PRFPMI or RSE for Joining O3

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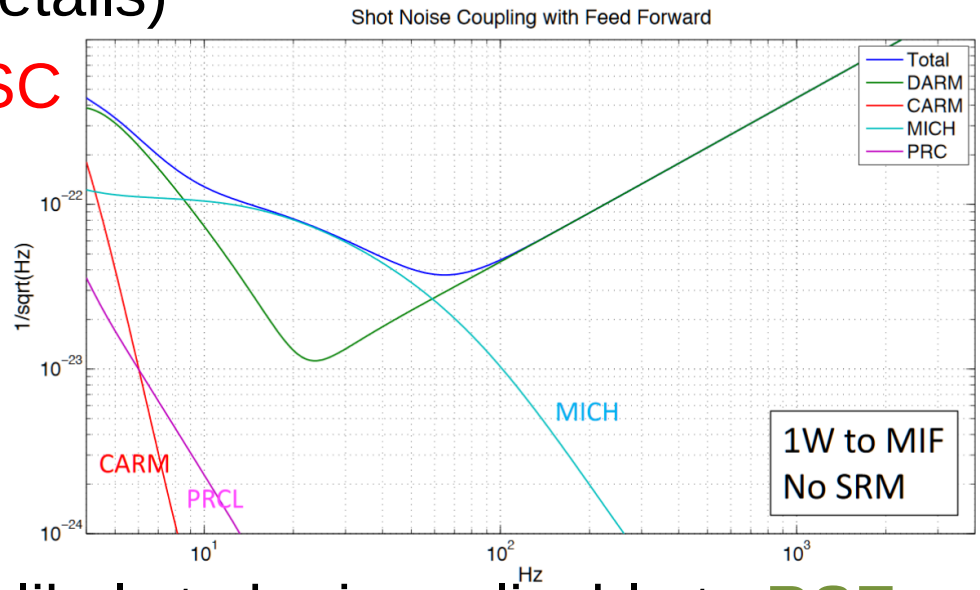
Summary on PRFPMI or RSE

	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

Our suggestion: **RSE for O3**

Locking Scheme

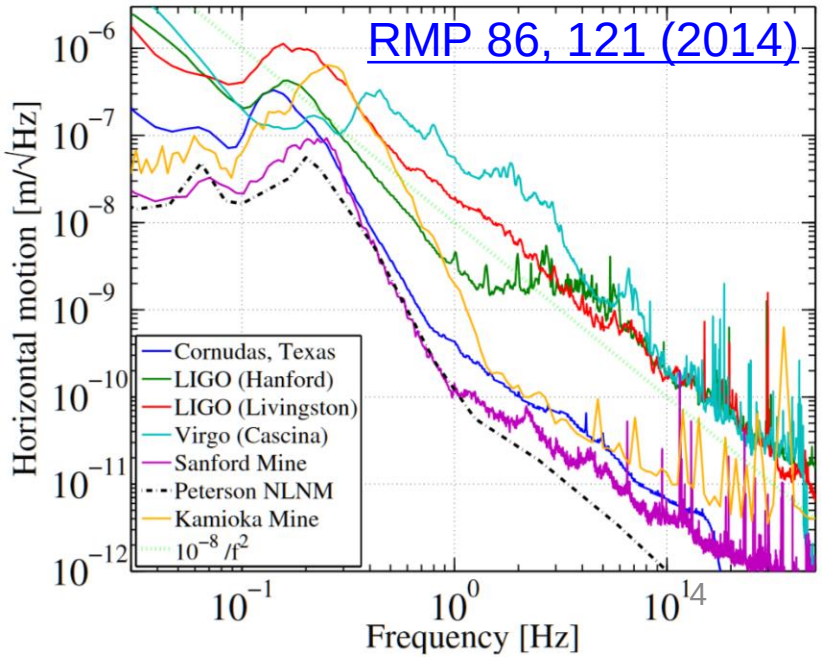
- Green locking and f3 AM generation is necessary for both PRFPMI and RSE
- For PRFPMI, other locking scheme is also possible if we develop new scheme from scratch
- In PRFPMI case, resonant condition for f1 will change, which result in ~ x3 worse shot noise, and couples to DARM (see JGW-G1707479 for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



- 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

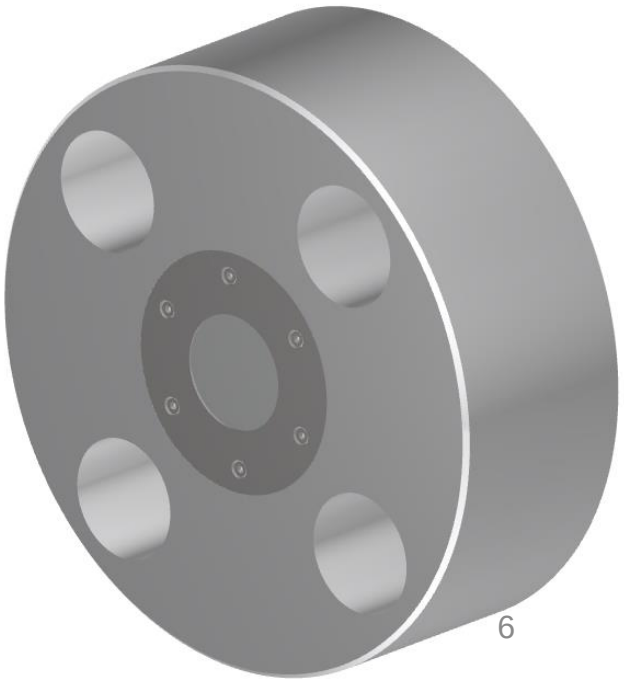
- Inspiral range of PRFPMI relies on low frequencies
- PRFPMI requires more noise hunting than RSE to achieve same inspiral range
- See JGW-T1707334 for details

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	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 installation
  - Blank one 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.
- Giving up green locking at this point do not accelerate the schedule
  - Independent manpower from CRY and VIS
- 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. 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).