

# COUPLED - SUSPENSION TECHNIQUES

OR LOW-FREQUENCY INTERFEROMETER OPERATION

CEGG

R.W.P. DREVER

S. J. ALBST

(LSC LIVINGSTON, MARCH 2000)

## OBJECTIVES IN EXTENDING OPERATION

### LOWER FREQUENCIES INCLUDE:-

CAN TRACK CHIRP SIGNALS (NS-MS, ETC) OVER LONGER TIME AND FREQUENCY RANGE

- IMPROVE SENSITIVITY FOR DETECTION

- BETTER DATA ON SOURCES AND ULTRA-RELATIVISTIC EFFECTS

- POSSIBILITY OF MORE WITHIN RANGE

MANY MORE PULSARS WITHIN RANGE

- INCLUDING KNOWN ONES

STOCHASTIC BACKGROUND SEARCHES IMPROVED, (SEPARATED SITES)

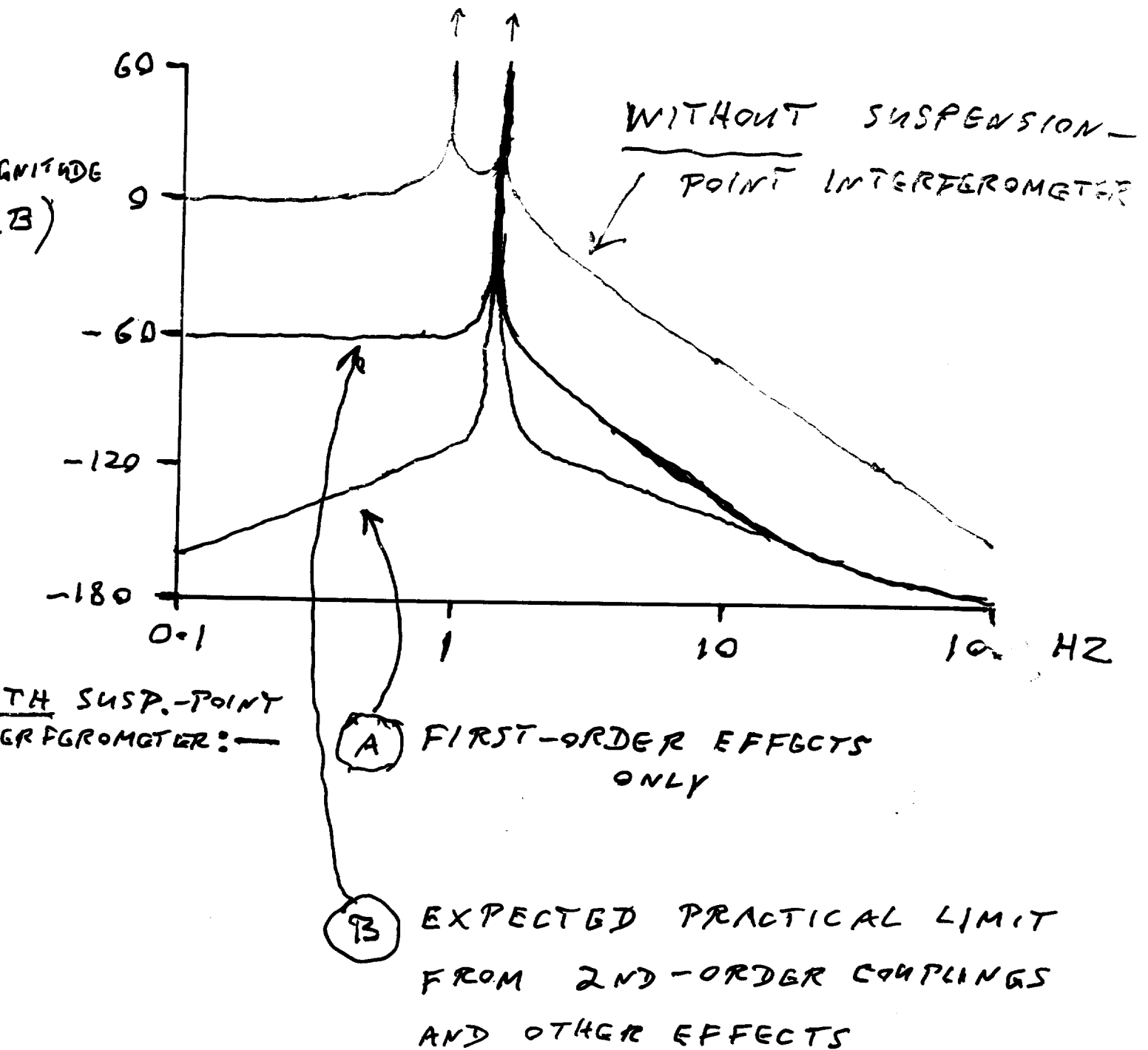
IN GENERAL - WIDEN SEARCH POSSIBLE.

ADDITION - IF COULD OPERATE AT  $\sim 1\text{Hz}$

AND LOWER, NEW POSSIBILITIES FOR GRAVITY GRADIENT MEASUREMENTS CAN OPEN - RELEVANT TO GEOPHYSICS, ETC.

ESTIMATED DIFFERENTIAL TRANSFER FUNCTIONS  
 FROM SUSPENSION-POINTS OF SECOND-LAST PENDULUMS  
 TO FINAL TEST MASSES

(TEST MASS FEEDBACK TURNED OFF)



PLAN TO TEST SOME OF THIS IN TEST INTERFEROMETER

- MEASURE GRAVITY GRADIENT BACKGROUND  
TO CHECK ESTIMATES OF LIMITS FOR G.W.

