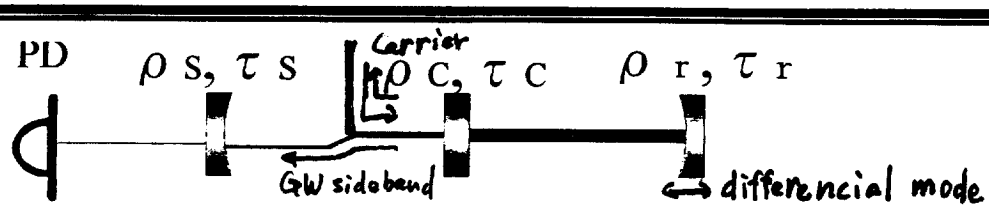
Response of narrow band cavity



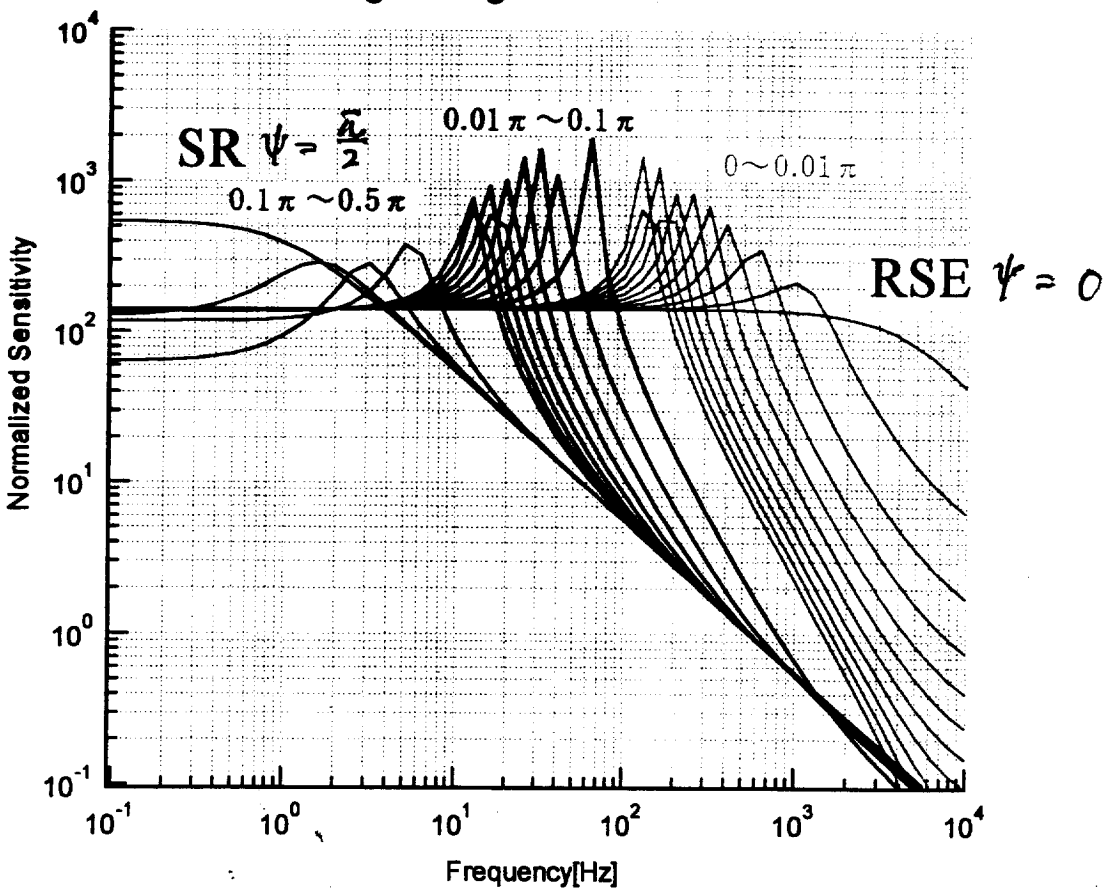
$$G(\omega) = \sqrt{g_{arm}} \times \frac{i\tau_{CM}}{1-\rho_{CM}\rho_r e^{-i\omega t_s}} \times \frac{\rho_r \omega_0}{4} \frac{1-e^{-i\omega t_s}}{i\omega}$$

Power Enhancement | Frequency response | Optical length

$$\rho_{CM} = \frac{\rho_C - \rho_S e^{-i2\phi_s}}{1-\rho_C\rho_S e^{-i2\phi_s}}, \tau_{CM} = \frac{\tau_C\tau_S e^{-i2\phi_s}}{1-\rho_C\rho_S e^{-i2\phi_s}}$$

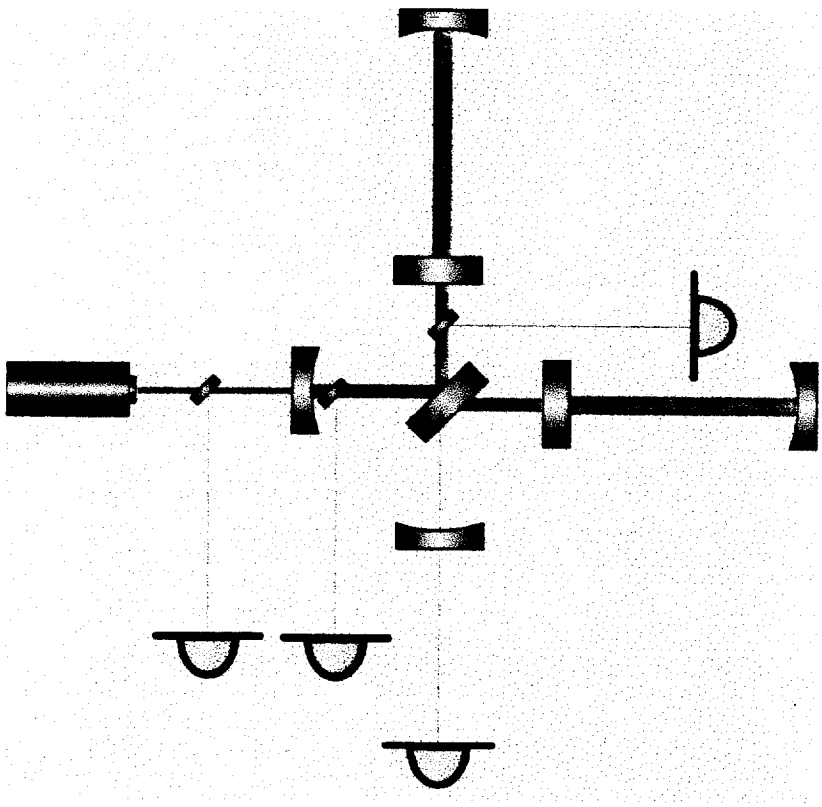
$$\phi_s = \frac{\omega l_s}{c} + \Psi, \quad \Psi = \frac{\omega_0 l_s}{c}$$: detuning parameter (one way)

Detuning of Signal Extracton Mirror



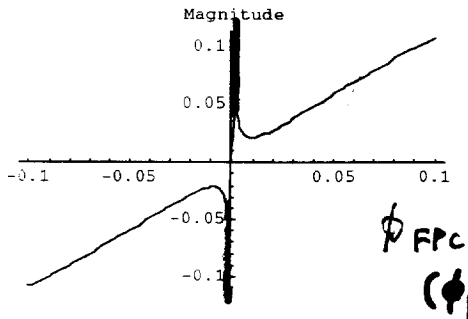
Calculation for signal extraction

We improved "Twiddle" to analyze full interferometer frequency response, DC error signal, power inside the cavity and dependence of $\frac{\partial H}{\partial \phi}$, power on various parameter(e.g. demodulation phase, reflectivity of recycling mirror, modulation frequency).



