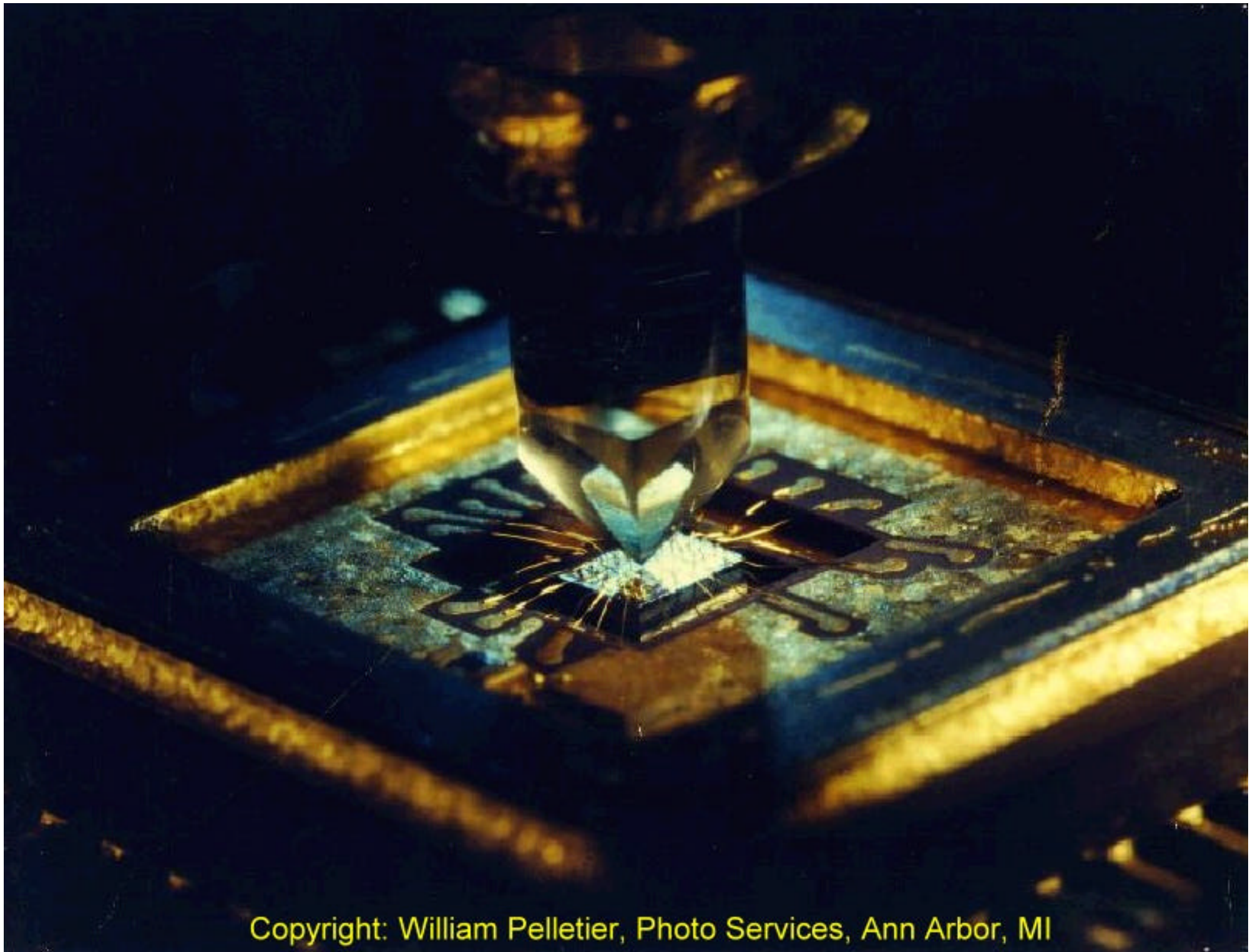


Electro-Optic Sampling

John Whitaker

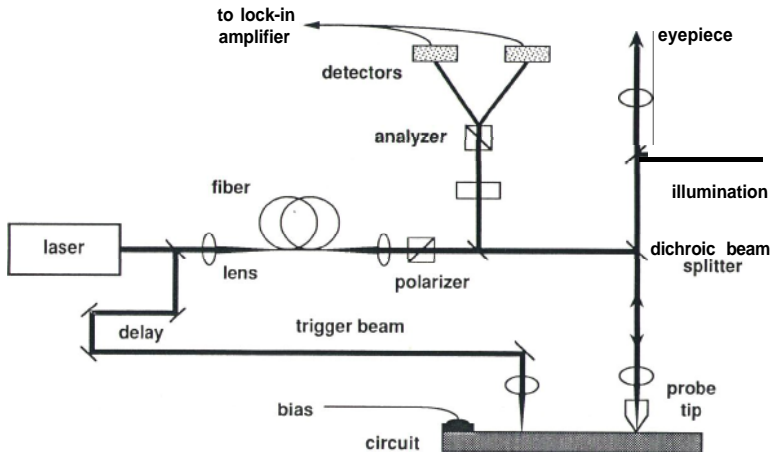
Center for Ultrafast Optical Science
University of Michigan, Ann Arbor, MI

A technique which utilizes short-pulse lasers and electro-optic materials for measuring electrical transients with extremely