OBSERVATION

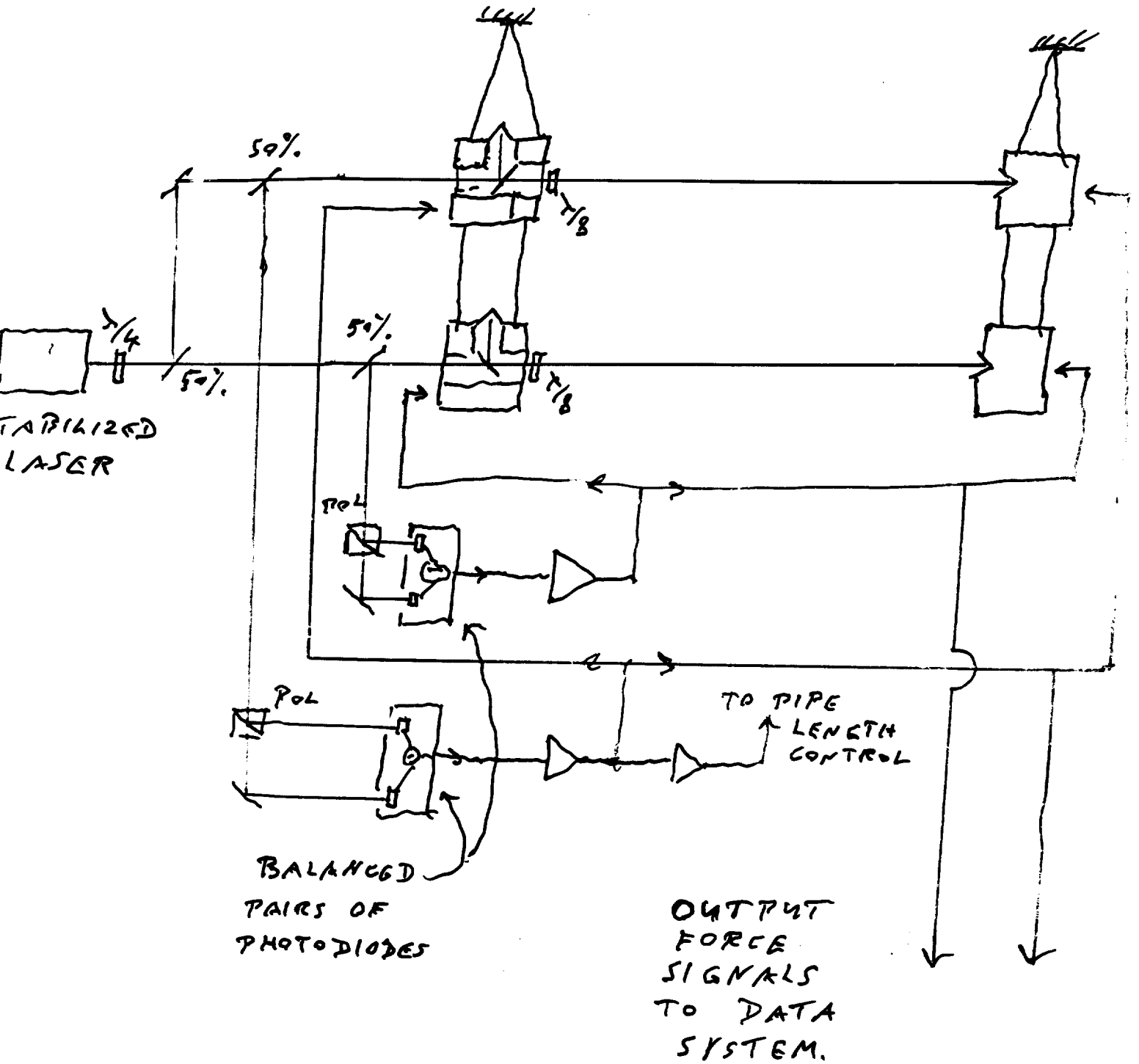
(AT NIGHTTIME - WHEN LITTLE  
TRAFFIC)

- RUN TO MEASURE AND UNDERSTAND THE  
GRAVITY GRADIENT BACKGROUND - AND  
POSSIBLY WAYS TO DISCRIMINATE AGAINST IT.
- FIND WHAT THE REAL PROBLEMS ARE.

PRELIMINARY TESTS WITH SIMPLEST POSSIBLE  
INTERFEROMETER.

