A method to observe and match the beam vertically in FFAG

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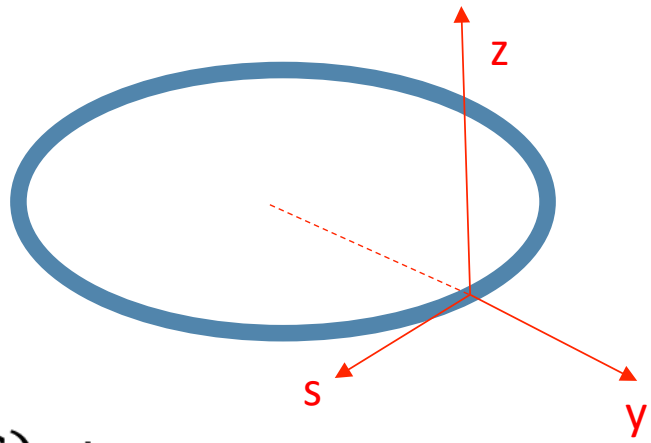
Introduction

- Hill's equation in vertical direction

$$\ddot{z} + K_z(s)z = 0$$

- Solution in phase-amplitude form



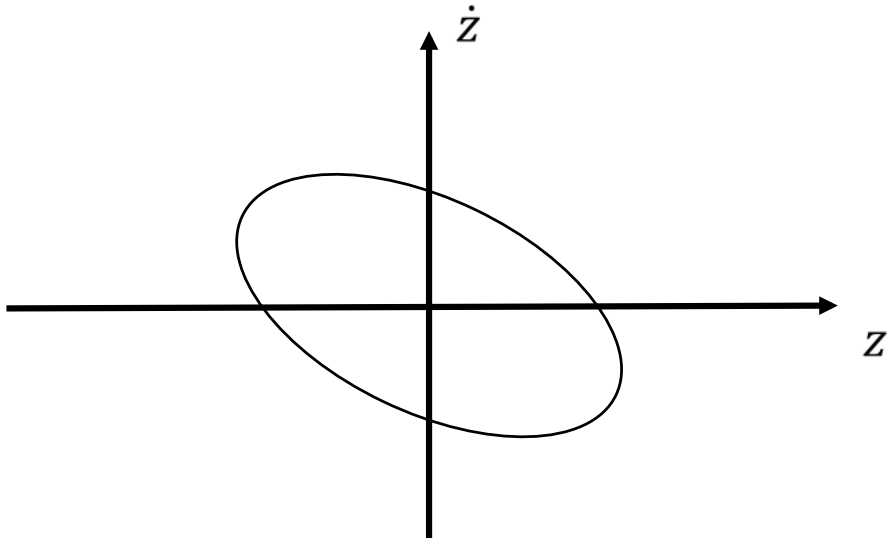
$$x(s) = A\sqrt{\beta(s)}\cos(\Psi(s) + \delta)$$

$$\dot{x}(s) = -\frac{A}{\sqrt{\beta(s)}}[\alpha(s)\cos(\Psi(s) + \delta) + \sin(\Psi(s) + \delta)$$

