IN: Yang, J.C., et al., Editors, Solid Propellant Gas Generators: Proceedings of the 1995 Workshop, NISTIR 5766, June 28-29, 1995, 173-182 pp, 1995

OXYGEN CONCENTRATION MEASUREMENTS USING DIODE LASERS

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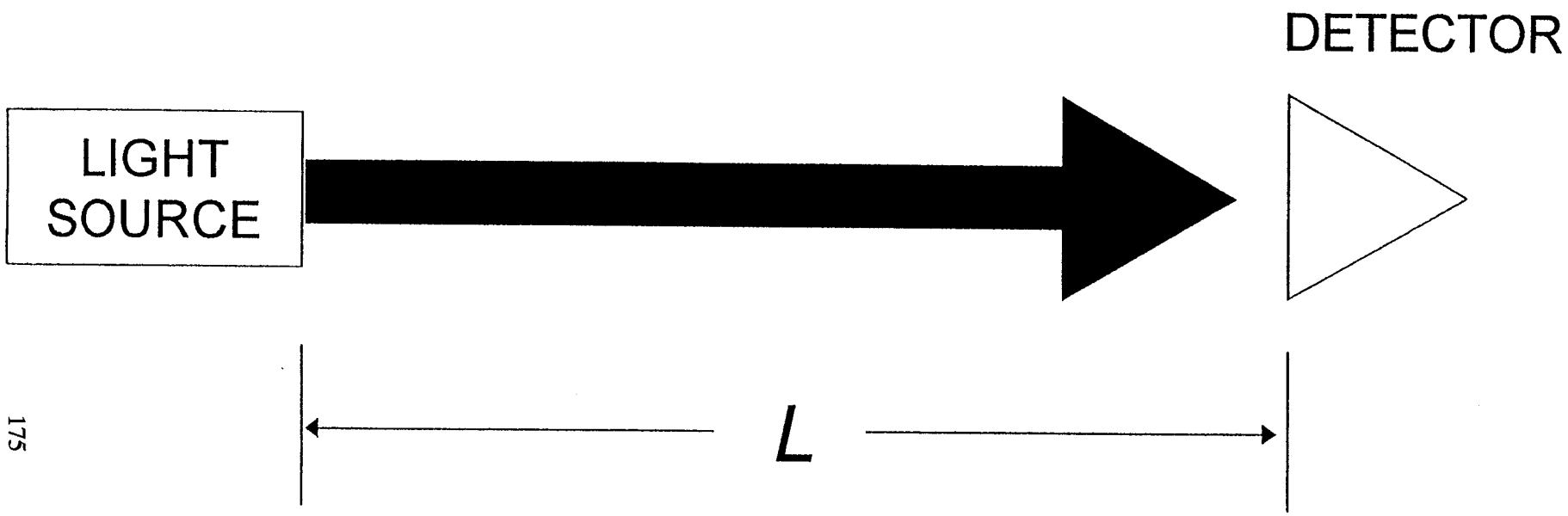
WHY USE DIODE LASERS?

- High selectivity avoids interferences
  - + O_2, CO, CO_2, H_2O, HF, NO, NO_2, HCN, HCl
- High sensitivity
  - + trace gas detection, OR
  - + rapid response
- Remote sensing using fiber optics or open paths
  - + intrinsic safety
  - + probe harsh environments

