

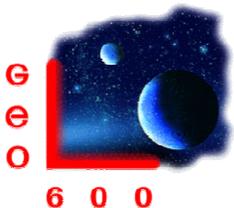


GEO-HF – a GEO Upgrade 2008+

Jim Hough for the GEO collaboration

LSC Hanford, August 04

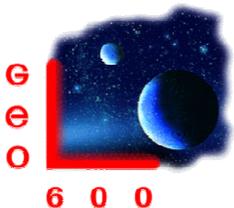
LIGO-G040400-00-Z



Motivation for Upgrade to GEO

- Astrophysics motivation for a detector to look for ringing of neutron star modes is high – triggered searches
- Background:
 - Upgrade to LIGO planned over the period 2009-2011
 - To minimise the spell in which no interferometers are running, propose that GEO take data until 2008.
 - At that time - VIRGO upgrade?
- After LIGO upgrade GEO design sensitivity will not be competitive
- **Propose:** ~ 2008, *GEO 600 be upgraded to a detector aimed at high frequency signals from neutron star oscillations to enable the study of neutron star seismology and fundamental physics - 'GEO-HF'*



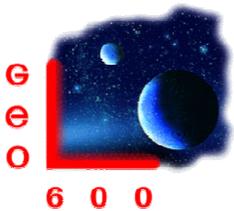


Requirements

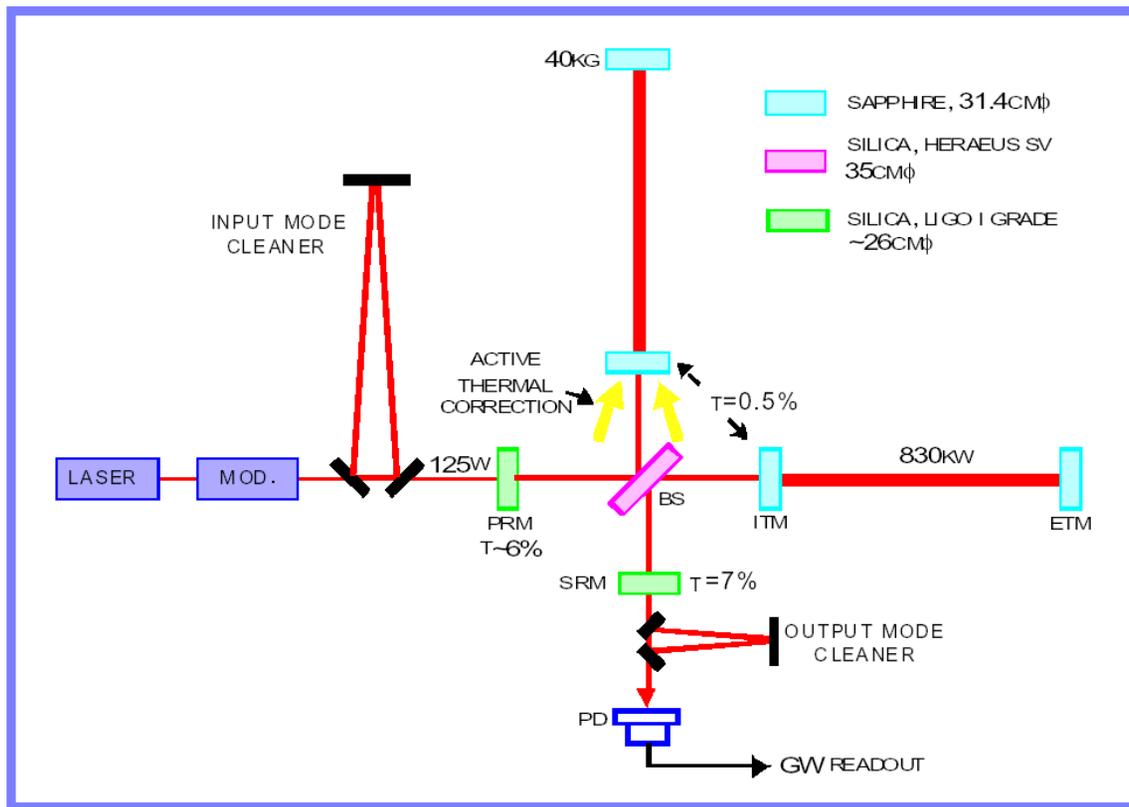
- An upgrade of the GEO 600 instrument tuned to the frequency band 2-4 kHz should observe n-star ringing at the level of an effective dimensionless amplitude of $h \sim 1 \times 10^{-23}/\sqrt{\text{Hz}}$.
- Experimental limitations at these frequencies:

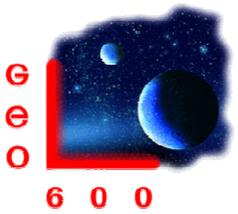
optical noise, ‘internal’ thermal noise





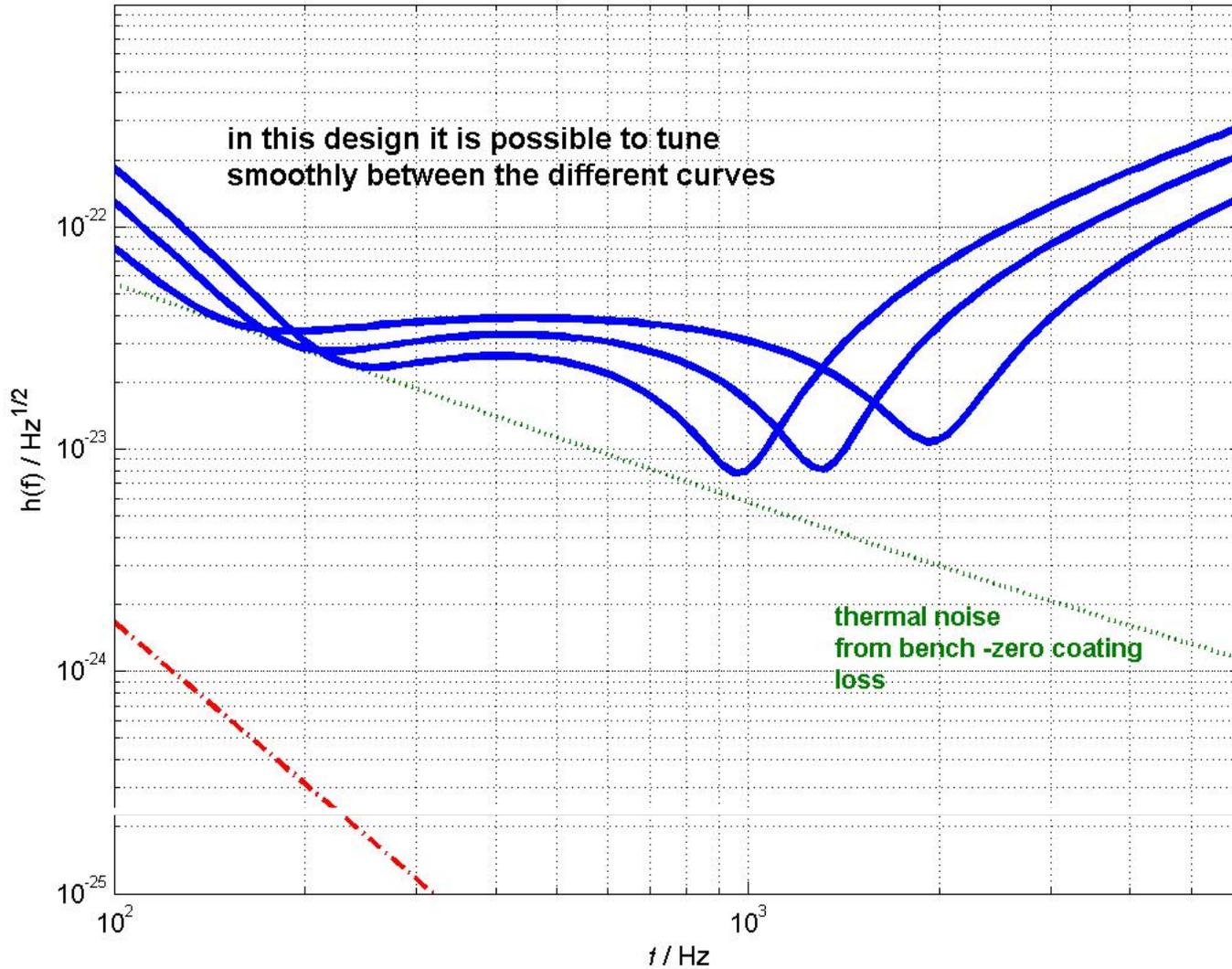
Use same scheme as AdLIGO?

