

T1300426 SR3 and SR2 Hole Edge Scatter
11/22/11

Motion of HAM table @ 100 Hz, m/rt Hz

$$x_{\text{ham}} := 3.7 \cdot 10^{-14}$$

laser wavelength, m

$$\lambda := 1.064 \cdot 10^{-6}$$

wave number, m⁻¹

$$k := 2 \cdot \frac{\pi}{\lambda} \quad k = 5.905 \times 10^6$$

IFO waist size, m

$$w_{\text{ifo}} := 0.012$$

IFO arm length, m

$$L := 4000.0$$

solid angle of IFO mode, sr

$$\Delta_{\text{ifo}} := \pi \cdot \left(\frac{\lambda}{\pi \cdot w_{\text{ifo}}} \right)^2 \quad \Delta_{\text{ifo}} = 2.502 \times 10^{-9}$$

Transfer function @ 100 Hz, BS from SR

$$TF_{\text{srbs}} := 4.46 \cdot 10^{-11}$$

Ref. T070247

transmissivity of SRM HR

$$T_{\text{srmhr}} := 0.2$$

Transmissivity of ITM HR

$$T_{\text{itmhr}} := 0.014$$

Reflectivity of ITM HR

$$R_{\text{itmhr}} := 1 - T_{\text{itmhr}} \quad R_{\text{itmhr}} = 0.986$$

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 both arms, W	$P_{rc} := \frac{2P_a \cdot T_{itmhr}}{4}$	$P_{rc} = 5.688 \times 10^3$
Gaussian power parameter in recycling cavity arm	$P_{0rc} := \frac{P_{rc}}{2}$	$P_{0rc} = 2.844 \times 10^3$
Power recycling cavity gain	$G_{rc} := \frac{P_{rc}}{P_{psl}}$	$G_{rc} = 45.5$
refl port signal ratio	$G_{refl} := 0.001$	
as port signal ratio	$G_{as} := 0.00108$	
output signal power, W	$P_{srm} := P_{psl} \cdot G_{as}$	$P_{srm} = 0.135$
power in signal recycling cavity, W	$P_{src} := \frac{P_{srm}}{T_{srmhr}}$	$P_{src} = 0.675$
Beam Waist after SR3	$w_{sr30} := 0.000114$	
BRDF, sr ⁻¹ ; CSIRO, surface 2, S/N 2	$BRDF_1(\theta) := \frac{2755.12}{(1 + 8.50787 \cdot 10^8 \cdot \theta^2)^{1.23597}}$	
incidence angle at COC, rad	$\theta_{coc} := \frac{120}{4 \cdot 10^6}$	$\theta_{coc} = 3 \times 10^{-5}$
BRDF of COC, sr ⁻¹	$BRDF_1(\theta_{coc}) = 1.364 \times 10^3$	

SR2 Scraper

SCATTER FROM ROUGH CUT SS HOLE EDGE

Radius of baffle hole, m	$R_{sr2baf} := 0.042$
tilt angle of SR2 scraper baffle, deg	$\theta_{sr2baf} := 57$

Gaussian beam radius at SR2 baffle

$$w_{sr2} := 0.00959$$

irradiance function at SR2 baffle, W/m²

$$I_{sr2}(r) := 2 \cdot \frac{P_{src}}{\pi \cdot w_{sr2}^2} \cdot e^{-2 \cdot \left(\frac{r^2}{w_{sr2}^2} \right)}$$

check total beam power, W

$$P_{srcchk} := \int_0^{10w_{sr2}} 2 \cdot \pi \cdot r \cdot I_{sr2}(r) \, dr$$

$$P_{srcchk} = 0.675$$

Irradiance at SR2 baffle hole, W/m²

$$I_{sr2}(R_{sr2baf}) = 1.022 \times 10^{-13}$$

thickness of baffle plate, m

$$t := 0.047 \cdot 0.0254 \quad t = 1.194 \times 10^{-3}$$

maximum width of exposed edge, m

$$w_{sr2e} := t \cdot \sin\left(\theta_{sr2baf} \cdot \frac{\pi}{180}\right)$$

$$w_{sr2e} = 1.001 \times 10^{-3}$$

exposed area of baffle hole edge, m²

$$A_{sr2e} := \int_{-R_{sr2baf}}^0 2 \cdot \sqrt{R_{sr2baf}^2 - x^2} \, dx - \int_{-R_{sr2baf} + w_{sr2e}}^0 2 \cdot \sqrt{R_{sr2baf}^2 - (x - w_{sr2e})^2} \, dx$$

