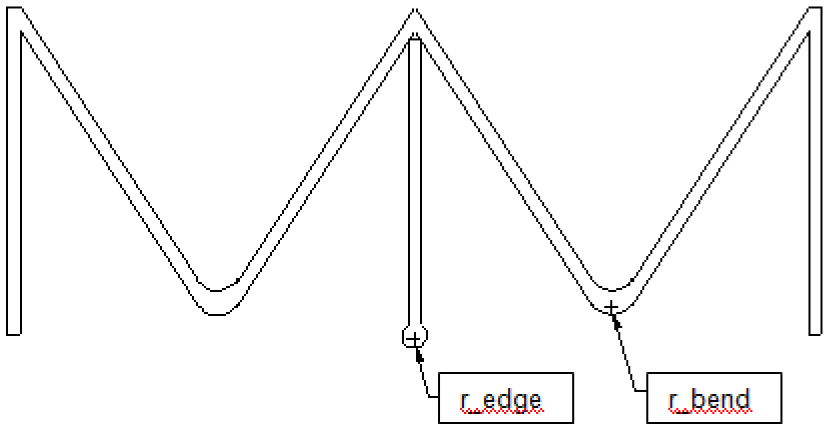
ACB scatter with various materials
8/16/13



Arm cavity power, W $P_a := 840000$

radius of baffle edge, m $r_{edge} := 0.0006$

radius of baffle bend, m $r_{bend} := 0.0024$

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

length of baffle bend, 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 $\Delta\Omega_{ifo} := \frac{\lambda^2}{\pi \cdot w_{ifo}^2} = 2.502 \times 10^{-9}$

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

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 $P_{psl} := 125$

Arm Power, W $P_0 := 834174$

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 $BRDF_1(\theta) := \frac{2755.12}{\left(1 + 8.50787 \cdot 10^8 \cdot \theta^2\right)^{1.23597}}$

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

height of ledge, m $H_L := 0.769 - 0.655 = 0.114$

$H_1 := R_{cryo} - H_L = 0.271$

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

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

$A_h = 0.093$

area of manifold/cryo baffle ledge, m^2 $A_L := \int_{H_1}^{R_{cryo}} 2 \cdot \sqrt{R_{cryo}^2 - H^2}\, dH$

$A_L = 0.043$

area of exposed ACB, m^2

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

power through the cryopump baffle aperture (hits
the arm cavity baffle), W

$$P_{acb} := P_a \cdot \int_0^{\theta_{cp}} 2 \cdot \pi \cdot \theta \cdot BRDF_1(\theta)\, d\theta$$

$$P_{acb} = 14.573$$

Area of cryopump baf aperture, m^2

$$A_{cp} := \pi \cdot R_{cp}^{2} = 0.464$$

incident intensity, W/m^2

$$I_i := \frac{P_{acb}}{A_{cp}} = 31.376$$

tilt angle of baffle edge, rad

$$\theta_t := 1 \cdot \frac{\pi}{180} = 0.017$$

$$\theta_{xy} := 0$$

incident angle, rad

$$\theta_i(\theta_t, \theta_{xy}) := \text{acos}\left(\cos(\theta_{xy}) \cdot \cos(\theta_t)\right)$$

input angle range, bend, rad

$$\theta_{xymaxbend} := 33 \cdot \frac{\pi}{180} = 0.576$$

input angle range, front edge, deg

$$\theta_{xymaxbdeg} := \theta_{xymaxbend} \cdot \frac{180}{\pi} = 33$$

input angle range, edge rad

$$\theta_{xymaxedge} := \frac{\pi}{2} = 1.571$$

input angle range, edge deg

$$\theta_{xymaxpdeg} := \theta_{xymaxedge} \cdot \frac{180}{\pi} = 90$$

Frontal area of baffle plate edge, m^2

$$A_{bp}(r_{edge}) := 2 \cdot r_{edge} \cdot H_p$$

$$A_{bp}(r_{edge}) = 7.86 \times 10^{-4}$$

incident power, W

$$P_{ibp}(r_{edge}) := I_i \cdot A_{bp}(r_{edge})$$

$P_{ibp}(r_{edge}) = 0.025$

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

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

large angle BRDF, sr^-1 $BRDF_{\theta 2} := 0.03$

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

back-scatter angle, rad $\theta_3 := 2 \cdot 3 \cdot \frac{\pi}{180} = 0.105$

back-scatter BRDF, sr^-1 $BRDF_{ACBoxy3}(\theta_3) = 0.337$

BRDF #4 Oxidized stainless steel, 57 deg inc.

Reflectivity of baffle surface $R := .04$

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

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

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

final slope modifier $\beta := 0.95$

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

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

large angle BRDF, sr^-1 $BRDF_{\theta 2} := 0.04$

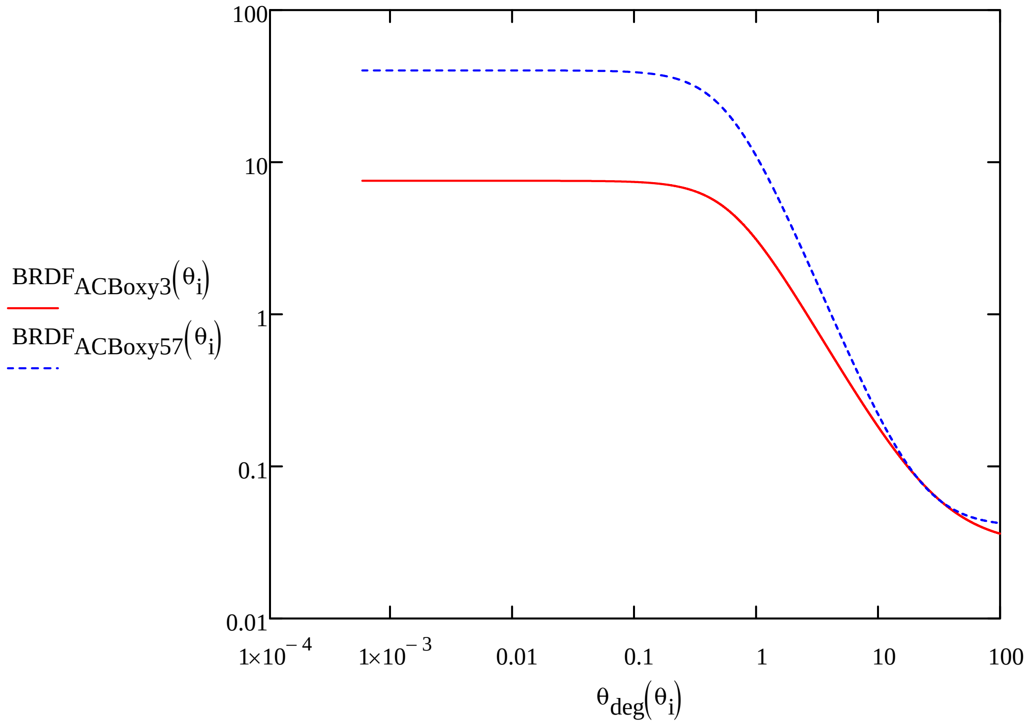
BRDF function, sr^-1 $BRDF_{ACBoxy57}(\theta_i) := \frac{BRDF_0}{\left(1 + C_{mr} \cdot \theta_i^2\right)^\beta} + BRDF_{\theta 2}$

back-scatter angle, rad $\theta_{57} := 2 \cdot 57 \cdot \frac{\pi}{180} = 1.99$

back-scatter BRDF, sr^-1 $BRDF_{ACBoxy57}(\theta_{57}) = 0.042$

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

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



BRDF Black Glass 57 deg inc.

specular reflectivity $R_{57} := 1.5 \cdot 10^{-3}$

break-over angle, rad $\theta_1 := 1 \cdot \frac{\pi}{180} = 0.017$

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

max BRDF, sr^-1 $BRDF_0 := 0.02$

final slope modifier $\beta := 1.4$

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

$C_{mr} = 2.103 \times 10^{3}$

large angle BRDF, sr^-1 $BRDF_{\theta 2} := 4 \cdot 10^{-5}$

BRDF function, sr^-1 $BRDF_{bg57}(\theta_i) := \dfrac{BRDF_0}{\left(1 + C_{mr} \cdot \theta_i^{\,2}\right)^{\beta}} + BRDF_{\theta 2}$

back-scatter angle, rad $\theta_{57} := 2 \cdot 57 \cdot \dfrac{\pi}{180} = 1.99$

back-scatter BRDF, sr^-1 $BRDF_{bg57}(\theta_{57}) = 4.006 \times 10^{-5}$

BRDF Black Glass 15eg inc.

specular reflectivity $R_{15} := 0.042$

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

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

max BRDF, sr^-1 $BRDF_0 := 0.12$

final slope modifier $\beta := .75$

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

$C_{mr} = 1.996 \times 10^{4}$

large angle BRDF, sr^-1 $BRDF_{\theta 2} := 1.5 \cdot 10^{-5}$

BRDF function, sr^-1

$$BRDF_{bg15}(\theta_i) := \frac{BRDF_0}{\left(1 + C_{mr}\cdot\theta_i^{\,2}\right)^{\beta}} + BRDF_{\theta2}$$

back-scatter angle, rad

$$\theta_{15} := 2\cdot 15\cdot\frac{\pi}{180} = 0.524$$

back-scatter BRDF, sr^-1

$$BRDF_{bg15}(\theta_{15}) = 2.036\times 10^{-4}$$

BRDF Black Glass 5 deg inc.

specular reflectivity

$$R_5 := 0.05$$

break-over angle, rad

$$\theta_1 := 0.5\cdot\frac{\pi}{180} = 8.727\times 10^{-3}$$

micro-roughness angle, rad

$$\theta_2 := 5\cdot\frac{\pi}{180} = 0.087$$

max BRDF, sr^-1

$$BRDF_0 := 0.15$$

final slope modifier

$$\beta := .85$$

micro-roughness constant

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

$$C_{mr} = 1.655\times 10^{4}$$

large angle BRDF, sr^-1

$$BRDF_{\theta2} := 1\cdot 10^{-5}$$

BRDF function, sr^-1

$$BRDF_{bg5}(\theta_i) := \frac{BRDF_0}{\left(1 + C_{mr}\cdot\theta_i^{\,2}\right)^{\beta}} + BRDF_{\theta2}$$

back-scatter angle, rad

$$\theta_5 := 2\cdot 5\cdot\frac{\pi}{180} = 0.175$$

back-scatter BRDF, sr^-1 $BRDF_{bg5}(\theta_5) = 7.655 \times 10^{-4}$

BRDF Black Glass fire polish (empirical estimate)

