

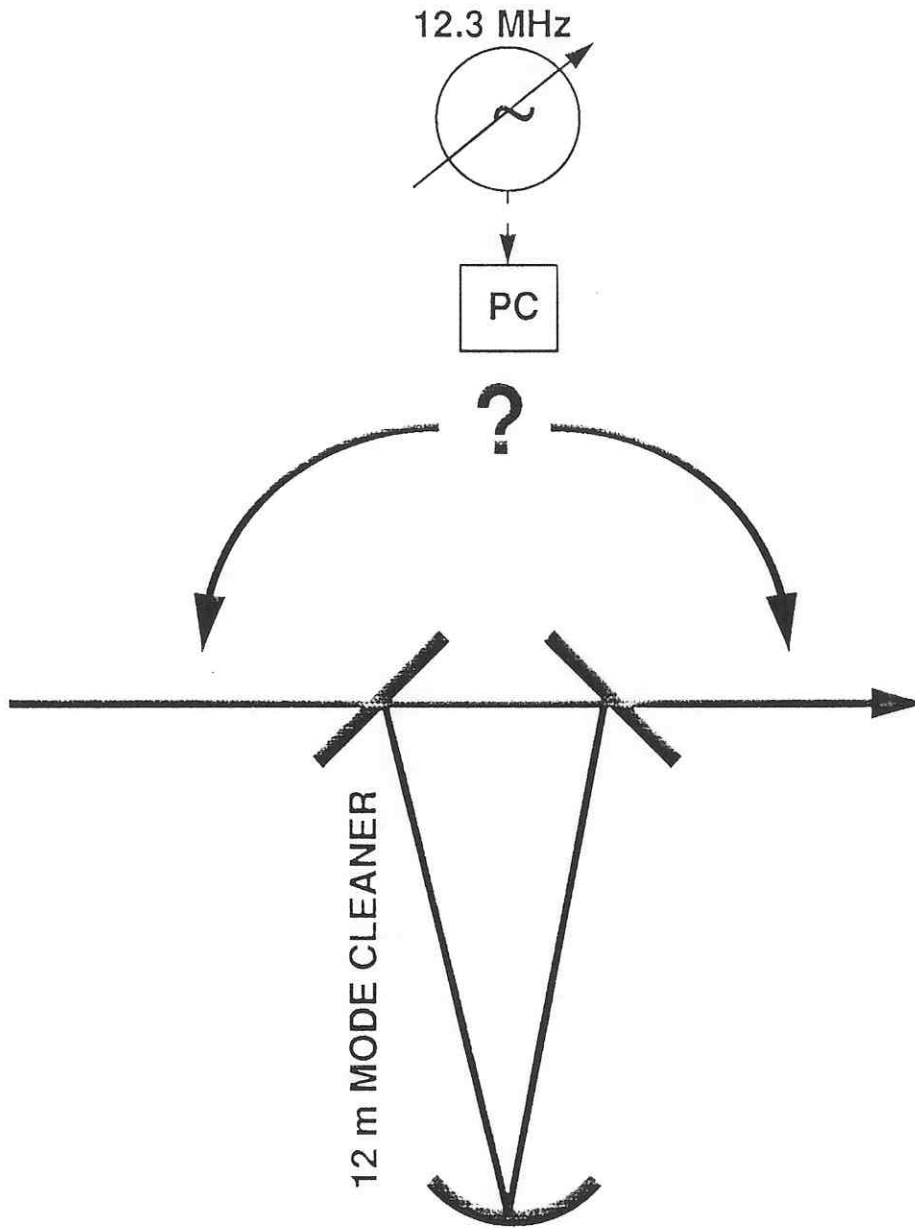
Where should the Pockels Cell be?

Alex Abramovici

LIGO-G950048

Where should the Fockels Cell Be?

