

HEVC/AVC Coding Results of Noise Reduced 4:2:0 and 4:4:4 HDR/WCG

Presentation

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JCTVC-U0044
m36274

Presentation Outline

Three Aspects of Noise Reduction Evaluation & Review

- Complete Separate Visual Review & Comparison of Original and Denoised:
 - ◆ denoised version had imperceptible loss of detail, sharpness and contrast
- Selected slide excerpts show original & denoised
- Parametric Plots Review Comparing Original and Denoised Clips
 - ◆ 4:2:0-denoised vs 4:2:0-original for **CRF**=7,12,17,22,27,32,37
 - ◆ 4:4:4 vs. 4:2:0 vs. denoised vs. original for **CQP**=7,12,17,22,27,32,37
 - ◆ Zoom-in plot of 4:2:0 vs 4:4:4 vs. denoised vs. original for **CQP**=7,12
- PSNR / MSE Noise Estimation Plots for Each Frame in Test Clips

Selected sample slides review of original & denoised

AutoWelding frame 227
Bike Sparklers frame 28
WarmNight (three sections)

AutoWelder frame 227



Noise-reduced

MSE: 55.064 for Y channel, 27.351 for Cb, 14.476 for Cr



Crop: 800x400+0+400

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Bike Sparklers Frame 28



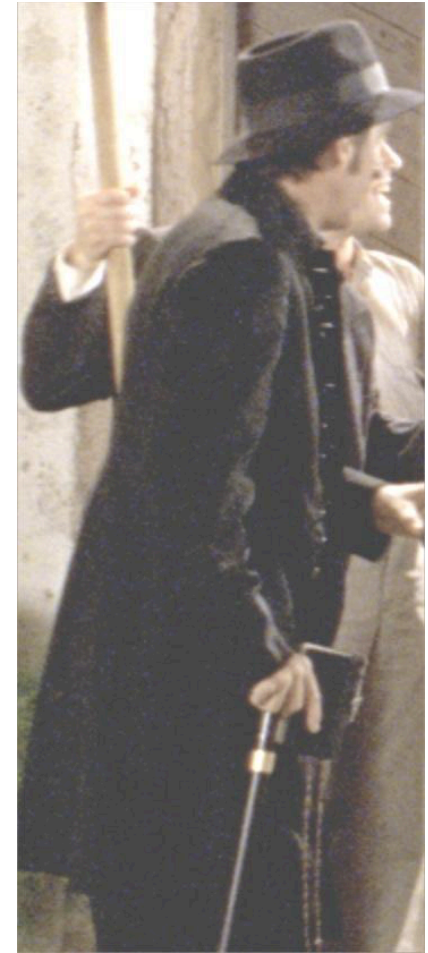
Noise-reduced



Crop: 512x384+0+500

JCTVC-U0044 / MPEG m36274

Original



Crop: 256x480+40+450



De-noised



Crop: 180x420+500+400



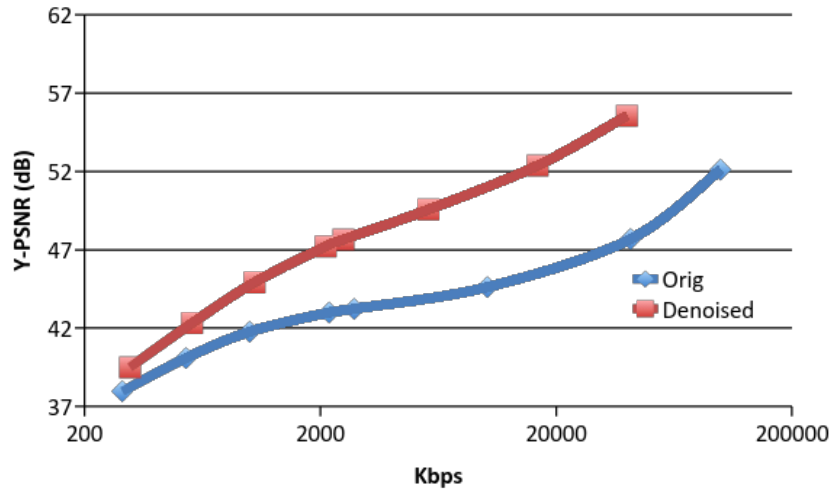
Crop: 420x96+1440+360

Parametric Plot Comparing Original and Denoised Clips

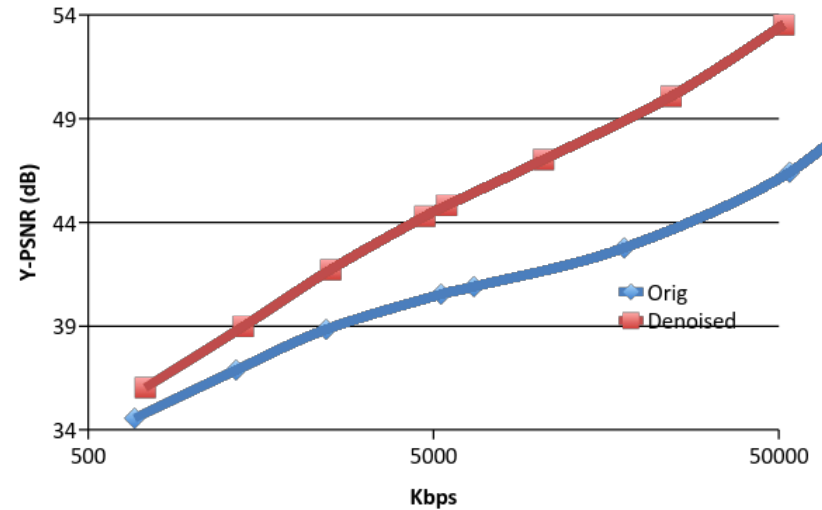
- Y-PSNR vs log-bitrate, HEVC main-10:
4:2:0-denoised vs 4:2:0-original for CRF=7,12,17,22,27,32,37
- Denoised vs original shows significant gains in PSNR for a given bitrate or lower-bitrates for a given PSNR

Original/Denoised Comparison

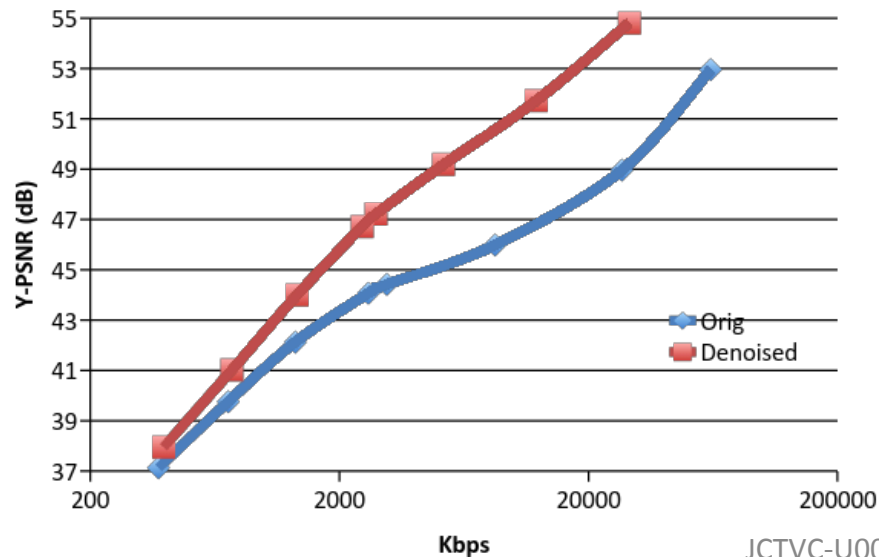
AutoWelding CRF Main10 x265 (veryslow)



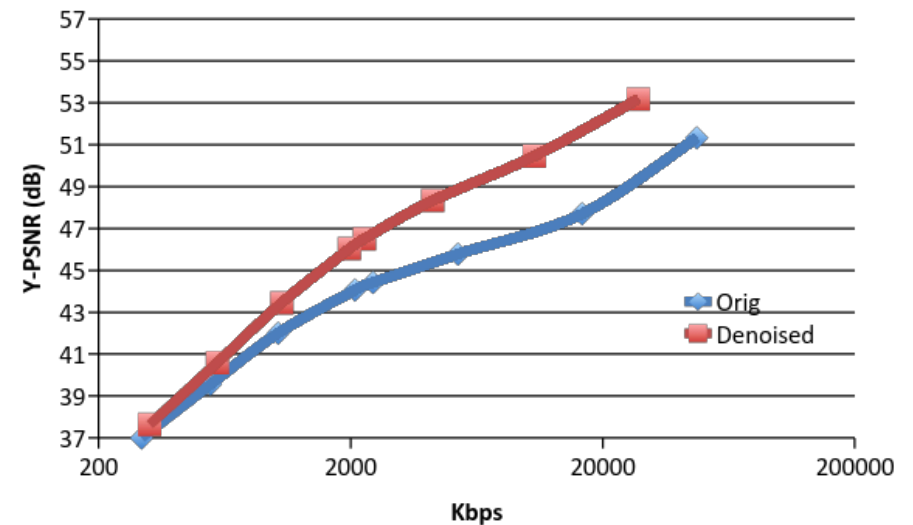
BikeSparklers CRF Main10 x265 (veryslow)



ShowGirl CRF Main10 x265 (veryslow)

