Numerical simulation of 2D scramjet combustor flow field

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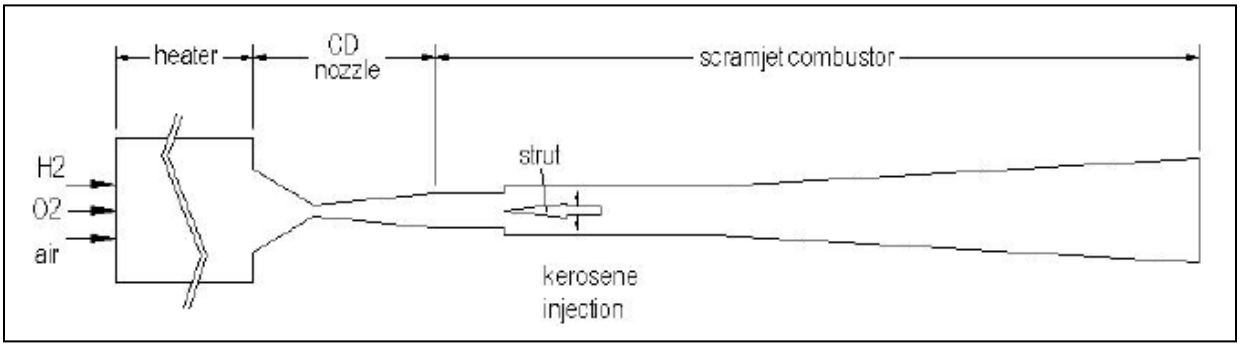
Overview of presentation

- Description of problem
- Mathematical formulation
- Various cases studied
- Results of simulated test condition
- Conclusion

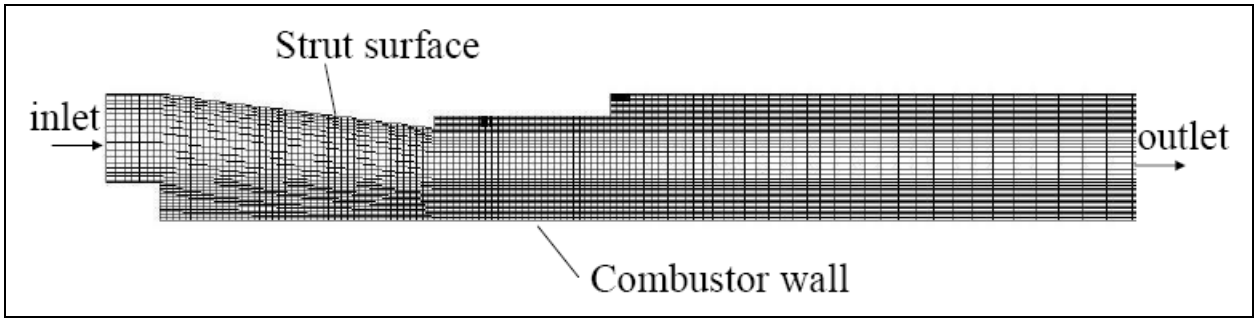
Test setup



Mathematical formulation

- 3D N-S equation
- k- ε turbulence model
- Eddy Dissipation combustion model
- Lagrangiandescription of droplet trajectoriesε

