Oct 22, 2014

Requirements for IMC Mirror Placement

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Scope

- Set the requirement for placement errors for input mode cleaner (IMC) mirrors

- References:
  - J. Opt. 13 055504 (2011)
    (triangular cavity eigenmode paper by Kawazoe)
  - JGW-T1402481 (calculation by T. Saito)

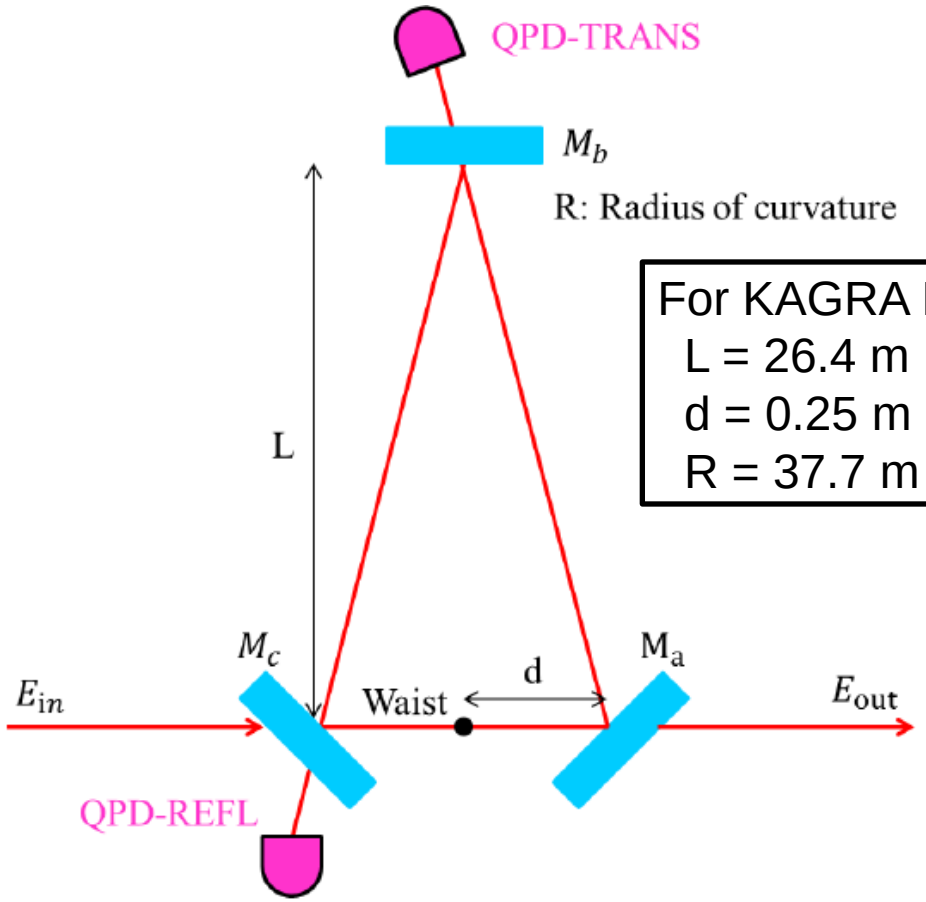
Summary

- If we set the requirement for the beam miscentering to be 10 cm (c.f. mirror diameter = 10 cm);
- MCi placement error should be
  yaw < 1.5 mrad, pitch < 1.5 mrad, disp < 4 cm
- MCo placement error should be
  yaw < 1.5 mrad, pitch < 1.5 mrad, disp < 4 cm
- MCe placement error should be
  yaw < 1 mrad, pitch < 1.5 mrad, disp < 7 cm
  (c.f. 1 mrad = 0.06 deg)

- It seems impossible to meet the angular requirement only by placing the optic. Fine adjustment should be done with picomotors on IMC suspensions.
  → angular requirement should be set from actuation range