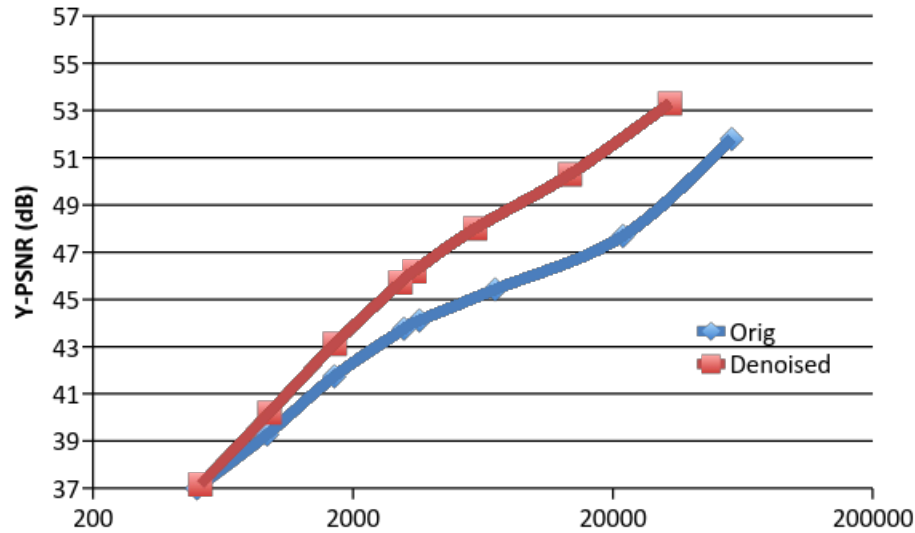


WarmNight CRF Main10 x265 (veryslow)

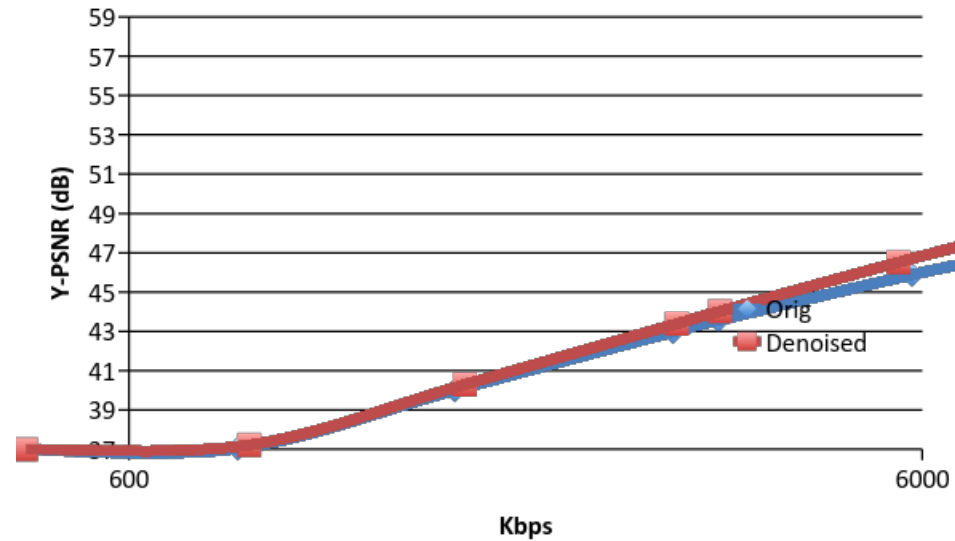


(..continued)

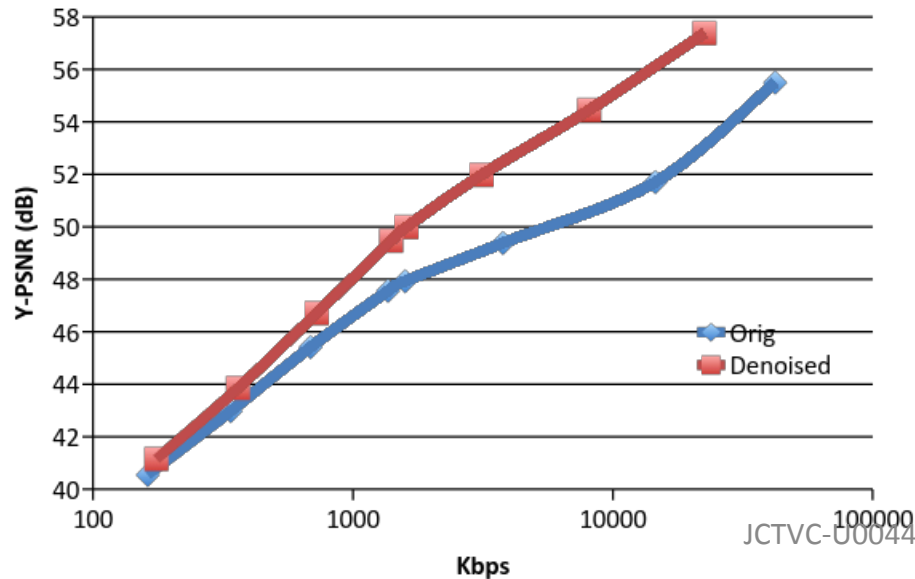
MagicHour CRF Main10 x265 (veryslow)



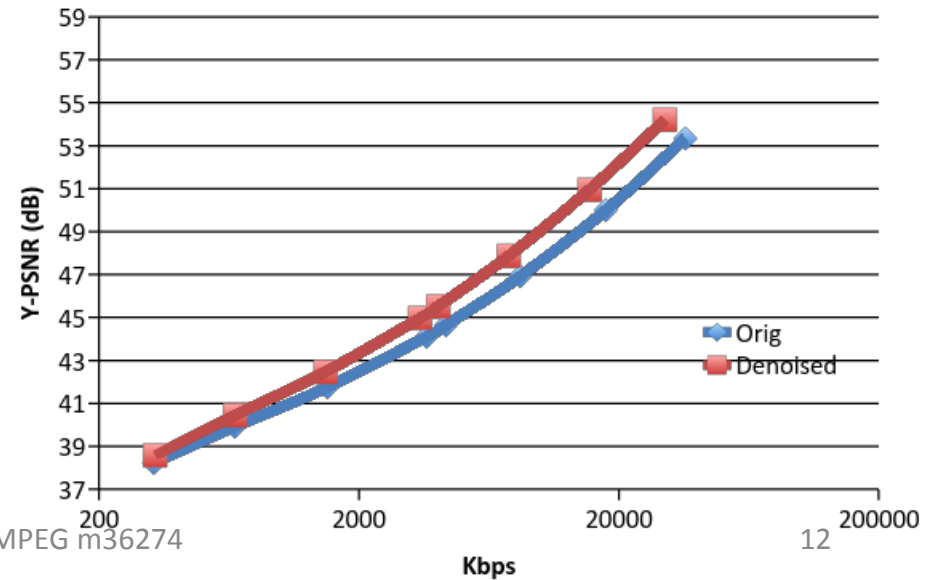
BalloonFestival CRF Main10 x265 (veryslow)



FireEater CRF Main10 x265 (veryslow)



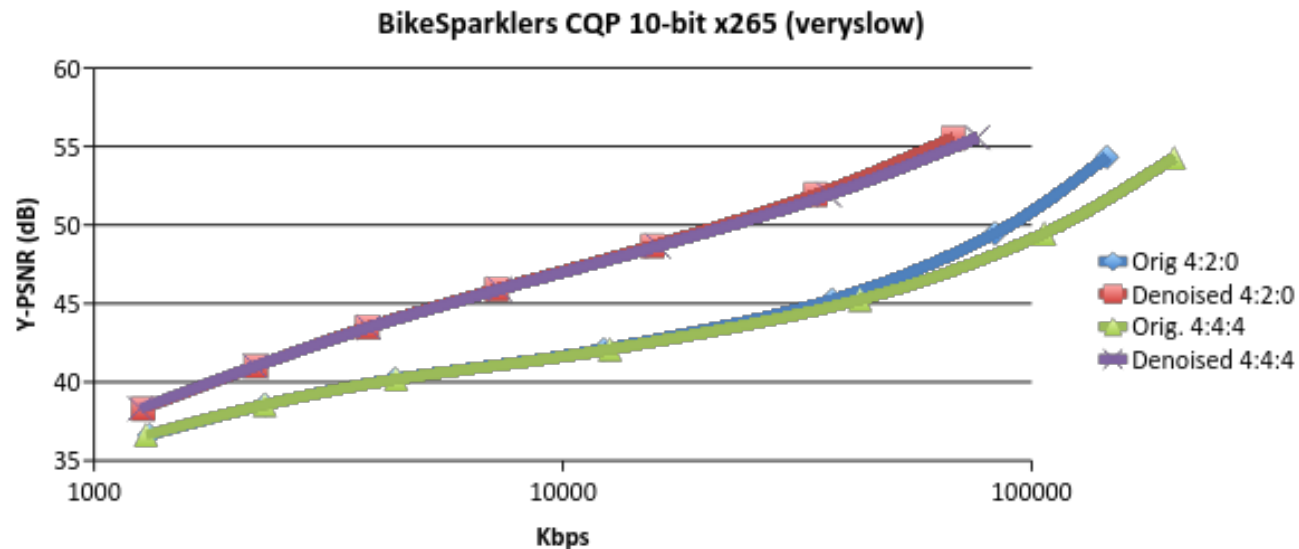
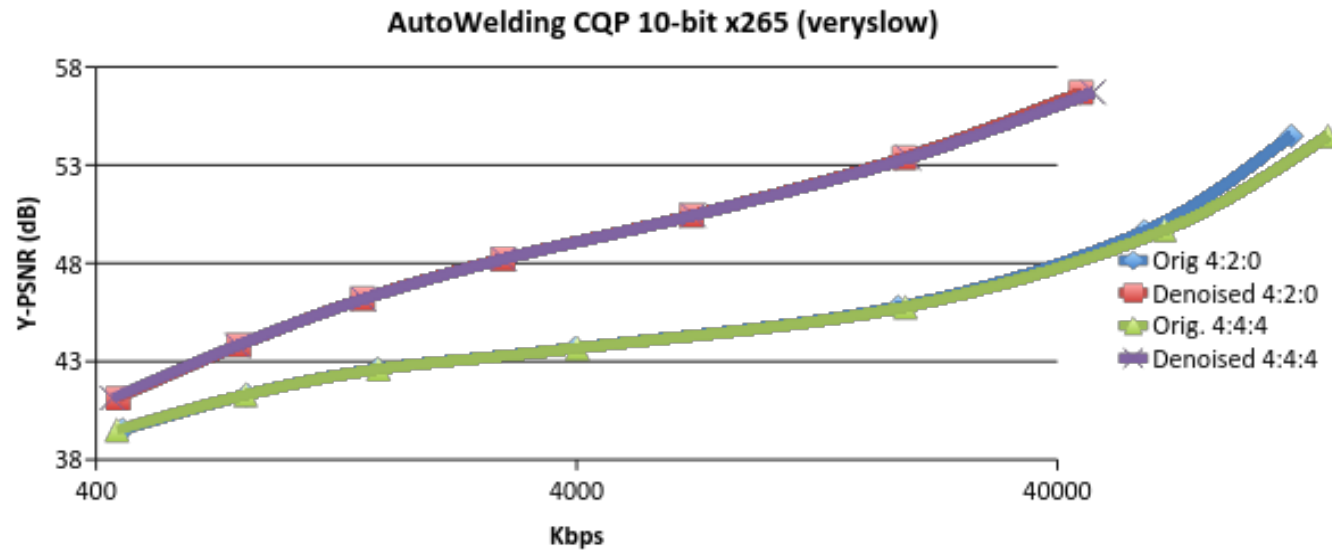
Tibul CRF Main10 x265 (veryslow)



