



PHENOAI|XPERT PRO

The Versatile Phenotyping
System for Laboratories

LemnaTec Alxpert Product Family

Documentation, Phenotyping, Seed Testing and more

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The Versatile Phenotyping System for Laboratories

The PhenoAlxpert Pro product family combines powerful analytical software with a range of hardware options. Thereby it enables reproducible and standardizable results in

plant research, breeding, product development, quality assessment, and beyond.

Features

- Image acquisition, storage, and advanced image analysis including machine learning options
- Metadata, annotation, and analysis directly linked to image
- Intuitive graphical user interface
- Advanced LED illumination options
- The laboratory phenotyping system is available with industry-grade cameras in horizontal-, vertical-positions, combined with different lighting and imaging technologies
- Phenotypic data include count, size, morphology, and color, as well as application-specific features
- Easy export of images and data



We bought a LemnaTec LabScanalyzer (the predecessor of PhenoAlxpert) in July 2018. The instrument was delivered to us and installed remotely by a Lemnatec technician that instructed us about the use of the instrument. We were happy about the service: very good communication and excellent instrument set-up. The Lemnatec LabScanalyzer works nicely and is even more user-friendly than we expected. Almost no training of new users is needed. We hope to expand the uses of the instrument to obtain additional phenotyping options in the future, by interacting with LemnaTec.

*Prof. Pierdomenico Perata
School of Advanced Studies, Pisa, Italy, Institute of life science*



Software Package

The PhenoAlxpert is delivered with a comprehensive software package. The software enables the users to provide sample information and control cameras and lights. After imaging all data are stored and accessible for image and data processing.

LemnaControl is the interface with which users operate the system. With LemnaControl, users carry out all settings that are required for image recording with the system. In particular, this comprises settings for the camera(s) and lights included in the system. All settings can be combined and scheduled to configure recordings. The available functions are tailored to the corresponding hardware. Each hardware system delivered by LemnaTec comes with its own control

software adapted for the functions of that system.

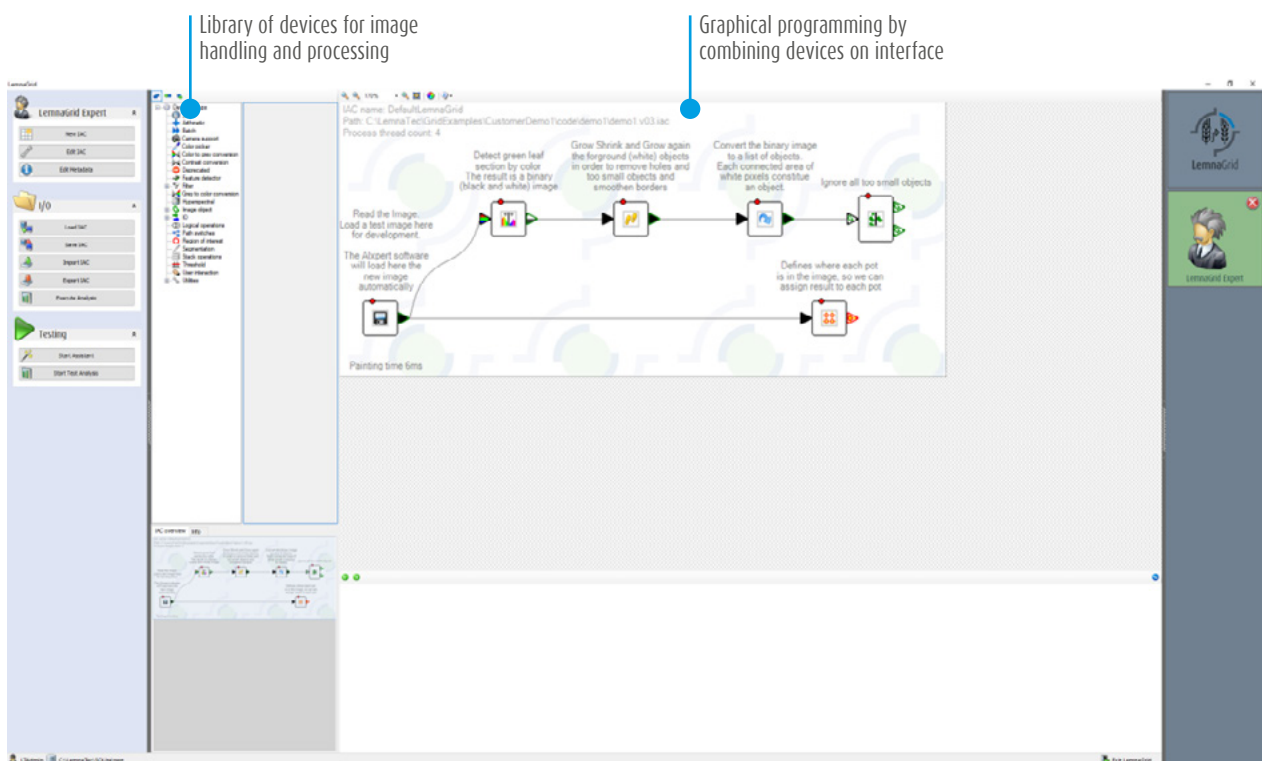
The LemnaGrid software module uses an intuitive graphical programming environment, which allows for easy integration of different image analysis algorithms. LemnaGrid phenotyping software offers high flexibility for user programming. The image processing workflow extracts desired properties/features from the original image and stores results in a dedicated storage system. LemnaGrid can include functions of state-of-the-art machine learning tools, next to standard image analysis to detect and extract features of interest. Guided by the LemnaGrid graphical user interface, users can build their own analytical workflows with pre-defined devices.

