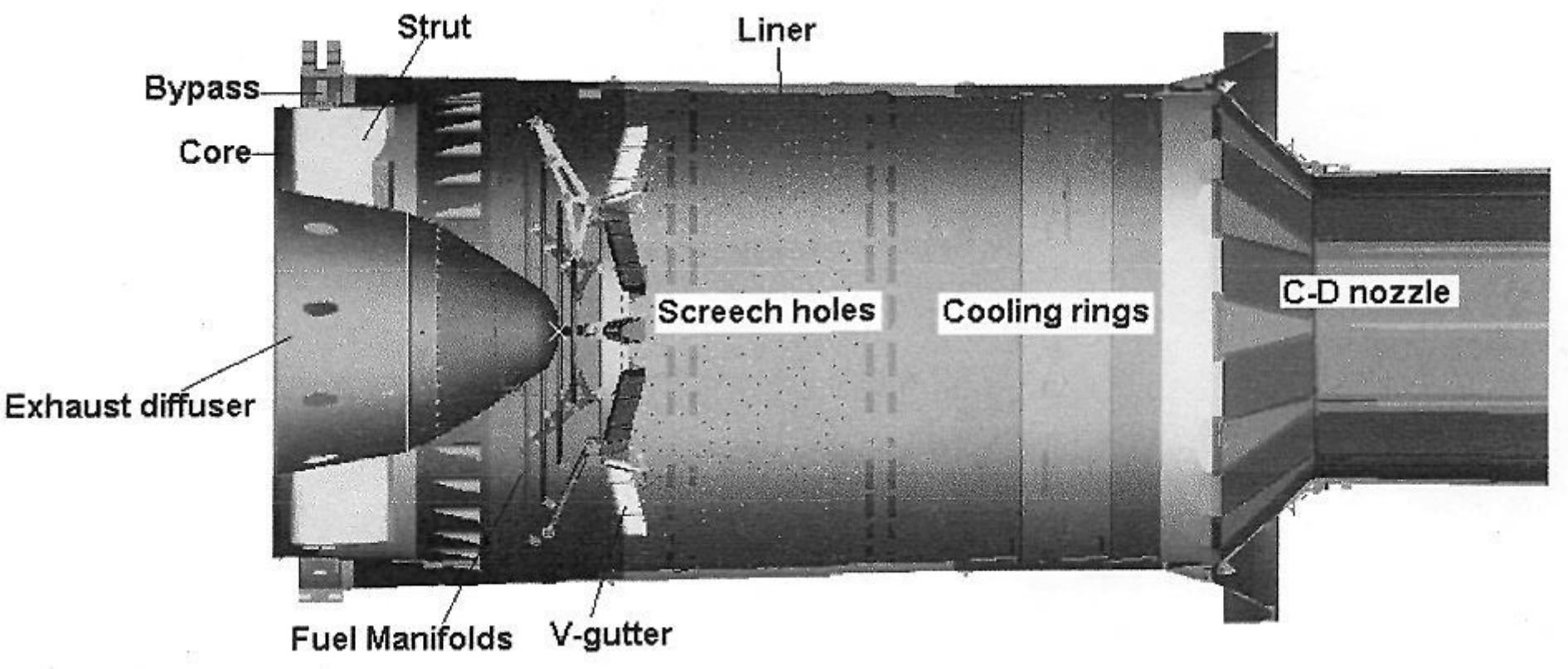
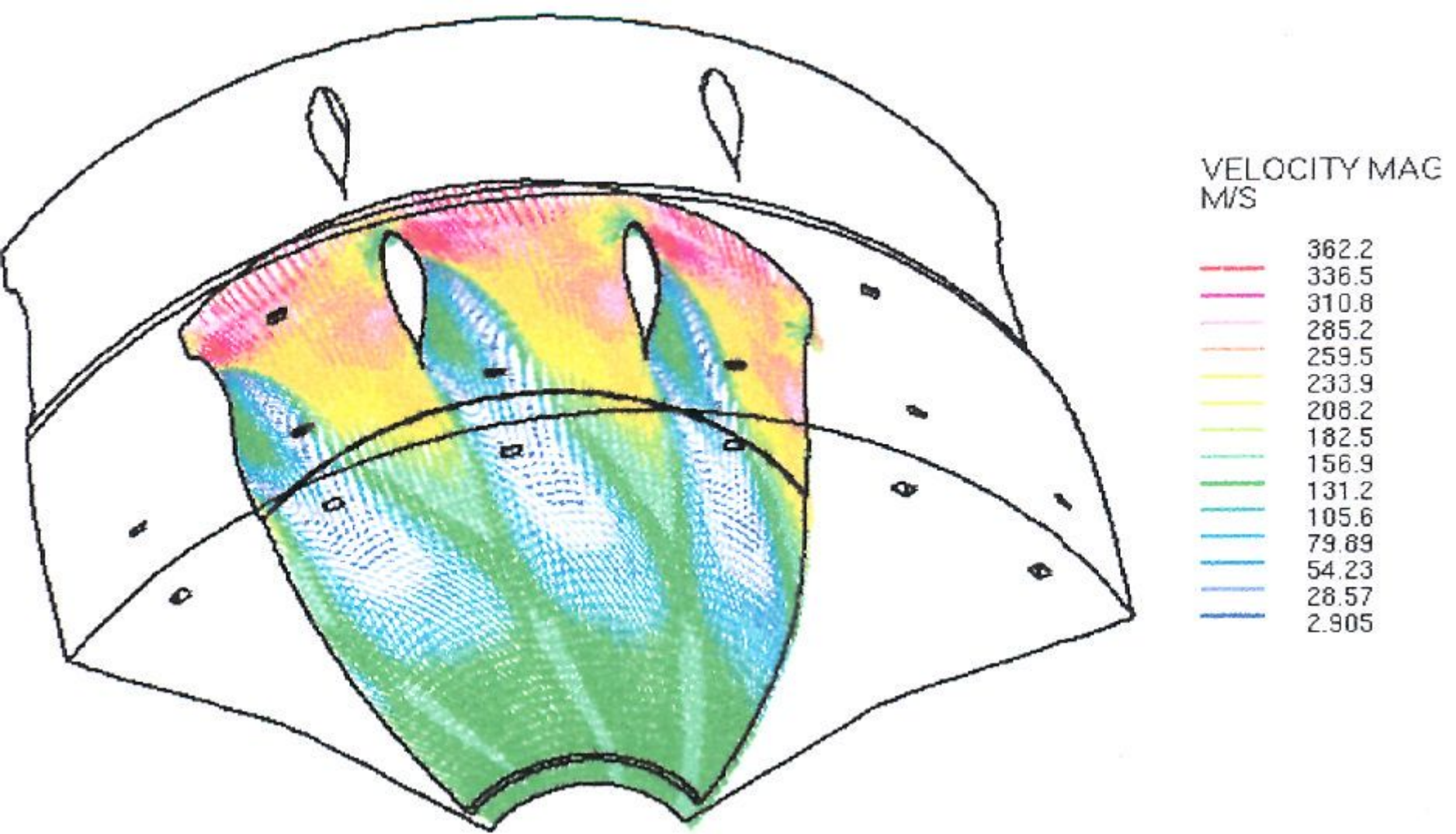
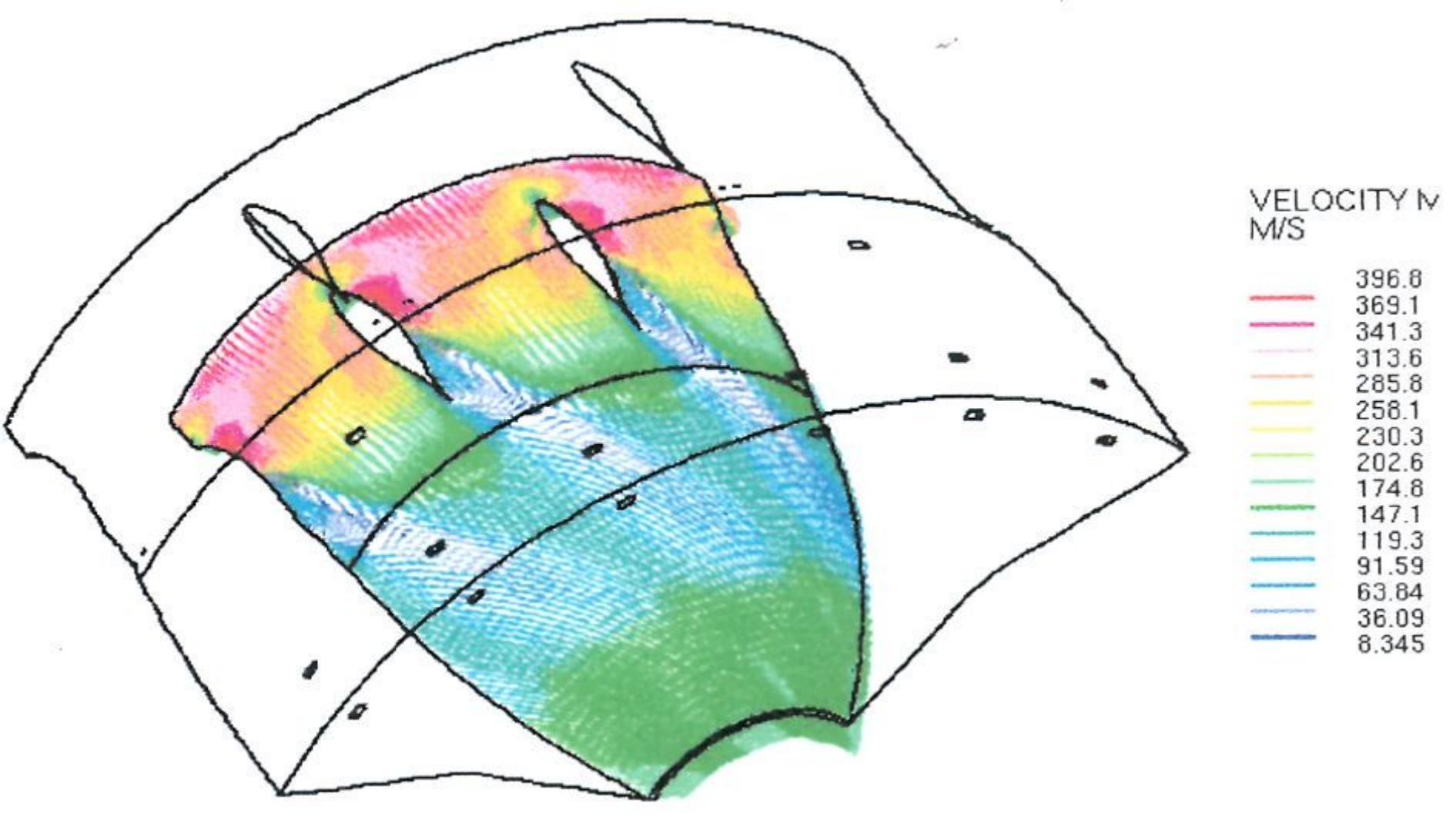
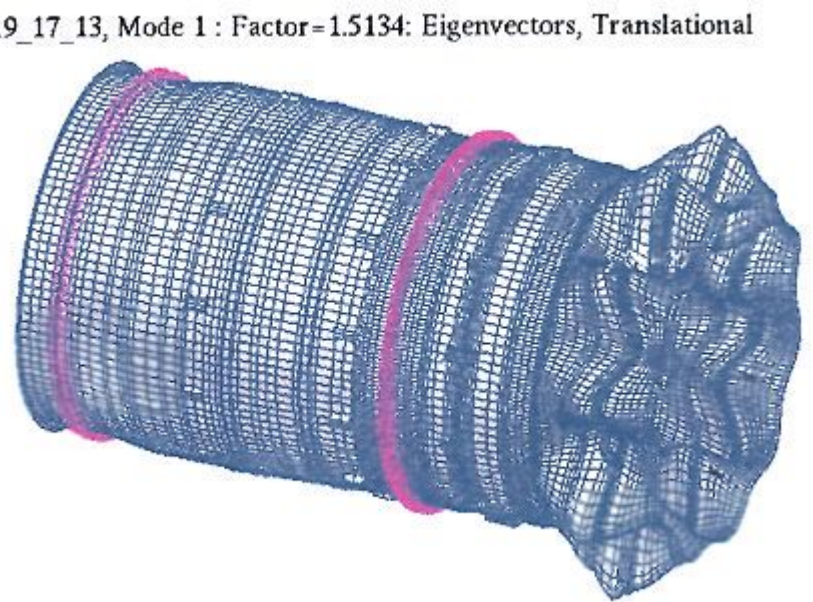
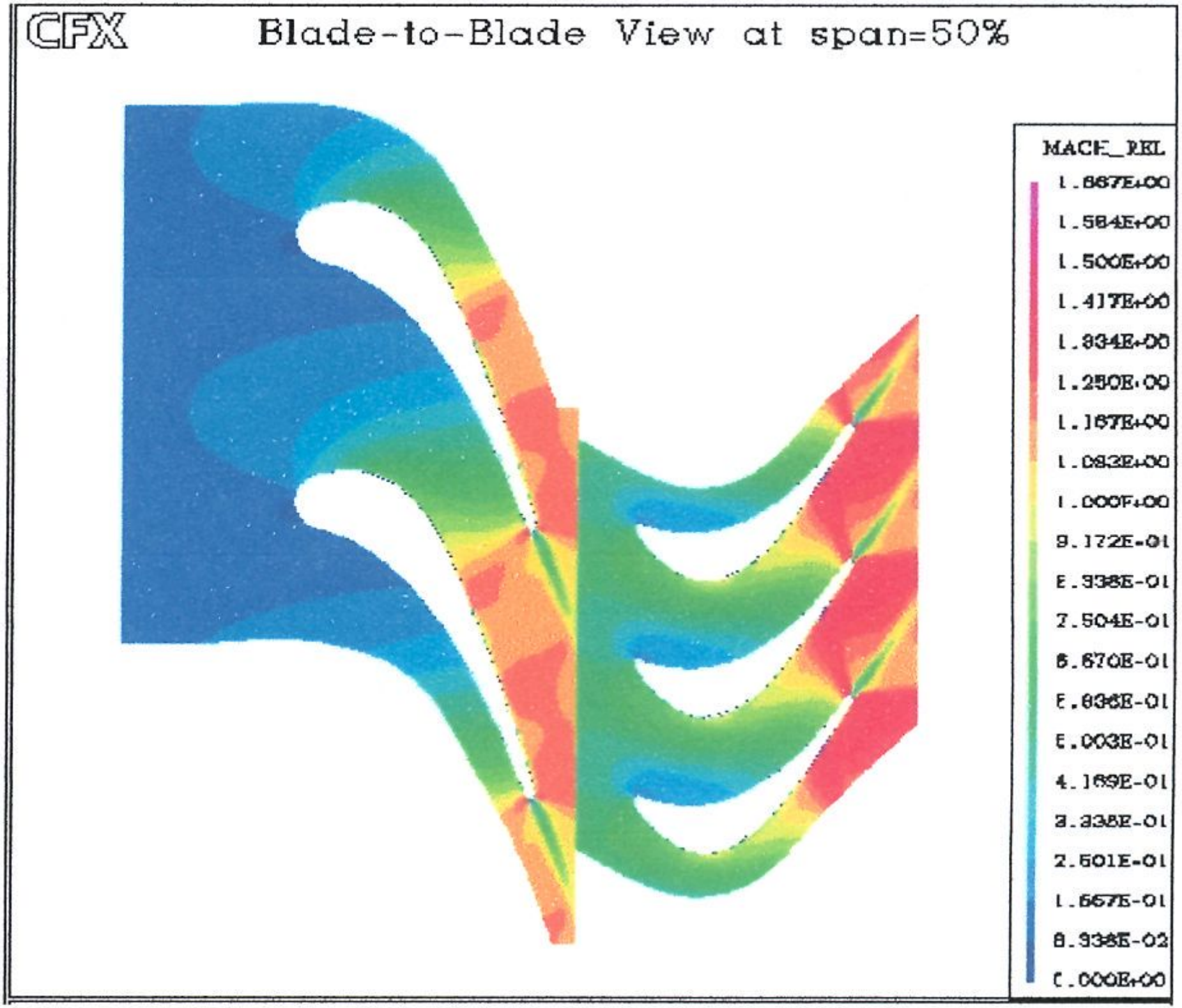

