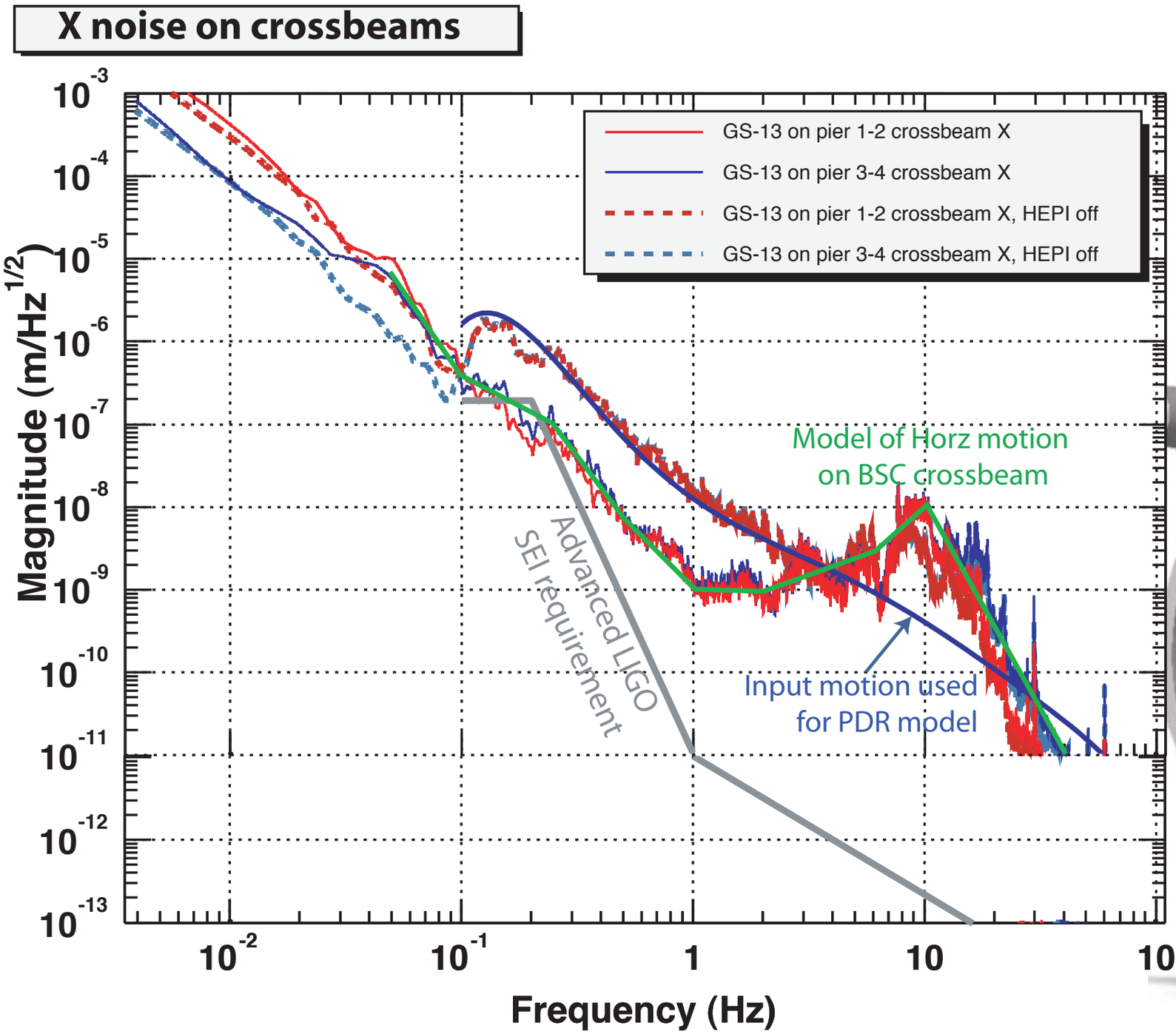
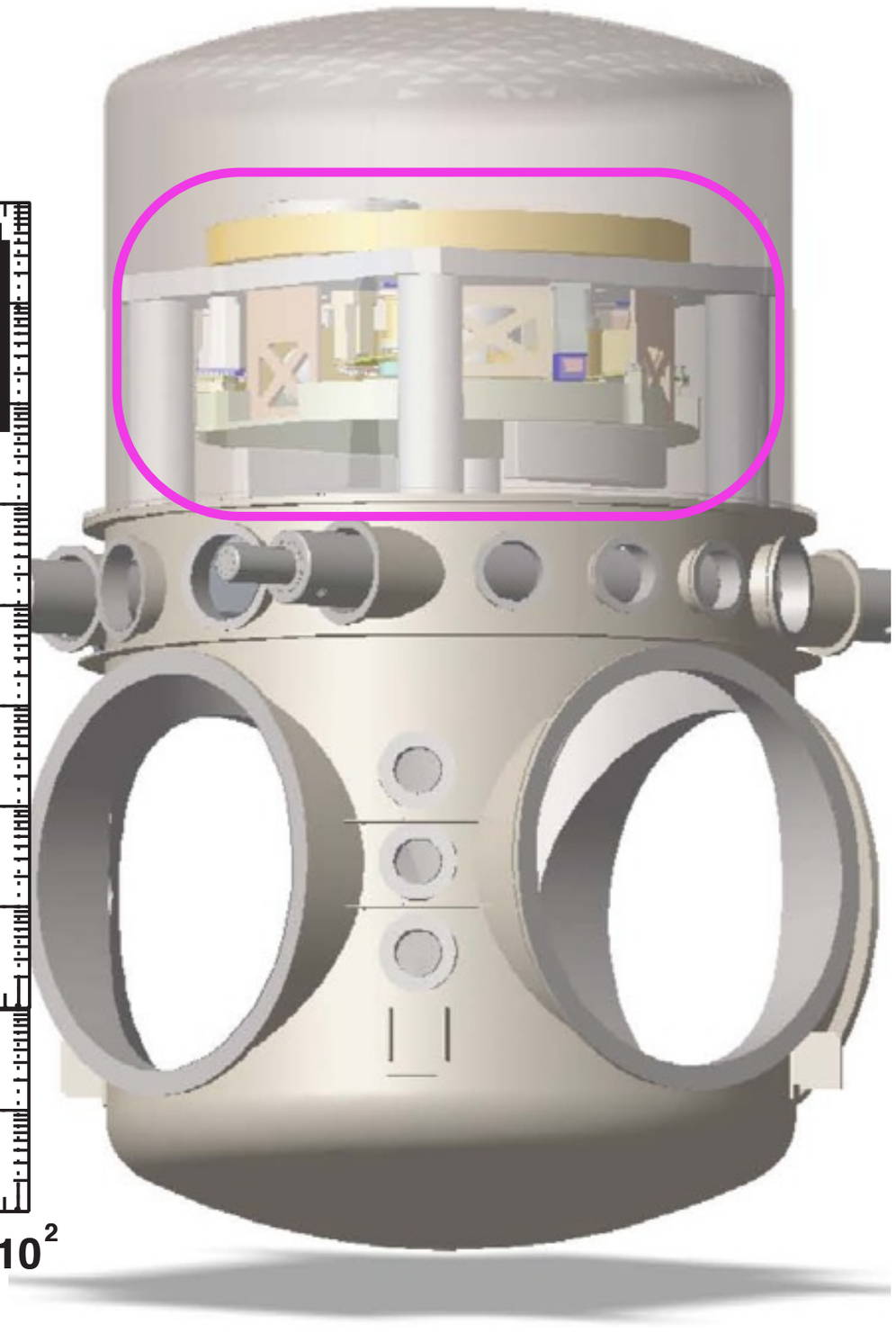
Progress on the Advanced LIGO Seismic Isolation and Alignment System

Presented by Brian Lantz
for the Advanced LIGO SEI team
LSC meeting, Aug. 17, 2005

BSC System for Advanced LIGO





original plot from J. Giaime

CAD drawing from ASI

Overview

Progress towards a successful BSC for Advanced LIGO

3 pieces of news from the ETF Tech Demo
- 1 Hz isolation factor of 100 has been shown
- 1 Hz performance requires improved sensor electronics
- 10 Hz performance limited by tilt & bandwidth

1 piece of news from LASTI
- 10 Hz pier amplification persists

ASI implementing design changes to improve 10 Hz isolation
- will give good performance for Advanced LIGO

