Operation Manual

mIRoSpark

Near Infrared Spectrometer part

GUT
Environmental Technologies

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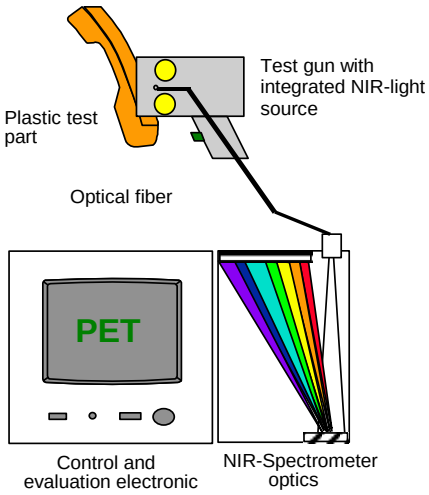
1 Setup of the mobile Infra-Red optic - mIRo

The device which is equipped with a carrying handle, mainly consists of three function groups. These are in part integrated in the housing in modular fashion:

- Measuring pistol with Near Infrared light source (NIR)
- NIR spectrometer optic
- Computer with control and measurement electronics

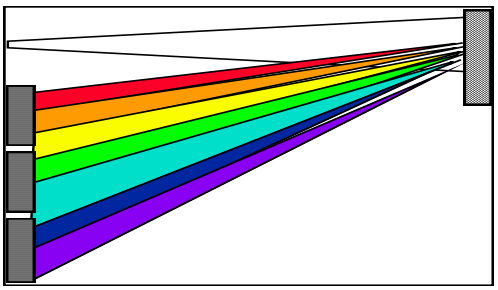
1.1 The Measuring Pistol

The measuring pistol is connected to the housing with a 2 m long metallic protective hose jacketed in PVC. The measuring pistol itself enables the device to be brought up to the sample in an easy manner. The cylindrical measuring head (∅ 50 mm) is attached on to the sample and the measurement is triggered by pressing the start button. Inside the measuring head a NIR-light-source is integrated. The polymer sample is radiated with infrared light and the reflected light of the measuring spot is transmitted into the spectrometer optics by a fiber optic. The end of the pistol head is protected against contamination with a NIR-filter window. The NIR-light-source is switched on by a relay and turned off when the pressing is stopped. A green LED signal on the measuring pistol indicates that the device is operational.



1.2 The Spectrometer Optic

The basic principle of the method is the diffuse near infrared reflection spectroscopy whereby characteristic absorption behaviours of different polymer types are used in the NIR wavelength region.



The diffuse near infrared reflected radiation is transported via the optical fibre to the slit of the multi-channel spectrometer to be scattered into its different wavelengths. From the end of the optical fibre the beam of light falls on an imaging diffraction grating. The light reflected by the grating falls on a sensor array. This photo-detector converts the light into electric analog signals. 32 pixels of the optical spectrum are scanned simultaneously, whereby an almost complete overview spectrum in the observed spectral range is recorded.

The signals are read opto-electronically after each scan. The analog signals are digitized on an interface board. The 12 bit digitized data then are transferred to the evaluation computer. To improve the signal/noise (S/N) ratio, the signals are accumulated by the software after each individual scan (runs) and then arithmetically averaged by the number of measuring cycles that has been set to give the spectral representation following. The dynamic range extends from 0 to 4096 arbitrary counts for a scan (12 bit intensity resolution). For a improved scaling the dynamic range is rounded to 4100.

1.3 The Computer with Control and Measurement Electronics

The functional tasks of the computer (PC/104 technology) are to transmit the parameters to the spectrometer electronics and to further process and evaluate the signals received before displaying them on the 6.5 " TFT flat screen. Direct operating of the software is made possible with an integrated touchscreen. The user enters the parameters via the menu-guided mIRo software. To ease handling further, the industrial PC supports the simultaneous connection of an external keyboard with a PS/2-plug. A serial interface (9 pole SUB-D plug) and an USB socket is provided for the transmission of data.

2 Hints and Instructions

2.1 Warnings and Safety Instructions

! In order to ensure that the device can operate properly, set it up in a manner so that it cannot slip and will not be subject to vibrations. Do not shake the device!

! Ensure that there is an adequate circulation of air for the device through the bottom cover plate. The slits are for ventilation purposes and may not be covered over or otherwise blocked. The openings are designed to ensure that the mIRo device can function properly.

! Take care that no liquid (water, rain etc) gets into the device or into the measuring pistol or inside the measuring head. This can lead to internal components being damaged or to a short-circuit.

! To avoid short-cuts, do not use the device near water or in moist ambient surroundings.

! The device may be operated only when connected to a socket with an earth line.

! Ensure that the 2m protective hose of the measuring pistol is not subjected to stress when being coiled up for transportation (damage of the fibre optic). Clamp the hose into the clip on the left side of the mIRo device. Put in the measuring pistol in its holder and fix it gently with the security screw.

! This measuring device consists of sensitive electronic components. Use not in accordance with the instruction may result in their destructions. Electrostatic discharges, induces voltage peaks and balance currents between different voltage potential are particularly harmful.

2.2 Technical Data

Rated voltage:	for Europe: 230Volt~/50Hz
Rated voltage:	for U.S.A: 115 Volt~, 50/60 Hz
Rated voltage:	for Japan: 100 Volt~, 50/60 Hz
Rated current:	2 A max.
Protection class:	I
Type of protection:	IP 20
Dimensions (WxHxD):	364x200x376 mm (mIRoSpark) or 364x200x316 mm (mIRo)
Weight:	14 kg (mIRoSpark) or 8 kg (mIRo)
Ambient temperature:	15...35°C
Max. relative air humidity:	Operating: 10%...90%

3 Operating instructions

3.1 Starting

1. Set up the device with the mounting grip at an angle and in a manner that it will not slip and where it will not be subject to vibration. Ensure that the mIRo system has an adequate circulation of air through the slits provided on the bottom side.

2. Connect the device to a grounded power supply socket.

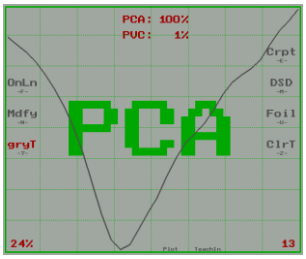
3. Check the protection window at the pistol measuring head and clean it with a soft tissue in case it is dirty. Do not scratch the protection window.

4. Power on the device at the rocker switch. The device starts booting and loads the main program for the plastic identification. At first[1], the mIRo starts with the message: ***First do Recalibration*** then the readiness of the device is signalled with the message ***mIRo***.

5. At first, recalibrate the system by pressing the **<Cal>** icon. Then attach the measuring head against the white ceramic plate and keep pressing the pistol trigger until the last message ***Stop triggering!*** appears. It signals the end of the recalibration procedure. If an error message appears, repeat the recalibration (see: Recalibration of mIRo). For the recalibration either the reference plate inside the pistol holder or the small ceramic plate for the finger or the big tile can be used.

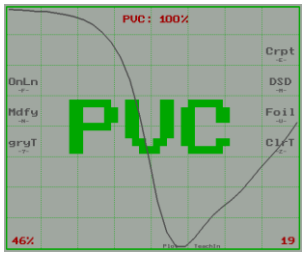
3.2 Measuring

1. Activate the restriction of the plastic identification to polymer types (All-, gryT-, clrT- or Foil functions) either to the most probable ones due to colour (All, gray Type) or property (Foil, clear Type) or which appears most plausibly due their polymer similarity. The activation of these functions are signalled in red in the Result display.



2. Press the measuring head against the surface of the sample part. The surface should be smooth and as clean as possible. If not, scratch the surface with the knife to obtain a fresh new material surface.

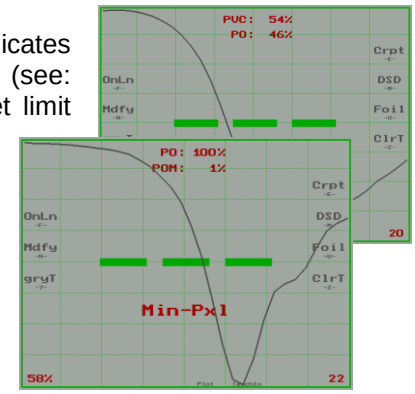
3. Trigger the start button at the measuring pistol and keep it pressed until the green LED-signal at the pistol turns off (ca. 1 sec). During this time a NIR-light-source inside the measuring head is switched on by a relay, the measurement is started and the identification result is displayed until the next measurement is triggered (Single mode). In the Circular-Mode[2] the NIR-light-source is continuously powered on while pressing the pistol trigger and the display shows the identification results after each measurement cycle.



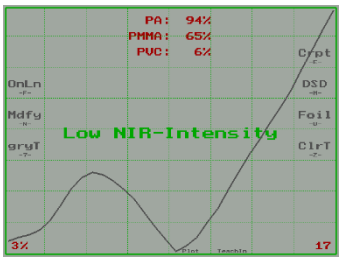
4. For foils, transparent, naturally or milky-like coloured materials a ceramic plate - acting like a mirror must be placed behind the parts to reflect back the NIR light into the measuring head. For easy handling the small tile designed as a finger ring should be used.

Avoid to press the pistol trigger continuously (e.g. longer than 30 sec.). The NIR-light-source inside the measuring head can be overheated and possibly reduces its life time.

[1] This message only appears for the stand-alone mIRo system and not for the mIRoSpark system.
[2] The Circular mode is recommended when small or thin samples (e.g. milled samples, granulates, foils) should be analyzed or polymer identification results seems to be not stable.



5. Non-Identification is signalled with the No-Result message (---). This indicates that the neuronal network was not able to identify the sample reliably (see: Polymer Type Identification by Neuronal Networks). Either the pre-set limit values have not been exceeded (e.g. 1st place less than 70 %, 2nd place greater than 30 % probability) or the minimum of the NetD curve is not in the range of the pre-set Min-/Max-Pixel values. In both cases repeat the measurement until a reliable statement appears. If repeated measurements still are producing this message, the sample might be unknown (not calibrated) or the wrong net model was selected for identification or new recalibration is necessary.



6. If the measured light intensity level is low than the message shown at the left is displayed. The Low NIR-Intensity message appears if the measured NIR-light intensity does not exceed the pre-set threshold value for the minimum light intensity (see:). Reasons may be that the sample is too dark[3] for the reflection principle or the plastic part is a kind of a diffuse scattering material and thus unsuitable[4] for the diffuse near infrared reflection measuring method.

7. For foils and transparent materials a ceramic plate - acting like a mirror - must be placed behind the parts to reflect back the NIR light into the measuring head for data evaluation. This handling also applies for most of the polymer types which comes up naturally coloured - or milky-like. In general for the identification of transparent thin materials the Foil Model should be activated**.** Due to the variable thickness of foils the absorption characteristic differs in comparison to solid materials. The typical minimum of the measured NIR curve (Min-Pxl) is usually different to solid materials. Thin foils should be folded several times thus a thickness at least 50-100 µm is achieved otherwise the result might not be reliable. Plastic parts thicker than 500 µm should be measured with the Standard or clear Type model.

8. The status of the system should be checked regularly by measuring the reference ceramic plate! If the message: ***Changed Condition! Do new Recalibration*** appears then a new recalibration should be carried out again (see: Recalibration of mIRo). The system is heated up causing a sensitivity gain drift of the electronics.

If either incorrect identification results are coming up with known samples or the system condition has been changed after the last recalibration like dis-/connecting an external keyboard or switching on/off the Mini-Plotter a new recalibration is always necessary to ensure the stability of the electronic environment!

