Magnetic Center Study

Measurements from ATF2 Beam Operation during 21th of May 2010.

MOTIVATION:

To improve the alignment of the quadrupoles by studying with precision the magnetic center position as the strength of the magnet is varied.

Magnetic Center Motion

The beam position between a quadrupole (i) and a BPM (j) is proportional to the offset of the quadrupole, the magnet strength and the R_{ij}

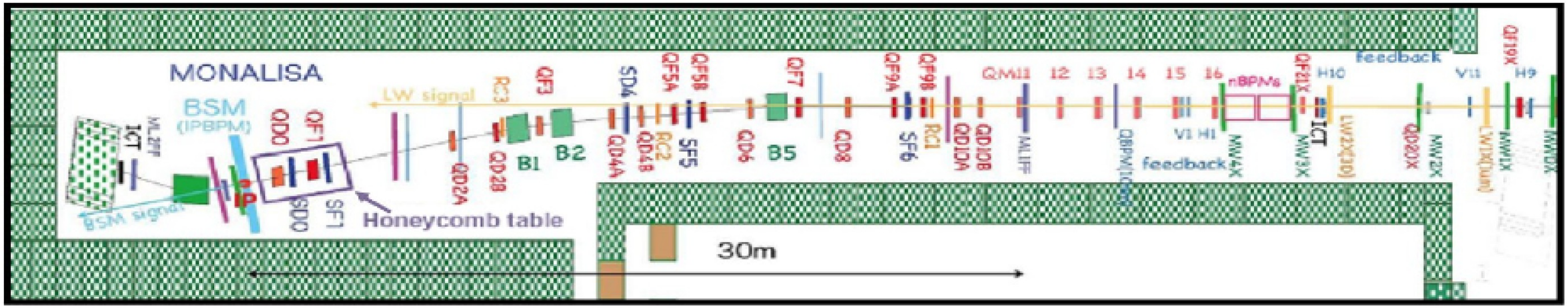
$$x(i,j)=x_d K_q R_{12}(i,j)$$

If the strength of the magnet is varied, and assuming that the magnetic center moves proportional to the magnet strength variation, then:

