Alignment and Adjustment of IPBPMs in the IP chamber

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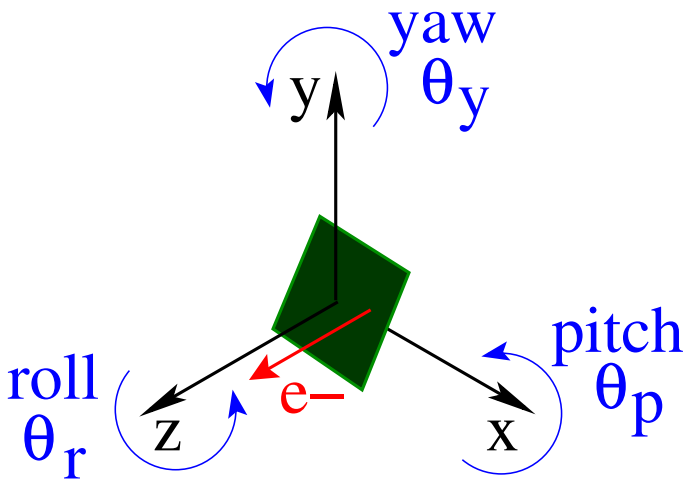
Coordinate system

Each BPM has its own coordinates with respect to a reference system centered **electrically** and aligned with the beam



Beam, BPMs

- Beam Position

  x_A, y_A, z_A

  x_B, y_B, z_B

  x_C, y_C, z_C

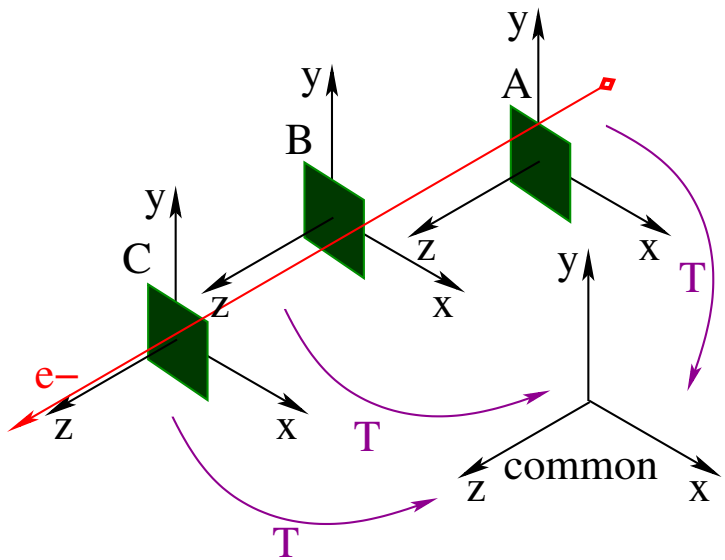
- BPM Angles respect to ref. system

  $\theta_{Ap}, \theta_{Ar}, \theta_{Ay}$

  $\theta_{Bp}, \theta_{Br}, \theta_{By}$

  $\theta_{Cp}, \theta_{Cr}, \theta_{Cy}$

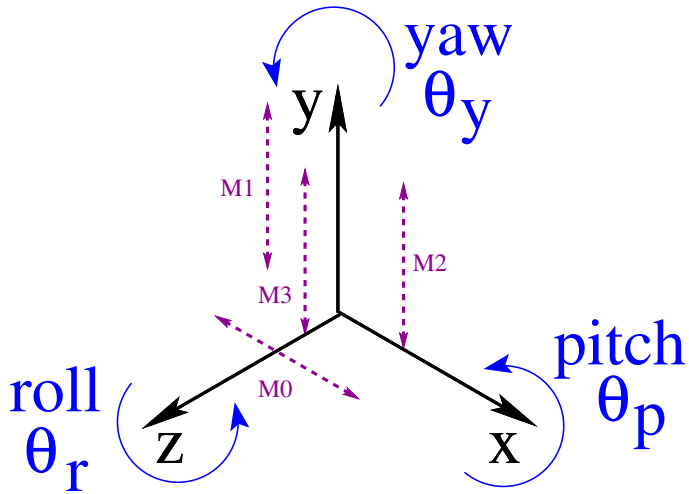
All systems relate to a common **mechanical** reference system, no rotations, just translations



