Script to compute transfer functions from GMT pier base forces to segment tip-tilt and piston

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Preamble

Radians to mili arc second conversion constant

Root of the sum of squared values function

Set telescope structural dynamics damping

Load Integrated Model subsystems

Structural model folder

Load telescope structural model

```
Loading modal model parameters from
/Users/rromano/Workspace/gmt-data/20220308_1335_MT_mount_zen_30_m1HFN_FSM_B/modal_state_space_model_2ndOrd
The model maximum eigenfrequency is 99.99385Hz

Static solution gain matrix loaded successfully from variable:
gainMatrixMountControlled
```

Load optical sensitivity matrices

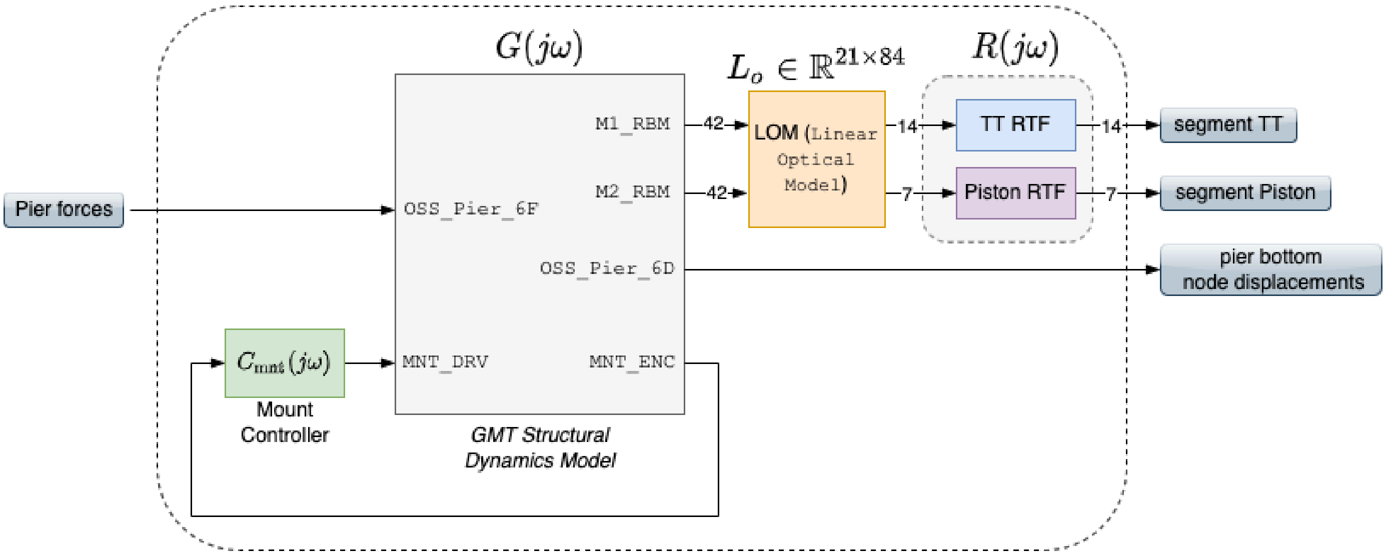
```
TT sensitivity matrix loaded from
/Users/rromano/Workspace/gmt-data/LOM-data/lom_tt_dt.mat

Piston sensitivity matrix loaded from
/Users/rromano/Workspace/gmt-data/LOM-data/D_seg_piston_dt.mat

WFE sensitivity matrix loaded from
/Users/rromano/Workspace/gmt-data/LOM-data/rbm2wfe.mat
```

Extract subsystem with relevant IOs

Subsystem with pier displacement outputs

Load MNT local controller

Compute frequency responses (FRs)



