Image Appearance Modeling

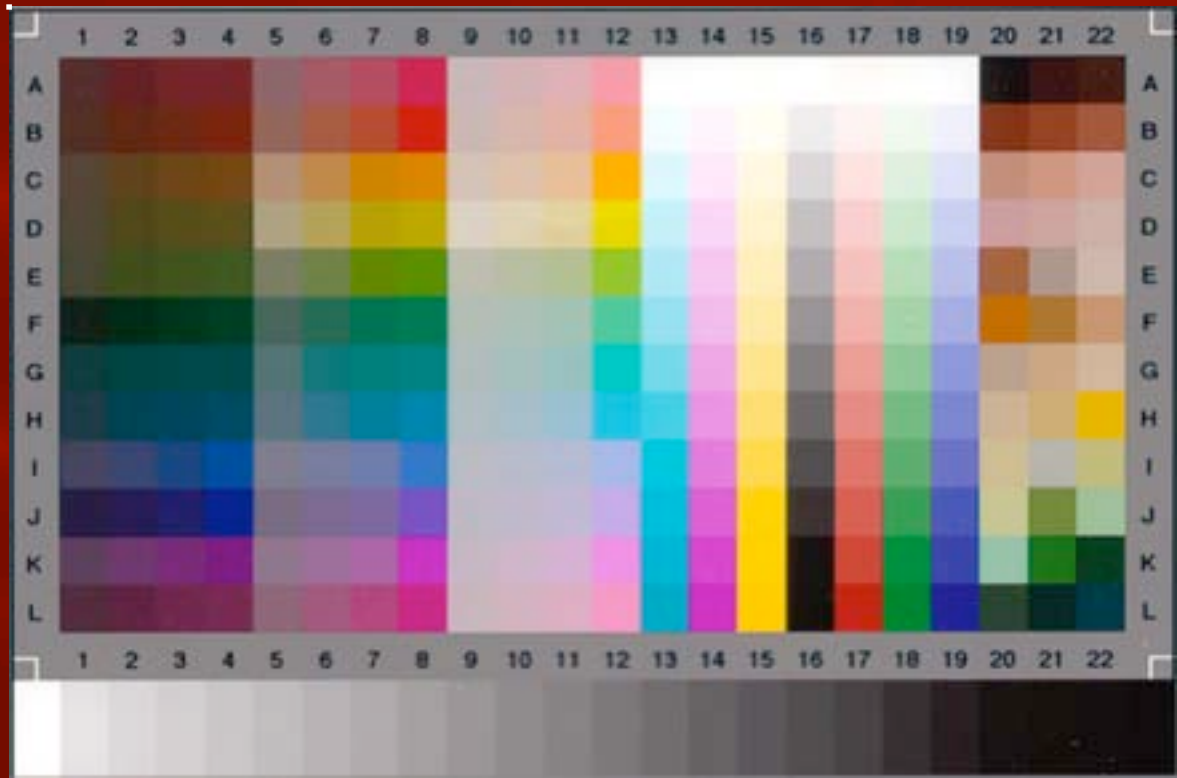
Mark D. Fairchild & Garrett M. Johnson
RIT Munsell Color Science Laboratory
www.cis.rit.edu/mcsl

Outline

- Background
- iCAM
- DV Extension

Image Colorimetry

- Device Dependent
- Device Independent
- Viewing-Conditions Independent



Color Appearance

- Viewing-Conditions Independent
- Spatially Localized

Image Appearance & Quality

- IQ (Thresholds & Magnitudes)
- Combine with Color Appearance

- Get "Image Appearance"

