

ADVANCING FIELDWORK

The Revolution of Substance Analysis

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

THE COMPANY

NIRLAB AG

Mobile AI lab to analyze anything anywhere instantly.
Established in 2018, NIRLAB AG, a Swiss spin-off from the University of Lausanne, has revolutionized the way professionals and organizations analyze materials using NIR and Raman spectroscopy and advanced machine learning.

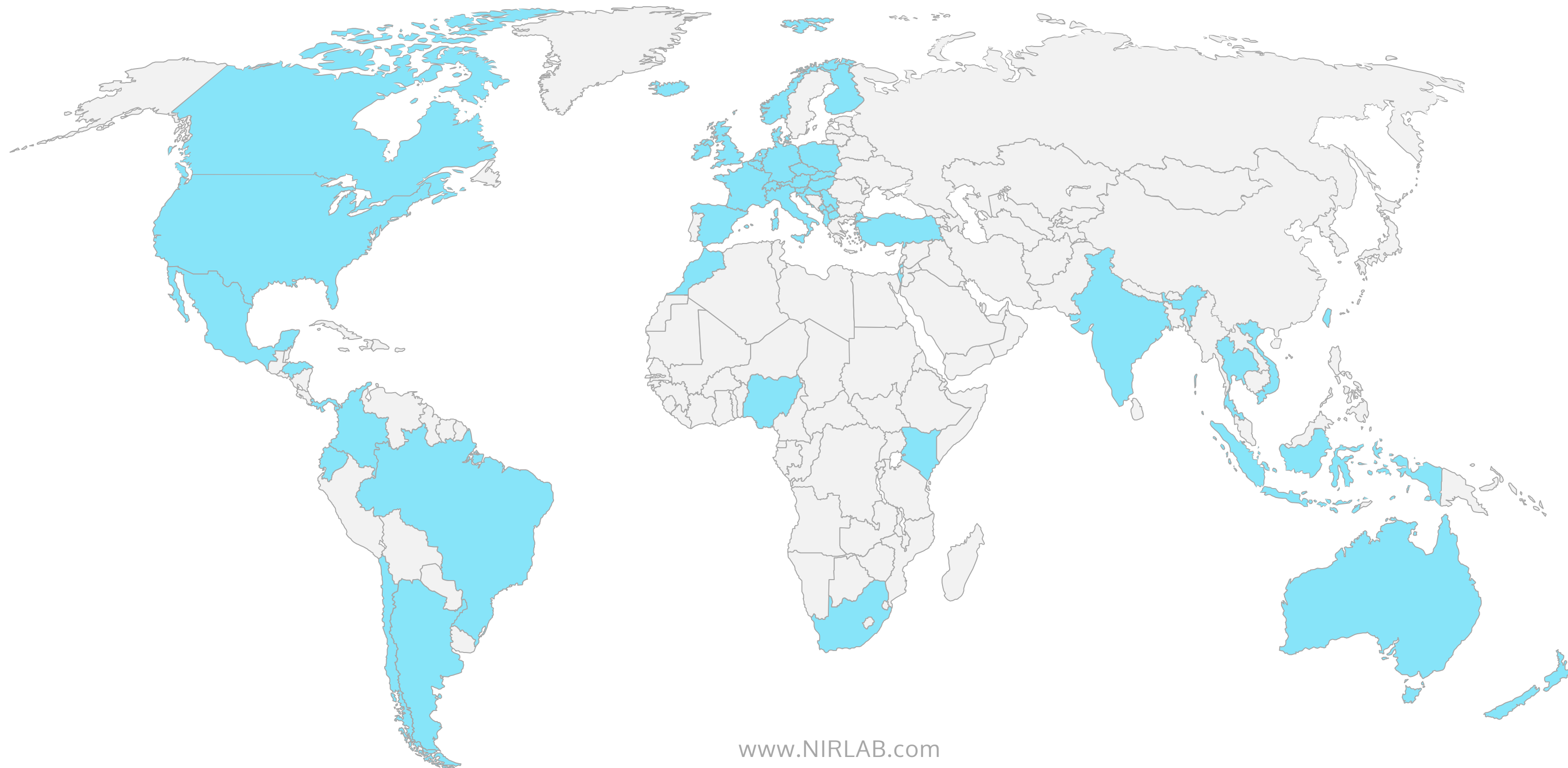
“With our digital ecosystem we bring high precision labs to the field and enable rapid decision making based on trustable data.”

Florentin Coppey, Founder NIRLAB AG



GLOBAL PRESENCE

Scanning Substances in +35 Countries across the Globe



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.



UNIL | Université de Lausanne

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

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Robert Deschenaux on the occasion of his retirement

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There has been significant interest within the forensic community regarding the use of handheld near-infrared (NIR) spectroscopy for the real-time analysis of cannabis specimens. This article introduces an innovative technology that combines the integration of a handheld device, specifically, *Viavi MicroNIR*, with a cloud-based server responsible for data processing and a mobile application for data visualization.

Impact of capacity with the method of this routine illness more common analysis of ultra-high-purity



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}, Dhousha Damergi^{c, d}, Cédric Schelling^{c, d}, Laureen Coic^c, Jean-Luc Veuthey^{c, d}, Pierre-Yves Sacré^a, Charlotte De Bleye^a, Philippe Hubert^a, Pierre Esseiva^a, Eric Ziemons^a

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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.

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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

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Cannabis
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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.

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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

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FIELDLAB by NIRLAB

High-precision handheld screening device for identifying and quantifying of substances across various industries.

INDUSTRIES

Application Areas

| | | | |
|--|--|--|---|
| <p>Available</p>  | <p>Available</p>  | <p>Available</p>  | <p>In process</p>  |
| <p>Law Enforcement & Harm Reduction Identification/ quantification of narcotics, cutting agents and precursors.</p> | <p>Polymers for Recycling Identification of all common polymers in plastics within 3 seconds.</p> | <p>Cannabis Quantification of cannabinoids (THC, CBD, CBN) in flowers and resins.</p> | <p>On-demand Development Many more applications for various industries are possible and in the making.</p> |

THE SOLUTION

FIELDLAB for Onsite Analysis

FIELDLAB is suitable for industries where instant identification and quantification of materials and substances are required.

Substance Library



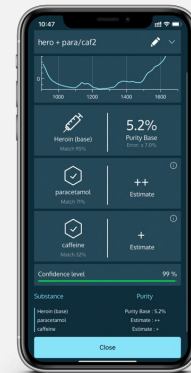
The substance library consists of highly precise data models for the specific application areas and acts as reference library.

NIRLight



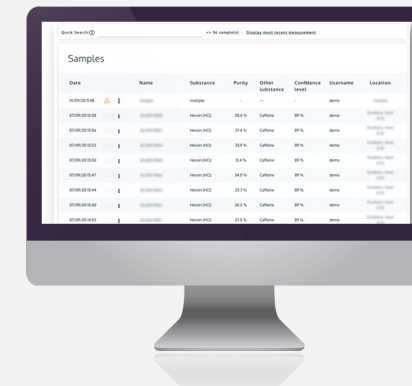
Substances can be easily scanned with NIR handheld devices. Device can be rapidly connected to a mobile NIRApp via Bluetooth.

NIRApp



NIRApp (iOS/Android) displays the analysis results instantly and enables standardized data collection and processing in the field.

NIRWeb



Desktop app and browser-accessible platform for data management. Various dashboards enable valuable insights across all scans and devices.

NIRCloud



Secure, high-speed server where analysis results and prediction models are trained and stored. Hosted on the University of Lausanne campus secured data center.

