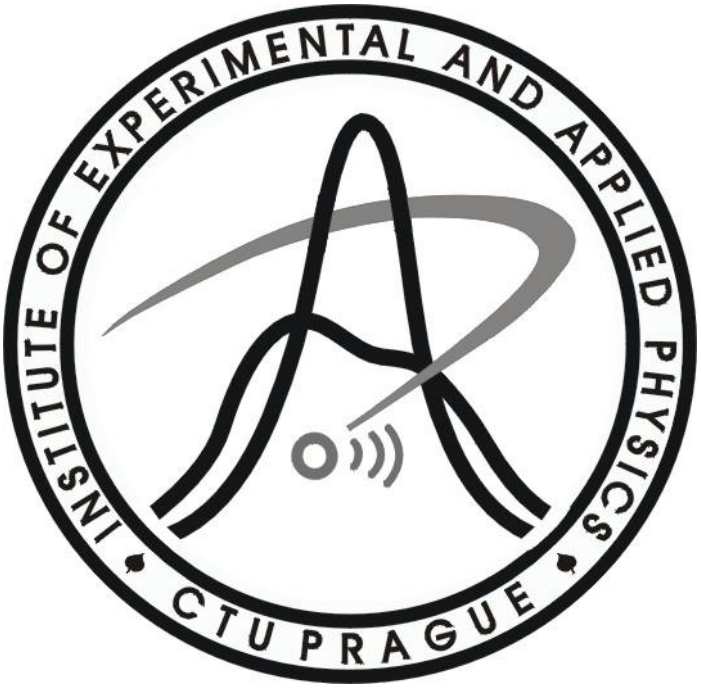
SIMPLE PREVIEW



1 Introduction

This software package is intended for the operation, DAQ, control and online visualization of pixel detectors of the Medipix type. These photon counting hybrid semiconductor detectors are developed in frame of the *Medipix Collaboration* based at CERN. . In these devices the read-out pixelated chip (256 × 256 pixel of pitch size 55 μm) is equipped with a radiation sensitive sensor which can be made of different semiconductor materials such as Silicon, GaAs or CdTe and with different thickness (e.g. 300, 700, 1000 μm). Incident radiation interacts in the semiconductor sensor creating electron/hole pairs. The charge created is collected in the the read-out chip where the signal registered is processed separately for each pixel. The hybrid architecture and per-pixel integrated electronics enable single-quantum detection and zero dark current operation.

Pixelman is the custom-made software package and is intended for control and visualization of measurements with Medipix and Timepix detectors. Pixelman is designed for maximal flexibility and interoperability with all types of Medipix detectors and can accommodate several devices to control complex measurements. This is achieved by a modular architecture that can be also extended by custom-made modules (plugins[1]) for enhanced operation, on-line data evaluation and analysis and integration and synchronization with other devices such as stepper motors and X-ray units. Pixelman is cross platform package which can be run in different operating systems (Windows, linux, mac OS).

The **Simple preview** is a standard plugin in the Pixelman software and offers basic functionality of Pixelman such as configuration and management of the detector settings (e.g. sensor bias, high frequency clock, threshold level), the measurement acquisition parameters (e.g. exposure time, number of data images so-called frames), visualization and data storing (e.g. selection of file format).

Further, the cluster-analysis plugin allows evaluating the measured data by using devoted pattern recognition algorithms of statistical and morphological properties in the collected frame[2] of individual signal events in the pixelated detector (called clusters[3]). This plugin was developed to simplify the operation of the original expert Pixelman interface when the user wants to focus on the measurement not distracted by the advanced settings of the detector.

2 Getting started

The Pixelman software is started by running the file JPixelman.exe. To use the Simple Preview plugin it is necessary first that java is installed on the computer (version 1.6 or later). If plugin is started for the first time, it has to be manually added using the Pixelman menu in the system tray[4] by the using "*Add Java Plugin"* menu (see Fig. 1). The name of the source plugin file is "JSimplePreview.jar" and is located in the jplugins folder inside the Pixelman root folder.

