Characterizations of 3D TV: Active vs Passive

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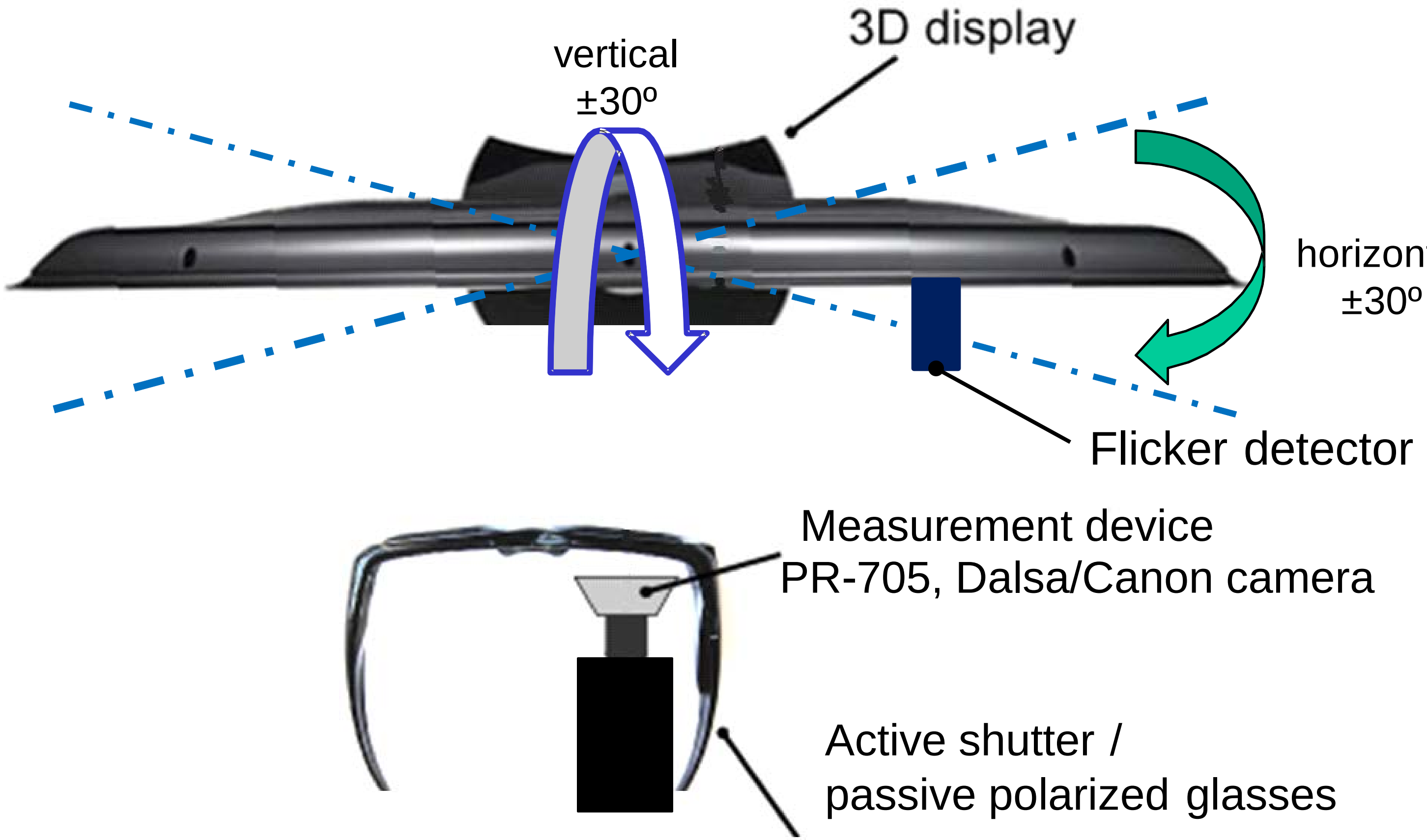
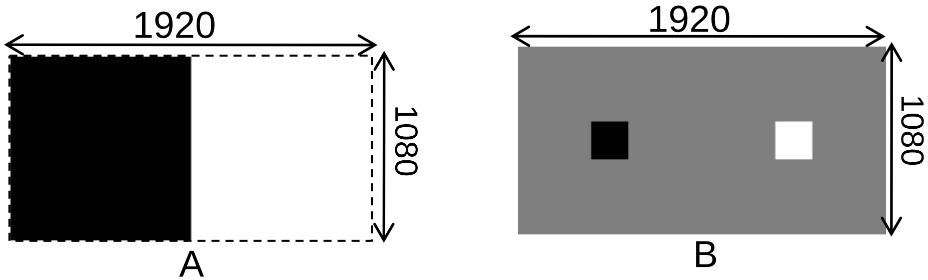
Introduction

- Compare active vs passive
  - Two 55 inch 3D TV: one active shutter glasses and one passive frame pattern retarder (FPR)
- TCO 3DTV methods and requirements
- Involvement in ICDM
- Tested parameters
  - Angular dependent Crosstalk
  - Resolution
  - Flicker visibility
  - Luminance
  - Colour