Strut
Liner
Bypass
Core
Screech holes
Cooling rings
C-D nozzle
Exhaust diffuser
Fuel Manifolds
V-gutter

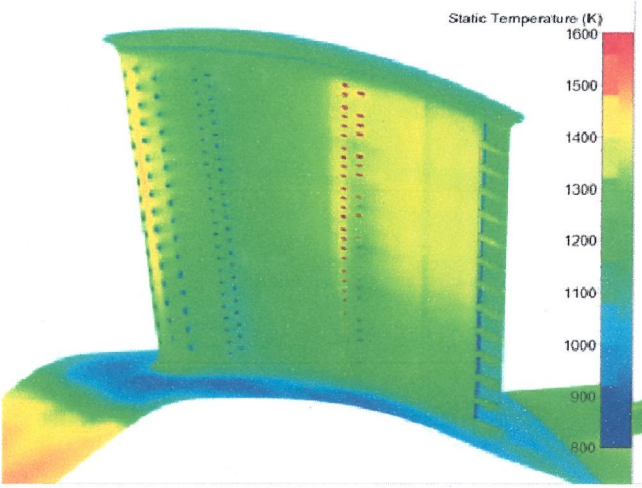

VELOCITY MAG
M/S
362.2
336.5
310.8
285.2
259.5
233.9
208.2
182.5
156.9
131.2
105.6
79.89
54.23
28.57
2.905

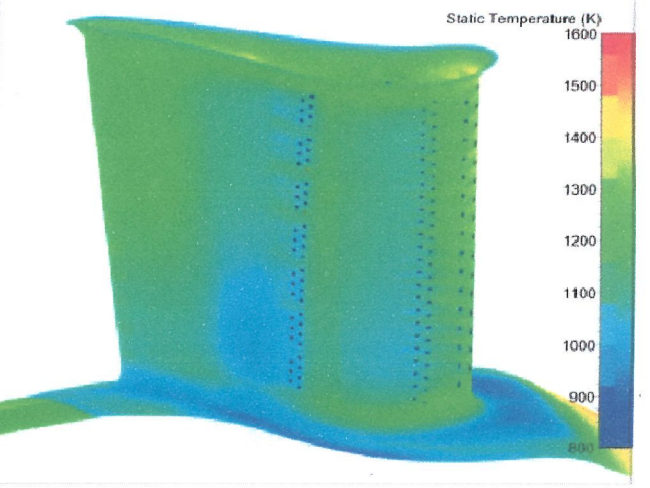

VELOCITY M
M/S
396.8
369.1
341.3
313.6
285.8
258.1
230.3
202.6
174.8
147.1
119.3
91.59
63.84
36.09
8.345

Deform:Fout_19_17_13, Mode 1 : Factor=1.5134: Eigenvectors, Translational



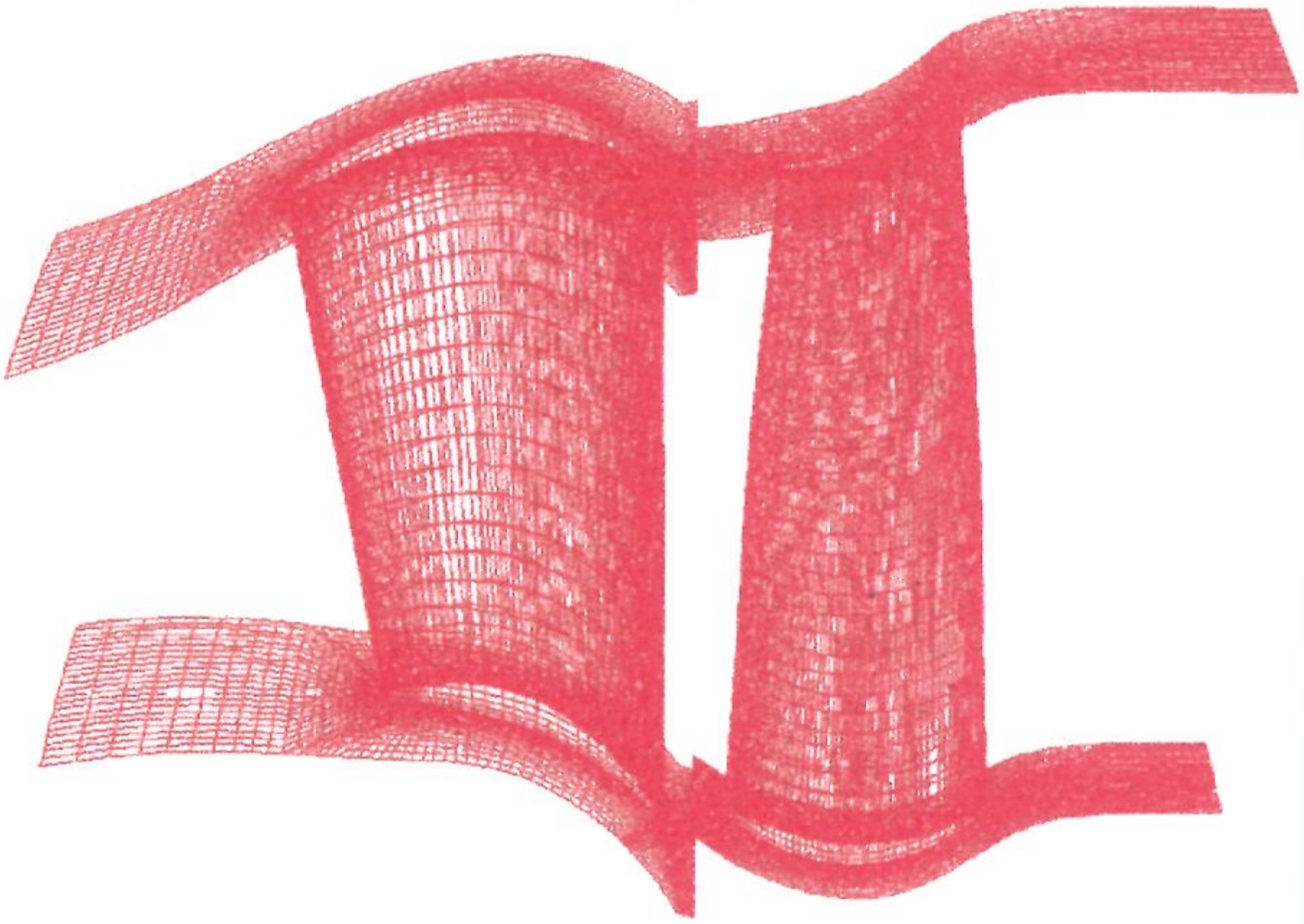

CFX
Blade-to-Blade View at span=50%
MACH_REL
1.667E+00
1.584E+00
1.500E+00
1.417E+00
1.334E+00
1.250E+00
1.167E+00
1.083E+00
1.000E+00
9.172E-01
8.338E-01
7.504E-01
6.670E-01
5.836E-01
5.003E-01
4.169E-01
3.335E-01
2.501E-01
1.667E-01
8.338E-02
0.000E+00

