Syngas Ignition Delay Times in a Shock Tube

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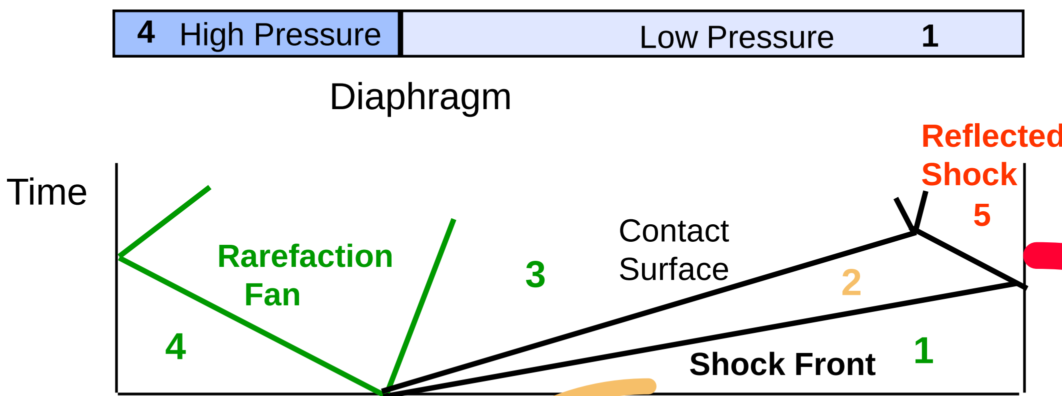
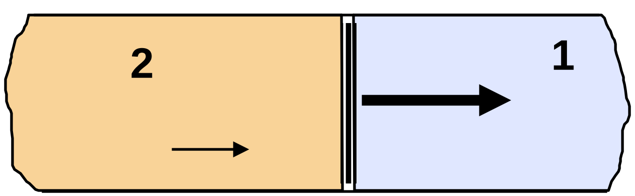
Shock Tubes

