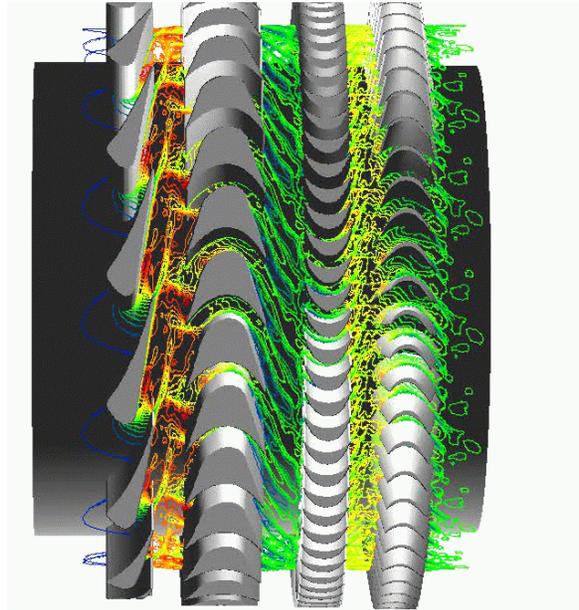

Pre- and Post-Processing Tools to Streamline the CFD Process



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Support of CFD



- **Pre-processing**
- **Interim-processing**
- **Post-processing**



- **FDNS**
 - general purpose CFD code
 - combustion, pump, and external flow simulations
- **CORSAIR**
 - code for unsteady turbomachinery simulations
 - turbines, compressors, and internal flow simulations

