

CAMBI: Introduction and Latest Advances

Mariana Afonso, Joel Sole, *Lukas Krasula*, Zhi Li, Pulkit Tandon

Encoding Technologies

MHV'2022, Denver, CO
lkrasula@netflix.com



The curious case of **banding**...



...if you didn't know about it... **sorry.**

Banding is manifested as false staircase-like edges in otherwise smooth transitions in a picture.

One of the most prominent causes for banding is the **quantization** step in video encoders.

A relatively small change of the original pixel values can produce an easily noticeable and visually annoying artifacts.

Banding artifacts are notoriously difficult to capture for objective quality metrics.

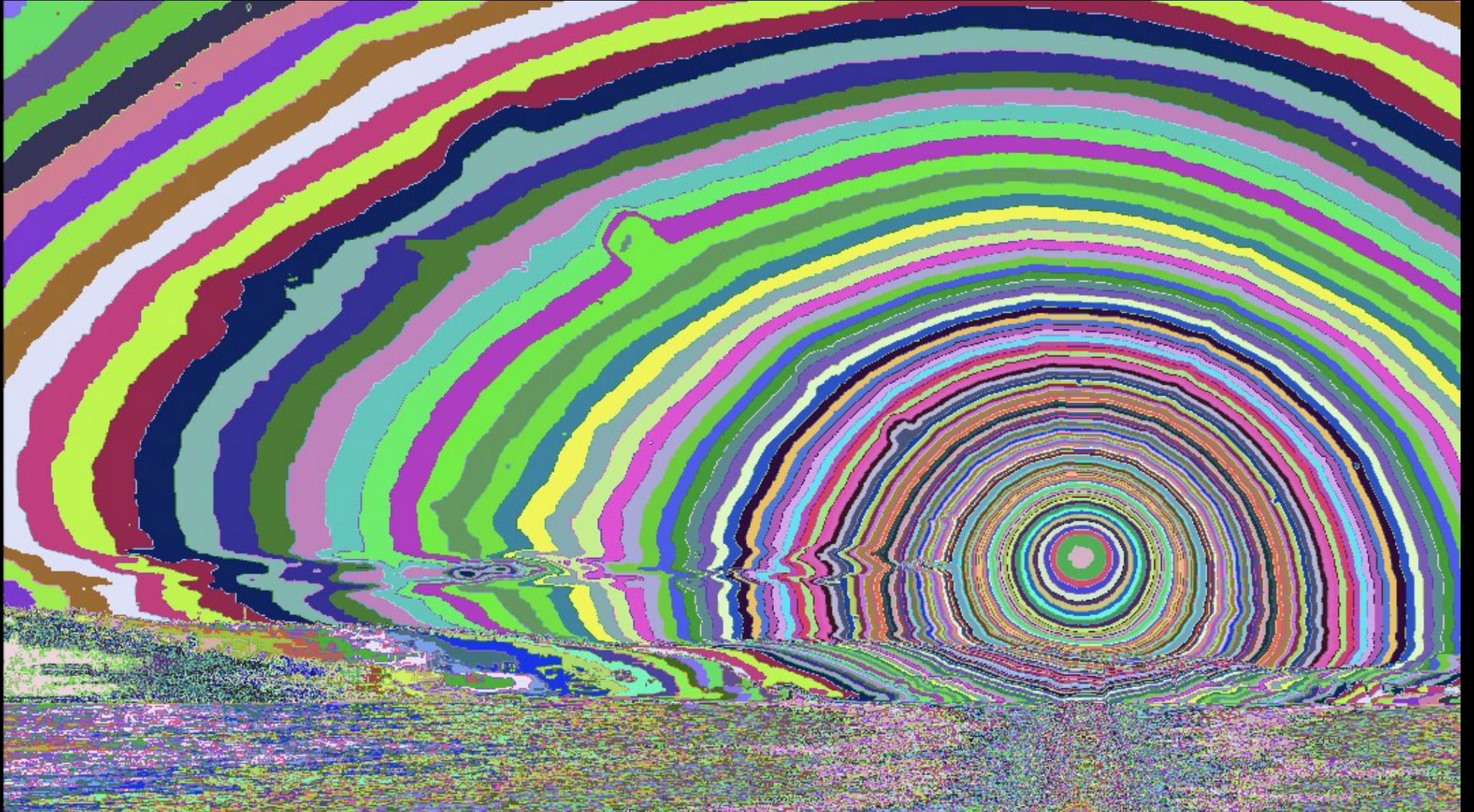
VMAF = 86
PSNR = 50 dB
MOS = 20



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PSNR = 50 dB
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Artificial colors to
highlight bands



