



# Visibility of Digital Artifacts in 3DTV

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GT Research on 2DTV : VQ-NR

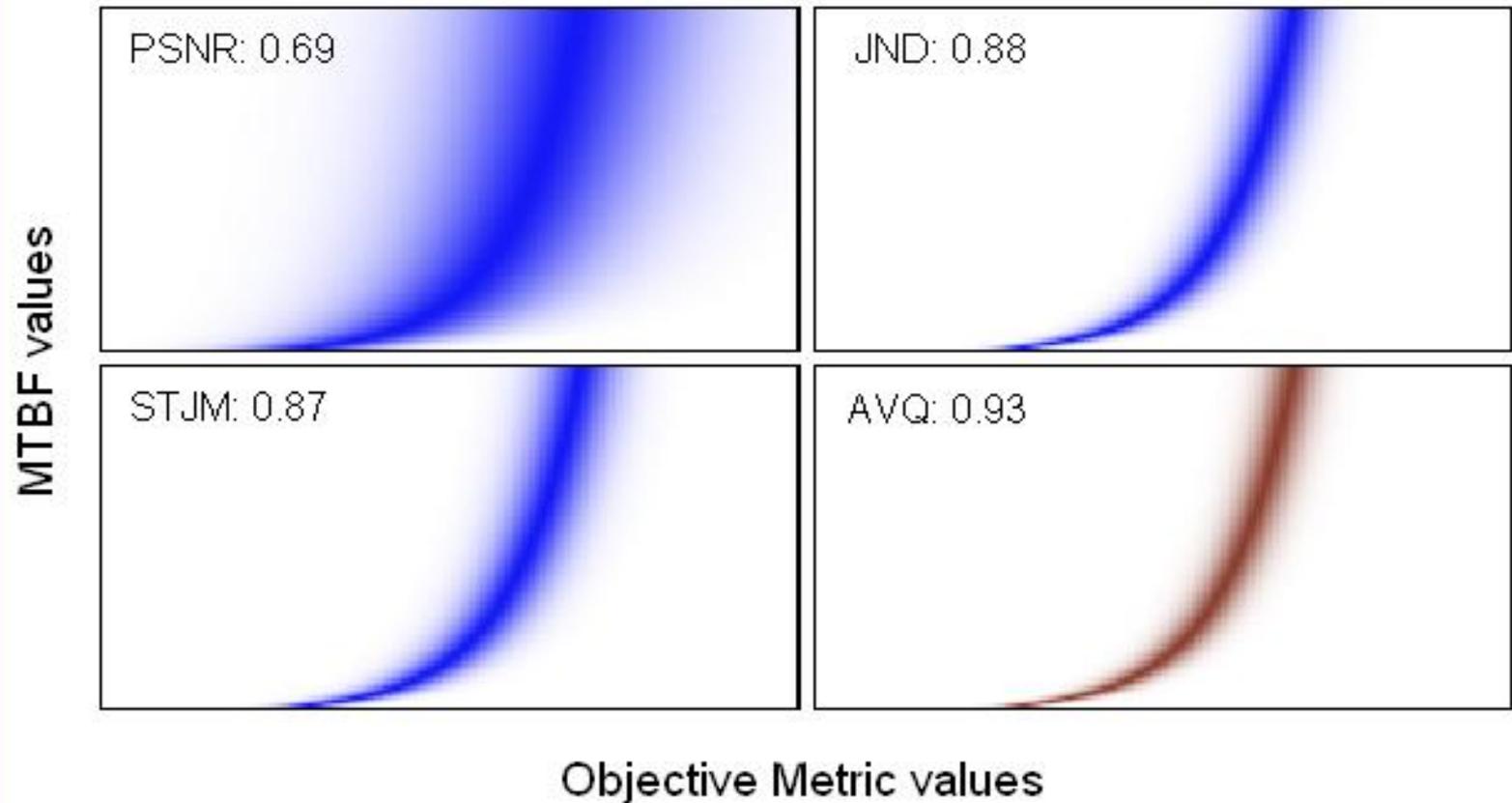
# Quantitative Calibration of VQ-NR

