T1300405 ACB edge scatter, porcelain vs oxidized SS
9/6/11

Arm cavity power, W $P_a := 8.125\times 10^5$

radius of baffle edge, m $r := 0.0005$

length of baffle plate edge, m $H_p := 0.655$

length of baffle bend edge, m $H_b := 2\cdot 0.239 = 0.478$

laser wavelength, m $\lambda := 1.064\cdot 10^{-6}$

wave number, m^-1 $k := 2\cdot\frac{\pi}{\lambda}$

$k = 5.905\times 10^6$

IFO waist size, m $w_{ifo} := 0.012$

solid angle of IFO mode, sr $\Delta\Omega_{ifo} := \frac{\lambda^2}{\pi\cdot w_{ifo}^2} = 2.502\times 10^{-9}$

Transfer function @ 100 Hz, ITM HR $TF_{itmhr} := 1.1\cdot 10^{-9}$

Gaussian beam radius at ITM, m $w := 0.055$

IFO arm length, m $L_{arm} := 4000$

PSL laser power, W $P_{psl} := 125$

radius of Cryopump aperture, m $R_{cp} := 0.3845$

half-angle from centerline to Rcp, rad $\theta_{cp} := \frac{R_{cp}}{L_{arm}}$

BRDF, sr^-1; CSIRO, surface 2, S/N 2 $BRDF_1(\theta) := \frac{2755.12}{\left(1 + 8.50787\cdot 10^8\cdot\theta^2\right)^{1.23597}}$

transformation to x, y, coords

$$\theta(x, y, x_0, y_0) := \frac{\sqrt{(x - x_0)^2 + (y - y_0)^2}}{L_{arm}}$$

BRDF, sr^-1; CSIRO, surface 2, S/N 2 in xy coords

$$BRDF_{xy}(x, y, x_0, y_0) := \frac{2755.12}{\left[1 + 8.50787\cdot 10^8 \cdot \left[\frac{\sqrt{(x - x_0)^2 + (y - y_0)^2}}{L_{arm}}\right]^2\right]^{1.2359}}$$

motion of ACB @ 100 HZ, m/rt HZ $\qquad x_{ACB} := 1\cdot 10^{-12}$

BRDF porcelainized steel, #2, 3 deg inc.

Reflectivity of baffle surface $\qquad R := 0.02$

break-over angle, rad $\qquad \theta_1 := 1.5\cdot 10^{-4} \qquad \theta_1 := 0.9\cdot\frac{\pi}{180} = 0.016$

micro-roughness angle, rad $\qquad \theta_2 := 10\cdot 10^{-2} \qquad \theta_2 := 6\cdot\frac{\pi}{180}$

$BRDF_0 := 50$

final slope modifier $\qquad \beta := 2.7$

micro-roughness constant

$$C_{mr} := \frac{2^{\frac{1}{(\beta)}} - 1}{\theta_1^{\,2}} \qquad C_{mr} = 1.186\times 10^3$$

large angle BRDF, sr^-1 $\qquad BRDF_{\theta 2} := 0.035$

parametric BRDF function, sr^-1

$$BRDF_{ACB}(\theta_i) := \frac{BRDF_0}{\left(1 + C_{mr}\cdot\theta_i^{\,2}\right)^{\beta}} + BRDF_{\theta 2}$$

Porcelainized steel BRDF function, sr^-1

$$BRDF_{ACBporc3}(\theta_i) := \frac{BRDF_0}{\left(1 + C_{mr}\cdot\theta_i^{\,2}\right)^{\beta}} + BRDF_{\theta 2}$$

$$BRDF_{ACBporc3}(\theta_1) = 25.035 \qquad BRDF_{ACBporc3}(\theta_2) = 0.075$$

$$\theta_{deg}(\theta_i) := \theta_i\cdot\frac{180}{\pi}$$

BRDF porcelainized steel, #2, 57 deg inc.

max BRDF, sr^-1 $\quad BRDF_0 := 10$

final slope modifier $\quad \beta := 2$

break-over angle, rad $\quad \theta_1 := 0.5\cdot\frac{\pi}{180} = 8.727\times 10^{-3}$

micro-roughness angle, rad $\quad \theta_2 := 3.4\cdot\frac{\pi}{180}$

micro-roughness constant $\quad C_{mr} := \frac{2^{\frac{1}{(\beta)}} - 1}{\theta_1^{\,2}} \qquad C_{mr} = 5.439\times 10^{3}$

large angle BRDF (use data from Liyuan), sr^-1 $\quad BRDF_{\theta 2} := 0.013$

parametric BRDF function, sr^-1

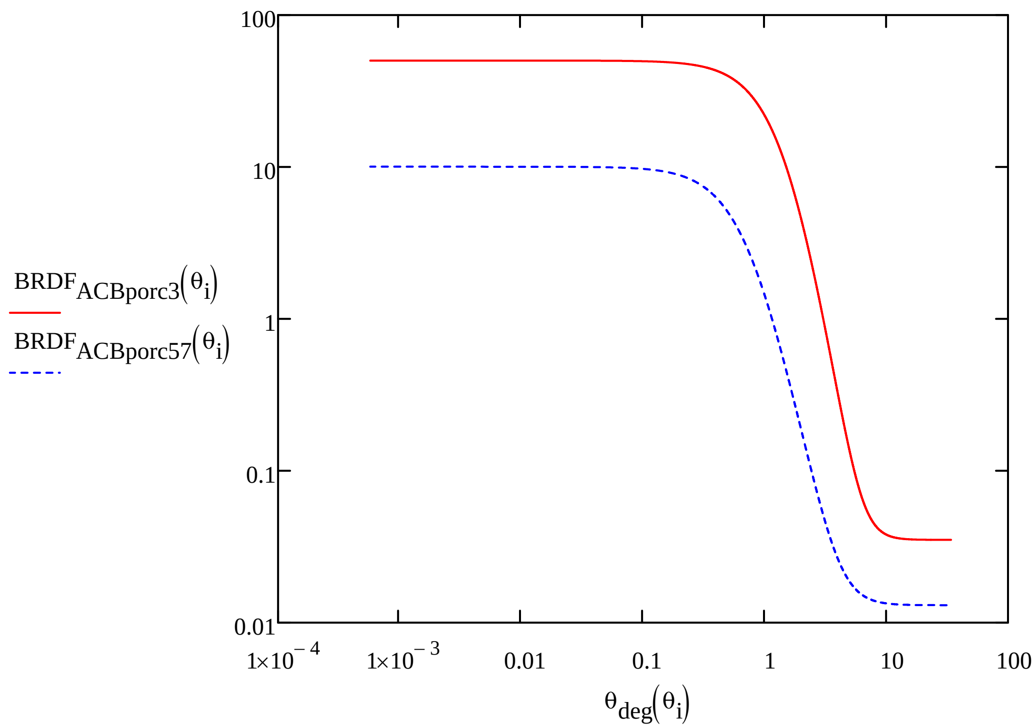
$$BRDF_{ACB}(\theta_i) := \frac{BRDF_0}{\left(1 + C_{mr}\cdot\theta_i^{\,2}\right)^{\beta}} + BRDF_{\theta 2}$$

Porcelainized steel BRDF function, sr^-1

$$BRDF_{ACBporc57}(\theta_i) := \frac{BRDF_0}{\left(1 + C_{mr}\cdot\theta_i^{\,2}\right)^{\beta}} + BRDF_{\theta 2}$$

$BRDF_{ACBporc57}(\theta_1) = 5.013$ $BRDF_{ACBporc57}(\theta_2) = 0.038$

$\theta_i := 0, 0.00001 .. 10\cdot\theta_2$



BRDF #4 Oxidized stainless steel, 3 deg inc.

Reflectivity of baffle surface $R := 0.02$

break-over angle, rad $\theta_1 := .8\cdot\frac{\pi}{180} = 0.014$

max BRDF, sr^-1 $BRDF_0 := 7.5$

final slope modifier $\beta := 0.7$

micro-roughness constant $C_{mr} := \dfrac{2^{\frac{1}{(\beta)}} - 1}{\theta_1^{\,2}}$

$C_{mr} = 8.678 \times 10^3$

large angle BRDF, sr^-1 $BRDF_{\theta2} := 0.03$

BRDF function, sr^-1 $BRDF_{ACBoxy3}(\theta_i) := \dfrac{BRDF_0}{\left(1 + C_{mr} \cdot \theta_i^{\,2}\right)^{\beta}} + BRDF_{\theta2}$

BRDF #4 Oxidized stainless steel, 57 deg inc.

Reflectivity of baffle surface $R := .04$

break-over angle, rad $\theta_1 := 0.6 \cdot \dfrac{\pi}{180} = 0.01$

micro-roughness angle, rad $\theta_2 := 10 \cdot \dfrac{\pi}{180} = 0.175$

max BRDF, sr^-1 $BRDF_0 := 40$

final slope modifier $\beta := 0.95$

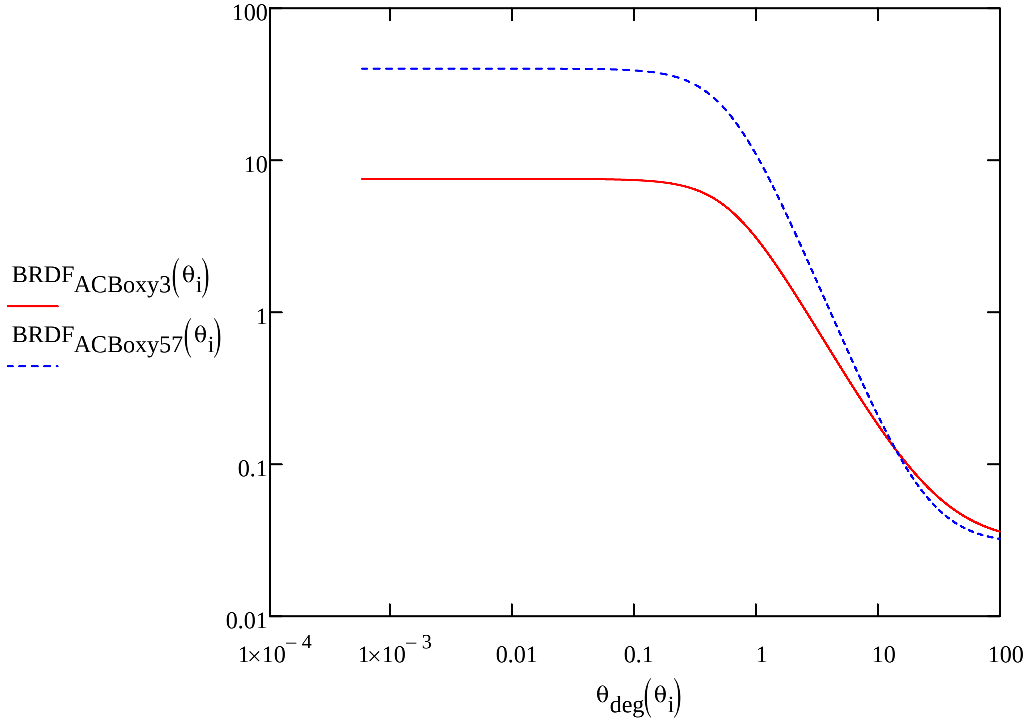
micro-roughness constant $C_{mr} := \dfrac{2^{\frac{1}{(\beta)}} - 1}{\theta_1^{\,2}}$

