

/ kjkwon@kari.re.kr

가

가

1.

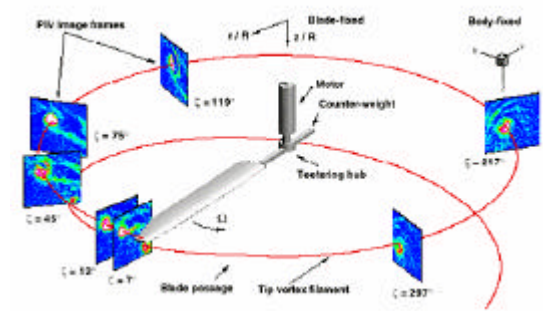
(Digitizing)

(Uncertainty)

[5]

가

가



(a)

(PIV)

1

(Particle

Image Velocimetry, PIV)

(Pressure Sensitive Paint, PSP)

NASA

12ft

[1],

F/A-18

[2]

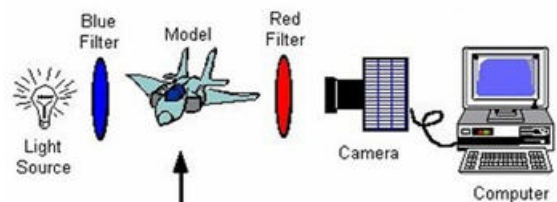
NAL LWT1

[3]

PIV

(Background Oriented Schlieren, BOS)

[4]



(b)

(PSP)

1.

10

2002

[6],

2. (PIV)

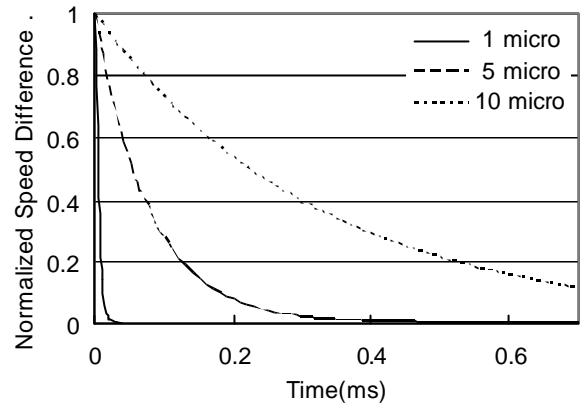
2

(t)

(Tracer particle)

(d)

(Digital image processing)



2.1

3

(Tracing particle)

1~3 μm

~10 μm SAFEX

10~100 μm polystyrene

가

2

3

가

(CFD)

(Interrogation window)

(Single exposure/double frame) PIV

가 2 (Pixel)

가

가

가

가

가

가

가

가

가

가

가

가

가

가

가

가

가

가

PIV

[5].

(Field of

1~2

가

가

가

가

2~5

5~10

2.2

가.

가

가

가

Expanding

beam

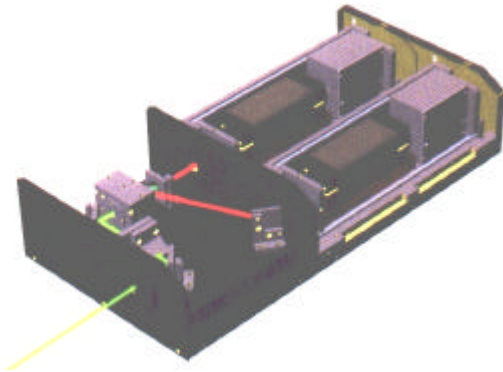
Dual head 가 PIV Nd-YAG

Expanding beam

3

가

가



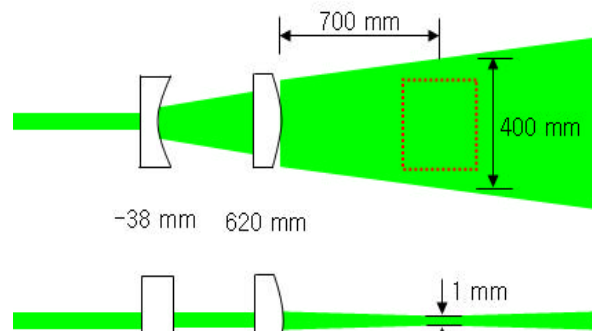
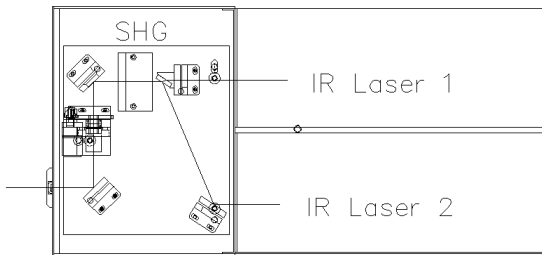
가

가

Iris aperture

PIV

4



3. Dual head Nd-YAG Laser

4.