PSNR and JND are Full-Reference Metrics

STJM is a Partial-reference Metric

AVQ is a No-Reference Metric

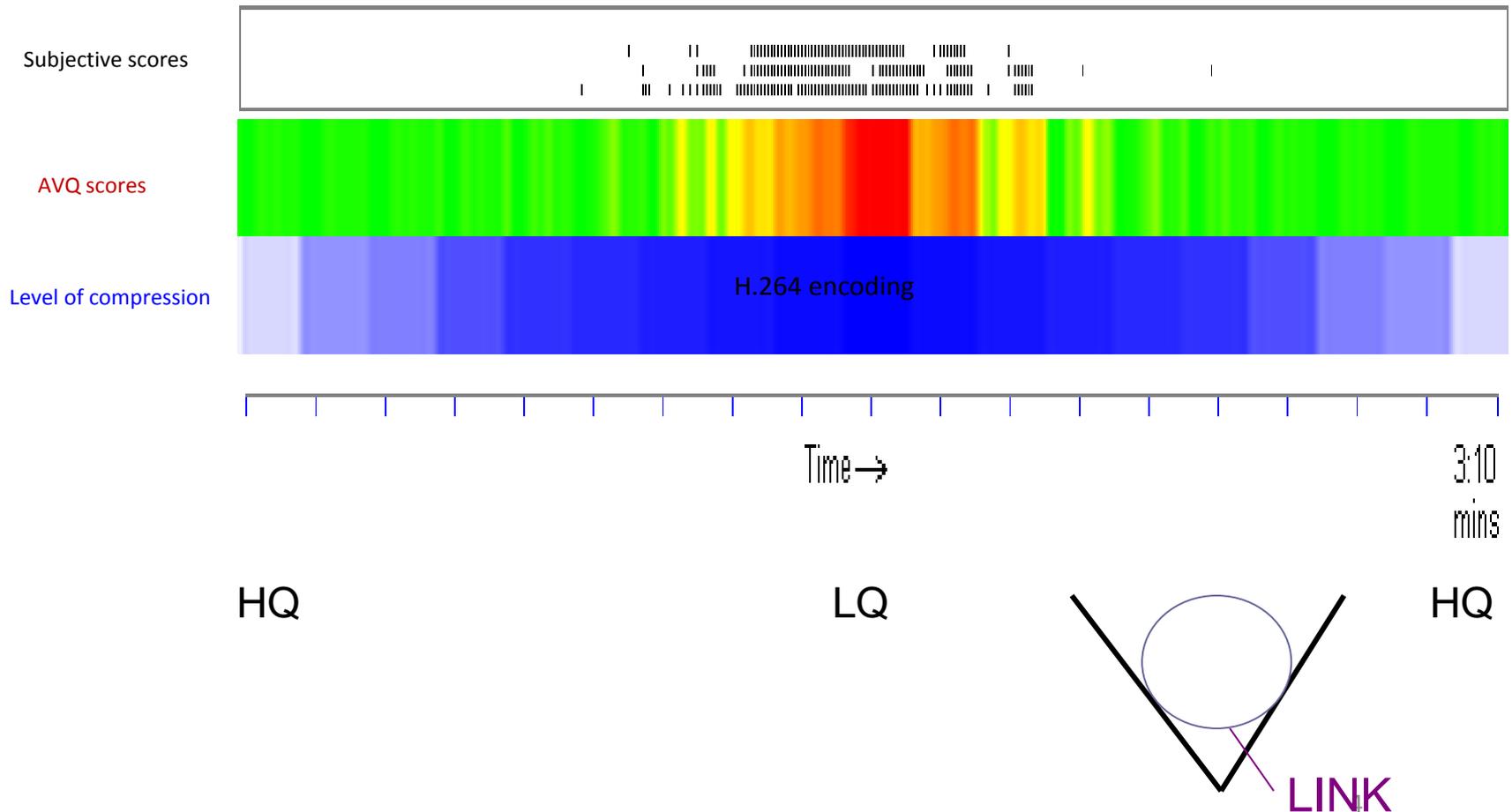
Numbers in the boxes represent correlations with MTBF



