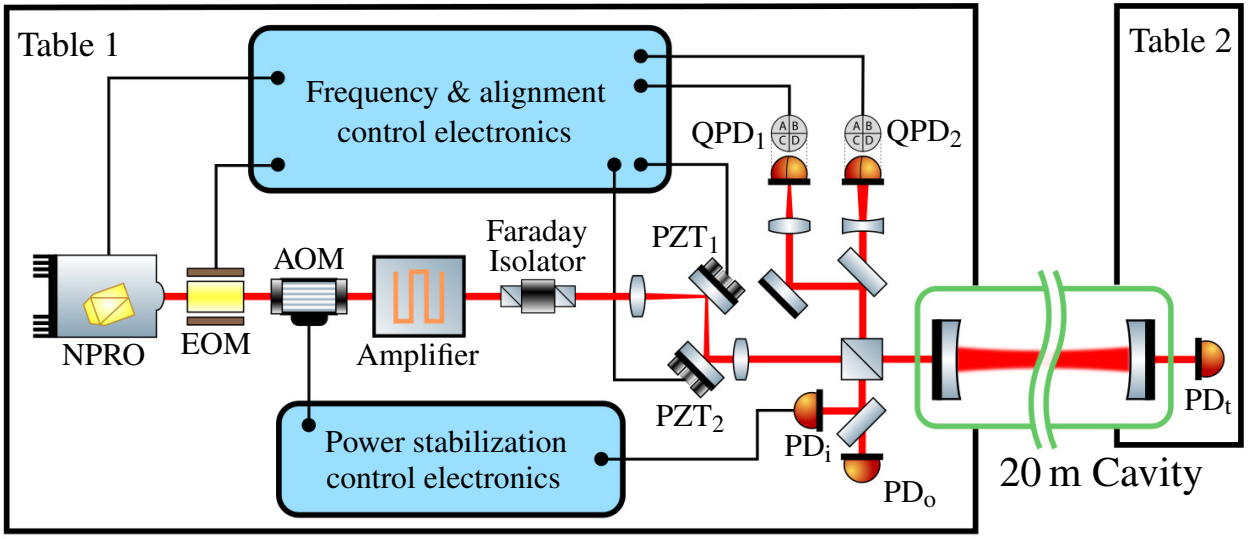
Status of ALPS IIa at DESY and how to continue with TDR optics design