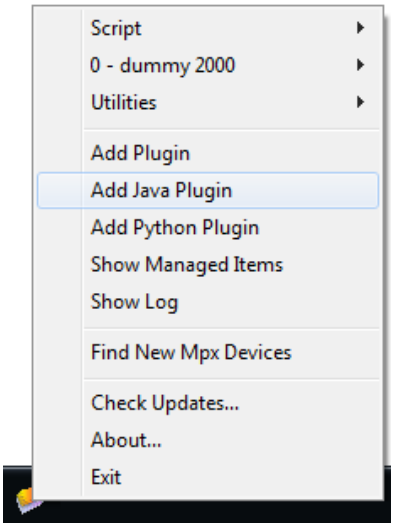


Figure 1: Adding the Java plugin into Pixelman.

The next time Pixelman is started, the plugin is launched automatically. The plugin can be removed by editing the "jmpxloader.ini" file in the Pixelman root folder (delete "=jplugins\JSimplePreview.jar" and choose save file).

3 Plugin description

Fig. 1 shows the plugin after launch (a device (i.e. a detector) has to be connected). This basic window contains several parts (the Program menu, Toolbar panel and Control panel will be discussed later).

The device name is a unique heading that contains the type of the readout interface (e.g. FITPix) and the detector serial number.

The field of view is intended to visualize online the data. It shows the response of all pixels of the connected detector. The vertical and horizontal axes indicate the position of the given pixel across the matrix of the detector. At the bottom is a color bar representing the range or depth of the pixels in the given frame. In the viewer it is possible to magnify (i.e. zoom in) the picture. By clicking the left mouse button, holding and dragging it over the desired region (zoom+). Double clicking the viewer with the mouse left button returns the picture to the original whole size.

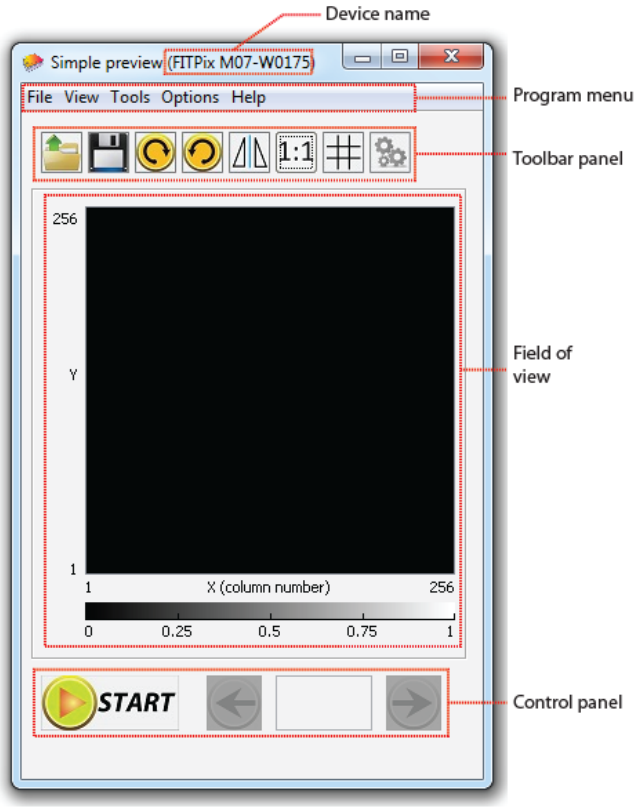


Figure 2: The Simple preview plugin. Basic plugin mode.

3.1 Toolbar panel

Open .txt file contains the measured stored data.

Save actual frame (visible in preview) to file with sufix .txt (program menu “file/save actual frame”). If the measured data consist of more frames it is possible to store them all by the program menu “File/Save measurement”.

Rotate all frames by 90° clockwise. The actual state of rotation of the display can be detected by the program menu “View/rotation”.

Rotate all frames by 90° counter clockwise.

