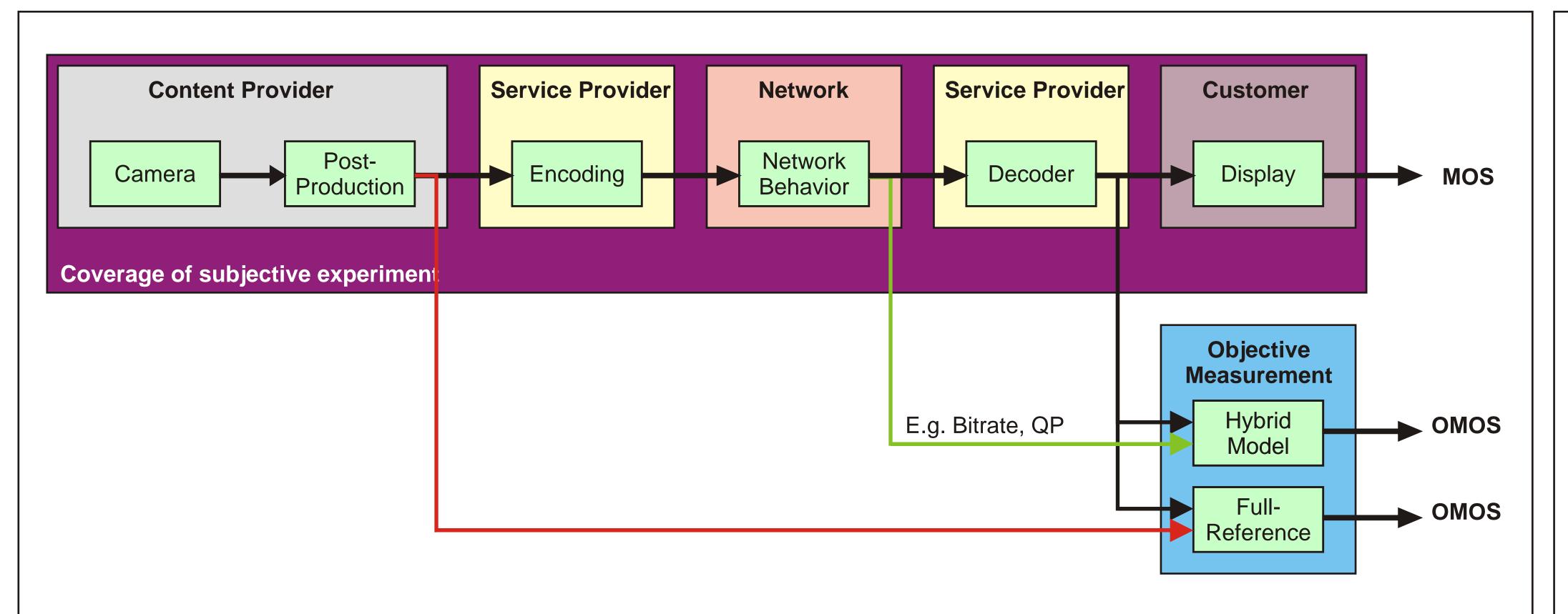# ANALYSIS OF FREELY AVAILABLE SUBJECTIVE DATASET FOR HDTV INCLUDING CODING AND TRANSMISSION DISTORTIONS
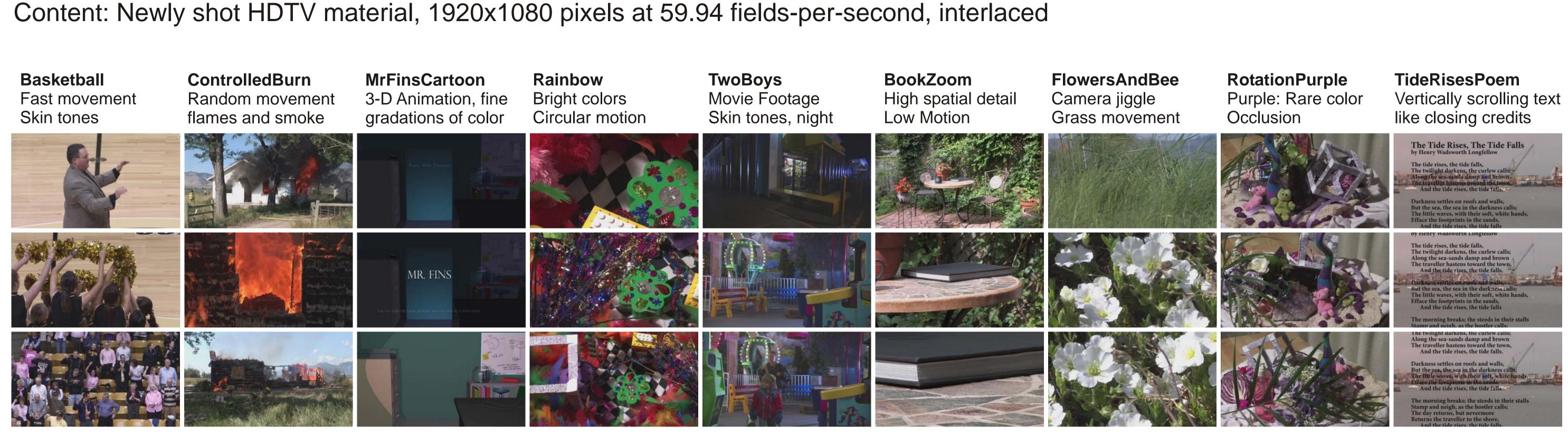
Marcus Barkowsky[1], Margaret Pinson[2], Romuald Pépion[1], and Patrick Le Callet[1]

