

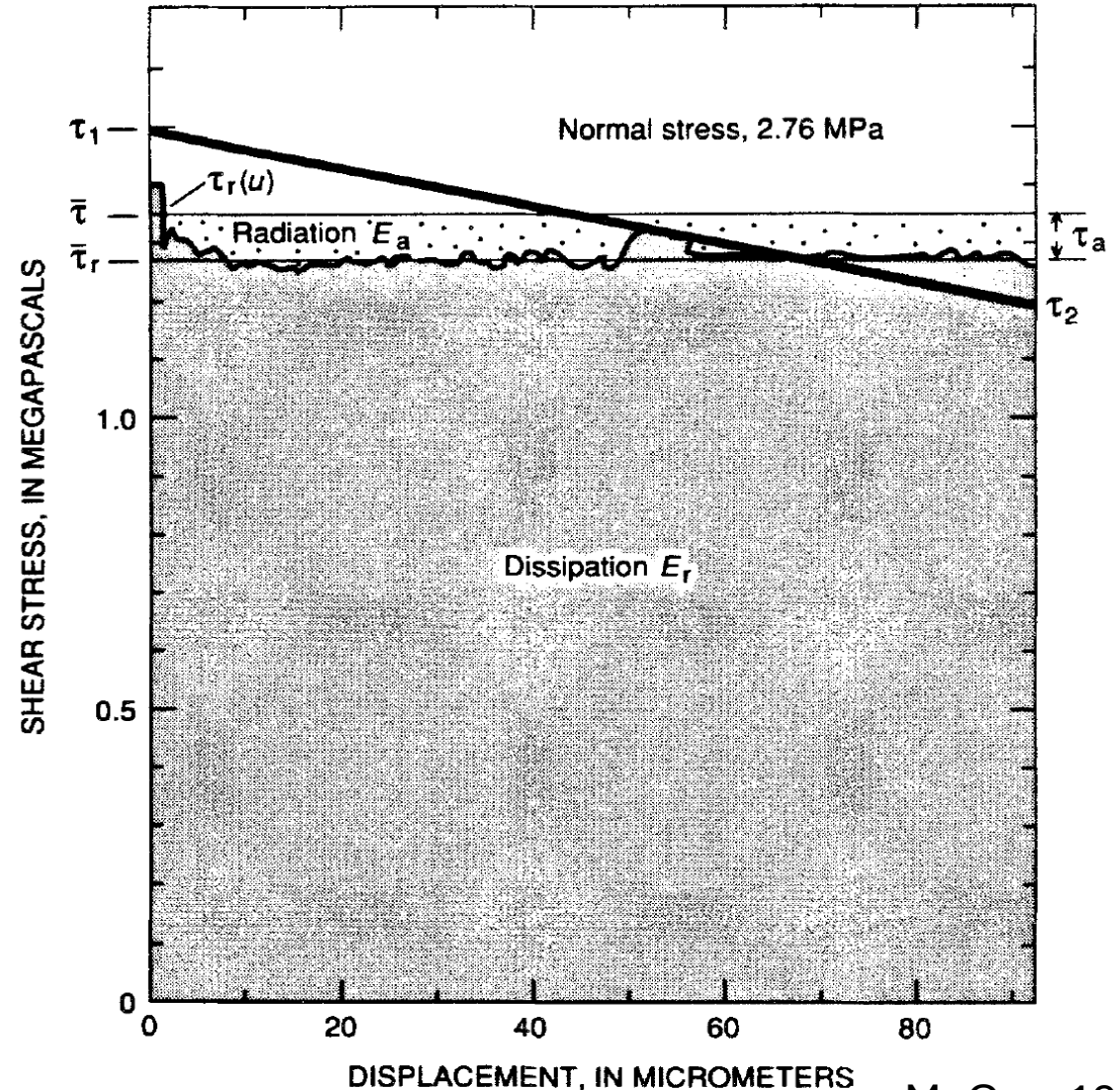
Laboratory Stress Drop and Fault Slip: Near-field stress measurements from a laser internal load cell

