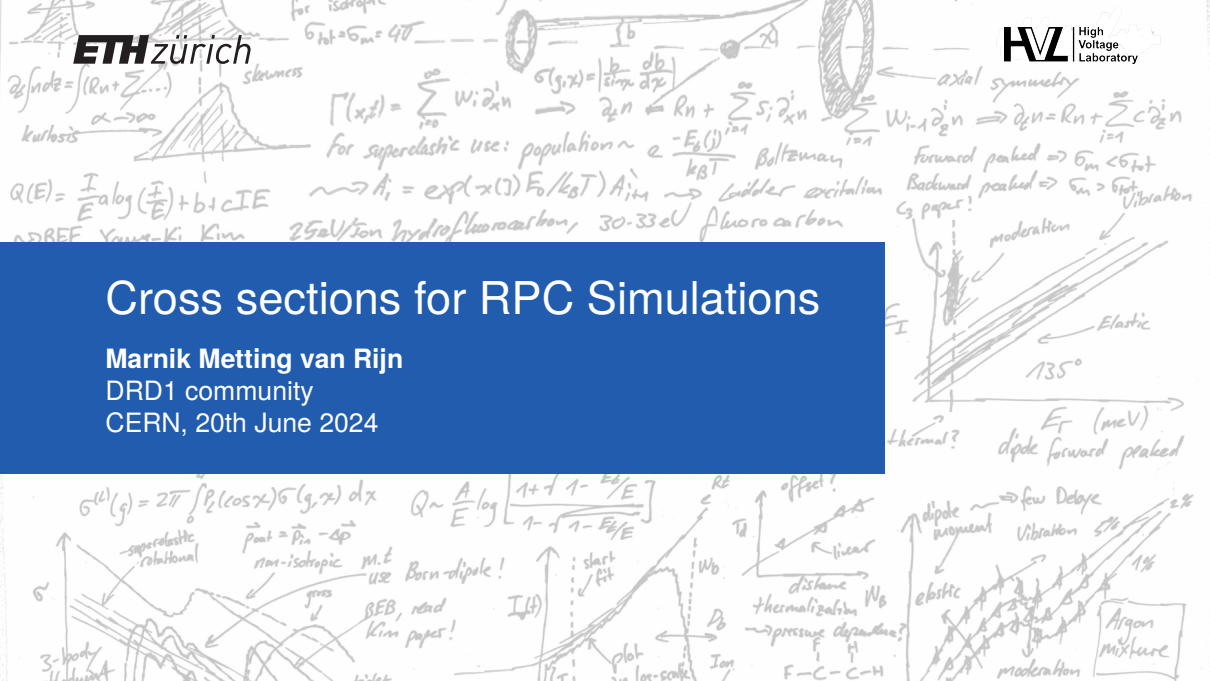


Cross sections for RPC Simulations

Marnik Metting van Rijn
DRD1 community
CERN, 20th June 2024

Collaboration

Christian Franck, Dario Stocco and
Marnik Metting van Rijn

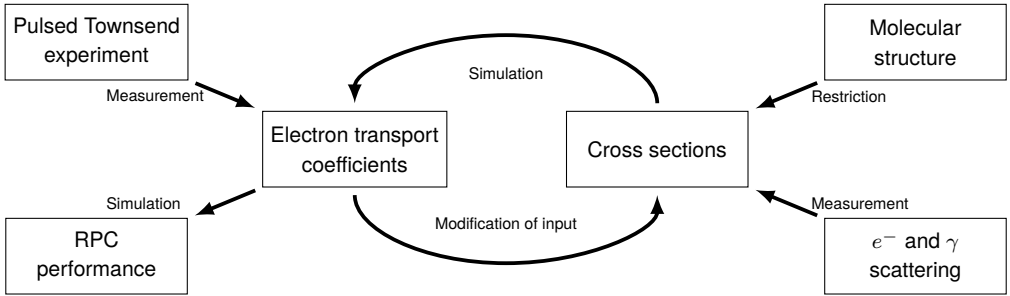
Piet Verwilligen, Roberto Guida, Rob Veenhof,
Beatrice Mandelli and Stephen Biagi

Project financed under SNF grant 200021_212060.