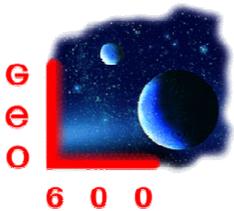




Detector Response 1

rse FPMI responses 5kg mirrors, AdLIGO loss, 120W used





Materials under thermal load

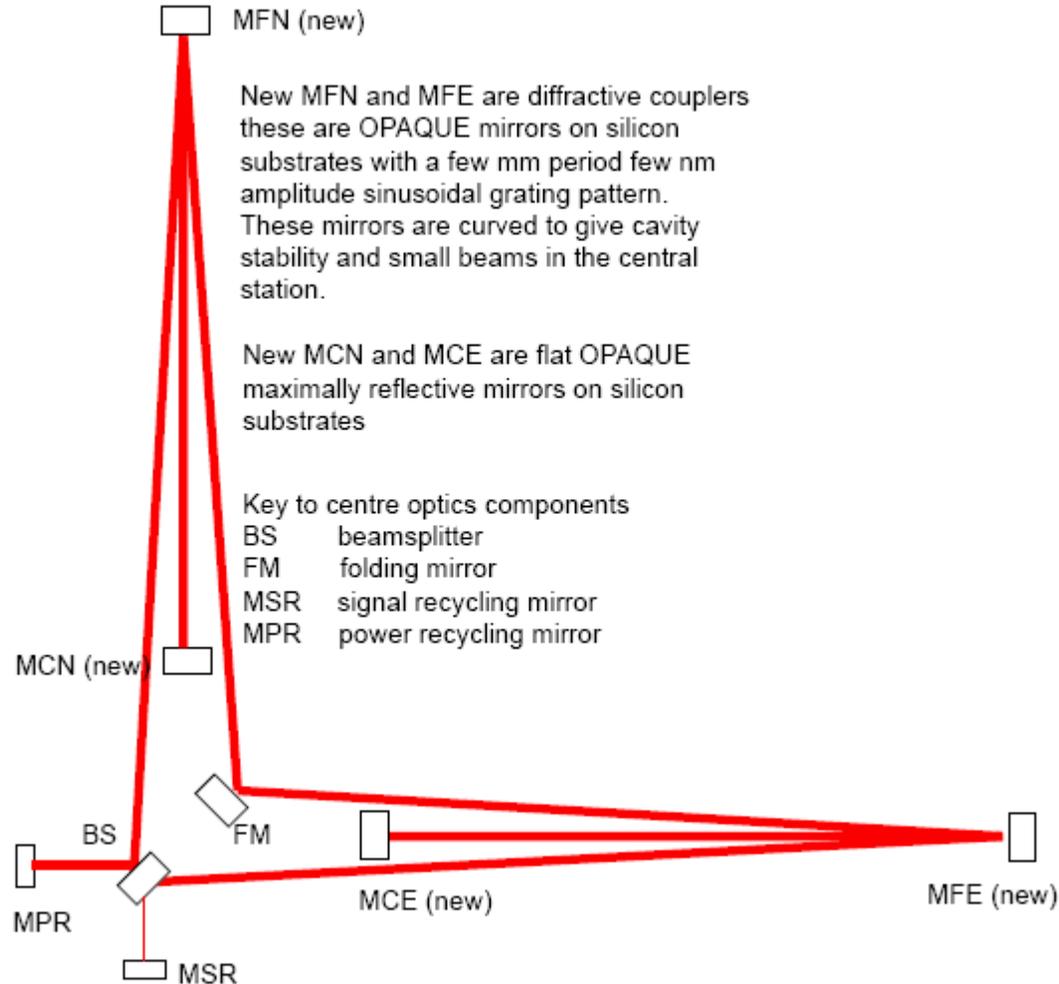
Material At 300K	Lensing Figure of merit (dn/dt)/K (nm/W)	Expansion Figure of merit (α /K) (nm/W)	Absorption (ppm/cm)	Power limit inside cavity (kW)
Transmissive				
Sapphire	250	125	20	630
Fused silica	7250	362	1	196
Reflective				
Sapphire	-	125	-	1.7×10^4
Fused silica	-	362	-	5.87×10^3
Silicon	-	17	-	1.27×10^5

