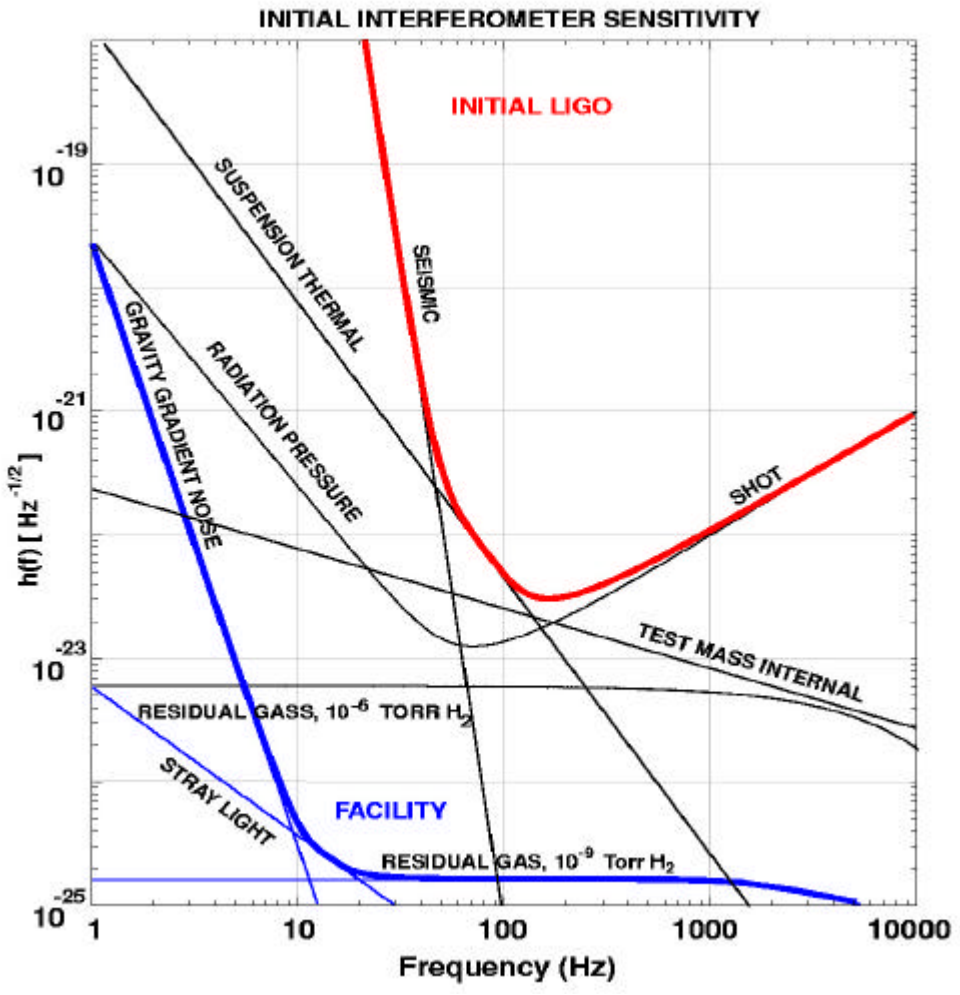
Response to NSF Review Committee Question: Detector Sensitivity Improvements

