February 25, 2015

Positive-g bKAGRA Arm Cavity ~ ASC Point of View ~

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Scope and Summary

- There's a proposal to make bKAGRA arm cavities to be positive-g for saving polishing fee
  ITM/ETM RoCs: 1900 m (default) → 7125 m (proposal)
- Since this creates the mode matching change, we also have to change PRM/SRM RoCs, and this also modifies the PRC/SRC round-trip Gouy phases (we cannot change PR2/3, SR2/3 since we have already ordered them)
- ASC simulation shows this result in the following sensitivity change (mainly because arm cavities are more unstable)

Official	Default with ASC	Positive-g with ASC
172.06 Mpc	172.02 Mpc	171.16 Mpc

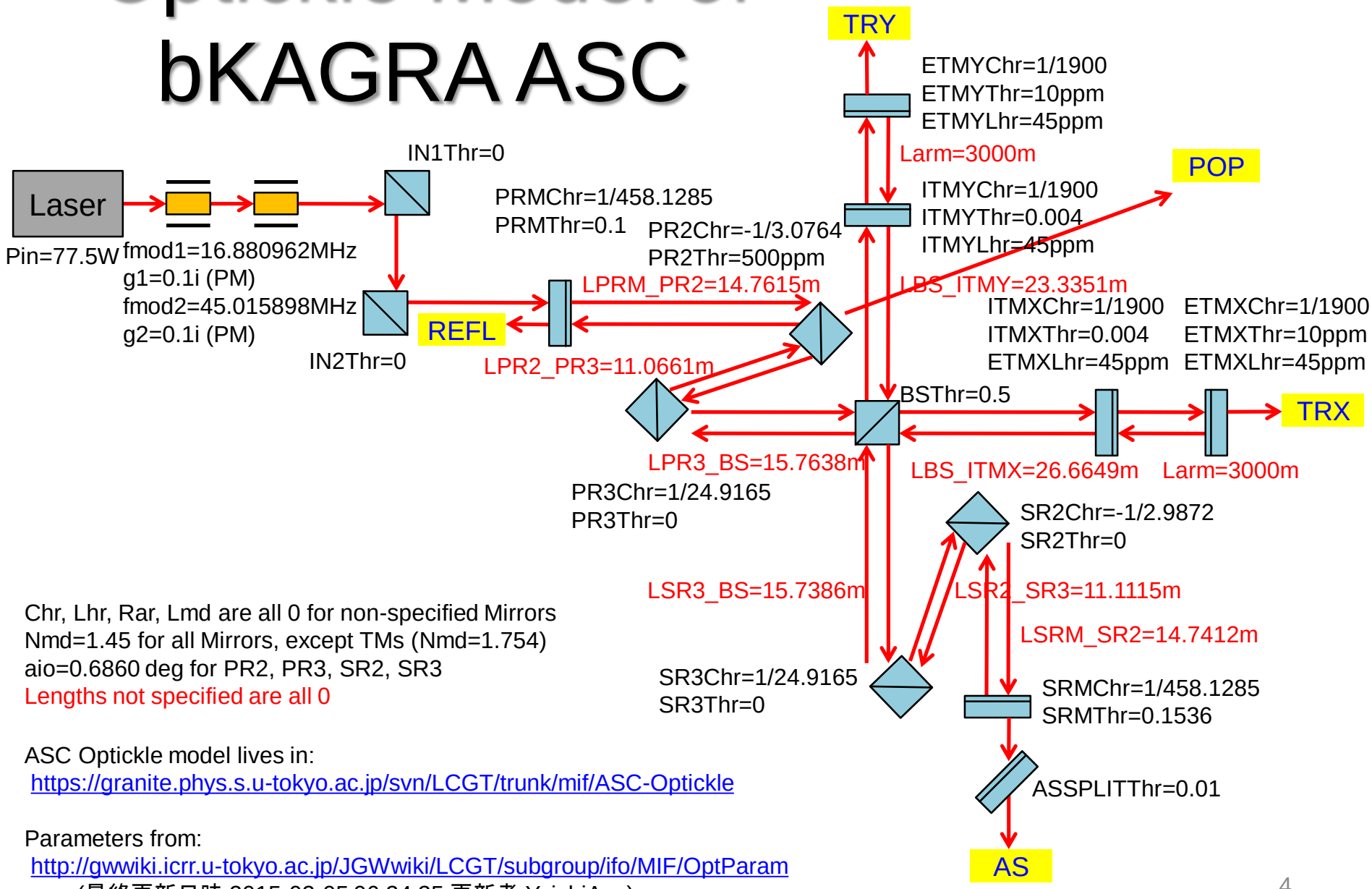
(1.4Ms-1.4Ms binary neutron star, SNR>8, sky average)

- In order to make the arm cavities stable with positive-g, intra-cavity power should be reduced from 380 kW to 7 kW ! (26 kW in negative case)

bKAGRA ASC
Default Case

Optickle Model of bKAGRA ASC

negative



Chr, Lhr, Rar, Lmd are all 0 for non-specified Mirrors
Nmd=1.45 for all Mirrors, except TMs (Nmd=1.754)
aio=0.6860 deg for PR2, PR3, SR2, SR3
Lengths not specified are all 0

ASC Optickle model lives in:
https://granite.phys.s.u-tokyo.ac.jp/svn/LCGT/trunk/mif/ASC-Optickle

Parameters from:
http://gwwiki.icrr.u-tokyo.ac.jp/JGWwiki/LCGT/subgroup/ifo/MIF/OptParam
(最終更新日時 2015-02-05 06:24:35 更新者 YoichiAso)
http://gwwiki.icrr.u-tokyo.ac.jp/JGWwiki/LCGT/subgroup/OCG/parametermeeting?action=AttachFile&do=view&target=interface_parameter_%28selected%29.pdf

WFS Sensing Matrix

negative

WFS Sensing Matrix [W/mrad]