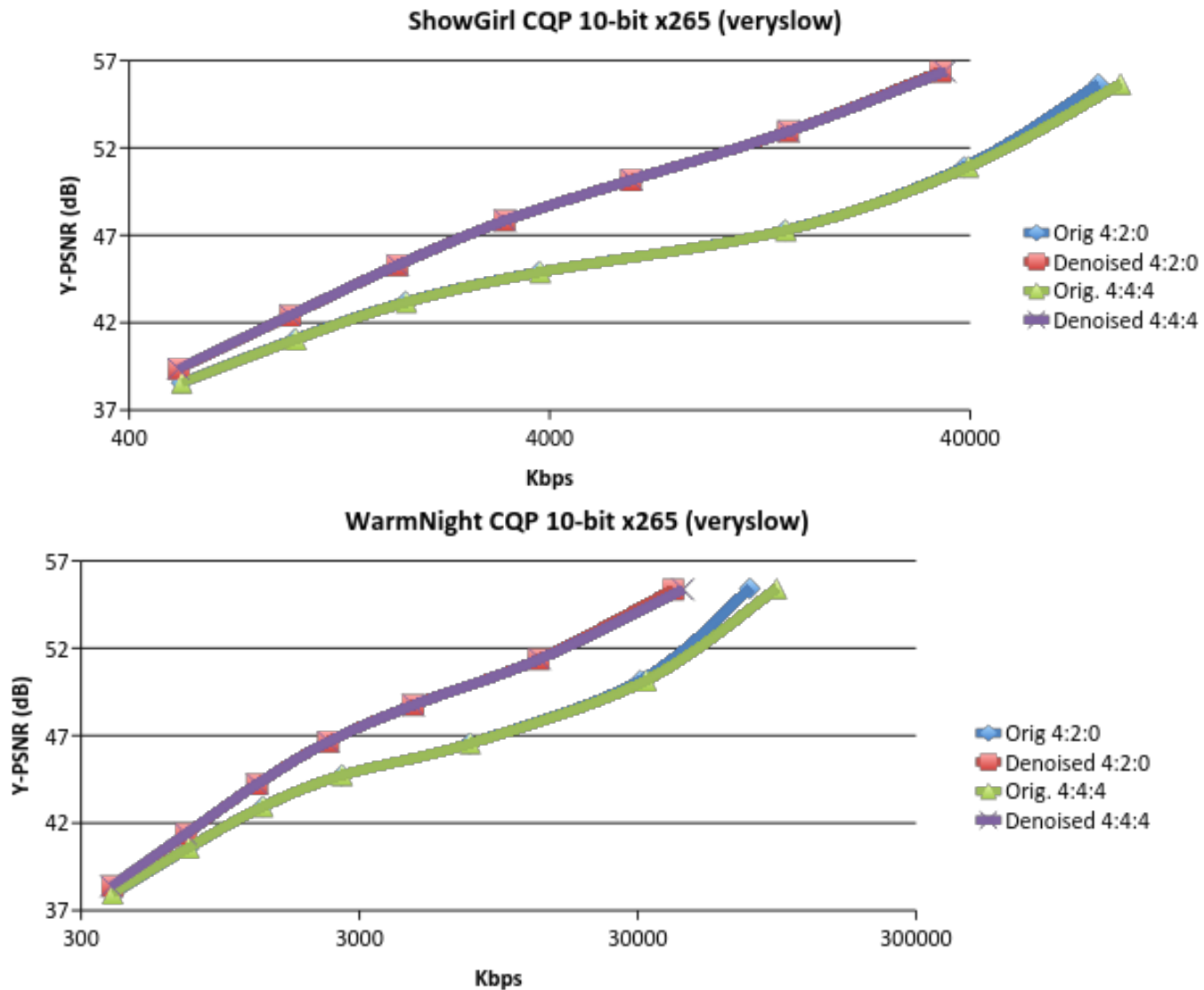
Parametric Plot Comparing Original and Denoised Clips

- Y-PSNR vs log-bitrate, HEVC main-10:
4:4:4-denoised vs 4:4:4-original vs 4:2:0-denoised vs 4:2:0-original
for Constant QP=7,12,17,22,27,32,37
- Shows significant gains in PSNR for a given bitrate or lower-bitrates
for a given PSNR for all chosen CQP settings and substantial parity
between 420 & 444

4:4:4 vs. 4:2:0 vs. denoised vs. orig



4:4:4 vs. 4:2:0 vs. denoised vs. orig

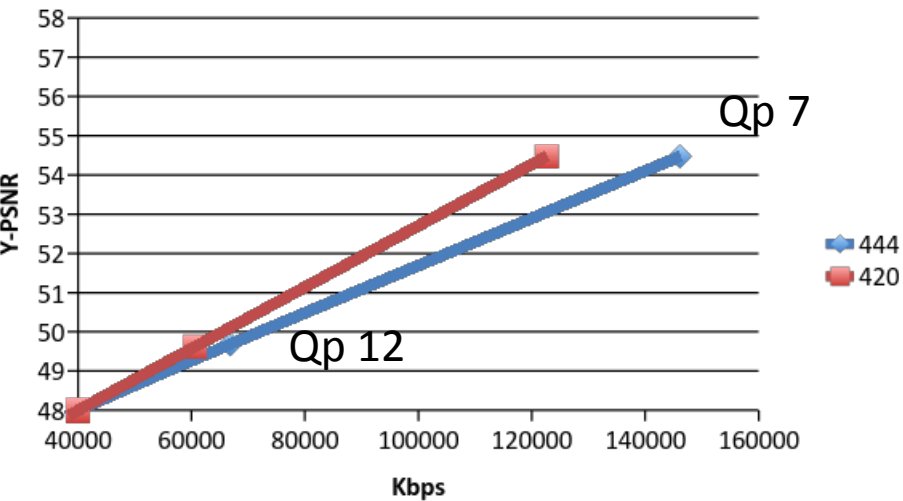


Parametric Plot Comparing Original and Denoised Clips

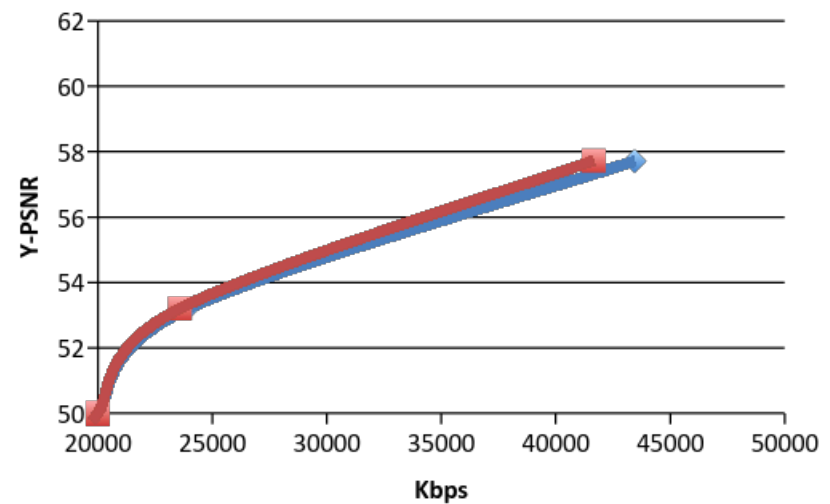
- Y-PSNR vs log-bitrate, HEVC main-10:
4:2:0-denoised vs 4:4:4-original for CRF=7,12
- Shows divergence of denoised 4:2:0 and 4:4:4 for low Qp (high bitrates)

4:4:4 vs. 4:2:0 original comparison (Constant Qp mode)

