Picture Coding Symposium 2006

Motion and Disparity Compensated Coding for Video Camera Arrays

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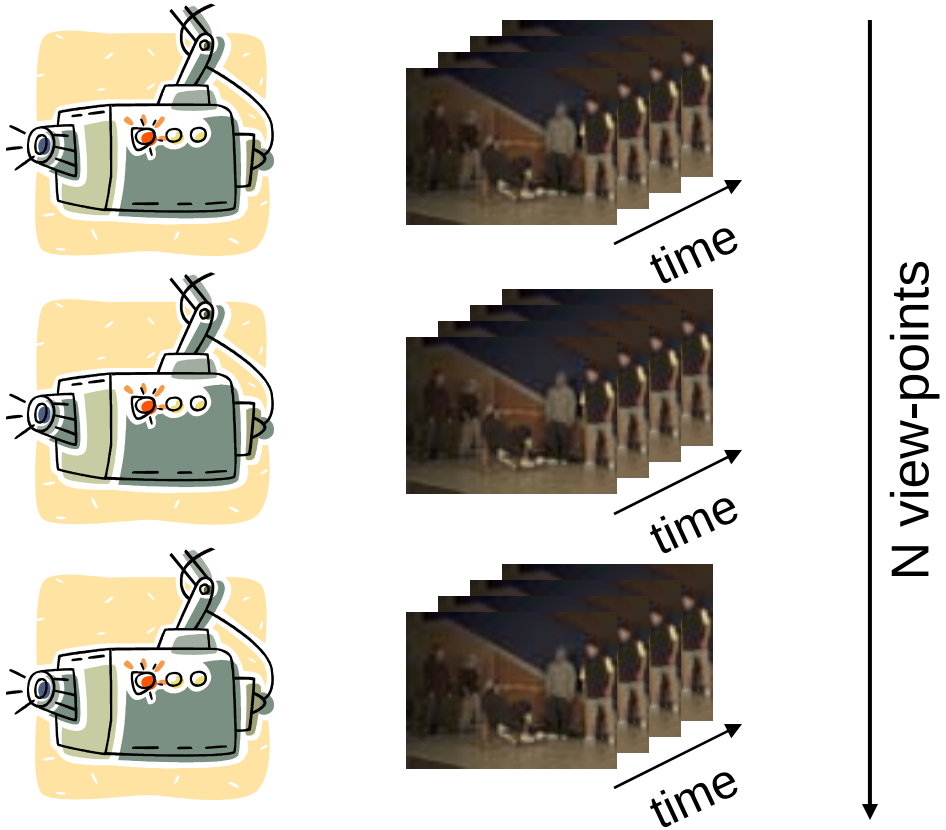
Motivation

[Breakdancing, courtesy of MSR]