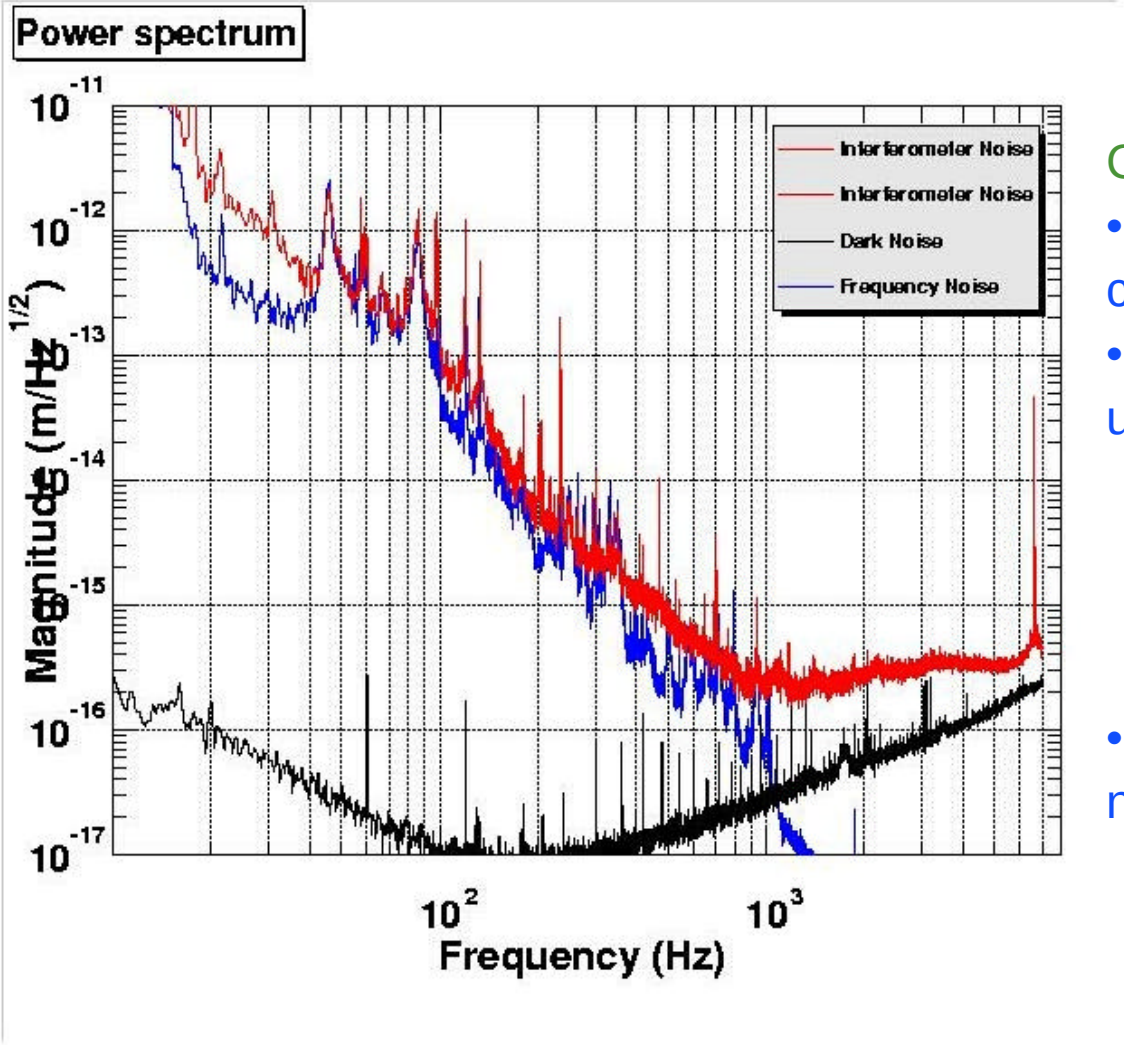
27 February 2001

Initial LIGO Sensitivity Goal



- Current noise level (February 1, 2001) sketched by hand
- Effective laser power 12 mW
- Partial implementation of interferometer control system

Known Contributors to Noise



Current limiting noise:

- Dark noise scales as P^{-1} at current level
- Frequency noise reduction underway
  - Laser vibration isolation
  - Tailoring of M/C servo
  - Feedback from arm common mode
- Possible suspension controller noise?
  - Engage low pass filters

Noise Budget

- "Fundamental" noise sources (seismic, thermal, shot) estimated by detail models
  - Models validated by prototype interferometers
- Non-fundamental noise sources all budgeted at 10% in amplitude of fundamental noise
  - Laser intensity noise
  - Electronics noise
  - Frequency noise
  - Thermal noise in non-fundamental degrees of freedom
  - Scattering
  - …

Subsystem Measurements Confirm Design

- Seismic noise
  - » In-vacuum seismic measurements match design model
  - » 1e6 attenuation at ~40 Hz
- Test mass thermal noise
  - » Suspension mode Q
    - – Design value 500,000, excluding reaction loss
    - – Measured 100,000, including reaction loss
  - » Internal Q
    - – Design value 2e6
    - – Measured values 1.5 – 8e6 (one mode at 2e5)
- Sensing noise
  - » Bench testing of photodiodes at full power
  - » Electronics noise meet requirements