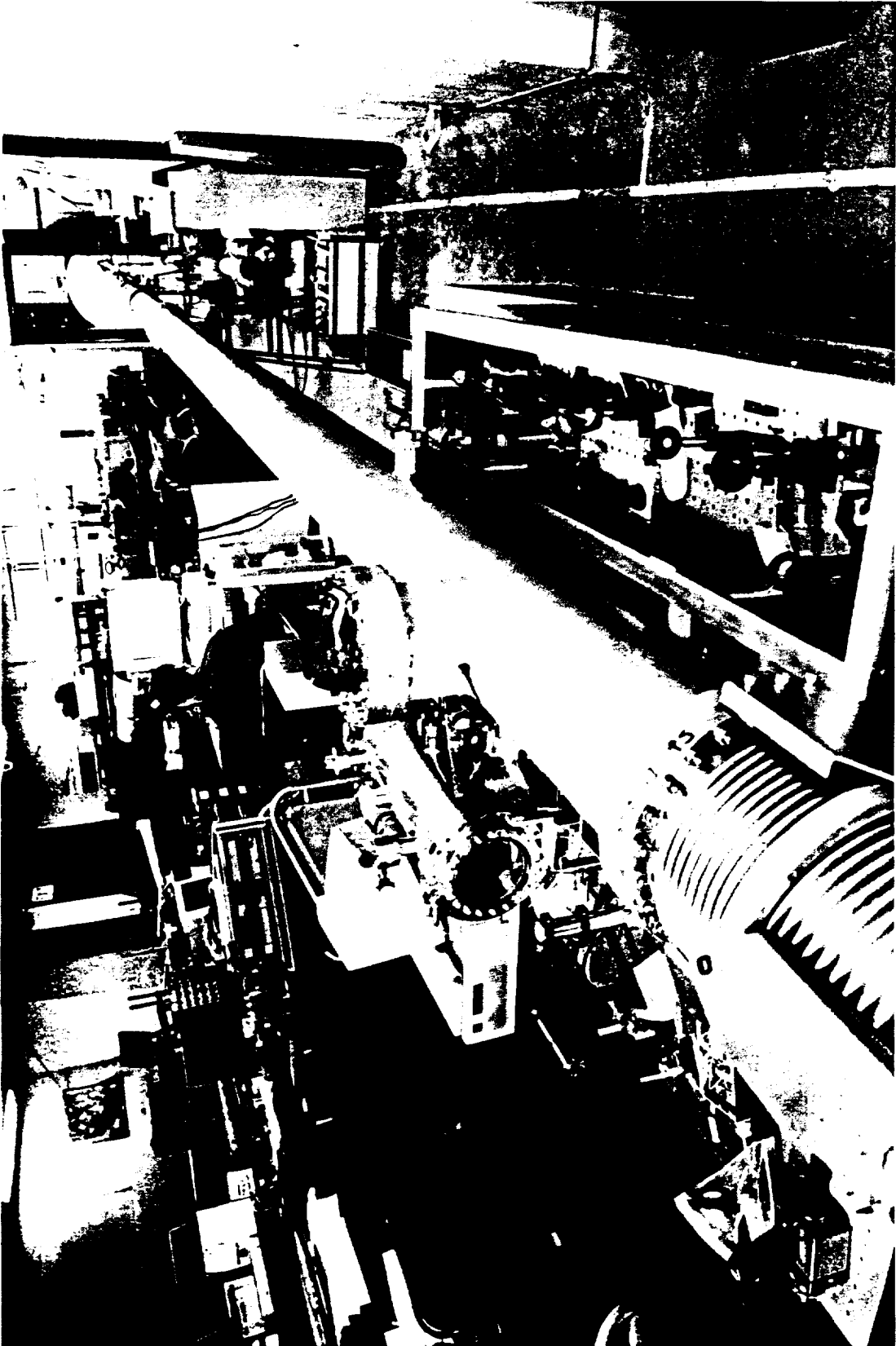
- ONE 40 m ARM  
LASER STABILIZED TO ATOMIC LINE (HE-NE LASER)
- ONE-BOUNCE UNEQUAL-ARM MICHELSON  
INTERFEROMETERS FOR UPPER AND  
LOWER BEAMS
- INITIAL FEEDBACK WITH COIL-MAGNET  
SYSTEMS