Definitions

- α/β for yaw/pitch misalignment
- γ for longitudinal displacement



For KAGRA IMC,
L = 26.4 m
d = 0.25 m
R = 37.7 m

Fig.1 Input Mode Cleaner

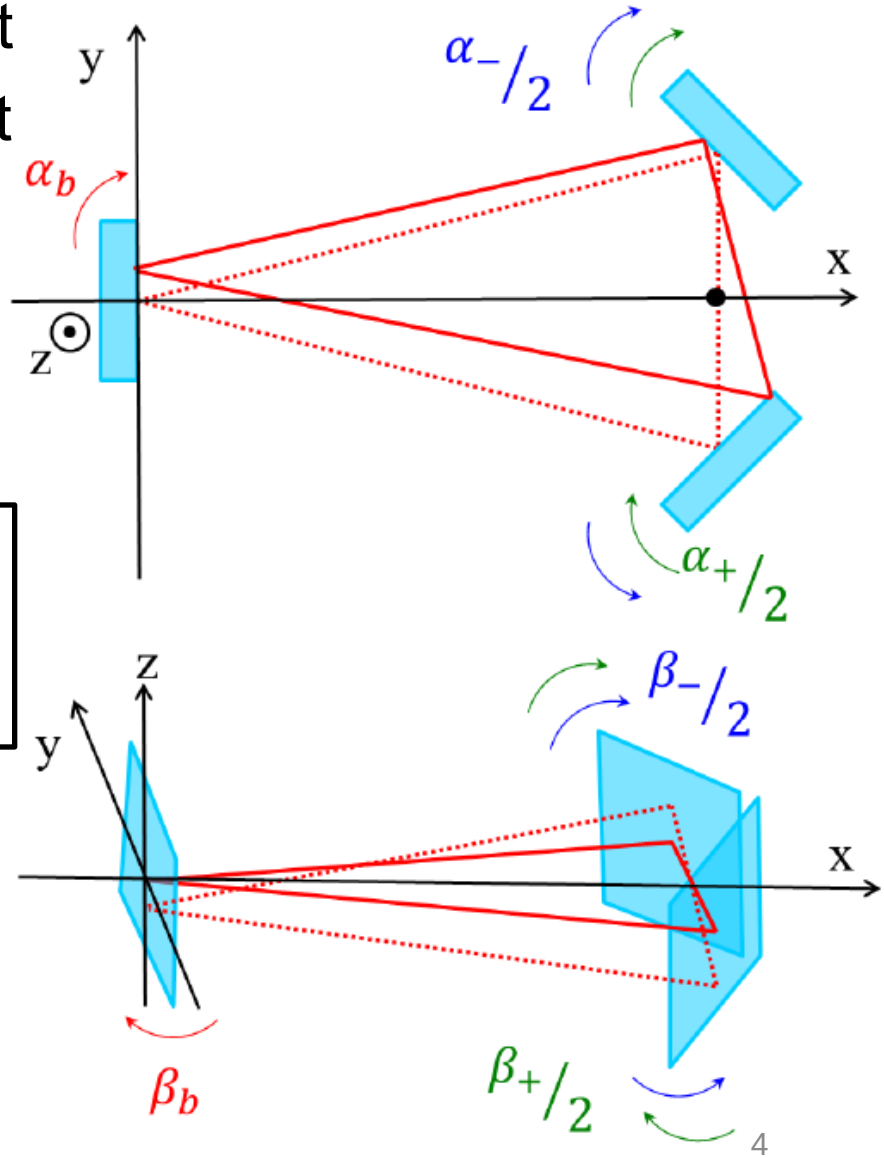


Fig.4.1 ミスアラインメント時の共振器軸の変化

Miscentering from Misalignments

- all values are in m/rad
- αb < 1 mrad
  α- < 3 mrad
  α+ < 100 mrad
  βb < 3 mrad
  β- < 500 mrad
  β+ < 3 mrad

	Δr_{c} (MCi)	Δr_{a} (MCo)	Δr_{b} (MCe)
α_{b}	$\frac{\sqrt{2}Rd}{R-L-d} = 1.21$	$\frac{\sqrt{2}Rd}{R-L-d} = 1.21$	$-\frac{R(L+d)}{R-L-d} = -90.9$
α_{-}	$\sqrt{2(L^2+d^2)} = 37.3$	$-\sqrt{2(L^2+d^2)} = -37.3$	0
α_{+}	$-\frac{\sqrt{2}(R-L)d}{R-L-d} = -0.362$	$-\frac{\sqrt{2}(R-L)d}{R-L-d} = -0.362$	$\frac{Rd}{R-L-d} = 0.853$
β_{b}	$-R = -37.7$	$-R = -37.7$	$-R = -37.7$
β_{-}	$\frac{d}{\sqrt{2}} = 0.177$	$-\frac{d}{\sqrt{2}} = -0.177$	0
β_{+}	$\frac{R-L}{\sqrt{2}} = 7.99$	$\frac{R-L}{\sqrt{2}} = 7.99$	$\frac{R}{\sqrt{2}} = 26.66$

Note that miscentering is defined by $\Delta r = \sqrt{(\Delta x)^2 + (\Delta y)^2 + (\Delta z)^2}$, where Δx, Δy, Δz are the displacements defined in J. Opt. 13 055504 (2011) .

Miscentering from Displacements

- all values are in m/m
- γc < 4 cm
  γa < 4 cm
  γb < 7 cm

	Δr_{c} (MCi)	Δr_{a} (MCo)	Δr_{b} (MCe)
γ_{c}	0	1	$\frac{R}{\sqrt{2}(R-L-d)} = 2.41$
γ_{a}	1	0	$-\frac{R}{\sqrt{2}(R-L-d)} = -2.41$
γ_{b}	$\sqrt{2}$	$\sqrt{2}$	0