Ideas about

All-Reflective Interferometry

for Gravitational-Wave Detectors

Email: Traeger@stanford.edu

LIGO II AT SQL

QND for advanced detector

- **Mirror as Kerr medium**
- **Variation Method**

Gain: Order of Unity at LIGO II power

LIGO III BELOW SQL

Much higher power required

Much harder absorption requirements for transmissive optics

All-Reflective Interferometry

ALL-REFLECTIVE INTERFEROMETER

- demonstrated in the lab

  (Sun+Byer, Opt. Lett. 23 (8) 567, 1997)

- dielectric DOE's available

Questions:

- cw power handling
- implementing in GWD

POWER HANDLING

no transmission $\Rightarrow$ no $\frac{\delta n/\delta T}{\kappa}$

coating absorption $\Rightarrow \frac{\alpha}{\kappa}$

Model:

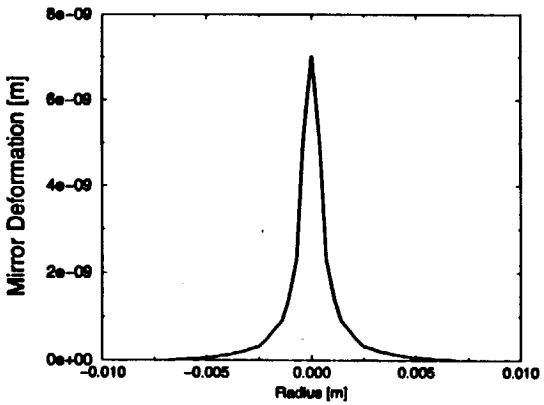
- "Winkler" based in the moment
- "Hello-Vinet" based comming soon

Experiment:

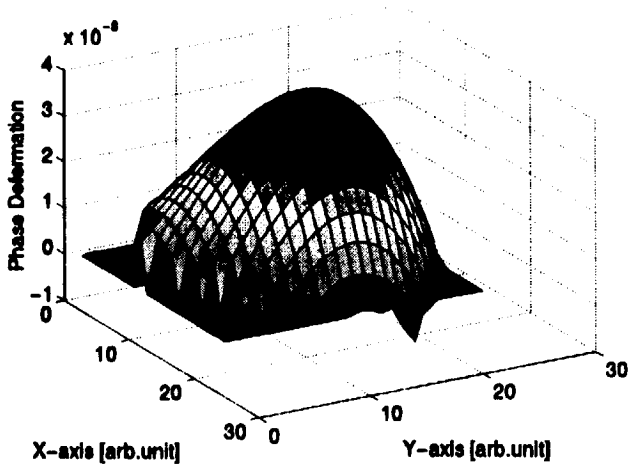
- Gold-coated grating
- Pump: Ar^+ - Probe HeNe
- Wavefrontsensor in reflected and diffracted order