Domain discretisation

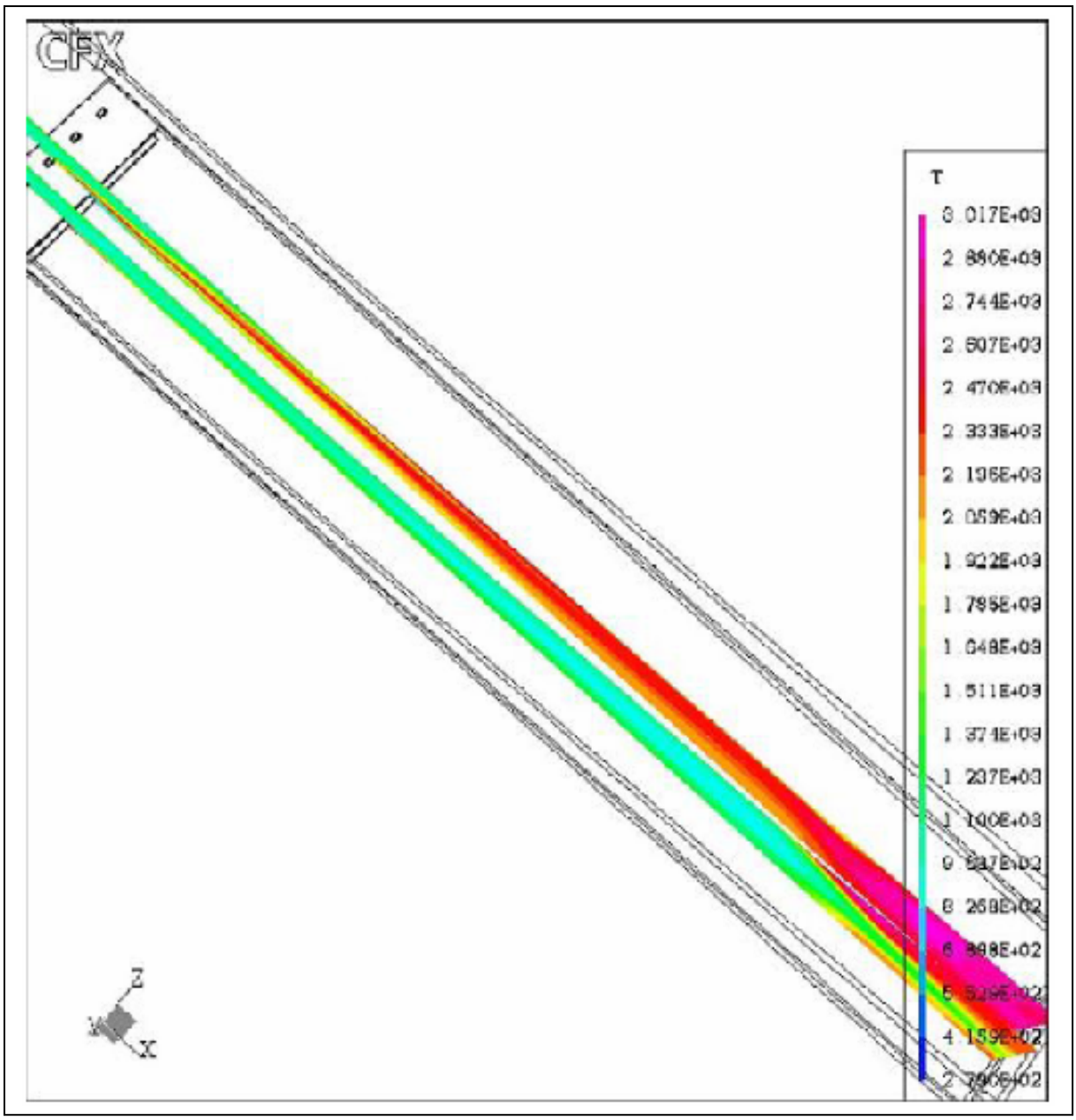


- Half the combustor is considered
- Total number of nodes 199000

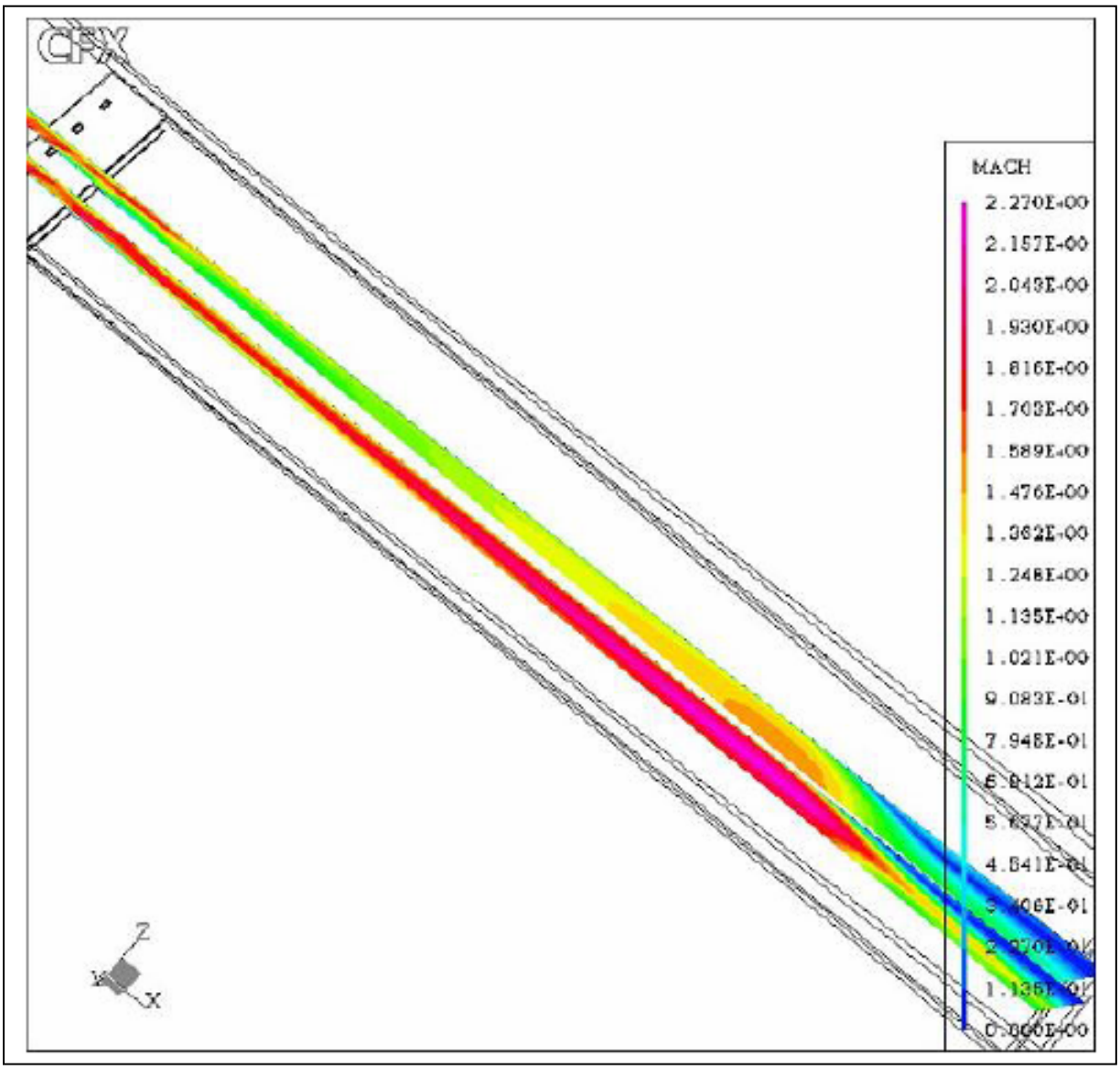
Cases Studied in the 2-D combustor

No of orifices	Mass Flow Rate	Inj. Velocity	Orifice Diameter
2	14	31	0.6
2	20	31	0.7065
2	20	44.17	0.6
4	20	22.05	0.6
4	20	35	0.4768
4	28	31	0.6
4	40	44.1	0.6
6	25	41.44	0.4
6	30	50	0.4

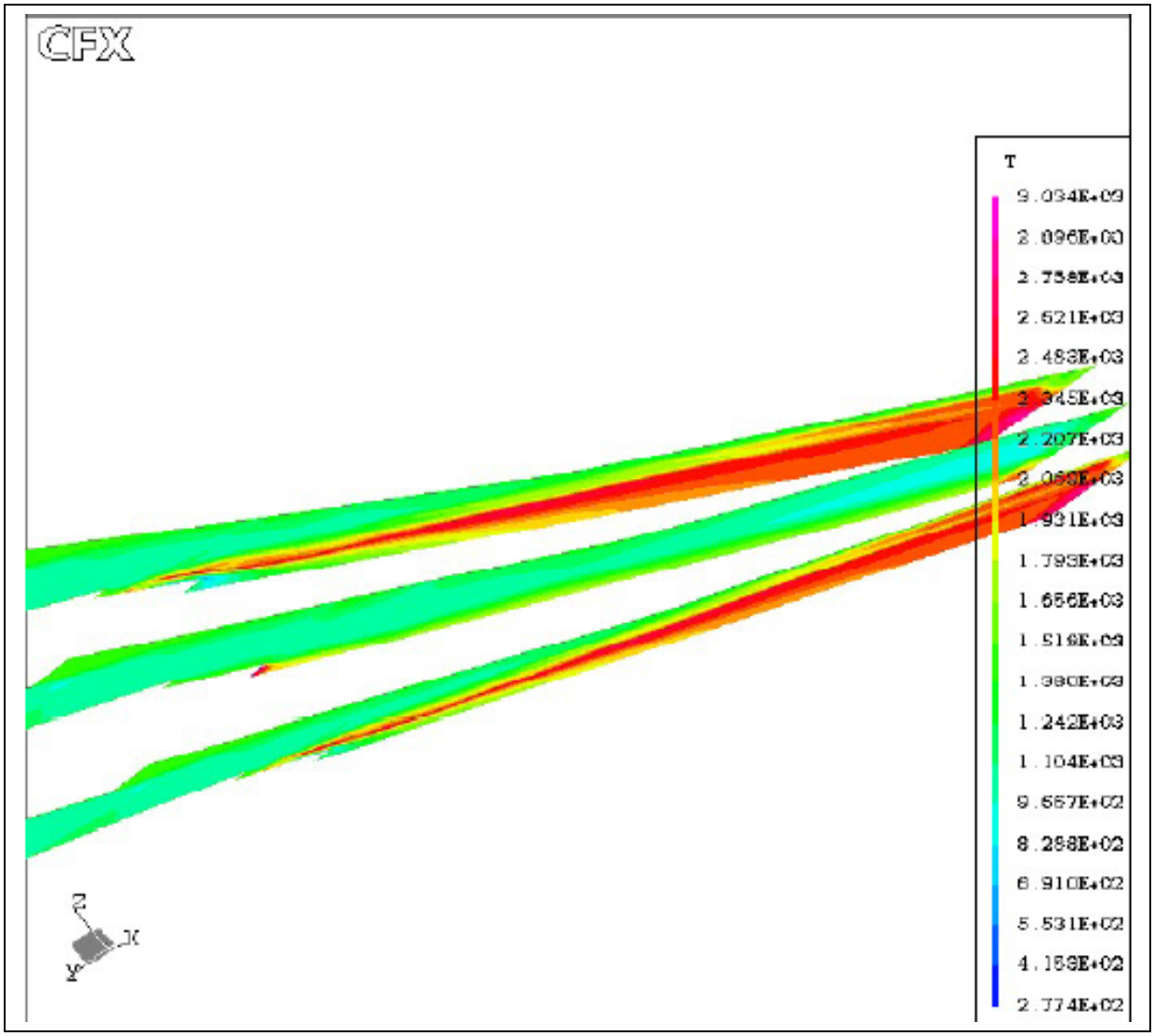
Two hole Injection temperature 20 gm/s fuel