One of the BPMs reference system could be chosen to coincide with the common

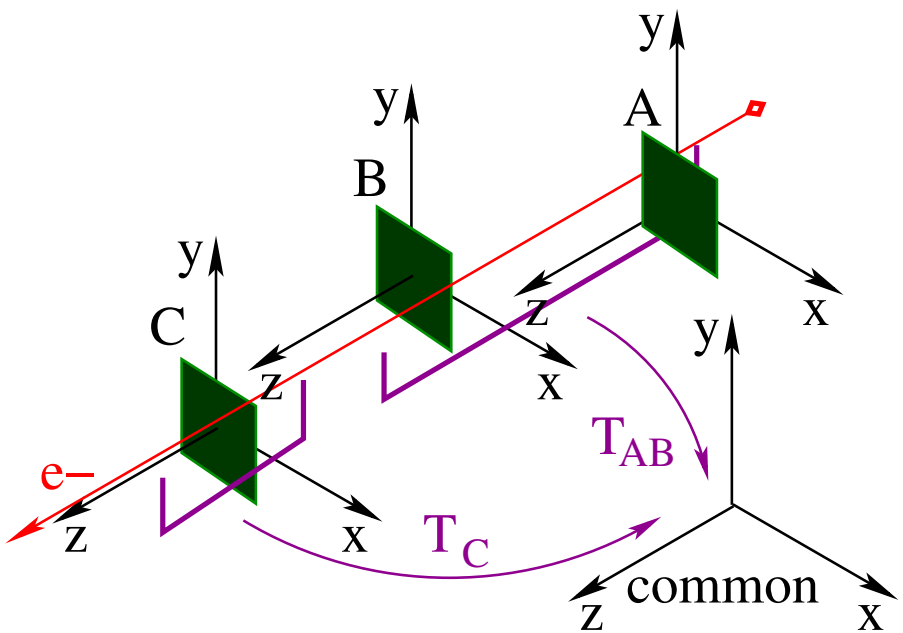
Movers

There is a set of movers to control BPM position



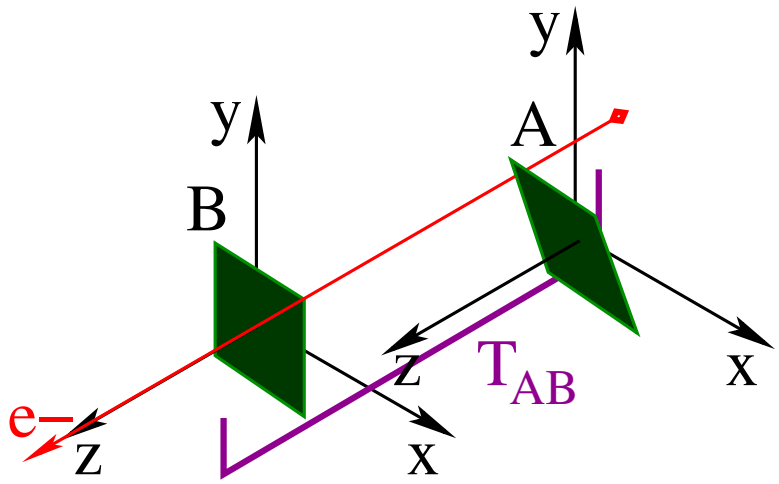
$$x = x_0 + f_x(M_0)$$
$$y = y_0 + f_y(M_1, M_2, M_3)$$
$$z = z_0$$
$$\theta_p = \theta_{p0} + f_p(M_1, M_2, M_3)$$
$$\theta_r = \theta_{r0}$$
$$\theta_y = \theta_{y0}$$

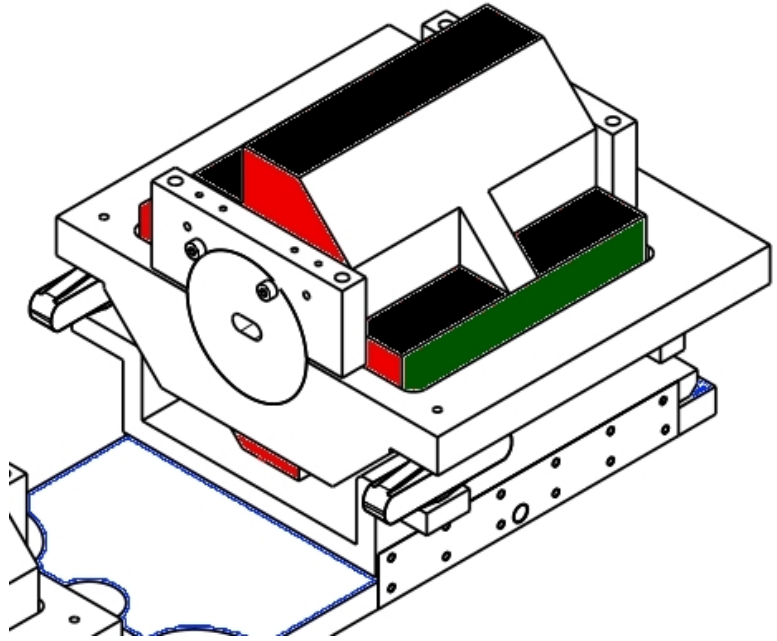
All initial values are set during the IP BPMs installation