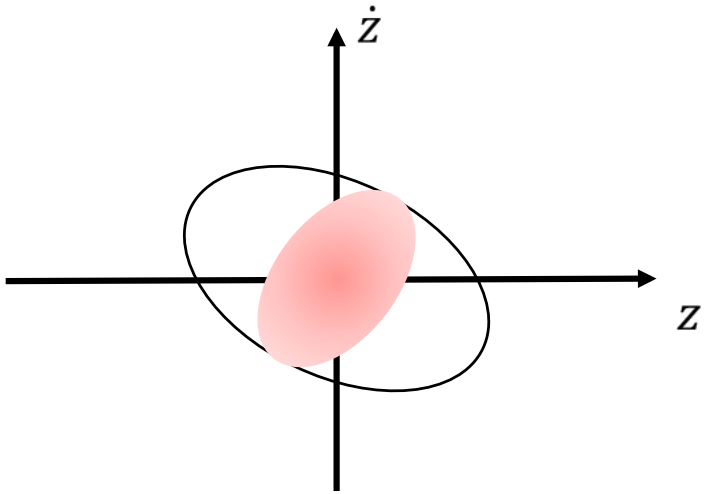
Introduction

- Ellipse in phase space

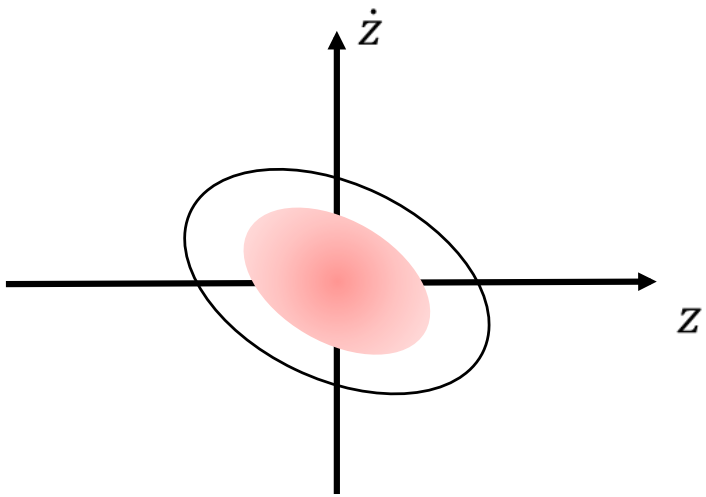
$$A^2 = \gamma(s)x(s)^2 + 2\alpha(s)x(s)\dot{x}(s) + \beta(s)\dot{x}(s)$$



