

Who am I ?

An independent consultant with 15 years of experience in video streaming and a focus on encoding and playback optimization

I've collaborated with

NTT Data, SKY, Intel, Adobe, VEVO, various startups

Blog: sonnati.wordpress.com

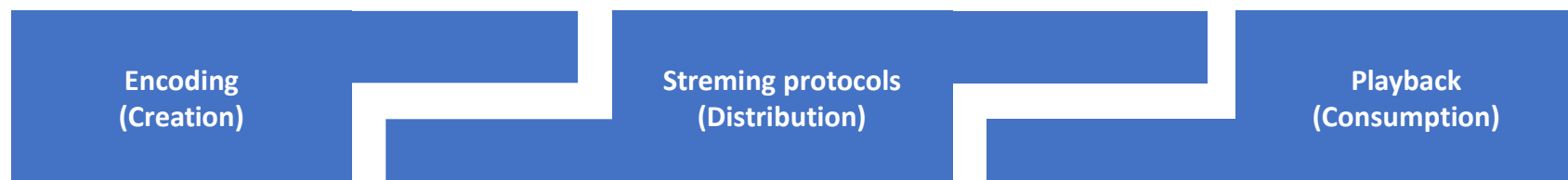
Twitter: @sonnati



End-2-End video streaming optimization



How to get the max out of your streaming service ?
Going from **intra-domain** to **inter-domains**, **joint** optimization

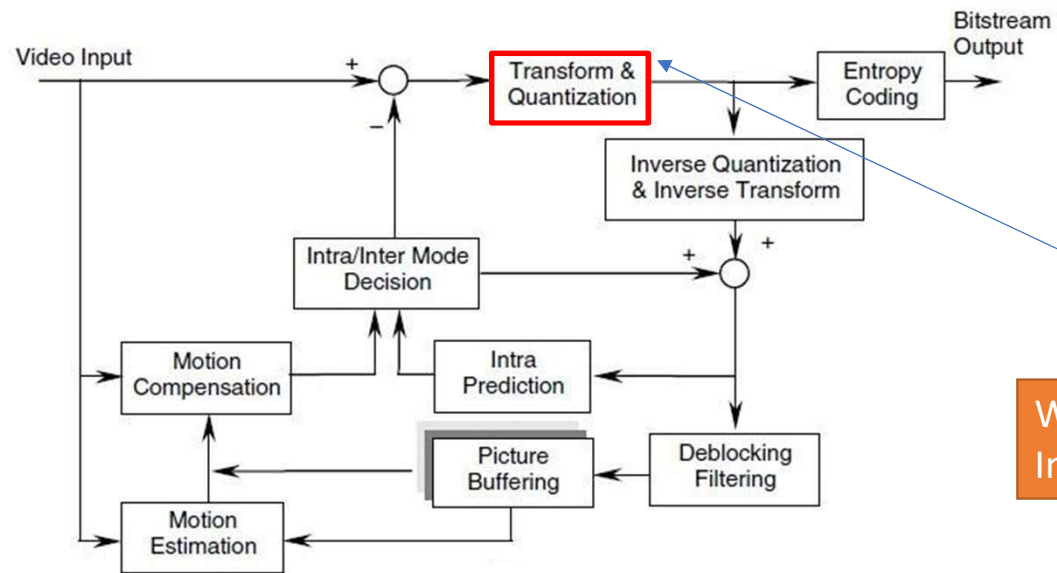


End-2-End video streaming optimization

After **Content-Aware Encoding** optimization (encoding) and **advanced player heuristics** (es: hybrid buffer-bandwidth logic) there is still space for optimizations in other unusual directions. Here we will explore one of those paths and try to provide an answer to this question:

Is it possible to reconstruct perceptually, during playback, part of the quality lost in compression ?

