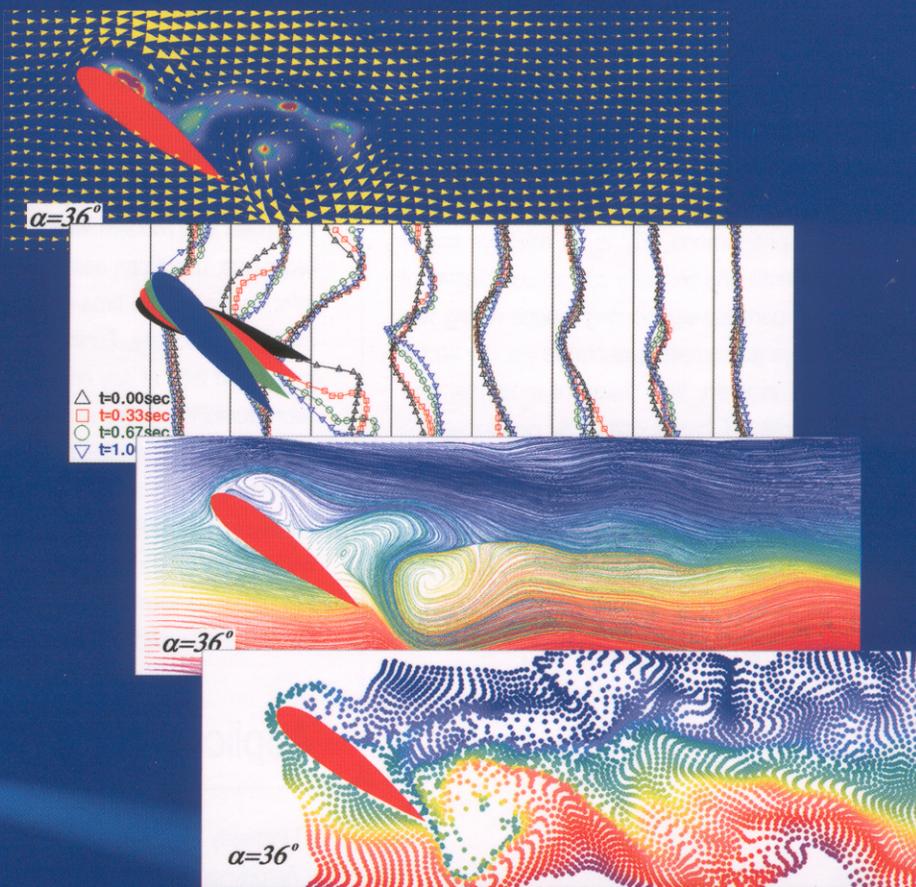The Best Choice of PIV Engine in the World

CACTUS 3.0

CACTUS is representative of multi-purpose PIV engine,
especially oriented for the ultimate user convinience.

$\alpha=36°$

△ t=0.00sec
□ t=0.33sec
○ t=0.67sec
▽ t=1.0

$\alpha=36°$

$\alpha=36°$

IIT Co., Ltd.

CACTUS 3.0

IIT Co., Ltd.

Image Information Technology Co., Ltd.(IIT) was established in 1997. IIT is a research-based venture enterprise, specified in the field of image measurements and related software developments. Its final goal is to create technological power and vision for the full satisfaction of users. Main product is Particle Image Velocimetry(PIV) and related operating software engine PIV is the most advanced measurement technique ever developed to acquire multi-dimensional, simultaneous, multi-points, on-line, and real-time velocity information in all kind of flow fields which usually accompany complicated phenomena. PIV is an effective image measurement system to identify the accurate spacial coordinates of discrete tracer particles or particle neighbouring groups during two short time intervals. It always guarantees quantitative velocity vector information encountered in every flow fields of industrial and research purposes. In Korea, IIT has successfully developed the CACTUS series PIV software engines by support of the well-experienced and highly-motivated research team. In the future, IIT will concentrate its all innovative energy to pioneer engineering software development in the field of 4-D image measurment, and its comprehensive post-processing such as virtual reality animation based on Internet and multi-media environment.

Outline of PIV

PIV (Particle Image Velocimetry) is the latest measurement technology which affords effective measurement of quantitative velocity vectors at multi-points and simultaneously from the visualized flow field by exploiting both the maximum CPU load of computer and modern image processing techniques. Adopting this technique, users can easily obtain the whole-field primative velocity information of the time-dependent flow fields continuously and multi-dimensionally. Furthermore, the recorded flow image will be processed later at any convenient time without data loss, to satisfy reproducibility of the experimental data. PIV can be used as a complemental method with the point-wise measurement techniques such as LDV or hot-wire anemometry to secure local measurement accuracy. Nowadays, PIV is recognized as sole alternative to the Computational Fluid Dynamics(CFD) which furnishes various advantages impossible in the conventional experimental world.

Applications of PIV

- Unsteady Turbulence Flow
- Aerodynamics (Vehicle, Aircraft, High-Speed Train etc.)
- Internal Flow of Engine
- Internal Flow of Heat Exchangers
- Internal Flow of Turbomachinery
- Wind Engineering
- Multiphase Flow
- Building Architecture and Environmental Flow
- Ocean Engineering
- Civil Engineering
- Bio-mechanics Flow
- Micro-Machine Flow
- Others

Features of CACTUS 3.0

- Velocity Measuring Range:
  - 0.1mm/s ~ 400m/s(5W Argon-Ion Laser+Gated I.I.Camera, 100mmx100mm)
- Spacial Resolution:
  - 640x480 Pixel(Standard)
  - 2Kx2K(Max.)
- Sampling rate:
  - NTSC Video Signal : 60Hz
  - High-Speed Camera : Arbitrary
- Algorithm:
  - Non-FFT Cross-correlation PIV & Binary PTV
- Uncertainty < 0.32%
- High-End Performance

- Fast Processing Time:
  - 6.5 seconds for 40x40 grids on
  - Pentium-III 500MHz(interrogation
  - window size is 35x35 pixel and
  - maximum displacement is 8 pixel)
- Host Computer:
  - PC with built-in image grabber(DT series)
- O/S:
  - Win9X, Windows2000 or NT
- Large Processing Image Capacity:
  - max. RAM memory or extended
  - allowable hard disk memory
- Wide illumination sources:
  - Continuous Ar-Ion Laser
  - Nd-Yag Dual Pulse Laser
  - General White Lights