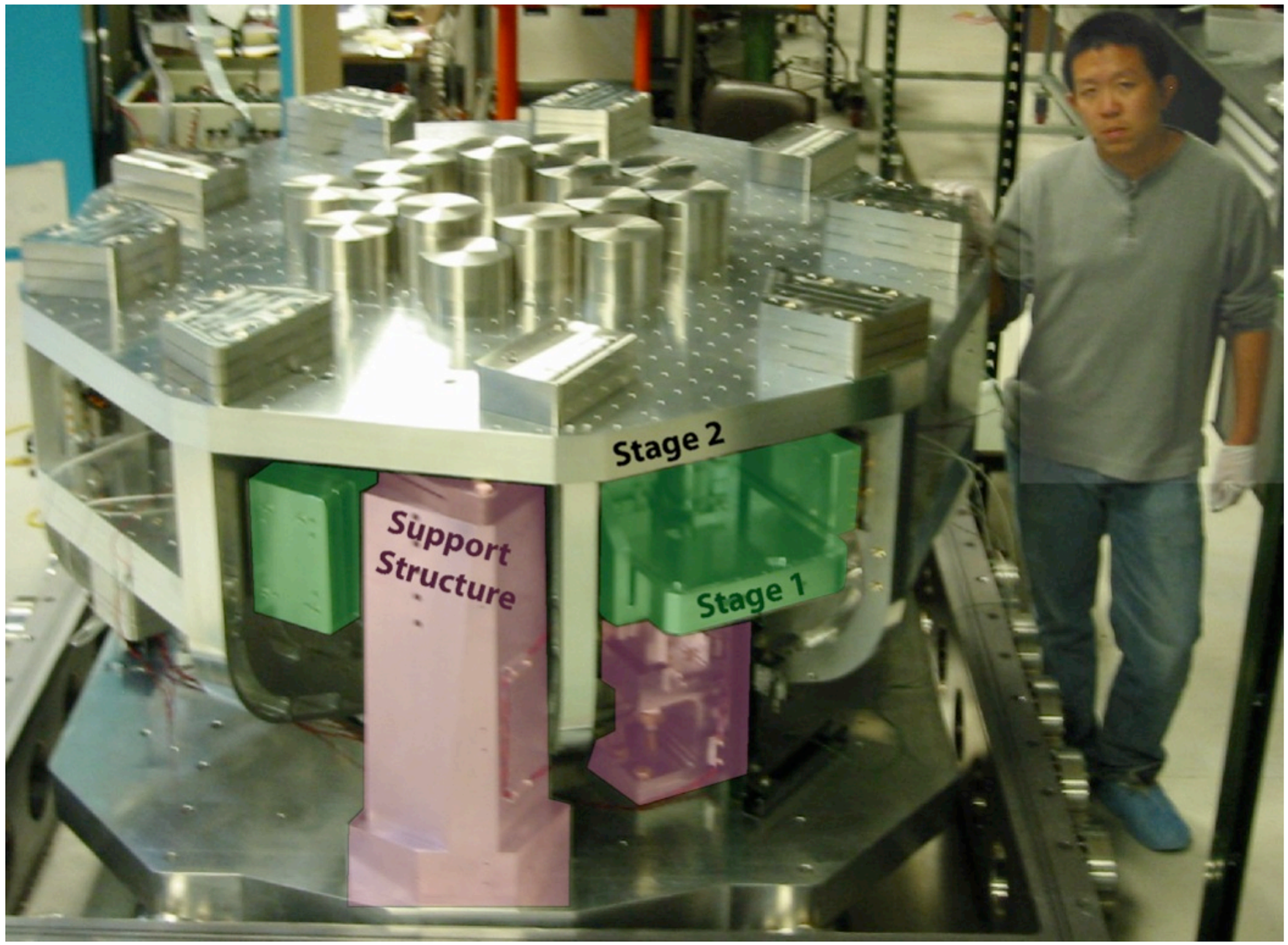
ETF Technology Demonstrator

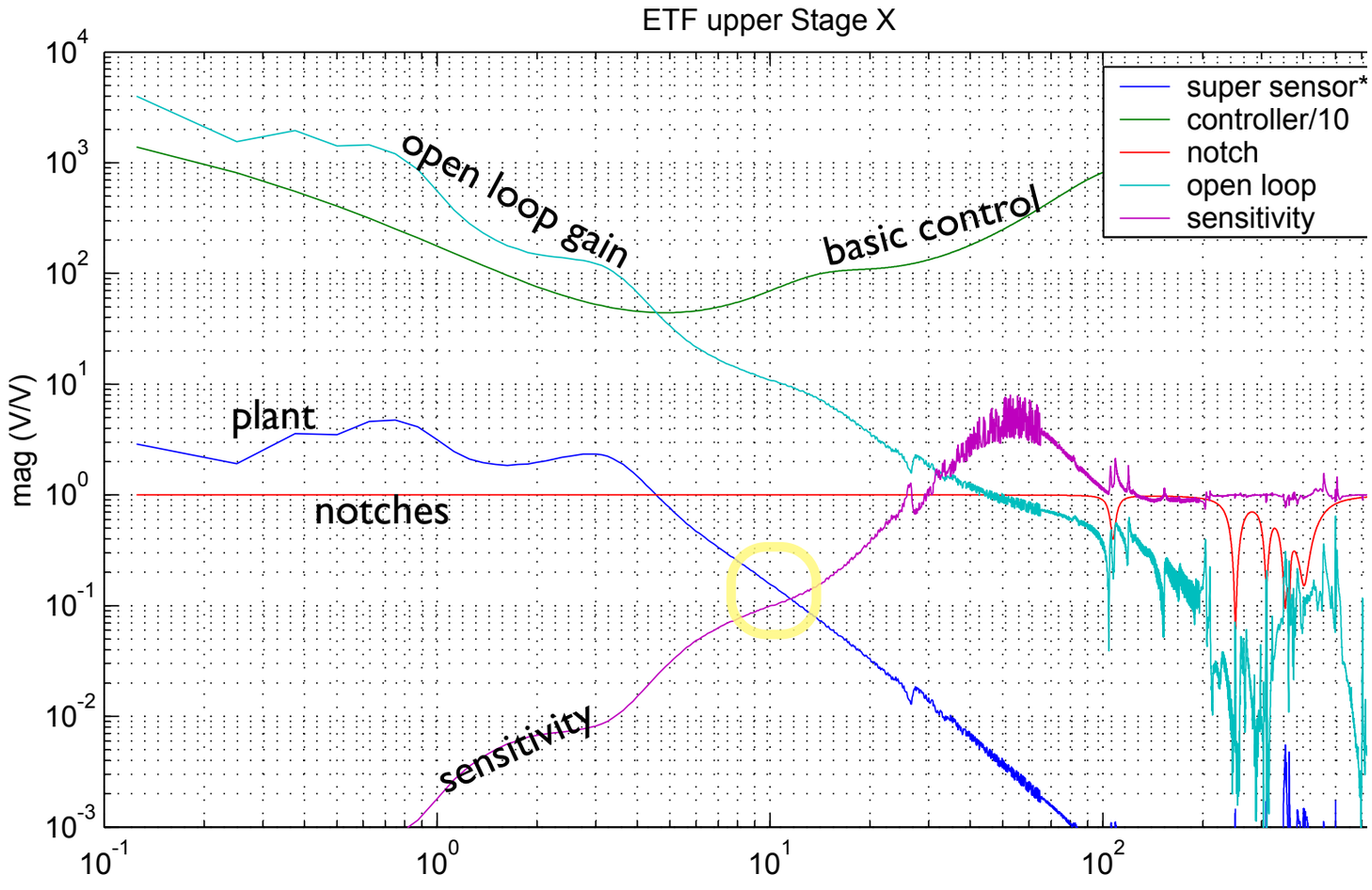
2 stage isolation and alignment system.

Each stage aligned and isolated in 6 DOF.

