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CFD ANALYSIS FOR HIGH SPEED INLETS

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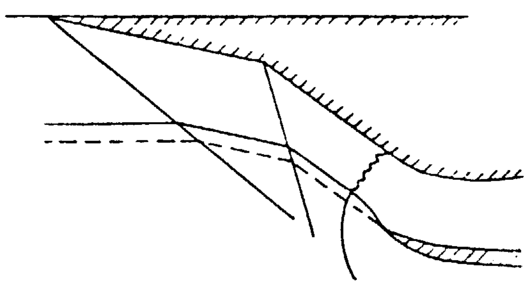
ABSTRACT

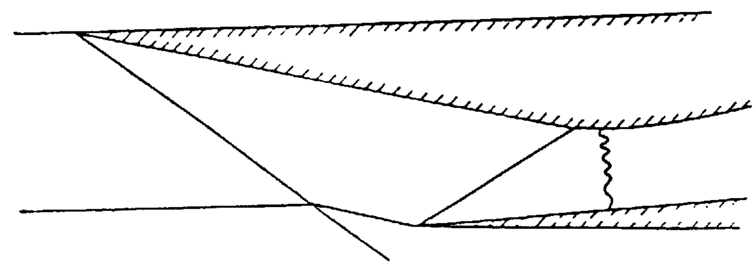
The increased national interest in high speed flight has increased research for high speed propulsion components. The highly three-dimensional flows present in supersonic/hypersonic inlets are currently being studied at NASA Lewis both experimentally and computationally using a family of steady PNS and NS solvers and unsteady NS solvers. This paper presents some of the results of these efforts with an emphasis on the comparison of the computational and experimental results.

The flow in high speed inlets typically involves the interaction of compression shock waves and boundary layers on the internal surfaces. The fundamentals of these interactions have been studied experimentally for many years, while more recently, computations have been used to study these complex three dimensional flow fields. Attempts to control the flow through boundary layer bleed are being investigated computationally prior to wind tunnel experiments. The ultimate goal of this research will be the higher performing inlets required for high speed flight.

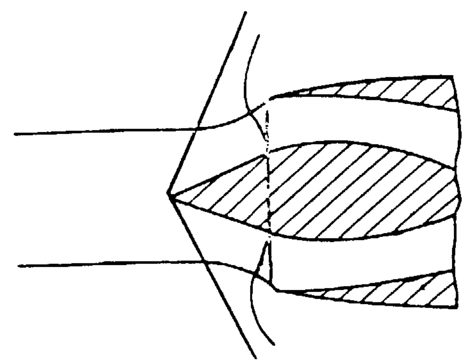
CFD FOR HIGH SPEED INLETS



EXTERNAL COMPRESSION



MIXED COMPRESSION



AXI-SYMMETRIC

THRUST DISTRIBUTION FOR SR-71

MACH NO	INLET	ENGINE	EJECTOR
2.2	13%	73%	14%
3. +	54%	18%	28%

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1.3 < MACH < 5.0

PHENOMENA

BUZZ
UNSTART
SHOCK/SHOCK INTERACTION
OBLIQUE SHOCK/BOUNDARY LAYER
NORMAL SHOCK/BOUNDARY LAYER
GLANCING SHOCK/BOUNDARY LAYER
CORNER FLOWS

