# O3 Estimated Sensitivity for FPMI, PRFPMI and RSE

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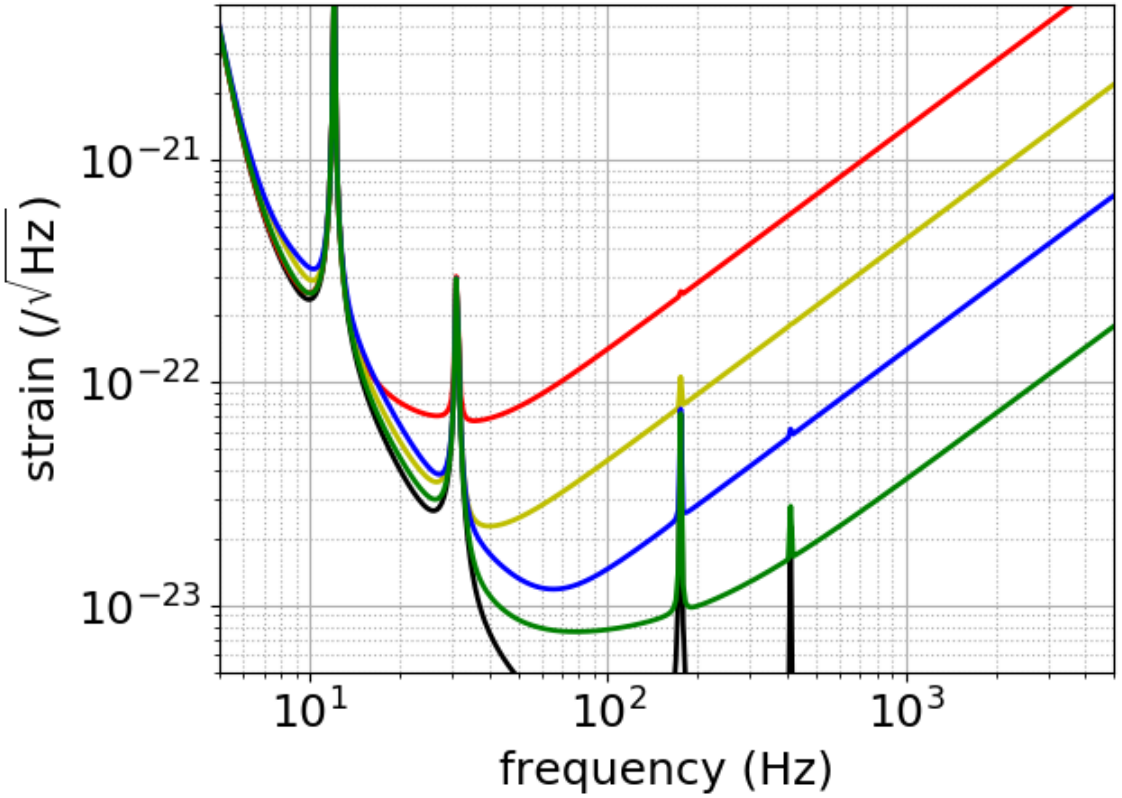
# Conditions

- 10W input
- Shot noise coupling with feedforward gain 100 included
- Four IFO configurations
  - FPMI with tilted PRM (equivalent to 1W input power)
  - FPMI with blank PRM
  - PRFPMI (R_SRM=0 %)
  - RSE with R_SRM=70 %
- Four excess noise models
  - No excess
  - aLIGO O1 level
  - 4x aLIGO O1 level (AdV O2 level)
  - 8x aLIGO O1 level
- Suspension and mirror thermal noise at 22 K

# Sensitivity with No Excess Noise




thermal

excess 0 x O1

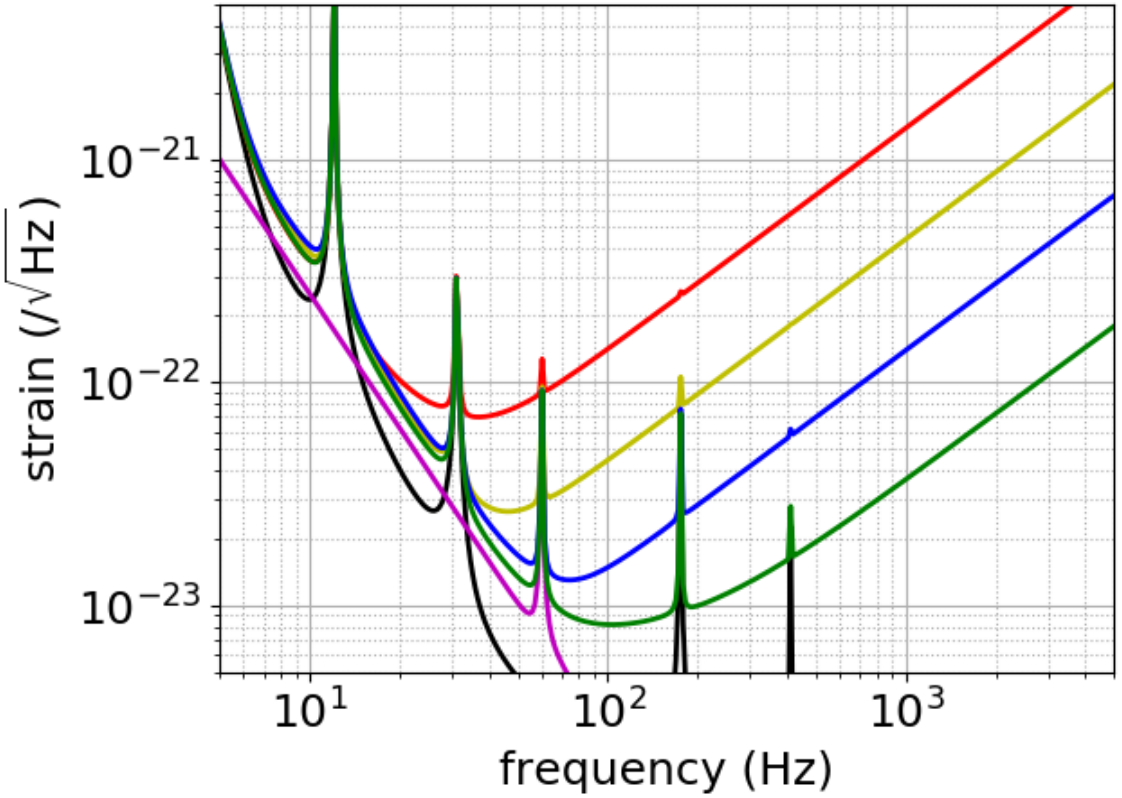
FPMI 1W (10W with PRM)
1.4-1.4 BNS: 18.0 Mpc
30-30 BBH:0.2349 Gpc