# Prediction of Visible Artifacts in H.264 with VQ-NR

Subjective results (artifact detections) are denoted by black dots

Objective Scores are color mapped in red-yellow-green



# Multichannel VQ-NR Product

AVQ-N v2.0 Manage Live Sessions Analyze Rankings avquser

239.3.3.1:1234 Pid: 68

MOS: 5 iMOS: 5

MOS iMOS CA NA U-NA

View: Live: Start Time: 2010/08/04 13:46:18

VQLink AVQ Player: Now Playing : udp://239.3.3.1:1234

Video: MPEG-2 - 1920x1080 pixel

VQLink AVQ Player: Now Playing : udp://239.3.3.1:1234

Video: MPEG-2 - 1920x800 pixel

239.3.3.2:1234 Pid: 69

MOS: 4.7 iMOS: 5

MOS iMOS CA NA U-NA

View: Live: Start Time: 2010/08/04 13:47:23

VQLink AVQ Player: Now Playing : udp://239.3.3.2:1234

Video: MPEG-2 - 1280x720 pixel

239.3.3.3:1234 Pid: 68

MOS: 4.1 iMOS: 3.5

MOS iMOS CA NA U-NA

Compression Artifact Diagnostics

Blocky Blurry Choppy MiceTh

Network Artifact Diagnostics

Streaky Stuck Lost Blank MP Gerr

Last Detection: 2010-08-04 14:27:11.206  
Total Seen: 546

Last Detection: 2010-08-04 14:25:43.202  
Total Seen: 36

View: Live: Start Time: 2010/08/04 13:47:55

239.3.3.4:1234 Pid: 80

MOS: 3.4 iMOS: 2.8

MOS iMOS CA NA U-NA

View: Live: Start Time: 2010/08/04 14:24:53

VQLink AVQ Player: Now Playing : udp://239.3.3.4:1234

Video: H.264 - 384x288 pixel

MOS: 3.4 iMOS: 2.8

MOS iMOS CA NA U-NA

VQLink AVQ Player: Now Playing : udp://239.3.3.4:1234

Video: H.264 - 384x288 pixel

MOS: 3.4 iMOS: 2.8

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Compression Artifact Diagnostics

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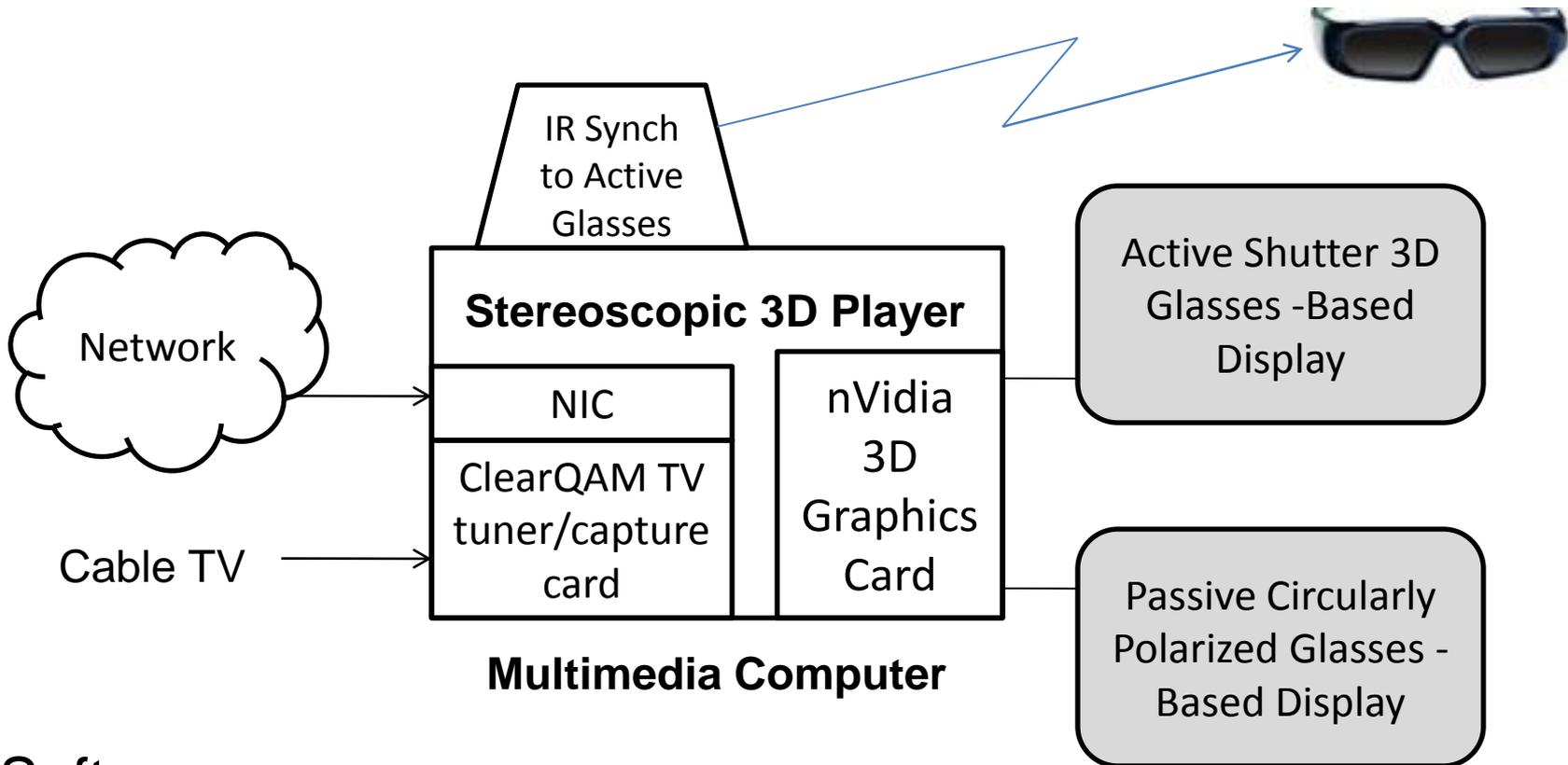
Last Detection: 2010-08-04 14:25:43.202  
Total Seen: 36

