

Understanding streamers using density models with mesh refinement

Gideon Wormeester – MAC3

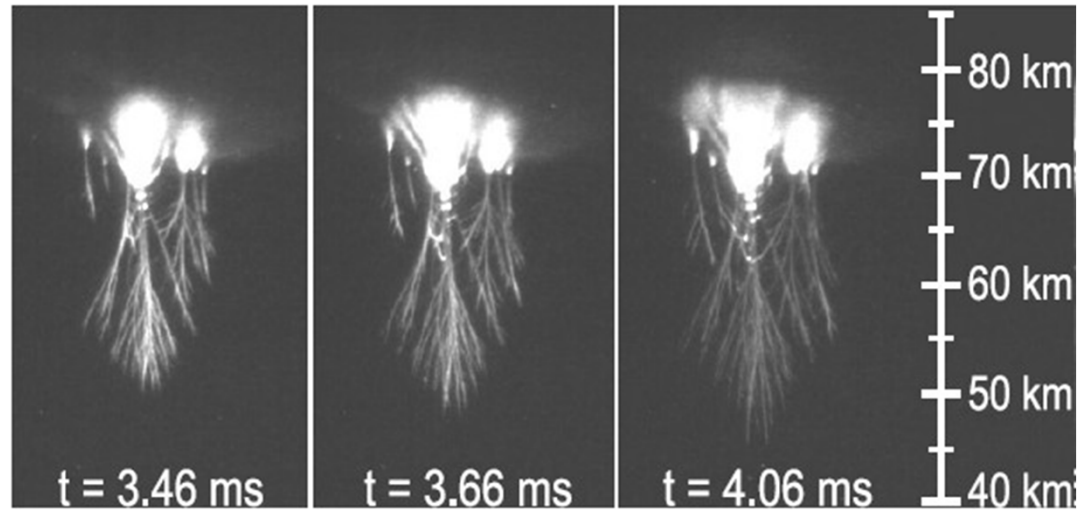
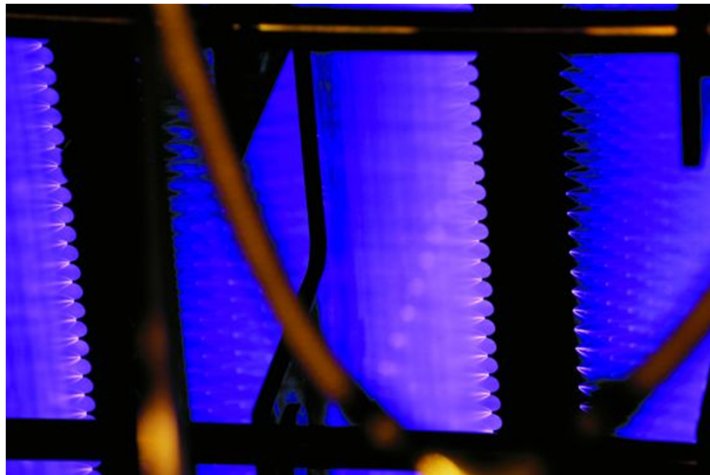


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Outline

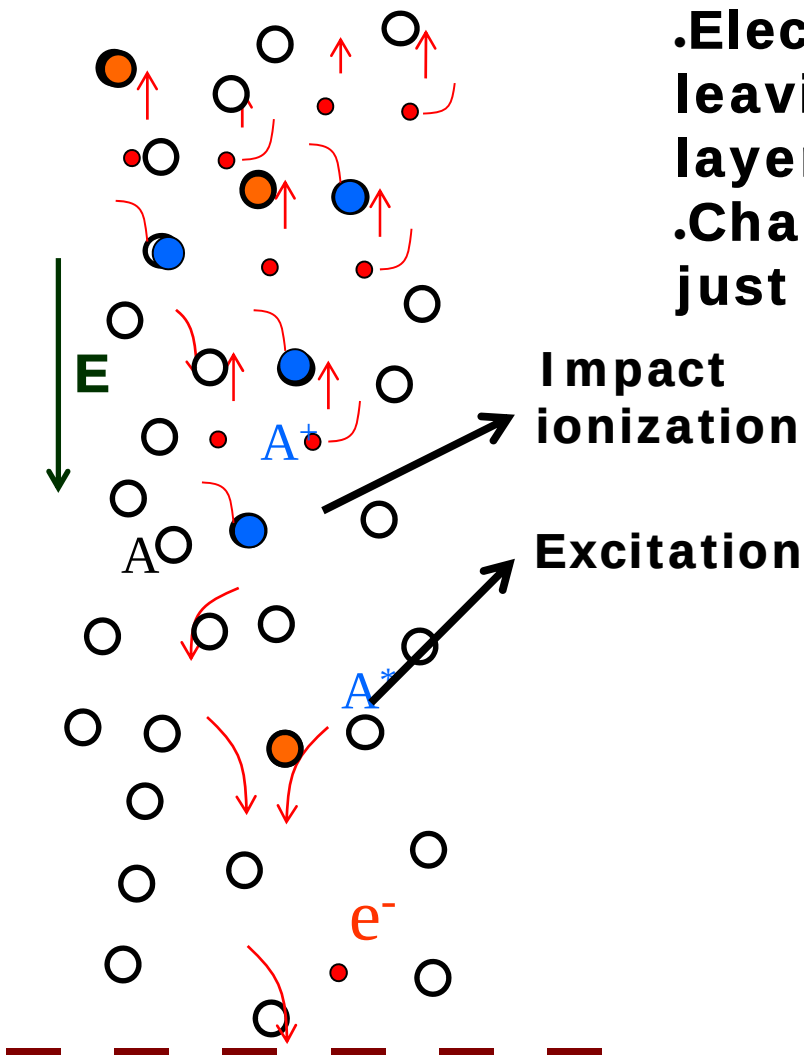
- **What are streamers?**
- **How do we model them?**
- **Some results and conclusions**

What are streamers?



