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CFD Applications in Propulsion

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An overview of various applications of CFD algorithms to propulsion problems is given. Problems of interest include incompressible, low speed compressible, transonic and supersonic. A common family of algorithms is used for all applications and emphasis is placed on maintaining accuracy and convergence efficiency for all problems. Specific problems include pump hydrodynamics, combustion and mixing simultaneous in rocket engines, viscous nozzle flow, and CFD applications to combustion stability.

CURRENT PROJECTS

- ROCKET COMBUSTOR MODELING
- COMBUSTION INSTABILITY MODELING
- PUMP FLOWFIELDS
- VISCOUS NOZZLE/PLUME FLOWS
- MAXWELL/NAVIER-STOKES ANALYSIS
- AUXILIARY PROPULSION
- LOW SPEED COMPRESSIBLE FLOWS

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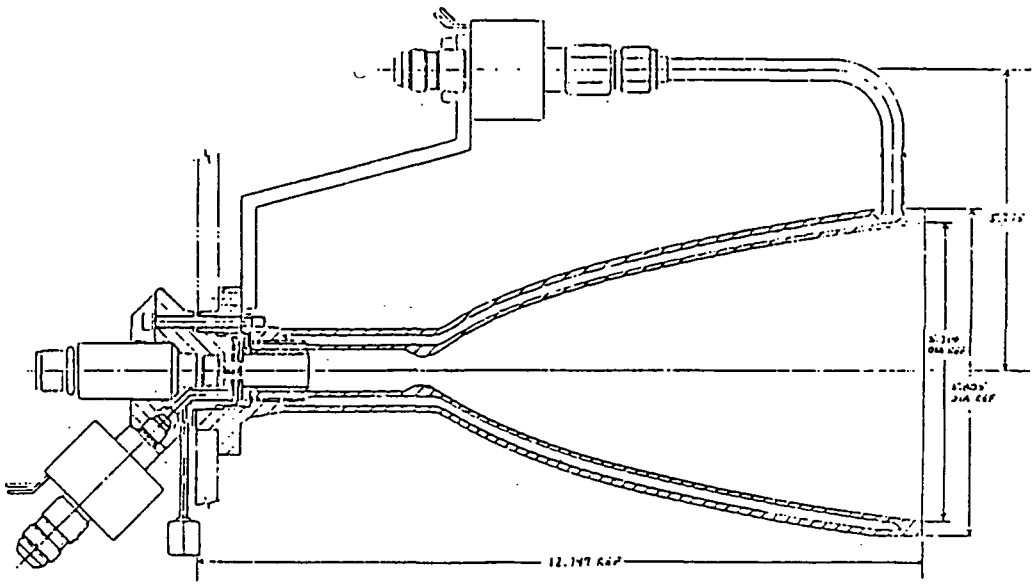
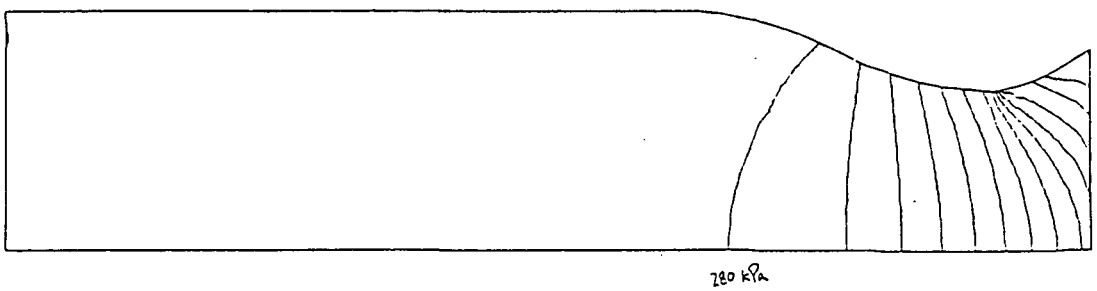
CFD PROBLEM FORMULATION

$$\Gamma \frac{\partial Q}{\partial t} + \frac{\partial E_i}{\partial x_i} = \frac{\partial}{\partial x_i} R_{ik} \frac{\partial \bar{Q}_k}{\partial x_j} + H$$

Steady	Compressible
Unsteady	Incompressible
Viscous	Upwind
Inviscid	Central



Schematic of small thruster geometry.



