

Today

Last Team 1 images

Reports: UG MEs, need to make sure you refer to physics more, include at least web-level references. Use self-assessment as check sheet. Ask if you are unsure where to look for info.

Finish Resolution

How much resolution is needed?

Consider range of scales:

3000 px wide image, can see $1:1000 = 3$ decades of scales

In flow, scales can be 3 minimum,

For turbulence need 4 or 5 decades minimum

Same scale considerations as for CFD:

If resolution is increased, is new information seen?

Is it important information?

In CFD, could have different physics

In Flow Vis, could lead to misinterpretation of physics

$$\frac{3000 \text{ px}}{1000} = X \text{ DECADES}$$

1 Decade
 $3 \rightarrow 30$
 2nd decade
 $30 \rightarrow 300$

Minute paper: In your GW image, how many decades of length scale was in your flow?

How many did your image capture?

Was your flow spatially resolved?

$300 \rightarrow 3000$

Examples from GW images; resolved vs not resolved. What if there aren't two things close together, how to estimate from an edge gradient?

Human eye resolution, 74 to >500 Mpx, depending on how you count.

Time resolution

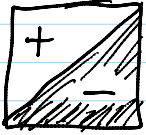
Shutter nomenclature:

2 = 1/2 sec, 20 = 20 1/20th sec etc.

2" = 2 sec

T = time = actuate open, actuate closed

B = bulb = open as long as actuated. Rare now.



To change exposure,

lighten image, overexpose compared to AE suggestion +++

Darken, underexpose compared to AE, -----

Other considerations of shutter speed:

Short enough to 'freeze' flow= TIME RESOLVED

VS long enough to get desired particle tracks
or long enough to be TIME AVERAGED.

If long shutter is needed, might be too much
light. Try a

NDF = Neutral Density Filter. Neutral = all 
wavelengths equally. Gray.

NDF 1 = 1 /10 light transmission.

NDF 2 = 1/100 etc. Log scale.

http://en.wikipedia.org/wiki/File:Strickland_Falls_Shadows_Lifted.jpg

30 seconds. NDF 8x



Need a tripod for macros, or shutters > 1/30 sec

Full size start at \$25. Highly recommended.

Several available for checkout.

Estimate motion blur *in pixels* to guide choice of shutter speed.

Example:

Field of view = 10 cm

Fluid moving at 0.5 m/s

10 Mpx sensor

Minute paper: what shutter speed will 'freeze' this flow?

Can tolerate maybe 5 px blur?

10 Mpx ~ 3750 X 2750

$0.1 \text{ m} / 3750 = 2.6 \text{ e-}5 = 0.000026 \text{ m/px} = 26 \mu\text{m/px}$

5 px = $1.3 \text{ e-}4 \text{ m} = 0.00013 = 0.13 \text{ mm}$ estimated acceptable object displacement x
time $t = x/\text{velocity}$

$1.3\text{e-}4 \text{ m} / (0.5 \text{ m/s}) = 2.6\text{e-}4 \text{ seconds}$

$2.6\text{e-}4 \text{ sec} = .00026 \text{ sec} = 260 \mu\text{sec} = 1/3750$ Very short. Can your camera do this?

$5/3750 = 0.0013 = 0.13\%$ of image width

distance in object plane