- Various Input Sources:
  - Analog CCD Camera
  - Digital Camera
  - Hi-8mm Camcorder
  - High Speed Video Camera
  - Gated Image Intensifier CCD
  - High Resolution Digital CCD(Up to 2K x 2K)
- 2-D Surface Flow Measurement at Arbitrary Camera Angle
- Multi-vision Measurement:
  - 3 CCD Camera (4:1 Aspect Ratio)
  - Mosaic Editing: Max. 15 Frames(H × V=5x3)
  - Support of Cinematic Animation

CACTUS 3.0

Merits of CACTUS 3.0

- Automatic on-line creation of AVI files for animation
  - Complete support for animation post-processing
  - Non-compressed base
- Velocity identification with high speed and real-time
- Complete arrangement of post-processing routines
  - High quality printout
  - Direct application of the original graphic software
- Minimum error occurrence
- High accuracy interpolation
- Support of user-friendly menu
- Programming tool : latest DELPHI visual language
- Continued version-up by module-type menu comfiguration

Benefits of CACTUS 3.0 User

- Exclusive Membership of PIV research group
- Participation of PIV annual technical seminars arranged by IIT
- Support of optimized PIV configuration to meet user needs
- Provision of latest informations on PIV accessories and visualization equipments
- Support of 4-dimensional PIV and virtual reality-based post-processing in the future
- Technical support of complicated customer flows
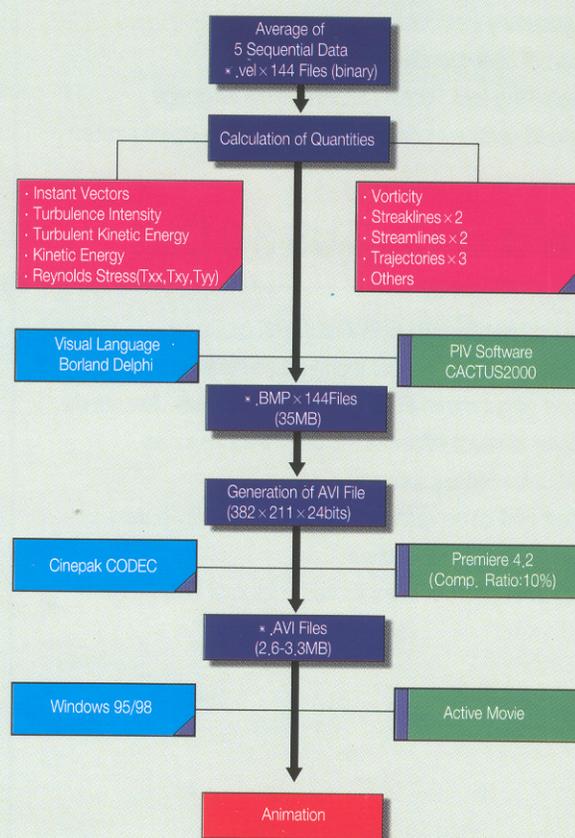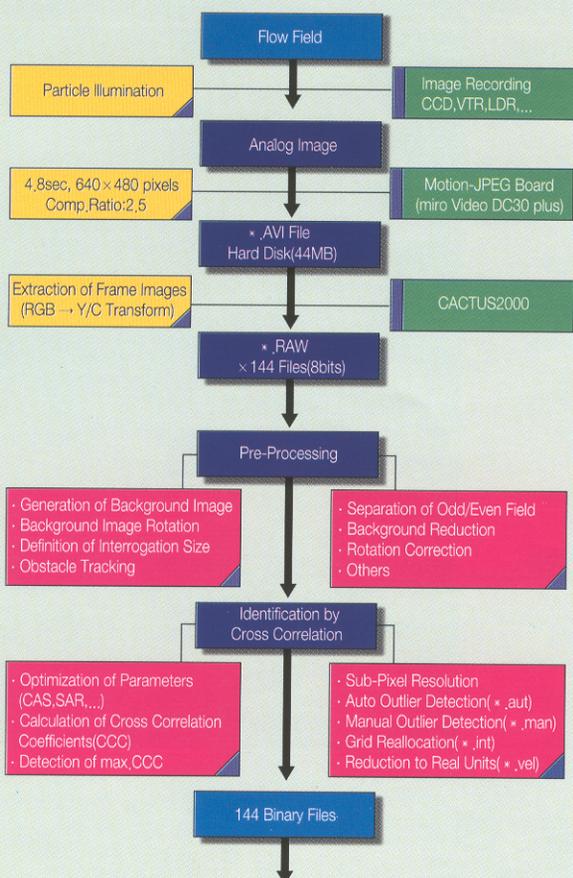
CACTUS 3.0 System

| Items	Specification	Remark
PIV Software	- Animation support	- Fundamental specification of CACTUS 3.0 - Academic version available with major features
Image Grabber	- DT series	
Hi-8mm Camcorder	- SVHS	
Host Computer	- IBM compatible	- Compatible with DT board
High-speed Camera & Accessories	- 240~600 pps - B&W or RGB color	- Good choice of animation for high-speed flow
Argon-Ion Laser	- 4~6W(Water-cooling)	- Continuous laser
	- 300~500mW(Air-cooling)	- Adequate for flow visualization
Nd-Yag Pulse Laser	- 30~300mJ/pulse	- Synchronization with pulse generator
Sheet-light Projector	- Optical fiber(10m) - Adjustable angle and thickness	- Generation of 2-Dimensional sheet-light(connected to laser)
CCD Camera	- B&W - 768x493 pixel	- For image input - Connected with Hi-8mm camcorder
Digital Camera	- 1024x1024 pixel	- For high-resolution input
Monitor	- 14~20 inch	- High resolution monitor
AOM	- 100MHz,1 μs	- For continuous Ar-Ion Laser - Pulse Generator connected
Gated Image Intensifier Camera	- Gate time :100ns - Max. Gain : $8.0 \times 10^3 \ell m/m^2/\ell x$	- Solution of the illumination problem for high-speed flow measurement. - Synchronization with pulse generator
Circulating water channel	- Velocity range:0~0.5m/s, 300mmWx400mmH	- Supply of multi-purpose flow visualization
Particle	- Nylon12 - PVC - Expancel	- Tracer particle for water or air