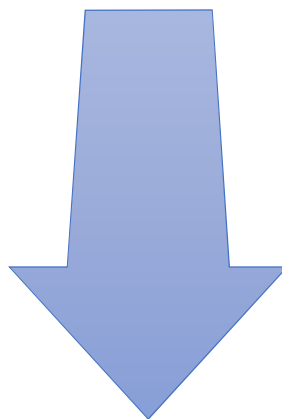
Back to the basics: Lossy Compression



Where is «loss» concentrated ?
In Quantization

Classic encoding artifacts

Increasing quantization
(and so compression) decreases
quality and generates typical artifacts



Types:

- 1 .Loss of high frequency details**
- 2 .Edges inconsistency & Ringing**
- 3. Motion/Blocking artifacts**

Even when working around good operating points, we still may have Artifacts of Type 1 except when encoding at very high bitrates. The typical Types 1 artifacts determine:

Loss of fine detail / film grain

«Banding»

Decrease of contrast / flatness



Example of banding artifact

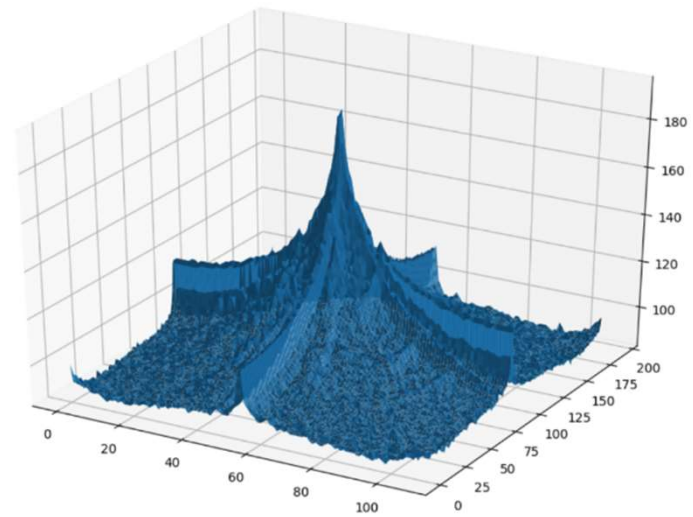
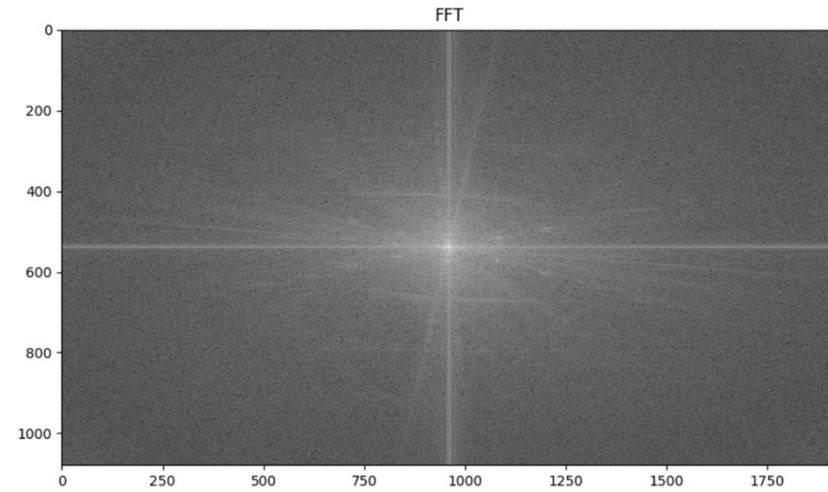