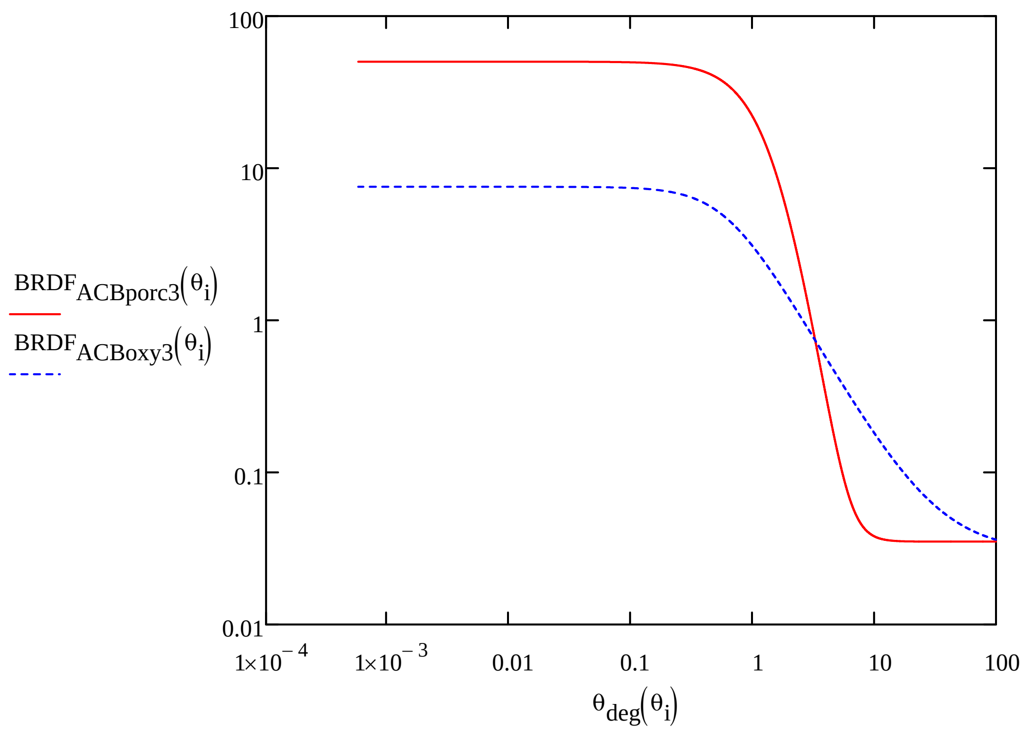
$C_{mr} = 9.797 \times 10^3$

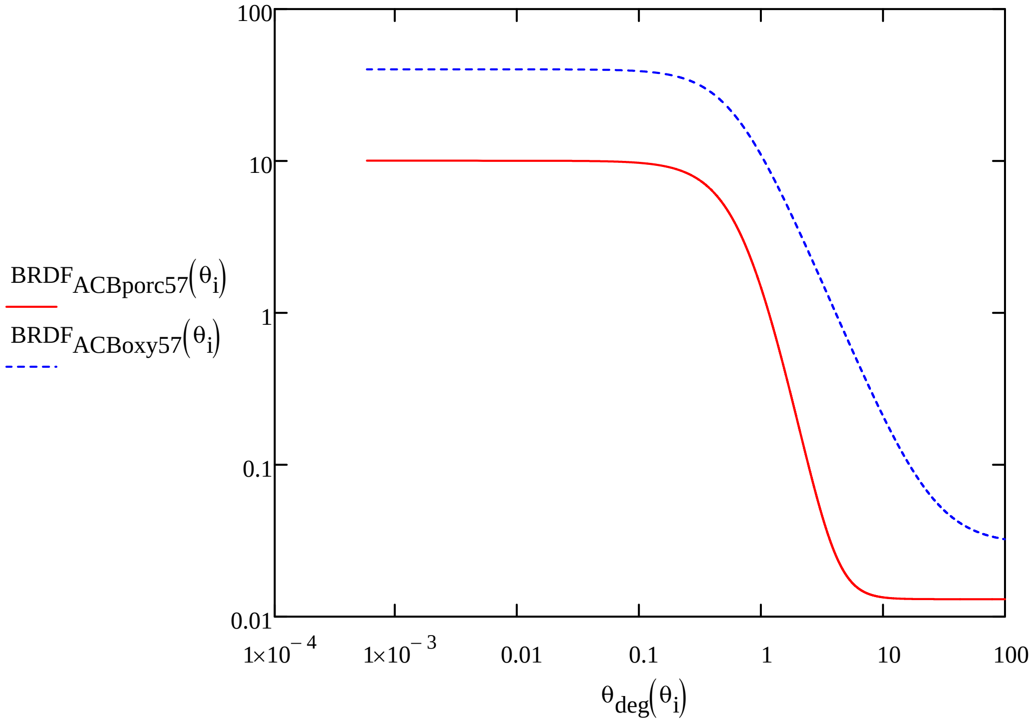
large angle BRDF, sr^-1 $BRDF_{\theta2} := 0.03$

BRDF function, sr^-1 $BRDF_{ACBoxy57}(\theta_i) := \dfrac{BRDF_0}{\left(1 + C_{mr} \cdot \theta_i^{\,2}\right)^{\beta}} + BRDF_{\theta2}$

$\theta_i := 0, 0.00001 .. 10 \cdot \theta_2$







BRDF Black Glass (hypothetical), 57 deg inc.

Reflectivity of baffle surface $R := .02$

break-over angle, rad $\theta_1 := 0.1 \cdot \frac{\pi}{180} = 1.745 \times 10^{-3}$

micro-roughness angle, rad $\theta_2 := 5 \cdot \frac{\pi}{180} = 0.087$

max BRDF, sr^-1 $BRDF_0 := 100$

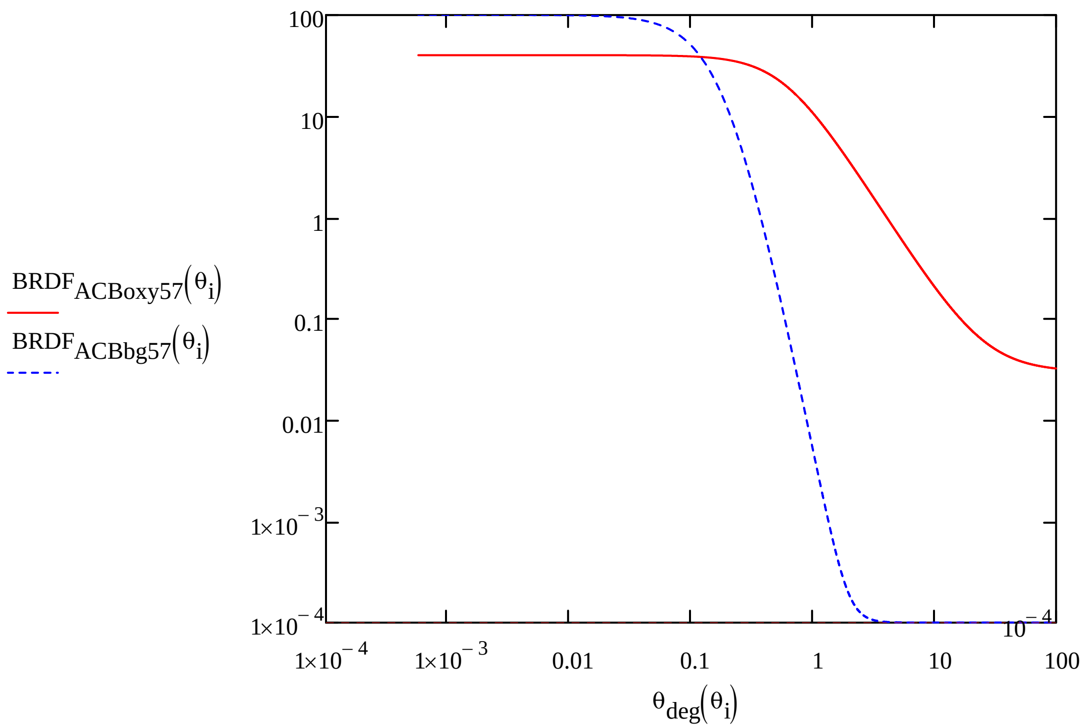
final slope modifier $\beta := 3$

micro-roughness constant $C_{mr} := \frac{2^{\frac{1}{(\beta)}} - 1}{\theta_1^{\,2}}$

$$C_{mr} = 8.533 \times 10^4$$

large angle BRDF, sr^-1 $BRDF_{\theta 2} := 0.0001$

BRDF function, sr^-1 $$BRDF_{ACBbg57}(\theta_i) := \frac{BRDF_0}{\left(1 + C_{mr} \cdot \theta_i^{\,2}\right)^{\beta}} + BRDF_{\theta 2}$$



power through the cryopump baffle aperture (hits the arm cavity baffle), W $$P_{acb\theta} := P_a \cdot \int_0^{\theta_{cp}} 2 \cdot \pi \cdot \theta \cdot BRDF_1(\theta)\, d\theta$$

$$P_{acb\theta} = 14.096$$

integration variable x, m $x := 0$

integration variable y, m $y := 0$

horizontal offset, m $x_0 := 0.2$

vertical offset, m $y_0 := 0.08$

power scattered out to radius Rcp, W

check the x, y calculation with no offset

$$x_0 := 0$$

$$y_0 := 0$$

$$R := R_{cp}$$

$$P_{acb} := P_a \cdot \left(\int_{-R}^{R} \int_{-\sqrt{R^2 - y^2}}^{\sqrt{R^2 - y^2}} \frac{BRDF_{xy}(x, y, x_0, y_0)}{L_{arm}^{\ 2}} \, dx \, dy \right)$$

$$P_{acb} = 14.096$$

$$P_{acb\theta} = 14.096$$

new value with offset

$$x_0 := 0.2$$

$$y_0 := 0.08$$

$$R := R_{cp}$$

$$P_{cp} := P_a \cdot \left(\int_{-R}^{R} \int_{-\sqrt{R^2 - y^2}}^{\sqrt{R^2 - y^2}} \frac{BRDF_{xy}(x, y, x_0, y_0)}{L_{arm}^{\ 2}} \, dx \, dy \right)$$

$$P_{cp} = 12.363$$

Area of cryopump baf aperture, m^2 $A_{cp} := \pi \cdot R_{cp}^{\ 2} = 0.464$

incident intensity, W/m^2 $I_i := \frac{P_{acb}}{A_{cp}} = 30.349$

tilt angle of baffle edge, rad $\theta_t := 1 \cdot \frac{\pi}{180} = 0.017$

incident angle, rad $\theta_i(\theta_t, \theta_{xy}) := \mathrm{acos}(\cos(\theta_{xy}) \cdot \cos(\theta_t))$

input angle range, bend, rad $\theta_{xymaxb} := 33 \cdot \frac{\pi}{180} = 0.576$

input angle range, bend, deg $\theta_{xymaxbdeg} := \theta_{xymaxb} \cdot \frac{180}{\pi} = 33$

input angle range, plate rad $\theta_{xymaxp} := \frac{\pi}{2} = 1.571$

input angle range, plate deg $\theta_{xymaxpdeg} := \theta_{xymaxp} \cdot \frac{180}{\pi} = 90$

Power Scattered into IFO

PORCELAINIZED STEEL

$S_p(\theta_t) := 1$

Scatter function from baffle plate edge

$$S_p(\theta_t) := \int_0^{\theta_{xymaxp}} \left[\int_{2 \cdot \theta_i(\theta_t, \theta_{xy}) - \frac{w_{ifo}}{L_{arm}}}^{2 \cdot \theta_i(\theta_t, \theta_{xy}) + \frac{w_{ifo}}{L_{arm}}} BRDF_{ACBporc3}(\theta_s + 2 \cdot \theta_i(\theta_t, \theta_{xy})) \cdot \sqrt{w_{ifo}^2 - [L_{arm} \cdot (\theta_s - 2 \cdot \theta$$

$S_p(\theta_t) = 5.43 \times 10^{-13}$

$P_{acbporcedgepsifo}(\theta_t, r) := 4 \cdot I_i \cdot r \cdot H_p \cdot BRDF_1(30 \cdot 10^{-6}) \cdot \Delta\Omega_{ifo} \cdot (S_p(\theta_t))$

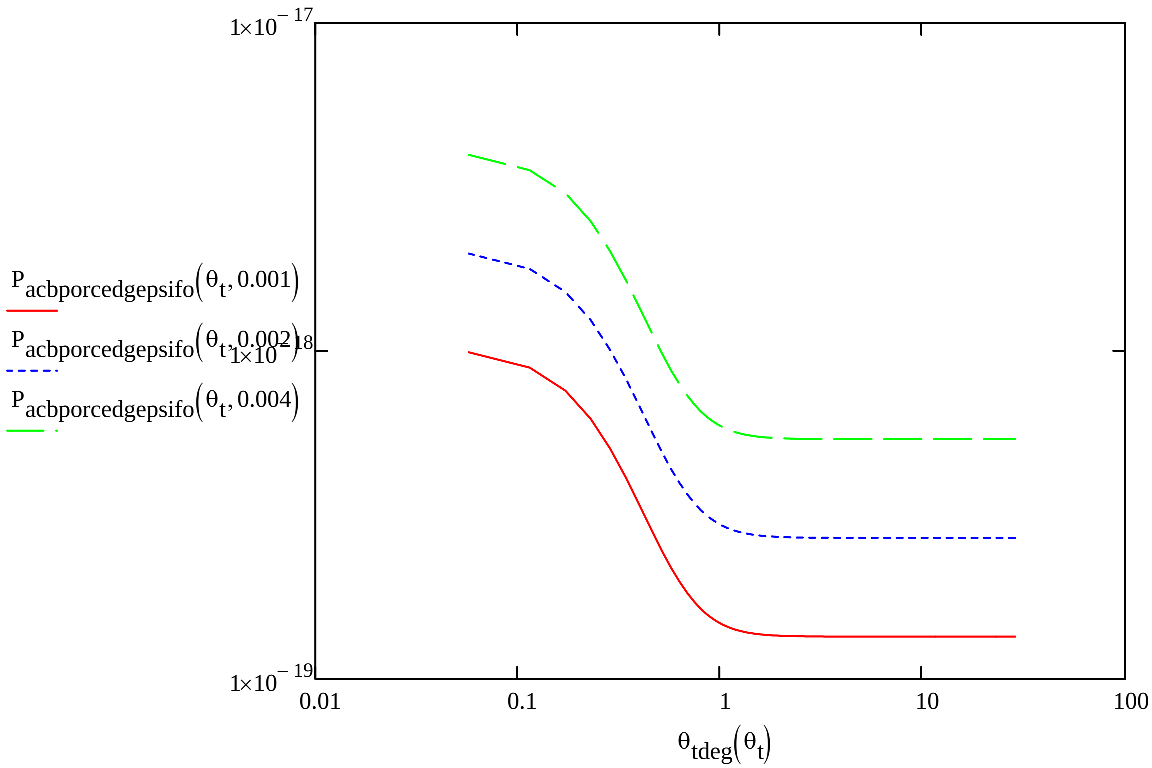
Incident power on edge, W $\quad P_{ip} := I_i \cdot r \cdot H_p \quad P_{ip} = 9.939 \times 10^{-3}$