HELMHOLTZ ASSOCIATION

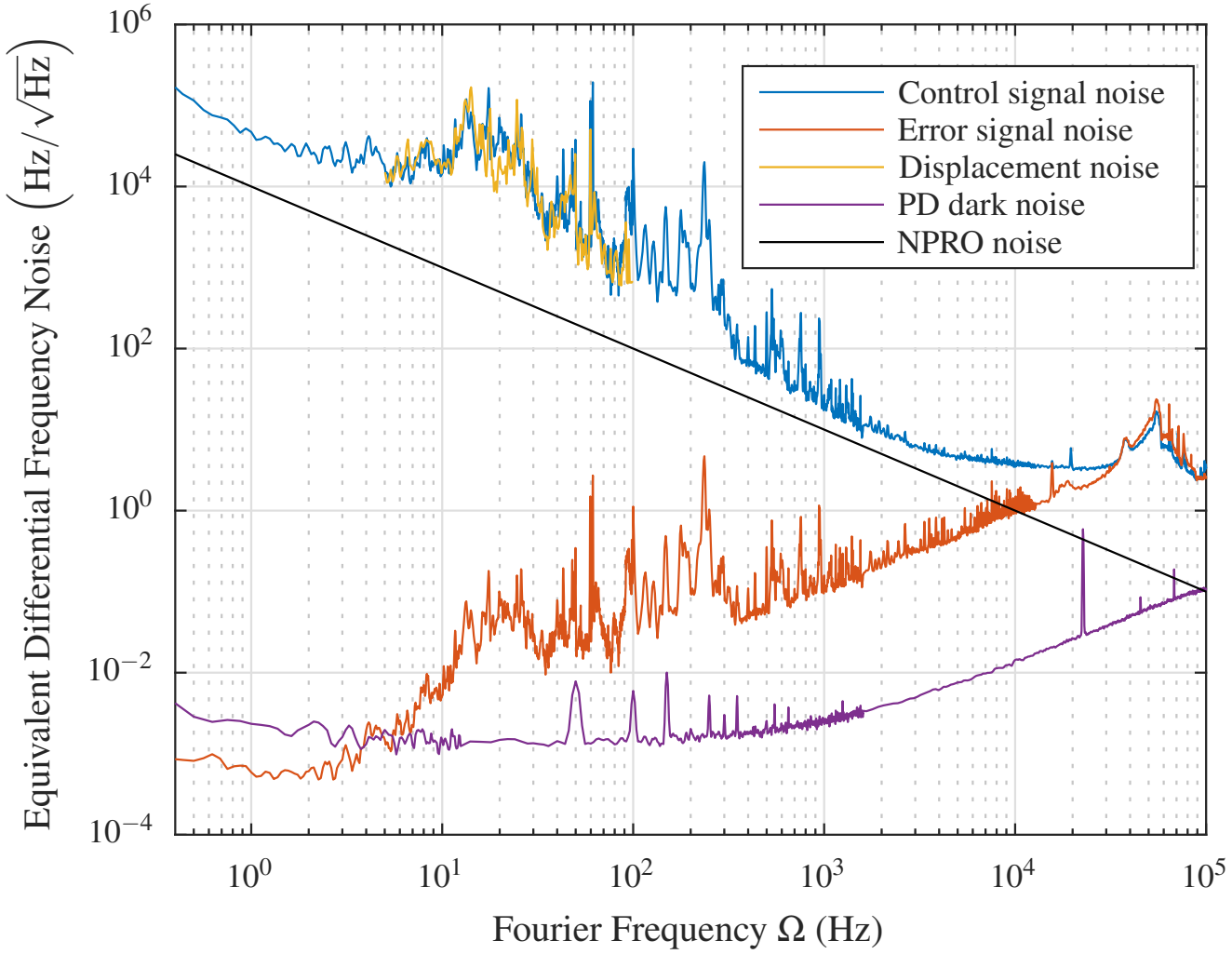
DESY

Results from 20m paper in a nutshell

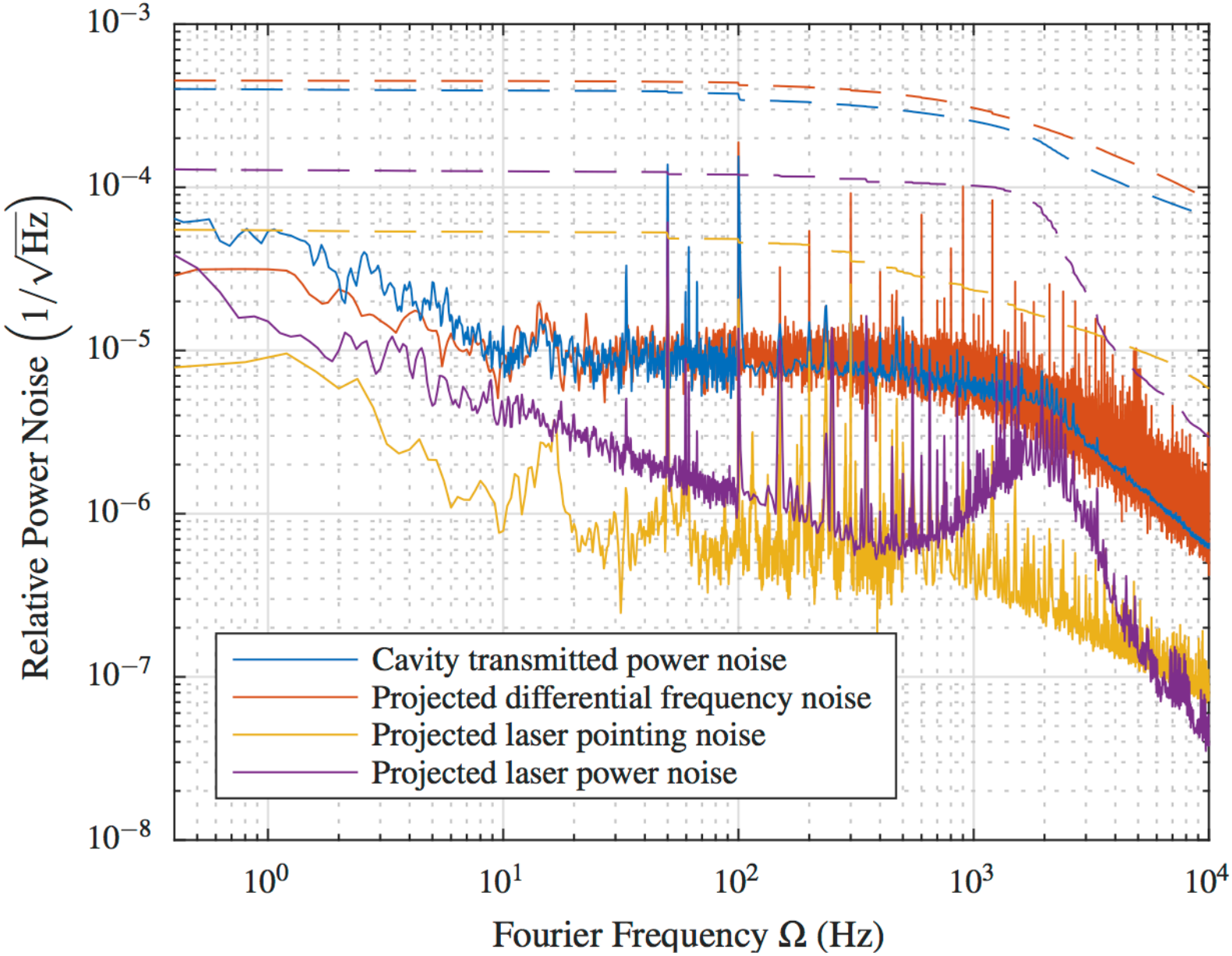
- arXiv:1609.08985
- 20m cavity characterization at 50mW input power in vacuum
- noise projections
- RMS power noise in transmission 3.8×10^{-4} (95% of it accounted for)
- differential seismic noise measurements in HERA north and west



