

# Portable electrochemical sensoristic system for the on-site measurement of cannabinoids



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MODENA E REGGIO EMILIA

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## Introduction:

In recent years, the EU common agricultural policy has provided subsidies for the cultivation of certain varieties of *Cannabis sativa* L. for industrial purposes, provided the main psychoactive constituent,  $\Delta^9$ -tetrahydrocannabinol ( $\Delta^9$ -THC), does not exceed 0.3% w/w [1]. However, in freely commercialized products it is not uncommon to find  $\Delta^9$ -THC concentrations exceeding the legal limit. Therefore, accurate analytical controls are mandatory to meet current regulations. The analysis of cannabinoids such as  $\Delta^9$ -THC, cannabidiol (CBD) and their natural acidic precursors (i.e.  $\Delta^9$ -THCA and CBDA), in *C. sativa* samples (female inflorescences) is typically performed using chromatographic techniques [2-4]. However, equipment cost, reagent consuming sample preparation, the need for trained personnel, and long analysis times represent significant drawbacks, limiting their applicability in situ.

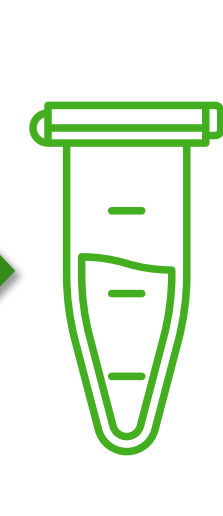
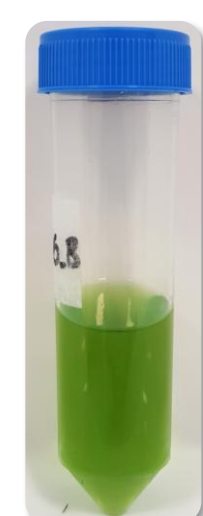
Electrochemical sensors have recently gained attention as promising alternatives for real-time and rapid cannabinoids screening, thanks to their low cost, ease of use, and potential for miniaturization [5]. Our research group has demonstrated that screen-printed electrodes (SPEs) modified with a carbon black (CB) coating can be used for the rapid quantification of  $\Delta^9$ -THCA in recreational *C. sativa* extracts [6] and, through a multivariate approach, for reliable classification of most *C. sativa* samples as legal or illegal based on total  $\Delta^9$ -THC and  $\Delta^9$ -THCA content [7]. These results indicate that the proposed method could serve as the basis for developing an automated device for rapid on-site pre-screening of the legality of marijuana samples.

Marijuana sample



Extraction method:

- Sample to solvent ratio 1:100 (w/v);
- EtOH ;
- Dynamic maceration;
- 15 mins (3x).



Electrolytic medium:

- 10% Extract;
- 20% EtOH;
- 70 % BRB;
- solution, pH ~ 7, KCl 0.1 M.

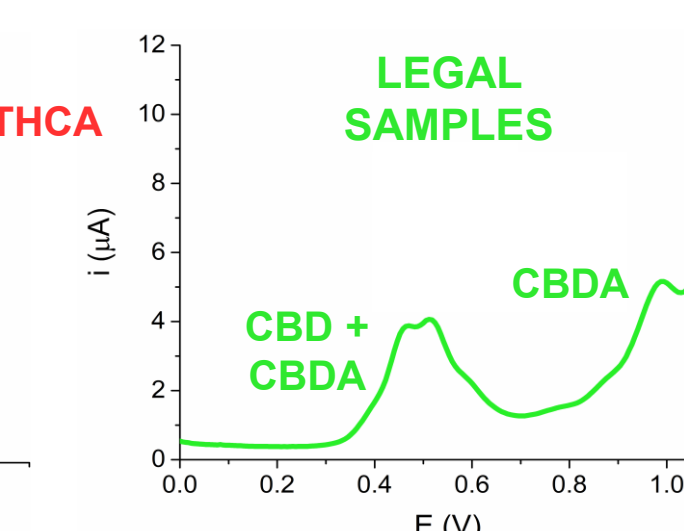
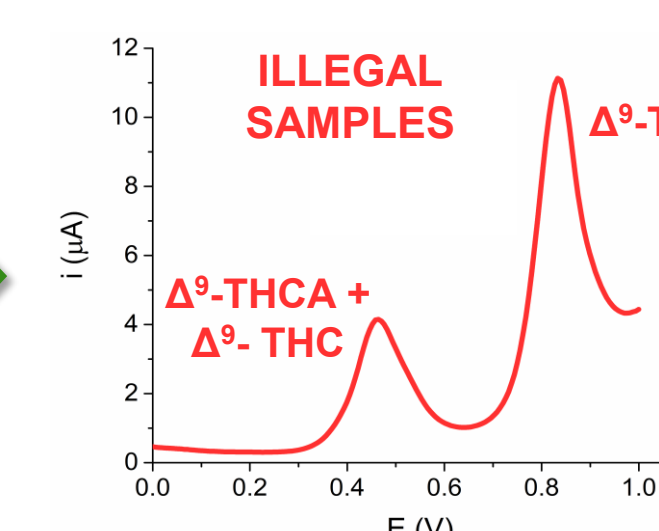
Differential Pulse Voltammetry

