Physics of Life

PHYS-468

Computer Representation of Images

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Slides from Thomas Braun,
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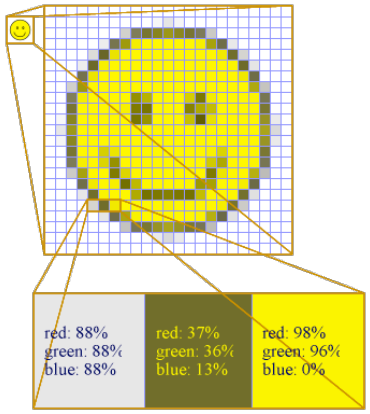
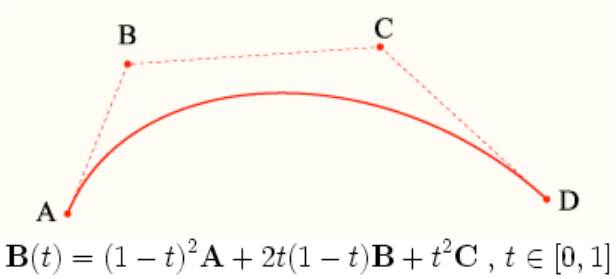
Graphical information

Raster graphics	Vector graphics
	
Generally rectangular array of pixels (points)	Geometrical primitives (points, lines, polygons) to represent graphic
Photographs	Computer generated line art
tiff, jpg, png Photoshop, GIMP, ImageJ	“postscript”, pdf Illustrator, Xfig, Corel draw

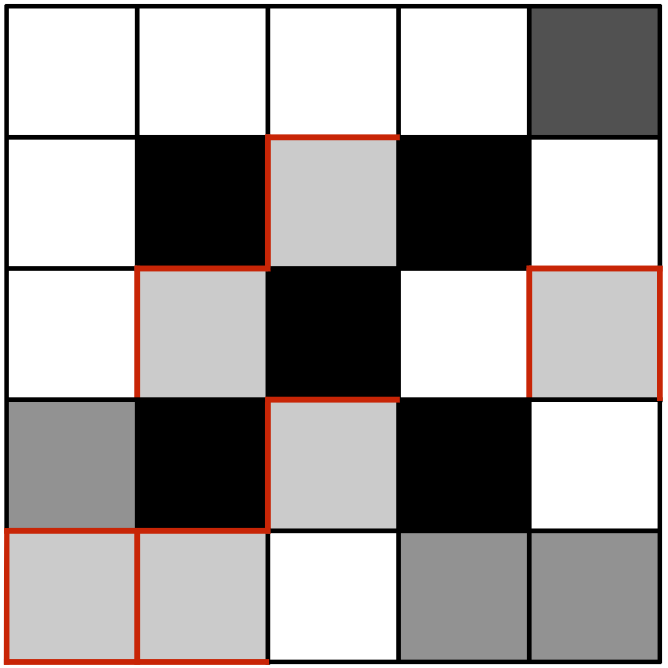
Illustrations: wikipedia.org

Quality measurements for raster graphics

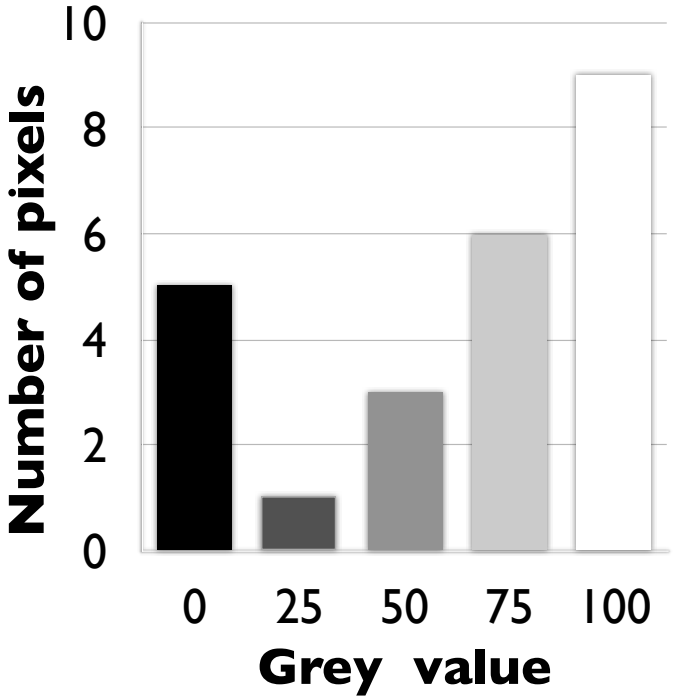
- Resolution: How many pixels encode a certain structure.
    - Warning: The resolution of the picture does not represent the resolution of the optical device.
- Dynamic range: How much information (computer memory) is reserved per pixel