Example:coupled cavity

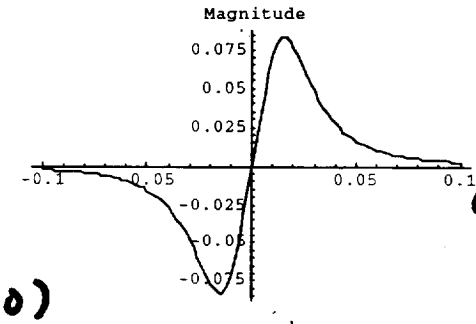
sweeping FP cavity



ϕ_{FPC}

$(\phi_{PRC}=0)$

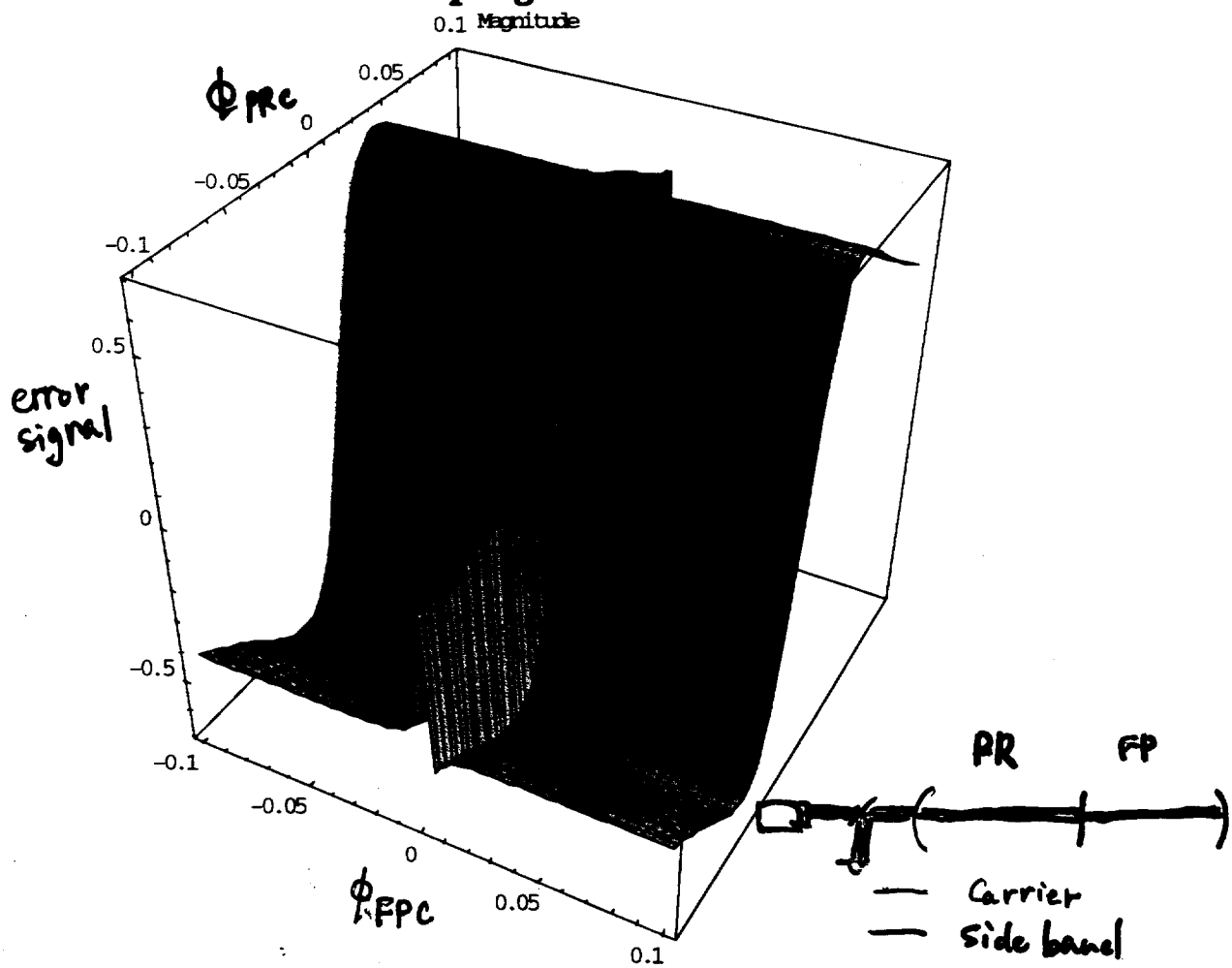
sweeping Recycling cavity



ϕ_{PRC}

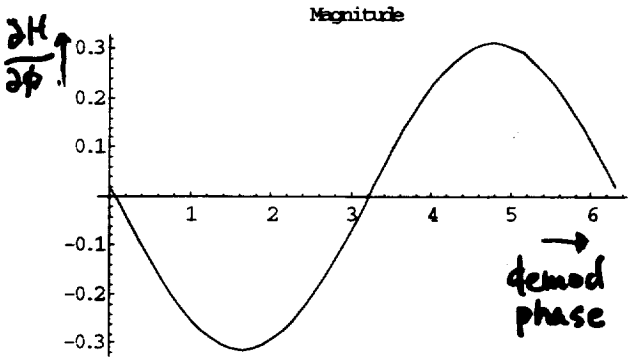
$(\phi_{FPC}=0)$

sweeping both at once

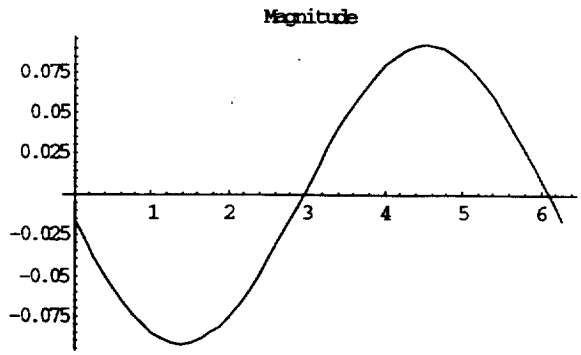


Example 2:Demodulation Phase Plot

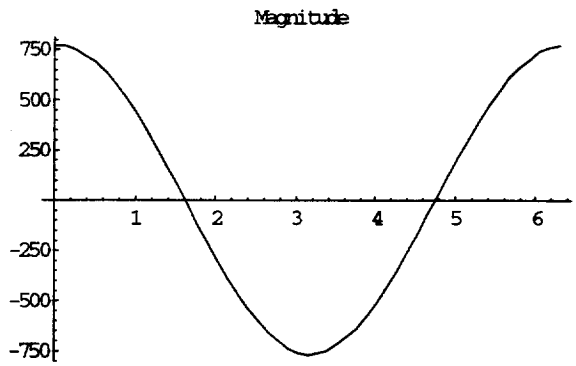
refrect port @ 3×modfreq demodulation



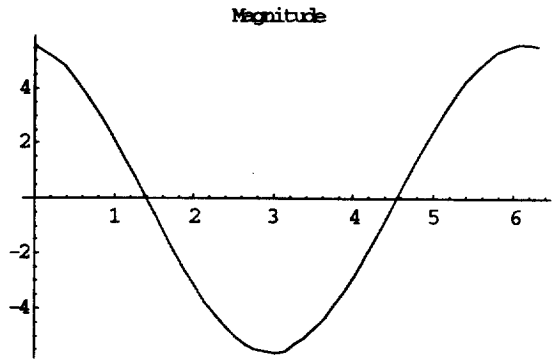
L-



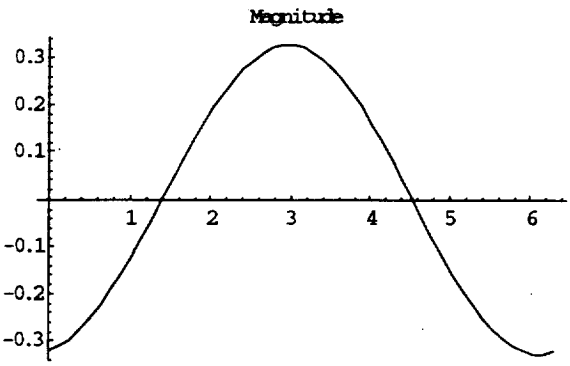
l-



L+



l+



ls

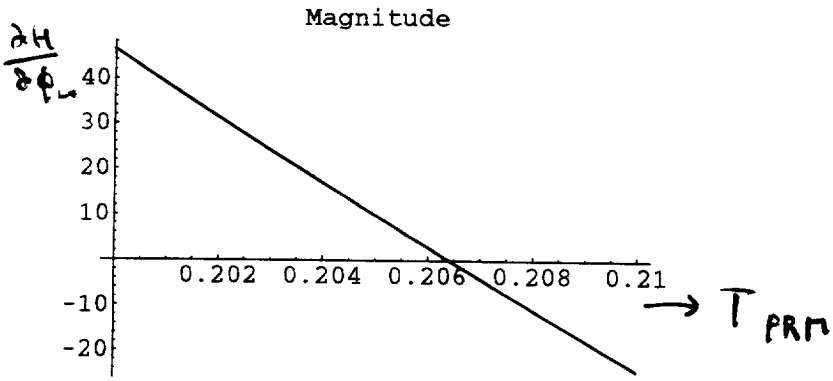
■ Ando method : Searching for the zero error signal point by moving Transmittency of Power Recycling Mirror

```
ClearBuff;
npoints = 30;
startparam = 0.2;
stopparam = 0.21;
outindex = index[m1, 1, 2];
ClearBuff;
shake[m3, 1];
shake[m5, 1];
CalcParamPlotArb[Pi, outindex, tt1];

ClearBuff;
shake[m1, 1];
CalcParamPlotArb[Pi, outindex, tt1];
```

