A New Potentiometric Method for Automated Detection of Bioaerosols

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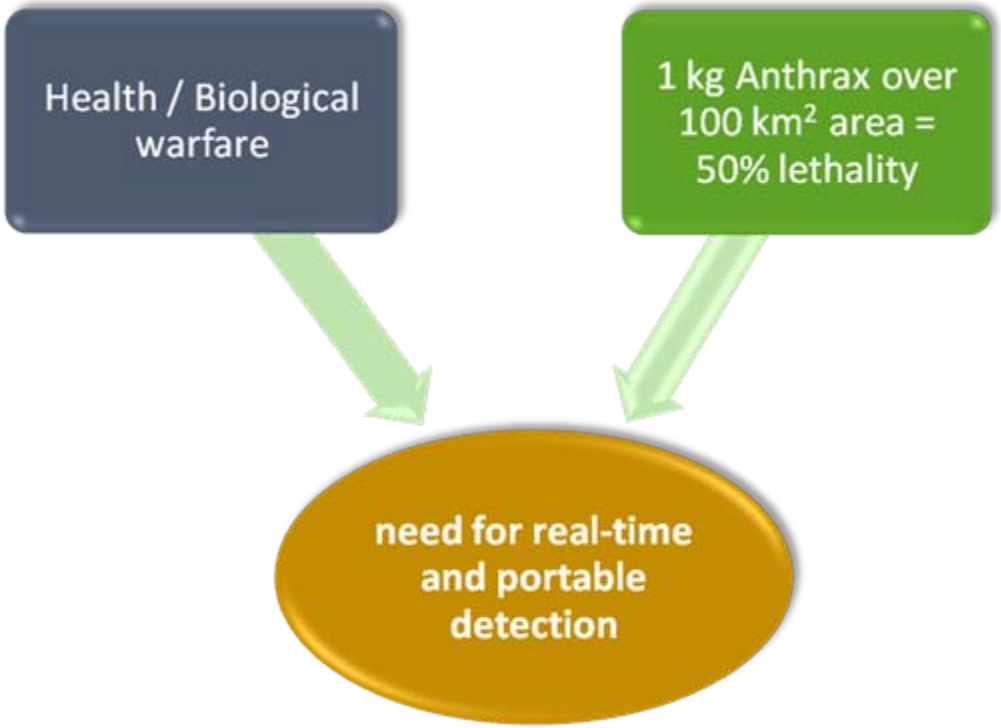
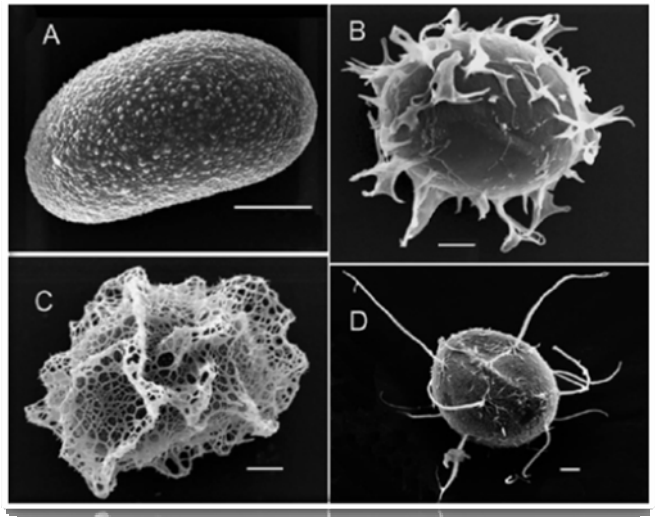
Current & Future Air Quality Monitoring
London, 15 Dec 2010

Outline

- Case for bioaerosol detection - Current technologies
- Flame Plasma Electrochemistry Concept
- Setup
- Potentiometry/Imaging Results of Pollen
- Analysis/Discussion
- Pros/Cons - Conclusions

A case for general bioaerosol detection

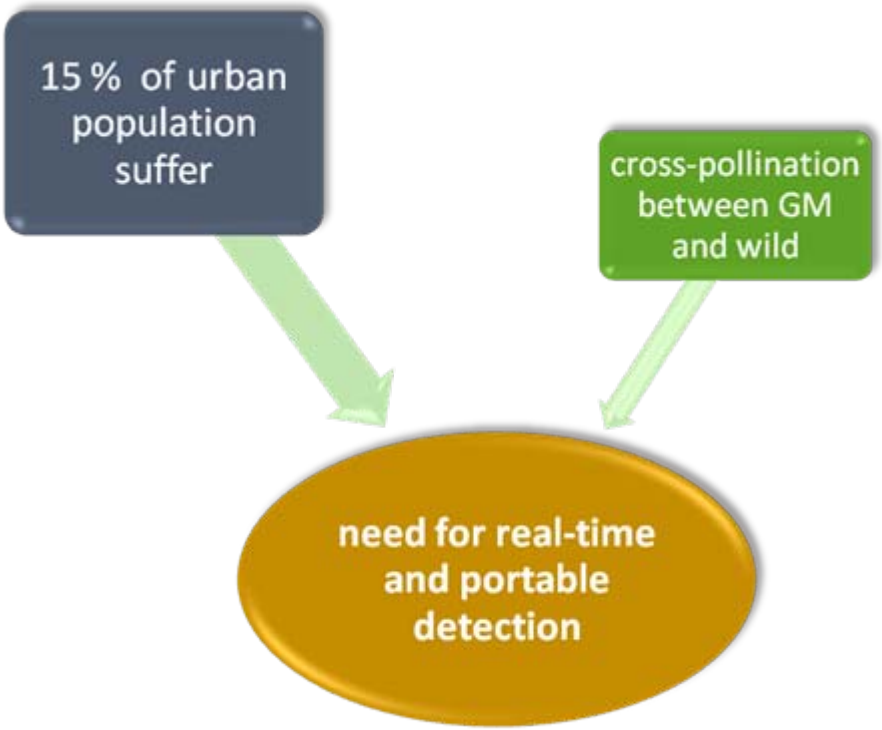




R. Joseph and R. Schild, *J. Cosmology*, **7**, 1616 (2010).
http://journalofcosmology.com/Panspermia1.html

- **Viruses**
- **Bacterial spores**
- **Fungal spores**
- **Pollen**

A case for pollen

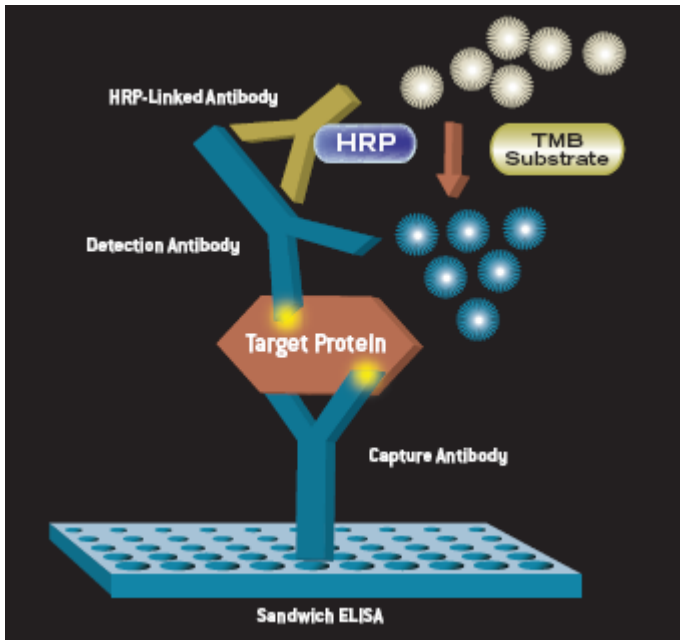


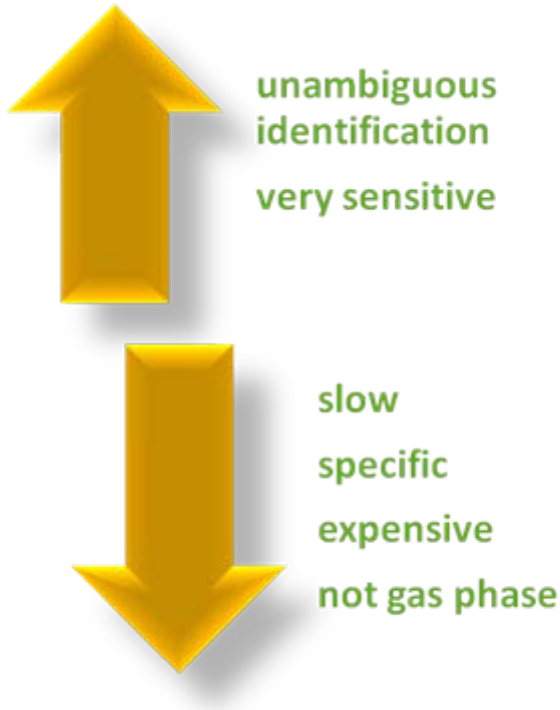
http://jeromeprophet.blogspot.com/2007/07/illinois-worlds-mold-and-pollen-capital.html

