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Detuned Twin-Signal-Recycling

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GWDs and Squeezed light

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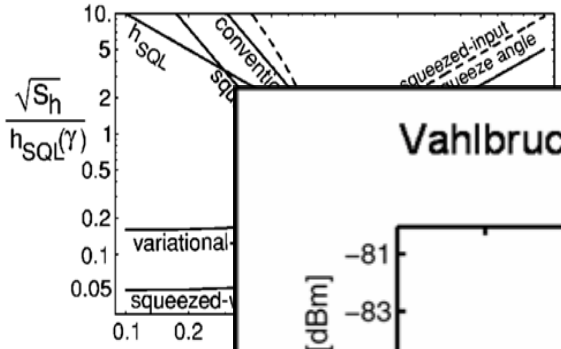
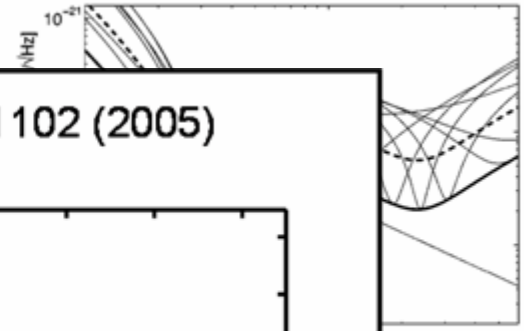
Kimble *et al.*, Phys. Rev. D 65 ,0222015 (2002)



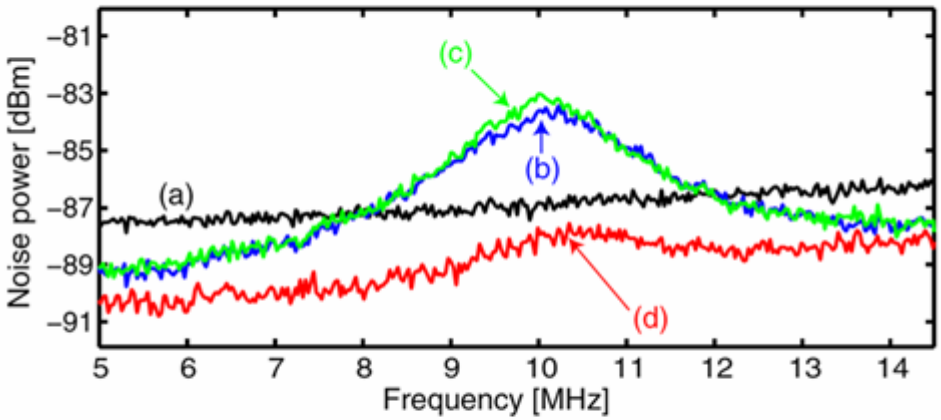
Filter-cavities allows
whole detection ban

Harms *et al.*, Phys. Rev. D 68, 042001 (2003)]



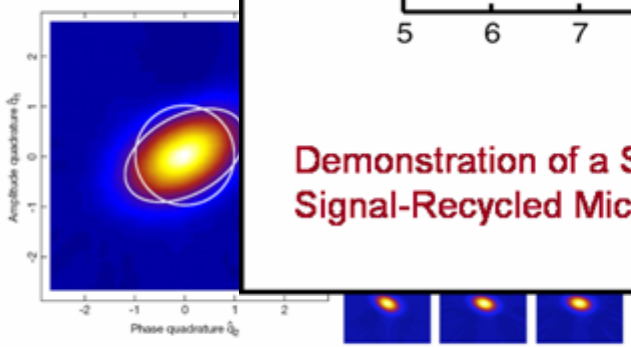
e sideband tuned

Vahlbruch *et al.*, PRL 95, 211102 (2005)



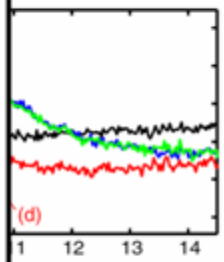
Demonstration of a Squeezed-Light-Enhanced Power- and Signal-Recycled Michelson Interferometer