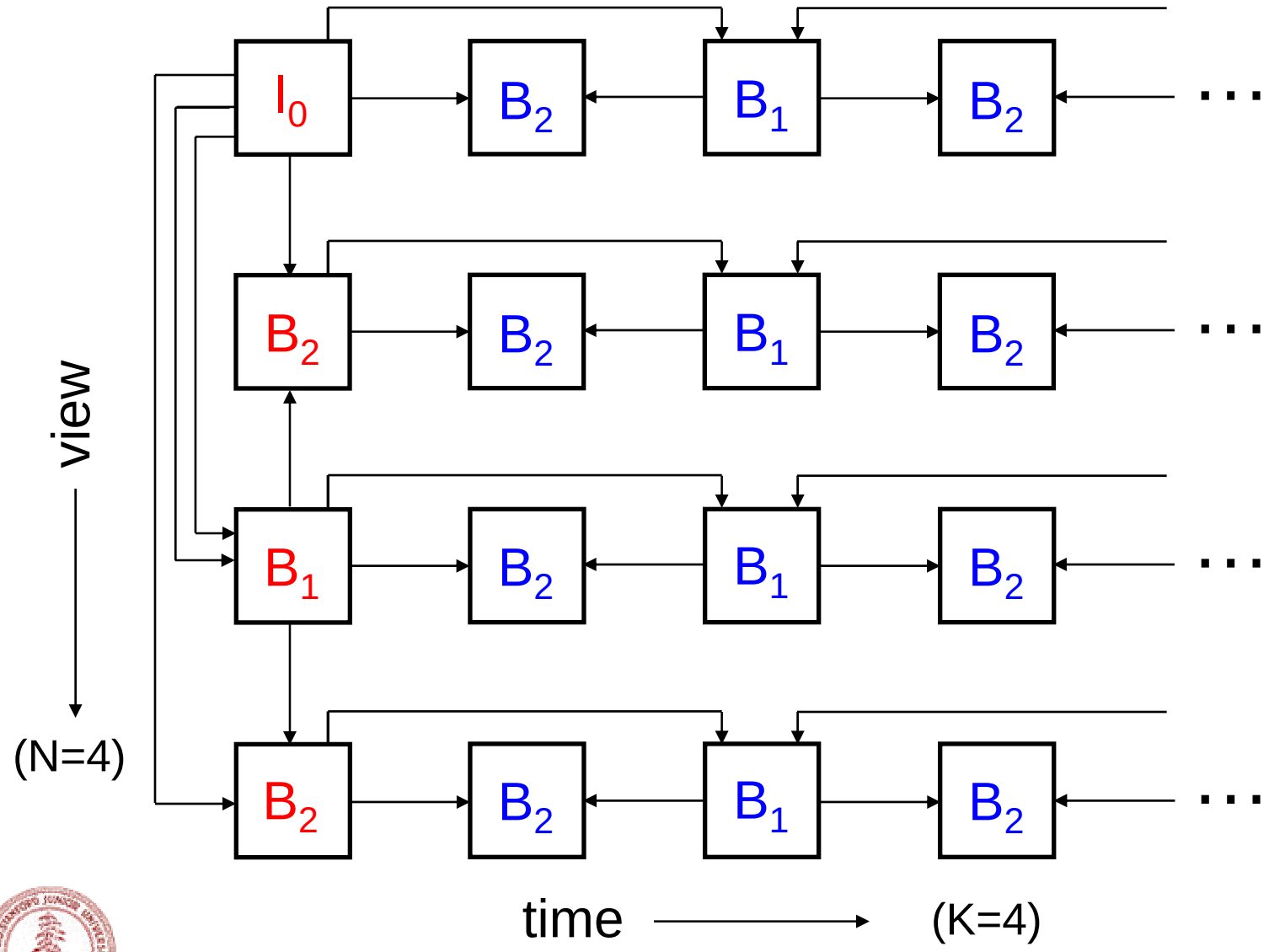


Efficient coding of video camera array signals with motion and disparity compensation

Outline

- H.264-based coding scheme
  - Matrix of pictures
  - Hierarchical B slices and bi-prediction
  - Experimental results
- Multi-view image-sequence model
  - Image-sequence model
  - Model for N image sequences
  - Assumptions
  - Model results

