BPM calibration for 3/14 optics status

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For the 3/14 optics run:

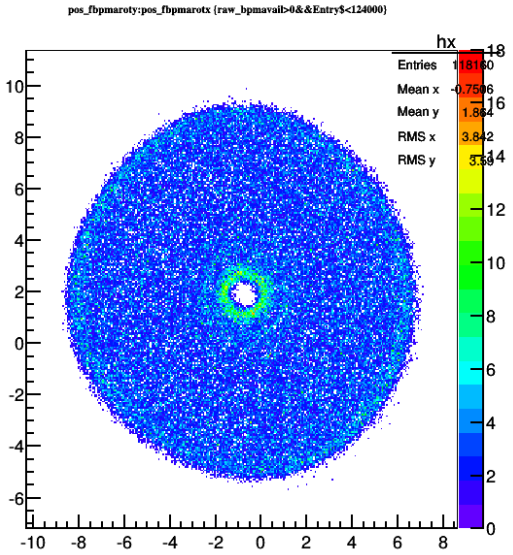
BPM A constant still working

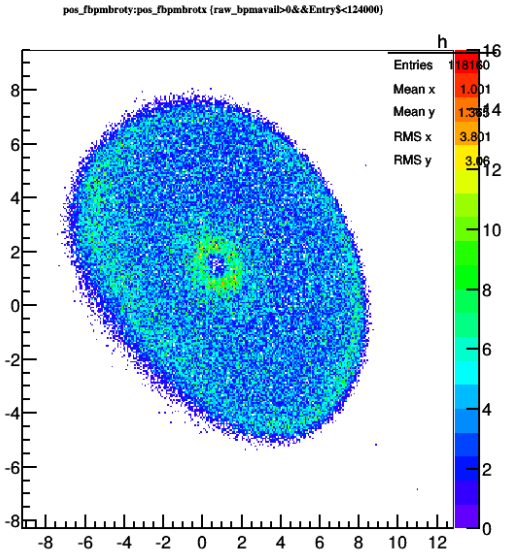
BPM B constant changed (div=2)

Harp scan data for div=2 BPMB:

With target magnet field on

only one available position

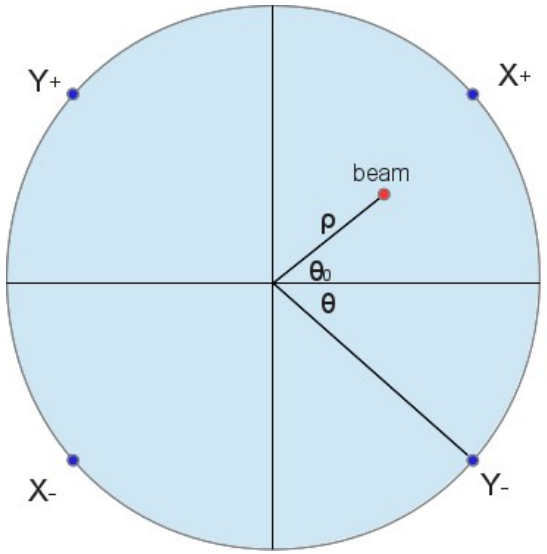




Main idea:

- Center position
  -- Use BPM A + harp05 → BPM B
- Size
  -- Raster size at BPM A+ Raster size at target → Raster size at BPM B
- Rotation
  -- Use two runs:
    - One only slow raster x on
    - One only slow raster y on

BPM calibration method



sum/diff
Minimize current affect

$$x_b = \frac{(A_+ - A_{+\,ped}) - g_x(A_- - A_{-\,ped})}{(A_+ - A_{+\,ped}) + g_x(A_- - A_{-\,ped})}$$

Non-linear correction

$$x = r x_b\left(\frac{1}{x_b^2 + y_b^2} - \frac{1}{\sqrt{x_b^2 + y_b^2}\sqrt{\frac{1}{x_b^2 + y_b^2} - 1}}\right)$$

Initial pos calculated by using bpm ADC data

$$\begin{bmatrix} x_{harp1} \\ x_{harp2} \\ x_{harp3} \end{bmatrix} = \begin{bmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix}$$

Only thing need to be calibrated

Real beam position(harp data)

Signal for each antenna:

$$\varphi = \varphi_0 \frac{r^2 - \rho^2}{r^2 + \rho^2 - 2r\rho\cos(\theta - \theta_0)}$$

$\theta = \frac{\pi}{4}\ \ \frac{3\pi}{4}\ \ -\frac{3\pi}{4}\ \ -\frac{\pi}{4}$ *angle for 4 antennas*