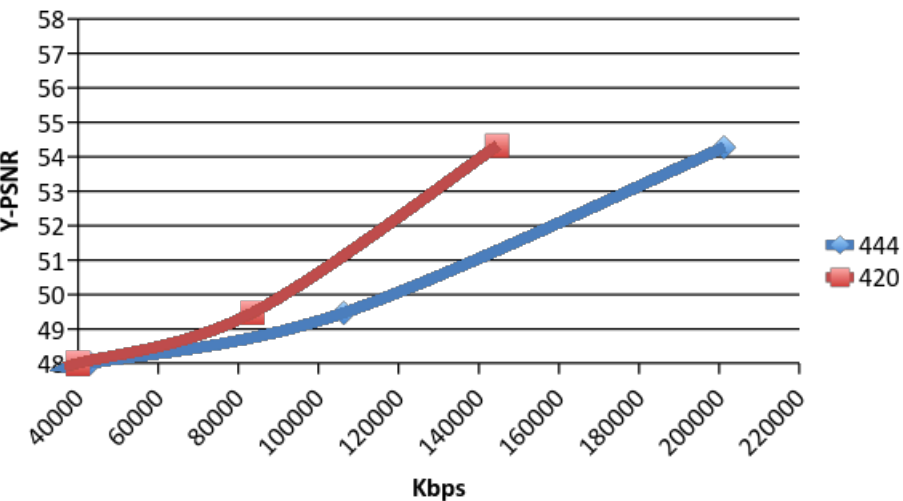
AutoWelding CQP 10-bit



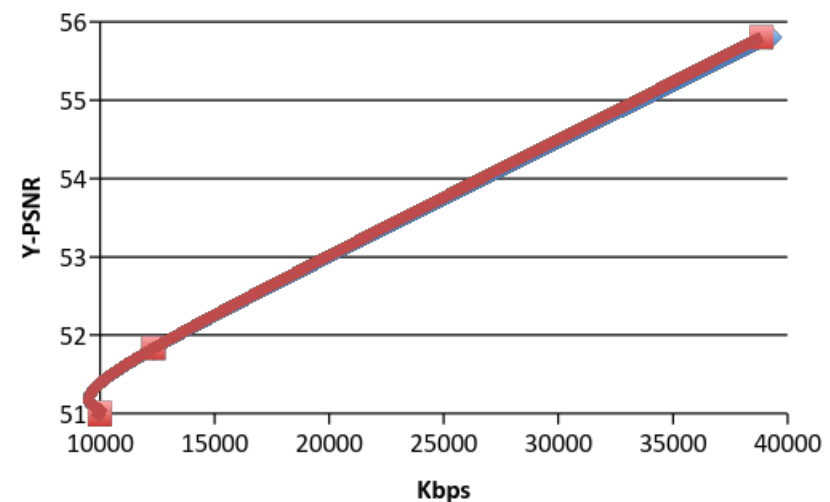
BalloonFestival CQP 10-bit



BikeSparklers CQP 10-bit

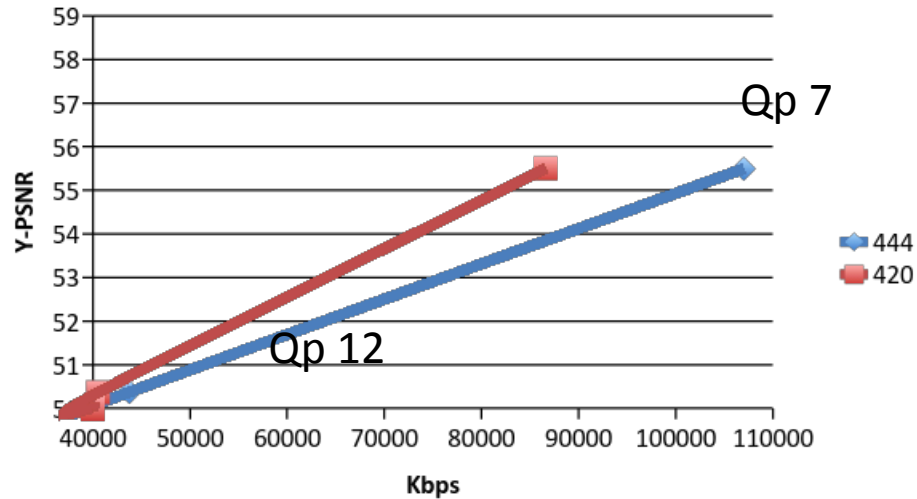


FireEater CQP 10-bit

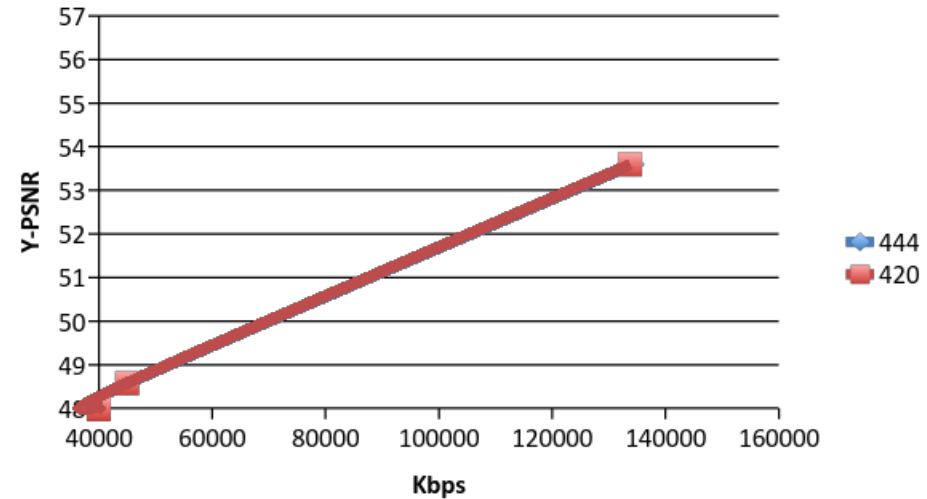


4:4:4 vs. 4:2:0 cont.

