Recent 3DTV studies @ Acreo

Kjell Brunnström

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MULTISCALE 2D LIKE DISTORSIONS 3DTV

SID 2013

- Brunnström, K., Ananth, I. V., Hedberg, C., Wang, K., Andrén, B., and Barkowsky, M. (2013). Comparison between different rating scales for 3D TV *SID Symposium Digest of Technical Papers*: *Proc of SID Display Week 2013, May 21-24, 2013, Vanvouver, Canada*, (pp. paper 36.4). SID Symposium Digest of Technical Papers: Society of Information Displays.

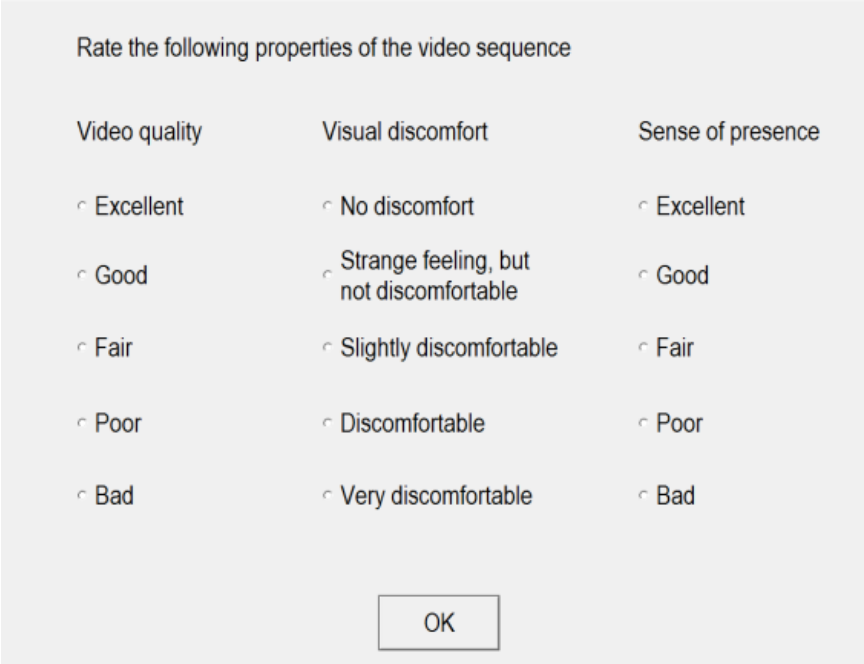
QUESTION

- Using a dataset with mainly 2D like degradations
- Will the Overall 3D experience follow the 2D video quality experience?
- Would one scale be sufficient?

EXPERIMENTAL METHOD

PVS1 | Vote | PVS2 | Vote | …

- **Video quality scale -** combined experience of 2D and 3D video quality.
- **Visual discomfort scale -** discomfort and the degree of it.
- **Sense of presence scale -** involvement or presence into the scene.



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EXPERIMENT DESIGN

- Splitting PVS in two set of equal quality distribution (Latin square)
- Repeating SRCxHRC set as common set (Basket)
- Two viewing distances (3H and 5H)

	3H	5H
Group 1	VideoSet A	VideoSet B
Group 2	VideoSet B	VideoSet A

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LAB ENVIRONMENT

- ITU-R Rec BT.500
- Hyundai S465D 46 inch
- White luminance 177 Cd/m^2 (78 Cd/m^2 eye-glasses
- Ambient illuminance about 150 lux
- Viewing distance 3H (2.1 m) and 5H (3.5 m)

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TEST PERSONS

- Naïve observers
- Various background (50% Swedish 50% international)
- 24 test persons kept (1 visually screened + 3 post screened)
- 9 test persons all conditions
- Age: mean 33.7, median 29, max 62 and min 18
- 32 % females
- Visual screening: visual acuity, colour vision, stereo acuity

VIDEO DATA

- NAMA3DS1 - COSPAD1 video dataset
- 10 source video (SRC)
- 11 degradations (HRC)
- 110 in total
- Duration 16 sec.










Urvoy, M., Barkowsky, M., Cousseau, R., Koudota, Y., Ricorde, V., Le Callet, P., Gutierrez, J., & García, N. (2012, July). NAMA3DS1-COSPAD1: Subjective video quality assessment database on coding conditions introducing freely available high quality 3D stereoscopic sequences. In *Quality of Multimedia Experience (QoMEX), 2012 Fourth International Workshop on* (pp. 109-114).

DEGRADATIONS

HRC	Type	Parameters
0	None – reference sequence	-
1	Video coding (H.264)	QP 32
2	Video coding (H.264)	QP 38
3	Video coding (H.264)	QP 44
4	Still image coding (JPEG2k)	2 Mbps
5	Still image coding (JPEG2k)	8 Mbps
6	Still image coding (JPEG2k)	16 Mbps
7	Still image coding (JPEG2k)	32 Mbps
8	Resolution reduction	Downsampling by a factor of 4
9	Image sharpening	Edge enhancement
10	Downsampling and sharpening	Combination of HRC8 and HRC9

