NIRLAB

POLYMER SOLUTION

The Revolution of Instant Polymer Analysis

A handheld screening device designed to identify and quantify polymer substances onsite within seconds.

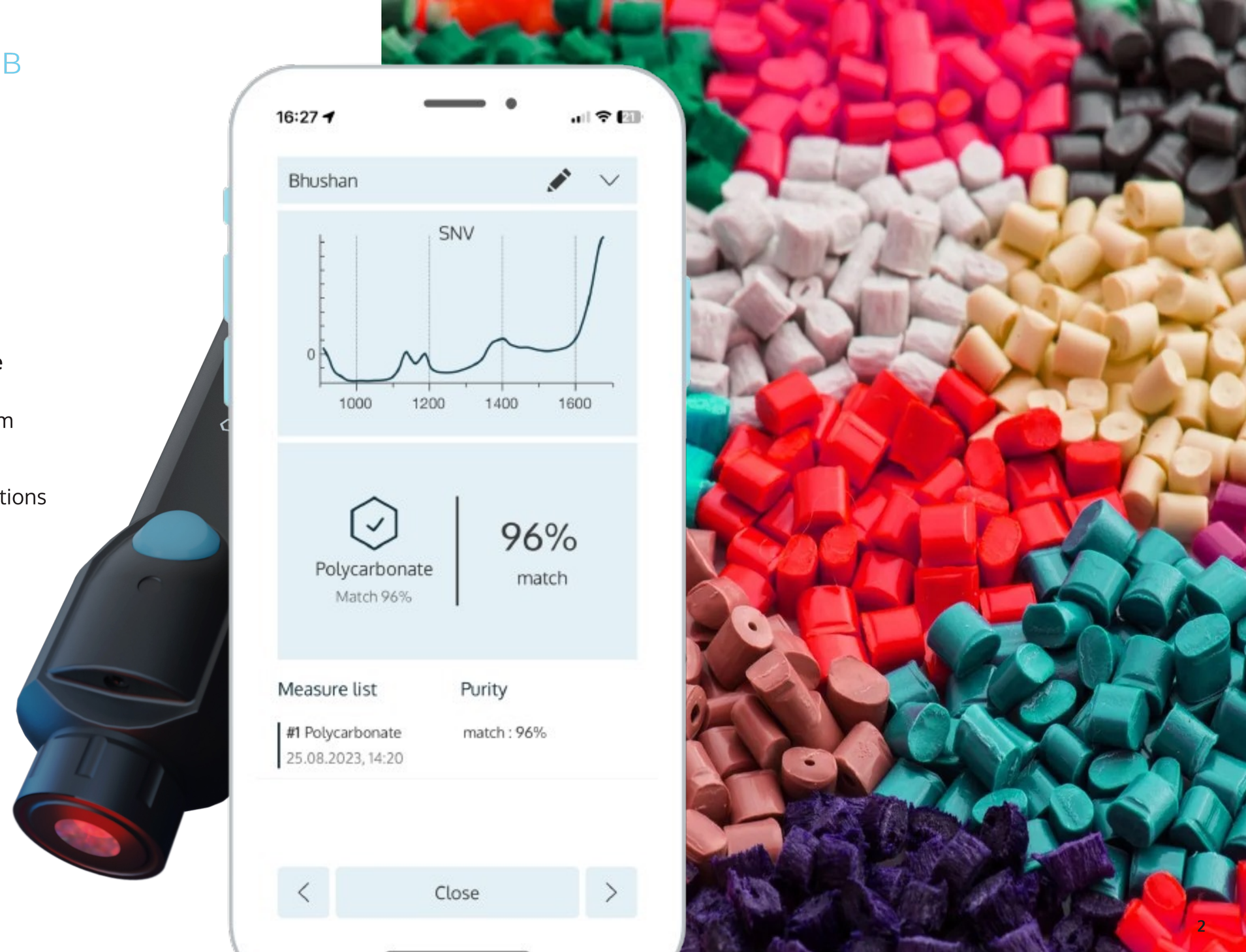
NIRLAB

THE COMPANY

NIRLAB AG

Mobile laboratory to make the invisible visible instantly.

NIRLAB AG, a Swiss spin-off from the University of Lausanne and established in 2018, has revolutionized the way organizations analyze materials using NIR spectroscopy and advanced machine learning.



“We bring high precision labs to the polymer industry and enable rapid decision making based on trustable data.”

Prof. Pierre Esseiva,
Co-Founder NIRLAB AG

UNIL | Université de Lausanne

THE SOLUTION

NIRLAB Polymers

NIRLAB provides recycling organizations worldwide with a portable NIR device that can swiftly and accurately identify and quantify all common polymers.

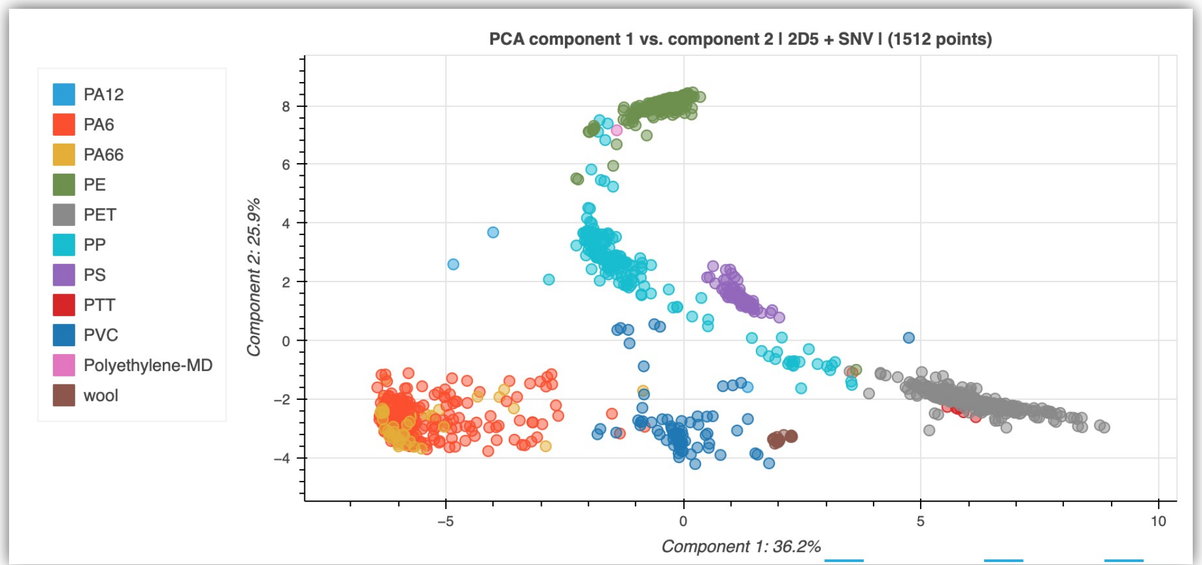
\+ **Library of 10’000 spectra**

\+ **Identification of more than 100 polymers**
PP, PE, PET, PVC, ABS, POM, PMMA, EVA, PC, PS, TPR, etc.

