Are people pixel-peeping 360 videos?

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Motivation

https://www.redsharknews.com/media/k2/items/src/a99475c9da7b69132aa0f2b1fa3d4aba.jpg

https://vrgineers.com/wp-content/uploads/2018/06/vrgineers-xtal-front.png

Scope

- Displaying 360° videos: Various technologies
  (360° projection walls, tablet PCs, PC with classical screen + mouse navigation)
- Focus on playback using HMDs
- In future: incresed resolution
- Series of studies for low-resolution HMDs
- Studies for higher-resolution HMDs currently not available

→ Motivation: study effect of higher screen resolution on

a) Perceived quality

b) Discrimination power of quality ratings

c) Usefulness of high-resolution contents + influence on head rotation behavior

→ Does 8K really provides better perceived quality than 6K 360° content?

→ Is head rotation behavior differing between single quality levels?

Experimental Setup & Test Method (1)

- 3 subjective tests, entertaining 360° contents, 20s duration
- 2 tests: HTC Vive + Vive Pro HMD, effect of resolution on
  a) Perceived video quality
  b) User behavior
- 1 test: HTC Vive Pro, 4K, 6K and 8K resolution
- All tests
  - Pre-screening: Ishihara + Snellen charts (20/25)
  - Head rotation behavior recorded (pitch/yaw/roll) using AVTrack360
  - Whirligig 4.2 (http://www.whirligig.xyz)

Experimental Setup & Test Method (2)

- 5-point ACR scale for rating quality
- After session: SSQ, afterwards ~10 min break
- Initial session: adjustment of HMD's IPD
- After each PVS: ACR scale in HMD
- HMD connected to VR PC

Total test Duration ~90 minutes

Pre-screening + SSQ (10 minutes)	Test Session 1 (10 minutes)	SSQ + Break (10 minutes)	Test Session 2 (10 minutes)	SSQ + Break (10 minutes)	Test Session 3 (10 minutes)	SSQ + Break (10 minutes)	Test Session 4 (10 minutes)	SSQ + Questions (10 minutes)

Selection and Preparation of Test Sequences (1)

Test 1 & 2

- Same set of test sequences (min. 3840x1920 px, 30 fps)

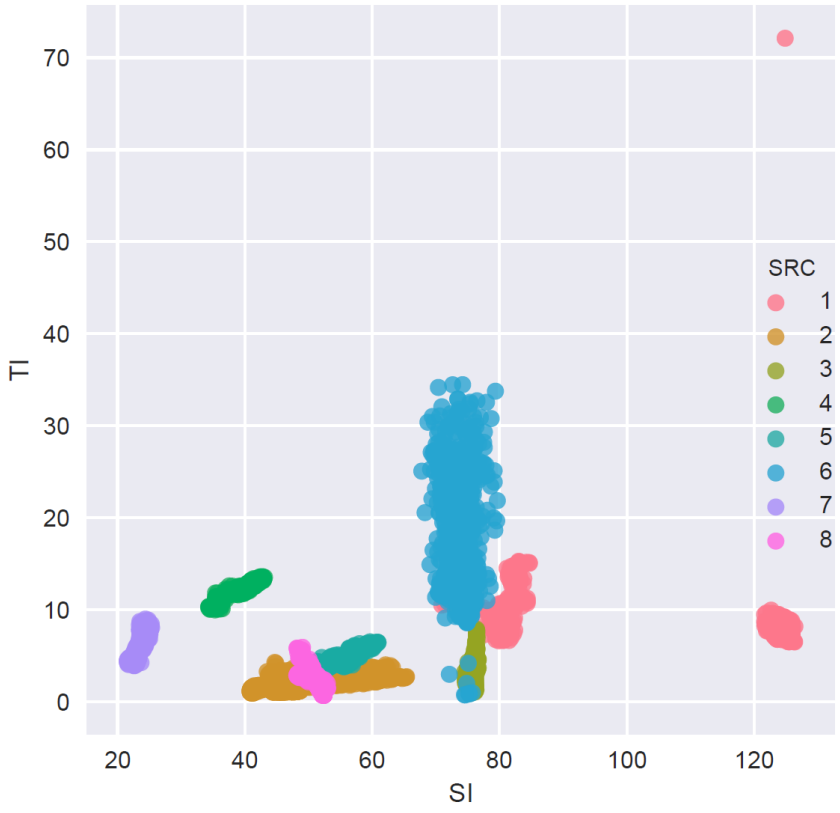
Test 3

- Test sequences (min. 7680x3840 px, 30 fps) partially matching with SRCs of test 1&2