Moving Image Appearance & Quality

- Temporal Adaptation & Filtering

The iCAM Framework

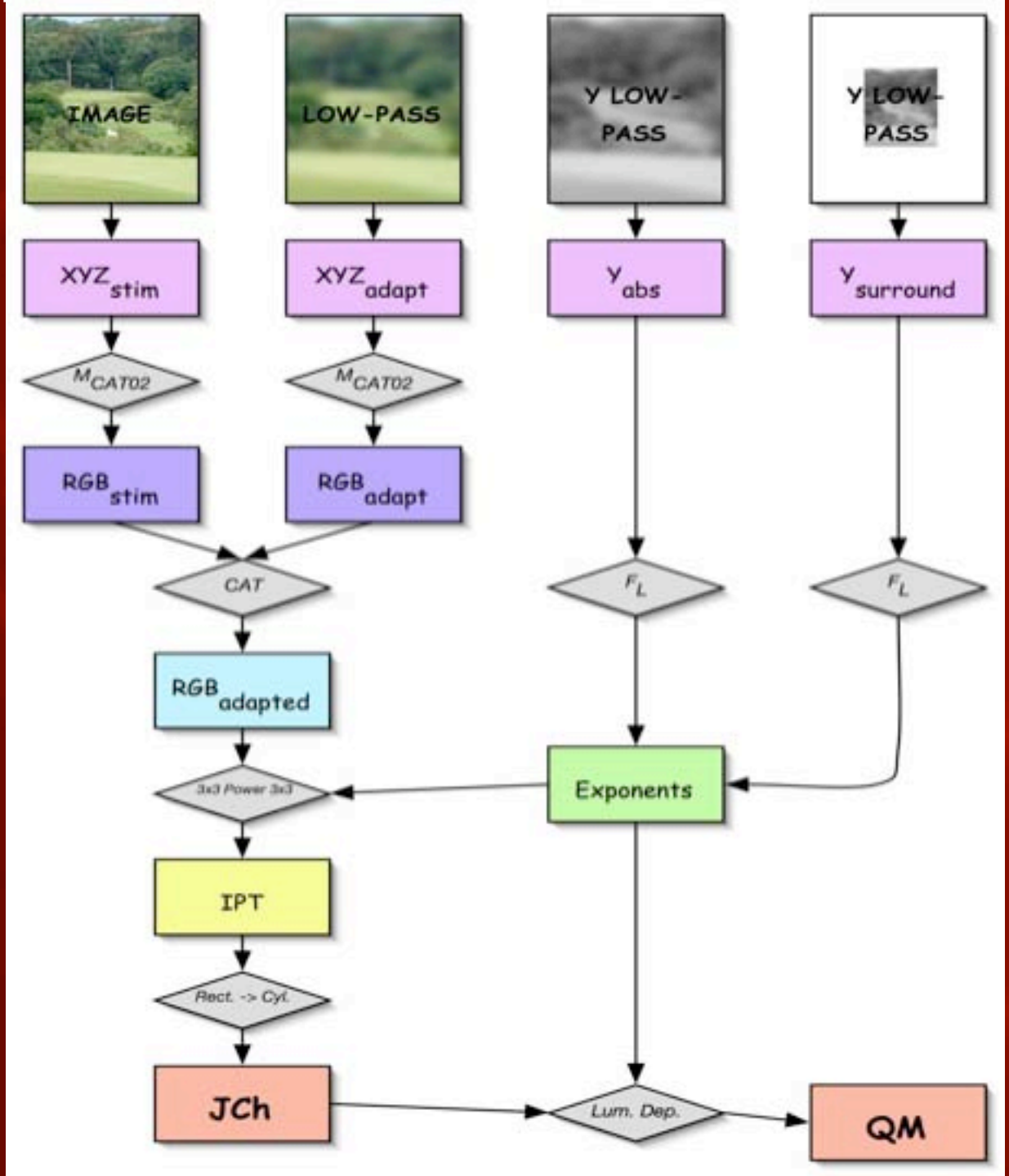
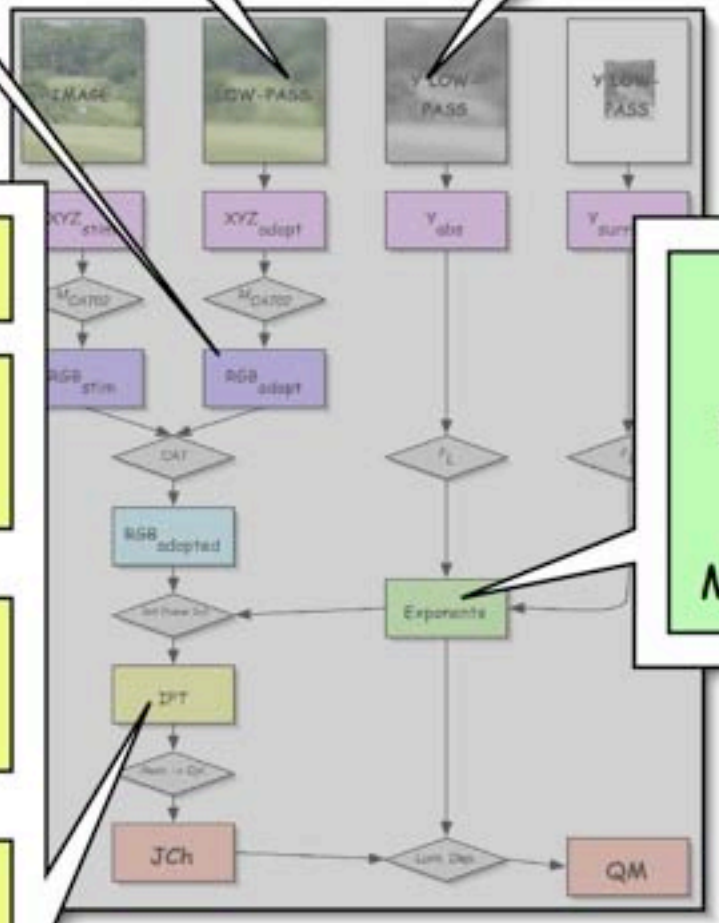


