



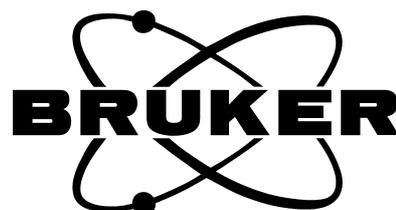
OPUS

Spectroscopy Software

Version 6

User Manual

FPA



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This manual is the original documentation for the OPUS spectroscopic software.

Table of Contents

1	Introduction	1
2	Hardware Requirements	3
3	Configuring the Hardware	5
3.1	Setting up the Transient Recorder	5
3.2	Setting up the Imaging Device	6
3.3	Setting up the Velocity	9
4	Continuous Scan Measurements using FPA Detector	11
4.1	Measurement Parameters	11
4.2	Video-assisted, continuous Scan Measurement using FPA Detector	15
4.2.1	Video Mode Interface	15
4.2.2	Pop-up Menu of the Live FPA Image	17
4.3	Background Measurement using FPA Detector	26
4.4	Continuous Scan Measurement using FPA Detector	26
4.5	Kinetic Measurement using FPA Detector	26
4.6	Displaying the Measurement Results	27
5	Step Scan Measurement using FPA Detector	29
5.1	Measurement Parameters	29
5.2	Video-assisted step scan Measurement using FPA Detector	31
5.2.1	Video Mode Interface	31
5.2.2	Pop-up Menu of the Live FPA Image	31
5.3	Non-video-assisted Step Scan-Measurement using FPA Detector	33
5.4	Displaying the Measurement Results	34

1 Introduction

The software package OPUS/FPA allows data acquisition using the microscope HYPERION™ 3000 or the external sample chamber IMAC in conjunction with an optional FPA detector (Focal Plane Array Detector). The FPA detector is a multi-element detector, i.e. the detector consists of a matrix with 64 x 64 or 128 x 128 detector elements. Similar to the CCD chip of a video camera, the detector elements lie equidistant in a plane. In contrast to a single-element detector (e.g. MCT detector), the FPA detector can acquire data simultaneously at as many points as the detector has elements (pixel) with one single measurement. An advantage of this detector type is the extremely short measurement time when analyzing sample surfaces. Normally, a measurement using the FPA detector takes only a few seconds.

With the software package OPUS/FPA you can perform both continuous scan measurements as well step scan measurements using the FPA detector. In case you want to create and save video images as well, the software package OPUS/VIDEO is required. For the control of the computer-controlled x/y-stage you need the software package OPUS/MAP. To display and evaluate the measurement data the software package OPUS/3D is necessary.

2 Hardware Requirements

Computer System

For measurements using the FPA detector at least one free PCI slot for the FPA frame grabber card and a RS232 port are necessary. In addition, video-assisted measurements require either a PCI video frame grabber card or a digital camera that is connected to a firewire (IEEE 1394) or USB interface. In case you work with a computer-controlled x/y-stage, you need also an external LANG controller that is connected to a RS232 interface or the internal LSTEP board that requires a long PCI slot.

For measurements with a continuous scanner movement (continuous scan measurements), there has to be an electrical connection between the optics and the FPA detector to synchronize the digitalization of the IR images with the scanner movement.

In case of accumulating measurements, all raw data are buffered and averaged in the RAM so that they need not read in again from the hard disk after the measurement. This involves a considerable saving of time. During this kind of measurement, a huge amount of data is generated which needs to be buffered in the RAM. In the following table, the required RAM storage capacity depending on the pixel number, the resolution and the band width is listed. (The listed values hold true for the acquisition mode *Double Sided, Forward-Backward*).

Number of FPA Detector Pixels	Resolution [cm ⁻¹]	Band Width [cm ⁻¹]	RAM Storage Capacity [MByte]
64 x 64	2	15800	1792
64 x 64	2	7900	903*
64 x 64	2	3950	460*
64 x 64	4	3950	240*
128 x 128	2	1580	7167
128 x 128	2	7900	3614
128 x 128	2	3950	1838
128 x 128	4	3950	950*

A logical conclusion drawn from this fact is that the PC should be equipped with a RAM having the highest possible storage capacity. But without additional provisions, Windows, however, can at most manage only a memory address space of 2 GByte. So, a RAM storage capacity of 2 GByte is a reasonable upper limit. In the above table, the cases marked by an asterisk can be realized with a 2 GByte RAM.

In case of kinetic measurements, the generated raw data are not buffered and averaged in the RAM but they are written on the hard disk in real time. This implies a considerably high data rate. If the data are read out at the FPA detector with 80% of the maximum frame rate as usual the data rate is 23.6 MByte/sec (in case of a FPA detector with 64 x 64 pixel and a maximum frame rate of 3773 Hz) or 40.25 MByte/sec (in case of a FPA detector with 128 x 128 pixel and a maximum frame rate of 1610 Hz). See the following table:

Pixel number of FPA detectors	Frame Rate [Hz]	Bytes/Frame [KByte]	Data Rate [MByte/sec]
64 x 64	0.8 x 3773	8	23.6
128 x 128	0.8 x 1610	32	40.25

To ensure these data rates without frame loss during a continuous measurement the computer ought not to perform other operations than acquiring data. Moreover, the data acquisition ought not to be interfered by other programs and services or mouse or keyboard inputs. To ensure an undisturbed data acquisition, make sure that the following conditions are fulfilled:

- The computer ought not to be integrated into a LAN.
- No additional software programs ought to be installed on the computer.
- Close all services that are not required.
- During data acquisition, do not press any mouse key or keyboard button.

In case of continuous scan measurements using the FPA detector, the FPA images are digitized, collected and accumulated between two mirror positions. This reduces the measurement time considerably but at the same time it makes high demands on the PC because a continuous minimum data transfer rate has to be ensured. Especially the newer FPA detectors are suitable for continuous scan measurements as they allow frame rates of several KHz.

Optics

Step scan measurements using a FPA detector require a spectrometer that is equipped with the step scan option. In case of this measurement mode, each mirror position is approached separately to accumulate and read out the images of the FPA detector. This measurement mode does not make high demands on the clock frequency which, however, leads to longer measurement times.

3 Configuring the Hardware

3.1 Setting up the Transient Recorder

After the installation of the FPA-frame grabber card in the PC, you have to setup this card in OPUS under *Transient recorder*. To do this, select in the *Measure* menu the function *Optic Setup and Service*. The dialog box *Optic Setup and Service* opens. Click on the *Devices/Options* tab. Activate the *Transient recorder* check box (figure 1) and click on the *Setup* button.

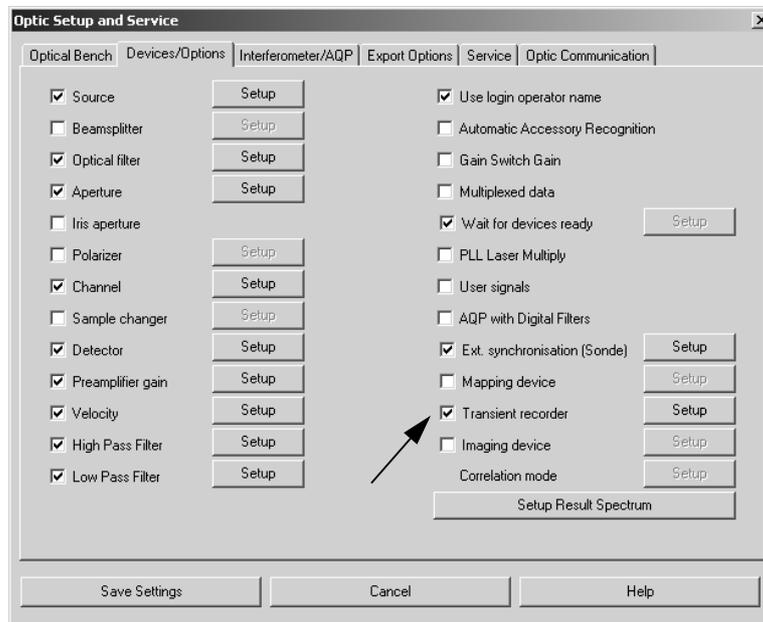


Figure 1: Setting up the Transient Recorder

The dialog window *Devices/Options* (figure 2) opens. Click on the *Add new item* button and enter for example $\delta = \text{FPA1}(pcdig.dll)$. You can define any number you like, however, the number (e.g. 8) at the beginning of the row should occur only once in the list. And you can specify also any name you like (e.g. FPA1). However, the supplement in brackets (*pcdig.dll*) is of crucial importance as it invokes the function library that is necessary for the FPA detector operation. In case the supplement in brackets is misspelled, the program library for FPA frame grabber can not be found. (The supplement is not case-sensitive.)

