Swisens Poleno

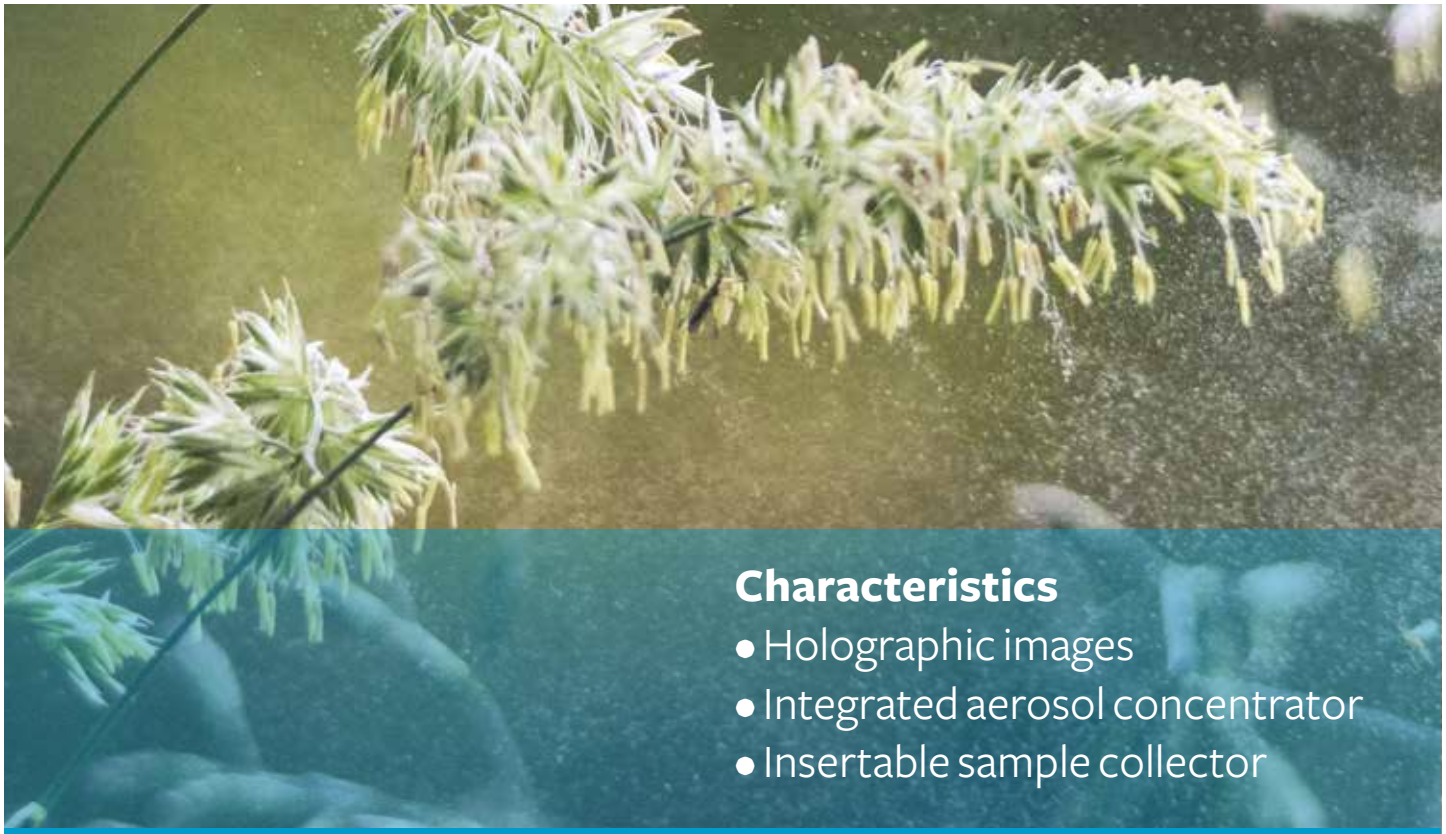
Highlights

- Outstanding pollen-taxation
- High time-resolution
- Low operation costs

Swisens Poleno is based on ground breaking technology for the precise and reliable identification of airborne particles and aerosols. It is specially optimized for the identification of pollen-taxa in real-time and for long-term monitoring. Swisens Poleno marks the beginning of a new era in the measurement of bioaerosols. – **Swisens goes beyond details**

Automatic pollen monitoring – Swisens Poleno is designed for the fully automatic and continuous monitoring of the concentration of the different pollen-taxa in the air relevant to people with allergies.