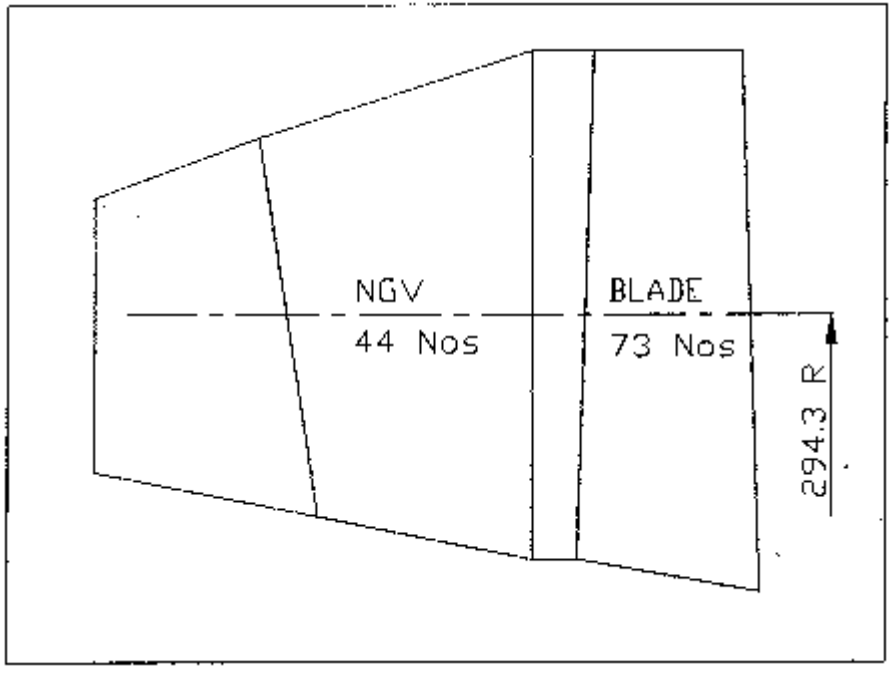

Static Temperature (K)
1600
1500
1400
1300
1200
1100
1000
900
800

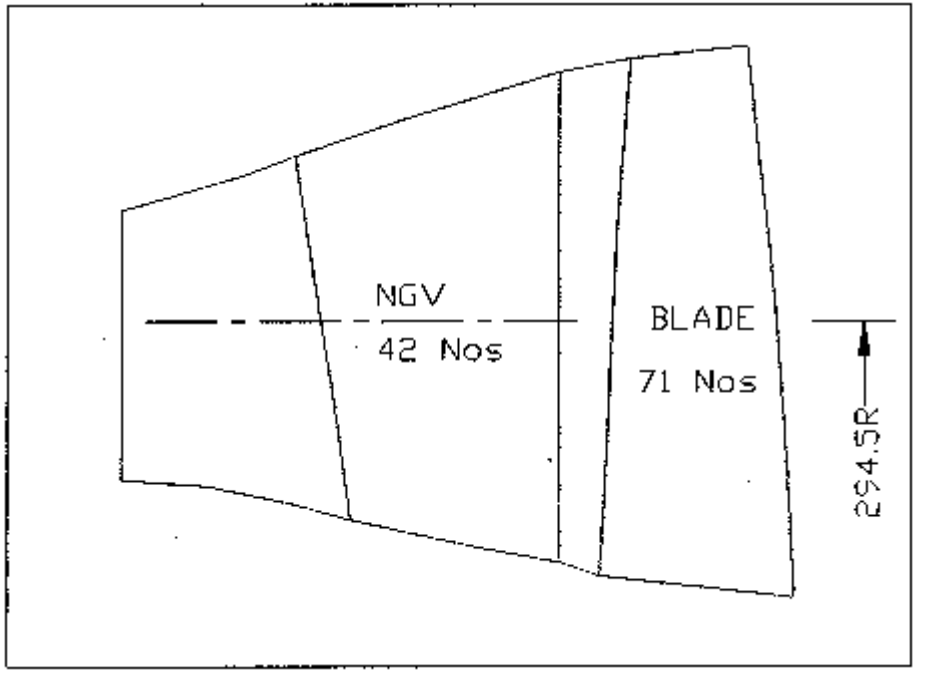

Static Temperature (K)
1600
1500
1400
1300
1200
1100
1000
900
800

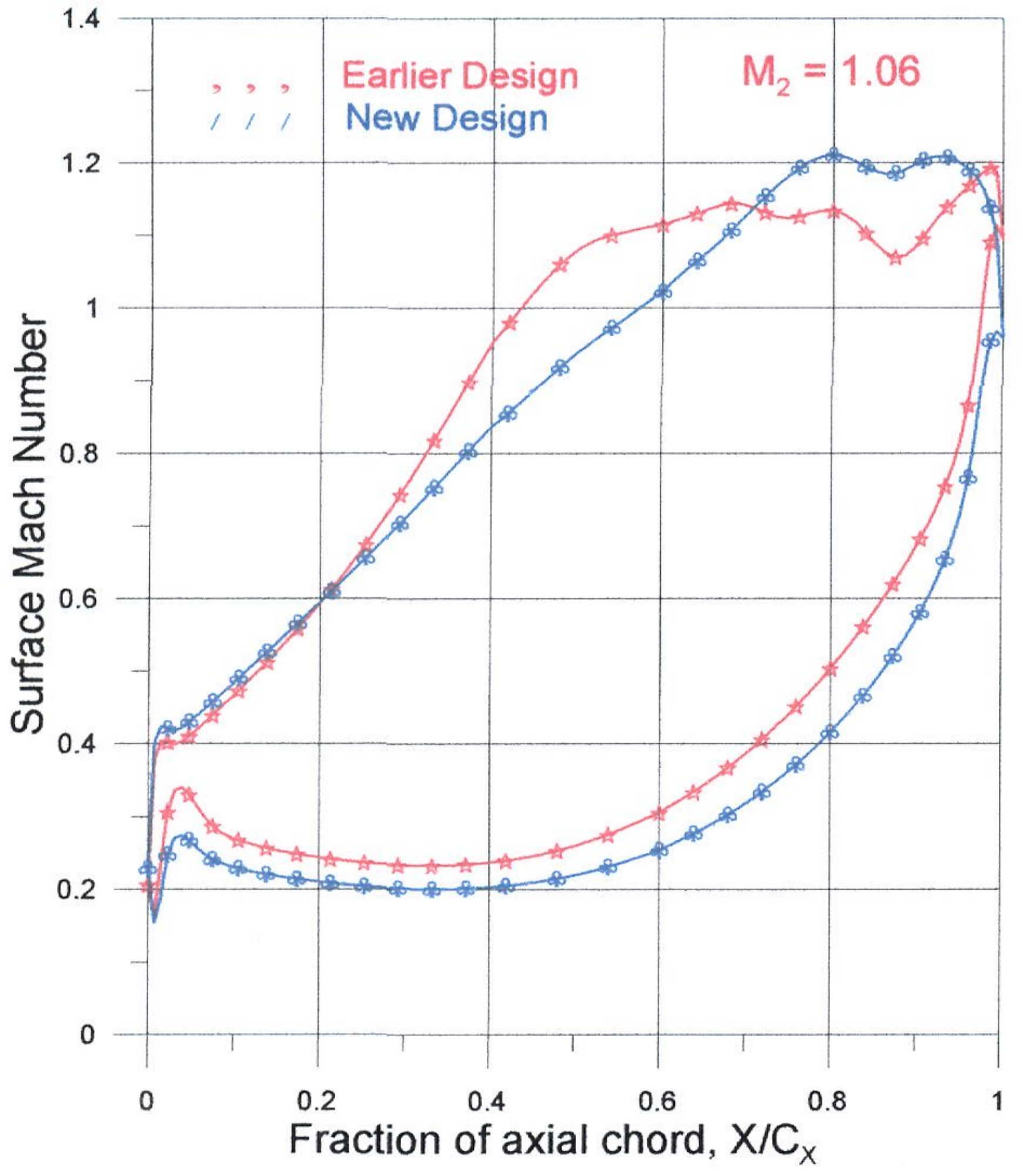
CFX

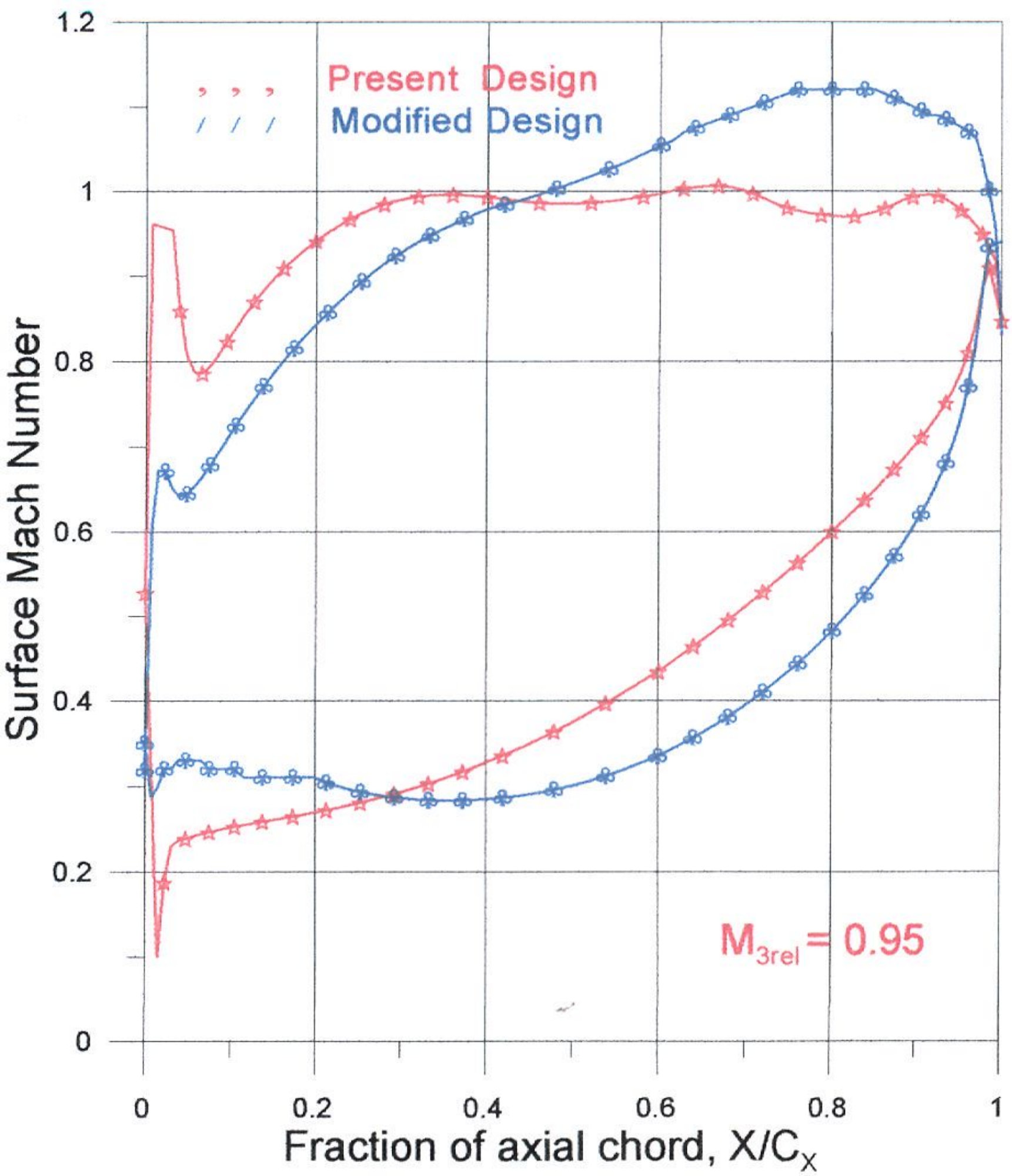
Three Dimensional View



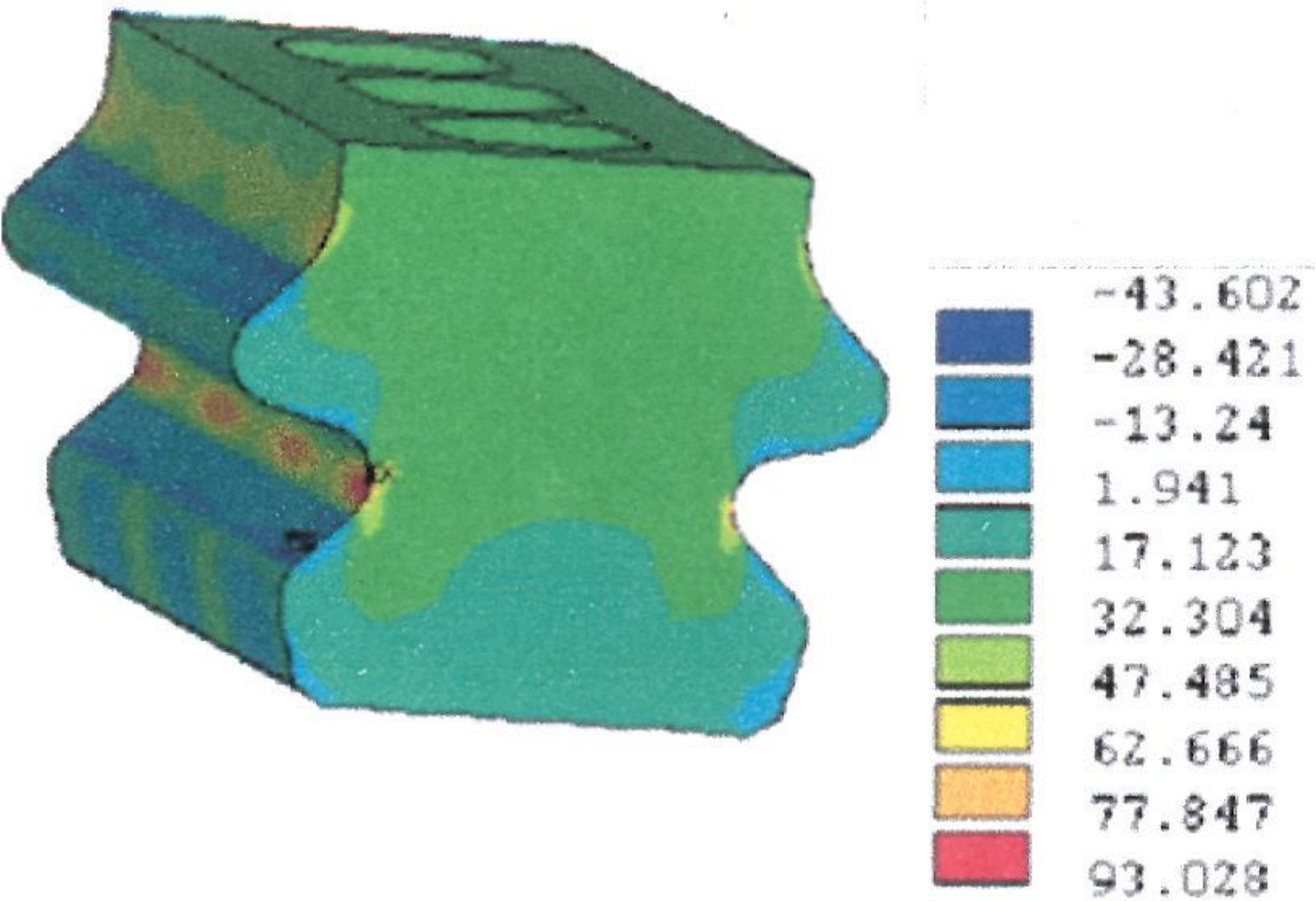

NGV
44 Nos
BLADE
73 Nos
294.3 R


NGV
42 Nos
BLADE
71 Nos
294.5R


Earlier Design
New Design
$M_2 = 1.06$
Surface Mach Number
Fraction of axial chord, X/C_X
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1


Present Design
Modified Design
$M_{3rel} = 0.95$
Surface Mach Number
Fraction of axial chord, X/C_X
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1


ANSYS 10.0
NODAL SOLUTION
STEP=1
SUB =1
TIME=1
SEQV (AVG)
PowerGraphics
EFACET=1
AVRES=Mat
DMX =5.077
SMN =.502077
SMX =896.915
.502077
100.104
199.705
299.306
398.908
498.509
598.111
697.712
797.314
896.915



