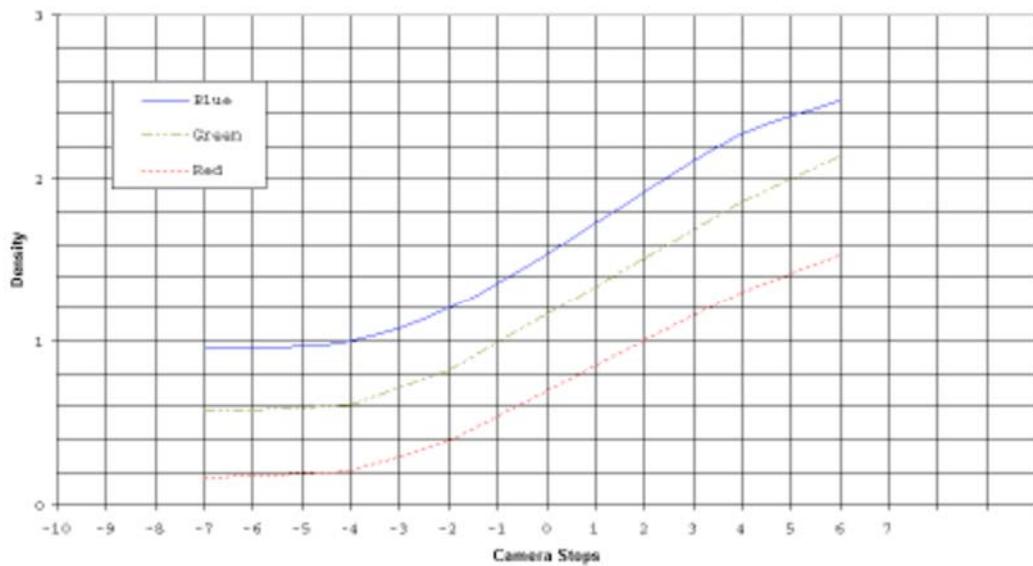
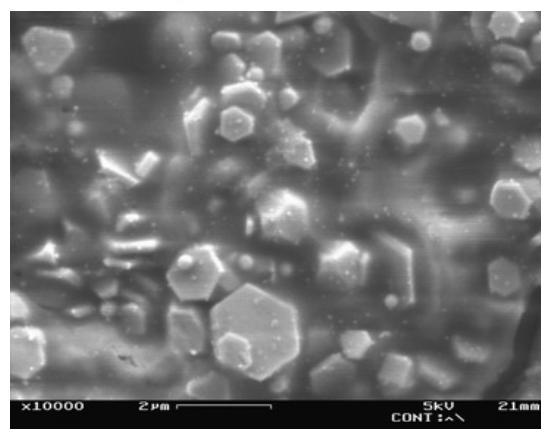


Dynamic Range and Photography

- Digital 8 bit (256 levels) is the standard
- High end Digital cameras do have 10-14 bit conversion
- But noise limit is about 8-10 bit at best ISO
- Film records a max dynamic range of 20,000:1 (~15 bit)
- Top and bottom saturation
- Comes from distribution of grain sizes
- Small grains low sensitivity – gets the bright end
- Large grains high sensitivity – get the dark end
- At most sensitive end film has some large grain halides
- Hence extension of sensitivity at high exposure end
- Best film 3 layer XR from EGG 10⁸:1 – better than the eye