\+ **Rapid classification of the major types**

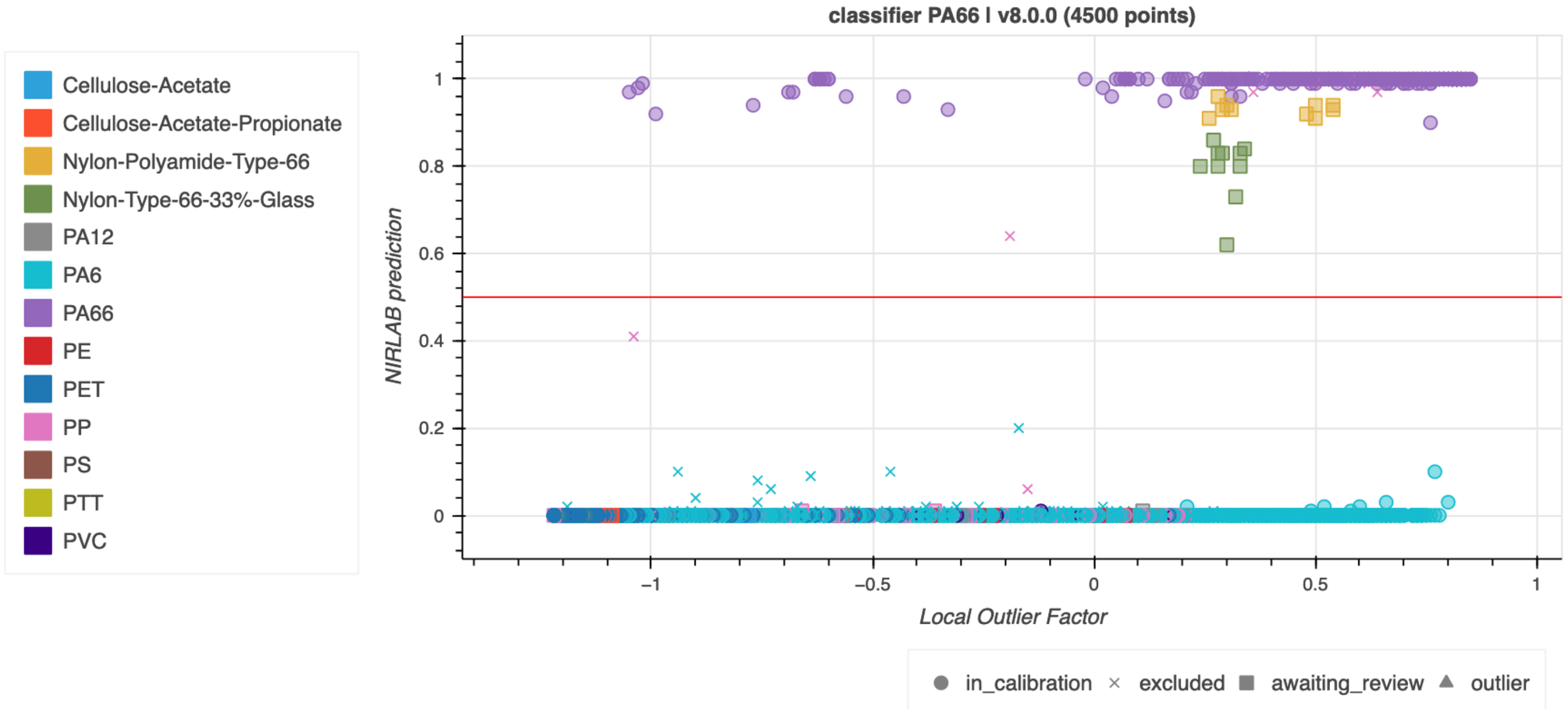
\+ **Distinction PA6 / PA66**

\+ **Classification of sub-groups**
- Ex. Polyethylene:
  - HDPE
  - LDPE
  - MDPE



