Measurement of the Speed of Light with Laser Pulses

Dean Reiter

PHYS 4410

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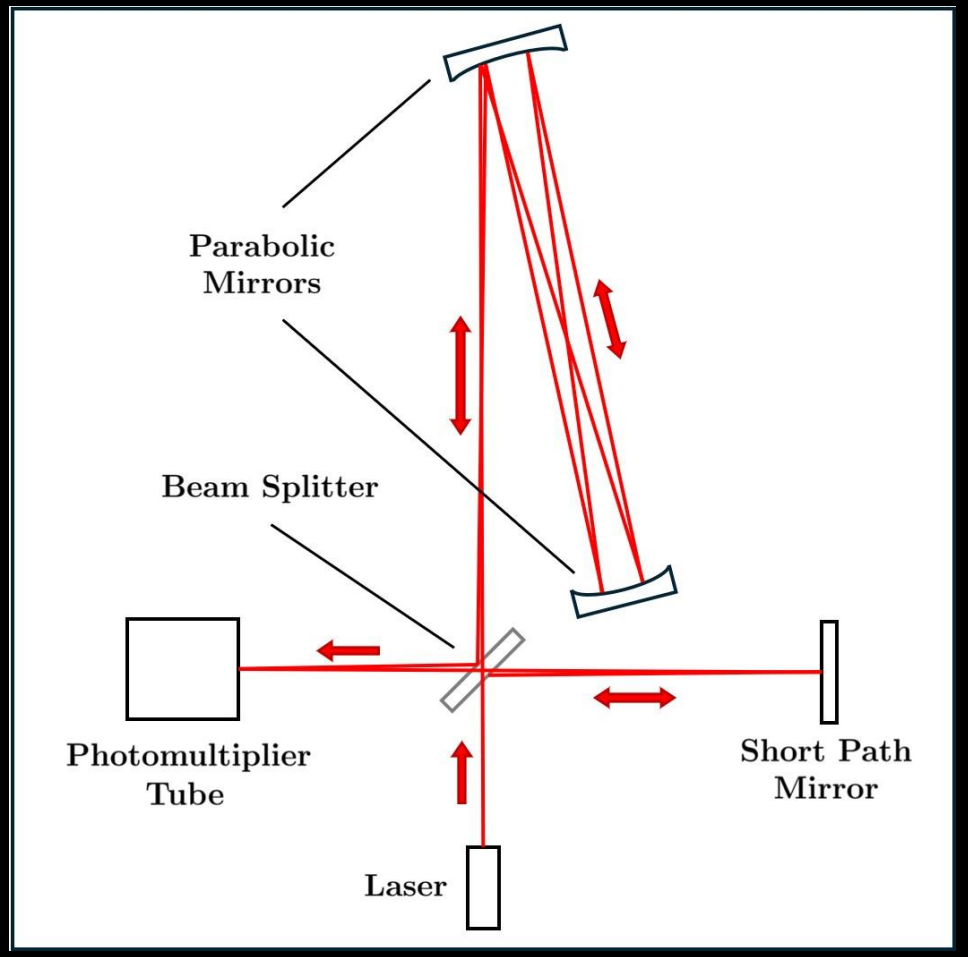
Background

- Measured with increasing precision since 1675
- e.g. Fizeau, Foucalt, Michelson
- In 1983 the speed of light was redefined as 299,792,458 m/s by international agreement

Albert Michelson’s mile-long experiment to measure c in 1931

Apparatus

- Laser beam split into long path and short path
- Path length difference (Δx) results in delayed arrival (Δt) of the split beams
- Δx = 102.6 ± 0.2 m
  - ~ 0.935 Football fields
- We expect Δt ~ 342 ns