Pollen-taxa prediction modeling – Particle identification within seconds allows for the calculation of the actual local pollen-taxa concentration with a time resolution in the range of minutes. This data can be used as input for pollen forecasts and numerical models.



Characteristics

- Holographic images
- Integrated aerosol concentrator
- Insertable sample collector

Overall Benefits

Better and reliable quality of pollen-taxa data

Swisens Poleno provides the most independent characteristic values per particle available on the market. It renders a mosaic of information about the particles going through the system including high-resolution images of every single particle. Based on this rich dataset and in combination with state-of-the-art classification algorithms, outstanding quality of the classification results is achieved. Thanks to the images, the verification of the measurement from every single particle can be made simply and intuitively.

High resolution local pollen-taxa concentration

The unique aerosol-concentrator of Swisens Poleno enables an unprecedented time resolution. Based on the information provided by the instrument in real-time, the beginning of the pollen release can be detected instantly, and daily as well as seasonal fluctuations of pollen concentration can be tracked. The real-time data with a time resolution in the range of minutes can be used to improve pollen prediction, detect local hot-spots and measure the local temporal fluctuations of pollen concentration.

Real-time data of local pollen concentration

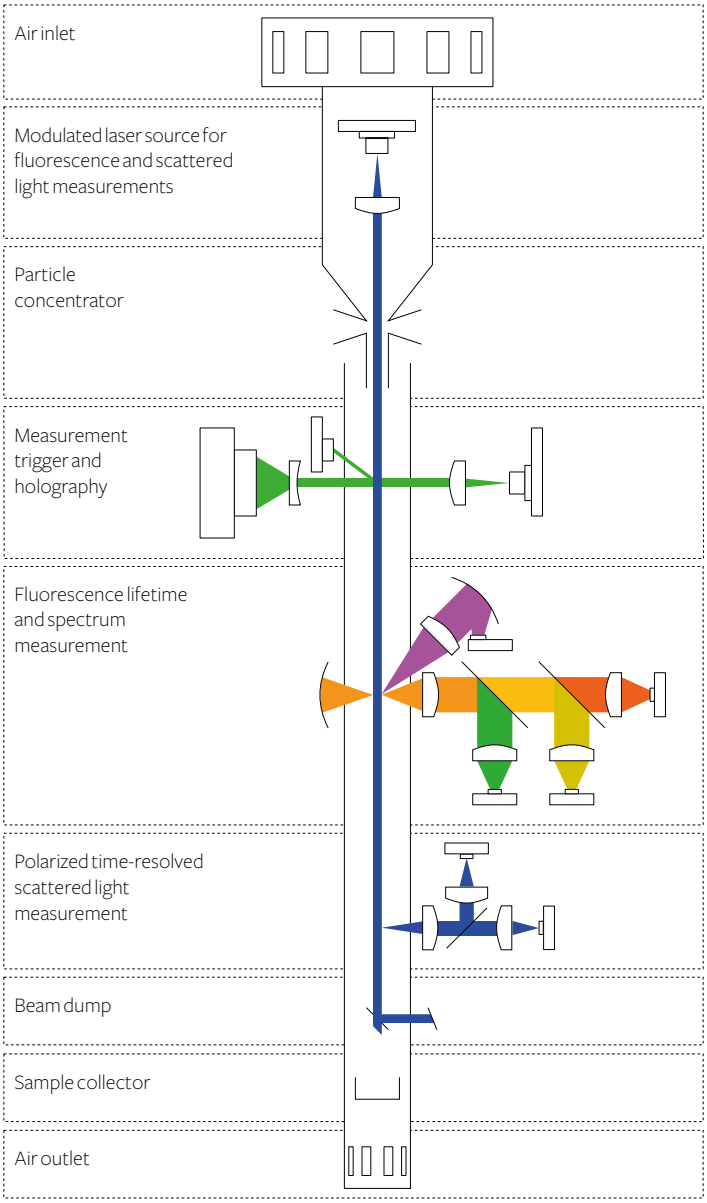
The time-consuming and expensive manual identification and counting of pollen in the laboratory as well as the collecting and shipping of adhesive sampling stripes from the classic Hirst-type pollen traps will be obsolete. The sampling and identification of particles is done by the instrument autonomously. Manual labor is no longer necessary. The raw data as well as analysis results can be obtained instantly using a network connection.