[1]IRCCyN UMR 6597 CNRS, Polytech' Nantes, rue Christian Pauc, 44306 Nantes, France

[2]National Telecommunication and Information Administration (NTIA), Institute for Telecommunication Sciences (ITS), 325 Broadway, Builder, CO 80305

Overview of Scenario
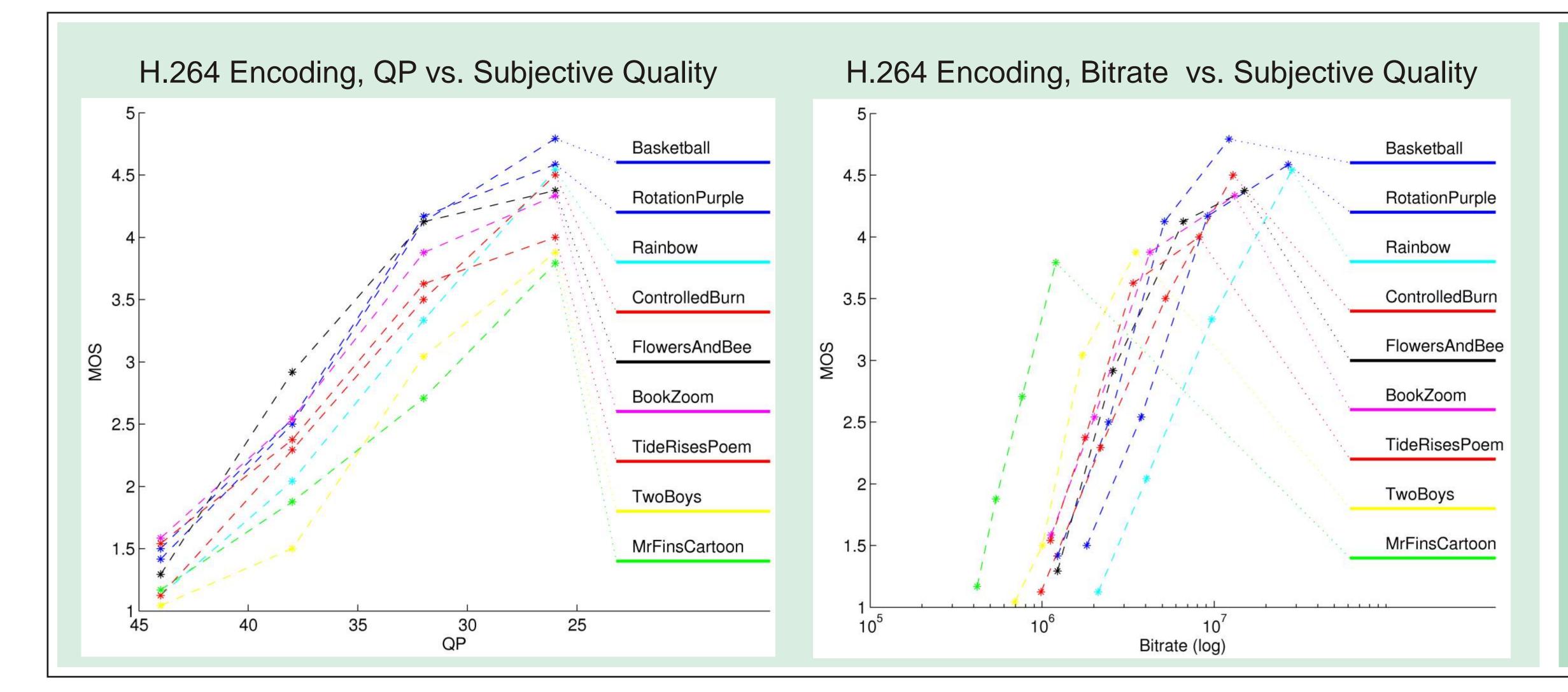

Subjective Test Design: Full Factorial Test

Content: Newly shot HDTV material, 1920x1080 pixels at 59.94 fields-per-second, interlaced

Basketball — Fast movement, Skin tones
ControlledBurn — Random movement, flames and smoke
MrFinsCartoon — 3-D Animation, fine gradations of color
Rainbow — Bright colors, Circular motion
TwoBoys — Movie Footage, Skin tones, night
BookZoom — High spatial detail, Low Motion
FlowersAndBee — Camera jiggle, Grass movement
RotationPurple — Purple: Rare color, Occlusion
TideRisesPoem — Vertically scrolling text like closing credits

15 Degradations + Reference:
Mixture of encoding, transmission degradations, resampling and recoding using H.264 and MPEG2 video codecs