PIV System

Arrangement of PIV System

- LLS Probe
- Optical Fiber Cable
- Inflow
- Experimental Apparatus
- Laser
- AOM Head
- Incidence Manipulator
- CCD Camera
- High Speed Camera
- Gated I.I. CCD Camera
- Digital CCD Camera
- Hi-8mm Camcorder
- Oscilloscope
- Pulse Generator
- CCD Controller
- Image Grabber
- Video Monitor
- Backup Device
- Printer
- Host Computer & CACTUS
- Sync Controller
- Laser Disk Recorder or DVD Recorder or Video Tape Recorder

PIV Procedure

Left column:

- Flow Field
- Particle Illumination
- Image Recording CCD, VTR, LDR,....
- Analog Image
- 4,8sec, 640×480 pixels Comp.Ratio:2,5
- Motion-JPEG Board (miro Video DC30 plus)
- ∗.AVI File Hard Disk(44MB)
- Extraction of Frame Images (RGB → Y/C Transform)
- CACTUS2000
- ∗.RAW ×144 Files(8bits)
- Pre-Processing
  - · Generation of Background Image
  - · Background Image Rotation
  - · Definition of Interrogation Size
  - · Obstacle Tracking
  - · Separation of Odd/Even Field
  - · Background Reduction
  - · Rotation Correction
  - · Others
- Identification by Cross Correlation
  - · Optimization of Parameters (CAS,SAR,...)
  - · Calculation of Cross Correlation Coefficients(CCC)
  - · Detection of max.CCC
  - · Sub-Pixel Resolution
  - · Auto Outlier Detection(∗ .aut)
  - · Manual Outlier Detection(∗ .man)
  - · Grid Reallocation(∗ .int)
  - · Reduction to Real Units(∗ .vel)
- 144 Binary Files

Right column:

- Average of 5 Sequential Data ∗.vel×144 Files (binary)
- Calculation of Quantities
  - · Instant Vectors
  - · Turbulence Intensity
  - · Turbulent Kinetic Energy
  - · Kinetic Energy
  - · Reynolds Stress(Txx,Txy,Tyy)
  - · Vorticity
  - · Streaklines×2
  - · Streamlines×2
  - · Trajectories×3
  - · Others
- Visual Language Borland Delphi
- PIV Software CACTUS2000
- ∗.BMP×144Files (35MB)
- Generation of AVI File (382×211×24bits)
- Cinepak CODEC
- Premiere 4,2 (Comp. Ratio:10%)
- ∗.AVI Files (2,6-3,3MB)
- Windows 95/98
- Active Movie
- Animation

4

Menu Description of CACTUS 3.0

CACTUS 3.0 Current Working Directory : C:/CACTUS/

File ImageProc PreProc ID PostProc View Window Tools Help

File

Load...	Ctrl+O
Close	
Close All	
Save As...	
Acquire...	
PassThru...	
Print...	Ctrl+P
Printer Setup...	
Preferences	General...	Ctrl+Z
	Change CACTUS Directory...	Ctrl+D
Exit		
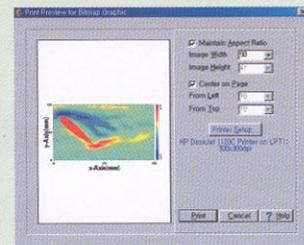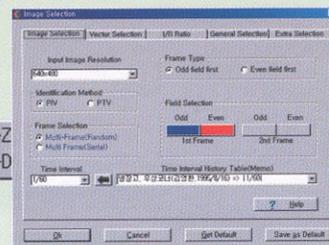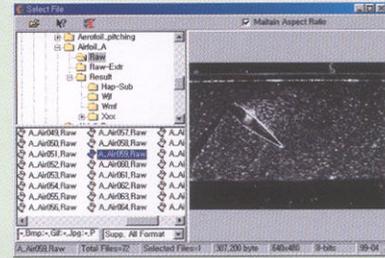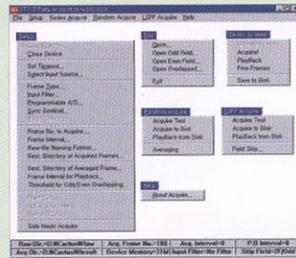
ImageProc

Zoom...
Line Profile...
Histogram...
Filtering...
Surface...

Karman vortex street behind a circular cylinder
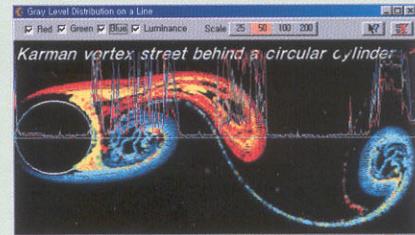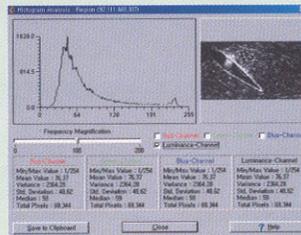
PreProc

Aspect Ratio Correction...
Rotate & Scale Images...
Transform OA Images...
Make Background...
Regress Log...
Rotate Raw BGD...
Coordinate Save...
Obstacle Setting...
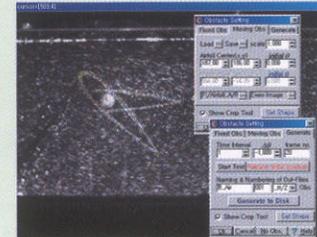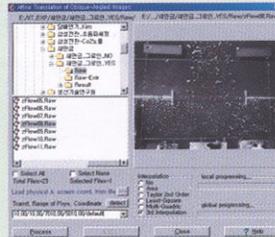
ID

Batch Mode...
Identification...
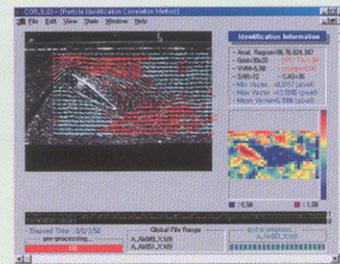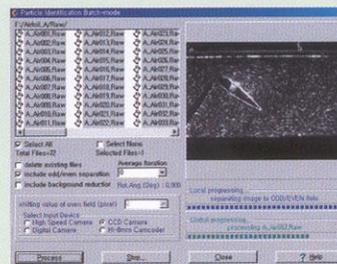
Menu Description of CACTUS 3.0

CACTUS 3.0   Current Working Directory : C:/CACTUS/

File   ImageProc   PreProc   ID   PostProc   View   Window   Tools   Help

---

PostProc

MK Coord...
Auto Error Removing...
Manual Error Removing...
ReAllocation on Grid...

