UF LIGO group

- Five faculty (Mitselmakher, Avery, Reitze, Tanner, Whiting), 1 research scientist, 4 postdocs, 2 grad. students, 2 u.g. students.

- Input optics.
  - ››Caltech subcontract.
  - ››Beam expansion, RF modulators, mode cleaner, mode matching.

- Advanced LIGO.
  - ››Dual recycling tabletop experiment.
  - ››Noise and data analysis.
  - ››Interferometer modeling and simulations.
  - ››~~Materials studies.~~

LIGO Livingston

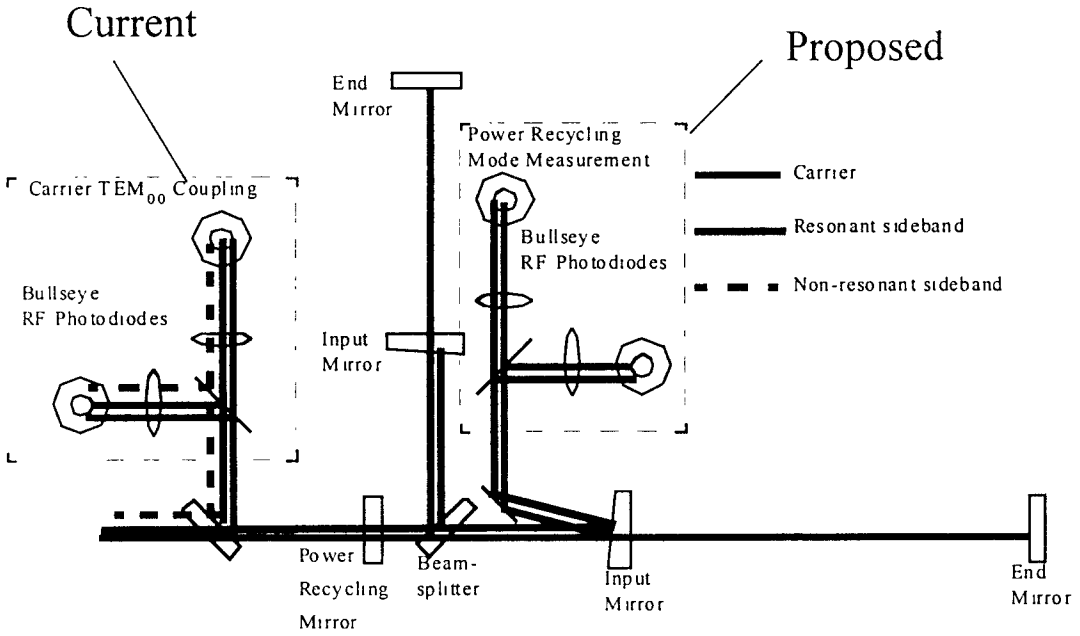
- From the beginning, involvement in the experiment has been a goal of UF LIGO group.