EXPERIMENTAL OBSERVATION

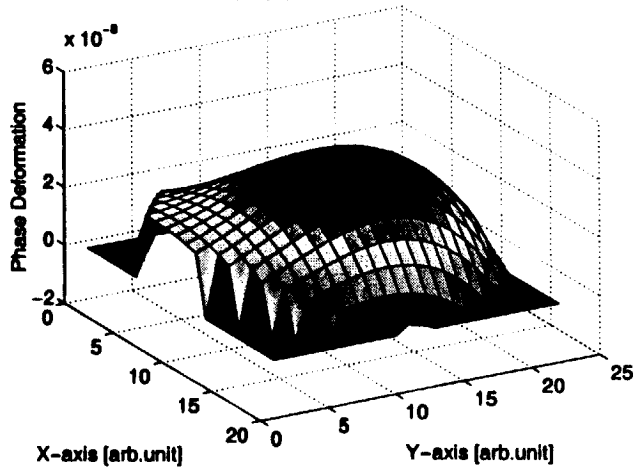
Model



Reflected



Diffracted



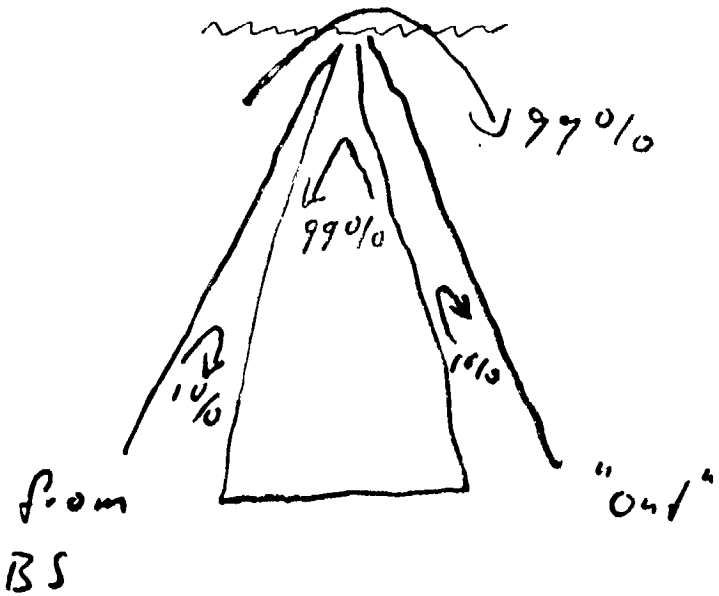
IMPLEMENTING IN GDW

Ring cavity to be arm cavity

- no scattered light problem
- no beam profile problem

RING CAVITY

Say: 1% coupling into diffracted order



Problem: Gravity-wave sidebands at "wrong" port

Solutions:

- **Additional mirror**
- **Mach-Zender Interferometer**

SUBSTRATE MATERIAL

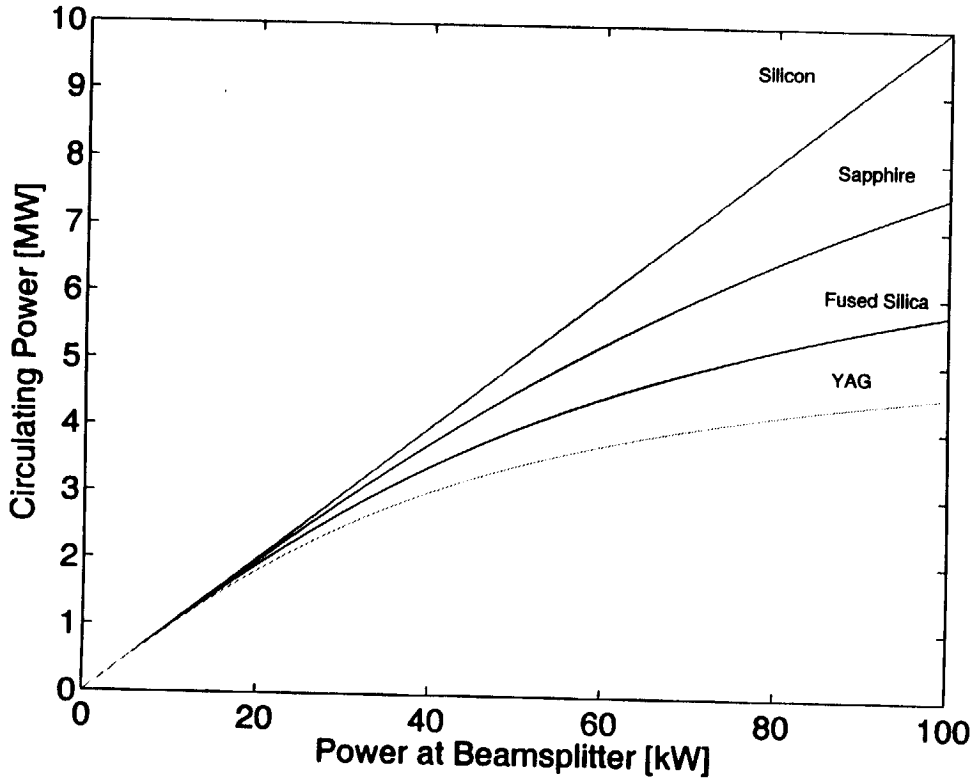
Silicon

- $\frac{\alpha}{\kappa} = 0.1 \times 10^{-7}$

  (Sapphire: 2×10^{-7}**)**

- **available in the required size**
- **can be polished with standard technique**
- **cheap**

ALL-REFLECTIVE LIGO ARM-CAVITY



F/π = 100 **Absorption Coating 1ppm**

Next steps:

- implementation in MELODY
- implementation in OptoCAD
- ring cavity with very high power

Future steps:

- table-top IF
- all-reflective prototype

Note 1, Linda Turner, 08/17/99 08:01:26 PM
LIGO-G990079-19-M