Histogram

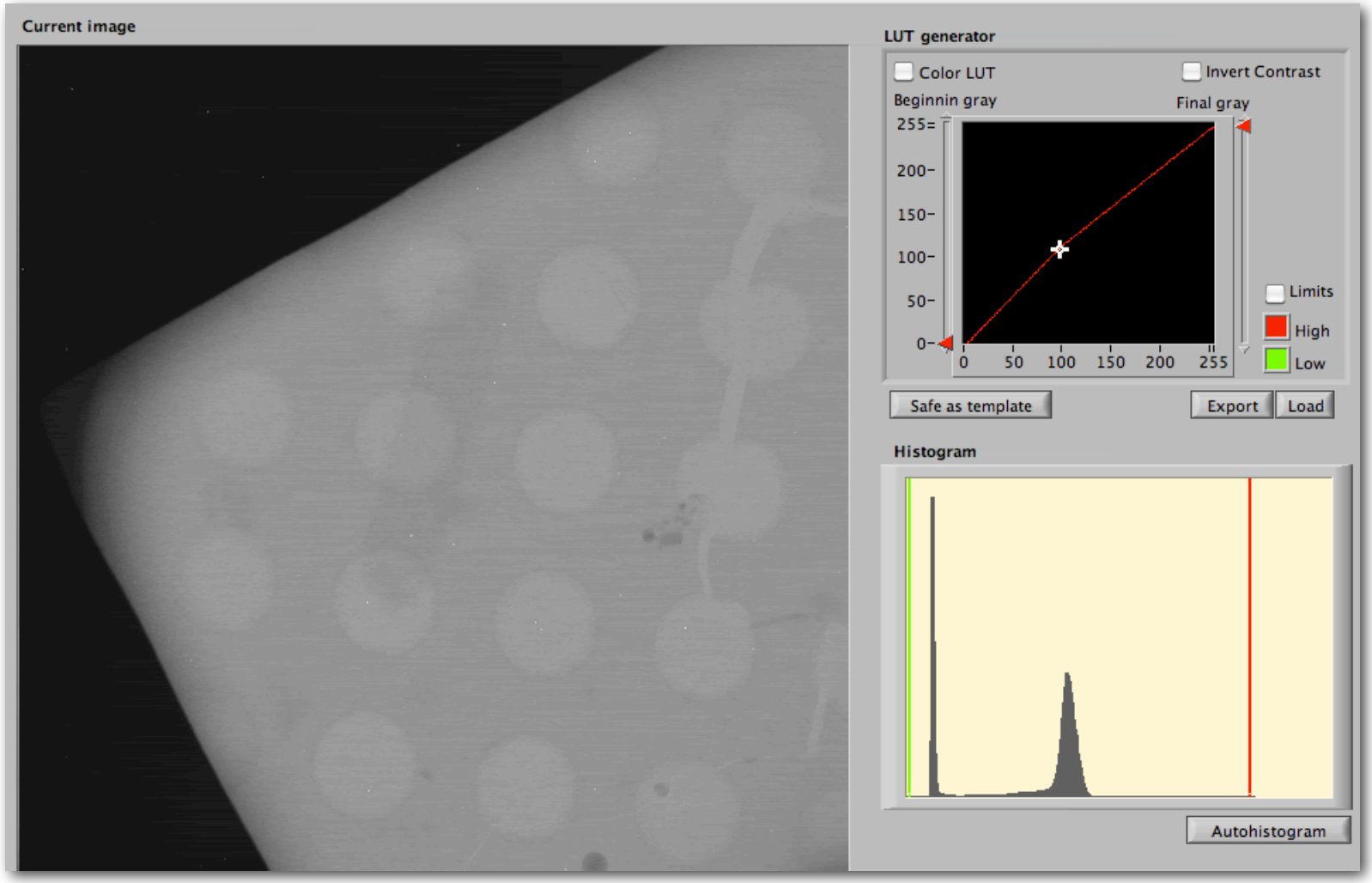
Image



Histogram



Histogram


Current image
LUT generator
Color LUT
Invert Contrast
Beginnin gray
Final gray
255=
