

“dual” a third kind of gw detector

thermal and back action noise and signal

interferometers

“single” resonators

bars and spheres

“*far*” from

“*at*”

system resonant modes

wideband

narrowband

“dual” resonators

“*in between*”

gw sensitive system resonant modes

wideband

- “*additive*” effect on signal
- “*subtraction*” effect on back action

Massimo Cerdonio, Livia Conti et al. PRL **87** (2001)

Michele Bonaldi et al. (submitted to PRD)

Michel Pinard et al. (submitted to PRD)

use ***non-resonant wide area*** displacement transducers

Francesco Marin et al Physics Lett.A (in press)



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www.auriga.lnl.infn.it

Massimo Cerdonio

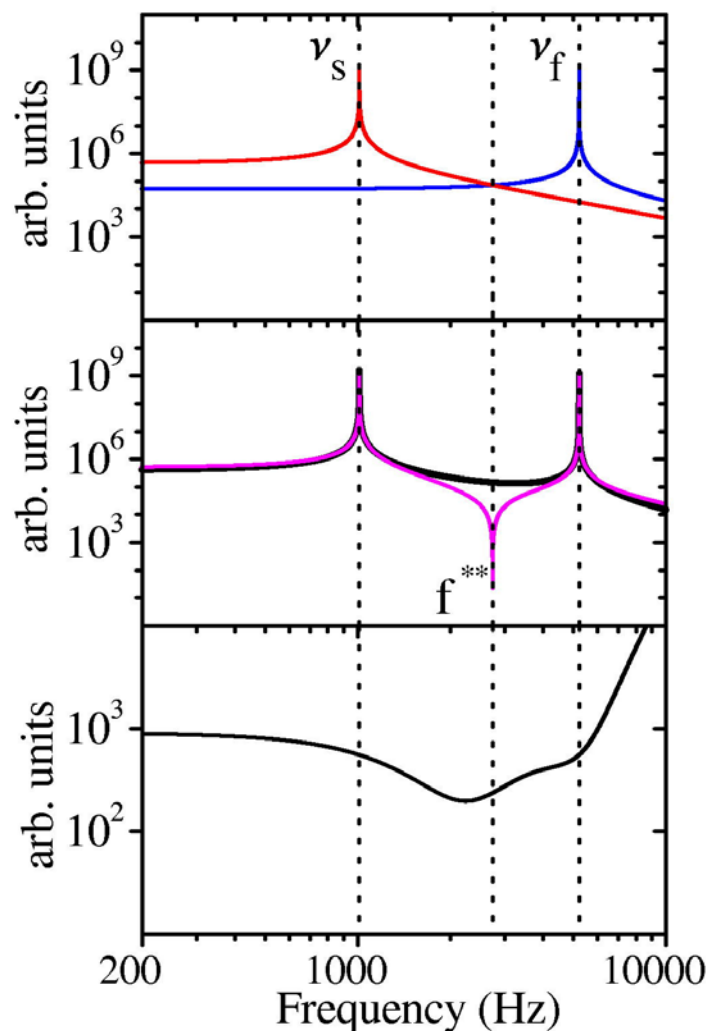
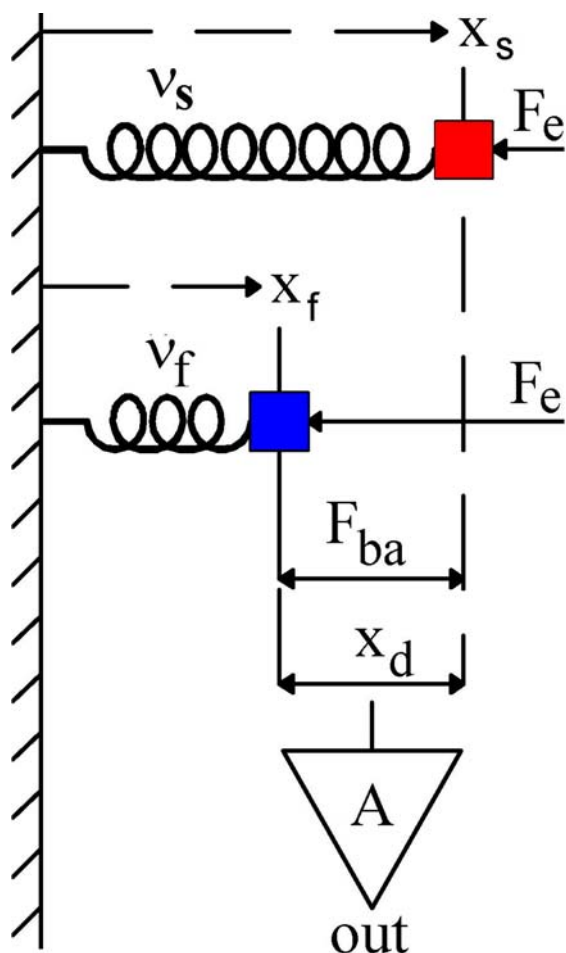
Aspen 02/03