All of the above with
BOUNDARY LAYER BLEED

CODES

3D PNS (PEPSIS)
- -BRILEY/MCDONALD LBI SCHEME

3D-STEADY NS (PARC)
- -BEAM/WARMING ADI

3D-UNSTEADY NS (PROTEUS)
- -BEAM/WARMING ADI
- -2nd ORDER TIME ACCURATE

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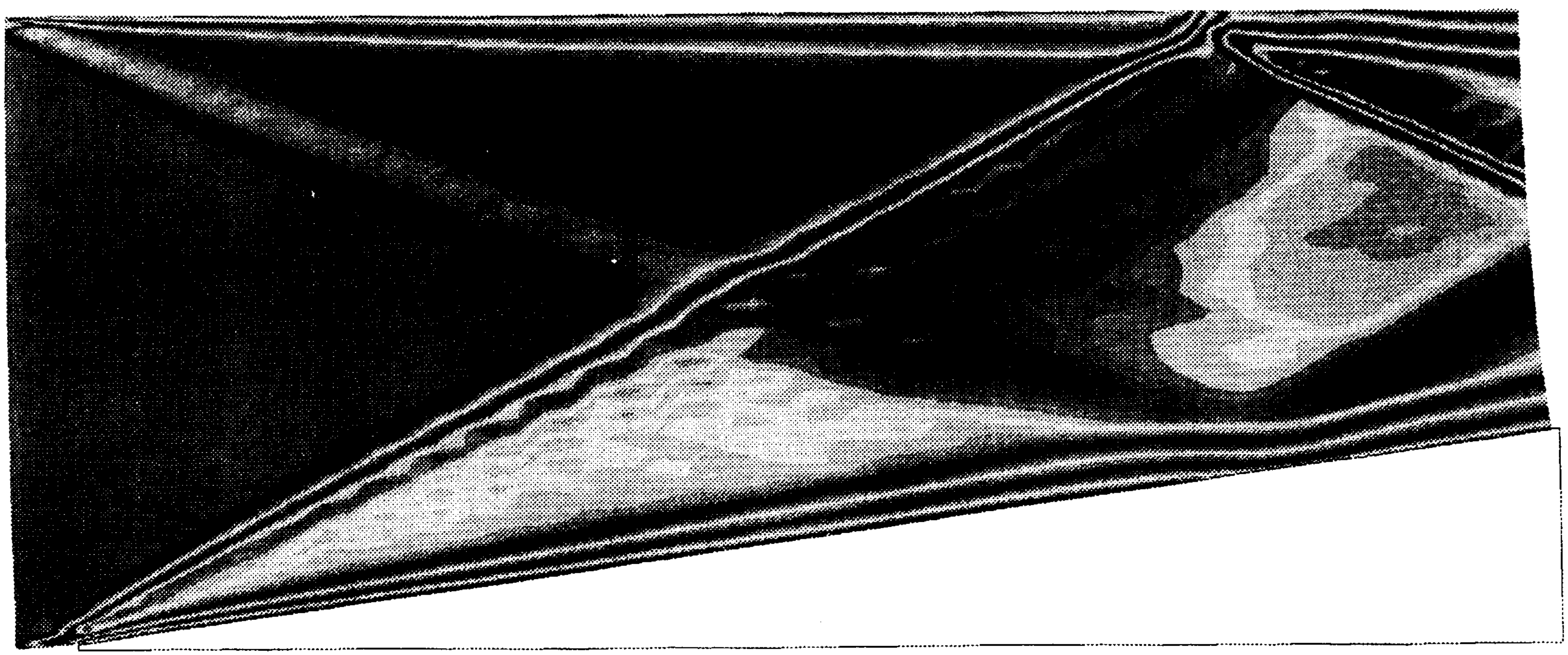
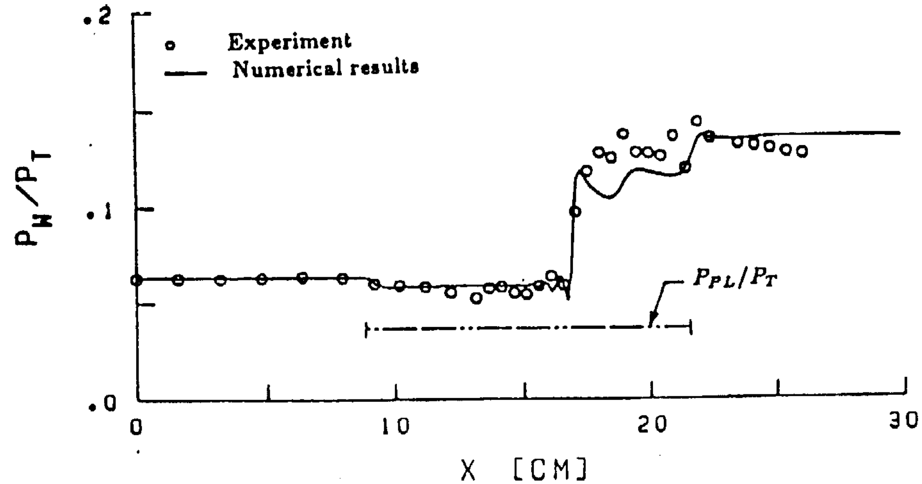
OBLIQUE SHOCK BOUNDARY LAYER INTERACTION