OPTICAL SPECTROSCOPY

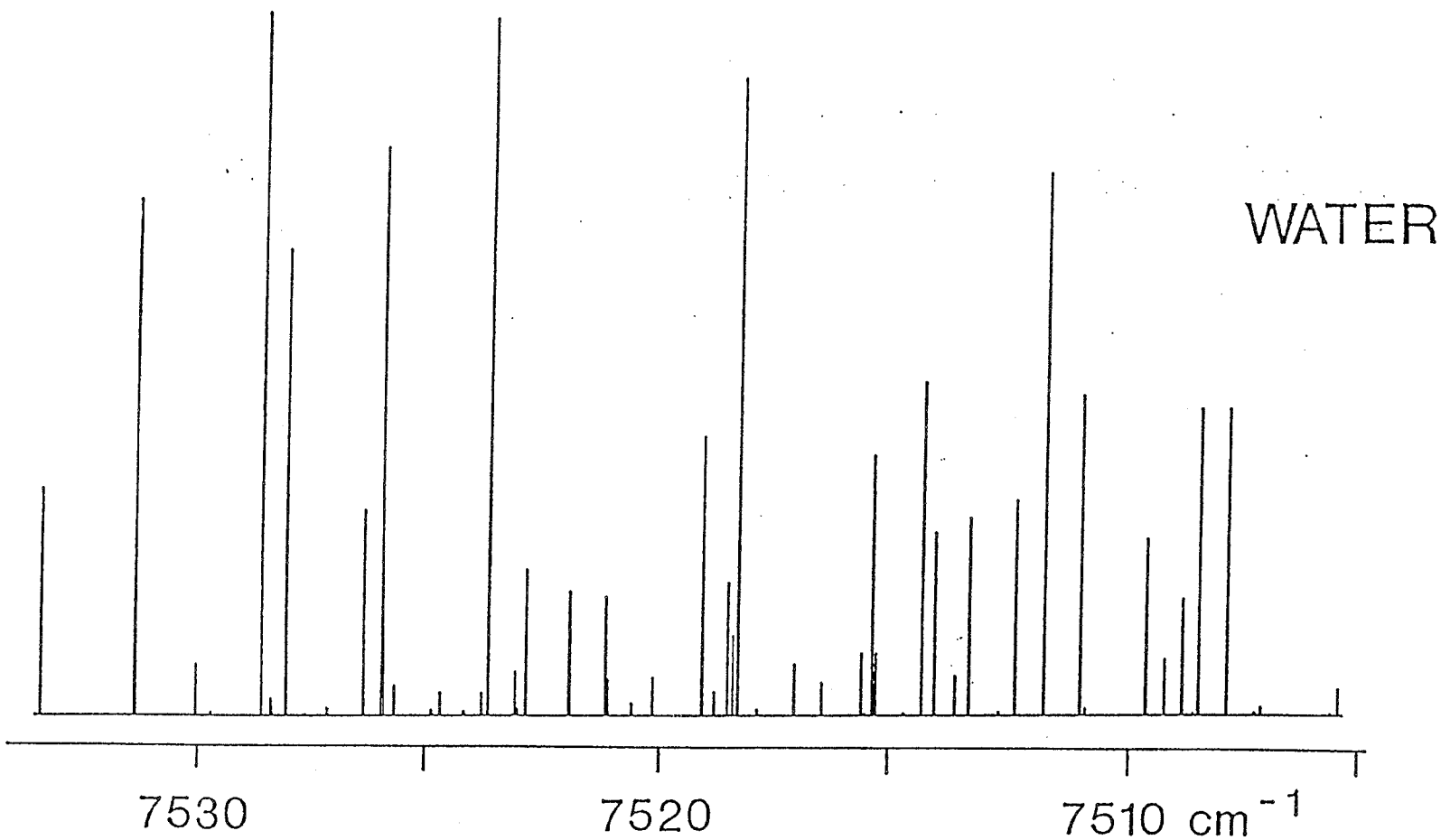


$$\frac{I}{I_0} = \exp(-n\,\sigma L) = \exp(-\alpha)$$

SENSITIVITY DEPENDS ON α_{MIN}

OPTICAL SPECTROSCOPY

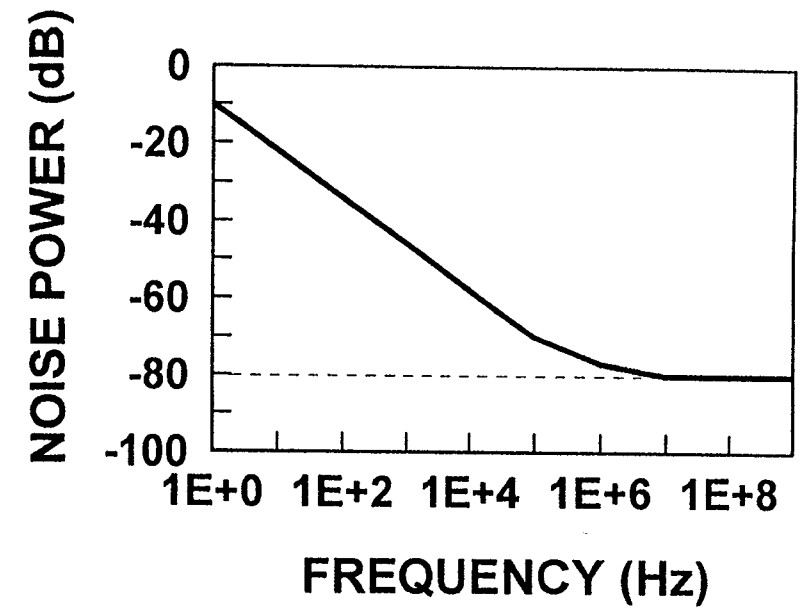
NARROW ABSORBANCE LINEWIDTHS