Pre-Processing Support for FDNS



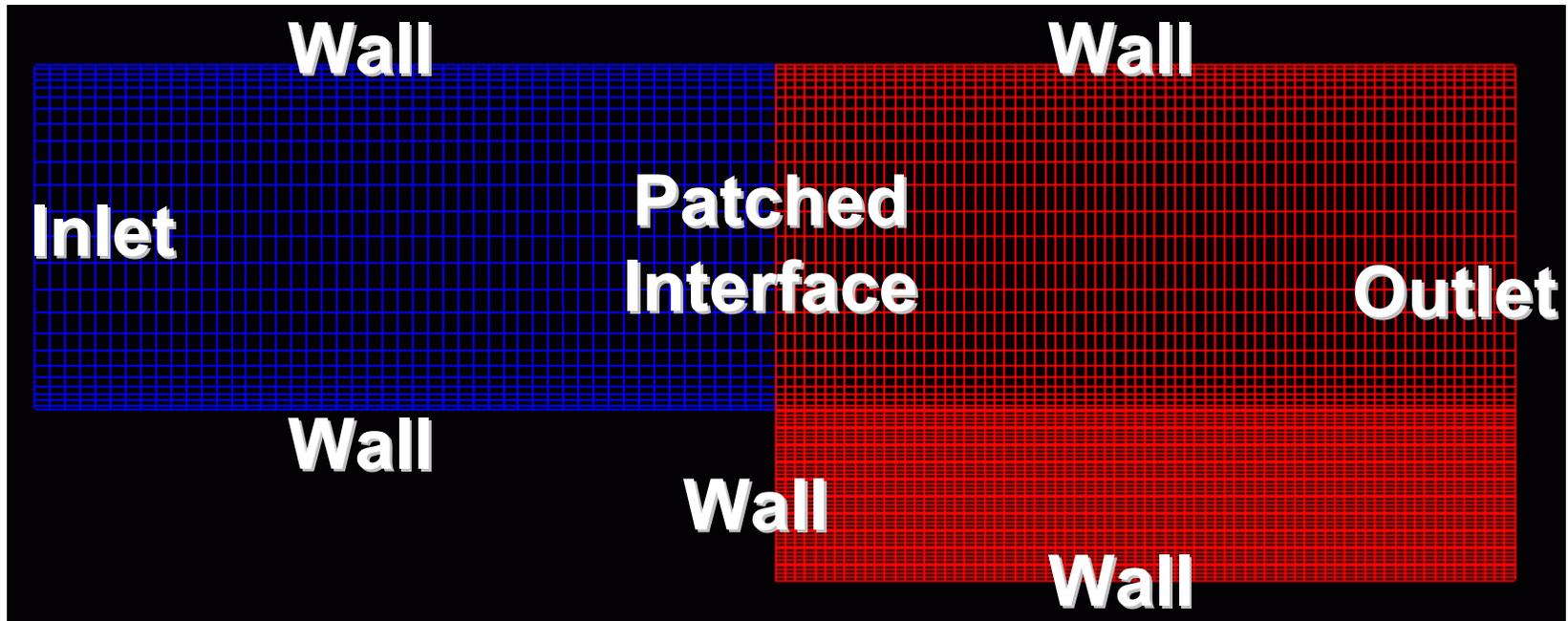
– Geometry specification

- generated by GridGen
- obtained by another source
- standard plot3d format

– Boundary condition specification

- generated by GridGen
- generated by hand

FDNS Boundary Conditions



Specification of Boundary Conditions

```
#IDIM
2
#IZON, IZFACE,  IBND,  ID,  ISNGL,  INPNT
      2      2      2      5      0      0
# IZT,  JZT,  KZT, LPROC,          CBG1,          CBV2
      50     25      1      1  0.000e+00  0.000e+00
      75     75      1      1  0.000e+00  0.000e+00
#THCYCX,  IZB1,  IZF1, IJZ11, IJZ12, JKZ11, JKZ12, INONUF, IPROC1
#          IZB2,  IZF2, IJZ21, IJZ22, JKZ21, JKZ22, IDFACE, IPROC2
      0.00      1      2      1      25      1      1      21      1
              2      1      51      75      1      1      0      1
#IBCZON, IDBC, ITYBC, IJBB, IJBS, IJBT, JKBS, JKBT, IVFINT, PRAT, IPZ, IPI, IPJ, IPK
      1      1      0      1      1      25      1      1      0 -1.000e+00  1      1      1      1
      2      2      2      75      1      75      1      1      0 -1.000e+00  1      1      1      1
#IWBZON,  L1,  L2,  M1,  M2,  N1,  N2, IWTM,  HQDOX, IWALL,  DENNX,  VISWX
      1      1      50      1      1      1      1      1  0.000e+00      0  1.000e+00  1.000e+00
      1      1      50      25      25      1      1      1  0.000e+00      0  1.000e+00  1.000e+00
      2      1      1      1      51      1      1      1  0.000e+00      0  1.000e+00  1.000e+00
      2      1      75      1      1      1      1      1  0.000e+00      0  1.000e+00  1.000e+00
      2      1      75      75      75      1      1      1  0.000e+00      0  1.000e+00  1.000e+00
      :
      :
      :
```

