

# "IN-SITU SOIL REMEDIATION OF ANTIBIOTIC CIPROFLOXACIN BY PULSED DIELECTRIC BARRIER DISCHARGE"

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## Introduction

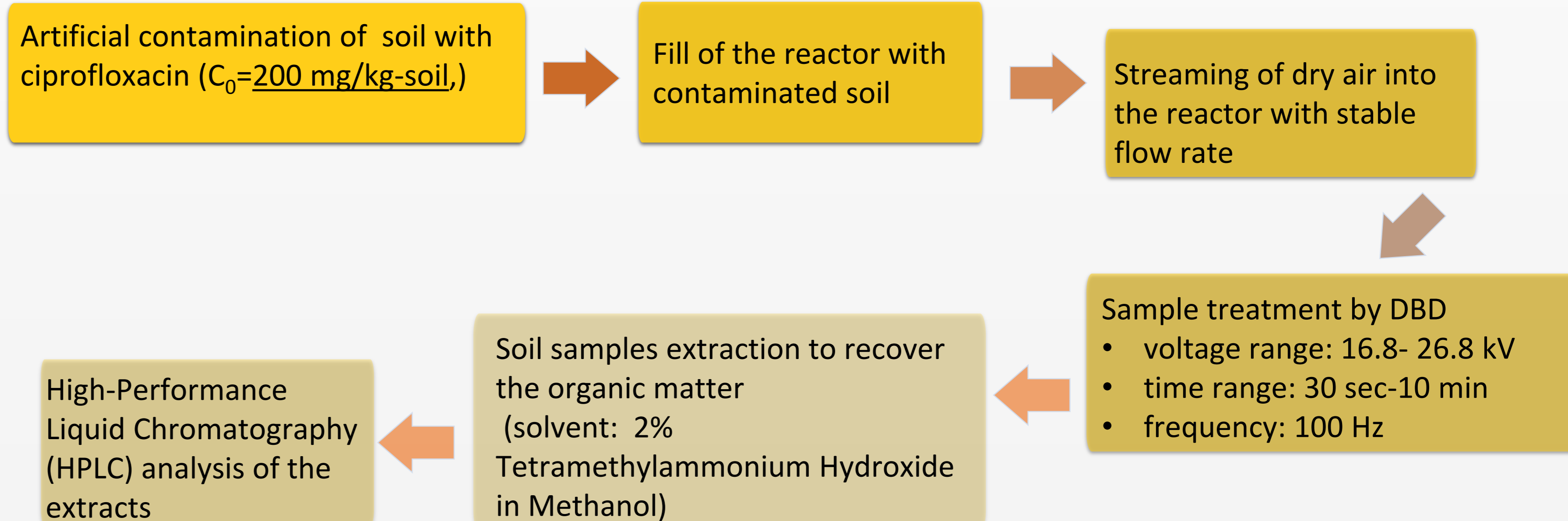
Ciprofloxacin is one of the most widely used antibiotics with concentration range in sludge and contaminated soil between 0.3-3 mg/kg [1]. It is strongly adsorbed onto soil surface and it is not easily biodegraded. Therefore, a cost-effective and environmentally friendly method has to be developed in order to remediate soil from ciprofloxacin. During the last decade, there is an increasing attention in CAP technologies for the removal of organic pollutants in soil [2]. CAP is a promising advanced oxidation process (AOP) due to its low energy consumption, short treatment time and low requirement for the pretreatment process of soil.

