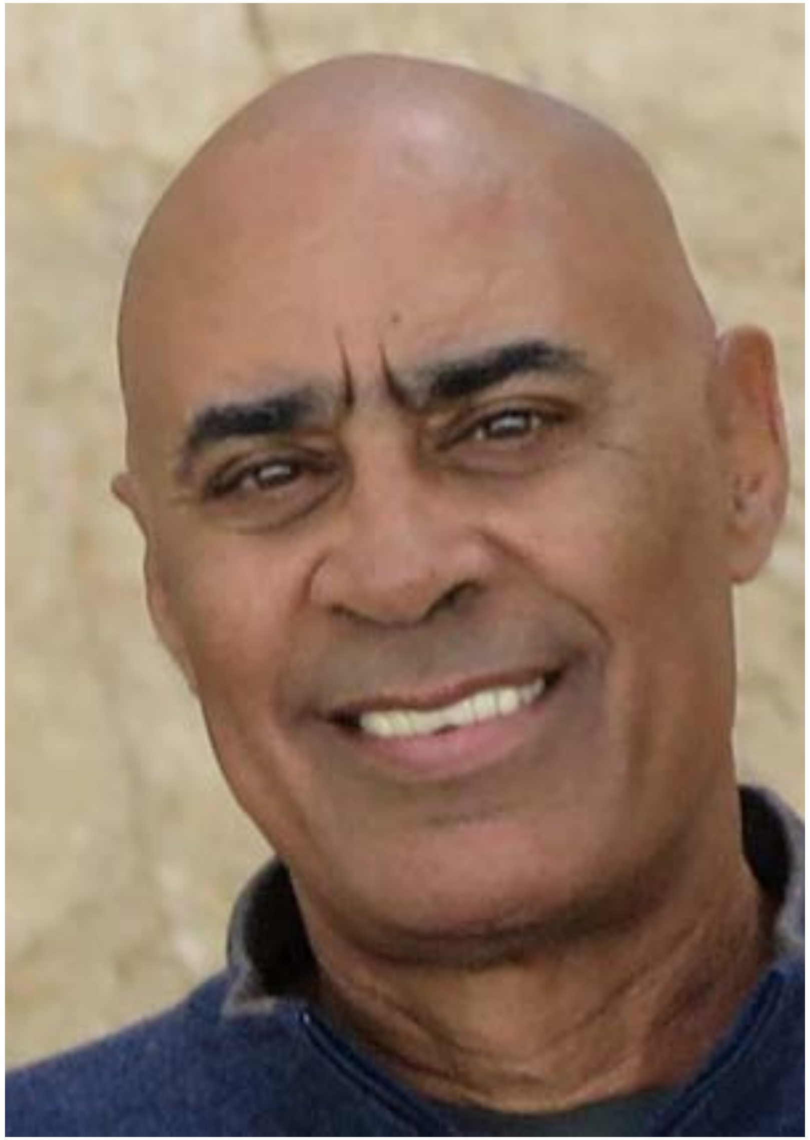
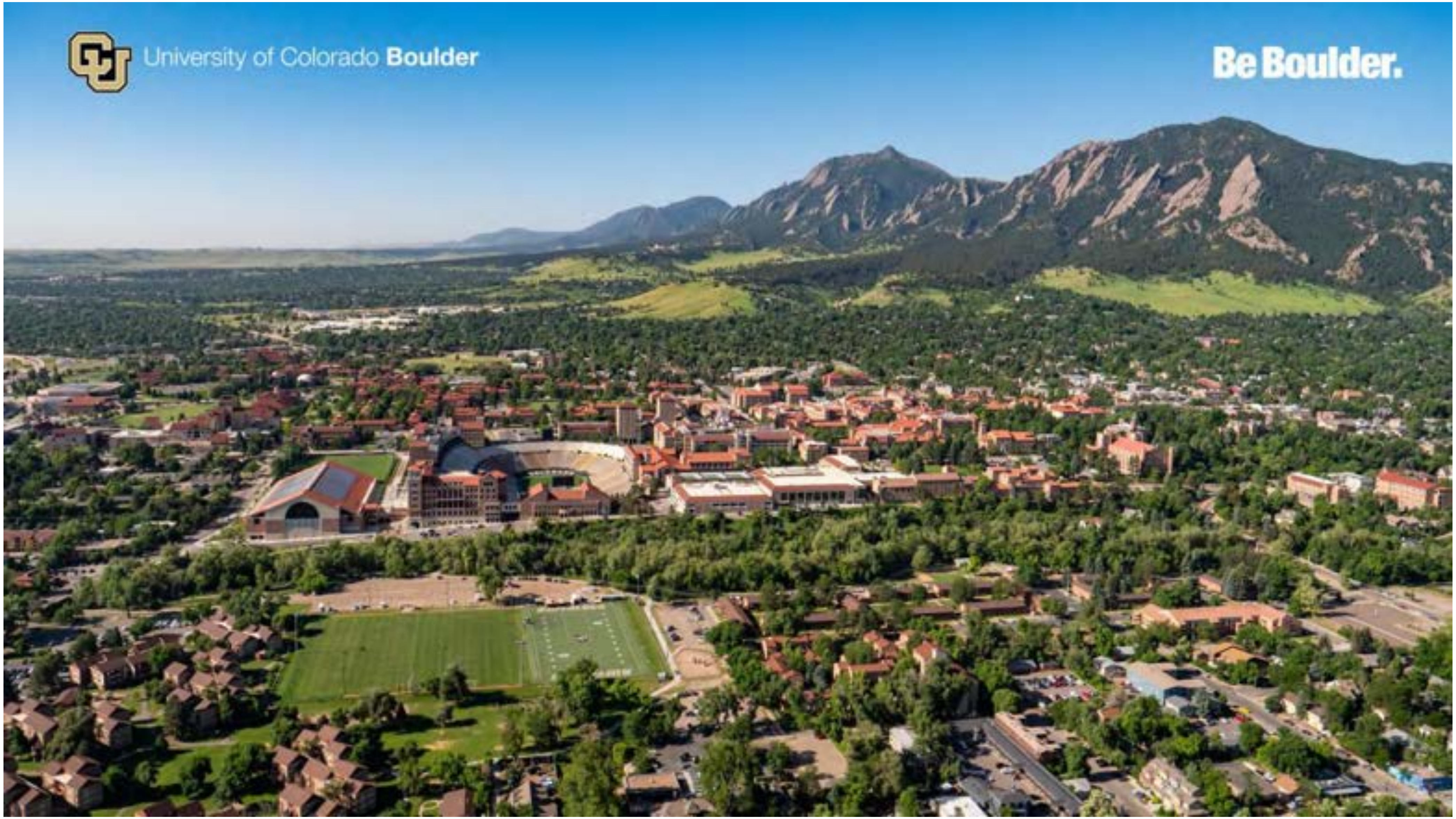
A Life in Experimental Combustion

