



D-ILA Cinema Technology:
Color Management Issues and Techniques

D-ILA™

The Technology for
IMAGES OF PERFECTION

Rod Sterling

JVC ILA Technology Group

Outline

- Color Management Issues
- Color Management Techniques
 - **D-ILA** Device
 - **D-ILA** Projector
 - Future Developments
- Summary

Color Management Issues

- Color Gamut
- Dynamic Range – Contrast Ratio
- Quantization / Gradation
- Data Processing
- White point
- Color Tracking

Color Management Issues

- Gamma
- Color of Black – 0 Video level
- Digital Interfaces
- Stability
- Non-linear effects

Color Management Techniques

- Proprietary **JVC D-ILA** LCOS Light Engine
 - Analog Vertically Aligned Liquid Crystal Device
 - Digital Backplane
 - Ultra High Resolution

Color Management Techniques

- JVC QX-1 Digital Projector
 - Large color Gamut
 - Digital Input and Processing
 - 10 bit input / 12 + bit Processing
 - High Contrast Optical System
 - High Light Levels and Stable
 - Pelletier Cooler

QXGA D-ILA Device

- 2048 x 1536 pixels
- 1.3" diagonal (4:3)
- Contrast ratio >



D-ILA Features

- ★ High Brightness & High Resolution
- ★ High Contrast Ratio
- ★ Analog Gradation
- ★ High-speed Response for Motion Pictures

- Reflective LCOS
- High Aperture Ratio
- Vertical Alignment Liquid Crystal
- No Spacer Configuration