Max Principal stress(kgf/mm2) distribution

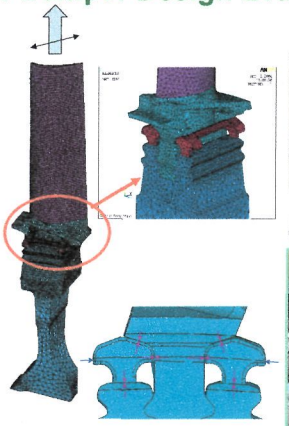
LPT Damper Design Evaluation

FE Analysis

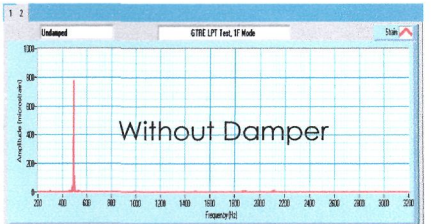
Bench Testing

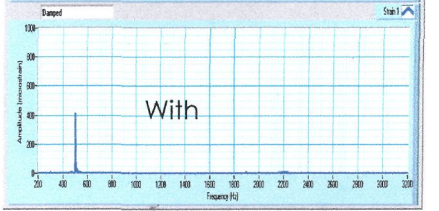
Spin Testing

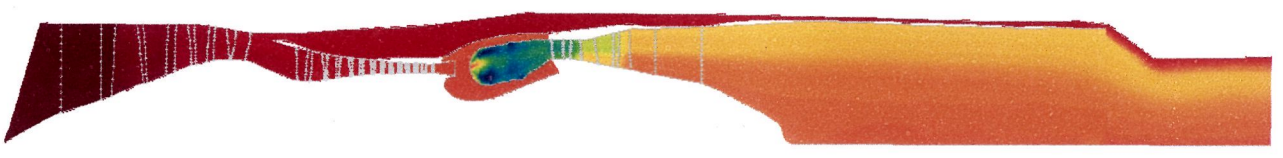
Design Improvement

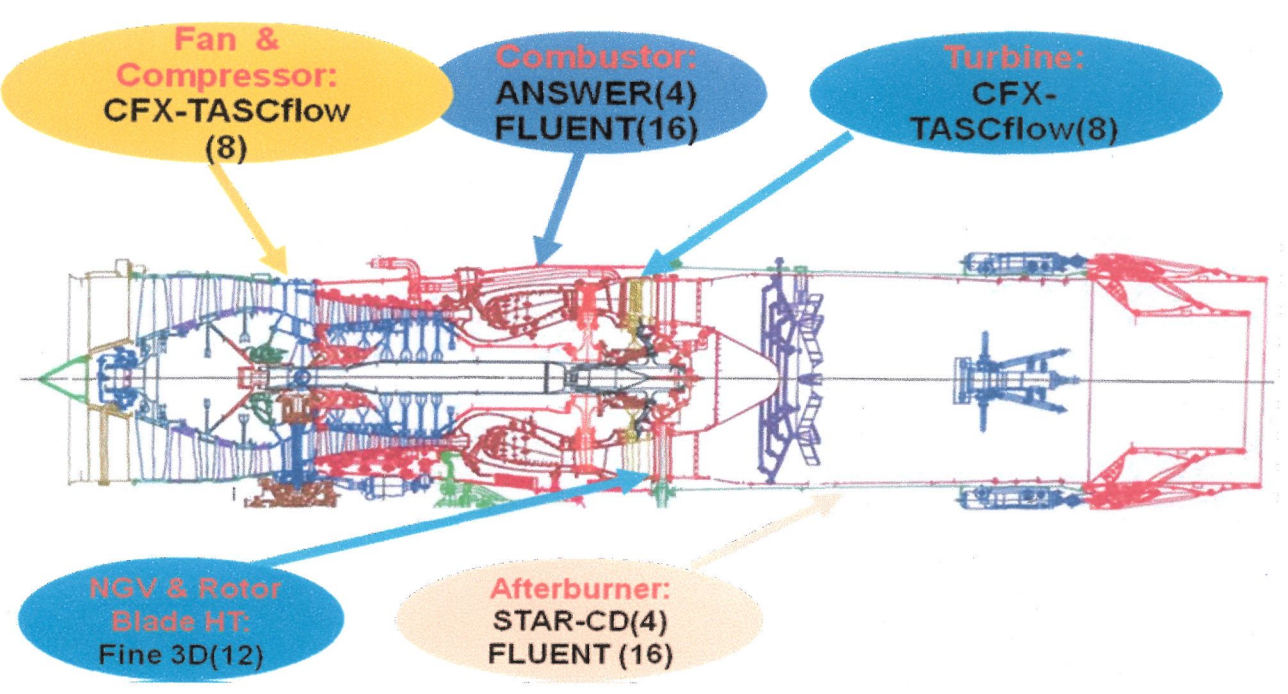


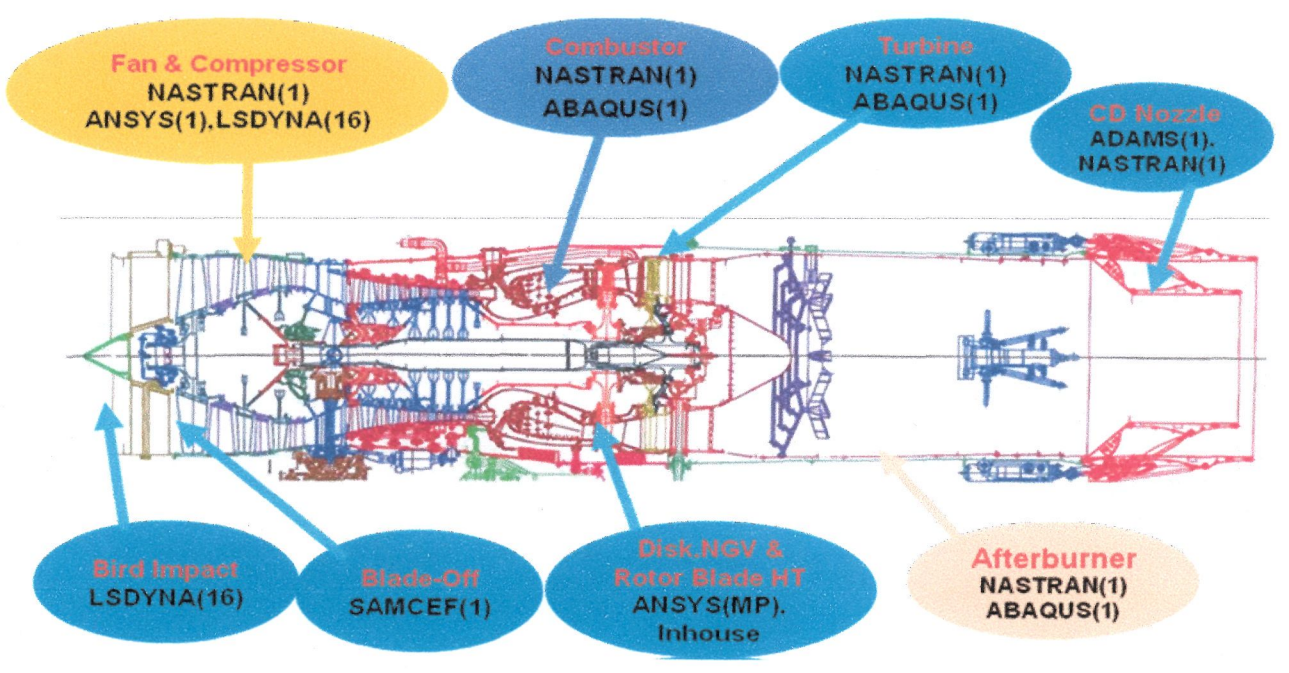
Damper Performance

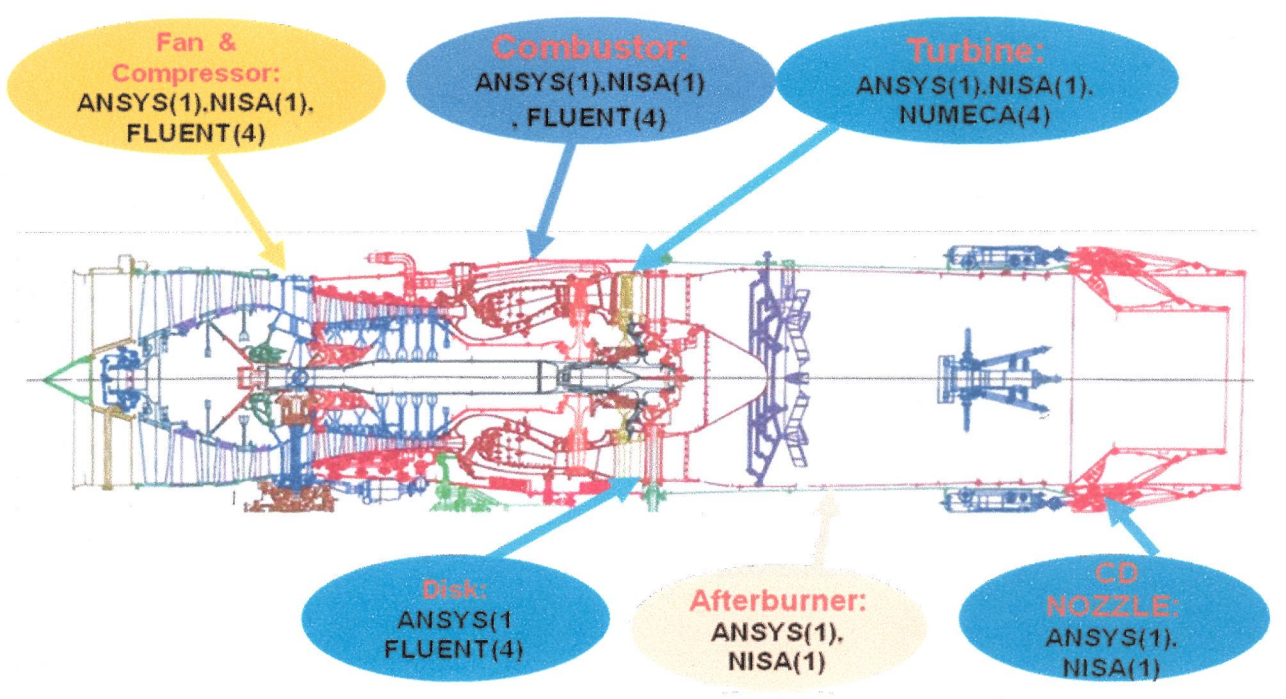


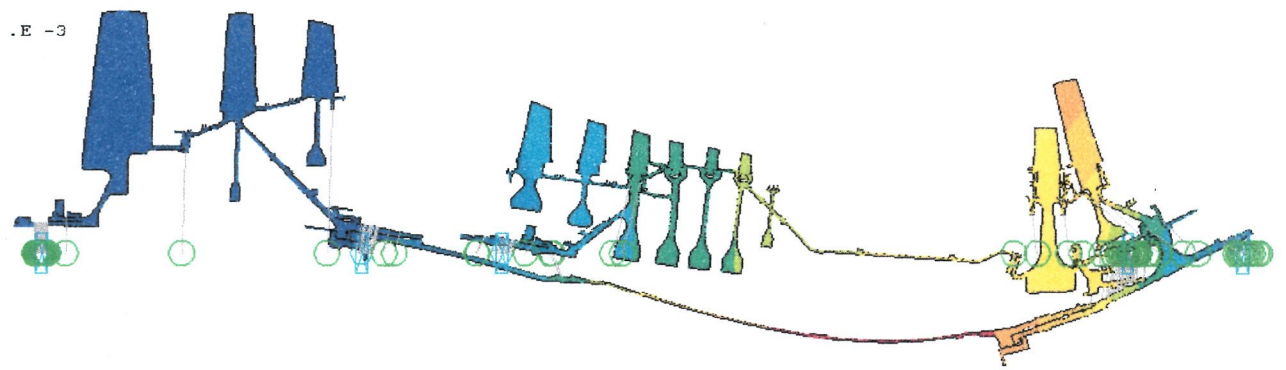


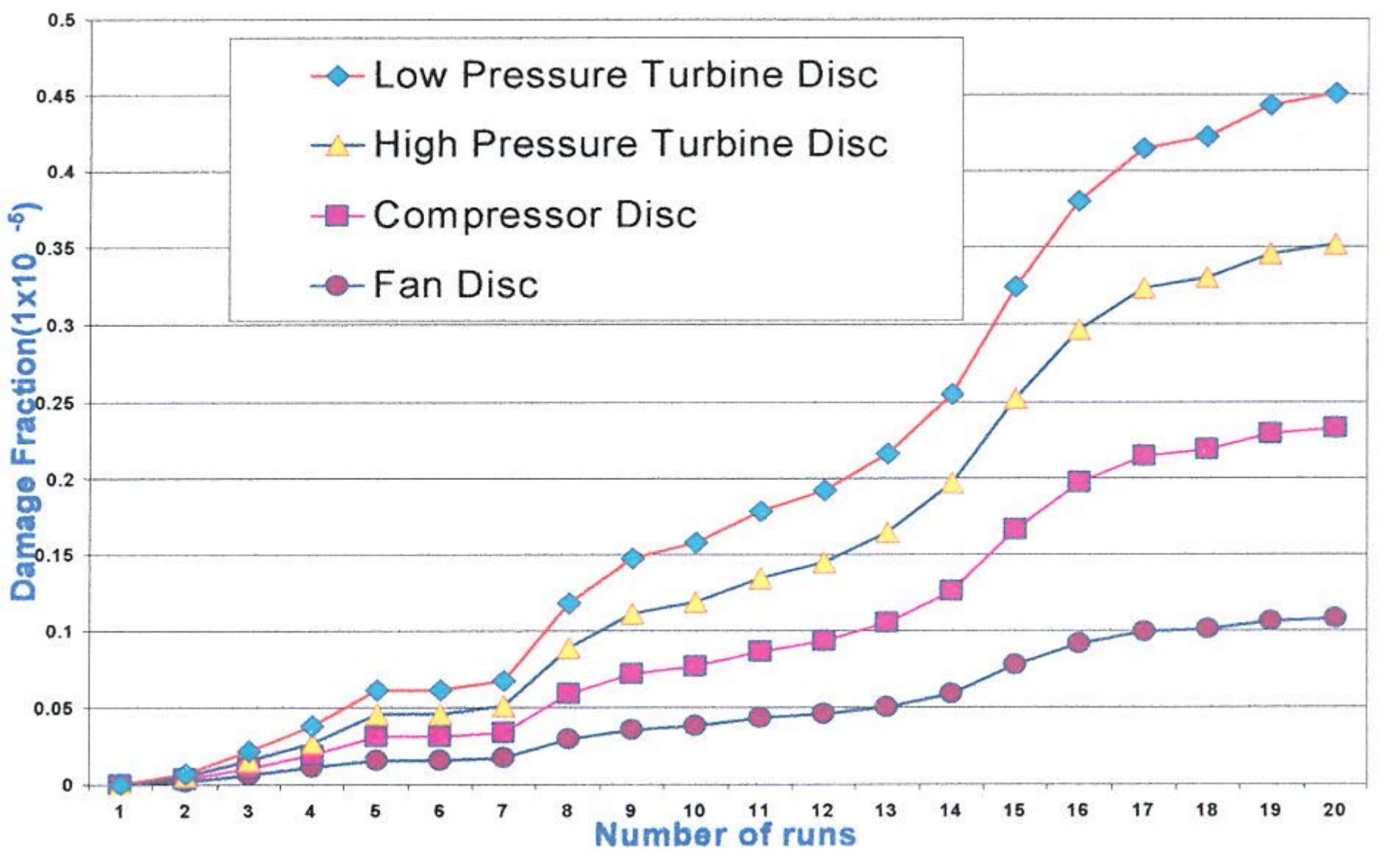


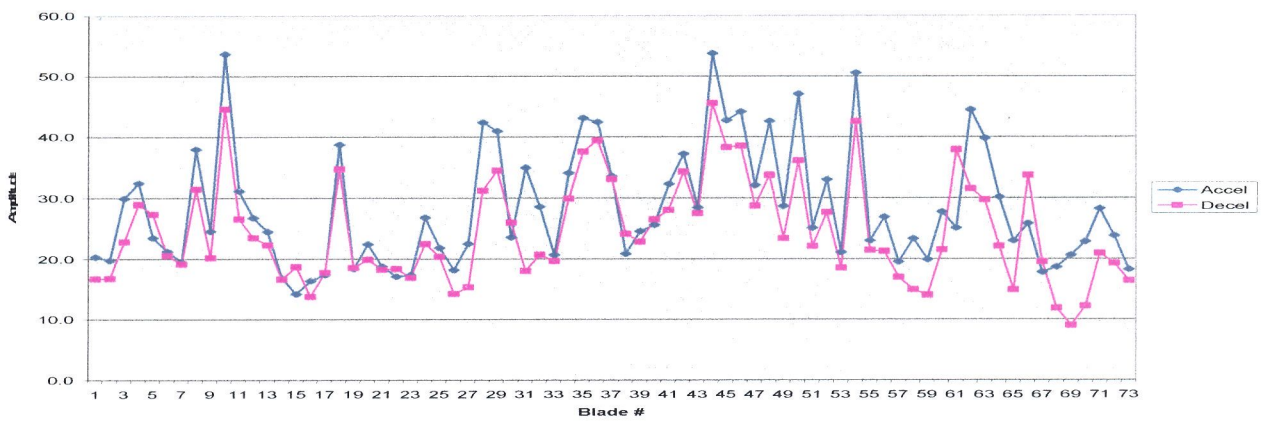

Fan & Compressor: CFX-TASCflow (8)
Combustor: ANSWER(4) FLUENT(16)
Turbine: CFX-TASCflow(8)
NGV & Rotor Blade HT: Fine 3D(12)
Afterburner: STAR-CD(4) FLUENT (16)

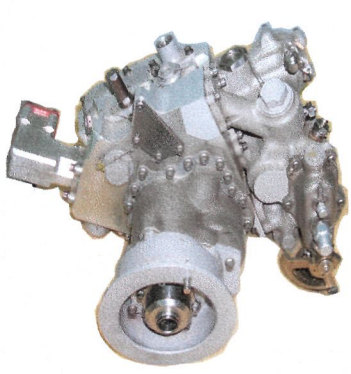

Fan & Compressor
NASTRAN(1)
ANSYS(1).LSDYNA(16)
Combustor
NASTRAN(1)
ABAQUS(1)
Turbine
NASTRAN(1)
ABAQUS(1)
CD Nozzle
ADAMS(1).
NASTRAN(1)
Bird Impact
LSDYNA(16)
Blade-Off
SAMCEF(1)
Disk.NGV &
Rotor Blade HT
ANSYS(MP).
Inhouse
Afterburner
NASTRAN(1)
ABAQUS(1)

