Squeezed Light in Advanced LIGO

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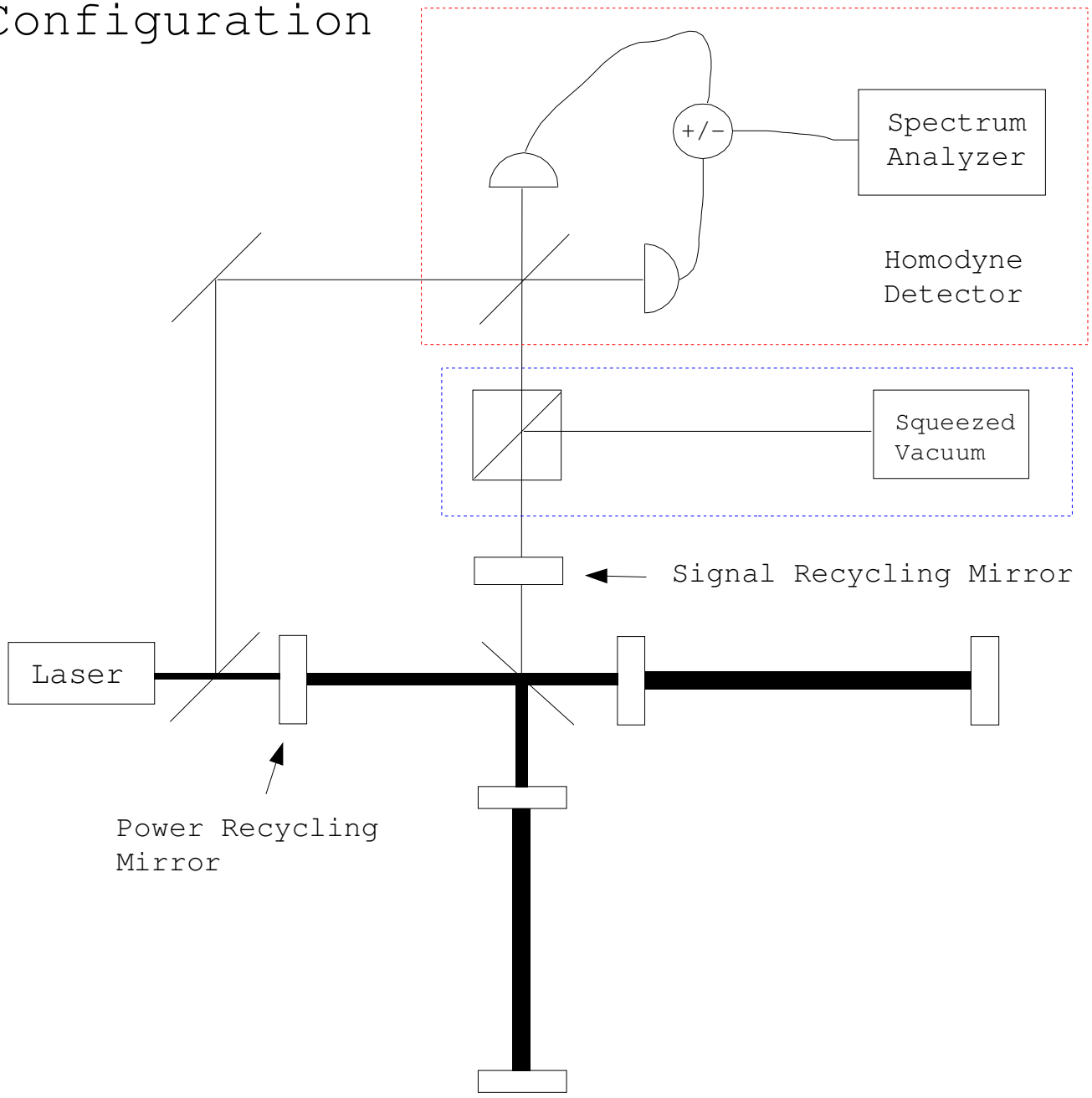
Outline

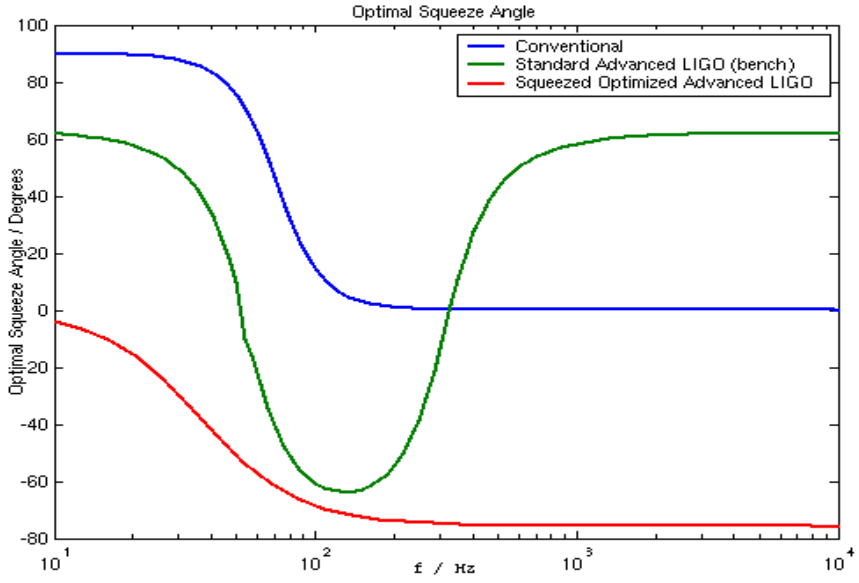
- Is squeezing useful in an Advanced LIGO configuration?
- What are the effects of losses in the performance of a squeezed interferometer in such as configuration?