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

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

max BRDF, sr^-1 $BRDF_0 := 0.1$

final slope modifier $\beta := 0.85$

micro-roughness constant

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

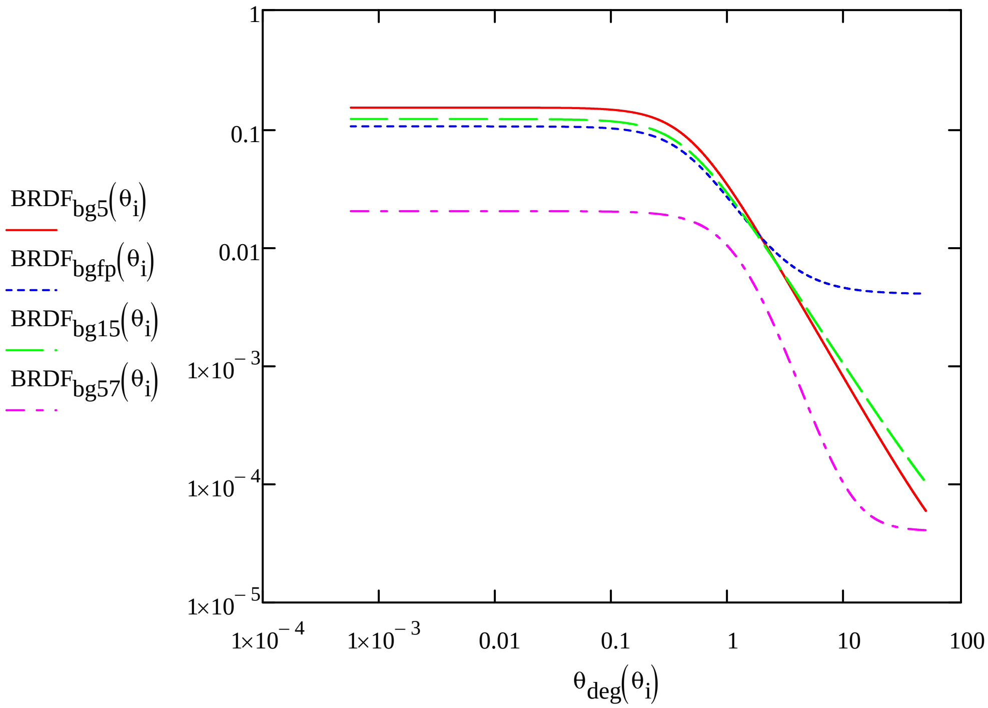
$$C_{mr} = 1.655 \times 10^4$$

large angle BRDF, fire polish, sr^-1 $BRDF_{bgfp} := 4 \cdot 10^{-3}$

BRDF function, sr^-1

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

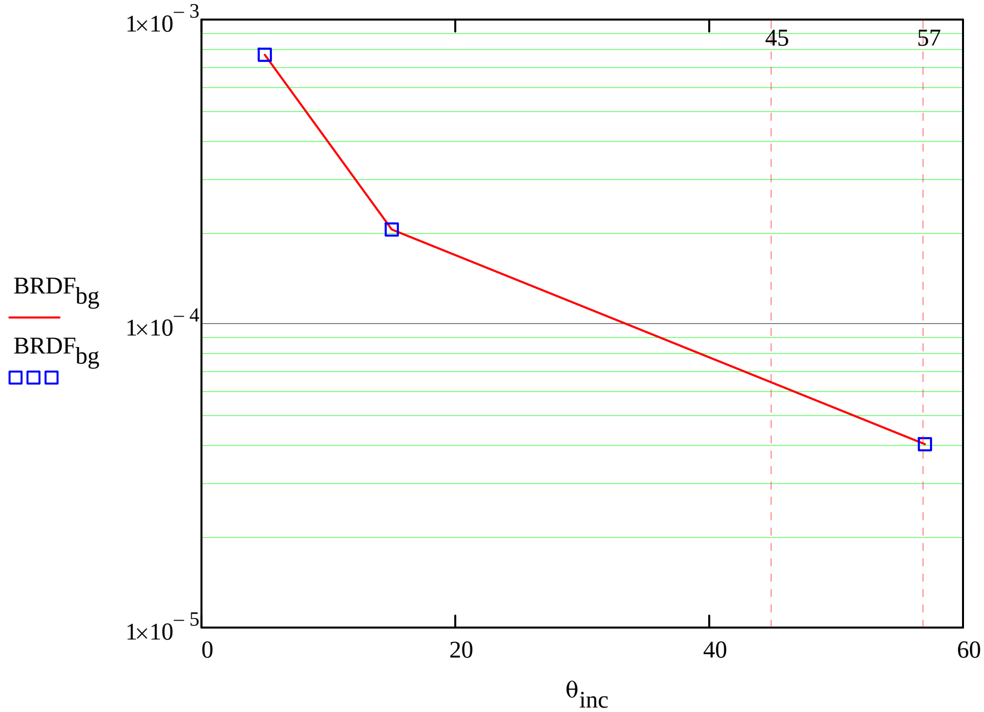
$$\theta_i := 0, 0.00001 .. 10 \cdot \theta_2$$



Black Glass BRDF Summary

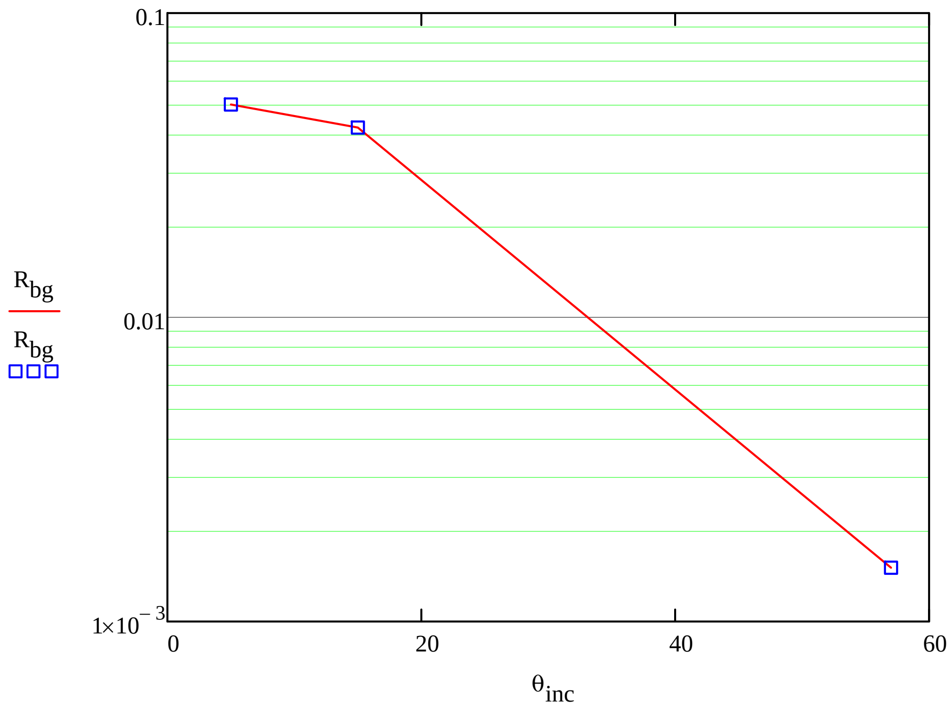
$$BRDF_{bg} := \begin{pmatrix} BRDF_{bg5}(\theta_5) \\ BRDF_{bg15}(\theta_{15}) \\ BRDF_{bg57}(\theta_{57}) \end{pmatrix}$$

$$\theta_{inc} := \begin{pmatrix} 5 \\ 15 \\ 57 \end{pmatrix}$$



Black Glass Reflectance Summary

$$R_{bg} := \begin{pmatrix} R_5 \\ R_{15} \\ R_{57} \end{pmatrix}$$



BRDF DLC 5 deg inc.

specular reflectivity $R_{dlc5} := 0.0048$

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

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

max BRDF, sr^-1 $BRDF_0 := 0.3$

final slope modifier $\beta := 0.9$

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

$C_{mr} = 1.523 \times 10^{4}$

large angle BRDF, sr^-1 $BRDF_{\theta 2} := 5 \cdot 10^{-6}$

BRDF function, sr^-1 $BRDF_{dlc5}(\theta_i) := \frac{BRDF_0}{\left(1 + C_{mr} \cdot \theta_i^{\,2}\right)^{\beta}} + BRDF_{\theta 2}$

back-scatter angle, rad $\theta_5 := 2 \cdot 5 \cdot \frac{\pi}{180} = 0.175$

back-scatter BRDF, sr^-1 $BRDF_{dlc5}(\theta_5) = 1.197 \times 10^{-3}$

BRDF DLC 15 deg inc.

specular reflectivity $R_{dlc15} := 0.0076$

break-over angle, rad $\theta_1 := 1.5 \cdot \frac{\pi}{180} = 0.026$

micro-roughness angle, rad $\theta_2 := 60 \cdot \frac{\pi}{180} = 1.047$

max BRDF, sr^-1 $BRDF_0 := 0.015$

final slope modifier $\beta := 0.7$

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

$C_{mr} = 2.468 \times 10^{3}$

large angle BRDF, sr^-1 $BRDF_{\theta 2} := 1.0 \cdot 10^{-6}$

BRDF function, sr^-1 $BRDF_{dlc15}(\theta_i) := \frac{BRDF_0}{\left(1 + C_{mr} \cdot \theta_i^{\,2}\right)^{\beta}} + BRDF_{\theta 2}$

back-scatter angle, rad $\theta_{15} := 2\cdot 15\cdot\frac{\pi}{180} = 0.524$

back-scatter BRDF, sr^-1 $BRDF_{dlc15}(\theta_{15}) = 1.574\times 10^{-4}$

BRDF DLC 57 deg inc.

specular reflectivity $R_{dlc57} := 0.11$

break-over angle, rad $\theta_1 := 4\cdot\frac{\pi}{180} = 0.07$

micro-roughness angle, rad $\theta_2 := 60\cdot\frac{\pi}{180} = 1.047$

max BRDF, sr^-1 $BRDF_0 := 0.02$

final slope modifier $\beta := 1.1$

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

$C_{mr} = 180.116$

large angle BRDF, sr^-1 $BRDF_{\theta 2} := 6.5\cdot 10^{-5}$

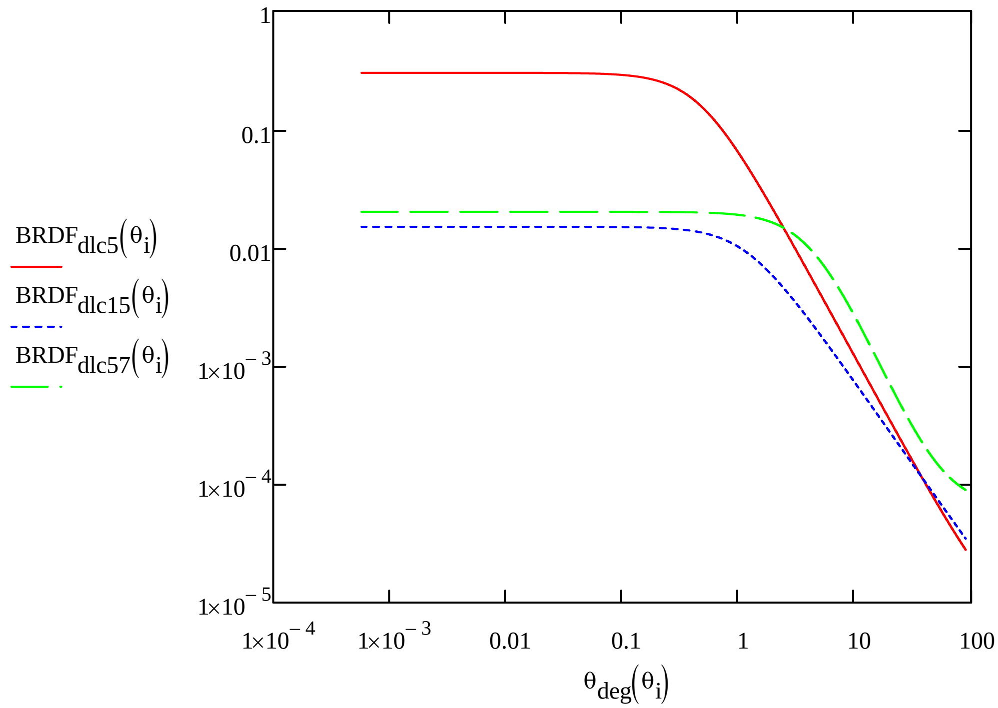
BRDF function, sr^-1 $BRDF_{dlc57}(\theta_i) := \dfrac{BRDF_0}{\left(1 + C_{mr}\cdot\theta_i^{\,2}\right)^{\beta}} + BRDF_{\theta 2}$

