

High Definition – a new challenge for broadcasters



ZDF investigations on scanning formats
and data rates for SDTV

Agenda

- **Introduction**
- **Introduction of HD formats 720p/50 & 1080i/25**
- **Methodologies for the assessment of the
quality of television pictures**
- **Production of test-sequences**
- **Presentation of test-sequences**
- **Results**
- **Conclusion**
- **Migration from SDTV to HDTV**

ZDF Investigations on picture quality of 1080i/25 & 720p/50

 **Introduction**

Motivation

- Hopefully one single HD format for usage use in Europe (except of 1080p/24/25)
 - USA: Usage of 720p/60 and 1080i/30 for the same kind of content (magazines, shows, sports)
 - Unfortunatly this seems unrealisable
- EICTA-Logos for HDTV-Flatpanels and -Receivers specify both formats



- BUT: Which scanning format delivers the better picture-quality ???

ZDF Investigations on picture
quality of 1080i/25 & 720p/50



Introduction 1080i/25 & 720p/50

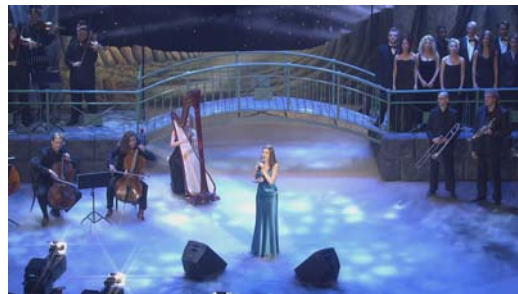
High Definition – a new challenge for broadcasters

1080i/25 & 720p/50



1080 vertical pixels

1920 horizontal pixels



720 vertical pixels

1280 horizontal pixels

interlaced & progressive



50 fields per second



50 frames per second

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**Methodologies for the assessment of the
quality of television pictures**

Recommendations for picture-quality measurement

- Recommendations of ITU & EBU for objective and subjective television quality measurement
- Overall picture quality can only be measured by subjective methods:

ITU-R BT.500-11

- Used Method: DSCQS (Double Stimulus Continuous Quality Scale)
- High number of observers guarantees high precision of results - Number of observers: **144**
- Two groups of observers:
 - Non-Experts: **114**
 - Experts: **28**

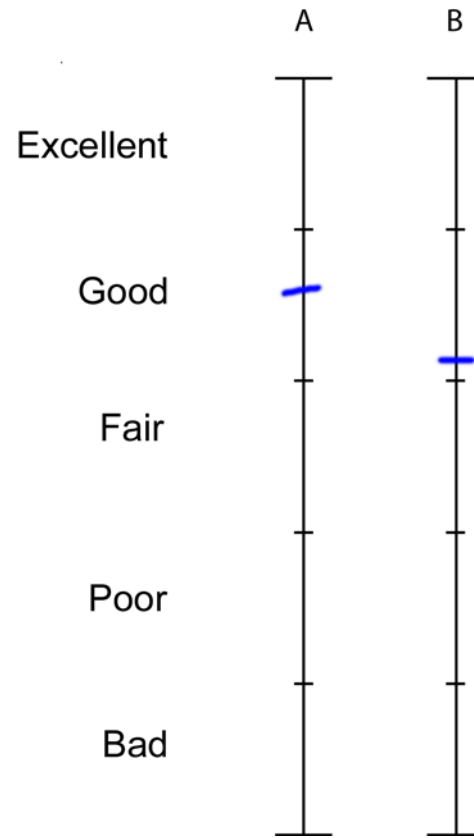
Presentation structure of test material



- T1: 10 s 720p/50: Sequence 1080i/25: Mid-grey
- T2: 3 s 720p/50: Mid-grey 1080i/25: Mid-grey
- T3: 10 s 720p/50: Mid-grey 1080i/25: Sequence

Pseudorandom order: Observer does not know, which HD format he actually rates!

Quality Rating Scale of DSCQS



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Production of test sequences

Production of test sequences

- production of comparable or better identical sequences
 - Usage of the same equipment for both HD formats
 - identical setup (camera, lens, recording-device)
- 1. Possibility: Usage of two cameras (parallel)
 - problem: mounting the cameras one upon the other or side by side will cause parallax
 - problem: the whole equipment is needed twice (2 cameras, 2 lenses, 2 recording devices...)
- 2. Possibility: Usage of a single camera
 - advantages: no parallax, only 1 camera, lens,... needed, two persons enough for production, availability of equipment, equal matched camera in both formats
 - disadvantage: no identical content in Live-production

Production of test sequences

- Avoidance of any quality diminishing factor:
 - No Compression: Transparent Recording on HDD in YCbCr, 4:2:2, 10 Bit (DVS Fileformat *.YUV10)
 - Use of HD-SDI-Interfaces
 - Avoidance of impairments by the optical system (lens)
 - use of midrange focal length settings
 - use of midrange aperture settings (~ 2.8 – 11)
 - no use of lens-focal-length-extender
 - Avoidance of standards-conversion (native capturing and playback)
 - Avoidance of extreme camera-settings (extreme knee, use of gain...)
 - No Compression or Standard-Conversion (HD-Format, File-Format, Color-Space...) in Post Production

Production Equipment

- Camera: Thomson LDK 6000 in two configurations:
 - Live-Configuration (Triax, CCU)
 - Compact-Configuration (“Viper”)
- Lenses:
 - Fujinon HA22x7.3 IASD BERDS48
 - Canon HJ21x7.5 IASDSX12
- Recording-Devices:
 - DVS HD-Station (Indoor)
 - DVC CineRam (Outdoor)
- Monitoring:
 - Tektronix WFM700HD
 - JVC 19” HD-CRT
- Postproduction: DVS Clipster

Selection of test-sequences

- Covering the most important TV-genres / type of TV-pictures:
 - Sports
 - Magazine (News-Anchorwoman)
 - Landscapes
 - Theatre
 - Show
 - Reportage

Selection of test-sequences



Sports: World-Championship Latin-Dance 2004
Leipzig (Germany)

Selection of test-sequences



Moderations/Studio: ZDF „Logo“ and others

Selection of test-sequences



Sports: gymnastics (floor exercises)

Selection of test-sequences



Show: „Show of the gladiators“ Europapark (Germany)

Selection of test-sequences



Reportage: Diverse (Wildwater and others)
Holiday-Park (Germany)

Selection of test-sequences



Theatre: „Der Menschenfeind“ Staatstheater Mainz

Selection of test-sequences



Landscapes: Rhine Valley near Koblenz (Germany)

Selection of test-sequences



Sports: Bicycle-artistics

Selection of test-sequences



Sports: Football

Selection of test-sequences



Show: ZDF-Show „Stargala zugunsten der Welthungerhilfe“

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Presentation of test sequences

Choice of Screening-Devices

- Market Research Studies:
 - Lose of market share for CRT-devices
 - Increasing market share for flat-panel-technologies in the near future
- Technology:
 - big screen-sizes necessary for HDTV (preferred viewing distance: 3 times the picture height)
 - CRTs only available in smaller sizes, big-sized CRTs are very heavy and hulky
 - Flatpanels (LCD, PDP) are available in sizes up to 50"