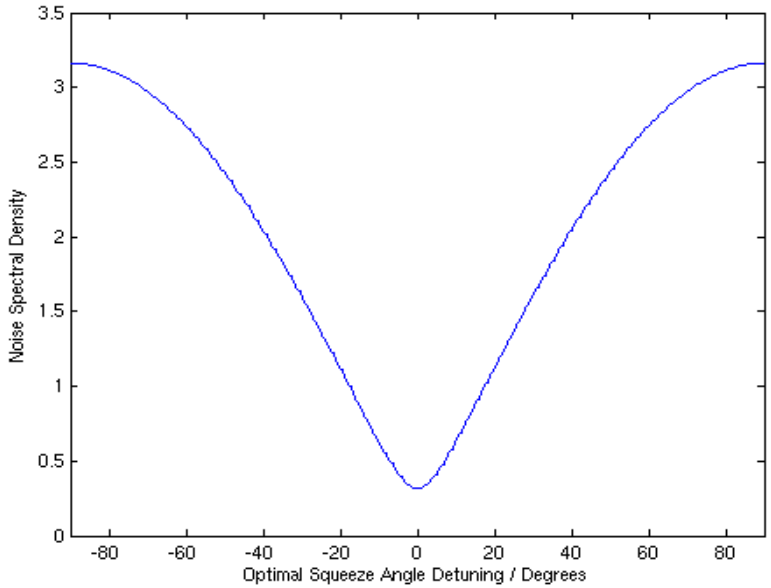
Adv. LIGO Configuration



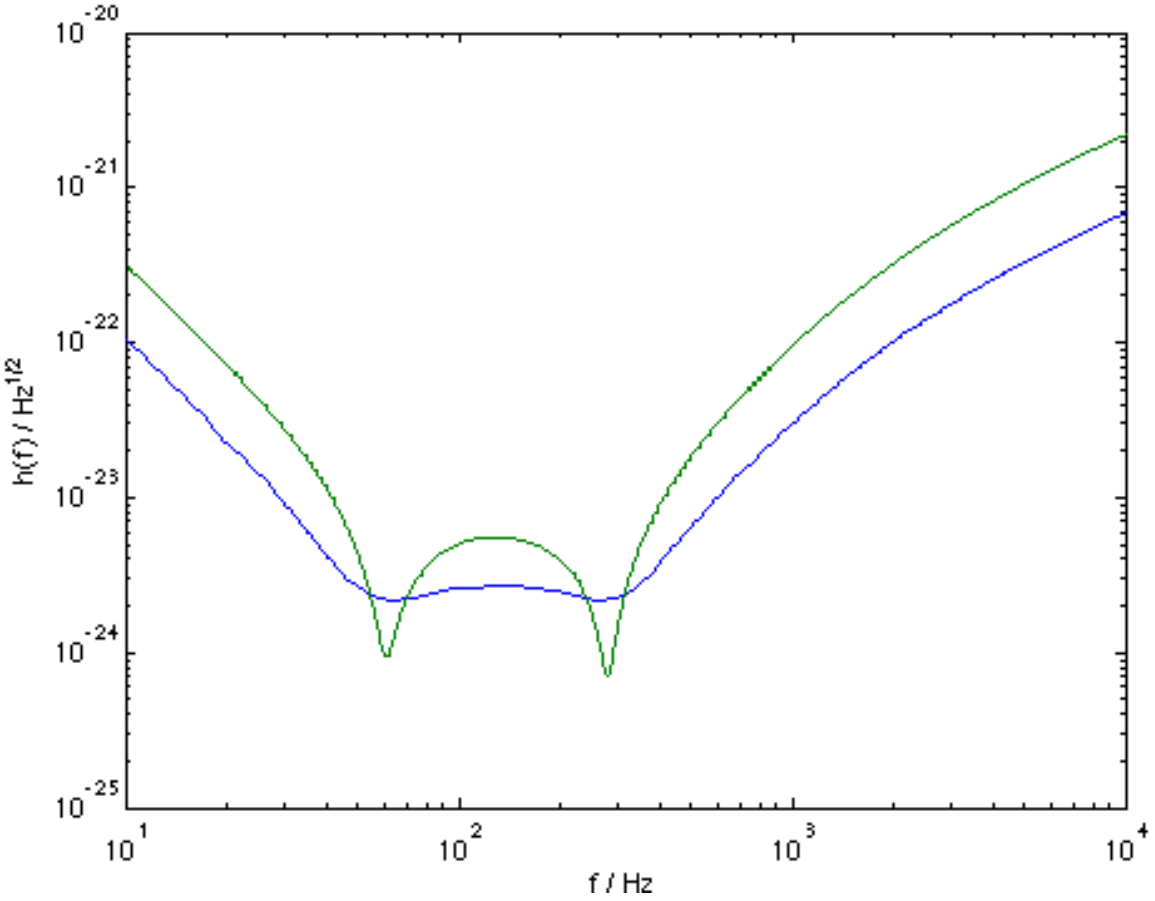
Difficulty of squeezing

We can't produce the required frequency dependent squeeze angle in general. We must choose a configuration that benefits from a fixed squeeze angle.