Shock Wave Heats Gas Mixtures to High Temperatures

Shock Tube



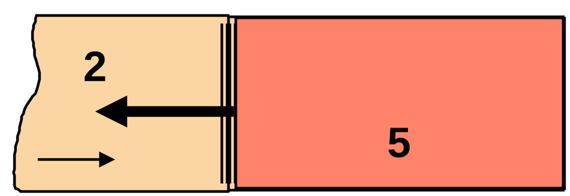
Lab-Frame Incident Shock



T_2 = 500-2000 K

$P_2 > P_1$

Lab-Frame Reflected Shock



T_5 = 1000-4000 K

$P_5 > P_2$

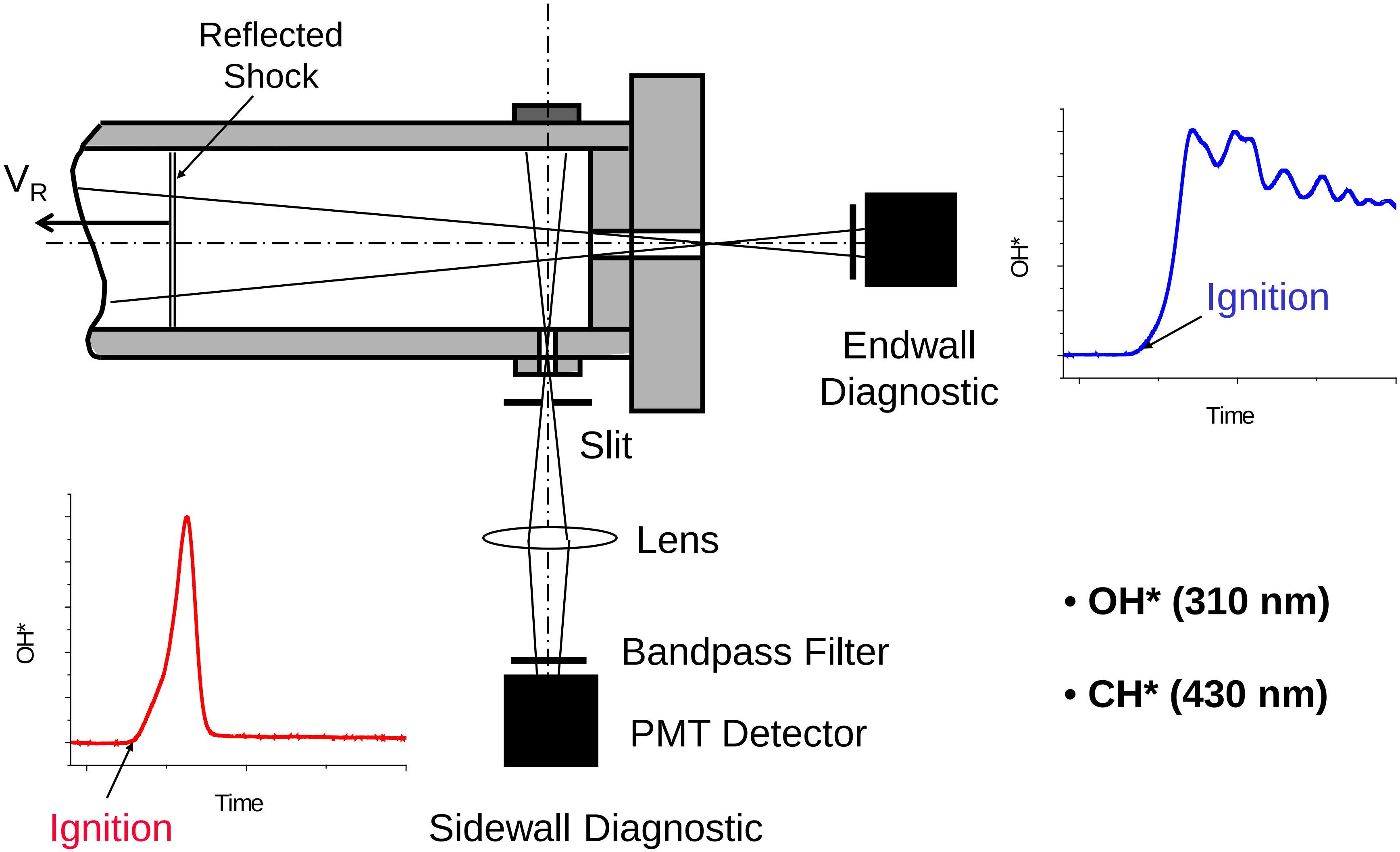
Shock Tubes

High pressure shock-tube facility at Texas A&M

- 304 Stainless Steel
- Driven Section
  - L = 4.72 m
  - d = 15.24 cm
- Driver Section
  - L = 2.46 m
  - d = 7.62 cm

Shock Tubes

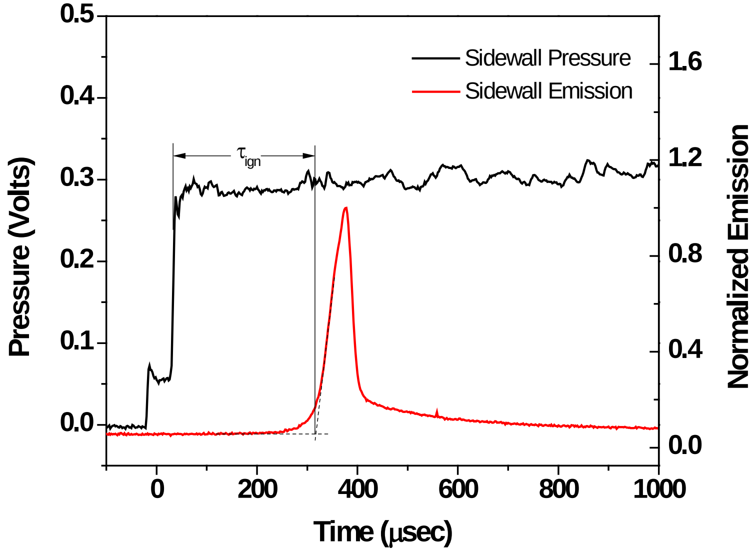
Emission and Pressure Measured from Endwall and Sidewall