Parameters:

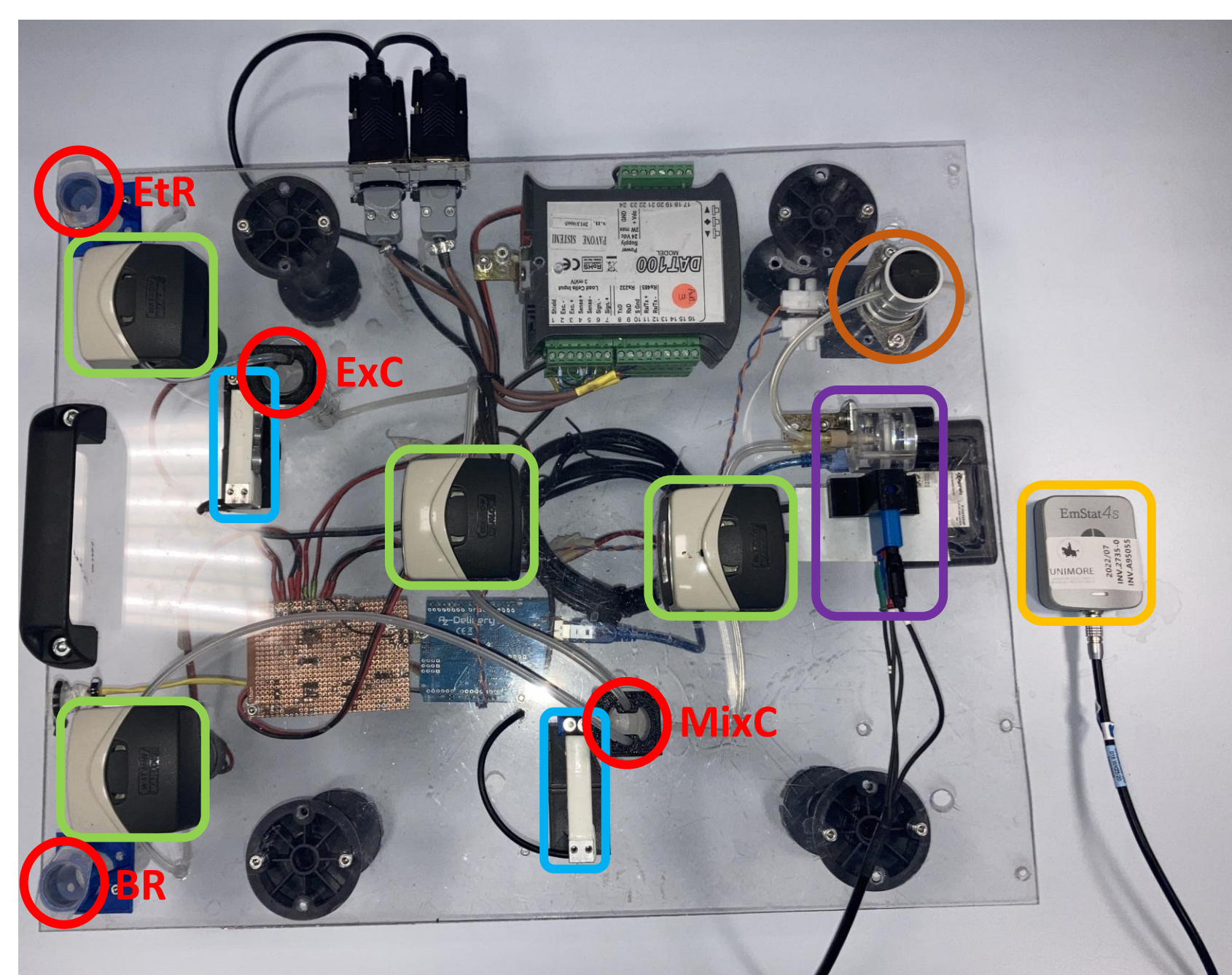
- PT= 0,1 s
- SP= 0,006 V
- IT= 0,4 s
- PA= 0,05 V