Choice of Screening-Devices

➤ Panasonic Plasma-Display 50“

- High-End Consumer-Device
- Resolution: 1366x768
- working progressive



➤ Sanyo LC-Projector

- High-End Professional-Device
- Resolution: 1920x1080
- working progressive



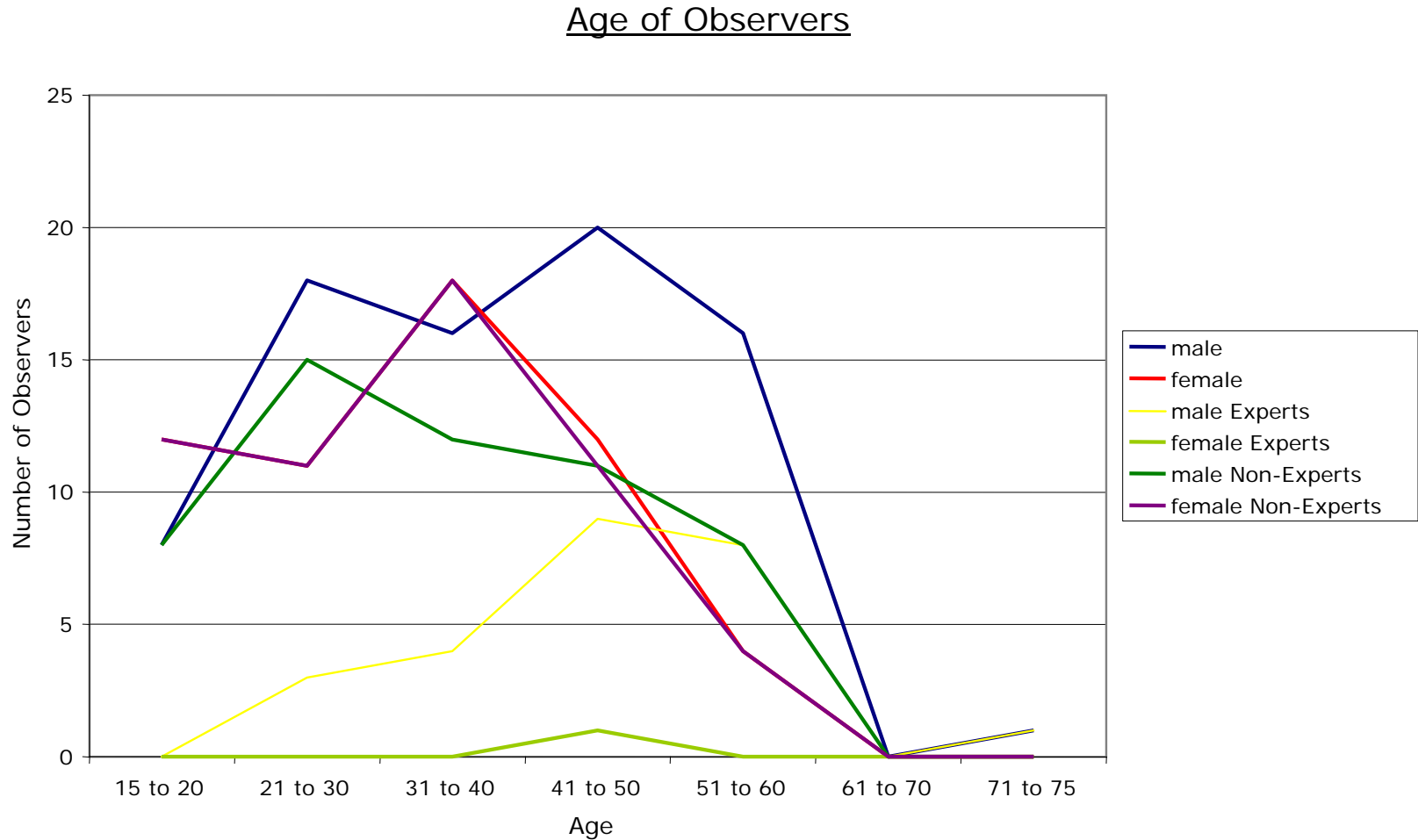
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 Results

Data Analysis

- Total number of Sequences: 26
- Observers:
 - Experts: 28
 - Non-Experts: 114
- Number of Sessions (Observer x Sessions)
 - PDP Experts: 462
 - LC-Projector Experts: 413
 - PDP Non-Experts: 1584
 - LC-Projector Non-Experts: 1602

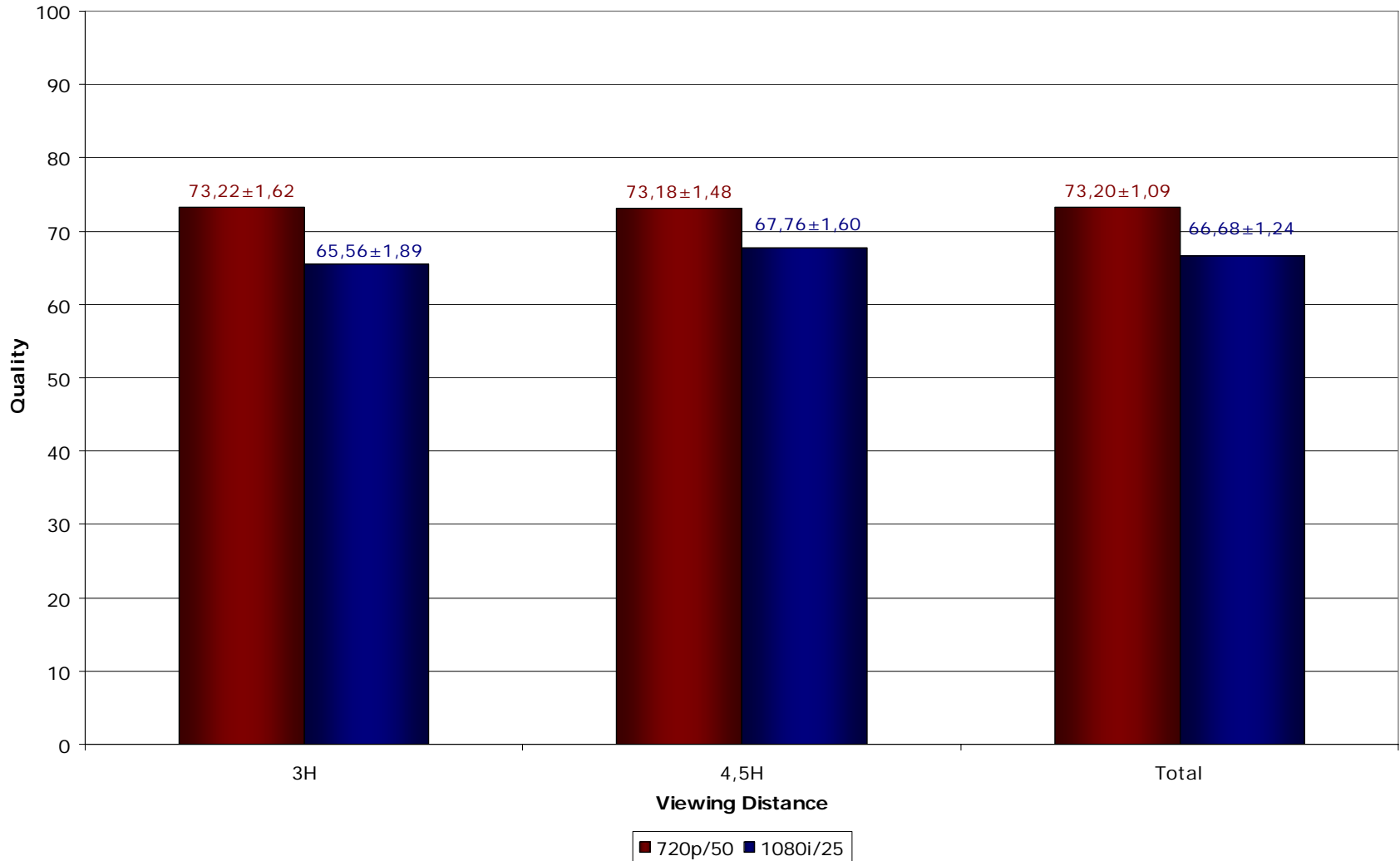
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- Experts:
 - PDP
 - LC-Projector
- Non-Experts:
 - PDP
 - LC-Projector

