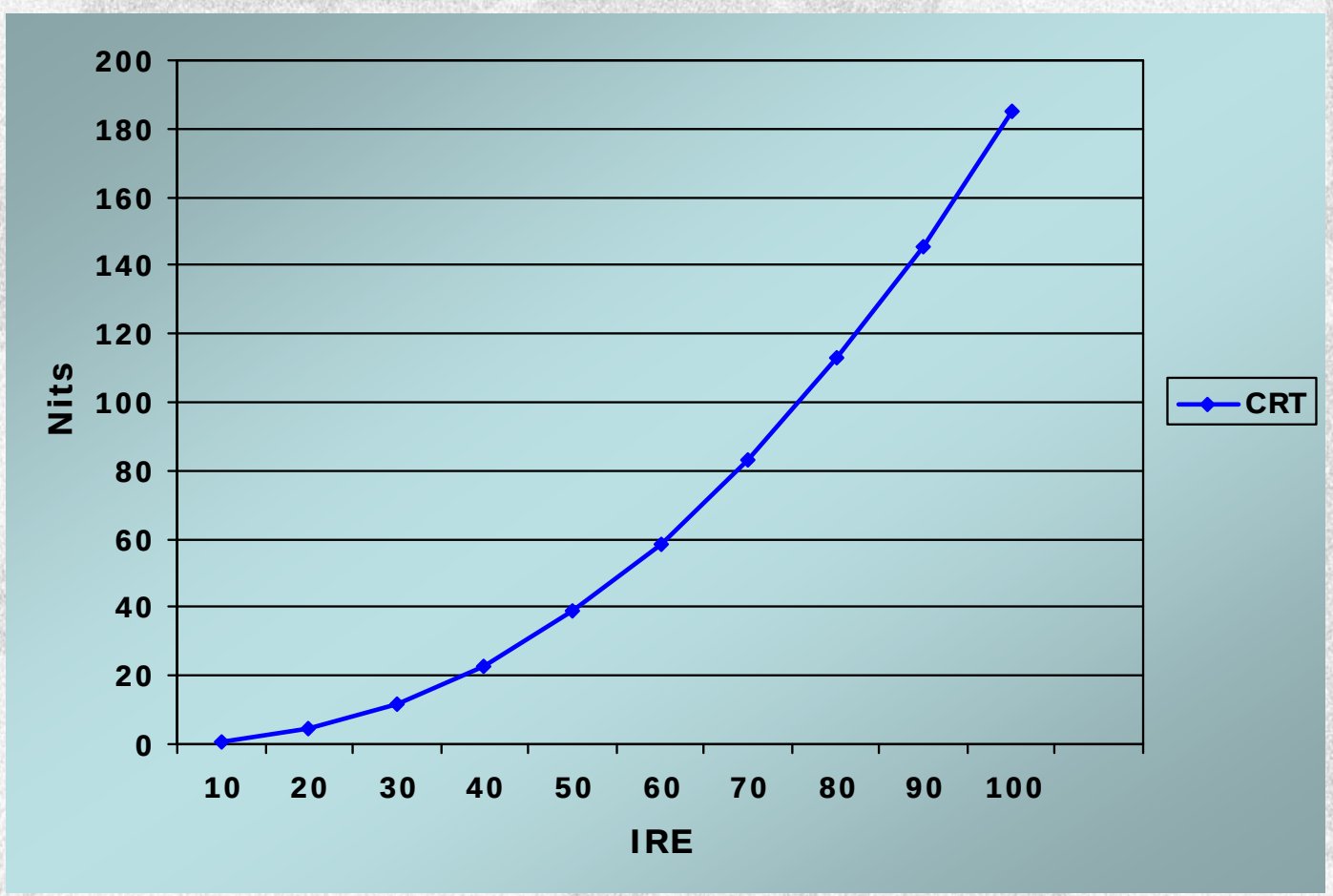
Evaluation Monitors and Projectors

Benchmarks and Observed Performance of LCD, Plasma, DLP, HTPS LCD, and LCoS

Grayscale Attributes

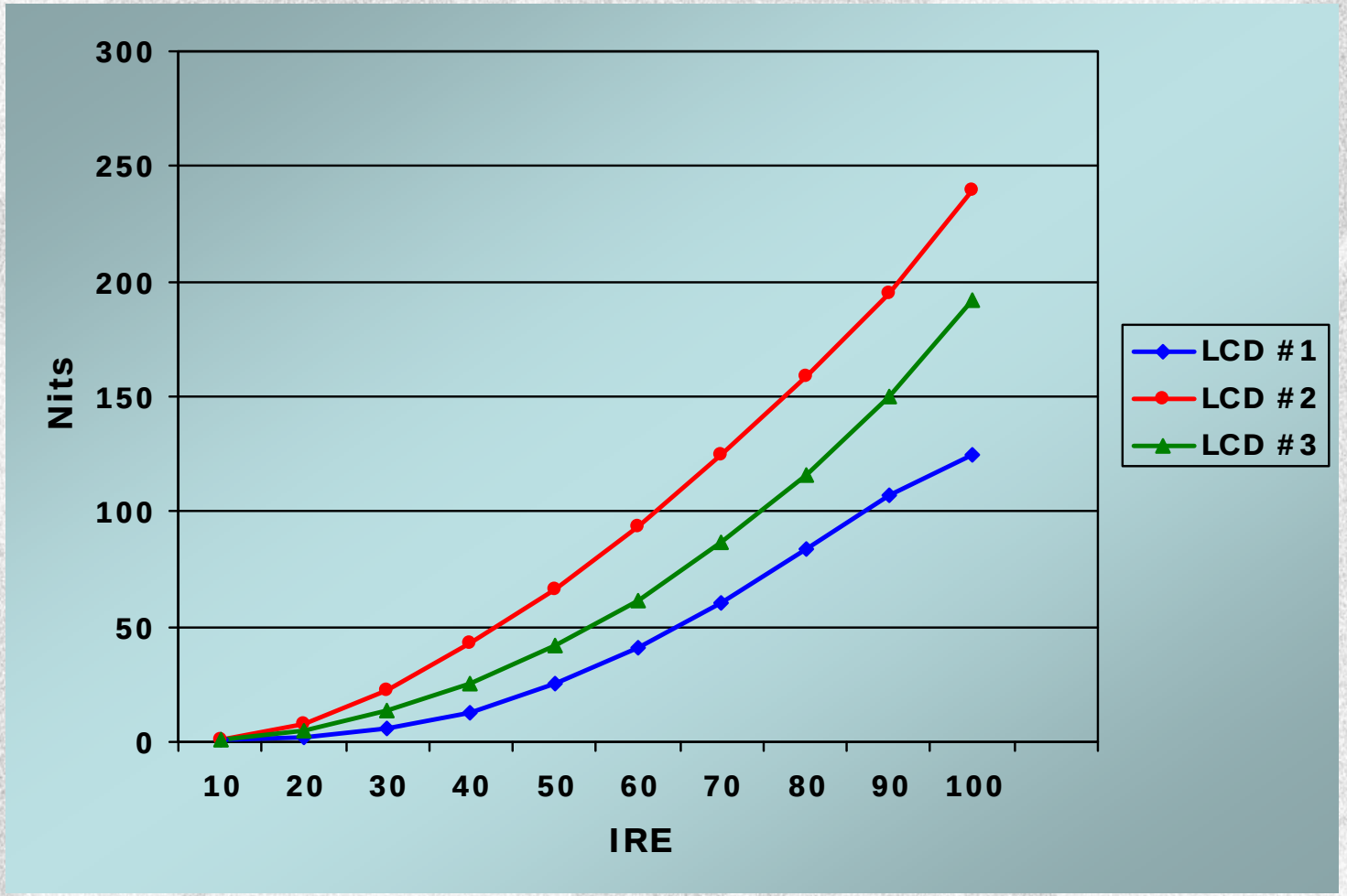
- Dynamic Range
  - Most LCD and plasma displays run too hot and cannot achieve consistent gamma
  - High-end clipping not unusual (white crush)
  - Most units are “tamed” when operated in the range of 100 – 150 nits (29 – 44 ft-L)
- Color Temperature
  - Consistent tracking of a given white point remains a challenge for TFT LCD
  - DLP, plasma, 3LCD, LCoS much better