Analysis devices include:

- filters
- threshold functions
- image converters
- object detectors
- feature detectors
- color analysis tools
- region of interest function
- combinatory functions
- and many more

All devices – graphically represented by boxes – can be combined on a interface by aligning the boxes to workflows. Along such workflows, each function can provide insights in the progress of the analysis by feeding out an

intermediate image. Image processing workflows can include branches and parallel paths that combine to a final result.



LemnaExperiment serves to manage experiments and measurements, and to schedule and run analyses. Moreover, it enables viewing, visualizing, and exporting results. It provides capabilities to access and browse through recorded images and to display metadata for samples and measurements. As core function, LemnaExperiment selects

recordings for analysis and assigns an image analysis pipeline –written in LemnaGrid or in Lemna3D– to a given set of recordings. After assignment, the analyses are run in the background by the Analysis Executor. Parameters of interest can be selected in LemnaExperiment so that they are displayed in the analysis output.



Imaging and Lighting Options

Standard RGB imaging

- Minimum 12 MPix RGB industrial camera with prime lens for distortion-free imaging
- Optimized white LED illumination

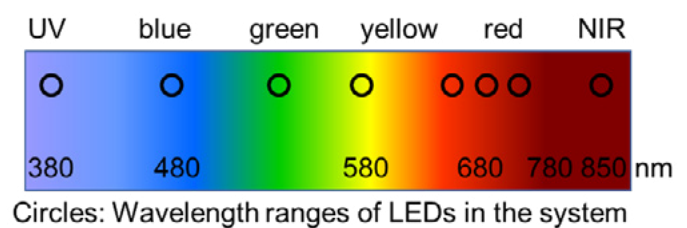
Multispectral and fluorescence imaging option