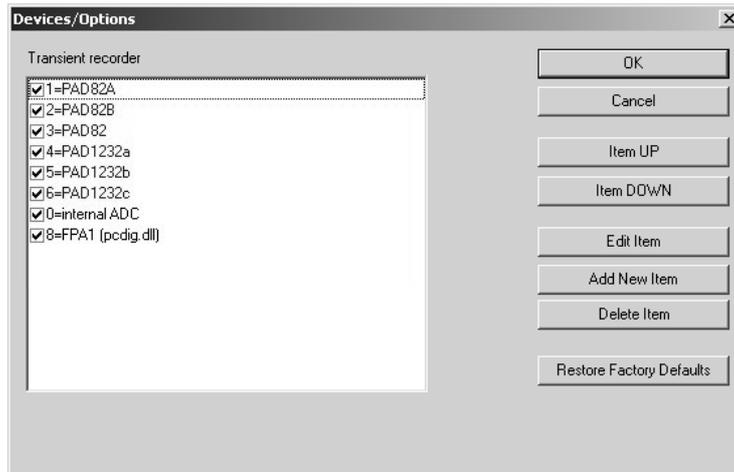


Figure 2: Setting up the Transient Recorder

It is recommended to select only those transient recorders which the PC is actually equipped with. If there are no PAD boards available for time resolved step scan measurements, for example, deselect all entries beginning with *PAD*.

First, click on *OK* button and then on the *Save Setting* button in the *Optic Setup and Service* dialog window (figure 1).

3.2 Setting up the Imaging Device

The imaging device is the combination of the available optics (microscope, IMAC), the capture device (video frame grabber with analog or digital camera), the x/y-stage and the FPA frame grabber card. To set up the imaging device, select in the *Measure* menu the *Optic Setup and Service* function and click on the *Devices/Options* tab. Activate the *Imaging Device* check box and click on the *Setup* button. See figure 3.

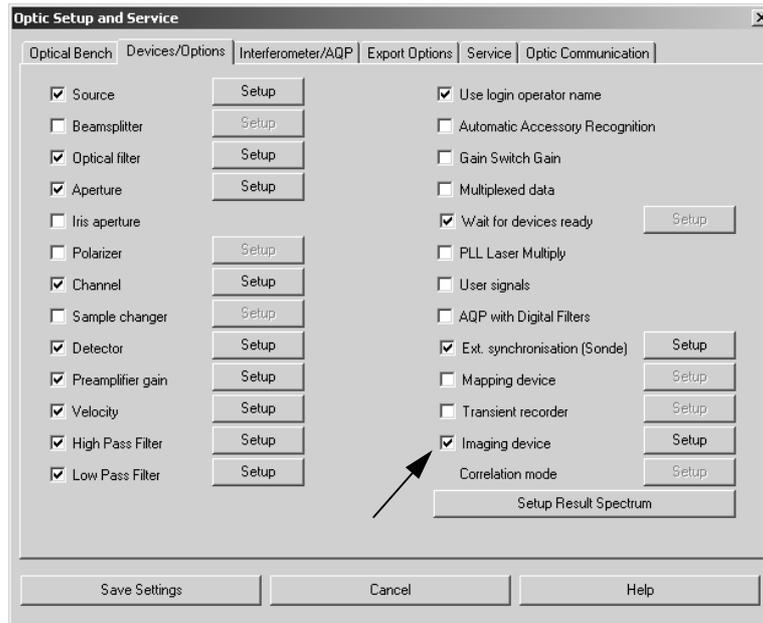


Figure 3: Setting up the Imaging Device

The *Devices/Options* dialog box (figure 4) appears. This dialog box contains all imaging devices you have set up so far. If you want to set up a new imaging device, click on the *Add new item* button and enter a character string having the following syntax: *number<equals sign>description of the imaging device* (e.g. *1=Hyp3000mitFPA*).

Note: You can enter any number you like. However, make sure that a number is assigned only to one imaging device in the list. When you define a description of the imaging device take into consideration that this description can be used as file name.

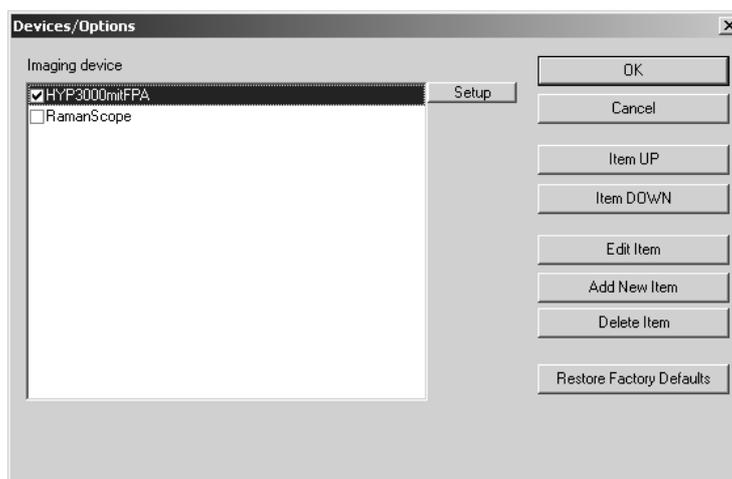


Figure 4: Dialog Box Devices/Options - Imaging Device

To set up an imaging device, first click on the entry in question and then on the *Setup* button next to the entry field. (See figure 4.) The *Setup for Imaging Device* dialog box appears:

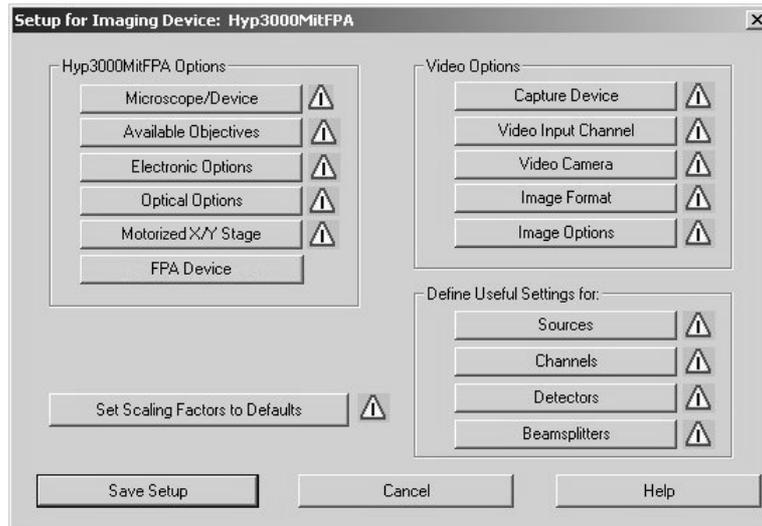


Figure 5: Dialog Box Setup for Imaging Device

All options and settings that have not yet been set up are indicated by a warning sign  next to the corresponding button. A warning sign disappears after the setup of an option has been completed. Before starting a measurement, you have to set up all options and settings with a warning sign. For more information about setting up the imaging device refer to the OPUS/VIDEO Manual.

As you want to perform a measurement using a FPA detector you have to select this detector. To do this, click on the *FPA Device* button. (See figure 5.) The following dialog box opens:

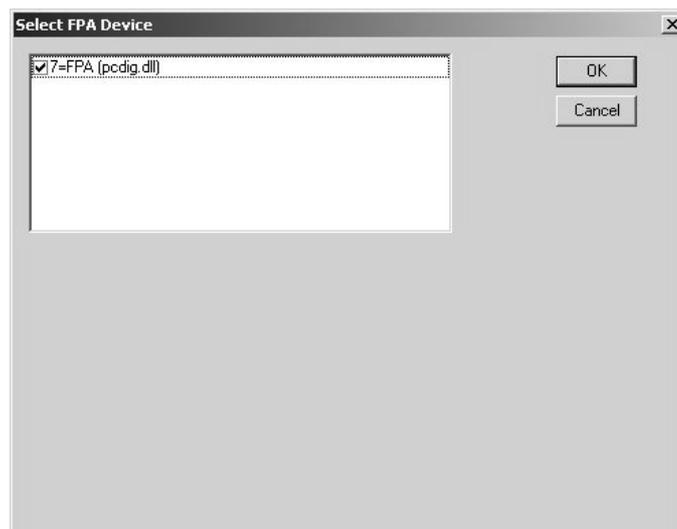


Figure 6: Selecting the FPA Detector

Select the FPA detector in question and click on the *OK* button.

3.3 Setting up the Velocity

For devices which communicate with the PC using an acquisition processor (AQP) you have to set up a variable velocity (i.e. that also other than the pre-defined velocities can be specified) before the measurement is started, provided your device is capable of step scan measurements.

To do this, select in the *Measure* menu the *Optic Setup and Service* function and click on the *Devices/Options* tab. Activate the *Velocity* check box and click on the *Setup* button. See figure 7.

