First experiences with the newly-developed Swisens Pollen Monitor

Erny Niederberger*, Reto Abt*, Philipp Burch**, Yanick Zeder***

*   **Lucerne University of Applied Sciences and Arts and Swisens AG**
**   **Swisens AG**
*** **Lucerne University of Applied Sciences and Arts**

Agenda

- Problem pollen allergy

- Pollen measurement and identification today

- Way to reduce the economic costs of pollen allergy

- Solution

- New measurement device: Swisens Poleno

- Integrated measuring methods

- Measurement data

- Results

- Conclusion

- Potential

Problem pollen allergy

High economic costs

- Switzerland: 15 to 20% of the population is affected by a pollen allergy

- Switzerland: More than 1.5 million pollen allergic people

- Europe: annual costs due to pollen allergy estimated > 100 billion Euro

- More than 60% of pollen allergy sufferers are not adequately medicated

➢**Worldwide ascending trend**

Pollen measurement and identification today

Today's method for pollen identification

Pollen

Tape

Pollen-species
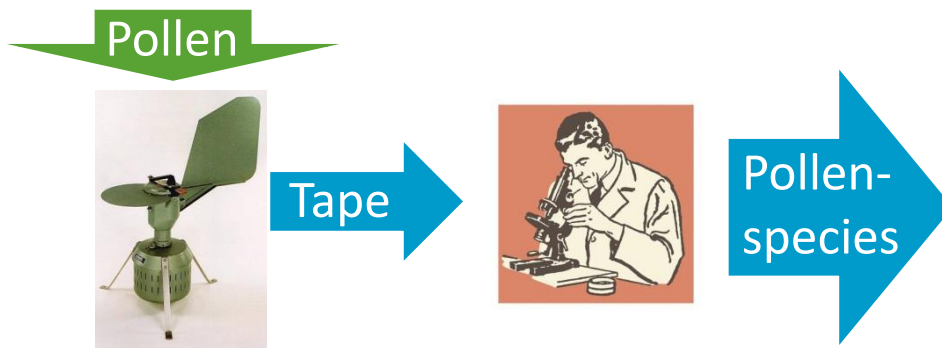
- Pollen identification is done manually under the microscope

- Measurement data is only available once a week

- **Real-time information** for a precise forecast **is missing**

Hirst pollen trap, design 1952

Effect of inaccurate forecast

- Due to **inaccurate pollen forecast**, today pollen allergy sufferers notice that the pollen is there because of their own symptoms**.**

- Then it's **already too late**, because they **got already into contact** with pollen

Way to reduce the economic costs of pollen allergy

Goals
- **Improve** the quality of the **pollen forecast**
- Change the behavior of affected people so that they use the predictions to take preventive measures

Target effects
- **Minimize contact** with the pollen
- Allow more effective preventive measures (examples)
  - Antihistamines must be taken before getting into contact with allergens to fully develop their effects
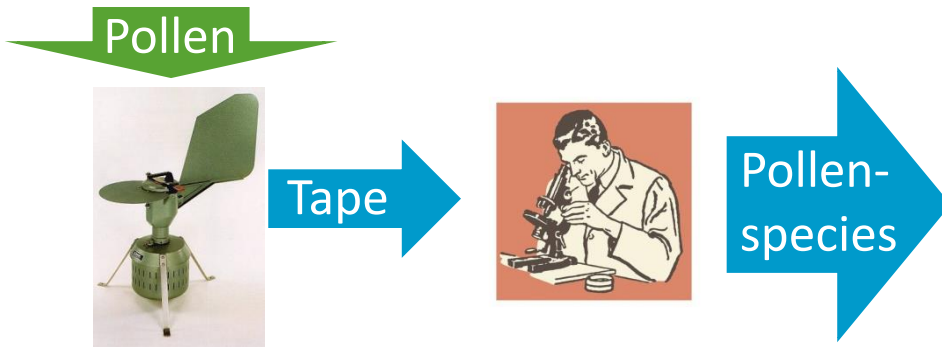 - Perform outdoor activities in areas with low pollen concentration

Benefit
- Reduction of the symptoms thus improving the quality of life
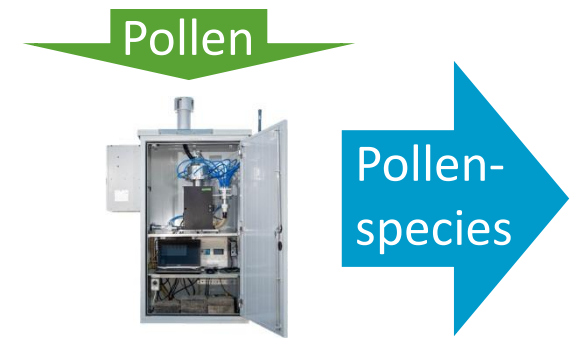- Retaining productivity
- ➢**Reduction of economic costs**