CRT Gamma



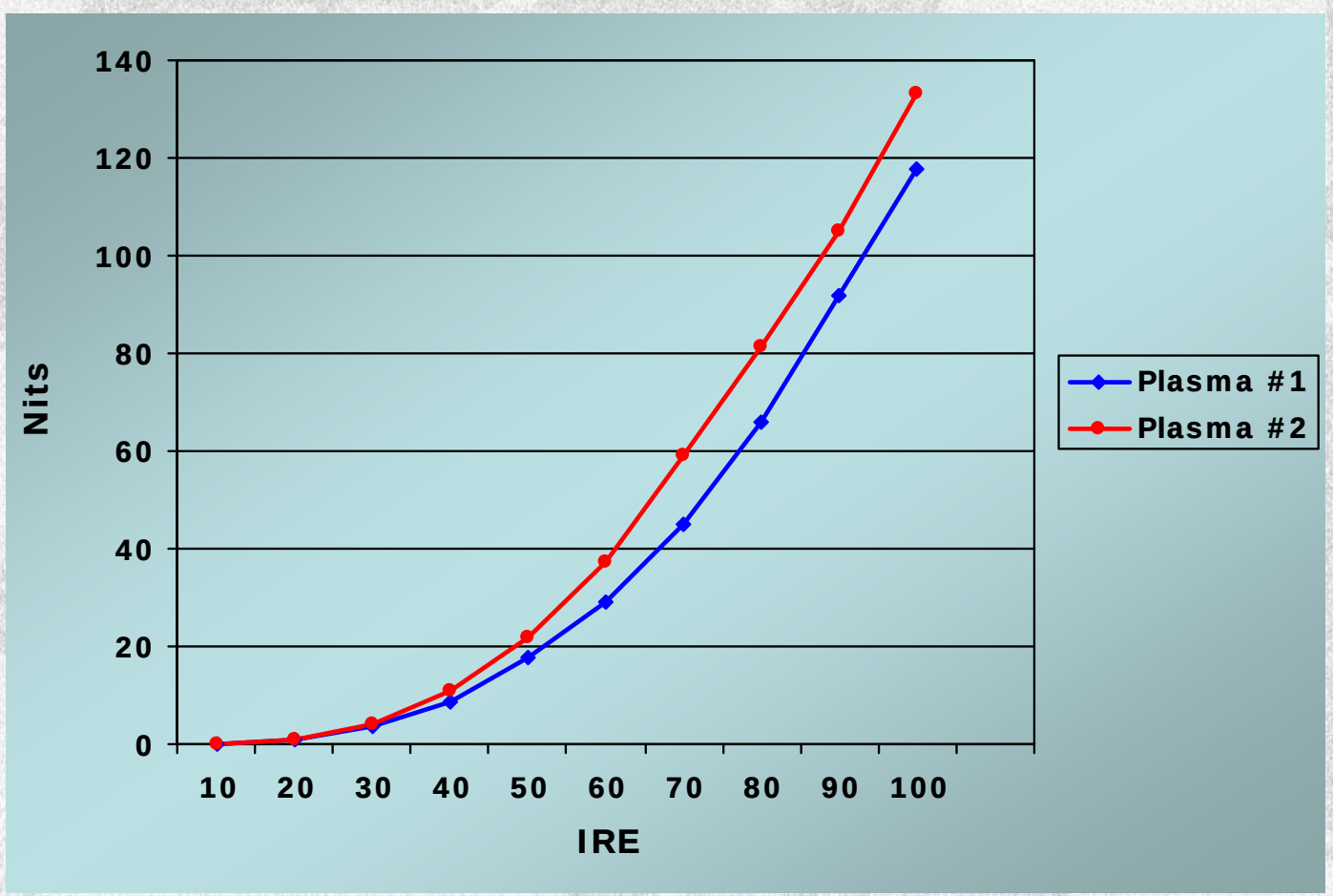
Plotted CRT Gamma Value – 2.3

TFT LCD Gamma



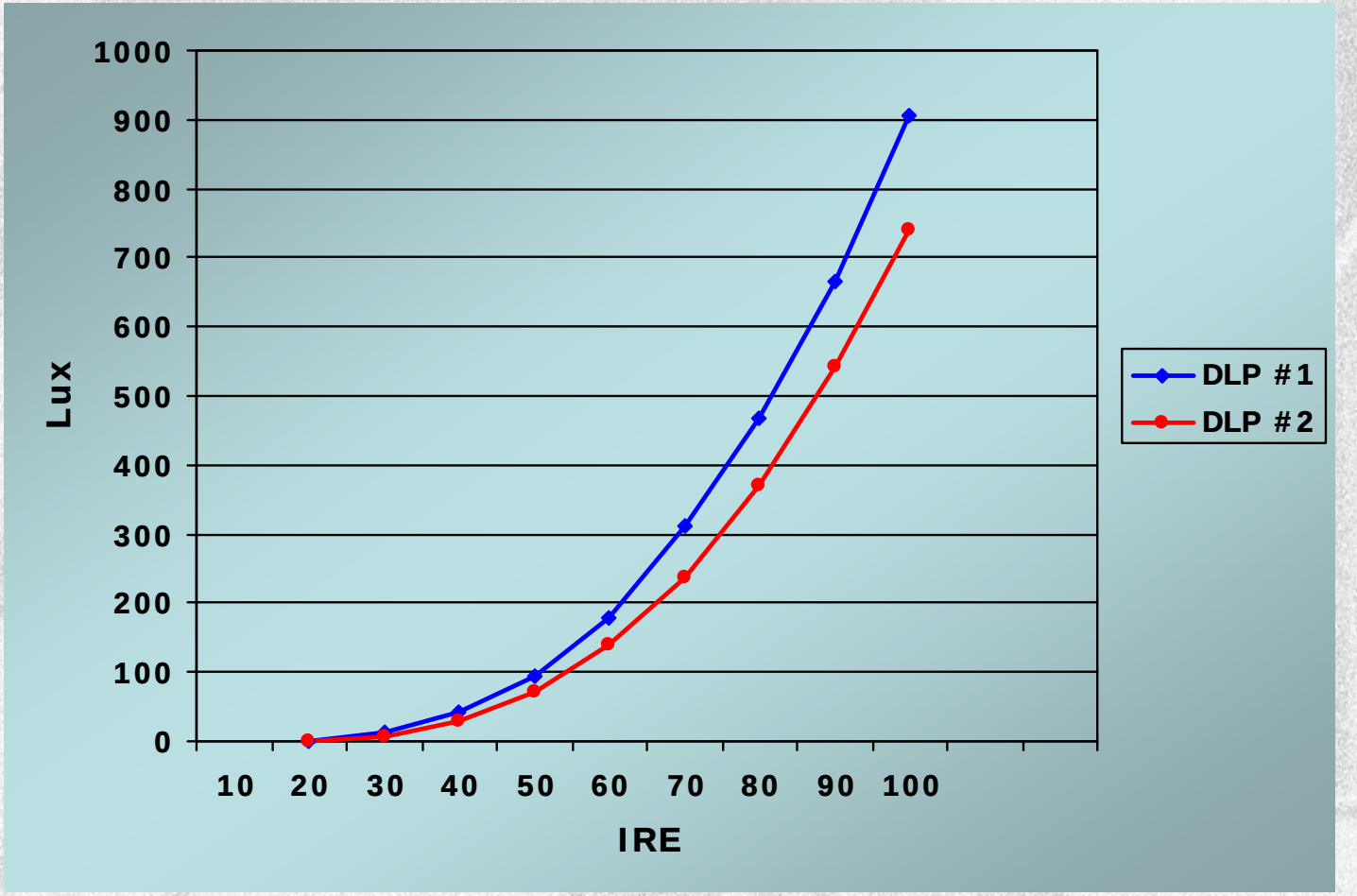
Grayscale clipping can be a problem with LCD (white crush)

