Arm Cavity g-factorを本当にどうするべきか?

- ビームサイズ:　本当に広げる必要があるか?
- PIをg-factorの決め手にするべきではない?(by reviewers)
- Sidles-Sigg: やはりNegative g-factorが良いようにも思える、、。
- 鏡研磨の精度がわからない、、。

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

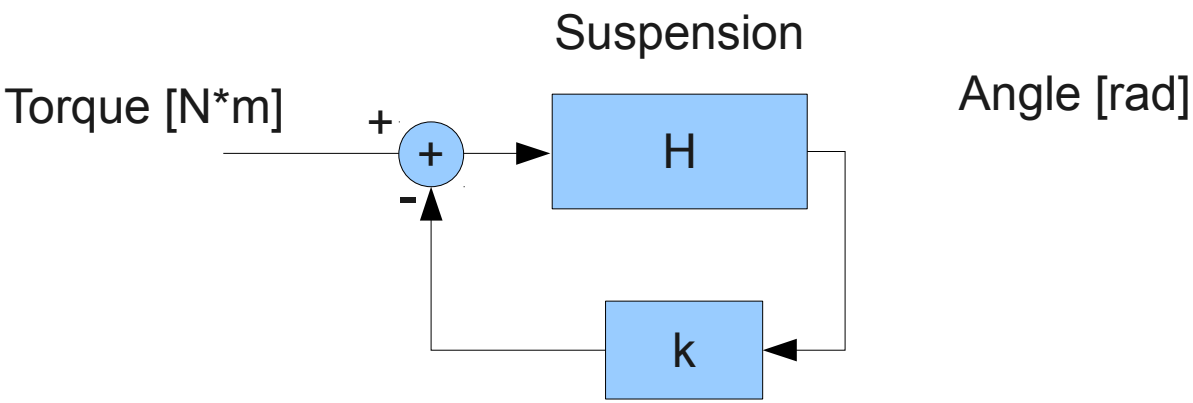
g1 = g2 = -0.586 --> R1 = R2 = 1.9km

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)



