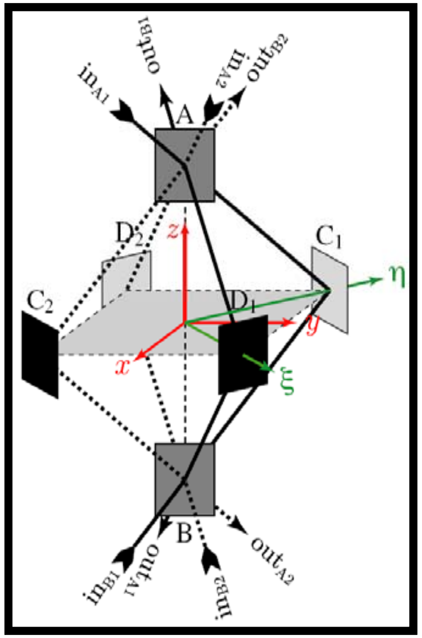
When displacement-noise-free GW detection is possible? It is possible when an interferometer responds *differently* to the GW and displacement noise.

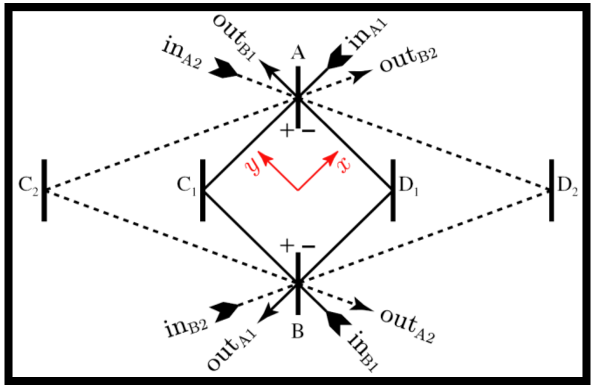
Why is it possible, in principle? It is possible, because displacement noise is a *localized* effect (phase of the optical wave is affected at the instants of reflection) while the GW is a *distributed* effect (phase of the optical wave is affected along the path).

Response: $\underbrace{\text{disp. noise} + a_0 (L/\lambda_{\rm GW})^0 h + a_1 (L/\lambda_{\rm GW})^1 h}_{\text{localized effects}} + \underbrace{a_2 (L/\lambda_{\rm GW})^2 h + a_3 (L/\lambda_{\rm GW})^3 h + \ldots}_{\text{distributed effects}}$

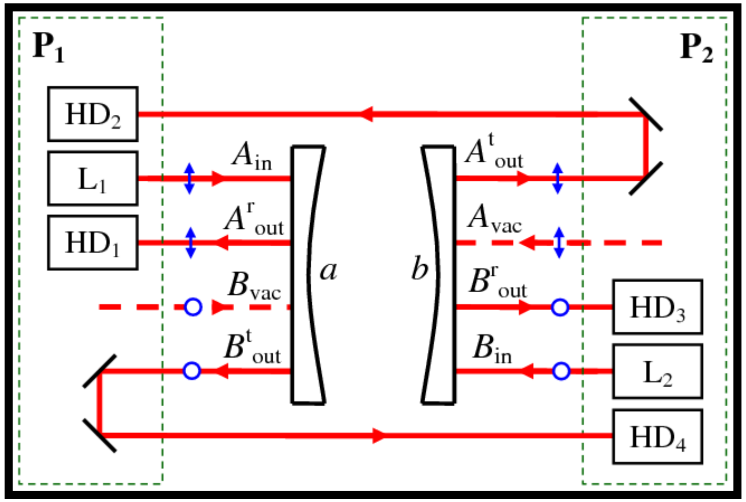
Complete displacement noise cancelation is only possible for $(L/\lambda_{\rm GW})^n,\ n \geq 2$. Otherwise, displacement noise will be canceled only *partially*.



