

**JVET-G0051**

**AHG8: A study on quality impact  
of line re-sampling rate in EAP**

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# Motivation

- EAP (Equal Area Projection) is the only projection format in 360Lib that has overall coding efficiency loss against ERP
  - Overall 11.7% BD-rate increase (E2E SPSNR-NN)
- Seek a way to improve the EAP performance

# Line Resampling Rate (ERP vs. EAP)



(a)



(b)

- ERP (a)

- 3D to 2D mapping 
$$\begin{cases} u = \frac{\phi}{2\pi} + 0.5 \\ v = -\frac{\theta}{\pi} + 0.5 \end{cases}$$
- Line resampling rate  $\left| \frac{\partial v}{\partial \theta} \right| = \frac{1}{\pi}, \theta \in [-\frac{\pi}{2} : \frac{\pi}{2}]$

- EAP (b)

- 3D to 2D mapping 
$$\begin{cases} u = \frac{\phi}{2\pi} + 0.5 \\ v = -0.5 * \sin \theta + 0.5 \end{cases}$$
- Line resampling rate  $\left| \frac{\partial v}{\partial \theta} \right| = 0.5 * \cos \theta, \theta \in [-\frac{\pi}{2} : \frac{\pi}{2}]$

# Viewport Quality at the North Pole (ERP vs. EAP)



- ERP

- 8K ERP=> 4K ERP=>1080p viewport



- EAP

- 8K ERP=> 4K EAP=>1080p viewport

# Viewport Quality at the North Pole (ERP)





# Viewport Quality at the North Pole (EAP)



# Viewport Quality at the North Pole (AEP)





# Adjusted EAP (AEP)



(a)

- EAP (a)

- 3D to 2D mapping 
$$\begin{cases} u = \frac{\phi}{2\pi} + 0.5 \\ v = -0.5 * \sin \theta + 0.5 \end{cases}$$

- EAP is a special case of AEP with  $\beta = 1$



(b)

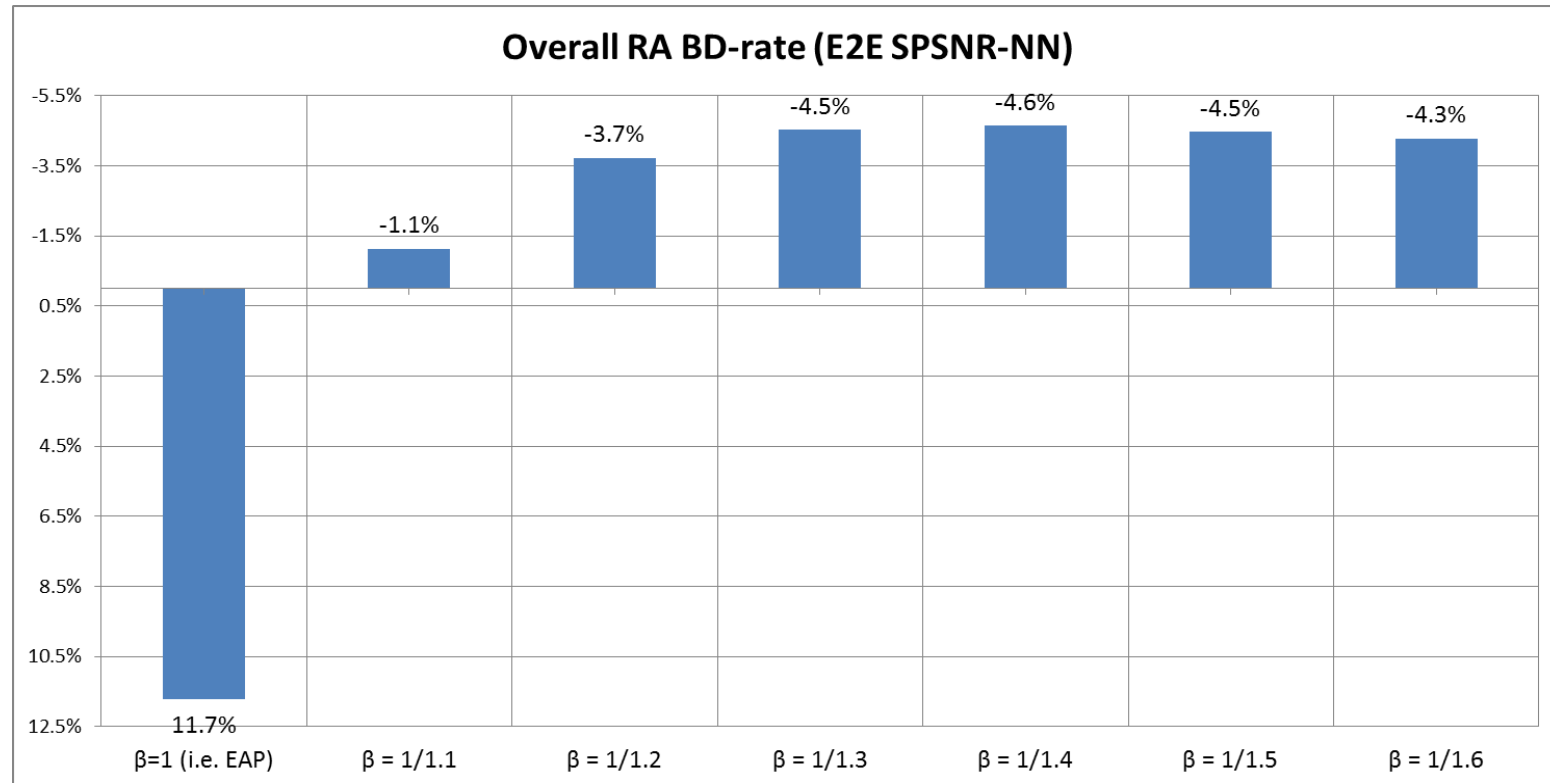
- AEP (b,  $\beta = \frac{1}{1.4}$ )

