LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
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Technical Note **LIGO-T9500xx- 00- R** 5/28/99

E2E Model of Hanford
2k-Interferometer Input Optics. Architecture of Control System

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file /home/malik/docs/ps/T9500xx.ps

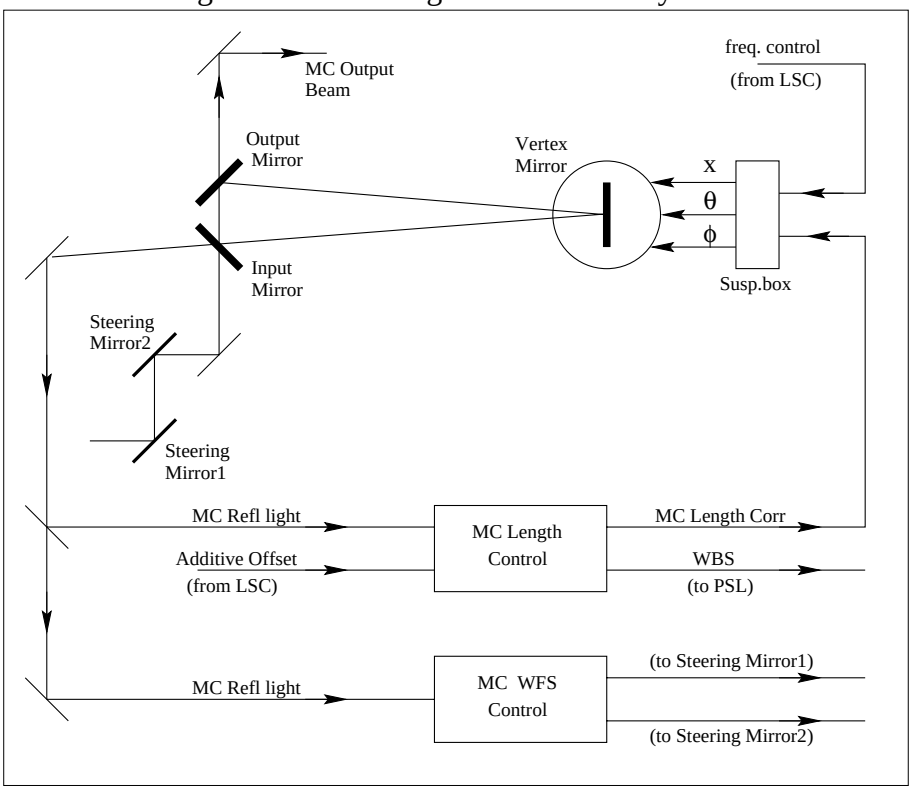
1 Functionality

Input Optics Control System consists of two major subsystems:

1. Mode Cleaner Length Control System (MC Length),
2. Mode Wave Front Sensing (MC WFS) and Steering Mirror Control.

These two subsystems are shown on Fig.1.

Figure 1: Block Diagram of Control System.



2 MC Length Control System

This subsystem is there to lock the Mode Cleaner and maintain it in lock.
This loop can be described as follows:

1. Mode Cleaner reflects the light to one of the viewports. Part of the reflected light is the leakage light from inside the Mode-Cleaner. This part carries information about the MC length.

2. The MC reflected light is collected by the RF-tuned photodiode (RF-PD), which is a part of the Pound-Drever locking electronics.

3. The output of the RF-tuned photodiode is mixed with the signal from the local oscillator, which has the same frequency as the corresponding EOM (side-band generator) on the PSL table. The demodulated signal is sent to low frequency filters of Length Control electronics.