Passive isolation above 1 Hz horz, 3 Hz vert

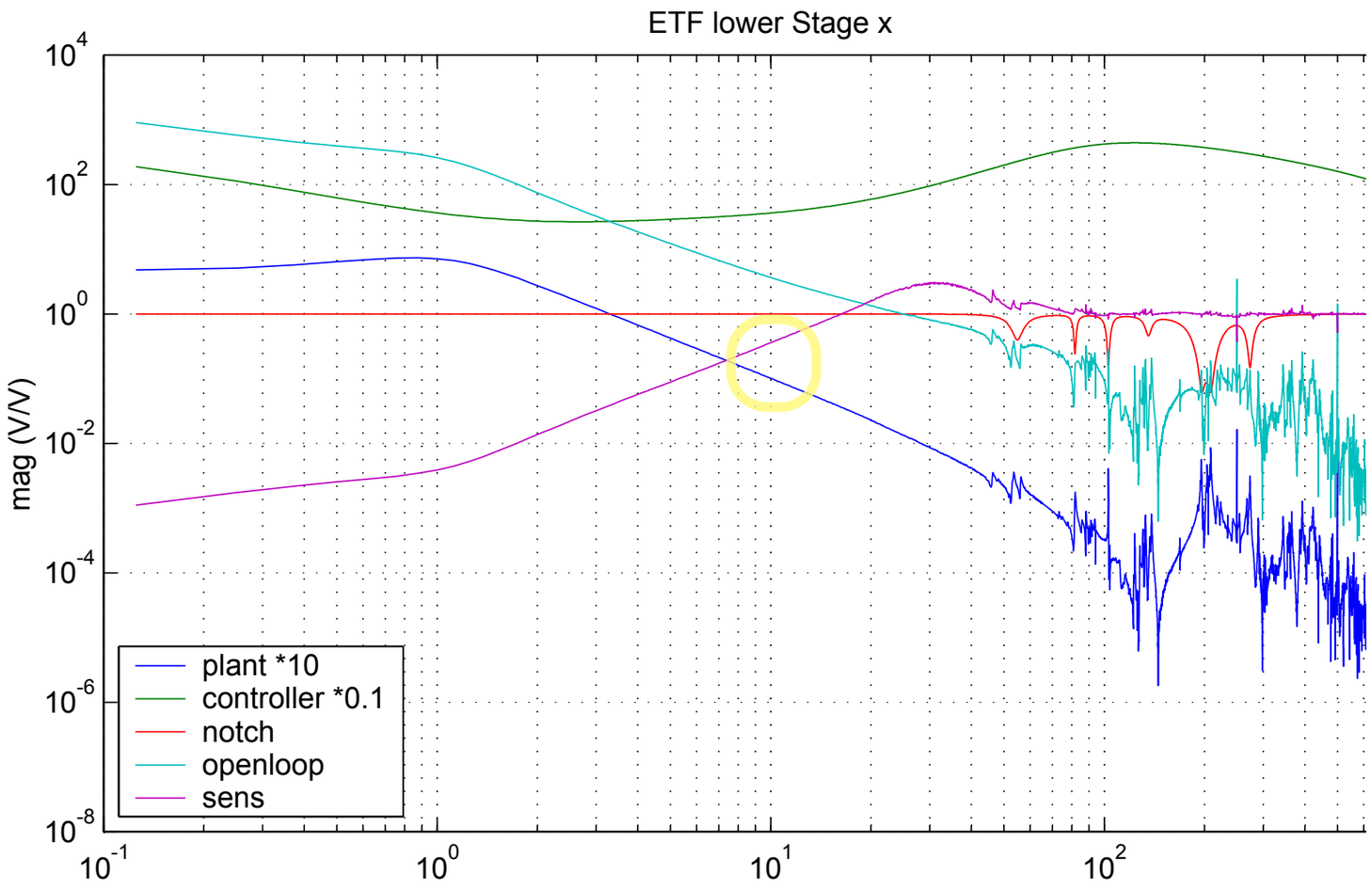
Active isolation below 30 Hz





ETF: X Control

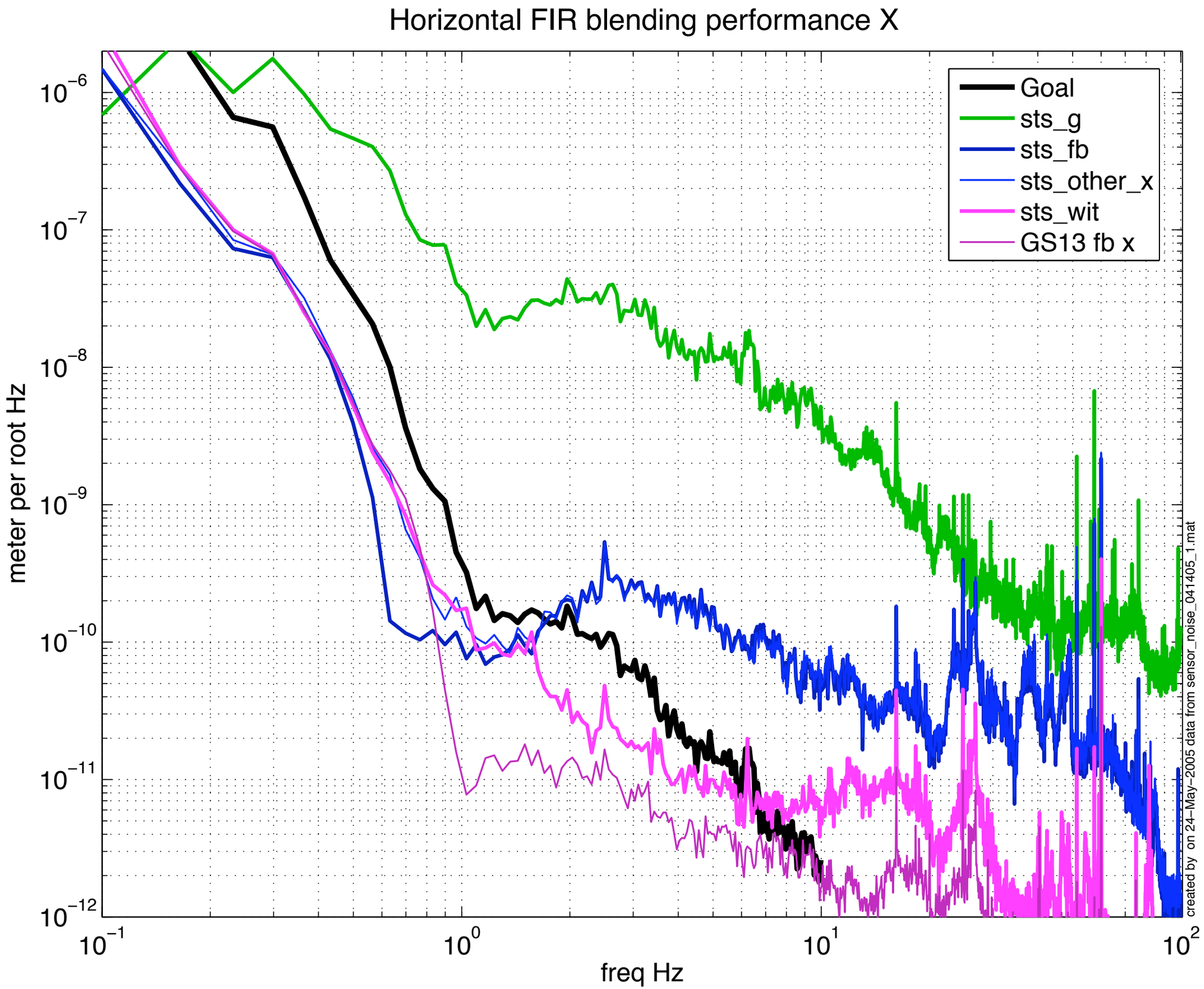
10 Hz predicted performance:
-Plant gives ~20
-Upper unity gain freq is ~ 45 Hz
Constrained by plant resonances
gives x10 improvement at 10 Hz



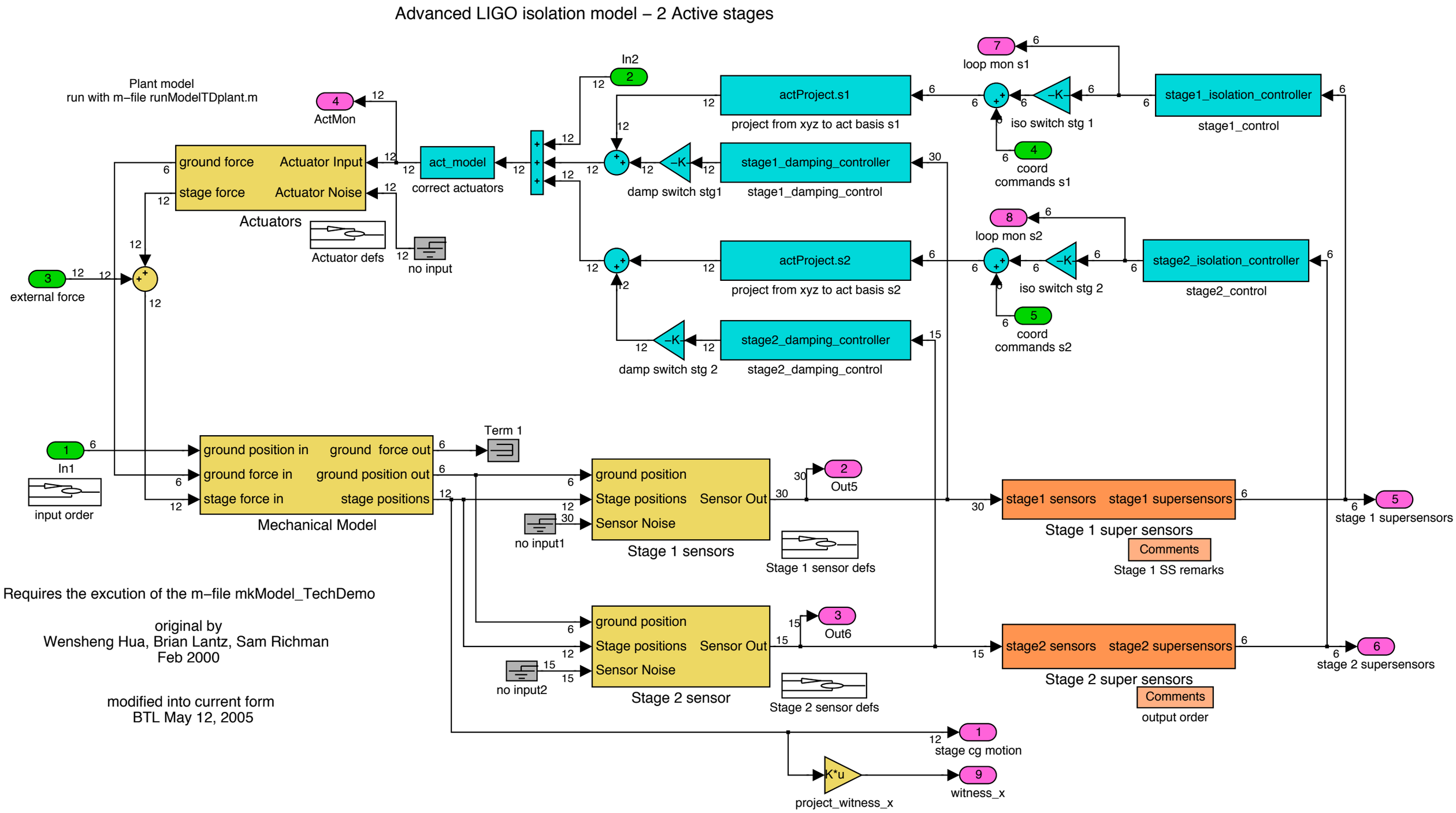
10 Hz predicted performance:
-Plant gives ~50
-Upper unity gain freq is ~ 30 Hz
Constrained by plant resonances
gives x3 improvement at 10 Hz