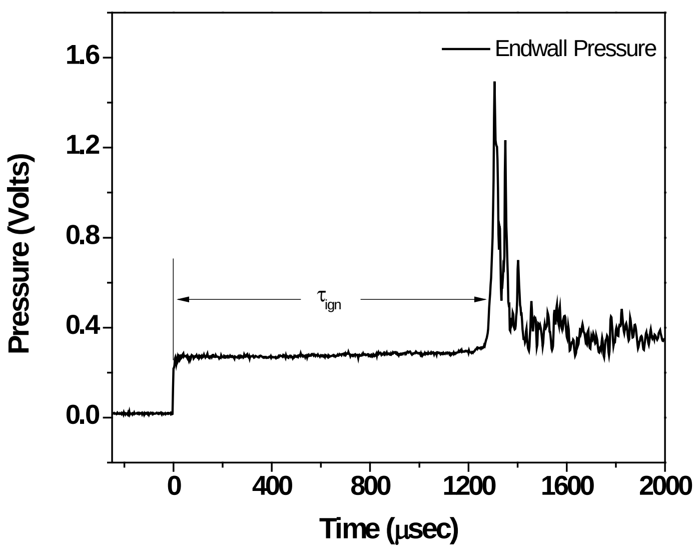
- **OH* (310 nm)**
- **CH* (430 nm)**

Ignition Delay Times

Ignition time determination methodology depends on mixture dilution level



Highly diluted mixtures use sidewall OH* emission



Non-diluted mixtures use endwall pressure (or emission) trace

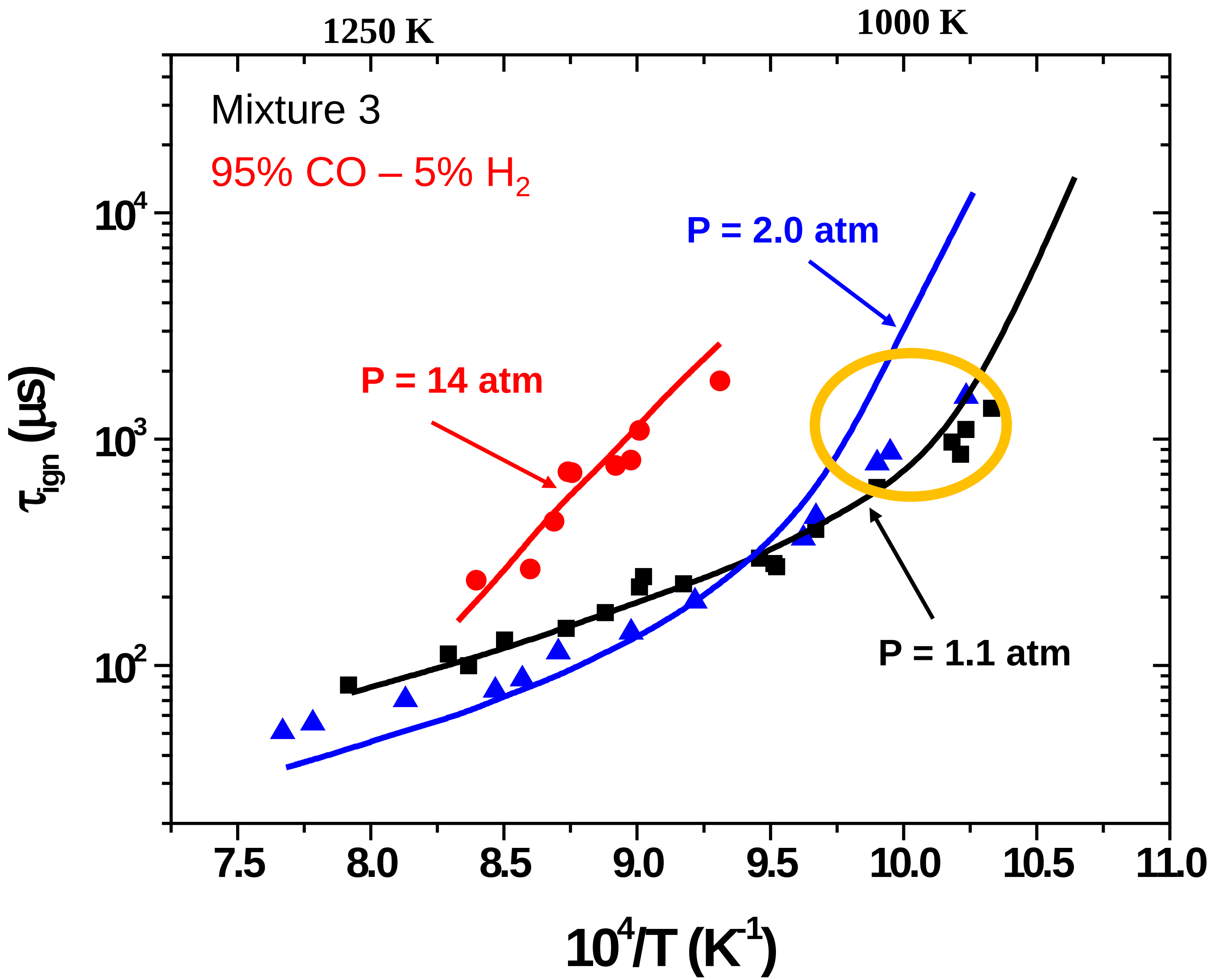
Syngas Ignition

UTSR-Funded Work Included H_2 and H_2/CO Blends in Air - Undiluted

- H_2/CO Mixtures from **0 to 95% CO**
- Elevated Pressures: **1 – 25 atm**
- Temperatures: **890 – 1300 K**
- Undiluted in Air
- Very Exothermic!