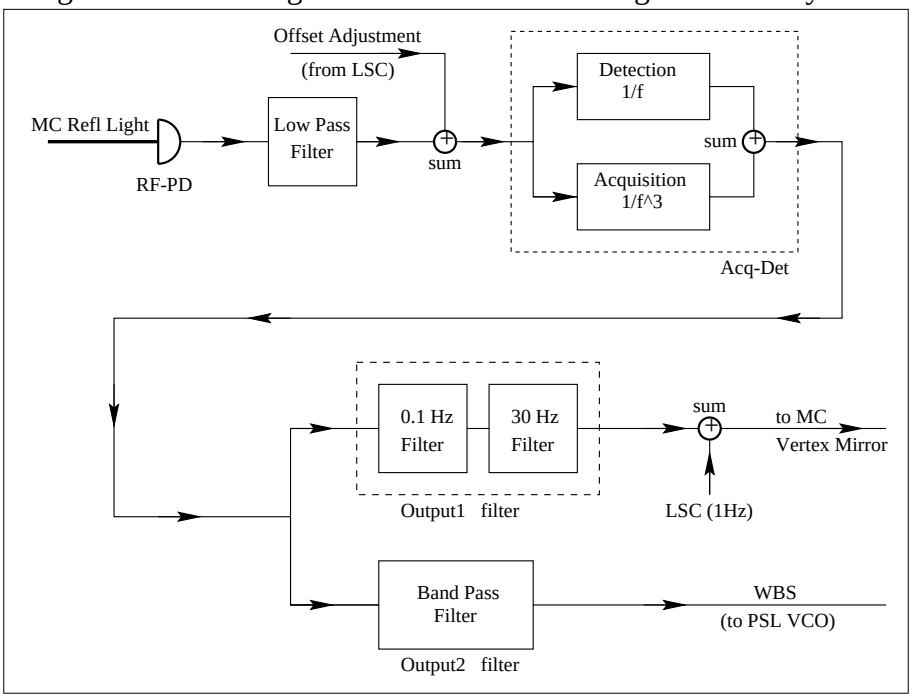
4. In the Length Control electronics the signal is properly shaped by various filters (digital filters in E2E).

5. The filtered output of the electronics, MC length error correction signal, is sent to the suspension controller (SC) of the Mode-Cleaner vertex mirror. This output is summed with the LSC frequency control inside the suspension controller. The result is the input (x-control force) for dynamics of the mirror position. The actual x-control force is a sum of the above force and the x-control force of the local damping system.

6. The local damping is a sum of two filters: velocity-proportional and 10-pole Chebyshev filter. In the suspension cotroller the control voltages are transformed into the corresponding degrees of freedom: POSITION, PITCH and YAW.

Another function of the MC Length Control System is to correct the offset of the PSL laser Frequency Stabilization System (FSS). For this the Length Control System forms Wide-Band Signal (WBS), with bandwidth of 2Hz - 100 kHz. This signal is sent to the VCO (voltage-controlled oscillator) of the PSL.

Figure 2: Block Diagram of Mode Cleaner Length Control System



3 MC WFS and Steering Mirror Control

This servo maintains the pointing of the beam incident on the Mode Cleaner by controlling pitch and yaw angles of the two Steering Mirrors on the PSL table.
This servo can be described as follows:

1. Reflected light from the Mode Cleaner is passed through the lense (Lense 1) to compensate for the divergence of the beam as it propagates a large distance (of order 4m) to the IOT-7.

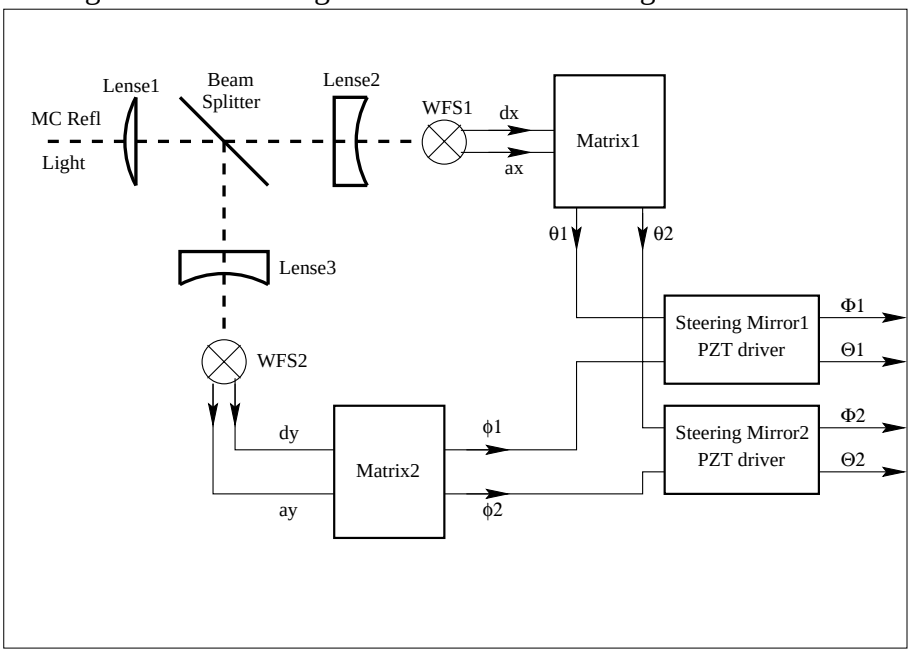
2. At the IOT-7 table the beam is split into two by the Beam Splitter. This is necessary in order to provide the detection of the degrees of freedom along two directions X and Y.