Structural plant frequency response model

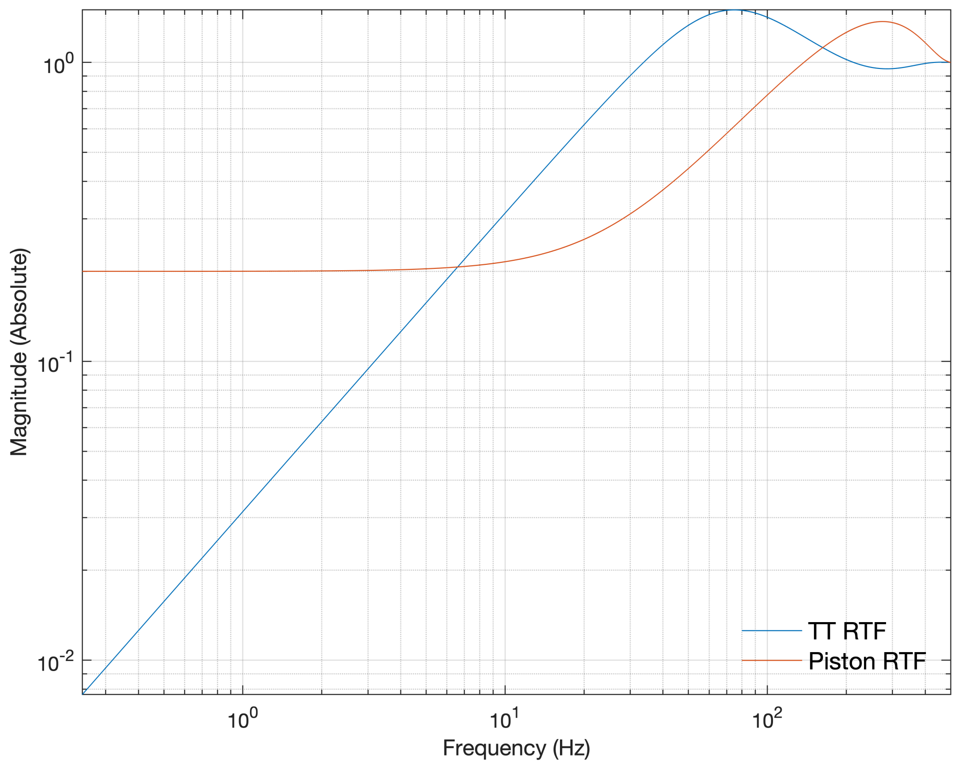
MNT Controller + drives FR models

Compute telescope FRF matrix considering the mount feedback control

Transfer function representing the effect of pier forces on the bottom pier displacements

Compute NS or LTAO RTFs for a particular frequency

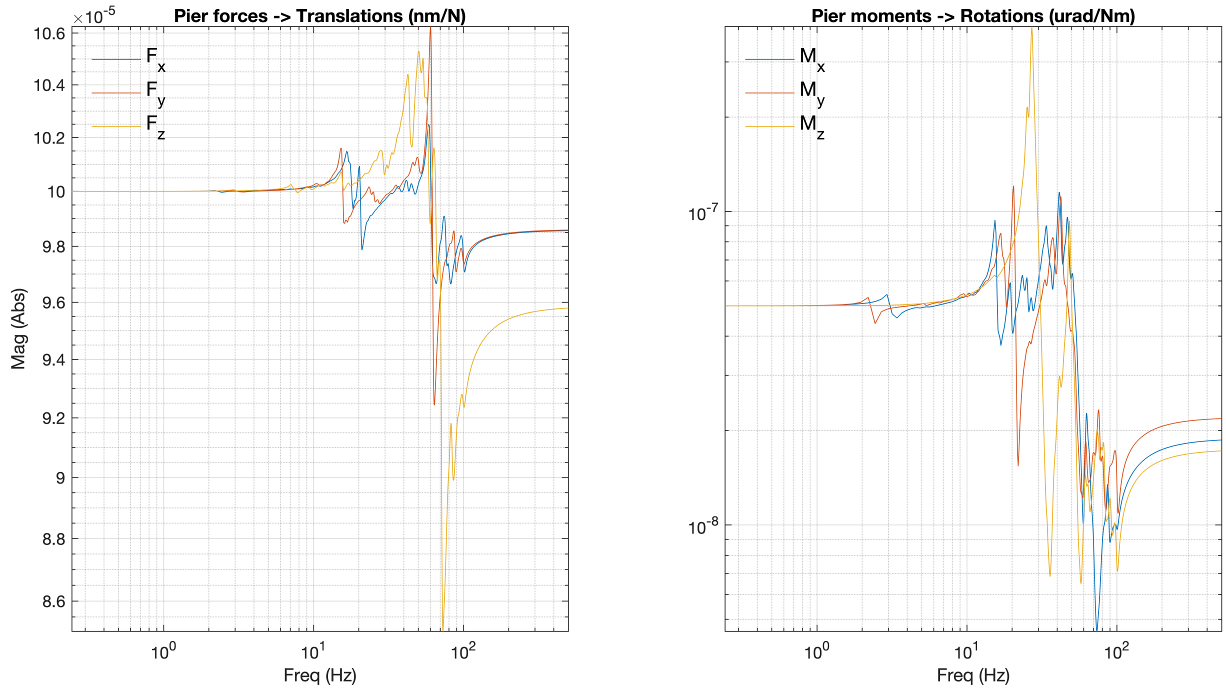
The variable `rtf` is a 21×21 matrix transfer function. The NS or LTAO (depending on the argument state of `NS_MODE`) tip-tilt rejection transfer function (RTF) fills the first 14 main diagonal entries. The differential piston RTF fills the last 7 diagonal elements if the checkbox is unchecked, meaning that one assumes the LTAO observing mode. Otherwise, those diagonals are filled with 1s. The rejection transfer function matrix aims at reproducing the effect of the wavefront control loops.