back-scatter angle, rad $\theta_{57} := 2\cdot 57\cdot\frac{\pi}{180} = 1.99$

back-scatter BRDF, sr^-1 $BRDF_{dlc57}(\theta_{57}) = 7.952\times 10^{-5}$

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

$\theta_i := 0, 0.00001 .. \frac{\pi}{2}$



DLC BRDF Summary

back-scatter BRDF, sr^-1

$$BRDF := \begin{pmatrix} 5 & BRDF_{dlc5}(\theta_5) & BRDF_{dlc5}(\theta_5) \\ 15 & BRDF_{dlc15}(\theta_{15}) & BRDF_{dlc15}(\theta_{15}) \\ 57 & BRDF_{dlc57}(\theta_{57}) & BRDF_{dlc57}(\theta_{57}) \end{pmatrix}$$

incident angle

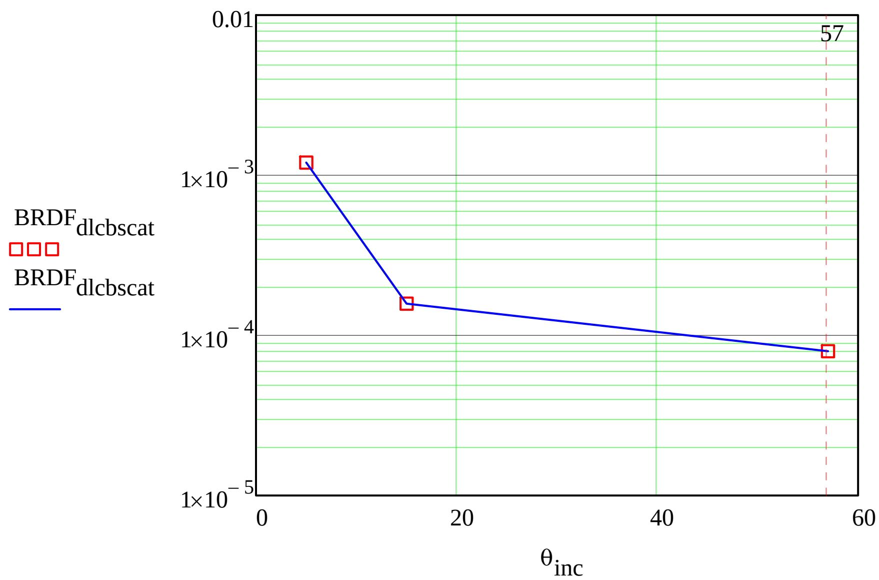
$$\theta_{inc} := BRDF^{\langle 0 \rangle}$$

$$\theta_{inc} = \begin{pmatrix} 5 \\ 15 \\ 57 \end{pmatrix}$$

back-scatter BRDF

$$BRDF_{dlcbscat} := BRDF^{\langle 1 \rangle}$$

$$BRDF_{dlcbscat} = \begin{pmatrix} 1.197 \times 10^{-3} \\ 1.574 \times 10^{-4} \\ 7.952 \times 10^{-5} \end{pmatrix}$$



DLC Reflectance Summary

Reflectance

$$R_{dlc} := \begin{pmatrix} 5 & R_{dlc5} & R_{dlc5} \\ 15 & R_{dlc15} & R_{dlc15} \\ 57 & R_{dlc57} & R_{dlc57} \end{pmatrix}$$

incident angle

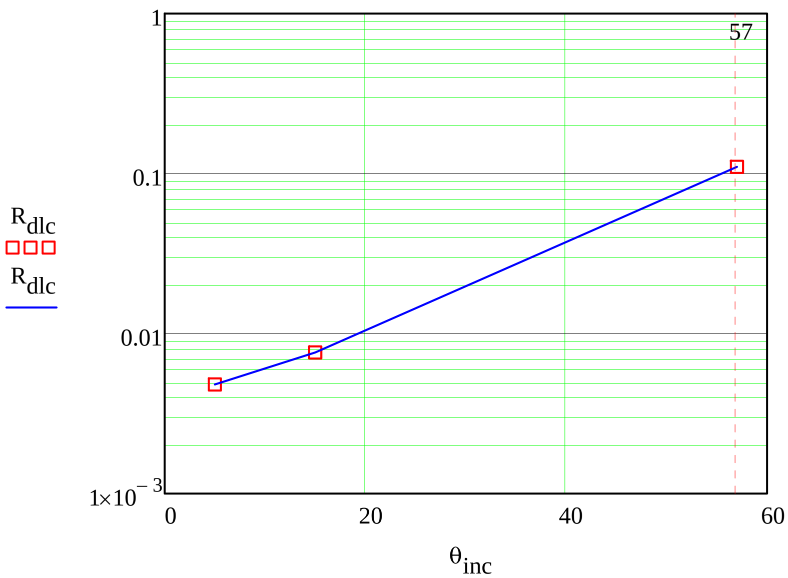
$$\theta_{inc} := R_{dlc}^{\langle 0 \rangle}$$

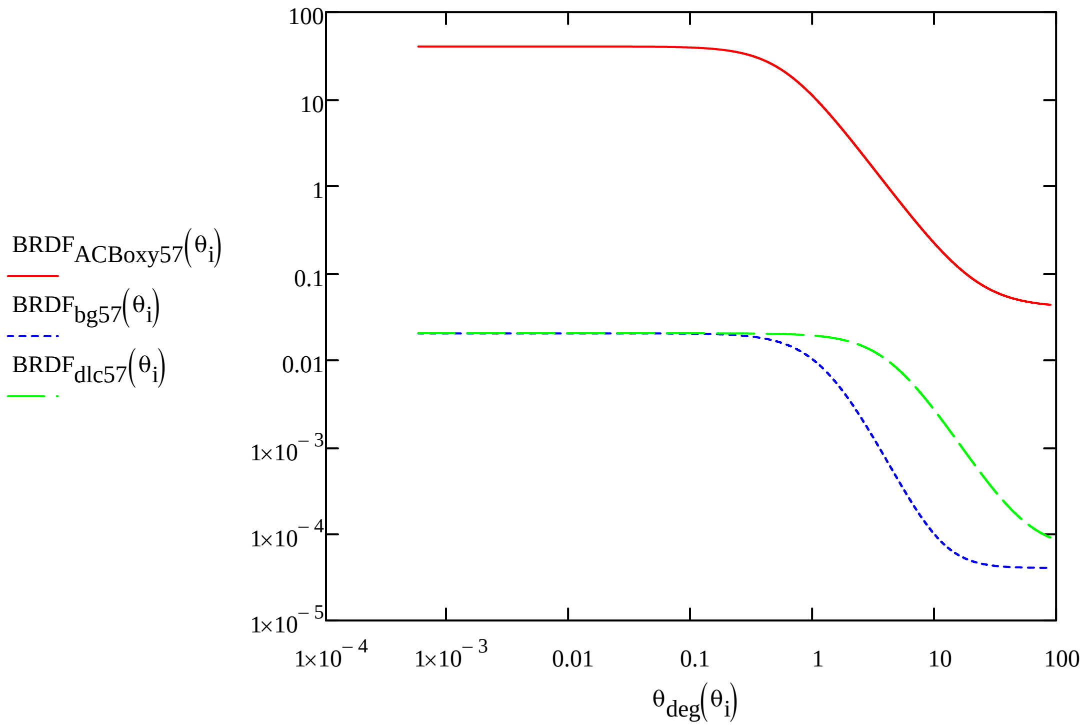
$$\theta_{inc} = \begin{pmatrix} 5 \\ 15 \\ 57 \end{pmatrix}$$

ReflectanceDF

$$R_{dlc} := R_{dlc}^{\langle 1 \rangle}$$

$$R_{dlc} = \begin{pmatrix} 4.8 \times 10^{-3} \\ 7.6 \times 10^{-3} \\ 0.11 \end{pmatrix}$$





OXIDIZED SS

incident angle, rad

$$\theta_t := 1 \cdot \frac{\pi}{180} = 0.017$$

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

$$\theta_i(\theta_t, \theta_{xy}) := \operatorname{acos}(\cos(\theta_{xy}) \cdot \cos(\theta_t))$$

Scatter function from baffle plate edge

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

$$S_{edgeoxy}(\theta_t) = 7.727 \times 10^{-13}$$

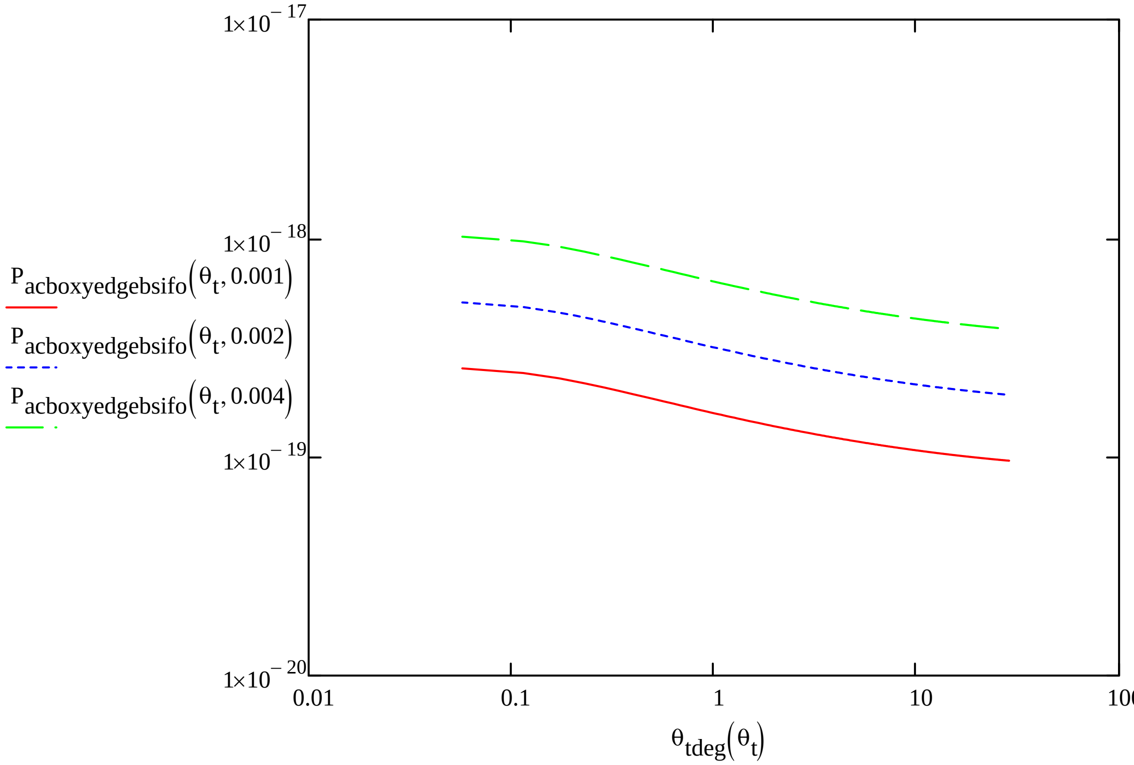
Scattered power into IFO from baffle plate edge