Example of banding artifact

Spatial Frequency Analysis #1



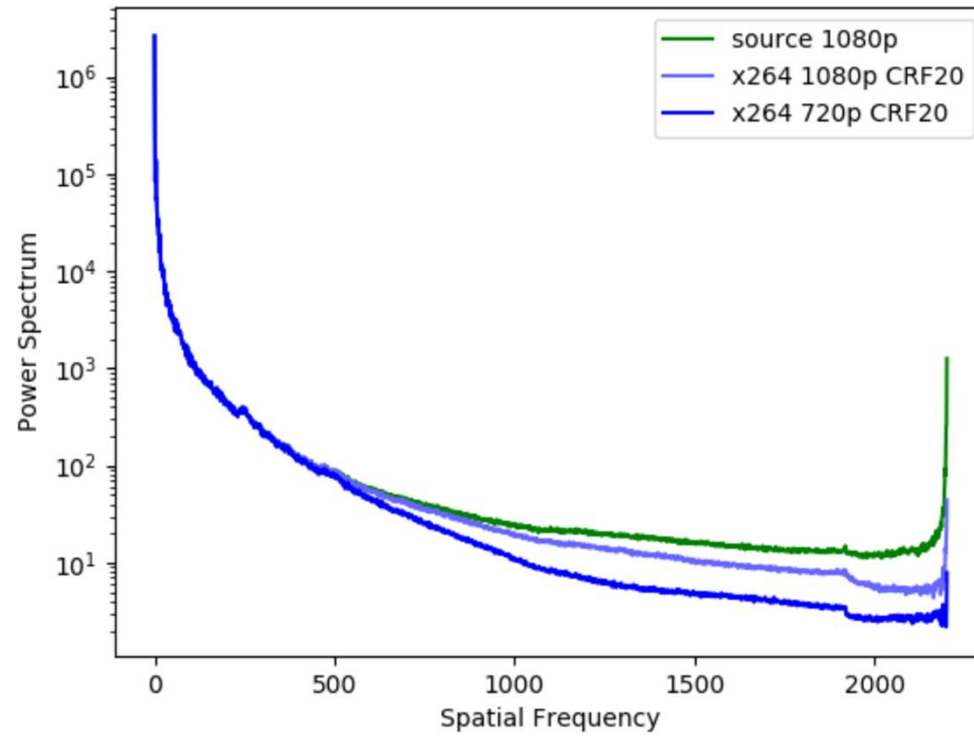
Meridian: challenging content with grain, glares, penumbra, smoke



FFT in 3D space

Spatial Frequency Analysis #2

Radial Averaged Power Spectrum to evaluate effects of compression





ORIGINAL 1080p



X264 1080p CRF20



ORIGINAL 1080p



X264 1080p CRF20

Reconstruction Model #1

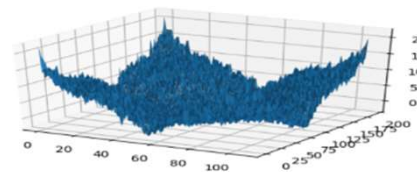
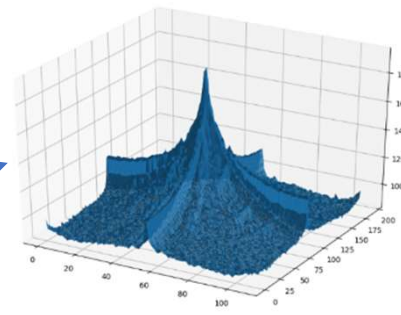
It is possible to use modern GPU and multiple realtime layered filters (pixel shaders) to reconstruct during playback different parts of the spectrum lost because of encoding.

It's not an «exact» reconstruction (no good for PSNR), it's based on «perception» principles (good for VMAF or subjective) and tries to mimic details compensating the spectral energy.