IMAGE
LOW-PASS
Y LOW-PASS
Y LOW-PASS
XYZstim
XYZadapt
Yabs
Ysurround
MCAT02
MCAT02
RGBstim
RGBadapt
CAT
FL
FL
RGBadapted
3x3 Power 3x3
Exponents
IPT
Rect. -> Cyl.
JCh
Lum. Dep.
QM

Image Appearance Applications (Rendering)

Luminance Adaptation Only

Gaussian Low-Pass
2-sigma = 1/4 Image Width
~4 Degrees



INVERSE FOR DISPLAY

IPT to RGB
(fixed exponent)

RGB to XYZ
(fixed adaptation)

XYZ to Display RGB
(characterization)

CIECAM02 F_L Function

Norm. to 1.0 at 1000 cd/m^2
Clipped to Min. of 0.3
Multiplied by IPT Exp. (0.43)

Image Quality Applications

(Difference Perceptibility)

RGB to IPT (linear)

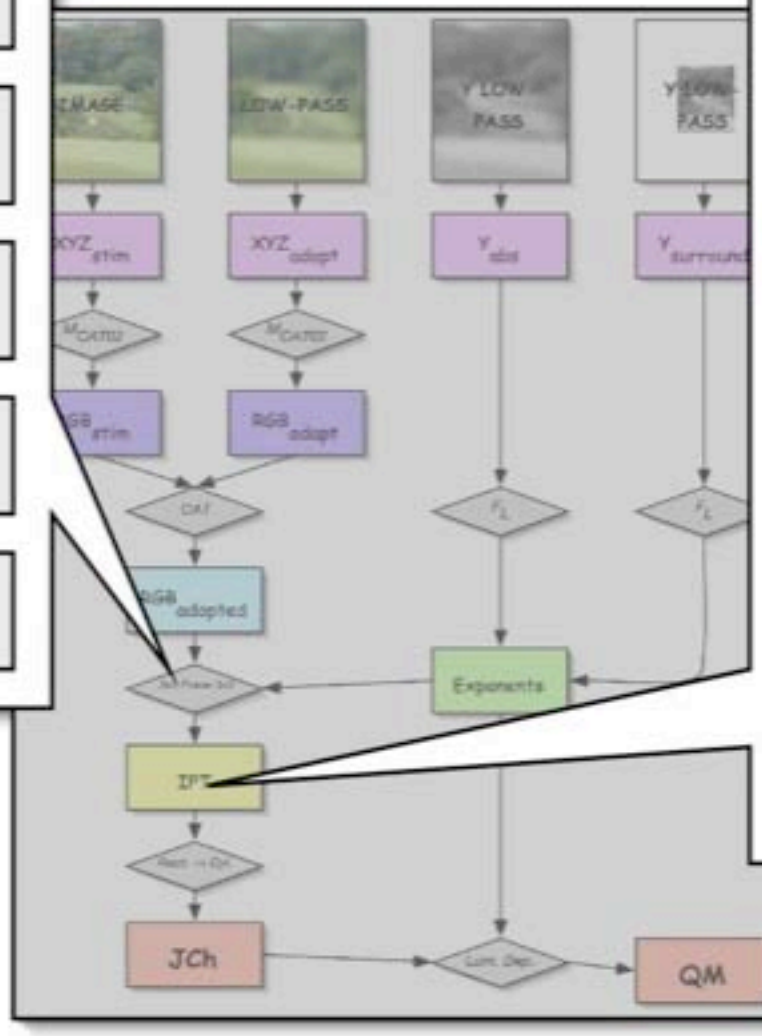
Spatial Filtering

Localization & Local Contrast

IPT (linear) to RGB

Power Functions

RGB (nonlinear) to IPT



ΔI ΔP ΔT

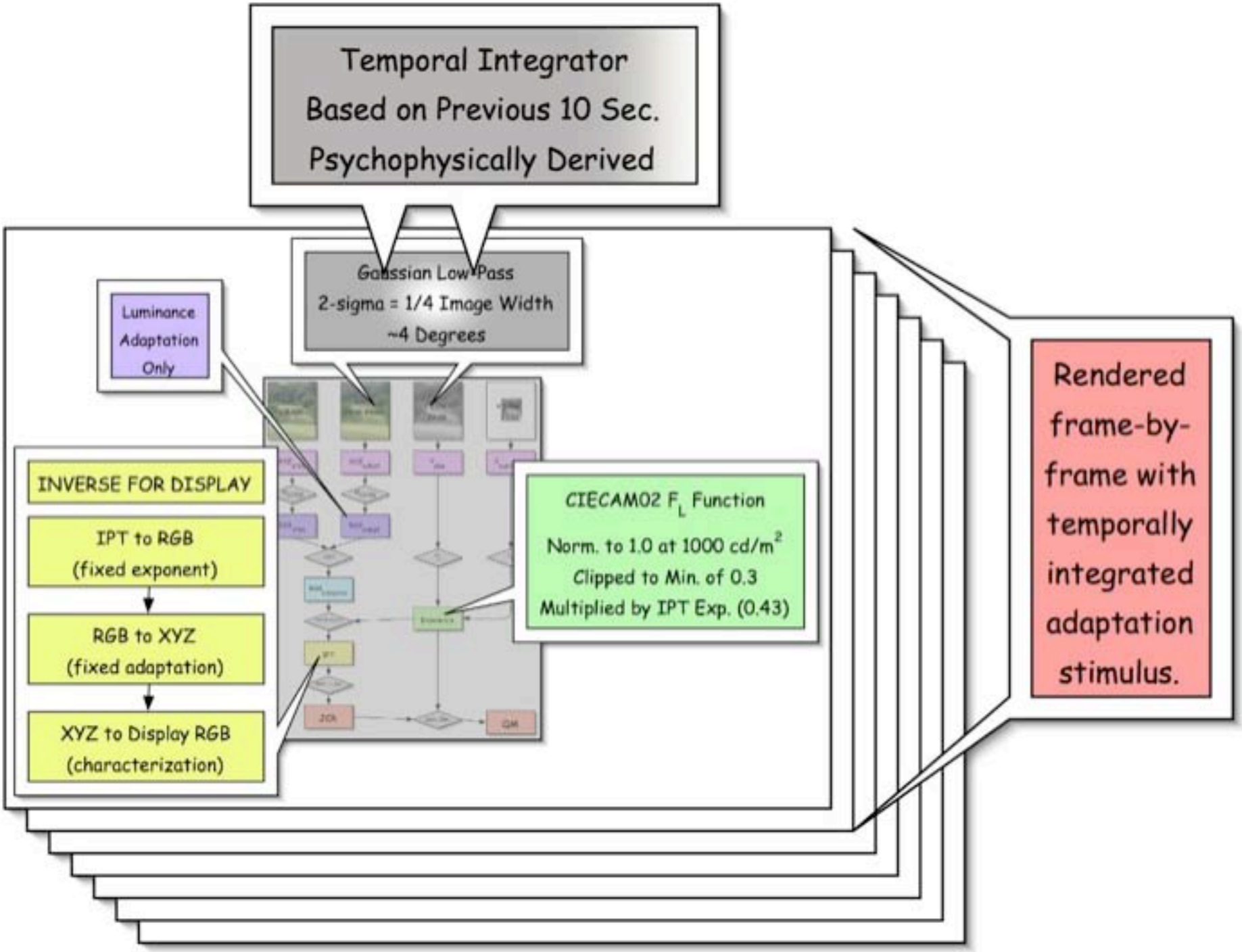
ΔIm = Euclidean Sum

Statistics: Mean, Median, Percentiles, Variance, etc.

