T1300413 ETM Manifold/cryopump Baffle
Mis-alignment IFO Beam Power Loss
6/14/11

wavelength, mm $\lambda := 1.064 \cdot 10^{-3}$

index of refraction of fused silica $n := 1.44963$

cavity length, mm $L := 3996000$

radius1 of ETM, mm
ref: T0900043 $R1_{ETM} := -2245000$

radius2 of ETM mm $R2_{ETM} := 10^{64}$

thickness of ETM mm $t_{ETM} := 200$

radius1 of ITM, mm
ref: T0900043 $R1_{ITM} := -1934000$

g − factors

$$g_1 := 1 - \frac{L}{-R1_{ITM}} \qquad g_1 = -1.066$$

$$g_2 := 1 - \frac{L}{-R1_{ETM}} \qquad g_2 = -0.78$$

$$g_1 \cdot g_2 = 0.832$$

$$g_1 + g_2 - 2 \cdot (g_1 \cdot g_2) = -3.509$$

$$g_1 \cdot g_2 \cdot (1 - g_1 \cdot g_2) = 0.14$$

IFO beam waist size, mm

$$w_{IFO} := \sqrt{\left(\frac{\lambda \cdot L}{\pi}\right) \cdot \frac{\left[g_1 \cdot g_2 \cdot (1 - g_1 \cdot g_2)\right]^{0.5}}{\left|g_1 + g_2 - 2 \cdot (g_1 \cdot g_2)\right|}}$$

IFO beam waist size, mm $w_{IFO} = 12.014$

distance of beam waist from ITM HR, mm

$$z_{itmw0} := \frac{g_2\cdot(1-g_1)\cdot L}{g_1+g_2-2\cdot(g_1\cdot g_2)} \qquad z_{itmw0} = 1.835\times 10^{6}$$

distance of beam waist from ETM HR, mm

$$z_{etmw0} := L - z_{itmw0} \qquad z_{etmw0} = 2.161\times 10^{6}$$

beam parameters at ETM HR

translation from beam waist to ITMHR

$$M_{ifoetmhr} := \begin{pmatrix} 1 & z_{etmw0} \\ 0 & 1 \end{pmatrix}$$

$$M_{ifoetmhr} = \begin{pmatrix} 1 & 2.161\times 10^{6} \\ 0 & 1 \end{pmatrix}$$

system matrix from beam waist to ETM HR

$$M := M_{ifoetmhr} \qquad M = \begin{pmatrix} 1 & 2.161\times 10^{6} \\ 0 & 1 \end{pmatrix}$$

$$w_{IFO} = 12.014$$

$$w_{ETM} := \left[\frac{\lambda}{\pi}\cdot\frac{-\left(M_{0,1}\right)^2-\left(M_{0,0}\right)^2\cdot\left(\pi\cdot\frac{w_{IFO}^{\,2}}{\lambda}\right)^2}{\pi\cdot\frac{w_{IFO}^{\,2}}{\lambda}\cdot\left(M_{0,1}\cdot M_{1,0}-M_{0,0}\cdot M_{1,1}\right)}\right]^{0.5}$$

beam radius at ETM mirror, mm $\qquad w_{ETM} = 62.094$

beam parameters at ITM HR

translation from beam waist to ITMHR

$$M_{ifoitmhr} := \begin{pmatrix} 1 & z_{itmw0} \\ 0 & 1 \end{pmatrix}$$

$$M_{ifoitmhr} = \begin{pmatrix} 1 & 1.835 \times 10^{6} \\ 0 & 1 \end{pmatrix}$$

system matrix from beam waist to ITM HR

$$M := M_{ifoitmhr} \qquad M = \begin{pmatrix} 1 & 1.835 \times 10^{6} \\ 0 & 1 \end{pmatrix}$$

$$w_{IFO} = 12.014$$

$$w_{ITM} := \left[\frac{\lambda}{\pi} \cdot \frac{-\left(M_{0,1}\right)^2 - \left(M_{0,0}\right)^2 \cdot \left(\pi \cdot \frac{w_{IFO}^{\ 2}}{\lambda}\right)^2}{\pi \cdot \frac{w_{IFO}^{\ 2}}{\lambda} \cdot \left(M_{0,1} \cdot M_{1,0} - M_{0,0} \cdot M_{1,1}\right)} \right]^{0.5}$$

beam radius at ITM mirror, mm

$$w_{ITM} = 53.109$$

beam radius @ 1/e^2 power, mm

$$r_{e2} := w_{ITM} \cdot \sqrt{2}$$

$$r_{e2} = 75.107$$

beam radius ITM @ 1ppm power, mm

$$r_{itm1ppm} := w_{ITM} \cdot \sqrt{\frac{6}{2} \cdot \ln(10)}$$

$$r_{itm1ppm} = 139.584$$

beam dia ITM @ 1ppm power, mm

$$d_{itm1ppm} := 2 \cdot r_{itm1ppm}$$

$$d_{itm1ppm} = 279.168$$

beam radius ETM @ 1ppm power, mm

$$r_{etm1ppm} := w_{ETM} \cdot \sqrt{\frac{6}{2} \cdot \ln(10)}$$

$$r_{etm1ppm} = 163.199$$

beam dia ETM @ 1ppm power, mm

$$d_{etm1ppm} := 2 \cdot r_{etm1ppm}$$

$$d_{etm1ppm} = 326.397$$

maximum integration radius, mm

$$r_{max} := \sqrt{\frac{6}{2} \cdot \ln(10)} \cdot w_{ITM}$$

$$r_{max} := 100 \cdot w_{ITM}$$

total power in Gaussian beam, W

$$P_t := \frac{2}{\pi \cdot w_{ITM}^{2}} \cdot \int_{0}^{r_{max}} 2 \cdot \pi \cdot r \cdot e^{\frac{-2 \cdot r^2}{w_{ITM}^{2}}} \, dr$$

$$P_t = 1$$

check power lost

$$P_l := 1 - P_t$$

$$P_l = 2.442 \times 10^{-15}$$

Gaussian beam function in cartesian coords

beam offset x, mm

$$x_0 := -200$$

beam offset y, mm

$$y_0 := -80$$

error offset x, mm

$$\delta := 0$$

cryopump radius, mm

$$R := 384.5$$

height of bottom ledge, mm $h := 269$

Intensity distribution function ETM, W/mm^2

$$I(x, y, x_0, y_0, \delta) := \frac{2}{\pi \cdot w_{ETM}^{2}} \cdot e^{\frac{-2\cdot\left[(x - x_0 + \delta)^2 + (y - y_0)^2\right]}{w_{ETM}^{2}}}$$

total power through cryopump baffle, W

$$P_{cryo}(\delta) := \int_{-R}^{R} \int_{-h}^{\sqrt{R^2 - x^2}} I(x, y, x_0, y_0, \delta)\, dy\, dx$$

fractional power hitting the cryopump baffle

$$P_{hcryo}(\delta) := P_{cryo}(0) - P_{cryo}(\delta)$$

$$P_{hcryo}(\delta) = 0$$

$\delta := 0, 1 .. 20$