Test Mass Material Considerations

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LIGO-T000141-00-D

Peter F.’s rubric, plus ...

- Current conceptual design
- Major technical challenges
- Fallbacks
- Testing

and, in addition,

- advanced options
- biggest worries

Test Mass Material
Conceptual Design

- Sapphire

  c-axis or other?
- Chosen for high *Q*, as well as desirable thermal properties
- Known from the start to be an “aggressive” design choice

Technical Challenges
(Thermal Noise considerations only)

- Is mat'l *Q* (structural damping) consistent at 2 to 3 x 10^8?
- Additional loss mechanisms?
  - Fundamental
    - thermoelastic, e.g.
    - others?
  - "Dirty"
    - impurities

Technical Challenges II

- "Engineering" damping
  - attachments
  - actuators (even electrostatic)
  - recoil
  - COATINGS
- Optimizing in the presence of thermoelastic thermal noise
  - beam radius dependence

Fallbacks

Fused silica

- latest estimate of penalty?
- Q may be better than 3×10^7
- if coatings are lossy enough, there may be no thermal noise advantage to sapphire

Testing Issues

- Measurement of thermal (or excess!) noise
  - TNI (or perhaps other test interferometers)
  - large interferometers (GEO600 or 1 LIGO ??)
- Measurement of Q or f (*vs.* f, ideally)
  - of materials, parts, and systems
  - domain of small labs
- Other properties
  - thermoelastic effect, e.g.

Advanced options

(Listed here as an antidote to despair)

- Real-time thermal noise monitor
- Cryogenics

My biggest worries

- Mild
  - Do we understand thermoelastic damping? Probably.
  - Manufacturability of low damping substrates
- Medium
  - Unknown damping mechanisms, noise sources
- Strong
  - COATINGS