Coding Scheme for Matrix of Pictures



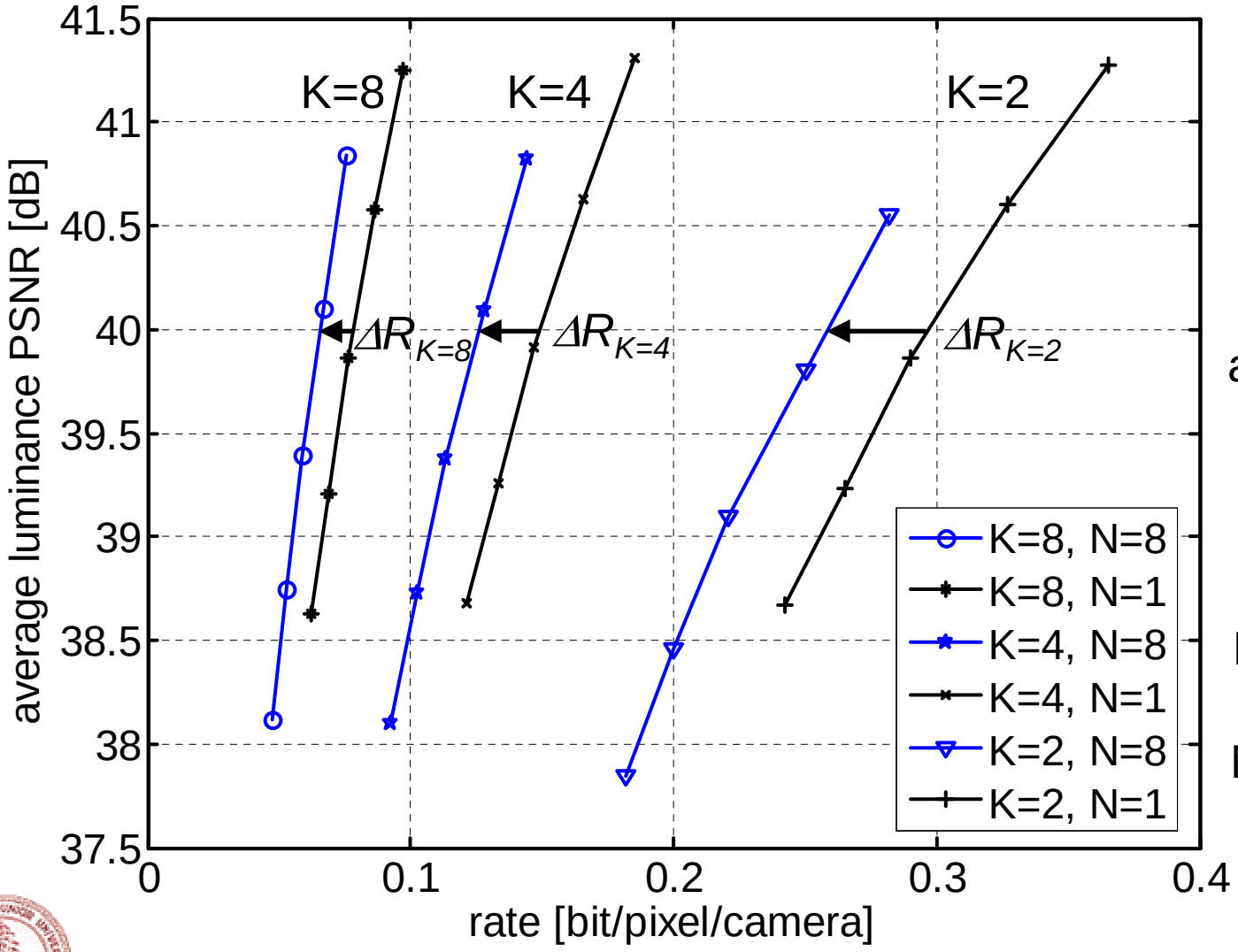
hierarchical coding structure

I
intra slice

B
B slice

slice:=picture

Experimental Results: PSNR vs. Rate



Ballet

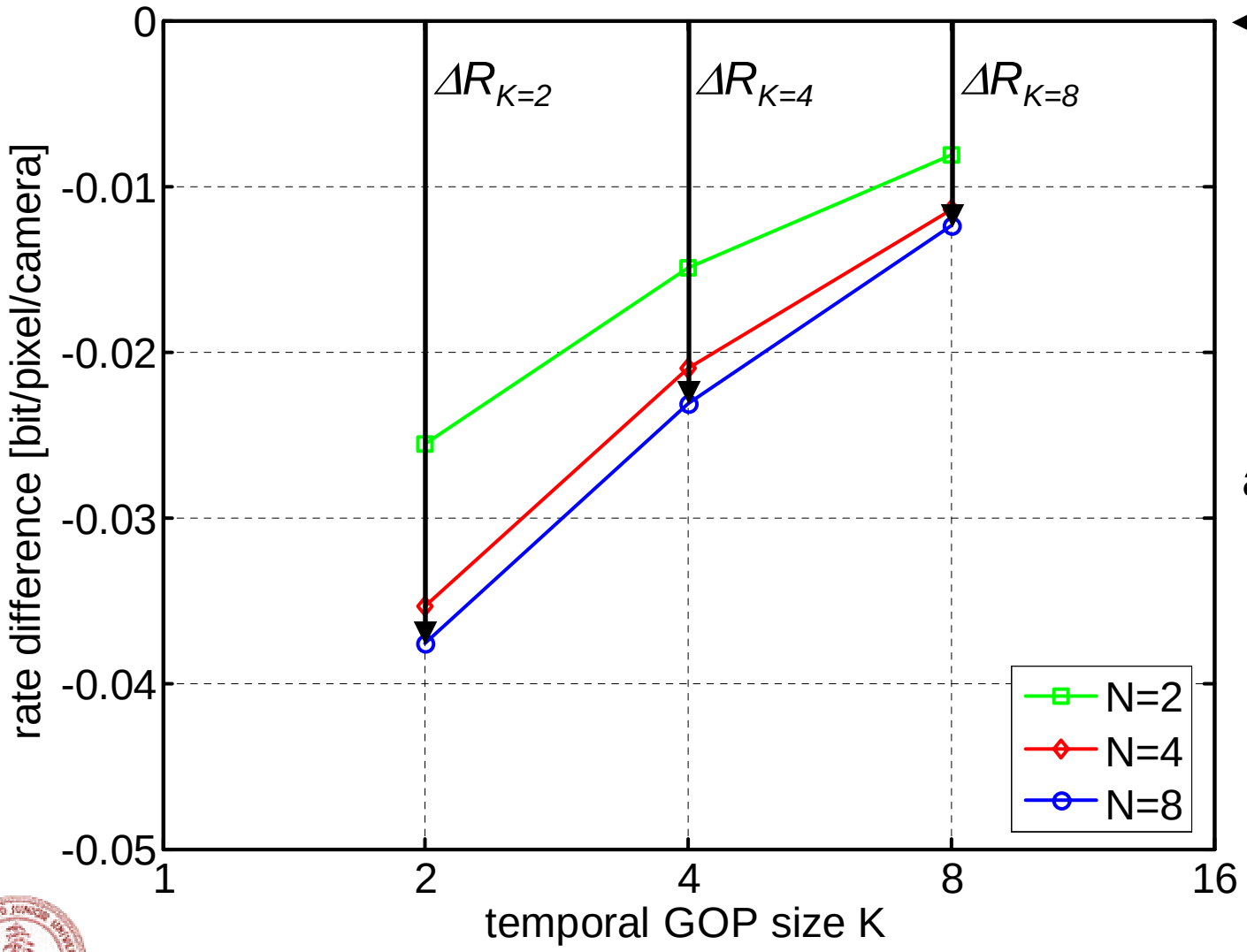
quarter-pel accurate disparity