SIMPLIFIED SCHEMATIC FOR FIRST PRELIMINARY TESTS

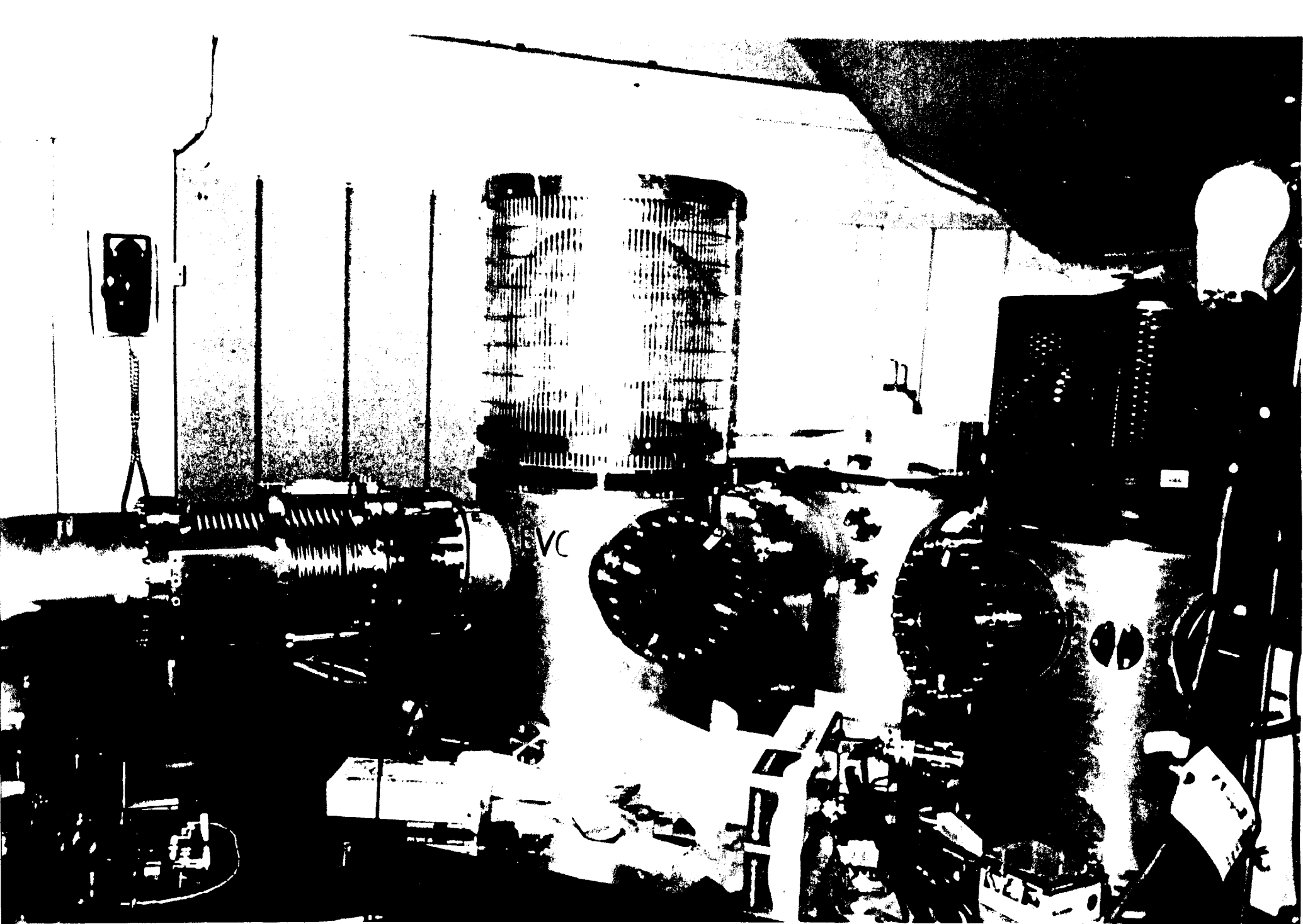


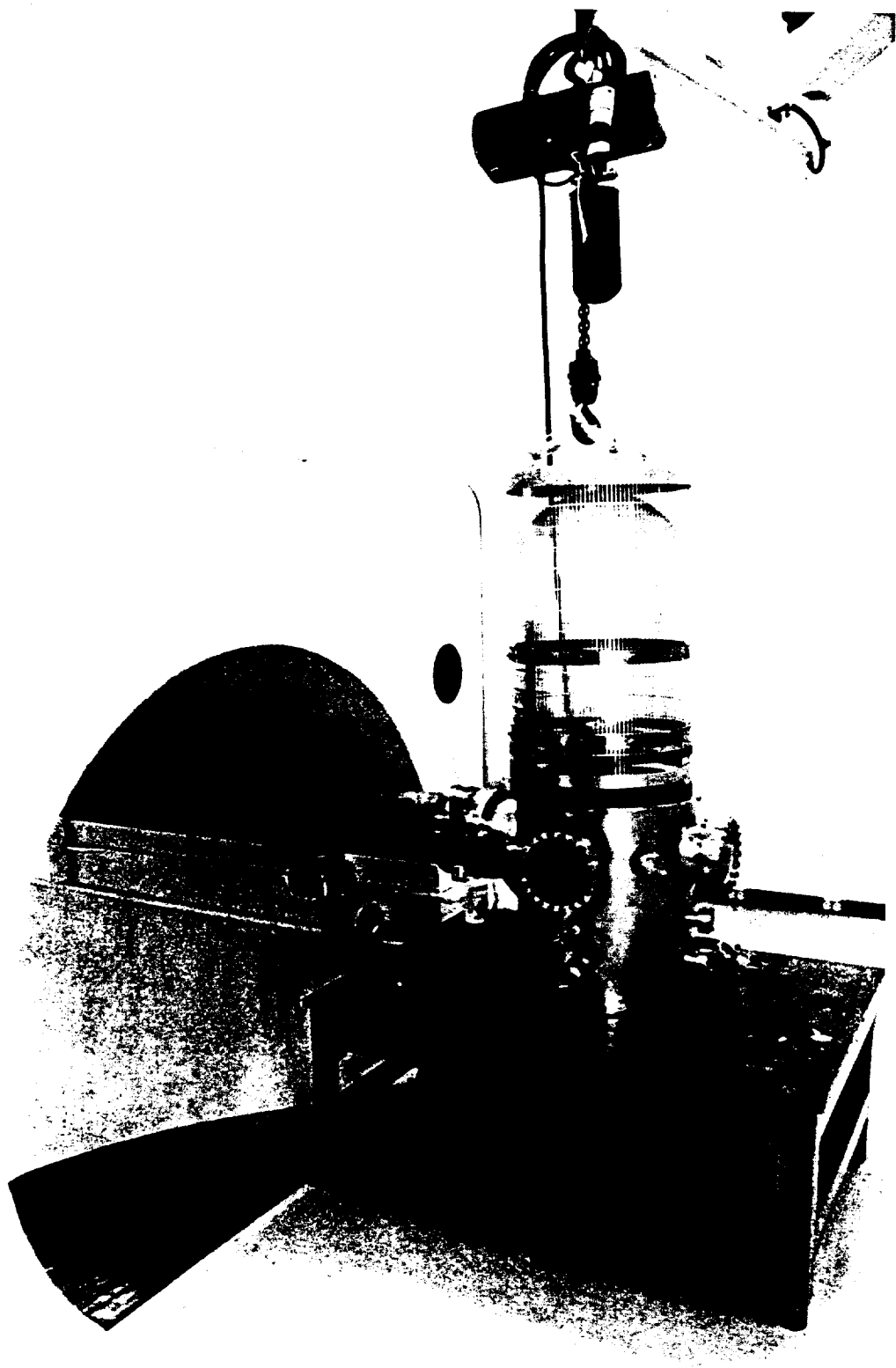


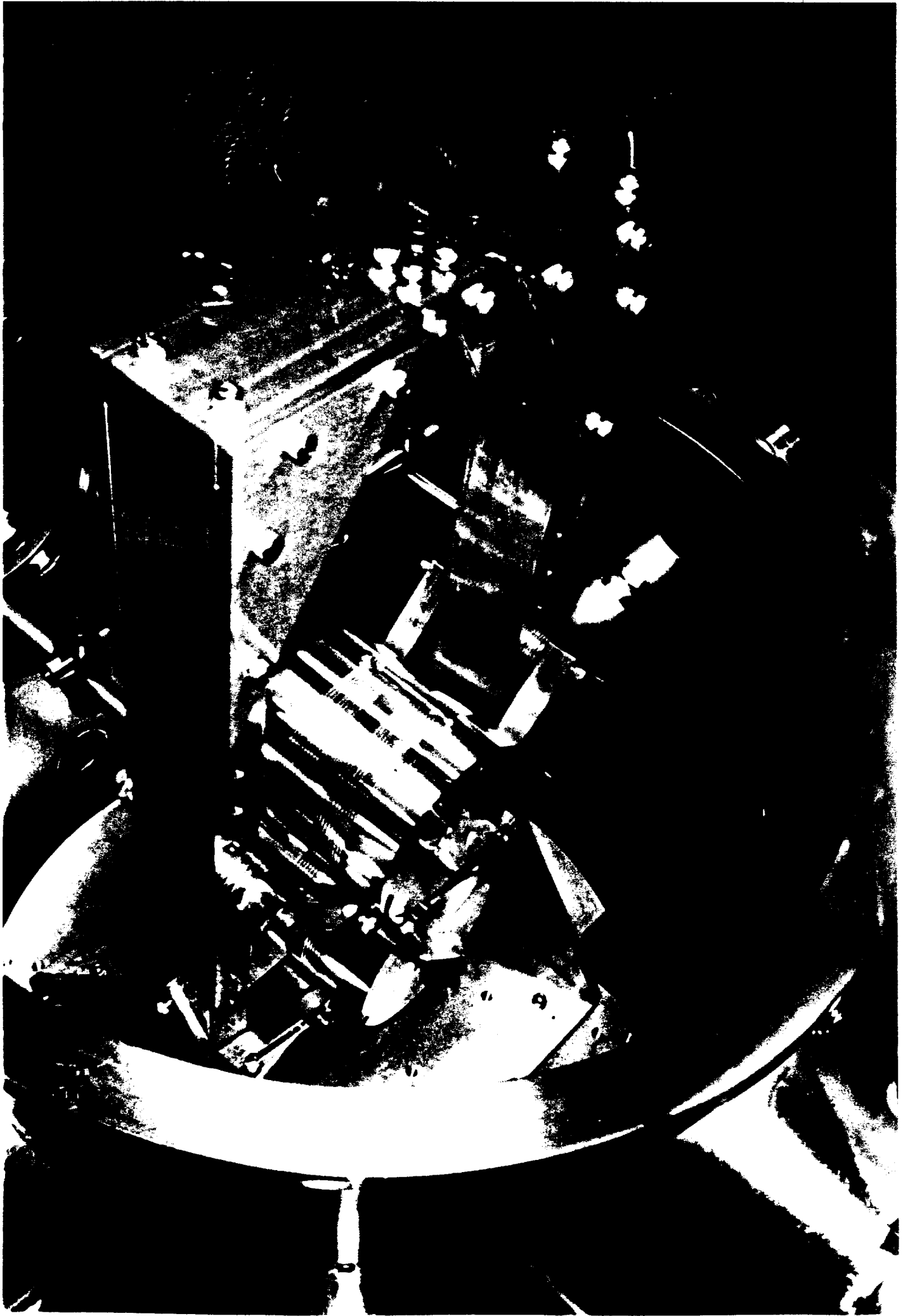
PRESENT LEVITATED SYSTEMS IN SOUTH TANK











## PRELIMINARY FINDINGS IN FIRST TESTS

BIG DAILY LOW FREQUENCY EFFECT