3D 22-Grid Case



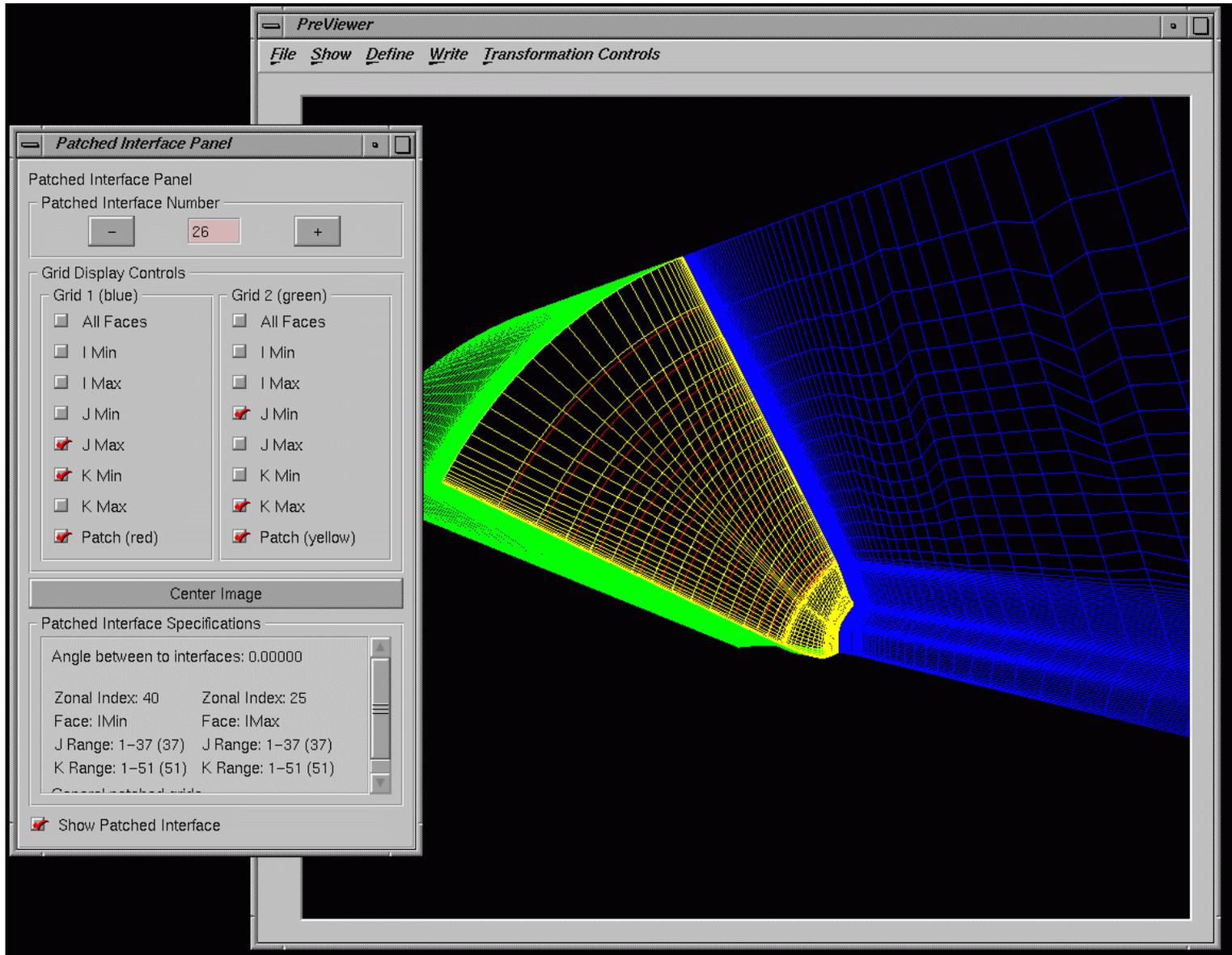
Type	# Values Needed	Occurrences	Total Values
Grid Dimensions	3	22	66
Patched Interfaces	17	37	629
Flow Boundaries	14	51	714
Walls	12	56	672
Total Values			2081

PreViewer



- **Visualization tool designed specifically for FDNS**
- **Interactive tool to visually inspect input files**
- **Automated error checking of input files**

Patched Interface Panel



Combined Panel



PreViewer

File Show Define Write Transformation Controls

Combined Boundary Panel

Combined Boundary Panel

Grid Number

- 6 +

Face Selection

Grid

- All Faces
- I Min
- I Max
- J Min
- J Max
- K Min
- K Max
- Vol. Walls

Legend

- Patched Interface
- Inlet
- Outlet Boundary
- Symmetry Plane
- Freestream B.C.
- Wall
- Singularity Line
- Unspecified Grid