Solution: Replace Hirst pollen traps with Swisens Poleno

Manual identification

Pollen →

Tape →

Pollen-species →

Hirst pollen trap, design 1952

Automatic identification

Pollen →

Pollen-species →
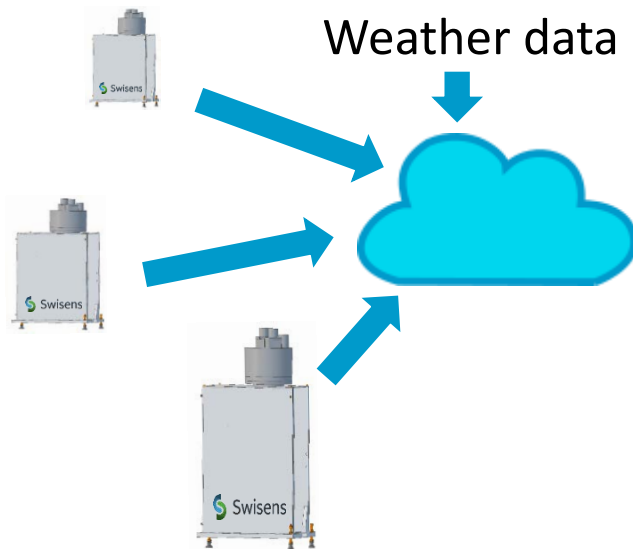
Swisens Poleno 2018

Vision: Pollen forecast as good as the weather radar

Pollen measurement network
Real-time measurement and identification

Pollen forecast
With early warning system

Benefit for allergic people

Weather data

Position

Push-Warning

- Less symptoms
- More productivity
- Economic benefits

➢ **Enabled by real-time pollen monitors**

Automatic pollen measurement with Swisens Poleno

The new Swisens instrument delivers the **local concentration** of the **different and most important pollen taxa** relevant for allergic people **fully automatic and in real-time**

Dimensions: 33 x 33 x 70 cm^3

Weight: 23 kg

- Total solution for long-term measurements

- Insulated weatherproof housing

- Integrated identification algorithms

- Measurement raw data as well as analysis results can be obtained instantly using a network connection

- Ready for easy setup of measuring networks

- Adaptable to customer needs

Swisens Poleno overview setup for measurement of single aerosol particles in flight
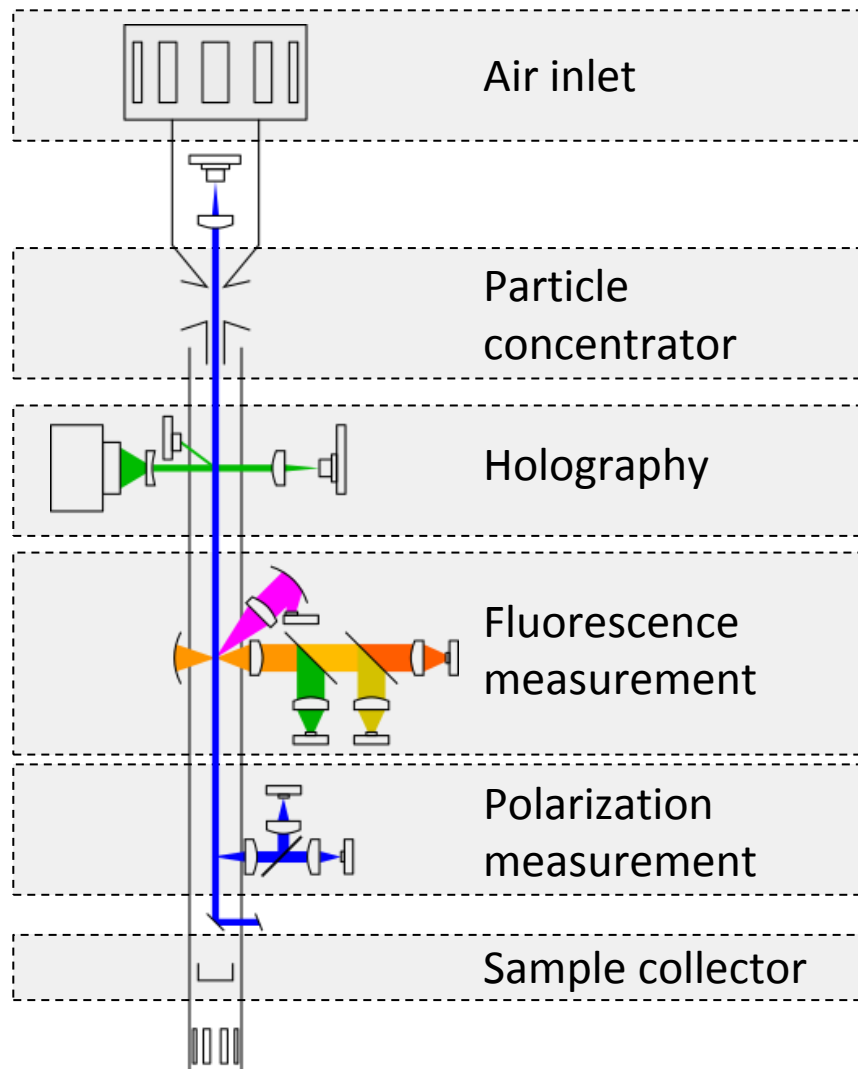
Sampling

- Particles Ø 1µm to 300µm

- Flow rate: 40 l/min

- Concentration factor 1000 (10µm to 300µm)

- Up to 30'000 particles per m^3

- Sigma 2 sampler

- Insertable sample collector

Measurements

- Holography: two 90° displaced images per particle

- Florescence measurements (intensity and lifetime)

- Polarization measurement

Benefits of integrated aerosol-concentrator

High resolution local pollen-taxa concentration

- Enabled through a new unique aerosol-concentrator design

- Concentration factor of 1000

- Enables a volume flow rate of 40 liters per minute to be analyzed

- High time resolution down to minutes

➢**Enables to use the measurement data for pollen forecast**

Methods for measuring morphological features

Optical measurement methods

- Holography setup which delivers images of the particles

- Polarized time resolved scattering light measurement

Technical specifications

- Resolution holography images: 0.56 µm/pixel

- 55 images/second

- Polarization measurement time resolution: 4 µs

115µm

Ambrosia

Quercus robur

Fagus sylvatica

Corylus avellana

Intensity (a.u.)