## Objectives

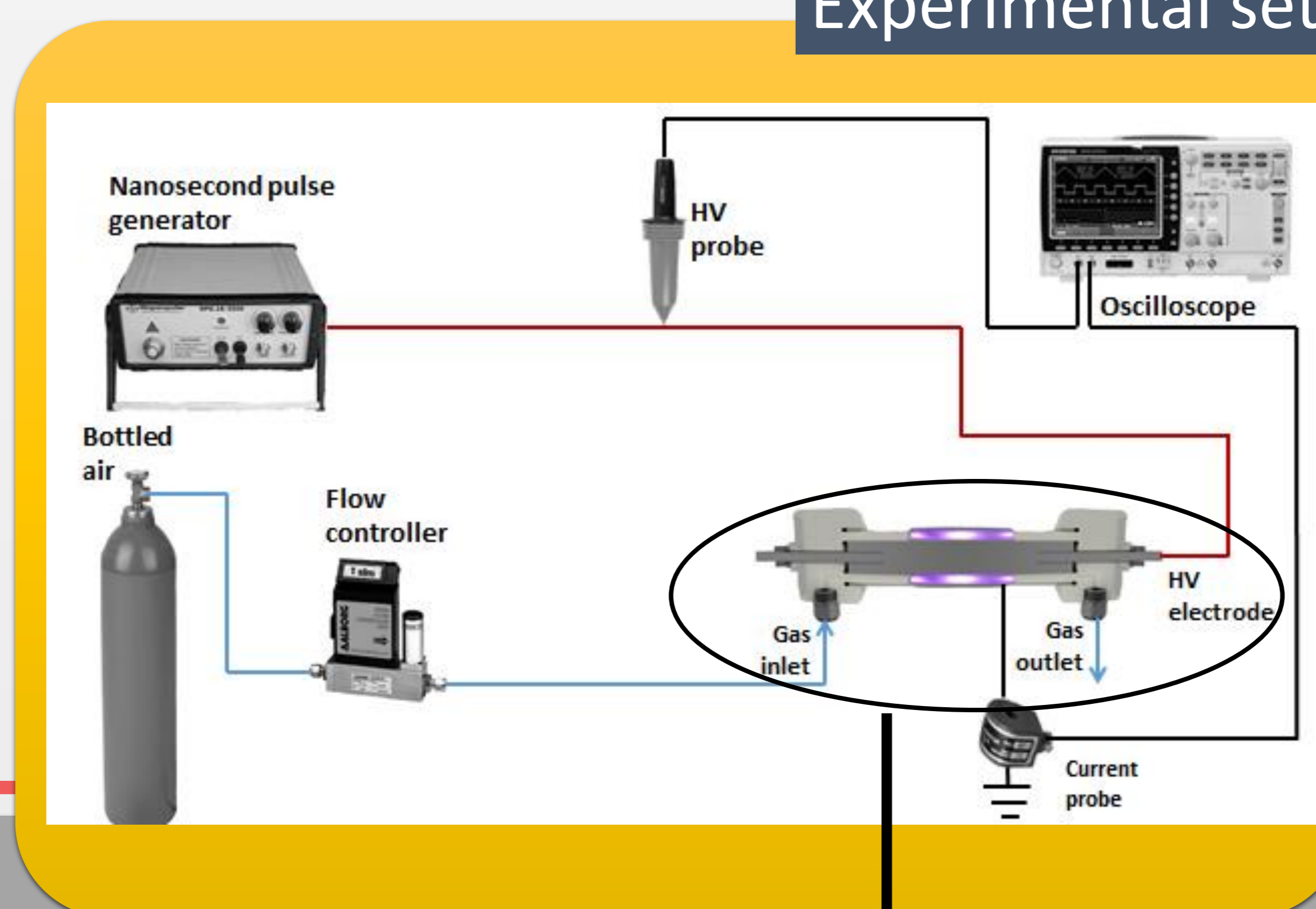
- Exploration of Cold Atmospheric Plasma (CAP) method for ciprofloxacin-polluted soil remediation.
- Investigation of experimental conditions (treatment time; pulse voltage; pulse frequency; energy efficiency).
- Testing of a novel cylinder-to-cylindrical grid Dielectric Barrier Discharge (DBD) reactor (*in-situ* remediation)