Prof Melvyn Branch
University of Colorado



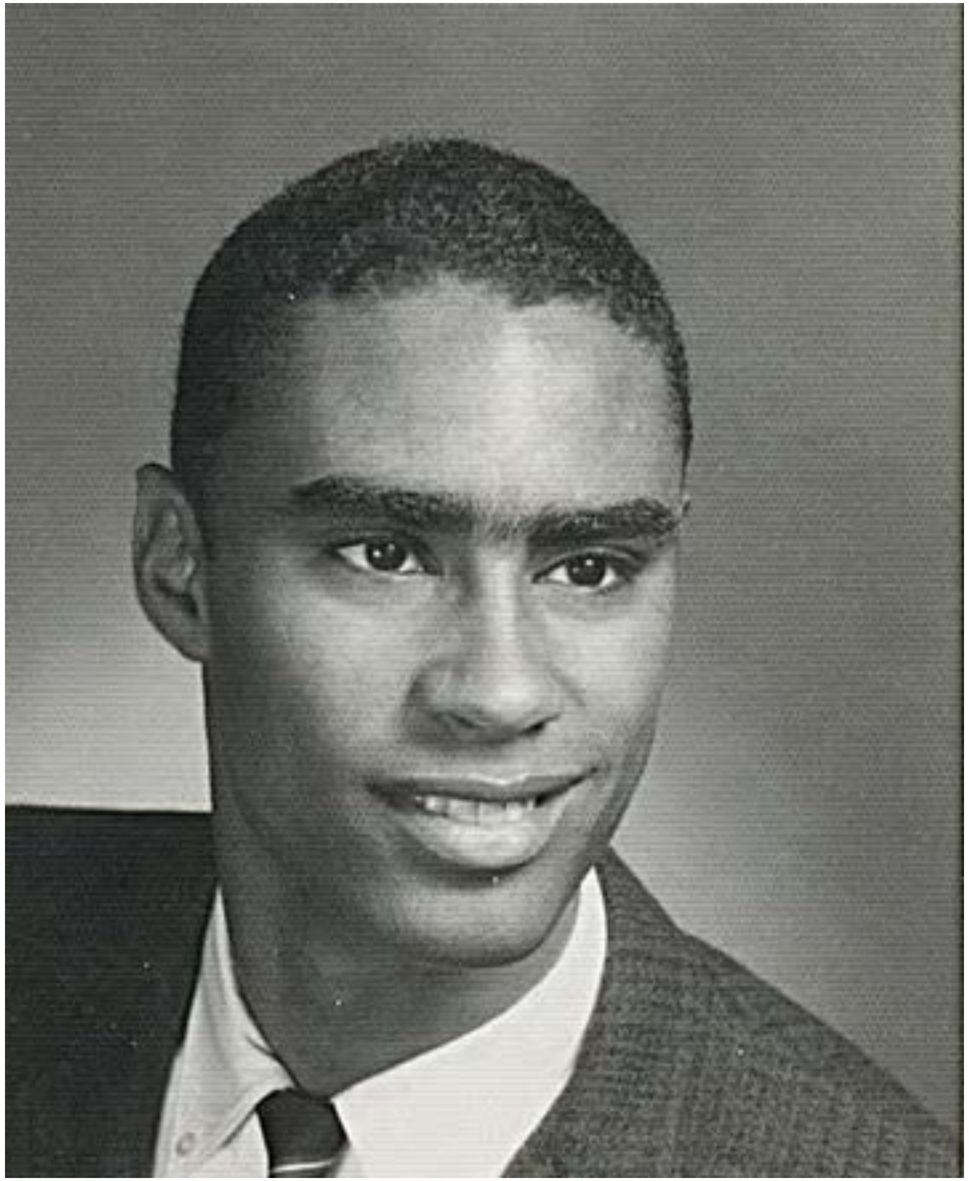

University of Colorado Boulder
Be Boulder.

OUTLINE

- BEGINNINGS AND INFLUENCES
- RETROSPECTIVE OF A LIFE IN ACADEME
- EXPERIMENTS IN NO REDUCTION
- EXPERIMENTS IN BURNING METALS
- EXPERIMENTS IN FLAME TREATMENT
- EXPERIENCES IN INTERNATIONAL EDUCATION

BEGINNINGS

- Undergraduate Experience at Princeton
- Graduate Experience at Berkeley
- Mentorship Influence



A LIFE IN ACADEME AT BOULDER

- TEACHING AND LEARNING
- RESEARCH ADMINISTRATION
- ACADEMIC ADMINISTRATION
- SERVICE TO OTHERS

EXPERIMENTS IN NO REDUCTION

- ORIGIN AND MOTIVATION
- IMPORTANT RESULTS
- INTERPRETATION AND IMPACT

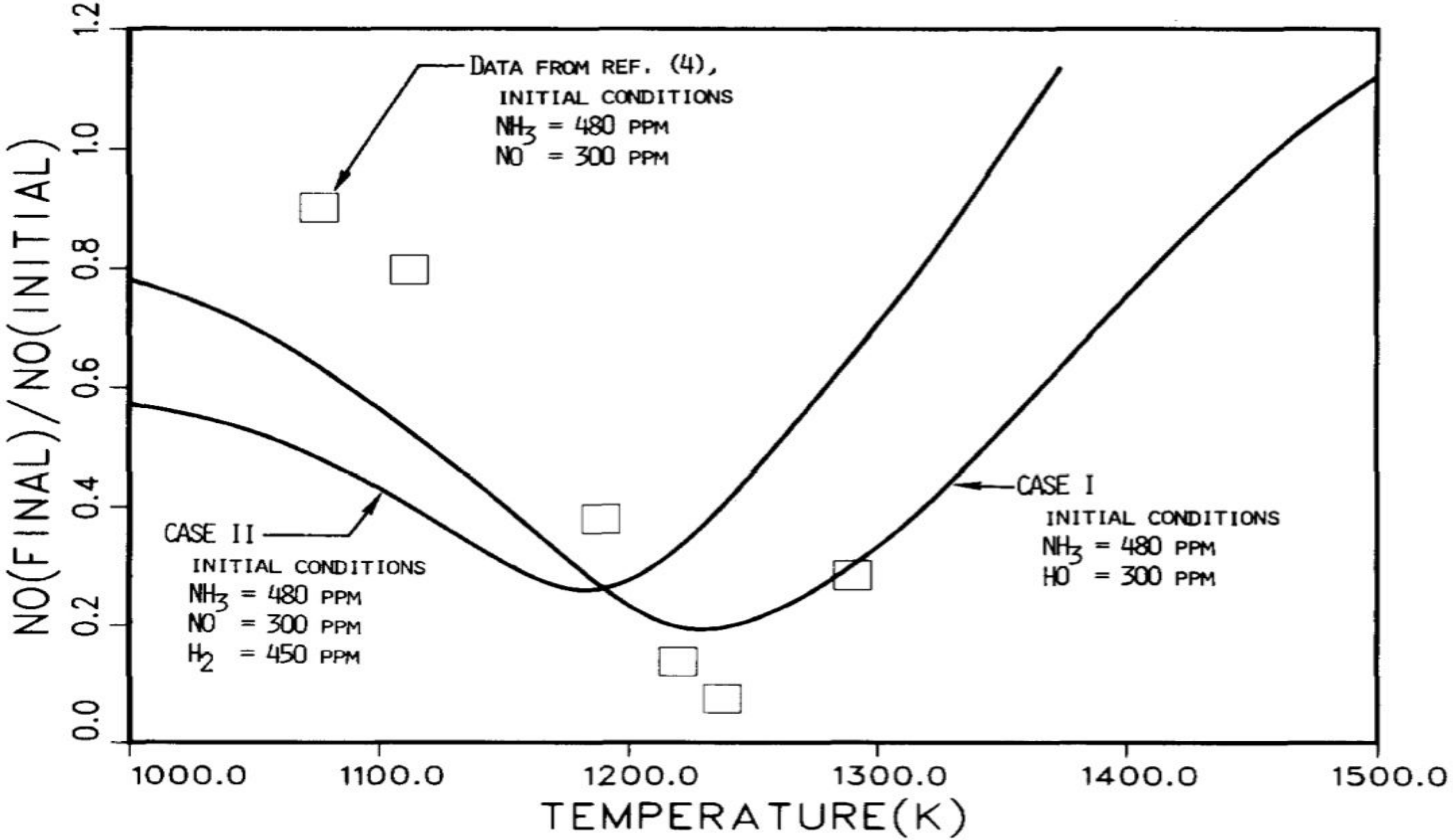


Fig. 2. Computed nitric oxide reduction at time $t = 0.70$ sec as a function of temperature compared to Muzio's [4] experimental results. Cooling rate for the calculations was $dT/dt = -100$ K/sec. Excess oxygen = 4%.