PDP Gamma



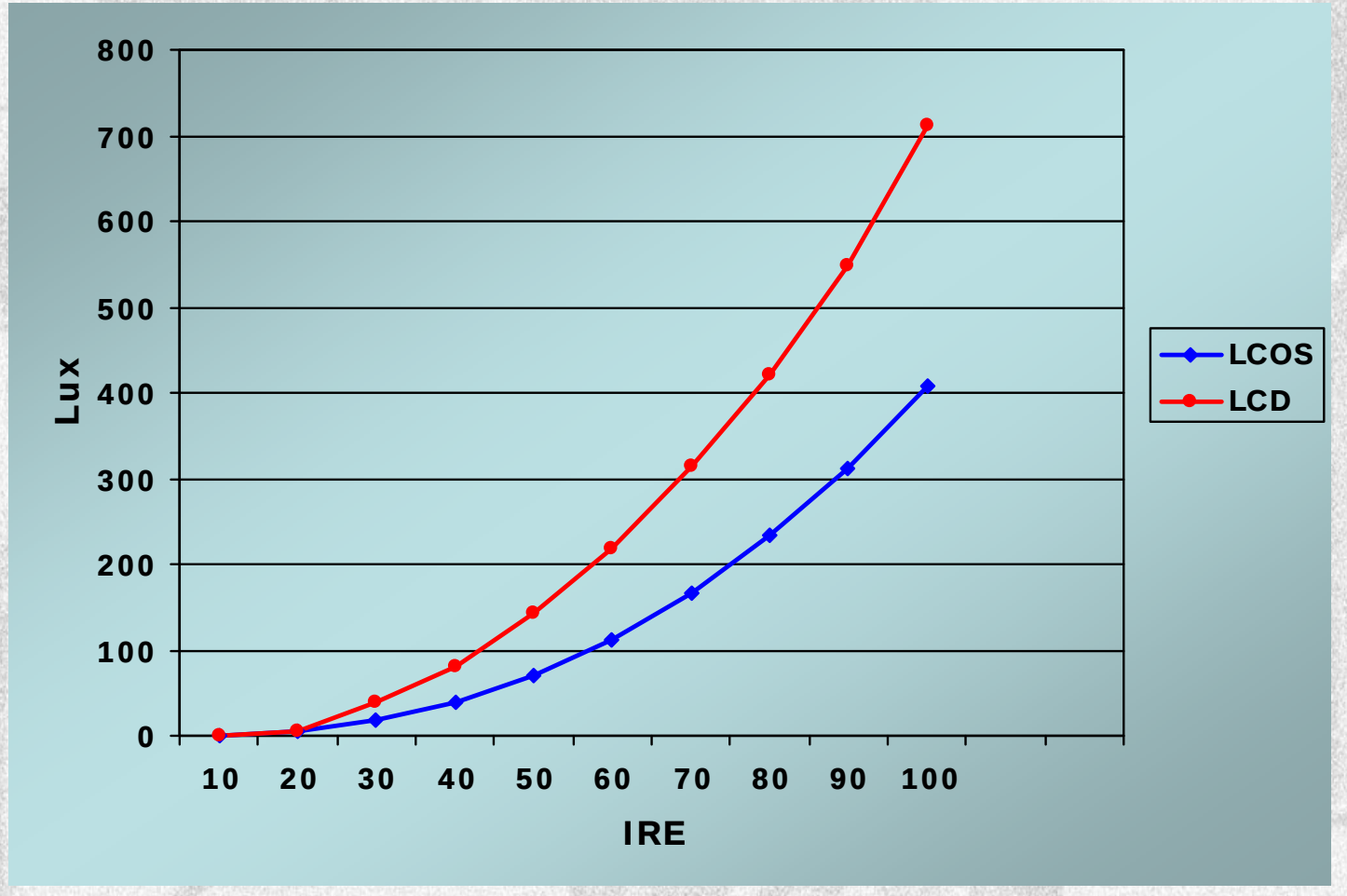
Gamma curves can flatten too quickly with plasma

DLP Gamma



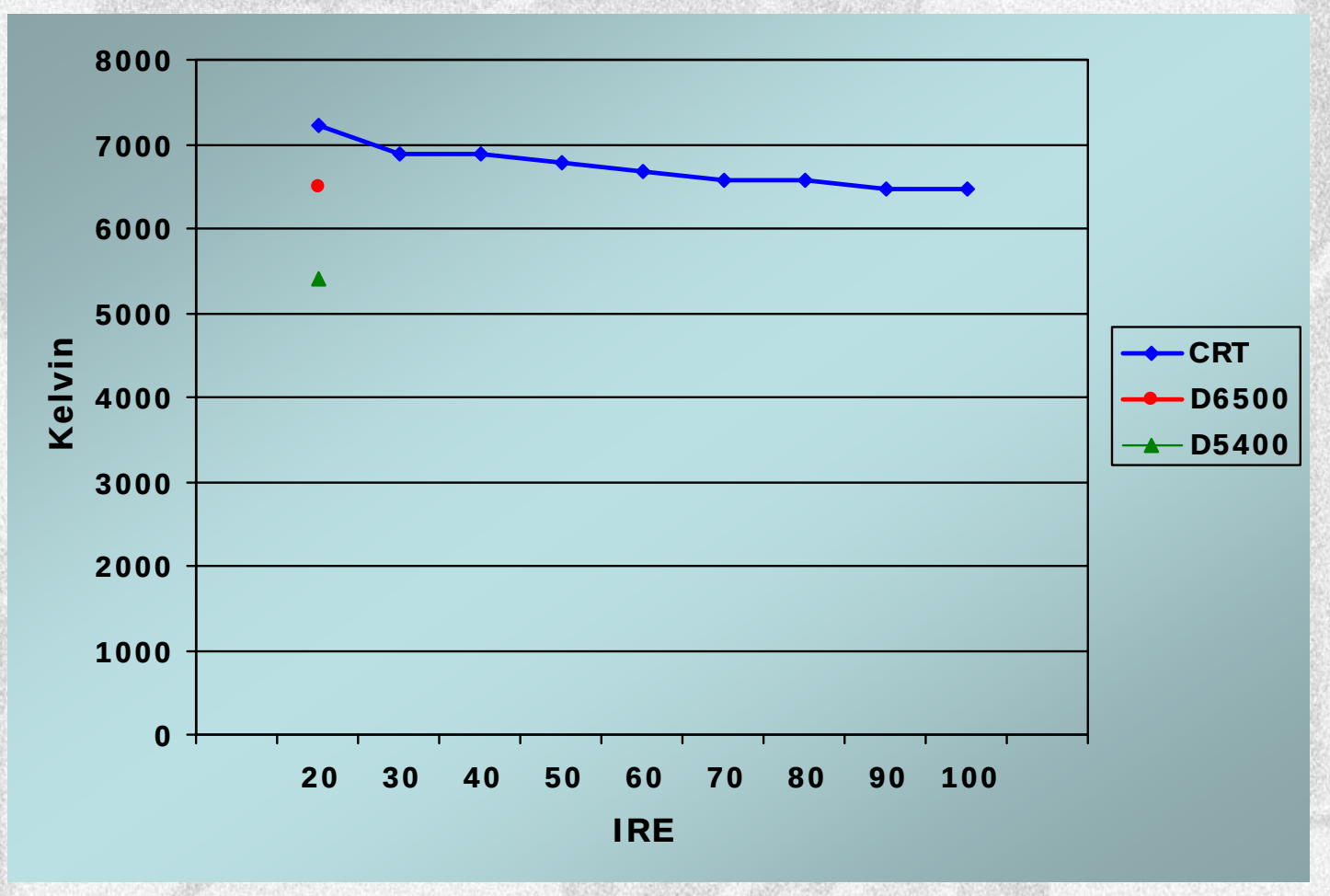
DLP can provide consistent gamma from black to white