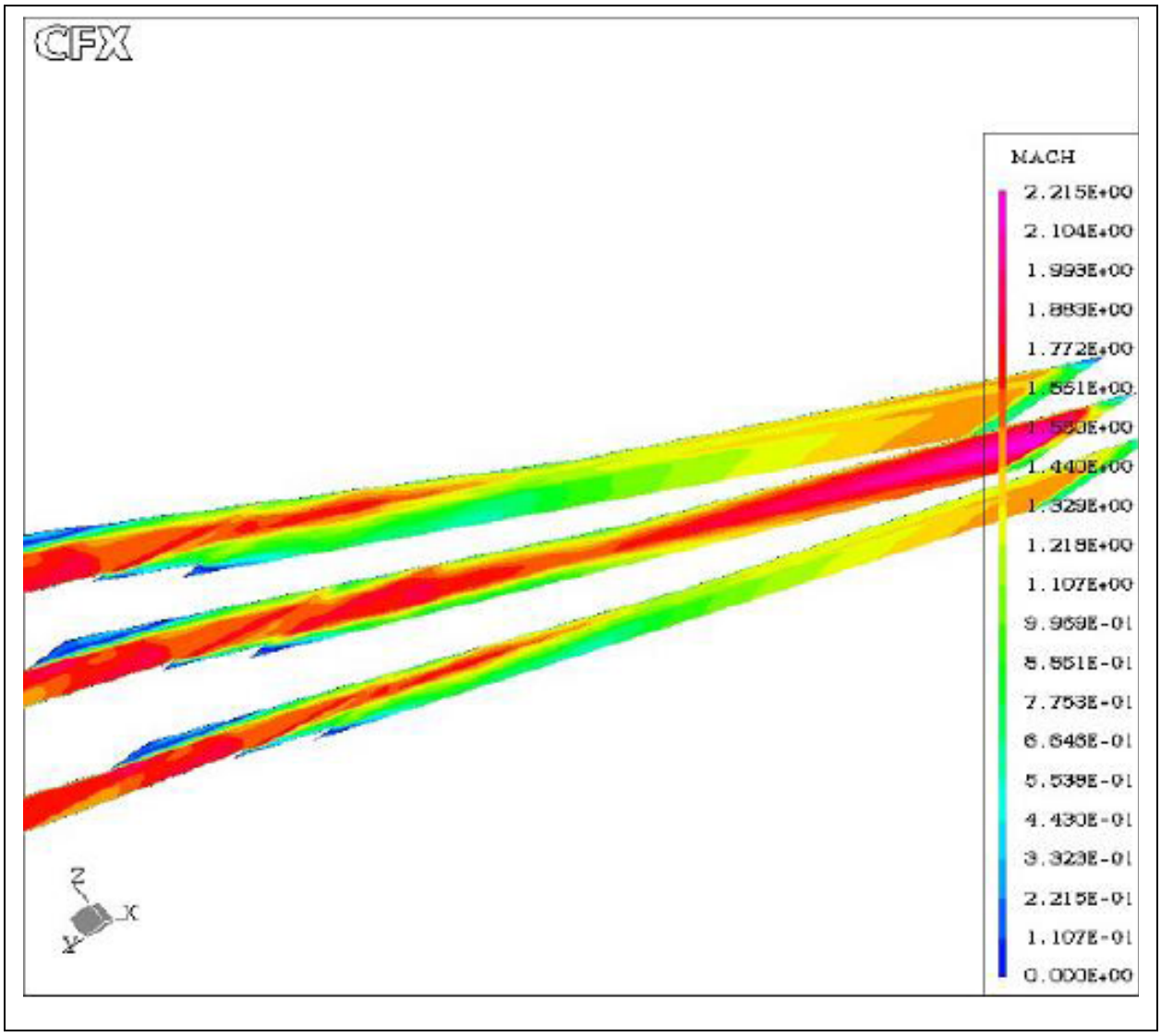
Two hole Injection Mach number 20gm/s fuel