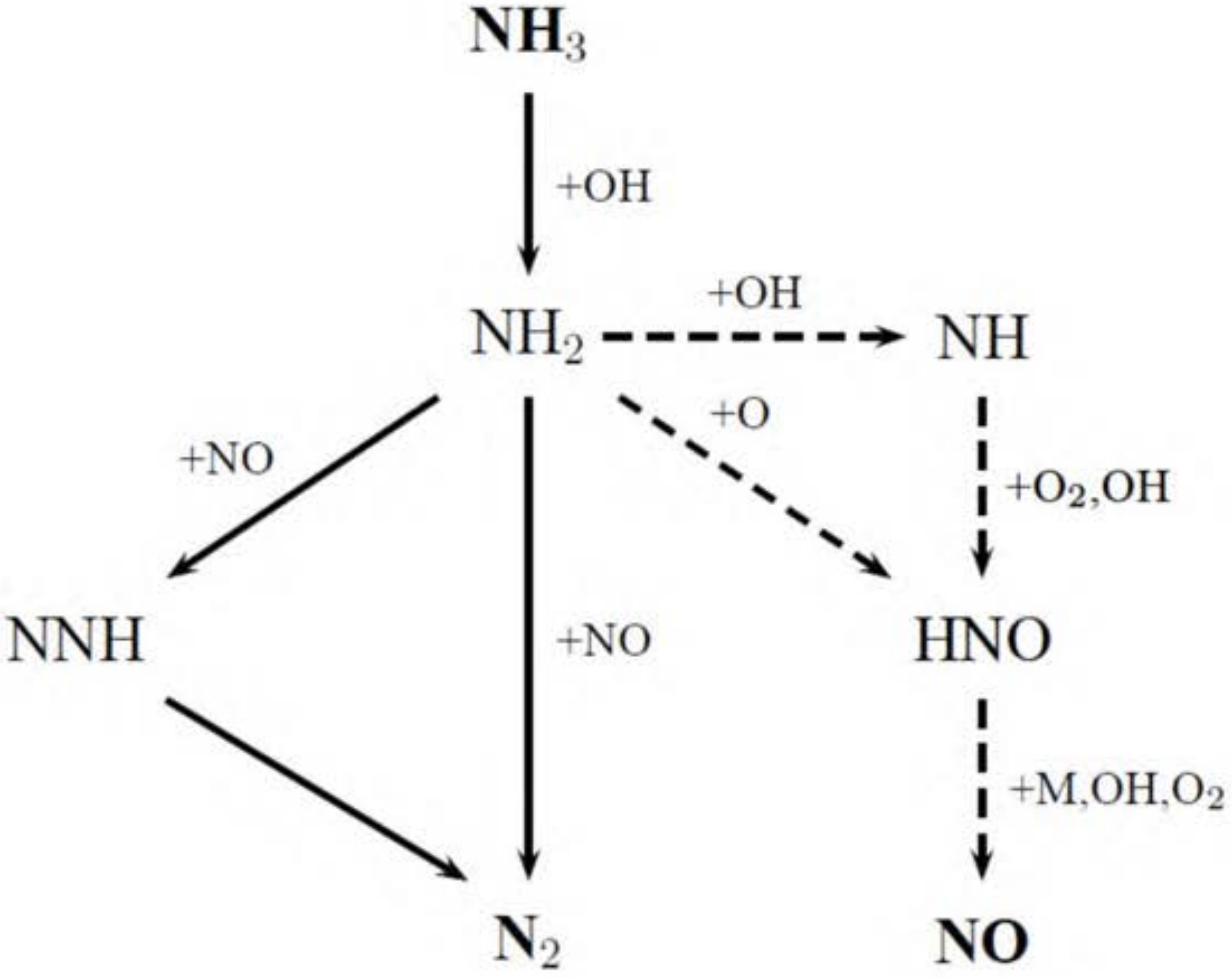
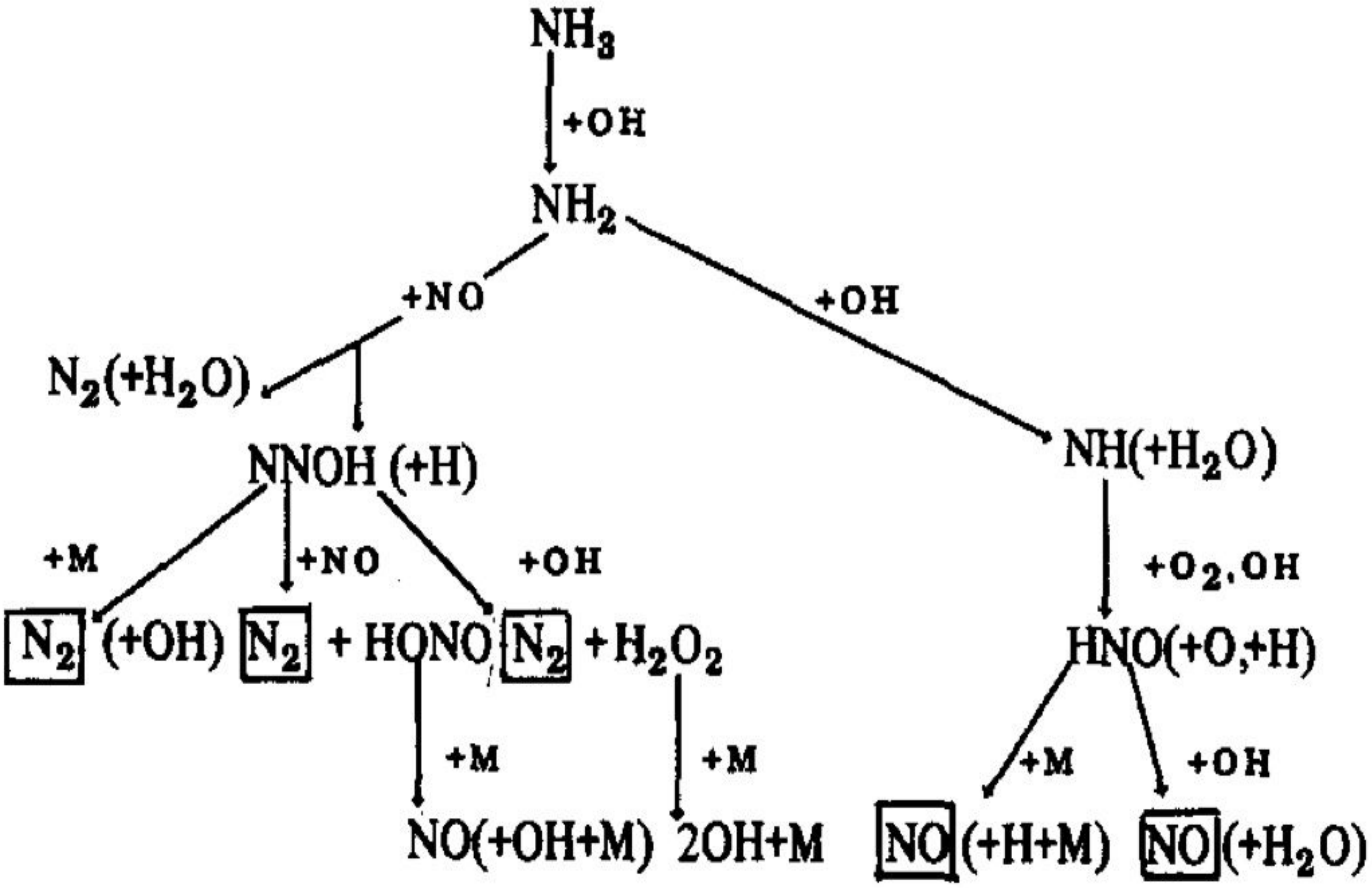


Figure 31: Reaction path diagram for the Thermal $DeNO_x$ process. Dashed lines denote pathways only important at high temperatures.


NH3
+OH
NH2
+NO
+OH
N2(+H2O)
NNOH (+H)
NH(+H2O)
+M
+NO
+OH
+O2,OH
N2 (+OH) N2 + HONO N2 +H2O2
HNO(+O,+H)
+M
+M
+M
+OH
NO(+OH+M) 2OH+M NO(+H+M) NO(+H2O)