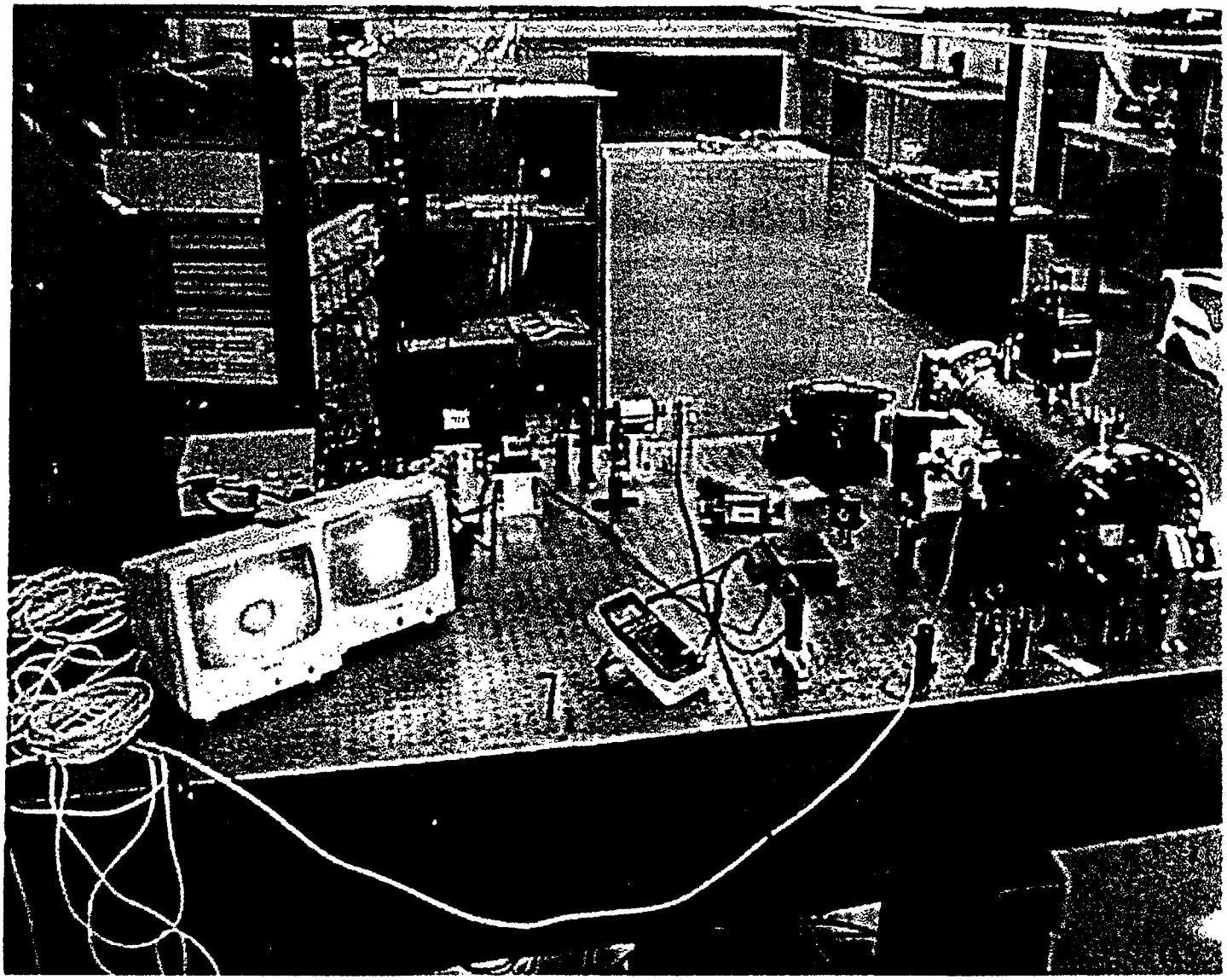
- Request:
  - ››50% supprt for 2 UF scientists (term appointment) at LLO.
  - ››To begin August 1999.
  - ››To conduct advanced LIGO research at the site.

- LIGO laboratory.
  - ››Would provide the other 50%. (Already committed.)
  - ››To support IOO and other laboratory operations.

Research program

- Bulls-eye mode measurement of coupling to Recycling cavity.
  - ››Pickoff within the recycling cavity.
  - ››Look at build-up of non TEM_{00} light in the cavity.
  - ››Extension of current design for measuring coupling from the IOO to the core optics.





Suspension characterization

- G. Gonzales, Penn State is the lead person; we collaborate with her.
- Takes advantage of the mode cleaner as an isolated cavity.
- Permits characterization of seismic isolation, non-gaussian noise.
- Needed for design requirements, design parameters, of advanced LIGO interferometer.
- Also provide data for the UF noise characterization/data analysis people.

