

# **In-loop reference frame denoising in HEVC reference software (JCTVC-D213)**

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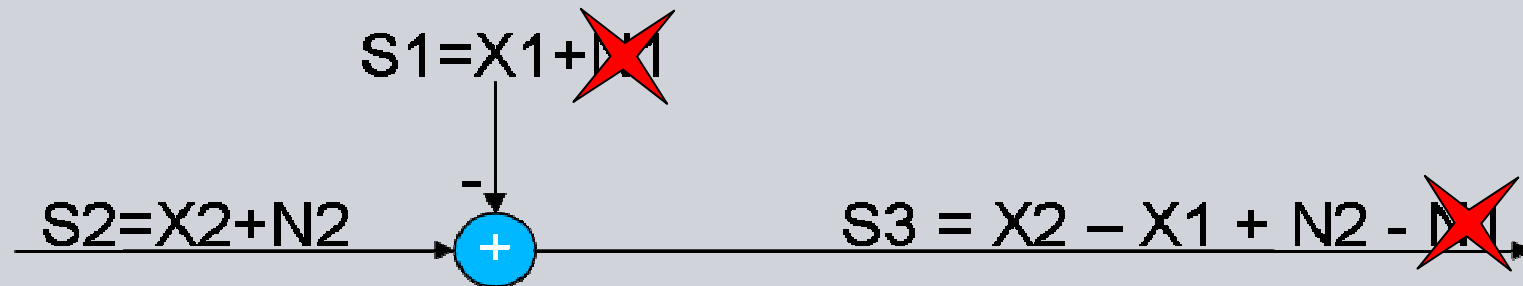
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## Outline

- Motivation & idea
- Simulation set-up & results
- Summary & conclusions

## Motivation and idea

- Modeling of temporal prediction process



- $S1$ : Predictor, i.e., buffer of previous frame(s)
  - $S2$ : Current picture to be encoded
  - $X1/X2$ : “Useful” signal
  - $N1/N2$ : Noise
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- Idea: Filtering of noise ( $N1$ ) from predictor ( $S1$ ) while coding the original signal ( $S2 = X2 + N2$ )
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- For more details see JCTVC-C219