PRESSURE CONTOURS

min = 23.4 kPa
max = 304 kPa
delta = 20 kPa

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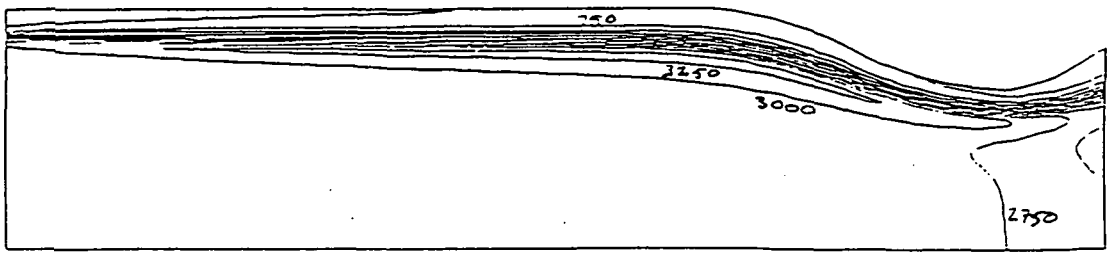
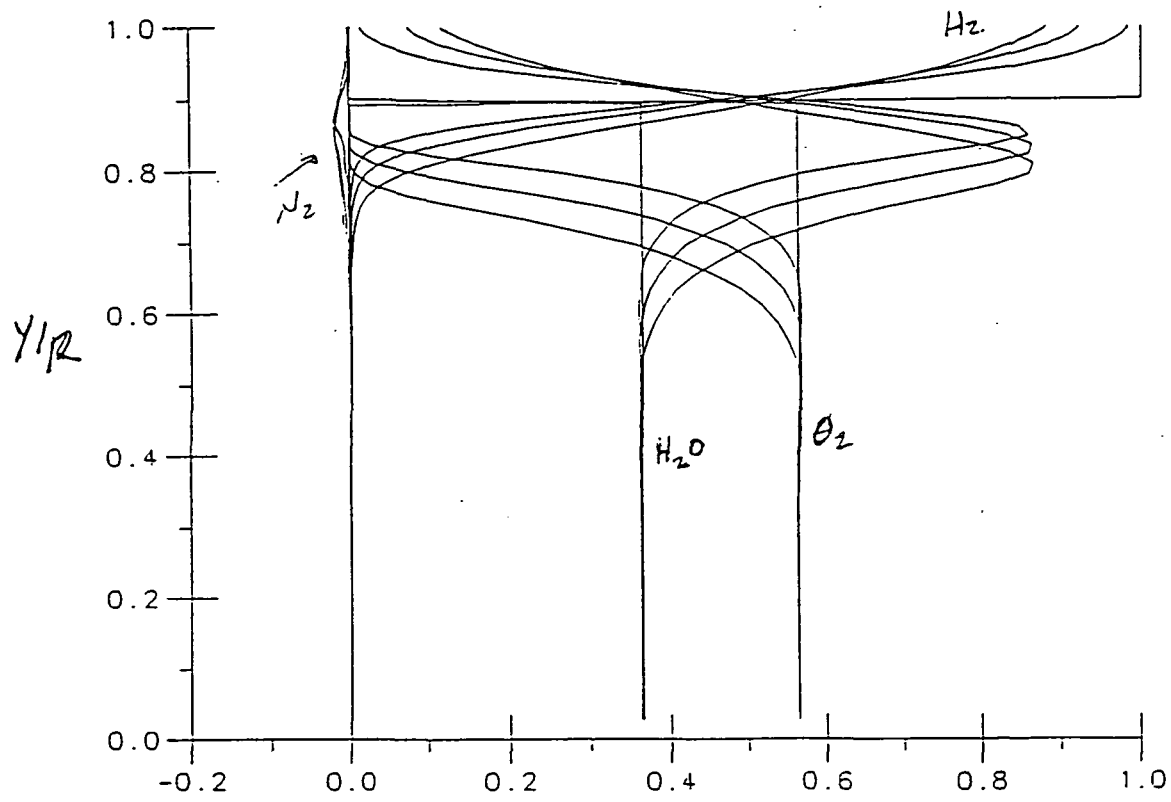
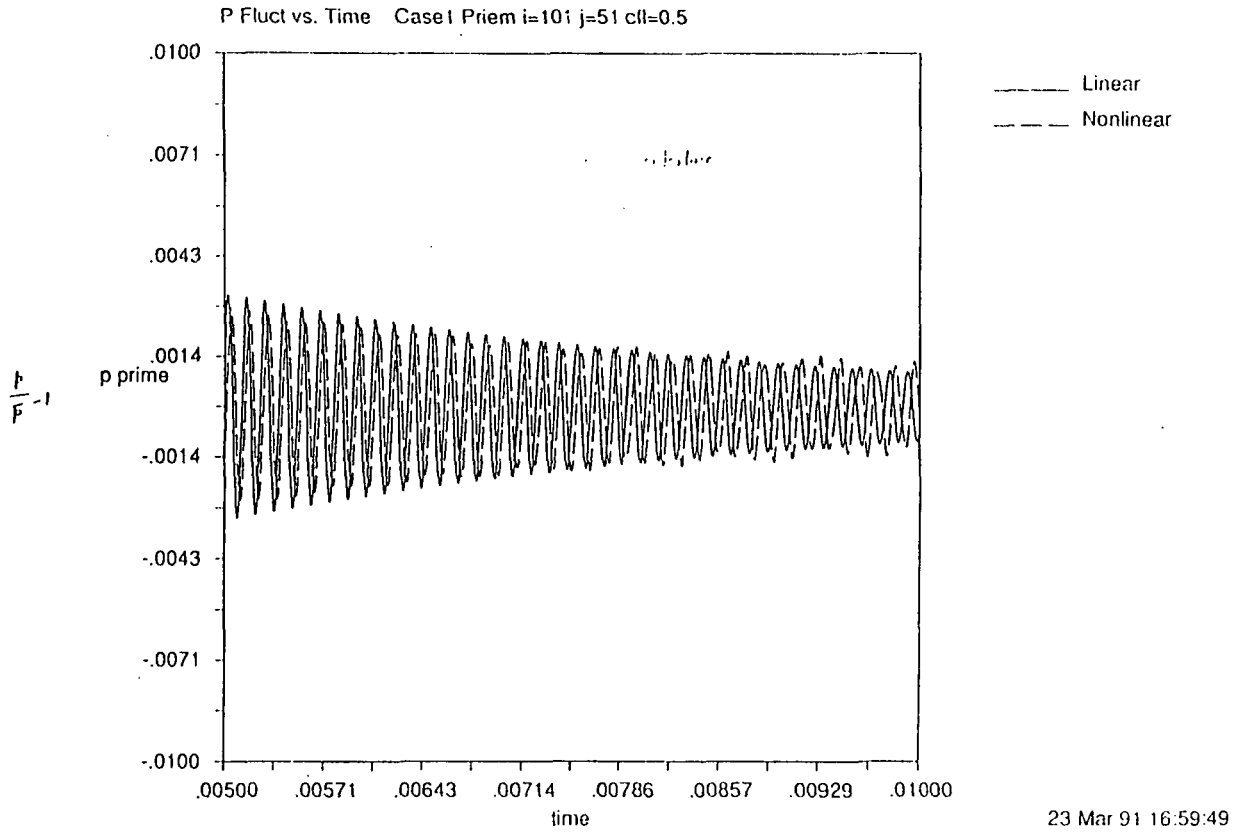
TURBULENT REACTING FLOW

