A Study comparing Synthetic Shutter and HFR for Judder Reduction

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Motivation

Methods

Results

Motivation

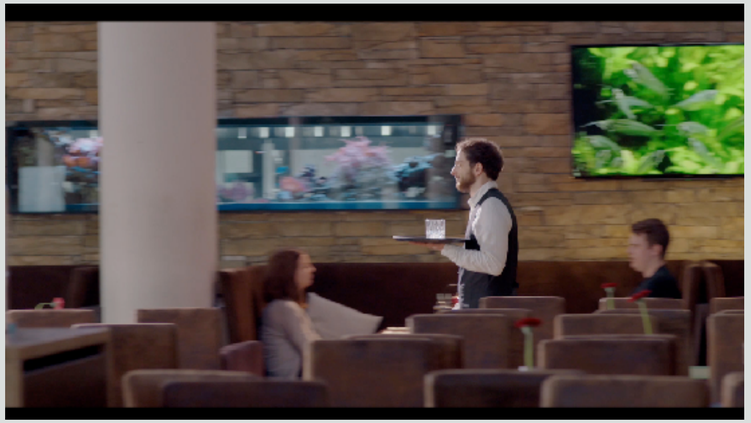
- High Dynamic Range (HDR) is entering the cinematic sector
- Higher luminance- and contrast levels
- Enhances the overall viewing experience
- BUT: enhances the perception of motion artefacts as well
- In this case: judder artefacts

- How to:
  - Reduce judder artefacts
  - While keeping the ‘cinematic look’ (24fps) in HDR

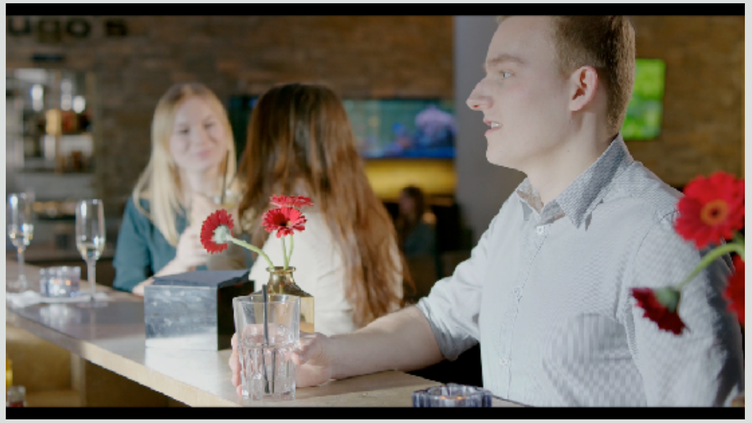
Capture Methods

- Footage in 24 fps at 180 degrees shutter and 192 fps at 356 degrees shutter
- Different kinds of motion
- Designed to show off differences between SFR and HFR

- ARRI AMIRA and ARRI Ultra Primes
- QuickTime, 2k, 12 bit LogC Wide Gamut, 330 Mbit/s intra-frame