200-
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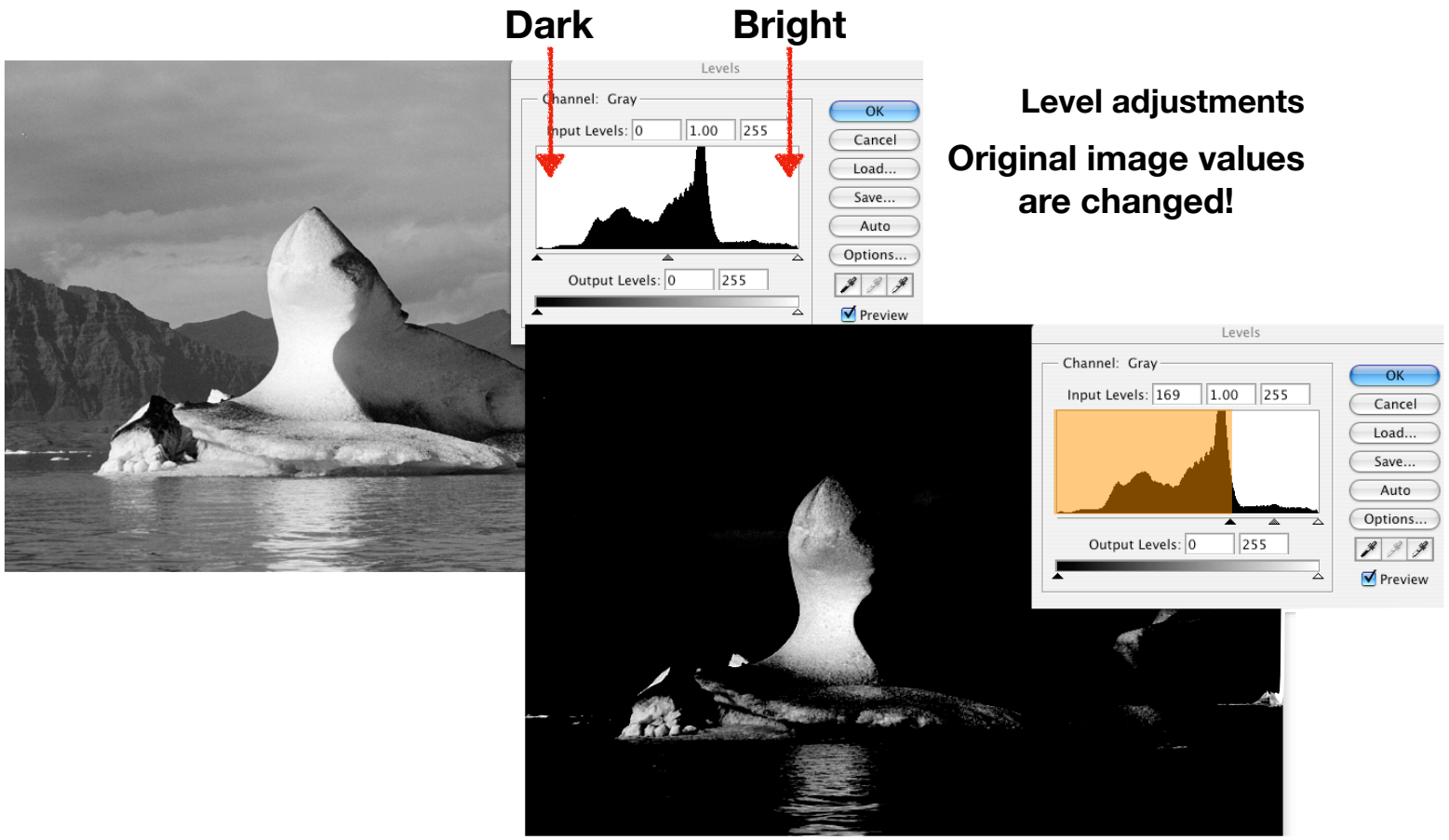
Limits
High
Low
Safe as template
Export
Load
Histogram
Autohistogram