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Things One Worries About

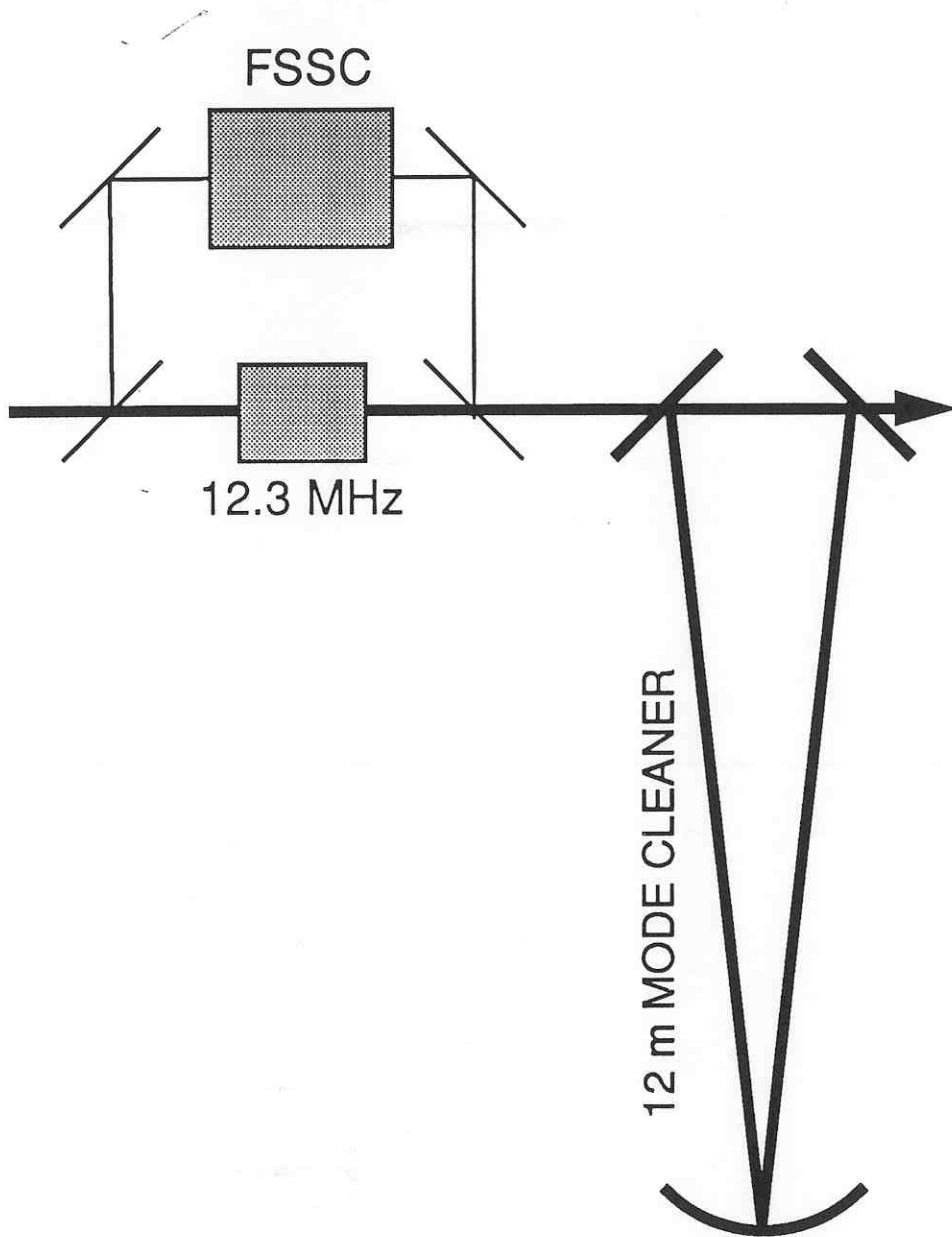
Pockels cell before mode cleaner

- Low frequency beam jitter causes low frequency AM of the 12.3 MHz phase modulation, due to electric field gradient in Pockels cell
- Electric field gradient in Pockels cell causes 12.3 MHz beam jitter, which is turned into RFAM when suppressed by mode cleaner

Pockels cell after mode cleaner

- Electric field gradient in Pockels cell causes 12.3 MHz beam jitter, which is turned into frequency noise
- Electric field gradient in Pockels cell causes 12.3 MHz beam jitter, which is turned into RFAM when suppressed by recycling cavity
- Beam distortion by Pockels cell, with no mode cleaner to suppress it

Location of 12.3 MHz PC: Part of a Bigger Question



12.3 MHz Beam Jitter from Pockels Cell After Mode Cleaner: Crude Scaling to LIGO

1. Starting point:

- No noise contribution to the 40 m interferometer spectrum is traced to the RF Pockels cell located after the mode cleaner.
 - Assume that possible adverse effect of 12.3 MHz jitter is related to beam jitter-to-phase noise conversion.
2. For LIGO, phase sensitivity will be enhanced $\sim 100x$, potentially increasing susceptibility to 12.3 MHz jitter by the same factor.
 3. LIGO arm cavity finesse will be $30x$ lower than in Mk II, increasing the conversion of jitter to frequency noise $30^2 \sim 10^3x$.
 4. The recycling cavity will suppress beam jitter $\sim 30x$.
 5. Beam jitter is converted to phase noise only in the presence of length control system gain. The unity gain frequency in LIGO will be $\sim 100x$ lower than in Mk II. Thus, gain at 12.3 MHz can easily be reduced $\sim 10^4x$, compared to Mk II.