FPMI 10W
1.4-1.4 BNS: 36.7 Mpc
30-30 BBH:0.4970 Gpc

PRFPMI 10W
1.4-1.4 BNS: 57.9 Mpc
30-30 BBH:0.8215 Gpc

RSE 10W, R_SRM=70%
1.4-1.4 BNS: 93.4 Mpc
30-30 BBH:1.4323 Gpc

# Sensitivity with O1 Excess Noise




thermal

excess 1 x O1

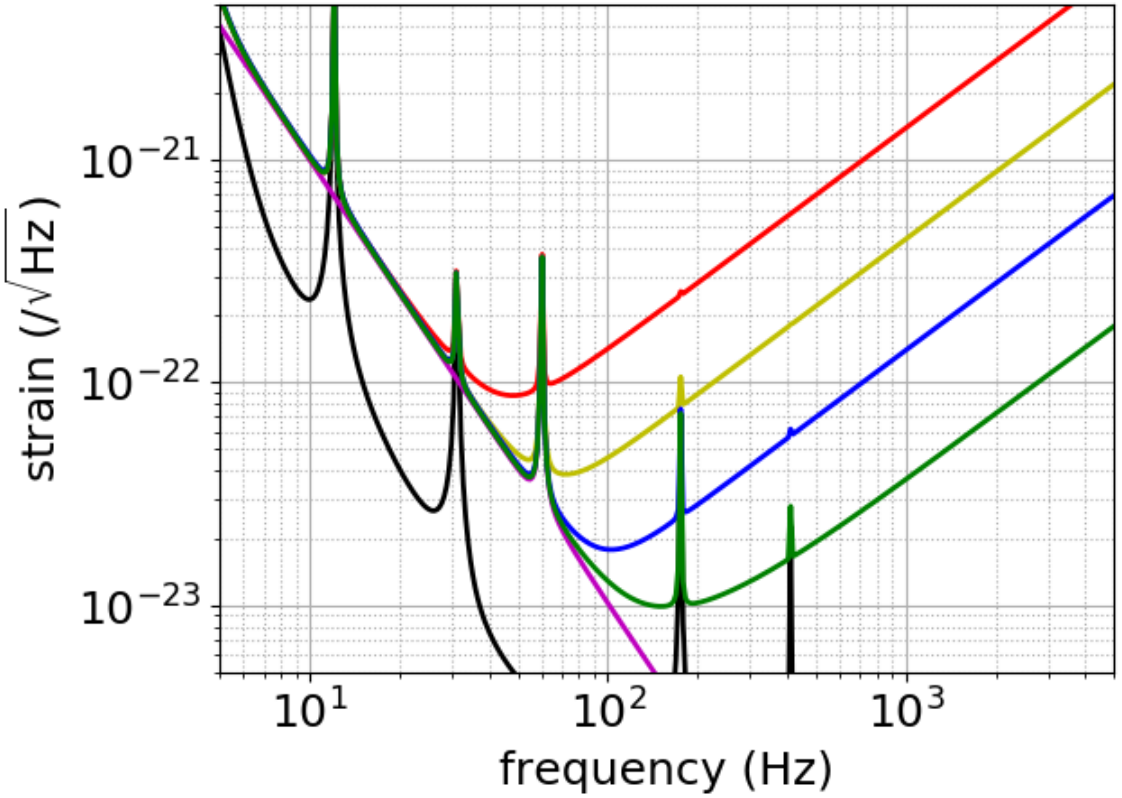
FPMI 1W (10W with PRM)
1.4-1.4 BNS: 15.6 Mpc
30-30 BBH:0.2025 Gpc

FPMI 10W
1.4-1.4 BNS: 30.0 Mpc
30-30 BBH:0.4016 Gpc

PRFPMI 10W
1.4-1.4 BNS: 47.6 Mpc
30-30 BBH:0.6649 Gpc

RSE 10W, R_SRM=70%
1.4-1.4 BNS: 71.0 Mpc
30-30 BBH:1.0673 Gpc

# Sensitivity with x4 O1 Excess Noise




thermal

excess 4 x O1

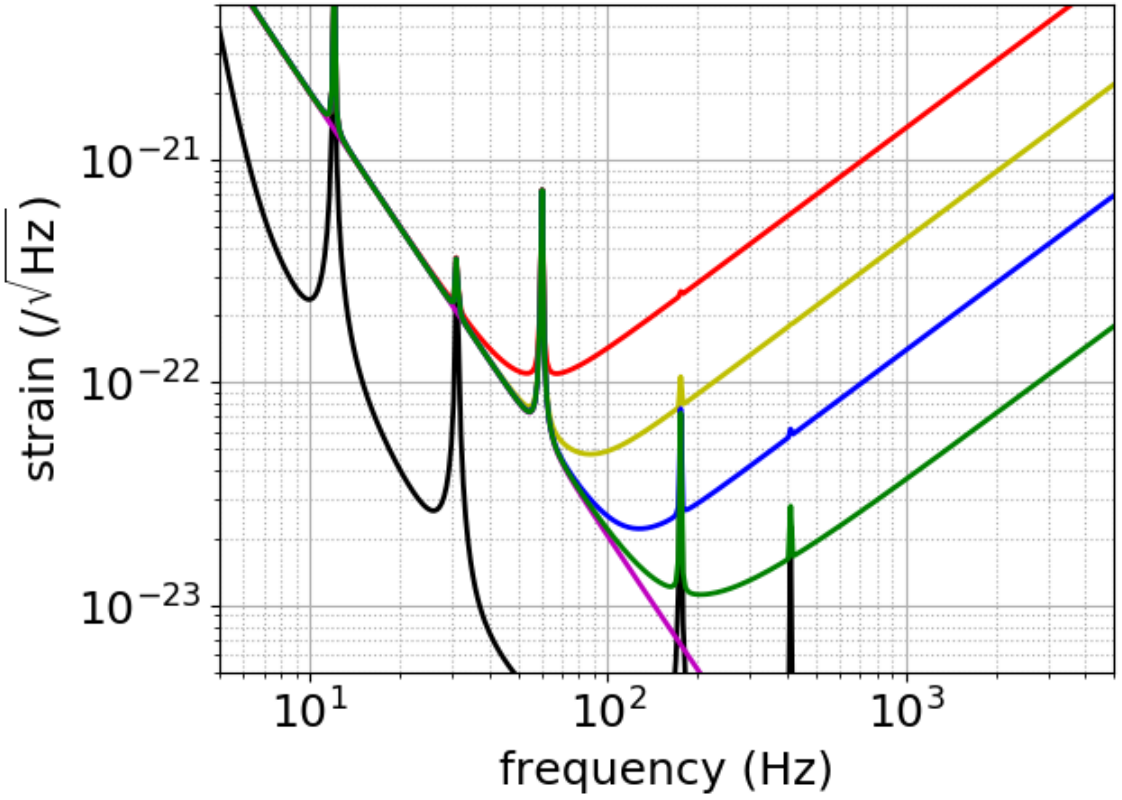
FPMI 1W (10W with PRM)
1.4-1.4 BNS: 9.5 Mpc
30-30 BBH:0.1228 Gpc

