



European
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Horizon 2020
European Union funding
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PIONEER
PLASMA CATALYSIS CO₂ RECYCLING



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Investigating CO_2 plasma fundamentals for a clean future

Antoine Salden

PhD Physics Workshop 2020, Trento



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 813393

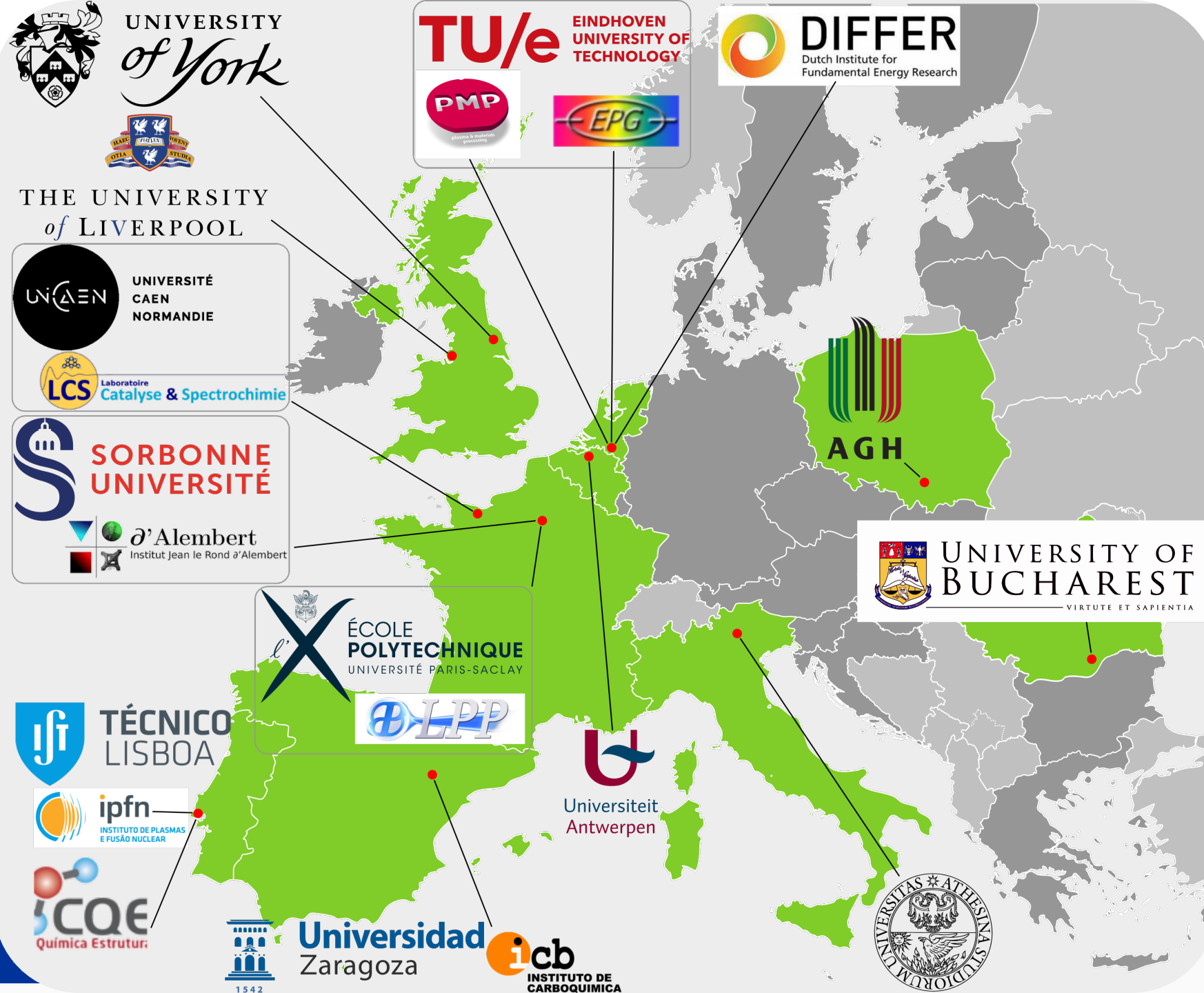
Personalia

- Dutch
- Masters @ Eindhoven University of Technology
- Currently: [Fisica Atomica e Molecolare](#) @ UniTN
 - Supervisor: Paolo Tosi



Person

- Dutch
- Master
- Current
- S
- Involvement
- P
- P
- P



ER

Motivation: closing the carbon cycle

The challenge of intermittency:

- Supply vs demand mismatch
- Poses problems for the power grid

→ Storage of energy @ surplus

- Batteries
- Hydrogen
- **Hydrocarbons?!**

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PERSPECTIVE

pubs.acs.org/JACS

Anthropogenic Chemical Carbon Cycle for a Sustainable Future

George A. Olah,* G. K. Surya Prakash, and Alain Goeppert

Loker Hydrocarbon Research Institute and Department of Chemistry, University of Southern California, University Park, Los Angeles, California 90089-1661, United States

ABSTRACT: Nature's photosynthesis uses the sun's energy with chlorophyll in plants as a catalyst to recycle carbon dioxide and water into new plant life. Only given sufficient geological time, millions of years, can new fossil fuels be formed naturally. The burning of our diminishing fossil fuel reserves is accompanied by large anthropogenic CO₂ release, which is outpacing nature's CO₂ recycling

formed over long geological times by anaerobic conversion of plant and animal life, we are increasingly using renewable alternative energy sources, such as hydro, geothermal, solar, wind, etc., including atomic energy, to satisfy our ever increasing energy needs.

In the natural carbon cycle, nature uses the sun's energy to recycle carbon dioxide from natural sources through photosynthesis. It captures CO₂ from the atmosphere with vegetation, which then releases it back into the atmosphere through respiration.

Anthropogenic Chemical Carbon Cycle for a Sustainable Future,
G.A.Olah et al, JACS, 2011, <https://doi.org/10.1021/ja202642y>

12/01/2020

PhD Workshop

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Motivation: closing the carbon cycle

Hydrocarbons work well, but...

- Limited supply of fossil fuels
- Increased CO_2 release by human activities

→ Issue of progeny, not of the compounds!

Closing the carbon cycle fixes a major issue!

One way to achieve this:

Plasma catalytic conversion

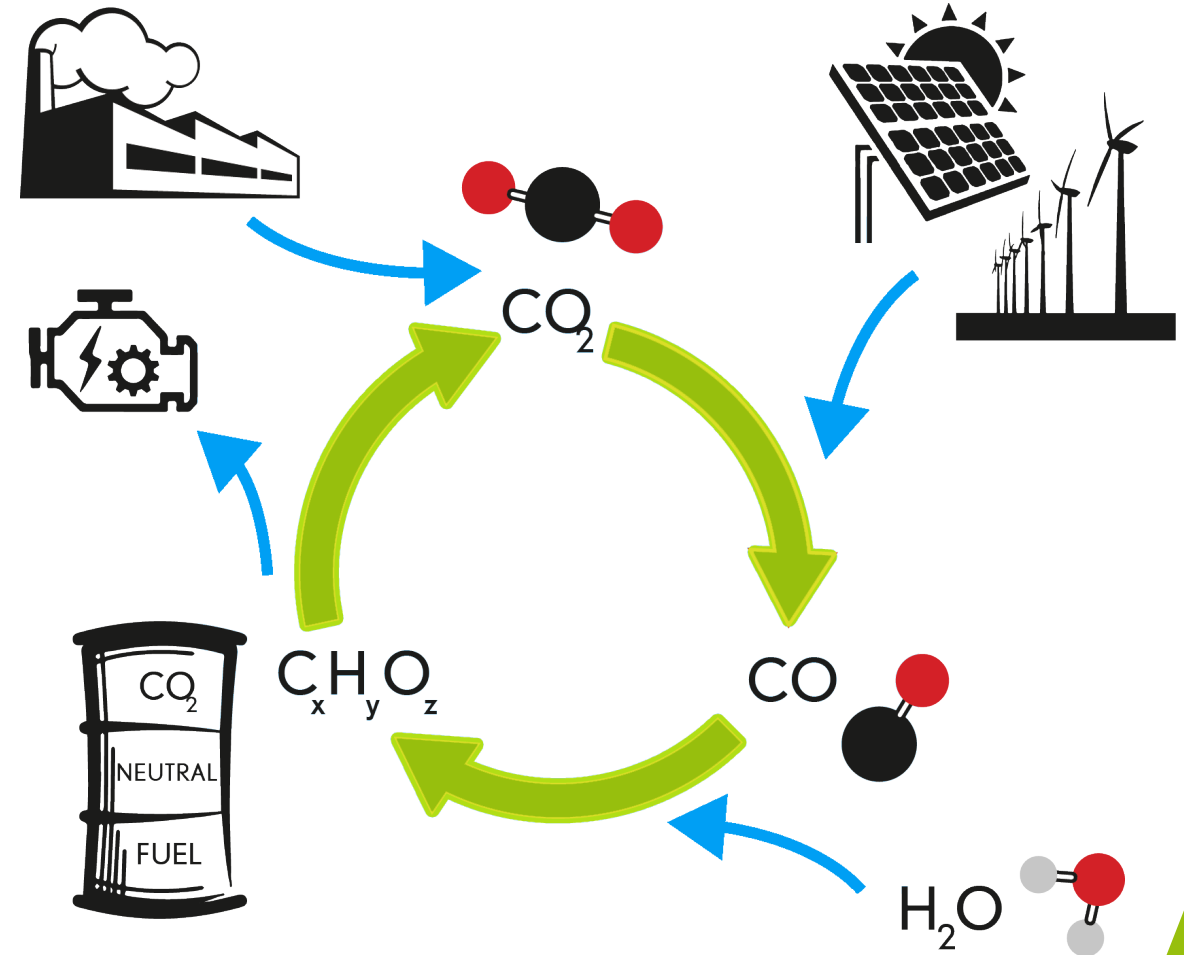


Figure adapted from: B. L. M. Klarenaar. *Vibrational kinetics of CO₂ in non-thermal plasma*. PhD thesis, Eindhoven University of Technology, 2018. ISBN: 978-90-386-4519-3.

My role within PIONEER

*"To gain deeper knowledge on the fundamentals
and mechanisms of CO₂ plasmas..."*

- The PIONEER mission

Investigate optimal mechanism to break CO₂ in a plasma

→ Fundamental understanding to improve the process

→ What are best avenues to improve catalysed conversion

Best plasmas are:

- atmospheric pressure
- non-equilibrium

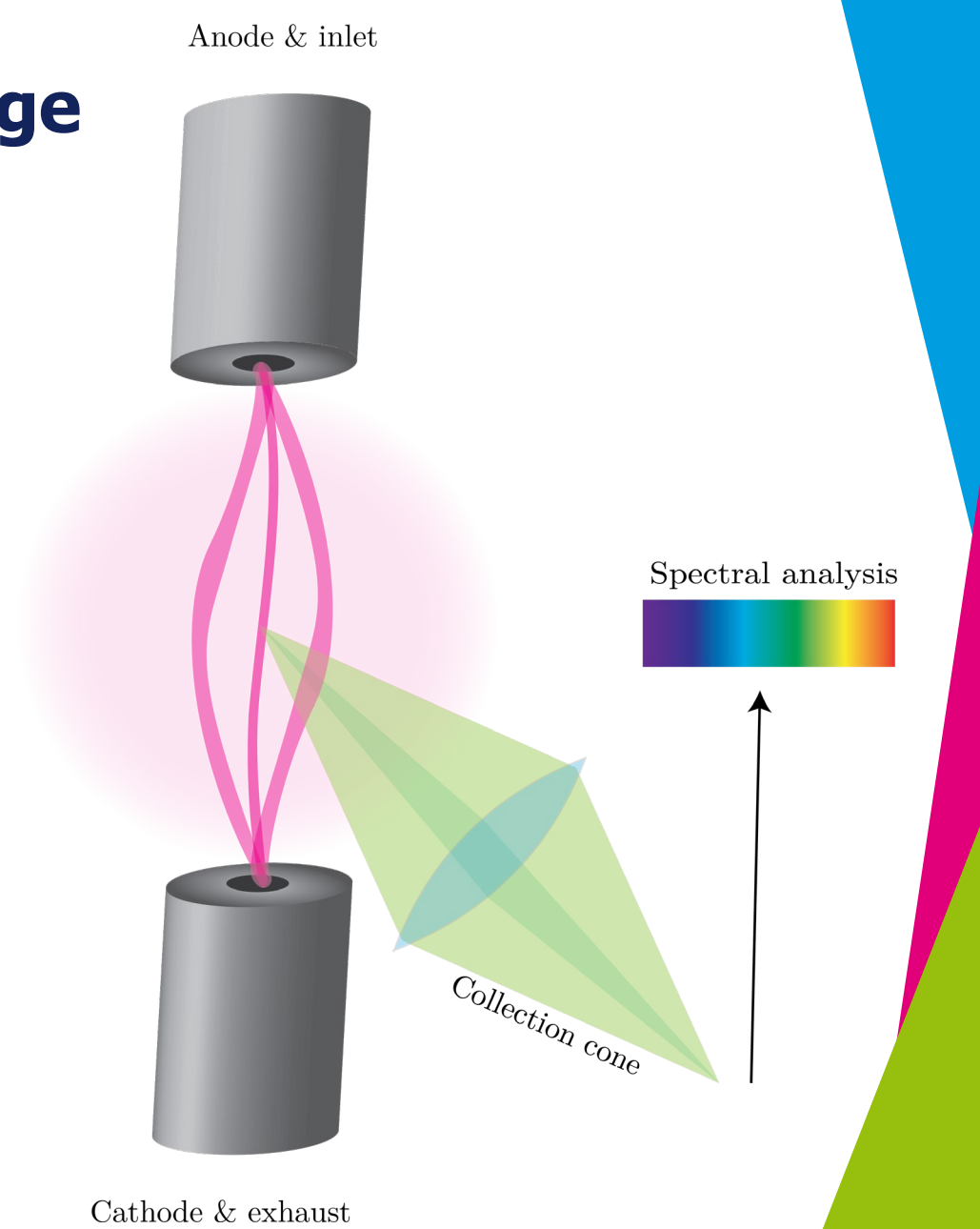
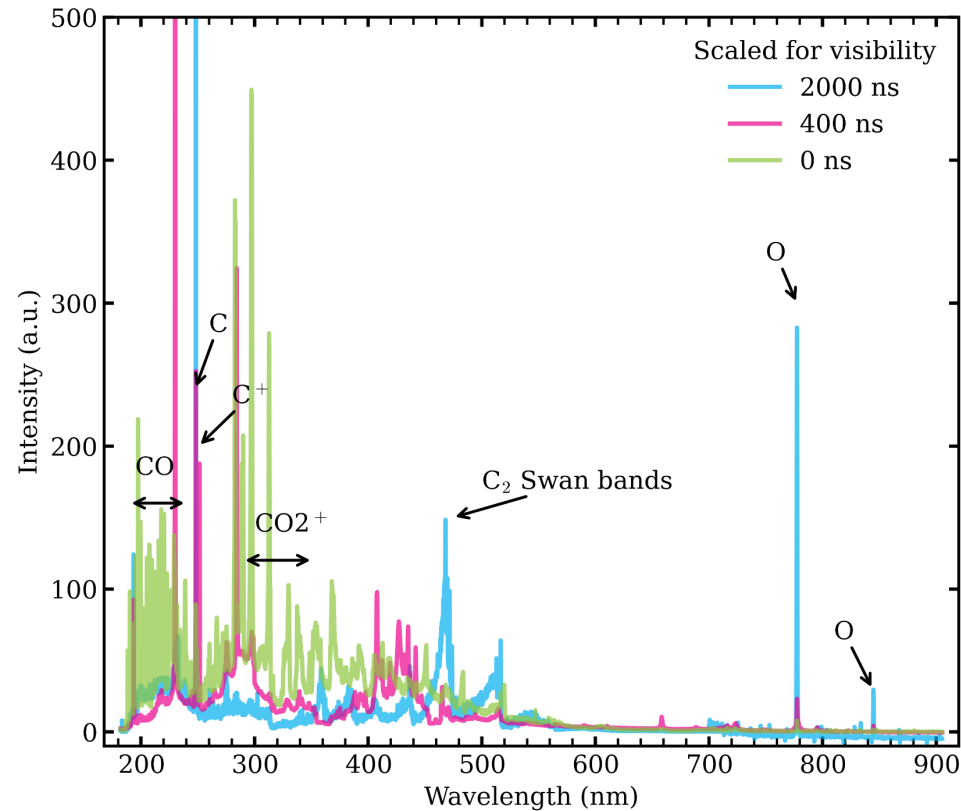
→ Challenge to investigate: strong variations in space and time