Multispectral and fluorescence imaging is available for shoot imaging using multi-channel LED pa-

nels combined with a dedicated camera and filter system

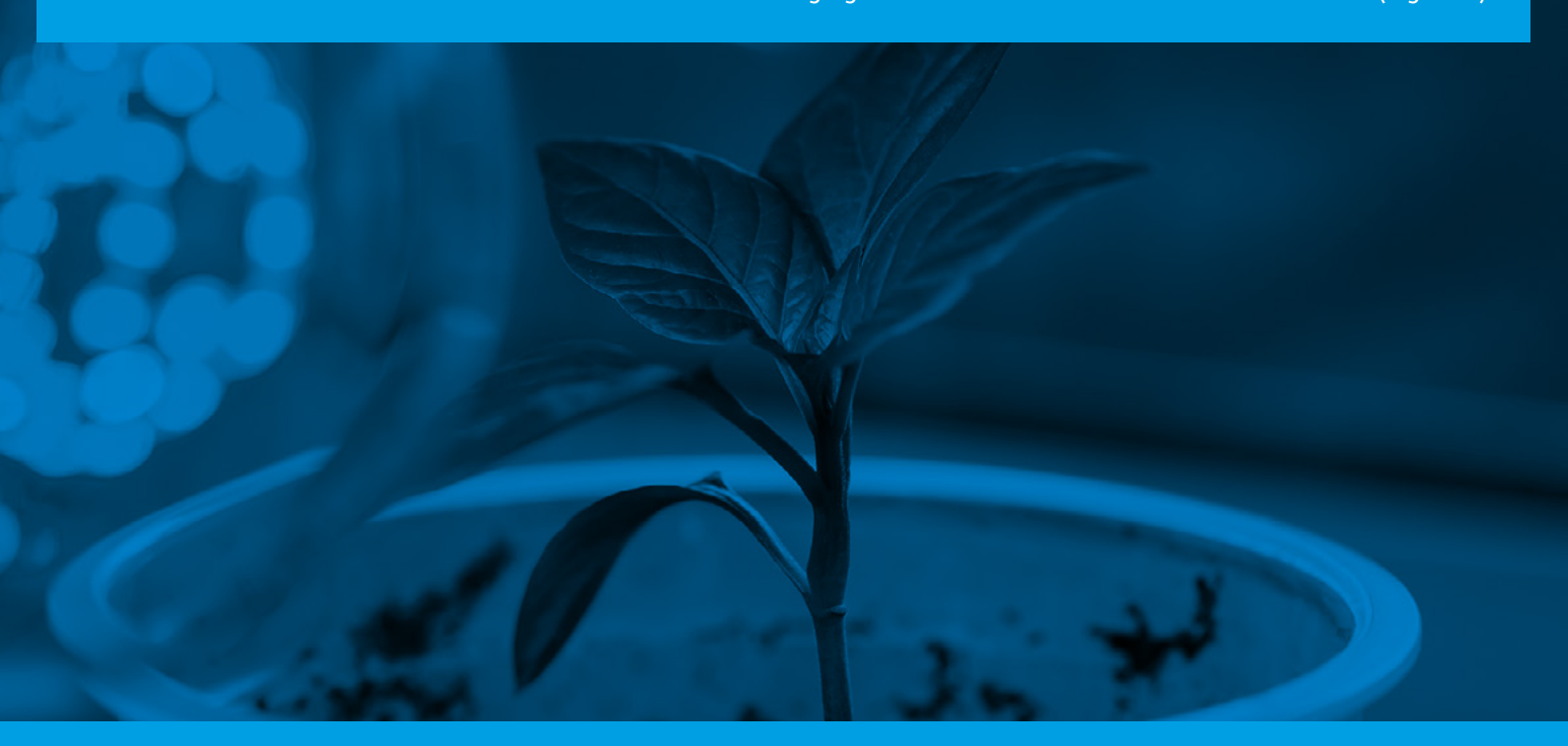
- 16 MPix Greyscale camera with prime lens for distortion-free imaging
- LEDs with a range of different wavelengths – camera images 16 MPix per channel
- Filter wheel for up to 6 different filters for filtering reflected or emitted light

In a typical setup, the LED array consists of UV, blue, green, yellow, red, deep red, far red and near-infrared wavelength LEDs. Thereby, an advanced analysis of the red edge is enabled as different images in the red range are provided and can be used for ratio calculation. The filter wheel enables filtering for reflectance or fluorescence, e.g. in the chlorophyll fluorescence range.