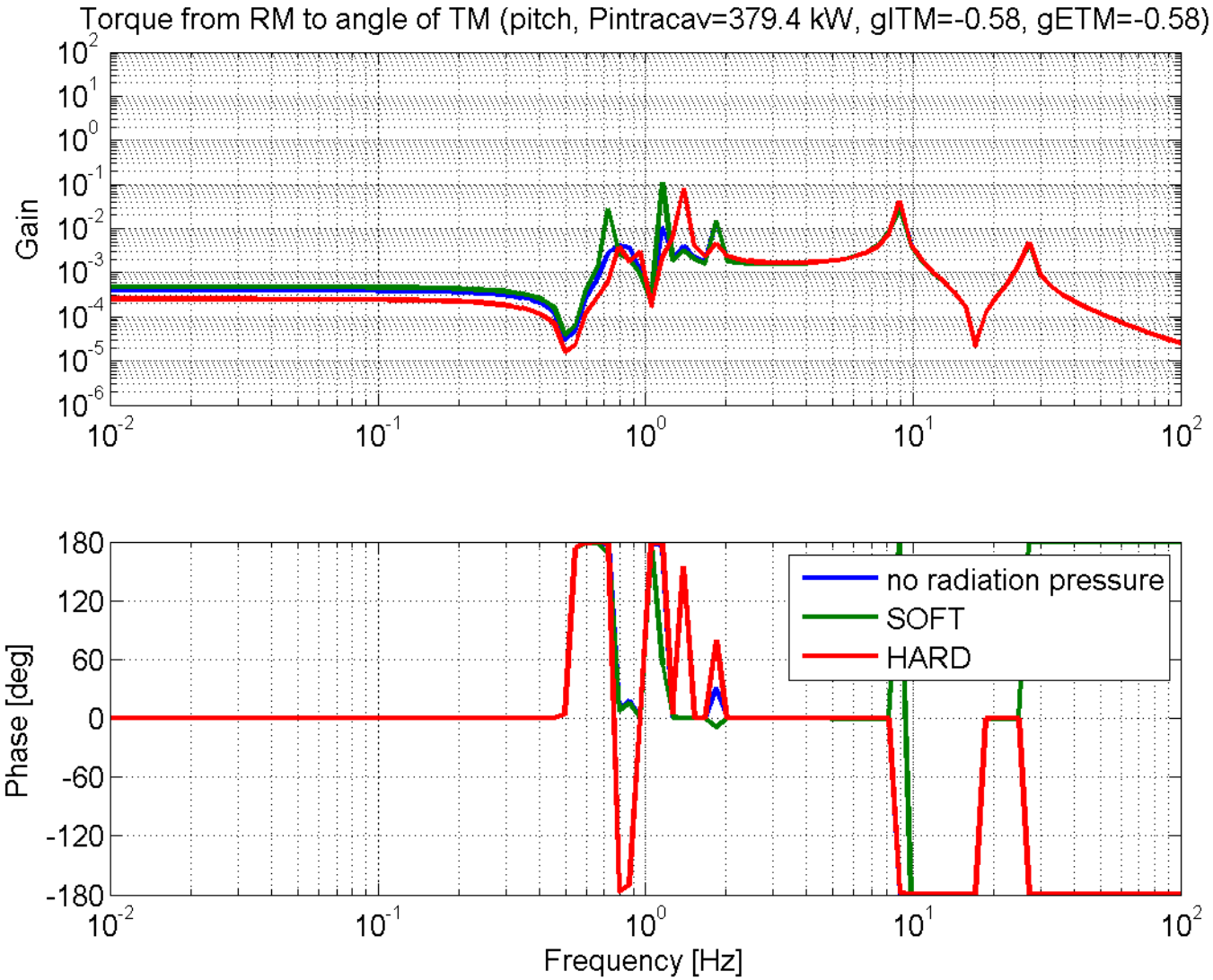
(Gouy phases at POP A:-8.0, POP B:-76.4 REFL A:88.3, REFL B:-88.4, AS A:6.7, AS B:-83.7, TR A:-61.4 deg)

	CS	CH	DS	DH	BS	PR3	PR2	PRM	SR3	SR2	SRM
TRX_ADC	-9.23	0.40	-9.23	0.38	0.00	-0.01	-0.00	-0.00	0.00	0.00	0.00
REFL_A2I	-52.89	-143.42	-0.56	0.83	8.28	25.80	3.60	4.37	-0.00	-0.00	-0.00
TRY_ADC	-9.23	0.40	9.23	-0.38	-0.01	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00
AS_A1Q	0.21	-0.21	6.88	25.78	0.11	-0.17	-0.02	-0.01	-0.28	-0.03	-0.01
POP_A1Q	0.02	-0.00	0.36	-0.36	0.25	-0.02	-0.00	-0.00	-0.01	-0.00	-0.00
POP_A2Q	-1.55	0.73	-0.00	0.00	1.00	2.86	0.35	0.17	-0.00	-0.00	-0.00
POP_BDC	0.17	-0.02	0.00	0.00	-0.12	-0.30	-2.09	-1.02	0.01	0.00	0.00
REFL_BDC	-3.39	0.29	-0.01	0.02	1.79	5.50	0.68	4.64	0.21	0.02	0.01
POP_B1I	1.93	-0.68	0.00	-0.00	-0.46	-2.41	-0.29	-0.15	-1.07	-0.13	-0.07
AS_BDC	-0.00	0.00	-0.10	-0.05	-0.06	-0.01	-0.00	-0.00	0.01	0.00	-0.04

TM Actuation TF (pitch)

negative

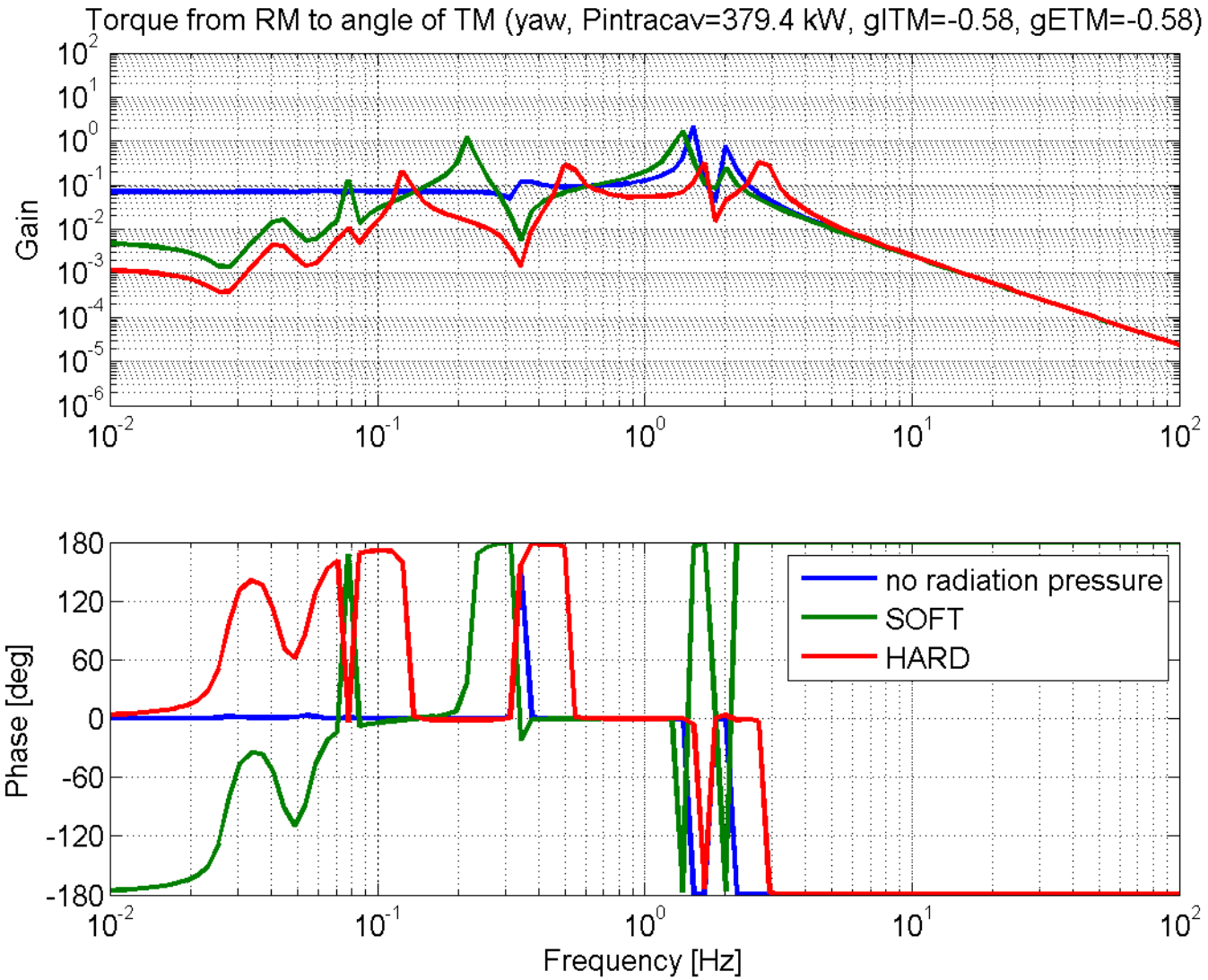
- SOFT/HARD modes are both stable



TM Actuation TF (yaw)

