www.ebm.vc

FLUOSTAR

FLUOSTAR® Rhodamine B-"encapsulating" microspheres are seeding particles optimized for Particle Image Velocimetry

Technical handbook ver.1, Feb, 2010

CONTENTS

1) Introduction of Fluorescent PIV(fPIV): Overview

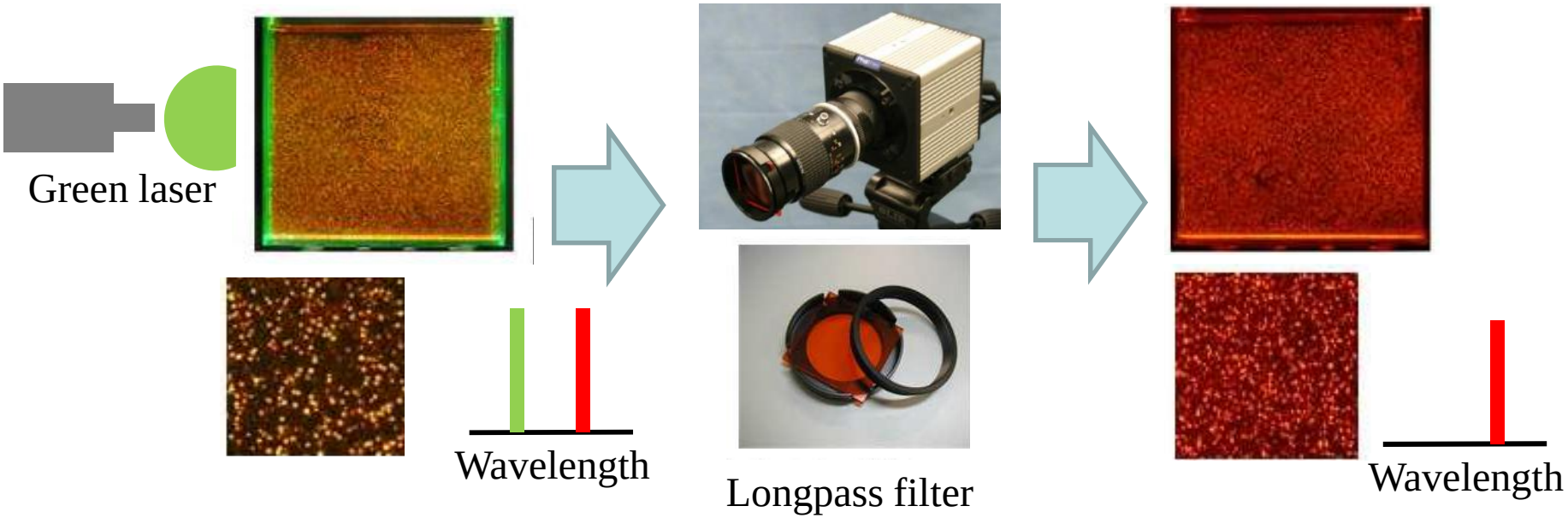
Fluorescent PIV (fPIV) is a hands-on advanced PIV liquid measurement using fluorescence-emitting particles rather than conventional non-fluorescent ones, such as glass spheres. When fluorescent particles are illuminated by a light source (Laser, LED etc.) , particles emits fluorescence with a different wavelength (or, color) from that of the light source. By using an **optical filter,** users can **"selectively"** obtain fluorescent particle images without any optical disturbance from the light source, This document explains fPIV and its optimal seeding particles, **FLUOSTAR®**. Users no longer suffer from undesired reflective light. Excellent signal-to-noise ratio can be achieved by using fluorescence, or changing the color.

	Conventional PIV (Non-fluorescent PIV)	**Fluorescent PIV**
Seeding particles	• Polystyrene • Glass spheres (GS) • Metal-coated hollow GS etc.	**Fluorescent particles (FLUOSTAR®)**
Particle visibility	**Scattering** light	**Fluorescent emission**
Wavelength	Same as light source	**Longer than light source**
Light source※1	Laser / LED	**Laser / LED**
Camera	CCD (CMOS) sensor	**CCD (CMOS) sensor**
Optical filter※2	No	**Yes**

※1 We assume a green laser or LED is a typical light source for modern PIV.

※2 A standard longpass filter is necessary for fPIV. In the case of FLUOSTAR ®, the filter should have a sharp cutoff wavelength at 550nm. Upon request, EBM Corp. recommends a suitable filter and attachment (see p3).