Narrowband Squeezing

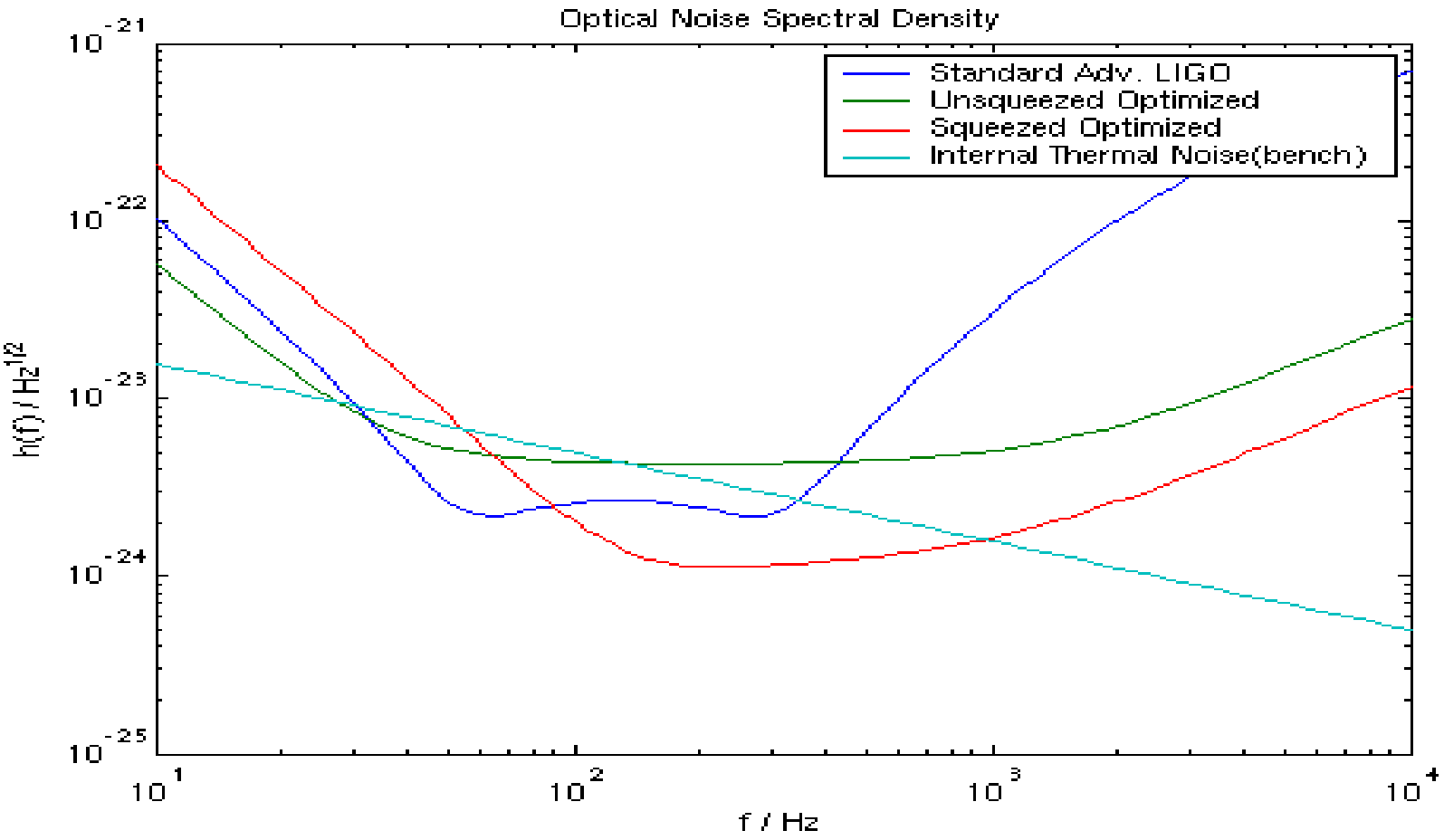


Optimized Configuration

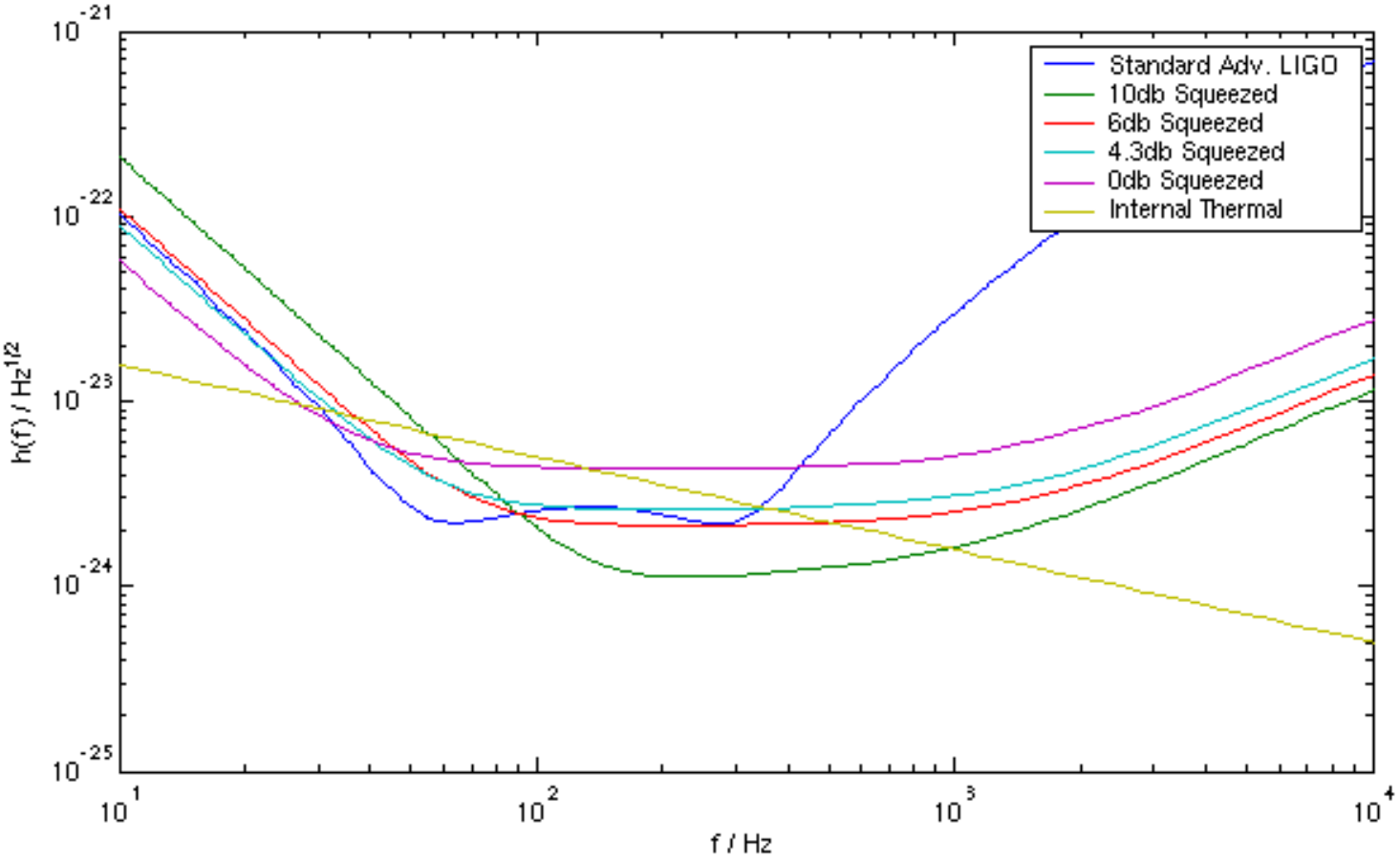
Silica

	Standard Adv. LIGO	Squeezed Adv. LIGO
SRM detuning:	87.4°	90°
SRM Transmittance:	6%	4%
Power on BS:	1350W	1500W
ITM Transmittance:	0.5%	0.5%
Squeeze Magnitude:	0	10db
Squeeze Angle:	0	-70°
Homodyne Phase:	10°	14.4°