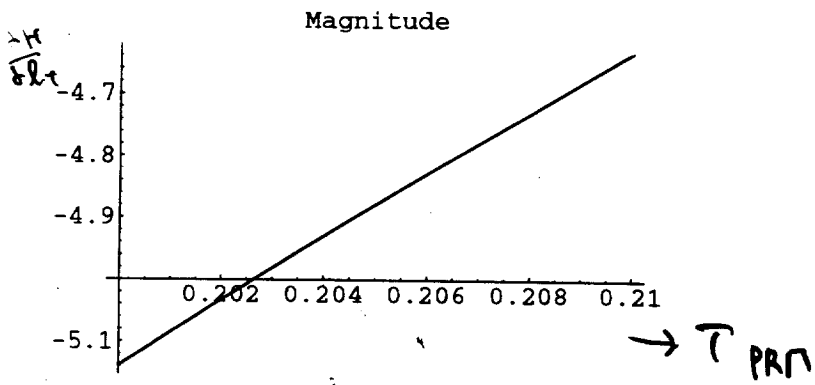
L+

Output at index 4, demodulation qori, at frequency 1



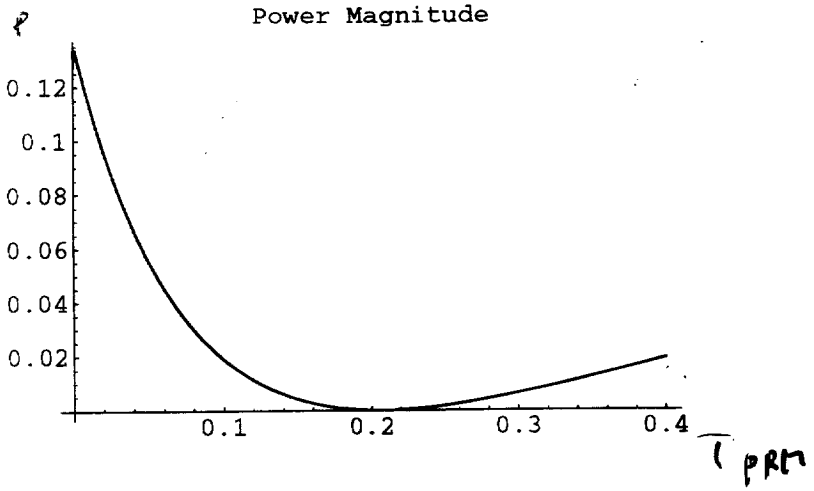
Output at index 4, demodulation qori, at frequency 1

I+

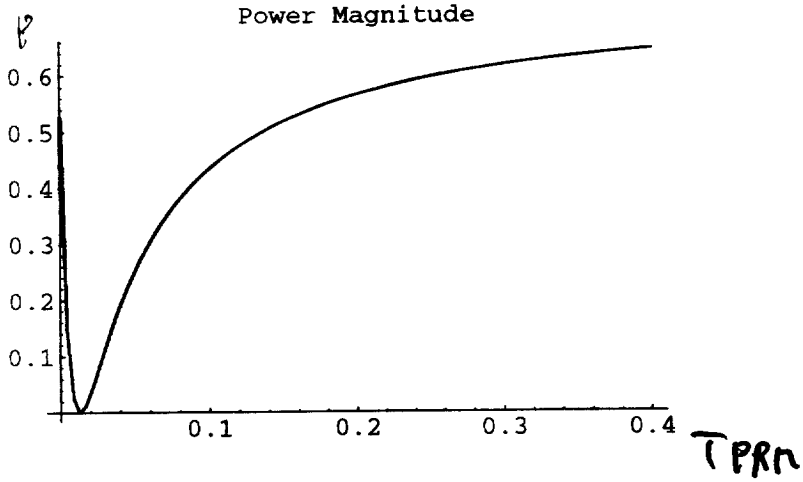


Power of the reflectivity of interferometer on moving Transmittency of Power Recycling Mirror

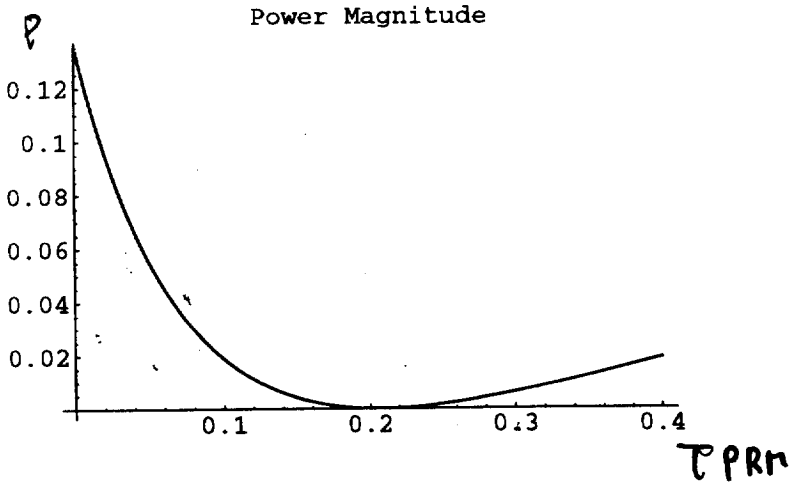
Lower sideband



Carrier



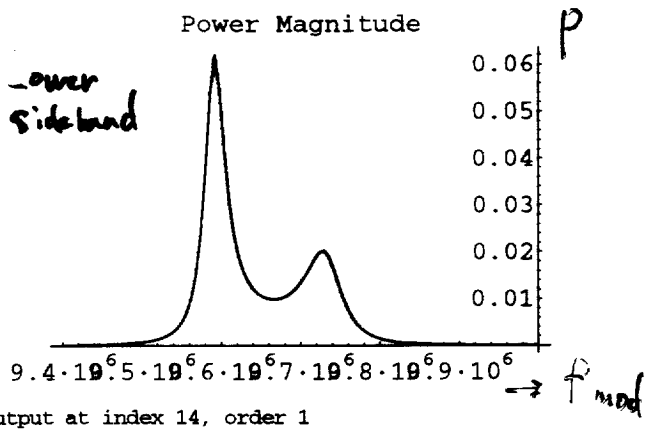
Upper sideband



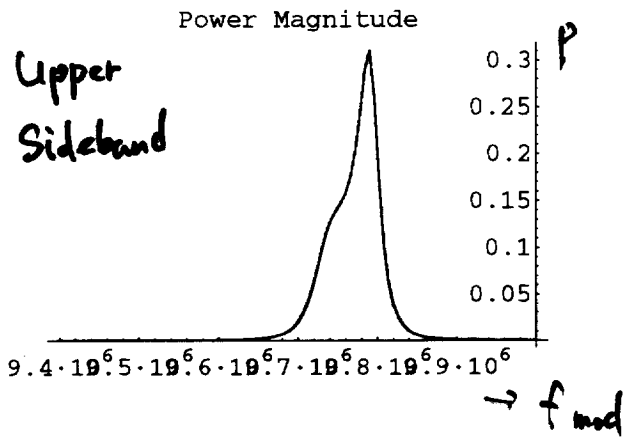
■ Sideband amplitude with Modulation Frequency