~20 x 50 x 10 x 3 = ~30,000

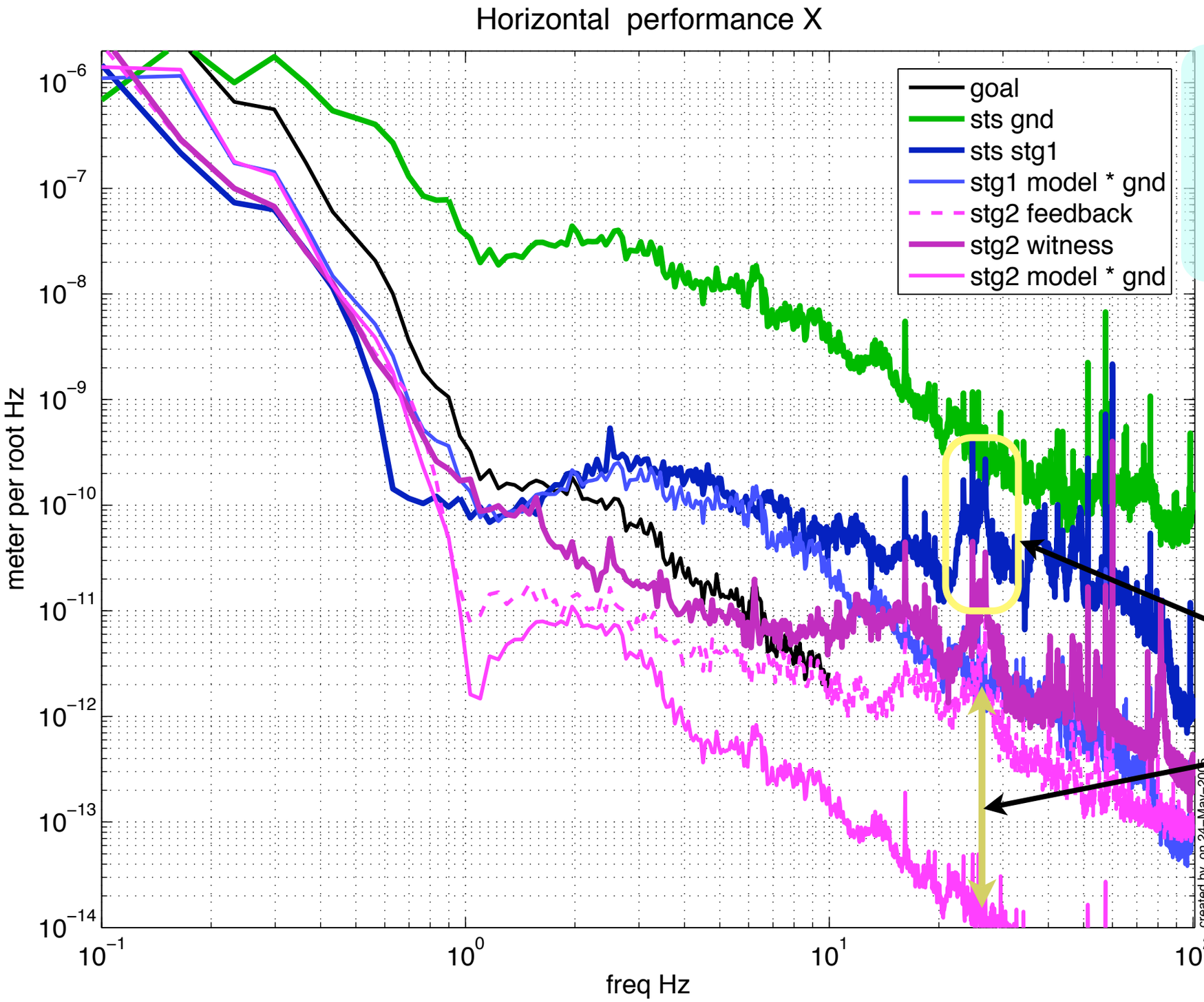
ETF: X Performance



Model of the Tech Demo



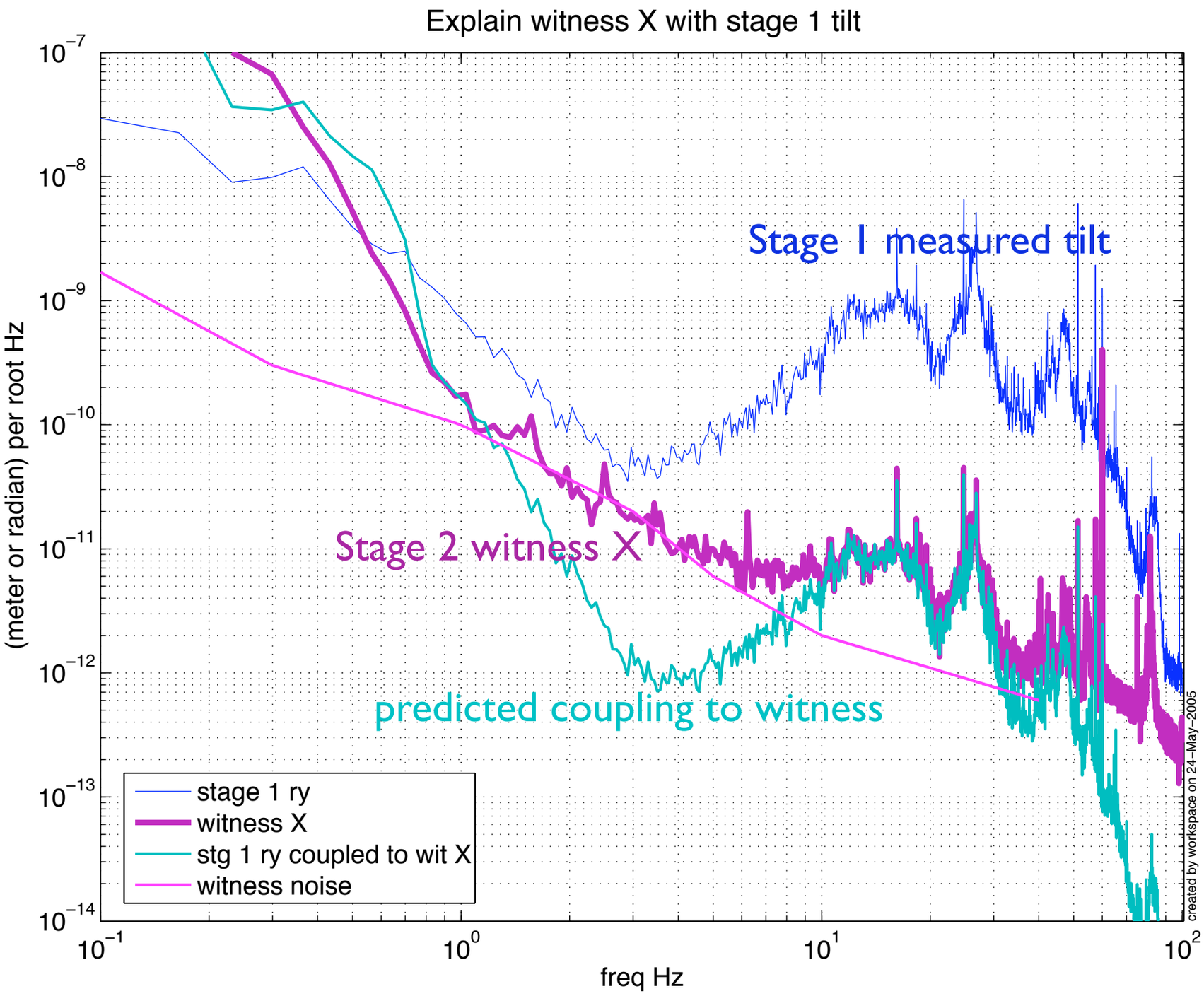
ETF: X Performance vs. model



X motion of witness is **not** caused by X motion of ground

Where's my isolation factor? get ~6, expect ~100

ETF: Tilt coupling

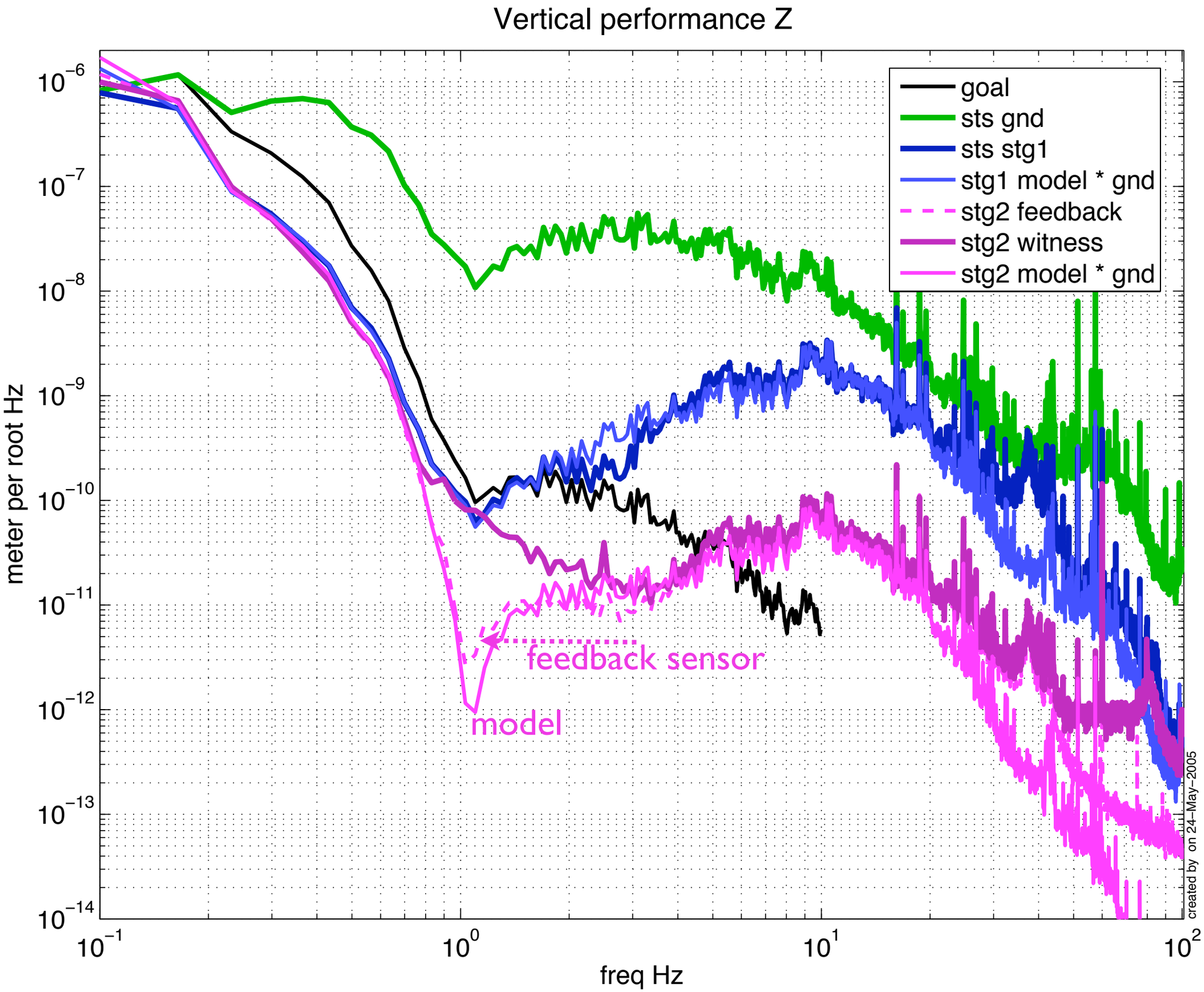