- PROBABLY DUE TO TEMPERATURE - PIPE EXPANDS AND MOVES TEST MASSES.

- INTRODUCE LENGTH CONTROL BY HEATING PART OF PIPE.

CORRELATION BETWEEN 2 OUTPUTS

- POSSIBLY PARTLY FROM LASER FREQUENCY CHANGES,

- POSSIBLY TILT EFFECTS, ETC.

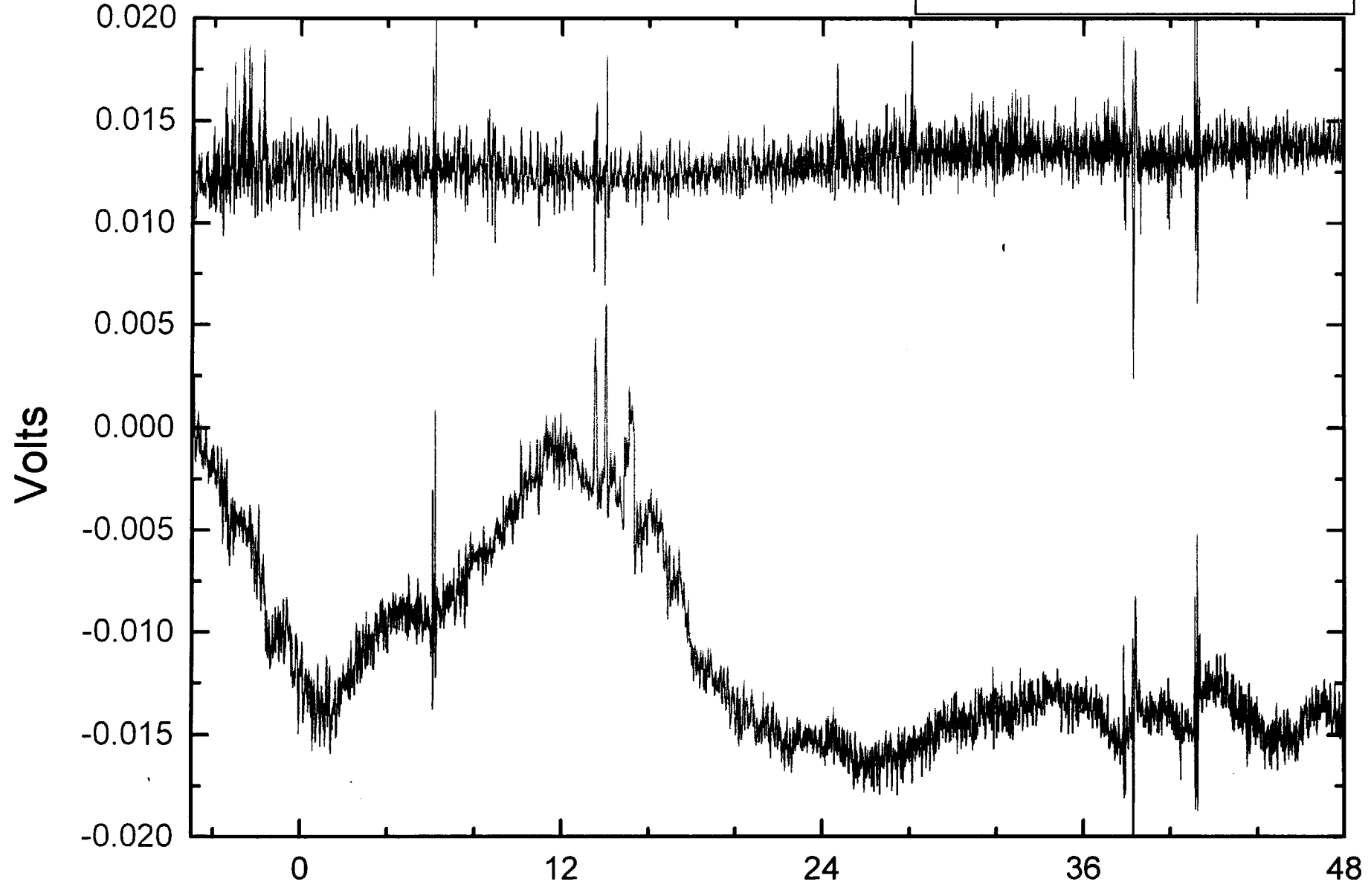
OCCASIONAL CORRELATION WITH MAGNETIC FIELD CHANGES SEEN.