High-power testing

- IOO design project required high power (10 W) testing of EOM, AOM, FI, windows, *etc.*
  - ››Used 10 W CW Nd:YAG laser loaned from Caltech.
  - ››Developed methods for measuring thermal lensing, depolarization, rf amplitude modulation, optical absorption.
  - ››Also did extended-time high-power treatment for damage studies.
- Propose to move the UF high-power testing lab to Optics Lab at Livingston.
  - ››Expertise (Sany Yoshida) probably would move there.
  - ››Continued testing of components is prudent.
- Upgrade to 100 W a future possibility.
  - ››Not at present, though.

EOM Transmission

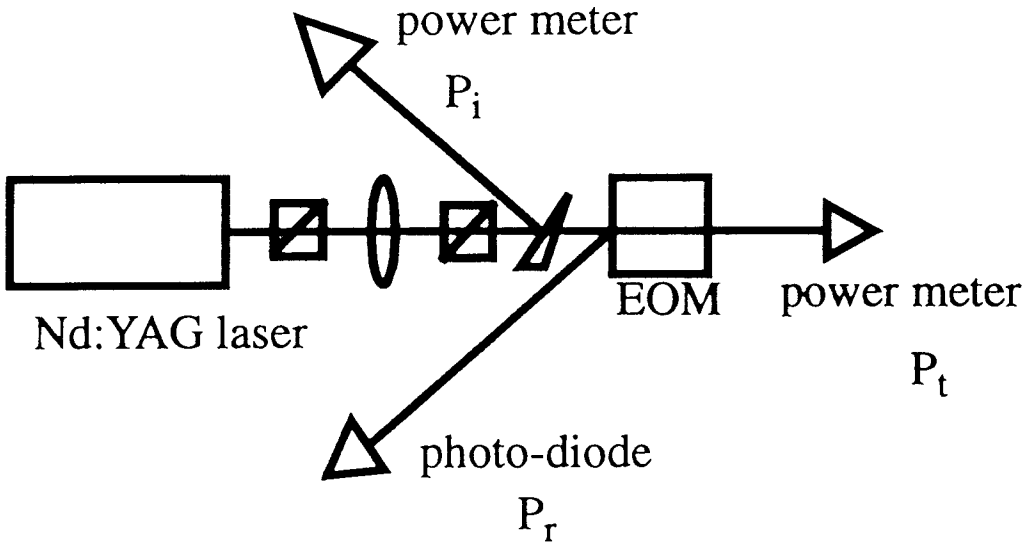
Initial transmission:

$T = P_t / P_i = 95.3\% \pm 1\%$

Transmission after 4 days of exposure

(> 8 hours exposure/day at max YAG power)

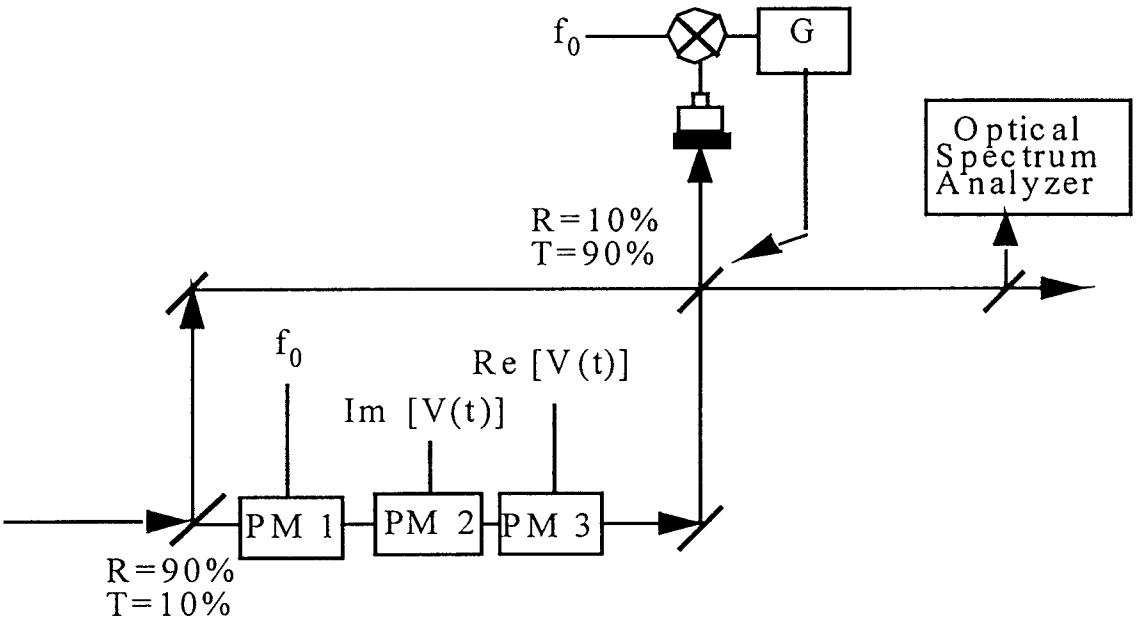
$T = P_t/P_i = 95.8\% \pm 1\%, \quad R = P_r/P_i = 0.2\% \pm 0.05\%$