3.3 Transportation Handling

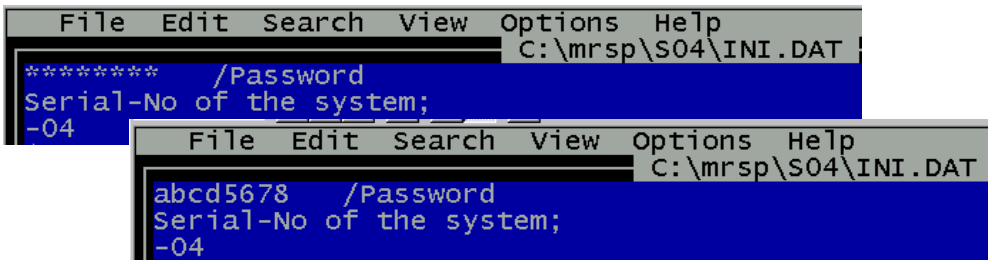
1. Leave the ***mIRo***-program with **<QUIT>** and switch the device off with the rocker switch[5]. The last settings are stored automatically and reloaded again for the next start of operation.

2. To transport the unit, coil up the protective hose(s) of the measuring pistol(s) into the coils (mIRo or mIRoSpark system). Ensure that the hoses are not subjected to any stress when being coiled up and attached to the clips. Fix the protective hose into the clips mounted aside of the device. Clamp the measuring pistol gently in its measuring holder with the aid of the knurled screw.

[3] In general, no dark colored and black samples or materials filled with soot can be analyzed using the NIR-technology. Soot absorbs the NIR radiation almost thus no diffuse reflection occurs.
[4] Low NIR-light reflection is observed by natural colored or milky-like Polyamides and Polyolefines (NIR-light scattering). Furthermore it must be stated due to the experiences of us that gray colored plastics (e.g. PP, PVC) which are containing lot of Talcum (20-40%) as a filling material reduces the NIR light reflection causing non reliable identification results.
[5] This way of operation is only applicable for the mIRo system and not for the mIRoSpark system.

4 Enter new Password

The system is secured with a password which activates the mIRo-program. In case the message: ***Program deactivated!…*** is displayed, please contact gutgmbh@online.de to obtain the actual password for the device.



To edit once the new password please proceed as following:

1. Connect an external keyboard (PS/2) to the system.
2. Edit on the DOS-prompt level of the given sub-directory the command line *edit ini.dat*
3. Replace the 8 stars (*) in the first line of the *ini.dat* with the new password (8 small characters!).
4. Save the ini.dat file (ALT+F(ile), ALT+S(ave)) and close the Text-editor (ALT+X(exit)).
5. Edit on the DOS-prompt level ***miro.exe*** to start the program.

5 Time and Date Setting

To enter a new Time and/or Date for example for correct Mini-Plotter printouts please do as follows:

1. Connect an external keyboard to the system.
2. Enter on the DOS-prompt level of the given sub-directory the command ***time*** or ***date***, resp..
3. Edit new date or time values and confirm/quit with **<ENTER>**.

6 The *mIRo*-program

6.1 Conventions in this Manual

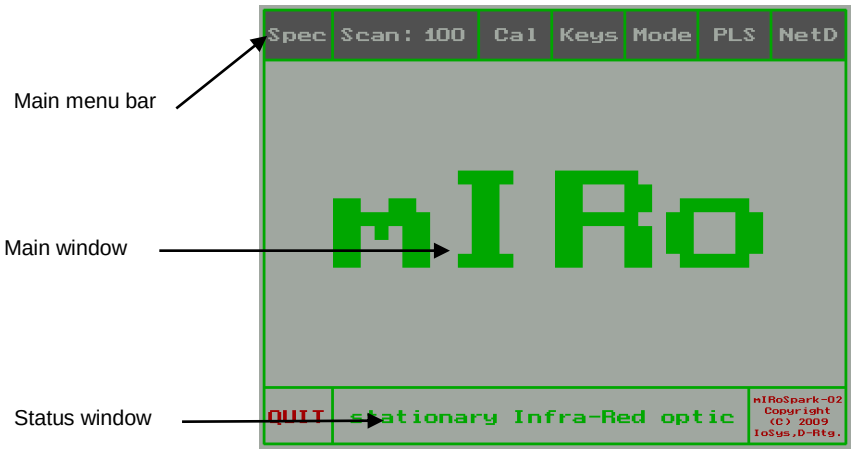
The device is designed in such a way that it can be operated from the touchscreen and/or from an external keyboard. In general a keyboard permits the menu-guided software to be handled more easily.

The following paragraph gives the writing conventions used in these operating instructions:

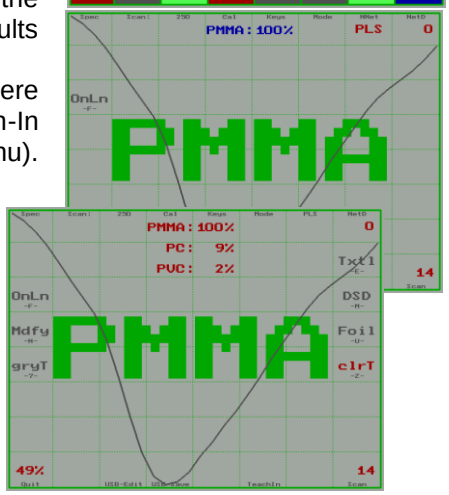
Operations to be carried out via the touch screen are given with the legend on the particular touch field and the word **<Icon>**. Those to be carried out with the external keyboard with the legend of the keyboard key and the word **<Key>.** Usually small characters should be entered. A touch field on the display only has to be touched briefly. If a number of keys or, as the case may be, touch fields have to be pressed simultaneously, then this is indicated with a plus sign (+) between the individual key or touch field legends, e.g. **<SHIFT>+<F1>**. In general only small characters of the keyboard are to be used!

Pressing a key or touching an icon activates or deactivates a mode or function. In general a repeatedly pressing the same key or touching the same icon again deactivates/activates the operation, respectively.

6.2 Operating Elements in the Start-Display

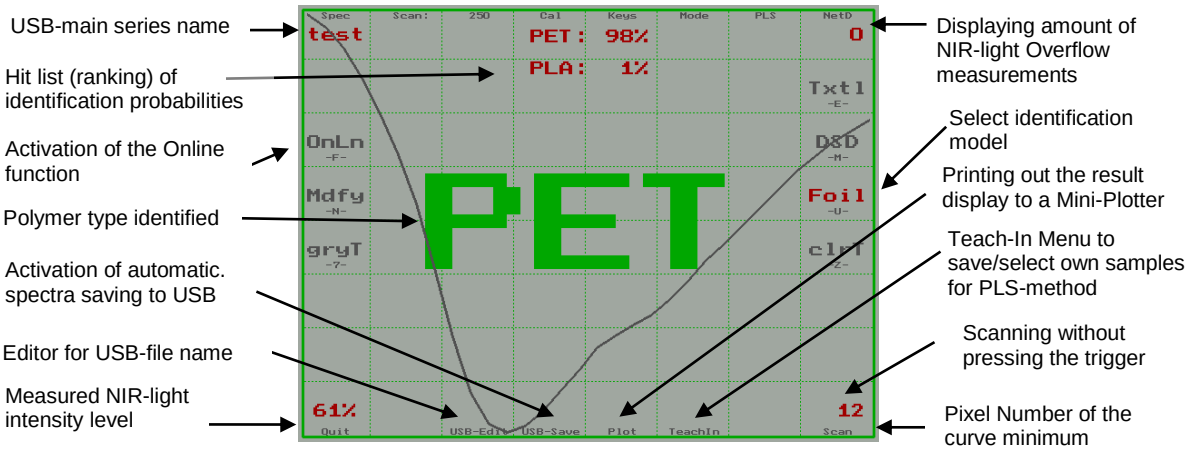


Icon	Key	Function
Spec	**F1**	Switches to **Spc-Mode** to view the NIR-Spectra or the transformed Net-Data and to carry out further actions (see: Operating Elements in the Spc-Mode).
Runs	**F2**	Increases (**<F2>**) or decreases (**<F3>**) the number of runs[6] (scan numbers) to form an average mean spectrum for evaluation.
Cal	**F4**	Starts the routine for the recalibration measurement with the ceramic reference plate (see: Recalibration of mIRo).
Keys	**F5**	Displays the assignment of the touchscreen fields and opens further menu options for testing, setting and editing systems files for the mIRo (see: Operating Elements in the Keys-Display).
Mode	**F6**	Switching between the **Single-Mode** and the **Circular-Mode**. In the Single-Mode the NIR-light-source inside the measuring head is switched on by a relay, the measurement is started and the identification result is displayed until the next measurement is triggered. In the Circular-Mode the NIR-light-source is continuously powered on while pressing the rod trigger and the display shows the identification results after each measurement cycle.
PLS	**F7**	Changes to the PLS model (Partial-Least-Square), where plastic identification is performed using selected Teach-In samples (see: Operating Elements in the Teach-In Menu). The activation of the PLS mode is displayed on the top and the ranking list appears now in blue letters and the icons to select the identification model are disappearing (no function). Pressing again the **<PLS>** icon switches back to the Neuronal network calculation and the hit list is displayed in red letters.
NetD	**F8**	Switches to the **Result-Display.** In the NetD (Network Data) mathematically transformed and auto scaled data are displayed. These data are used by neuronal network or PLS processing for plastic identification. On the right bottom side of the screen the Pixel number of the curve minimum is displayed in red letters. The position of the curve minimum (e.g. 12, 15, 20 etc.) is typical[7] for a polymer type. On the left side the measured NIR-intensity[8] is shown in percentage range. If this intensity level is less than the pre-set limit value for minimum light intensity (e.g. 5%) than the message ***Low NIR-intensity*** is shown[9].
QUIT	**ESC**	Leaves the program and returns back to the DOS prompt level or back to the SSS2 program (mIRo software in mIRoSpark)

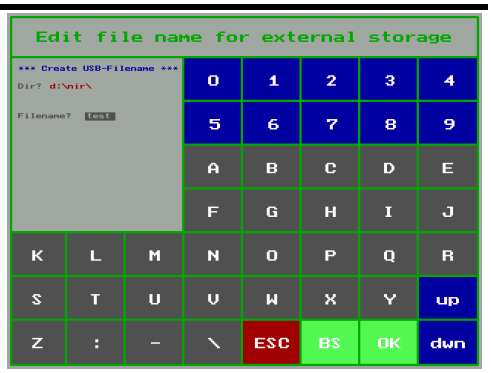


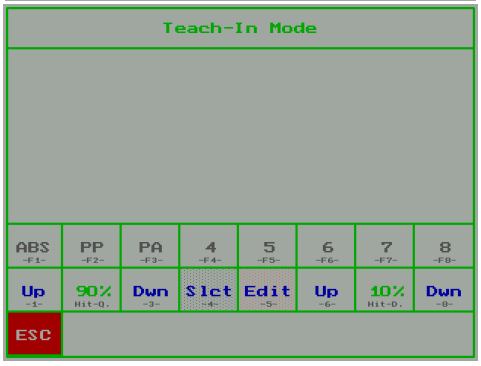
[6] The higher the scan number (Runs), the better the resulting average spectra (improved signal/noise ratio of the calculated mean), the more stable is the identification result. However, the measuring time takes longer. On the other hand, the smaller the scan number (1..1000), the more noisy the resulting spectra for evaluation, the less stable is the identification result. On the other hand the measuring time takes shorter.
[7] Depending on the spectrometer system.
[8] The measured NIR intensity is the difference of the left intensity (Pixel number 1) to the right value (Pixel number 32) in %.
[9] It means that the diffuse reflected light intensity of the sample is too weak to identify the sample reliably. The pre-set limit value for the minimum light intensity has not been exceeded. This threshold value can be altered in the Ini.net file.