RESULTS

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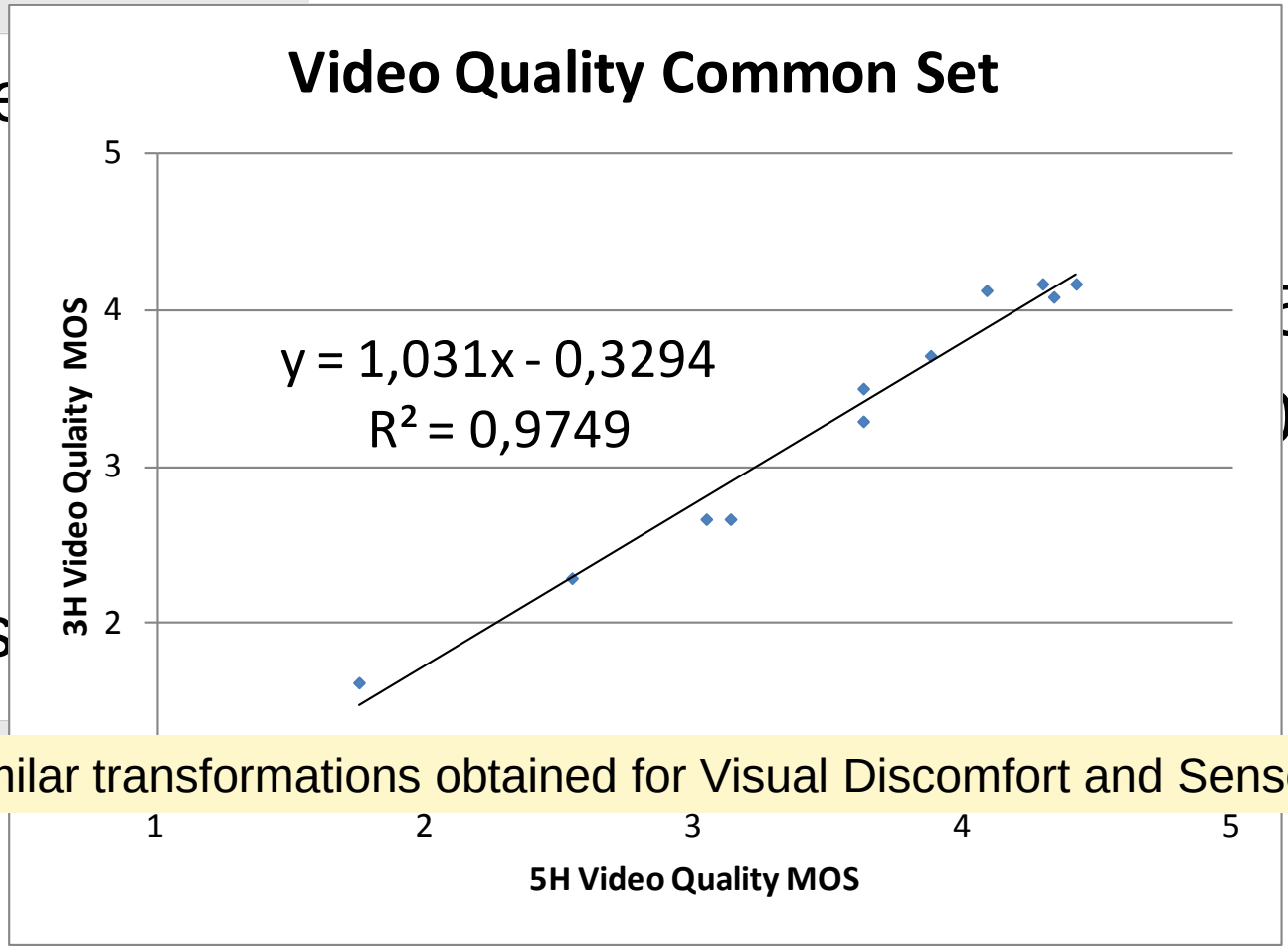
ANALYSIS COMMON SET

- Vie
  -
  - 5)
  - .30)
- Us 3H



Similar transformations obtained for Visual Discomfort and Sense of Presence

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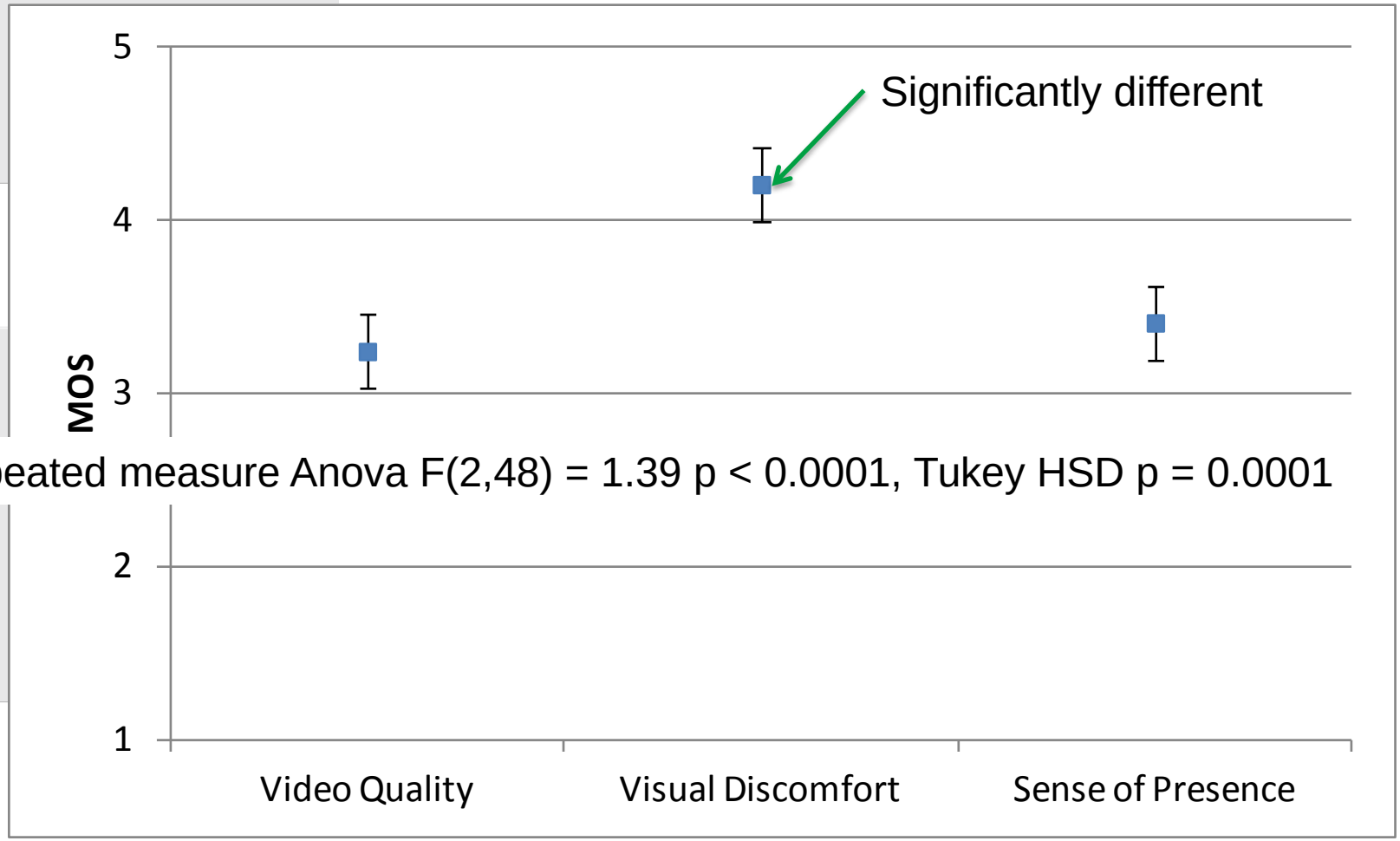
MAIN EFFECT