General bioagents detection: state-of-the-art

ELISA (enzyme immunoassay)

PCR (polymerase chain reaction)





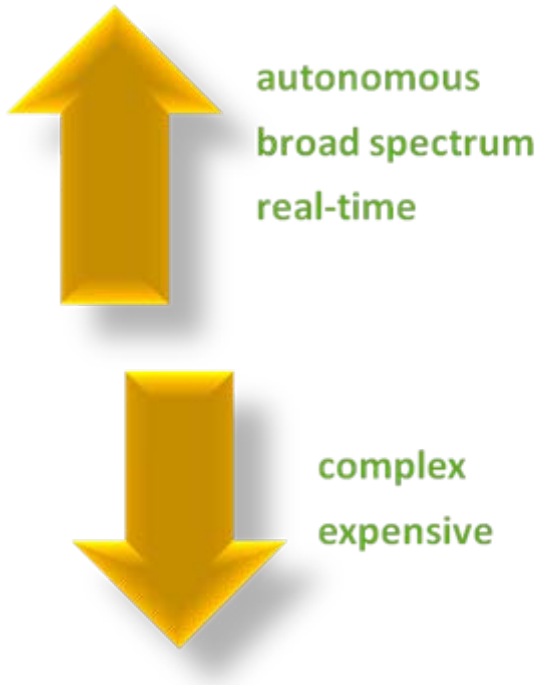
http://www.interferonsource.com/New_InterferonSource/ELISA/ELISA_Description.html

Emerging technologies

Single-Particle Aerosol Mass spectrometry

Lawrence Livermore National Laboratory

https://www.llnl.gov/news/newsreleases/2008/NR-08-06-05.html



P.T. Steele et al., *Anal. Chem.,* **80** 4583 (2008).

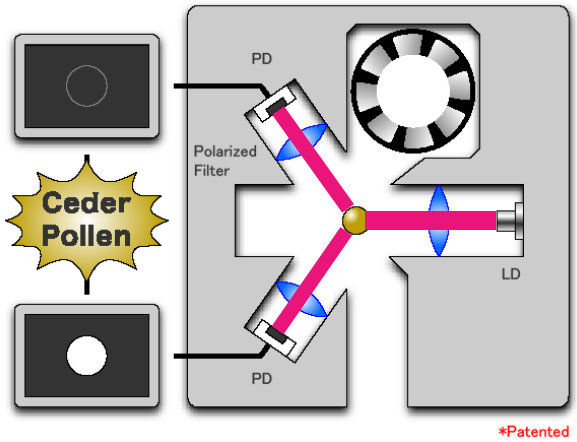
Pollen detection: state-of-the-art

Burkard sampler (UK)

http://www.pollenuk.co.uk/aero/pm/RPC1.htm

Emerging technologies

Shinyei (Japan)



automatic

low cost

compact size

underestimation bias

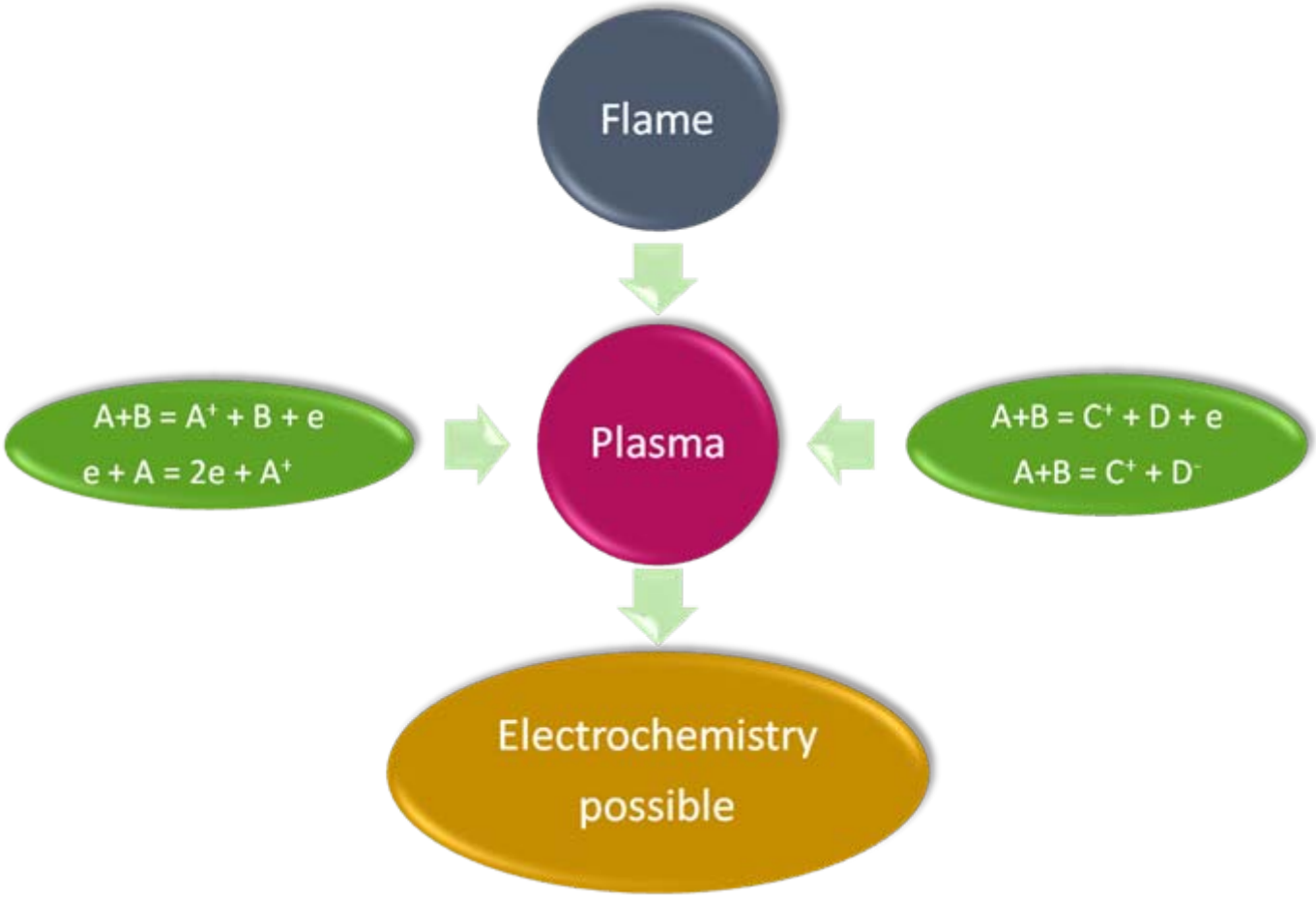
discrimination issues

high detection limit

http://www.shinyei.co.jp/stc/optical/poln/poln_e.html

J.J. Delaunay et al., *Ann. Allergy Asthma Immunol.,* **98** 553 (2007).