6.3 Operating Elements in the Result-Display



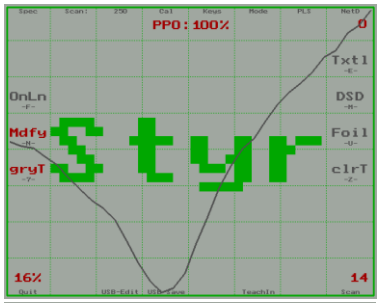
Icon	Key	Function
USB-Edit	**Enter**	Opens the menu to edit the main file name (max. 4 characters) for the automatic spectra saving onto an external USB-stick storage device.
USB-Save	**BS**	Activates the automatic USB-saving function[10] (**<Backspace>**). Spectra are saved with consequent numbers up to –999 behind the main series file name[11] in the pre-set subdirectory path of the USB-storage device (see: The Initialization File). Repeated touch deactivates the function.
Plot	**F9**	Printing out the result as a screen dump by a Mini-Plotter. The rocker switch located at the integrated the plotter must be turned on. Touching the touchscreen or pressing any key on the keyboard stops the actual plotting process.
TeachIn	**F10**	Opens the **TeachIn-Menu** to teach-in or to select known samples (see: Polymer Type Identification by PLS) for polymer identification using the PLS algorithm. (Partial-Least-Square, "best fitting curve"). The PLS mode is automatically activated and the hit list (ranking) is displayed in blue letters. The advantage of the PLS method is that the user can teach-in own test samples to carry out simple a rapid analysis. The disadvantage is that PLS works for NIR-spectra only which obviously have big spectral differences. Pressing the **<PLS>** icon brings the display back to the neuronal network calculation (see: Polymer Type Identification by PLS)
Scan	⇑	Starts a scan without pressing the trigger.
OnLn	**F**	Start the Online mode for the transmission operation (optional feature) using an external light source.



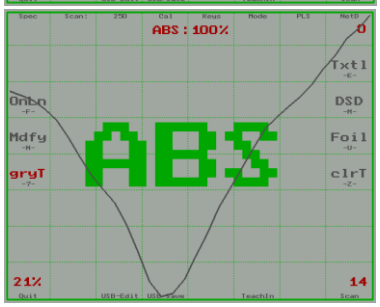


[10] To avoid senseless savings, spectra are only automatically saved when the trigger is kept pressed after measurement and no message Low-Intensity appears.
[11] e.g. main series file name test-1 up to test-999.

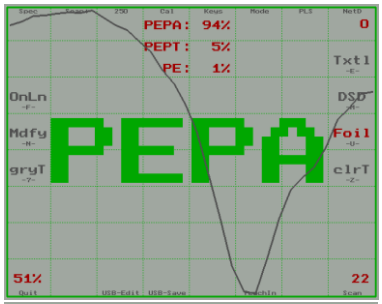
Mdfy **N** Due to spectra similarity the distinction of some polymer types is sometimes uncertain and could be random-like. To modify the identification result means that the determined probability in the network model (1st ranking in the Hit list) is altered to the main polymer group. The identification will be simplified like (ABS, PS, PPO ⇒ Styr). The Modify function can just be activated/deactivated if one of the mentioned polymer types is displayed. A temporary modification of an identification result is then signalled in red.



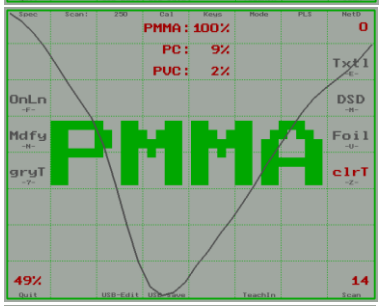
gryT **7** This identification model is recommended when gray-coloured plastic parts coming from the electro- and electronic dissembling area (e.g. computer waste) are to be detected, because the amount of polymer types for fine differentiation of the styrene-containing sub-group within this model is extended and other types are neglected to enhance the identification performance. Modified results Modified results **(Mdfy)** switches ABS, PS and PPO ⇒ Styr and PCA, PCPT ⇒ PC. In this gray-Type model the identification of **PA, PP, Styr** (ABS, PS, PPO)**, PC** (PCA, PCPT)**, APVC** and **PVC** is calibrated.



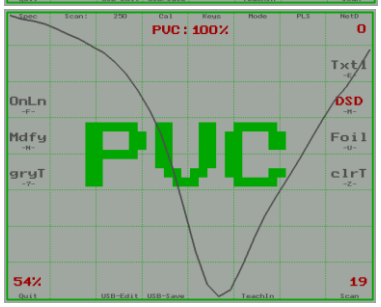
Foil **U** This identification model is recommended when thin materials like foils are to be detected. The thin foils should be folded several times to achieve a thickness of at least 50 - 100 µm, otherwise the result might not be reliable. Materials which are thicker than 500 µm should be measured using the Standard model (All). Modified results **(Mdfy)** switches PEPA or PEPT ⇒ PE and PPPT ⇒ PP. Identification of **PA, PP** (PPPT)**, PE** (PEPA, PEPT)**, PS, PET, PVC, PLA** and **CLLS** foils.



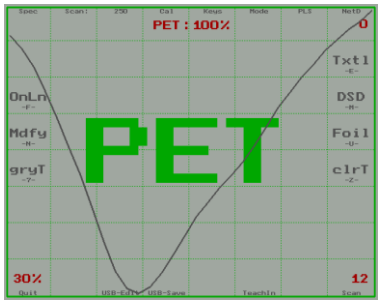
clrT **Z** Restriction of the polymer identification to few clear types which can normally occur also or only as clear, transparent plastic parts (thickness: 0.5 - 6 mm). This identification model is recommended, because the amount of polymer types for fine differentiation of the styrene-containing sub-group is extended within this model and other types are neglected to enhance the identification performance. Modified results **(Mdfy)** switches ABS, SAN (AS) and PS ⇒ Styr. Identification of **PO, Styr** (ABS, PS, SAN)**, PET, PC, PMMA** and **PVC**.



DSD **M** This identification model is recommended when typical plastic parts and foils[12] coming from the household and packing area (MWS) are to be detected, because the amount of polymer types is restricted to five polymer types which normally occur as household and packaging plastics (DSD = Duales System Deutschland, Green Dot). Modified results **(Mdfy)** switches PP, PE ⇒ PO. In this DSD-model the identification of **PP, PE, PS, PET** and **PVC** is calibrated only.



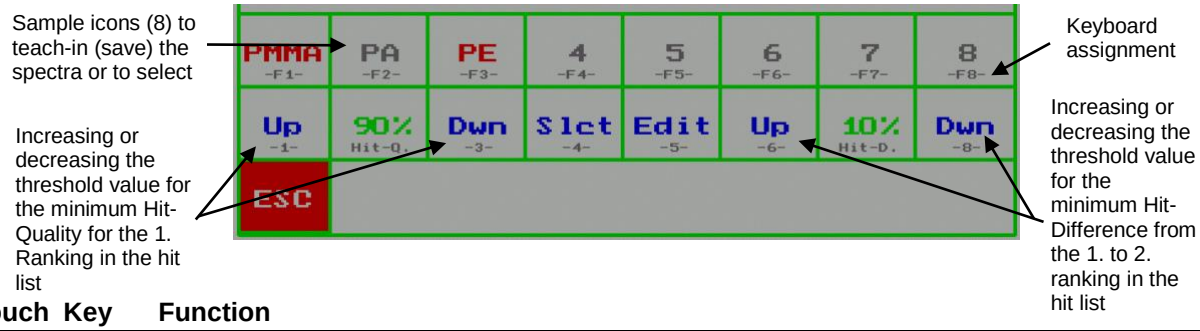
./. **./.** This Standard identification[13] model (no special model activated in red) is recommended when coloured, natural- or milky-like plastic parts (not gray, not black and not transparent) are to be detected. Herein the amount of polymer types for fine differentiation of the styrene-containing sub-group is reduced. Modified results **(Mdfy)** switches PA6x, PA12 ⇒ PA and PP, PE ⇒ PO and ABS, PS ⇒ Styr and PBT, PET ⇒ PES and PCA, PCPT ⇒ PC. Identification of **PA**[14] (PA6x, PA12), **PO** (PP, PE), **Styr** (ABS, PS), **PES** (PBT, PET)**, PC** (PCA, PC, PCPT)**, PMMA, POM** and **PVC.**



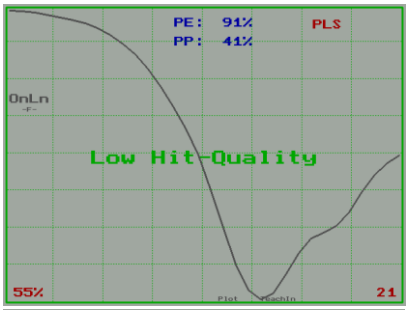
Txtl **E** This optional identification model is recommended when carpets or textiles are to be detected. In this model the identification of **PA**, **PP, PET, PolyCotton**, **PET+Cotton-blend, Acrylic, Silk, Wool, Cotton, Cotton+PA-blend, Cotton+PET-blend** and **Acetate** is calibrated

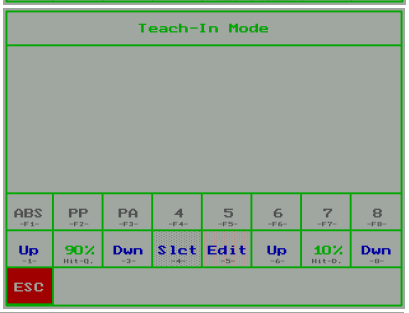
[12] No PA-, PEPT- and PLA foils are calibrated and due to the spectra similarity the multilayer foil PEPA was taught in as PE.
[13] IoSys uses the following abbreviations: PA=Polyamide, PO=Polyolefine, Styr=Styrene containing polymers, PES=Polyester, PCA=PC+ABS, PCPT=PC+PBT or PC+PET, APVC=ABS+PVC, PLA=Polylactoseacetate-biodegradable, CLLS= Cellulose; Multilayers: PEPA=PE+PA, PEPT=PE+PET, PPPT=PP+PET.
[14] Fine differentiation of PA6 and PA66 polymer types is not reliable. Therefore both types are calibrated and combined to PA6x.