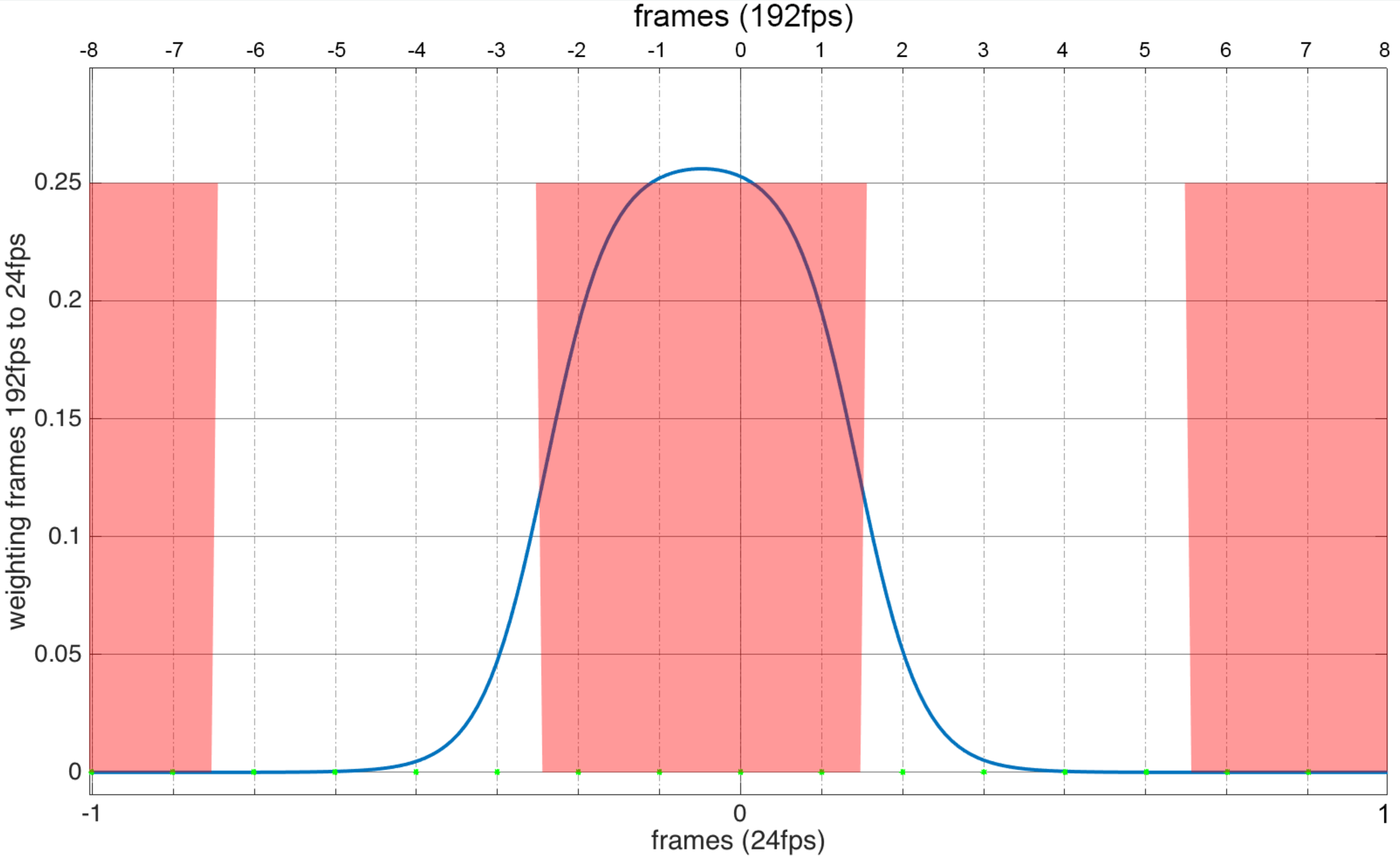


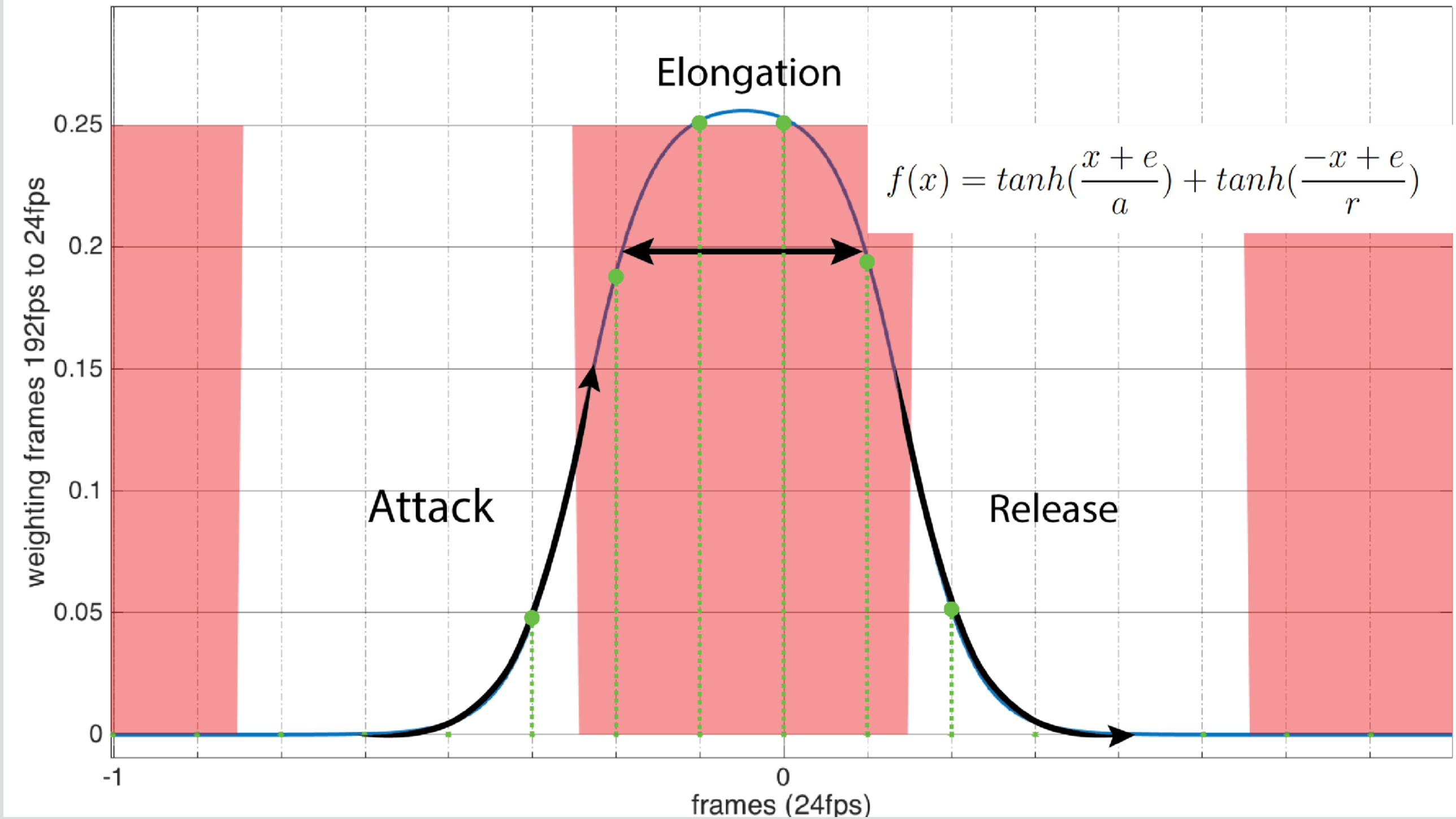

Hugo's



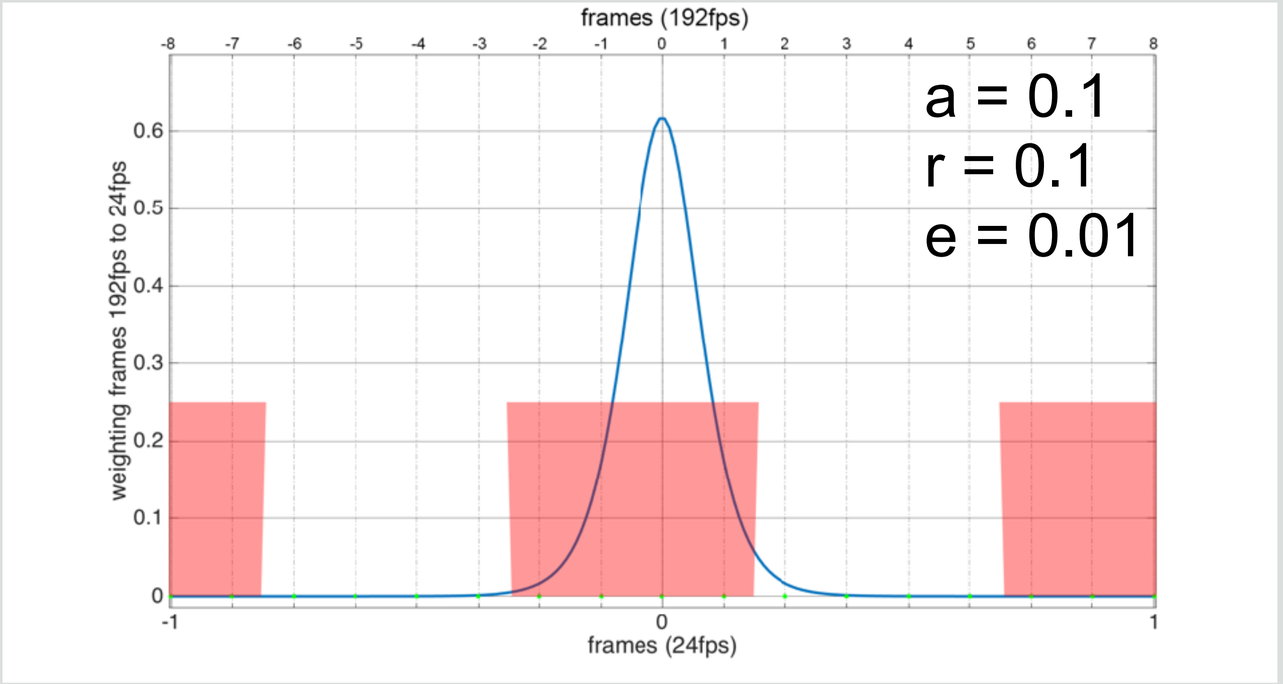
Post Production Methods

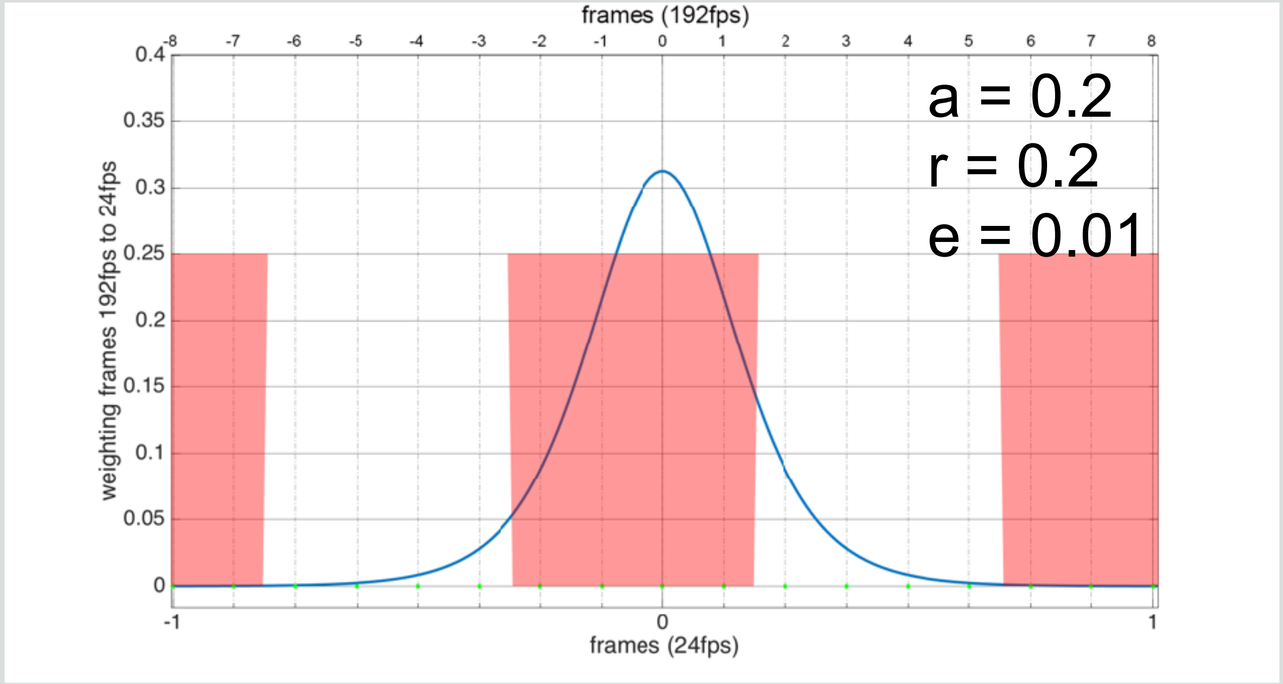
- Basic idea: reducing judder artefacts through the addition of motion blur
