

technicolor



# Considering 3D display characteristics in setting-up subjective quality tests for stereoscopic 3D video

Quan Huynh-Thu, Laurent Blondé  
Technicolor Research & Innovation



# Outline

---

- Background
  - Subjective 3D video quality measurement requirements
  - 3DTV characterization
- 3DTV measurements:
  - Variability aspects:
    - Angular
    - Spatial
  - Technologies:
    - Display
    - Glasses
- Conclusions
  - Subjective 3D video quality testing
    - Placement of viewer
    - Selection of technology

# Background

---

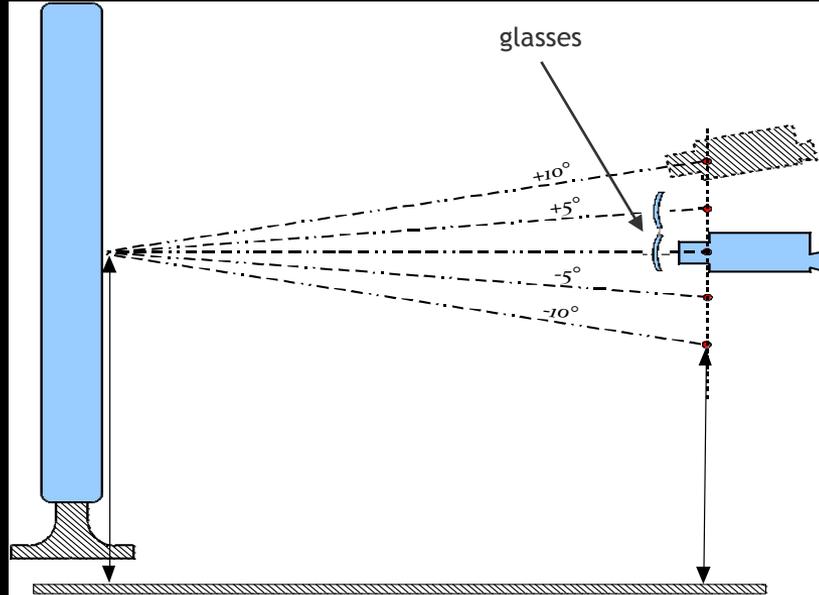
- Context:
  - Subjective quality assessment methodologies and set-up for stereoscopic 3D video
- Subjective 3D video quality measurement requires:
  - Selection of a 3D ‘reference’ display
  - Positioning viewer(s) in front of the display
    - Number of simultaneous viewers
    - Viewing distance
  - Matching between content observation geometry and shooting geometry
- Test environment and viewing conditions still to be defined/standardized:
  - Existing proposal to start with similar environment and viewing conditions to 2D video tests
  - Investigate which requirements need to be modified
  - Investigate new requirements
- Scope of this contribution:
  - Impact of 3D display characteristics on number of simultaneous viewers
  - Impact of viewing angle on 3D distortion
  - Impact of viewing angle on display signal measurement

# Background

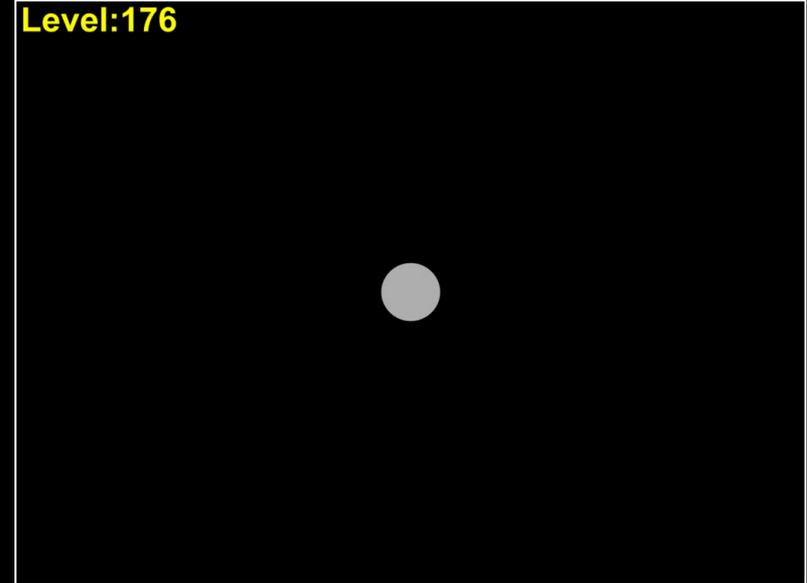
---

- 3DTV characterization
  - Display
  - Glasses
  - Display + Glasses
- Different types of display/glasses technologies
  - LCD panel (active or passive glasses)
  - Plasma panel (active glasses)
  - Different technologies of active-shutter glasses