Performance of Squeezed Interferometer

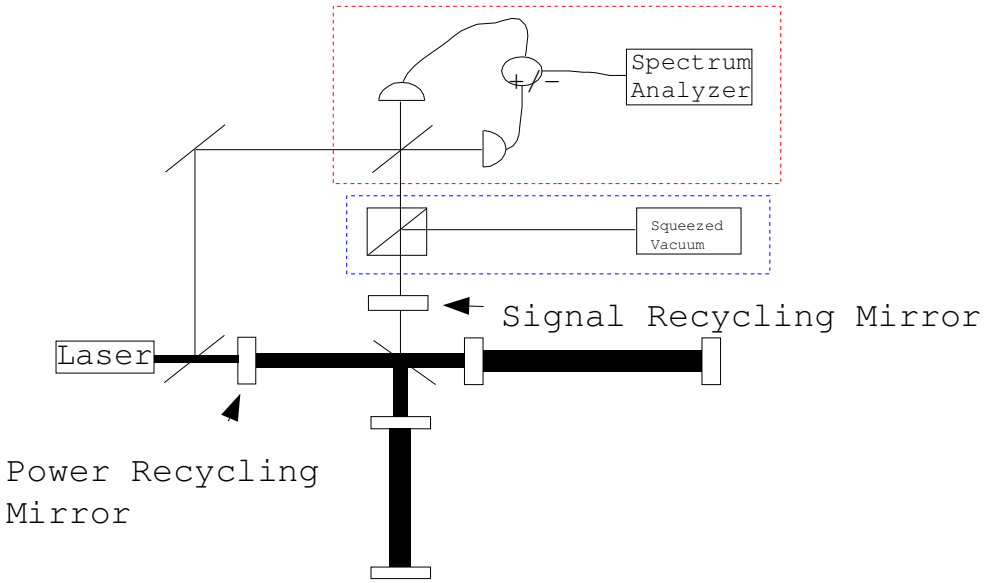


How much squeezing?



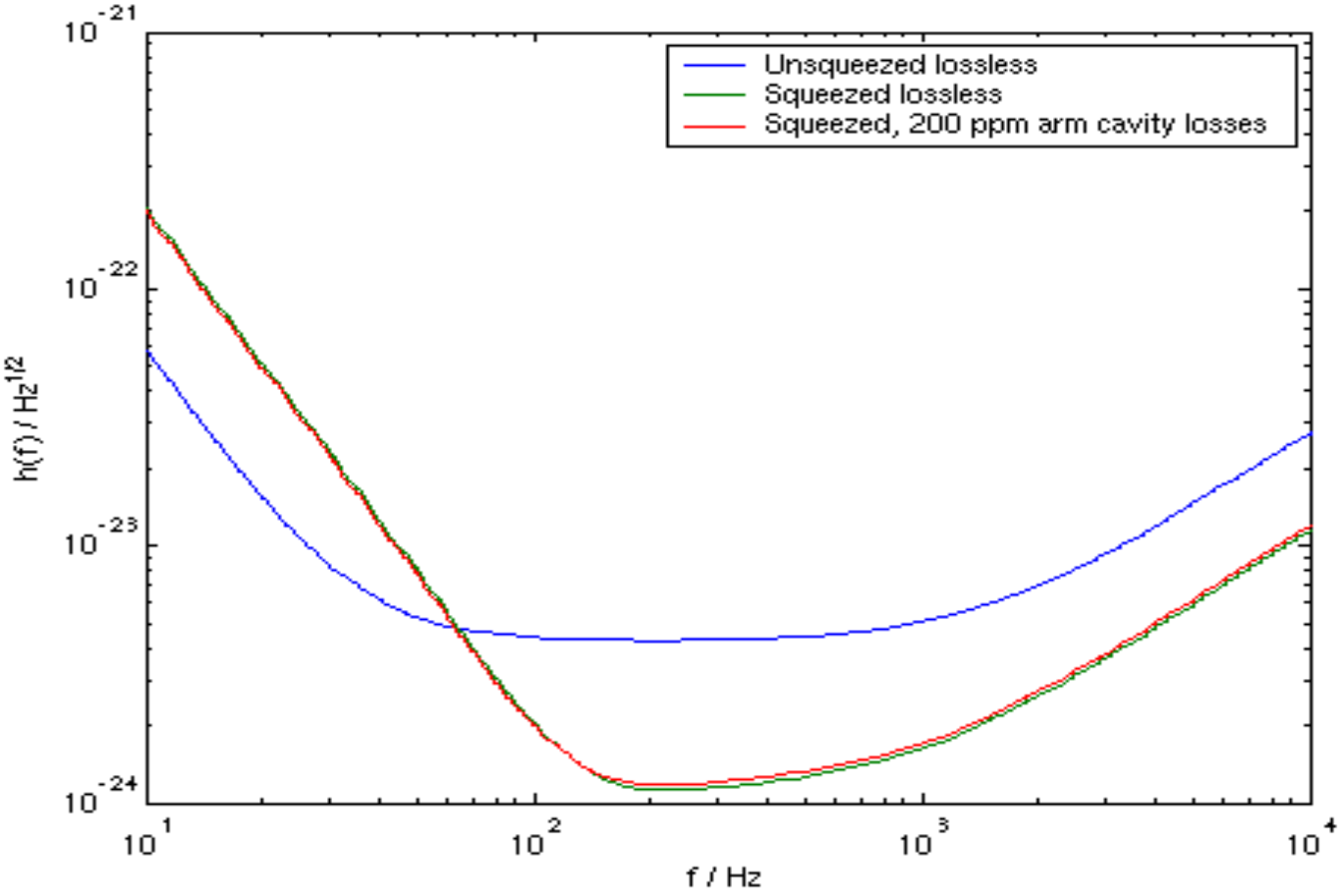
Optical Losses

- Arm Cavity Losses
- Signal Recycling Cavity Losses (beamsplitter, SRM, ITM)
- Detection Inefficiency