Ideally all x_0, y_0 are equal when movers at mid-range, z_0 is the BPM center and all angles are zero.
System is composed only for **two** independent blocks (AB,C)

Block AB Alignment

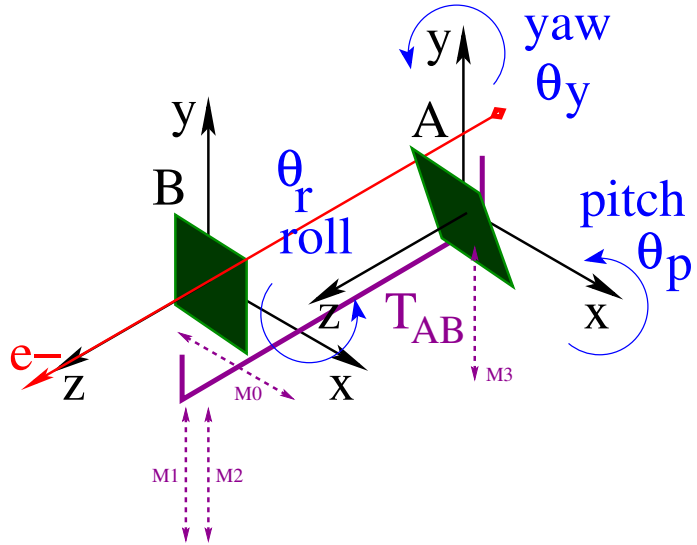




Using BPMB as reference, 1000β_y optics

	Beam		Mech
	B	A	A
x_0 [μm]	0 ± 5	53 ± 5	42 ± 50
y_0 [μm]	0 ± 3	$\mathbf{-34 \pm 3}$	-83 ± 66
z_0 [mm]	not meas.	not meas.	not meas.
θ_{p0} [mrad]	0 ± 0.1	$\mathbf{1.6 \pm 0.1}$	1.6 ± 1.0
θ_{r0} [mrad]	not meas.	not meas.	-0.7 ± 0.9
θ_{y0} [mrad]	not meas.	not meas.	$\pm 0.9 \mp 1.1$

Block AB Adjustment

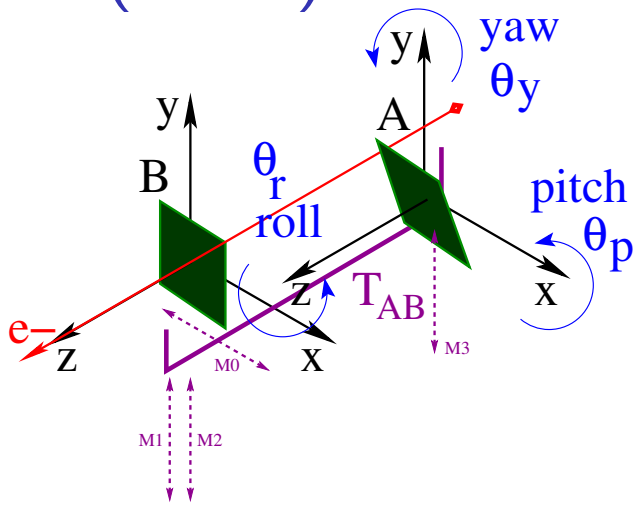


Using BPMB as reference, $1000\beta_y$ optics

	Adjustment (if BPM B is reference and centered)	
	B	A
x [μm]	$0 + 125M_0$	$53 + 125M_0$
y [μm]	$0 + 94.8M_{1,2} + 30.2M_3$	$-34 + 11.2M_{1,2} + 113.8M_3$
z [mm]	not meas.	not meas.
θ_p [mrad]	$0 + 1.03(M_3 - M_{1,2})$	$1.6 + 1.03(M_3 - M_{1,2})$
θ_r [mrad]	not meas.	-0.7
θ_y [mrad]	not meas.	± 0.9

$$-1 < M_{0,1,2,3} < 1, \Delta M_{0,1,2,3} \geq 1.25 \times 10^{-2}$$

Block AB Adjustment (cont.)