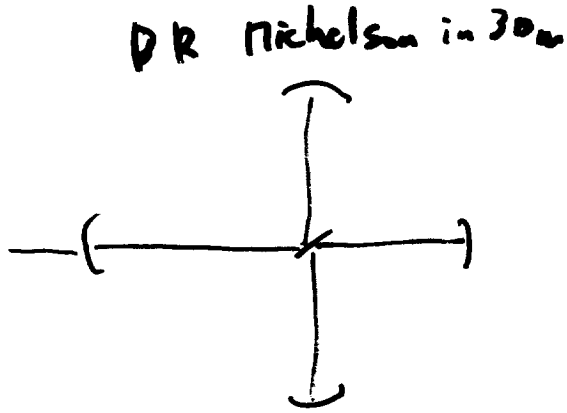
```
ClearBuff;
npoints = 100;
startparam = 9.4 10^6;
stopparam = 10 10^6;
outindex = index[bs1, 4, 2];
ClearBuff;
powerParamPlot[outindex, -1, mfreq];
powerParamPlot[outindex, 1, mfreq];
```

Output at index 14, order -1



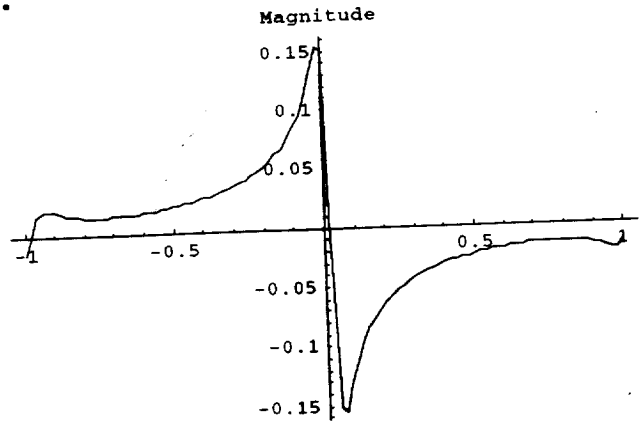
Output at index 14, order 1



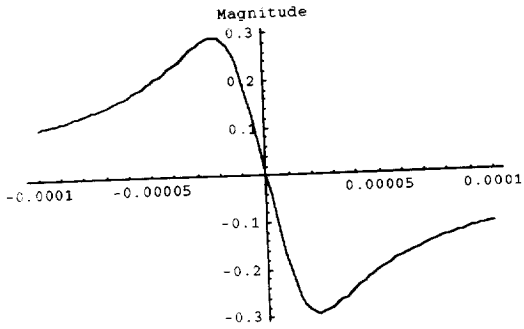


Calculation for signal extraction

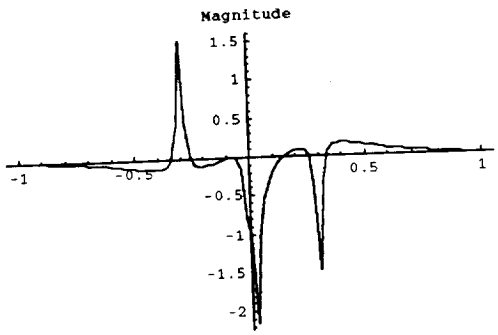
If we detune, there are some off-set in all port except for L-.



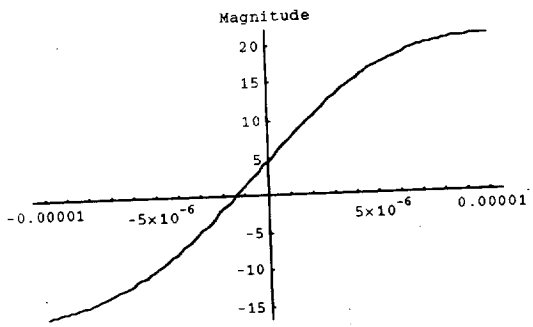
ls



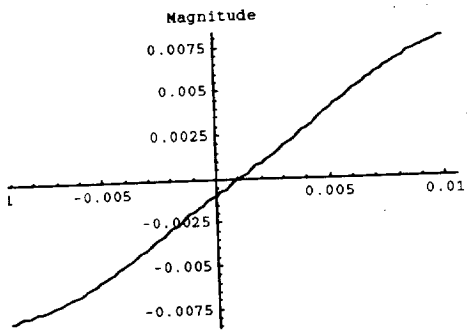
L-(no off-set)