## Simulation set-up: SVT test set

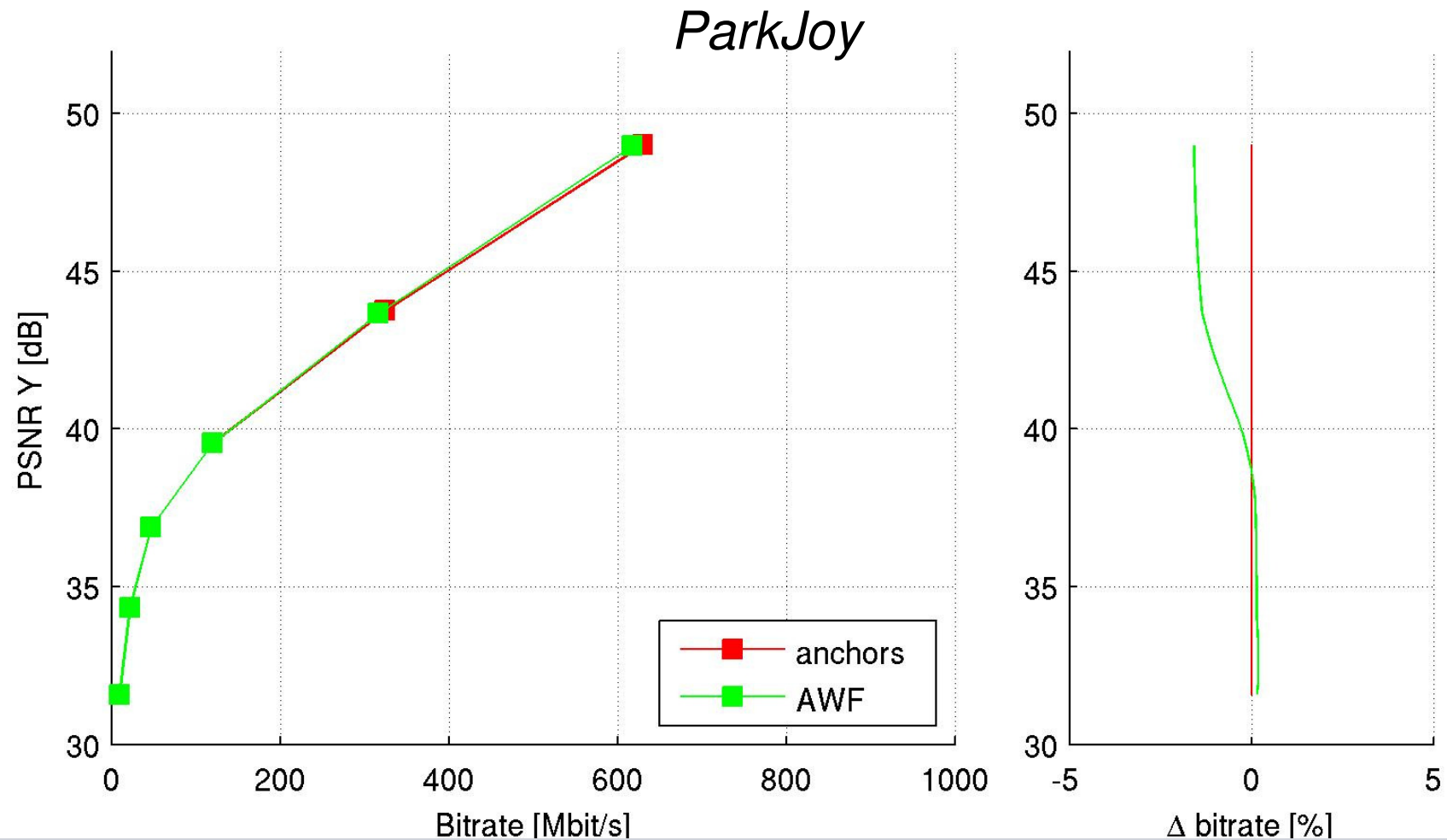
### General settings

- Software basis: HM 0.9 (LD/HE settings)
- Sequences: *ParkJoy*, *CrowdRun*, *InToTree*, *OldTownCross*, *DucksTakeOff* (cropped to 2560x1600, 50 fps)
- Settings: IBBB, 100 frames
- Number of reference frames: 2
- Quantization parameters: 37, 32, 27, 22, 17, 12