Compressed Video



1. Upscale to screen size
2. Model for Loss Estimation & Compensation



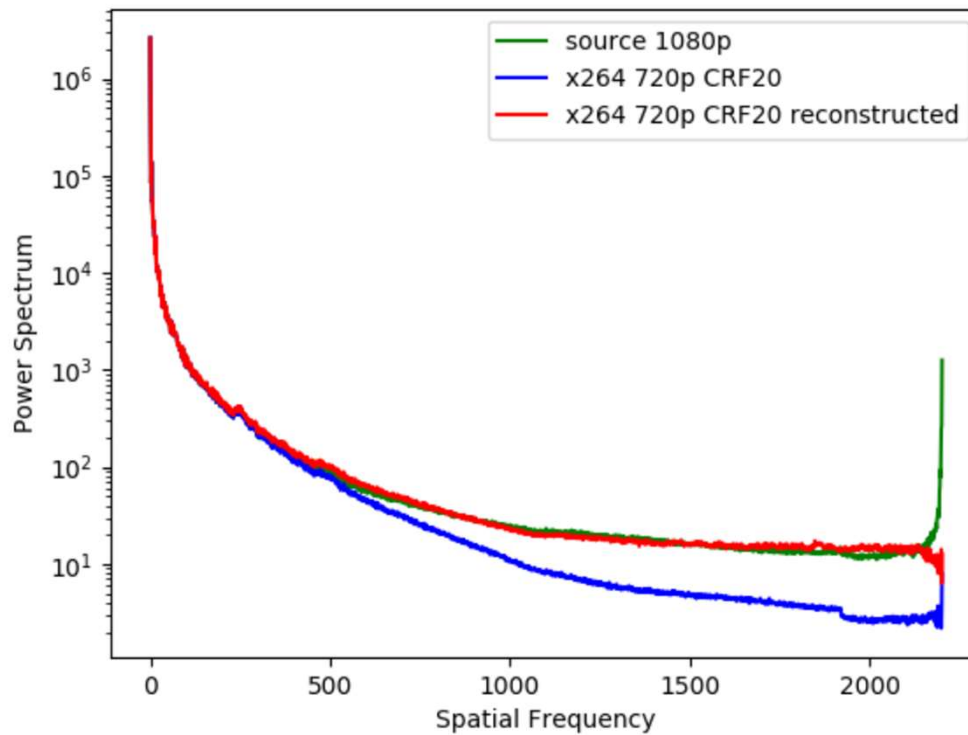
Reconstructed Video



3. Apply GPU filters to:
 - Enhance contrast and details
 - «Deband»
 - Reconstruct film grain

Spatial Frequency Analysis #3

Radial Averaged Power Spectrum to evaluate effects of GPU-based spectral reconstruction



x264 720p CRF20 – **VMAF = 86.7**

X264 720p CRF20 recon. – **VMAF = 91.5**

Source: Meridian



ORIGINAL 1080p



Compressed 720p



720p reconstructed



ORIGINAL 1080p



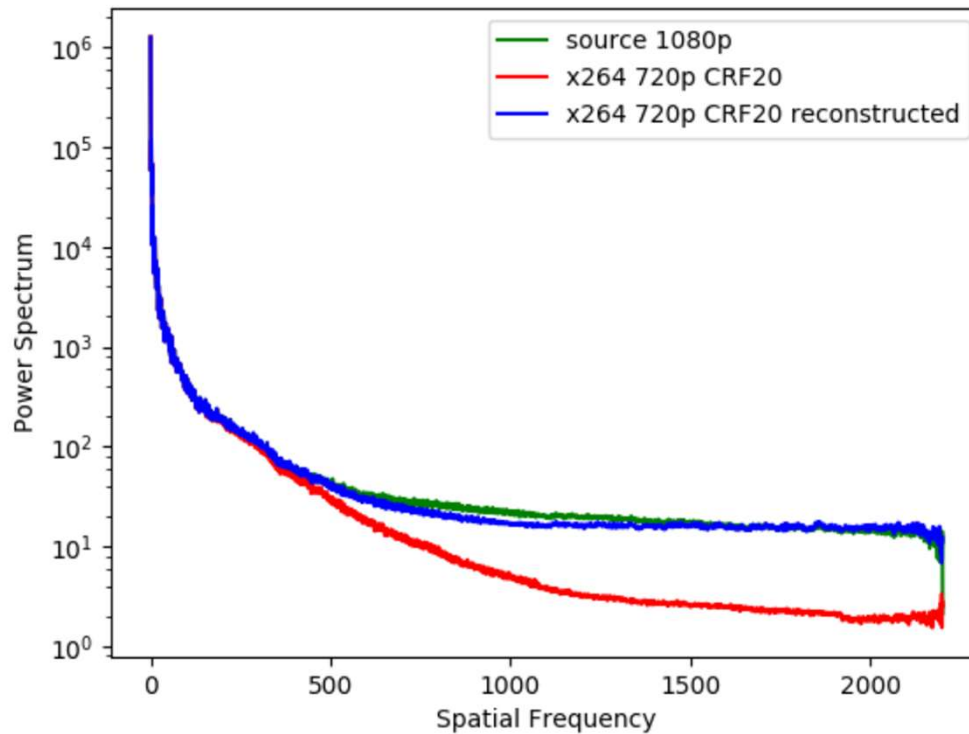
Compressed 720p



720p reconstructed

Spatial Frequency Analysis #4

Radial Averaged Power Spectrum to evaluate effects of GPU-based spectral reconstruction