$\theta_t := 1 \cdot \frac{\pi}{180}$

$P_{acbporcedgepsifo}(\theta_t, 0.001) = 1.474 \times 10^{-19}$

power scattered into IFO mode, W

$\theta_t := 0, 0.001 .. 0.5 \qquad \theta_{tdeg}(\theta_t) := \theta_t \cdot \frac{180}{\pi}$



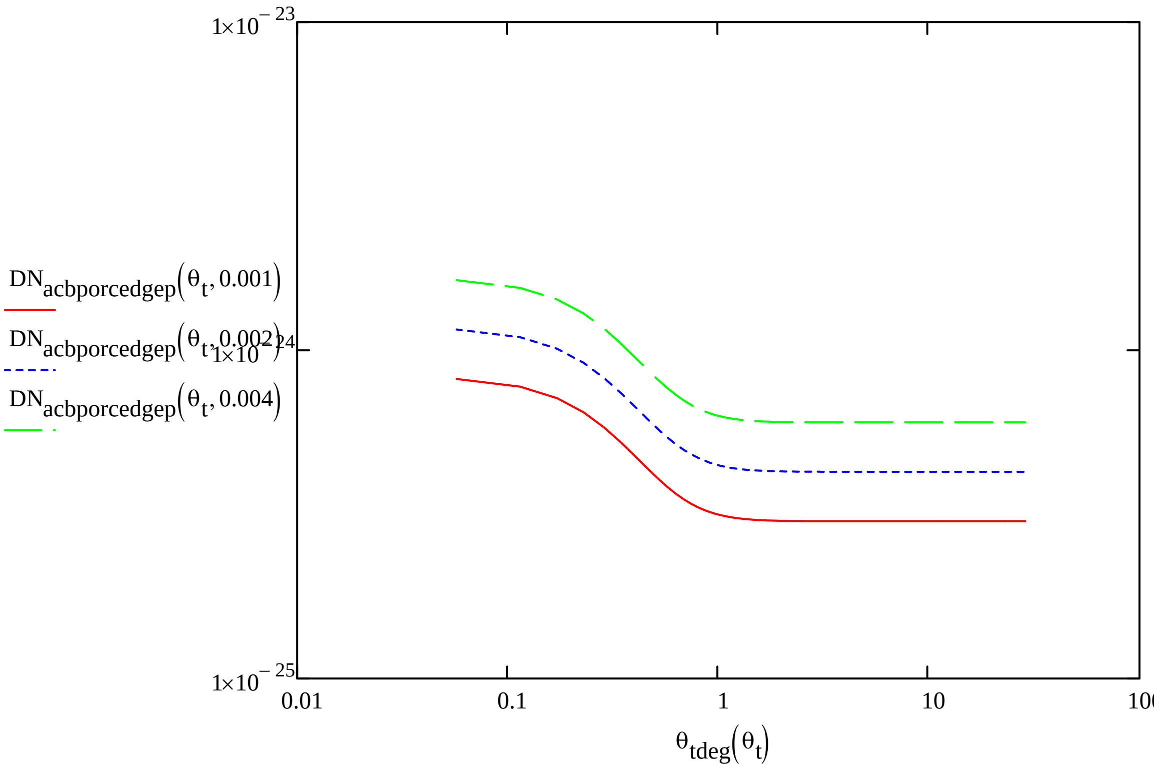
displacement noise @ 100 Hz,
m/rtHz

$$\theta_t := 0$$

$$DN_{acbporcedgep}(\theta_t, r) := TF_{itmhr} \cdot \left(\frac{P_{acbporcedgepsifo}(\theta_t, r)}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot \frac{2}{\sqrt{2}} \cdot k$$

$$DN_{acbporcedgep}(\theta_t, 0.001) = 8.325 \times 10^{-25}$$

$$\theta_t := 0, 0.001 .. 0.5$$



Scatter from louver bend

$\theta_{xymaxb} = 0.576$

$\theta_t := 0$

$$S_b(\theta_t) := \int_0^{\theta_{xymaxb}} \left[\int_{2\cdot\theta_i(\theta_t,\theta_{xy}) - \frac{w_{ifo}}{L_{arm}}}^{2\cdot\theta_i(\theta_t,\theta_{xy}) + \frac{w_{ifo}}{L_{arm}}} BRDF_{ACBporc3}(\theta_s + 2\cdot\theta_i(\theta_t,\theta_{xy}))\cdot\sqrt{w_{ifo}^2 - [L_{arm}\cdot(\theta_s -}\right.$$

$S_b(\theta_t) = 3.521 \times 10^{-12}$

Incident power on bend, W

$P_{ib} := I_i\cdot r\cdot H_b$

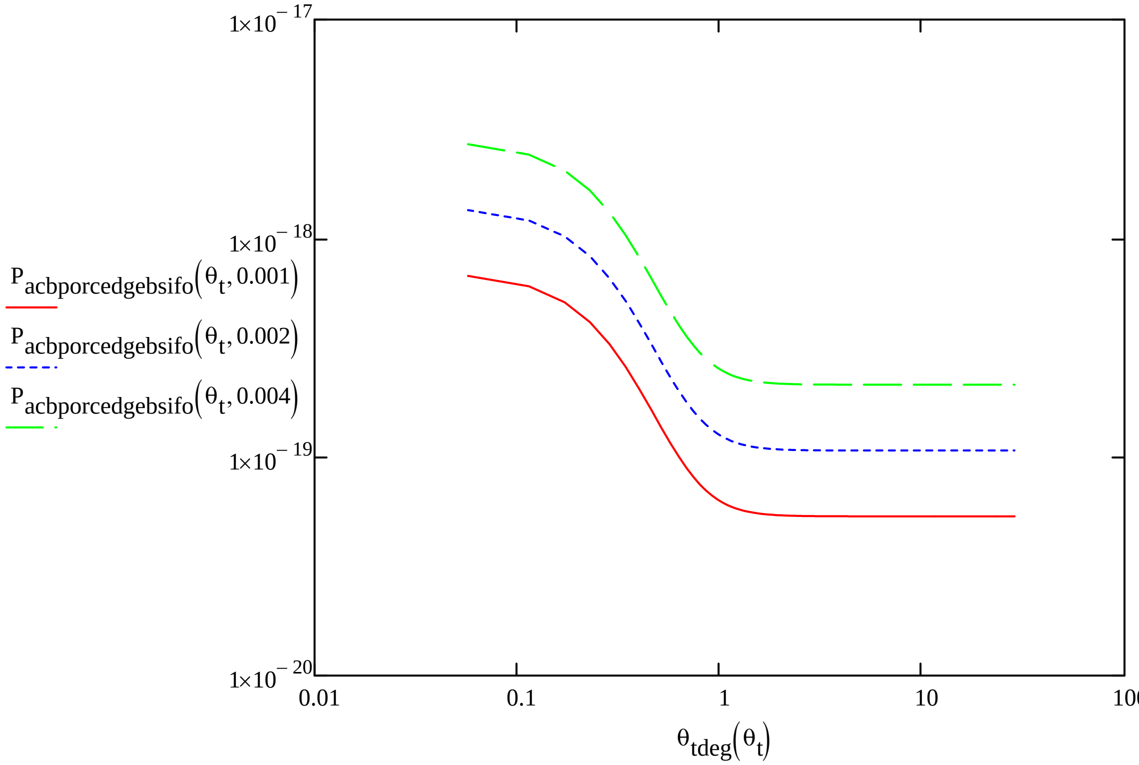
$P_{ib} = 7.253 \times 10^{-3}$

$$P_{acbporcedgebsifo}(\theta_t, r) := 4\cdot I_i\cdot r\cdot H_b\cdot BRDF_1(30\cdot 10^{-6})\cdot\Delta\Omega_{ifo}\cdot(S_b(\theta_t))$$

$\theta_t := 0$

$P_{acbporcedgebsifo}(\theta_t, 0.001) = 6.976 \times 10^{-19}$

$\theta_t := 0, 0.001 .. 0.5$ $\theta_{tdeg}(\theta_t) := \theta_t \cdot \frac{180}{\pi}$



ACB displacement @ 100 HZ, m/rt HZ $x_{ACB} := 1 \cdot 10^{-12}$

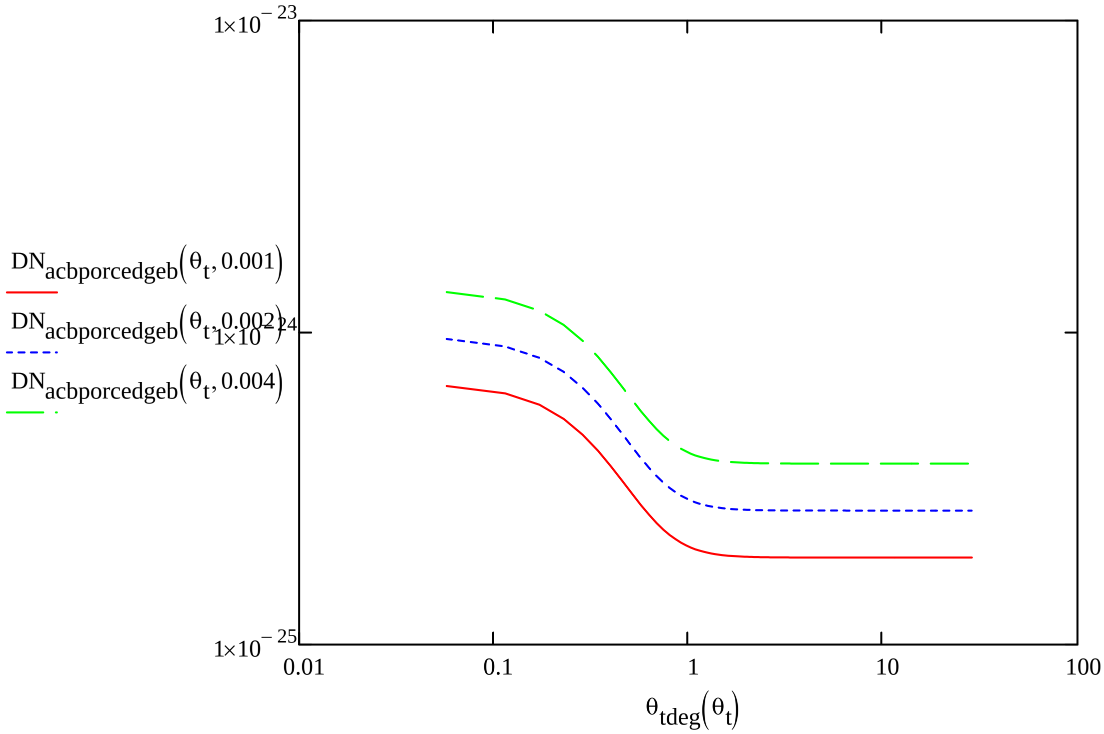
displacement noise @ 100 Hz, m/rtHz

$$\theta_t := 1 \cdot \frac{\pi}{180}$$

$$DN_{acbporcedgeb}(\theta_t, r) := TF_{itmhr} \cdot \left(\frac{P_{acbporcedgebsifo}(\theta_t, r)}{P_{psl}}\right)^{0.5} \cdot x_{ACB} \cdot \frac{2}{\sqrt{2}} \cdot k$$

$$DN_{acbporcedgeb}(\theta_t, 0.001) = 2.061 \times 10^{-25}$$

$\theta_t := 0, 0.001 .. 0.5$



Power Scattered from the louver portion of baffle

radius of manifold/cryo baffle, m $R_{cp} := \frac{0.769}{2} = 0.385$

height of manifold/cryo baffle ledge, m $H_L := 0.769 - 0.655 = 0.114$

height of opening above ledge, m $H_1 := R_{cp} - H_L = 0.271$

radius of ACB hole, m $r_{acbhole} := 0.172$

area of ACB hole, m^2 $A_h := \pi \cdot r_{acbhole}^{\ 2} = 0.093$

area of manifold/cryo baffle ledge, m^2

$$A_L := \int_{H_1}^{R_{cp}} 2\cdot\sqrt{R_{cp}^2 - H^2}\,dH$$

$$A_L = 0.043$$

area of exposed ACB, m^2

$$A_{ACB} := \pi\cdot R_{cp}^2 - 2.A_h - A_L = 0.236$$

BRDF of louver plate

$$BRDF_{ACBporc57}\left(2\cdot 57\cdot\frac{\pi}{180}\right) = 0.013$$

Incident power on baffle louvers, W $P_{iacb} := I_i\cdot A_{ACB}$ $P_{iacb} = 7.151$

