Updated Plan for Separate Suspension of Beamsplitter Components in the 40 m Protoype

M. E. Zucker x4017

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1 Purpose of Project

In the current prototype configuration the main beamsplitter, directional isolators and beamsteering optics are all mounted on a single pre–1984 vintage test mass (called "Dewey") suspended in the vertex chamber. This arrangement is unsatisfactory in that the large mass obscures precious beam aperture, takes up nearly the entire usable chamber area, and is believed to contribute noise associated with its motion and internal vibrations. In addition it is incompatible with planned future interferometer configurations, including beam recombination.

We will remove the Dewey mass and hang each individual component or subsystem of a new, simplified optical arrangement on a separate wire suspension. Each component or subsystem will be subject to independent control of orientation and position.

2 Description of Planned Configuration

The eventual goal is to upgrade the interferometer to a simple recombined–beam configuration and then to a recycled configuration compatible with planned LIGO initial interferometers. The current Dewey vertex chamber is far too small to accommodate the recombined optics setup, so additional

satellite chambers (which are now nearly completed in the CES shop) will be added to house the Newey test masses and various auxiliary components. The vertex chamber will contain the beamsplitter. It is most sensible to upgrade the vacuum system right up front, even though we may not actually need all the new space for some months. Initially, minimal changes from the current optical configuration will be introduced and tested, and gradual small introductions will slowly build up the system's complexity and capabilities. Here we discuss only the initial assembly (the first configuration to be tried after removing the present Dewey mass) in detail. This configuration is shown in Figure 1.

The current cavity–mirror masses and their suspensions should suffice throughout this initial phase, although we may wish to add shark detector damping to the two currently uncontrolled linear degrees of freedom of each test mass if the parts are available. We need to arrange totally new suspensions and control systems for the beamsplitter proper and the two quarter waveplate/polarizing beamsplitter circulators. Each of these will be controlled along five axes by shark detector/transducers which are currently being developed in the lab (see "Preliminary Report on Shark Sensor/Transducer Development," M. E. Zucker, 4/28/89). The circulator assemblies, being relatively noncritical, will be controlled locally by signals derived from the sharks themselves; the beamsplitter will require global optical lever controls for its more critical alignment. The reference will be provided by a HeNe-laser optical system (which may later be upgraded to a modulated laser diode) with provision for cancelling out angular motion of the laser source. The altitude and azimuth (or 'pitch' and 'yaw') of the beamsplitter will be sensed by a quadrant photodetector. The orientation signals will be processed by an analog 3×3 matrix multiplier circuit and fed to the shark coils to provide appropriate corrective torques to the beamsplitter without influencing its mean position, which will remain referenced to the shark detectors. At startup, or upon loss of the global beam, the shark–derived signals can also serve to damp and coarsely control the splitter until the global servo is restored, thus replacing our current "local" optical levers.

3 Upgrade Paths

To reach the recombined configuration we would remove the isolators, install a compensating plate, and install Pockels cells and additional pickoff plates for locking the two cavities. All these would best be suspended and shark controlled, although none are likely to require the precision of global optical levers. The chamber plan view, with a possible recombined interferometer layout, is shown in Figure 2. This shows the simplest conceivable arrangement, without side arm modulation.

Figure 1: This is (at least topologically) the same beamsplitter layout as is currently used in the 40m prototype. The $\lambda/4$ plate and polarizing beamsplitter circulators currently mounted on Dewey will be remounted to disks which can be suspended and shark–controlled like a mirror (the output beam actually comes out the bottom or top of the polarizers, since the beamsplitter we have will demand S polarization). The Dewey tank and the beam–preparation tank are the same ones we use now, as will be the beam conditioning optics (not shown) between the mode cleaner and the beamsplitter. The two new "satellite" chambers will contain the Newey test masses, whose suspension systems will simply be transferred to the new tank hardware, and the circulators. Transverse shark detectors (not shown) will probably be added to all four test masses as well.