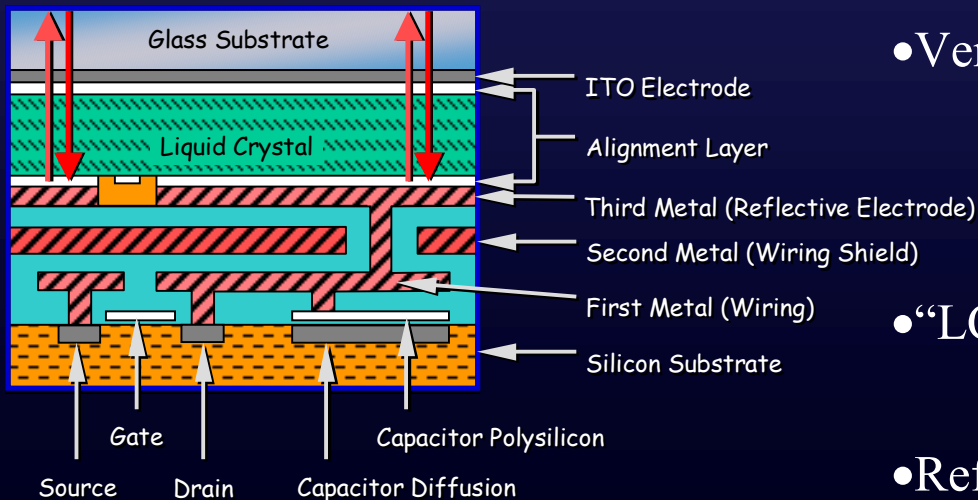
- Film-like High Picture Quality

- Advancing Device

- Higher resolution
- Downsized
- Higher efficiency
- Lower cost

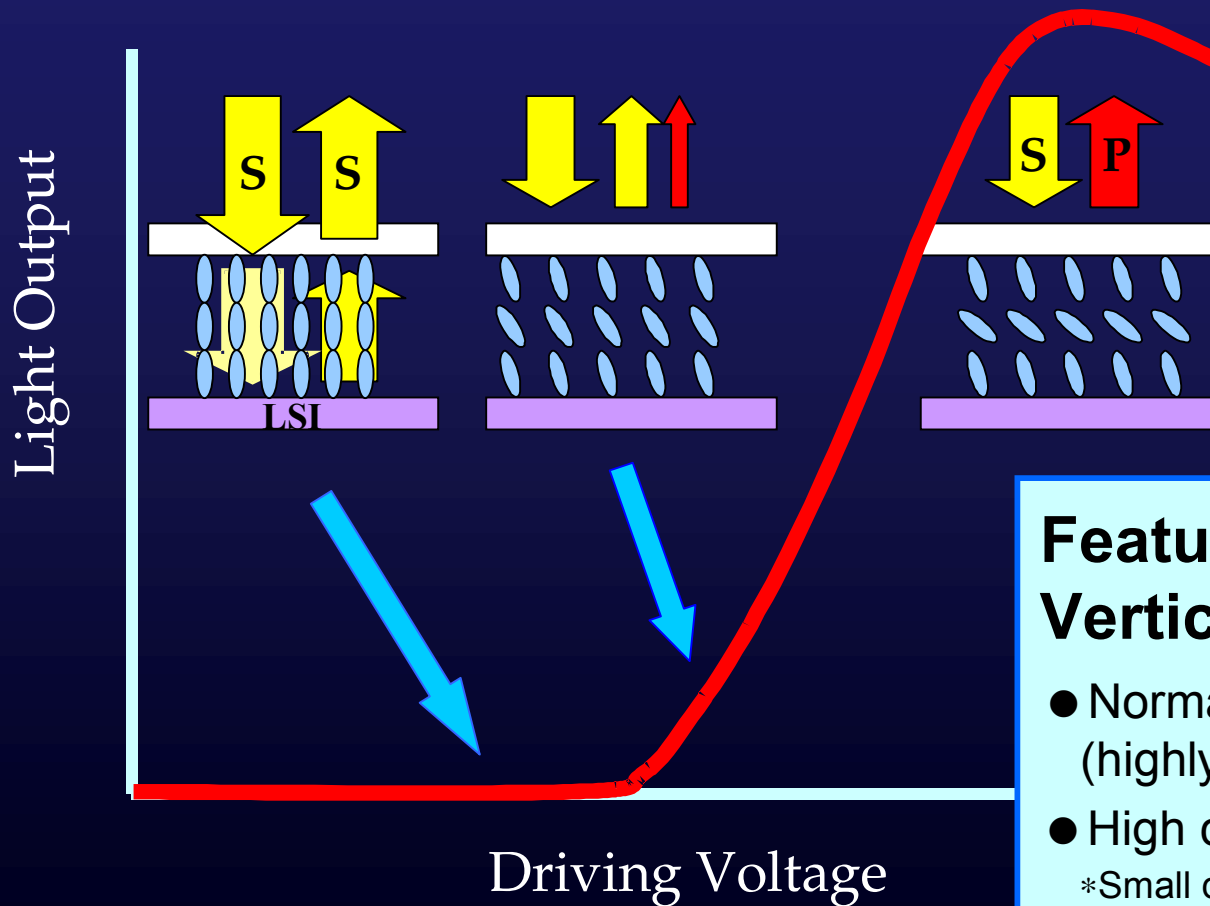
D-ILA Technology

- Highest resolution, exceeding 2048 x 1536 (*3860 x 2048 Demonstrated at SIGGRAPH 2001*)
- Highest density resulting in highest aperture ratio (93%) with least pixel gap for “Images Smooth as Silk”



- Vertically aligned (“homeotropic”) liquid crystal structure delivering higher contrast ratio of more than 1500:1
- “LC Fringing Effect” minimizes sharp edge on pixels for “Smooth Look”
- Reflective design for high brightness and durability

Vertically Aligned Liquid Crystal



Features of Vertical-alignment LC

- Normally-black Operation (highly controllable for black)
- High contrast Ratio
 - *Small dispersion at any wave length
 - *Small dependence on the light angle
- High-speed Response