THE HARDWARE

NIRLight

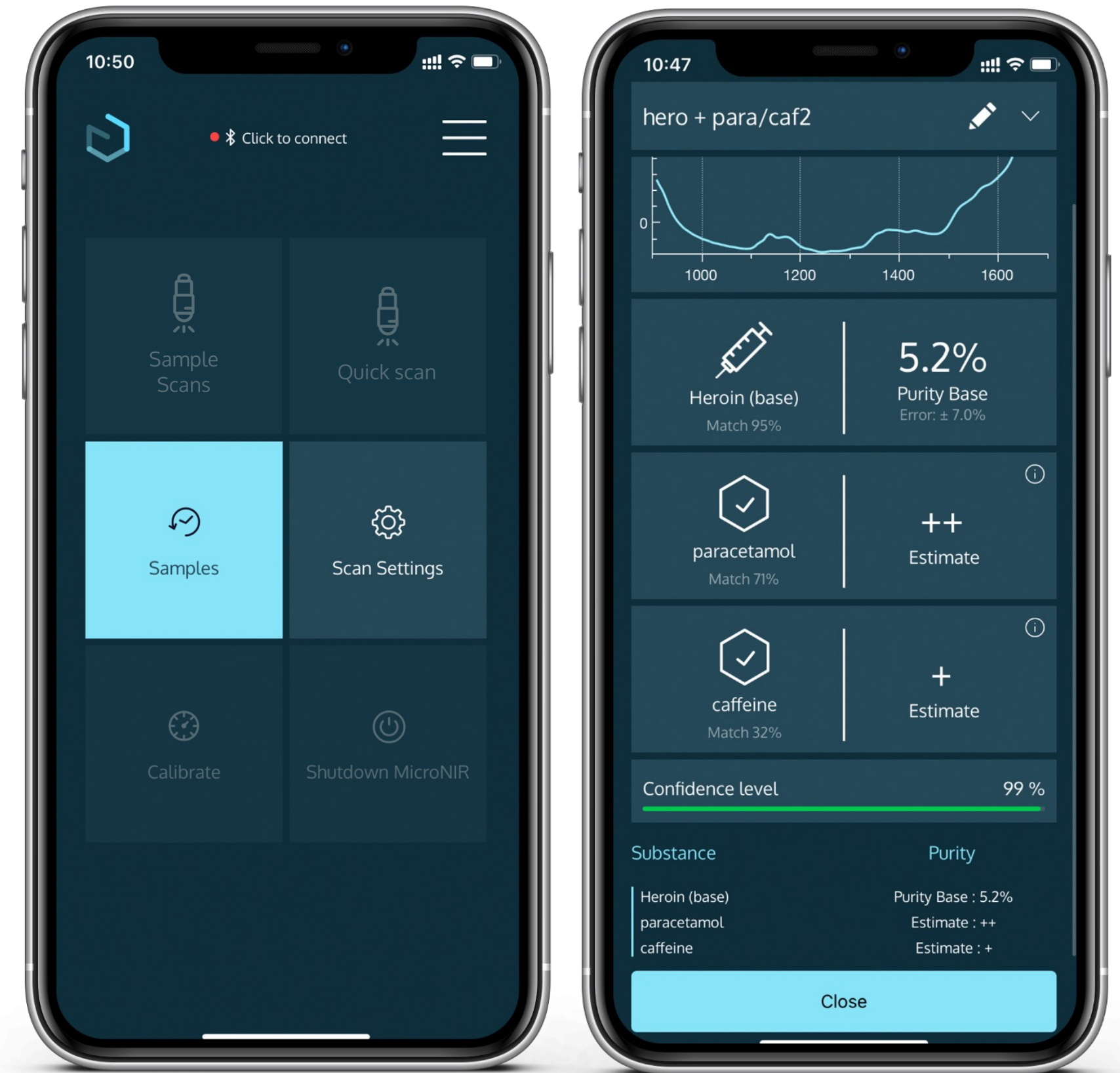
- + **Signal to Noise Ratio**
Among the highest in the field of handheld devices.
- + **Wireless, compact, rugged and ergonomic.**
Designed for use in the field as well as in the laboratory.
- + **IP65 and IP67 rated**
Made for wet and dusty environments.
- + **Destruction-free analysis**
Little or no 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 and 10 hours of continuous use.
- + **Bluetooth and USB**
Simple and fast connectivity to tablet or PC.



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.

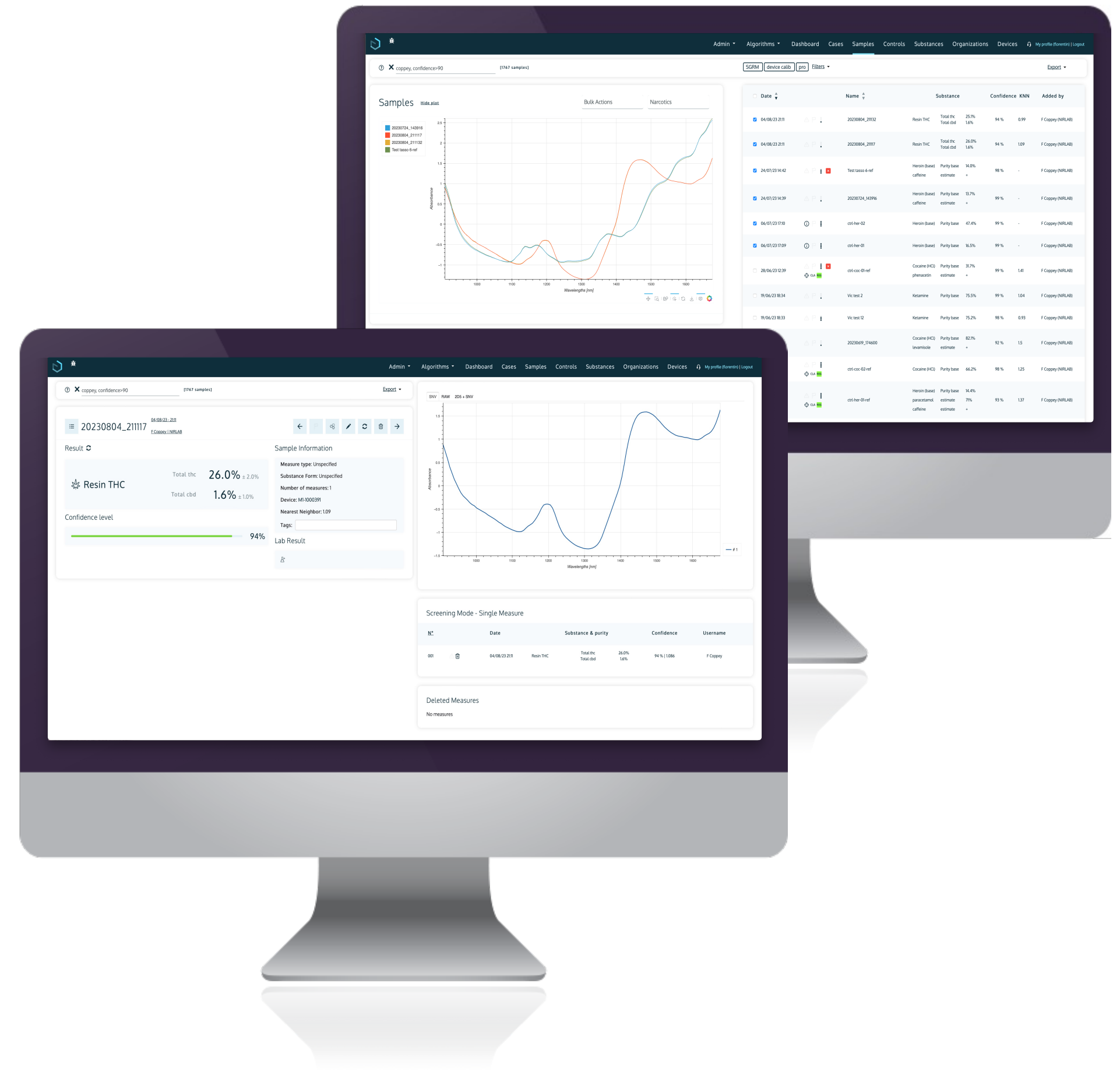


THE SOFTWARE

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



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.
- + **No sensitive data**
Sample names are coded, and no suspect information is shared.



INDUSTRIES

Narcotics

Available

Law Enforcement & Harm Reduction
Identification/ quantification of narcotics, cutting agents and precursors.

Available

Polymers for Recycling
Identification of all common polymers in plastics within 3 seconds.

Available

Cannabis
Quantification of cannabinoids (THC, CBD, CBN) in flowers and resins.

In process

On-demand Development
Many more applications for various industries are possible and in the making.

THE SOLUTION

NIRLAB Narcotics

NIRLAB provides law enforcement and harm reduction organizations worldwide with a portable NIR device that can swiftly and accurately identify and quantify illicit drugs, cutting agents and precursors.

- + Lab grade analysis with results within 5 seconds.
- + Identification and quantification of more than 150 substances.
- + No sample preparation required.
- + Point-and-click solution.
- + Up to 3 substances in a mixture.



