NSpec

Scanning Probe and confocal optical microscope software

User manual

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This user guide is intended for installation and operation of NSpec software. The program is used for control scanning probe and optical confocal microscopes and scanning probe microscope controller EG series. Before installation and working with this software it is recommended to read this user manual. On all matters related to technical support and upgrades for this product, under the additional features, contact the following addresses:

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Content

Introduction

NSpec – is a program for Nano Scan Technologies Ltd. devices control. The program works together with SPM controllers EG-3000, EG-1000 series and operates devices connected to the controller. Besides, the program can work with CCD-cameras and the spectrometers connected directly to the personal computer.

Basic functions of NSpec:

- parameters and function of SPM head Certus control;
- parameters and function of scanning stage Ratis control;
- full control of the system Centaur, including spectrometer and CCD camera;
- stepper motor control;
- basic data processing.

Minimum system requirements:

- Windows XP;
- 256 Mb RAM;
- video card with OpenGL;
- 50 Mb free disk space.

Recommended system requirements:

- Windows 7;
- 512 Mb RAM;
- NVIDIA video card;
- more then 50 Mb free disk space.

NSpec software is used to following equipment operations:

- Certus Light;
- Certus Standard;
- Certus Optic;
- Certus NSOM;
- Centaur I;
- Centaur U;
- Centaur I HR;
- Centaur U HR;

- Snotra;
- Ratis;
- Vectus.

The program is based on multythread kernel, written in C++ and built by compiler GCC4. The program interface is built using cross-platform libraries and libraries QT4, QWT. The program is compatible with all current versions of OS Windows (XP, 2003, Vista, 7). Upon request, the program can be transferred to the operating system Linux, * BSD, MacOS. Only basic functions of data processing are implemented to NSpec software, and tools for optimal adjustment of scanning parameters. Specialized software is recommended to use for full data processing, such as Gwyddion. For processing the spectral data is also recommended to use specialized programs such as GRAMS. To facilitate the transfer of data to other applications NSpec program supplied by the filters of import/ export formats ASCII, gwy (Gwyddion), spc (GRAMS).

1. Basic information about NSpec

In this chapter general information about NSpec is presented – installation, structure, main units description and etc.

1.1. Distribution of NSpec

The Nspec software is distributed with Nano Scan Technologies Ltd. devices and equipment on CD or other data store. Latest program version is on the web site **www.nanoscantech.ru** in **"Software"**. There is NSpec program for Windows XP/Vista/7 OSes. But it can be compiled for Linux и MacOS by user request.

The program NSpec is distributed in .zip or .rar archives.

Archive with current version of NSpec has name:

Soft_Package_№.zip, where № - version number.

URL for latest version download **NSpec:**

ftp://nanoscantech.ru/shared/NSpec/

1.2. NSpec software installation

Before working with the program NSpec, an archive containing the program files, you need to unzip to a local or removable drive.

Installation is not required. The program runs directly from the *. exe file. To work with the program is to start by double clicking the left mouse button or file **nst. exe** or **NSpec_№. exe** in the folder **Soft_Package_ №**. When you run **nst. exe** or **NSpec_ №. exe** will run the program. After performing the above action, main window NSpec displays. Following the withdrawal of the main window on the screen you can start working with the program and connected equipment.

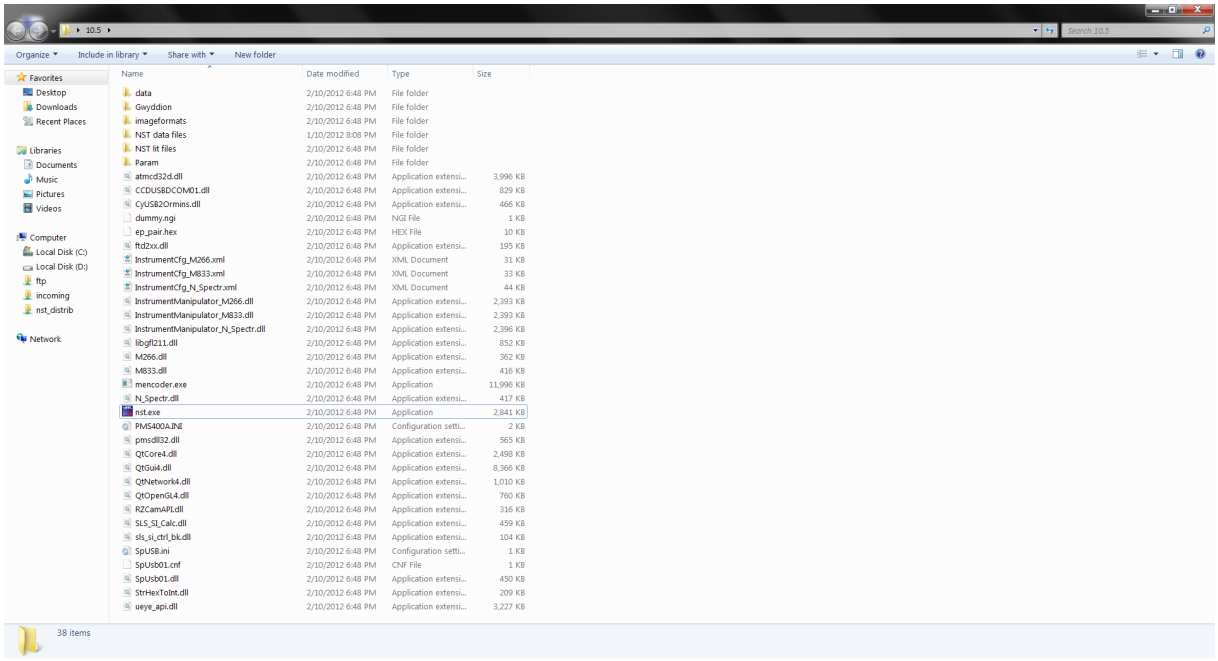


Fig. 1.1 Choosing NSpec executing file.

Fig. 1.2 NSpec is starting.

After program has started on the screen to be deduced the main window of program NSpec. Now one may start working.

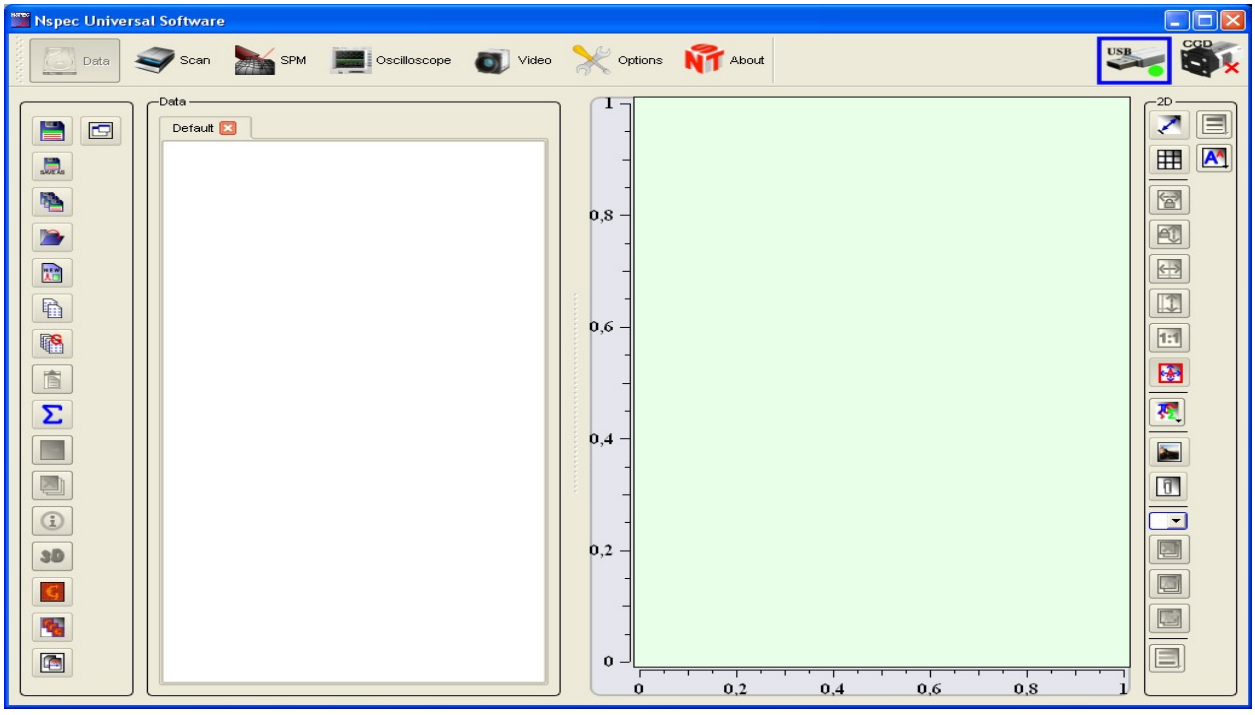


Fig. 1.3. Nspec main window.

1.3. Basic unit panel. Tools description

1.3.1. Basic units description

There is the units panel in window top part. In the panel there is buttons for basic units arising. Pressing the chosen button leads to transition to a window of the corresponding module, and the icon of the active module becomes pale.

Fig. 1.4. Units panel.

1.3.2. Basic unit brief description

	Data	Unite for working with data – collecting, processing, saving and so on.
	Spectroscopy	Unite for spectrometer calibration, adjustment and spectroscopic information obtaining.
	Scan	Unite for obtaining raster data from scanning devices – scanning probe microscope, laser or spectral confocal microscope.
	SPM	Unite for adjustment and controlling of SPM. It is requires to SPM adjustment, probe approach, scan process control.
	Oscilloscope	Unite for system signal controlling and for scan system calibration.
	Video	Unite for video camera connected to the device.
	Lithography	Unite for device adjustment and working with lithography mode.
	Settings	Open window with user interface settings – language, icon size, UI units.
	About	About the program.

1.4. Working mode indicators

There is the working mode indicators in top right corner of NSpec window.

Indicator	Mode	Description
SPM controller to USB connection indicator		Controller is connected.
		Controller is disconnected.
		Emulation mode without controller.
CCD to USB connection indicator		CCD is connected. (only Centaur).
		CCD is disconnected. (only Centaur).
		Emulation mode without CCD.
If additional controller EG-1000 is used, the additional indicator is displayed.		
Additional SPM controller to USB connection indicator		Controller is connected.
		Controller is disconnected.
		Emulation mode without controller.

1.5. NSpec directory structure

NSpec directory tree:

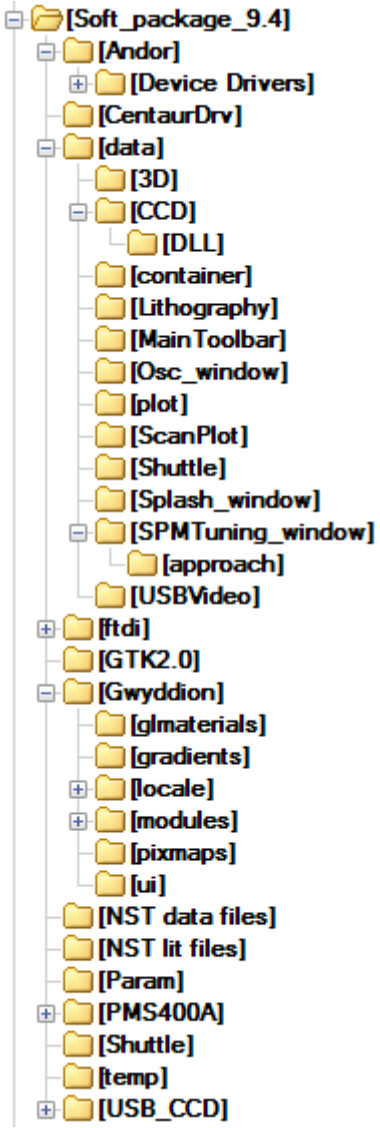
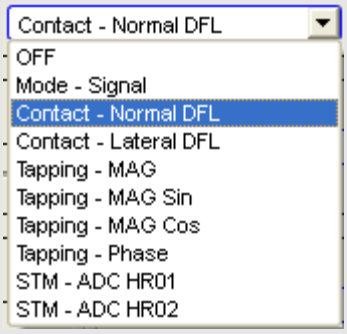
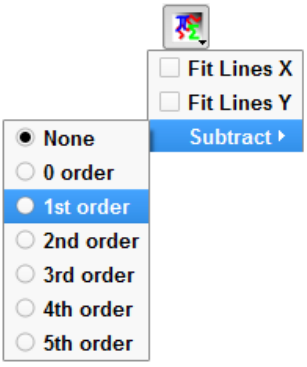
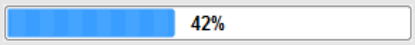
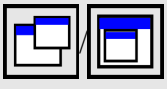
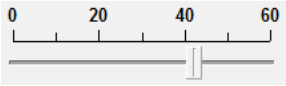


Fig. 1.5 NSpec directory tree.

Andor		Directory with CCD matrix drivers.
CentaurDrv		Directory with drivers for confocal unit and monochromator.
data		Directory with program pictogram and translation files.
ftdi		Directory with drivers of EG series USB controller.
GTK2.0		Library of interface tools.
Gwyddion		Gwyddion program for SPM data processing
NST data files		Default folder for data saving.
	AutoSave.nstdat	Autosave data file.
NST lit Files		Default folder for lithography drawing.
Param		Directory with program settings and configuration files
	ccd.conf	File contains nonlinear correction parameters.
	ccd_data.par	File contains spectrometer parameters and calibration.
	controller.conf	File contains controller options.
	data_motor.par	Stepper motors configuration file.
	default.par	File contains scanners, connected to EG-3000, calibration parameters – the range, nonlinear correction coefficients for scanners and sensors, etc. This data corresponds calibration tables in the Oscilloscope unit.
	default2.par	File contains scanners, connected to EG-1000, calibration parameters – the range, nonlinear correction coefficients for scanners and sensors, etc. This data corresponds calibration tables in the Oscilloscope unit.
	Emulator.conf	Emulators configuration file: USB_Emulator – USB controller emulation, CCD_Emalator – CCD spectrometer emulation. Its states are shown in the right top corner of the NSpec window.
	ExtraCalib.par	Service calibration file for DAC/ADC scale and offset.
	gui.conf	File contains program interface settings.
	laser.conf	File contains external laser settings.
	lithography.conf	File contains lithography settings.
	palette.txt	File contains color palettes settings.
	pms.conf	File contains photons measurement counter settings.
	shuttle.conf	File contains remote controller settings.
	SPM.conf	File contains autosaved controller and program configurations. Automatically load configuration when program starts.
PMS400A		Directory with photons measurement counter drivers.
Shuttle		Remote controller drivers.
temp		Service avi codec directory.
USB_CCD		CCD video camera drivers.
nst.exe		Executable file.

2. Common interface controls

	The usual button of unitary inclusion of functions, by pressing doesn't change the form..
	Two-state button, switches on/off of functions. On state – red frame, off state – black frame.
	The input field of numerical value, black color means the current established value. For value change guide in the field the mouse cursor, and press the left button of the mouse of 1 times.
	The input field for numerical value after activation. After input of new numerical value it is required to press Enter key - color becomes again black, designating that is spent the data are accepted correctly and sent in the controller. If the color remains red – it means, the entered value falls outside the limits admissible values of parameter.
	The combo box control of a choice of parameter of the list or the scrolled list, offers a choice of parameter from a set of certain values.
	Drop-down menu control. This element is intended for a choice of values of certain functions. As the example, is resulted the list for a filtration 2D the data: lines fitting of scanning and subtraction of the set surface from the received data.
	Progress bar indicates a process execution progress in percentages.
	Element of visualization of any variable parameter of system.
	Button to show unit in individual window / in main window. By pressing this button the active unit is displayed in separate window and this window can be moved by screen. Only Data unit cannot be separated form main window. The button  sends the unit window backward in the program main window.

	Slider control.
	Separator.

Slider - the combined control element, includes a movable indicator and input field of the data in a numerical kind. To enter the data it is possible, both moving the movable indicator by the mouse, and entering value in the input field. Movable indicator position automatically links with value in the field of the data, and on the contrary.

Using a mouse wheel it is possible to scale a range of moving of a Movable indicator in the current position, double click by the left button of the mouse on the movable indicator returns a full range.

For scale moving guide the cursor at a scale and keep the mouse pressed the left button to drag a scale in the chosen direction to a toddler. If necessary to move the movable indicator and to repeat operation.

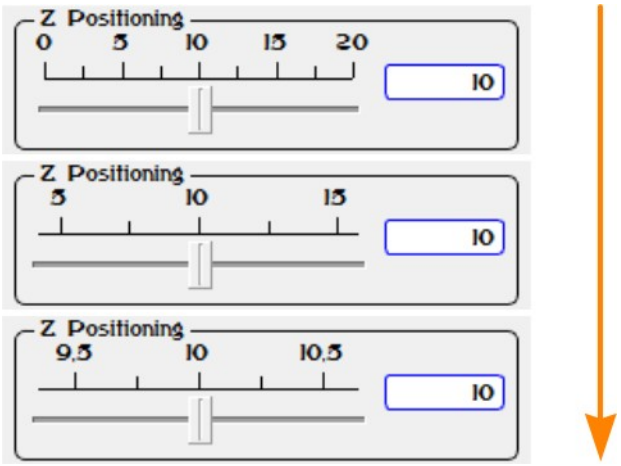


Fig. 2.1. Zooming the slider scale by mouse scroll.

Similarly the scale changes in raster images. For this purpose guide the cursor at the chosen site and rotate a mouse scroll to change image scale. Thus the image center there is a point under the cursor.

The interface element a Separator is intended for change of the sizes of separate fields. For its use guide at it the mouse cursor and, having clamped the left mouse button, move in the chosen direction.

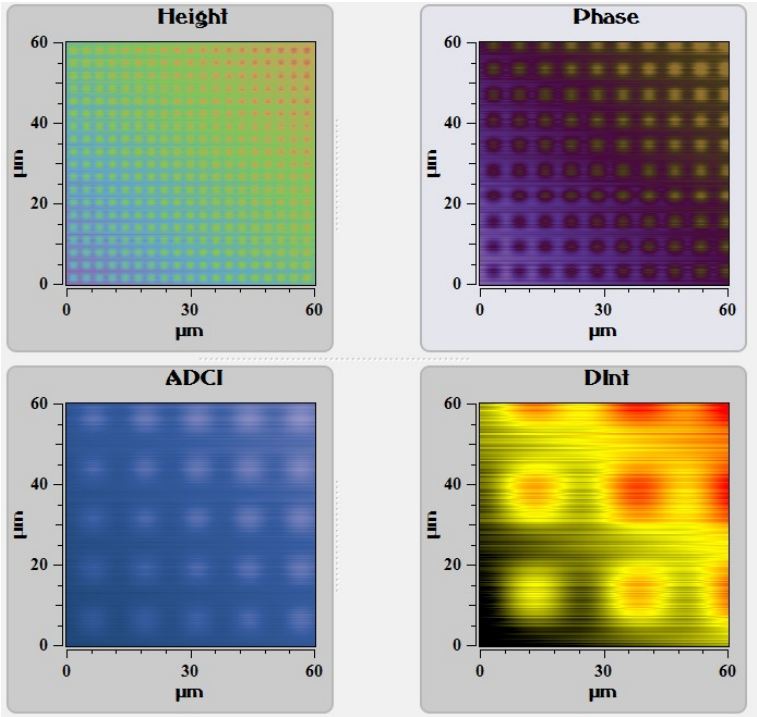


Fig. 2.3. Scan fields before separators has moved.

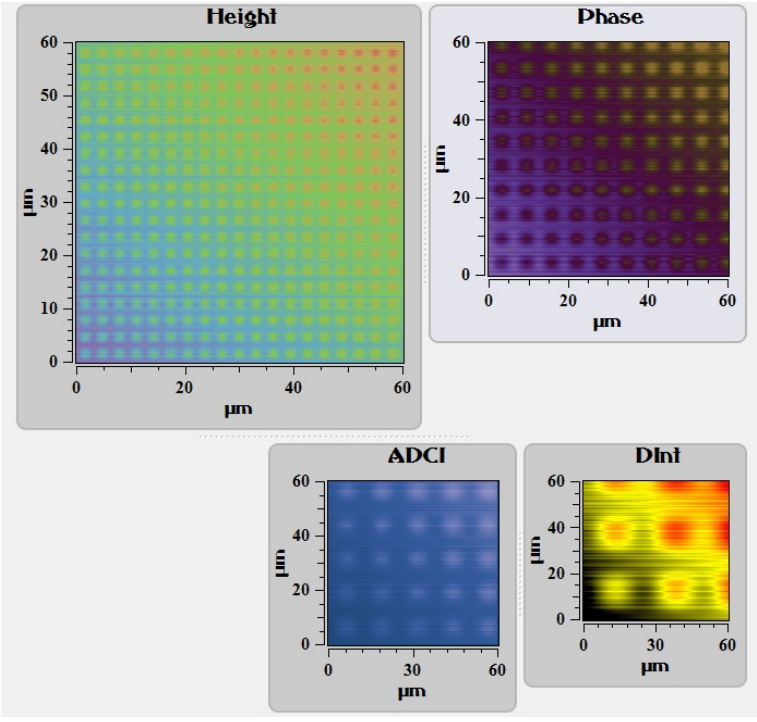


Fig. 2.4. Scan fields after separators has moved.

3. Data — unit for data processing

3.1. Data unit description

Data unit is intended for working with images. Data unit tools allow to carry out minimum processing of data that has been received or stored early.

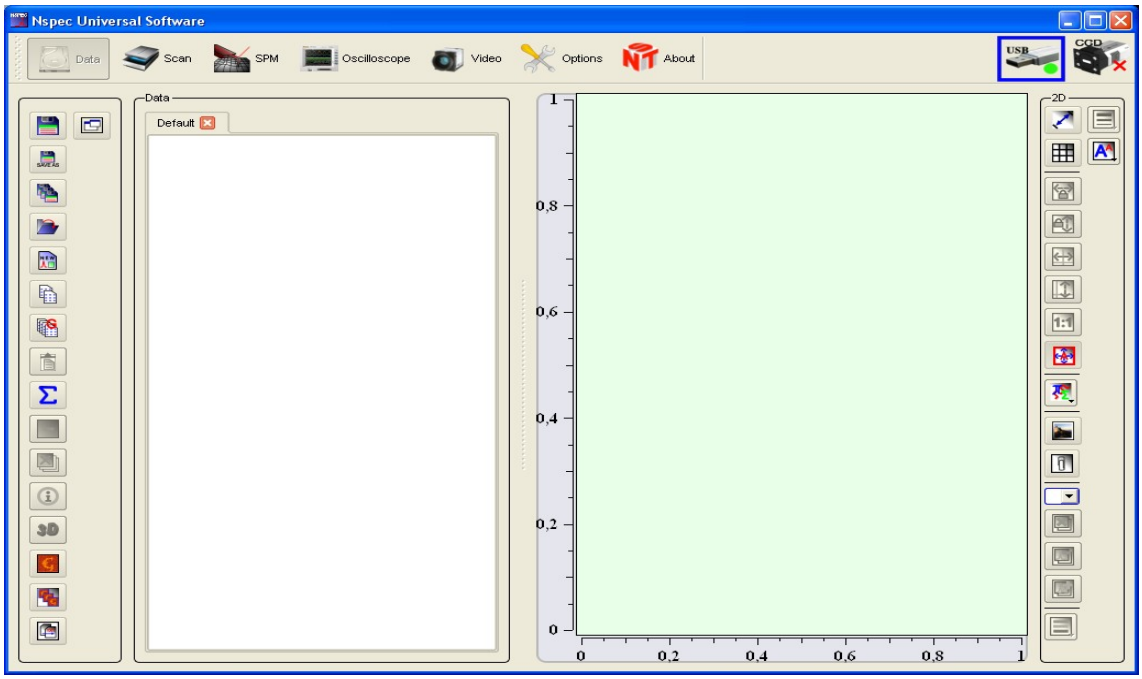


Fig. 3.1. Data unit overview.

To entry **Data** unit press the button 

, that is situated on the top panel of the NSpec window. After transition in a window of the program the button becomes pale 

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3.2. Supported file types

By default the program NSpec supports two file types of data (*.nstdat, *.nst-meta). Data represents the three-dimensional data array including value of the studied parameter and its distribution in plane XY, or the four-dimensional data array including spectra in points in plane XY.

***.nstdat** — NSpec native file format

***.nstmeta** – file format for spectral images

3.3. Loading and saving images. Working with tabs

The basic options of work on saving and opening of images are located on the tools panel. The description of functions of buttons presents below.

	Save	Save current tab data in corresponding file. If there is still no file **Save as...** dialog will be opened.
	Save as	Save data in new file by standard **Save as...** file dialog.
	Save all	Save all data from all tabs. If there is still no file **Save as...** dialog will be opened.
	Open	Open data file by standard O**pen file** dialog.
	Add new tab	Add new tab with no data.
	Copy selected data	Copy selected image to the clipboard.
	Copy selected group	Copy selected group to the clipboard.
	Insert	Insert image from the clipboard in the current tab.
	Merge all tabs	Images from all tabs merges in new tab.
	Delete all	Delete all data in the current tab.
Attention! Pressing this button leads to removal from program memory of the allocated image. Before pressing be sure that the given image is stored.		
	Delete	Delete images selected in the tab.
Attention! Pressing this button leads to removal from program memory of the allocated image. Before pressing be sure that the given image is stored.		
	Show attributes	Show current image attributes in a table.
	Show 3D view	Show data in 3D image mode. 3D mode tools appear.
	Convolution function	Convolution function. It is displayed only at work with spectral images.
	Convolution function range selection	Convolution function range selection. It is displayed only at work with spectral images.
	Display units	Change of a unit of measure on an axis X for the spectral data. It is displayed only at work with spectral images.

	Export to Gwyddion.	Export current image to Gwyddion (program for SPM data processing).
	Export tab to Gwyddion.	Export current tab in Gwyddion.
	Export to ASCII	Export data to ASCII file.

3.3.1. Working with tabs

All obtained or opened data on the Data panel is grouped in tabs. Each tab corresponds to an open file or a created file at preservation. By default all obtained data remains in the Base tab. Tabs not having at the heart of the kept file are designated as the New tab. Tabs on the basis of the kept files have a name of a file, given at saving.

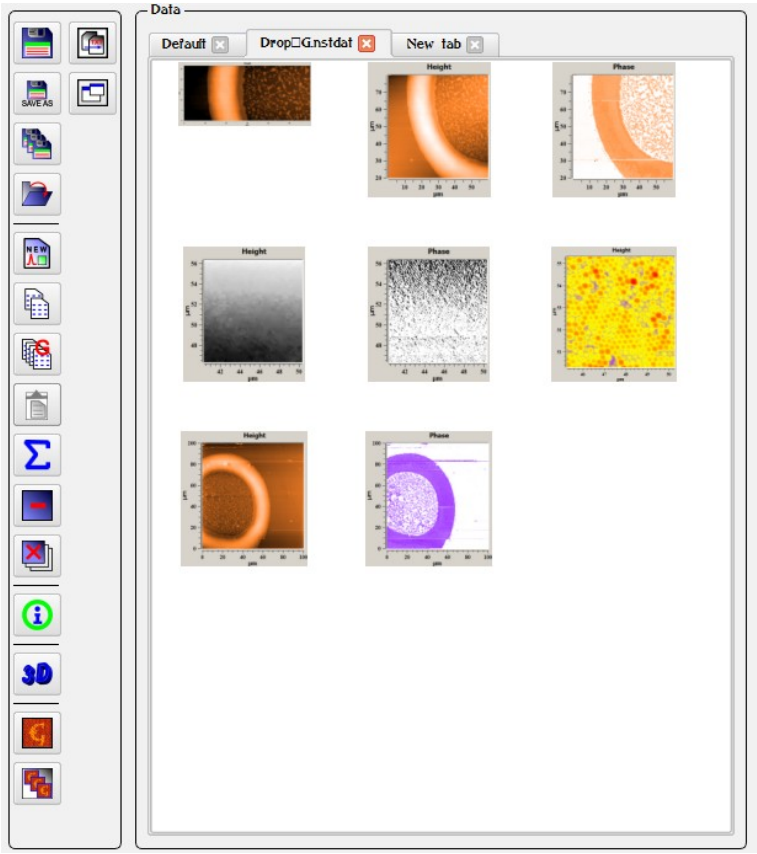


Fig. 3.2. Tabs overview.

3.3.2. Default tab

All new data received during scanning or spectrum accumulation in a point moves to the **Default tab**.

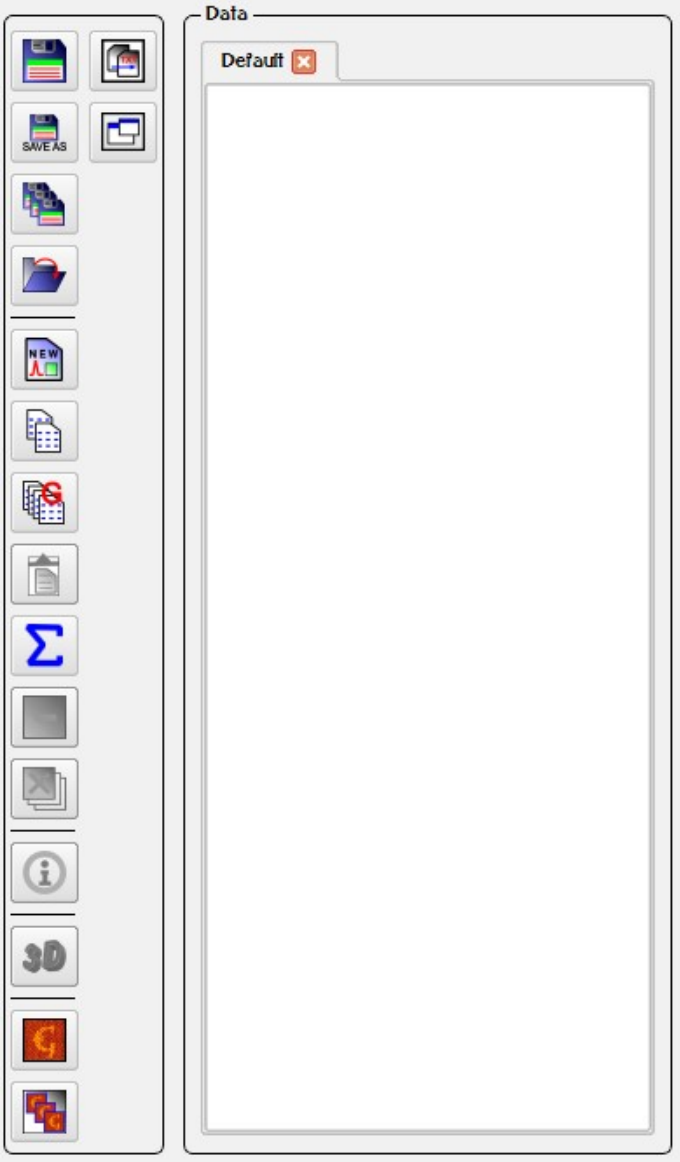


Fig. 3.3 Default tab.

This tab opens by default in the started program.

3.3.3. Load data

After pressing of the button **Open**  the Open file dialog is deduced on the screen. In this window the list of available data is shown, virtual folders of the current user account and supported files types is displayed.

For loading saved data choose the necessary file and open it by pressing the Open button or double clicking by the left mouse button on the chosen file.

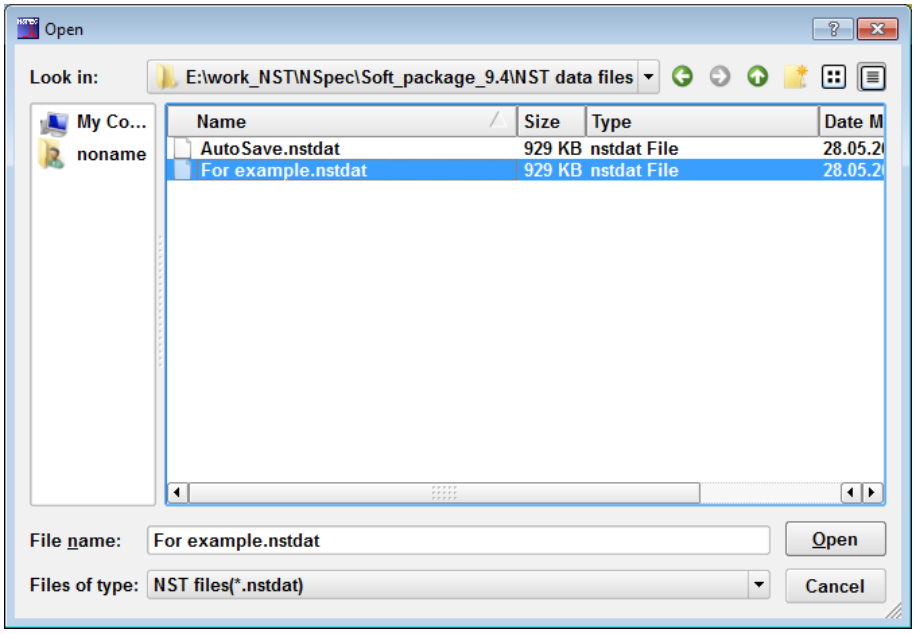


Fig.3.4. Selection of file for opening.

After a choice of the necessary file the new tab in which opens all images available in a given file are displayed. After the image is loaded, it is possible to start to work with images.

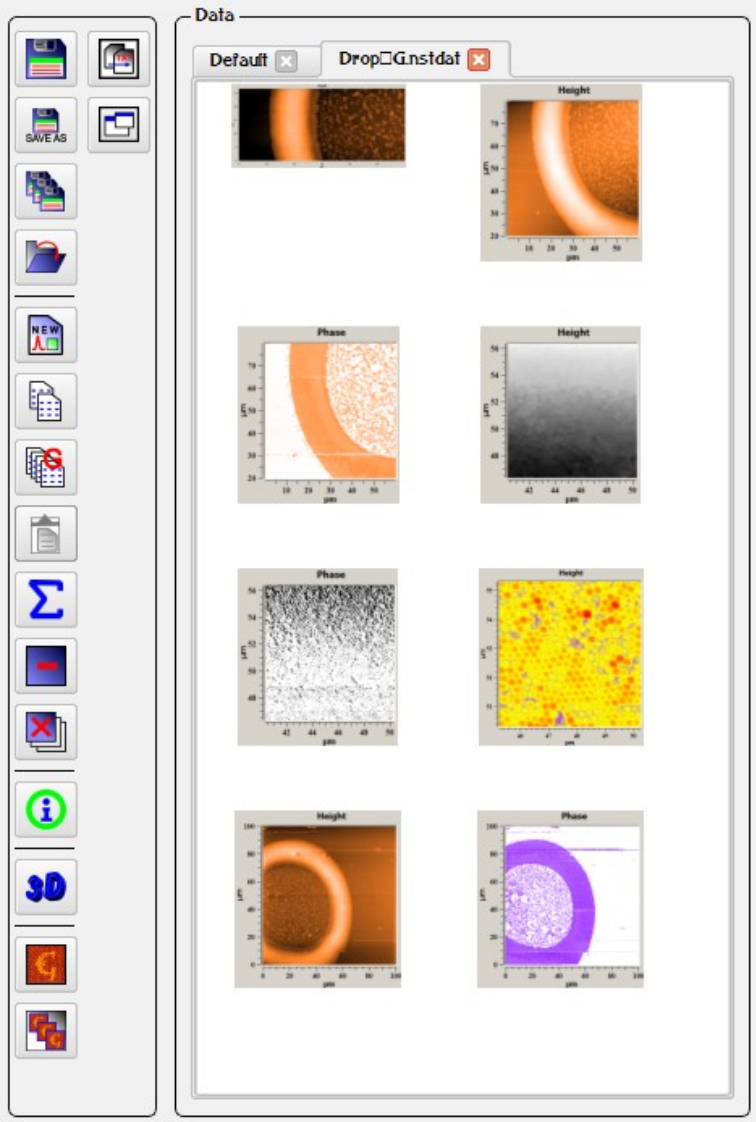


Fig. 3.5. Images in a new tab.

3.3.4. Saving images from the tab

After pressing of the button **Save**  the Save file dialog is deduced on the screen. In this window the list of available data is shown, virtual folders of the current user account and supported files types is displayed. At use of this button the data from current open tab saves only. For saving data from other tabs or activate them and press **Save**, or use saving functions described below.

After a choice of a path for saving the file, it is required to fill a field the File Name and to press the button **Save**. After saving of the chosen files it is possible to close program NSpec if necessary.

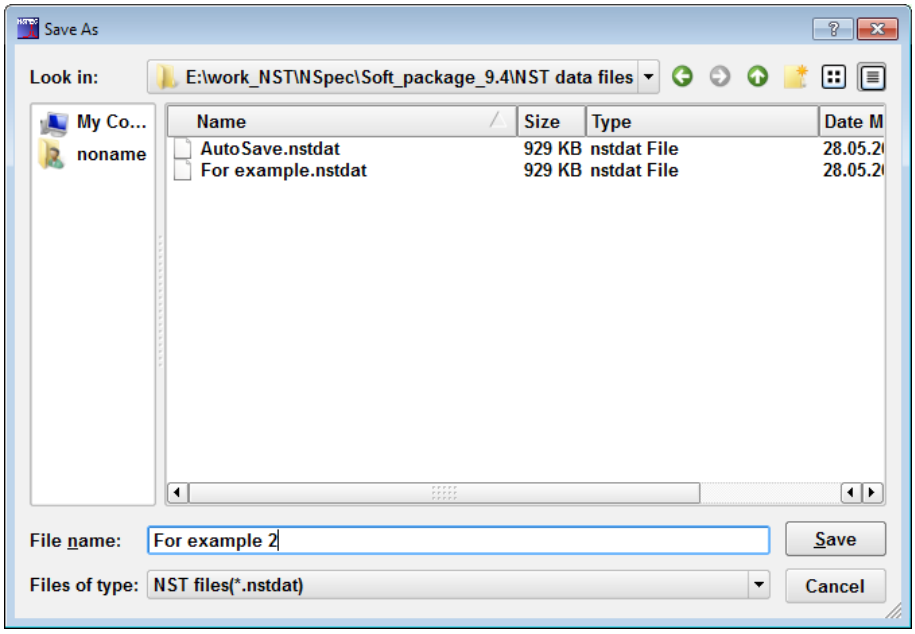


Fig. 3.6. File save dialog.

If all data contains in the Default tab, by pressing this button **Save as...** file dialog is deduced on the screen. After data saving the new tab is automatically created and all data from a default tab is transferred in it. Thus the default tab is cleared of the information.

If there are some tabs with no saved file it is required to use the button to **Save as...** In this case file save dialog is deduced on the screen, in witch it is required to fill out a name of a saving file and the path. Only the active tab thus saves. For saving other tabs activate consistently tabs required saving.

3.3.5. Saving all tabs

To save data from all opened tabs press the button  **Save all**. Tabs having saved files will save in same files. For tabs not having saved files the Save file dialog will be opened.

3.3.6. Creating new tabs

To create new tab press the button **Add new tab**  . After this the new tab with the name **New tab** will be created in the end of tab list. New tab is empty. For filling it with images and graphs use tools for copying of images/graphs and groups.

3.3.7. Tabs merging

If it is necessary to send data from all tabs in one file use the button **Merge all tab**  . By pressing this button new tab will be created and data from all tabs will be sent in the new one. To save this tab use functions of saving separate tabs.

3.4. Image grouping

3.4.1. About image grouping

View of single scan and simultaneous received scans is not the same. A single scan has own color. Simultaneous received scans merges in one group and have common color. With this scans all sections and cropped images merges in the one group.

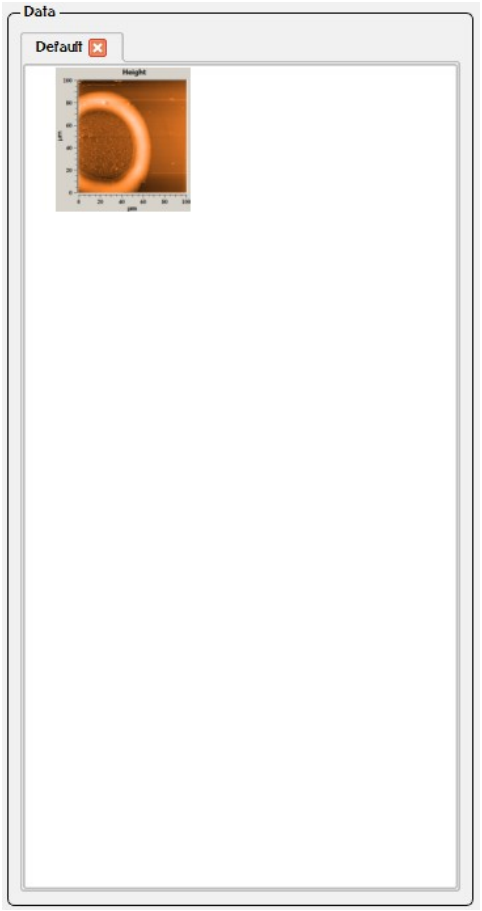


Fig. 3.7. Single image.

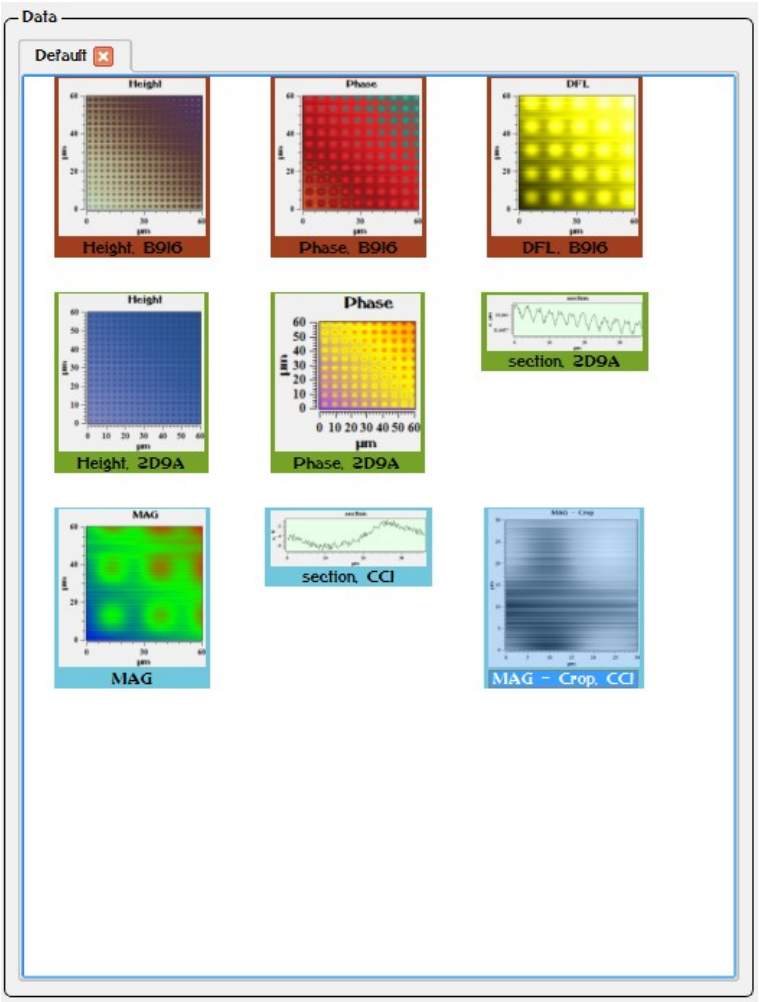


Fig. 3.8. Grouped images.

3.4.2. Images copy and transfer functions

To image copy and transfer from one tab to another use the button **Copy selected data**  . By pressing this button the selected image will be copy to the clipboard. After pressing the button **Paste date**  copy of image will be created. By pressing this button in new tab image will be copied in this tab.

3.4.3. Group copy and transfer functions

To group copy and transfer from one tab to another use the button **Copy selected group**  . By pressing this button the selected group will be copy to the clipboard. After pressing the button **Paste date**  copy of group will be created.

3.4.4. Images and tabs deleting

To delete selected image from tab use the button **Delete**  .

To delete all images from tab use the button **Delete all**  .

To close or delete tab press the button  in the tab header.

3.4.5. Info panel

	Show image information
	Add new parameter
	Delete selected parameter
	Save image info in txt file
	Set scanning parameters from image to the scan parameters

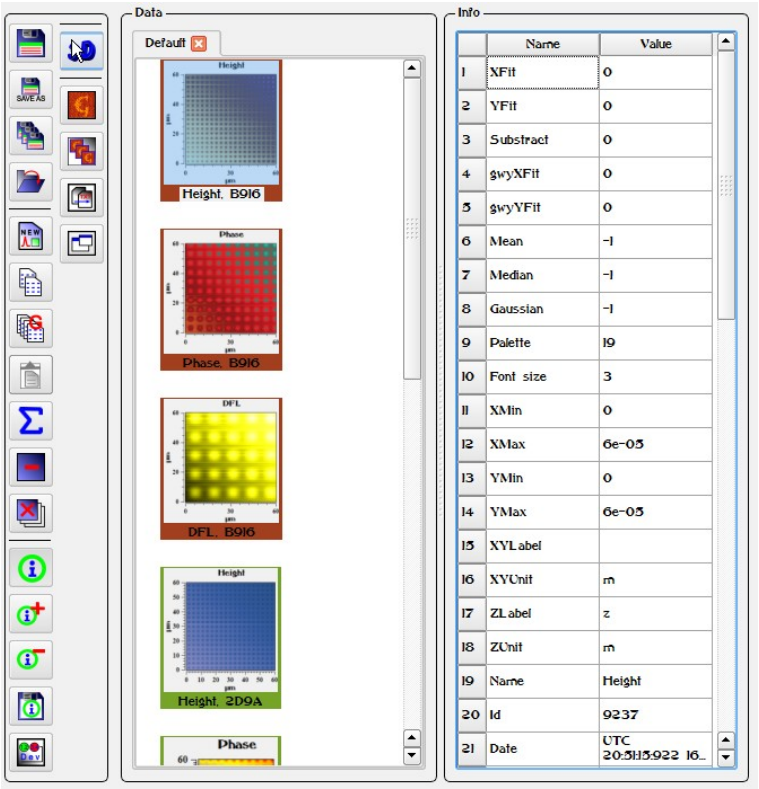


Fig. 3.9 Info panel.

On the **Info** panel main scan parameters are shown – scan size, device setting, applied filters and palette. To change parameter value in the table it is required to double mouse click on the cell, to enter new value and to press Enter key.