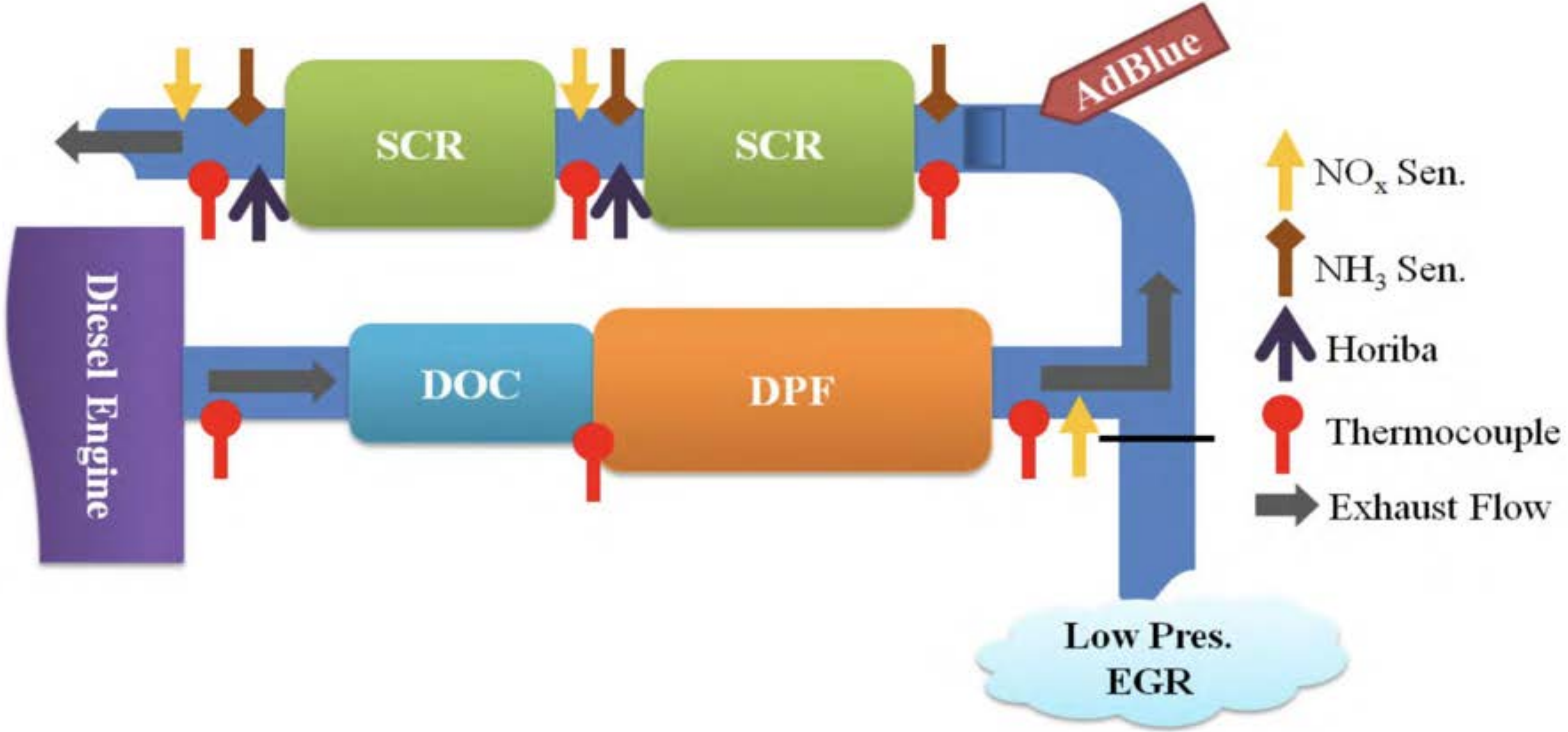
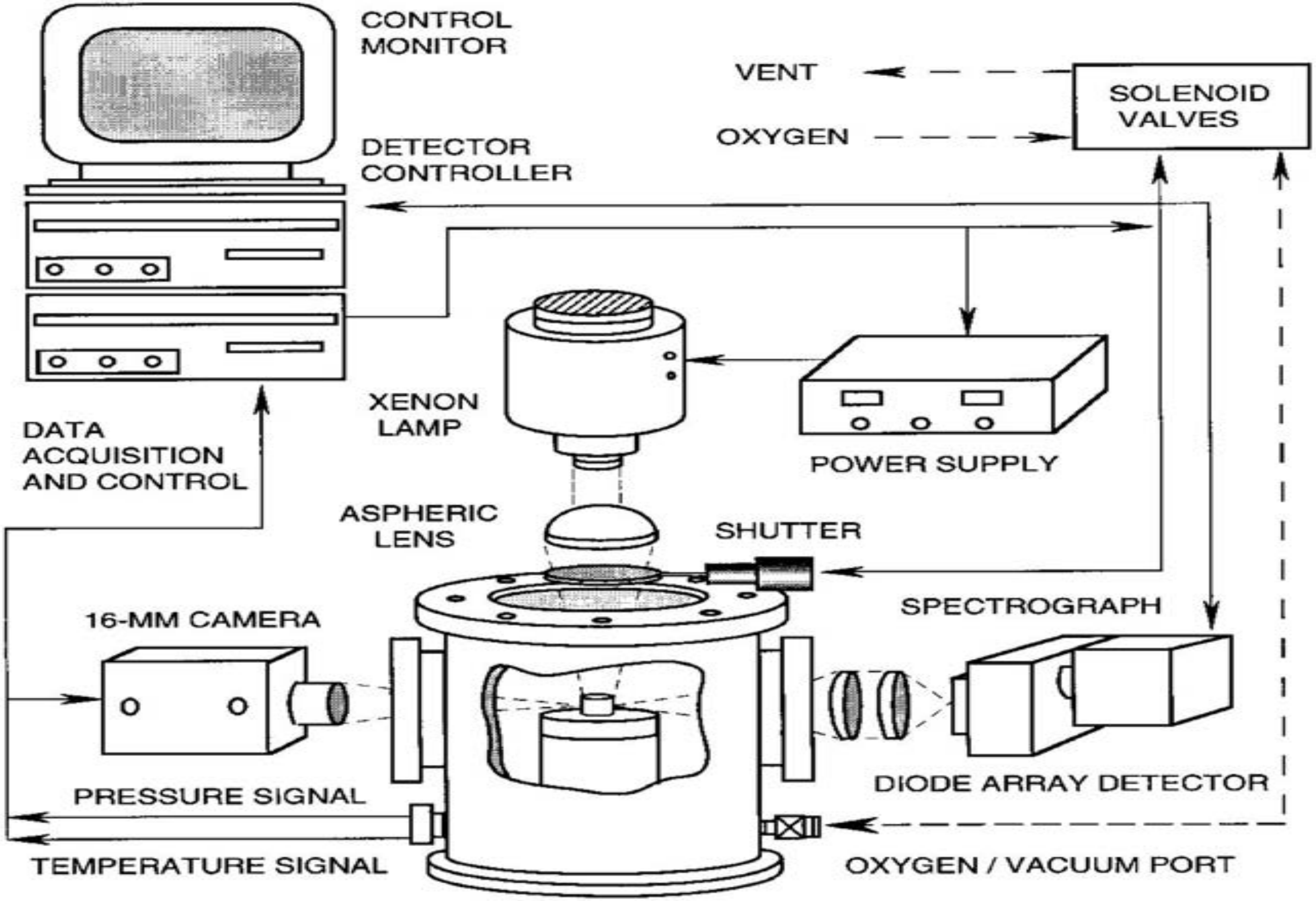
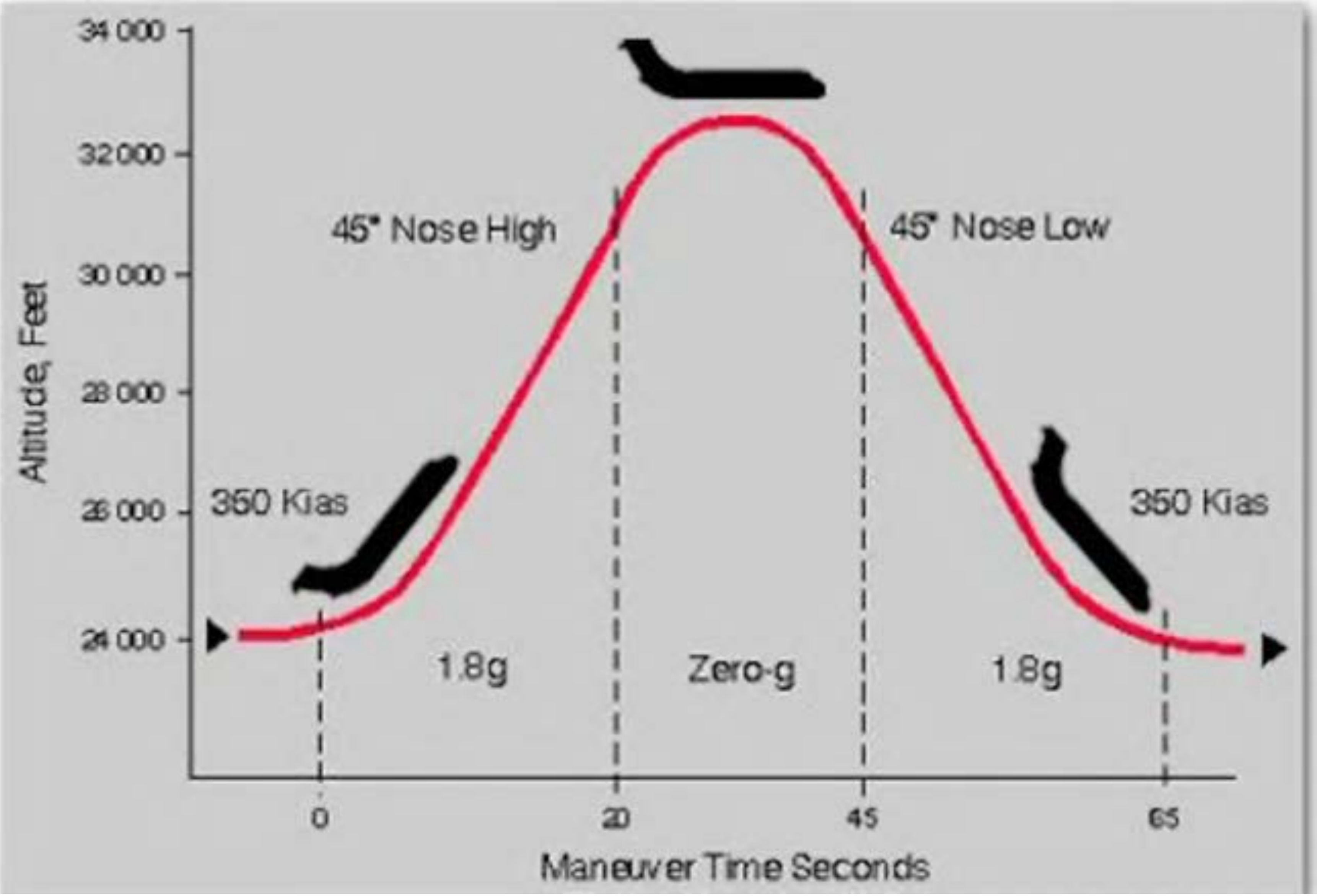


Figure 3. Schematic presentation of the experiment setup

EXPERIMENTS IN METAL COMBUSTION

- ORIGIN AND MOTIVATION
- IMPORTANT RESULTS
- INTERPRETATION AND IMPACT


CONTROL
MONITOR
VENT
SOLENOID
VALVES
OXYGEN
DETECTOR
CONTROLLER
XENON
LAMP
POWER SUPPLY
DATA
ACQUISITION
AND CONTROL
ASPHERIC
LENS
SHUTTER
SPECTROGRAPH
16-MM CAMERA
DIODE ARRAY DETECTOR
PRESSURE SIGNAL
TEMPERATURE SIGNAL
OXYGEN / VACUUM PORT