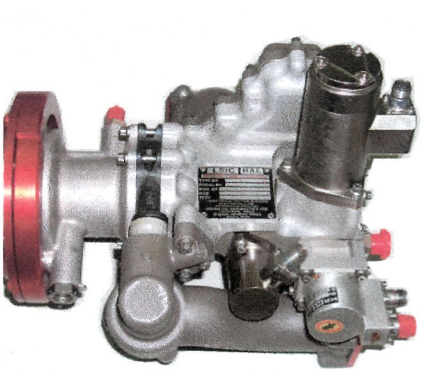

Fan &
Compressor:
ANSYS(1).NISA(1).
FLUENT(4)
Combustor:
ANSYS(1).NISA(1)
. FLUENT(4)
Turbine:
ANSYS(1).NISA(1).
NUMECA(4)
Disk:
ANSYS(1
FLUENT(4)
Afterburner:
ANSYS(1).
NISA(1)
CD
NOZZLE:
ANSYS(1).
NISA(1)

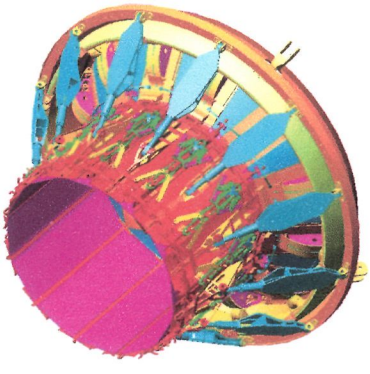

.E -3

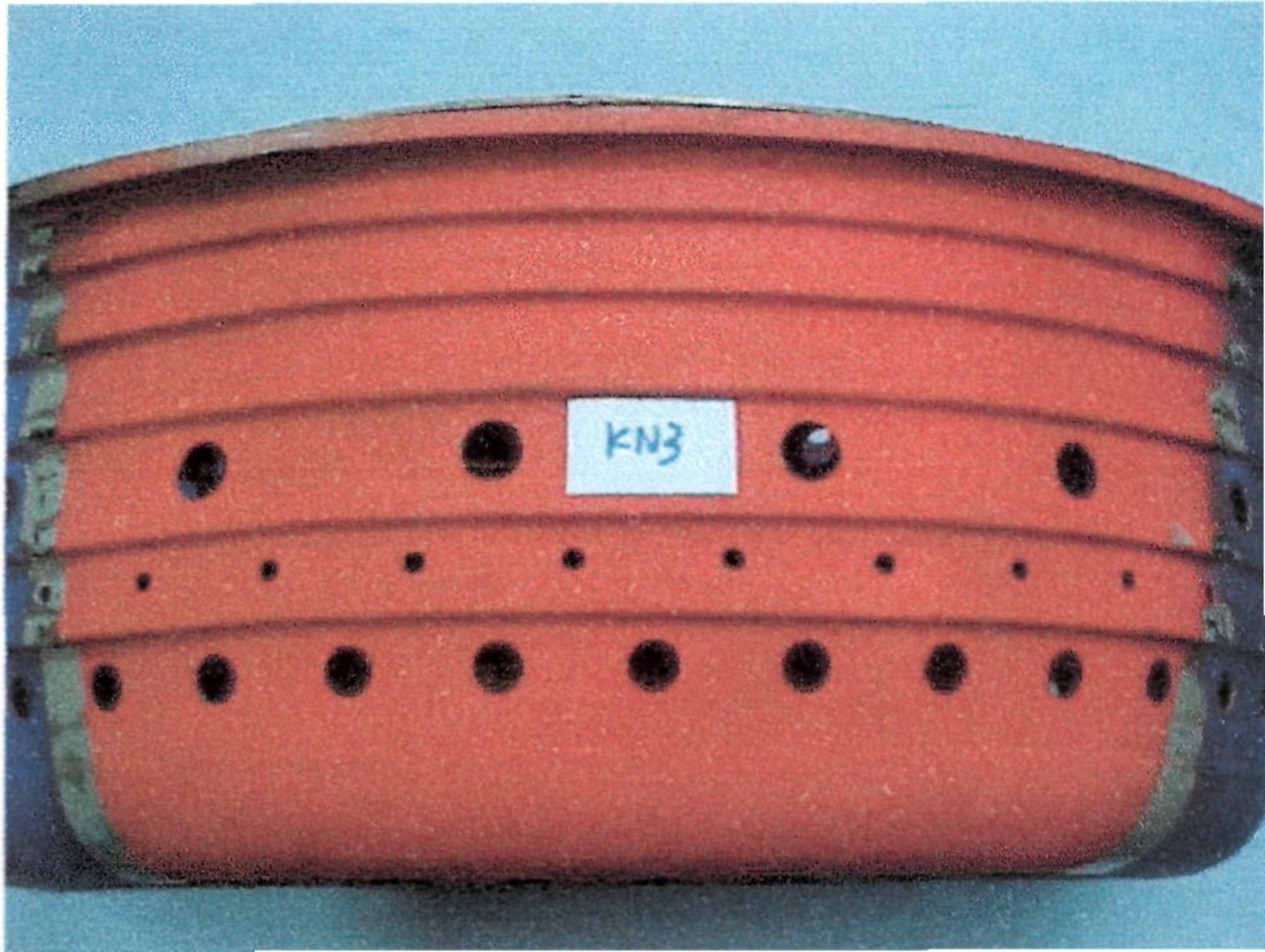

Low Pressure Turbine Disc
High Pressure Turbine Disc
Compressor Disc
Fan Disc
Damage Fraction(1x10 -6)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Number of runs

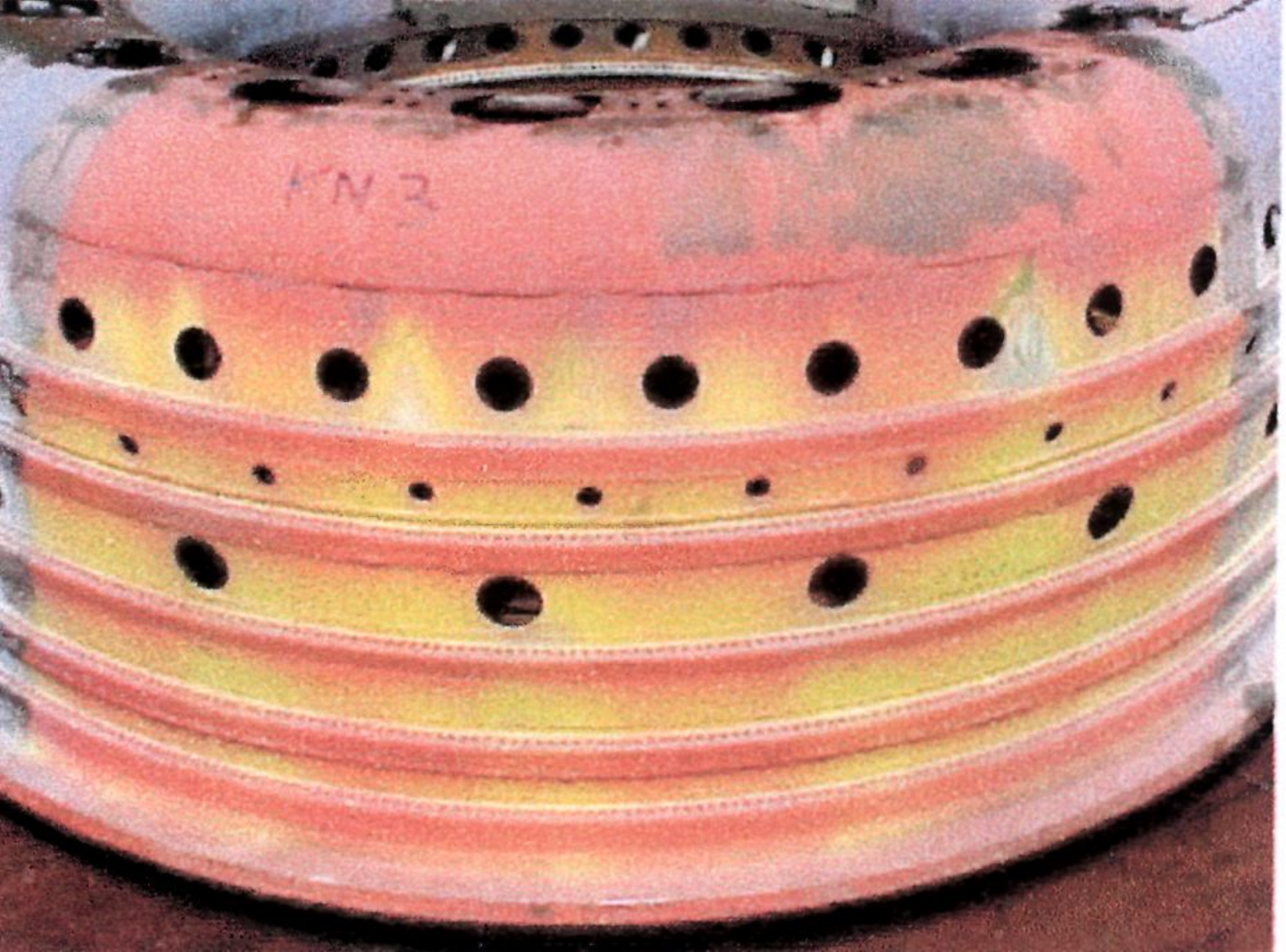

60.0
50.0
40.0
30.0
20.0
10.0
0.0
Amplitude
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73
Blade #
Accel
Decel

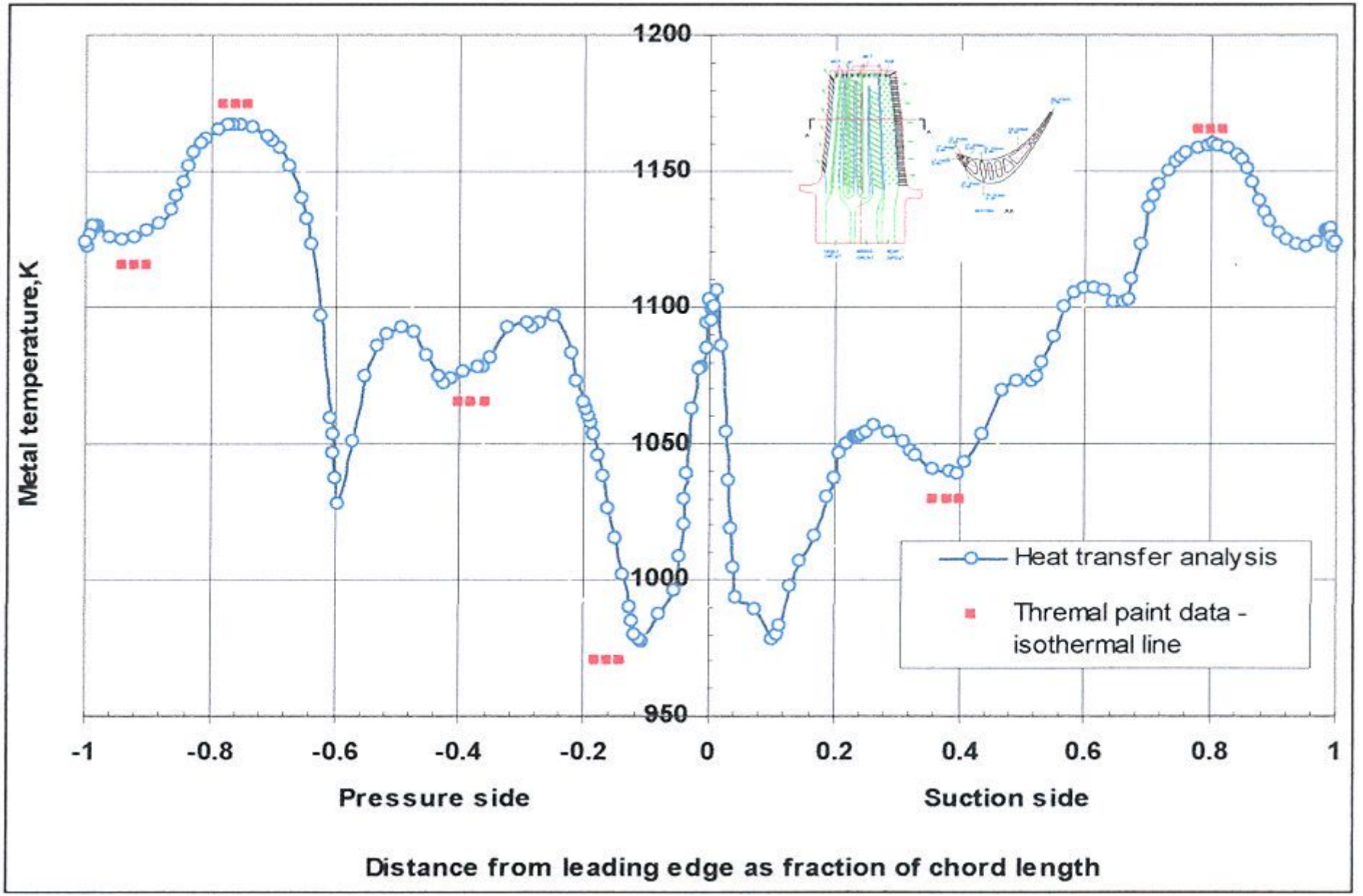







KN3



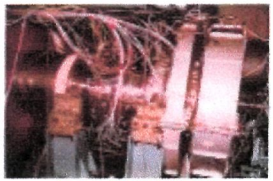

1200
1150
1100
1050
1000
950
Metal temperature,K
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
Pressure side
Suction side
Distance from leading edge as fraction of chord length
Heat transfer analysis
Thremal paint data - isothermal line