Figure 2: The "simplest" recombined interferometer, that is, one without any side arm modulation or recycling, would look like this. Once again, all the pre–beamsplitter optics is the same as now. The circulators have been replaced by pickoff plates which reflect a few percent of the light returning from each arm to the individual cavity locking diodes. A compensating plate, identical (except for coating) to the beamsplitter, has been added in one arm; and 1 cm aperture Pockels cells, mounted in metal rings and suspended, have been introduced in each arm for modulation and fast feedback. Slow feedback could be provided by shark coils added to the Newies (not shown).

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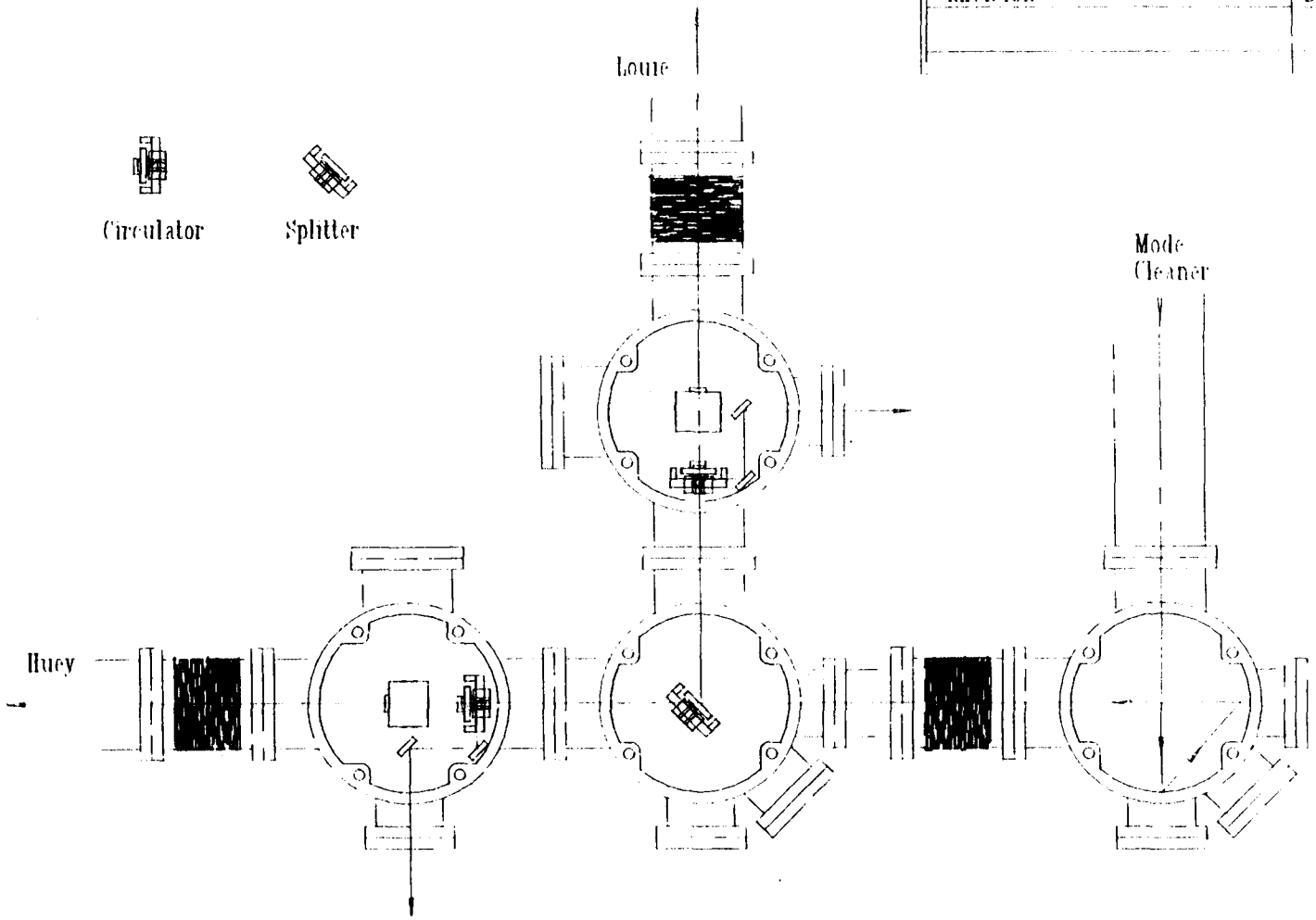