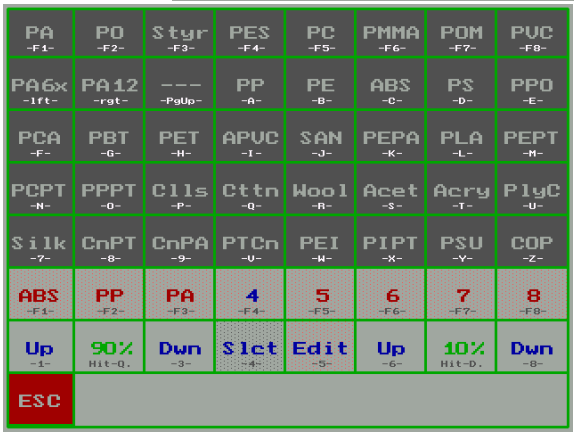
6.4 Operating Elements in the Teach-In Menu

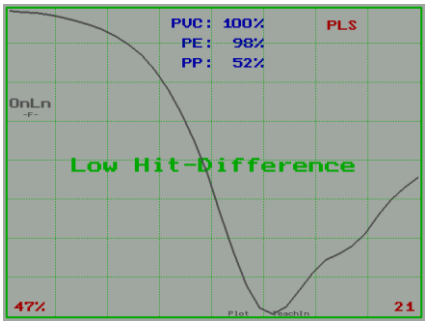


Touch	Key	Function
1..8	**F1..F8**	By pressing one of the eight sample icons the actual spectrum will be stored as a Teach-In sample. A gray coloured touch icon indicates that in respective slot no spectrum was stored before or it was deactivated (see **<Slct>**). The PLS mode must be activated to use the Teach-In spectra for polymer type identification (see: Operating Elements in the Result-Display).
Up	**1**	Increases the threshold value of the minimum Hit-Quality for the 1st ranking in the hit list[15]. If the 1st ranking percentage is less than the pre-set Hit-Quality value then the message ***Low Hit-Quality*** is shown.
Dwn	**3**	Decreases (Down) the threshold value of the minimum Hit-Quality for the 1st ranking in the hit list.
Slct	**4**	Switch to the **Select-Bar** for activation/deactivation of respective Teach-In samples for the PLS-algorithm (dotted pattern style appears and the **<Slct>** icon changes to the **<Clr>** icon). Deactivated or not available storing places are shown in gray letters Pressing the **<Clr>** icon deletes all stored Teach-In samples (Clear) and renames the referring sample to numbers 1 to 8. Repeated touch of the **<Clr>** icon confirms the deletion process.
Edit	**5**	Switch to **Edit-Menu** for editing of the names of given plastic types. The function is only active if a sample icon has been selected before. Other names with max. 4 characters can be edited by opening the Teach-In File (see: The System Files for mIRo).
Up	**6**	Increases the threshold value for the minimum Hit-Difference from the 1st to the 2nd ranking in the hit list. If percentage difference[16] from the 1st to the 2nd ranking is less than the pre-set Hit-Difference then the message ***Low Hit-Difference*** is shown.
Dwn	**8**	Decreases (Down) the threshold value for the minimum Hit-Difference from the 1st to the 2nd ranking in the hit list.
ESC	**ESC**	Leaves the **Teach-In Menu** and returns back to the **Result-Window**. All settings are automatically saved in the system file *Teach-XX.dat* which will be loaded when starting the system (see: The Teach-In File).







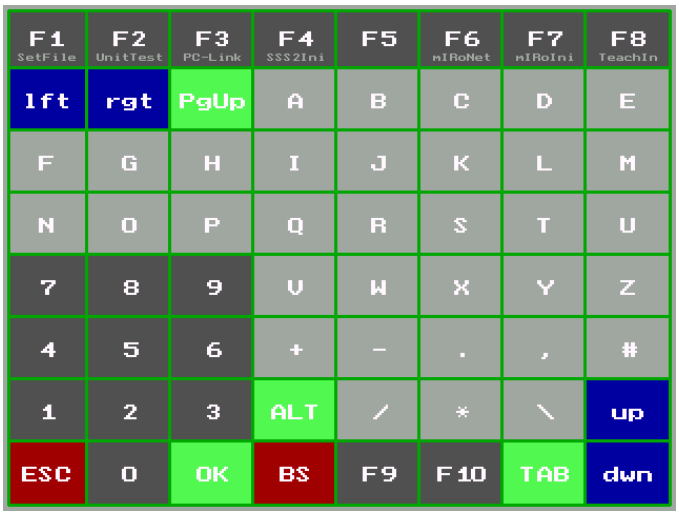


[15] The Hit-Quality is the first threshold value, which the actual spectrum must exceed (degree of spectral curve similarity in % to the trained-in and stored Teach-In samples) to be indicated. For example: the NetD curve resembles to the Teach-in sample named PE to 91% and to the PP to 41%. If the pre-set Hit-Quality value for the 1st ranking is set higher than 91% (in this example) then the message ***Low Hit Quality*** is shown.

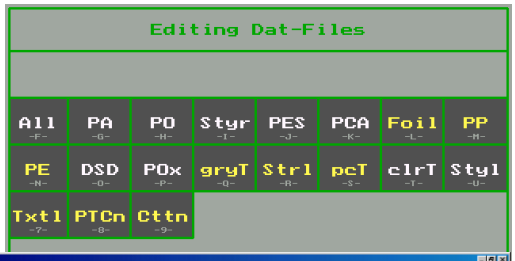
[16] The Hit-Difference is the difference-threshold value, which must be exceeded (spectra difference of 1. to 2. ranking expressed as percentage ranges). For example: the NetD curve resembles to the Teach-in sample named PVC to 100 and to the PE to 98%. If the pre-set Hit-Difference value for the 1st to the 2nd ranking is set higher than 2% (in this example 100%-98% = 2% Hit-D) then the message ***Low Hit Difference*** is shown.

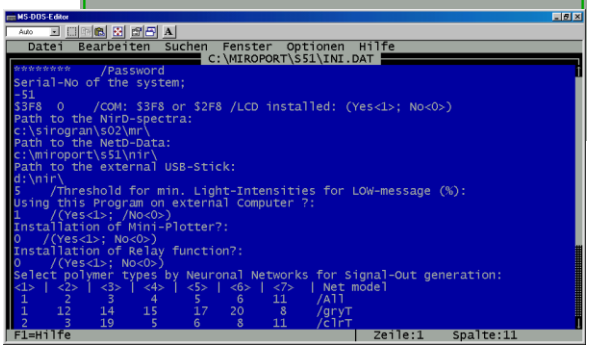
6.5 Operating Elements in the Keys-Display

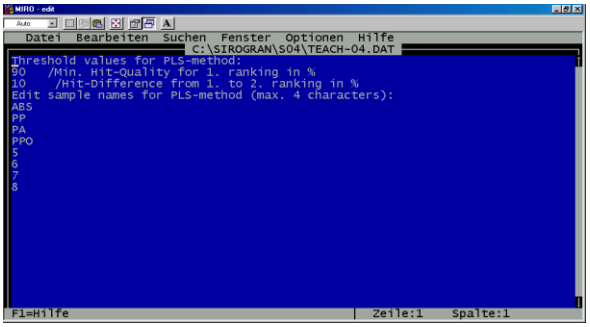
The operationg elements in the Keys-Display for the mIRo program are not active in the mIRoSpark unit. These options are active in the SSS2 program of the mIRoSpark (see: Manual of mIRo**Spark** for the SSS2 part)!



Icon	Key	Function[17]
PC-Link	**F3**	Starts the **PC-Link program** (intersvr.exe) to enables data exchanges for updates or copying files to another computer (see: Data Exchange).
mIRoNet	**F6**	Opens a further window with a menu bar to select neuronal network[18] calibration files and system files. Pressing an icon/key starts the editor with automatically loading the selected Dat- or Ini-Files (see: The Dat-Files).
mIRoIni	**F7**	Starts the text editor with automatically loading the initialization file *ini.dat* for the mIRo to change e.g. pre-set password or subdirectory path for saving and loading spectra files (see: The Initialization File).
TeachIn	**F8**	Starts the text editor with automatically loading the initialization file teach-XX.*dat* for the mIRo to edit sample names and pre-set threshold values (see: The Teach-In File).
QUIT	**ESC**	Leaves the **Keys-Display** and returns back to the **Start-Display**.



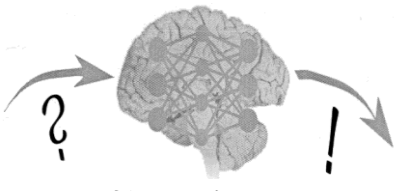




Do not make any changes to the formatting in the text files. Do not insert a decimal point with integer numbers.

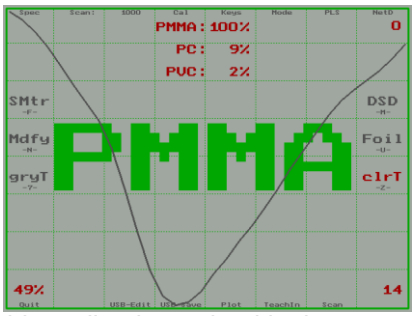
[17] To operate the text editor an external keyboard should be connected. In general – if not otherwise noted - quitting the editor resets the loaded text file therefore modifications are directly taken over.
[18] The additional Dat-Files of the Textile model are only shown, if the unit is equipped with this optional feature.

6.6 Polymer Type Identification by Neuronal Networks

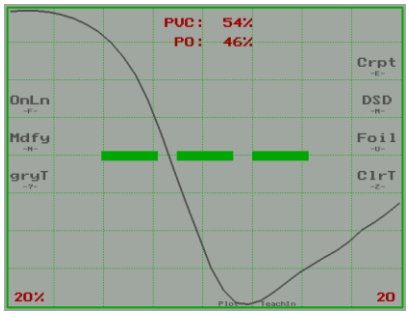


The identification of the polymer type using neuronal network is the result of a mathematical model for polymer identification This data processing simply means a comparison with a pre-set pattern recognition[19]. Different types of plastics are categorized into a main group and into a number of sub-groups for fine differentiation.

Due to this it is very important to select the right identification net model to obtain the correct identification result depending on colour (Standard or gray Types), thickness (Foils) or properties (clear Type) of the plastics to be measured.

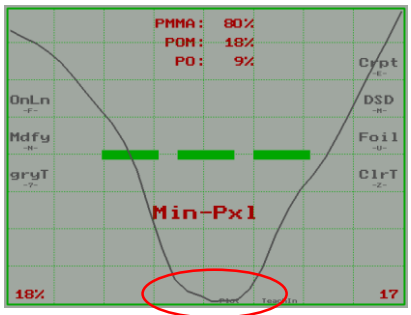


After the measurement, the near infrared intensity data (NirD) are mathematically transformed in ratio to the actual reference spectrum of the white ceramic plate and then normalized and scaled into network data (NetD). These values are processed with given weighting factors and special algorithms of the neuronal network model and stored. The pre-set data of the net model have been created, trained and stored by calibration beforehand. The result of the calculation is a ranking list of the most probable polymer types ranging between 0% and 100%. In the top of the Results window the three polymer types with the highest degrees of probability are displayed in red letters. The percentage value expressed the hit quality determined in the network model. It is not indicating the composition of a polymer blend!. If the results of the measurement for a polymer type exceed the pre-set probability threshold values, then the plastic in the first place in the hit list is additionally displayed in large green letters in the middle of the display.

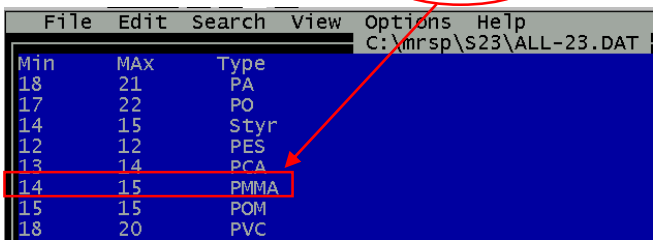


If the pre-set limit values have not been exceeding following values (e.g. 1st place less than 70 %, 2nd place greater than 30 %), it indicates that the neuronal network was not able to identify the sample reliably. Non-identification is signalled with the No-Result message (---). This is a request to repeat the sample measurement again. If repeated measurements still produce this message, the sample might be unknown (not calibrated) or the wrong net model was selected for identification or new recalibration is necessary.

6.6.1 The Min-Pxl statement



The pixel minimum of the NetD curve (Min-Pxl) is very characteristic[20] for a polymer type and can alter depending on the thickness[21] of the sample. In the file head of a Dat-file the specific Min-Pxl positions of plastics are listed as Minimum- and Maximum ranges. These values were determined during the calibration of the device for each polymer type. In case that the actual pixel minimum of the NetD curve (here: 17) is not in the range of the pre-set Min-/Max-Pixel value of a polymer identified (here: PMMA as the 1st hit list ranking of the identification probability) then the message ***Min-Pxl*** is shown (here: pre-set PMMA range 14-15). It indicates a logical restriction of the identification result due to the experiences made during the specific system calibration of the manufacture.