High Definition – a new challenge for broadcasters

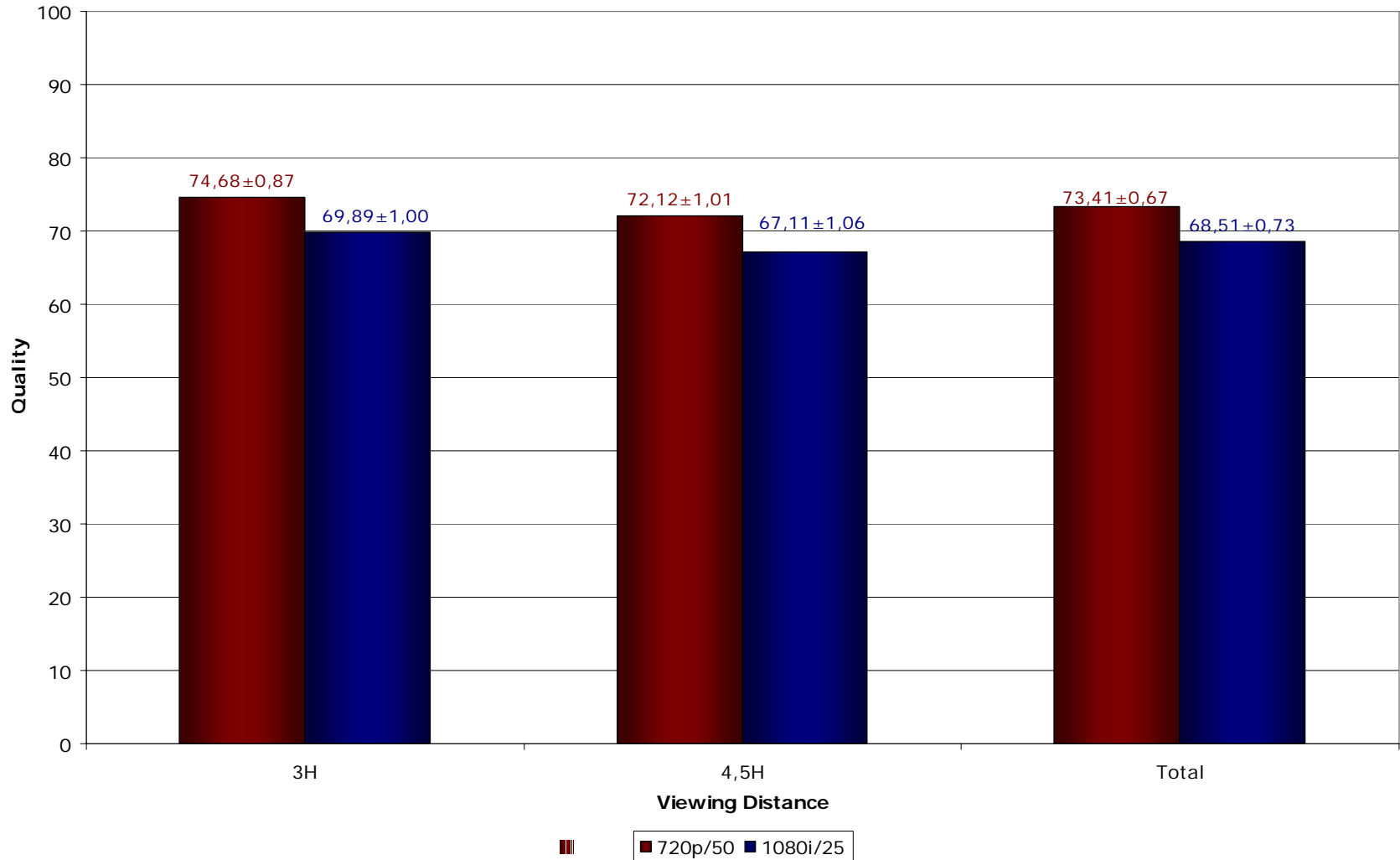
Experts PDP



- Panasonic PDP (absolute value):
 - Experts:
 - majority of observers prefers 720p/50
 - very high discrepancy:
 - ~63% of votings prefer 720p/50
 - ~23% of votings prefer 1080i/25
 - ~14% of votings: no difference

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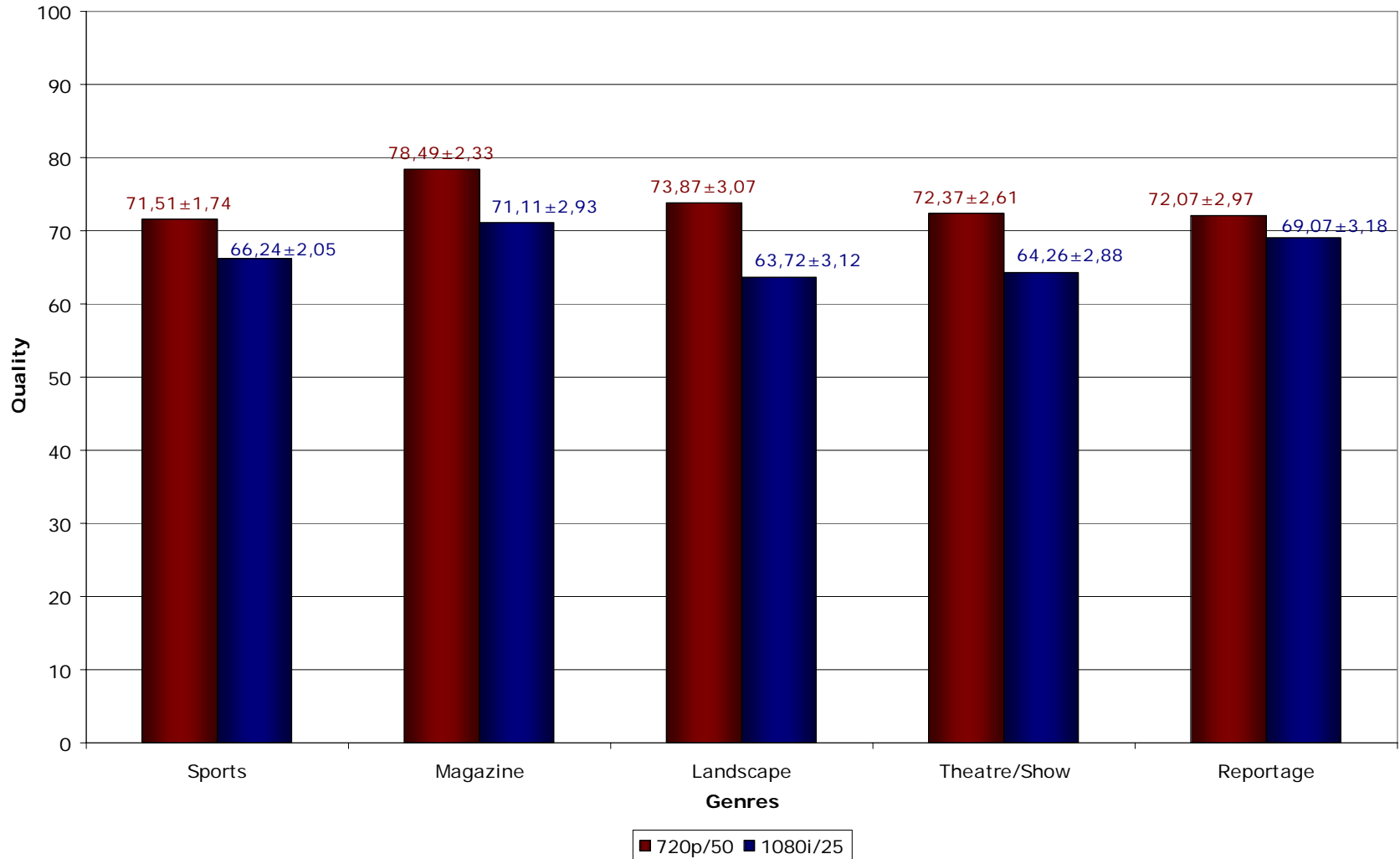
Non-Experts PDP