Measurements – frequency noise



Power noise in transmission



Milestones achieved for 10m PC

- CBB alignment with single mirror with current infrastructure
- initial alignment procedure
- high power operation for production cavity (500mW in transmission)
- automatic alignment
- frequency control with 50kHz UGF
- minimized unaccounted loss production cavity to 88ppm

Analysis of Seismic Noise Spectrum

- PZT resonance in the end mirror of RC at ~ 200Hz limits UGF
- It may be possible to perform length lock on the RC with 532nm light with a UGF > 100 with seismic isolation
    - No power build for 1064nm without seismic isolation
- Simulations of power build up for 1064nm light performed with seismic isolation
    - Isolation modeled with a 20cm single stage pendulum
    - Three model of the control electronics for the length control electronics used
        - One with 3 integrators and 2 zeros
        - Two with 5 integrators and 4 zeros
    - Cavity pole frequency for 532nm light well about UGF

Power Buildup with different UGF

- Power Buildup % with varying UGF and double zeros
- Requirements are 95% Power buildup

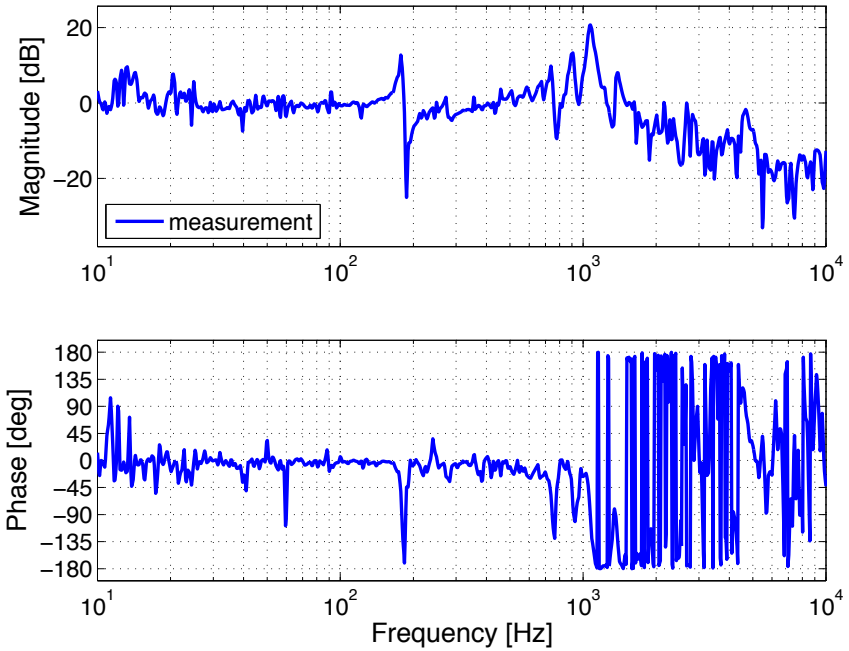
	3 Integrators	5 Integrators	
UGF	Power Buildup %	Power Buildup % (Less Aggressive)	Power build up % (More Aggressive)
400 Hz	93.9%	95.3%	99.7%
300 Hz	81.3%	84.7%	98.5%
200 Hz	52.5%	56.8%	87.9%
100 Hz	14.6%	17.7%	38.4%