Flanagan-Thorne reciprocity scattering cross-section

Flanagan-Thorne scattering cross-section

$$\sigma := \lambda^2\cdot BRDF_1\left(30\cdot 10^{-6}\right)$$

irradiance of TM by power scattered from adjacent surface, W/m^2

$$E_s := P_{iacb}\cdot BRDF_{ACBporc57}\left(2\cdot 57\cdot\frac{\pi}{180}\right)\cdot\frac{1}{L_{arm}^2}$$

power scattered by TM into IFO mode

$$P_{sTMifo} := E_s\cdot\sigma$$

$$P_{sTMifo} := P_{iacb}\cdot BRDF_{ACBporc57}\left(2\cdot 57\cdot\frac{\pi}{180}\right)\cdot\frac{\lambda^2}{L_{arm}^2}\cdot BRDF_1\left(30\cdot 10^{-6}\right)$$

$$P_{sTMifo} = 8.975\times 10^{-18}$$

Smith scattering formalism

power scattered by ACB louver into IFO, W

$$P_{acbporcsifo} := P_{iacb} \cdot BRDF_{ACBporc57}\left(2 \cdot 57 \cdot \frac{\pi}{180}\right) \cdot \frac{\pi \cdot w_{ifo}^{2}}{L_{arm}^{2}} \cdot BRDF_{1}\left(30 \cdot 10^{-6}\right) \cdot \Delta\Omega_{ifo}$$

$$P_{acbporcsifo} = 8.975 \times 10^{-18}$$

Note: the identical results for coupled power into the IFO indicates that wifo is the correct beam radius for coupling into the IFO mode.

Total scattered power from baffle edge, bend, and louvers

Total scattered power, W

$$P_{acbporctsifo}\left(\theta_t, r\right) := P_{acbporcedgepsifo}\left(\theta_t, r\right) + P_{acbporcedgebsifo}\left(\theta_t, r\right) + P_{acbporcsifo}$$

total displacement noise @ 100 Hz,
m/rtHz

baffle tilt angle, deg $\theta_t := 3 \cdot \frac{\pi}{180}$

edge radius, m $r = 5 \times 10^{-4}$

$$P_{acbporcedgepsifo}\left(\theta_t, r\right) = 6.724 \times 10^{-20}$$

$$P_{acbporcedgebsifo}\left(\theta_t, r\right) = 2.675 \times 10^{-20}$$

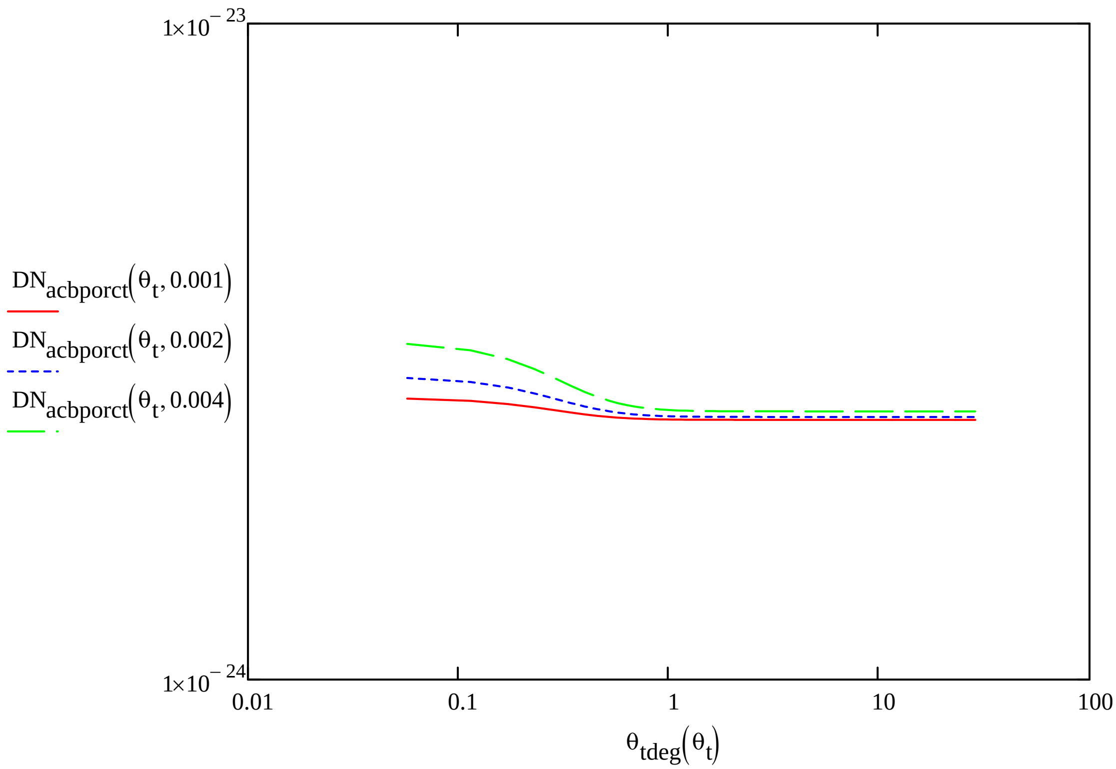
$$P_{acbporcsifo} = 8.975 \times 10^{-18}$$

Total scattered power, W $P_{acbporctsifo}\left(\theta_t, r\right) = 9.069 \times 10^{-18}$

$$DN_{acbporct}(\theta_t, r) := TF_{itmhr} \cdot \left(\frac{P_{acbporctsifo}(\theta_t, r)}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot \frac{2}{\sqrt{2}} \cdot k$$

$$DN_{acbporct}(\theta_t, 0.0005) = 2.474 \times 10^{-24}$$

$$\theta_t := 0, 0.001 .. 0.5$$



OXIDIZED SS

Power Scattered into IFO

$$S_{poxy}(\theta_t) := 1$$

$$P_{acboxyedgepsifo}(\theta_t, r) := 4 \cdot I_i \cdot r \cdot H_p \cdot BRDF_1\left(30 \cdot 10^{-6}\right) \cdot \Delta\Omega_{ifo} \cdot \left(S_{poxy}(\theta_t)\right)$$

Scatter function from baffle plate edge

$$\theta_t := 0$$

$$S_{poxy}(\theta_t) := \int_0^{\theta_{xymaxp}} \left[\int_{2 \cdot \theta_i(\theta_t, \theta_{xy}) - \frac{w_{ifo}}{L_{arm}}}^{2 \cdot \theta_i(\theta_t, \theta_{xy}) + \frac{w_{ifo}}{L_{arm}}} BRDF_{ACBoxy3}\left(\theta_s + 2 \cdot \theta_i(\theta_t, \theta_{xy})\right) \cdot \sqrt{w_{ifo}^2 - \left[L_{arm} \cdot (\theta_s - \right.}$$

$$S_{poxy}(\theta_t) = 1.264 \times 10^{-12}$$

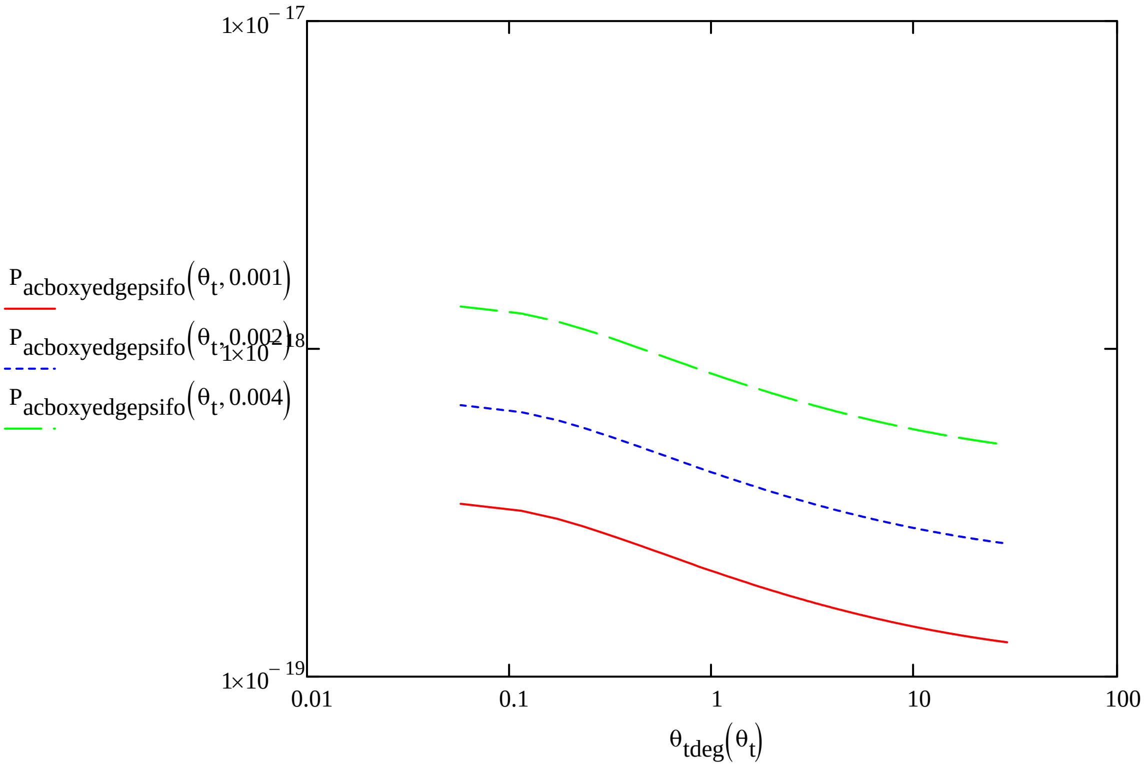
$$P_{acboxyedgepsifo}(\theta_t, r) := 4 \cdot I_i \cdot r \cdot H_p \cdot BRDF_1\left(30 \cdot 10^{-6}\right) \cdot \Delta\Omega_{ifo} \cdot \left(S_{poxy}(\theta_t)\right)$$

$$\theta_t := 1 \cdot \frac{\pi}{180}$$

$$P_{acboxyedgepsifo}(\theta_t, 0.001) = 2.098 \times 10^{-19}$$

power scattered into IFO mode, W

$\theta_t := 0, 0.001 .. 0.5$ $\theta_{tdeg}(\theta_t) := \theta_t \cdot \frac{180}{\pi}$