Mirror all frames. The actual state of display can be detected by the program menu “View/mirror”.

Settle sides of the frame.

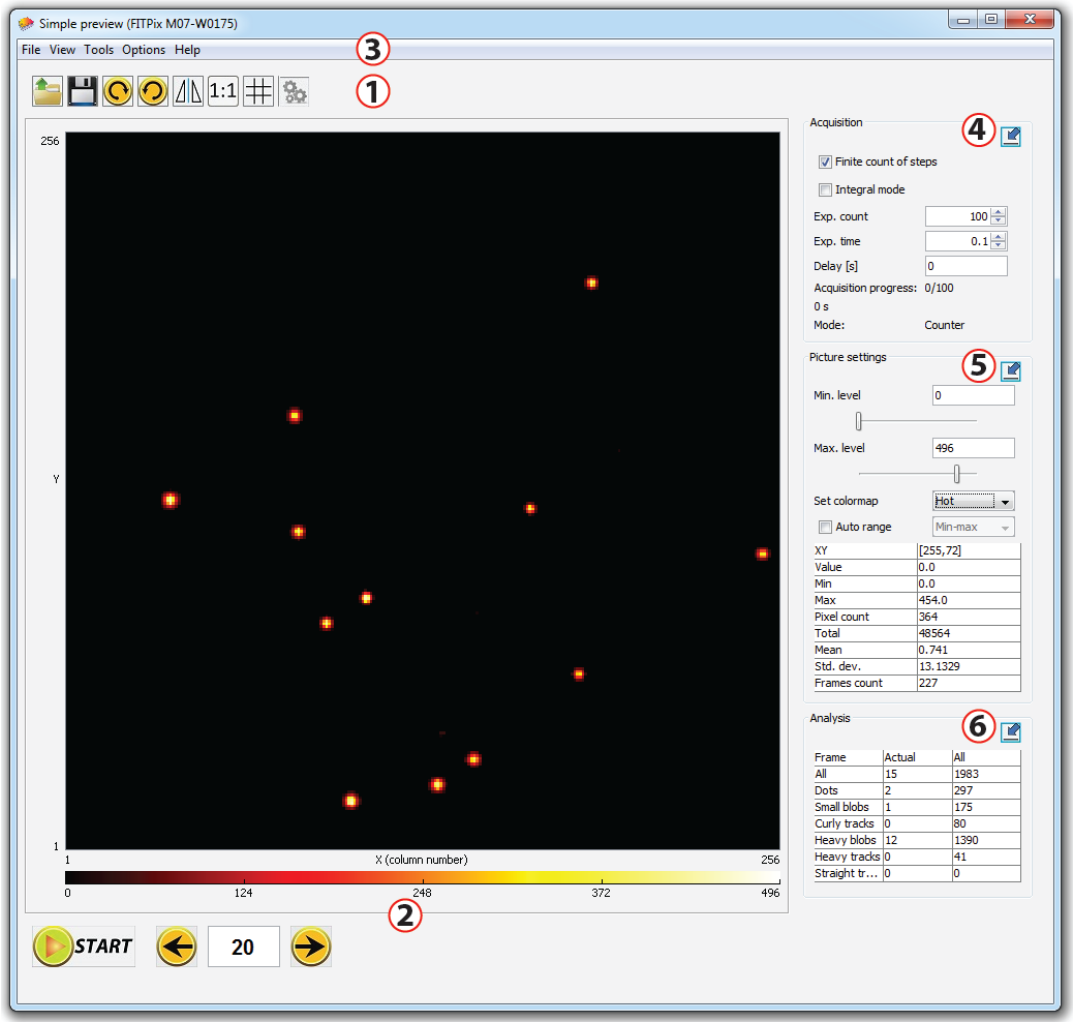
Display/hide the pixel grid (accessible also in the program menu “View”/Show grid”). Each element of the grid represents one pixel of the detector.

Display/hide the advanced settings (advanced plugin mode – Fig. 3).