l-

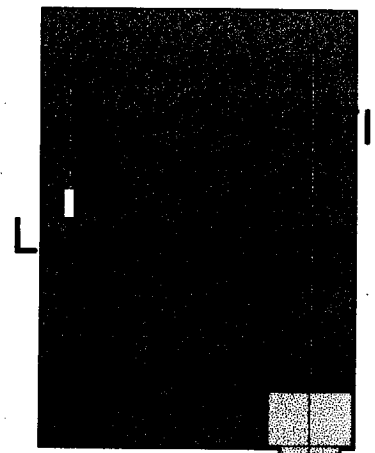


L+

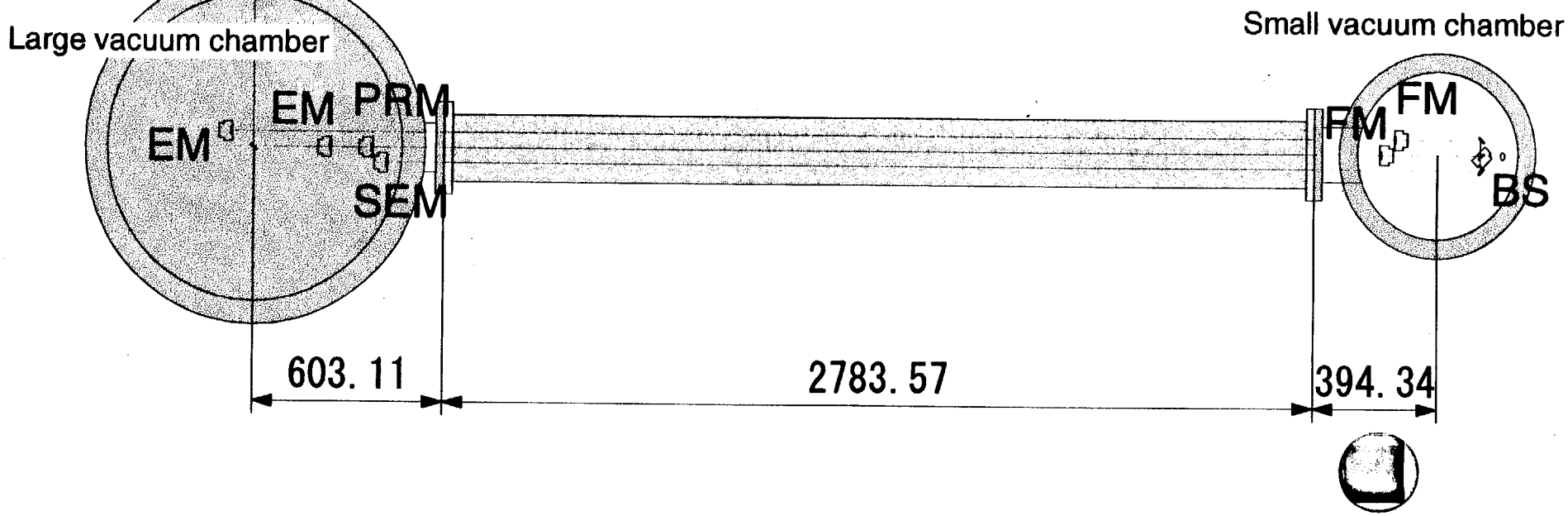


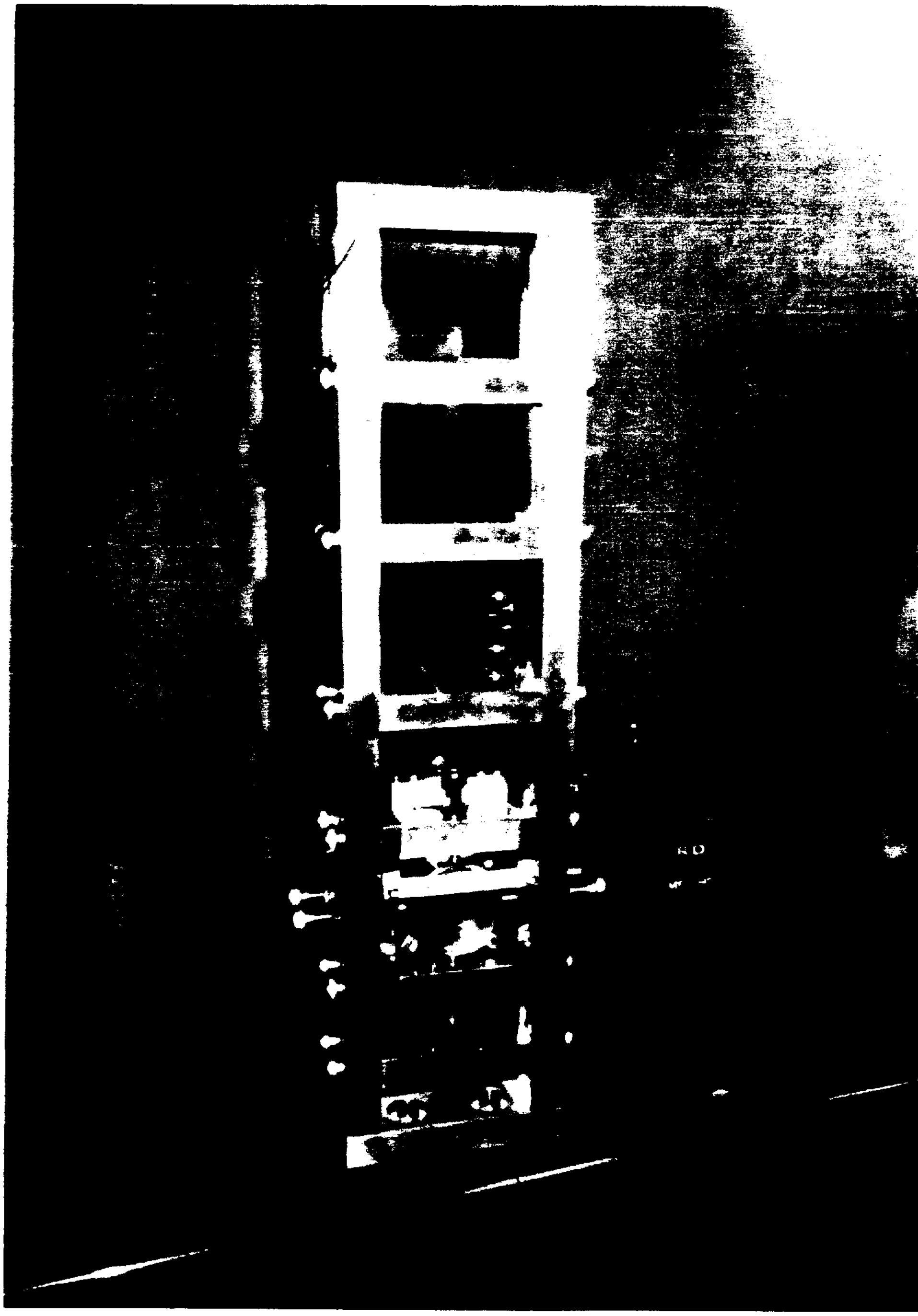
l+

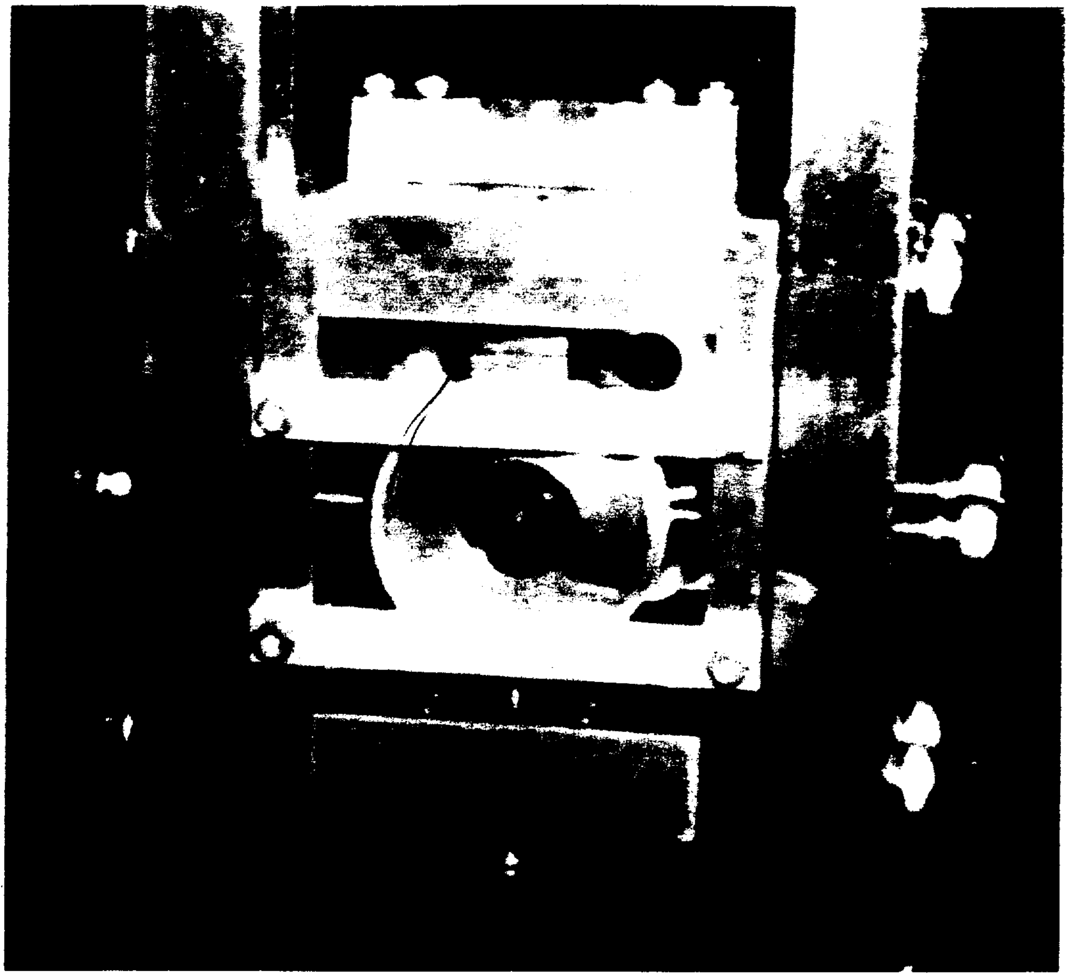
Setting of Optical Components for RSE



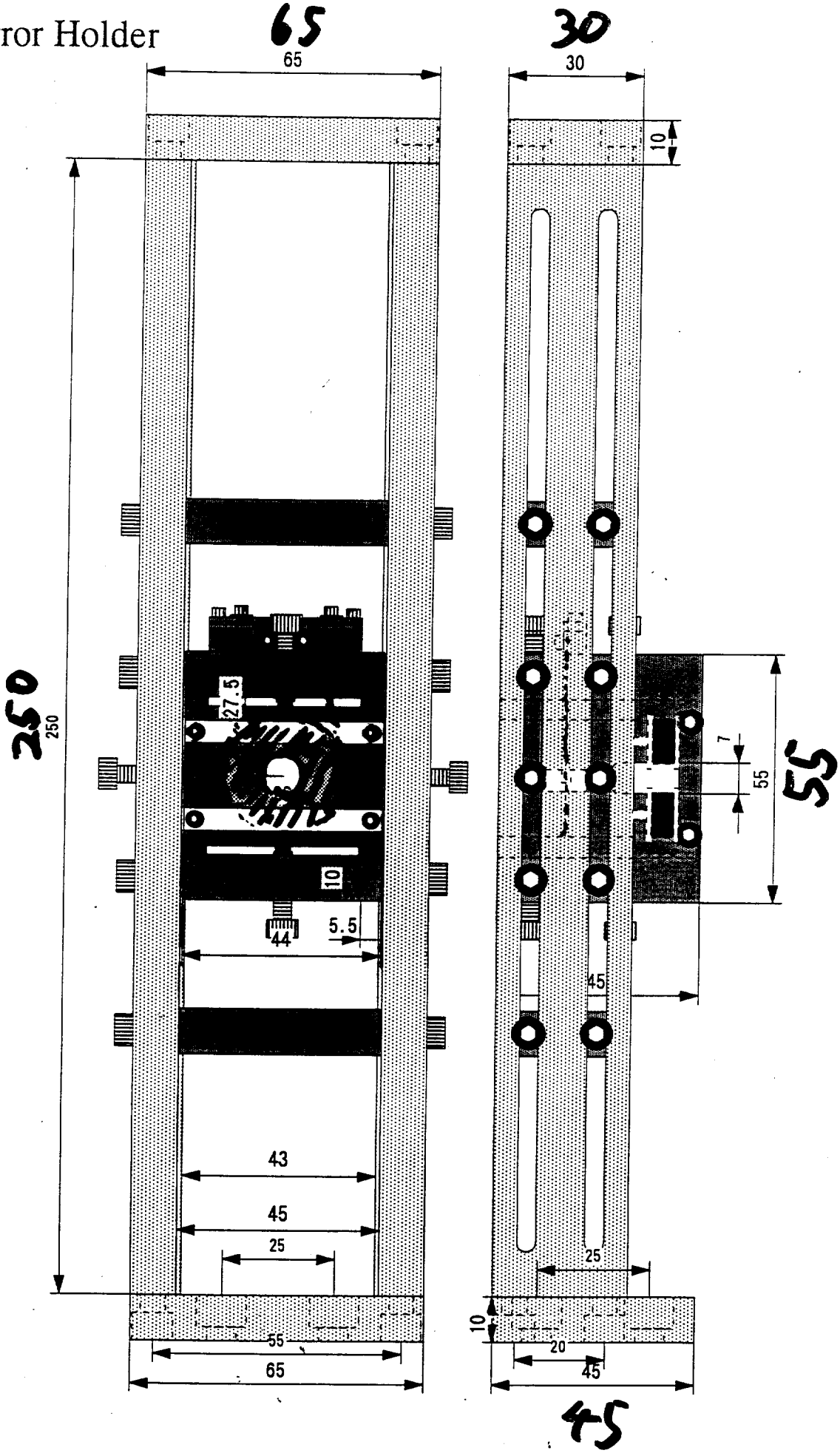
- two vacuum chamber
- 4 rays in one pipe
  - two 4m Fabry-Perot cavities
  - Power Recycling cavity
  - Signal Extraction cavity
- small mirrors suspended by 1 loop wire







Mirror Holder

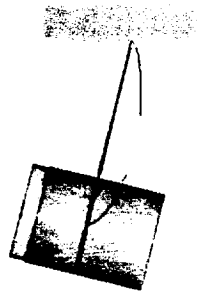


Small Suspension System

- This suspension system