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

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

$$P_{acboxyedgebsifo}(\theta_t, 0.001) = 1.583 \times 10^{-19}$$

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



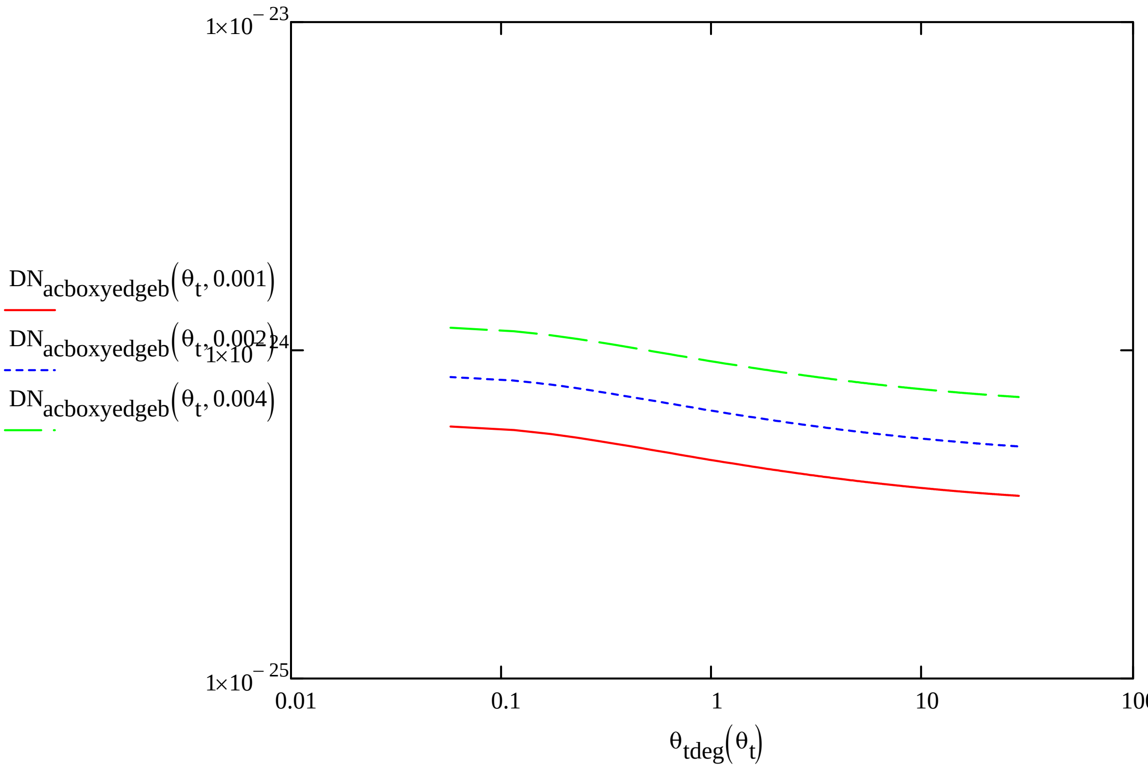
displacement noise @ 100 Hz,
m/rtHz

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

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

$$DN_{acboxyedgeb}(\theta_t, 0.001) = 4.623 \times 10^{-25}$$

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



Scatter from baffle bend

$$\theta_t := 0$$

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

$$S_{boxy}(\theta_t) = 1.034\times10^{-12}$$

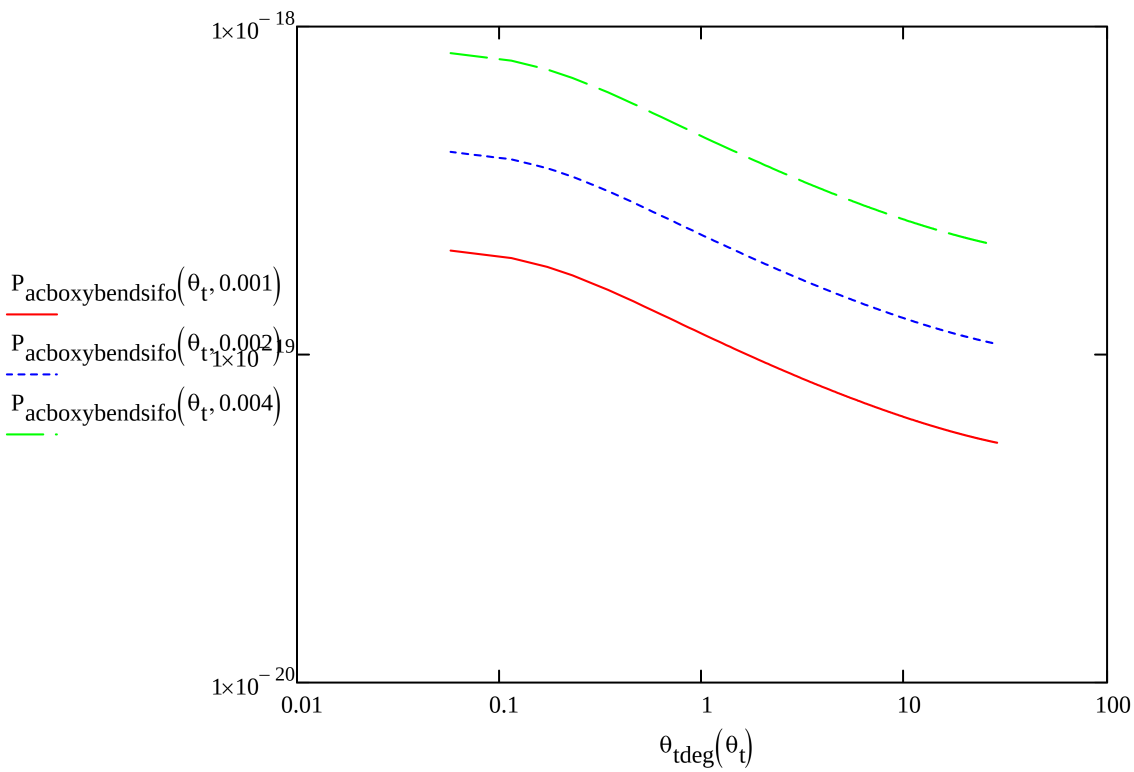
Power Scatter from baffle bend into IFO

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

$$\theta_t := 0$$

$$P_{acboxybendsifo}(\theta_t, 0.001) = 2.119 \times 10^{-19}$$

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



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

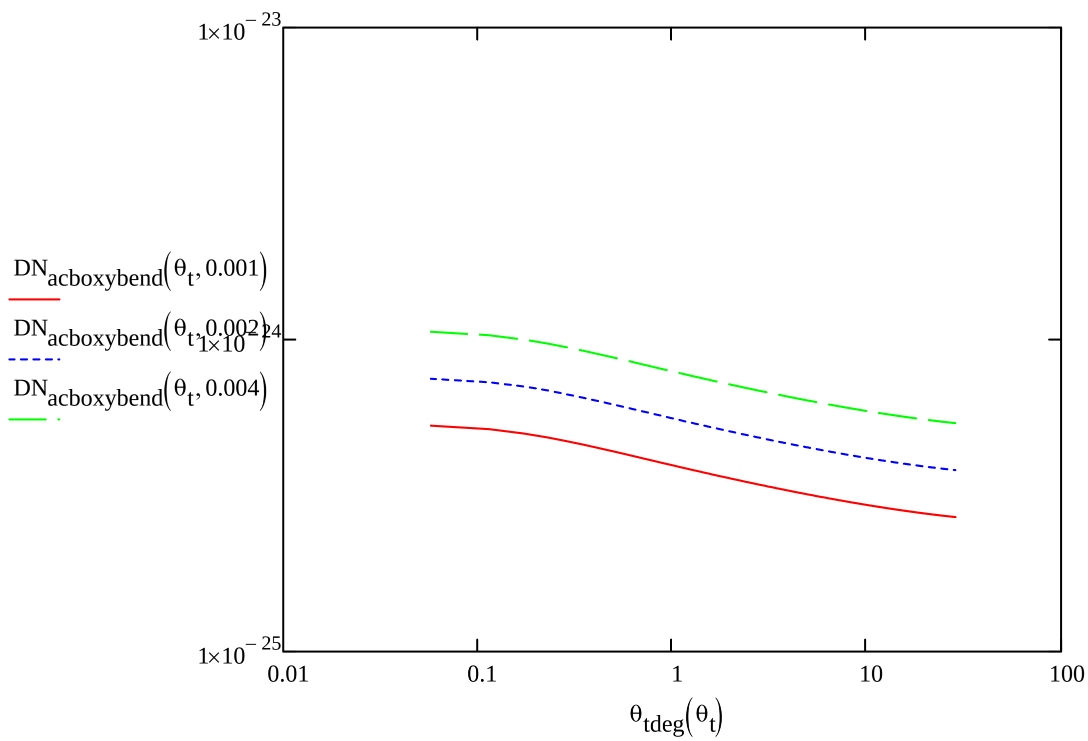
displacement noise @ 100 Hz,
m/rtHz

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

$$DN_{acboxybend}(\theta_t, r_{bend}) := TF_{itmhr}\cdot\left(\frac{P_{acboxybendsifo}(\theta_t, r_{bend})}{P_{psl}}\right)^{0.5}\cdot x_{ACB}\cdot 2\cdot k$$

$$DN_{acboxybend}(\theta_t, 0.001) = 3.951\times 10^{-25}$$

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



Power Scattered from the louver portion of baffle

$$BRDF_{ACBoxy57}\left(2\cdot 57\cdot\frac{\pi}{180}\right) = 0.042$$

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

$$P_{acboxylouvsifo} = 9.485\times 10^{-18}$$

displacement noise @ 100 Hz,
m/rtHz

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

$$DN_{acboxylouv}(\theta_t) := TF_{itmhr}\cdot\left(\frac{P_{acboxylouvsifo}}{P_{psl}}\right)^{0.5}\cdot x_{ACB}\cdot 2\cdot k$$

$$DN_{acboxylouv}(\theta_t) = 3.579\times 10^{-24}$$

$$P_{acboxytsifo}(\theta_t, r_{edge}, r_{bend}) := P_{acboxyedgebsifo}(\theta_t, r_{edge}) + P_{acboxybendsifo}(\theta_t, r_{bend}) + P_{acl}$$

$$\theta_t := 0$$

$$P_{acboxytsifo}(\theta_t, 0.001, 0.003) = 1.038\times 10^{-17}$$

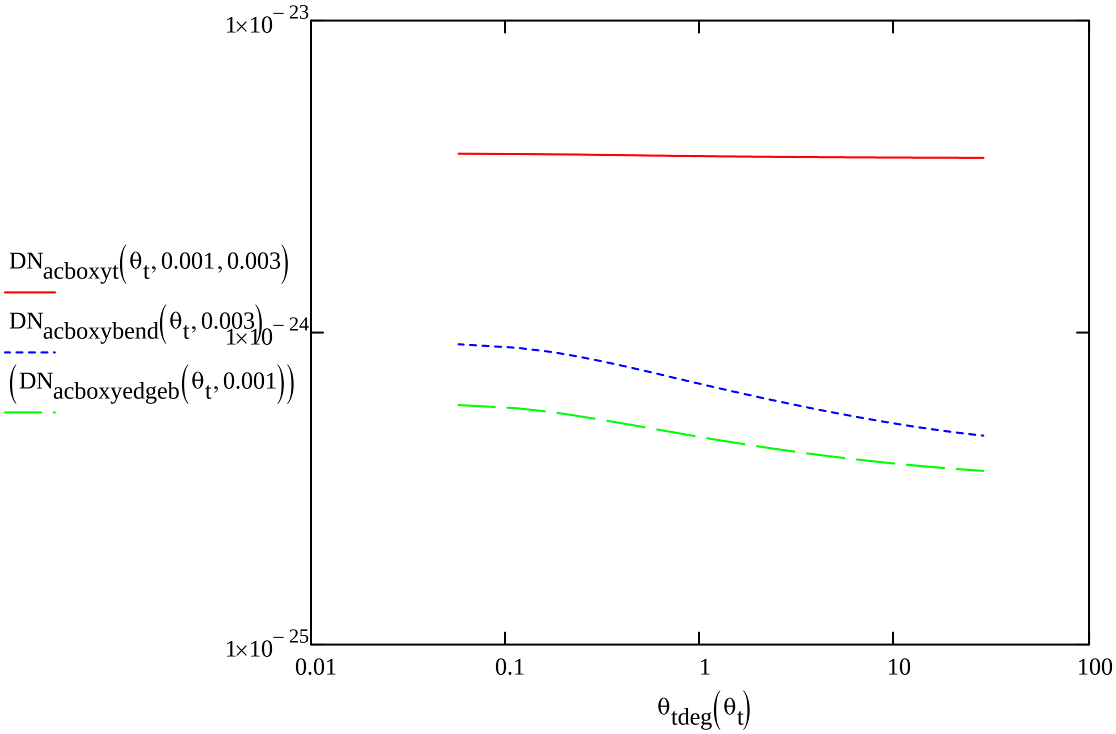
total displacement noise @ 100 Hz,
m/rtHz