If this icon is visible on the right side of the toolbar panel, configuration files are missing.

Advanced plugin mode (Fig. 3) consists of:

1. Toolbar panel
2. Control panel
3. Program menu
4. Acquisition panel
5. Picture settings panel
6. Analysis panel



Picture 3: Advanced plugin mode

3.2 Control panel

Starts the measurement (when clicked the button changes to stop). If there were previous data in the memory buffer these will be lost (deleted from the buffer). In the basic plugin mode the measurement is continuous until the user interrupts by clicking the stop button. Acquisition parameters can be changed in advanced plugin mode. During measurement some functions of the plugin are disabled.

Stops the ongoing measurement and enables the functions which are disabled during measurement.

After a measurement is stopped (or after a file is loaded) it is possible to sequentially browse frames forward and backward by clicking the arrows. The field between the arrows is to directly choose a particular frame.

3.3 Program menu

3.3.1 File

- *Save measurement* – Saves all measured data into .txt files. For each data frame in addition two files are also created. One with extension .dsc (description) contains the information of the measurement parameters (e.g. frame exposure time) and detector settings (e.g. DAQs). A second file also with extension .dsc is intended only for inner functionality of the program and for the user is not readable.

- *Export actual frame* –Saves the displayed frame as a graphics file[5] (png format).

- *Export all frames* – Saves all frames as graphics files (png). If the target folder contains pictures with same names they will be overwritten.

- *Exit* – Exits the program (closes Pixelman).

3.3.2 View

1. *Warning* – All values above/under the chosen value in the advanced settings – minimal and maximal level on Picture settings panel – will be shown by distinctly different colors.

3.3.3 Tools

2. *Histograms of particle properties*
The acquired data can be also evaluated online by custom made pattern recognition algorithms. The display of all histograms (names and number of bookmarks) depends on the type of analysis (these are selected on the program menu "Options/Analysis type"). Each histogram contains three types of data export. *"Export data"* saves the chosen bookmark to text file. *"Export all data"* saves the data of all bookmarks. "Export picture" saves the histogram as graphics (png) file. Rendering of the histogram can be modified by the histogram menu "View".

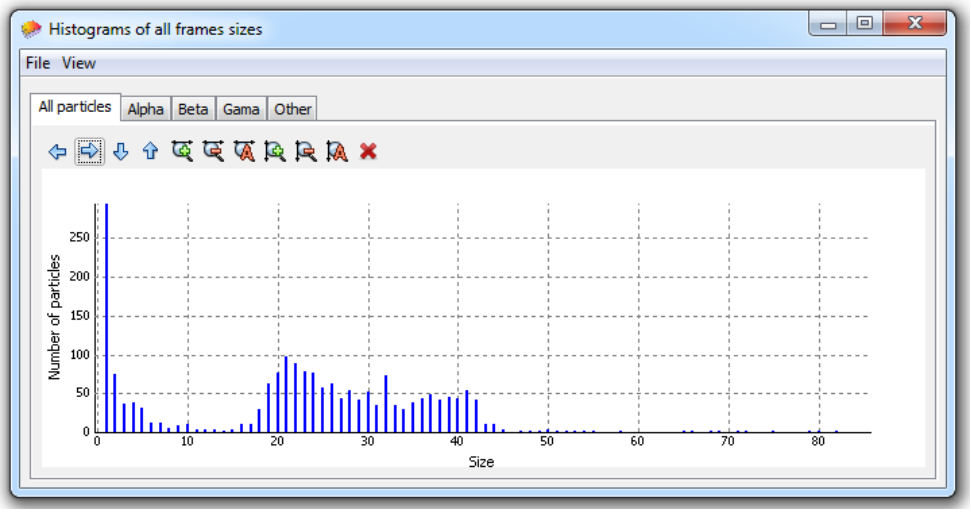


Figure 5: Histogram of sizes of event clusters acquired from the whole measurement (all frames). The toolbar on top contains the display settings – e.g. moving and zooming.

