

T1300407-v2 BS Elliptical Baffle Scatter
 7/3/12

BRDF of ellip baf, sr ⁻¹	$BRDF_{\text{ellbaf}} := 0.030$	
Motion of BS frame @ 100 Hz, m/rtHz	$x_{\text{sus}} := 3.1 \cdot 10^{-14}$	
laser wavelength, m	$\lambda := 1.064 \cdot 10^{-6}$	
wave number, m ⁻¹	$k := 2 \cdot \frac{\pi}{\lambda}$	$k = 5.9052 \times 10^6$
Transfer function @ 100 Hz, ITM AR	$TF_{\text{itmar}} := 3.16 \cdot 10^{-11}$	
ITM beam radius, m	$w_{\text{itm}} := 0.053168$	
IFO waist size, m	$w_{\text{ifo}} := 0.0120$	
transformed beam waist after ITM AR surface (see H1 Signal Recycling Cavity beam size_8-12-13)	$w_{\text{itmar0}} := 0.008342$	
solid angle of ITM AR beam waist, sr	$\Delta_{\text{itmar}} := \pi \cdot \left(\frac{\lambda}{\pi \cdot w_{\text{itmar0}}} \right)^2$	
	$\Delta_{\text{itmar}} = 5.1784 \times 10^{-9}$	
see BS Ellip Baf scatter overlap integral.xmcd		
effective scattering solid angle note: this work is not completed	$\Delta\omega_{\text{effbsellipbaf4pt}} := 3.507 \times 10^{-10}$	
ITM elliptical baffle minor semi-axis, m	$a := \frac{0.21 + 0.014}{2}$	$a = 0.112$
ITM elliptical baffle major semi-axis, m	$b := \frac{0.260 + 0.014}{2}$	$b = 0.137$
vertical aperture in BS ellip baf, m	$r_{\text{bsellipy}} := 0.13$	

horizontal aperture in BS ellip baf, m $r_{\text{bsellipx}} := 0.105$

Ref. T070247

Transmissivity of ITM HR $T_{\text{itmhr}} := 0.0140$

input laser power, W $P_{\text{psl}} := 125$

arm cavity gain $G_{\text{ac}} := 13000$

arm cavity power, W $P_{\text{a}} := \frac{P_{\text{psl}}}{2} \cdot G_{\text{ac}} \quad P_{\text{a}} = 8.125 \times 10^5$

Ref. Hiro e-mail 8/29/11

power in power recycling cavity arm, W $P_{\text{rca}} := \frac{P_{\text{a}} \cdot T_{\text{itmhr}}}{4}$

$$P_{\text{rca}} = 2.8438 \times 10^3$$

radius of ITM, m $r_{\text{itm}} := 0.170$

exitance function from ITM, W/m² $I_{\text{itm}}(x, y) := 2 \cdot \frac{4 \cdot P_{\text{rca}}}{\pi \cdot w_{\text{itm}}^2} \cdot e^{-2 \cdot \left(\frac{x^2 + y^2}{w_{\text{itm}}^2} \right)}$

power exiting from ITM toward elliptical baffle, W $P_{\text{itm}} := 4 \cdot \int_0^{r_{\text{itm}}} \int_0^{\sqrt{r_{\text{itm}}^2 - \frac{y^2}{2}}} I_{\text{itm}}(x, y) dx dy$

$$P_{\text{itm}} = 1.1375 \times 10^4$$

Power passing through the ITM elliptical baffle, W

$$P_{itmellbaftran}(\delta x, \delta y) := \left(\int_{\delta y-b}^{\delta y+b} \int_{\delta x-a \cdot \sqrt{1-\frac{y^2}{b^2}}}^{\delta x+a \cdot \sqrt{1-\frac{y^2}{b^2}}} I_{itm}(x, y) dx dy \right)$$

$$P_{itmellbaftran}(0,0) = 1.1374 \times 10^4$$

arm power exiting from ITMAR passing through
 BS elliptical baffle, W

$$P_{itmarbsellbaf} := 4 \cdot \int_0^{r_{bsellipy}} \int_0^{r_{bsellipx} \cdot \sqrt{1-\frac{y^2}{r_{bsellipy}^2}}} I_{itm}(x, y) dx dy$$

$$P_{itmarbsellbaf} = 1.1373 \times 10^4$$

Power hitting BS baffle, W

$$P_{bsbaf} := P_{itmellbaftran}(0,0) - P_{itmarbsellbaf}$$

$$P_{bsbaf} = 1.0931$$

Scatter efficiency of BS Elliptical Baffle

$$\eta_{bsellbaf} := \frac{P_{bsbaf}}{P_{itm}}$$

$$\eta_{bsellbaf} = 9.6097 \times 10^{-5}$$

BS ELLIPTICAL Baffle Scatter

Power scattered into IFO mode
 from both arms, W

$$P_{bsellbafs} := \sqrt{2} \cdot P_{bsbaf} \cdot BRDF_{ellbaf} \cdot \Delta_{itmar}$$

$$P_{bsellbafs} = 2.4015 \times 10^{-10}$$

displacement noise @ 100 Hz,
m/rtHz

$$DN_{\text{bsellbaf}} := TF_{\text{itmar}} \cdot \left(\frac{P_{\text{bsellbafs}}}{P_{\text{psl}}} \right)^{0.5} \cdot x_{\text{sus}} \cdot 2 \cdot k$$

$$DN_{\text{bsellbaf}} = 1.6036 \times 10^{-23}$$