View: Live: Start Time: 2010/08/04 14:24:53

# Goals of 3DTV Research

- Understanding visibility of artifacts in 3D ( vs 2D)
- Developing an actionable taxonomy of 3D artifacts
- Creating an objective VQ tool as in 2D: 3DVQ-(NR)
- Use of 3DVQ in enhancing QoE in 3DTV
  - Initial Focus on Compression and Networking Effects

# Testbed Architecture



## Software

Stereoscopic Player (3DTV.at)

nVidia stereo

Adobe Creative Suite4 for 3D

Creating, editing, encoding , transcoding

# Content: Initial Database for Research

- [www.nvidia.com/object/3d-vision-3d-movies.html](http://www.nvidia.com/object/3d-vision-3d-movies.html)
  - 3D Racing clip as full 3D reference
  - Heidelberg clip for studying isolation
- [www.stereomaker.net/sample/index.html](http://www.stereomaker.net/sample/index.html)
  - Disney, sled and flower clips for compression effects
- [www.youtube.com/watch?v=TV12dCXctCA&fmt=22](http://www.youtube.com/watch?v=TV12dCXctCA&fmt=22)
- [www.youtube.com/watch?v=moINIZuG38E](http://www.youtube.com/watch?v=moINIZuG38E)
- [www.youtube.com/watch?v=3DFizuDjkNQ&playnextfrom=TL&videos=Ub\\_z52EU4RU](http://www.youtube.com/watch?v=3DFizuDjkNQ&playnextfrom=TL&videos=Ub_z52EU4RU)
- ClearQAM HD captures including Masters Clip

