Report on Simulation Studies on Interferometer Configuration for O3

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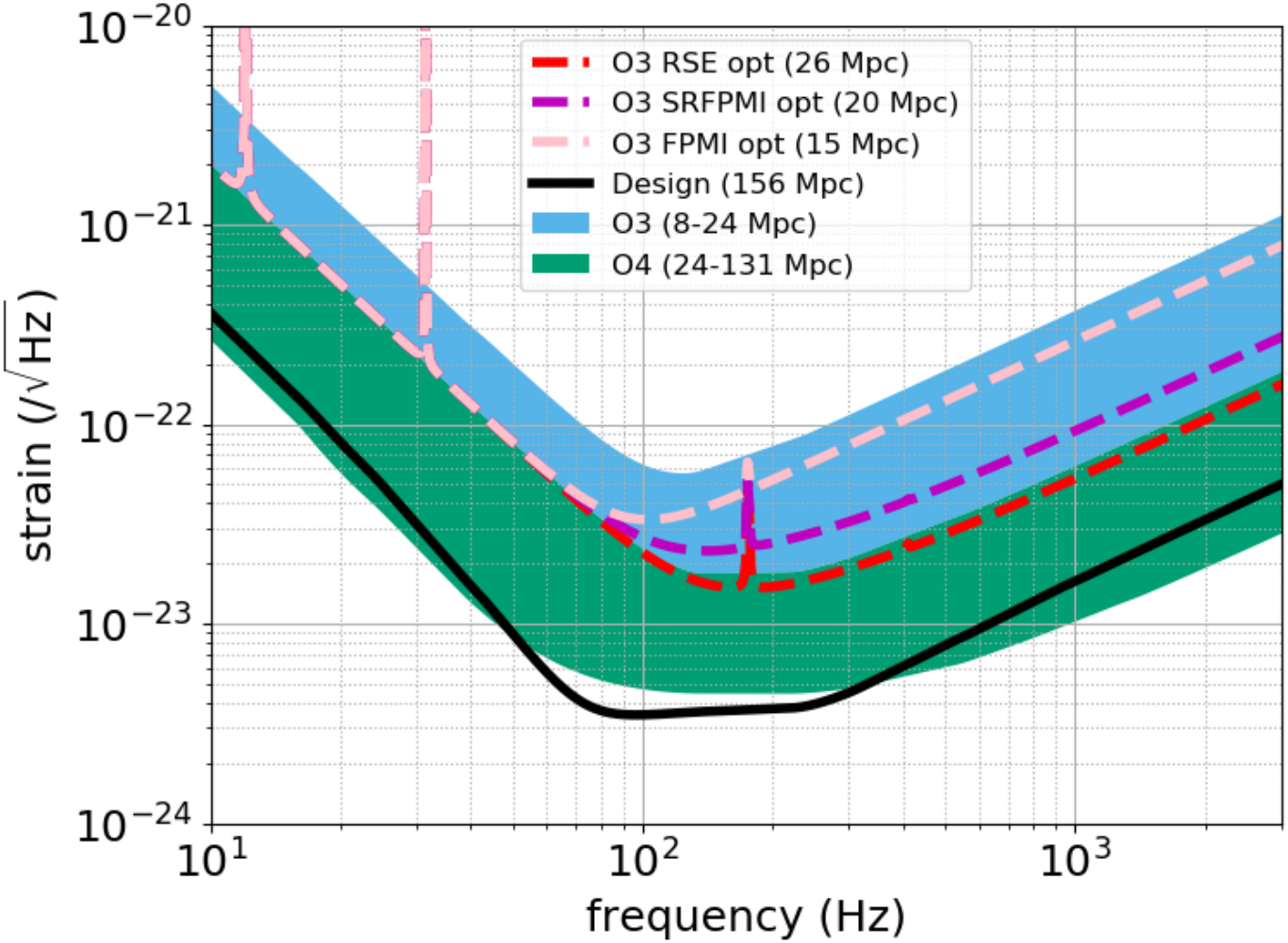
Quantum Noise

- If we can reach quantum noise, FPMI can achieve 15 Mpc in BNS range

JGW-G1910389



Frequency and Intensity Noise

- Current frequency and intensity noise are very bad, but in principle, they shouldn't affect the sensitivity if DRFPMI, even if there's ITM asymmetry
- Frequency and intensity noise will be 10 times higher for FPMI and SRFPMI. For frequency noise, CARM shot noise might be O(10) times higher due to more power (which require more attenuation) on REFL
- Note that frequency and intensity noise coupling will be even higher when we consider ITM inhomogeneity (arXiv:1907.12785)
- See JGW-T1910352 for details
- Actual frequency and intensity noise coupling measurements will improve the sensitivity estimate