Time (ms)
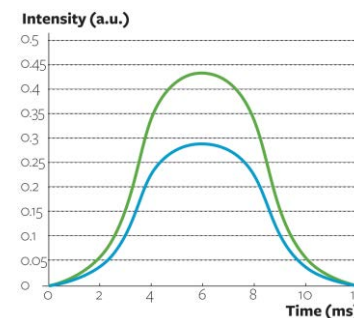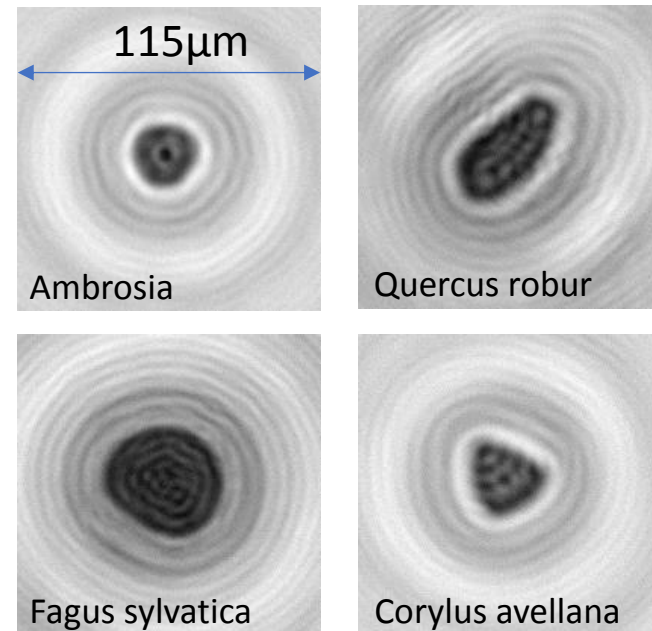
Benefits of the holographic measurement

Intuitive verification of the measurement data from every single particle

- Images of the particles of interest are recorded for analysis

- Thanks to the images the verification of the measurement data from every single particle can be made simple and intuitive

Corylus avellana   Fagus sylvatica   Ambrosia   Quercus robur
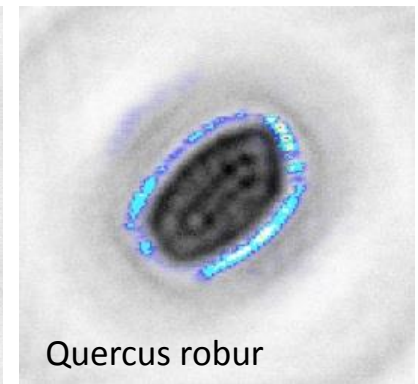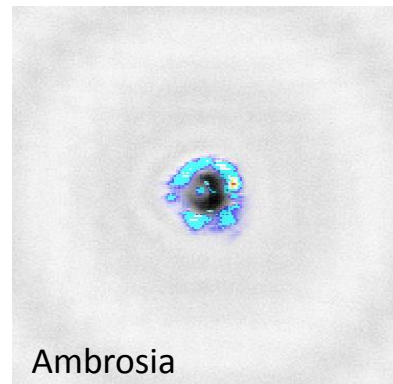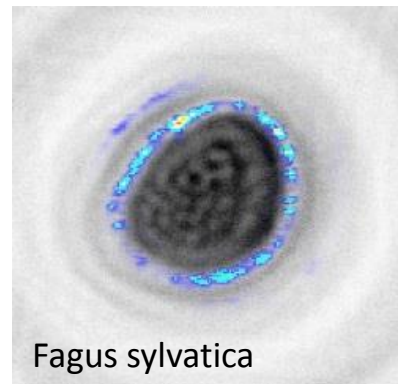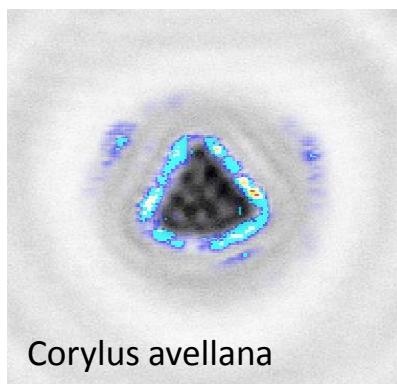
Methods for measuring biochemical composition

Fluorescence measurements
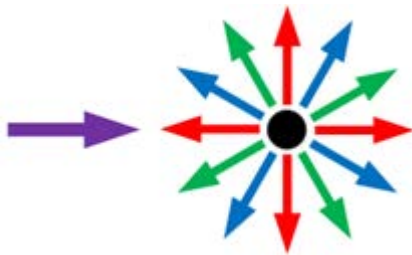
Autofluorescence

Natural emission of light by biological structures after appropriate excitation

Measurements

- Spectrally resolved fluorescence intensity
- Spectrally resolved fluorescence lifetime

- Collects **complementary information** in addition **to the morphological features**
- This characteristic values delivers an additional dimension of information leading to a **rich mosaic of information** for each measured particle