# Angular variability: micro-polarized LCD panel (passive)



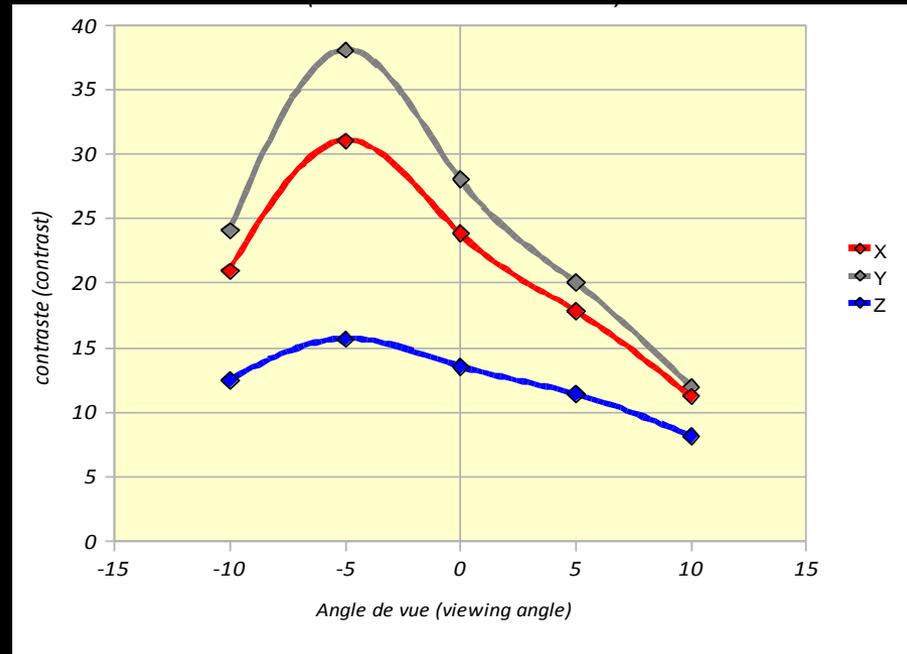
Spectrometer measurement



Central target

- Central target with varying grey level (16, 32, 48, 64, 80, 96, 112, 128, 144, 160, 176, 192, 208, 224, 240 et 255)
  - Target presented on left (right) view with right (left) view set to 0
- Measurement of colorimetric components (X,Y,Z) through glasses at different vertical viewing angles

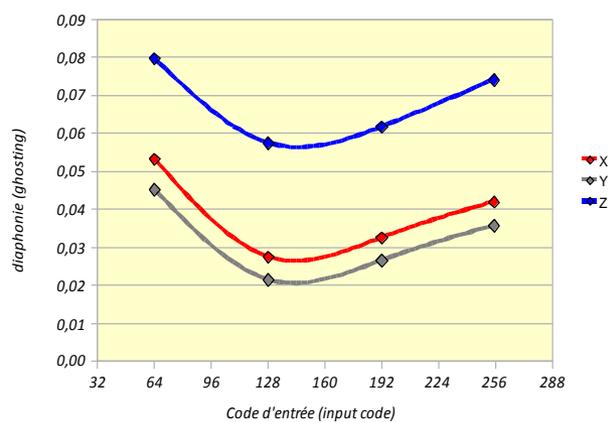
# Angular variability: micro-polarized LCD panel (passive)



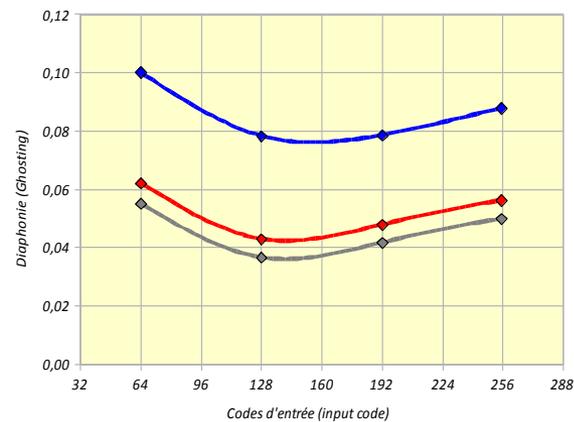
- Stereoscopic contrast as a function of the viewing angle for the different colorimetric components
  - Variations with viewing angle with optimum for a given non-zero viewing angle on this display
  - Color-dependent effect