Histogram

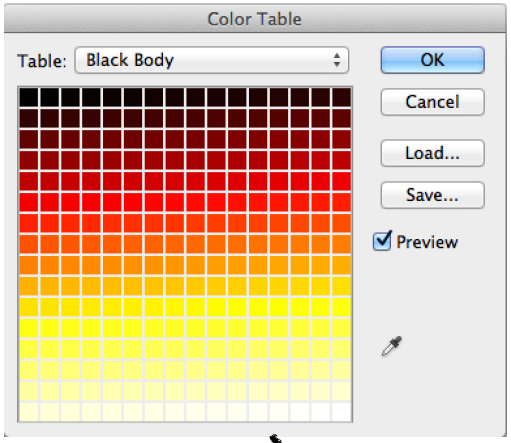


Level adjustments

Original image values are changed!

Look-up tables (LUT)

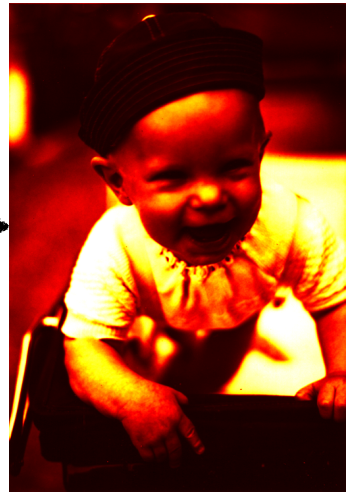
8bit image



LUT

Defines for all grayscale values a color

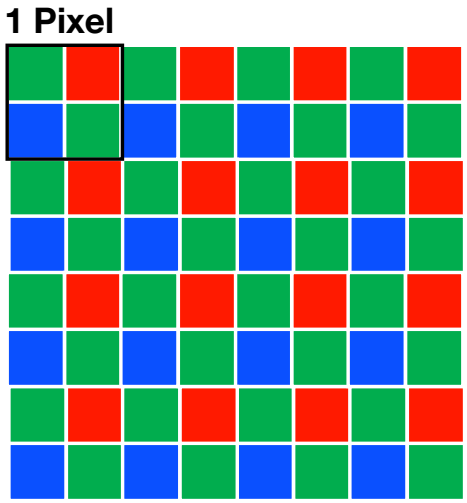
“False color” image



For every pixel value, the color is picked ans image is displayed

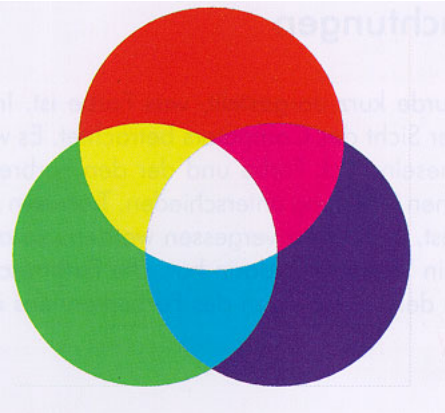
CCD and color:
Bayer pattern

- The CCD is monochromatic: Mostly used like that in science
- To get color images, color-filters in front of the photo-cites
- Most used pattern: Bayer-pattern
- Our eyes are most sensitive to green (more green-sensors)
- RAW format: Saved Bayer pattern