Bottom line:

With RF Pockels cell after the mode cleaner, phase noise effects in LIGO due to 12.3 MHz beam jitter can be made $\sim 3x$ smaller than in Mk II, relative to shot noise limited phase sensitivity.

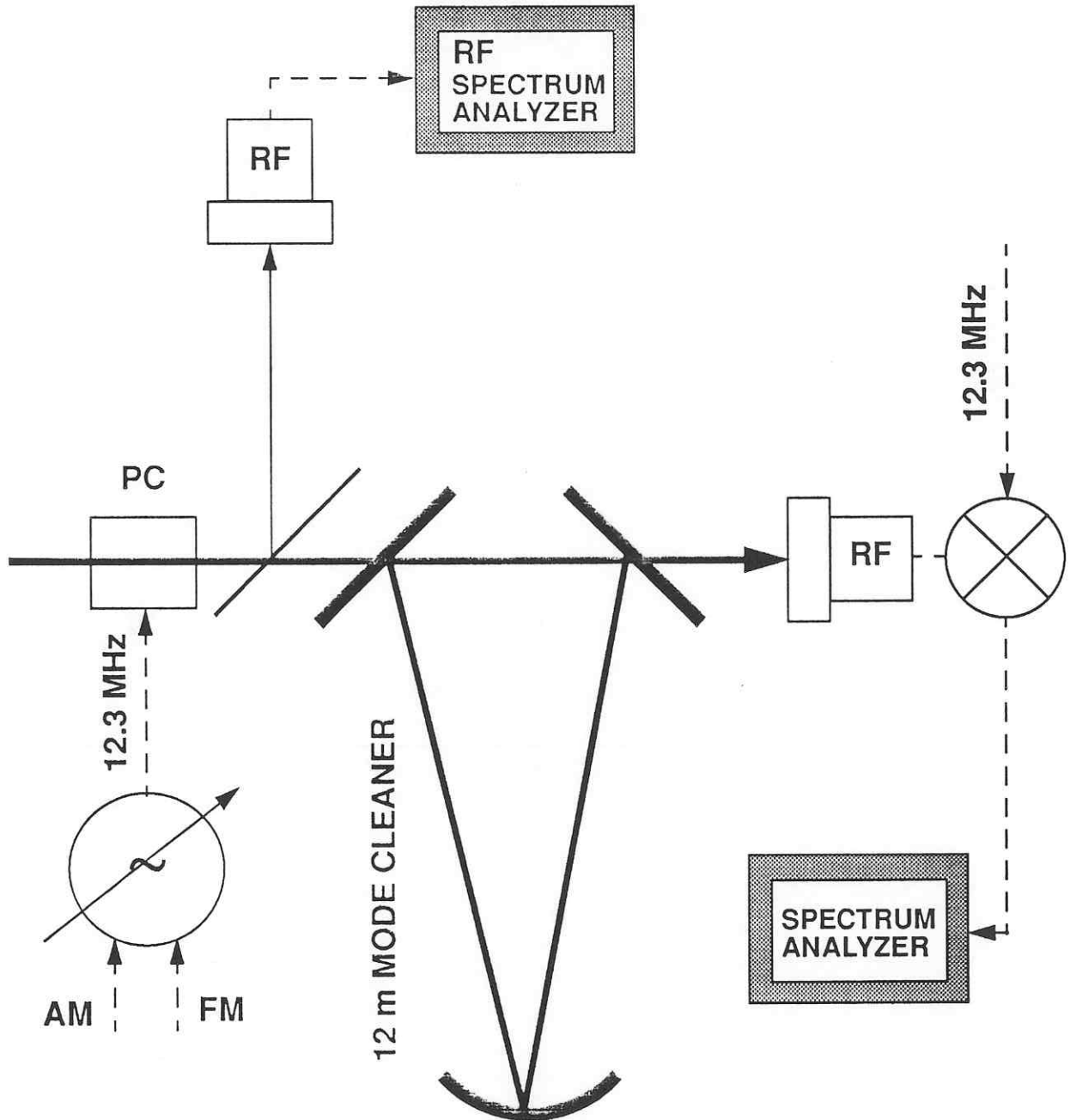


Personal View on 12.3 MHz Pockels Cell Location

1. Set the default Pockels cell location after the mode cleaner.