Fluorescence measurement

Technical specifications

- Lifetime range 0.5ns to 20ns

- Three excitation sources
  - LED: 280nm, 365nm
  - Laser diode: 405nm
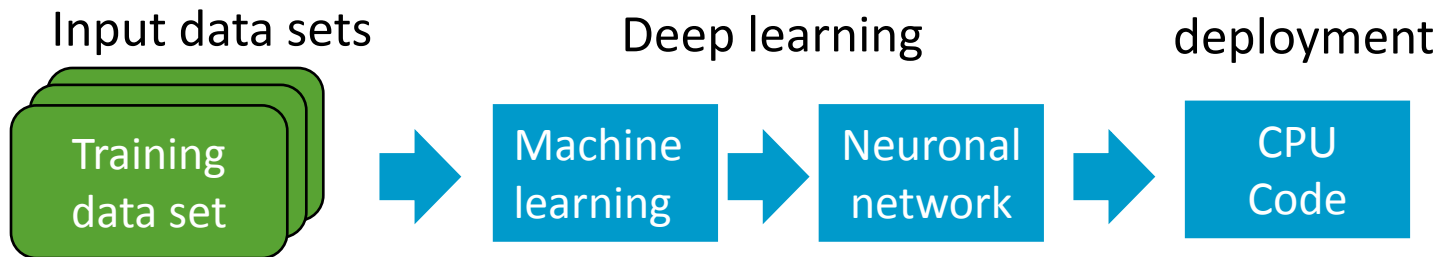
- Five receiver windows between 320nm and 750nm
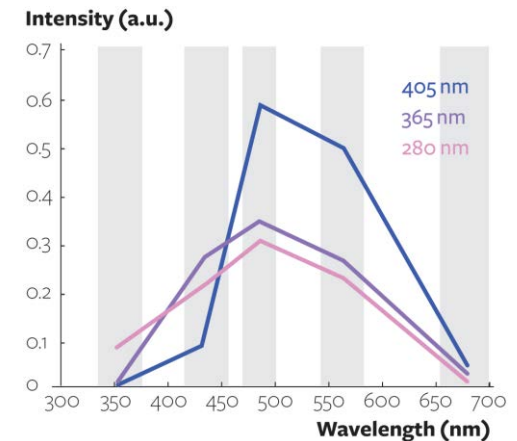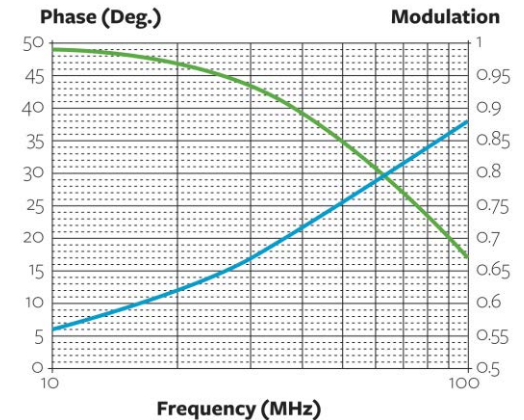
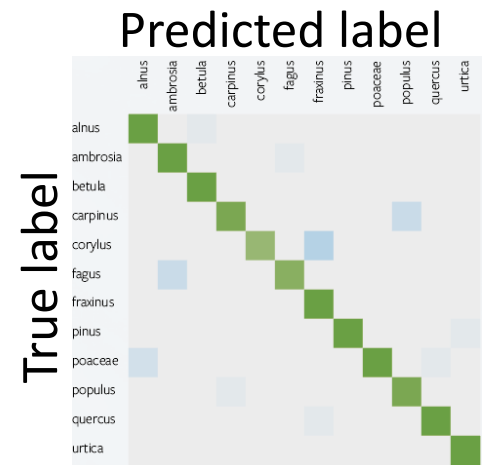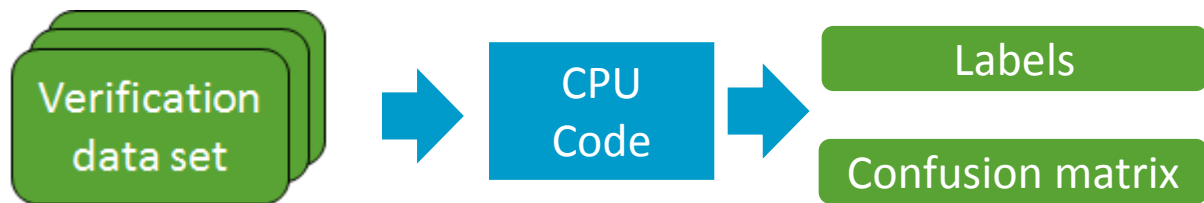# Data sets for machine learning based identification

"nebulized" pollen samples

Feed in

Meas. data

Clean up

Training data set

Verification data set

Repeat with different pollen-taxa samples

Results

Training data set

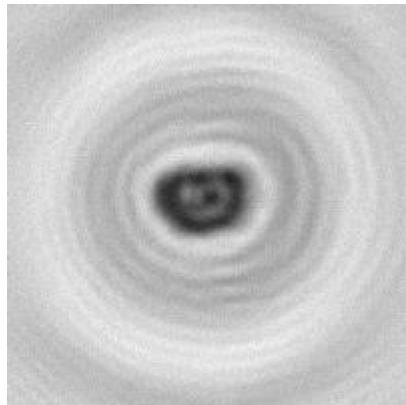Verification data set
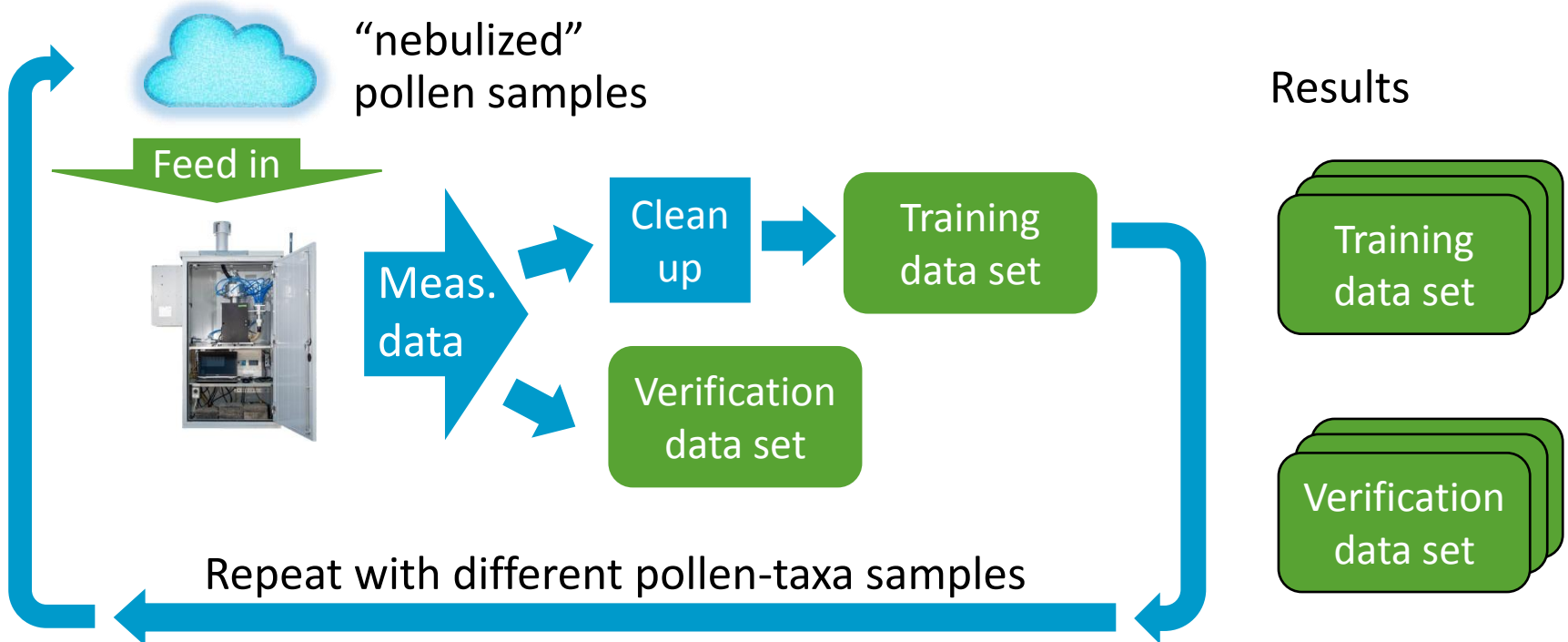
Machine learning based identification