3. Then the beam is expanded to match the surface of the Wave Front Sensors by the lenses #1 and #2. The photodiodes WFS1 and WFS2 collect the beam and form two outputs each: shift and tilt of the beam on the photodiodes surface. The output of the 1st photodiode is: dx and α_x. The output of the 2d photodiode is: dy and α_y.

4. The voltages, proportional to the shift and tilt, are transformed into two angles θ and ϕ by the linear circuits (matrix 1 and matrix 2).

5. The outputs of the linear curcuits are amplified by the PZT drivers and sent to the PZT actuators of the Steering Mirrors.

Figure 3: Block Diagram of WFS and Steering Mirror Control



4 Connection Diagrams

4.1 MC Length Box Structure

The MC Length Control box consists of:

- MC Reflected Light (field2complex),
- Acq-Det (box),
- RF-PD (demodpd),
- Low Pass filter (dfilter),
- Output filter 1 (box),
- Output filter 2 (dfilter),

The box has 4 inputs:

- MC Refl Light (field),
- k (real),
- Offset Adjust (real),
- LSC 1Hz-BW Signal (real),

and 2 outputs:

- MC Length Correction Signal (real),
- WBS (real).

Figure 4: Mode Cleaner Length Control Box Structure

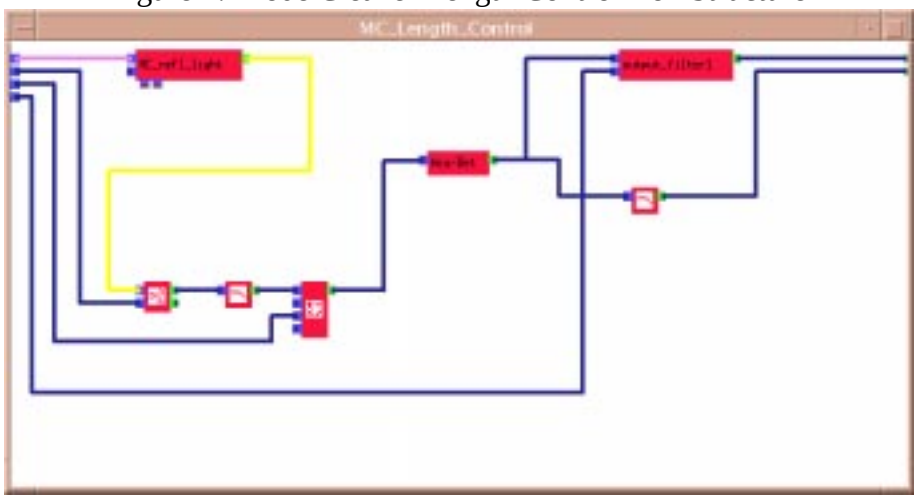


Figure 5: Structure of Output Filter 1 Box

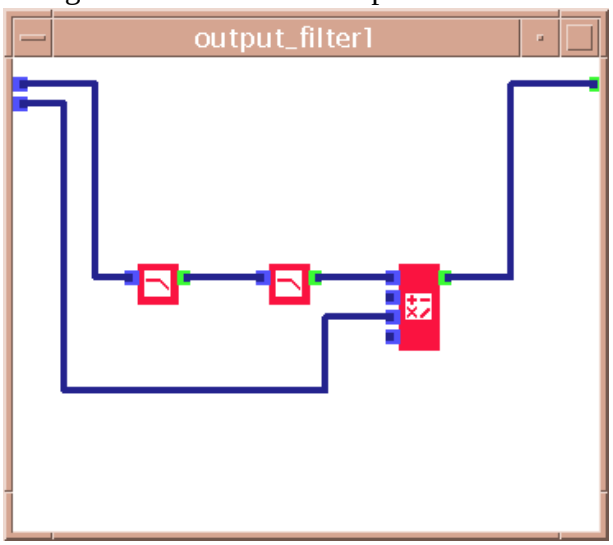
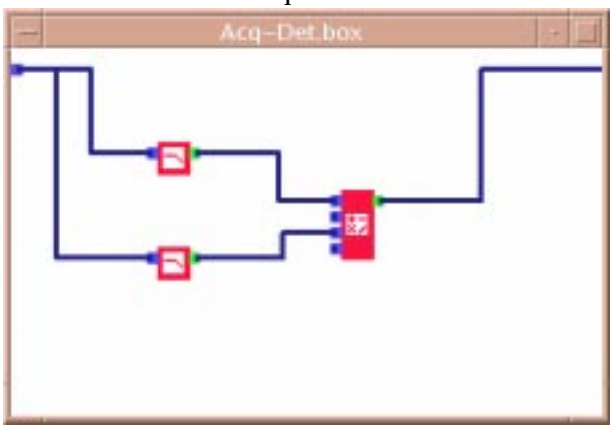