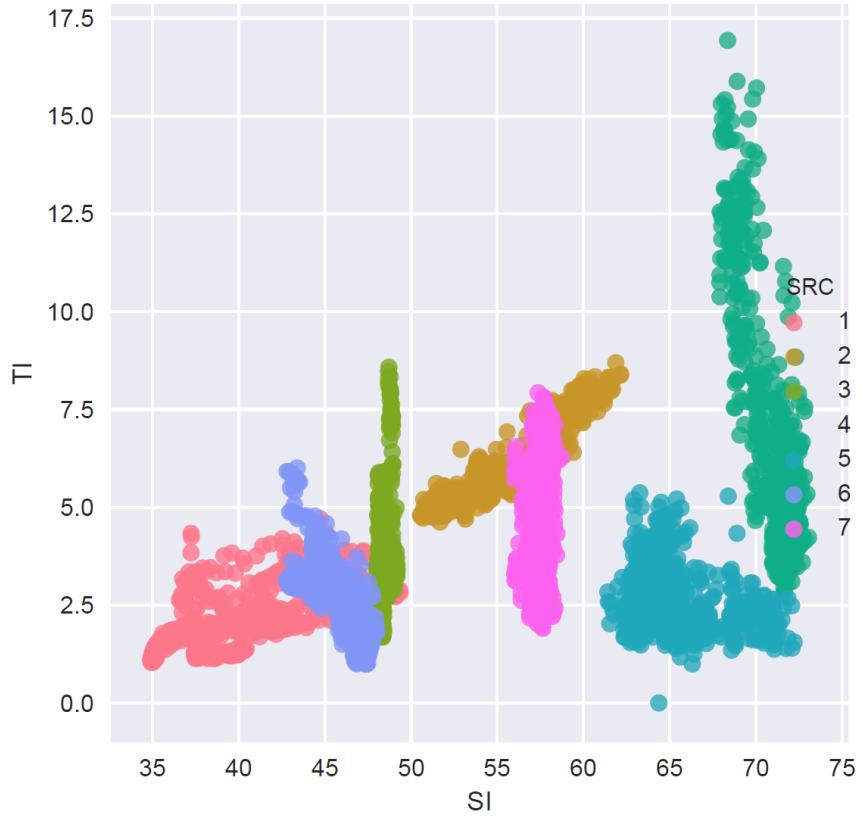
- SI/TI values computed using https://github.com/Telecommunication-Telemedia-Assessment/SITI
- Broad range of spatial + temporal information complexity
- Lower number of high TI contents for avoiding SS

Selection and Preparation of Test Sequences (2)

SI/TI values Test 1 & 2



SI/TI values Test 3



Selection and Preparation of Test Sequences (3)

Test 1 & 2

- Same test design
- 2 resolutions, 4 bitrates/resolution, 8 SRCs → 64 PVS
- Encoded using *ffmpeg* 4.0, *libx265* + 2-pass encoding
- Audio at fixed bitrate (256k), *aac* codec

Condition	Resolution	Bitrate [Kbps]
Q1	1920x1080	500
Q2	1920x1080	1000
Q3	1920x1080	3500
Q4	1920x1080	7000
Q5	3840x2160	1000
Q6	3840x2160	2000
Q7	3840x2160	6000
Q8	3840x2160	12000

Selection and Preparation of Test Sequences (4)

Test 3

- 3 resolutions, 3 bitrates/resolution, 7 SRCs → 63 PVS
- Encoded using *ffmpeg* 4.0, *libx265* + 2-pass encoding
- Audio at fixed bitrate (256k), *aac* codec

Condition	Resolution	Bitrate [Kbps]
Q1	3840x1920	500
Q2	3840x1920	2000
Q3	3840x1920	6000
Q4	5760x2880	1000
Q5	5760x2880	4500
Q6	5760x2880	13500
Q7	7680x3840	2000
Q8	7680x3840	8000
Q9	7680x3840	24000

Participants

Test ID	#Subjects	Avg./Med. Age	Outliers
1	27 (14f, 13m)	28/26	6
2	28 (12f, 16m)	26/24	3
3	27 (13f, 14m)	28/27	4