1) Introduction of Fluorescent PIV(fPIV): illustration

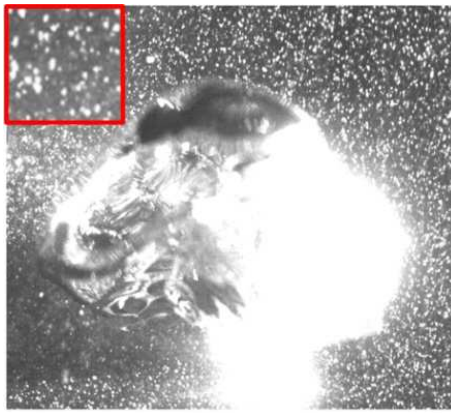


For clarity, FLUOSTAR® images were taken by a color CCD sensor.
Particles were seeded in water within a Perspex-made container and illuminated by a Nd:YLF laser (527nm)

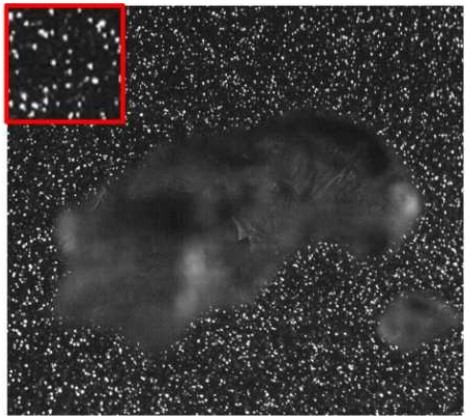
1) Introduction of Fluorescent PIV(fPIV): applications

Bubbly flow meas.

Hardware setup
- Nd:YLF laser (527nm, Photonics Industries)
- 5 mJ-energy high-rep. pulsed green laser
- Standard CMOS camera, Fastcam 1024 (Photron)
- 1Kfps time-resolved measurement



Non-fluorescent particles

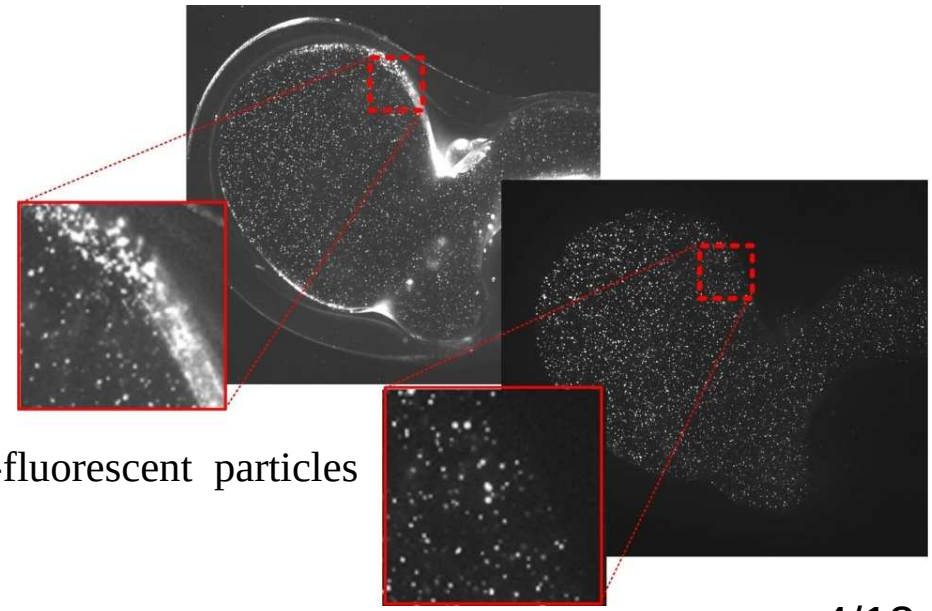


FLUOSTAR® microspheres

Near-wall flow meas.

Similar as above

Excellent particle visibility!