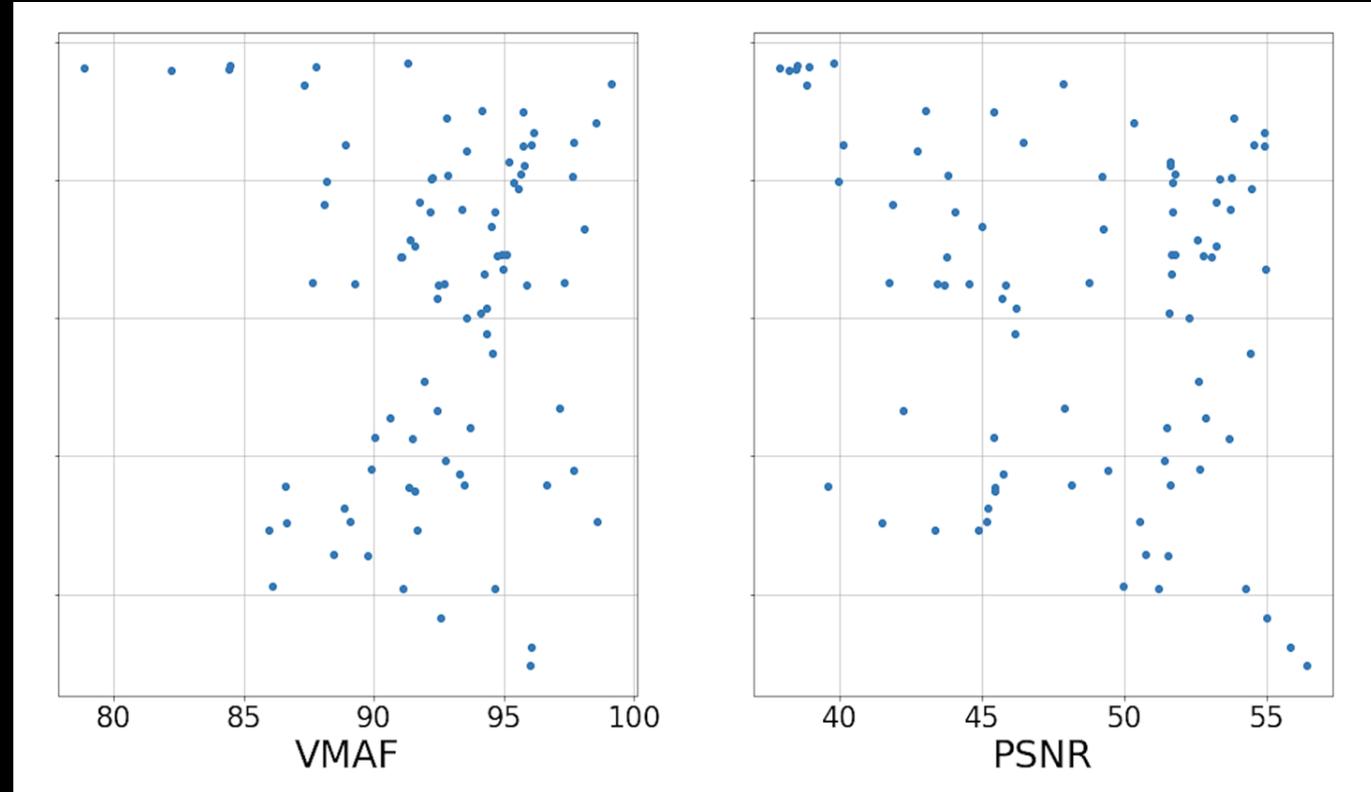
Banding artifacts are notoriously difficult to capture for objective quality metrics.