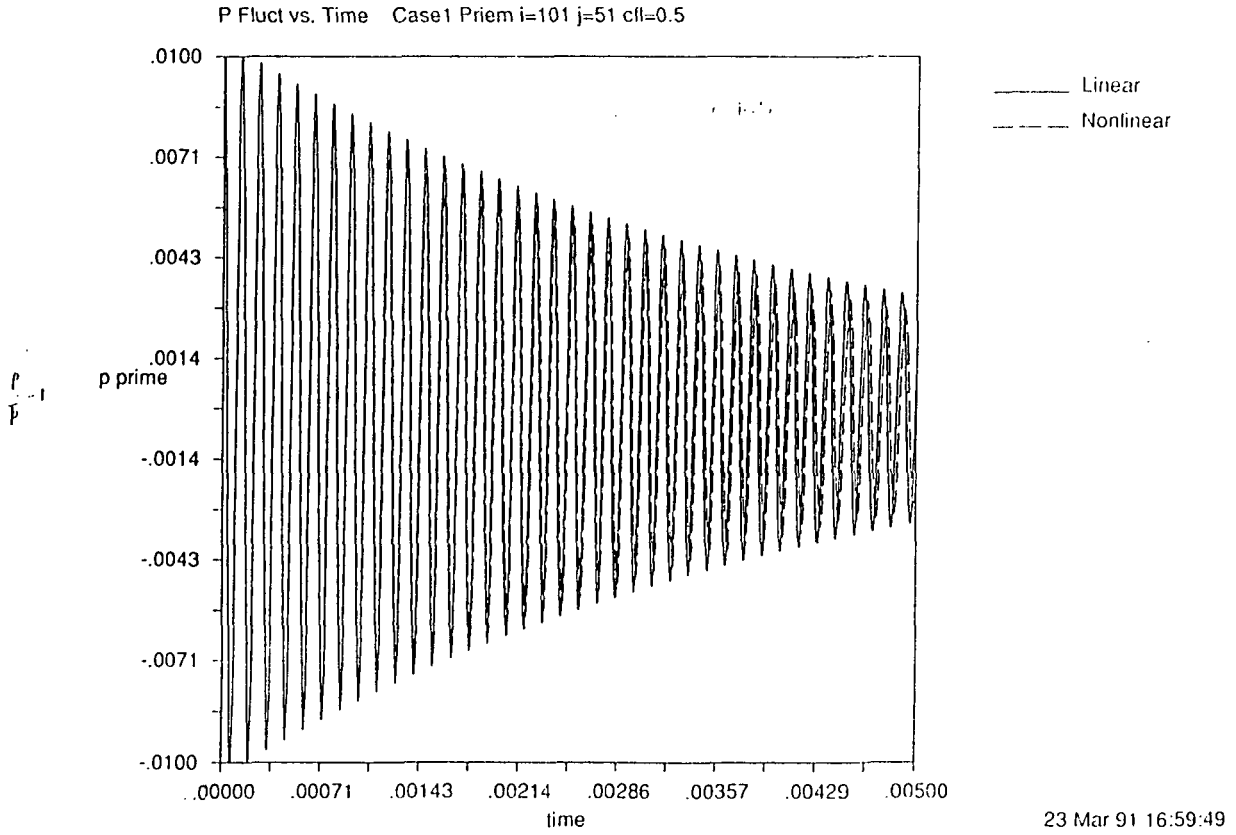


TEMPERATURE CONTOURS MIN = 346.9 K
MAX = 3302 K
delta = 250 K



SPECIES MASS FRACTION y_i





