bpm calibration status

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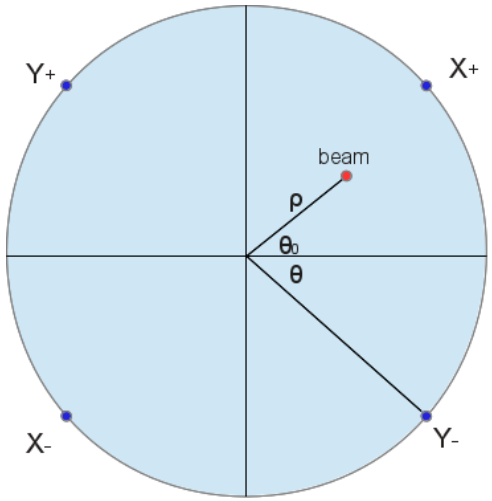
2013-8-14

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

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

Signal for each antenna:

$$\phi = \phi_0 \frac{r^2 - \rho^2}{r^2 + \rho^2 - 2r\rho\cos(\theta - \theta_0)}$$

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

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

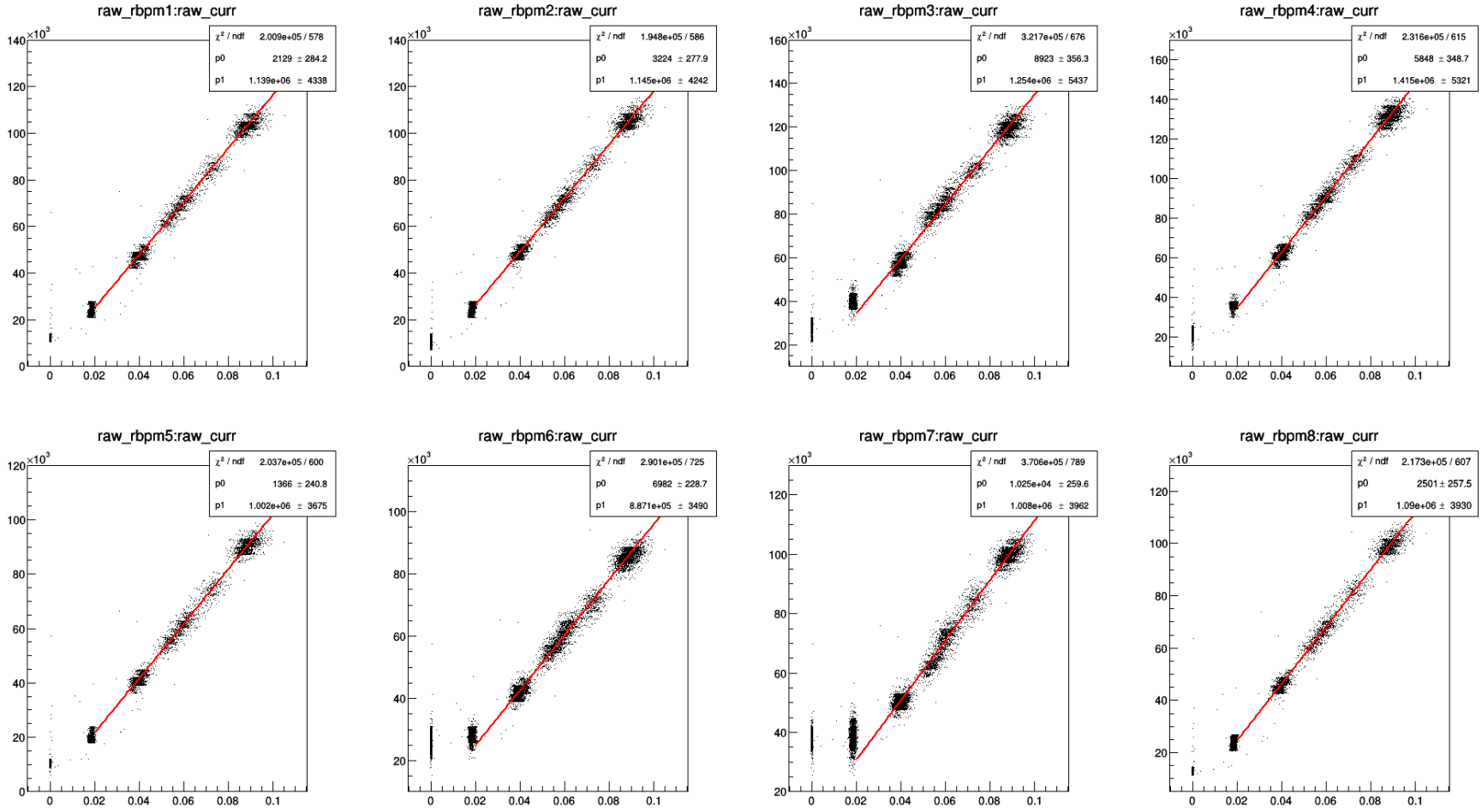
ρ: *radial position of beam*
θ_0: *angle position of beam*