Basic test set-up



Angular dependent crosstalk measurement Background



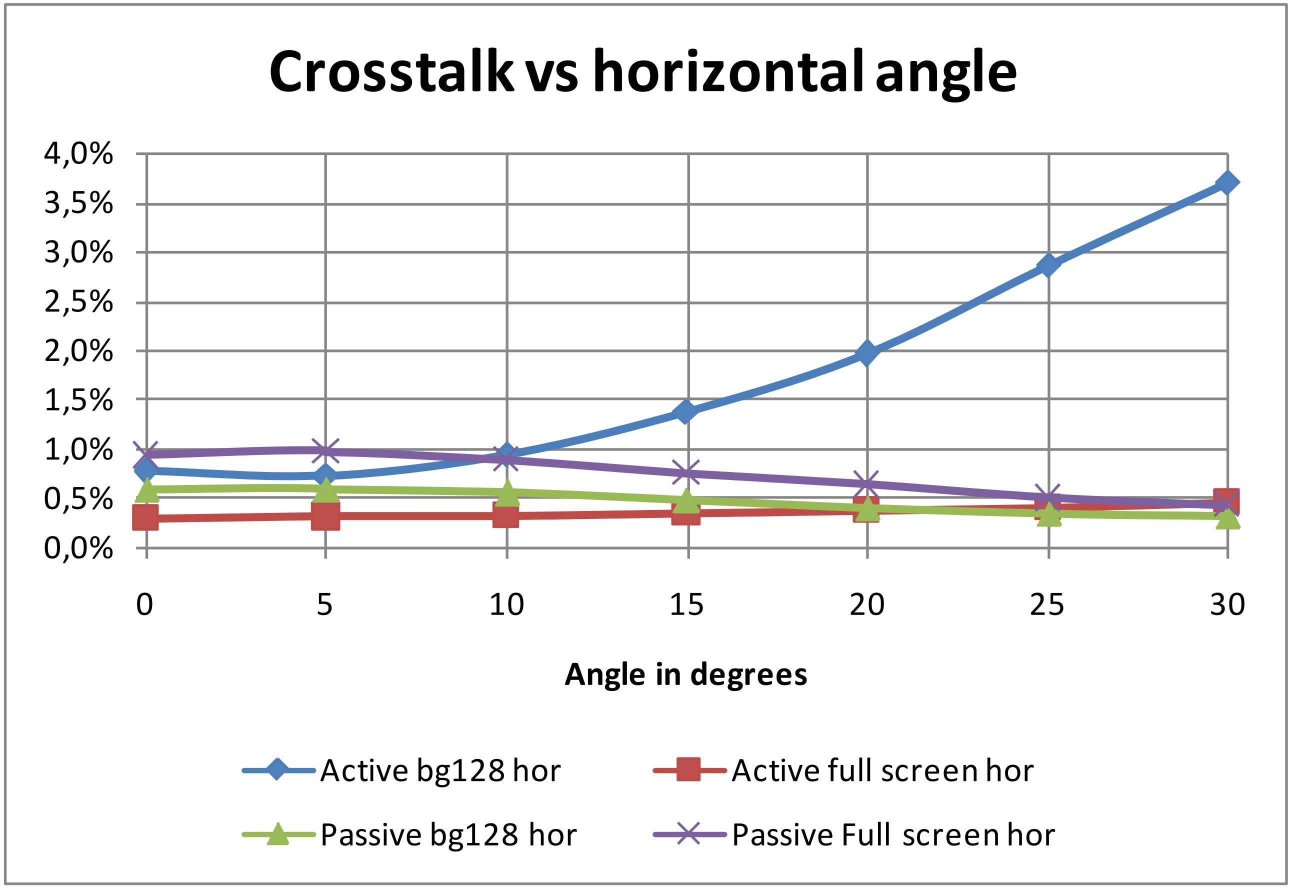
- Test crosstalk horizontal and vertical angle.
- Tests influence of test image design
- Two different test patterns (side-by-side)
    - A full screen (left) and B on 128 grey (right).
- B turns dynamic backlight off
- B closer to real imagery on average grey level

Angular dependent crosstalk measurement Method

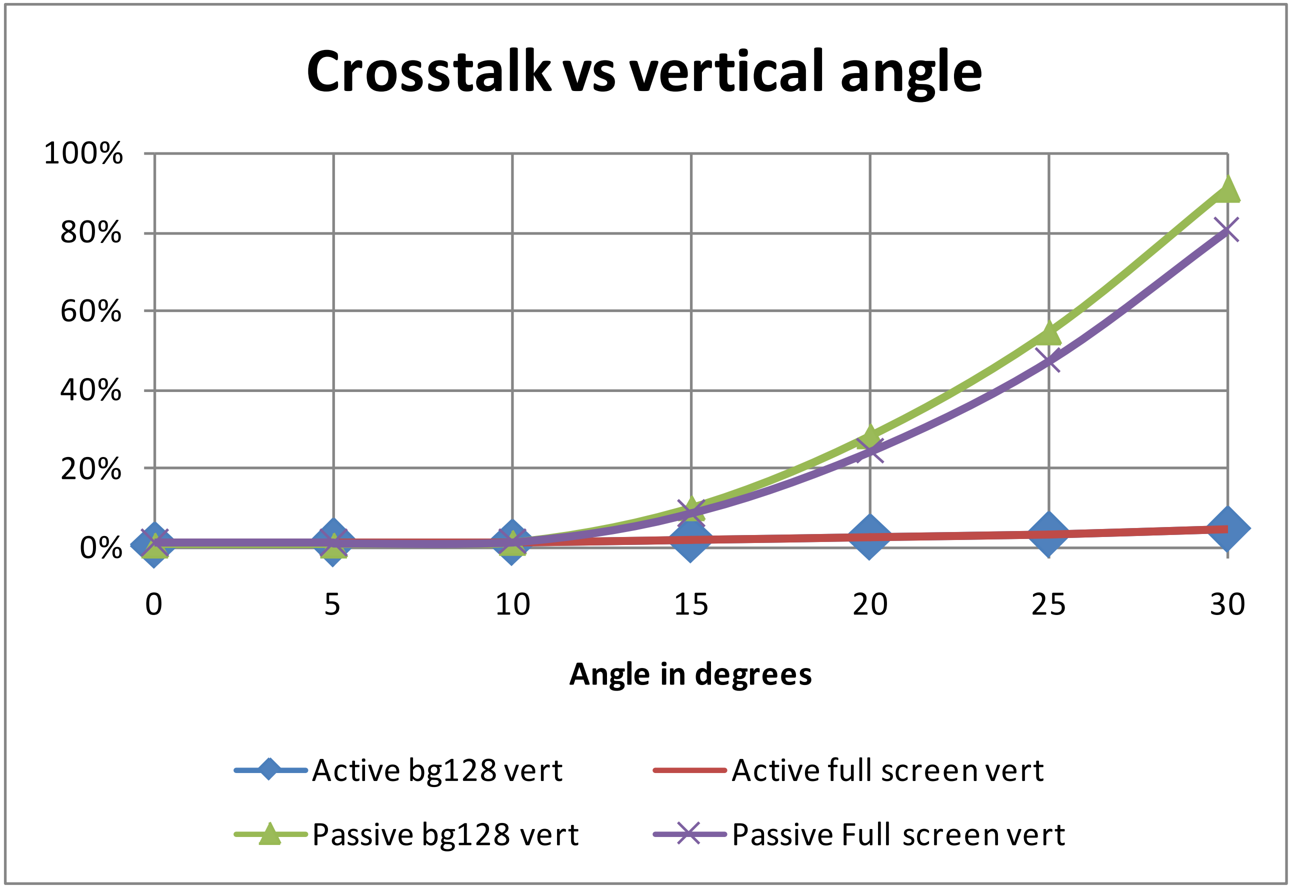
- NVIDEA 3D vision
- PhotoResearch 705 spectroradiometer
- Crosstalk calculated using:

$$\text{Crosstalk}(\%) = 100 \cdot \frac{L_{bw} - L_{bb}}{L_{wb} - L_{bb}}$$

Angular dependent crosstalk measurement
Results



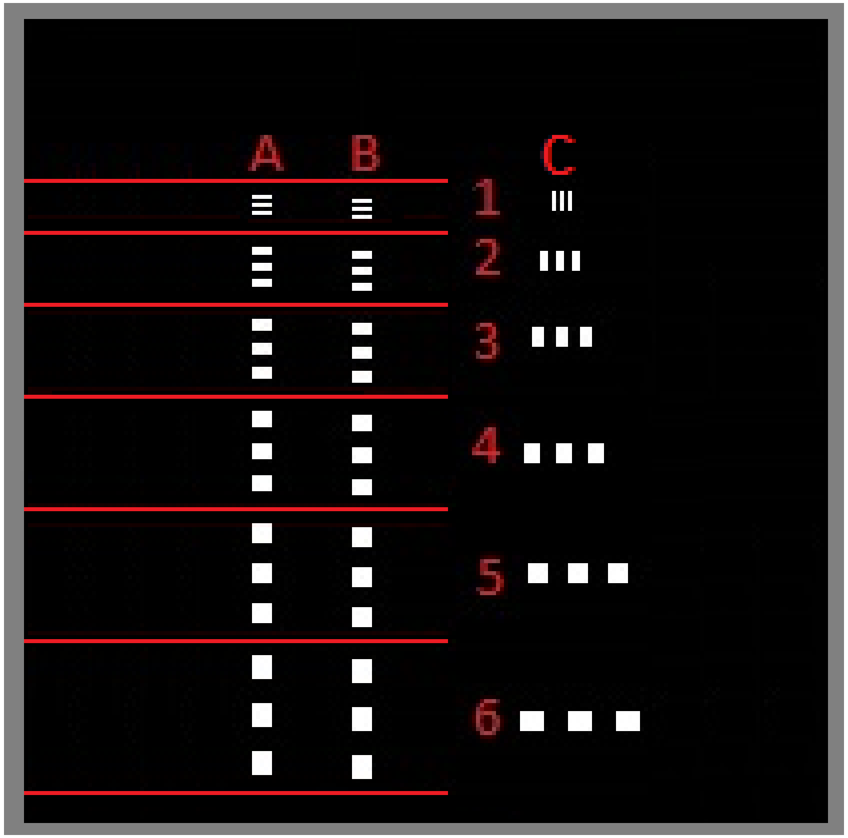
Angular dependent crosstalk measurement Results



Angular dependent crosstalk measurement
Conclusions

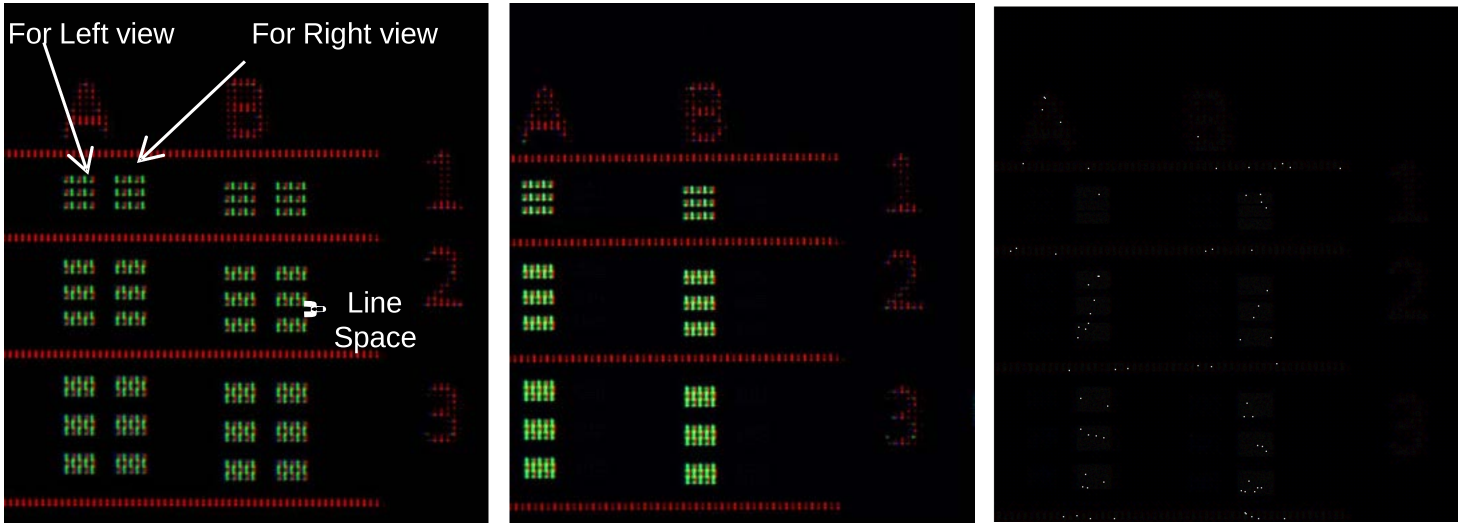
- Passive
  - More sensitive for vertical positioning
  - Crosstalk increase rapidly > 10 degrees (vertical)
- Active
  - Some sensitivity to test pattern
  - Still quite low crosstalk
  - May be influence of dynamic backlight
- L_{bb} usually very small minor influence

Resolution test
Test target



- 3 columns (A, B and C)
- 6 groups in vertical direction of bar patterns (1 to 6)
- The B column is shifted 1 vertical pixel line down from the A column
- A and B for vertical resolution and C column is for horizontal
- The 6 groups contain 3-bars with a bar thickness of 1 pixel line (group 1) to 6 pixel lines (group 6)

