

**Ideas about**  
**All-Reflective Interferometry**  
**for Gravitational-Wave Detectors**

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# LIGO II AT SQL

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**QND for advanced detector**

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

**Gain: Order of Unity at LIGO II power**

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# **LIGO III BELOW SQL**

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**Much higher power required**

**Much harder absorption requirements for transmissive optics**

**All-Reflective Interferometry**

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# ALL-REFLECTIVE INTERFEROMETER

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- **demonstrated in the lab**

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

- **dielectric DOE's available**

## Questions:

- **cw power handling**
  - **implementing in GWD**
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# POWER HANDLING

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no transmission  $\Rightarrow$  no  $\frac{\delta n}{\delta T}$   
coating absorption  $\Rightarrow \frac{\alpha}{\kappa}$

**Model:**

- "Winkler" based in the moment
  - "Hello-Vinet" based coming soon
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## **Experiment:**

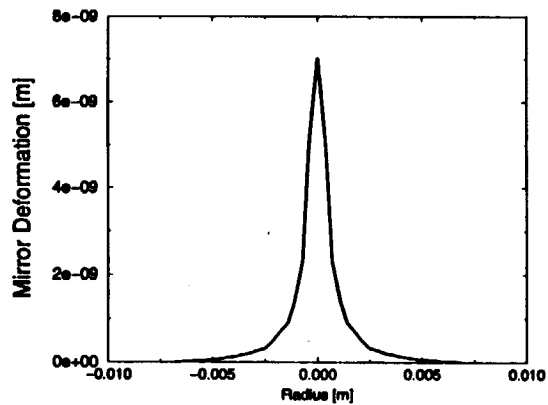
- **Gold-coated grating**
- **Pump:  $\text{Ar}^+$  - Probe HeNe**
- **Wavefrontsensor in reflected and diffracted order**



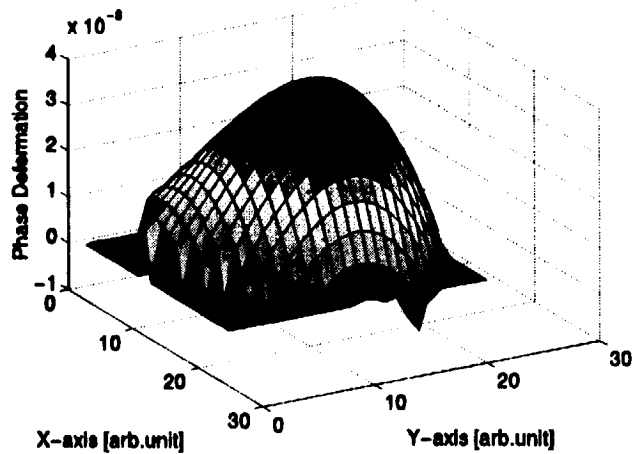
# EXPERIMENTAL OBSERVATION

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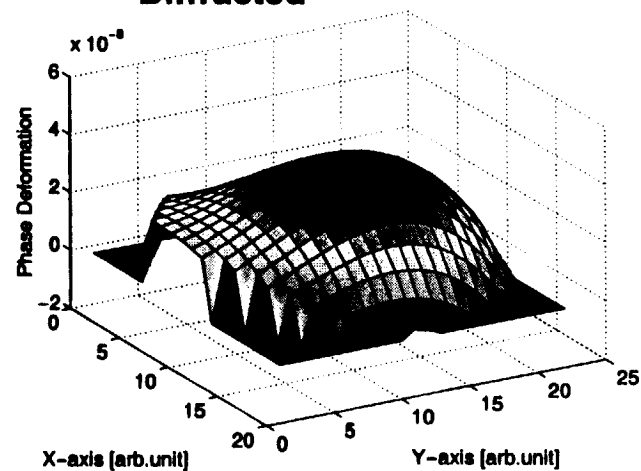
**Model**