3 Nd-YAG 가
 (Cavity) Q - (Quality switch)

CCD

PIV

PIV

가 Nd-YAG 1064nm
 Harmonic generator
 (532nm)

가

가

CCD

가

PIV

CCD

CCD

beam

Scanning beam

Expanding

가

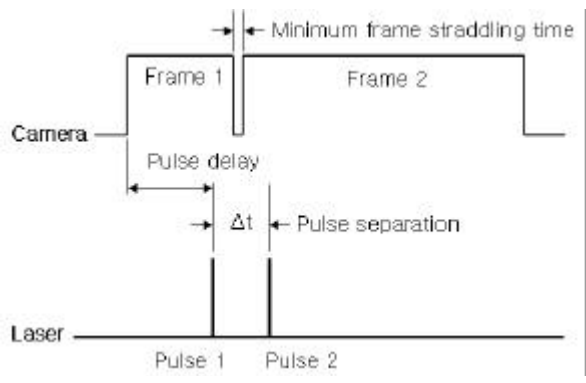
Scanning beam

(Shift)

PIV

Q-
가
Q-
3 PIV 가
2.3

가
5
2
가
가



5.

가.
PIV

가
가
가

PIV
가
2
5
가
(Flash lamp)

가
가
가
2
가
가
Fi(NI, 1), Fo(

1) NIFiFo > 8
95%

FFT

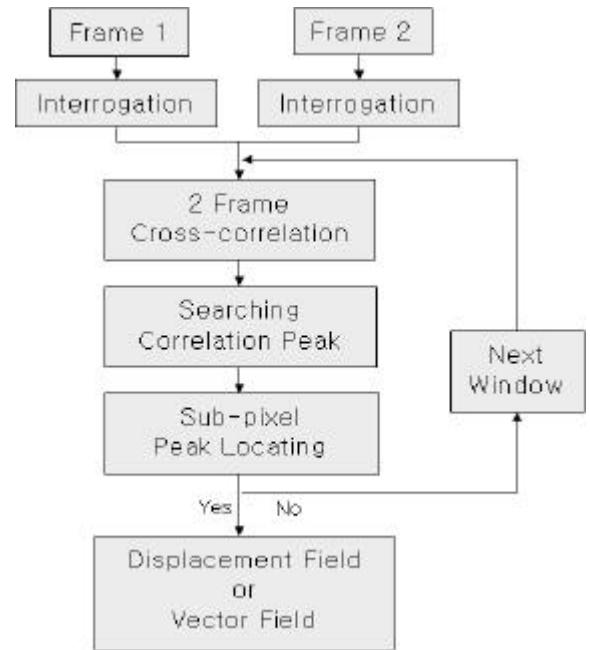
3 가 2 PIV 가 가

t

가

PIV

6



6.

nl nl'

3

$$B_{\Pi}(x', \lambda) = \sum_{i=-K}^K \sum_{\Gamma} I(i') I(i' + x' + \lambda)$$

가

가 가

가

function

가 3x3 5x5
Weighting

Global histogram operator
Dynamic mean value operator가
Global histogram operator

2.4 PIV

2 PIV

PIV

(Threshold, thresh) 가

PIV

$$| \Omega_{exp}(x) - \Omega(x) | < \epsilon_{exp}$$

U(n)

, U(i, j)

PIV

7

(Length

scale)

가

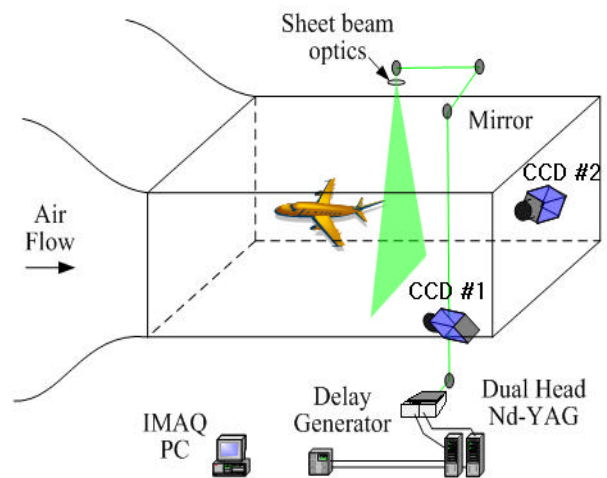
Dynamic mean value operator

(|U(i, j)|) 가 가

(μ(i, j))

3x3

가 가 8



7. PIV

thresh

가

가

$$| \Omega(x) - \Omega(x) | < \epsilon_{exp}$$

8

(Scheimpflug Condition)

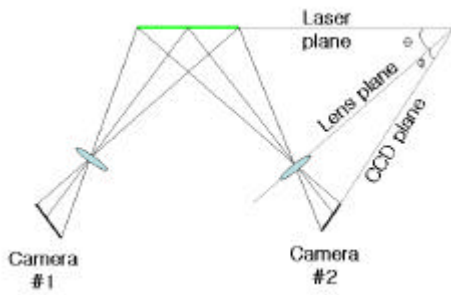
가

가 가

Weighting

PIV

2



8. PIV

PIV

2

가

PIV

200 mm,

16 % 가 2

1m

25 m/s

300,000

1. PIV

	Dual head 200 mJ 15 Hz repetition rate 6 ns duration 0.5 mrad beam divergence
	5 Mirrors Cylindrical lens(-35 mm) Convex Lens(600 mm)
	Laskin nozzle DEHS, Olive Oil
	Kodak ES4.0 2k x 2 k

$$U = \frac{U_r \tan \alpha_l + U_l \tan \alpha_r}{\tan \alpha_r + \tan \alpha_l}$$

$$V = \frac{V_r \tan \beta_l + V_l \tan \beta_r}{\tan \beta_r + \tan \beta_l}$$

$$W = \frac{U_l - U_r}{\tan \alpha_r + \tan \alpha_l} = \frac{V_l - V_r}{\tan \beta_r + \tan \beta_l}$$

l r (#1)