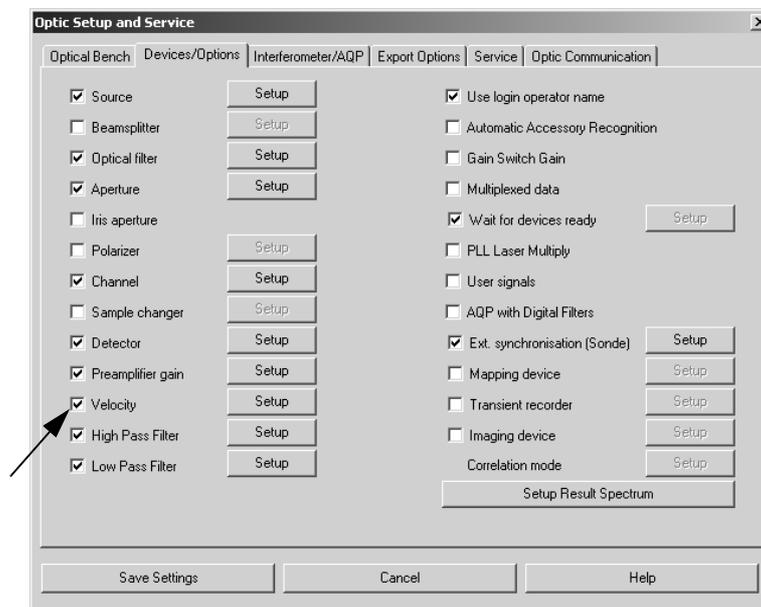


Figure 7: Setting up the Velocity

As a result, the following dialog box opens:

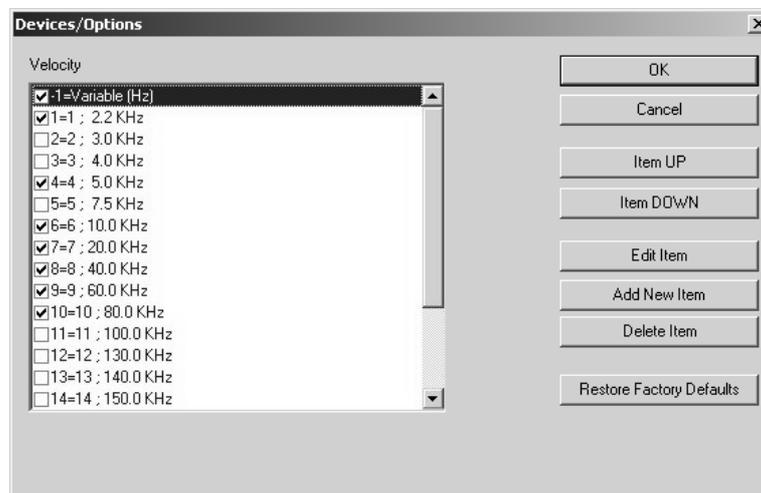


Figure 8: Selecting the variable Velocity

If the list already includes an entry for a variable velocity (-1=Variable Hz), select it. Otherwise, you have to add such an entry by clicking on the *Add new item* button and selecting it afterward.

For devices that are connected to the PC via Ethernet, you need not to set up a variable velocity.

4 Continuous Scan Measurements using FPA Detector

Select in the *Measure* menu the *Continuous Scan FPA Measurement* function. As a result, the corresponding dialog window opens. See figure 9.

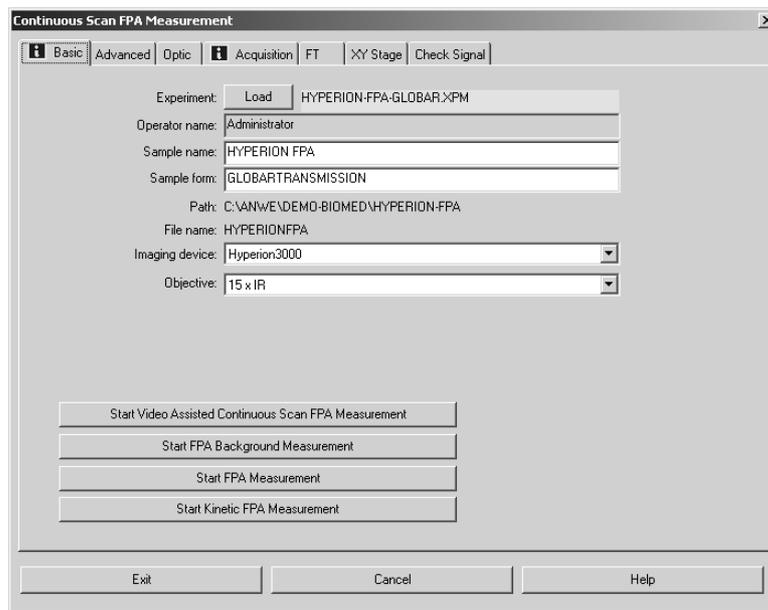


Figure 9: Continuous Scan FPA Measurement - Basic

4.1 Measurement Parameters

Most pages of this dialog window (*Advanced*, *Optic*, *Acquisition* and *FT*) are identical to a great extent to the corresponding pages of *Advanced Measurement* dialog window. For information about these measurement parameters refer to the OPUS Reference Manual. For a detailed description of the *XY Stage* page, see OPUS/VIDEO Manual.

Basic

Select in the *Imaging device* drop-down list the option you have set up before, as described in chapter 3. A field with a yellow background indicates that the FPA detector has to be evacuated as soon as possible. (For information about evacuating the FPA detector refer to the HYPERION User Manual.)

FT

Select in the *Phase Correction mode* drop-down list either the option *Power/No Peak Search* or *Mertz/No Peak Search* to prevent that the interferogram maximum (peak) is searched for every interferogram separately. Otherwise, in case of weak signal, the peak position of several interferograms may be found too far away from the desired position. As a consequence of this, the spectra will be incompatible and the spectra calculation will be canceled.

Optic

For devices which communicate with the PC using an acquisition processor (AQP), you have to define a variable velocity. To do this, you have to set up a variable velocity beforehand. See chapter 3, section 3.3.

Select in the *Velocity* drop-down list the option *Variable (Hz)* and enter the desired velocity (in Hz) in the field that appears on the right of the drop-down list. (See figure 10.) This value is the effective scanner velocity at a bandwidth of 7900cm^{-1} .



Figure 10: Specifying a variable Scanner Velocity

Values smaller than 100 cause an error status that is indicated by a red background of the entry field and the error message *Velocity should be bigger than 100*. (The error message appears when you position the cursor on the red entry field.)

Note: The reason why the lower limit value has been set to 100 is the unstable control of the scanner movement with smaller scanner velocity values.



Figure 11: Scanner Velocity Value is too small

Also the allowable maximum scanner velocity value has been limited; it has to be smaller than 80% of the specified frame rate of the FPA detector. Otherwise, an error status is displayed as well by a red background of the entry field and an error message.

Check Signal

The *Check Signal* page of the *Continuous Scan FPA Measurement* dialog window differs significantly from corresponding page of the *Measurement* dialog window.

In the ‘oscilloscope display’, the intensity values of all pixels (i.e. detector elements of the FPA detector) are displayed versus the pixel number. (See figure 12.) This kind of display allows you to recognize immediately pixels with a too high signal intensity. You can set the signal level optimally by changing the parameters *Frame Rate*, *Offset* and *Gain*. See figure 13a.

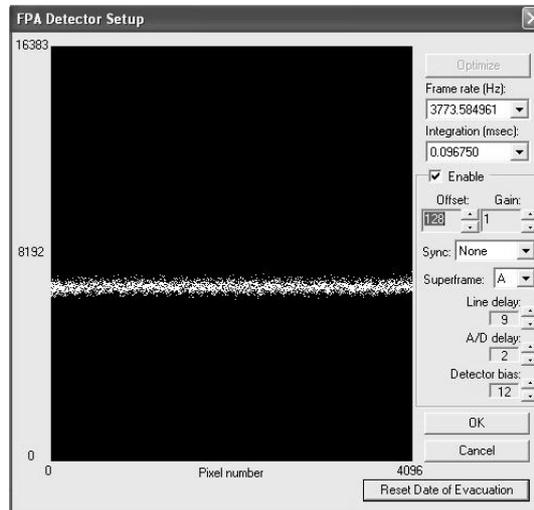


Figure 12: FPA-Detector Setup

Frame Rate

The frame rate (Hz) is the velocity with which the images are read out from the detector.

For the FPA detector SBFJ108 applies the following: The smaller the frame rate value is the more signal is detected by each detector element. However, do not enter a too small frame rate value as this leads to a detector overload. See figure 14. For transmission measurements, enter a frame rate value of 252 or 315Hz and for reflection measurements use a frame rate of 180 or 210Hz.

For the FPA detector SBF161 applies the following: Select the maximum possible frame rate value (3773Hz) and change the integration value correspondingly.

Integration

In case of FPA detector SBFJ108 of which the integration time is a fixed percentage of the frame rate you can only change the frame rate value in order to optimize the signal intensity. In this case the *Integration* drop-down list is grayed.

FPA detectors (SBF161) for which the frame rate and the integration time can be changed independently from each other, select the highest possible frame rate value (3773Hz) and change only the integration value in such a way that the signal intensity is sufficient but neither the upper nor the lower signal values are cut off.

Offset

The parameter *Offset* is used to shift the signal in y-direction. The *Offset* value is set optimally when the signal intensity is as high as possible with no sample in the optical path (in case of background measurement) and when the signal intensity is as low as possible with an interrupted IR-beam (e.g. by switching to the VIS mode or by placing an IR-nontransparent material in the optical path).

Gain

If the signal intensity is not sufficient after increasing the integration time you can amplify the signal using the parameter *Gain*. Note, however, that in case of a too high signal amplification the noise increases to the same degree.

Ensure that the detector is not overloaded. In the IR mode, the signal intensity values should not be above 50% of the maximum value (16383) in oscilloscope window. In the VIS mode, the signal intensity values should not fall below 10% of the maximum value (16383) in the oscilloscope window.

Note: In case of step scan measurements, in the IR mode, the signal intensity values should not be above 15% of the maximum value (16383) in the oscilloscope window and in the VIS mode, the signal intensity values should not fall below 10% of the maximum value (16383) in the oscilloscope window.