quarter-pel accurate motion

K: temporal GOP

N: group of views

Experimental Results: Rate Difference vs. GOP Size



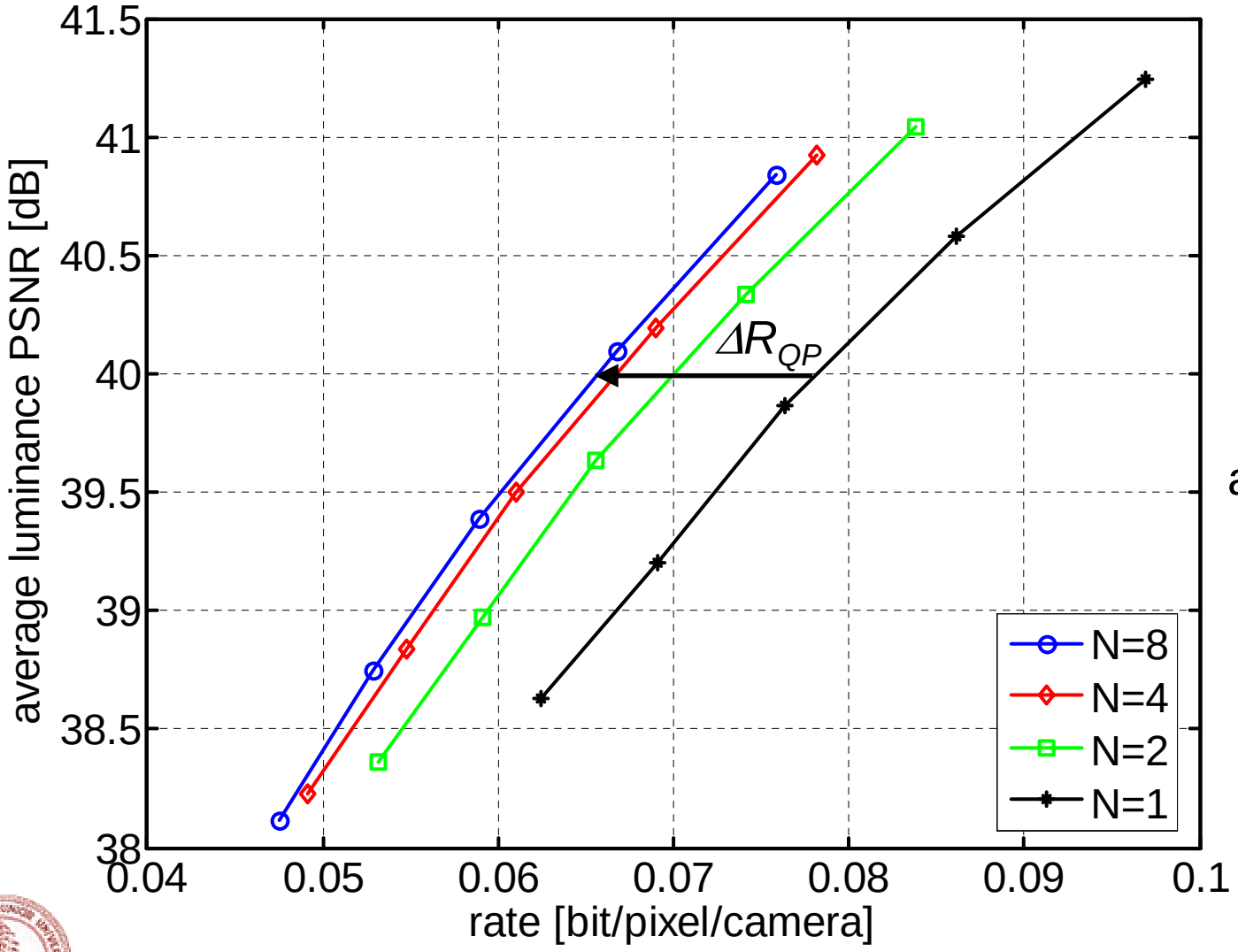
Ballet

PSNR = 40 dB

quarter-pel accurate disparity

quarter-pel accurate motion

Experimental Results: PSNR vs. Rate