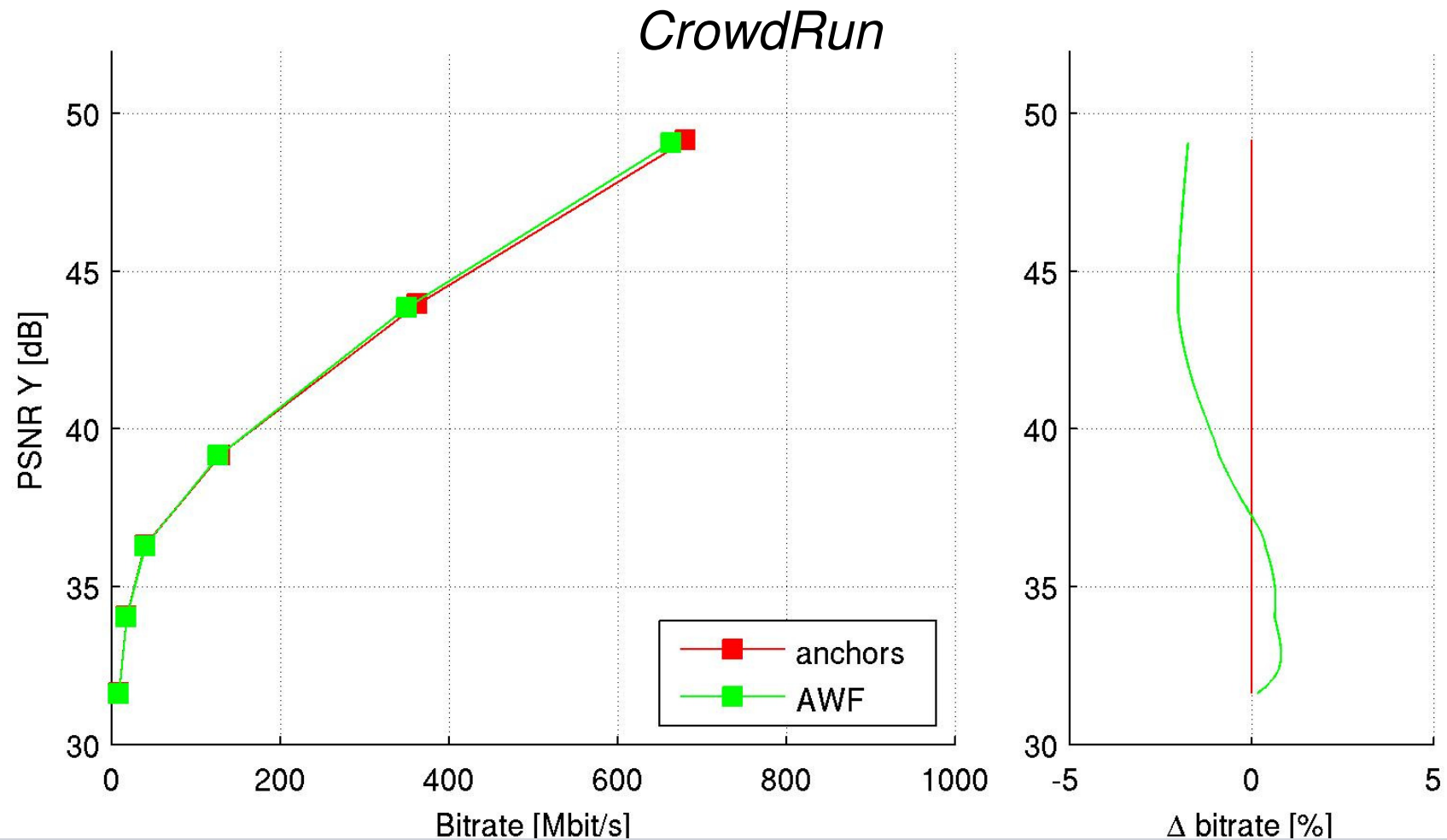
### Algorithm settings

- $M=1 \rightarrow 