

From the Seed to the Plant

Advanced Technology for
Controlled Climatic Conditions
for Cultivation of Test Plants



- | | | | |
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| 1 | Company | 7 | Light |
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Production of Environmental Simulation Equipment for

1. Research

2. Development

3. Quality Control



Certified Quality for a Fair Price

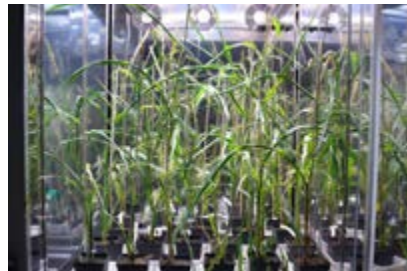
- Optimum quality for a fair price
- Certification according to DIN ISO 9001-2015
- Made in Germany
- ATEX Certificates for Safety T-Line and X-Line
- Environmental Management System
- Customs Certification (AEO)



Life Science



■ In Vitro Cultivation



■ Plant Growth



■ Bees



■ Arabidopsis



■ Protein Crystallization



■ Seed Test



■ Drosophila Breeding



■ Algae Toxicity
according to ISO8692

Plant growth cabinets for smaller test series

- 6 Design Sizes from 210 to 1700 Litres
- Attachment parts can be easily removed for insertion
- Space-saving high design
- Suitable for high growth height or with 2-3 light levels for low growth height

**P 210****P 350****P 530****P 850****P 1060****P 1700**

Plant growth cabinets for large test series

- Individual size, configurable pattern of 100 mm
- Much space for larger test series
- High growth height possible
- Height adjustable lamp shelves, space-saving for low growth height



The 4 Environmental Parameters

Temperature



Humidity



Light



CO₂



The Temperature

Precise and constant

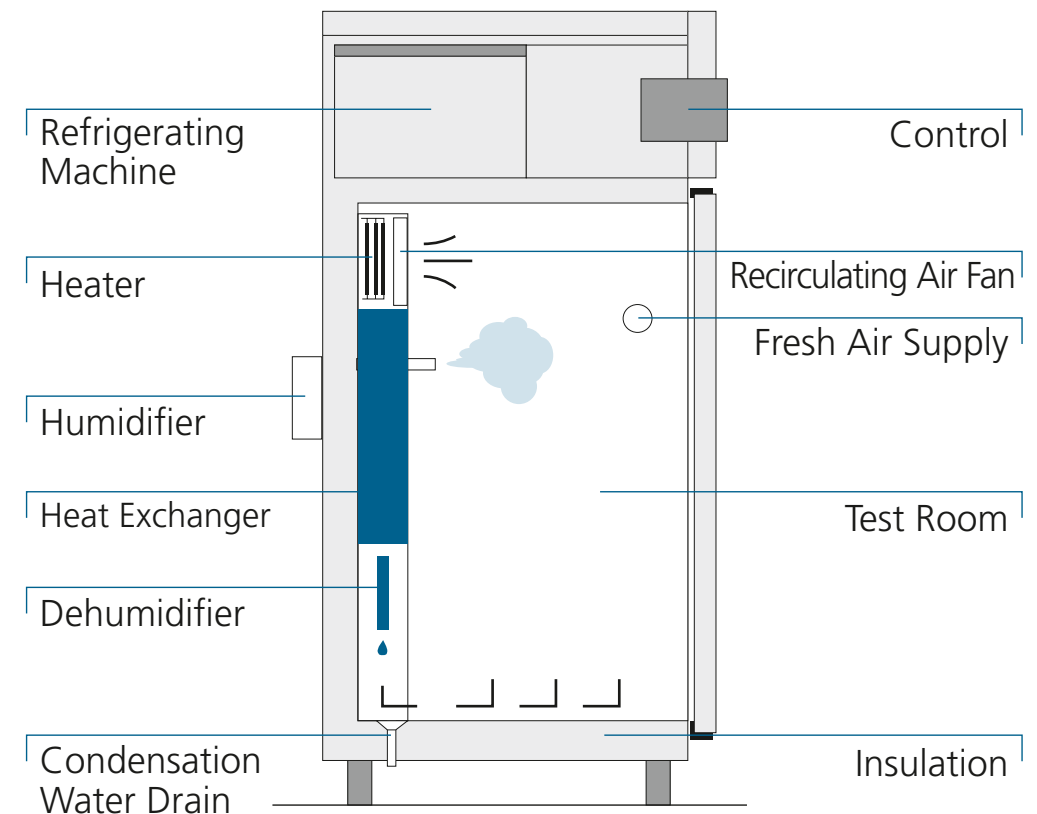
Standard: 0 to +50°C

Optional for icing tests: -20°C



Appliance Features:

- Heater with continuous and contactless control for fine dosing
- Recirculating air with defined air conduction via vertical flow channel for optimum temperature distribution in space
- Recirculating air fan with continuous control avoids drying of cultures



Efficient Refrigeration Technology:

- Precise cooling due to solenoid valve bypass circuit
- Full cooling capacity is available anytime and can be activated on demand
- Fan of the refrigerating machine with speed control for noise reduction
- Partially vibration-free for application protein crystallization
- If cooling capacity had not been required for a longer period, the chiller will be switched-off automatically
- Annual tightness test is not required, since the CO₂ equivalent is significantly below 5,000 or 10,000 kg

Exemplary calculation for P 1700 (0 °C):

$$\begin{aligned} \text{GWP} \quad \times \text{Refrigerant} &= \text{CO}_2\text{equivalent} \\ 4 (\text{GWP}) \times 1,3 \text{ kg (Refrigerant)} &= 5,2 \text{ kg} \\ &< 5.000 / 10.000 \text{ kg} \end{aligned}$$

Refrigerant Overview:

| Unit Type | old | | new | |
|-----------------|-------------|-----------|-------------|--------------------|
| | Refrigerant | GWP-Value | Refrigerant | GWP-Value |
| ECO | R 134a | 1430 | R 600a | 3 |
| Premium (0°C) | R 134a | 1430 | R 1234 yf | 4 |
| Premium (-30°C) | R 404A | 3922 | R 452A | 2141 (temporarily) |
| | | | R 290 | 3 (under test) |



Compressor

versus

Peltier

High cooling capacity
Independent of the ambient temperature

Rather minor cooling capacity depends on
the ambient temperature

Expensive

Low-cost

Low current consumption

High current consumption

Temperature range -30°C to +80°C

Temperature range +10°C to +80°C

Suitable for almost all applications

Universal application is not possible

Running noise of the compressor + fan
(RUMED execution is quieter due to output-
related speed control of the fan)

Running noise only from the fan,
since the fan is required for cooling of the
hotter side

The Humidity

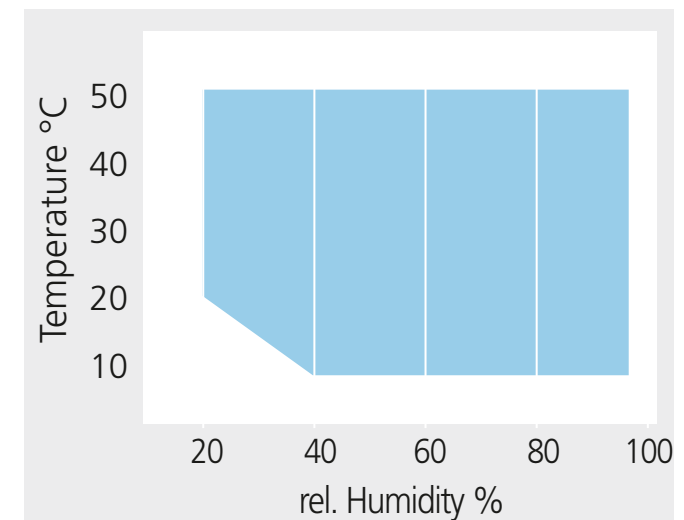
Decisive for the optimum climate

Humidity range up to
95 % relative humidity



Advantages of the Ultrasonic Humidification:

- High humidity values with low temperature possible
- Hardly any energy consumption (approx. 45 instead of 1,000 Watts for steam humidification)
- Hardly any heat introduction into the test room, so counter cooling (=dehumidification) is avoided and humidity accuracy is improved
- Immediate availability of humidity on demand. Thus, time-consuming water boiling, such as with vapour, is not required. Hence, the humidity accuracy is improved due to the quick reaction of the humidifier.
- Hardly any water consumption, which results in low formation of condensate. (Solution with canister is possible: rinsing of the humidifier is omitted!)



- Customer saves installation costs for water and sewage water
- Flexibility concerning installation or later displacement of the unit
- Not every room has a water and sewage water installation (such as basement rooms)
- Condensation of the humidity at a special plate dehumidifier; the water leaves the unit directly through the condensate drain
- Fully automatic defrosting
- Condensate collecting vessel for manual emptying or condensate evaporation pan
- No installation costs, full flexibility concerning the choice of the location



The Lighting

The Right Variant
for Every Application

Lighting to max. 800 $\mu\text{E}/\text{sm}^2$



Light Parameters

Direction of light incidence

- From above
(natural direction)
- Light from the sides
(highest flexibility concerning the height arrangement without shading)

Intensity

- Change is possible by dimming or by variation of the distance plants/lamps
- With double distance the luminous intensity is only a quarter
- Therefore, the indication of the intensity is important, for instance $300 \mu\text{E}/\text{sm}^2$ with a distance of 300 mm

Spectrum

- Not only the height of the luminous intensity is important
- The exact spectral distribution counts
- Blue light has a higher energy than red light. But if the share of blue light is too high, the plants will still not grow

Lamps



**Thermal Insulation
with High
Luminous Intensity**



**LED-Light Bars
(Level Lighting)**



**LED-Light Bars
(Lateral Lighting)**

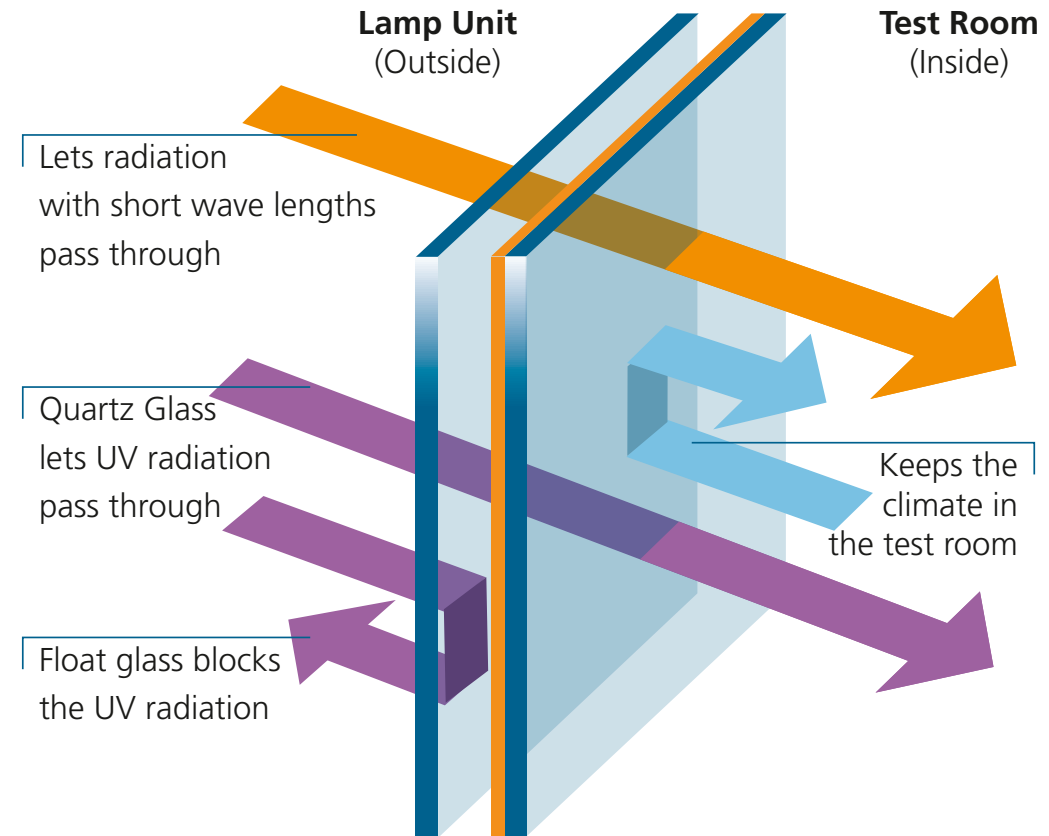
Thermal Insulation of the Lighting

Advantages:

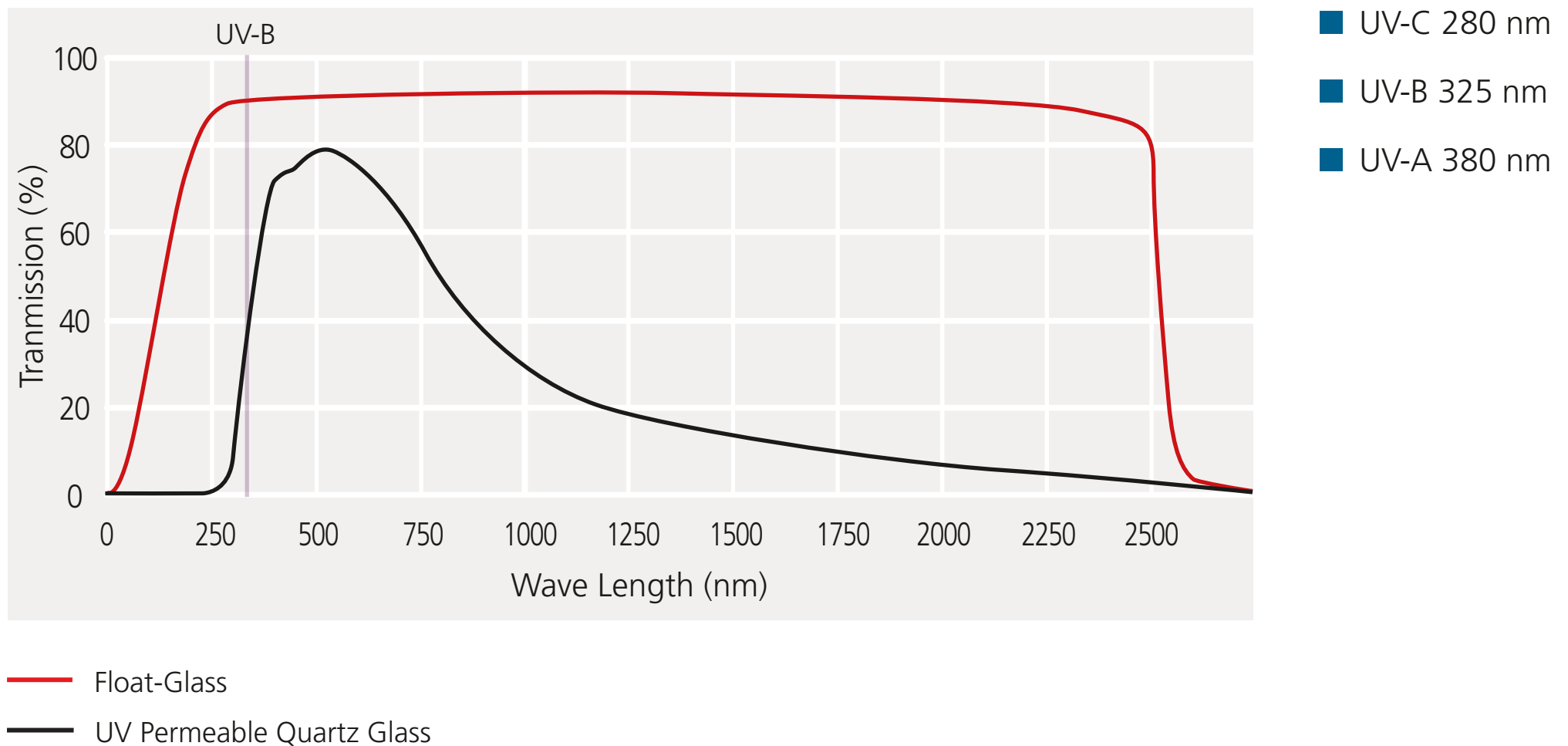
- The waste heat of the lighting will be dissipated directly out of the lamp by means of fans
- Energy-saving, since the waste heat is not dissipated via the refrigerating system, but it is dissipated directly
- Even with powerful lighting, the climate in the plant growth cabinet remains largely unaffected

Disadvantages:

- This is not possible in case of level lighting/light shelves due to design
- Low/small transmission of the UV share with float glass



UV Permeability with Thermal Insulation



Characteristics of the Fluorescent Lamp

Advantages:

- Cost-efficient
- Easy replacement by the user
- Variation of the spectrum with change of the fluorescent lamp type (such as Daylight, Grow-Lux, Bio-Lux etc.)
- Low heat dissipation into the test room (ballasts can be arranged outside the test room)
- Mixed spectrum possible (in this case, group connection is required)
- Dimmable
- Directed light with reflector
- Energy-saving

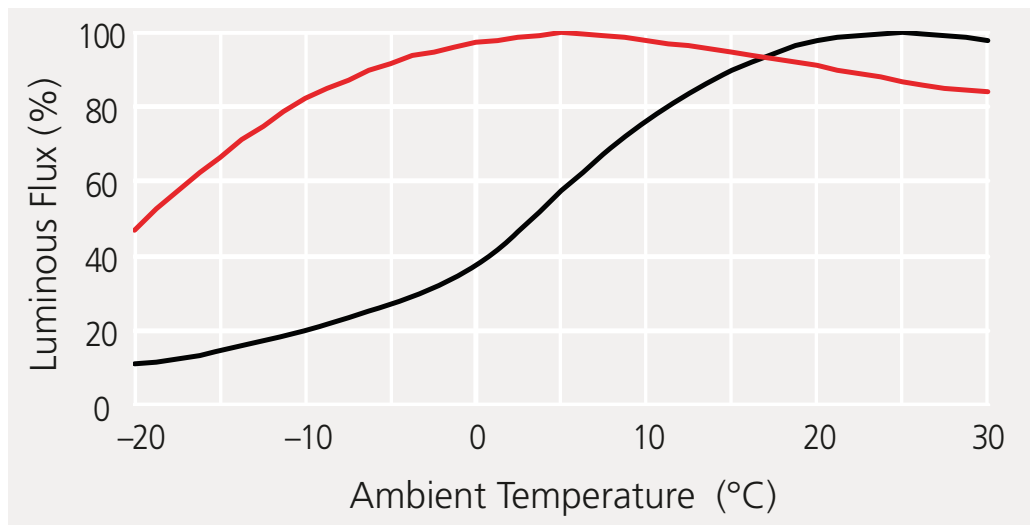
Disadvantages:

- Only particular dimensions are available
- Availability is more and more reduced in the future



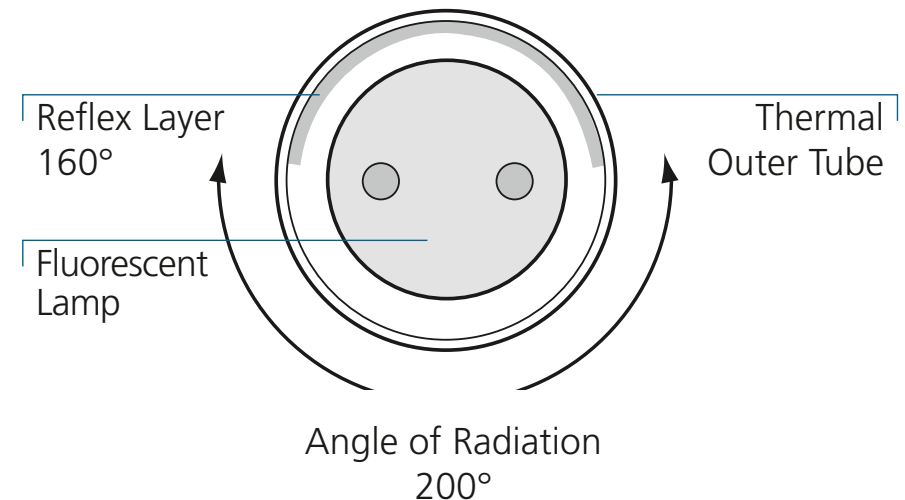
Design and Efficiency of Thermal Reflector Fluorescent Lamps

Relative luminous flux in dependence of the temperature



— Thermal Execution Ø38mm

— Normal Execution Ø26mm



Advantages of LED

- Dimmable
- Energy-saving
- Homogeneous light distribution via incorporated lenses
- Level lighting can be removed easily for cleaning or with plants of larger growth height (low weight and thin cables with special plug)
- Individual spectral components can be controlled on the basis of daytime and intensity via our multi-channel control
- Space-saving due to extremely flat design (10 mm)