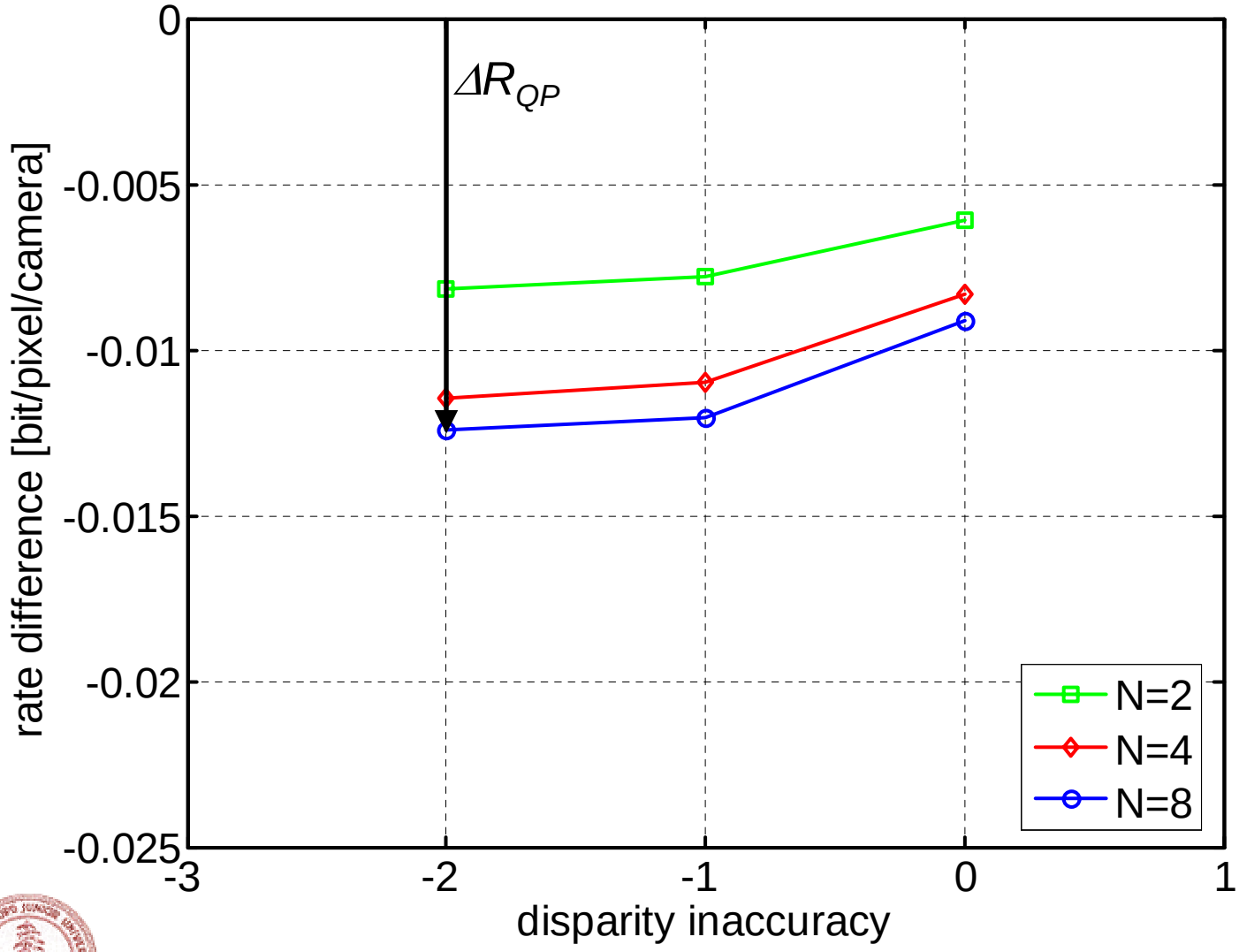
Ballet

GOP size K=8

quarter-pel accurate disparity

quarter-pel accurate motion

Experimental Results: Rate Difference vs. Disparity



← N=1

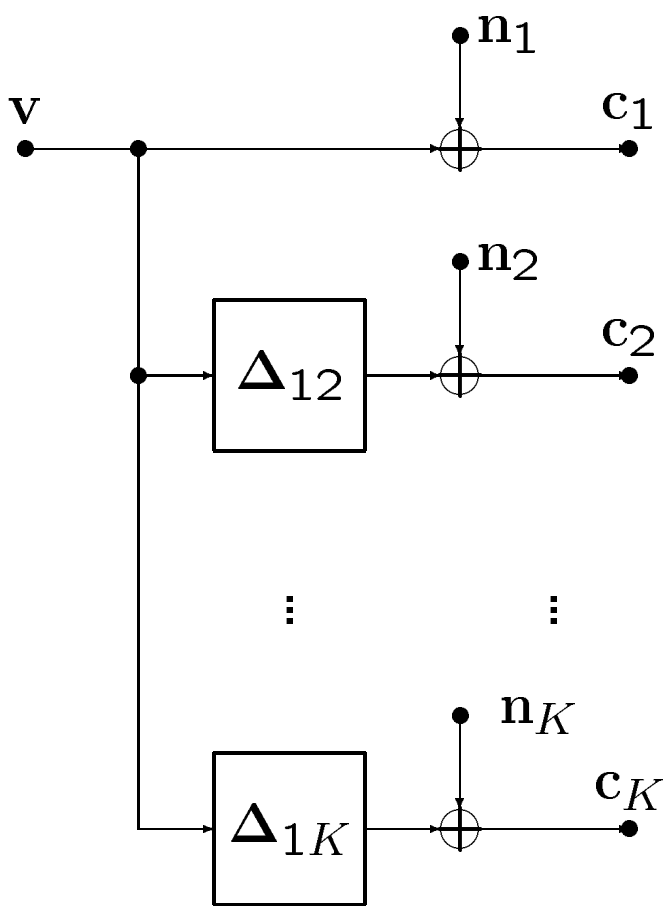
Ballet

GOP size K=8

PSNR = 40 dB

quarter-pel accurate motion