Another possibility of optimizing the signal intensity is closing the aperture in such a way that only 50% of the light impinges on the detector elements. Set the parameter values *Gain* and *Offset* in such a way that the signal intensity values are not above 15% of the maximum value (16383) in oscilloscope window and not below 15% of the minimum value (0). In this case you need not switch between the IR and the VIS mode.

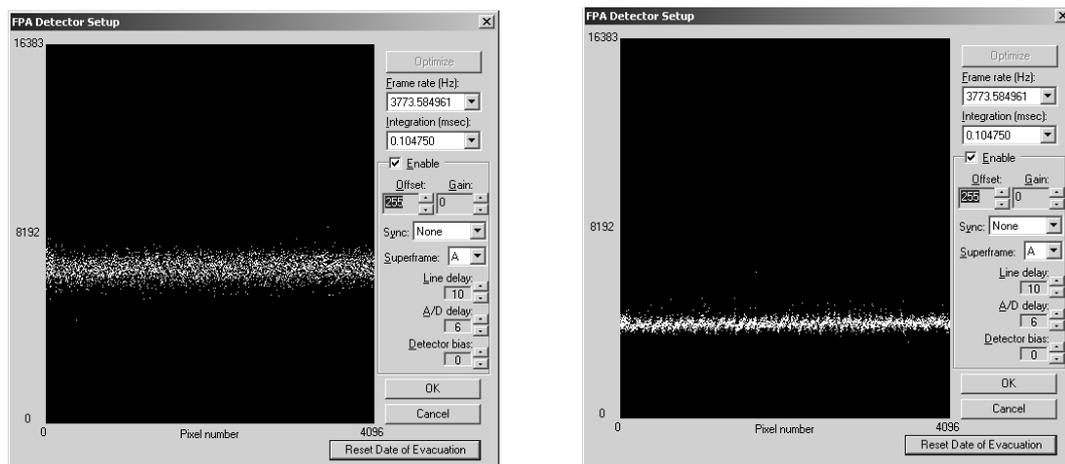


Figure 13: a) Optimal Signal Intensity

b) IR beam does not impinge on the Detector (VIS)

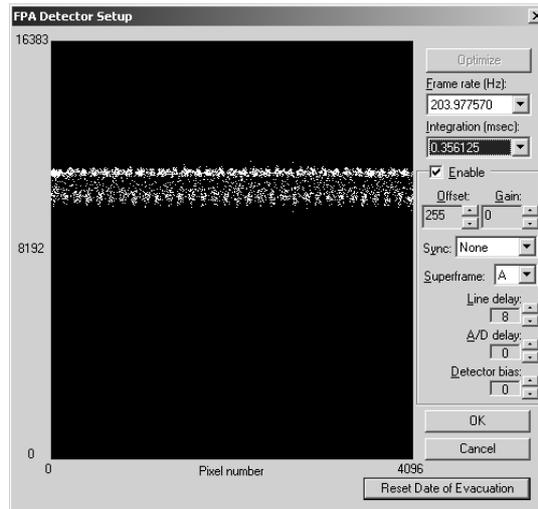


Figure 14: Signal in case of Detector Overload

Select in the drop-down list *Sync* (synchronization) the option *None*. In this mode, the images are generated in an asynchronous manner i.e. not synchronous with the interferogram scanning. During the measurement the synchronization mode is changed automatically by program so that the images are generated synchronously with the data acquisition.

The default settings of the parameters **Line delay**, **A/D delay** and **Detector bias** need not to be changed because the detector manufacturer has already set meaningful values for these parameters.

The *Reset Date of Evacuation* button is used to mark the date of the last detector evacuation. Click on this button after you have evacuated the FPA detector. (For information about evacuating the detector refer to the HYPERION User Manual.) As a result of this, the yellow background of the drop-down list *Imaging Device* on the *Basic* page disappears.

Note: A yellow background of the drop-down list *Imaging Device* indicates that the default maximum hold time of the detector vacuum (48 days) has been exceeded and the FPA detector needs to be evacuated as soon as possible.

4.2 Video-assisted, continuous Scan Measurement using FPA Detector

4.2.1 Video Mode Interface

When you click in the *Continuous Scan FPA Measurement* dialog window (page *Basic*) on the *Start Video Assisted Continuous Scan FPA Measurement* button the following video mode interface appears. The video mode interface consists of three subwindows. See the following figure.

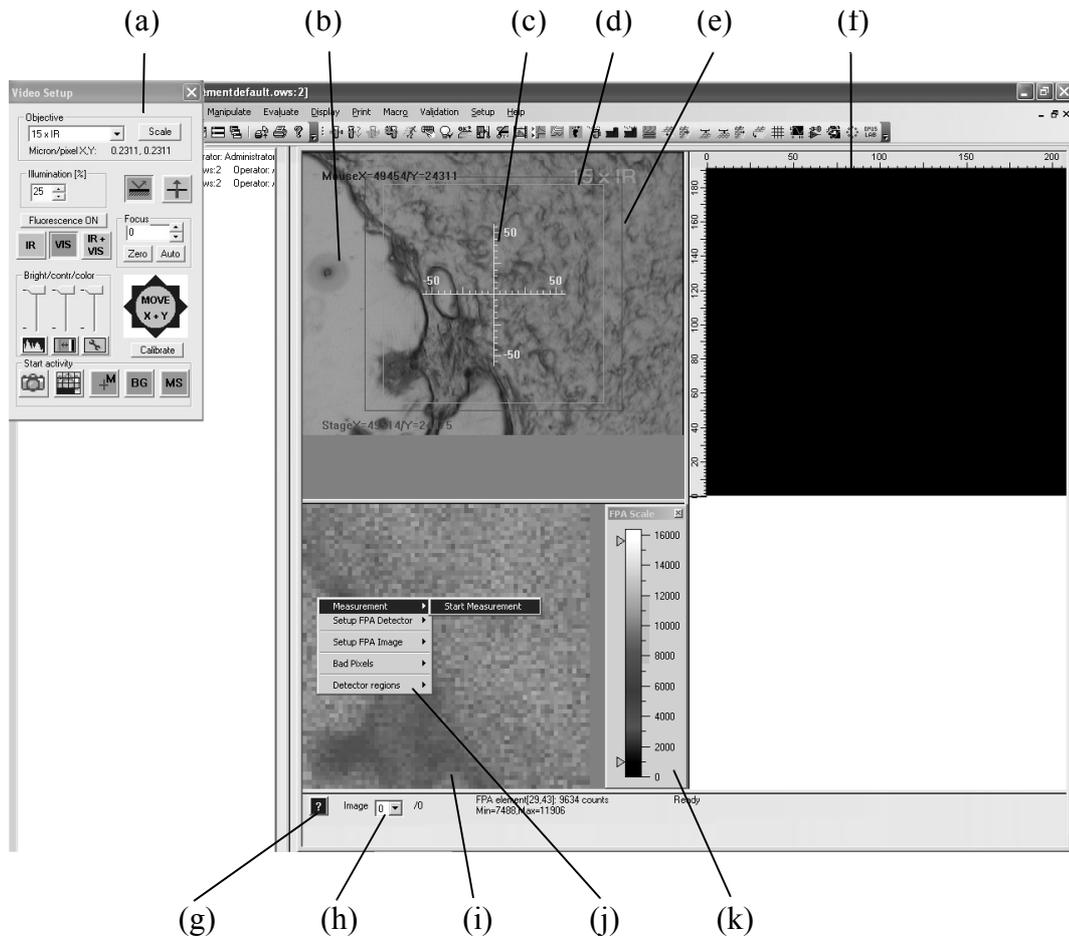


Figure 15: Video Mode Interface

- a) Video Setup dialog box (hardware control panel)
- b) Live video image window
- c) Cross hairs
- d) Green frame (indicating the area detected by the detector)
- e) Red frame (indicating the used CCD area)
- f) Overview video image window
- g) Online help button
- h) Image selection drop-down list (for the Overview video image window)
- i) Live FPA image window
- j) Pop-up menu of the live FPA image
- k) Color intensity scale for the live FPA image

When you activate the video mode interface (figure 15) the *Video Setup* dialog box (a) appears automatically in the upper corner on the left. Use this dialog box to define, among other things, the measurement mode and set the illumination, the brightness, the contrast and the color. To close this dialog box click on the  button in the upper right corner of the dialog box. If you want to open the *Video Setup* dialog box once again, right-click on the live video image and select in the pop-up menu the function *Hardware control...* → *Hardware Parameters*. (For detailed information about the *Video Setup* dialog box refer to the OPUS/VIDEO Manual.)

The live video image window (b) displays the video image in real time as recorded by the camera. Normally, the live video image is used to specify measurement positions and to define sample areas for generating an overview video image (consisting of several individual images). (For more information about generating an overview image refer to the OPUS/VIDEO Manual.) The video image window (f) is intended for the overview video image. Initially, the overview video image window is black.

In the live video image window there is a red frame (e) indicating that part of the live video image which will be used to assemble the overview video image. This frame can be resized interactively. The green frame (d) indicates that part of the sample which is detected by the detector. The cross hairs (c) in the center of the live video image help you to size and position your sample. The green frame as well as the cross hairs can be deactivated by right-clicking on the live video image, selecting in the pop-up menu the function *Video Image...* and deselecting the option *Overlay Detector Size* or *Overlay Crosshair*. (Depending on whether you right-click on the live video image or the overview video image, two slightly different pop-up menus appear. Their functions are described in detail in the OPUS/VIDEO Manual.)