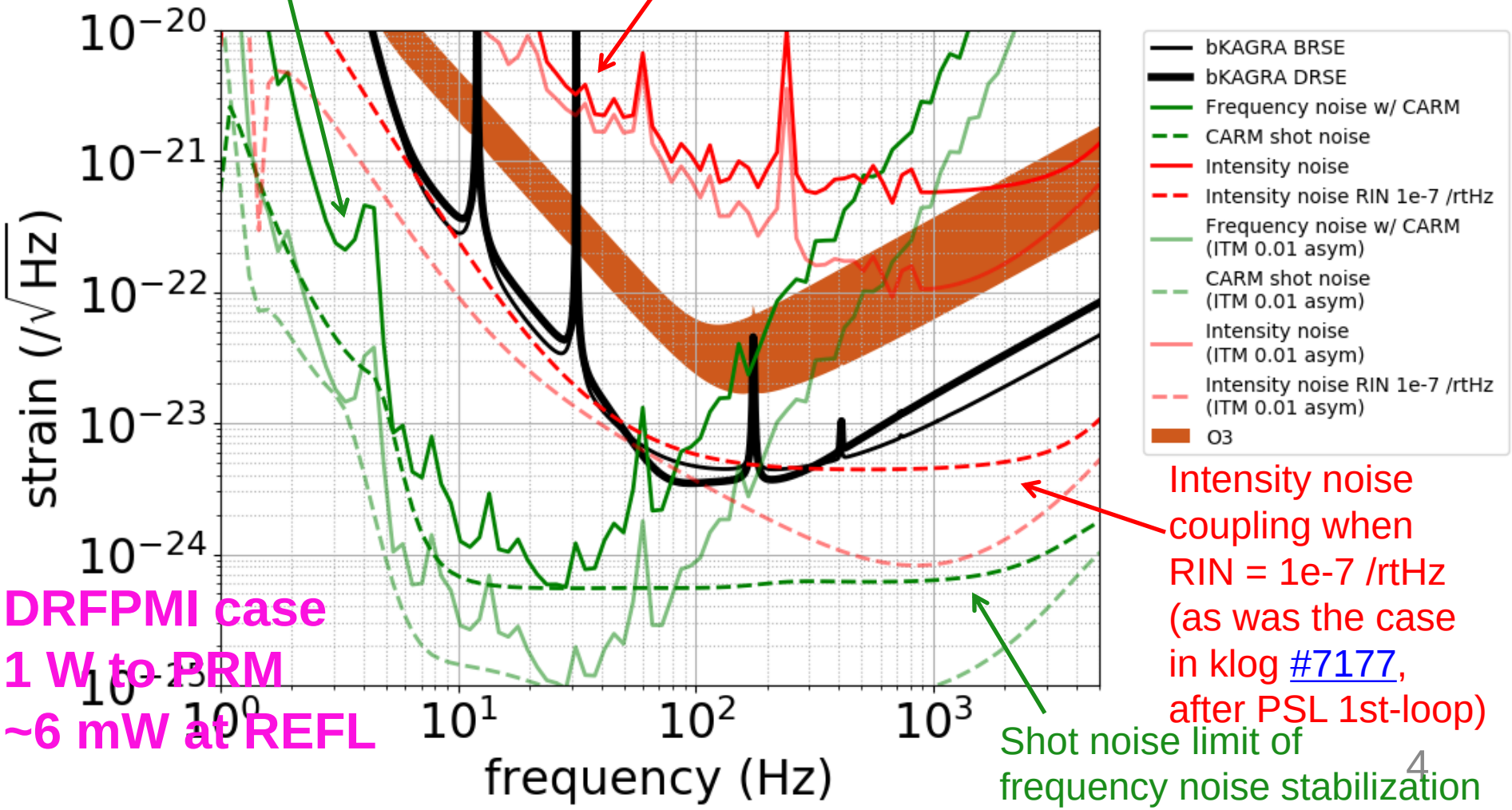
JGW-T1910352

Result

Frequency noise coupling estimated with current measured frequency noise; CARM loop turned on (could be limited by measurement noise at high frequencies)

Intensity noise coupling estimated with current measured intensity noise (stabilization servo not on yet)

Dim lines represent same curves when ITM transmission asymmetry was 0.01



DRFPMI case
1 W to PRM
~6 mW at REFL

Intensity noise coupling when RIN = 1e-7 /rtHz (as was the case in klog #7177, after PSL 1st-loop)

Shot noise limit of frequency noise stabilization

Alignment Sensing and Control

- Shot noise coupling should be OK for any configurations (JGW-T1910359)
- PRFPMI might be the worst in terms of ASC shot noise

- ASC could be much worse than calculations done in JGW-T1910359 since the effects from ITM inhomogeneity and birefringence are not considered (work in progress)

Mode-Matching

- Removal of PRM will not pose a critical impact on mode-matching (JGW-T1910582)
- We have a blank SRM and mode-matching will be OK in SRC side