Banding is:

MOS

- 100 Imperceptible
- 80 Perceptible, but not annoying
- 60 Slightly annoying
- 40 Annoying
- 20 Very Annoying

86 videos, 23 subjects



	VMAF	PSNR
SROCC	0.088	-0.202
PLCC	0.000	-0.271

Existing banding detectors are usually designed for **user-generated 8-bit images**.

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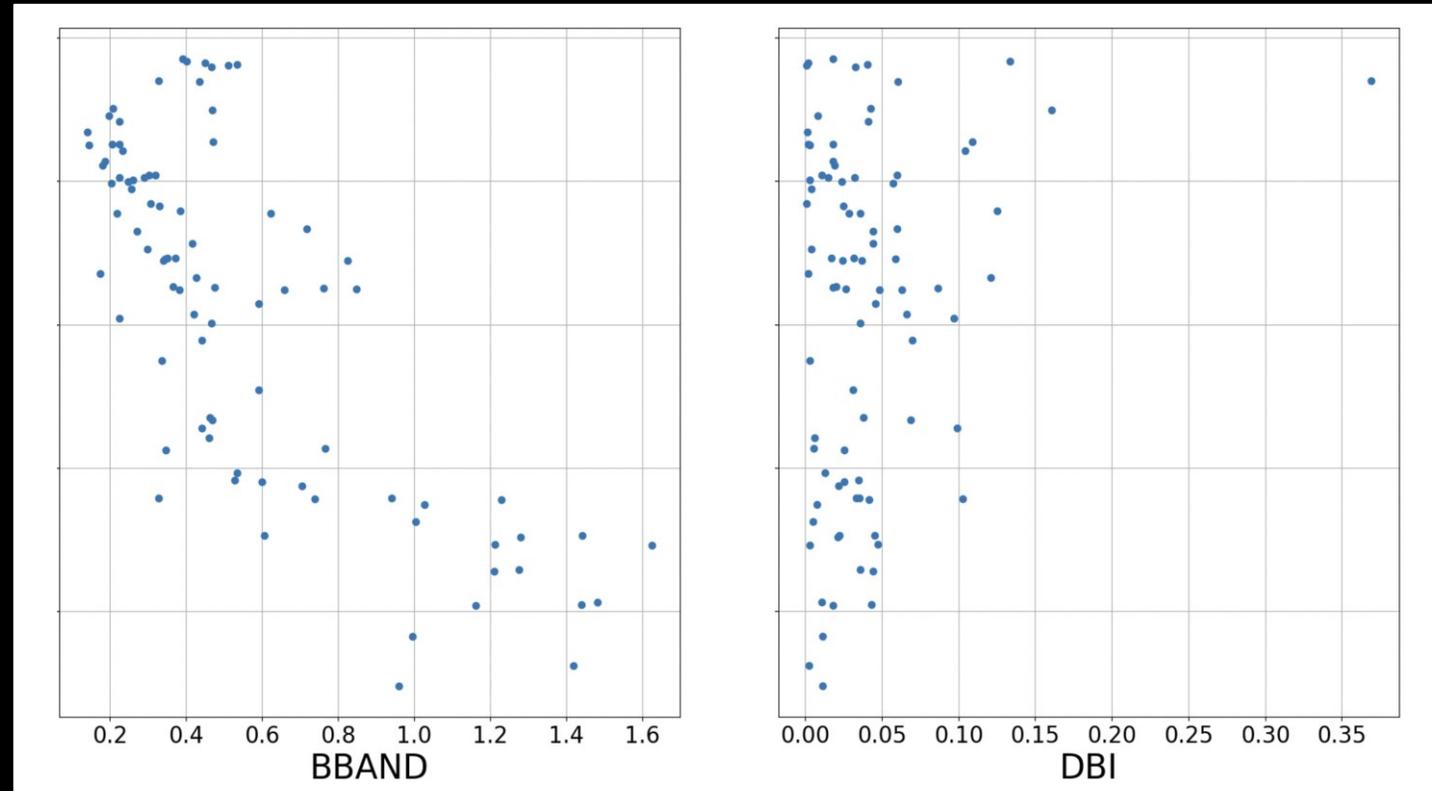
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* Z. Tu, J. Lin, Y. Wang, B. Adsumilli and A. C. Bovik, "BBAND INDEX: A NO-REFERENCE BANDING ARTIFACT PREDICTOR," ICASSP 2020