negative

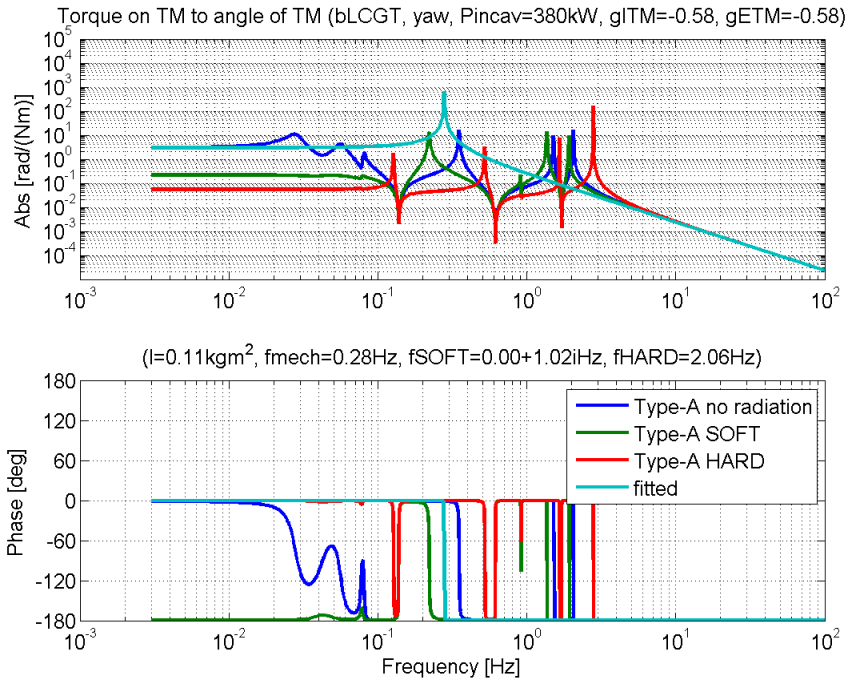
- SOFT mode is unstable (at 1.02i Hz)

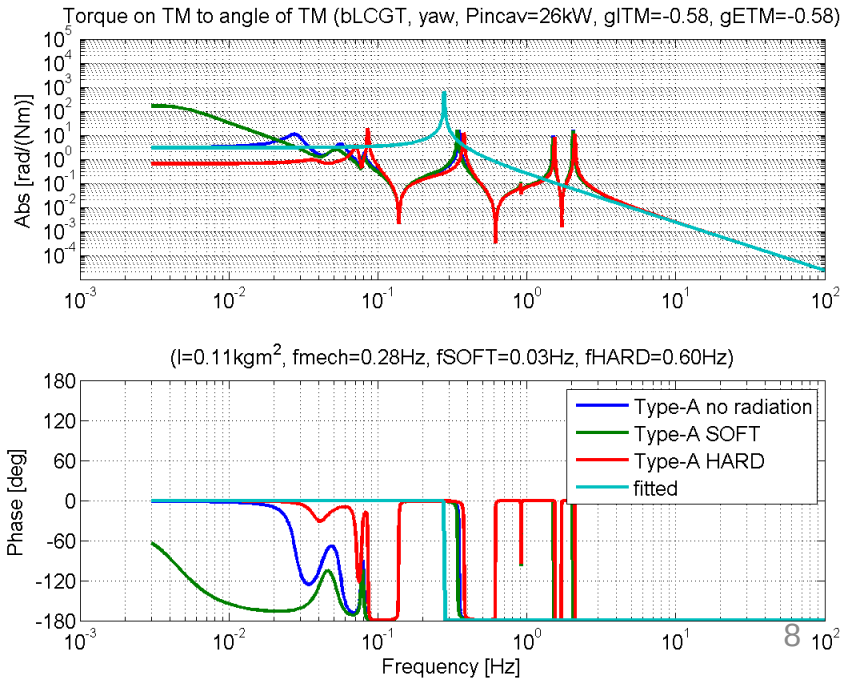


Opto-mechanical TFs (yaw)

negative

- If intra-cavity power is 380 kW (default), yaw is unstable at 1.02i Hz (bottom left figure)
- To avoid instability, intra-cavity power should be reduced to 26 kW (bottom right figure)

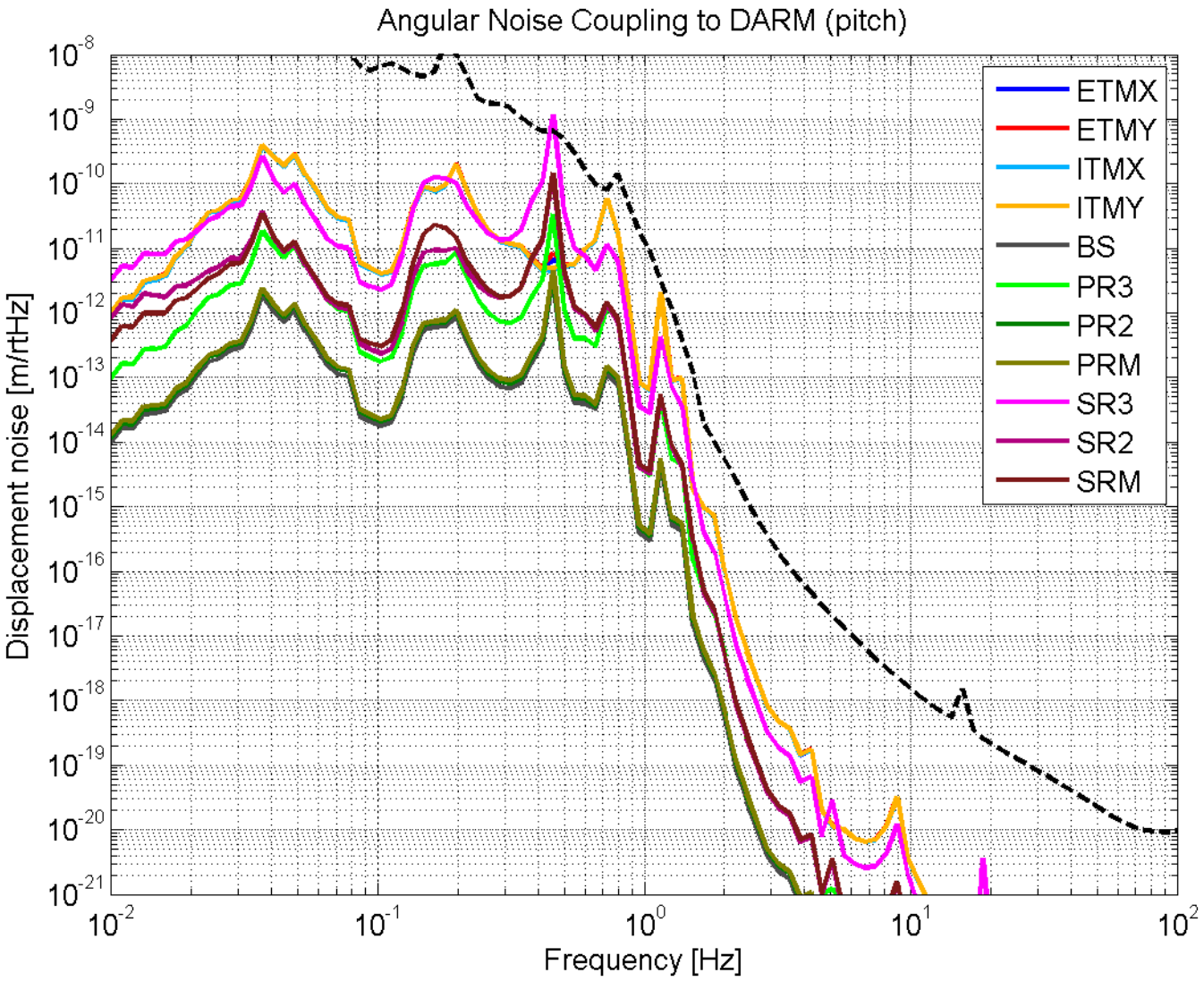




Angle to DARM (pitch)

negative

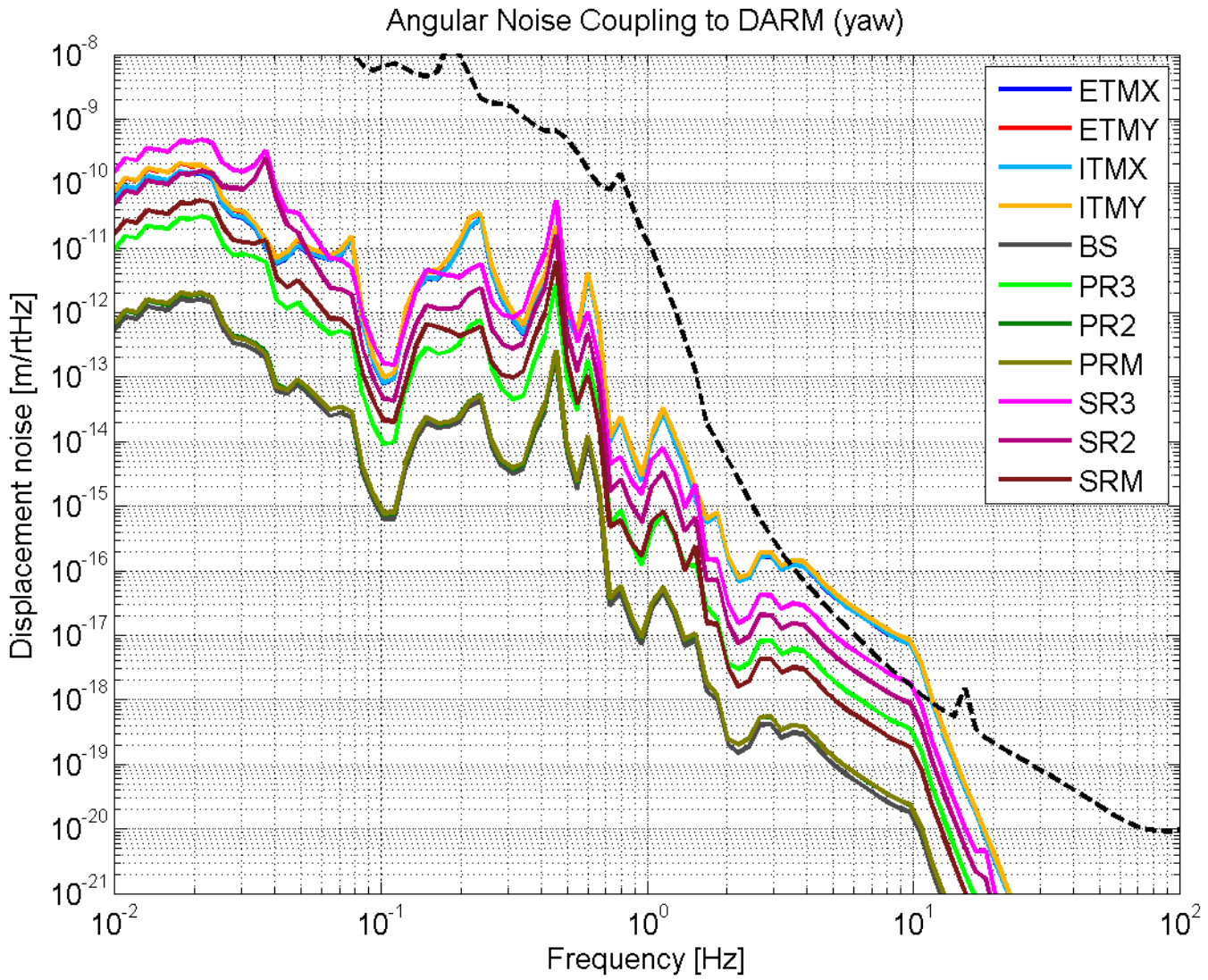
- No impact on bKAGRA sensitivity



Angle to DARM (yaw)

negative

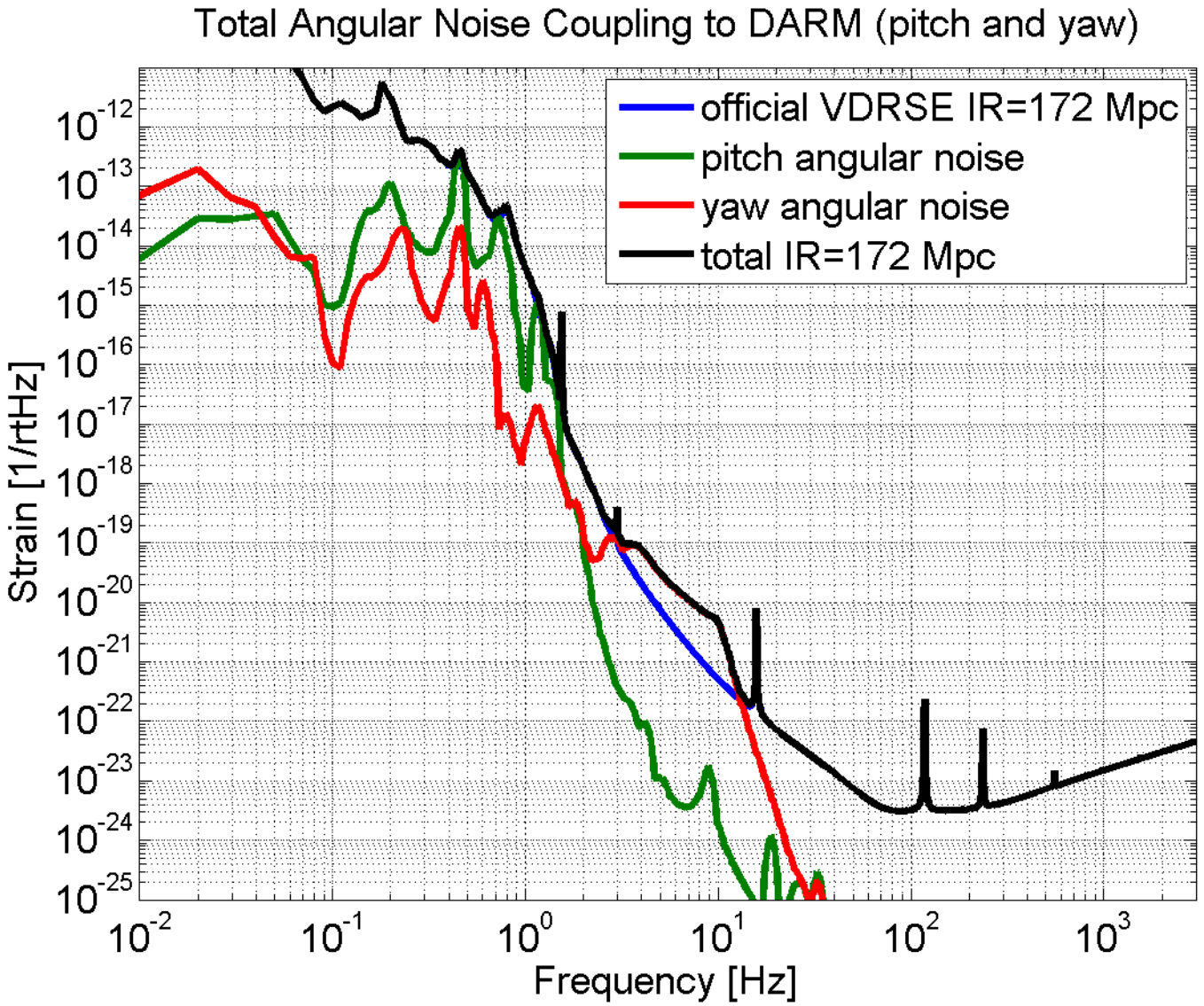
- Slight impact on bKAGRA sensitivity below ~12 Hz



Total Noise

negative

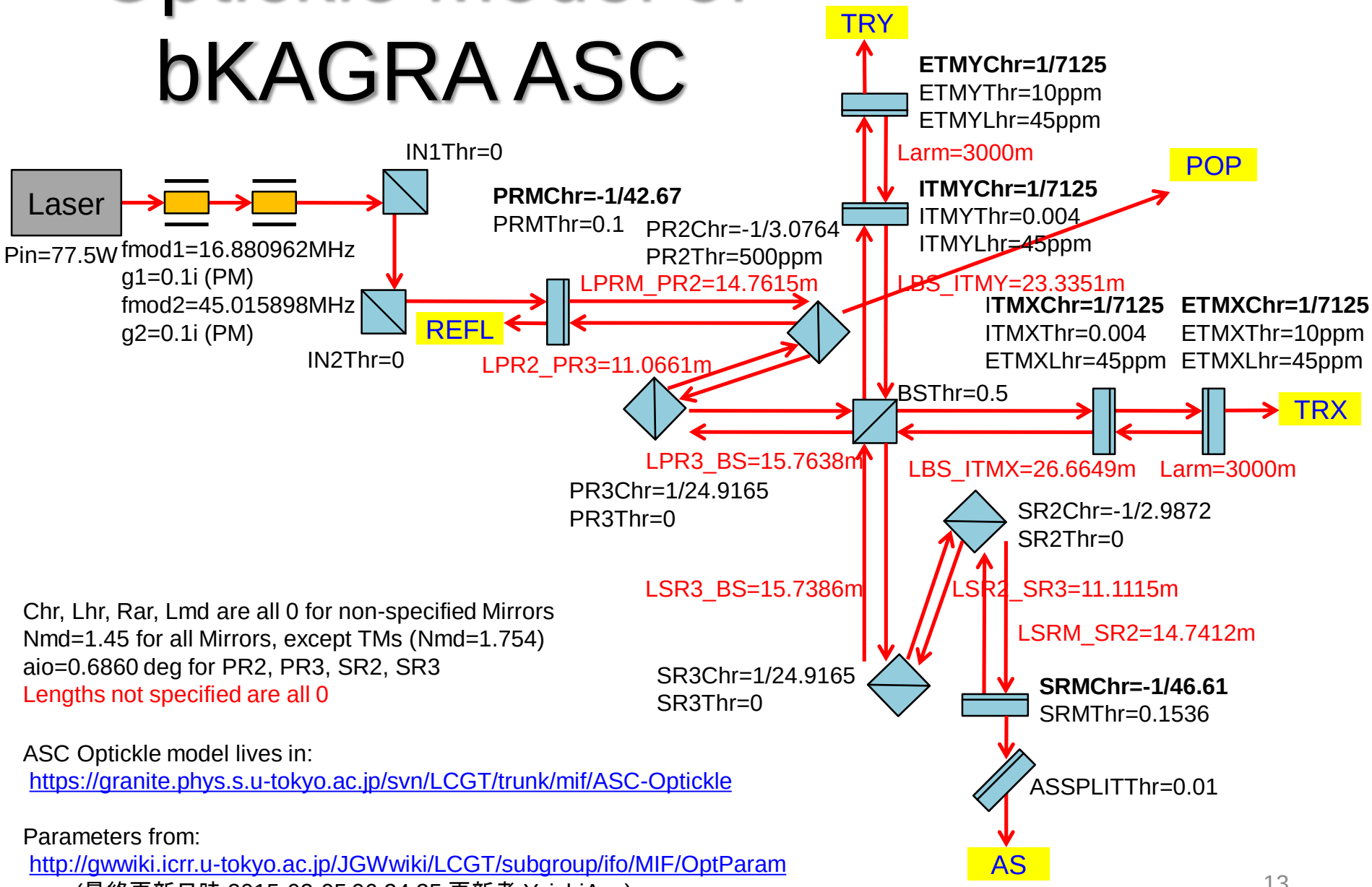
- Total angular noise reduces IR less than 1 Mpc



bKAGRA ASC
Positive-g Case

Optickle Model of bKAGRA ASC

positive



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Parameters from:
http://gwwiki.icrr.u-tokyo.ac.jp/JGWwiki/LCGT/subgroup/ifo/MIF/OptParam
(最終更新日時 2015-02-05 06:24:35 更新者 YoichiAso)
http://gwwiki.icrr.u-tokyo.ac.jp/JGWwiki/LCGT/subgroup/OCG/parametermeeting?action=AttachFile&do=view&target=interface_parameter_%28selected%29.pdf

WFS Sensing Matrix

positive

WFS Sensing Matrix [W/mrad]

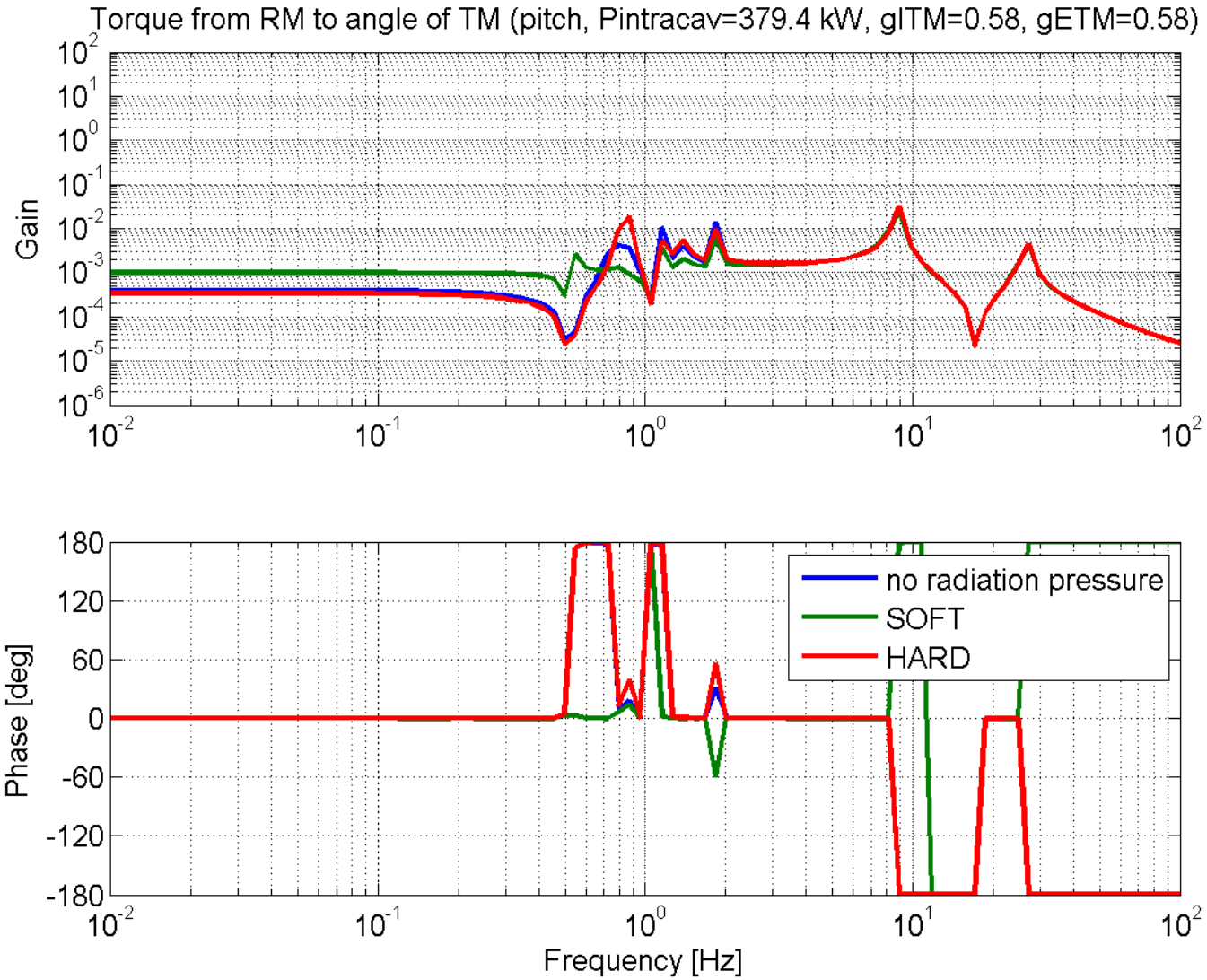
(Gouy phases at POP A:-45.2, POP B:38.8 REFL A:89.1, REFL B:88.4, AS A:2.4, AS B:-87.6, TR A:62.6 deg)

	CS	CH	DS	DH	BS	PR3	PR2	PRM	SR3	SR2	SRM
REFL_A2I	-225.72	-54.61	-0.81	0.90	3.03	11.44	1.99	4.08	-0.00	-0.00	-0.00
TRX_ADC	0.01	9.23	-0.02	9.23	-0.00	-0.01	-0.00	-0.00	0.00	0.00	0.00
AS_A1Q	0.09	-0.08	9.51	2.54	0.04	-0.07	-0.01	-0.00	-0.10	-0.01	0.00
TRY_ADC	0.01	9.23	0.02	-9.23	-0.01	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00
POP_B1Q	0.00	-0.00	0.58	-0.57	0.41	-0.00	-0.00	-0.00	0.00	0.00	0.00
POP_A2Q	-3.57	0.46	-0.01	0.01	0.79	2.29	0.27	0.08	-0.00	-0.00	-0.00
POP_ADC	0.02	-0.39	0.01	0.00	-0.22	-0.62	-1.44	-0.39	-0.00	-0.00	-0.00
REFL_BDC	0.07	0.19	-0.03	-0.01	0.13	0.31	0.04	-1.63	-0.01	-0.00	-0.00
POP_A1I	2.02	-0.23	0.01	-0.00	-0.16	-0.85	-0.10	-0.03	-0.38	-0.04	-0.01
AS_BDC	-0.01	0.00	0.00	0.03	-0.03	-0.01	-0.00	-0.00	0.02	0.00	-0.01

TM Actuation TF (pitch)

positive

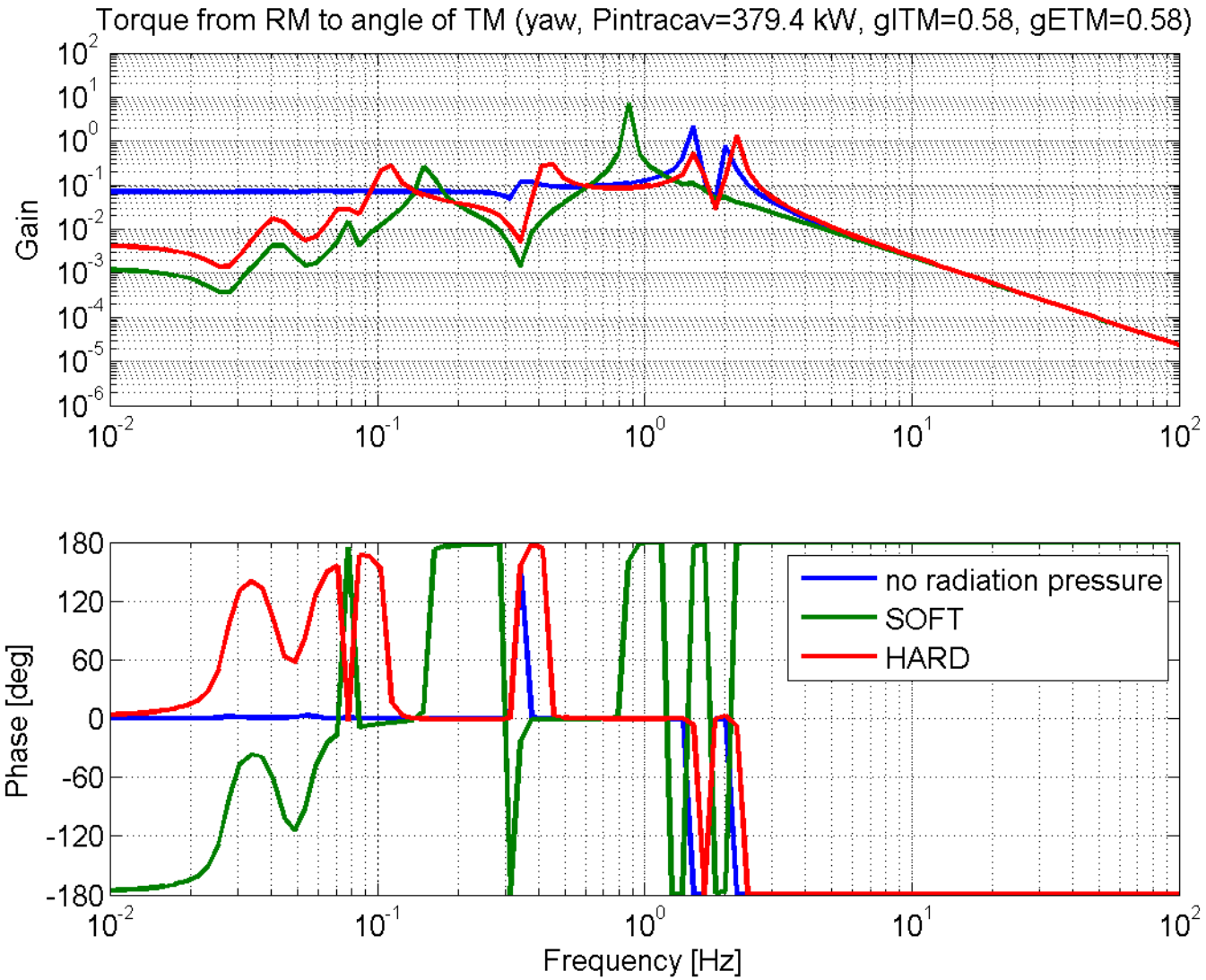
- SOFT/HARD modes are both stable



TM Actuation TF (yaw)

positive

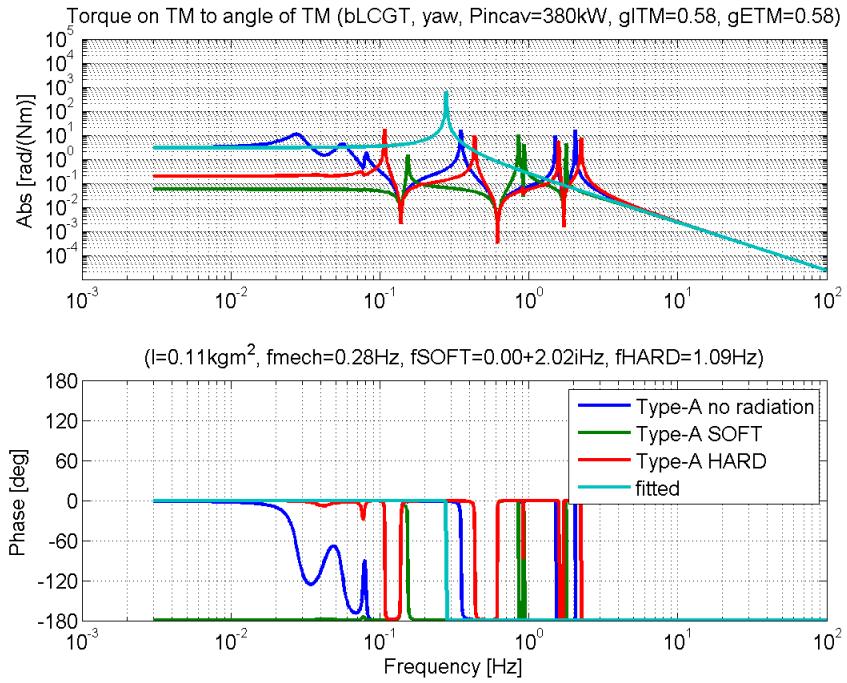
- SOFT mode is unstable (at 2.02i Hz)