Resolution test
Active shutter-glass 3D TV



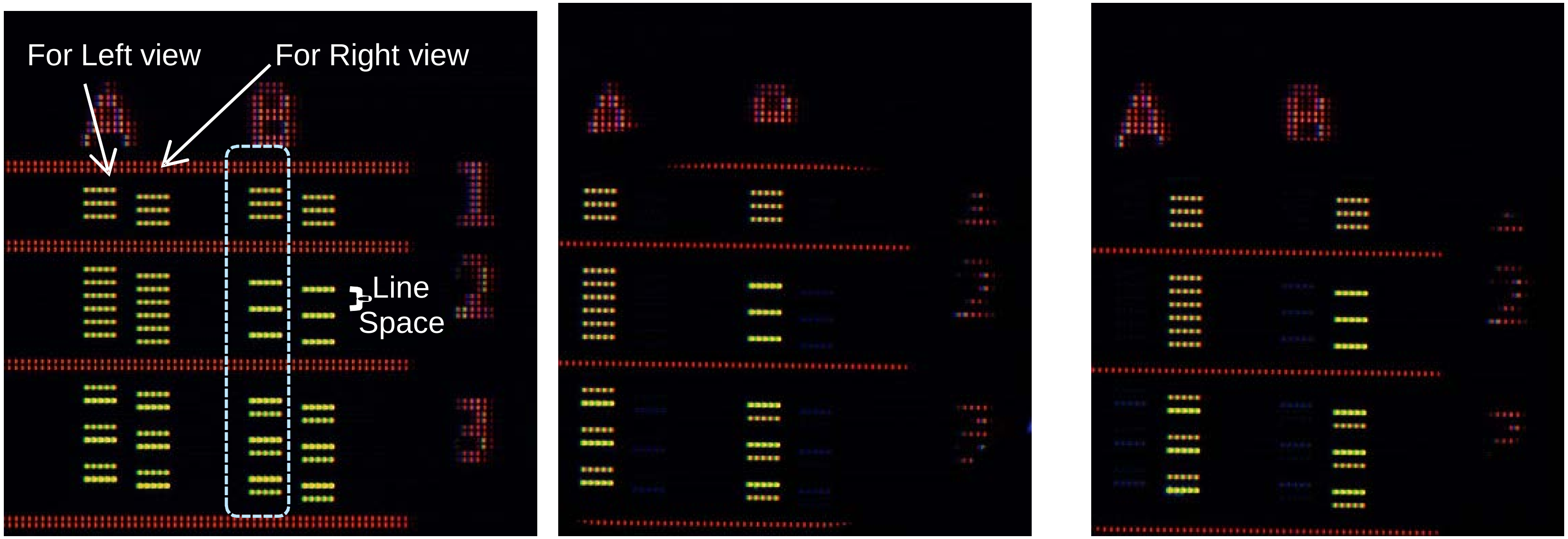
(a) 3D Without Eye-glass (b) Though left eye-glass (c) Though right eye-glass

All 6 groups of bars in the vertical test pattern are shown correctly for all columns (A & B)

Resolution test
Passive FPR 3D TV

Passive FPR 3DTV in 2D-mode

Resolution test
Passive 3D TV



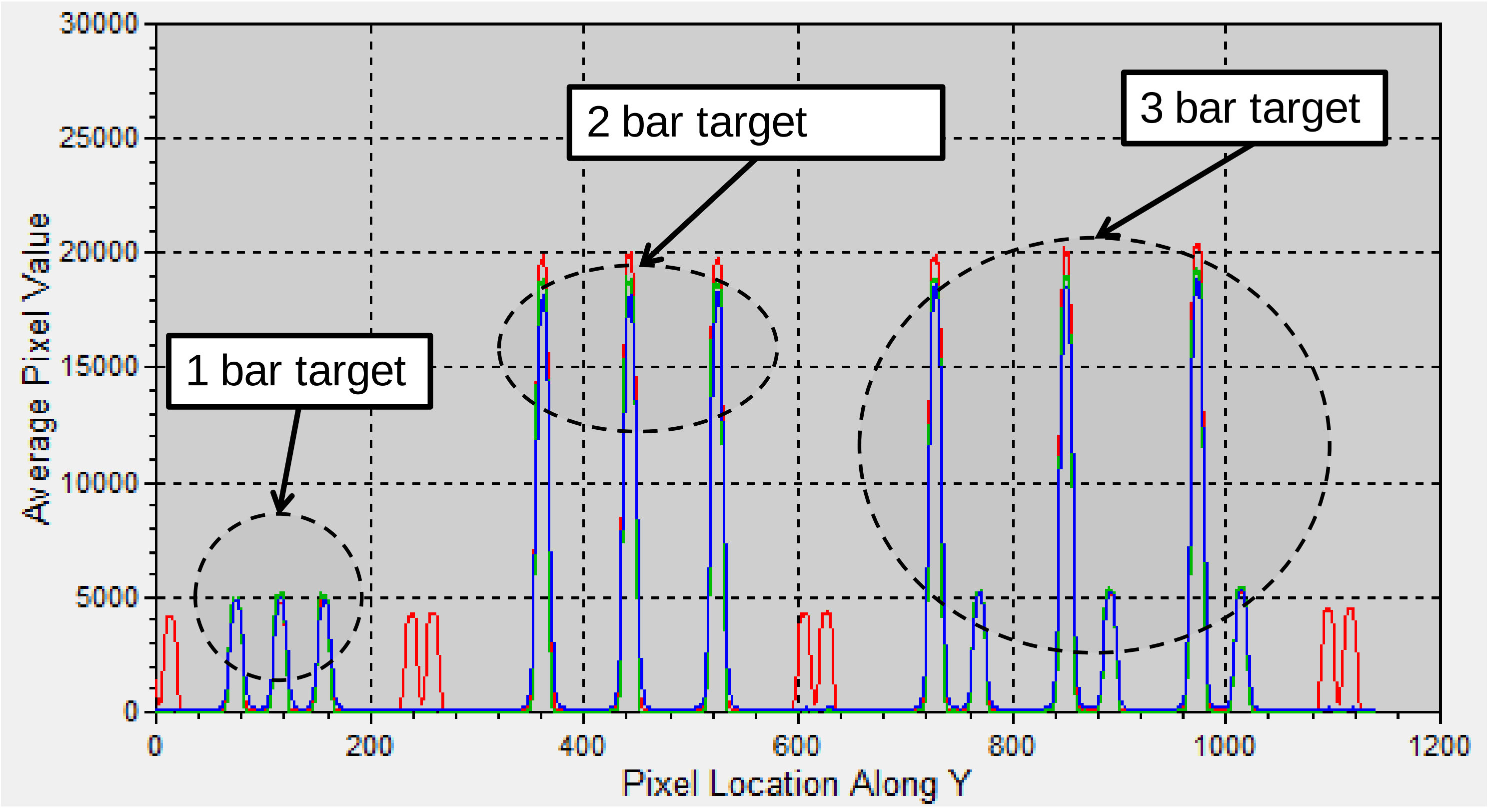
(a) 3D Without Eye-glass (b) Though left eye-glass (c) Though right eye-glass