$$x(i,j)=(x_d+x_j)[K_q+dK_q]R_{12}(i,j)$$

$$x'=R_{12}(i,j)[(x_d+\dot{x}K_q)dK_q+\dot{x}\,dK_q^2]$$

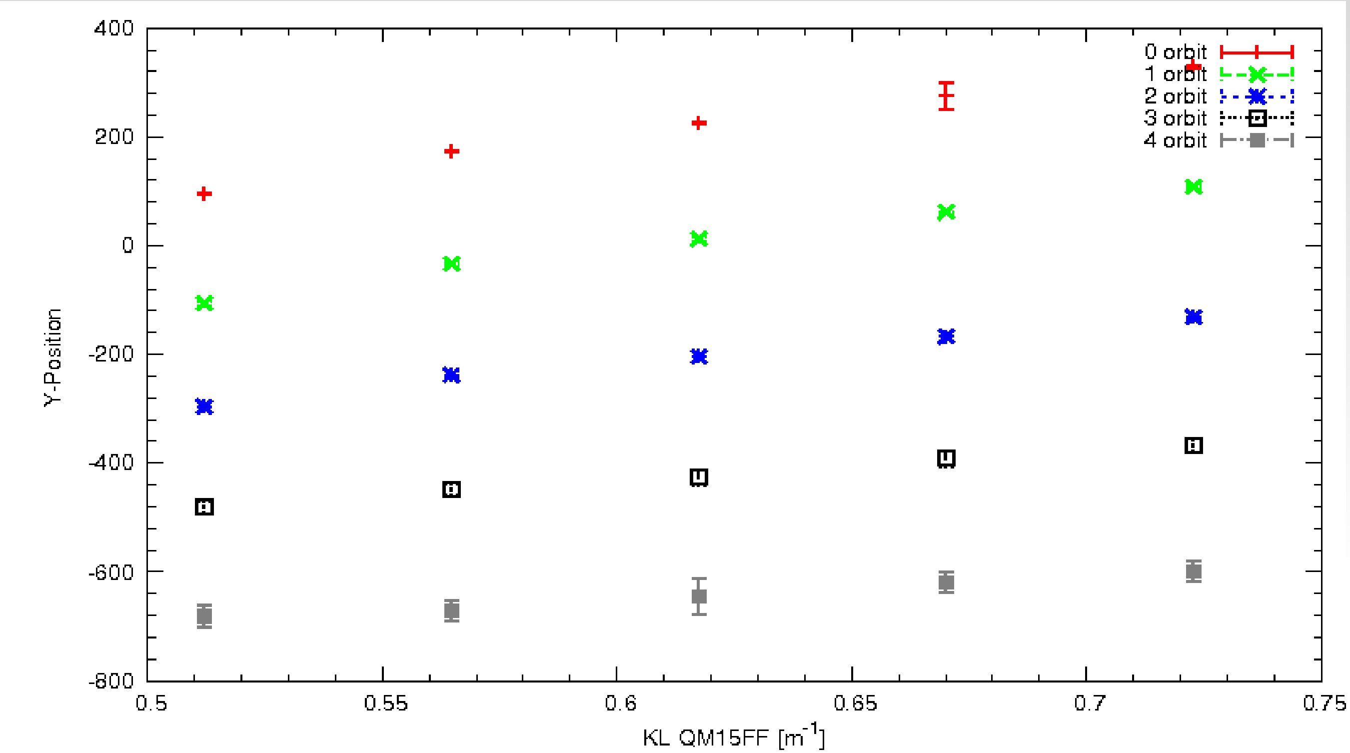
Our study consists in changing the strength of QM16FF within 20% to define 5 different orbits at QM15FF. At each orbit the strength of QM15F is scanned within 20%.



Reference:

"Resolution and Systematic Limitations in Beam-Based Alignment" P.Tenenbaum and T.O.Raubenheimer. SLAC-PUB-8359 March, 2000