Learning phase

Input data sets   Deep learning   deployment

Training data set → Machine learning → Neuronal network → CPU Code

Verification phase

Verification data set → CPU Code → Labels / Confusion matrix

Predicted label

True label

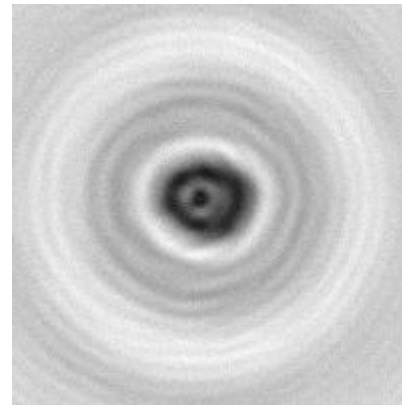alnus, ambrosia, betula, carpinus, corylus, fagus, fraxinus, pinus, poaceae, populus, quercus, urtica

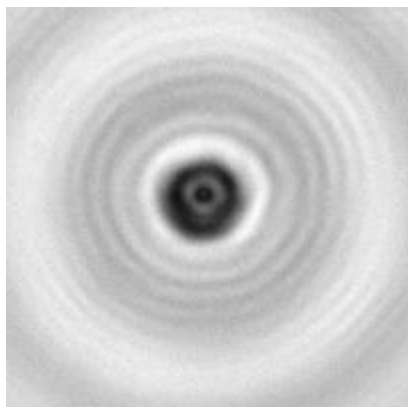# Dry pollen images taken by Swisens Poleno
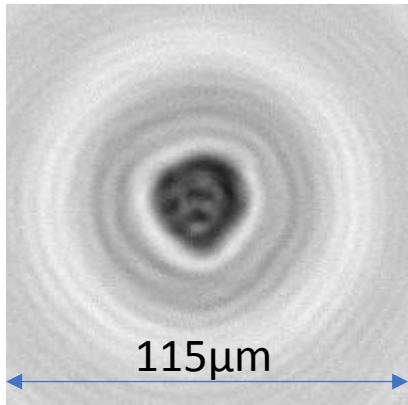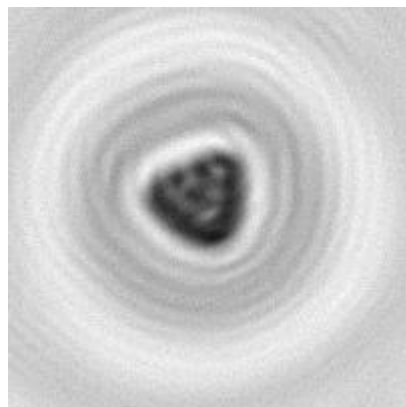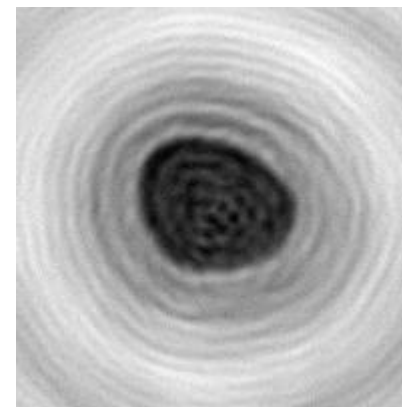