high temporal resolution, < 300 femtoseconds (3×10^{-13} seconds). This instrument is the fastest (highest bandwidth) oscilloscope ever developed.

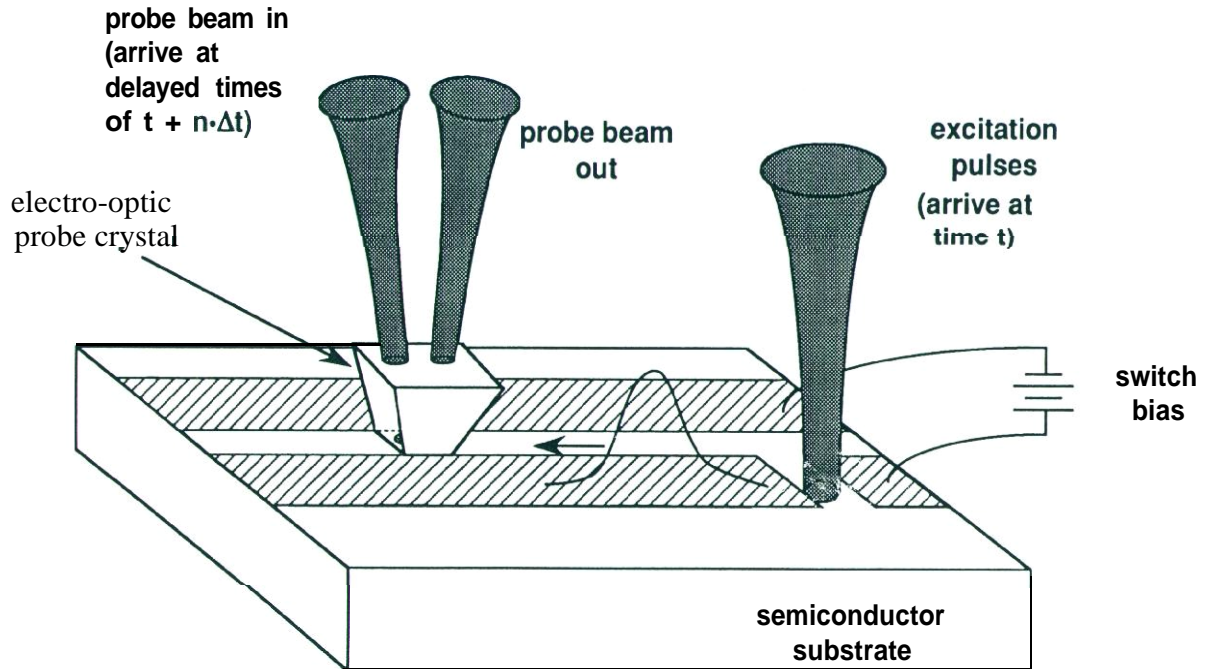


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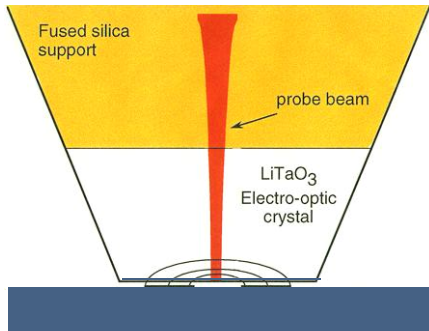
Electro-Optic Sampling System Schematic