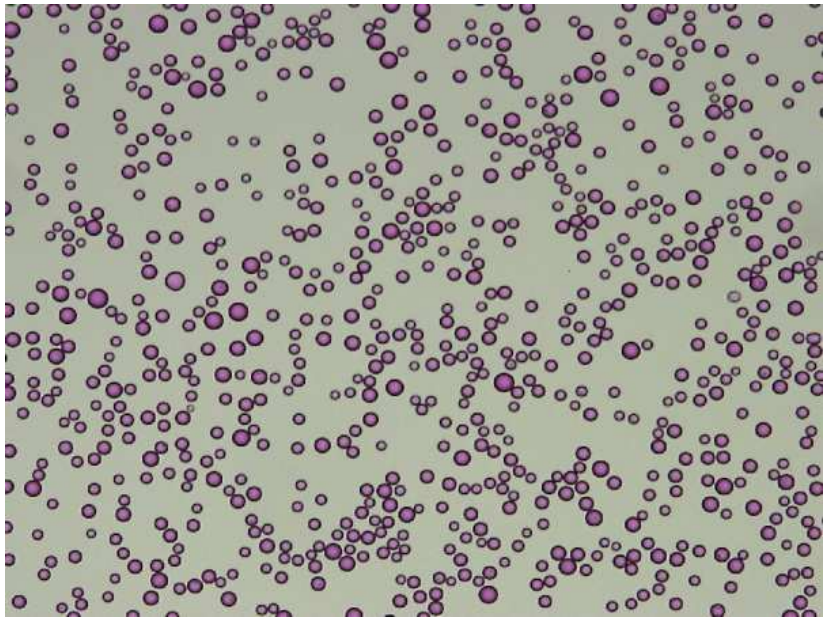


Non-fluorescent particles

FLUOSTAR® microspheres

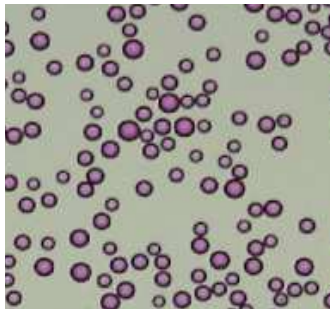
2) Advantage of FLUOSTAR® microsphere

Shape	Sphere
Density	**1.1 g/cm^3**
Mean size	**15 µm**
Size distribution	**Less than 20% in C.V. ※1**
Fluorescent emission	**Excellent brightness (P6)**
Water dispersibility	**Excellent (P7, 8)**
Water stability (heating, durability)	**Excellent (P9, 10)**
Particle supply	Dry powder

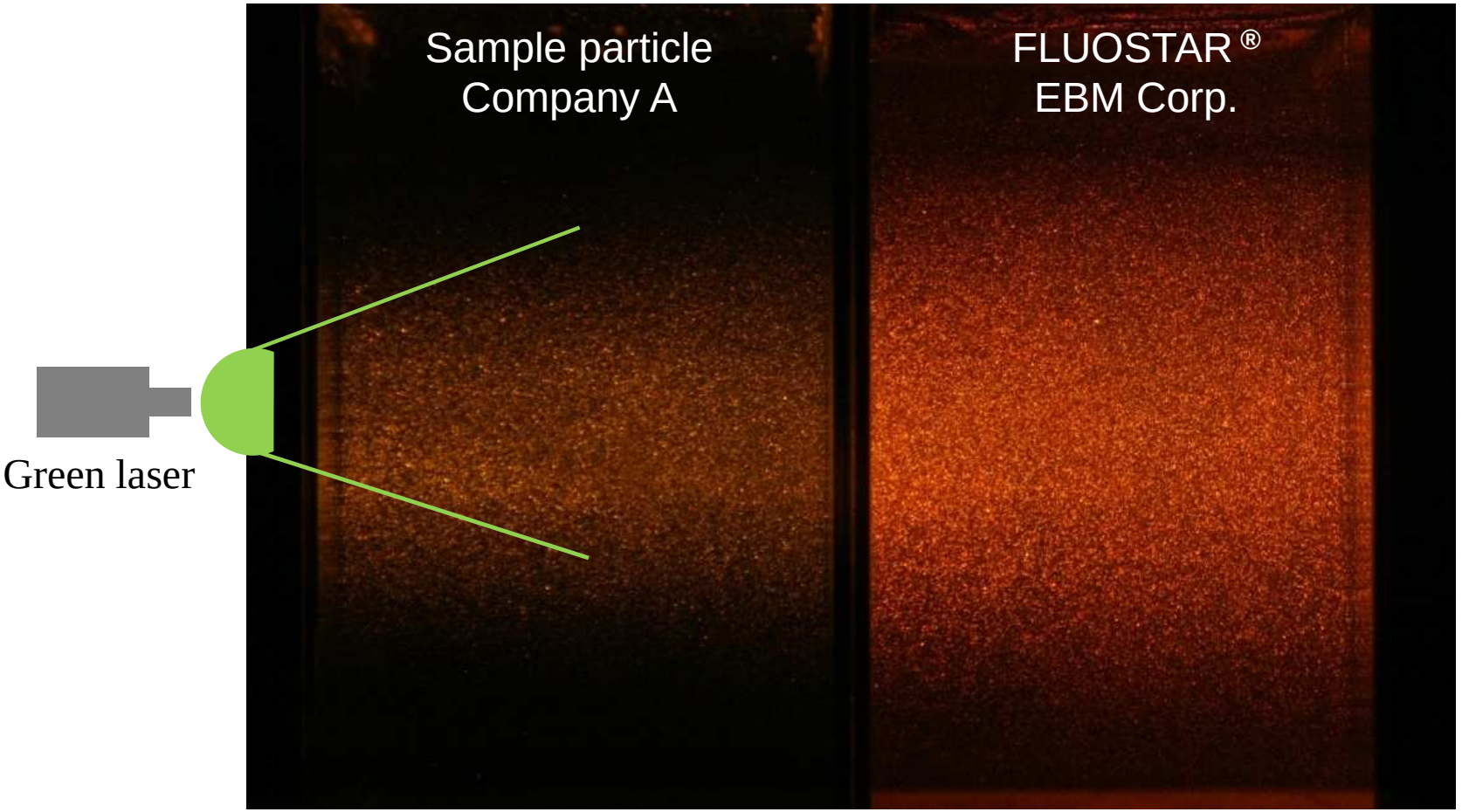


Microscope image (×10)

※1 C.V. denotes coefficient of variation, (standard deviation divided by mean diameter)

Zoomed view 

2) FLUOSTAR® technique: excellent brightness



Particle conditions:

FLUOSTAR® was compared in brightness with a sample fluorescent particle commercially available. Particle concentration was **5 mg / litter** for both in fresh water. The size of each particle was similar in mean diameter (15 µm).