## Results

### General Research Methodology



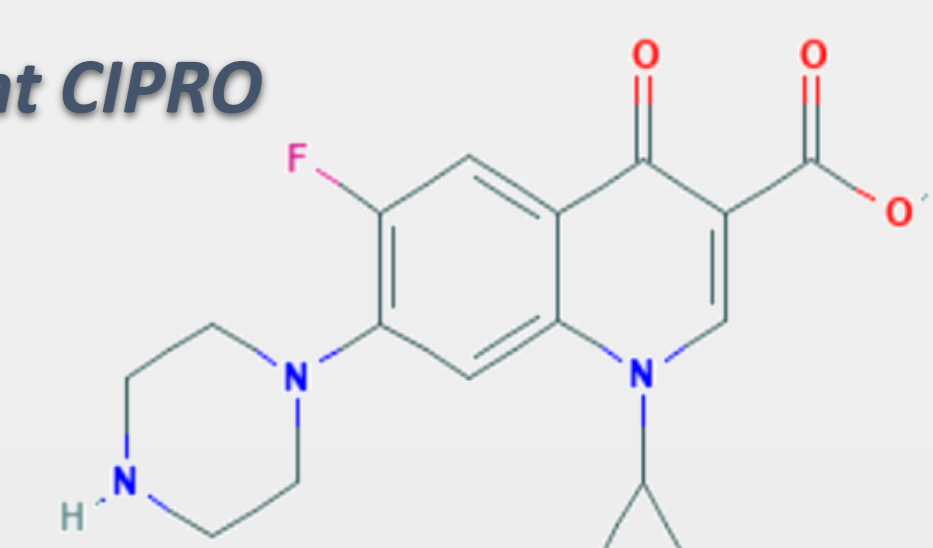
### Experimental setup