LCOS - LCD Gamma

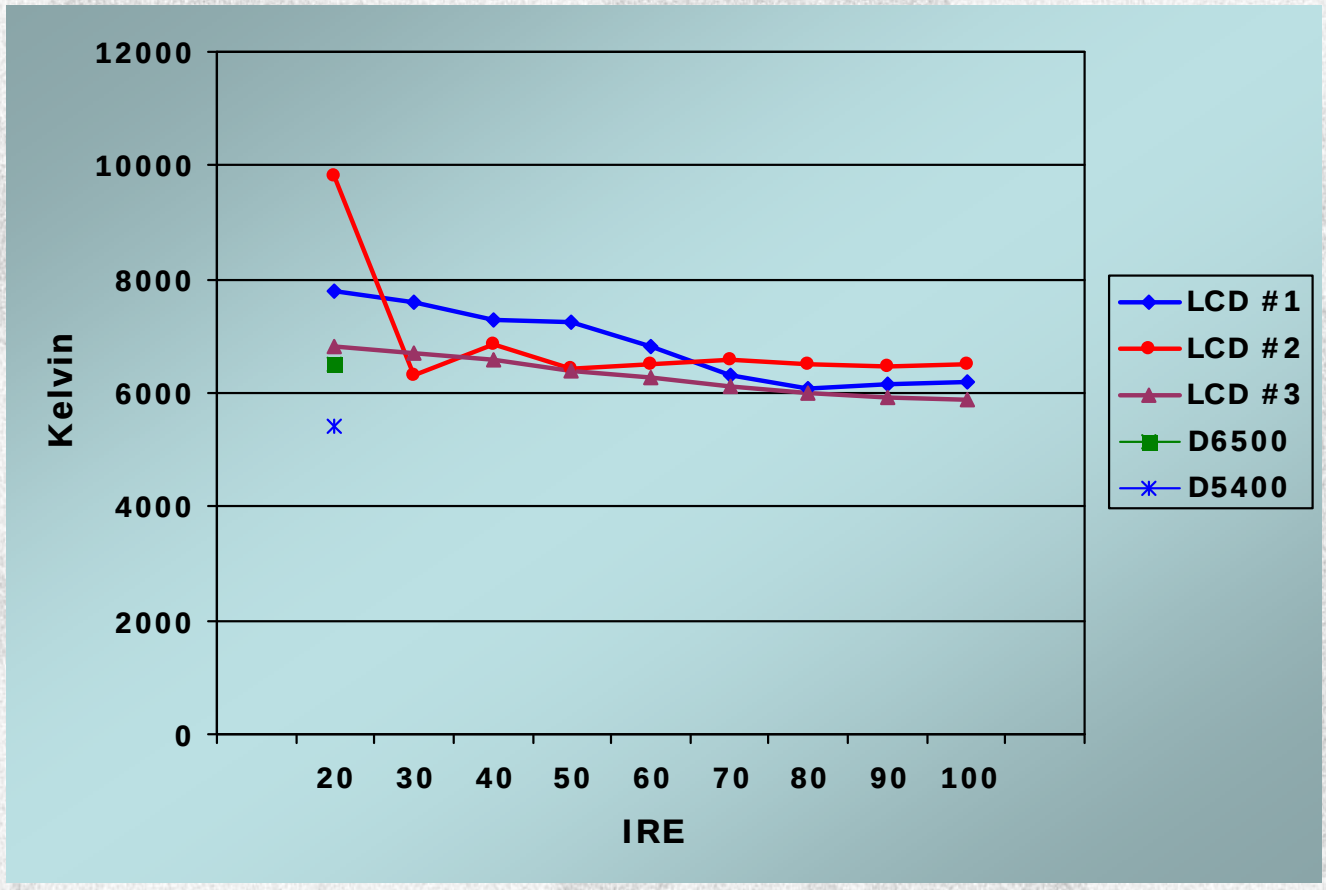


LCOS and LCD can emulate CRT gamma, too

CRT Grayscale Track

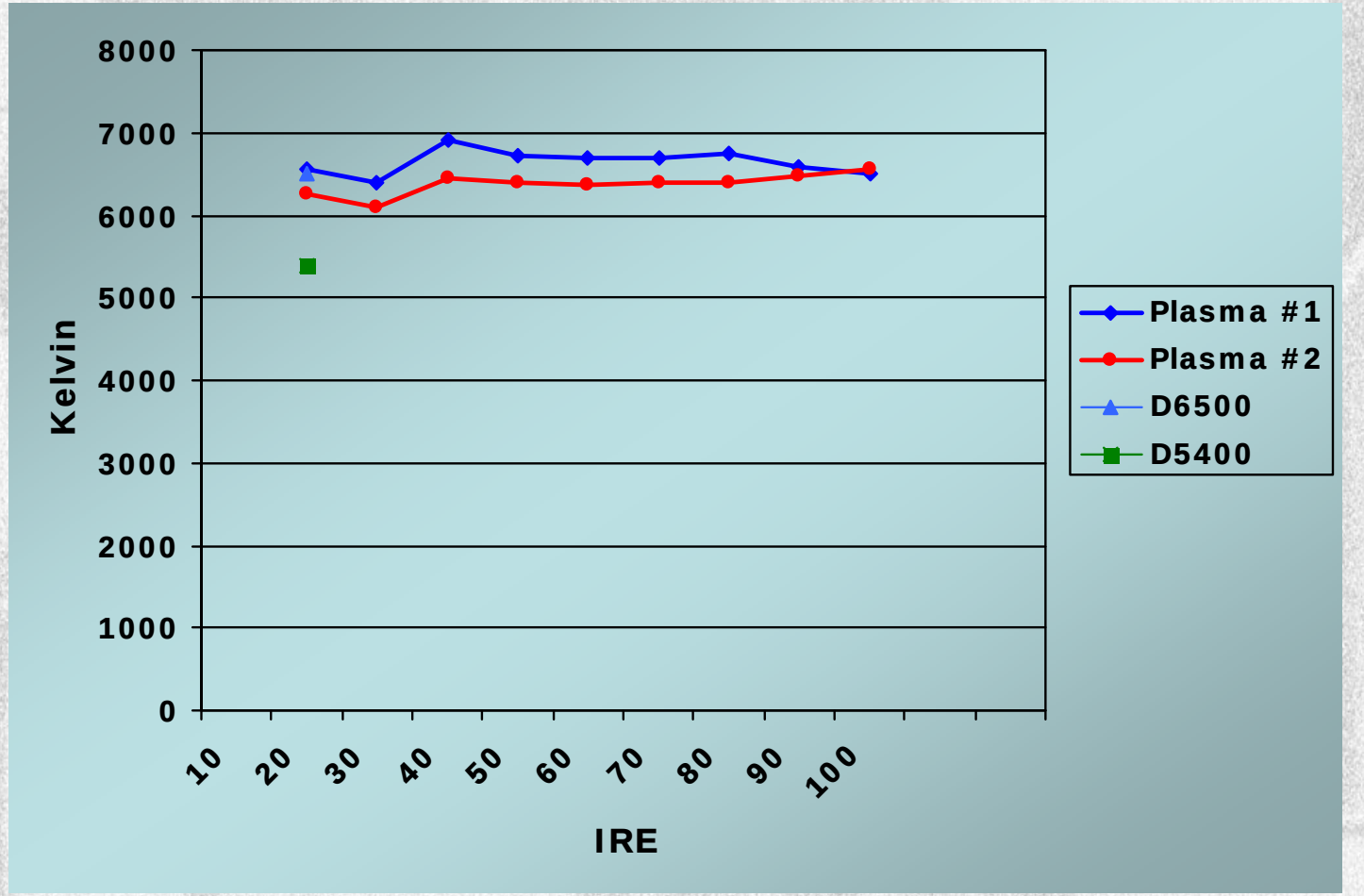


TFT LCD Grayscale Track



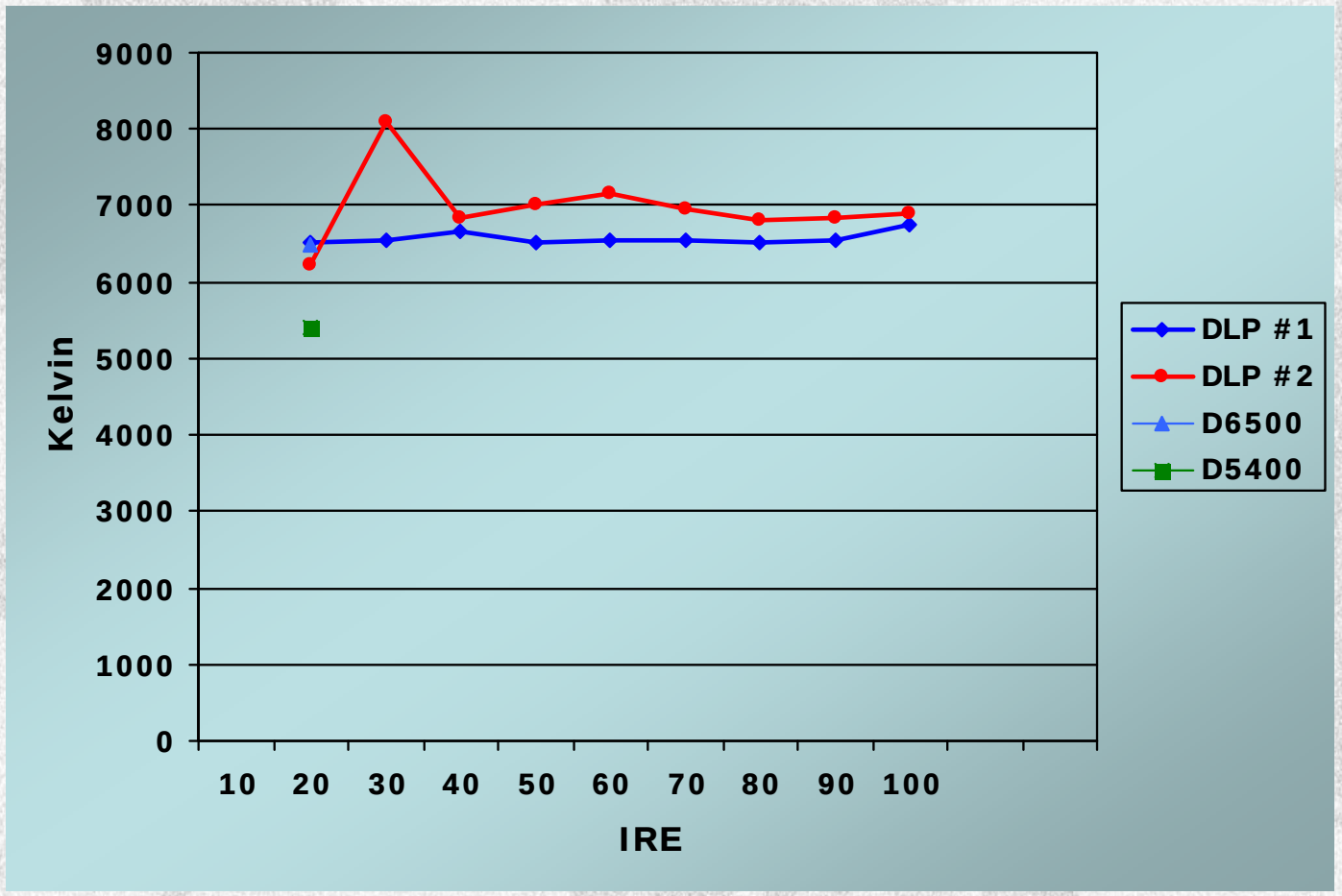
LCD grayscale tracking varies widely among brands