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

Rotation and correction with harp pos

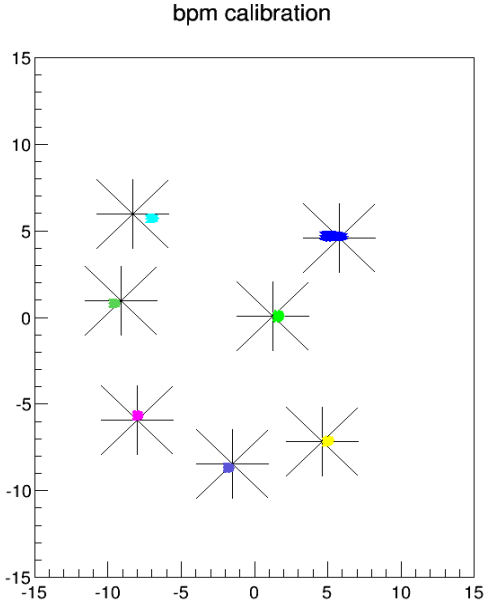
1.Pedestal subtraction

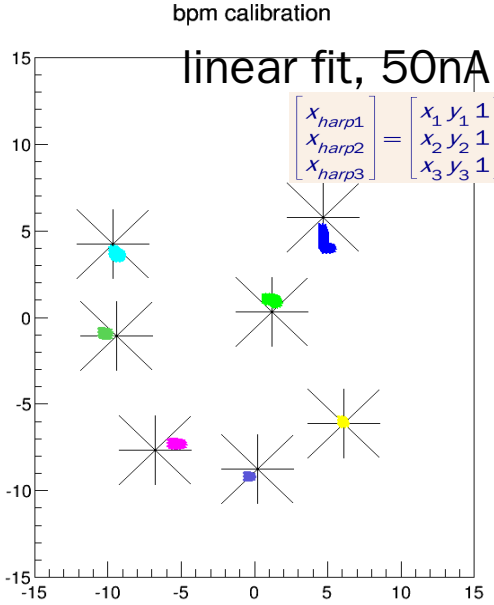
(old presentation)



Signal shoud be propotional to current

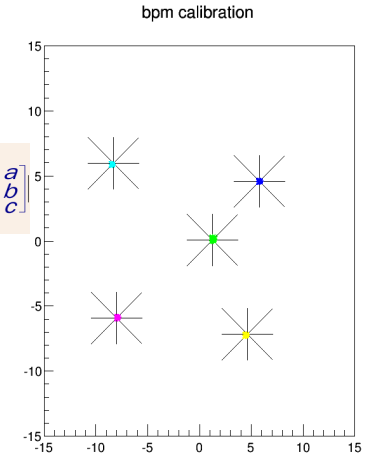
Use pedestal calculated by curr vs signal fit