Project Workflow

Research question

This project aims to determine the absolute electron-molecule collision cross sections of promising candidate gases within the energy regime ranging from 10 meV up to 100 eV. Swarm, electron-scattering, and photoabsorption measurements serve as primary experimental-verification methods.



Revised R134a Cross Sections

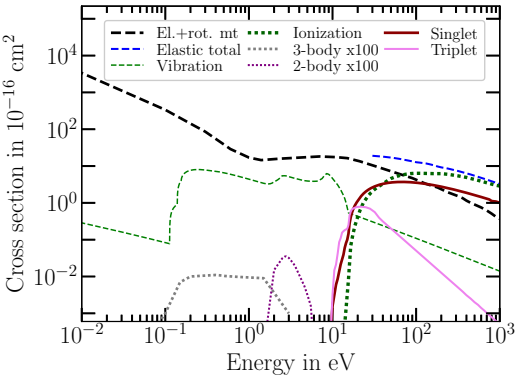


Figure: Cross section as a function of incident electron energy for different processes. [1]

Modifications to previous set:

- ➢ Elastic cross section
- ➢ Vibrational energy thresholds
- ➢ First vibrational resonance
- ➢ Triplet excitations

Revised cross sections available in MAGBOLTZ 11.19

[1] Marnik Metting van Rijn *et al* 2024 *J. Phys. D: Appl. Phys.* **57** 355202

Swarm Experiments in R134a

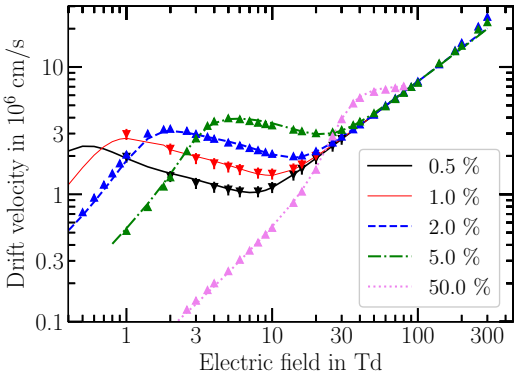


Figure: Drift velocity in argon-diluted mixtures [2]. [1]

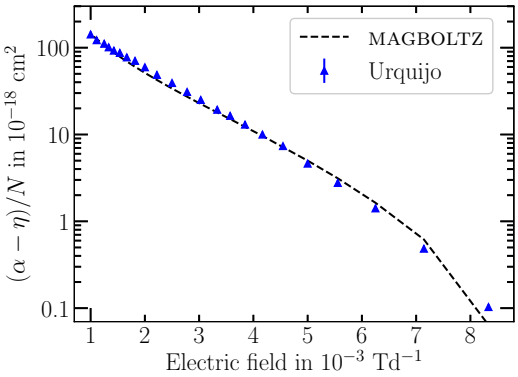


Figure: Ionization rate measurements from [2]. [1]

[1] Marnik Metting van Rijn *et al* 2024 *J. Phys. D: Appl. Phys.* **57** 355202
[2] Urquijo *et al* 2009 *The European Physical Journal D* **51** 241–246

Standard Mixture: $95.2\,\%$ R134a $4.5\,\%$ iC_4H_{10} and $0.3\,\%$ SF_6

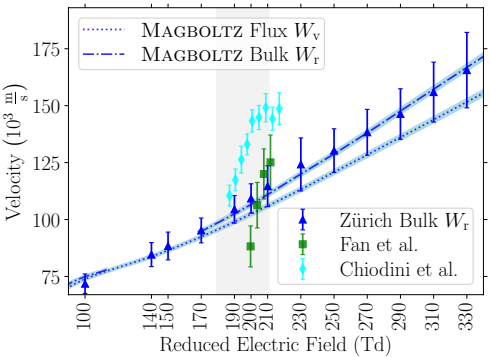


Figure: Drift velocity in standard mixture. [3]