Flame plasma electrochemistry concept



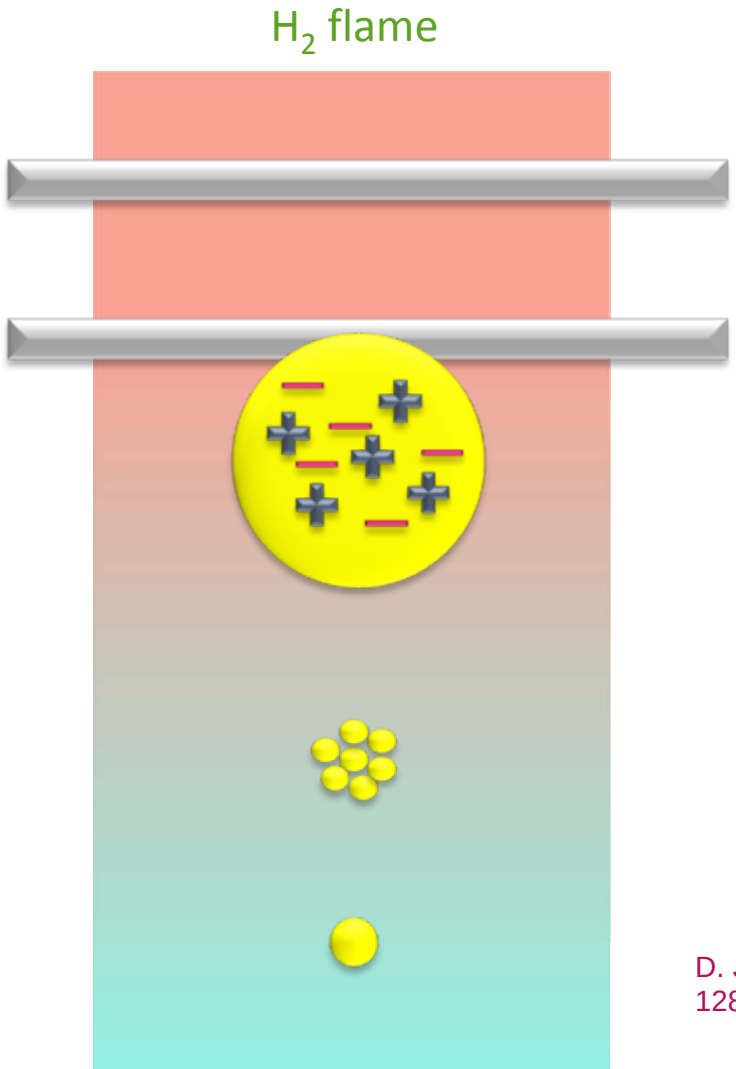
Rationale

Grain/spore injection

Breakdown-amplification

Ionisation-charge separation

Voltage detection



Hypothesis

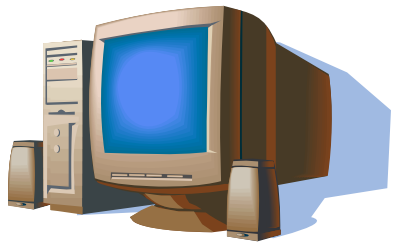
Voltage generated uniquely related to size and physical properties of combusted particle