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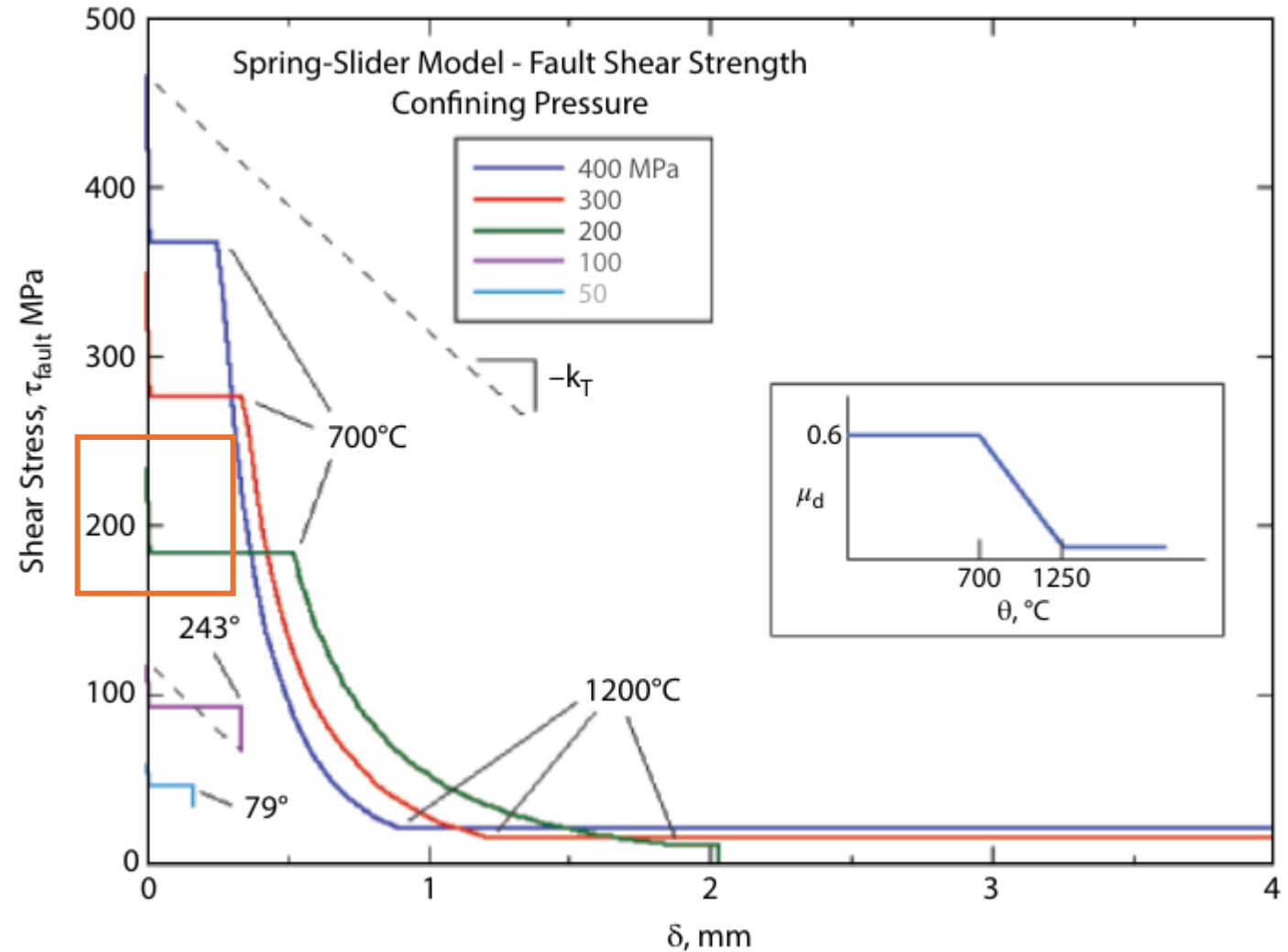
Motivation: Why study fault slip and stress drop in the lab?

- Energy partitioning: depends on strength during slip
- In the lab we know initial and final states well
- Difficult to measure strength and slip in between



Strength Model

- Dynamic friction = 0.6
- Melt above 700C
- We're focused on measuring pre-melt weakening



Motivation: Why study fault slip and stress drop in the lab?

- Lab slip weakening distances:
 - Rotary experiments: 100-1000 mm
 - Thermal pressurization expts: 10 mm
 - Stick-slip: 0.01- 10 mm
- Can we measure at least slip or stress drop in-situ at representative pressure?
 - Target stress in the short term, slip later