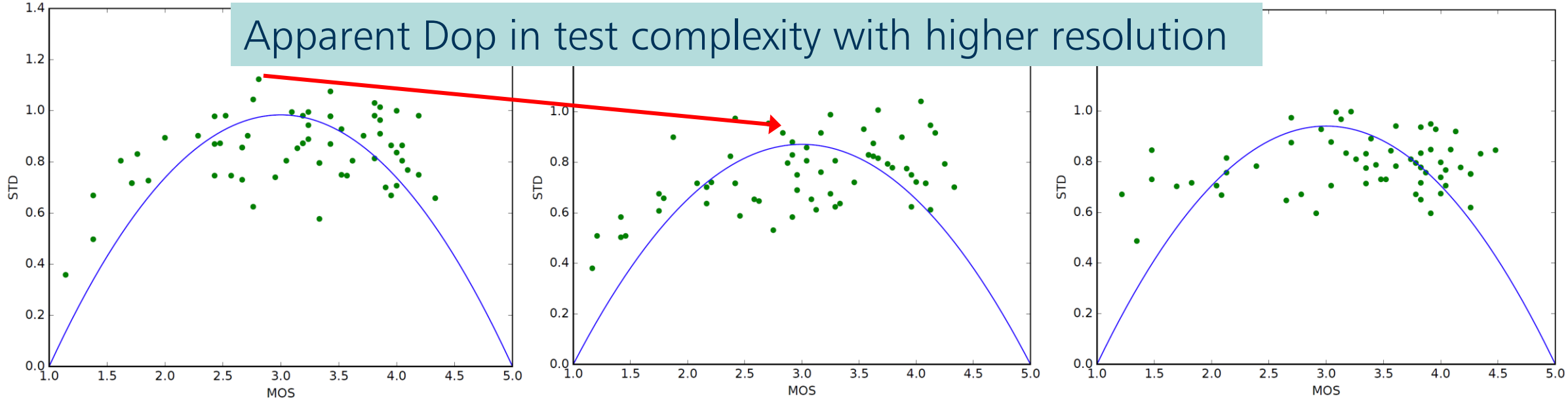
Video Quality Evaluation (2)

SOS analysis test 1 (a≈0.246)

SOS analysis test 2 (a≈0.218)

SOS analysis test 3 (a≈0.235)

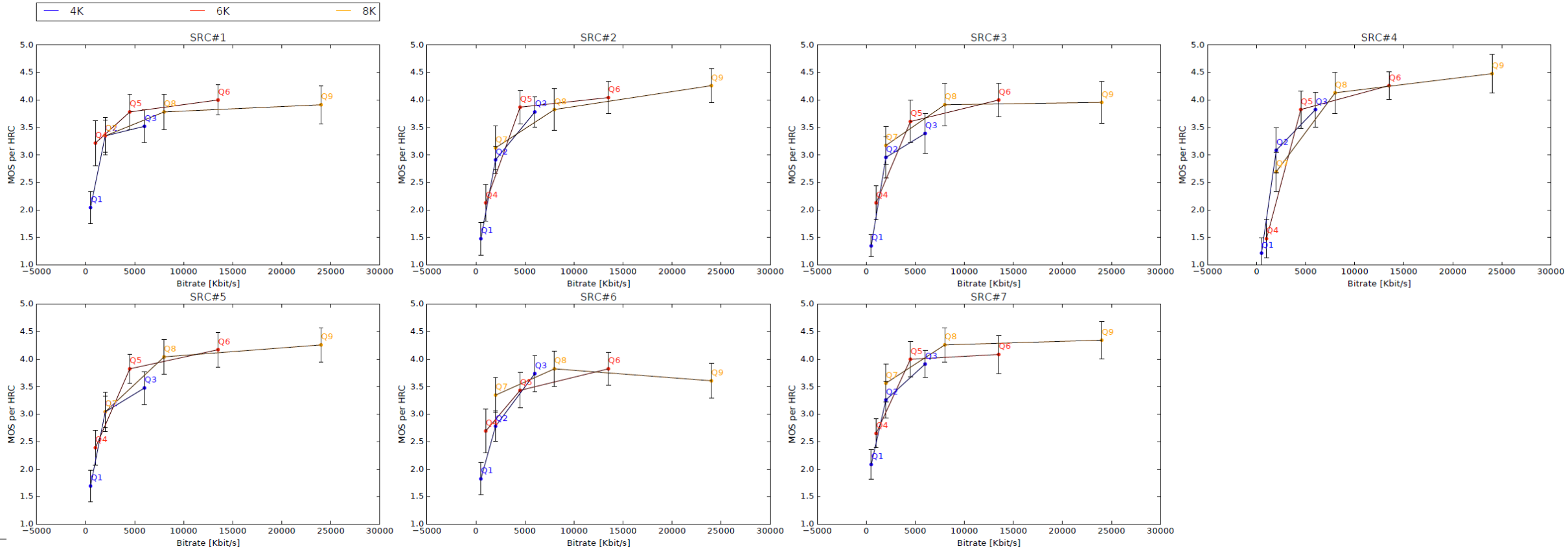
Apparent Dop in test complexity with higher resolution