At the bottom of the main window there is a help button (g) providing information about the OPUS software. The *Image* drop-down list (h) contains all video images acquired so far and shows which of the images is currently displayed.

4.2.2 Pop-up Menu of the Live FPA Image

When you right-click on the live FPA image the following pop-up menu (figure 16) appears.



Figure 16: Pop-up Menu Item - Measurement

Starting a Measurement

To start a measurement select in the pop-up menu the function *Measurement* —> *Start Measurement*. As a result, the following dialog box appears:

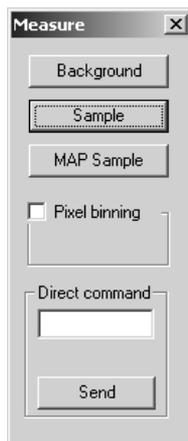


Figure 17: Measure Dialog Box

This dialog box allows you to start either a background measurement, a sample measurement or a mapping sample measurement. When you activate the *Pixel Binning* check box, 2 x 2, 4 x 4 and so on neighboring pixels can be put together to one big pixel. This measure reduces the image noise and the result file size, however, it also worsens the image resolution. The *Direct command* field is intended for entering commands (e.g. MOT commands for controlling certain mirrors) and sending them to the optics.

Clicking on the *Background* button opens the following dialog box:

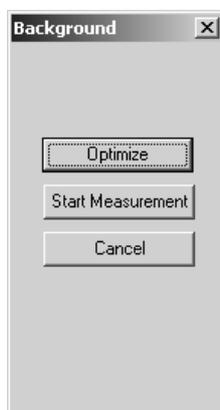


Figure 18: Background Dialog Box

This dialog box allows you to optimize the FPA parameter settings, to start a background measurement or to return to the previous dialog box (figure 17) by clicking on the corresponding button.

If data blocks (like *Transmission* or *Absorption*) are to be generated during the measurement you first have to perform a background measurement. Note that the background measurement and the following sample measurement have to be performed with the same FPA parameter settings. This applies especially for the parameter *Pixel Binning*.

Clicking on the *Optimize* button opens the following dialog box:

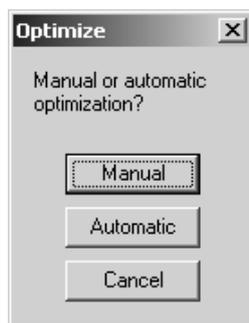


Figure 19: Optimize Dialog Box

This dialog box allows either a manual or an automatic optimization of the FPA parameter settings. In case of an automatic optimization, several test measurements are performed with a low resolution. The results of these test measurements are used to determine the optimal FPA parameter values. In case of a manual optimization, the *FPA Detector Setup* dialog box (figure 12) appears in which you can enter the desired parameters manually. (See section 4.1, *Measurement Parameters*.)

When you click in the *Measure* dialog box (figure 17) on the *Sample* button, you can either first optimize the FPA parameter settings or start the sample measurement. See the following figure.

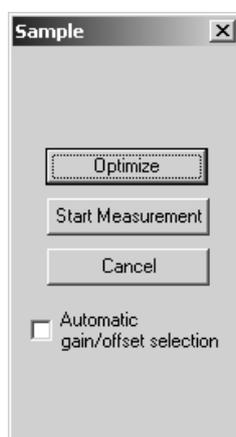


Figure 20: Dialog Box Sample

If the already acquired background spectrum is to be used for the calculation of transmission spectra or absorption spectra, it is advisable not to optimize the FPA parameter settings once again. In this case, the background measurement and the sample measurement have to be performed using the same parameter settings (especially the same frame rate value). An exception are the 'uncritical' parameters *Gain* and *Offset*. These parameters can be optimized automatically once again by activating the *Automatic gain/offset selection* check box. It is useful to optimize these parameters at this point as normally, the signal with sample (sample measurement) is usually smaller than the signal without sample (background measurement).

To start the actual sample measurement click on the *Start Measurement* button. During the measurement, the live video image is faded out and after measurement, it is faded in again. If desired, the spectra calculation and the generation of the result data block (transmission or absorption) are done automatically after the measurement.

Note: To display the generated 3D file you first have to close the video mode interface. For information about displaying, manipulating and evaluating the spectra of a 3D file refer to the OPUS/3D Manual.

When you click on the *MAP Sample* button in *Measure* dialog box (figure 17) the following dialog box appears:

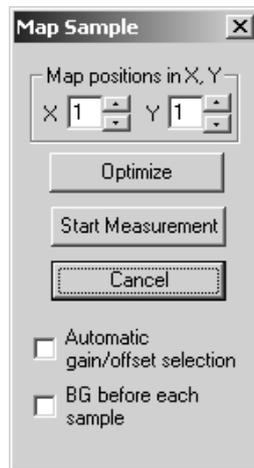


Figure 21: MAP Sample Dialog Box

This dialog box allows you to perform several measurements in succession (mapping measurement) and to assemble the acquired spectra to a 3D image, provided your microscope is equipped with a computer-controlled sample stage.

Define the measurement positions by entering the desired number of individual measurements in x- and y-direction. The result is a rectangular measurement grid with the actual stage position being the lower left measurements position in the grid. The complete grid of measurement positions is displayed in the overview video image window (provided you have defined a sufficiently large overview video image) and can be shifted belatedly.

Like in case of individual measurements, it is recommended to perform the background and the sample measurements with the same FPA parameter settings, i.e. not to optimize these settings once again. But also in this case, the ‘uncritical’ parameter settings *Gain* and *Offset* can be optimized automatically once again before the sample measurement. Optionally, a new background spectrum can be acquired at each measurement position. This option, however, doubles the measurement time.

During the measurement, the live video image is faded out and you can observe in the live video image window the progress of the mapping measurement. Measurement positions that have already been measured are displayed in green.

The measurement position in process is displayed in yellow and the still unprocessed positions are gray. See the following figure. After the completion of the measurement close the video mode interface.

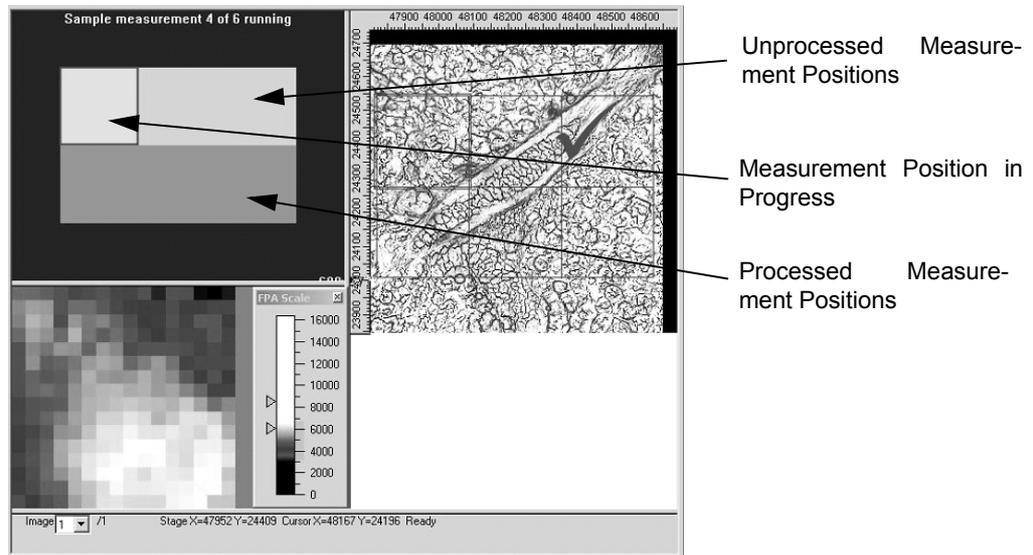


Figure 22: Mapping Measurement in Progress

Setting up the FPA Detector

To set the FPA detector parameters manually select in the pop-up menu the function *Setup FPA Detector* → *Show Control Panel*.

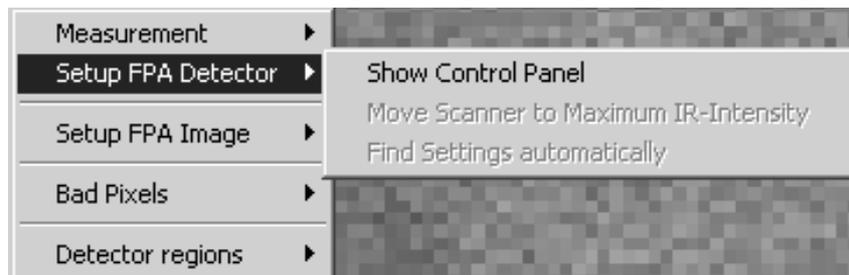


Figure 23: Pop-up Menu Item - Setup FPA Detector

As a result, the *FPA Detector Setup* dialog box (figure 12) appears. This dialog box is described in detail in section 4.1, *Measurement Parameters*.

Setting up the FPA Image

To change the color display of the live FPA image, select in the pop-up menu the function *Setup FPA Image* → *Show FPA Image as*.