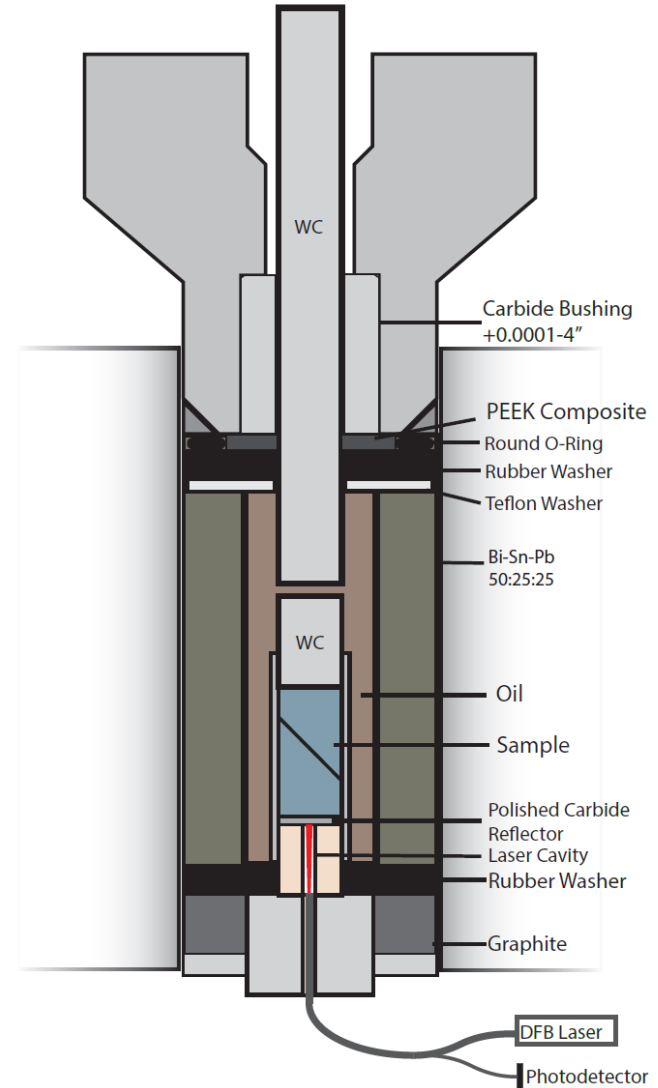
Methods

- Griggs (Triax)

- Load Cell
- Displacement Sensor (AMR)
- Fiber entering base

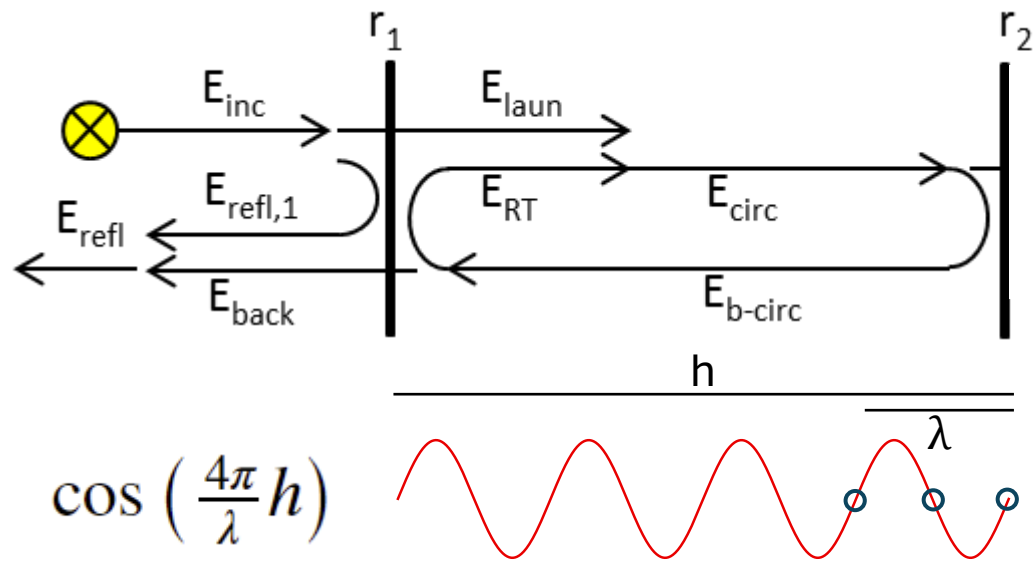


25 mm

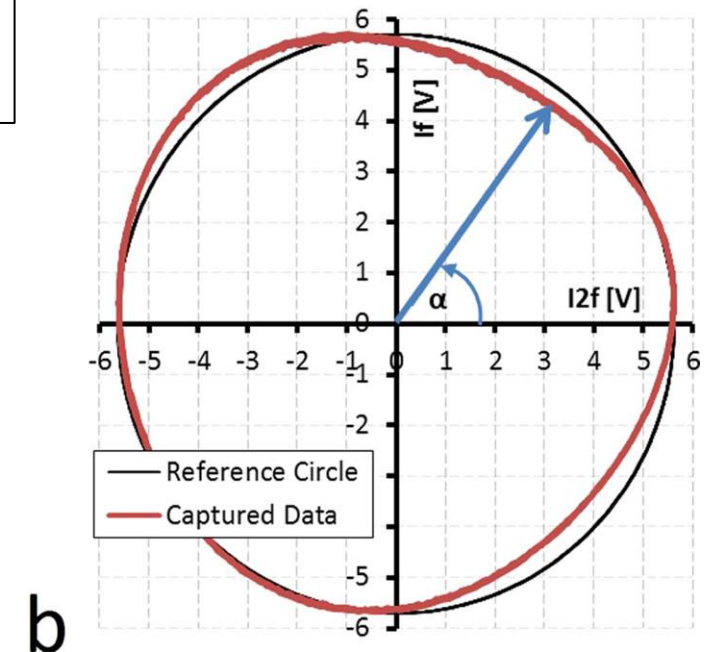
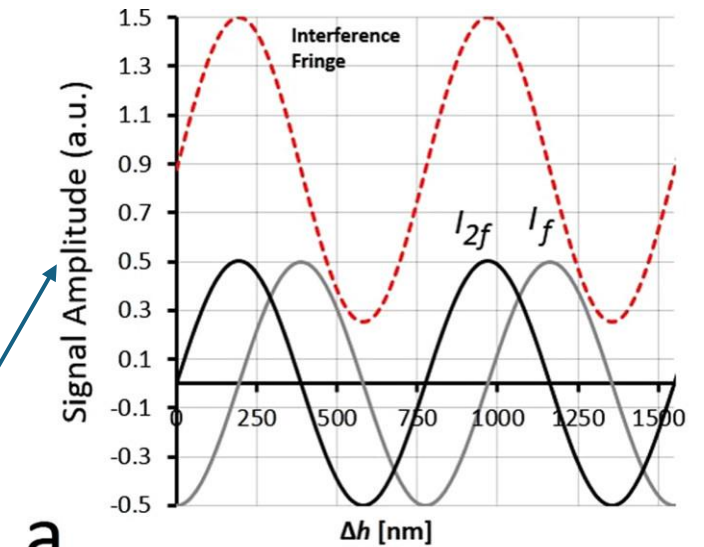