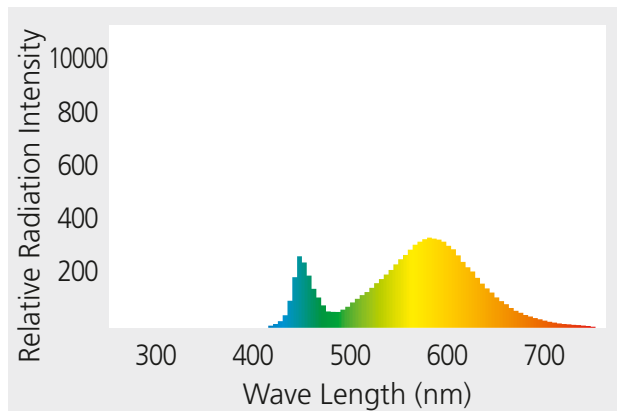
Disadvantages of LED

- Not suitable for high temperatures
- Not powerful in the UV Range

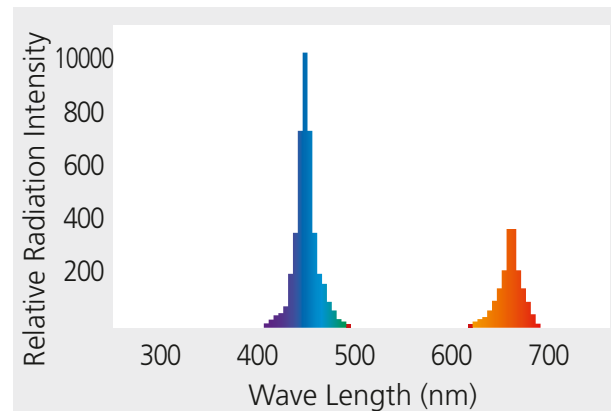


Spectral Distribution of Radiation of the Lamps

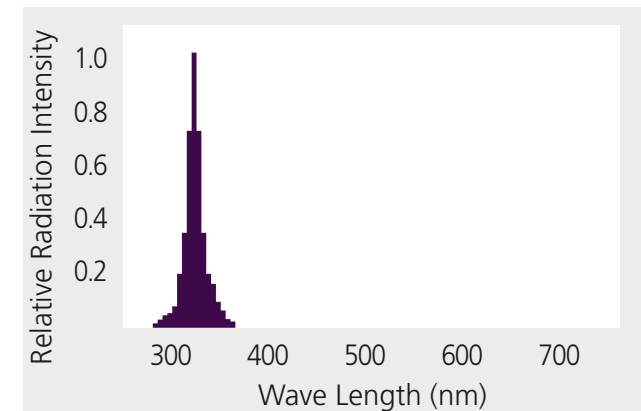
LED Warm White



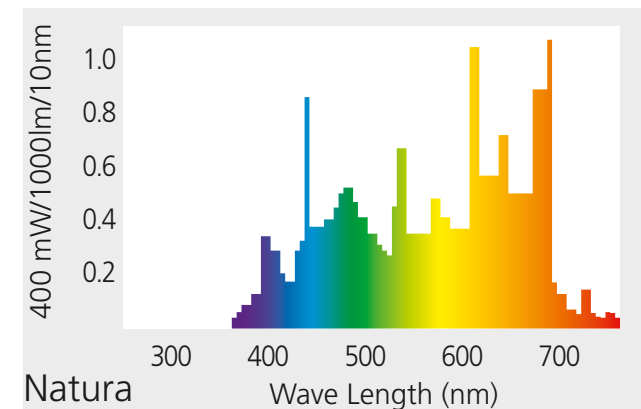
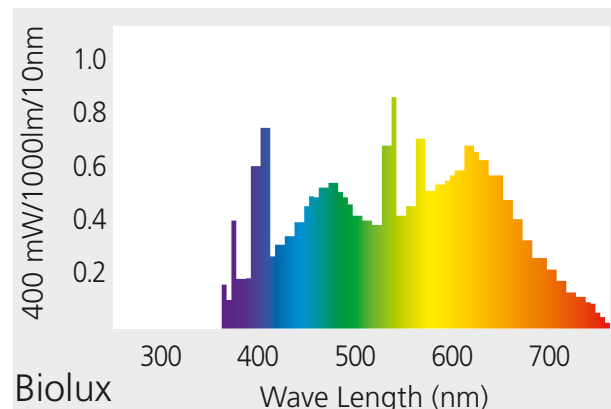
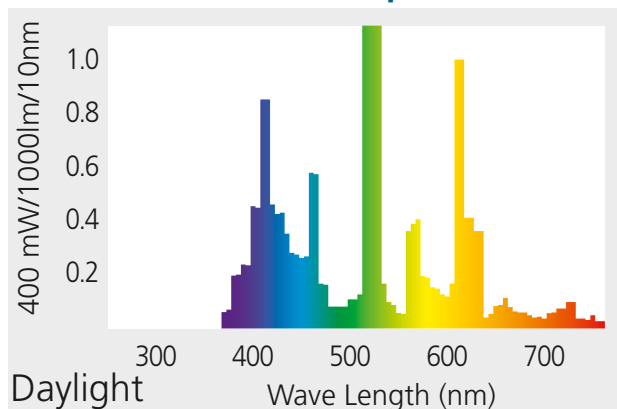
LED Plant Growth



UV Fluorescent Lamps



Fluorescent Lamps



Air Flow

- Extremely high heat introduction by lamps in the lighting shelves
- Cold air is blown in to keep the temperature constant
- Adjustable air inlets, which are specially designed by us, ensure the following:
 - Strong air flow in the area of the fluorescent lamps (sources of heat)
 - Air flow at the plants max. 0.3m/s



Plant Growth Cabinet with Lamp Shelves
(approx. 16 KW waste heat of lighting)



Irregular plant growth, if the flow rate of cold air is too high

Light from Above

- Natural lighting equipment
- Lighting above the test room. Thermal insulation by double glazing for high luminous intensity
- Lighting installed below the test room ceiling for low luminous intensity
- Disadvantage: only one charging level advisable (shading)



Lighting in several levels

- Lighting is arranged directly in the test room
- Lighting is removable and adjustable in height
- Thermal insulation is not possible
- Optimum utilization of the test room height for cultures with low growth height
- Different luminous intensities on the individual levels are possible by means of the multi-channel light control



Light from Both Sides

- Arranged in the test room or thermally insulated by means of a double glazing, if outside the test room
- Full flexibility concerning the distribution of the shelf height
- High luminous intensities are possible with thermally insulated lighting arranged on the outside
- Optionally with UV permeable glazing, if the UV share is relevant for the tests