Stage 2 horizontal motion result of tilt coupling.

- so -

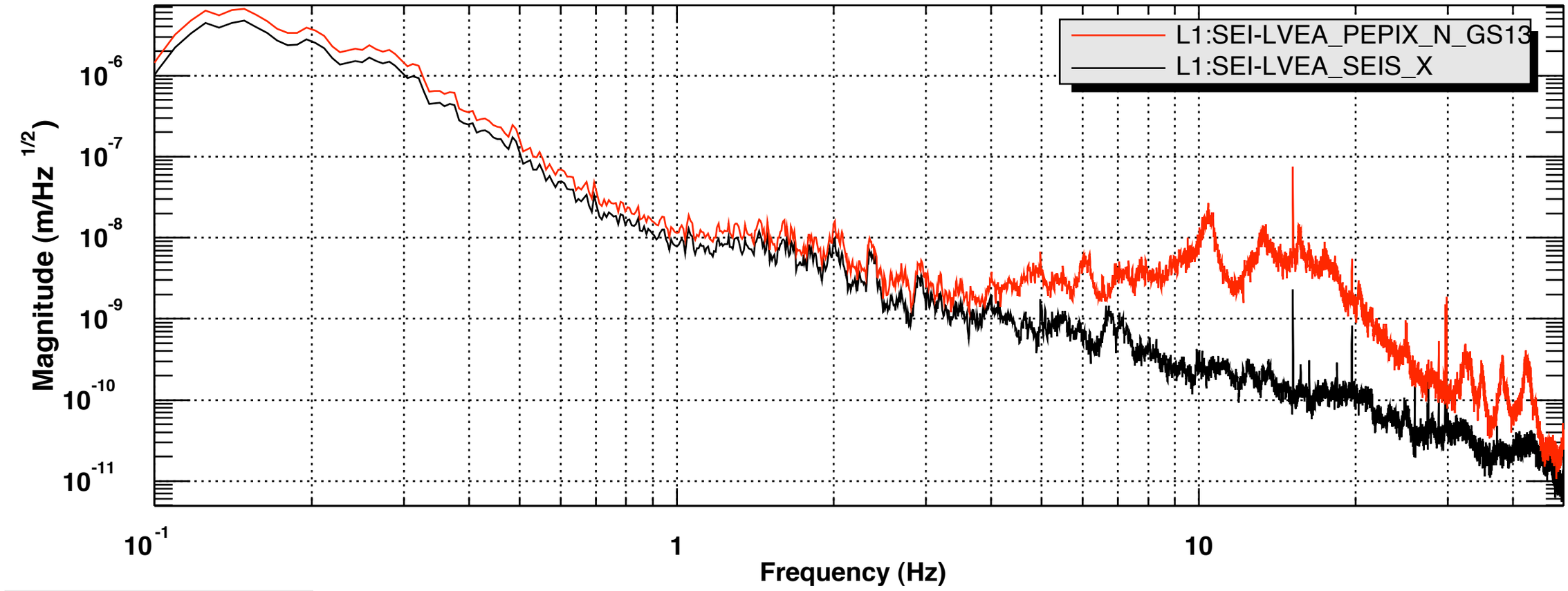
To get better horizontal performance, improve (differential) vertical isolation

ETF:Vertical Performance



LASTI: 10 Hz pier amplification

At 10 Hz, LIGO crossbeams move more than ground.



Rich Mittleman leading work at LASTI to study pier.

- is it from the stack?
- what will it look like for Ad LIGO?