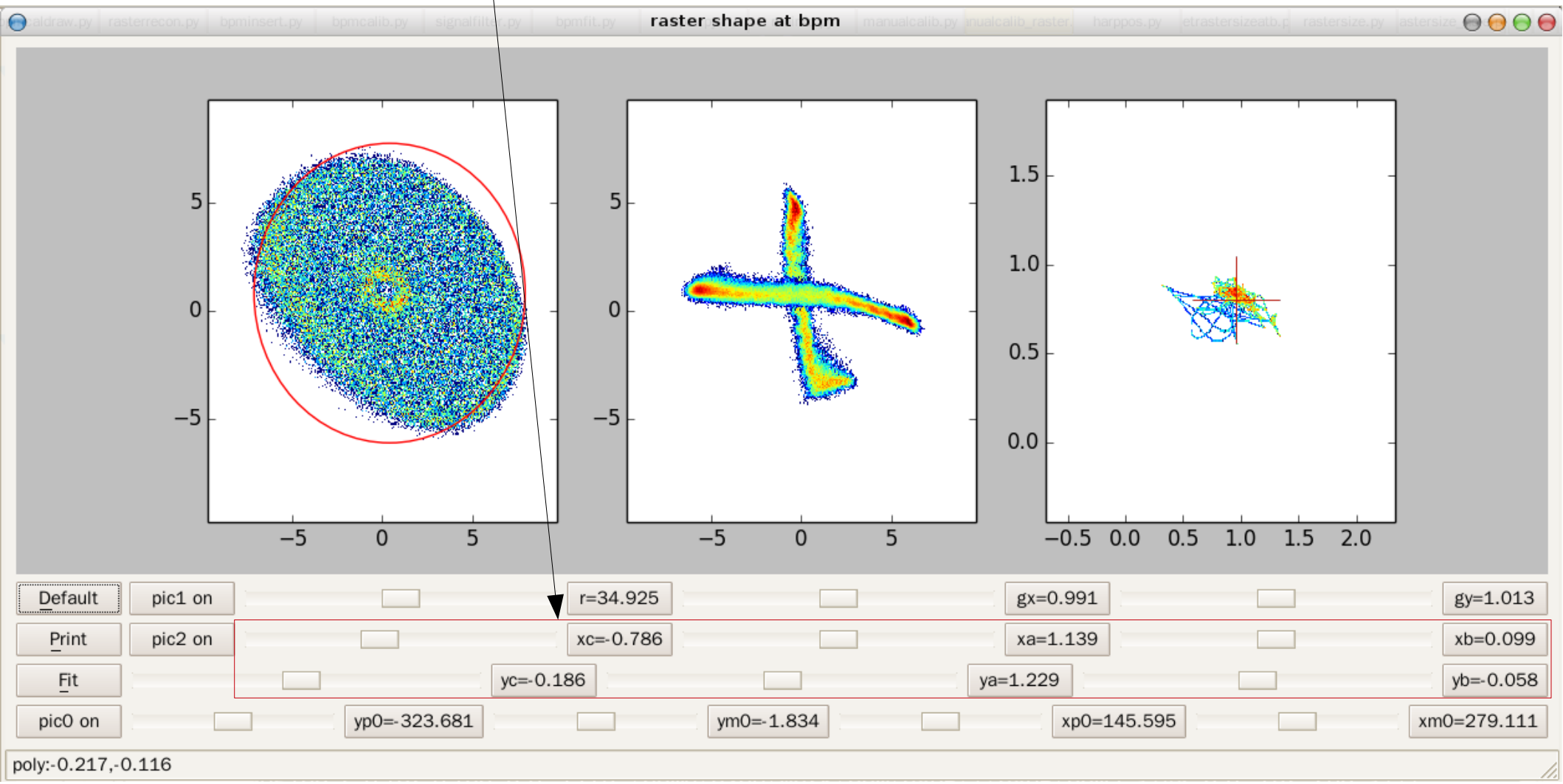
r: *BPM vacuum chamber radius* (17.3mm)

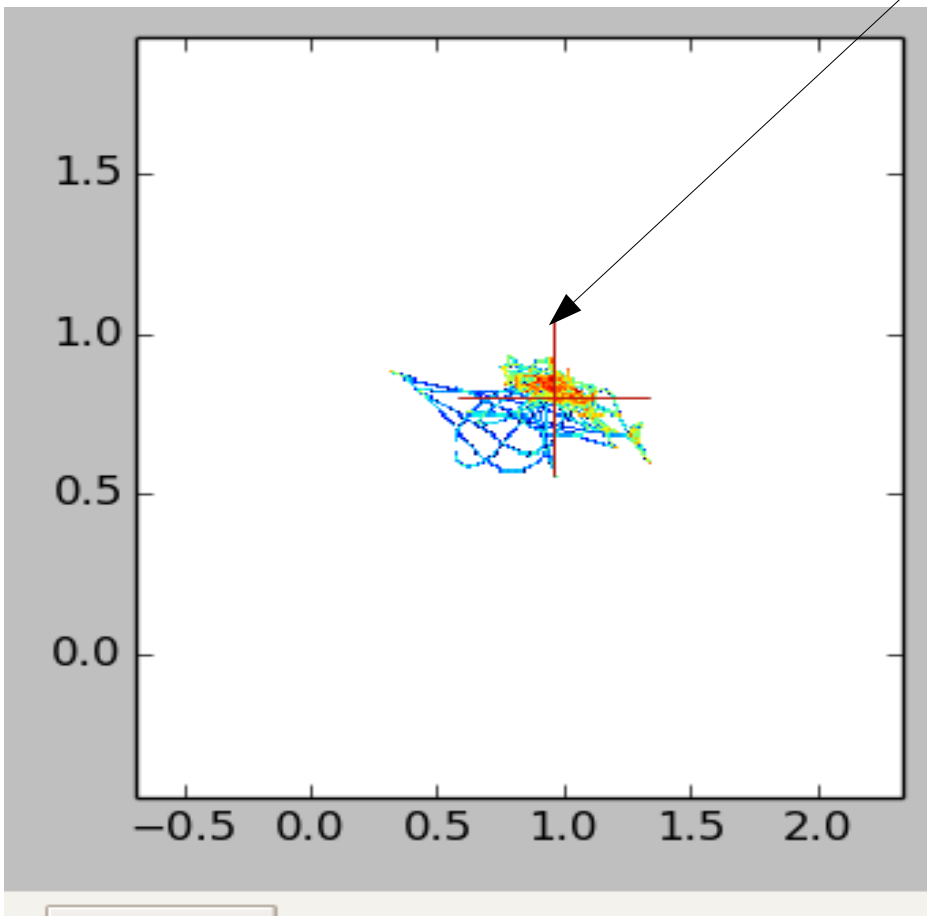
ρ: *radial position of beam*
θ_0: *angle position of beam*