What are streamers?

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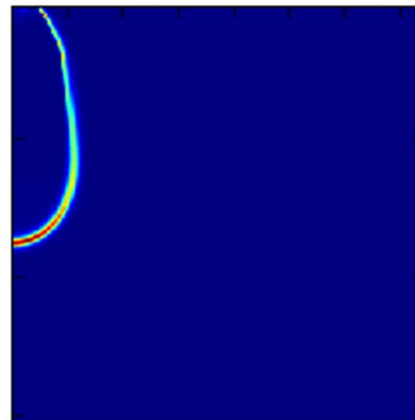


.High electric field creates many electron-ion pairs.

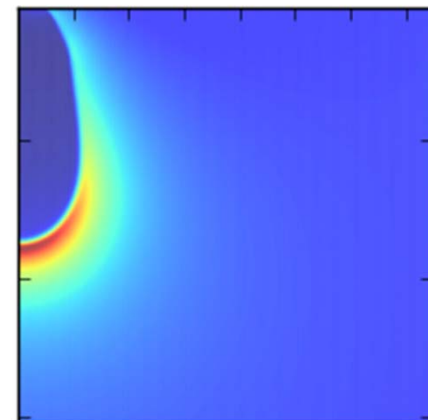
.Electrons move into the channel, leaving a thin, positively charged layer.

.Charged layer generates a high field just in front of it.

Charge density



E



Modeling streamers

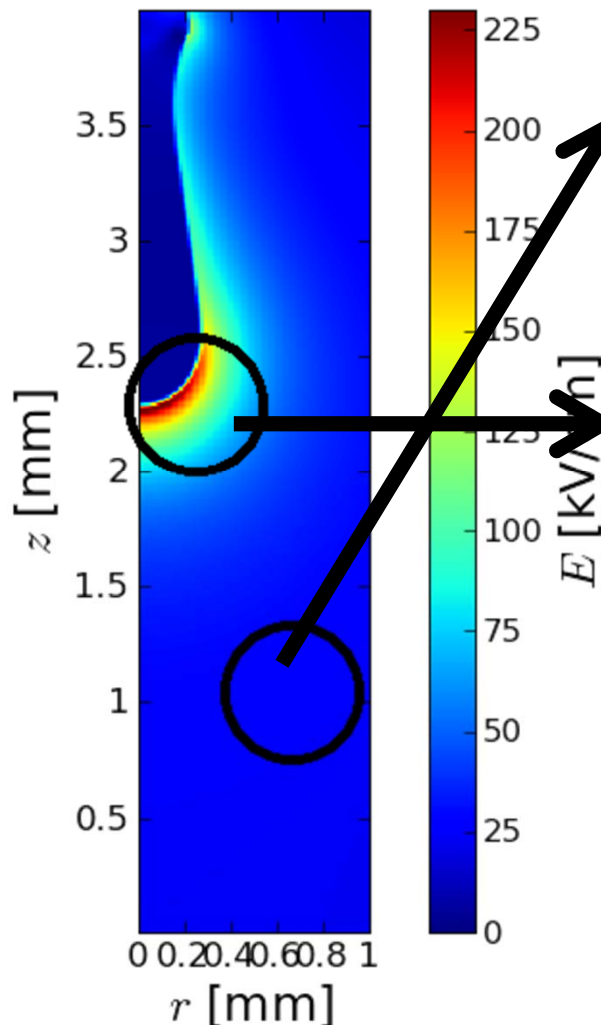
Approximate particles as continuous densities, obeying drift-diffusion-reaction equations:

$$\frac{\partial n_e}{\partial t} = \nabla \cdot (n_e \mu_e \mathbf{E}) + D_e \nabla^2 n_e + S_e$$

$$\frac{\partial n_i}{\partial t} = S_i$$

$$\epsilon_0 \nabla \cdot \nabla \phi = -q$$

Modeling streamers



.Low n_e , E
.Smooth gradients
.Large cells for performance

.High n_e , E
.Steep gradients
.Small cells needed to resolve all details

.Adaptive grid refinement scheme
provides high spatial resolution where
it is needed
.Originally designed for air (C. Montijn,
A. Luque, *et al.*), other gases need
other criteria

Results

Main streamer properties (velocity, diameter) are remarkably insensitive to large changes in gas composition (→ this implies strongly non-linear behavior, to be investigated further)

Some predictions made on streamer morphology (smoothness, branching) as a function of $N_2:O_2$ ratio, but stochastic nature requires a particle model to fully study this.

Both of these points are in agreement with experiments performed at Eindhoven University.

Streamer research in MAC3

At CWI

- .Ute Ebert**
- .Willem Hundsdorfer**
- .Margreet Nool**
- .Chao Li**
- .Aram Markosyan**
- .Christoph Koehn**
- .Jannis Teunissen**
- .Gideon Wormeester**

External collaborators

- .Sasa Dujko (Belgrade)**
- .Sander Nijdam (Eindhoven)**
- .Alejandro Luque (Granada)**
- .Sergey Pancheshnyi (Den Haag)**

Thank you for your attention!