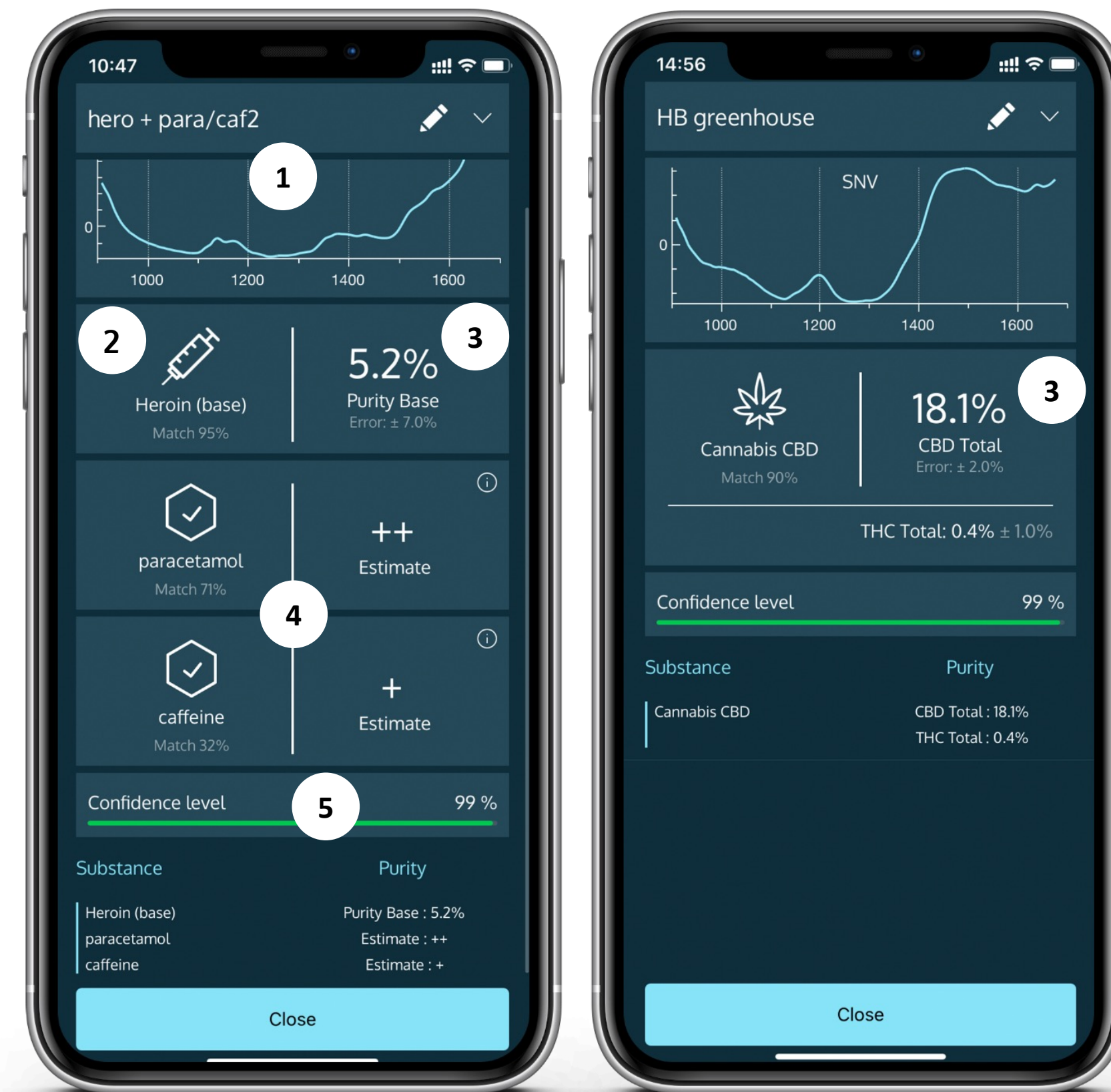
THE SOFTWARE

What can be Measured

- + **Identify and quantify more than 150 substances**
Scan results are shown on mobile app within seconds.
- + **Analyze substances in various forms**
Powders (e.g. Cocaine), pills (e.g. MDMA), crystals (e.g. Methamphetamine) or flowers (e.g. Cannabis).
- + **Identify cutting agents and precursors**
Analyze up to 3 substances in a mixture.

The result in the NIRLAB app shows:

1. The measured spectrum of questioned substance
2. Identification of the substance
3. Quantification of the substance
4. Cutting agent (if applicable)
5. Confidence level



FIELDLAB DATA

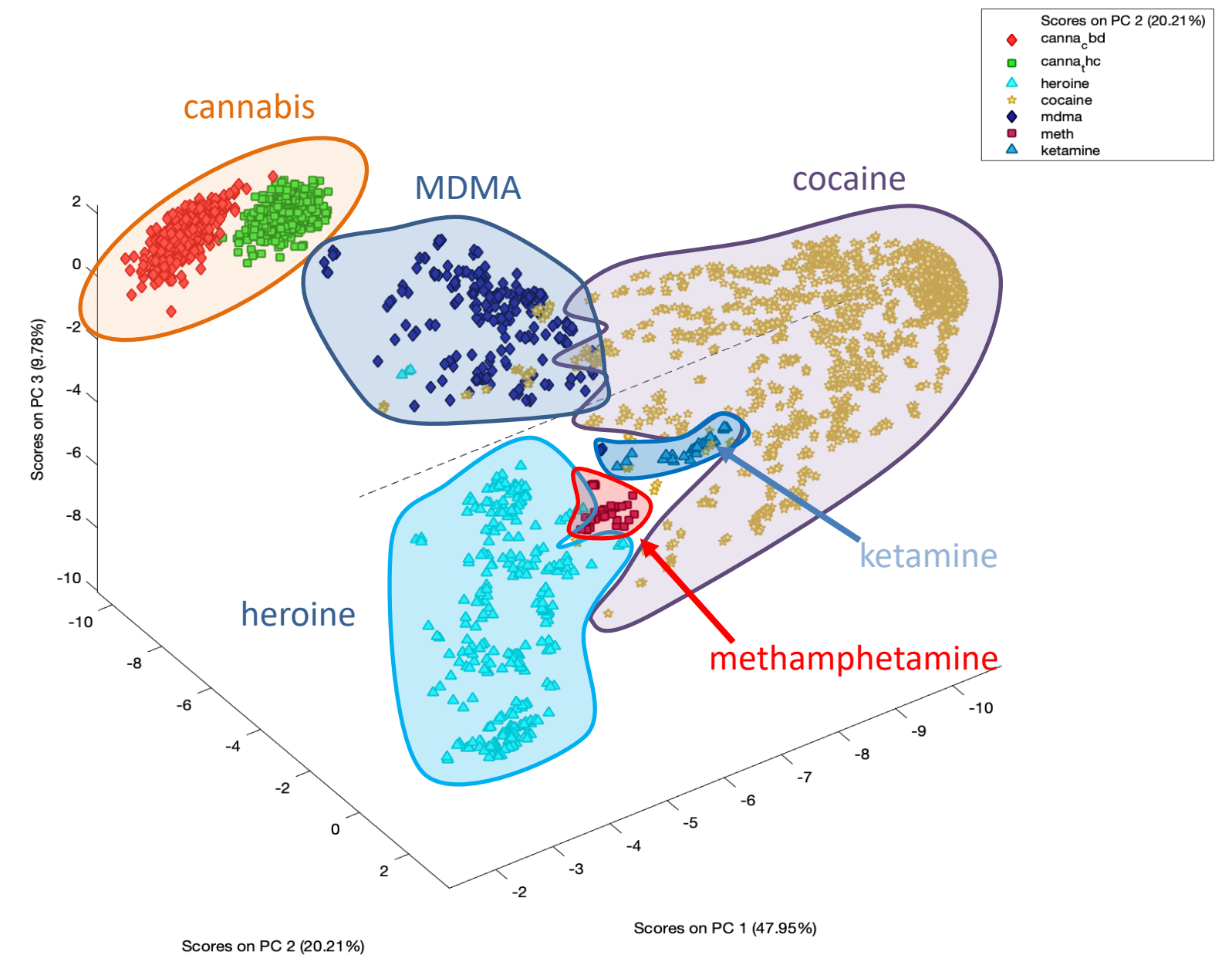
Narcotics Database

- + **150 substances identified and 40'000 spectra**
 - All major drugs of abuse and cutting agents
 - Many Cathinones and other new psychoactive substances

- + **22 substances quantified in mixtures**
 - Cocaine, heroin in base and salt form
 - Phenethylamines (MDMA, amphetamine, meth)
 - Ketamine
 - THC, CBD and CBN in Cannabis
 -