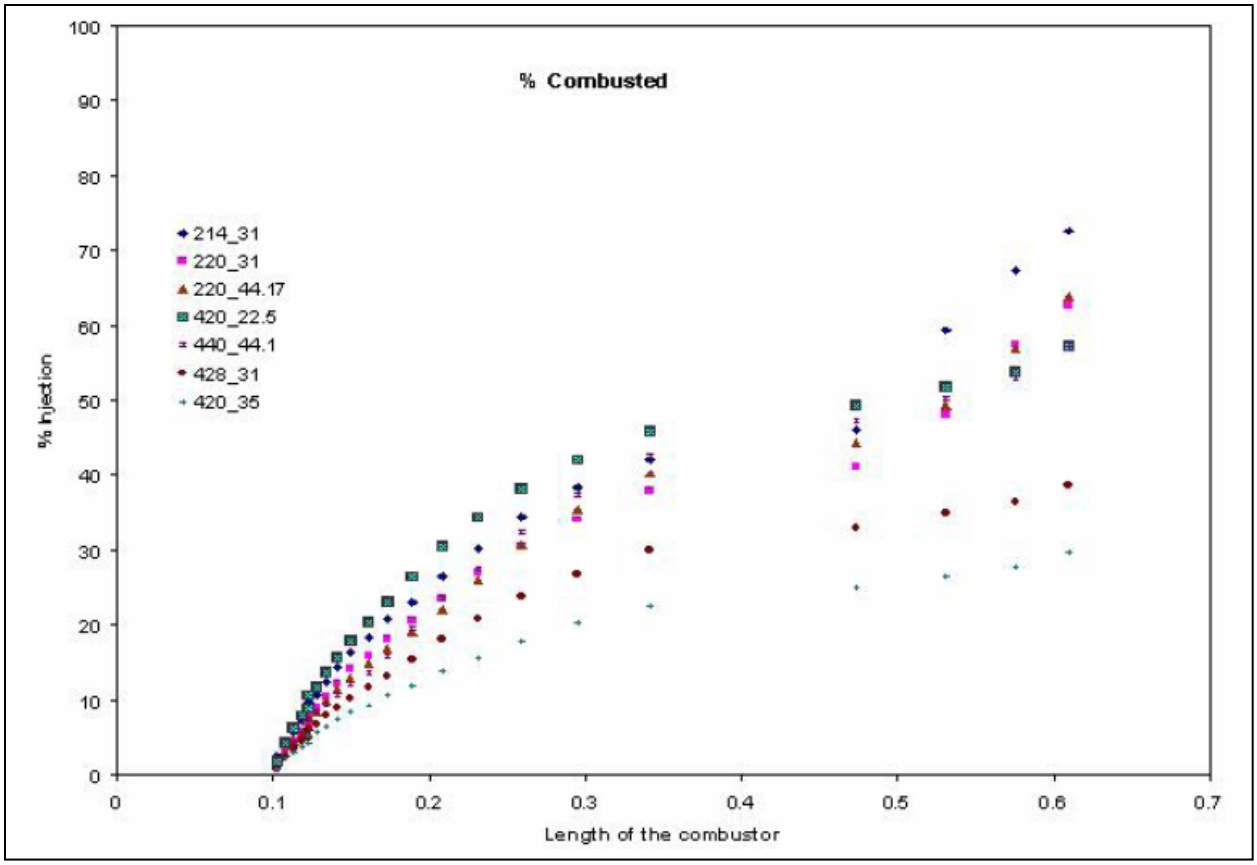
Four holeInjection temperature 40gm/s fuel



Four hole Injection Mach number 40gm/s fuel



Axial variation of Combustion efficiency



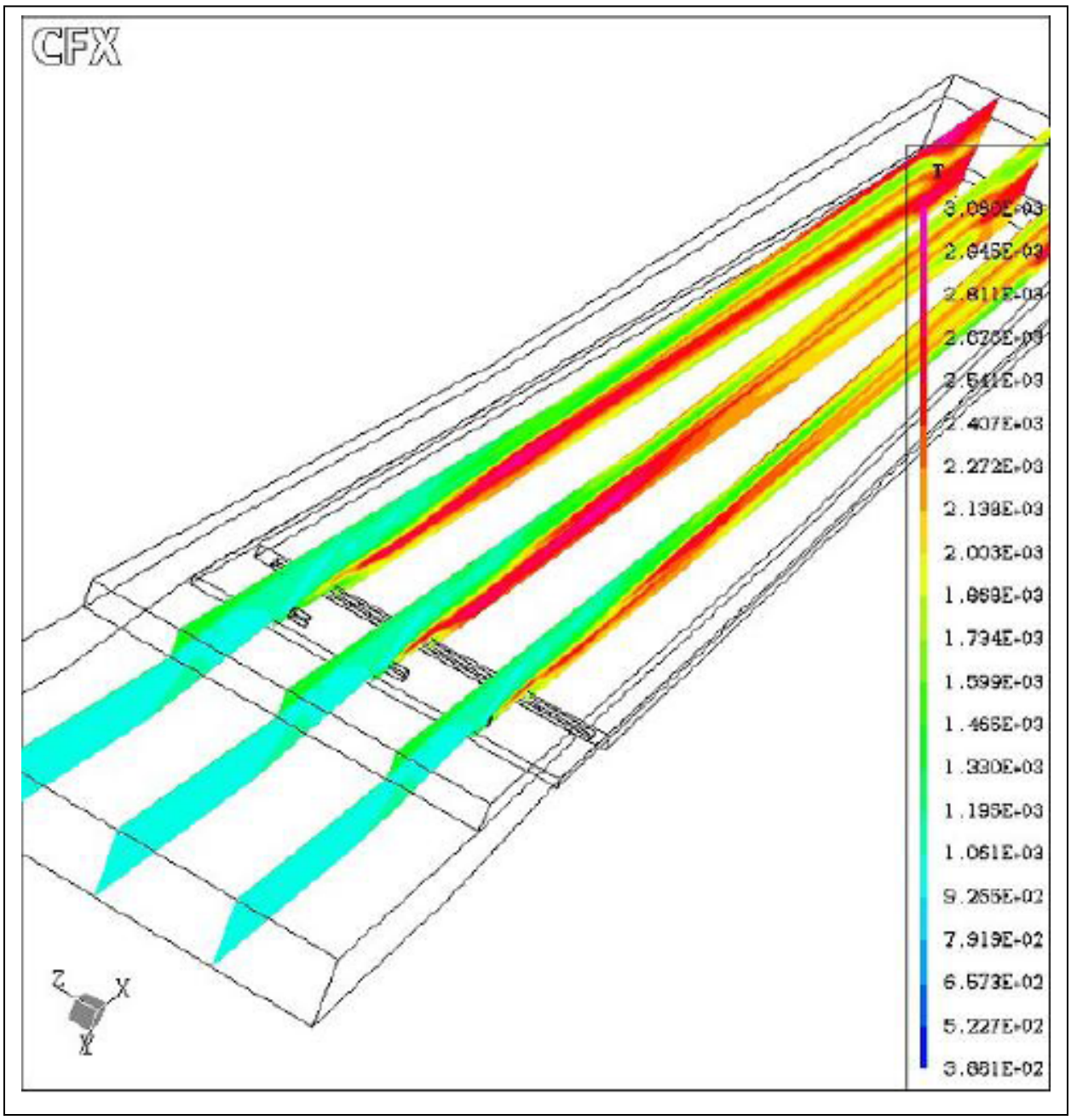
Summary of results for two and four hole injection

- Temperature distribution not satisfactory for all cases
- For higher equivalence ratio, flow decelerates locally to a lower Mach number
- Lower combustion efficiency (<50%)