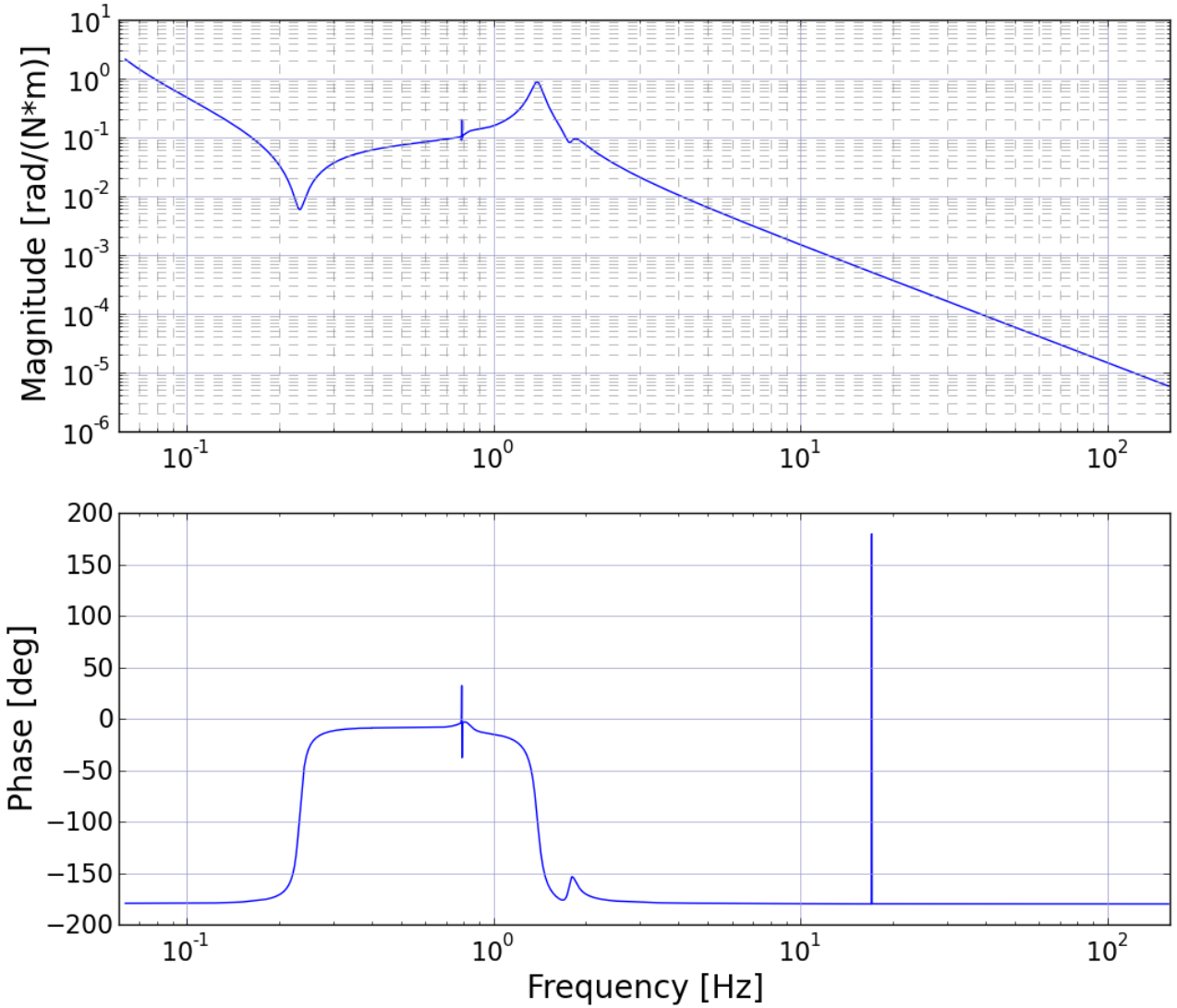
Optical angular spring constant

Open Loop Gain: G = k*H

Check Stability

Suspension TF (by Sekiguchi-kun)