Group 1: Able to reproduced

Group 2: Not able to reproduce. Affects by one pixel shifts

Group 3: Not able to reproduce. Affects by one pixel shifts

Resolution test
Intensity distribution on passive 3D TV



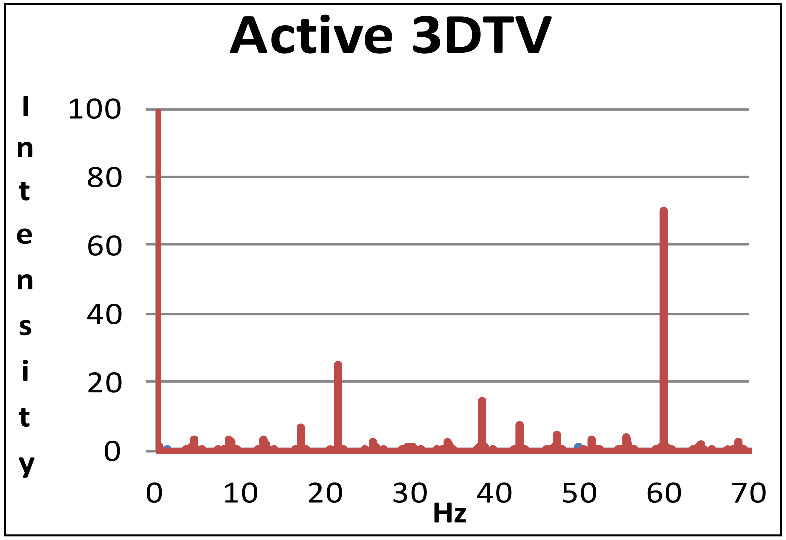
Flicker visibility
Background

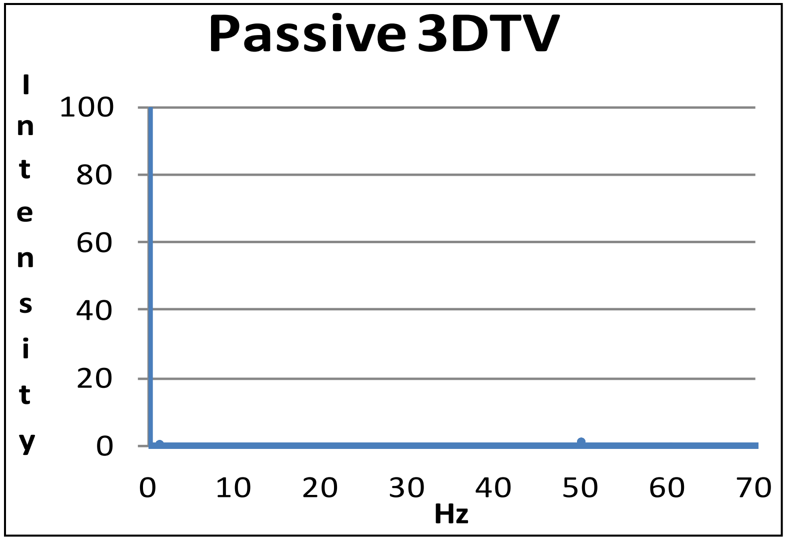
- Test if we can expect flicker from 3DTV
- To get an idea about the levels to expect
- To evaluate the ICDM procedure
- To evaluate methods for the TCO 3DTV and find suitable requirement
- To see how much the eye-glasses could influence the results

Flicker visibility Method

- Computer controlled oscilloscope (PicoScope 3204)
- Hagner V(λ) corrected detector SD3 Extra sensitive
- Amplifier is made by Acreo
- Measurements with and without eye-glasses

Flicker visibility
Results





- At 0Hz the relative intensity is 100%
- The relative intensity is 70% at 60Hz
- At about 22Hz the intensity is 25%
- At about 39Hz the intensity is 17%
- The Passive 3DTV has no problem

Flicker visibility Calculations

$$J_{flicker} = TCSF(R) \times C_R$$

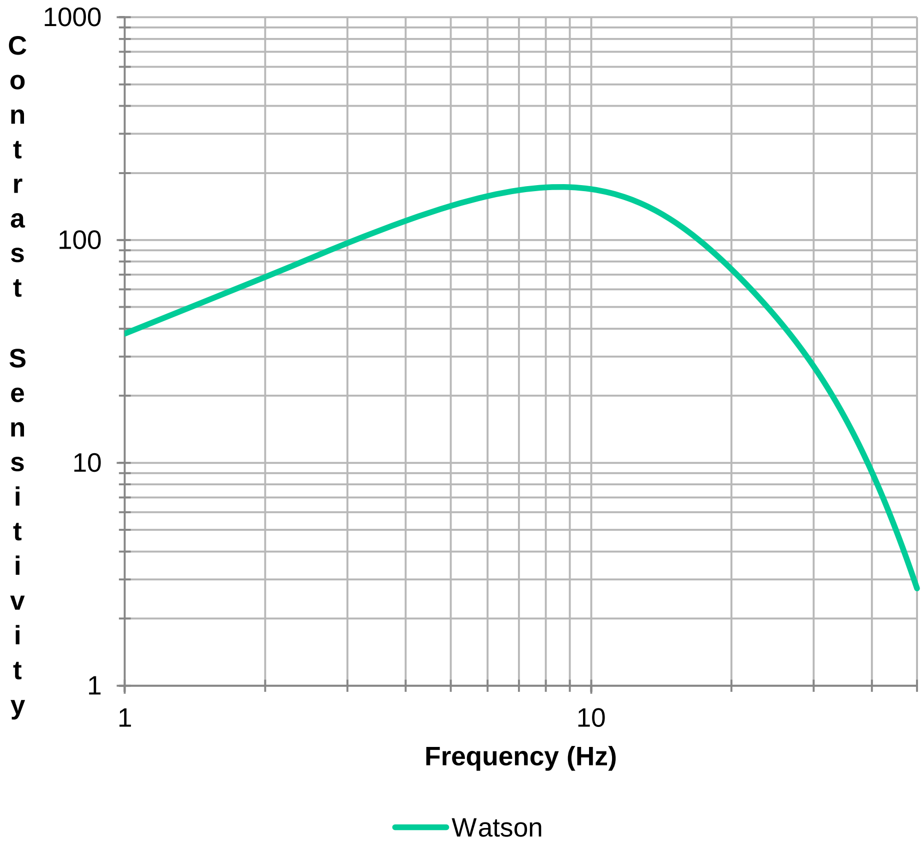
$$C_R = 2 \times \left|\frac{K_{Nf}}{K_0}\right|$$