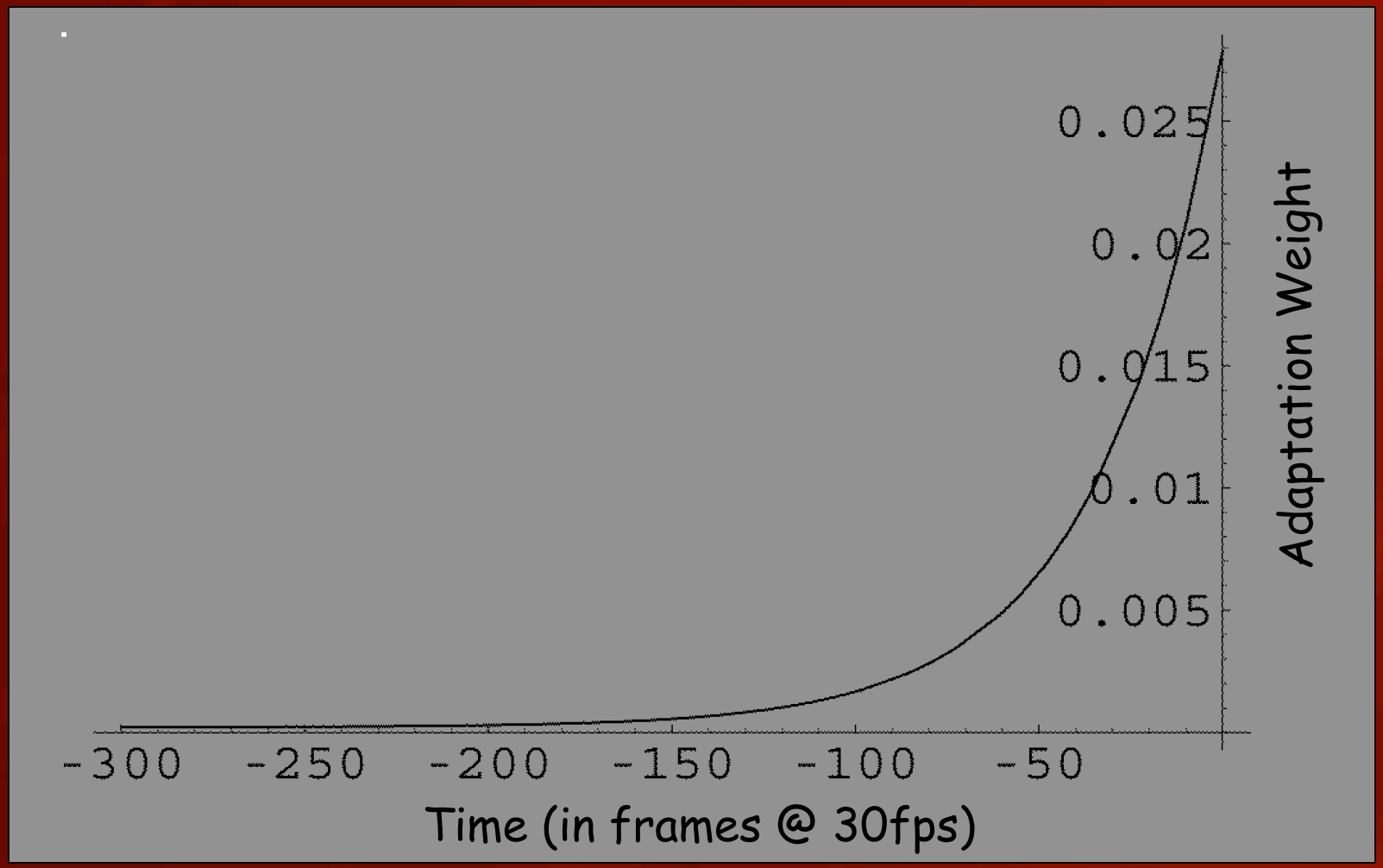
Image Rendering Examples

<www.debevec.org>

Digital Video Rendering

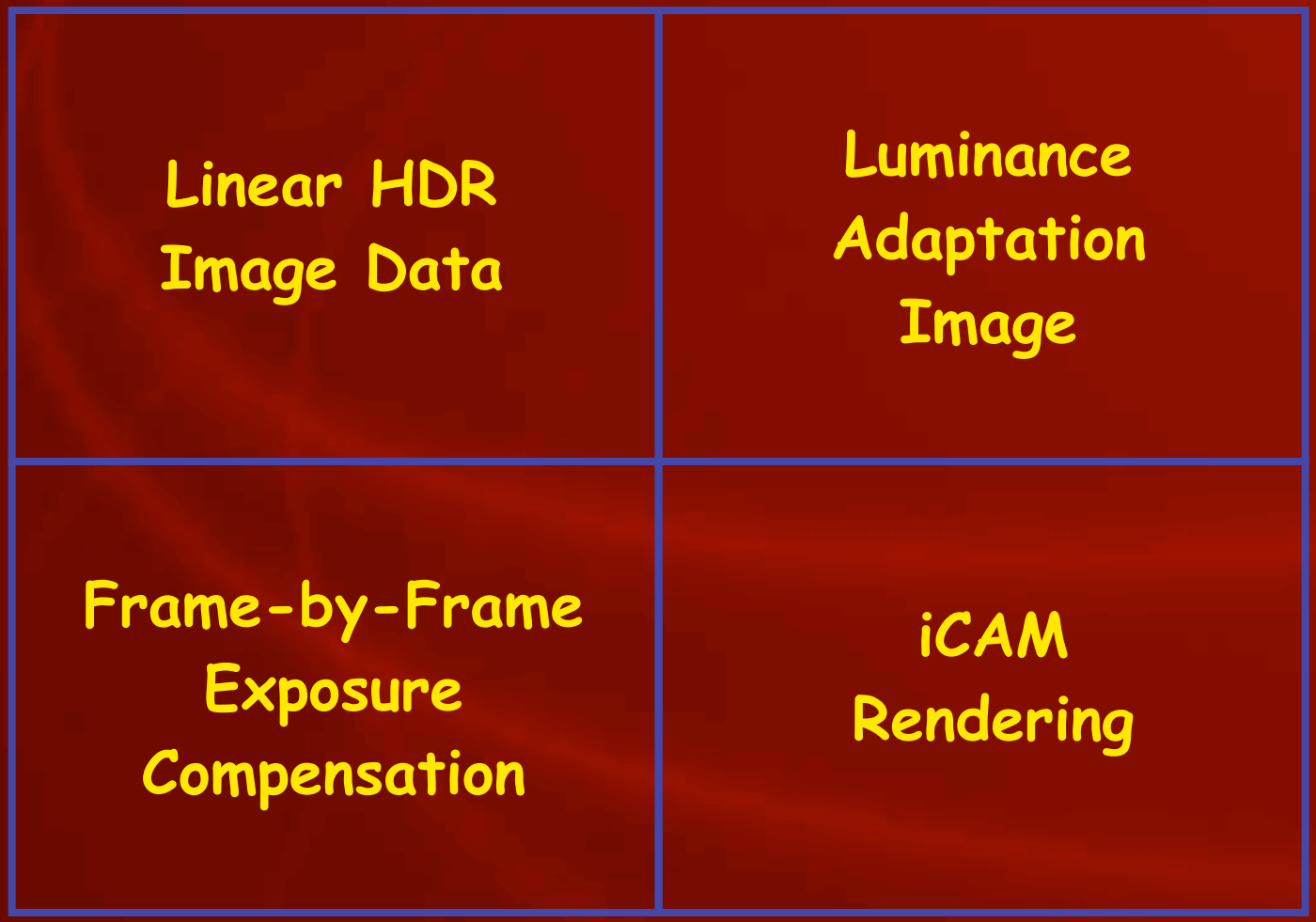

Temporal Integrator
Based on Previous 10 Sec.
Psychophysically Derived
Gaussian Low Pass
2-sigma = 1/4 Image Width
~4 Degrees
Luminance
Adaptation
Only
INVERSE FOR DISPLAY
IPT to RGB
(fixed exponent)
RGB to XYZ
(fixed adaptation)
XYZ to Display RGB
(characterization)
CIECAM02 F_L Function
Norm. to 1.0 at 1000 cd/m^2
Clipped to Min. of 0.3
Multiplied by IPT Exp. (0.43)
Rendered
frame-by-
frame with
temporally
integrated
adaptation
stimulus.