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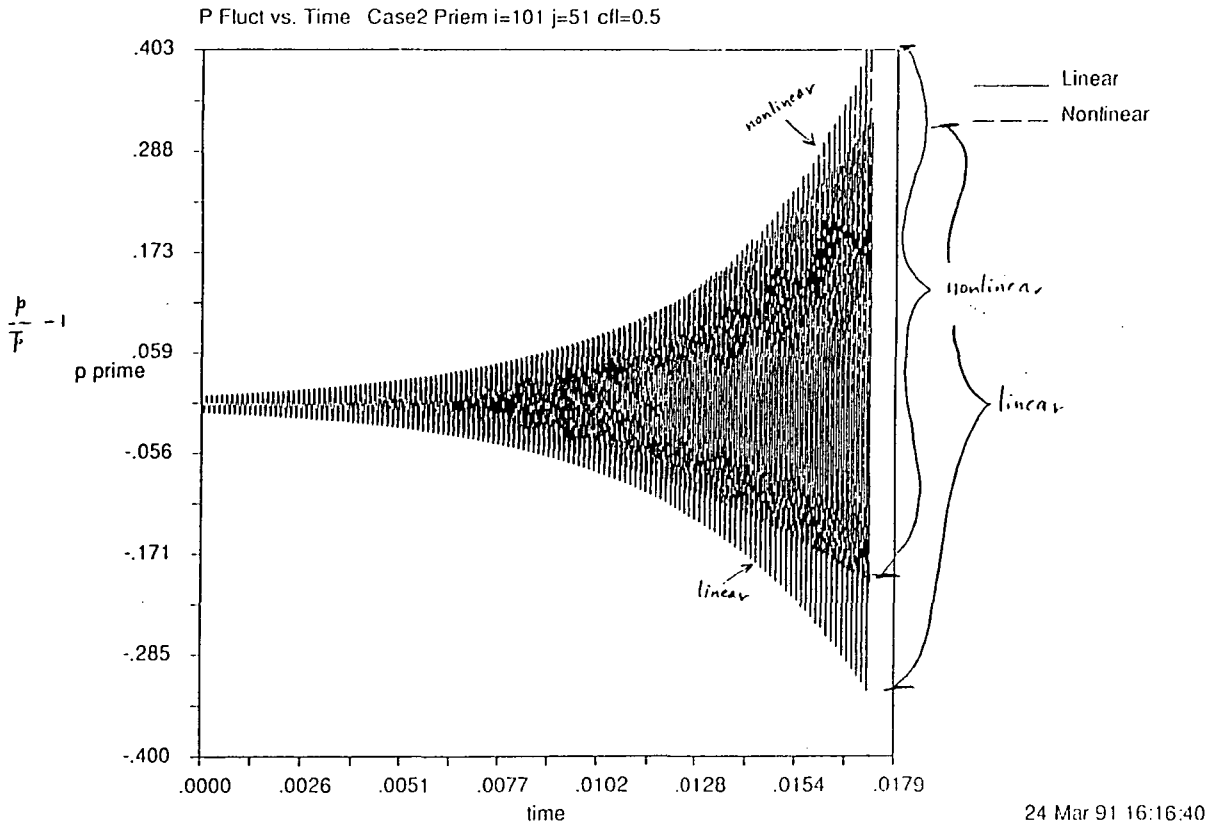
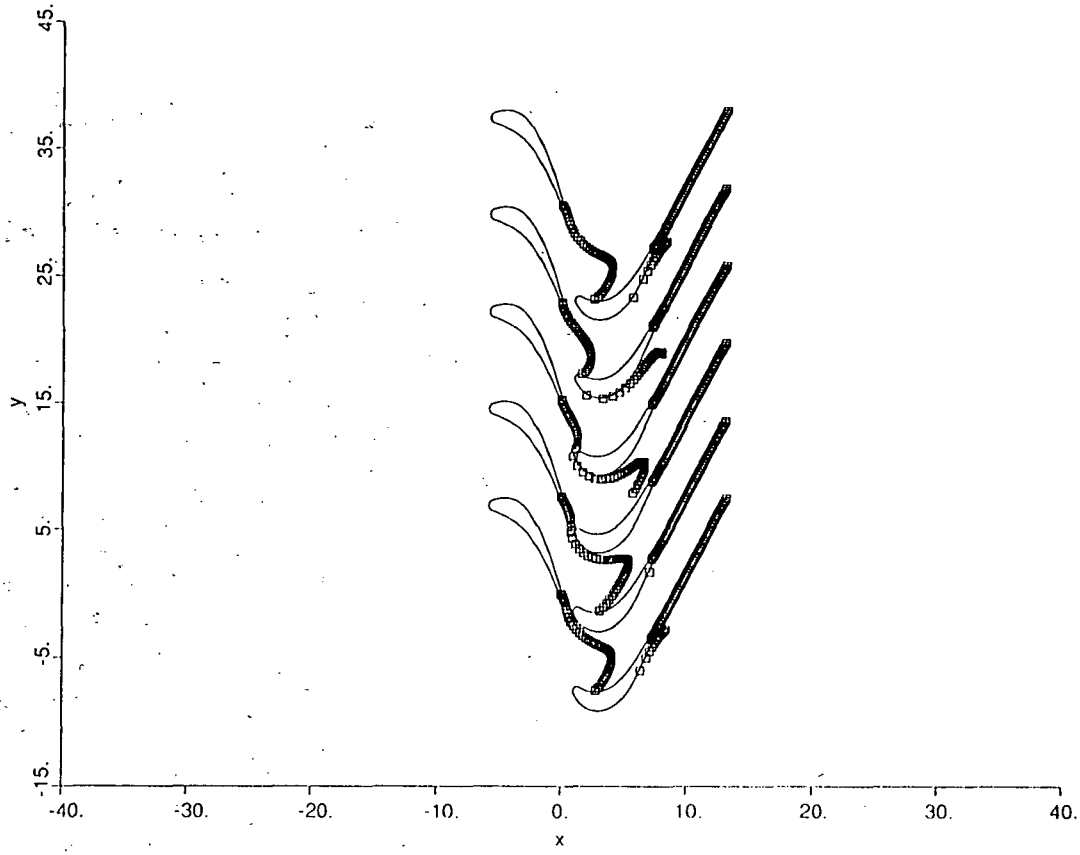
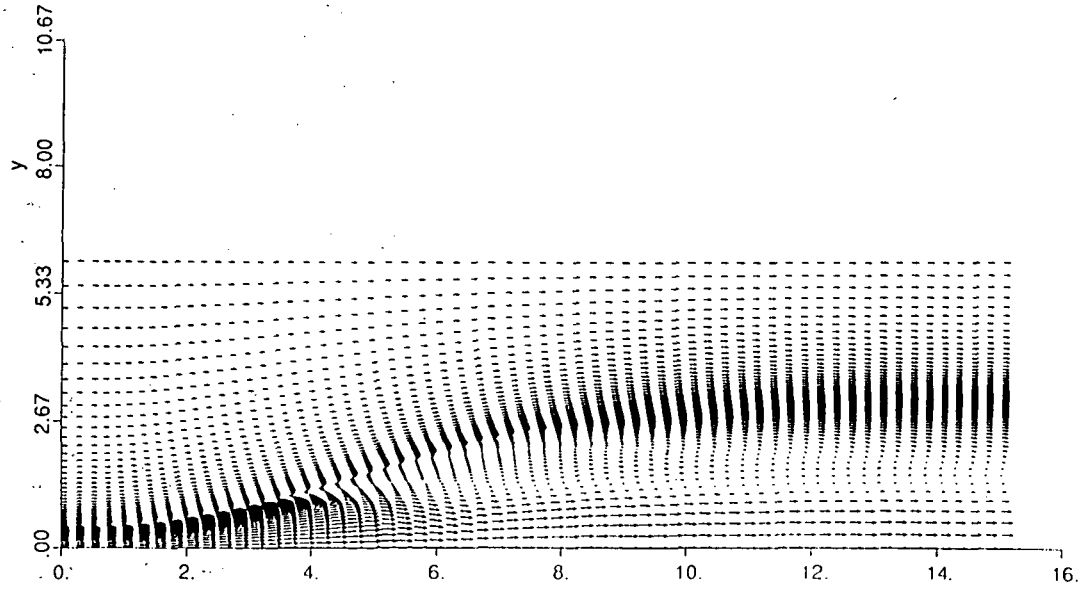