3 \times 3$  window for filtering
- $\xi = 6$

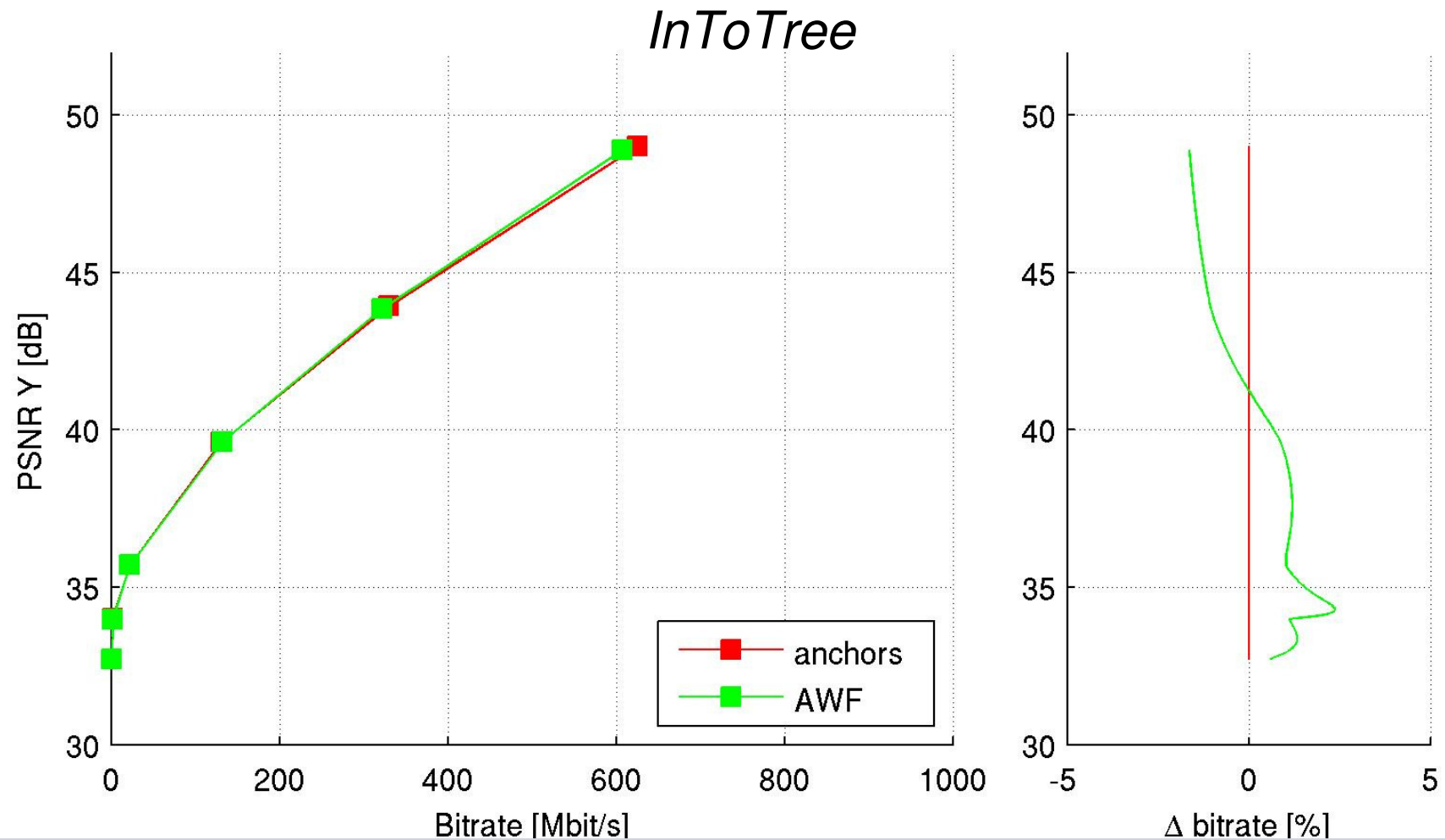