D. J. Caruana and J. Yao, *The Analyst*, **128**, 1286 (2003).

Setup

5 k fps

voltage data acquisition 100 kHz



burner

H2

O2

N2

MFC

MFC

MFC

mixing chamber

40.00 mm

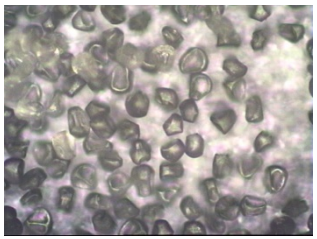
sample chamber

syringe pump

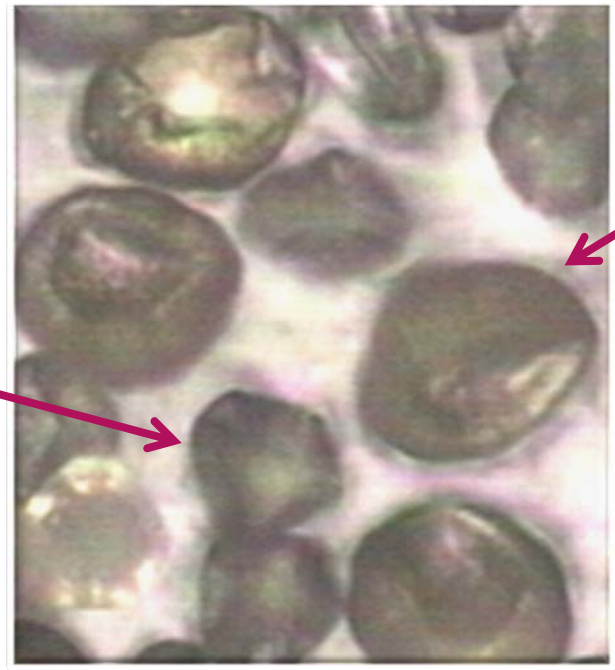
Results

Samples

Bermuda grass pollen

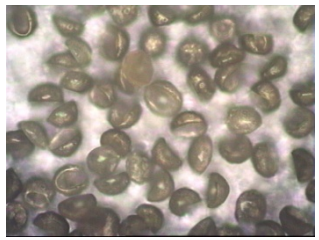


25 µm



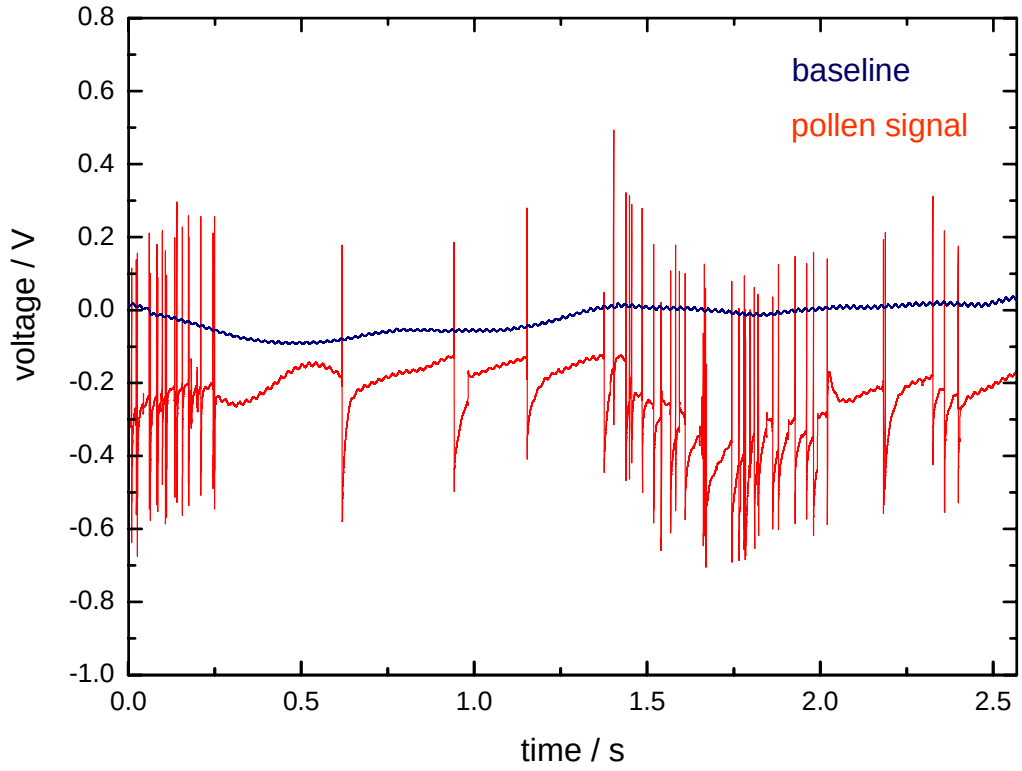
50 µm

Black walnut pollen



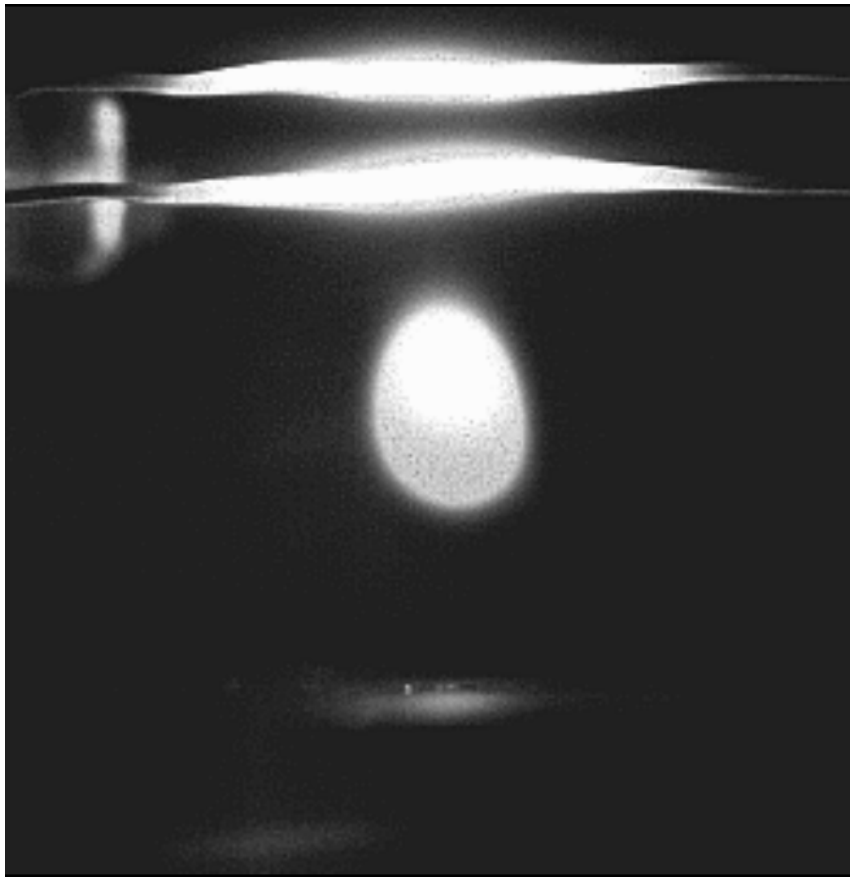
37 µm