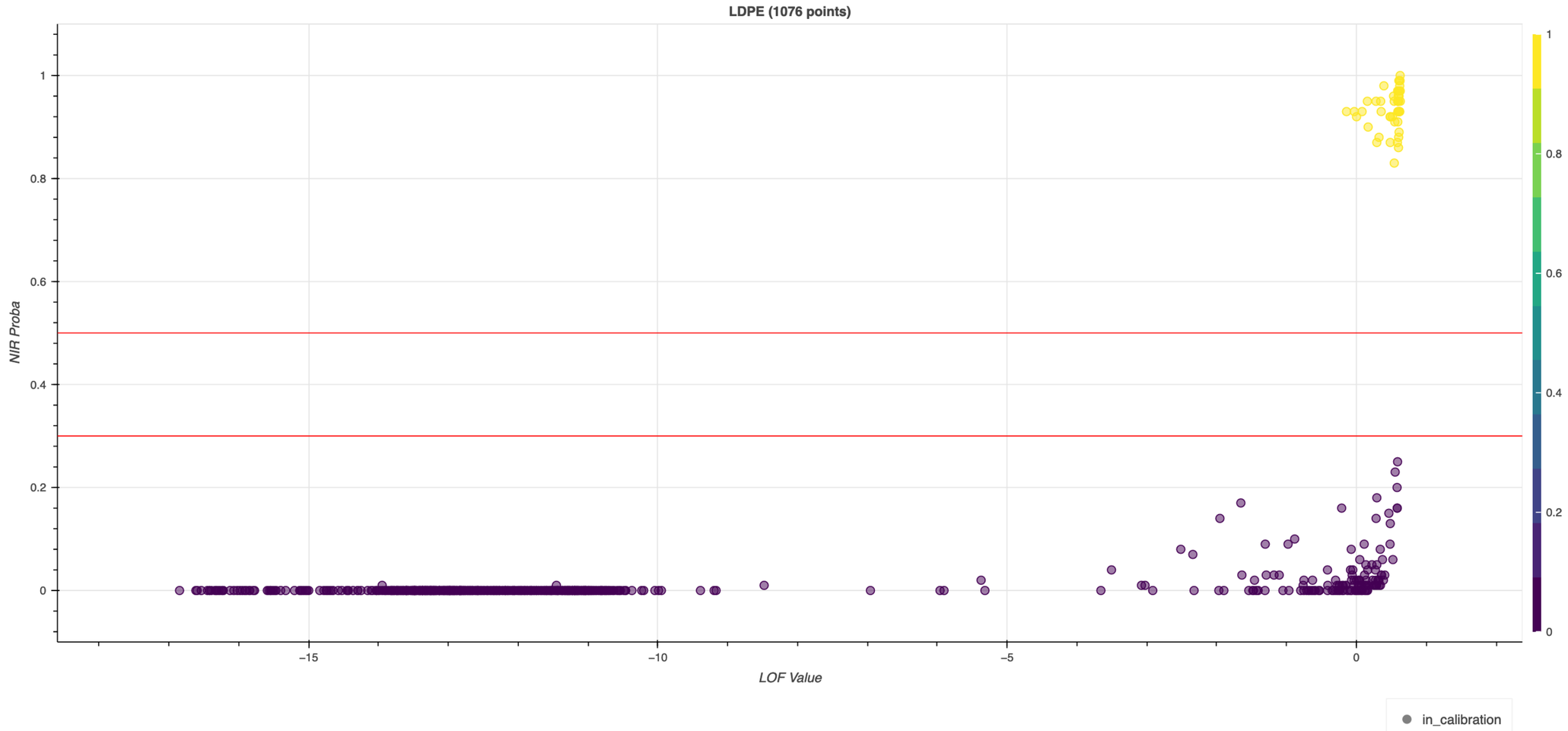
NIRLAB POLYMERS

Application Example: PA6 vs. PA66



NIRLAB POLYMERS

Application Example: LDPE vs. HDPE



What we offer

THE SOFTWARE

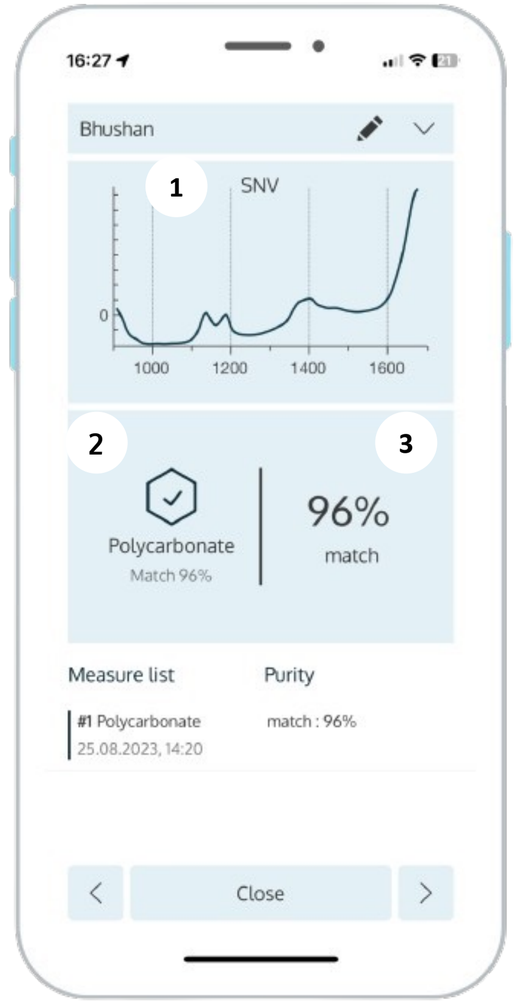
What can be Measured

+ **Identify and quantify more than 40 substances**
  Scan results are shown on mobile app within seconds.

+ **Analyze substances in various forms**

The result in the NIRLAB app shows:

1. The measured spectrum of questioned substance
2. Identification of the substance
3. Quantification of match



THE SOFTWARE

NIRLAB Mobile App

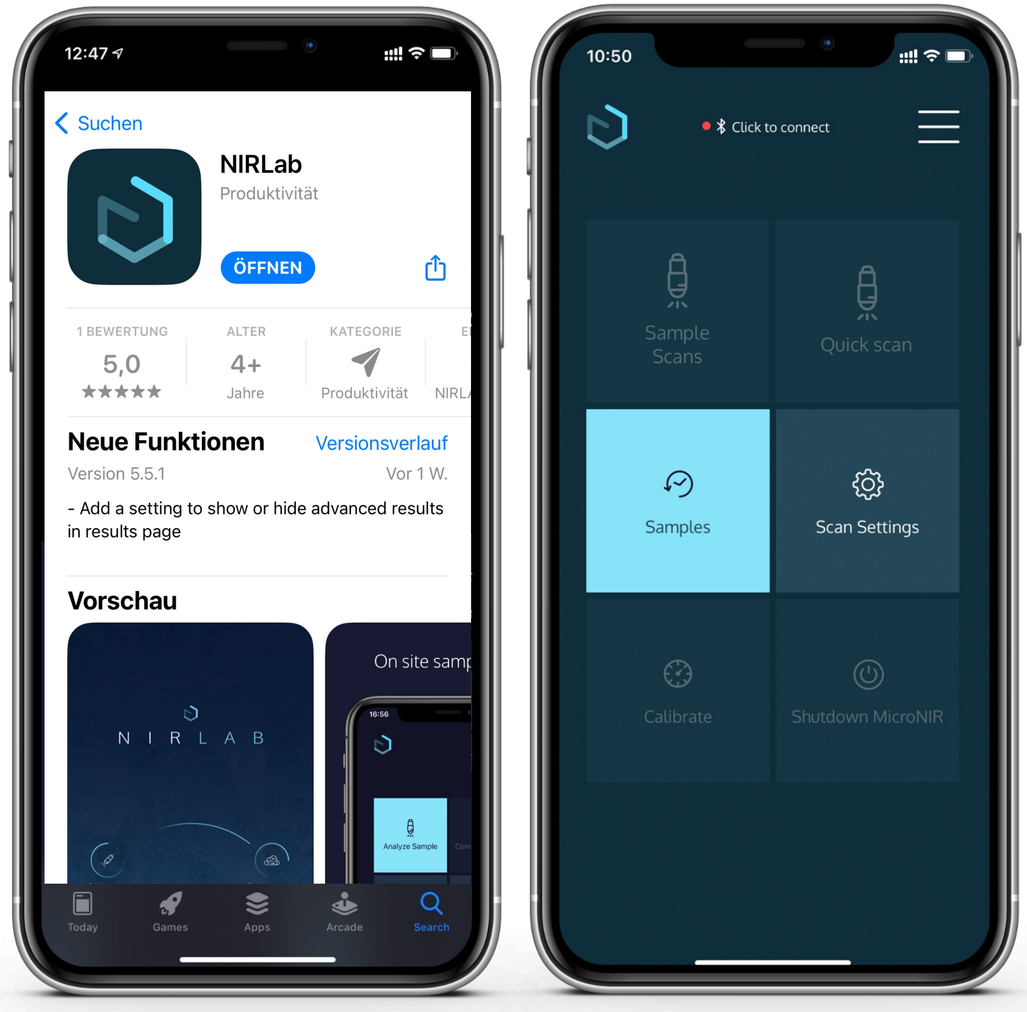
+ **User-friendly interface**
Easy to use app and straight-forward results on screen.