Experiment ongoing: Measurement of wavefront underway

Phase modulation techniques

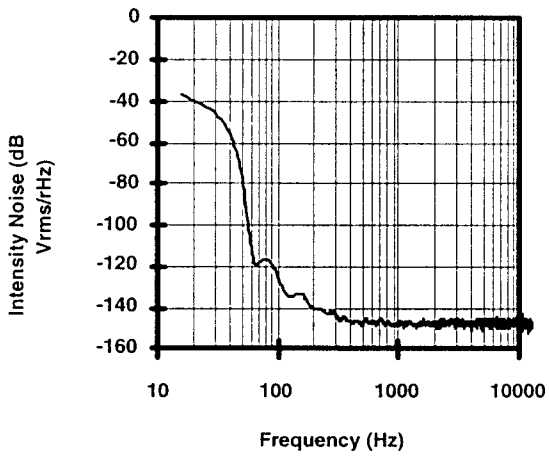
- Advanced LIGO will have 100 W of laser power.
- How to apply rf sidebands without thermal problems in EOMs?
  - ›› Mach-Zender interferometer



  - ››Combine with amplitude/phase modulation to get only first-order sidebands.

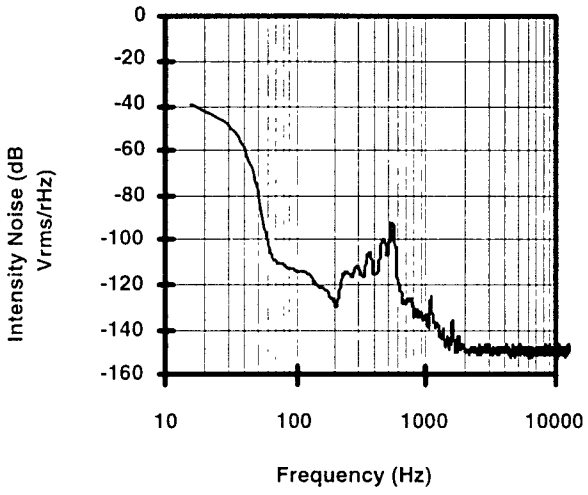
RF Modulation (con't.)