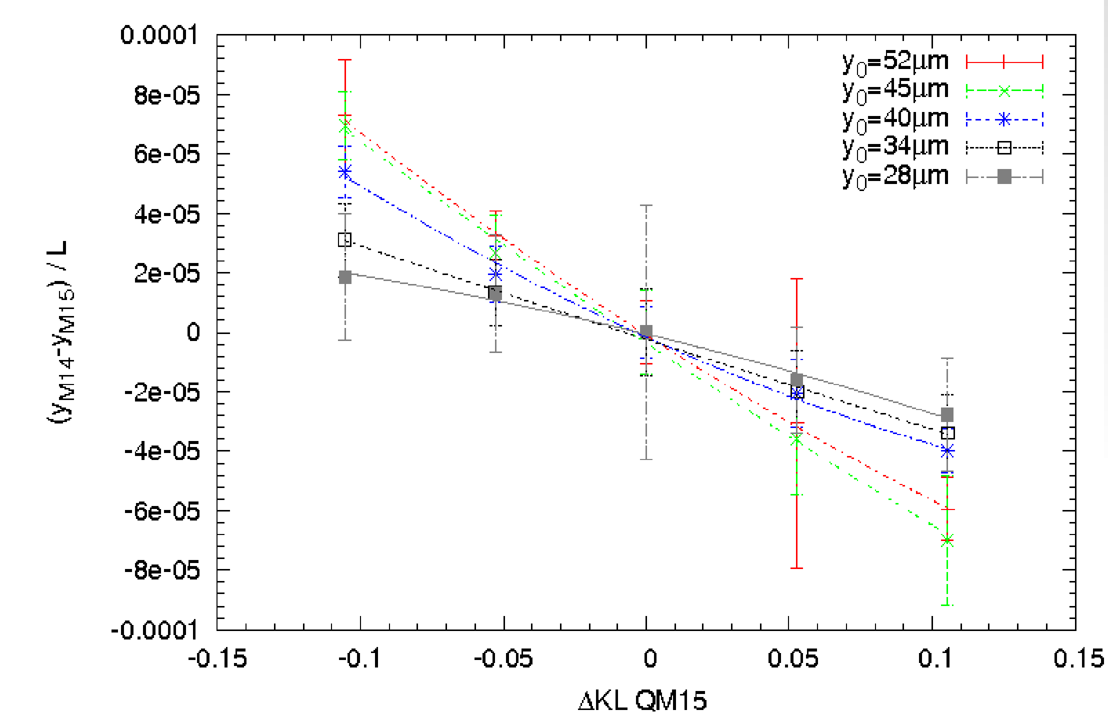
Lectures from the BPM



- Resolution from the BPM is good enough to differ all the orbits.

Scanning QM16FF and QM15FF

- Regarding the beam position at two different BPMs: MQM14FF, MQM13FF and knowing the distance between them L=1.64m



- Linear coefficient [m]

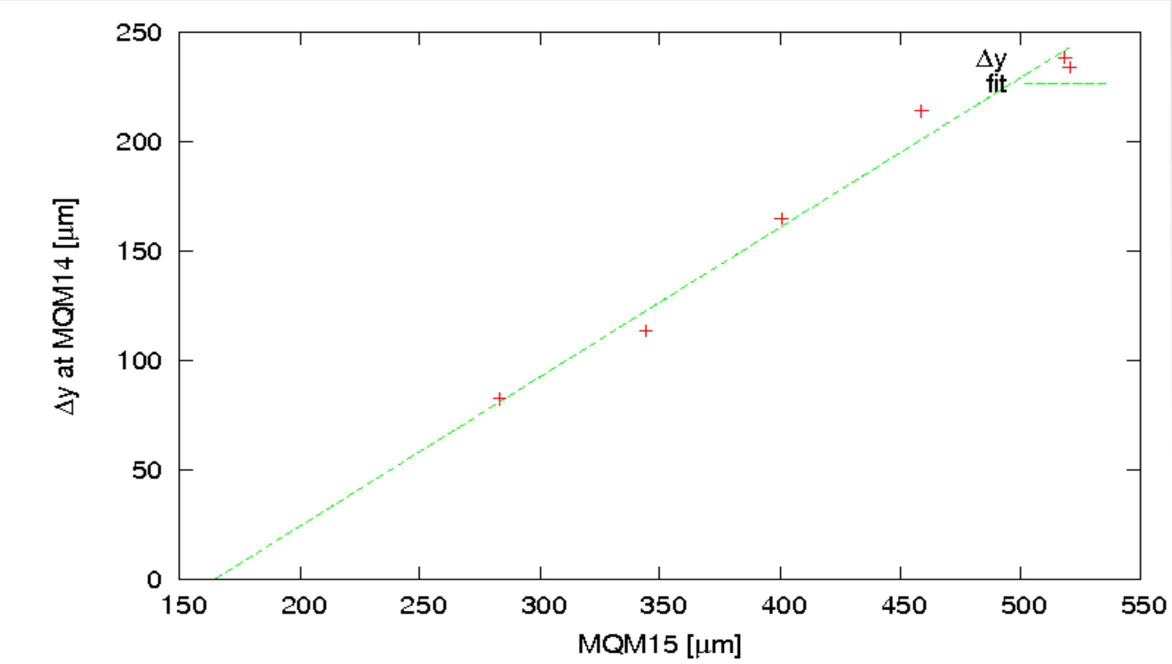
Parabolic coefficient [m^2]:

b0 = -0.000618674 +/- 1.001e-05
b1 = -0.000644943 +/- 3.412e-05
b2 = -0.000434813 +/- 1.899e-05
b3 = -0.000308512 +/- 1.143e-05
b4 = -0.000232296 +/- 1.685e-05

c0 = 0.000631093 +/- 0.0001534
c1 = 0.000337915 +/- 0.0004919
c2 = 0.000739157 +/- 0.0003102
c3 = 6.07789e-05 +/- 0.0001904
c4 = -0.000351068 +/- 0.0003101