Convert To Real Unit...
Special Vector Average...
Averaging Vectors...

Compose Vectors...

u,v Component Extract...
Kinetic Energy...
Turbulence Intensity...
Vorticity...

1   2   3
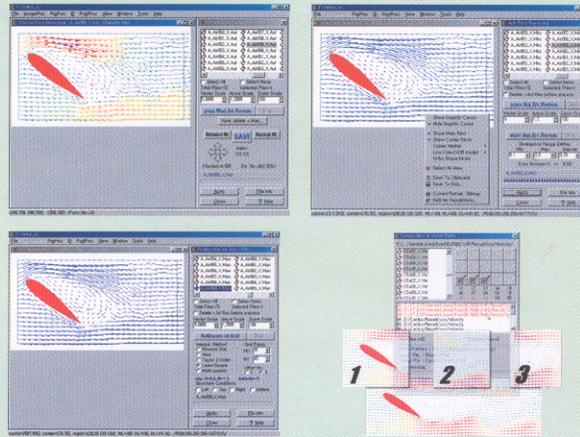
View

ID9 Vector...
Mkc Vector...
Aut Vector...
Man Vector...
Int Vector...

Vel Vector(Simple)...
Vel Vector...
Vel Vector(Lines)...

Contour (Lined & Filled)...
Surface...
Flow Lines...

Frequency Analysis...
X-Y Graph...
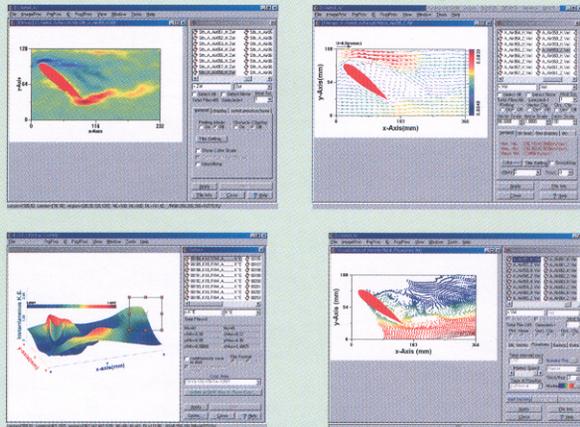
Tools

Odd/Even Separation...
Sequential Raws...
Pathline...
Eval, Threshold...

Extract Raw8 from AVI...
Convert Bmp vs. Raw...
Ascii to Vel...
Binary to Ascii...
Wif to Wmf...

File Attribute Change...
Rename ROK...

Palette Generation...
Create Various Pictures...
Create AVI clip...
Compose Bitmaps...

Labeling Images...
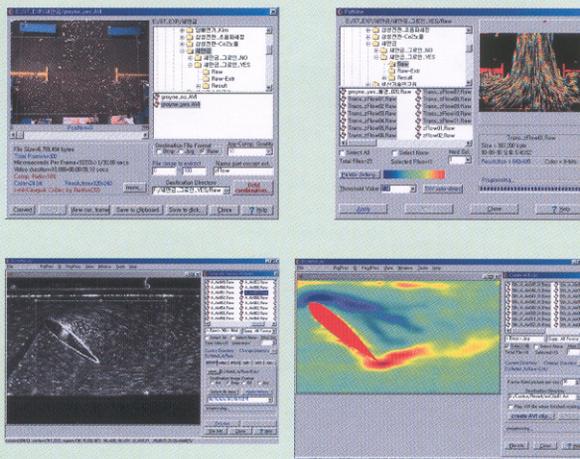
Window

Tile   Shift+Ctrl+F5
Cascade   Shift+Ctrl+F4
Arrange Icons

✓ 1 640x480-08 [OSA21.RAW]

Help

Help Topics...   F1

IIT Home Page...
About...

PIV Standard Project

Velocity & K.E.(mean)

v Fluctuation(mean)
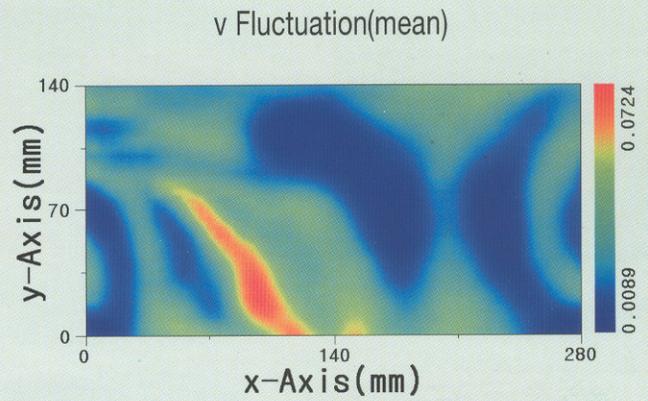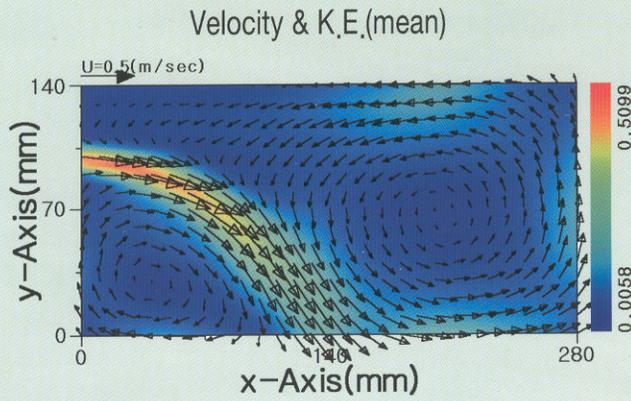
Refrigerator Evaporator Room