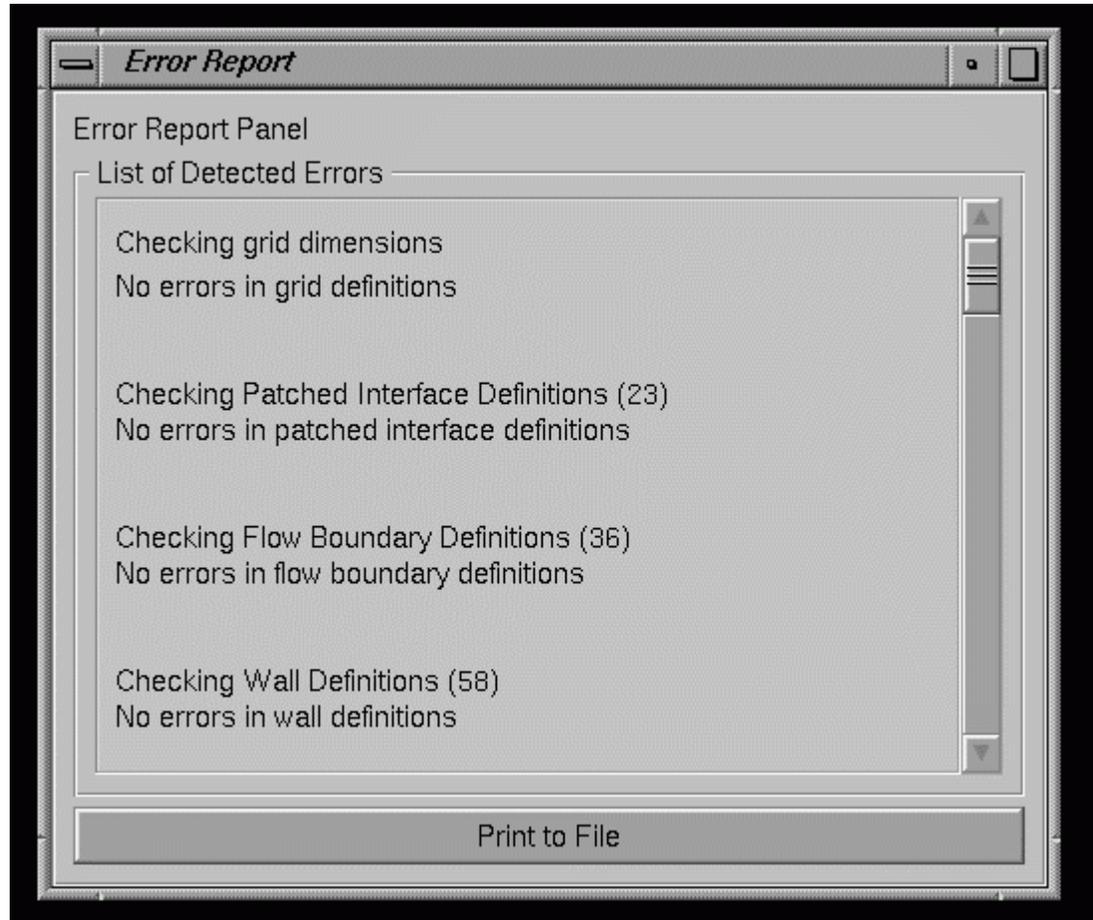
Center Image

Face Specifications

Grid: 6
I Dim: 1-46 J Dim: 1-20 K Dim: 1-59

Show Boundaries
 Show Grid Outlines

Error Report Panel



Future Plans for PreViewer



- **Expand Error Checking**
- **Expand ability to define boundary conditions**
- **Set up specification files for interim- and post-processing tools**

Interim-Processing



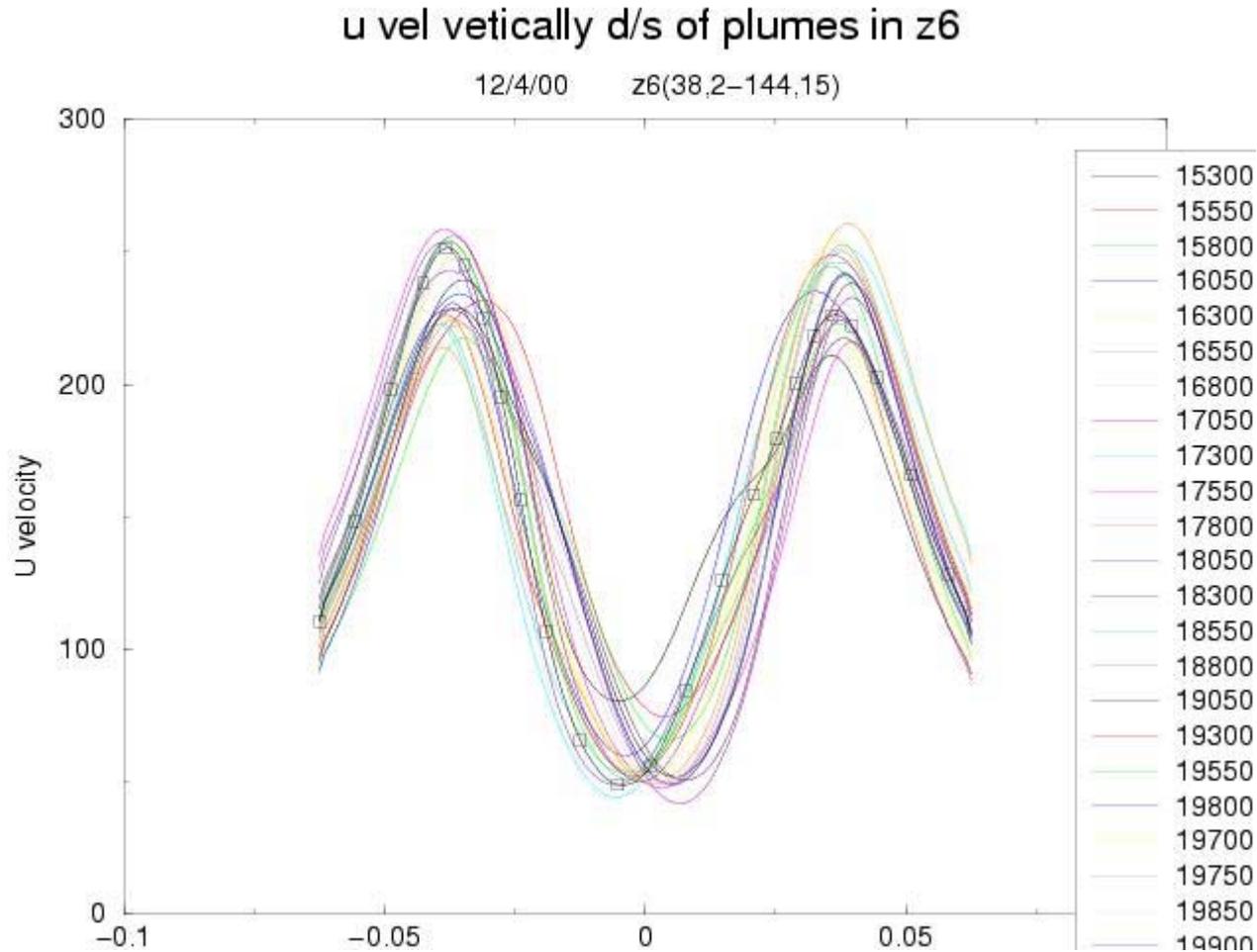
- **Process**
 - generates line plots of results while the solution is forming
- **FlowShow**
 - generates an animation of contour or vector plots of solution while it is forming
- **Monitor**
 - updates screen images of mass conservation, delta, contours, vectors, and line plots of a solution while it is forming