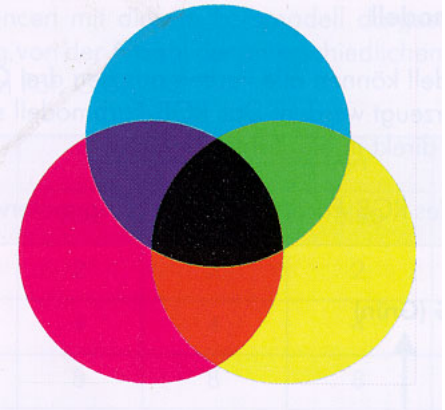
Color models

Bayern RAW color data must be recalculated ("development")



RGB = Red, Green, Blue

Color synchronization: Major problem, has to be calibrated by special software



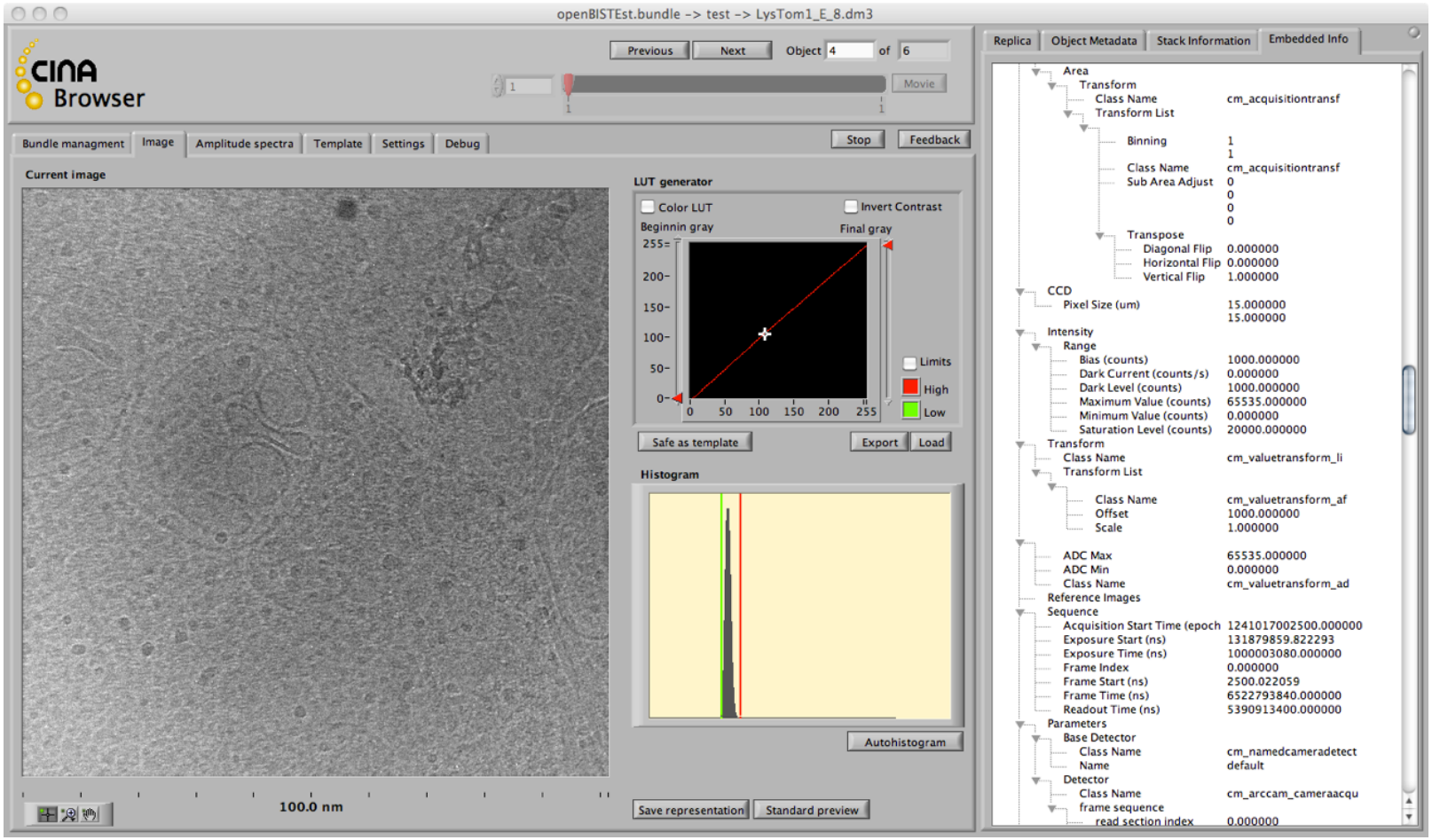
CMYK = Cyan, Magenta, Yellow, blacK

File formats

	RAW	Lossless	Compressed
Format	NEF (Nikon), CRW (Canon), GATAN format...	TIFF, PNG, PSD, DM3	JPG, GIF...
Use	Full information from CCD (Bayer pattern).	Full resolution, 8 bit or 16bit (TIFF) per pixel. Lossless compression (PNG).	Compressed image. Different compression factors. “Endformat”.
+	“Negative”, contains maximum of information	High resolution, “computer friendly” (RGB or CMYK), Portable. Good for image Modifications.	Portable, Small. Ideal as a final format.
-	Large files. Needs a lot of precessing power to handle. Manufacture (Camera) specific.	Large files.	Information is lost. Danger of compression artifacts and moiré patterns.