•In this example, for the active 3DTV the C_R is *2 x 0.25 = 0.5* for the peak at about 22Hz .

•The *TCSF* is about 63 at 22Hz giving a Flicker visibility $J_{flicker}$ of about 31jnd.

•The peaks of about 39 Hz and at 60 Hz give only about 1 jnd due to the TCSF is so low.

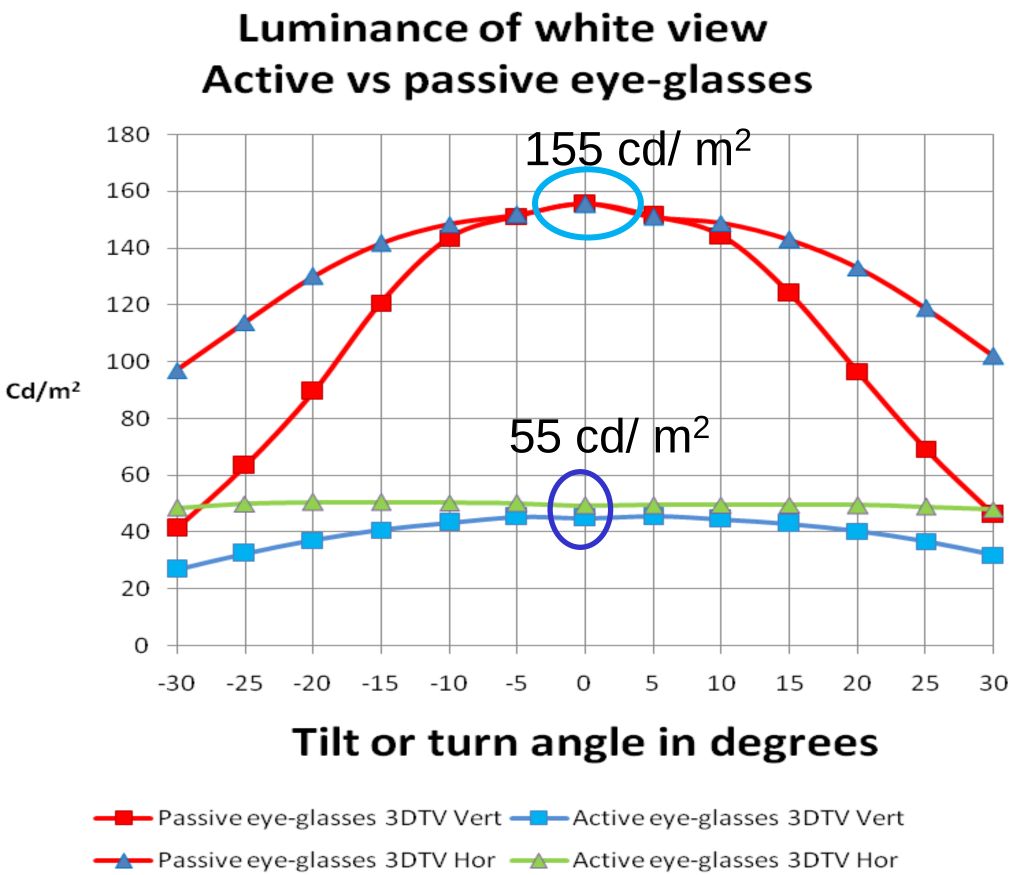
Temporal Contrast Sensitivity Function TCSF



Flicker visibility
Discussion

- Flicker problem for active not for passive.
  - 22 Hz flicker observed on other active 3DTVs - intensities varies
  - The 22 Hz flicker is not due to eye-glasses and is present at all 3D modes and inputs
  - Influence of eye-glasses is very small
- Flicker visibity evaluation
  - Furthermore, more research is needed to see the influence of real images and videos
  - Many more test subjects are needed. In the studies performed so far too few have been used (Barten 1999; De Lange, 1956).