PDP Grayscale Track



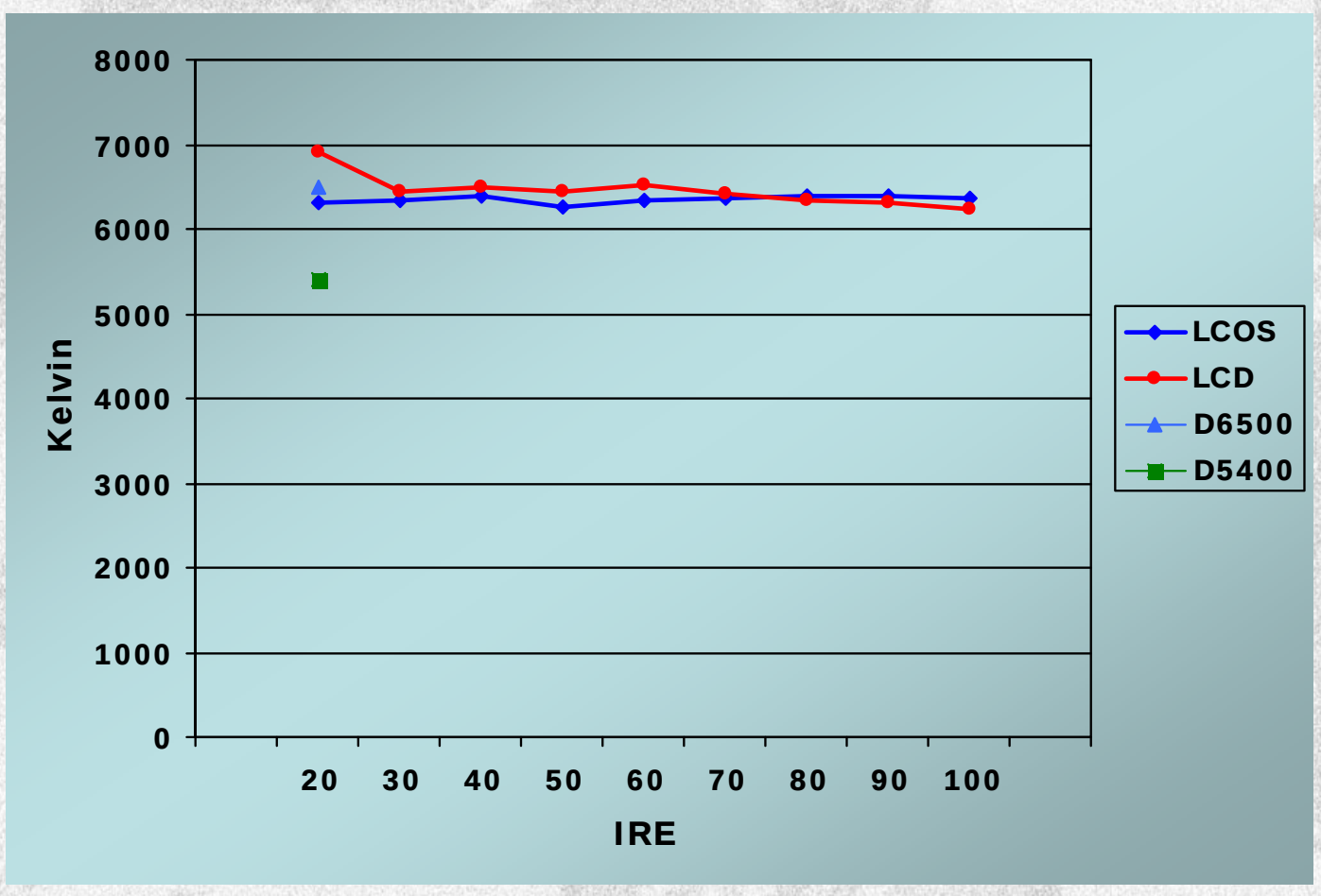
PDP grayscale track is generally more stable than LCD

DLP Grayscale Track



Accurate grayscales depend on driving circuitry

LCOS - LCD Grayscale Track

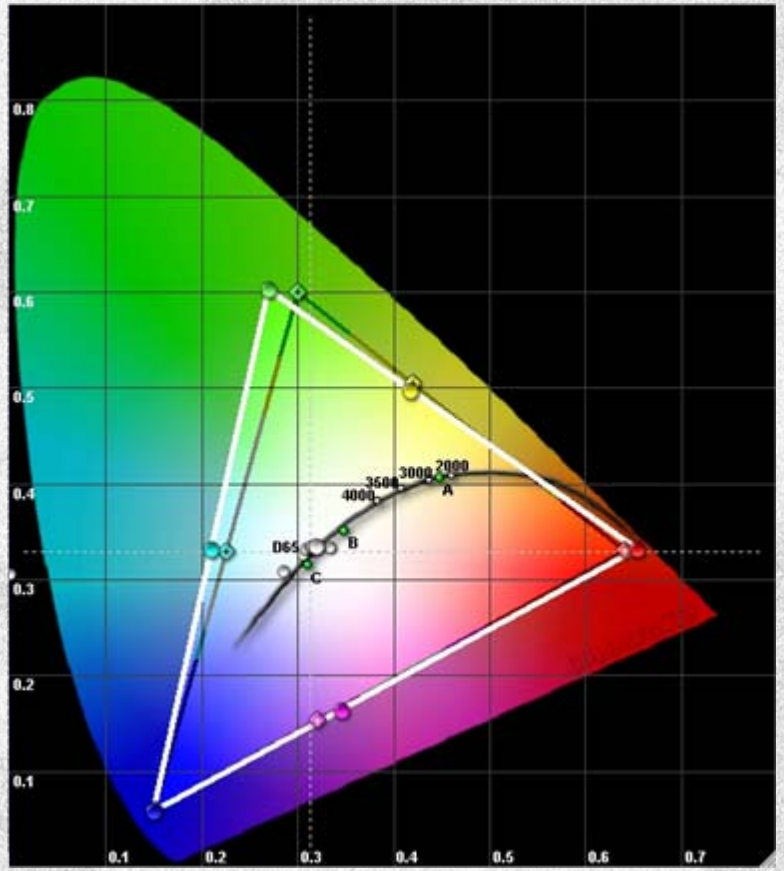


Both technologies can track clean grayscales

Color Attributes

- Color Saturation
  - Range of saturable colors widest with color filters (dichroics), less with phosphors
  - RGB has wider gamut than sequential color
- Color Accuracy
  - Many displays have more cyan than yellow in the green channel for brighter images
  - Blue, red easier to line up accurately
  - Cyan, yellow often tough to match correctly

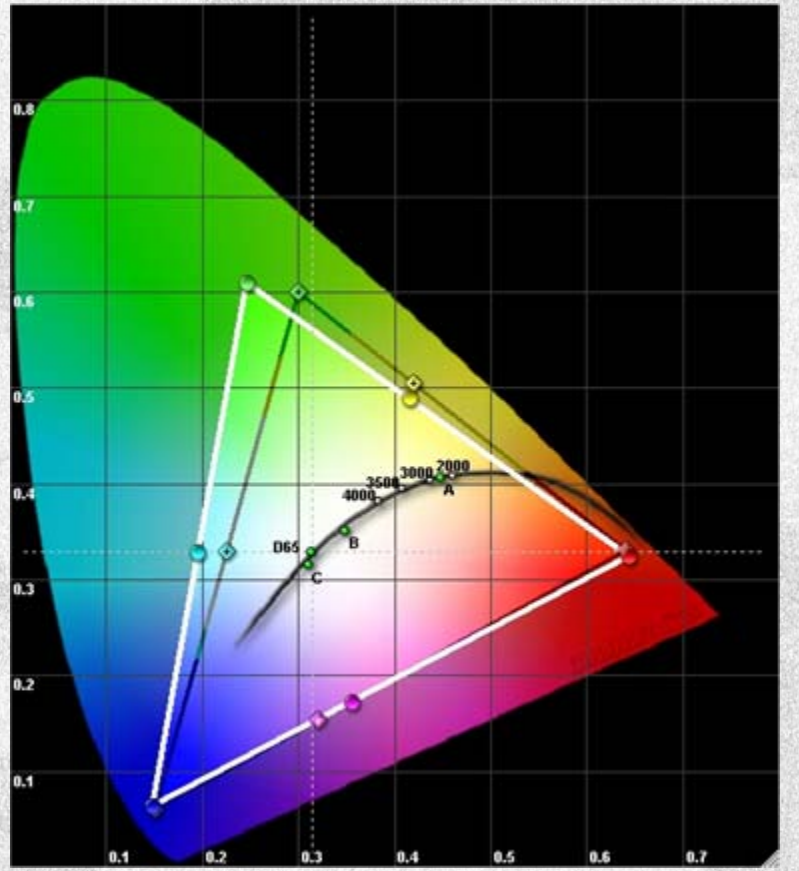
CRT Example 1



CRT compared to REC709

- SMPTE-C phosphor formulations used
- Blue close to ideal
- Red close to ideal
- Cyan, yellow close to ideal
- Magenta shifted towards red
- Green shifted towards cyan slightly, but with equivalent luminance value
- Close match to REC709 gamut, but not enough saturation possible for DCI