Introduction



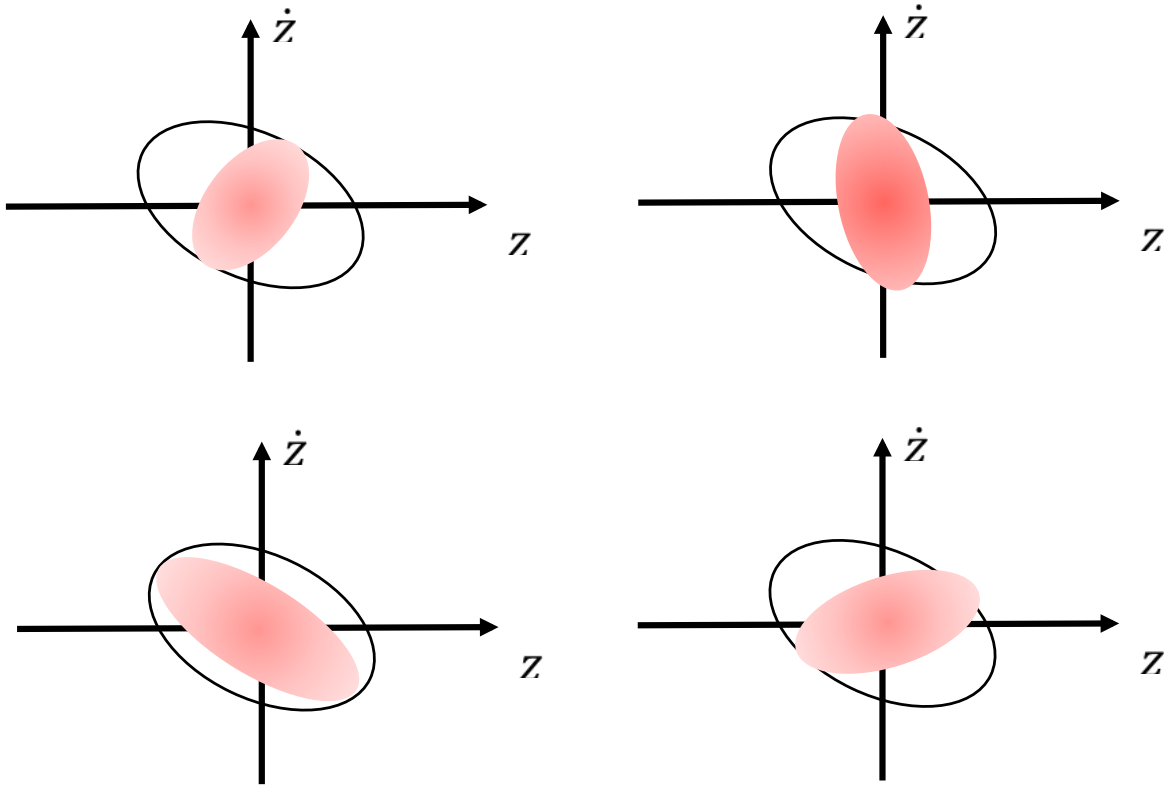
Mismatched Beam



Well Matched Beam

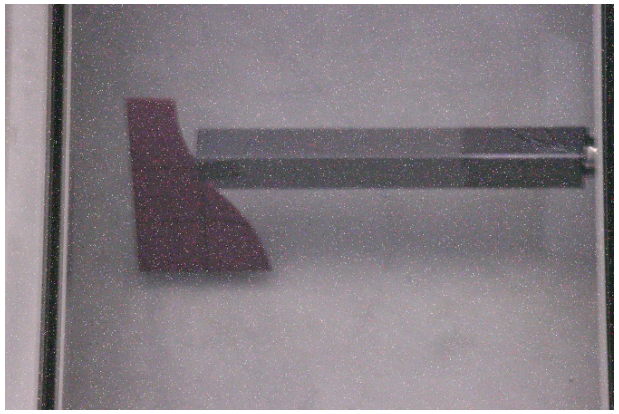
Introduction

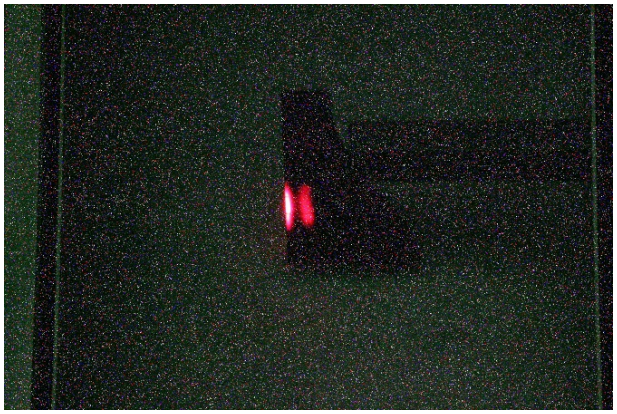
- Mismatched beam will oscillate if observed at a same phase position in different section, but matched beam will not.