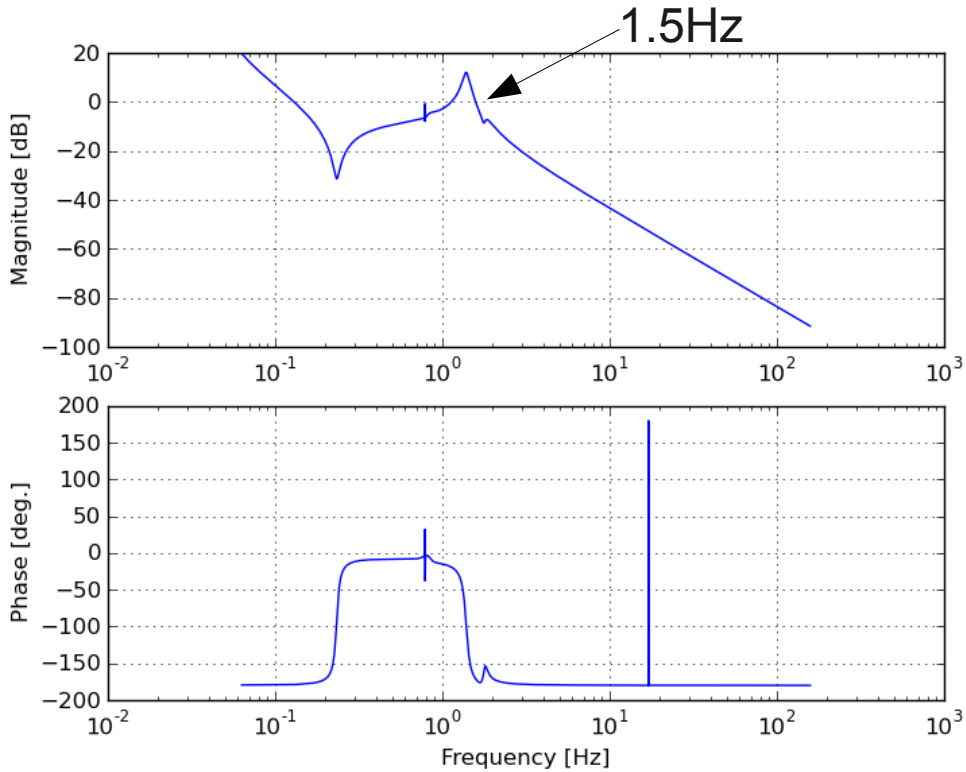
Yaw Torque -> Yaw Angle



This is H

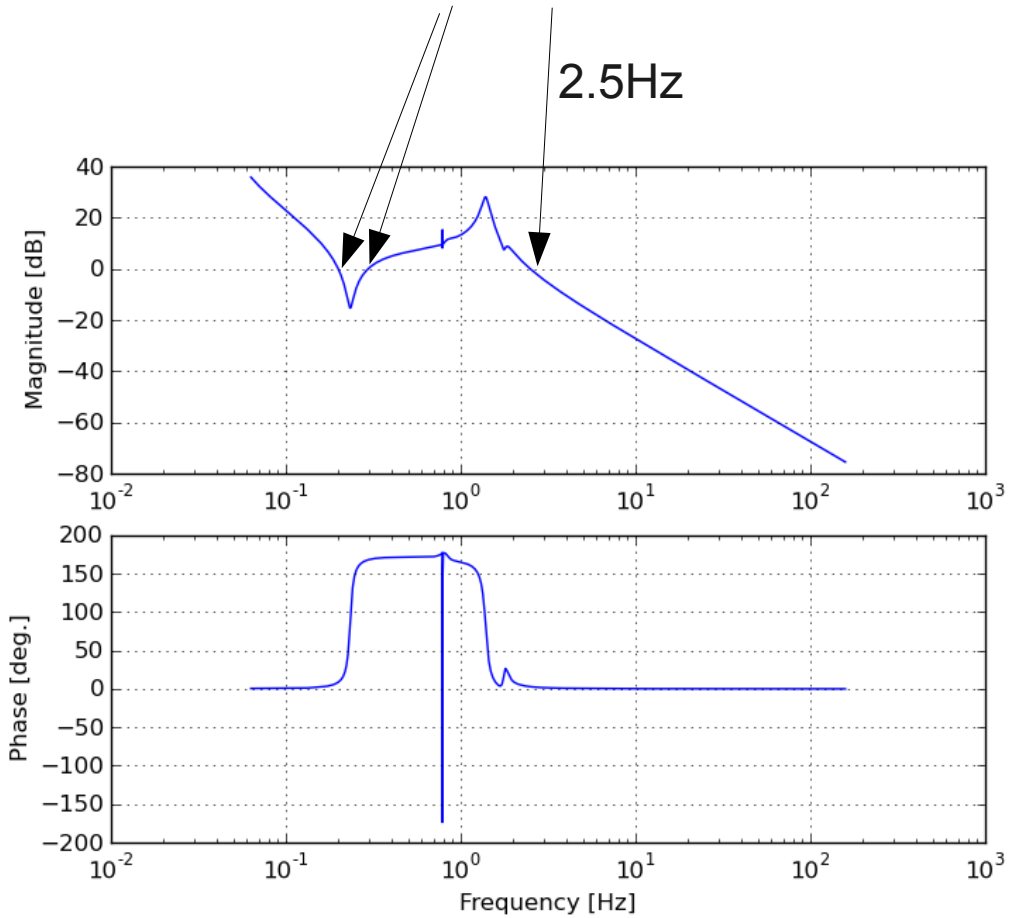
Open Loop TF

New g-factor, positive



Stable

Unstable

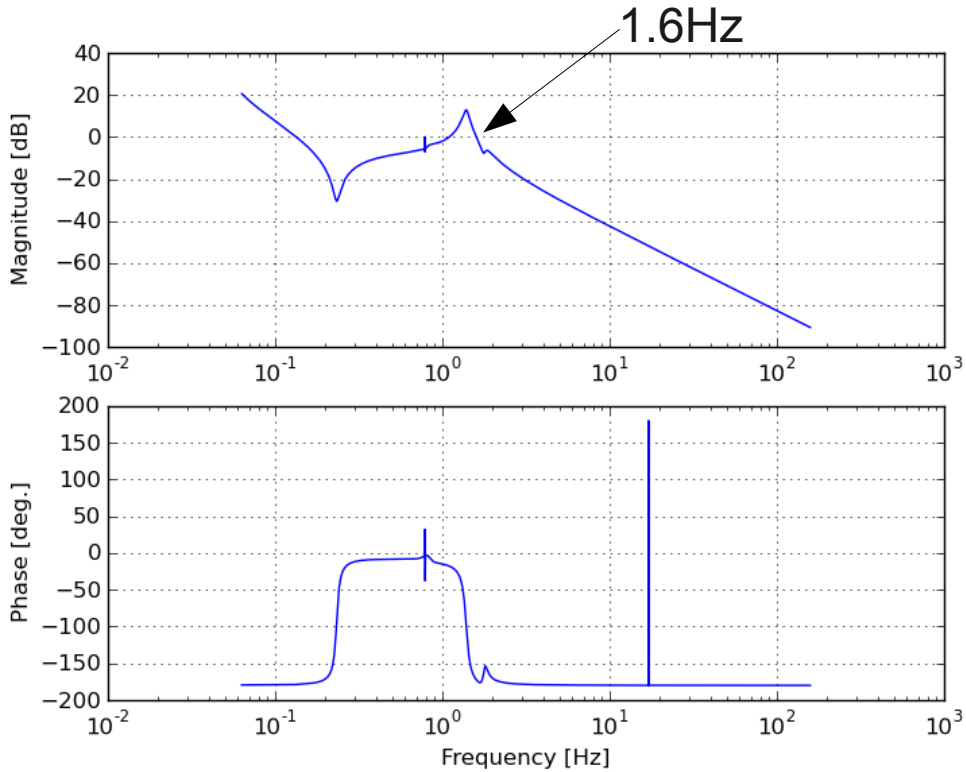


Unstable frequency

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