FPMI 10W
1.4-1.4 BNS: 16.3 Mpc
30-30 BBH:0.2137 Gpc

PRFPMI 10W
1.4-1.4 BNS: 27.1 Mpc
30-30 BBH:0.3737 Gpc

RSE 10W, R_SRM=70%
1.4-1.4 BNS: 41.6 Mpc
30-30 BBH:0.6219 Gpc

# Sensitivity with x8 O1 Excess Noise




thermal

excess 8 x O1

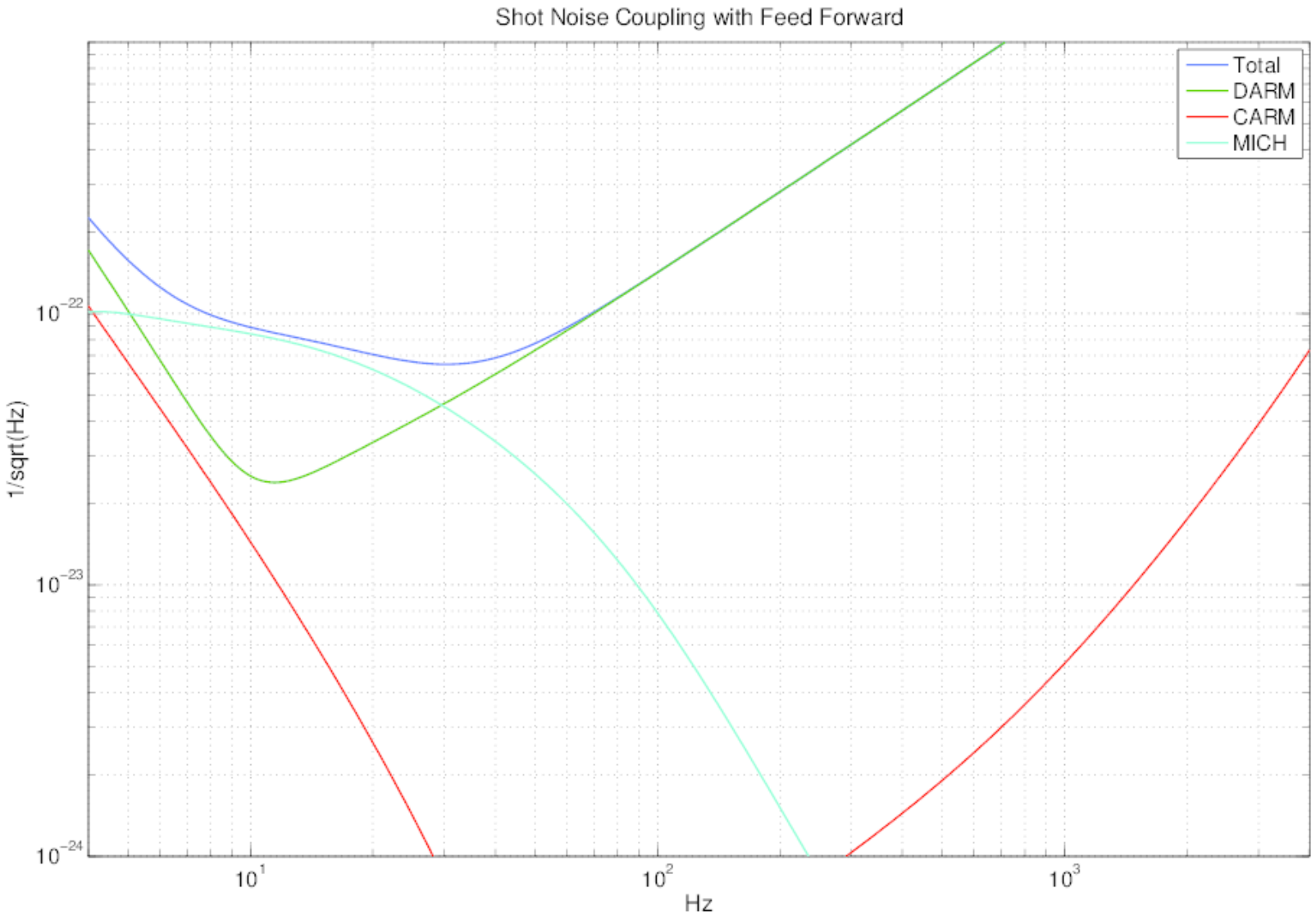
FPMI 1W (10W with PRM)
1.4-1.4 BNS: 6.7 Mpc
30-30 BBH:0.0859 Gpc

FPMI 10W
1.4-1.4 BNS: 11.2 Mpc
30-30 BBH:0.1477 Gpc

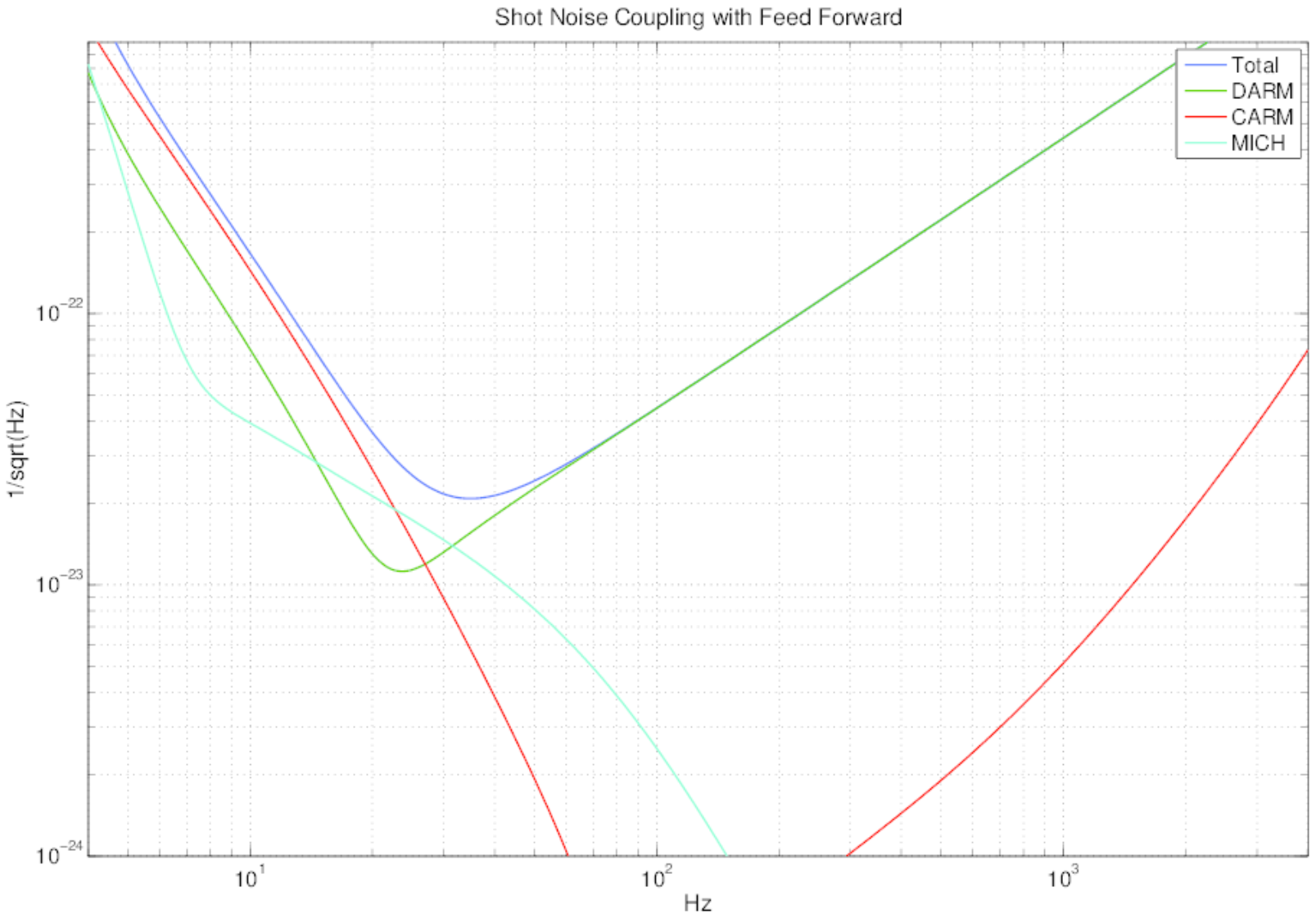
PRFPMI 10W
1.4-1.4 BNS: 19.0 Mpc
30-30 BBH:0.2637 Gpc