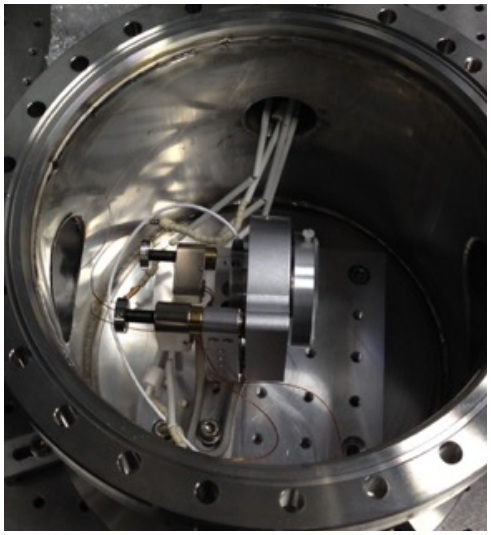
Conclusions and Possible Plans

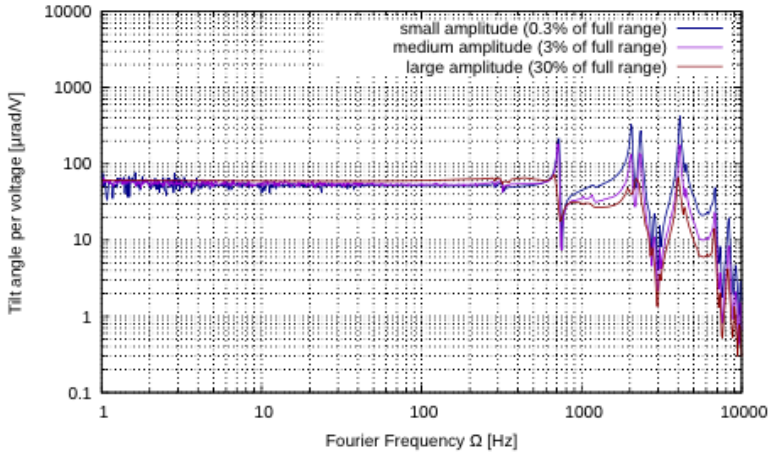
- Its possible to perform a length lock of the RC that maintains 95% power buildup and with seismic isolation
  - UGF > 200Hz
    - This requires dealing with the PZT resonance
- Possible Plans:
  - 1: Design new mount for the PZT
  - 2: Length lock of RC without seismic isolation (no power buildup)
  - 3: Design and implement seismic isolation
  - 4: Length lock of RC with seismic isolation