(MANY EFFECTS UNDER STUDY NOW)

NOTE: SCATTERING BETWEEN BEAMS IS EXPECTED, AND A.O. FREQUENCY SHIFTING OF ONE BEAM WILL BE INTRODUCED SOON.

FEEDBACK FORCE  
SIGNAL

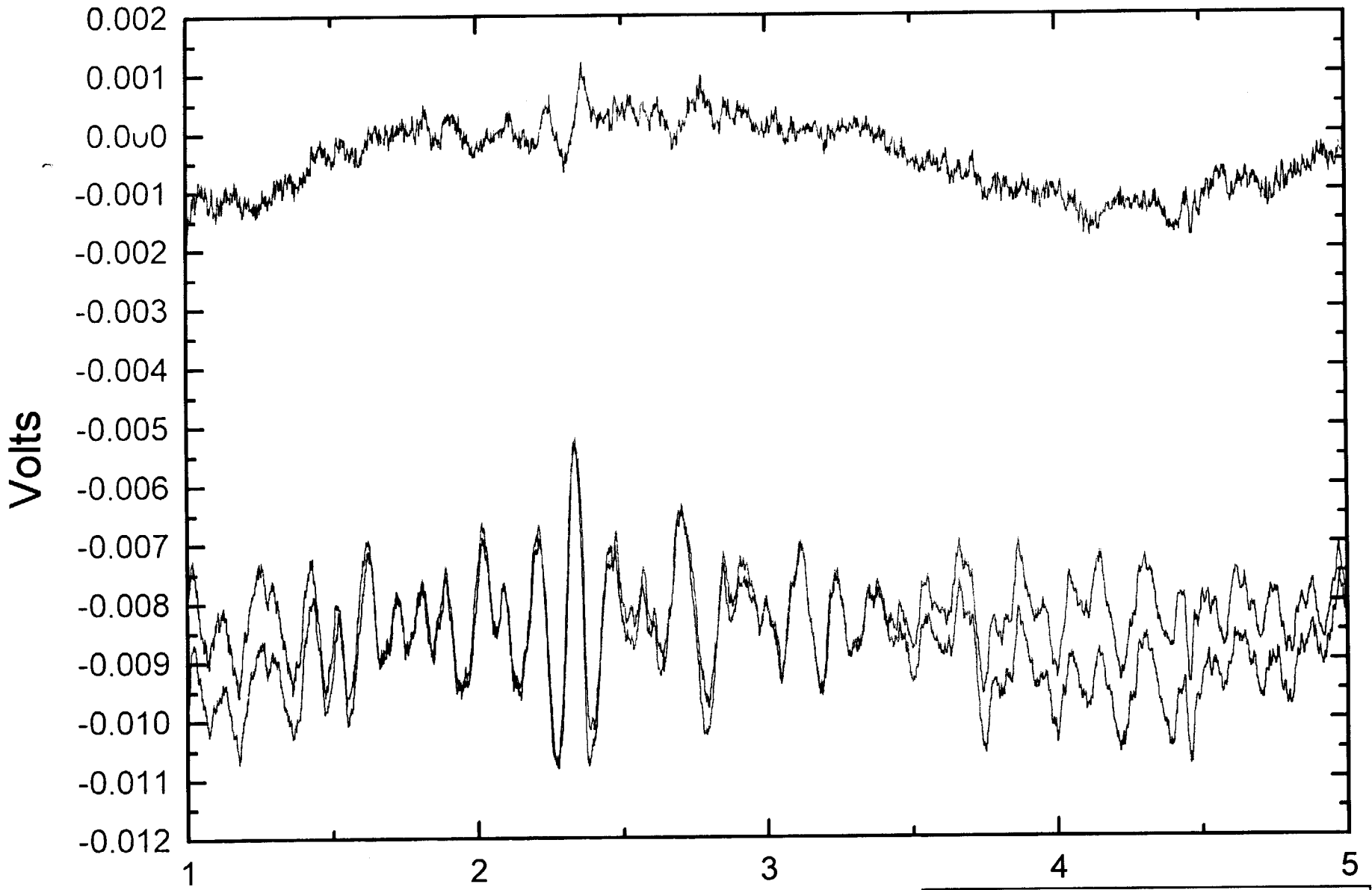
Top Coil  
Bottom Coil



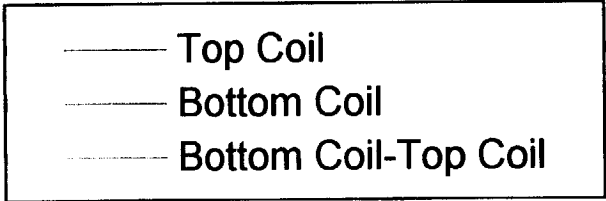
Volts

Time (hours)