DENSITY GRADIENTS

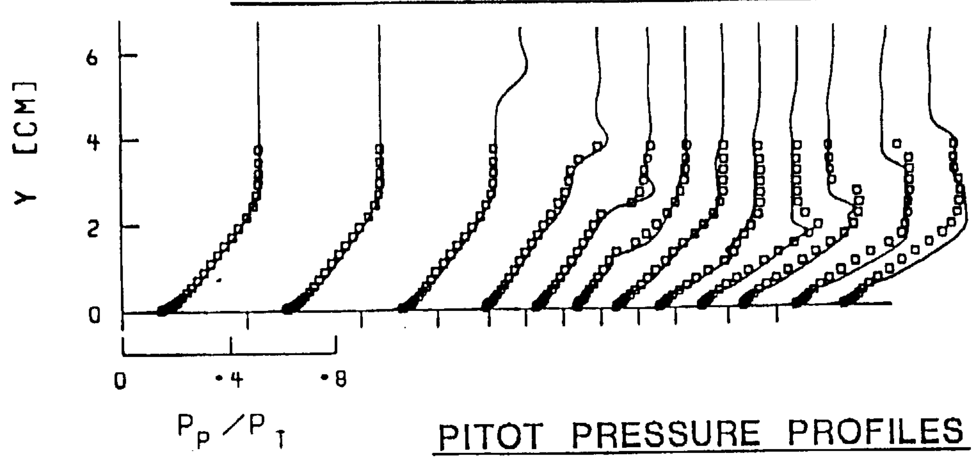
SHOCK/BOUNDARY LAYER/BLEED INTERACTION
EXPERIMENT/COMPUTATION COMPARISON



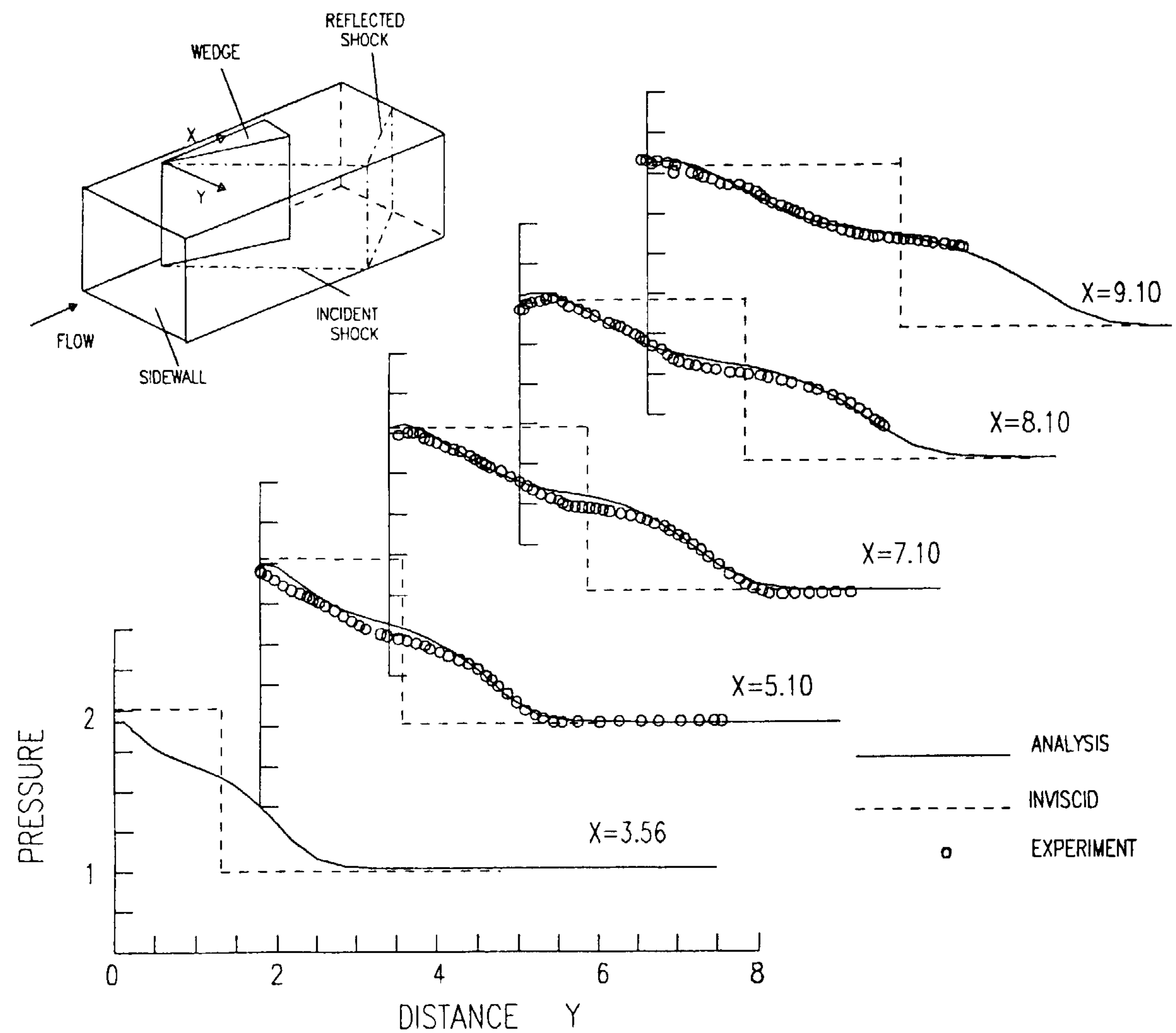
WALL PRESSURE DISTRIBUTION

M=2.46

Ang=6.5 deg



PITOT PRESSURE PROFILES


REFLECTED SHOCK
WEDGE
X
Y
FLOW
SIDEWALL
INCIDENT SHOCK
X=9.10
X=8.10
X=7.10
X=5.10
X=3.56
PRESSURE
2
1
0
2
4
6
8
DISTANCE Y
ANALYSIS
INVISCID
EXPERIMENT

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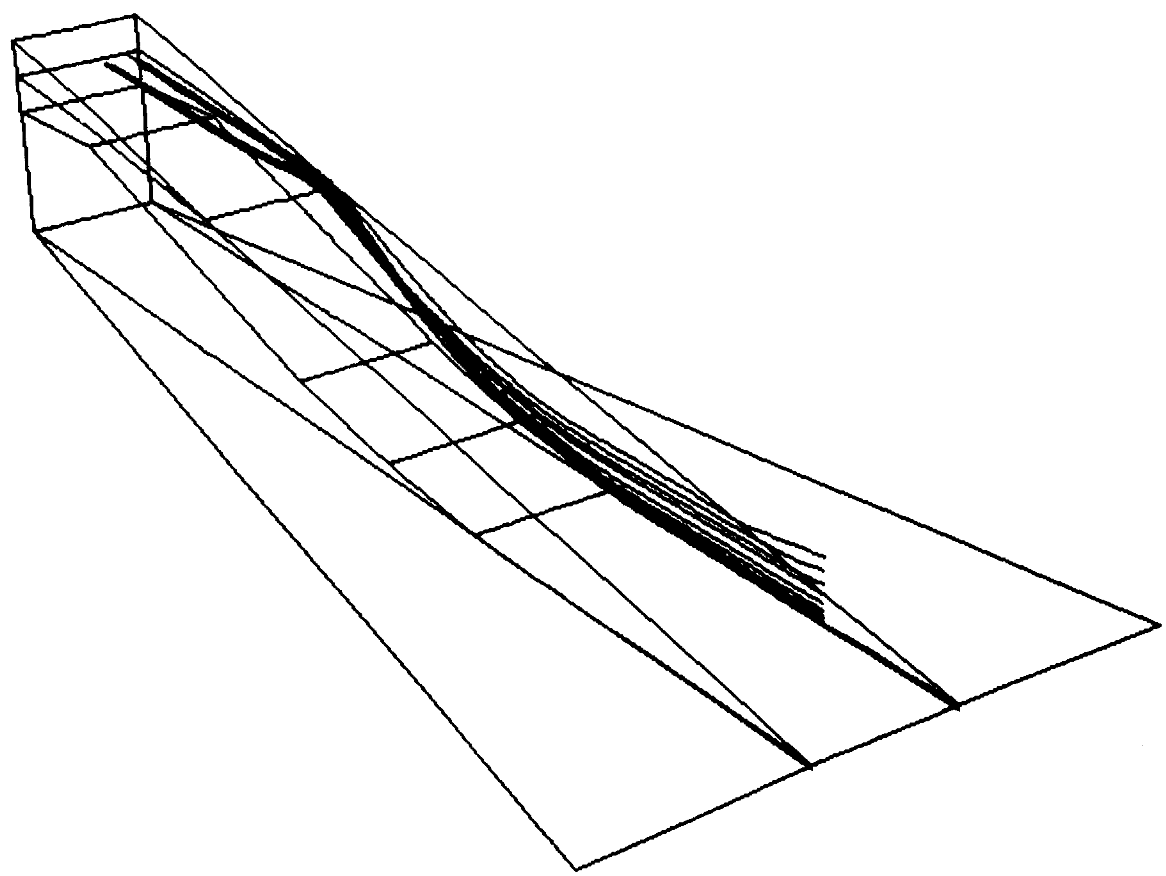
MACH 5.0 INLET
STREAMLINE TRACES



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SUMMARY

Combined computational/experimental investigation has identified importance of 3D shock/boundary layer interactions for rectangular inlets at high speeds

Possible control of glancing shock/boundary layer interaction through bleed now being explored. Little success to date.

Understanding of three dimensional interactions may lead to better methods of flow control in inlets.