# Results SVT



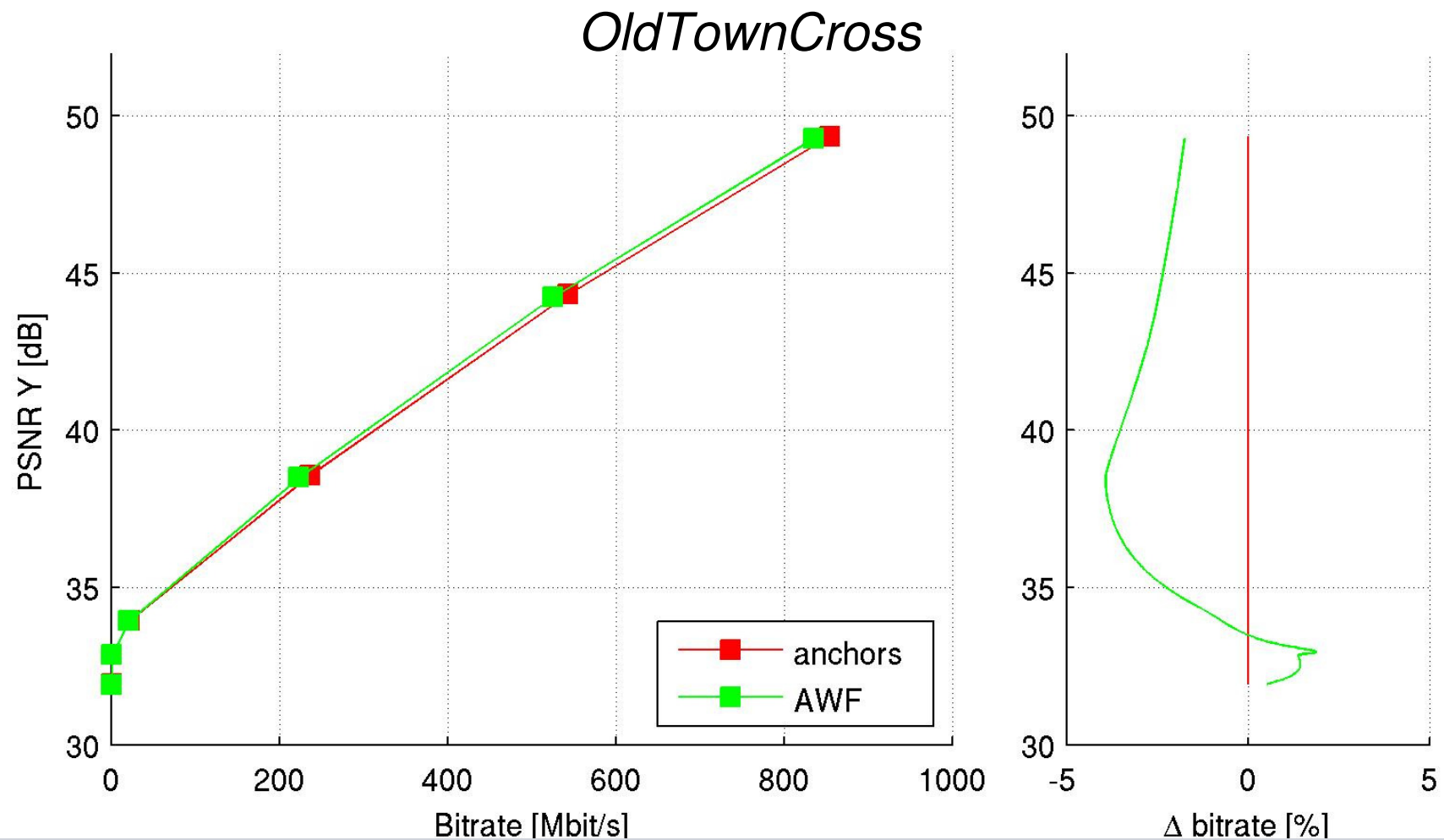
# Results SVT (cont.)