- Panasonic PDP (absolute value):
 - Non-Experts:
 - majority of observers prefers 720p/50
 - very high discrepancy:
 - ~56% of votings prefer 720p/50
 - ~32% of votings prefer 1080i/25
 - ~12% of votings: no difference

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Genres Experts PDP



➤ Panasonic PDP – Experts (absolute value):



- Sports: ~52% of votings prefer 720p/50
~33% of votings prefer 1080i/25
~15% of votings: no difference



- Magazine: ~65% of votings prefer 720p/50
~17% of votings prefer 1080i/25
~18% of votings: no difference



- Landscape: ~80% of votings prefer 720p/50
~12% of votings prefer 1080i/25
~ 8% of votings: no difference



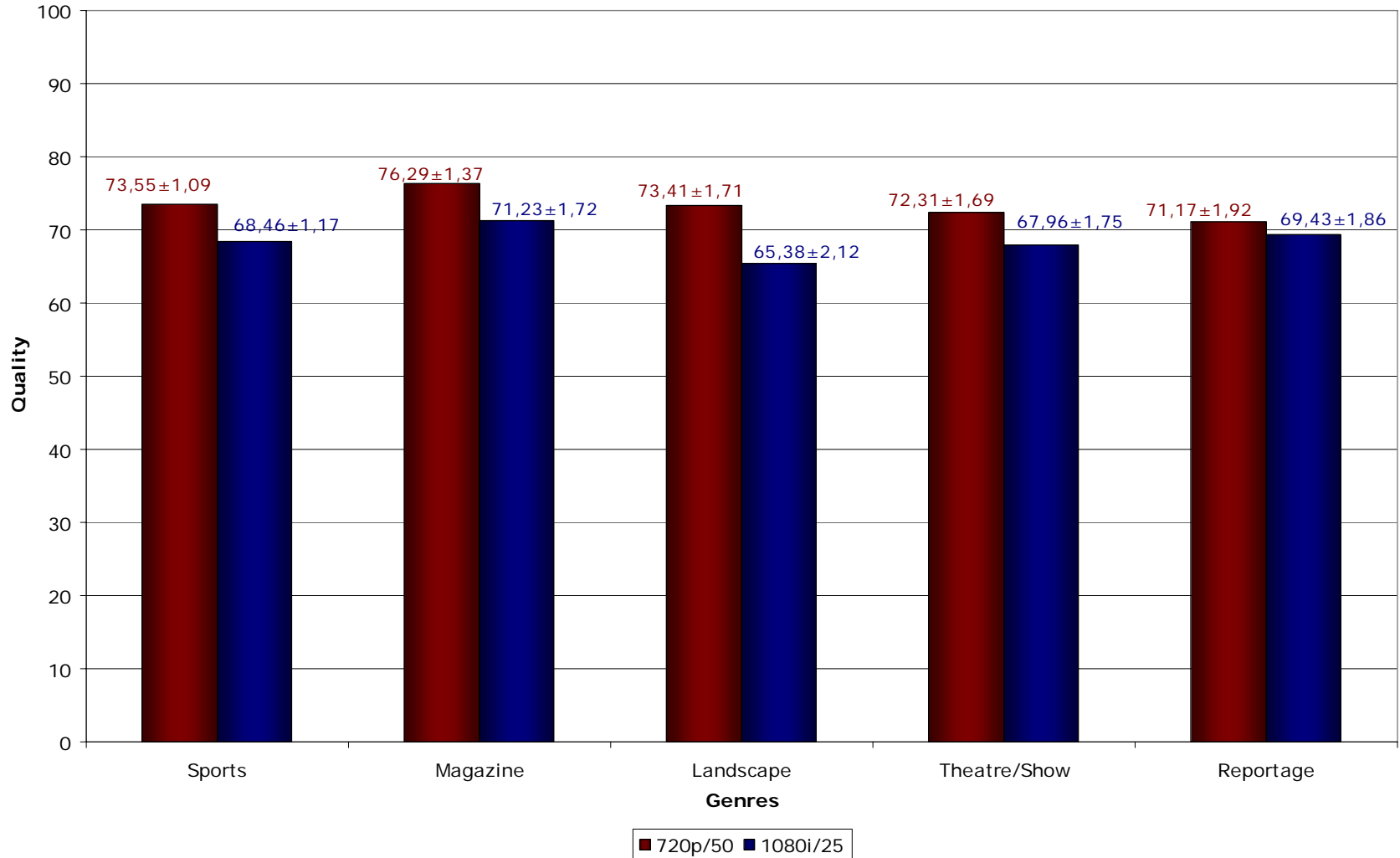
- Theatre/Show: ~67% of votings prefer 720p/50
~19% of votings prefer 1080i/25
~14% of votings: no difference



- Reportage: ~47% of votings prefer 720p/50
~38% of votings prefer 1080i/25
~15% of votings: no difference

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Genres Non-Experts PDP



➤ Panasonic PDP – Non-Experts (absolute value):



- Sports: ~56% of votings prefer 720p/50
~32% of votings prefer 1080i/25
~12% of votings: no difference



- Magazine: ~54% of votings prefer 720p/50
~27% of votings prefer 1080i/25
~19% of votings: no difference



- Landscape: ~63% of votings prefer 720p/50
~30% of votings prefer 1080i/25
~ 7% of votings: no difference