FAN

TURBINE

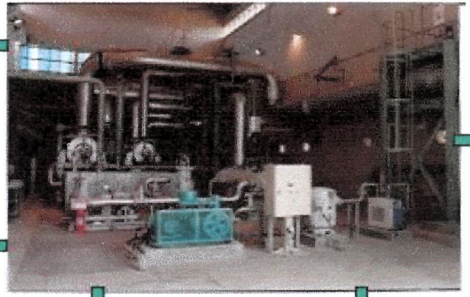
AFTERBURNER

TEST CELLS



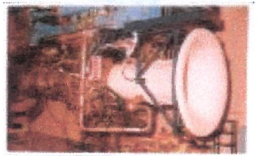
COMBUSTOR

HIGH PRESSURE AIR SUPPLY FACILITY



RAM AIR

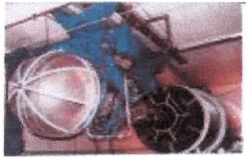
HEAT TRANSFER



HP COMPRESSOR

JFS-HAT

ECS-TEST

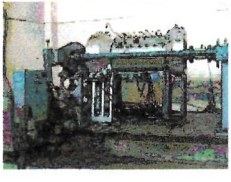


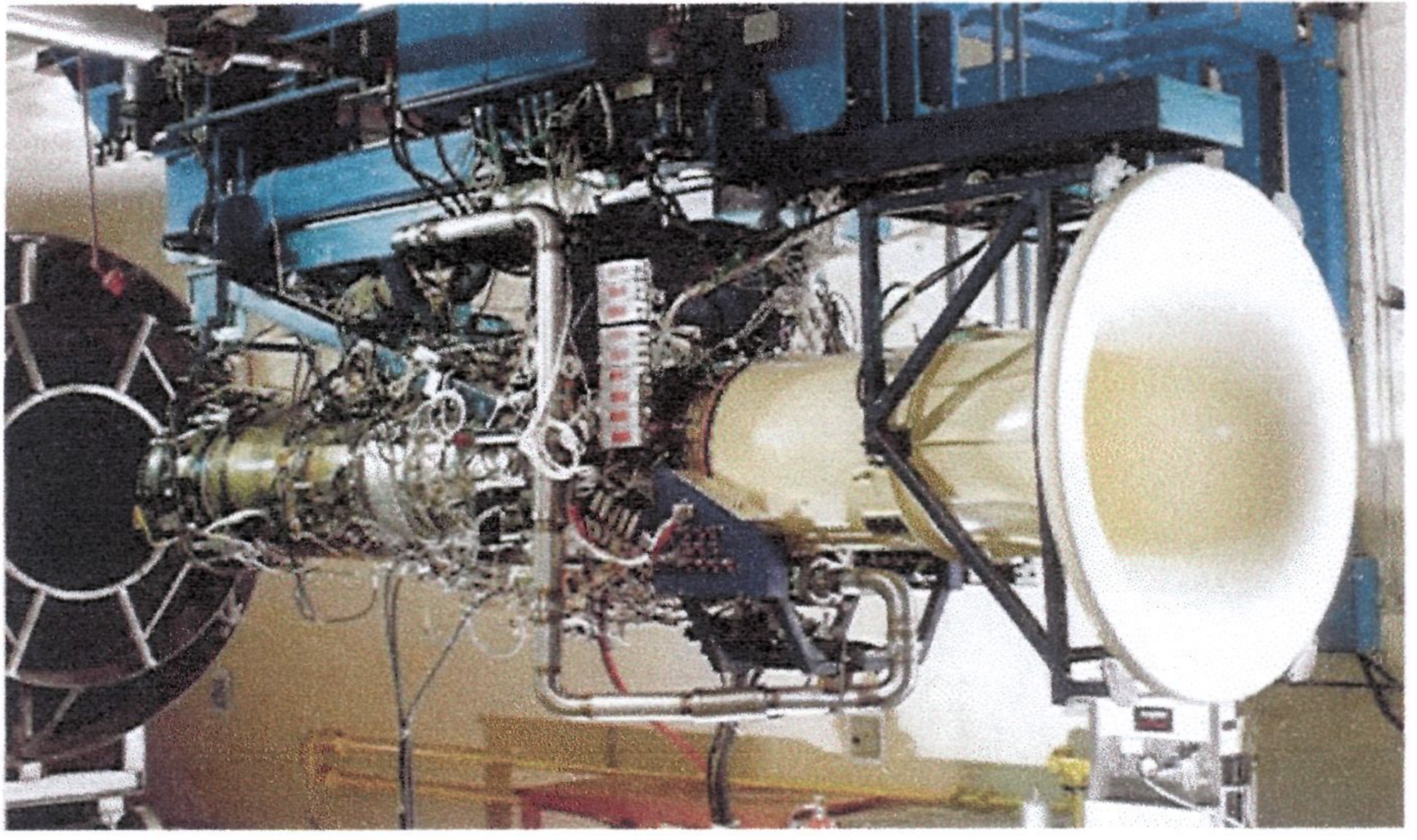
TEST FACILITIES