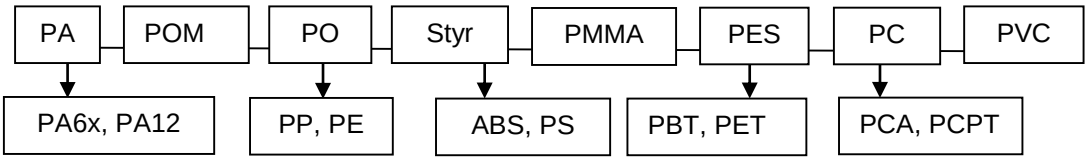
The pre-set Min-/Max-Pixel range for a polymer type should be adjusted[22], if repeated measurements with known samples and correct identification probabilities for the 1st ranking still produce a No-Result message with the Min-Pxl statement.

[19] The relative disadvantage of any neuronal network algorithm is that after the production no other polymer types can be calibrated by the user. The model is only valid for the given main and sub-groups. Modifications must be carried out on demand by the manufacturer.
[20] Depending on the spectrometer system.
[21] As an example: the Min-Pxl of a thin PE foil is usually at 22 whereby the Min-Pxl of solid PE sample ranges between 20-21.
[22] Displacements of the predefined pixel positions in the spectrometer optics can occur as a result of temperature effects.

6.6.2 Standard Model (All, for coloured, natural or milky-like plastic parts):

This identification[23] model is recommended when coloured, natural- or milky-like plastic parts (not gray, not black and not transparent) are to be detected. Herein the amount of polymer types for fine differentiation of the styrene-containing sub-group is reduced. Modified results **(Mdfy)** switches PA6x[24], PA12 to PA and PP, PE to PO and ABS, PS to Styr and PBT, PET to PES and PCA, PCPT to PC. It means the identification will be simplified. The fine differentiation of the polymer type in the sub-group is modified/altered to the main group.

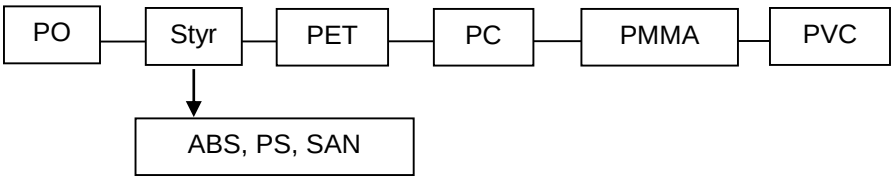
Identification of **PA** (PA6x, PA12), **PO**[25] (PP, PE), **Styr**[26] (ABS, PS), **PES** (PBT, PET)**, PC** (PCA, PCPT)[27]**, PMMA, POM** and **PVC:**



6.6.3 Clear Type Model (clrT, for clear, transparent plastic parts):

Restriction of the polymer identification to few clear types which can normally occur also or only as clear, transparent plastic parts. This identification model is recommended (thickness: 0.5 – 6 mm), because the amount of polymer types for fine differentiation of the styrene-containing sub-group is extended and other types are neglected to enhance the identification performance. Materials which are thicker than 6 mm the result for clear materials might become not reliable and for materials which are thinner than 0.5 mm the Foil model should be selected. Modified results **(Mdfy)** switches ABS, SAN (AS), PS to Styr.

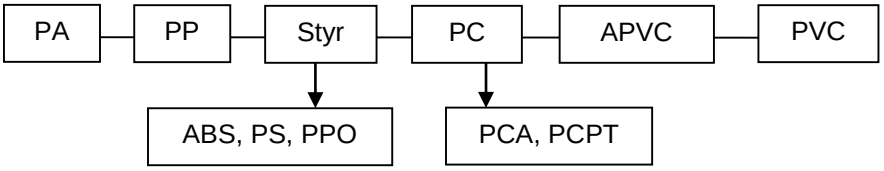
Identification of **PO**[28] (PE, PP), **Styr** (ABS[29], PS, SAN[30]), **PET**, **PC, PMMA** and **PVC:**



6.6.4 Gray Type Model (gryT, for gray-coloured plastic parts):

This identification model is recommended when gray-coloured plastic parts[31] coming from the electro- and electronic dissembling area (e.g. computer waste) are to be detected, because the amount of polymer types for fine differentiation of the styrene-containing sub-group is extended and other types are neglected to enhance the identification performance. The restriction of the polymer identification to gray-coloured materials helps to work out the distinctive marks in the NIR spectra enhancing the NIR-identification performance for these materials. Modified results **(Mdfy)** switches PPO, PS and ABS to Styr and PCA, PCPT to PC.

Identification of **PA**[32]**, PP, Styr** (ABS, PS, PPO)**, PCA** (PC, PCPT)[33]**, APVC** and **PVC**

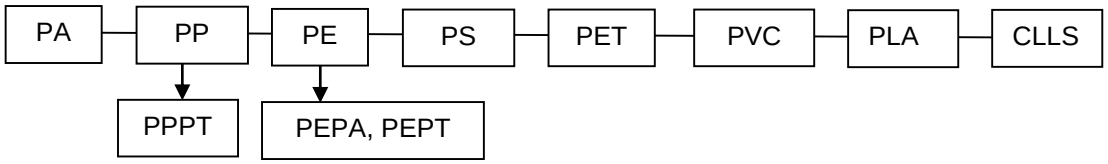


[23] IoSys uses the following abbreviations: PA=Polyamide, PO=Polyolefine, Styr=Styrene containing polymers, PES=Polyester, PCA=PC+ABS, PCPT=PC+PBT or PC+PET, APVC=ABS+PVC, PLA=Polylactoseacetate-biodegradable, CLLS= Cellulose; Multilayers: PEPA=PE+PA, PEPT=PE+PET, PPPT=PP+PET.
[24] Fine differentiation of PA6 and PA66 polymer types is not reliable. Therefore both types are calibrated and combined to PA6x.
[25] To distinguish each Polyolefine group for the neuronal network calculation IoSys uses the following abbreviations: PO for Standard (All) and POx for DSD model.
[26] To distinguish each styrene-containing group for the neuronal network calculation and editing IoSys uses the following abbreviations: Styr for Standard (All), Styl for clear Type, Strl for gray Type model.
[27] Due to their polymer similarity the identification of coloured PC, PCPT and PCA polymer types is sometimes uncertain. Blend ratios from PC/PBT or from PC/PET of 60:40, 50:50 and 40:60 are calibrated as “PCPT”.
[28] No fine differentiation of transparent polyolefine is made in ClrT. Fine identification should be done via Standard (ALL) model. Nowadays transparent PO could be a polyethylene with copolymer like Surlyn® of DuPont™
[29] Usually transparent ABS material is a blend which contains PMMA, too.
[30] SAN = Styrene-Acryl-Nitril is also named as AS = Acryl-styrene.
[31] Due to the experiences of IoSys it must be stated that gray coloured plastics (e.g. PA, PP, PVC) which are containing lot of Talcum or glass fibers (20-40%) as a filling material reduces the NIR light reflection causing non reliable identification results.
[32] Fine differentiation of PA6, PA66 and PA12 polymer types is not reliable. Therefore all types are calibrated and combined to PA.
[33] Due to their polymer similarity the identification of gray coloured PC, PCPT and PCA polymer types is sometimes uncertain.

6.6.5 Foil Model (Foil, for thin materials):

This identification model is recommended when transparent thin materials like foils are to be detected. Due to the variable thickness of foils the absorption and reflection characteristic differs in comparison to solid materials. These differences appear in the position number of the NIR-curve minimum for the polymer types (Min-Pixel). The Thin foils should be folded several times thus a thickness at least 50 - 100 µm is achieved, otherwise the result might not be reliable. Materials which are thicker than 500 µm should be measured using the Modified results (Mdfy) switches PEPA, PEPT to PE[34] and PPPT to PP.

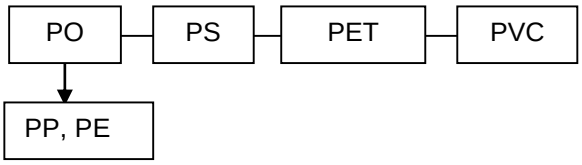
Identification of **PA, PP** (PPPT)**, PE** (PEPA, PEPT)**, PS, PET, PVC, PLA**[35] and **CLLS**:



6.6.6 DSD Model (for household and packaging plastics):

This identification model is recommended when typical plastic parts and foils coming from the household and packing area (MWS) are to be detected, because the amount of polymer types is restricted to few polymer types which normally occur as household and packaging plastics (MWS= DSD =Duales System Deutschland). To enhance the spectral variances, the database of ABS, PS are combined to PS and PBT, PET as PET. In the DSD model no PA-, PEPT-, PLA- and CLLS foils are calibrated and due to the spectra similarity the multilayer foil PEPA was taught in as PE. Modified results **(Mdfy)** switches PP, PE to PO.

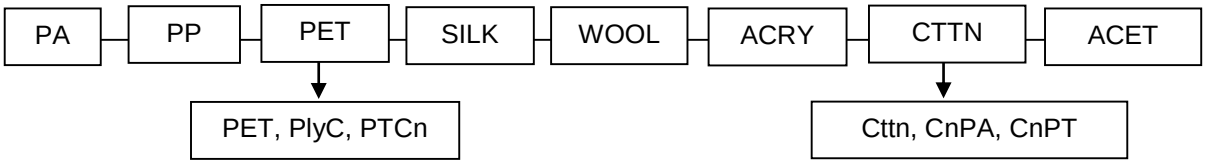
Identification of **PO** (PP, PE)**, PS, PET** and **PVC:**



6.6.7 Textile-Model (Txtl, for textile and carpet fabrics):

This identification model (optional feature, sometimes named as **Crpt**) is recommended when carpets or textiles are to be detected. Modified results **(Mdfy)** switches PlyC, PTCn to PET and CnPA, CnPT to Cttn.

Identification of **PA**[36], **PP, PET** (Polyester)**, PlyC** (PolyCotton[37]), **PTCn** (PET+Cotton-blend[38])**, Acrylic, Silk, Wool, Cttn** (Cotton), **CnPA** (Cotton+PA-blend[39]), **CnPT** (Cotton+PET-blend[40]) and **Acetate.:**

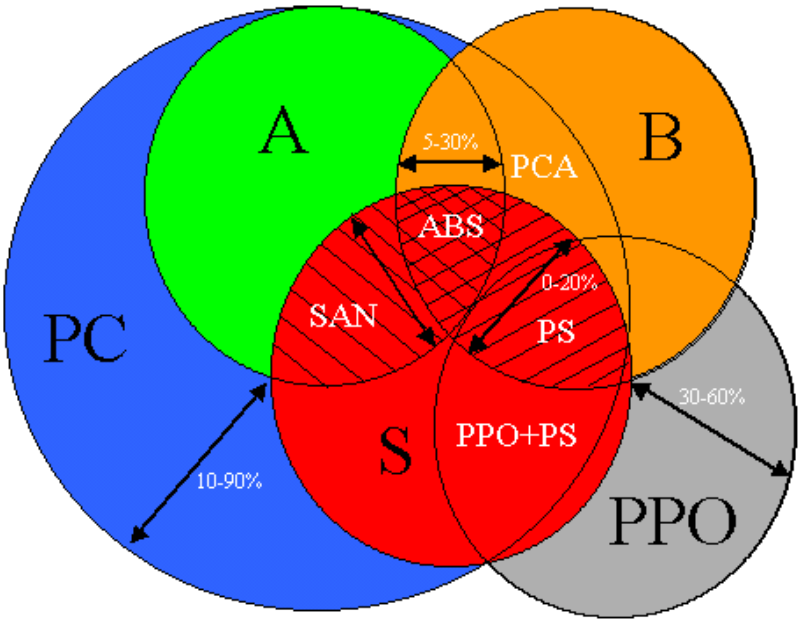


[34] Due to the fact that the thickness of the layers are always different, the identification results are sometimes not reliable.
[35] PLA=Polylactoseacetate-biodegradable, CLLS= Cellulose (paper, cotton)
[36] Fine differentiation of PA6, PA66 and PA12 fabrics is not reliable. Therefore all types are calibrated and combined to PA.
[37] Blends made of Polyester-Cotton fabrics (ratio ~ 65:35 and/or 50:50). IoSys uses the abbreviation PlyC for PolyCotton
[38] Cotton fabrics which are coated with a polyester layer. IoSys uses the abbreviation PTCn for PET+Cotton-blend.
[39].Blends made of Cotton-Polyamide fabrics (ratio ~ 50:50). IoSys uses the abbreviation CnPA for Cotton+PA-blend
[40] Blends made of Cotton-Polyester fabrics (ratio ~ 80:20). IoSys uses the abbreviation CnPT for Cotton+PET-blend.