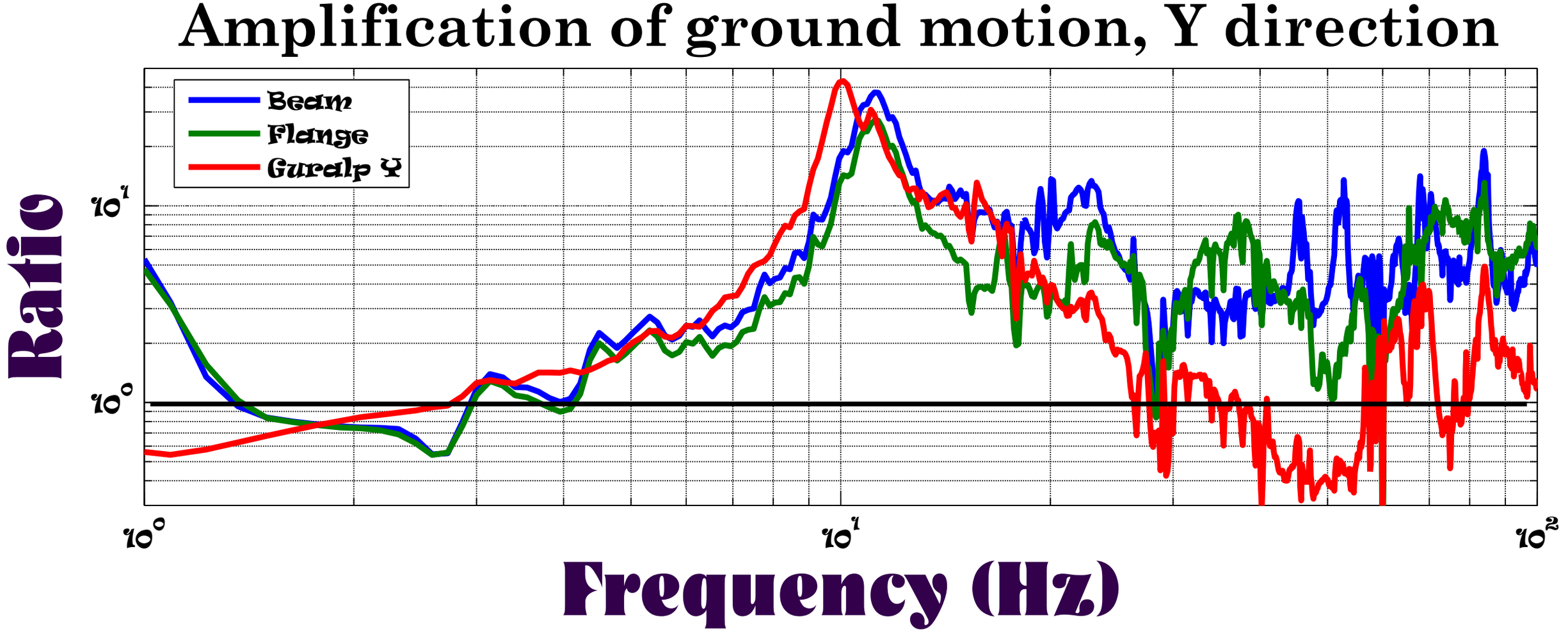
LASTI: 10 Hz pier amplification

Stacks removed, amplification still present

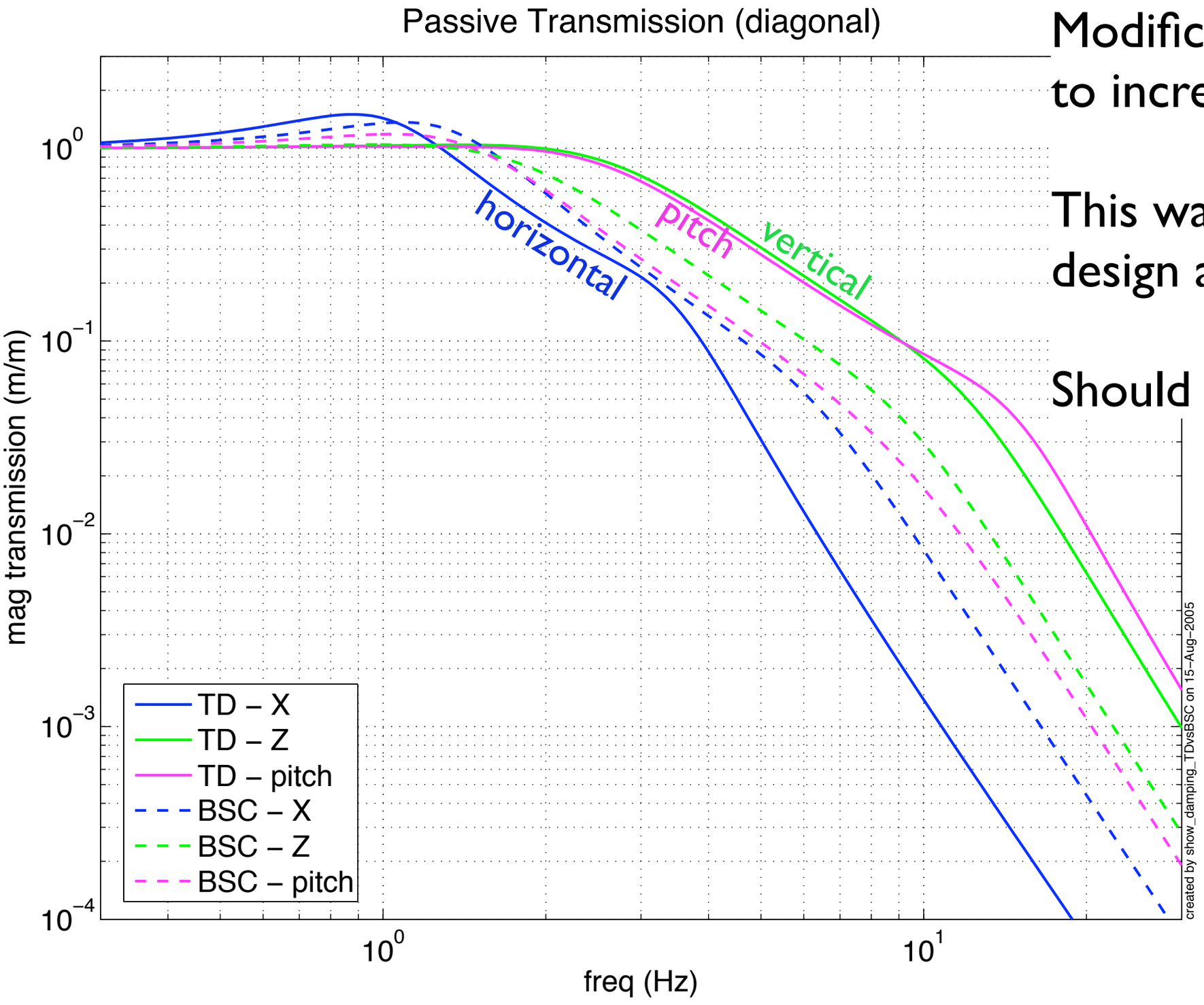
Best guess: resonance of BSC chamber with floor, drags piers along.