Conceptual Image of Resolutions

QXGA 3.2M

2048×1536

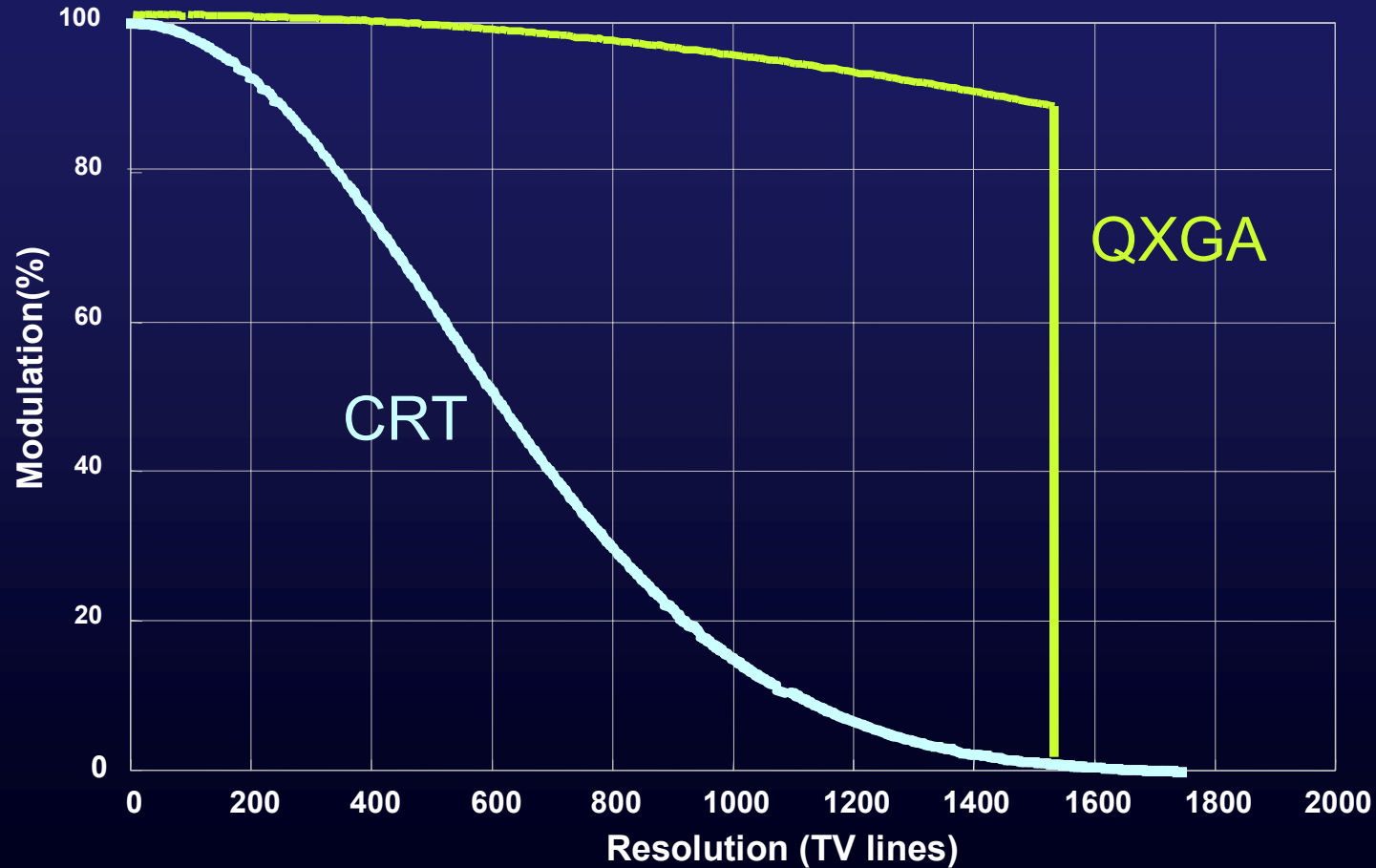
HDTV 2.1M

1920×1080

SXGA 1.4M

1365×1024

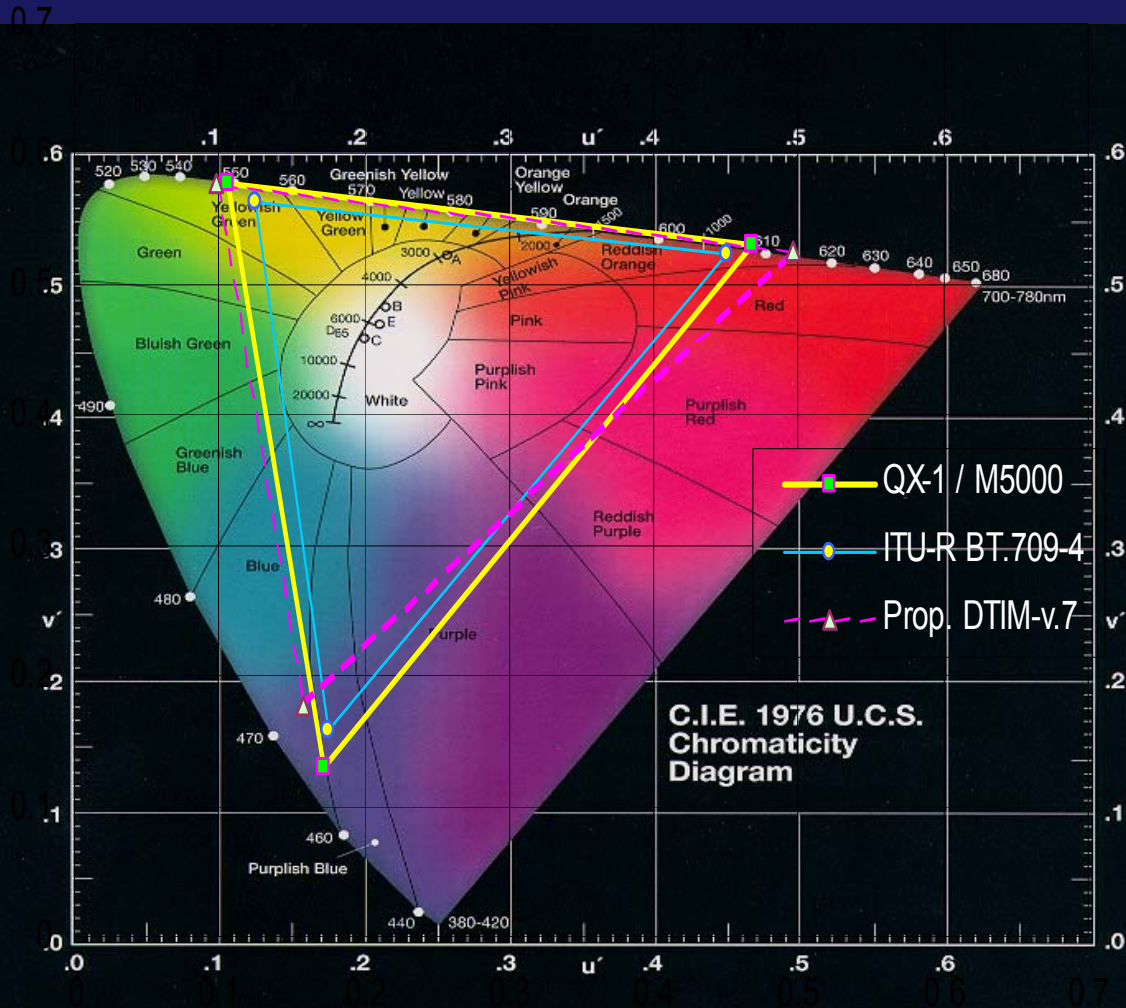
Spatial Frequency Response



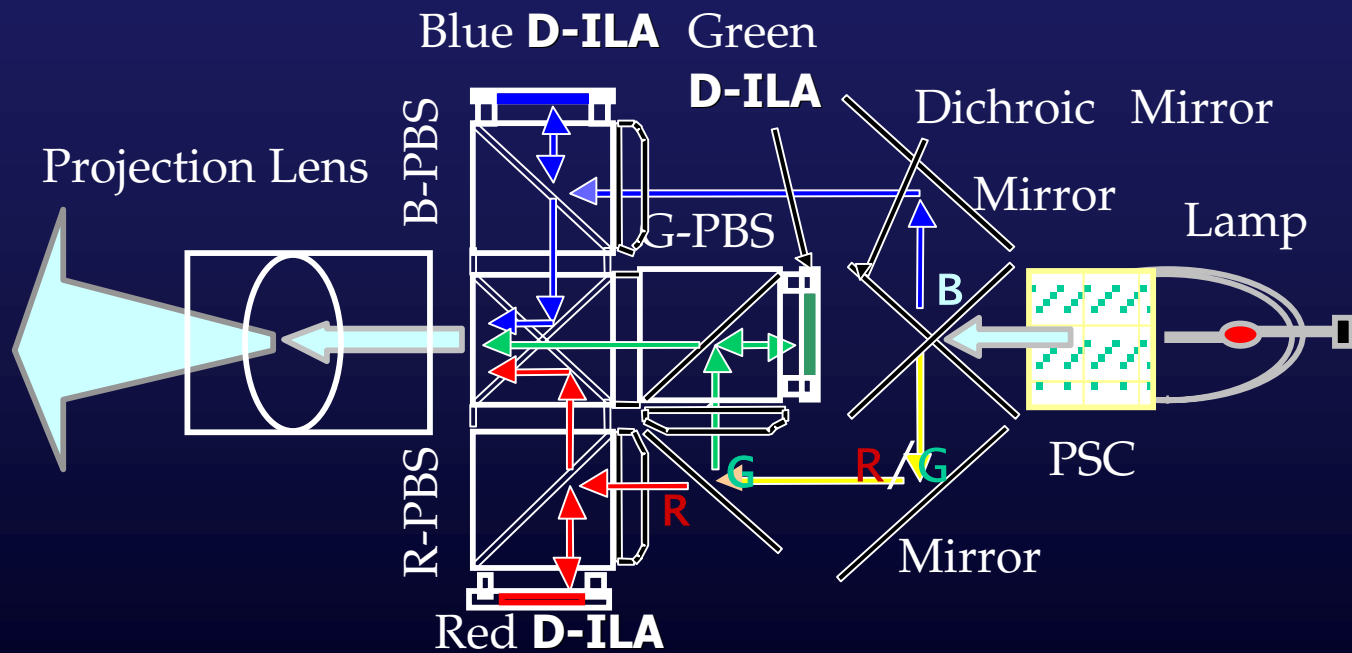
QX-1 **D-ILA** Projection Technology

- Color Gamut exceeds Rec. 709
- High Contrast Optical System
- Analog Gray Scale Gradation
 - Low S/N Black Level Detail
- 12 + bit Signal Processing
- Adjustable White Point – Choose one

