Change to Nd:YAG Lasers

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Process for Making Working Decision to Change Lasers

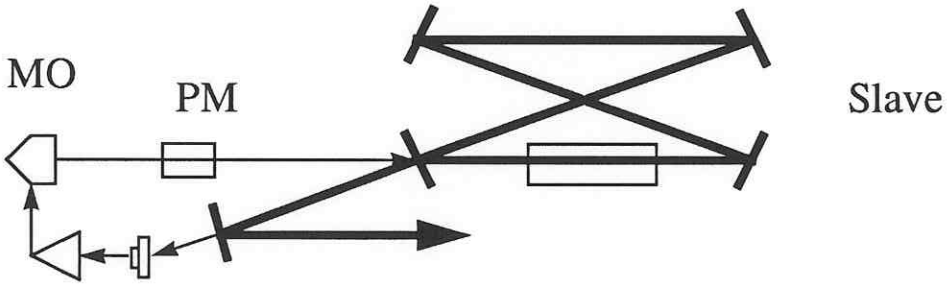
- Discussion of Issues and Questions at Science/ Integration Meeting in May
- Report on Technical Comparison / Status and Plans of Other Groups -- August
- Special Meeting of Science Team to Discuss Report and Options for Change -- August
- Working Decision Announced by Barish -- September
- Formal Action by Change Control Board to be Taken When Plans Advance Enough to Fully Assess Technical, Cost, and Schedule Impact

Reasons for Changing Lasers

- Growing Maturity of Diode-Pumped Nd:YAG
  - ››High Volume OEM Products with Power and Reliability Required for Initial LIGO Detectors
  - ››Demonstrations of Performance at Stanford, VIRGO, GEO
- Expectation of Future Laser Improvements Gives Path for Enhanced Detectors
  - ››100 W Class Single Frequency Lasers Under Development
  - ››Kilowatt Diode-Pumped Lasers Demonstrated
- Benefits Due to Longer Wavelength
  - ››Higher Frequency Modulators
  - ››Higher Power Photodetectors
  - ››Lower Scatter, Lower Contamination on Optics (?)
- Benefits of Sharing Technology with Other GW Groups

Laser Configuration for Initial Detectors

- Requires 10 W IR Power to Replace 5 W Argon Laser -- Available in Commercial Products
- Injection-Locked Oscillator



  - +Slave Reproduces Properties Of Master Oscillator
  - +Demonstrated with Nd:YAG at Stanford, VIRGO, GEO
  - +No Lossy Tuning Elements In Slave
  - -Requires One (Simple) Additional Locking Circuit
- Master Oscillator/Power Amplifier
  - +No Locking Required
  - -Possible Loss of Efficiency

Master Oscillator

- Both Configurations Allow Near-Term Tests at ~1 W Level with Stabilized Master Oscillator
- Master Oscillator Performance
  - ›› Frequency Noise <200 $Hz/Hz^{-1/2}$ at 100 Hz (100x Better than Argon Laser
  - ›› Intensity Noise $<10^{-5}$ $1/Hz^{-1/2}$ above 100 Hz
  - ›› Shot-noise-limited above ~10 MHz
- Options for Master Oscillator
  - ›› Lightwave Electronics (700 mW, Single-Frequency, Integrated Frequency Control, Built-in Relaxation Oscillation Suppression)
  - ›› Laser Zentrum Hannover (up to 1W, Single-Frequency, Integrated Frequency Control, Built-in Relaxation Oscillation Suppression)

Impact on R&D Activities

- Plans Still Preliminary Due to Procurement Uncertainties
- Phase Noise Interferometer
  - ››Most Stringent Test of Laser Properties (Frequency, Intensity Stability)
  - ››Highest Priority for 10 W Laser When Available
  - ››Convert to Near-IR as Soon as Optics and MO Laser Are Available (4-6 Months?)
  - ››Will Proceed with Green Recycling in Interim
- 40 m Interferometer
  - ››Most Near-term Tasks Independent of Wavelength (New Test Mass Suspension, Recycling Controls Test)
  - ››Will Defer Installation of 12m Suspended Mode Cleaner (To Be Used for Nd:YAG Laser Tests)
  - ››Procure Optics and MO Laser for Conversion in 1996

Impact on Detector Design and Plans

- Laser Development
  - ››Work with Industry, Other GW Groups to Develop Laser
  - ››Repeat Stabilization Design and Testing
  - ››Gain Immediate Experience with Stabilization of MO
- Impact on Other Detector Subsystems
  - ››Interferometer Configuration: Modulation Frequencies
  - ››Optical Layout: Increased Beam Clearances
  - ››Optics: Substrates, Coating Uniformity, Metrology
  - ››Suspension Design: Optics Size
  - ››I/O Optics: Beam Sizes, Telescopes
  - ››Photodetectors, Modulators

Minimal Impact on Facilities Design

- Beam Tube
  - ››Diameter Already Sized to Accommodate Multiple IR Beams
  - ››Baffle Performance Required for Visible and Near-IR, Independent of Initial Interferometer Choice
- Vacuum Equipment
  - ››No Major Impact
- Buildings
  - ››Ultimate Power Requirements for Advanced Solid-State Lasers (100+ W Class) ~ Same as Initial Argon Lasers
  - ››Can Defer Installation of Chiller Plant Module, Some Cooling Distribution Lines