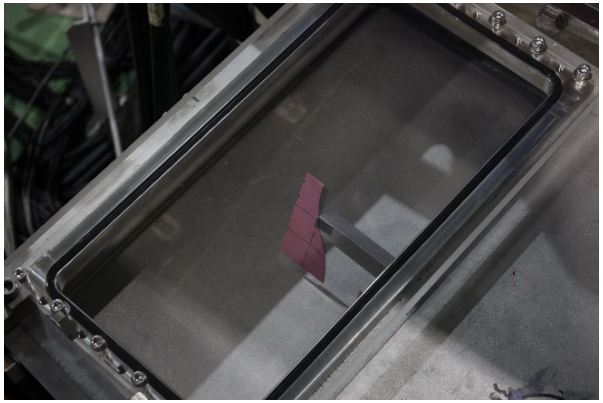
Experiment

- Fluorescent monitors



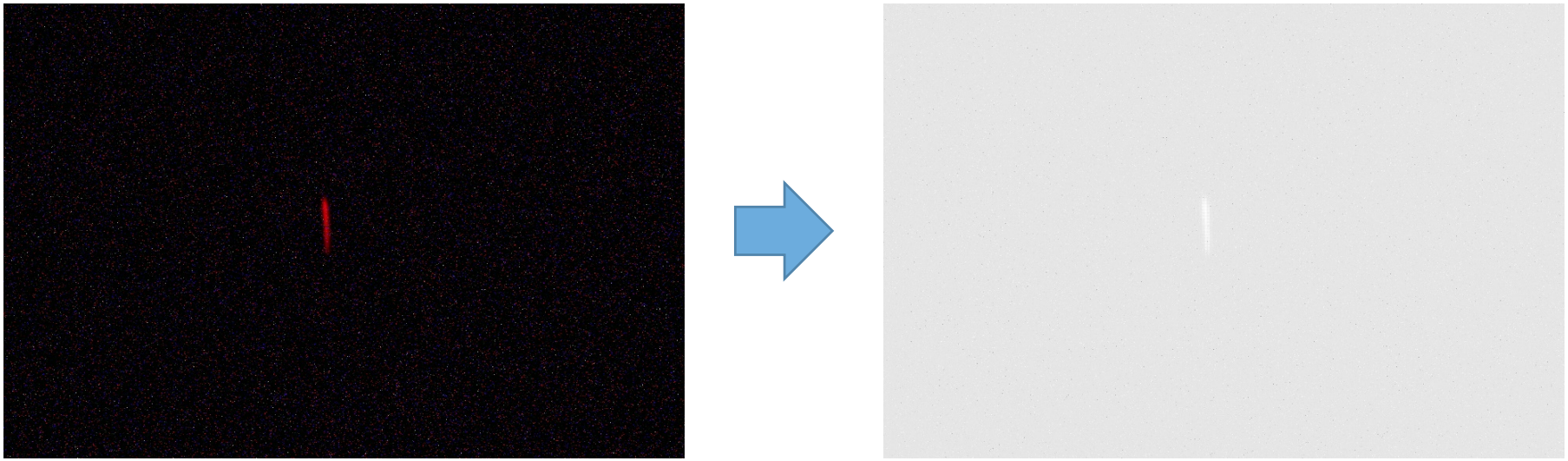


- Canon EOS Kiss 3X

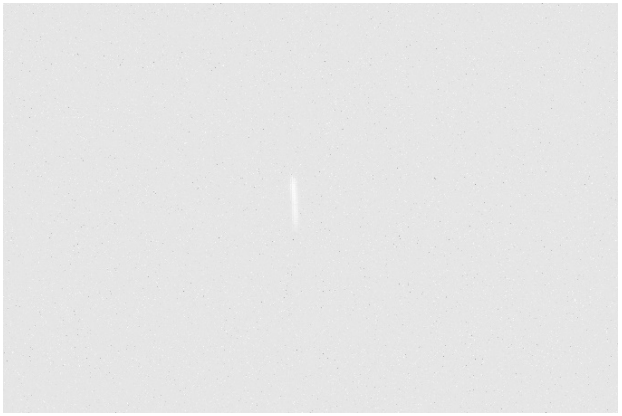


Experiment

- We converted the pictures to grey-scale maps, so we are able to extract the brightness information to observe the beam profile.



Data analysis



29	0	27	59	29
27	27	27	26	22
29	27	29	28	26
27	28	26	23	25
29	28	27	26	25
28	28	28	26	23
28	28	30	26	28
27	27	28	27	24
29	26	28	29	28