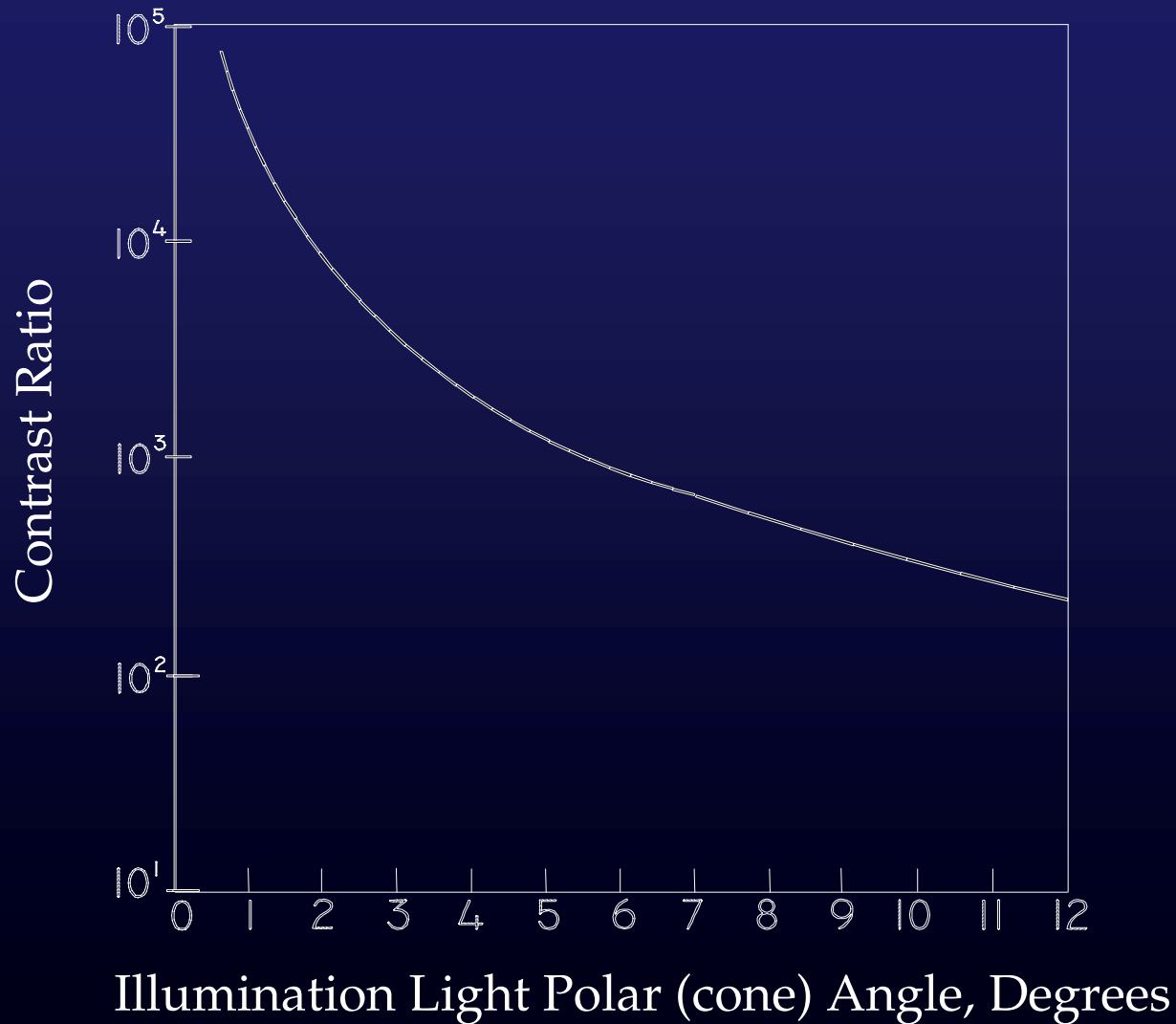
QX-1 / M5000 Color Gamut



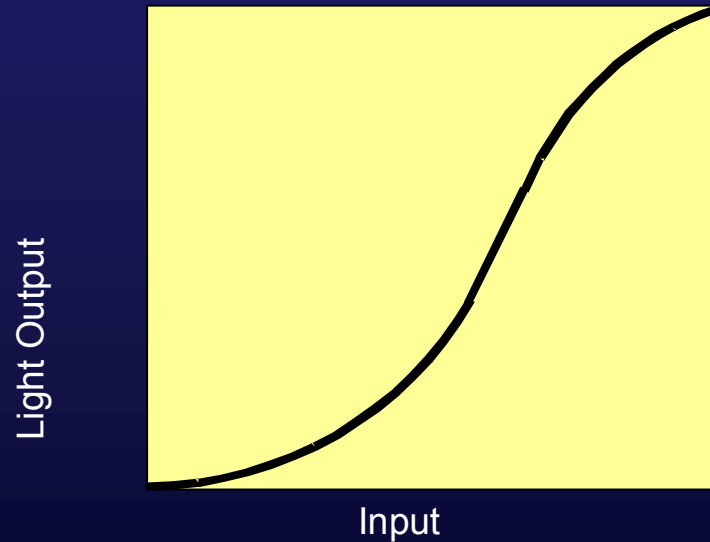
Optical System of **D-ILA** Projector



Theoretical Sequential Contrast Ratio



D-ILA Gamma Characteristic

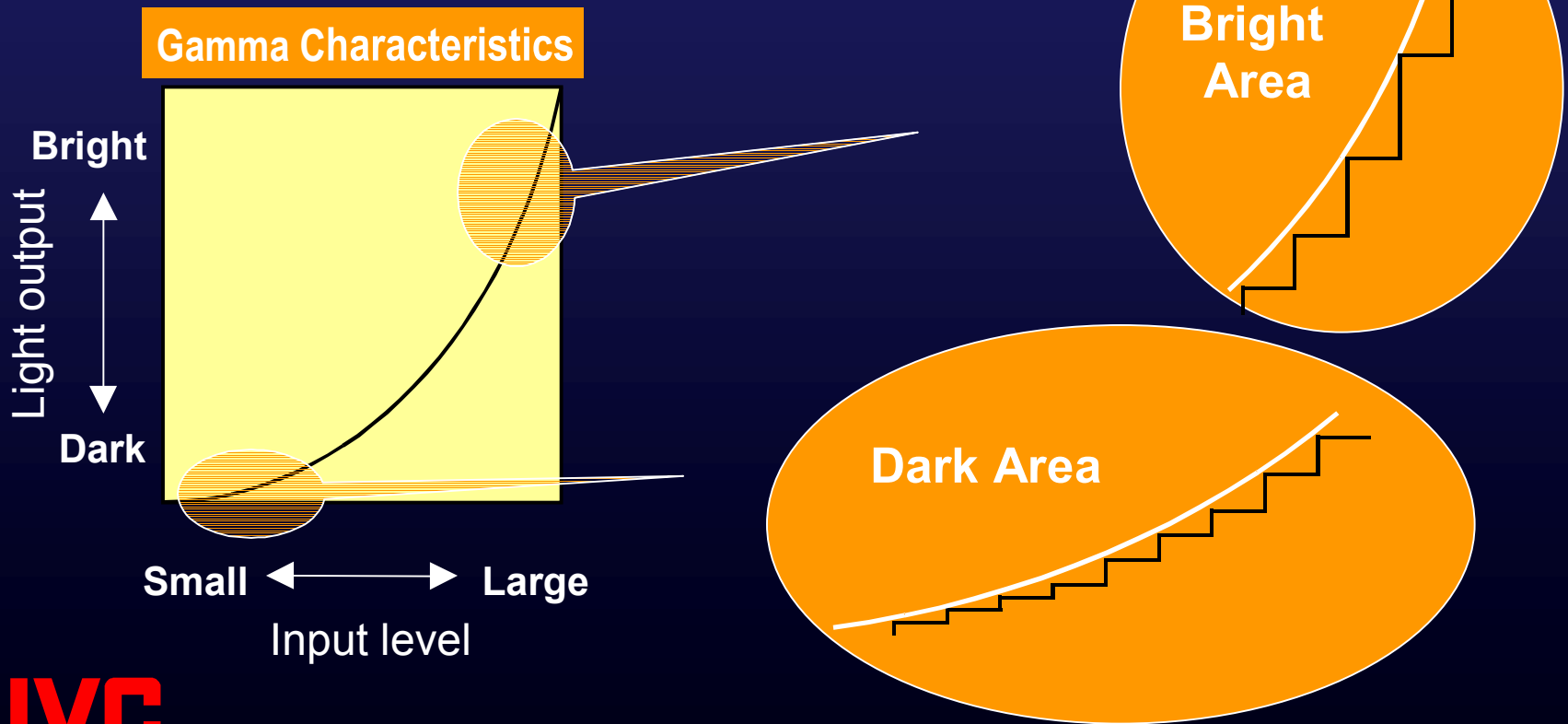


S-shape Characteristics

Device has a Non-linear Characteristics
Compressed in Dark Area and Expanded in Bright Area.

Gamma Processing and Gradation Reproduction

To Reproduce Dark Areas,
Bit Accuracy Is Required.

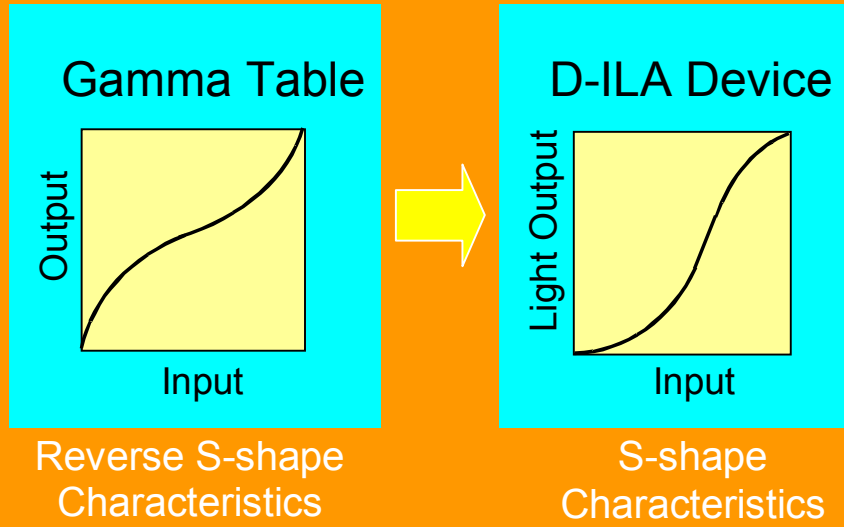


Black Level Detail with Analog Gradation

Analog Gradation

Favorable Reproduction
in Theory for Dark Areas

D-ILA Projector



Expansion Processing
for Dark Area

Margin for
Bit Accuracy

Continuous Light
Output

Large S/N
in Even Dark Areas

Error Diffusion in Digital Gradation

What can we do about insufficient bit accuracy?

Answer: At a cost to the S/N, more detail tone can be reproduced.

Error Diffusion

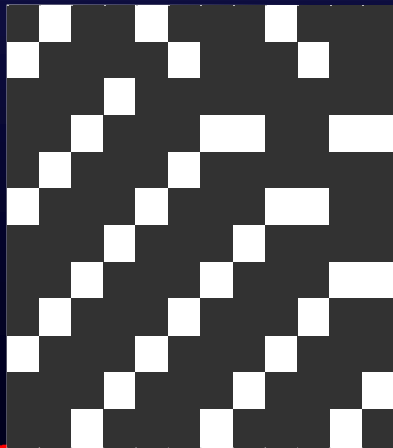
- ★ Spatial processing
- ★ Temporal processing