X_harp= c+ ax+by

Y_harp= c+ ay+bx

Constant needed to be calibrated : c, a, b





Red cross:

Real position

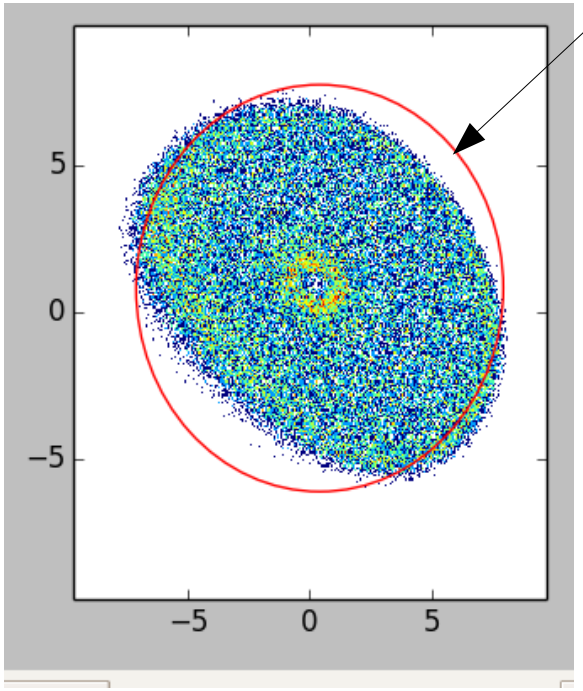
Calculated by using BPM A and harp 05

(with survey data)

The target magnet will bend beam ~0.02mm at BPM Position, can be ignored

Working BPM A

Harp scan data

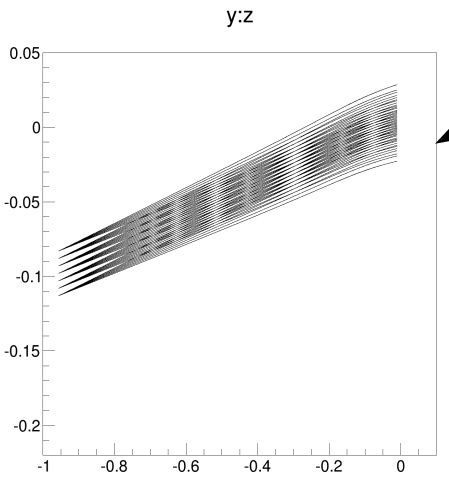


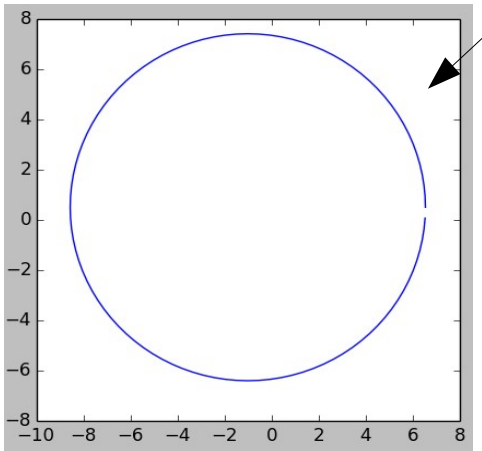
Red ellipse(oval):

Size at BPM B calculated by using raster size at BPM A and target (getting from carbon hole size)

Center position set same as the calculated center position from BPM ADC data

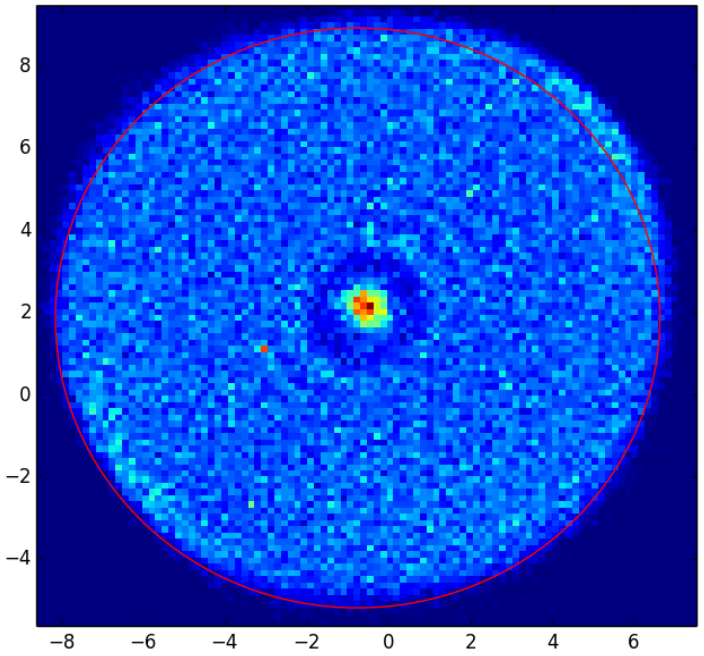
To get raster size at BPM B , A transportation function is needed