wideband “dual” gw detectors

- signal *addition*
- back-action *reduction*

(simplified two modes model)

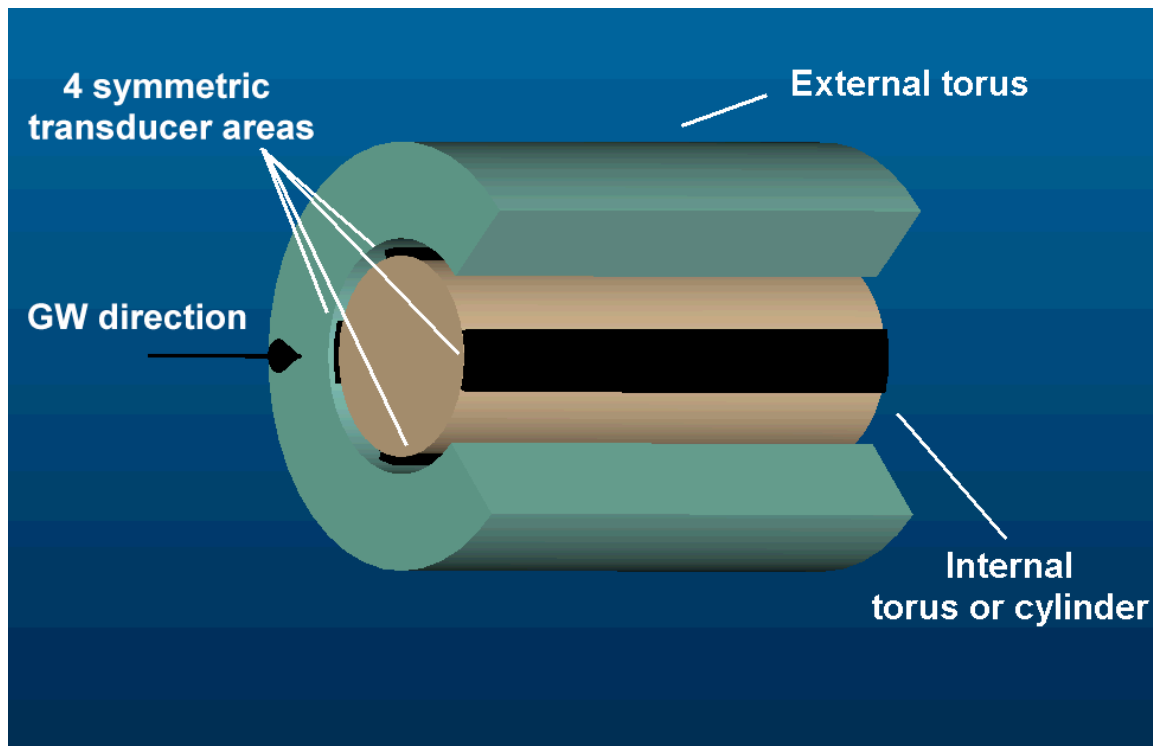


SNR is enhanced at “in between” frequencies



in an actual many-modes system, thermal and back-action noise contributions from non gw sensitive modes tend to wipe out the “dual” SNR enhancement

the “*selective*” read-out recovers the features of the simplified two modes model simpler for a “dual” cylinder