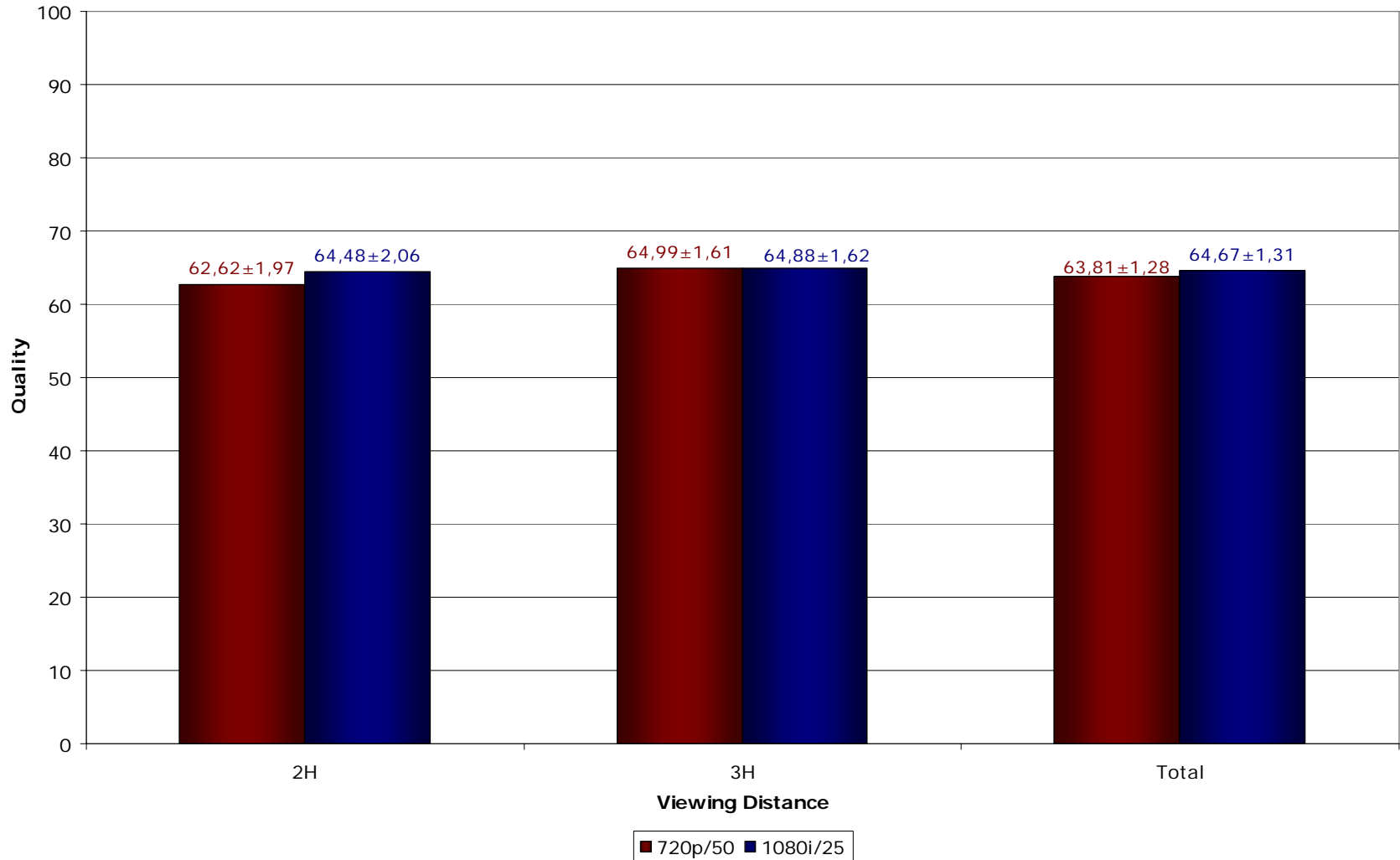
- Theatre/Show: ~57% of votings prefer 720p/50
~34% of votings prefer 1080i/25
~ 9% of votings: no difference



- Reportage: ~48% of votings prefer 720p/50
~41% of votings prefer 1080i/25
~11% of votings: no difference

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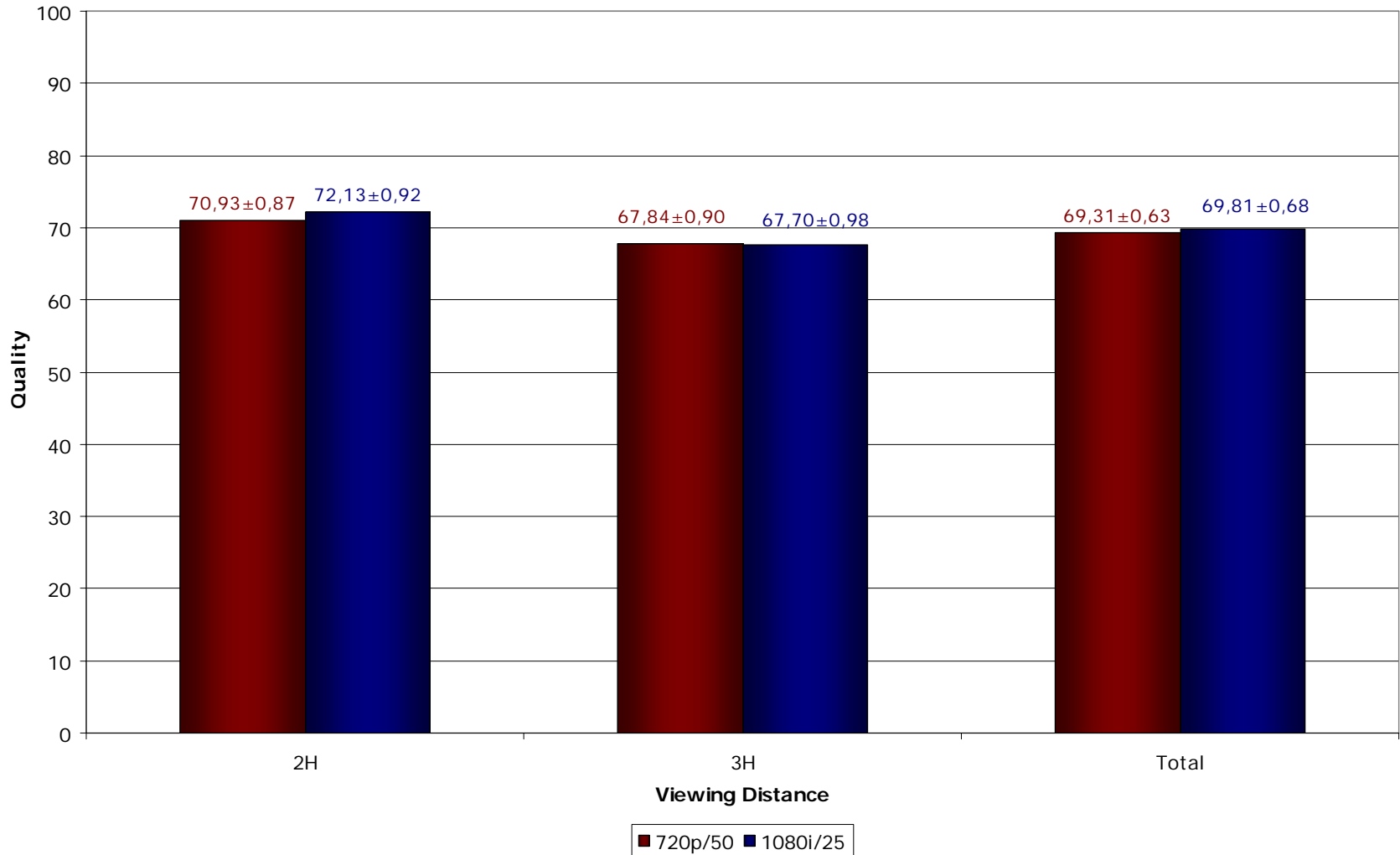
Experts LC-Projector