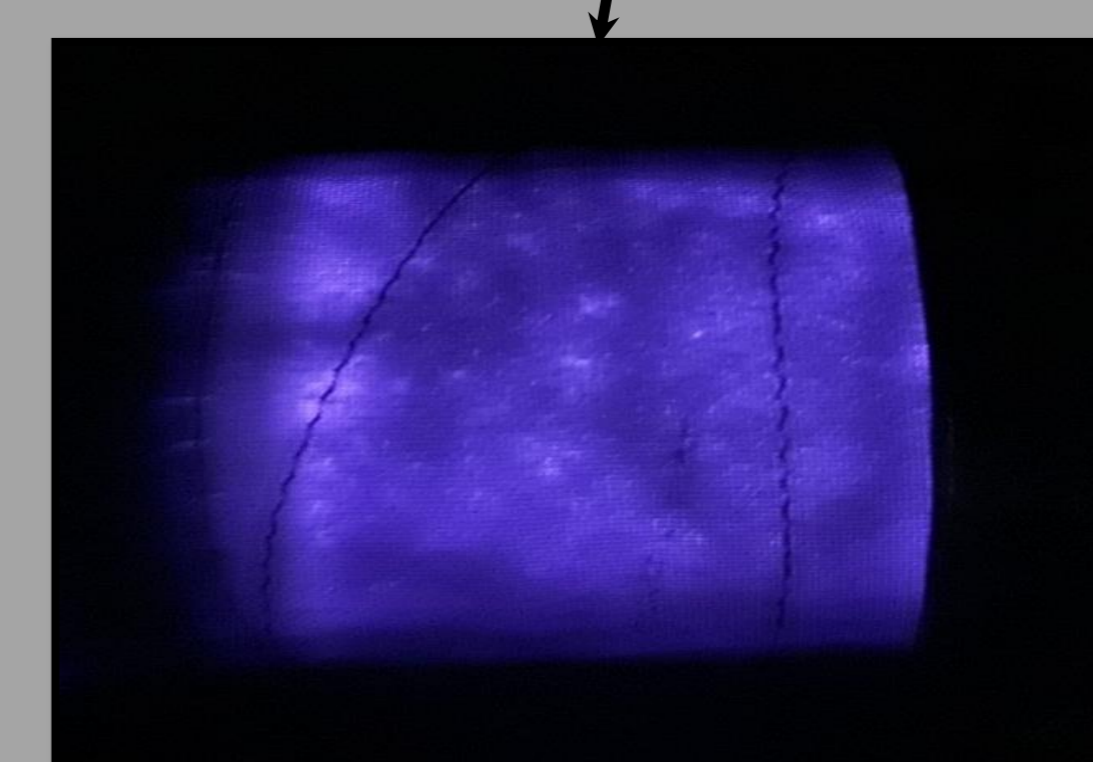
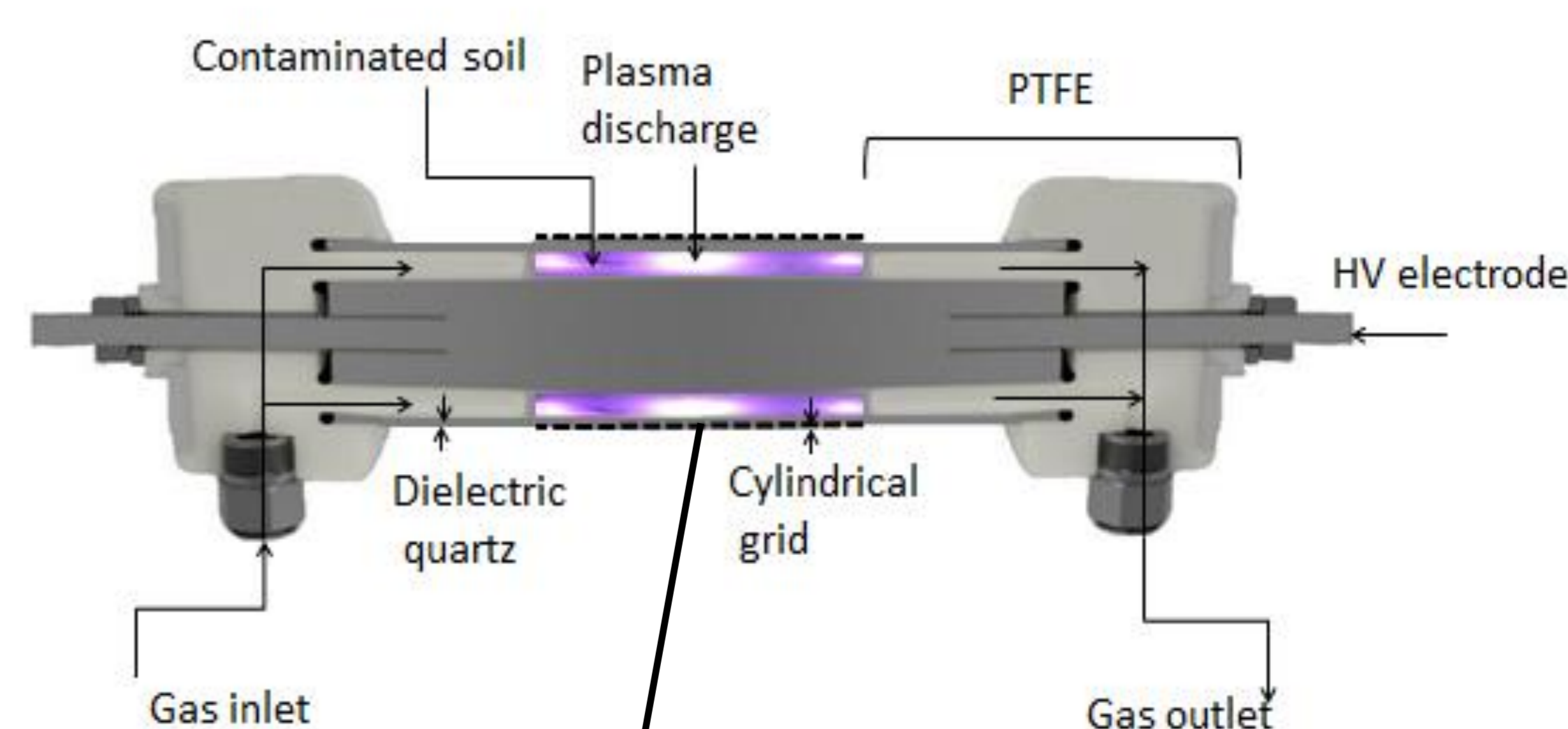
### Properties of model soil