**Reflected**



**Diffracted**



# IMPLEMENTING IN GDW

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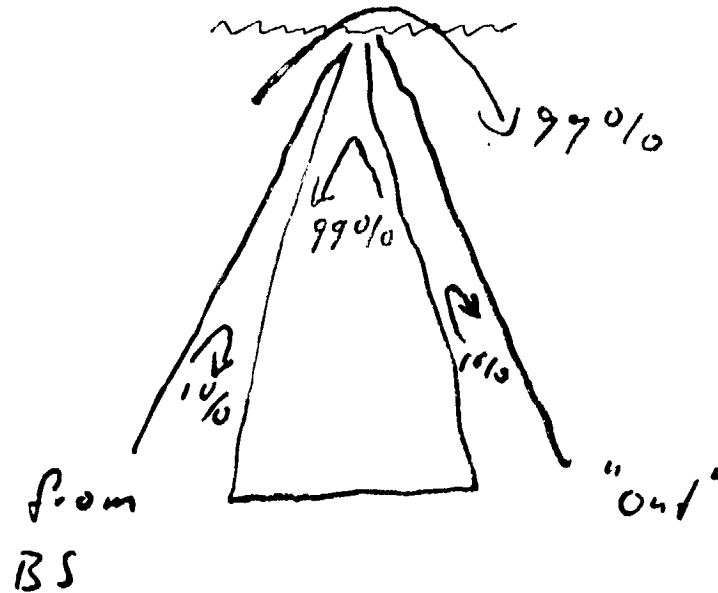
**Ring cavity to be arm cavity**

- **no scattered light problem**
  - **no beam profile problem**
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# RING CAVITY

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Say: 1% coupling into diffracted order



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**Problem: Gravity-wave sidebands at "wrong" port**

**Solutions:**

- **Additional mirror**
  - **Mach-Zender Interferometer**
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# SUBSTRATE MATERIAL

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## Silicon

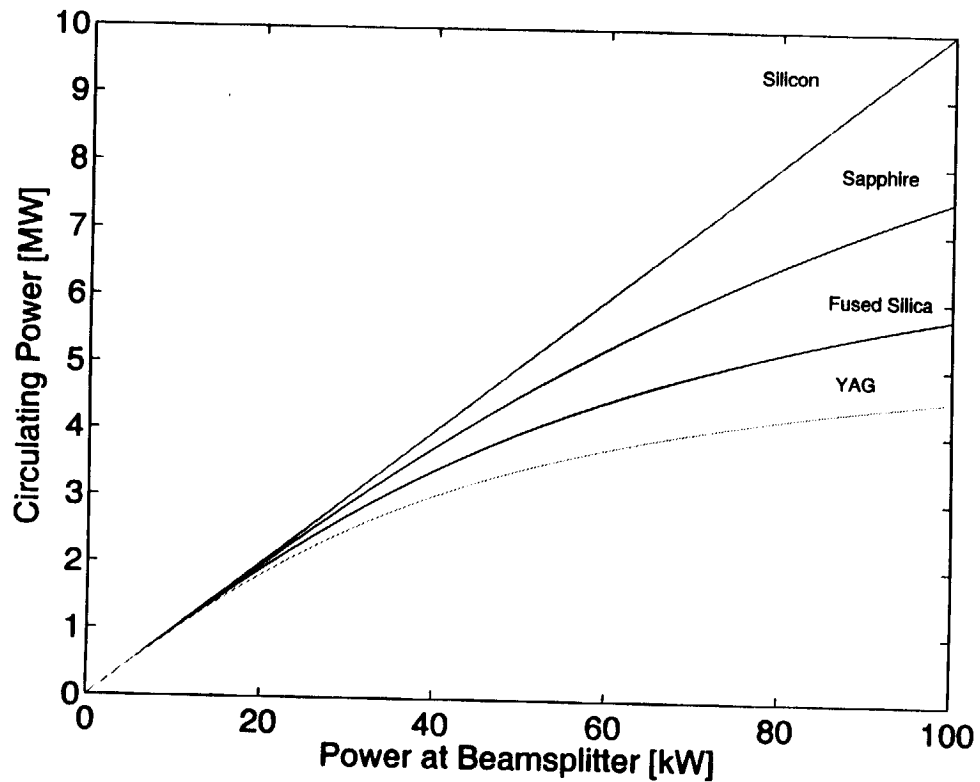
- $\frac{\alpha}{K} = 0.1 \times 10^{-7}$

(Sapphire:  $2 \times 10^{-7}$ )

- **available in the required size**
  - **can be polished with standard technique**
  - **cheap**
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# ALL-REFLECTIVE LIGO ARM-CAVITY

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$F/\pi = 100$  Absorption Coating 1ppm

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## **Next steps:**

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

## **Future steps:**

- **table-top IF**
  - **all-reflective prototype**
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*Note 1, Linda Turner, 08/17/99 08:01:26 PM*  
LIGO-G990079-19-M