A repeated measure Anova $F(2,48) = 1.39$ $p < 0.0001$, Tukey HSD $p = 0.0001$

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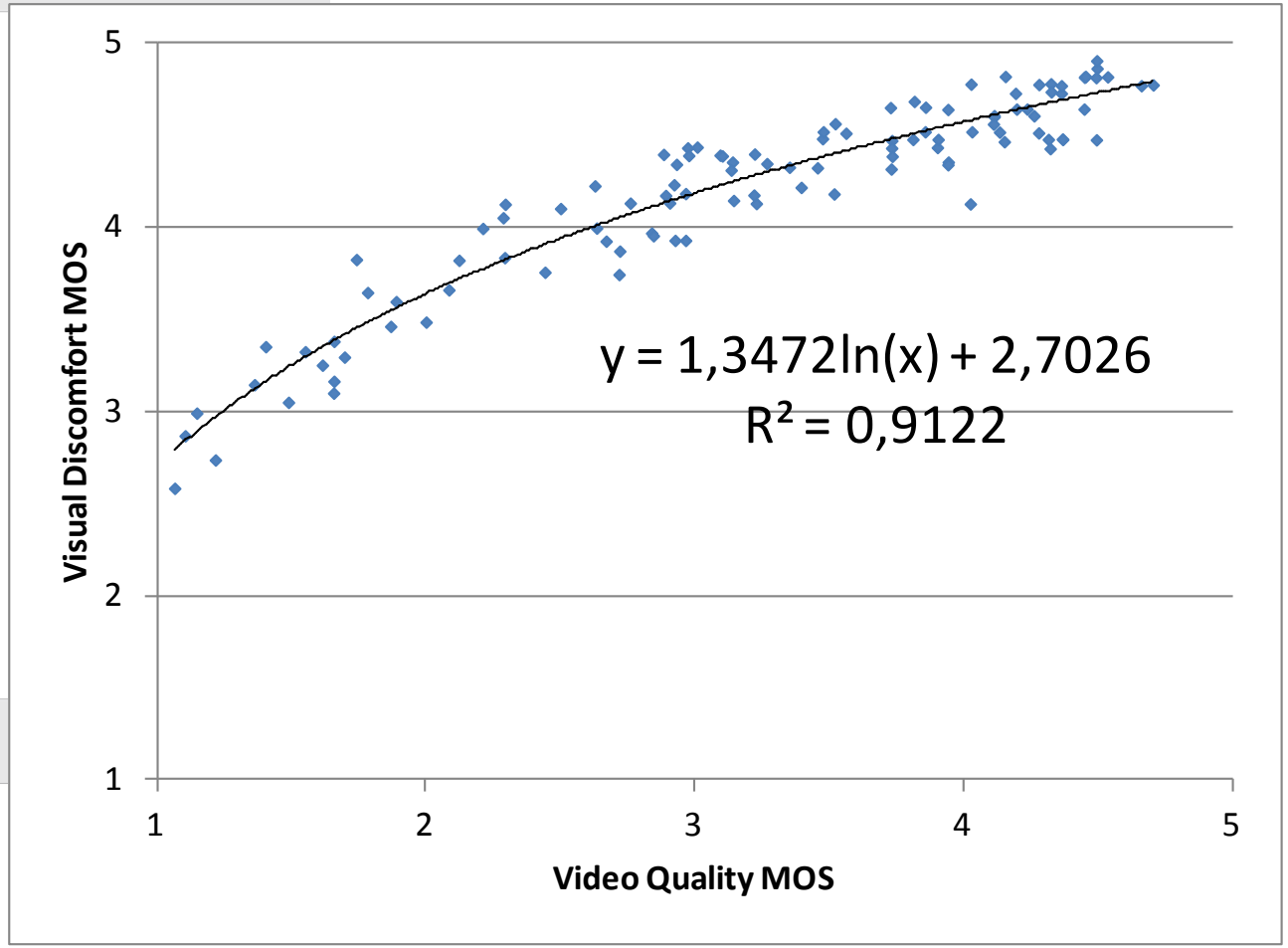
VIDEO QUALITY VS VISUAL DISCOMFORT



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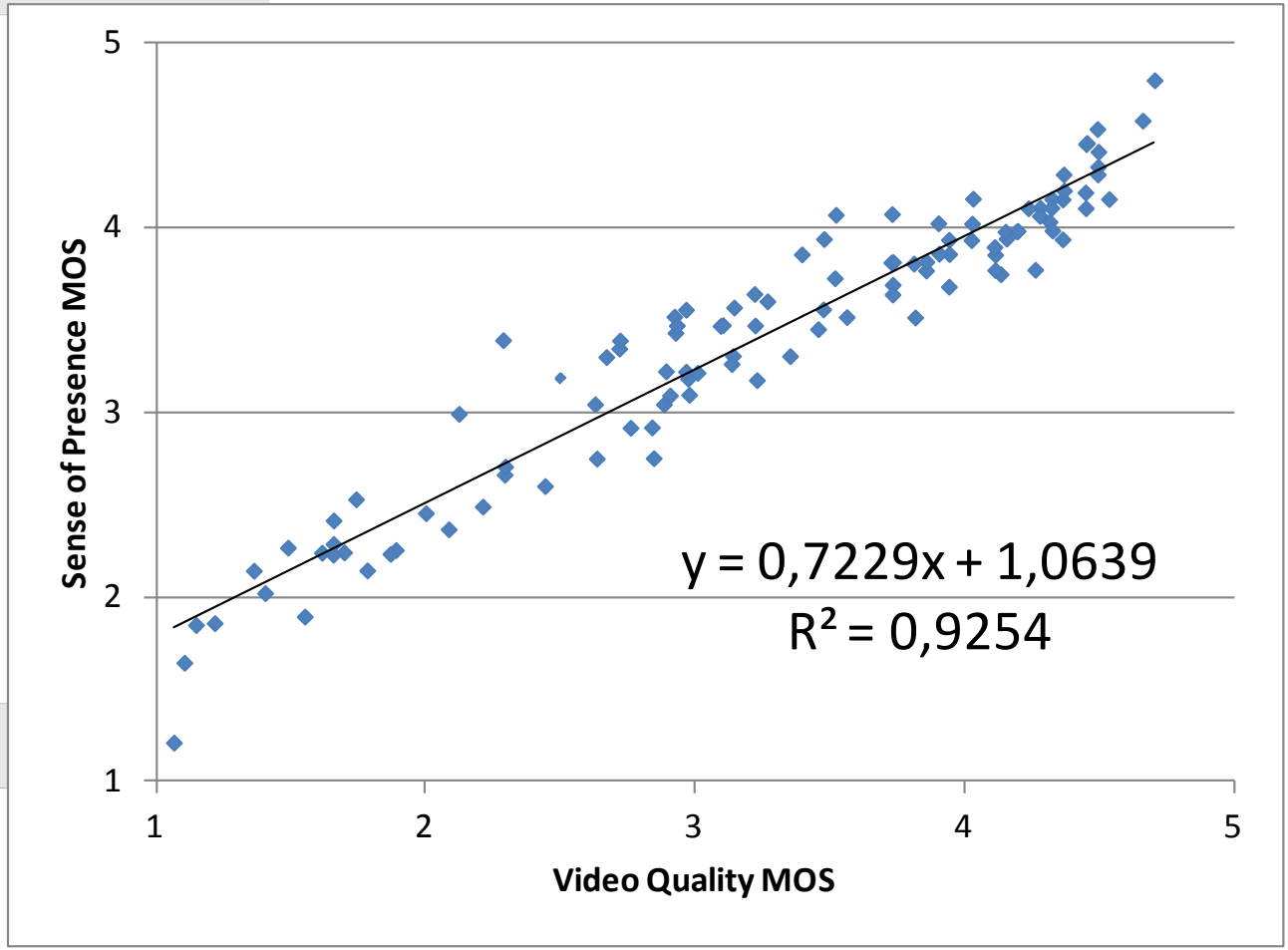
VIDEO QUALITY VS SENSE OF PRESENCE