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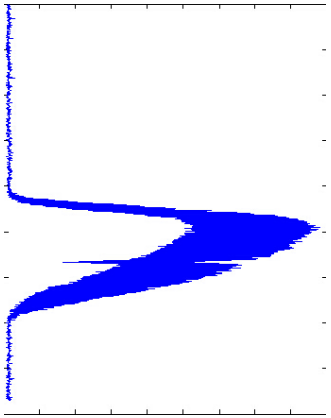
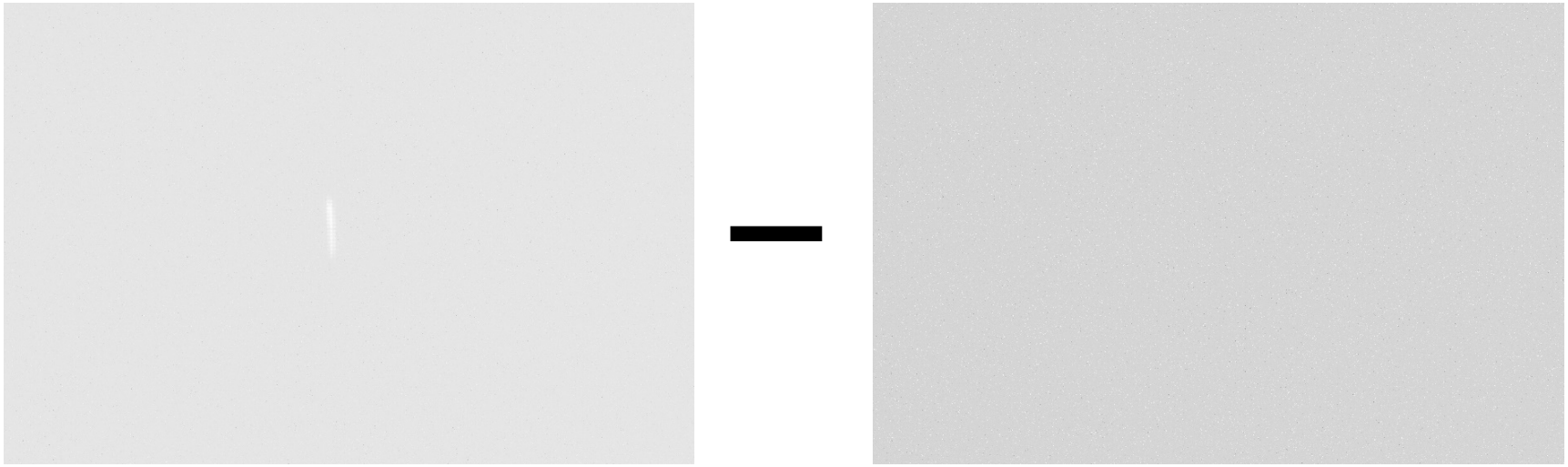
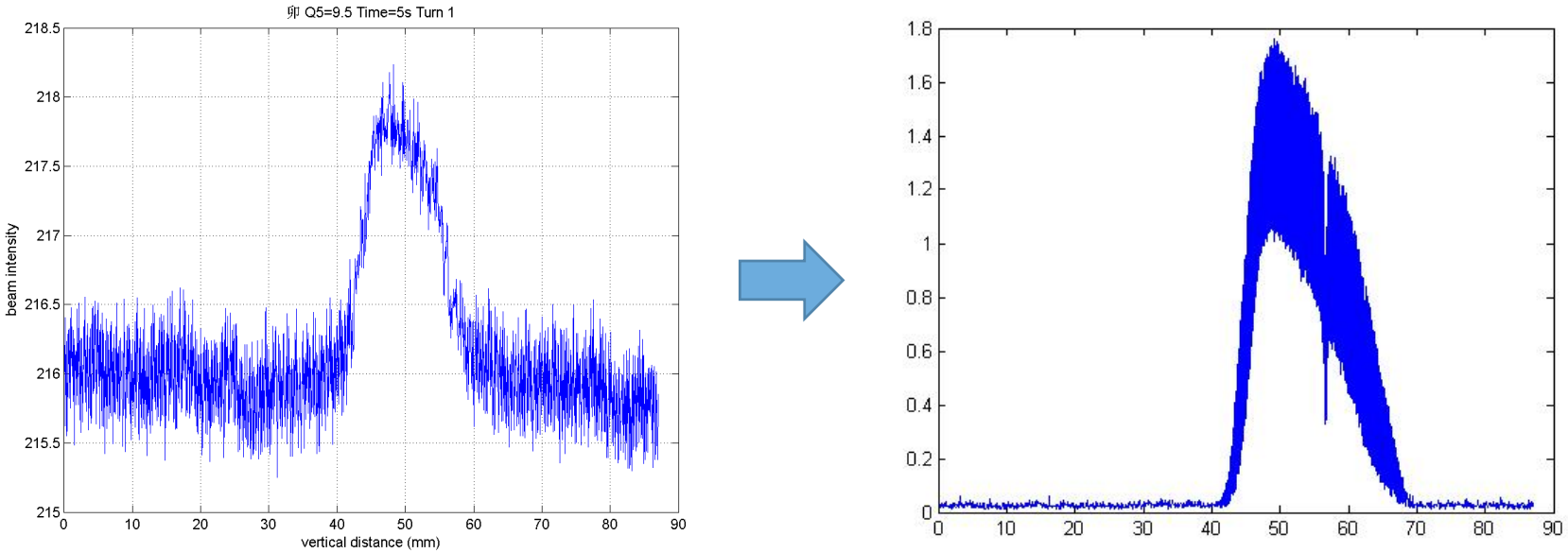