Original Image
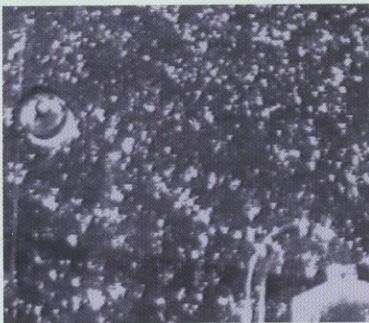
Pathlines
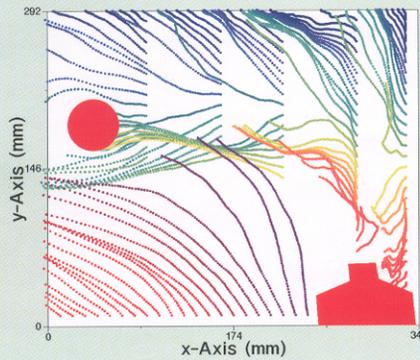
Kinetic Energy
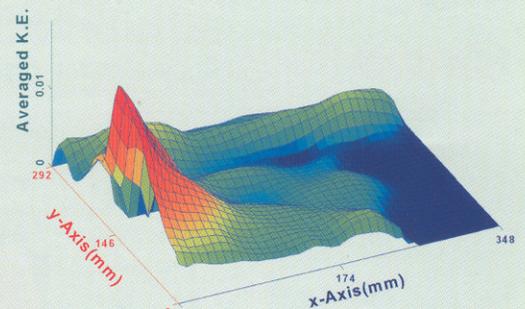
Tundish

Velocity Vectors
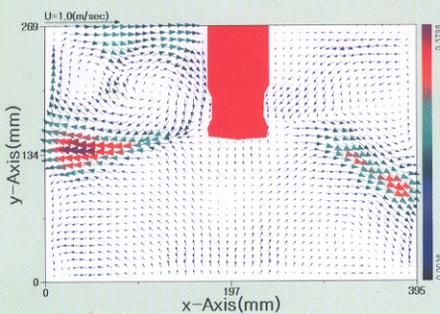
Quasi-streamlines

Kinetic Energy
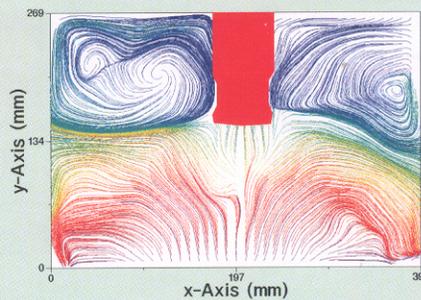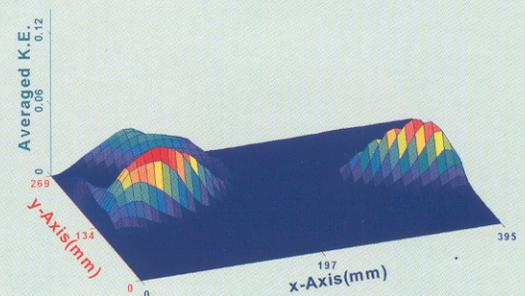
These pictures are post-processing results by CACTUS 3.0

Cylinder Wake Karman Vortex

Pathlines
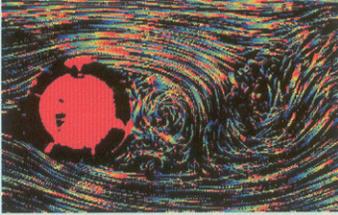
Velocity Vectors
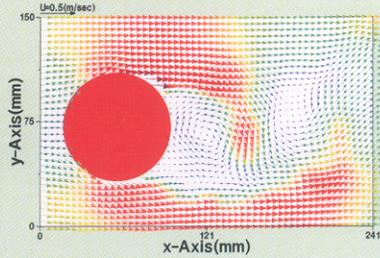
Streaklines
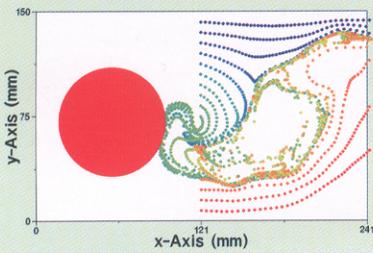
Quasi-streamlines
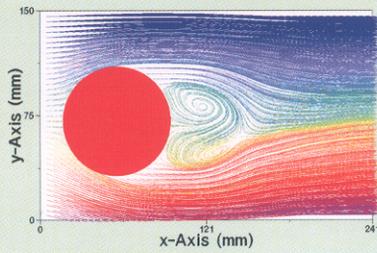
Cleaning by Supersonic wave

Pathlines

초음파발생기
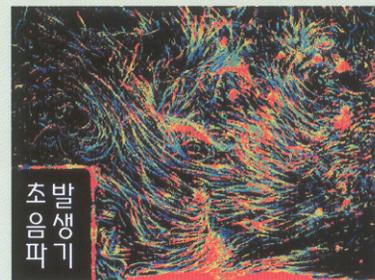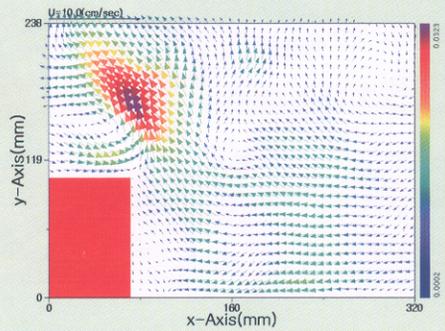
Velocity Vectors

Quasi-streamlines
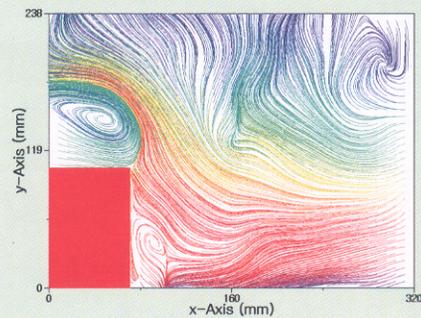
Diffuser Pump Application of Gated I.I.Camera