x264 720p CRF20 – **VMAF = 91.7**
X264 720p CRF20 recon. – **VMAF = 96.1**

Source: Oblivion



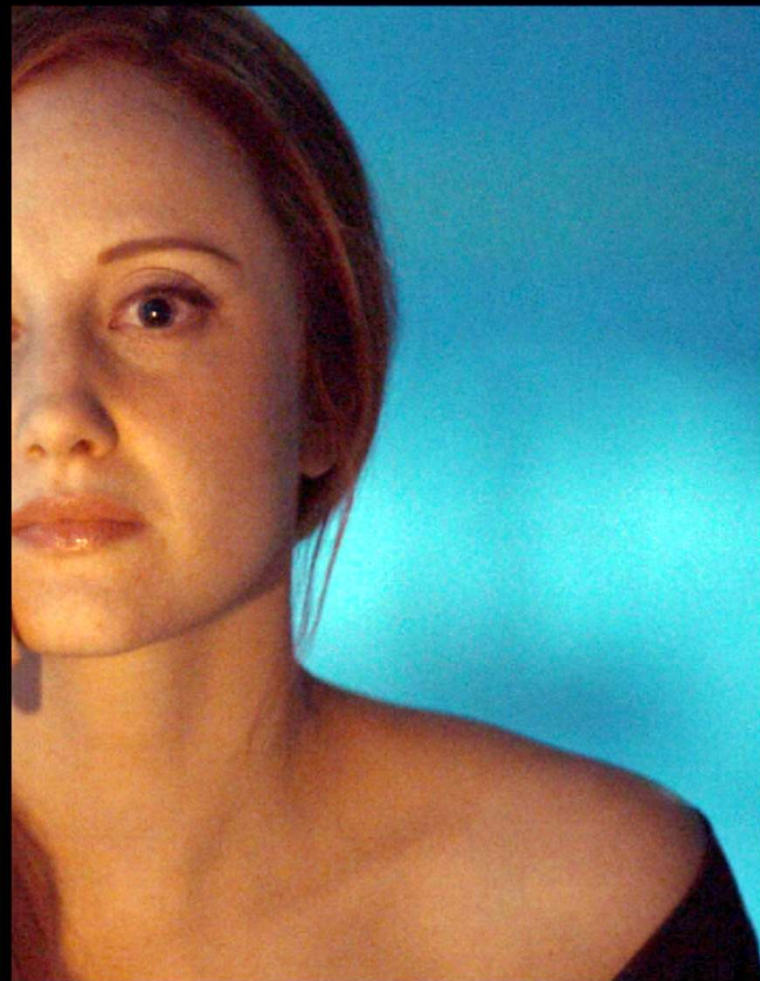
ORIGINAL 1080p



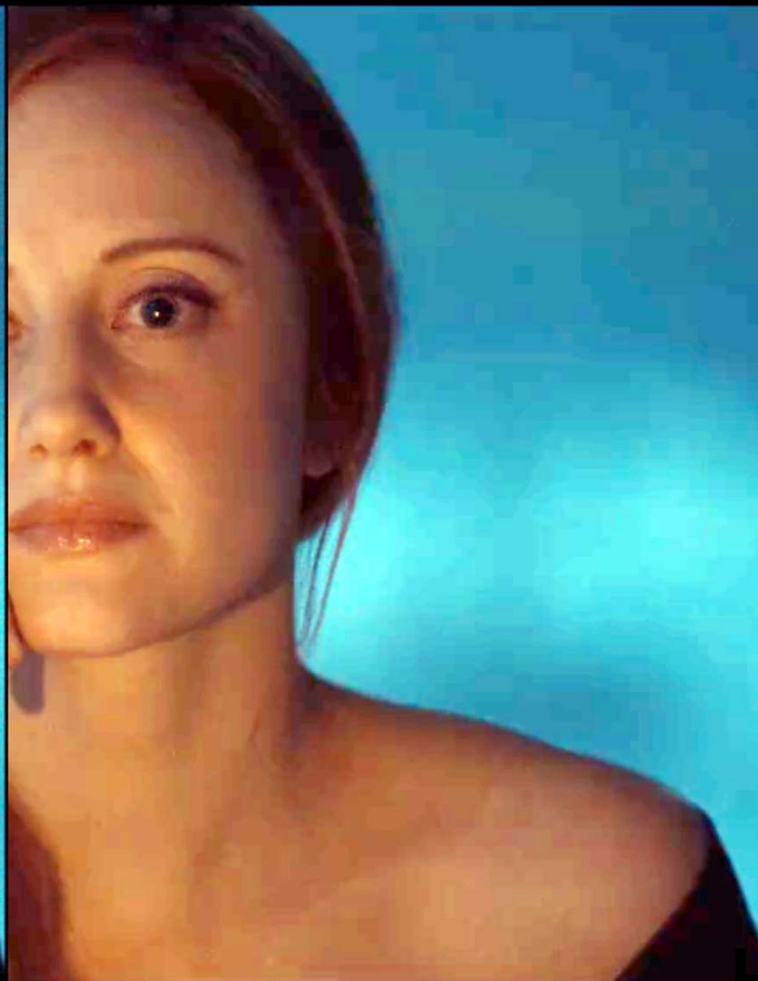
Compressed 720p