General Method for Interim-Processing



- Track a file that is being written by the flow solver during execution
- Processing is triggered each time file is updated/written
- Specified data is extracted from the file
- Line plots or images are updated, or new frames are generated

Process: Check for Convergence

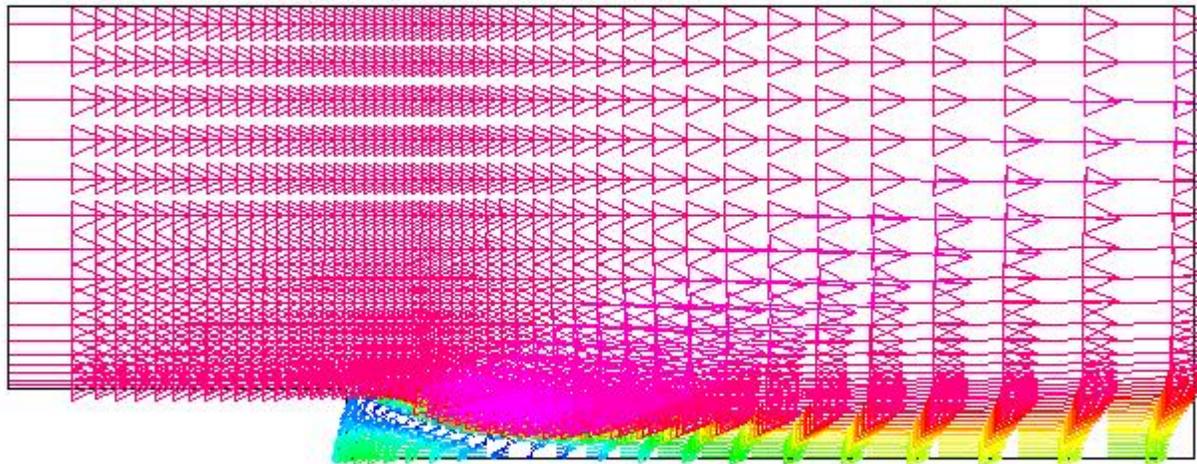
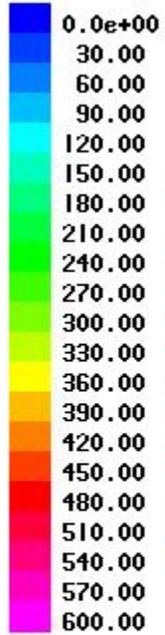