PROVIDE SELECTIVITY

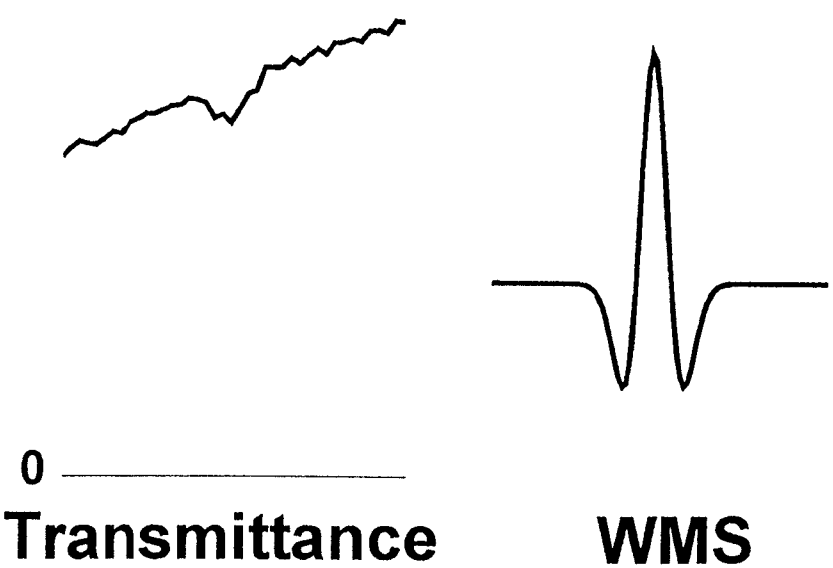


WMS DETECTION

Increase Sensitivity By Shifting Detection Band to High Frequency

Modulate Laser Frequency at *f*, Detect at 2*f*





Advantages of Diode Laser WMS:

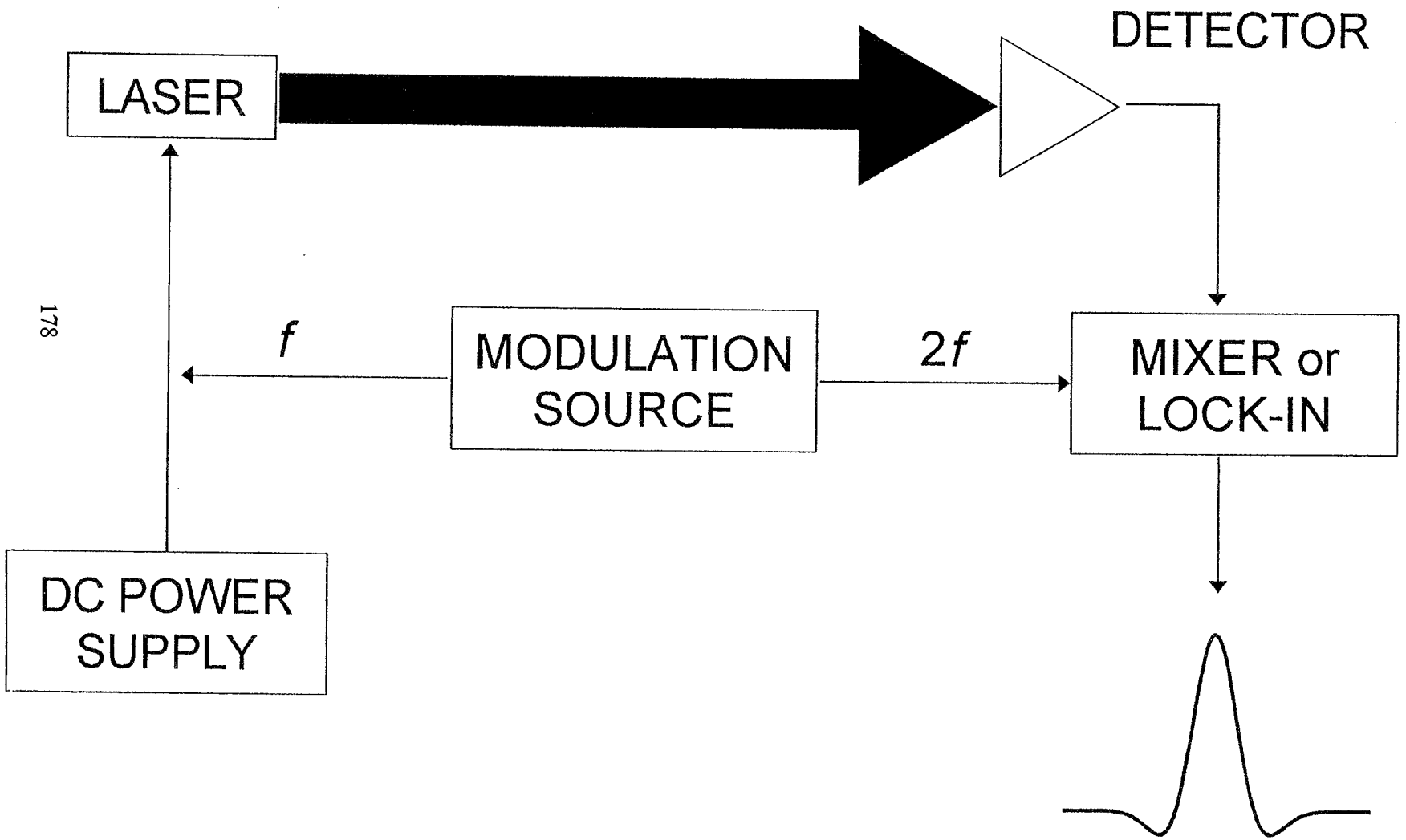
Exceptional Sensitivity $\alpha \sim 10^{-7}$