6.6.8 Composition of Styrene-containing Polymers

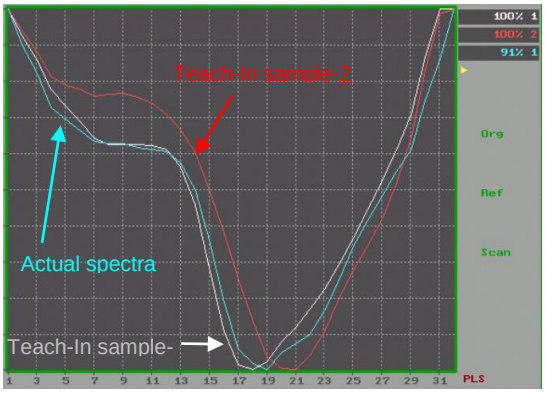
In general the differentiation of styrene-containing polymer types like ABS, PS, PPO, SAN (AS), PCA und APVC are difficult with the NIR Technology due to their polymer similarity. Most of them are blends of each other in different concentrations. But restriction of the polymer identification either to their colours (if coloured, natural- or milky-like (Standard) or if gray-coloured (gryT)) and to their material properties (if transparent (clrT) or thin (Foil)) or their characteristic fire retardant compositions helps to work out the distinctive marks enhancing the identification performance for these materials.

ABS:	Acyrilnitril-Butadien-Styrol,	A: 5-30%,	FR: Br (Cl)
PS:	Polystryrol ; HIPS = S/B;	B: 0-20%,	FR: Br, Cl
PPO:	Polyphenylenoxid+PS (S/B),	PS: 30-60%,	FR: P
PCA:	PC+ABS-Blend,	PC/ABS: 10-90%,	FR: P
SAN (AS):	Styrol-Acrylnitril (Acrylnitril-Styrol)		



6.7 Polymer Type Identification by PLS

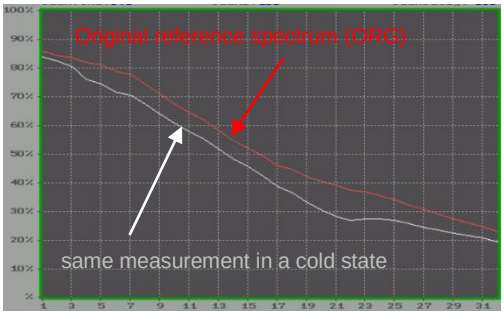
The identification of the polymer type using the PLS[41] method (Partial Least Square) is the result of a comparison of the measured spectrum with the stored Teach-in spectra (best fitting curve). It means that an actual spectrum (here: blue curve) is compared with all teach-in sample data which are activated (here: gray & red curves). The more the blue curve resembles to one of the Teach-in curves, the higher the Hit-Quality percentage. In this case the blue curve has the best fit to the gray one. As an example: the actual curve resembles to the blue curve to 91%.



[41] The advantage of the PLS method is that the user can teach-in own test samples to carry out simple rapid analysis. The disadvantage is that PLS works for NIR-spectra only which obviously have big spectral differences.

6.8 Recalibration of mIRo

The background to the recalibration routine is that different known types of plastic have been calibrated against a reference standard (white ceramic plate). It means that the near infrared intensity data (NirD) of the known samples were mathematically transformed in ratio to this reference standard, normalized and auto scaled into network data (NetD) for modelling neuronal networks for plastic identification (see:). At that point of time the mIRo system was calibrated (the so-called Design state[42]), this reference spectrum was stored as the "original reference spectrum" (ORG).



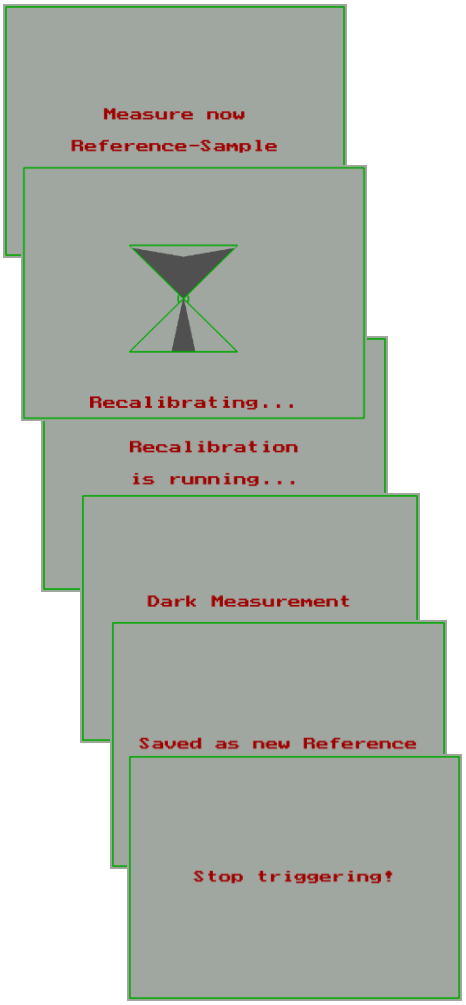
Due to temperature effects, deviations in the sensitivity of the scanning electronics are shown up and therefore the resulting intensity data differ. In general, when the device is just powered on or if the system is used in a cold environment (cold state[43]) the NIR-signals of a measurement are less intense in comparison to the design state. Through the used ratio method, the effect of changes to the state of the system are almost eliminated through the formation of intensity ratios (sample spectrum divided by the current reference spectrum). However, the identification capabilities of the spectrometer can be reduced in the cold state. A priori, the identification performance is best when the current signal output is similar to the design state.

In order to operate the system immediately (no waiting time for warming up), a recalibration routine is used. The recalibration procedure for diffuse reflection measurements automatically adjusts the measurement electronics in a way that the current signal output of the reference standard closely fits to the stored original reference.

<u>Proceed as follows to recalibrate the mIRo:</u>

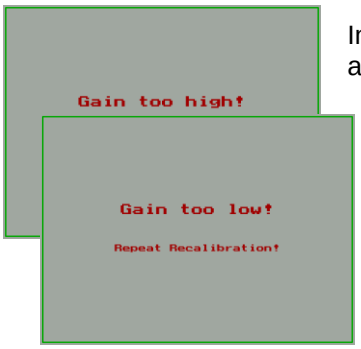
1. Press the **<Cal>** icon to start the recalibration.

2. Attach the measuring head against the white ceramic reference and keep pressing one of the both triggers (in manual operation mode only) until the last message: ***Stop triggering*** indicates the end of the recalibration routine. During the recalibration procedure the following messages will be shown up:



At first, (while pressing the trigger) the message ***Recalibrating…*** with a hour-glass appears. This status indicates that the auto-gain-adjustments is running. If the electronic adjustment has adjusted the current signal output similar to the Design state the message ***Recalibration running...*** is displayed. At that moment the actual reference measurement with NIR-light is carried out. Afterwards the light is powered down automatically and the message: ***Dark Measurement now running...*** is displayed to measure the dark signals (still keep pressing the trigger!).

The message: ***Saved as new Reference*** signals that the measurement has been accepted.



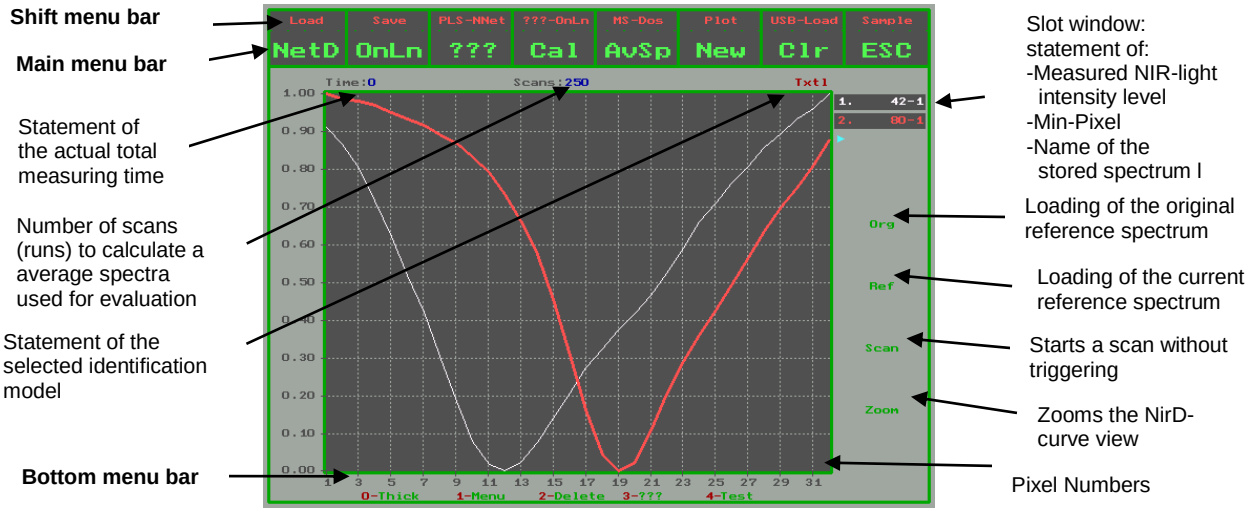
In case that the intensity data of the actual reference measurement differs from the last signal curve, error messages like ***Gain too high!*** or ***Gain too low!*** are shown up. The reason could be that the measuring head was not constantly attached to the ceramic plate causing that non-reproducible spectra. The recalibration procedure has to be repeated.

If the message: ***Changed Condition! Do new Recalibration*** appears then the recalibration should be carried out again as described before (gain drifting because electronics are heated up).

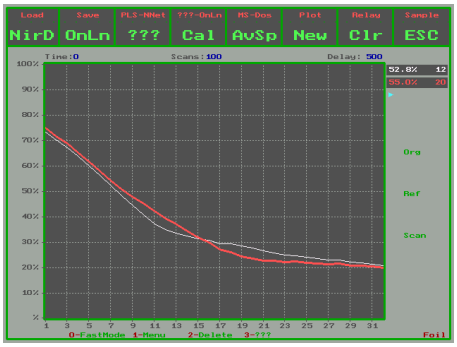
[42] Design state: For mIRo calibration the system was always powered on 2 hours before at a room temperature of 22 °C to ensure that the device was in a thermal equilibrium and thus the resulting signals were stable and reproducible.
[43] Cold state: When the mIRo is just powered on, it is not in a thermal equilibrium. At the beginning the spectra are lower in intensity, drifting towards higher values within 2 hours, i.e. the signal outputs are unstable and non-reproducible.

