The strain is computed in the GDS pipeline as the sum of three components (as the actuation is split into the tst stage and the pum/uim stage). We wish to consider the strain at the DARM line frequency, 37.3 Hz:

$$\begin{aligned}\Delta L_{free} &= \frac{1}{\kappa_c}\Delta L_{res} + \kappa_{tst}\Delta L_{tst} + \kappa_{pu}\Delta L_{pu} \\ &= \frac{1}{\kappa_c}A_{res}cos(\omega_{darm}t - \phi_{res}) + \kappa_{tst}A_{tst}cos(\omega_{darm}t - \phi_{tst}) \\ &\qquad + \kappa_{pu}A_{pu}cos(\omega_{darm}t - \phi_{pu}) + n(t).\end{aligned}$$

In order to find the relative magnitude and phase of this line in the residual, tst, and pum/uim portions of the strain, we can demodulate each of these separately *before* they are added to produce the strain and compare them to one another:

$$\begin{aligned}Demod(\Delta L_{res}) &= lowpass[e^{-i\omega_{darm}t} * \Delta L_{res}] \\ &= A_{res}lowpass[e^{-i\omega_{darm}t} * \frac{1}{2} * (e^{-i\phi_{res}}e^{i\omega_{darm}t} + e^{i\phi_{res}}e^{-i\omega_{darm}t})] \\ &\qquad + lowpass[e^{-i\omega_{darm}t} * n(t)] \\ &= \frac{1}{2}A_{res}e^{-i\phi_{res}} \\ Demod(\Delta L_{tst}) &= \frac{1}{2}A_{tst}e^{-i\phi_{tst}} \\ Demod(\Delta L_{pu}) &= \frac{1}{2}A_{pu}e^{-i\phi_{pu}}\end{aligned}$$

I added code to the GDS pipeline to compute these values (without kappas applied) and write them to file around GPS time 1167765312 (attached plots were made using data from this time), yielding these results:

$$\begin{aligned}\frac{Demod(\Delta L_{res})}{Demod(\Delta L_{tst})} &= \frac{A_{res}}{A_{tst}}e^{i(\phi_{tst}-\phi_{res})} = -0.725 + 0.550i = 0.910e^{i(143^o)} \\ \frac{Demod(\Delta L_{pu})}{Demod(\Delta L_{tst})} &= \frac{A_{pu}}{A_{tst}}e^{i(\phi_{tst}-\phi_{pu})} = -0.31403 - 0.51367i = 0.60206e^{i(238.56^o)} \\ \frac{Demod(\Delta L_{res})}{Demod(\Delta L_{pu})} &= \frac{A_{res}}{A_{pu}}e^{i(\phi_{pu}-\phi_{res})} = -0.150 - 1.505i = 1.512e^{i(264.3^o)}\end{aligned}$$

Just for a sanity check:

$$\begin{aligned}\frac{Demod(\Delta L_{res})}{Demod(\Delta L_{tst})} / \frac{Demod(\Delta L_{pu})}{Demod(\Delta L_{tst})} &= \frac{0.910}{0.60206}e^{i(143^o - 238.56^o)} \\ &= 1.511e^{i(264.44^o)} \approx \frac{Demod(\Delta L_{res})}{Demod(\Delta L_{pu})}\end{aligned}$$

Now we compute the effect of applying the κ's on the line height of the DARM line. Letting $\phi_{res} = 0$:

$$\begin{aligned}
\Delta L_{free} &= A_{tst}[\frac{0.910}{\kappa_c} cos(\omega_{darm} t) + \kappa_{tst} cos(\omega_{darm} t - 143^o) \\
&\quad + 0.60206\kappa_{pu} cos(\omega_{darm} t - 264.3^o)] + n(t) \\
&= A_{tst}[(\frac{0.910}{\kappa_c} + \kappa_{tst} cos(143^o) + 0.60206\kappa_{pu} cos(264.3^o)) cos(\omega_{darm} t) \\
&\quad + (\kappa_{tst} sin(143^o) + 0.60206\kappa_{pu} sin(264.3^o)) sin(\omega_{darm} t)] + n(t) \\
&= A cos(\omega_{darm} t - \phi),
\end{aligned}$$

where

$$A = A_{tst}\sqrt{\left(\frac{0.910}{\kappa_c} - 0.7986\kappa_{tst} - 0.0598\kappa_{pu}\right)^2 + (0.6018\kappa_{tst} - 0.59908\kappa_{pu})^2},$$

and we will not bother to compute ϕ. Now, let us consider the case where $\kappa_c = 1.0558, \kappa_{tst} = 0.9946$, and $\kappa_{pu} = 0.9966$, the constant values that were applied to produce the attached plots. This yields $A = 0.158A_0$, where A_0 is the value of A when all the κ's are zero. As a second comparison, I also computed the ratio of the strain demodulated at the DARM line frequency with and without κ's applied. This resulted in:

$$\frac{Demod(h_\kappa(t))}{Demod(h_0(t))} = 0.22,$$

agreeing quite well with the ASD ratio plot (not surprisingly), and also fairly close to the value obtained above.