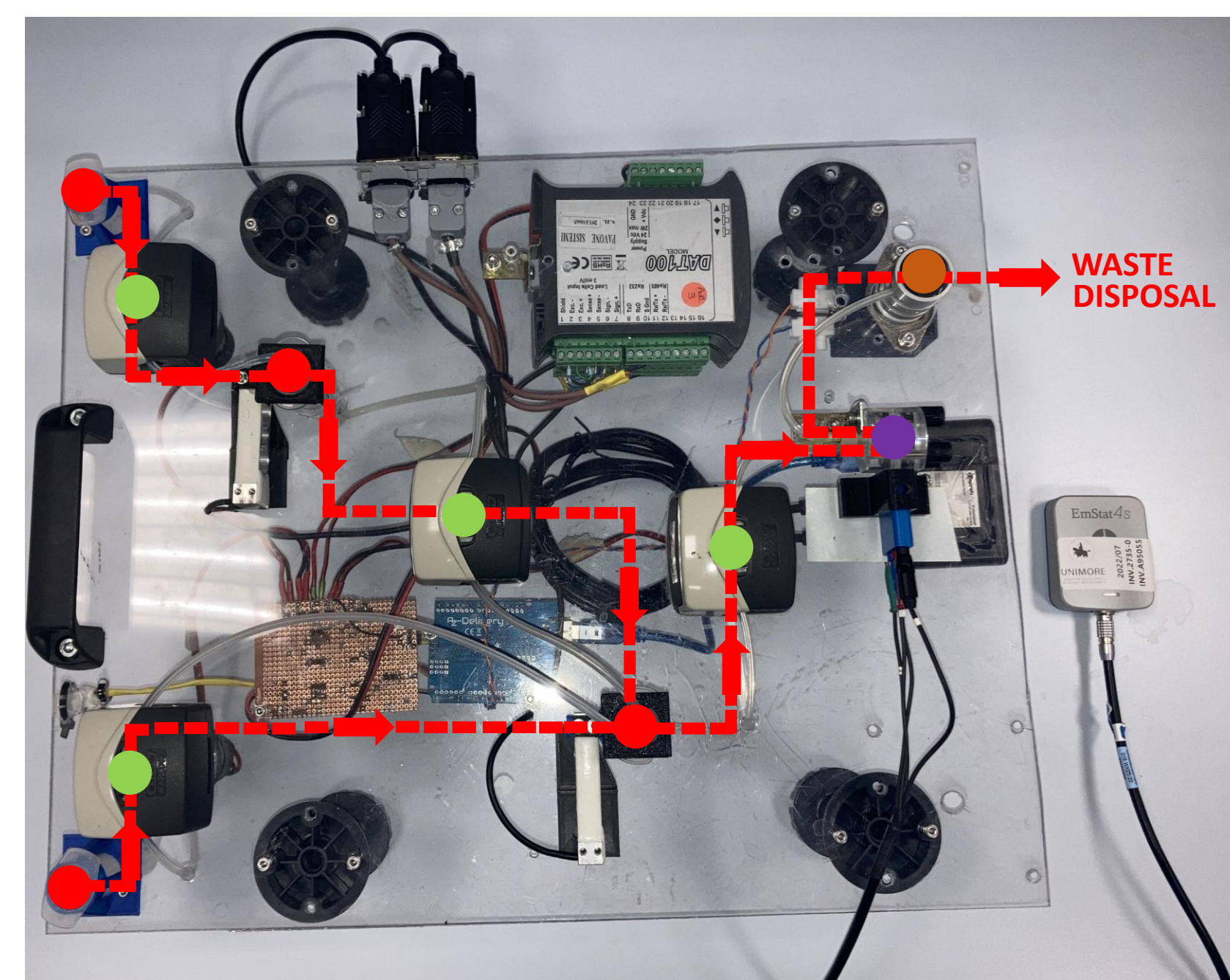
SPE-CB



## Device description and functioning:



- Reservoirs (EtR = ethanol reservoir, BR = buffer reservoir, ExC = extraction chamber, MixC = mixing chamber);
- Micropumps;
- Microbalances;
- Portable potentiostat;
- Flow cell (FLC) + SPE-CB;
- Closing valve.