  is simple setting compared with PZT control.
  has wide dynamic range for ray axis direction.
  $\sim 100\ [\mu m]$
  can apply to alignment control.
  DC dynamic range $\sim\ 8\times10^{-3}$ [rad]
- Max 9 ray in one pipe.
- Resonant frequency can be set up optionally.

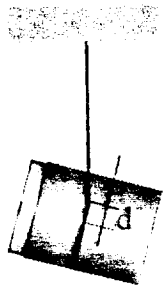
Pendulum

$$f=\frac{1}{2\pi}\sqrt{\frac{l}{g}}=3.0\,[\mathrm{Hz}]$$



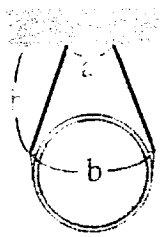
Pitch

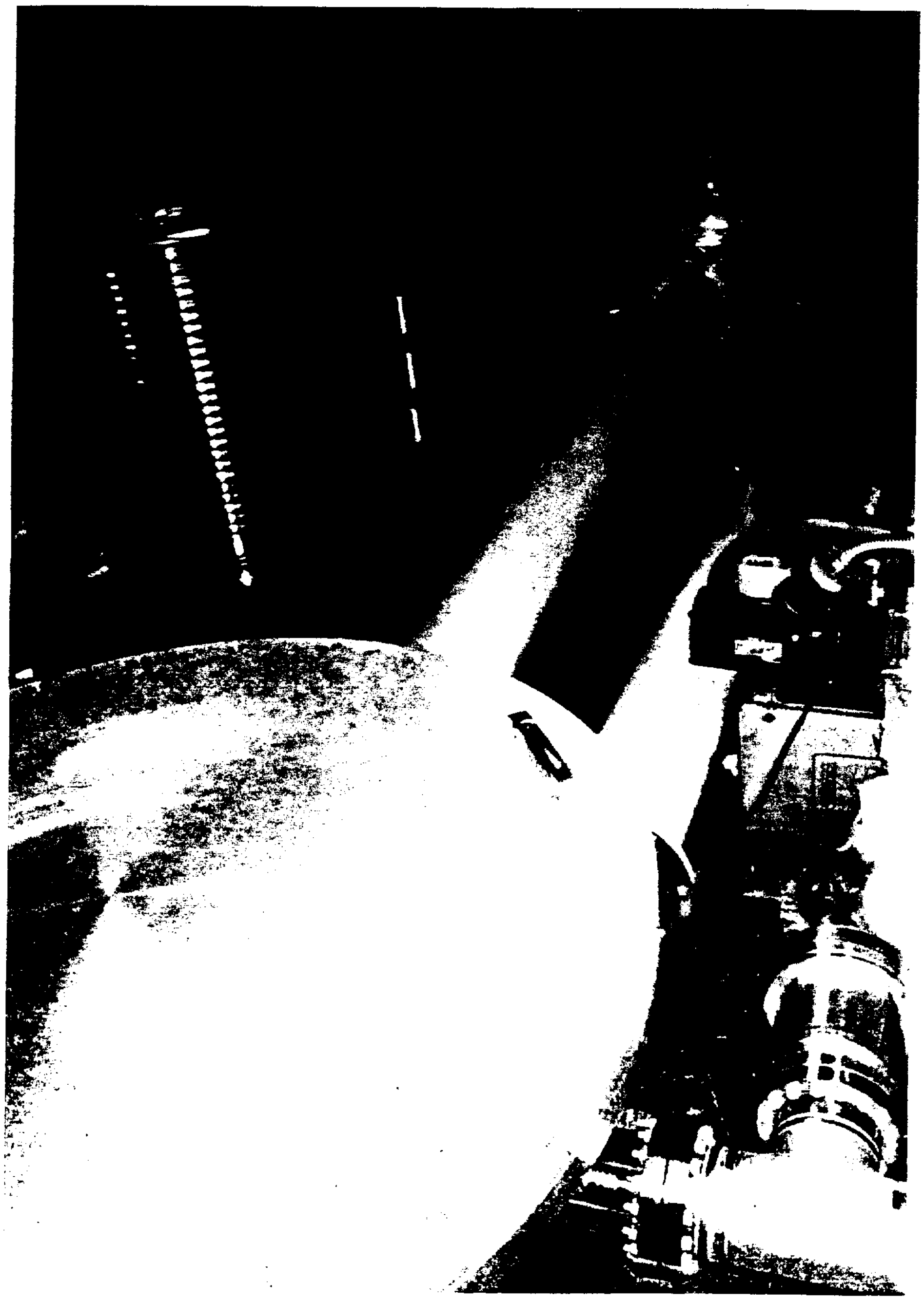
$$f=\frac{1}{2\pi}\sqrt{\frac{mgd}{I}}=2.0\,[\mathrm{Hz}]$$