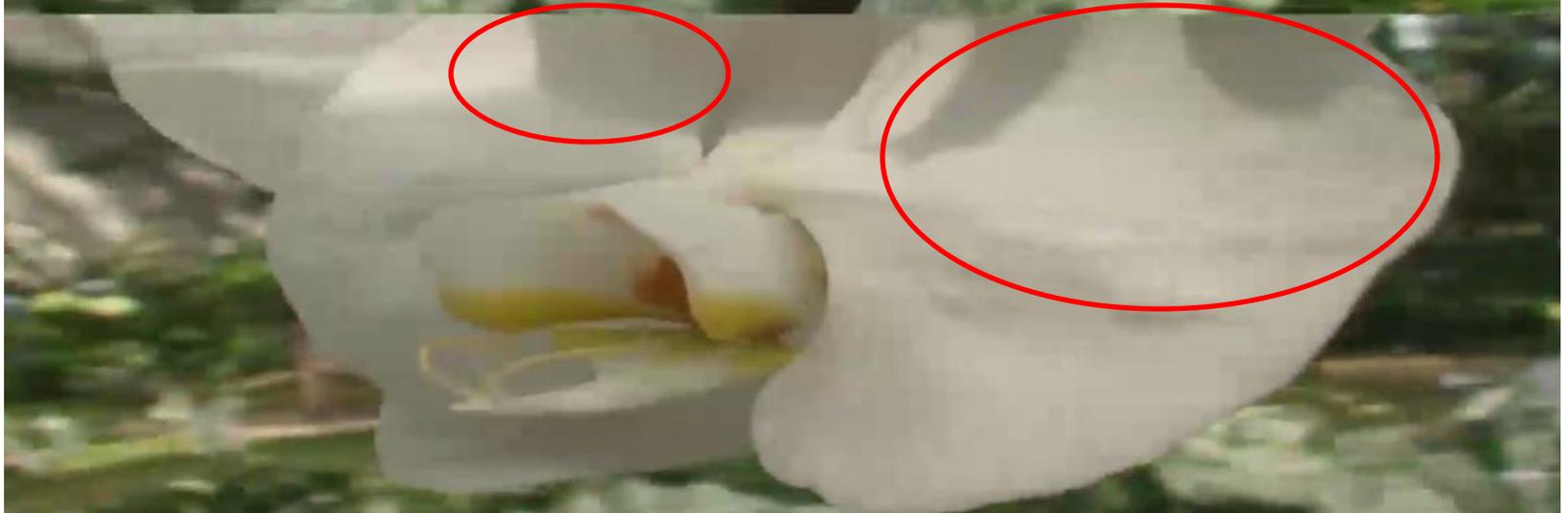
# Example of 3D Artifacts: Blockiness

left view is worse...more prominent in video view

Left Eye View



Right Eye View



# Example of 3D Artifacts: Blurriness

this demo better in still..loss of detail in oval area

Left Eye View

Right Eye View



# Example of 3D Artifacts: Washed away look

left is better...clear in video view as well



Left Eye View



Right Eye View

Transmitted frame compatible video signal

# Compression Artifact in 3D FC Example

*Left more jagged in Zoom*



Re-expanded left eye view (magnified)