Syngas Ignition

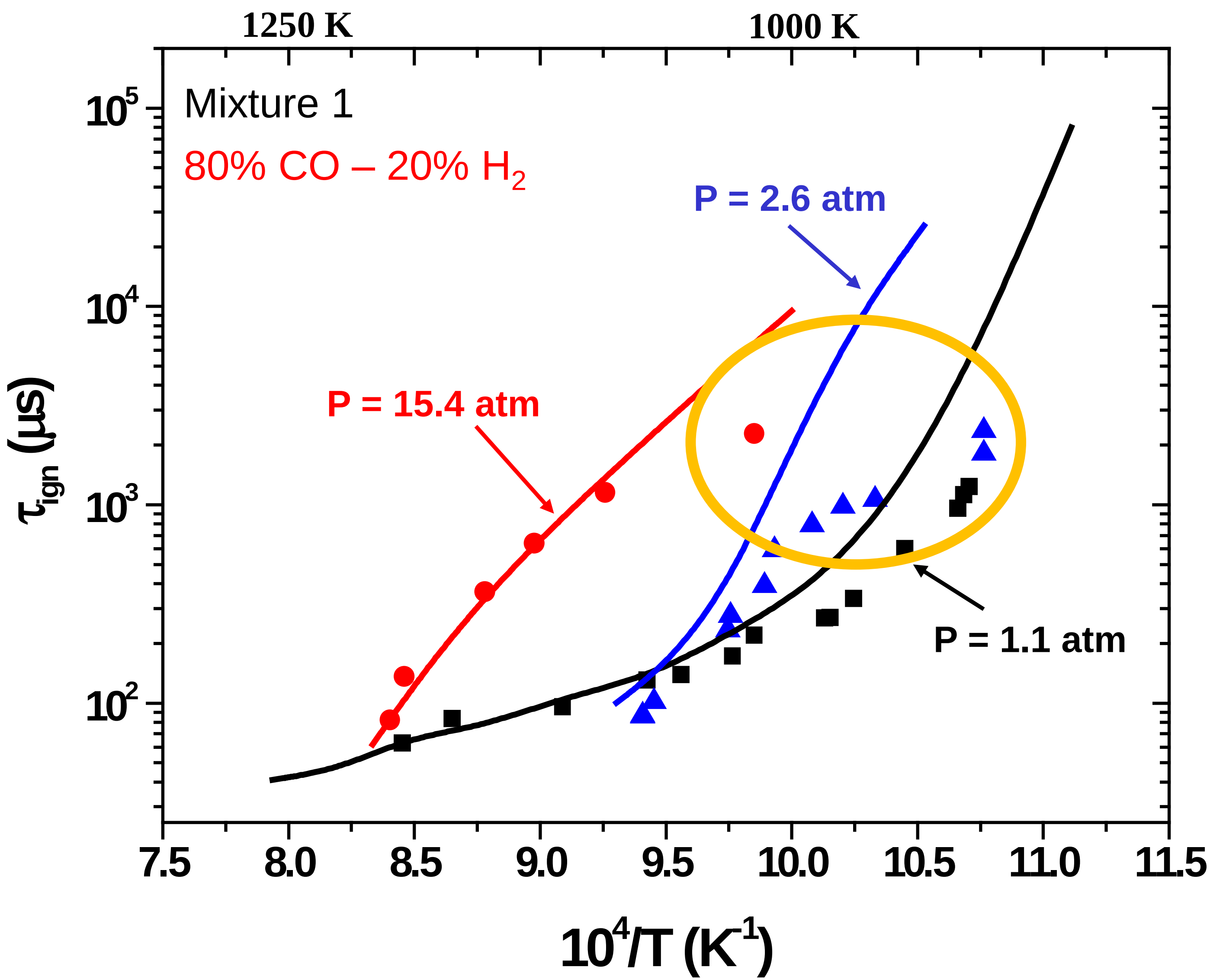
*Results for **Mostly CO Mixtures***



- 95/5 CO/H_2
- ϕ = 0.5
- Solid lines: USC Model

Syngas Ignition

Results for ***Mixtures with 20% H_2***