# Results SVT (cont.)

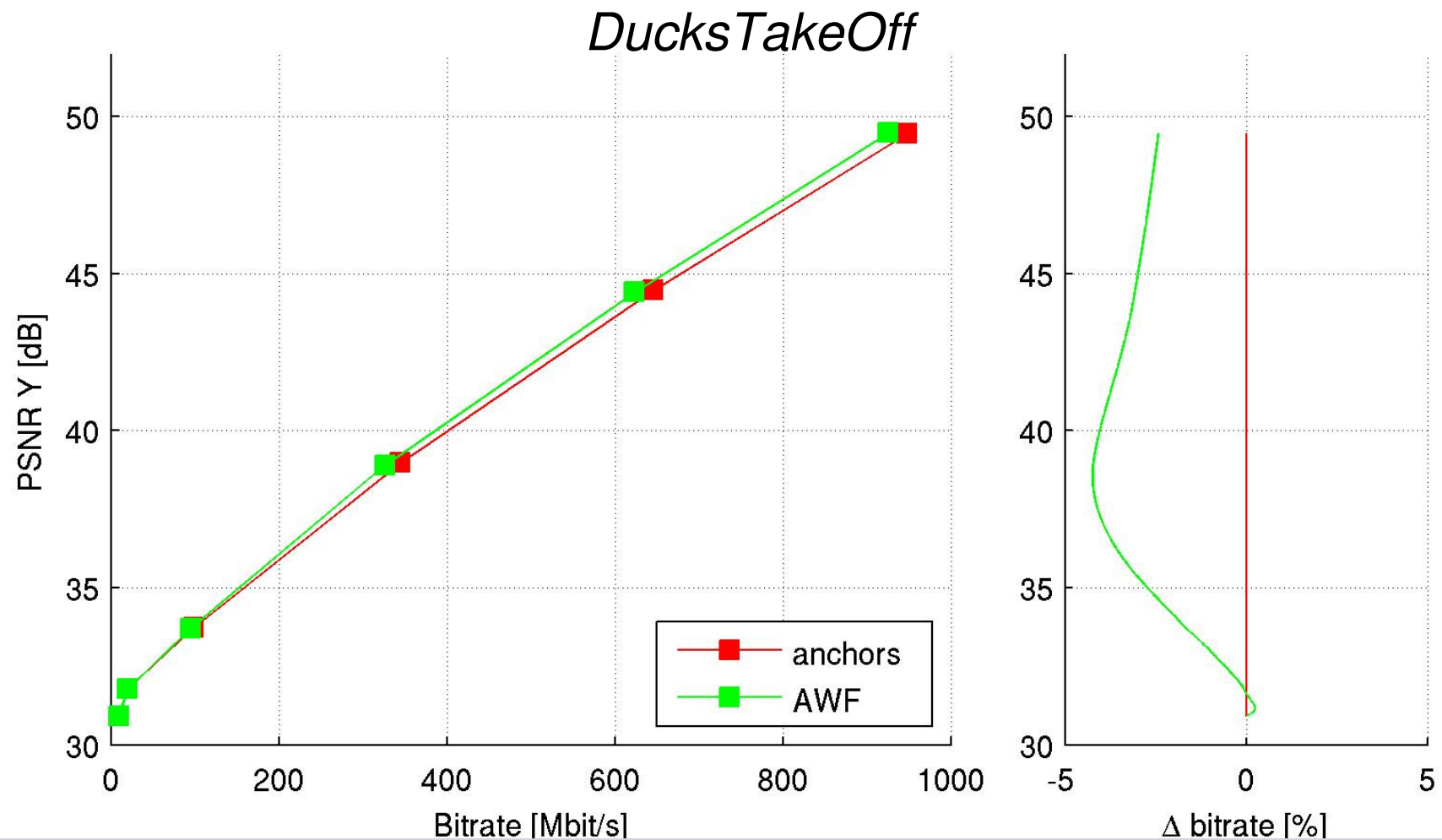


# Results SVT (cont.)





# Results SVT (cont.)



## Results SVT (cont.)

- Summary

Sequence	delta bitrate [%]		
	HQ	MQ	max
ParkJoy	-0,94	-0,16	-1,57
CrowdRun	-1,46	-0,55	-2,03
InToTree	-0,34	0,74	-1,63
OldTownCros	-2,60	-2,39	-3,92
DucksTakeO	-3,27	-3,20	-4,23