- Weighted frame blending from 192fps to 24fps based on synthetic shutters

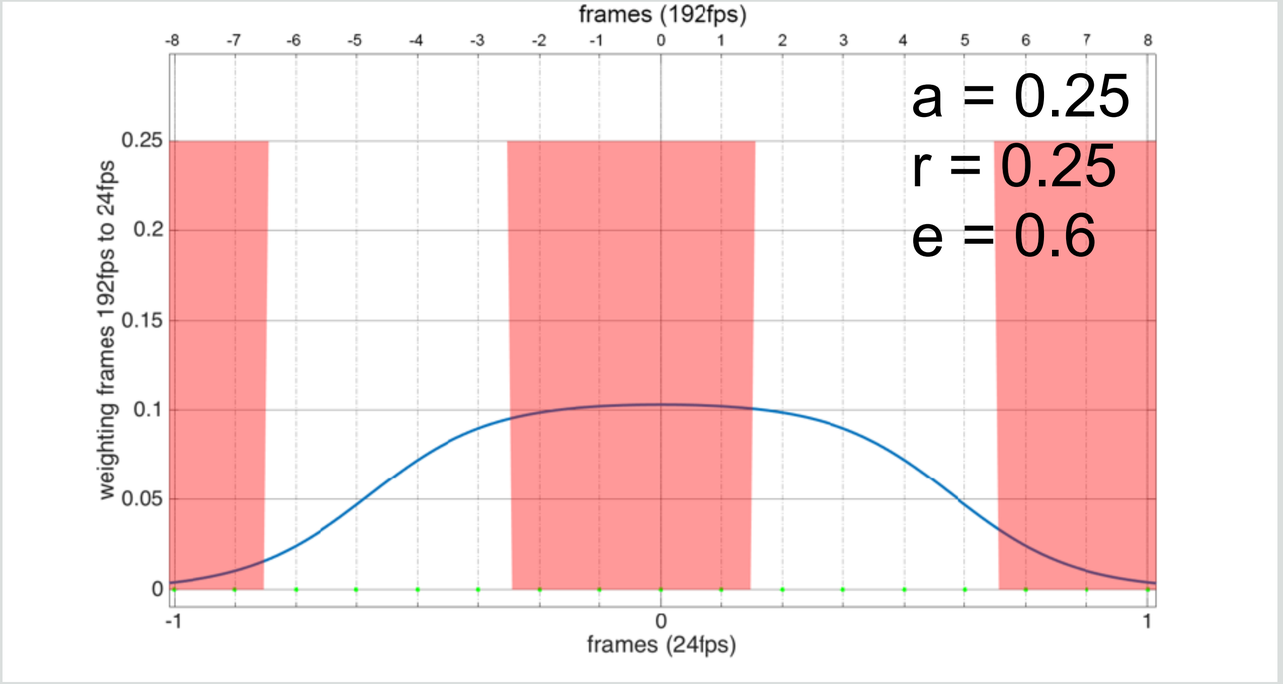

frames (192fps)
-8
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
0.25
0.2
0.15
0.1
0.05
0
weighting frames 192fps to 24fps
-1
0
1
frames (24fps)