Linear combination of 4 responses is completely DNF and GW response is $\propto (L/\lambda_{\rm GW})^2 h$

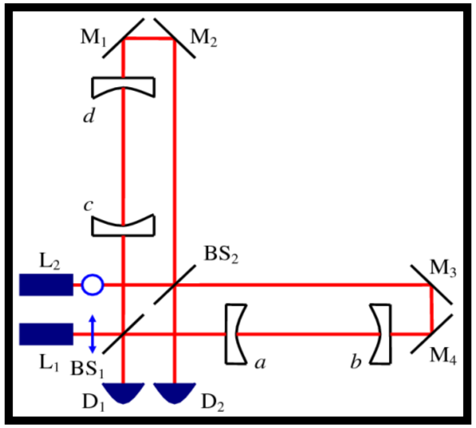


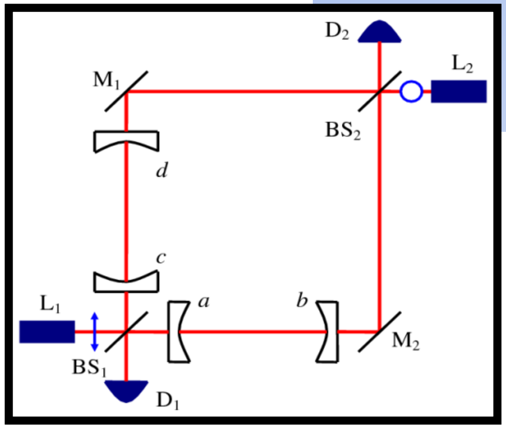
GW response is $\propto (L/\lambda_{\rm GW})^3 h \approx 10^{-7} \times h$ for $L = 10$ km and $f_{\rm GW} = 100$ Hz.



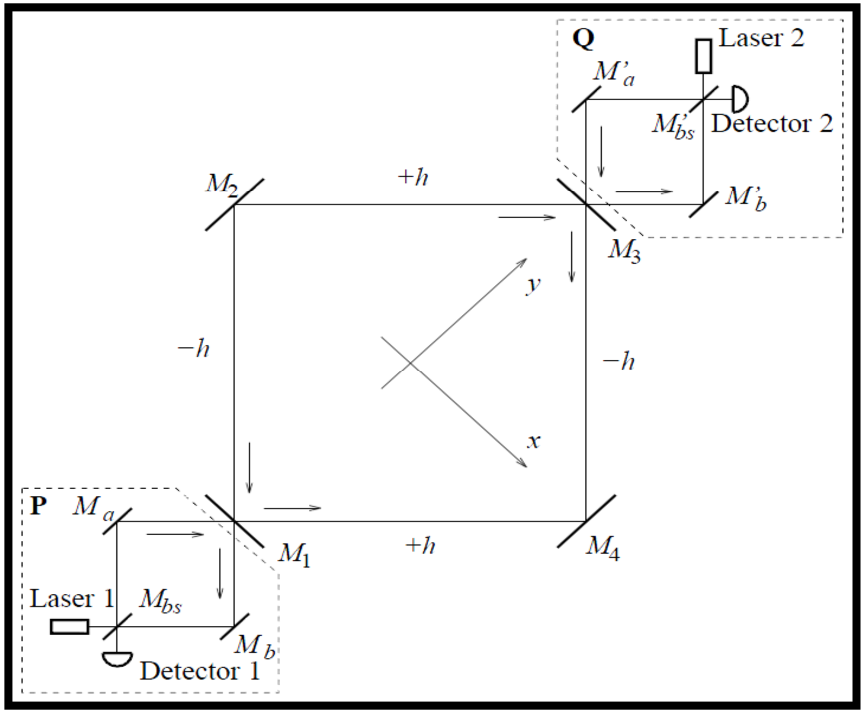
Double-pumped FP cavity is an example of partial DFI with the GW response $\left(L/\lambda_{\rm GW}\right)^0 h$ (no resonant gain). Displacement noise of the cavity mirrors is canceled. Sensitivity is limited by laser noise and residual displacement noise of the optical benches.

Balanced schemes allow laser noise suppression, however, residual noise of additional mirrors still remain.