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

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

$$DN_{acboxyt}(\theta_t, r_{edge}, r_{bend}) = 3.648\times 10^{-24}$$

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



MIXED: OXIDIZED STEEL EDGE, BLACK GLASS LOUVER

Scattered power into IFO from baffle plate edge

$\theta_t := 1$

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

$S_{edgeoxy}(\theta_t) = 4.471 \times 10^{-13}$

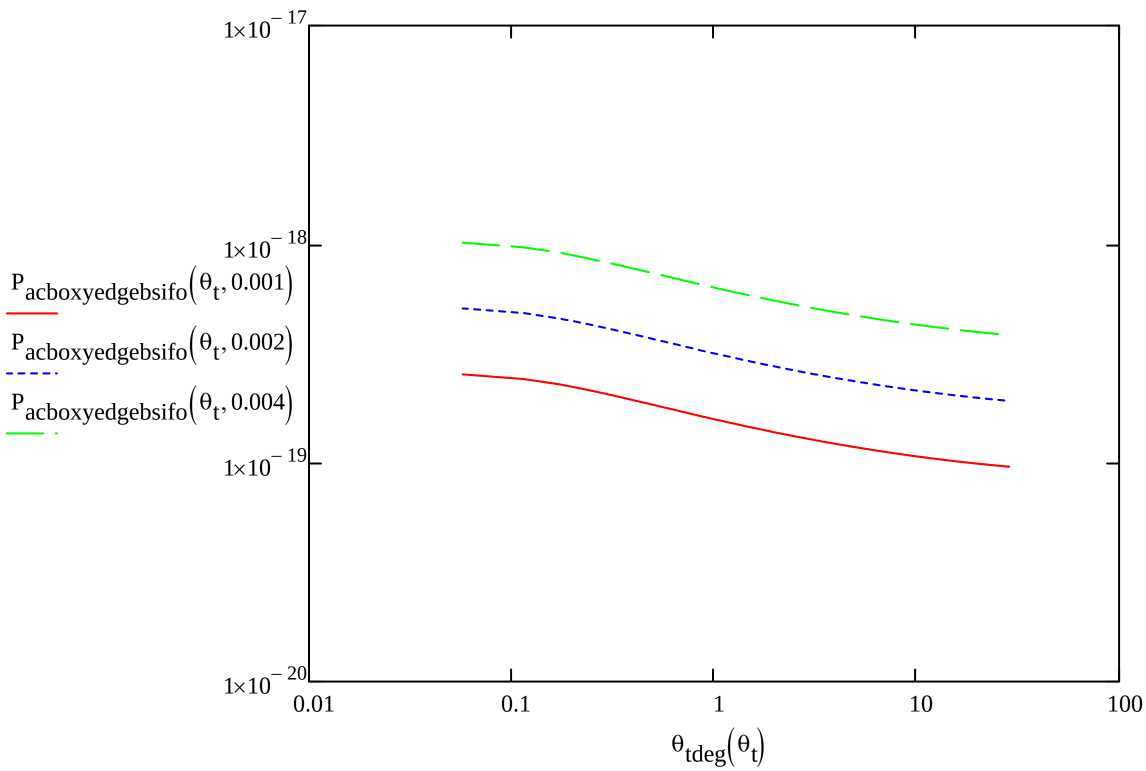
Scattered power into IFO from baffle plate edge

$$P_{acboxyedgebsifo}(\theta_t, r_{edge}) := 4 \cdot I_i \cdot r_{edge} \cdot H_b \cdot BRDF_1\left(30 \cdot 10^{-6}\right) \cdot \Delta\Omega_{ifo} \cdot \left(S_{edgeoxy}(\theta_t)\right)$$

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

$$P_{acboxyedgebsifo}(\theta_t, 0.001) = 1.583 \times 10^{-19}$$

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



ACB displacement @ 100 HZ, m/rt HZ

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

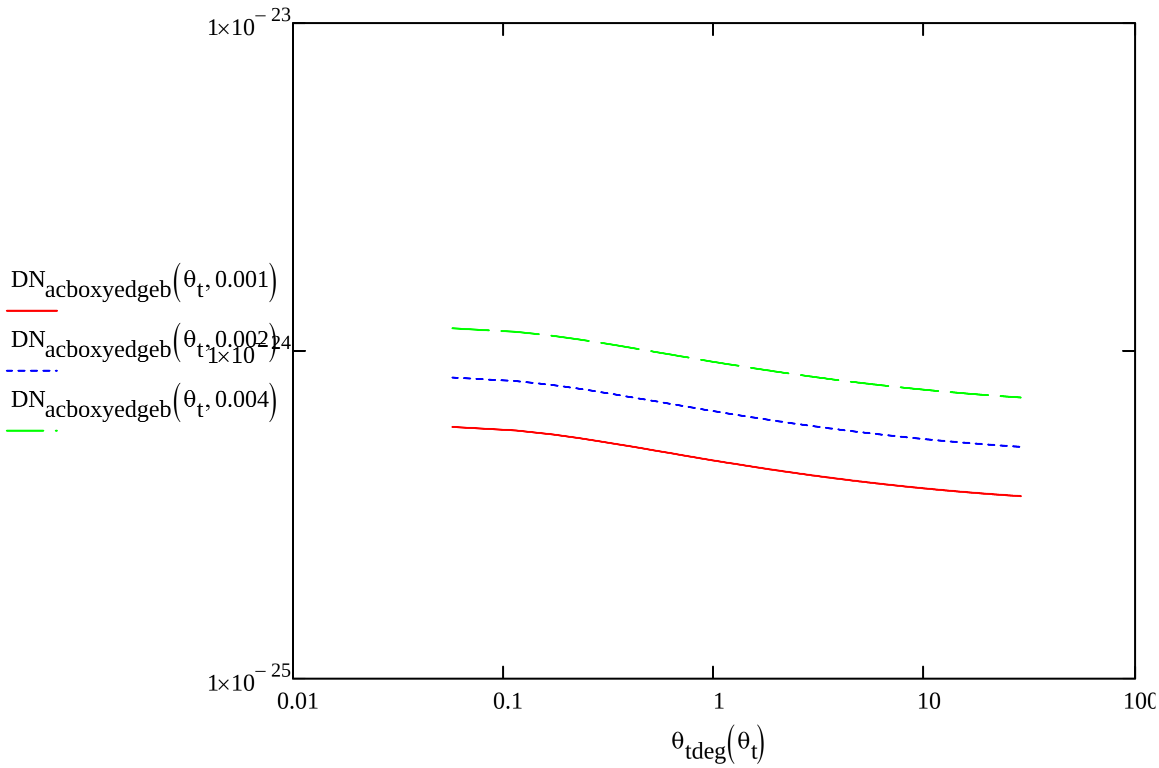
displacement noise @ 100 Hz, m/rtHz

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

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

$$DN_{acboxyedgeb}(\theta_t, 0.001) = 4.623 \times 10^{-25}$$

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



Scatter function from baffle bend, oxidized steel

$\theta_t := 0$

$$S_{bbg}(\theta_t) := \int_0^{\theta_{xymaxbend}} \left[\int_{2\cdot\theta_i(\theta_t,\theta_{xy})-\frac{w_{ifo}}{L_{arm}}}^{2\cdot\theta_i(\theta_t,\theta_{xy})+\frac{w_{ifo}}{L_{arm}}} BRDF_{bg57}(\theta_s + 2\cdot\theta_i(\theta_t,\theta_{xy}))\cdot\sqrt{w_{ifo}^2 - [L_{arm}\cdot(\theta_s - 2\cdot\theta$$

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

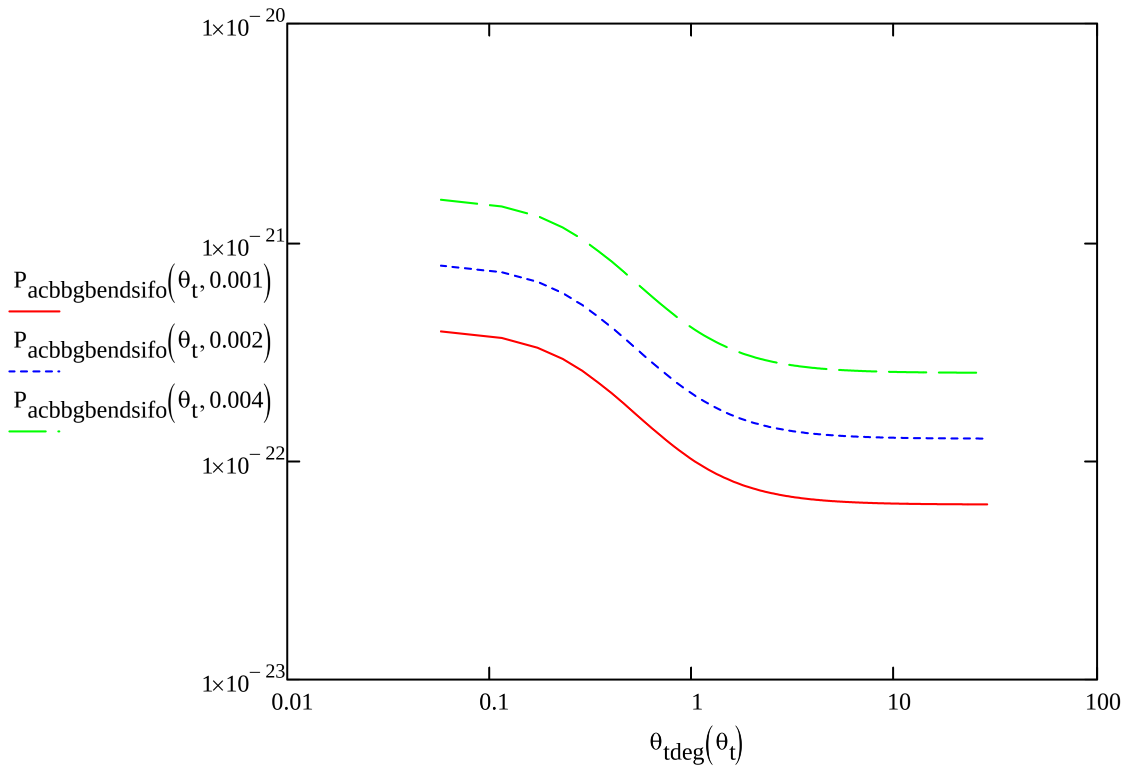
Power Scatter from baffle bend into IFO

$$P_{acbbgbendsifo}(\theta_t, r_{bend}) := 4\cdot I_i\cdot r_{bend}\cdot H_b\cdot BRDF_1(30\cdot 10^{-6})\cdot \Delta\Omega_{ifo}\cdot S_{bbg}(\theta_t)$$