RSE 10W, R_SRM=70%
1.4-1.4 BNS: 30.2 Mpc
30-30 BBH:0.4572 Gpc

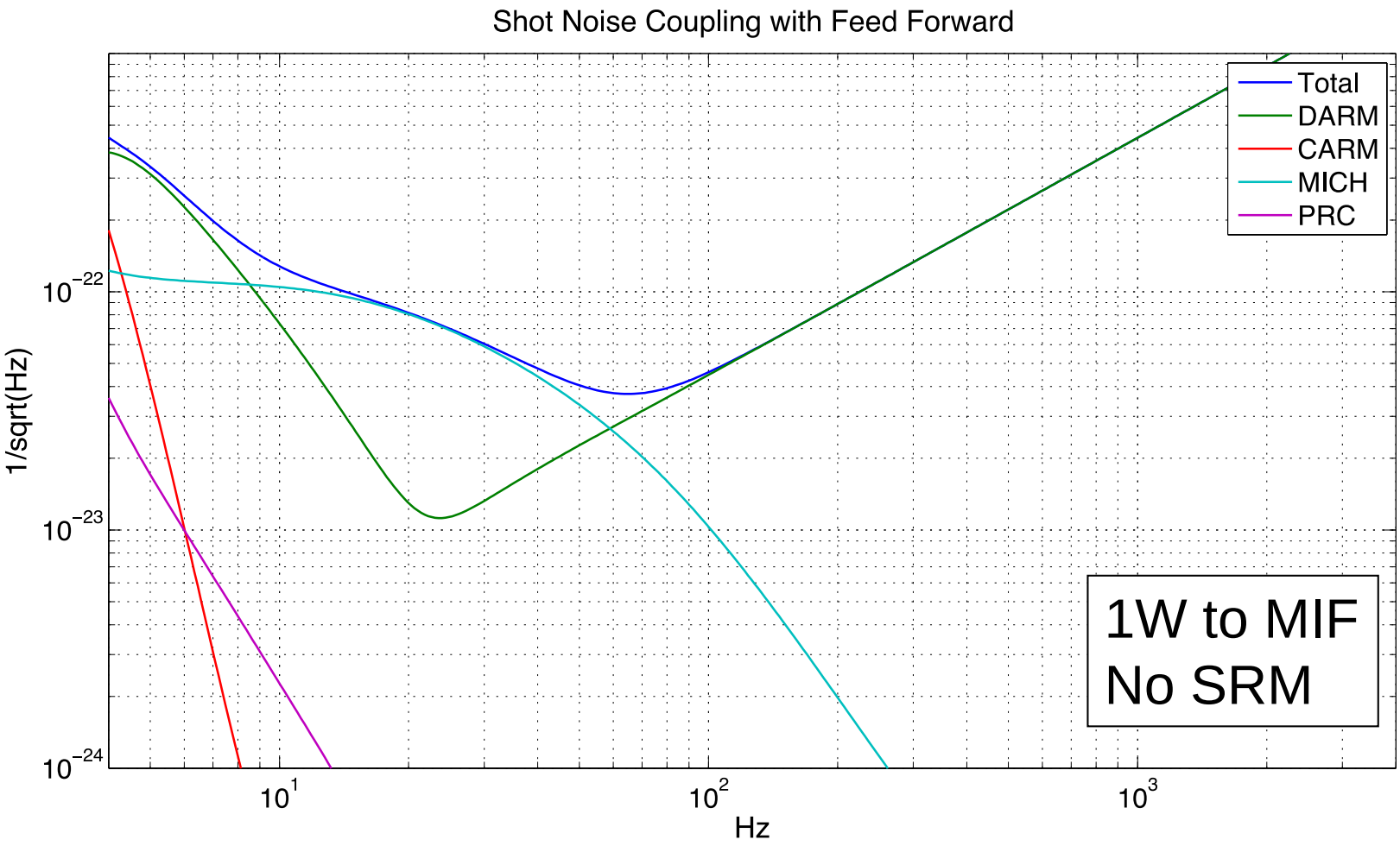
# Shot Noise Coupling FPMI 1W



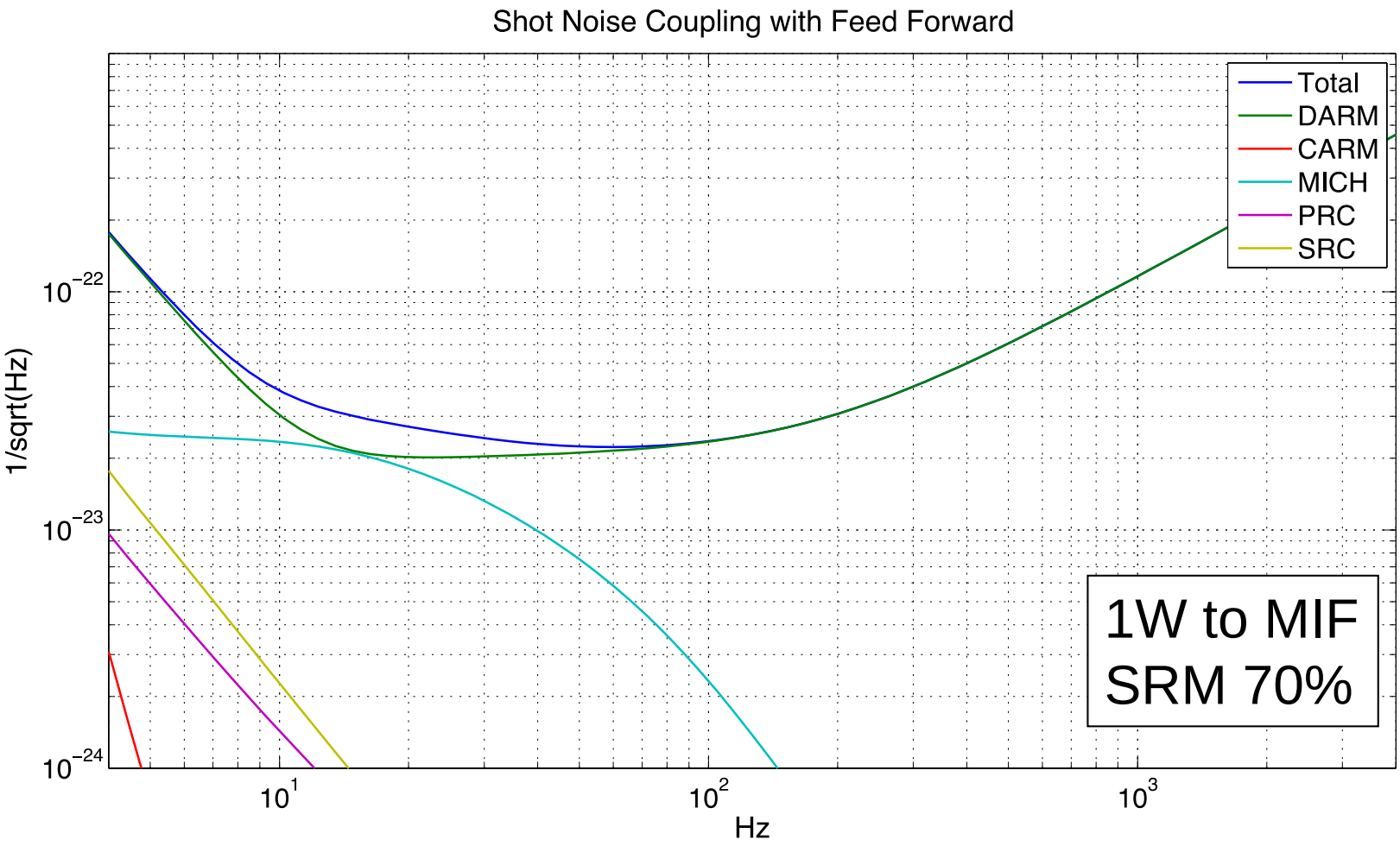
# Shot Noise Coupling FPMI 10W



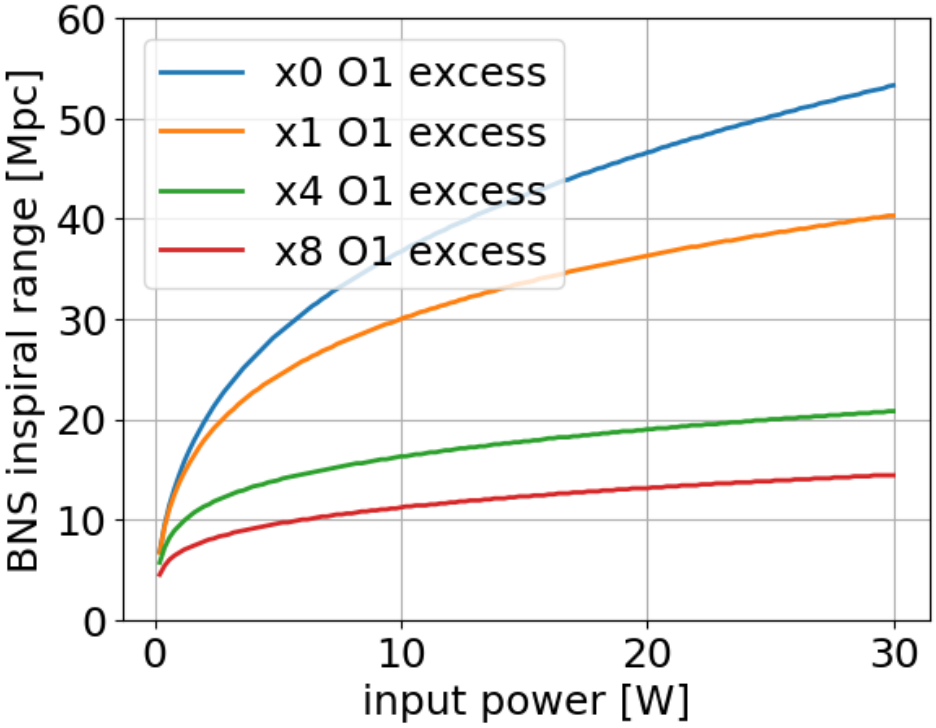
# Shot Noise Coupling PRFPMI

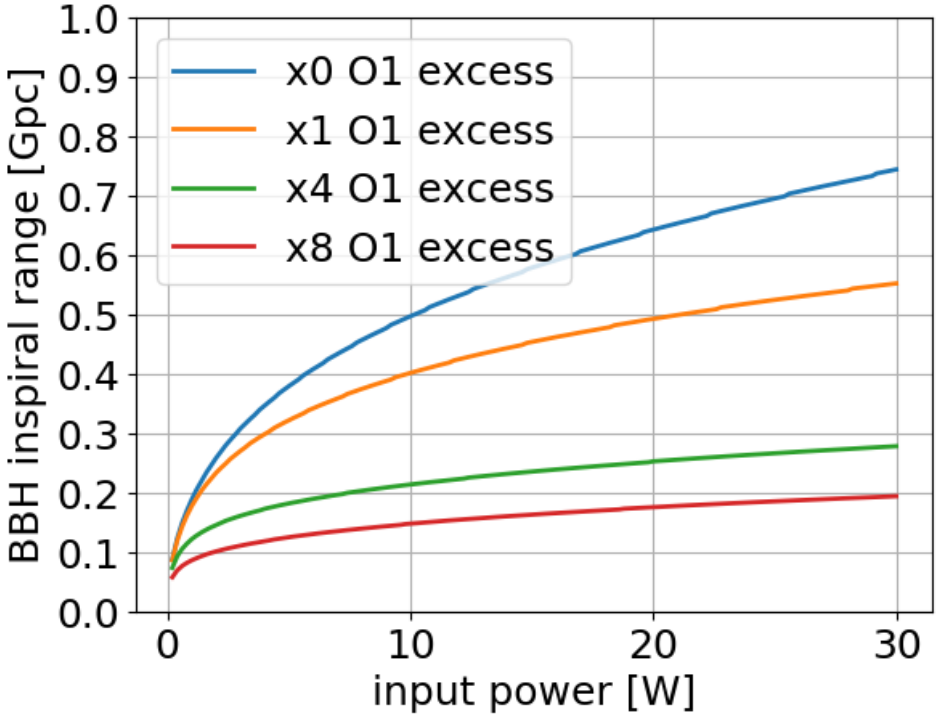


# Shot Noise Coupling RSE



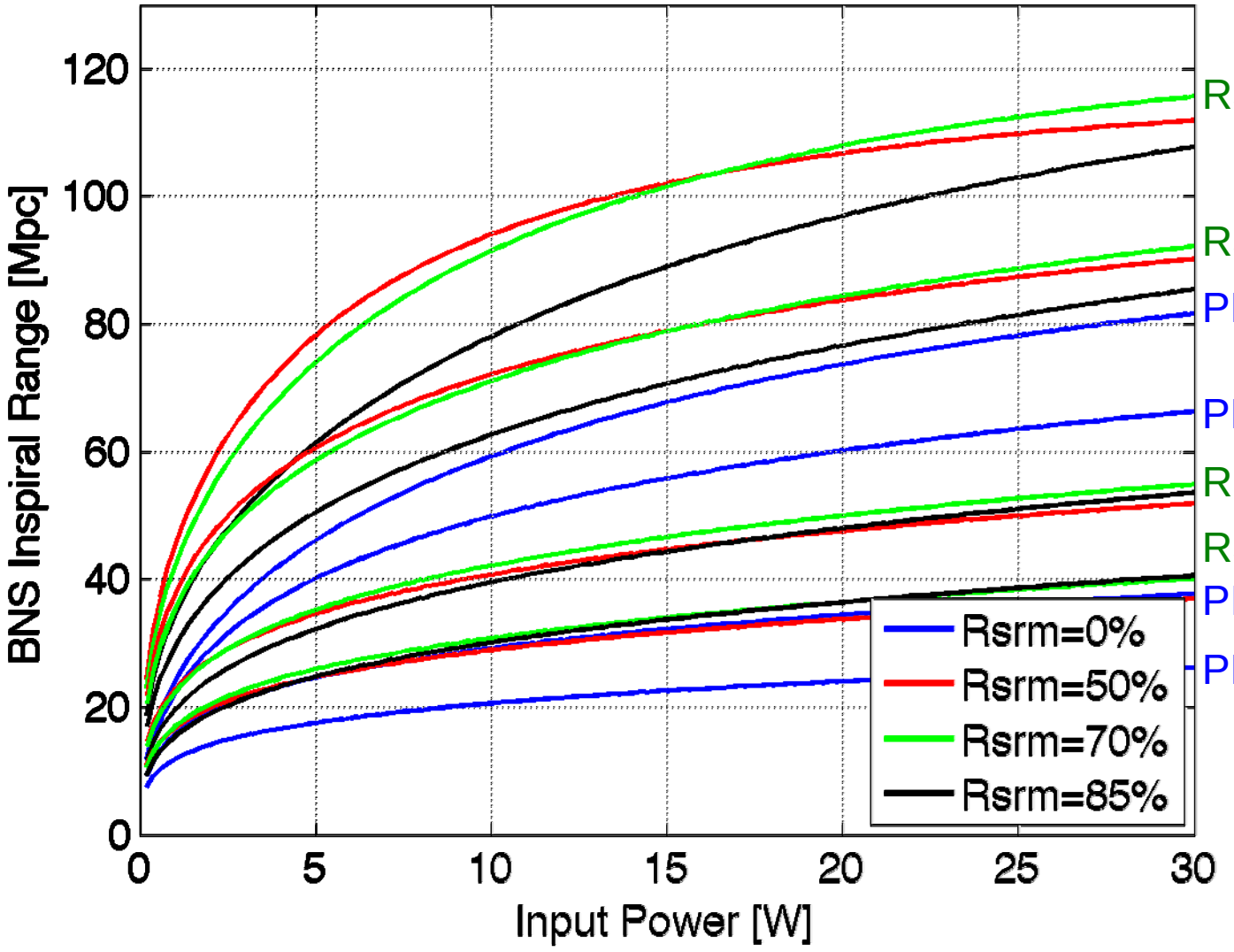