Chelkowski *et al.*,



Generation and characterization of frequency dependent squeezed light

1102 (2005)



Demonstration of a Squeezed-Light-Enhanced Power- and Signal-Recycled Michelson Interferometer

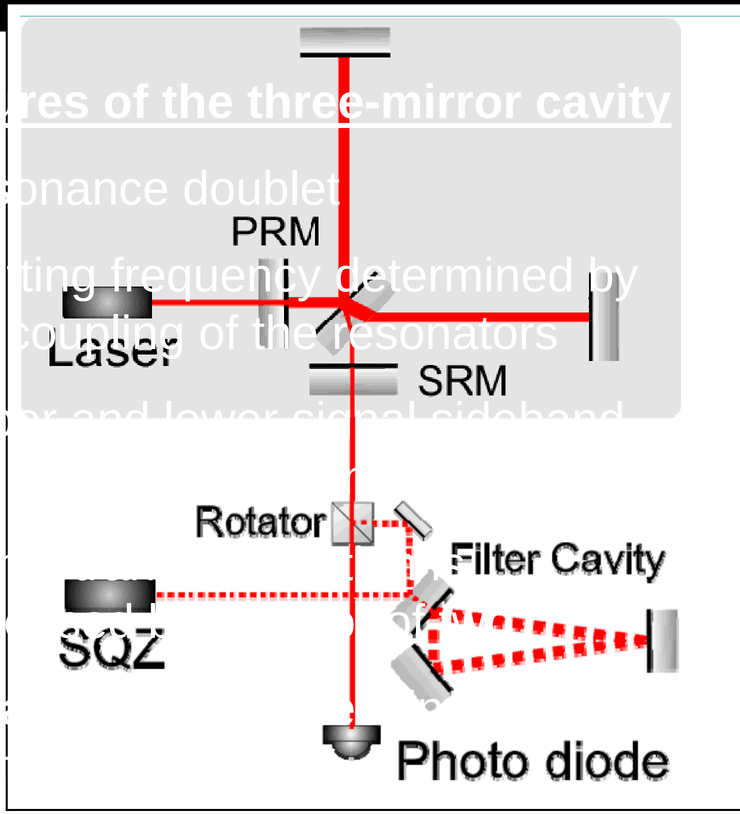
Twin-Signal-Recycling Topology

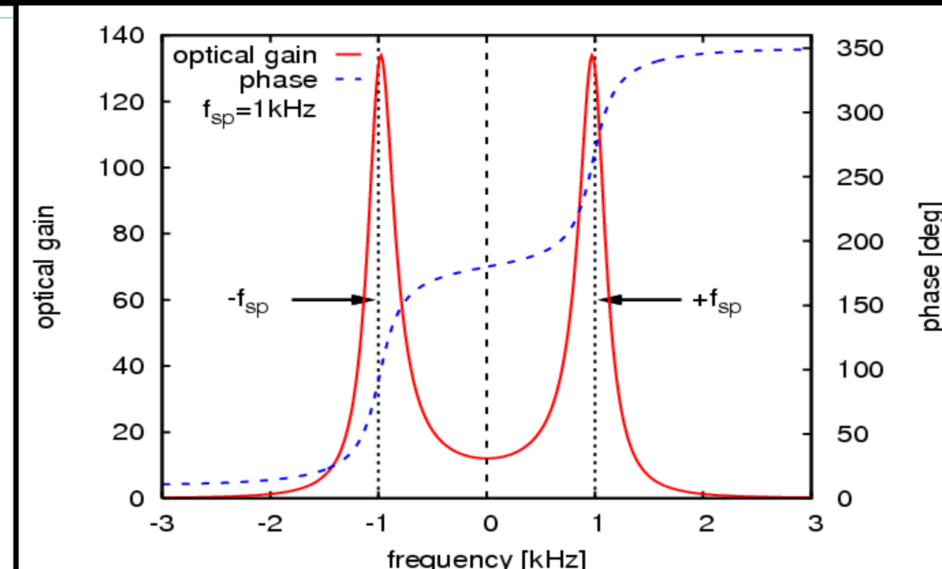
F... res of the three-mirror cavity

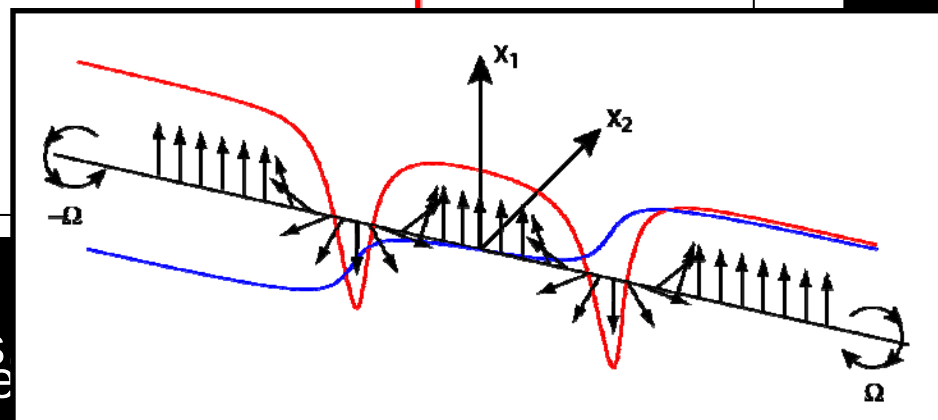
- ...sonance doublet