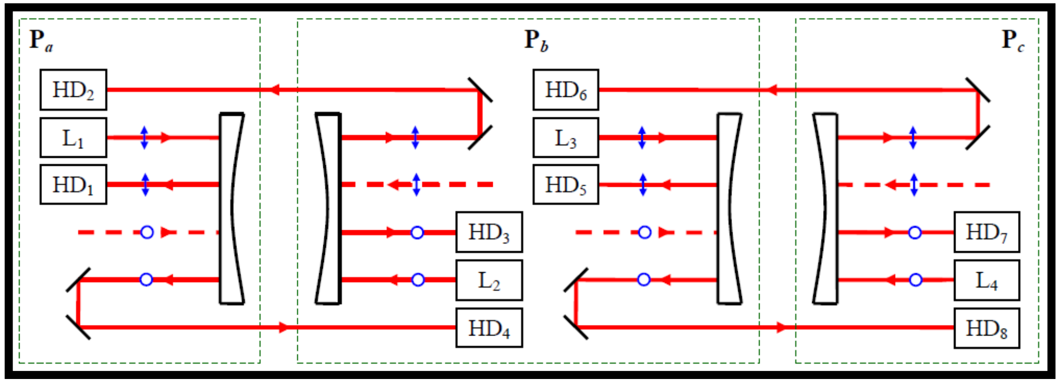


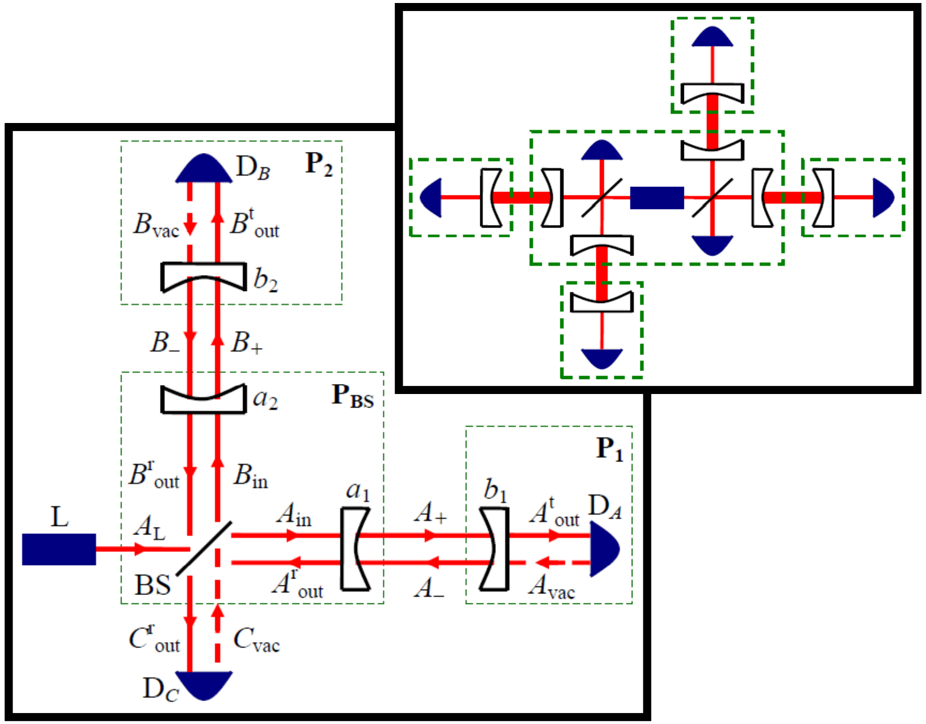
Double-pumped resonant speed meter is an example of partial DFI with the GW response $\left(L/\lambda_{\rm GW}\right)^1 h$ with the resonant gain. It has laser noise suppressed (balanced scheme) but sensitivity is limited by displacement noise of auxiliary mirrors.



Two symmetrically positioned double-pumped FP cavities. Allow complete displacement noise cancelation with the resonantly amplified $(L/\lambda_{GW})^2 h$ response.

Limitations: domination of laser noise (unbalanced scheme); cavity mirrors, laser, detectors and all auxiliary optics is required to be mounted on the platforms.





Two symmetrically positioned Michelson/FP interferometers is a balanced modification (laser noise free) of the two-cavities scheme. GW response is $(L/\lambda_{GW})^2 h \approx 10^{-5} \times h$ for $L = 10$ km and $f_{GW} = 100$ Hz. Resonant amplification (factor approx. 10^3) gives totally $h(L/\lambda_{GW})^2/(\gamma L/c) \approx 10^{-2} \times h$ for $\gamma = 10$ Hz (cavity half-bandwidth).

Major limitation: requirement of rigid platforms.

Possible solution: multi-frequency pump (being considered now).