Re-expanded right eye view (magnified)

Transmitted frame compatible video signal

# Network Artifact in 3D FC example



Re-expanded left eye view



Re-expanded right eye view

# Blocked View Artifact in 3D FC Example

Poor filming

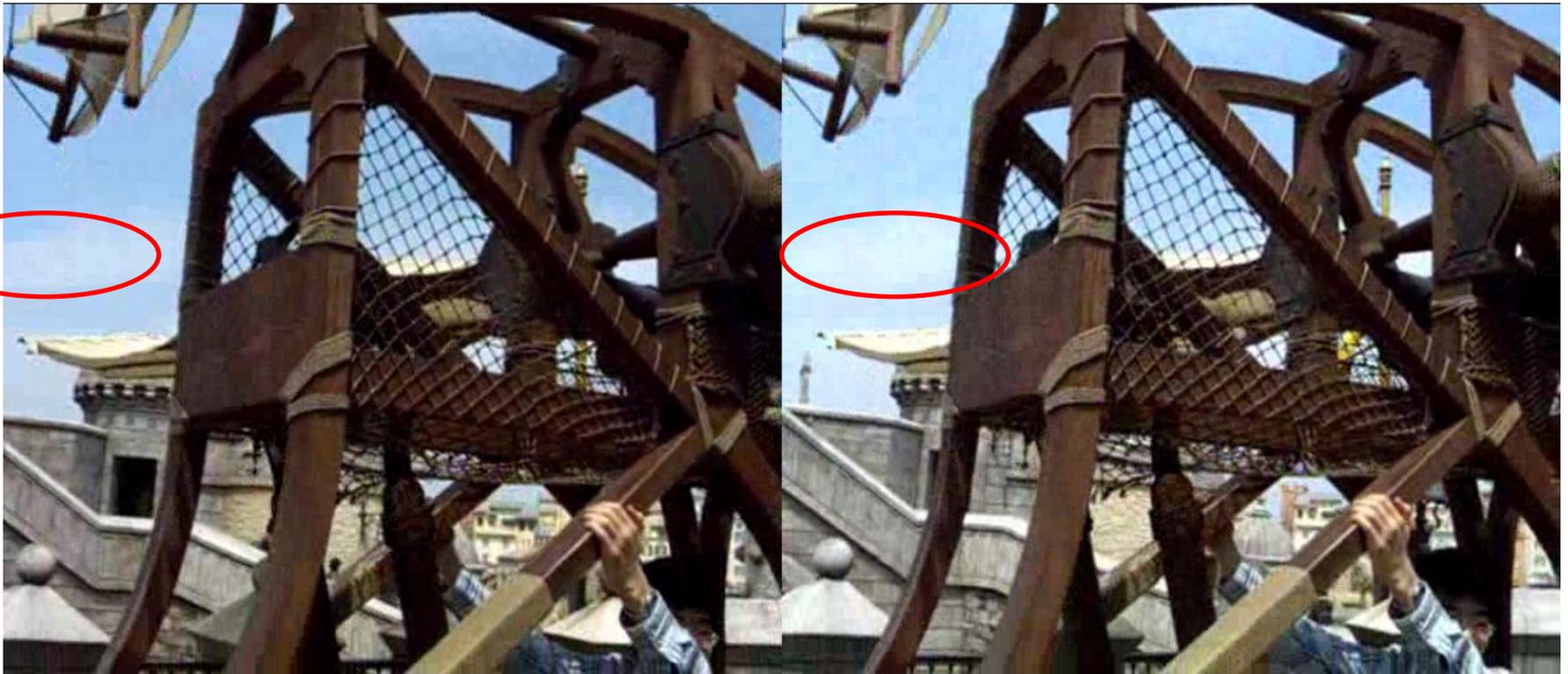


# Subjective Test Goals and Design

- Understanding of artifacts in 3D vs 2D
- Calibration of Frame Compatible 3DTV example
- Comparison of active (AS) and passive (PP) displays
- Clips shown to viewers in both AS and PP displays
- Still images shown to viewers in some cases
- Total of 30 subjects, including trained and untrained