- ...ting frequency determined by coupling of the resonators
- ...per and lower signal sideband
- Less demanding requirements for squeezed field injection

Adding an additional mirror forms a linear coupled three

A. Thüring *et al.* Optics Letters







Twin-Signal-Recycling Topology

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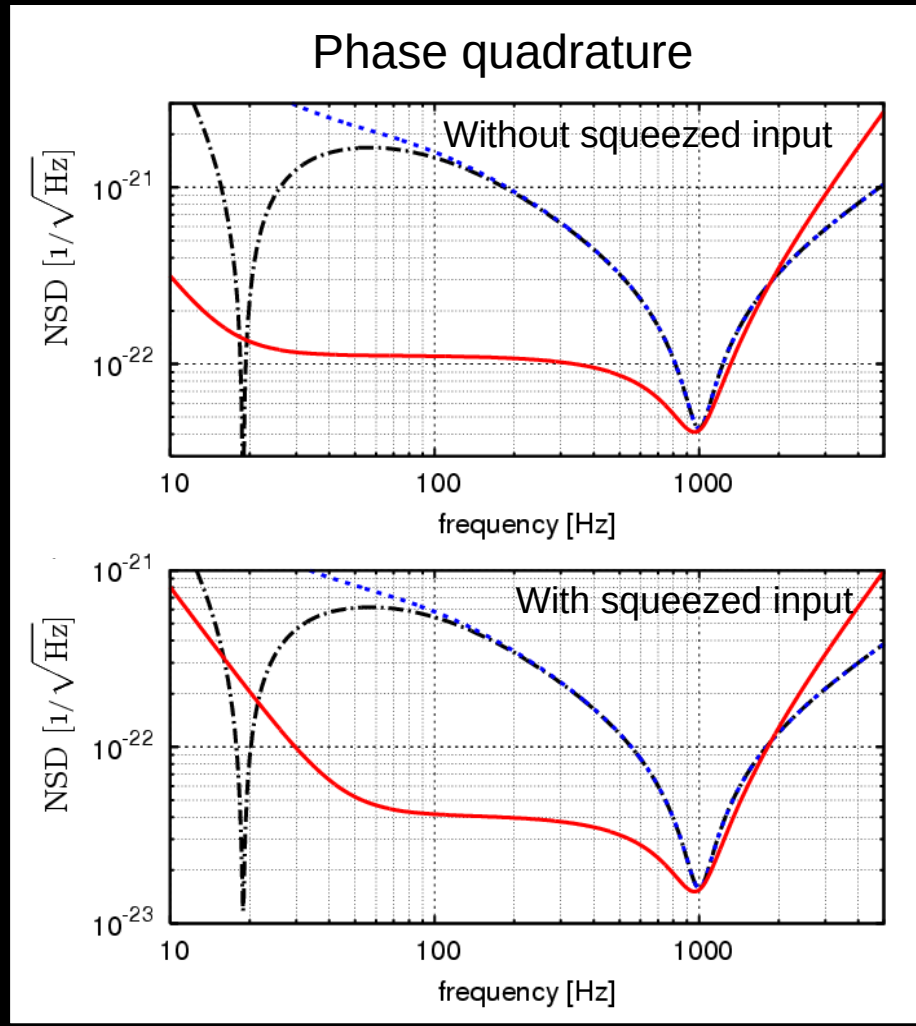
Used Parameters:

- Power in IFOs 10 kW
- GEO600:
  1200 m SR-cavity
  Rsr=0.99
  Single filter cavity

- Twin-Signal-Recycling:
  2x 1200 m coupled cavites
  R_C=0.997 for 1 kHz frequency splitting
  R_{TSRM}=0.963 leads to the peak senitivty of GEO600



The Experiment

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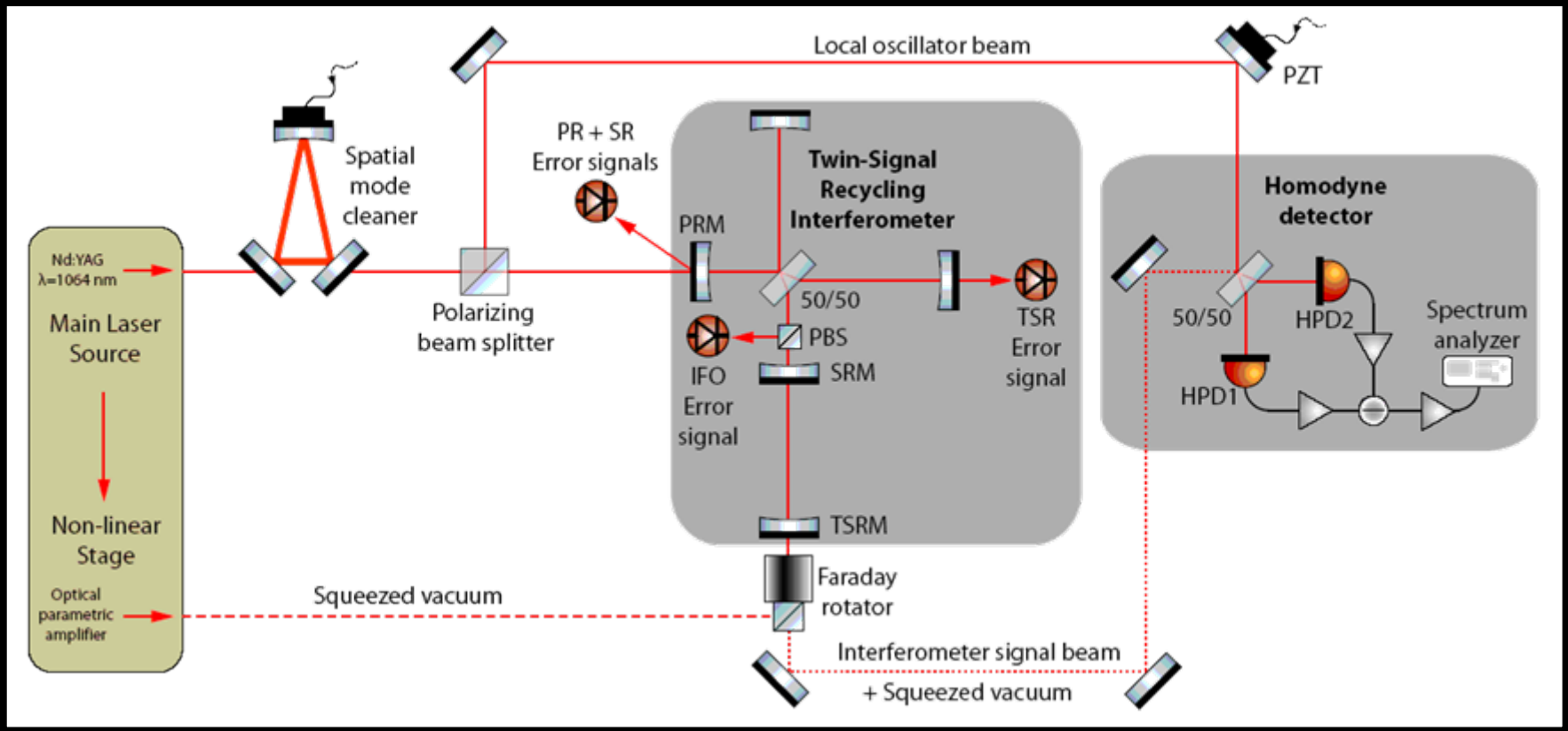