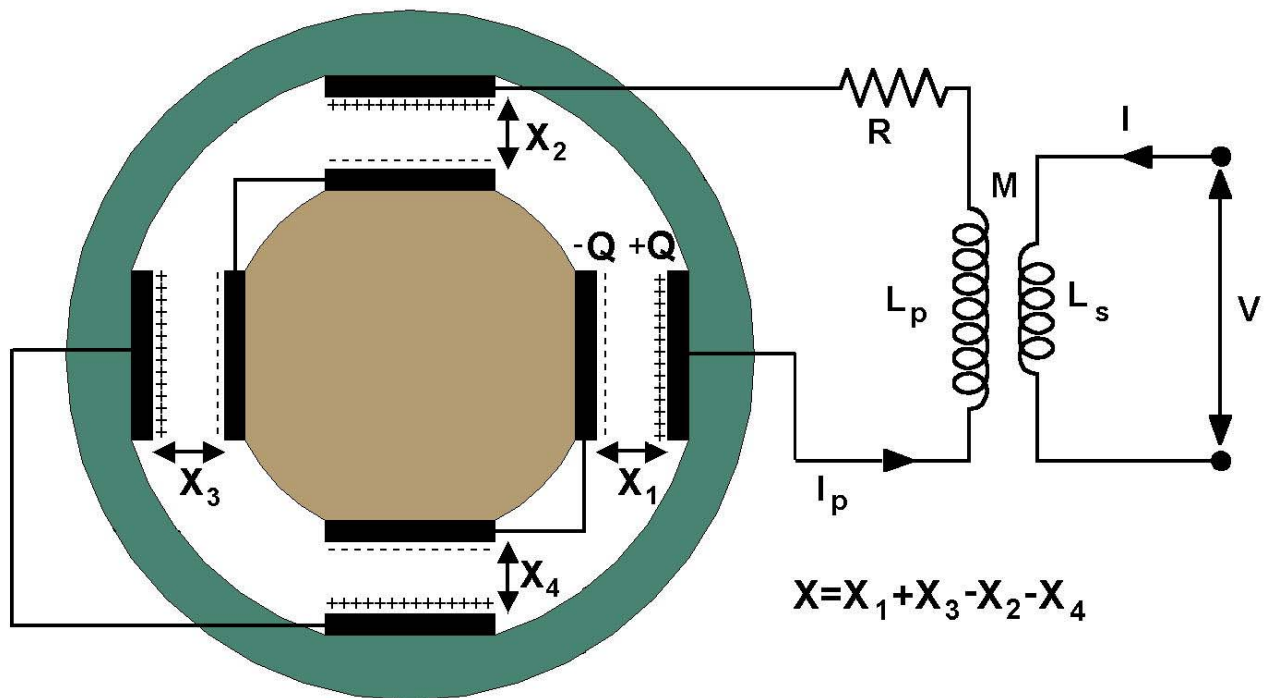
effectively rejects thermal and back action noise contributions from all *non-gw* active normal modes

off-resonance noise $\sim (\text{linear dimension of read-out})^{-1}$
>>> need *wide area* transducers