$$A_{sr2e} = 8.409 \times 10^{-5}$$

BRDF of edge, sr⁻¹

$$BRDF_{edge} := 0.1$$

power incident on SR2 Scraper hole edge, W

$$P_{\text{sr2scraperedge}} := I_{\text{sr2}}(R_{\text{sr2baf}}) \cdot A_{\text{sr2e}}$$

$$P_{\text{sr2scraperedge}} = 8.596 \times 10^{-18}$$

power scattered from SR2 GBHR3 toward SR3, W

$$P_{\text{sr2scraperedges}} := P_{\text{sr2scraperedge}} \cdot \text{BRDF}_{\text{edge}} \cdot \frac{w_{\text{ifo}}^2}{w_{\text{sr30}}^2} \cdot \frac{\pi \cdot w_{\text{ifo}}^2}{L^2} \cdot \text{BRDF}_1(30 \cdot 10^{-6}) \cdot \Delta_{\text{ifo}}$$

$$P_{\text{sr2scraperedges}} = 9.195 \times 10^{-31}$$

displacement noise @ 100 Hz,
m/rtHz

$$\text{DN}_{\text{sr2scraperedge}} := \text{TF}_{\text{srbs}} \cdot \left(\frac{P_{\text{sr2scraperedges}}}{P_{\text{psl}}} \right)^{0.5} \cdot x_{\text{ham}} \cdot 2 \cdot k$$

$$\text{DN}_{\text{sr2scraperedge}} = 1.672 \times 10^{-33}$$

SR3 HR baffle

SCATTER FROM ROUGH CUT SS HOLE EDGE

Radius of baffle hole, m

$$R_{\text{sr3baf}} := 0.132$$

tilt angle of SR2 scraper baffle, deg

$$\theta_{\text{sr3baf}} := 5$$

Gaussian beam radius at SR3 baffle

$$w_{\text{sr3}} := 0.0543$$

irradiance function at
SR3 baffle, W/m²

$$I_{\text{sr3}}(r) := 2 \cdot \frac{P_{\text{src}}}{\pi \cdot w_{\text{sr3}}^2} \cdot e^{-2 \cdot \left(\frac{r^2}{w_{\text{sr3}}^2} \right)}$$

check total beam
power, W

$$P_{sr3chk} := \int_0^{10w_{sr3}} 2 \cdot \pi \cdot r \cdot I_{sr3}(r) \, dr$$

$$P_{srcchk} = 0.675$$

Irradiance at SR3 baffle hole, W/m²

$$I_{sr3}(R_{sr3baf}) = 1.073 \times 10^{-3}$$

thickness of baffle plate, m

$$t := 0.047 \cdot 0.0254 \quad t = 1.194 \times 10^{-3}$$

maximum width of exposed edge, m

$$w_{sr3e} := t \cdot \sin\left(\theta_{sr3baf} \cdot \frac{\pi}{180}\right)$$

$$w_{sr3e} = 1.04 \times 10^{-4}$$

exposed area of baffle hole edge, m²

$$A_{sr3e} := \int_{-R_{sr3baf}}^0 2 \cdot \sqrt{R_{sr3baf}^2 - x^2} \, dx - \int_{-R_{sr3baf} + w_{sr3e}}^0 2 \cdot \sqrt{R_{sr3baf}^2 - (x - w_{sr3e})^2} \, dx$$

$$A_{sr3e} = 2.747 \times 10^{-5}$$

BRDF of edge, sr⁻¹

$$\text{BRDF}_{\text{edge}} := 0.1$$

power incident on SR3 Scrapper hole
edge, W

$$P_{sr3scraperedge} := I_{sr3}(R_{sr3baf}) \cdot A_{sr3e}$$

$$P_{sr3scraperedge} = 2.948 \times 10^{-8}$$

power scattered from SR3 GBHR3 toward BS, W

$$P_{\text{sr3scraperedges}} := P_{\text{sr3scraperedge}} \cdot \text{BRDF}_{\text{edge}} \cdot \frac{\pi \cdot w_{\text{ifo}}^2}{L^2} \cdot \text{BRDF}_1(30 \cdot 10^{-6}) \cdot \Delta_{\text{ifo}}$$

$$P_{\text{sr3scraperedges}} = 2.846 \times 10^{-25}$$

displacement noise @ 100 Hz,
m/rtHz

$$\text{DN}_{\text{sr3scraperedge}} := \text{TF}_{\text{srbs}} \cdot \left(\frac{P_{\text{sr3scraperedges}}}{P_{\text{psl}}} \right)^{0.5} \cdot x_{\text{ham}} \cdot 2 \cdot k$$

$$\text{DN}_{\text{sr3scraperedge}} = 9.3 \times 10^{-31}$$

$$x_{\text{ham}} = 3.7 \times 10^{-14}$$

