PRFPMI or RSE for Joining O3

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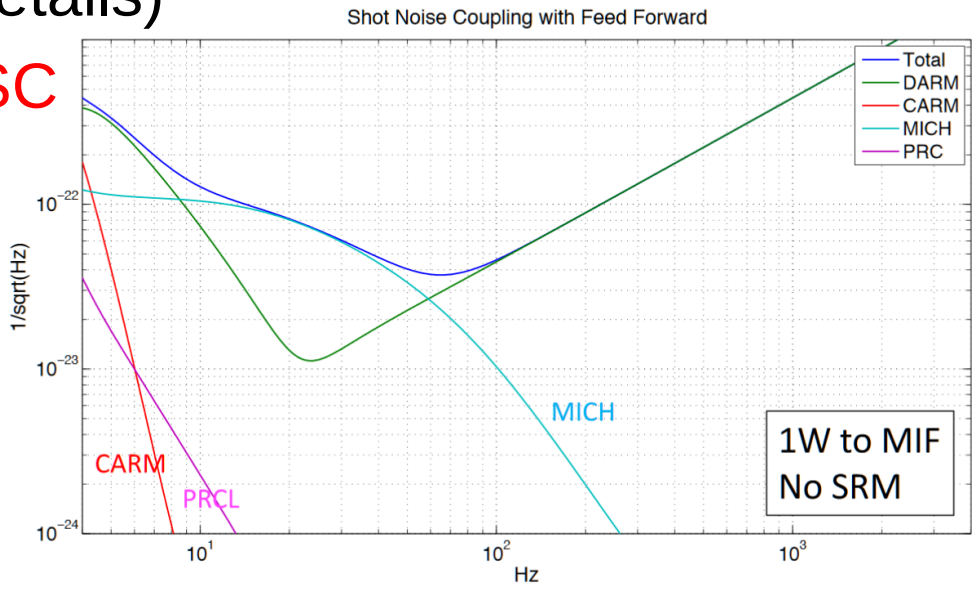
Summary on PRFPMI or RSE

	PRFPMI	RSE
Locking scheme	green locking + f3 (or develop new scheme from scratch)	green locking + f3
# of degrees of freedom	LSC: 4, ASC: 10	LSC: 5, ASC: 11 → more DoF
Tolerable excess noise to achieve AdV O2 sensitivity	~ x4 O1 level (with 10 W input) → requires more noise hunting	~ x8 O1 level (with 10 W input)
SRM Installation	Blank SRM	70 % SRM
OMC	Required	Required

Locking Scheme

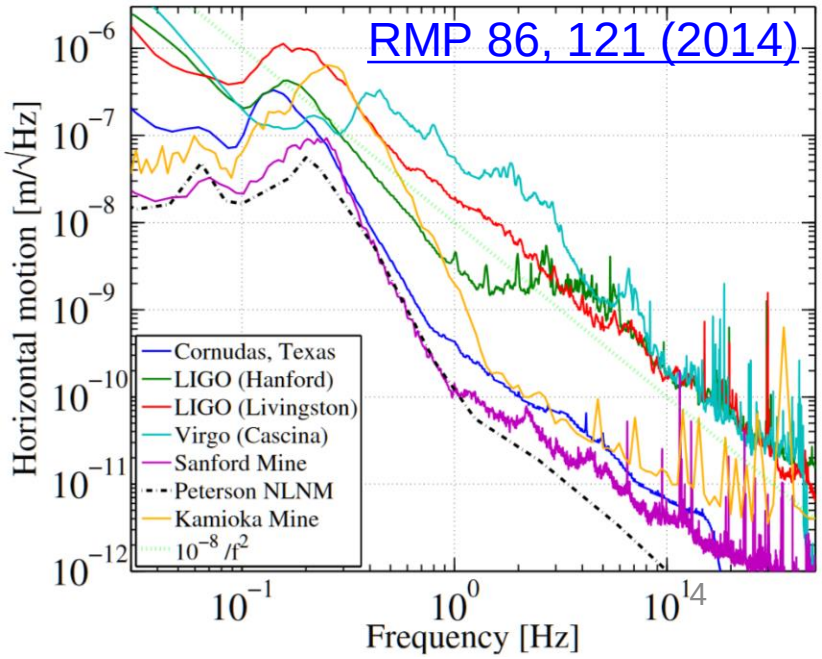
- Green locking and f3 AM generation is necessary for both PRFPMI and RSE
- For PRFPMI, other locking scheme is also possible if we develop new scheme from scratch
- In PRFPMI case, resonant condition for f1 will change, which result in ~ x3 worse shot noise, and couples to DARM (see JGW-G1707479 for details)
- We also need to design ASC for PRFPMI from scratch
- RSE has 1 more degrees of freedom for LSC and ASC



- New locking scheme for PRFPMI without green will likely to be inapplicable to RSE

New Locking Scheme for PRFPMI?