** Akshay Kapoor, Jatin Sapra and Zhou Wang, "CAPTURING BANDING IN IMAGES: DATABASE CONSTRUCTION AND OBJECTIVE ASSESSMENT", ICASSP 2021

	BBAND*	DBI**
SROCC	-0.693	0.046
PLCC	-0.762	0.212

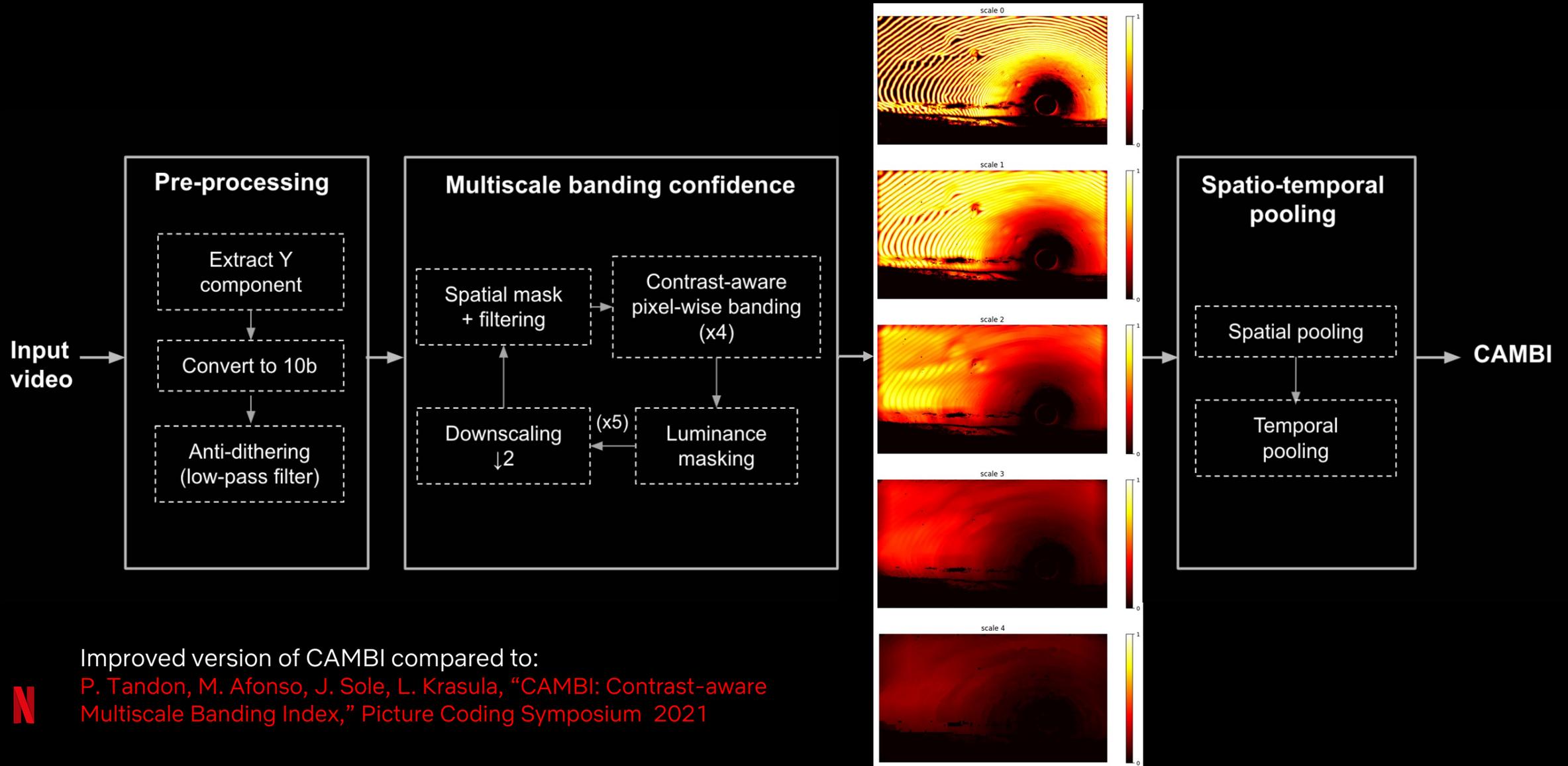
CAMBI:

Contrast-Aware Multiscale Banding Index

CAMBI: Notable features

- Focused on detection of banding in high-quality encodes (VMAF>80)
- Can deal with different resolutions and dithered content
- Validated on subjective data (both 8-bit and 10-bit SDR content)
- Open-sourced as a libvmaf feature ([link](#))
- Published: initial [version](#) in PCS 2021, Medium [techblog](#)

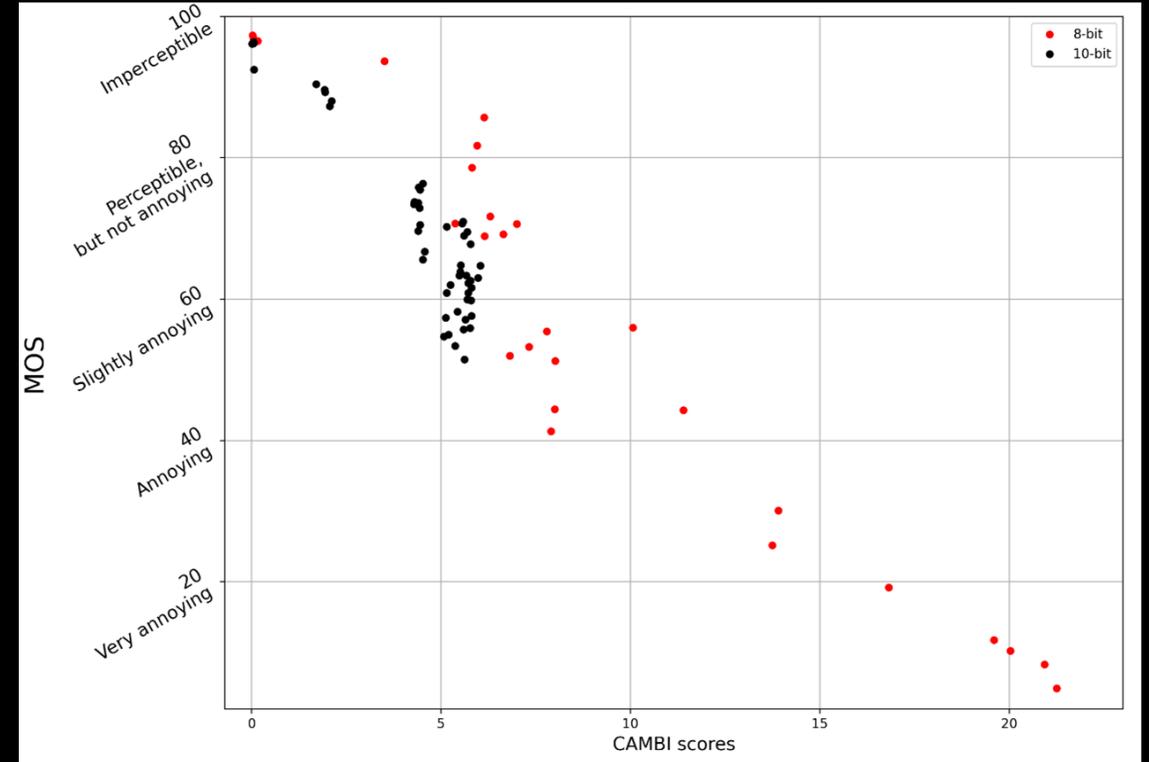
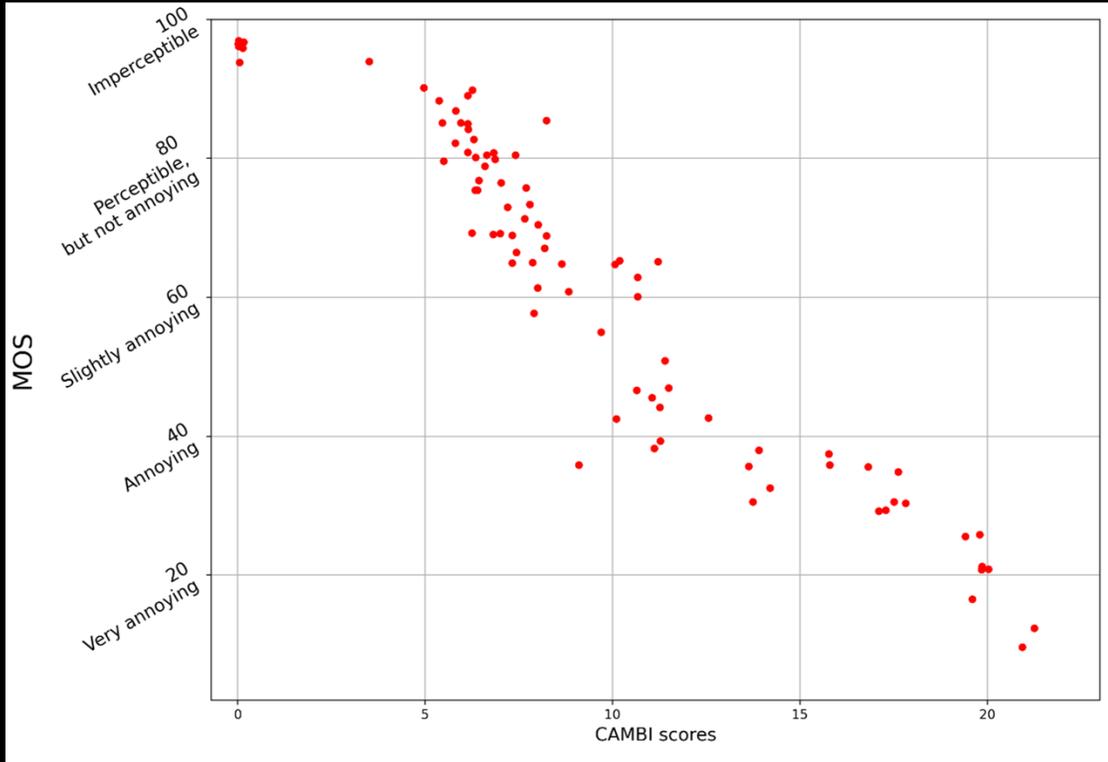
CAMBI is a white box solution derived from basic principles of human vision with just a few, perceptually-motivated, parameters.