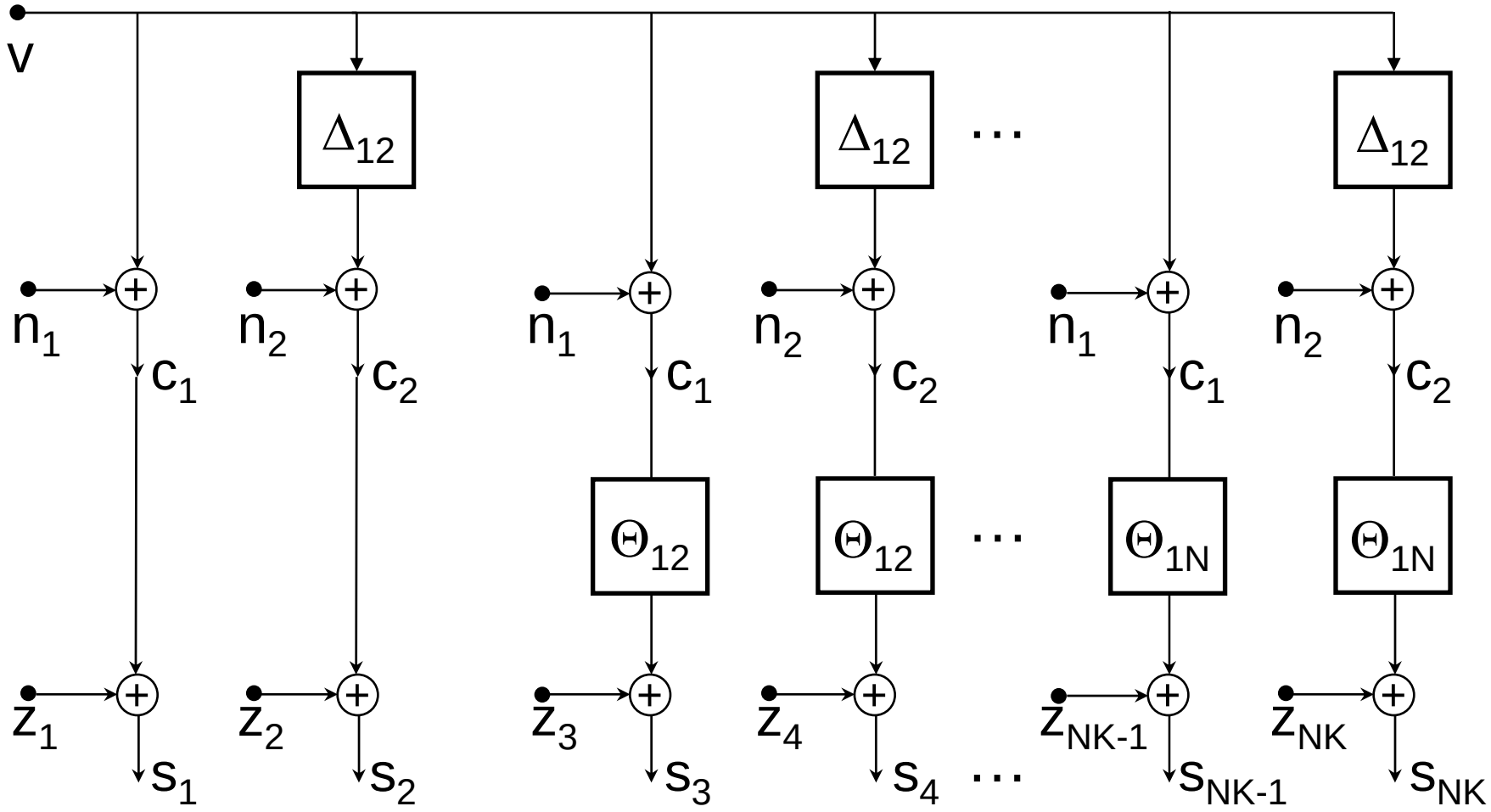
Image-Sequence Model



Model for motion-compensated subband coding
[Flierl & Girod, 2003]

$\mathbf{v}$	model picture
Δ_{1k}	k-th displacement error
$\mathbf{n}_k$	k-th model error of motion compensation
$\mathbf{c}_k$	k-th motion-compensated signal