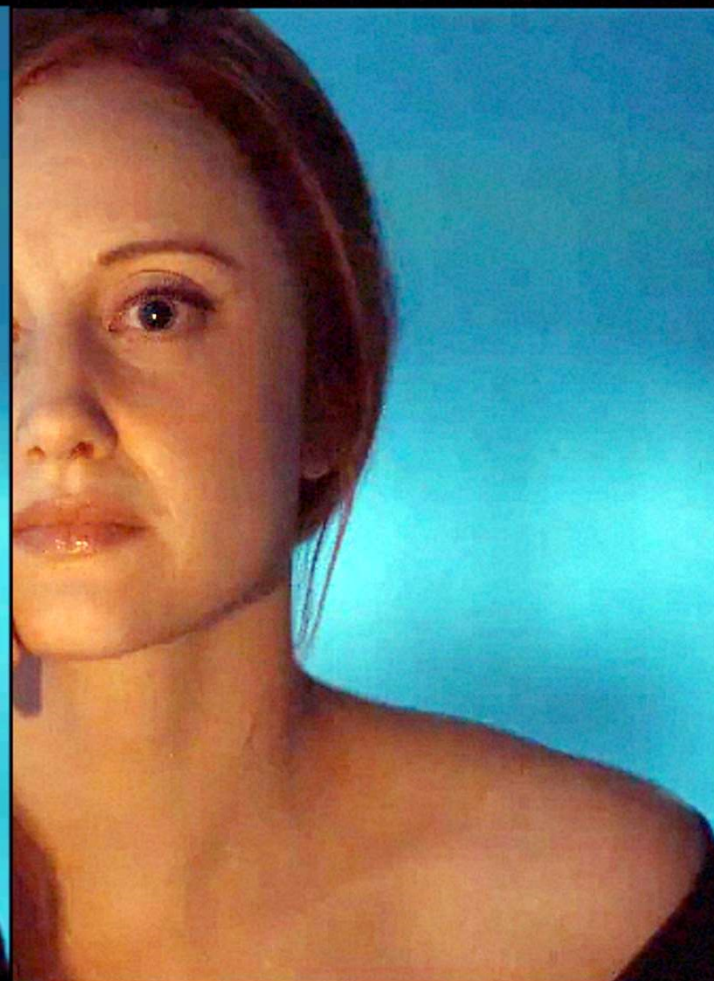
720p reconstructed



ORIGINAL 1080p



Compressed 720p



720p reconstructed



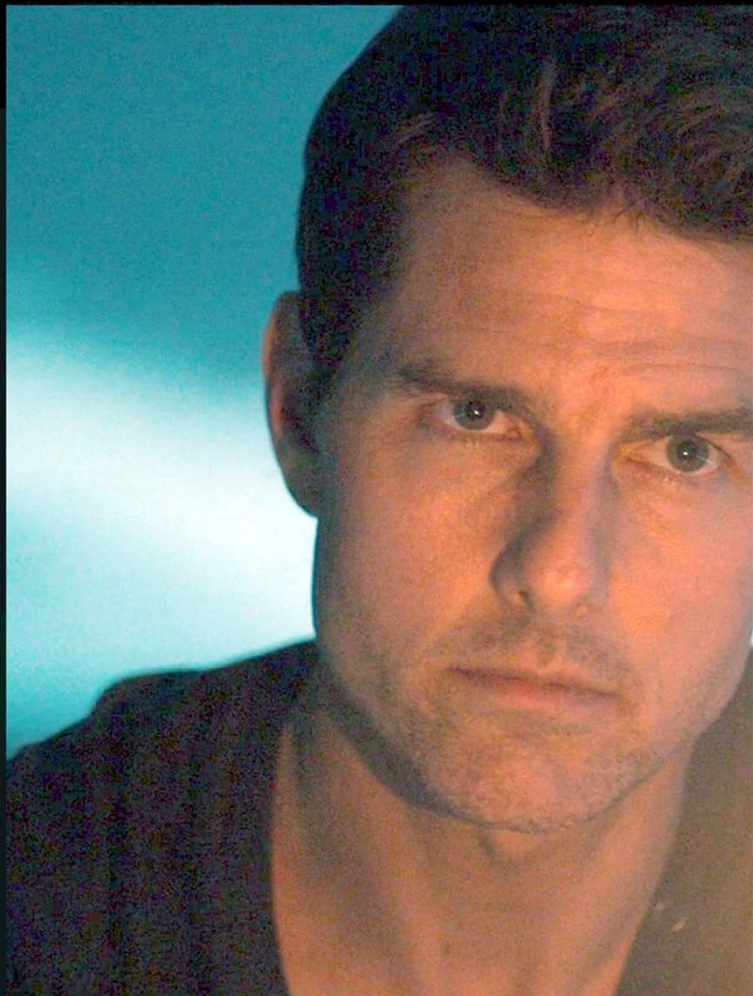
ORIGINAL 1080p



Compressed 720p



720p reconstructed