The big picture



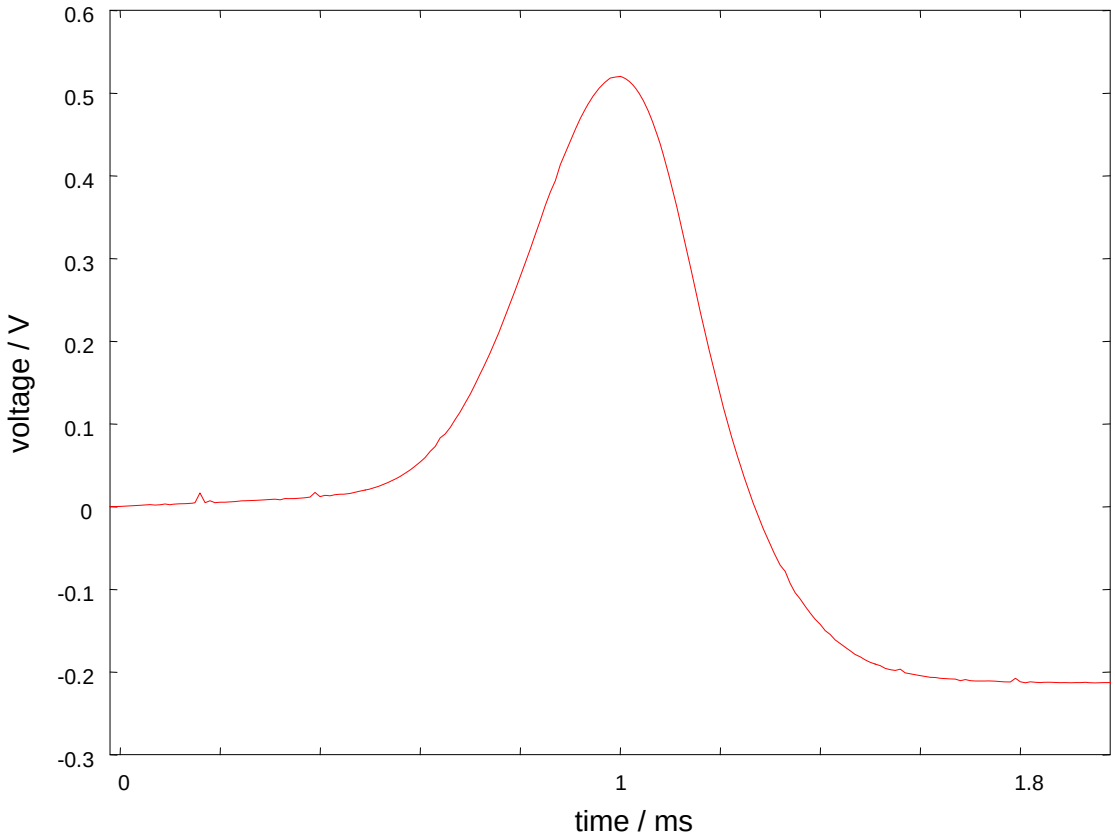
Bermuda pollen burning

single event



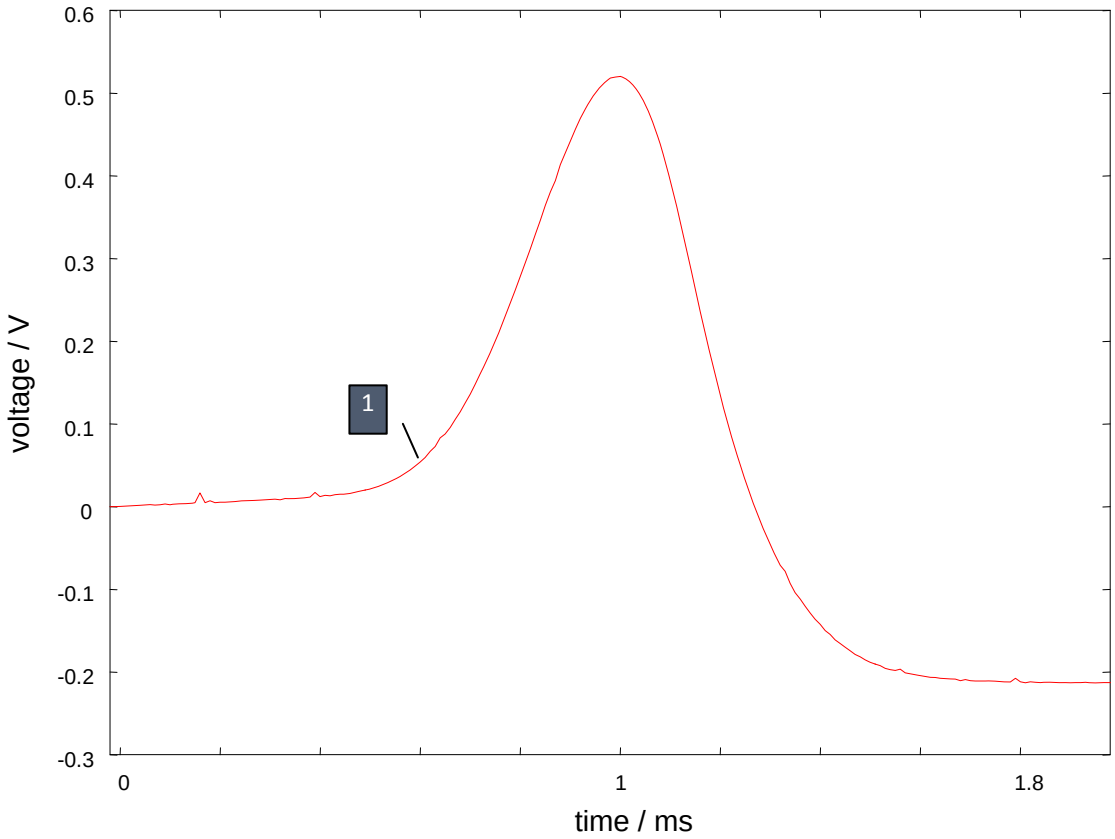
Potentiometry

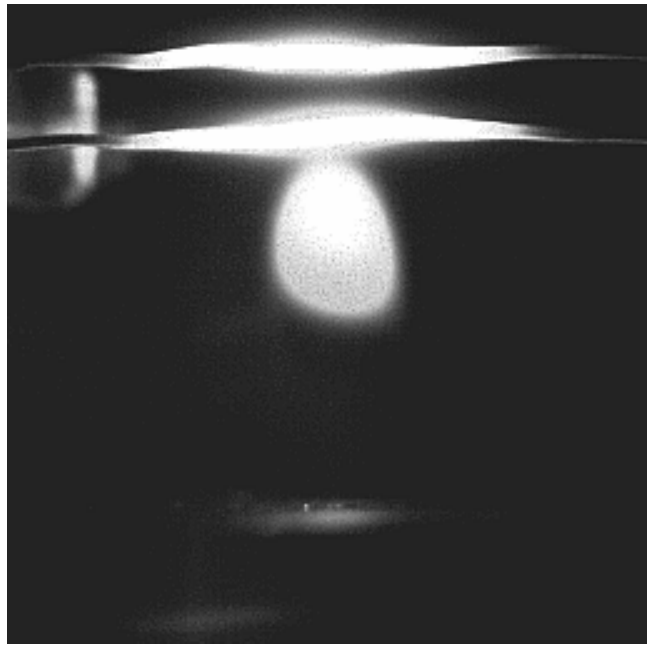
single event



Potentiometry

single event

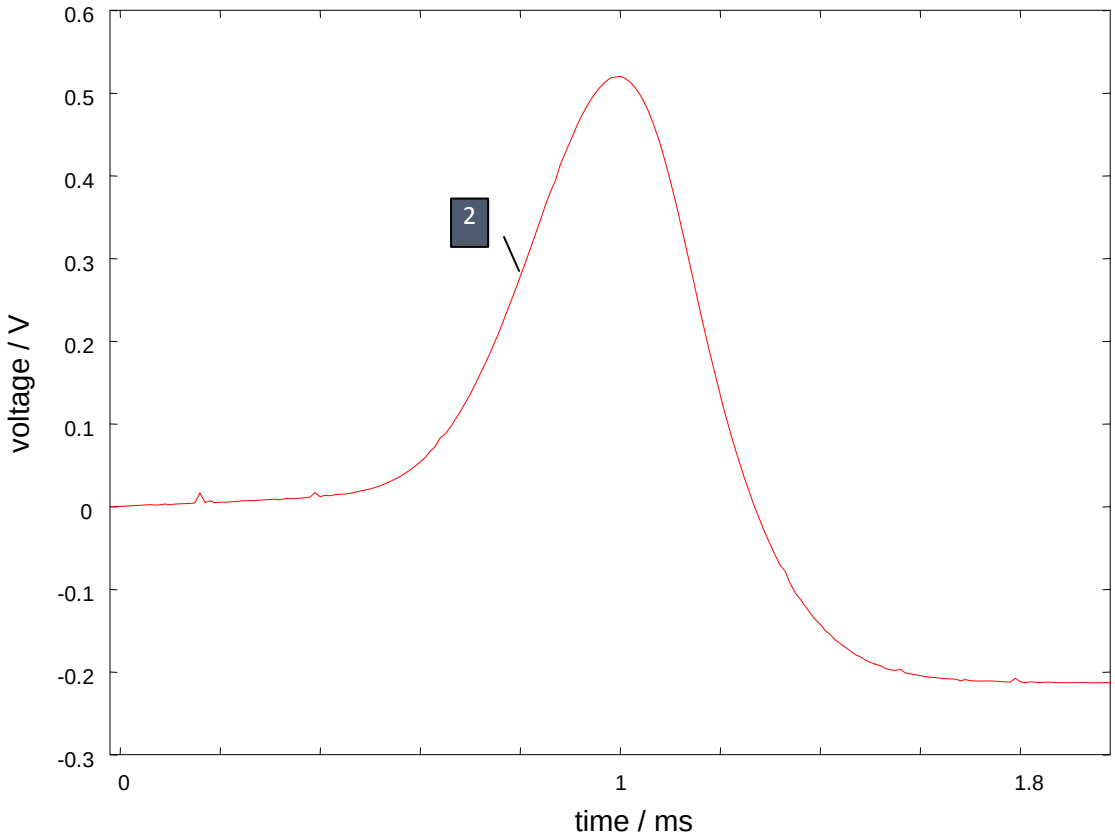


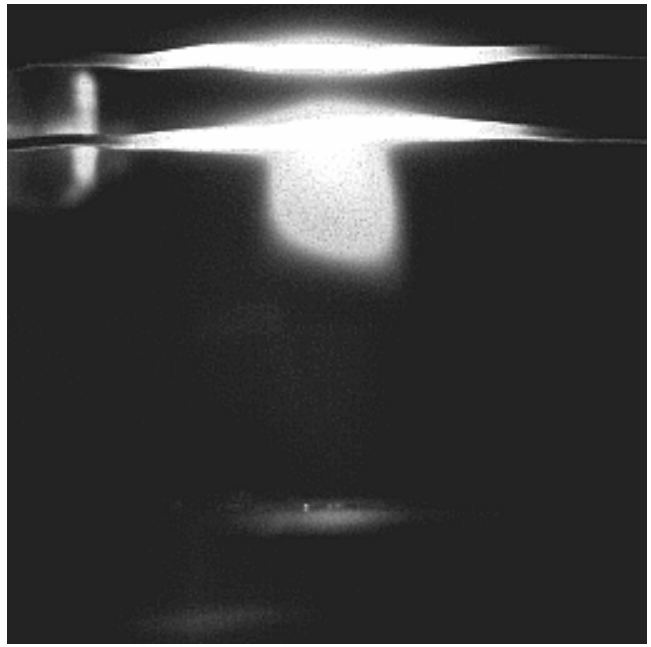


5 mm

Potentiometry

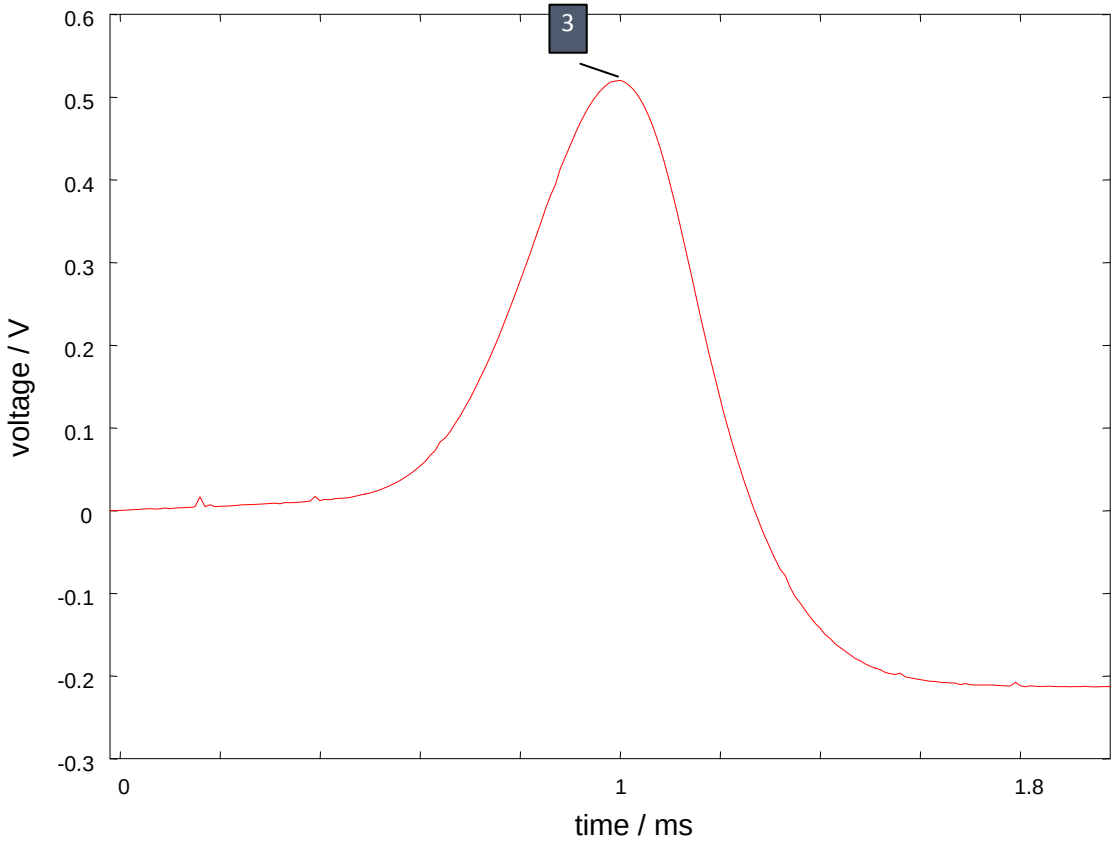
single event

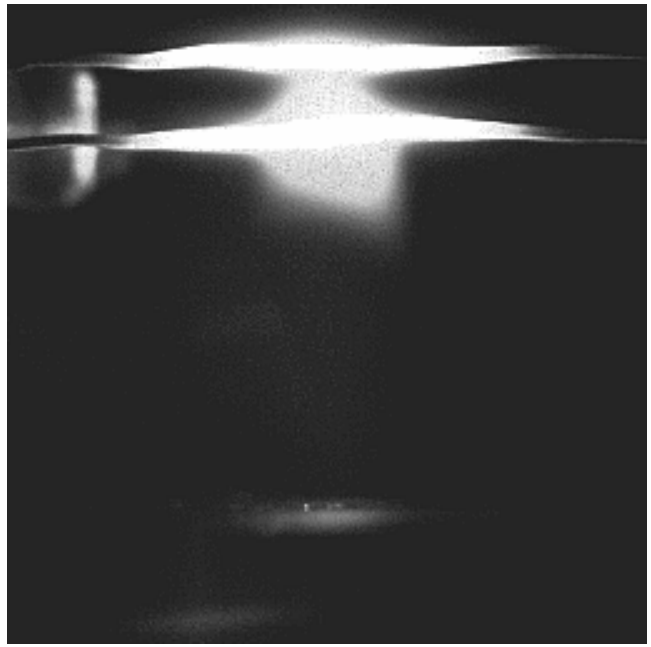




Potentiometry

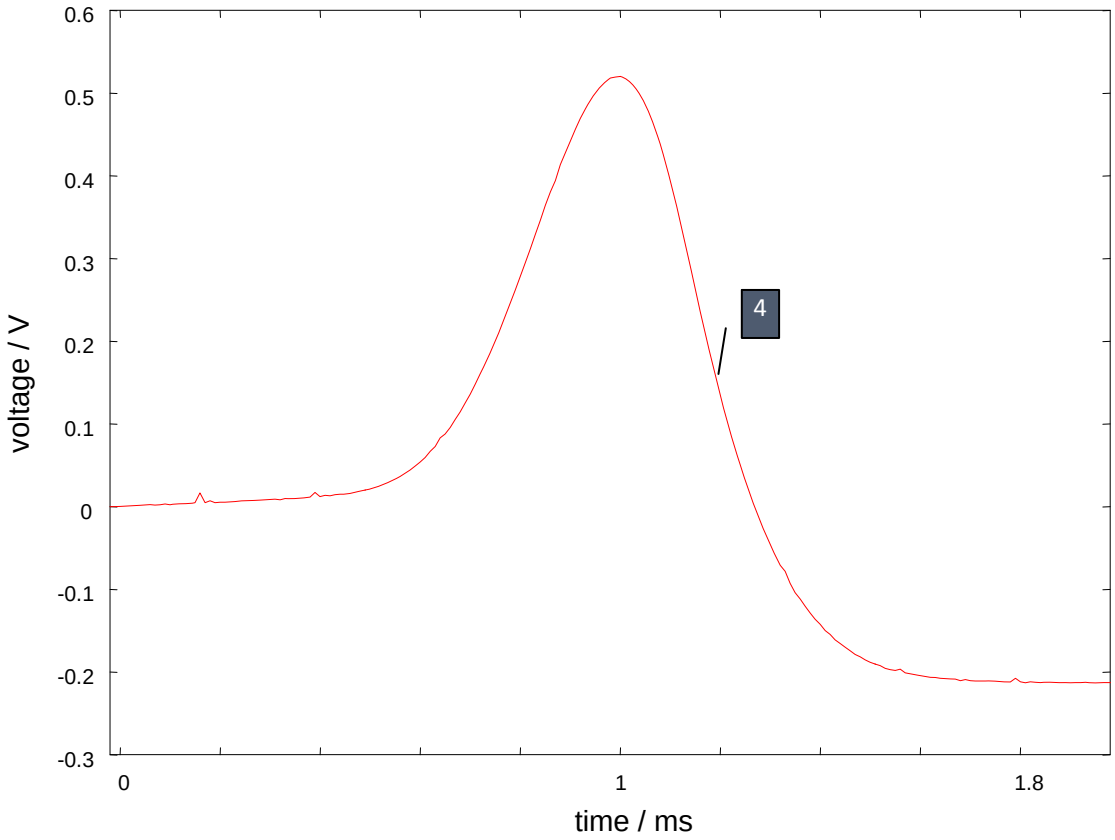
