

# Towards a recycling paper based platform for printed electrochemical biosensors

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## MOTIVATION

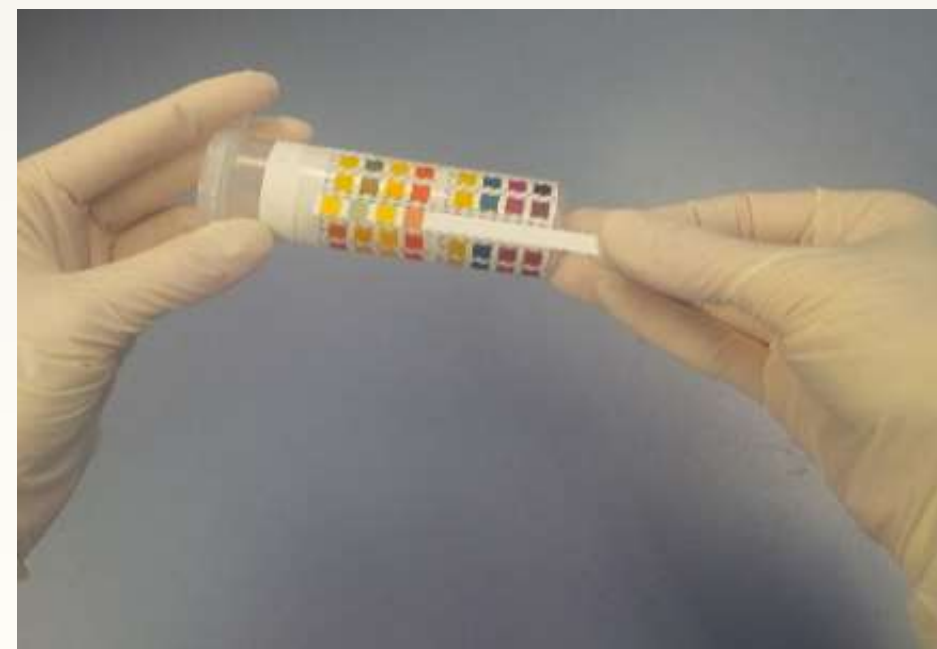
The **decentralization of the health care system**, driven by the demographic change, creates a strong demand for sustainable **high volume and low cost biosensors** that enable molecular diagnostics outside of laboratories.

To **overcome these limitations**, we aim to realise an electrochemical **single-use sensor**, which i) is based on **recycling paper** as substrate to enable environment-friendly production and disposal, ii) detects quantitatively glucose and ketone bodies in urine to permit the diagnosis of ketoacidosis [1], iii) is able to contactless communicate the measured values.

## State of the art: Single-use test strips using color indicators

### Urine test strips

- Plastic substrate
- Subjective visual perception
- No electronic data recording
- Detect only acetoacetic acid



➔ No present point of care system can detect beta-hydroxybutyric acid and acetoacetic acid



### Paper manufacturing

- Cellulose matrix for biofunctionalisation
- Surface for electrodes



### Roll-to-roll printing

- Electrodes
- Hydrophobic barriers



### Microelectronics

- Printed antenna
- Assembly of bare dies

## Electrochemical biosensing for the quantification of glucose and ketone bodies (beta-hydroxybutyric acid and acetoacetic acid)

### PIONIER demonstrator

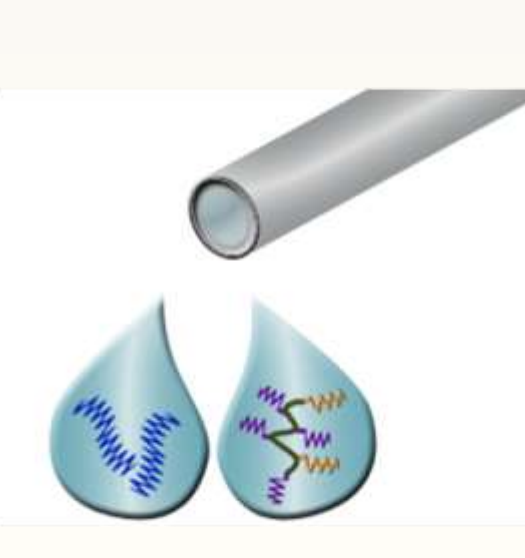
- Paper substrate
- Quantitative results
- Contactless read-out
- Battery-free
- Automatic data recording
- Environment-friendly