Remedy

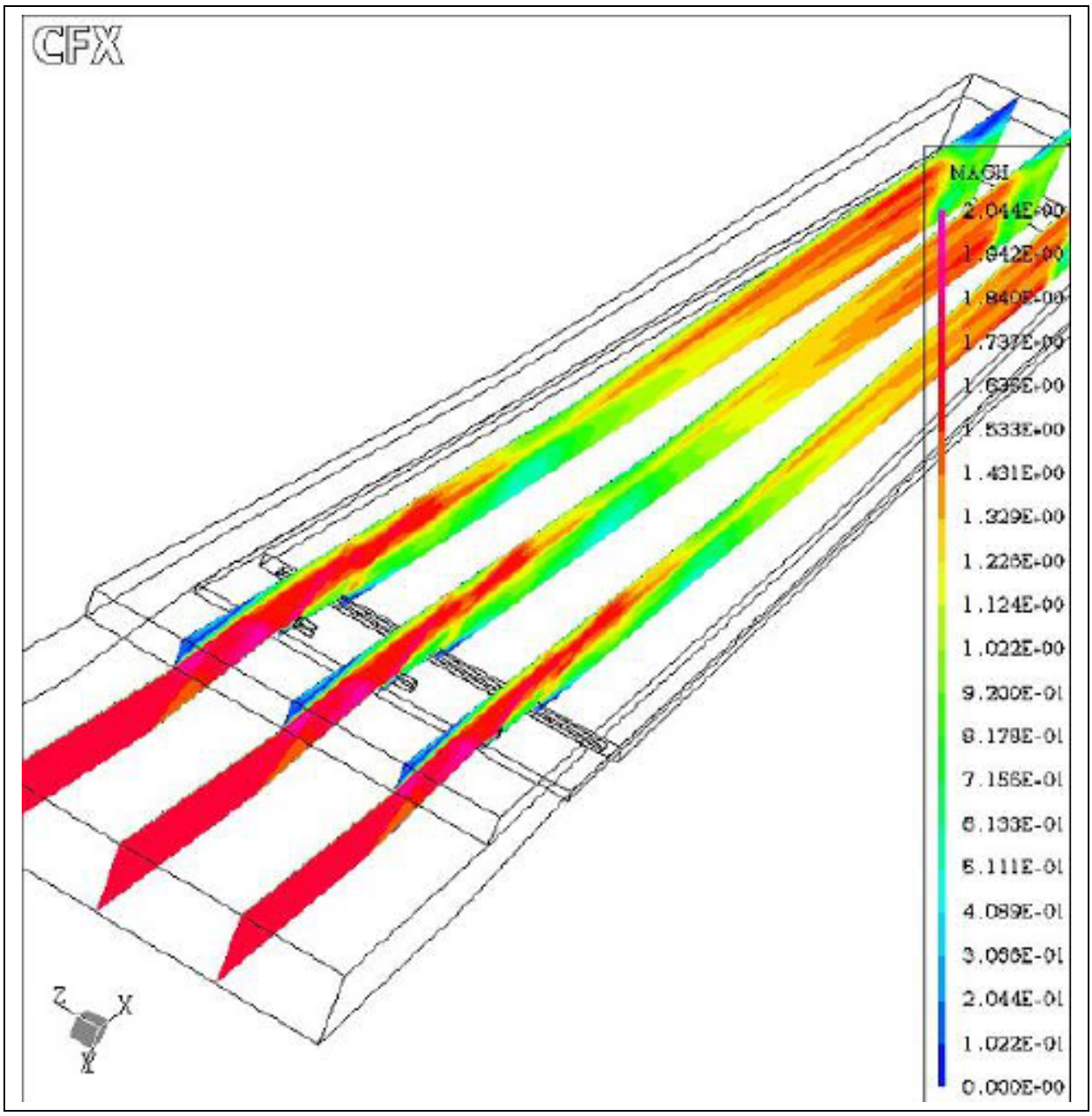
- Distribute fuel through more number of injectors
- Smaller injector holes

Six hole Injection temperature



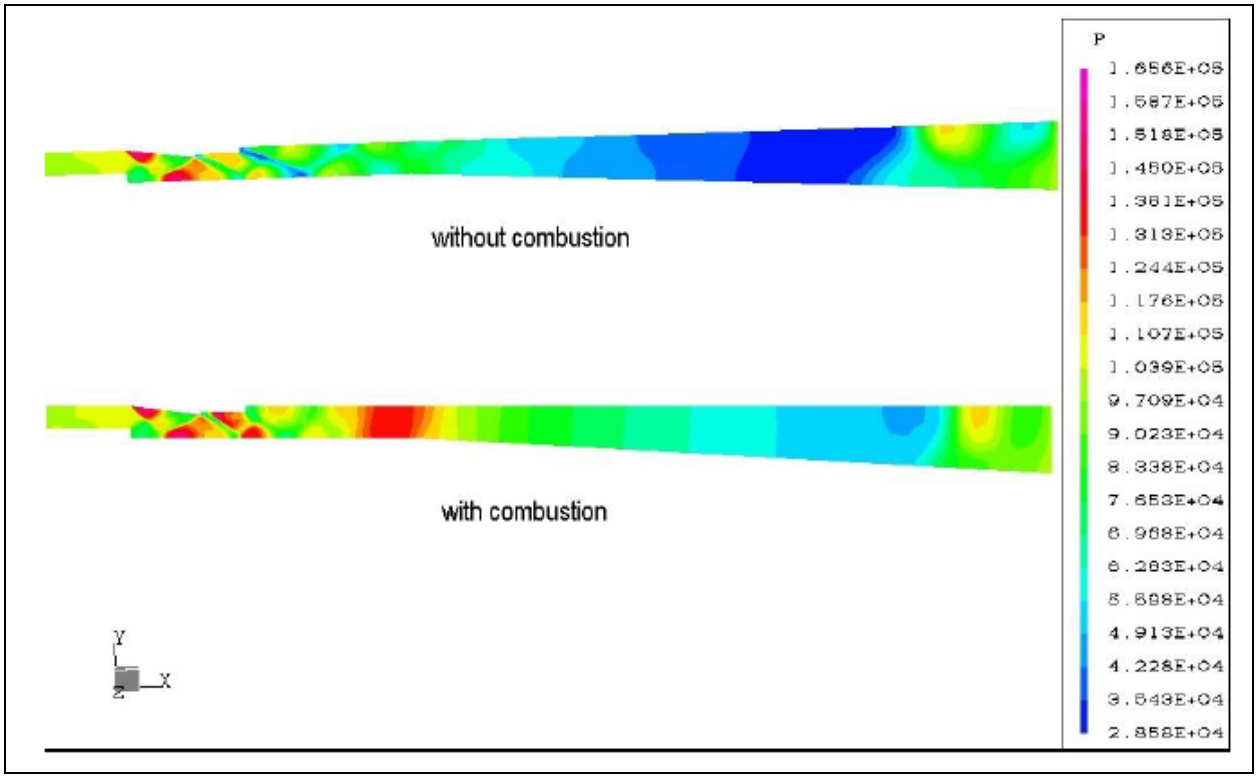
30gm/s fuel

Six hole Injection Mach no.