Open Loop TF

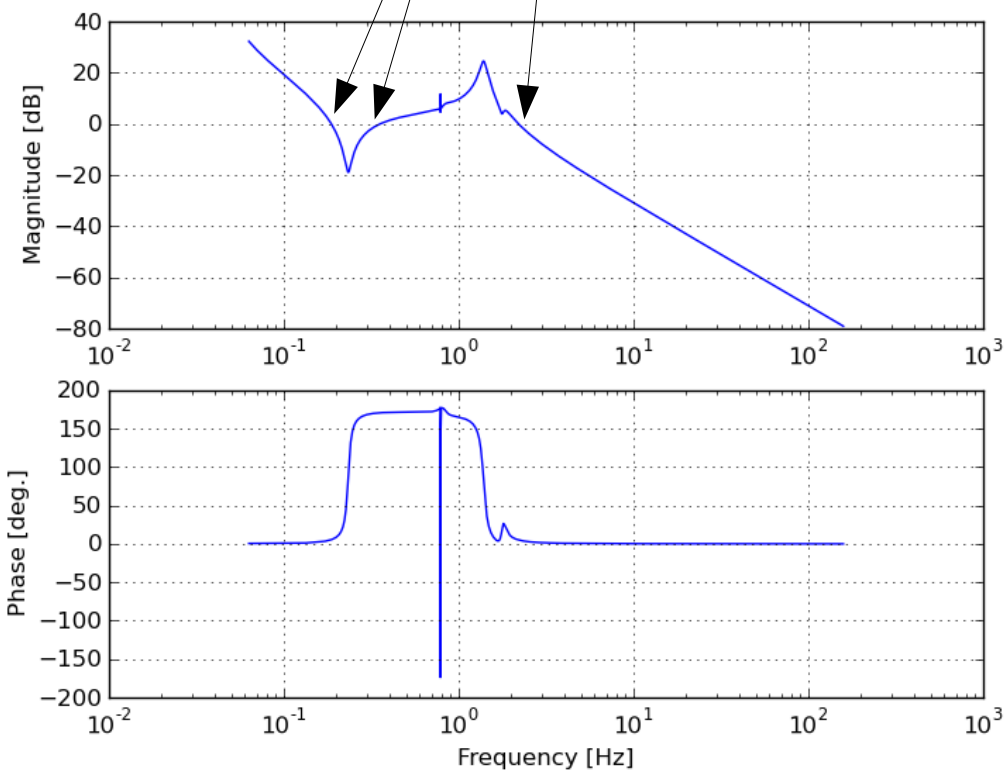
Old g-factor, positive



Stable

Unstable

2.2Hz



Unstable frequency

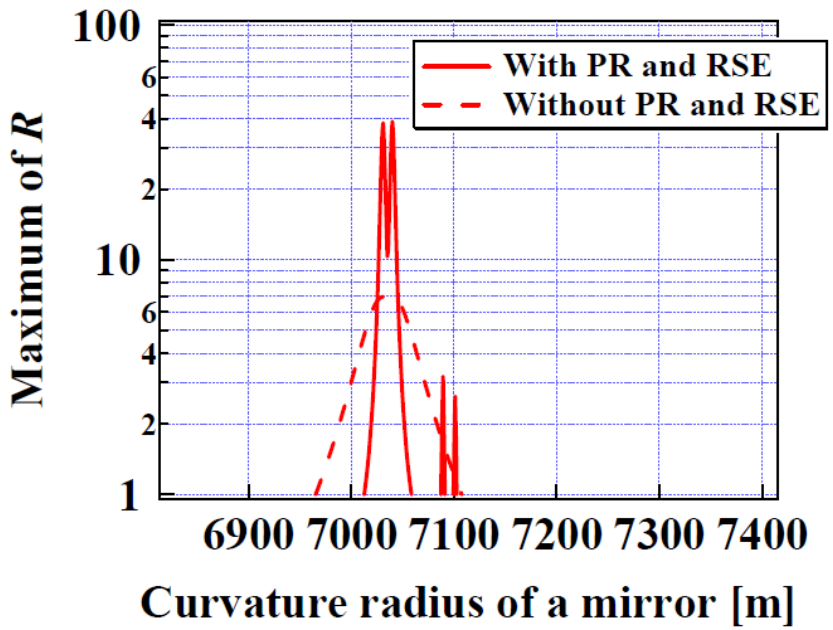
Positive g-factor: 2.2Hz
Negative g-factor: 1.6Hz

No big difference in terms of the Sidles-Sigg instability