Improved version of CAMBI compared to:

P. Tandon, M. Afonso, J. Sole, L. Krasula, "CAMBI: Contrast-aware Multiscale Banding Index," Picture Coding Symposium 2021

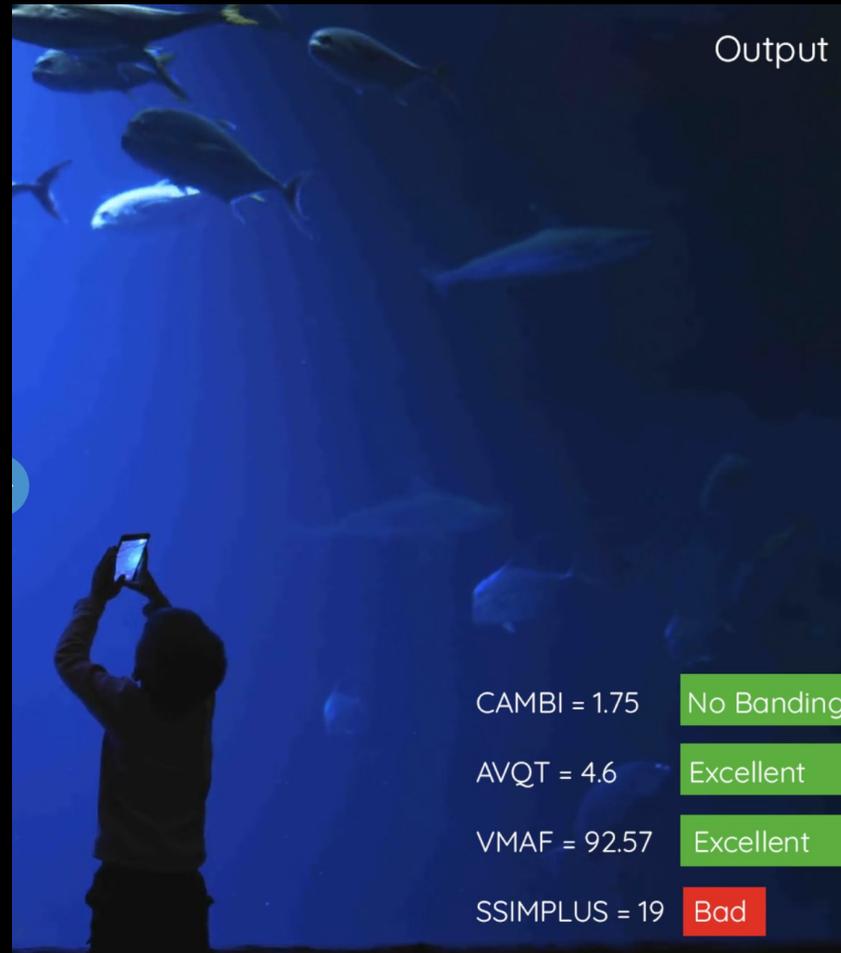
CAMBI significantly outperforms existing metrics and banding detectors on Netflix content and works for both 8 and 10 bit videos.



	CAMBI	BBAND	VMAF	PSNR
SROCC	-0.958	-0.693	0.088	-0.202
PLCC	-0.947	-0.762	0.000	-0.271

	CAMBI	BBAND	VMAF	PSNR
SROCC	-0.762	N/A	-0.294	-0.561
PLCC	-0.928	N/A	-0.385	-0.556

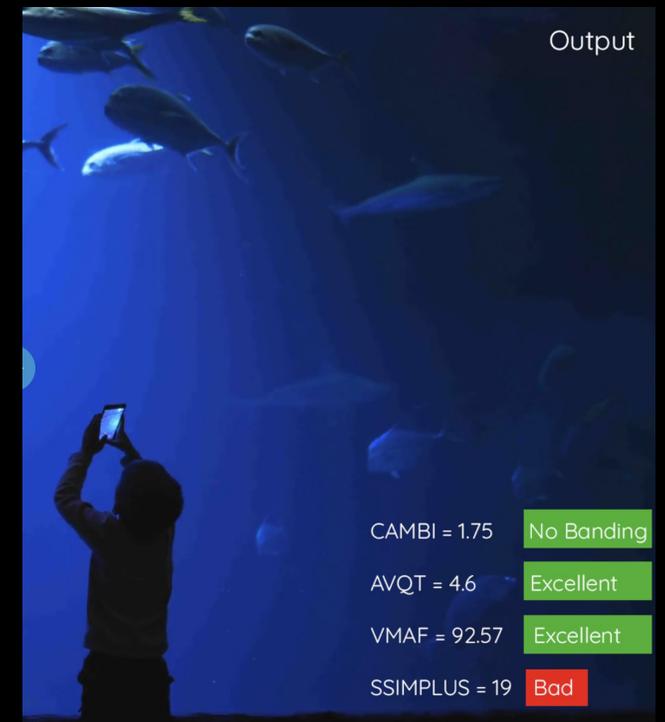
The beauty of **open-sourcing**...



...is that you get to find **corner cases** really quickly!

Houston, do we have a problem?!