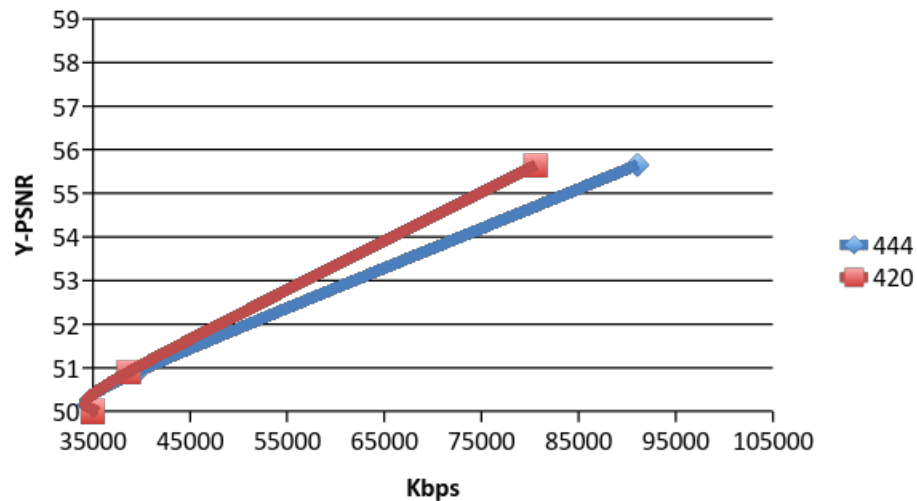
MagicHour CQP 10-bit



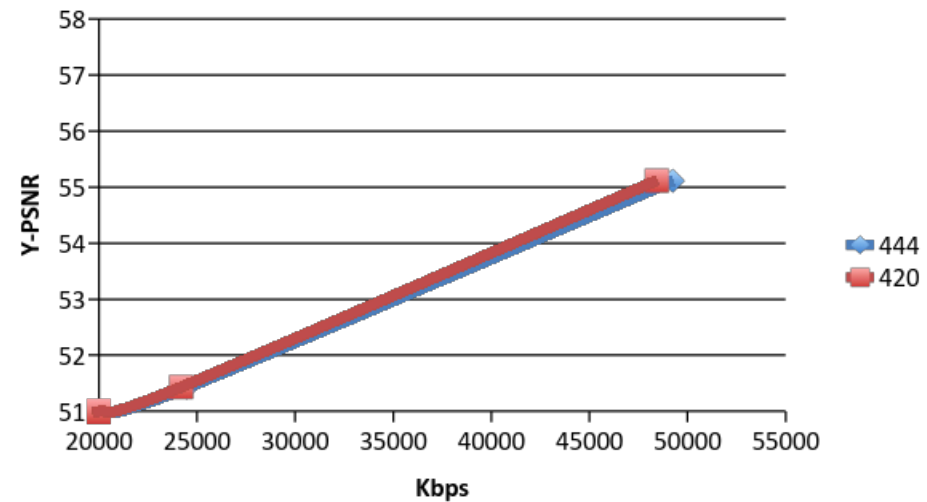
Market CQP 10-bit



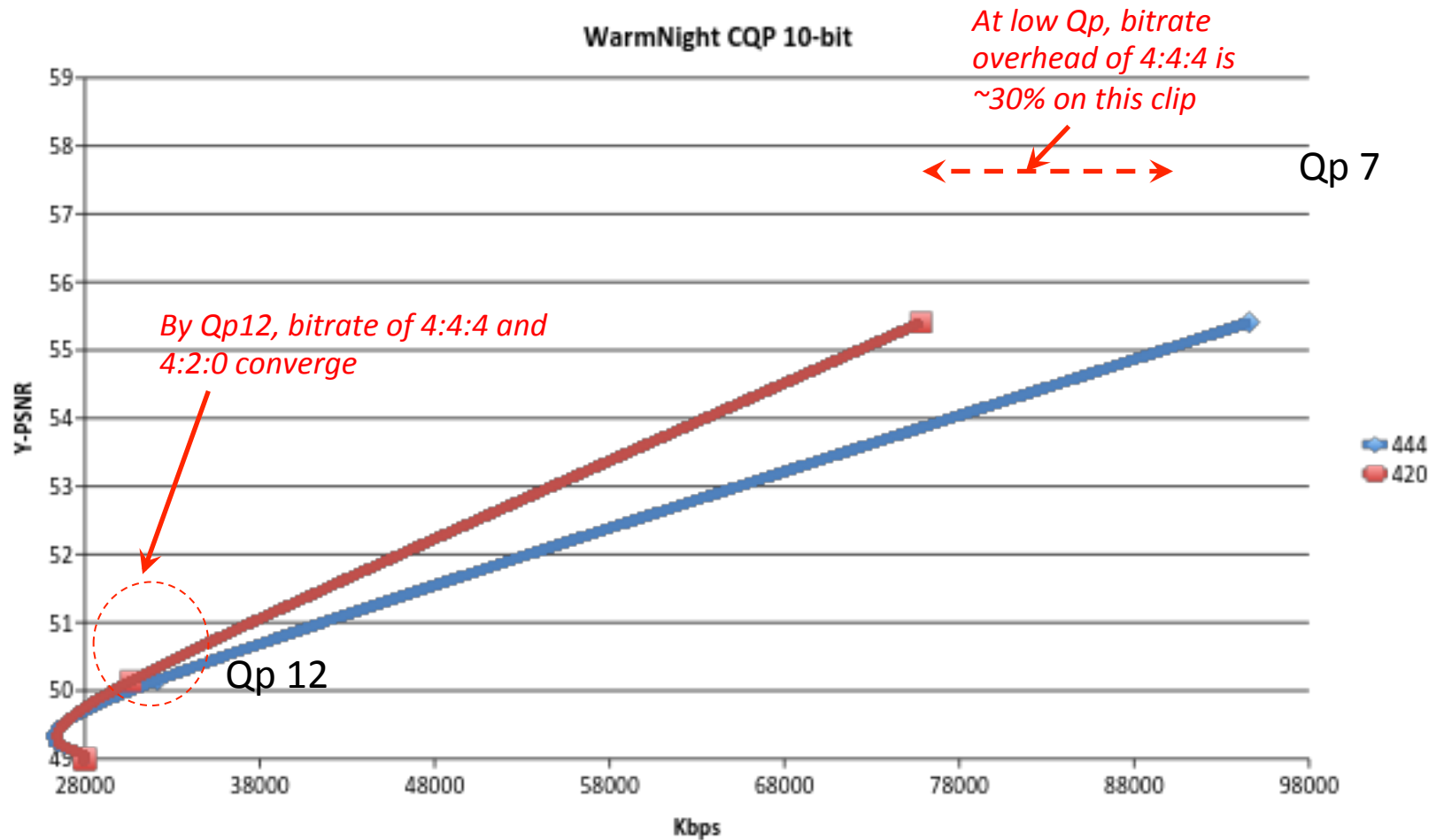
ShowGirl CQP 10-bit



Tibul CQP 10-bit



4:4:4 vs. 4:2:0 cont.



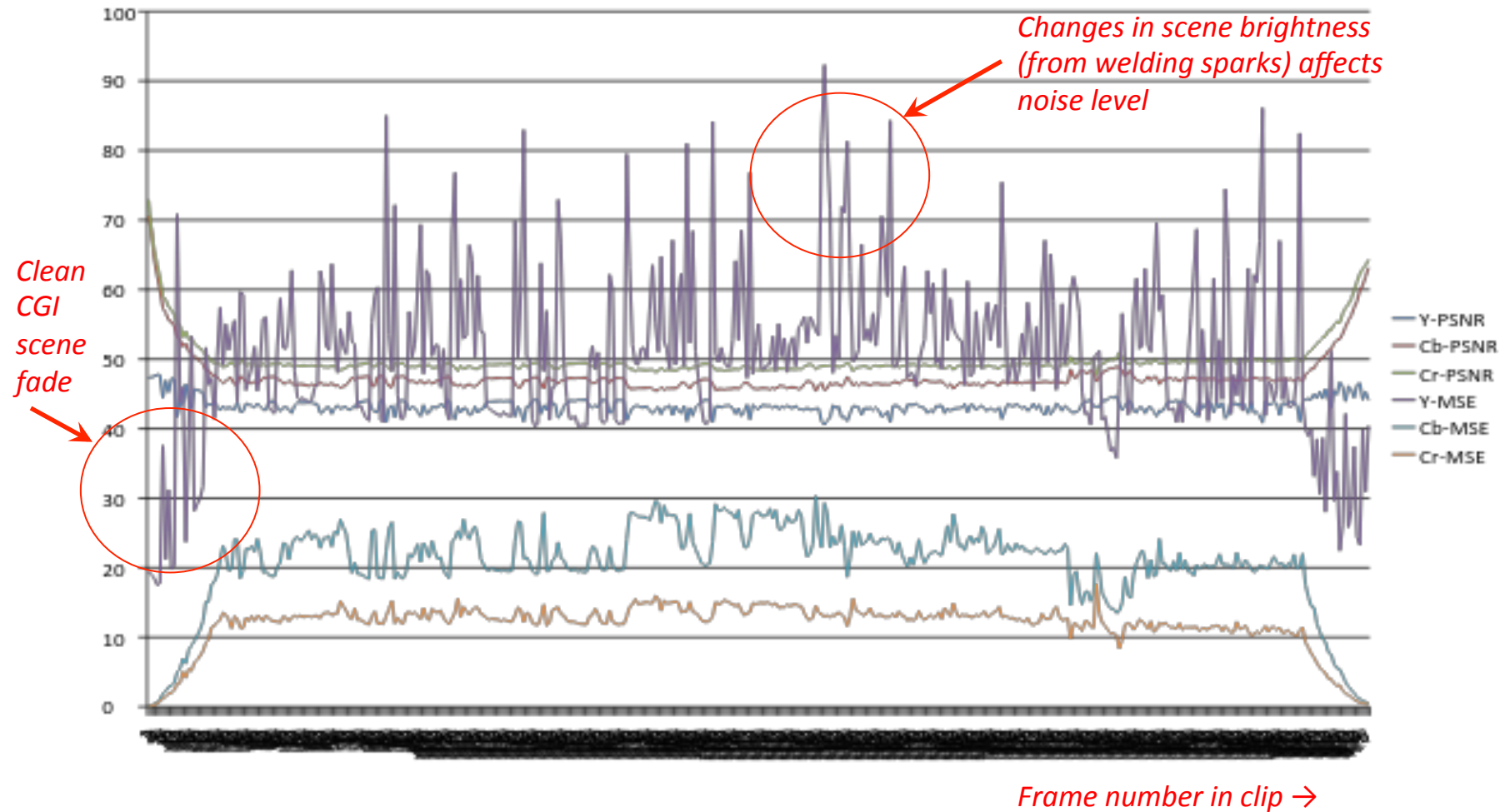
PSNR and MSE Plots for Each Frame in Test Clip

- Mean-Squared-Error (MSE) of each component is based on “error”: the difference between noisy original and noise reduced Y,Cb,Cr equivalent to 10-bit representations.
- $PSNR = 20 \cdot \log_{10}(2^{10} - 1) - 10 \cdot \log_{10}(MSE)$
- Vertical axis numbering is shared by the MSE scale and PSNR scale, but each have different units.

Observations:

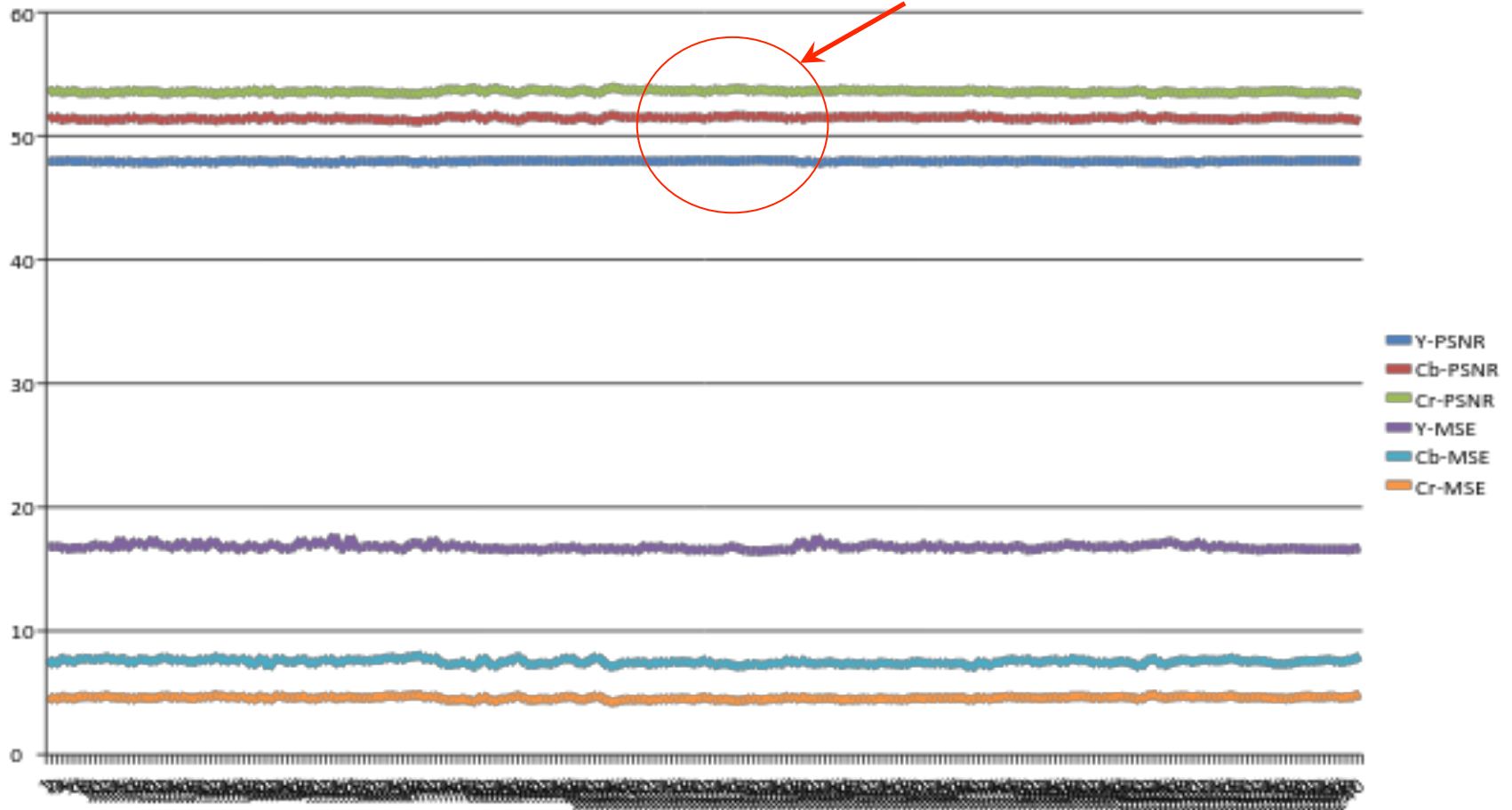
- MSE & PSNR correlate with luminance fluctuations in “AutoWelder”
- Film sections in “BikeSparklers” have much higher MSE vs electronic sensors
- Graphs are smooth in scenes with no motion or smooth motion, indicating stable operation of noise reduction
- Future updated versions of the MSE & PSNR plots will be available at http://www.isovideo.com/jct-vc-denoise_2015.php