Multi-channel LED illumination combined with filters enables various imaging settings

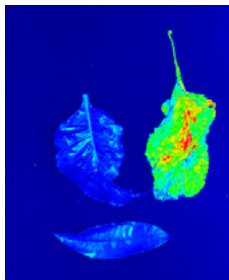
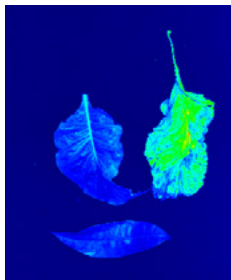
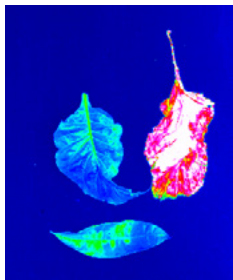
- Channel-wise imaging
- NDVI and other indices
- Chlorophyll autofluorescence
- Combination of channels
- Fluorescence imaging
- Fluorescent biomarkers (e.g. GFP)



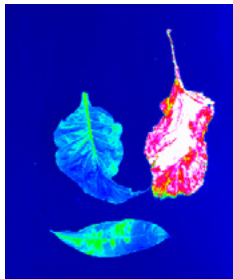
Multispectral imaging example with intact leaf (left) dead dry leaf (right) and stress-damaged leaf (bottom)



Combined RGB channels



Red, green, and blue channel imaging – color-coded visualization of reflectance



Combining red and infrared image (color-coded visualization of reflectance) to NDVI image (greyscale intensity of NDVI values: light-grey high NDVI, dark-grey low NDVI)

Hardware Options

PhenoAlxpert Pro

- PhenoAlxpert Pro – top and side view imaging and phenotyping.
- Horizontal and vertical views of plants, and multi-view imaging using a turntable for pots.
- Optional multispectral and fluorescence imaging in top-view and side-view



Optional Accessories

- Sample holders for pots - easy positioning of the samples
- Recessed sample holder for plants up to 600 mm height (not in combination with turntable unit)

800 mm x 1800 mm footprint

1780 mm height

Weight: approx. 475 kg

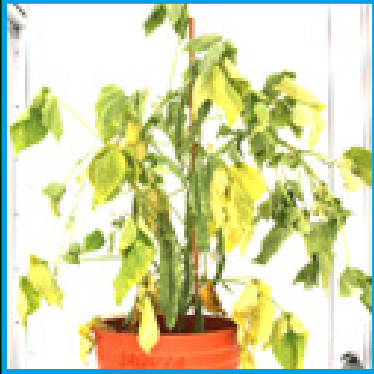
Optional Accessories (all versions)

- Barcode reader

Future features

- Database connectivity
- Cloud services

Application Examples



Bean Phenotyping

Bean plants were exposed to stress and phenotyped for stress responses. Images were recorded and processed with PhenoAIxpert Pro. This system enables vertical and horizontal multi-view imaging. Phenotypic traits comprise growth, morphology, and color analysis, e.g. as stress indicator for chlorosis and necrosis.



Arabidopsis Growth Assay

Trays with growing Arabidopsis plants were imaged with PhenoAIxpert and images were processed for plant growth, morphology and color. Individual plants were identified and phenotypic properties of their visible plant area were assessed. Such tests serve for e.g. candidate screening, genetic studies, treatment effects, environmental responses.

**Zealquest AI Netherlands B.V.**

Sir Winston Churchilllaan 299a, 2288 DC, Rijswijk, The Netherlands

Zealquest Asia Pte.Ltd

101, Thomson Road #28-03A United Square Singapore 307591



info@zealquest.com



[www.zealquestgroup.eu\(NL\)](http://www.zealquestgroup.eu(NL))
[www.zealquest-asia.sg\(SG\)](http://www.zealquest-asia.sg(SG))