The automated device developed for the electrochemical analysis of *C. sativa* samples consists of a series of containers connected through tubes, micropumps, and a microbalance, enabling automatic preparation of the solution used for electrochemical measurements. An Arduino Nano board controls all components. A simplified 10-minute extraction procedure was adopted for sample preparation inside the device. Since automated stirring has not yet been implemented, mixing must still be performed manually. The ground sample is placed inside the extraction chamber (ExC), and after weighing, the device adds 10 mL of ethanol (EtOH) from the ethanol reservoir (EtR). During extraction, manual stirring is carried out using the dedicated sample holder, which also acts as a filter. Subsequently, the device withdraws 1 mL of extract and 9 mL of buffer from the buffer reservoir (BR), preparing the measurement solution inside the mixing chamber (MixC). Finally, the solution is transferred into the flow cell (FLC), where measurements are performed using the SPE-CB connected to a portable potentiostat.

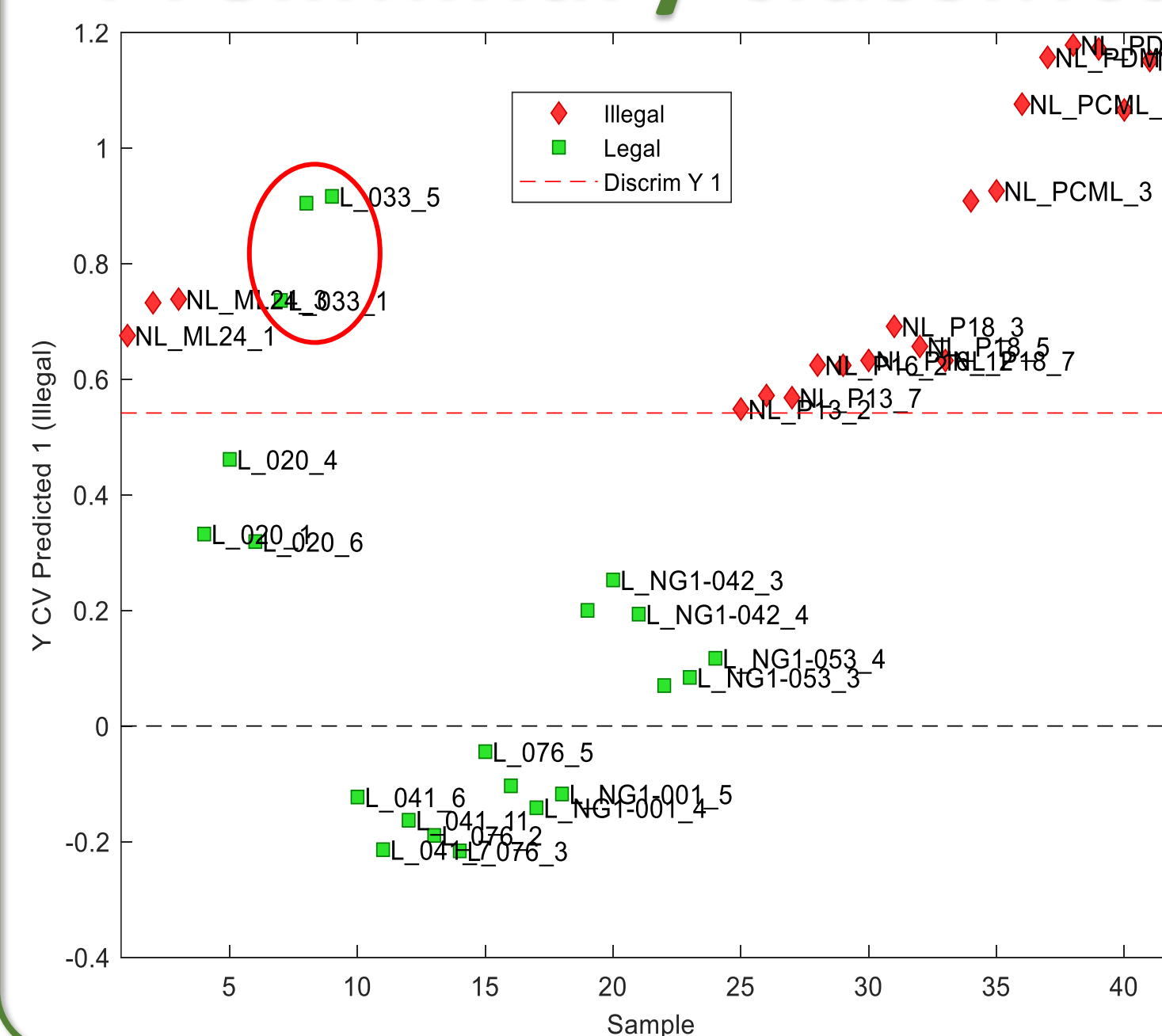
## Reproducibility results:

Fourteen *C. sativa* samples—both legal and illegal—were analyzed. To assess the reproducibility of the voltammetric signals, 10 replicate measurements were conducted on 3 representative samples. Relative standard deviations % (RSD%) were calculated for the intensity, position, and area of the voltammetric peaks.

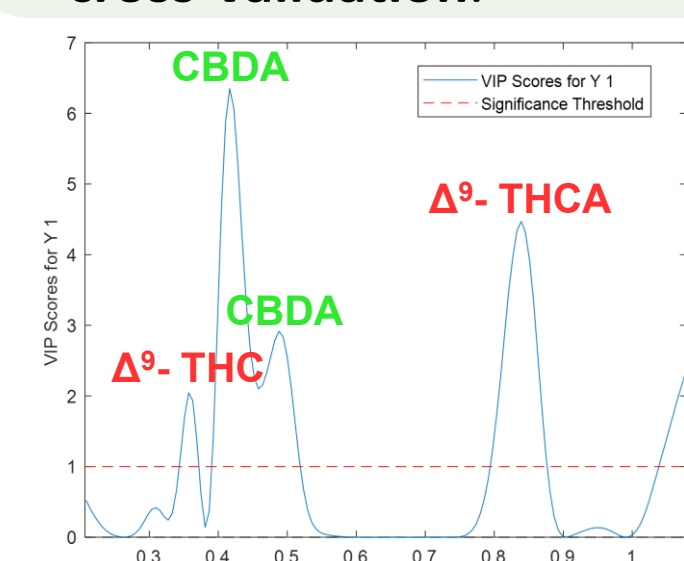
Sample name	Peak n°	Average E (V)	RSD% "E"	Average i (μA)	RSD% "i"	Average Area (V·μA)	RSD% "Area"
P13	1	0,340	1,76	6,15	11,4	0,760	13,2
	2	0,830	1,45	0,49	25,3	0,040	32,5
B041	1	0,420	2,14	6,53	12,9	1,235	13,8
	2	0,940	0,53	0,38	33,7	0,028	42,9
P18	1	0,320	3,75	7,73	14,2	1,333	16,2
	2	0,820	2,44	1,30	38,5	0,122	43,4

Average RSD% ≈ 15%

## Preliminary classification model:



- PLS-DA applied for classification;
- 3 replicates for each of the 14 samples;
- spectra preprocessed with Baseline Correction, SNV and Mean Centering;
- results obtained through cross-validation.



## Conclusions:

The automated device developed for the electrochemical analysis of *C. sativa* samples proved to be functional and effective for rapid pre-screening, allowing reliable classification of samples as legal or illegal based on their voltammograms. Although some features—such as automated stirring—remain to be implemented, the results are promising. Expanding the dataset will further strengthen the multivariate classification model. Overall, the project successfully delivered a portable, simple, and low-cost device suitable for fast on-site assessment of the legality of marijuana samples.

## References:

- [1] <https://www.emcdda.europa.eu/news/2018/lowthc-cannabis-products-being-sold-in-the-EU-legal-issues/en>
- [2] V. Brighenti et al. 2021. Journal of Pharmaceutical and Biomedical Analysis. Vol: 192, pp. 113633-113657.
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- [4] A. L. Capriotti et al. 2021. Journal of Chromatography A. Vol: 1655, pp. 462492-462512.
- [5] B. Zanfognini et al. 2020. Journal of Solid State Electrochemistry. Vol: 24, pp. 2603-2616.
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