- Sanyo LC-Projector (absolute value):
 - Experts:
 - majority of observers prefers 1080i/25
 - little discrepancy:
 - ~39% of votings prefer 720p/50
 - ~42% of votings prefer 1080i/25
 - ~12% of votings: no difference

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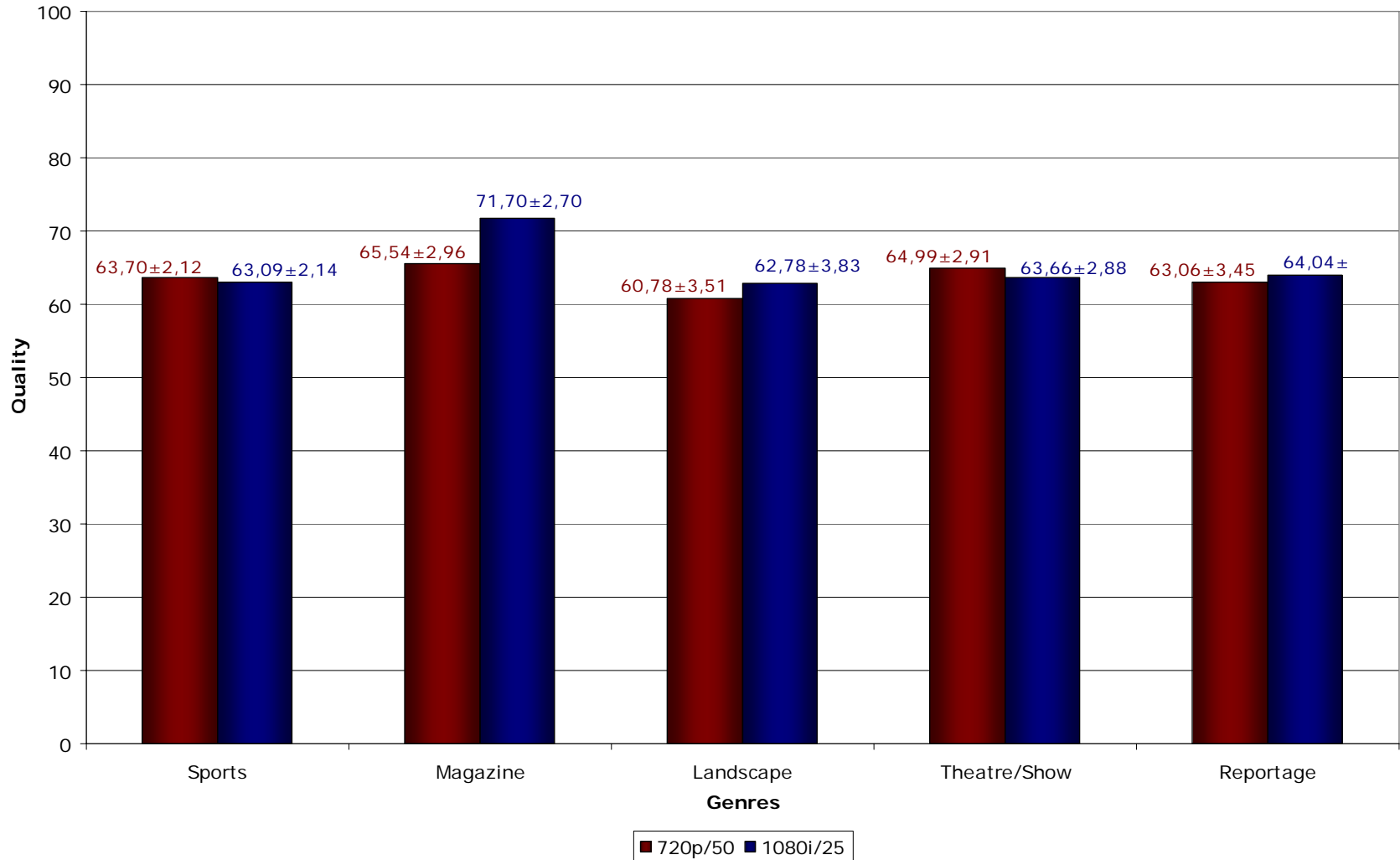
Non-Experts LC-Projector



- Sanyo LC-Projector (absolute value):
 - Non-Experts:
 - majority of observers prefers 1080i/25
 - little discrepancy:
 - ~42% of votings prefer 720p/50
 - ~48% of votings prefer 1080i/25
 - ~10% of votings: no difference

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Genres Experts LC-Projector



➤ Sanyo LC-Projector - Experts (absolute value):



- Sports: ~45% of votings prefer 720p/50
~36% of votings prefer 1080i/25
~19% of votings: no difference



- Magazine: ~23% of votings prefer 720p/50
~58% of votings prefer 1080i/25
~19% of votings: no difference



- Landscape: ~42% of votings prefer 720p/50
~46% of votings prefer 1080i/25
~12% of votings: no difference