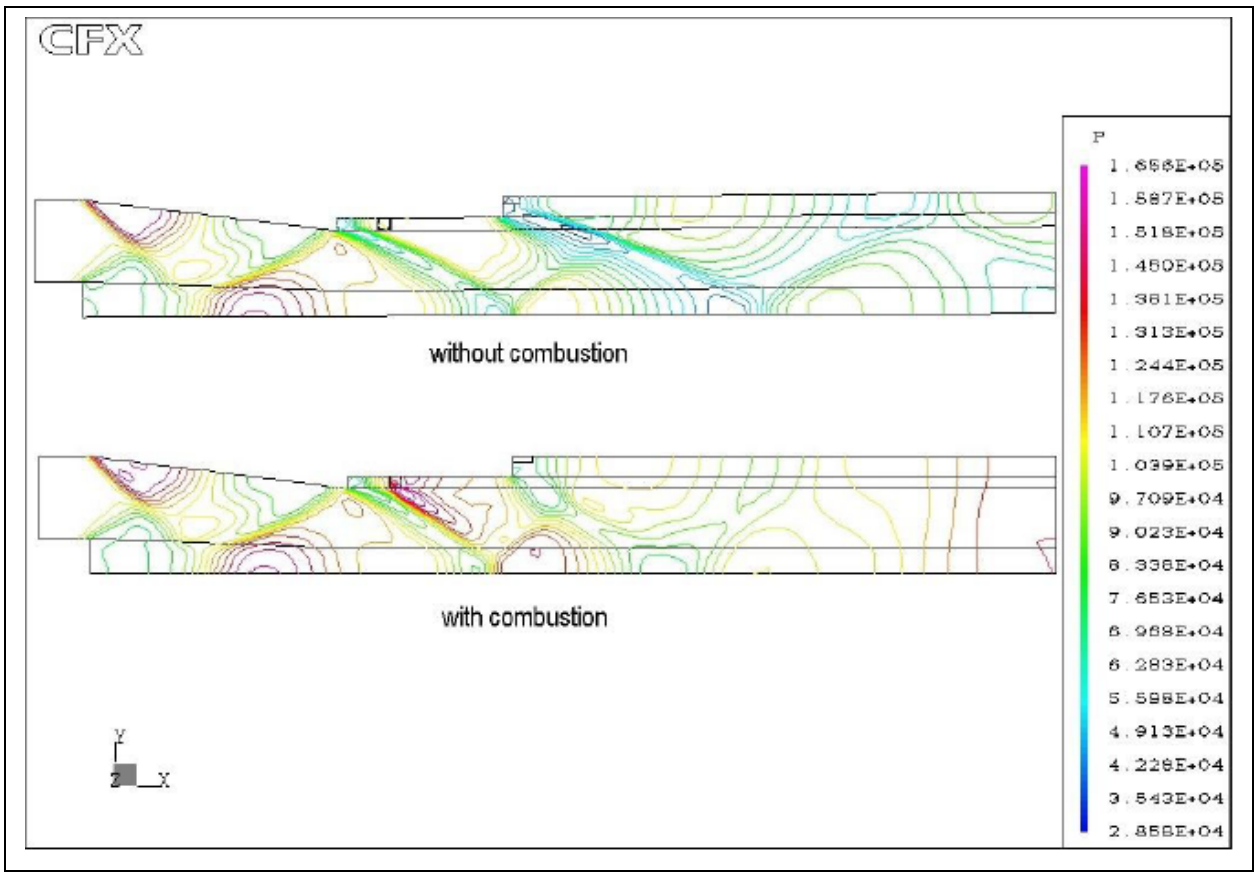


30gm/s fuel

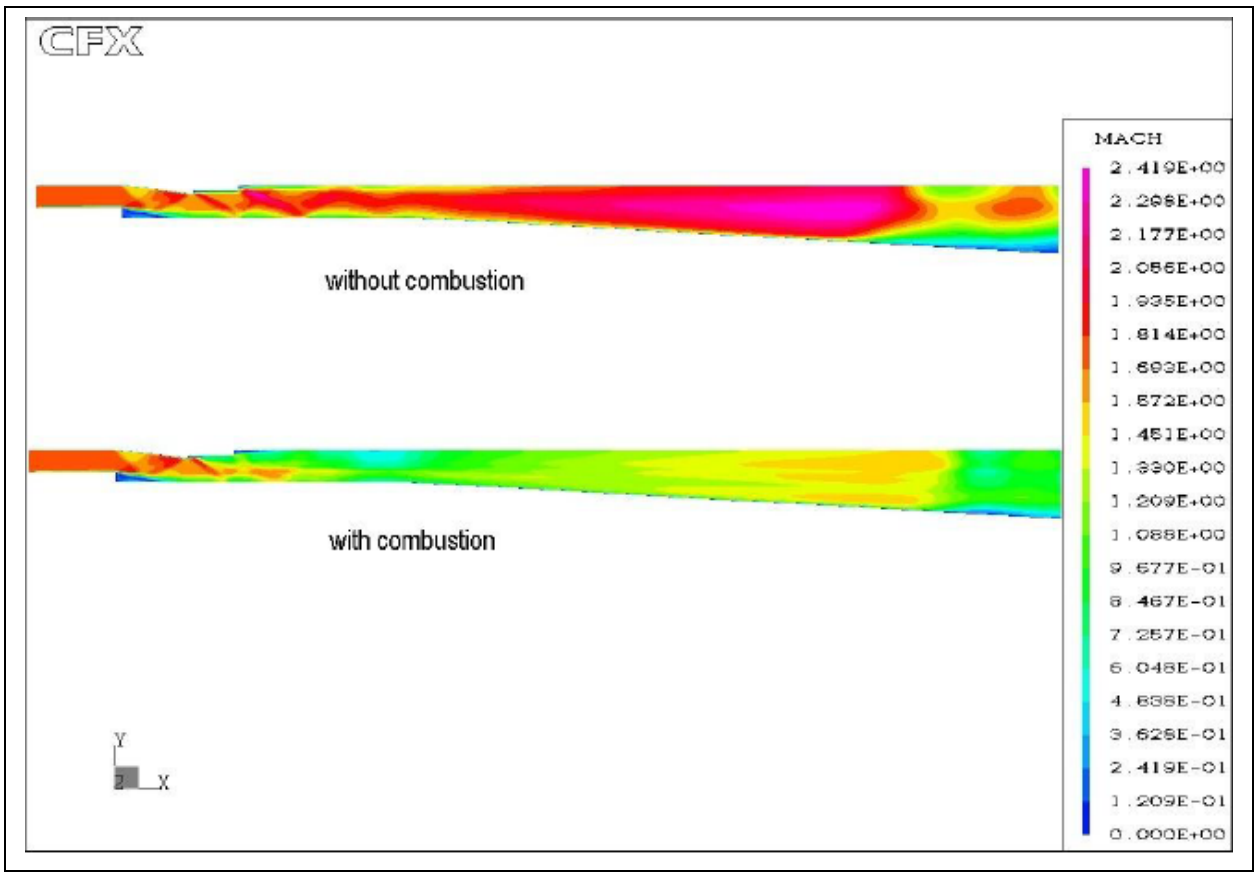
Pressure distribution for 30gm/s fuel through 6 injectors