# Angular variability: micro-polarized LCD panel (passive)

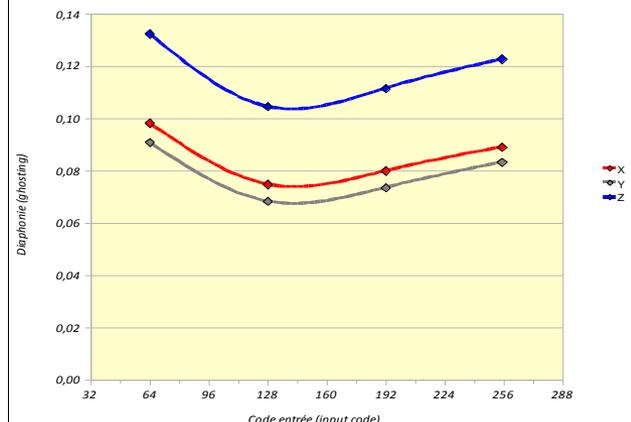
0° viewing angle



5° viewing angle



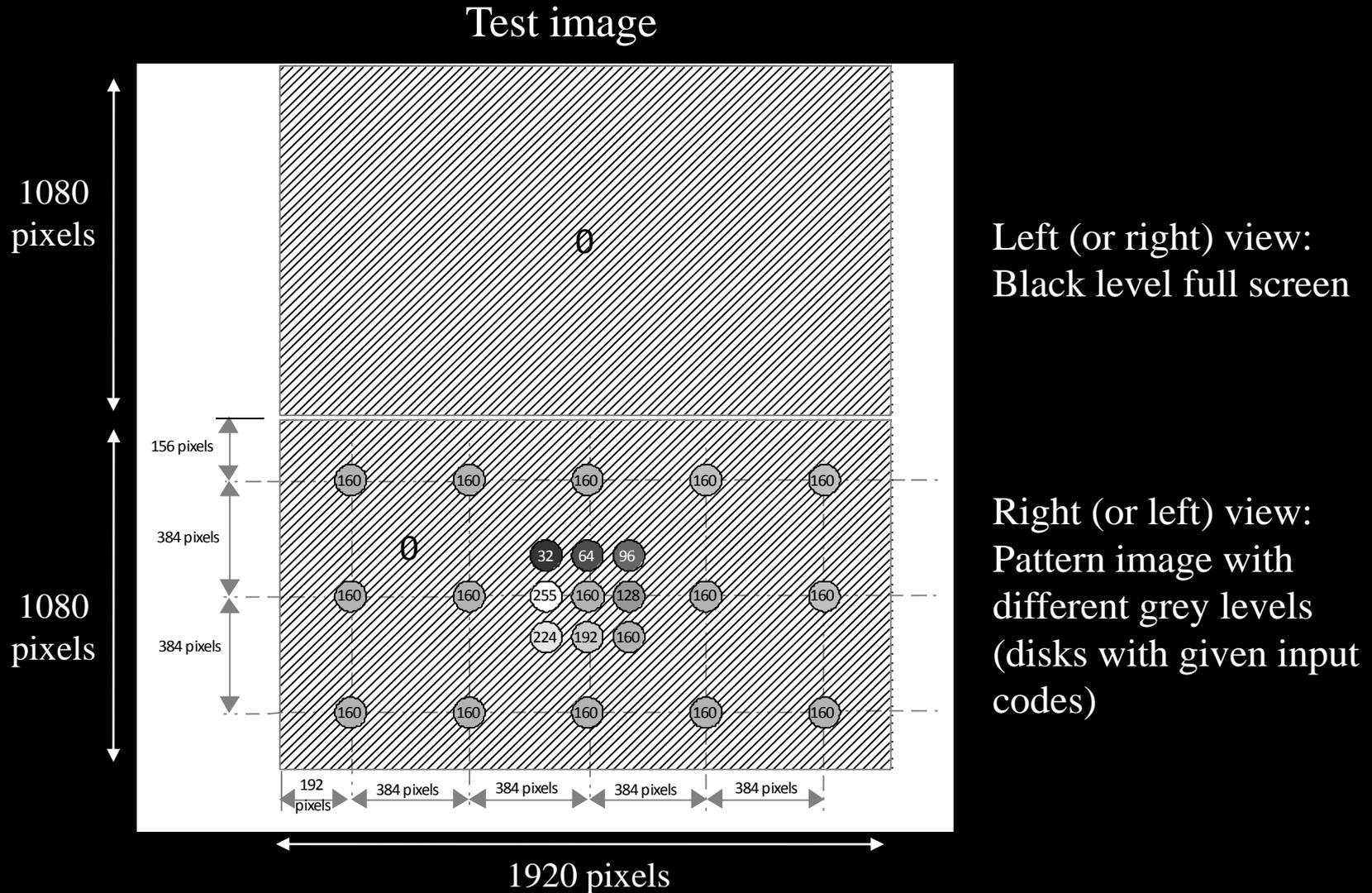
10° viewing angle



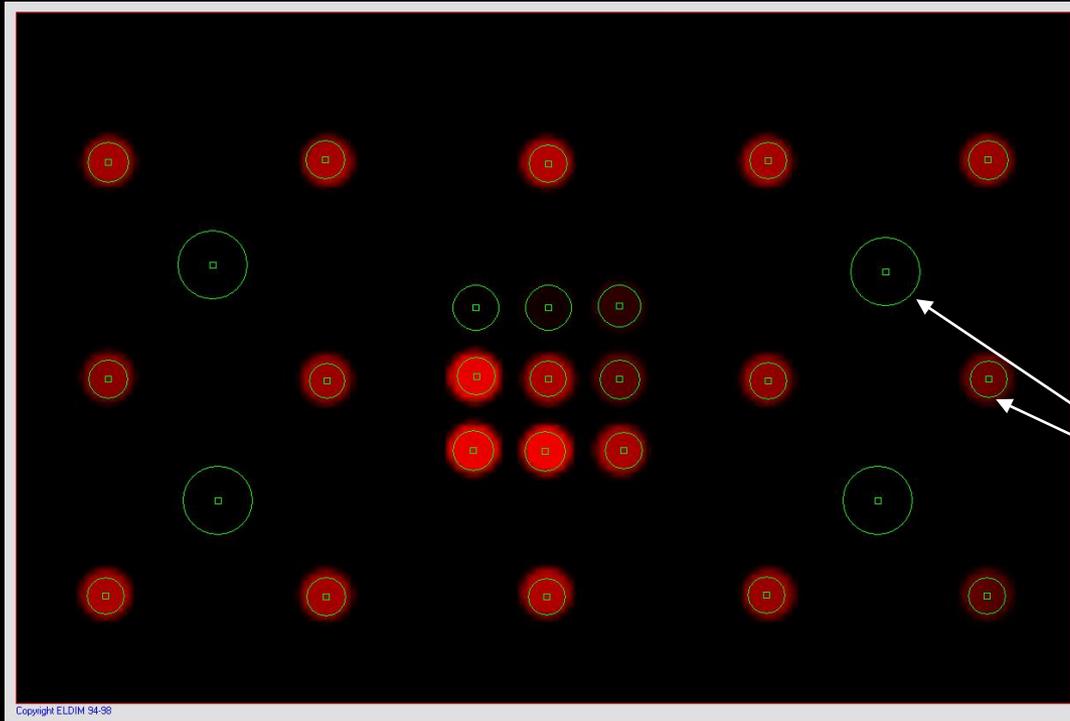
Ghosting dependence on viewing angle (0°, 5°, 10°), input code (64 to 255) and color

- Ghosting measurement on the zero-signal channel:
  - For a given viewing angle, variation with input level
  - For a given input level, variation with viewing angle