+ **Instant reporting**
Scanning results are shown on screen within seconds.

+ **Wireless usage**
NIRLab app pairs with NIRLight via bluetooth and communicates with servers via Wi-Fi or 3G.

+ **Easy and fast download**
The iOS and Android app can be downloaded from Apple or Google store.

+ **Secured cloud**
Complete set of applications communicating with a secured cloud to manage measures and results.



THE HARDWARE

NIRLight – Everyone Can Use It

+ **Wireless, compact, rugged and ergonomic.**
Designed for use in the field as well as in the laboratory.

+ **IP65 and IP67 rated**
Made for wet and dusty environments.

+ **Destruction-free analysis**
Little or no sample preparation is needed. No special training required.

+ **No maintenance**
No maintenance is required. The glass and lamp are replaceable if broken.

+ **Long battery life**
USB charging. Fully charged device lasts minimum of 10 hours of continuous use. Can be left uncharged when not used.

+ **Bluetooth and USB**
Simple and fast connectivity to tablet or PC.

THE SOFTWARE

NIRLAB Web App

Desktop app- and browser-accessible platform for data management.

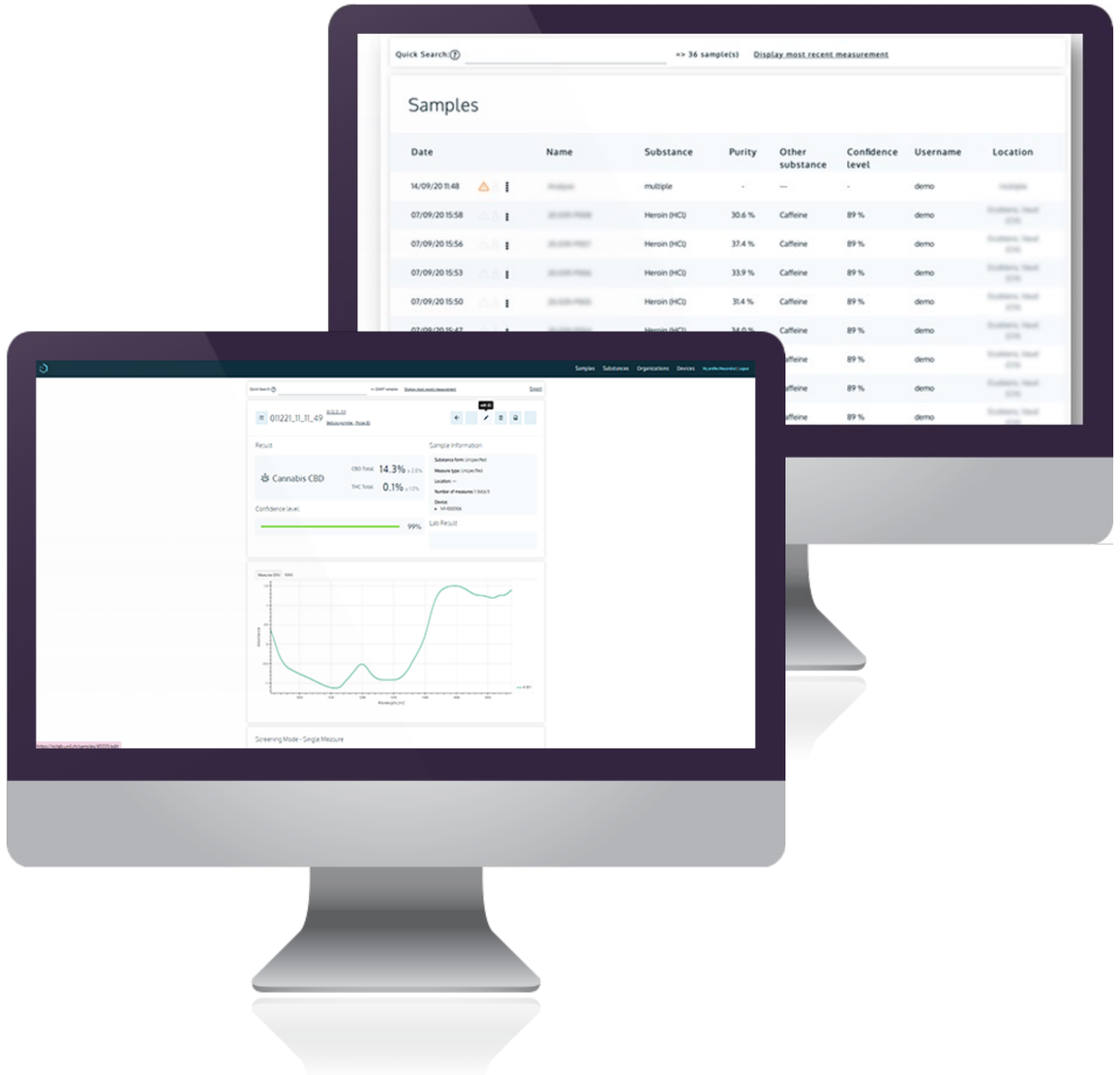
+ **Report history**
Track, manage and compare scans across devices at one place.

+ **Simple data management**
Name, mark, delete or edit analysis results.

+ **Export of data**
Simple data export to Excel sheet.

+ **Save as PDF**
Download the analysis report and save it in PDF format.

+ **User Management**
Organizations and user management tool.



NIRLAB

THE SOFTWARE

Web App Dashboards

Various dashboards enable valuable insights of all scans across all devices.