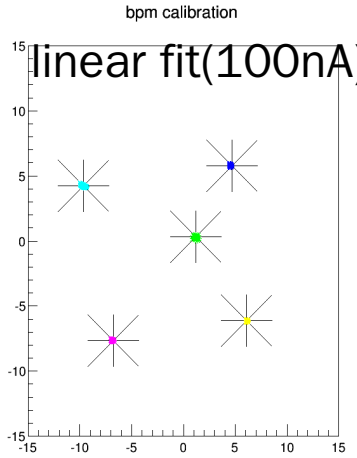




linear fit, 50nA

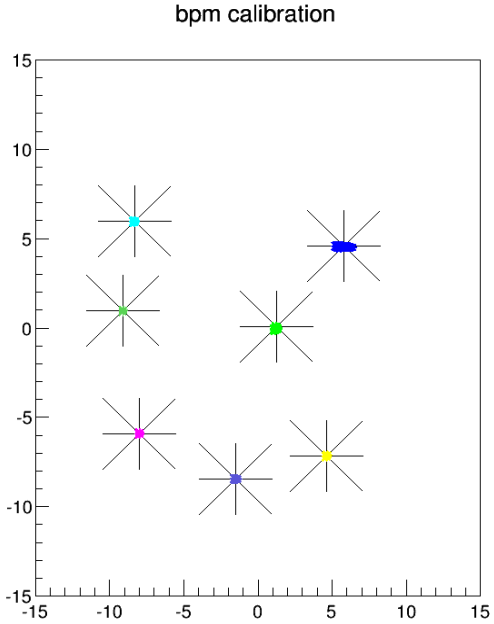
$$\begin{bmatrix} x_{harp1} \\ x_{harp2} \\ x_{harp3} \end{bmatrix} = \begin{bmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{bmatrix} \begin{bmatrix} a \\ b \\ c \end{bmatrix}$$

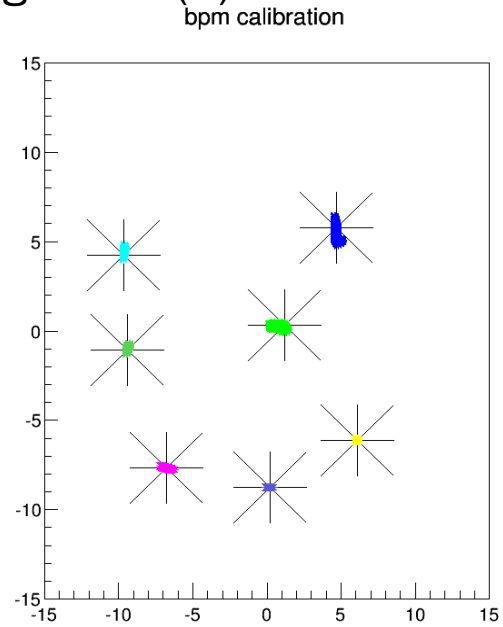




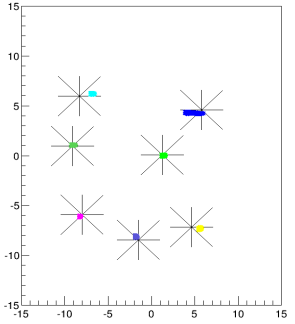
linear fit(100nA)

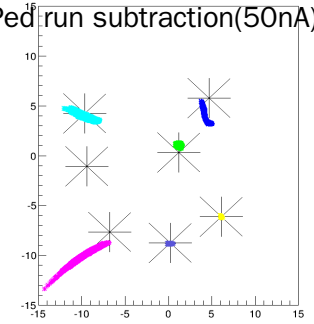
High order(3) correction



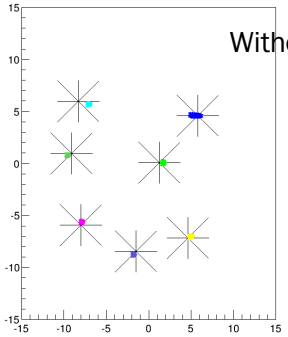


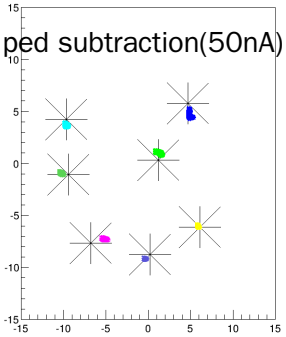
Compare:





Ped run subtraction(50nA)





Without ped subtraction(50nA)

(old presentation)

Different position get different pedestal

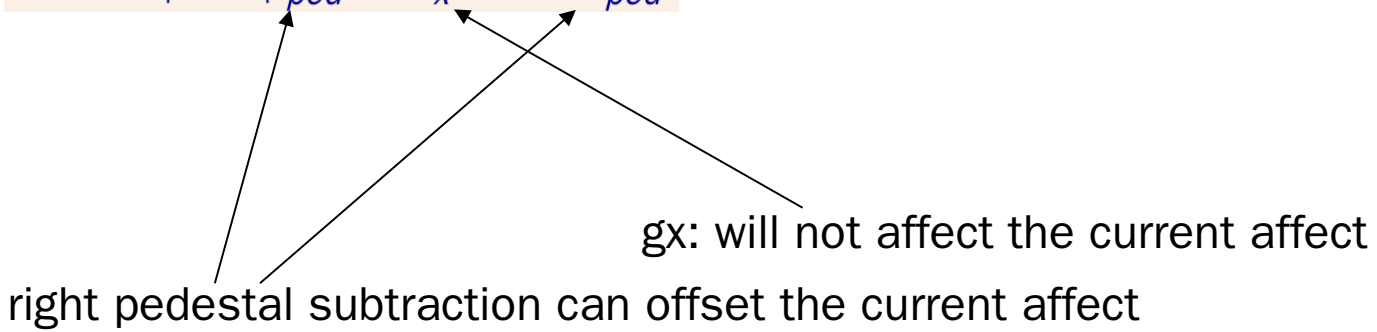
bpmpos	bpmbchan1	bpmbchan2	bpmbchan3	bpmbchan4
[1,0][1,0]	1365.83402926	6981.51670063	10249.7948502	2501.10584004
[-8,5][-9,4]	2527.35060936	13369.723759	16537.7006168	4652.90071211
[4,-7][6,-6]	1539.81226746	10090.4852376	9887.00451064	3175.53950969
[-7,-5][-6,-7]	3028.75550714	8516.97961566	21230.0960905	4251.32182552
[5,4][4,5]	2947.37915424	20622.3265791	13121.1982386	2892.41817999