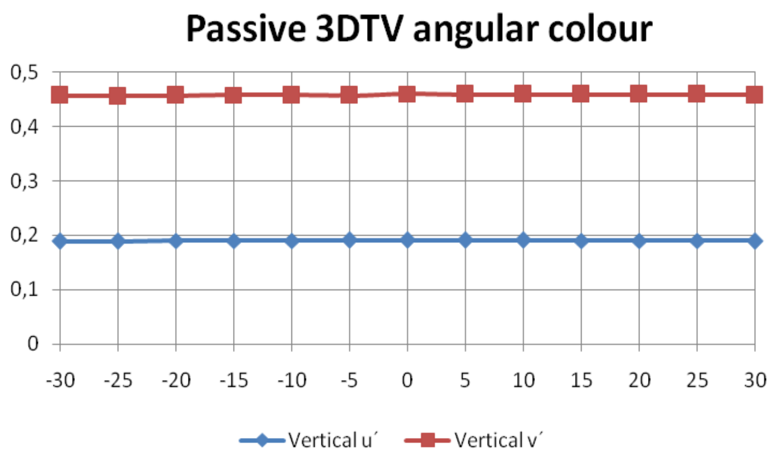
Luminance measurement

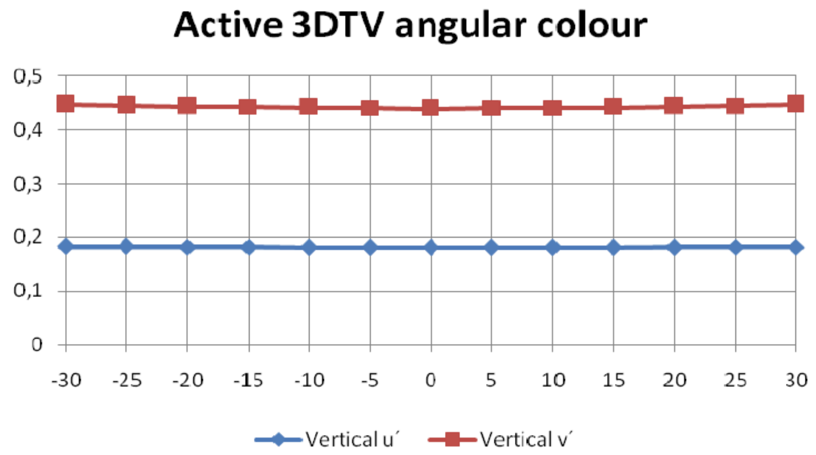


- Luminance 2D mode (without glasses): both types about 300 cd/ m^2
- Passive type transmittence 54%; active type 18%
- Passive luminace angular fall-off 1.6:1 (horizonal 0-30º), 1.3:1 (vertical 0-15º)
- Active type has better angular characteristic, but lower transmitted luminance

Colour measurement

Colour characteristics expressed in CIE 1976 u´v´-values



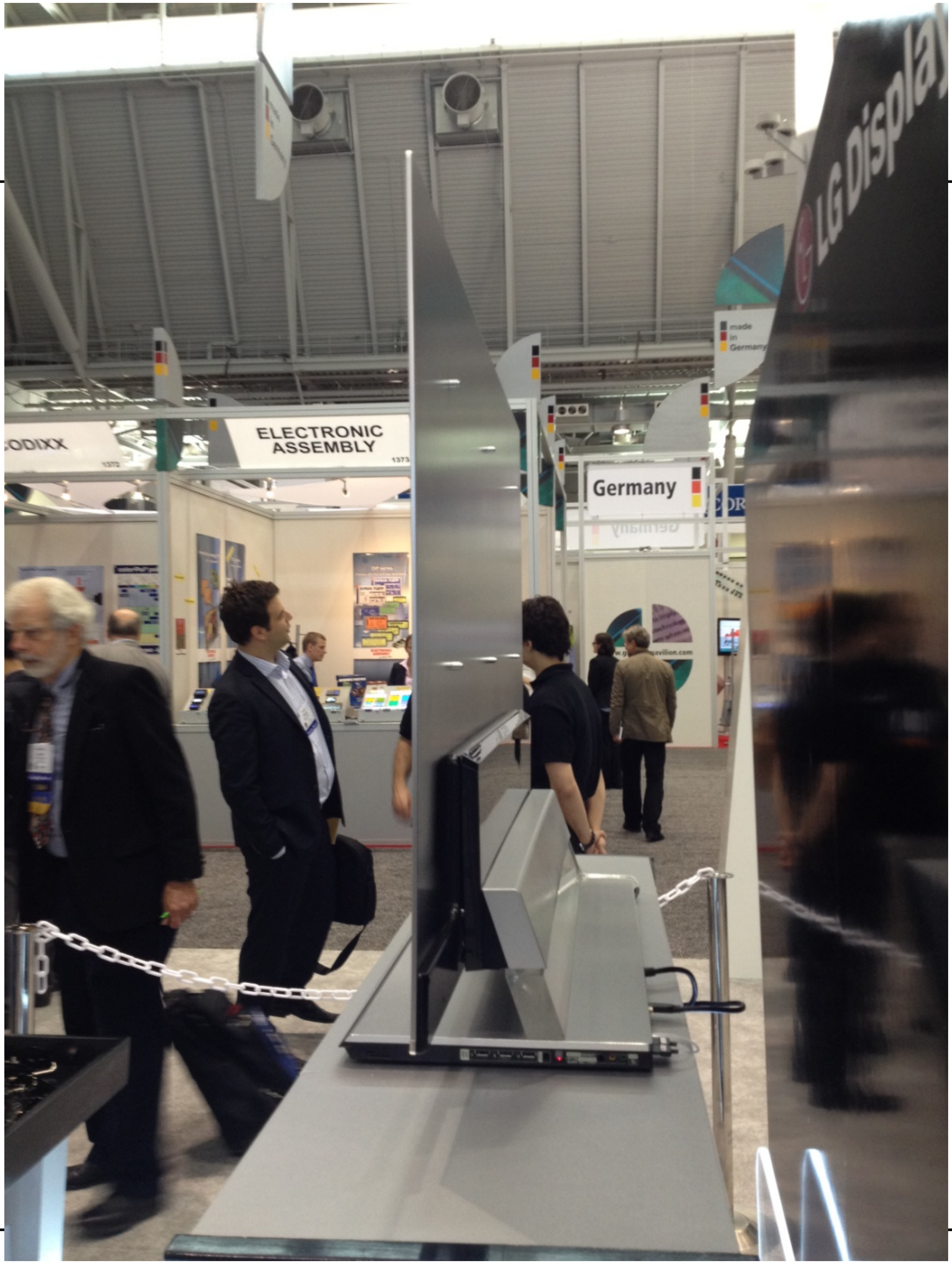


Colour temperature (K)	passive	active
2D mode	7500-8500	8000-8500
3D mode	7500-8500	11500
MireK shift (10e6/CCT)	15	38

General conclusions

- **Angle dependent crosstalk**
  - Passive problems vertically
  - Test pattern influenced active horizontal crosstalk
- **Resolution**
  - Active no resolution reduction
  - Passive shows problems reproducing a number of small scale patterns
  - Comes from subsampling step
- **Flicker**
  - Active shows disturbing flicker at 22 Hz
  - Passive show no flicker
- **Luminance**
  - Active less angular dependence, but lower absolute transmittance
  - Passive more angular dependence, but higher absolute transmittance
- **Colour**
  - No angular dependence
  - Active glasses has an influence on colour temperature