+ **Purity evolution**
Track the development of substance purity over time.

+ **Map**
Observe scans across locations, if geolocation is enabled.

+ **Number of sample scans by region**
Measure device usage across time and region.

+ **Custom reporting**
Export data as csv to run own reports.

PRIVACY

Data Security

+ **Secured data center**
Cloud developed by top-level IT group from the School of Computer Sciences in EPFL, Lausanne, hosted on the university campus secured data center.

+ **Encrypted**
Encrypted communication between mobile app and server.

+ **Full control**
Full control of the information shared in the cloud.

+ **Geolocation**
Geolocation of measurements can be turned on or off.

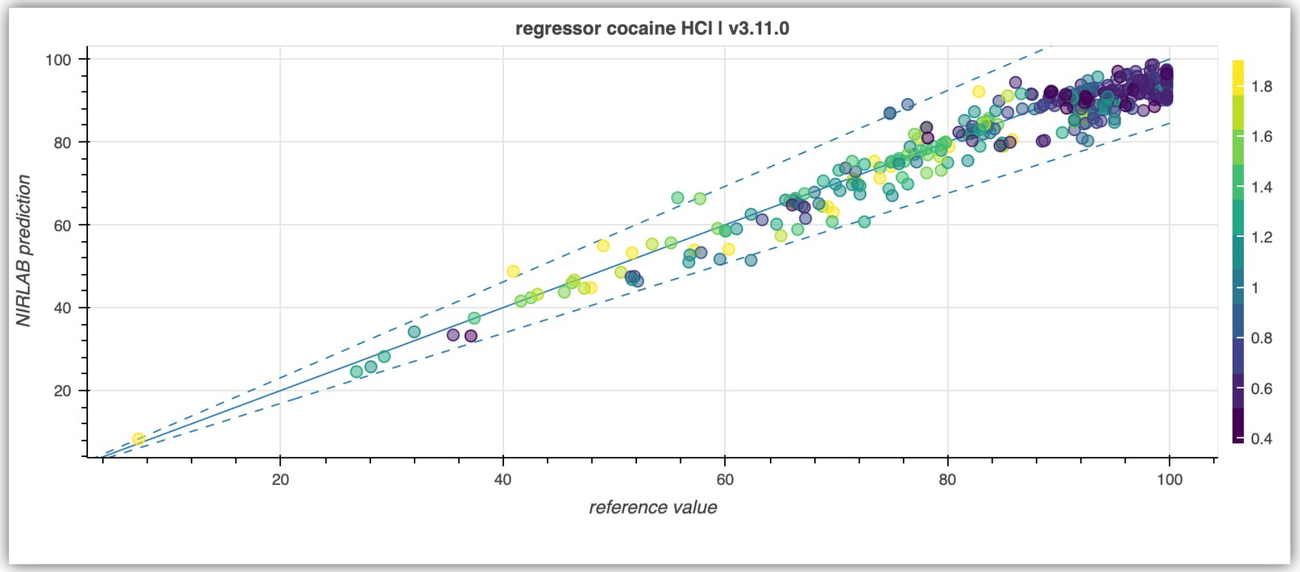
+ **Encoded measures**
Sample names are encoded, and no sensitive data is shared in the cloud.

CERTIFICATIONS

Accredited Laboratory

In 2022, the **Forensic Laboratory of the University of Lausanne** received the first ever **ISO 17025 accreditation** for the analysis of cocaine and heroin with a handheld device.

Accuracy of ±15% relative to the reference value of wet chemistry



International Organization for Standardization
ISO
17025
ACCREDITED LABORATORY

How it works

THE APP

How it works

1. Connect

Pairing of NIRLAB app and device is done automatically via Bluetooth connection following two steps:

a) Turn on the device

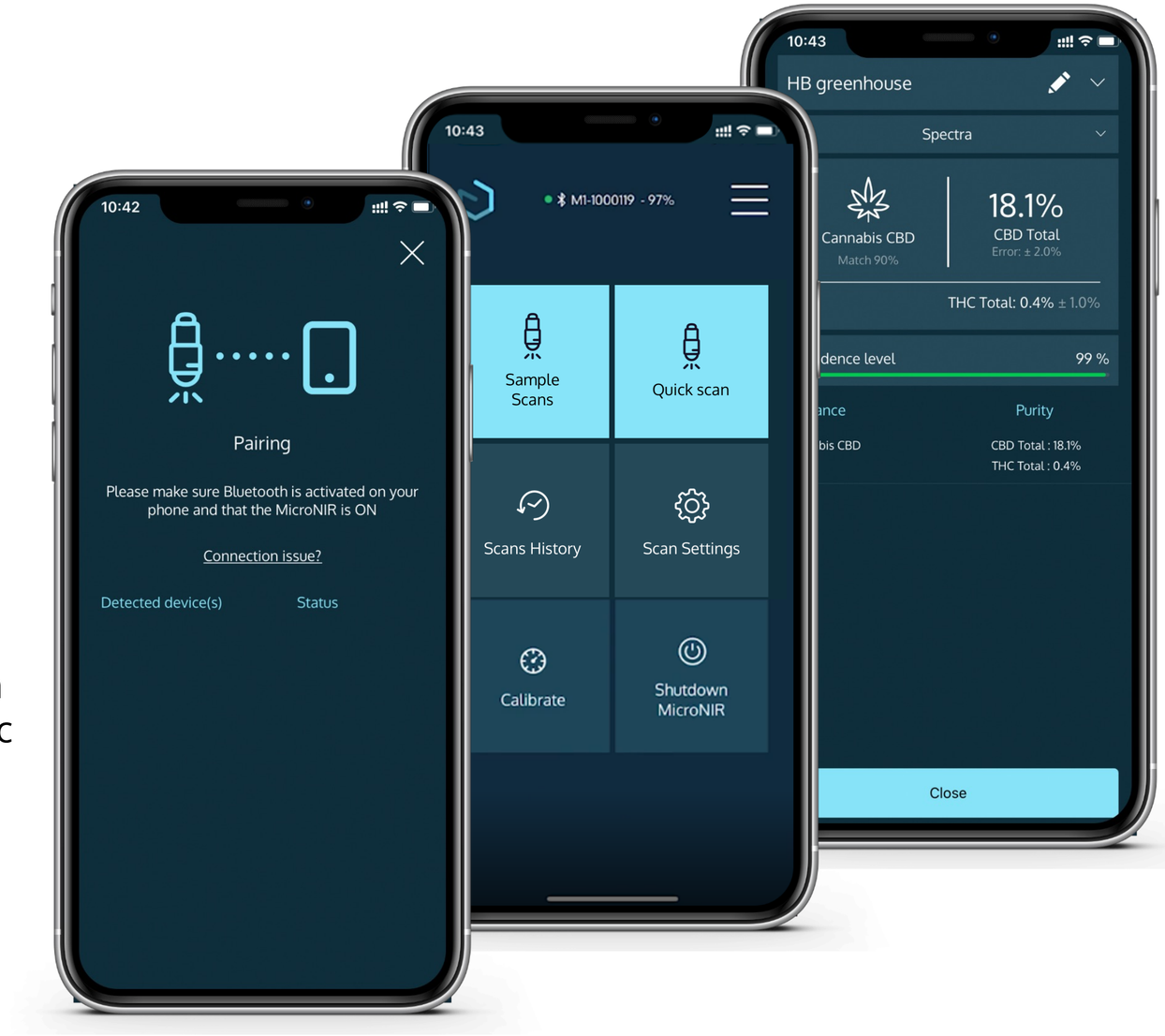
b) Open NIRLAB app on mobile phone

2. Scan

To perform a scan, point the device on a questioned substance and press the multifunctional button. Scan can be performed with direct contact or through a thin plastic bag.

3. Read

After a few seconds, result of the scan is shown on the screen of your mobile phone.



THE APP SETUP

Calibration

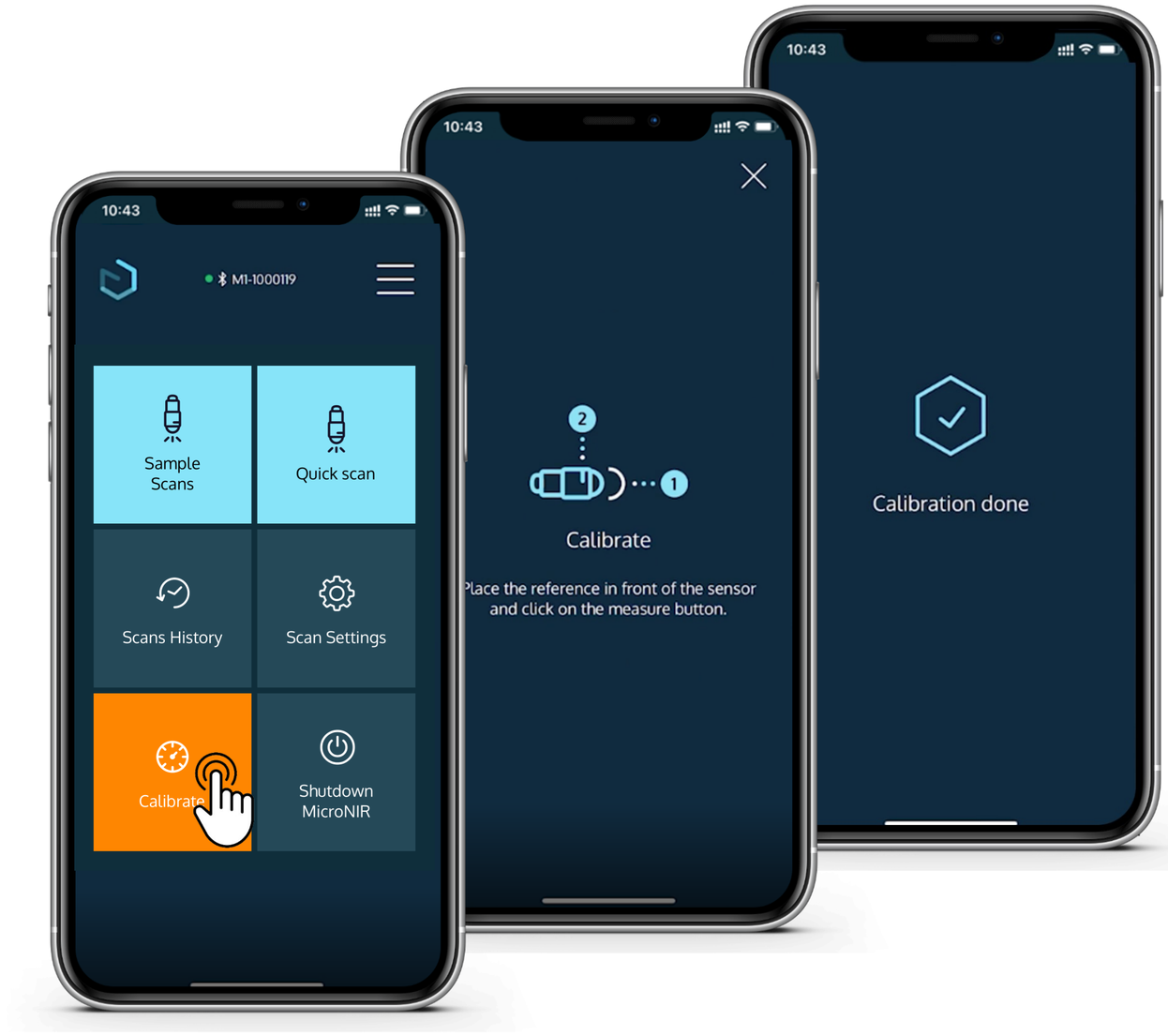
At every start of the app, calibration needs to be performed.

1. To perform a calibration, apply the white reference mirror to the device.

2. Then click on *Calibrate* in the main menu of the app and push the multipurpose button on the device.

3. The process takes a few seconds and is done automatically.

TIP: We recommend to calibrate the device regularly according to the app's notification.