# IR vs Power FPMI




Note: Shot noise coupling calculation is done only at 10 W and scaled with $1/\sqrt{P}$

# IR vs Power PRPFMI/RSE




RSE x0 O1 excess

RSE x1 O1 excess

PRFPMI x0 O1 excess

PRFPMI x1 O1 excess

RSE x4 O1 excess

RSE x8 O1 excess

PRFPMI x4 O1 excess

PRFPMI x8 O1 excess

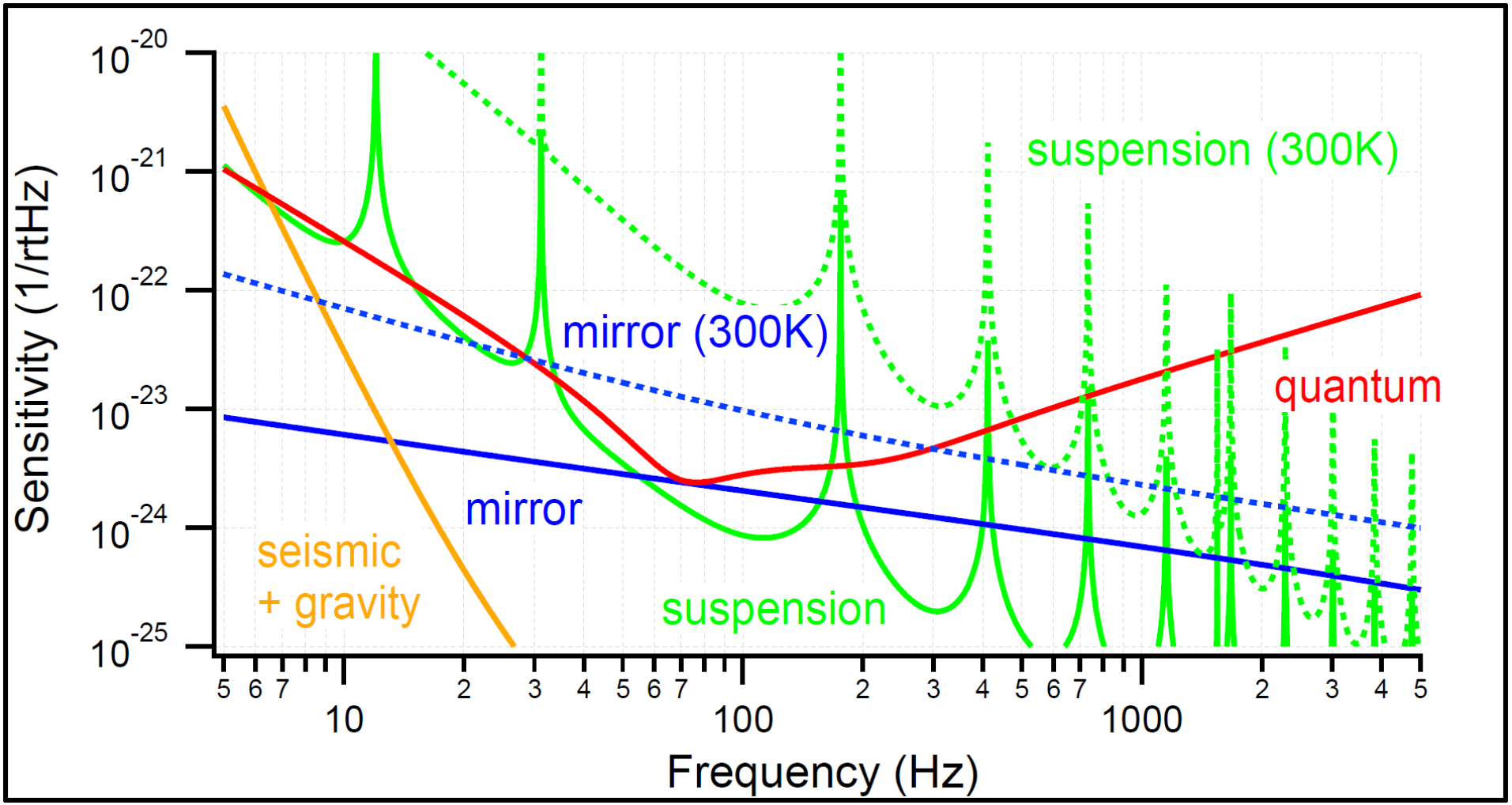
# Necessity

◎: Necessary for locking
○: Can be omitted with extra work
△: Can be omitted with sensitivity degradation
×: Not necessary

| Sensitivity (10W, x4 O1 excess) | RSE (42 Mpc) | PRFPMI (27 Mpc) | FPMI (9.5 / 16 Mpc) |
|---|---|---|---|
| ALS (green lock) | ◎ | ○ | × |
| f3 AM (MZI) | ◎ | ○ | × |
| Extra locking simulation | × | ◎ | × |
| SRC ASC | ◎ | × | × |
| SRM | ◎ | ○ (Blank or move OMMT) | ○ (Blank or move OMMT) |
| OMC | △ | △ | △ |
| Comment | SRC ASC might be tough | f1 will be 1/10, no SRC mode cleaning | PRM: tilt or blank or move IMMT<br>No PRC jitter attenuation |