- 3D to 2D mapping 
$$\begin{cases} u = \frac{\phi}{2\pi} + 0.5 \\ v = -\frac{0.5 * \sin(\beta * \theta)}{\sin(0.5 * \beta * \pi)} + 0.5 \end{cases}$$



# Quality Impact of Line Resampling Rate

- Software HM16.15 + 360Lib-3.0, JVET 360 CTC
- RA results of AEP with *variable*  $\beta$  values



# Experimental Results – with Compression

- Software HM16.15 + 360Lib-3.0, JVET 360 CTC
- RA results of AEP with  $\beta = \frac{1}{1.4}$

AEP1.4 vs. ERP	FW	FH	SPSNR-NN (End to End)			SPSNR-I (End to End)			CPP-PSNR (End to End)			WS-PSNR (End to End)		
			Y	U	V	Y	U	V	Y	U	V	Y	U	V
Trolley	4096	2048	-1.8%	-1.0%	-2.6%	-1.8%	-1.1%	-2.6%	-1.8%	-1.1%	-2.7%	-1.8%	-1.1%	-2.7%
GasLamp	4096	2048	-4.0%	-0.3%	2.6%	-4.1%	-0.3%	2.6%	-4.1%	-0.3%	2.6%	-4.0%	-0.2%	2.6%
Skateboarding_in_lot	4096	2048	-9.8%	-11.0%	-9.9%	-9.9%	-11.1%	-10.0%	-9.9%	-11.1%	-10.0%	-9.8%	-11.0%	-10.0%
Chairlift	4096	2048	-6.1%	-3.6%	-3.7%	-6.1%	-3.7%	-3.7%	-6.0%	-3.6%	-3.8%	-6.0%	-3.6%	-3.7%
KiteFlite	4096	2048	0.5%	-1.4%	-2.3%	0.6%	-1.4%	-2.3%	0.3%	-1.5%	-2.3%	0.4%	-1.5%	-2.3%
Harbor	4096	2048	-5.2%	-1.9%	-2.0%	-5.2%	-2.0%	-2.1%	-5.7%	-2.1%	-2.1%	-5.5%	-2.1%	-2.1%
PoleVault	3328	1664	-5.3%	-5.8%	-5.6%	-5.0%	-5.7%	-5.7%	-5.0%	-5.7%	-5.8%	-5.3%	-5.8%	-5.7%
AerialCity	3328	1664	-2.6%	-2.8%	-2.9%	-2.7%	-2.9%	-3.0%	-2.7%	-2.9%	-3.1%	-2.6%	-2.8%	-3.0%
DrivingInCity	3328	1664	-4.7%	0.3%	-1.0%	-4.4%	0.1%	-1.1%	-4.3%	0.0%	-1.3%	-4.7%	0.2%	-1.1%
DrivingInCountry	3328	1664	-7.3%	-7.0%	-8.6%	-6.7%	-7.1%	-8.5%	-6.9%	-7.2%	-8.6%	-7.4%	-7.1%	-8.6%
Overall			-4.6%	-3.5%	-3.6%	-4.5%	-3.5%	-3.6%	-4.6%	-3.6%	-3.7%	-4.7%	-3.5%	-3.6%