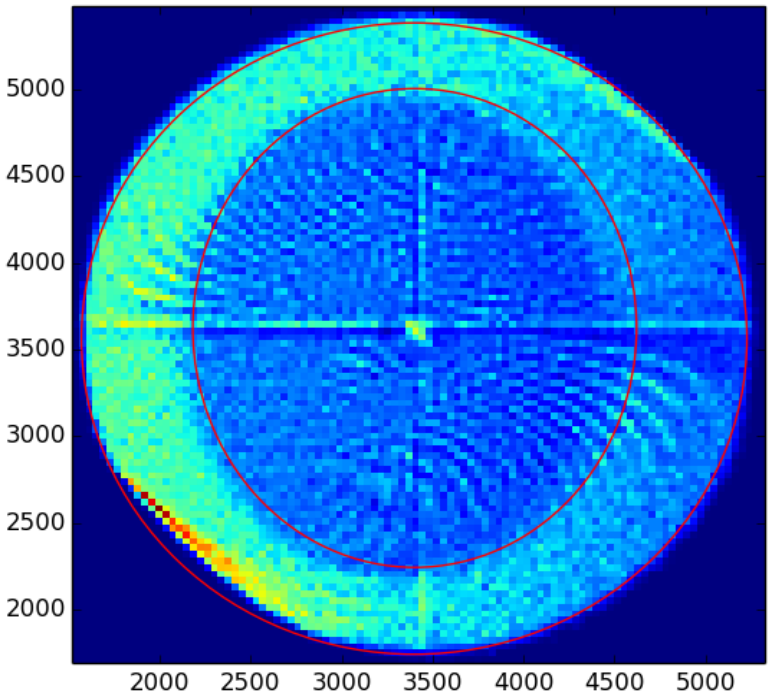


- Use target field map and BdL code generated a group tracking data from BPMA,BPMB to target
- Fit BPM B x y with input parameter BPM A x,y and target x,y
- Get raster size and position beam position at BPM A and target, generate a group of oval shape data at BPM A and target with same size and position as calculated, use fitted function to get raster size at BPM B

From test, The beam position chosen at target will not affect the size at BPM B (~0.02mm flactuation, can be ignored)