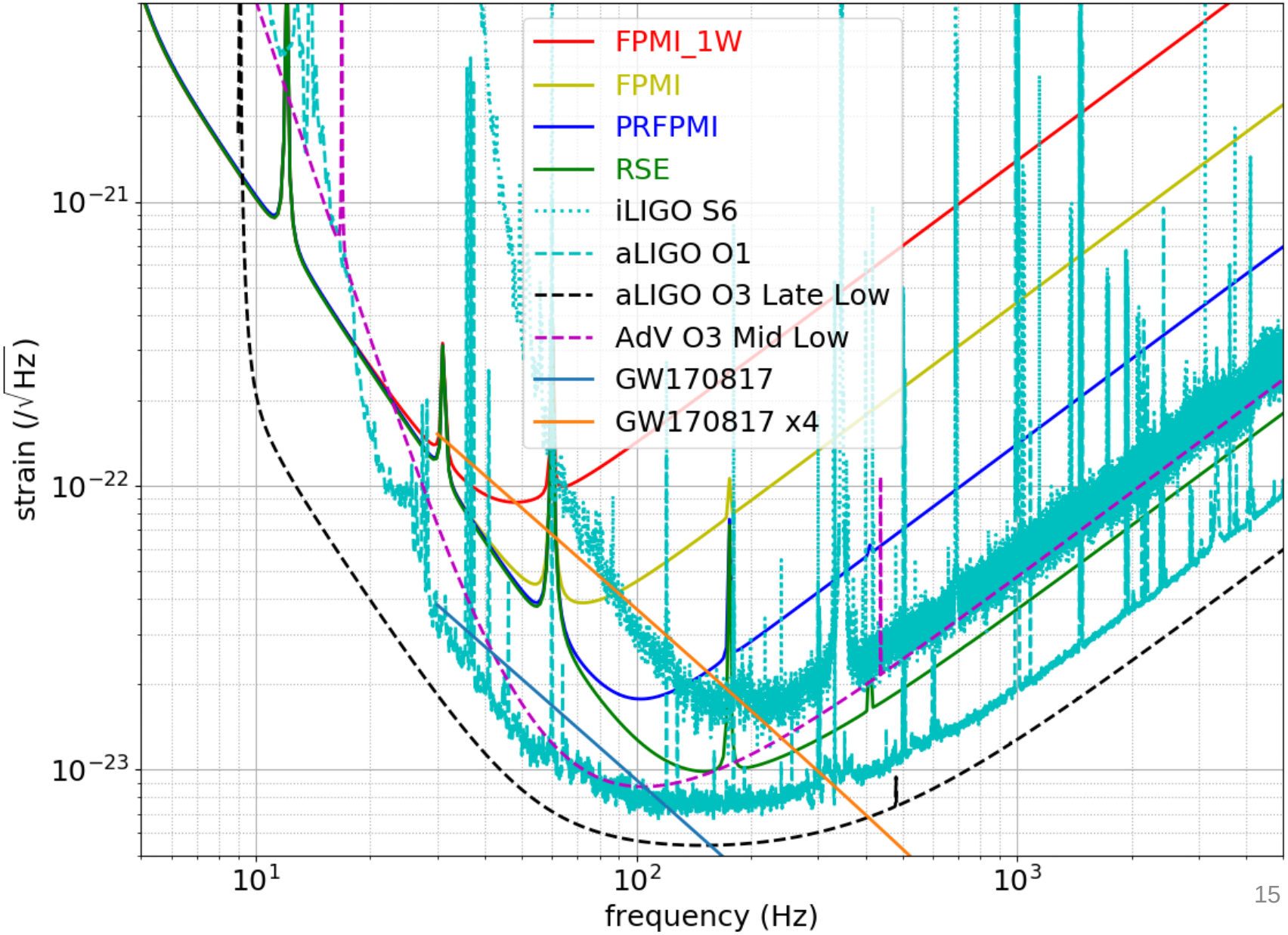
# Cryogenics: Necessary

- 300K suspension thermal noise is x100 worse




By K. Somiya (see [kagra-isc 01736] 300K sensitivity)

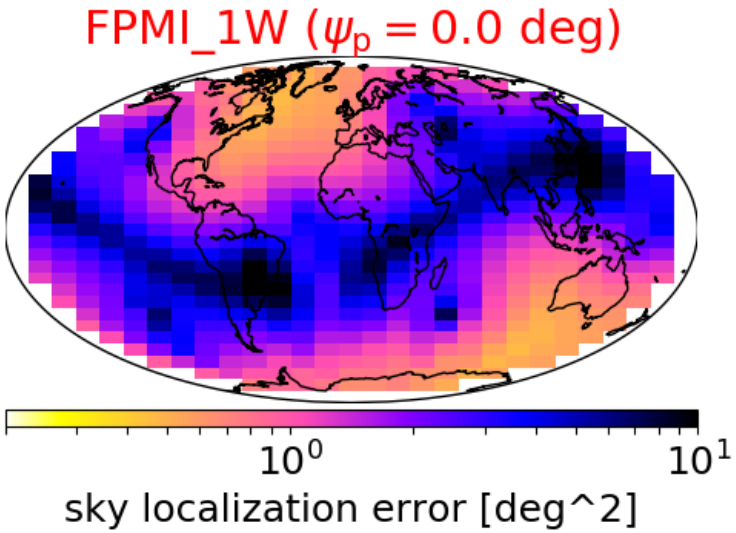
# Sensitivity Comparison

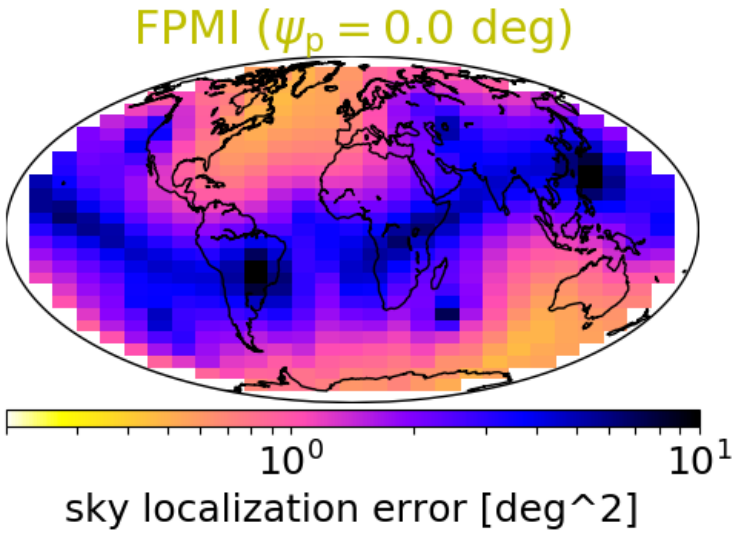


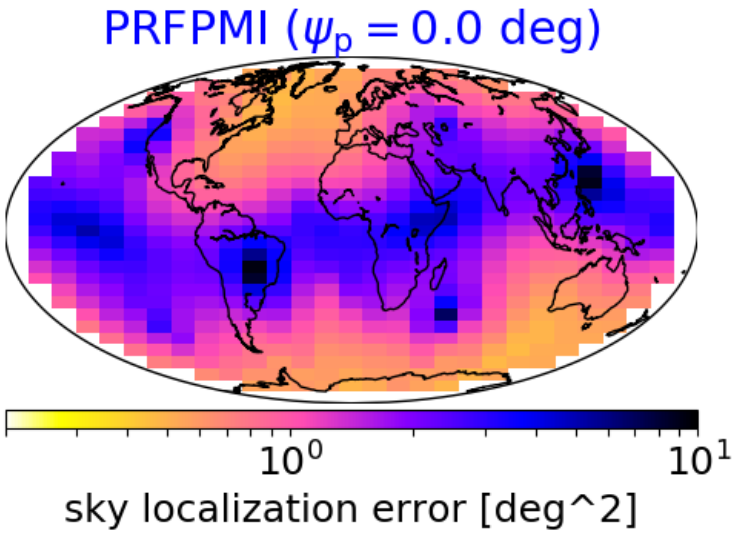
# Sky Localization Calculation

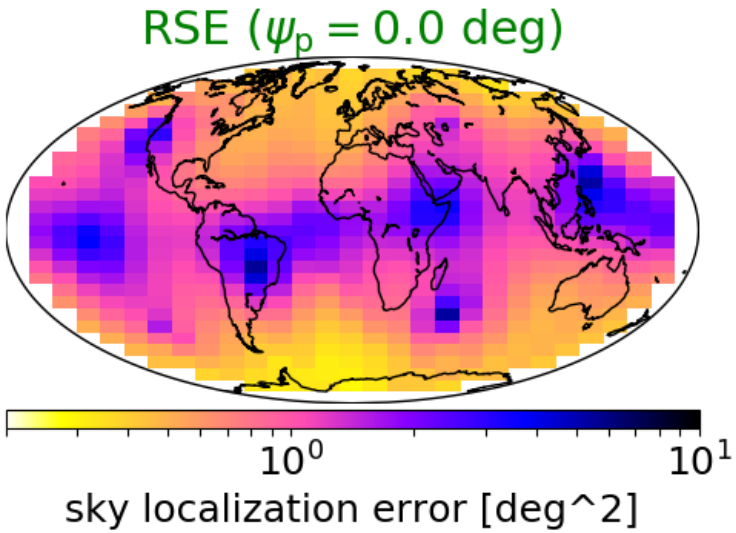
- 10W input, x4 O1 excess noise
- Source parameters (GW170817-like, no spins)
  - redshift: 0.009 (~ 40 Mpc)
  - total/chirp mass: 2.74 / 1.188 Msun
  - inclination angle: 28 deg
  - source locations: equally distributed 648 locations
  - polarization angle: 3 angles
  -> 1944 realizations
- Waveform
  PhenomD upto inspiral (PRD 93, 044007 (2016))
  fmin=10Hz, fmax=fISCO~1.6 kHz
- Network sensitivity
  - aLIGO: Late Low (116 Mpc) LIGO-P1200087
  - AdV: Mid Low (63 Mpc) LIGO-P1200087
- Fisher analysis (see, also JGW-T1808090)

# Sky Localization Map



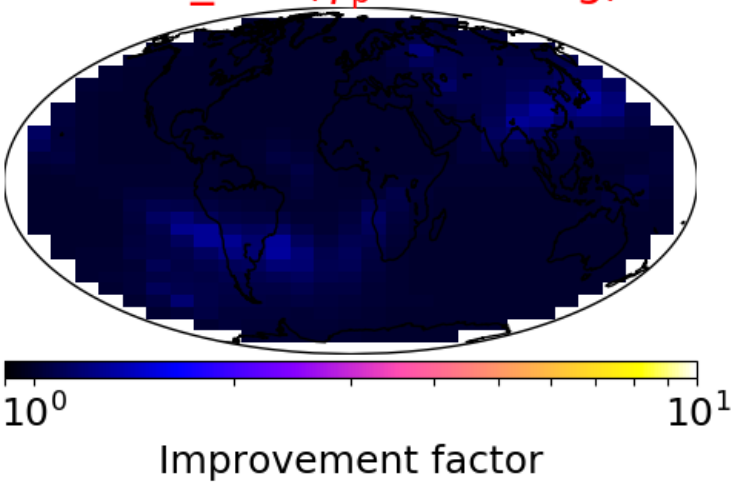



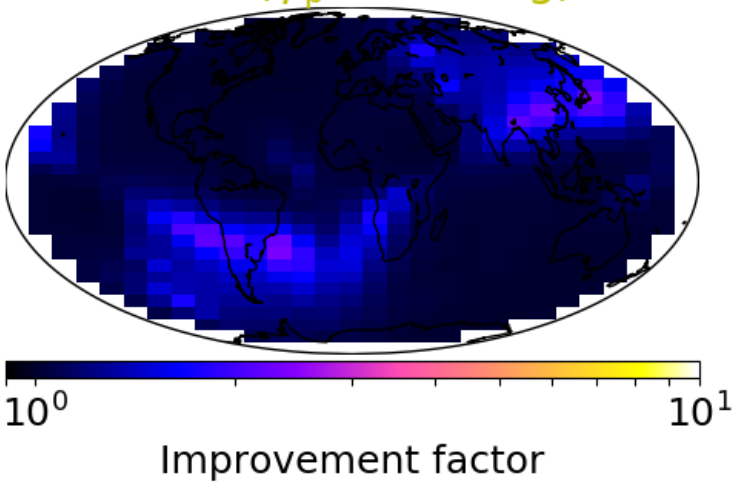
# Sky Localization Improvement Map

Improvement factor = HLVK / HLV

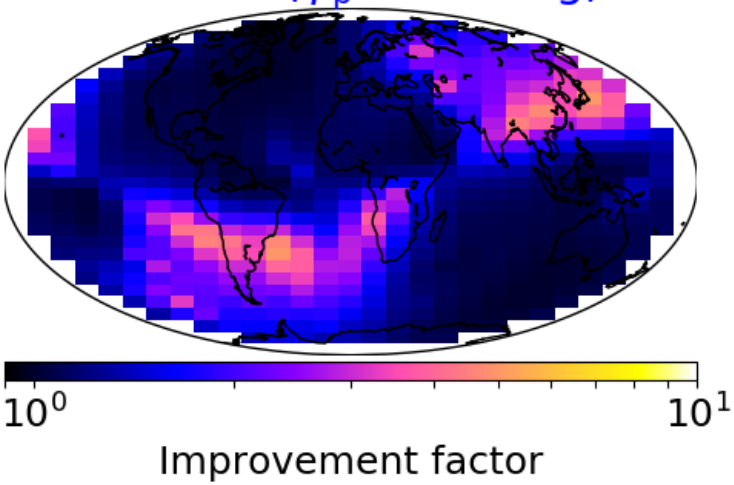
FPMI_1W ($\psi_p = 0.0$ deg)



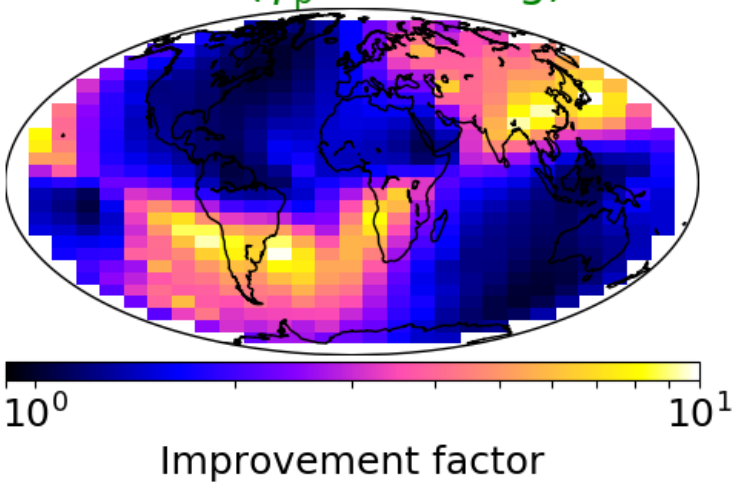

FPMI ($\psi_p = 0.0$ deg)




PRFPMI ($\psi_p = 0.0$ deg)




RSE ($\psi_p = 0.0$ deg)



# Sky Localization Distribution

Improvement factor = HLVK / HLV