- + **Database constantly updated and made available to everyone**

- + **Measurements in direct contact or through packaging**

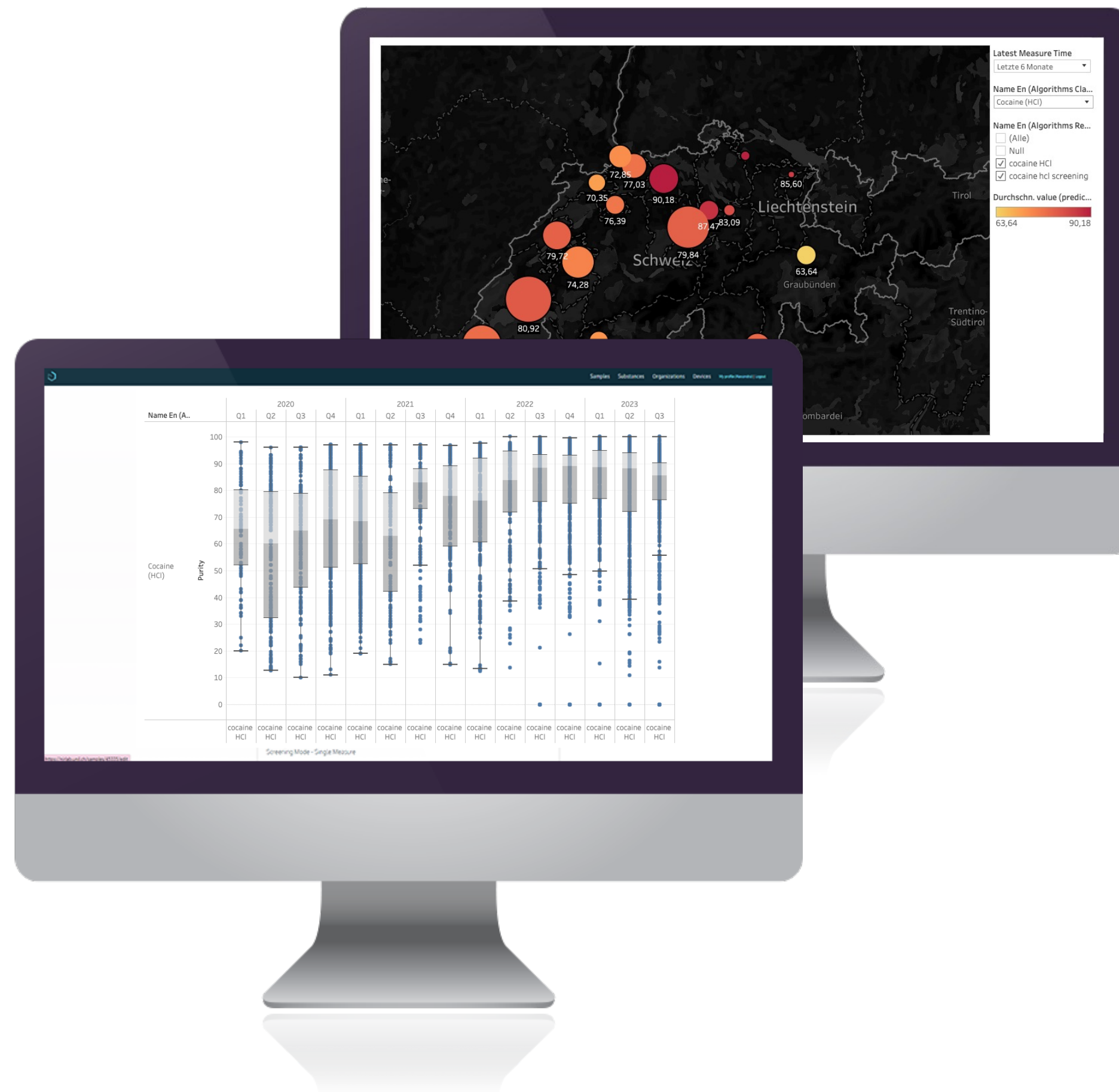


THE SOFTWARE

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.

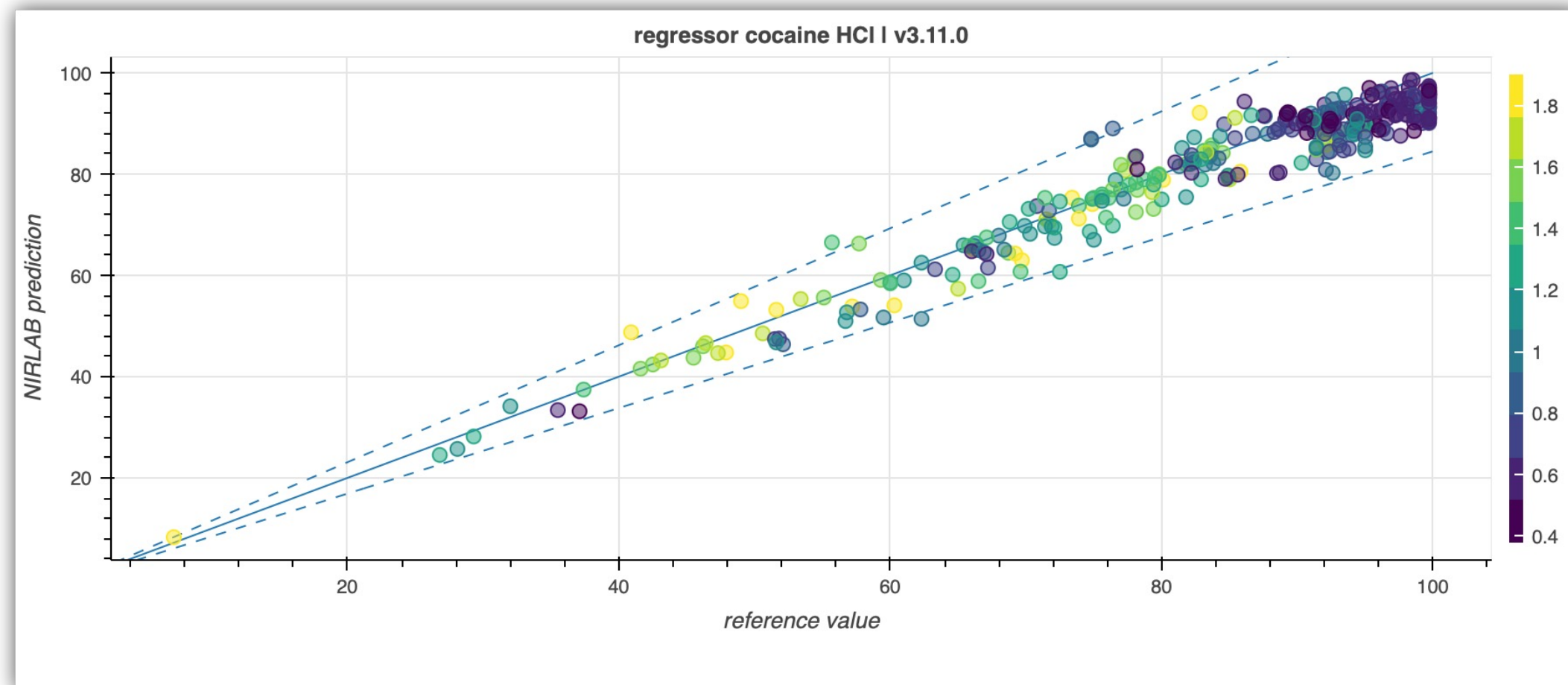


CERTIFICATIONS

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 $\pm 15\%$ relative to the reference value of wet chemistry



THE COMPARISON

Advantages of NIRLAB's solution

| | NIRLAB | RAMAN SPECTROSCOPY & OTHER SOLUTIONS |
|---------------------------------------|--|---|
| QUANTIFICATION | Yes | Not possible |
| AFFECTED BY FLUORESCENCE | Little <i>(capable to quantify heroin, THC/CBD, MDMA)</i> | Significantly <i>(limitation on identifying heroin, THC/CBD, MDMA pills)</i> |
| COMPLEXITY OF INSTRUMENT AND SOFTWARE | Extremely simple usage | Generally, more complex usage |
| HAZARDOUS AND SAFETY | No risk for operator or sample <i>(due to low energy radiation)</i> | Potential safety risks or risk of sample damage <i>(due to high power lasers)</i> |
| SUBSTANCE LIBRARY UPDATES | Continually refined for improved detection <i>(ongoing updates thanks to cloud solution)</i> | Library may not be regularly updated |
| ANALYSIS TIME | 2 - 5 seconds | 1 minute |
| INTELLIGENCE, PROFILING, ANALYTICS | Available <i>(online dashboards and analytics)</i> | Not available |
| CUSTOMIZATION | Tailored solutions are possible | Not available |

INDUSTRIES

Polymers

Available

Available

Available

In process

Law Enforcement & Harm Reduction
Identification/ quantification of narcotics, cutting agents and precursors.

Polymers for Recycling
Identification of all common polymers in plastics within 3 seconds.

Cannabis
Quantification of cannabinoids (THC, CBD, CBN) in flowers and resins.

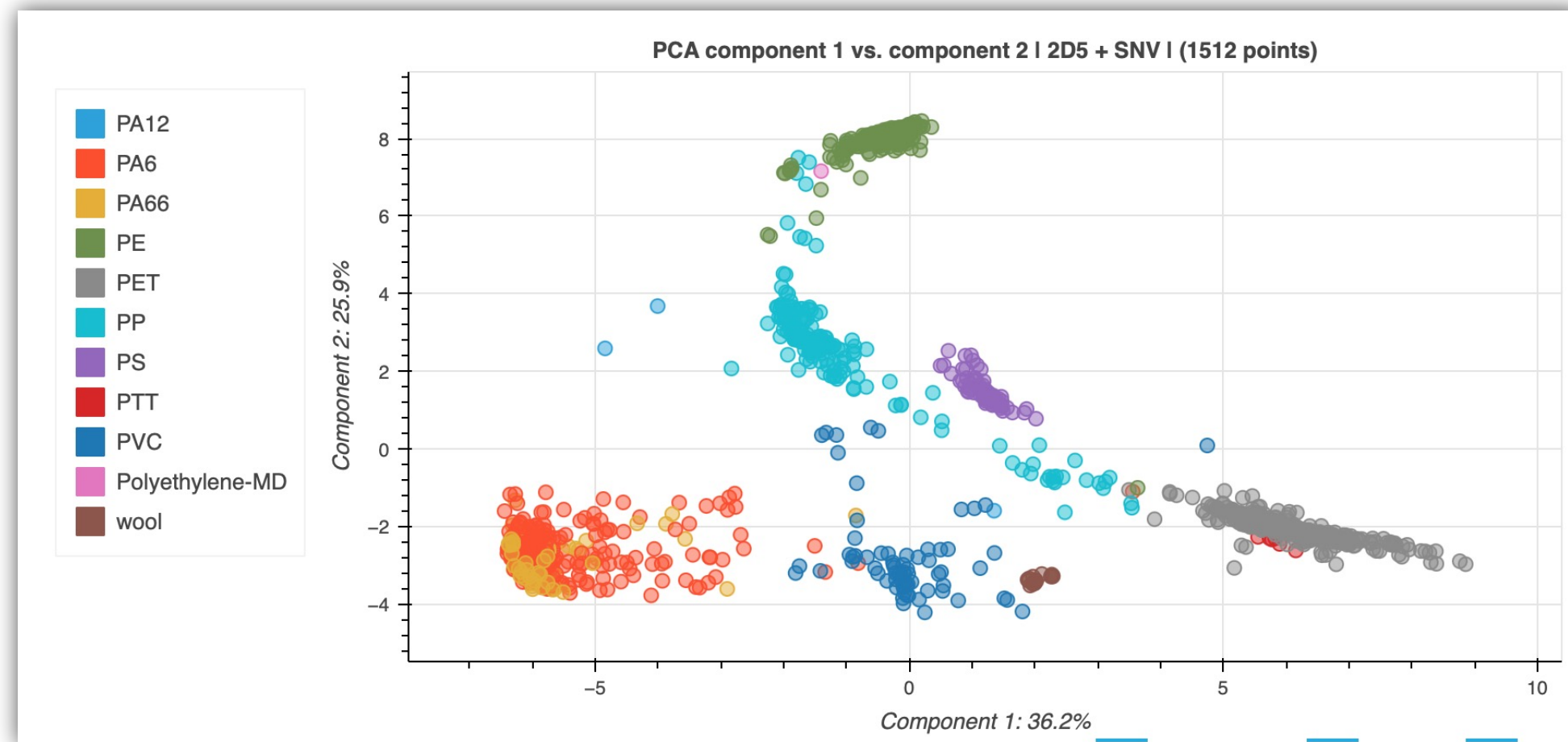
On-demand Development
Many more applications for various industries are possible and in the making.