Interferometer length control

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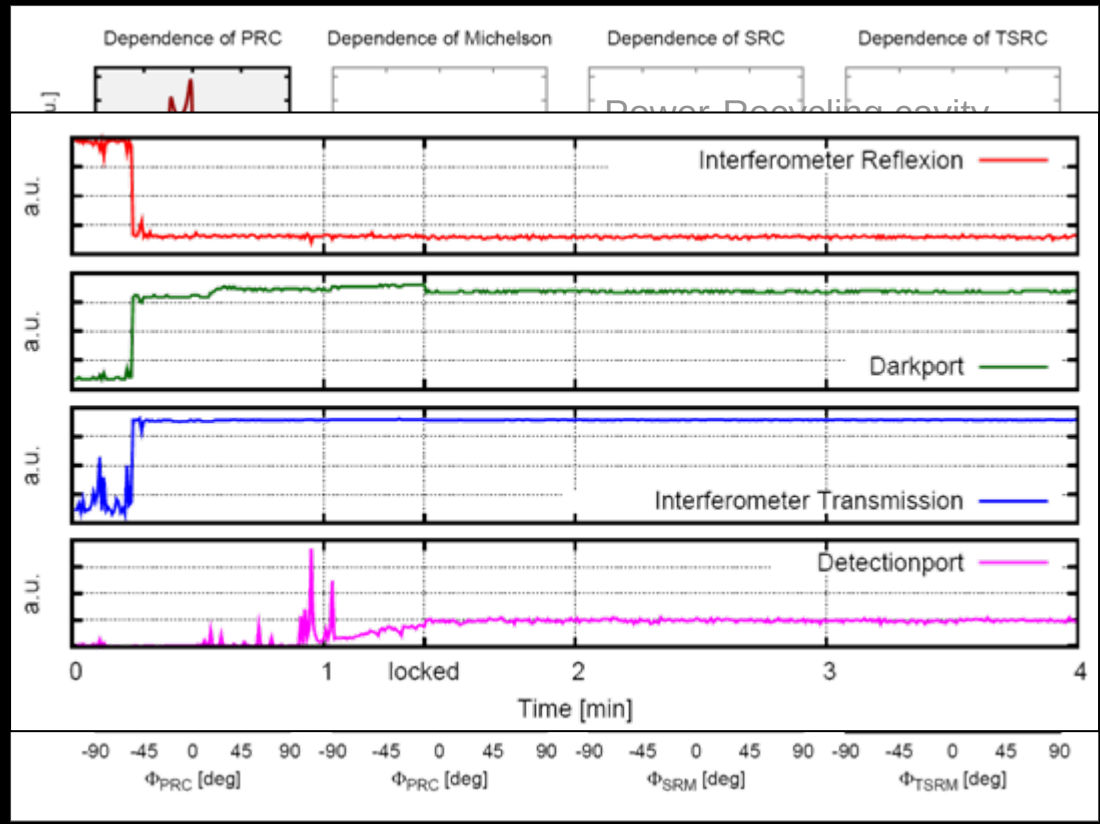
Fast facts

- Two modulation frequencies 15 MHz and ~125 MHz
- Mixed polarization allows for a decoupling of MI error signal
- PRC and MI error signal almost perfectly decoupled from the other DOFs
- SRC and TSRC error signals show strong coupling with PRC and MI
- At least a linear independent control matrix was achieved