Lots of work put into this by Mittleman & Mason

1) Work is ongoing, 2) 10 Hz is problematic



New system from ASI

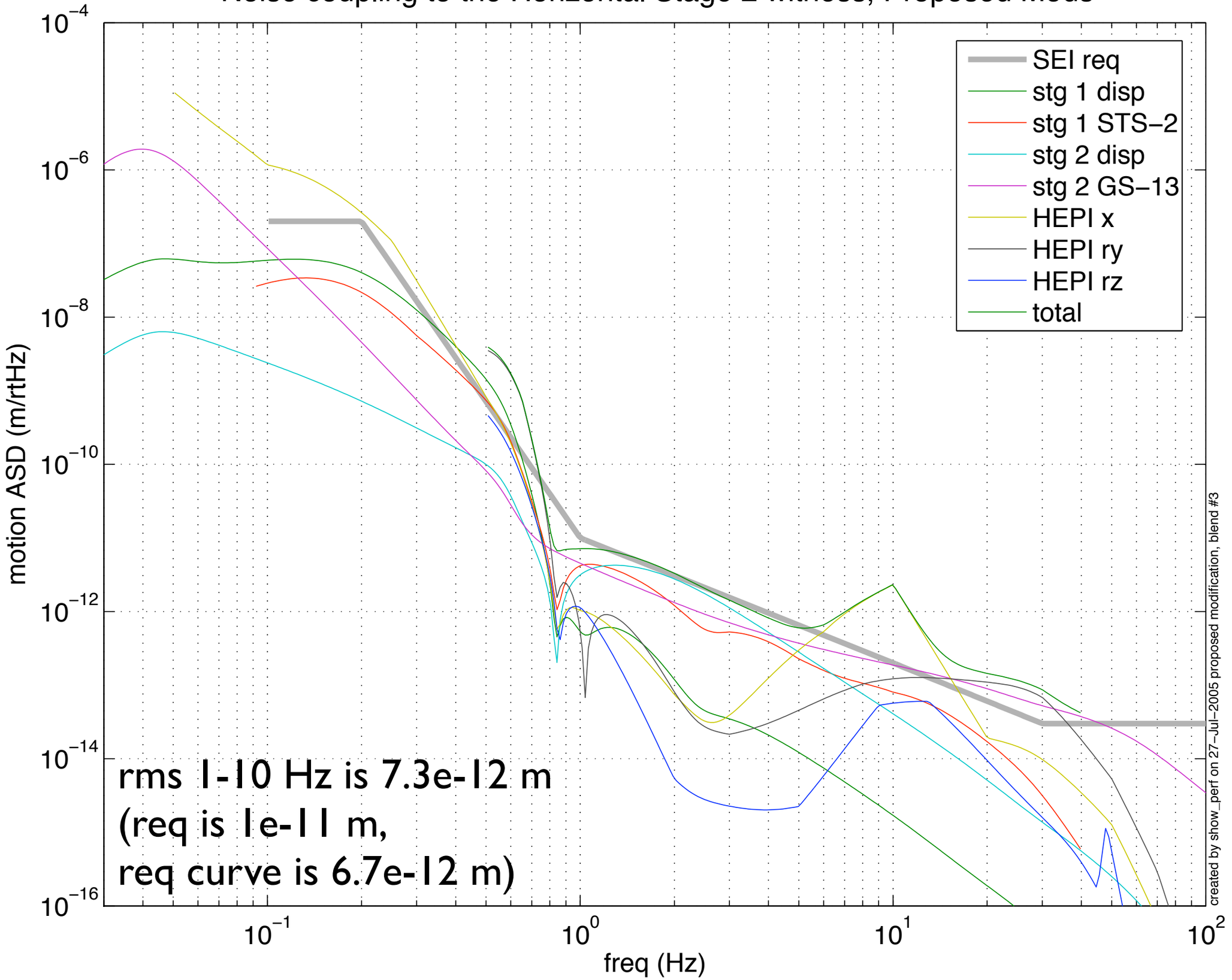


Modifications made to the plant to increase the passive isolation

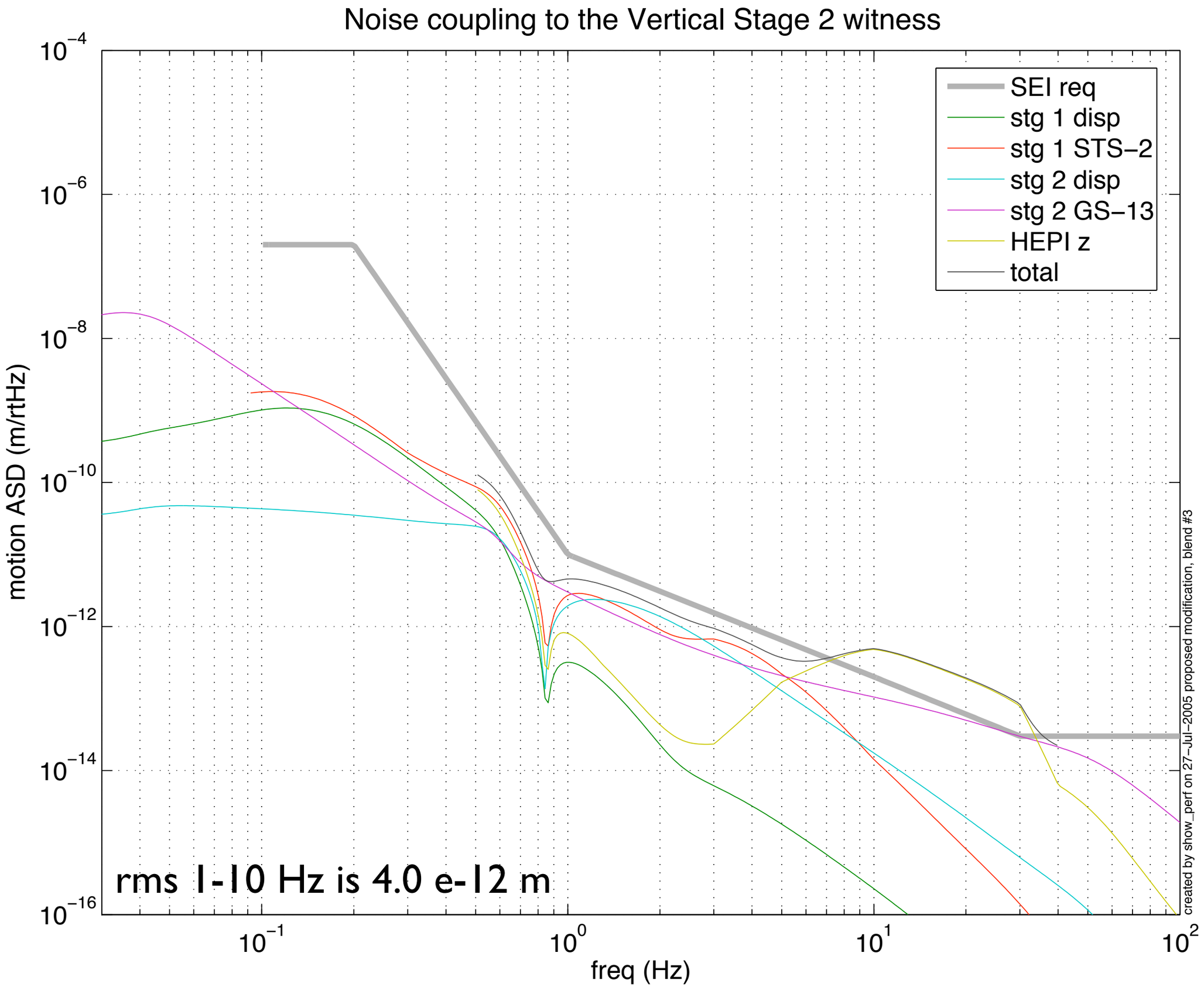
This was a minimal change in design as received.

Should give good performance

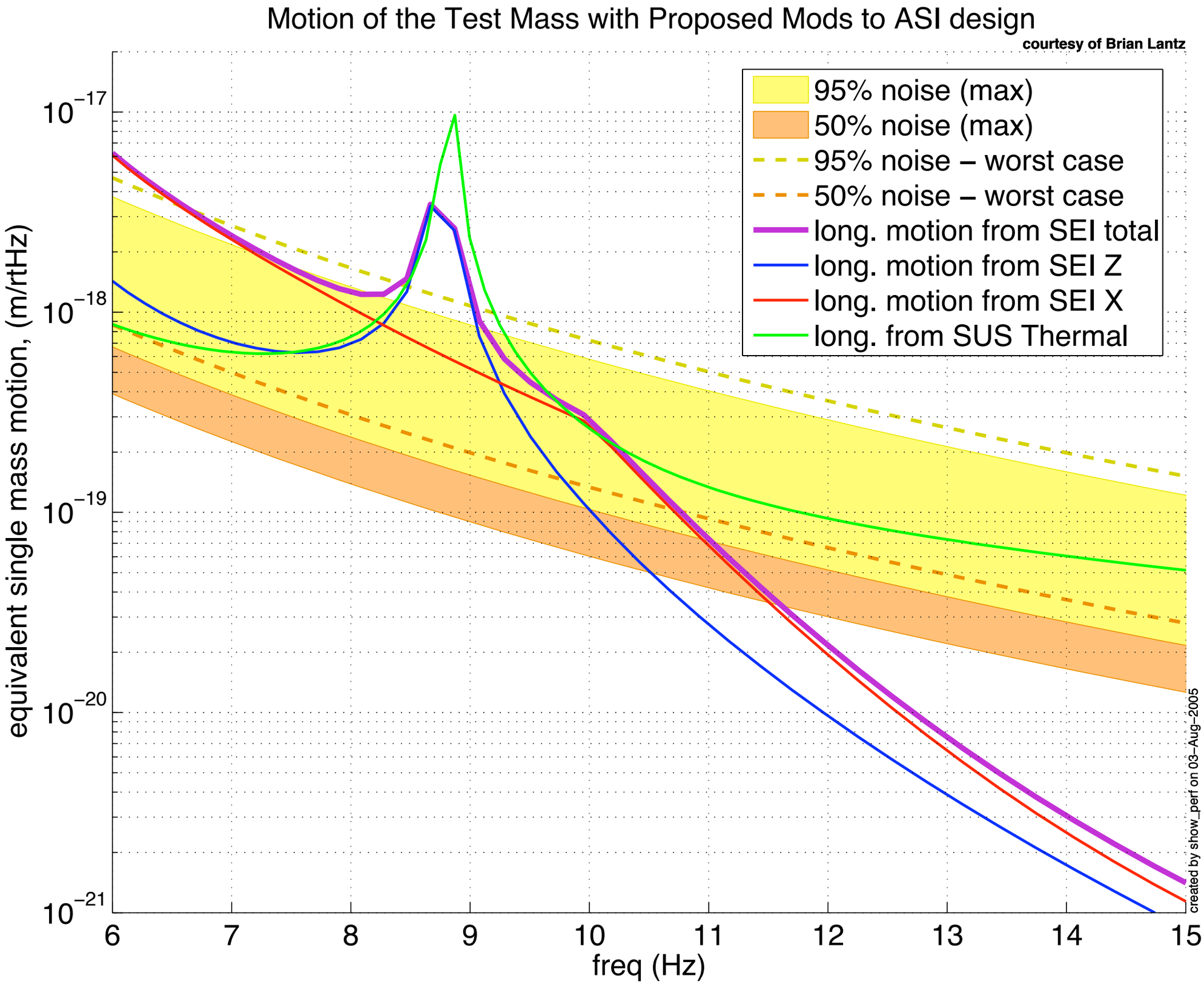
Predicted Performance: X



Predicted Performance: Z



Predicted Performance w/ Pendulum



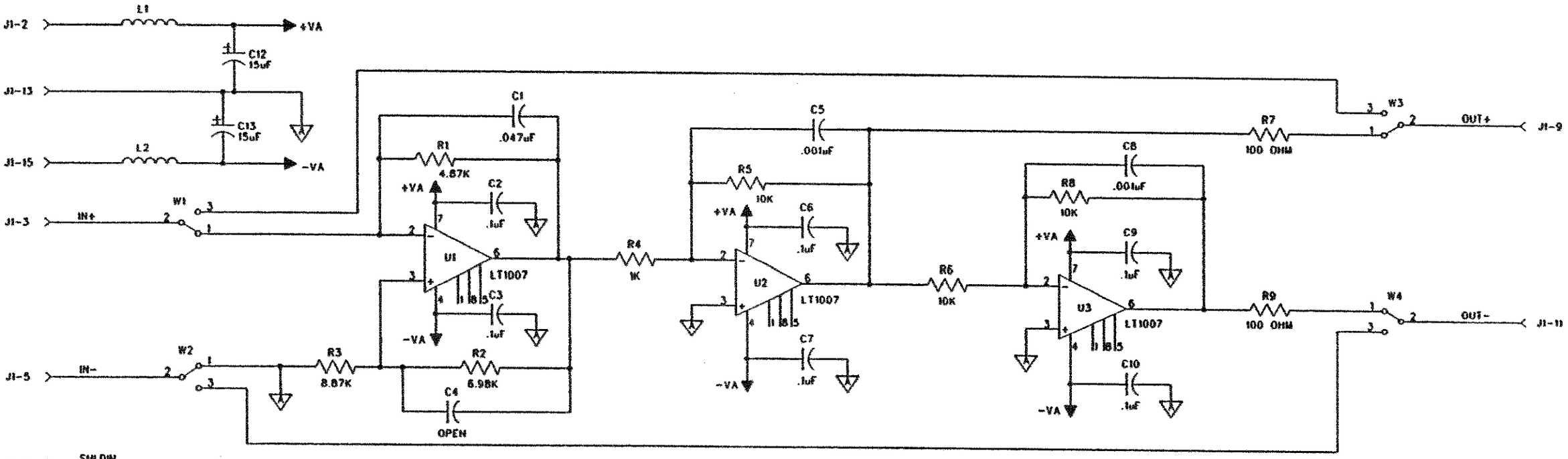
Conclusions

-Expected performance at 10 Hz not quite as good as we'd originally predicted.
  - Pier amplification troublesome (opportunity)
Has minor impact on system performance.