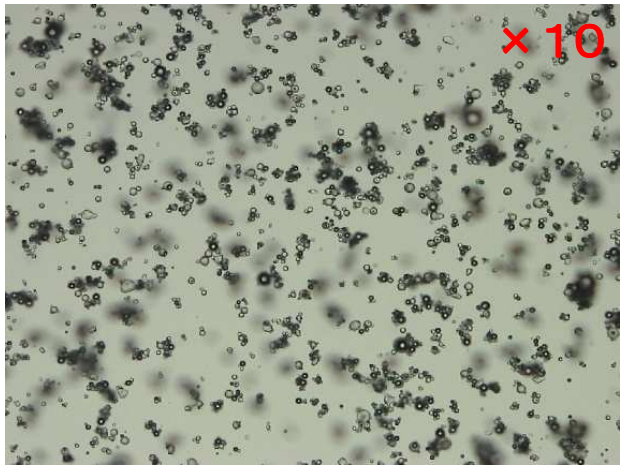
2) FLUOSTAR® technique : Water dispersibility

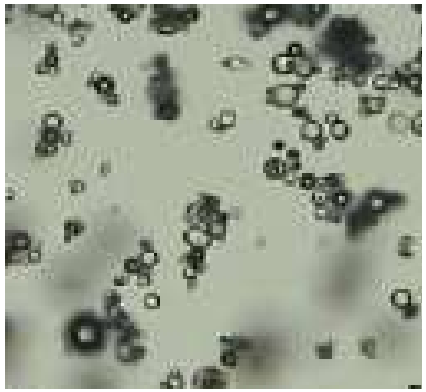
FLUOSTAR ® is **hydrophilic,** or **wettable,** particles**!!!**

Movie available
http://ebm.vc/news/107?category=info_e

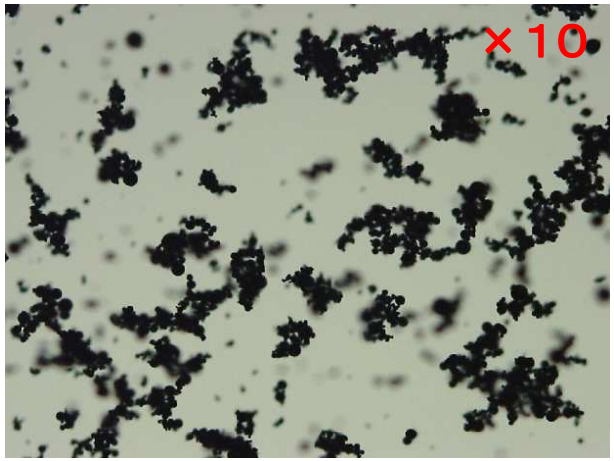
2) FLUOSTAR® technique : Comparison of water dispersibility