Selectivity $\Delta\nu \sim .001\ cm^{-1}$

Rugged Solid State Device

Fiber Optic Compatible

WAVELENGTH MODULATION SPECTROSCOPY



GAS DETECTION LIMITS

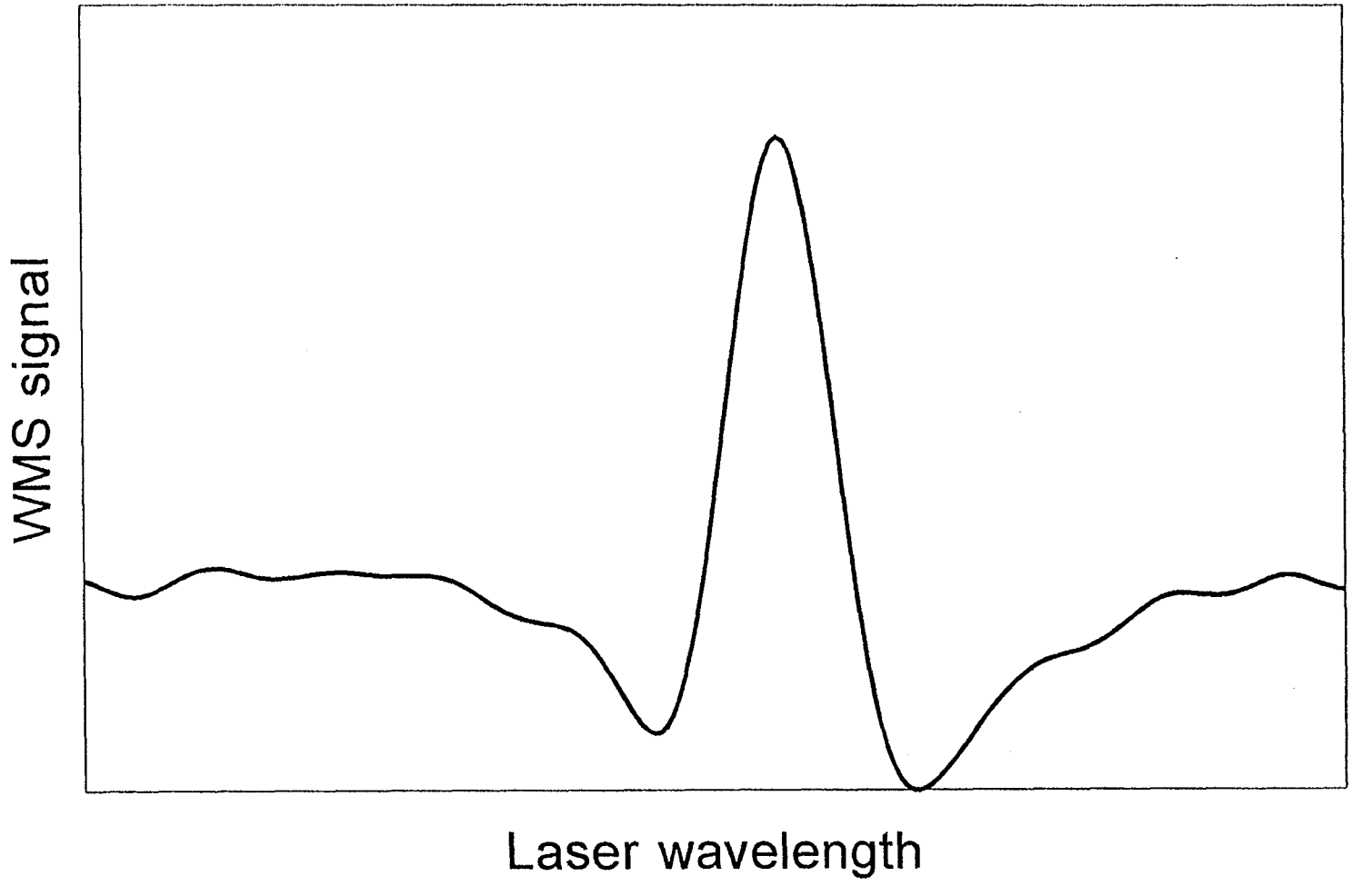
- 10 cm path length & 10 msec response time

GAS	DETECTION LIMIT	LASER WAVELENGTH
O_2	800 ppm	(761 nm)
HF	0.17 ppm	(1321 nm)
CO	275 ppm	(1565 nm)
CO_2	430 ppm	(1602 nm)
HCl	0.75 ppm	(1740 nm)
HCN	25 ppm	(1548 nm)
NO_2	90 ppm	(760 nm)

FIELD APPLICATIONS

- Airborne hygrometer
- Methane fluxmeter
- Microgravity combustion experiments
- Industrial open path monitor