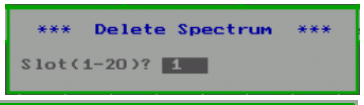
6.9 Operating Elements in the Spc-Mode

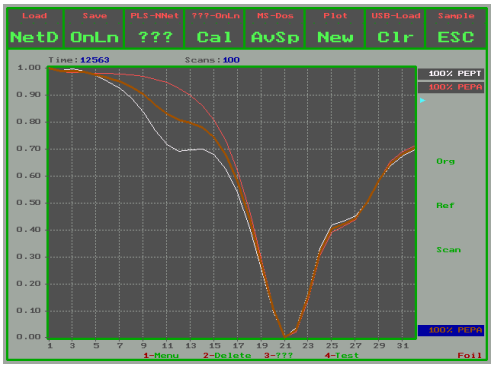
6.9.1 The Main Menu



Icon	Key	Function
NirD	**F1**	Switches between the representation views. In the **<NirD>** mode the raw intensity data are shown and in the slot window the measured NIR-light intensity level and Pixel number of the curve minimum is listed (Min-Pxl). In the **<NetD>** mode mathematically transformed intensity data are displayed. In the slot window the slot number and the sample file name is listed if stored before.
OnLn	**F2**	Starts the **Online-Mode** wherein the spectrometer optic is continuously reading out without triggering. The online spectrum is displayed in slot place#1. The Online-Mode allows to display simultaneously other spectra or permits e.g. external light sources held in front of the measuring head to be adjusted for the transmission mode (optional feature). Pressing again the **<OnLn>** icon stops the online measurement.
???	**F3**	Activates the polymer type identification (PLS or neuronal network) for all displayed spectra. In the NetD-mode the identification result and the 1st ranking percentage for each spectrum is listed in the corresponding slot window. Pressing again the **<???>** icon returns back to the statements of NIR-light intensity and Min-Pxl or sample file name.
Cal	**F4**	Starts the same recalibration routine (see: Recalibration of mIRo). In the NirD mode the original reference spectrum is automatically loaded in slot place#2 for better comparison and the actual raw intensity data are displayed in slot place#1. If the **<Cal>** function is unintentionally pressed the recalibration can be stopped touching the **<F7>** key or **<Clr>** icon, resp..
AvSp	**F5**	Forms an average spectrum (not auto scaled) from all the spectra which are displayed and plots it in slot place#20 as a brown thick line with a blue coloured slot window. Pressing the icon again cancels arithmetic forming of an average mean.
New	**F6**	Opens the **New-Menu** to delete the representation of a spectrum at a slot place. The next spectrum now appears at the slot place marked with „ ▸ ".
Clr	**F7**	Deletes all the spectra represented at the slot places.
ESC	**F8**	Leaves the **Spc-Mode**, back to the **Start-Display**.

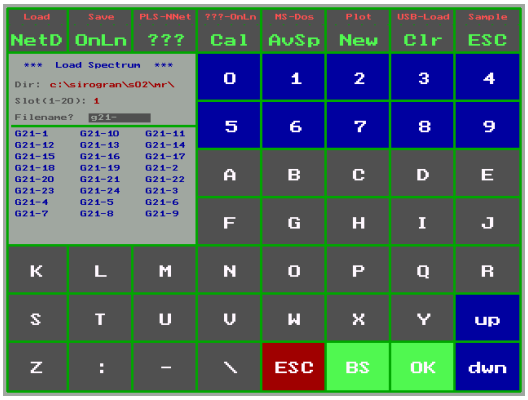


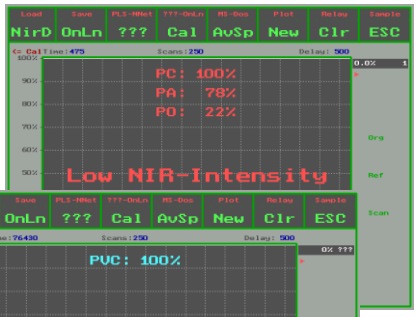


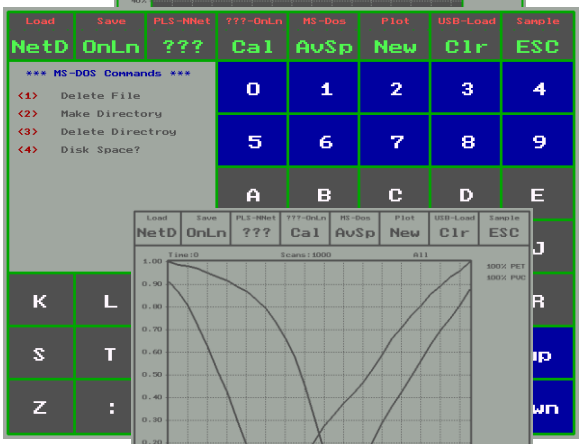


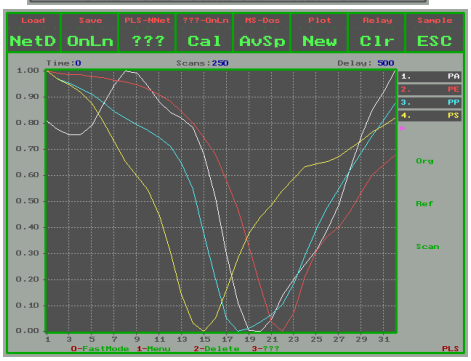
6.9.2 The Shift Menu

Icon	Key	Function
Load	**Sft+F1**	Opens the **Load-Spectrum Menu** to open spectra which were saved in the directory path edited under Dir (max. 22 letters). A temporary change to the pre-set directory (edited in the Initialization File) and path can be carried out under Dir. The files are listed in filtered form in accordance with the characters[44] entered. Moving within the window can be done with the **<Enter>** or **<Cursor up>** or **<Cursor down>** key. Loaded spectra are shown in different colours after quitting the menu.
Save	**Sft+F2**	Opens the **Save-Spectrum Menu** to permit spectra to be stored in the directory path edited under Dir (max. 22 letters). A saved spectrum file gets the file suffix „*.spc“ and is written in a Flat-ASCII text format.
PLS-NNet	**Sft+F3**	Switches between the PLS model (Partial-Least-Square) or the Neuronal Network calculation.
???-OnLn	**Sft+F4**	Starts the Online identification mode[45] which continuously displays the identification result with the hit list ranking. The hit list is displayed in red letters for neuronal network and in blue letters for the PLS mode. Pressing the **<OnLn>** or **<Clr>** icon stops the online identification measurement.
MS-Dos	**Sft+F4**	Opens the **MS-Dos Menu** for carrying out given MS-Dos operation commands:
Plot	**Sft+F6**	Prints[46] out the actual display as a screen dump to a Mini-Plotter (optional feature). Touching any field of the touchscreen or pressing any key on the Keyboard stops the plotting process.
USB-Load	**Sft+F7**	Opens the **USB-Load Menu** to load spectra which were saved in an external USB-stick[47] in the pre-set subdirectory (e.g. in *d:\nir*). Operating elements are the same as described under **Load.**
Sample	**Sft+F8**	Loads all activated Teach-in samples (max. 8 spectra with the edited file names in the slot #1 up to slot #8. This function gives an overview of the stored Teach-in sample data set.
./.	**Sft+F9**	Starts the recalibration routine without auto-gain-adjustment (not displayed in the Shift menu bar). This procedure is recommended if own application (analysis method) is created whereby the reference spectrum should not have the same intensity level as the stored original reference spectrum (e.g. reference signal as blank signal).









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[44] A backslash (\) edited at first of the file name activates the loading/saving of a file series. For example, the entry \kal-0 loads/saves all spectra beginning with the file from kal-1; an entry \kal-1 loads/saves all spectra beginning from kal-11.

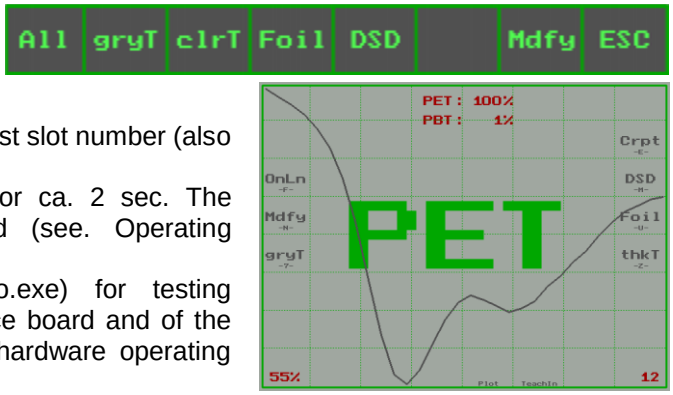
[45] The Online function in the SPC mode operates faster as in the Ready window, because less time is needed for the screen setup. Either the Circular mode while pressing the rod trigger or the Online mode for transmission operation is possible.

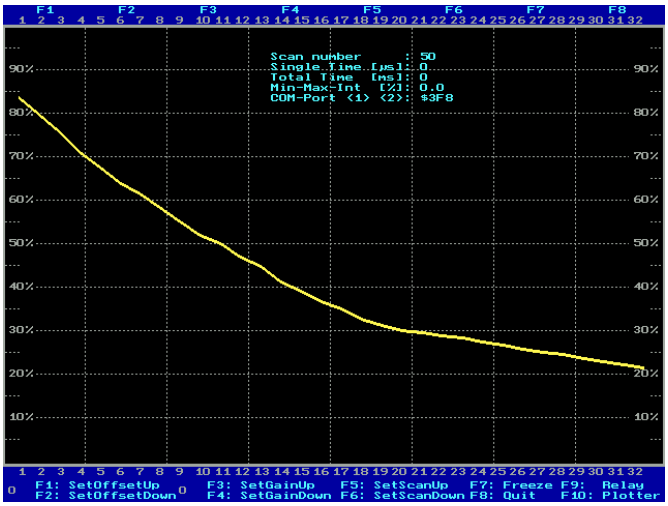
[46] Only active if a the Mini-Plotter is connected and the hardware is activated in the initialization file Ini.dat.

[47] The stored NIR-spectra at the USB-Stick have a different file format (in rows/lines), thus these files can not be read and load with the Load-Function (F1).

6.9.3 The Bottom Menu

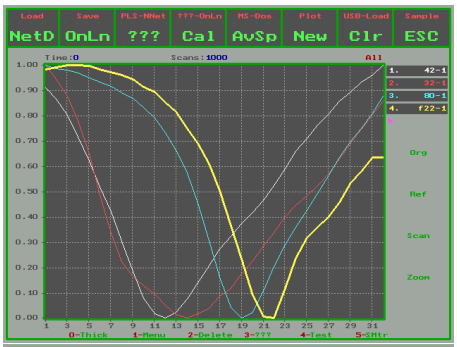
Icon	Key	Function
./.	**0**	Displaying the last NIR-curve (highest Slot-number) as a thick curve (or **<t>** key).
Menu	**1**	Opens the **Menu Bar** (also with **<ENTER>**) to select a net model for polymer type identification (**<F1>..<F6>**[48]).
Delete	**2**	Deletes the spectrum with the highest slot number (also with **<Backspace>)**.
???	**3**	Switches to the **Result-Display** for ca. 2 sec. The spectrum at slot#1 is evaluated (see. Operating Elements in the Result-Display).
Test	**4**	Starts the **Test-Program** (mIRo.exe) for testing electronic parts on the NIR-interface board and of the X/Y-table device part. In case of hardware operating malfunctions this diagnostic program helps to locate the error. For example: The gain adjustment function of the electronics are checked by using **<F3>** or **<F4>** or with the means of the Hotkeys **<d>** (gain down), **<m>** (gain mid) and **<u>** (gain up).