Using BPMB as reference, $1000\beta_y$ optics

	Adjustment (if BPM B is reference and centered)	
	B	A
y [μm]	$0 + 94.8M_{1,2} + 30.2M_3$	$-34 + 11.2M_{1,2} + 113.8M_3$
θ_p [mrad]	$0 + 1.03(M_3 - M_{1,2})$	$1.6 + 1.03(M_3 - M_{1,2})$

POSSIBLE CORRECTIONS

V: $y_B = 0\mu$m, $\theta_{Bp} =$ **0mrad**, $y_A = -34\mu$m, $\theta_{Bp} = 1.6$mrad

$y_B =$ **0μm**, $\theta_{Bp} = 0.4$mrad, $y_A =$ **0μm** , $\theta_{Bp} = 2.0$mrad

$y_B = 0\mu$m, $\theta_{Bp} =$ **-0.8mrad**, $y_A = -64.9\mu$m, $\theta_{Bp} =$ **0.8mrad**

$y_B = 21.9\mu$m, $\theta_{Bp} = -1.6$mrad, $y_A = -107.64\mu$m, $\theta_{Bp} =$ **0mrad**

Block AB Adjustment (cont.)

	Adjustment (BPMB as reference to BPMA)	
	B	A
x [μm]	$x_{B0} + 125M_0$	$x_{A0} - x_{B0} + 125M_0$
y [μm]	$y_{B0} + 94.8M_{1,2} + 30.2M_3$	$y_{A0} - y_{B0} + 11.2M_{1,2} + 113.8M_3$
z [mm]	z_{B0}	$z_{A0} - z_{B0}$
θ_p [mrad]	$\theta_{Bp0} + 1.03(M_3 - M_{1,2})$	$\theta_{Ap0} - \theta_{Bp0} + 1.03(M_3 - M_{1,2})$
θ_r [mrad]	θ_{Br0}	$\theta_{Ar0} - \theta_{Br0}$
θ_y [mrad]	θ_{By0}	$\theta_{Ay0} - \theta_{By0}$

$$-1 < M_{0,1,2,3} < 1, \Delta M_{0,1,2,3} \geq 1.25 \times 10^{-2}$$

POSSIBLE CORRECTIONS

H: B $\pm 125\mu$m, or, A$\pm 125\mu$m

V: B $\pm 125\mu$m, or, A $\pm 125\mu$m

B $\pm 90\mu$m and $\mp$1mrad, or, A $\pm 110\mu$m and $\pm$1mrad

B $\mp$2mrad, or, A $\pm$2mrad

NOTE: Angle correction goes in opposite directions

Block AB Adjustment (cont.)

y [μm]	$y_{B0} + 94.8M_{1,2} + 30.2M_3$	$y_{A0} - y_{B0} + 11.2M_{1,2} + 113.8M_3$
θ_p [mrad]	$\theta_{Bp0} + 1.03(M_3 - M_{1,2})$	$\theta_{Ap0} - \theta_{Bp0} + 1.03(M_3 - M_{1,2})$

Vertical signals I_y, Q_y depend on y, θ_p, it might be possible to find a minimum for $\sqrt{(I_y^2 + Q_y^2)}$ for A and B at the same time.

x [μm]	$x_{B0} + 125M_0$	$x_{A0} - x_{B0} + 125M_0$
θ_y [mrad]	θ_{By0}	$\theta_{Ay0} - \theta_{By0}$

Horizontal signals I_x, Q_x depend on x, θ_y.

θ_r [mrad]	θ_{Br0}	$\theta_{Ar0} - \theta_{Br0}$

Coupling depends on θ_r.

Conclusions

- Block AB mechanical alignment shows relative good agreement with measurements made on Dec. 2013.
- Movers adjustment is explicitly writen in order to clarify movers capabilities.
- If pitch angle of 2mrad is acceptable, then BLOCK AB is OK. Otherwise movers could minimize signals I_y, Q_y on either A or B but not all at same time.

I THANK YOU ALL!

Open Questions

- Required alignment precision $(x_0, y_0, z_0, \theta_{p0}, \theta_{r0}, \theta_{y0})$ in order to check during munufacturing and assembly.
  What to check? How to check?

Support slides