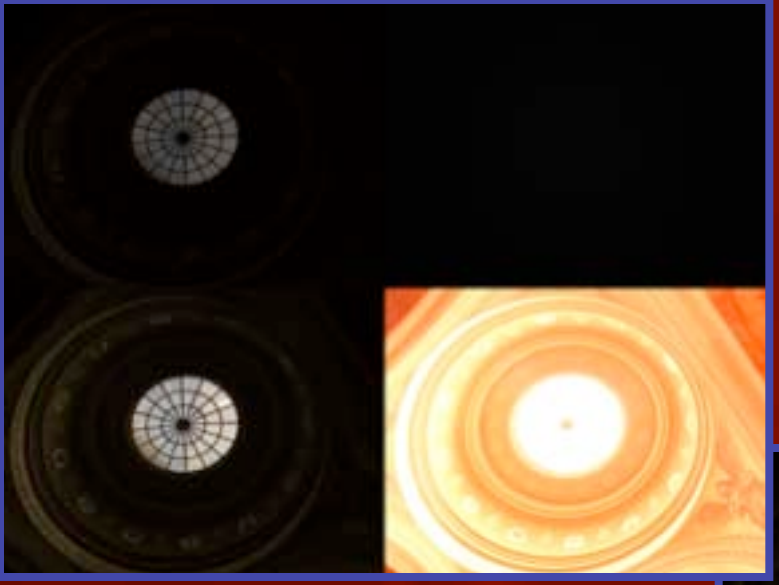
Temporal Integrator

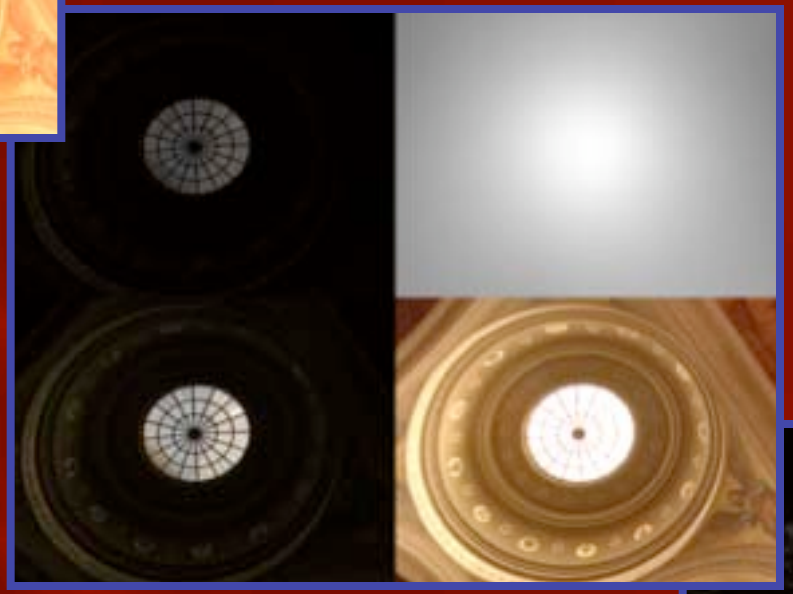


Fairchild & Reniff (1995)

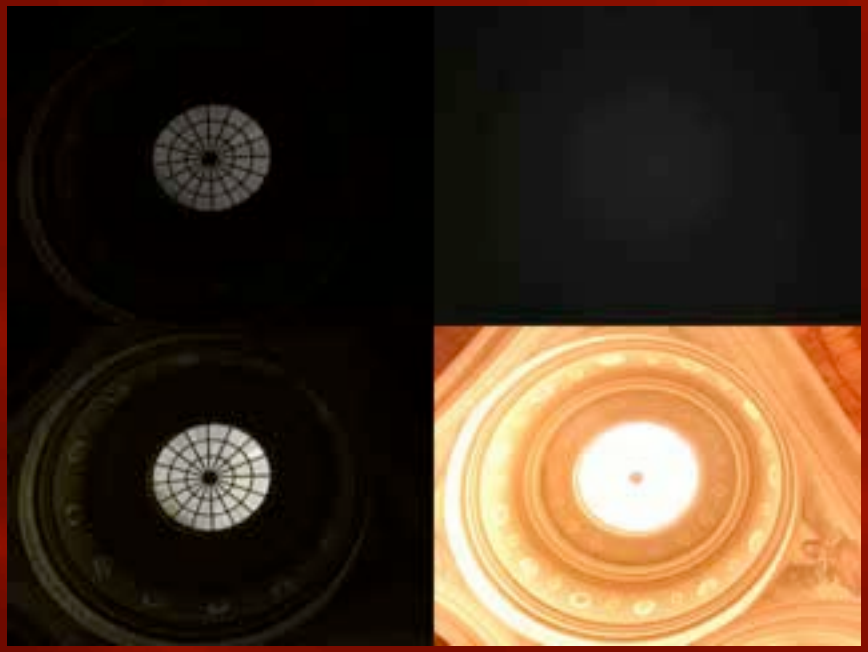
Example Frames







Example Video Sequence



Conclusions

- **Ingredients**
  - Color Appearance Model
  - Spatial Adaptation & Filtering Models
  - Temporal Adaptation & Filtering Models
  - Image Difference Metrics
- **Results**
  - Still & Video Rendering Algorithms
  - Still & Video Quality Metrics

Thank You.

Fuji, Kodak, IBM

<www.cis.rit.edu/mcsl/iCAM>