Pump Geometry
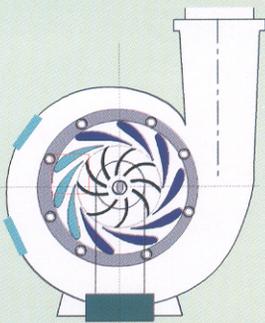
Velocity Vectors

Kinetic Energy

Turbulence Intensity

These pictures are post-processing results by CACTUS 3.0
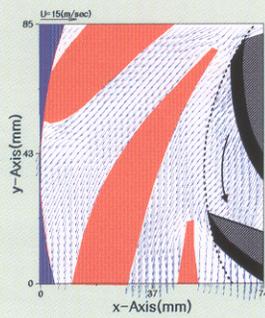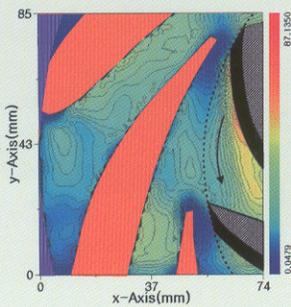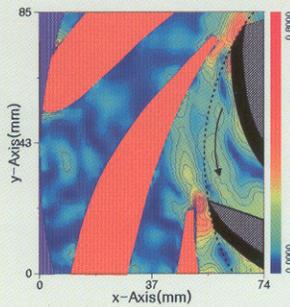
Application of CACTUS 3.0

Measurement Conditions

- **Algorithm** : Cross-Correlation PIV
- **Particle** : CO_2
- **Laser** : 300mW Ar-Ion Laser
- **Input** : I.I. Gated Camera

- **Pulse Generator** : $1\mu s$ Res.
- **Pulse width** : $6\mu s$
- **Pulse Interval** : $6\mu s$

Unit m/s	Min. Velocity	Max. Velocity	Mean Velocity
Instantaneous velocity field	36.5	149.6	82.1
Mean velocity field	49.0	98.6	75.2

Arrangement of PIV System

Pulse Generator — Image Intensifier Controller Unit — I.I. Gated Camera — Nozzle — CO_2

Ar-Ion Laser(300mW) — Cylindrical Lens
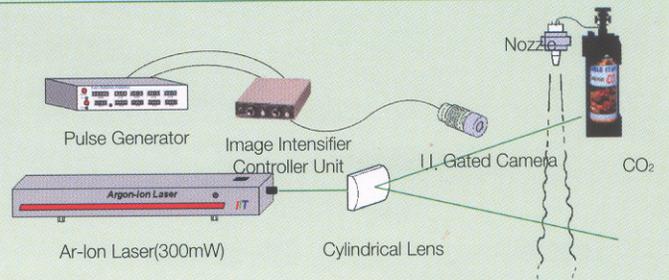
CO_2 Nozzle for Semi-conductor Cleaner

(A) Instantaneous

Original Image | Velocity Vectors | Velocity Profile

Kinetic Energy | Kinetic Energy | Vorticity

(B) Time Averaged
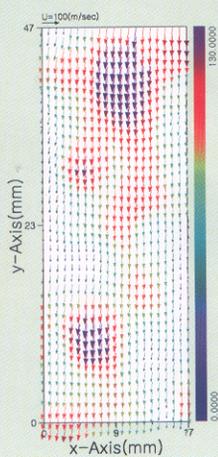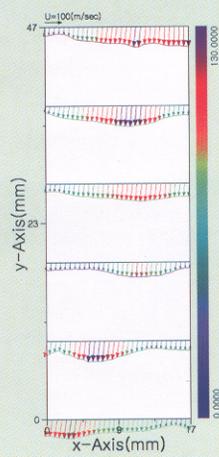
Path line | Velocity Vectors | Velocity Profile
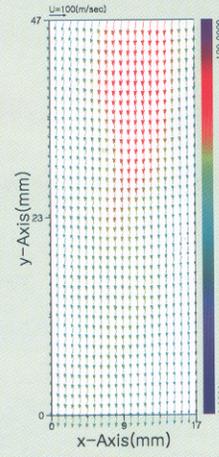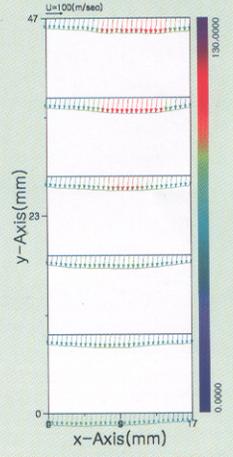
Kinetic Energy | Kinetic Energy | Vorticity

These pictures are post-processing results by CACTUS 3.0
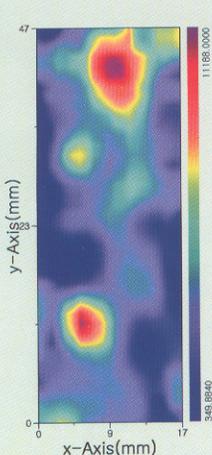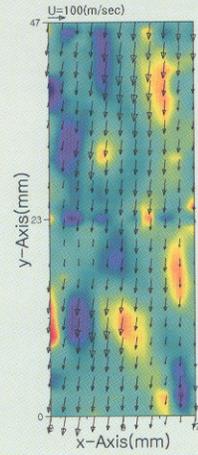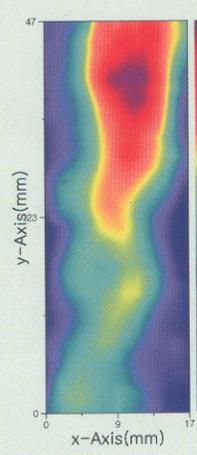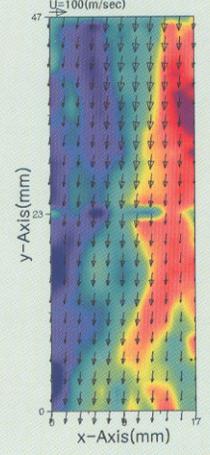
Surface Flow PIV