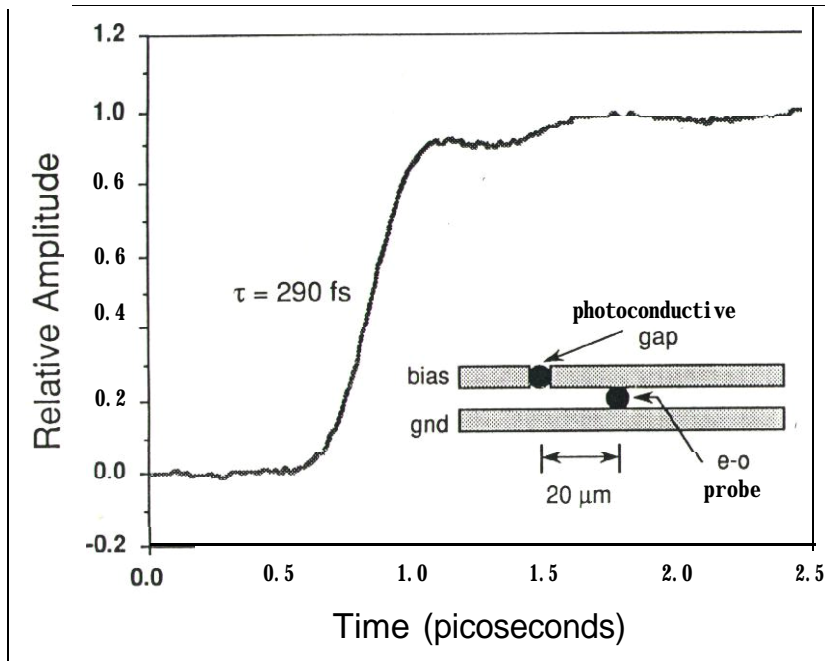
EXTERNAL ELECTRO-OPTIC SAMPLING SCHEME



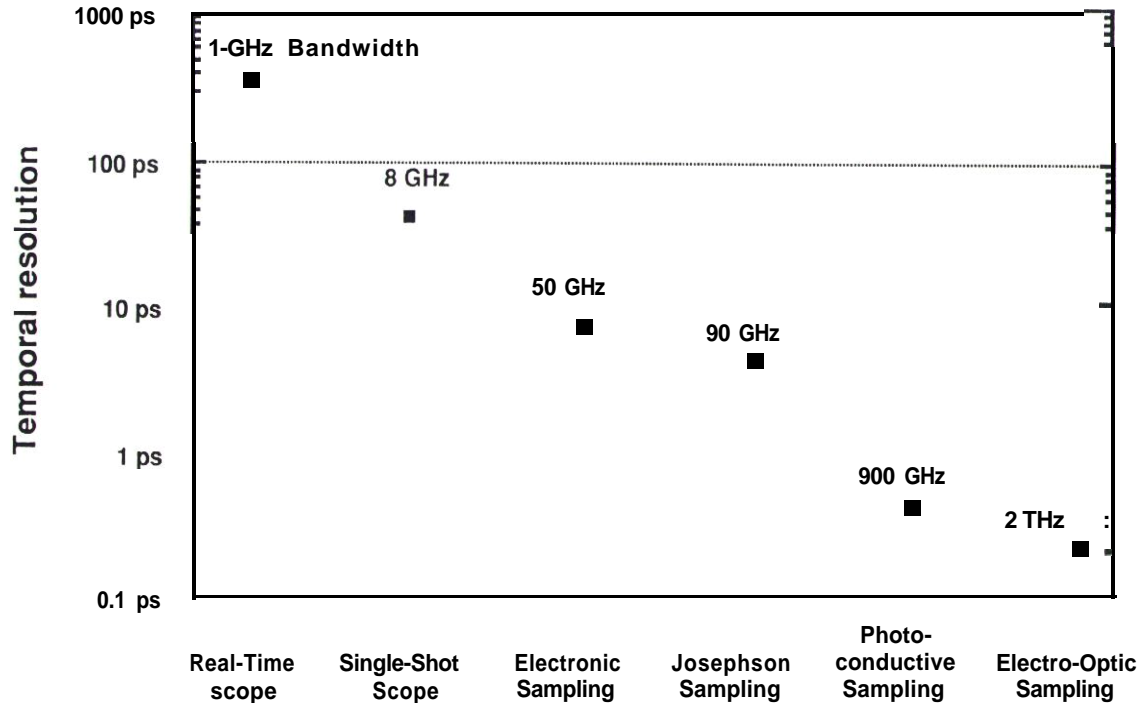
Electro-Optic Probe



1 THz Bandwidth Sampling



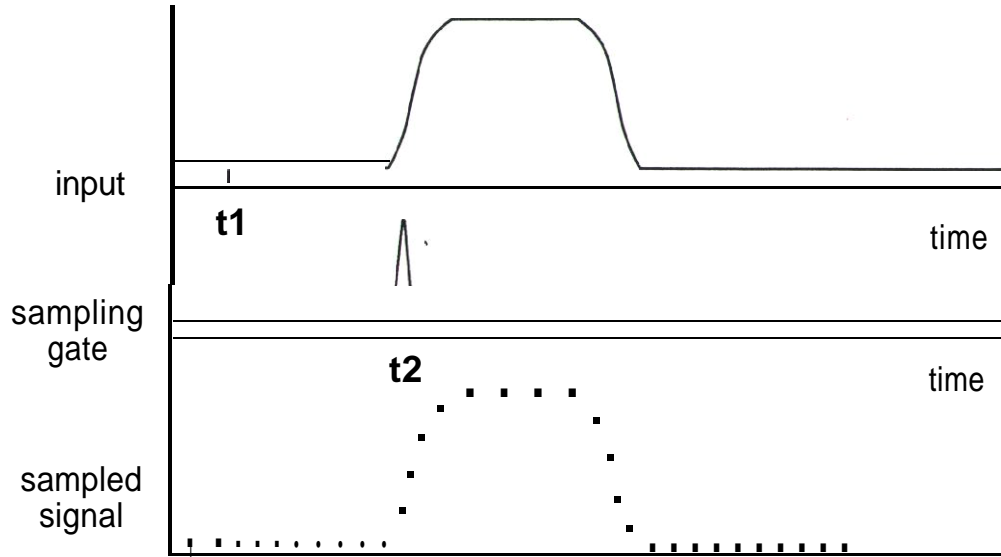
Impact of Optics on Ultrafast Electronics



External Electro-Optic Sampling with LiTaO_3

- Sensitivity
 - typically: $1\text{mV}/\sqrt{\text{Hz}}$
 - enhanced: $< 300\mu\text{V}/\sqrt{\text{Hz}}$
 - can measure $< 10^{-7}\text{Io}$
 - linearity: 1% for $\pm 160\text{V}$
- Laser
 - modulation frequency: typically 2-3 MHz
 - repetition rate: 90 MHz
 - power: 100 mW/beam
- Probe
 - half-wave voltage: 2.7 kV
 - permittivity: ~ 43
 - reduced to ~ 3 with use of e-o polymers
 - effect on transmission line impedance: $\Delta(Z_0) = 10\%$
- System
 - bandwidth: $> 1\text{THz}$
 - temporal response: $< 300\text{fs}$
 - dynamic range: typically 100 dB

Sampling of Repetitive Signals- Short Gate Duration



delay time
 $\Delta(t) = t_2 - t_1$