Workflow

Metadata


openBISTEst.bundle -> test -> LysTom1_E_8.dm3
CINA Browser
Previous
Next
Object 4 of 6
Movie
Bundle managment
Image
Amplitude spectra
Template
Settings
Debug
Stop
Feedback
Current image
100.0 nm
LUT generator
Color LUT
Invert Contrast
Beginnin gray
Final gray
Limits
High
Low
Safe as template
Export
Load
Histogram
Autohistogram
Save representation
Standard preview
Replica
Object Metadata
Stack Information
Embedded Info
Area
Transform
Class Name cm_acquisitiontransf
Transform List
Binning 1 1
Class Name cm_acquisitiontransf
Sub Area Adjust 0 0 0 0
Transpose
Diagonal Flip 0.000000
Horizontal Flip 0.000000
Vertical Flip 1.000000
CCD
Pixel Size (um) 15.000000 15.000000
Intensity
Range
Bias (counts) 1000.000000
Dark Current (counts/s) 0.000000
Dark Level (counts) 1000.000000
Maximum Value (counts) 65535.000000
Minimum Value (counts) 0.000000
Saturation Level (counts) 20000.000000
Transform
Class Name cm_valuetransform_li
Transform List
Class Name cm_valuetransform_af
Offset 1000.000000
Scale 1.000000
ADC Max 65535.000000
ADC Min 0.000000
Class Name cm_valuetransform_ad
Reference Images
Sequence
Acquisition Start Time (epoch 1241017002500.000000
Exposure Start (ns) 131879859.822293
Exposure Time (ns) 1000003080.000000
Frame Index 0.000000
Frame Start (ns) 2500.022059
Frame Time (ns) 6522793840.000000
Readout Time (ns) 5390913400.000000
Parameters
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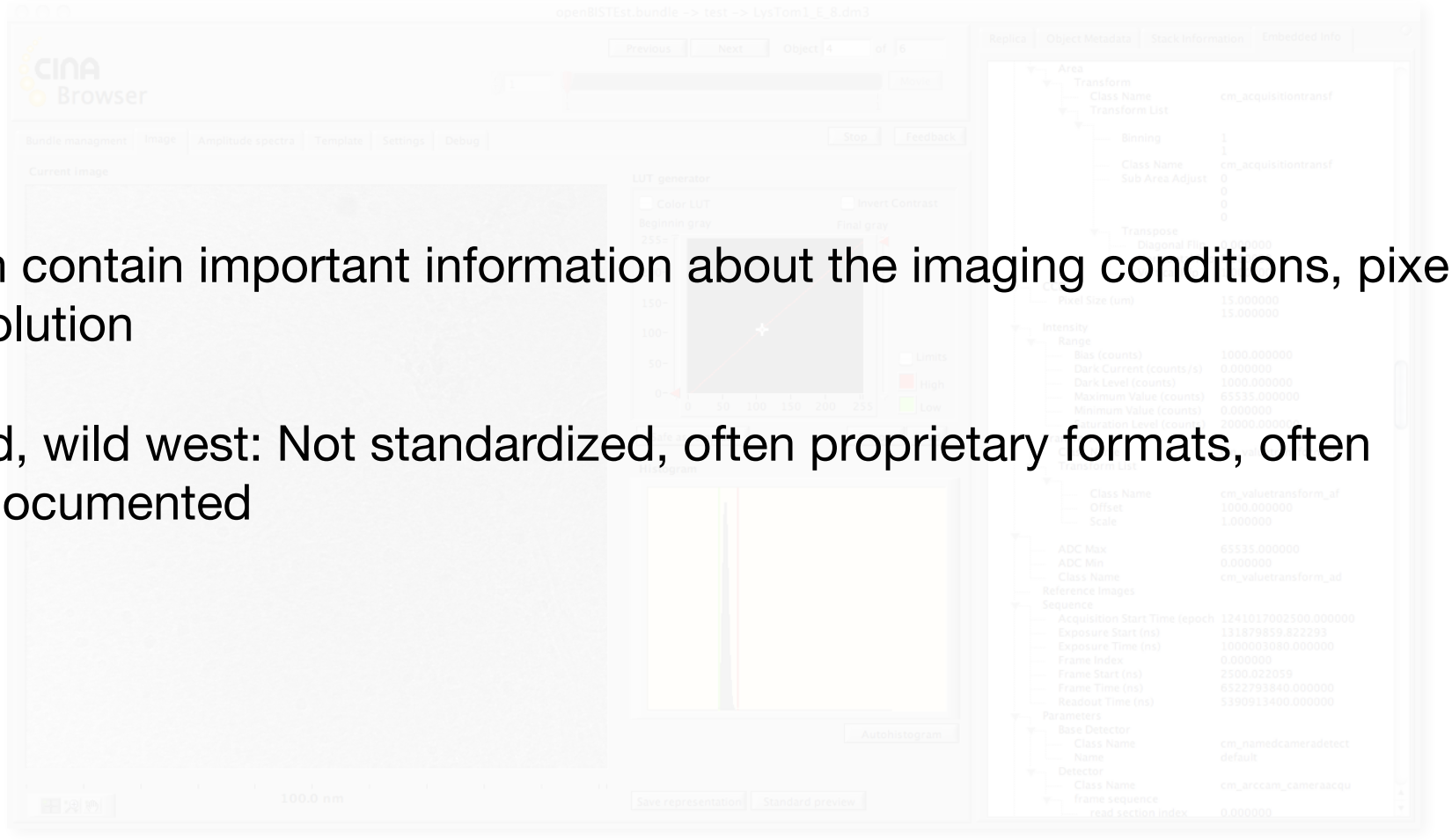
Class Name cm_namedcameradetect
Name default
Detector
Class Name cm_arccam_cameraacqu
frame sequence
read section index 0.000000

Metadata



- Can contain important information about the imaging conditions, pixel resolution
- Wild, wild west: Not standardized, often proprietary formats, often undocumented