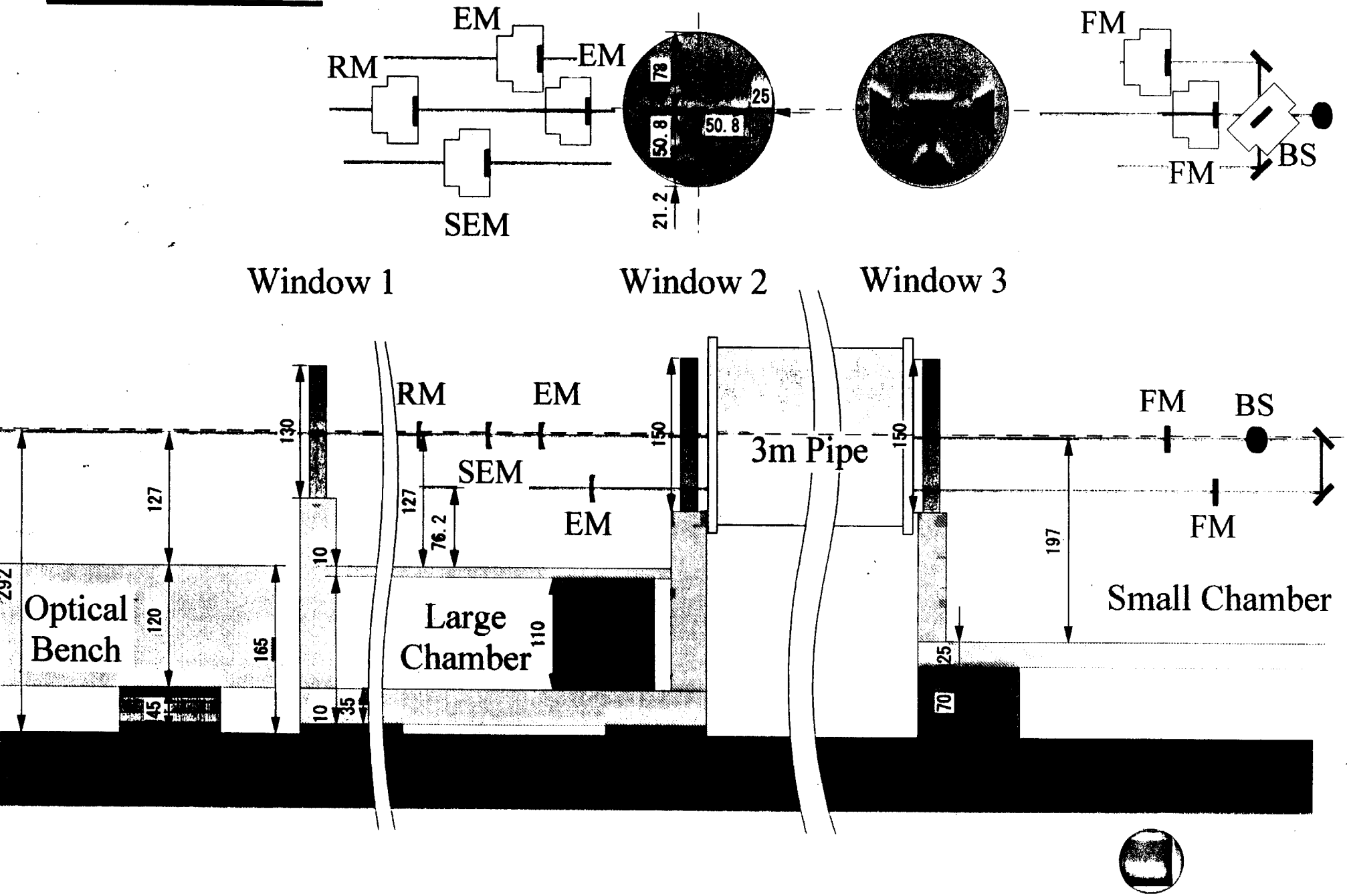
Yaw

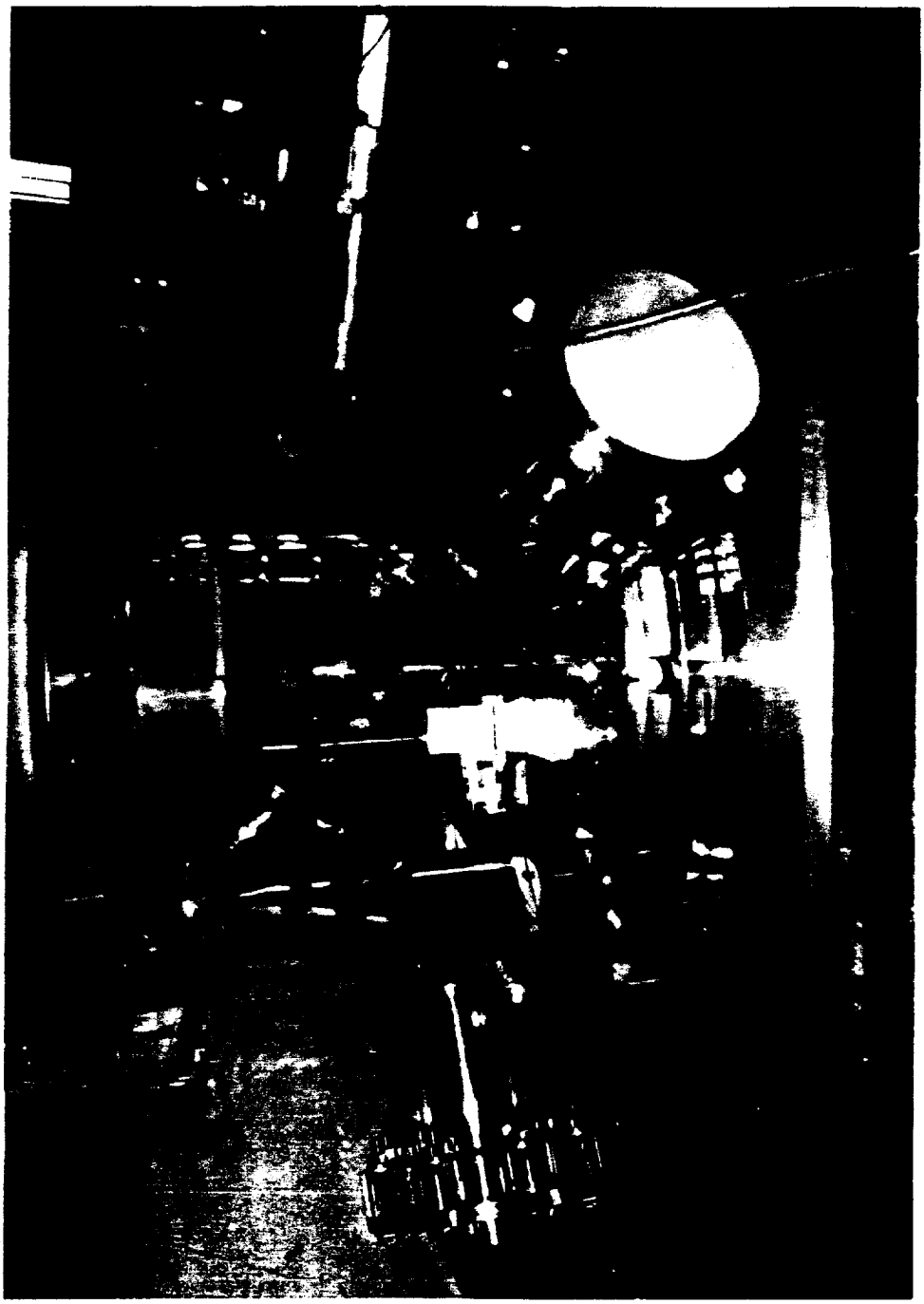
$$f=\frac{1}{2\pi}\sqrt{\frac{mgab}{4Ih}}=1.5\,[\mathrm{Hz}]$$