Raster shape at BPM A

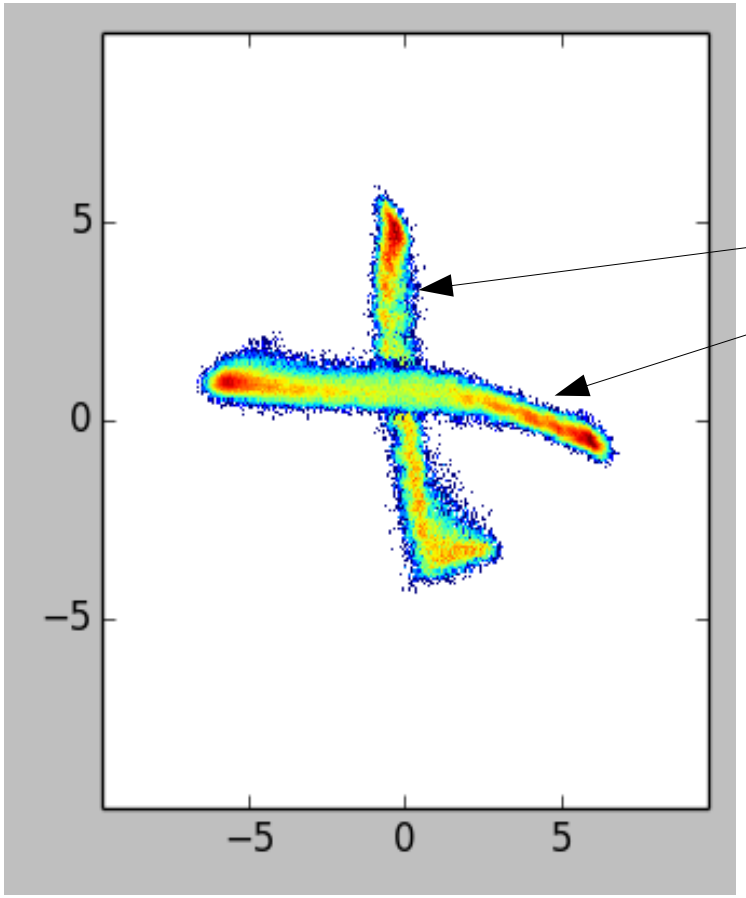


Raster with Carbon hole

Using minuit fit to get raster size at BPM A and carbon hole size at target

3D function fit

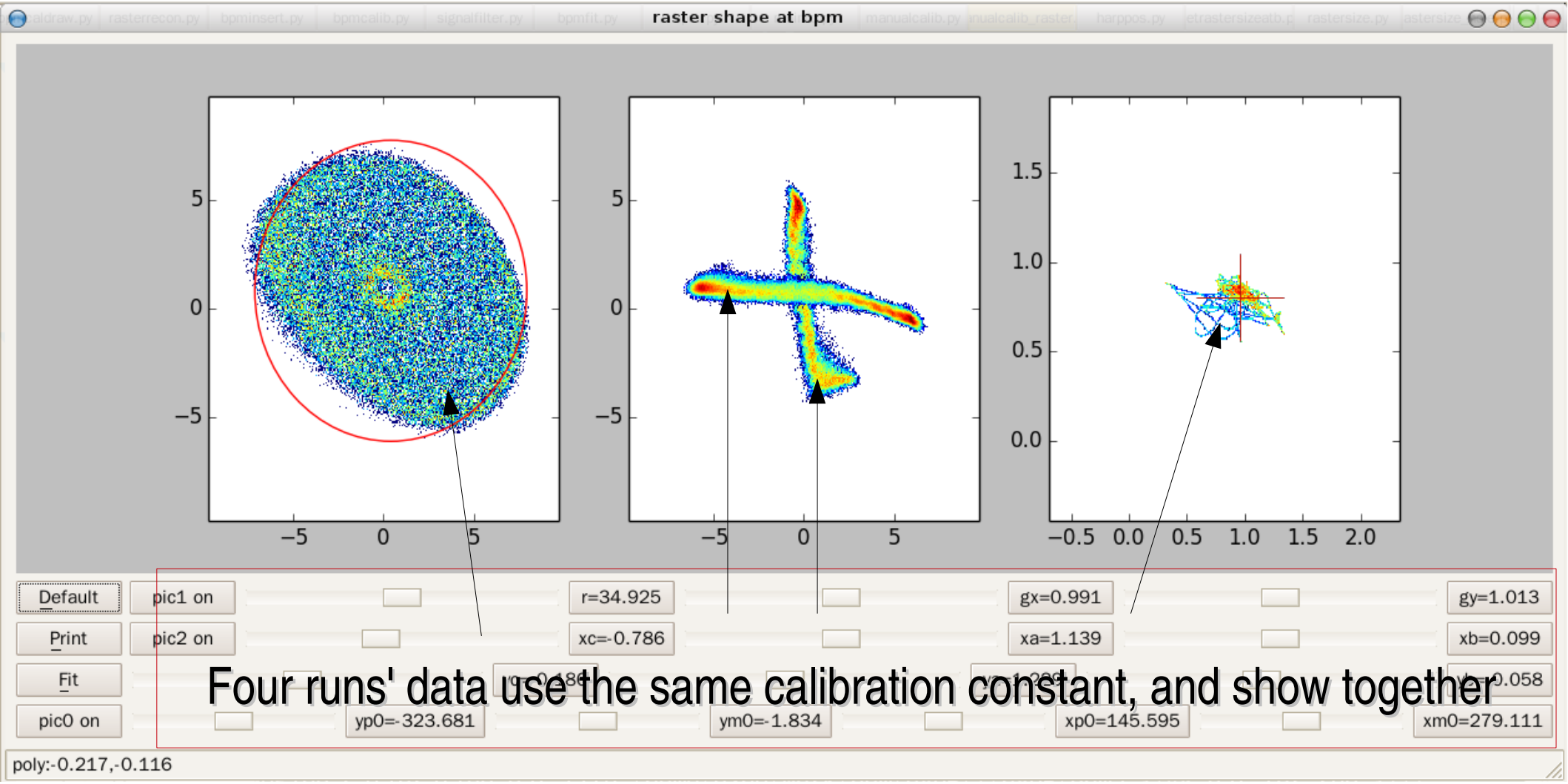
----- x,y, 2D histogram bin size



Two runs, one with only raster x on

One with only raster y on