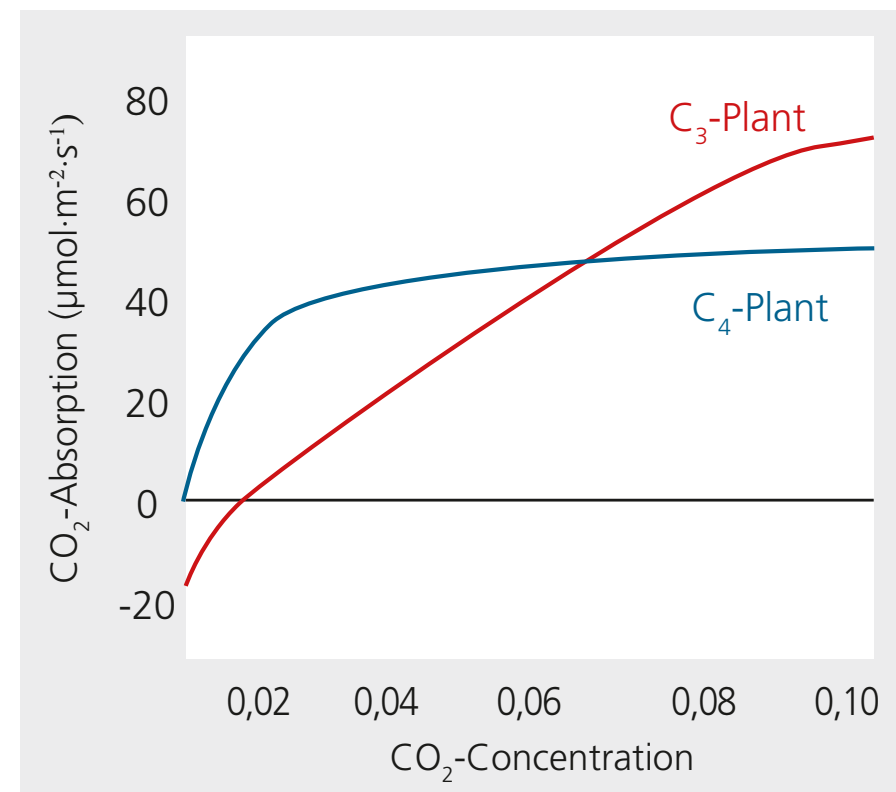
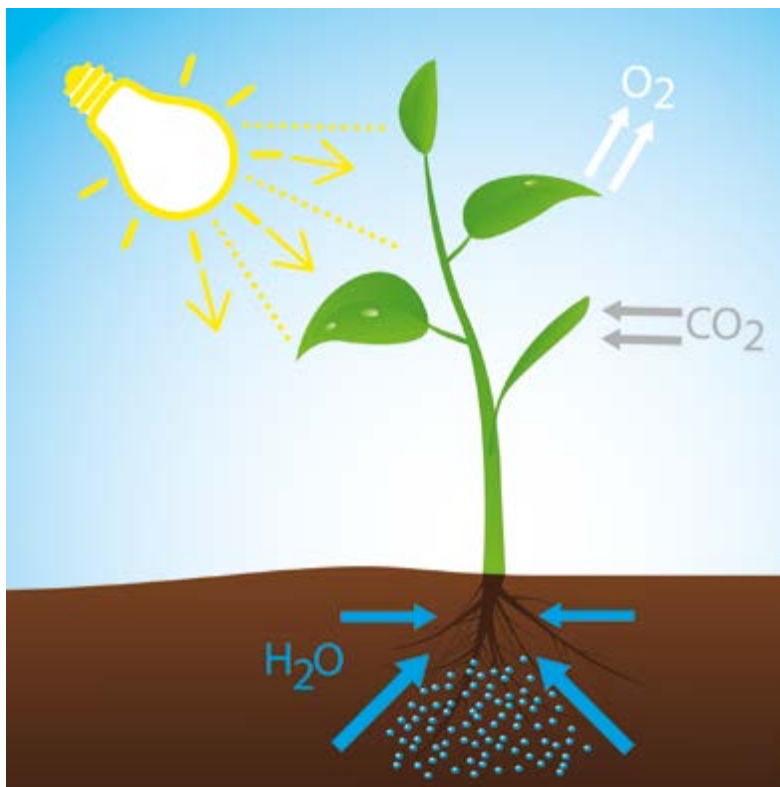
CO₂-Gassing

Stimulation of
the photosynthesis

up to 3000 ppm



Increase of the CO₂ concentration for plant growth by controlled gas supply



Seed-Line

Ideally applicable for
systematic ISTA compliant
seed tests



Soil Divider

- Reliable and representative separation of two samples of the same size
- Easy handling
- Easy cleaning without residues
- Electro-polished surfaces avoid adhering residues
- Completely manufactured from stainless steel



Vacuum Seed Counter

- Simplifies the laborious and time-consuming counting and allows uniform depositing of seed
- Particularly suitable for uniformly sized, smooth seed
- The counter consists of three components:
 - Vacuum system with connecting hose
 - Several counting heads corresponding to the number of seed types
 - Valve for release of the vacuum
- 2 Counting heads included in the delivery



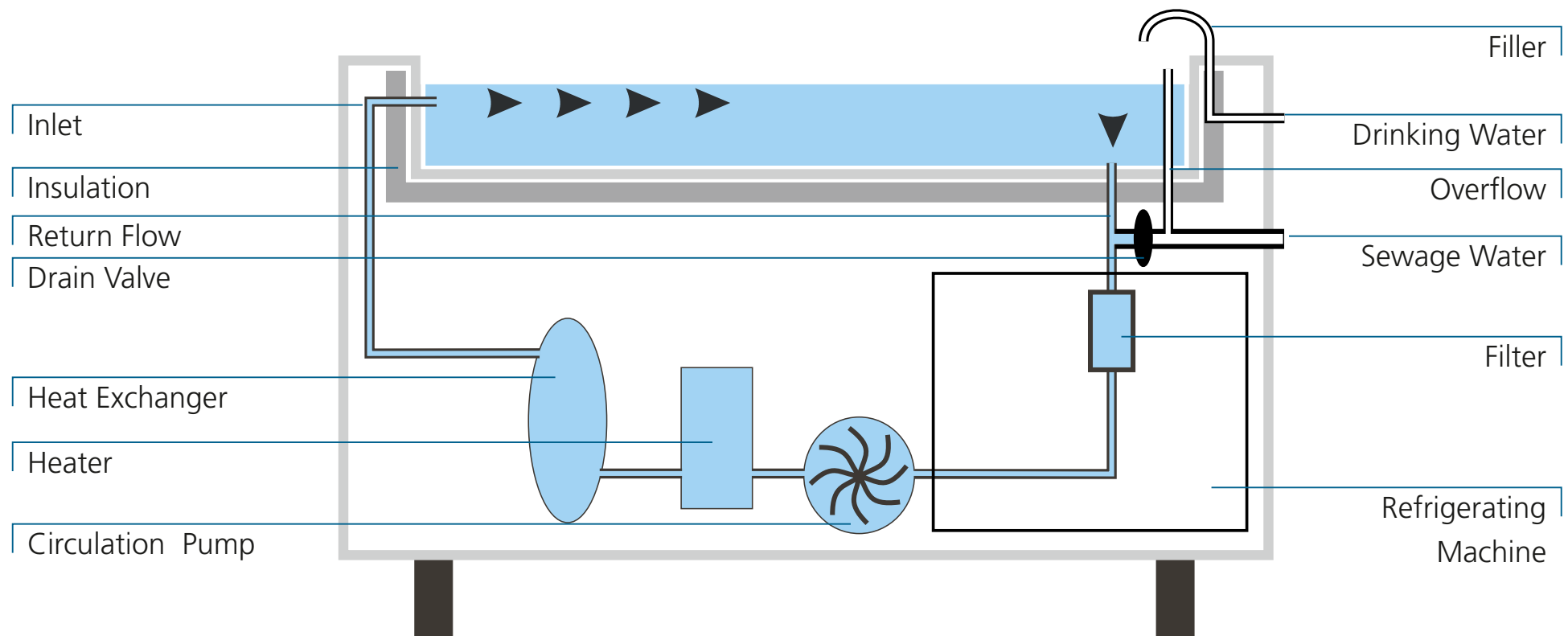
The Jacobsen Method

- The germination plate is temperature-conditioned by water bath (automatic temperature control)
- Germination spirals, paper wick and paper substrate are placed on the germination plate
- The wick supplies the required humidity and the desired temperature to the paper substrate
- The required air humidity for germination is generated by the transparent germination dome
- A hole in the top of the dome ensures supply of fresh air and minimum evaporation
- Active cooling (optionally) for day/night alternation or any desired temperature profile
- Lighting (optionally)