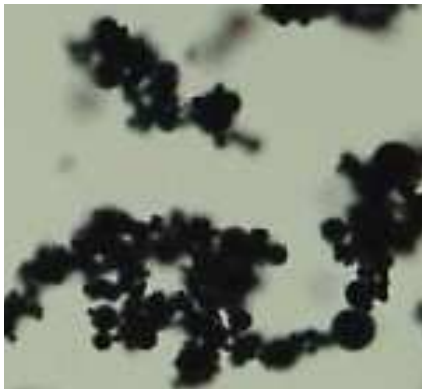
Hollow glass (HG) sphere



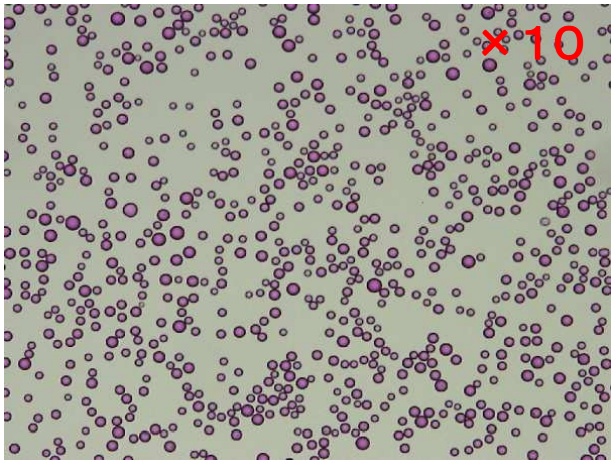


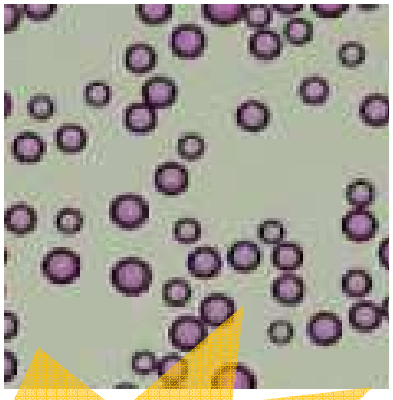
Silver-coated HG sphere





FLUOSTAR®

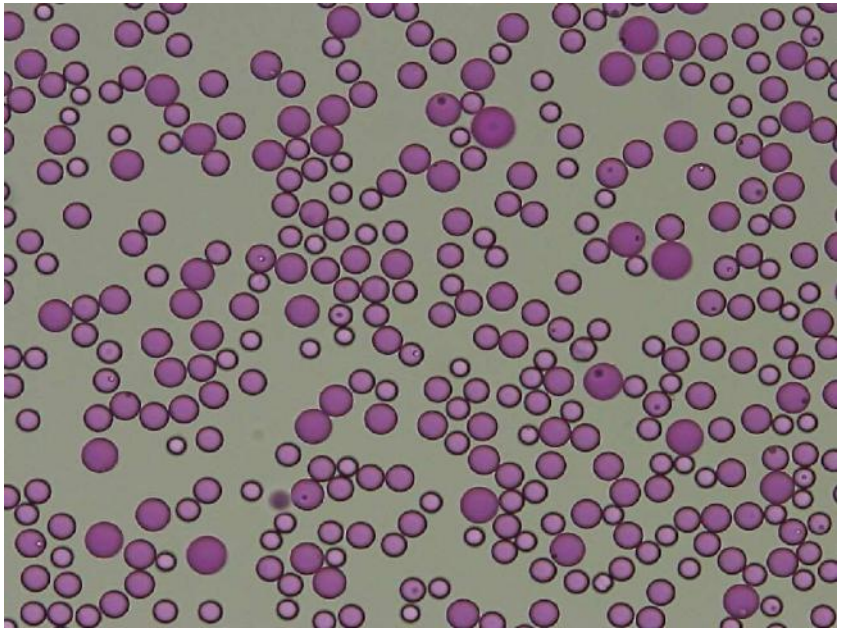




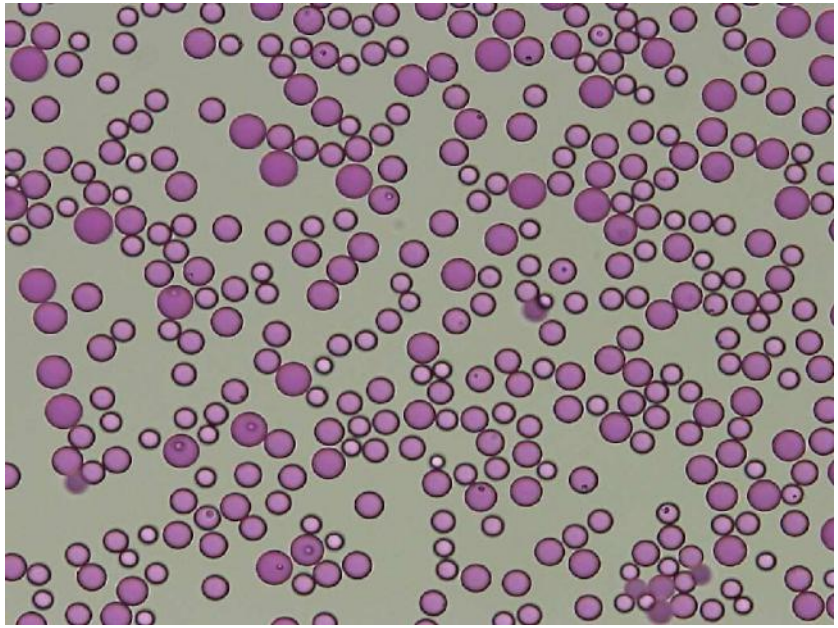
Hollow glass and silver-coated HG particles were mixed in water and then stirred in a mixing device. Despite that, these particles still formed aggregations . In contrast, Fluostar does not make aggregations even without stirring because of prominent wettability.