To check if rotation correct

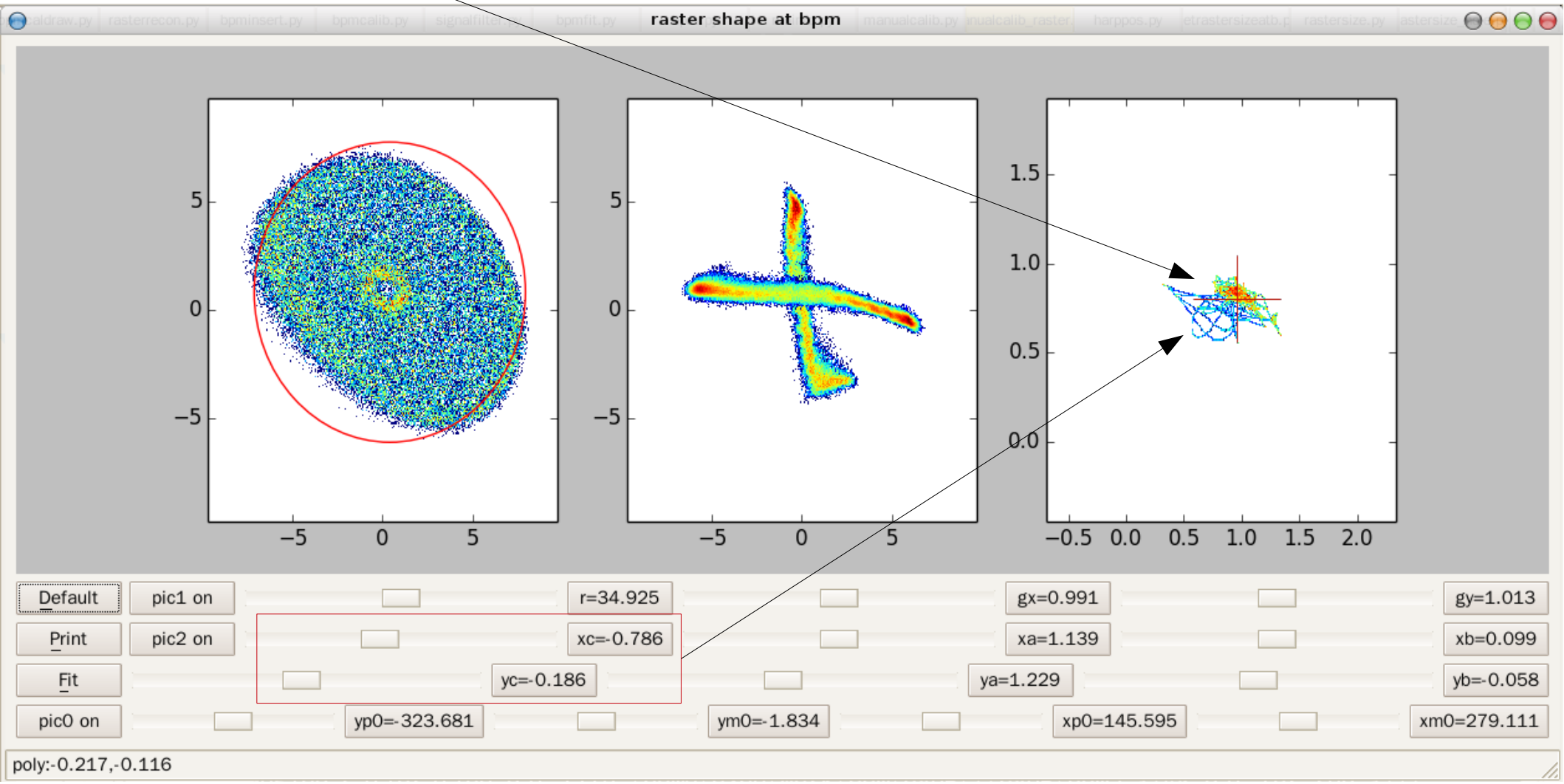


Four runs' data use the same calibration constant, and show together

X_harp= c+ ax+by

Y_harp= c+ ay+bx

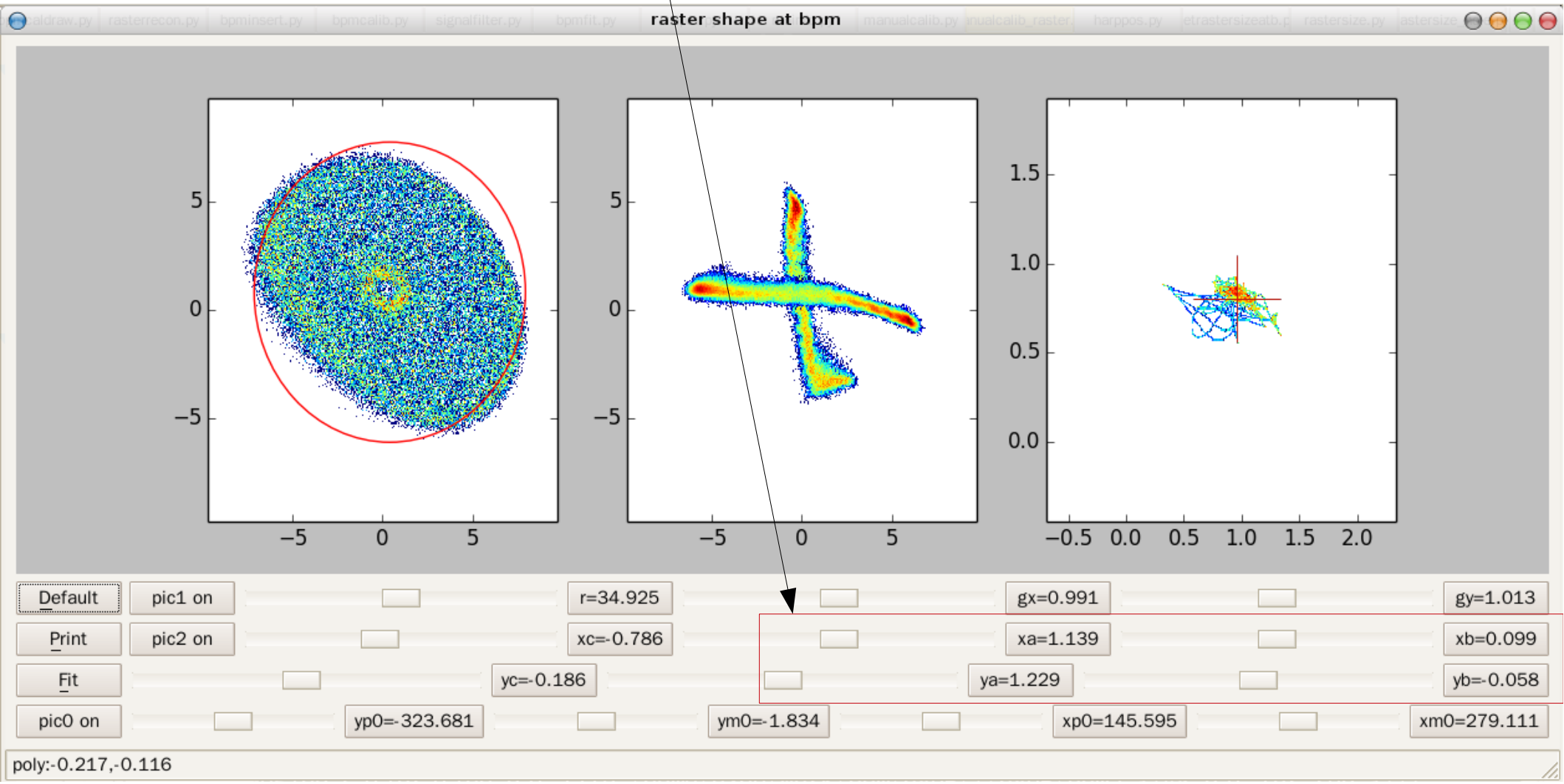
Constant part “c” fixed by using harp data every time other parameters changed