Methods

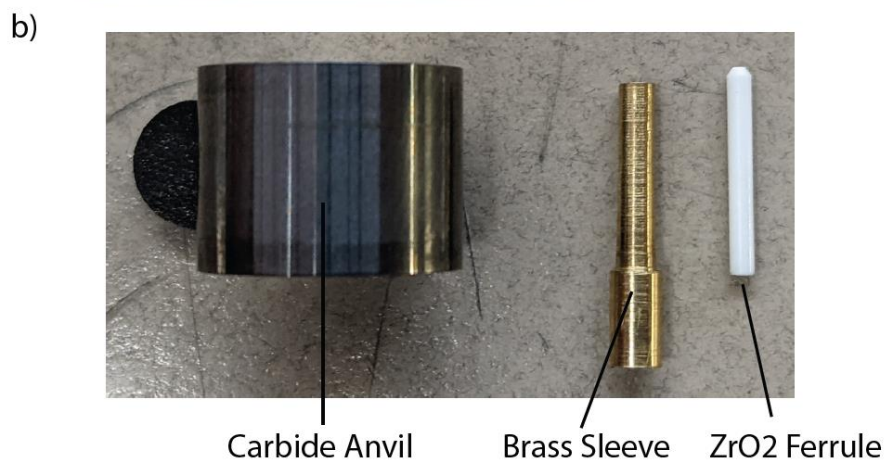
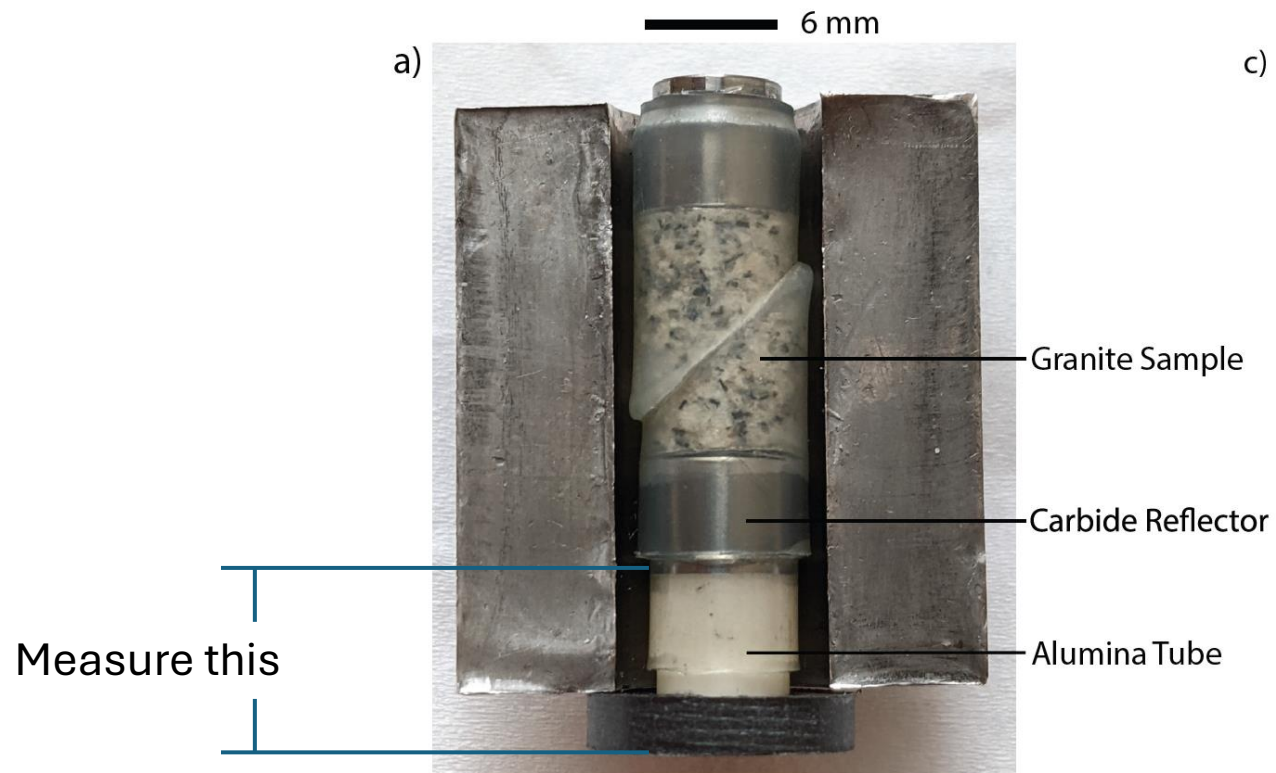
- Lasers!
- Measure distance between reflectors:
fiber head, polished carbide
 - Convert to stress via elasticity