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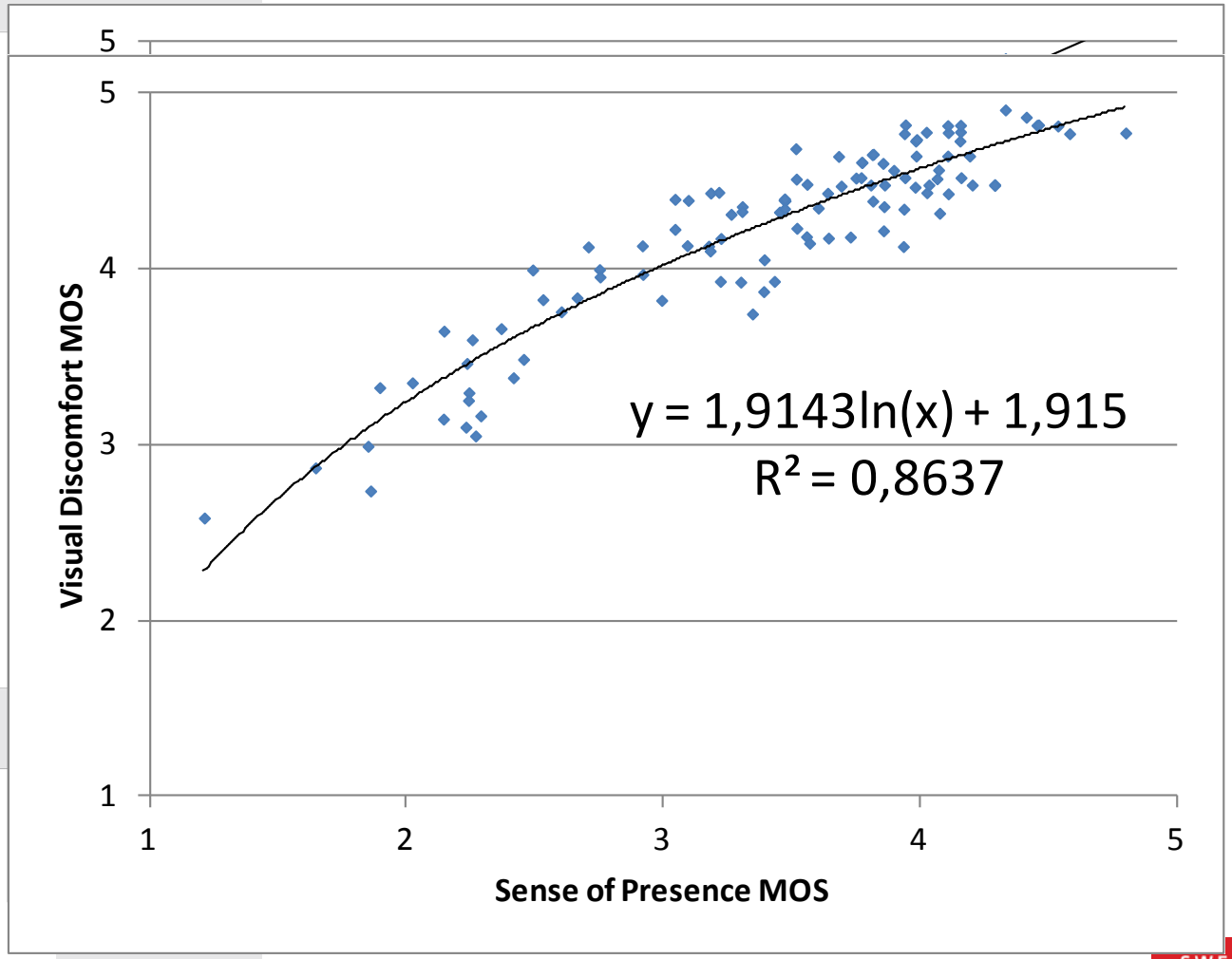
SENSE OF PRESENCE VS VISUAL DISCOMFORT



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MULTISCALE CROSSLAB 3DTV

QoMEX 2013

- Kulyk, V., Tavakoli, S., Folkesson, M., Brunnström, K., Wang, K., and Garcia, N. (2013). 3D Video Quality Assessment with Multi-scale Subjective Method *Proc of Fifth International Workshop on Quality of Multimedia Experience, QoMEX 2013, Klagen furt am Wörthersee, Austria*, (pp. paper 60). IEEE Xplore.