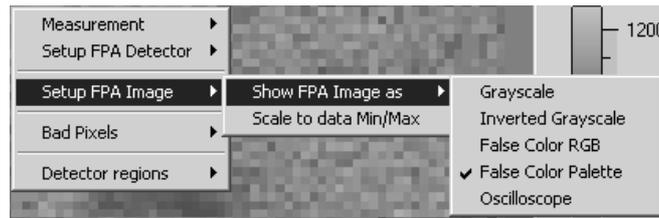


Figure 24: Pop-up Menu Item - Setup FPA Image

By default, the live FPA image is shown as false color palette (i.e. minimum signal intensity values: black, maximum signal intensity values: white, intermediate signal intensity values: colored).

The other display options are shown in the following figures 25a and b as well as 26a and b.

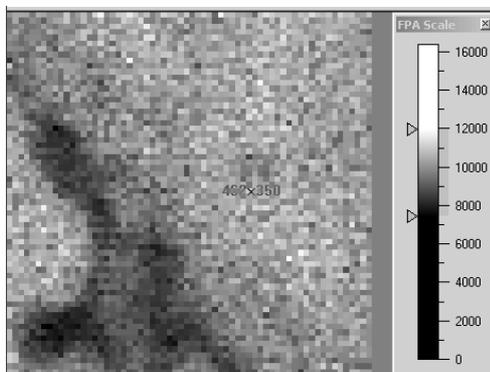
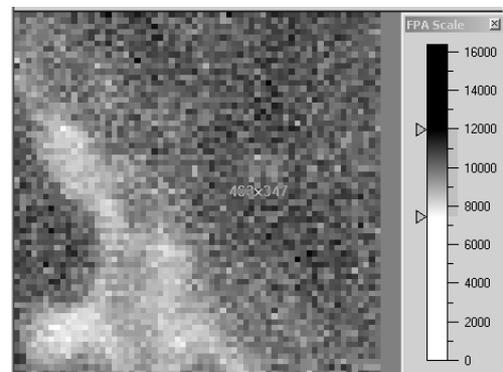


Figure 25: a) Grayscale



b) inverted Grayscale

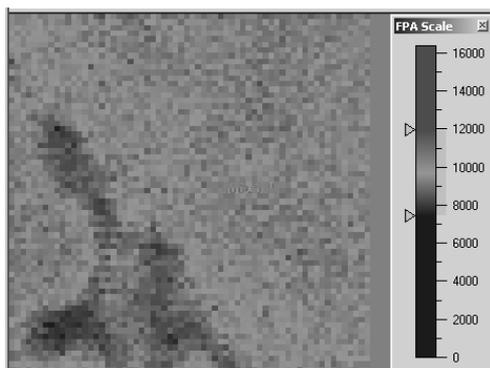
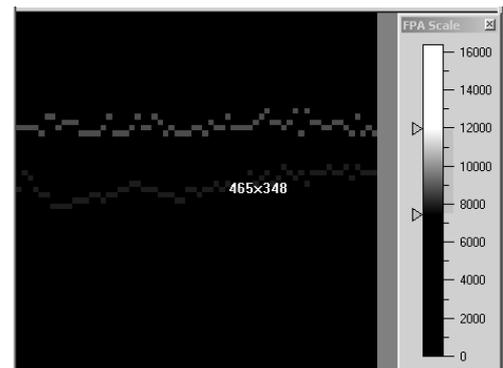


Figure 26: a) False Color RGB



b) Oscilloscope

- **Grayscale:** The signal intensity values are assigned to gray tones between black (minimum intensity value) and white (maximum intensity value).
- **Inverted Grayscale:** The signal intensity values are assigned to gray tones between black (maximum intensity value) and white (minimum intensity value).
- **False Color RGB:** The signal intensity values are displayed as follows: minimum intensity value: blue, intermediate intensity values: green, maximum intensity value: red.

- **Oscilloscope:** This option displays the minimum signal intensity value of a column (in the detector element matrix) in blue and the maximum signal intensity in red. It allows you to find out extreme intensity values very quickly.

As an alternative to the pop-up menu, you can switch between the individual display options by double-clicking on the FPA Scale.

Selecting the function *Scale to data min/max* (figure 24) adapts the color scale to the existing dynamic range in the FPA image with the result that maximum intensity values are displayed in the ‘maximum color’ (e.g. red in case of the display option *False Color RGB*) and minimum intensity values in the ‘minimum color’ (e.g. blue in case of the display option *False Color RGB*). Alternatively, you can adapt the color scale to the signal intensity in the FPA image by double-clicking on the live FPA image. And you can change the assignment of the color scale to an intensity region interactively by moving the triangular sliders in *FPA Scale* box using the mouse.

Bad Pixels

Every FPA detector has some ‘bad’ detector elements (pixels) of which the signal deviates from the other pixels regarding offset, noise and gain. Especially bad offset pixels (i.e. pixels of which the signal is too low or too high) are easily discernible in the live FPA image. You can mark these pixels interactively by clicking on them using the mouse. To do this, select in the pop-up menu the function *Bad Pixels* → *Mark bad pixels with mouse*.



Figure 27: Pop-up Menu Item - Bad Pixels

As a result, the marked pixels are displayed in the ‘maximum color’ of the corresponding display option. (See description above.) Then the intensities values of these marked pixels are not used but substituted by the values of intact neighboring pixels. This, however, leads to a reduction of the spatial resolution in the area of these pixels, but only the elimination of extreme intensity values makes a meaningful display and evaluation of the measurement data possible.

Note: The positions of the bad pixels are stored in a file (in the OPUS directory) with the name *FPA_<serialnumber>.bad* with <serialnumber> being the serial number of the FPA detector. The text file includes the row and column position of the bad pixels and can be edited using a text editor, if required. The numbering of the positions is done from the left to the right column and from the lower to the upper row, beginning with zero. In case of a FPA detector with 64 x 64 detector elements, for example, pixel 0,0 is in the left lower corner and pixel 63,63 in the right upper corner.

Clear list of bad pixels

Clears all entries in the list of bad pixels.

Save list of bad pixels

Saves the list containing the position of the bad pixels and activates the pixel correction.

Correct bad pixels

Activates or deactivates the automatic pixel correction.

Detector Regions

This menu item allows the automatic recognition of contiguous regions (in the live FPA image) of which the intensity values do not exceed or fall below the defined limit values. If a sample has regions with different intensities, for example the concentric rings becoming weaker outwards as shown in figure 28, you can define an upper and a lower limit value. To do this, select in the pop-up menu the function *Detector regions* → *Define new regions*.

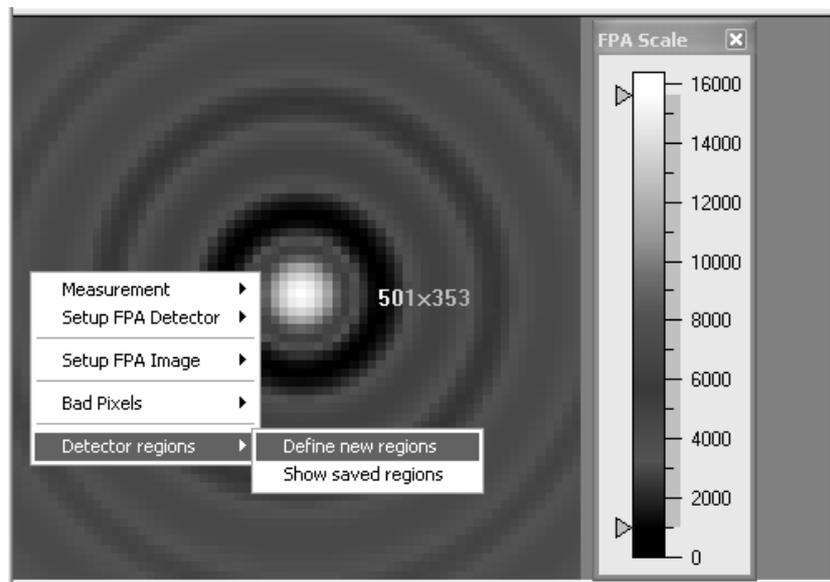


Figure 28: Pop-up Menu Item - Detector Regions

As a result, the following dialog box appears:

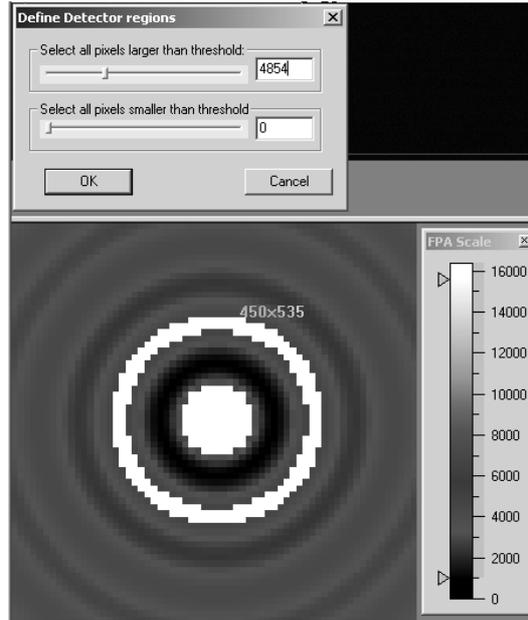


Figure 29: Define Detector Regions

All pixels with intensity values that are within the limits specified by you are displayed in the ‘maximum color’ (in our example in white, see figure 29).