The button **Set info to device**  is intended for adjustment of scanning parameters to similarly options of already received scan. By pressing this button all significant parameters of scanning are automatically set according to the saved data.

3.5. Data processing

3.5.1. Choice of the image for work

After loading or reception of images for processing guide the cursor on necessary images at Data panel the and once click the left mouse button. After an image choice on the screen the chosen image and a scale of heights will be displayed.

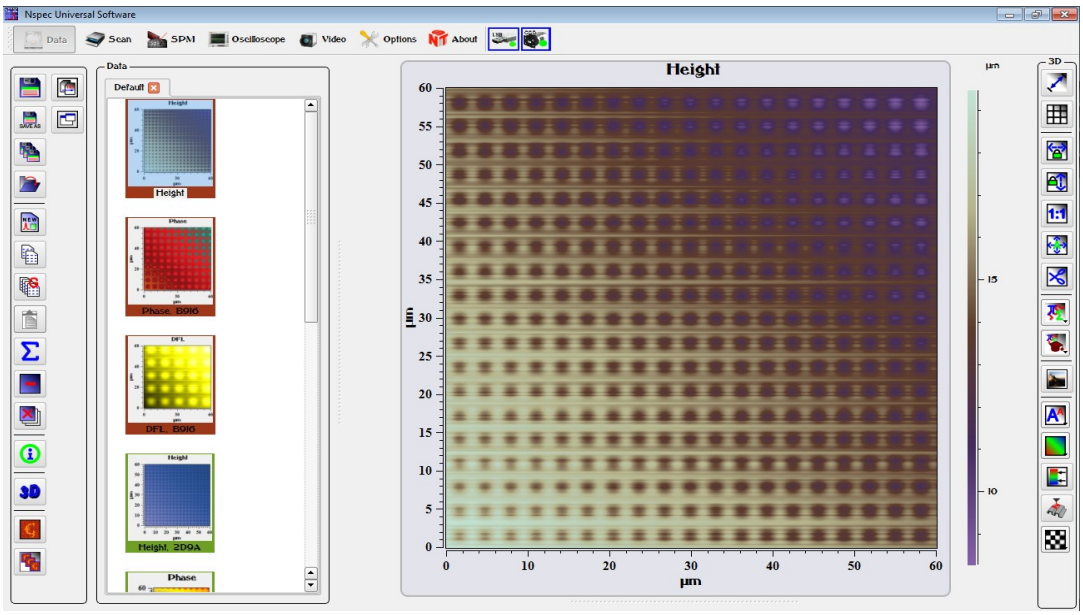
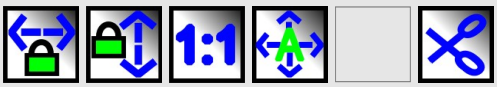
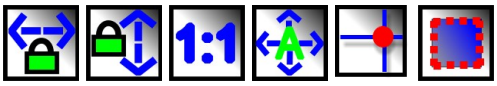
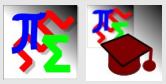
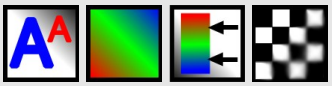
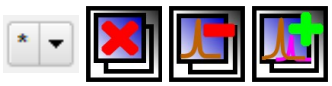


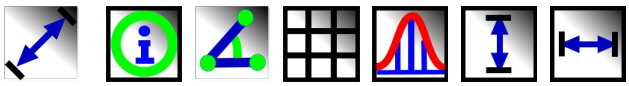
Fig. 3.10. Opened image.

3.5.2. Description of image processing panel

In all units (except **Lithography**) basic images, curves and specters processing tools are placed on the image processing panel. This panel tools is grouped by functions and purposes. The panel has **3D** name for three- and four-dimensional data, and **2D** name for curves and specters.

	Tools for 3D images measurement.
	Tools for 2D curves measurement.
	Tools for 3D image scaling and cropping.
	Tools for 2D curves scaling.
	Tools for 3D image scaling and cropping (Unit Scan).
	Basic images filters.
	Export and copy images buttons.
	Image view tools
	Curves processing tools.
	Curves display settings.
	Use image for lithography.
	Clear the clipboard.

3.5.3. Measurement tools

The group measurements tools has two kinds. Tools for work with raster images  and for work with curves and graphics  . For inclusion of a totality of tool set it is necessary to press the button **Markers**  . By pressing this button the group is activated completely. Thus on the chosen image markers and section lines are displayed.

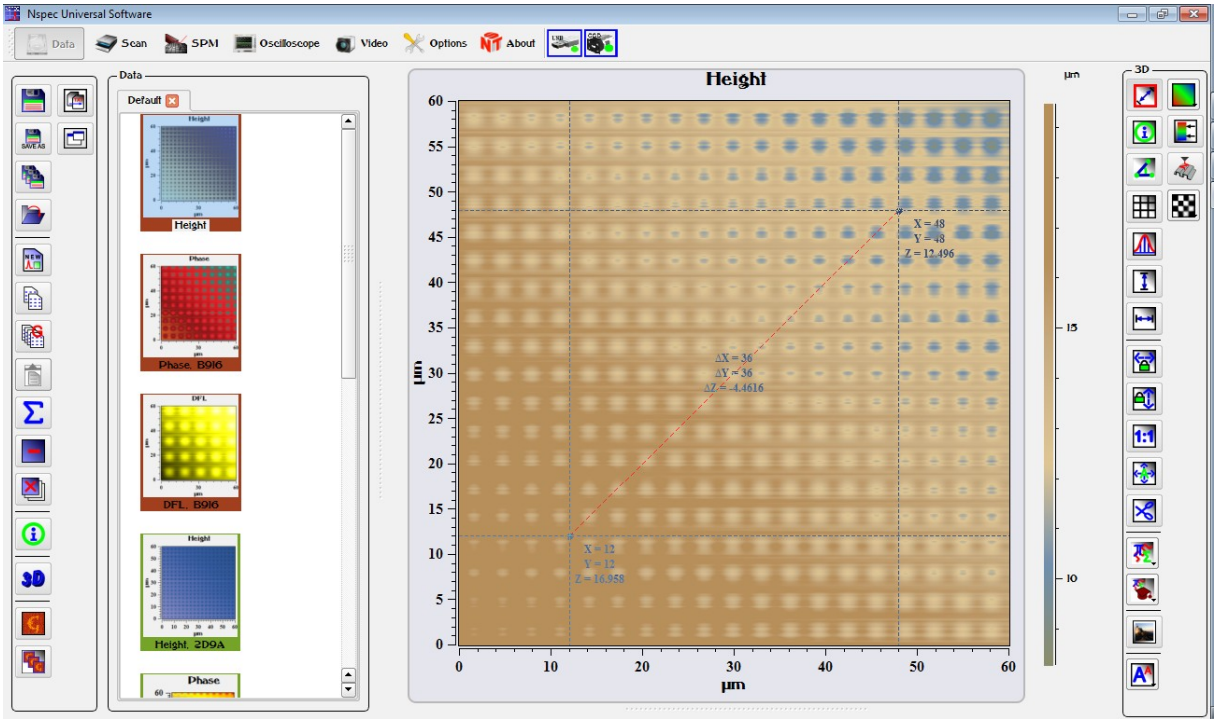


Fig. 3.15 Cut section markers and line.

	Markers	The button of cut sections creation, by pressing the button is displayed full group of tools for carrying out of measurements. At activation of markers on the chosen image there are two markers (A, B), limiting the chosen section, and all information on position of the given markers. For moving of a marker across the field of the image it is necessary to guide the cursor at a marker and, keeping it by means of the left button of the mouse, to drag in a new point. At moving of markers across the field of the image the profile getting to section automatically changes. Similarly given tool operates at measurements on curves and schedules.
	Detailed markers info	The button of switching on/off of a field with the data about position of markers. By pressing the button the window containing the detailed information on position of markers and value of measured indicators in a point of their installation is displayed. Thus the information displayed earlier at markers, is deduced in this window.
	Angle measurement	By pressing the button in the field of the image additional marker C is displayed. For its moving across the field of the image guide at it the cursor and, keeping the left mouse button, drag in the chosen point. Thus in a window displaying the information on value of markers (it is activated by pressing the button the Data about markers), after button pressing in the field with values of corners the corner size between pieces AC and AB is deduced.
	Show grid	By pressing the button the grid is displayed.
	Cut section	By pressing this button the field of construction of profiles of the chosen sections is displayed.
	Vertical section	The button of creation of vertical sections. By pressing this button only vertical sections can be created. To pass to construction of sections in other directions press the button repeatedly.
	Horizontal section	The button of creation of horizontal sections. By pressing this button only horizontal sections can be created. To pass to construction of sections in other directions press the button repeatedly.

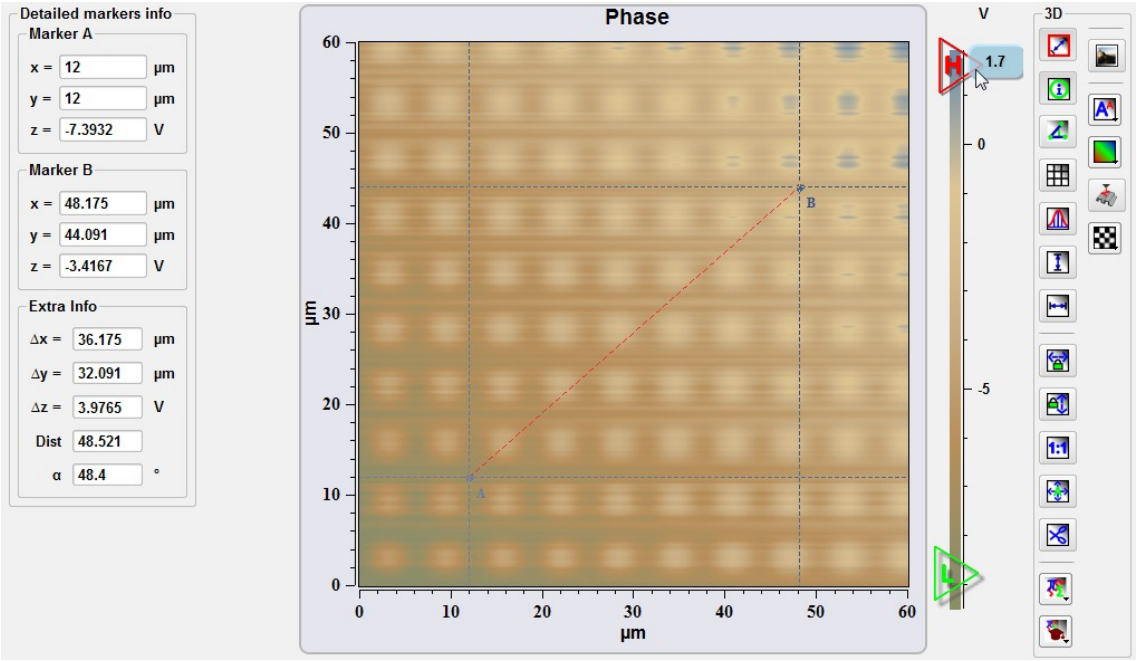


Fig. 3.16 Markers information in the Detailed markers info filed.

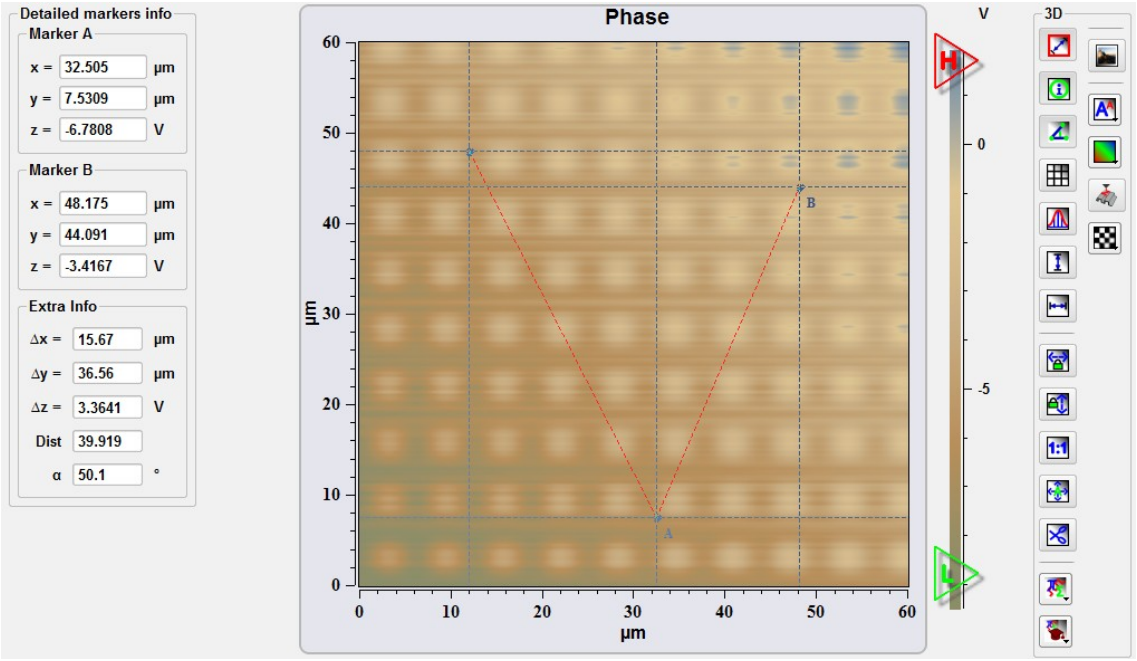


Fig. 3.17. Angular measurement.

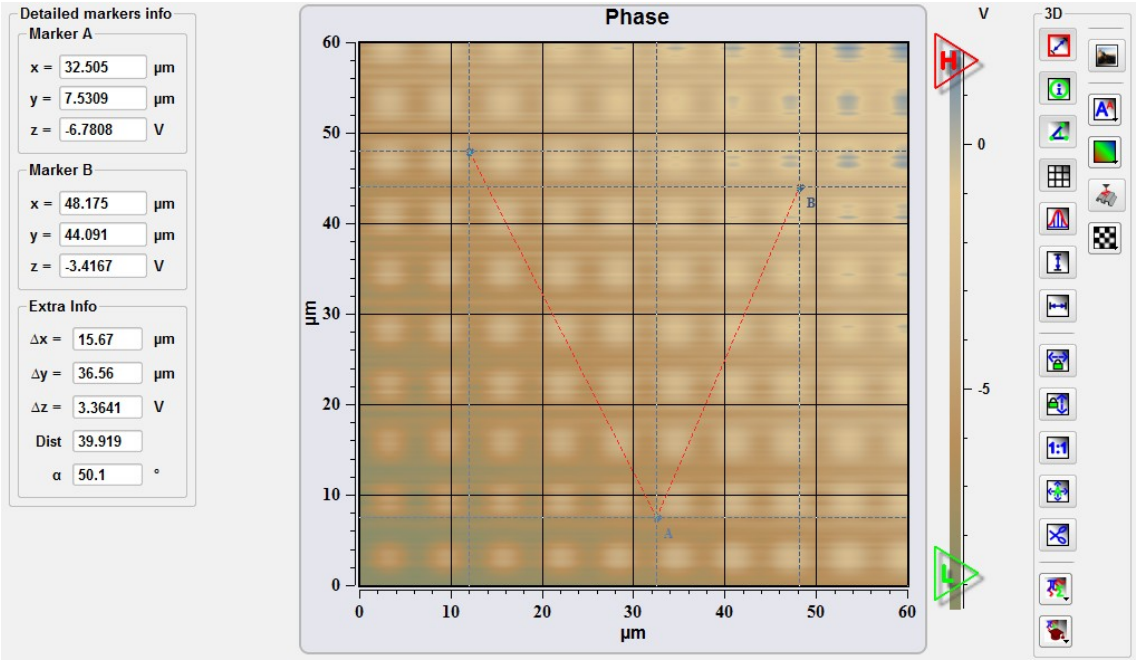


Fig. 3.18. Displaying the grid.

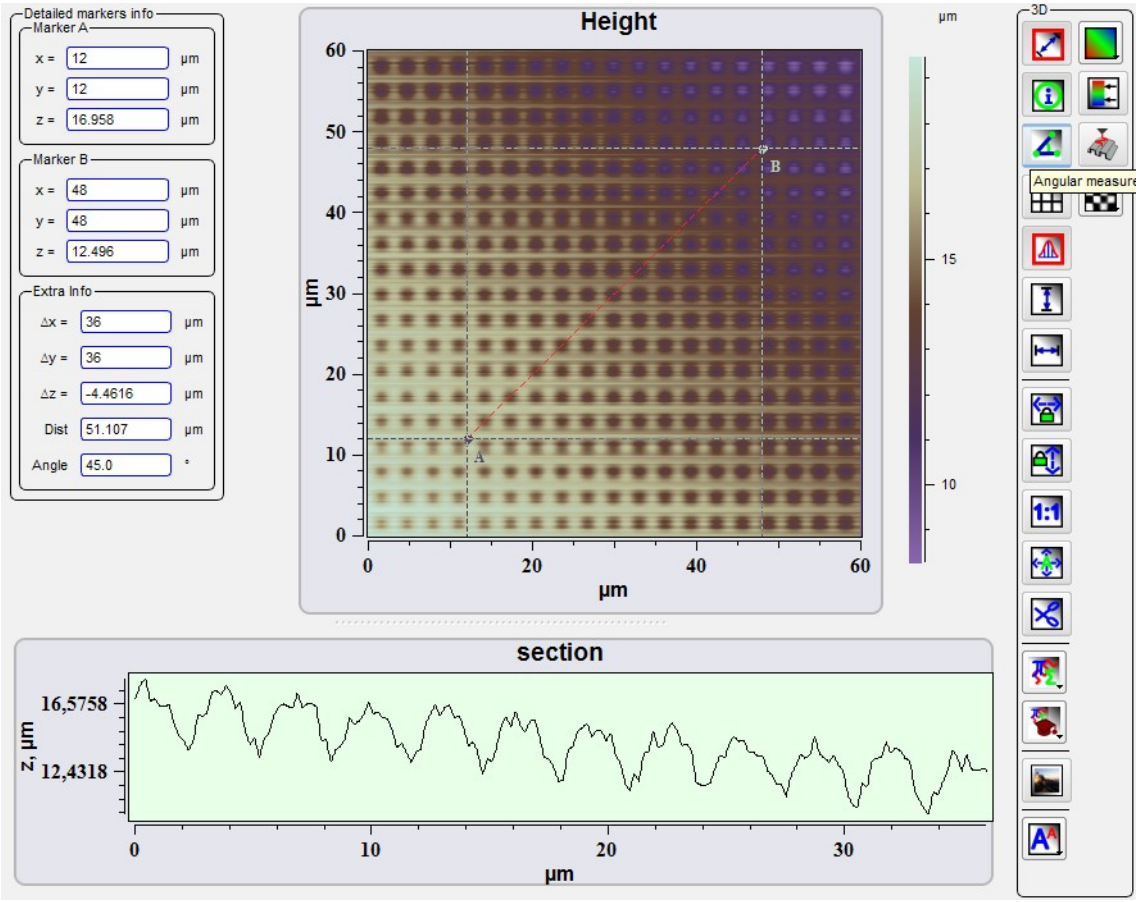


Fig. 3.19. Cut section in free direction.

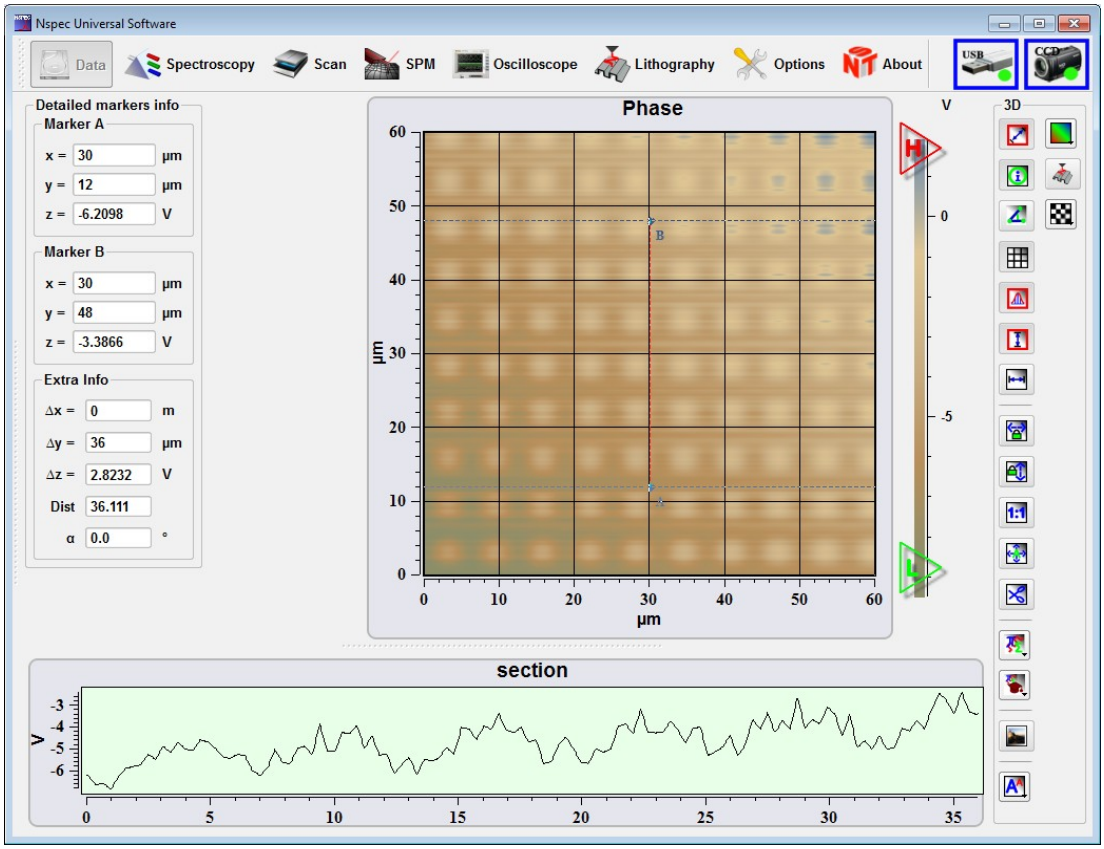


Fig. 3.20. Vertical cut section.

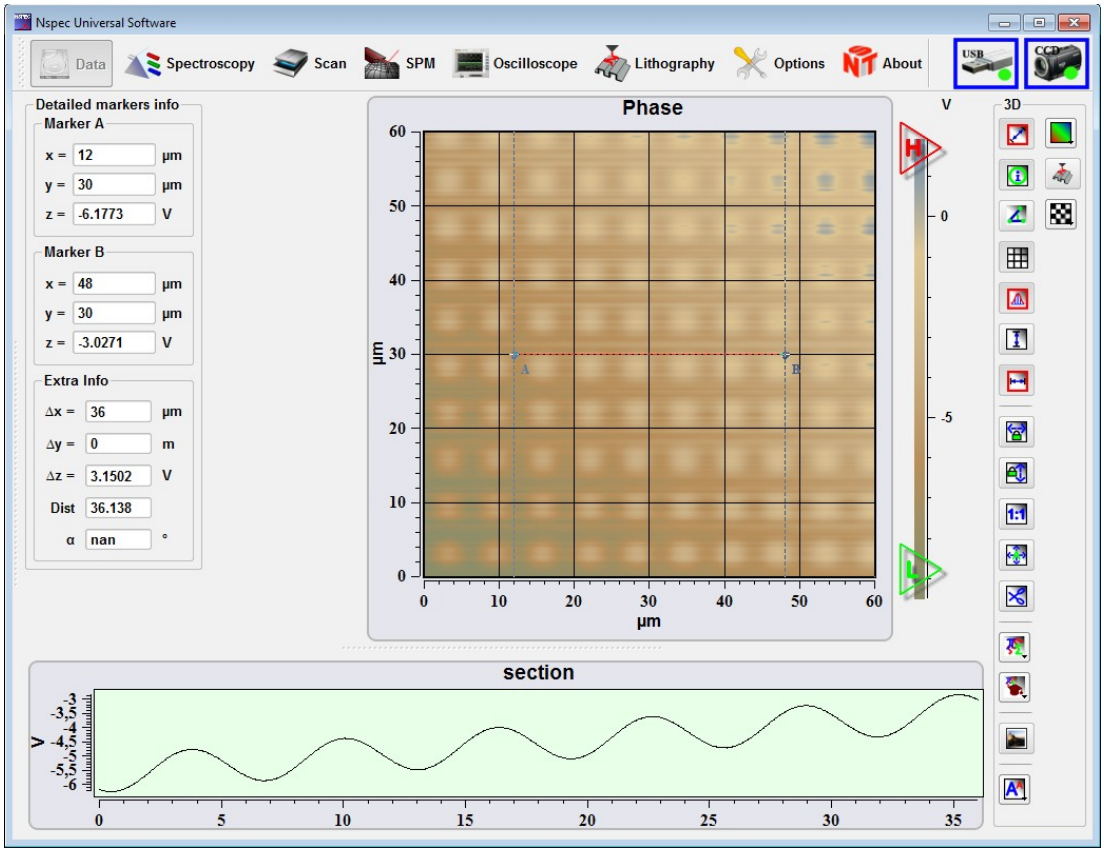


Fig. 3.21 Horizontal cut section

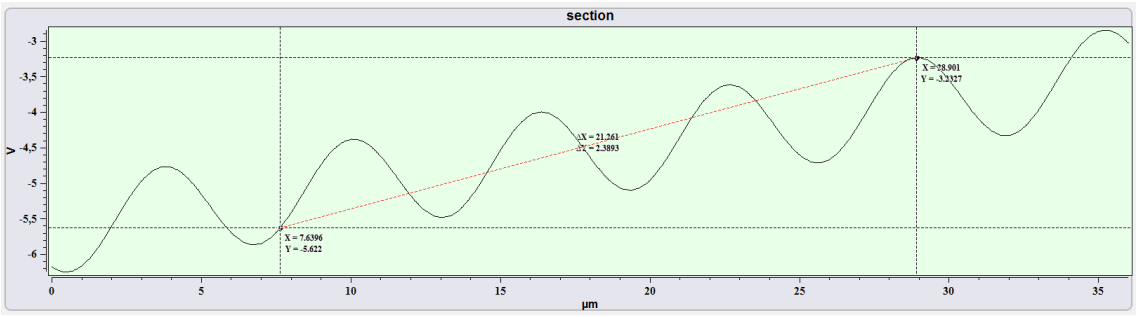


Fig. 3.22. Markers for sections.

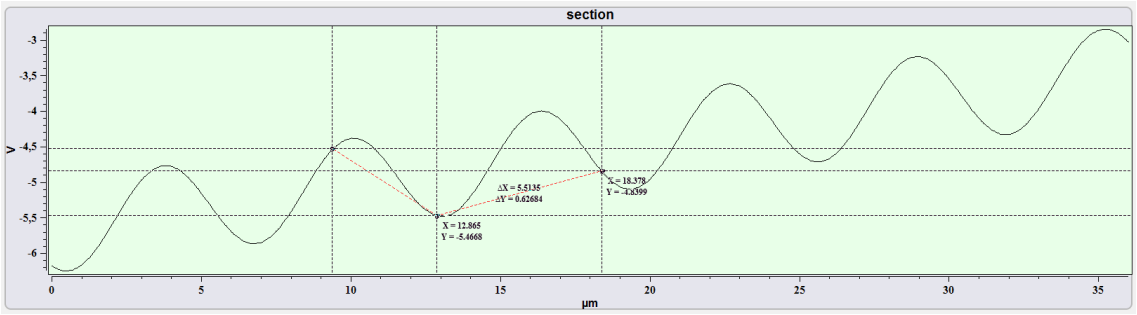


Fig. 3.23 Markers for sections.

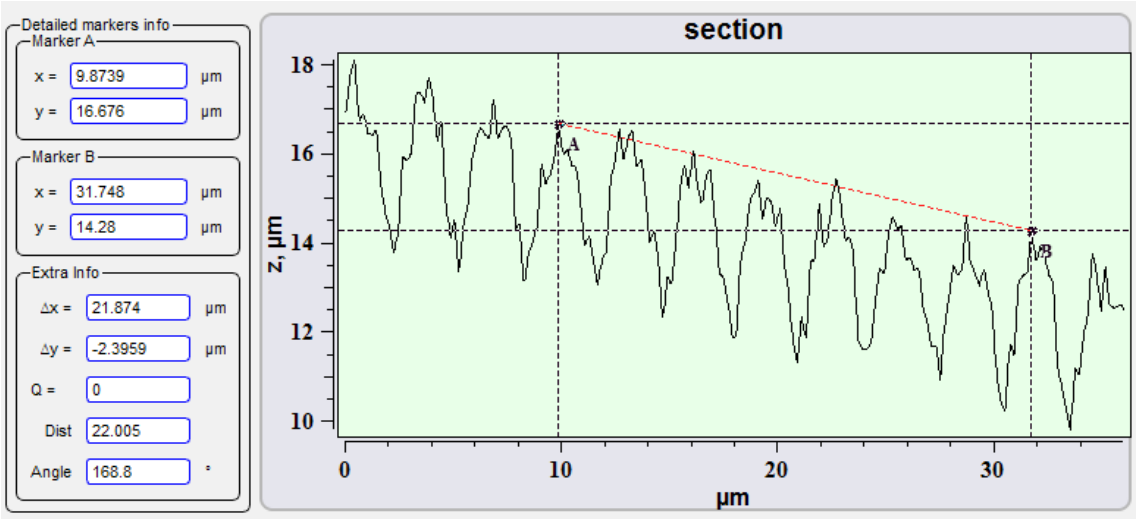


Fig. 3.24 Markers and info for sections. .

3.5.4. Scaling tools

The group of tools is intended for management in the images sizes.

		Fix X direction zoom	Fix X axes scale while zooming. Only Y scale changes.
		Fix Y direction zoom	Fix Y axes scale while zooming. Only X scale changes.
		Autoscale in X axes	Autoscale in X axes
		Autoscale in Y axes	Autoscale in Y axes
		Restore scale	Restore image scale to 1:1.
		Allow/deny autoscaling	By pressing this button all actions on scale change are cancelled. When the button is pressed, described above the button pass in an inactive condition.
		Point selection	SPM tip positioning button.
		Show specter in point	Show spectrum in chosen point. Available only for 4D spectroscopy data. For display of a spectrum from an image point press this button, guide the cursor at the image and press of the left mouse button to specify a point for which it is necessary to display a spectrum.
		Area selection	The button of a choice of a site of scanning. For example, at work in windows Scanning or Spectroscopy this button allows to establish the scan sizes on height and width. By pressing the button panels of tools there are additional buttons.
		Apply	The button of acknowledgment of the chosen area and installation of new borders of the image.
		Cancel	Cancel area selection.
		Select full area	Extend selected area to full scan.
		Crop	Cropping image tool. Actions of the button are similar to button Area selection. It is available only at work in DATA unit.

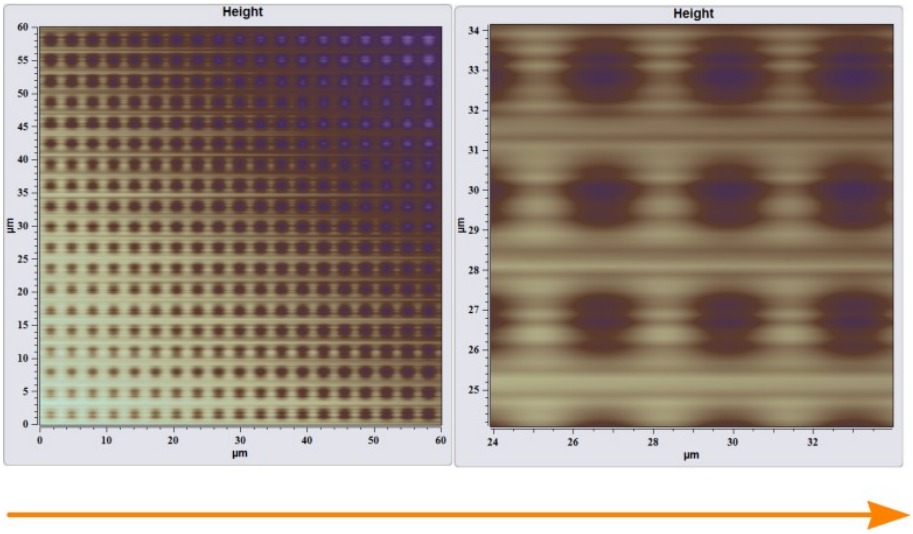


Fig. 3.25 Zoom in.

For zooming in or out of image establish the mouse cursor in the chosen place and scrolling a mouse scroll to increase or reduce the chosen object.

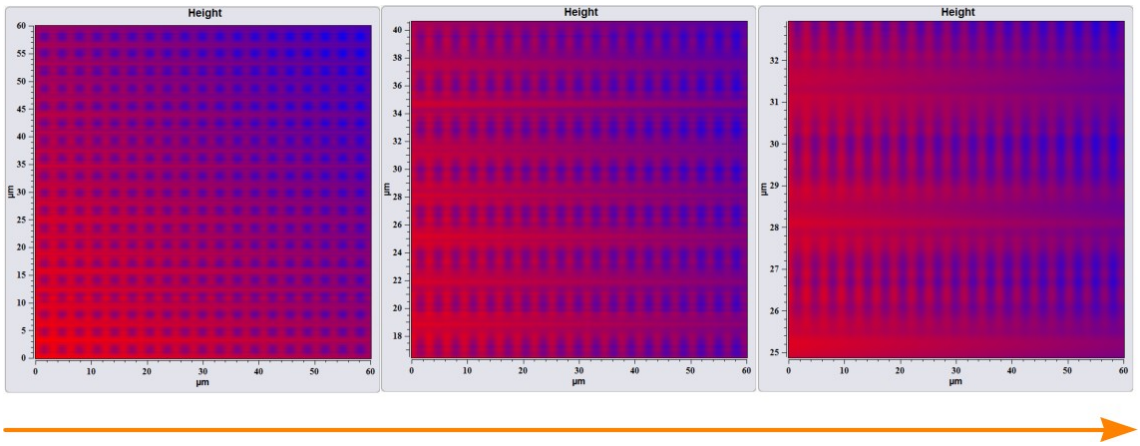
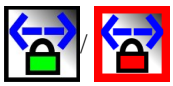


Fig. 3.26 Illustration of Fix X direction zoom tool 

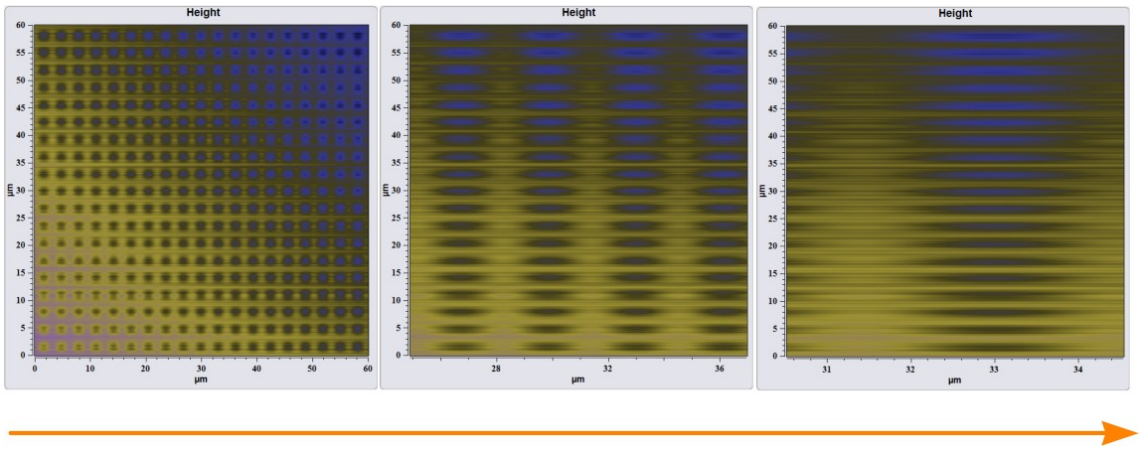
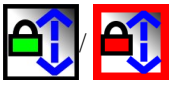


Fig. 3.27 Illustration of Fix Y direction zoom tool 

For similar actions at scaling of curves and spectra disconnect function **Allow scaling** .

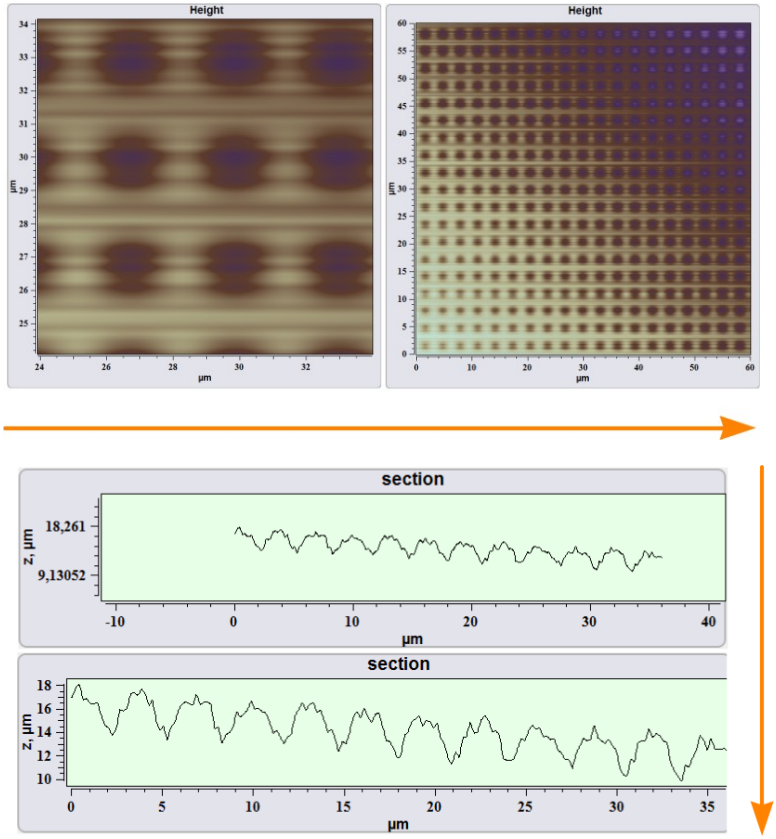


Fig. 3.30 Illustration of restore scale tool .

Action of **Deny autoscaling** is similar to **Restore scale** tool action**.** The main difference consists that at reception of images, sections, spectra the tool **Allow/deny Automatic scaling** automatically levels a scale on the maximum and minimum values. In such a manner that in a corresponding window the data received at present completely is displayed. At switching-off of this tool the part of received images, profiles and spectra oversteps the bounds of windows. For full display of the data in a corresponding window include the given function, or level the data manually with use of other scaling tools.

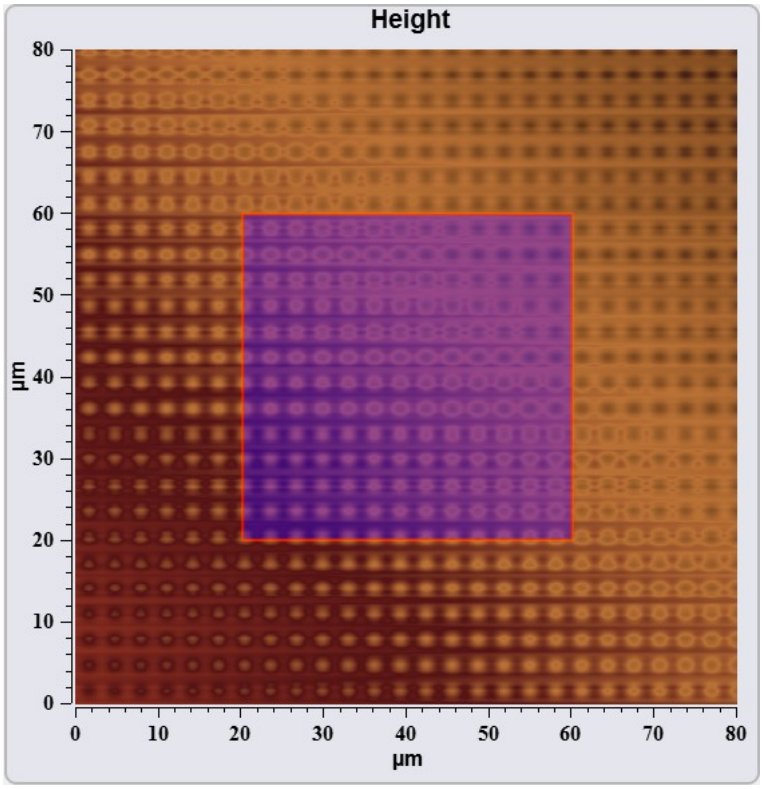


Fig. 3.32 Crop tool illustration 

To change the image sizes guide the mouse cursor at border of a rectangle of allocation and, keeping the mouse pressed the left button, stretch an allocation rectangle in the chosen direction. After pressing **Apply** button  area of scanning will take the form also the sizes of area of allocation. To cancel of area selection press the button **Cancel**  . The new image is attached to group of the initial image.

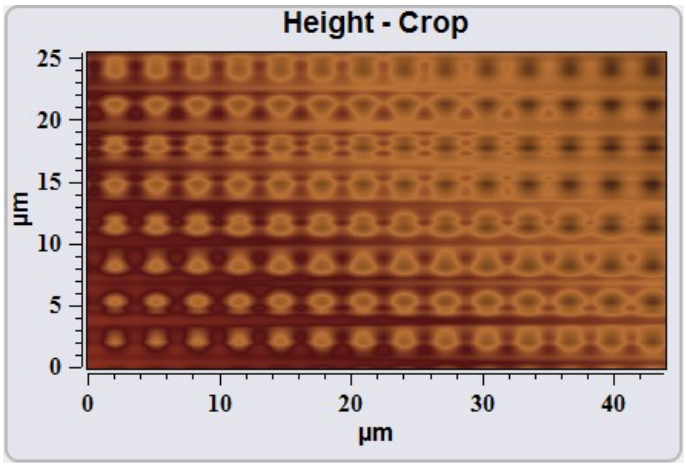


Fig. 3.34 Cropped image.

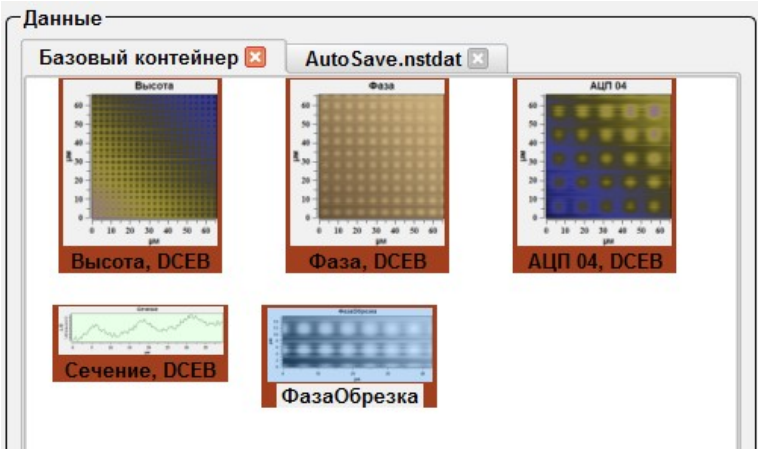
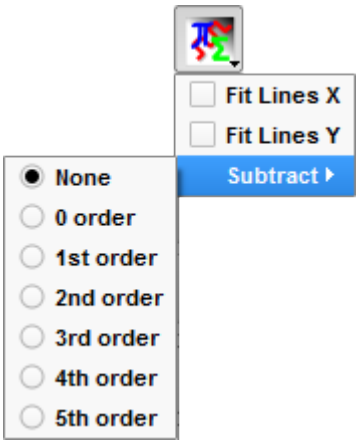
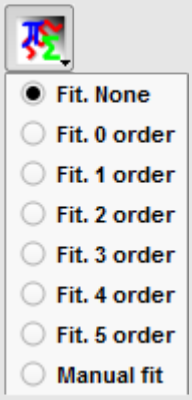
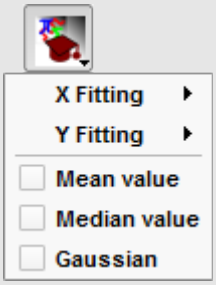
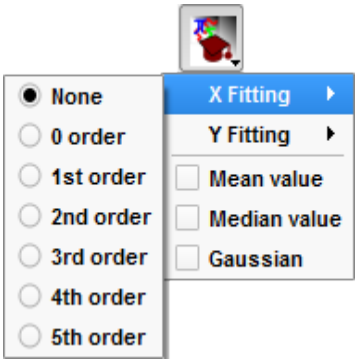
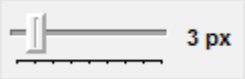


Fig. 3.35 Group of original and cropped images.

3.5.5. Image filters

 Filters	The button of a call of the basic mathematical filters. By pressing it there is the drop-down menu having a various appearance in case of work with the spectral or SPM data. Differs for 2D and 3D images.
	Drop-down basic filter list for 3D images (scans). The polynominal surface of the specified order will be subtracted from the image. Fit. None – Fit 5 order – Order of substrate surface.
Fit Lines X	Fit lines by X axes. Выравнивание средних значений линий вдоль x
Fit Lines Y	Fit lines by Y axes.
	Drop-down list of substrate polynomial from curves (specters and sections). The polynomial of the specified order will be subtracted from the curve. Fit. None – Fit 5 order – Order of substrate curve. Manual fit – manual choice of substrate line.

	Apply fitting.
	Cancel fitting.
	Reset manual fitting line.
	Additional mathematical filters for 3D images (scans).
	Drop-down list of Line-by-line subtraction of the specified order approximating curve in X direction. Fit. None – Fit 5 order – Order of the substrate curve. The sane menu for Y direction.
Mean value	Moving-average filter. Window size sets in pixels.
Median value	Median filter with square window
Gaussian	Gaussian filter modifies the input signal by convolution with a Gaussian function
	Size of averaging window.