ACB displacement @ 100 HZ, m/rt HZ $x_{ACB} := 1 \cdot 10^{-12}$

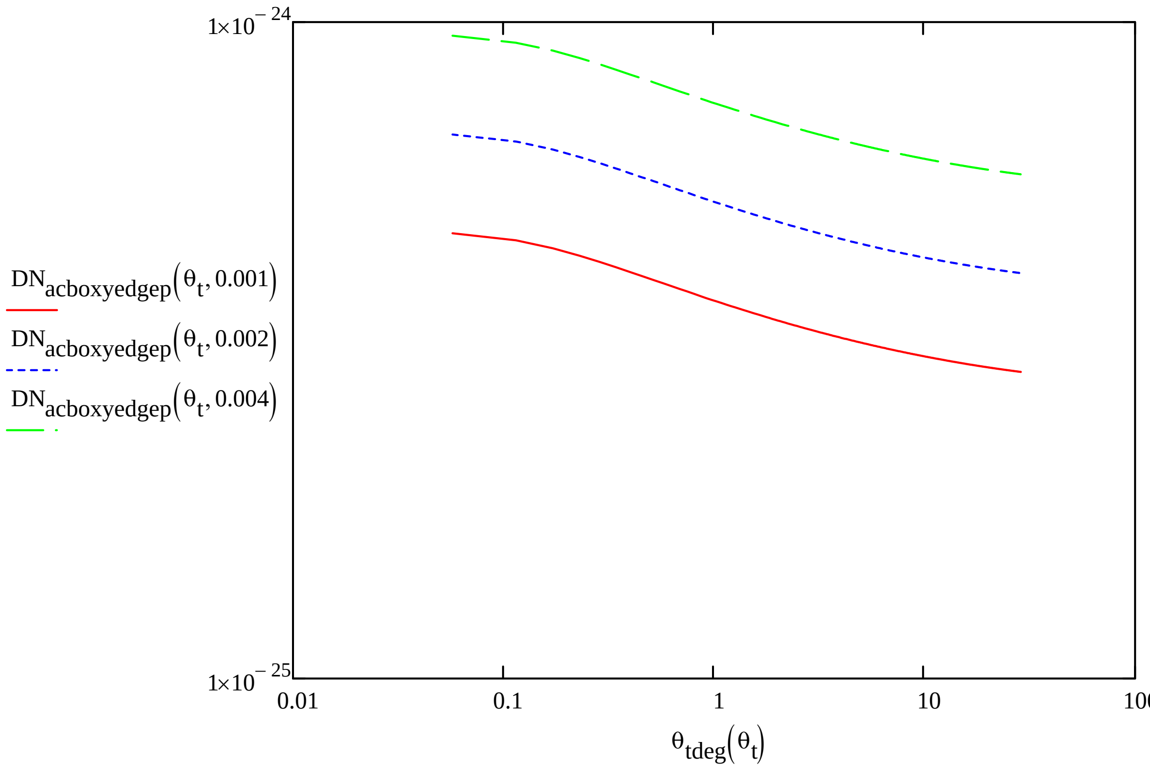
displacement noise @ 100 Hz, m/rtHz

$\theta_t := 0$

$$DN_{acboxyedgep}(\theta_t, r) := TF_{itmhr} \cdot \left(\frac{P_{acboxyedgepsifo}(\theta_t, r)}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot \frac{2}{\sqrt{2}} \cdot k$$

$$DN_{acboxyedgep}(\theta_t, 0.001) = 4.814 \times 10^{-25}$$

$\theta_t := 0, 0.001 .. 0.5$



Scatter from baffle bend

$$\theta_t := 0$$

$$S_{boxy}(\theta_t) := \int_0^{\theta_{xymaxb}} \left[\int_{2\cdot\theta_i(\theta_t,\theta_{xy})-\frac{w_{ifo}}{L_{arm}}}^{2\cdot\theta_i(\theta_t,\theta_{xy})+\frac{w_{ifo}}{L_{arm}}} BRDF_{ACBoxy3}(\theta_s + 2\cdot\theta_i(\theta_t,\theta_{xy}))\cdot\sqrt{w_{ifo}^{\;2} - [L_{arm}\cdot(\theta_s$$

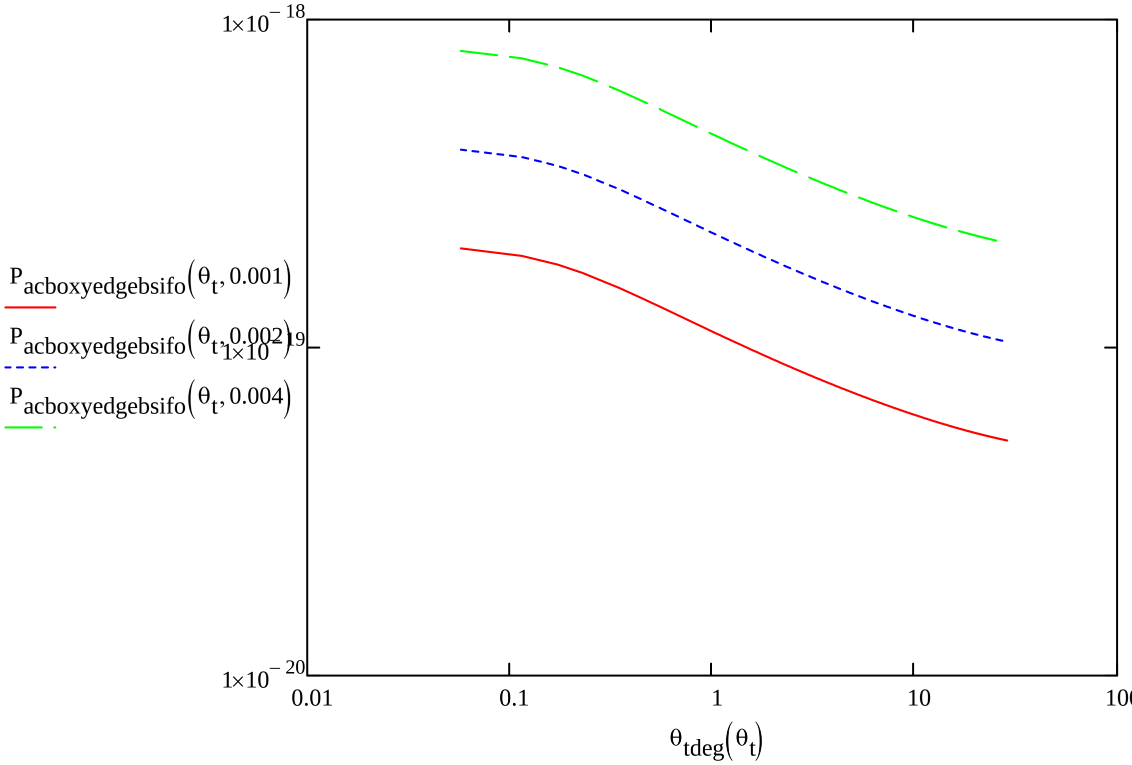
$$S_{boxy}(\theta_t) = 1.034 \times 10^{-12}$$

$P_{acboxyedgebsifo}(\theta_t, r) := 4 \cdot I_i \cdot r \cdot H_b \cdot BRDF_1(30 \cdot 10^{-6}) \cdot \Delta\Omega_{ifo} \cdot (S_{boxy}(\theta_t))$

$\theta_t := 0$

$P_{acboxyedgebsifo}(\theta_t, 0.001) = 2.049 \times 10^{-19}$

$\theta_t := 0, 0.001 .. 0.5$ $\theta_{tdeg}(\theta_t) := \theta_t \cdot \frac{180}{\pi}$



ACB displacement @ 100 HZ, m/rt HZ $x_{ACB} := 1 \cdot 10^{-12}$

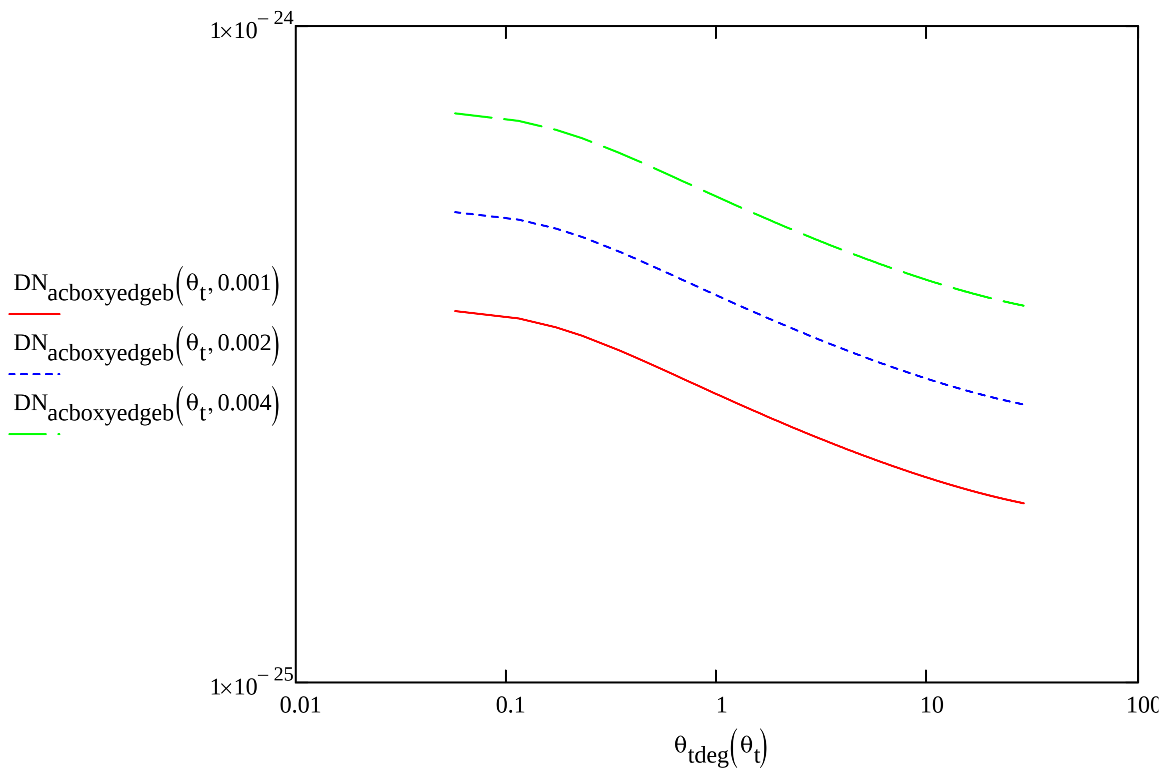
displacement noise @ 100 Hz,
m/rtHz

$$\theta_t := 1 \cdot \frac{\pi}{180}$$

$$DN_{acboxyedgeb}(\theta_t, r) := TF_{itmhr} \cdot \left(\frac{P_{acboxyedgebsifo}(\theta_t, r)}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot \frac{2}{\sqrt{2}} \cdot k$$

$$DN_{acboxyedgeb}(\theta_t, 0.001) = 2.748 \times 10^{-25}$$

$$\theta_t := 0, 0.001 .. 0.5$$



Total scattered power from baffle edge, bend, and louvers

Power Scattered from the louver portion of baffle

$$BRDF_{ACBoxy57}\left(2\cdot 57\cdot\frac{\pi}{180}\right) = 0.032$$

$$P_{acboxysifo} := I_i\cdot A_{ACB}\cdot BRDF_{ACBoxy57}\left(2\cdot 57\cdot\frac{\pi}{180}\right)\cdot\frac{w_{ifo}^{2}}{L_{arm}^{2}}\cdot BRDF_1\left(30\cdot 10^{-6}\right)\cdot\Delta\Omega_{ifo}$$

$$P_{acboxysifo} = 6.977\times 10^{-18}$$

$$P_{acboxytsifo}(\theta_t, r) := P_{acboxyedgepsifo}(\theta_t, r) + P_{acboxyedgebsifo}(\theta_t, r) + P_{acboxysifo}$$

$$\theta_t := 0.052$$

$$P_{acboxytsifo}(\theta_t, 0.001) = 7.229\times 10^{-18}$$

total displacement noise @ 100 Hz,
m/rtHz

vertical tilt angle, rad $\theta_t := 3\cdot\frac{\pi}{180}$ $\theta_t = 0.052$

$$DN_{acboxyt}(\theta_t, r) := TF_{itmhr}\cdot\left(\frac{P_{acboxytsifo}(\theta_t, r)}{P_{psl}}\right)^{0.5}\cdot x_{ACB}\cdot\frac{2}{\sqrt{2}}\cdot k$$