single event

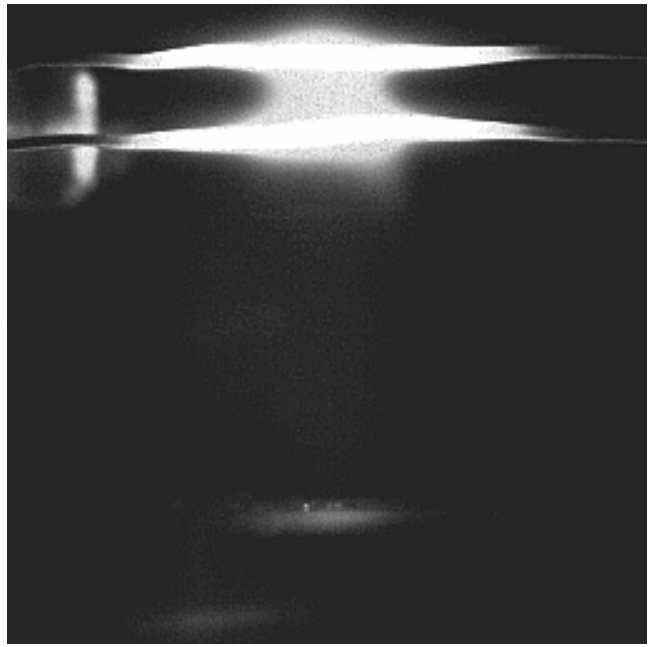




Potentiometry

single event

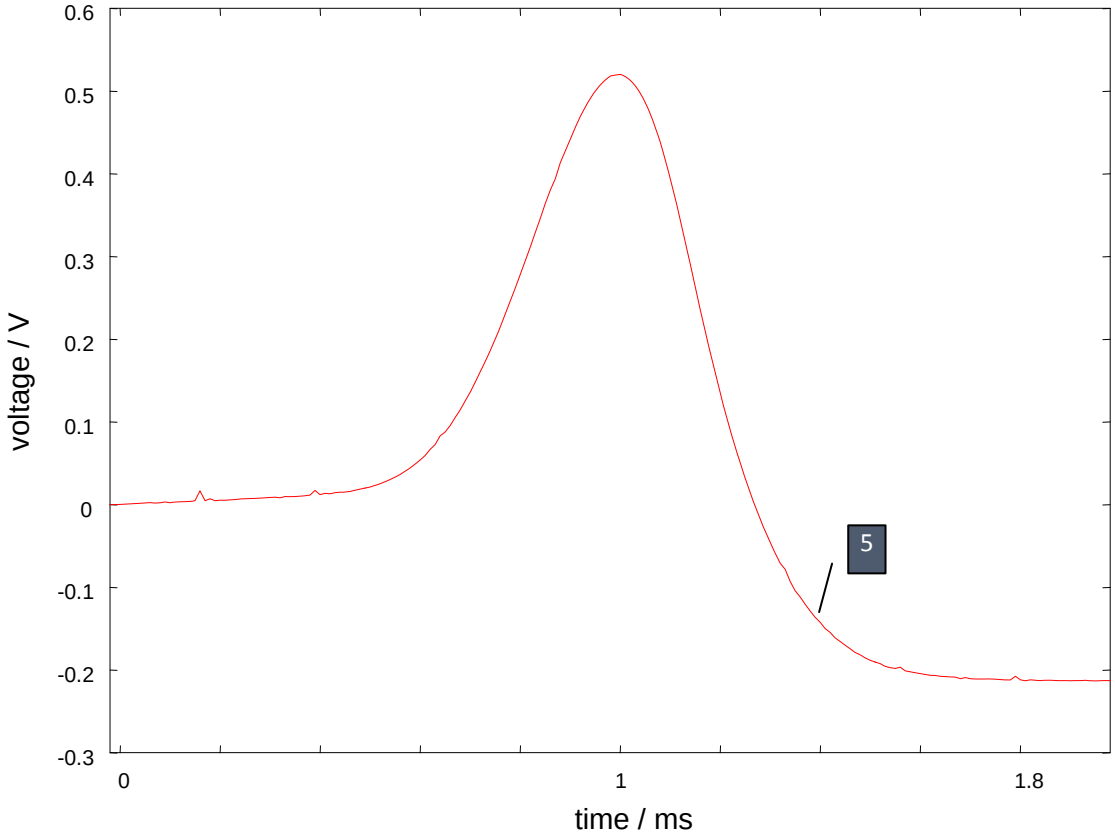


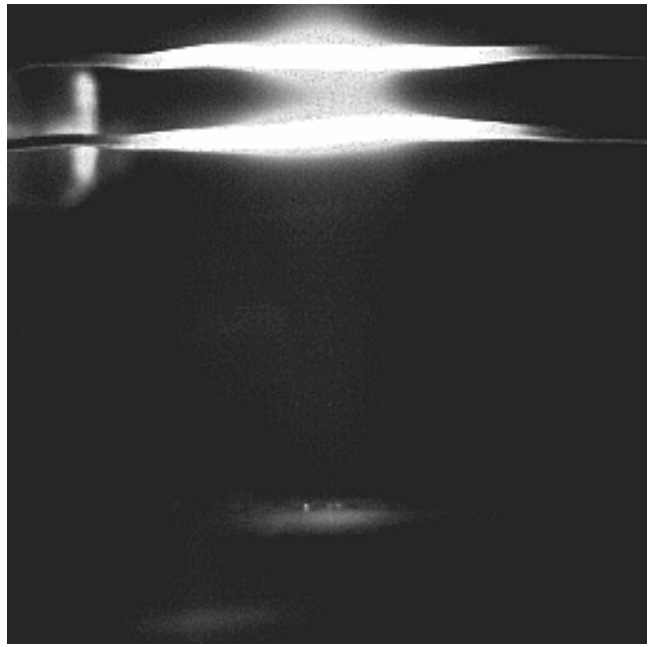


5 mm

Potentiometry

single event

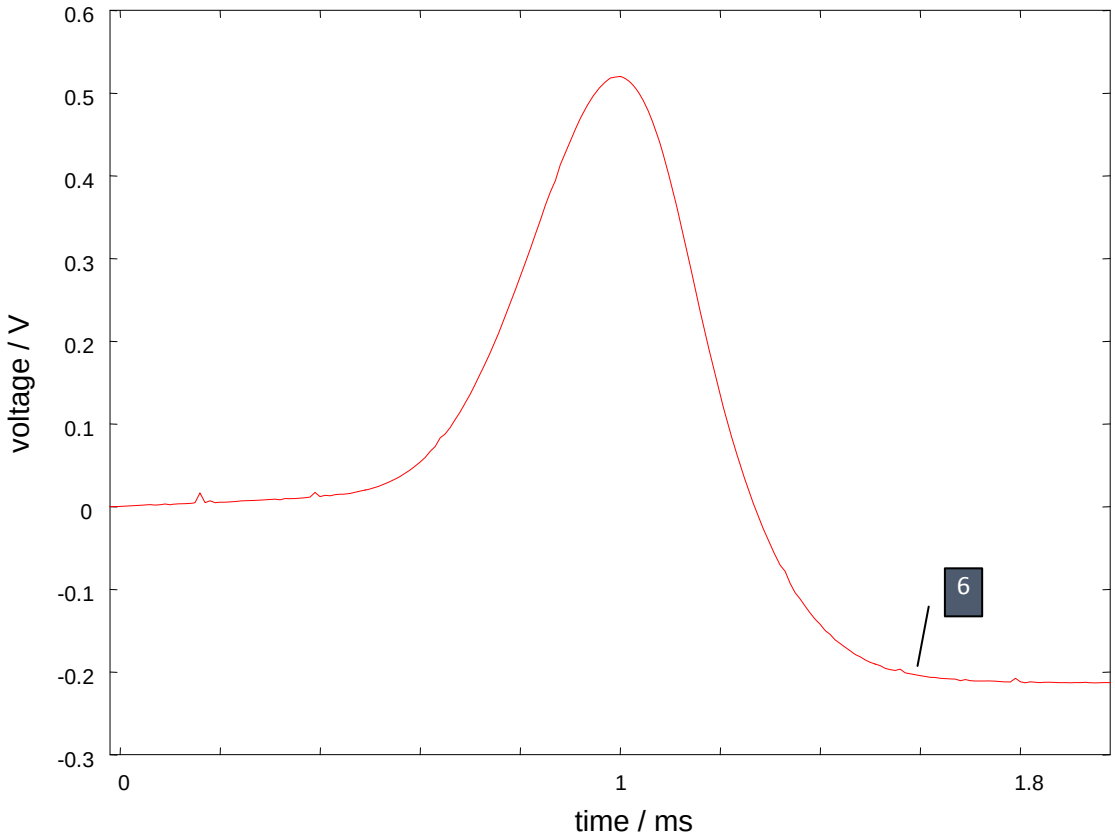


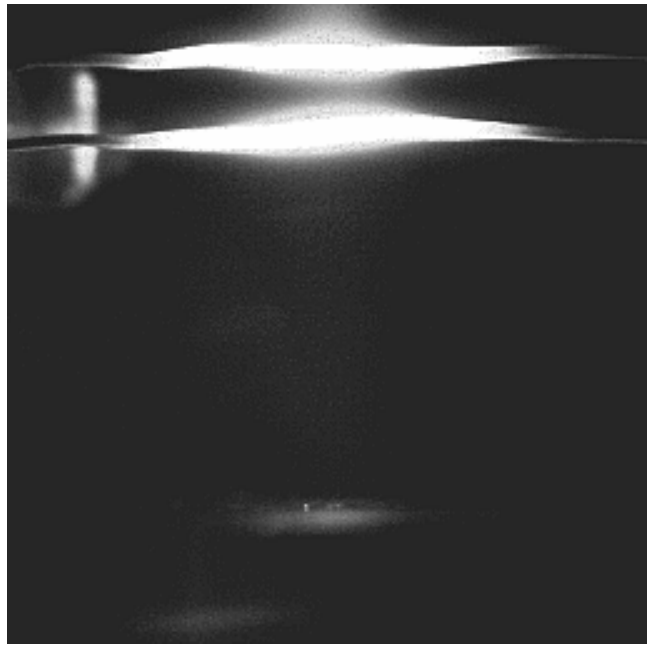


5 mm

Potentiometry

single event

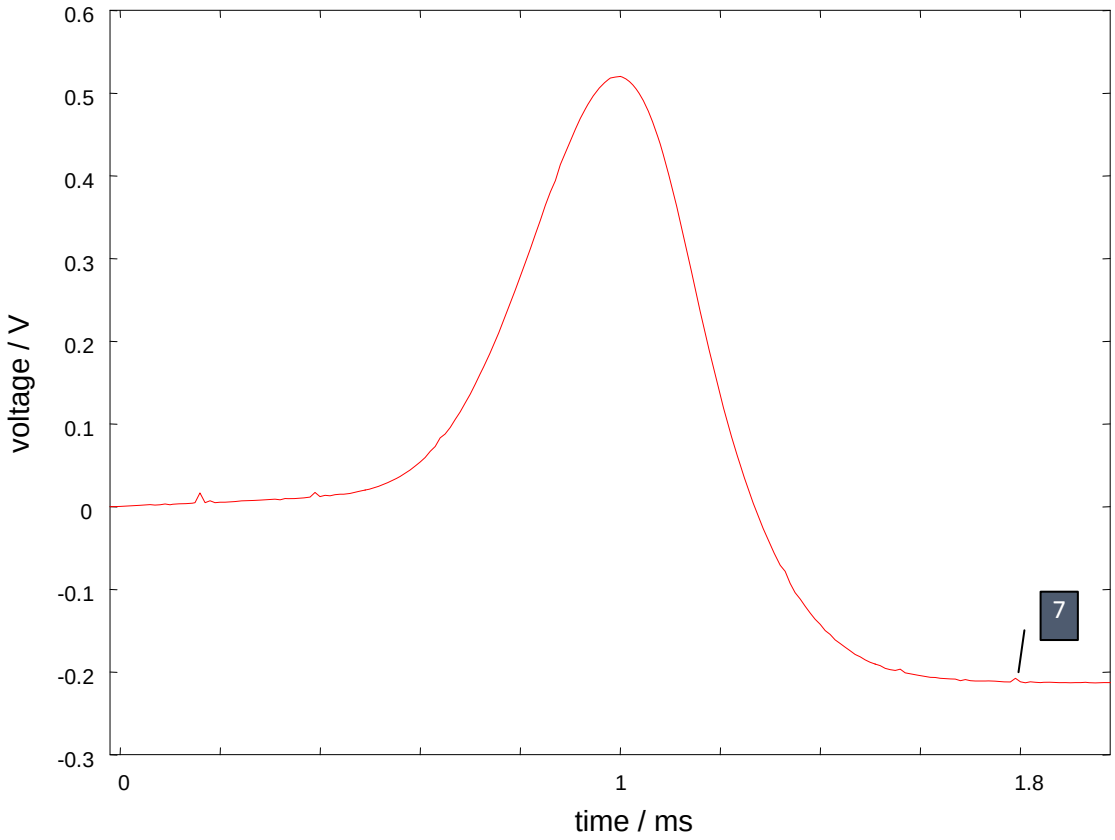


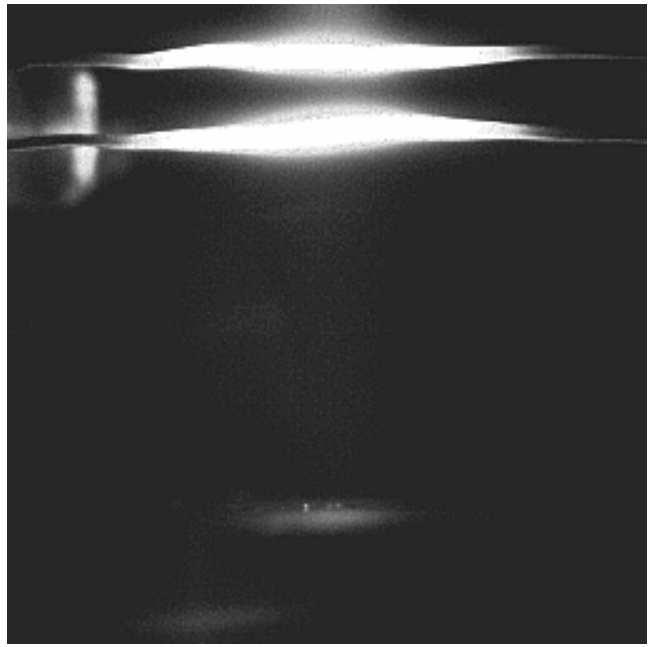


5 mm

Potentiometry

single event

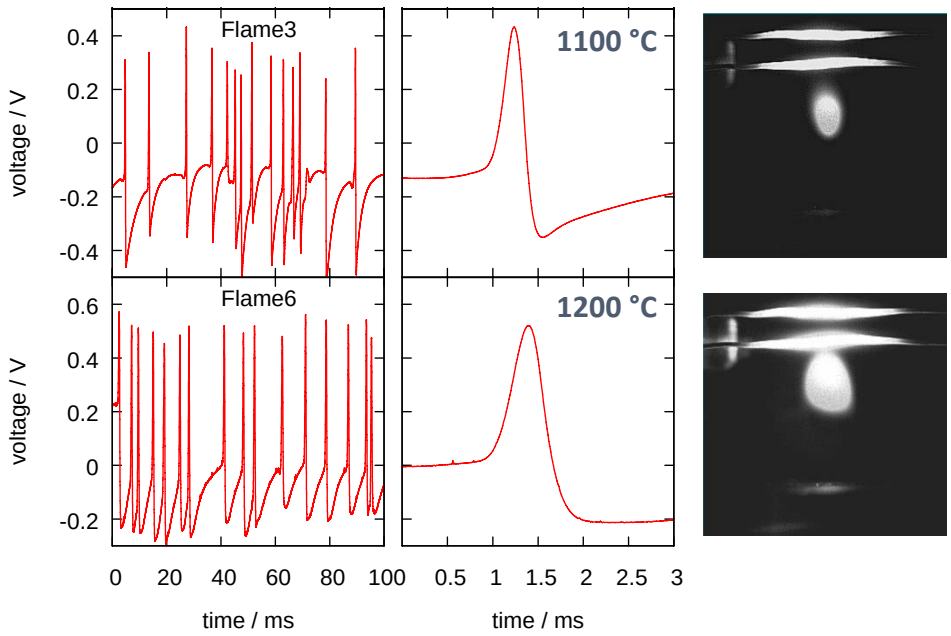