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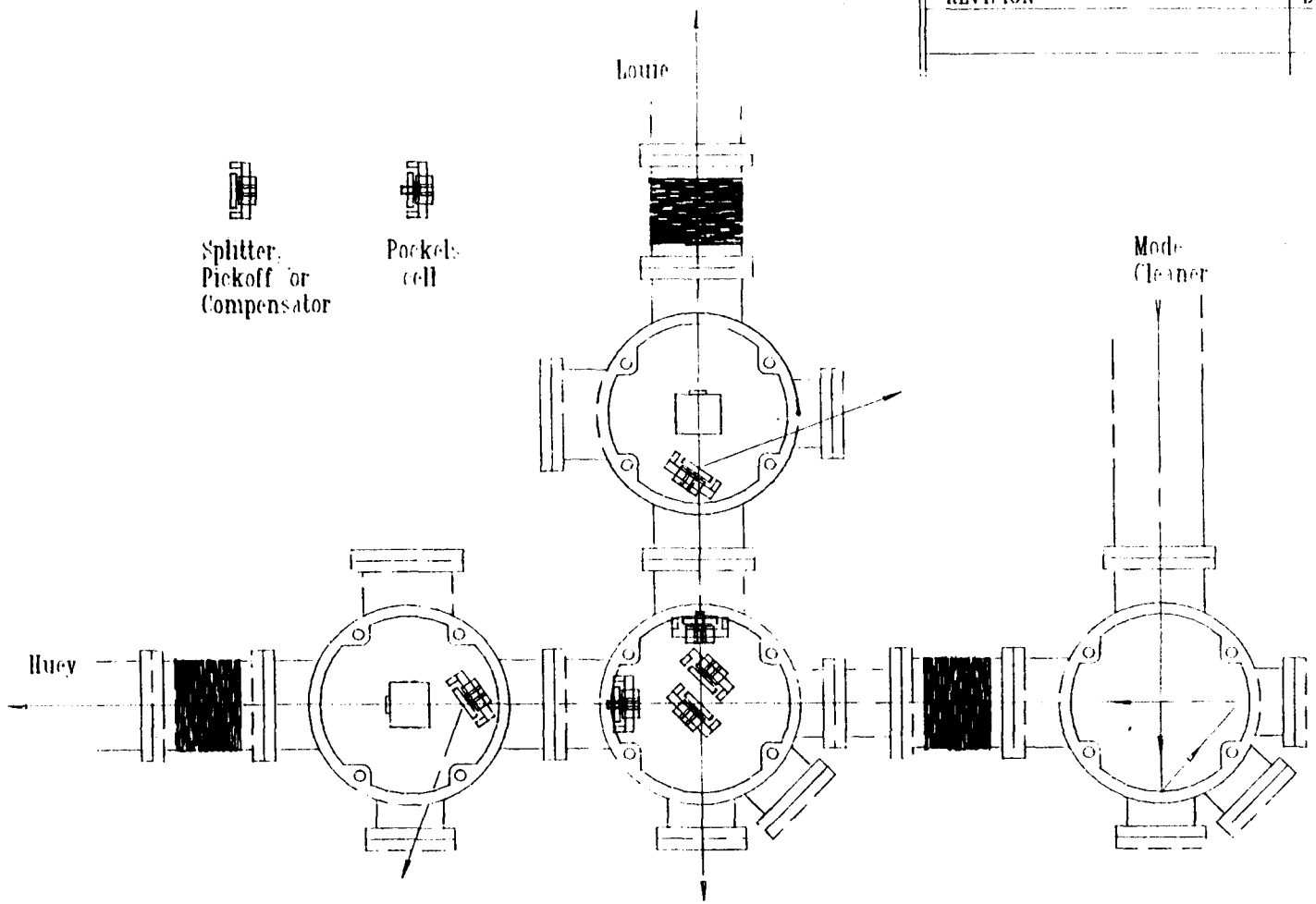

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