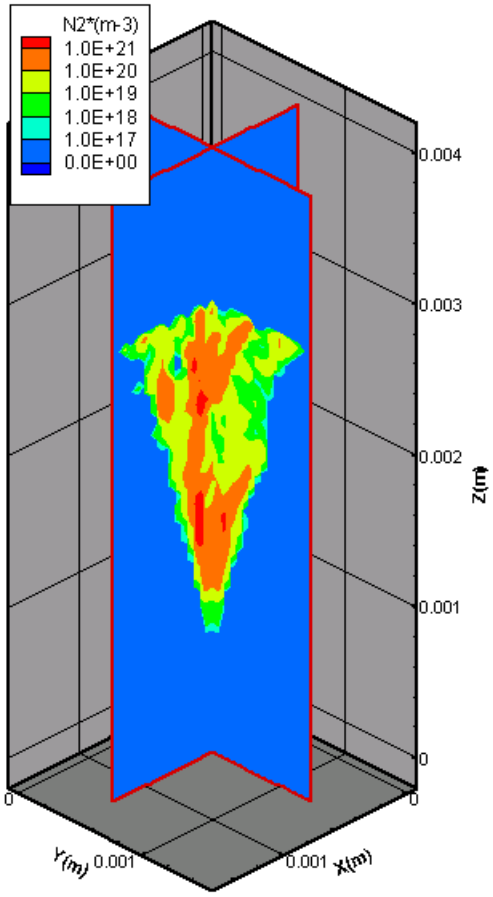
DIELECTRIC BARRIER DISCHARGE:

Plasma Products at 10 nsec – N_2^+, N_2^*, N

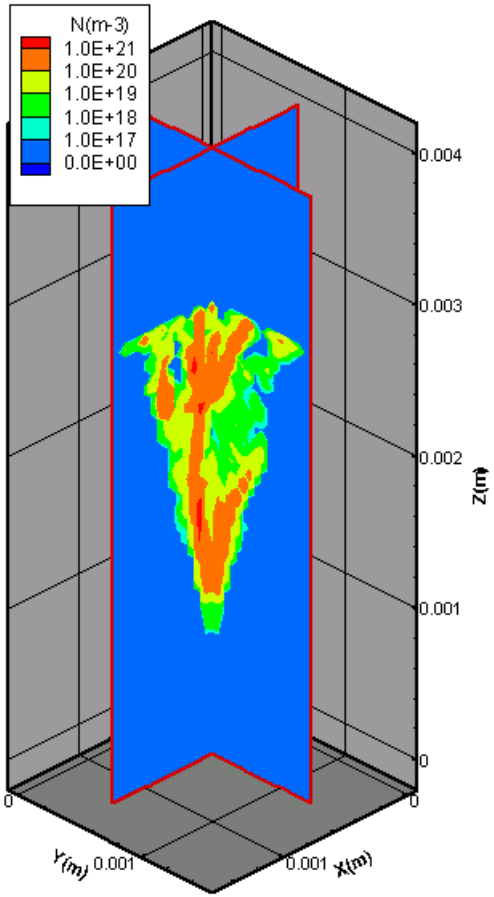
N_2^+



N_2^*

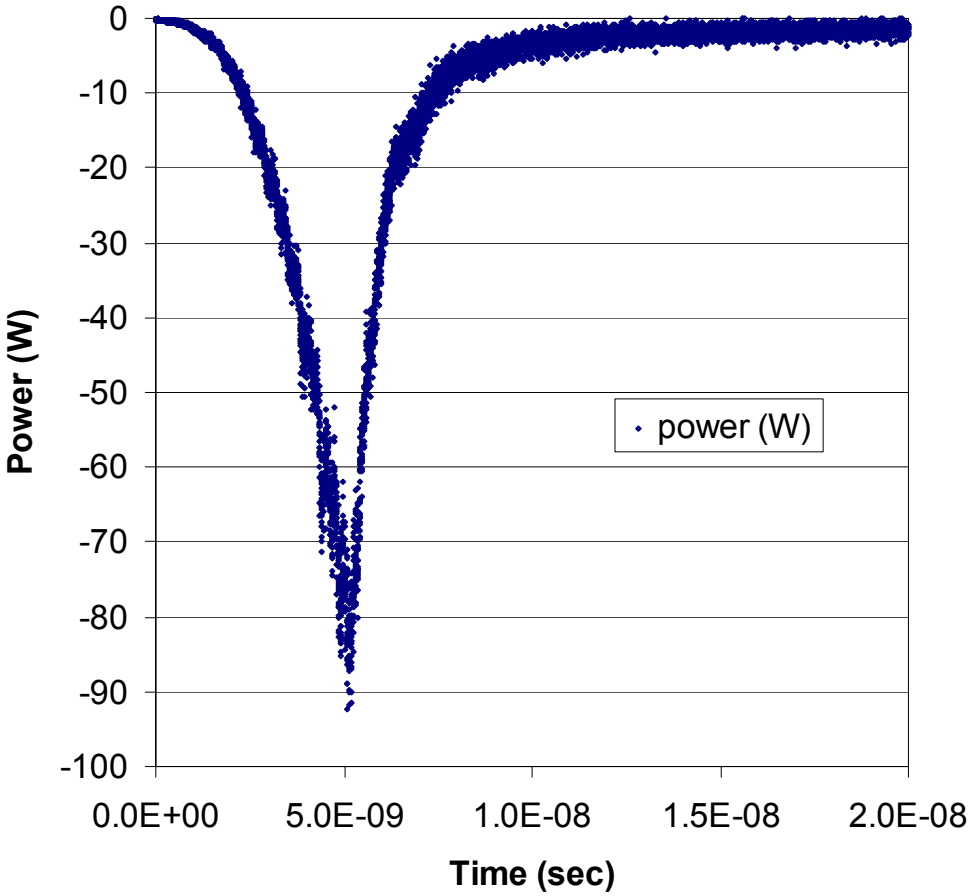


N



KINEMA

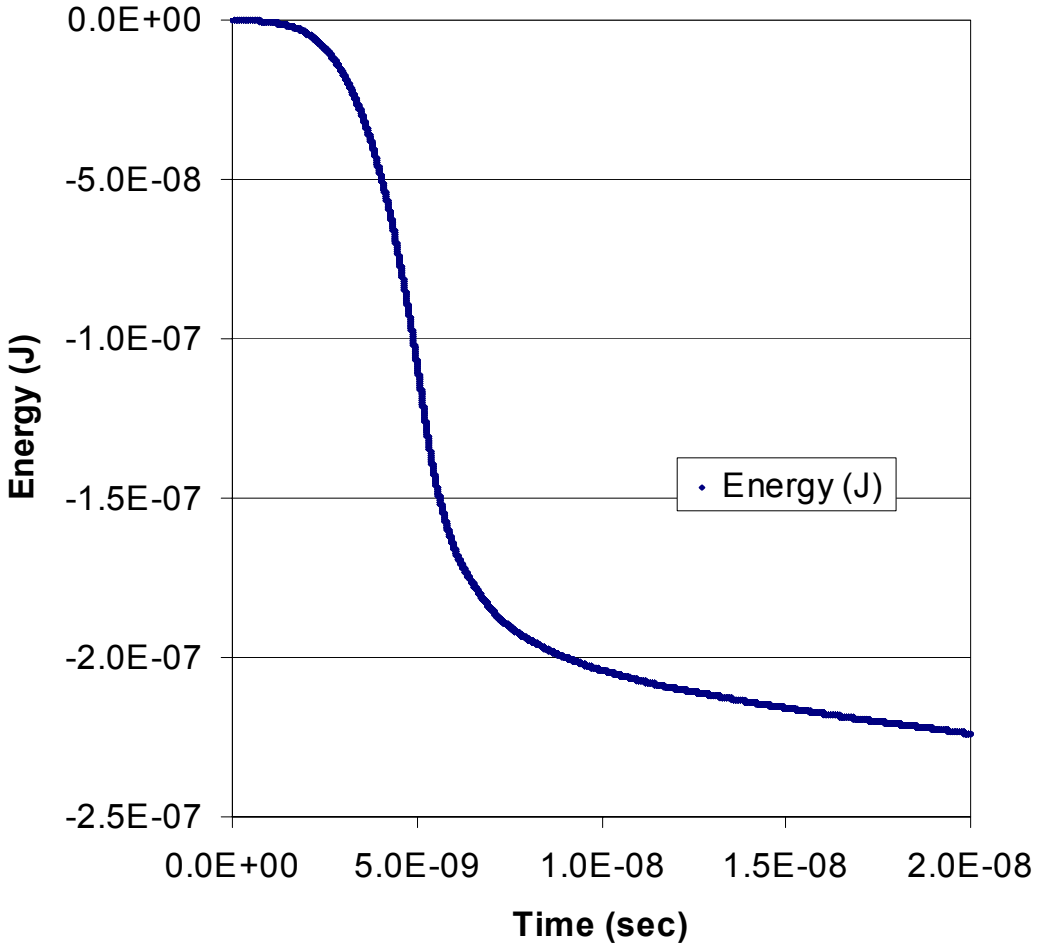
DIELECTRIC BARRIER DISCHARGE:
Power Utilization*



*negative because energy is extracted from the field

DIELECTRIC BARRIER DISCHARGE:

Expended Energy*



*negative because energy is extracted from the field

KINEMA

DIELECTRIC BARRIER DISCHARGE:
Summary

3D particle simulations were carried out of a dielectric barrier discharge in Nitrogen gas. The results showed:

- 3D simulations of arbitrary geometry dielectric barrier discharges are now possible on industrial time scales on a desk-top pc.
- The electron streamer halts expansion after about 5 nsec, when it reaches the upper dielectric and the impacting electrons diminish and/or reverse the electric field.
- Under the current conditions, a single streamer shows a peak power of about 90 Watts and a total energy consumption of under 2.5×10^{-7} Joules.