  - Color-dependent effect

# Spatial variability: LCD panel (active-shutter glasses)



# Spatial variability: LCD panel (active-shutter glasses)

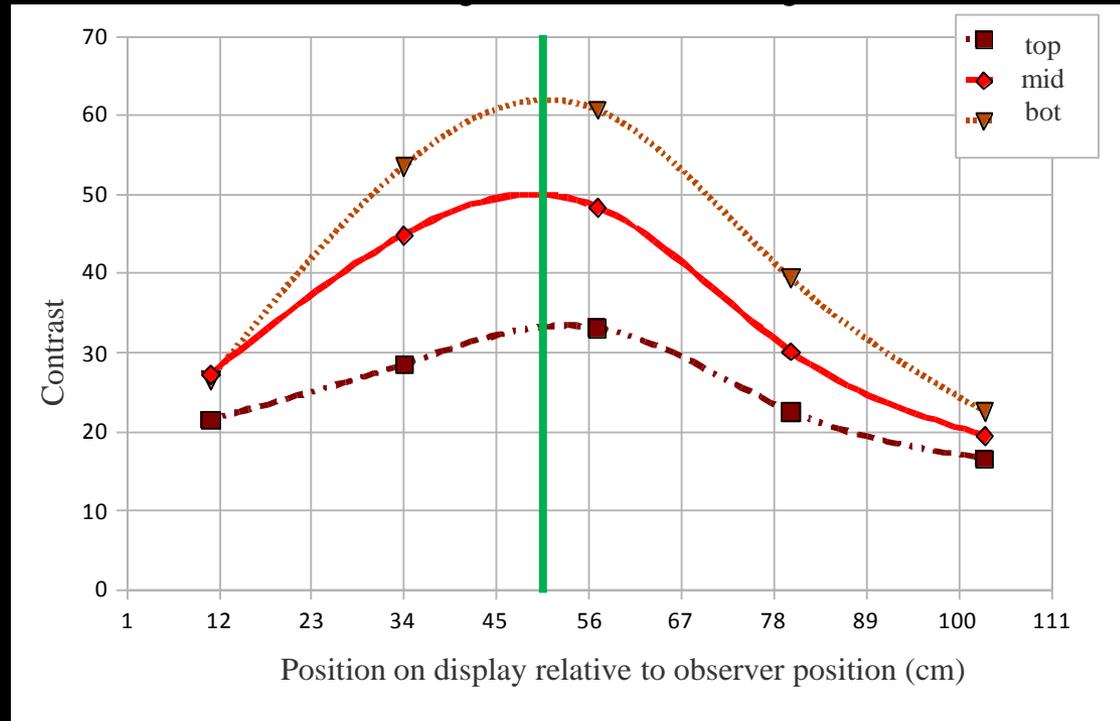


Luminance of the left channel with red patches on the left channel

Measurement points (green circles)

- Measurements with ELDIM Muratest imaging colorimeter
  - Luminance level and colorimetric values of each measurement point
  - Measurement made through opened glass and then closed glass