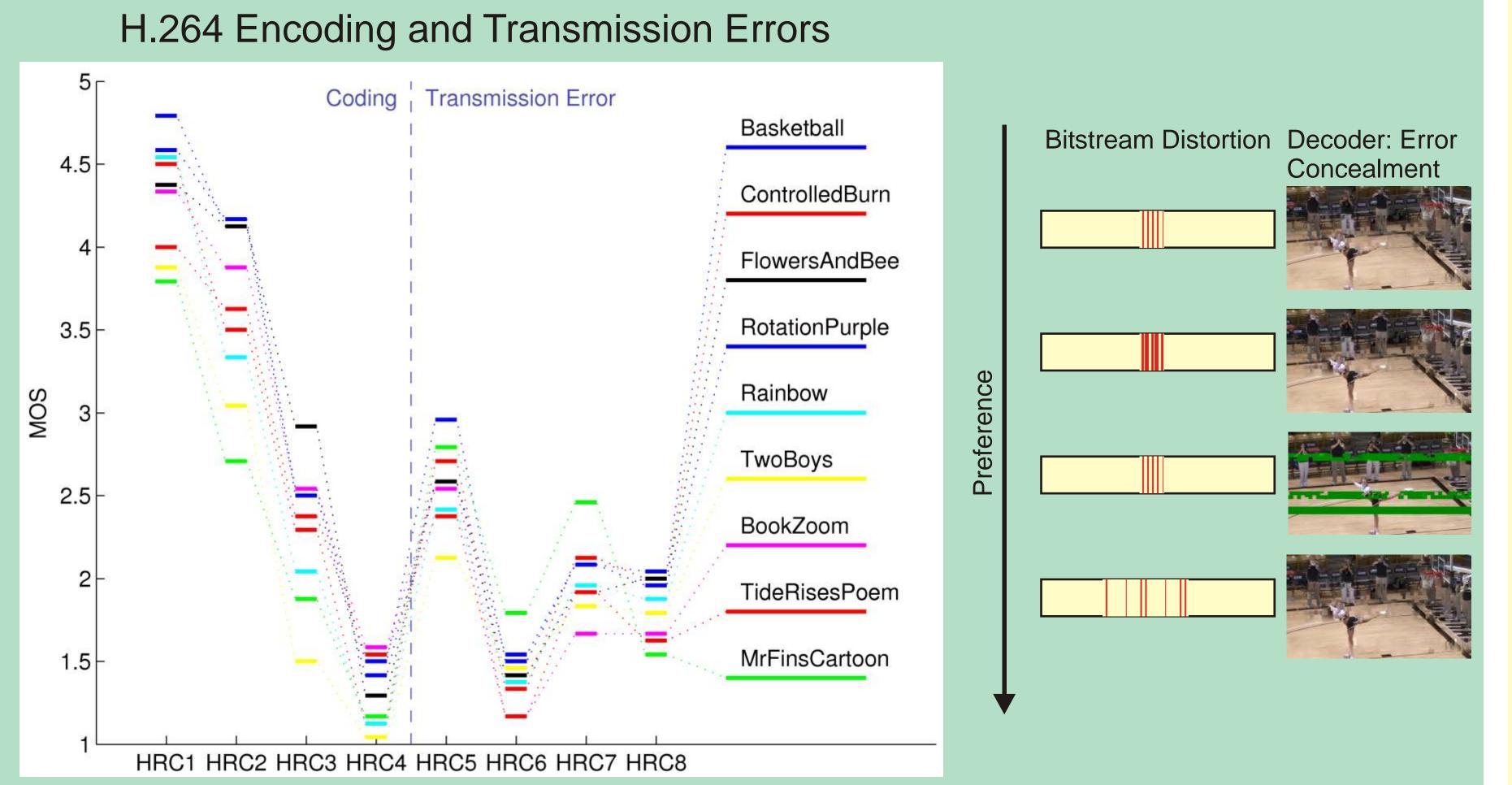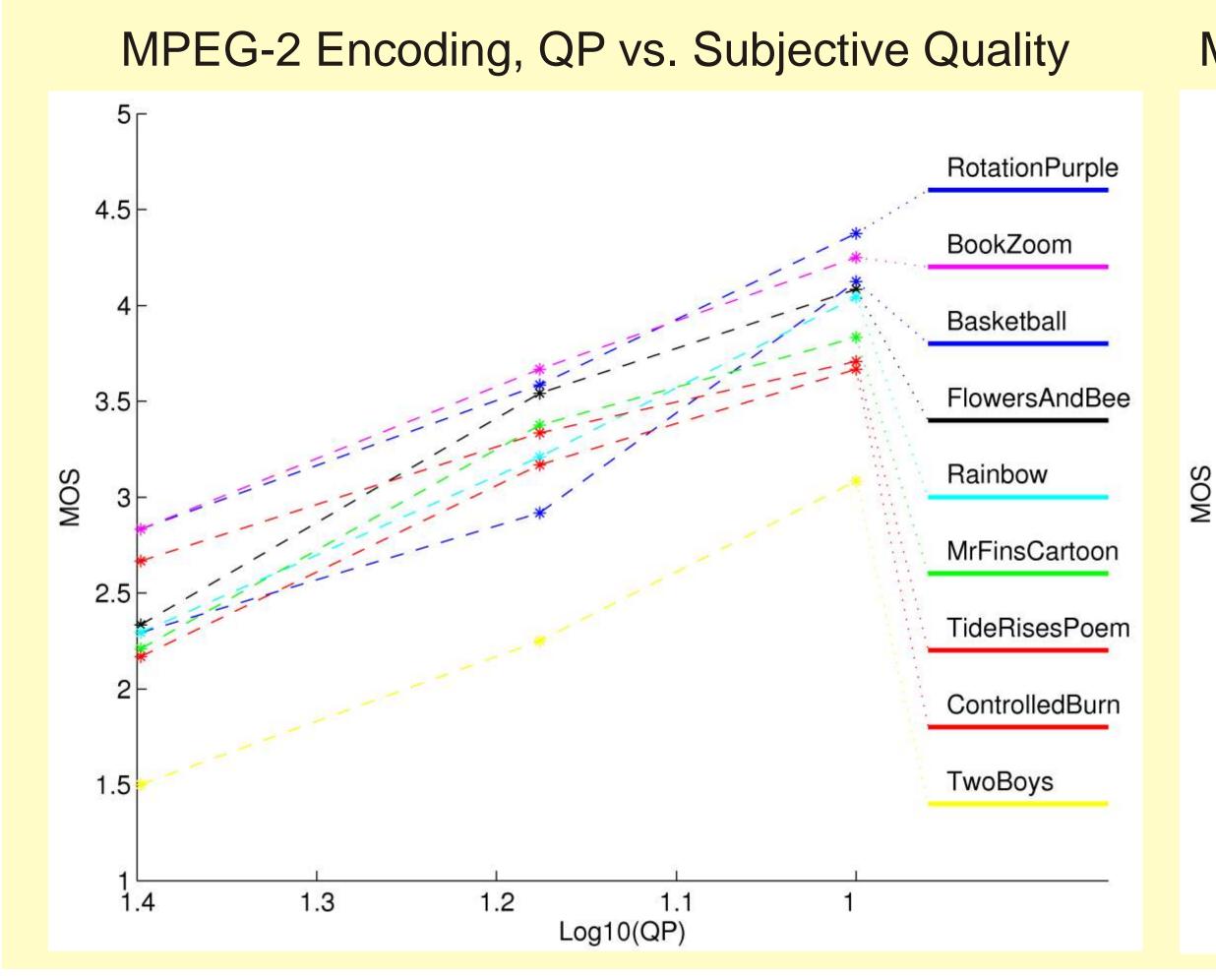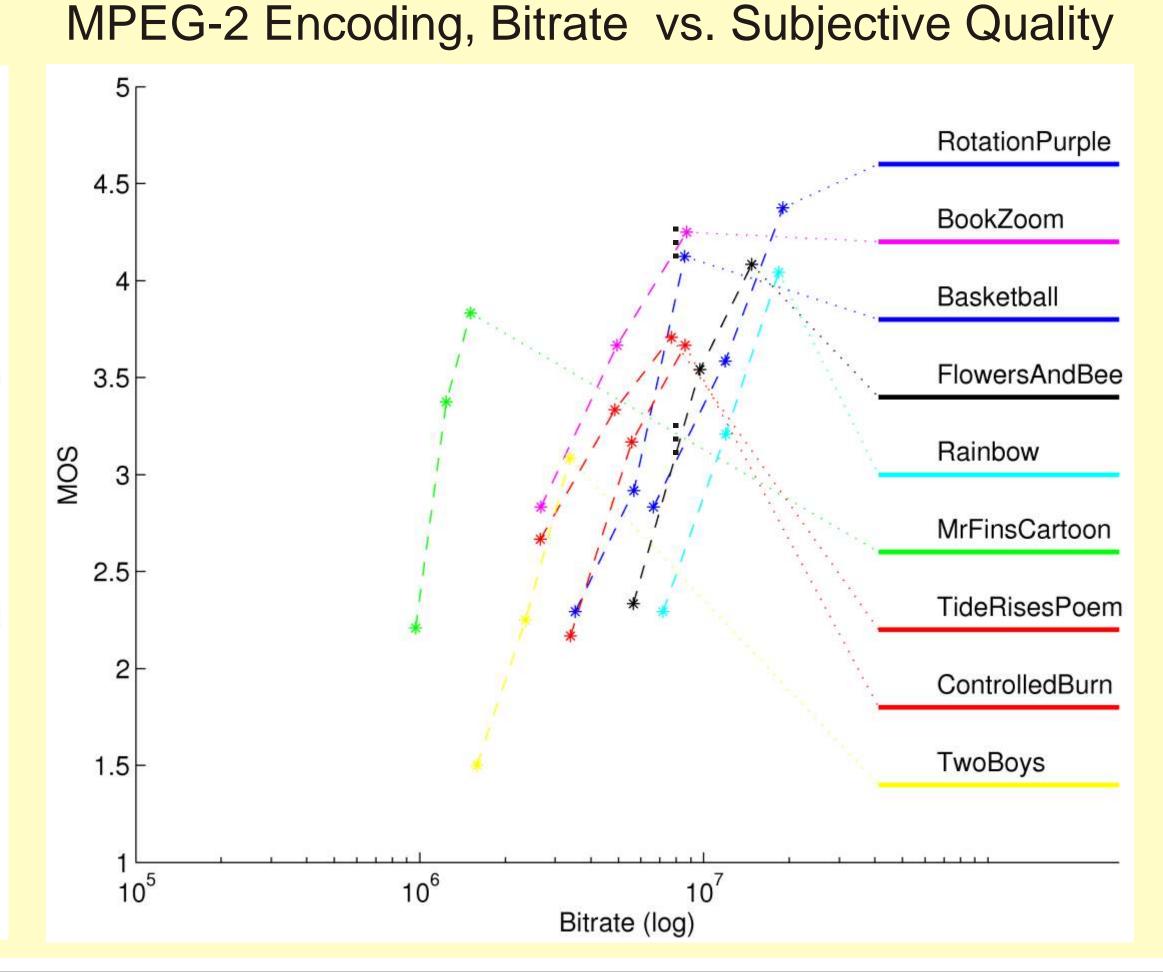|	
H.264:	4 Conditions encoding only (QP26, 32, 38, 44)
H.264:	4 Conditions encoding and transmission errors
H.264:	2 Conditions rescaling to 720p and encoding
MPEG2/H.264:	1 Condition transcoding
MPEG2:	3 Conditions encoding (QP 10, 15, 25)
MPEG2:	1 Condition encoding and transmission errors