When you click on the *OK* button the program assumes your limit values, calculates the number of contiguous regions of which the intensity values are within the specified limits (in our example: 2 contiguous regions) and determines to which region a pixel belongs. The result is stored in a text file with the name *<Detector>.rgn* with *<Detector>* being the transient recorder you have set up as described in chapter 3.) The text file contains a table with four columns:

Region	Row no. of the pixel	Column no. of the pixel	continuous no. of the interferogram/spectrum
1	29	16	1053
1	30	16	1054
.....
2	30	27	1758
.....

The first column indicates the region to which a pixel belongs. The second and the third column contain the row number and the column number of the pixel (detector element) in the detector matrix. The numbering begins with (0,0) in the lower left corner of the matrix and ends with (63,63) in the upper right corner. This table can be used, for example, by a script or macro to calculate an average spectrum on the basis of all spectra belonging to a certain region.

4.3 Background Measurement using FPA Detector

To start the background measurement directly, click on the *Start FPA Background Measurement* button in the *Continuous Scan FPA Measurement* dialog window on the *Basic* page (figure 9). After the sample measurement, the acquired background spectrum is used for the calculation of the result spectra (e.g. transmissions spectra, absorptions spectra or reflection spectra).

This measurement is not a video-assisted measurement, i.e. the video mode interface window does not appear.

4.4 Continuous Scan Measurement using FPA Detector

To start the sample measurement directly, click on the *Start FPA Measurement* button in the *Continuous Scan FPA Measurement* dialog window on the *Basic* page (figure 9). In case a background spectrum has been acquired before, the result spectra (e.g. transmission spectra, absorption spectra or reflection spectra) can be calculated after the completion of the sample measurement. This is done by dividing the sample spectra by the background spectrum. Note that the background measurement and the sample measurement have to be performed using the same measurement parameters (except the parameter *Scan Time*). This measurement is not a video-assisted measurement, i.e. the video mode interface window does not appear.

4.5 Kinetic Measurement using FPA Detector

When you click on the *Start Kinetic FPA Measurement* button in the *Continuous Scan FPA Measurement* dialog window on the *Basic* page (figure 9), N individual measurements are started with N being the number of scans you have specified. (In this measurement mode, the specified number of scans is not used for averaging in order to reduce the noise.) The acquired individual spectra are arranged one after the other in a 3D file. This measurement mode is suitable for the analysis of samples that change during the measurement (e.g. chemical reactions). This measurement is not a video-assisted measurement, i.e. the video mode interface window does not appear.

4.6 Displaying the Measurement Results

For displaying the results of a measurement using the FPA detector, the software package OPUS/3D is required. Immediately after the measurement you can display the results in an 3D window. At that time, however, the spectra are displayed versus the pixel number and not as intensity over the detector surface because during the measurement no trace has been generated that assigns an intensity value to each pixel. Therefore, the measurement result does not yet contain a trace block. After the measurement, you have to generate such a trace block using one of the OPUS *Evaluate* functions (e.g. integration, quantitative analysis, identity test, factorization). To display the intensity over detector surface, drag and drop the trace block (and not the AB or TR block) into the 3D window. In case the trace block is the result of a kinetic measurement, there is an additional combo box in the 3D window allowing to select the number of the measurement that is to be displayed and ‘scrolling’ through the individual measurements. For more information refer to the OPUS/3D Manual.

5 Step Scan Measurement using FPA Detector

Step scan measurements using a FPA detector can only be performed with a step-scan capable optical bench that communicates with the PC via an acquisition processor (AQP). Otherwise, the following message appears: *This function is not supported for this optical bench.*

Select in the *Measure* menu the *FPA Step-Scan* function. As a result, the following dialog window opens:

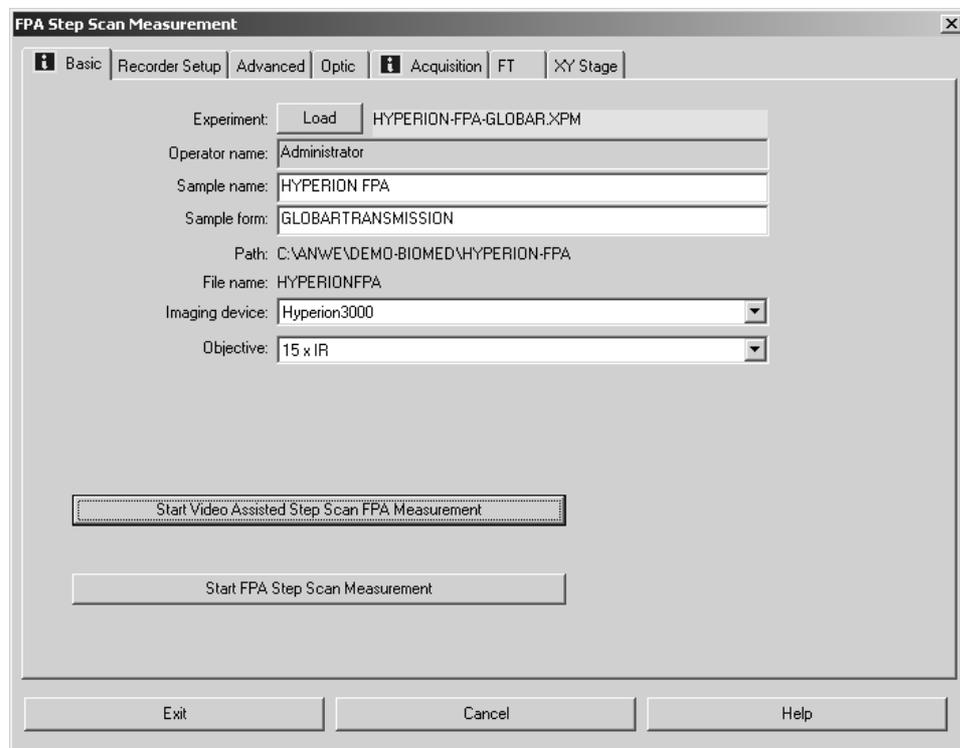


Figure 30: FPA Step Scan Measurement - Basic

5.1 Measurement Parameters

Most pages of this dialog window (*Basic*, *Advanced*, *Optic*, *Acquisition* and *FT*) are identical to a great extent to the corresponding pages of *Advanced Measurement* dialog window. For information about these measurement parameters refer to the OPUS Reference Manual.

Basic

Select in the *Imaging device* drop-down list the option you have set up before (as described in chapter 3). A field with a yellow background indicates that the FPA detector has to be evacuated as soon as possible. (For information about evacuating the FPA detector refer to the HYPERION User Manual.)

Recorder Setup

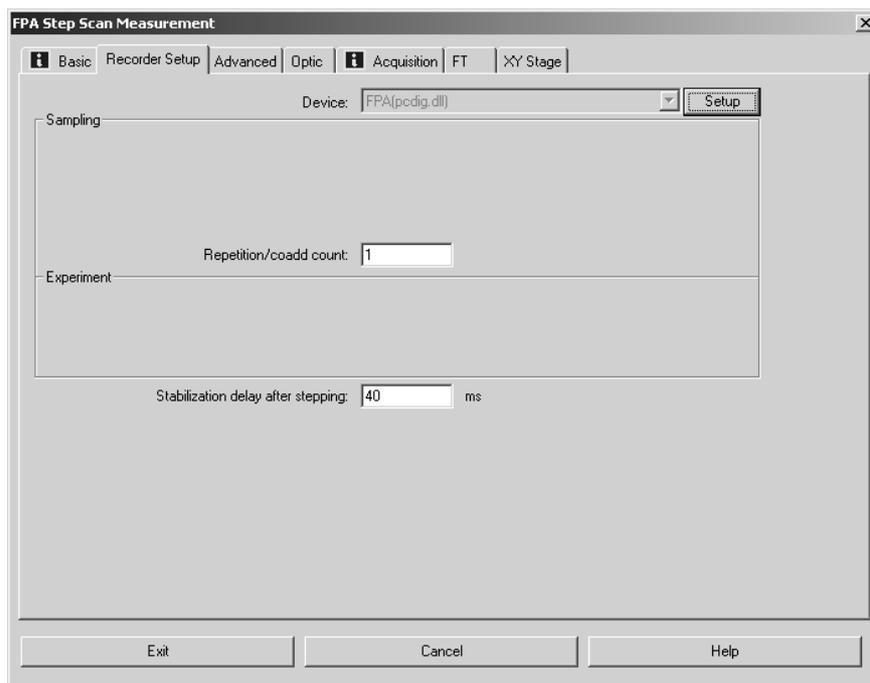


Figure 31: FPA Step Scan Measurement - Recorder Setup

Enter in the field *Device* the transient recorder (FPA detector) you have set up before (as described in section 3.1). As the software attempts to initialize the FPA detector, the FPA frame grabber card has to be installed and connected already to the switched on detector.

When you click on the *Setup* button next to the field, the *FPA Detector Setup* dialog box appears. (See figure 12.) This dialog box allows you to set the FPA detector signal in such a way that the dynamic range of the A/D converter is used in the best possible way without cutting off the upper or lower signal intensity values. (For more information refer to chapter 4, section 4.1, subsection *Check Signal*.)

Enter in the *Repetition/coadd count* field the number of measurements that are to be performed and averaged at each mirror position. Note that the higher this value is the less the noise and the longer the measurement time become. We recommend a value between 10 and 50. A higher value (e.g. higher than 100) does not improve the signal-to-noise ratio significantly any more because step scan measurements are sensitive to vibration. Therefore, repeat the measurement several times instead of using a high coadd count value.