### Single step biofunctionalisation

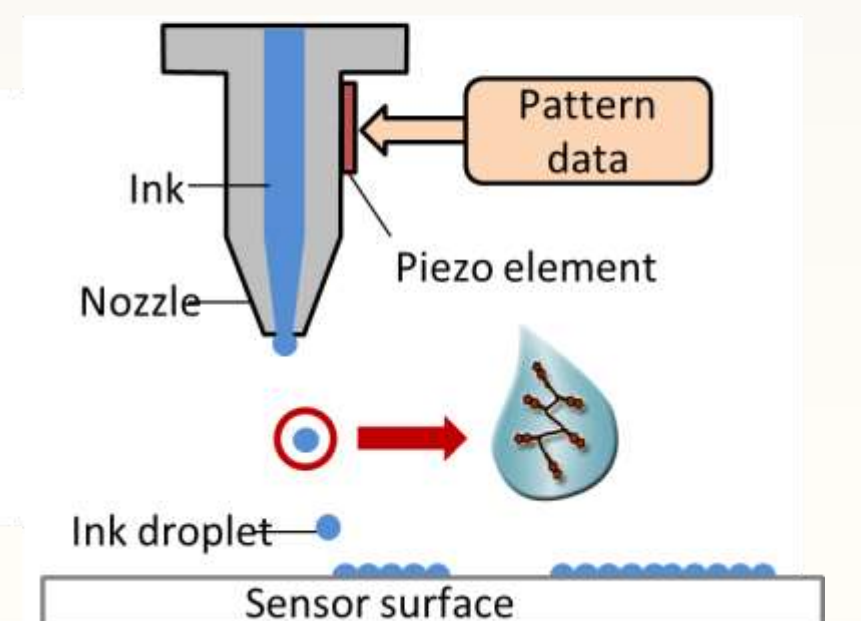
#### Material inkjet printer



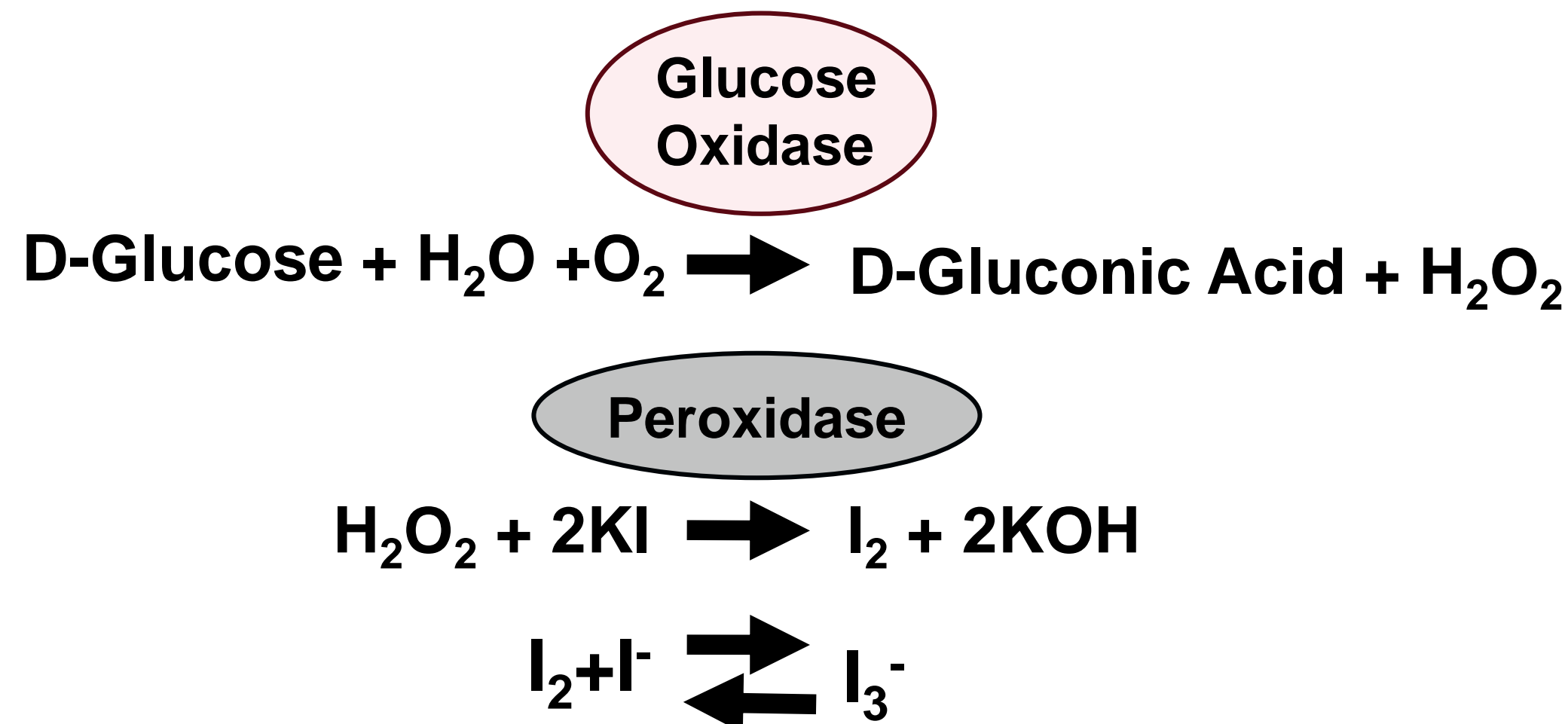