## Simulation set-up: HEVC

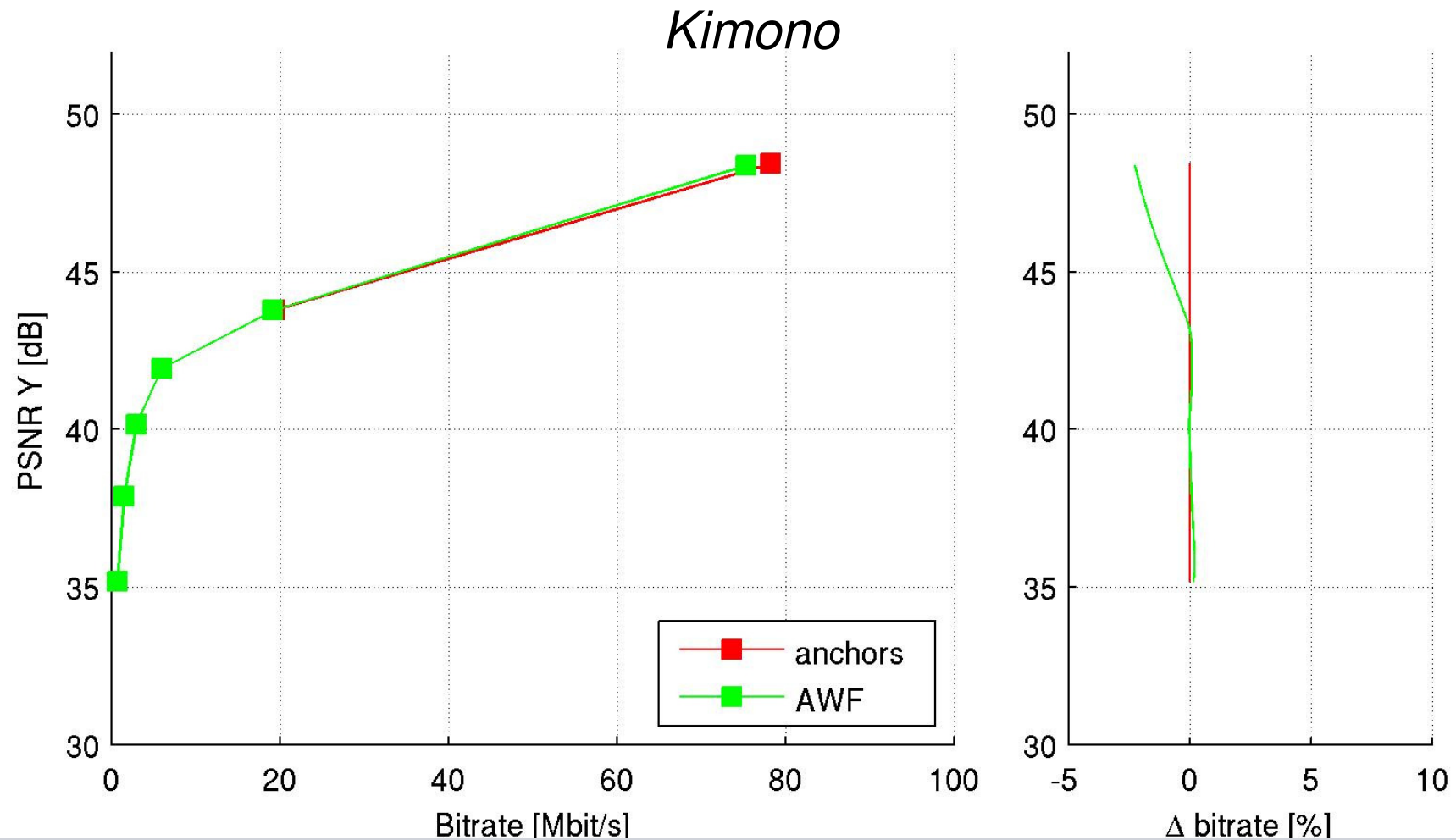
### General settings

- Software basis: HM 0.9 (LD/HE settings)
- Sequences: Class B: *Kimono1*, *ParkScene* (1920x1080, 24 fps)
- Settings: IBBB, 240 frames
- Number of reference frames: 2
- Quantization parameters: 37, 32, 27, 22, 17, 12