X_harp= c+ ax+by

Y_harp= c+ ay+bx

a and b getting from minuit fit



X_harp= c+ ax+by
Y_harp= c+ ay+bx

Method to fit a and b:

1.Calculate “a” by using ideal size(getting from BPM A and carbon hole)

a=a*idealsize/xsize

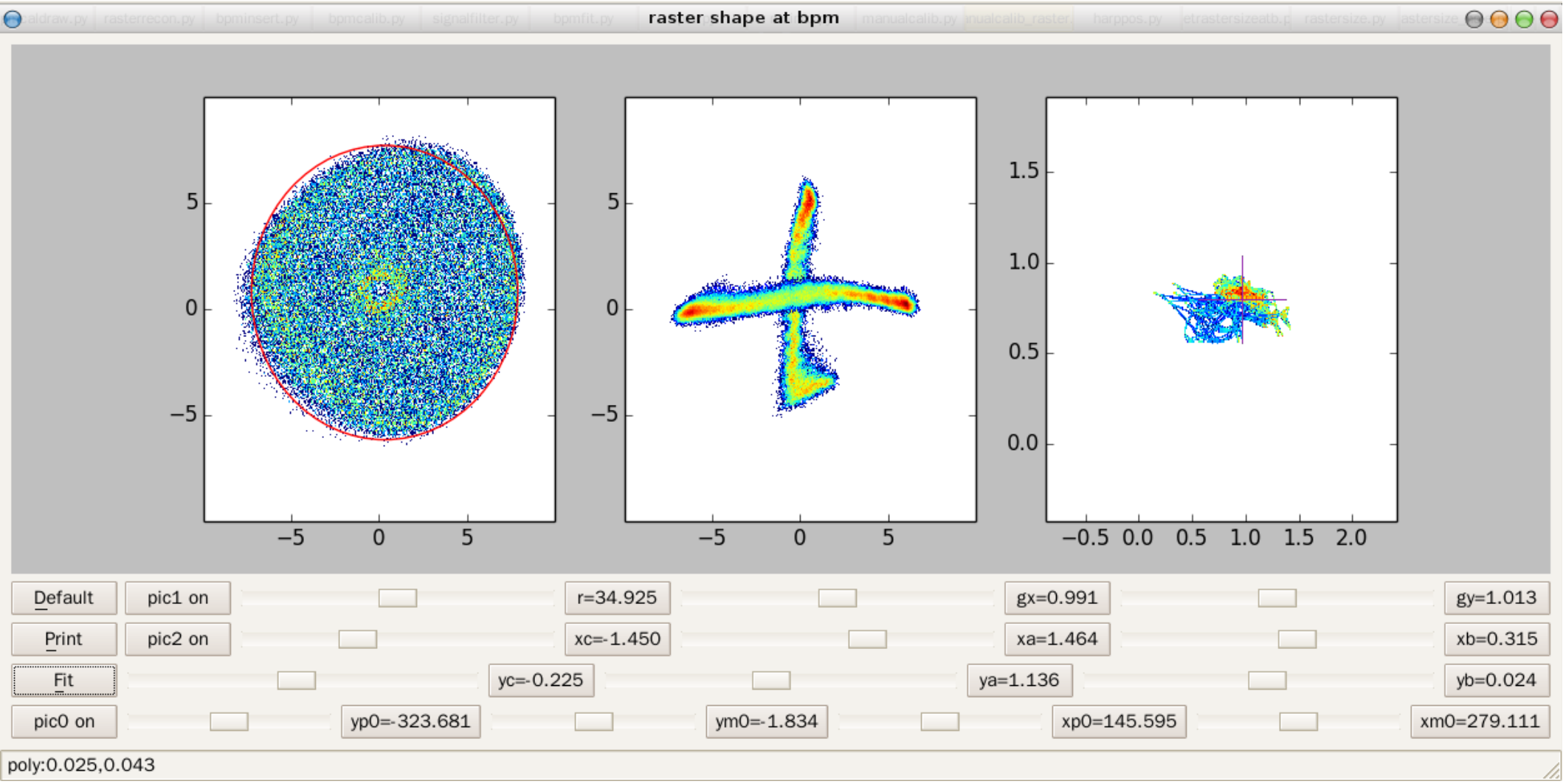
Size from Bpm A and hole

Get from minuit fit(same as page8)