Video Quality Evaluation (5)

Does 8K provide better quality compared to 6K or 4K?

- Computed MOS for test 3



Behavioral Analysis

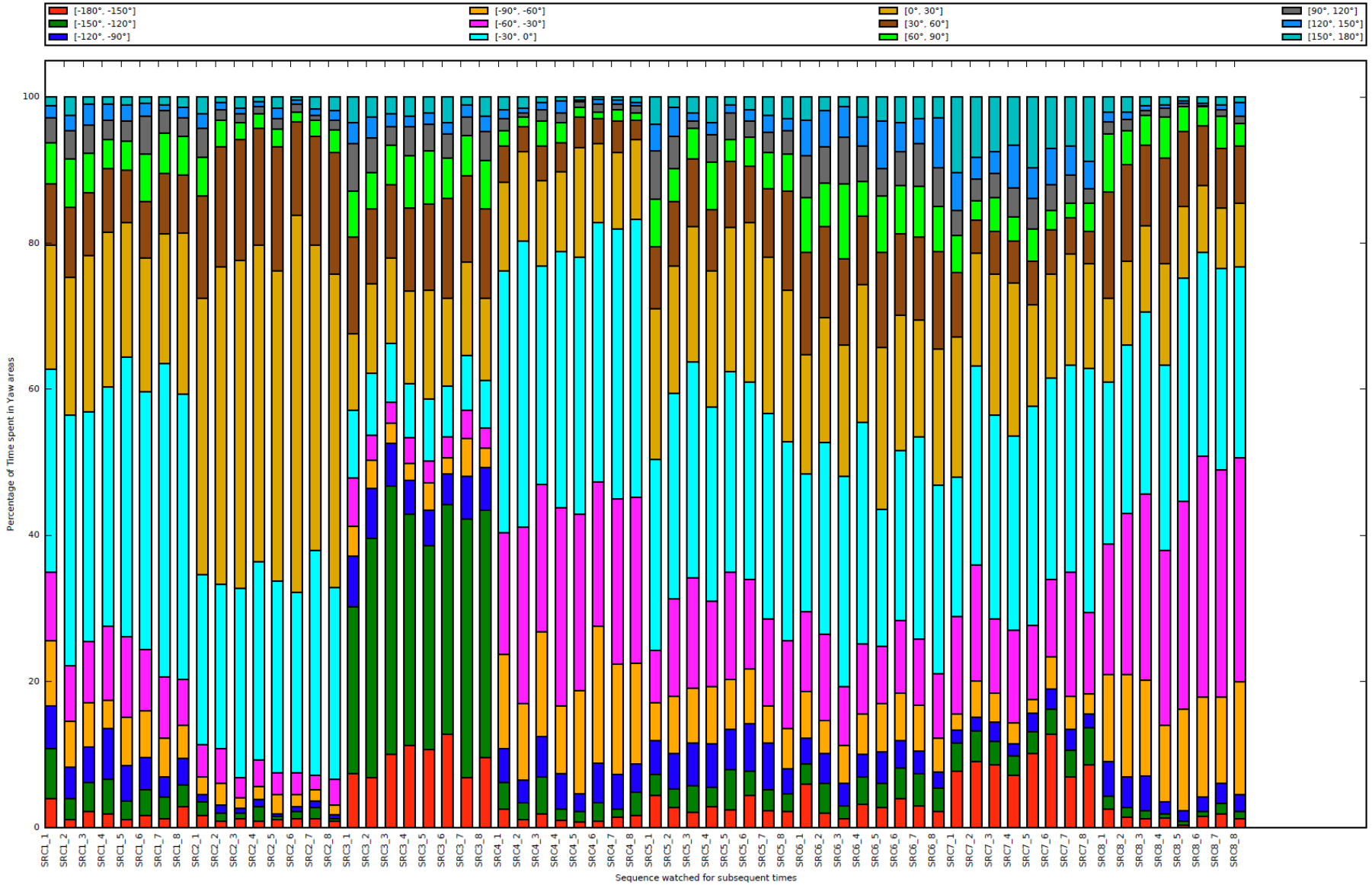
Differences of head rotation behavior of participants?