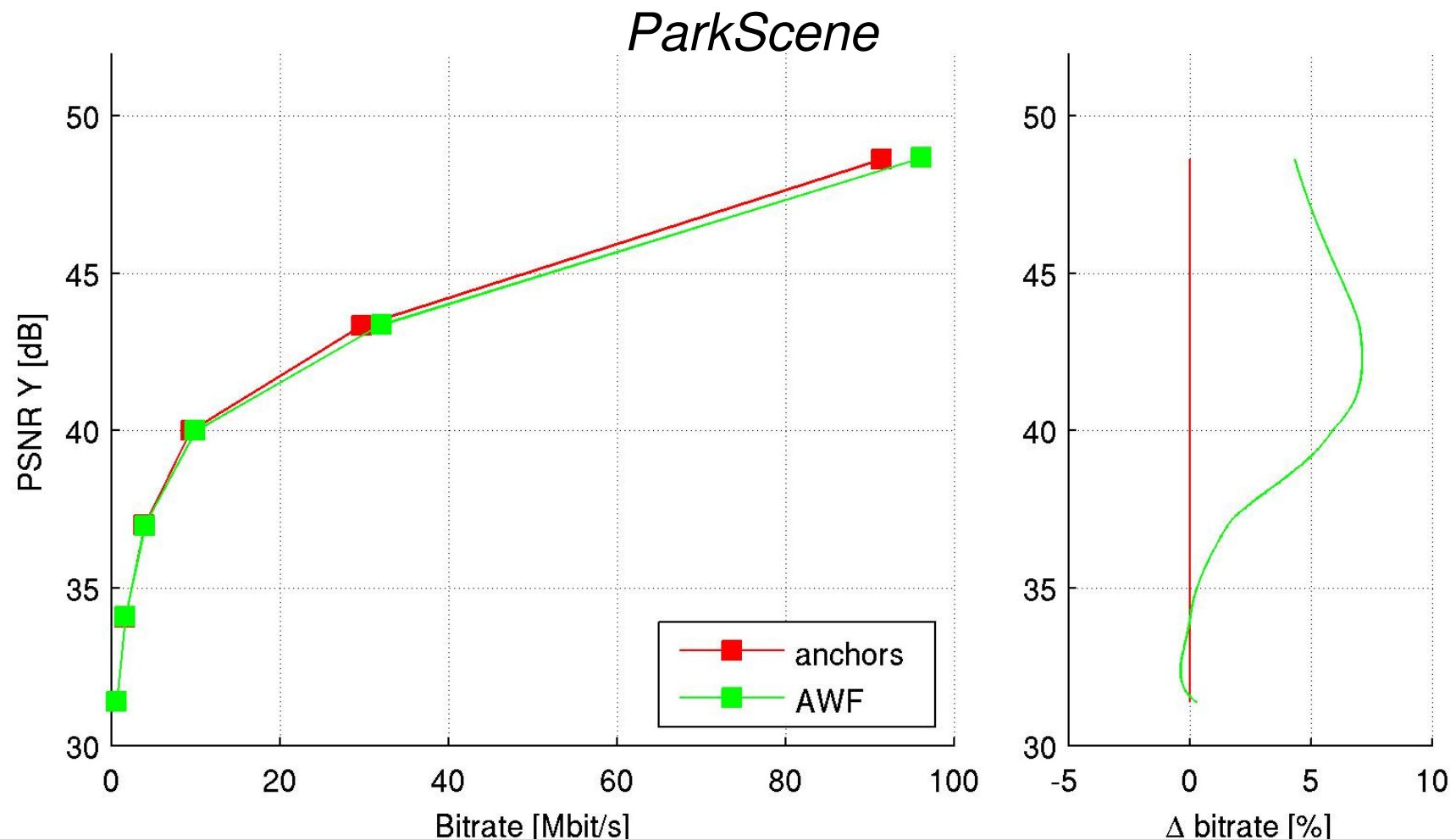
### Algorithm settings

- $M=1 \rightarrow 3 \times 3$  window for filtering
- $\xi = 6$

# Results HEVC



# Results HEVC (cont.)



## Summary and conclusions

- **In-loop reference frame denoising**: Method to improve the temporal predictor by local noise filtering
- Same algorithm at encoder and decoder
- No filter parameters need to be transmitted
- Promising results on HM 0.9 for medium to high bit-rates and high definition material
- Problems with HEVC test sequences due to wrong noise estimation