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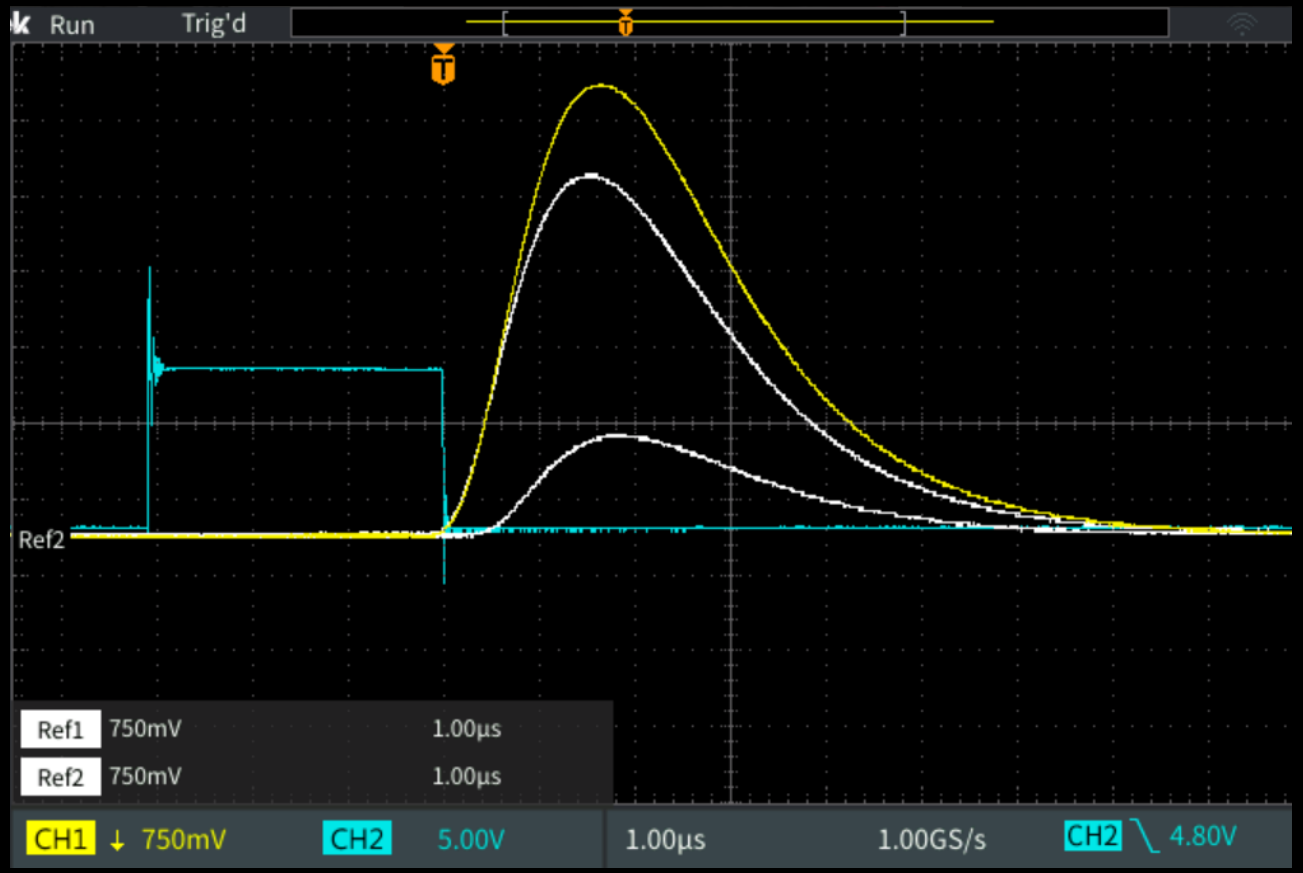
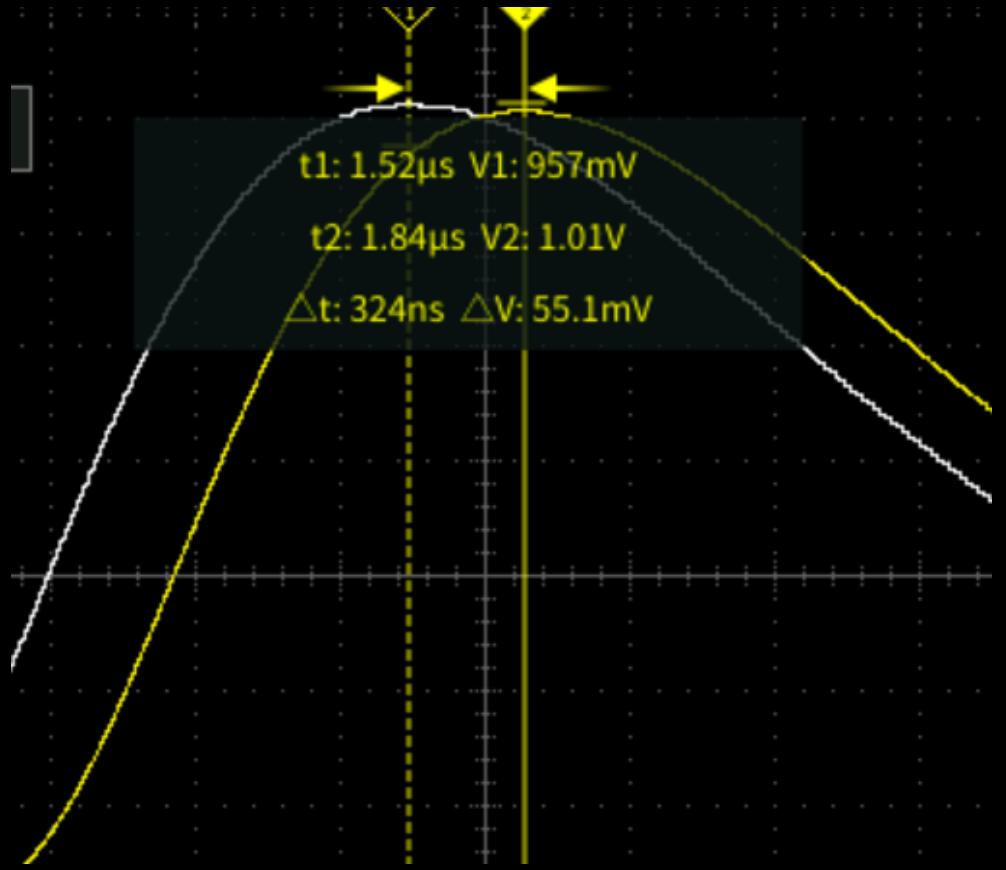
Electronics Setup