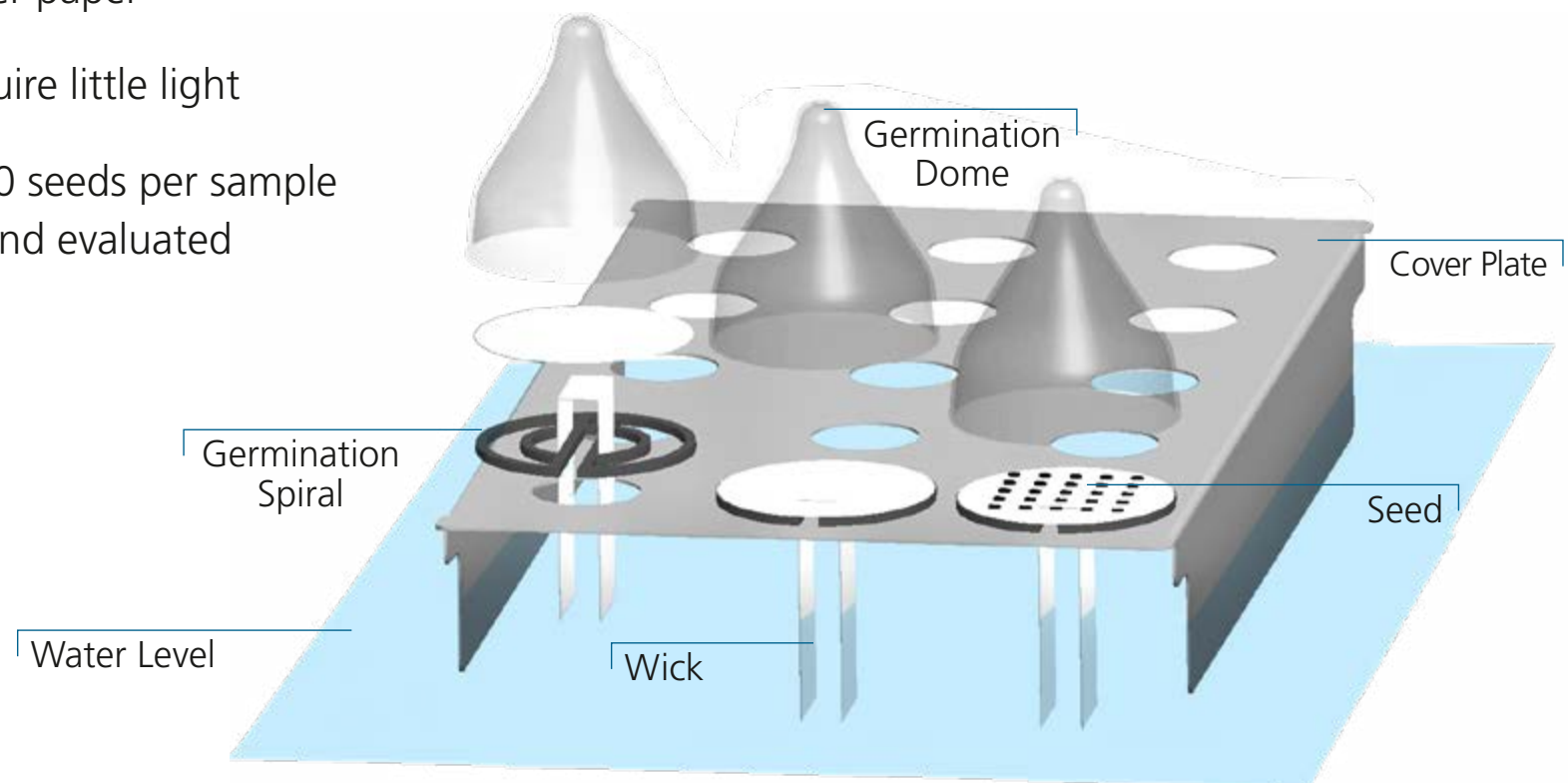
Water Basin

- The water basin keeps the temperature constant by support plates, which are immersed into the water

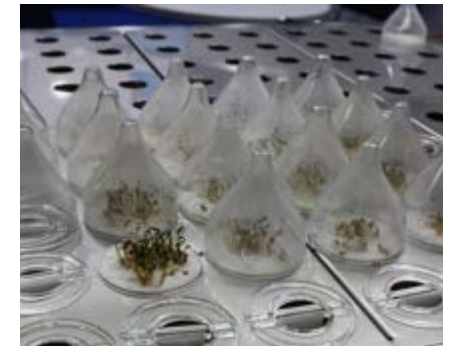
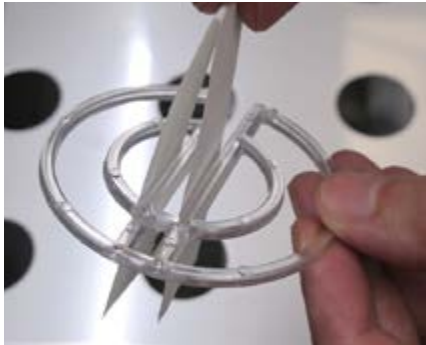


Determination of Germination

- The humidity, which is required for germination, is transferred from the wicks hanging in the water basin to the filter paper
- Germination tests require little light
- According to ISTA, 400 seeds per sample must be germinated and evaluated

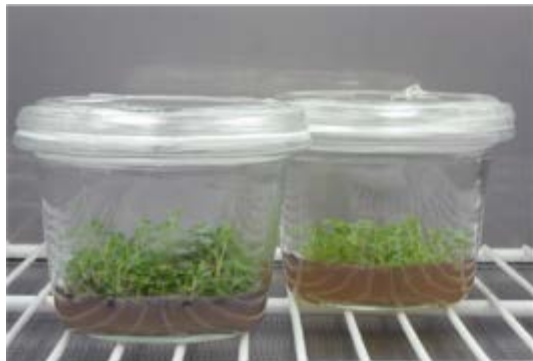


Germination Test TOP (Top on Paper)