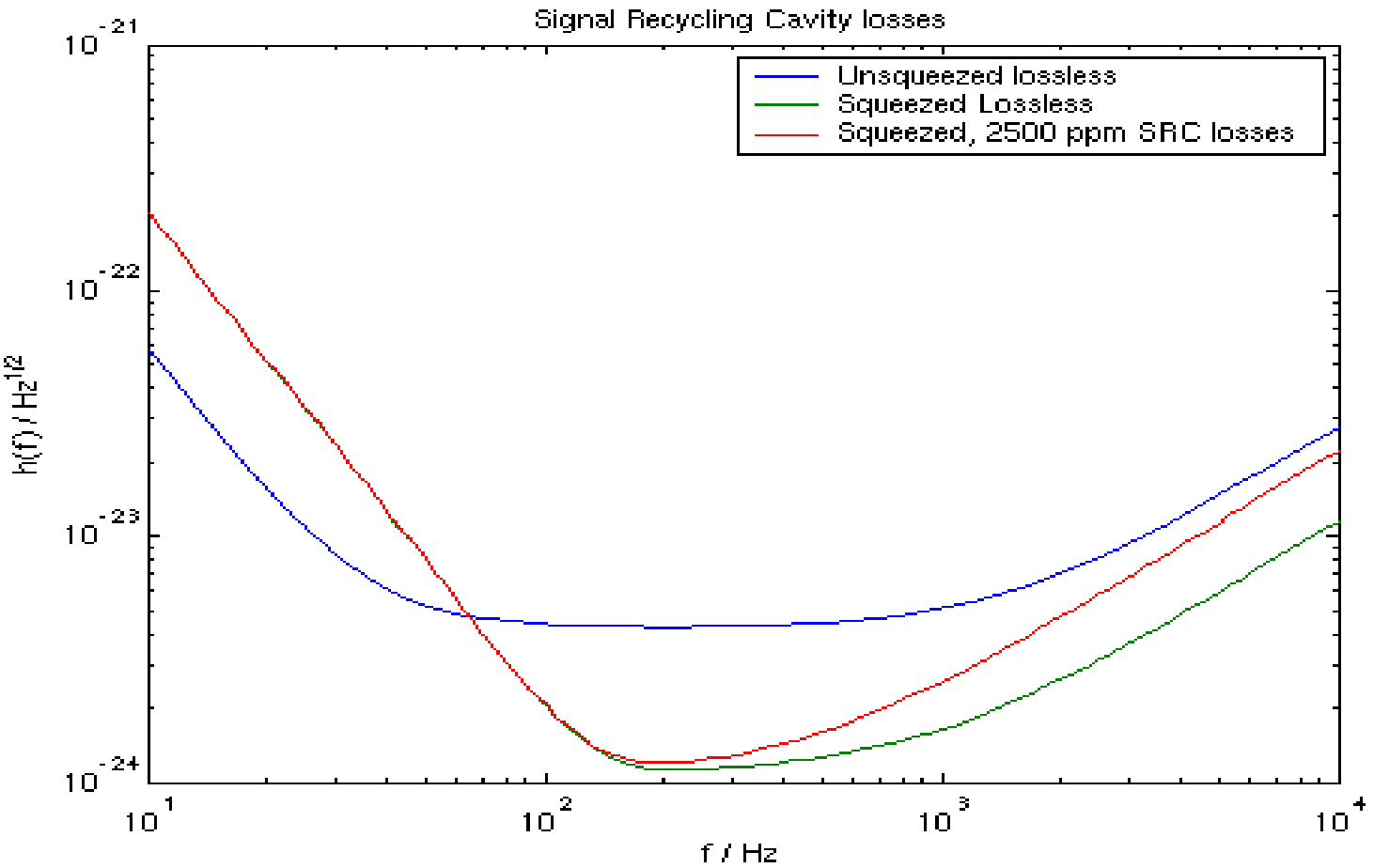
Arm Cavity Losses

- Losses destroy the effects of squeezing
- Very small effect from arm cavities!