- Laser pulse ~ 6 µs width
- Pulse frequency at 1kHz (one per millisecond)
- Photomultiplier signal amplified and measured on oscilloscope

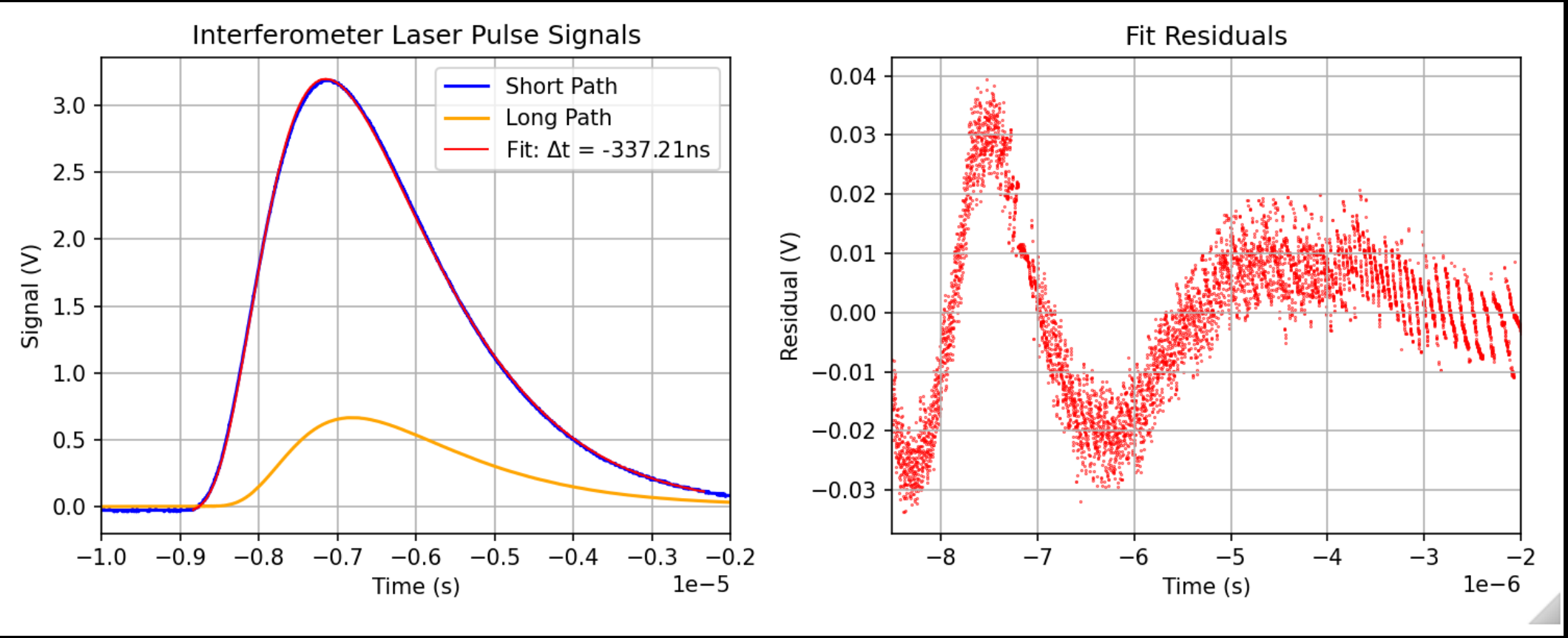


Initial Measurement

- Measured Δt directly on oscilloscope
- $3.17 \pm 0.40 \times 10^{8}$ m/s
- Needed to analyze entire waveform to increase precision



Data Analysis



- Long-path signal fitted to short-path
- Note the pattern in the residuals

Result

- $3.017 \pm 0.005 \times 10^8$ m/s

- Final result is combination of two repeated measurements
- Disagrees with known value of 2.998
- True systematic error is unknown

Thank you!