# Experimental Results – Conversion Only

- Software HM16.15 + 360Lib-3.0, JVET 360 CTC, “lossless” mode
- 46.50 dB for **E2E WSPSNR**, about 0.87 dB and 2.46 dB higher than that of ERP (45.63 dB) and of EAP (44.14 dB).

AEP ( $\beta=1/1.4$ )	FW	FH	E2ESPSN R-NN Y	E2ESPSN R-NN U	E2ESPSN R-NN V	E2ESPSN R-I Y	E2ESPSN R-I U	E2ESPSN R-I V	E2ECPP- PSNR Y	E2ECPP- PSNR U	E2ECPP- PSNR V	E2EWS- PSNR Y	E2EWS- PSNR U	E2EWS- PSNR V
Trolley	4096	2048	42.9383	57.6113	57.4895	43.1501	58.9597	58.8603	43.1227	58.9833	58.8902	42.9004	57.5964	57.4825
GasLamp	4096	2048	48.5558	58.4211	57.195	48.8531	59.8017	58.5142	48.8327	59.8128	58.5345	48.5017	58.4074	57.182
Skateboarding_in_lot	4096	2048	47.9291	60.6137	60.3767	48.1825	61.3721	61.1493	48.1968	61.3809	61.1436	47.9347	60.6273	60.3636
Chairlift	4096	2048	48.0052	58.752	58.957	48.1749	59.4987	59.7835	48.1447	59.5122	59.7917	47.9465	58.7586	58.9576
KiteFlite	4096	2048	43.5707	57.2111	57.2131	43.7418	58.5155	58.5192	43.791	58.543	58.5467	43.587	57.2111	57.2137
Harbor	4096	2048	46.9654	58.7367	57.6746	47.2142	60.1126	59.0071	47.2195	60.1386	59.0315	46.9458	58.7349	57.6651
PoleVault	3328	1664	46.8948	48.7845	50.6134	48.6402	50.7929	52.7045	48.6355	50.8627	52.7678	46.8864	48.7931	50.6177
AerialCity	3328	1664	46.43	54.1964	53.5553	48.4612	56.3544	55.7567	48.4244	56.5257	55.9119	46.426	54.1843	53.5359
DrivingInCity	3328	1664	49.1788	58.2091	57.7462	50.9275	60.0401	59.5727	50.8629	60.1638	59.6842	49.2009	58.2064	57.7328
DrivingInCountry	3328	1664	44.7402	58.4635	58.538	46.4117	60.3181	60.4146	46.3822	60.4434	60.4993	44.7199	58.4423	58.5194
Overall			<b>46.52083</b>	<b>57.09994</b>	<b>56.93588</b>	<b>47.37572</b>	<b>58.57658</b>	<b>58.42821</b>	<b>47.36124</b>	<b>58.63664</b>	<b>58.48014</b>	<b>46.50493</b>	<b>57.09618</b>	<b>56.92703</b>

# Recommendation

- Extend EAP to support AEP in 360Lib
- Use AEP ( $\beta = \frac{1}{1.4}$ ) as a new reference data point for EAP in the future exploration of alternative 360 projection formats