

# PRFPMI or RSE for Joining O3

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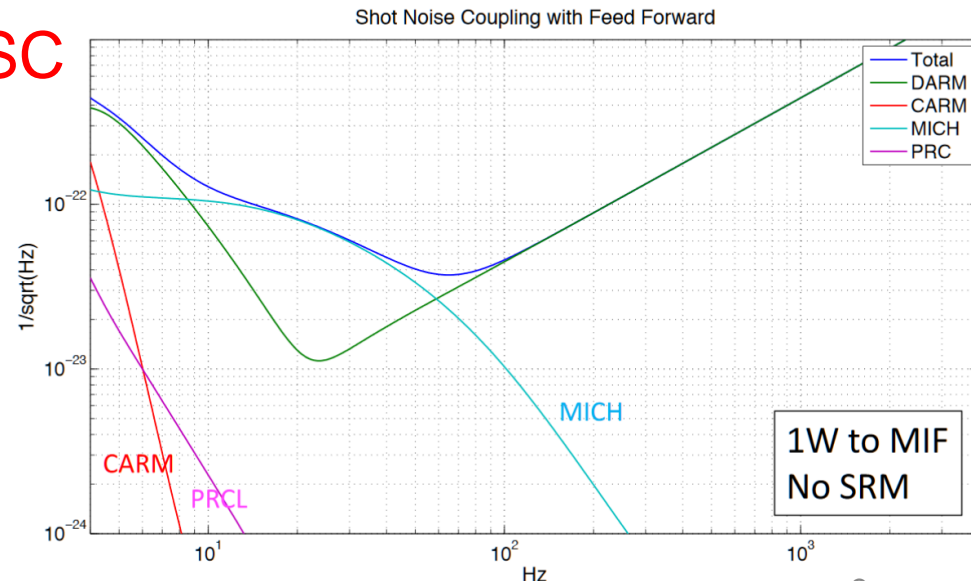
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# Summary on PRFPMI or RSE

	<b>PRFPMI</b>	<b>RSE</b>
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 (or move OMMT by ~ few cm)	70 % SRM
OMC	Required	Required

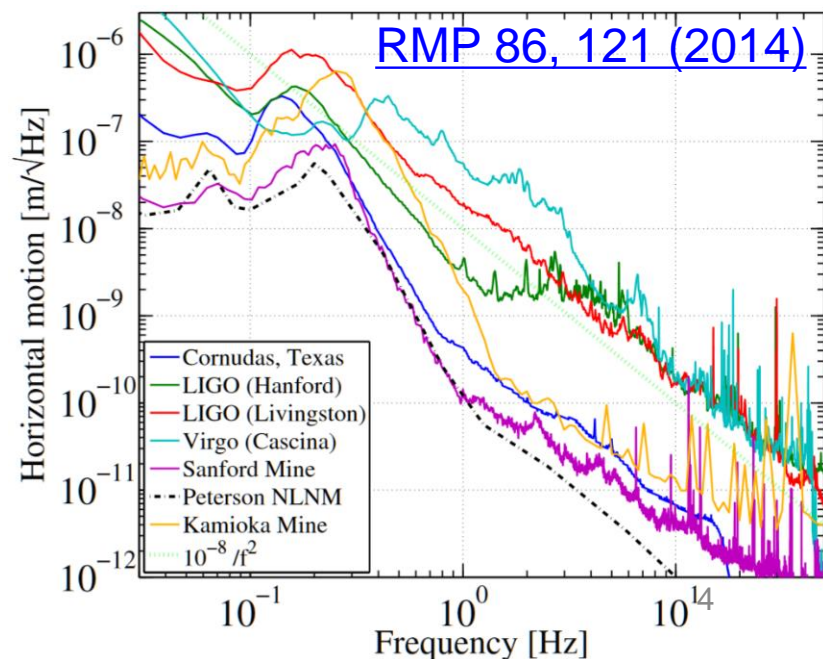
# Interferometer Sensing and Control

- 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 in MICH**, 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 1<sup>st</sup> gen. detectors
  - New scheme necessary
- Micro-seismic noise for KAGRA is not low
  - Stochastic locking will be tougher
  - Locking KAGRA **PRFPMI** without green **will be tough**



# Sensitivity

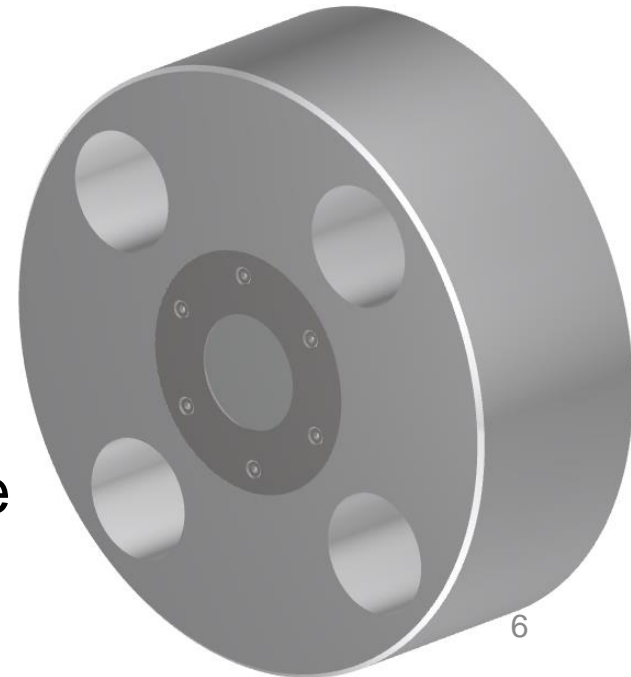
- Inspiral range of **PRFPMI** relies on low frequencies
- **PRFPMI** requires **more noise hunting** than **RSE** to achieve same inspiral range
- See [JGW-T1707334](#) for details

<b>Excess noise</b>	<b>PRFPMI</b>	<b>RSE</b>
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  
(w/o SRM is possible by moving OMMT by ~ few cm)
- 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 **does 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)



# Check Before Omitting Things!

- Green locking
  - Simulations, calculations, new electronics for new locking scheme
- OMC
  - How much is the sensitivity degradation if there's no OMC?
- Full Type-B SR2 and SR3
  - Installation and preparation of electronics really unfeasible for O3?
  - Scattered light
- SRM
  - SRM really unfeasible for O3?
  - Doughnut metal mass status? Black coating?
  - Mode-matching to OMC (-> OK by moving OMMTs)
- How much is the required sensitivity?
  - People say different things
  - 10 Mpc gives only 10 % improvement in terms of sky localization  
([Haino MCMC](#))
  - But maybe any contribution is OK

# Survey on PRFPMI or RSE

- PRFPMI

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- RSE

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# 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).