# Spatial variability: LCD panel (active-shutter glasses)

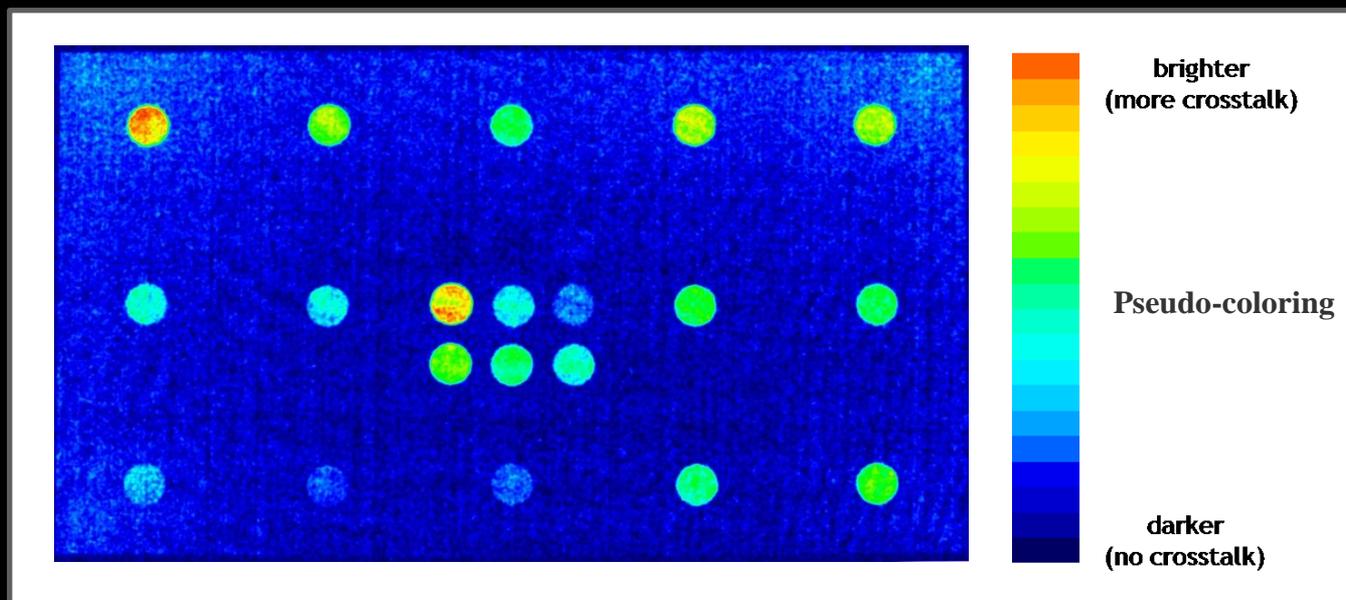


- Contrast variation with position on screen for given observer position



- Contrast variation with field of view

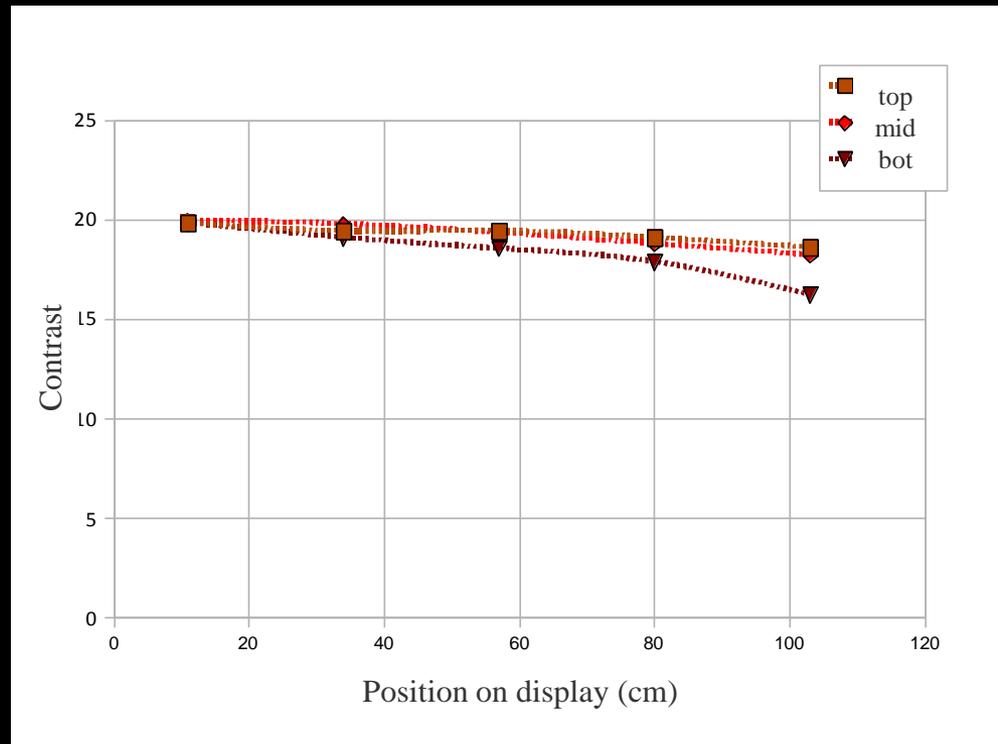
# Spatial variability: LCD panel (active-shutter glasses)