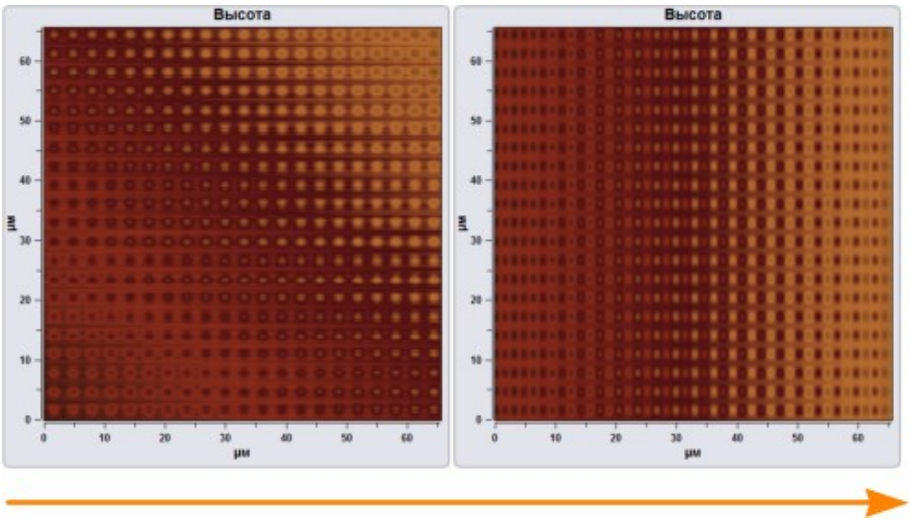


Fig. 3.36 Fit line X.

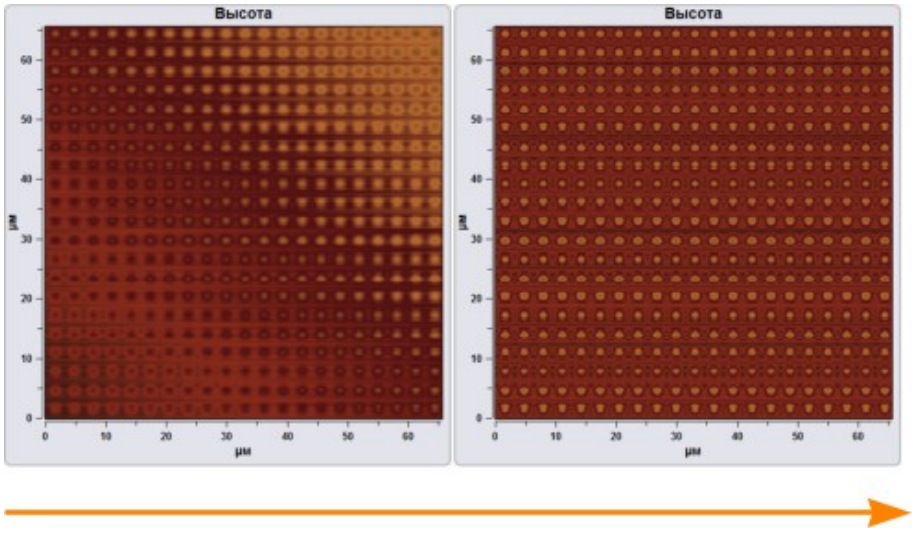


Fig. 3.37 Plane substrate.

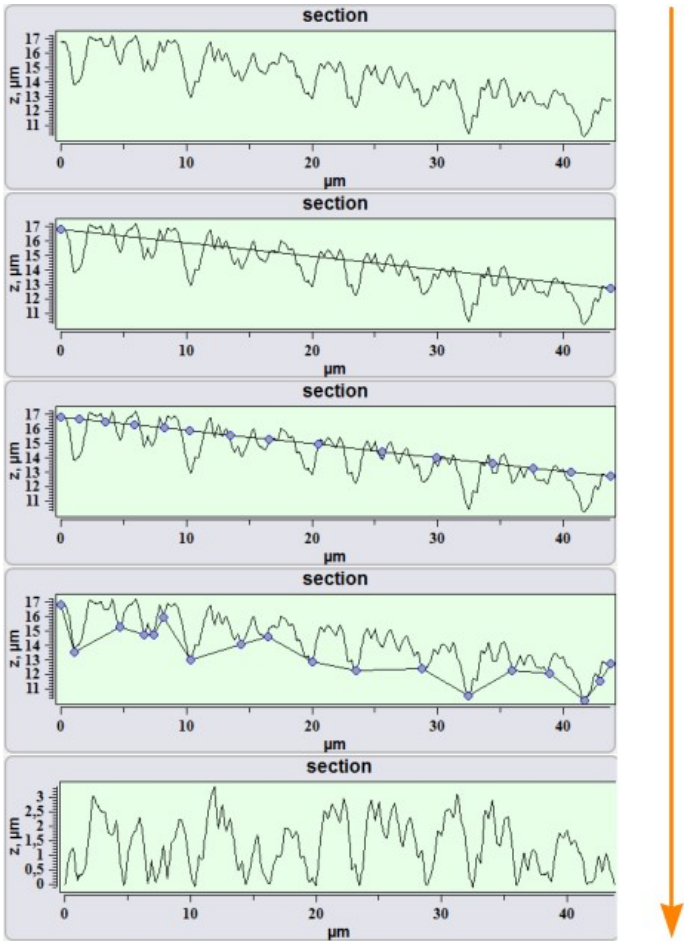


Fig. 3.38 Substrate base line manually.

At subtraction of a base line manually check in **Manual Fit** for curves filters. After that to press the button to **Reset base line**. There will be a straight line between start and final points of a curve on the screen.

At prompting of the mouse cursor on a line and pressing by the left button lines

points are formed. For moving of points establish the cursor on the point and, having clamped the left button, move the point. After creation of a base line for subtraction press **Accept**  . For cancellation of subtraction of a base line manually it is necessary to press **Cancel**  .

3.5.6. Export tools

	Save image as	Save image to a hard disk in *.png, *.jpg, *.tiff, *.bmp format by standard dialog.
	Send to Data	The selected data will be sent to the current tab in the Data unit.

3.5.7. Image view tools

	Font size	Select caption font size
	Palettes	Select image palette.
	Set Z range by selection	Enabling of manual image contrast by image area selection.
	Interpolation mode	Select image interpolation method.

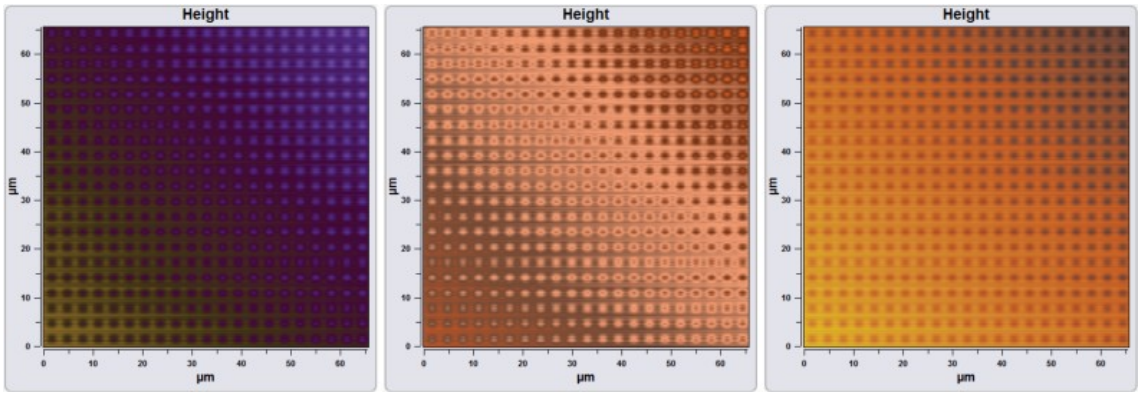


Fig. 3.41 Different palettes.

To add new palette in the list create new section in the file Soft_package_№/Param/palette.txt in such manner:

```
#start
#RGB
Orange
0 0 0
255 127 36
255 255 255
#end
```

or

```
#start
#HEX
Bilberry
#0000FF
#FF0000
#endq
```

3.5.8. Height scale

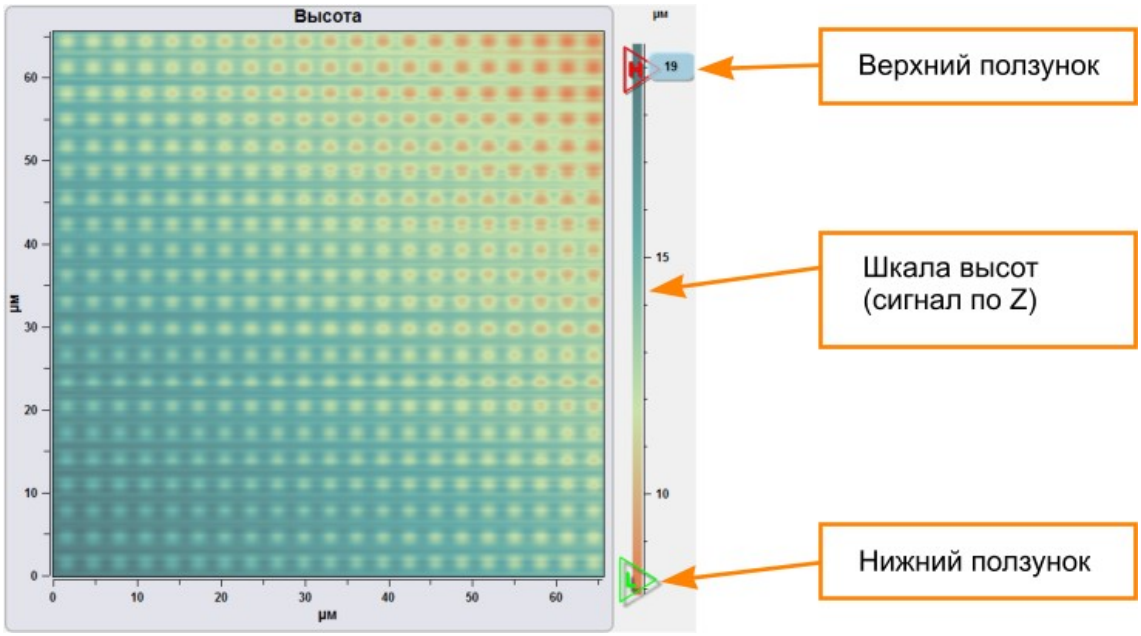


Fig. 3.42 Using Z scale.

To change the image contrast and to display Z signal distribution the scale of heights (a signal on Z) is used. To the minimum value of a signal there corresponds the

bottom part of a scale, to the greatest value of a signal there corresponds the top part of a scale. To change the image contrast move sliders on the scale. Sliders are displayed only at cursor pointing on a scale of heights.

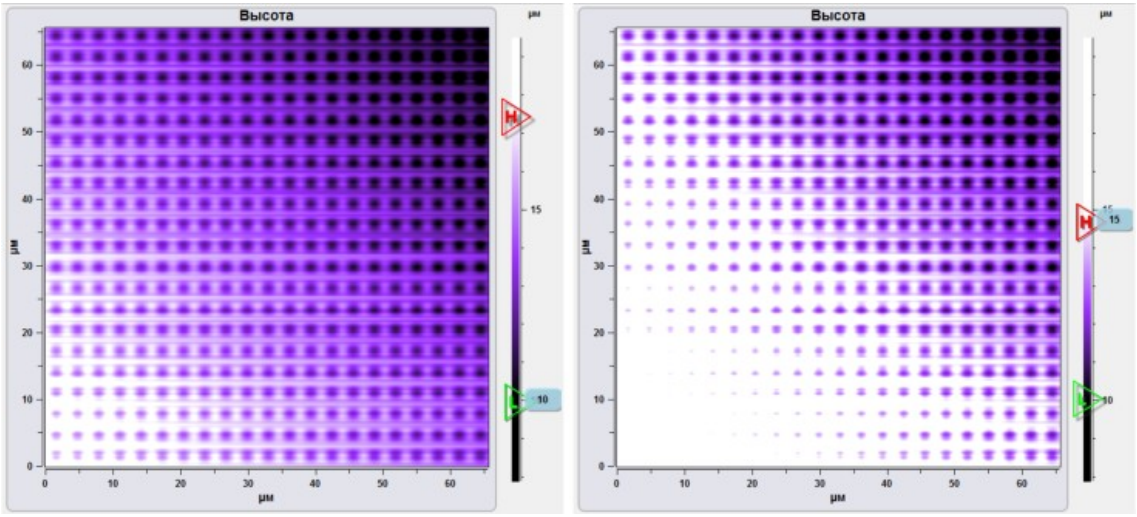


Fig. 3.43 Sample usage of height scale.

3.5.9. Set Z range by selection

If necessary to set Z scale according to the part of image use **Set Z range by selection**  . At using this function Z scale maximum correspond to the maximum of selected image part, and the minimum of the scale – the minimum of selected image part. To select scan area press the button  and select the rectangular interested area on the image.

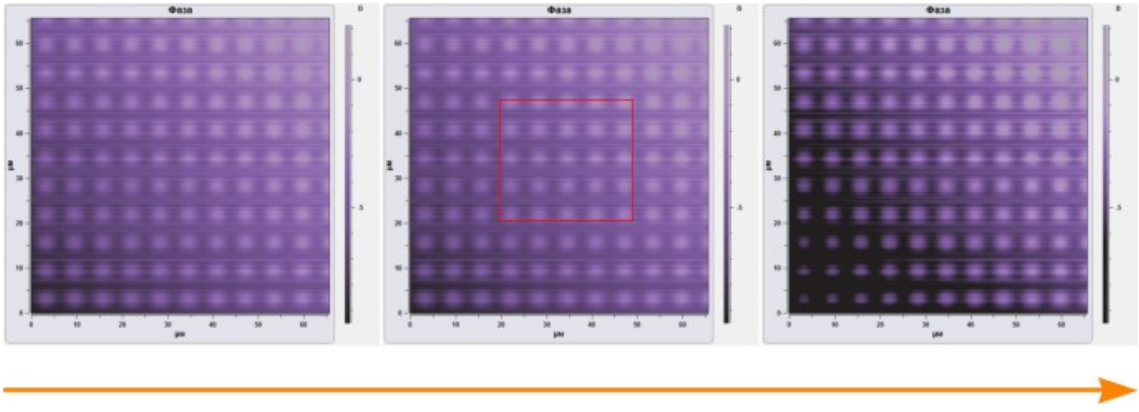


Fig. 3.44 Set Z range by selection usage.

3.5.10. *Image pixel interpolation*

There are three modes of pixel interpolation in the program NSpec:

Nearest neighborhood.	Without interpolation.
Bilinear.	Bilinear interpolation.
Bicubic.	Bicubic interpolation.

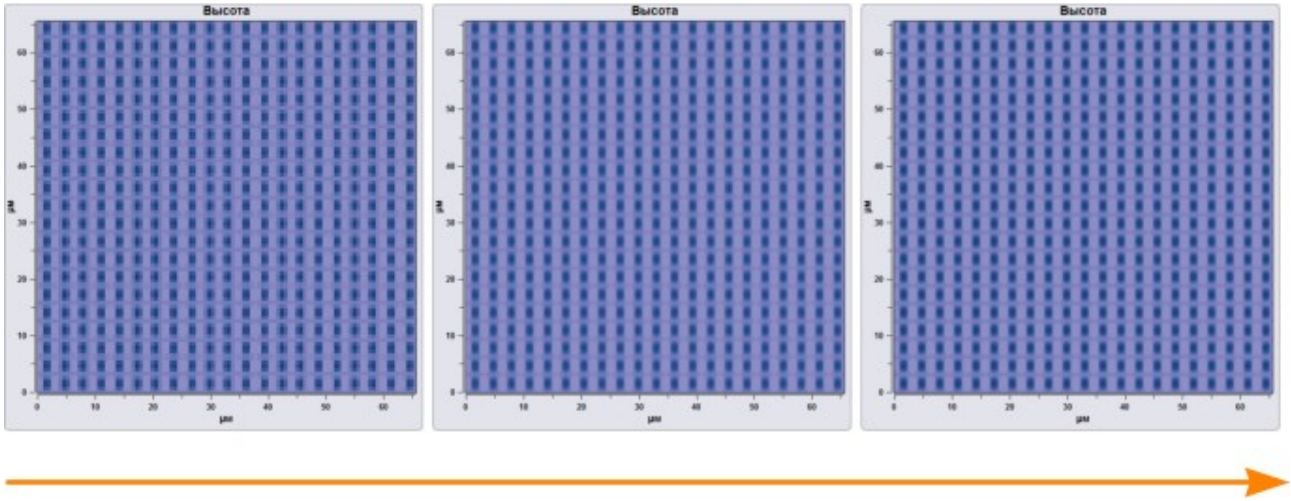


Fig. 3.45 Others interpolation method usage.

3.5.11. *Curves processing tools*

The tool group is intended for work with several curves in the field of display 2D plots.

*1	List of available curves.
Delete all curves	Delete all displaying curves.
Delete current curve	Delete the current curve, that is selected in the list.
Copy curve to the buffer	Add current curve to the available curves list. At curve addition serial number is appropriated. To attach curve to the default tab select curve number in the list and **Send to Data** button. To save all curves select “All”. Current curve names ***1.**
Line color	Color selection of active curve.

Line thickness	Select line thickness.
Font size	Select size of font on the plot.

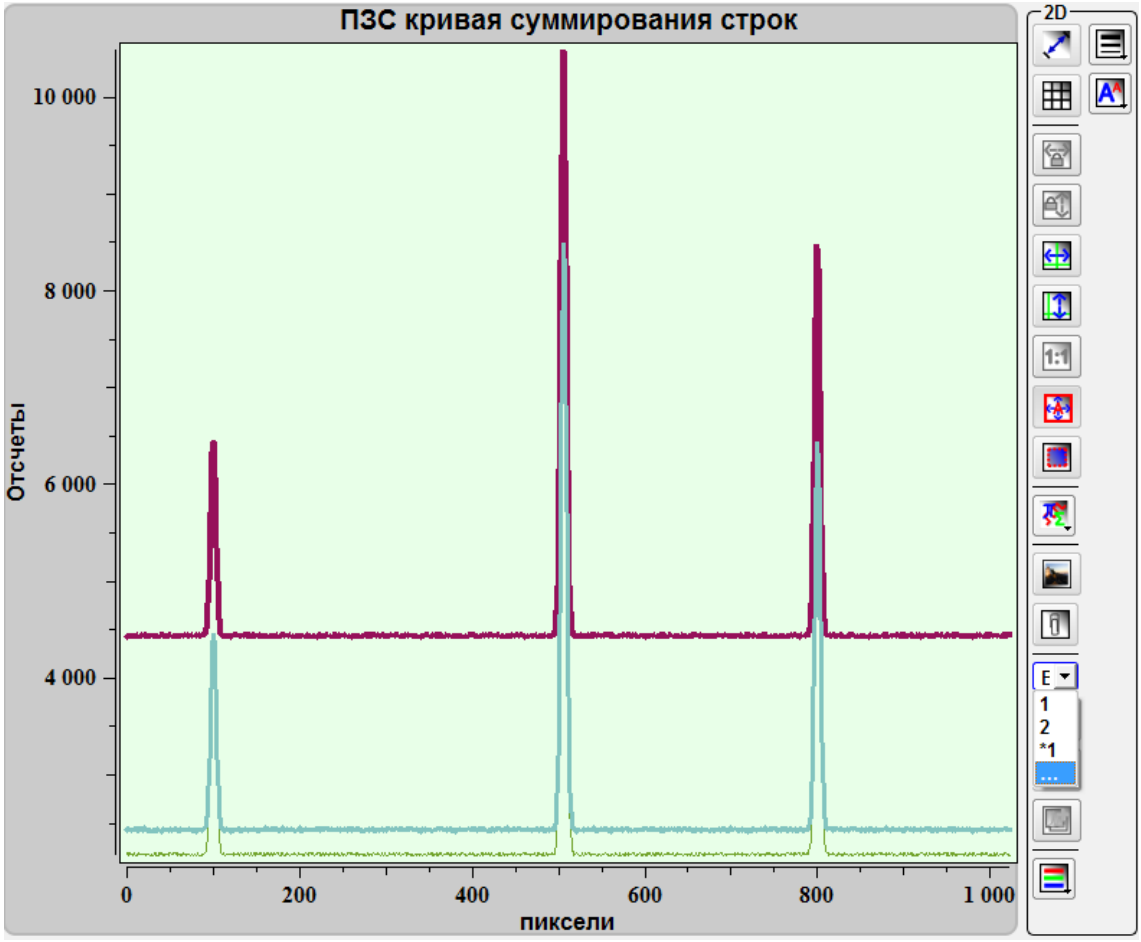


Fig. 3.47 Several 2D curves and its list.

3.5.12. Image 3D showing

To create 3D view select the image in a tab and press the button **Show 3D view**  . The image planar view will 3D view. At switching between images in this mode all images will be displayed in 3D. To exit from the 3D mode press the button  repeatedly**.**

To rotate the image press and hold the left mouse button and move mouse. Thus the image will be rotated corresponding to mouse movement.

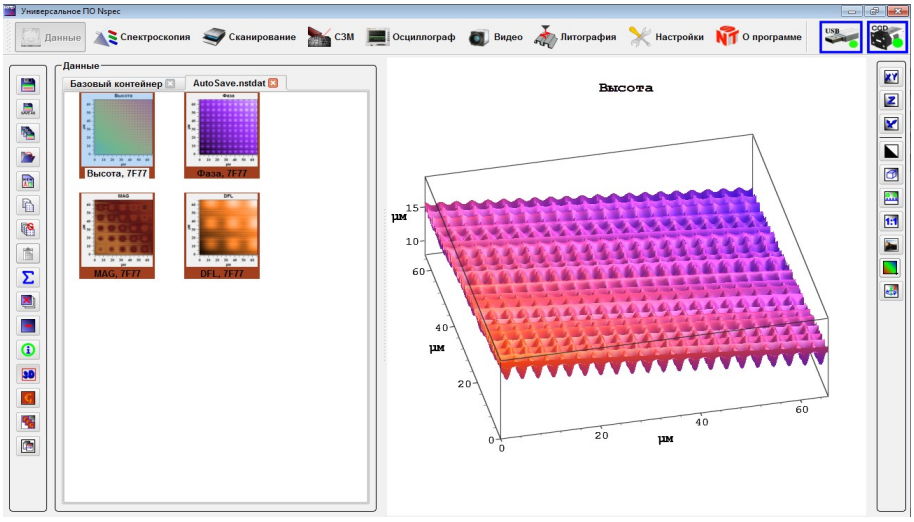


Fig. 3.48 3D view mode.

	Scale XY axis	By pressing the button and mouse up/down moving over the image XY scale will be change.
	Scale Z axes	By pressing the button and mouse up/down moving over the image Z scale will be change.
	Move image	Press this button and move image.
	Invert background	Image background switching before black and white.
	Show box	Show box around 3D image.
	Show graph scale	Toggle graph axes.
	Restore scale	Restore initial scale.
	Save image as	Save image to a hard disk in *.png, *.jpg, *.tiff, *.bmp format by standard dialog.
	Palette	Choice the palette.
	Auto rotation	Toggle auto rotation of 3D image around the vertical axes.

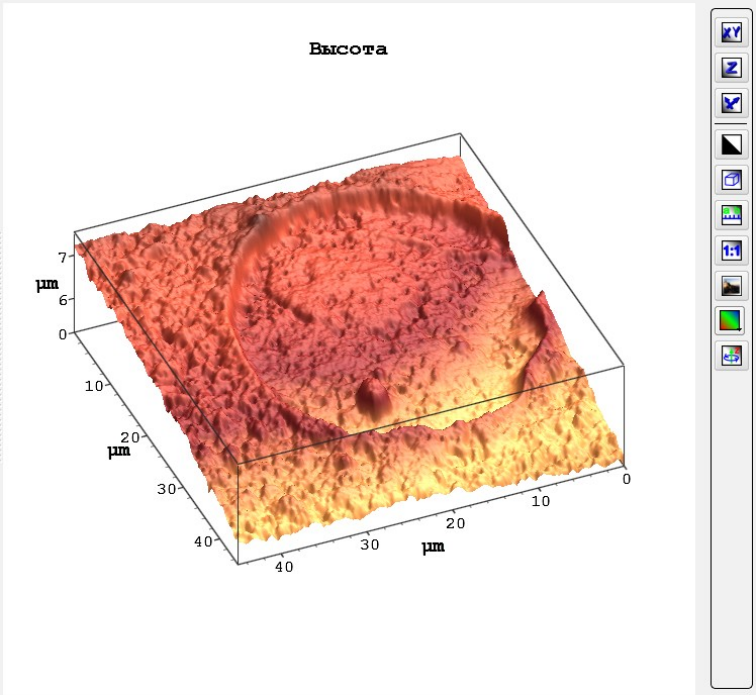


Fig. 3.49 Displaying axis and box.

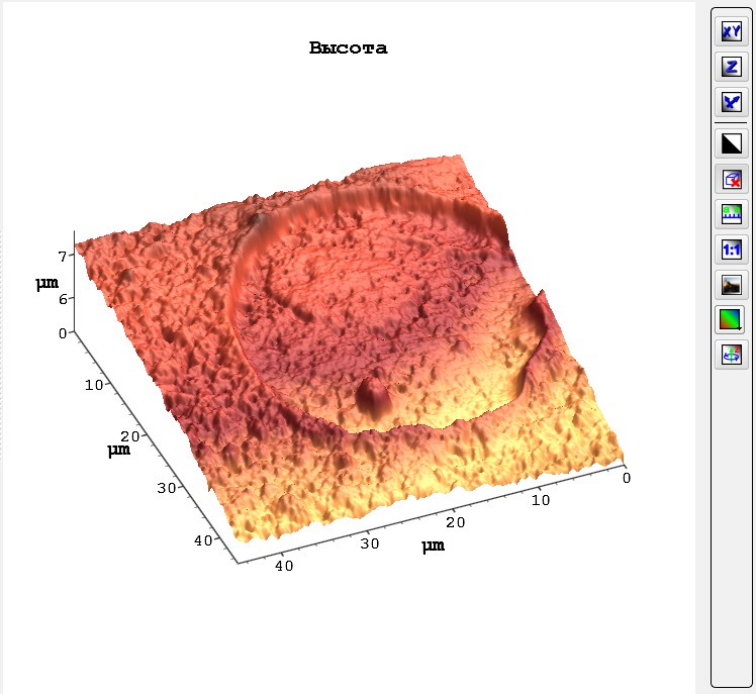


Fig. 3.50 Displaying only axis.

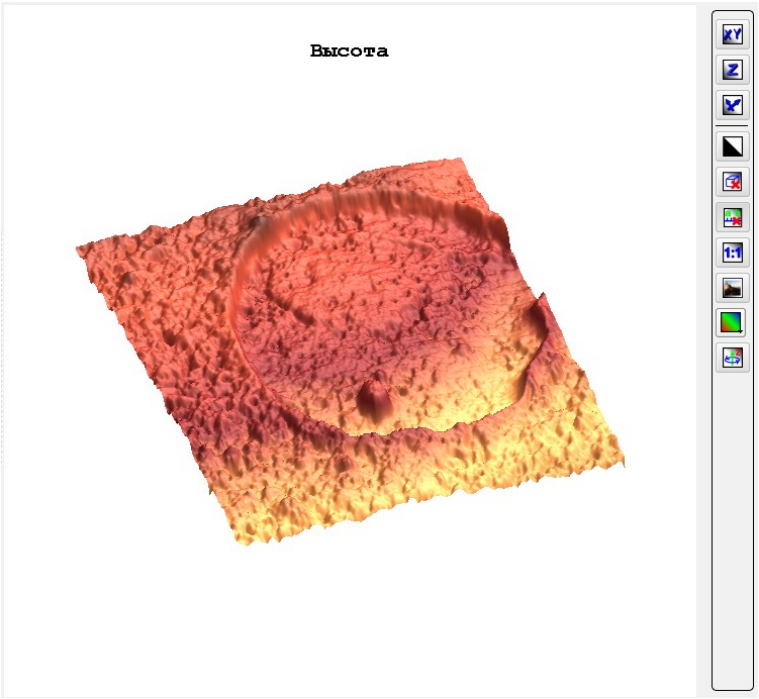


Fig. 3.51 3D view without axis and box.

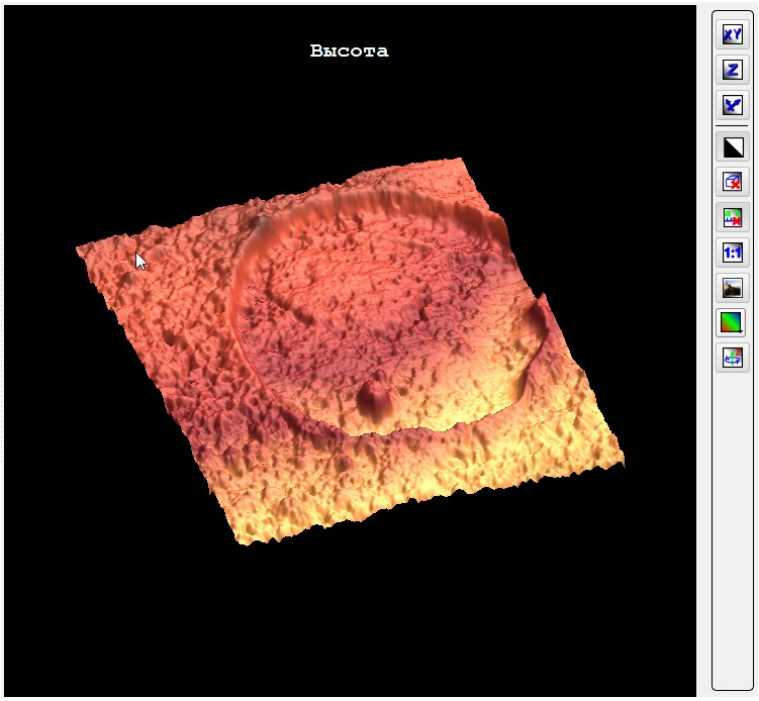


Fig. 3.52 Inverted background color.

3.5.13. *Working with spectral images*

For work with spectral images the following tooling is used:

		Convolution	Choice of a way of construction of the image on the basis of the spectral data. It is displayed only at work with spectral images.
		Integral	Image construction on integral of intensity from the received spectra in the chosen range.
		Maximum	Image construction on intensity maximum from the received spectra in the chosen range.
		Maximum position	Image construction on intensity maximum position from the received spectra in the chosen range.
		Mass center position	Построение изображения по положению на поверхности центра масс максимумов спектров.
		Convolution function range selection	Select range of specter curve to construct image. It is displayed only at work with spectral images.
		Display units	Physical units of spectral images X axes оси X – wavelength (nm), Raman shift (cm^{-1}) or pixels (corresponding to CCD pixels). It is displayed only at work with spectral images.
		Спектр из точки изображения	Отобразить спектр в выбранной точке изображения. Данная функция отображается и работает только при работе со спектральными 4D изображениями. Для отображения спектра из точки изображения необходимо нажать на эту кнопку, навести курсор на изображение и нажатием левой кнопки мыши указывать точку для которой необходимо отобразить спектр.

This tools are required to 4D spectral images visualization (intensity by XY position and wavelength). To construct an image from a 4D data array require to select the convolution function range  . After pressing this button under the spectral image the window for spectra and a range of convolution function will be displayed. For moving and changing the range guide the mouse cursor at the range and having pressed the left mouse button move the range on the spectrum or guide the cursor at borders of the range and having pressed the left mouse button expand or narrow the range.

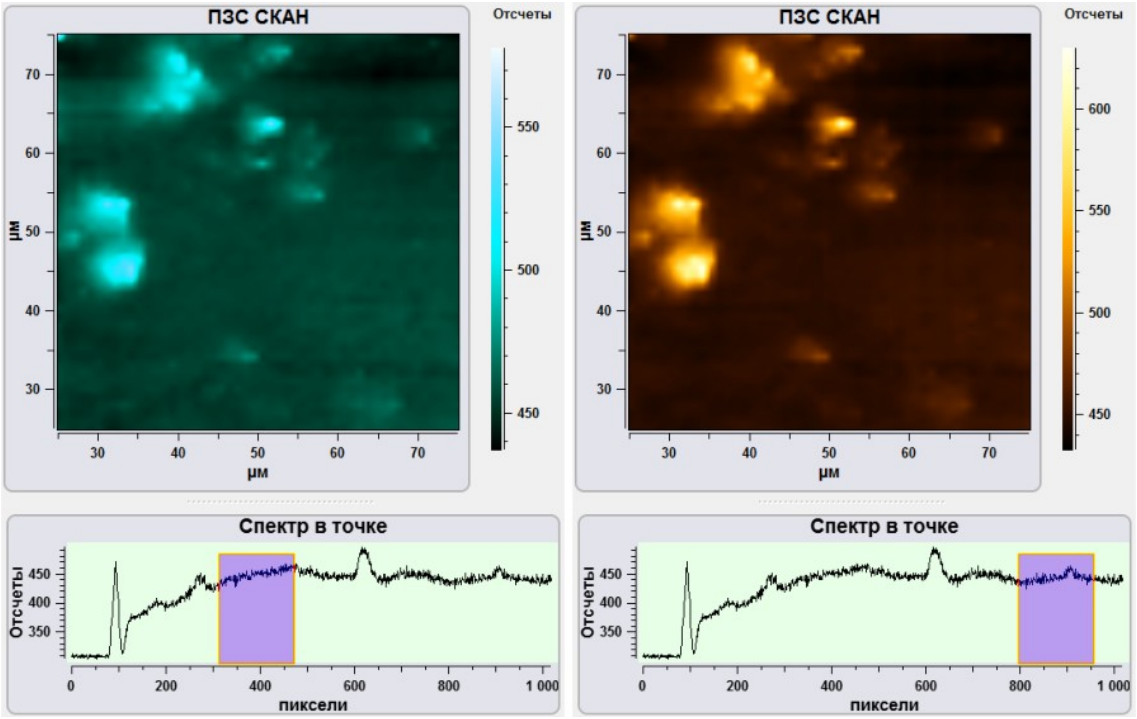


Fig. 3.54 Changing convolution function range.

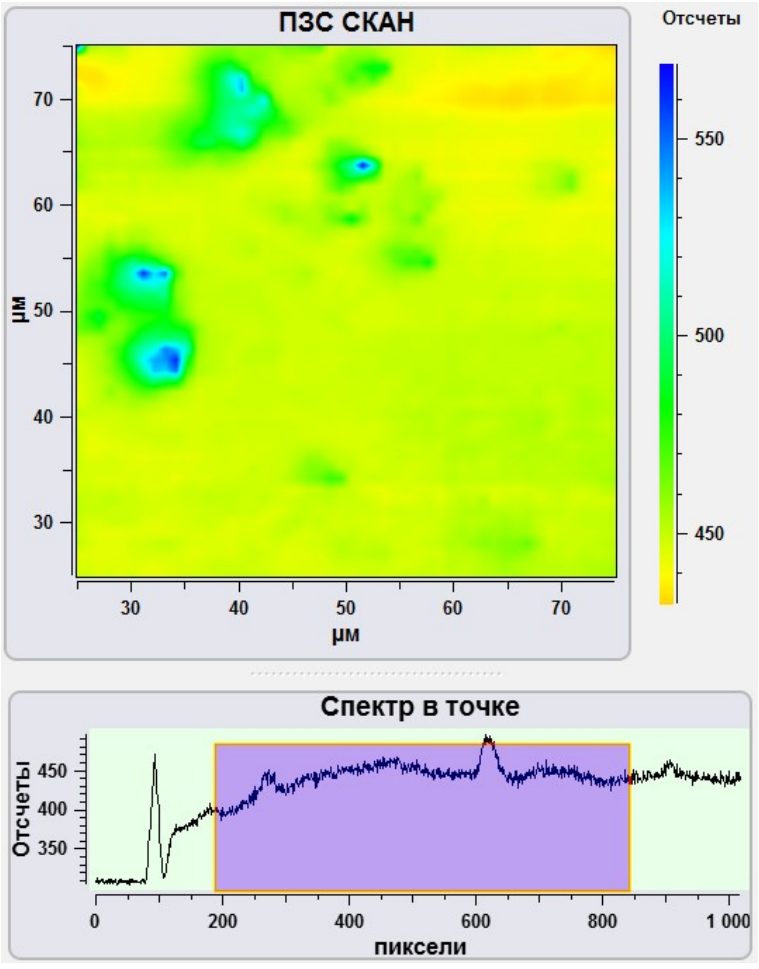


Fig. 3.55 convolution function range expansion.

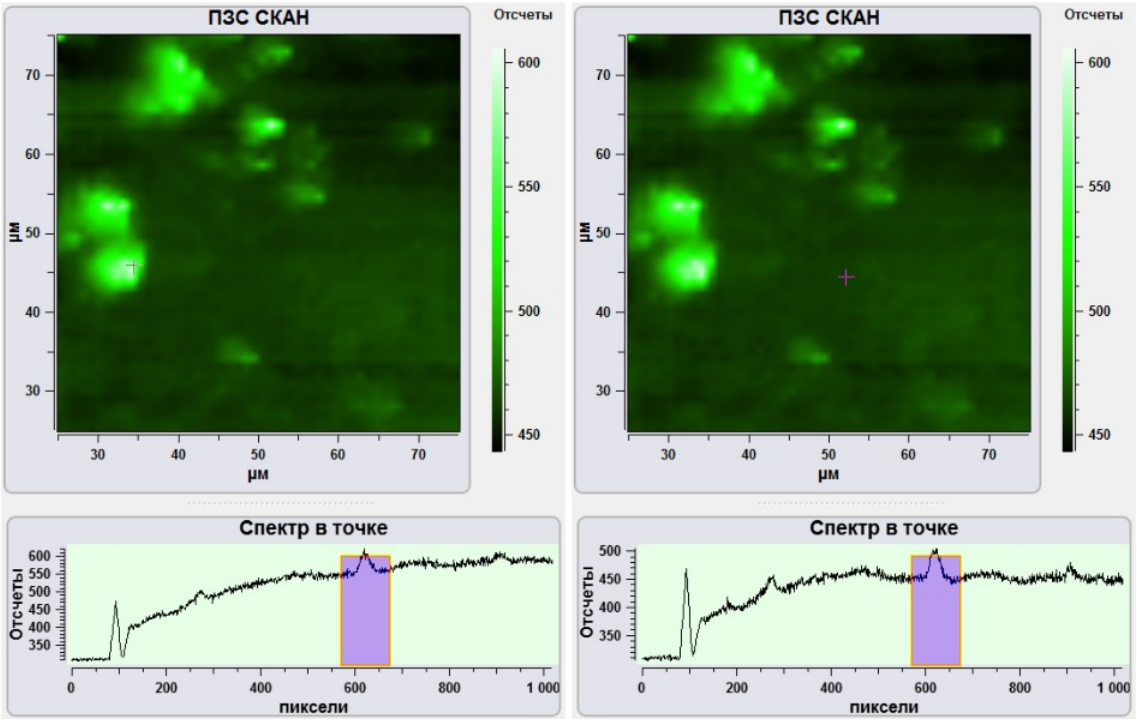


Fig. 3.56 Spectra in other points .

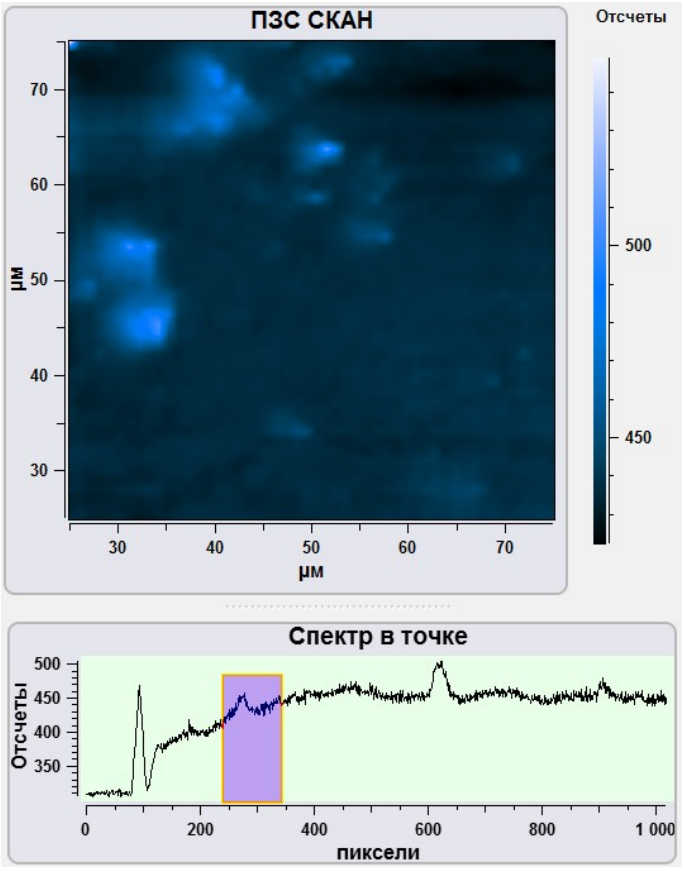


Fig. 3.57 Spectrum by integral of intensity from the received spectra in the chosen range.

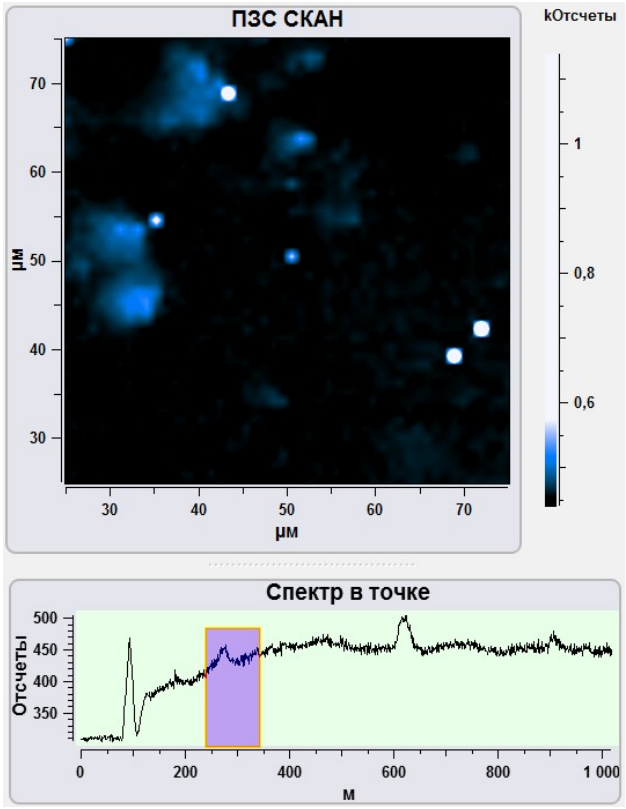


Fig. 3.58 Image construction on intensity maximum from the received spectra in the chosen range.

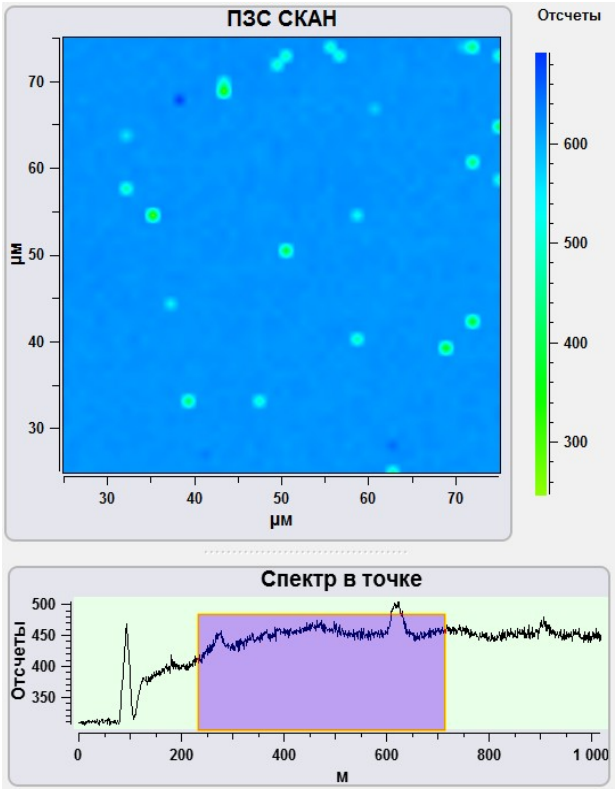


Fig. 3.59 Image construction on spectra intensity maximum position.

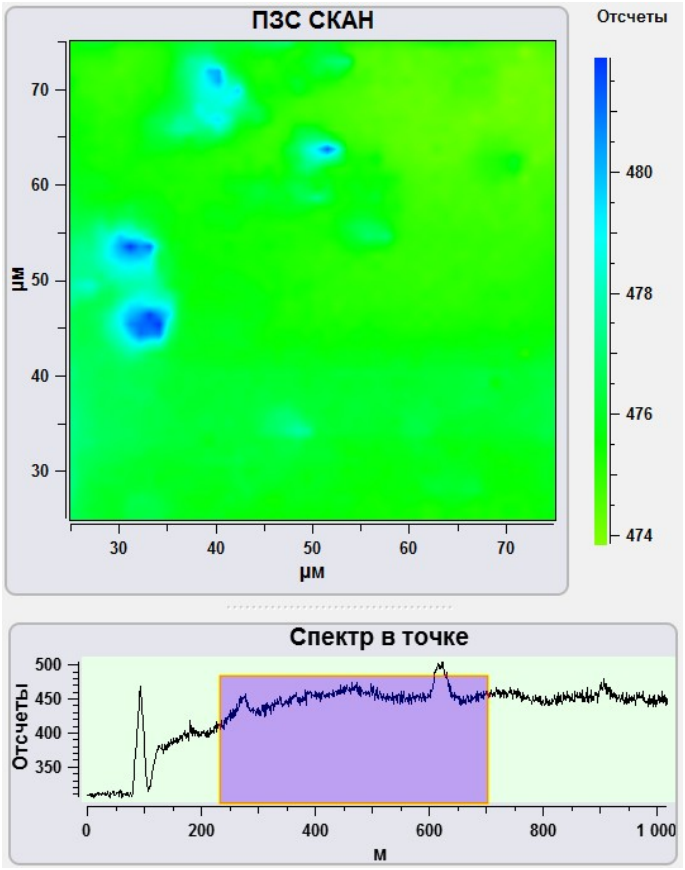


Fig. 3.60 Построение изображения по положению на поверхности центра масс максимумов спектров.

3.6. Images import and export

For data export to other data processing programs the following tools are used:

	Export data to Gwyddion.	Export current image data to Gwyddion (SPM data processing program). The Gwyddion program (extended together with program NSpec) is started. Selected data frame is automatically transferred to program Gwyddion.
	Export tab to Gwyddion.	Export data from current tab to Gwyddion. The Gwyddion program is started. All data from the tab is automatically transferred to program Gwyddion.
	Export to ASCII	Save data in ASCII file.