No more aggregation and adhesion

2) FLUOSTAR® technique : Water stability



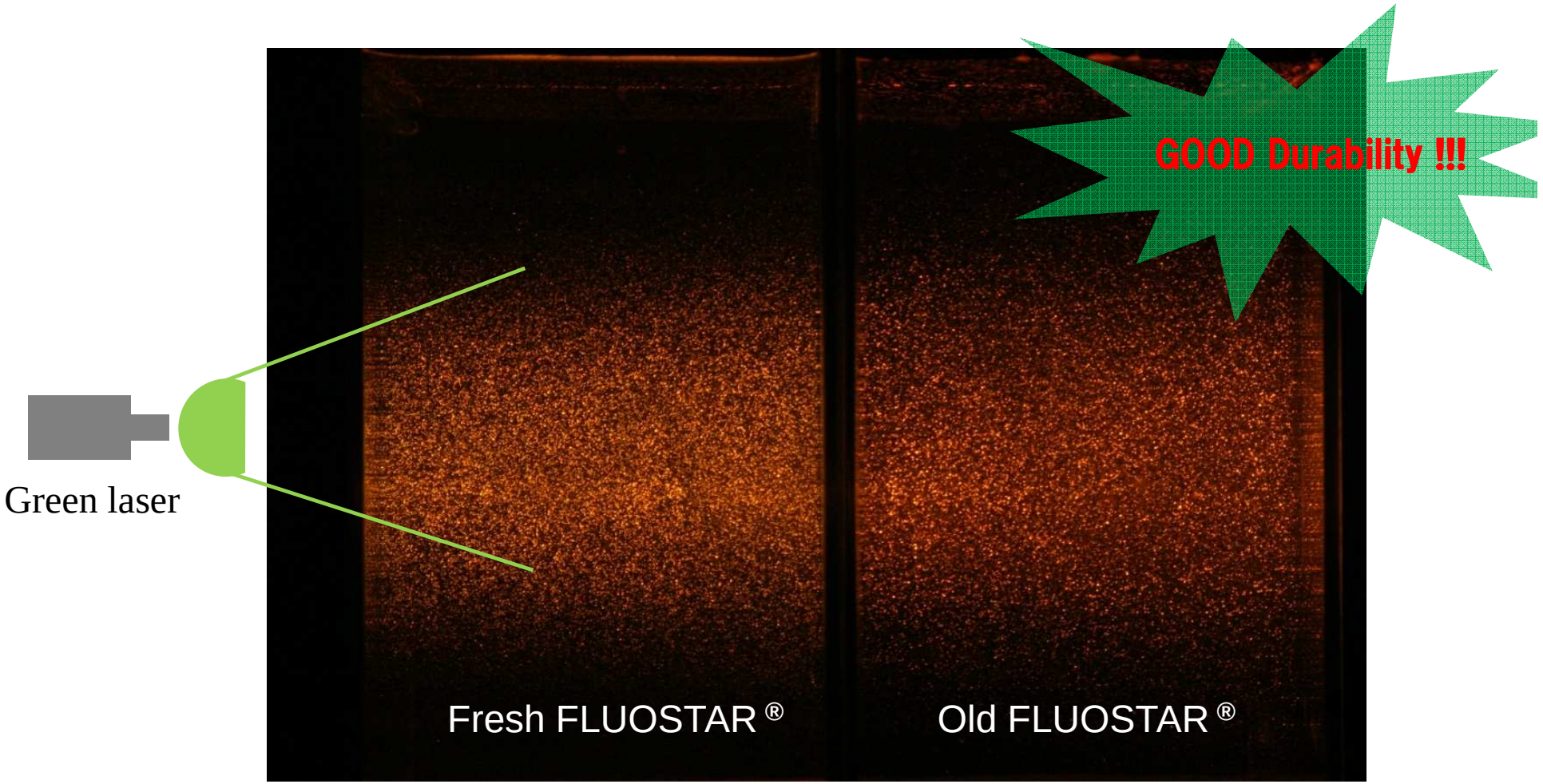
Water at 25℃



Heated in boiling water (100℃, 1 h）

Excellent durability for heating

2) FLUOSTAR® technique : Durability test



Particle conditions:

FLUOSTAR® was preserved in refrigerator as suspended in water for a period of **two months**. Then, the old particles were compared in brightness in contrast to fresh ones with the same particle density using fresh water for both.