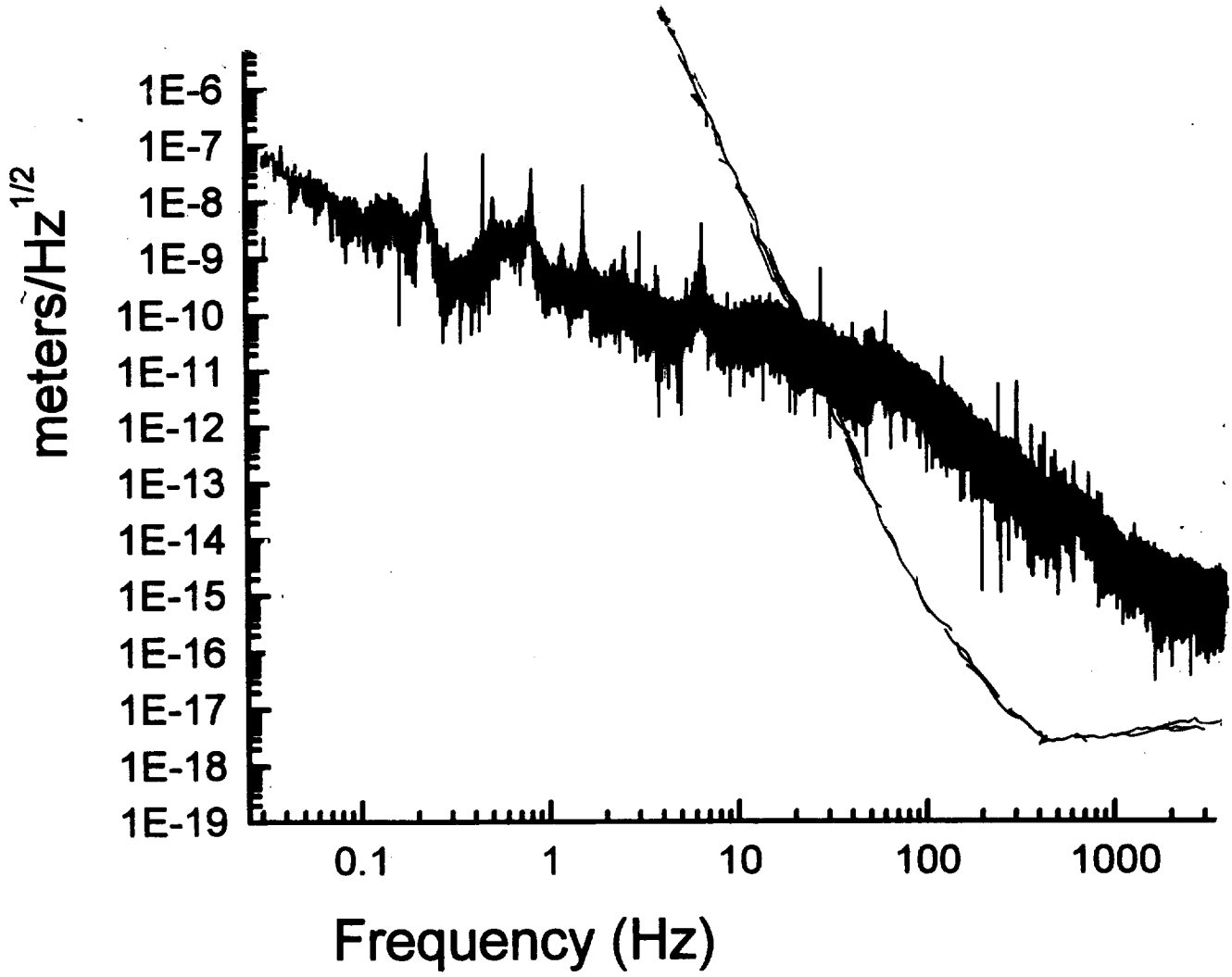
↑  
PERIOD OF HEAVY RAIN



Time (hours) 1am to 5am 16 Feb. 2000



CALCULATED EQUIVALENT DIFFERENTIAL MOTION  
OF FREE TEST MASSES CORRESPONDING TO  
THE FEEDBACK FORCES MEASURED IN SYSTEM.



DATA FROM FEBRUARY 16, 2000.