(A) Groyne not used

Original Image

Transformed Image
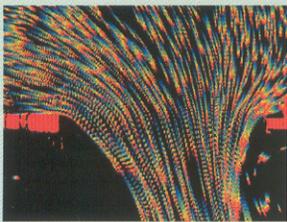
Pathlines
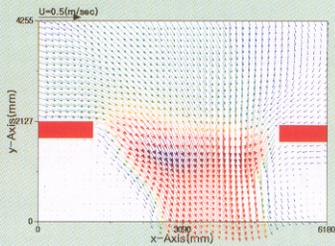
Velocity Vectors
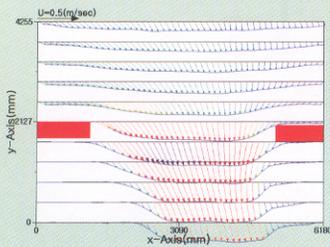
Velocity Profiles

Instantaneous
Quasi-streamlines
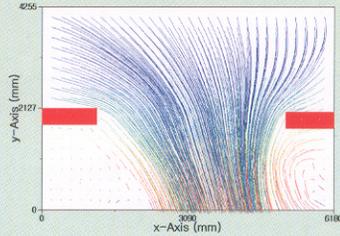
(B) Groyne used

Original Image
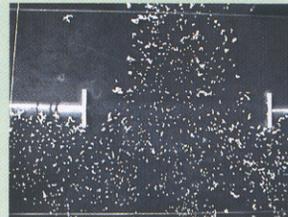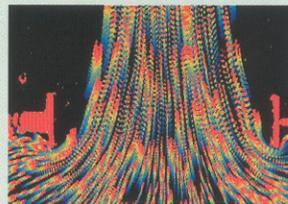
Transformed Image

Pathlines

Velocity Vectors

Velocity Profiles
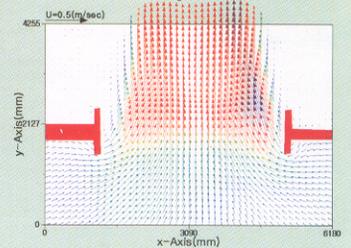
Instantaneous
Quasi-streamlines
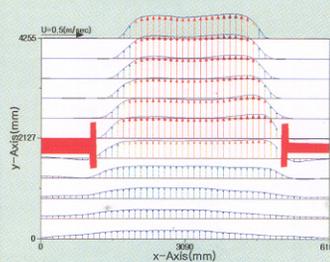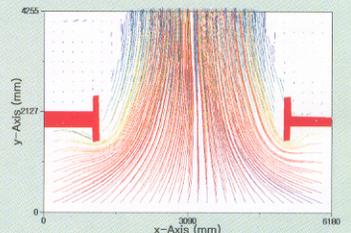
These pictures are post-processing results by CACTUS 3.0

Pitching Aerofoil Multi-Vision PIV

Aerofoil : NACA0018, Attack Angle : 18° ~48°

Original Image
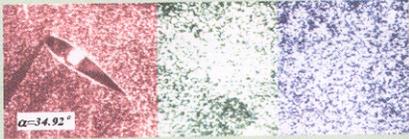
Instantaneous Velocity Vectors
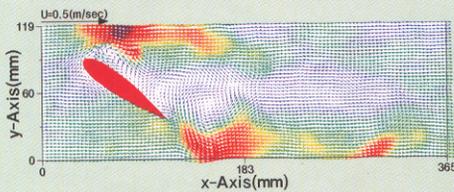
Instantaneous Kinetic Energy
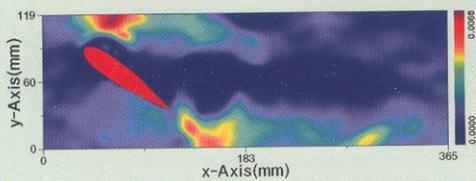
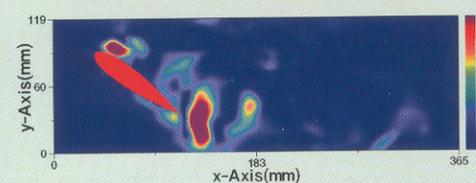### Instantaneous Vorticity
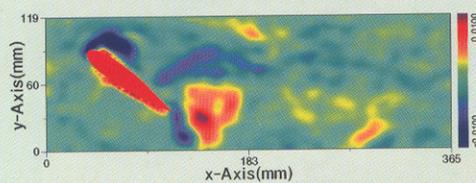
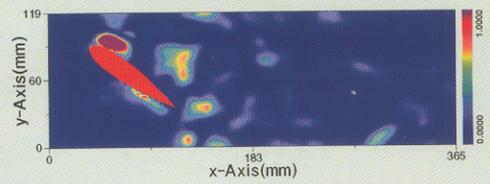### Instantaneous Turbulence Intensity
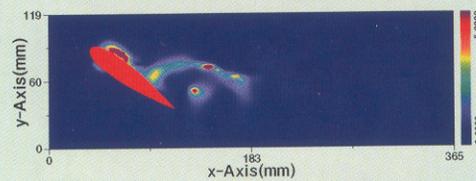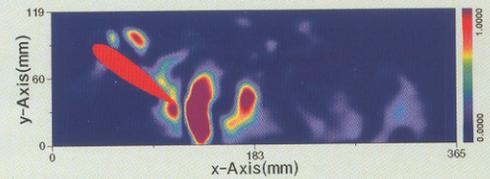

Instantaneous T.I. & Velocity
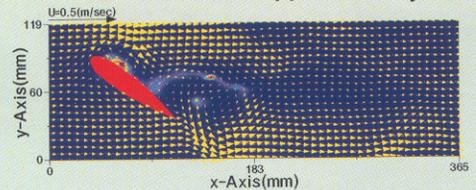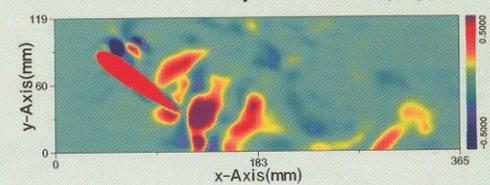

Instantaneous Turbulence K.E.