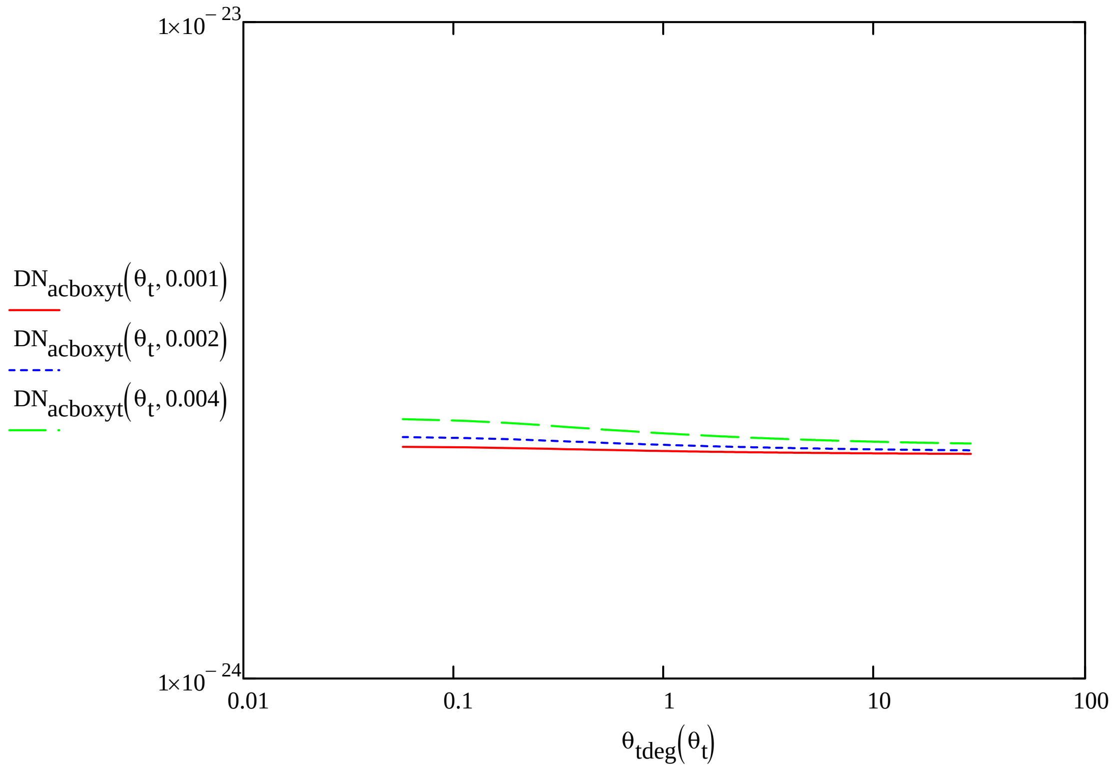
$$DN_{acboxyt}(\theta_t, 0.0015) = 2.228\times 10^{-24}$$

$$DN_{acbporct}(\theta_t, 0.0015) = 2.5\times 10^{-24}$$

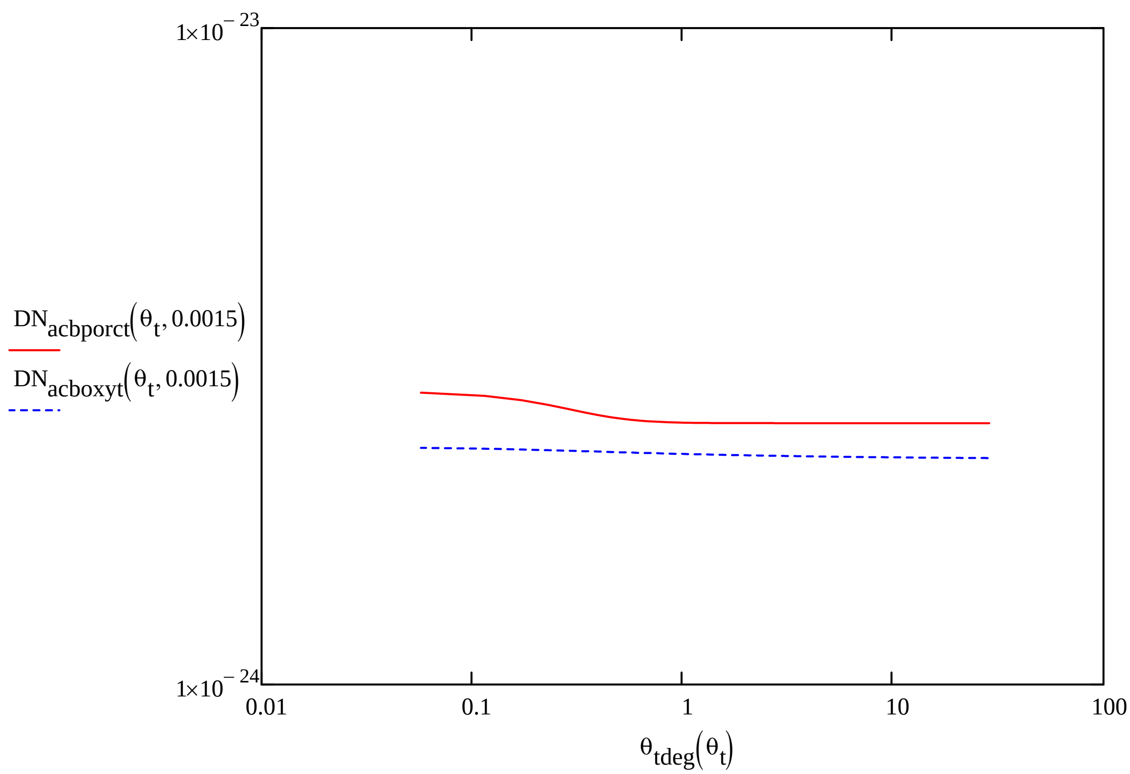
$$Ratio\_acboxyt\_acbporct := \frac{DN_{acboxyt}(0.052, 0.0015)}{DN_{acbporct}(0.052, 0.0015)}$$

$$Ratio\_acboxyt\_acbporct = 0.891$$

$$\theta_t := 0, 0.001 .. 0.5$$



1×10^−23
1×10^−24
0.01
0.1
1
10
100
DNacboxyt(θt, 0.001)
DNacboxyt(θt, 0.002)
DNacboxyt(θt, 0.004)
θtdeg(θt)



1×10^−23
1×10^−24
0.01
0.1
1
10
100
DNacbporct(θt, 0.0015)
DNacboxyt(θt, 0.0015)
θtdeg(θt)

MIXED: OXIDIZED STEEL EDGE, BLACK GLASS LOUVER

Power Scattered into IFO

$S_{poxy}(\theta_t) := 1$

Scatter function from baffle plate edge, oxidized steel

$\theta_t := 0$

$$S_{poxy}(\theta_t) := \int_0^{\theta_{xymaxp}} \left[\int_{2\cdot\theta_i(\theta_t,\theta_{xy})-\frac{w_{ifo}}{L_{arm}}}^{2\cdot\theta_i(\theta_t,\theta_{xy})+\frac{w_{ifo}}{L_{arm}}} BRDF_{ACBoxy3}(\theta_s + 2\cdot\theta_i(\theta_t,\theta_{xy}))\cdot\sqrt{w_{ifo}^2 - \left[L_{arm}\cdot(\right.}\right.$$

$S_{poxy}(\theta_t) = 1.264 \times 10^{-12}$

$\theta_t := 1\cdot\frac{\pi}{180}$ $\qquad$ $P_{acboxyedgepsifo}(\theta_t, 0.001) = 2.098 \times 10^{-19}$

Scatter function from baffle plate edge, black glass

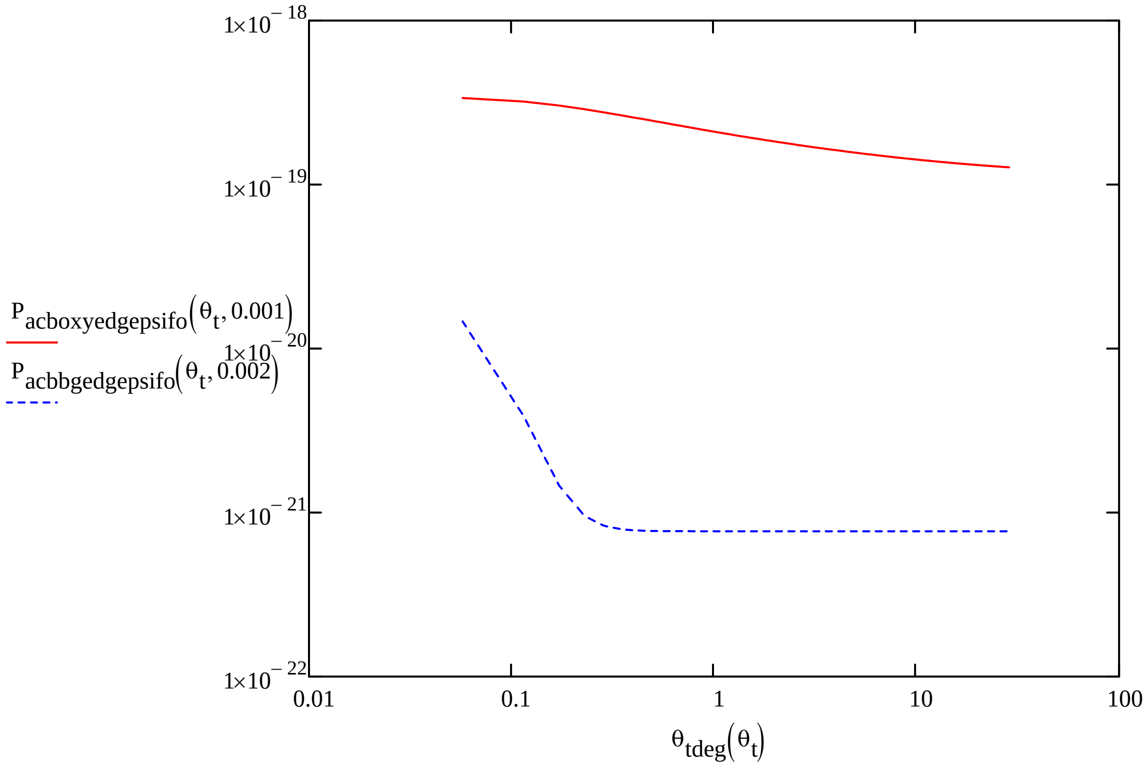
power scattered into IFO mode, W

$$S_{pbg}(\theta_t) := \int_0^{\theta_{xymaxp}} \left[\int_{2\cdot\theta_i(\theta_t,\theta_{xy})-\frac{w_{ifo}}{L_{arm}}}^{2\cdot\theta_i(\theta_t,\theta_{xy})+\frac{w_{ifo}}{L_{arm}}} BRDF_{ACBbg57}(\theta_s + 2\cdot\theta_i(\theta_t,\theta_{xy}))\cdot\sqrt{w_{ifo}^2 - [L_{arm}\cdot(\cdots\right.$$

$$S_{pbg}(\theta_t) = 1.414\times 10^{-15}$$

$$P_{acbbgedgepsifo}(\theta_t, r) := 4\cdot I_i\cdot r\cdot H_p\cdot BRDF_1(30\cdot 10^{-6})\cdot\Delta\Omega_{ifo}\cdot(S_{pbg}(\theta_t))$$

$$\theta_t := 0, 0.001 .. 0.5 \qquad \theta_{tdeg}(\theta_t) := \theta_t\cdot\frac{180}{\pi}$$



ACB displacement @ 100 HZ, m/rt HZ $\quad x_{ACB} := 1 \cdot 10^{-12}$

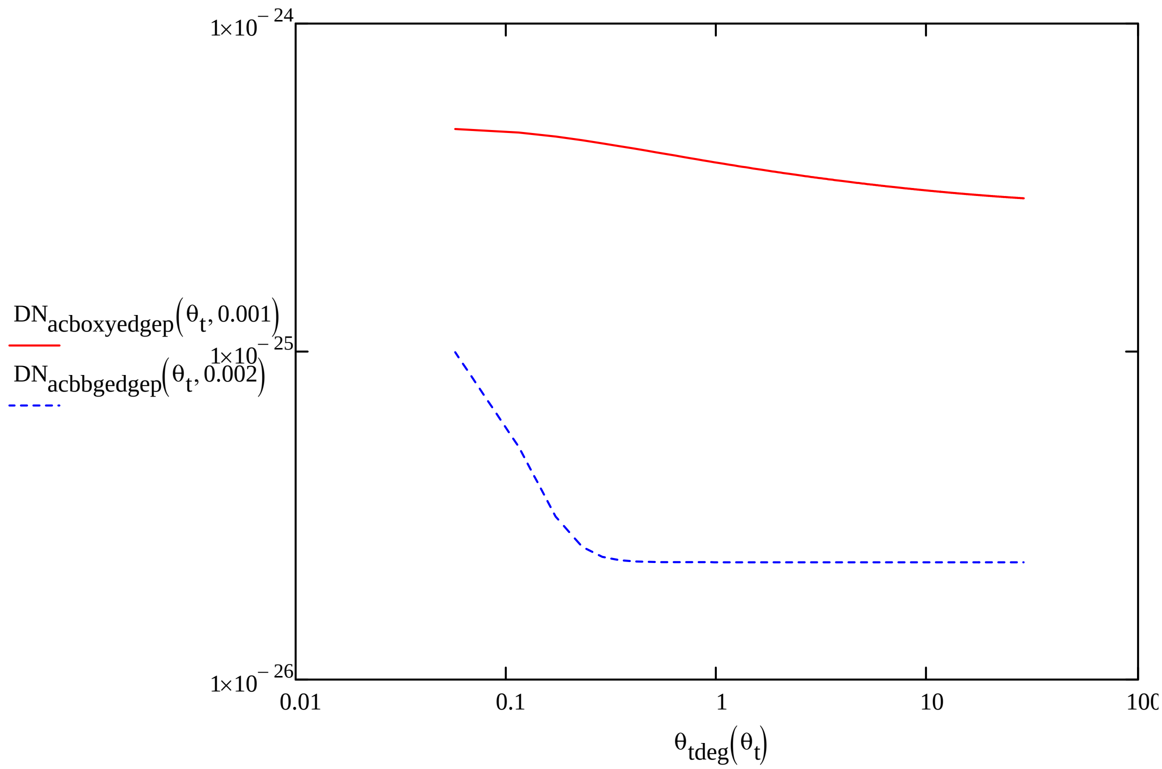
displacement noise @ 100 Hz, m/rtHz

$$\theta_t := 0$$

$$DN_{acbbgedgep}(\theta_t, r) := TF_{itmhr} \cdot \left(\frac{P_{acbbgedgepsifo}(\theta_t, r)}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot \frac{2}{\sqrt{2}} \cdot k$$