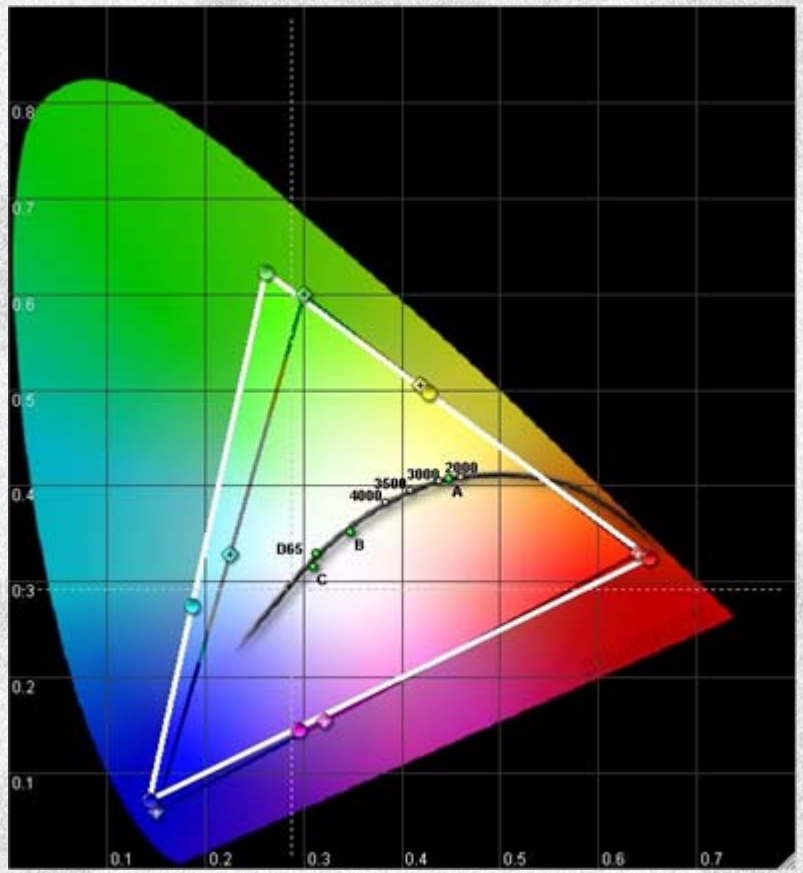
CRT Example 2



CRT compared to REC709

- SMPTE-C phosphor formulations used
- Blue close to ideal
- Red close to ideal
- Yellow close to ideal
- Magenta shifted towards red
- Cyan shifted towards blue
- Green shifted towards cyan
- Close match to REC709 gamut, but not enough saturation possible for DCI

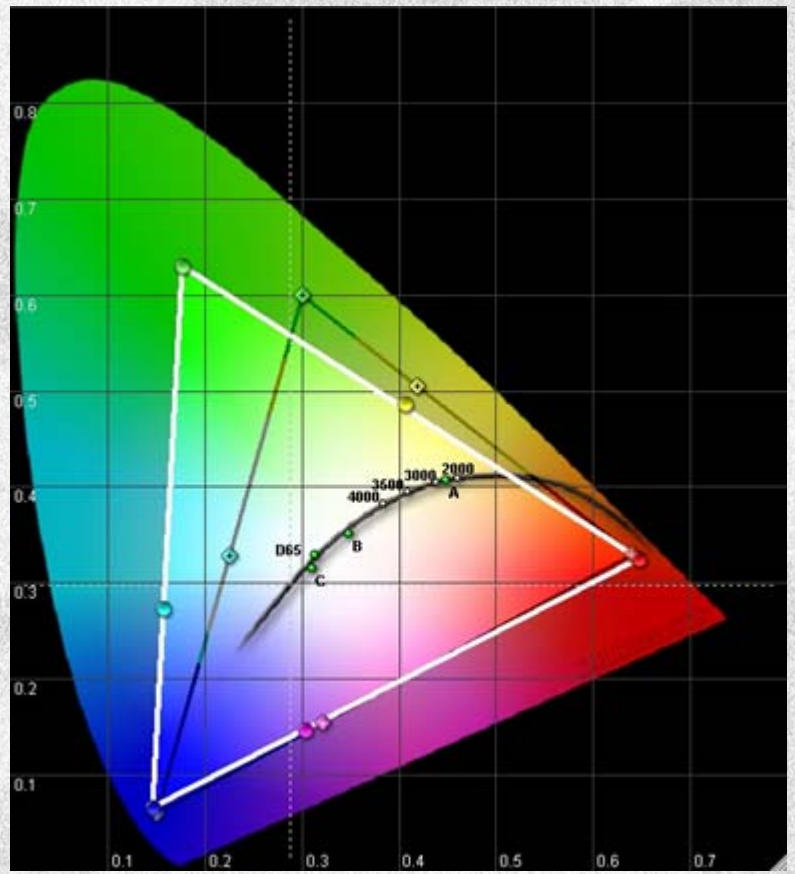
LCD Example #1



Raw CCFL color gamut

- Standard CCFL backlight used (no enhancements)
- Raw gamut slightly exceeds REC.709
- Blue undersaturated
- Green has too much cyan, correct with +30 to +50R
- Red slightly oversaturated
- Tough to match 709 space exactly as blue channel is undersaturated

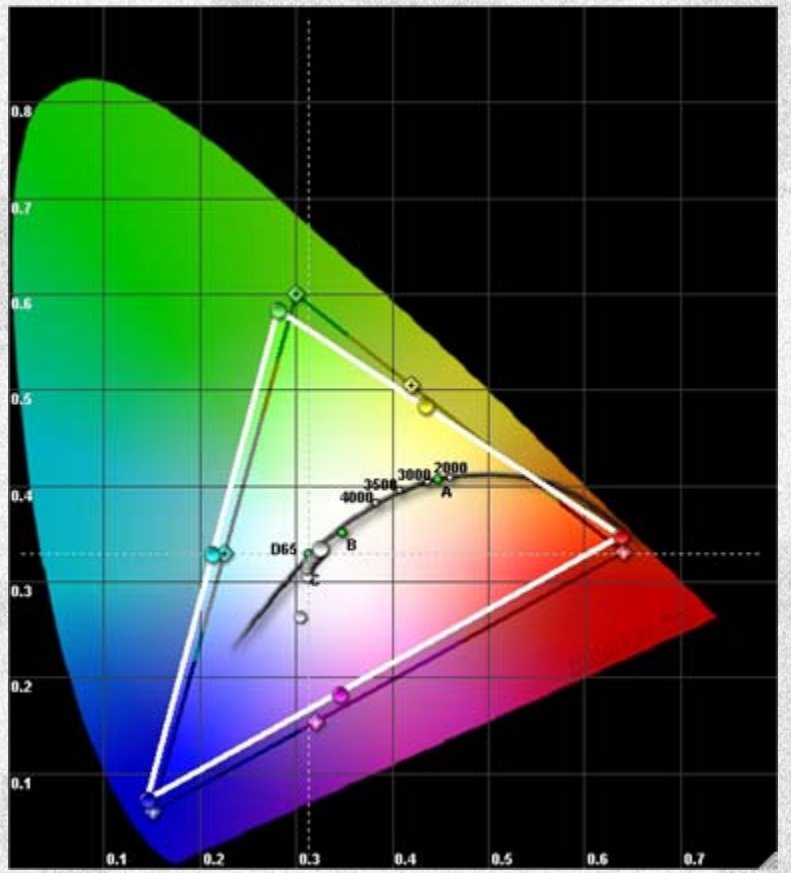
LCD Example #2



Raw CCFL color gamut

- Standard CCFL backlight used (no enhancements)
- Raw gamut slightly exceeds REC.709 in area
- Blue close to ideal
- Green has too much cyan
- Red slightly oversaturated
- Not appropriate for use as a “critical” monitor as color space is inaccurate