Soil	pH	Color	Main Content
Sandy soil	7.5	White to beige	SiO <sub>2</sub>

### Model pollutant CIPRO



### Cylinder-to-cylindrical grid DBD reactor

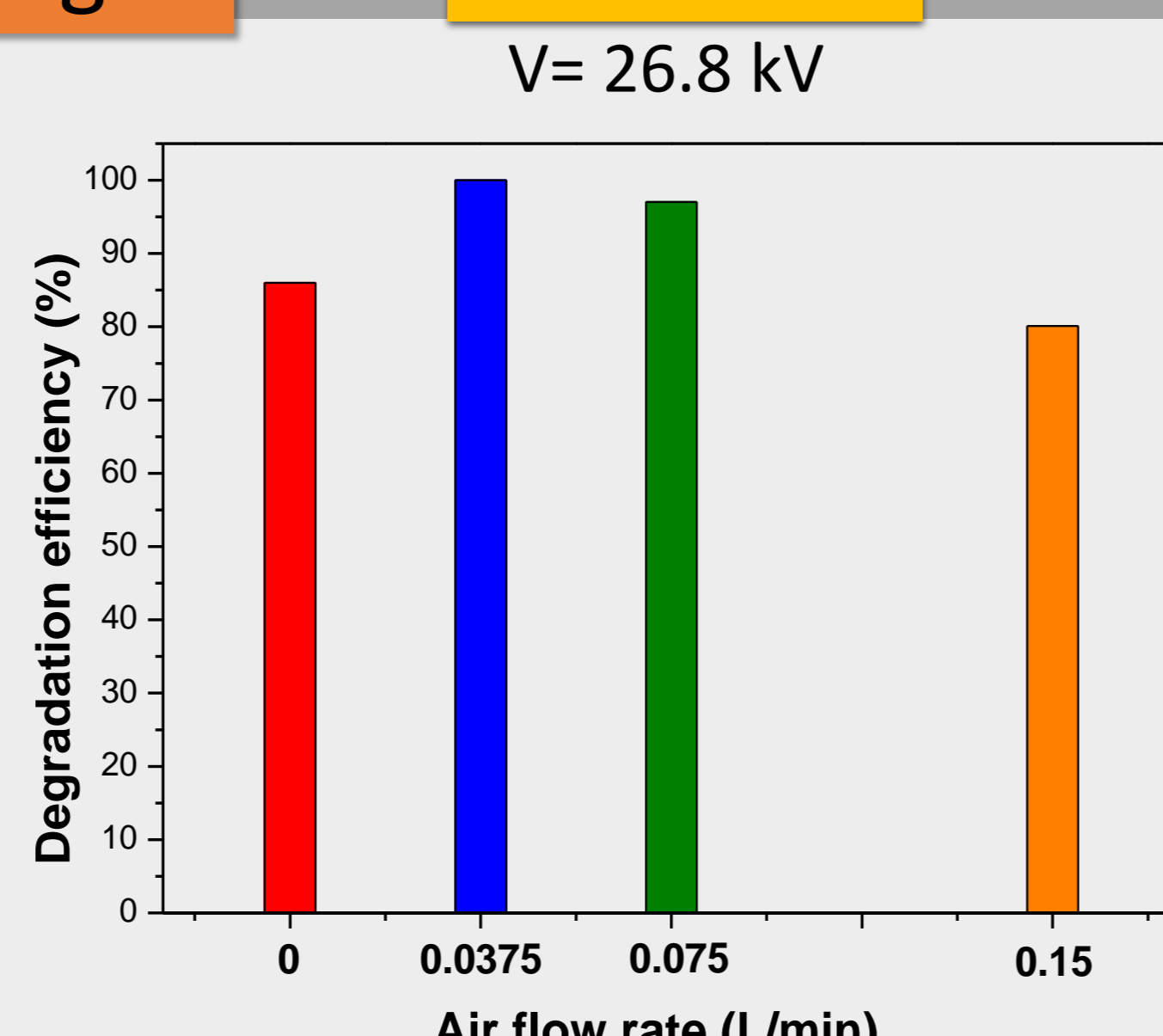
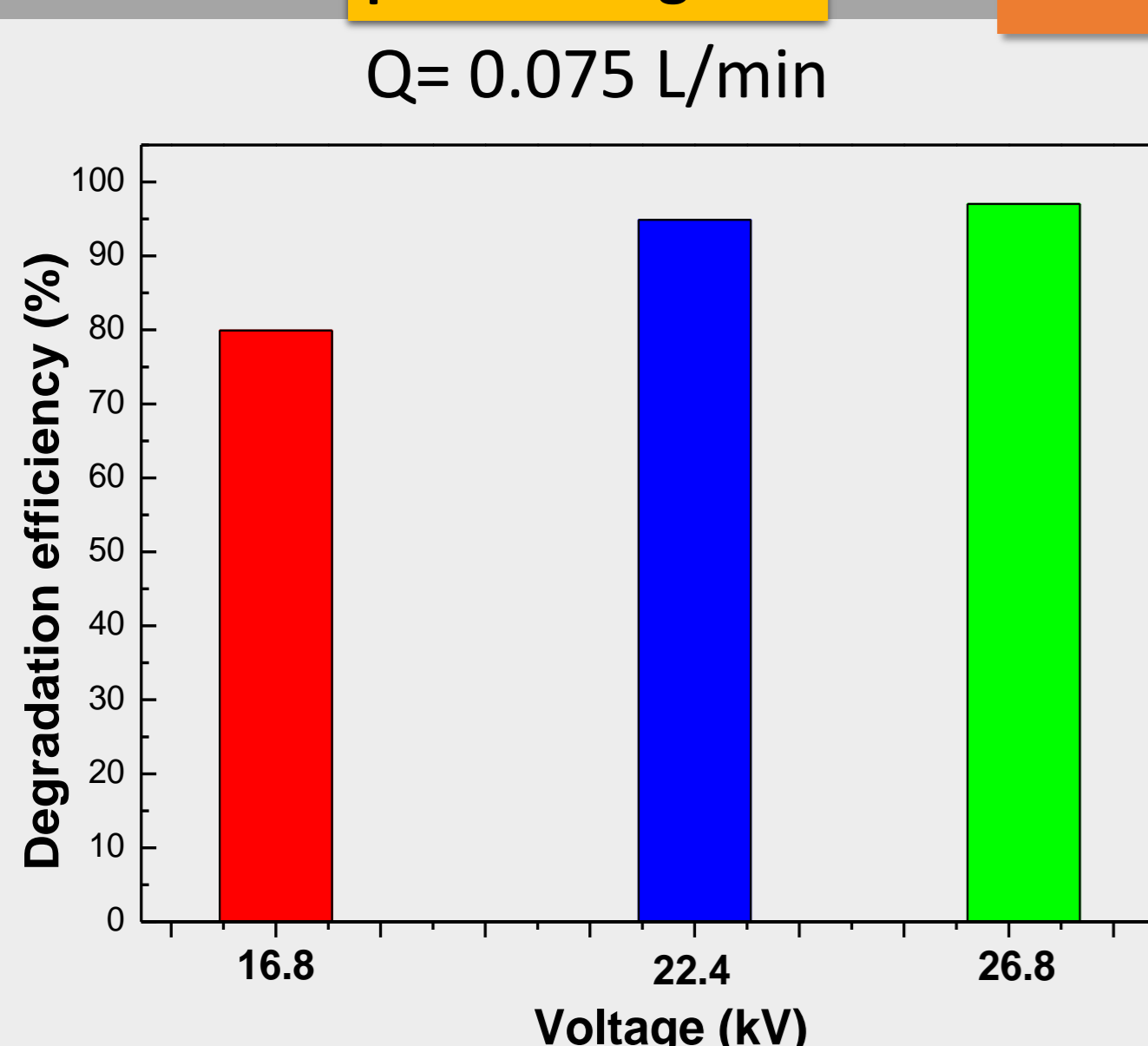