Low operation costs

The whole measurement equipment in Swisens Poleno is semiconductor-based and does not require periodical replacement. The device is designed for an operating time of at least ten years and a maintenance interval of nine to twelve months depending on the air pollution.

Integrated removable sample collector

To examine the system‘s performance and to validate its functions, a petri dish can be inserted into the measuring channel as an impaction filter. Aspirated particles accumulate on it and can then be evaluated manually and compared with the data measured on the device.



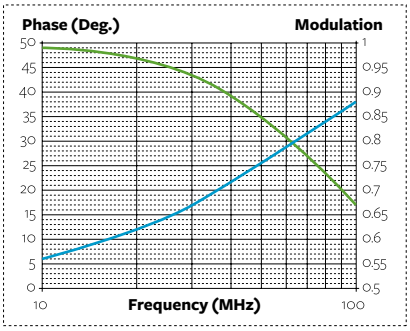


Figure 1 above: Fluorescence lifetime measurement data visualization

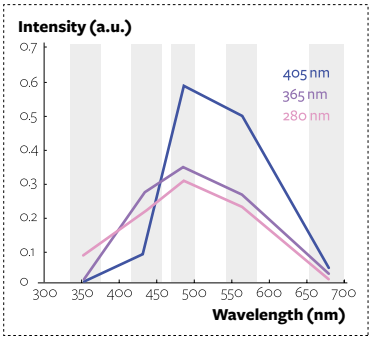


Figure 2 right: Fluorescence intensity measurement data visualization

Figure 3 left: Swisens Poleno schematic overview

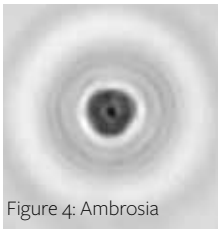


Figure 4: Ambrosia

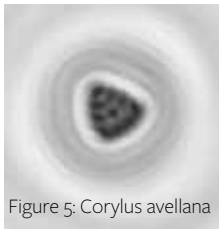


Figure 5: Corylus avellana

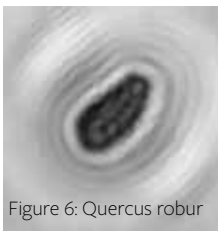


Figure 6: Quercus robur


Figure 7: Fagus sylvatica

Function principles

The schematic structure of the device above shows an air-flow cytometer based on the analysis of light scattering, holographic images and UV-induced fluorescence. With these measurement methods, many independent features can be determined, allowing for excellent quality of particle identification.

An aerosol-concentrator with a concentration factor of 1000 enables a volume flow rate of 40 liters per minute to be analyzed, which enables high time resolution for the measurement of local pollen concentration down to minutes.

Morphological features

Information about the morphology of each individual pollen-grain is collected with a high-resolution holography setup delivering images of the particles. The advantages of the setup include a wide field of view in x, y and z-axis while maintaining a very high resolution. Figures 4 to 7 show reconstructed images of pollen grains taken in flight with the holography measurement setup. The whole image shows an area of 115 x 115 µm².