Deterioration of S/N in Dark areas

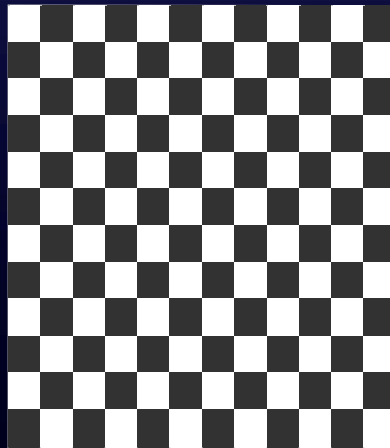
In Motion pictures

At Movement of viewing point

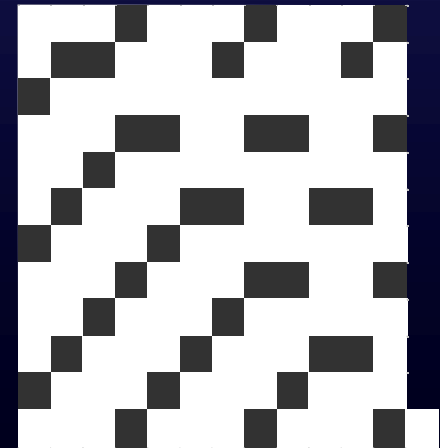
0.25



0.5



0.75

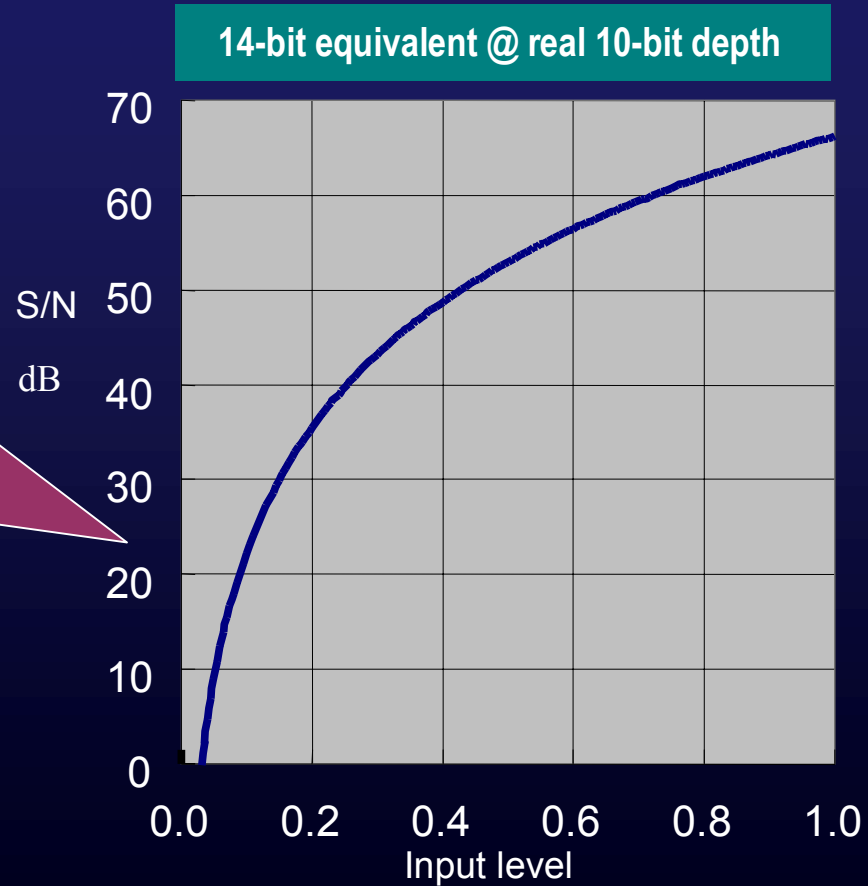


JVC

Examples processed by Error Diffusion with "0" and "1".

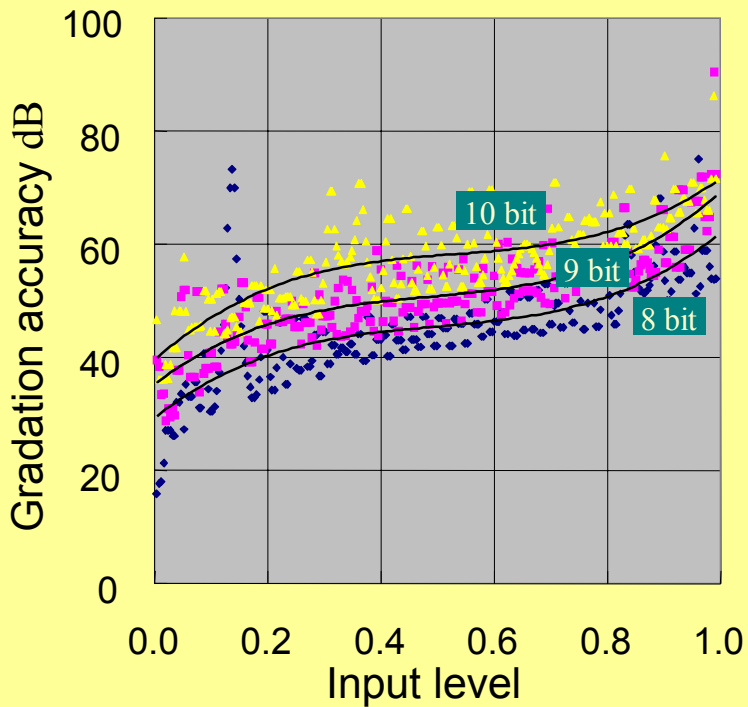
Digital Gradation Deterioration of S/N due to Error Diffusion

S/N
Deteriorates
Suddenly
Under 20%
Dark Levels.