Data analyse

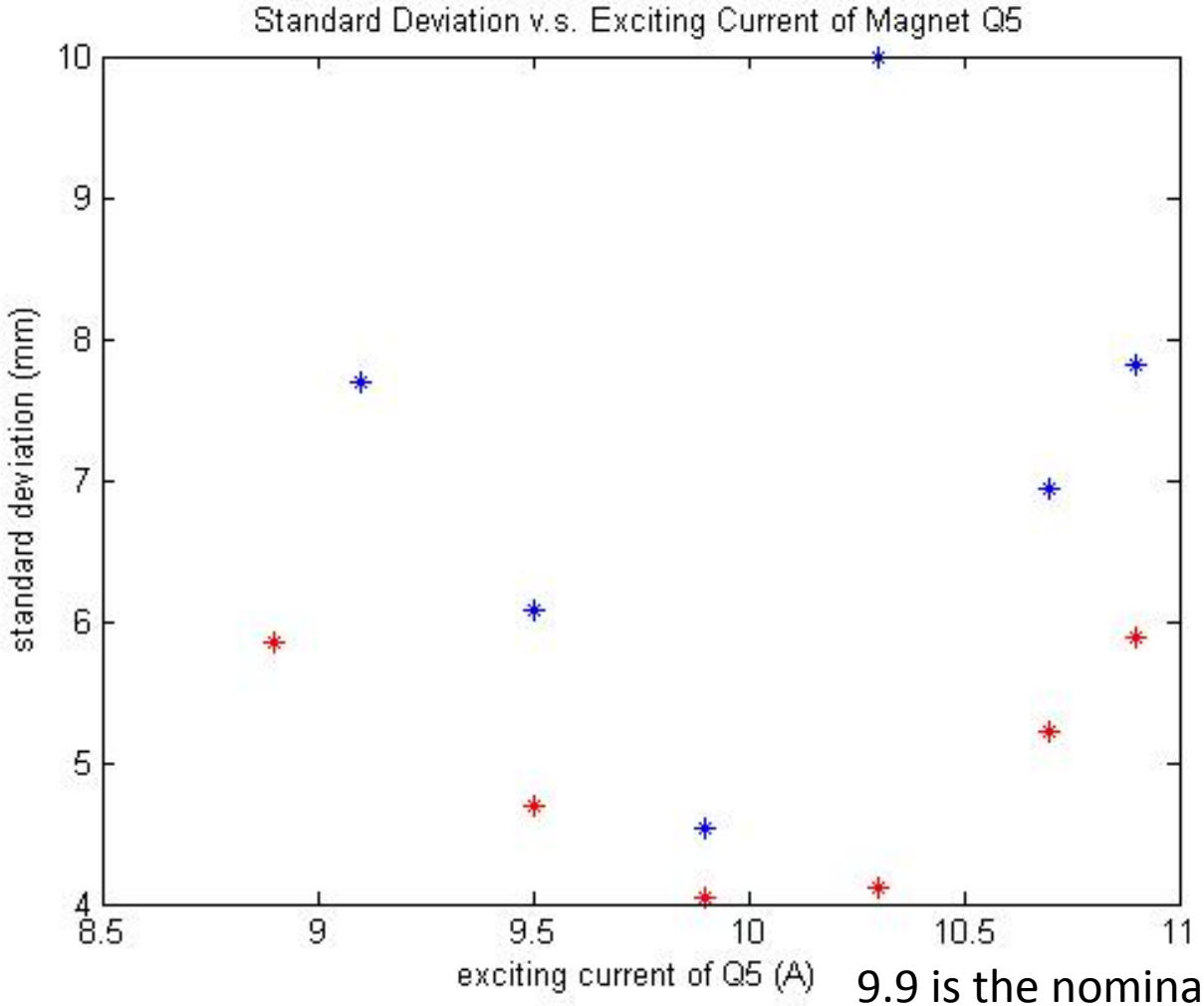
- We use background picture to reduce the noise.