a) Between HMDs

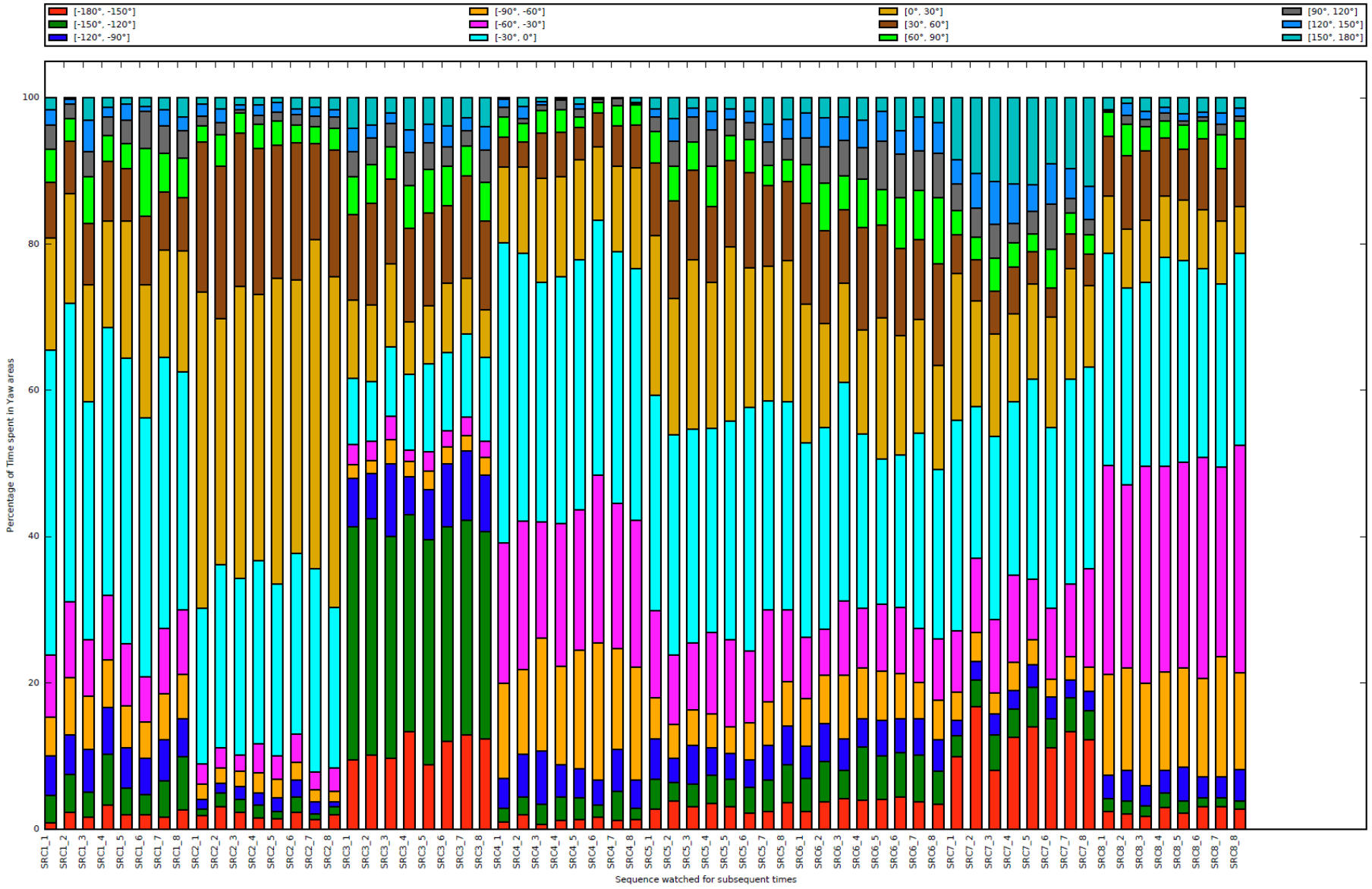
b) In-between PVSs

- Head rotation data quantized by steps of 30°
- Plots showing percentage of time spent in quantized yaw areas (ranging from -180°>0>180°)