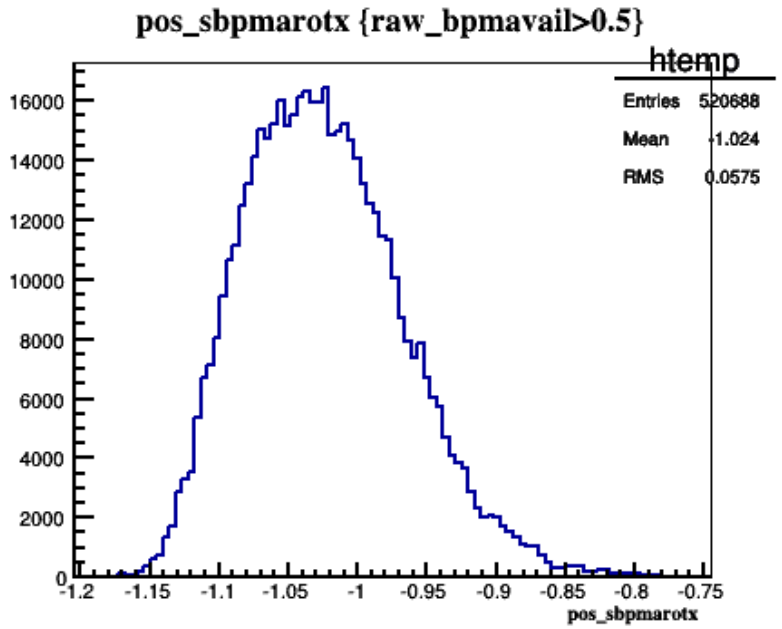
2. linear fit for two runs(only x on and only y on) ,get slope of them

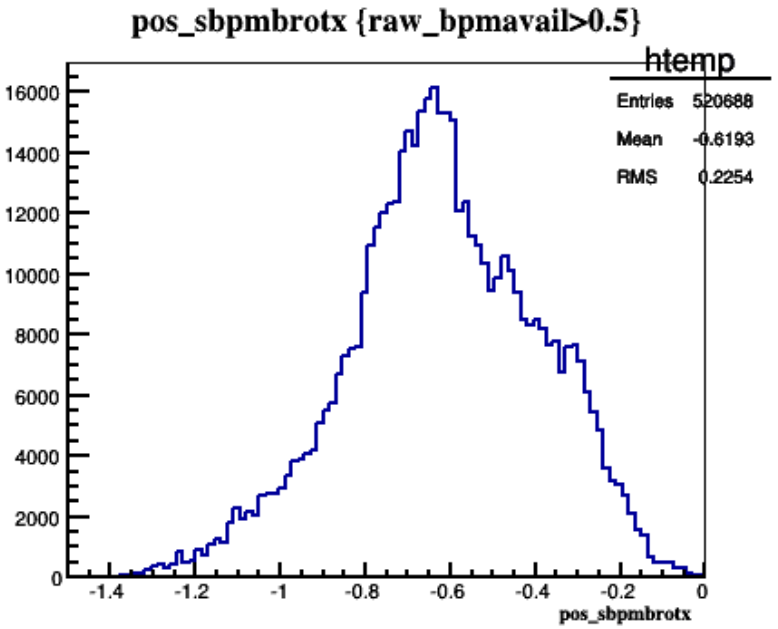
3. minimization fit with parameter abs(slope1)+abs(slope2),let slope1 and slope 2 minimum → with correct rotation

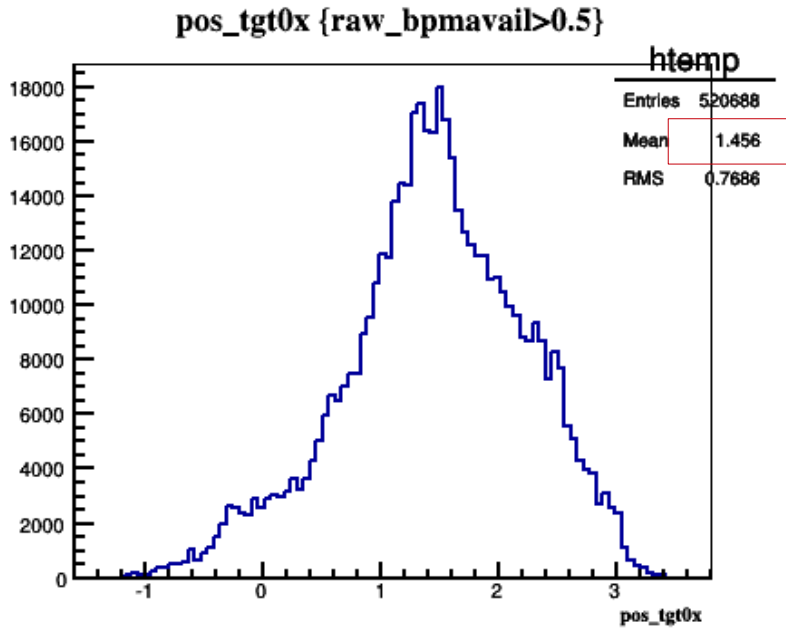
Final result after fit



Problem:







1.456

Mismatch with Chao's result

Fitted X_{beam}
-3.5mm