Data analysis

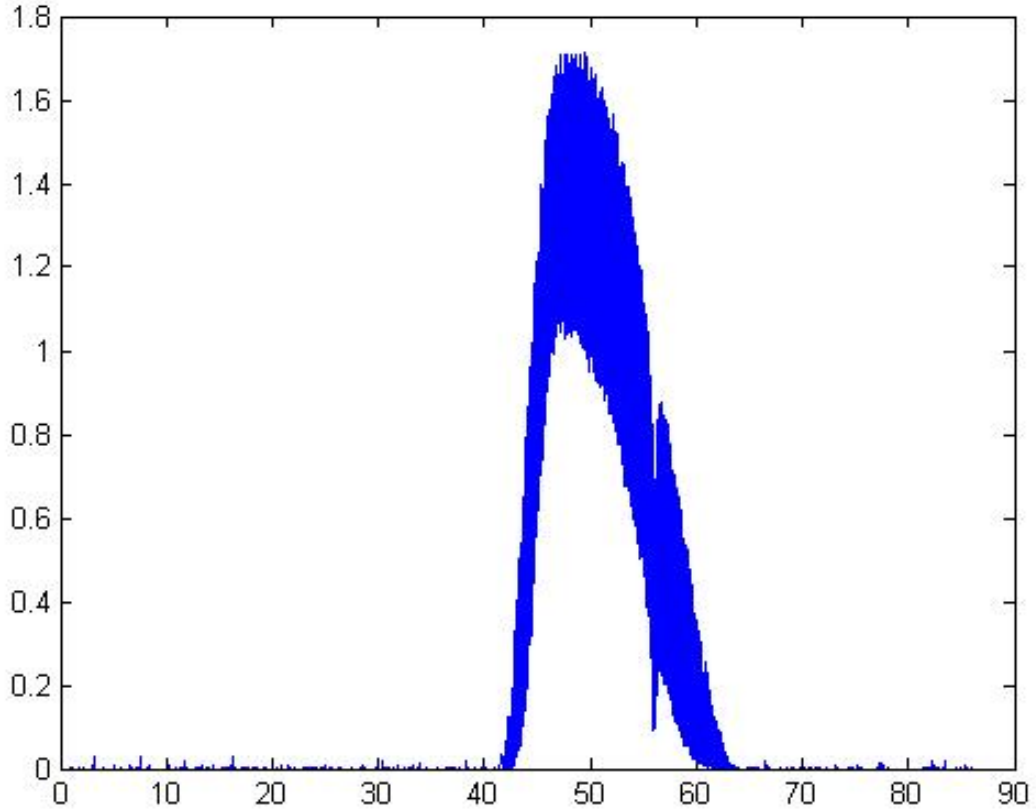


Result



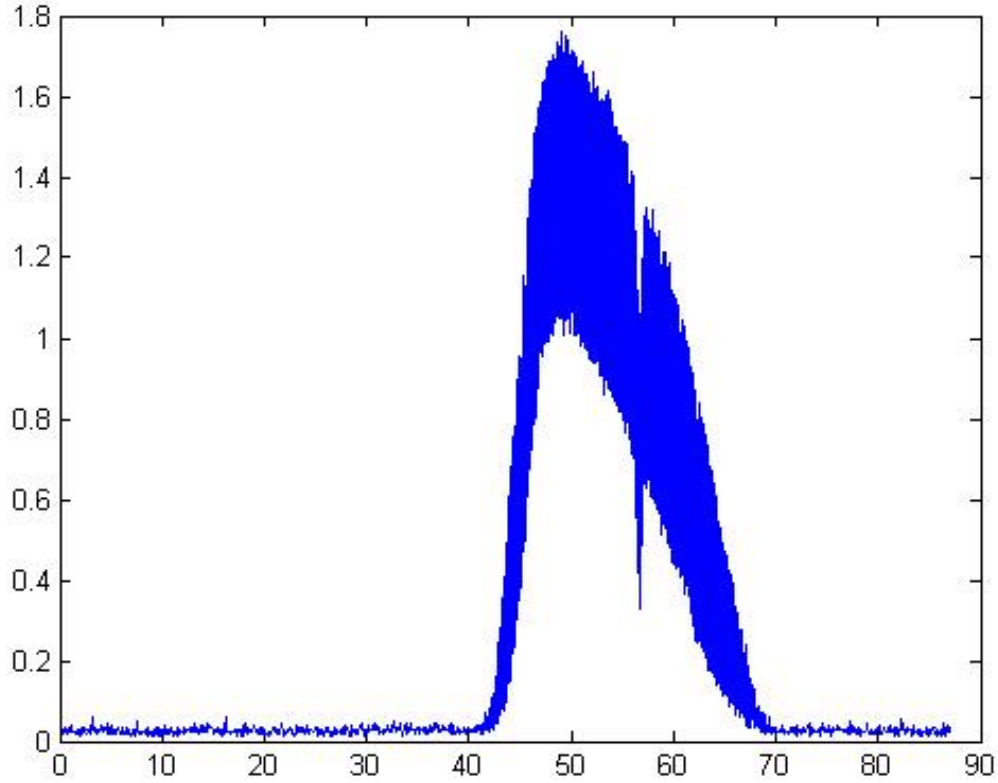
9.9 is the nominal