- **80/20 CO/H_2**
- **ϕ = 0.5**
- **Solid lines: USC Model**

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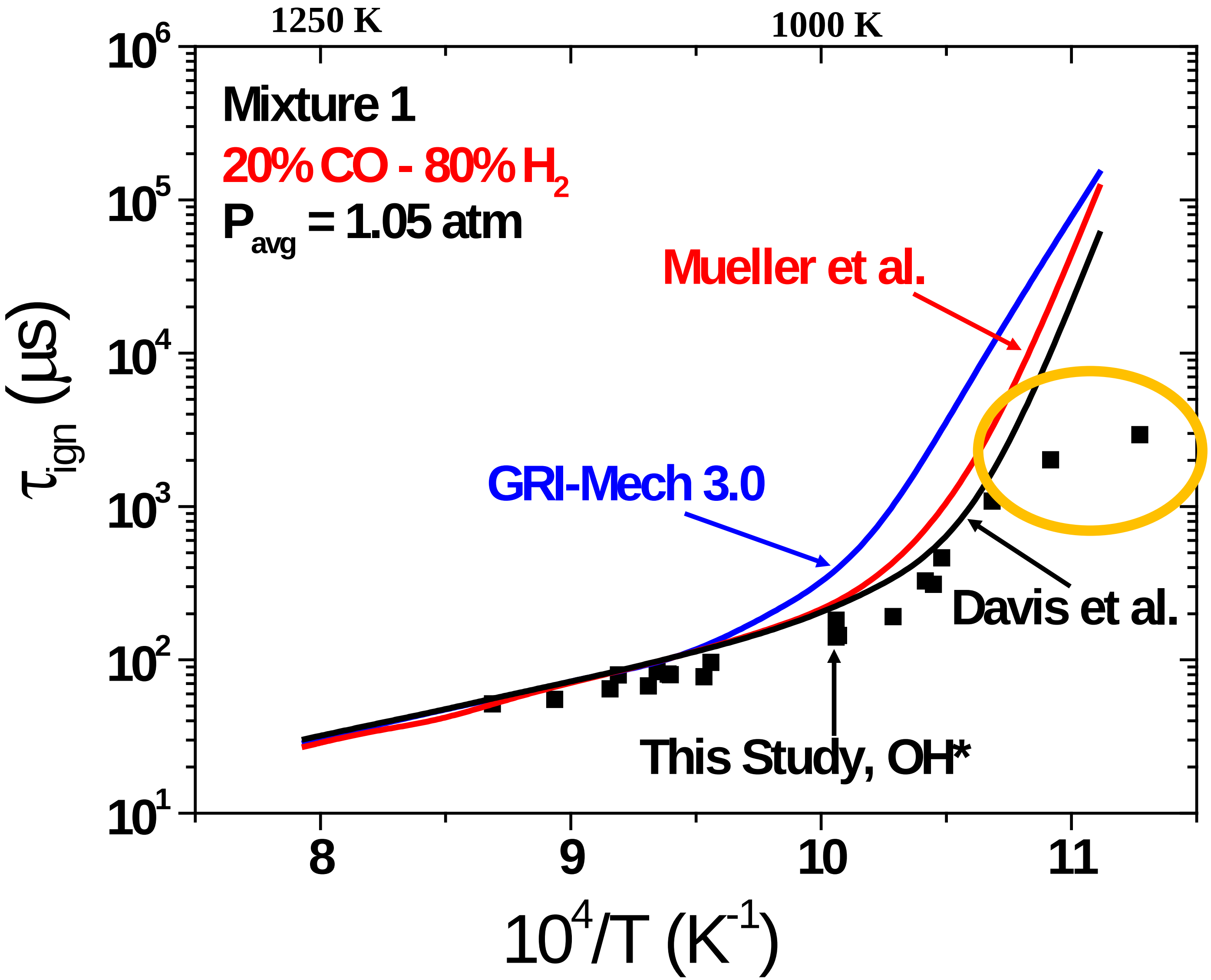
*Results for **Mixtures with 80% H_2***