#### Printable bioink formulation



#### Direct bioink printing process



## Glucose assay [2] in recycling paper



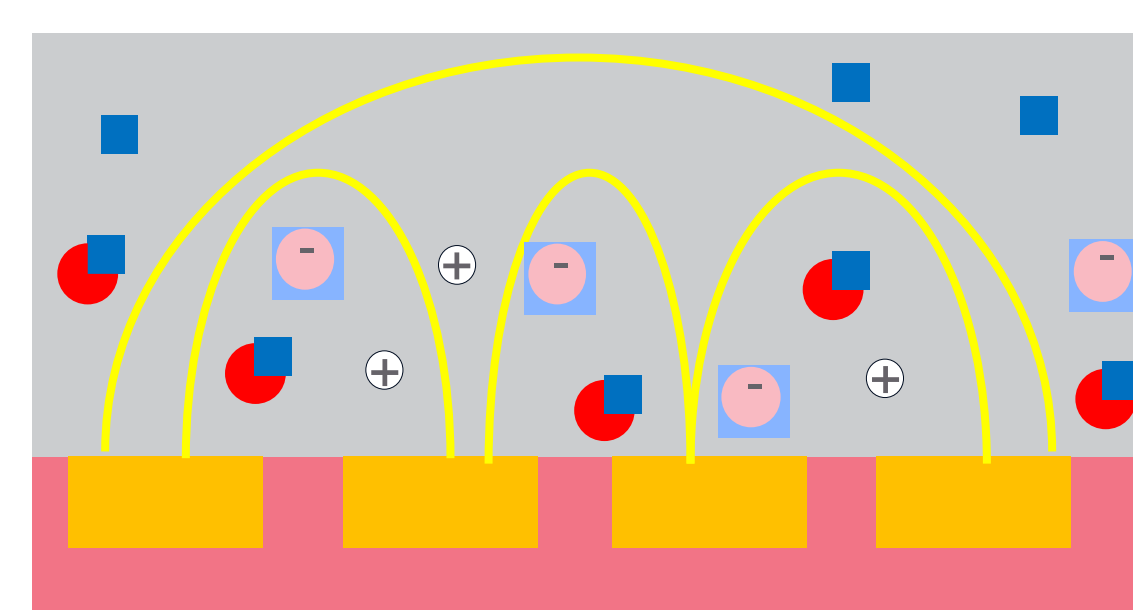
### Paper substrate



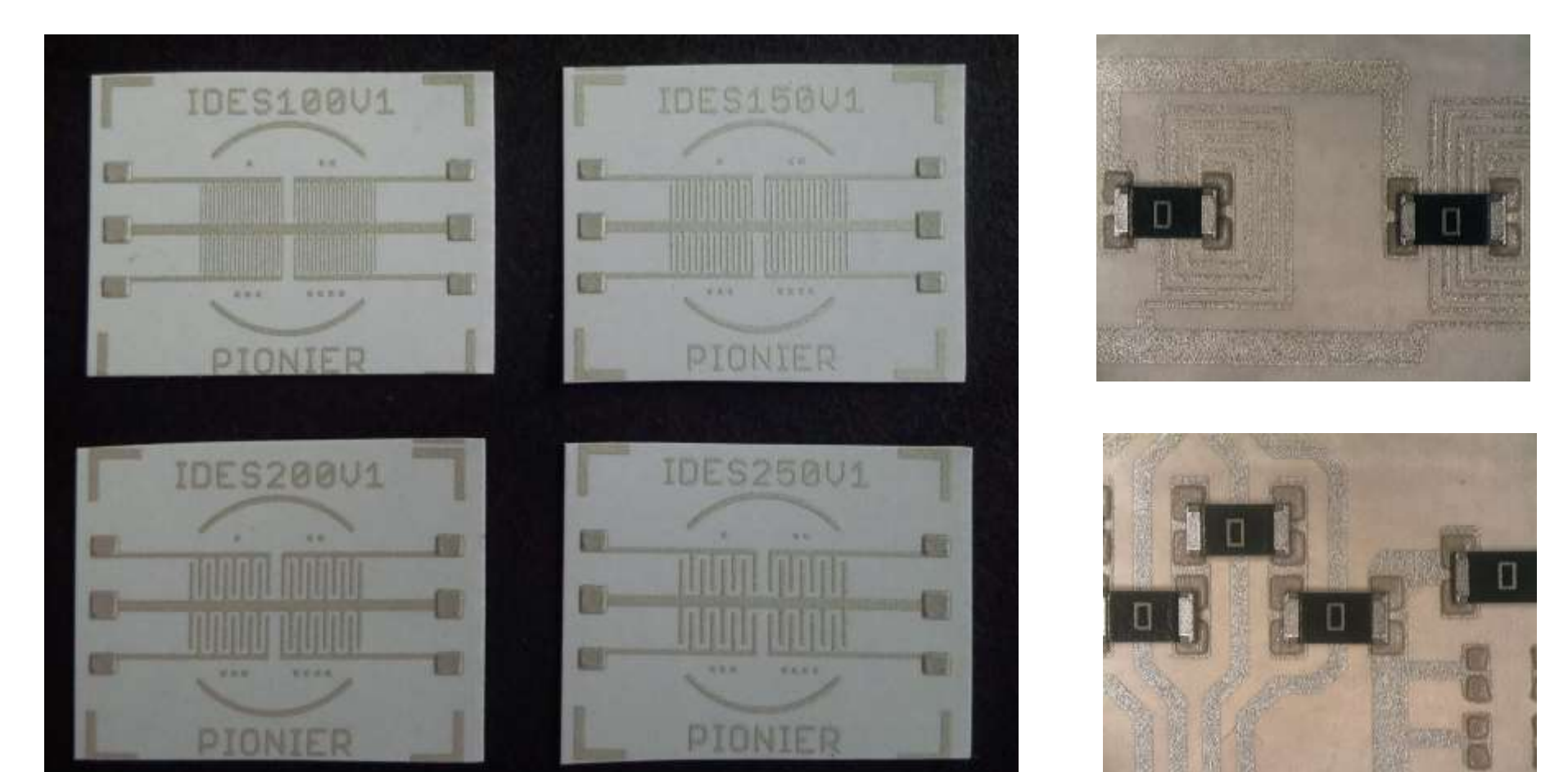
## PIONIER prototype [3]