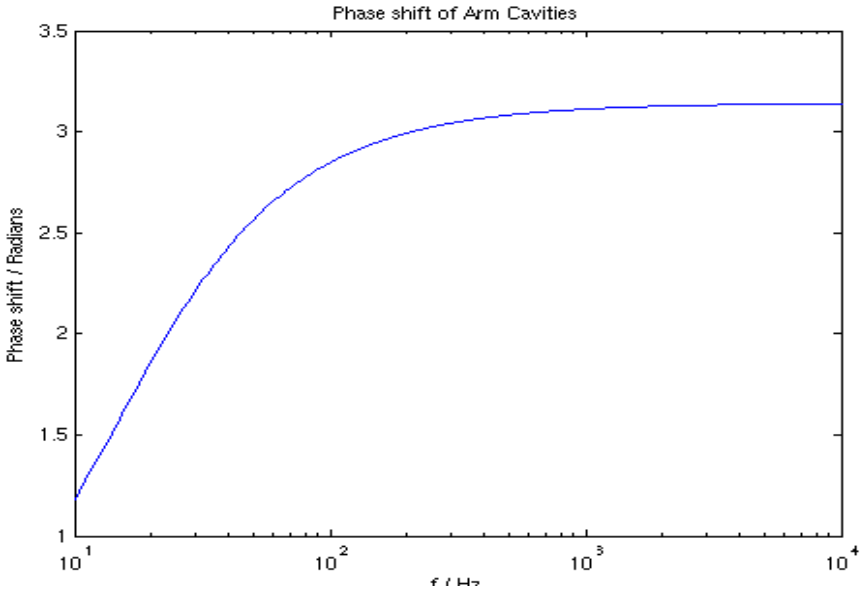


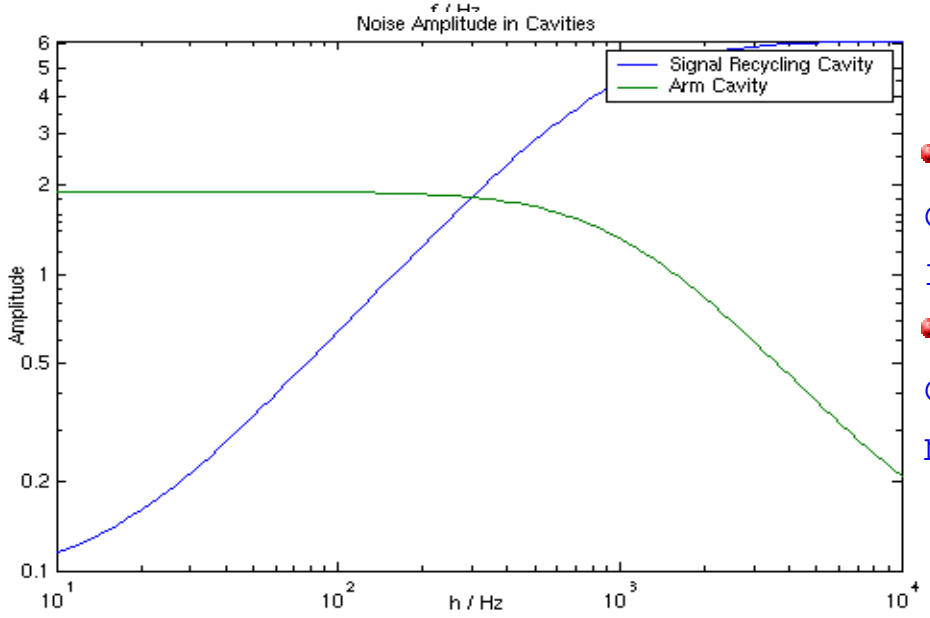
Signal Recycling Losses

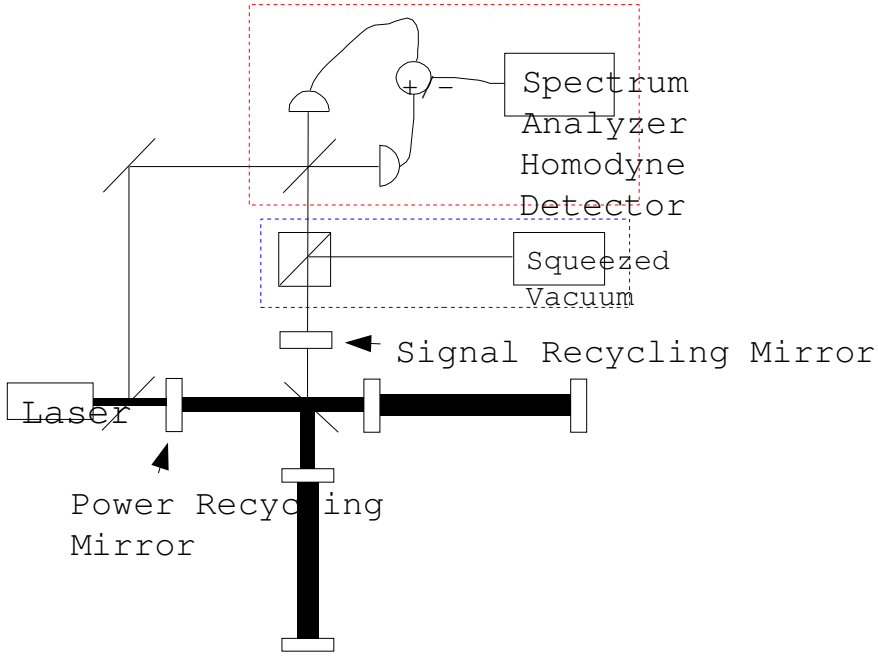
- Effect is frequency dependent
- Much larger effect than arm cavity losses