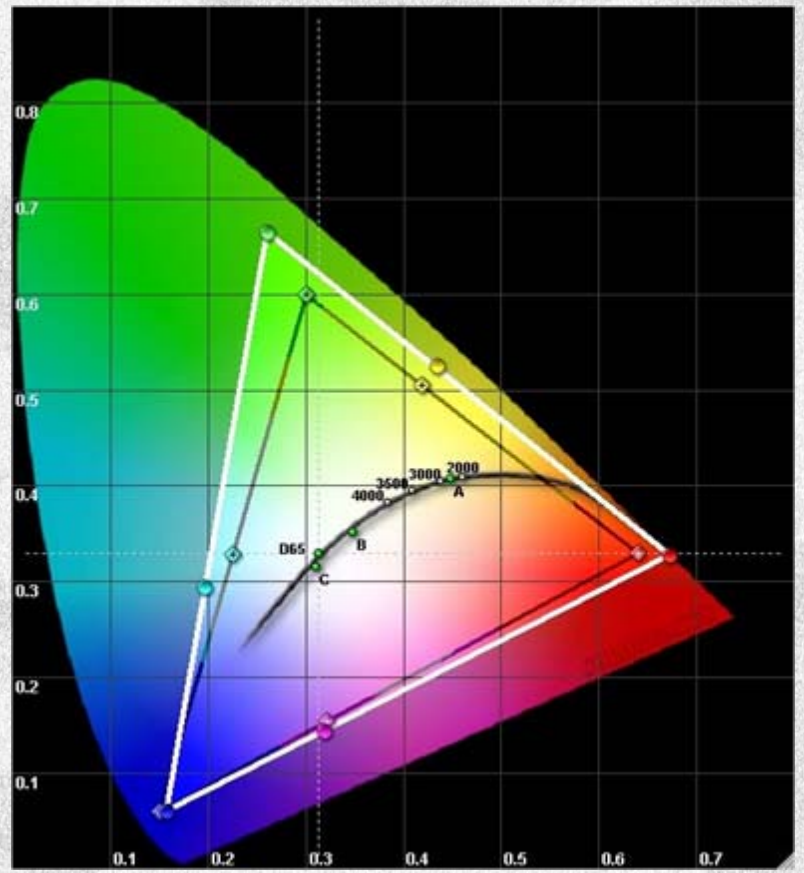
LCD Example #3



Raw CCFL color gamut

- Standard CCFL backlight used (no enhancements)
- Raw gamut smaller than the REC.709 space
- Blue close to ideal
- Green has too much cyan
- Red has too much yellow
- Cyan coordinates are close
- Not appropriate for use as a “critical” monitor as color space is undersized

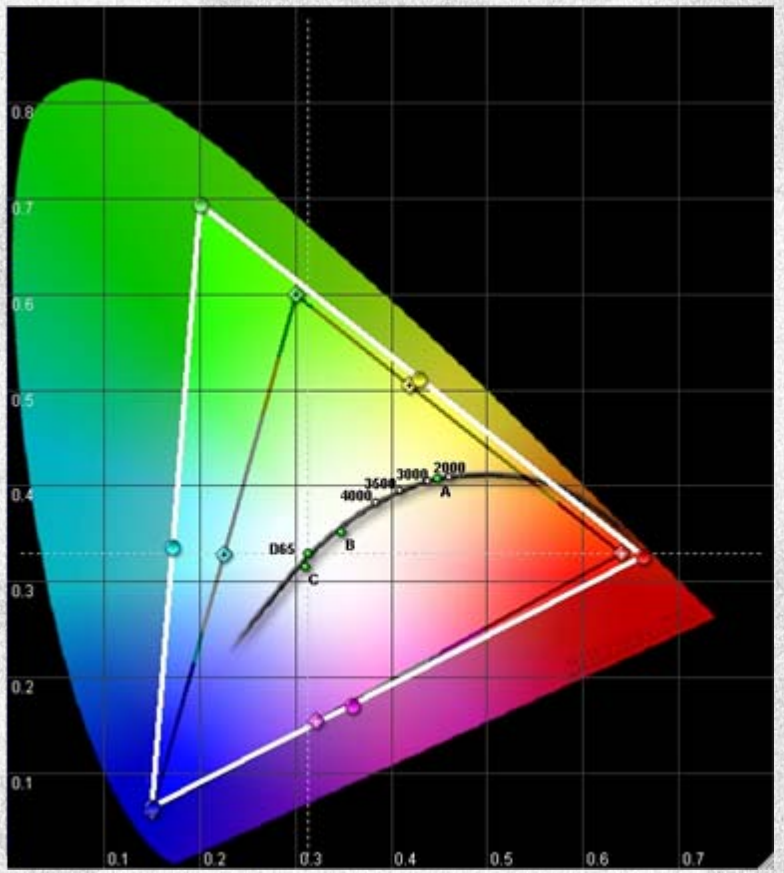
Plasma Example #1



Raw color gamut

- Standard PDP phosphor formulations used
- Blue close to ideal
- Red is over-saturated
- Green needs more yellow and less cyan (add +30R)
- Closer match to REC.709 gamut than LCD, also closer to DCI gamut

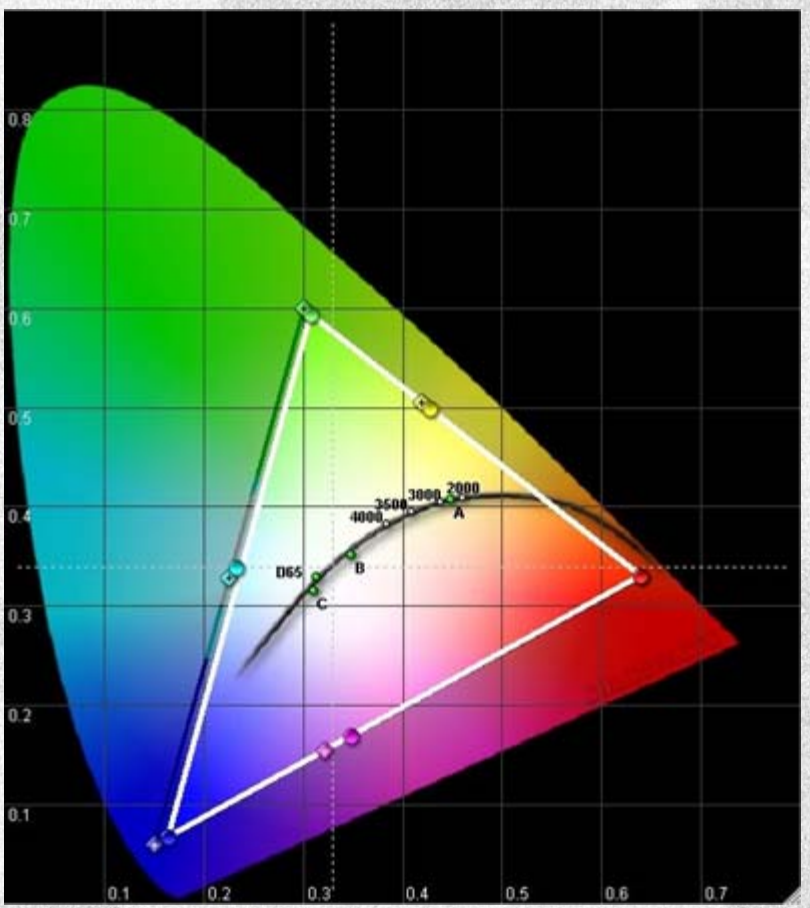
Plasma Example #2



Raw color gamut

- Standard PDP phosphor formulations used
- Blue close to ideal
- Red is slightly over
- Green has too much cyan/blue to be correctable
- Not appropriate for use as a “critical” monitor without gross correction in green channel

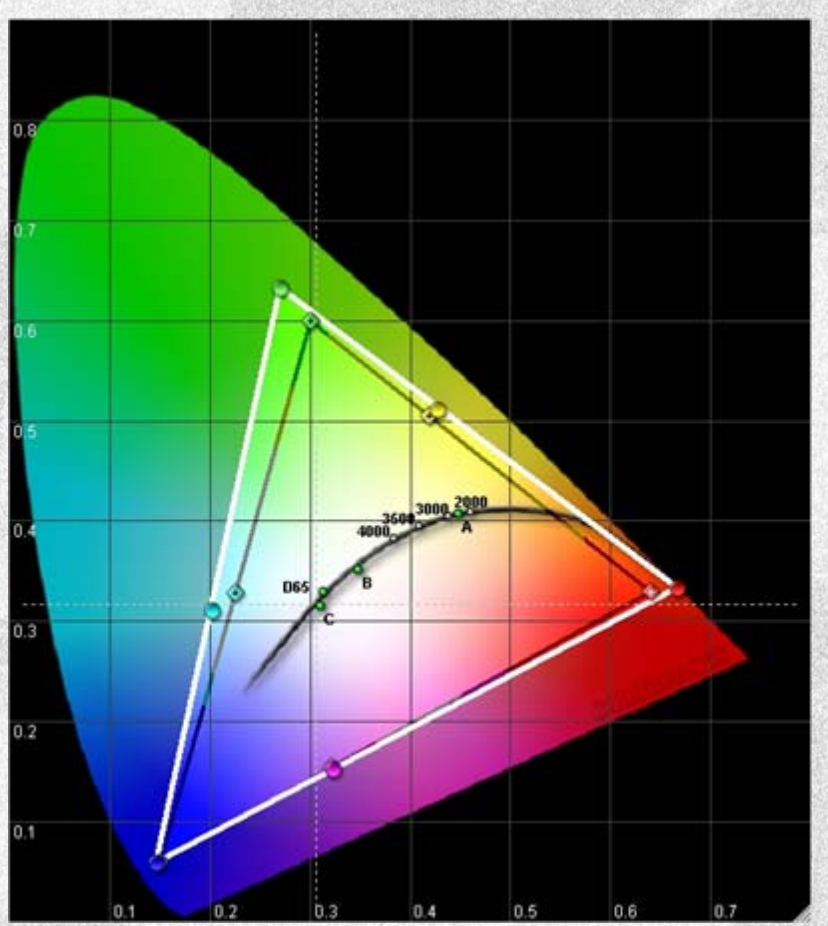
DLP Example #1



Gamut constrained to REC.709

- Single-chip DLP HT projector
- Resolution: 1280x720
- Advanced color gamut mapping used
- Lamp – 250W UHP
- Covers virtually all of the REC709 color space
- Blue and green are slightly undersaturated