FlowShow: Super-Sonic Back Facing Step



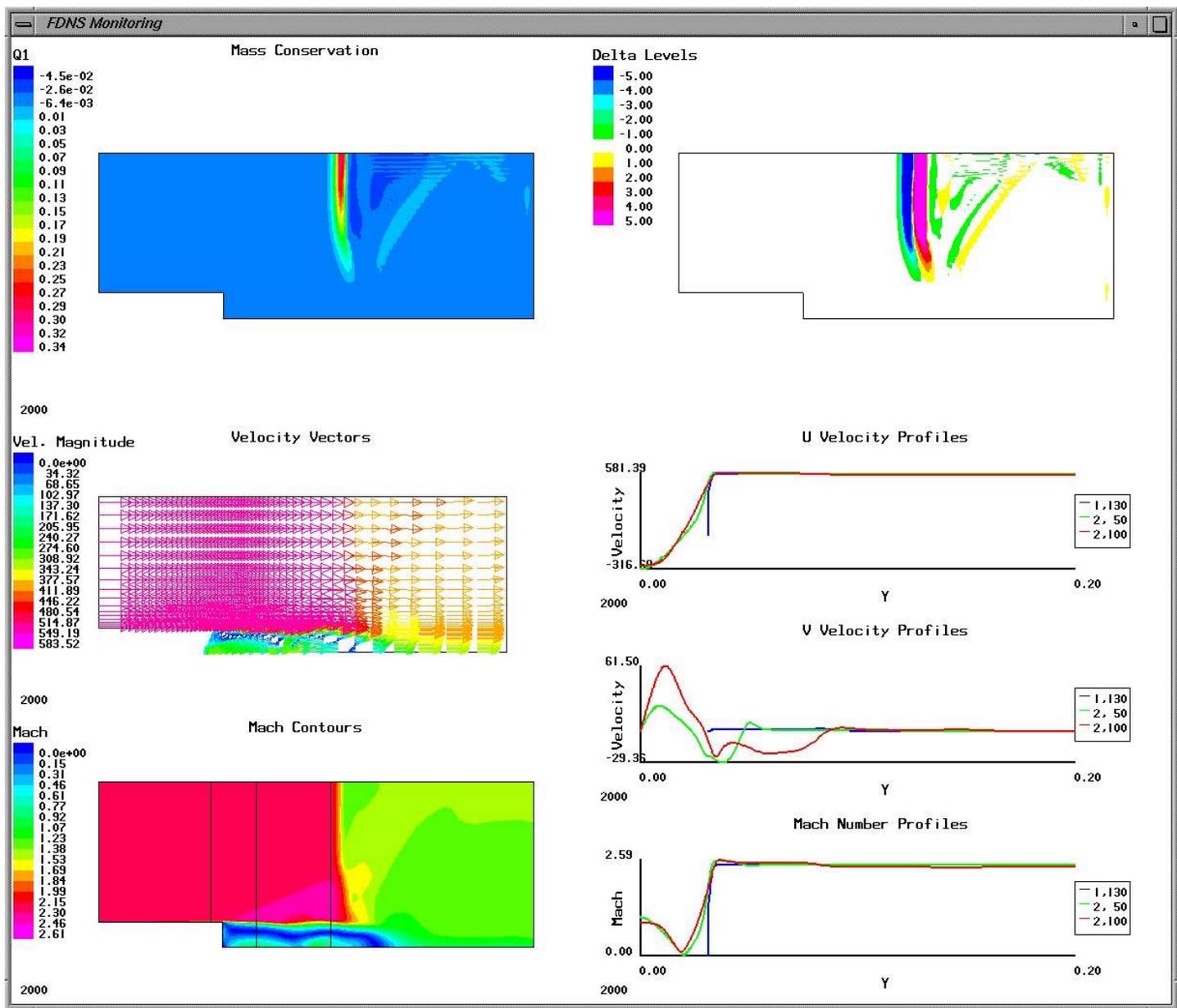
Vel. Mag.