3.6.1. Data export to Gwyddion

In program Gwyddion extended together with program NSspec, the unit for import of the processed images from Gwyddion in NSpec is built in.

	Send data back to NSpec	Import active image data back to Nspec Default tab from Gwyddion.
	Send graph data to back to NSpec	Import active graph data back to Nspec Default tab from Gwyddion.
	Send all data to back to NSpec	Import all data back to Nspec Default tab from Gwyddion.

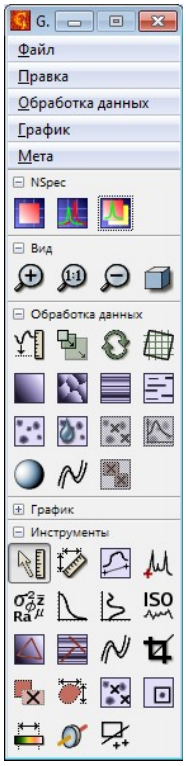


Fig. 3.61 NSpec unit in the program Gwyddion.

3.6.2. Export in ASCII file

Any active data – curves, graphs, scans and spectra can be imported from the unit **Data** to an ASCII file by the button  . Standard file save dialog will be opened.

3.7. Clear data

In case of buffer overflow of program NSpec at work in the unit **Data** it is recommended to use the button  for clearing of the program buffer.

4. Video unit

The optical microscope with CCD matrix is built in Certus Standard, Certus Optic I/U, Centaur (HR) I/U, Certus NSOM devices. **Video** unit of program is designed for configuration and working with this video cameras

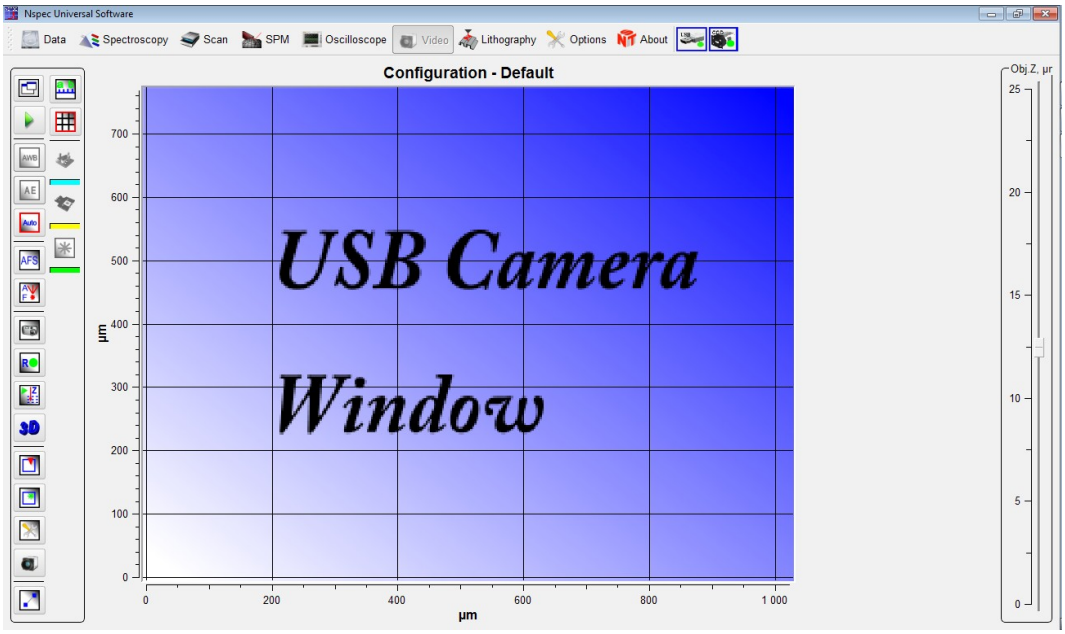
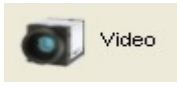


Fig. 4.1 Video unit.

4.1. Video unit basic functions

For entering Video unit press the button 

on the top panel, после этого кнопка примет вид 

и на экране отобразится общий вид модуля видео (Fig. 4.1).

	Start/stop	Start/stop CCD camera video imaging.
	Automatic white balance	Enables automatic white balance adjustment. Repeated pressing of the button disables this.
	Automatic exposure	Enables automatic exposure adjustment. Repeated pressing of the button disables this.
	Autoadjustment	Enables automatic white balance and exposure adjustment. Repeated pressing of the button disables this.

		Autofocus by image	Enables automatic focusing by image. Lens Z position is controlled by the slider Obj. Z.
		Autofocus by laser spot	Automatic focusing by maximum reflected laser. Enabled with only Centaur device. Данная функция работает только на комплексах Centaur (HR) с установленной однокоординатной подвижкой Vectus и при включенном источнике лазерного излучения. Подробный алгоритм работы с автофокусировкой по лазеру дан в руководстве по эксплуатации для комплексов Centaur. Положение объектива по оси Z управляется вертикальным слайдером Obj.Z.
		Save image	Saving current CCD image in the raster format file.
		Start recording	Recording CCD video in *. avi file.
		Show tip scan area	При нажатии на эту кнопку на изображении отображается поле сканирования зондом и поле сканирования основанием. Данные поля соответствуют диапазону сканирования установленных в приборе сканеров и могут иметь разные размеры.
		Show laser scan area	При нажатии на эту кнопку на изображении отображается поле сканирования образцом относительно фокуса лазера.
		Settings	Lenses settings.
		Measure distance	Distance measurement by video image. It makes sense when only the lens has a calibration.
		Show axes	Enables axes on the video image. It makes sense when only the lens has a calibration.
		Show grid	Enables grin on the video image.

Fig. 4.2 Scan by probe area selection demonstration  .

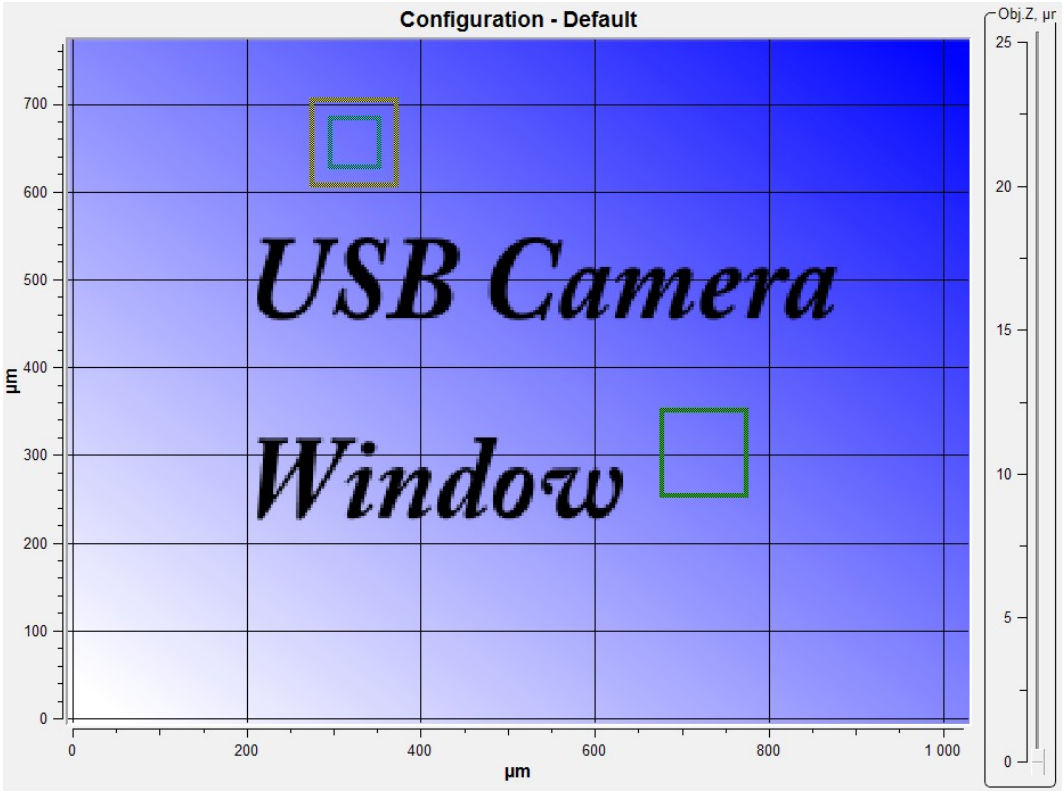


Fig. 4.3 Scan by laser area selection demonstration  .

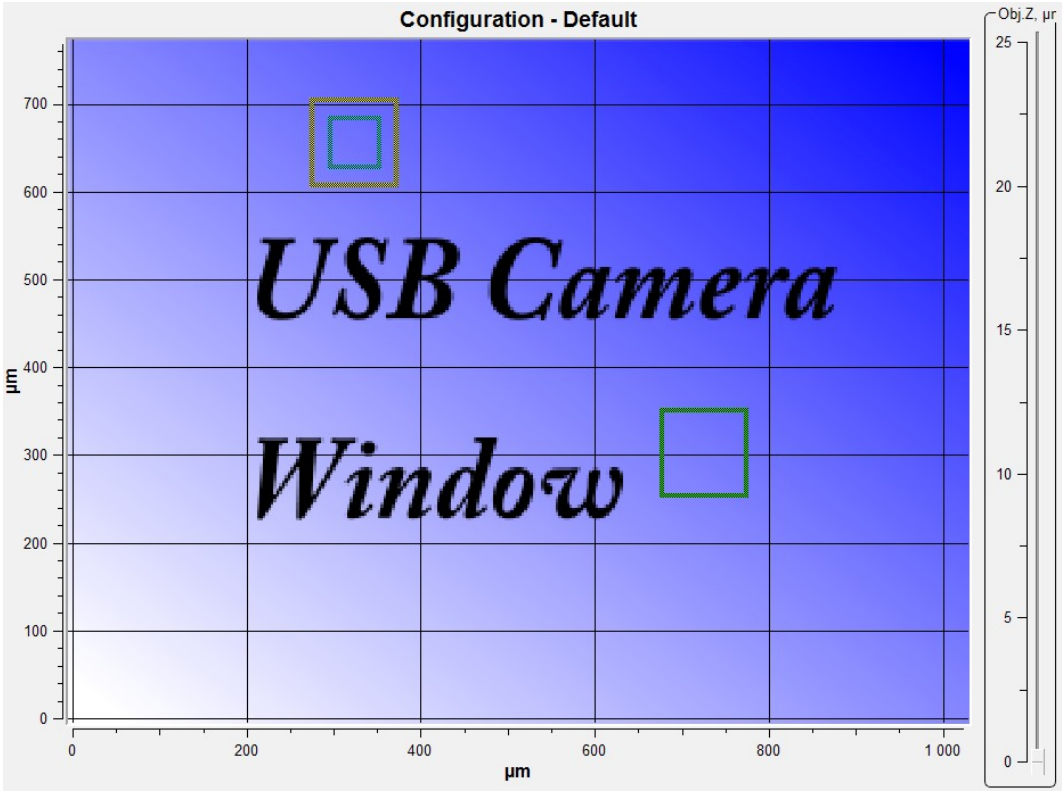


Fig. 4.4 Scan by probe and by laser area selection demonstration  and  .

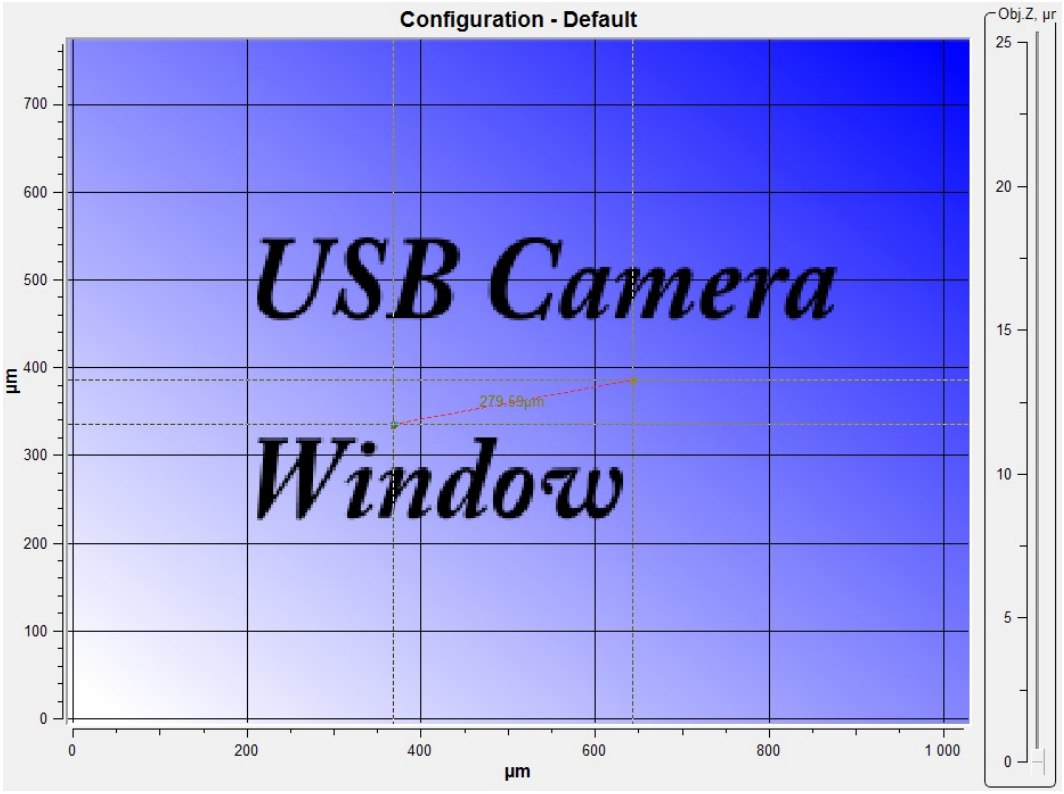


Fig. 4.5 Measuring tool  .

Each scan area has its own color. Scan area by SPM head has the blue. Scan area by stage has the yellow.

Fig. 4.6 Color indicators of scanning area.

To disable the axes press the button  .

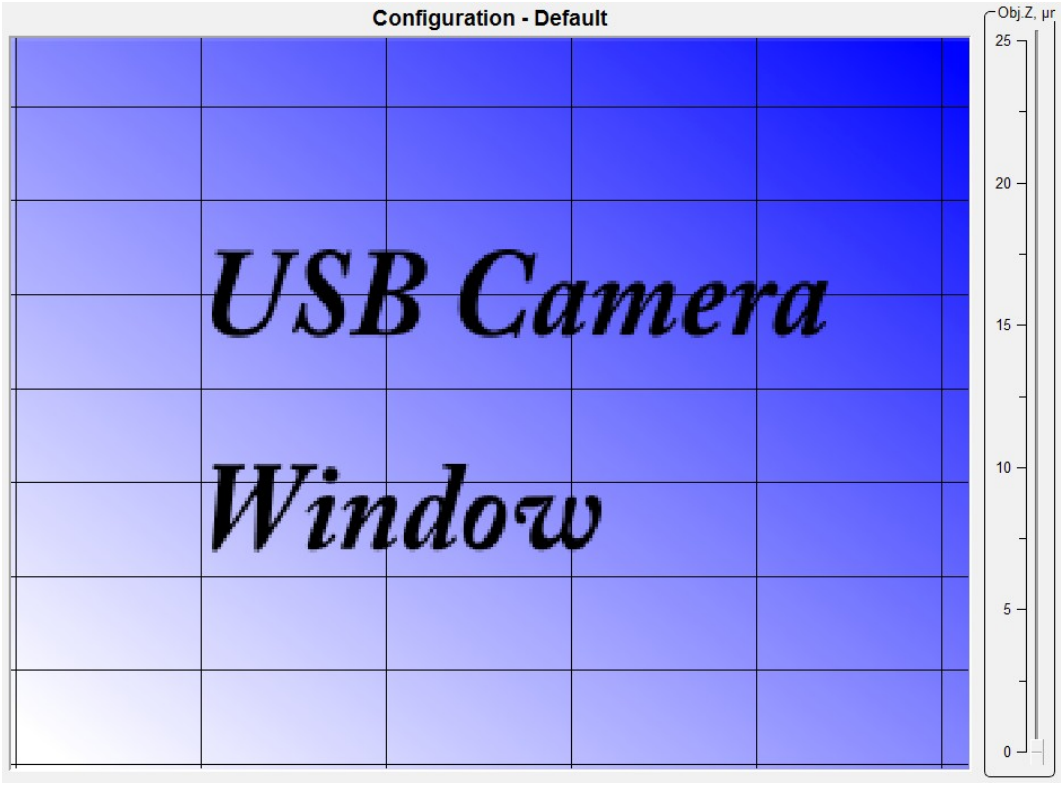


Fig. 4.7 Video without axes.

To disable the grid press the button  .

Fig. 4.8 Video without axes and grid.

4.2. Lenses calibration

Work with devices and complexes form company «Nano Scan Technology» means possibility to use various lenses of various manufacturers. As lenses have various characteristics, such as the zoom, focal length and work distance, it is necessary to spend adjustment for each used lens. Lens adjustment includes calibration on the test sample and combination of scanning fields of SPM with the optical image.

4.2.1. Settings panel main functions

For lens adjustment or configuration changing press the button **Settings**  . The panel of options will be displayed.

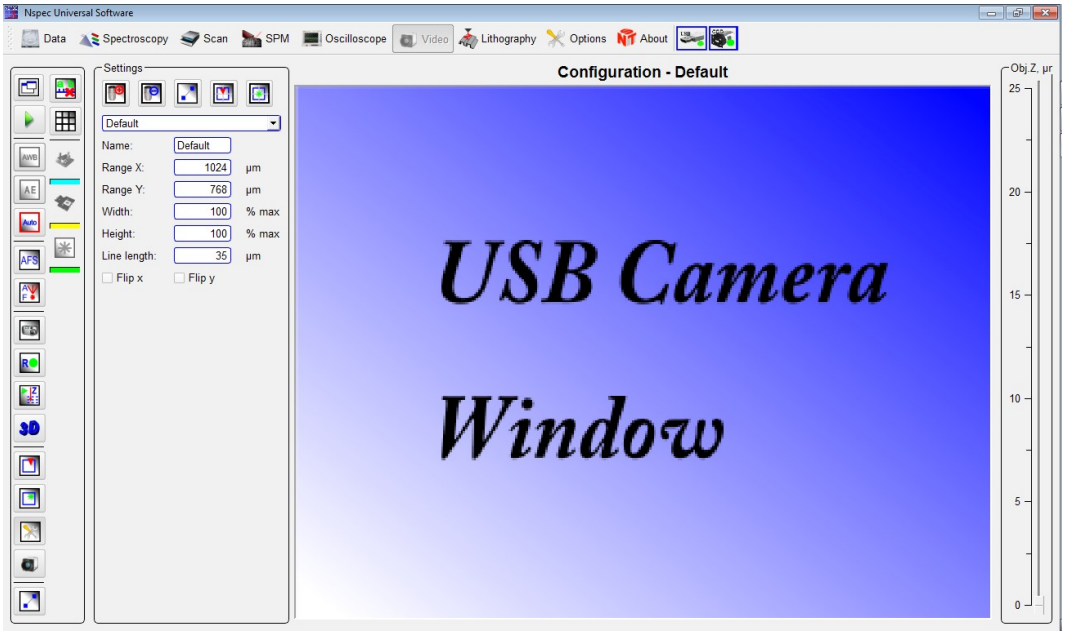


Fig. 4.9 Video with lens settings panel.

		Add new configuration	Creates new lens configuration
		Remove current configuration	Remove current lens configuration
		Measure reference	Tool for measuring reference length. The reference length is entering in the Line length field.
		Tip scan area center alignment.	The scan areas by tip and by stage are shown on the video image. By mouse clicking scan area center moves to mouse point.
		Laser scan area center alignment (not available in Certus Standard)	The scan areas by stage are shown on the video image related to laser spot. By mouse clicking scan area center moves to mouse point.

4.2.2. Tools panel Settings

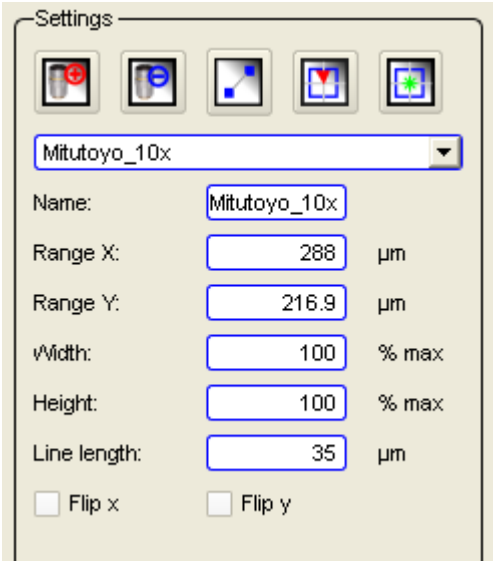


Fig. 4.10 Settings panel

Combo box with available configurations.	The list of available configurations is enumerate in the combo box.
Name:	Current configuration name. Name of new configuration is entered here.
Range X:	X axes field of view size
Range Y:	Y axes field of view size
Width	Width of the image in percentage of width of a matrix
Height	Height of the image in percentage of height of a matrix
Line length	The field to enter the reference size of the test structure.
Flip X.	Horizontal image flip.
Flip Y.	Vertical image flip.

4.2.3. New lens calibration

For new lens calibration it is necessary to focus on the test sample surface and produce following steps:

- Press the button Add new configuration  ;
- Enter the configuration name;
- Enter reference size of the test structure;
- Using tool **Measure reference**  select reference structure on the video image. Irrespective of a numerical ruler length on the image its length will make a preset value and all axes will be calibrated according to set the reference.

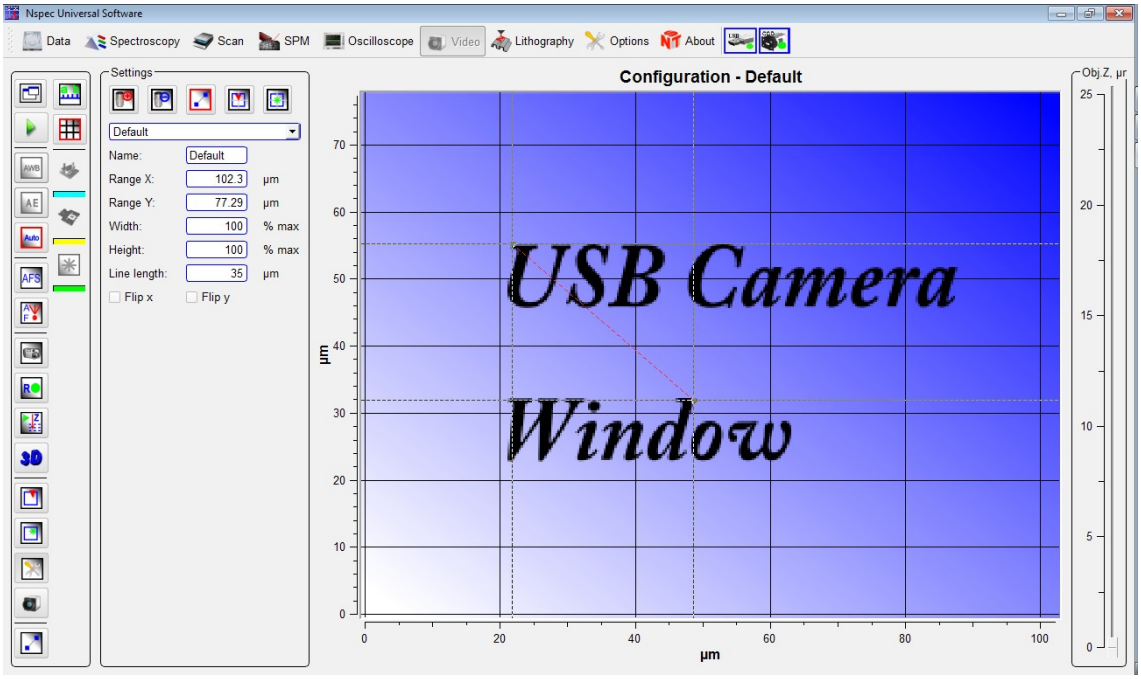


Fig. 4.12 Creating new lens configuration.

After input of the reference size and its choice on the image there will be a change of axes scale of the image according to the reference size.

4.2.4. Scan field selecting

After lens calibration and creation of a new profile it is possible to spend combination and/or installation of fields of scanning. For this purpose it is necessary to press the button **Tip scan area center alignment**  and having clicked on object on the video image to define a scanning field center. The sizes of scan fields are set according to the sizes stored in the file of options.

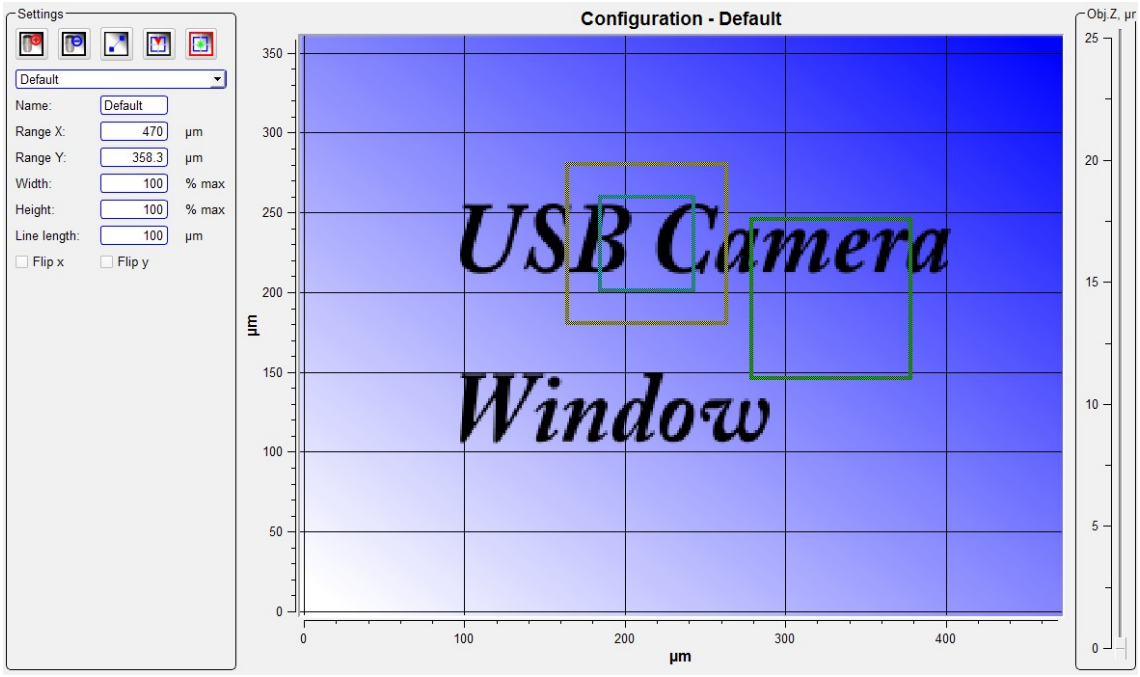


Fig. 4.13 Scan fields select.

5. SPM – scanning probe microscope adjustment

To entry **SPM** unit press the button 

, that is situated on the top panel of the NSpec window.

Key parameters of adjustment a scanning probe microscope are located in the **SPM** unit. In the **SPM** unit feedback parameters are set, stepper motor are controlled, scanning mode are set and etc.

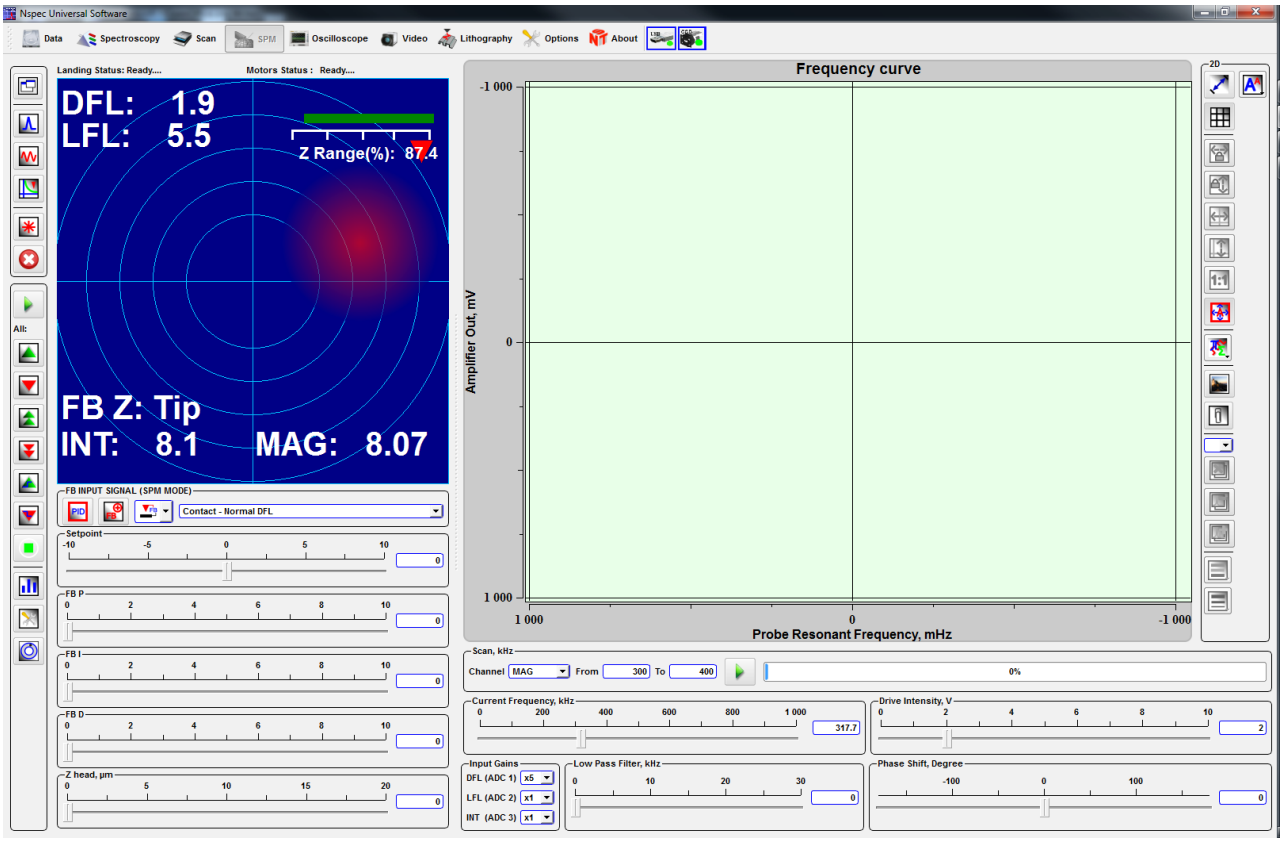


Fig. 5.1 **SPM** unit drawing.

5.1. Plot mode control

In the left part of a window there is a panel of **Plot mode control**. It is used for display resonant curve and others signals received by system from sensors and a digital microscope.

Fig. 5.2 Plot mode control.

	Frequency curve mode	A field of the probe amplitude-frequency curve is displayed in the right window part.
	Oscilloscope mode	An oscilloscope field is displayed in the right window part. There are average and RMS of selected signal values fields under oscilloscope curve.
	Spectroscopy mode	A land/lift curves, Z spectroscopy and spectroscopy parameters panel are displayed in the right window part.

5.1.1. Resonant curve acquisition

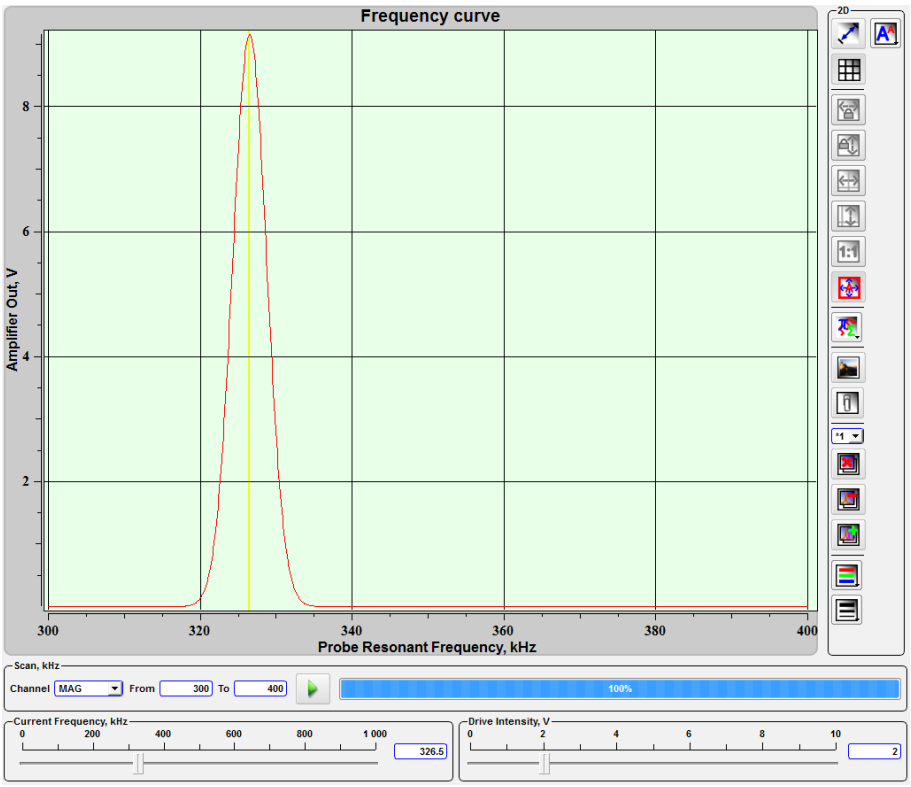


Fig. 5.3 Cantilever resonant frequency acquisition

The signal for plotting the frequency curve is selected in the **Channel** combo box on the **Frequency scan** panel. In the near fields the frequencies range is completely set. By default, in the **Channel** combo box is selected signal **Mag** used for reception of resonant frequency of probes.

Fig. 5.4 Signals available for the frequency curve.

The button  performs frequency scanning. The nearby progress bar shows scanning complete progress with percents. The current resonant frequency value is displayed on the **Current frequency** slider. It can be set in other value if necessary. The **Drive intensity** slider controls probe piezodrive output voltage.

5.1.2. Oscilloscope mode

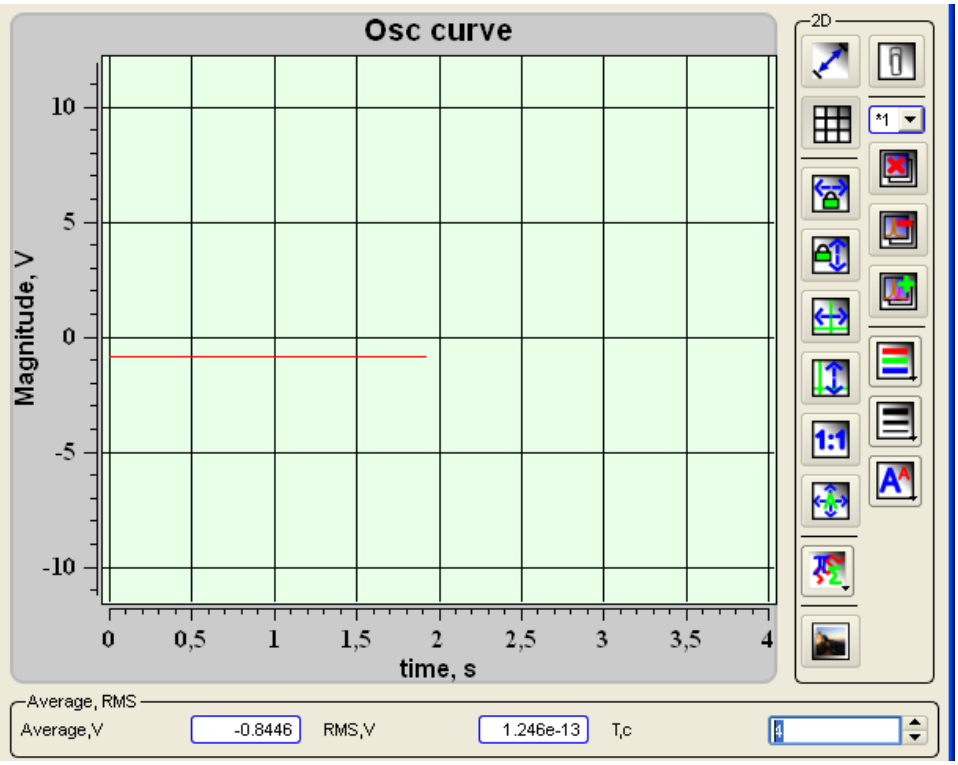


Fig. 5.6 Oscilloscope plot window.

An average value of the signal magnitude is displayed in the **Average, V** field. A root mean square of the signal is displayed in the **RMS, V** field. In the **T, s** field sets a time interval.

5.1.3. Land/lift curves

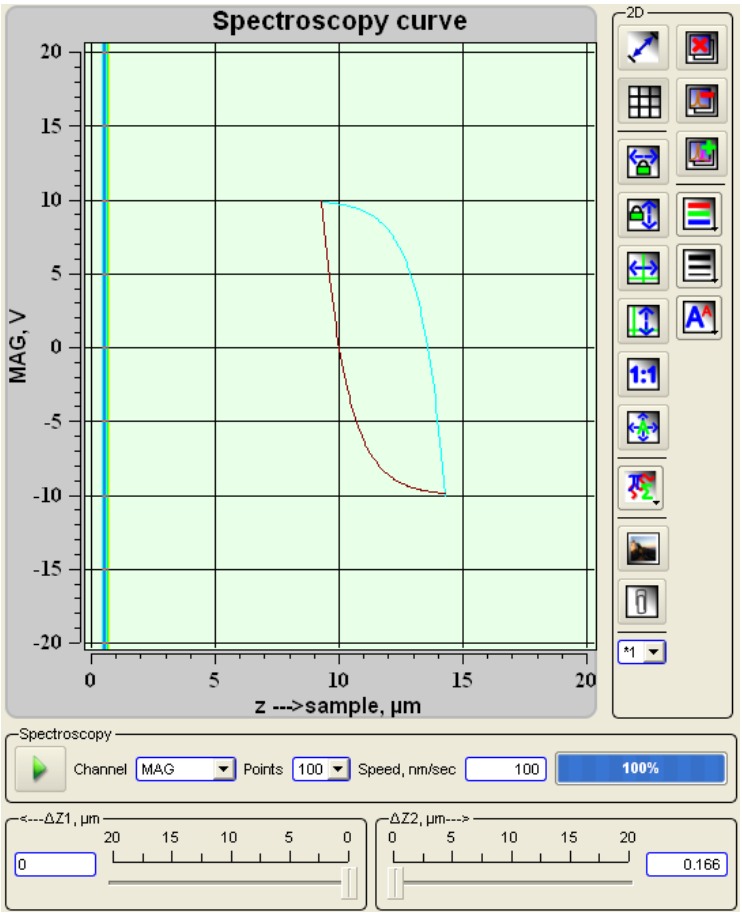


Fig. 5.7 Z spectroscopy curve.

The red strip displays current position of probe Z0, and two dark blue strips display limits of construction of a curve and correspond to positions Z0-Z1 and Z0+Z2. At construction the curve probe moves to point Z0+Z2 then moves downwards to point Z0-Z1, further it makes movement in the opposite direction and comes back to an initial position. The slider <--ΔZ1, µm sets start position Z0-Z1. The slider ΔZ2-->, µm sets final position Z0+Z2. It is also possible to set start and final position value in the fields nearby the sliders. After typing-in the number value from the keyboard press the button Enter Key.

In the **Channel** combo box it is necessary to selected signal for curve acquisition. The **Points** combo box sets a number of curve points. In the **Speed, nm/sec** field it is possible to set curve scanning speed. The button  runs curve acquisition process.

5.2. Probe Z position control

There is a probe Z position slider in the left upper corner of the SPM window for setting up current probe Z position. To set up Z probe position using keyboard type value in the input field and press Enter key.

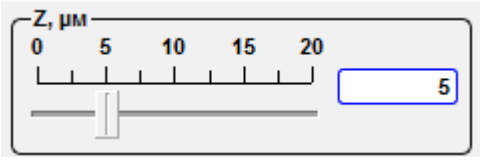


Fig. 5.8 Probe Z control slider.

5.3. The control of the stepper motors

There is a **Motors control** panel in the left part a window.

Fig. 5.9 Motors control panel drawing.

This instrument panel are used to control and operate with the stepper motors. The motors are utilized for automatic approaching the tip to the sample by moving down scanning head.

		Move up	By pressing this button movement of stepper motors upwards with the set speed on the set distance is carried out.
		Move down	By pressing this button movement of stepper motors downwards with the set speed on the set distance is carried out.
		Fast movement upwards to limit switch	By pressing this button movement of stepper motors upwards with the set speed to limit switch is carried out.
		Fast movement downwards to limit switch	By pressing this button movement of stepper motors downwards with the set speed to limit switch is carried out.
		Landing	By pressing this button automatic approaching is carried out.
		Step up	By pressing this button stepper motors perform one step up
		Step down	By pressing this button stepper motors perform one step down.
		Motor options	This button invokes motor options window
		Control for each motor	Switching in the each motor control mode. Not available with Certus Light device.
		Shuttle options	This button invokes remote control properties window.

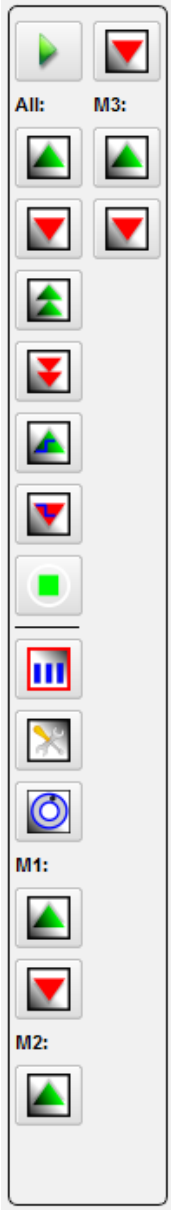


Fig. 5.10 Drawing of the motors control panel in the each motor control mode.

5.3.1. Stepper motors settings

By pressing the button  additional **Motors options** window is opened**.**

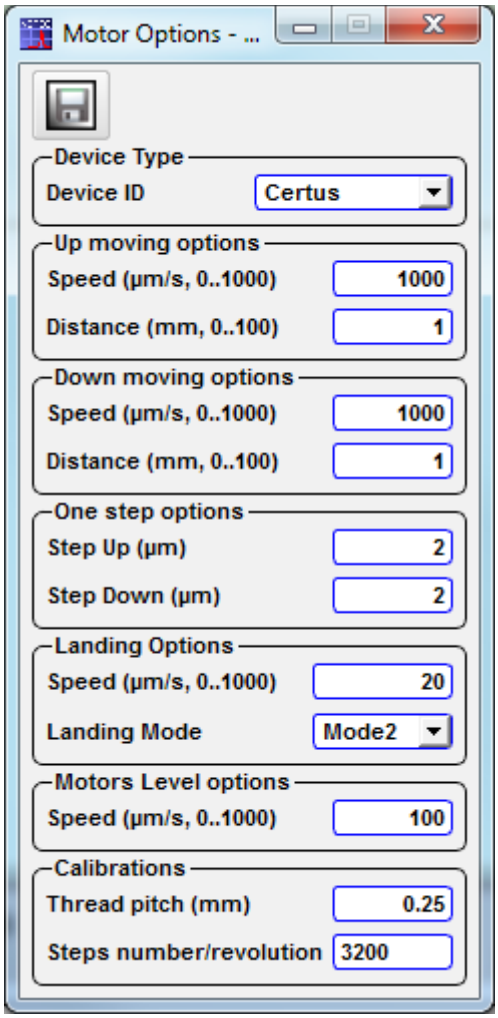


Fig. 5.11 Motor options window.

In the **Device type** combo box you can choose «Nano Scan Technologies Ltd.» microscope configuration that you have.

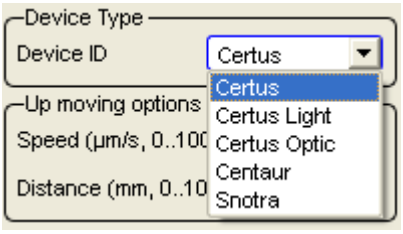


Fig. 5.12 Choosing microscope configuration.

In the **Up moving options** the **Speed** (up 0 to 1000 µm/s) and the **Distance** (up 0

to 1000 mm) for upward moving are set up. In a similar way set up options for downward moving. With **One step options** sets the values of the motors step in relevant directions for **One Step Up**  and **One Step Down**  button.

In the **Landing options** parameters of automatic approach by 

button are set up. **Landing mode** means:

Mode 1 – the approach is carried out by only one motor (rear motor, № 3);

Mode 2 – the approach is carried out by three motors.

The Speed (µм/сек, 0…1000) in the **Motor level options** means the motor speed when **Fast movement upwards (downwards) to limit switch** buttons pressed.

On the **Calibrations** panel parameters of stepper motor calibration are set. In the field the **Thread pitch** (mm) is set a thread pitch. In the **Step number** field is set full quantity of steps.

5.4. Remote control adjustment

The **Remote control**  button calls remote control adjustment window.

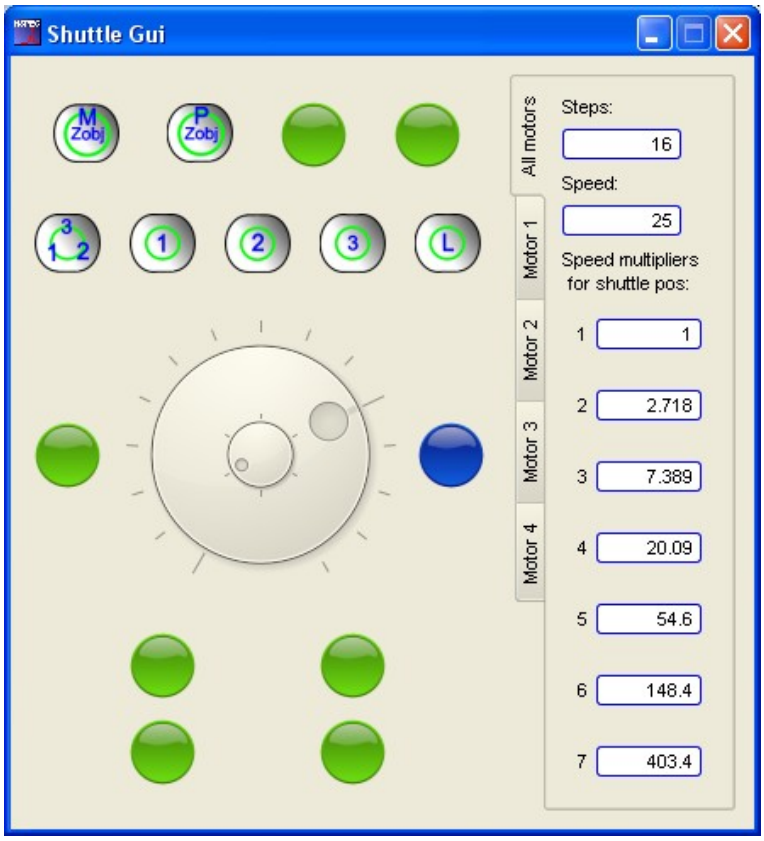


Fig. 5.13 Remote control GUI.