- **20/80 CO/H_2**
- $\phi = 0.5$
- P = 1 atm

Syngas Ignition

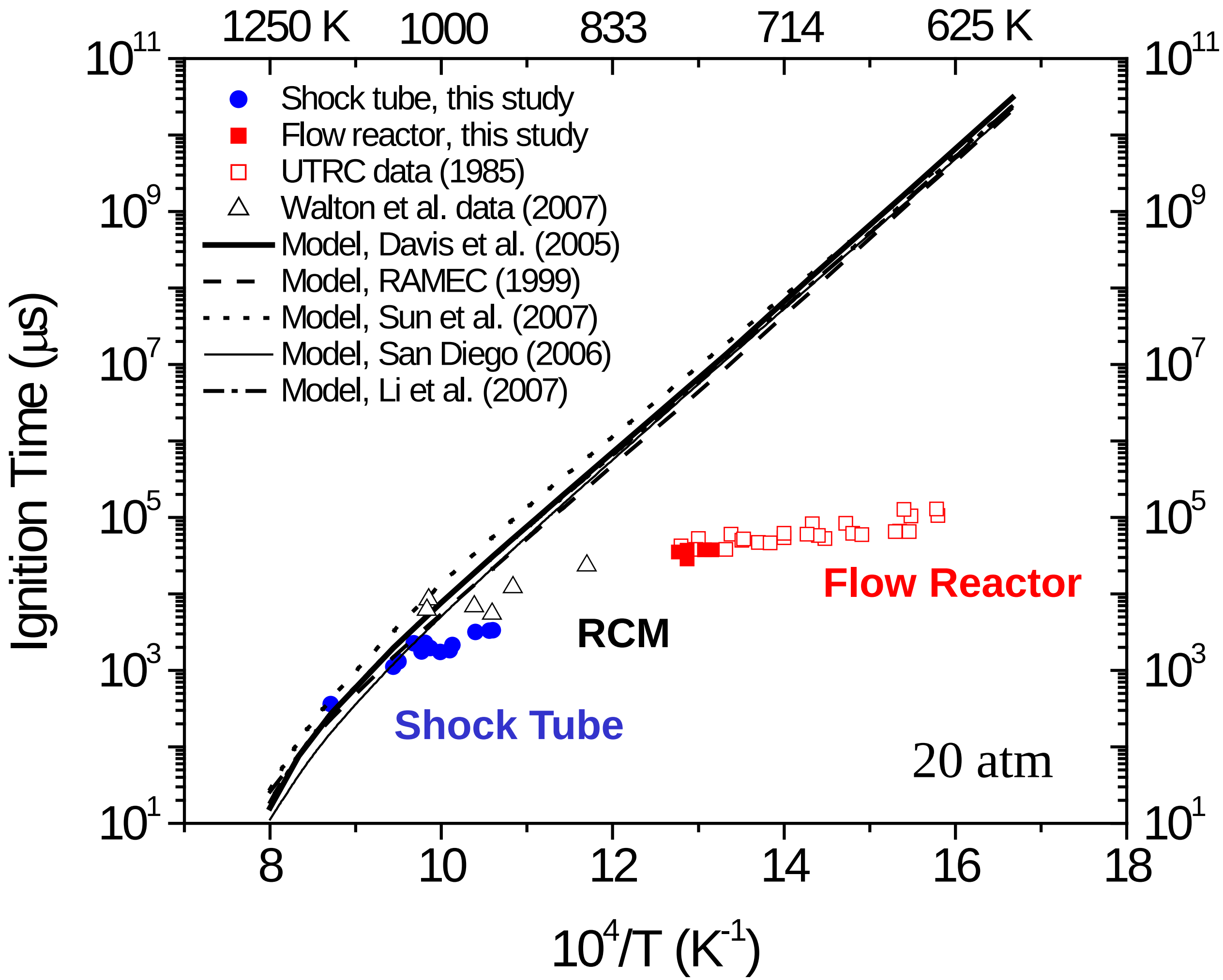
Syngas Experiments *Show Significant Discrepancy w/Models at Lower T, Higher P*

Mixture:

39% H_2

51%CO

10% CO_2



Syngas Ignition

Behavior at Higher Pressure, Lower Temperature due to Non-Homogeneous Effects

Reasons for Behavior in Shock Tubes:

- Facility Effects
- Early Ignition or "Hot Spots"

Controversy Led to Several Efforts in and Outside of UTSR Effort:

- Tests for Enhanced Understanding of Shock-Tube Nonidealities
- Improvements in Shock-Tube Operation (Hanson et al.)
- Numerical Simulations of Shock-Tube Flow Fields

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