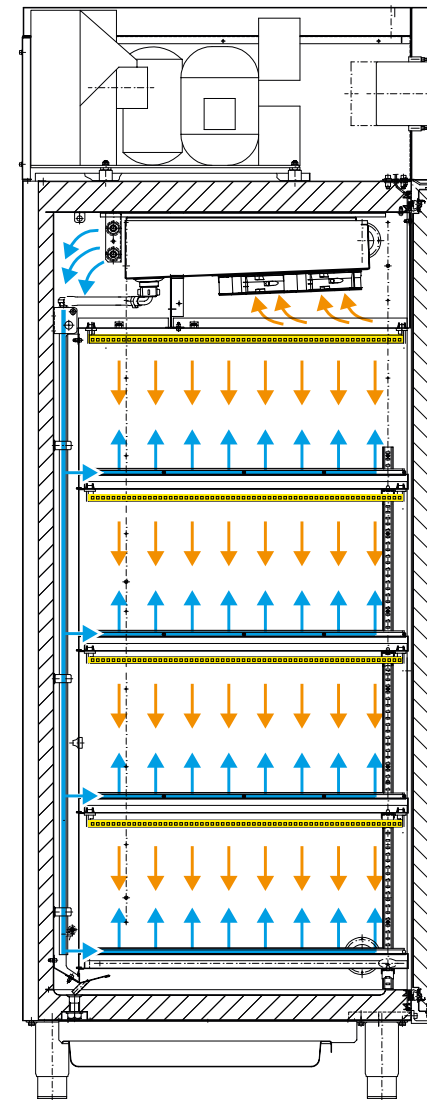
Vegetable Tissue Cultures

- Special recirculating air system for avoidance of condensation



Vegetable Tissue Cultures

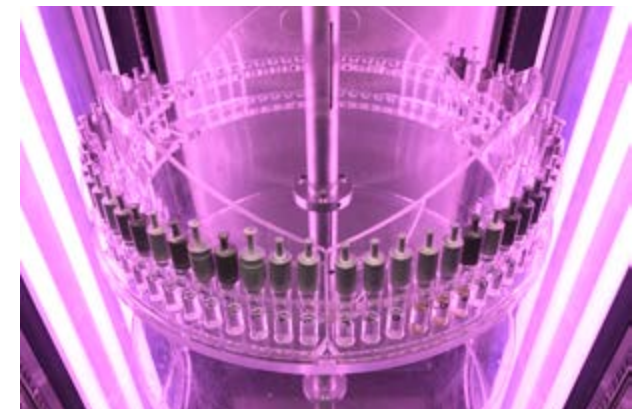
- Special air conduction of **cooled air** through the shelves for compensation of **radiation heat** of the lighting
- No condensation below the covers of the culture vessels, if the light had been switched off through the night and there is no radiation heat
- Discontinuation of the different refraction of light by water drops below the covers of the culture vessels
- No contamination within the culture by dripping condensate



- Cooled Air
- Radiation Heat
- Lighting

Algae Cultures

- Rotational stand for homogeneous lighting
- Shaking device against sedimentation of the algae
- Possibility of gassing for each flask, separately adjustable by needle valve



CONTROL2015 *touch*

One Control Unit Only

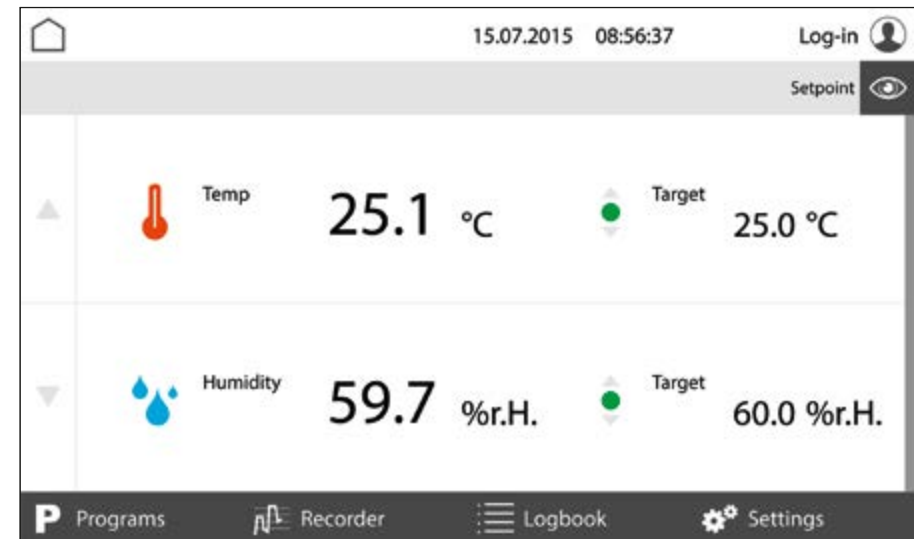


- Easy:** Intuitive operation of the clearly arranged 7" colour touchscreen display.
- Good:** High-precision sensors and the possibility of adjustment allow highly precise working, which is qualifiable and validatable at any time.
- Safe:** The documentation by means of the integrated recorder and the logbook ensures transparency, is easy to operate and can be conveniently filed. The optional digital signature provides conformity with 21CFR part 11.



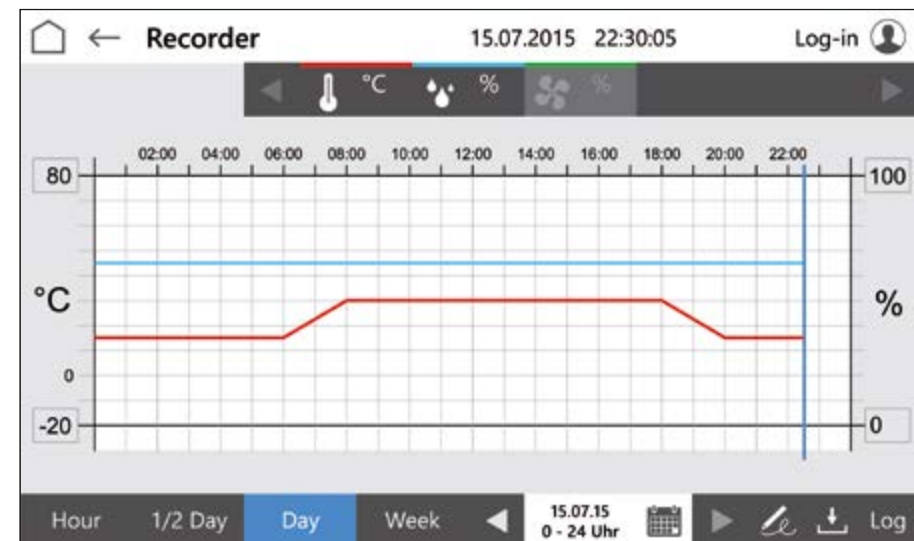
Intuitive Operation

- Clearly arranged and easy to operate representation of the actual values and setpoints of all regulator and control circuits.
- The favourite function for the main page ensures that the user has always an overview of the data, which are important to him.
- Convenient operation with language support in many languages.



Integrated Screen Recorder

- Recording of actual values of all regulator and control circuits.
- For clearness, all channels can be shown or hidden.
- Past periods can be scrolled conveniently page-by-page.
- Even with power failure, a restricted, battery backed monitoring is effected.



Calendar

- The calendar function allows quick direct access to past recording periods - no matter if to the recorder, to the logbook or for data export.
- All days, for which data have been recorded, are colour-highlighted.



Program Control is Standard

- Day, week or process time programs are possible.
- The user can name the programs created by him meaningfully.