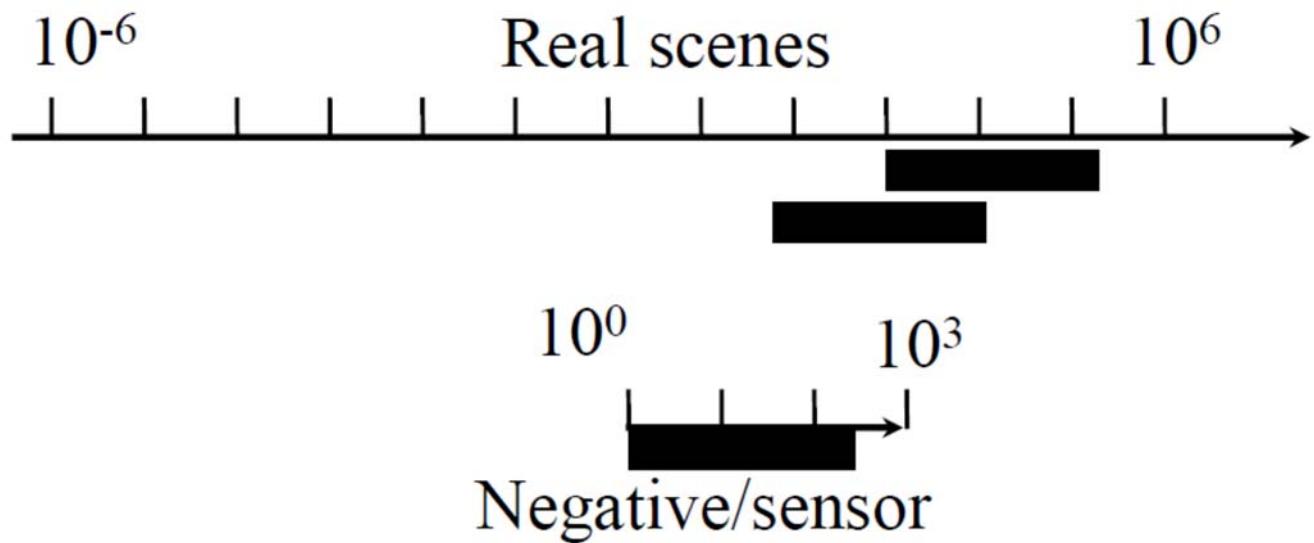


Notice: While the data presented are typical of production coatings, they don't represent standards which must be met by Eastman Kodak Company. Variable storage, exposure, and processing conditions will affect results. The company reserves the right to change and improve the product characteristics at any time.



High Dynamic Range Imaging Problem

- Problem is the Camera range is much smaller than the human eye
- Human eye about 60,000 to 1
- But in actual scene range is 10^{10} to 10^{12} range
- Noise limits our camera dynamic range
- With multiple images could record a larger range
- But even if we could take that full range cannot display it
- Hence need to do Tone Mapping
- Great notes on HDR by Fredo Duran at MIT lecture at Stanford
<https://graphics.stanford.edu/courses/cs448a-10/hdr-bilateral-26jan10-opt.pdf>
-