Plunging Airfoil

Wake behind utrc stator/rotor





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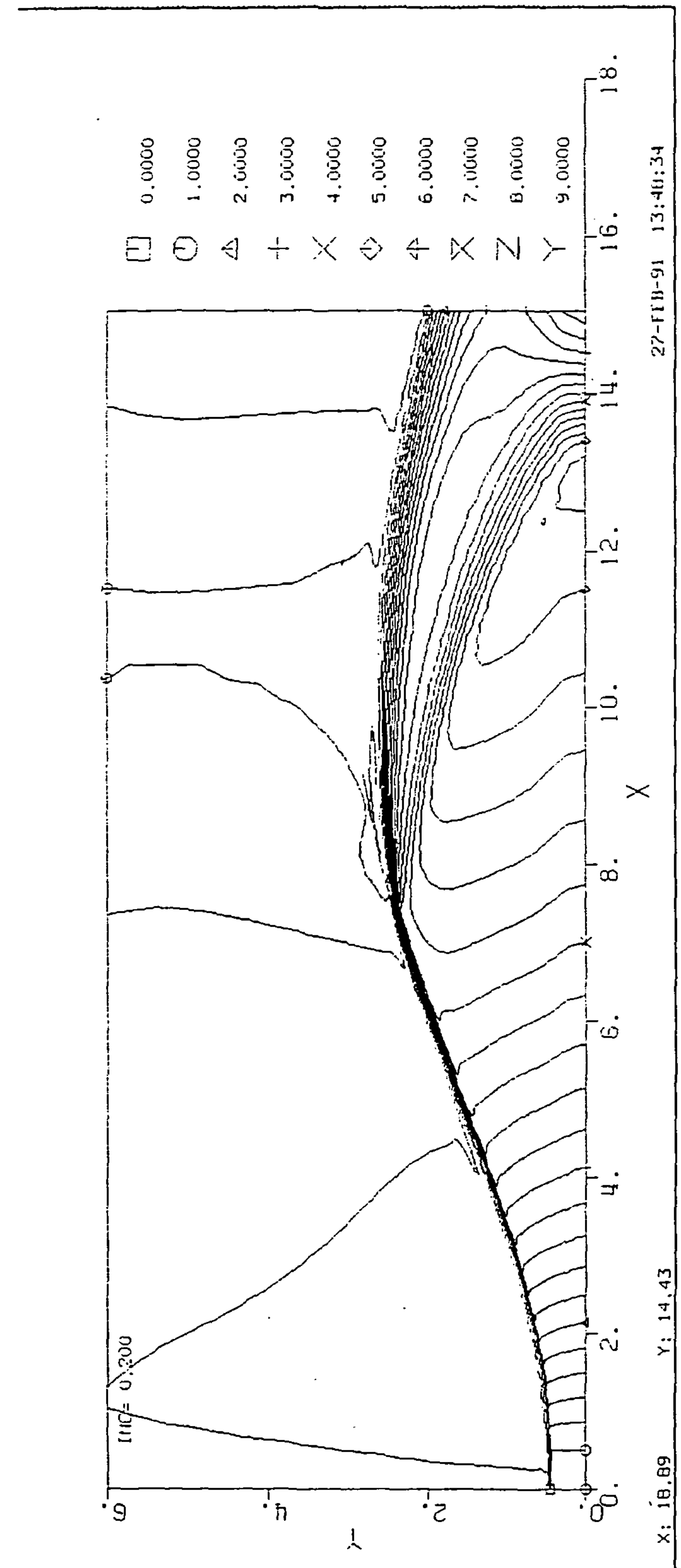