- Intensity noise: Pre-stabilized laser

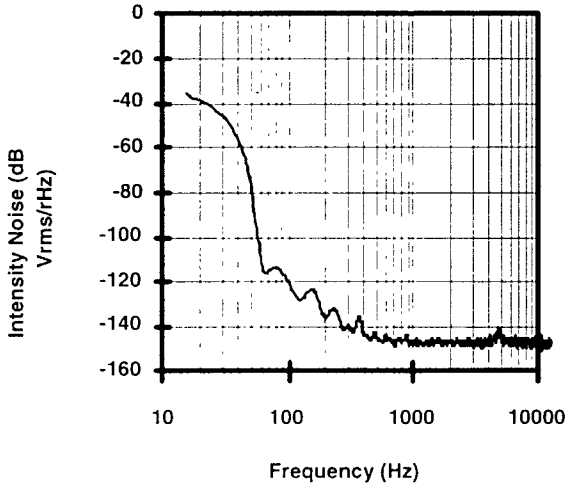


- Intensity noise: after modulation

open loop



closed loop

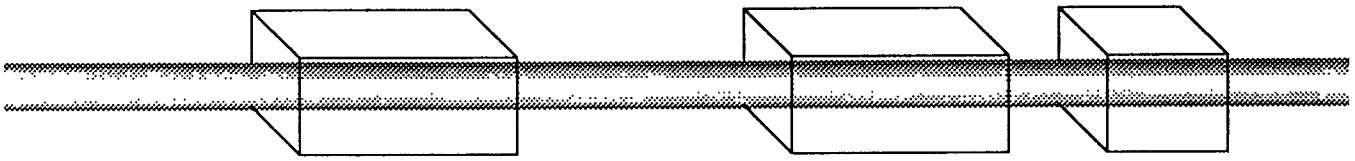


Complex Optical Modulation

$$E = e^{-i(\omega t + f(t))}$$

$$f(t) = \phi(t) + i\alpha(t)$$

Phase Modulator Amplitude Modulator

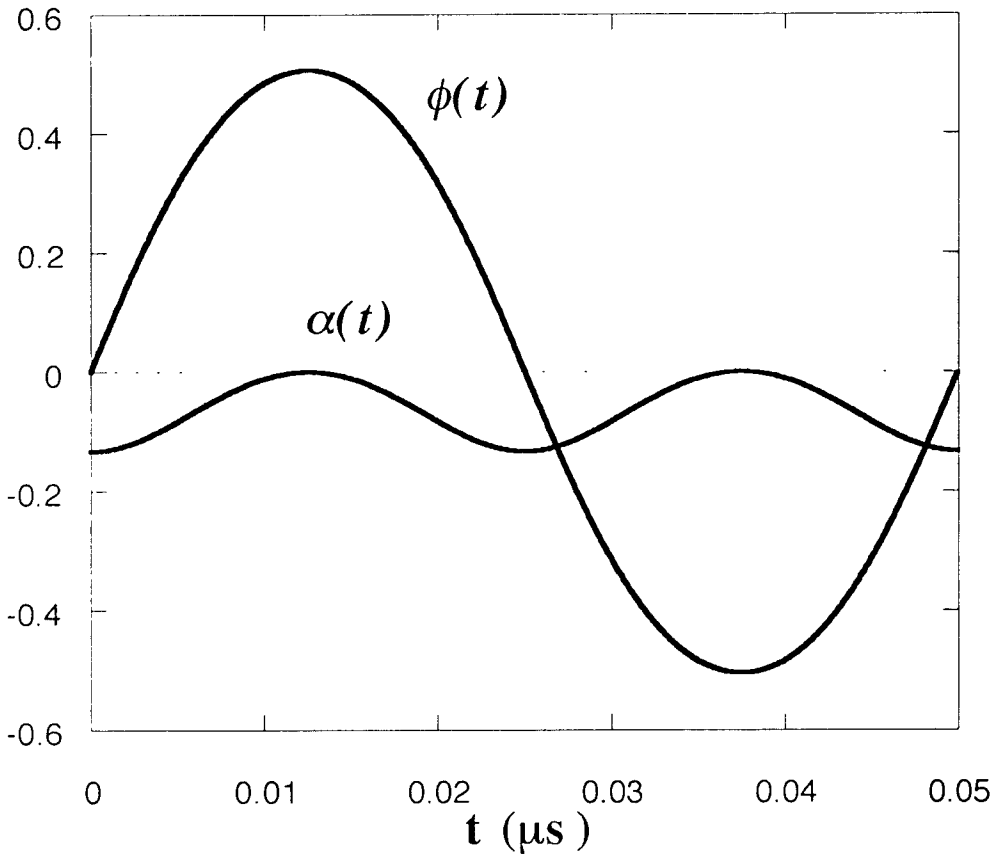


$\phi_1(t)$ $\phi_2(t) + i\alpha(t)$