115μm
Betula pendula

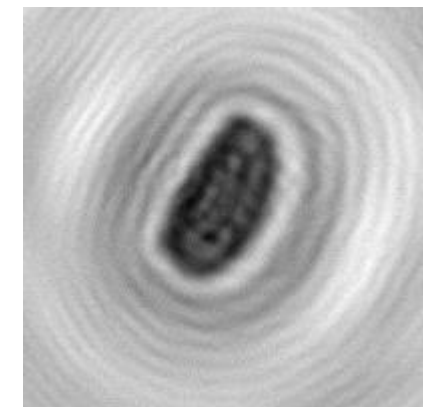Alnus glutinosa

Fraxinus excelsior
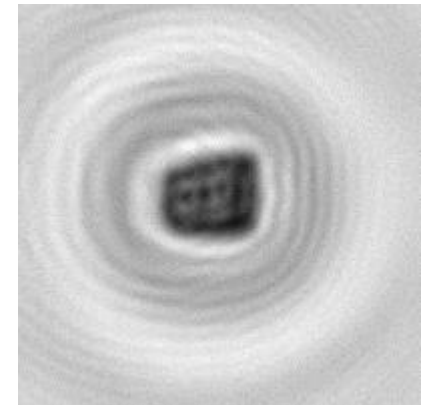
Dactylis glomerata

Ambrosia

Corylus avellana

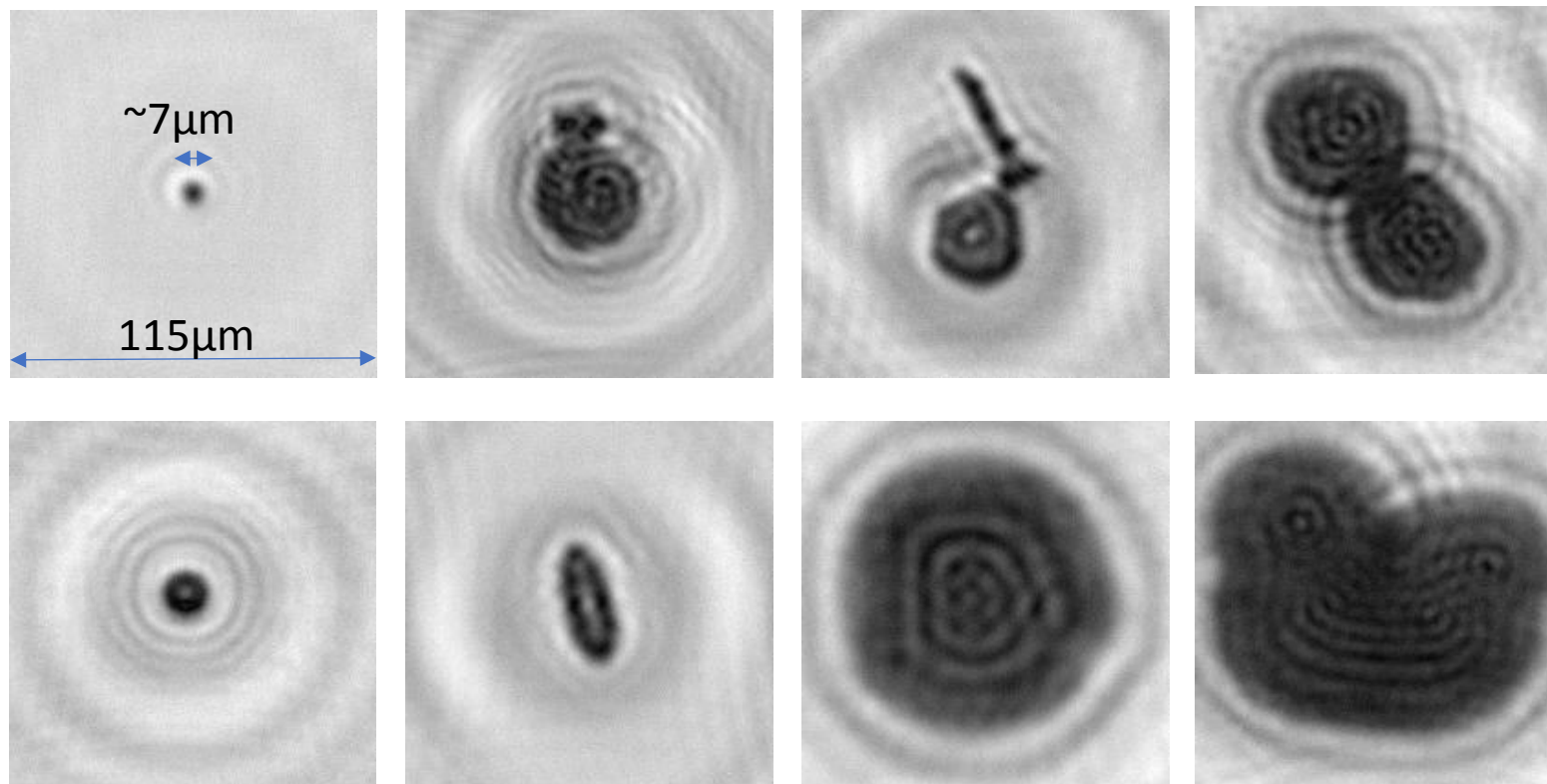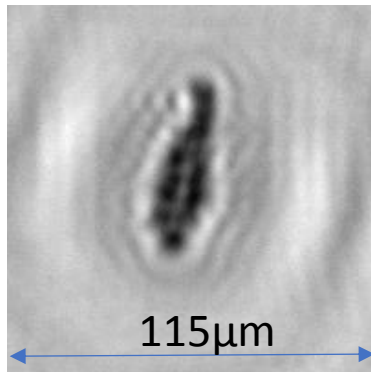Fagus sylvatica

Quercus robur

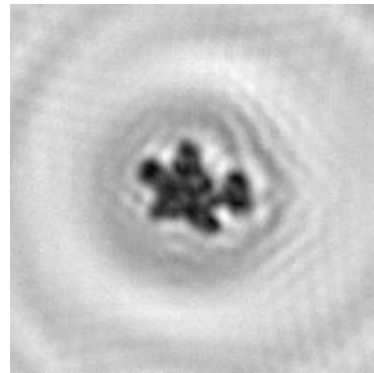# Divers particles images taken by Swisens Poleno
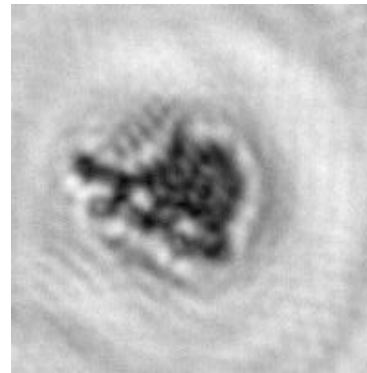