Frequency Dependent Losses

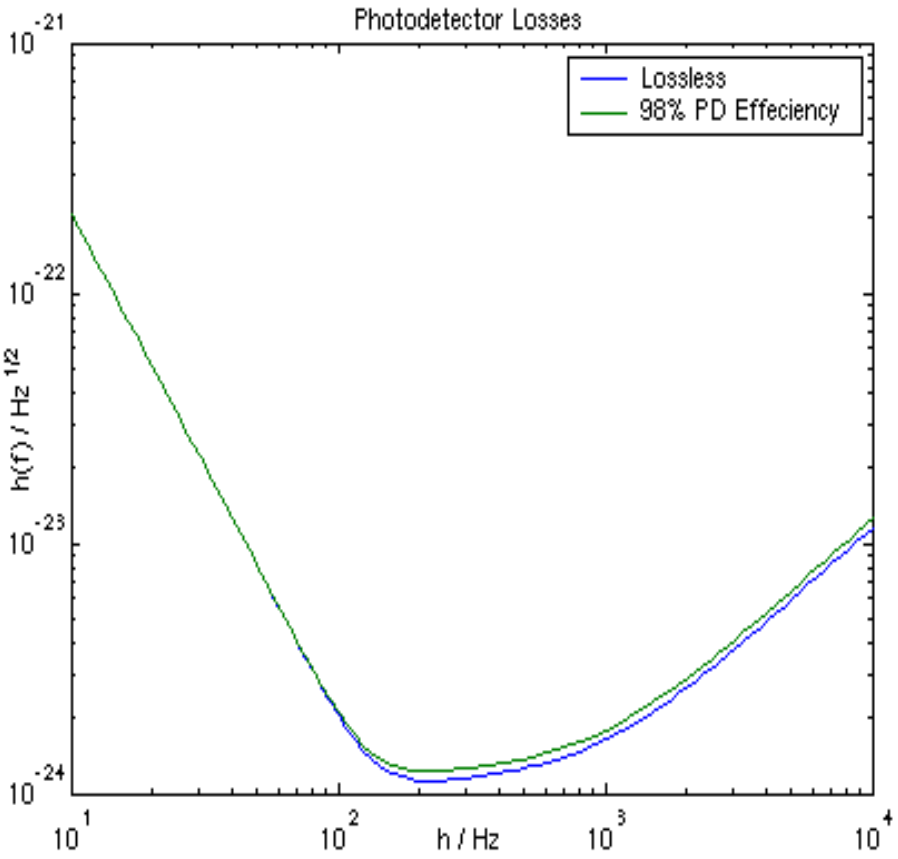


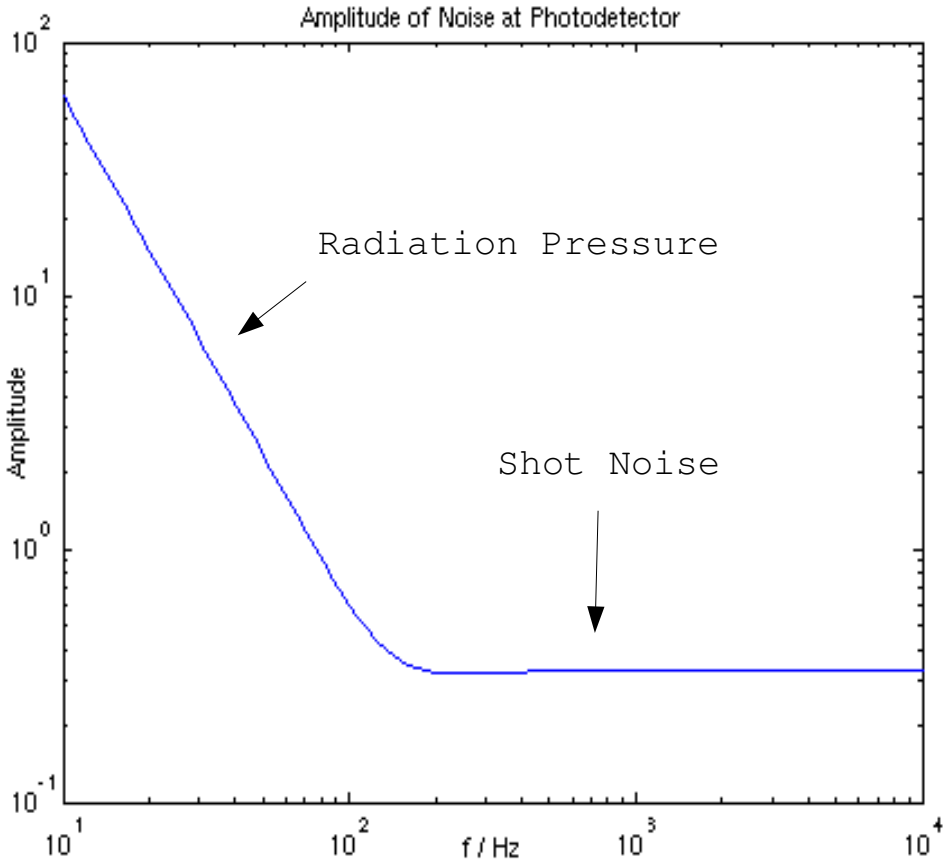




- Cavity between SRM and arm cavities resonates at high frequencies.
- Signal recycling cavity and arm cavities conspire to supress noise buildup in arm cavities.

Detection Inefficiency





Conclusions

- Squeezing can increase the tunability of Advanced LIGO, as well as increasing its broadband broadband performance.
- Configurations optimized for squeezing are not necessarily greatly different from standard configurations.
- The effects of losses are frequency dependent.
- In the given configuration are manageable at realistic levels, and are dominated by losses in the signal recycling cavity, not the arm cavities.