$\theta_t := 0$

$P_{acbbgbendsifo}(\theta_t, 0.003) = 1.2 \times 10^{-21}$

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



ACB displacement @ 100 HZ, m/rt HZ

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

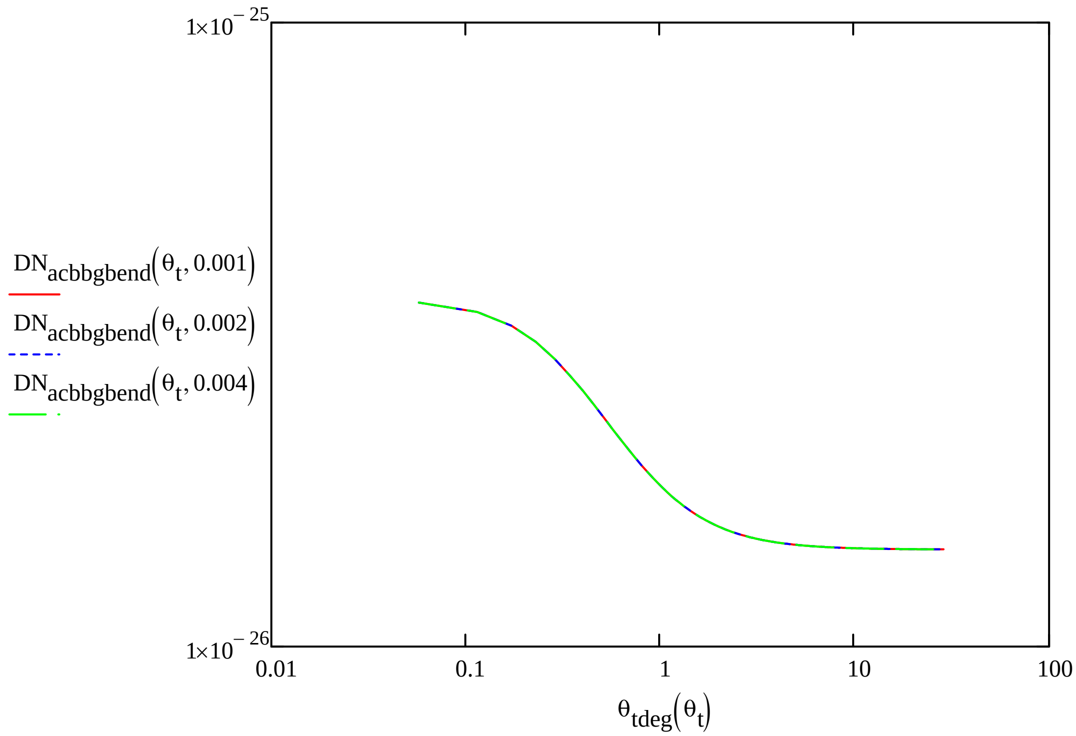
displacement noise @ 100 Hz, m/rtHz

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

$$DN_{acbbgbend}(\theta_t, r) := TF_{itmhr} \cdot \left(\frac{P_{acbbgbendsifo}(\theta_t, r_{bend})}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot 2 \cdot k$$

$$DN_{acbbgbend}(\theta_t, 0.001) = 1.811 \times 10^{-26}$$

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



Power Scattered from the louver portion of baffle, black glass

$$BRDF_{bg57}\left(2\cdot 57\cdot\frac{\pi}{180}\right) = 4.006\times 10^{-5}$$

$$P_{acbbglouvsifo} := I_i\cdot A_{ACB}\cdot BRDF_{bg57}\left(2\cdot 57\cdot\frac{\pi}{180}\right)\cdot\frac{w_{ifo}^{2}}{L_{arm}^{2}}\cdot BRDF_1\left(30\cdot 10^{-6}\right)\cdot\Delta\Omega_{ifo}$$

$$P_{acbbglouvsifo} = 9.102\times 10^{-21}$$

displacement noise @ 100 Hz,
m/rtHz

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

$$DN_{acbbglouv}(\theta_t) := TF_{itmhr} \cdot \left(\frac{P_{acbbglouvsifo}}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot 2 \cdot k$$

$$DN_{acbbglouv}(\theta_t) = 1.109 \times 10^{-25}$$

Total Power Scattered from the edge, bend, and louver, black glass

$$P_{acboxybgtsifo}(\theta_t, r_{edge}, r_{bend}) := P_{acboxyedgebsifo}(\theta_t, r_{edge}) + P_{acbbgbendsifo}(\theta_t, r_{bend}) + P_{acbbglouvs}$$

$\theta_t := 0$

$$P_{acboxybgtsifo}(\theta_t, 0.001, 0.002) = 2.689 \times 10^{-19}$$

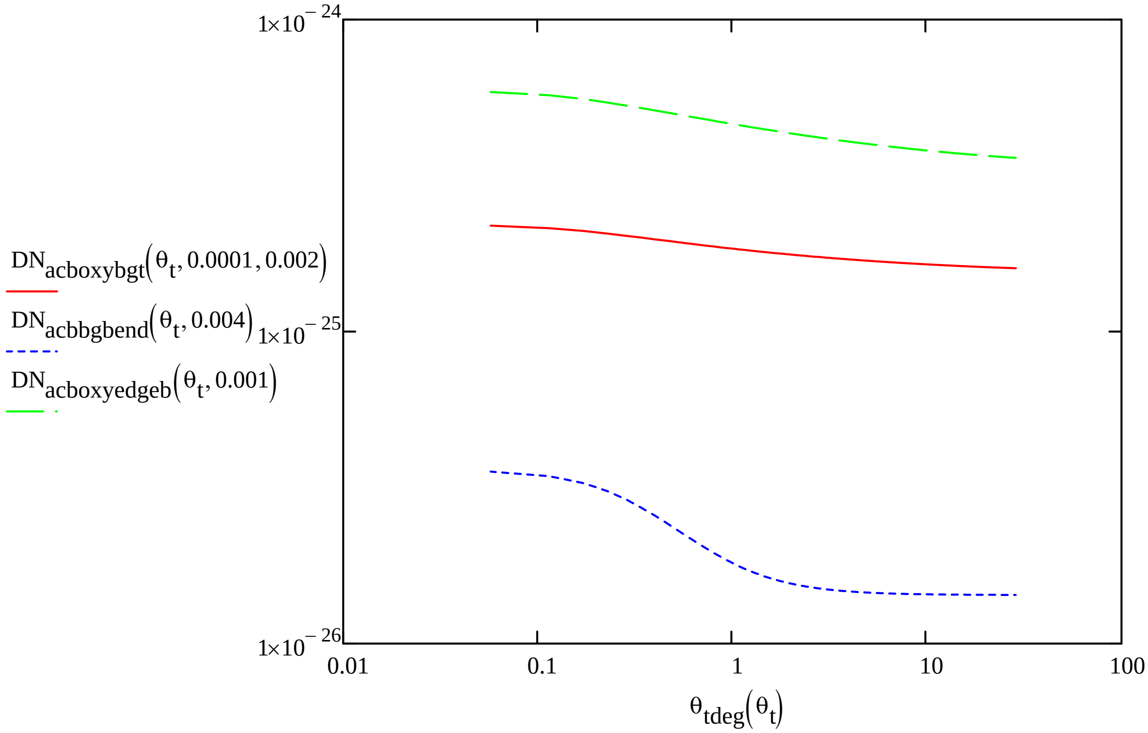
total displacement noise @ 100 Hz,
m/rtHz

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

$$DN_{acboxybgt}(\theta_t, r_{edge}, r_{bend}) := TF_{itmhr} \cdot \left(\frac{P_{acboxybgtsifo}(\theta_t, r_{edge}, r_{bend})}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot 2 \cdot k$$

$$DN_{acboxybgt}(\theta_t, r_{edge}, r_{bend}) = 3.753 \times 10^{-25}$$

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



ALL BLACK GLASS

$\theta_t := 1$

$$S_{edgebg}(\theta_t) := \int_0^{\theta_{xymaxedge}} \left[\int_{2\cdot\theta_i(\theta_t,\theta_{xy})-\frac{w_{ifo}}{L_{arm}}}^{2\cdot\theta_i(\theta_t,\theta_{xy})+\frac{w_{ifo}}{L_{arm}}} BRDF_{bg57}(\theta_s + 2\cdot\theta_i(\theta_t,\theta_{xy}))\cdot\sqrt{w_{ifo}^{\;2} - [L_{arm}\cdot(\theta_s - \right.$$

$S_{edgebg}(\theta_t) = 5.656 \times 10^{-16}$

Scattered power into IFO from baffle plate edge

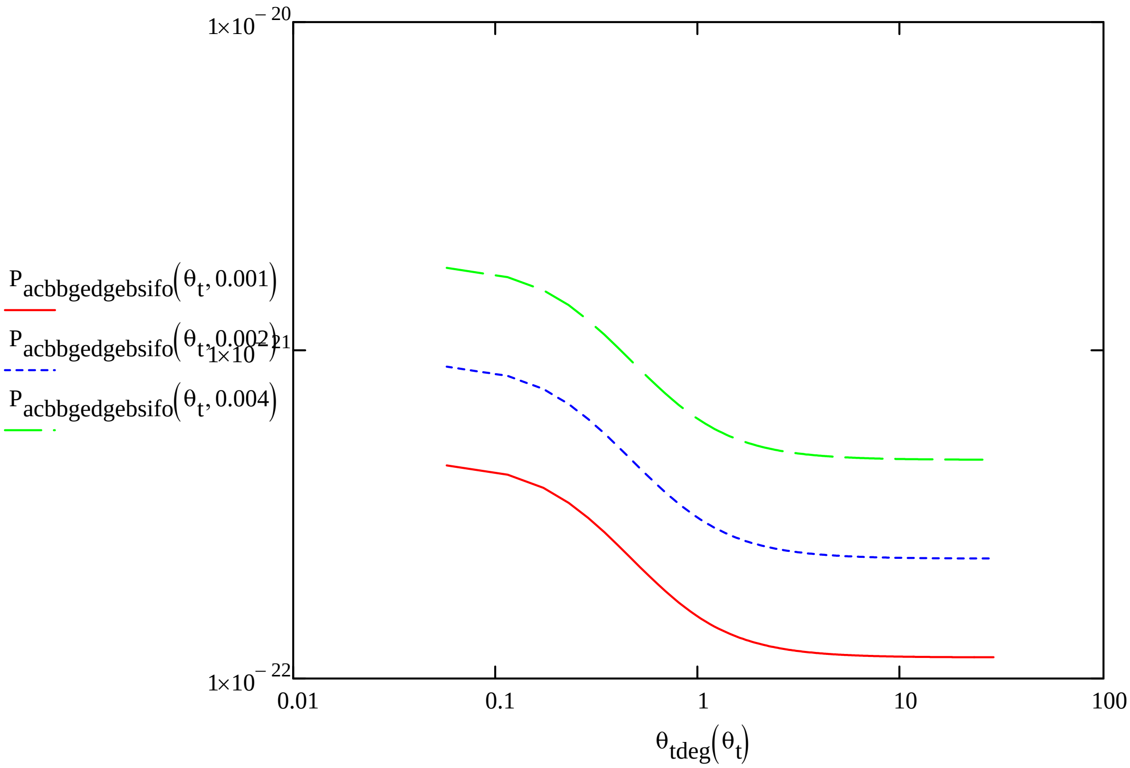
$$P_{acbbgedgebsifo}(\theta_t, r_{edge}) := 4 \cdot I_i \cdot r_{edge} \cdot H_b \cdot BRDF_1(30 \cdot 10^{-6}) \cdot \Delta\Omega_{ifo} \cdot (S_{edgebg}(\theta_t))$$