CROSSLAB AND MULTISCALE

- Labs: Ericsson Research and Acreo, Kista, Sweden
- Scales @ Ericsson: Depth Naturalness, Video Quality and Visual Discomfort
- Scales @ Acreo: 3D Realism, Depth Quantity” and Video Quality

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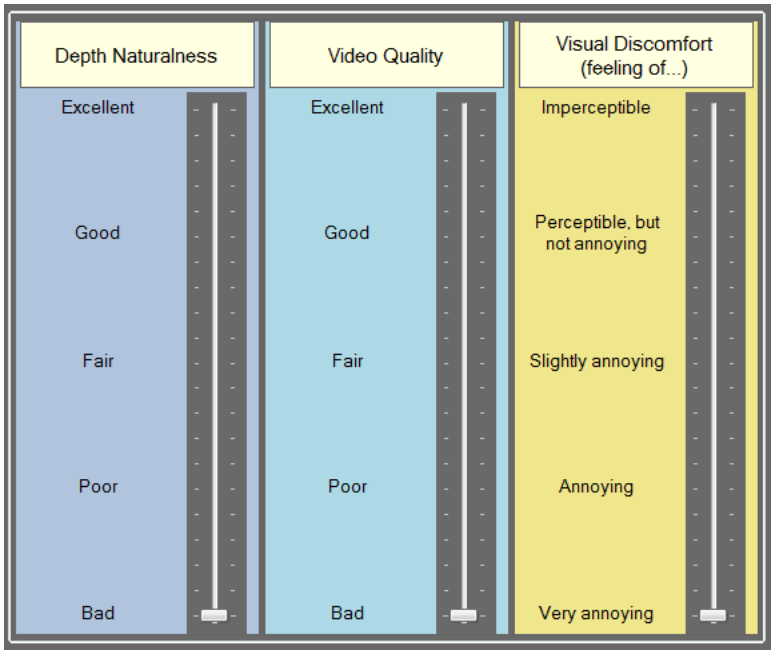
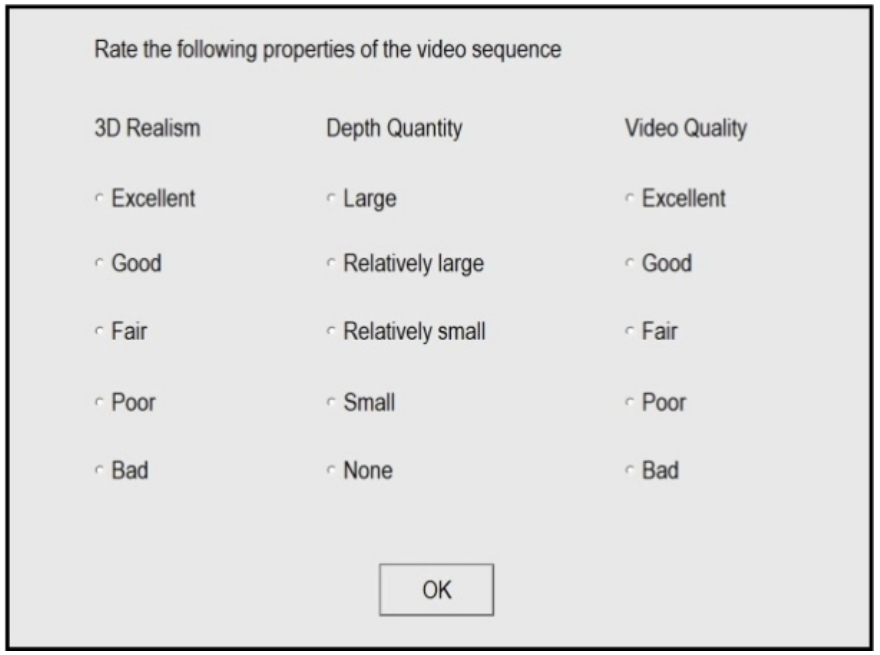
VOTING INTERFACES





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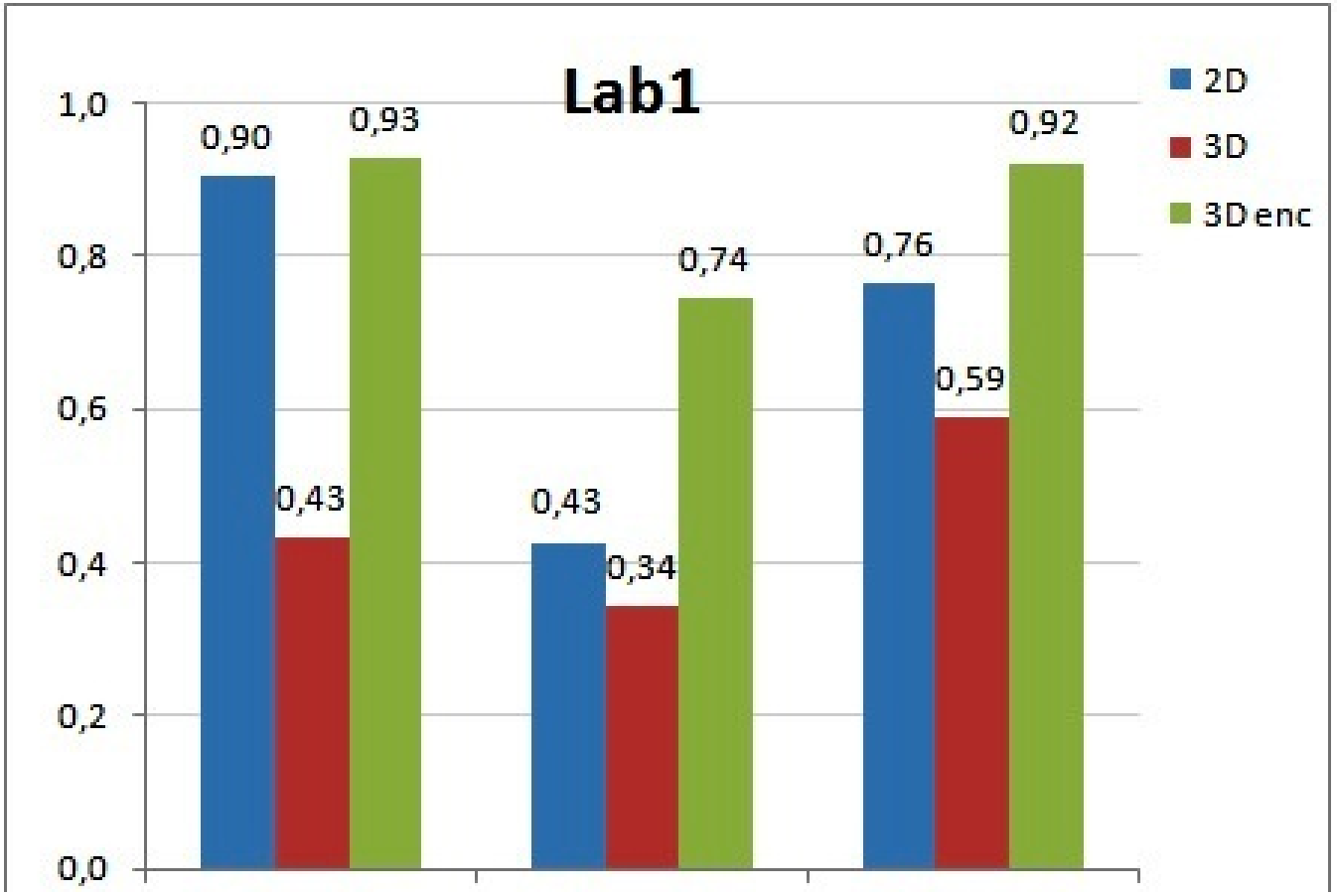
HRC