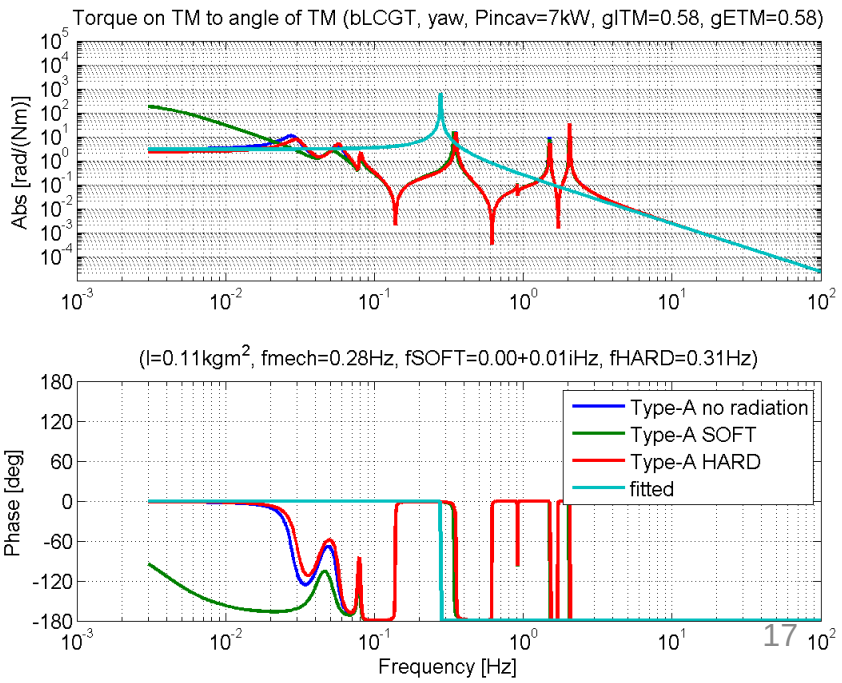


positive

Opto-mechanical TFs (yaw)

- If intra-cavity power is 380 kW (default), yaw is unstable at 2.02i Hz (bottom left figure)
- To avoid instability, intra-cavity power should be reduced to 7 kW (bottom right figure)

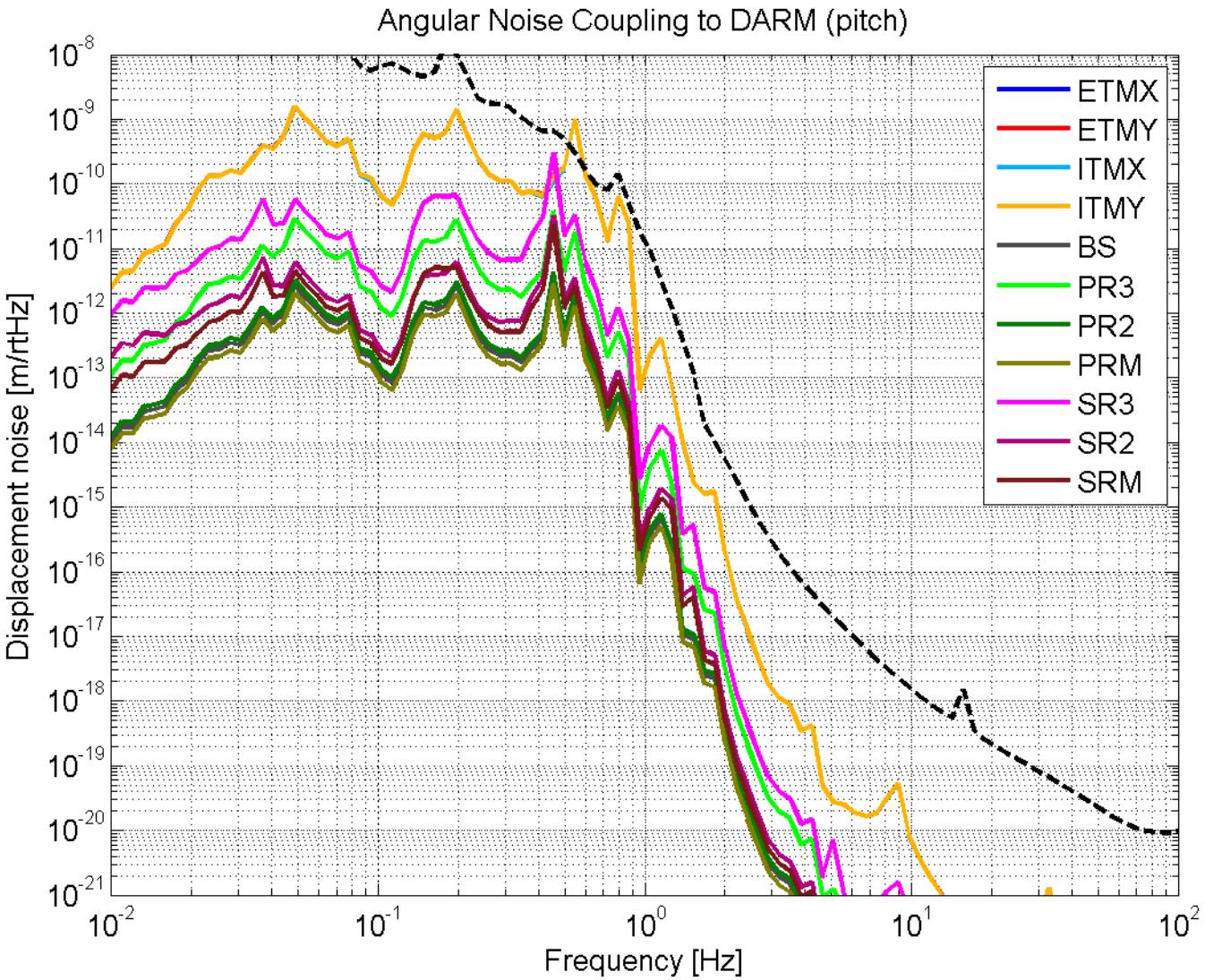




Angle to DARM (pitch)