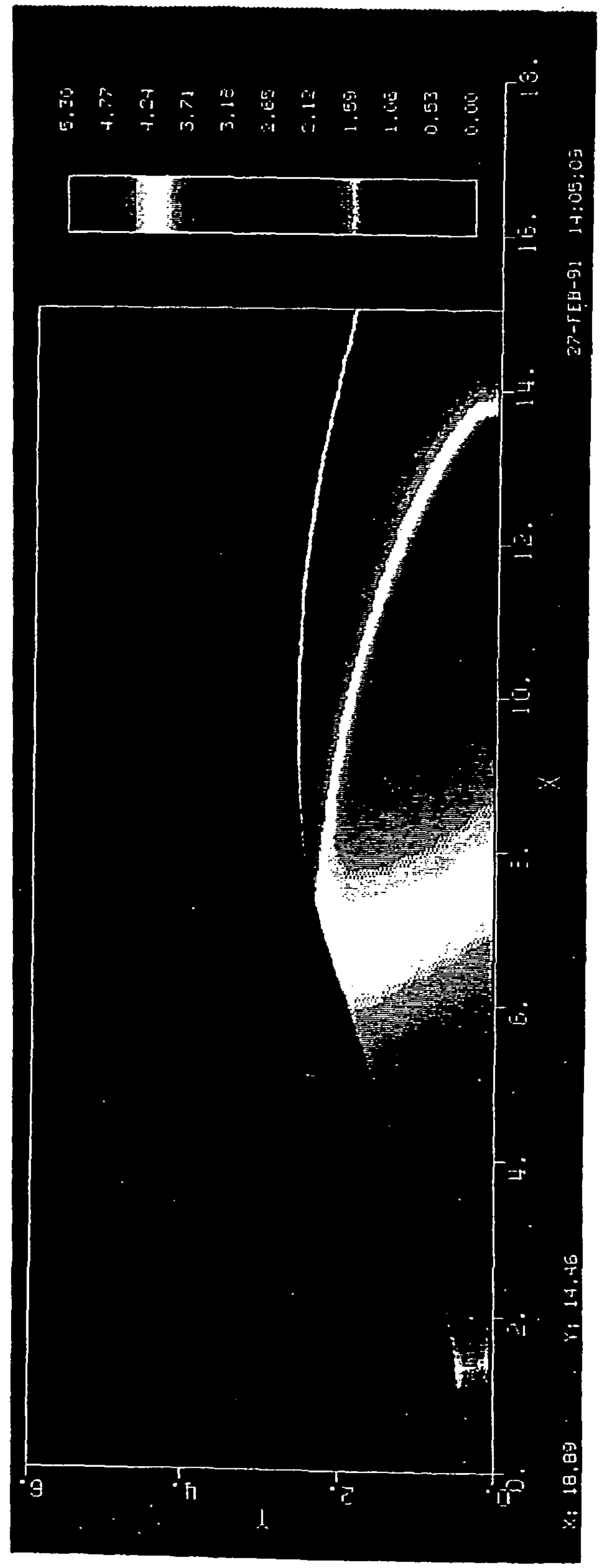

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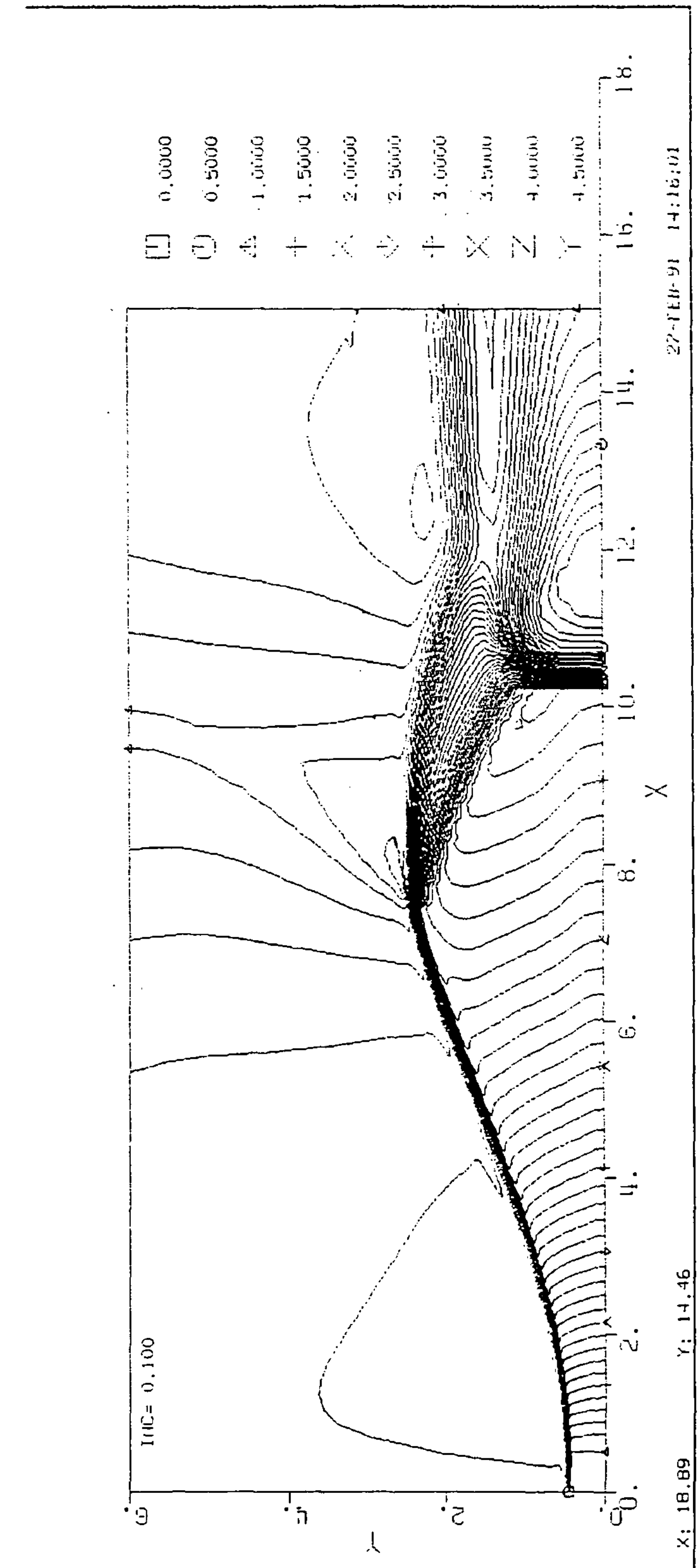