Development of Velocity Vectors



4000

Monitor: Super-Sonic Back Facing Step



Future Plans for Interim-Processors



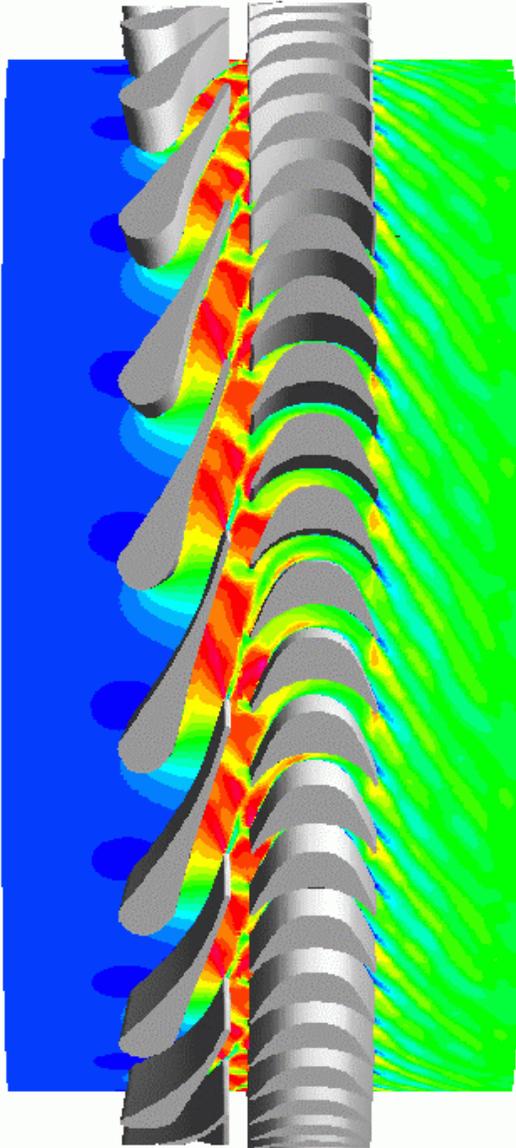
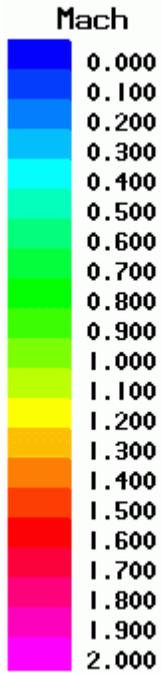
- Generate GUI's for specification of input files
- Combine functionality between tools
- Add display of experimental data

Post-Processing

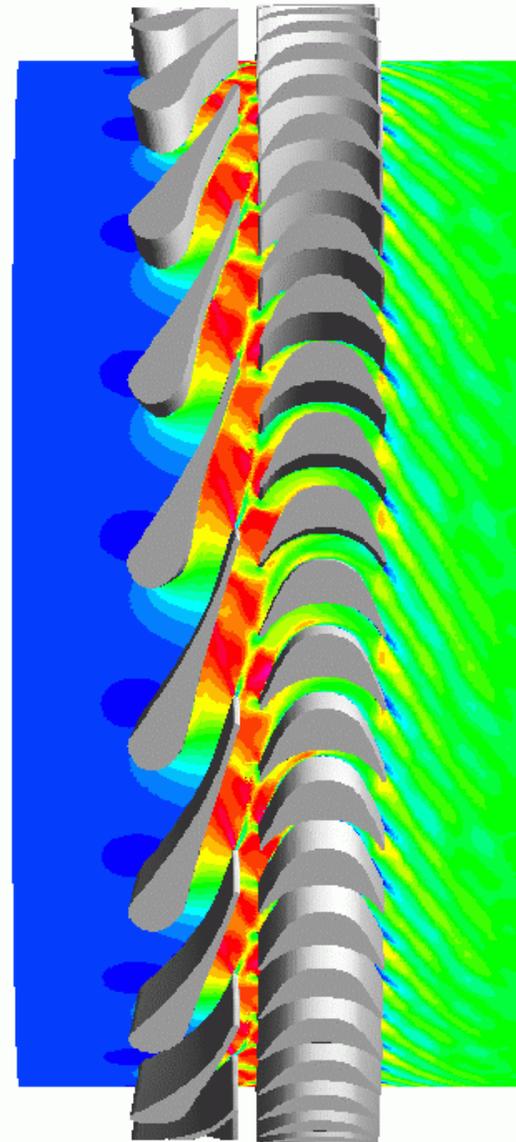


- Animations
 - simple format specifications
 - runs in batch mode
 - engineer friendly