Luminance of the right channel with red patches on the left channel (crosstalk image)

- Crosstalk is not uniform across display surface
- Results shown for red patches; similar variations for green and blue

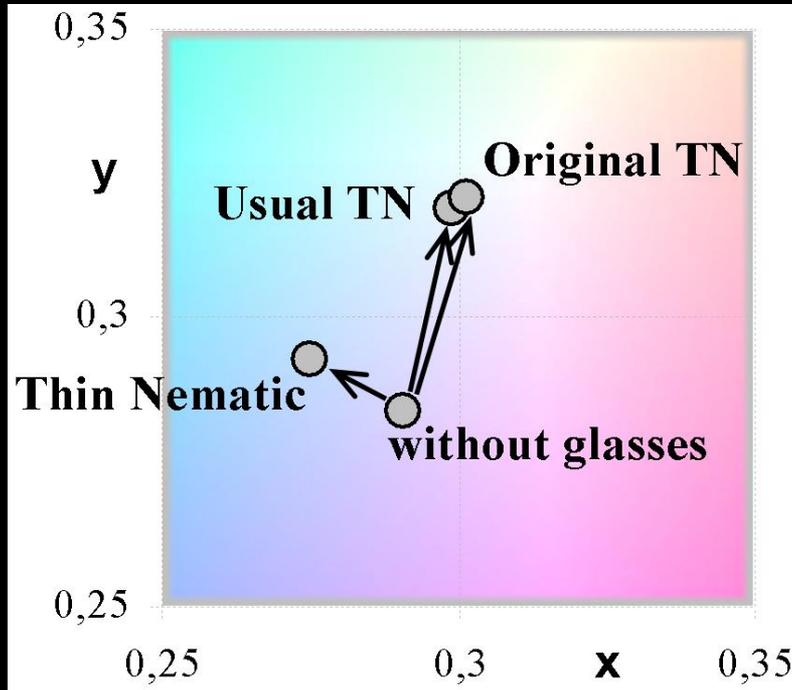
# Spatial variability: PDP panel (active-shutter glasses)



- Some small contrast variation with position on screen
- Much less variation compared to LCD

# Color changes: active-shutter glasses with PDP panel

x and y coordinates of the CIE 1931 color space



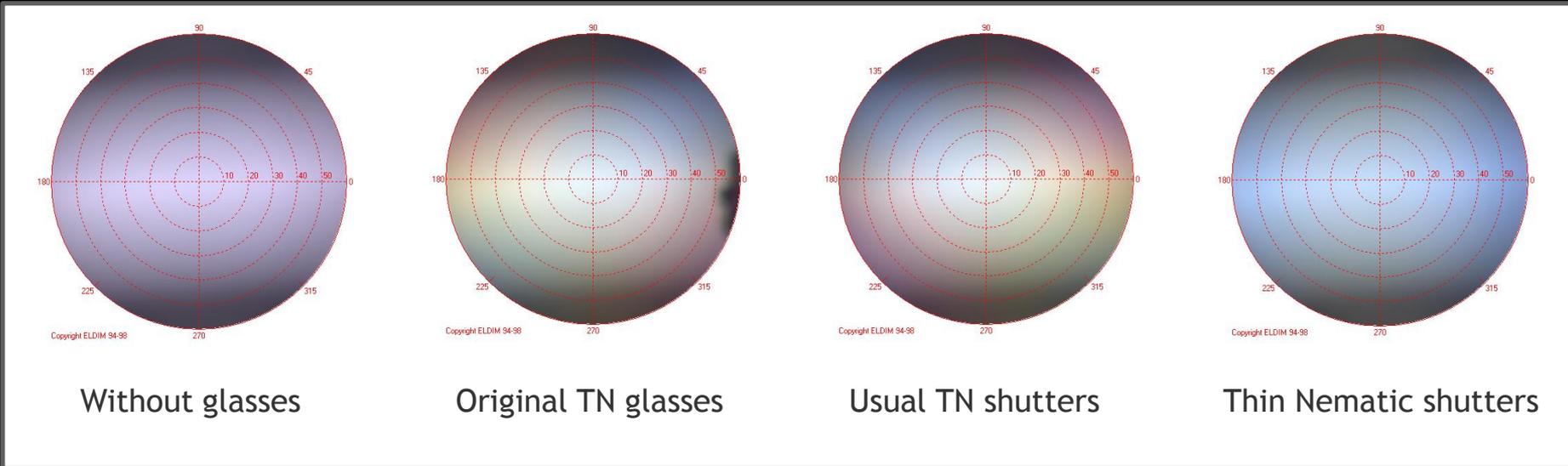
Color changes for a white image displayed on PDP and viewed through different technologies of active-shutter glasses

Display color was set on 'normal' mode

Brightness and contrast set to medium level

- All active-shutter glasses introduced hue changes
- The color changes could be compensated by image pre-processing
- Nevertheless, this compensation could be possible only if the hue changes are uniform for all viewing directions