	Mechanical Z-mover motion	Shuttle controls lens mechanical mover.
	Piezo Z-mover motion	Shuttle controls lens piezo mover.
	Control 3 motors together	Shuttle controls stepper motors together.
	Control first motor	Shuttle controls stepper motors number 1
	Control second motor	Shuttle controls stepper motors number 2.
	Control third motor	Shuttle controls stepper motors number 3.
	Run approach	Start/stop head soft approach.
	Other functions keys	Keys for other device and functions controlling.

Tabs **All motors** and **Motor 1 ÷ 4** are contained control options by the joystick. **Steps** — number of steps on one turn of a wheel for stepper moving. **Speed** — number of steps in a second at turn of a shuttle for fast movement on the first position. S**peed Multipliers for shuttle positions-m**ultipliers on which speed increases at installation of a shuttle for fast moving by the chosen position.

For control from the program devices operated the joystick it is necessary to guide the cursor at a wheel of management (it is shown on the figures more low) and to move to the necessary position. For a stop of movement it is required to return a wheel of management in former position.

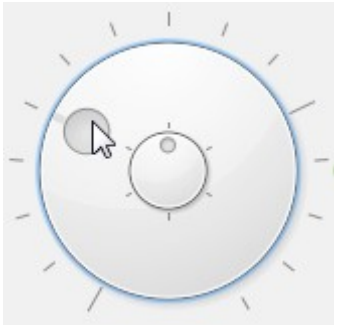


Fig. 5.14 Shuttle fast moving.

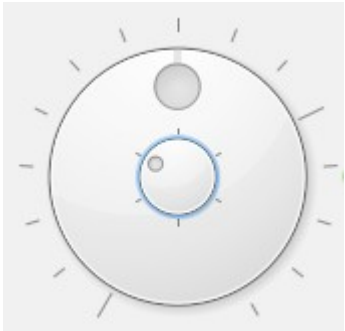


Fig. 5.15 Wheel for step-by-step moving.

5.5. Feedback parameters

The **Feedback** panel contains a field of display of laser reflected from a cantilever beam signal strength, elements of management of the laser, and also elements of management of feedback system.

On a blue field intensity of the laser reflected from a cantilever beam to the four-section photo diode is displayed by a red stain. Position of a stain in a midfield means that the stain from the laser is in the central part of the four-section photo diode, thus values of DFL and LFL signals have values zero or close to zero values.

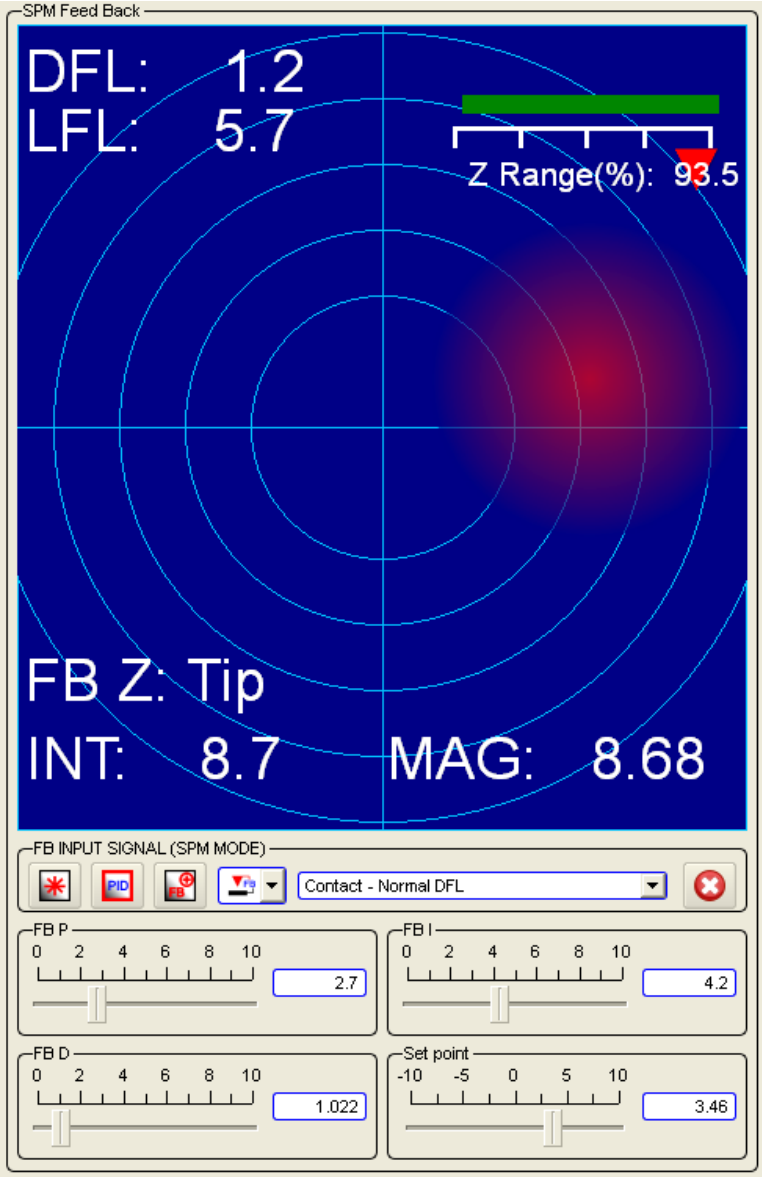


Fig. 5.16 SPM Feedback panel.

In the left bottom corner of the blue field the laser intensity signal **INT** is displayed. **INT** Value is comparable to the sizes of a red stain. **FB Z** means the device car-

rying out feedback (by scan stage or head). In the right bottom corner the **Mag** signal value is displayed. There is head scanner Z position bar in the right top corner. Green color corresponds to a safe approach of a probe, and red means that the probe is too close to the sample and there is a probe damage possibility.

	SPM laser on/off	SPM laser on/off button.
	Show PID parameters	The button causes displaying feedback Integral, Differential and Proportional components and Setpoint.
	Feedback sign	The button changes feedback sign.
	Feedback on/off	The feedback on/off switch button.
	Feedback by head/stage	Switching head/stage Z scanner for caring out the feedback.

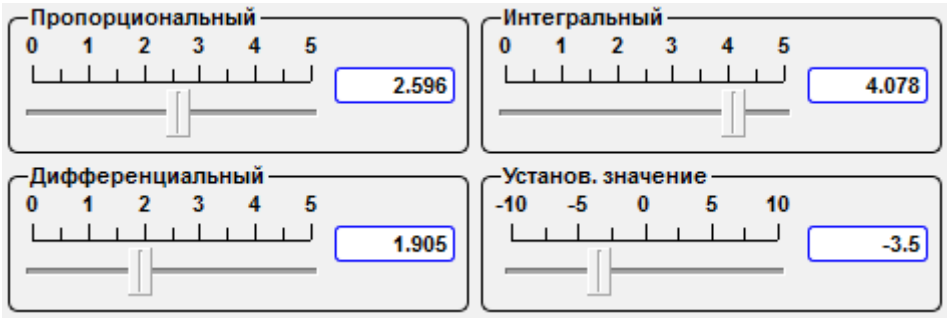


Fig. 5.17 Feedback parameters sliders.

In the drop-down menu the signal on which feedback, and a mode of scanning corresponding to it keeps is established.

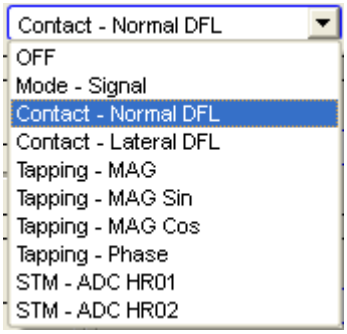


Fig. 5.18 Choosing feedback input signal.

The automatic landing state indicators are shown in this window additionally:

		Landing complete	The probe has landed to the surface.
		Move tip down/up	Launches landing or lifting the probe to the sample.
		Lower/upper limiter	Lower/upper limiter has reached.

When choosing microscope type Snotra in a stepper motors options menu it will be running in a resonance microscopy mode using quartz resonators – Tuning-fork (TF mode).

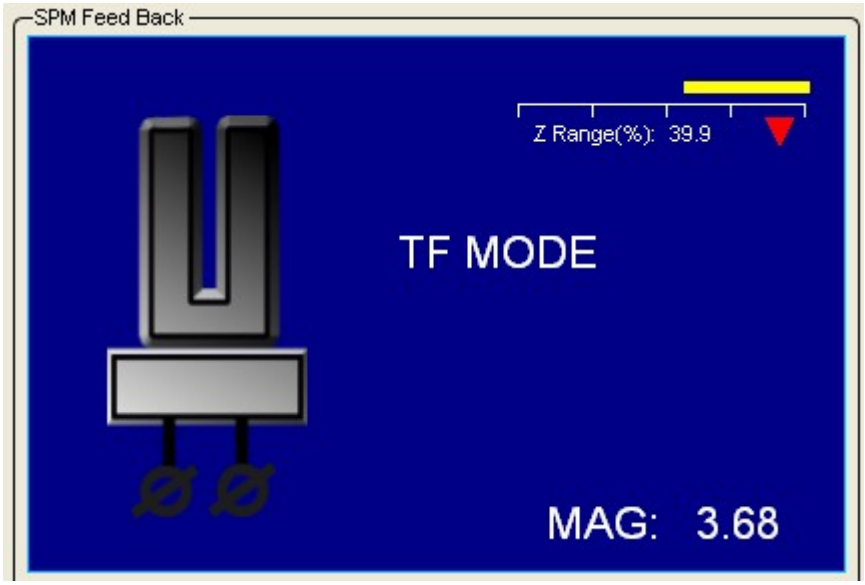


Fig. 5.19 Switching in a resonance microscopy mode using quartz resonators.

5.6. Additional scan parameters

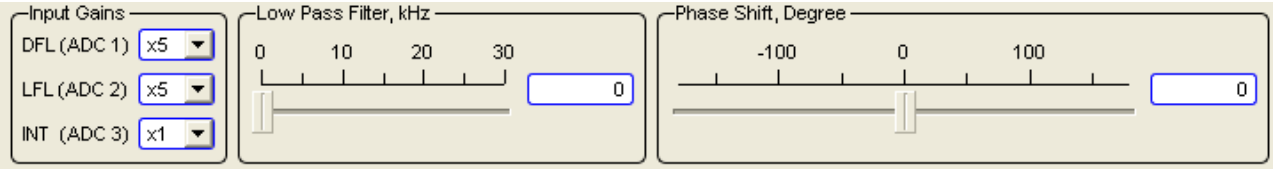


Fig. 5.20 Additional scan parameters panel.

Gain factors for the **DFL, LFL, Int** signals are established in the corresponding combo box. The frequency of the **low-pass filter** are established by corresponding slider and entry field. The **phase shift** for lock-in phase detector are established by corresponding slider and entry field. It is also possible to set the value in the fields nearby the sliders. After typing-in the number value from the keyboard press the Enter Key.

6. Scan - окно получения растровых 3D изображений

In the **Scan** unit scan key parameters, such as number of image points, its sizes, a scanning direction, scanning speed and others, are presented. Four fields for displaying of the received data are located in the central part of the **Scan** unit.

To entry **SPM** unit press the button 

, that is situated on the top panel of the NSpec window.

Fig. 6.1 Scan unit drawing.

There are four graphic frames in the central part of the window, that shows accumulated data while scanning.

In the left top corner of the **Scan** unit there are two tabs – **Head scan, Stage scan**. By switching this tabs you choice the corresponding device to perform scanning. Stage scanning is possible, if your complex has the scanning stage option. In minimal SPM complex there is no scanning stage.

6.1. Adjustment of scan parameters

To establish scan parameters **Scan** and **Feedback** tabs are used.

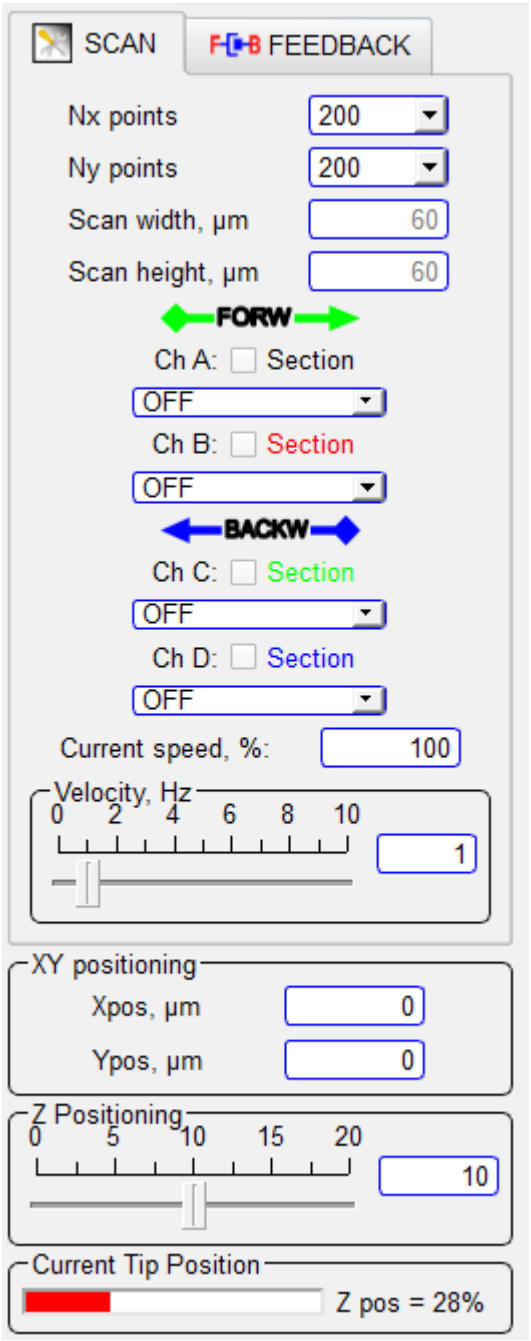


Fig. 6.3 Scan parameters.

Nx size		Points number of in X scan direction.
Ny size		Points number of in X scan direction
Scan width, µm		Scan width in µm. Scan width and height field are active only when the **Area selection**  button has pressed.
Scan height, µм		Scan height in µm. Scan width and height field are active only when the **Area selection**  button has pressed.
Channel A and B		The signals received in forward scan direction are selected in the combo box 
Channel C and D		The signals received in backward scan direction are selected in the combo box 
Section		The check box for cut section construction for relevant channel. The title color is relevant to the cut section color.
Velocity, Hz		The slider sets a scan velocity. A scan velocity value also can be set in the edit field near the slider (press Enter key after changing the value). Above the Velocity slider scan complete percents are displayed.
	Lift mode	Enables double-pass scan techniques.
		Disables double-pass scan techniques.
	Directions	Combo box for scan direction choosing. The arrow means fast scan direction.
		Along X axes, from upper left corner.
		Along Y axes, from upper left corner.
		Along X axes, from upper right corner.
		Along Y axes, from upper right corner.
		Along X axes, from lower left corner.
		Along Y axes, from lower left corner.

	Along X axes, from lower right corner.
	Along Y axes, from lower right corner.

By pressing the Feedback tab occurs feedback control panel opening. On it are displayed sliders of feedback **Integral**, **Differential** and **Proportional** component and **Setpoint.**

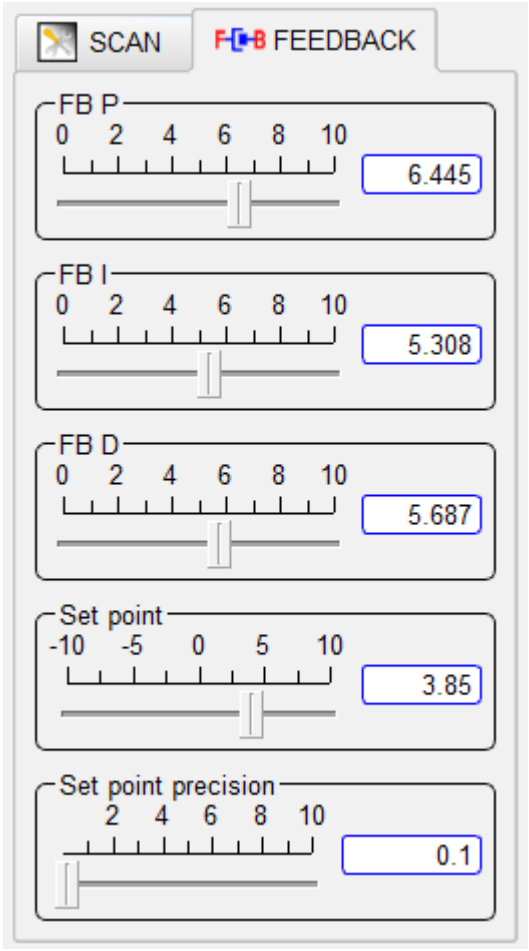


Fig. 6.4 Feedback page.

6.1.1. Signal description

Height	Sample surface topography.
DFL	Signal proportional to a probe deviation concerning a normal. Pays off as a difference between signals from the top and bottom half of four-section photodiode. (Fig. 4.43). DFL= (A+B)-(C+D).
LFL	Signal proportional to a probe deviation concerning a torsion. Pays off as a difference between signals from the left and right half of four-section photodiode. LFL= (B+D)-(A+C).
MAG	Magnitude of DFL signal…
MAG Sin	In-phase components of DFL signal
MAG Cos	Quadrature components of DFL signal
Phase	Phase of DFL signal.

MAG, MAG Sin, MAG Cos, Phase signals are computational result of ADC1 with phase-lock detector.
The direct digital synthesizer of frequency (DDS) which creates harmonious fluctuations with the set frequency and amplitude lies at the heart of the phase-lock detector. This signal is deduced for a probe excitation and is used for demodulation of the signals coming on the synchronous detector input.
ADC1 input signal arrives on a preamplifier (PGA) where can amplify in 1…100 times. The amplified signal arrives on an input high-speed ADC. The digital signal from ADC output arrives on a multiplier input where it is multiplied with a basic signal, and also with the basic signal shifted on 90º. The received signals pass through low frequencies filters, thus on an output signals MAG Sin and MAG Cos are formed. Amplitude (MAG) and the Phase signals are calculated mathematically from these signals.

DInt	Total signal from all four sections of the photo diode. This signal is proportional to intensity of the laser beam reflected from a cantilever. Dint=A+B+C+D.
ADC 01	ADC01 signal, DFL
ADC 02	ADC02 signal, LF
ADC 03	ADC03 signal, DInt.
ADC 04	ADC04 signal.
ADC 05	ADC05 signal.
X sensor	The signal from capacity sensor by X scan head axes.
Y sensor	The signal from capacity sensor by Y scan head axes.
Z sensor	The signal from capacity sensor by Z scan head axes.
Ux	High voltage output for X axes head piezostack.
Uy	High voltage output for Y axes head piezostack.

Uz	High voltage output for Z axes head piezostack.
X2 sensor	The signal from capacity sensor by X scan stage axes.
Y2 sensor	The signal from capacity sensor by Y scan stage axes.
Z2 sensor	The signal from capacity sensor by Z scan stage axes.
Ux2	High voltage output for X axes stage piezostack.
Uy2	High voltage output for Y axes stage piezostack.
Uz2	High voltage output for Z axes stage piezostack.
ADC HR 1	Auxiliary analog input.
ADC HR 2	Auxiliary analog input.

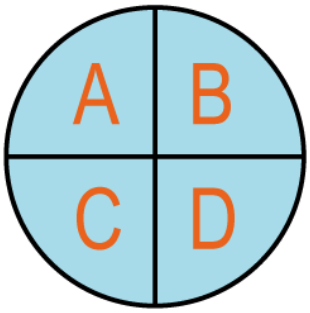


Fig. 6.6 Foursection photodiode drawing.

6.2. Multi-pass technique

By pressing the button 

the scanning two-through passage technique is activated. On the **Scan tab** there is a field **LM height, нм** for distance value on axis Z on which the second pass of a probe will be carried out is established. Near to the fields of a signals choice (Channel A, Channel B, Channel C, Channel D) appear buttons  . Pressing such buttons  means the signal is chosen for obtaining on the second pass of a probe.

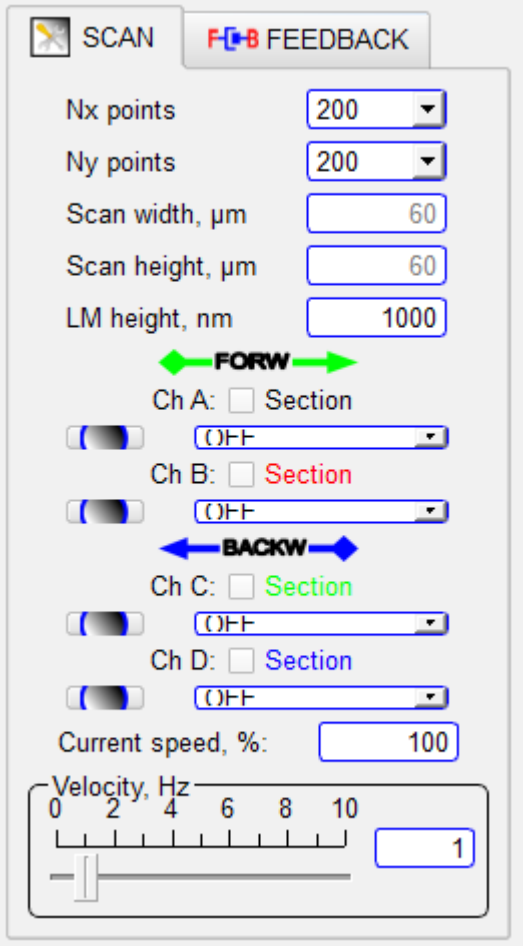


Fig. 6.7 Scan tab in two-pass mode drawing.

6.3. Additional scan parameters

The probe position is shown in the **XY probe positioning** panel, when the button **Point selection**  has pressed.

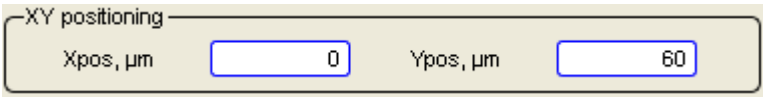


Fig. 6.8 Probe positioning panel drawing.

The **Z Positioning** slider is necessary for moving of a probe on axis Z. Position Z can be set from the keyboard in the field near to the slider. After typing-in the number value from the keyboard press the button Enter Key. Depending on a choice of a way of scanning slider control or position on Z in a scanning head, or position on Z in a

scanning stage.

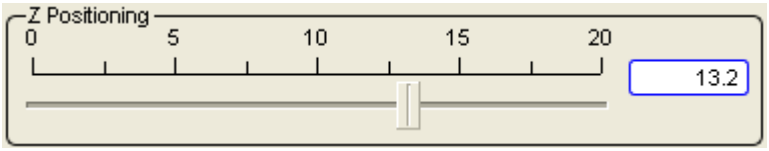


Fig. 6.9 Z positioning.

The **Current Tip Position** bar indicates Z scanner lever in percents. Green color of the indicator corresponds to a safe supply of a probe, and red means that the probe is too close to the sample and there is a possibility of probe damaging.

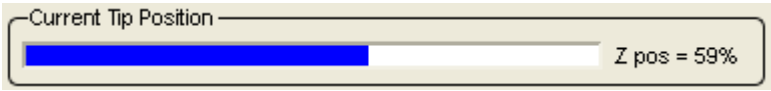


Fig. 6.10 Z position.

Fig. 6.11 Escaping high voltage amplifiers.

Set high voltages HYZ to zero – by pressing the button an output of high-voltage amplifiers of the head scanner pressure is established to zero.

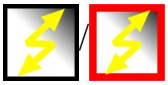


Fig. 6.12 Fast scanning button.

By pressing the **Fast scanning** button enables algorithm allowing to carry out fast scanning by special algorithm.

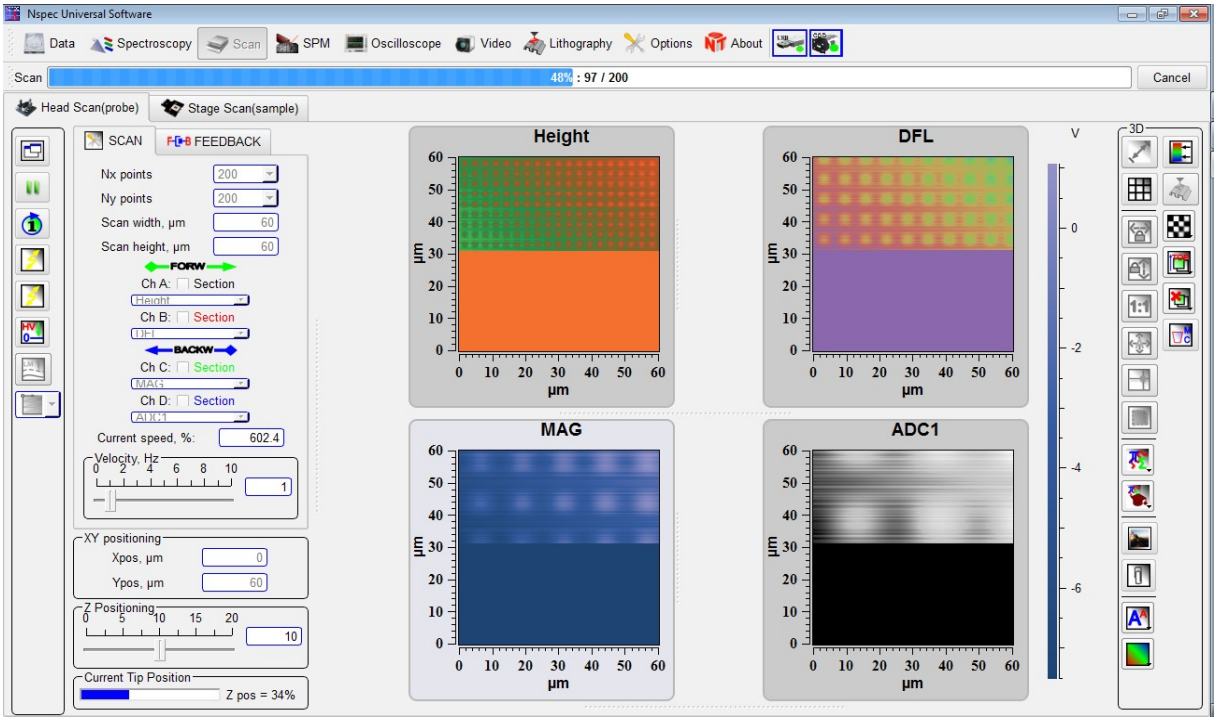
6.4. Scanning

For start scanning press the button **Start** 

. For stop scanning press again this button 

. Scanning is started only after a choice of signals on the Channel 1-4. For start enough one signal.

Fig. 6.13 Start scanning.



The check box for cut section construction for relevant channel. The title color is relevant to the cut section color.

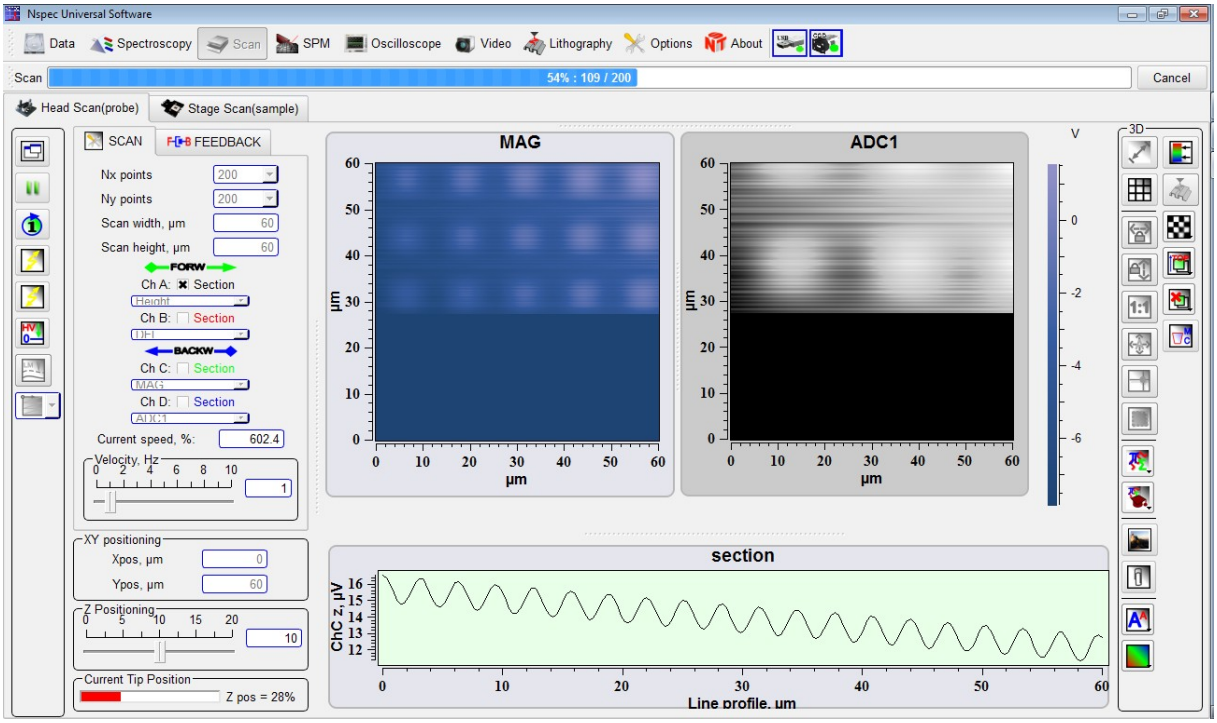


Fig. 6.14 Start scanning with line cut section.

6.5. Layers

At scanning of one sample site in different modes or with the various resolution for display already made scans **Layers** functions is used.

	Move layer on top	By pressing this button list of available layers is showing in the drop-down list. To move the layer on top press on the layer name in the list.
	Delete layer	By pressing this button list of available layers is showing in the drop-down list. To delete the layer on top press on the layer name in the list.

7. Oscilloscope unit

Oscilloscope unit is intended to observation signals from controller in time.

To entry **Oscilloscope** unit press the button 

, that is situated on the top panel of the NSpec window.

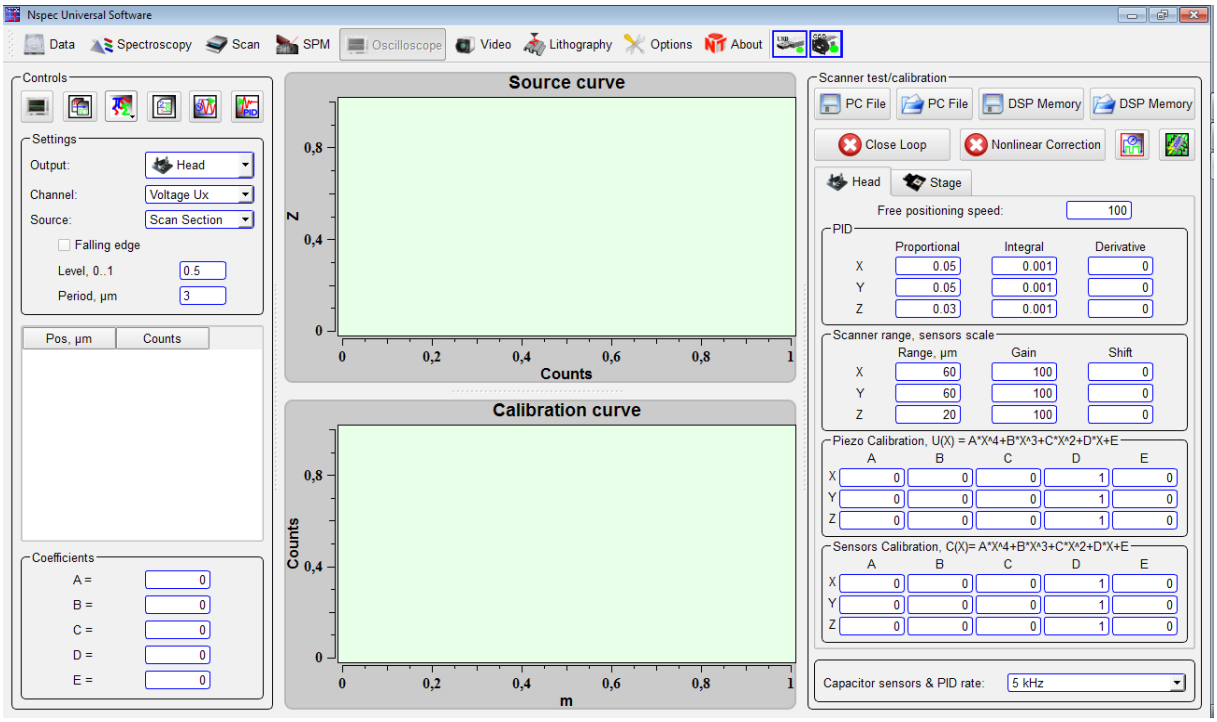


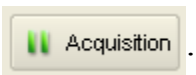
Fig. 7.1 Oscilloscope unit.

7.1. Signal visualization

Oscilloscope controls are placed on the left side of the NSpec window. It contains displaying signal combo boxes and signal parameters.

In the fields **Average** and **RMS** are displayed average and root-mean-squire value of a signal during accumulation for each channel. In the field **T, sec** time of signals accumulation is established.

To run the oscilloscope press the button 

, to stop — press it again 

.

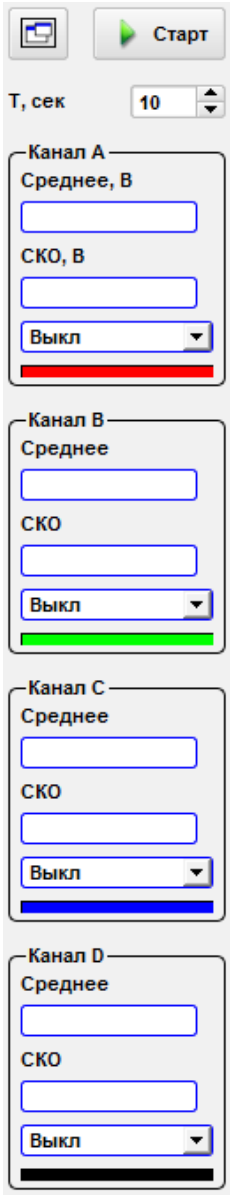


Fig. 7.2. Oscilloscope controls.

DAC 01, V slider is required to set the value of controller output channel voltage. The channel can be selected in the nearby combo box.

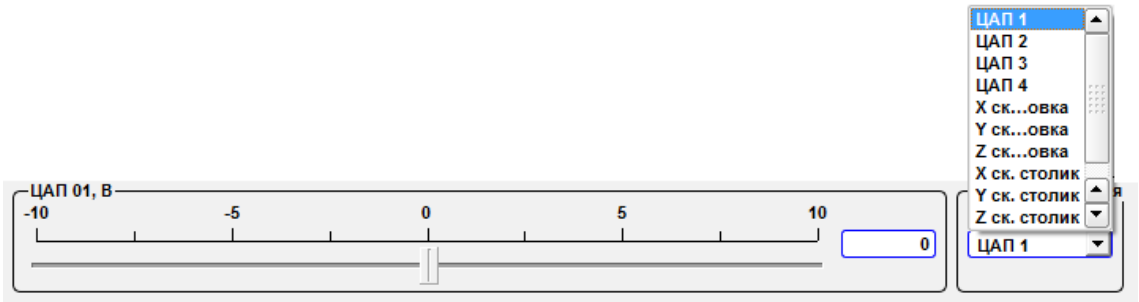


Fig. 7.3 DAC slider.

DAC 1	
DAC 2	
DAC 3	
DAC 4	
X head	DAC that moves head X axes
Y head	DAC that moves head Y axes
Z head	DAC that moves head Z axes
X stage	DAC that moves stageX axes
Y stage	DAC that moves stage Y axes
Z stage	DAC that moves stage Z axes
Z objective	DAC that moves lens piezomover.

7.2. Scanner calibration

In the right pane there is the **Scanner test /calibration** panel.

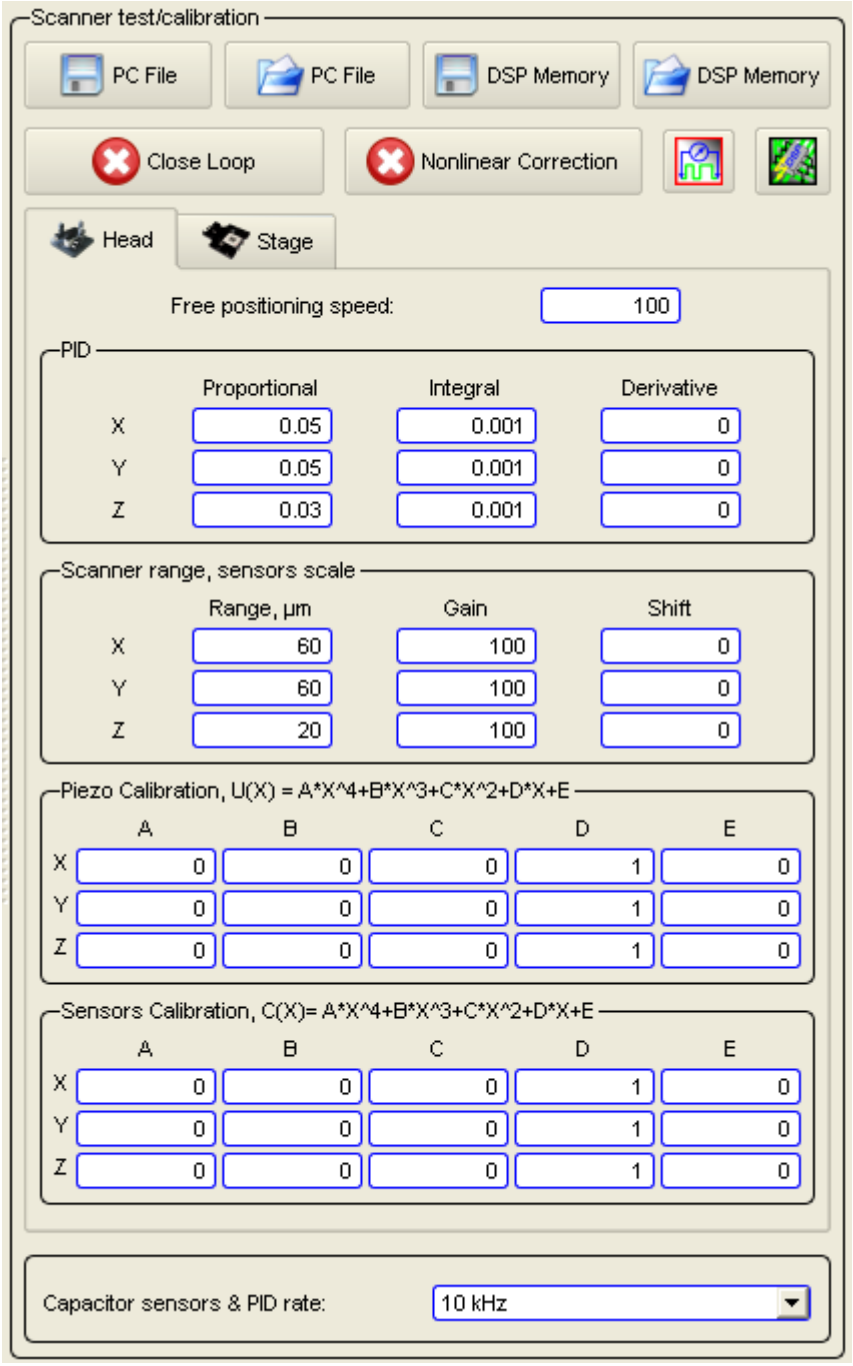


Fig. 7.5 Scanner calibrations tables.

	Close loop	The button of on/off switching of scanner close loop. When close loop is on the button has blue color.
	Non-linear correction	The button of on/off switching of scanner nonlinear correction. When close loop is on the button has green color.

		PC File	Save calibrations in PC file.
		PC File	Load calibrations from PC file.
		DSP Memory	Save calibrations in DSP.
		DSP Memory	Load calibrations from DSP (internal controller memory).
		Show/hide calibration window	Show/hide calibration window
		Firmware upgrade	Firmware upgrade from file function.

Tabs **Head/Stage** on the **Scanner test /calibration** panel contains calibration tables for head scanner and stage scanner corresponding.

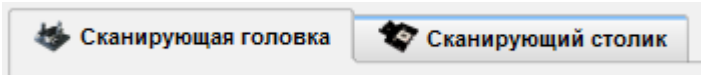


Fig. 7.6 Tabs with Head/Stage calirbations.

Speed [μm/s] of probe or stage moving in an start scan point or new position from the previous position is in the field **Free Positioning speed** established.

The **PID** panel is designed to set PID control coefficients of capacity sensors close loop. In fields **Proportional, Integrated and Differential** corresponding factors for each axis are set (X, Y, Z).

Fig. 7.7 Панель ПИД.

On the panel **Scanner Range** in the field Range**, μm** scanning range for each axes are set. The fields **Scale gain and shift** are designed to service adjustment of sensors.

Fig. 7.8 Sensors range panel.

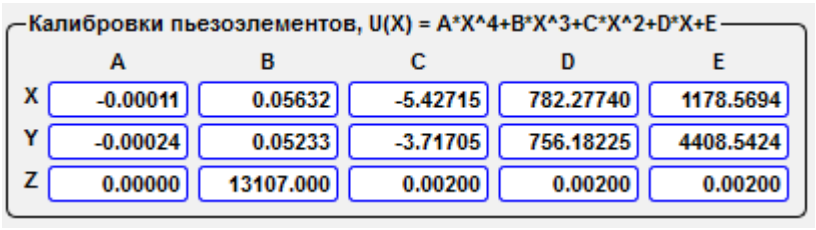


Fig. 7.9 Piezostacks calibration panel.

On the **Piezo calibrations** panel for each axis (X, Y, Z) are set nonlinear calibration coefficients without sensors close loop. This panel contains the table of coefficients of program piezostack nonlinear correction. This table coefficients is necessary for non-linear conversion of the voltage U applied to piezostack to X movement. In the system EG-3000

$$U(X)=A\times X^4+B\times X^3+C\times X^2+D\times X+E,$$

U – voltage in DACs counts 0…65535, X – displacement in µm, $0\ldots X_{max}$, this function is working at NLC is ON 

. If NLC button is off, voltage is calculates by linear relationship

$$U(X)=65535\times\frac{X}{X_{max}}\ .$$

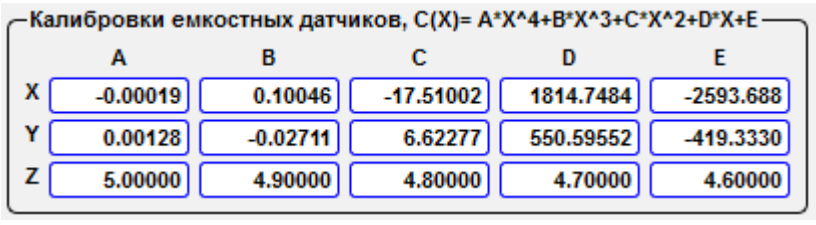


Fig. 7.10 Sensors calibration panel.

On the **Senors calibrations** panel for each axis (X, Y, Z) are set sensor calibration coefficients for sensors close loop. This panel contains the table of coefficients of program sensor nonlinear correction. This table coefficients is necessary for non-linear conversion of the capacity C of the sensor to piezostack to X movement. In the system EG-3000

$$C(X)=A\times X^4+B\times X^3+C\times X^2+D\times X+E,$$

C – sensor capacity in DACs counts 0…65535, X – displacement in µm, $0...\ X_{max.}$ this function is working at close loop is ON  . If **close loop** is off  , capacity is calculates by linear relationship

$$C(X)=65535\times\frac{X}{X_{max}}\ .$$

7.3. Calibration procedure

7.3.1. Calibration mode

For scanner calibration go to calibration mode by pressing **Show/Hide calibration window**  . Then in a window there will be tools for carrying out of calibrations.

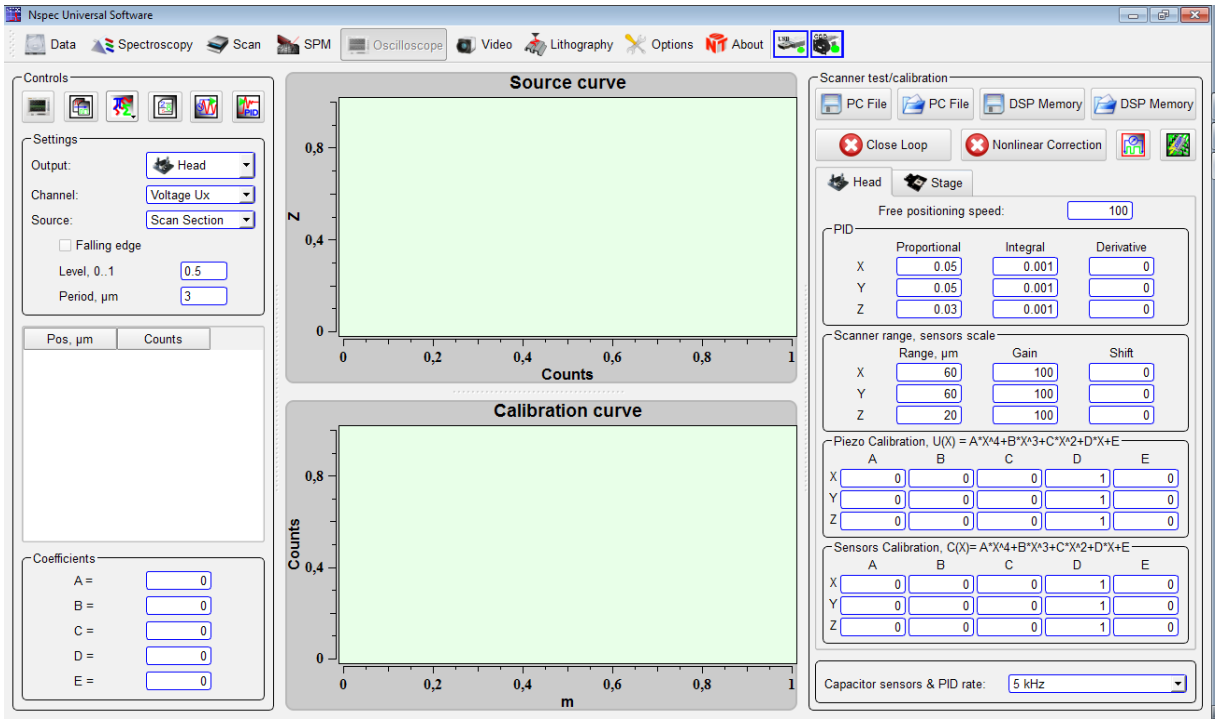


Fig. 7.11 Oscilloscope window in the calibration mode drawing.