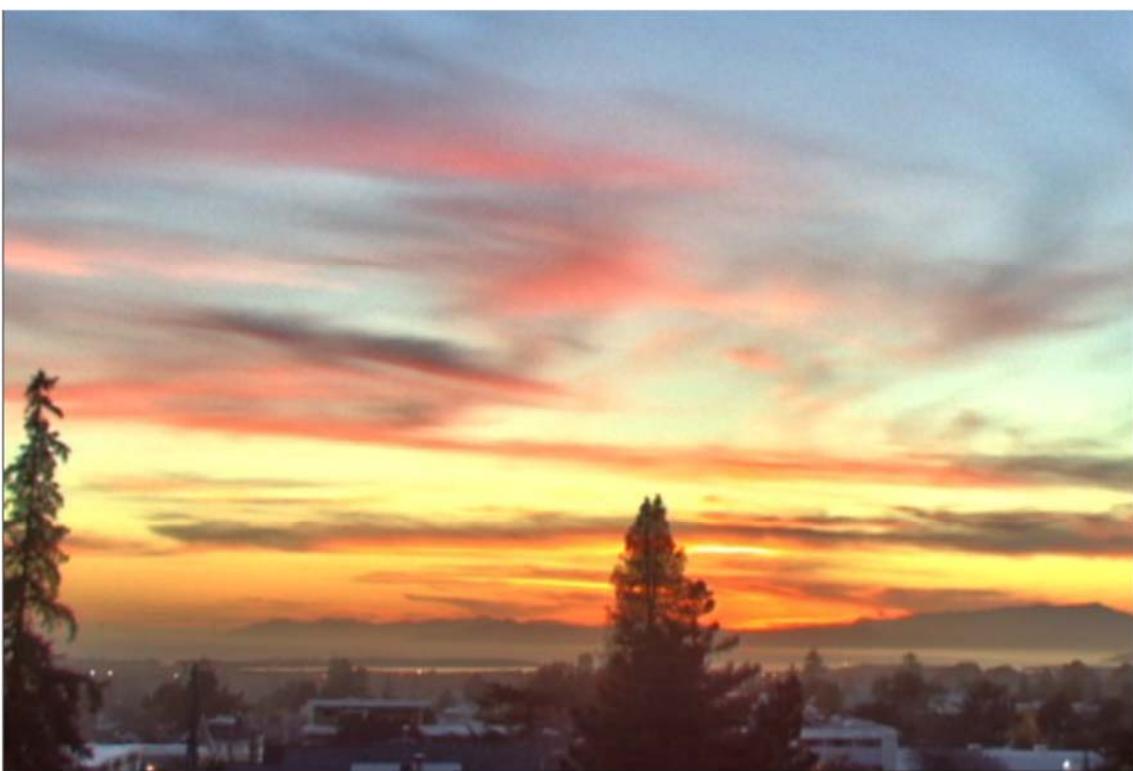


What HDR can do

- We want to replace the blown out (white) areas with information
- Also the dark areas with new information
- Creates an image that is compressed but close to what we see



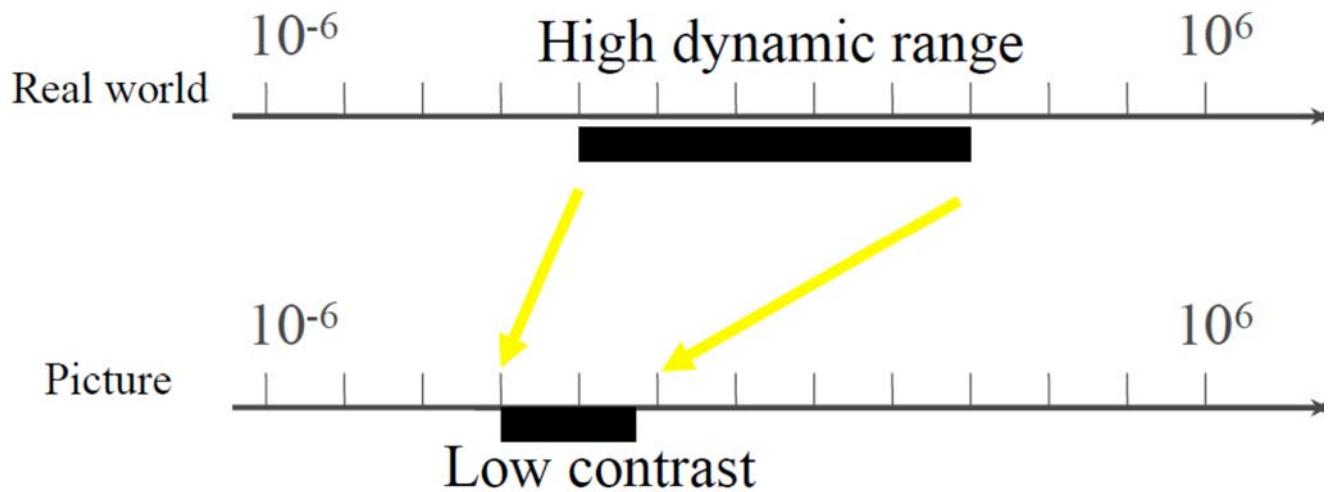
Camera



HDR

HDR Tone Mapping

- Compressing the Dynamic range
- Use software to intelligently do the substitution
- But this can create strange artifacts



HDR Problems

- Tone mapping can create artificial images
- Substitution creates something that looks wrong