34 000
32 000
30 000
28 000
26 000
24 000
Altitude, Feet
45° Nose High
45° Nose Low
350 Kias
350 Kias
1.8g
Zero-g
1.8g
0
20
45
65
Maneuver Time Seconds

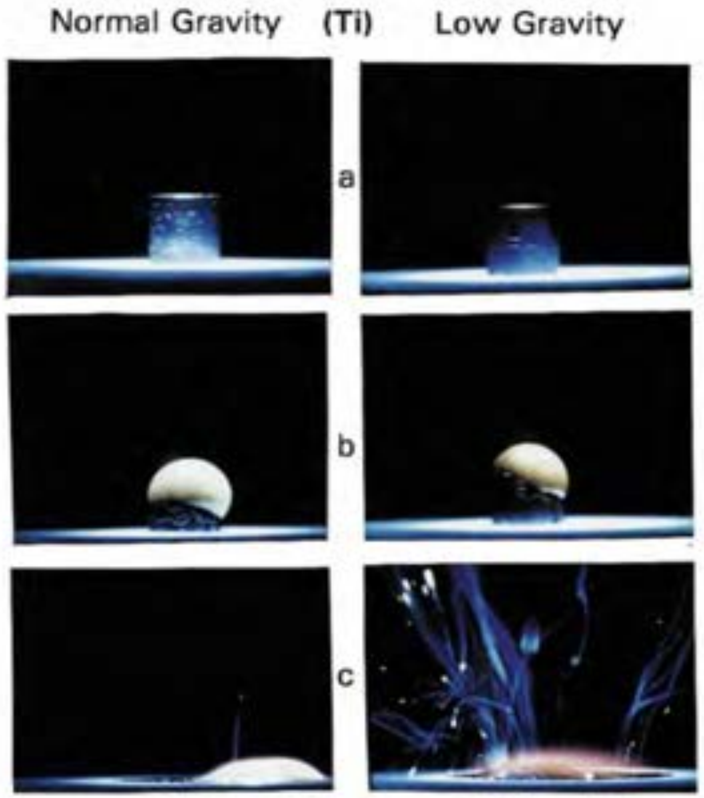


FIG. 3. Sequence of high-speed photographs of the heating, ignition, and combustion events of bulk Ti specimens in pure O_2 at 1 atm under normal and low gravity conditions. (a) Heating and surface oxidation (around 1400 K); (b) steady-state propagation (200 ms after ignition); (c) particle shower and fragmentation during combustion.

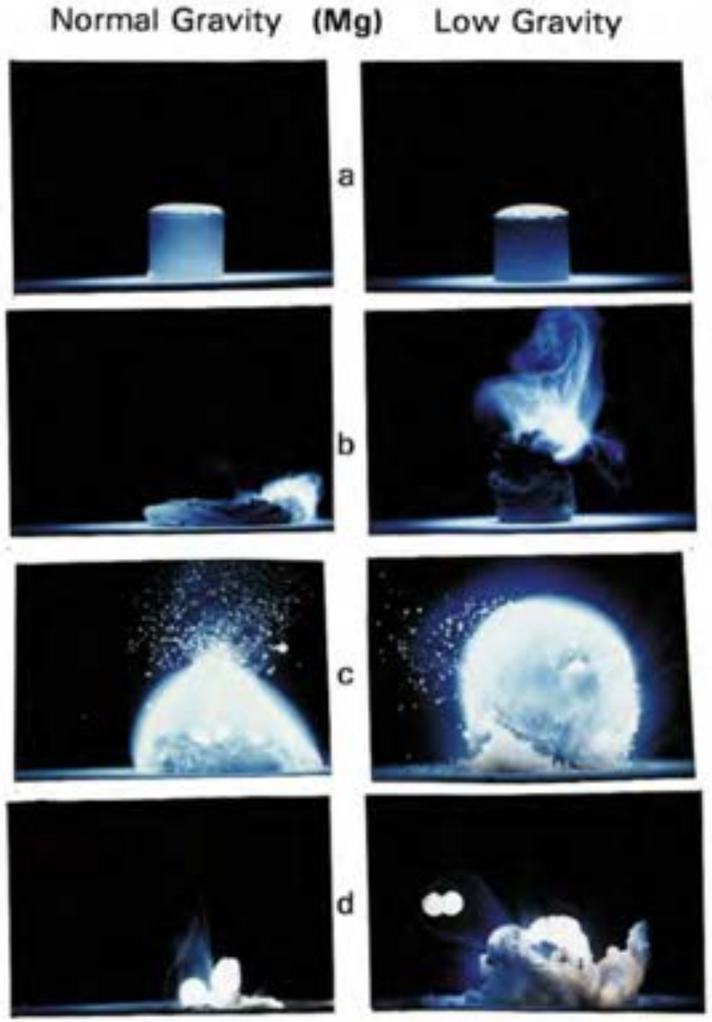


FIG. 4. Sequence of high-speed photographs of the heating, ignition, and combustion events of bulk Mg specimens in pure O_2 at 1 atm under normal and low gravity conditions. (a) Beginning of melting stage (around 923 K); (b) ignition wave propagation (7 ms after ignition); (c) fully developed combustion; (d) end of combustion.

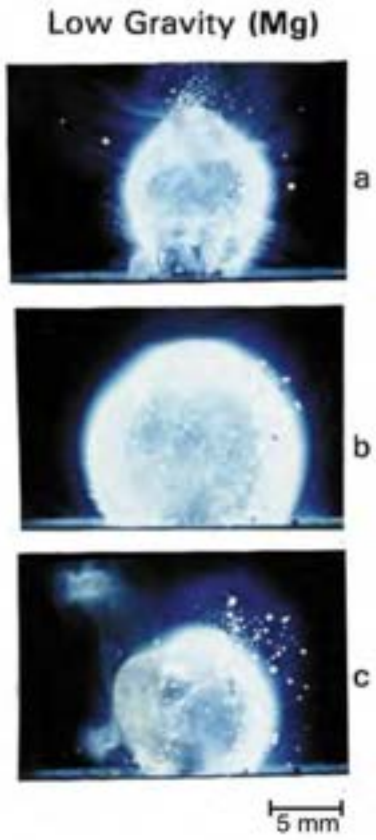
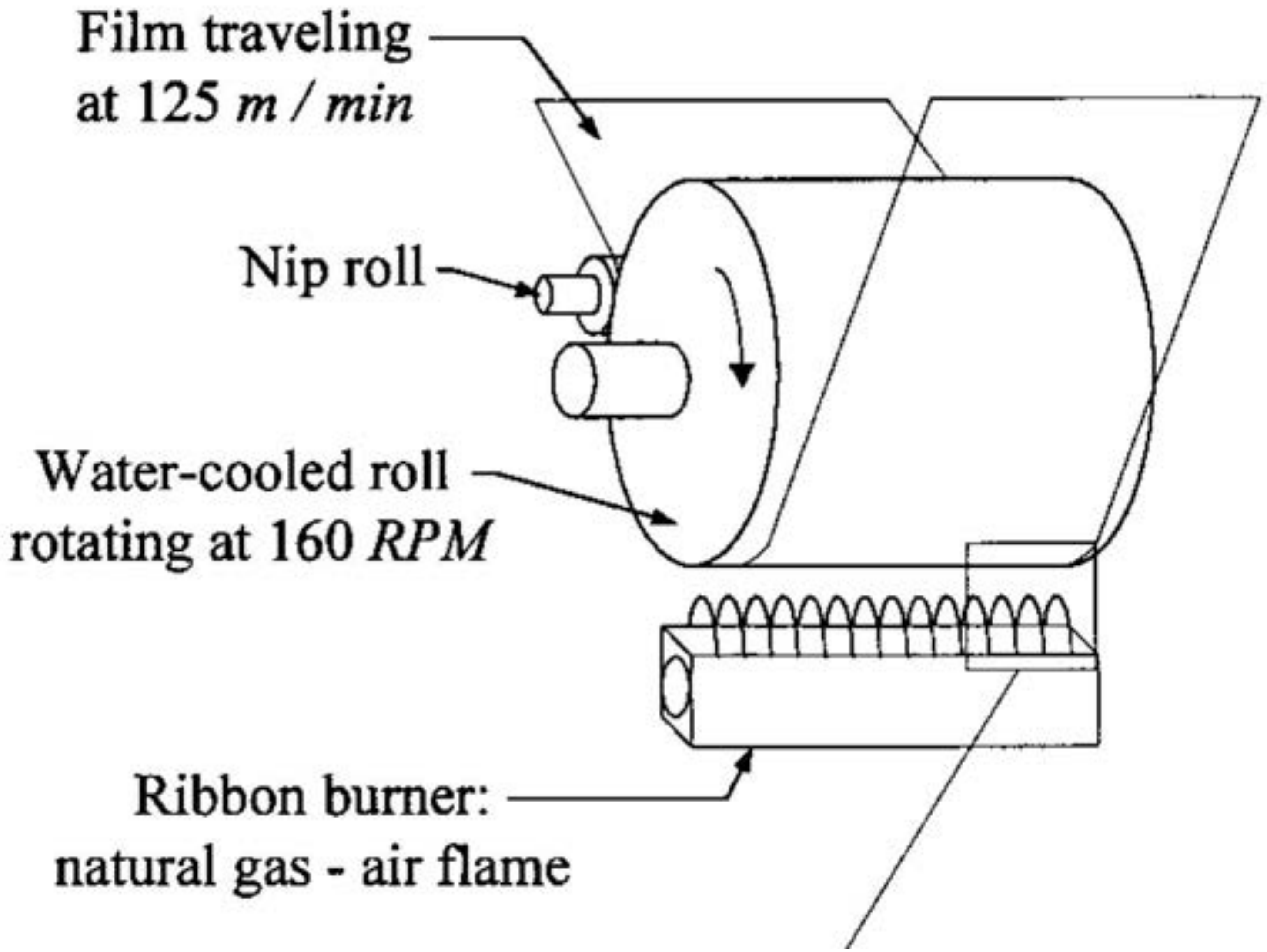


