Main Interferometer Meeting

2011/2/9

Agenda

- SRC Folding, Yes or No ?
- Decide on the Arm cavity g-factor
- Dynamic range
- f1 frequency. Is 11.25MHz really OK ?
- ASC status
- Green lock design
- Mirror specs
- Task assignment

SRC Folding

Reason for PRC Folding

- If straight: PRC g-factor = 0.9996 -> Transverse mode spacing = FSR/158
- PRC Finesse = 57 ---> Up to 3rd order HOMs are well within the cavity resonance.
- Unpredictable spatial mode of RF SBs in the PRC

How about SRC Folding

- Straight SRC is equally unstable to the PRC
- f1 SB resonates in the PRC-SRC coupled cavity
- HOMs not resonating in PRC won't resonate in the coupled cavity
- SRC could be unstable for f1 in principle.
- Yi Pan and others suggested the GW SBs may be lost by the unstable SRC.

Cavity g-factor

Relevant Issues

- Beam spot size --> Mirror Thermal Noise
- Angular radiation pressure (Sidles-Sigg Instability)
- Parametric Instability

Proposed g-factors from Detector Configuration Group

g1 = 0.87, g2 = 0.6 --> R1 = 23km, R2 = 7.7km

or

g1 = -0.87, g2 = -0.6 --> R1 = 1.6km, R2 = 1.9km

Possible ?

Old g-factors

g1 = g2 = 0.586 --> R1 = R2 = 7.2km

or

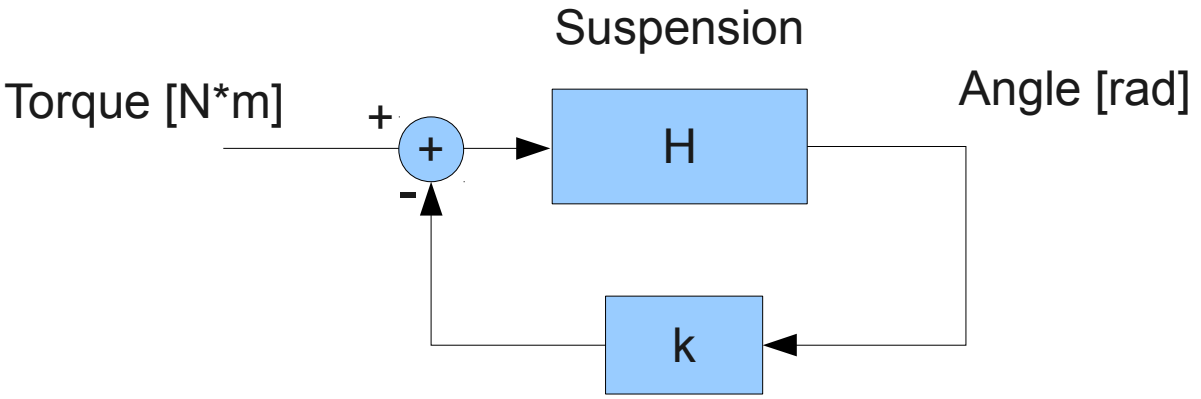
g1 = g2 = -0.586 --> R1 = R2 = 1.9km

Sidles-Sigg Stiffness Matrix

Angular Optical Spring Constant k [N*m/rad]

New g-factors
4.59, -29.2 (g1 = 0.87, g2 = 0.6)
-4.59, 29.2 (g1 = -0.87, g2 = -0.6)

Old g-factors
5.0, -19.33 (g1 = g2 = 0.586)
-5.0, 19.33 (g1 = g2 = - 0.586)



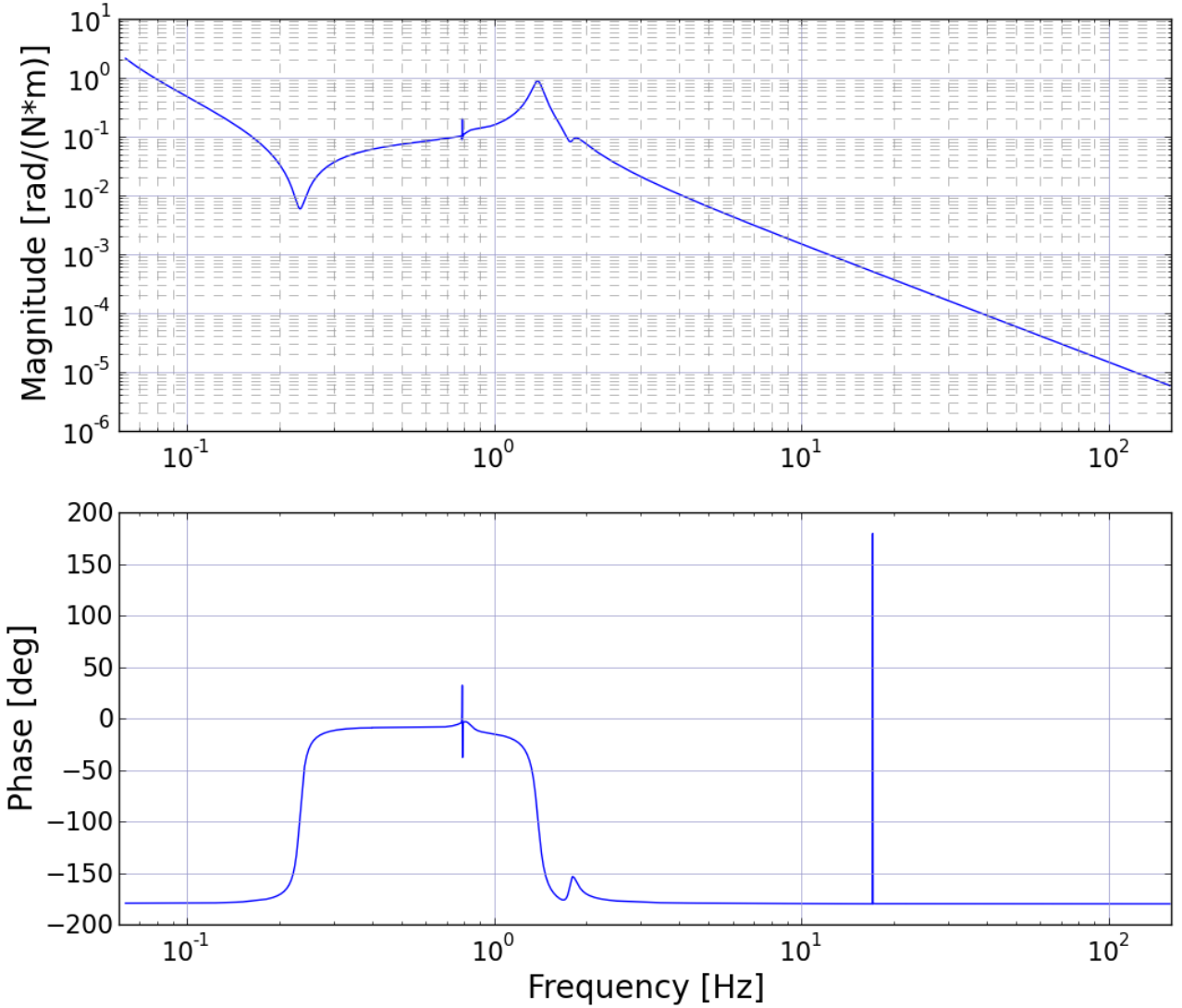
Optical angular spring constant

Open Loop Gain: G = k*H

Check Stability

Suspension TF (by Sekiguchi-kun)

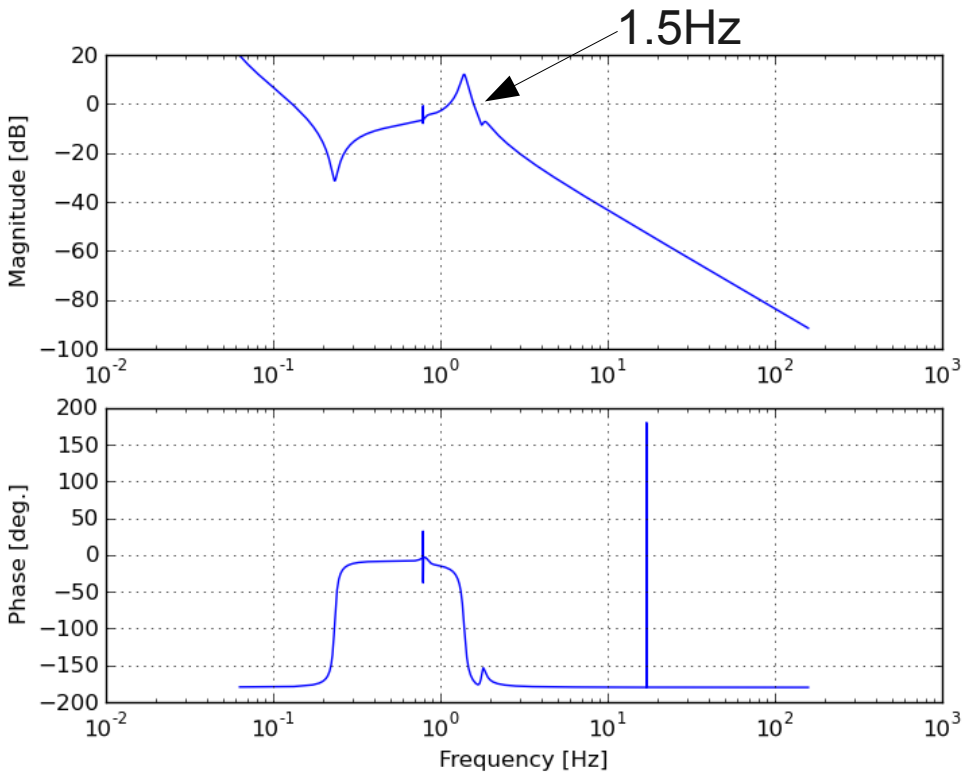
Yaw Torque -> Yaw Angle



This is H

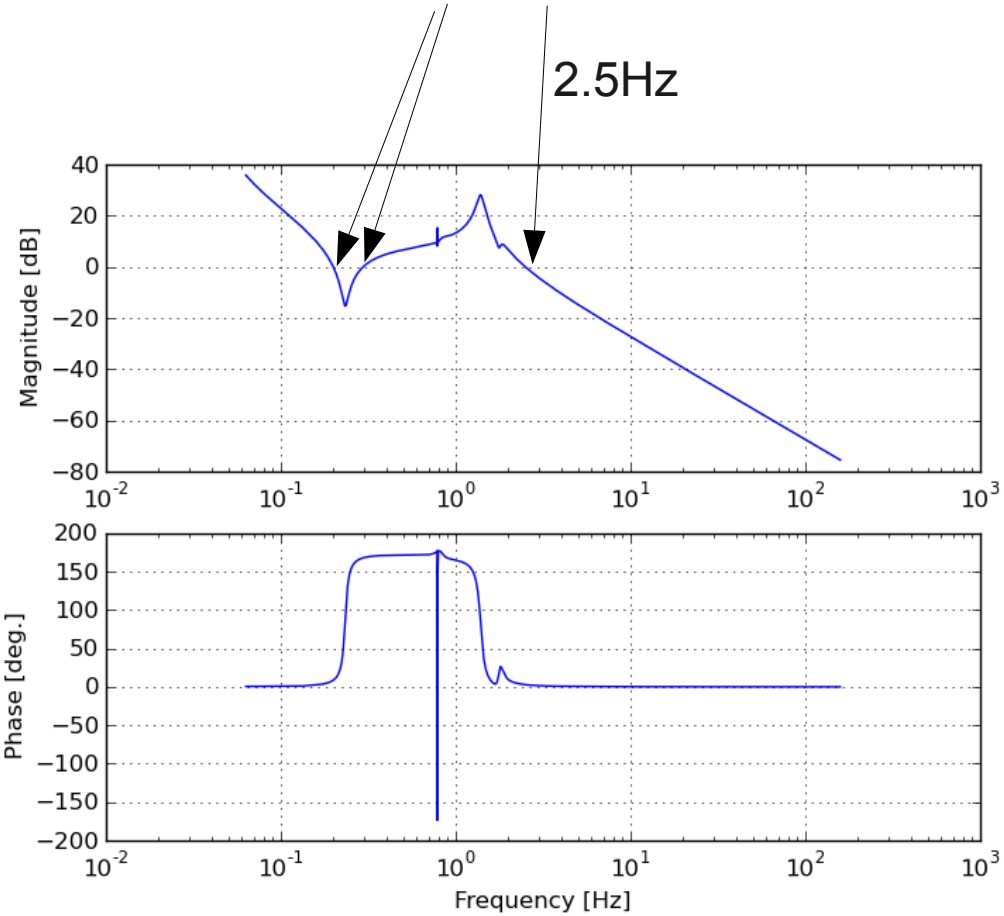
Open Loop TF

New g-factor, positive



Stable

Unstable

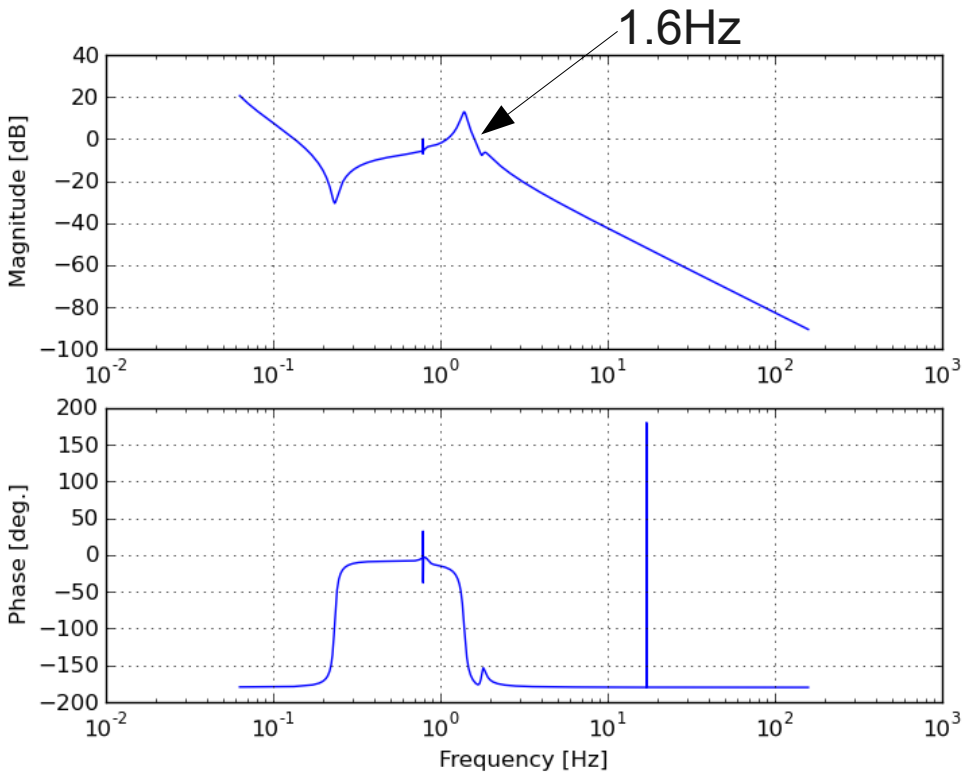


Unstable frequency

Positive g-factor: 2.5Hz
Negative g-factor: 1.5Hz

Open Loop TF

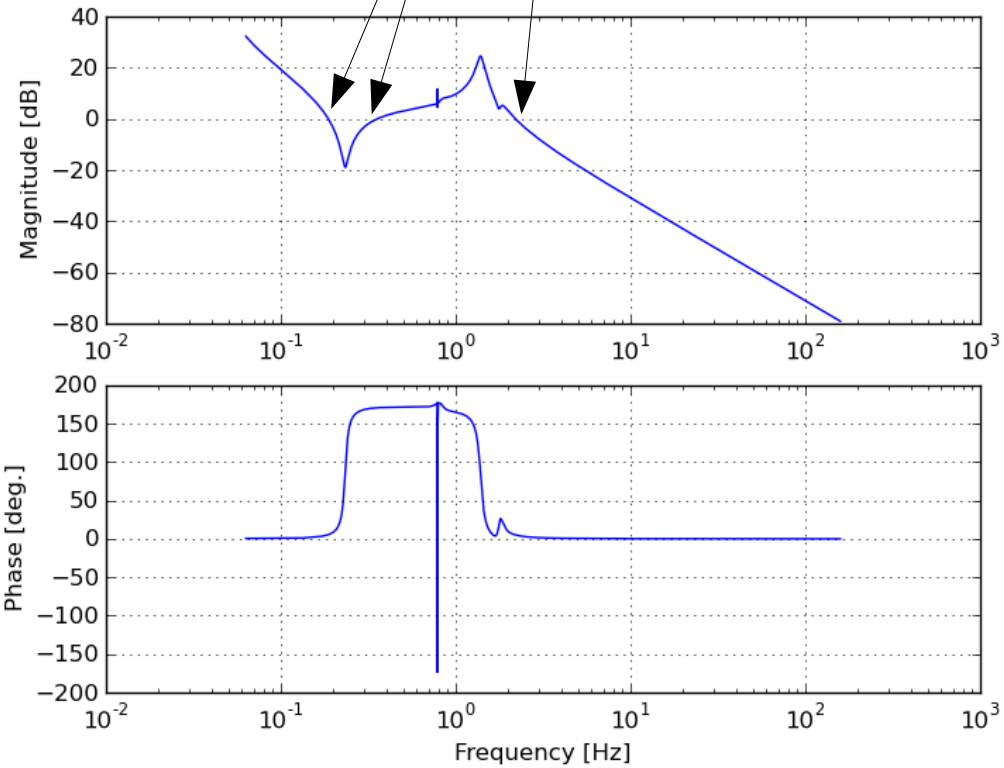
Old g-factor, positive



Stable

Unstable

2.2Hz



Unstable frequency

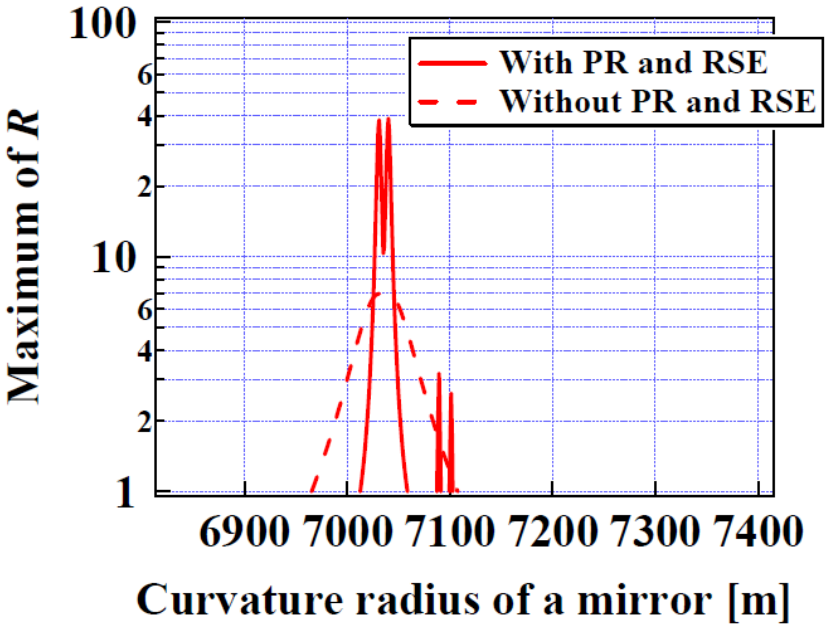
Positive g-factor: 2.2Hz
Negative g-factor: 1.6Hz

No big difference in terms of the Sidles-Sigg instability

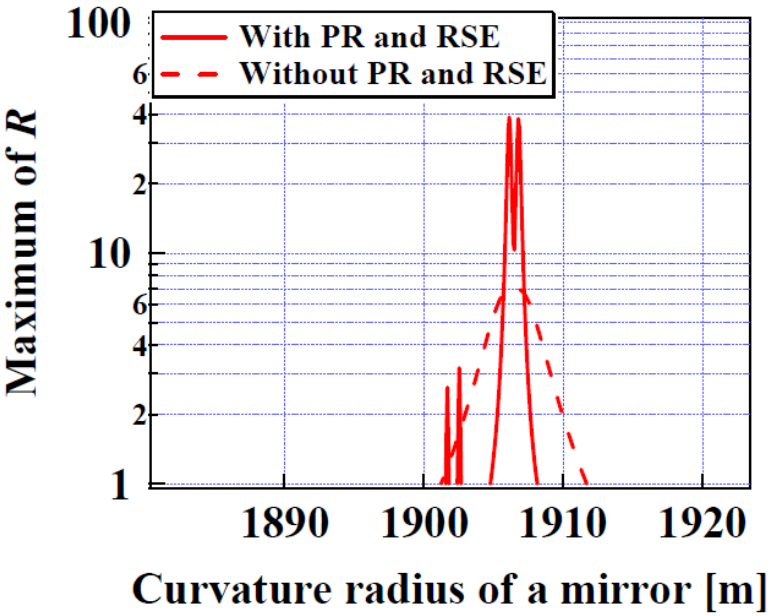
Parametric Instability

There are dangerous regions to avoid in the g-factor space

Positive g-factor



Negative g-factor



The error requirement on the mirror ROC is stricter for the negative g-factor.
by (R_p/R_n)

Negative g-factor: R ~ 1.9km
Positive g-factor: R > 7km

→ Negative g-factor is about 3.7 times more severe to ROC error in terms of PI

10m ROC errror for 1.9km mirror -> 0.5% error
100m ROC errror for 7km mirror -> 1.5% error

Conclusion on g-factor

Please vote !

		Thermal Noise (IR) DRSE/BRSE [Mpc]	Optical Spring Unstable Freq.	PI	Other
(a)	g1=0.87 g2=0.6	273/245	2.5Hz	Easy	ROC=23km may not be possible
(b)	g1=-0.87 g2=-0.6	273/245	1.5Hz	Severe	
(c)	g1=0.586 g2=0.586	266/241	2.2Hz	Easy	iLIGO mirrors can be used.
(d)	g1=-0.586 g2=-0.586	266/241	1.6Hz	Severe	

Modulation Frequencies

Concerns about 11.25MHz scheme

- f1:f2 = 1:4 prohibits the use of 3rd harmonics demodulation
- f3 = 7/2*f1 --> f2 -f3 ~ 5.6MHz too low ?
- MICH reflectivity for f1 is about 50%, SRC resonance is not sharp
  --> MICH signal may be too small.

Test other frequencies

(a) 11.25MHz - 45MHz: Lmc = 26.6m, Lprc = Lsrc = 73.3m, Las = 3.3m, Rmi=50%

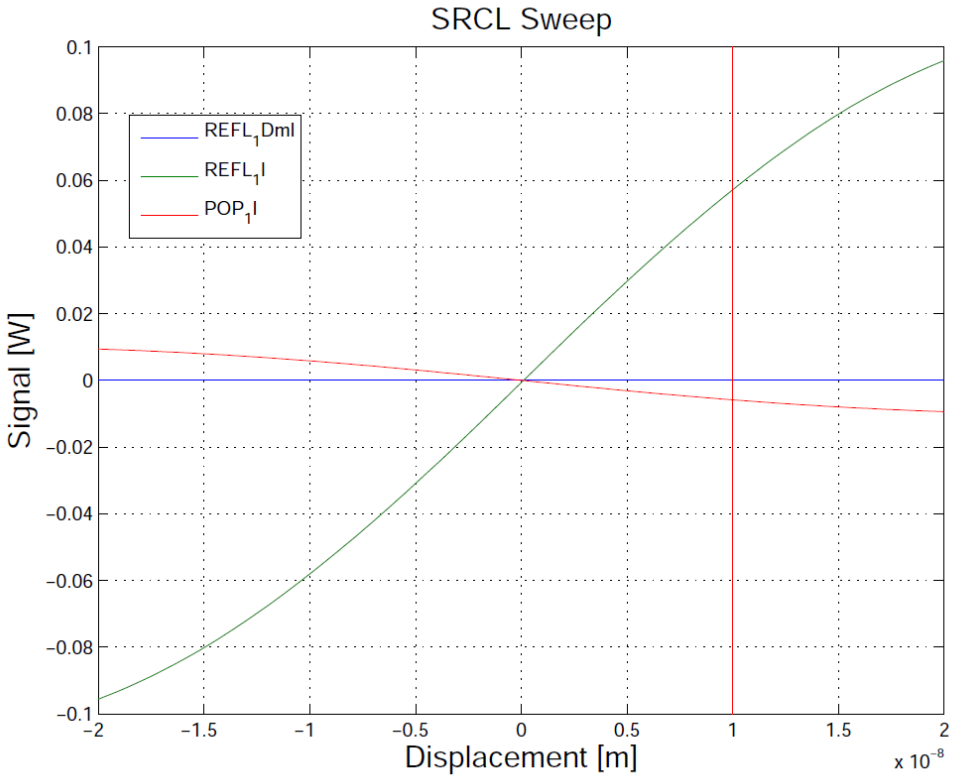
(b) 9MHz - 45MHz: Lmc = 33.3m, Lprc=Lsrc=74.9m, Las = 6.6m, Rmi=10%

(c) 12.857MHz - 45MHz: Lmc=23.3m, Lprc=Lsrc=81.6m, Las=6.6m, Rmi=5%

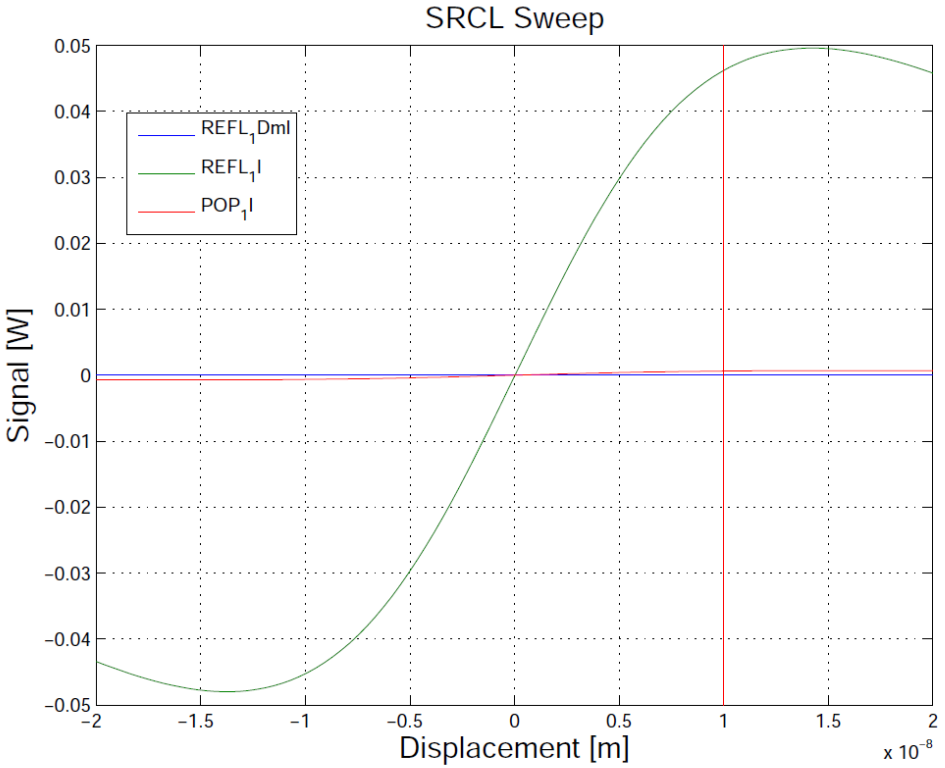
(d) 13.5MHz - 45MHz: Lmc = 33.3m, Lprc=Lsrc=83.3m, Las=3.3m, Rmi = 34%

SRC Detuning

(a) 11.25MHz-45MHz

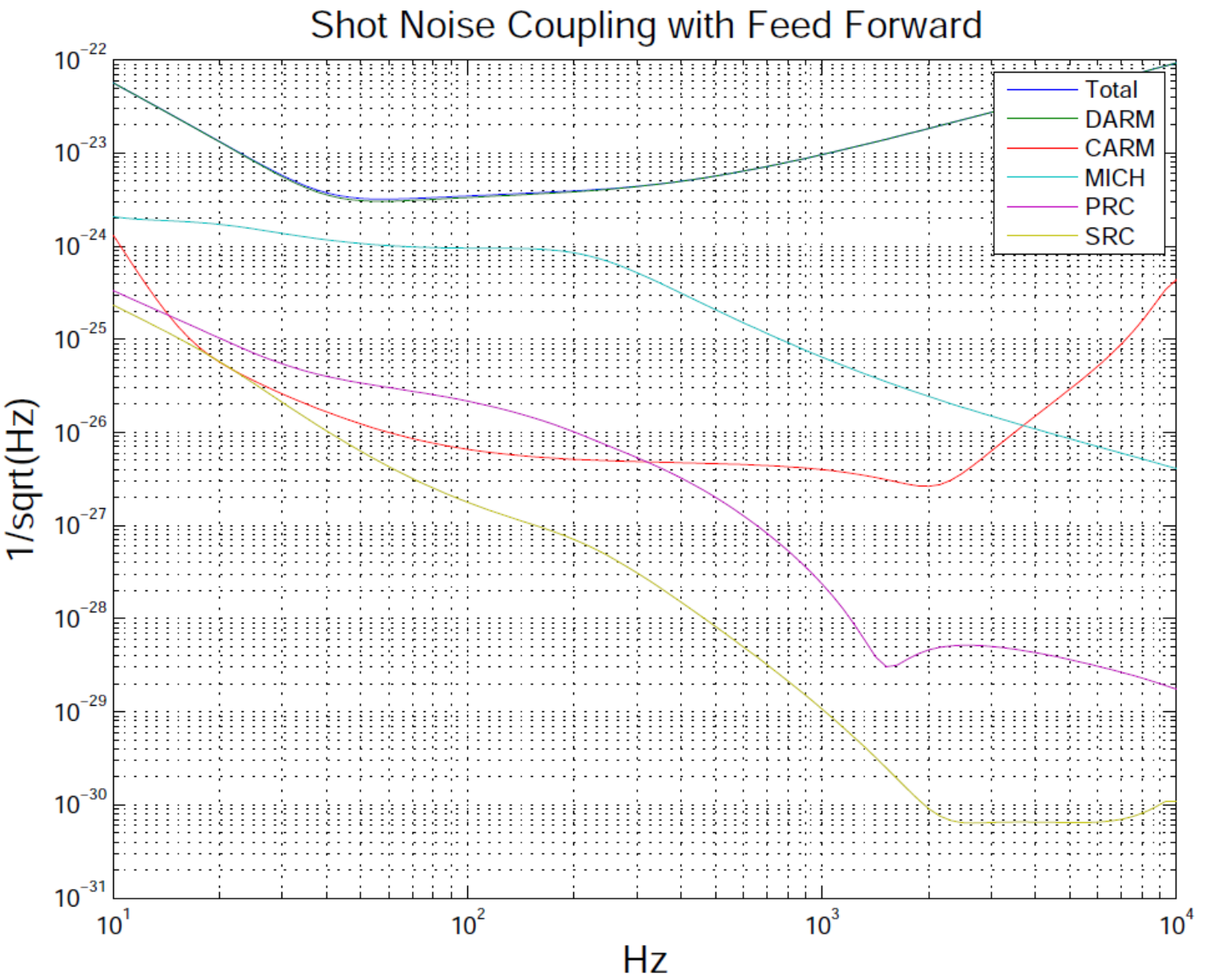


(b) 9MHz-45MHz



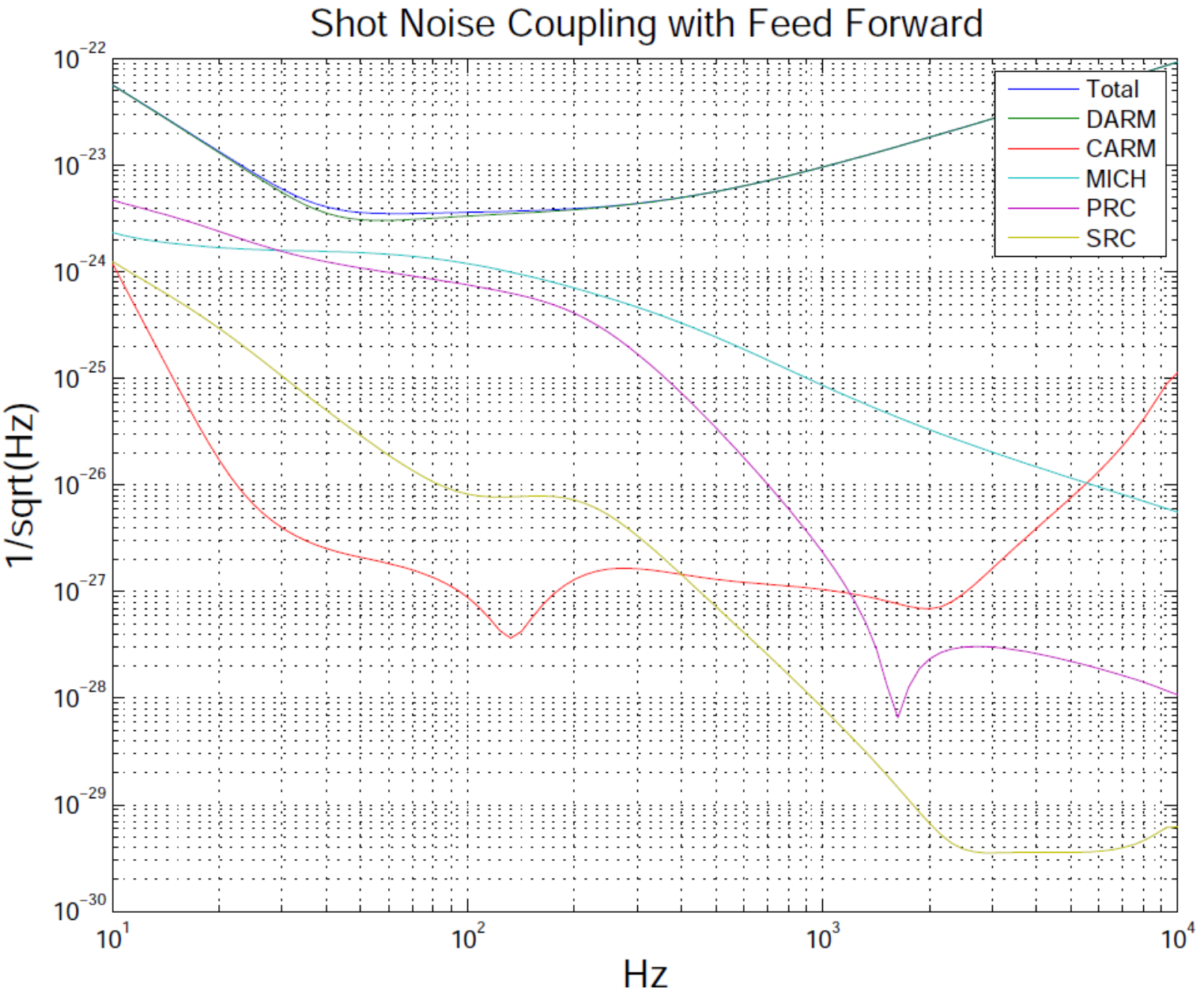
Loop Noise: BRSE 11.25MHz DDM with NRS

Feed forward gain = 100, MICH UGF=50Hz



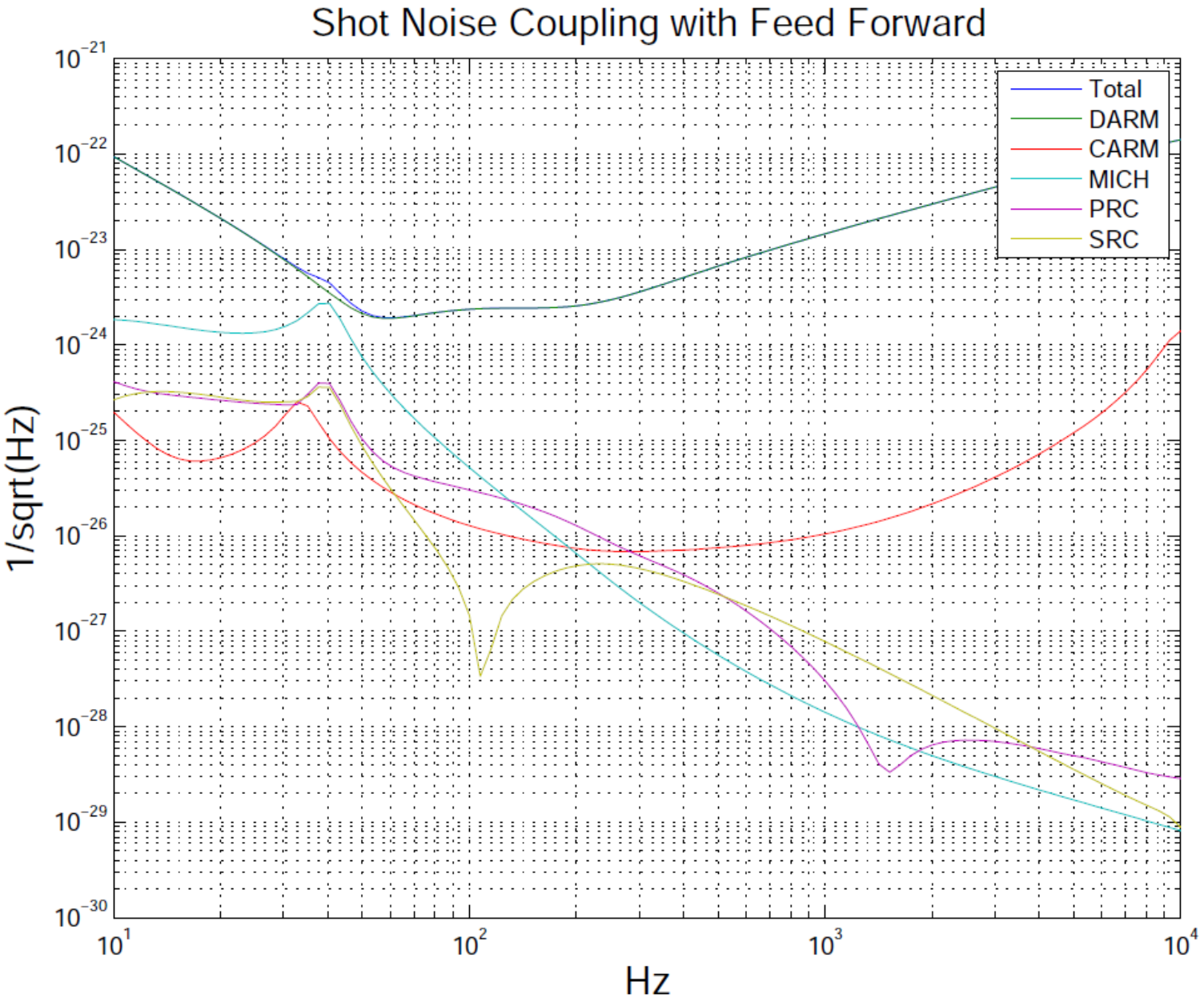
Loop Noise: BRSE 11.25MHz SDM

Feed forward gain = 100, MICH UGF=50Hz



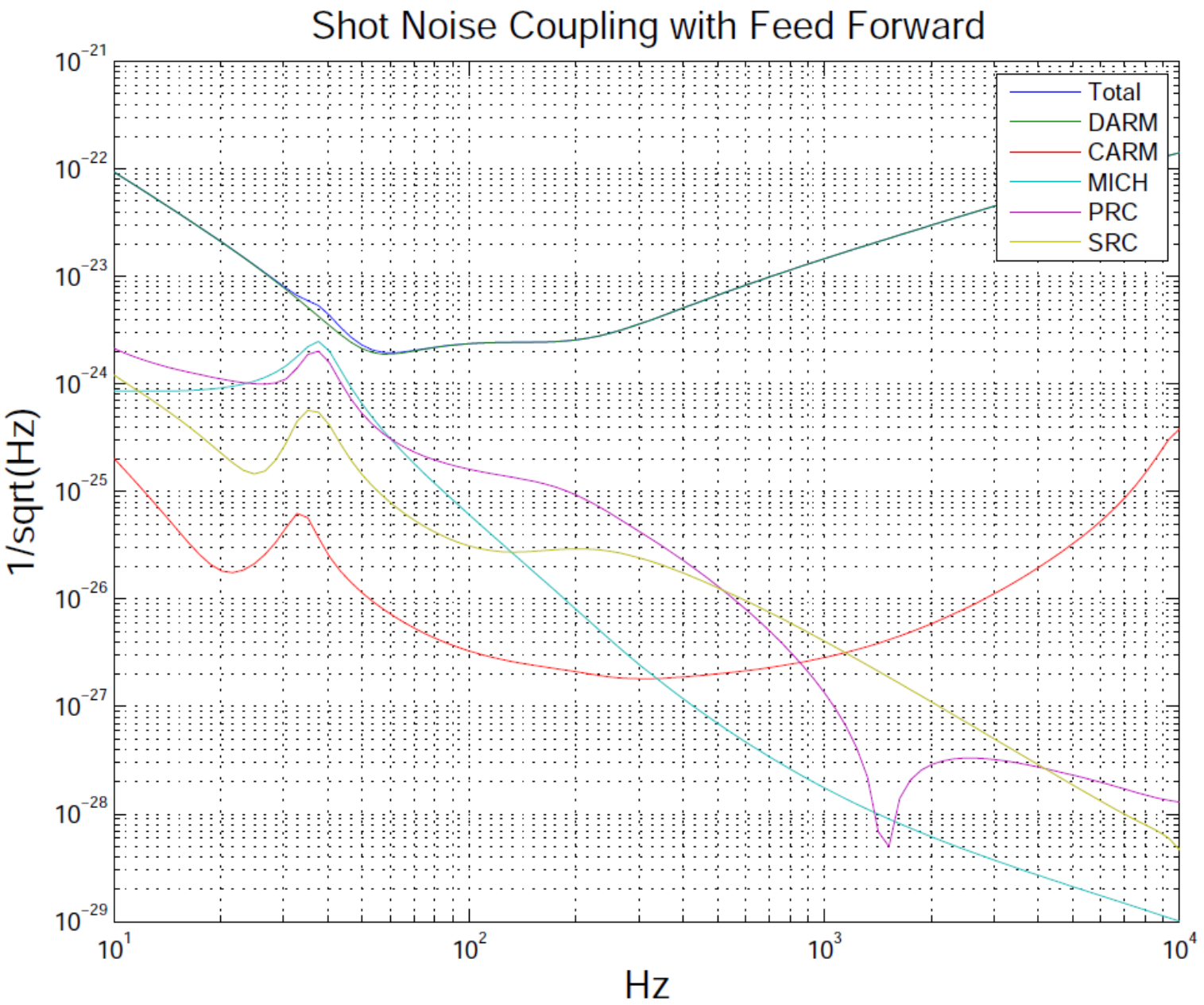
Loop Noise: DRSE 11.25MHz DDM with NRS

Feed forward gain = 100, MICH UGF=10Hz



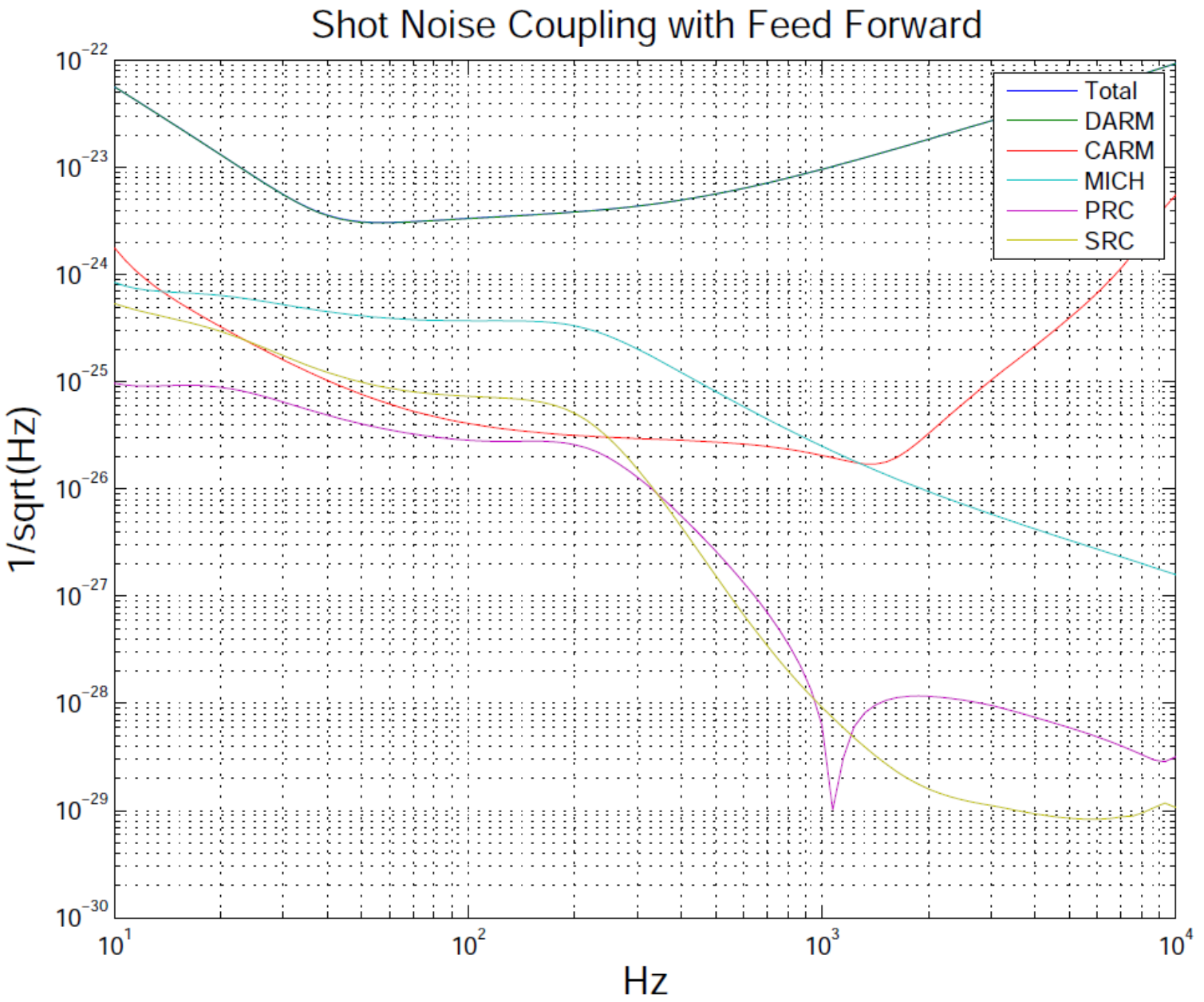
Loop Noise: DRSE 11.25MHz SDM

Feed forward gain = 100, MICH UGF=10Hz



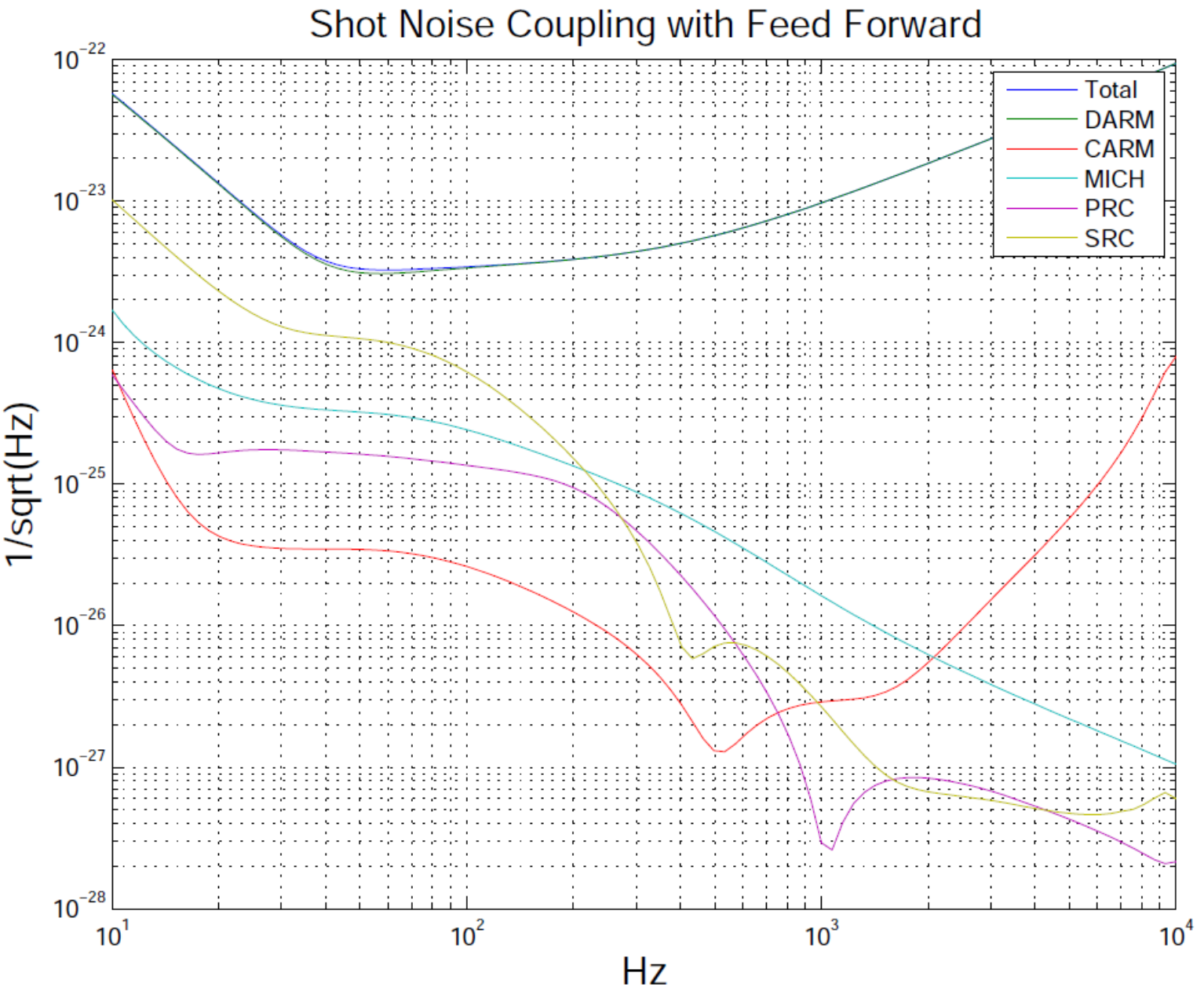
Loop Noise: BRSE 9MHz DDM with NRS

Feed forward gain = 100, MICH UGF=50Hz



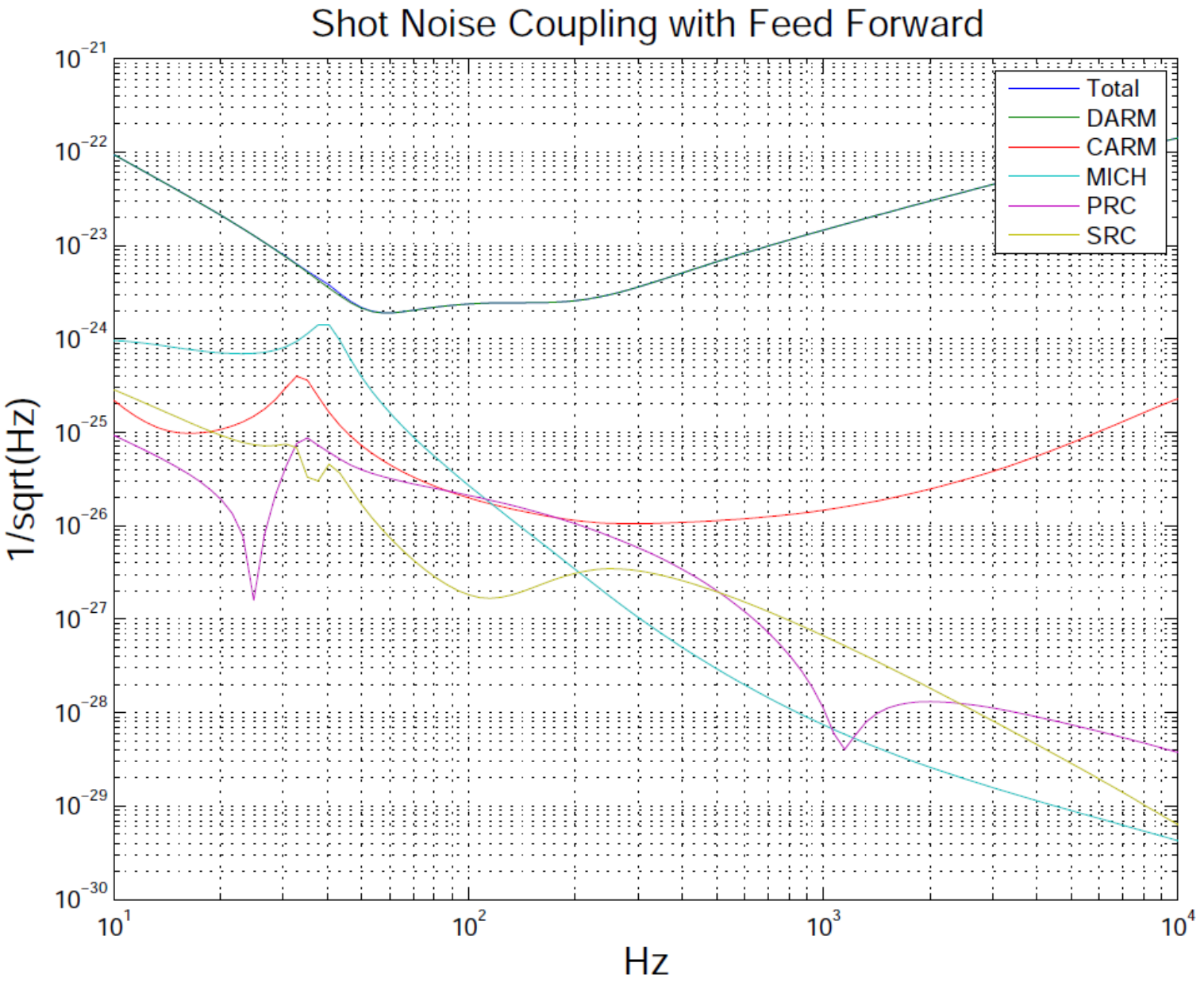
Loop Noise: BRSE 9MHz SDM

Feed forward gain = 100, MICH UGF=50Hz



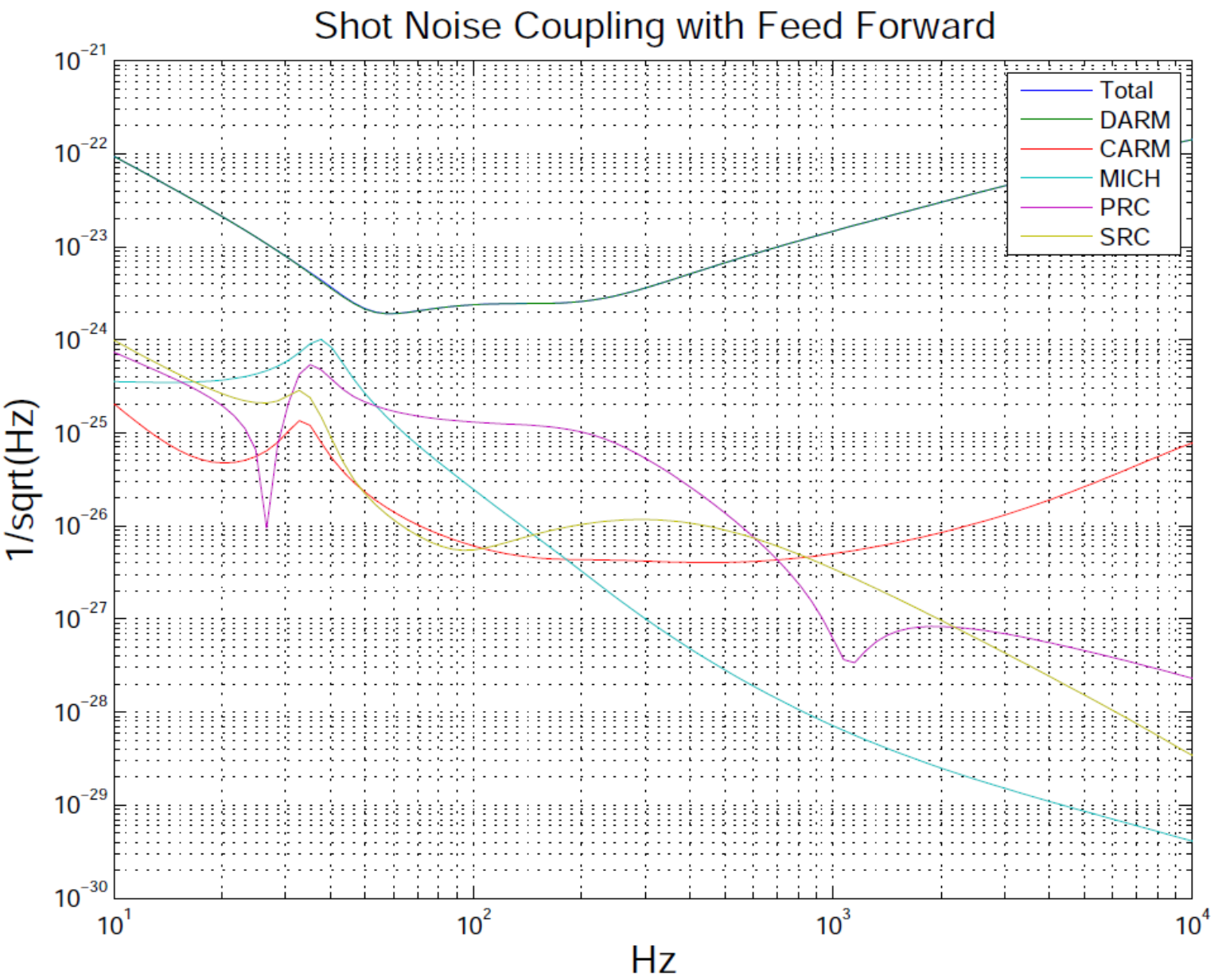
Loop Noise: DRSE 9MHz DDM with NRS

Feed forward gain = 100, MICH UGF=10Hz



Loop Noise: DRSE 9MHz SDM

Feed forward gain = 100, MICH UGF=10Hz



Change the modulation frequencies ?

- 9MHz seems better than 11.25MHz
- f3 = 7/2 * 9MHz = 31.5MHz, f3-f1 = 22.5MHz, f2-f3 = 13.5MHz
- Lmc and Las are a bit longer
- (d) is not much different from (a)
- (c) is not as good as (b) (have to check why)

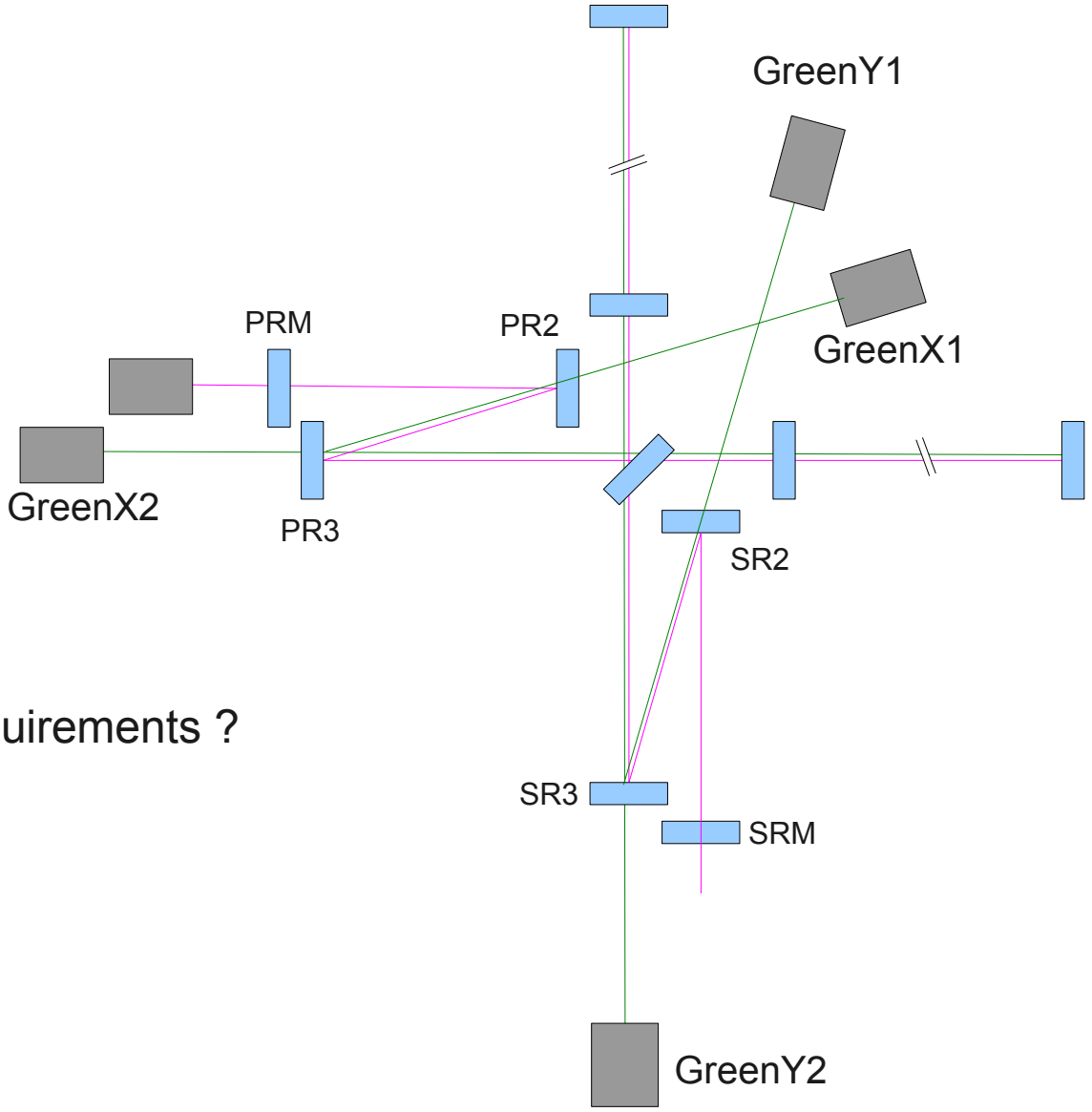
We have to decide Now !

Green Lock Scheme

We need to have mirror specs for 532nm soon.

Where to inject green ?
PR2 or PR3

PR2: Beam size is smaller
PR3: No 532nm coating for PR2



- End injection ?
- How tolerant are the green coating requirements ?