7.3.2. Piezostack calibration

- Switch off nonlinear correction and sensors close loop  ;
- Scan test sample with the full amount of points (1000 x 1000) in the direction of the calibration, and the full range, the direction of the fast scan X (measurements should occur on the growth of the voltage from minimum to maximum)  ;
- Produce a horizontal section of the image;
- Calculate calibration coefficients using **Controls** panel tools (Procedure of coefficients calculatiing is described below in point 4.17.5);
- Store new coefficients in the related table;
- Save data.

7.3.3. Sensors calibration

- Switch off nonlinear correction and switch on sensors close loop ;
- Scan test sample with the full amount of points (1000 x 1000) in the direction of the calibration, and the full range, the direction of the fast scan X (measurements should occur on the growth of the voltage from minimum to maximum) ;
- Produce a horizontal section of the image;
- Calculate calibration coefficients using **Controls** panel tools (Procedure of coefficients calculatiing is described below in point 4.17.5);
- Store new coefficients in the related table;
- Save data.

*7.3.4. Tool panel **Settings***

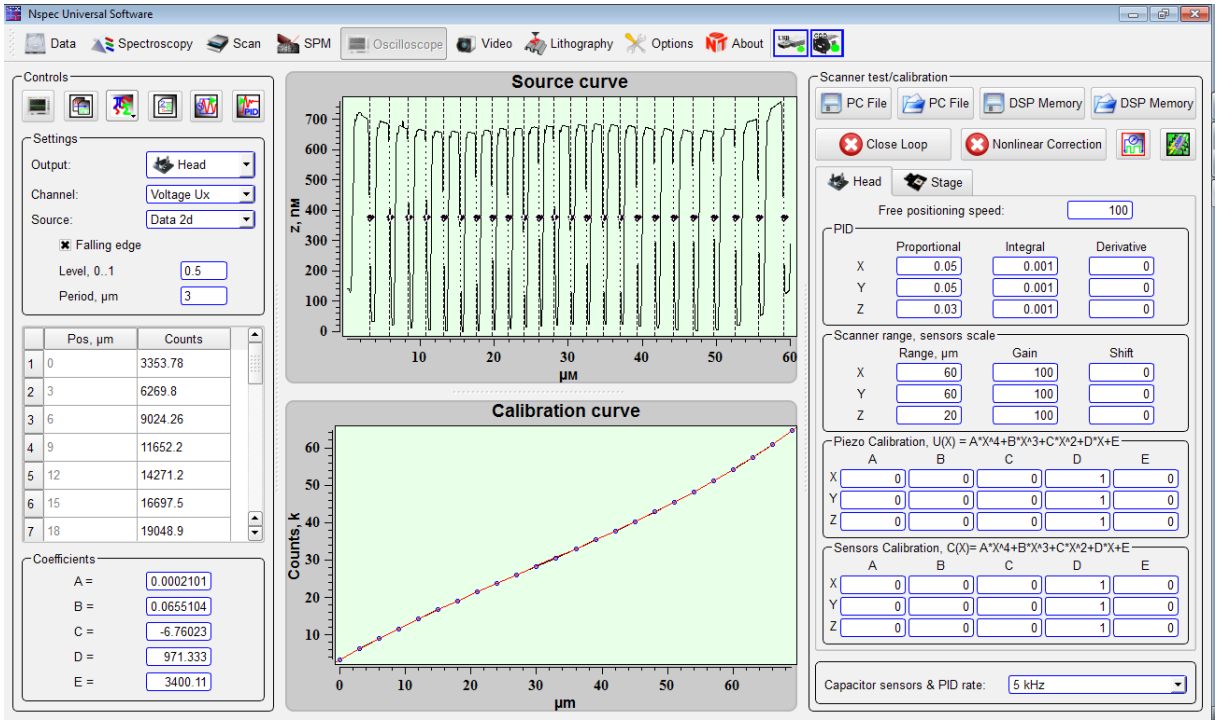


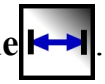
Fig. 7.12 Controls panel.

	Acquire data	Get data from the selected source.
	Filters	Standard filters for curves.
	Save to settings	Store obtained coefficients in the related table.
	Sensors autoadjustment	Run sensors automatic adjustment.

Tools panel **Settings**:

Output		Combo box for device for calibration choise: head or stage
Channel		Combo box for calibration channel choice
	Voltage Ux	X piezostack calibration
	Voltage Uy	Y piezostack calibration
	Voltage Uz	Z piezostack calibration
	Sensor Cx	X sensor calibration
	Sensor Cy	Y sensor calibration
	Sensor Cz	Z sensor calibration
Source		
	Scan section	For calibration the profile is used directly from the scanned image
	Section from 3D data	For calibration the profile is used from the earlier saved one
	Section from Data	Use for calibration the section stored in the file.
Falling edge		Installations of points of a binding on the falling edge of test structures:
	Level, 0…1	Point level,
	Period, μm	Test structure period.

7.3.5. Calibration coefficients obtaining

Let's consider the example. For piezostack calibration of a scanning head on an axis X by the image saved in a file earlier it is necessary to go to the **Data** unit, to open earlier scanned image of a test grating and to construct its section. For constructing the section set up marker on the scan by the button **Marker**  , press the button **Cross Section**  and the button **Markers Horizontal mode**  .

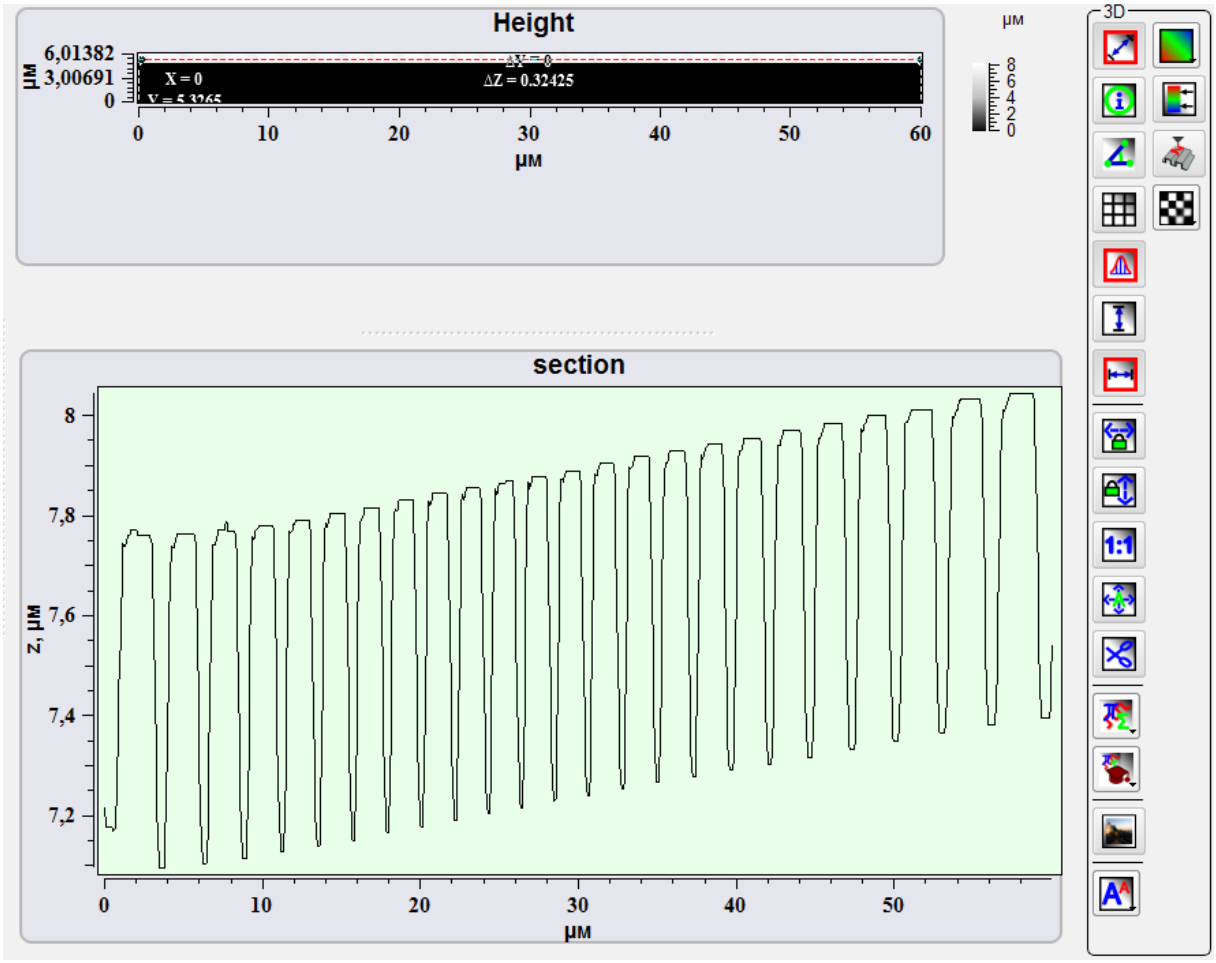


Fig. 7.13 Profile for calibration.

Then go to **Oscilloscope** unit, press **Show/Hide calibration window**  , select **Head** in the **Device** combo box, select **Voltage Ux** in the **Channel** combo box, select **3D data Section** in the **Source**, and type-in the gratings period. And then press the button **Acquire data**  .

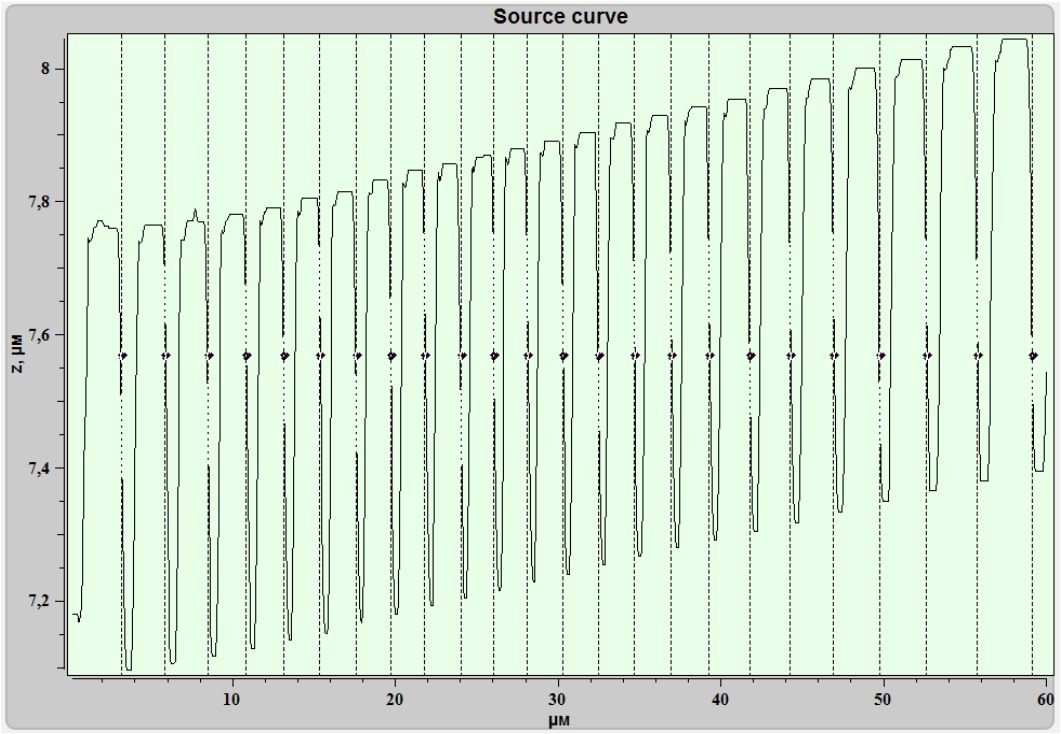


Fig. 7.14 Calibration curve.

Apply filters for section nonlinear correction  .

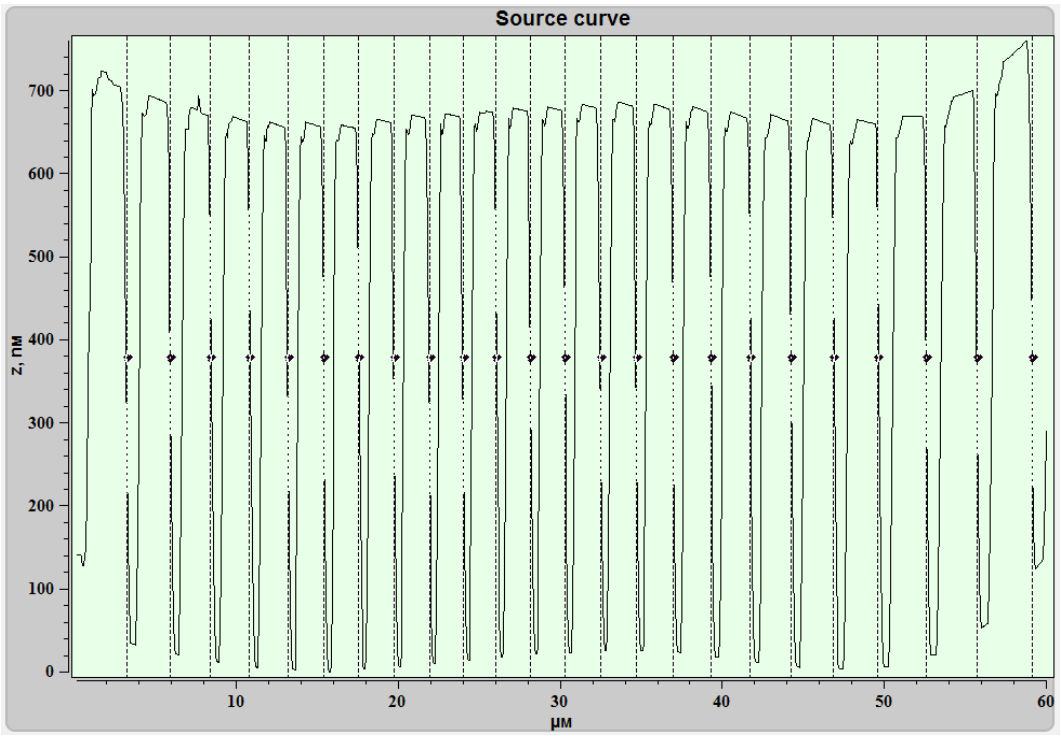


Fig. 7.15 Calibration curve after filter applying.

Markers on the curve can be moved manually in case of wrong automatic installation.

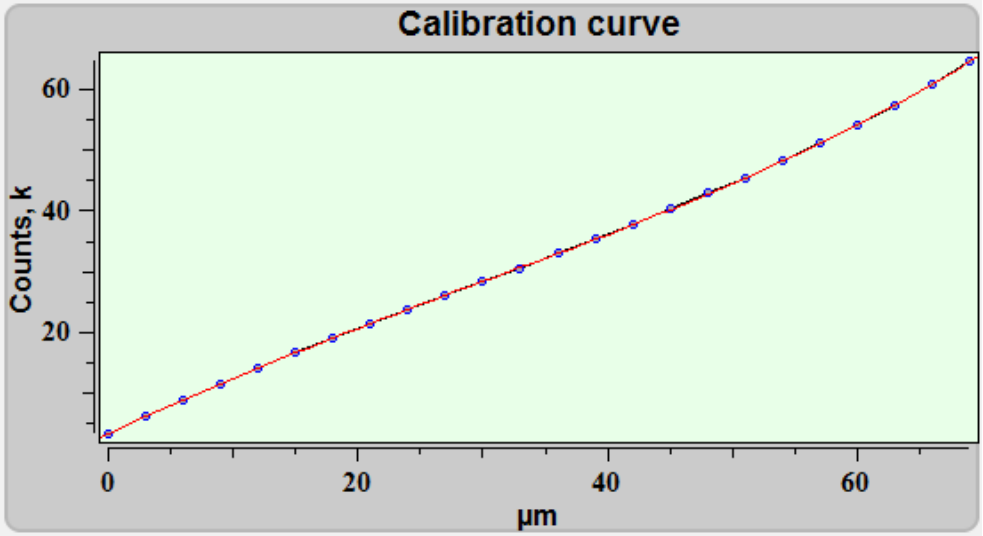


Fig. 7.16 Calibration curve.

After loading calibration structure curve and carrying out all steps for calculation of polynomial coefficients, in the frame **Coefficients** it will be shown.

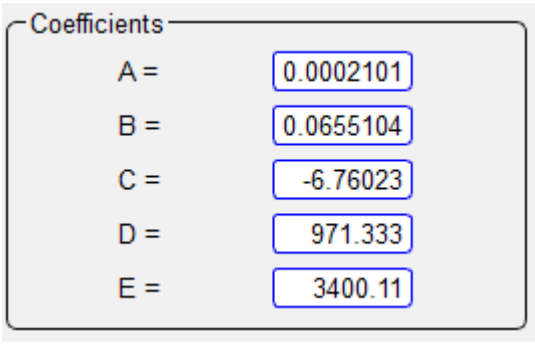


Fig. 7.17 Polynomial coefficient.

Then press the button **Save to settings**  , to store polynomial coefficients on the chosen axis in the Piezo Calibration table.

Similarly coefficients are defined for other axes and scanners, and for capacitor gauges. After getting all coefficients it is necessary to keep options by pressing the button **PC File**  .

8. Spectroscopy

Spectroscopy unit is intended to obtaining spectral images.

To entry **Spectroscopy** unit press the button 

, that is situated on the top panel of the NSpec window.

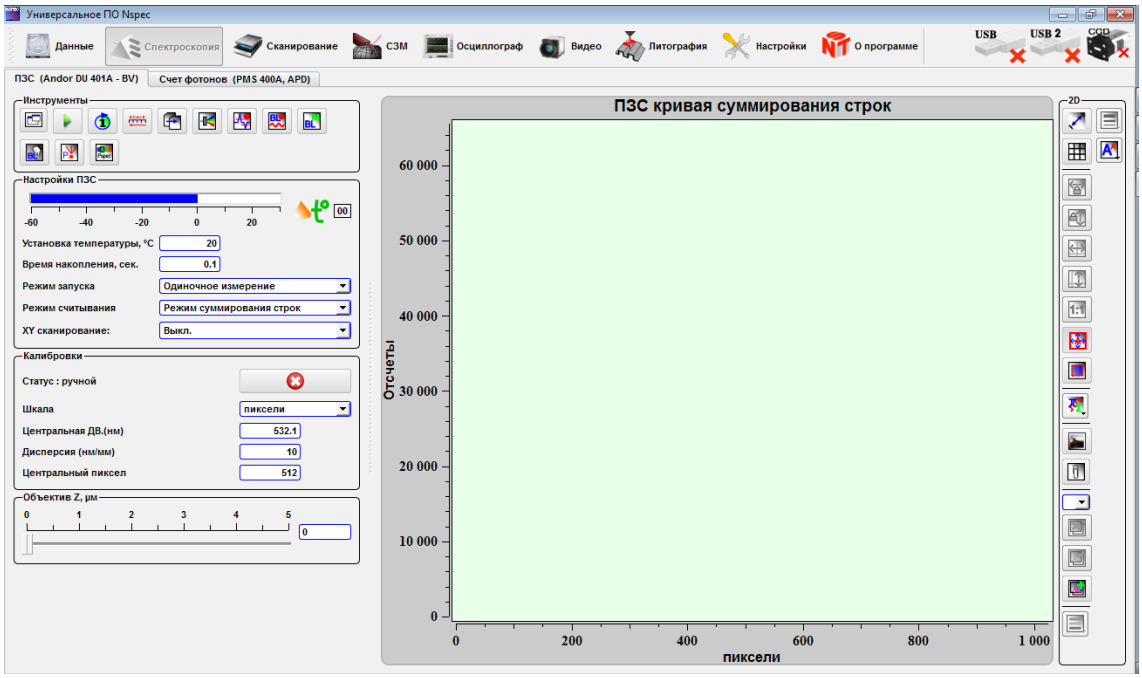


Fig. 8.1 Spectroscopy unit.

The tools collected in this window, are intended for obtaining of spectra in a point and spectral confocal images from surface. Besides, these tools allow to spend preprocessing of the obtained spectra and spectral images.

There are two tabs – **CCD matrix** and **PMS** (Photon Counting Systems) – in the spectroscopy unit.

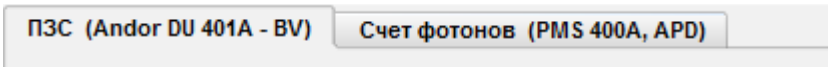


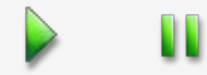
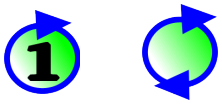
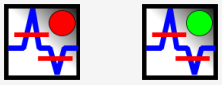
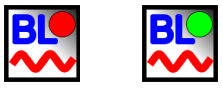
Fig. 8.2 CCD and PMS tabs.

8.1. Tools for spectrum obtaining and processing

8.1.1. Tools

The basic tools for work with spectra are collected on the **Tools** panel on the CCD tab.

Fig. 8.3 Spectroscopy tools panel.

	Start/stop	Start/stop spectrum acquisition. The spectrum will be shown only after operation end.
	Single/continuous	Single - The spectrum collects once for fixed exposition time. Continuous – The cycle of spectrum for fixed exposition time accumulation infinitely repeats. On the screen the spectrum is updated after end of the next cycle of a spectrum accumulation. For operation stop press the button Start/stop again.
	Scale reverse	By pressing this button the direction of scale on X axes reverses.
	Data export	Export spectrum in spc file by standard File save dialog.
	Opto-mechanical unit control	By pressing this button the management window by the automated parts of the opto-mechanical module is deduced
	Delete spikes	This button enables an algorithm of subtraction of traces of influence of space particles on a CCD spectrometer matrix from a spectrum.
	Baseline subtract	This button enables a baseline subtraction from a spectrum.
	Store current spectrum as baseline	Current spectrum will be saved in the clipboard to use as baseline in the baseline subtraction function.
	Create baseline manually	Tools for manually baseline creation will be displayed.

	Laser power	The buttons calls laser control window.
	Toggle panorama mode	Turn-on panorama specter mode

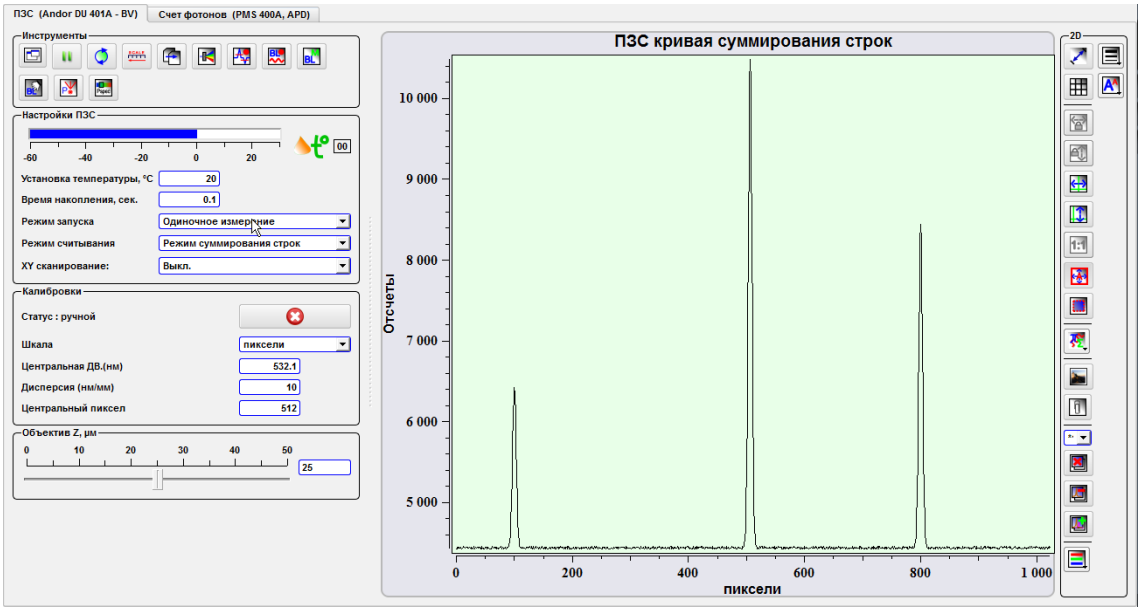


Fig. 8.4 Obtaining spectrum in the point.

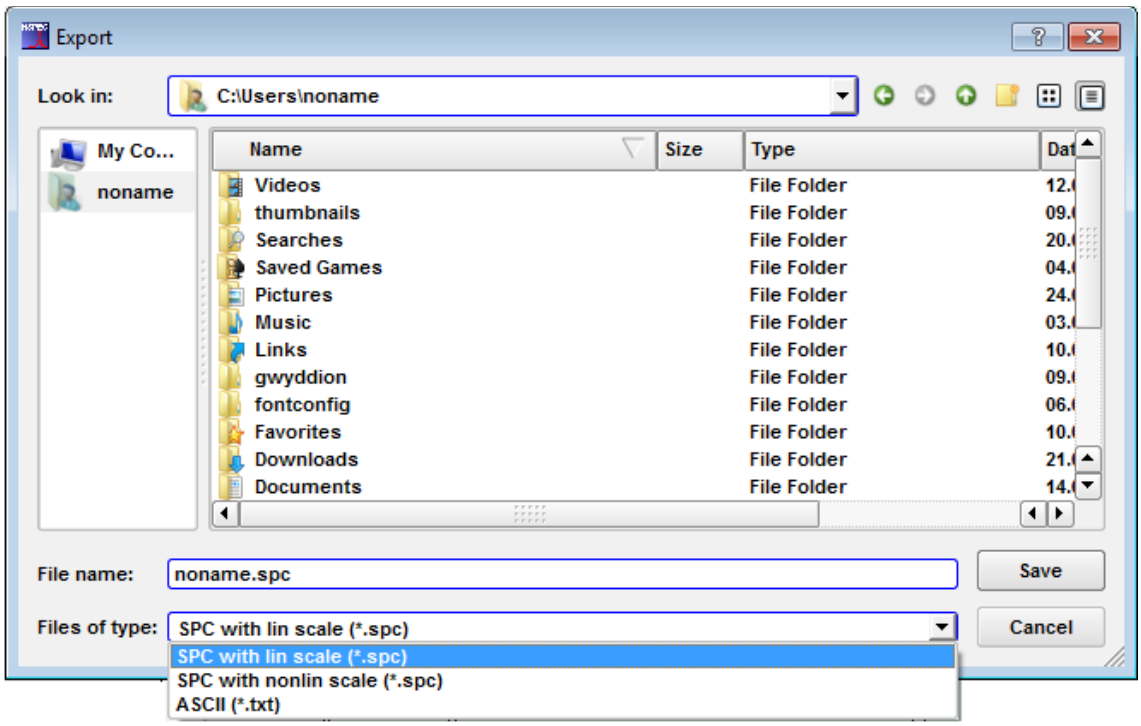


Fig. 8.5 Spectrum export file save dialog.

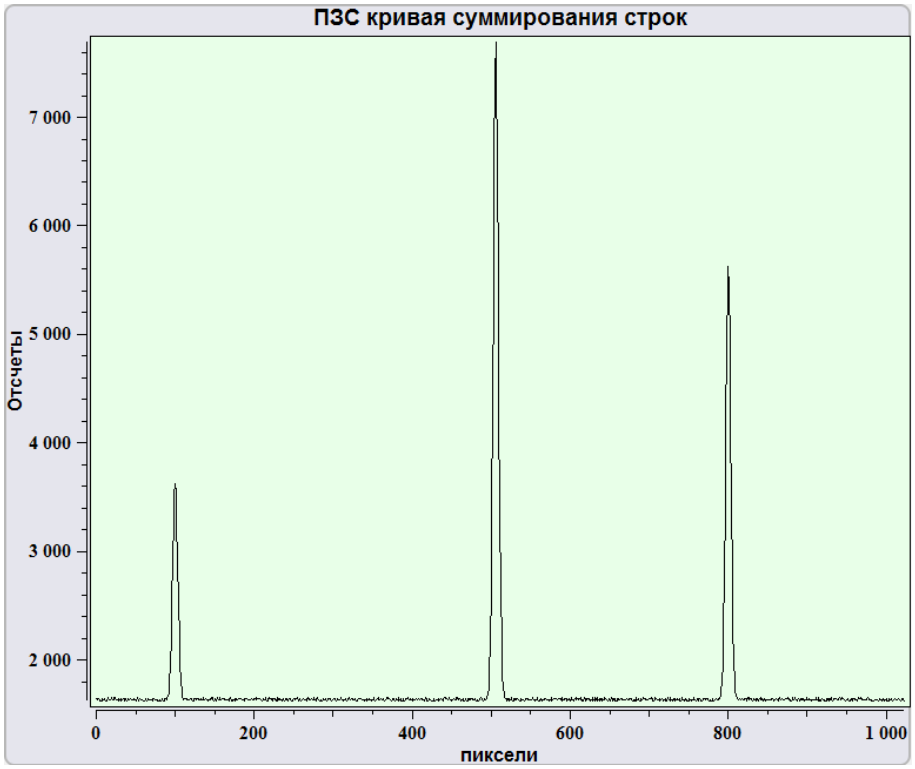


Fig. 8.7 Спектр без вычитания базовой линии.

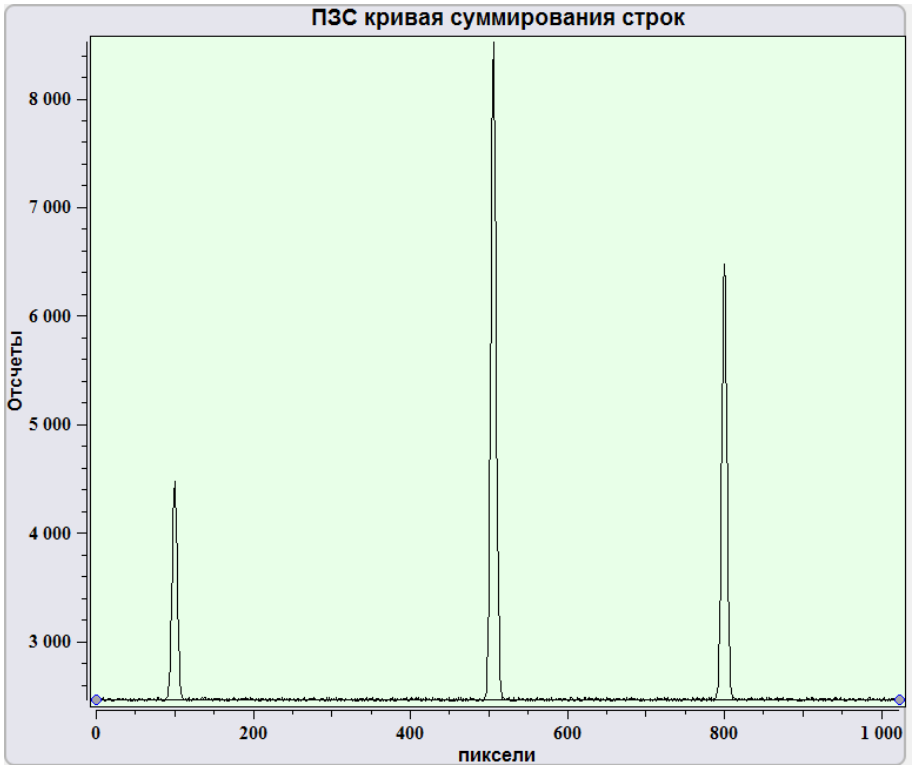


Fig. 8.8 Спектр с вычитанием базовой линии. В качестве базовой линии использован спектр отображенный на Fig. 8.7.

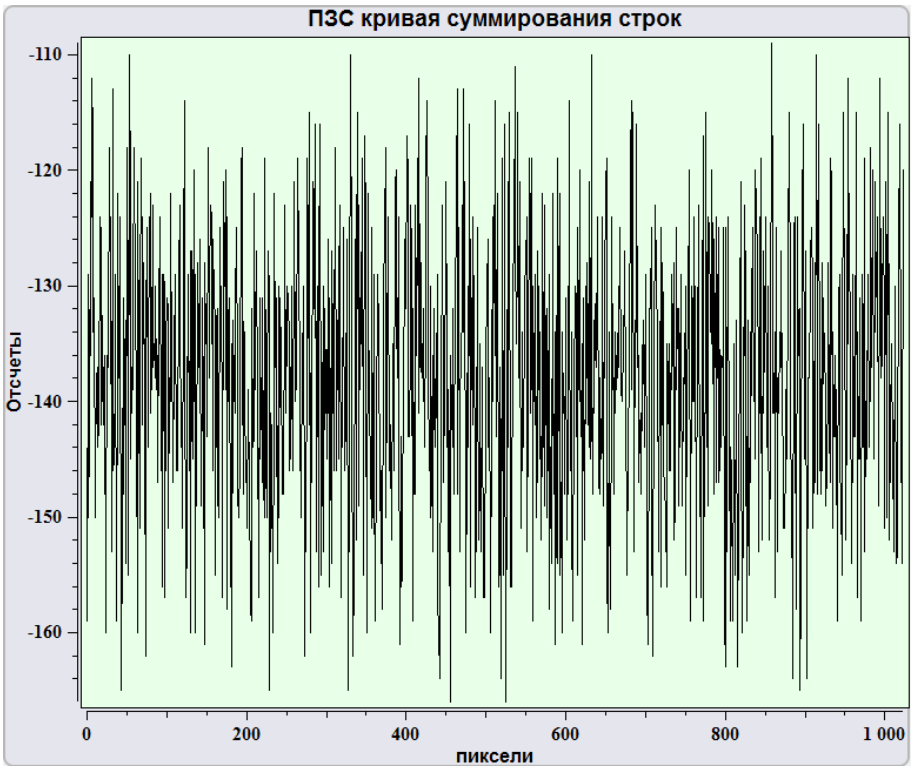


Fig. 8.9 Первоначальный вид базовой линии установленной вручную.

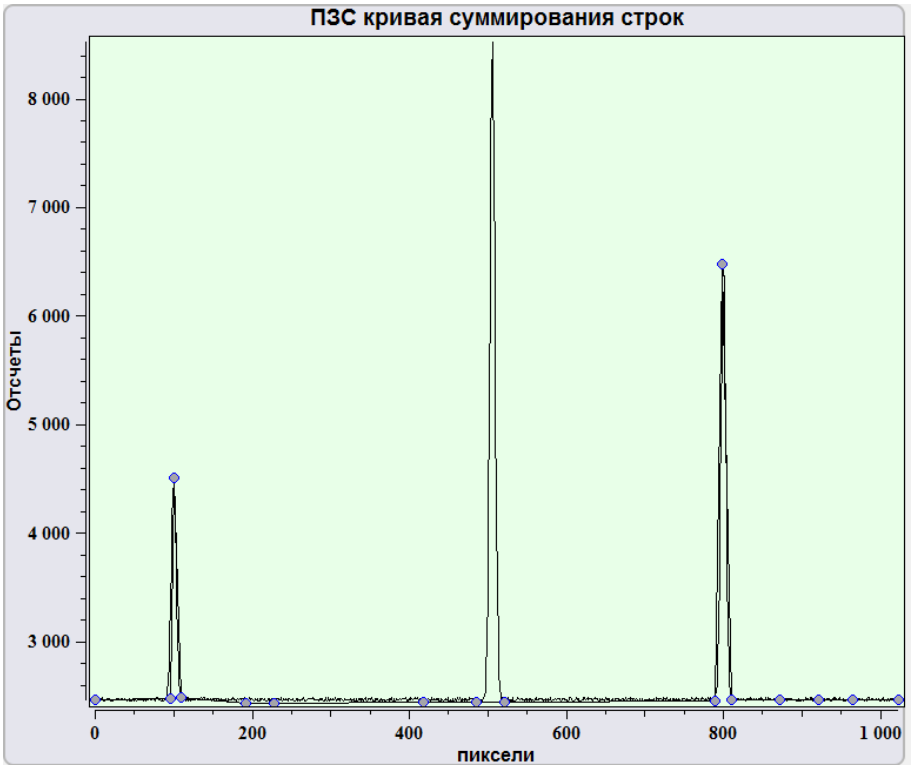


Fig. 8.10 Установка дополнительных точек на базовой линии и установка базовой линии.

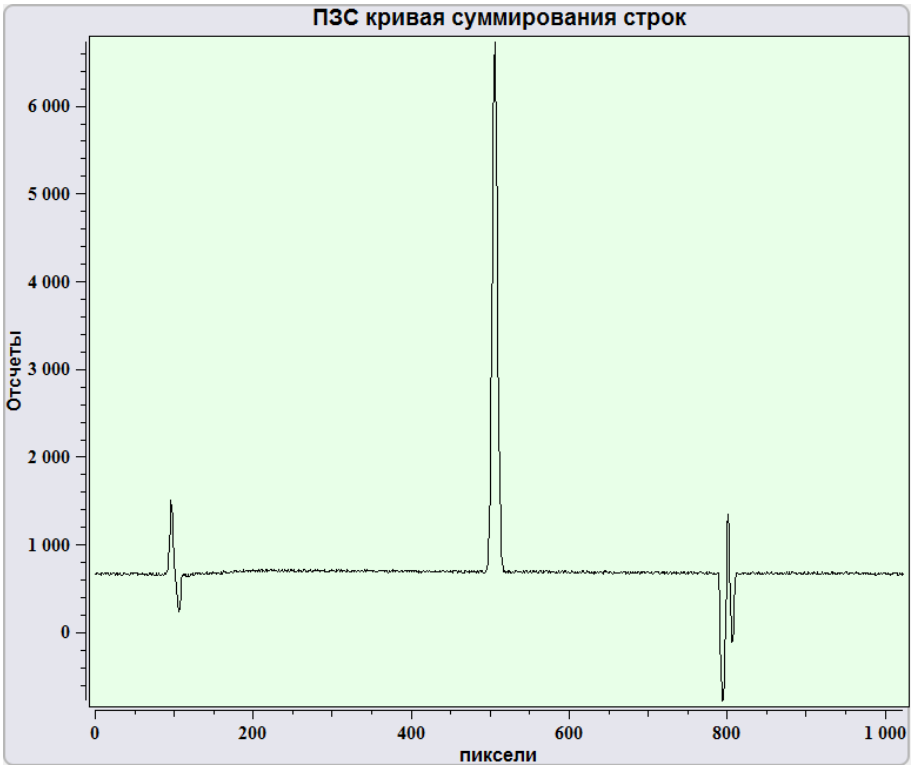


Fig. 8.11 Спектр, полученный после вычитания базовой линии.

	Apply Baseline substrate
	Cancel Baseline substrate
	Reset baseline

To manual subtraction of a baseline press the button to **create a baseline manually**  . On the finished spectrum there will be a straight line between start and final curve points. At prompting of the mouse cursor on a line and pressing by the left button lines points are formed. For moving of points establish the cursor on the point and, having clamped the left button, move the point. After creation of a base line for subtraction press **Accept**  and **Subtract baseline**  . For cancellation of subtraction of a base line manually press **Cancel**  .

8.1.2. CCD matrix tools.

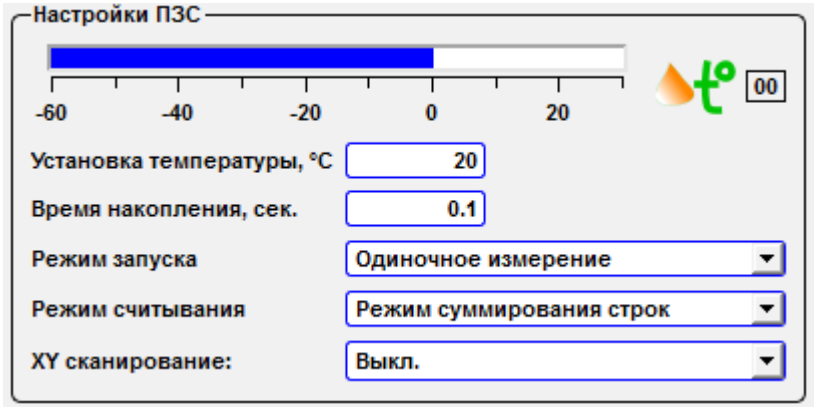


Fig. 8.12 Панель инструментов для настройки ПЗС (CCD) матрицы.

The matrix temperature indicator is displaying on the panel **CCD settings**. If a matrix is disconnected to the computer indicator shows value 00 ºC. When a matrix is connected indicator shows current matrix temperature from embedded matrix sensor.

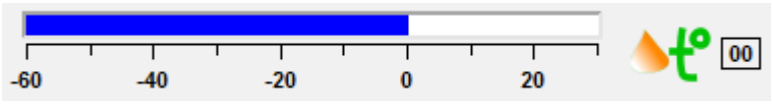
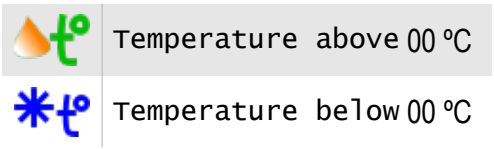


Fig. 8.13 Matrix temperature indicator.



To set matrix temperature enter desired value in the enter field **Set temperature**. Minimal temperature is different for various matrices and cooler type.

On the termination of measurements before device switching-off it is recommended to establish temperature 20 ºC and switch off the device only on achievement of this or indoor temperature.

CCD matrix parameters is established in following combo boxes:

Exposition time		Signal storage time varies from 0,001 to 99999 seconds. The time is determined by user depends on signal intensity, noise level and other parameters.
Acquisition mode		Mode of spectrum acquisition
	Single scan	Obtain single spectrum with fixed exposition time.
	Accumulate	Obtain summarized spectrum with fixed exposition time by some cycles.
	Kinetic series	Obtain series of spectra.
Read mode		Matrix information read mode.
	Full vertical binning	Values of all matrix vertical pixels summarize in each column.
	Single track	Values of selected vertical pixels summarize in all column.
	Image	Full matrix 2D image will be shown.
XY scanning		Scanning mode selection.
	Off	Obtain spectrum in one point.
	Head Scan	Scanning by the probe in XYZ directions.
	Stage scan	Scanning by the sample stage in XY directions.

To obtain single spectrum from the point with fix time select **Single scan** in the combo box **Acquisition mode**.

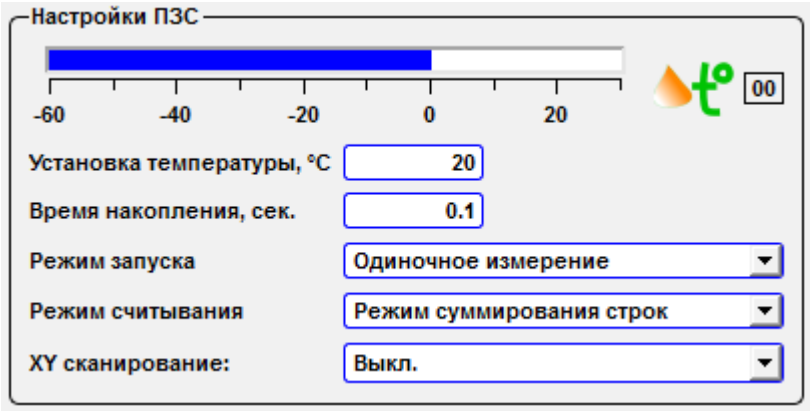


Fig. 8.17 Spectrum in one point, single scan mode.

For accumulative acquisition mode set additional parameters in **Accumulative options** panel.

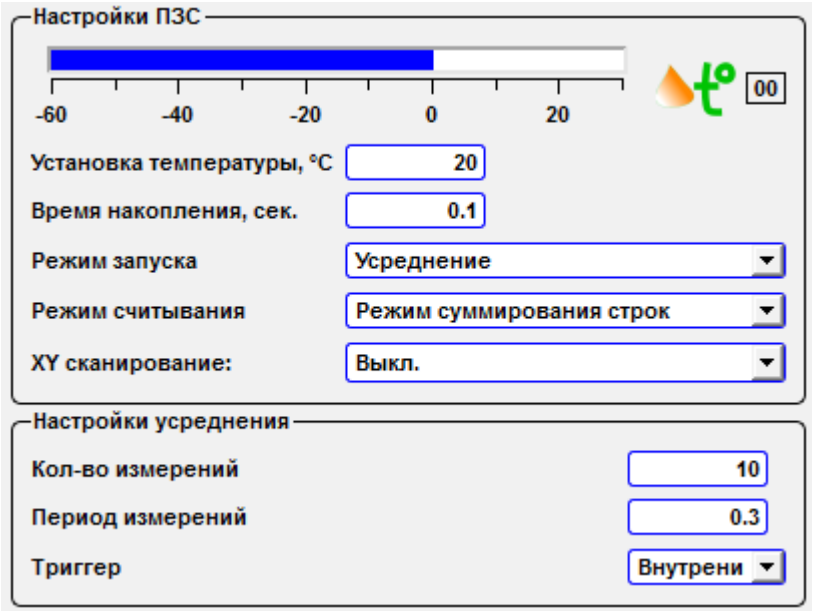


Fig. 8.18 Spectrum in one point, accumulative mode.

Accumulative options	
Number of accumulations	Number of accumulative cycles with exposition time. Can be set from 1 to 99999 cycles.
Accumulative cycle time	Delay between single cycles. Can be set from 0 to 99999 seconds.
Set trigger mode	Matrix signal read trigger selection – external or internal. By default – internal.