FIG. 5. Radiation-Induced Metal Explosion (RIME) in a bulk Mg specimen at low gravity. (a) Start of cycle; (b) maximum flame diameter; (c) oxide layer explosion.

EXPERIMENTS IN FLAME TREATMENT

- ORIGIN AND MOTIVATION
- IMPORTANT RESULTS
- INTERPRETATION AND IMPACT


Film traveling
at 125 m / min
Nip roll
Water-cooled roll
rotating at 160 RPM
Ribbon burner:
natural gas - air flame

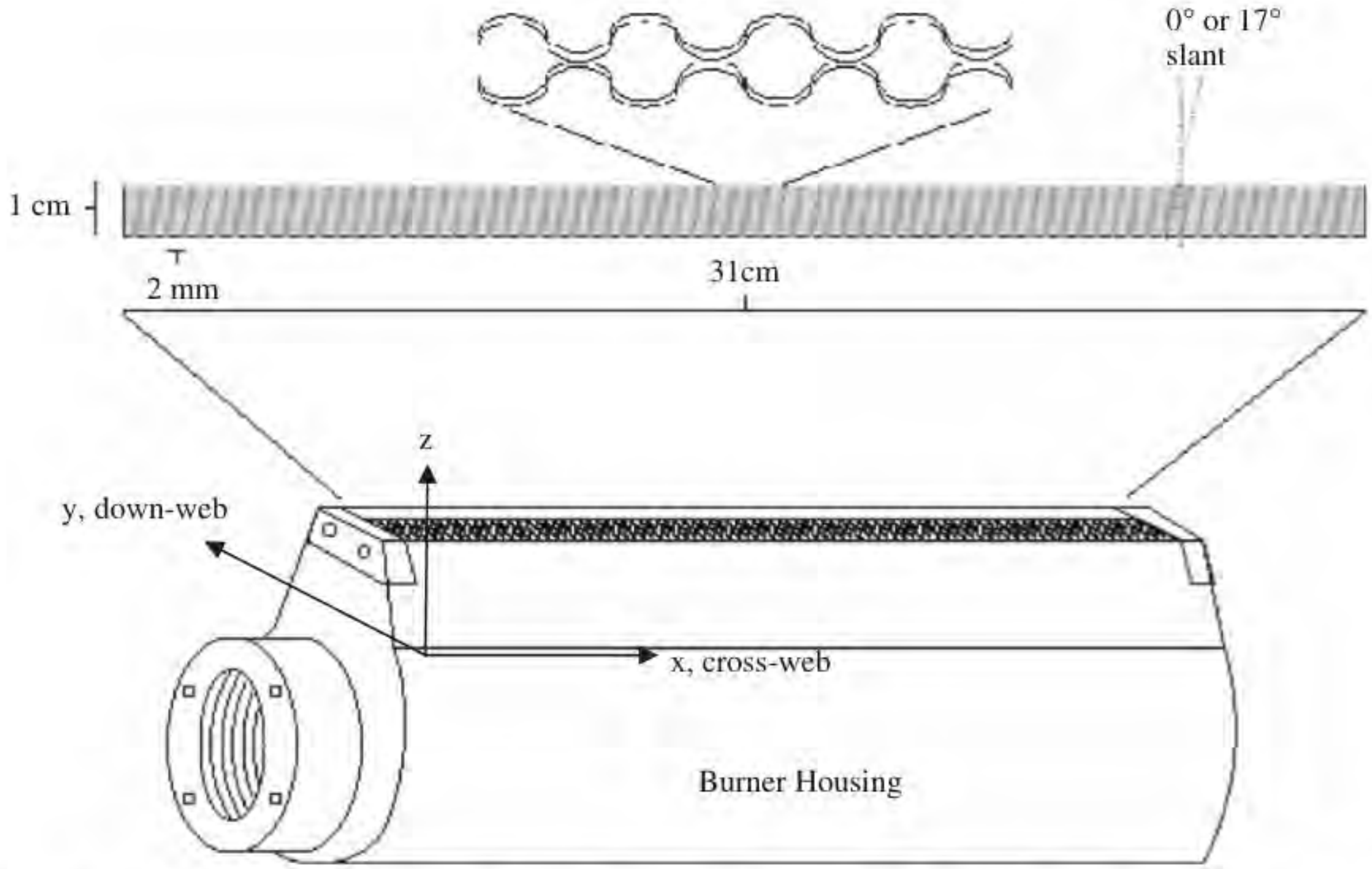


Fig. 2. Side view showing burner housing and top view of ribbon placement along with the orientation of experimental axes. Direction *x* is cross-web and direction *y* is down-web (−*y* is up-web).