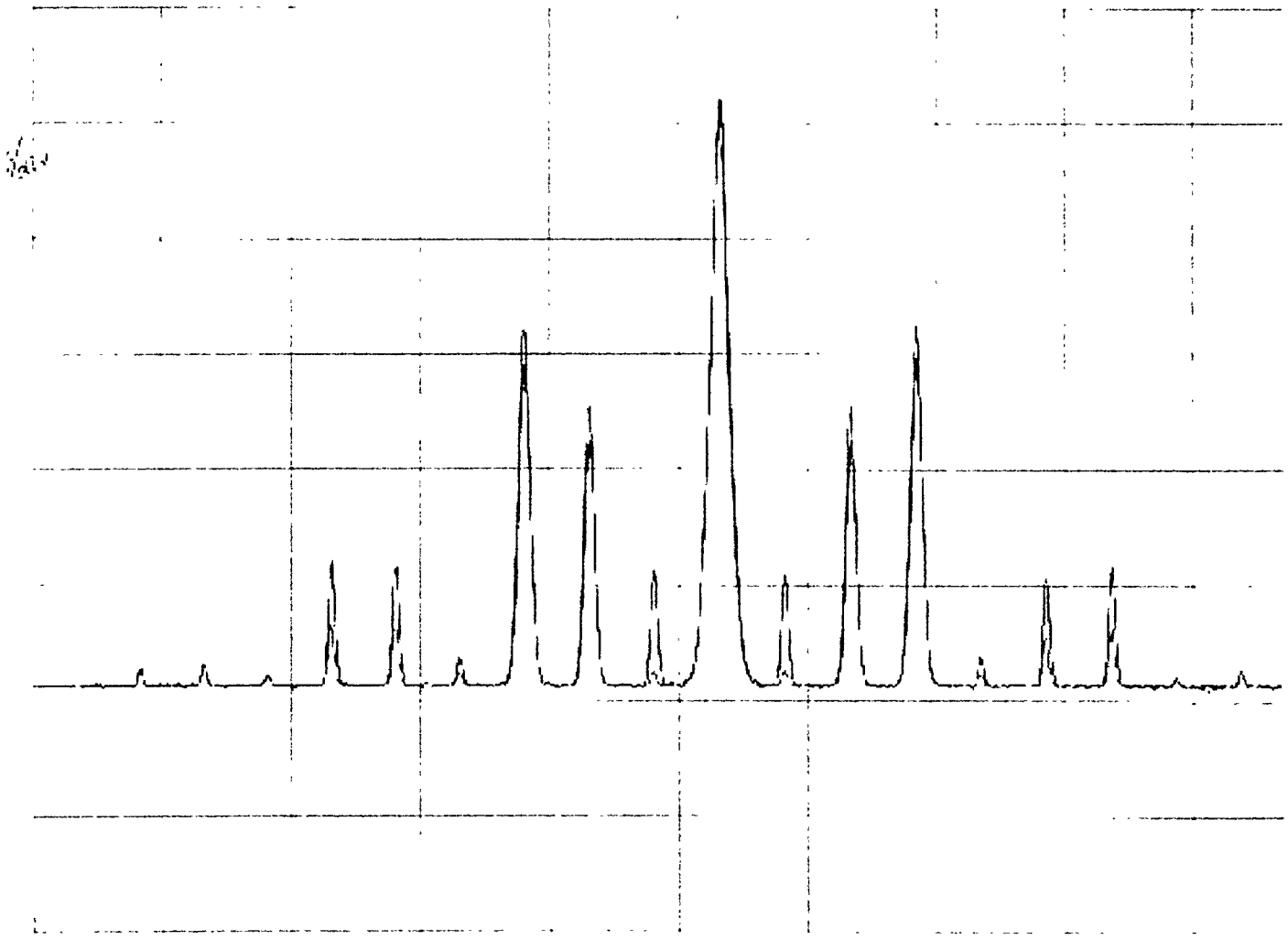
$$\phi(t) = \phi_1(t) + \phi_2(t)$$

Single Frequency Sidebands

Waveforms of the phase and amplitude modulation



Complex modulation



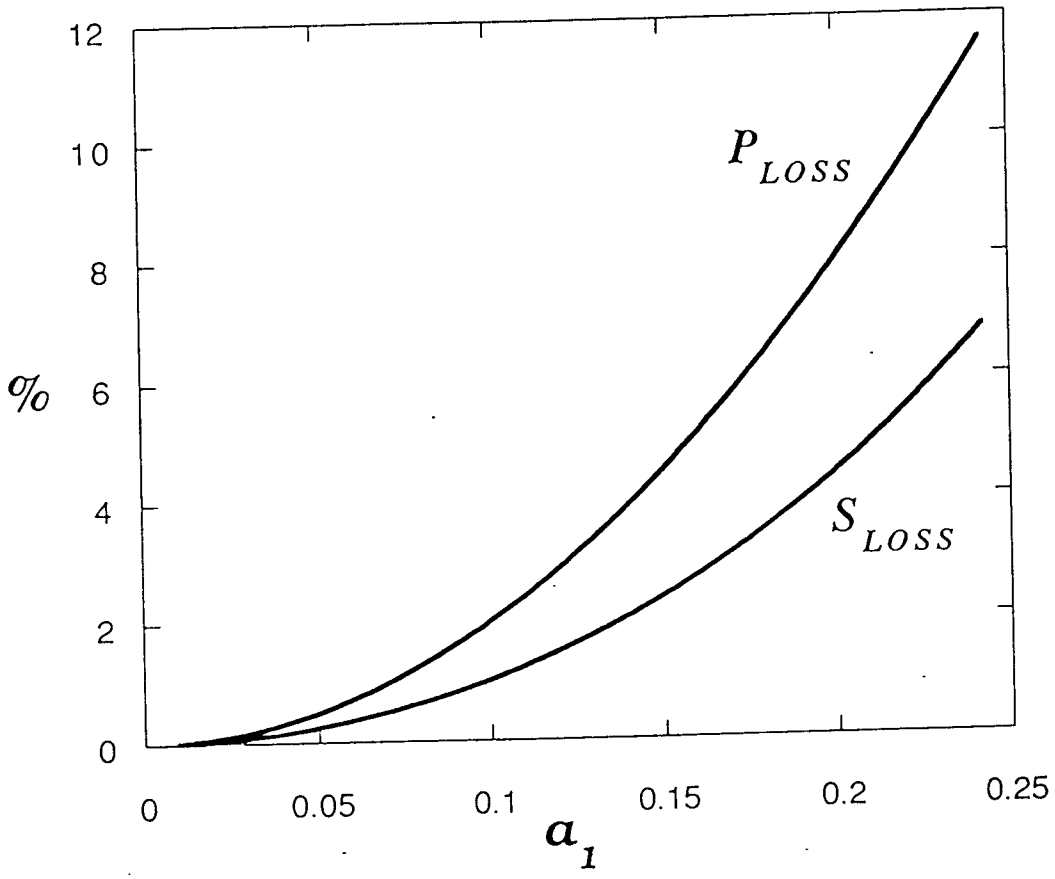
- Two arbitrary function generators; 30 Mhz range.
- Blue: phase modulation only; Red: complex modulation

UF LIGO

Single Frequency Sidebands

Power Loss and Signal Loss

$\Gamma = 0.5$



(relative to input field amplitude)

Summary

- UF is interested in participating *at the site* in LIGO experiments and operations.
  - ››Provides quick access to data.
  - ››Provides input to simulations, through participation in "machine studies."
- The Livingston detachment would provide links for the UF group.
  - ››Encourage travel to---and time spent at---the site.