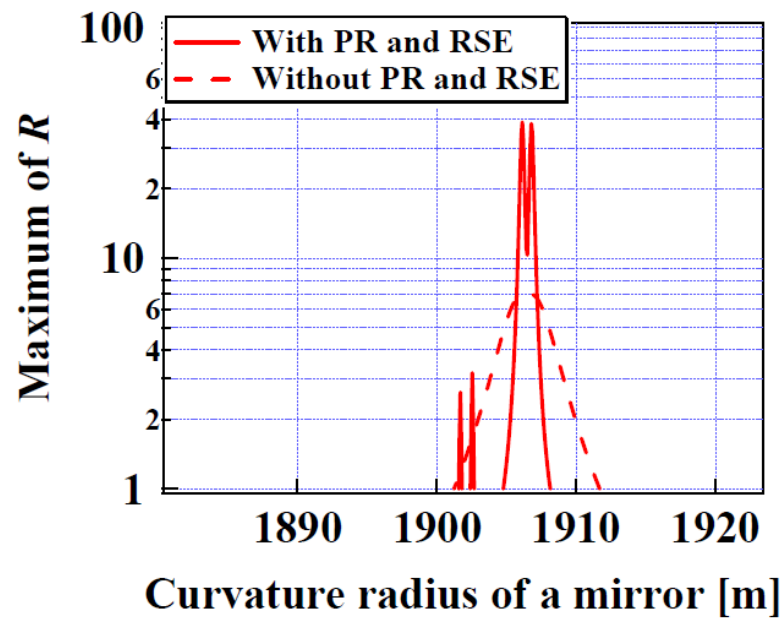
Parametric Instability

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

Positive g-factor



Negative g-factor



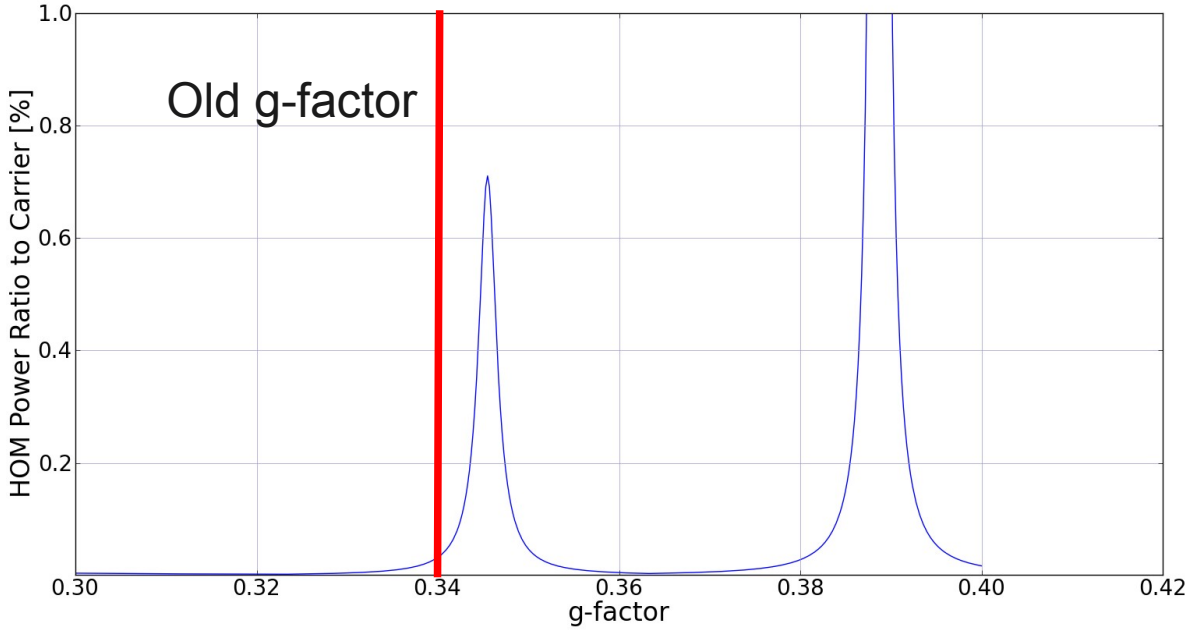
The error requirement on the mirror ROC is stricter for the negative g-factor.
by (R_p / R_n)