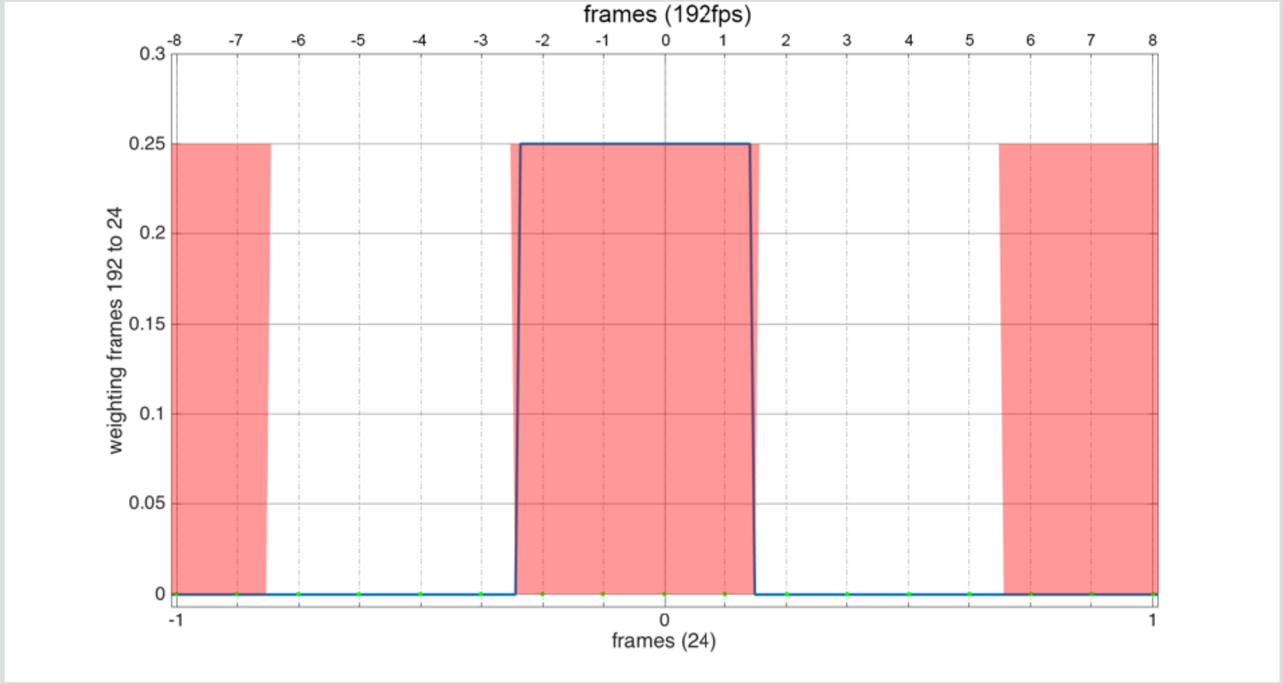

Elongation
$f(x) = tanh(\frac{x+e}{a}) + tanh(\frac{-x+e}{r})$
Attack
Release
weighting frames 192fps to 24fps
0.25
0.2
0.15
0.1
0.05
0
-1
0
frames (24fps)

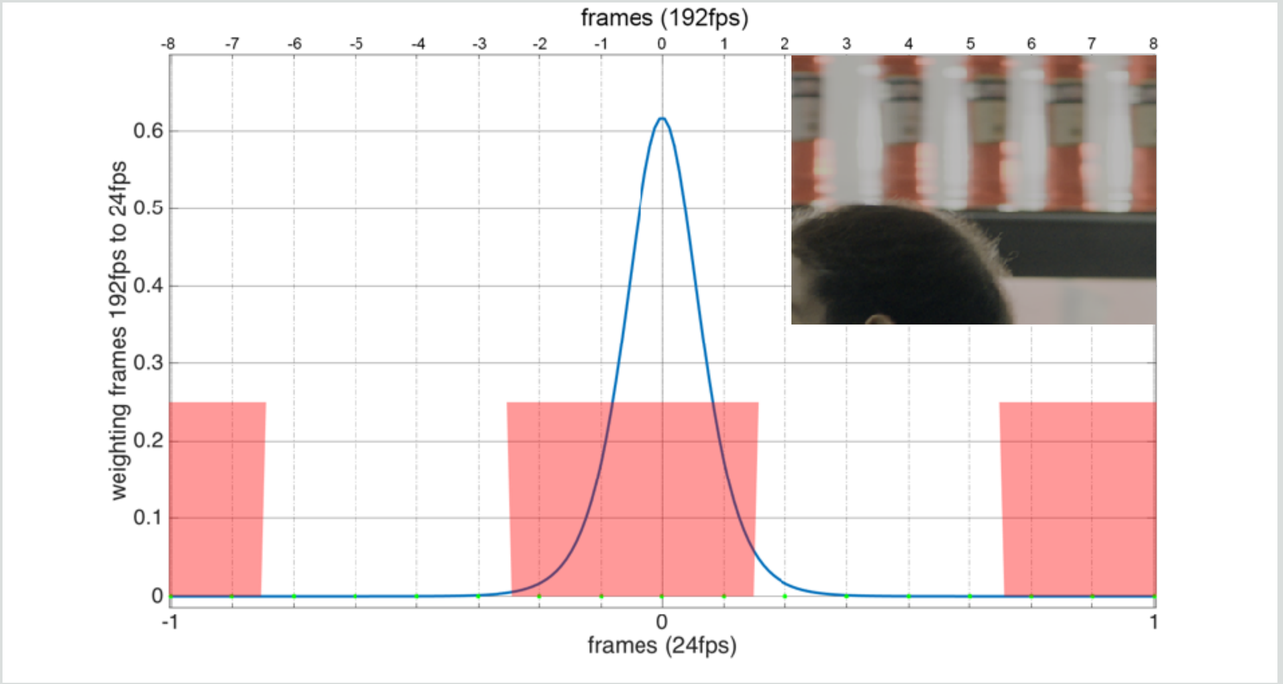
- Visual study
- Three gaussian-like shutters and one reference 180degree box shutter