HRC Nr.	Test condition	HRC code	HRC group
1	Uncompressed 2D, content 1	2D1	2D
2	Uncompressed 2D, content 2	2D2	
3	Uncompressed 2D, content 3	2D3	
4	Uncompressed 2D, all content types	2D4	
5	Uncompressed anamorphic 2D,720p	2D5	
6	2D using the left view of 3D compressed at r04, 720p	2D6	
7	Compressed 2D at r02	2D7	
8	Uncompressed 3D, content1	3D1	3D
9	Uncompressed 3D, content2	3D2	
10	Uncompressed 3D, content3	3D3	
11	Uncompressed 3D, all content types	3D4	
12	Uncompressed 3D, 720p SbS	3D5	
13	Simulated 3D (2D-to-3D conversion by geometrical distortion)	3D6	
14	Simulated 3D (uneven depth in vertical direction)	3D7	
15	Simulated 3D (temporal mismatch between left & right views)	3D8	
16	3D,720p SbS, compressed at r01	3Denc1	3Denc
17	3D,720p SbS, compressed at r02	3Denc2	
18	3D,720p SbS, compressed at r03	3Denc3	
19	3D,720p SbS, compressed at r04	3Denc4	
20	3D,720p SbS, compressed at r05	3Denc5	

RESULTS



Depth Naturalness – Video Quality Video Quality – Visual Discomfort

Depth Naturalness – Visual Discomfort

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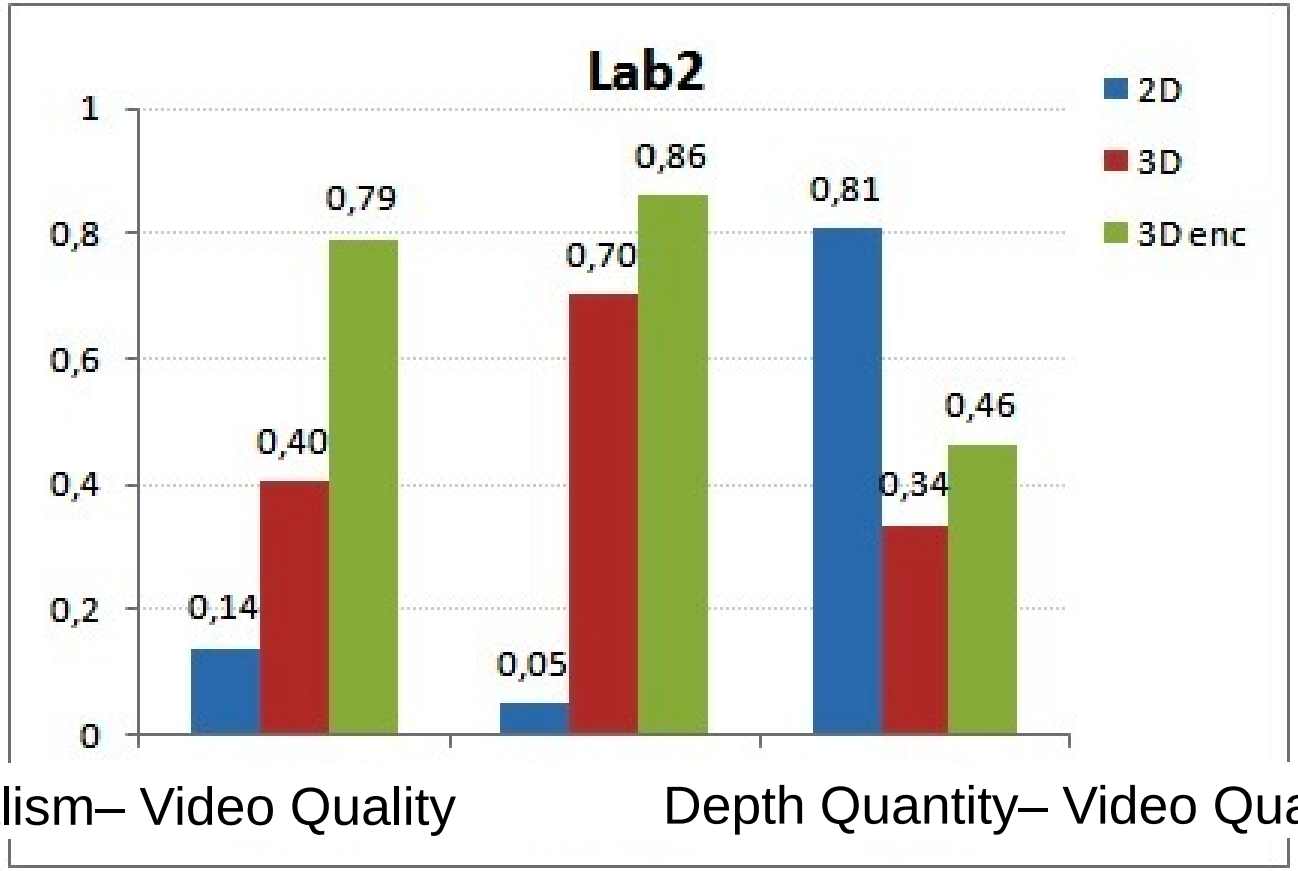
RESULTS