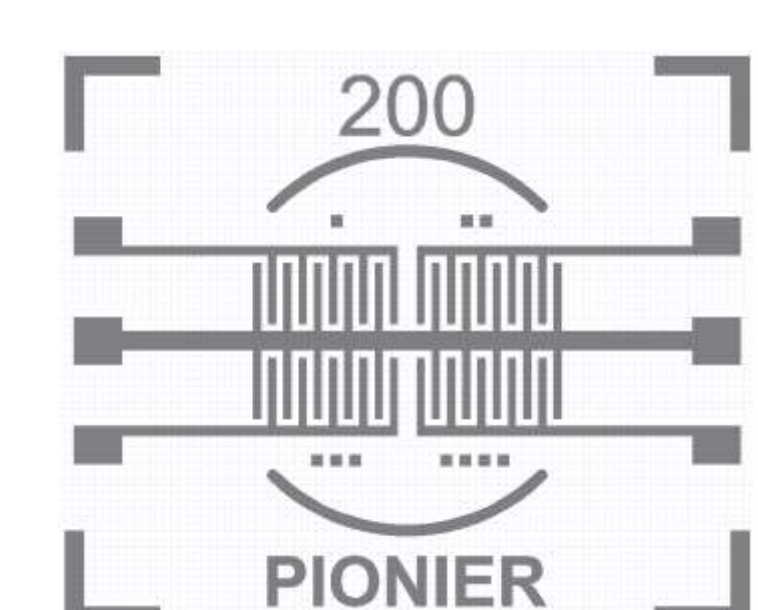
### Biosensing



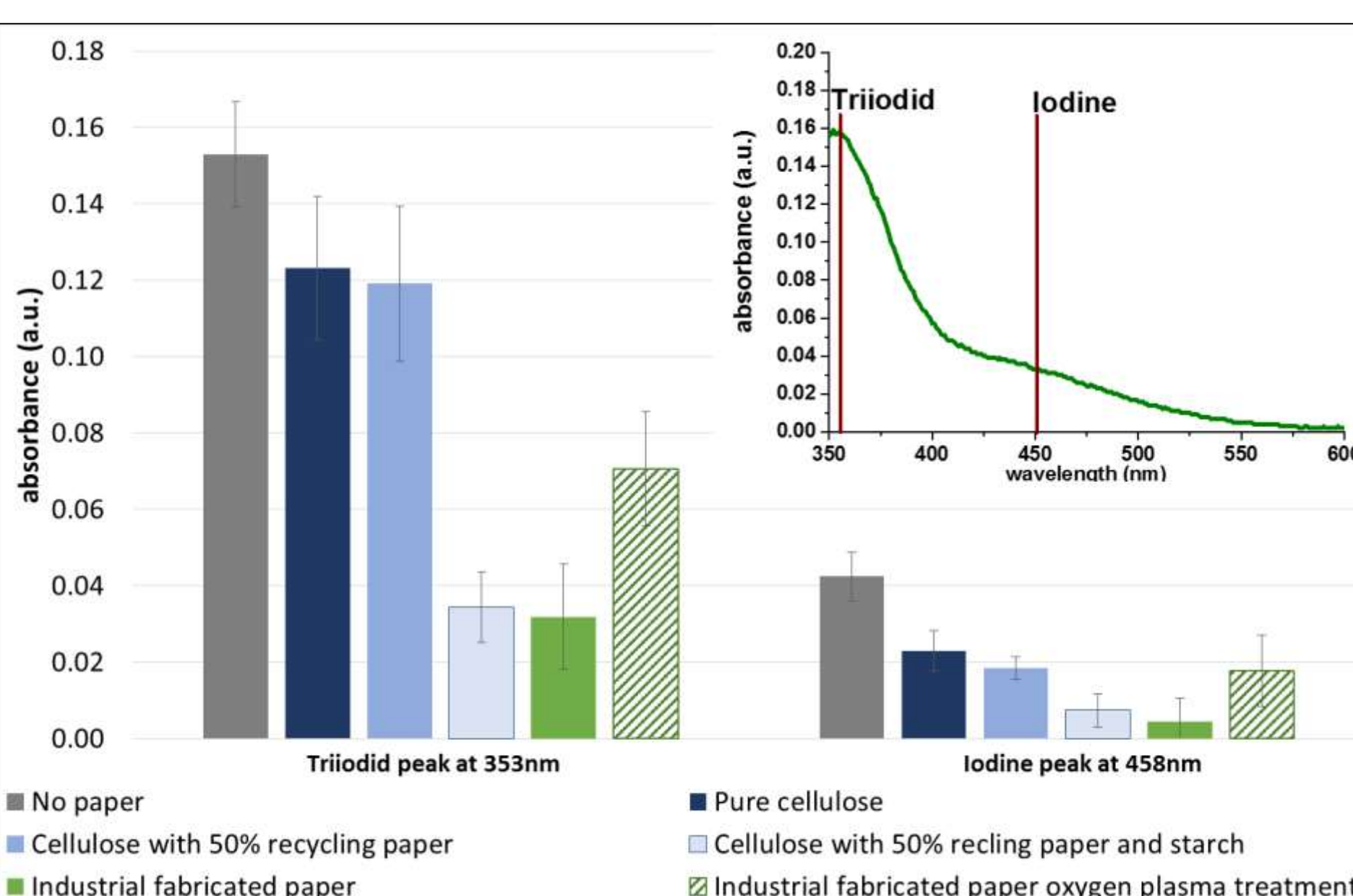
## Silver printing on paper



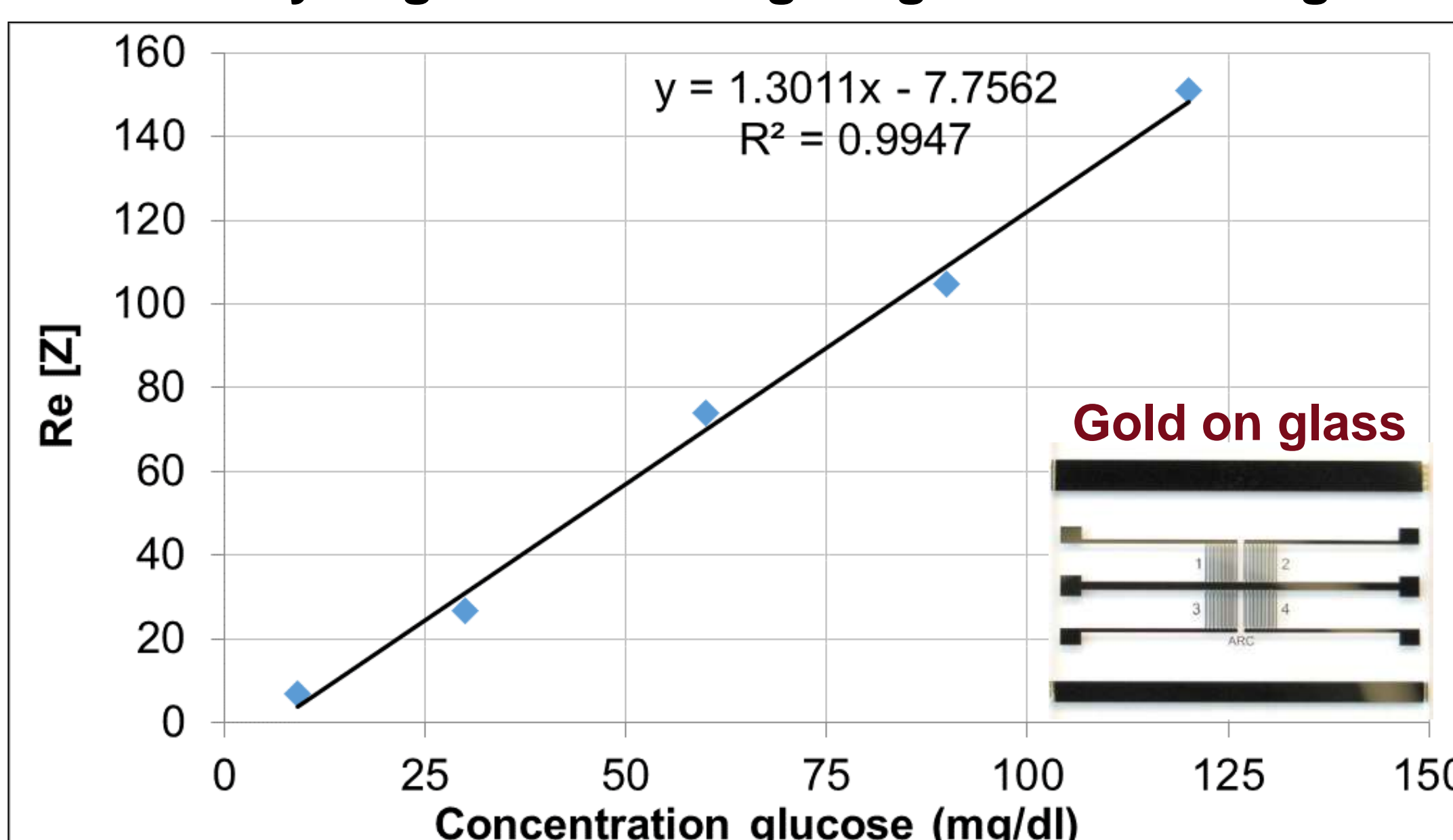
### Tested sensors



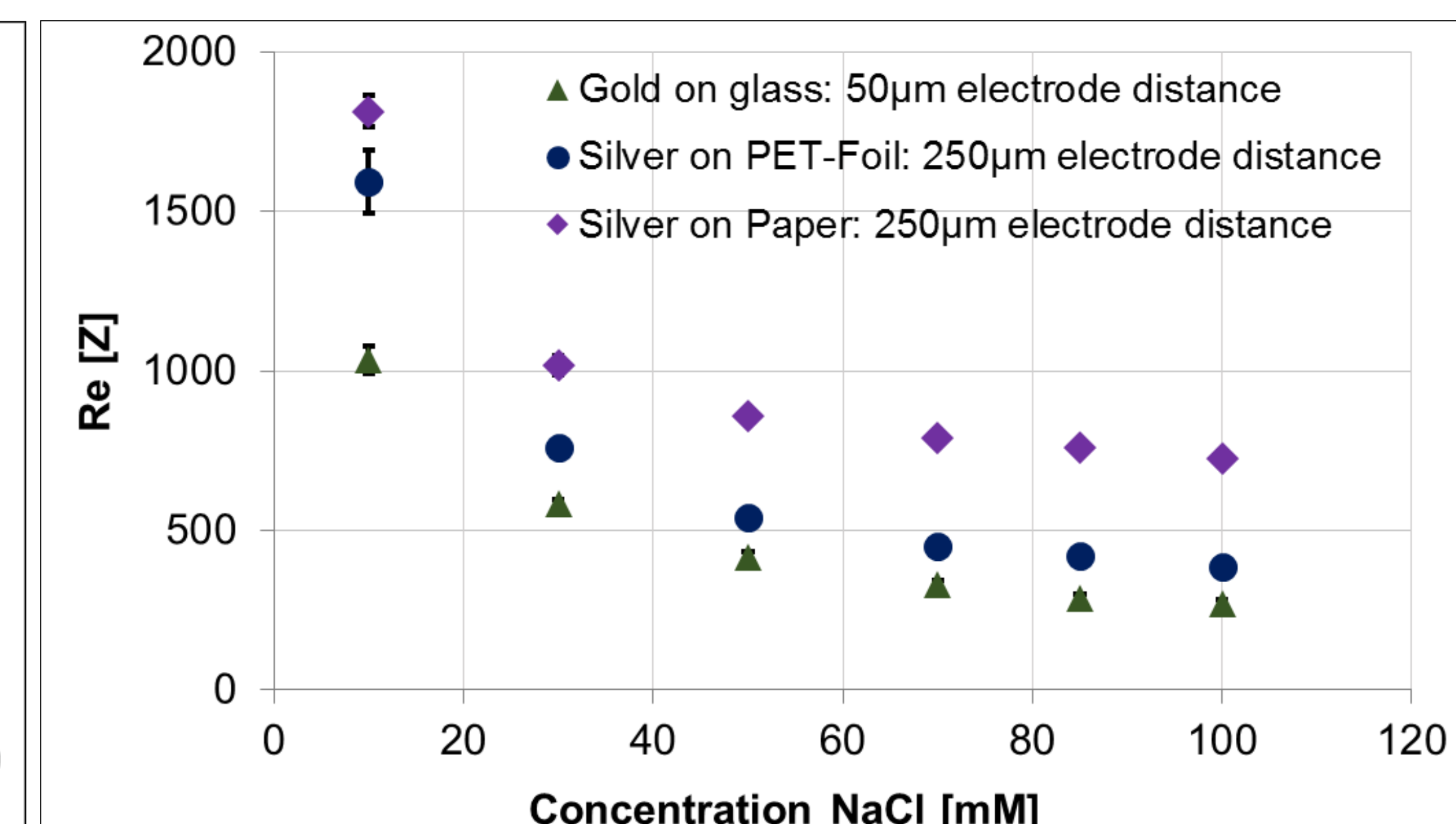
### Feasibility of glucose testing in paper substrate



### Feasibility of glucose testing on gold sensor on glass



### Impedance detection on different sensors



## References

1 L. Laffel, Diabetes Metab Res Rev, 15:412– 426 (1999)  
 2 A. W. Martinez., S. T. Phillips, E. Carrilho, S. W. Thomas, H. Sindi, M. Whitesides, Anal. Chem. 3699–3707 (2008).  
 3 J. Wissenwasser, M. Vellekoop, R. Heer, Review of scientific instruments 81, 025106 (2010)