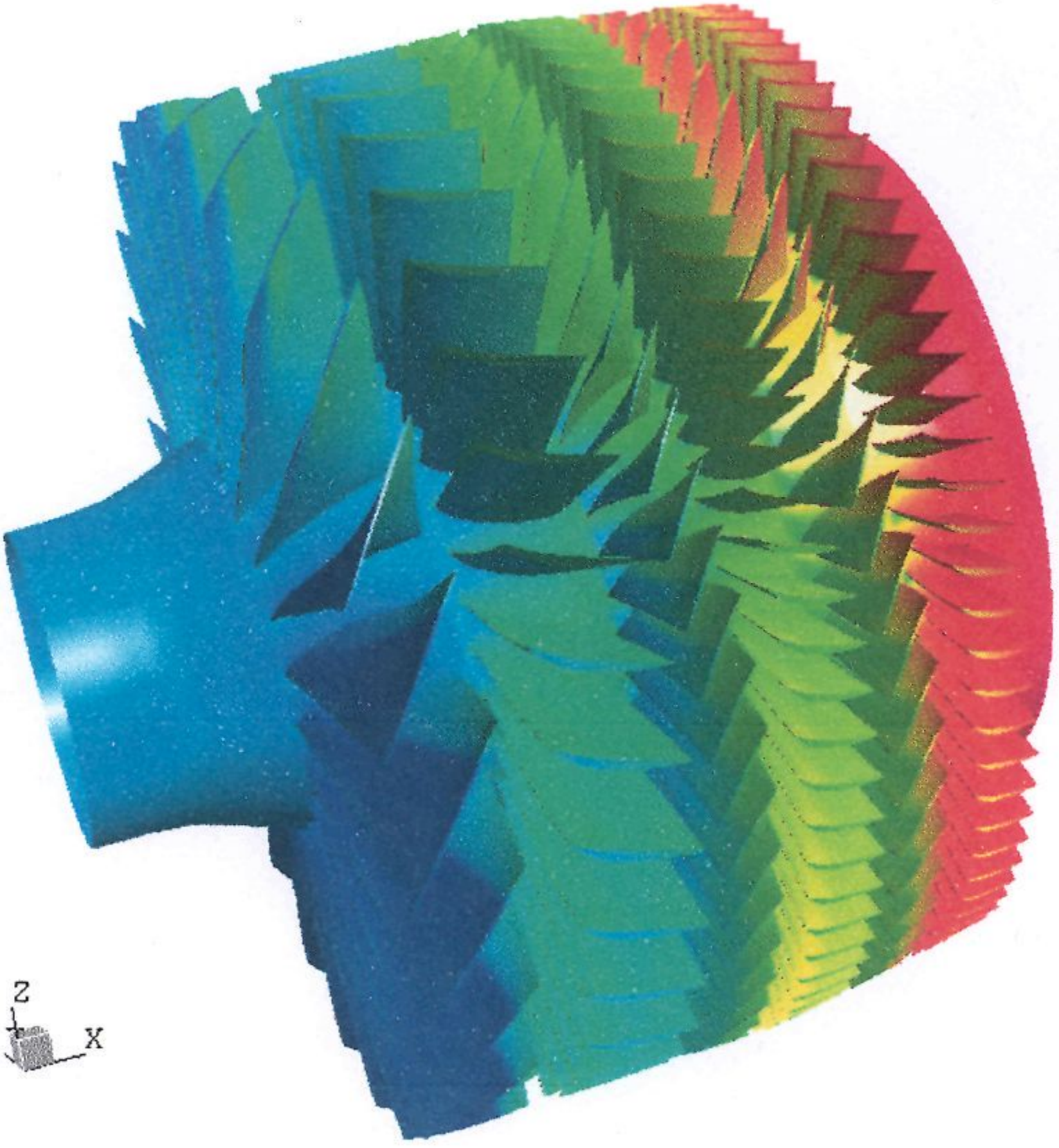
Bird Ingestion Test

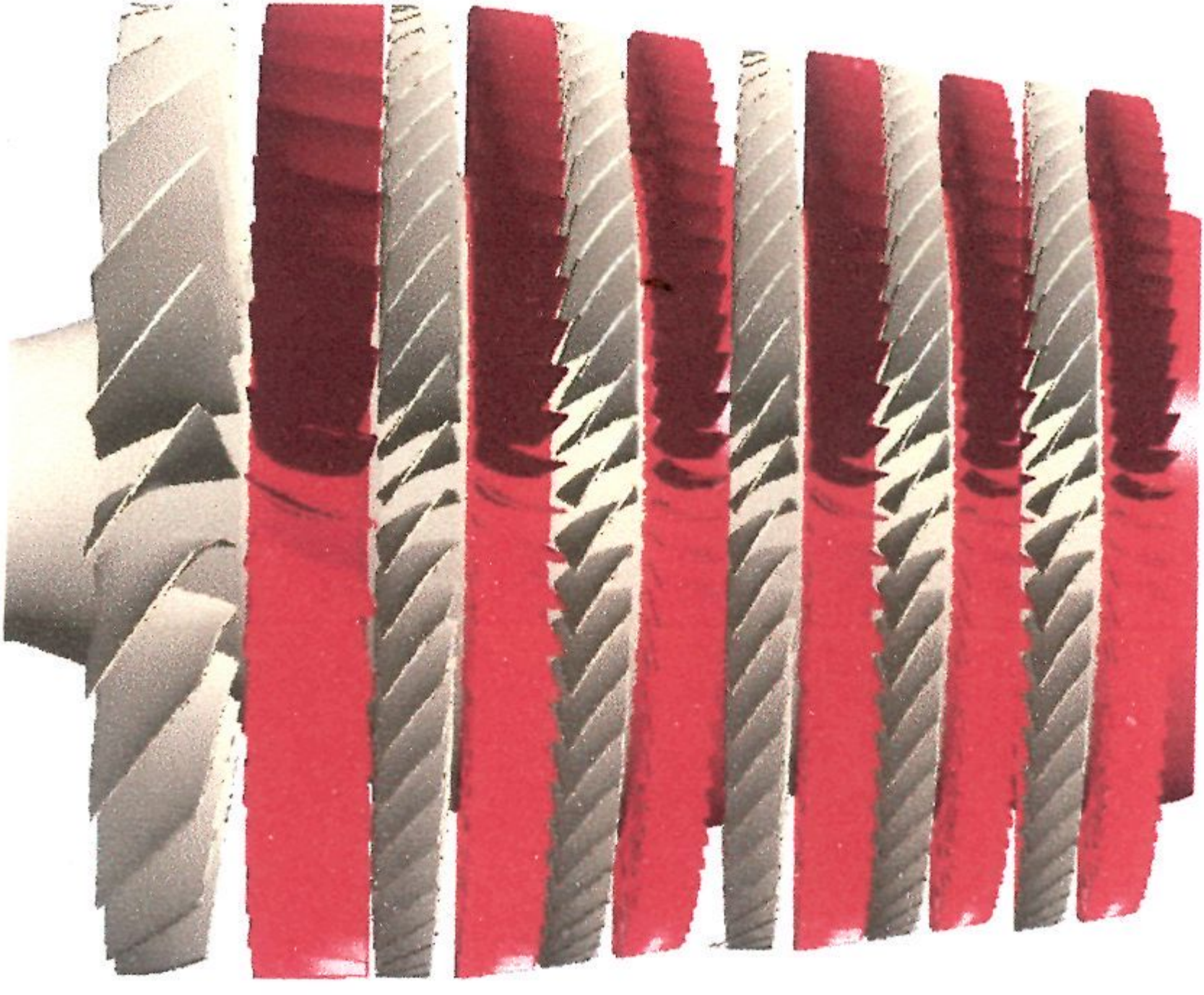
Gear Box Endurance Test

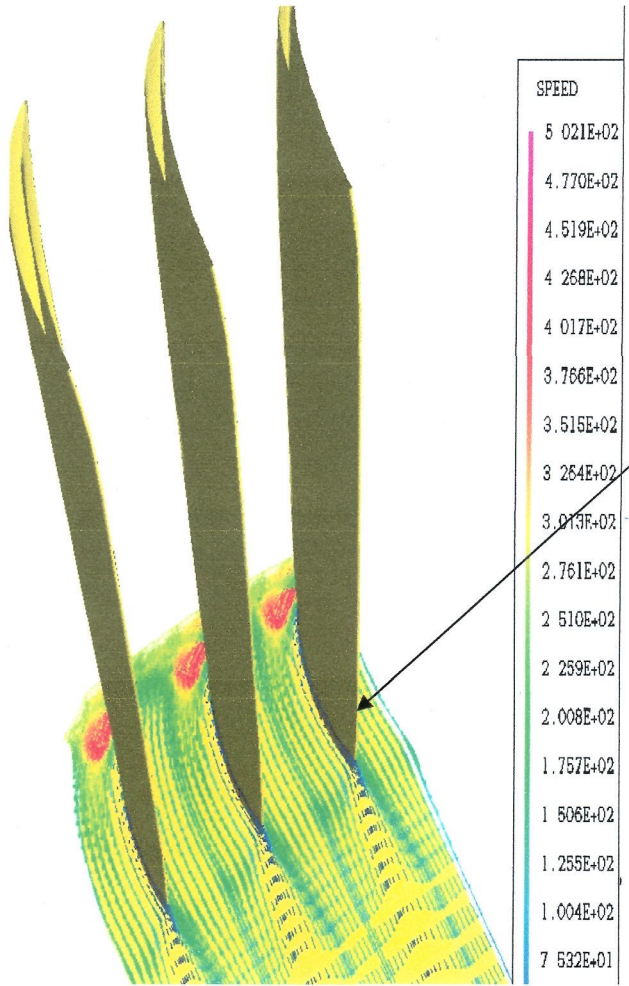
Disc LCF Test



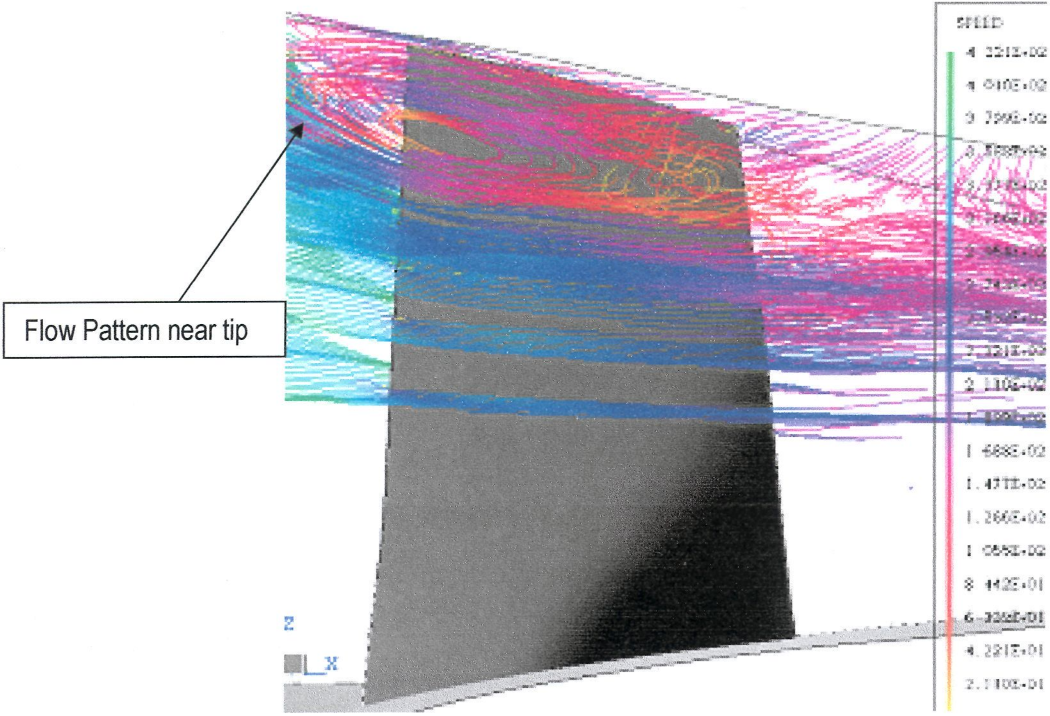



Z
X

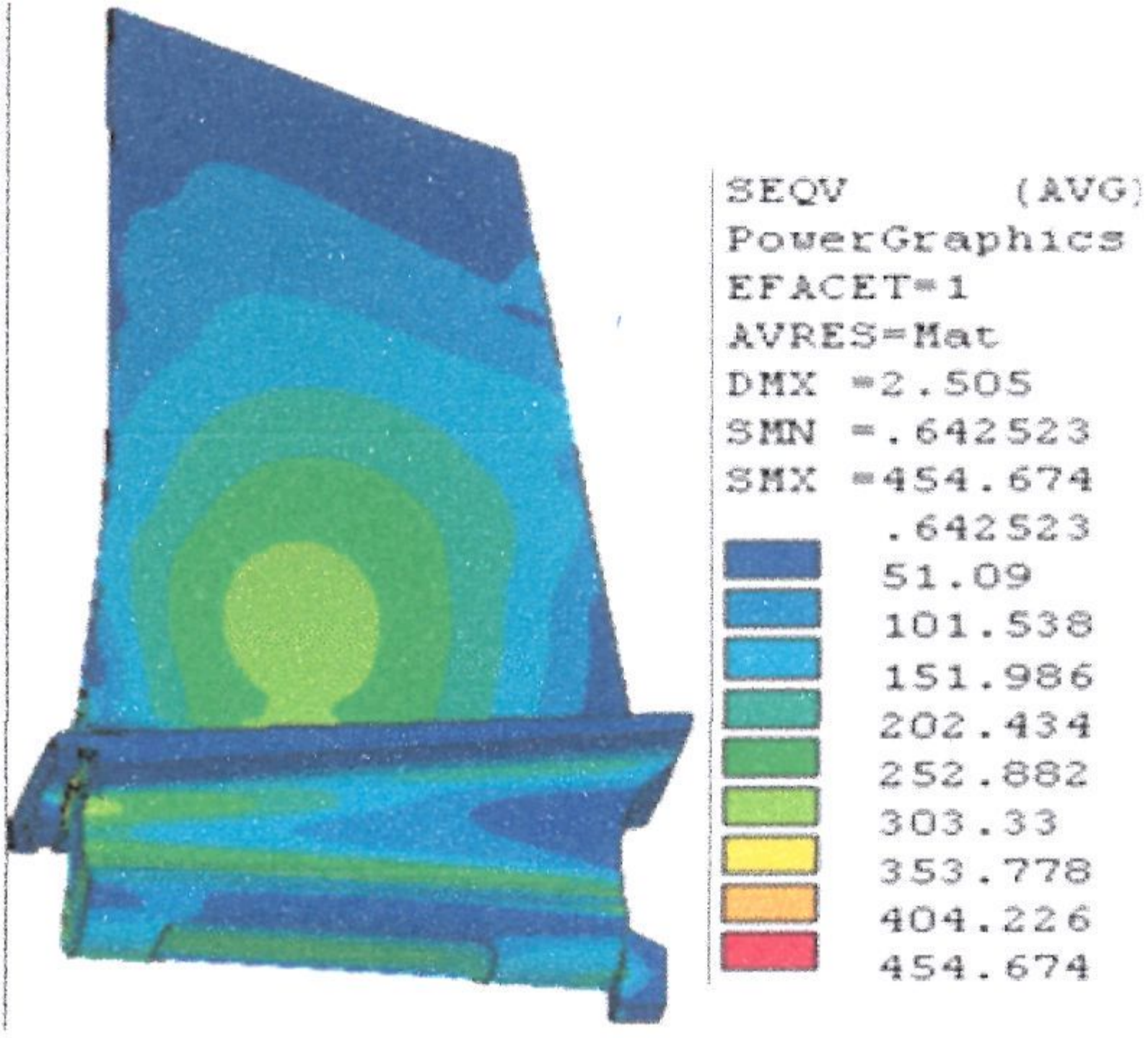




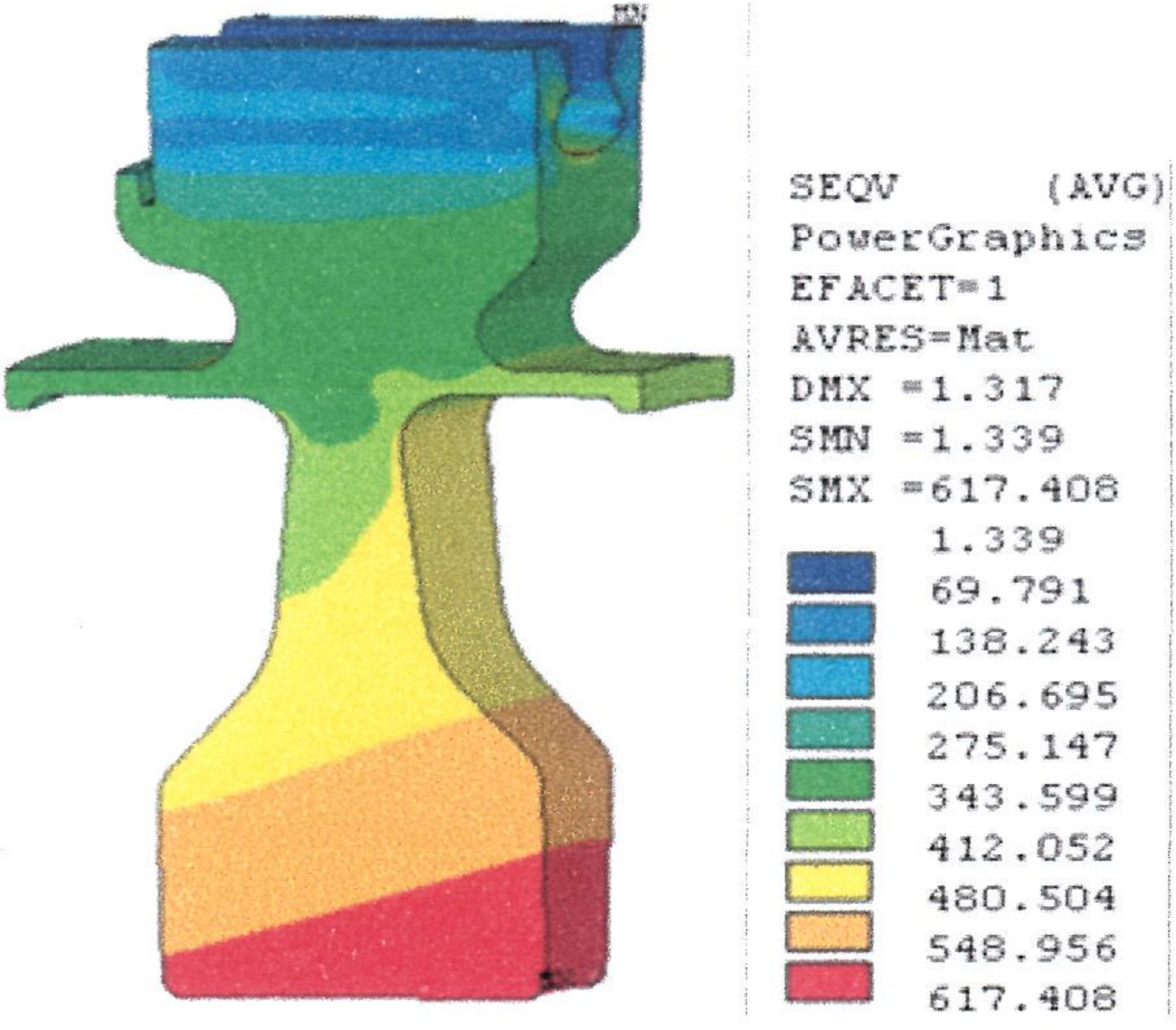
Stall criteria – Separation of flow anywhere in the compressor