Depiction of plasma discharges inside soil pores during CAP treatment of soil

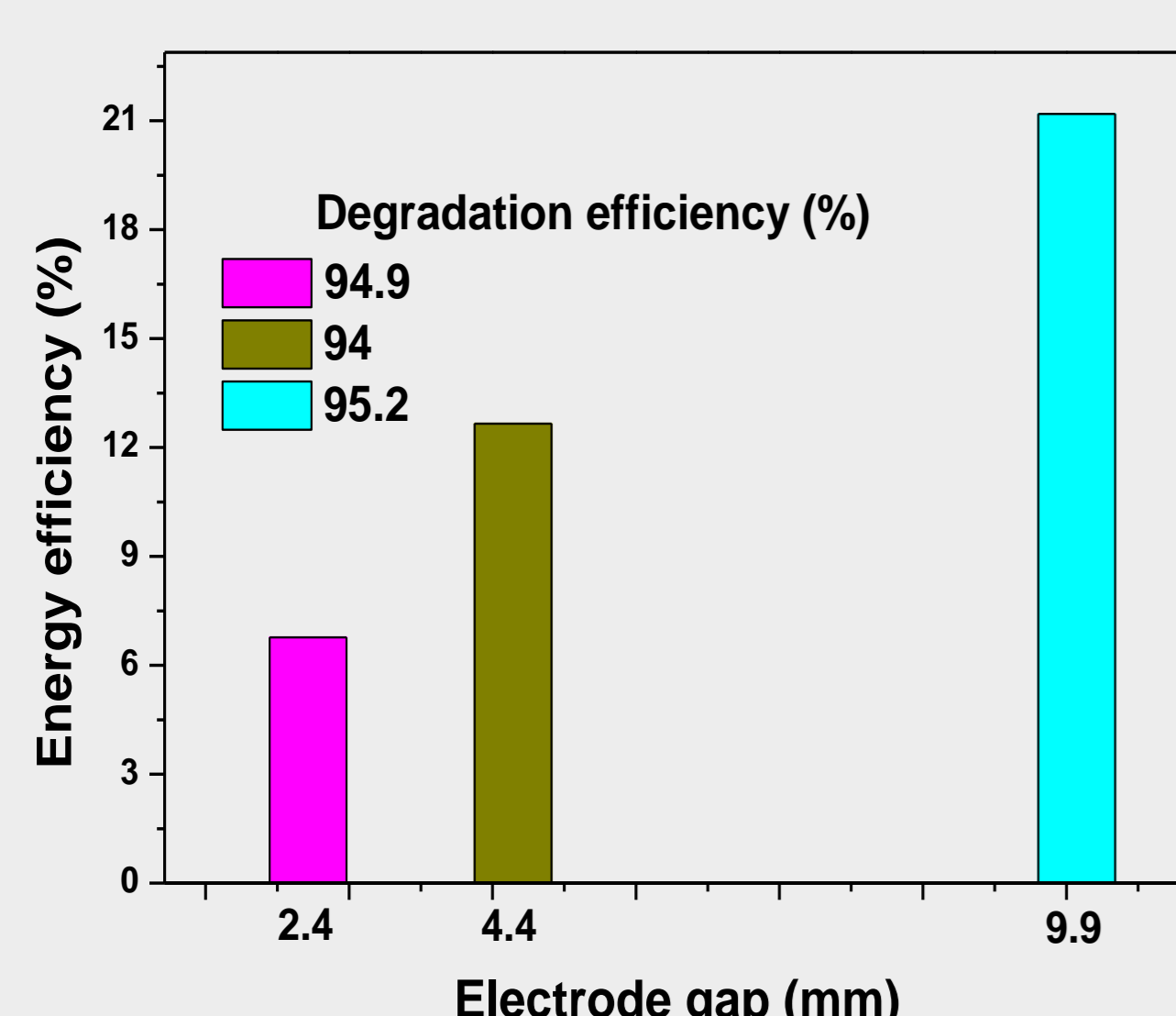
### Effect of pulse voltage

$t_{\text{treatment}} = 5 \text{ min}$   
 $m_{\text{soil}} = 6.1 \text{ g}$

### Effect of air flow rate



### Energy efficiency-Effect of electrode gaps



Soil remediation technique	Pollutant/Soil	Soil mass (g)	Treatment time	Degradation efficiency (%)	Energy efficiency (mg/kJ)	Ref.
In-situ nsp-DBD	Ciprofloxacin (200 mg kg <sup>-1</sup> )/sandy soil	16.7	5 min	94,1	21.2	This work
Ex-situ nsp-DBD	Ciprofloxacin (200 mg kg <sup>-1</sup> )/sandy soil	5	3 min	99	4.6	[2]
Microwaves	hydrocarbons	20	100 min	100	0.028	[3]

## References

1. E. Martinez-Carballo, C. Gonzalez-Barreiro, S. Scharf, O. Gans, (2007). Environ. Pollut., 148: 570–579.
2. C.A. Aggelopoulos, M. Hatzisymeon, D. Tataraki, G. Rassias, Chemical Engineering Journal, Volume 393, 2020, 124768, ISSN 1385-8947.
3. Falciglia, Pietro & Vagliasindi, Federico. (2015).. Journal of Soils and Sediments. 10.1007/s11368-015-1130-6.

## Acknowledgments



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## Conclusions

- Complete and fast removal of ciprofloxacin from sandy soil (< 3 min of CAP treatment).
- High impact of voltage and air flow rate on degradation efficiency.
- High energy efficiency (21.2 mg/kJ) of the nsp-DBD cylinder-to-cylindrical grid reactor (16.7 g contaminated, 95.2% degradation efficiency).