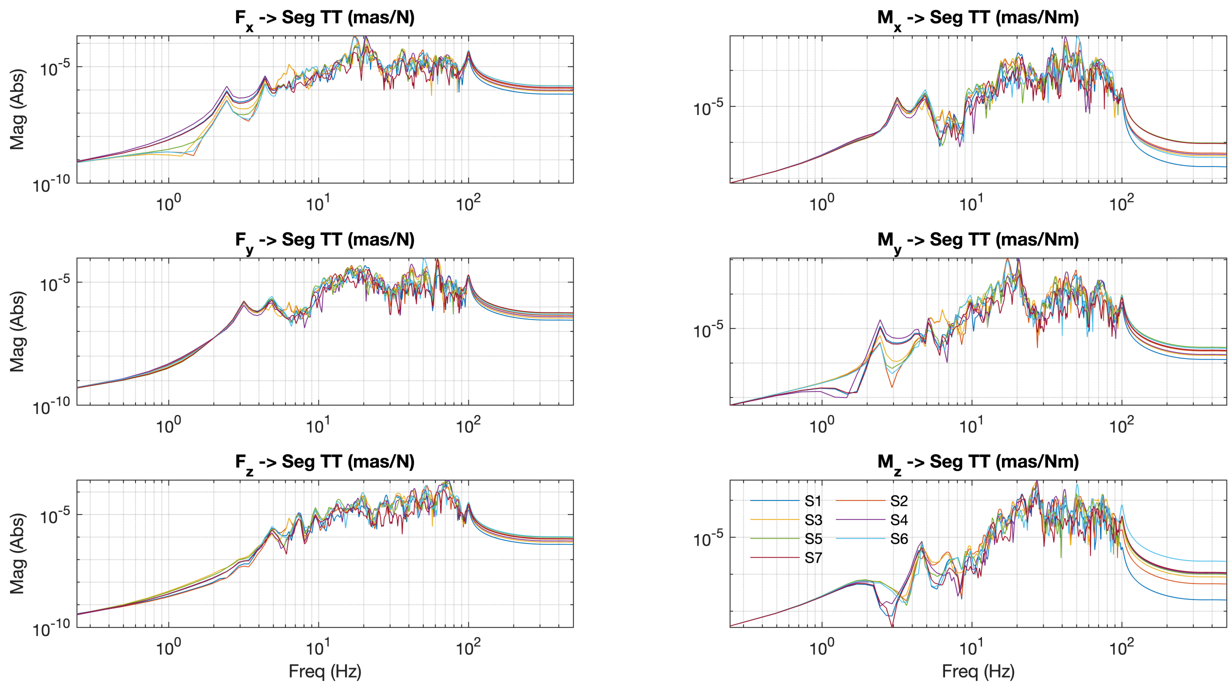
Apply rejection transfer functions

Evaluate vibration TF frequency responses

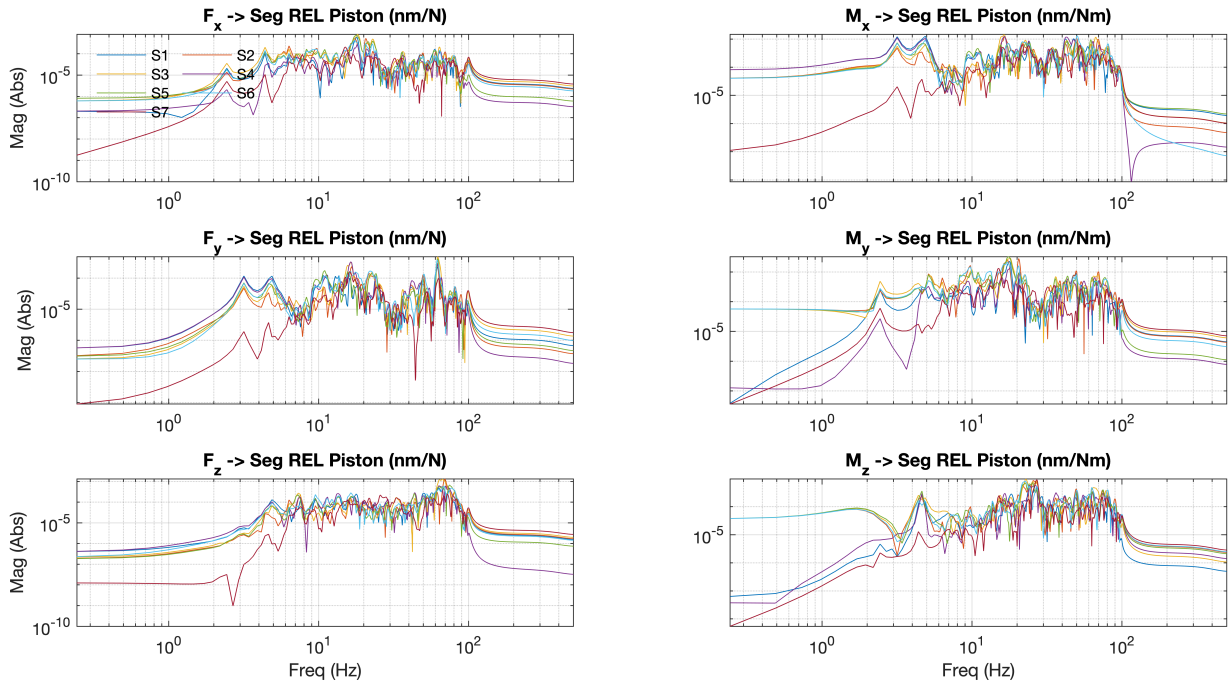
Pier forces to displacements



Segment TT



Segment Piston



White-noise wavefront error (WFE) responses

Let $Y_{\mathrm{tt}}(j\omega) = H_{\mathrm{tt}}(j\omega)U_{\mathrm{pier}}(j\omega)$ the 14-dimensional vector of segment tip-tilt. Similarly, $Y_{\mathrm{piston}}(j\omega) = H_{\mathrm{piston}}(j\omega)U_{\mathrm{pier}}(j\omega)$ denotes the 7-dimensional vector segment piston response to a particular input $U_{\mathrm{pier}}(j\omega)$. One can approximate the wavefront error***** induced by $U_{\mathrm{pier}}(j\omega)$ as

$$Y_{\mathrm{wf}}(j\omega) = \sqrt{\left(\rho \breve{Y}_{\mathrm{tt}}(j\omega)\right)^2 + \left(\breve{Y}_{\mathrm{piston}}(j\omega)\right)^2},$$