$$DN_{acboxyedgep}(\theta_t, 0.001) = 4.814 \times 10^{-25}$$

$$\theta_t := 0, 0.001 .. 0.5$$



Scatter from baffle bend

$$\theta_t := 0$$

$$S_{bbg}(\theta_t) := \int_0^{\theta_{xymaxb}} \left[\int_{2\cdot\theta_i(\theta_t,\theta_{xy})-\frac{w_{ifo}}{L_{arm}}}^{2\cdot\theta_i(\theta_t,\theta_{xy})+\frac{w_{ifo}}{L_{arm}}} BRDF_{ACBbg57}(\theta_s + 2\cdot\theta_i(\theta_t,\theta_{xy}))\cdot\sqrt{w_{ifo}^{\,2} - \left[L_{arm}\cdot(\theta_s - \right.}$$

$$S_{bbg}(\theta_t) = 6.613 \times 10^{-13}$$

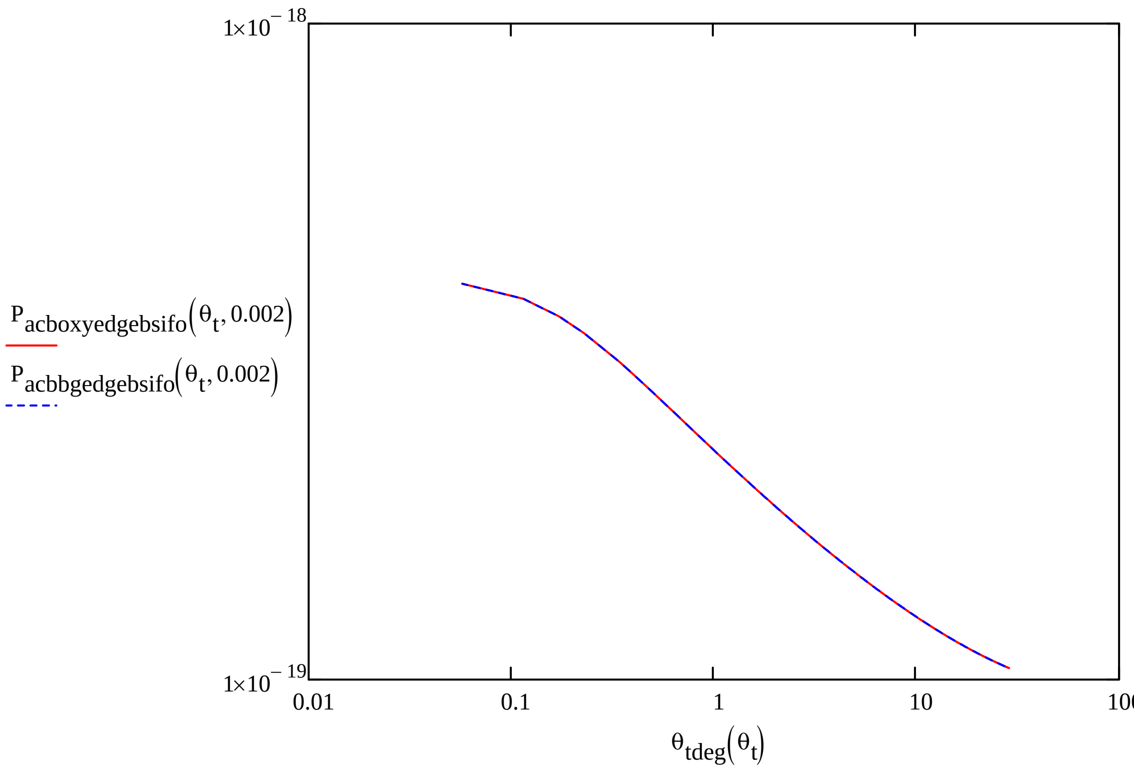
$$P_{acbbgedgebsifo}(\theta_t, r) := 4\cdot I_i\cdot r\cdot H_b\cdot BRDF_1(30\cdot10^{-6})\cdot\Delta\Omega_{ifo}\cdot(S_{boxy}(\theta_t))$$

$\theta_t := 0$

$P_{acbbgedgebsifo}(\theta_t, 0.001) = 2.049 \times 10^{-19}$

$\theta_t := 0, 0.001 .. 0.5$

$\theta_{tdeg}(\theta_t) := \theta_t \cdot \frac{180}{\pi}$



ACB displacement @ 100 HZ, m/rt HZ

$x_{ACB} := 1 \cdot 10^{-12}$

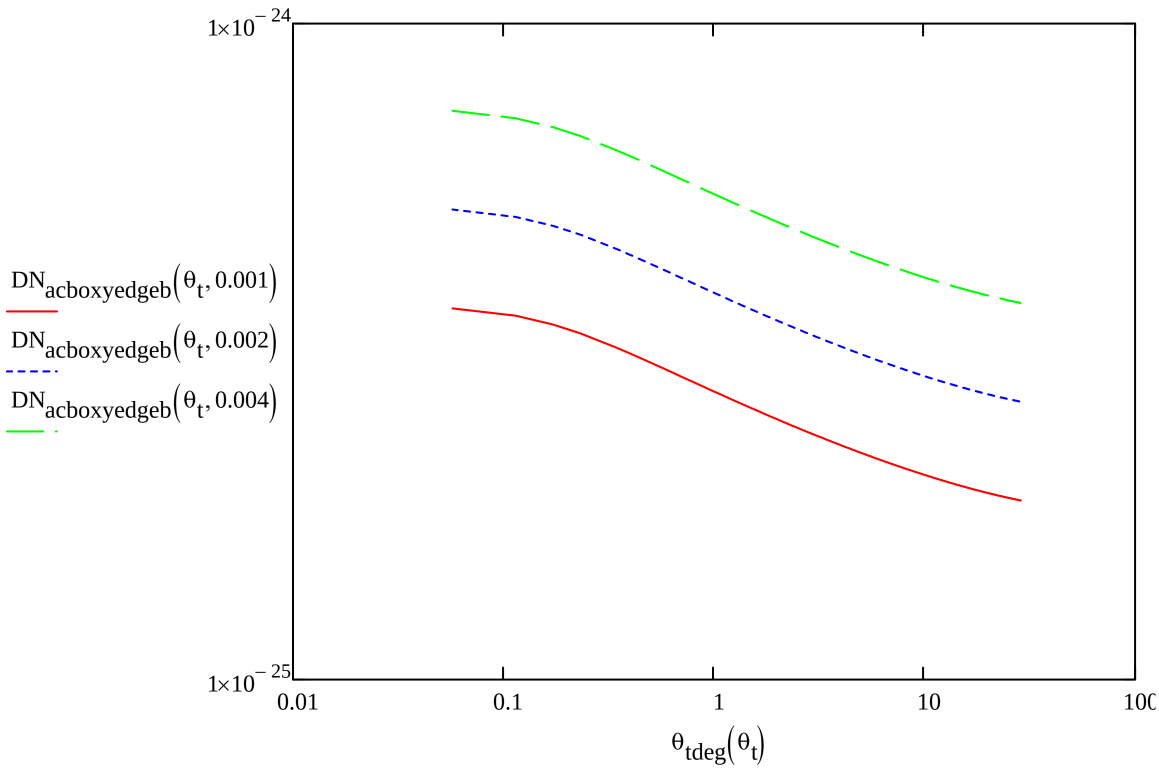
displacement noise @ 100 Hz, m/rtHz

$$\theta_t := 1 \cdot \frac{\pi}{180}$$

$$DN_{acboxyedgeb}(\theta_t, r) := TF_{itmhr} \cdot \left(\frac{P_{acboxyedgebsifo}(\theta_t, r)}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot \frac{2}{\sqrt{2}} \cdot k$$

$$DN_{acboxyedgeb}(\theta_t, 0.001) = 2.748 \times 10^{-25}$$

$\theta_t := 0, 0.001 .. 0.5$



Total scattered power from baffle edge, bend, and louvers

Power Scattered from the louver portion of baffle

$$BRDF_{ACBoxy57}\left(2\cdot 57\cdot\frac{\pi}{180}\right) = 0.032$$

$$P_{acboxysifo} := I_i\cdot A_{ACB}\cdot BRDF_{ACBoxy57}\left(2\cdot 57\cdot\frac{\pi}{180}\right)\cdot\frac{w_{ifo}^{\;2}}{L_{arm}^{\;2}}\cdot BRDF_1\left(30\cdot 10^{-6}\right)\cdot\Delta\Omega_{ifo}$$

$$P_{acboxysifo} = 6.977\times 10^{-18}$$

$$I_i\cdot A_{ACB} = 7.151$$

$$\theta_t := 2\cdot 3\cdot\frac{\pi}{180}$$

$$r := 0.004$$

$$P_{acboxytsifo}(\theta_t, r) := P_{acboxyedgepsifo}(\theta_t, r) + P_{acboxyedgebsifo}(\theta_t, r) + P_{acboxysifo}$$

$$P_{acboxyedgepsifo}(\theta_t, r) = 6.076 \times 10^{-19}$$

$$P_{acboxyedgebsifo}(\theta_t, r) = 2.784 \times 10^{-19}$$

$$P_{acboxysifo} = 6.977 \times 10^{-18}$$

$$P_{acboxytsifo}(\theta_t, 0.004) = 7.863 \times 10^{-18}$$

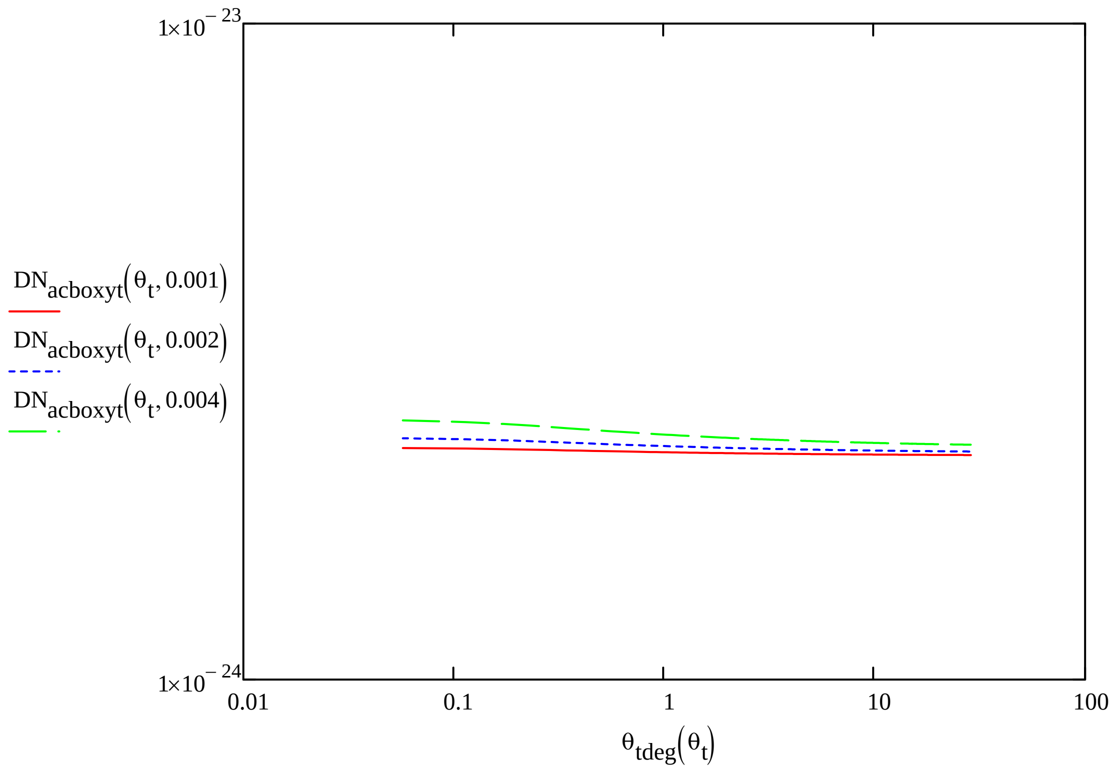
total displacement noise @ 100 Hz,
m/rtHz