The *Stabilization Delay after Stepping* is a wait time of the system allowing the mirror to stabilize after it has moved to a new position. Enter a value between ca. 10 and 20ms.

Acquisition

In case of step scan measurements, select in the *Acquisition mode* drop-down list only the option *Single sided* or *Double sided* and **do not** select the options *Single-Sided*, *Forward-Backward* or *Double-Sided*, *Forward-Backward*.

FT

Select in the *Phase Correction mode* drop-down list either the option *Power/No Peak Search* or *Mertz/No Peak Search* to prevent that the interferogram maximum (peak) is searched for each interferogram separately. Otherwise, in case of a weak signal, the peak position of several interferograms may be found too far away from the desired position. As a consequence of this, the spectra will be incompatible and the spectra calculation will be canceled. Note that the option *Power* should only be selected in case of a double-sided acquisition mode.

XY Stage

For information about the *XY Stage* page refer to the OPUS/VIDEO Manual.

5.2 Video-assisted step scan Measurement using FPA Detector

5.2.1 Video Mode Interface

When you click in the *FPA Step Scan Measurement* dialog window (page *Basic*) on the *Start Video Assisted Step Scan FPA Measurement* button (figure 30) the video mode interface appears. The video mode interface consists of three subwindows (live video image window, overview video image window and FPA image window) and the *Video Set* dialog box. (See figure 15.) Layout and operation of this video mode interface are identical to the video mode interface of video-assisted, continuous scan measurements. For more information refer to chapter 4, section 4.2.1.

5.2.2 Pop-up Menu of the Live FPA Image

Right-clicking on the FPA image opens a pop-up menu that differs only slightly from corresponding pop-up menu for video-assisted, continuous scan measurements. Therefore, this section restricts only to the description of the differences. (For detailed information about the identical pop-up menu functions refer to chapter 4, section 4.2.2.)

Starting the Measurement

To start a measurement select in the pop-up menu the function *Measurement* → *Start FPA Measurement*. As a result, the measurement starts immediately.

Setting up the FPA Detector

When you select in the pop-up menu the function *Setup FPA Detector* → *Show Control Panel* two dialog boxes appear: the *Spectrometer* dialog box and the *FPA Detector Setup* dialog box (figure 33). (The *FPA Detector Setup* dialog box is already described in detail in chapter 4, section 4.1.)

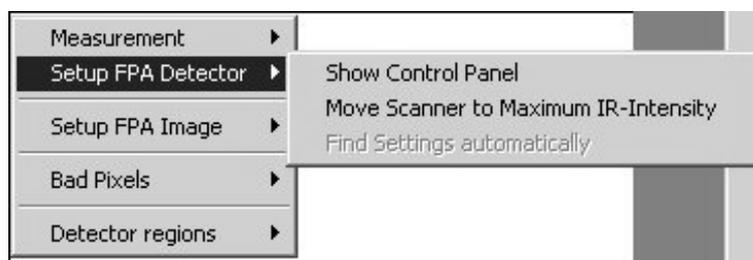


Figure 32: Pop-up Menu Item - Setup FPA Detector

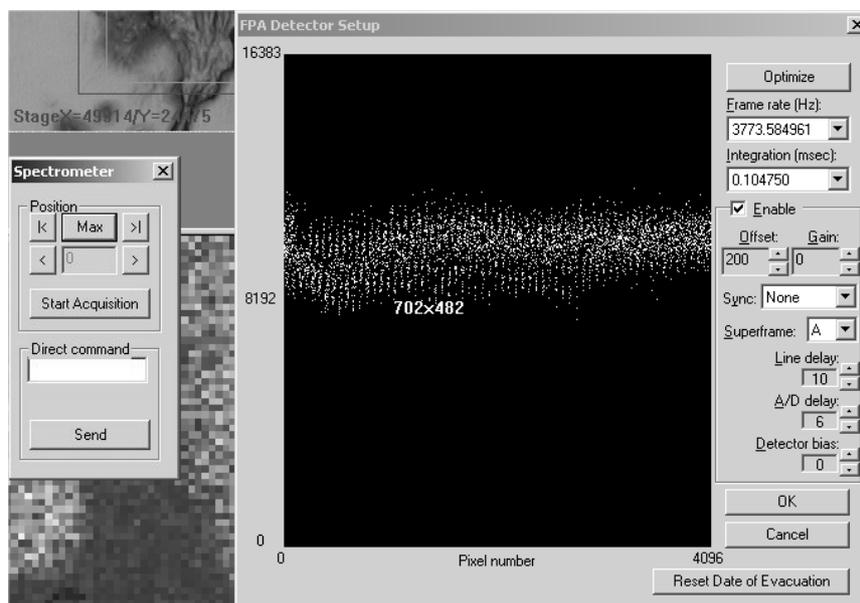


Figure 33: Dialog Boxes Spectrometer and FPA Detector Setup

The *Spectrometer* dialog box allows you to change the mirror position interactively. When you click on the *Max* button the mirror moves automatically to the position at which the interferogram has maximum signal intensity. (The same effect is achieved by selecting in the pop-up menu the function *Setup FPA Detector* → *Move Scanner to Maximum IR-Intensity*.) With this mirror position, you can now set up the FPA detector signal in the best possible way using the *FPA Detector Setup* dialog box.

Clicking on the buttons |< or >| the mirror moves to the beginning or end of the interferogram. To change the mirror position gradually click on the buttons < and/or >. The current mirror position is displayed in the field between these two buttons.

To start the measurement click on the *Start Acquisition* button.

The *Direct command* field is intended for entering and sending commands (e.g. MOT commands for controlling certain mirrors) to the optics.

For this kind of measurement, the *Optimize* button in the *FPA Detector Setup* dialog box is available. This button allows you to optimize the FPA detector parameter settings automatically in such a way that the dynamic range of the A/D converter is used in the best possible way without cutting off the upper or lower signal intensity values. (This function works properly only with the slower detectors SBFJ108.)

The purpose of a manual or automatic optimization is to set the parameters *Frame Rate*, *Integration*, *Offset* and *Gain* in such a way that in the IR mode, the signal intensity values are not above 15% of the maximum value (16383) in the oscilloscope window and in the VIS mode, the signal intensity values do not fall below 10% of the maximum value (16383) in the oscilloscope window.

Setting up the FPA Image

For a detailed description of this pop-up menu item refer to chapter 4, section 4.2.2.

Bad Pixels

For a detailed description of this pop-up menu item refer to chapter 4, section 4.2.2.

Detector Regions

For a detailed description of this pop-up menu item refer to chapter 4, section 4.2.2.

5.3 Non-video-assisted Step Scan- Measurement using FPA Detector

This measurement is not a video-assisted measurement, i.e. the video mode interface window does not appear. For information about step scan measurements refer to the OPUS/STEP Manual.

5.4 Displaying the Measurement Results

For displaying the results of a measurement using the FPA detector, the software package OPUS/3D is required. Immediately after the measurement you can display the results in an 3D window. At that time, however, the spectra are displayed versus the pixel number and not as intensity over the detector surface because during the measurement no trace has been generated that assigns an intensity value to each pixel. Therefore, the measurement result does not yet contain a trace block. After the measurement, you have to generate such a trace block using one of the OPUS *Evaluate* functions (e.g. integration, quantitative analysis, identity test, factorization). To display the intensity over detector surface, drag and drop the trace block (and not the AB or TR block) into the 3D window.

For more information refer to the OPUS/3D Manual.

Index

Numerics

3D image 20
3D window 27, 34

A

A/D delay 15
Acquisition processor 9, 12, 29

B

Background measurement 18, 26
Background spectrum 19, 20, 26
Bad offset pixel 23
Bad pixel 23, 33
Band width 3

C

Computer-controlled x/y-stage 1, 3
Continuous scan measurement 4, 11, 26

D

Data rate 4
Detector bias 15
Detector element 1, 13, 23, 25
Detector evacuation 15
Detector matrix 25
Detector region 24, 33

F

False color palette 22
False color RGB 22
FPA detector 3, 5, 8, 11, 12, 13, 15, 21, 23, 30, 32
FPA frame grabber card 3, 5, 6, 30
FPA image 4, 23, 33
Frame rate 4, 12, 13, 33

G

Gain 14, 19, 20, 23, 33
Grayscale 22

I

Imaging device 6, 7, 11
Integration 33
Integration time 13
Interferogram 12, 15, 25, 31, 32, 33

Inverted grayscale 22
IR mode 14, 33

K

Kinetic measurement 26

L

LANG controller 3
Line delay 15
Live FPA image 17, 21, 24, 31
Live FPA image window 16
Live video image 20
Live video image window 16, 17, 20
LSTEP board 3

M

Mapping measurement 20

N

Noise 23

O

Offset 14, 19, 20, 23, 33
Oscilloscope 23
Overview video image 17
Overview video image window 16, 20

P

Pixel binning 18

R

RAM storage capacity 3
Resolution 3

S

Signal intensity 13, 14, 22, 30, 32, 33
Step scan measurement 4, 9, 29, 31, 33

T

Trace block 27
Transient recorder 5, 6, 25, 30

V

Variable velocity 9, 10, 12
Video mode interface 15, 16, 26, 31
Video-assisted, continuous scan measurement 15
VIS mode 14, 33