PZT actuator

TF PZT z−axis ==> control signal of PDH control loop







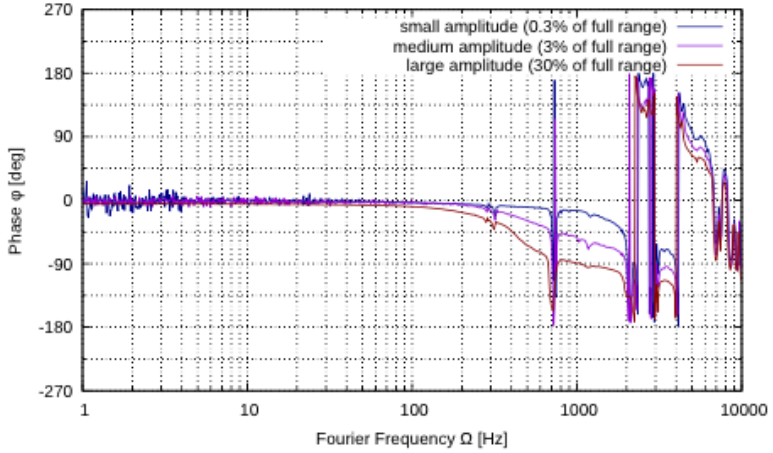


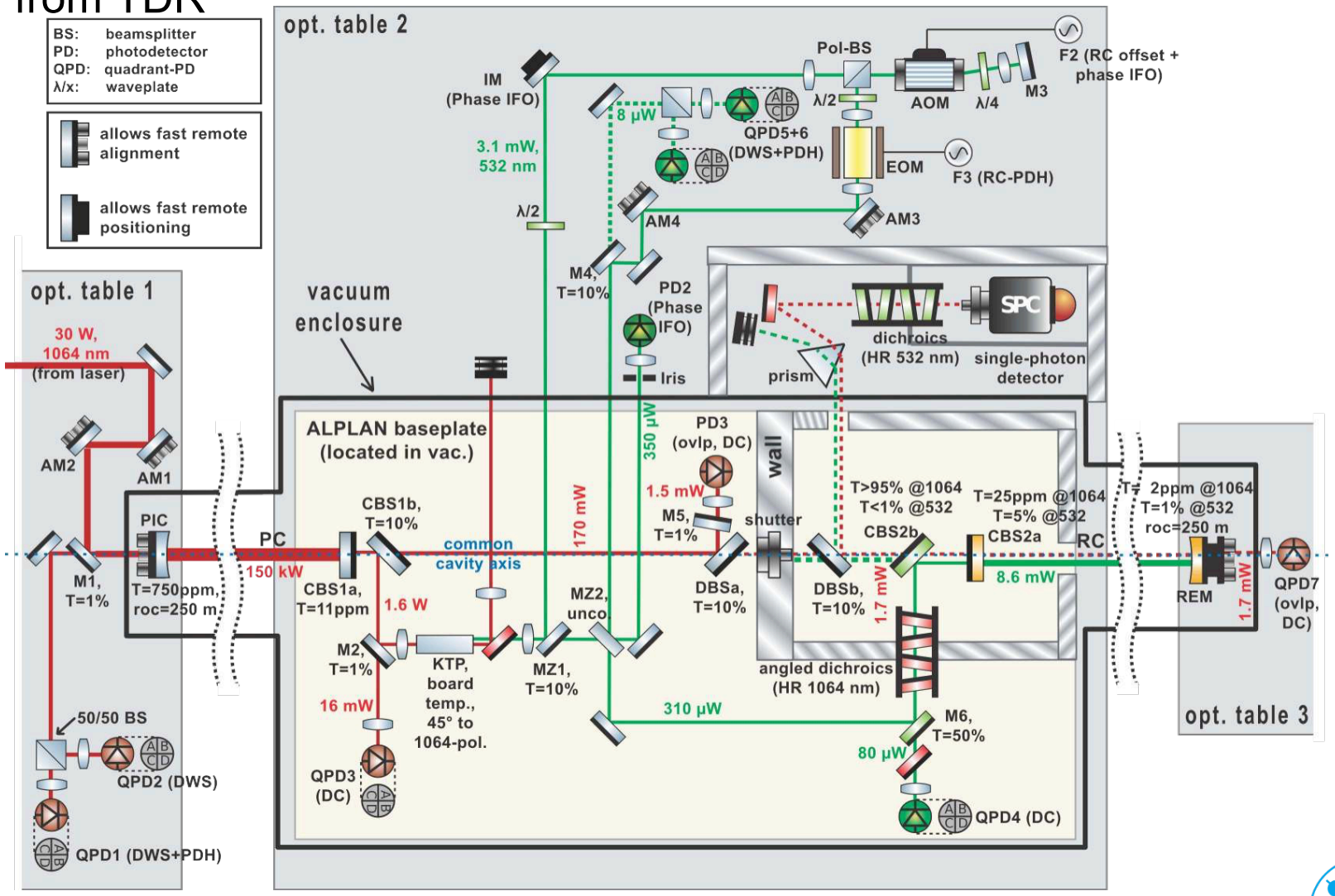
Figure 3.6: Bode plot of transfer function from PZT alignment actuat
including driver from input voltage to tilt angle.

Measurements this year

- Characterization at high power
  - thermal effects
  - robust lock
  - automatic alignment
  - optimization of frequency stabilization control loop
  - swap photodetectors and improve power stabilization control loop
- CBB
  - Kanioar…
- Regeneration Cavity
  - lock with green light

Prospects

- from TDR



Prospects II

- stick to baseline TDR design first and try to characterize the RC
  - Second laser on central table?
  - → PLL in red to amplify green power?
  - → frequency feedback possible
  - → split feedback?
  - → use phase IFO to analyze differential frequency noise
- objectives:
  - characterize noise for regeneration cavity
  - try to optimize length/frequency stabilization control loop for RC (more integrators, faster PZT)
  - is it possible to achieve power buildup for IR light without seismic isolation?
  - is it possible to proceed implementing light tight shielding?
  - do we need automatic alignment for the RC?