selective read-out

- wide area non-resonant capacitive transducers on a “dual” cylinder



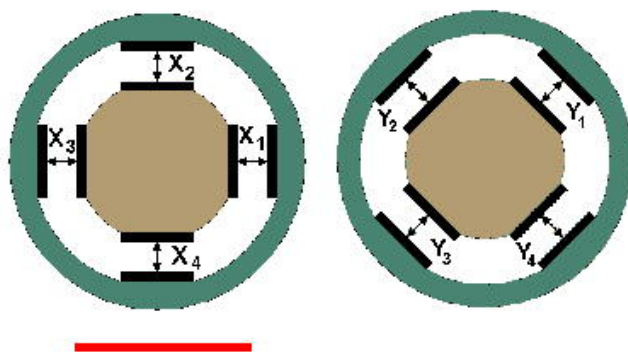
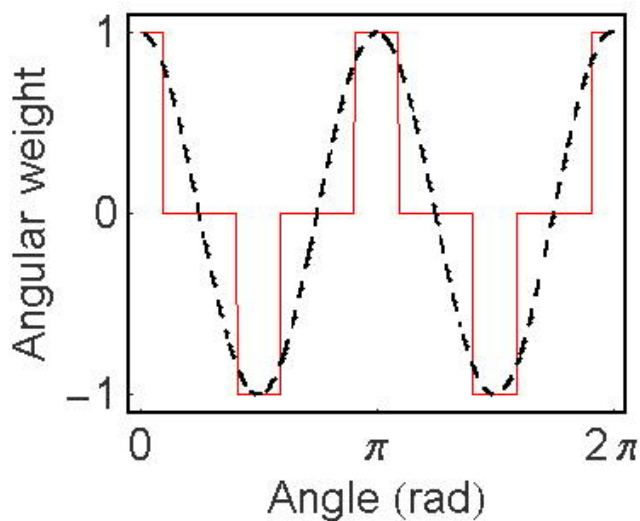
- optomechanical transducer with a “folded” Fabry-Perot cavity

(F.Marin, L.Conti and M.DeRosa *Physics Letters A* (in press))

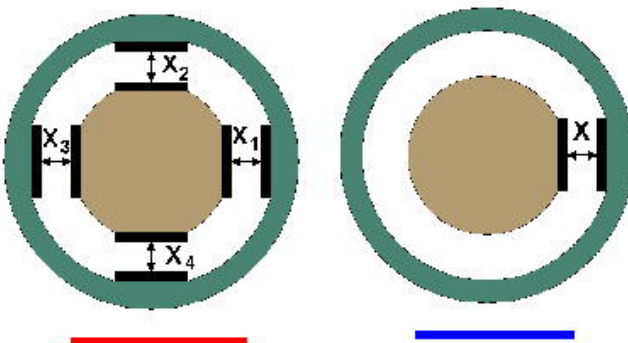
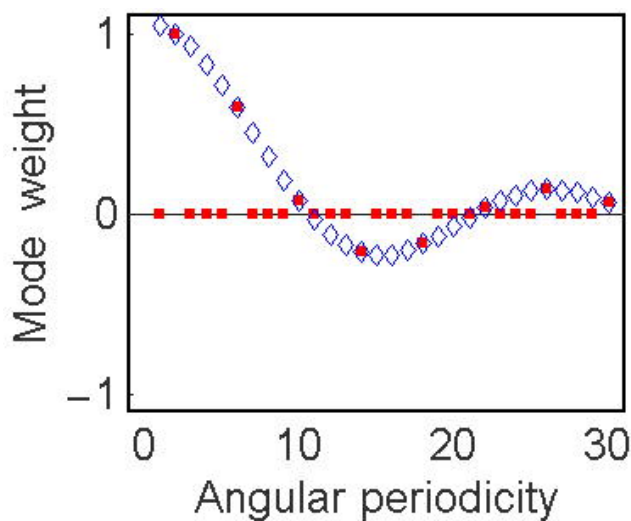


the weight function of the “selective” read-out on a “dual” cylinder...

two such systems at an angle of $\pi/4$ resolve the two polarization states for gw incoming along the axis



...and its selectivity



Mo Dual:

inner cylinder diam 0.50 m weight 4.8 t
outer torus int/ext diam 0.52m/0.94m weight 11.6 t height 2,35 m fundamental quadrupolar modes 1012 Hz and 5190 Hz