THE SOLUTION

NIRLAB Polymers

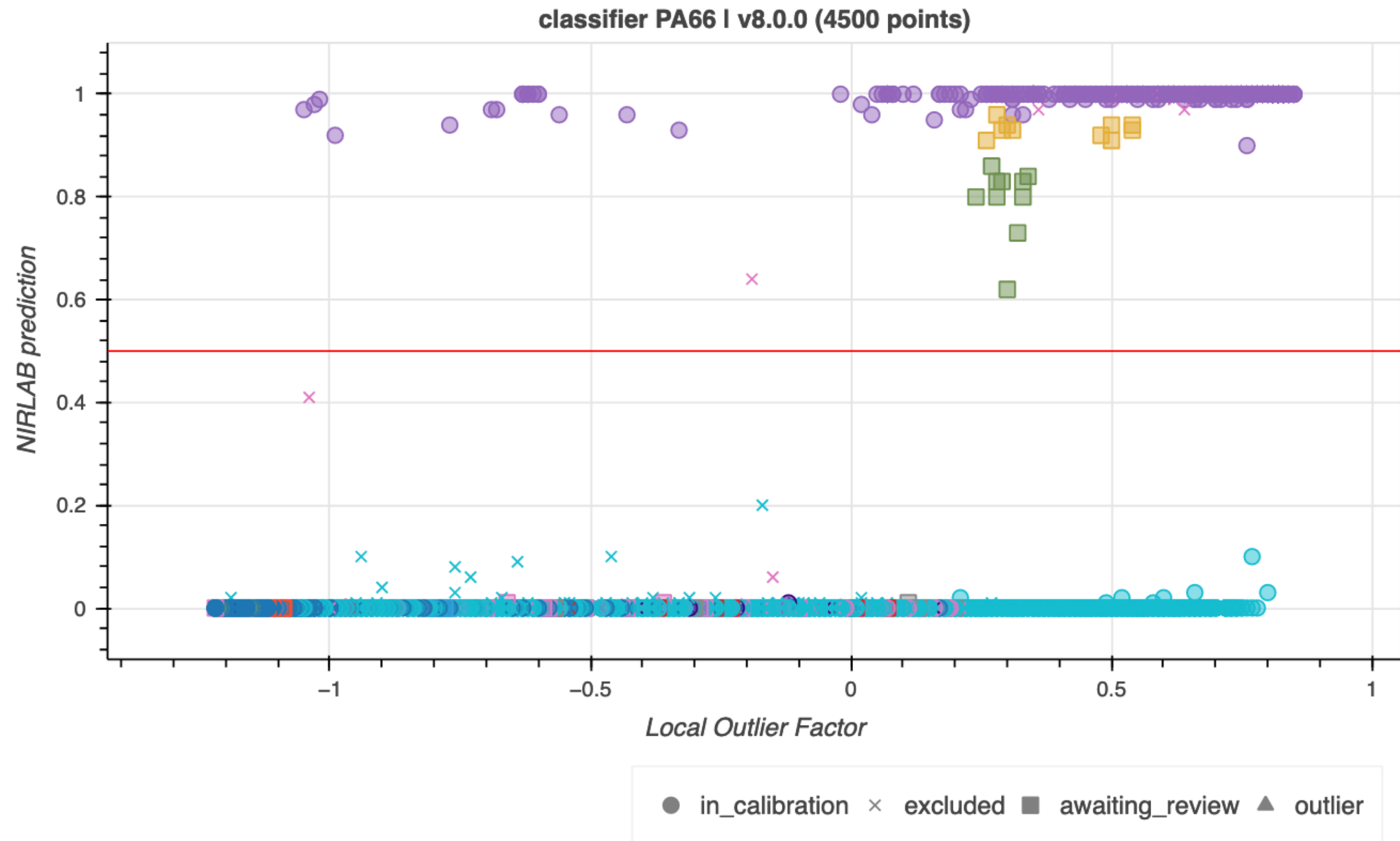
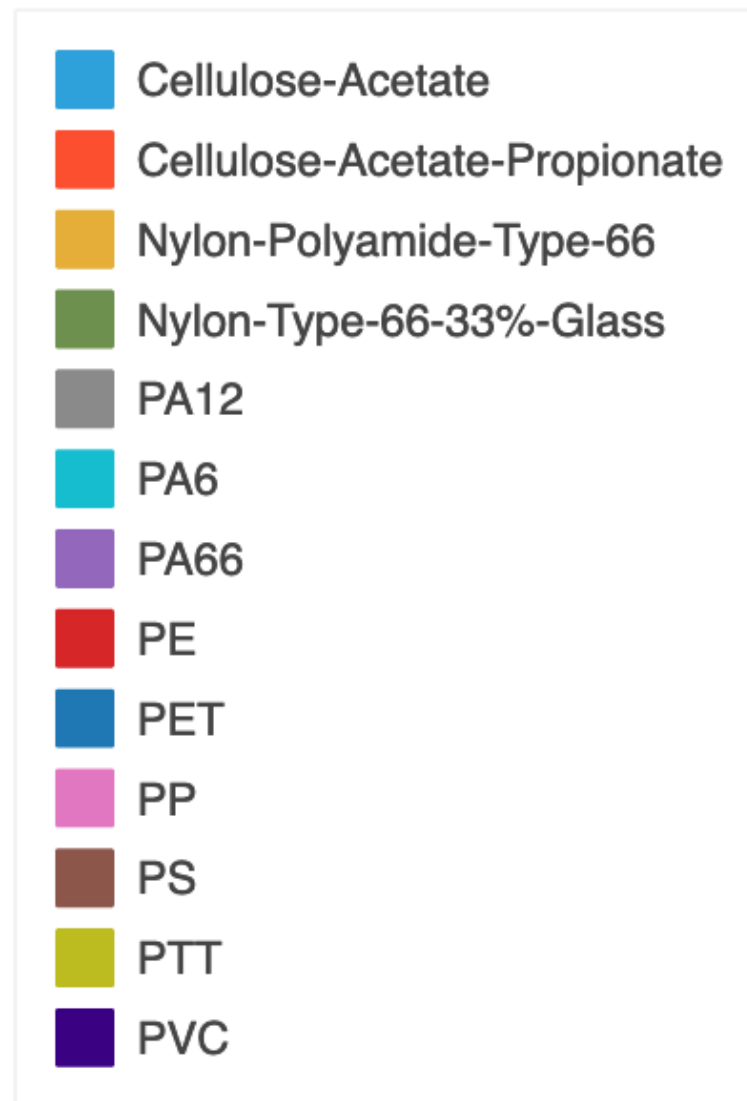
NIRLAB provides recycling organizations worldwide with a portable NIR device that can swiftly and accurately identify and quantify all common polymers.