-1 Hz performance looks good

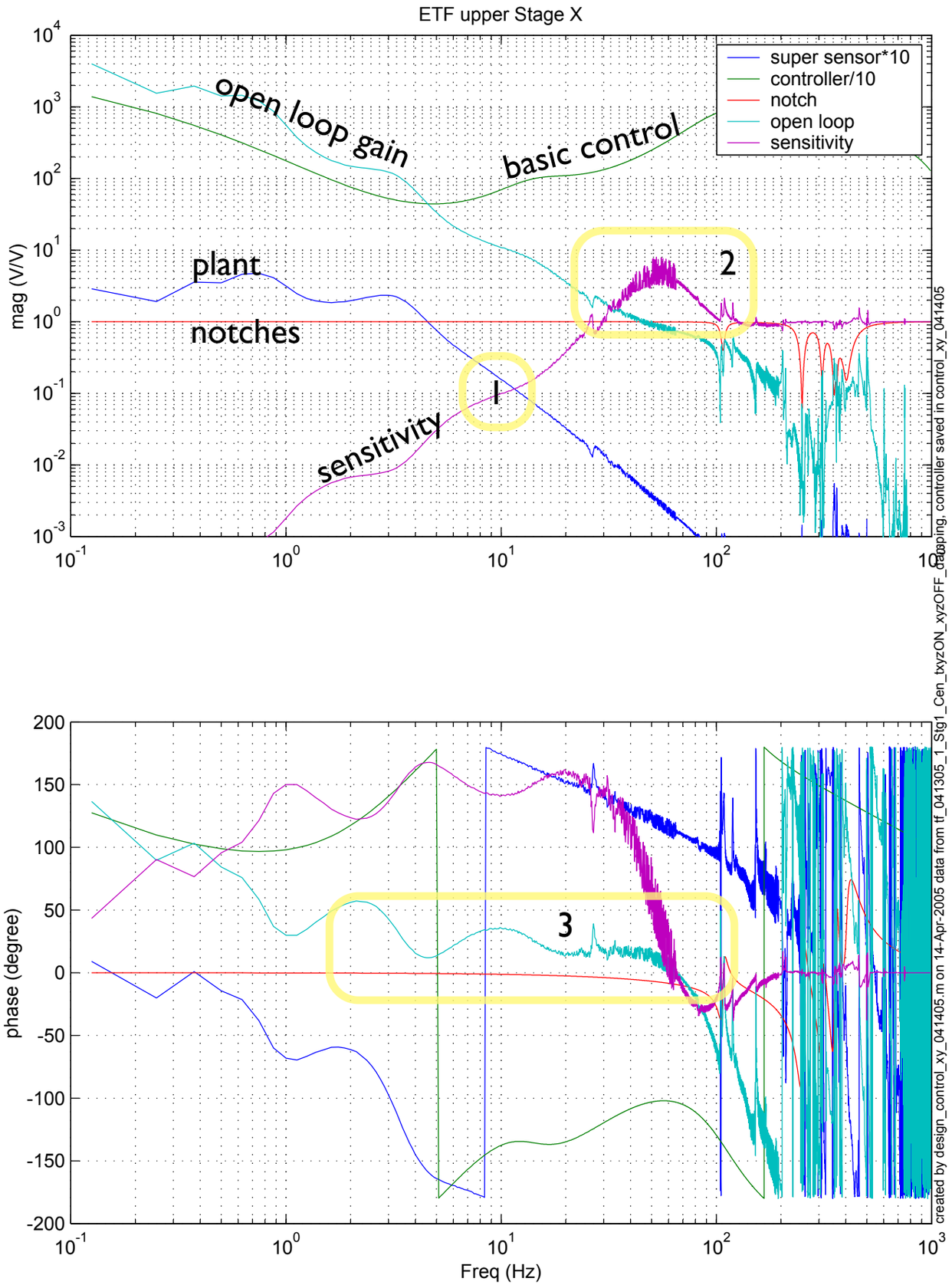
-We look forward to getting the prototype into LASTI

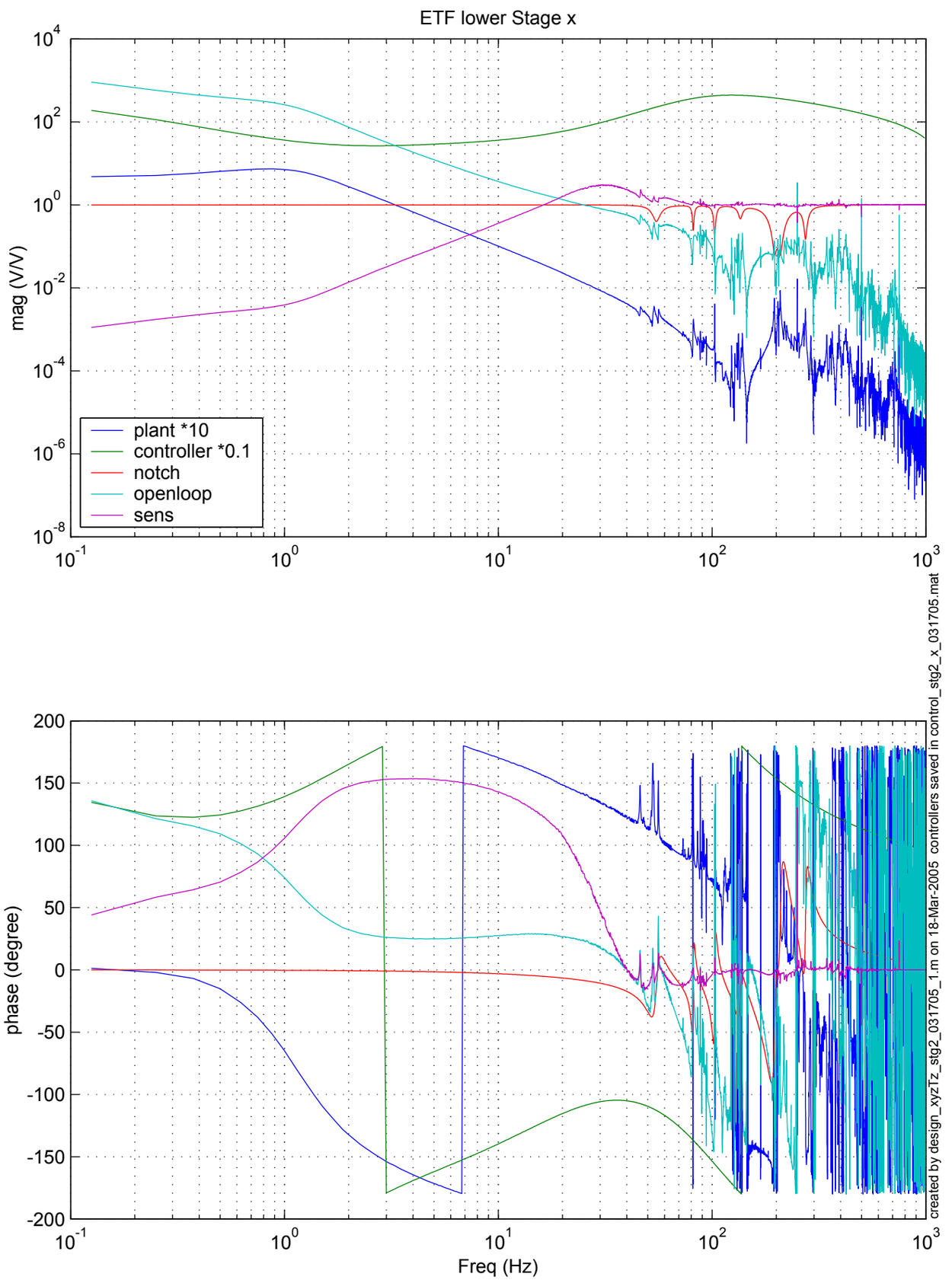
GS-13 -03 preamp



PRE-AMPLIFIER CIRCUIT

ETF: X Control





10 Hz pier amplification