3) FLUOSTAR® application: vascular flow modeling

Cerebral aneurysm model

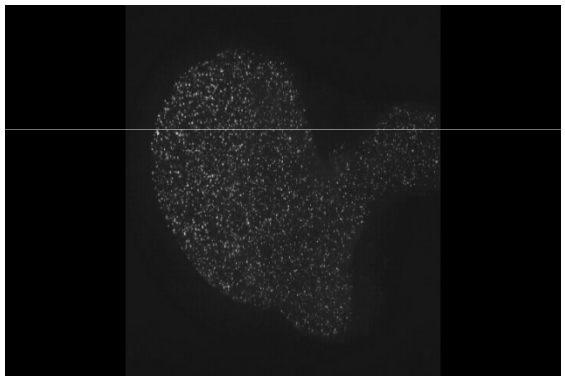
FLUOSTAR®

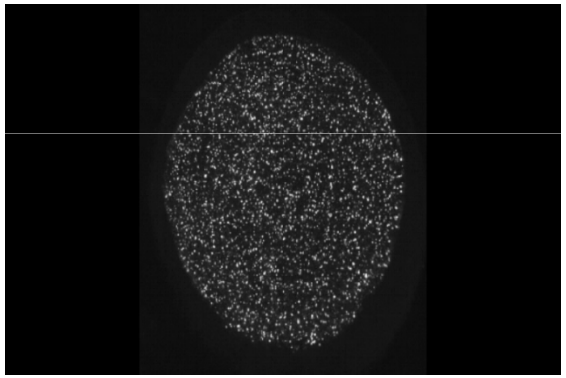
Non-fluorescent particles

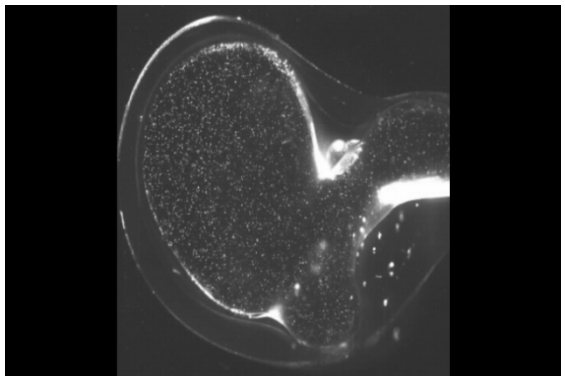
No more reflection!!!