Model for N Image Sequences



reference view

$\Theta_{1\nu}$: ν-th disparity error

z_i : i-th view model error

s_i : i-th motion & disparity compensated signal

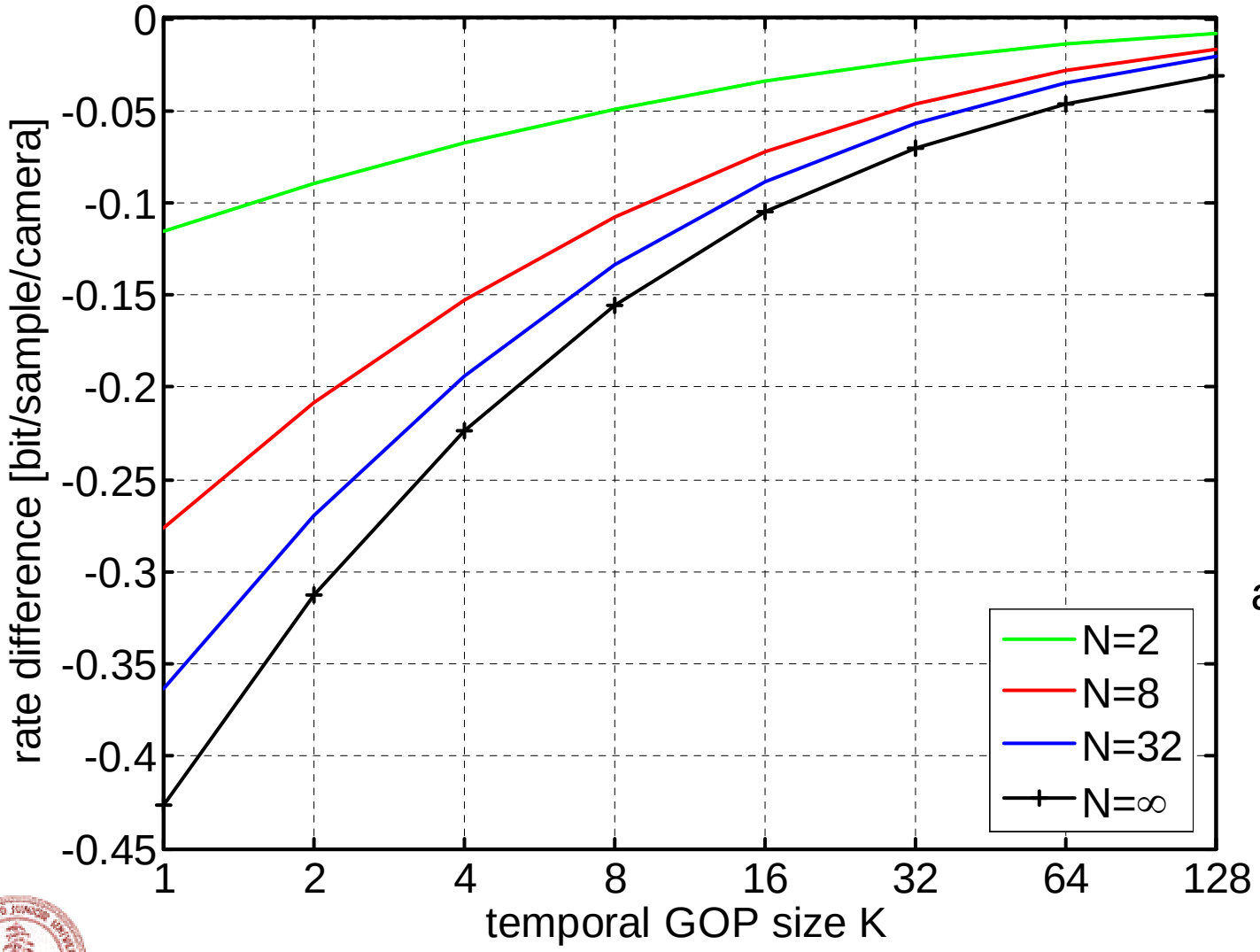
Model Assumptions

- Assumptions for the image-sequence model:
  - True motion is additive, i.e., $d_{\kappa\mu} + d_{\mu\nu} = d_{\kappa\nu}$
  - Estimated motion is additive
  - Displacement error is additive
  - Accuracy of motion compensation is identical
- Assumptions for the multi-view model
  - True and estimated disparity is additive
  - Disparity error is additive
  - Accuracy of disparity compensation is identical
  - Displacement and disparity error are independent

Performance Bounds

- Transform coding of NK pictures at high rates
- Compare optimum transform coding of NK pictures to independent coding of N image sequences each with K pictures
- At high rates and for the same mean squared reconstruction error, we measure the average rate difference to independent coding of N image sequences