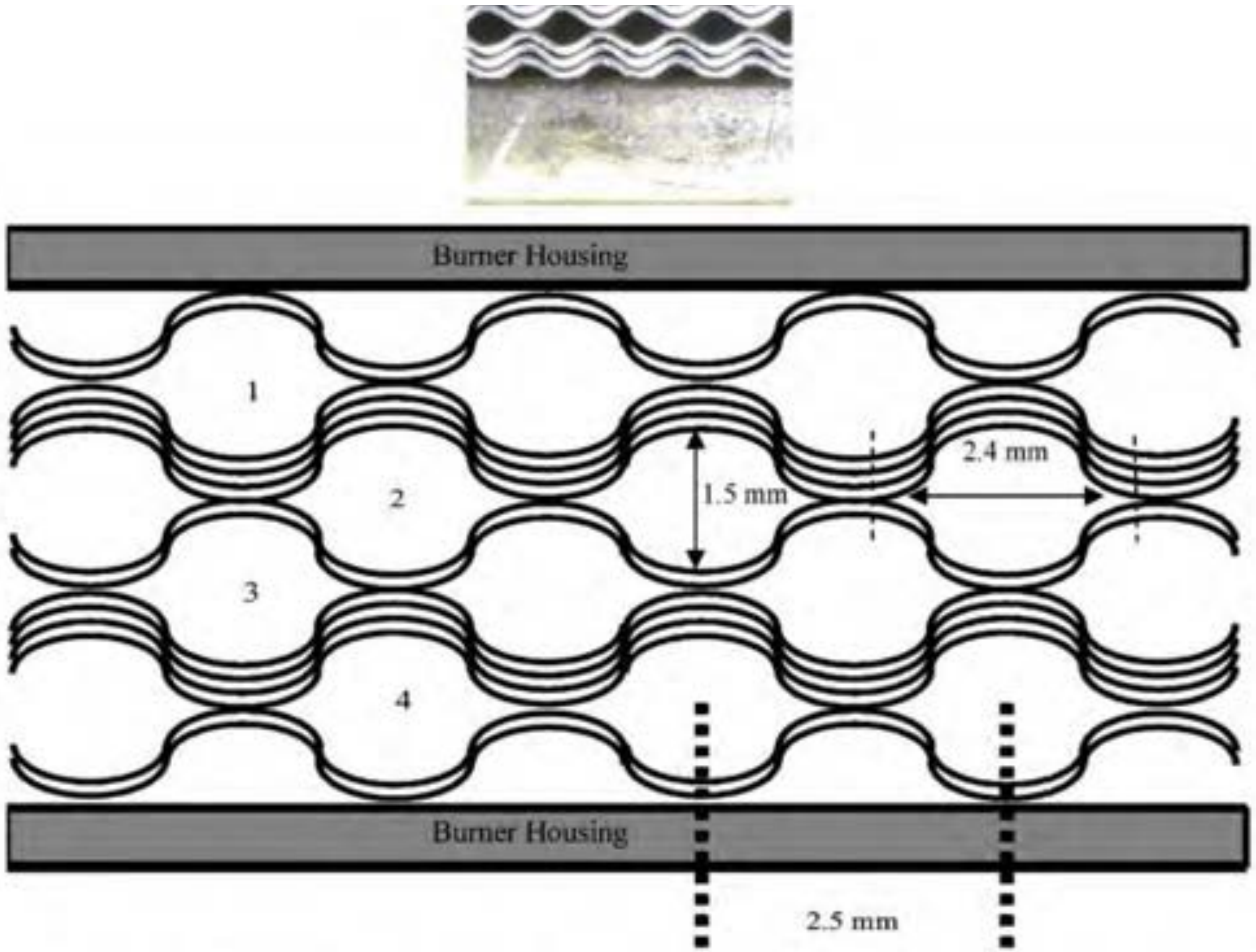
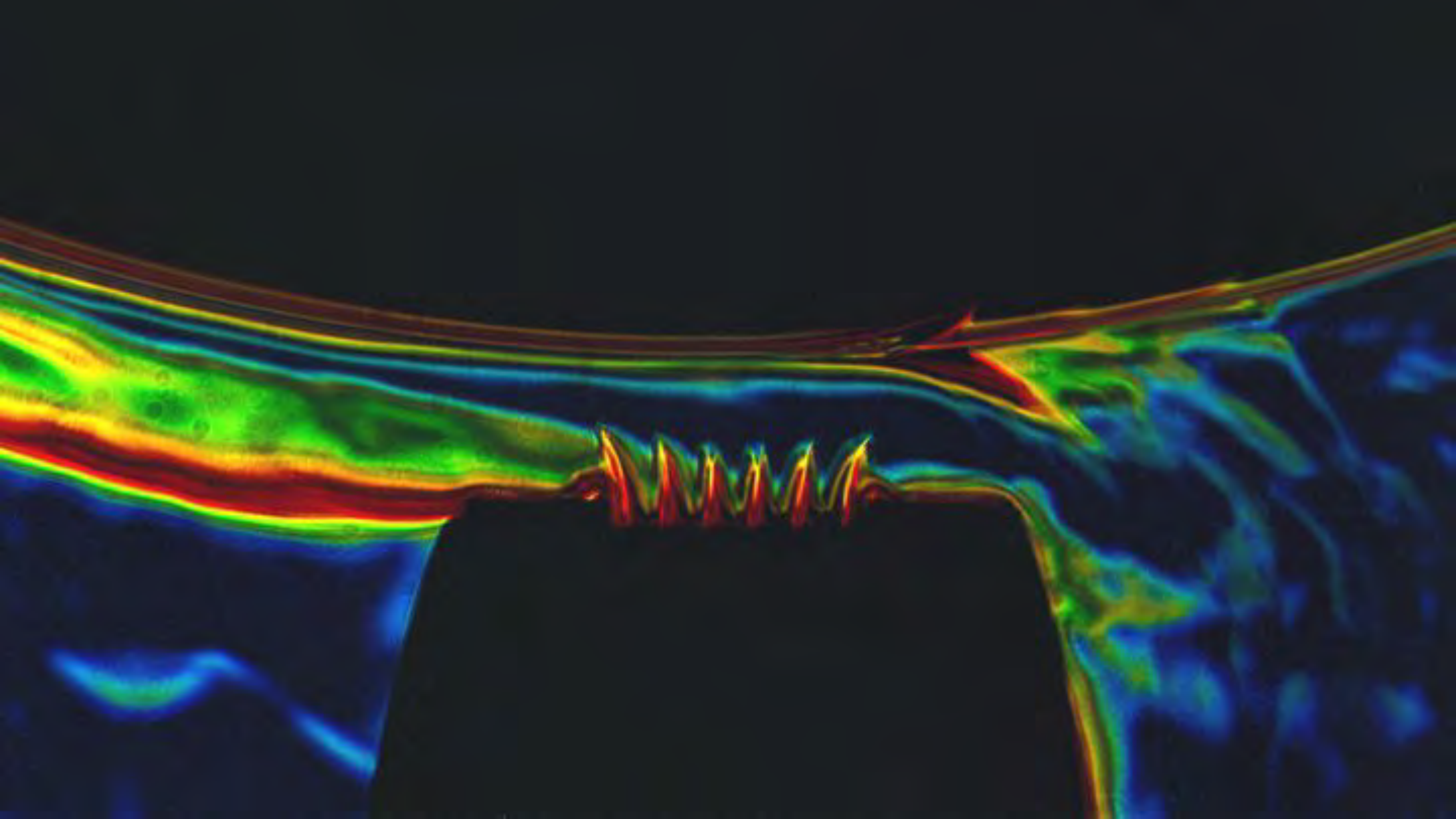


Fig. 1. A photograph coupled with a schematic diagram of the ribbon burner showing port nomenclature. Ports 1 and 4 are primer ports, while ports 2 and 3 are main ports. Ports 1 and 3 form the upstream pair of burner outlets, while ports 2 and 4 form the downstream pair.



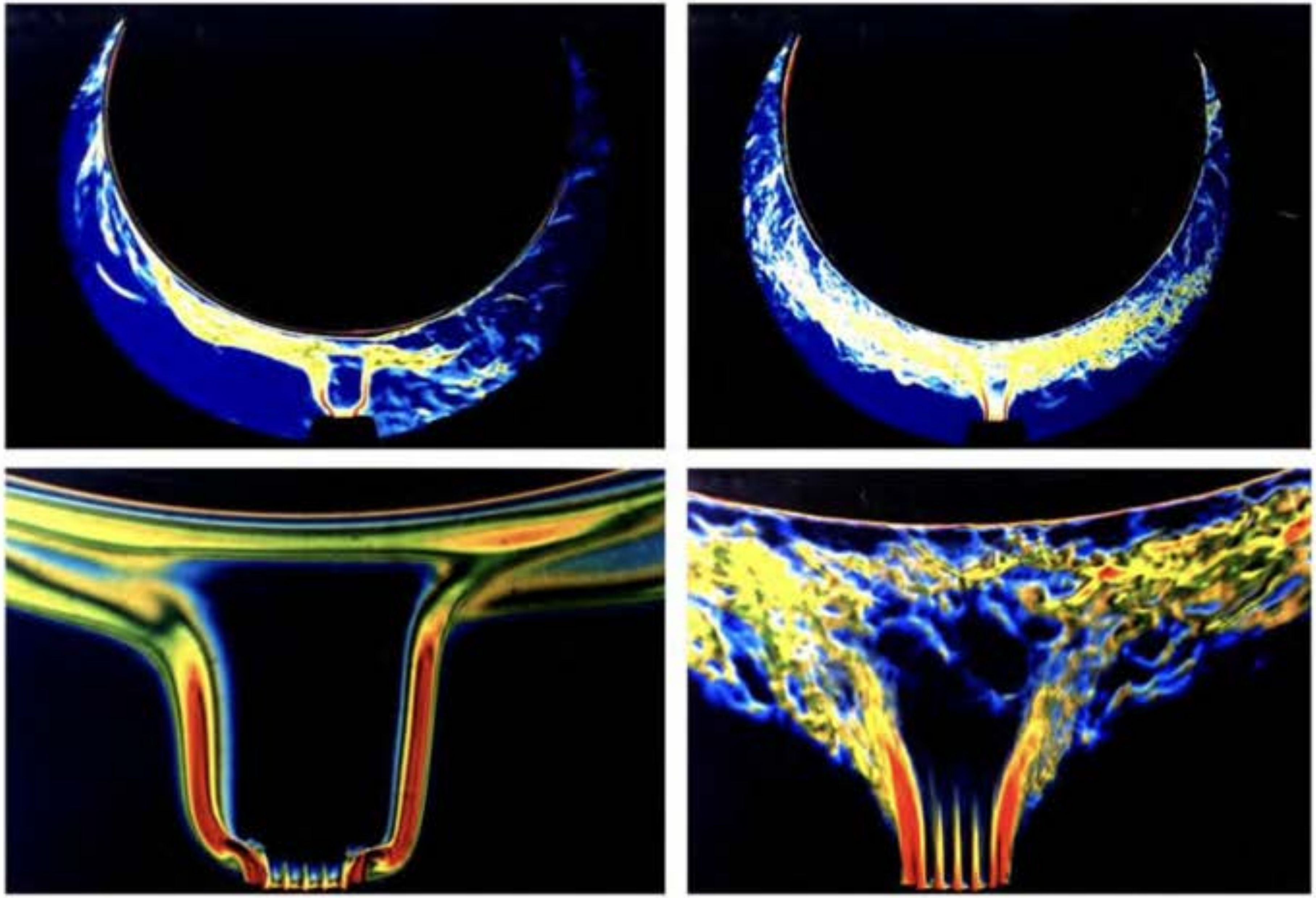


Fig. 3. Schlieren images of non-impinging conditions (50 mm gap) for a 4-port burner with a clockwise roll rotation of 0.785 m/s: left Images—low flame power (309 W/cm^2) and right Images—high flame power (1570 W/cm^2).