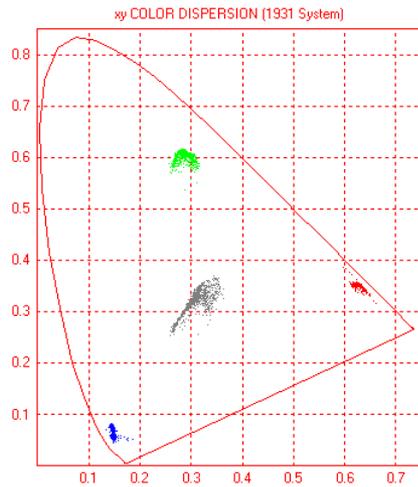
# Plasma Display Panel: viewing angle dependency



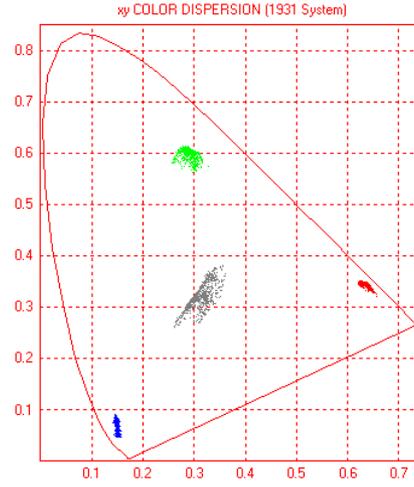
Angular dependence of the color for a white screen viewed without glasses and with glasses using various technologies of shutters

- The color changes produced by the Thin Nematic shutters [newer technology] are weaker
- Angular dependency of Thin Nematic shutters is smaller
- An influence of glasses technology choice on observed images

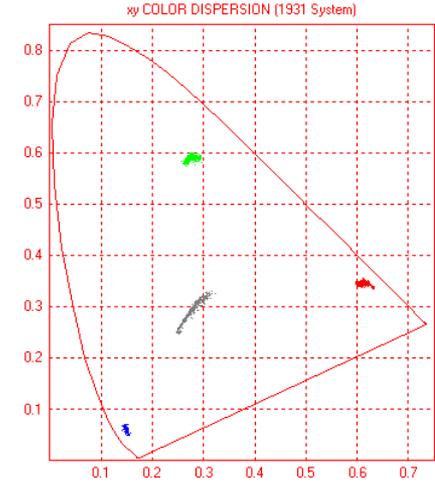
# Plasma Display Panel: viewing angle dependency



Original TN glasses



Usual TN shutters

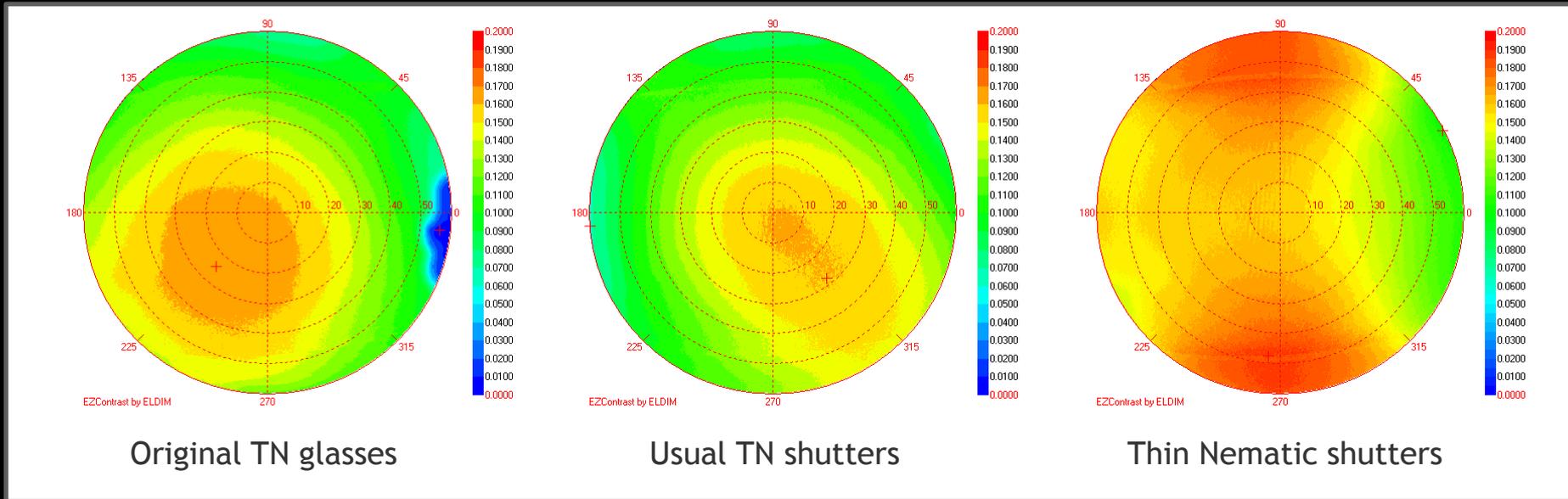


Thin Nematic shutters

Color dispersion of the White (grey dots), Red, Green and Blue for screens viewed through active-shutter glasses with various technologies