Model Results: Rate Difference vs. GOP Size

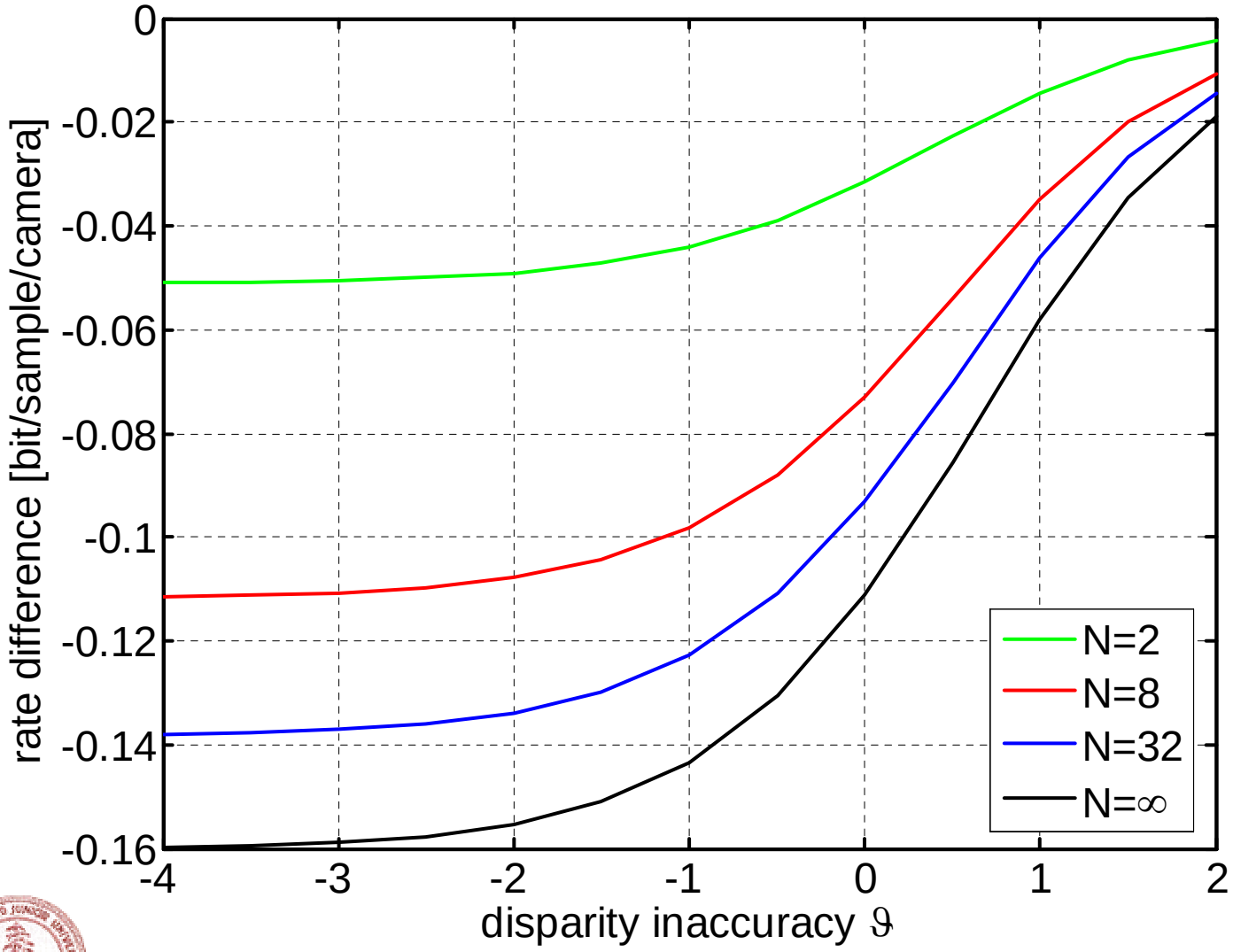


motion-RNL
-30 dB

view-RNL
-10 dB

quarter-pel
accurate motion
and disparity

Model Results: Rate Difference vs. Disparity



GOP size K=8

motion-RNL
-30 dB

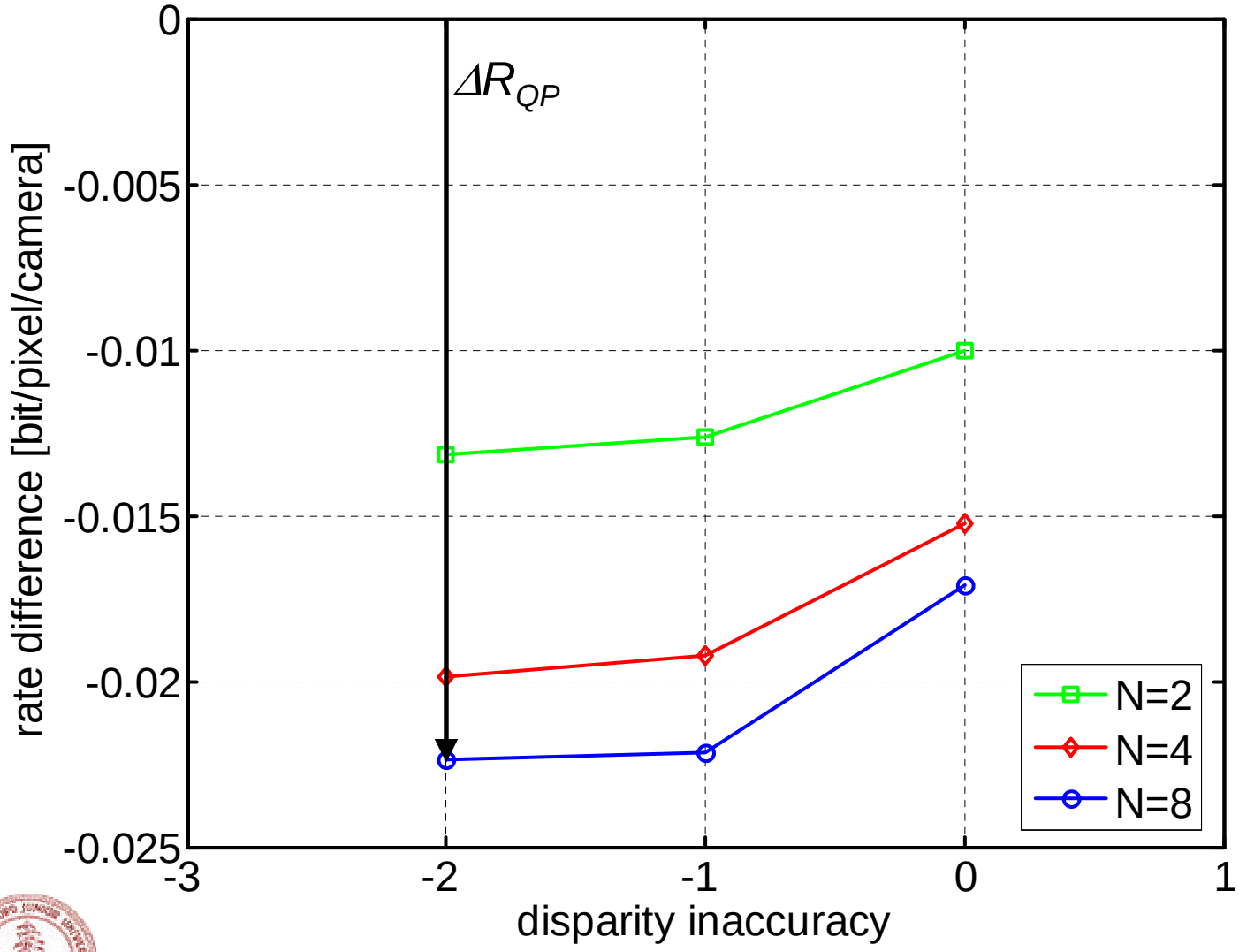
view-RNL
-10 dB

quarter-pel
accurate motion

Conclusions

- Motion and disparity compensated coding for video camera arrays
- Experimental and model results show that
  - for a given GOV size N, the coding gains decrease with increasing temporal GOP size K,
  - the coding gains saturate for increasing GOV size N, independent of the temporal GOP size K,
  - the relative gains due to more accurate disparity compensation increase with growing GOV size N, and
  - these relative gains saturate for large GOV sizes N.

Experimental Results: Rate Difference vs. Disparity



Breakdancing

GOP size K=8

PSNR = 40 dB

quarter-pel accurate motion