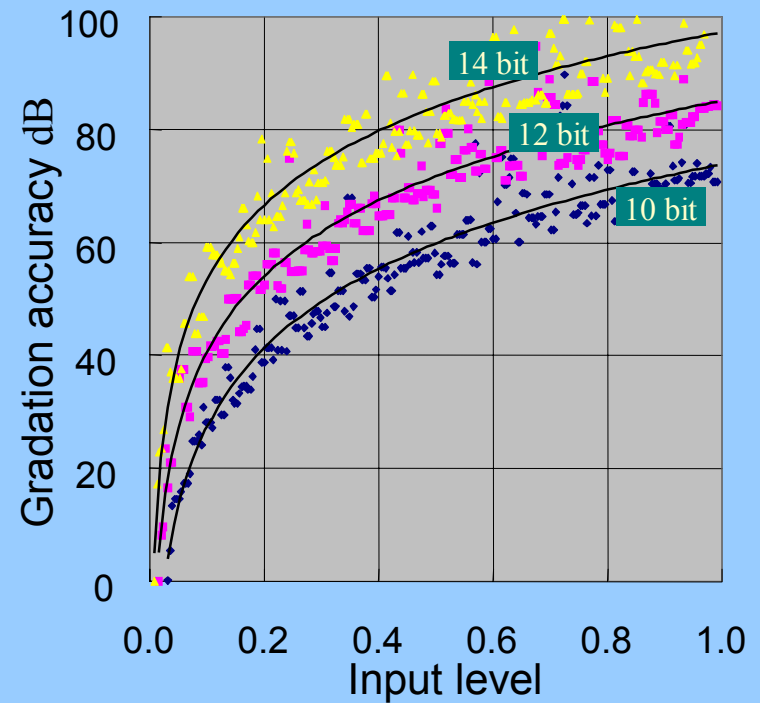


Analog vs. Digital Black Levels

Analog Gradation



Digital Gradation



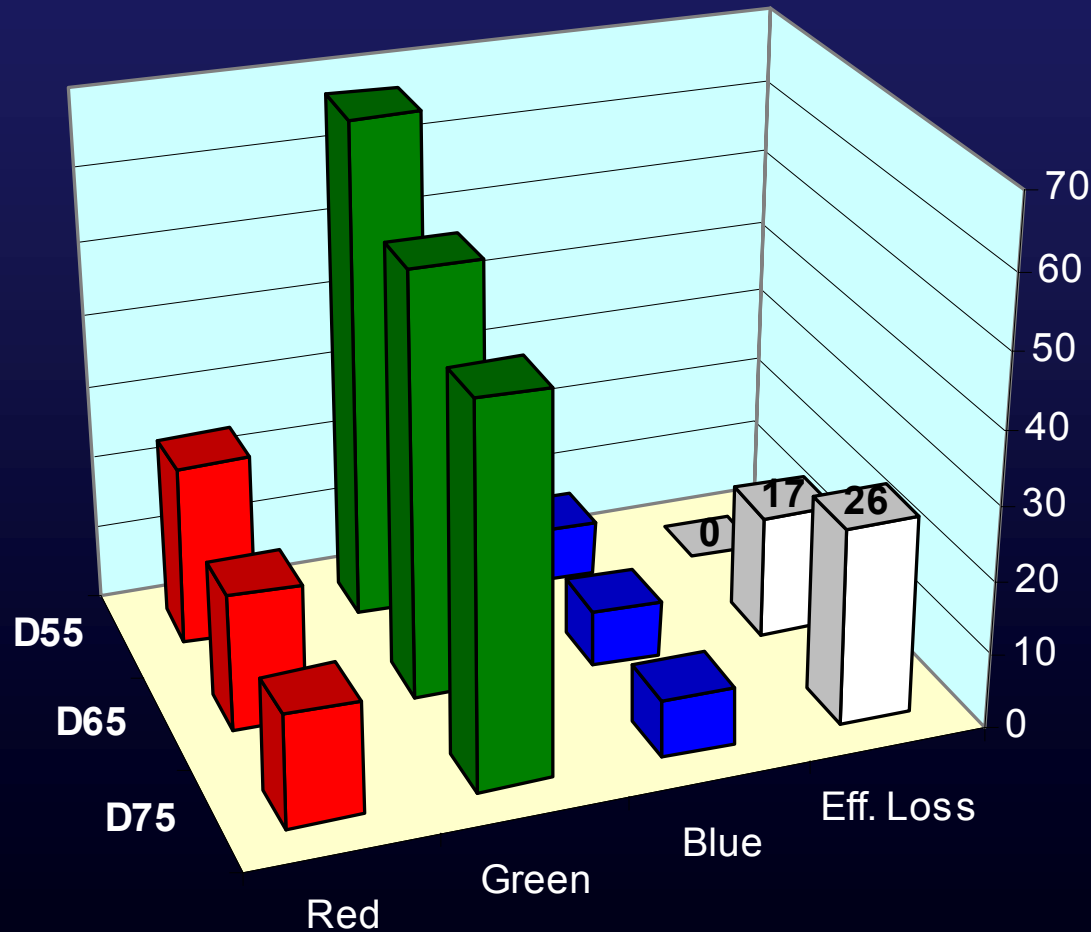
QX-1 **D-ILA** Projector Gamma

- 12 Bit gamma Look Up Tables (LUT)
- 3 Programmable LUT for different profiles and color temperatures
- Ability to adjust 0 video level to same Color Temperature as White

White Point

- In Digital Projection, the White point is adjustable and can even account for screen
- While Blue is typically the limiting color in a birefringent system, the Optical System can be Optimized for almost any White Point
- Need to specify for final projector to Optimize Efficiency

Effect of White Point on Efficiency with Constant Blue Output



Projector Interfaces

- Currently, SMPTE 292M and 374M Dual Link Interface for 1920 x 1080 Picture Raster (proposed), meet DTIM 0.7 proposal
- Interface for QX-1 resolution at 10/12 bit color depth still needs to be resolved

Future Projector Issues

- User Downloadable 3-D LUTs for color mapping
- Improved Red color Gamut
- Further Improve Contrast Ratio
- 10K – 15K Lumens
- Improved Small Area Contrast
- Continue to listen to the Community and SMPTE groups for guidance

D-ILA High-quality Picture Technology

Advanced LCOS Technology
& Precision Optics

Film-like
picture

High Brightness
& High Resolution

High Aperture Ratio,
High Density
Reflective Device

Real Resolution with
Near Invisible Pixels

High Contrast Ratio

Vertical Alignment
Liquid Crystal,
Normally Black

Clear & Sharp
Picture

Analog Gradation

High Bit Accuracy,
Dark Tone
Reproduction
with High S/N,
High-speed Response

Smooth & Noiseless
Motion Picture

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JVC QX-1 2K Projector



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