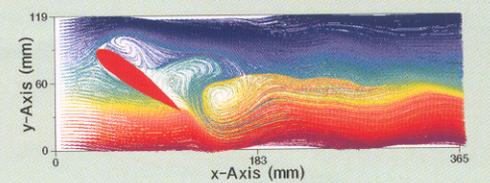### Instantaneous Reynolds Stress(Txx)

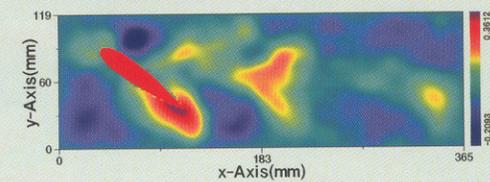### Instantaneous Reynolds Stress(Tyy)
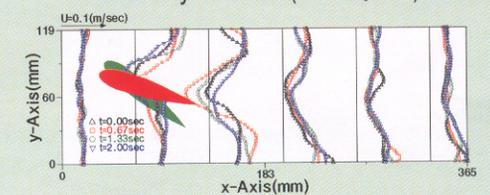

Instantaneous Reynolds Stress(Txy)

Instantaneous Quasi-streamlines

Instantaneous Pressure Distribution

Velocity Profiles(△t=0.667)

Pathlines(grid : 101×61)

Streaklines(grid : 41×31)

These pictures are post-processing results by CACTUS 3.0
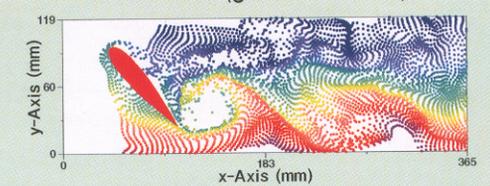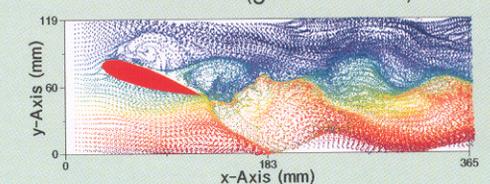
Animation of Pitching Aerofoil — Multi-Vision PIV

Velocity Vectors	Quasi-streamlines	Pathlines
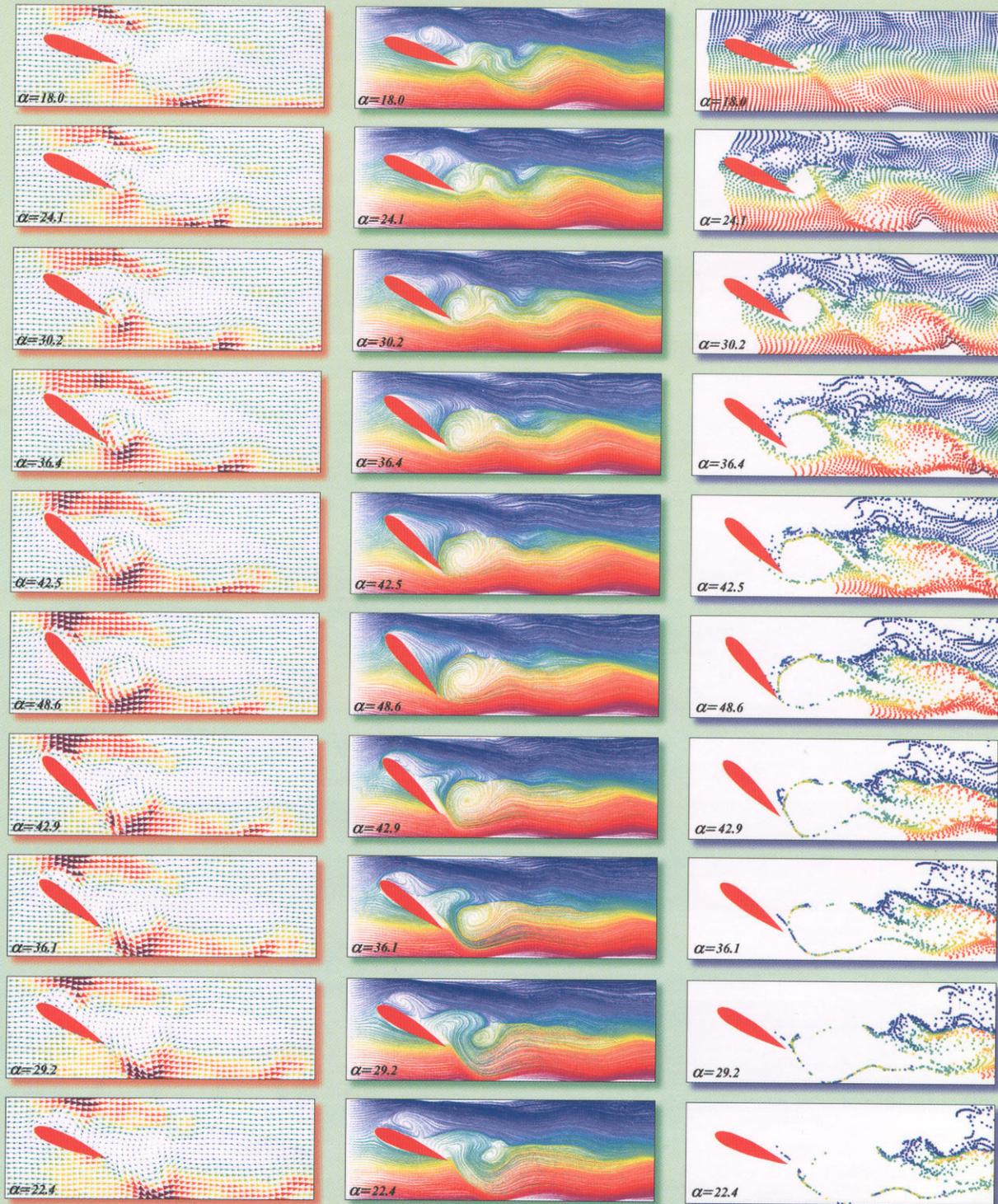
$\alpha = 18.0$, $\alpha = 24.1$, $\alpha = 30.2$, $\alpha = 36.4$, $\alpha = 42.5$, $\alpha = 48.6$, $\alpha = 42.9$, $\alpha = 36.1$, $\alpha = 29.2$, $\alpha = 22.4$

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