Experimental Results

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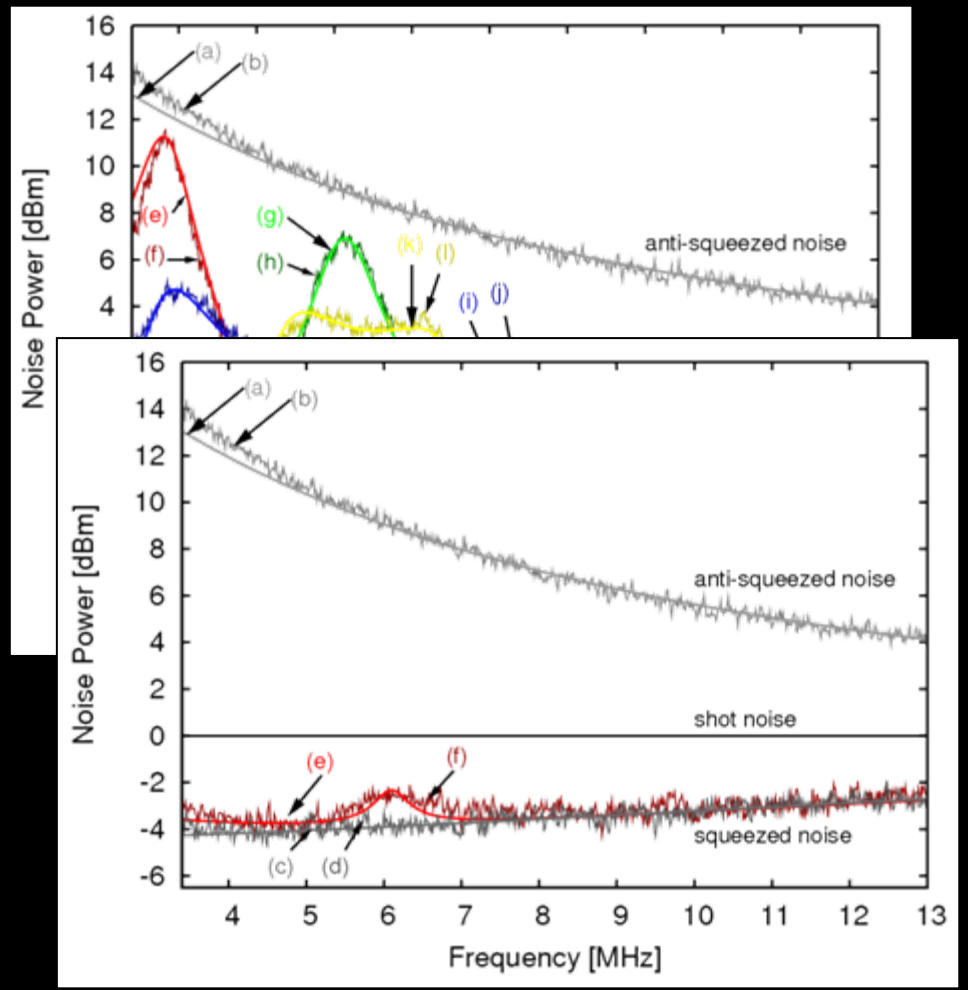
Measurement of the quantum-noise transfer function

- Injection of squeezed states with fixed quadrature angle
- Homodyne read-out with external LO
- Investigation of noise spectra for several IFO-operation points
- Rotation from squeezed to anti-squeezed quadrature observed for the non-optimum states
- Optimum operation point shows the predicted cancellation of the quadrature rotation
- Measurements and simulation are in a good agreement



Conclusion

- We have demonstrated a broadband noise reduction by a factor of up to 4 dB
- The experimental results are in good agreement with theory
- The TSR-Topology is optimum if one wants to have peak sensitivities at a certain sideband frequency
  - Upper and lower sideband are recycled simultaneously
  - A factor of two compared to Signal-Recycling/RSE
  - Squeezing can be injected without filter-cavity yielding a broadband sensitivity enhancement