2. If new data from the 40 m lab, new theoretical insights or experience with LIGO demand it, relocate Pockels cell between the laser and the mode cleaner.



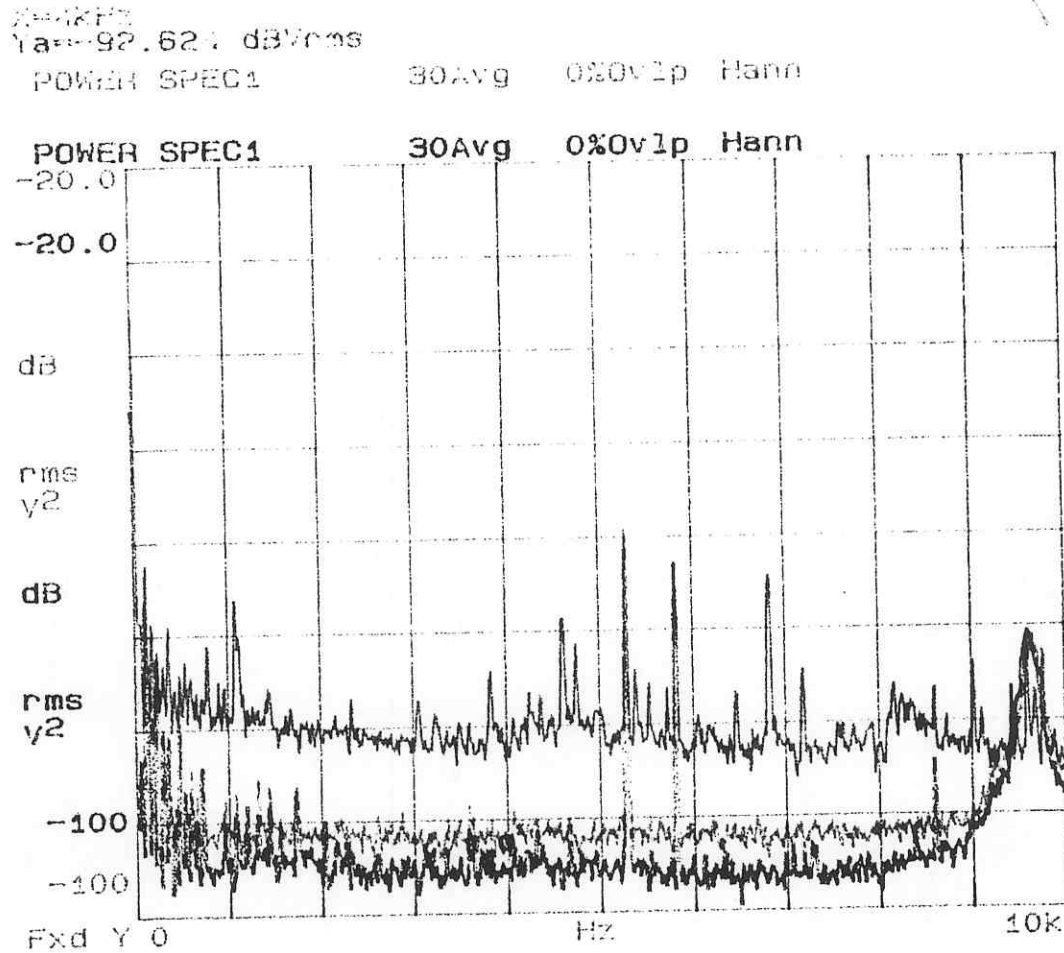
RFAM Test Arrangement



25-Feb-95, 17:15

Analyzer diode demodulated RF output

Components & arrangement: Same as 17:00



• range: RF AM, same as red trace at 17:00

• blue: shot noise, 200 mV flash light.

• red: dark noise.