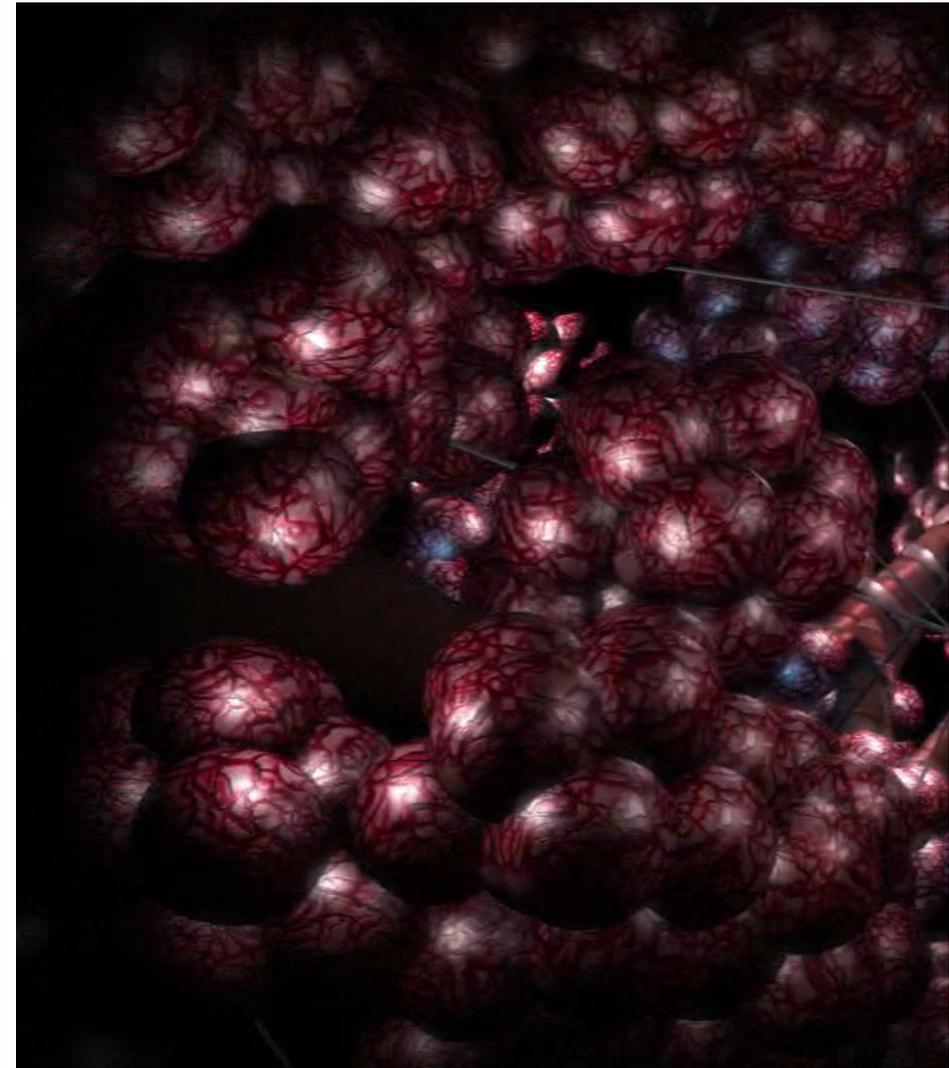
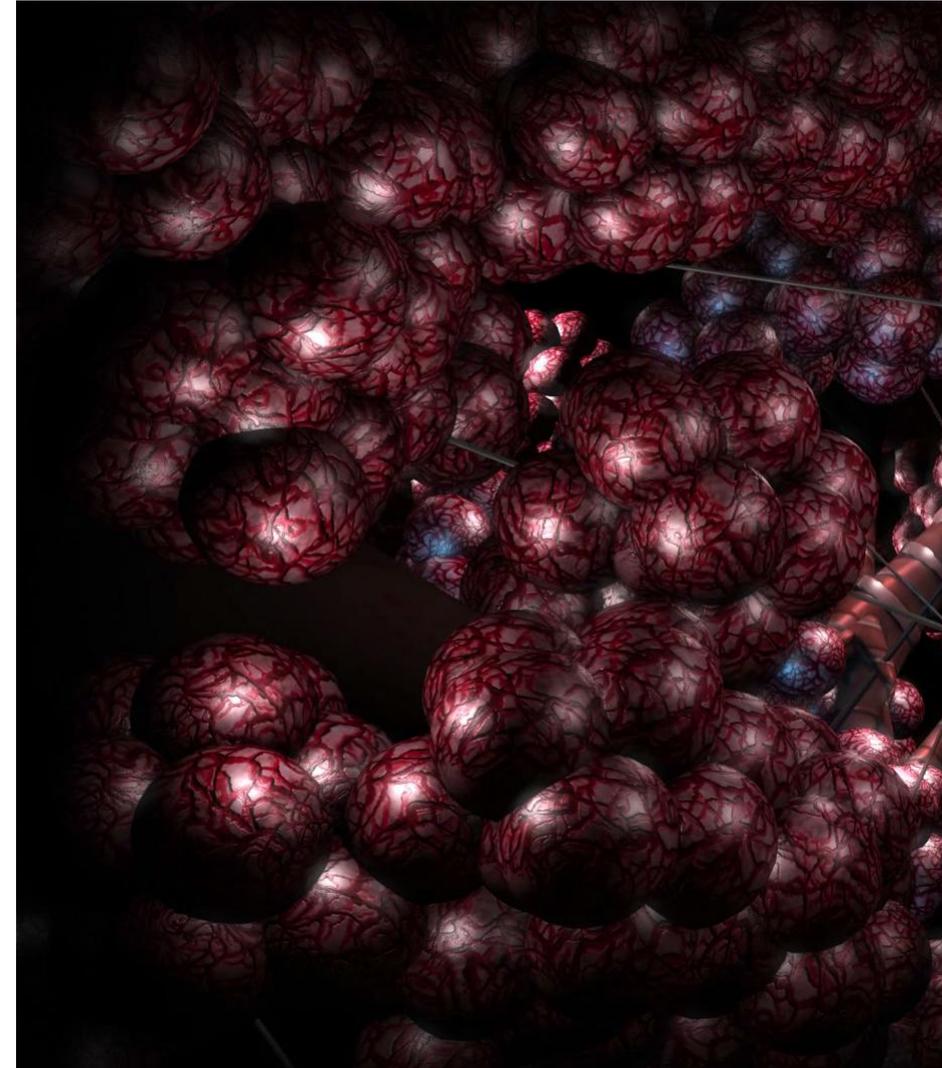
# Example of Stimulus in Test: 2D and 3D Views