Oxygen in 1 atmosphere air
20 cm optical path
10 msec response time



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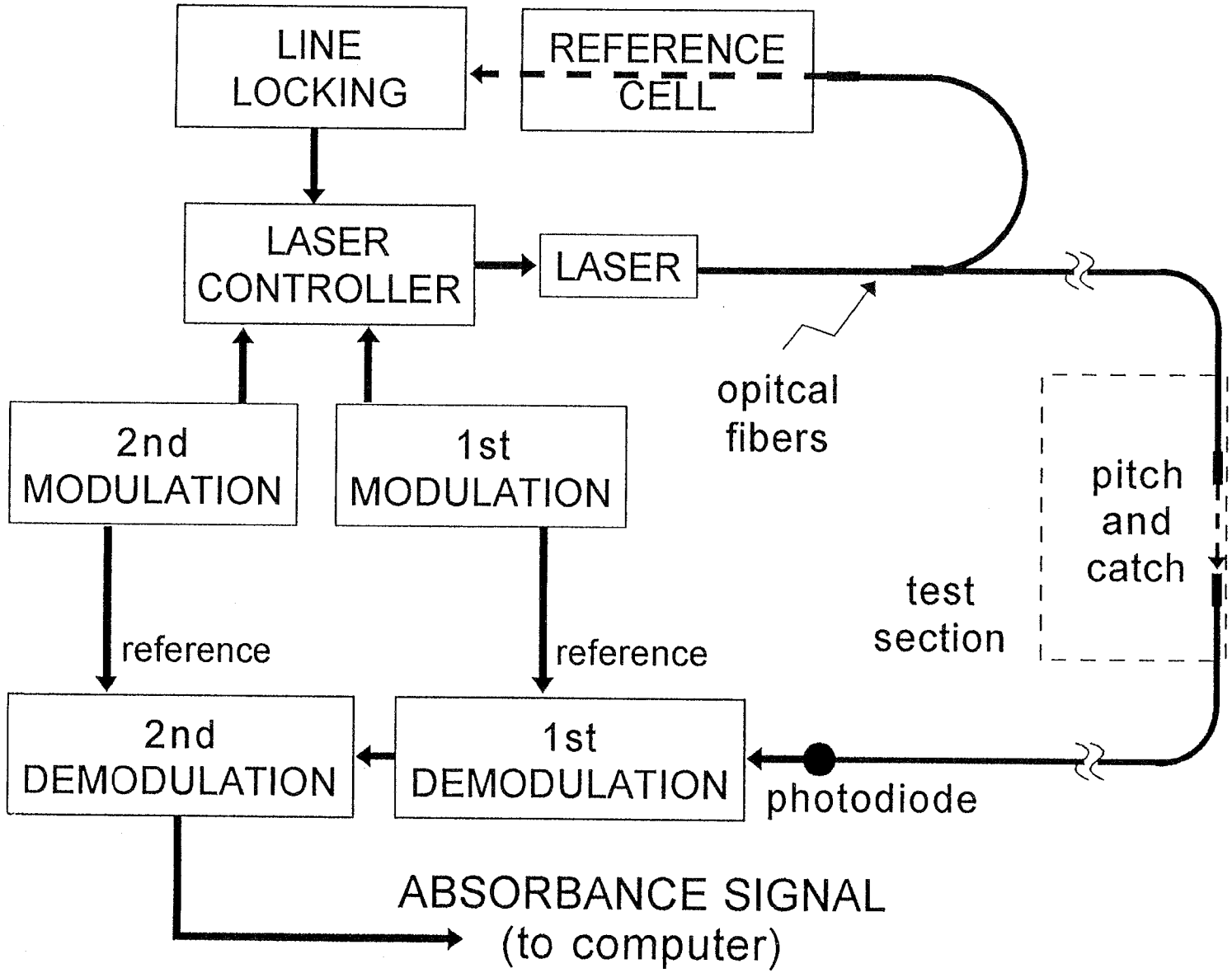
INSTRUMENT DESIGN
USES PATENT-PENDING DUAL MODULATION