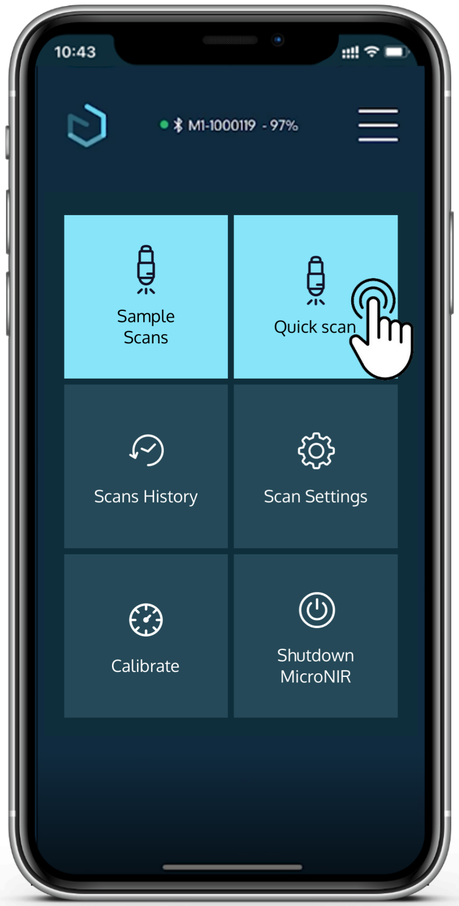
SCANNING MODES

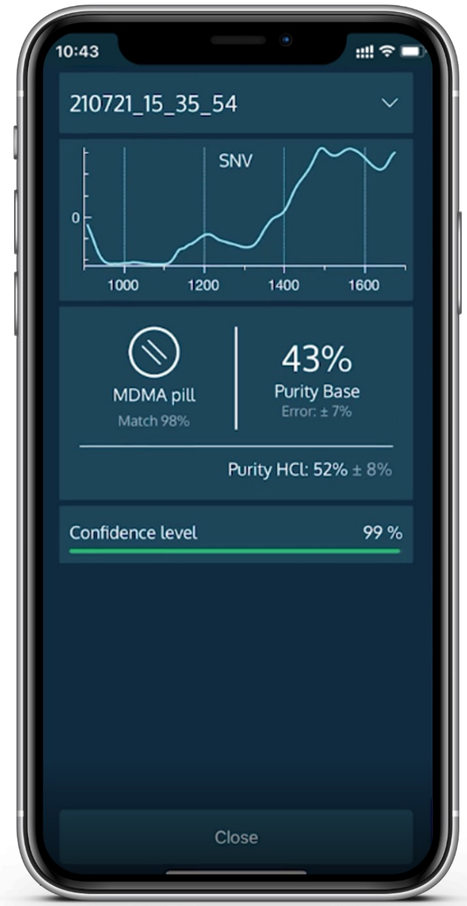
Quick Scan

Click on *Quick Scan* for rapid identification and quantification of a substance.

Procedure:

1. Push the device button
2. Wait a few seconds
3. See the result on screen!





SCANNING MODES

Sample Scan

Click on *Sample Scan* to get an average result of multiples scan to improve accuracy of quantification.

Procedure:

1. Click on *Sample Scan*
2. Fill in information about your sample
3. Push the device button
4. Wait a few seconds

Repeat step 3. and 4. as many times as you need

5. See the averaged result on the screen.

RECOMMENDATION

Scanning Tips

+ **All substances can be measured in direct contact or through thin plastic.** Direct contact produces the best accuracy, especially for quantification.

+ **The sapphire glass should be cleaned** before each scan. This can easily be done by a bit of ethanol on a tissue.

+ **To better assess homogeneity,** *Sample Scans* mode is recommended for powders and high quantity samples.

+ **Small samples** should be measured in an aluminum cup which has a neutral effect on the spectrum.

+ **Point device downwards** when scanning. It is NOT recommended to measure with the device pointing upwards.

TUTORIAL

www.nirlab.com

CLICK HERE to watch a tutorial video.

SUBSTANCES

Ongoing Updates

+ **The list of detected substances is constantly evolving.**

+ **Thanks to the predictions in cloud, each user always benefits from an up-to-date list.**

+ **Latest updated list can be accessed at this address:**
https://nirlab.unil.ch/algorithms/substances (access by login)

+ **If you need to identify a substance that is not on the list, feel free to contact NIRLAB team and we will add it if possible.**

NIRLAB

THE SCIENCE

Pioneering Scientific Innovation

At NIRLAB, we're more than just a business; we're at the cutting **edge of scientific discovery**.

Our esteemed partnership with the **Forensic Institute of the University of Lausanne** in Switzerland has made us a recognized name in global scientific circles.

Our **contributions to top-tier forensic, science, and pharmaceutical journals** validate our commitment to advancing knowledge and pushing technological frontiers.

Forensic Science International 317 (2020) 110498

Contents lists available at ScienceDirect

Forensic Science International

journal homepage: www.elsevier.com/locate/forsciint

Providing illicit drugs results in five seconds using ultra-portable NIR technology: An opportunity for forensic laboratories to cope with the trend toward the decentralization of forensic capabilities

Florentin Coppey[a], Andy Bécue[a], Pierre-Yves Sacré[b], Eric M. Ziemons[b], Philippe Hubert[b], Pierre Esseiva[a,*]

[a] École des Sciences Criminelles/School of Criminal Justice, University of Lausanne, Building Batochime, CH-1015, Lausanne, Vaud, Switzerland
[b] University of Liege (ULiege), CIRM, Vibra-Santé HUB, Department of Pharmacy, Laboratory of Pharmaceutical Analytical Chemistry, CHU, Avenue Hippocrate 15, B36, Liège, 4000, Belgium

ARTICLE INFO

Article history:
Received 27 December 2019
Received in revised form 23 June 2020
Accepted 2 September 2020
Available online 10 September 2020

Keywords:
Forensic science
Cocaine
Heroin
Cannabis
Big data
Machine learning
Near infrared
Statistical model
Validation

ABSTRACT

The analysis of illicit drugs faces many challenges, mainly regarding the production of timely and reliable results and the production of added value from the generated data. It is essential to rethink the way this analysis is operationalised, in order to cope with the trend toward the decentralization of forensic applications. This paper describes the deployment of an ultra-portable near-infrared detector connected to a mobile application. This allows analysis and display of results to end users within 5 s. The development of prediction models and their validation, as well as strategies for deployment within law enforcement organizations and forensic laboratories are discussed.

1. Introduction

In the context of the analysis of illicit drugs, the time required to get an analytical response remains at the heart of the concerns of magistrates and police officers, who want to know rapidly if the seized product contains an illicit drug. In Switzerland, information about the purity of seized material is also required, as it allows categorization of the case as a minor crime (e.g., personal consumption) or a major one (e.g., trafficking). For example, if a person is arrested with less than 12 g of pure heroin or 18 g of pure cocaine, the prosecutor can dispose of the case by simply seizing the illicit drugs and imposing a fine. However, if these limits are exceeded, the case is classified as a trafficking offence and the prosecutor continues the inquiry. Such a legal system relies on the ability to obtain fast and reliable results from seized material, ideally at the street (as opposed to the laboratory) level. The gold standards for drug analysis are high-performance liquid chromatography (HPLC) or gas chromatography (GC) techniques, coupled with diode-array detection (DAD) [1], flame- ionization detection (FID) [2,3] or mass spectrometry (MS) [4,5]. The primary weak points of these analytical techniques are related to the sample preparation, the analysis time, and the destructive nature of the analysis. Additionally, these techniques quickly generate problematic workloads that prevent laboratories from meeting their customers' expectations. Finally, they are difficult to deploy at the street level. In this context, the search for a fast and portable analytical method is of great interest.