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

$$P_{acbbgedgebsifo}(\theta_t, 0.001) = 1.54 \times 10^{-22}$$

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

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



ACB displacement @ 100 HZ, m/rt HZ

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

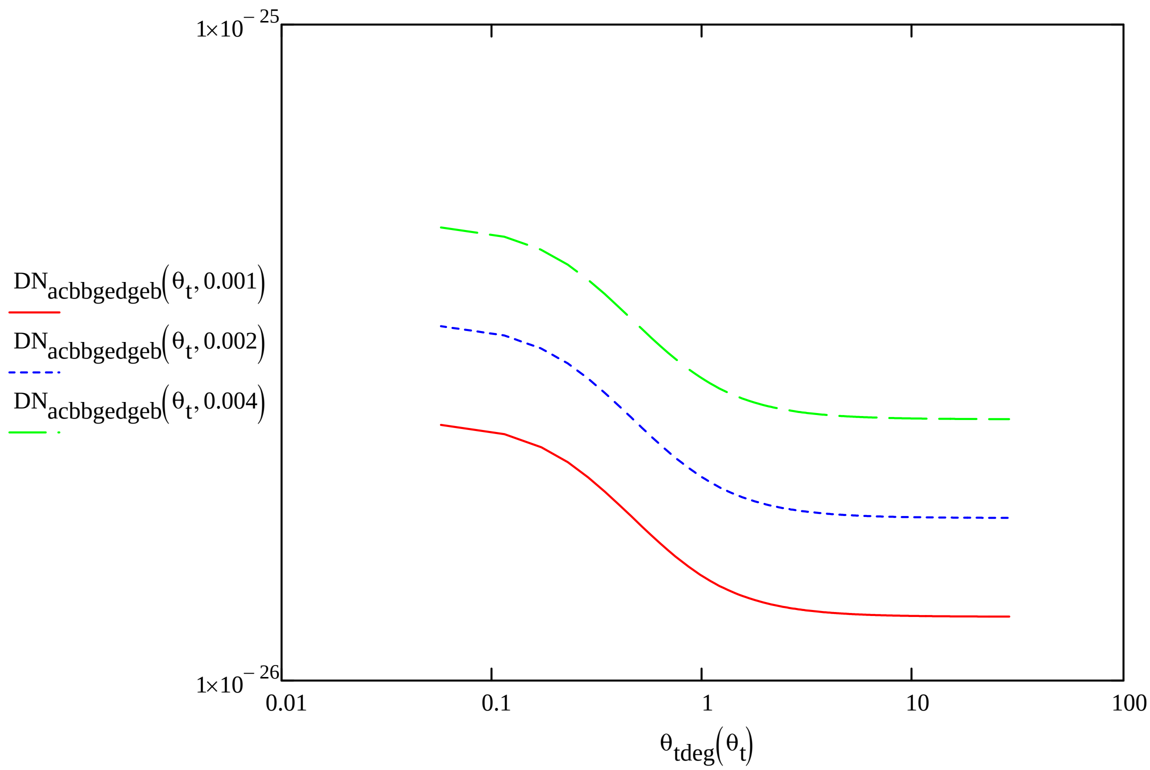
displacement noise @ 100 Hz, m/rtHz

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

$$DN_{acbbgedgeb}(\theta_t, r_{edge}) := TF_{itmhr} \cdot \left(\frac{P_{acbbgedgebsifo}(\theta_t, r_{edge})}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot 2 \cdot k$$

$$DN_{acbbgedgeb}(\theta_t, 0.001) = 1.442 \times 10^{-26}$$

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



displacement noise @ 100 Hz,
m/rtHz

Scatter function from baffle bend, black glass

$\theta_t := 0$

$$S_{bbg}(\theta_t) := \int_0^{\theta_{xymaxbend}} \left[\int_{2\cdot\theta_i(\theta_t,\theta_{xy})-\frac{w_{ifo}}{L_{arm}}}^{2\cdot\theta_i(\theta_t,\theta_{xy})+\frac{w_{ifo}}{L_{arm}}} BRDF_{bg57}(\theta_s + 2\cdot\theta_i(\theta_t,\theta_{xy}))\cdot\sqrt{w_{ifo}^2 - [L_{arm}\cdot(\theta_s - 2\cdot\theta \right.$$

$S_{bbg}(\theta_t) = 1.953 \times 10^{-15}$

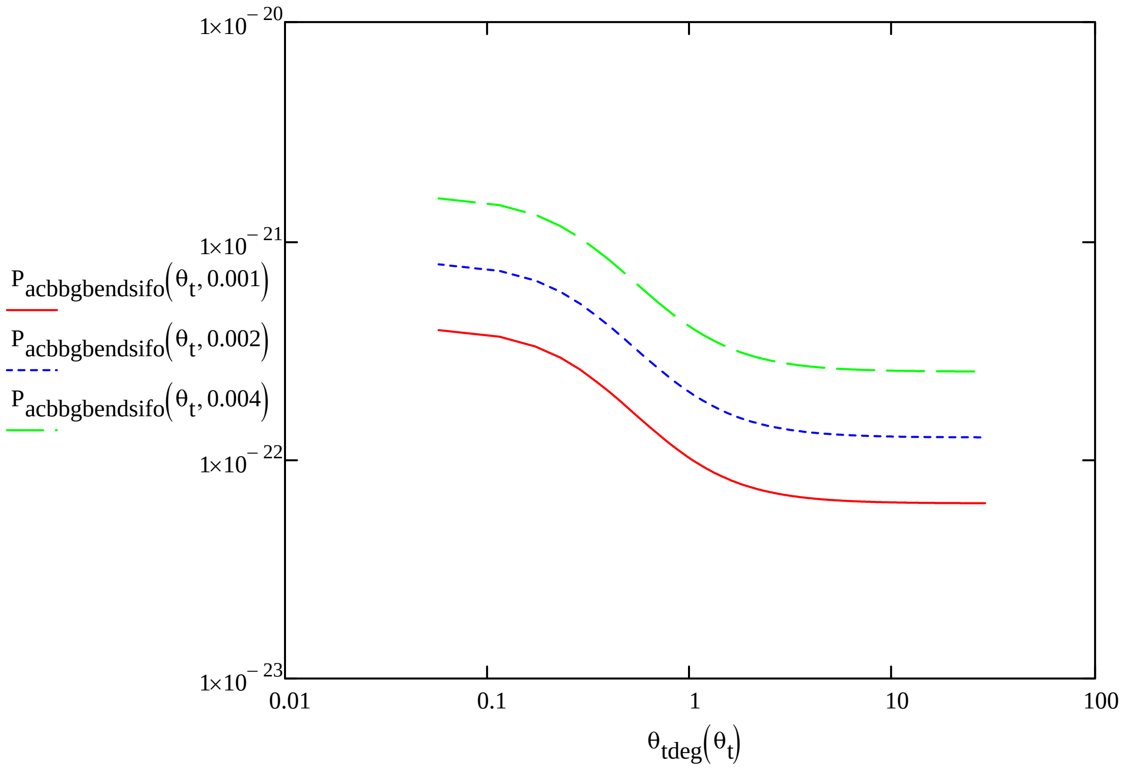
Power Scatter from baffle bend into IFO

$$P_{acbbgbendsifo}(\theta_t, r_{bend}) := 4\cdot I_i\cdot r_{bend}\cdot H_b\cdot BRDF_1(30\cdot 10^{-6})\cdot\Delta\Omega_{ifo}\cdot(S_{bbg}(\theta_t))$$

$\theta_t := 0$

$P_{acbbgbendsifo}(\theta_t, 0.001) = 4.001 \times 10^{-22}$

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



ACB displacement @ 100 HZ, m/rt HZ

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

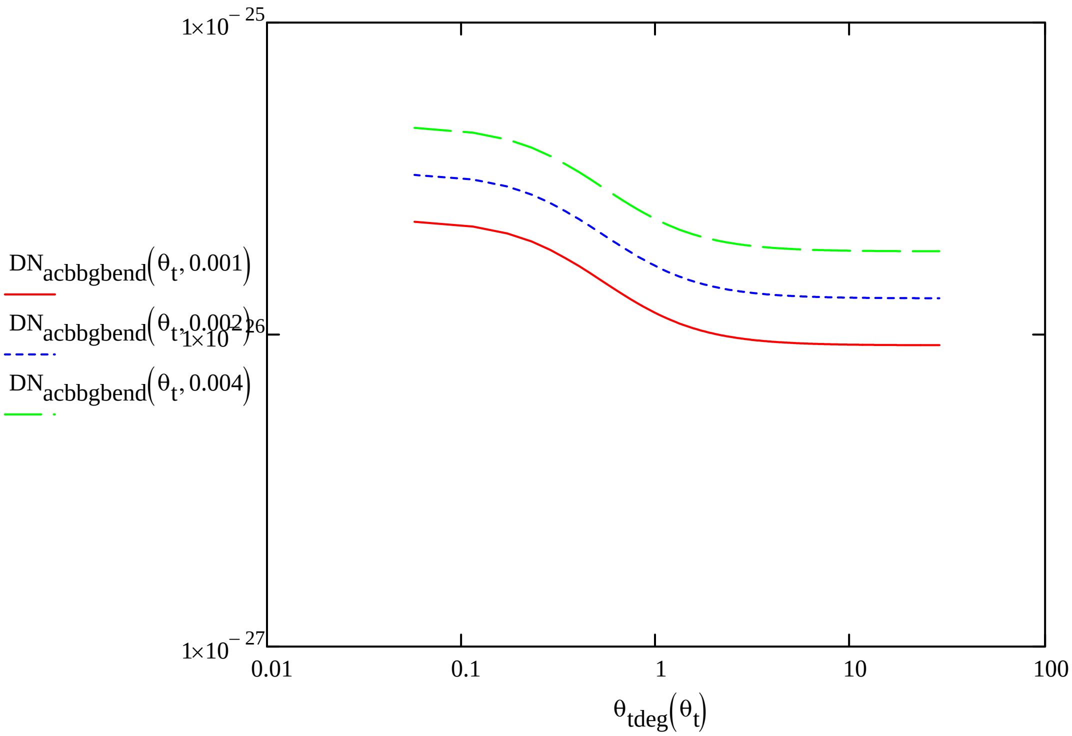
displacement noise @ 100 Hz, m/rtHz

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

$$DN_{acbbgbend}(\theta_t, r_{bend}) := TF_{itmhr} \cdot \left(\frac{P_{acbbgbendsifo}(\theta_t, r_{bend})}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot 2 \cdot k$$

$$DN_{acbbgbend}(\theta_t, 0.001) = 1.169 \times 10^{-26}$$

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



Power Scattered from the louver portion of baffle, black glass

$$P_{acbbglouvsifo} := I_i \cdot A_{ACB} \cdot BRDF_{bg57}\left(2 \cdot 57 \cdot \frac{\pi}{180}\right) \cdot \frac{w_{ifo}^{\;2}}{L_{arm}^{\;2}} \cdot BRDF_1\left(30 \cdot 10^{-6}\right) \cdot \Delta\Omega_{ifo}$$