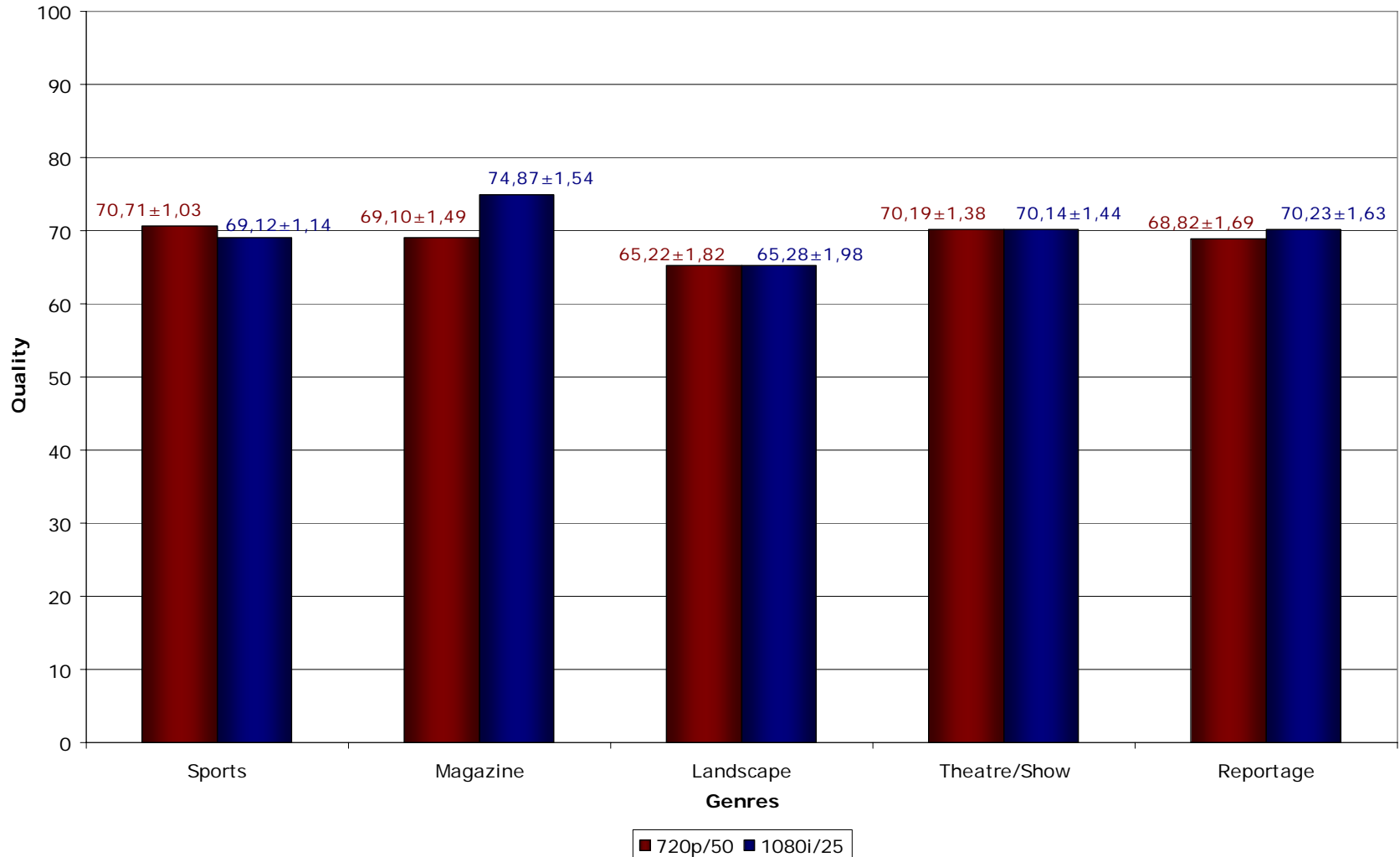
- Theatre/Show: ~42% of votings prefer 720p/50
~34% of votings prefer 1080i/25
~24% of votings: no difference



- Reportage: ~37% of votings prefer 720p/50
~48% of votings prefer 1080i/25
~15% of votings: no difference

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Genres Non-Experts LC-Projector



➤ Sanyo LC-Projector – Non-Experts (absolute value):



- Sports: ~48% of votings prefer 720p/50
~41% of votings prefer 1080i/25
~11% of votings: no difference



- Magazine: ~22% of votings prefer 720p/50
~64% of votings prefer 1080i/25
~14% of votings: no difference



- Landscape: ~44% of votings prefer 720p/50
~46% of votings prefer 1080i/25
~10% of votings: no difference



- Theatre/Show: ~44% of votings prefer 720p/50
~46% of votings prefer 1080i/25
~10% of votings: no difference



- Reportage: ~40% of votings prefer 720p/50
~52% of votings prefer 1080i/25
~ 8% of votings: no difference

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quality of 1080i/25 & 720p/50

 Conclusion

Conclusion

➤ Panasonic PDP:

- Massive preference of 720p/50
- Complex Scaling of both formats to the resolution of 1366x768 is necessary
- De-Interlacing is necessary for 1080i/25
- Accruelement of massive impairments by de-interlacing of 1080i/25

→ **720p/50 delivers a much better picture quality on flat-panel-devices customary in the trade (WXGA and similar resolutions) than 1080i/25**

Conclusion

➤ LC-Projector:

- Little preference of 1080i/25
- Scaling from 1280x720 to 1920x1080 is necessary for 720p/50
- No Scaling of 1080i/25 necessary
- De-Interlacing is necessary for 1080i/25
- Impairments caused by scaling of 720p/50 are worse than impairments caused by de-interlacing of 1080i/25

➔ 1080i/25 delivers a slightly better picture quality in native reproduction than 720p/50 in non-native reproduction

Conclusion

→ Comparison of the scanning-formats in native reproduction (720p on a native 1280x720-panel & 1080i on a native 1920x1080-panel) has finally to result in a much better picture quality of 720p/50

Conclusion

- Other objective arguments in favour of 720p/50:
 - a progressive system provides a similar vertical resolution to an interlaced system with about 35% less pixels in the vertical direction (S. Pigeon)
(1080 pixel subtracting 35% = 702 pixel)
 - increased quality in slow-motion
 - increased quality in keying-applications
 - easy freezing of frames
 - increased coding-efficiency with today's compression schemes (MPEG2, H.264 etc.) of about 15%-20% in comparison of an interlaced system (with similar datarate)

Conclusion

- Compression of interlaced systems:
 - typical interlaced frame with motion between the two corresponding fields:

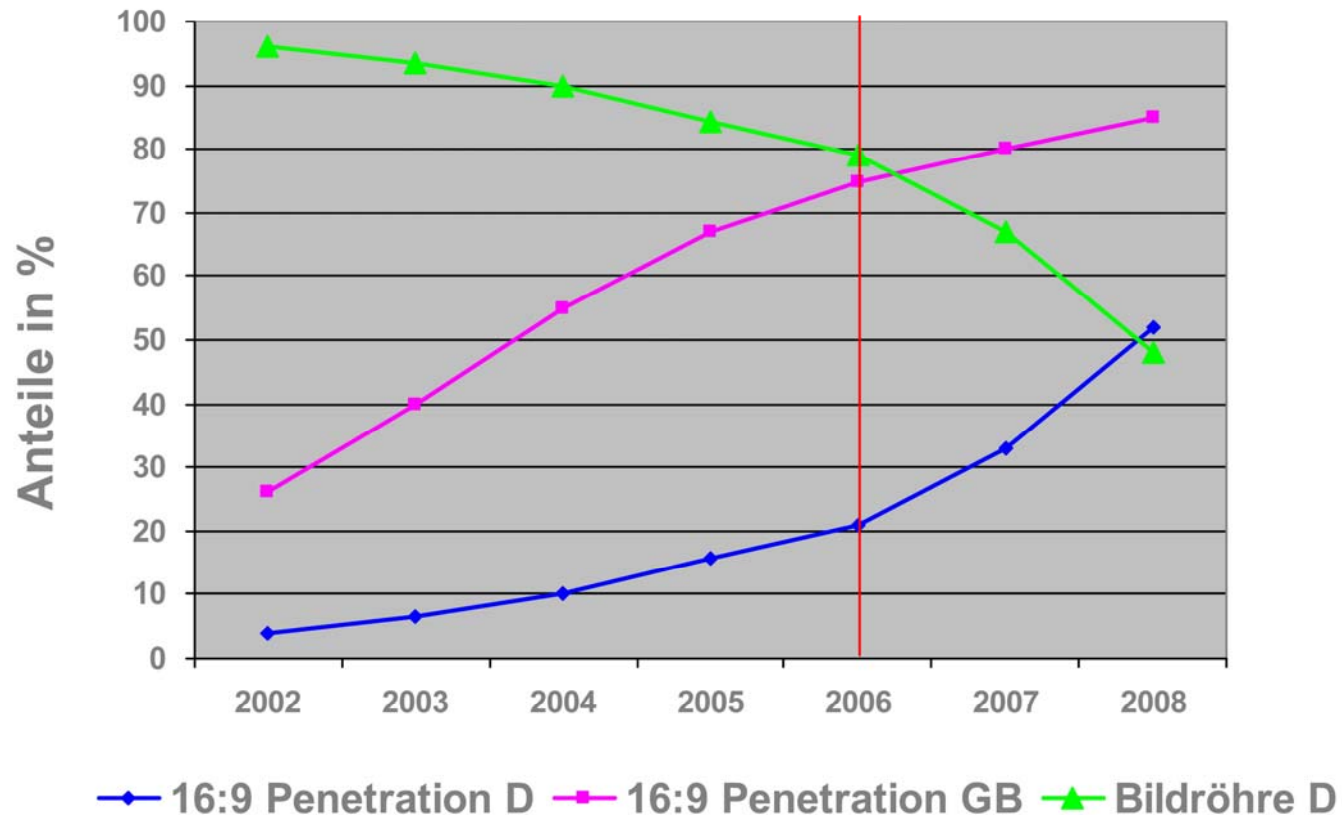


Conclusion

- Compression of interlaced systems:
 - Frame-DCT-based compression-schemes produce a lot of coefficients unequal zero because of the comb-like structures in typical interlaced frames with motion -> more bits for coding are necessary -> higher datarate
 - Field-DCT-based compression-schemes suffer from the spatial distance between two neighbouring pixels in the vertical direction; motion-compensation algorithms suffer from higher temporal distance between two fields of same parity
 - decreasing picture quality because of wrong motion-vectors as a cause of interlaced-artefacts

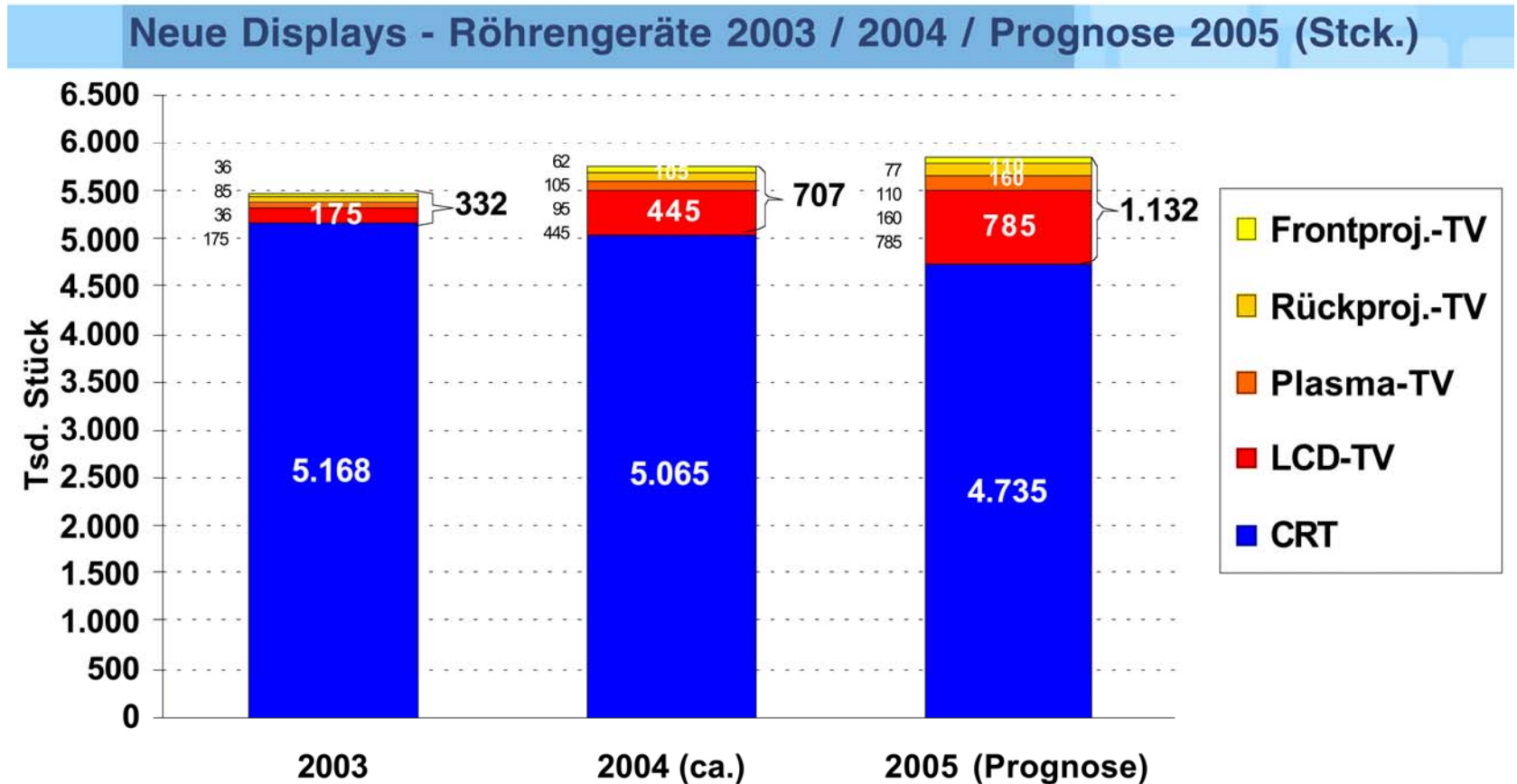
ZDF – Migration from SDTV to HDTV

Market share of 16:9-displays...



Source: ZVEI

Market share of non-CRT displays...



Source: GfU

Picture quality on big flat-panel-displays...

- poor picture quality of SDTV on big flat-panel-displays as a result of low datarates in transmission:
 - DVB-T: ~2 to 4 Mbit/s
 - DVB-S: ~3 to 6 Mbit/s
 - DVB-C: ~3 to 6 Mbit/s



Three steps from today's SDTV to HDTV

- First Step: Increase of programmes produced and broadcasted in 16:9-ratio (since mid 2005)
- Second Step: Increase of SDTV-picture quality by increasing transmission data-rates:
 - Reduction of programmes in the ZDF-Multiplex from 8 to 6 (1st January 2006)
 - 6 programmes in a 33 MHz transponder, DVB-S, ~38 Mbit/s capacity, results in ~8 Mbit/s (MPEG2) for ZDF-main-programme (DVD-quality!) and ~6 Mbit/s for the 5 additional programmes
 - German Cable-Operators take over this higher quality (DVB-C)
 - Unfortunately no space for higher datarates in DTT (DVB-T)

Three steps from today's SDTV to HDTV

➤ Third Step: Start of HDTV-services by ZDF in a few years (not before 2008)

- in first instance ZDF-main-programme
- some years later perhaps also the additional programmes
- Scanning-Format: 720p/50
- Compression Scheme: H.264
- Satellite-transmission: DVB-S2
- Cable-transmission (depends on operators): QAM256
- Unfortunately no space for terrestrial HDTV-services in the near future

High Definition – a new challenge for broadcasters



Thank you !