- Viewers shown left eye view in 2D and then 3D version to see if CA were more or less visible in 3D than 2D
- Red oval shows area that viewers noticed as different



# Example of Stimulus in Test: Still Image Pairs

Blurriness in 3DFC



# Example of Stimulus in Test

## Program Isolation Triplet

Viewers had to block an eye (program) in absence of driver control

Composite



Program 1



Program 2



# Questionnaire

- Viewers were asked the following questions  
(A : active shutter display, B: passive polarization display) :
  - Q1. Full 3D clip: Which was better? (A/B)
  - Q2. Did you see a big difference between full 3D vs. Frame Compatible 3D? (Y/N in A,B)
  - Q3. Are (compression) artifacts more or less visible in 3D? (More/Less in A,B)
  - Q4. Are video artifacts more visible in A or B?
  - Q5. Was the 2-Channel demo better in A or B?
  - Q6. How is your desire to buy a 3DTV or 3D computer monitor after the test? (More/Less/Same)

# Results: A=Active Shutter, B=Passive Polarization

Q1. Full 3D clip: Which was better? (A/B)

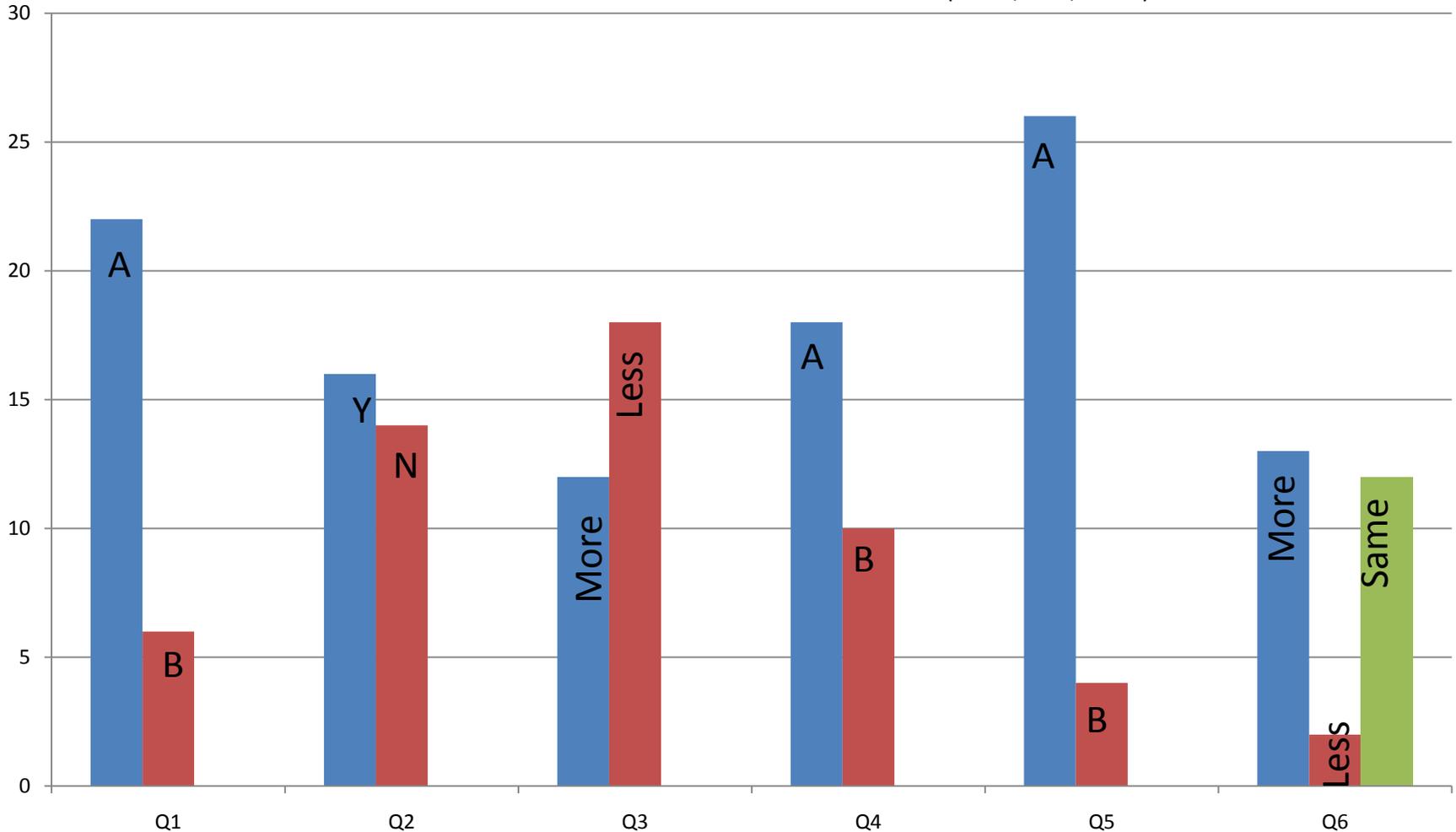
Q2. See a big difference full 3D vs. Frame Compatible? (Y/N)

Q3. Video artifacts more or less visible in 3D? (More/Less)

Q4. Video artifacts more visible in A or B?

Q5. 2-Channel demo better in A or B?

Q6. Desire to buy a 3DTV or 3D computer monitor after demo? (More/Less/Same)



# Conclusions from Subjective Test

- Compared to passive polarization, the active shutter display gave
  - Better full 3D
  - More visibility of artifacts
  - Better isolation for independent channel viewing by multiple viewers
  - But still not good enough separation for serious independent channel viewing
- Subjects were nearly evenly split on
  - Desire to buy a 3DTV after demo:
    - 13 more, 12 same, 2 less
  - Seeing difference in Frame Compatible format
    - 16 yes, 14 no
- Detectability of artifacts in 3D vs. 2D
  - 18 said less detectable in 3D
  - 12 said more detectable in 3D

# Next steps in 3D TV Research @ GT

- Creation of a more comprehensive 3DTV database with controllable parameters for encoding and distribution
- Systematic study of artifact causes, masking and cross-masking
  - subsampling, compression, interpolation, display
- Quantifying depth artifacts due to coding and transmission
- Extension of earlier 2DTV research for quantifying 3DTV artifacts
- Enhancement of 3DTV coding beyond frame-compatible coding:
  - optimization of multiview and scalable video coding (MVC, SVC)
  - preprocessing, compression, error concealment, enhancement
- Usability studies in single-display multiple programs
- Application in 3DTV and Multiplayer games
- Opportunities for Industry Partnership

# References

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