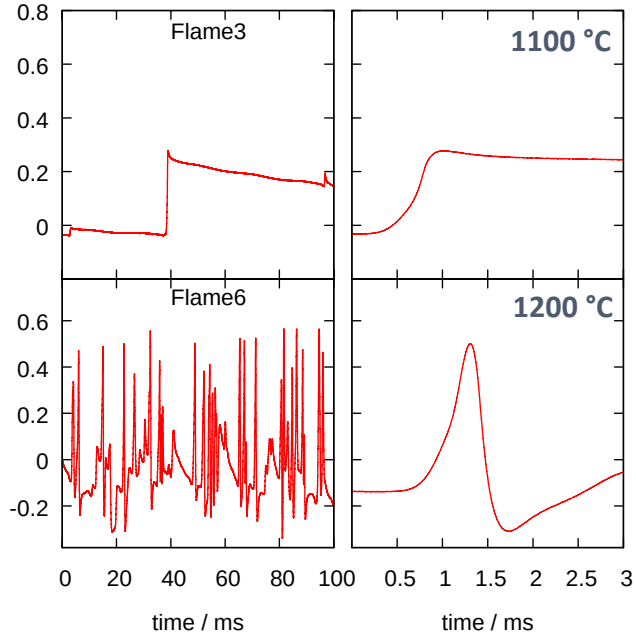
5 mm

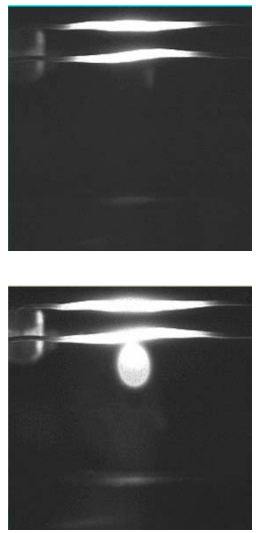
Pollens comparison

Bermuda



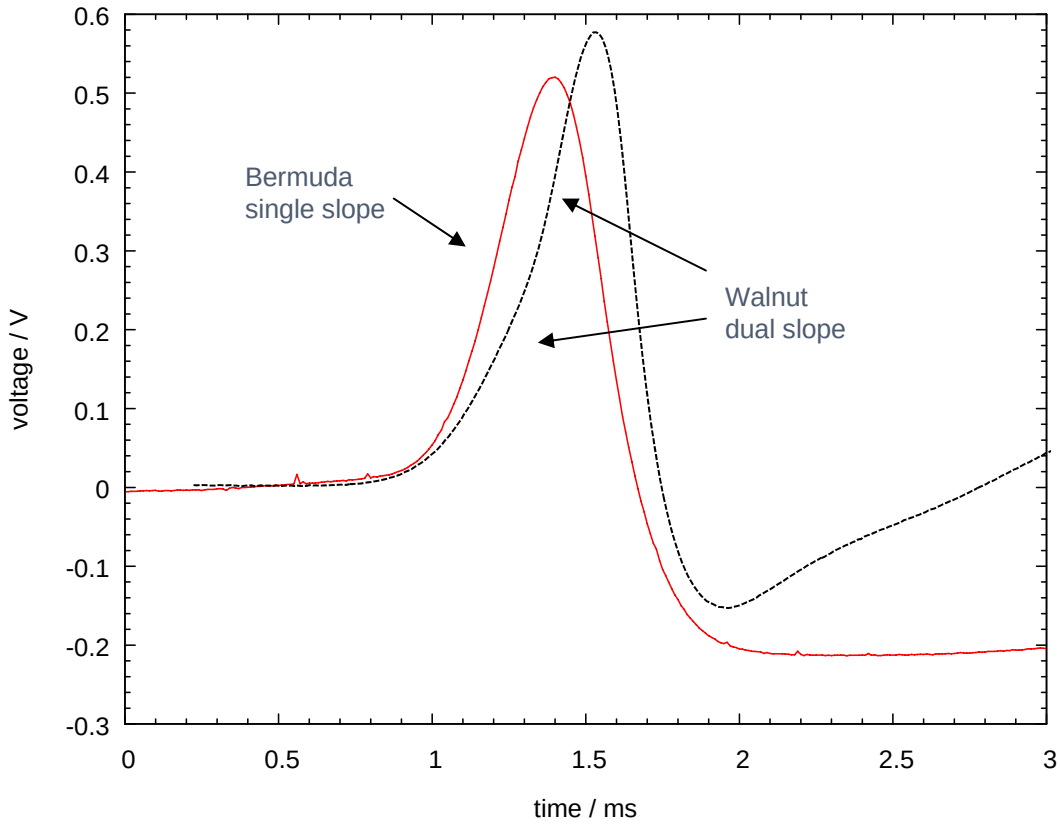
Walnut



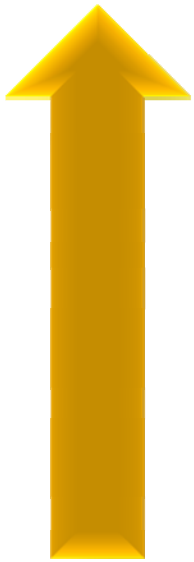


D. Sarantaridis and D.J. Caruana, *Anal. Chem.*, **82**, 7660 (2010).

Pollens comparison



Concept Pros/Cons



Built-in amplification

Real-time detection based on physical principle

Low cost

Scalable

High temperatures

Fuel/flame management

Interference species uncertainties

Conclusions

- Method can detect/count single pollen combustion events
- Promising results for discriminating between different species
- Great potential for a low cost versatile automatic sensor system

Next steps

- Test other bio and non-bio aerosols
- Build prototype

Acknowledgments

- Engineering and Physical Sciences Research Council Contract no. EP/F028423/1
  Engineering Instrument Loan Pool
- Beloe Fellowship
  The Worshipful Company of Scientific Instrument Makers
- Richard Gilham

Thank You