By Anthony Wong,

<http://abduzeedo.com/20-beautiful-hdr-pictures-part-3>



HDR when it is right

- However sometimes creates what we see

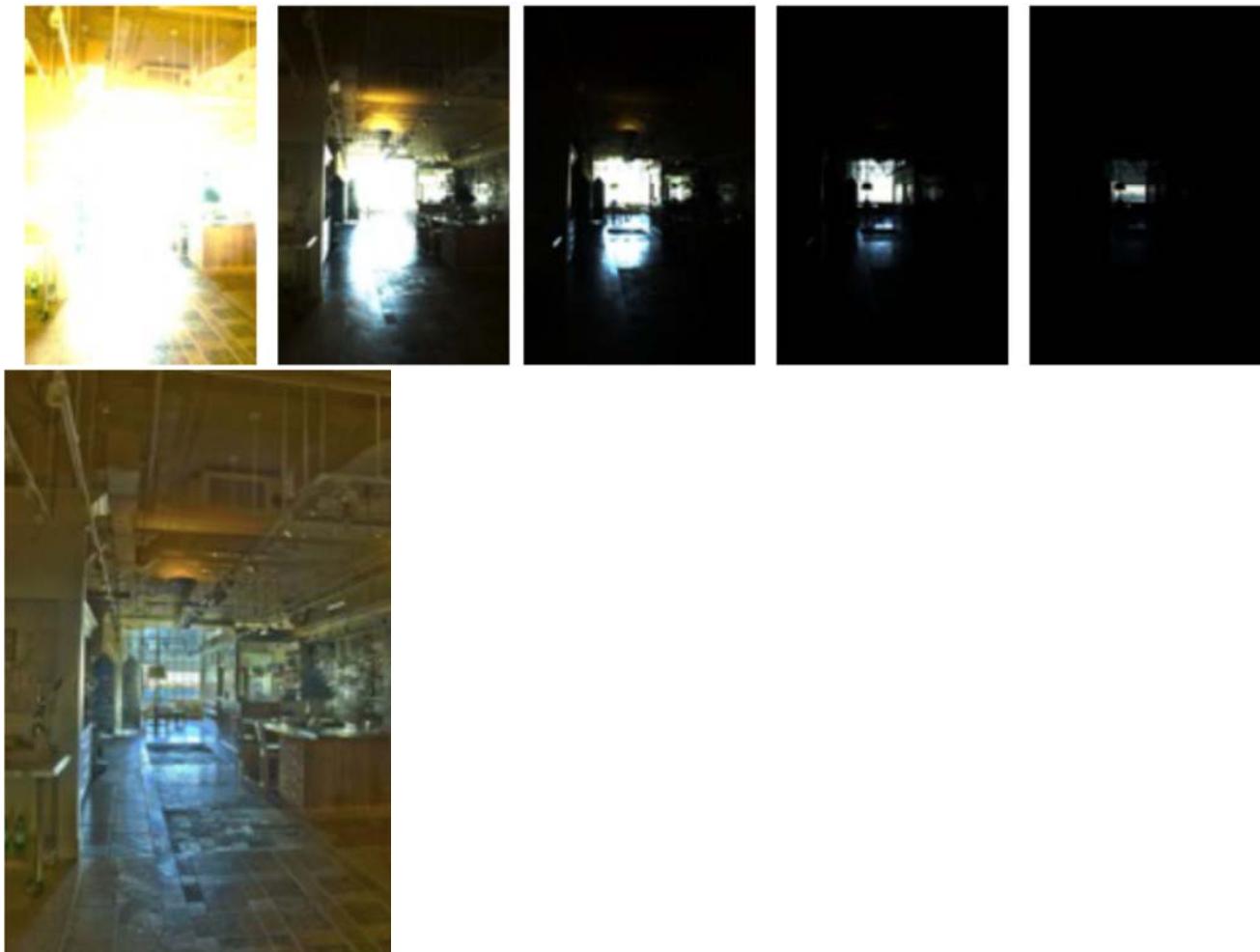
By Alexandre Buisse

<http://luminous-landscape.com/essays/hdr-plea.shtml>

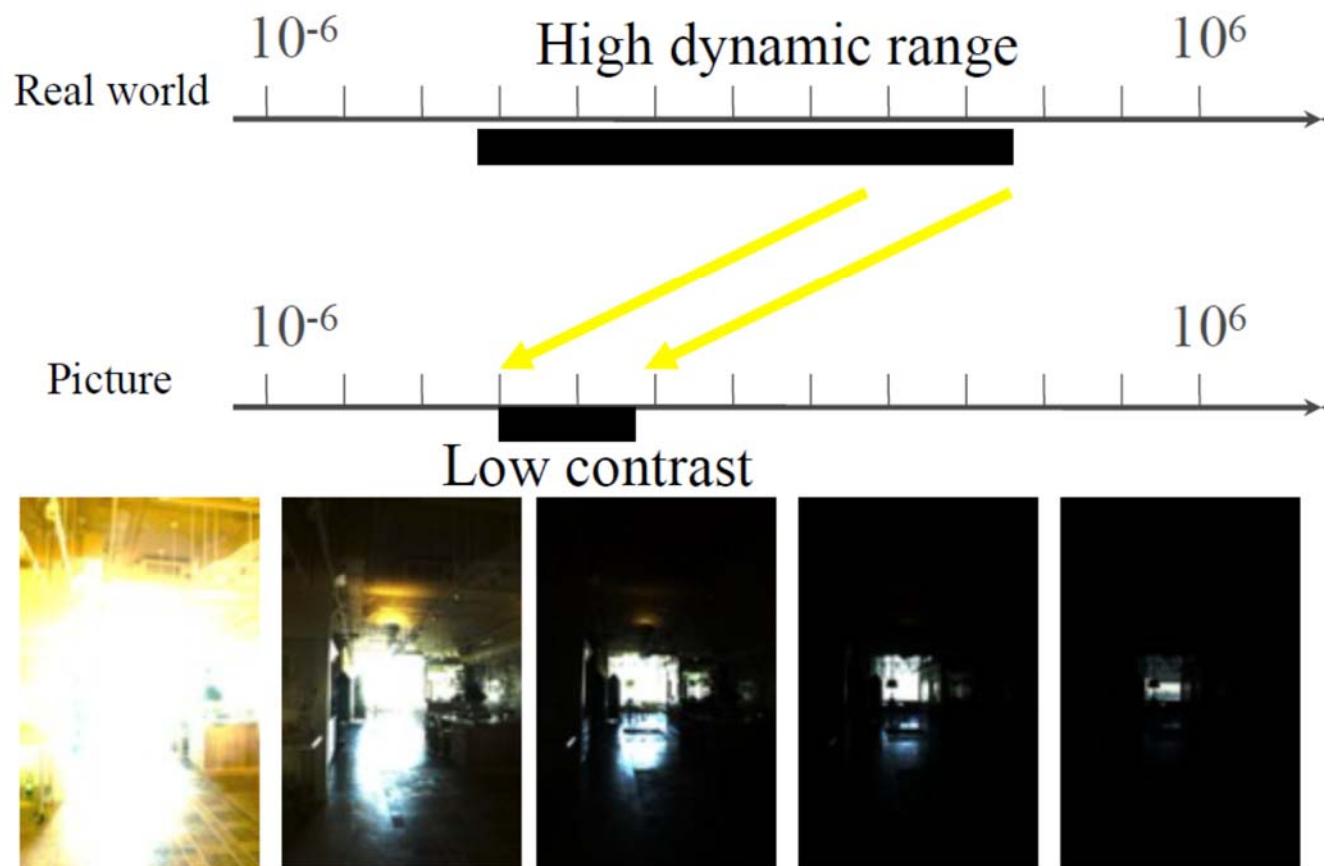


Multi Exposure HDR

- Take many exposures at different exposure levels
- Typically 2 – 3 stops difference



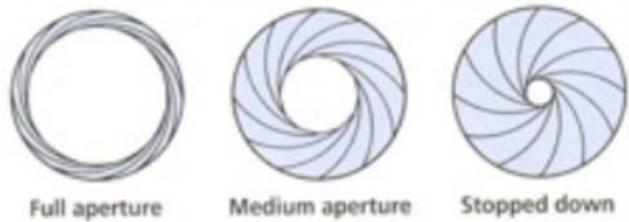
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Getting the Images

- 4 Choices –
- Aperture (F#)
- ISO (gain on sensor)

Aperture (F#)