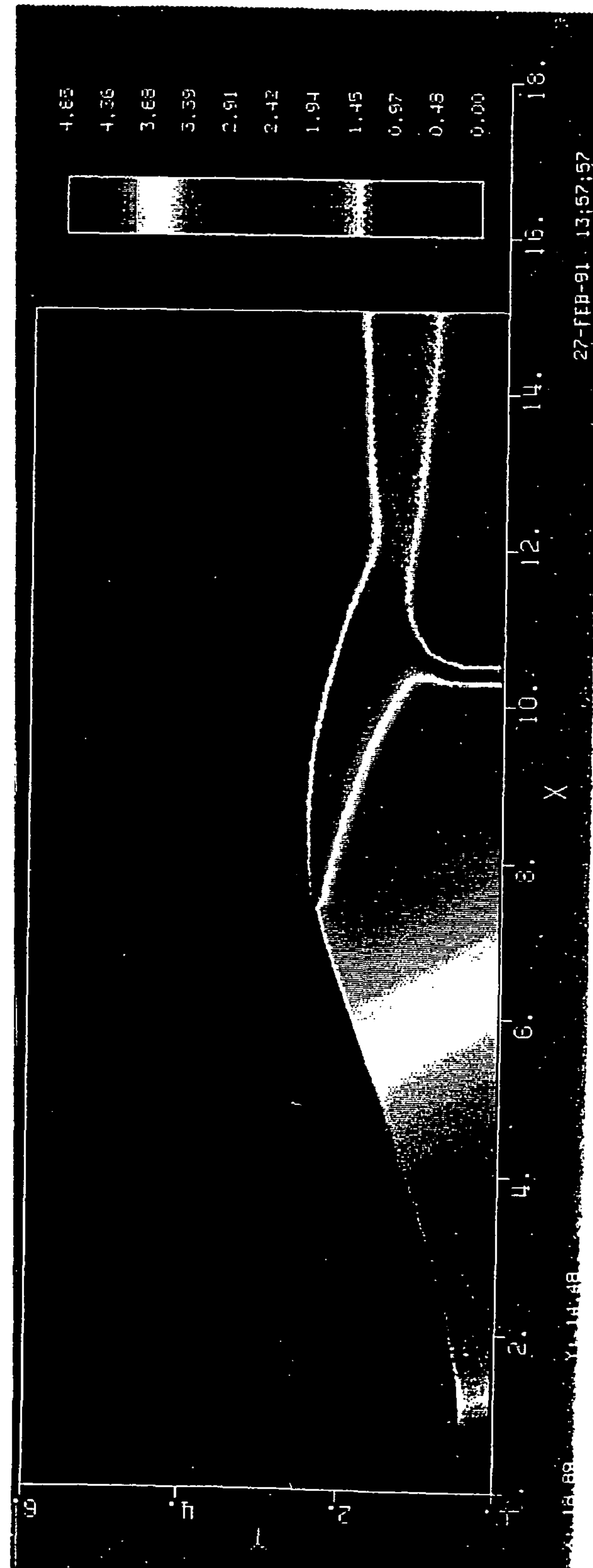

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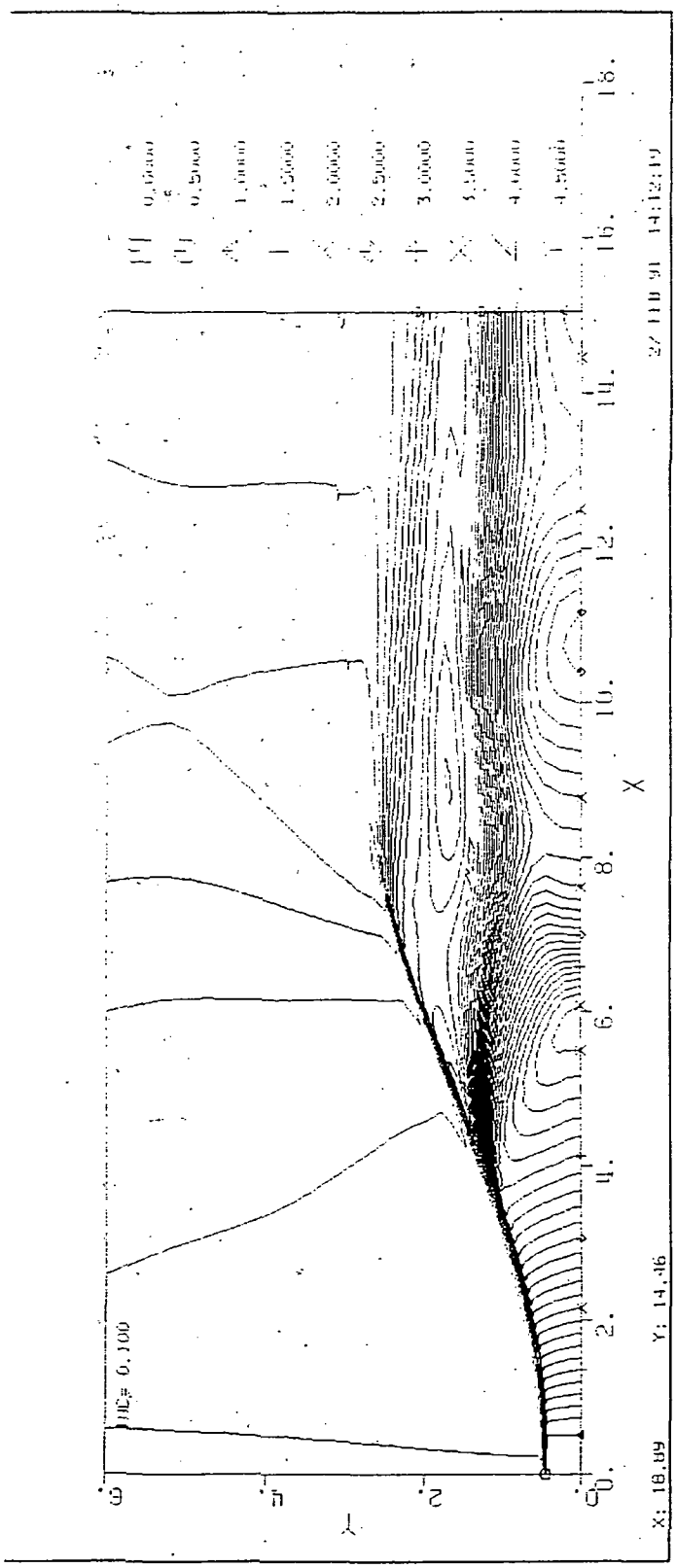