(#2)

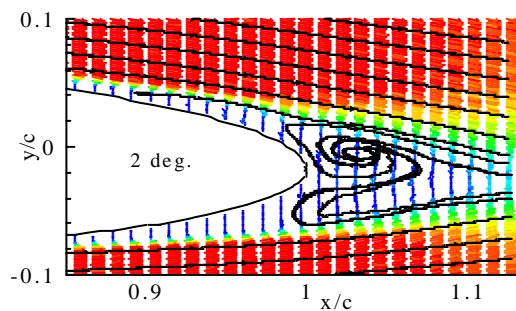
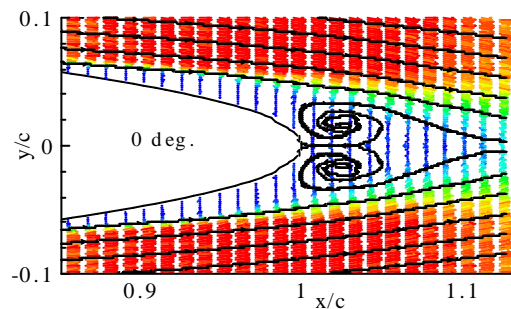
가

64pixel/mm

32 x 8 pixel

0.06mm

9



9. 2

3.

PIV

1

3.1 2

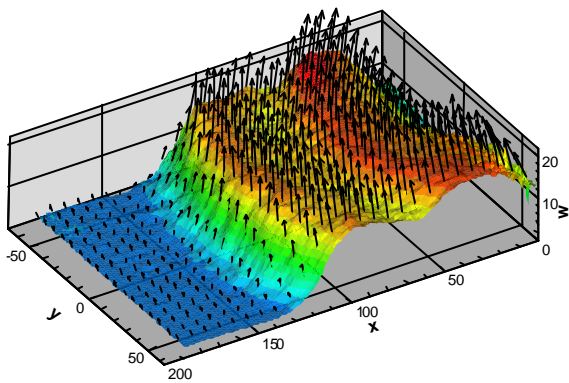
3.2

4.

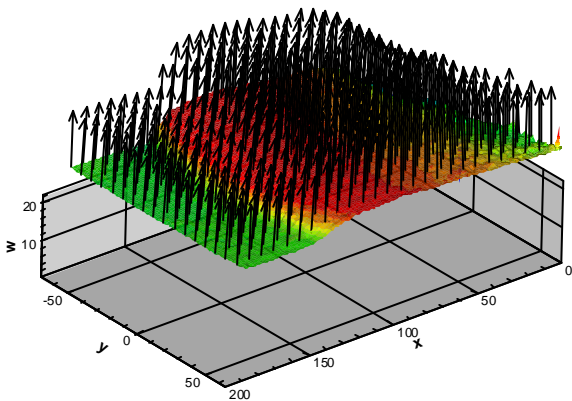
PIV
 220mm
 10
 10
 $x=y=0$
 (w, m/s)
 10(a)
 4000 rpm
 20m/s
 가 4000rpm
 가

가

2



(a) U = 0 m/s, 4000 rpm



(b) U = 20 m/s, 4000 rpm

10. PIV

1. A.W.Burner, TianshuLiu, SanjayGrag, J.H.Bell, and D. G. Morgan, "Unified model deformation and flow transition measurements," J. Aircraft, Vol 136, No. 5, pp.898-901, 1999.
2. A. W. Burner, W. A. Lokos, and D. A. Barrows, "In-flight aeroelastic measurement technique development," NASA-2003-48spie-awb, 2003.
3. S.Watanabe, and H.Kato, "Stereo PIV applicatins to large-scale low-speed wind tunnels." 41st Aerospace Science Meeting & Exhibit, Reno, Nevada, Jan. 6-9, 2003.
4. N. M. Skornyakova, E.M.Popova, B. S. Rinkevichius, and A. V. Tolkachev, "Correlation precessing of BOS pictures," 5th International Symposium on Particle Image Velocimetry, Busan, Korea, Sep. 22-24, 2003.
5. M. Raffel, C. Willert, and J. Kompenhans, Particle Image Velocimetry - A Practical Guide, springer.
6. K. J. Kwon, J. Y. Lee, and B. Sung, "PIV measurements on the boundary layer flow around Naro Space Center," 5th International Symposium on Particle Image Velocimetry, Busan, Korea, Sep. 22-24, 2003.