positive

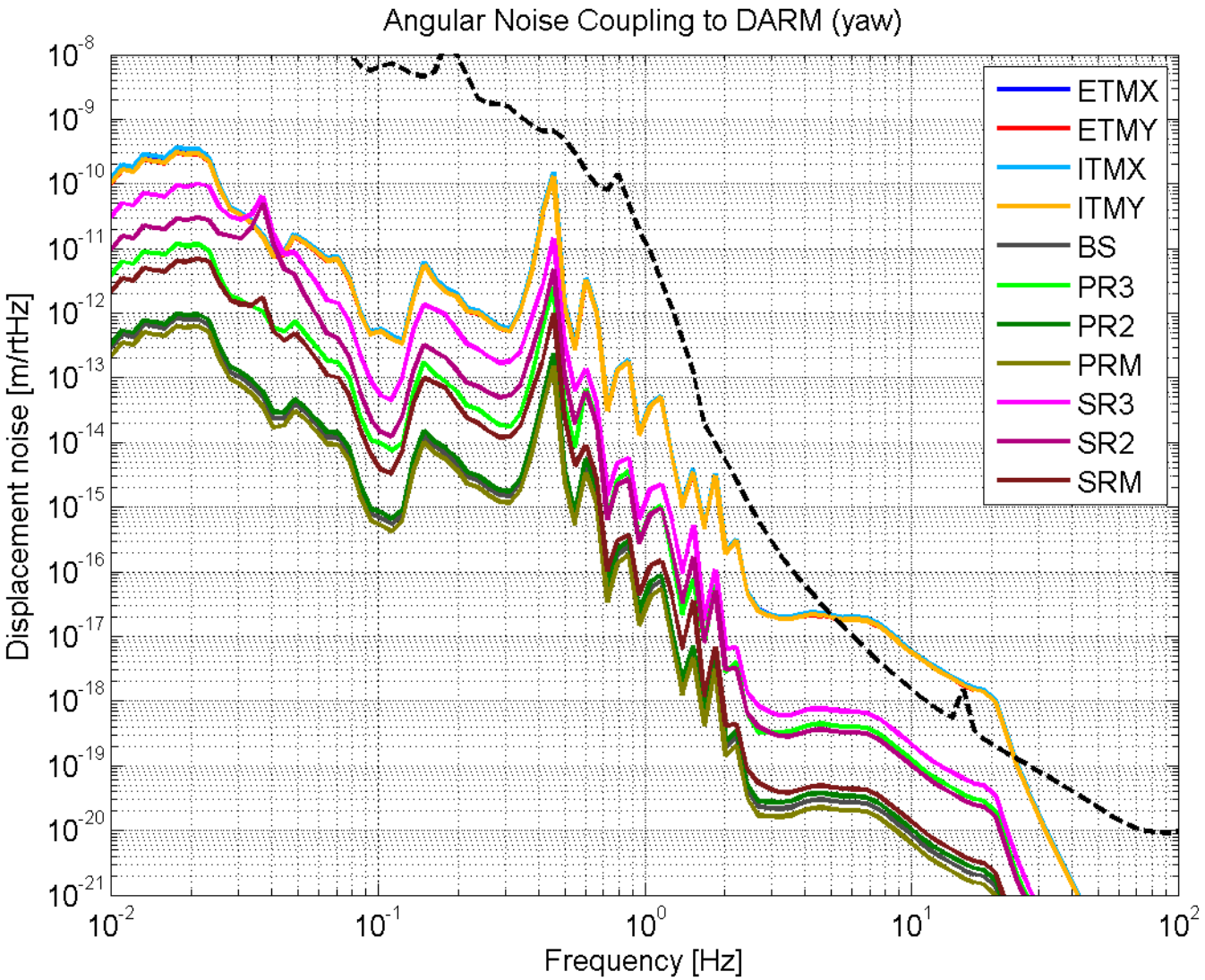
- No impact on bKAGRA sensitivity



positive

Angle to DARM (yaw)

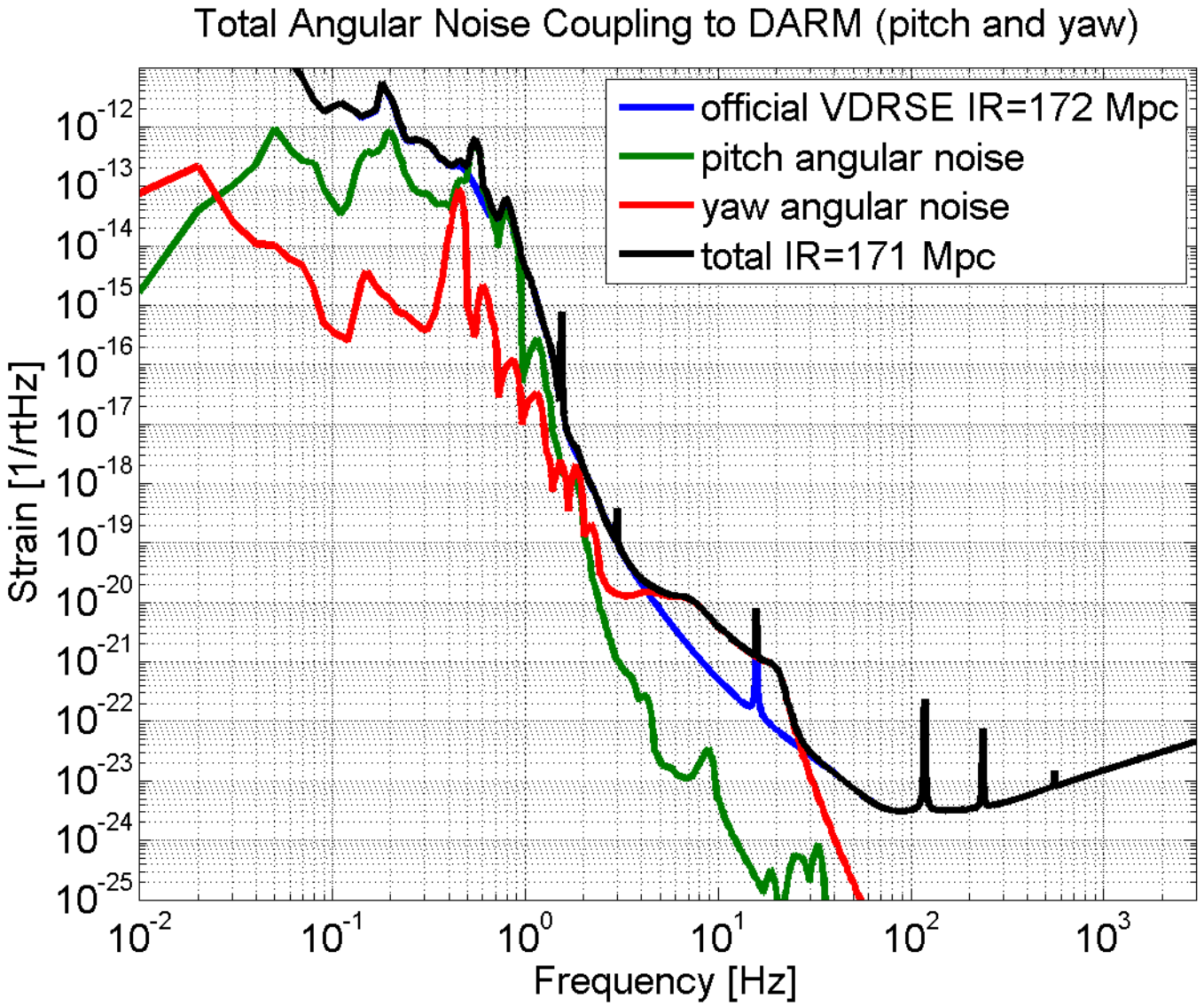
- Slight impact on bKAGRA sensitivity below ~24 Hz



Total Noise

positive

- Total angular noise reduces IR by ~1 Mpc



WFS Shot Noise Summary

- shot noise (signal degeneracy) is almost the same
- See Phys. Rev. D 88, 043007 (2013) for the meaning of the noise figure

	Default	Positive-g
ETMX	1.9E-14	1.7E-14
ETMY	1.9E-14	1.7E-14
ITMX	2.8E-14	2.8E-14
ITMY	2.8E-14	2.8E-14
BS	7.5E-13	4.7E-13
PR3	2.7E-13	1.9E-13
PR2	1.0E-13	1.5E-13
PRM	8.9E-14	1.2E-13
SR3	4.0E-13	5.5E-13
SRM	1.4E-12	3.0E-12

unit: rad/rtHz