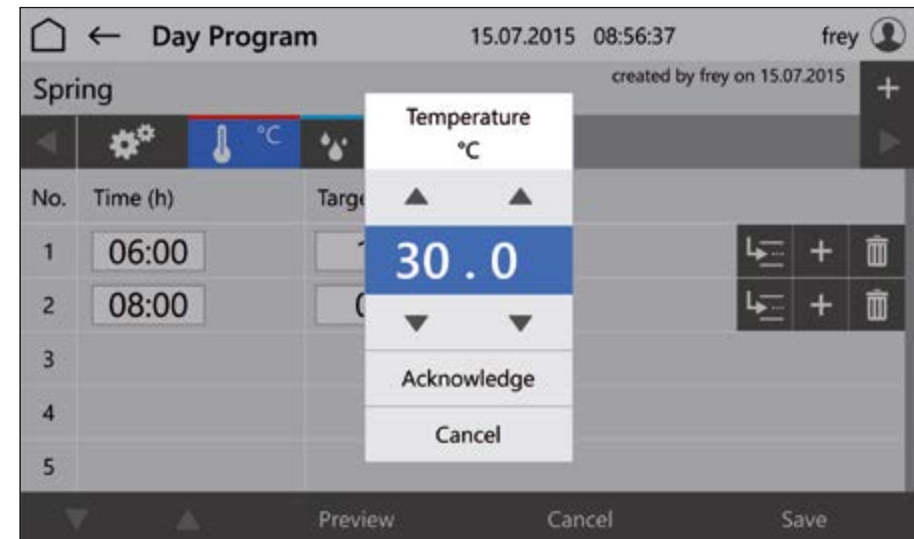
The screenshot shows a mobile application interface titled 'Programs'. At the top, there is a status bar with a home icon, a back arrow, the title 'Programs', the date and time '15.07.2015 08:56:37', and the user name 'frey' with a profile icon. Below the status bar is a table with four columns: 'Name', 'Type', 'Action', and 'Preview'. The table contains four rows of data:

| Name | Type | Action | Preview |
|------------------------------|--------------|--------|---------|
| Stress test Seed Preparation | Process time | ▶ | 🔍 |
| Spring | Day Program | ▶ | 🔍 |
| Accelerated Germination | Week Program | ▶ | 🔍 |
| Product Preparation | Week Program | ▶ | 🔍 |

At the bottom of the screen, there is a dark grey bar with five buttons: a downward arrow, an upward arrow, 'New', 'Copy', and 'Delete'.

Program Input

- Tabular arrangement of the program input, convenient editing and preview function.
- No limitation of the program steps and of the number of programs.
- Programs can be linked to each other.



User Login

- In the user management, the preferred language can be assigned to the users. A quick change is possible at any time.
- Thanks to the user management, the activities of each user can be traced exactly.
- In connection with the option Electrical Door Release, even the door opening can be allocated to a user.

The screenshot displays a user login interface. On the left, a language selection menu lists: Deutsch (German flag), English (UK flag, selected with a blue checkmark), Français (French flag), Italiano (Italian flag), Polski (Polish flag), Русский (Russian flag), and Español (Spanish flag). Below this is a 'Language' button with a globe icon. The main area is titled 'WELCOME' and shows a user profile for 'R. Klose' with a silhouette icon. To the right of the profile, the following information is displayed: Name: Richard Klose, Capacity: Labor, Log-in: 15.07.2015 08:50:25 Uhr, and Last Log-out (inactive): 14.07.2015 17:55:23 Uhr. A 'ge Password' button is visible next to the profile icon. At the bottom, there are 'Log-out' and 'Continue' buttons with arrows.

User Management

- The user management can be customized: It can be deactivated completely, or different rights can be allocated to the users. Passwords can be restricted in time, and the access can be locked after a defined number of failed login attempts.
- The user management allows the use of the appliance in conformity with 21CFR part 11.



|  | User Management | | | 16.07.2015 15:06:40 | Log-in  |
|---|-----------------|-----------------|----------|---------------------|--|
| | User ID | First Name/Name | Capacity | Status | Created on |
|  | blume | Anna Blume | Laborant | new | 01.08.2014 |
|  | fernandez | Sylvia Fernadez | Laborant | blocked | 28.08.2014 |
|  | klose | Richard Klose | QT | inactive | 02.02.2015 |
|  | wimmer | Erwin Wimmer | Leitung | active | 20.05.2015 |
|  | frey | Otto Frey | Laborant | active | 19.06.2015 |
| | | | | | |
| | | | | | |
|   New Copy Edit | | | | | |

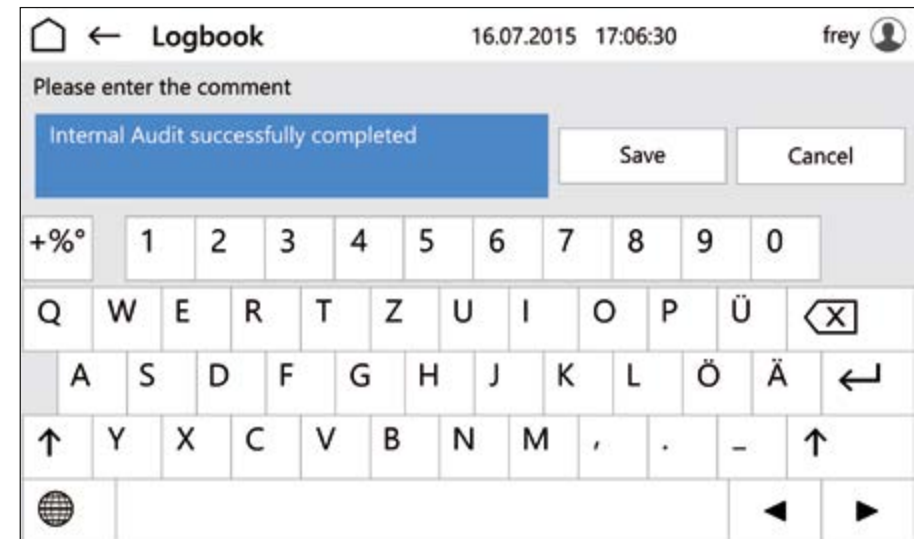
Logbook

- Gapless event documentation in real time, inseparably connected with the recorded data.
- Filter function for the quick, selective display of the events.
- Free comments with login name are possible at any time.

| Logbook | | 16.07.2015 17:03:30 | frey  |
|---------------------------|--|---------------------|--|
| Date | Message | All |  |
| 16.07.2015 08:04:23 Uhr |  Door open | Note | |
| 16.07.2015 08:05:34 Uhr |  Door closed | Note | |
| 16.07.2015 08:30:02 Uhr |  Door open | Note | |
| 16.07.2015 08:32:21 Uhr |  Door closed | Note | |
| ▼ 16.07.2015 14:02:45 Uhr |  Interior had been cleaned (frey) | Comment | |
| 16.07.2015 16:59:29 Uhr |  Door open | Note | |
| 16.07.2015 17:00:29 Uhr |  Door closed | Note | |

Comment Entry

- Complete keyboard for entry of comments into the logbook and for entry of individual names for program creation.
- The assignment of the keys is adapted automatically to the selected language.



Digital Signature

- Signature of the checked periods directly at the recorder of the control in conformity with 21CFR part 11.
- Undersigned areas are marked correspondingly in the recorder.



Calibration and Adjustment

- The 5 adjustment points per sensor ensure highest precision.
- If the user has noticed a deviation, he can easily effect a readjustment.
- The tabular entry of the supporting points and correction values can be displayed at any time, thus offering highest transparency.

| | | | |
|----------------------|----|---------------------|-------|
| Adjustment | | 16.07.2015 16:06:40 | admin |
| ▼ Temperature Sensor | | | |
| Correction Value 0 | °C | | 0.6 |
| Supporting Point 1 | °C | | -20.0 |
| Correction Value 1 | °C | | 0.6 |
| Supporting Point 2 | °C | | 0.0 |
| Correction Value 2 | °C | | 0.5 |
| Supporting Point 3 | °C | | 25.0 |
| Correction Value 3 | °C | | 0.4 |
| Supporting Point 4 | °C | | 60.0 |
| Correction Value 4 | °C | | 0.3 |

Thank you for your attention

Do you have any questions?

www.rumed.de/en/downloads/vortraege