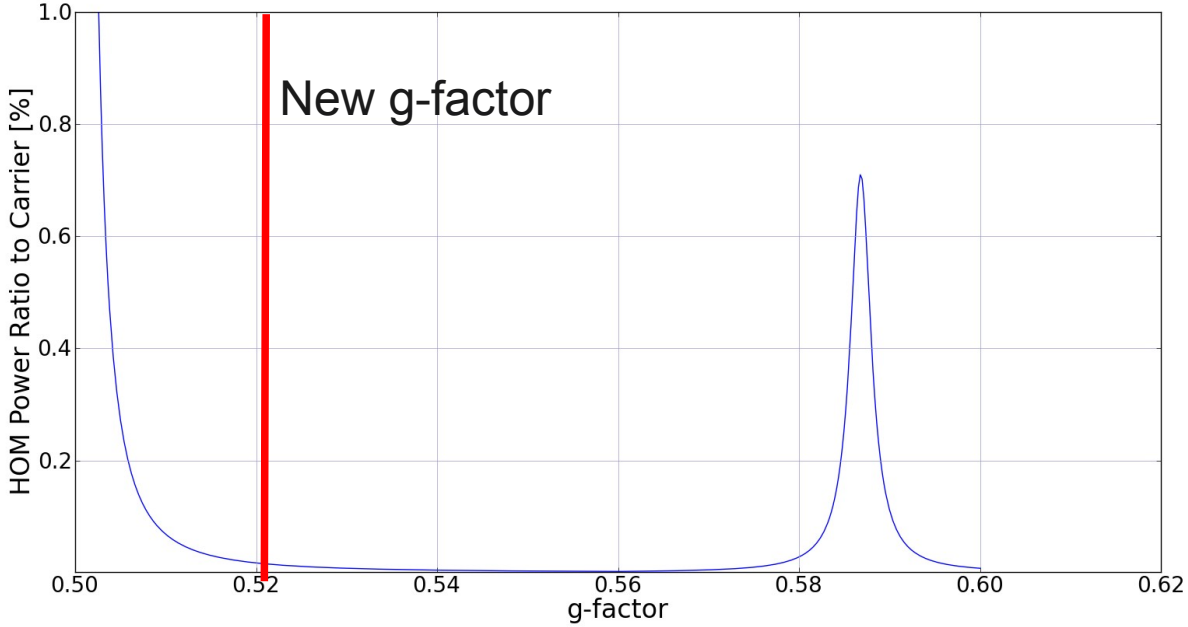
Negative g-factor: R ~ 1.9km
Positive g-factor: R > 7km

→ 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

Max HOM Resonances in the arm





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	

三尾先生のコメント

超長曲率半径鏡の件、問い合わせをしていますが、回答がありません。フラットだとダメなんですか？0.5%の話は一応、会社に伝えてありますが、測れないというのが現状でしょう。
どっちにしろ、測定ができれば、磨けると思います。たぶん。
どっちが難しいかというのは、あまりいい質問のように思えません。どっちも難しいということになりそう。
ごめん、あんまり、きちんと対応できる時間と頭がありません。

23kmミラー -> 出来るかどうか不透明
0.5%エラー -> 出来るかどうか不透明

↓

現状で選択できるのは(c)しかない?