- How much is the power necessary ?

Mirror Specs

We have to provide more detailed mirror specs to Mio-san as soon as possible.

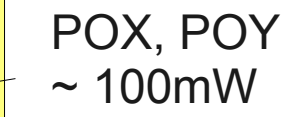
TM Specs (Draft)

HR@1064nm=99.6%+/-0.01%(ITM), >99.9945% (ETM)
HR@1064nm imbalance between X and Y: ???

HR@532nm = 80%+/-10% (R_ITM < R_ETM)
HR loss@1064nm < 45ppm (loss imbalance: ???)
HR loss@532nm < 1%

AR@1064nm=200ppm+100/-0ppm
AR@532nm<5%

ROC = 7177m +50/-20m
Wedge angle = 0.25deg (+/-0.01deg?)



BS Specs (Draft)

HR@1064nm=50%+/-0.1%

HR@532nm = 10%
HR loss@1064nm: 0.01%? Set from thermal lens
HR loss@532nm < 10%

AR@1064nm < 50ppm
AR@532nm < 10%

ROC = flat (how flat ?)
Wedge angle = 0.48deg (+/-0.01deg?)

PRM Specs (Draft)

HR@1064nm=90%+0/-0.1%

HR loss@1064nm: < 100ppm

AR@1064nm < 50ppm

ROC = 316m +/-1m
Wedge angle = 2deg (LIGO mirror)

SRM Specs (Draft)

HR@1064nm=84.64%+/-0.01%??

HR loss@1064nm: < 100ppm

AR@1064nm < 50ppm

ROC = 316m +/-1m
Wedge angle = 2deg (LIGO mirror)

PR2/SR2 Specs (Draft)

HR@1064nm = 99.95%+/-0.01%
HR@532nm < 10%

HR loss@1064nm: < 100ppm
HR loss@532nm: < 1%

AR@1064nm < 500ppm
AR@532nm < 10%

ROC = -3.964m +/-1cm
Wedge angle = 2deg (LIGO mirror)

PR3/SR3 Specs (Draft)

HR@1064nm > 99.95%
HR@532nm > 80%

HR loss@1064nm: < 100ppm
HR loss@532nm: < 1%

AR@1064nm < 1000ppm
AR@532nm < 10%

ROC = 32.1m +/-10cm
Wedge angle = 2deg (LIGO mirror)

Task Assignment

LSC: Aso + ...
ASC: Michimura, Agatsuma
ISC Check: Somiya, Miyakawa + ...

Optical Layout: Aso --> Manual check by some student
Mirror Specs: Aso -> ....

Green Lock: Akutsu, Izumi