- The very high thermal conductivity of silicon allows it to support almost 10 times more power than sapphire



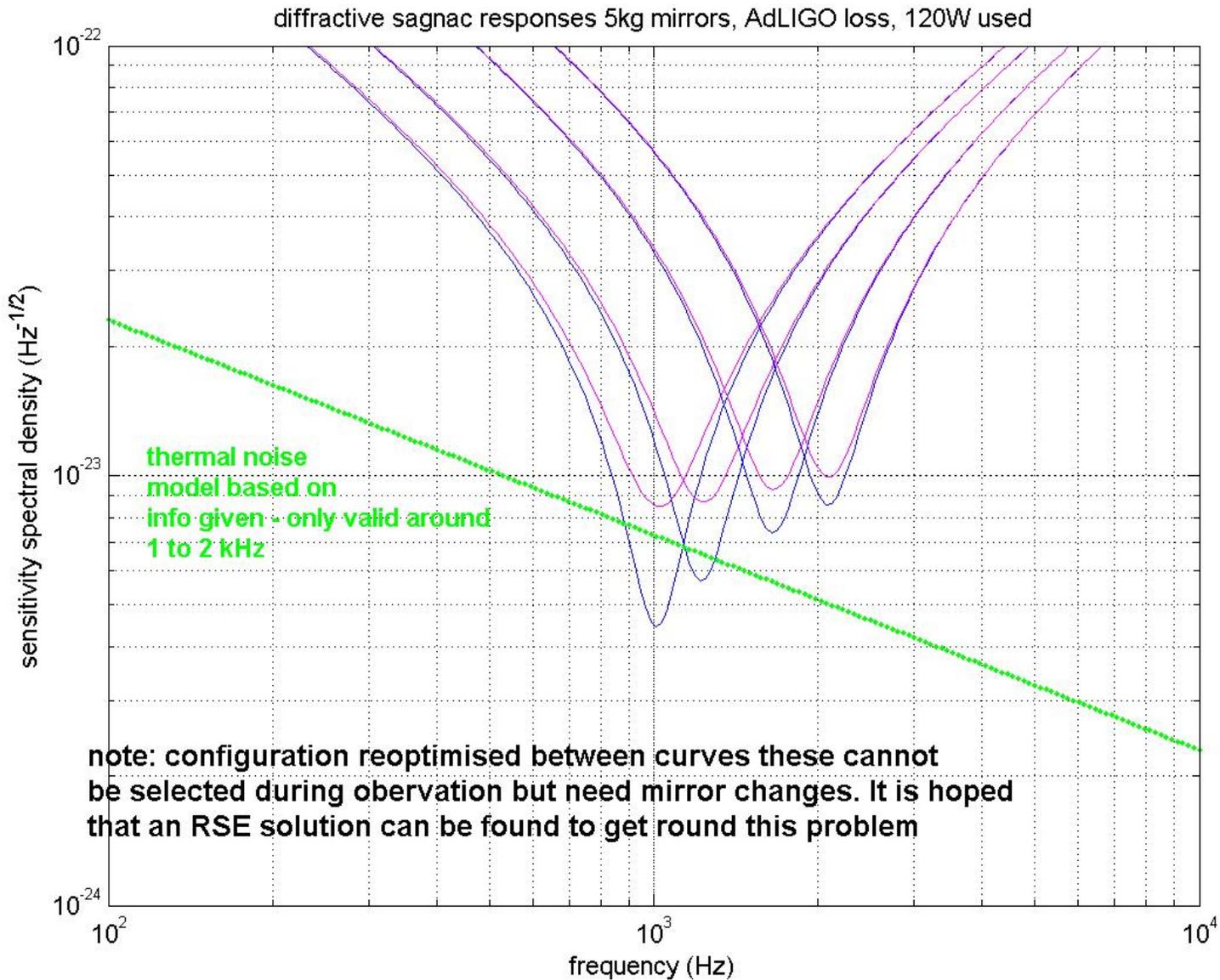
A Proposed Optical Scheme GEO-HF

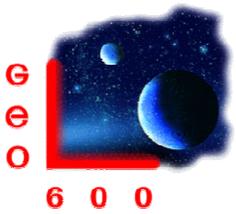
Diffractively coupled ring cavity Sagnac