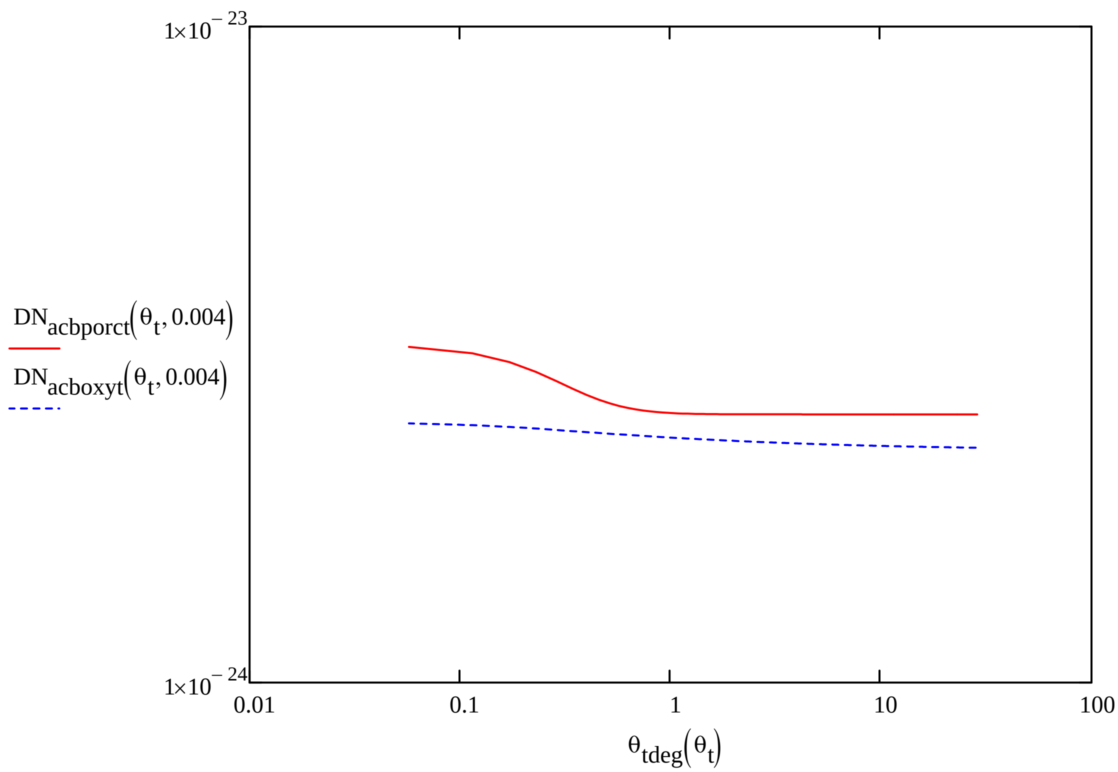
$$\theta_t := 2 \cdot 3 \cdot \frac{\pi}{180}$$

$$DN_{acboxyt}(\theta_t, r) := TF_{itmhr} \cdot \left(\frac{P_{acboxytsifo}(\theta_t, r)}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot \frac{2}{\sqrt{2}} \cdot k$$

$$DN_{acboxyt}(\theta_t, 0.004) = 2.304 \times 10^{-24}$$

$$\theta_t := 0, 0.001 .. 0.5$$


1×10^− 23
1×10^− 24
DNacboxyt(θt, 0.001)
DNacboxyt(θt, 0.002)
DNacboxyt(θt, 0.004)
0.01
0.1
1
10
100
θtdeg(θt)


1×10^− 23
1×10^− 24
DNacbporct(θt, 0.004)
DNacboxyt(θt, 0.004)
0.01
0.1
1
10
100
θtdeg(θt)

Comparison of porcelain and polished oxidized SS

total displacement noise @ 100 Hz, m/rtHz

vertical tilt angle, rad $\theta_t := 3 \cdot \frac{\pi}{180}$ $\theta_t = 0.052$

$$DN_{acboxyt}(\theta_t, r) := TF_{itmhr} \cdot \left(\frac{P_{acboxytsifo}(\theta_t, r)}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot \frac{2}{\sqrt{2}} \cdot k$$

$$DN_{acboxyt}(\theta_t, 0.0015) = 2.228 \times 10^{-24}$$

$$DN_{acbporct}(\theta_t, 0.0015) = 2.5 \times 10^{-24}$$

$$Ratio\_acboxyt\_acbporct := \frac{DN_{acboxyt}(0.052, 0.0015)}{DN_{acbporct}(0.052, 0.0015)}$$

$$Ratio\_acboxyt\_acbporct = 0.891$$

SCATTER FROM ROUGH CUT SS HOLE EDGE

Radius of baffle hole, m $R_{bh} := 0.170$

thickness of baffle plate, m $t := 0.047 \cdot .0254$

maximum width of exposed edge, m $w_e := \frac{t}{\cos\left(33 \cdot \frac{\pi}{180}\right)}$

$$w_e = 1.423 \times 10^{-3}$$

exposed area of baffle hole edge, m^2

$$A_{bpe} := \int_{-R_{bh}}^{0} 2 \cdot \sqrt{R_{bh}^2 - x^2}\, dx - \int_{-R_{bh}+w_e}^{0} 2 \cdot \sqrt{R_{bh}^2 - (x - w_e)^2}\, dx$$

$$A_{bpe} = 4.84 \times 10^{-4}$$

incident power from opposite arm, W

$$P_{ie} := I_i \cdot A_{bpe} = 0.015$$

BRDF of edge, sr^-1

$$BRDF_{edge} := 0.1$$

power scattered into IFO mode, W

$$P_{acbedgesifo} := 4 \cdot I_i \cdot A_{bpe} \cdot \left(BRDF_{edge} \cdot \pi \cdot \frac{w_{ifo}^{2}}{L_{arm}^{2}} \right) \cdot BRDF_1\left(30 \cdot 10^{-6}\right) \cdot \Delta\Omega_{ifo}$$

$$P_{acbedgesifo} = 5.672 \times 10^{-19}$$

displacement noise from cut edge
@ 100 Hz, m/rtHz

$$DN_{acbedge} := TF_{itmhr} \cdot \left(\frac{P_{acbedgesifo}}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot \frac{2}{\sqrt{2}} \cdot k$$

$$DN_{acbedge} = 6.188 \times 10^{-25}$$

Power Scattered from the louver portion of baffle

$$P_{acboxysifo} = 6.977 \times 10^{-18}$$

displacement noise from louvers @
100 Hz, m/rtHz

$$DN_{acboxys} := TF_{itmhr} \cdot \left(\frac{P_{acboxysifo}}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot \frac{2}{\sqrt{2}} \cdot k$$

$$DN_{acboxys} = 2.17 \times 10^{-24}$$

Ratio of cut edge to louver displacement noise

$$Ratio\_edge\_louver\_noise := \frac{DN_{acbedge}}{DN_{acboxys}}$$

$$Ratio\_edge\_louver\_noise = 0.285$$

REFLECTED ACB SCATTER

reflectivity of porcelain @ 57 deg $R_{porc57} := 0.001$

reflectivity of porcelain @ 3 deg $R_{porc3} := 0.02$

net reflectivity of porcelain after 4 bounces $R_{pnet4} := R_{porc57} \cdot R_{porc3}{}^{3}$

$R_{pnet4} = 8 \times 10^{-9}$

reflectivity of stainless steel @ 57 deg $R_{ss57} := 0.04$

reflectivity of stainless steel @ 3 deg $R_{ss3} := 0.02$

net reflectivity of ss after 4 bounces $R_{snet4} := R_{ss57} \cdot R_{ss3}{}^{3}$

$R_{snet4} = 3.2 \times 10^{-7}$

power through the cryopump baffle aperture (hits the arm cavity baffle), W $P_{acb} = 14.096$

Area of cryopump baf aperture, m^2 $A_{cp} = 0.464$

incident intensity, W/m^2 $I_i := \frac{P_{acb}}{A_{cp}} = 30.349$

area of exposed ACB, m^2 $A_{ACB} = 0.236$

power hitting ACB, W $P_{ACB} := I_i \cdot A_{ACB}$

$P_{ACB} = 7.151$

BRDF of chamber wall

$BRDF_{wall} := 0.1$

$\Delta_{ifo} := 2.72 \times 10^{-9}$

$L := 4000$

Power reflected from porc baffle, W

$P_{acbporcrefl} := R_{pnet4} \cdot P_{ACB}$

$P_{acbporcrefl} = 5.721 \times 10^{-8}$

Power reflected from ACBporc
scattered into IFO mode , W

$$P_{acbporcrefls} := \sqrt{4} \cdot P_{acbporcrefl} \cdot R_{pnet4} \cdot BRDF_{wall} \cdot \frac{\pi \cdot w_{ifo}^{2}}{L^{2}} \cdot BRDF_{1}\left(30 \cdot 10^{-6}\right) \cdot \Delta_{ifo}$$

$P_{acbporcrefls} = 9.605 \times 10^{-33}$

Motion of BSC chamber @ 100 Hz, m/rt Hz

$x_{bscchamber} := 2 \times 10^{-11}$

displacement noise @ 100 Hz,
m/rtHz

$$DN_{acbporcrefl} := TF_{itmhr} \cdot \left(\frac{P_{acbporcrefls}}{P_{psl}}\right)^{0.5} \cdot x_{bscchamber} \cdot 2 \cdot k$$

$DN_{acbporcrefl} = 2.278 \times 10^{-30}$

Power reflected from ss baffle, W

$P_{acbsscrefl} := R_{snet4} \cdot P_{ACB}$

$P_{acbsscrefl} = 2.288 \times 10^{-6}$

Power reflected from ACBss
scattered into IFO mode , W

$$P_{acbssrefls} := \sqrt{4} \cdot P_{acbsscrefl} \cdot R_{snet4} \cdot BRDF_{wall} \cdot \frac{\pi \cdot w_{ifo}^{2}}{L^{2}} \cdot BRDF_{1}\left(30 \cdot 10^{-6}\right) \cdot \Delta_{ifo}$$

$$P_{acbssrefls} = 1.537 \times 10^{-29}$$

Motion of BSC chamber @ 100 Hz, m/rt Hz $x_{bscchamber} := 2 \times 10^{-11}$

displacement noise @ 100 Hz,
m/rtHz

$$DN_{acbssrefl} := TF_{itmhr} \cdot \left(\frac{P_{acbssrefls}}{P_{psl}}\right)^{0.5} \cdot x_{bscchamber} \cdot \frac{2}{\sqrt{2}} \cdot k$$

$$DN_{acbssrefl} = 6.442 \times 10^{-29}$$

Ratio of reflected scatter from oxidized stainless and porcelainized steel

$$Ratio\_acbssrefl\_acbporcrefl := \frac{DN_{acbssrefl}}{DN_{acbporcrefl}}$$

$$Ratio\_acbssrefl\_acbporcrefl = 28.284$$

$$\left.\left.\theta_i\left(\theta_t,\theta_{xy}\right)\right)\right]^2\cdot\frac{L_{arm}}{L_{arm}^{2}}\,d\theta_s\right]\cdot\cos\left(\theta_{xy}\right)d\theta_{xy}$$

0

$$\overline{2\cdot\theta_i\left(\theta_t,\theta_{xy}\right)\Big)\Big]^2}\cdot\frac{L_{arm}}{L_{arm}^{\;2}}\,d\theta_s\Bigg]\cdot\cos\left(\theta_{xy}\right)\,d\theta_{xy}$$

0

$$\overline{2\cdot\theta_i\left(\theta_t,\theta_{xy}\right)\big)\big]}^2\cdot\frac{L_{arm}}{{L_{arm}}^2}\,d\theta_s\Bigg]\cdot\cos\left(\theta_{xy}\right)d\theta_{xy}$$

)

$$- 2\cdot\theta_i\left(\theta_t, \theta_{xy}\right)\Big)\Big]^2 \cdot \frac{L_{arm}}{L_{arm}^{\,2}}\, d\theta_s \Bigg] \cdot \cos\left(\theta_{xy}\right) d\theta_{xy}$$

)

$$\overline{\left(\theta_s - 2\cdot\theta_i\left(\theta_t,\theta_{xy}\right)\right)\Big]}^2\cdot\frac{L_{arm}}{L_{arm}^{\ 2}}\,d\theta_s\Bigg]\cdot\cos\left(\theta_{xy}\right)\,d\theta_{xy}$$

$$\overline{\theta_s - 2\cdot\theta_i\left(\theta_t, \theta_{xy}\right)\big)\Big]}^2 \cdot \frac{L_{arm}}{{L_{arm}}^2}\, d\theta_s \Bigg] \cdot \cos\left(\theta_{xy}\right) d\theta_{xy}$$

)

$$\left.\overline{- 2\cdot\theta_i\left(\theta_t,\theta_{xy}\right)\right)\Big]^2}\cdot\frac{L_{arm}}{L_{arm}^{\,2}}\,d\theta_s\right]\cdot\cos\left(\theta_{xy}\right)d\theta_{xy}$$

)

)