Unstable pedestal caused current dependent

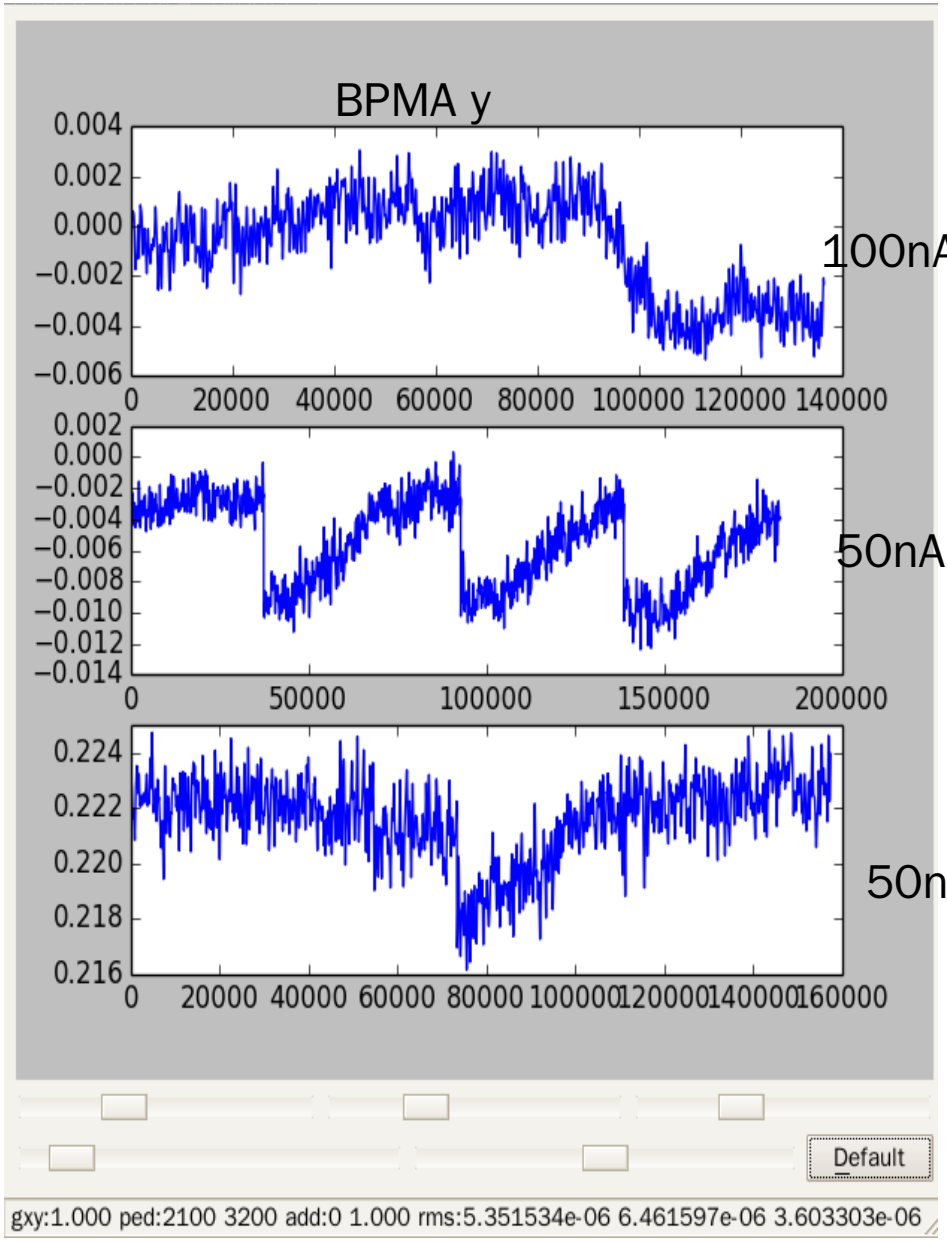
Will do a whole experiment period wide to check if it is change during time like pedestal run result soon

Sum/diff

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



If manually change the pedestal value:

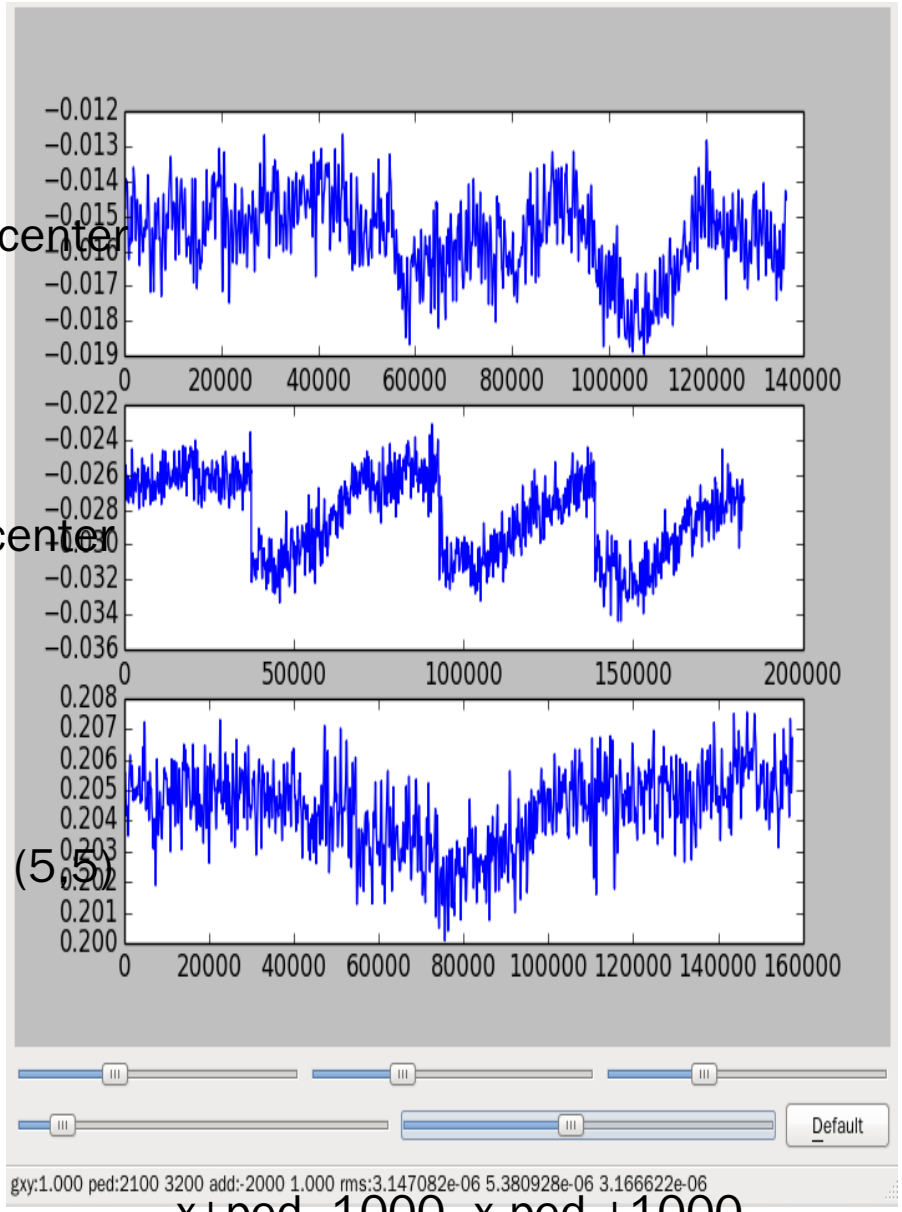


initial

100nA center

50nA center

50nA (5,5)



x+ped -1000, x-ped +1000

But if there have large ped value unstability in page 5, can not find a value that can reduce all of the current affect

Pedestal subtraction:

1.use pedestal run --- get rid of this method
2.use current fit result --- much better now, but still have current dependent, and unstable value in different position. Now choise center point value, in order to let center point have better result
3.manually find pedestal value --- not a good idea
4.without subtraction --- use it for autogain run (earlier run)

Uncertainty composition

1.BPM hardware resolution plus additional noise from radiation

Representation:

1.rms presented in rootfile – 0.05mm after adding filter, if current stable

2.current dependent shift – hidden in rms if current stable

--main uncertainty, ~0.1mm per 5nA in 35~40nA

2.survey uncertainty

Beampackage

➢ Optimized the calculation part code, use numpy's array instead of python's list, use matrix operation instead of for loop --- much faster, can easily run in lower than 2GB ram PC

- 761MB dumped data for a 7M events production run(170MB target position+204MB bpm position+391MB raw data)
- 4.3min decoding + 3.6min calculating + 56min inserting(root package speed limit,can reduce to 4.3min if create a new rootfile) in my own laptop

➢ The package is ready to calibrate bpms and rasters for all of periods (repetition work) ,only fast raster calibration have some difficulties(a few good runs, large current with different gain setting,failure shape reconstruction with unknown frequency)