ORIGINAL 1080p



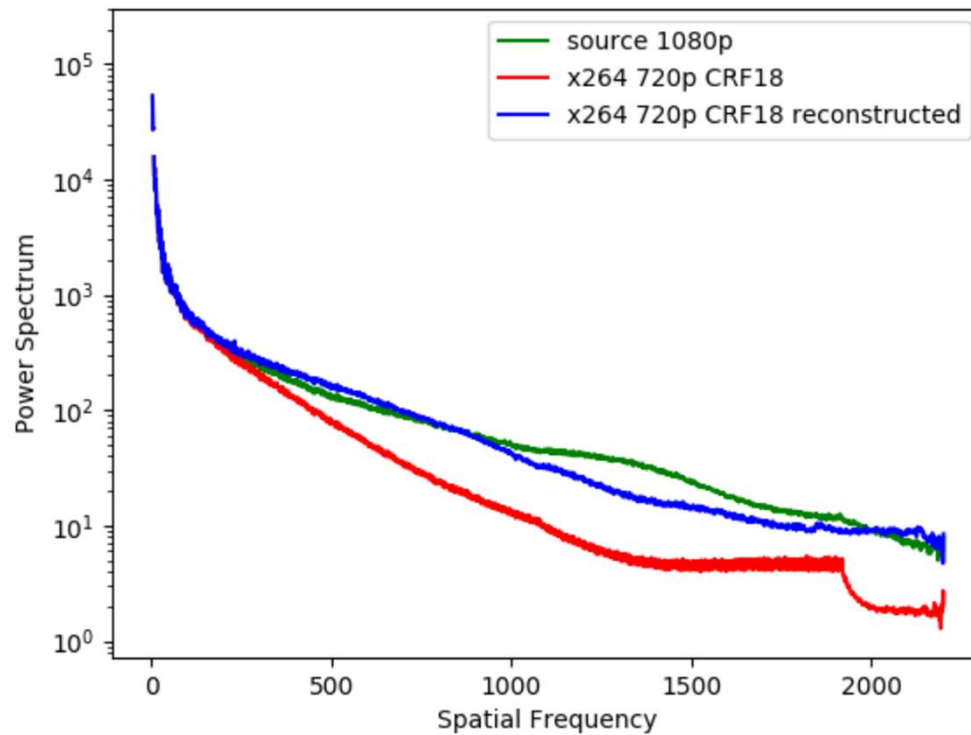
Compressed 720p



720p reconstructed

Spatial Frequency Analysis #5

Radial Averaged Power Spectrum to evaluate effects of GPU-based spectral reconstruction