Noise estimate: AutoWelder

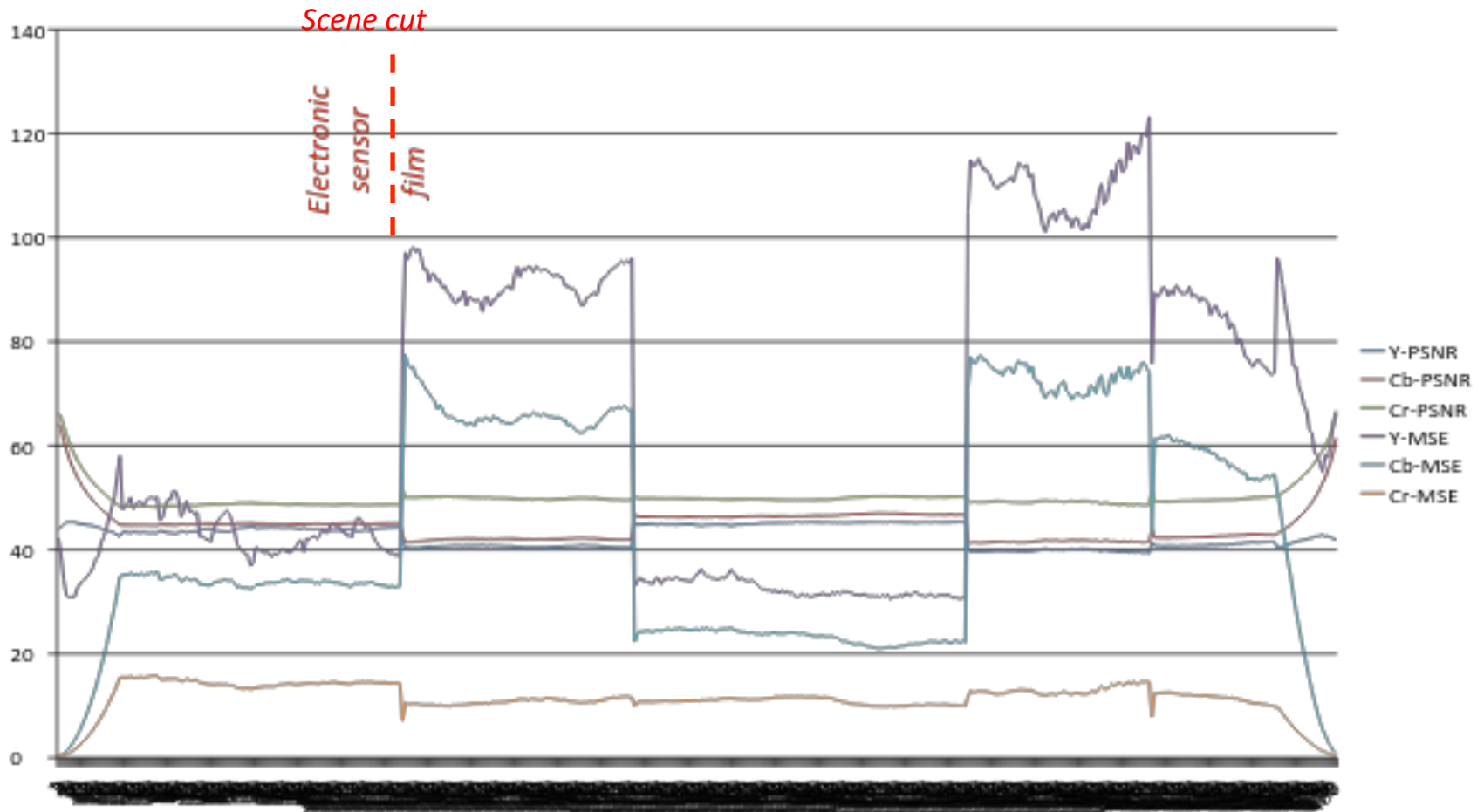


Noise estimate: BalloonFestival

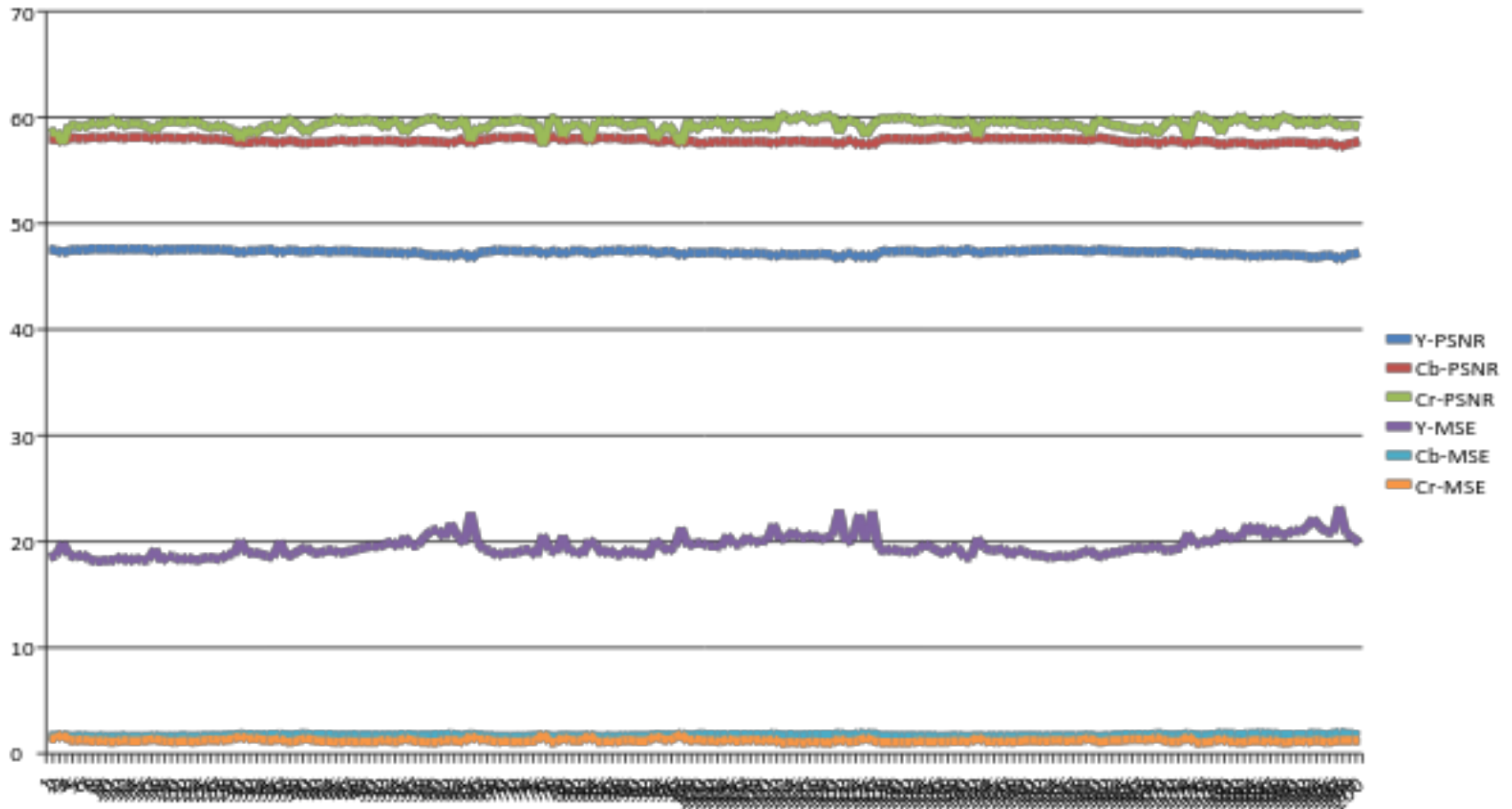
Stable, high PSNR between original and denoised indicates low noise in source