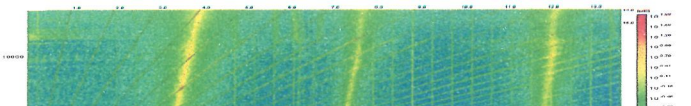
Flow Pattern near tip
SPEED
Z
X

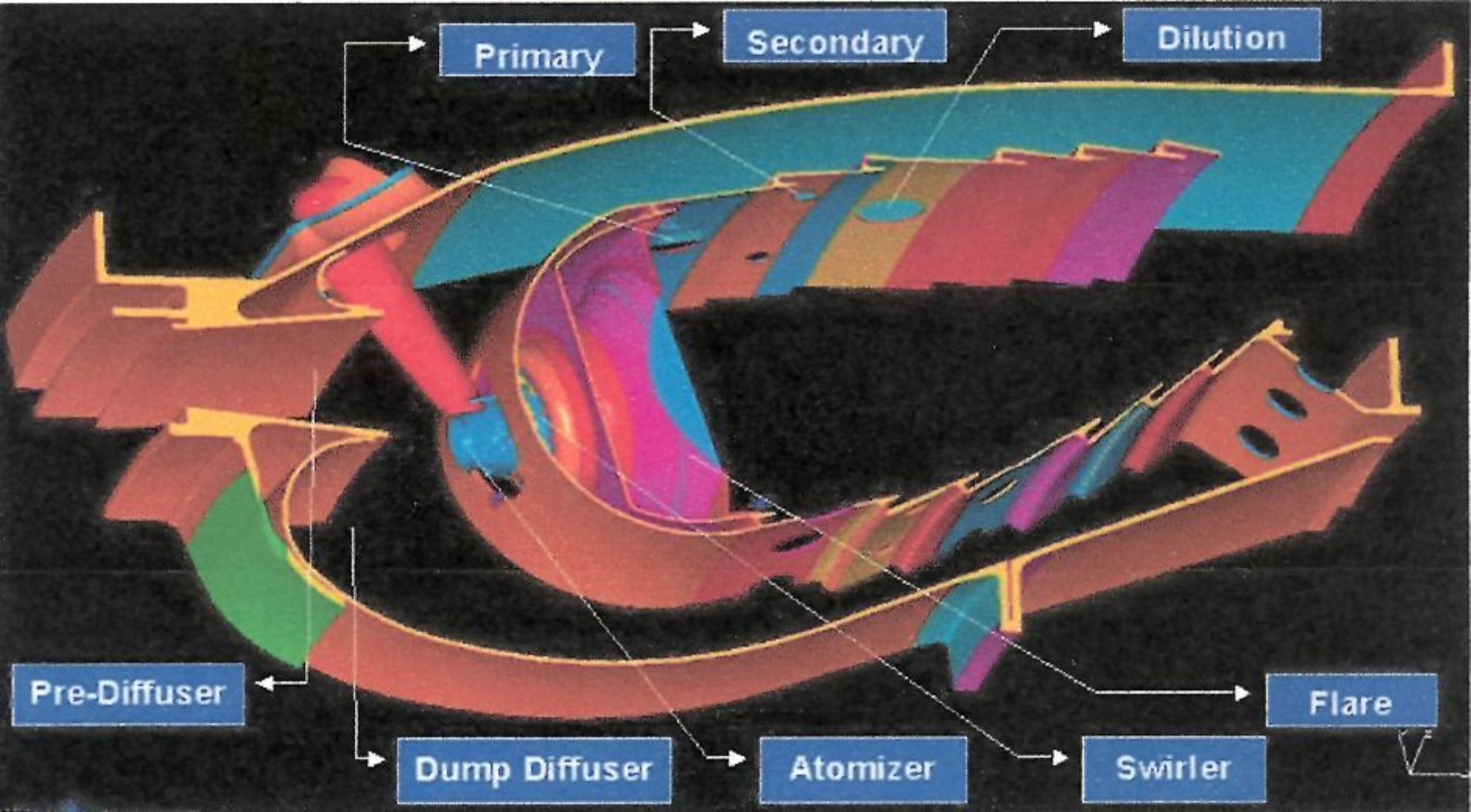


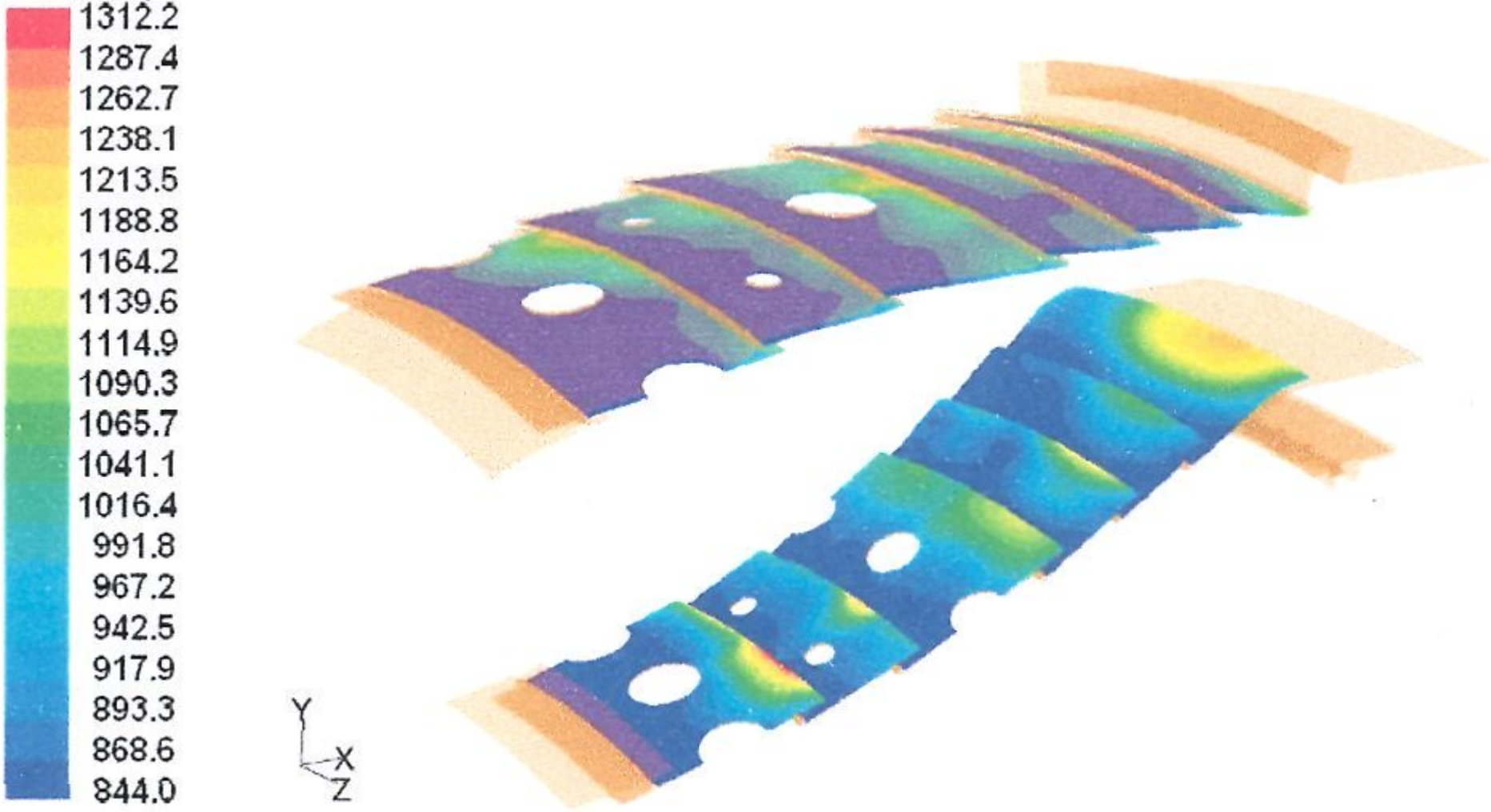
vonMises Stress Distribution (MPa)

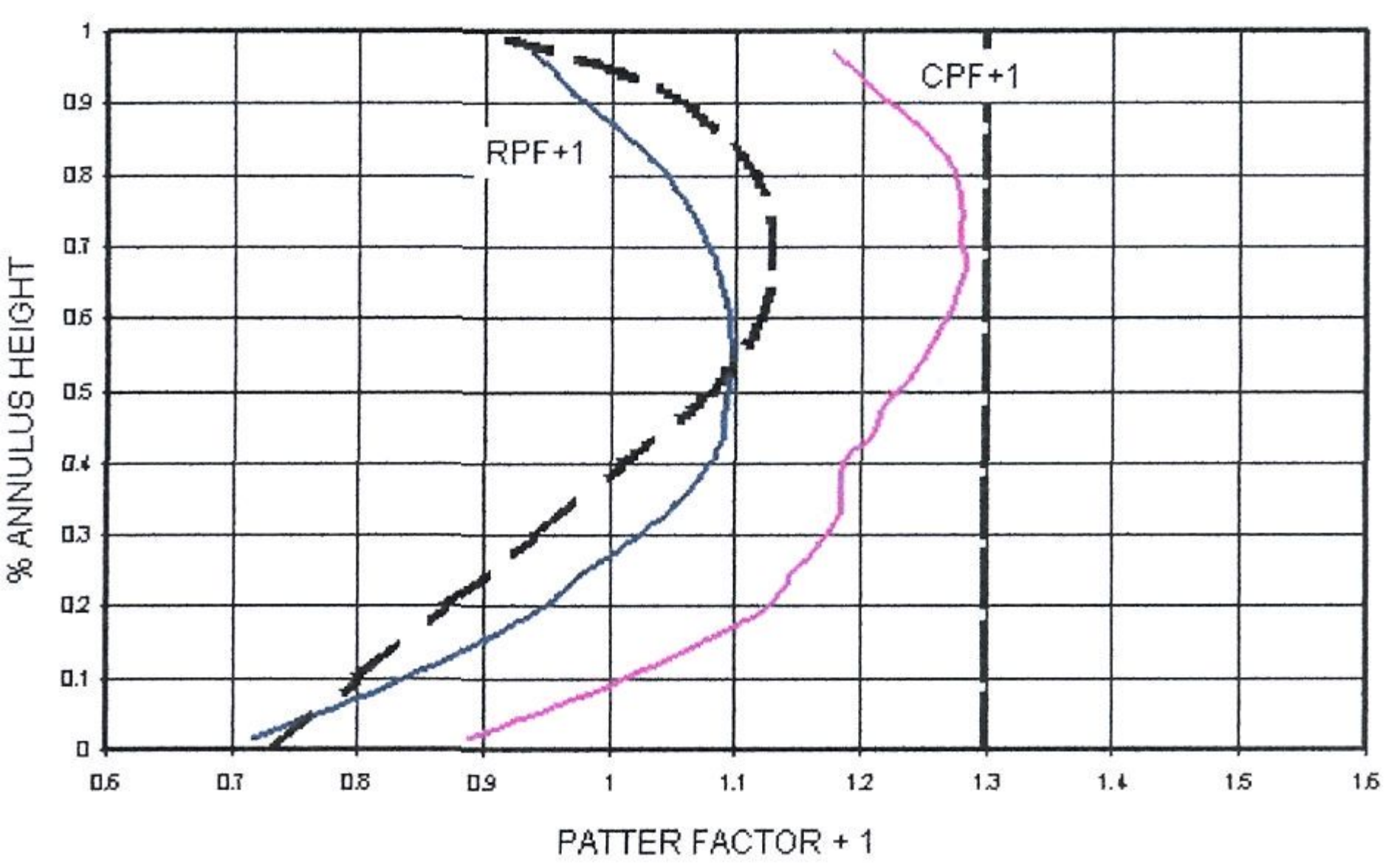


vonMises stress distribution (MPa)


RPM
10000
5000
1000
2000
3000

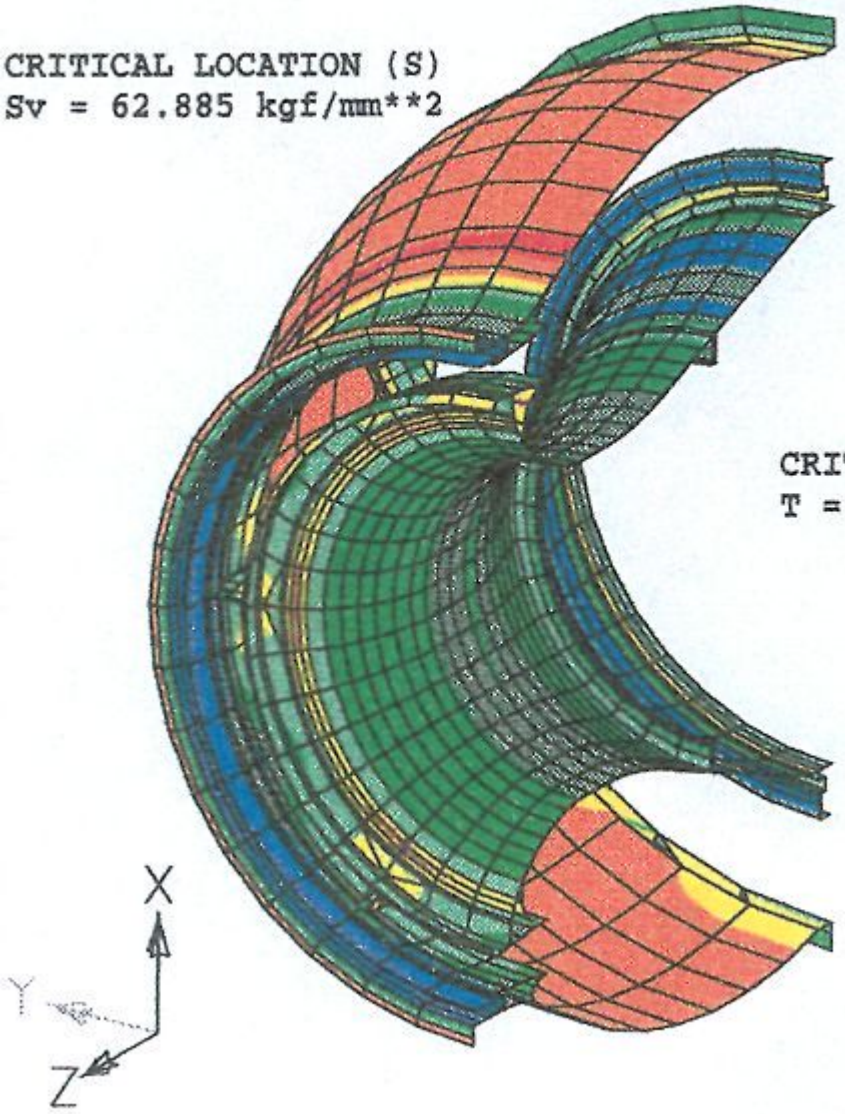

Primary
Secondary
Dilution
Pre-Diffuser
Flare
Dump Diffuser
Atomizer
Swirler


1312.2
1287.4
1262.7
1238.1
1213.5
1188.8
1164.2
1139.6
1114.9
1090.3
1065.7
1041.1
1016.4
991.8
967.2
942.5
917.9
893.3
868.6
844.0
Y
X
Z


CPF+1
RPF+1
% ANNULUS HEIGHT
PATTER FACTOR + 1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6

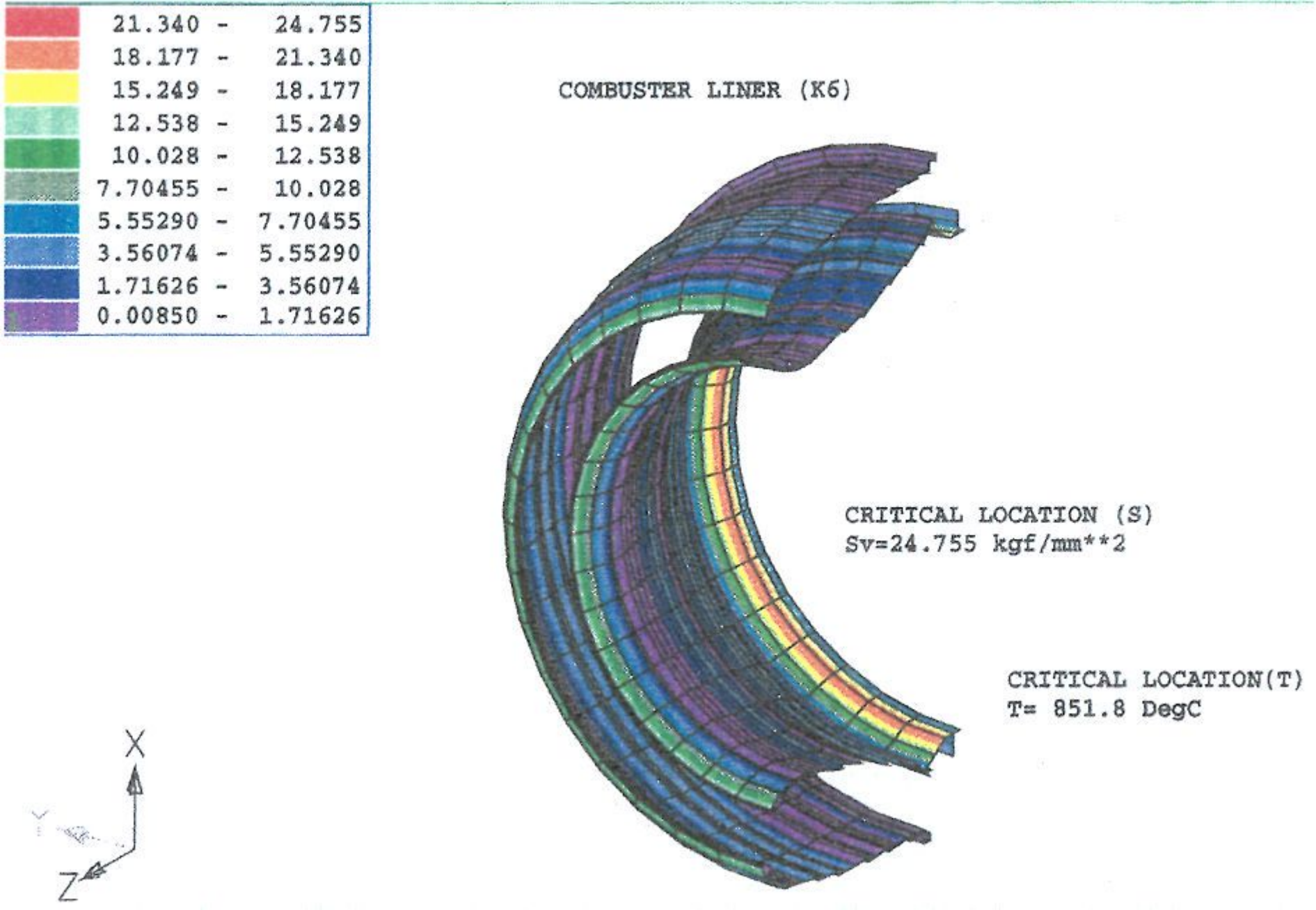
COMBUSTER OUTER CASE (K6)

CRITICAL LOCATION (S)
Sv = 62.885 kgf/mm**2



CRITICAL LOCATION (T)
T = 646 DegC

47.801 -	62.885
36.122 -	47.801
27.079 -	36.122
20.077 -	27.079
14.656 -	20.077
10.459 -	14.656
7.20892 -	10.459
4.69269 -	7.20892
2.74447 -	4.69269
1.23603 -	2.74447


21.340 - 24.755
18.177 - 21.340
15.249 - 18.177
12.538 - 15.249
10.028 - 12.538
7.70455 - 10.028
5.55290 - 7.70455
3.56074 - 5.55290
1.71626 - 3.56074
0.00850 - 1.71626
COMBUSTER LINER (K6)
CRITICAL LOCATION (S)
Sv=24.755 kgf/mm**2
CRITICAL LOCATION(T)
T= 851.8 DegC
X
Y
Z