Results of the subjective experiment

H.264 Encoding, QP vs. Subjective Quality

H.264 Encoding, Bitrate vs. Subjective Quality

H.264 Encoding and Transmission Errors

MPEG-2 Encoding, QP vs. Subjective Quality

MPEG-2 Encoding, Bitrate vs. Subjective Quality

Results of analysis

- Nearly linear relationship between visual quality and QP for H.264
- Nearly linear relationship between visual quality and log(Bitrate) for H.264
- Nearly linear relationship between visual quality and log(QP) for MPEG-2
- Nearly linear relationship between visual quality and log(Bitrate) for MPEG-2

- Strong dependency on video content, especially for log(Bitrate) and MPEG2

- For the transcoding scenario, the bitrate requirement increased by an average of 8% at approximately the same visual quality

- The same amount of lost packets leads to a visual degradation if spread wider

- The error concealment algorithm influences the visual quality, in our experiment a difference of 0.7 MOS was measured

Discussion of Fixed QP vs. Fixed Bitrate

Advantages of fixed QP evaluations:
- The coarseness of the quantization in the encoder is the most important loss of information and it is controlled by the QP
- Rate control algorithms are not part of video coding standards
- Only limited temporal variation of visual quality within a processed video sequence, thus easy to rate for naive observers
- Each content can be evaluated for its complete range of visual qualities (content that is easy to encode is not always displayed at high quality levels)
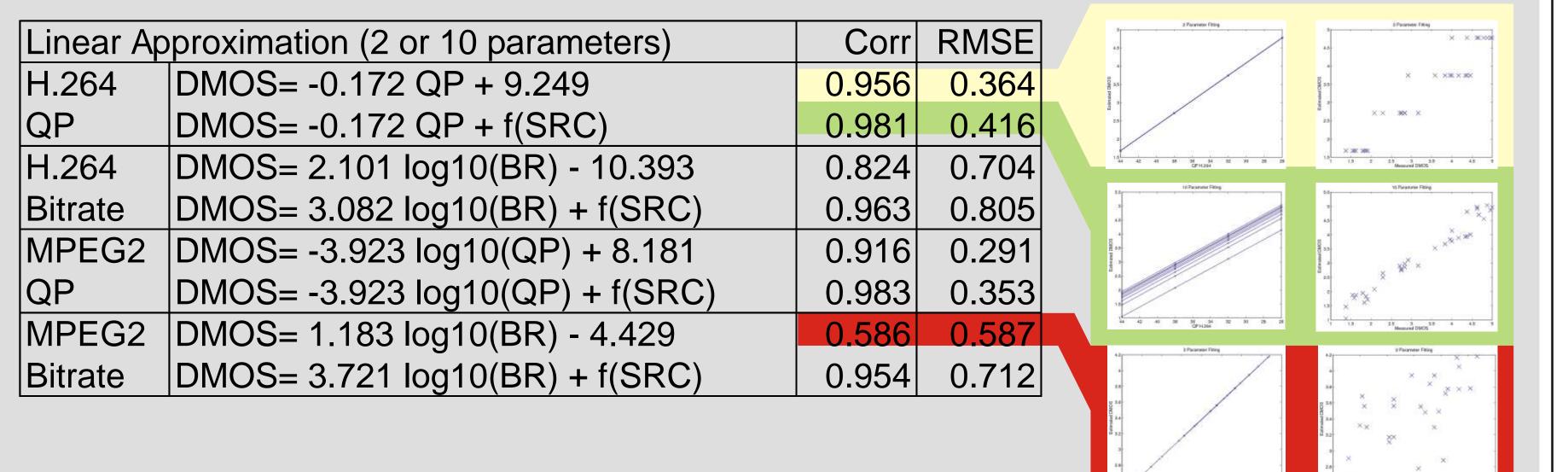
Advantages of fixed bitrate encoding:
- Typical scenario for broadcasting
- Limitation of maximum bitrate often necessary even in offline storage