3D Realism– Video Quality

Depth Quantity– Video Quality

3D Realism – Depth Quantity

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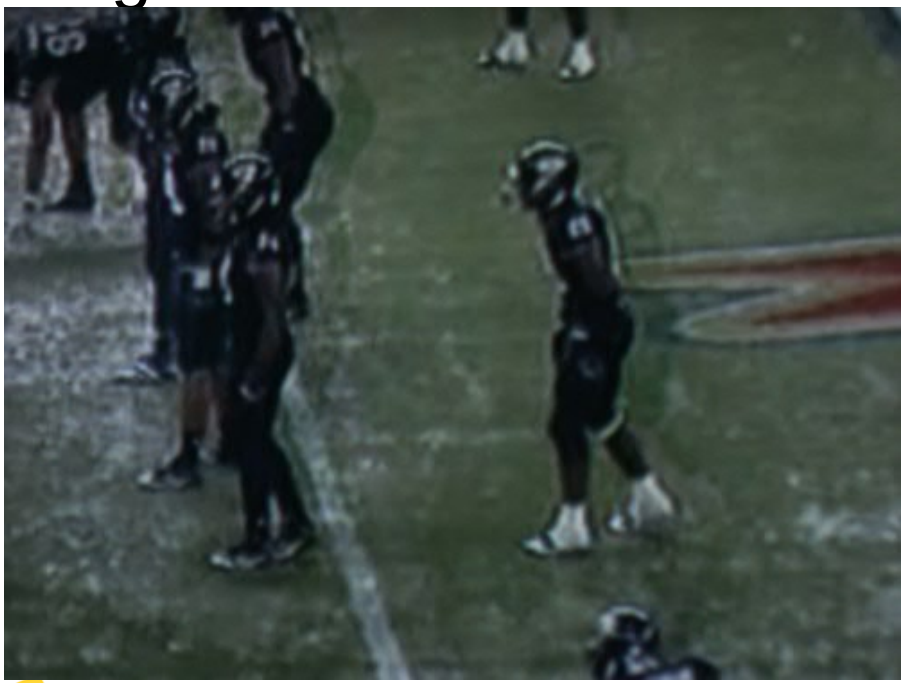
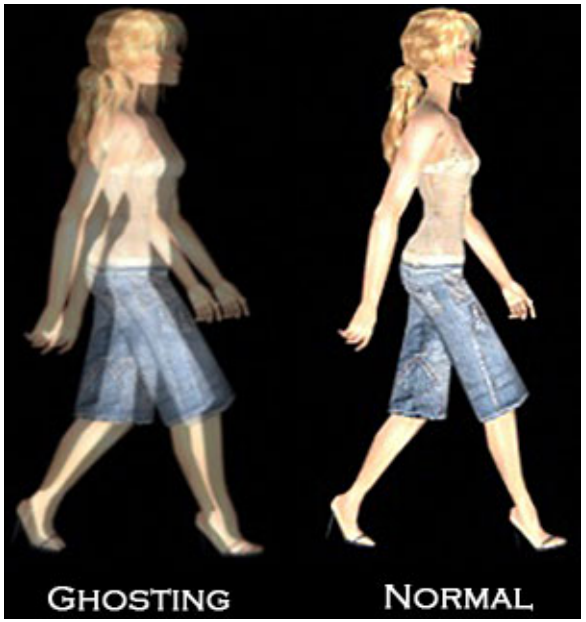
RESULTS

Scales	PCC (PVS MOS)	PCC (HRC MOS)
VQ1,VQ2	0.913	0.96
DN, 3DR	0.905	0.97
DN, DQ	0.68	0.90
VC, DQ	- 0.53	- 0.61
VC, 3DR	- 0.24	- 0.38

EXPERIENCE OF 3D CROSSTALK

- Crosstalk is the light leakage between the views
- Perceptually it shows up as ghosting i.e. double images





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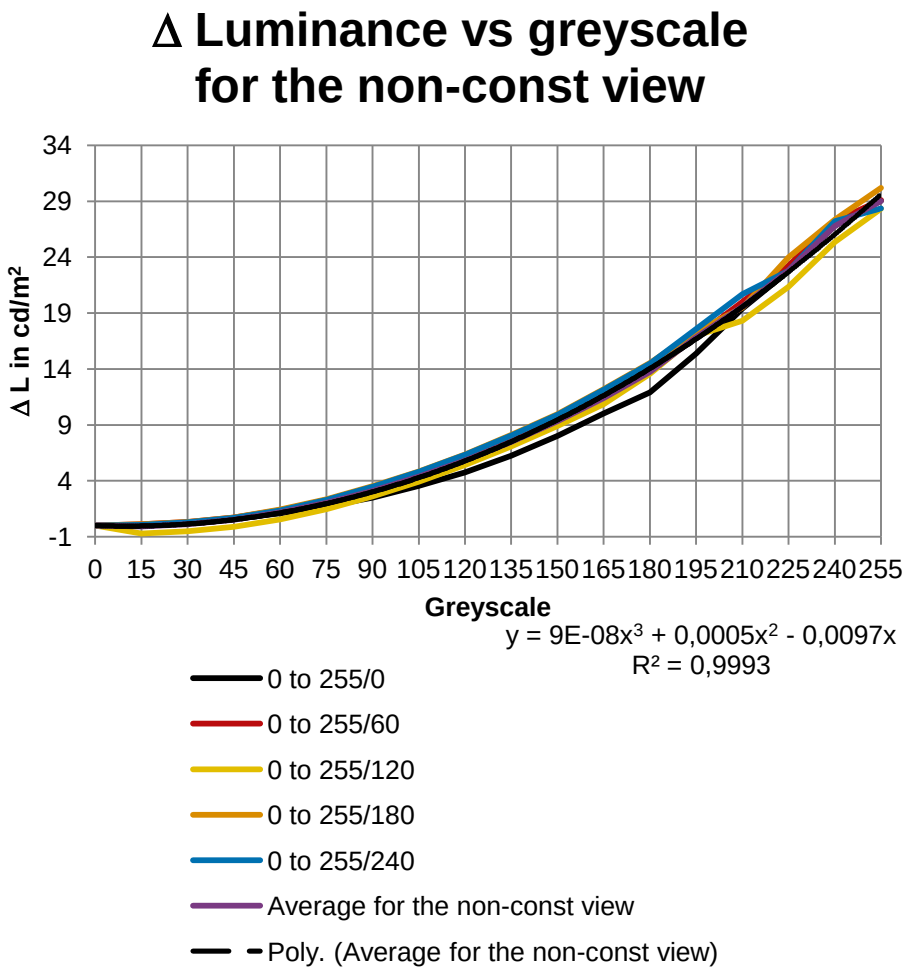
EXPERIMENT