The program offers online analysis of the following detected clusters parameters:

Size of the detected clusters:

a) *Size* – calculates and displays the representation of the size distribution of all clusters in the frame shown. The size of the event is defined as the number of all adjacent nonzero pixels in the cluster.

b) *Sizes – all frames* – gives the representation of the size distribution of all particles in all frames.

Volume of the detected clusters

c) *Volumes* – calculates and displays the representation of the volume distribution of all clusters in the frame shown. This distribution corresponds with the energy spectrum of the particles collected in the frame (if the pixels are operated in TOT mode). The volume of a cluster is defined as the sum of all values of all pixels in the given cluster.

d) *Volumes – all frames* – gives the representation of the volume distribution of all clusters in all frames. It corresponds with the energy spectrum across all frames together.

Number of selected particles in the measurement

e) *Histogram of rate* – is divided into two parts. The upper histogram displays the number of clusters in the particular frames (displays the number of clusters against the number of all frames). The bottom histogram displays the number of frames according to the number of detected clusters.

3. *Histogram of a picture* – classical histogram of a picture (frame). The intensity is displayed against the number of pixels of appropriate intensity.
4. *Integral frame* – This tool adds all frames from the buffer into one (it sums up frames). The functions to work with the multi frame picture will be forbidden. Unchecking this choice splits the multi frame into the original number of frames.

3.3.4 Options

- *Measurement mode* – switches the measurement mode of the detector. **Counter** mode or so-called medipix mode is the event counting mode. Each event above the threshold increments the counter by 1. This corresponds to Medipix2 functionality. **Spectrometer** mode corresponds to the so-called Time over Threshold (TOT) mode in which the counter is incremented continuously as long as the signal is over threshold. It is used to measure the particle energy.
- *Analysis type* – deals with the range of the picture applied for analysis of the detected tracks (basic, extend, off). The type of histograms is affected by this choice.
- *BIAS* – sets the bias voltage applied on the sensor (provided e.g. in the FITPix interface of negative polarity in the range 5 – 100 V – suitable for standard silicon 300 μm sensors). The default value at program launch is 18 V. Change of sensor bias can regulate for example the speed of charge collection and thus the extent of charge sharing. For most measurements the default value 18 V is optimal (for silicon 300 μm sensors).

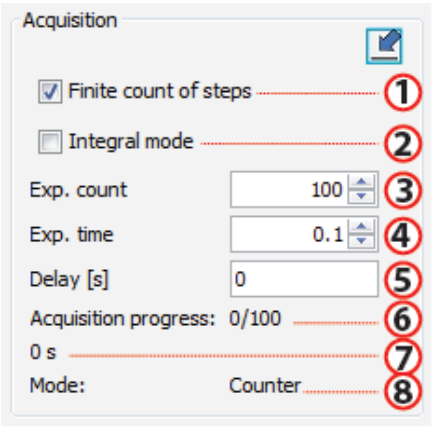
3.3.5 Help

- *Help* – displays the online help menu.
- *About* – shows the software release version.

3.4 Advanced settings

Advanced settings can be displayed by the button *"Show advanced settings"* on the right of the toolbar panel (this icon). This setting consists of three panels which can be minimized and maximized by the icons at the right top corner.

3.4.1 Acquisition panel



1.) Checking this choice sets the measurement to a finite number of steps as appropriate to the exposition count. The measurement will be then stopped. Unchecking this choice creates an endless loop of measurement which can be only stopped manually by clicking the "Stop" button. It creates a FIFO[6] buffer of size equal to the exposition count (number 3 in the Fig).

2.) In integral mode the frames are added into one integral frame.

3.) Exp. count sets the number of frames that will be acquired.

4.) Exp. time sets the exposure time of each frame (time period the detector shutter is opened).