→ lower off

28-Feb-95 15:00

RF PHOTODIODE : RF OUTPUT

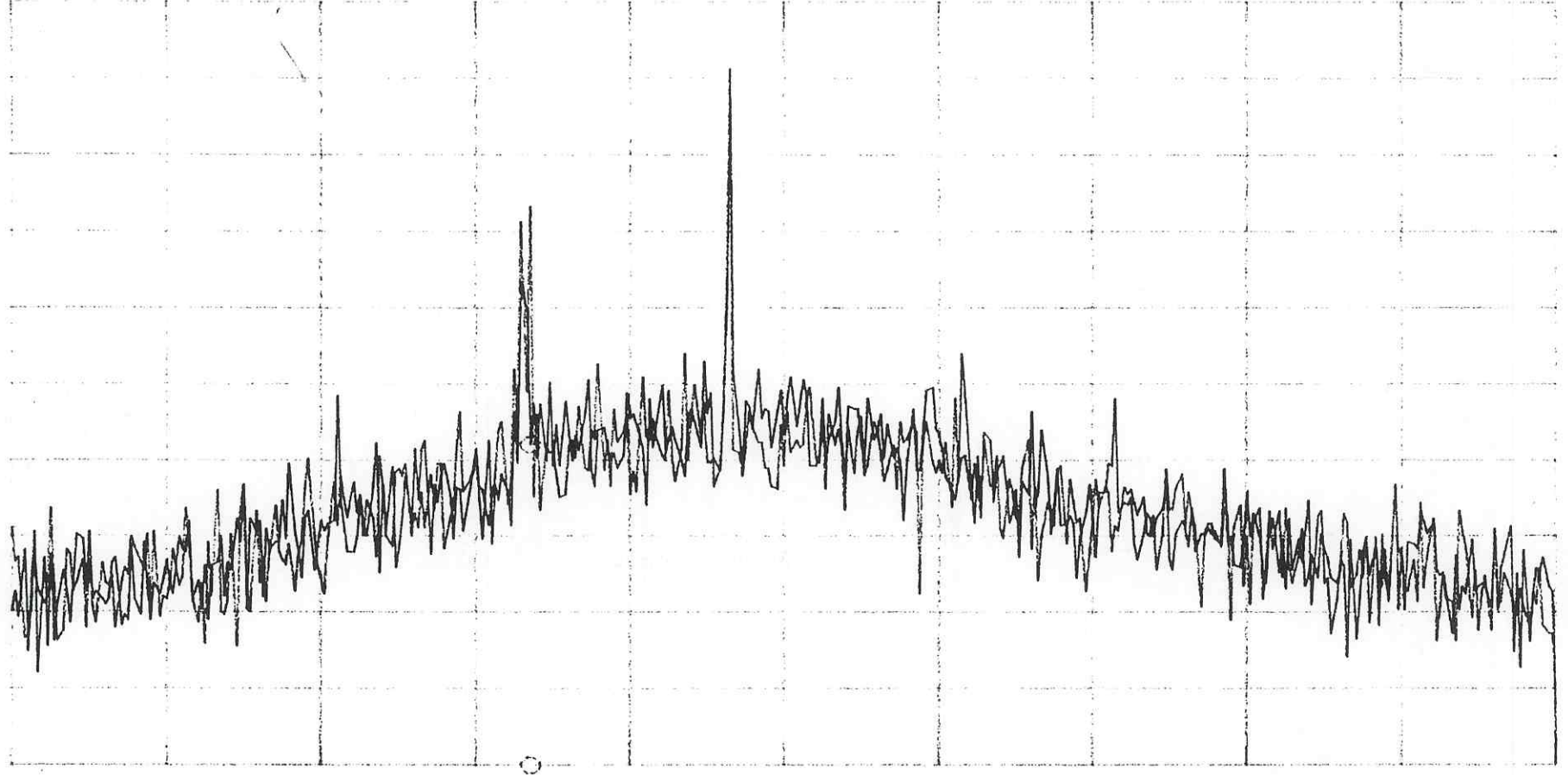
- Red: 290 mV of green light
- Blue: 290 mV of flash light

Note: PD bandwidth increased by replacing 10 k PD load w. 1.1 k load

SPECTRUM

A: REF B: REF
 -66.00 -66.00
 [dBm] []