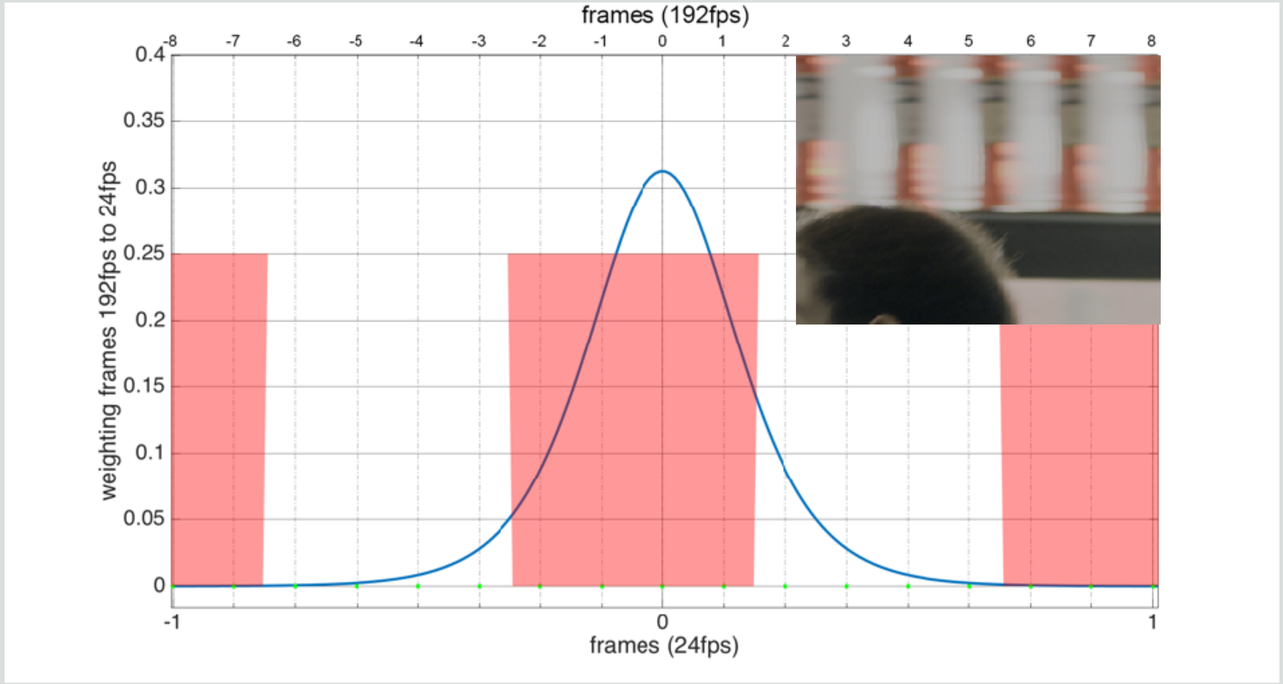

frames (192fps)
weighting frames 192fps to 24fps
frames (24fps)
a = 0.1
r = 0.1
e = 0.01

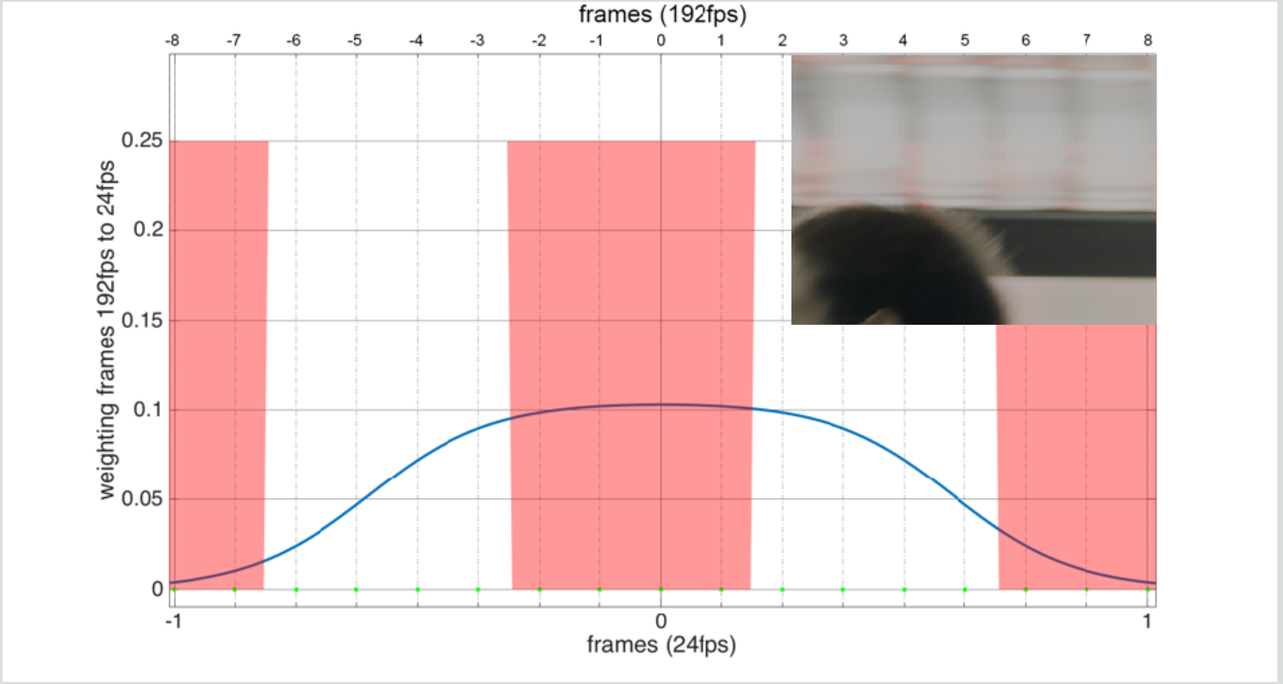

frames (192fps)
weighting frames 192fps to 24fps
frames (24fps)
a = 0.2
r = 0.2
e = 0.01