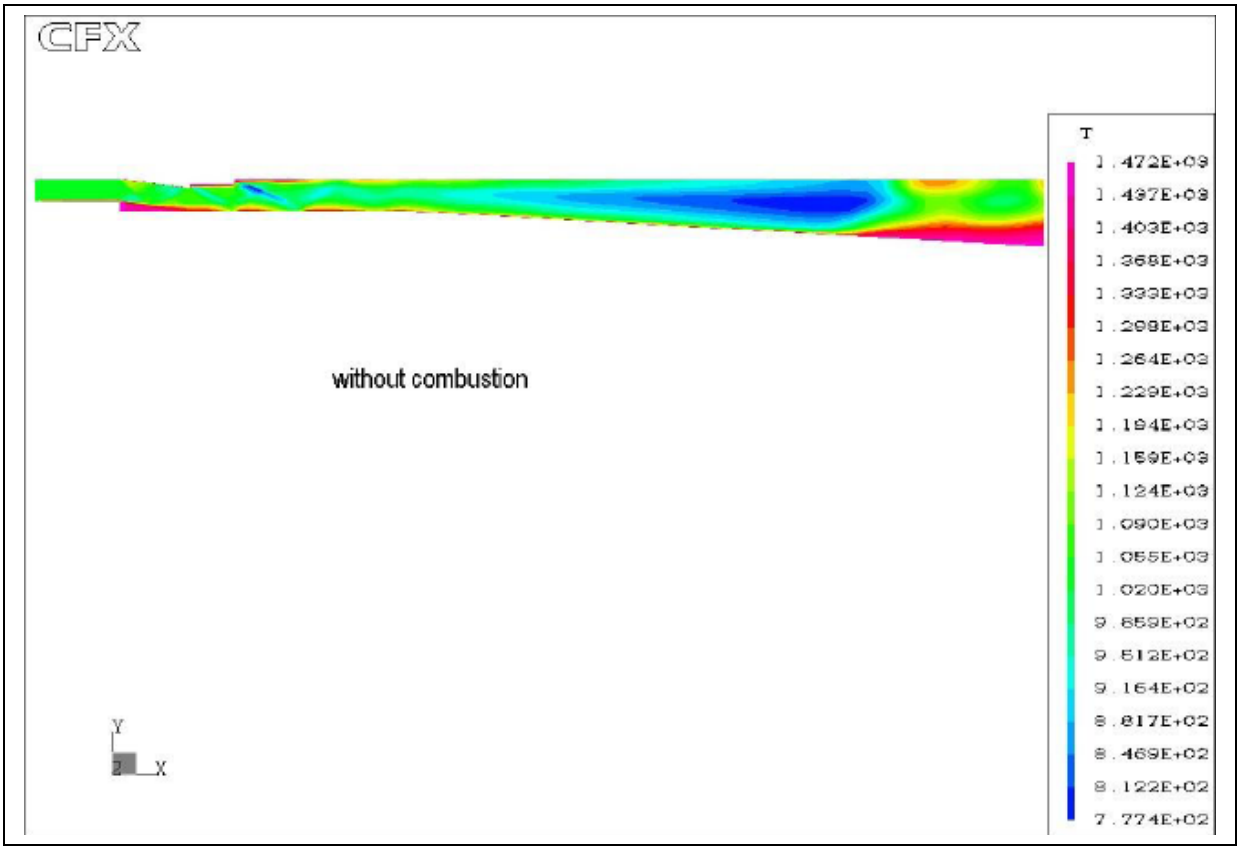
Blown - up view of pressure distribution near strut