The time-resolved measurement of the vertical and horizontal polarized scattered light provides information about the surface structure, size and the polarization factor.

Biochemical composition

Complementary information in addition to the morphological features is collected by spectrally resolved fluorescence intensity and fluorescence lifetime measurements. This characteristic value delivers an additional dimension of information and allows for the extremely accurate identification of the different pollen-taxa.

Figure 1 shows the correlation phase and correlation magnitude for a single particle measured at different modulation frequencies. By means of curve fitting the different lifetime components can be extracted. Figure 2 shows the fluorescence intensity measured at five different wavelength ranges between 320 and 750nm. There are three different modulated light sources to excite the particles while flying by.

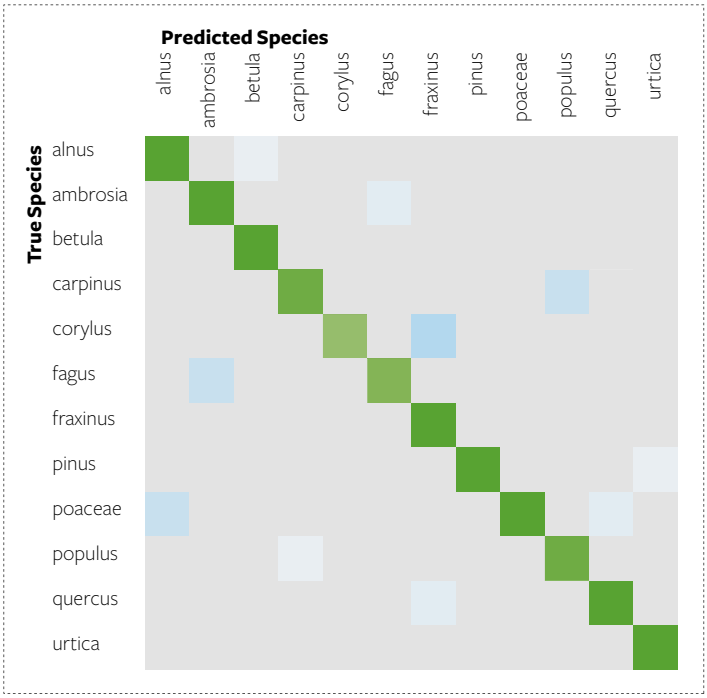


Figure 8: Identification quality shown by the confusion matrix

Automatic pollen-taxa identification

The multifaceted mosaic of information gathered from each particle passing through the system is processed by state-of-the-art machine learning algorithms / neuronal networks. Figures 9 to 12 show the region of interest the algorithm is trained to regarding to the holographic images.

Performance

These algorithms are integrated in each instrument and complete the classification with the help of a calibration library which can be updated online. Nevertheless all raw data is accessible for the user as well. Alternatively, the raw data can be uploaded to a cloud server to be processed there.

The confusion matrix in Figure 8 shows the outstanding performance of Swisens Poleno. More than 12 different pollen species can be separated with very good quality.

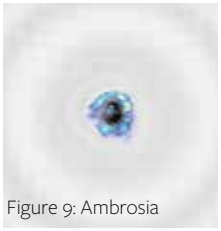


Figure 9: Ambrosia

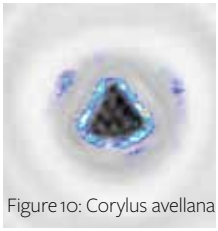


Figure 10: Corylus avellana

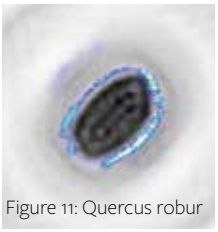
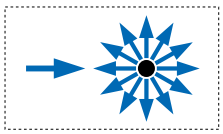


Figure 11: Quercus robur

Figure 12: Fagus sylvatica



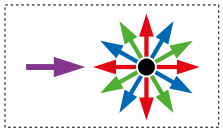


Figure 13 above: elastic light scattering

Figure 14 below: fluorescence emission

Measured physical properties

Elastic light scattering / stray light

Figure 13 visualizes the principle of elastic light scattering. The large blue arrow on the left indicates the illumination light. This light hits the particle (black dot). The surface of a particle typically reflects and absorbs part of the incident light. The small size of the particles also leads to diffraction, which in addition to reflection and absorbtion causes non-uniform stray light patterns characteristic for various particles.