The kinetic series mode allow to obtain series of periodic spectra both in the single scan and the accumulative mode. When choosing the mode of obtaining the kinetic series (**Kinetic series**) opens the additional toolbar settings – **Kinetic series options:**

Kinetic series options		
	Number of kinetic series	Desired number of kinetic series.
	Kinetic series time	Delay between single series.

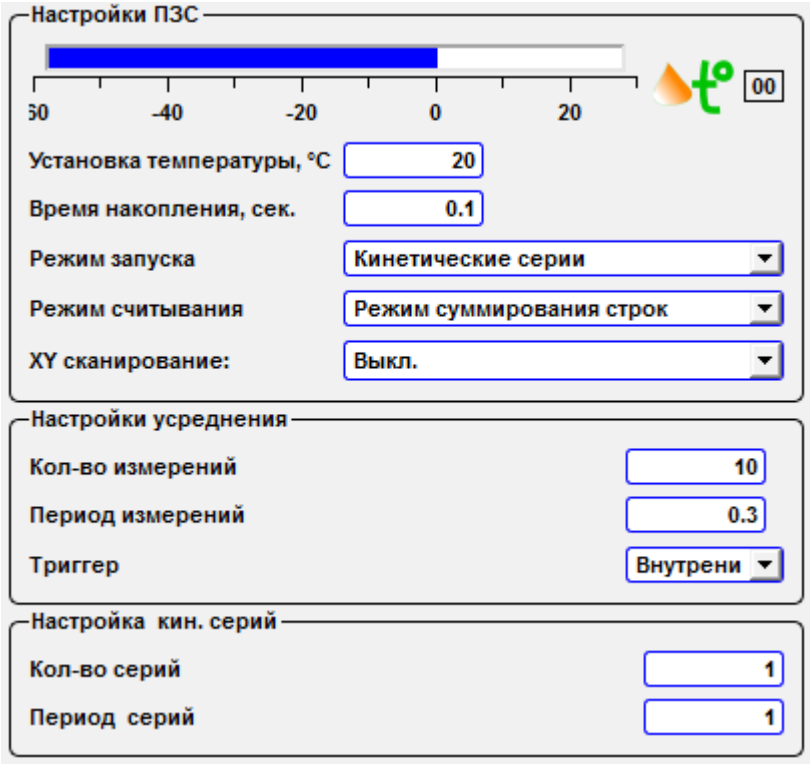


Fig. 8.19 Spectrum in one point, kinetic series mode.

Three ways of matrix information reception are possible: **Full vertical binning, Single track, Image**.

In the **Full vertical binning** mode values of all matrix vertical pixels summarize in each column. In this mode the matrix works like CCD line array. In the **Single track** mode values of selected vertical pixels summarize in all column.

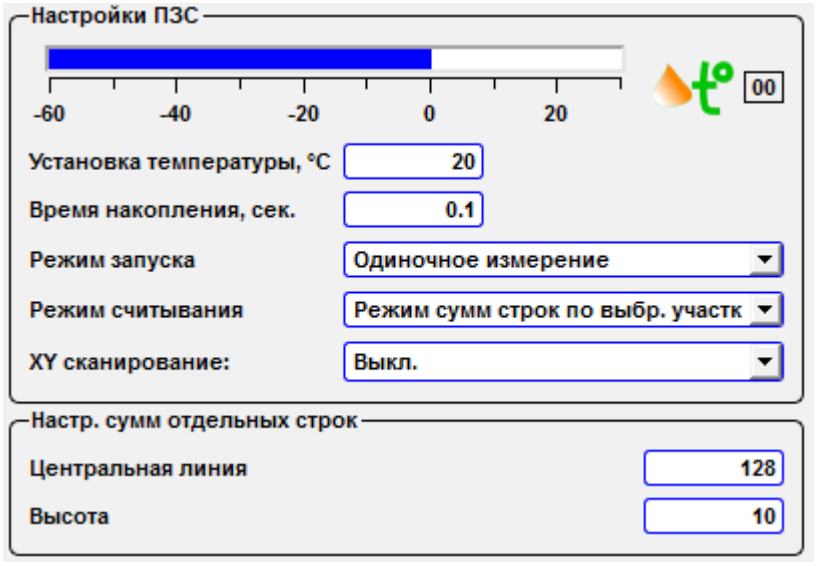


Fig. 8.20 Single track mode options.

Single track mode		Selection rows, which is the summation. Matrix resolution 1024x256 (128) pixels.
	Central row	Selection central row, px.
	Height	Selection height in px.

In the **Image** mode the image from the CCD matrix is shown on the screen.

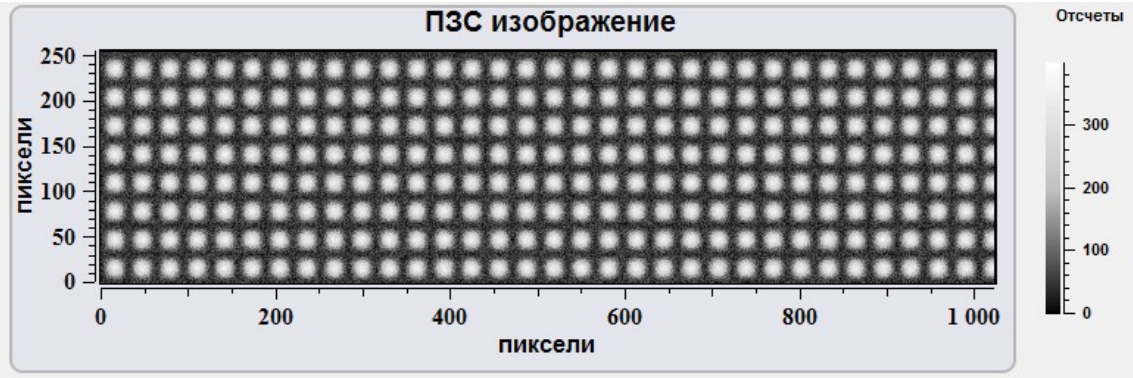


Fig. 8..21 CCD matrix image.

8.1.3. CCD matrix calibration

To calibrate of the CCD matrix use **Calibrations** tool box.

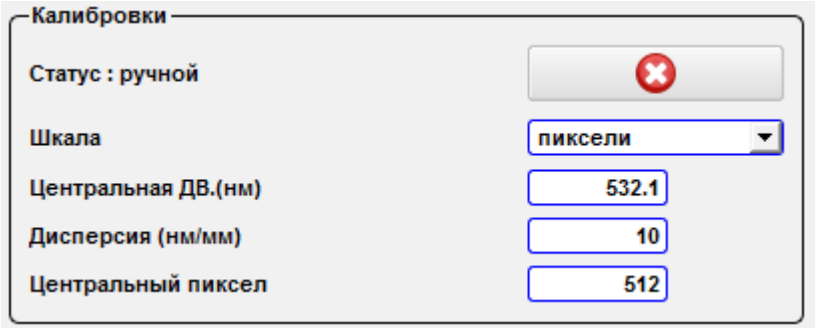


Fig. 8.22 CCD matrix calibration tool box.

Status		CCD matrix parameters entering mode.
	Manual	Manually entering.
	Auto	Automatic loading from matrix memory/
Scale		Spectral scale physical units:
	pixels	Matrix pixels.

	wavelength	Walelength in nm.
	Raman shift	Inverse centimeter for Raman shift spectra.
Central pixel		Set central pixel.
Central WL (nm)		Set central wavelength.
Dispersion (nm/mm)		Set monochromatic dispersion.

8.1.4. Lens Z mover

For management of position of an optical microscope objective on axis Z at obtaining of the spectral information use the slider **Objective Z, µm**.

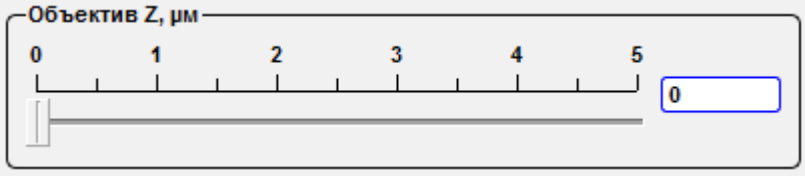


Fig. 8.23 Objective Z slider.

8.2. Obtaining spectral scans

Centaur и Centaur HR complexes allow to obtain raster spectral images of the sample surface.

To entry the raster spectral images mode select **Head scan** or **Stage scan** in the **XY Scan mode** combo box, that is situated on the **CCD settings** panel.

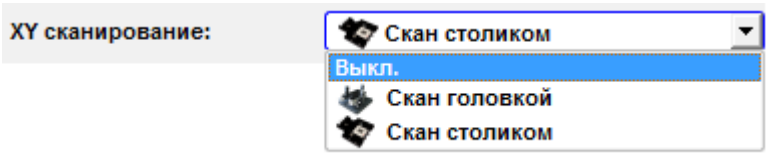


Fig. 8.26 Scanning mode.

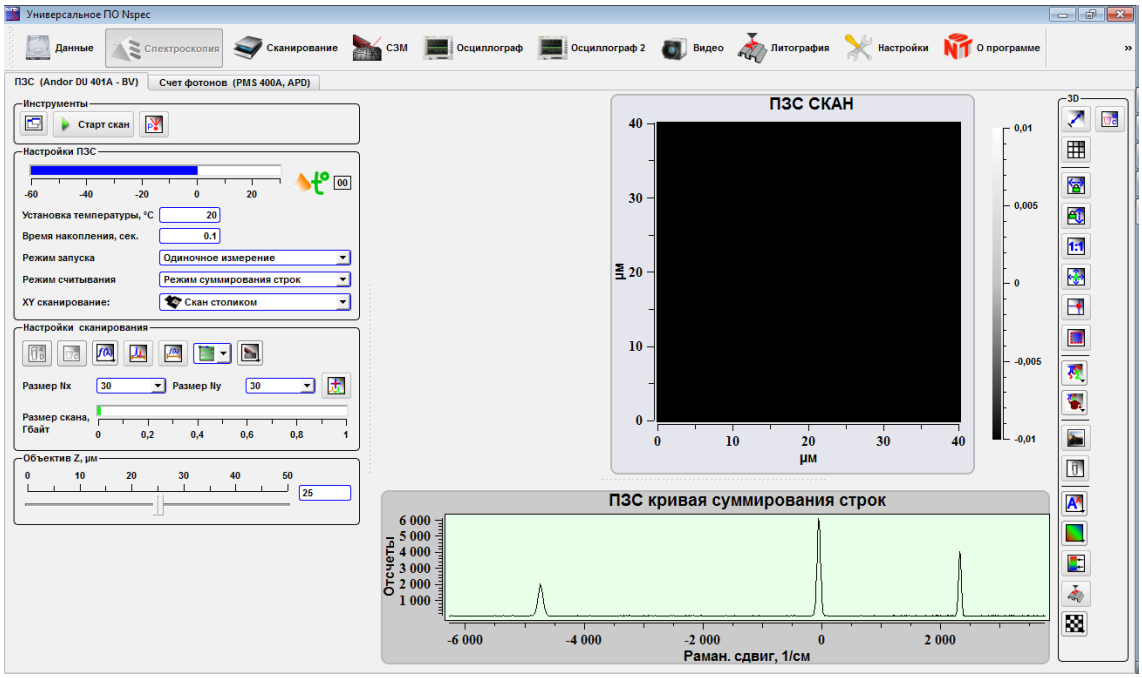


Fig. 8.27 Spectroscopy unit in the raster spectral images mode.

Basic tool set for CCD matrix adjustment is similar to tool set for spectrum obtaining on one point. Additionally specialized tool set on the **Scan option** panel is displayed for raster spectral images.

8.2.1. Settings and tools to work with spectral images

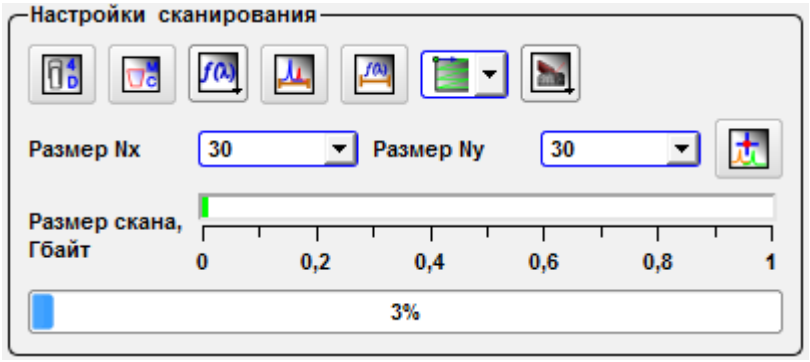
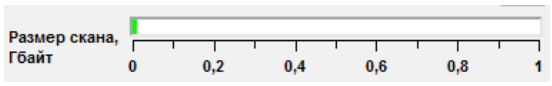


Fig. 8.28 Spectral scan options panel.

	Send to Data		Send obtained spectral image in the Data unit.
	Clear spectrum		Clear clipboard if it is overload by earlier obtained scans.
	Convolution function		Choice of a way of construction of the image on the basis of the spectral data. It is displayed only at work with spectral images.
		Integral	Image construction on integral of intensity from the received spectra in the chosen range.
		Maximum	Image construction on intensity maximum from the received spectra in the chosen range.
		Maximum position	Image construction on intensity maximum position from the received spectra in the chosen range.
		MassCenter position	Построение изображения по положению на поверхности центра масс максимумов спектров.
		Select spectrum range/ scan point.	Select spectrum wavelength range to record. By default full range is recorded.
		Select convolution range	Select range of specter curve to construct image. It is displayed only at work with spectral images.
			Selection of scanning direction.
	SPM scan connection		Select scanning mode.
		Single CCD	Only CCD matrix data scanning.
		Dual CCD/SPM	Simultaneously spectral (photoelectric multiplier)

			and SPM scanning with same resolution.
		Dual smart CCD/SPM	Simultaneously spectral (photoelectric multiplier) and SPM scanning with different resolution.
		Show spectrum in scan point	Switch between get spectrum in the selected point and move sample to the selected point.
			Estimate size of spectrum scan data.

Spectral data, obtained by Centaur and Centaur HR complexes, represents 4-dimensional array of intensity dependence from wavelength in each scan point (XY). For processing of similar images use the software NSpec.

8.2.2. Convolution functions choice

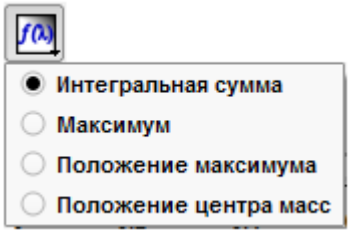


Fig. 8.29 8.2.2. Choice of spectral images convolution function.

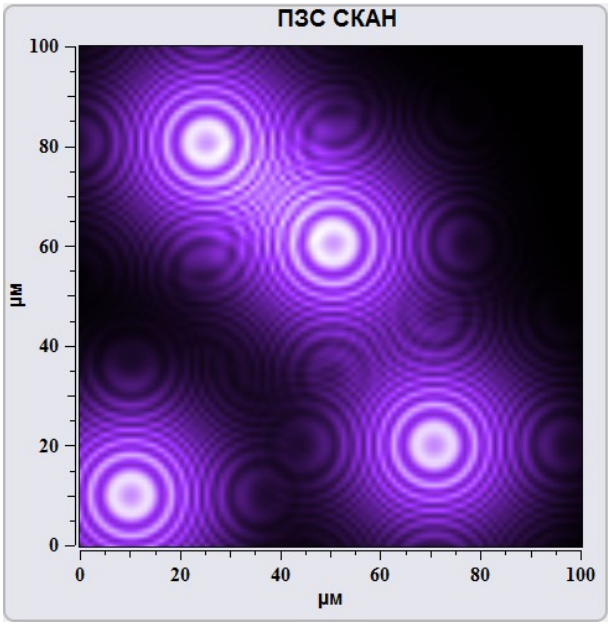


Fig. 8.30 Интегральная сумма.

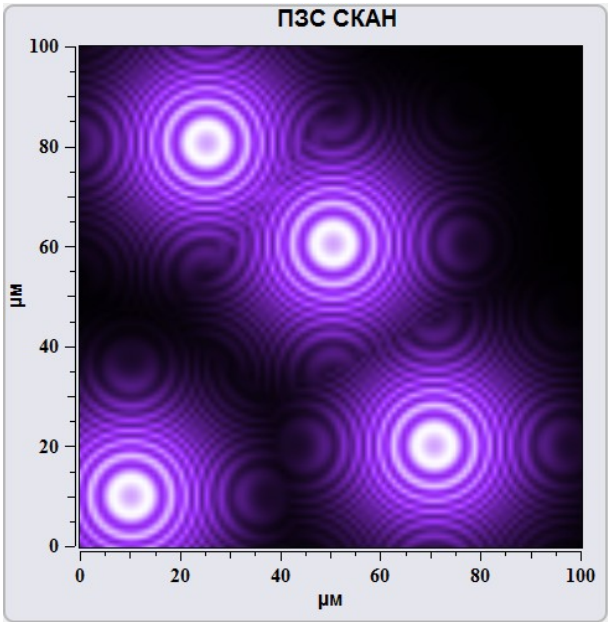


Fig. 8.31 Максимум.

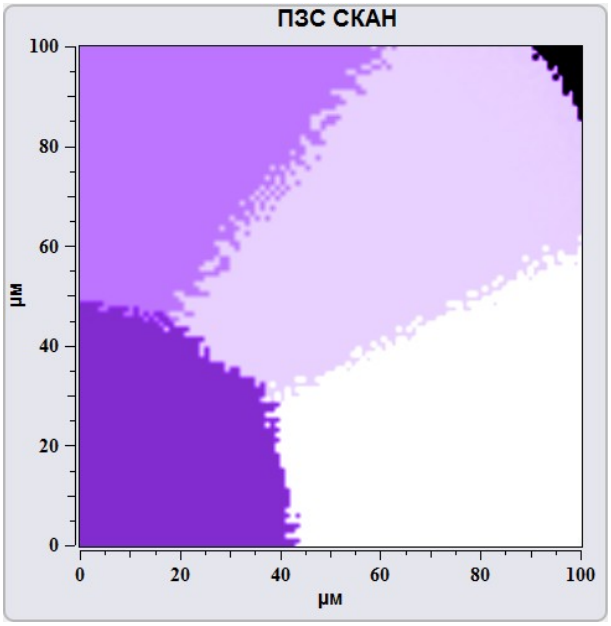


Fig. 8.32 Положение максимума.

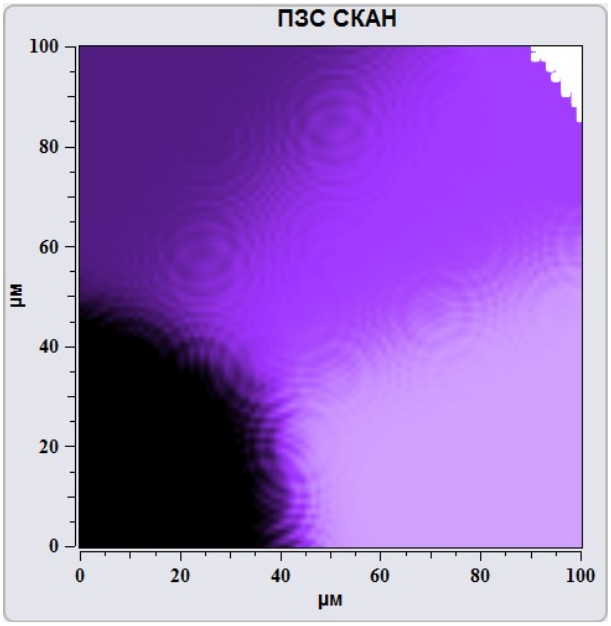


Fig. 8.33 Положение центра масс.

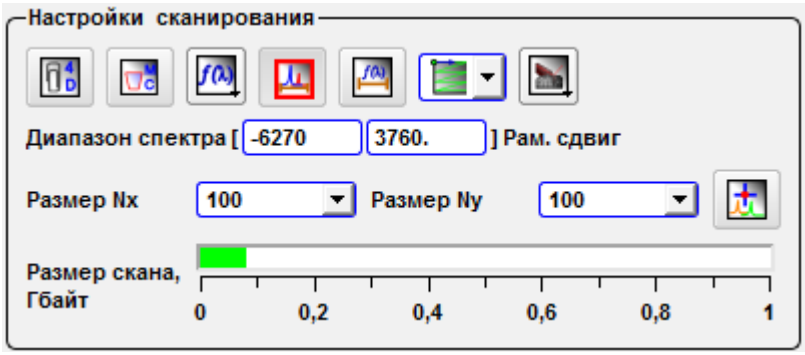


Fig. 8.34 Select spectrum range.

By pressing the button **Select spectrum range**  input fields for changing of spectral range is appeared on the **Scan options** panel. In this input fields the range of recorded spectrum is established. In the window of spectrum the allocation area which occupies all range of a spectrum is displayed.

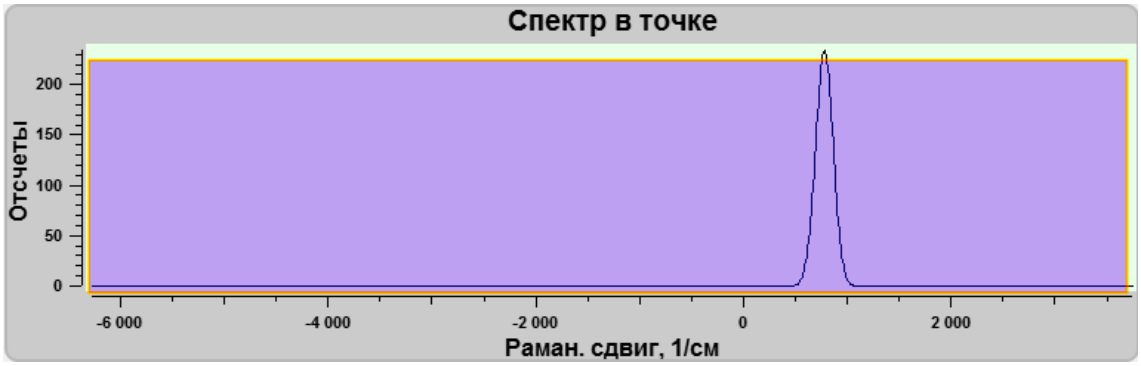


Fig. 8.35 Select spectrum range. Full range selected.

At prompting of the mouse cursor on vertical borders of allocation area the cursor assumes a standard shape of change of allocation area. Moving border of allocation area across the field of a spectrum, it is possible to establish area of recorded spectral data manually.

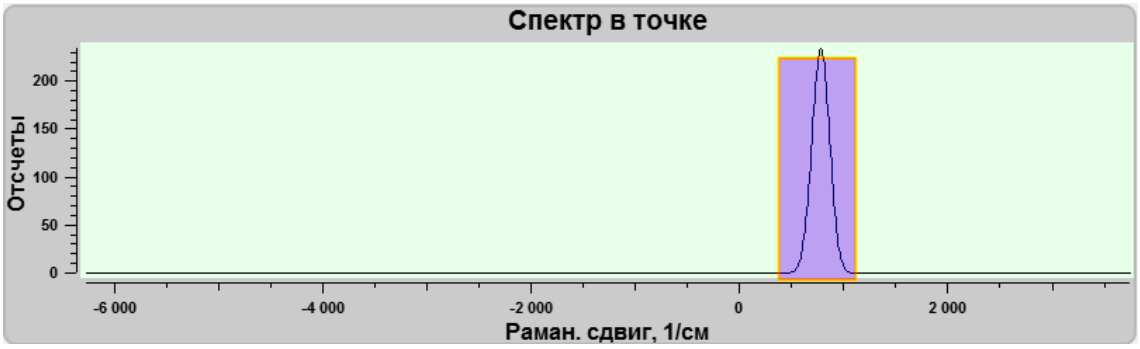


Fig. 8.36 Select spectrum range.

After a choice of a site of recorded spectrum it is required either to confirm a choice, or to return to a former range pressing buttons:

	apply	Apply changing allocation area
	Cancel	Cancel changing allocation area

In case of change of the range and start of process of scanning the range of recording spectrum will be limited by the chosen borders.

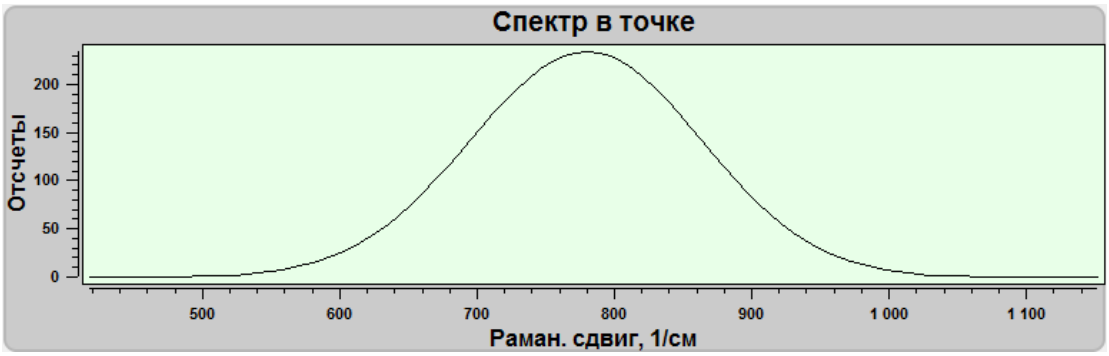


Fig. 8.37 Recording spectral range after choosing the range.

8.2.3. Displayed range of a spectrum

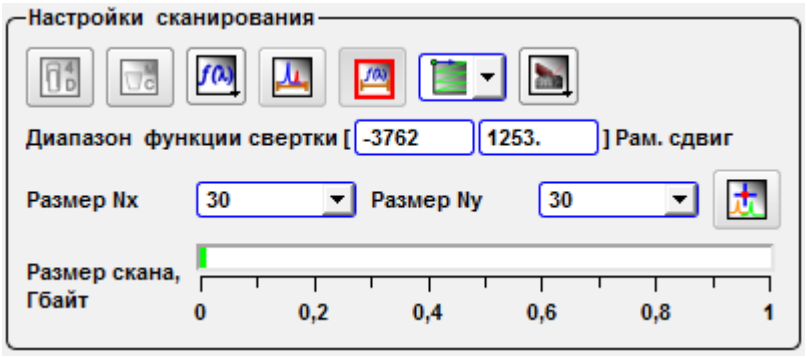


Fig. 8.38 Choice of a displayed range of a spectrum for convolution.

By pressing the button **Function convolution range selection**  input fields for changing of spectral range of convolution function is appeared on the **Scan options** panel. In this field the range of a written down spectrum in used units of measure is established. In the window of spectrum the allocation area which occupies all range of a spectrum is displayed.

Fig. 8.39 Выбор участка отображения спектра.

Changing the size of allocation area and moving it, on the spectral image it is possible to allocate sites with various intensity in the given spectral range.

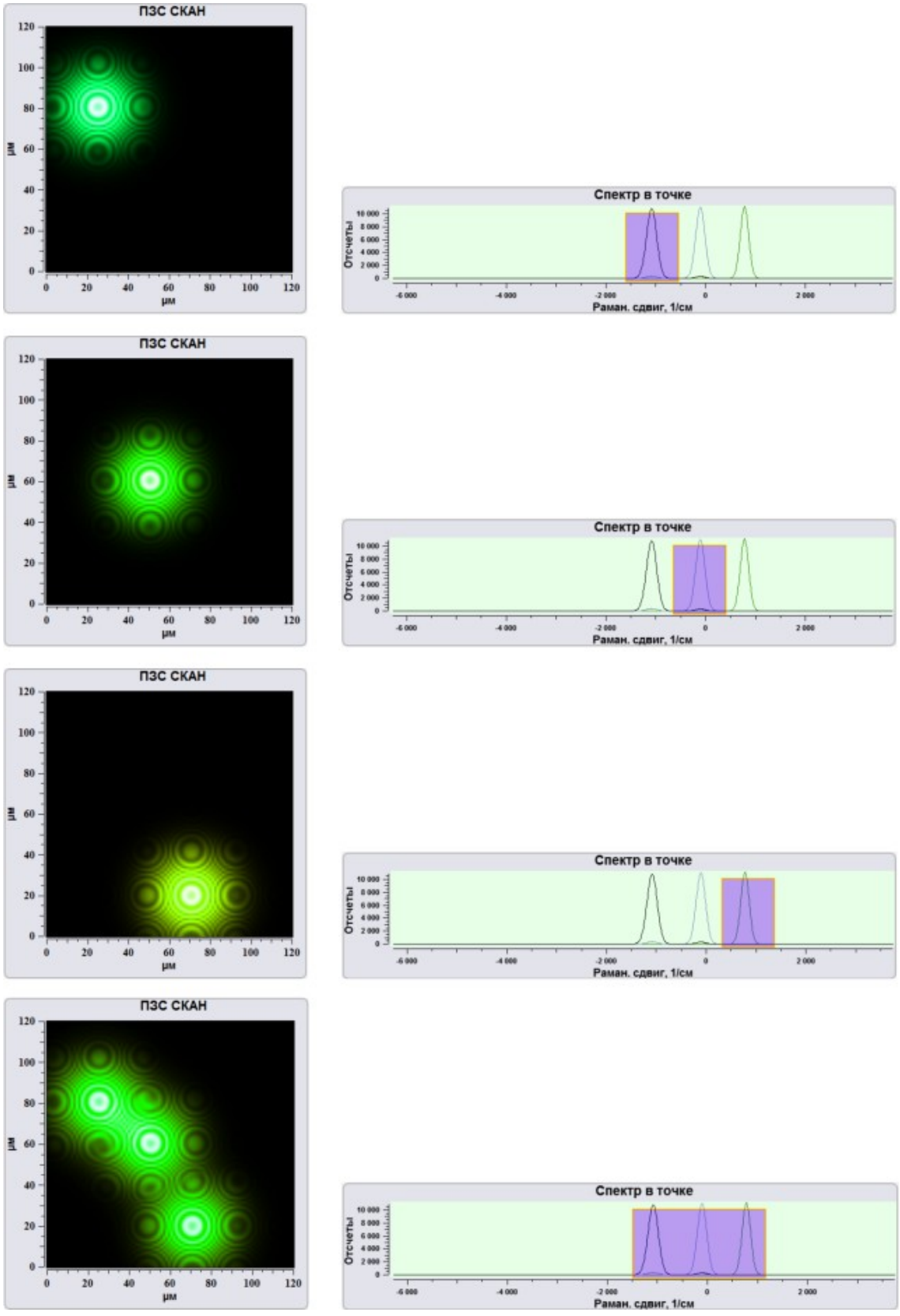


Fig. 8.40 Example of changing convolution function range of spectrum.

8.2.4. Scan direction

	Scan direction	Drop-down list with scan directions. The arrow shows fast scan direction.
		Along X axes, from upper left corner.
		Along Y axes, from upper left corner.
		Along X axes, from upper right corner.
		Along Y axes, from upper right corner.
		Along X axes, from lower left corner.
		Along Y axes, from lower left corner.
		Along X axes, from lower right corner.
		Along Y axes, from lower right corner.

8.2.5. Scanning mode

For a choice of a mode of scanning it is necessary to activate the drop-down list **SPM scan connection**  .

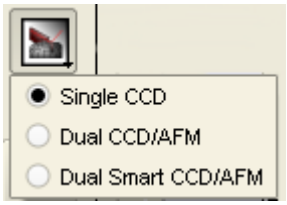


Fig. 8.41 Choosing of scanning mode.

In the case of **Single CCD** passes only scanning in a mode of confocal spectral microscope.

In the case of **Dual CCD/AFM** or **Dual Smart CCD/AFM** it is in addition possible to receive images on still three AFM signals in the **Scan** unit. In the first mode all images will have same resolution in points, in the second – AFM images may have dif-

ferent resolution from CCD one. At a choice of one of modes of joint scanning in the **Scan** unit automatically one of the plotter occupies the projection of the spectral image.

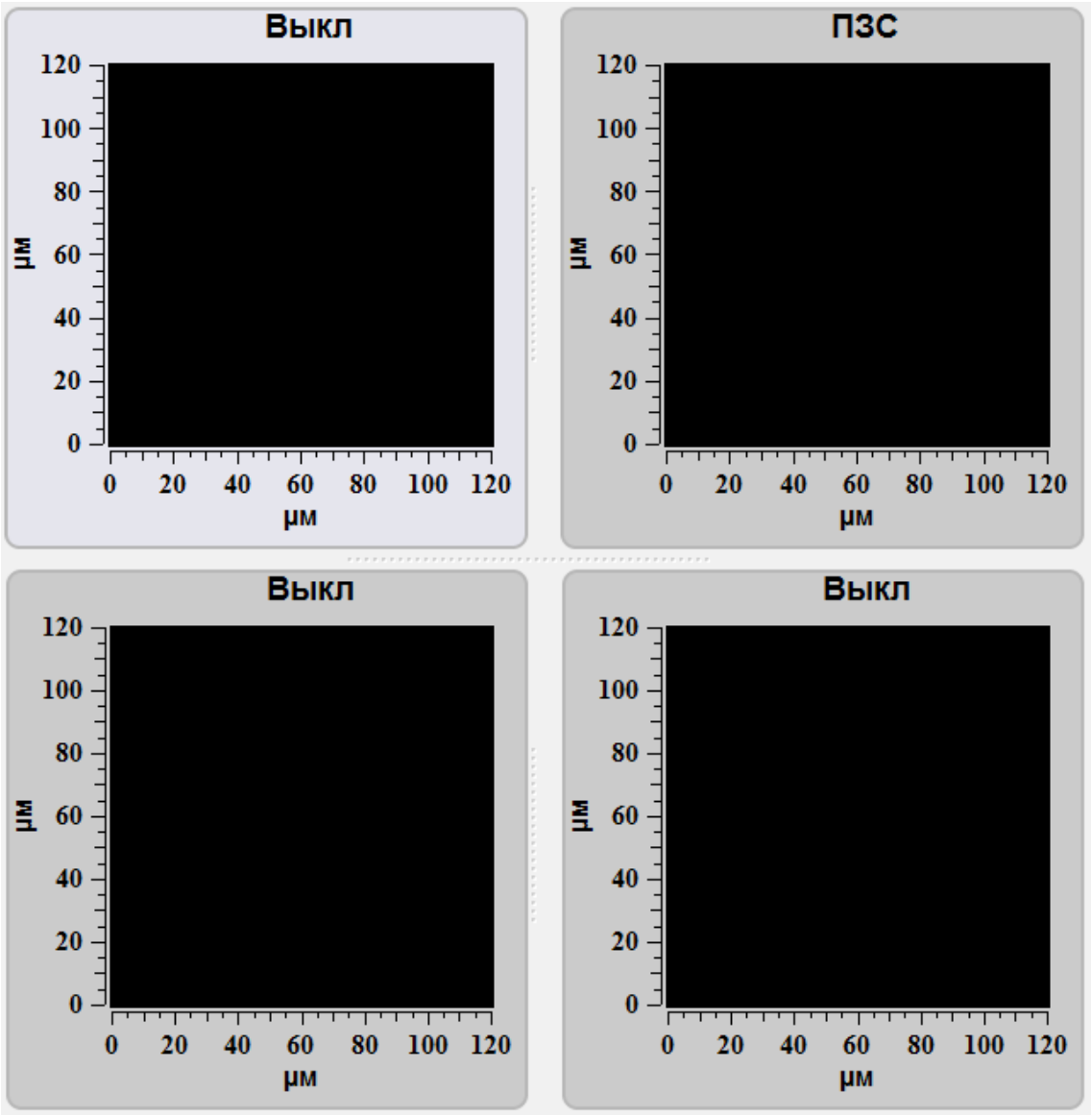


Fig. 8.42 Scan result plotters view in Dual CCD/AFM or Dual Smart CCD/AFM modes.

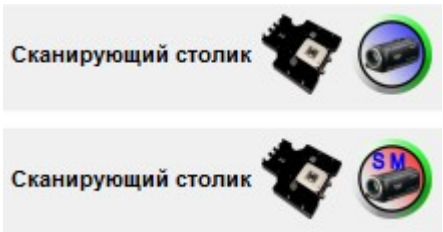


Fig. 8.43 Scanning mode indicator. Dual CCD/AFM and Dual Smart CCD/AFM.

For a choice of the image resolution (number of points) drop-down lists **Nx points, Ny points** are used.

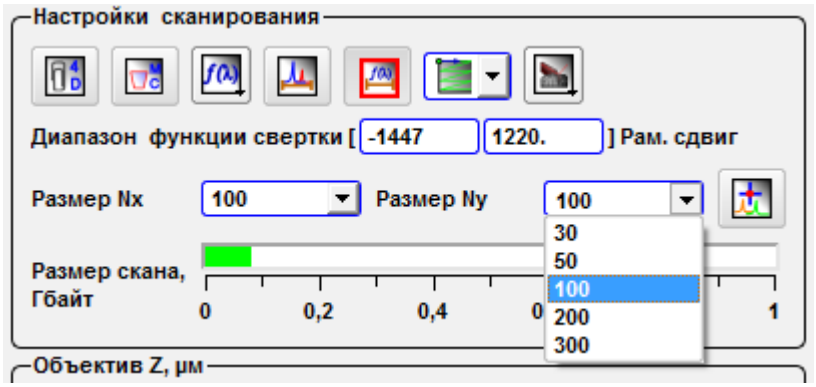


Fig. 8.44 Scan resolution.

For management of position of an optical microscope objective on axis Z at obtaining of the spectral information use the slider **Objective Z, µm**.

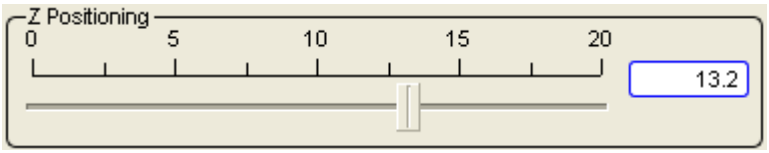


Fig. 8.23 Objective Z slider.

8.3. Panoramic spectrum

The mode of a panoramic spectrum is used when width of a spectrum is more than CCD sensor width. For full read of a spectrum in that case it is necessary to turn diffractional a lattice that all spectrum passed on a matrix. At a choice of the mode of the **Panoramic spectrum** 

in addition there is the tools panel **Panoramic spectrum.**

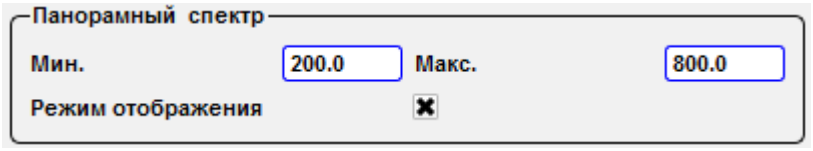


Fig. 8.47 Panoramic spectrum panel.

On this panel the minimum and maximum wavelengths is established for a range in which there will be a spectrum obtaining. The check box a **display Mode** allows to show on the screen intermediate results in the course of scanning of a panoramic spectrum.

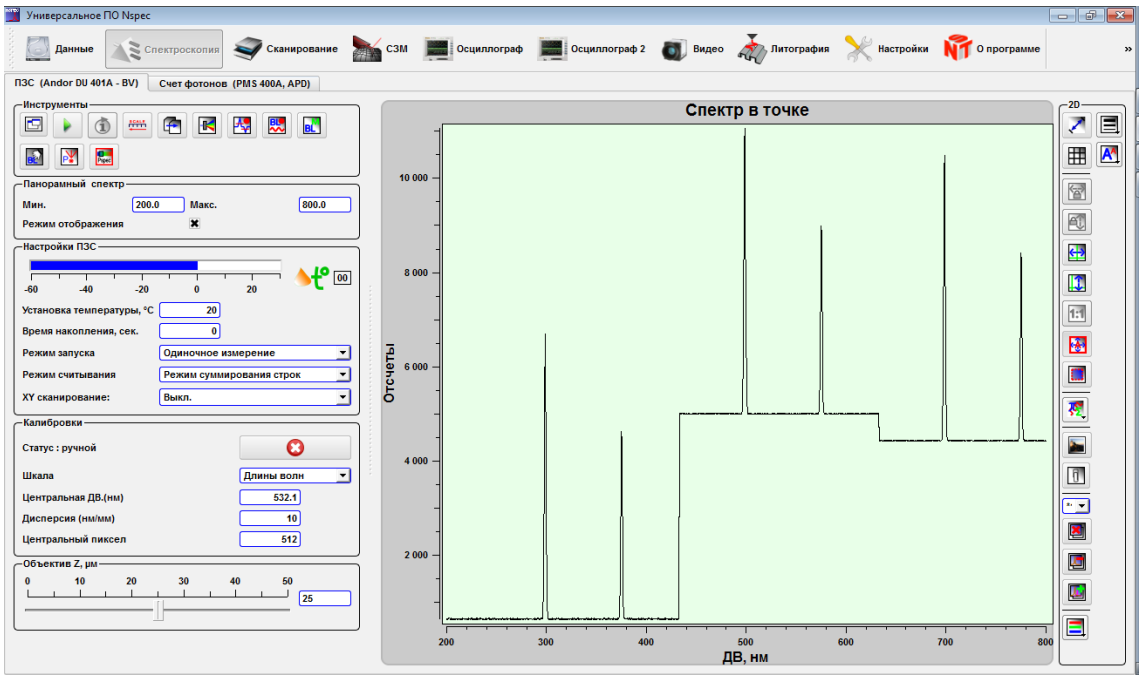


Fig. 8.48 Spectroscopy. Panoramic spectrum mode.

8.4. Photons counter adjustment

For transition to management of the photons counter device pass in the tab **Photon counter** in the unit **Spectroscopy.**

		Start/Stop	Start/stop of photon counting.
		Additional options	Call of the additional options panel.
		Scanning mode	Scanning mode drop-down list.
		None	Photon counter mode on the constant wavelength.
		Spectrum mode	Photon counter mode in the wavelength range.
		Head scan	Raster scanning of surface by the SPM head in a mode of the account of photons.
		Stage scan	Raster scanning of surface by the stage in a mode of the account of photons.

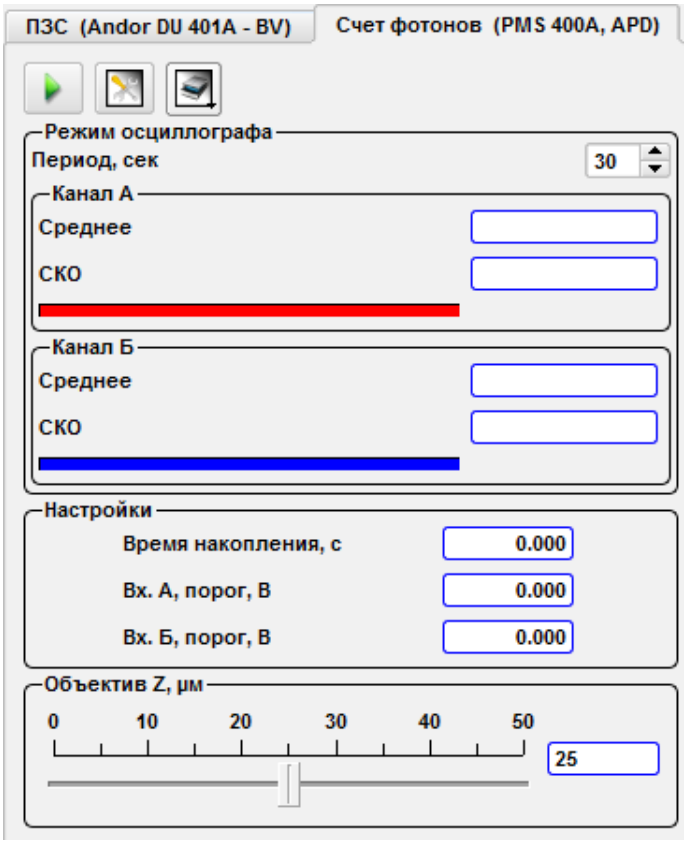


Fig. 8.49 Photons counter.

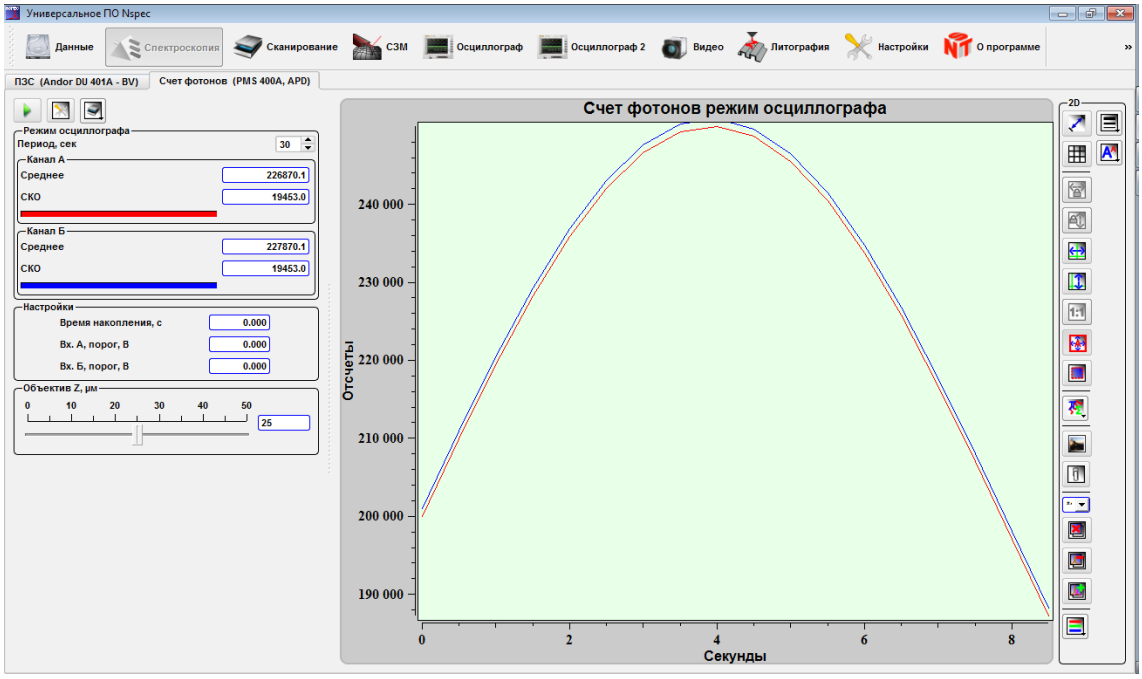


Fig. 8.50 Spectroscopy unit in the photons counter mode.

8.4.1. Photons counter device options

For adjustment of the photons counter device the tools panel **Settings** is used.