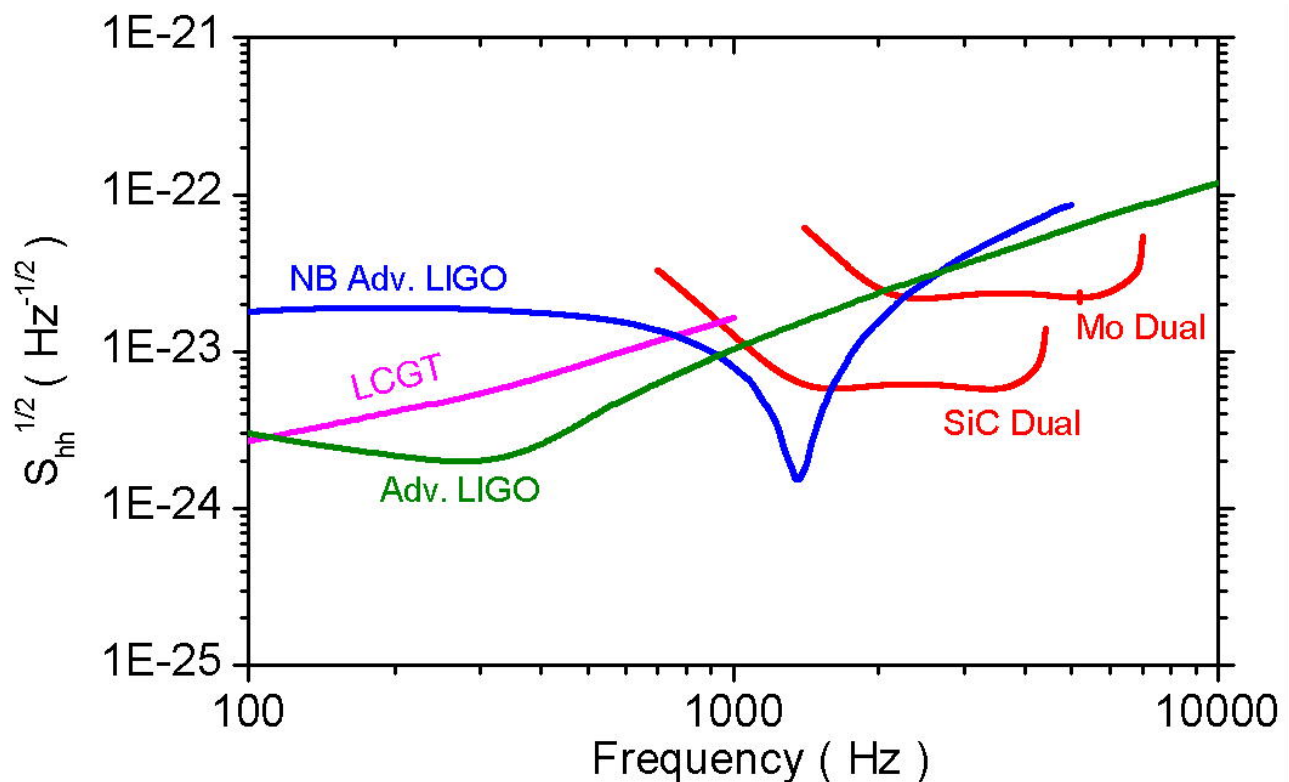
$$Q/T > 2 \cdot 10^8 \text{ K}^{-1} \quad S_{xx} = 5 \cdot 10^{-46} \text{ m}^2/\text{Hz}$$

SiC Dual:

inner cylinder diam 1.64 m weight 4.8 t
outer torus int/ext diam 1.66m/2.88m weight 11.6 t height 3 m fundamental quadrupolar modes 595 Hz and 3280 Hz

$$Q/T > 2 \cdot 10^8 \text{ K}^{-1} \quad S_{xx} = 3 \cdot 10^{-46} \text{ m}^2/\text{Hz}$$

(both at their Standard Quantum Limit)



current activities

INFN Legnaro Natl.Lab., INFN Sections of Padua+Trento, Florence, Ferrara, Genua, Fund. Physics Dept. Barcelona, Kastler-Brossel Lab. ENS-CNRS

- studies of “dual” configurations
dual sphere and dual torus of
Mo, Be, Be-Mo, SiC, C/SiC,...
- screening of candidate materials (as above)
mechanical quality factor $Q > 10^6$ at low T
low temperature thermal properties
fabrication
high cross section (ρv_s^5)
- FEM studies of suspensions
- FEM studies of dissipation and thermal noise in
the sensitive resonant mass
- thermal noise and “quantum limits” in the read-out
optical transducers
capacitive + SQUID transducers
- apply for funding for an aggressive R&d on the above
to Italian Ministry of Research (done)
to European Community (through ApEC)
to INFN (done)
to EGO (in preparation)