ISO (gain on sensor) 50 to 406K

Neutral density filter

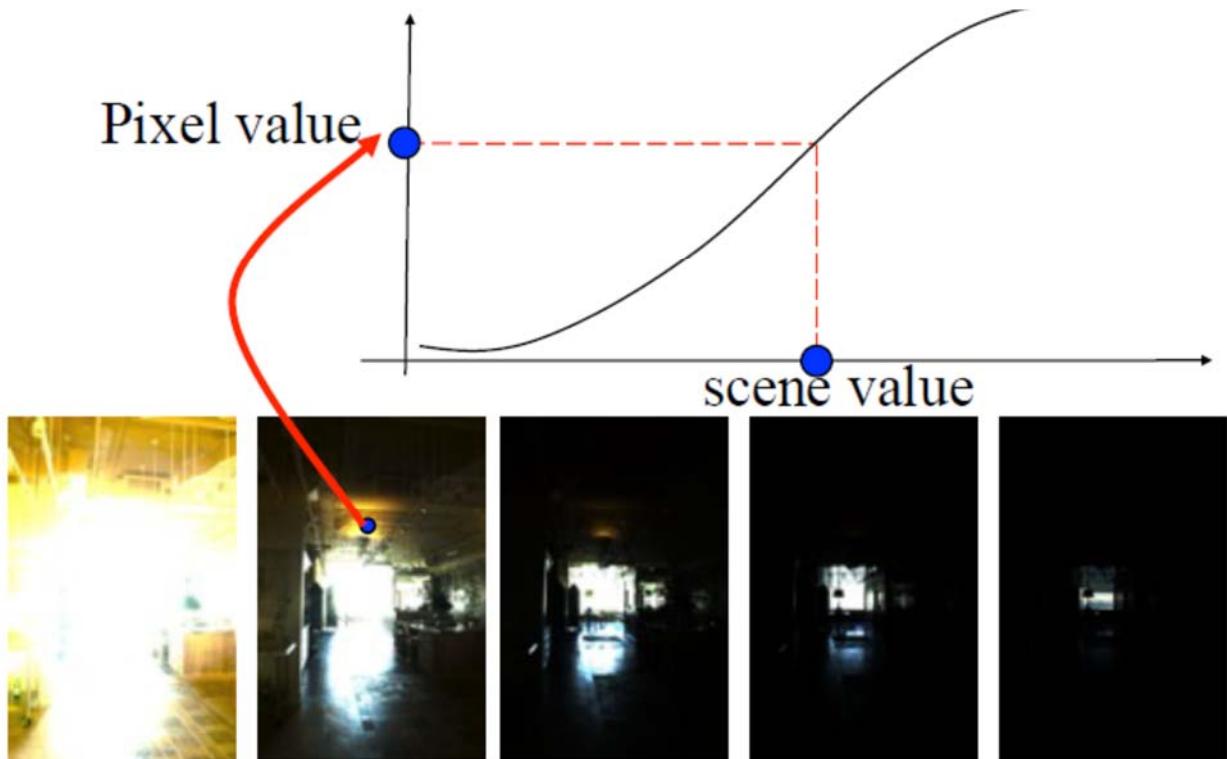


4 Ways of creating image Range

- Change exposure speed – 30 sec to 1/8000 sec
- Reliable and linear
- Keeps depth of focus same
- But slow speed may need to keep camera still
- Also lots of noise
- Aperture: Change F# - speed constant
- F/1.4 to f/32
- Now can be hand held
- But depth of focus changes with images
- ISO change
- 50 to 406K ISO change
- But noise changes with high ISO
- Neutral Density Filters
- Up to 8 stops
- Can be combined
- Note really colour neutral
- Drops the light in the scene so can keep exposure

Response Curve

- Take the response curve for each frame
-



HDR – Creating a smooth curve

- Do a transformation for each part of image
- Create a smooth response curve

Image series



$\Delta t =$
10 sec



$\Delta t =$
1 sec



$\Delta t =$
1/10 sec

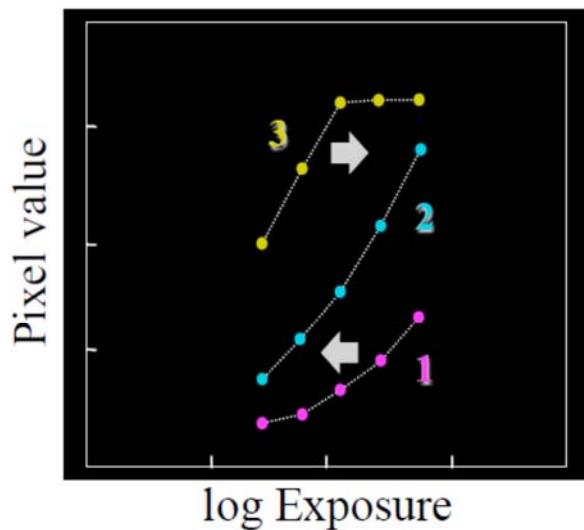


$\Delta t =$
1/100 sec



$\Delta t =$
1/1000 sec

Assuming unit radiance
for each pixel



After adjusting radiances to
obtain a smooth response
curve