$$P_{acbbglouvsifo} = 9.102 \times 10^{-21}$$

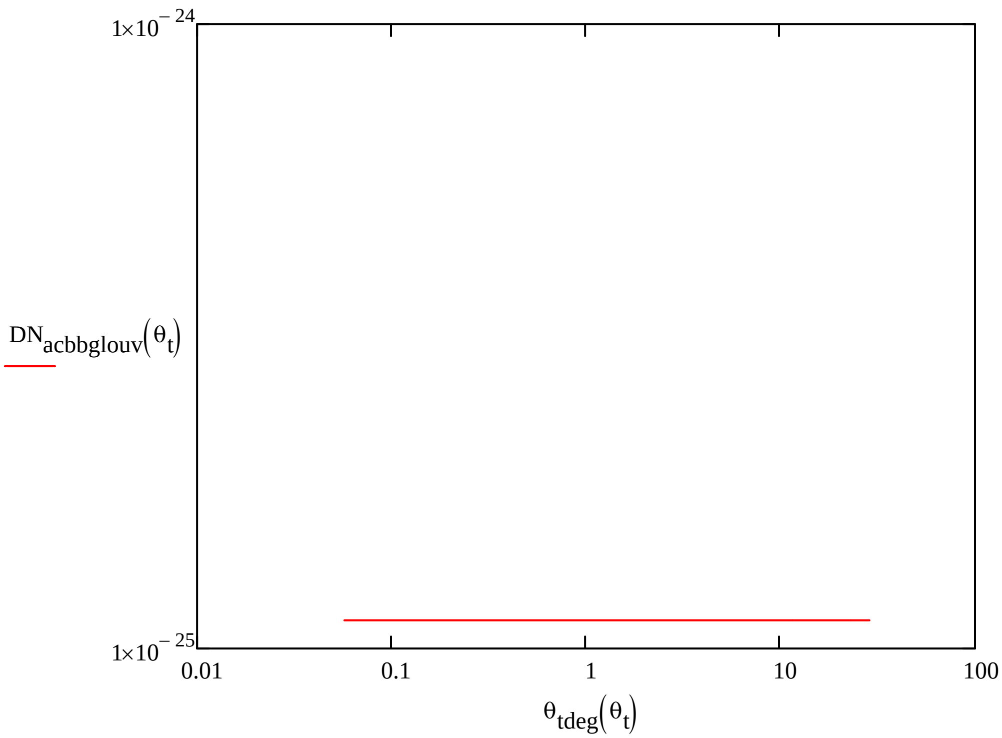
displacement noise @ 100 Hz,
m/rtHz

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

$$DN_{acbbglouv}(\theta_t) := TF_{itmhr} \cdot \left(\frac{P_{acbbglouvsifo}}{P_{psl}}\right)^{0.5} \cdot x_{ACB} \cdot 2 \cdot k$$

$$DN_{acbbglouv}(\theta_t) = 1.109 \times 10^{-25}$$

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



Total Power Scattered from the edge, bend, and louver, black glass

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

$$P_{acbbgtsifo}(\theta_t, r_{edge}, r_{bend}) := P_{acbbgedgebsifo}(\theta_t, r_{edge}) + P_{acbbgbendsifo}(\theta_t, r_{bend}) + P_{acbbglouvsifo}$$

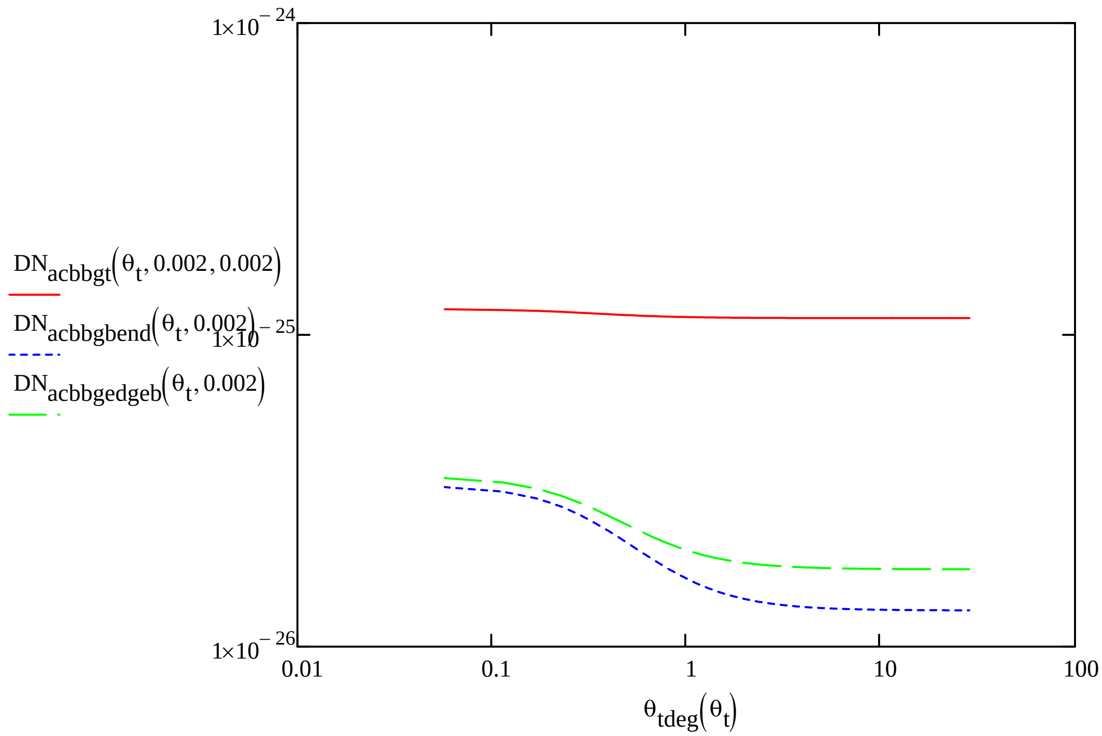
$$P_{acbbgtsifo}(\theta_t, 0.001, 0.002) = 9.459 \times 10^{-21}$$

total displacement noise @ 100 Hz,
m/rtHz

$$DN_{acbbgt}(\theta_t, r_{edge}, r_{bend}) := TF_{itmhr} \cdot \left(\frac{P_{acbbgtsifo}(\theta_t, r_{edge}, r_{bend})}{P_{psl}} \right)^{0.5} \cdot x_{ACB} \cdot 2 \cdot k$$

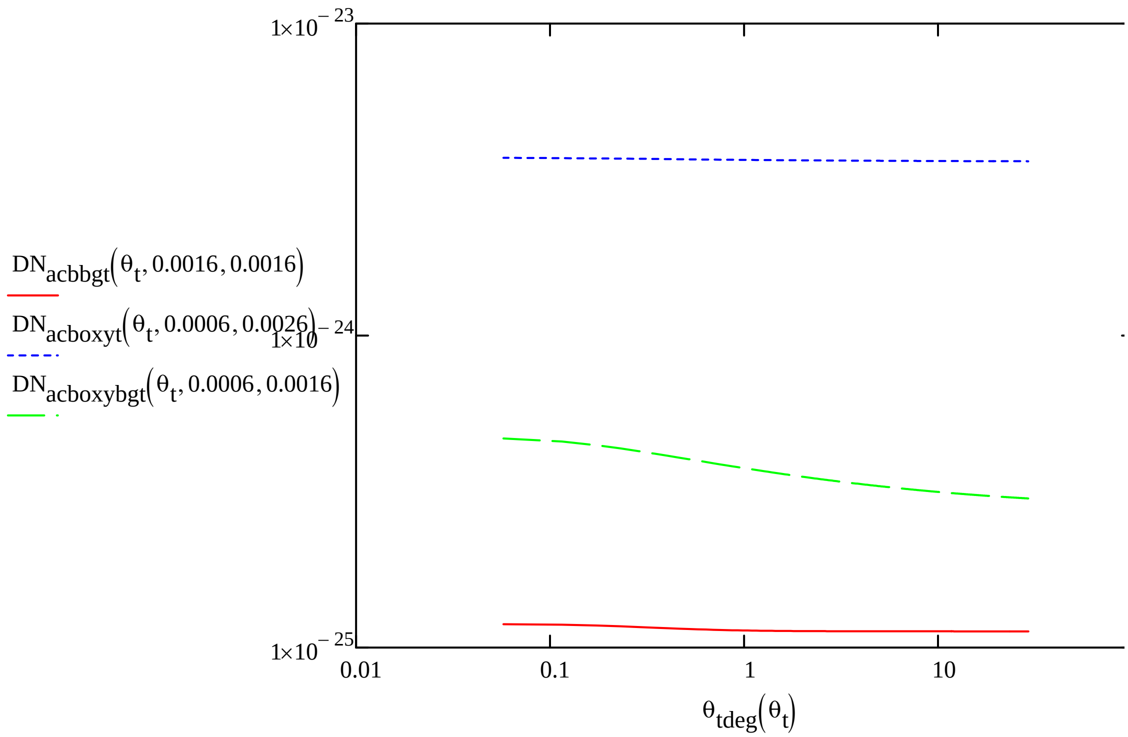
$$DN_{acbbgt}(\theta_t, r_{edge}, r_{bend}) = 1.129 \times 10^{-25}$$

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



Comparison of Baffle Materials

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



REFLECTED ACB SCATTER

reflectivity of black glass @ 57 deg $R_{bg57} := 0.001$

reflectivity of black glass @ 3 deg $R_{bg3} := 0.02$

net reflectivity of all black glass after 4 bounces $R_{bgnet4} := R_{bg57} \cdot R_{bg3}^{3}$

$R_{bgnet4} = 8 \times 10^{-9}$

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

$R_{ssnet4} := R_{ss57} \cdot R_{ss3}{}^{3}$

$R_{ssnet4} = 3.2 \times 10^{-7}$

net reflectivity of mixed black glass and ss after 4 bounces

$R_{bgssnet4} := R_{bg57} \cdot R_{ss3}{}^{2} \cdot R_{bg3}$

$R_{bgssnet4} = 8 \times 10^{-9}$

power through the cryopump baffle aperture (hits
the arm cavity baffle), W

$P_{acb} = 14.573$

Area of cryopump baf aperture, m^2

$A_{cp} = 0.464$

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

incident intensity, W/m^2

$I_i := \frac{P_{acb}}{A_{cp}} = 31.376$

area of exposed ACB, m^2

$A_{ACB} = 0.236$

power hitting ACB, W

$P_{ACB} := I_i \cdot A_{ACB}$

$P_{ACB} = 7.393$

BRDF of chamber wall

$BRDF_{wall} := 0.1$

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

$L := 4000$

Power reflected from mixed bg baffle, W

$P_{acbbgrefl} := R_{bgnet4} \cdot P_{ACB}$

$$P_{acbbgrefl} = 5.914 \times 10^{-8}$$

Power scattered into IFO mode from ACBporc, W

$$P_{acbporcrefls} := \sqrt{4} \cdot P_{acbbgrefl} \cdot R_{bgnet4} \cdot BRDF_{wall} \cdot \frac{\pi \cdot w_{ifo}^{2}}{L^{2}} \cdot BRDF_{1}\left(30 \cdot 10^{-6}\right) \cdot \Delta_{ifo}$$

$$P_{acbporcrefls} = 9.93 \times 10^{-33}$$

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

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

displacement noise @ 100 Hz, m/rtHz

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

$$DN_{acbporcrefl} = 2.316 \times 10^{-30}$$

Power reflected from ss baffle, W

$$P_{acbsscrefl} := R_{ssnet4} \cdot P_{ACB}$$

$$P_{acbsscrefl} = 2.366 \times 10^{-6}$$

Power scattered into IFO mode from ACBss, W

$$P_{acbssrefls} := \sqrt{4} \cdot P_{acbsscrefl} \cdot R_{ssnet4} \cdot BRDF_{wall} \cdot \frac{\pi \cdot w_{ifo}^{2}}{L^{2}} \cdot BRDF_{1}\left(30 \cdot 10^{-6}\right) \cdot \Delta_{ifo}$$

$$P_{acbssrefls} = 1.589 \times 10^{-29}$$

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

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

displacement noise @ 100 Hz,
m/rtHz

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

$$DN_{acbssrefl} = 9.263 \times 10^{-29}$$

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

)

)

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

ifo

38

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

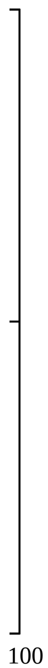
)

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

sifo

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

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