Setup basics of nanosecond discharge

Discharge between two pins

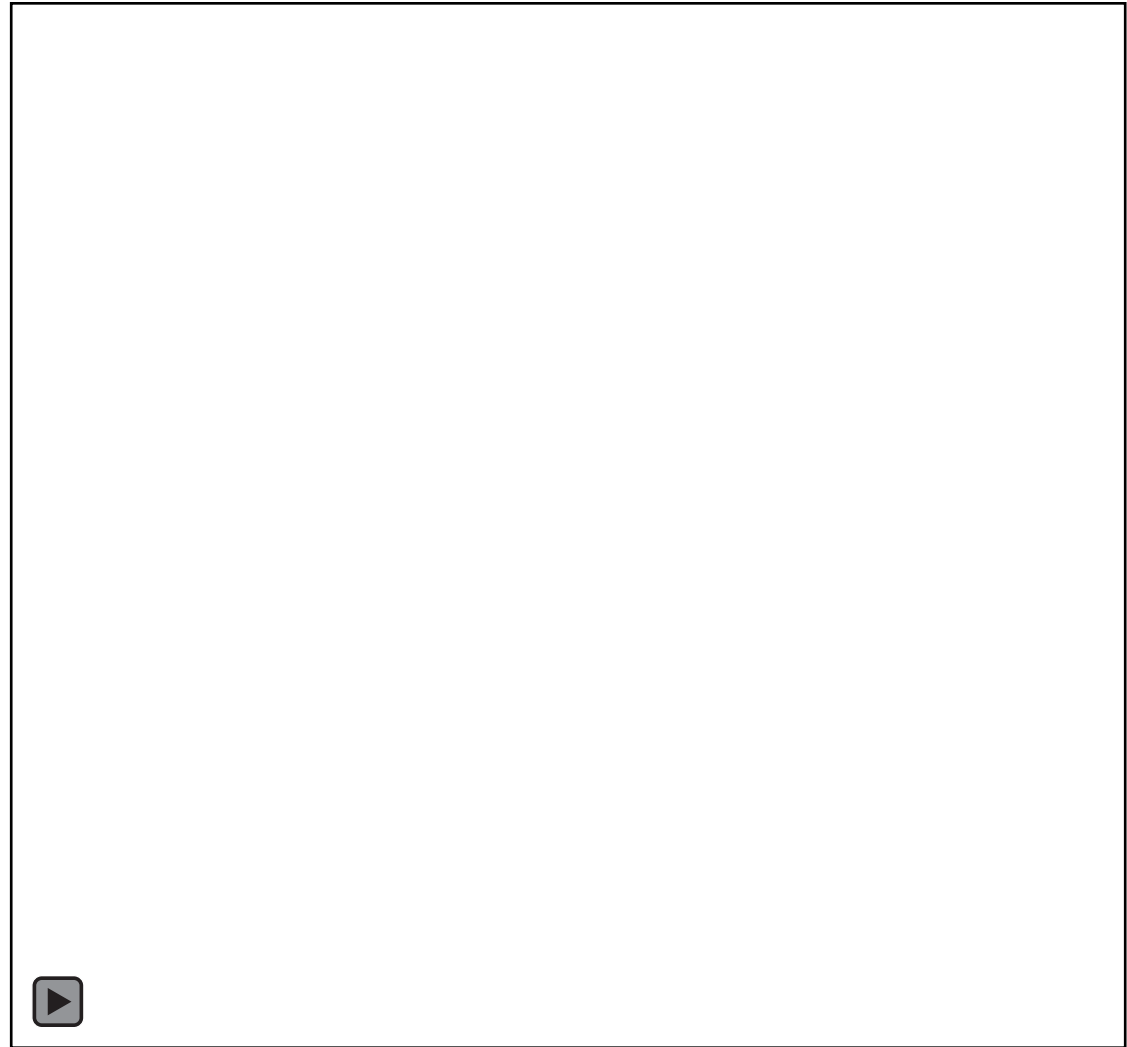
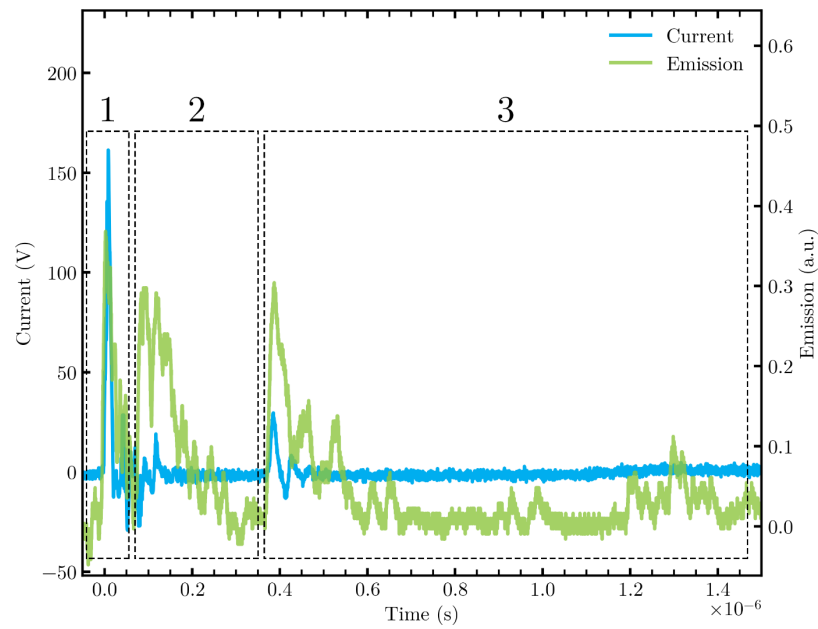
Plasma emits light:

- Excited species
- Extract (local) information
- Time resolved



Electron density from Oxygen line width

- Bounds for electron density n_e
 - Time resolved
- Non-invasive





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Thank you for your attention



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