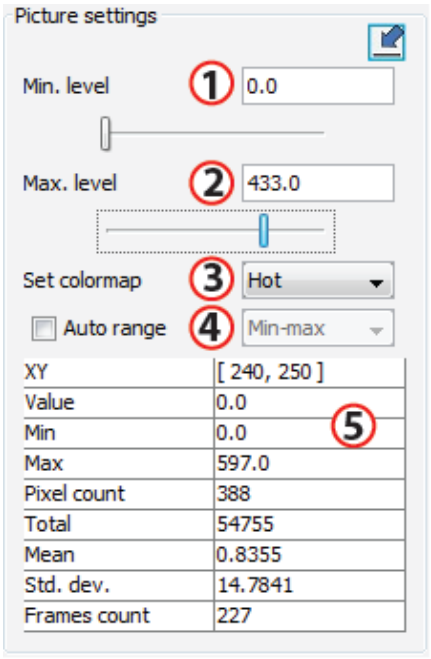
5.) Delay is time delay between repetitions (default value is zero).

6.) Acquisition progress displays the number of frames taken with the number of frames remaining (per repetition set).

7.) Real time of measurement displays the added time of measurement (given by the number of frames taken times the exposure time)

8.) *Mode* displays the selected type mode of the measurement (chosen in the program menu "Options/Measurement mode")

3.4.2 Picture settings panel



1. Min. level sets thelow level of the color range shown in the online display window. Events below this values are not displayed.
2. Maximal value sets the upper limit in the color range in the online display window. Values above this threshold are displayed at same intensity.
3. Sets colormap of the display
4. Auto range – automatically sets the range – to visualize the whole color range of the data. For example "Min-max" sets minimal and maximal value to lowest and highest value in frame. If auto range is chosen the values cannot be modified manually.
5. Table of parameters contains:
    - *XY* – position of the mouse cursor in the coordinates of the frame displayed
    - *Value* – registered value of the pixel at the mouse cursor position
    - *Min* – minimal pixel value in the frame or in the frame selection
    - *Max* – maximal pixel value in the frame or in frame selection
    - *Pixel count* – number of nonzero pixels in the frame or in the frame selection
    - *Total* – sum of all pixel values in the frame or in the frame selection
    - *Mean* – mean pixel value in the frame or in frame selection – sum of all nonzero pixels divided by the number of the pixels in the frame
    - *Standard deviation* – standard deviation in the frame or in the frame selection
    - *Frames count* – number of frames in the measurement or in the loaded file

3.4.3 Analysis panel

After the program starts this panel is hidden and it can be displayed by left mouse click on the icon  at the right corner of panel. The panel contains the table of particles divided into categories by parameters of the analysis. The view of the panel depends on the type of analysis (program menu *"Settings/Type of analysis"*). If analysis off is checked, the program does not compute the analysis. The choices of display are:

- *Basic analysis (default) contains the categories:*
  - *Alpha* – number of alpha particles in the frame, corresponds to *Heavy blobs* and *Heavy tracks*
  - *Beta* – number of detected electrons in the frame, corresponds to *Small blobs* and *Curly tracks*
  - *X-rays* – number of detected events cause by X-rays
  - *Other*
  - *All*

- *Extended analysis (program menu "Settings/Type of analysis/Extend")*
  - *All* – number of all detected events
  - *Dots* – number of single pixel events
  - *Small blobs* – number of small, few pixel events, together with *Dots* most often represents X-rays or higher energy electrons
  - *Curly tracks* – number of events with "curly" character, represents lower energy electrons
  - *Heavy blobs* – number of large round events represented by heavy charged particles, e.g. alpha particles
  - *Heavy tracks* – number of wide long events, together with *Heavy blobs* represents the number of energetic heavy charged particles
  - *Straight tracks* – long thin straight lines, usually represented by energetic light charged particles (e.g. muons from secondary cosmic radiation)

This particle analysis is optional and only recommendatory. Determination and characterization of particles always depend on the evaluation by the experimenter, measurements conditions and recorded experience (samples shown in Fig. 6).