Figure 6: Structure of Acquisition-Detection Filter Box



5 MC WFS Box Structure

The Mode Cleaner WFS and Steering Mirror control box has the following structure:

- lenses 1, 2 and 3 (lense)
- Beam Splitter (mirror2)
- WFS 1 and 2 (box)
- matrix 1 and 2 (box)
- Steering mirror PZT driver 1 and 2 (box)

There is 1 input to the box:

- Mode Cleaner Reflected Light (field)

and 4 outputs:

- SM1 pitch (real)
- SM1 yaw (real)
- SM2 pitch (real)
- SM2 yaw (real)

Figure 7: Structure of Mode Cleaner WFS Box

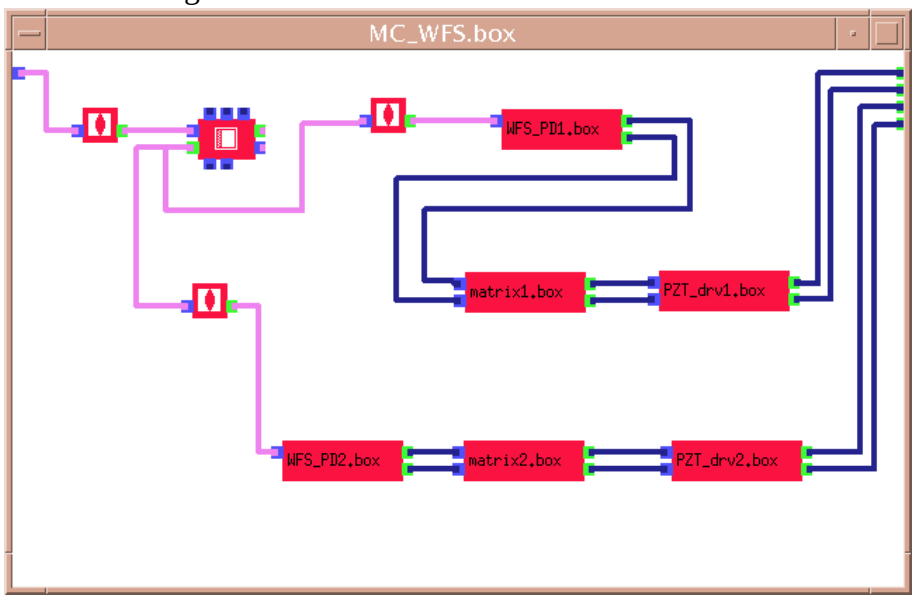


Figure 8: Structure of PZT Driver Box

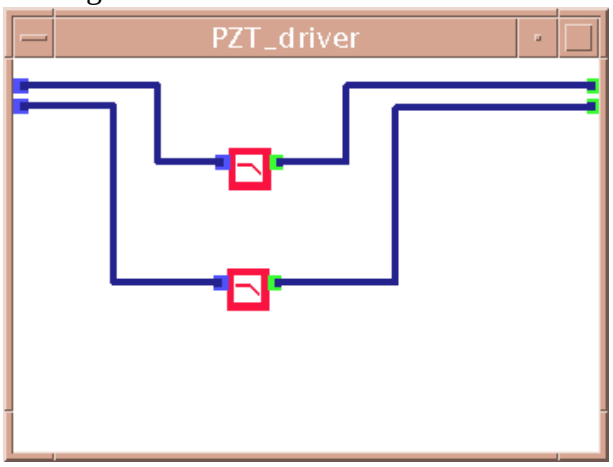


Figure 9: Structure of Matrix Box