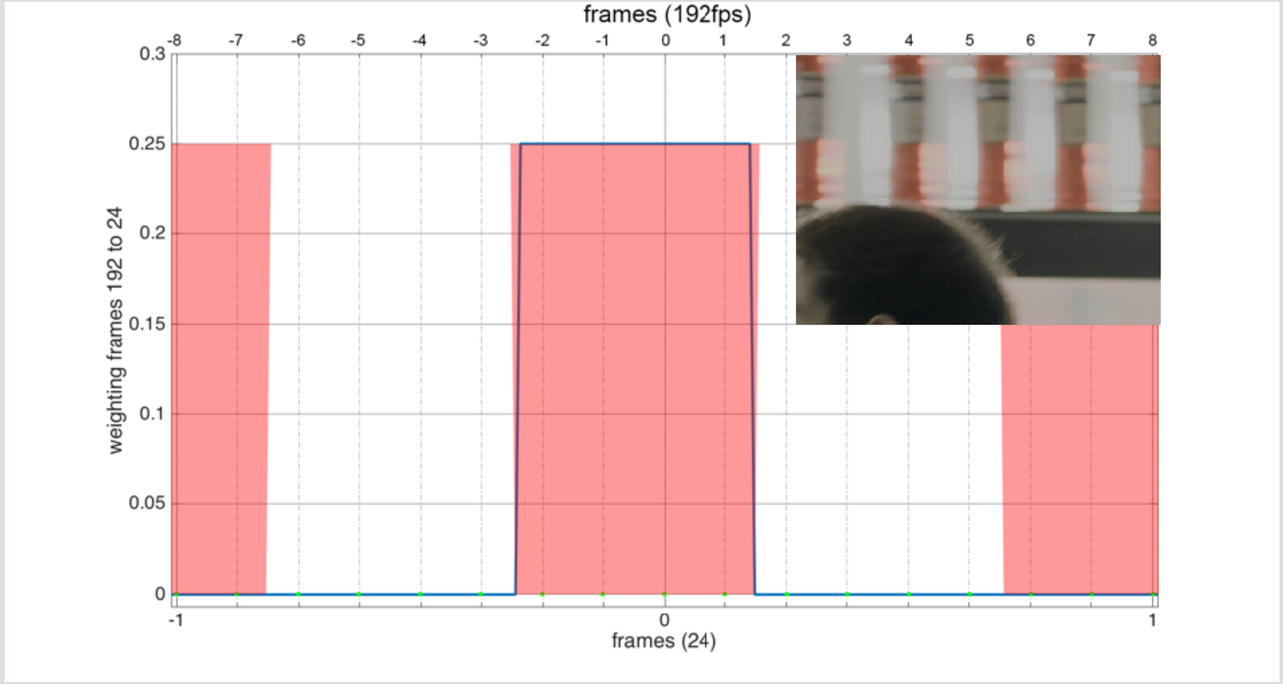

frames (192fps)
weighting frames 192fps to 24fps
frames (24fps)
a = 0.25
r = 0.25
e = 0.6


frames (192fps)
weighting frames 192 to 24
frames (24)

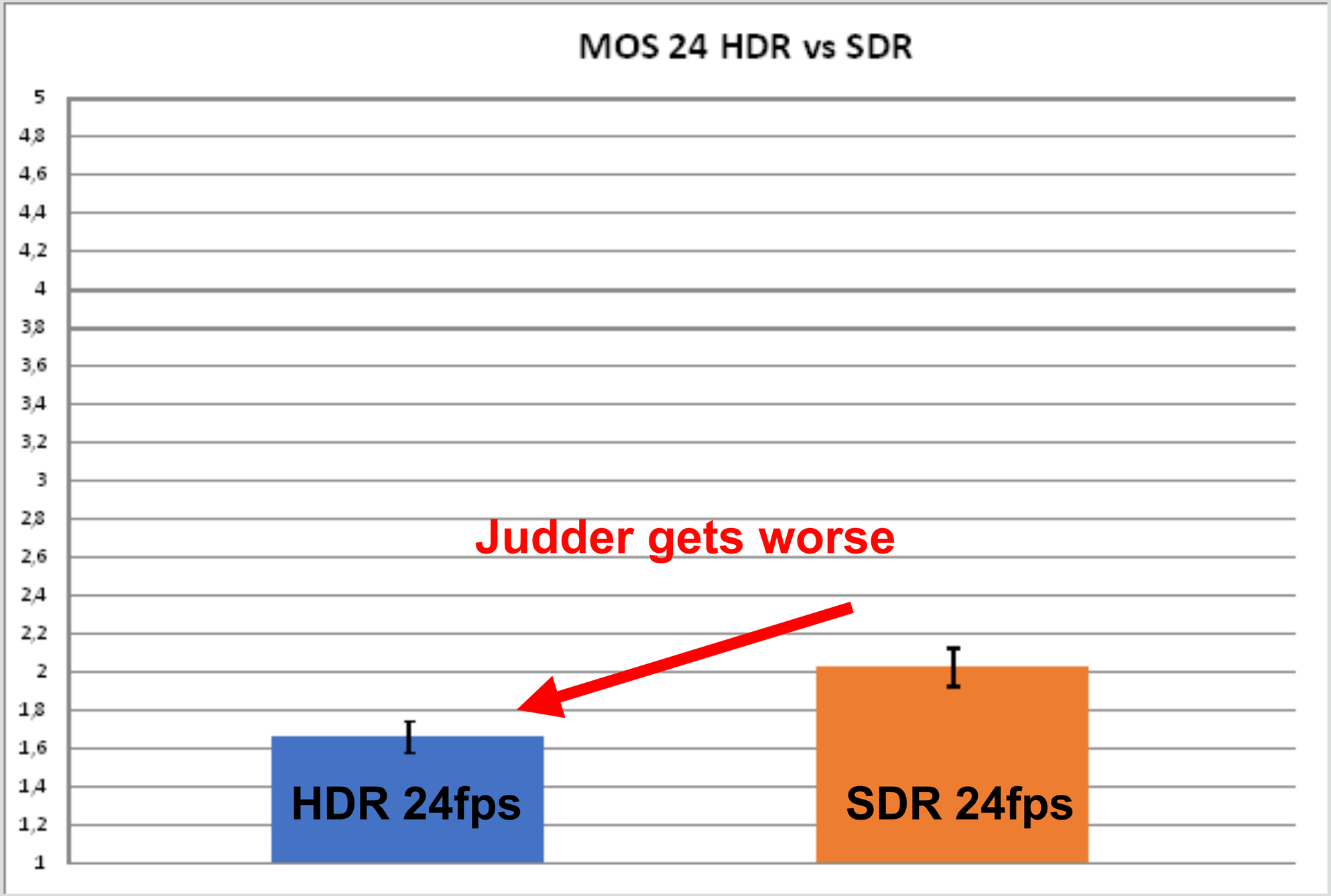

frames (192fps)
weighting frames 192fps to 24fps
frames (24fps)

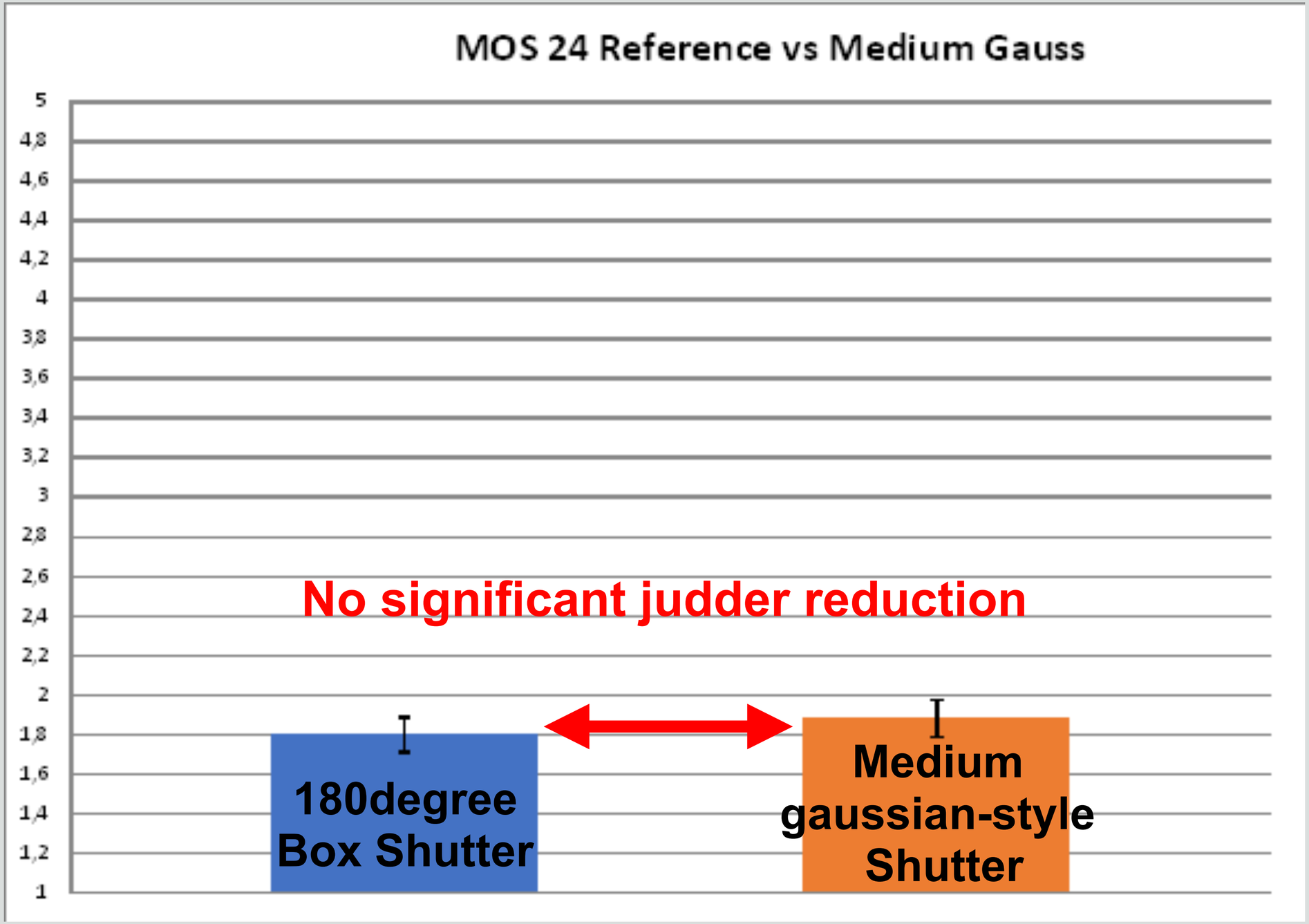

frames (192fps)
weighting frames 192fps to 24fps
frames (24fps)

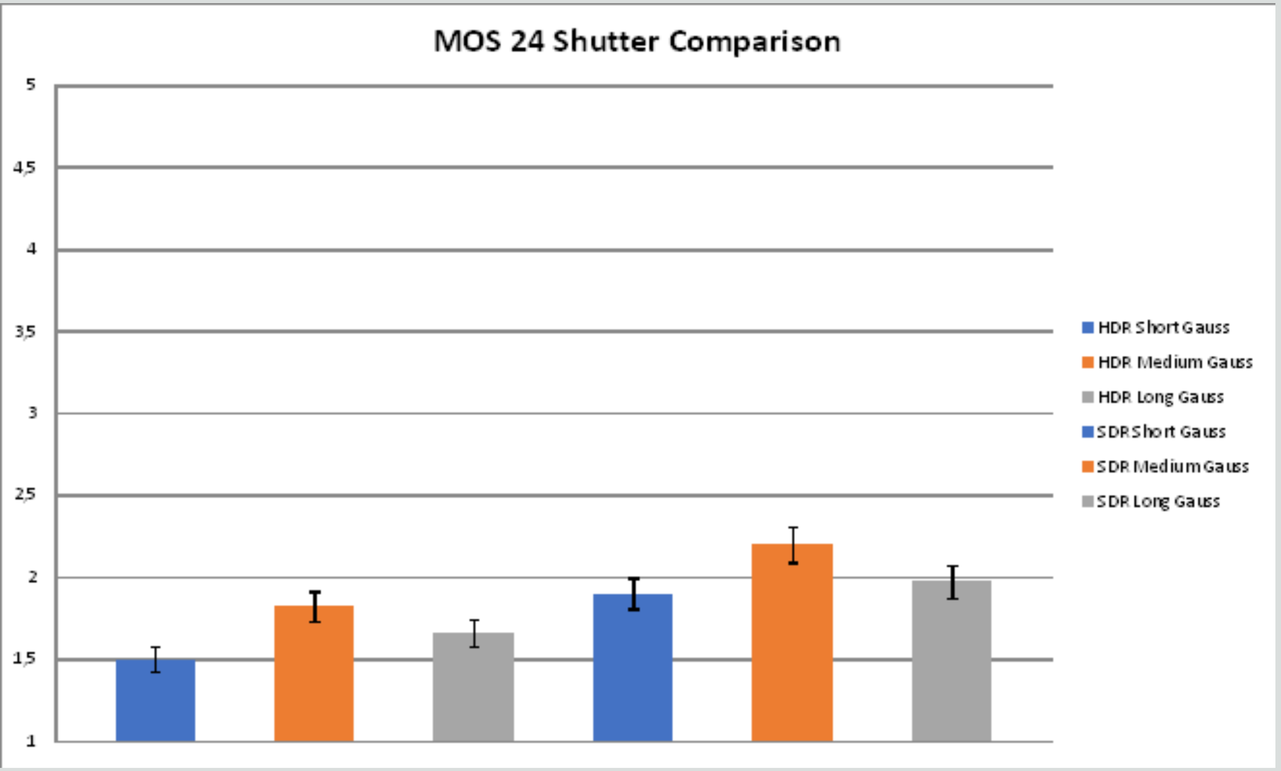

frames (192fps)
weighting frames 192fps to 24fps
frames (24fps)


frames (192fps)
weighting frames 192 to 24
frames (24)

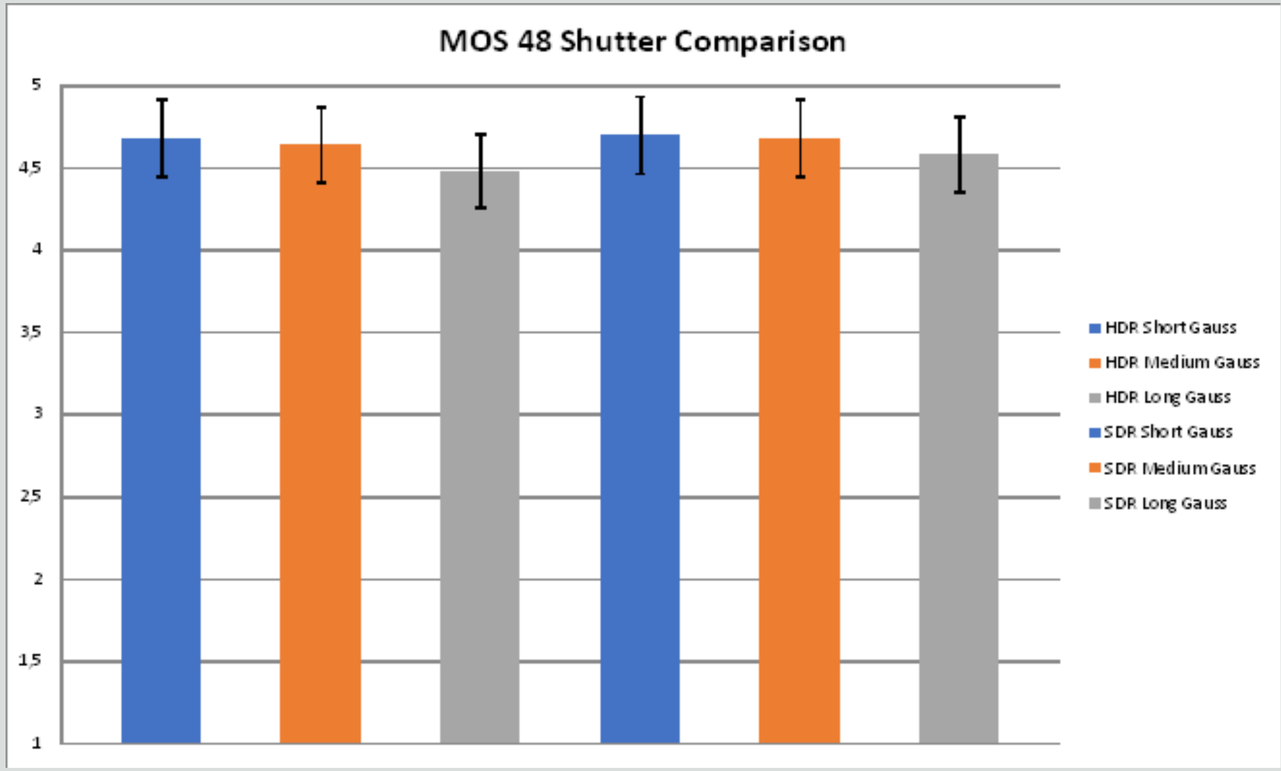
Results


MOS 24 HDR vs SDR
5
4,8
4,6
4,4
4,2
4
3,8
3,6
3,4
3,2
3
2,8
2,6
2,4
2,2
2
1,8
1,6
1,4
1,2
1
Judder gets worse
HDR 24fps
SDR 24fps


MOS 24 Reference vs Medium Gauss
5
4,8
4,6
4,4
4,2
4
3,8
3,6
3,4
3,2
3
2,8
2,6
2,4
2,2
2
1,8
1,6
1,4
1,2
1
No significant judder reduction
180degree Box Shutter
Medium gaussian-style Shutter


MOS 24 Shutter Comparison
5
4,5
4
3,5
3
2,5
2
1,5
1
HDR Short Gauss
HDR Medium Gauss
HDR Long Gauss
SDR Short Gauss
SDR Medium Gauss
SDR Long Gauss

24fps


MOS 48 Shutter Comparison
5
4,5
4
3,5
3
2,5
2
1,5
1
HDR Short Gauss
HDR Medium Gauss
HDR Long Gauss
SDR Short Gauss
SDR Medium Gauss
SDR Long Gauss

48fps

- In 48fps:
  - Judder is hardly perceived
  - No significant difference between HDR and SDR
- Frame rate increase equals serious judder decrease

Key Findings

- Judder is more disturbing in HDR compared to SDR
- Synthetic shutter shapes can NOT significantly reduce judder in 24fps presentation
- HFR resolves judder issues, but motion is rendered less cinematic

Future Work: How to maintain cinematic look in HFR?

Pfiads eich !

Bavarian dialect for: Goodbye !