- The frame is created by converting to 6 bits and back
 - This creates bands with relatively high luma distance
 - Steps are too large for CAMBI's default setting
- Although our codecs do not seem to produce banding with such large steps, we now allow users to change the CAMBI setting to capture this
 - See *max_log_contrast* on the [CAMBI usage page](#)
- Setting *max_log_contrast = 3* leads to
 - CAMBI **1.75** \Rightarrow **13** for the corner case
 - SROCC **-0.958** \Rightarrow **-0.955** for 8 bit dataset
 - SROCC **-0.762** \Rightarrow **-0.754** for 10 bit dataset
- Considering larger steps increases **false positive rate**
 - Full reference variant can help (now also open-sourced)

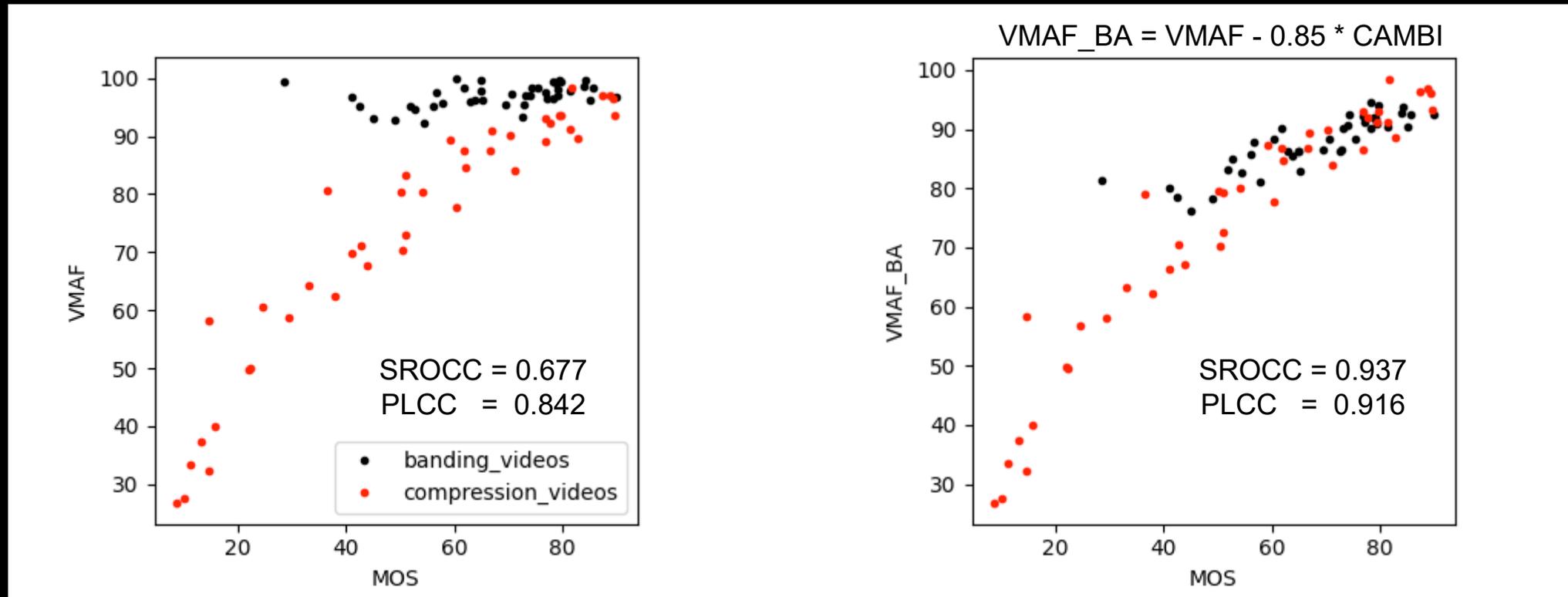


Summary of **improvements** since the first version

- **4x speed-up** (for 2160p resolution) and **memory savings**
- Extension to bit-depths **larger than 12 bits**
- Full-reference version
- **HDR** version with **PQ** EOTF
- Adding *max_log_contrast* user parameter
- Providing **heat-maps** for deeper analysis

CAMBI can be combined with VMAF into a **banding-aware video quality metric**.

- Dataset of videos with banding and videos with compression artifacts



Future work

- Integration into VMAF as an elementary feature
- Investigation of interaction between heavy compression and heavy banding
- Mapping to an interpretable scale



Thank you!



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