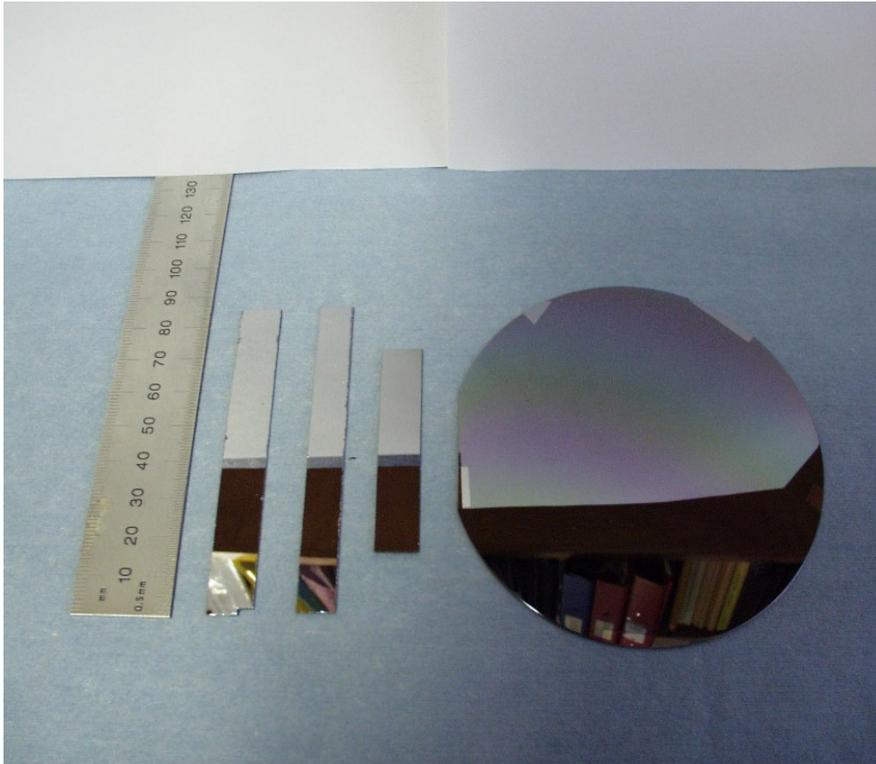


Detector Response 2





Silicon for Substrates and Suspension Elements

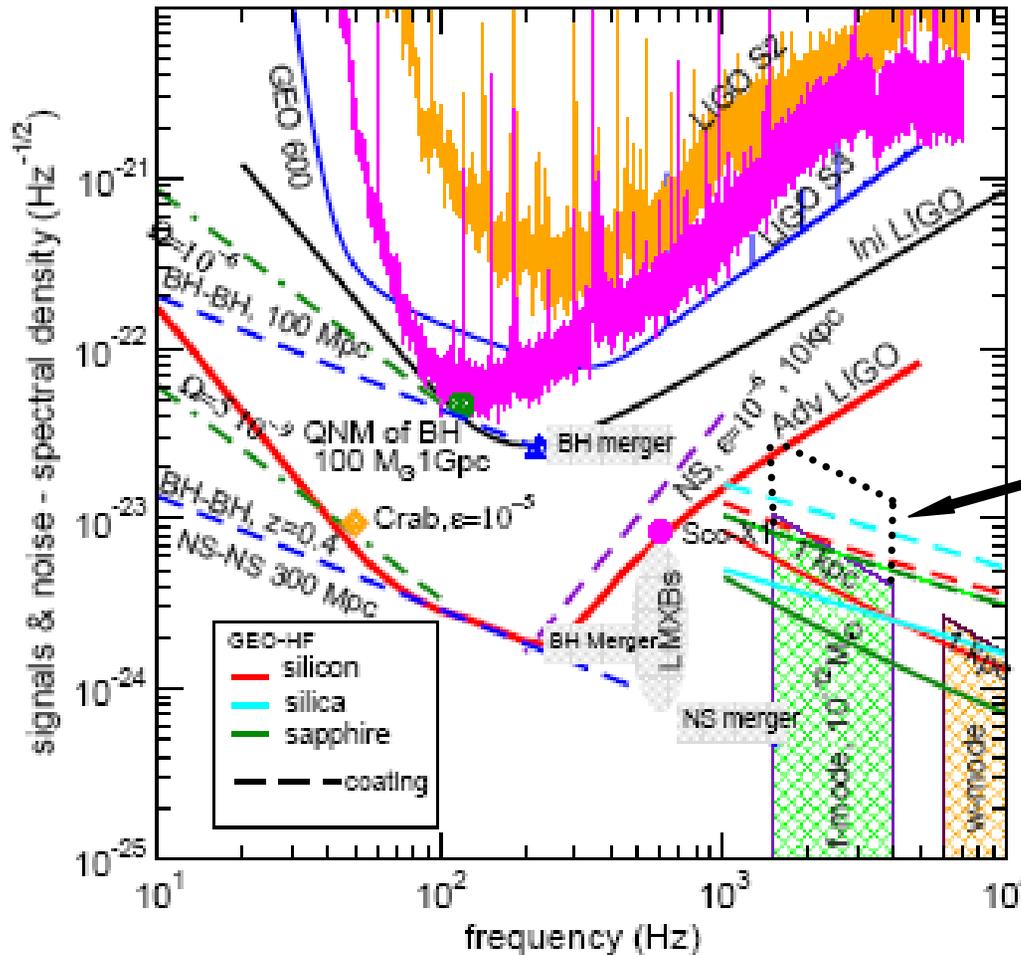


Collaboration with LSC (Stanford) and European groups (STREGA)





Thermal noise limitations in the kHz range



But could expect $10^{-11} M_{\odot}$ from magnetars

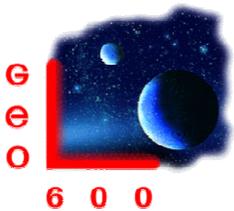




Mirror material

- Silicon or Sapphire both look attractive
- About equal for present situation of coating loss
- Sapphire could be better for thermal noise if coatings significantly improved
- Silicon better at handling power





Conclusion

- GEO HF looks to be worth considering
 - Produce strawman design over next 9 months
 - Optical configuration trade study
 - Mirror material selection
 - All input welcome from LSC and VIRGO groups
 - Rough cost estimate (capital) – \$16.5M