Scanning QM16FF and QM15FF

- Regarding the beam position at two different BPMs: MQM14FF, MQM13FF and knowing the distance between them L=1.64m



- Linear coefficient [m]

a0 = -112.55   +/- 23.98
B0 = 0.683291 +/- 0.05846   The offset error is 41 μm.

Conclusions

The BPM resolution is good enough to carry out the study.

The parabolic coefficient which describes the magnetic center motion is ~4.3 10^{-5} m^2

Acknowledgments

To ATF / ATF2 to giving me the possibility to take the measurements.

SVD Analysis

- The SVD analysis allows to “clean” the noise present in the BPM data.

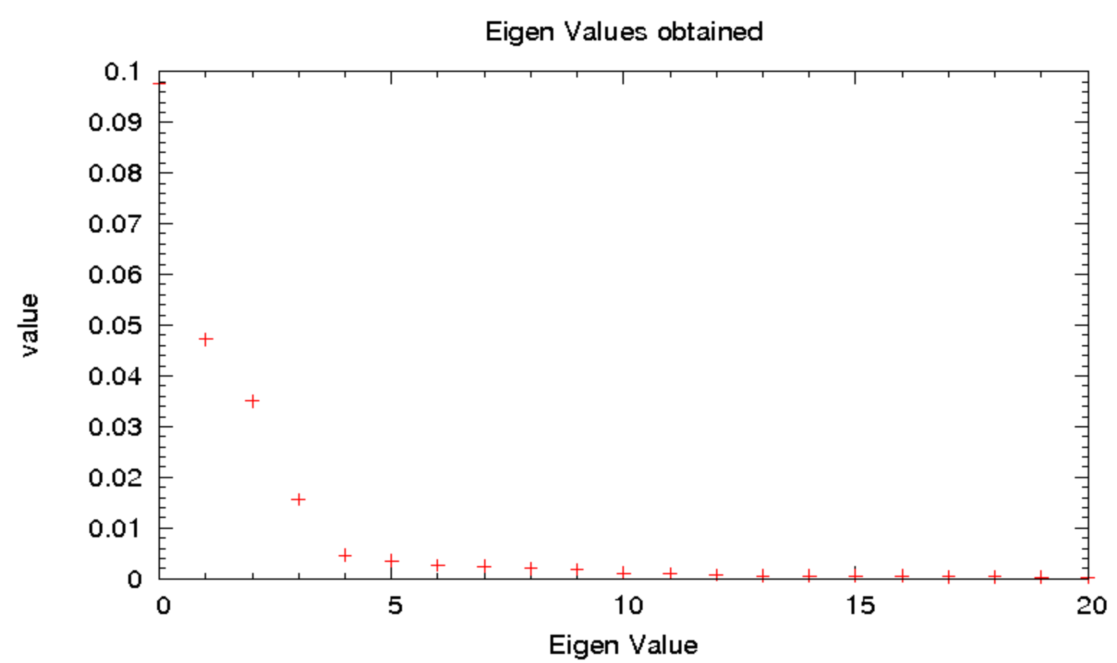
  - Assuming:

    M bpms

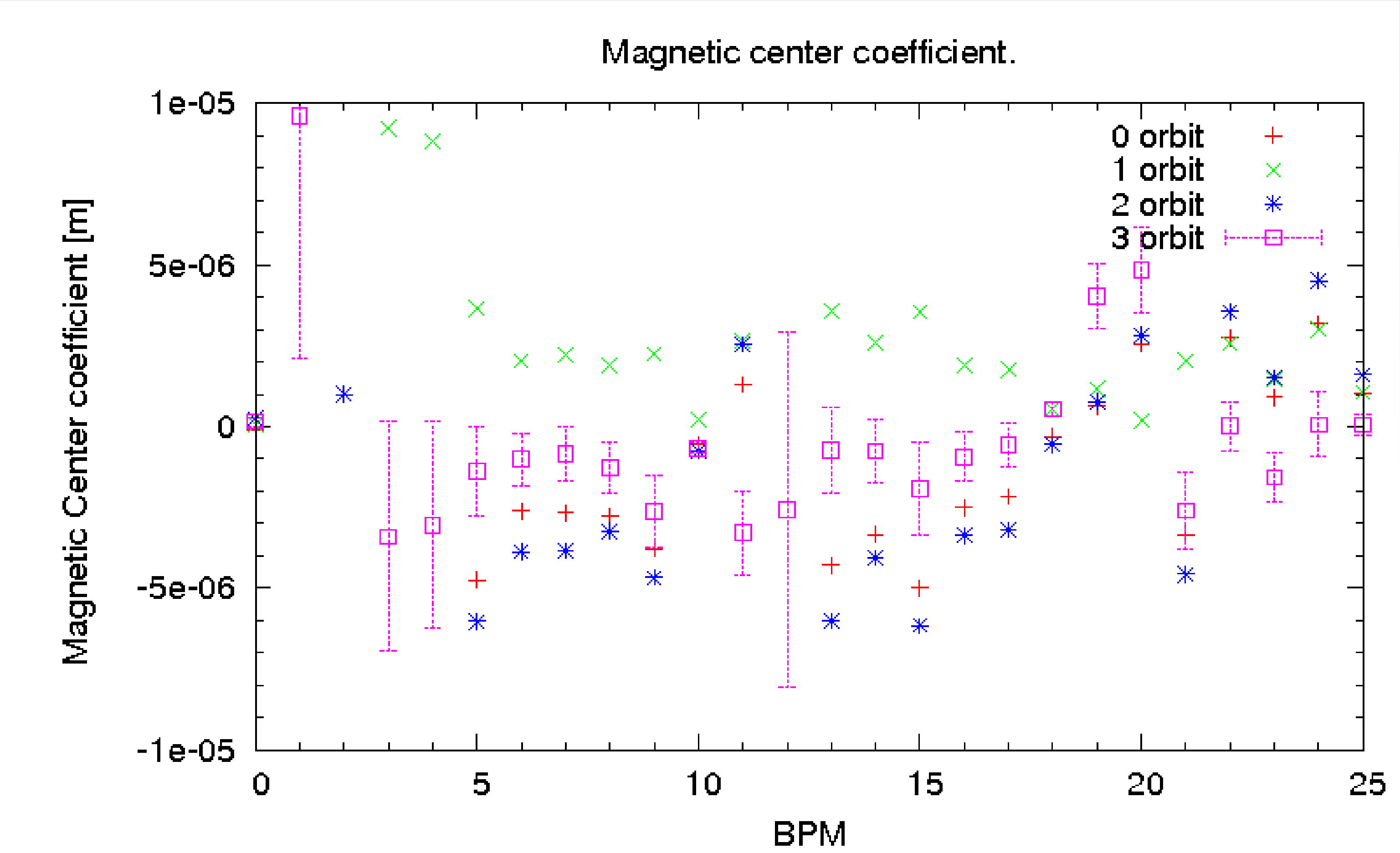
    N readings at each bpm

$$\begin{bmatrix} A-bpm_1 & \dots & \dots & M-bpm_1 \\ \vdots & \dots & \dots & \vdots \\ \vdots & \dots & \dots & \dots \\ A-bpm_n & \dots & \dots & M-bpm_n \end{bmatrix}$$

- Only the first four mode are considered for the following calculations.



Global result for all the BPMs



- Linear and parabolic coefficients: