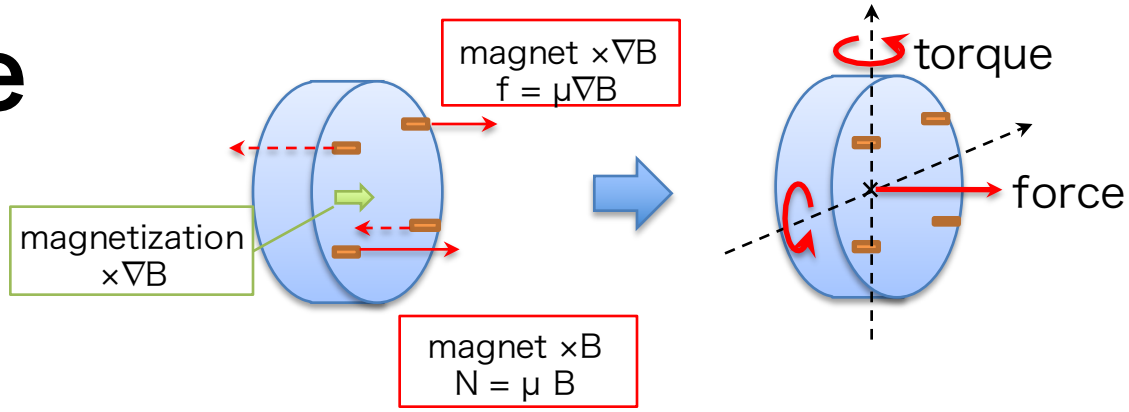
Magnetic noise

$$F = \mu \times \nabla B$$
$$N = \mu \times B$$



Force on magnet -> force on mirror

$$F_1 = \delta\mu_{\mathrm{mag}} \cdot \widetilde{\nabla B} \qquad \text{(magnetic moment tolerance)}$$

$$F_2 = \mu_{\mathrm{mag}} \cdot \frac{\delta(\nabla B)}{\nabla B} \cdot \widetilde{\nabla B} \qquad \text{(magnetic field nonuniformity)}$$

$$F_3 = \frac{\chi_{\mathrm{m}}}{\mu_0} V_{\mathrm{mir}} \cdot \widetilde{B} \cdot \overline{\nabla B} \qquad \text{(magnetization of substrate)}$$

$$F_4 = \frac{\chi_{\mathrm{m}}}{\mu_0} V_{\mathrm{mir}} \cdot \overline{B} \cdot \widetilde{\nabla B} \qquad \text{(magnetization of substrate)}$$

parameter	value
magnetic momet tolerance : δμ/μ	0.2
magnetic field nonuniformity : δB/B	0.1
magnet position error : δx	1mm

Force on magnet -> torque on mirror

$$N_1 = \delta\mu_{\mathrm{mag}} \cdot \widetilde{\nabla B} \cdot x_{\mathrm{mag}} \qquad \text{(magnetic moment tolerance)}$$

$$N_2 = \mu_{\mathrm{mag}} \cdot \frac{\delta(\nabla B)}{\nabla B} \cdot \widetilde{\nabla B} \cdot x_{\mathrm{mag}} \qquad \text{(magnetic field nonuniformity)}$$

$$N_3 = \mu_{\mathrm{mag}} \cdot \widetilde{\nabla B} \cdot \delta x_{\mathrm{mag}} \qquad \text{(magnet position error)}$$

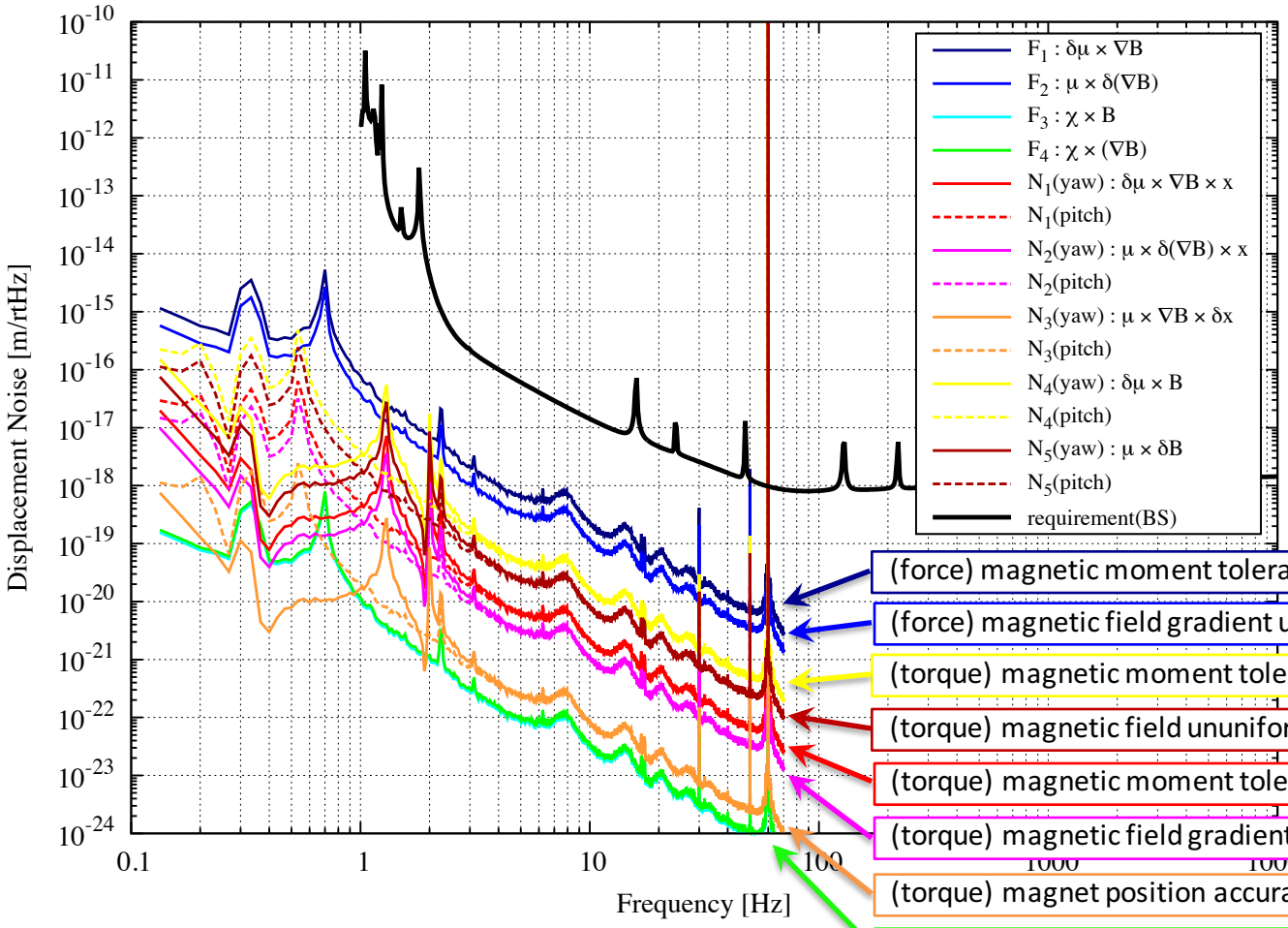
Torque on magnet -> torque on mirror

$$N_4 = \delta\mu_{\mathrm{mag}} \cdot \widetilde{B} \qquad \text{(magnetic moment tolerance)}$$

$$N_5 = \mu_{\mathrm{mag}} \cdot \frac{\delta B}{B} \cdot \widetilde{B} \qquad \text{(magnetic field nonuniformity)}$$

Magnetic noise for BS

parameter	value
mirror mass M [kg]	18.9
magnetic moment of magnets : μ [A・m^2]	0.074
magnetic field B [T]	4.7×10^{-5}
fluctuation of B $\tilde{B}$ [T/rtHz]	5×10^{-13} @10Hz
magnetic field gradient ∇B [T/m]	4.7×10^{-5}
fluctuation of ∇B $\tilde{\nabla B}$ [T/m/rtHz]	5×10^{-13} @10Hz



(force) magnetic moment tolerance δμ ~ 0.2μ

(force) magnetic field gradient ununiformity δ(∇B) ~ 0.1(∇B)

(torque) magnetic moment tolerance δμ ~ 0.2μ

(torque) magnetic field ununiformity δB ~ 0.1 B

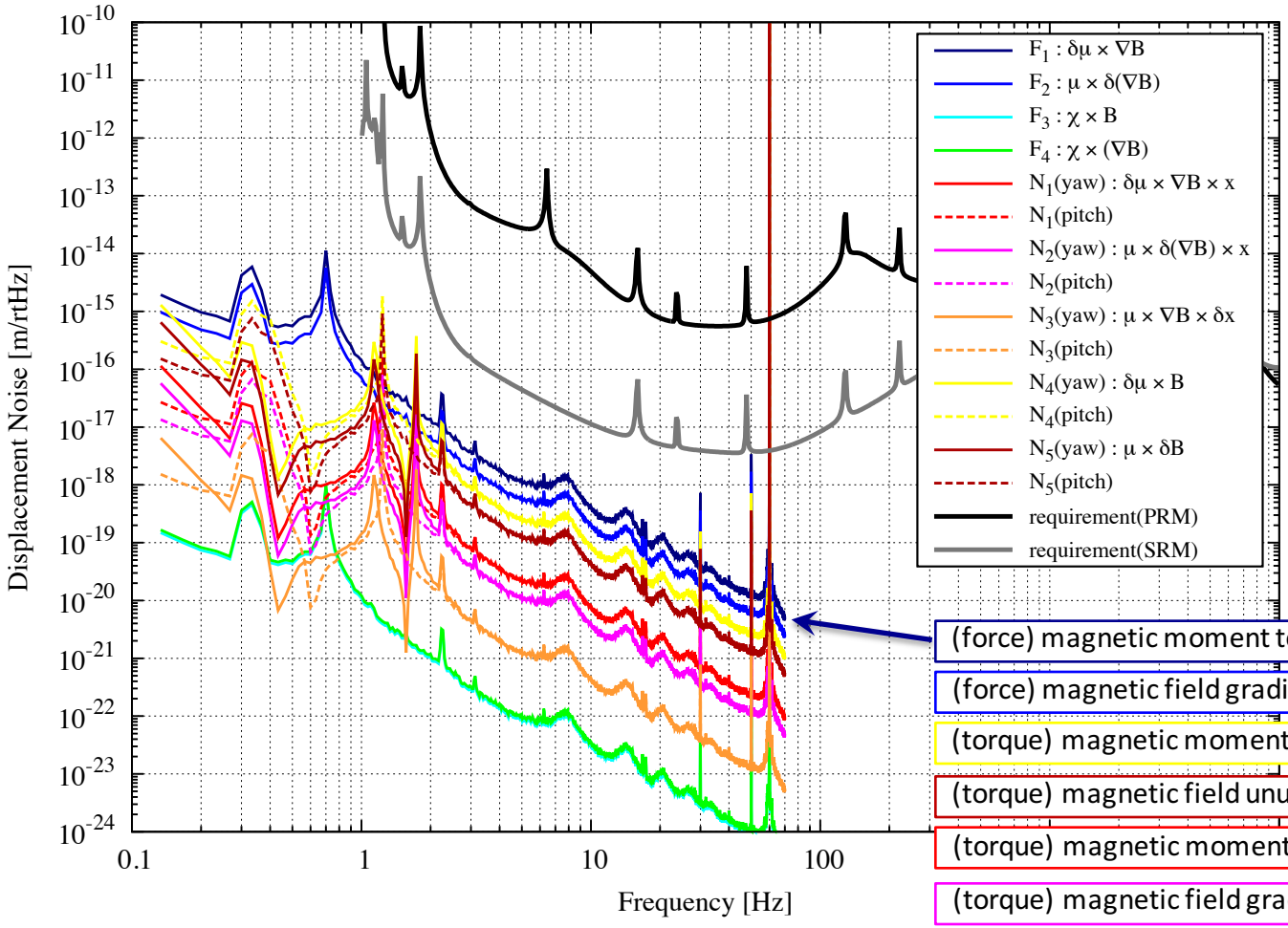
(torque) magnetic moment tolerance δμ ~ 0.2μ

(torque) magnetic field gradient ununiformity δ(∇B) ~ 0.1(∇B)

(torque) magnet position accuracy δx ~ 1[mm]

(force) magnetization of the mirror

Magnetic noise for PRM/SRM



parameter	value
mirror mass M [kg]	10.8
magnetic moment of magnets : μ [A・m^2]	0.074
magnetic field B [T]	4.7×10^{-5}
fluctuation of B $\tilde{B}$ [T/rtHz]	5×10^{-13} @10Hz
magnetic field gradient ∇B [T/m]	4.7×10^{-5}
fluctuation of ∇B $\tilde{\nabla B}$ [T/m/rtHz]	5×10^{-13} @10Hz

(force) magnetic moment tolerance δμ ~ 0.2μ

(force) magnetic field gradient ununiformity δ(∇B) ~ 0.1(∇B)

(torque) magnetic moment tolerance δμ ~ 0.2μ

(torque) magnetic field ununiformity δB ~ 0.1 B

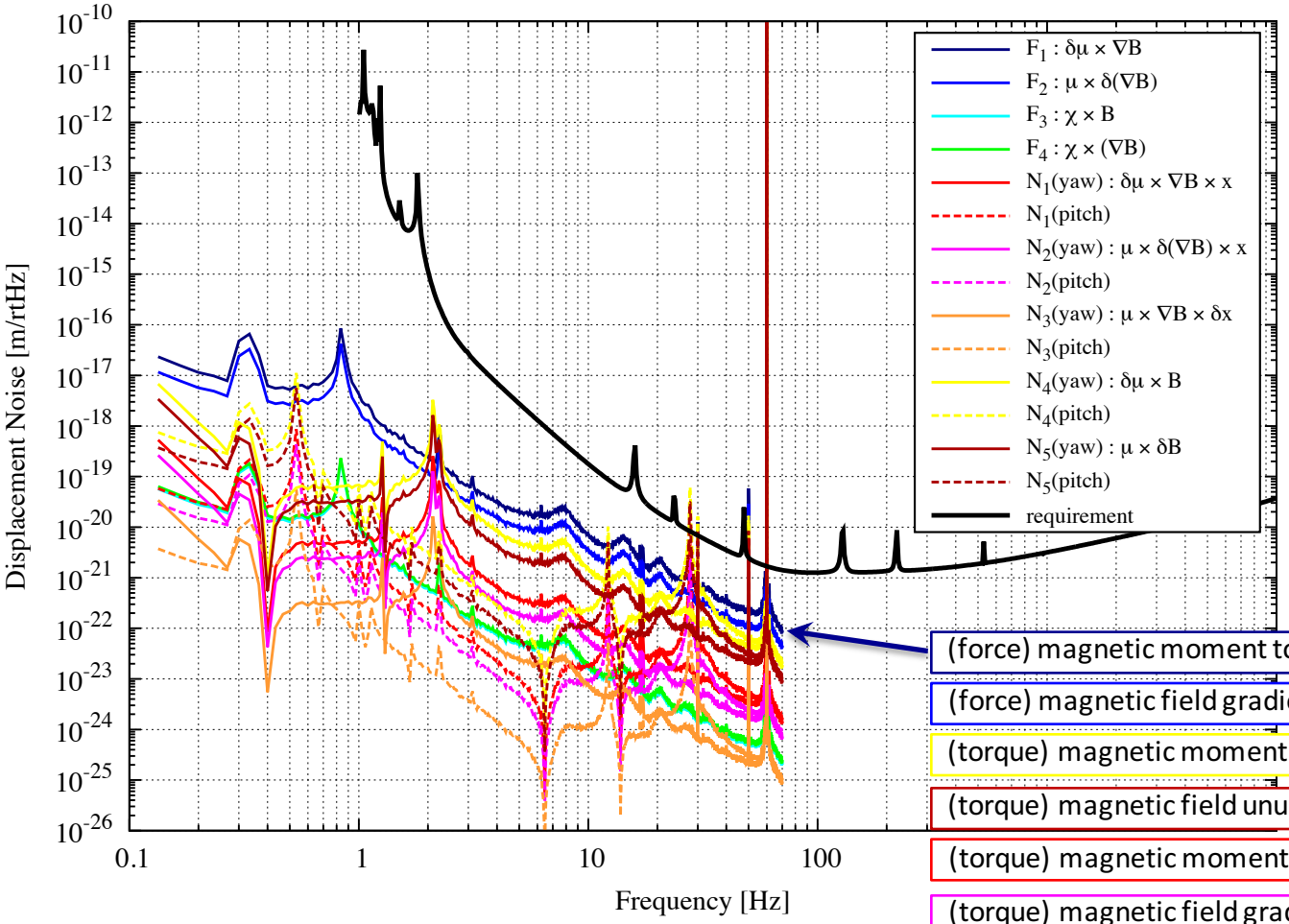
(torque) magnetic moment tolerance δμ ~ 0.2μ

(torque) magnetic field gradient ununiformity δ(∇B) ~ 0.1(∇B)

(torque) magnet position accuracy δx ~ 1[mm]

(force) magnetization of the mirror

Magnetic noise for ITM/ETM



parameter	value
mirror mass M [kg]	22.7
magnetic moment of magnets : μ [A・m²]	0.0027
magnetic field B [T]	4.7×10^{-5}
fluctuation of B $\tilde{B}$ [T/rtHz]	5×10^{-13} @10Hz
magnetic field gradient ∇B [T/m]	4.7×10^{-5}
fluctuation of ∇B $\tilde{\nabla B}$ [T/m/rtHz]	5×10^{-13} @10Hz

(force) magnetic moment tolerance δμ ~ 0.2μ

(force) magnetic field gradient ununiformity δ(∇B) ~ 0.1(∇B)

(torque) magnetic moment tolerance δμ ~ 0.2μ

(torque) magnetic field ununiformity δB ~ 0.1 B

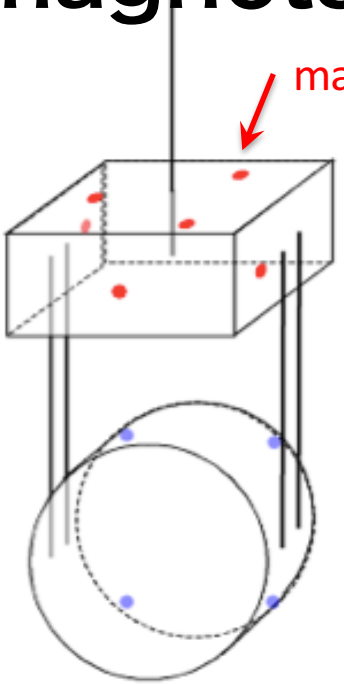
(torque) magnetic moment tolerance δμ ~ 0.2μ

(torque) magnetic field gradient ununiformity δ(∇B) ~ 0.1(∇B)

(torque) magnet position accuracy δx ~ 1[mm]

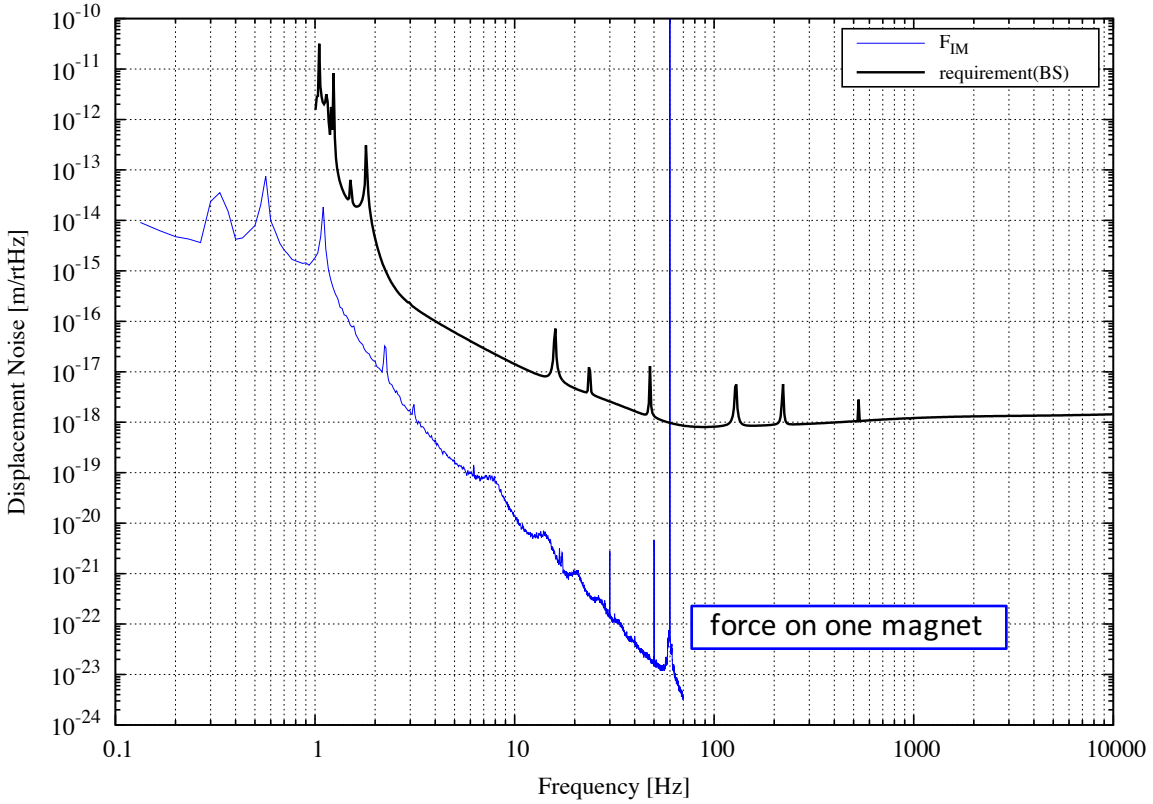
(force) magnetization of the mirror

Magnetic noise from IM(Intermediate Mass) magnets of BS suspension system

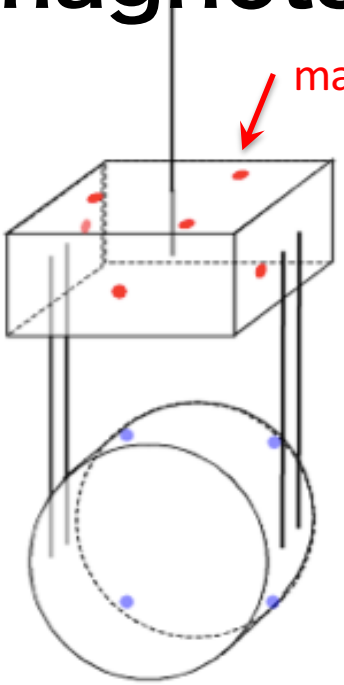


- NO cancellation between magnets
- larger magnets than the magnets on the mirror

parameter	value
IM mass M_{IM} [kg]	36.5
magnetic moment of magnets : μ [A・m²]	0.69
fluctuation of ∇B $\widetilde{\nabla B}$ [T/m/rtHz]	5×10^{-13} @10Hz



Magnetic noise from IM(Intermediate Mass) magnets of PRM/SRM suspension system



- NO cancellation between magnets
- larger magnets than the magnets on the mirror

parameter	value
IM mass M_{IM} [kg]	15.6
magnetic moment of magnets : μ [A・m²]	0.69
fluctuation of ∇B $\widetilde{\nabla B}$ [T/m/rtHz]	5×10^{-13} @10Hz