LIGO R&D After Recycling/Phase Noise Measurements

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Science/Integration Meeting

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Baseline IFO R&D During Construction

- ● **40 Meter baseline plan**
  - » Recycling experiment completed for LSC final design (3Q97)
  - » Exercise data collection/analysis/study of non-gaussian noise/operational studies (1997)
- ● **5 Meter baseline plan**
  - » Phase sensitivity measurement at 514 nm (1996)
  - » Phase sensitivity measurement at 1064 nm (1997)
- ● **Construction budget support for these capabilities ends when these are completed**
  - » both of these programs are completed by late 1997

Options for the Future

- Shut down one or the other or both instruments and focus resources and attention on larger instruments at the sites
  - » Main mission of gravitational wave research is seriously impacted by developmental use of large instruments
- Operations
  - » R&D to characterize and improve initial LIGO interferometers
  - » Test operational innovations
- Advanced Detector R&D
  - » Research to underpin enhancements to initial interferometers and entirely new interferometers

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5 Meter/40 Meter Options Beyond Construction

- ● Caltech group will study future program for 40 Meter
  - » Robbie will carry out this study
  - » Though of intense local interest this will be a LIGO-wide study
- ● MIT group has already begun this study due to scheduled demolition of Building 20
  - » vacuum system move/renovation/modification is related to future program at MIT
- ● Both programs must develop to benefit LIGO overall but both are of intense local interest
  - » Doctoral students, postdocs, on campus vitality of program

Robbie

LIGO

4
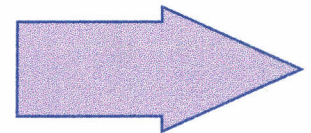
Goals - Construction

- Zucker - "Lock up Hanford #1" - separate talk
- Weiss - Reduce risk
  - » recycling
  - » full scale stack test in vacuum with at least one cavity
  - » diagnostics (so you know what is going on)
- Sanders - beyond lock at Hanford
  - » bring 40 Meter into full, reliable sensitive operation
  - » collect data, analyze data
  - » study non-gaussian noise
  - » set improved limit on gravitational waves
    - – narrow band search with bar
    - – solo pulsar search (Barish/Prince discussion)

5

Goals

- ## Spero - Current Configuration
  - » PSL
    - study/eliminate lock acquisition bounce
    - eliminate feed-around signal's disruption of lock
    - investigate alignment shift (slow PZT?) on lock reacquisition
    - full loop characterization, including calibration of sliders in terms of gain, measurement of subloop gains, and study of Pockels Cell/fast PZT crossover oscillation
    - assessment of 60 Hz multiples and of noise due to digital electronics
    - install switches to open individual/overall servo loops
    - install software-controllable electromechanical shutter at laser output, in front of photodiodes
    - software for automatic offset setting

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Goals

- ## Spero - Current Configuration
  - » PSL
    - add features to control screen: record settings and voltages, restore settings, television monitor of mode cleaner transmitted mode, alignment knob box enhancements
    - incorporate Sammi or equivalent enhancements to user display, such as better strip-chart plotting, power meter with appropriate full-scale setting
    - implement Chen's algorithm for automatic alignment of mode cleaner
    - software for automatic I/V curve tracer to monitor health of laser tube
    - automatic shutdown/startup sequencing
    - implement software-controlled ringdown

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Goals

- ## Spero - Current Configuration

  - » Slow Monitor and Noise Correlations

    - Build circuitry to monitor the rms noise output of the interferometer, as a function of time
    - Build circuitry and software for real-time pulse height histograms
    - Design and use hardware/software system to correlate above to various slow monitor signals with objective to find subsystems that are responsible for noise or pulses
    - Identify significant sources of drift in interferometer performance

  - » Other Improvements

    - implement Hess's algorithm for guided lock acquisition of optical levers
    - develop data collection and analysis software

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Goals

- ### Spero - Beyond Current Configuration
  - » New beamsplitter with VME/EPICS control. Verify performance, integrate with existing alignment systems.
  - » Installation of operator's console, including diagnostic systems, and shift routine operations to control room.
  - » Change to 32 MHz modulation frequency, including new reference source and phase shifters. Requires new photodiode front ends and associated electronics.
  - » Recycling mirror added, with alignment and position controlled by VME/EPICS. Lock acquisition may require hardware/software modifications.
  - » VME/EPICS controls of test masses (and new suspensions for all but EV.)
  - » YAG laser and 12 m mode cleaner.

9

Goals - Operations

- Camp
  - » Non-linear servo operation: acquisition and stability
  - » ...

Goals - Advanced R&D

- Double Pendulum
- Active Seismic
- Advanced Passive/Active Seismic
- 100 watt 1064 nm laser
- Advanced Core Optics
- Sapphire Core Optics
- Resonant Sideband Extraction or Dual Recycling

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Other Issues

- Construction - baseline is known
- Operations - must plan along with commissioning and evolution of organization to operations/functional
- Advanced R&D
  - » use LIGO PAC for review
  - » must decide which tasks conducted at CIT or MIT interferometers
- Consider all activities beyond construction to be based upon formal proposals to LIGO Directorate, reviewed by PAC
- Proposals from outside of LIGO may be competitive

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To Do...

- LIGO management seeks individual input now
- MIT must study its local options
  - » relocation/renovation plan for MIT test interferometer needed
- Robbie will carry out local CIT study of options
- PAC will be asked for advice
- PAC will review advanced R&D proposals
- Seiji - RSE/SR
- David - Double Pendulum

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