Modulate:
 $\lambda = \cos(2\pi f)$

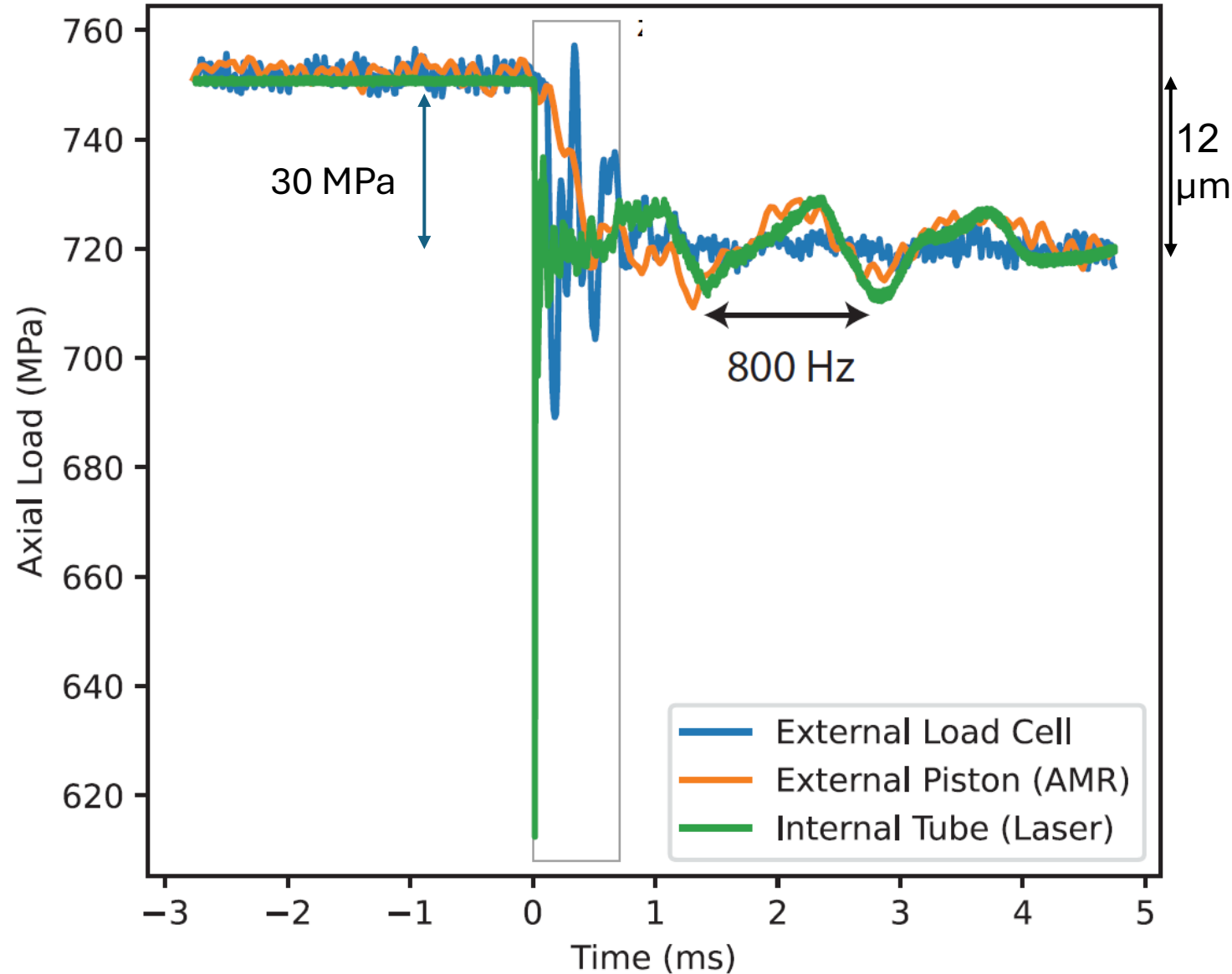


Methods



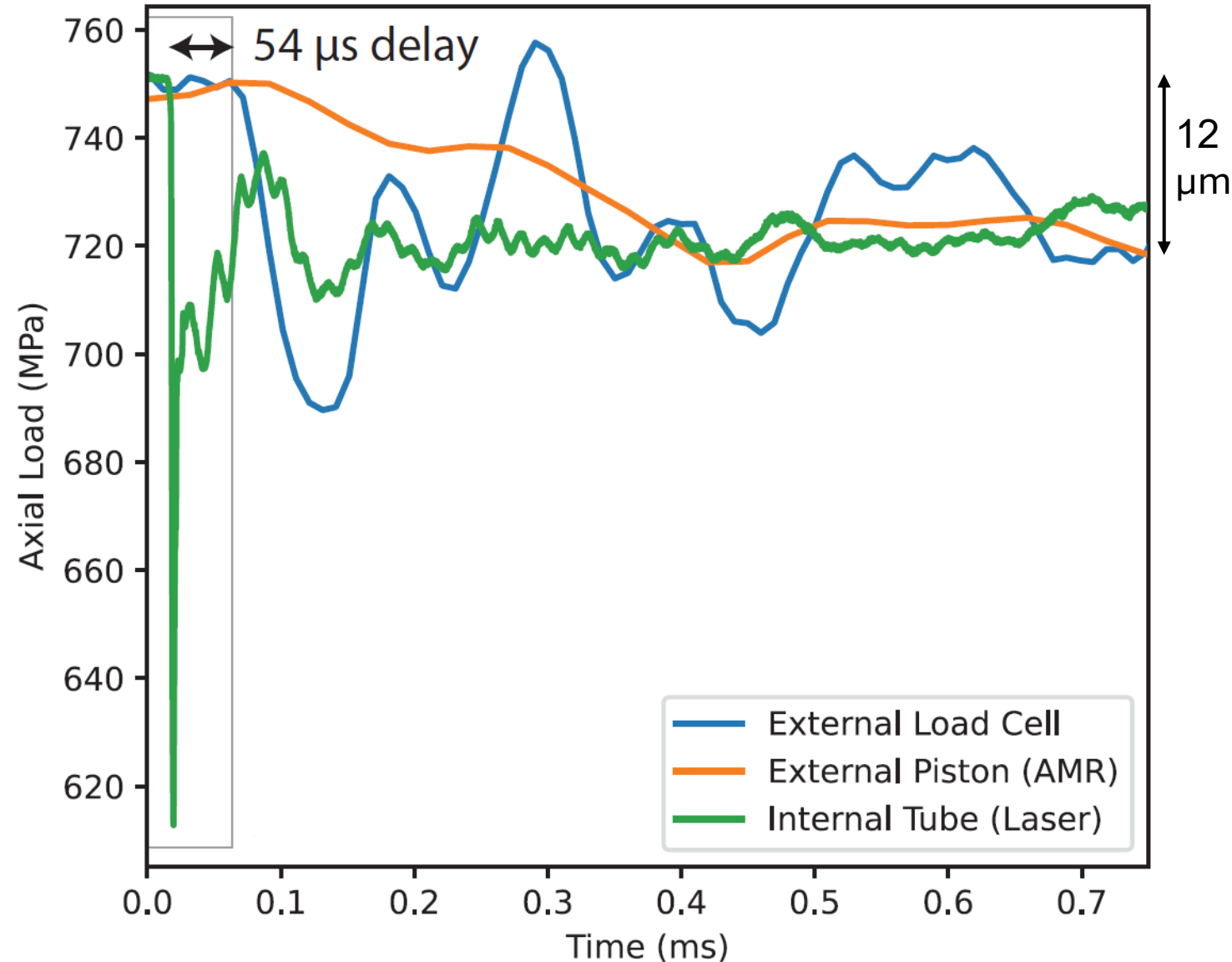
Results

- 250 MPa confining pressure
 - $\tau \sim 250$ MPa, $\mu \sim 0.5$
- $\Delta\sigma = 30$ MPa
- Event duration < 1 ms
- Frame rings @800 Hz