An elegant alternative, already intensively used in the pharmaceutical industry for quality control, is near-infrared (NIR) technology [6–8]. This technology has also been used for the analysis of falsified pharmaceuticals [9–12] and the identification and quantification of illicit drugs [13–18].

The development of portable analytical NIR capabilities offers the possibility of bringing the laboratory to the field. It also contributes to the trend toward decentralization and increasing need of rapid support and information for investigative and intelligence activities. As described by Casey et al. [19] in their study of the Kodak Syndrome, the decentralization and

* Corresponding author.
E-mail address: Pierre.Esseiva@unil.ch (P. Esseiva).

http://dx.doi.org/10.1016/j.forsciint.2020.110498
0379-0738/

doi.org/10.1002/hlca.202300052 RESEARCH ARTICLE HELVETICA

Cloud-Enabled Handheld NIR Spectroscopy: A Transformative Approach for Real-Time Forensic Analysis of Cannabis Specimens

Florentin Coppey,[a] Cédric Schelling,[b, c] Jean-Luc Veuthey,[b, c] and Pierre Esseiva*[a]

[a] University of Lausanne, School of Criminal Justice, CH-1015, Lausanne, Switzerland,, e-mail: pierre.esseiva@unil.ch
, University of Geneva, CMU – Rue Michel Servet 1, CH-1211, Geneva 4, Switzerland
of Western Switzerland, University of Geneva, CMU – Rue Michel Servet 1, CH-1211, Geneva 4, Switzerland

Robert Deschenaux on the occasion of his retirement

been significant interest within the forensic community regarding the provide real-time results. This article introduces an innovative technology s the integration of a handheld device, specifically, *Viavi MicroNIR*, with a n encompasses a server responsible for data processing and a mobile

Journal of Pharmaceutical and Biomedical Analysis 202 (2021) 114150

Contents lists available at ScienceDirect

Journal of Pharmaceutical and Biomedical Analysis

journal homepage: www.elsevier.com/locate/jpba

New perspective for the in-field analysis of cannabis samples using handheld near-infrared spectroscopy: A case study focusing on the determination of Δ^9-tetrahydrocannabinol

Riccardo Deidda[a,*,1], Florentin Coppey[b,1], Dhouha Damergi[c,d], Cédric Schelling[c,d], Laureen Coïc[a], Jean-Luc Veuthey[c,d], Pierre-Yves Sacré[a], Charlotte De Bleye[a], Philippe Hubert[a], Pierre Esseiva[b], Éric Ziemons[a]

[a] University of Liège (ULiège), CIRM, Vibra-Santé HUB, Laboratory of Pharmaceutical Analytical Chemistry, B36 Tower 4 Avenue Hippocrate 15, 4000, Liège, Belgium
[b] University of Lausanne, School of Criminal Justice, 1015, Lausanne, Switzerland
[c] School of Pharmaceutical Sciences, University of Geneva, CMU - Rue Michel Servet 1, 1211, Geneva 4, Switzerland
[d] Institute of Pharmaceutical Sciences of Western Switzerland, University of Geneva, CMU – Rue Michel Servet 1, 1211, Geneva 4, Switzerland

ARTICLE INFO

Article history:
Received 15 March 2021
Received in revised form 6 May 2021
Accepted 10 May 2021
Available online 19 May 2021

Keywords:
Cannabinoids
THC
Cannabis
Handheld
Near infrared spectroscopy
NIR

ABSTRACT

The aim of the present study was to explore the feasibility of applying near-infrared (NIR) spectroscopy for the quantitative analysis of Δ^9-tetrahydrocannabinol (THC) in cannabis products using handheld devices. A preliminary study was conducted on different physical forms (entire, ground and sieved) of cannabis inflorescences in order to evaluate the impact of sample homogeneity on THC content predictions. Since entire cannabis inflorescences represent the most common types of samples found in both the pharmaceutical and illicit markets, they have been considered priority analytical targets. Two handheld NIR spectrophotometers (a low-cost device and a mid-cost device) were used to perform the analyses and their predictive performance was compared. Six partial least square (PLS) models based on reference data obtained by UHPLC-UV were built. The importance of the technical features of the spectrophotometer for quantitative applications was highlighted. The mid-cost system outperformed the low-cost system in terms of predictive performance, especially when analyzing entire cannabis inflorescences. In contrast, for the more homogeneous forms, the results were comparable.

The mid-cost system was selected as the best-suited spectrophotometer for this application. The number of cannabis inflorescence samples was augmented with new real samples, and a chemometric model based on machine learning ensemble algorithms was developed to predict the concentration of THC in those samples. Good predictive performance was obtained with a root mean squared error of prediction of 1.75 % (w/w). The Bland-Altman method was then used to compare the NIR predictions to the quantitative results obtained by UHPLC-UV and to evaluate the degree of accordance between the two analytical techniques. Each result fell within the established limits of agreement, demonstrating the feasibility of this chemometric model for analytical purposes.

Finally, resin samples were investigated by both NIR devices. Two PLS models were built by using a sample set of 45 samples. When the analytical performances were compared, the mid-cost spectrophotometer significantly outperformed the low-cost device for prediction accuracy and reproducibility.

1. Introduction

The analysis of cannabis samples mainly concerns two general areas: quality control laboratories (often for medicinal cannabis) and forensic laboratories (seized cannabis samples). The simplest medicinal cannabis samples available on the market consist of dried flower tips with the aim for use in various therapeutic indications (from multiple sclerosis to epilepsy) [1]. This product is

* Corresponding author.
E-mail address: riccardo.deidda@uliege.be (R. Deidda).
[1] These authors have equally contributed to this article.

https://doi.org/10.1016/j.jpba.2021.114150
0731-7085/

UNIL | Université de Lausanne

for your attention

Thank you

Let’s create truth together!

NIRLAB AG

Orsières, Switzerland

+41 21 692 46 57

matteo@nirlab.com

www.nirlab.com