Autofluorescence

Autofluorescence is the natural emission of light by biological structures after an appropriate excitation. For example, pollen and spores are autofluorescent. The light emission depends on the autofluorescent molecules of the biological structure and the excitation wavelength. Measuring the fluorescence emission spectra and the fluorescence lifetime of different pollen-taxa makes it possible to distinguish between them.

Spectral fluorescence intensity

Figure 14 illustrates the fluorescence effect when a fluorescent particle is illuminated. Fluorescence occurs after a fluorescent particle has absorbed energy / photons. The large violet arrow on the left indicates the illumination, also called excitation light. A fluorescent particle emits light with a longer wavelength than the excitation light. In Figure 14 the excitation is for example in the ultra-violet region and could be 360 nanometers. The fluorescent emission maybe in blue, green and red which is in the range of 320 to 750 nanometers.

Fluorescence lifetime

The fluorescence lifetime refers to the average time the molecule stays in its excited state before emitting a photon. Typical lifetimes with excitation in the range of UV to near infrared are within 0.5 to 20 nanoseconds. The fluorescence lifetime values provide additional information on the sample and allow for improved quality of differentiation of biological particles like pollen-taxa for example.

Features

- Long-term measurements
- Insulated weatherproof housing
- Adaptable to customer needs

Specifications of Swisens Poleno

Particle type
Pollen, spores, airborne solids

Particle size range
1 µm to 300 µm

Air inlet
Sigma-2 geometry

Max. recom. particle concentration
30‘000 particles per m^3

Sampling time
Continuous operation

Flow rate
40 l/min

Particle concentrator
Concentr. factor 10 to 300 µm: 1000

Holography setup
Two 90° displaced images per particle
Pixel resolution: 0.56 µm/pixel
Number of pixels: 2048 x 1536
Frame rate: up to 55 images/second

Polarization measurement
Time resolution: 4 µs

FL excitation
LEDs: 280 nm, 365 nm
Laser diode: 405 nm

FL emission measurement ranges
Five carefully chosen spectral windows in the range of 320 to 750 nm

FL lifetime measurement range
0.5 to 20 ns for each of the five spectral windows

Power
100 to 240 VAC, 50/60Hz, 38W excl. integrated computer and HVAC

Ambient conditions
10°C to 40°C, 10 to 90% R.H., non-condensing. For field operation, the device must be installed in a weatherproof housing (see accessories).

Dimensions
~ 30 x 30 x 50 cm^3

Weight
23 kg

Communications
Ethernet, GSM/UMTS/LTE

Consumables
No consumables
(no filter change required)

Included items
- Analytical instrument
- Internal computer
- Software

Warranty
Two years

Optional accessories
- Air-conditioned weatherproof housing
- GSM/UMTS/LTE modem with antenna
- Sigma-2 inlet
- Integration of sensors for gauge air temperature, relative humidity, radiation, wind direction, wind speed on request

Contact information
Swisens AG
Technikumstrasse 21
6048 Horw
Switzerland

https://swisens.ch
info@swisens.ch

About Swisens AG
Swisens AG was founded in 2016 as a project spin-off of the Lucerne University of Applied Sciences and Arts. Swisens AG develops advanced sensor technologies to monitor environmental threats in our surrounding air.

„We want to return some quality of life to allergy sufferers“. Swisens offers solutions based on optical detectors for real-time airborne bioaerosol monitoring, especially allergenic particles.

Visit our website at: https://swisens.ch