~7μm

115μm

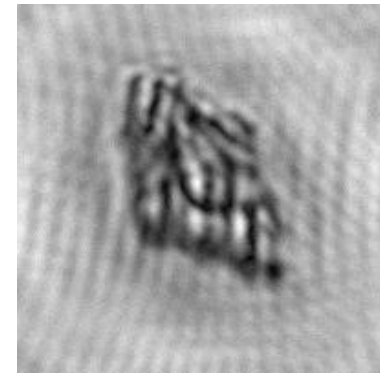# Natural art objects taken by Swisens Poleno (;-)

115μm

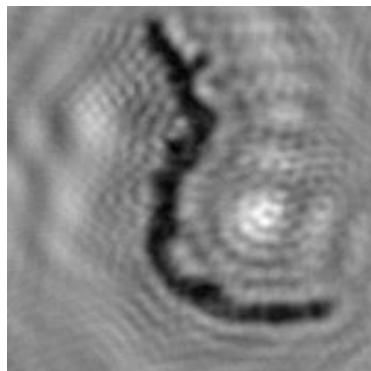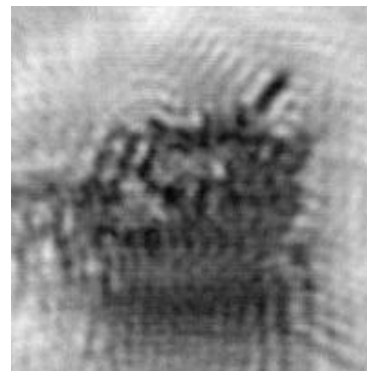Micro bulb   Hammer dwarf   Viking helmet   Space ship

Slim sea horse   Ballerina   Millipede portrait   Wave front
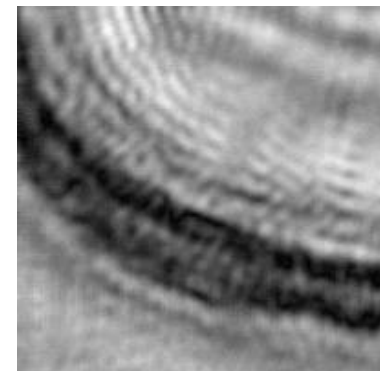
Classifications results presented by MeteoSwiss at ICA2018

First results showing in average better then 90% classification

- Visual inspection allows to **clean** training dataset (e.g. dust, wrong taxa)

- Checking the results with new calibrations not used for training: **confirmed**

- **Very promising first results**, images also helpful for quality control

- Device opens **new perspectives** for research and monitoring
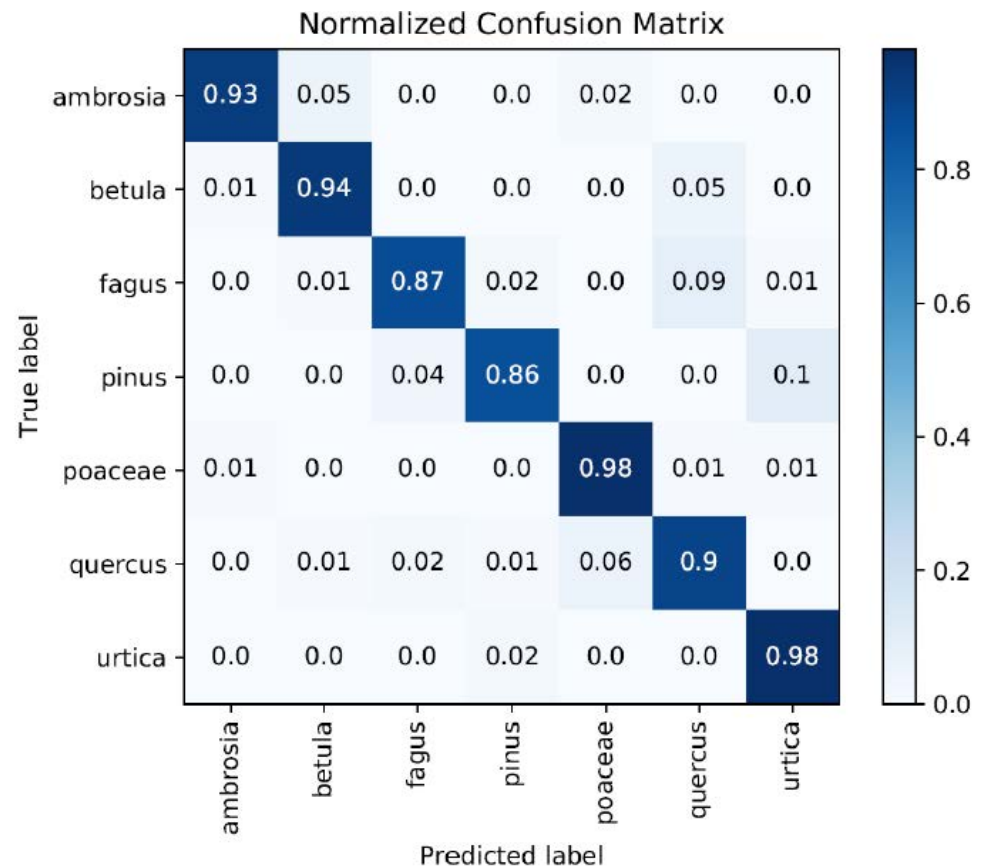
Source: Benoit Crouzy MeteoSwiss

Conclusion for first Swisens product: Swisens Poleno

The new Swisens instrument marks the beginning of a new era for the measurement of bioaerosols