- Simulate different levels of Crosstalk
- Projector + passive or active glasses
- Characterize the gamma function of system



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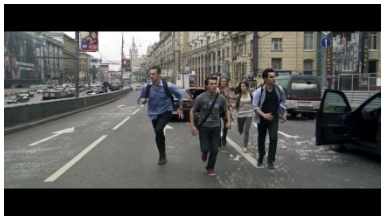
CROSSTALK SIMULATION

- Transform Greylevel (Y) to Luminance
- Add Crosstalk in Luminance domain
- Transform back to Greylevel (Y)
- Use movie like content

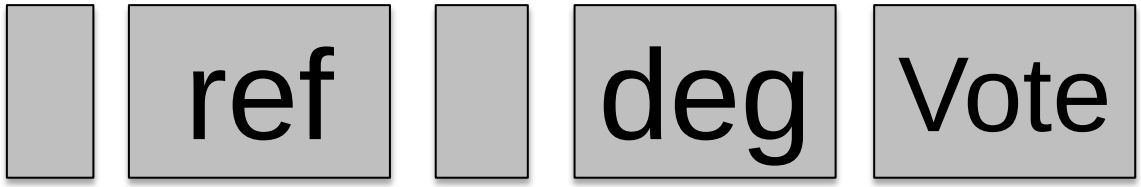






TEST PROCEDURE

- Double Stimulus Impairment Scale



- 5 Imperceptible
- 4 Perceptible but not annoying
- 3 Slightly annoying
- 2 Annoying
- 1 Very annoying

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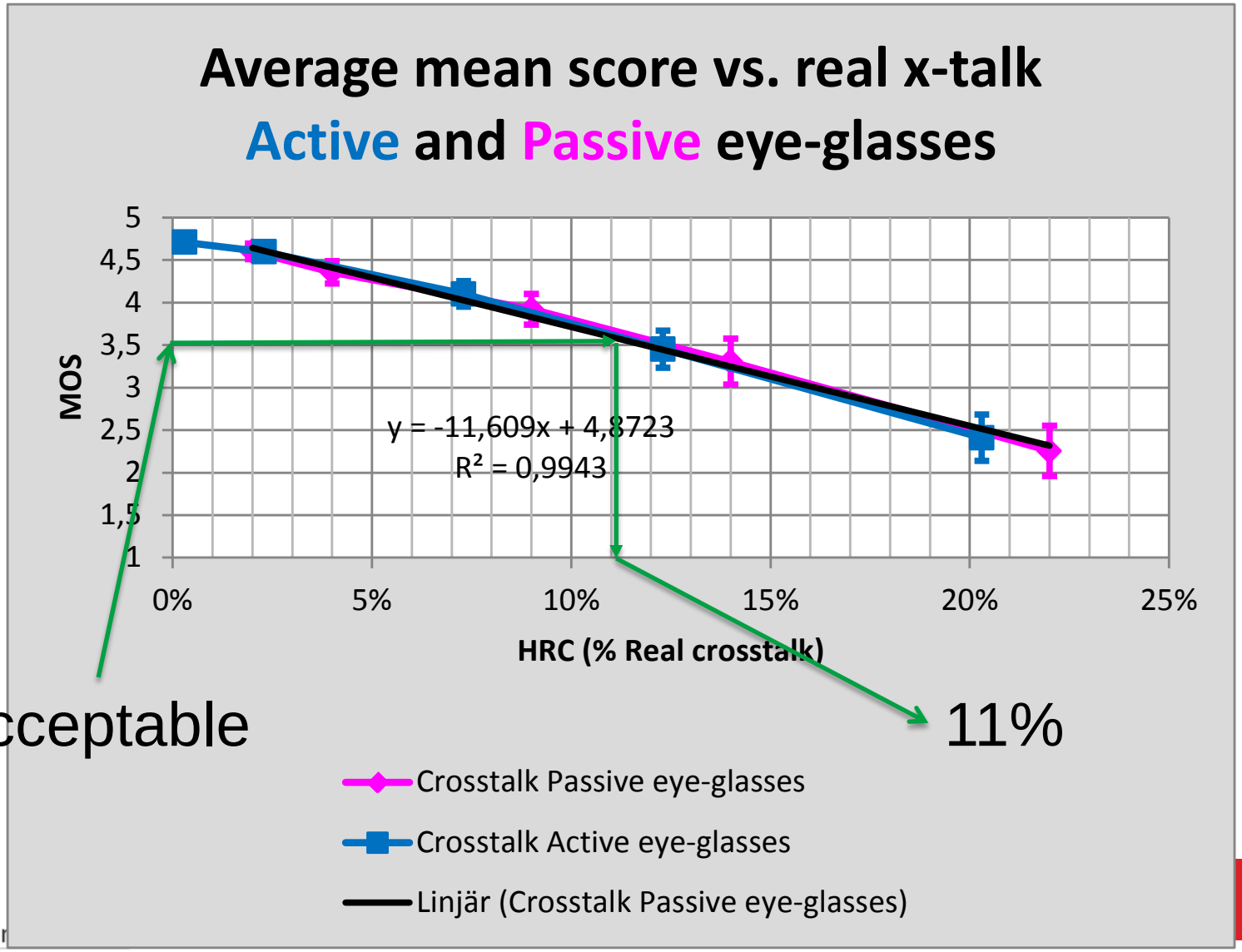
RESULTS


Average mean score vs. real x-talk
Active and Passive eye-glasses
MOS
5
4,5
4
3,5
3
2,5
2
1,5
1
0%
5%
10%
15%
20%
25%
HRC (% Real crosstalk)
y = -11,609x + 4,8723
R² = 0,9943
Acceptable
11%
Crosstalk Passive eye-glasses
Crosstalk Active eye-glasses
Linjär (Crosstalk Passive eye-glasses)

SUMMARY

- One scale is sufficient for 2D like distortions
- More than one scale needed with more complex distortions
- Crosstalk annoyance linear with added crosstalk

- Finally we would like thank our sponsors:
  - VINNOVA (The Swedish Governmental Agency for Innovation Systems), TCO Development, Alkit, LC-Tec and Intertek Semko

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