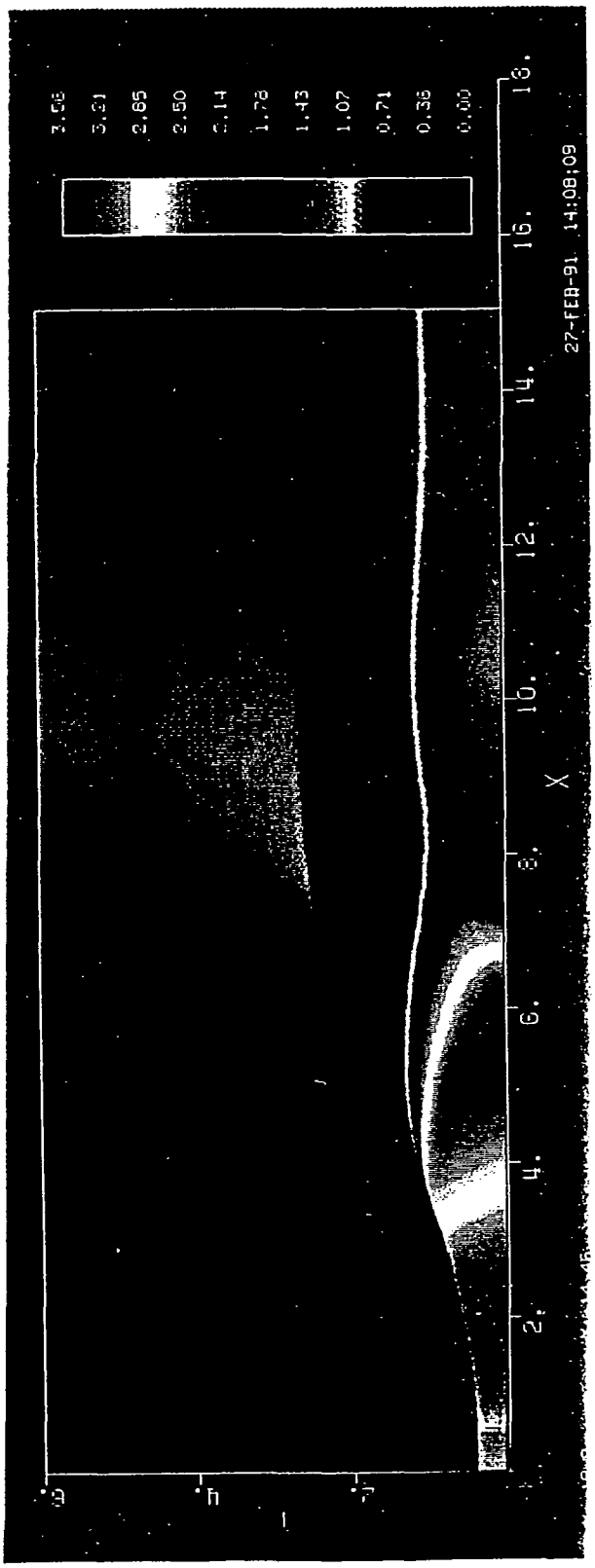

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