→ Any configuration is OK in terms of mode-matching

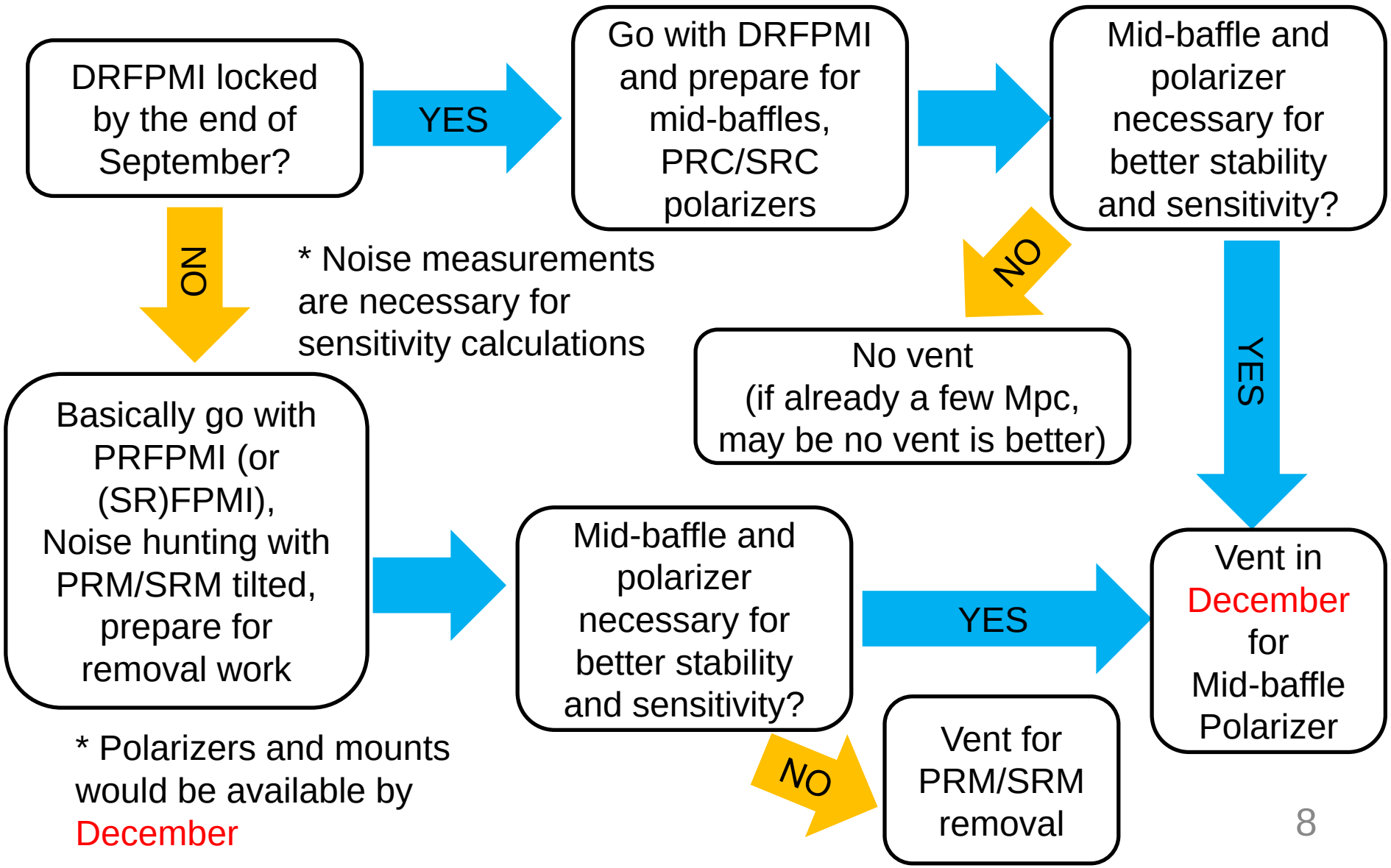
- But removing things require opening of vacuum chambers
- May be better to open the chamber only once before O3

Summary

- Simulations suggest any configuration is OK if we do it correctly
- Frequency and intensity noise in FPMI and SRFPMI sounds scary
- We cannot say that “xx Mpc is not possible with xx configuration” or “at least xx Mpc is possible with xx congifuration” at this point

- Classical noise estimation with correlation measurements (Phys. Rev. A 95, 043831 (2017)), frequency and intensity noise measurements are important for estimating the sensitivity with different configurations

Suggestion from MIF



Suggestion from MIF

- We are very close to PRFPMI lock (klog #10449)
- Frequency and intensity noise couplings in FPMI and SRFPMI sounds scary
- Therefore, we should basically go with PRFPMI or DRFPMI. The issue is whether to replace 2-inch SRM or not and when to replace it
- Since mid-baffles, polarizers and mounts will be available by December, we should vent in December and do their installations and SRM replacement at once, if necessary
- PRFPMI or DRFPMI basically only changes the quantum noise and controls noise coupling. Classical noise measurements by December is very important