NOW BETTER BY FACTOR ~ 6

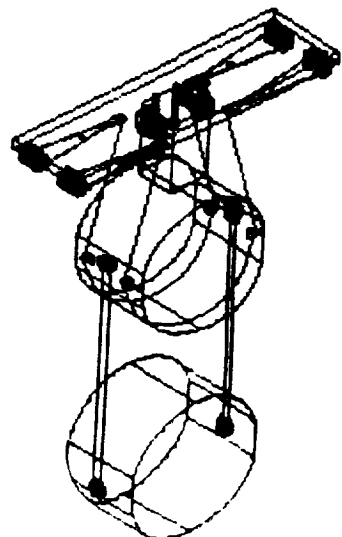
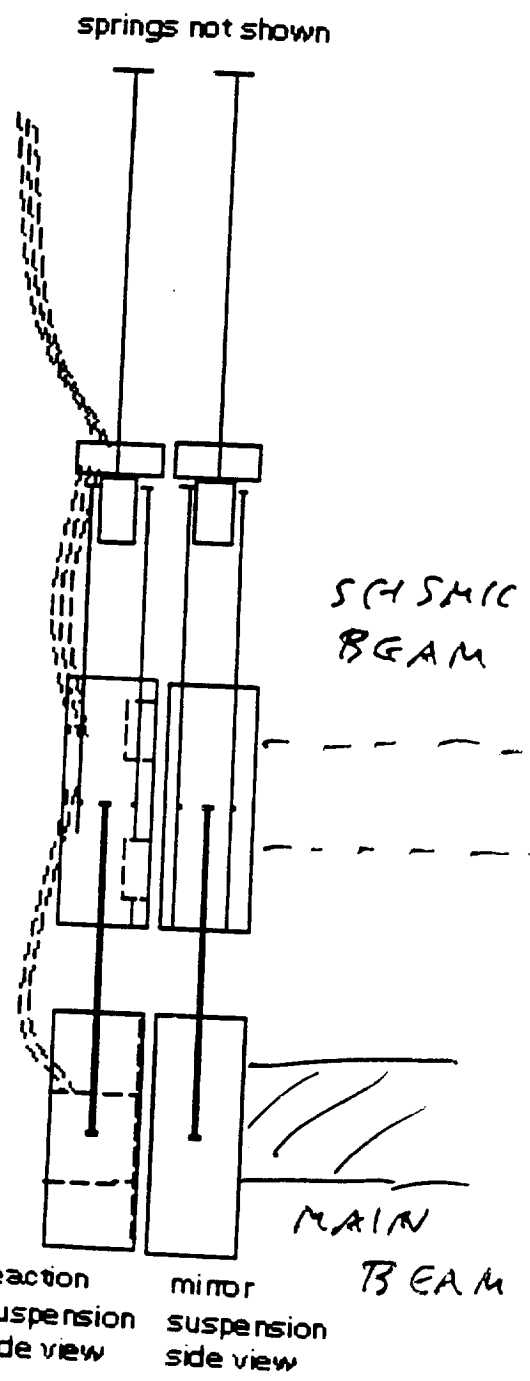
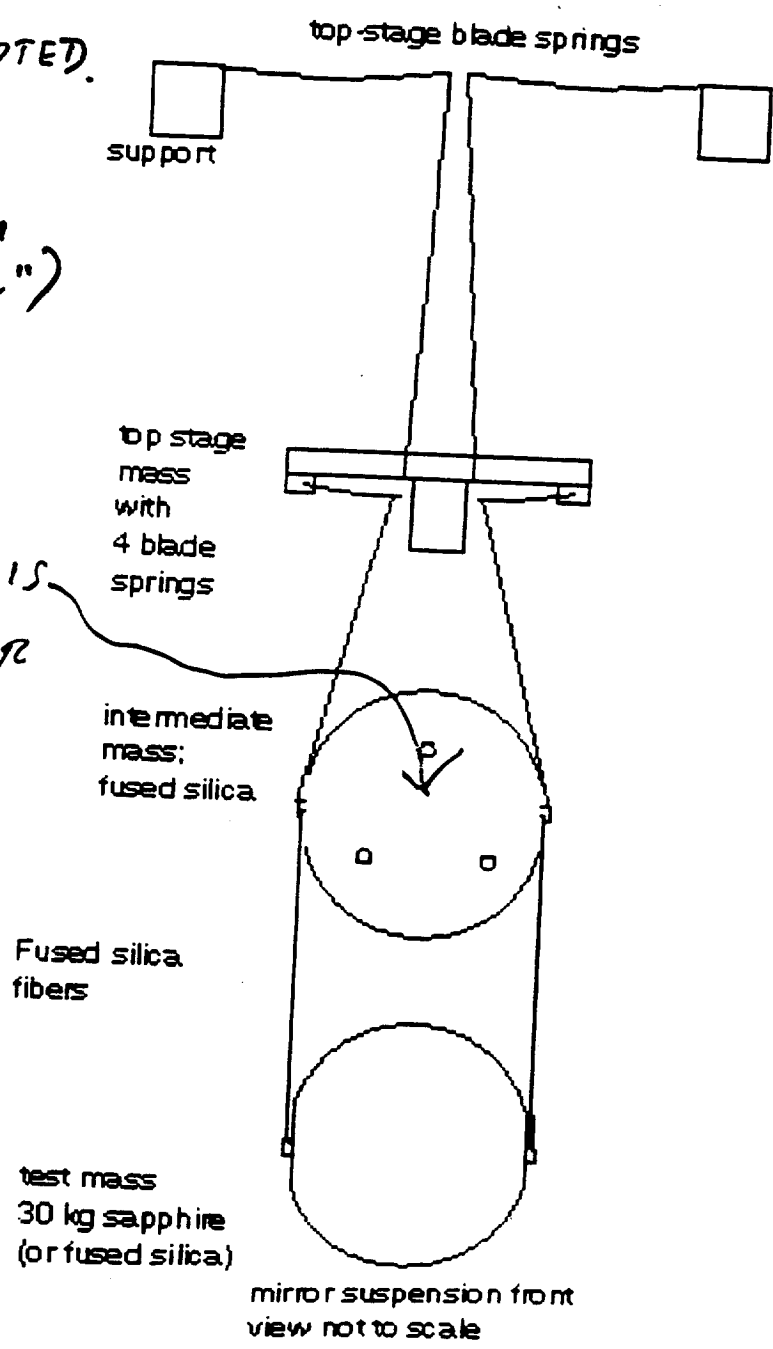
(MARCH 14, 2009)

GO ILLA CURRENT LSC SUSPENSION DESIGN COULD BE

EASILY ADAPTED.

TRIPLE  
PENDULUM  
SUSPENSION")

TAKE THIS  
MIRROR  
FOR  
SEISMIC  
BEAM





## MAIN POINTS.

CAN REDUCE DIRECT SEISMIC NOISE OVER FREQUENCIES  
FROM  $> 100 \text{ Hz}$  TO  $\ll 1 \text{ MILLIHERZ}$ .

EXTENDS OPERATION TO LIMITS FROM OTHER  
NOISE SOURCES — (INCLUDING QUIETEST TIMES)

MAKES POSSIBLE EXPLOITATION OF

(A) IMPROVED THERMAL NOISE

(INCLUDING CRYOGENICS)

(B) GRAVITY-GRADIENT REDUCTION METHODS

SENSITIVITY FALLS AT LOWEST FREQUENCIES

— BUT CAN STILL BE USEFUL FOR STRONG  
SIGNALS AND GEOPHYSICS

MAY HELP TURN THE "BRICK WALL" INTO  
A GENTLE HILL. !

SUGGESTION: CURRENTLY COMPATIBLE AS ADD-ON  
TO LIGO-II SUSPENSION

SUGGEST RETAIN THIS POSSIBILITY IF  
PRACTICABLE AS MORE DATA IS OBTAINED.

*Note 1, Linda Turner, 05/09/00 01:47:49 PM*  
LIGO-G000074-00-D