Source: Forest

x264 720p CRF20 – VMAF = 88.1

X264 720p CRF20 recon. – VMAF = 92.5



Original

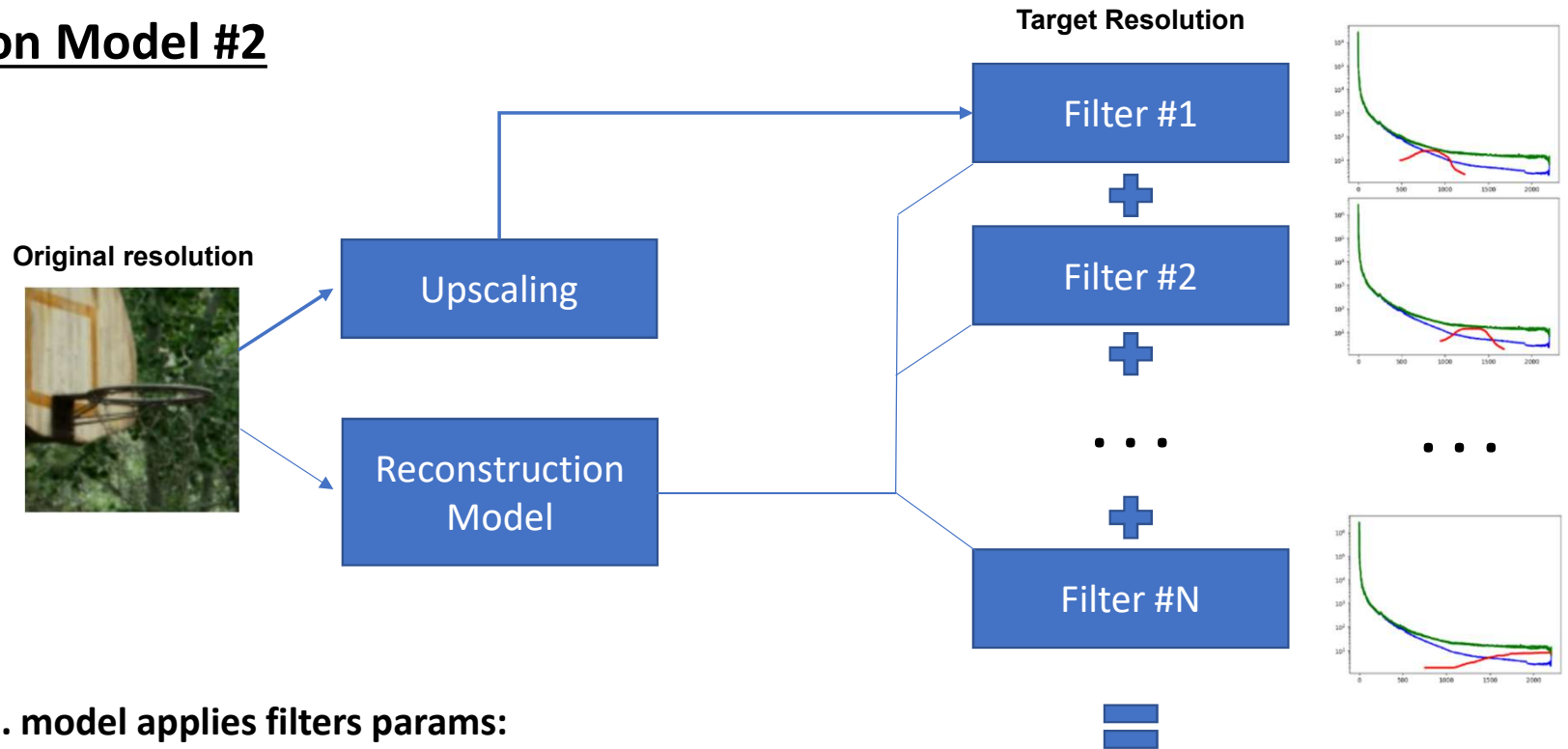


720p compressed



720p recon.

Reconstruction Model #2

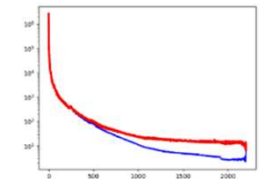


How the recon. model applies filters params:

1. Info received by the encoder (many options of joint optimization)
2. Or predicted using a ML algorithm trained to maximize VMAF (useful when you do not control the source of video)



On screen



Conclusion

- The answer is **yes**, under certain conditions it is possible!
- Perceptual Quality increases (VMAF)
- We can use the logic to restore quality or increase efficiency in other scenarios like ultra compression for mobile
- Specific encoding optimizations can be designed to enhance reconstruction or overall efficiency (joint optimization)
- Works in modern browsers using WebGL (including mobile)
- What's next: need to work on perf tuning and logic consolidation