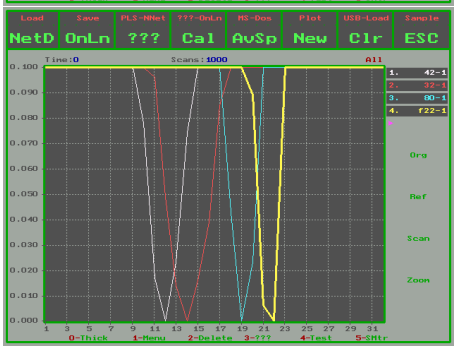




6.9.4 Additional Operating Elements

Icon	Key	Function
Scans	**A**	Sets the scan numbers[49] (scans/runs) in steps of 1, 10, 50, 100, 250, 500 and 1000. The scan numbers can be changed by pressing the **<a>** icon repeatedly. The default value is 100 scans, a priori, to obtain a stable average spectrum for polymer type identification.
Org	**O**	Loads the original-reference spectrum into the next vacant slot.
Ref	**R**	Loads the current reference spectrum into the next vacant slot.
Scan	**#**	Starts a scan without pressing the trigger (also with **<Space>**).
Zoom	**⇑**	Zooms the representation view of the displayed data curves. In the **<NetD>** mode the intensity percentage ranges then from 0-0.1% which makes it easier to see peak minima (e.g. to detect abnormal curve shapes). In the **<NirD>** mode the spectra is auto scaled between the first and last Pixel value. Pressing the **<Cursor-up>** icon again returns back to the full image representation
./.	**P**	Activates the polymer type identification (PLS or neuronal network) for all displayed spectra (same as **<???>** icon).





[48] <F6> icon is shown if the Textile-Model (as an optional feature) is implemented.

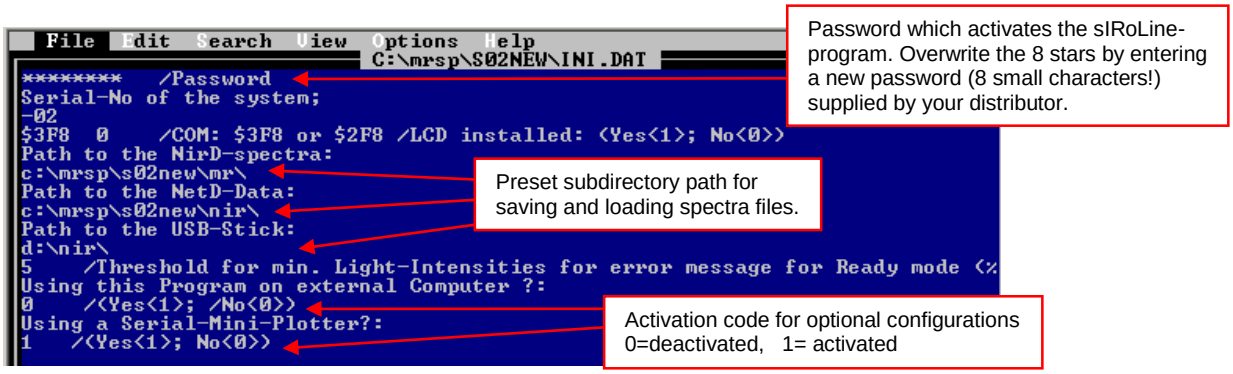
[49] The higher the scan number (Runs), the better is the resulting average spectra (improved signal/noise ratio of the calculated average) and the more stable the identification result. However, the measuring time is longer. On the other hand, the smaller the scan number, the more noisy is the resulting spectrum for evaluation, the less stable is the identification result. However, the measuring time is shorter.

7 The System Files for mIRo

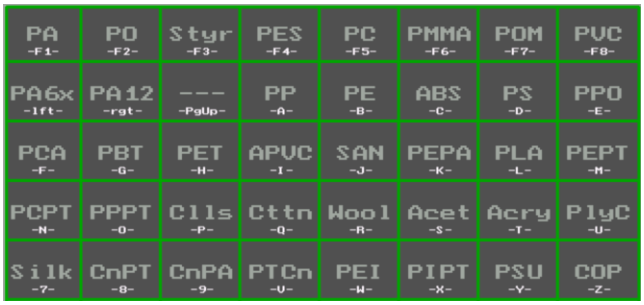
7.1 The Initialization File

Pre-set parameters like the serial number of the unit, hardware address, directory paths and the activation of optional features are stored in the file: *ini.dat*. This text file can be opened by pressing the **<F7>** (mIRoIni) in the **Keys-Display** (see: Operating Elements in the Keys-Display).

As an example a typical initialization file is listed: (data always differ depending on the system!).

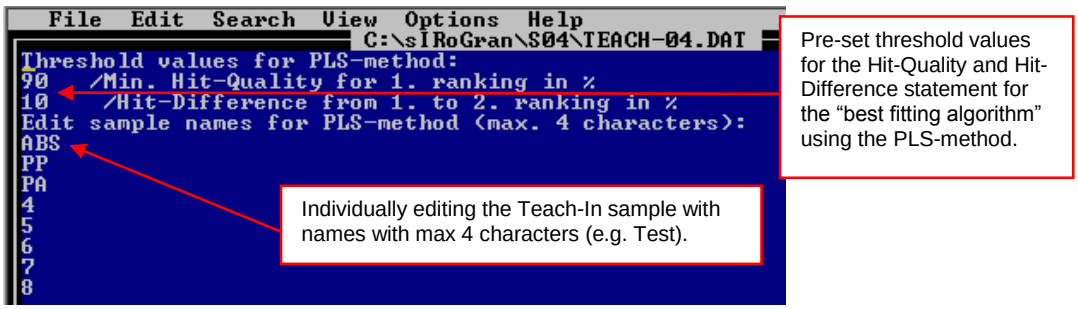


7.2 The Teach-In File

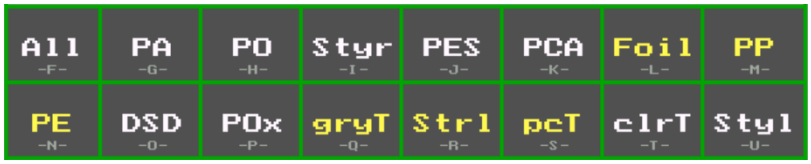


Sample names and pre-set threshold values edited in the Teach-In menu are stored in the file: *teach-XX.dat* (XX=series number). This text file can be opened by pressing the **<F8>** (TeachIn) in the **Keys-Display**. Herein other sample names can edited compare to the given polymer types list.

As an example a typical Teach-In file is listed:

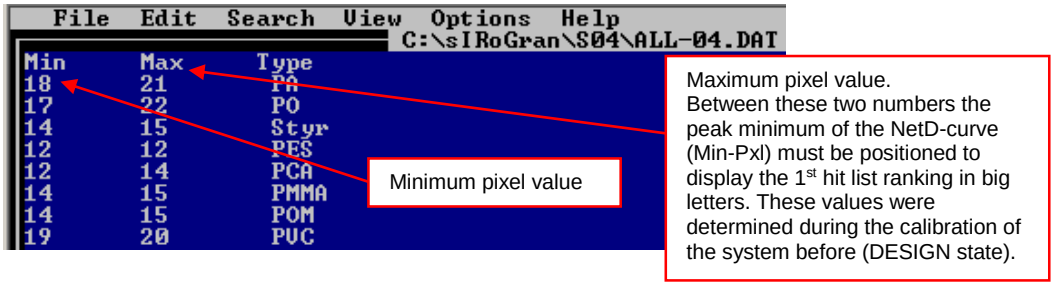


7.3 The Dat-Files



The Min-/Max-Pixel range of the NetD curve minimum and given values of the neuronal network models (weighting factors) are stored in the Dat-files *modelname-XX.dat* (XX=series number). These text files can be opened as described before in the **Keys-Display** by switching into the **mIRoNet Menu** with **<F6>** and then pressing the **<f>..<u>** keys or model name icons.

As an example for a typical Dat-file of the Standard (All) model is listed (data always differ depending on the actual individual unit!).



8 Data Exchange

8.1 Using PC-Link cable

For communication with other computers and the update of software the MS-DOS communication system Interlink/Interserver can be used for the communication between the device system and other computers (only working for computers equipped with Windows95® or Windows98®) for with the aid of the serial interface, a zero modem cable (Laplink-cable, 9p-SUB-D).

Copy the interlnk.exe file (supplied by Floppy-Disk or e-mail) to a directory on the computer (e.g. your Desktop or Laptop computer) where you want to make the communication with the systems. The interlnk.exe file should be placed in the main root c:\ of the external computer and should get an entry in the config.sys file[50] as following.

device=c:\interlnk.exe /com /noprinter /auto.

1. Connect a serial zero modem cable to the COM interfaces of the device (acts as Server) and the external computer (acts as Client).
2. Switch off the integrated Mini-Plotter (optional feature) with the rocker switch locate aside before to avoid data transfer malfunctions.
3. Press the **<PC-Link>** icon (or **<F3>**) in the KEYS-Menu to start data exchange program (intersvr.exe).
4. Reboot the external computer (e.g. your Laptop or Desktop-PC) to start the data exchange program. The drives of the measuring device (e.g. A:\, C:\) will appear now as additional drives (e.g. F:\, G:\) at your external computer which you can now access to copy files for updates or to copy stored spectra to your computer.

5. If no computer link could be established then restart the external computer again and press repeatedly **<F8>** to enter the Microsoft Window 98 Start Menu. Press **<5>** to select the Dos prompt level.
6. Power down the device to quit the PC-Link-program.

8.2 Using a USB-Stick

For data exchange with other computers and software updates an USB stick can be connected to the USB port of the system. Before booting up[51]. the system the USB-Stick must inserted correctly into the USB slot.

Access to the USB-stick can be done by the means of an external keyboard and by editing **<d:>** usually.

Sometimes there is no access to the USB-Stick at first time and the following error message[52] is shown: ***Unzulässiger Datenträgertyp beim Lesen von Laufwerk D:***
Quit the error message by editiing **<u>** like (U)ebergehen and enter **<d:>** again.

Attention: Before putting the USB-stick into an external computer, the **<MKSHEET>** (Make Sheet) command has to be executed first as a MS-Dos command on the active storage directory of the USB-Stick to convert the **.spc* files of any measurement series into a file *data.txt*, which afterwards can be read by table calculation programs like Excel on an external computer. All existing **.spc* files on this subdirectory will be converted to the new created file *data.txt*, so that it is advisable to delete eventually remaining older **.spc* files beforehand.

[50] Please recognize that there might be some config.xxx files on your computer in the root directory (usually c:\) depending on the operating system you may have for initial starts or the later change to MS-DOS. In such a case all files named config.xxx should be altered accordingly with the above mentioned line. Please make sure that also the lastdrive command is giving enough figures for the deviated disks on your computer when connecting to the mIRo. Always place the new command at the end of the config.xxx files to avoid conflicts with other commands redirecting drives. Then either from the Windows Explorer or alternatively starting the MS-DOS mode, updates for the unit can be easily copied.
[51] The USB stick will be recognized by the MS-DOS system at time of booting only ! When the USB stick is disconnected while system operation and connected again then it will not recognize the USB stick again. The unit must be restarted again.
[52] German based MS-DOS is used.