- + **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



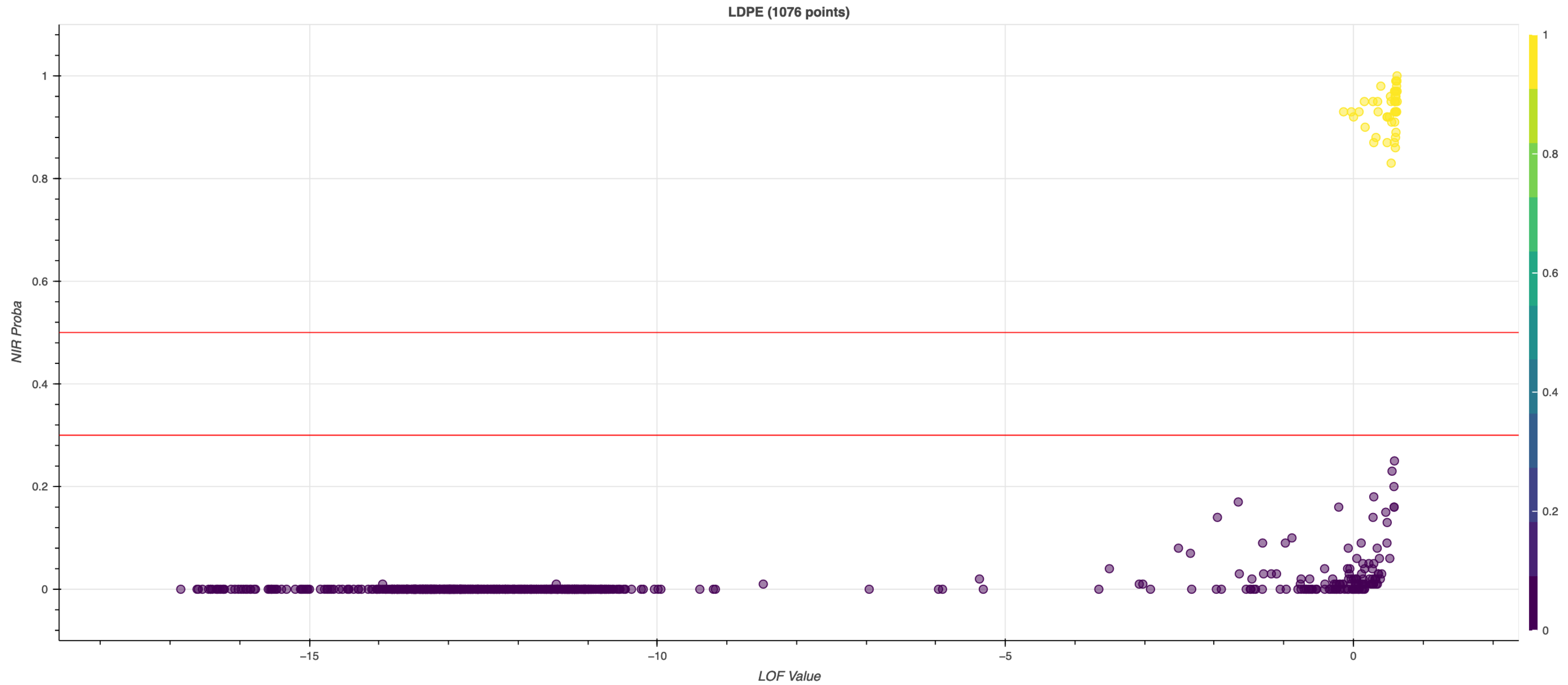
NIRLAB POLYMERS

Application Example: PA6 vs. PA66



NIRLAB POLYMERS

Application Example: LDPE vs. HDPE



INDUSTRIES

Cannabis

Available

Law Enforcement & Harm Reduction
Identification/ quantification of narcotics, cutting agents and precursors.

Available

Polymers for Recycling
Identification of all common polymers in plastics within 3 seconds.

Available

Cannabis
Quantification of cannabinoids (THC, CBD, CBN) in flowers and resins.

In process

On-demand Development
Many more applications for various industries are possible and in the making.

THE SOLUTION

NIRLAB Cannabis





NIRLAB provides cannabis companies worldwide with a portable NIR device that can swiftly and accurately identify and quantify cannabinoids such as THC, CBD, CBN, CBG and HHC.

- + No sample preparation and analysis direct on the flower.
- + Analysis of dried whole flower and ground flower as well as hash and resin.
- + Instant quantification of major cannabinoids and moisture.
- + Detects washed, infused flowers.



INDUSTRIES

On-Demand Development

| | | | |
|--|--|---|---|
| <p>Available</p>  | <p>Available</p>  | <p>Available</p>  | <p>In process</p>  |
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THE SOLUTION

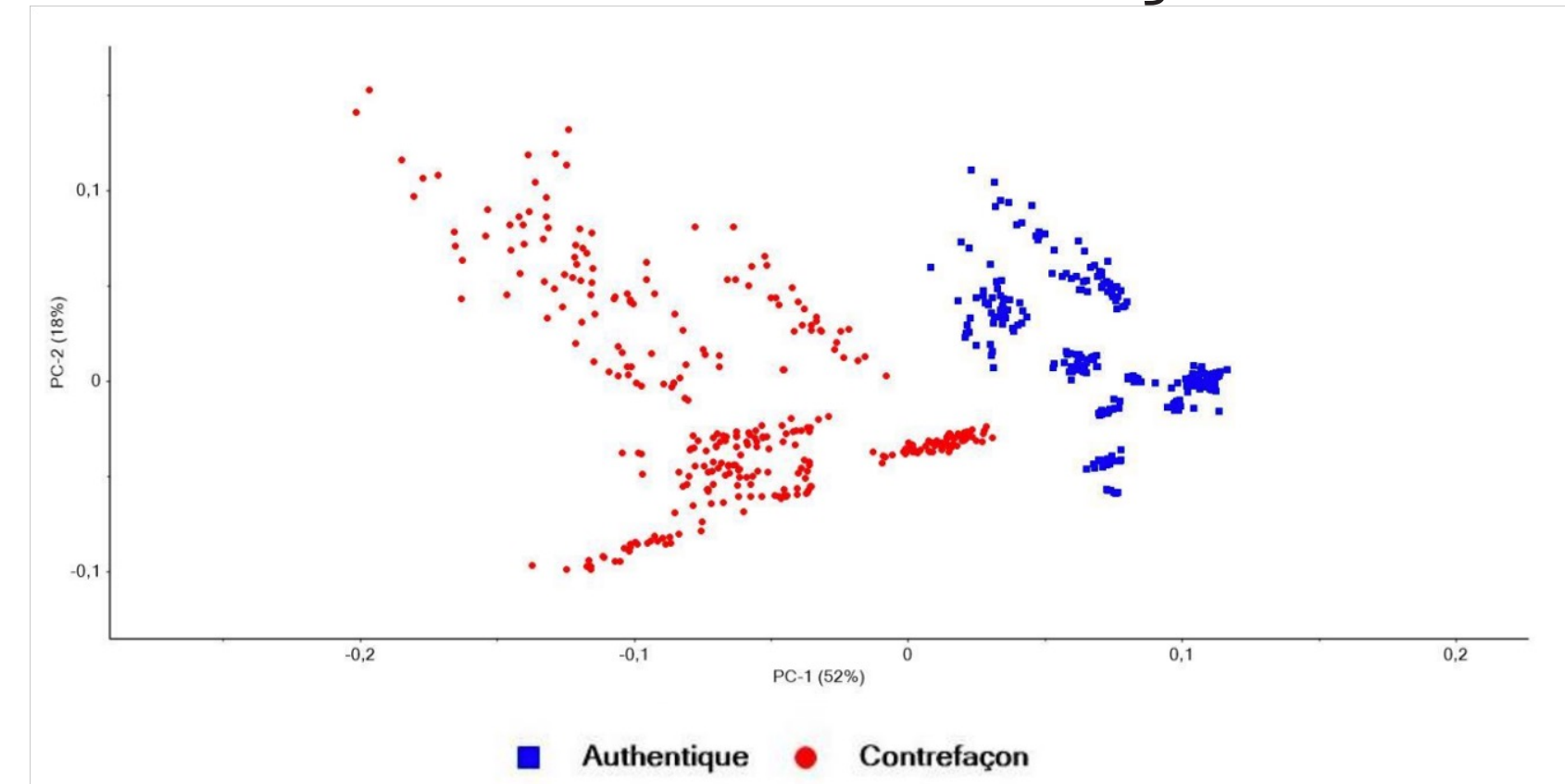
On-Demand Developments

NIRLAB provides tailor-made services and on-demand development projects to companies across various industries.