Highlights

- Outstanding pollen-taxation

- High time-resolution

- Low operation costs
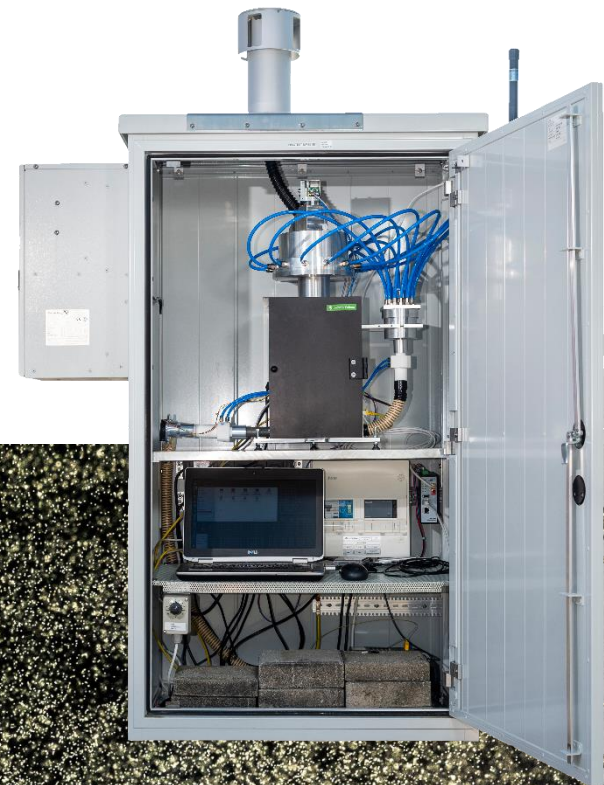
New means for exploring the bioaerosol micro cosmos

Scientists

- Changes in flora can be detected faster

- Developing new methods for qualification of biodiversity

- Tracking of changes of the biodiversity

- Measuring aerosol transport in real-time

- Locate hidden sites of Ambrosia/Ragweed

New means for exploring the bioaerosol micro cosmos

Swisens Poleno enables the discovery of a new world

- Images of particles in flight can be taken

- Library of bioaerosols can be built up

- Visualization of agglomerates on particles

- Measurement of real size and shape of single particles in flight

Contact information / booth number

Contact Swisens

Swisens AG

Technikumstrasse 21
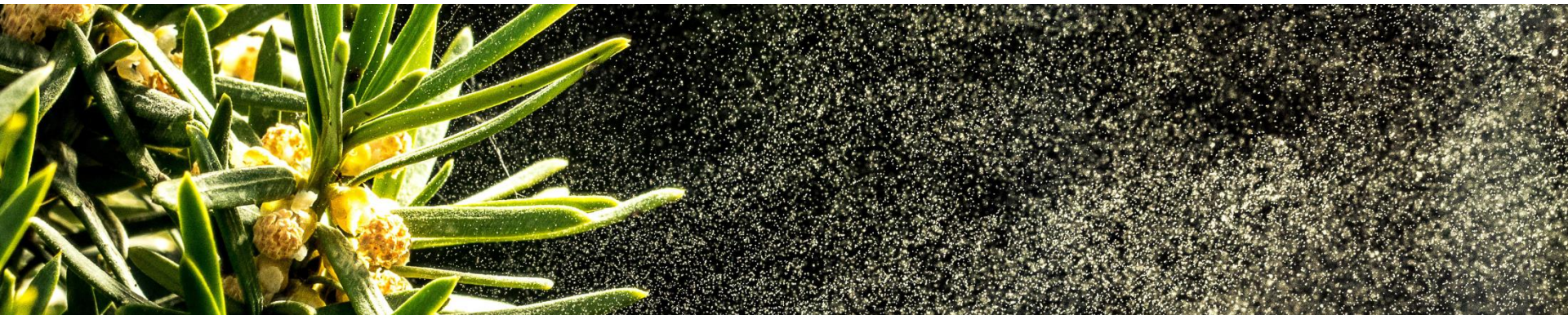
6048 Horw

Switzerland

https://swisens.ch

info@swisens.ch

Visit Swisens AG at MTWX booth 9060

Erny Niederberger
erny.niederberger@swisens.ch

+41 79 761 97 34

Appendix

- About Swisens AG

- Partners

- Swisens Poleno applications

- Benefits

About Swisens AG

- Founded in 2016

- "We want to give back a piece of quality of life to allergy sufferers"

- Spin-off of Lucerne University of Applied Sciences and Arts

- Develops advanced sensing technologies to monitor environmental threats in our surrounding air

- Swisens offers solutions based on optical detectors for real-time airborne bioaerosol monitoring, especially allergens

- Specially developed technology protected by patent applications

Beyond details

Partners

Innosuisse

Lucerne University of Applied Science

- Experts for fluorescence, optics, fluiddynamics, …
- Support through student works (bachelor and master)

Mentoring start-up support: smart-up, genisuisse, CTI-Startup

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Swisens Poleno applications

Automatic pollen-taxa season monitoring

- Designed for fully automatic and continuous long term monitoring of the concentration of the different pollen-taxa

- Identification and counting of the different pollen-taxa which are relevant for allergic people

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Swisens Poleno applications

Pollen-taxa prediction modeling

Modeling of the pollen concentration forecast will become much more accurate

- Particle identification within seconds

- Calculation of the actual local pollen-taxa concentration

- Time resolution in the range of minutes

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Benefits

Lower operation costs

- The time-consuming and expensive manual recognizing and counting of the pollen in the laboratory as well as the collecting and shipping of the adhesive sampling stripes from the pollen traps will be obsolete

- Sampling and identification of the particles is done by the instrument autonomously

- No manual labor is necessary anymore

- Measurement raw data as well as analysis results can be obtained instantly using a network connection

Hirst Pollen trap

Design from 1952

Benefits

Advantage of high time resolution

- Pollen release can instantly be detected

- Tracking of daily as well as seasonal fluctuations of the pollen concentration

- Measure local temporal fluctuations of the pollen-taxa concentrations

- Detect local hot-spots

- Improved pollen forecast

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