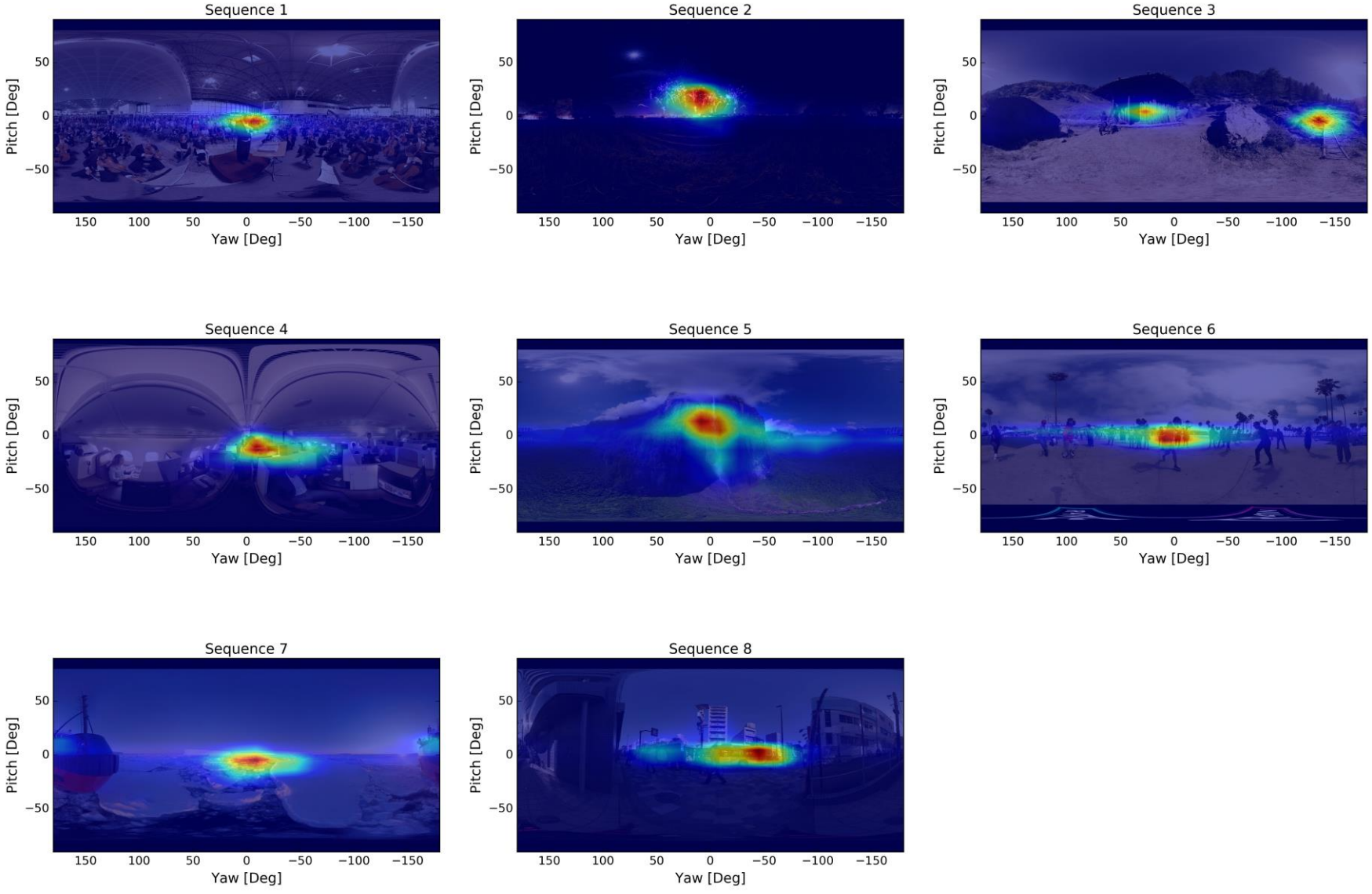
Time spent on specific yaw areas test 1



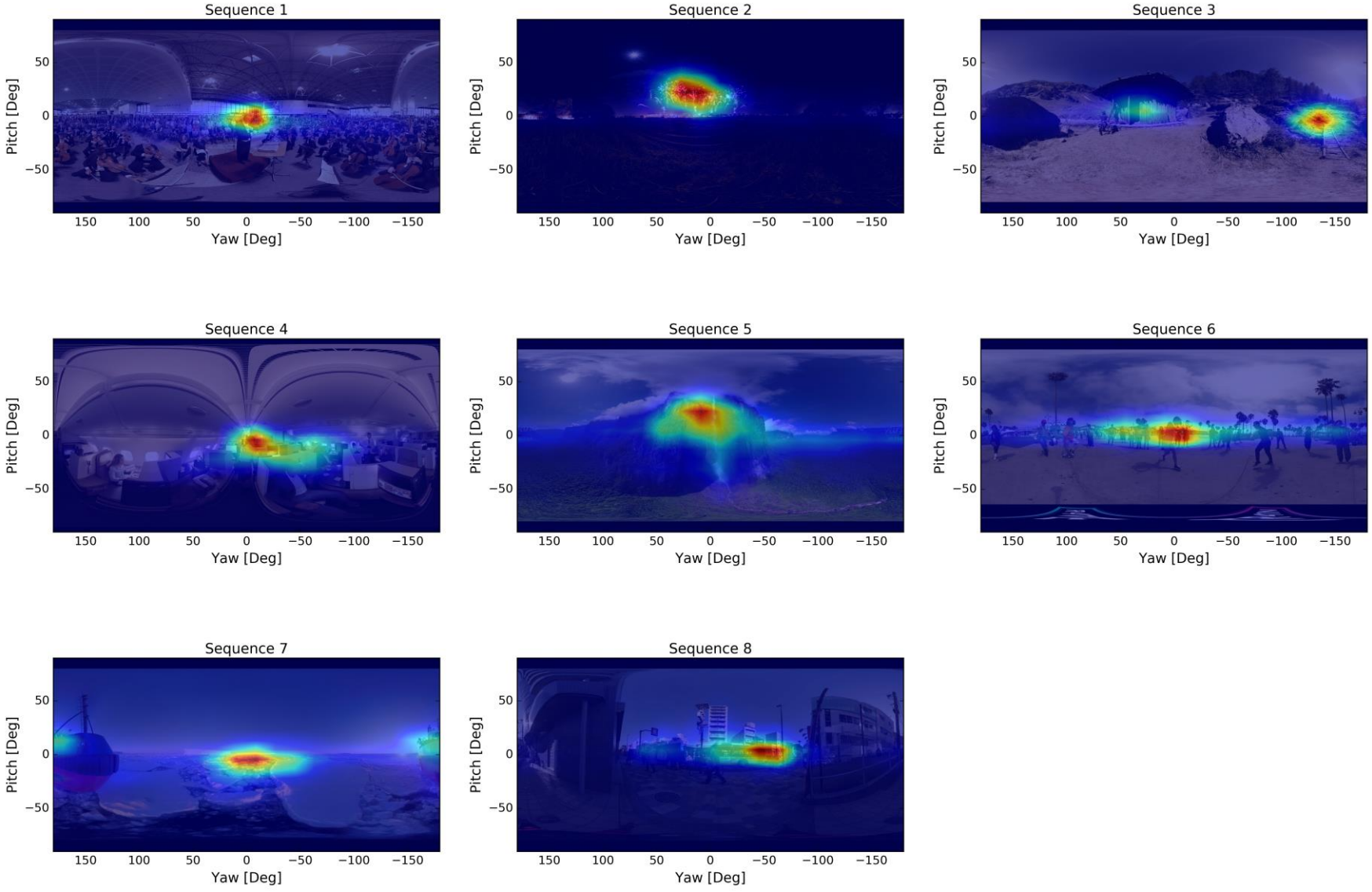
Time spent on specific yaw areas test 2



Heatmaps test 1



Heatmaps test 2



Conclusions

- 3 tests, 2 different HMDs, various conditons
- Higher resolution → More reliable quality evaluation
- Difference between 13,5 Mbit/s@6K or 24 Mbit/s @8K nearly not perceivable
- "pixel-peeping" of 360° videos, focus on parts more suitable for quality rating
- Higher resolution itself has no significant influence on head rotation behavior
- Future research: Establish link between user behavior, quality + technical system properties

Questions?

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