Proposal:
- use fixed QP to learn about the visual quality of different content in a subjective experiment
- Perform separate experiments to learn about the influence of the change of QP by the rate control algorithms of video encoder implementations

Towards a Hybrid Model

Linear fit for QP or Bitrate indicates an upper bound on the expected performance

Linear Approximation (2 or 10 parameters)		Corr	RMSE
H.264 QP	DMOS= -0.172 QP + 9.249	0.956	0.364
	DMOS= -0.172 QP + f(SRC)	0.981	0.416
H.264 Bitrate	DMOS= 2.101 log10(BR) - 10.393	0.824	0.704
	DMOS= 3.082 log10(BR) + f(SRC)	0.963	0.805
MPEG2 QP	DMOS= -3.923 log10(QP) + 8.181	0.916	0.291
	DMOS= -3.923 log10(QP) + f(SRC)	0.983	0.353
MPEG2 Bitrate	DMOS= 1.183 log10(BR) - 4.429	0.586	0.587
	DMOS= 3.721 log10(BR) + f(SRC)	0.954	0.712

Results:
The QP provides a higher correlation and a lower RMSE than the Bitrate
The sequence dependency is important and should thus be modeled
Many aspects are missing in the model fit: framerate, image size, transmission distortions, different codec implementations, temporal variations due to rate control

Summary

Subjective experiment:
- Freely available HDTV content was recorded and categorized for subjective experiments
- Impairments were designed that span two video coding standards, several transmission distortions, and a transcoding scenario
- The processed sequences and the subjective data are freely available for testing objective video quality prediction algorithms

Modeling:
- A first approach towards modeling for a Hybrid Model and the upper bounds on the expected accuracy were presented
- The QP may be better suited for modeling than the bitrate
- The content dependency needs to be taken into account