- + Development of new application areas for the identification and quantification of new material and substances
- + Integration of new NIR and Raman devices into the existing setting
- + White-labelling of our mobile and web application
- + Consulting services on data acquisition, data modelling and calibration

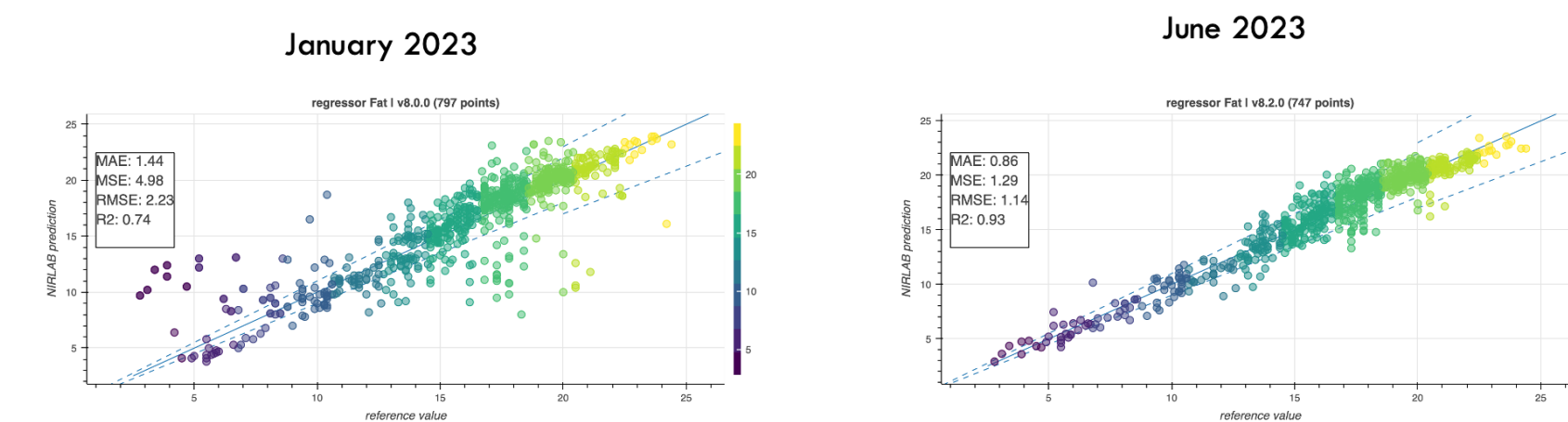
Example:

Falsification of medicine – the case of Viagra



Example:

Fat content in fish



Root mean squared error reduced by 50% from 2.23 to 1.14

NIRLAB Pro Chemometric Suite

Developing high quality data models at a new level of speed and precision.

FOR PROFESSIONALS

NIRLAB Pro Chemometrics Software

Enabling rapid development of high-quality models for spectral data in a seamless and automatic workflow.

NIRLAB Pro Suite

- + Create reference library
- + Associate lab results
- + Modelling and dataset selection
- + Machine learning
- + Visualization
- + Validation

The screenshot displays the NIRLAB Pro Suite interface. On the left is a sidebar with 'VISUALIZE' and 'MACHINE LEARNING' sections. The main area shows 'PLOTS' with a PCA scatter plot and a spectral plot. Below the plots are 'FILTERS' and a table of '231 SELECTED SAMPLES'.

| DATE | NAME | STATUS | NIR RESULT | LAB RESULT | CONFIDENCE | BULK ACTIONS |
|--------------------|---------------|--------|--|--|------------|---------------|
| 2021-06-07 22:41 | 421857-4-50-R | | Cannabis CBD THC total: 5.9% CBD total: 0.1% | Cannabis CBD THC total: 6.1% CBD total: 0.1% | 94% | Select Action |
| 2021-06-07 22:41 | 421857-4-52-R | | Hashish THC THC total: 14.3% CBD total: 3.8% | Hashish THC THC total: 14.7% CBD total: 4.2% | 91% | Select Action |

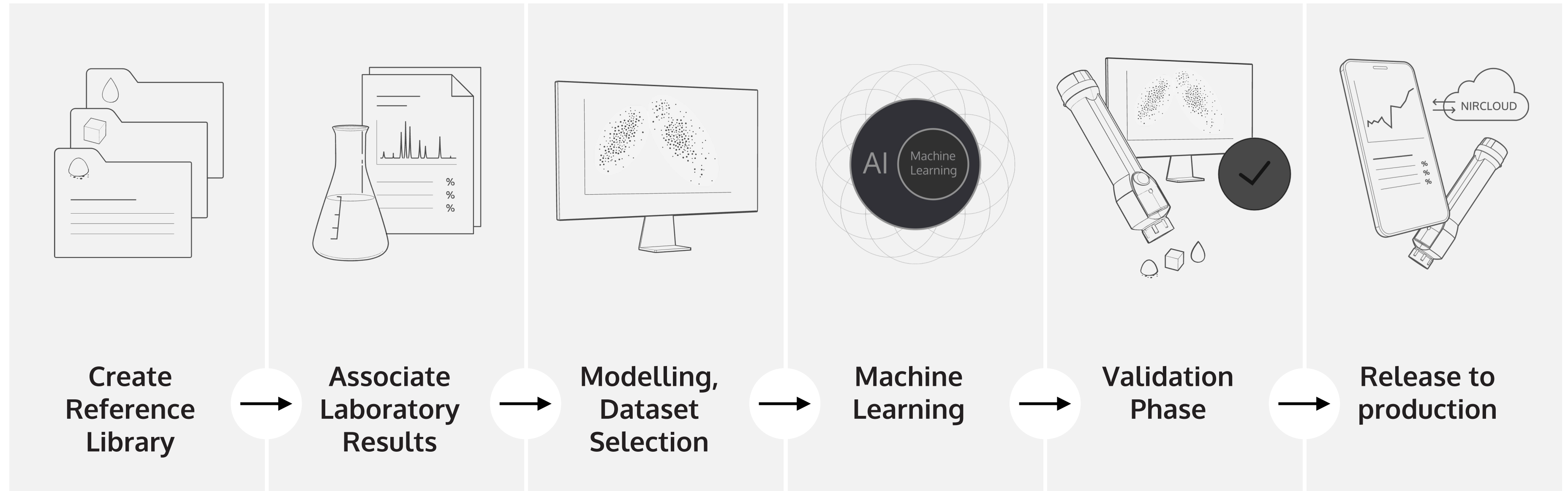
AI Machine Learning

From data acquisition, through model training to release into production, all available in one automatized and customizable software.

NIRLAB Pro

How it Works

From data acquisition to production, a highly automatized and customizable interface.



NIRLAB Pro

Advantages

NIRLAB Pro chemometric software is tailor-made to the needs of science teams, quality assurance teams, or research and development departments that have the resources to create their own reference library.

- + Easy and precise model creation
- + Automatic pre-processing
- + Automatic machine learning
- + Specific attributes customization
- + Rapid outlier detection

| DATE | NAME | STATUS | NIR RESULT | LAB RESULT | CONFIDENCE |
|--------------------|---------------|--------|--|--|------------|
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| 2021-06-07 22:41 | 421857-4-50-R | | Cannabis CBD THC total: 5.9 % CBD total: 0.1 % | Cannabis CBD THC total: 6.1 % CBD total: 0.1 % | 94 % |

How it works

The background of the slide is a dark blue, almost black, field filled with a complex, glowing network of white lines and nodes. The lines are thin and connect various points, creating a dense, interconnected web that resembles a molecular structure or a data network. The nodes are small, bright white dots that serve as the connection points for the lines. The overall effect is one of a dynamic, interconnected system.

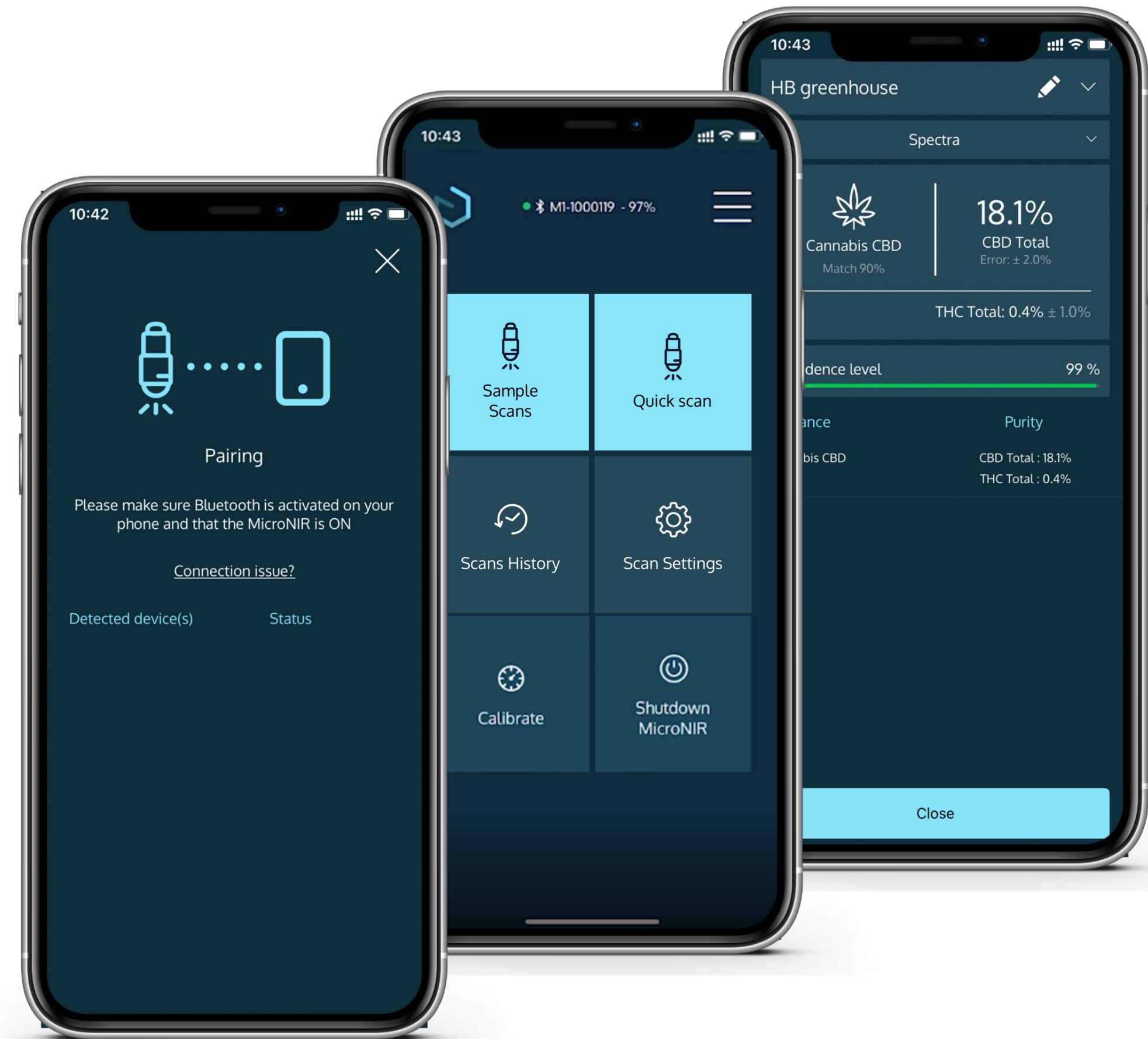
THE APP

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.