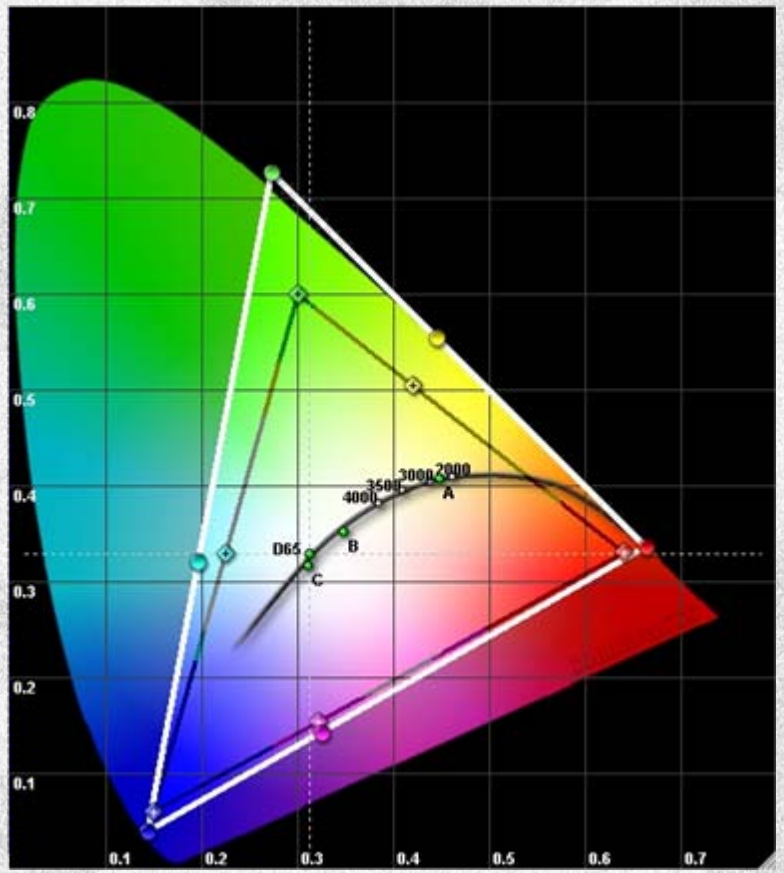
DLP Example #2



Raw color gamut

- Single-chip DLP HT projector
- Resolution: 1920x1080
- Advanced color gamut mapping used
- Lamp – 250W UHP
- Blue coordinate is close
- Green coordinate shifted towards cyan
- Red coordinate shifted towards yellow
- Difficult to match REC709

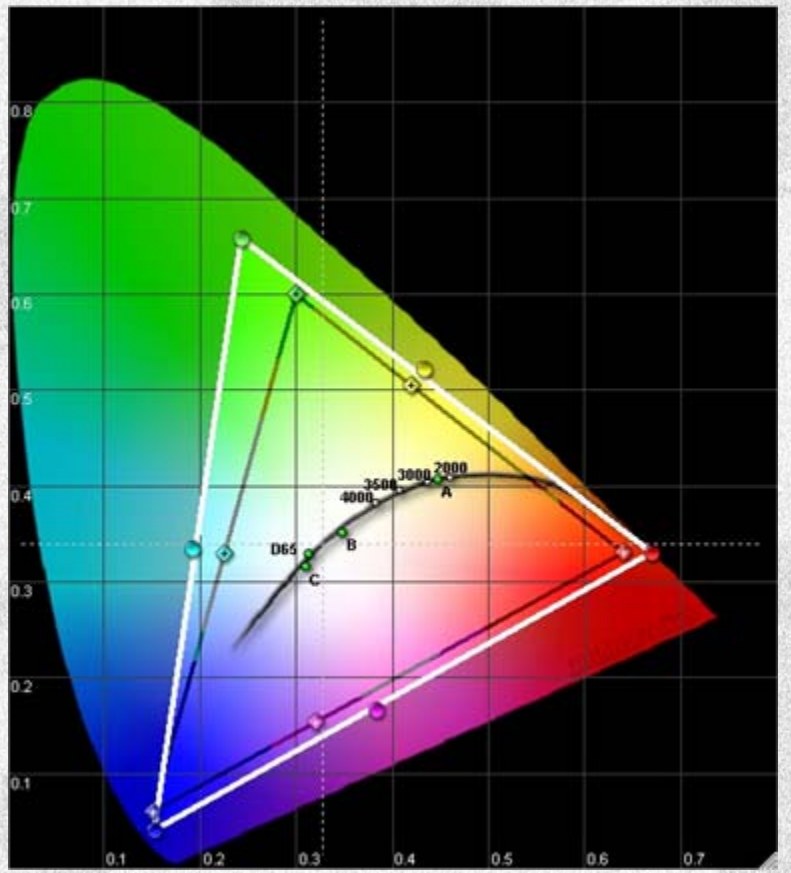
LCOS Example



Raw color gamut

- 3-panel LCOS HT projector
- Resolution: 1920x1080
- Advanced color gamut mapping used
- Lamp – 200W UHP
- Splits REC709 and DCI gamut
- Red and blue points slightly off from optimum

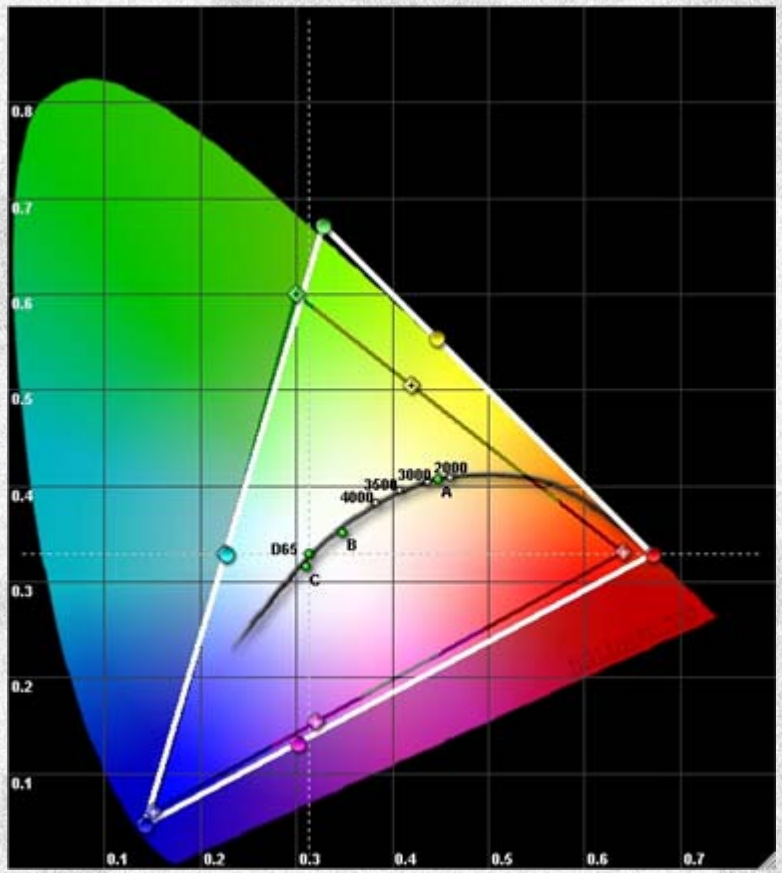
3LCD Example #1



Raw color gamut

- 3-panel LCD HT projector
- Resolution: 1920x1080
- Advanced color gamut mapping used
- Lamp – 150W UHP
- Covers 100% of REC709 space (uncorrected)
- Blue and red points need minor correction, green has too much cyan in it (correct with +60 to +80R)

3LCD Example #2



Raw color gamut

- 3-panel LCD HT projector
- Resolution: 1920x1080
- Advanced color gamut mapping used
- Lamp – 160W UHP
- Covers most of REC709 space
- Blue and red points need minor correction, green has slightly too much yellow (correct with +20 to +30C)