with $\rho = 10.2\,\frac{\mathrm{nm}}{\mathrm{mas}}$,

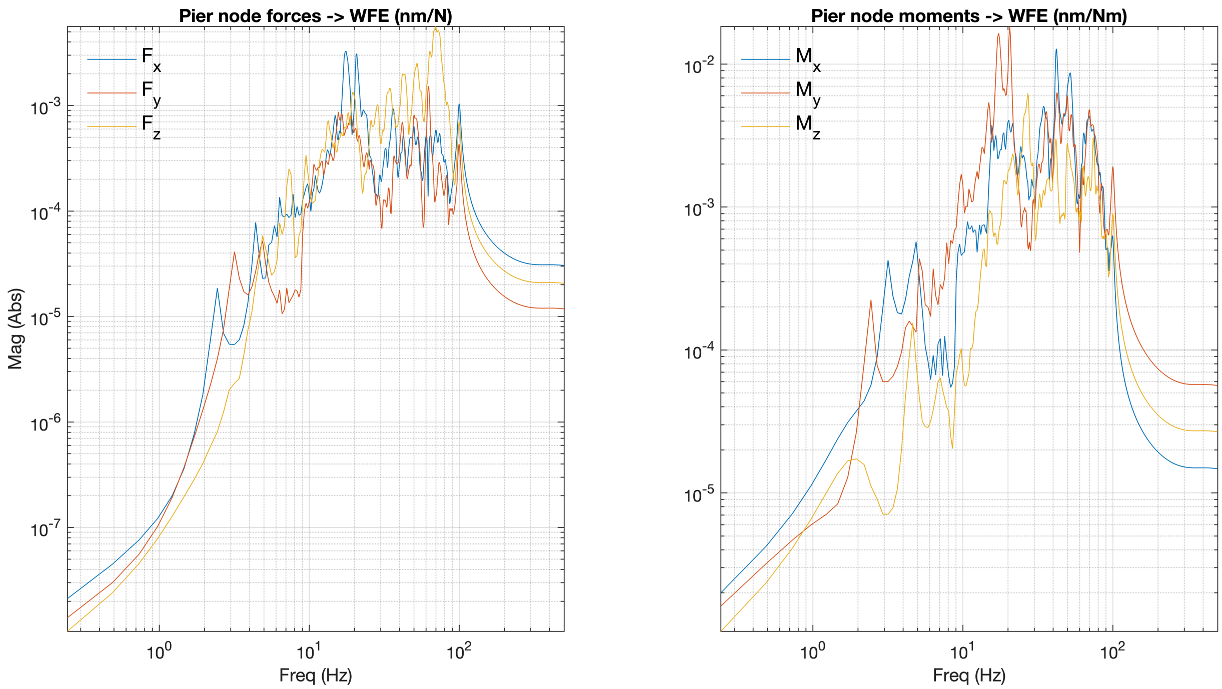
$$\breve{Y}_{\mathrm{tt}}(j\omega) = \sqrt{\frac{1}{7}\sum_{i=1}^{7} (Y_{\mathrm{tt},i}(j\omega))^2 + (Y_{\mathrm{tt},i+7}(j\omega))^2}$$

and

$$\breve{Y}_{\mathrm{piston}}(j\omega) = \sqrt{\frac{1}{7}\sum_{i=1}^{7}\left(Y_{\mathrm{piston},i}(j\omega) - \frac{1}{7}\sum_{i=1}^{7} Y_{\mathrm{piston},i}(j\omega)\right)^2},$$

where $Y_{\mathrm{tt},i}(j\omega)$ and $Y_{\mathrm{piston},i}(j\omega)$ denote the i^{th}-element of $Y_{\mathrm{tt}}(j\omega)$ and $Y_{\mathrm{piston}}(j\omega)$, respectively.

In the following, we present the white-noise response $Y_{\mathrm{wf}}(j\omega)$.



Auxiliar functions providing the NS/LTAO RTFs (Rejection Transfer Functions)

Function to compute the NS RTF (according to REQ-L3-OAD-35337)

Function to compute the GLAO RTF (according to REQ-L3-OAD-35398)

Function to compute the differential piston RTF