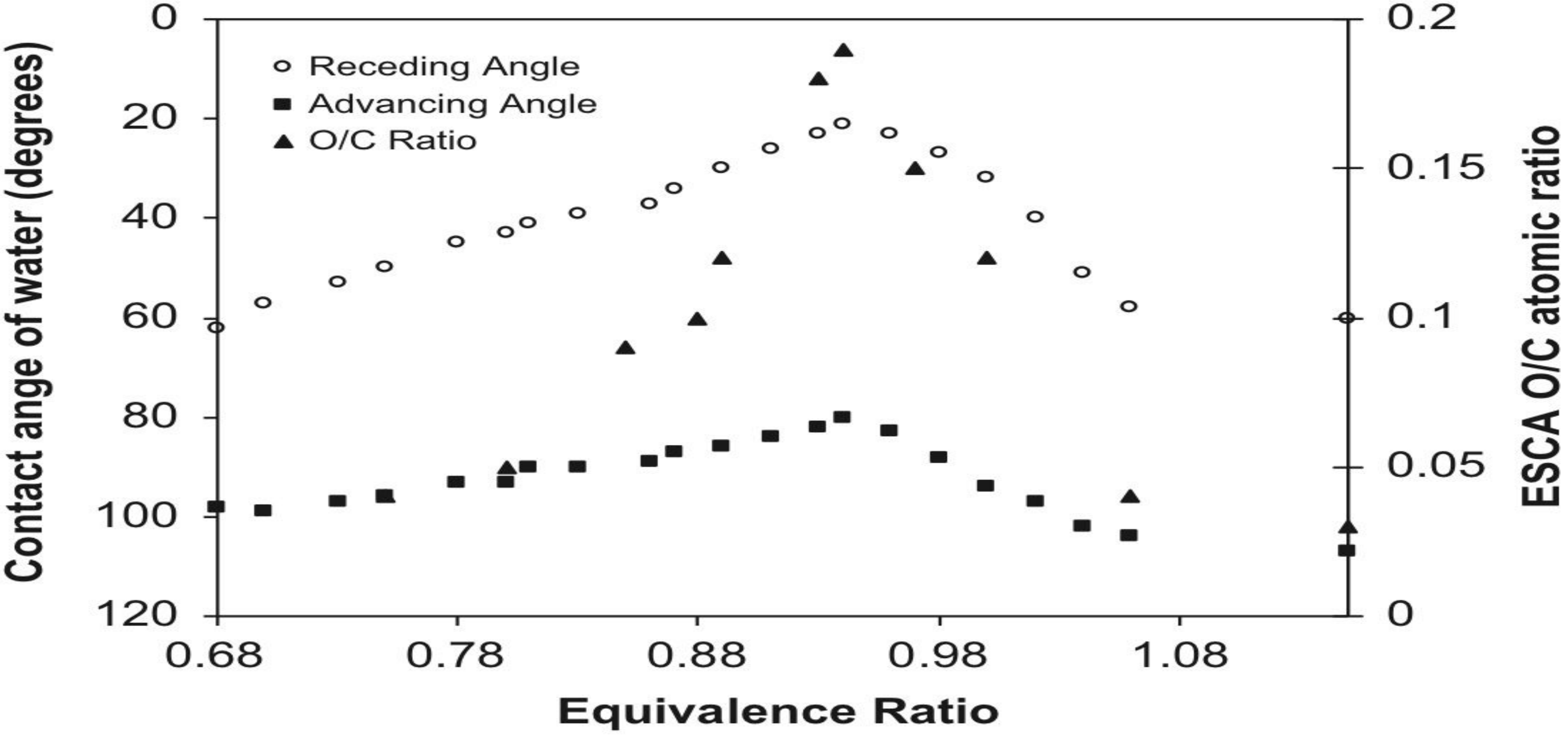


Fig. 8. Plot of the ESCA O/C atomic ratio and the contact angles of water on flame-treated polypropylene as a function of the equivalence ratio with a constant burner-to-film separation of 5 mm. Optimum treatment occurs at $\varphi = 0.93$ where oxidizing-species concentrations are at a maximum.

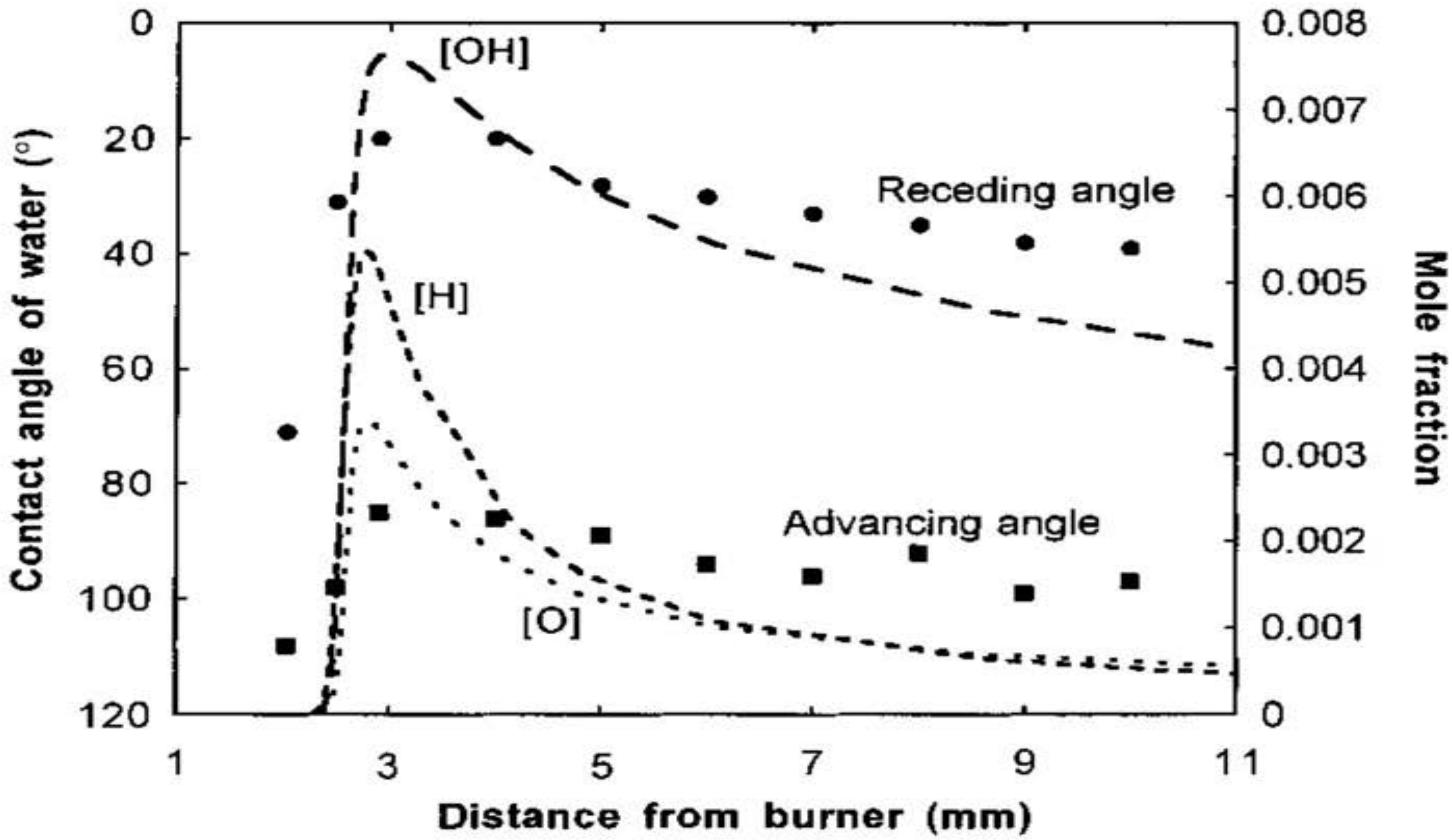


FIG. 4. The advancing and receding contact angles of water on flame-treated polypropylene and PREMIX calculated O, OH, and H mole fractions as a function of dis-


Scotch® Magic™
Tape
Matte Finish
Magic™ Tape
3/4 IN × 300 IN (8.3 YD)
19 mm × 7,62 m
Scotch
3M

EXPERIENCES IN INTERNATIONAL ACCREDITATION

- WHAT IS ACCREDITATION?
- HOW IS IT DONE?
- WHAT ARE THE RESULTS?


School Bus
NISSAN
I 71670

A LIFE IN TRAVEL

- A LIFELONG PASSION
- WHAT I HAVE LEARNED
- THE VALUE OF EXPERTISE

"These smug pilots have lost touch with regular passengers like us.
Who thinks I should fly the plane?"

Combustion: Past, Present and Future

Vaclav Smil,“How the World Really Works,” 2022

Four materials form the basis of Modern Civilization: Cement, Steel, Plastics and Ammonia

All depend on burning fossil fuels, for which there are no readily available substitutes.