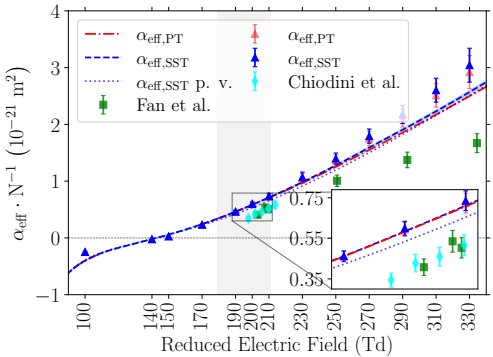


Figure: Ionization rate measurements. [3]

[3] Stocco *et al* 2024 *NIM-A* **1064** 169441

HFO1234ze(E) cross sections

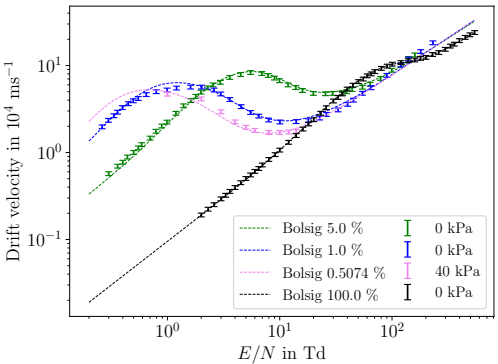


Figure: Drift velocity in argond-diluted HFO mixtures [4].

[4] Petrović, Zoran Lj *et al* 2019 *POSMOL 2019* **102** 145

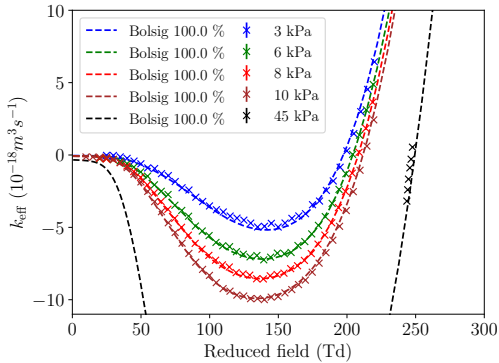


Figure: Ionization rate in pure HFO1234ze(E) for varying pressure [5].

[5] Chachereau, Alise *et al* 2016 *Plasma Sources Science and Technology* **25.4** 045005

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Swarm Experiments in HFO1234ze(E)

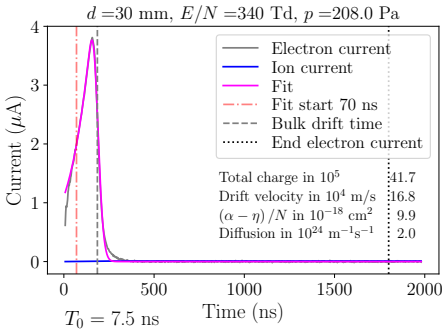

Figure: Pulsed Townsend experiment in pure HFO1234ze(E). Strong ionization restricts to low pressure.

Swarm data for HFO1234ze >500 Td scarce, but essential to fit the ionization and electronic excitation. RPC's operate at around 200 Td.

$\Rightarrow$ More measurements required!

Conclusion and Outlook

- ➢ R134a cross sections revised and available in MAGBOLTZ 11.19
- ➢ Cross sections validated in the standard mixture
- ➢ Progress achieved in HFO1234ze(E) low-energy cross section fitting
- ➢ Swarm data at high electric field required

Marnik Metting van Rijn *et al* 2024 *J. Phys. D: Appl. Phys.* **57** 355202
Stocco *et al* 2024 *NIM-A* **1064** 169441

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Cross sections for scattering of electrons on tetrafluoropropene hfo1234ze obtained from the swarm data.
POSMOL 2019, 102:145, 2019.

[5] Alise Chachereau, Mohamed Rabie, and Christian M Franck.
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