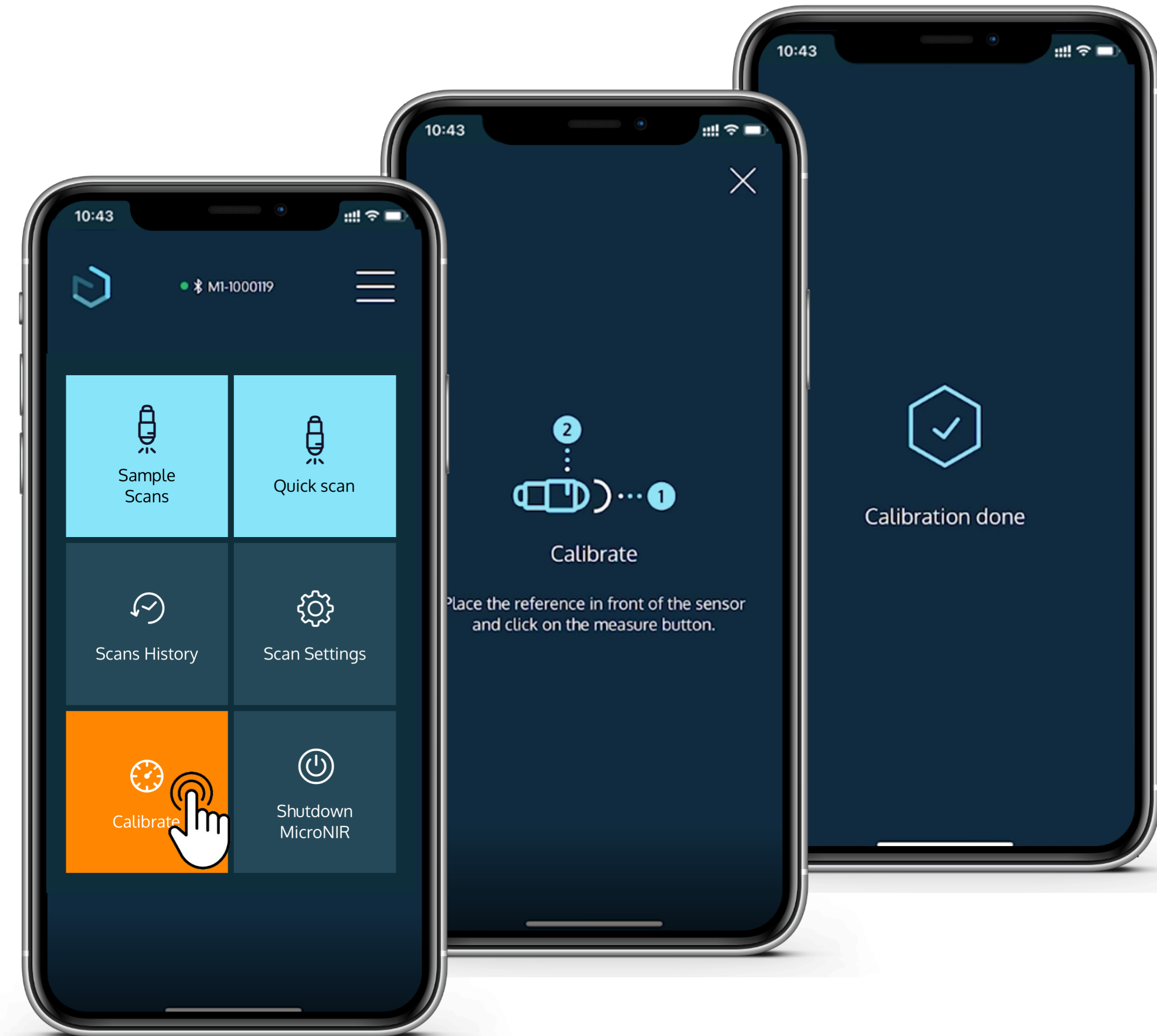
THE APP SETUP

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.



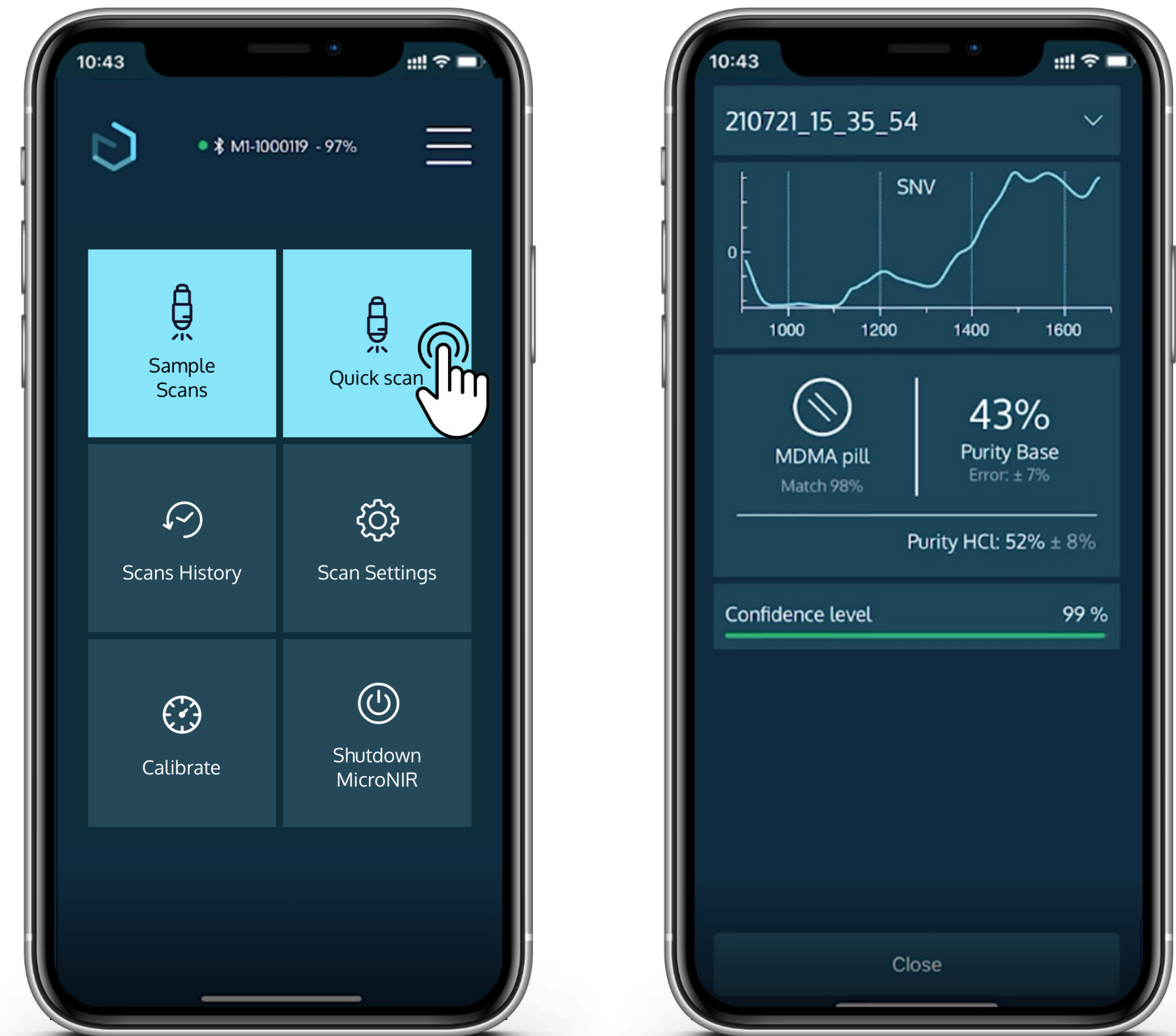
SCANNING MODES

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.](#)





Thank you!

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