

# Required processing of flea-camera data on the Epics level for the FEMTO-project

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The FLEA-cameras will serve at the FEMTO-beamline

- (i) to sample autocorrelation traces to measure the laser pulse width
- (ii) to measure beam position for laser alignment and active beam stabilization
- (iii) to determine beam waist for beam characterization.

For this purposes we need that the following functions are programmed on the EPICS level.

## 1) Print maximum Pixel value

To avoid saturation we must need the value of the maximum pixel in the image.

## 2) Save Option

We need the option to save an individual image that can be later further processed by IDL, wave ...

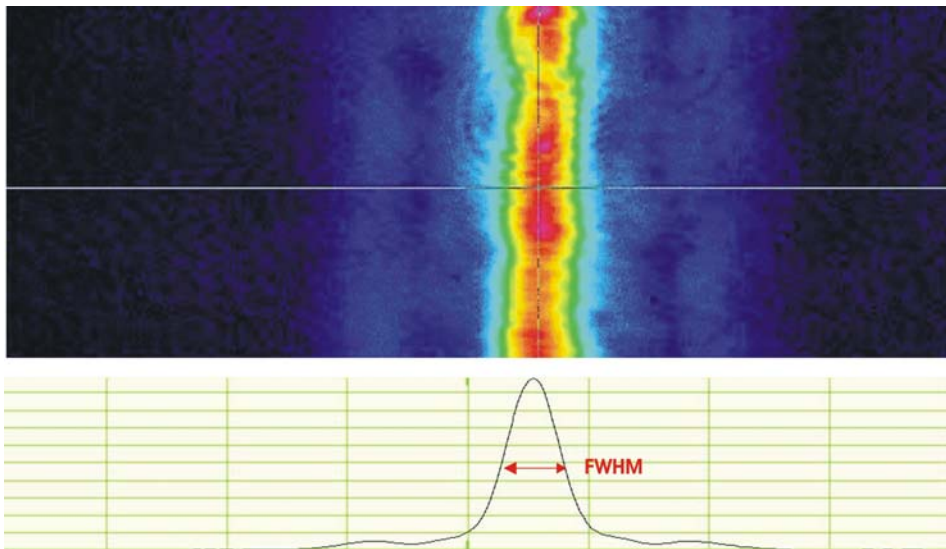
## 3) Background subtraction

To get reliable data it should be possible to take and save a dark image (when the laser is blocked). From subsequent images this dark image is subtracted before the images are further processed.

## 4) Autocorrelation mode

For the Autocorrelation mode we need the following (see sketch below):

- a) **Plot Horizontal profile:** (averaged over all columns). It should be the possible to limit the window where the data are processed



- b) **Print full width at 50% of peak intensity (FWHM)** of this profile in a window on the screen (good readable)
- c) **Print the x-position of the maximum point of the horizontal profile** in a window on the screen.

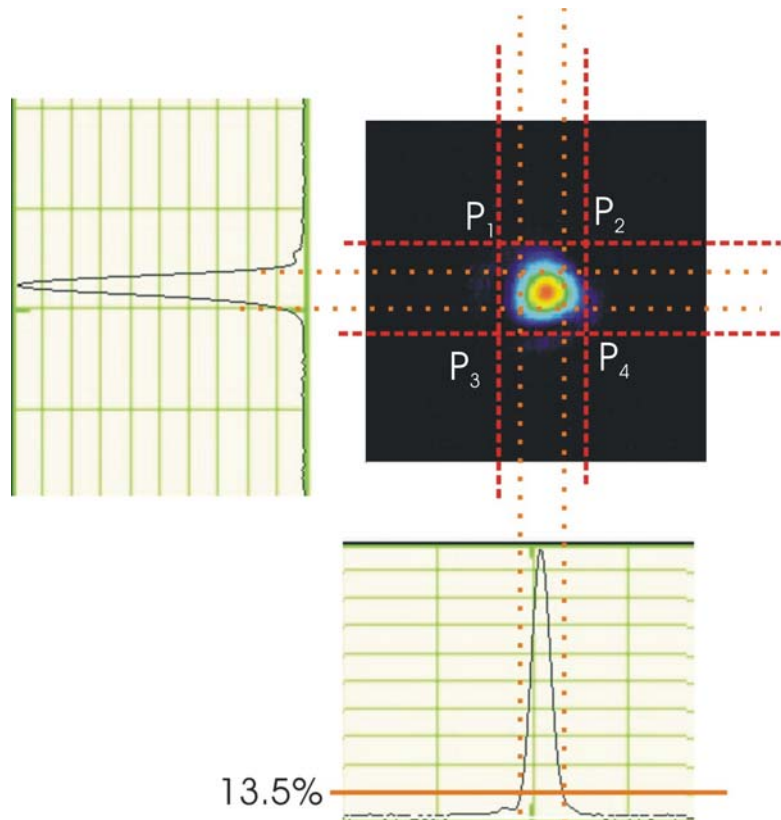
### 5) Beam characterization mode

To characterize the position and width of the laser profile we need the following tools:

- a) **Plot Horizontal & vertical profile:** (averaged over all columns and rows, respectively).
- b) Determine the **Centroid Position (x,y)** of the beam and print it readable in window on the screen.
- c) Determine the **standard deviations ( $\sigma_x, \sigma_y$ )**. Print  $\sigma_x$  and  $\sigma_y$  of this profile profile in a window on the screen.

In order to get reliable data it is important to limit the window from which the centroids and the  $\sigma$ 's are computed else noise pixels far away from the beam will significantly contribute. Usually this is done by defining an ellipse surrounding the beam and setting all pixels outside this ellipse to zero.

Because this is rather difficult task in EPICS we propose the following procedure by limiting the calculations on a square which should be computed from the 13.5% intensity points of the profiles (see sketch below).



- (i) from the horizontal and vertical profiles determine the Positions where the profiles cross the 13.5% level of the maximum intensity ( $x_1, x_2, y_1, y_2$ ).

- (ii) Go back to the original 2D-image and limit further processing to a window with the following corner points (rectangular given by the dashed red line in figure):

$$P_1 = (1.5 * x_1 - 0.5 * x_2, 1.5 * y_2 - 0.5 * y_1)$$

$$P_2 = (1.5 * x_2 - 0.5 * x_1, 1.5 * y_2 - 0.5 * y_1)$$

$$P_3 = (1.5 * x_1 - 0.5 * x_2, 1.5 * y_1 - 0.5 * y_2)$$

$$P_4 = (1.5 * x_2 - 0.5 * x_1, 1.5 * y_1 - 0.5 * y_2)$$

- (iii) Determine centroid positions on this window:

$$x_c = \frac{\sum_i x_i \sum_j Val_{ij}}{\sum_{i,j} Val_{ij}}, \quad y_c = \frac{\sum_j y_j \sum_i Val_{ij}}{\sum_{i,j} Val_{ij}}$$

**Important:** print the centroid position in the coordinate of the original image and **not** in that of the reduced image.

- (iv) Determine the standard variations in x & y over the same reduced window:

$$\sigma_x = \frac{\sum_i (x_i - x_c)^2 \sum_j Val_{ij}}{\sum_{i,j} Val_{ij}}$$

$$\sigma_y = \frac{\sum_i (y_i - y_c)^2 \sum_j Val_{ij}}{\sum_{i,j} Val_{ij}}$$