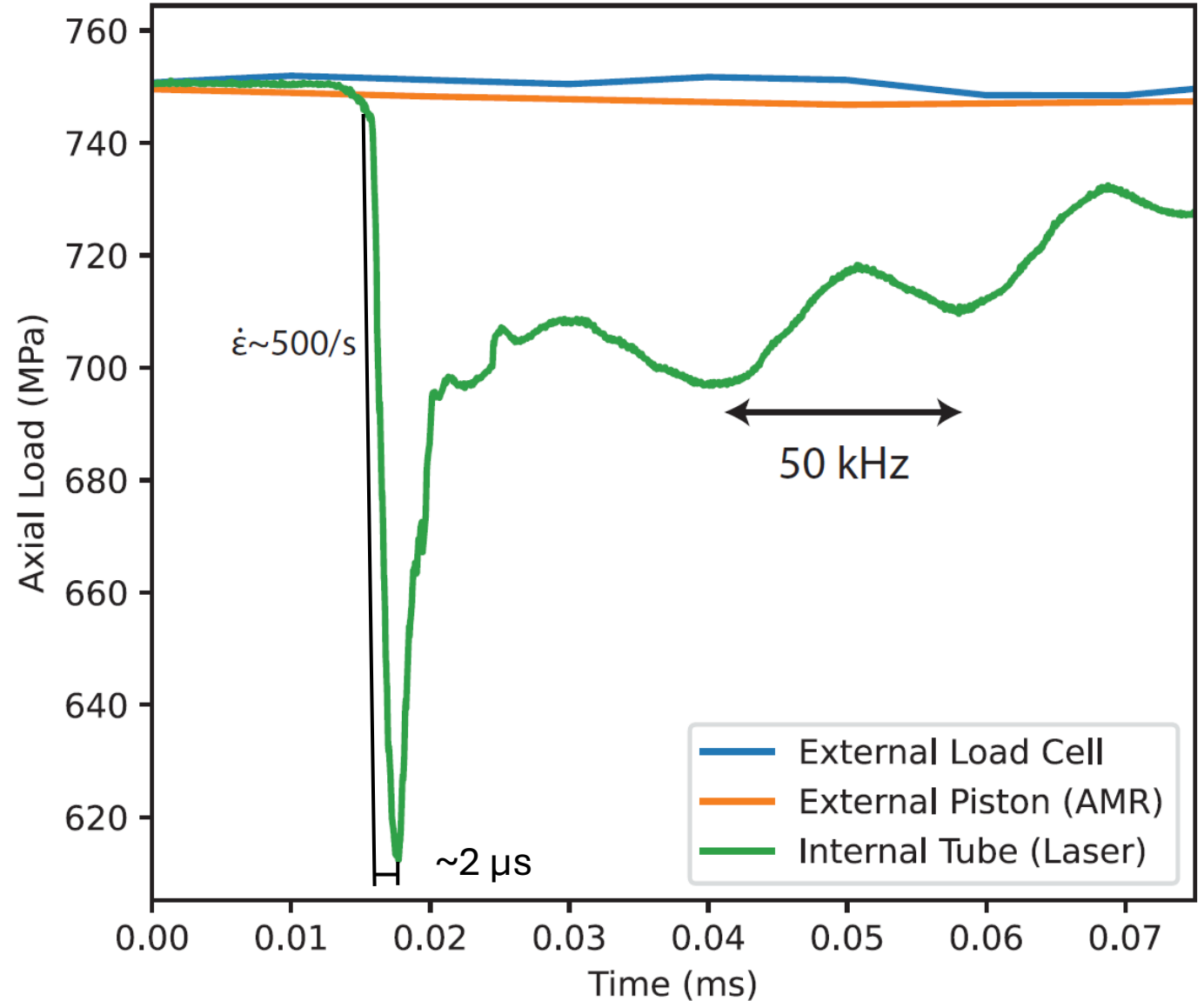
Results

- 54 μs delay
- Ringing of individual column pieces
- 400 μs slip duration? (orange)