- Advanced Virgo could lock PRFPMI because they had long experience on their variable finesse scheme
  - detailed time-domain simulation (e2e)
  - guided lock
  - experienced people from Initial Virgo
- KAGRA has higher arm cavity finesse (1530) than Advanced LIGO (450) and Advanced Virgo (460), or any other 1st gen. detectors
- Micro-seismic noise for KAGRA is not low
  → Stochastic locking will be tougher
  → Locking KAGRA PRFPMI without green will be tough



Sensitivity

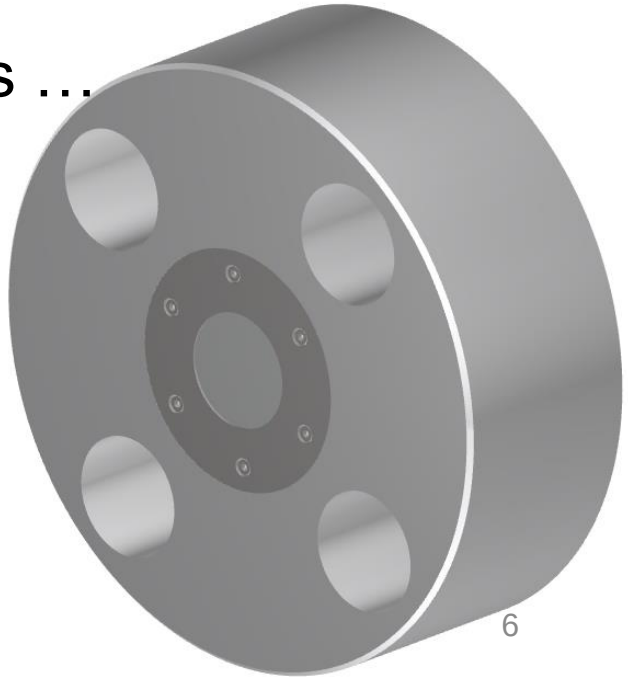
- Inspiral range of PRFPMI relies on low frequencies
- PRFPMI requires more noise hunting than RSE to achieve same inspiral range
- See JGW-T1707334 for details

Excess noise	**PRFPMI**	**RSE**
No excess	BNS: 58 Mpc BBH: 0.82 Gpc	BNS: 93 Mpc BBH: 1.4 Gpc
x1 O1 level (~ KAGRA suspension thermal noise)	BNS: 48 Mpc BBH: 0.66 Gpc	BNS: 71 Mpc BBH: 1.1 Gpc
x4 O1 level (AdV O2 level)	BNS: 27 Mpc BBH: 0.37 Gpc	BNS: 42 Mpc BBH: 0.62 Gpc
x8 O1 level	BNS: 19 Mpc BBH: 0.26 Gpc	BNS: 30 Mpc BBH: 0.45 Gpc

* Assumed 10 W input for inspiral range calculation. Includes shot noise coupling

Schedule

- Both PRFPMI and RSE requires SRM and OMC installation
  - Blank SRM for PRFPMI for mode-matching to OMC
- Both PRFPMI and RSE requires green locking and f3 AM
  - If we give up green locking, PRFPMI requires development of new locking scheme
- PRFPMI would also require full SR2 and SR3
  - scattering, mode-matching to OMC, continuous beam steering to OMMTs …
- Giving up green locking at this point do not accelerate the schedule
- We already ordered blank SRM and 70% SRM. Switching to blank one can be done at later stages if we had some trouble in locking DRMI (~Dec 2018) or RSE (~ March 2019)



Our Suggestion: RSE for O3

- PRFPMI can be done without green only if we successfully develop new locking scheme from scratch, which will likely to be inapplicable to RSE. Concentrating our resources to green (not new scheme) seems to be a better idea.
- RSE requires one more degrees of freedom to lock. PRFPMI requires more noise hunting. Latter is more unpredictable in terms of scheduling.
- Switching to PRFPMI from RSE can be done at later stages, only by replacing SRM. Switching to RSE from PRFPMI without green is almost impossible.
- Making a solid schedule is important for joining O3. PRFPMI relies on fragile assumptions (new locking scheme not guaranteed and more noise hunting).