MFR 0.50000000 Hz
 MAG -83.3893 dBm
 MAG



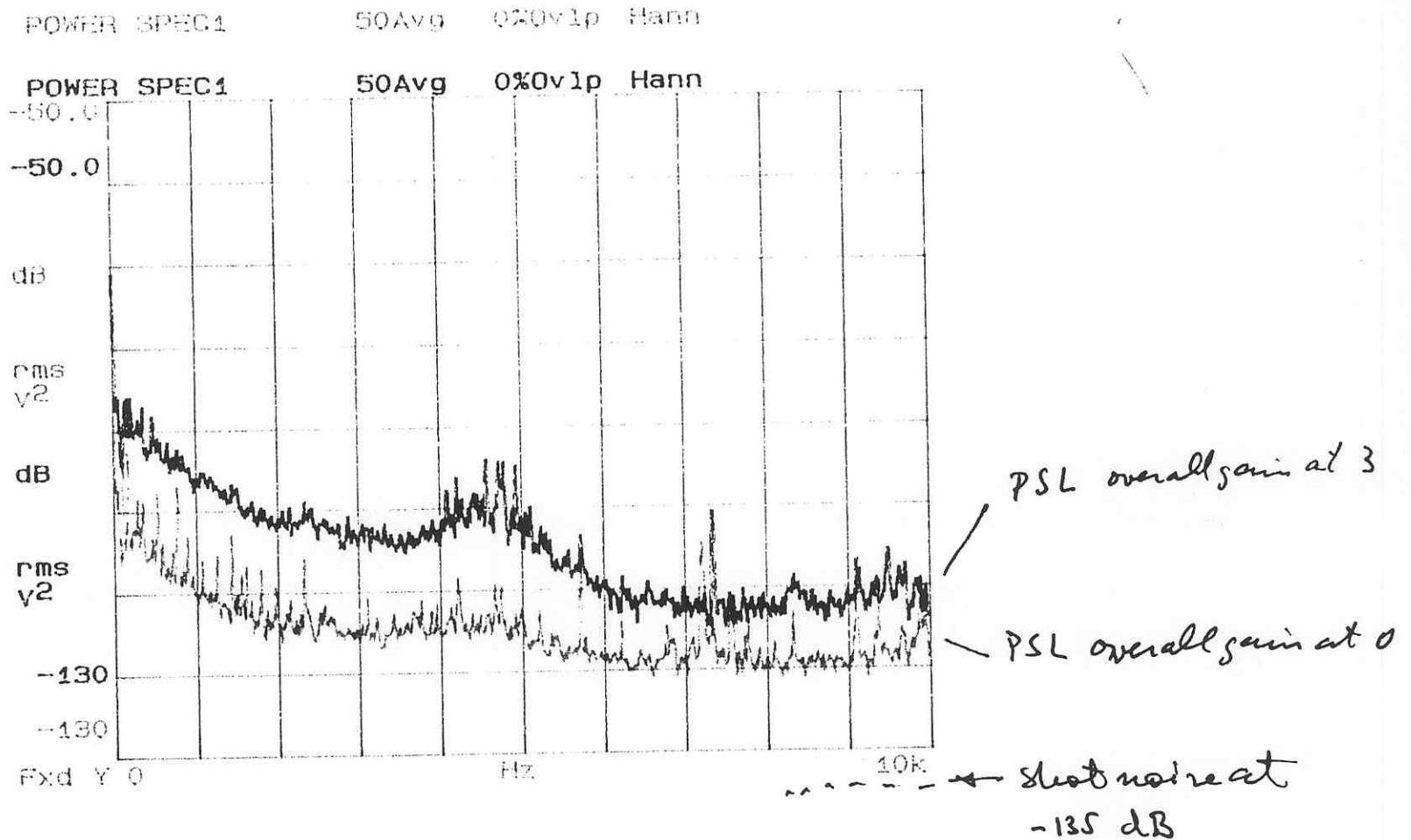
DIV DIV START 10 000 000.000 Hz
 3.000 3.000 STOP 15 000 000.000 Hz
 RBW: 1 KHZ ST: 19.5 sec RANGE: R=-20, T=-10dBm
 RBW= 1 KHZ