Mach number for 30gm/s fuel through 6 injectors



Temperature for 30gm/s fuel through 6 injectors



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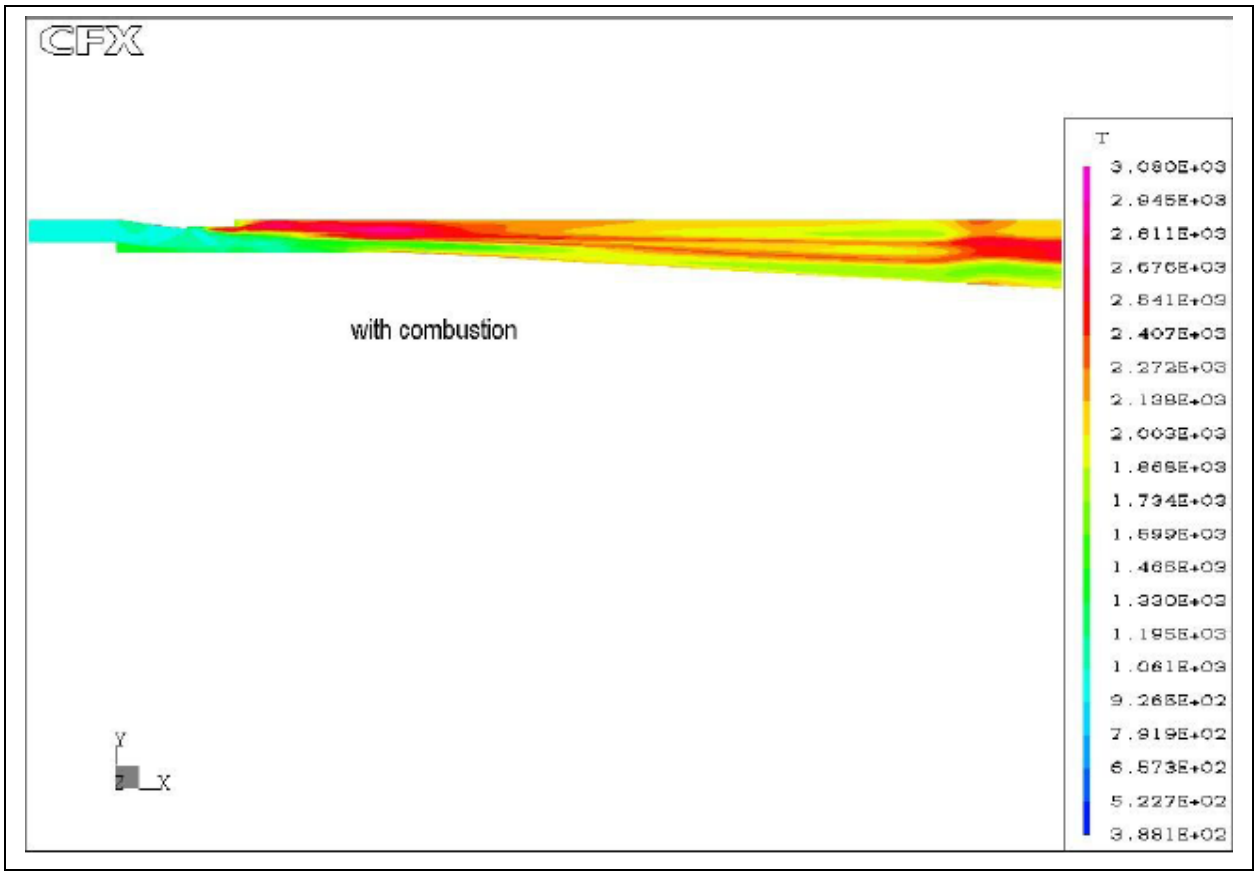
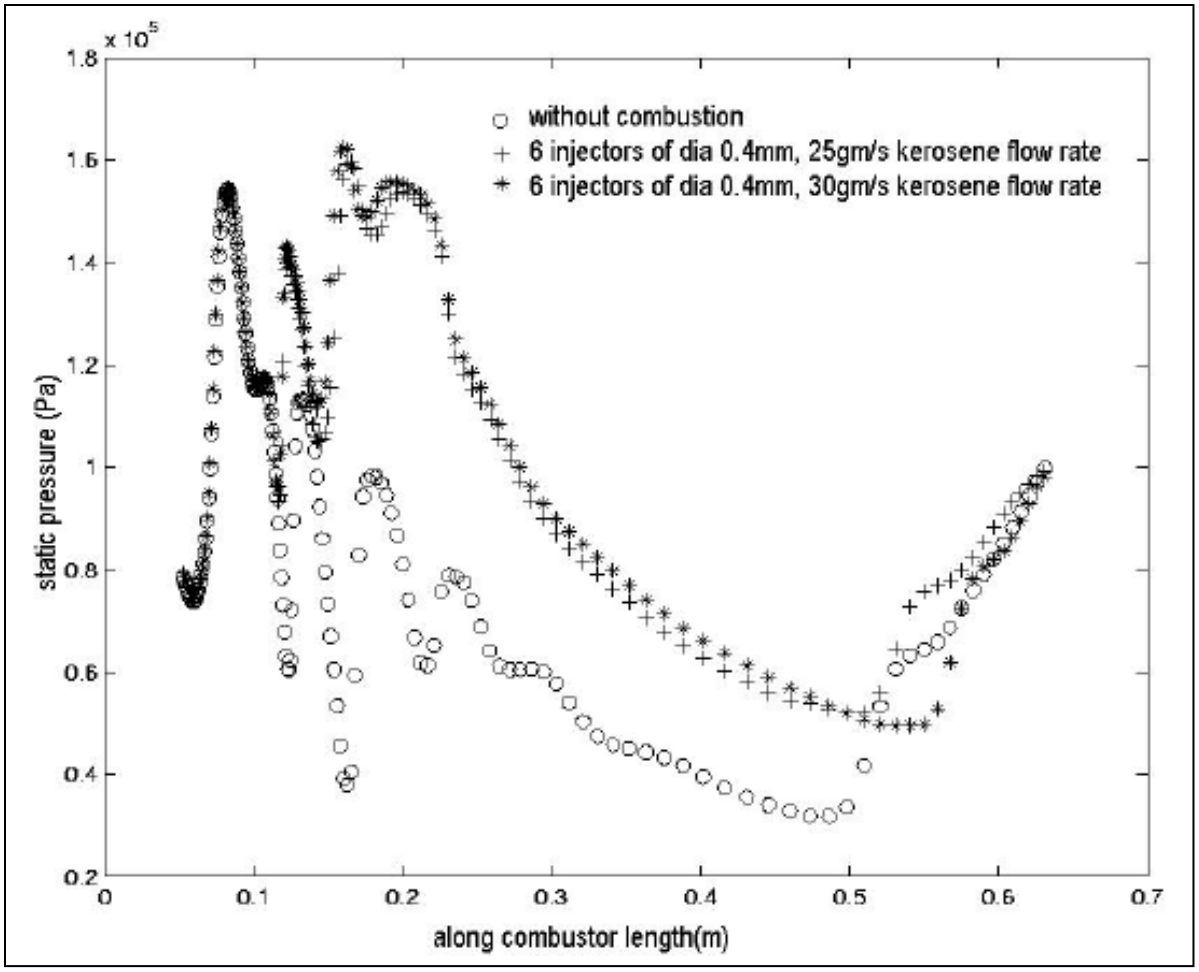


Wall pressure distribution at combustor mid plane



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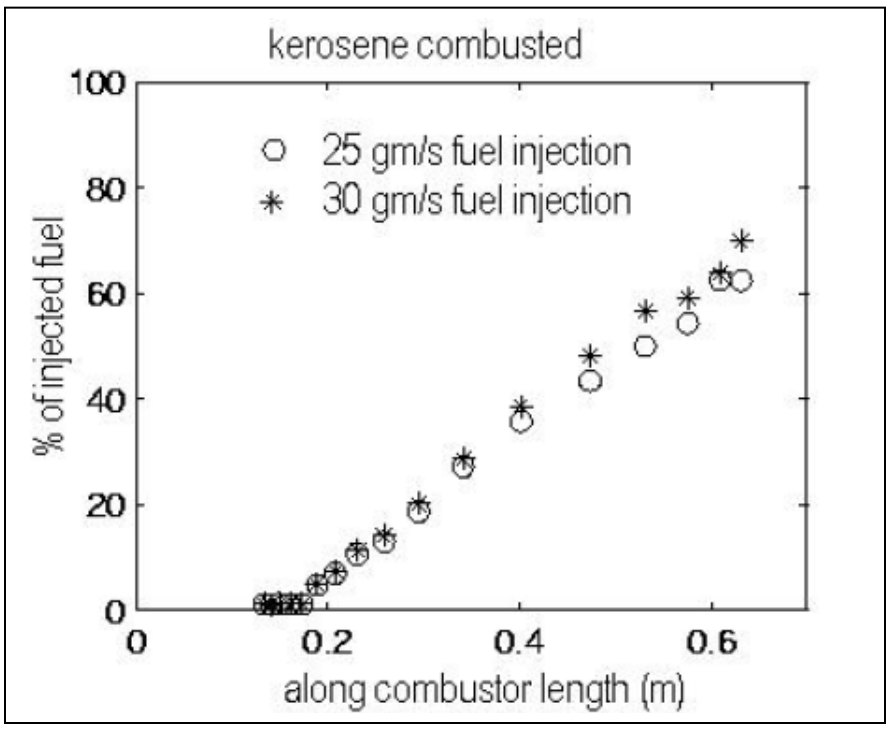

Conclusions

- The flow field of 2D combustor was simulated numerically using CFX TascFlow software
- The simulation captures all essential features of the flow field
- Parametric studies were conducted for various fuel flow rates, injector diameter.
- Simulation ensured supersonic combustion for a equivalence ratio (0.47) by redistributing fuel injectors