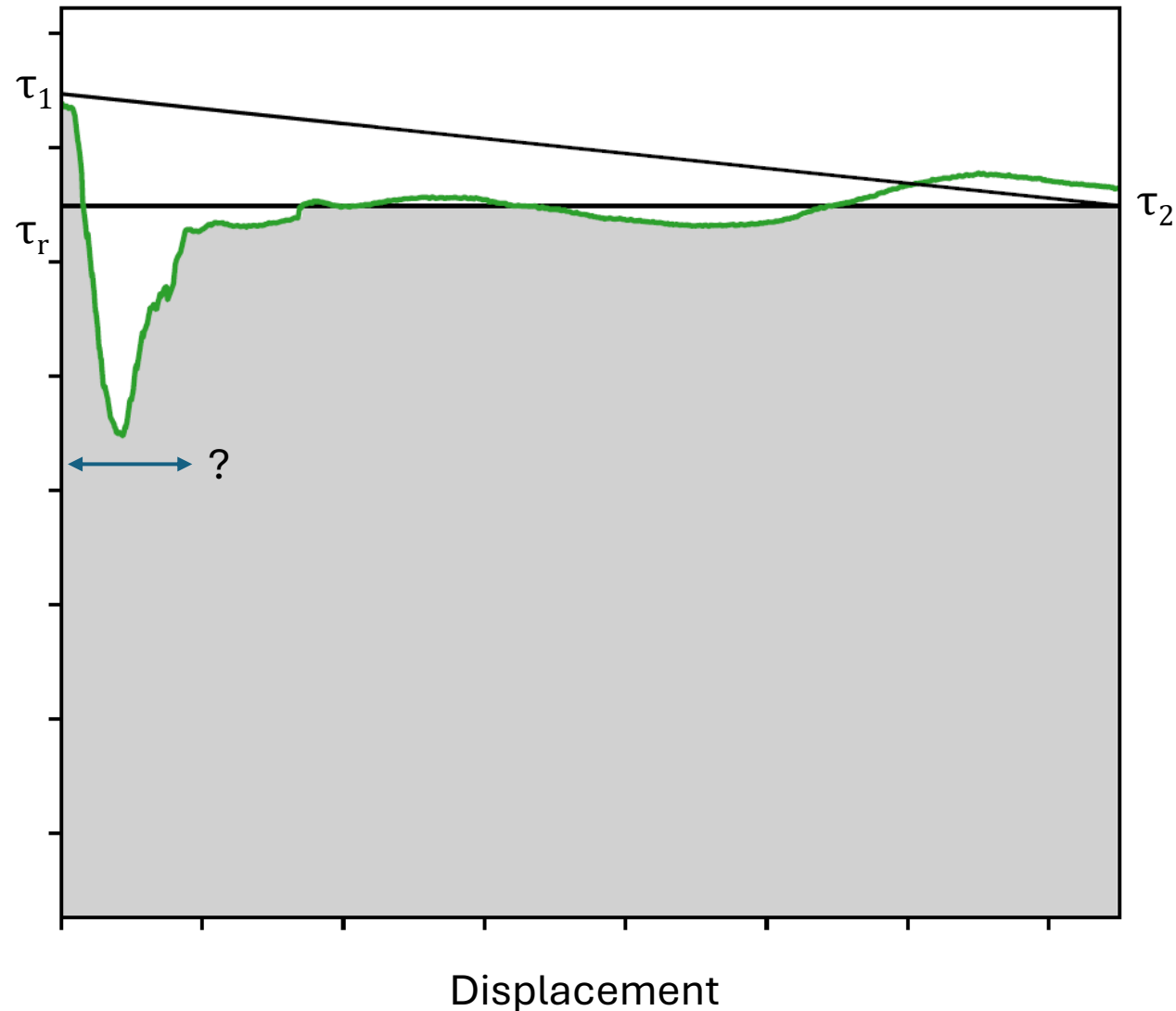
Results

- Initial stress drop:
 - 4x static stress drop
- Duration $\sim 2 \mu\text{s}$
 - Expected rupture duration $\sim 3\text{-}4 \mu\text{s}$ (?)
- 50 kHz \rightarrow expected $\frac{1}{4}$ " carbide resonance



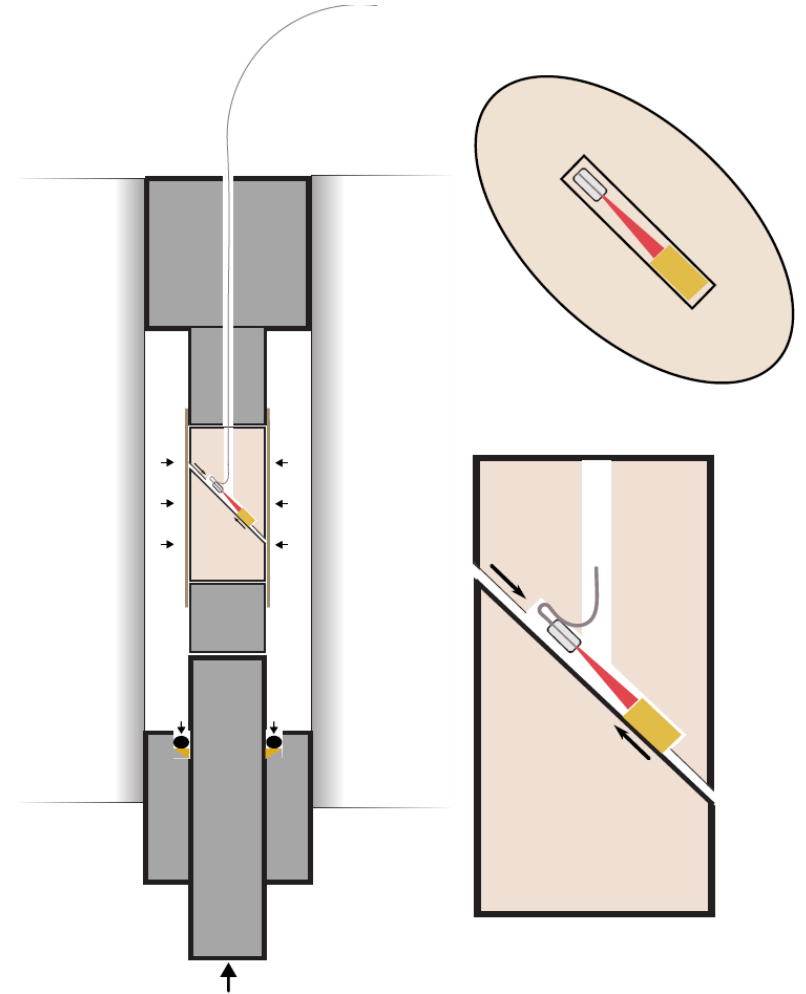
Implications

- What does this stress measurement indicate?
 - Very short weakening distance ($<12\ \mu\text{m}$)
 - Non-monotonic weakening
 - Substantial radiated energy is produced during initial stages of weakening



Outlook

- Clearly weakening distance is short, but how short?
- Need to measure slip AND stress ->
- Measurement is limited by maximum velocities (1 m/s), so we're only measuring small stress drops
 - Have equipment needed to build and test a faster setup



Questions?

- What does this stress measurement indicate?
 - Very short weakening distance ($<12\ \mu\text{m}$)
 - Non-monotonic weakening
 - Substantial radiated energy is produced during initial stages of weakening