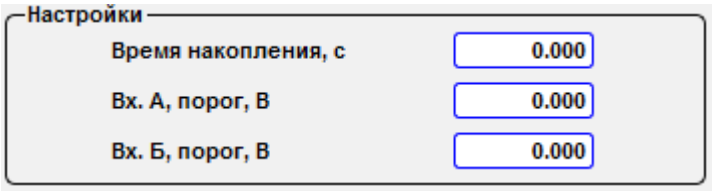


Fig. 8.51 Photon counter device basic settings.

Exposure time, s	Exposure time
Ch A threshold level, V Ch B threshold level, V	Counters threshold voltage. A count is initiated when the input signal crosses the trigger threshold. The input amplitude should be in the range between 20 mV and 1 V.

8.4.2. Photons counter device additional options

For a display on the screen of the panel of additional options of the photons counter device press the button **Additional options**  .

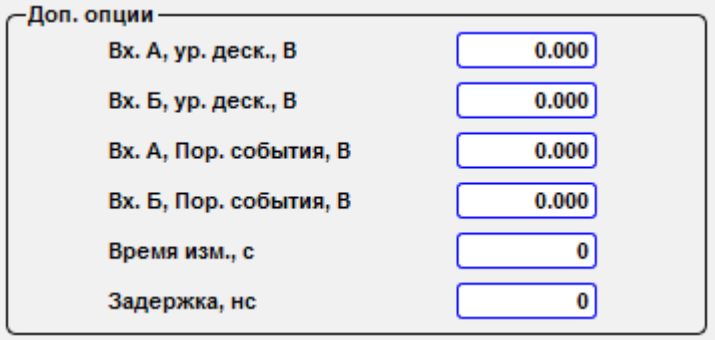


Fig. 8.52 Photon counter device additional settings.

Ch A gate level, V	Gates threshold voltage. Fast gating of the counter operation is accomplished by using the GATE inputs. The pulse edges at the COUNT input are counted only as long as an appropriate level at the GATE input is present. The pulse amplitude at the gate inputs should be in the range from 20 mV to 2 V.
Ch B gate level, V	
Ch A event threshold	
Ch B event threshold	
Collect time, s	Time of photons collection.
Input hold-off, ns	Delay after operation before the beginning of following measurement.

8.4.3. Photons counter modes

For a choice of an operating mode of the photons counting device it is necessary to use the dropping out list **Scanning mode**  .

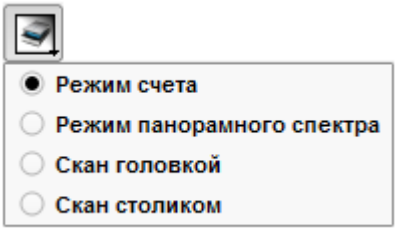


Fig. 8.53 Operating mode choice of photons counter.

8.4.4. Counting mode

At a choice an **account Mode** the tools panel an oscilloscope **Mode** is active. In this mode of the photons counter goes on constant length of a wave with development on time.

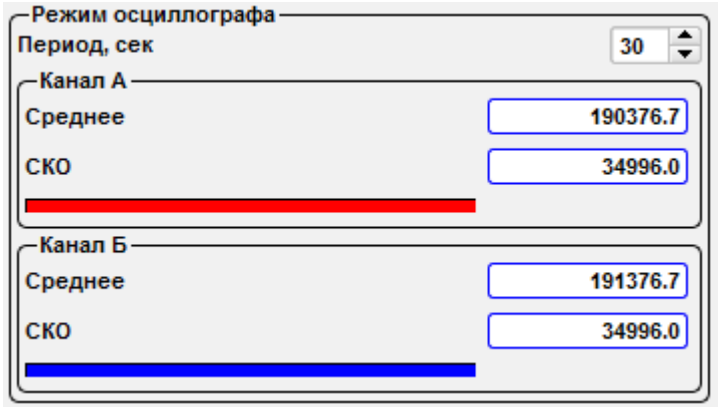


Fig. 8.54 Панель инструментов Режим осциллографа.

On this tool panel the period of accumulation is established and average value and root-mean-square deviation is displayed

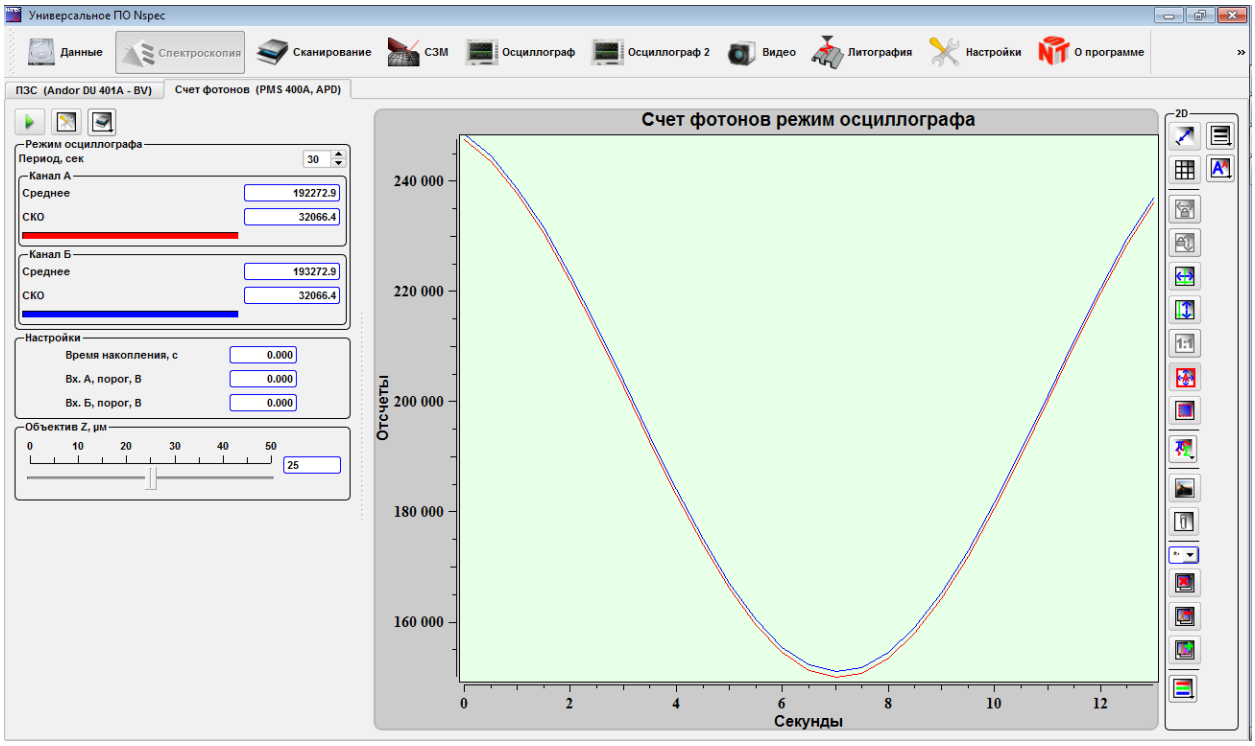


Fig. 8.55 Photons counting mode.

8.4.5. Spectrum mode

In the **Spectrum mode** the tool panel **Spectrum mode** is active. Photons counter mode counts in the wavelength range selected by monochromator with fixed points number.

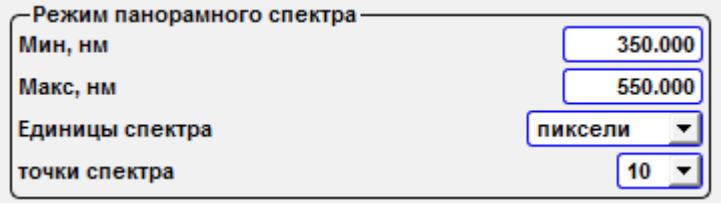


Fig. 8.56 tool panel **Spectrum mode**.

On this panel of tools range borders in lengths of waves (Minute, nanometer and Max, nanometer), units of measure (pixels, lengths of waves, Raman shift) and number of points on a range are established.

8.4.6. Scanning mode

At a choice of **stage scan** or **head scan** the tool panel for adjustment of scanning in a surface is displayed.

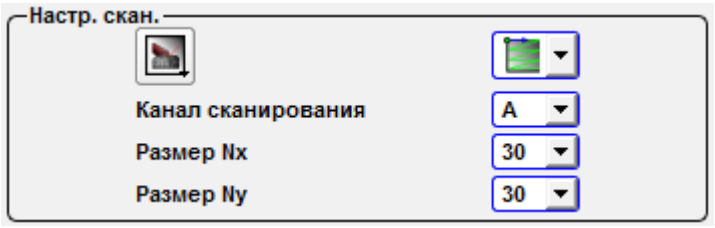


Fig. 8.58 Панель инструментов Режим Скан столиком.

		Select scanning mode.
	Single CCD	Only photons counter data scanning.
	Dual CCD/SPM	Simultaneously photons counter and SPM scanning with same resolution.
	Dual smart CCD/SPM	Simultaneously photons counter and SPM scanning with different resolution.
	Scan direction	Drop-down list with scan directions. The arrow shows fast scan direction.
	Scan channel	Choice of the channel of the photons counter for scanning
	Nx points	Scan size in X
	Ny points	Scan size in Y

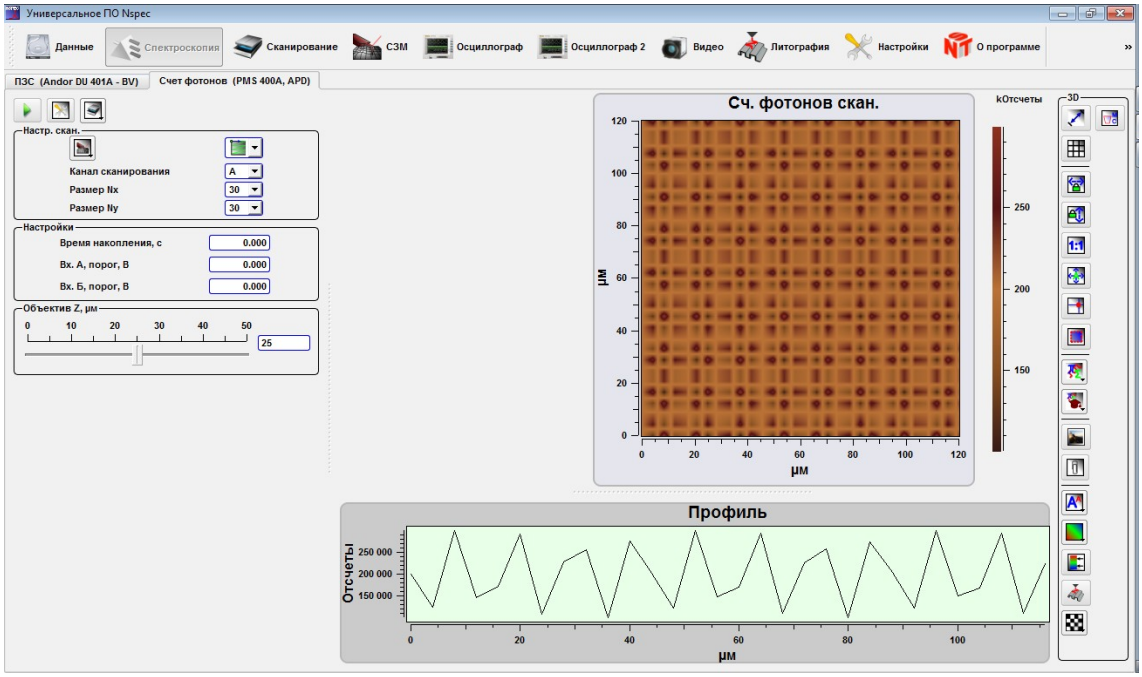


Fig. 8.59 Общий вид панели Счет фотонов в Режиме Скан столиком.

In the case of **Single photons counter** passes only scanning in a mode of confocal spectral microscope.

In the case of **Dual CCD/AFM** or **Dual Smart CCD/AFM** it is in addition possible to receive images on still three AFM signals in the **Scan** unit. In the first mode all images will have same resolution in points, in the second – AFM images may have different resolution from CCD one. At a choice of one of modes of joint scanning in the **Scan** unit automatically one of the plotter occupies the projection of the photons counter image.

9. Optomechanical unit adjustment and control

For additional options of complexes Centaur and Centaur HR in modes confocal spectral microscope and confocal laser microscope use function **Run Centaur instrument control**  . After pressing of this button the screen the window of tools of management will be deduced by the optomechanical module.

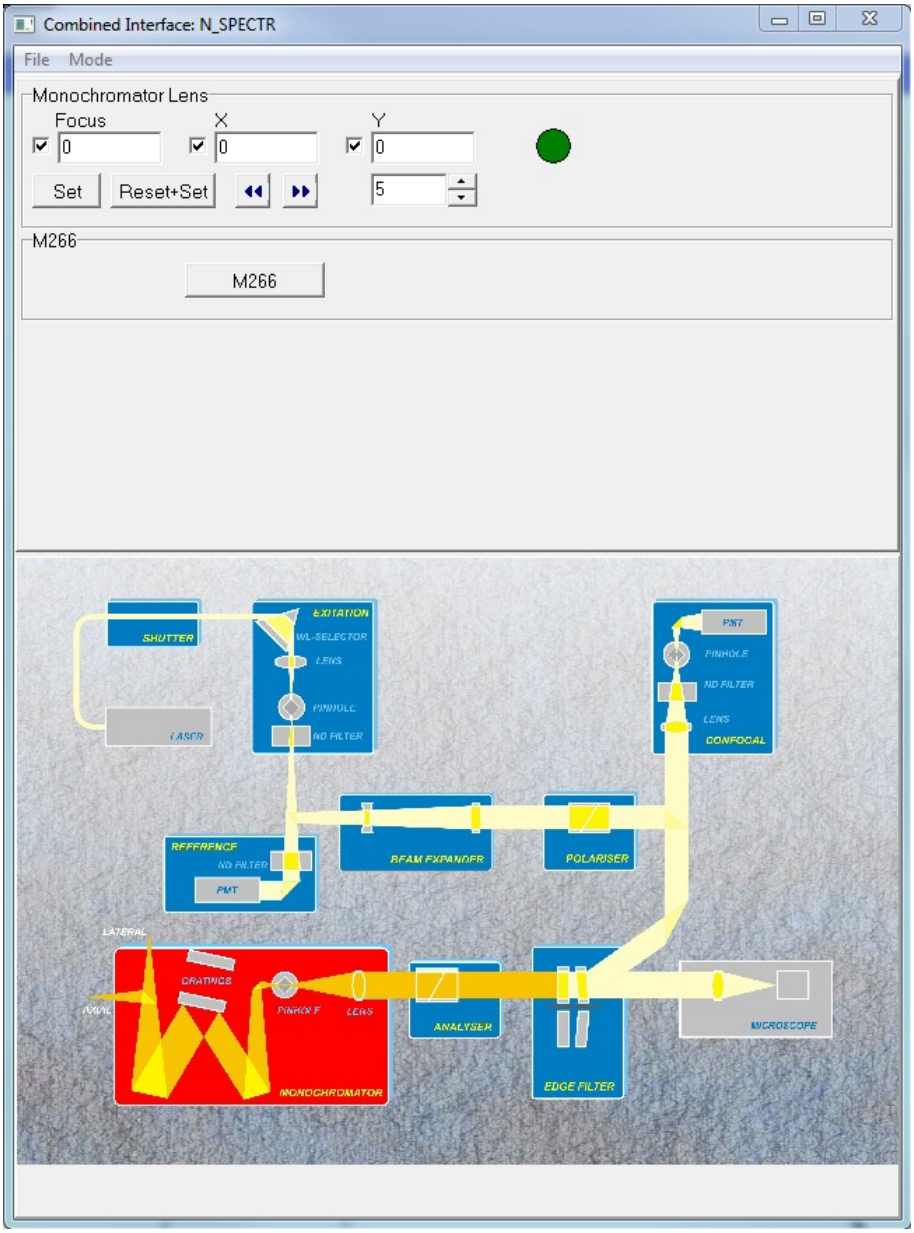


Fig. 9.1 Centaur instrument control window.

This tools window has three operating modes. For a choice of a mode of display it is necessary to pass in menu **Mode** and to choose a necessary mode from the drop-down list. In mode **Inner** the choice of the operated device carries out on a circuit diagram.

The chosen device is highlighted by red light and in the field of options changeable parameters are deduced.

Fig. 9.2 Centaur instrument control window, Inner mode.

The similar kind has mode **Image,** except that the circuit diagram and the field of options are deduced in different windows.

At a choice of mode **Tree** a device circuit diagram not to be deduced, and devices accessible to change are displayed in the tree form.

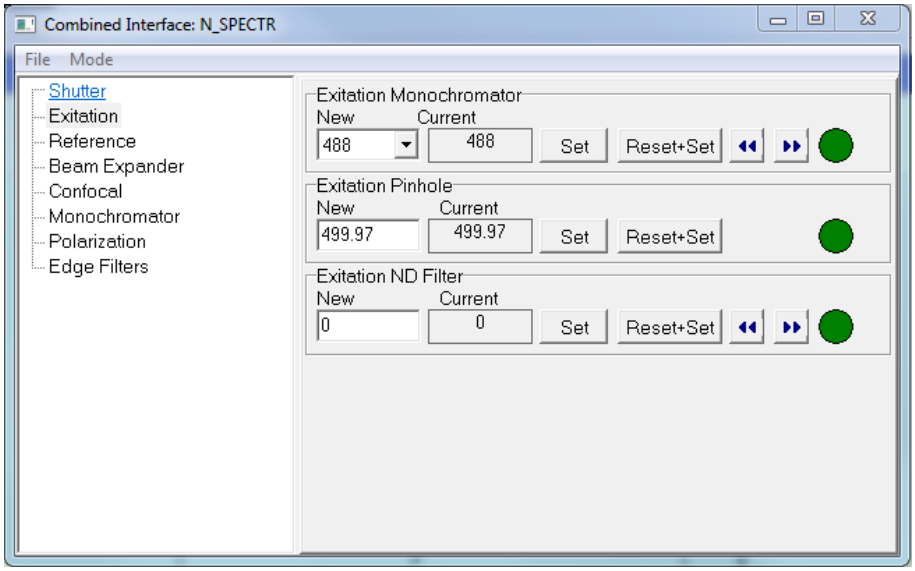
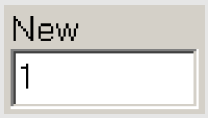
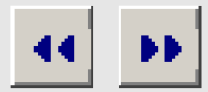
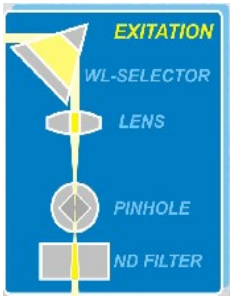
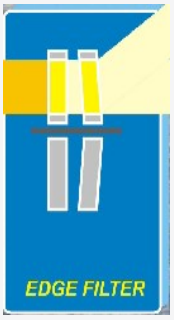
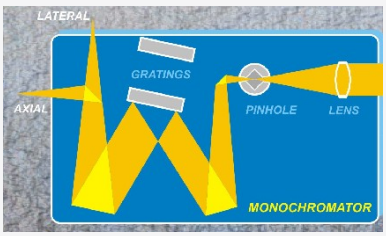
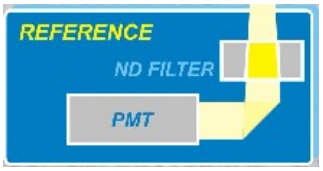


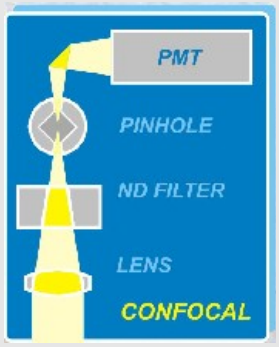
Fig. 9.3 Centaur instrument control window, Tree mode

9.1. The general interface elements of options management

		The device which options are changed.
		The device which options may be changed now.
		The device which options are closed for changes.
		Open/close shutter.
		Parameter input field.
		Parameter value.
		The step-by-step mover at first is translated in extreme position to the end, then established in demanded position.
		Apply parameters and options.
		Indicator of options applying status. Applied or in process.
		Check box.
		Step-by-step moving.
		Step value.
		Additional devices adjustment.
		Combo box control.

9.2. Units list

	Shutter
	Wavelength selector
	Beam Expander
	Polarizer
	Edge filter
	Analyzer
	Monochromator
	Reference photoelectric multiplier

	Confocal unit
	Additional devices adjustment.

9.2.1. Collimator

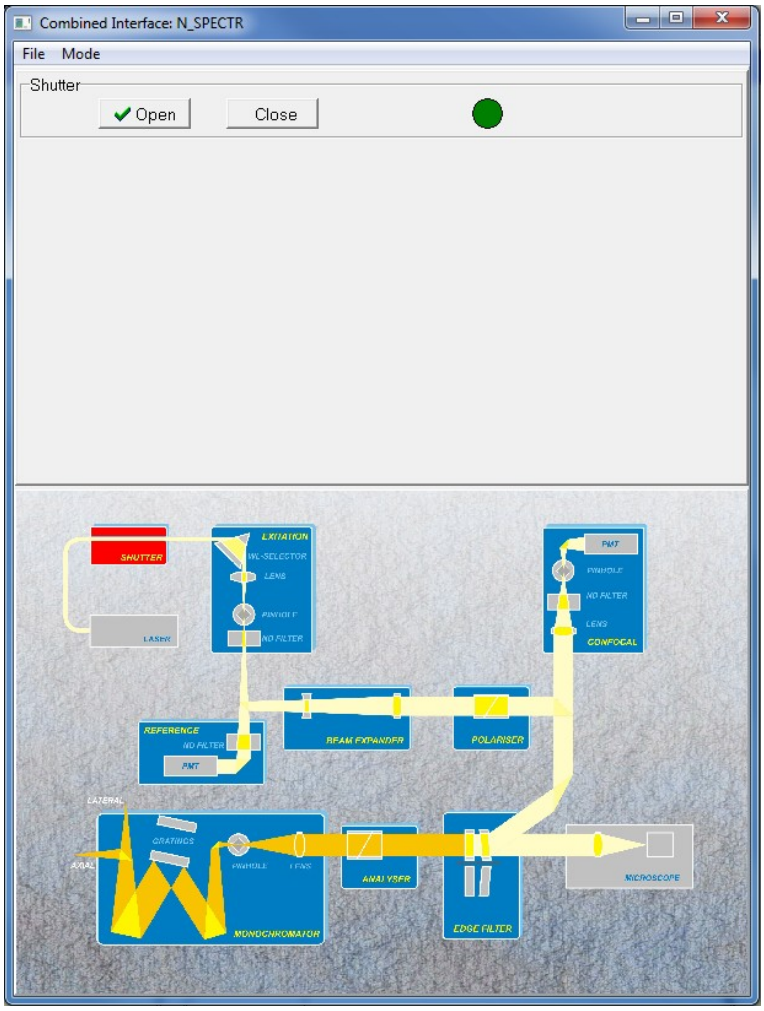
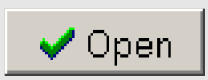


Fig. 9.4 Collimator options.

		Open collimator shutter.
		Close collimator shutter.

9.2.2. Wavelength selector

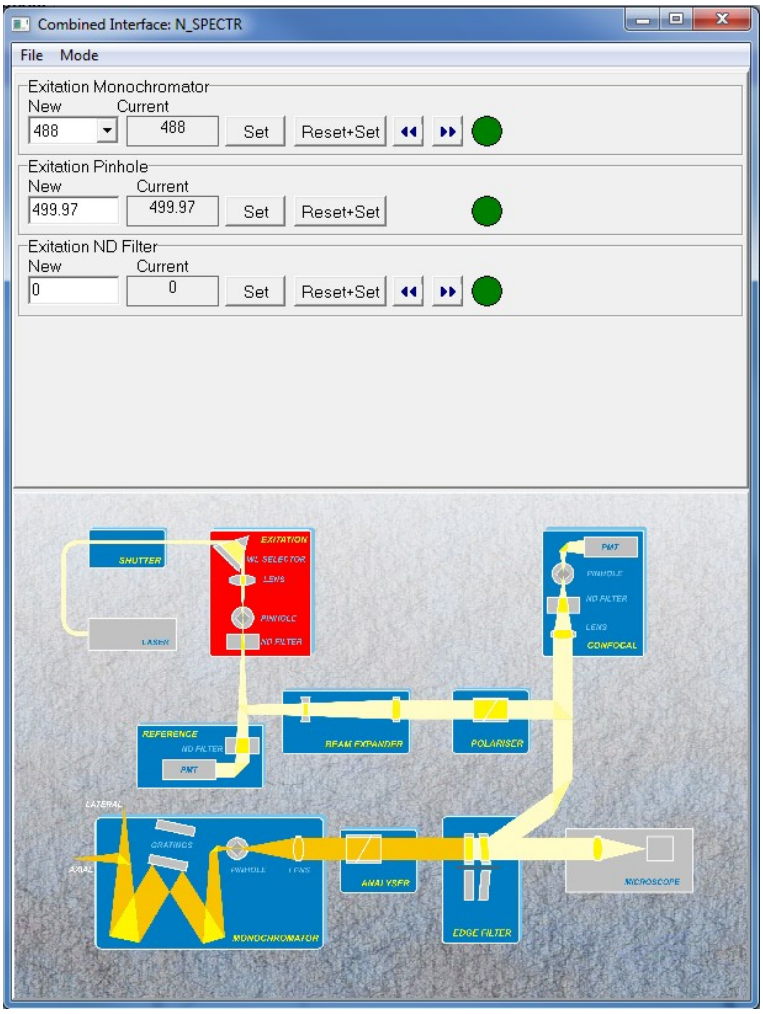


Fig. 9.5 Wavelength options.

Excitation Monochromator		Laser wavelength.
Excitation Pinhole		Size of two-dimensional crossed pinhole – from 0 to 1000 μm.
Excitation ND Filter		The neutral filter of variable density. Numerical value means an order of damping of the laser signal
	0	Without damping.
	1	10-fold damping.
	2	100-fold damping.
	3	1000-fold damping.
	4	10000-fold damping.

9.2.3. Beam expander

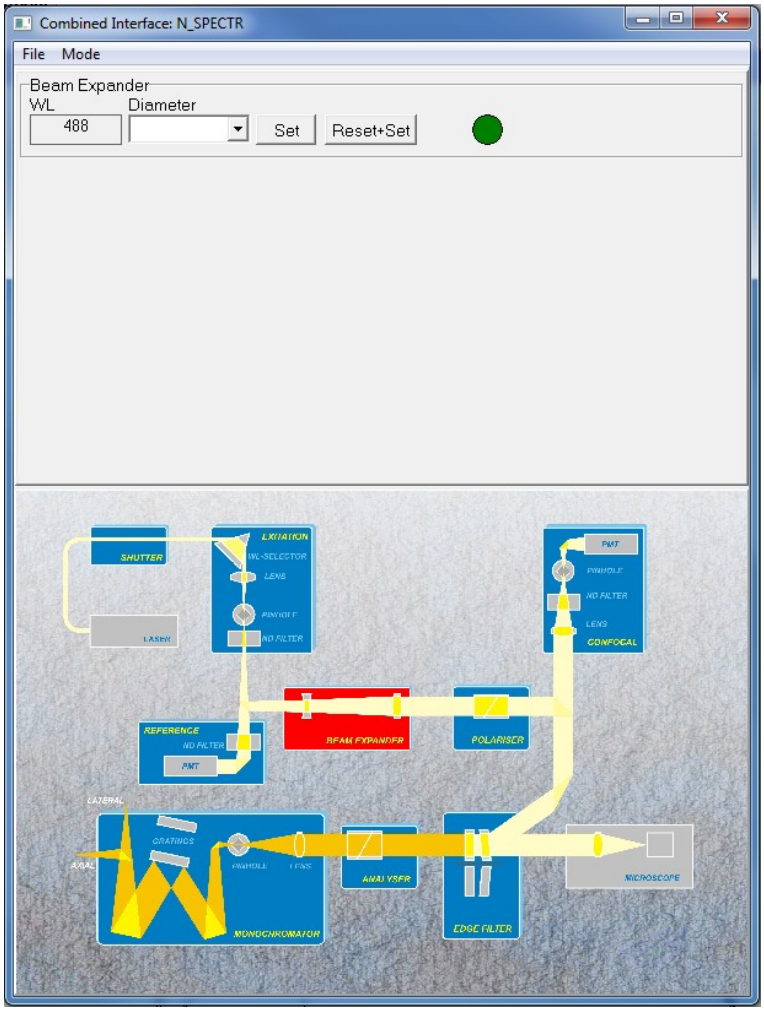


Fig. 9.6 Beam expander options.

Beam Expander

Diameter Beam diameter.

9.2.4. Polarizer

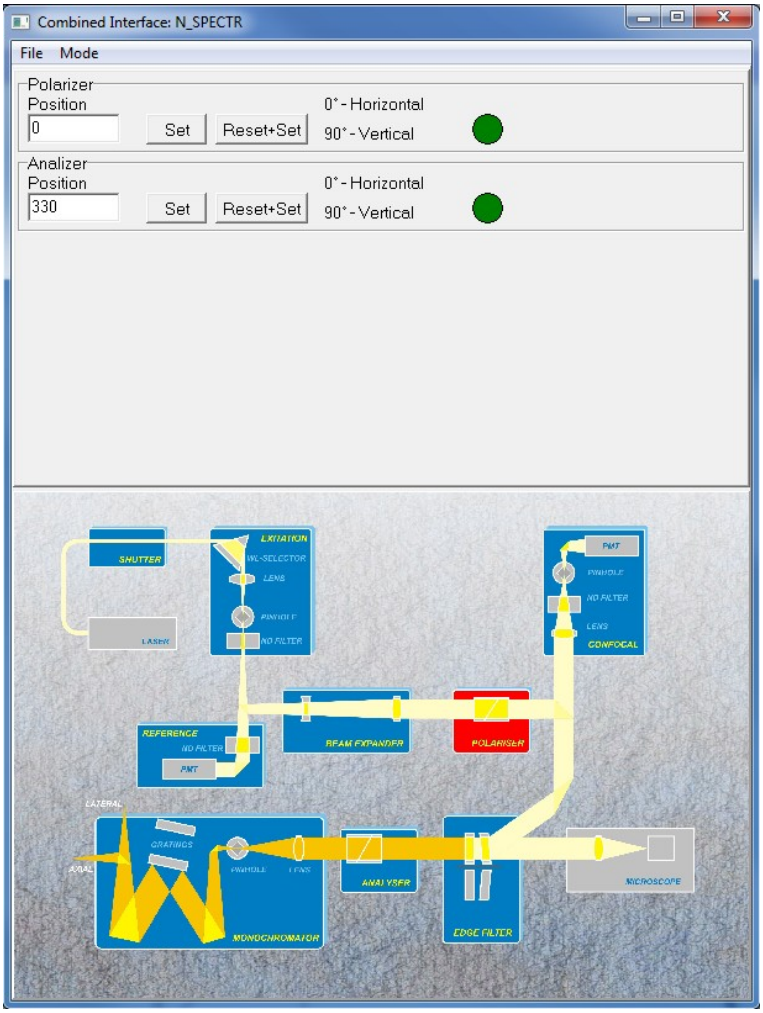


Fig. 9.7 Polarizer options.

Polarizer		Establishing of a polarization angle.
	Position	Angle in grad.
Analyzer		Establishing of a polarization angle.
	Position	Angle in grad.

9.2.5. Edge filters

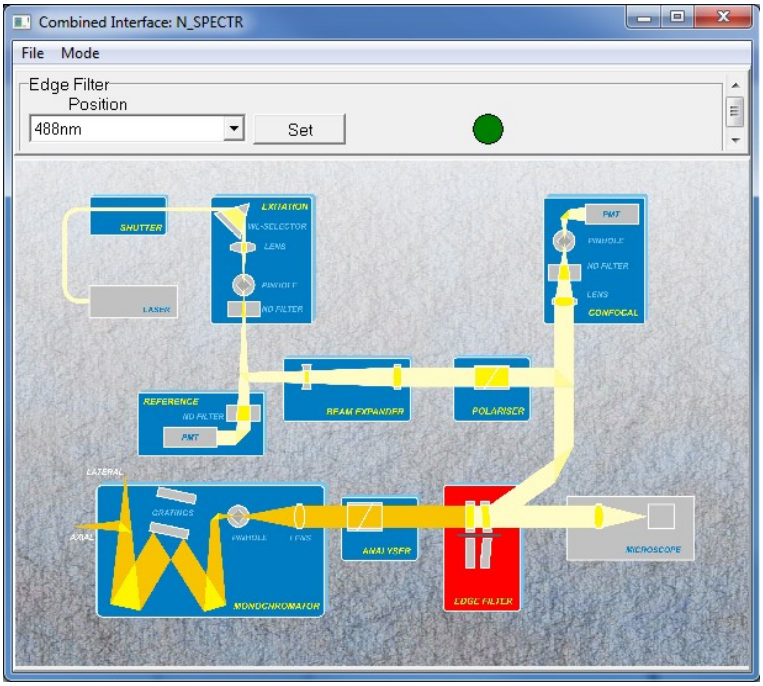


Fig. 9.8 Edge filters adjustment.

Edge Filter		List of available filters. Filters is mounted on the turning wheel with four positions.

9.2.6. Monochromator

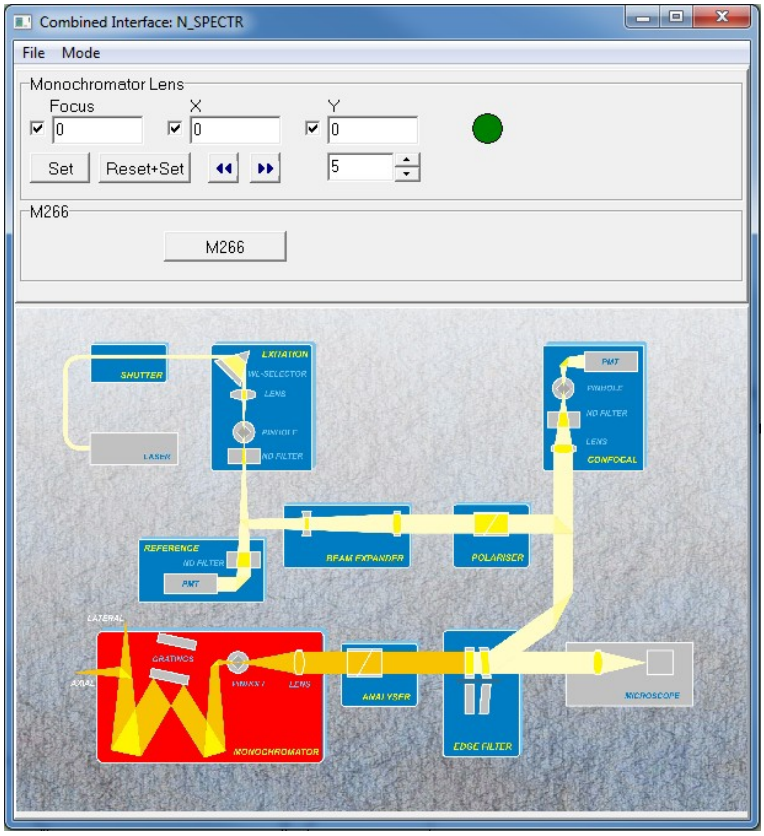


Fig. 9.9 Monochromator options.

Monochromator Lens		Management of objective position in the monochromator.
	Focus	Focusing along optical axis.
	X	Objective moving on an axis of X perpendicularly optical axis.
	Y	Objective moving on an axis of Y perpendicularly optical axis.
M266		External monochromator adjustment.

9.2.7. External monochromator adjustment

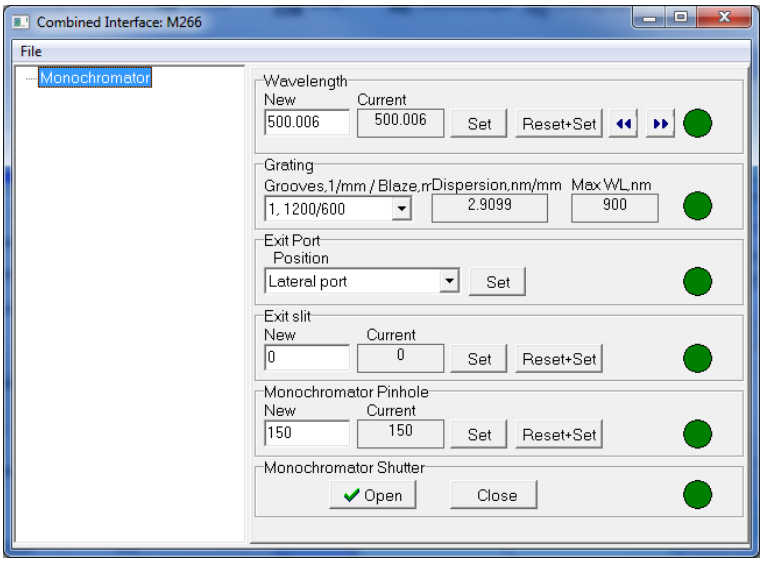


Fig. 9.10 External monochromator options.

Wavelength	nm	Central wavelength falling on the grating.
Grating		Choosing diffraction grating (Centaur) or pair of gratings (Centaur HR).
	0/0	Mirror (Centaur), not available on Centaur HR.
	1	First grating or gratings pair.
	2	Second grating or gratings pair
	3	Third grating or gratings pair
Exit slit		Crossed exit pinhole size control, from 0 to 1000 μm.
Monochromator Pinhole		Crossed pinhole of monochromator size control, from 0 to 1000 μm.
Monochromator Shutter		Monochromator Shutter.
		Open shutter.
		Close shutter.

9.2.8. Confocal unit

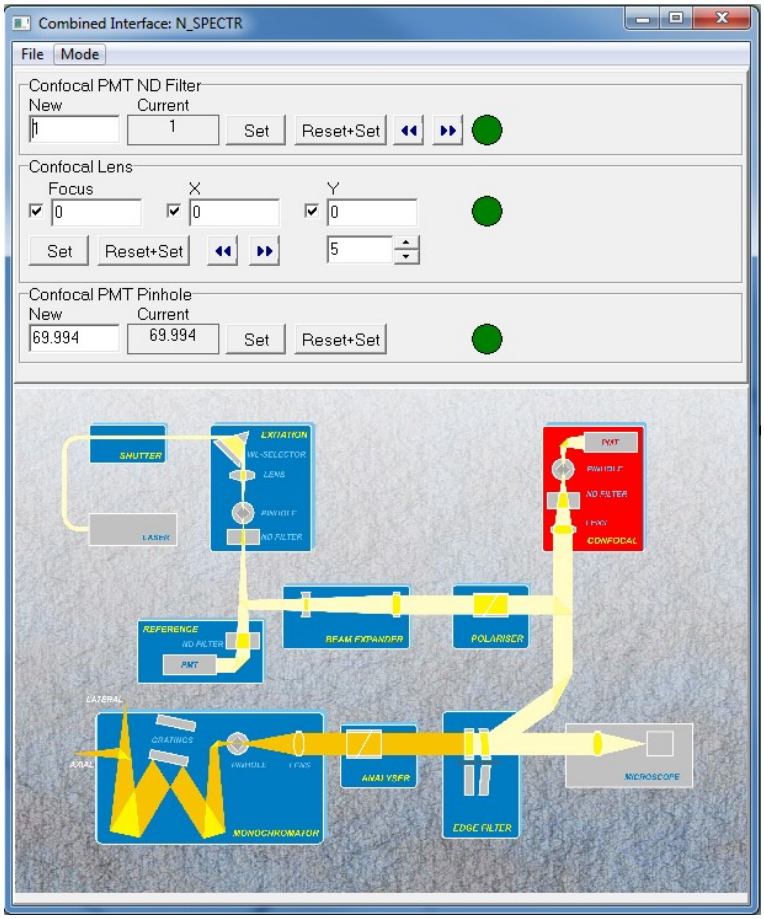


Fig. 9.11 Confocal unit control.

Confocal PMT ND Filter		The neutral filter of variable density. Numerical value means an order of damping of the laser signal
	0	Without damping.
	1	10-fold damping.
	2	100-fold damping.
	3	1000-fold damping.
	4	10000-fold damping.
Confocal Lens		Management of objective position in the confocal unit.
	Focus	Focusing along optical axis.
	X	Objective moving on an axis of X perpendicularly optical axis.
	Y	Objective moving on an axis of Y perpendicularly optical axis.
Confocal PMT pinhole		Crossed confocal pinhole size control, from 0 to 1000 μm.

9.2.9. Reference

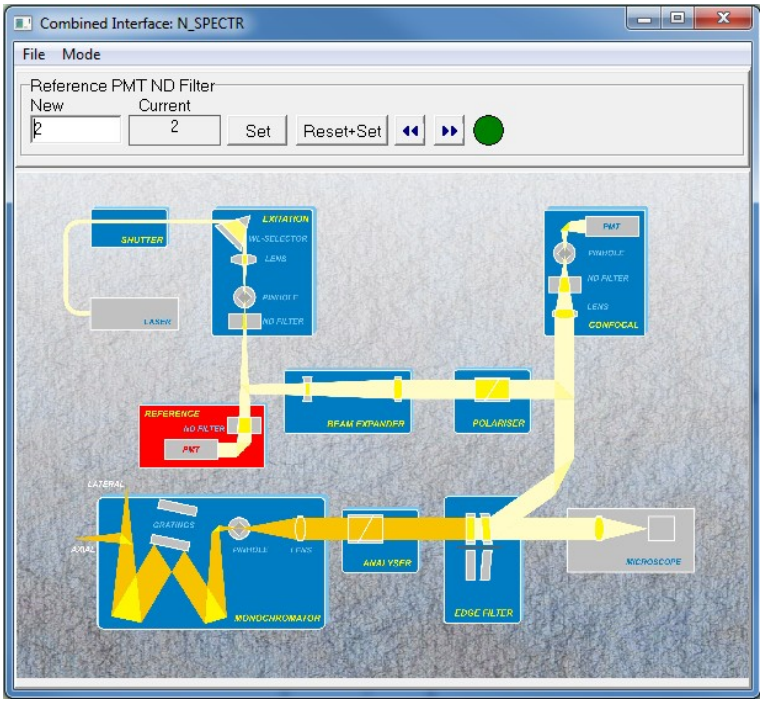


Fig. 9.12 Reference photoelectric multiplier control.

Reference PMT ND Filter		The neutral filter of variable density. Numerical value means an order of damping of the laser signal
	0	Without damping.
	1	10-fold damping.
	2	100-fold damping.
	3	1000-fold damping.
	4	10000-fold damping.

10. NSpec interface options

For program interface tuning is used **Options** unit, that is located on the basic instruments panel 

. After pressing this button program options window appears.

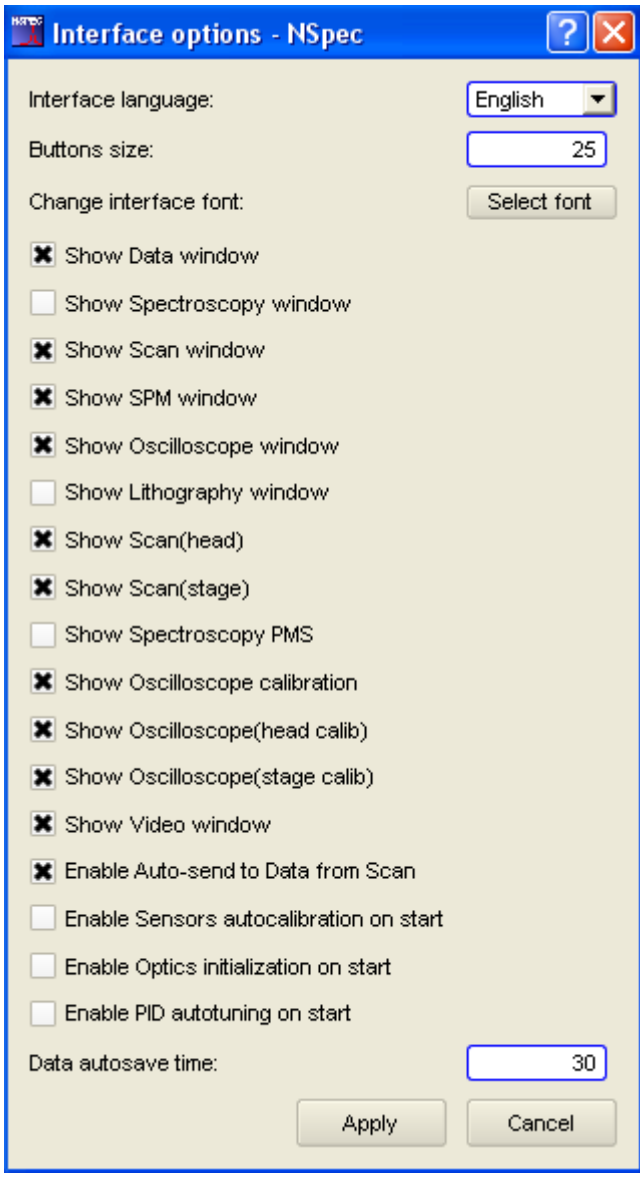


Fig. 10.1 NSpec user interface options.

Interface language	Interface language combo box
Buttons size	Interface buttons size (px)
Select font	Calls “Select font” standard dialog
Show data window	Data unit on/off check box
Show spectroscopy window	Spectroscopy unit on/off check box

Show scan window	Scan unit on/off check box
Show SPM options window	SPM unit on/off check box
Show oscilloscope window	Oscilloscope unit on/off check box
Show lithography window	Lithography unit on/off check box
Show scan (Head) window	Scanning by head tab in the Scan unit on/off check box
Show scan (Stage) window	Scanning by stage tab in the Scan unit on/off check box
Show photons counter tab	Show/hide photons counter tab in the Spectroscopy unit check box.
Show oscilloscope calibration	Oscilloscope calibration window on/off check box
Show head calibration window	Scanning head calibration tab in the Oscilloscope unit on/off check box
Show stage calibration window	Scanning stage calibration tab in the Oscilloscope unit on/off check box
Show video window	Video unit on/off check box
Enable auto-send to Data from Scan	Auto-send obtained data to the Data unit on/off check box
Enable Sensors autocalibration on start	Sensors autocalibration with device start on/off check box
Enable Optics initialization start	Optics initialization with device start on/off check box
Enable PID autocalibration on start	PID autocalibration with device start on/off check box
Data auto-save time, min	Sets data auto-save interval in the Data unit. If 0 – auto-save disabled