21-Feb-95

18:00

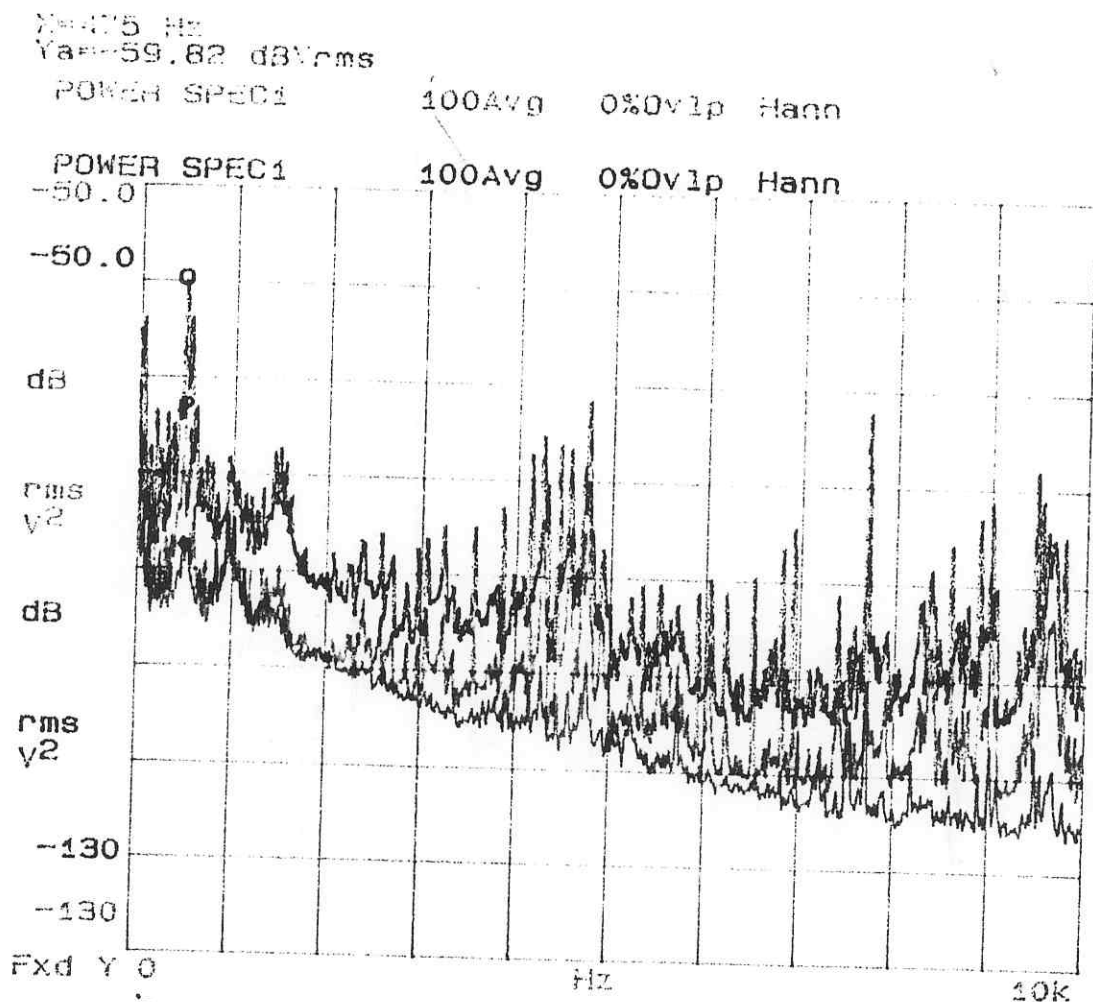
RFAM Measured after mod cleaner: effect of healthy PSL servo (Set-up: as in 20 Feb, 21:00)

Note: bypass on in MC servo.

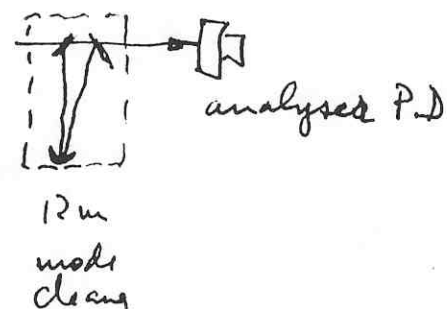


18-10-75

Demodulated RF signal from ~~modulator~~
(companion to trace at 17:20, direct diode illum).



- Red: $f_m = 12.335 \text{ MHz}$
 - Blue: $f_m = 12.3347777 \text{ MHz}$
 - Orange: $f_m = 12.33467 \text{ MHz}$
- Minimum RFAM
measured with this
set-up.



Light level: -200mV

← line corresponding
to 200 mV of
flash light.