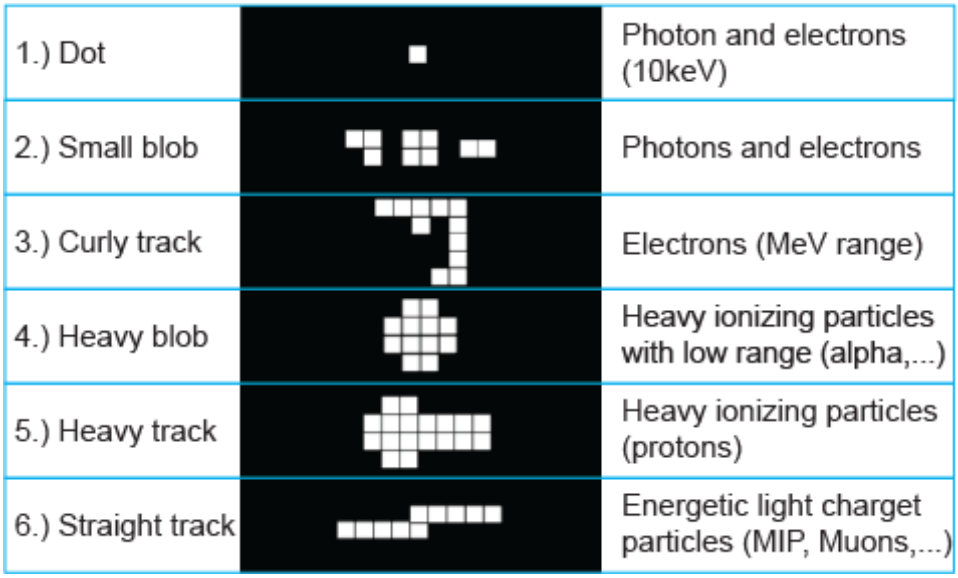


Figure 6: Samples of evaluation of different types of detected radiation by pattern recognition of characteristic tracks.

Evaluation and determination of the particles into categories is based on morphology analysis and pattern recognition of the detected events.
Terminology:
Pixel is one pixel on the detector matrix not on the screen of computer, in field of view means one picture element (can be shown by button "*Show grid"*)
Cluster is group of nonzero adjacent pixels generated by a single particle
Analysis parameters:

- **Dot pix. Count = 1** – Max number of pixels in the cluster that is considered as dot
- **Small blob size xy = 2** – Max size x and max size y of the cluster to be considered as small blob
- **Heavy blob inner pixel count** = 1 – to consider the cluster as heavy blob where the number of inner pixels must be higher than this number
- **Heavy blob radius deviation = 1.1 –** Ratio between the radius of the cluster area and the radius of most distance pixels
- **Heavy blob in-border ratio = 0.08 –** Ratio of the inner pixel to the surrounding pixels which has to be greater than this value.
- **Heavy track in-border ratio = 0.2 - –** Ratio of inner pixels to surrounding pixels which has to be greater than this value.
- **Heavy track inner pix count = 3 -** to consider the cluster as heavy track the number of inner pixels must be higher than this number
- **Straight track min inline count = 20 –** Straight track minimal inline pixels
- **Curly track –** Every cluster which does not correspond with previous criterion is included in this category

4 Terminology

1. **Plugin –** A piece of task-oriented software which performs a particular task (e.g. cluster analysis) or enhances another software application but cannot be run independently.

2. **Frame** –the data of the entire pixel matrix which is displayed in the by "online display" window of the plugin Simple Preview.

3. **Cluster –** the group of neighboring nonzero pixels which usually represents one particle but not necessarily (the cluster can be composed by more particles (event pile-up)).

4. **System tray –** A notification area - the portion of the taskbar that displays icons for the system and program features that have no presence on the desktop as well as the time and the volume icon.

5. **Png file –** Portable Network Graphics is a bitmap image format that employs lossless data compression. PNG supports palette-based image (with palettes of 24-bit RGB).

6. **FIFO –**acronym for **F**irst **I**n, **F**irst **O**ut. If the plugin does all expositions (Exp. count) delete the first frame and get new exposition and repeat it until user interruption.