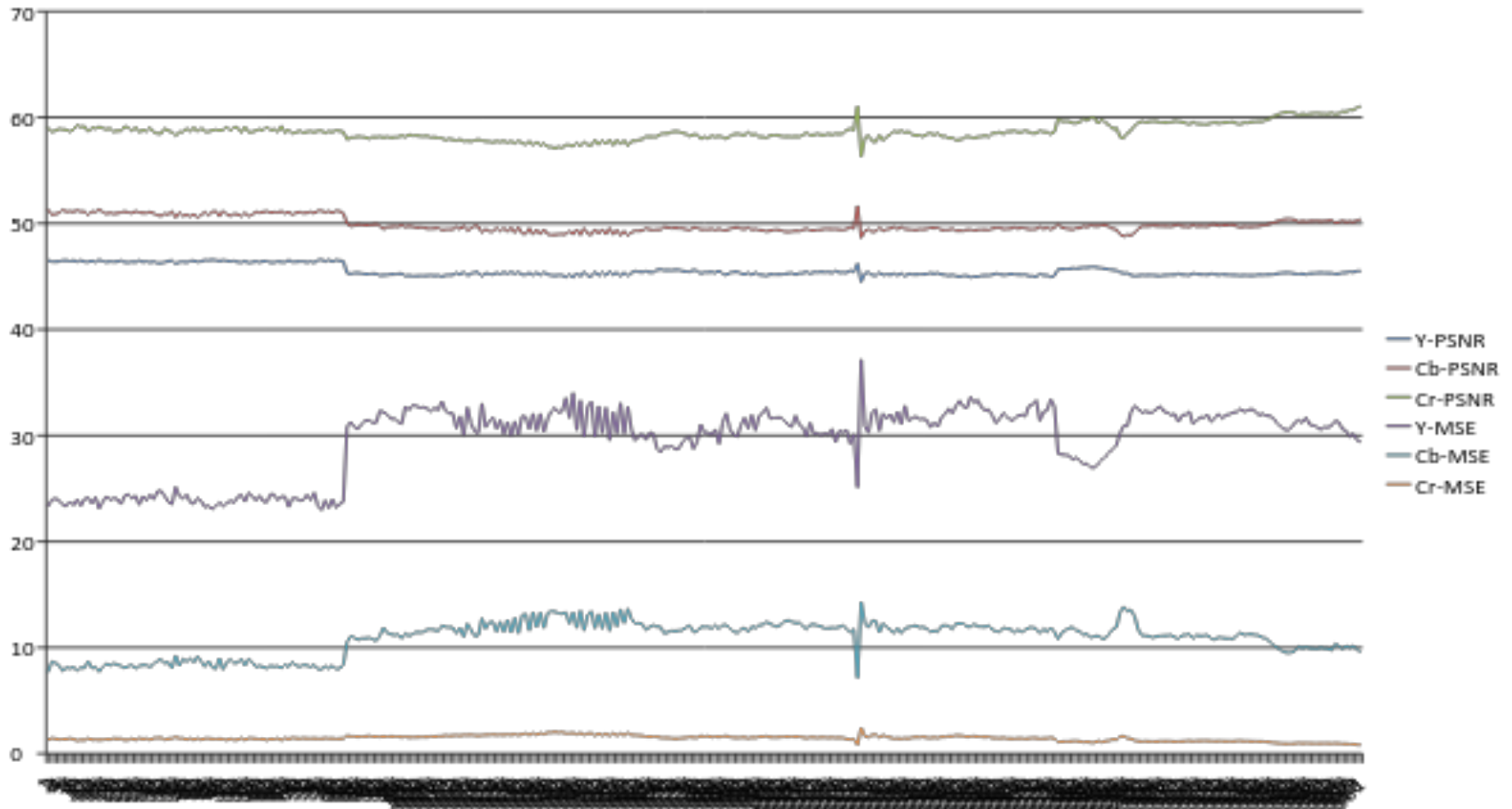
Noise estimate: BikeSparklers



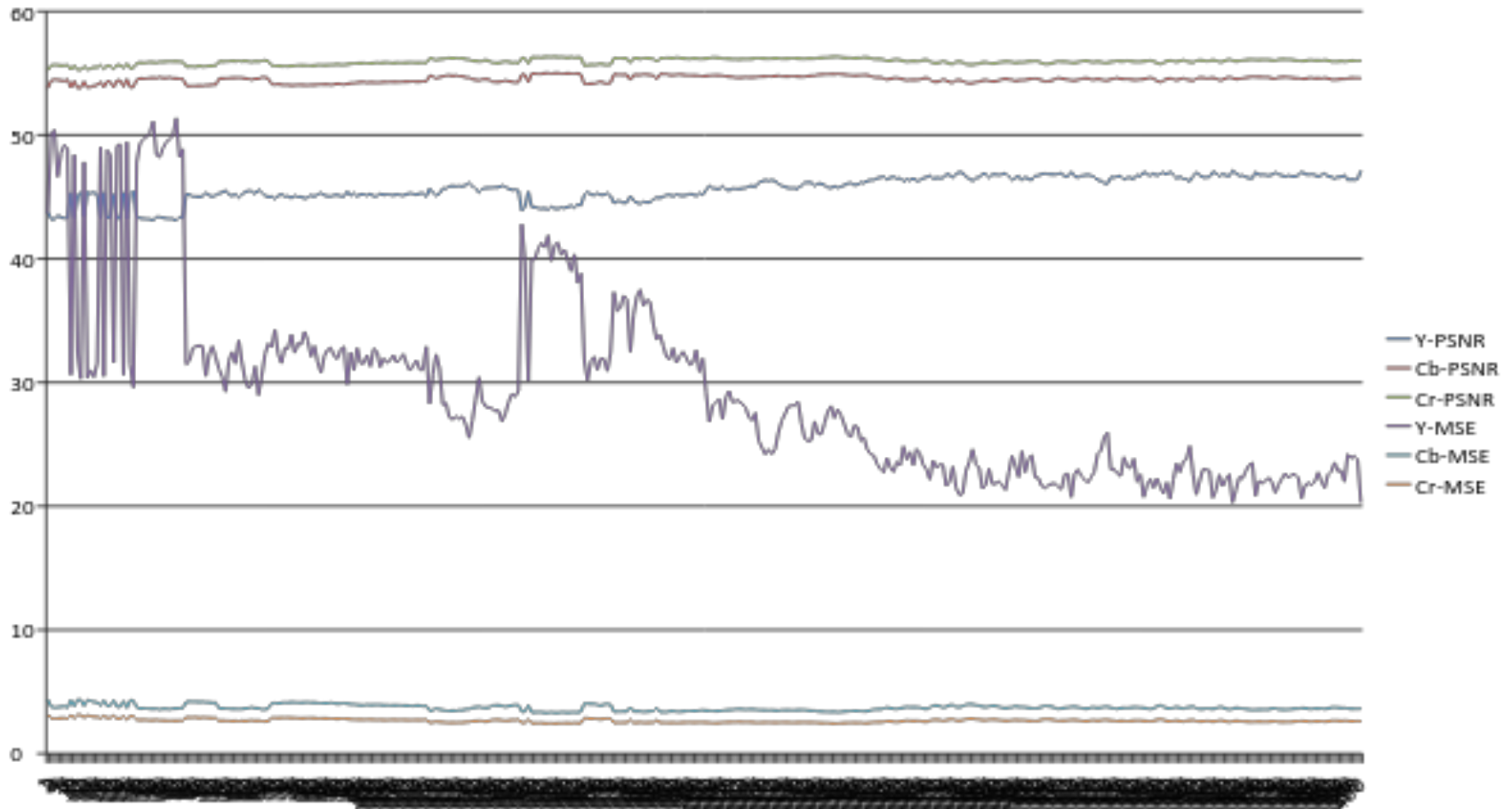
Noise estimate: FireEater



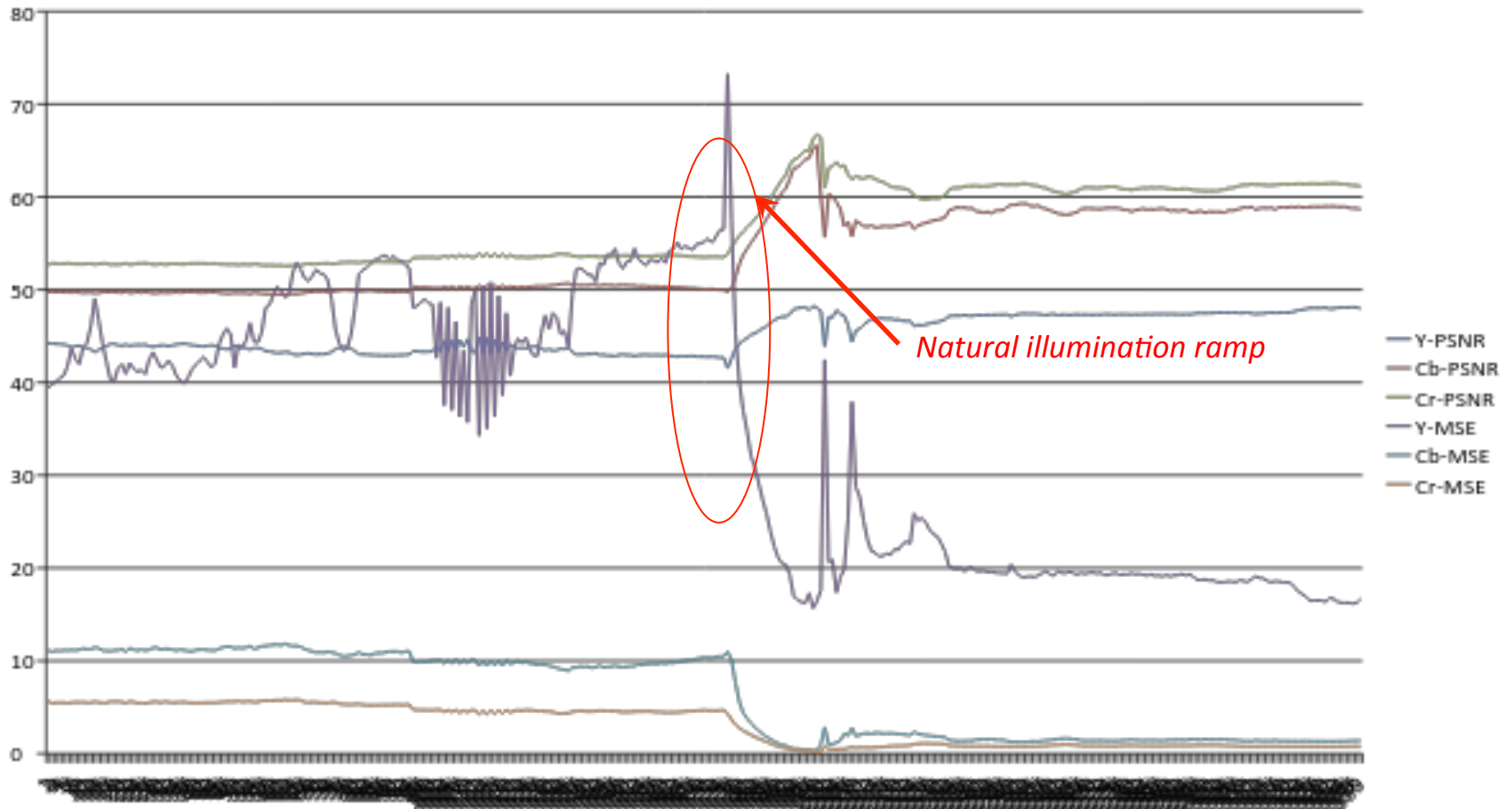
Noise estimate: MagicHour



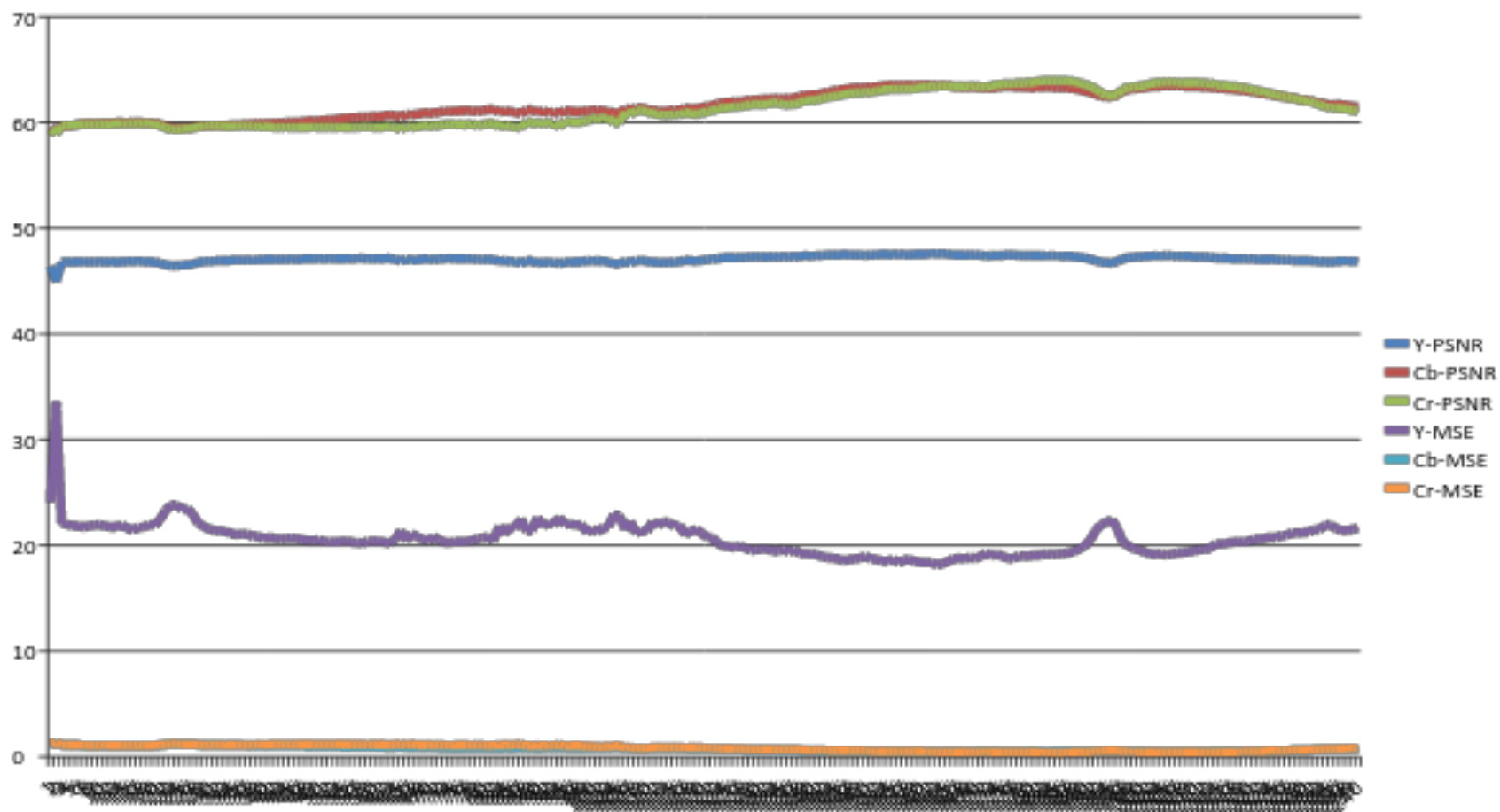
Noise estimate: Market



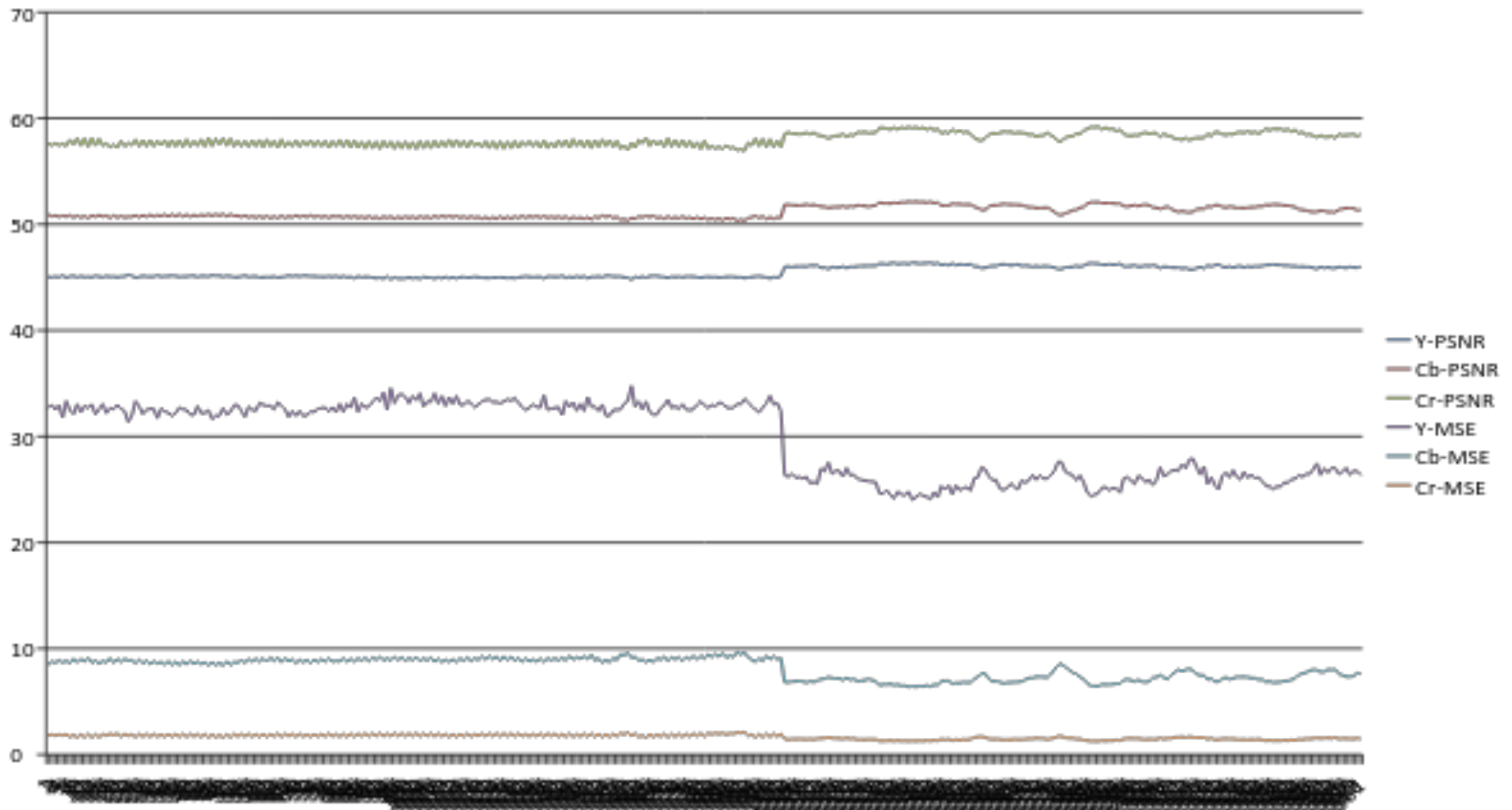
Noise estimate: ShowGirl



Noise estimate: Tibul



Noise estimate: WarmNight



Conclusions

- Complete visual review of clips & comparison of original and denoised shows denoised version had imperceptible loss of detail, sharpness and contrast.
- Parametric plots of denoised vs original shows significant gains in PSNR for a given bitrate, or lower-bitrates for a given PSNR for all chosen settings of CRF or CQP, especially for noisier clips
- Frame-based MSE Noise estimation / PSNR and visual playback of denoised & original shows that noise reduction tracks noise level to give smooth, uniform denoise operation.
- The main 0044 .doc file is also available and the long version of the paper and further update is available at http://www.isovideo.com/jct-vc-denoise_2015.php