value, which is Close to the optimum

Result



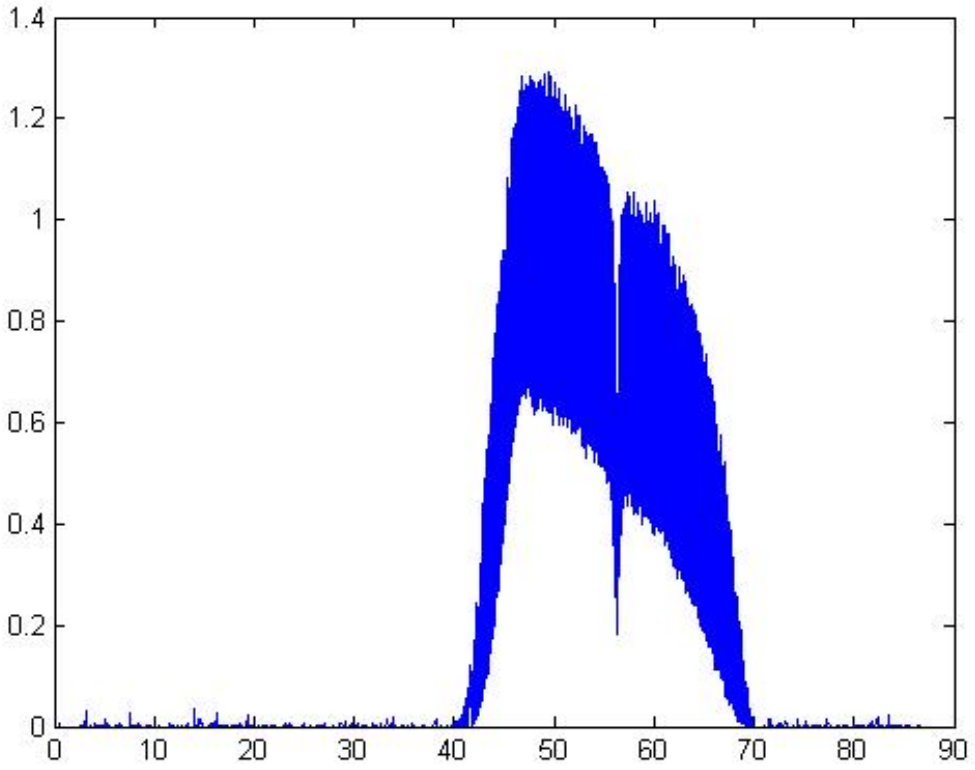
I=9.9A

Result



I=10.3A

Result



I=10.7A