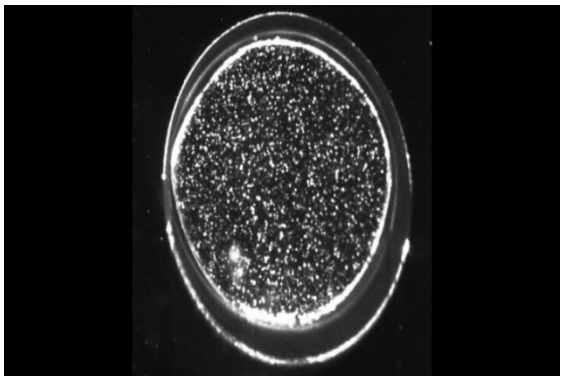
Side plane

Top plane







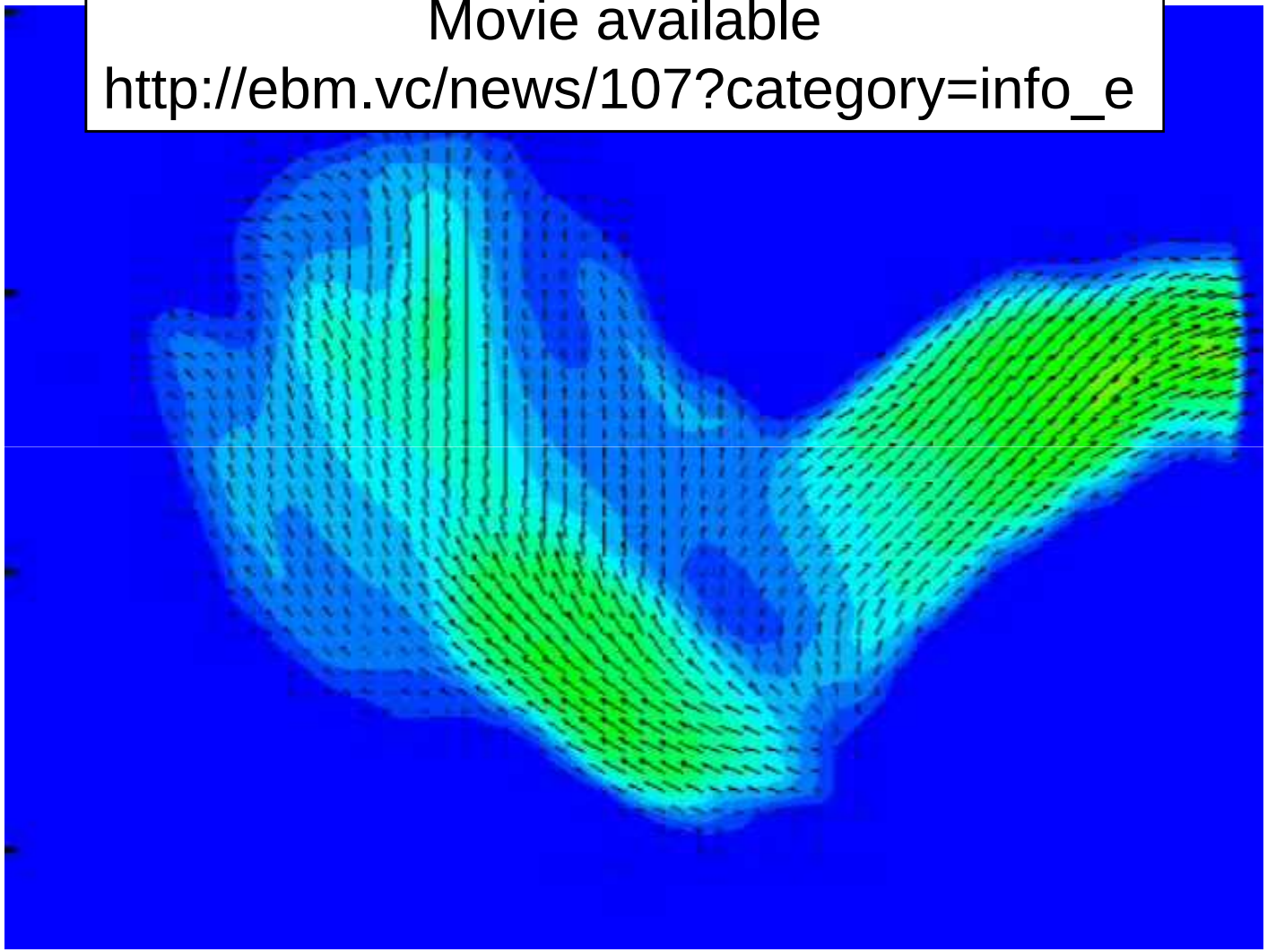


Presented by T. Yagi, at PIV09, 2009

Movie available http://ebm.vc/news/107?category=info_e

2) FLUOSTAR® application : 2D time-resolved PIV

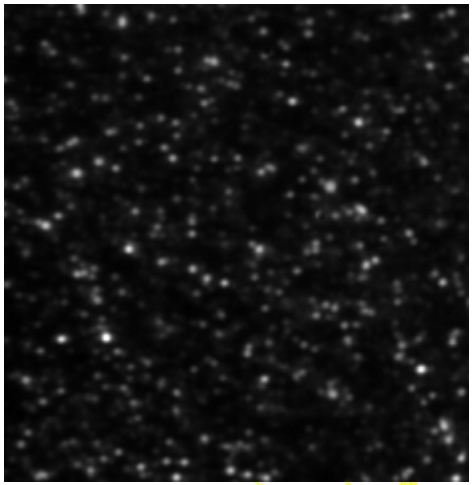
Movie available
http://ebm.vc/news/107?category=info_e



Standard PIV processing using original images (no image enhancement)

Presented by T. Yagi, at PIV09, 2009

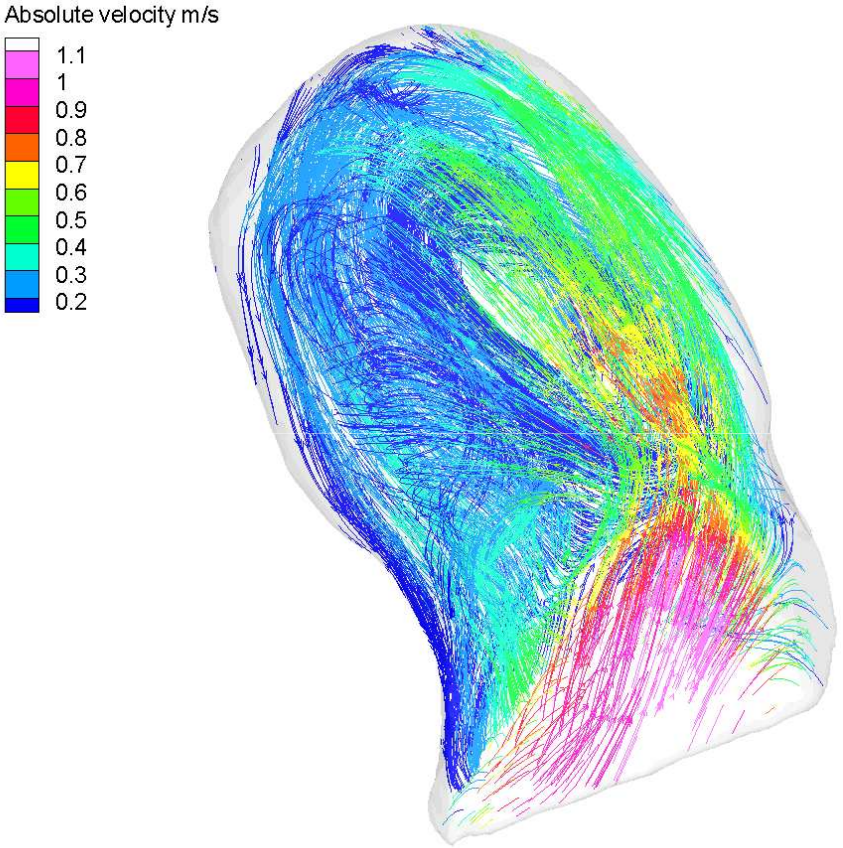
3) FLUOSTAR® application : 3D Stereo PIV

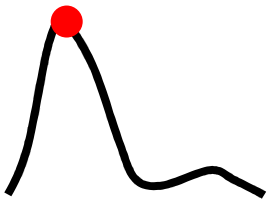


Raw image at **f#=16**

Excellent brightness

Movie available http://ebm.vc/news/107?category=info_e





Interrogation size :(16×16pixel^2)
Spatial resolution: 110 μm
Laser light thickness: 80~100μm
Overlap: 50%(55μm)
Scanning plane: 80

Presented by T. Yagi, at PIV09, 2009