Instantaneous Mach Contours



Timestep 0



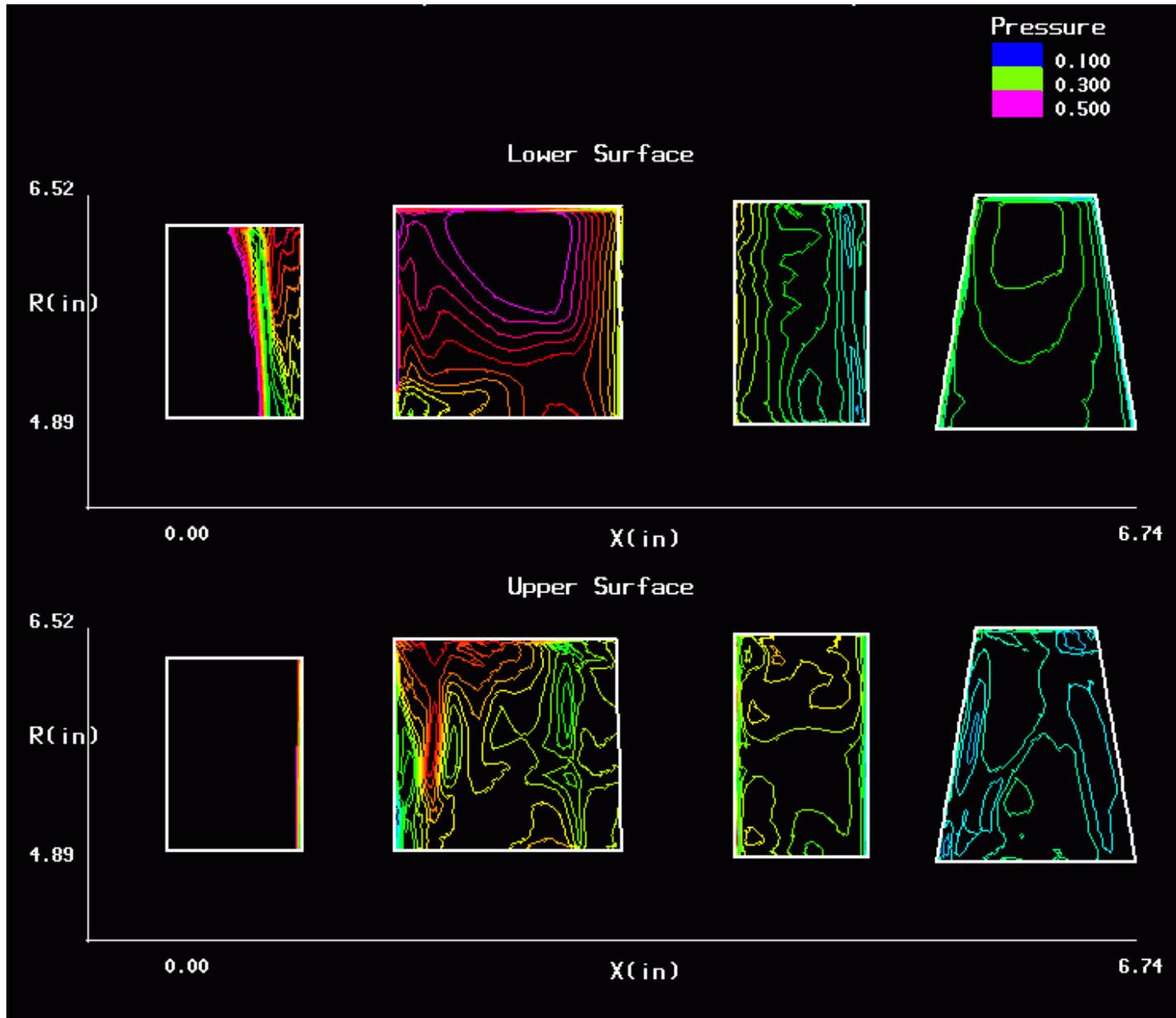
Timestep 16

Animator



- **Generates MPEG animation files in batch mode**
- **Allows input files to be compressed**
- **Input Data Files**
 - CORSAIR - customized output files
 - General Codes
 - standard Plot3D files
 - xy point files
- **Types of Animations**
 - envelopes
 - line plots
 - contours
 - vectors
- **Customization of animations**

2-Stage Turbine Pressure Contour



Future Plans for Animator



- Add the calculation of streamlines/streaklines
- Include a GUI to specify the view in 3D
- Include automated feature extraction

Conclusions



- **Pre-Processing**
 - significantly reduced time needed for error checking
 - eliminate ambiguities in input files
- **Interim-Processing**
 - improved ability to detect convergence
 - improved understanding of underlying flow mechanisms
- **Post-Processing**
 - improved understanding of underlying flow mechanisms
 - improved technology transfer
- **Improved Designs**