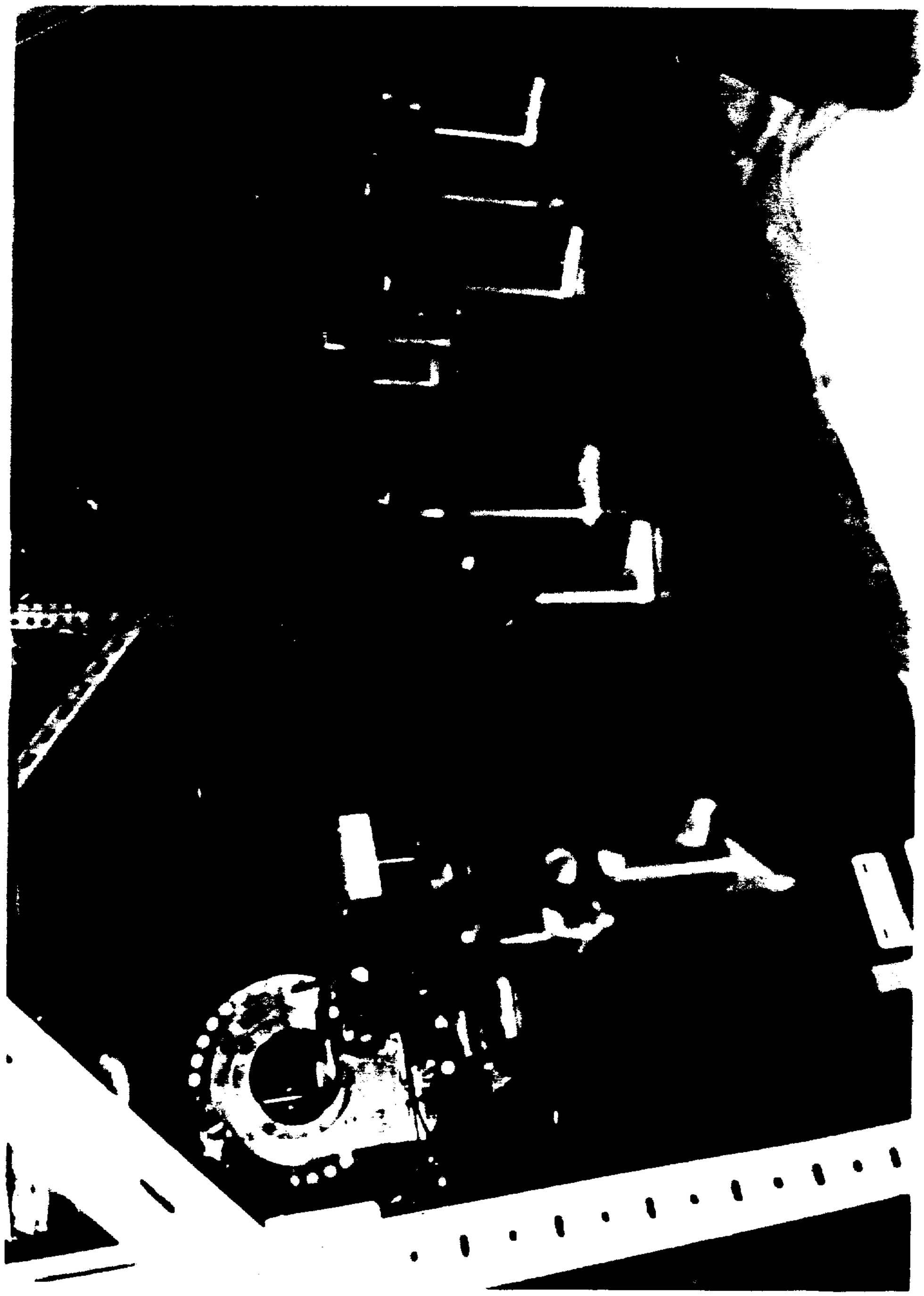




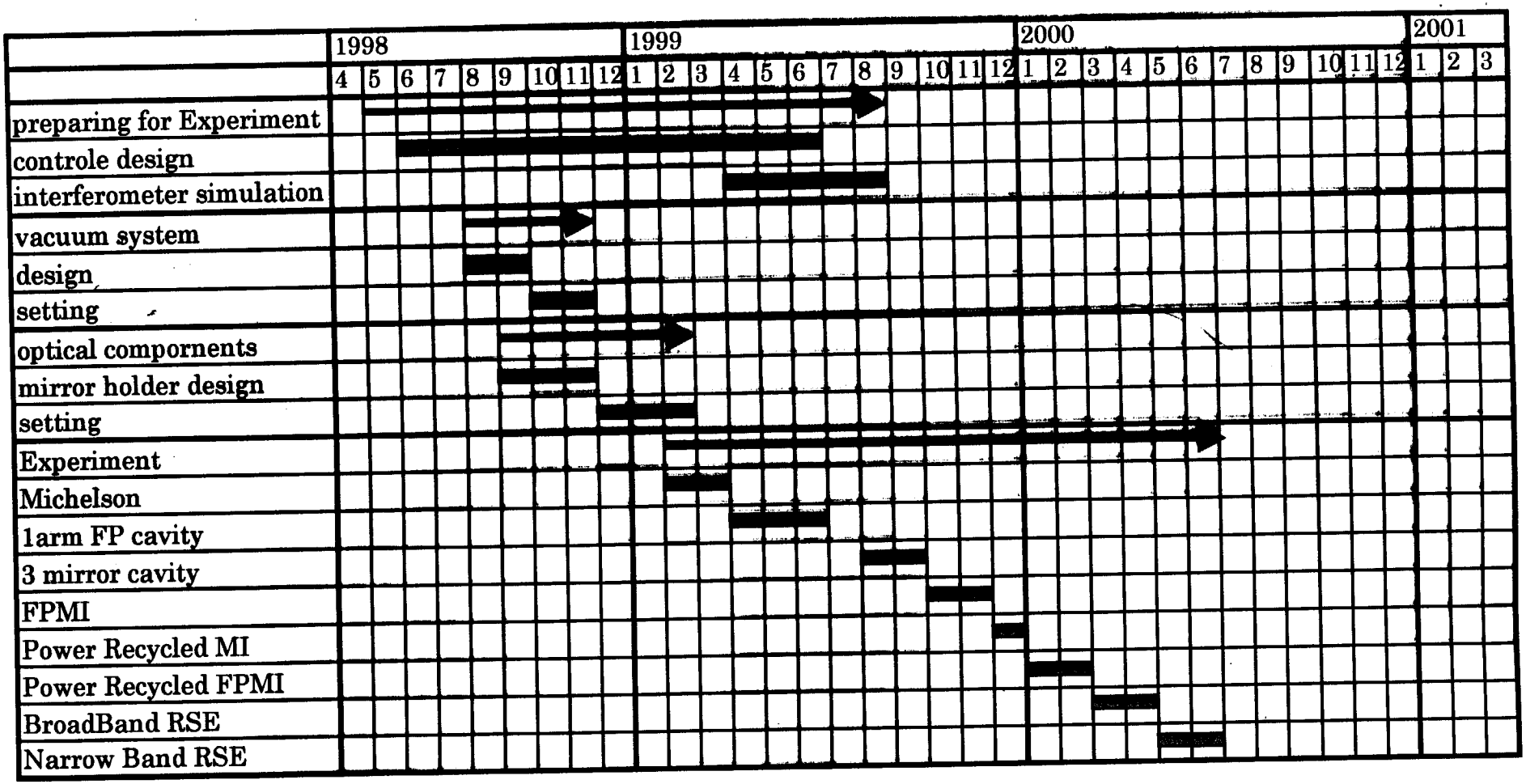
Beam Height


EM
RM
EM
SEM
78
25
50.8
50.8
21.2
FM
FM
BS
Window 1
Window 2
Window 3
RM
EM
SEM
EM
3m Pipe
FM
BS
FM
Optical Bench
Large Chamber
Small Chamber
130
127
292
120
165
10
10
35
45
127
76.2
150
150
110
197
25
70





Resonant Sideband Extraction Experiment Plan



Theoretical work

- We improved "Twiddle".
- We are investigating the signal extraction method using one modulation.
- We are investigating a possible configuration which gives the peak of the narrow-band case above the corner frequency of the broad-band one.

Experimental work

- Simple Michelson was locked by small pendulum system.
- We are trying to lock a single FP cavity. The small pendulum systems have still high Q for pitch and yaw motion. We need more damping.
- We will purchase very low loss mirrors from REO.

Note 1, Linda Turner, 08/17/99 08:09:24 PM
LIGO-G990079-22-M