- TN shutters: lack of uniformity of the color changes for both
- Thin Nematic shutters: exhibit a smaller color dispersion with viewing angle

# Plasma Display Panel: viewing angle dependency



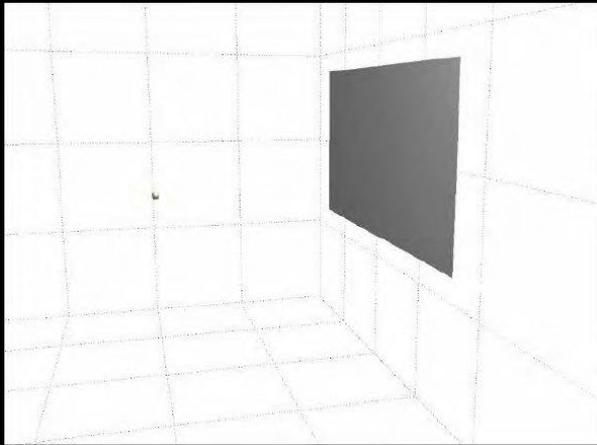
Angular dependence of the optical transmission for a white screen for operating glasses using various technologies of LCD shutters

- Angular dependence for the different shutter technologies
  - TN shutters: preferential viewing direction at 45° beside the polarizers
  - Thin Nematic shutters: viewing angle is more symmetric

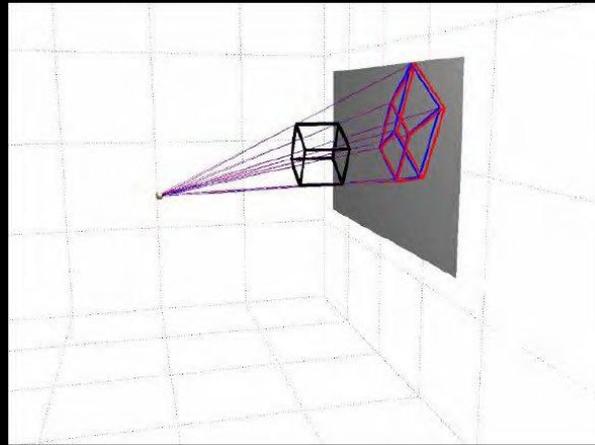
# Geometric distortions due to viewing angle

From J. Read, 'Why does S3D work?'

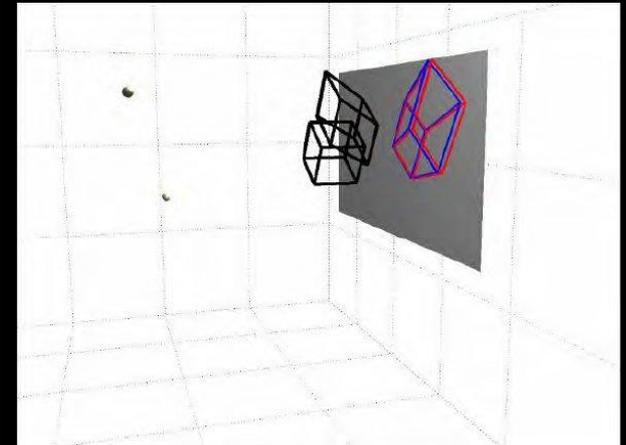
One viewer



One viewer viewing  
a cube in 3D



Two viewers viewing the same  
projection of 3D object



- The same image specifies two different geometric 3D objects for two different viewers at two viewing angles

# Conclusions

---

## ■ Conclusions:

- Influence of display technology on optimum placement of viewer
- Influence of glasses technology choice on observed images

## ■ Proposals:

- Use of only one viewer at a time placed [horizontally and vertically] centrally in front of screen
  - Guarantee that all viewers will be exposed to the same rendering (minimize angular variations/dependencies)
- If several viewers are used simultaneously
  - Display must be clearly measured and characterized due to variations with viewing angle influencing rendering
  - Display characteristics have to be reported in subjective experiment information

# References

---

- 3D (geometric) distortion and viewing angle

[1] J. Read, “Why does S3D work?”,

[http://data.memberclicks.com/site/hopa/2012\\_TR\\_Pres\\_JennyRead.pdf](http://data.memberclicks.com/site/hopa/2012_TR_Pres_JennyRead.pdf)

- 3D display measurements

[2] L. Blondé, J.-J. Sacré, D. Doyen, Q. Huynh-Thu, and C. Thébault, “Diversity and coherence of 3D crosstalk measurements,” in Society of Information Display (SID) Symposium, June 2011, vol. 42(1), pp. 804-807

[3] L. Blondé *et al.*, “Towards adapting current 3DTV for an improved 3D experience,” in Proc. IS&T/SPIE Conference on Stereoscopic Displays and Applications, San Francisco, vol.8288, Jan. 2012

[4] ICDM, SID, VESA “Information and Display Measurements Standard”, June 2012

<http://www.icdm-sid.org>

# Acknowledgments

---

- Some figures and measurements were provided by Telecom Bretagne / E3S