Resolution

256 x 256
pixels

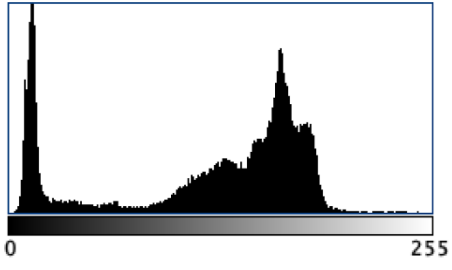
128 x 128
pixels

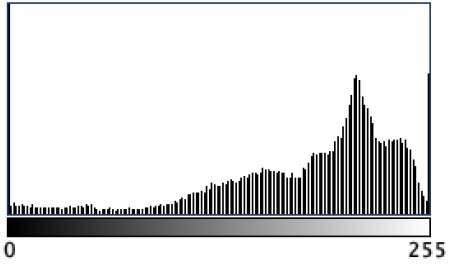
64 x 64
pixels

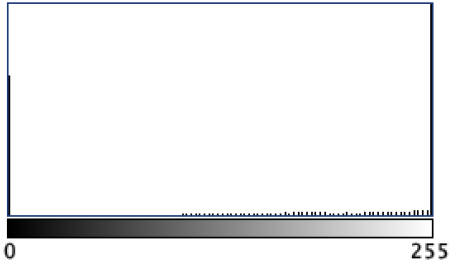
32 x 32
pixels

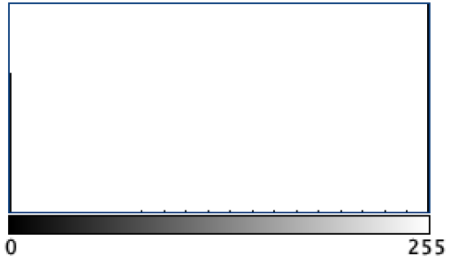
Dynamic range





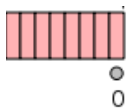




Numbers in bits

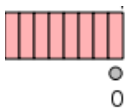
Examples

8bit unsigned integer



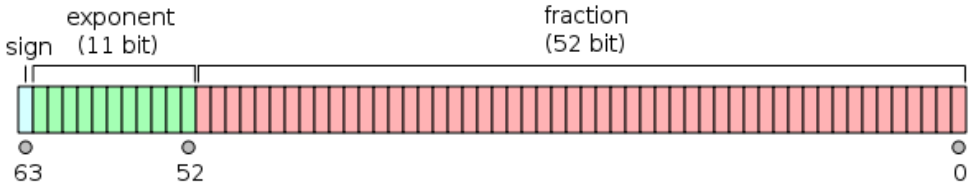
2^8 possible integers
Interpretation: 0..255

8bit signed integer



2^8 possible integers
Interpretation: -127..128

64bit floating point

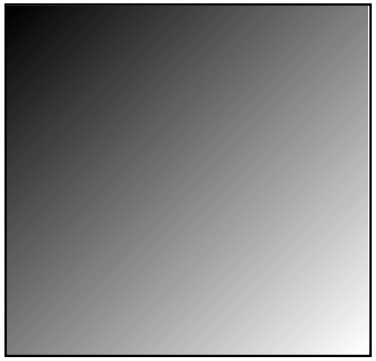


Fraction: approx. 15 to 17 decimal digits precision
Exponent: 10^{-308} to 10^{308}

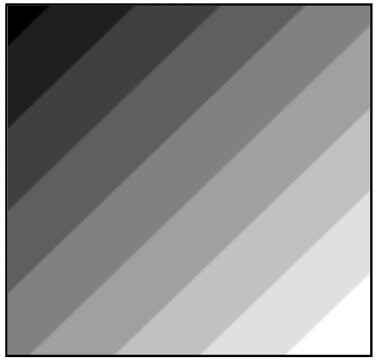
“Memory effects”

Image I has 128x128 pixel

8bit unsigned integer

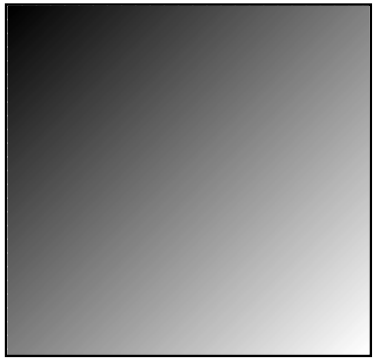


image=x-y

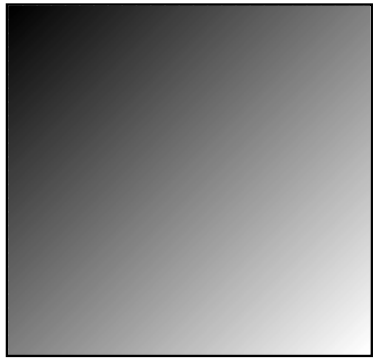


I=(image/30)*30

32bit floating point



image=x-y



I=(image/30)*30