SID '12 OLED Breakthrough


ELECTRONIC
ASSEMBLY
Germany
LG Display


Please
don't touch.
3D OLED
SAMSUNG

SID ’12 Interesting presentations

Comparison of Simultaneous Measurement of Lens Accommodation and Convergence in Natural Vision and 3D Vision

Tomoki Shiomi et al

University of Fukui, Nagoya Bunri Unversity, Kobe Women's University, Aichi Gakuin University,Fukuyama City University, Japan

SID ’12 Interesting presentations

Effective Spatial Resolution of Temporally and Spatially Interlaced Stereo 3D Televisions

Joohwan S. Kim, Martin S. Banks

Vision Science Program, University of California, Berkeley

•Finally we would like thank our sponsor:

•Acreo’s work was supported by VINNOVA (The Swedish Governmental Agency for Innovation Systems), TCO Development and Intertek Semko

Thank you

Resolution test
Results

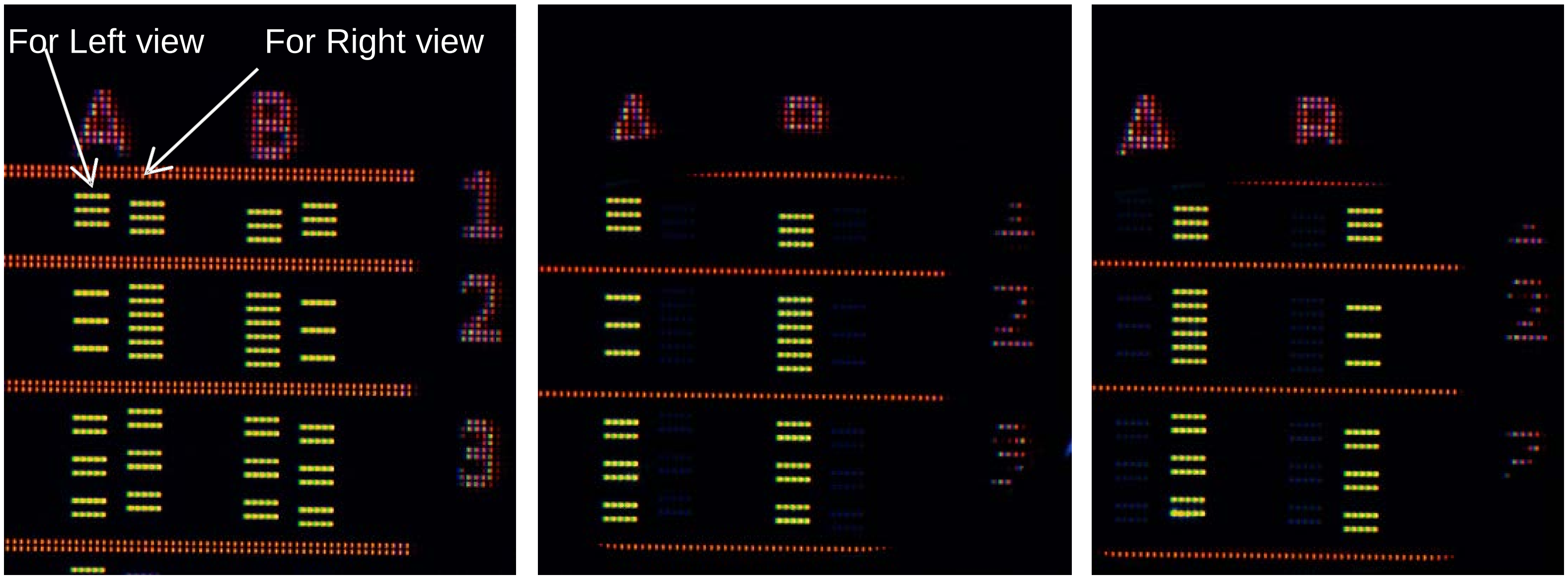
- The left view B1 bar target has 3 groups and the correct number of bars, but the intensity is about ¼ of B2
- The left view B2 bar target has 3 groups and correct intensity, but the bars are ½ width
- The left view B3 bar target has 3 groups, but the groups consist of 2 bars instead of 3, with 1 bar with 1/4 intensity, 1 bar with full intensity and 1 bar is missing

Angular dependent crosstalk measurement Results continue

	Degrees→	0	5	10	15	20	25	30
	Direction→	hor	hor	hor	hor	hor	hor	hor
Active	**bg128**	**0,76%**	**0,73%**	**0,95%**	**1,38%**	**1,96%**	**2,86%**	**3,69%**
	Full screen	**0,30%**	**0,31%**	**0,32%**	**0,34%**	**0,37%**	**0,41%**	**0,45%**
Passive	bg128	0,59%	0,60%	0,55%	0,48%	0,40%	0,34%	0,33%
	Full screen	0,93%	0,97%	0,88%	0,76%	0,63%	0,50%	0,43%

	Degrees→	0	5	10	15	20	25	30
	Direction→	vert	vert	vert	vert	vert	vert	vert
Active	**bg128**	**0,76%**	**0,82%**	**1,21%**	**1,73%**	**2,58%**	**3,42%**	**4,43%**
	Full screen	**0,93%**	**0,93%**	**1,25%**	**1,80%**	**2,52%**	**3,41%**	**4,48%**
Passive	bg128	0,59%	0,73%	1,22%	9,98%	28,07%	54,54%	90,75%
	Full screen	0,93%	0,99%	1,46%	8,33%	24,35%	47,24%	80,37%

Bar test patterns displayed in Passive FPR *3D TV* (temporal interpolation function on)



(a) 3D Withouteye-glass (b) Thoughlefteye-glass (c) Thoughrighteye-glass

Luminance
Comments

- The 3D luminance is lower for the active eye-glasses 3DTV due to denser eye-glasses at the same 2D luminance than for the FPR
- The adaptation of the human visual system compensate for this but not to 100%.
- The angular luminance is less uniform for the FPR 3DTV than for the active 3DTV, but it is hard to see if you do not move horizontally or vertically.
- Surrounding objects like playing children will be harder to see if the eye-glasses are too dark in home environments.