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JCTVC-J0181
On Deblocking filter parameter

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- Proposal
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Summary

- This contribution proposes to increase the adaptive capability of deblocking filter by expanding the effective value range of variable β, especially for high QPs.
  - HM7.0:
    - Parameter tc is enlarged for high QPs in the 9th Geneva meeting.
    - Parameter β is selected within [0, 64]
  - Proposal:
    - Can provide larger β value to use stronger filtering
    - Can control Deblocking strength more flexibly
- Proposed methods can reduce blocking artifacts. Better visual quality can be observed.
- Have no influence on common test conditions

Introduction

- ## Problem statement:
  - — For sequence like "riverbed", even the largest $\beta(= 64)$ and $tc(=24)$ is selected, which means the strongest setting of current filter, visible block noises still remain
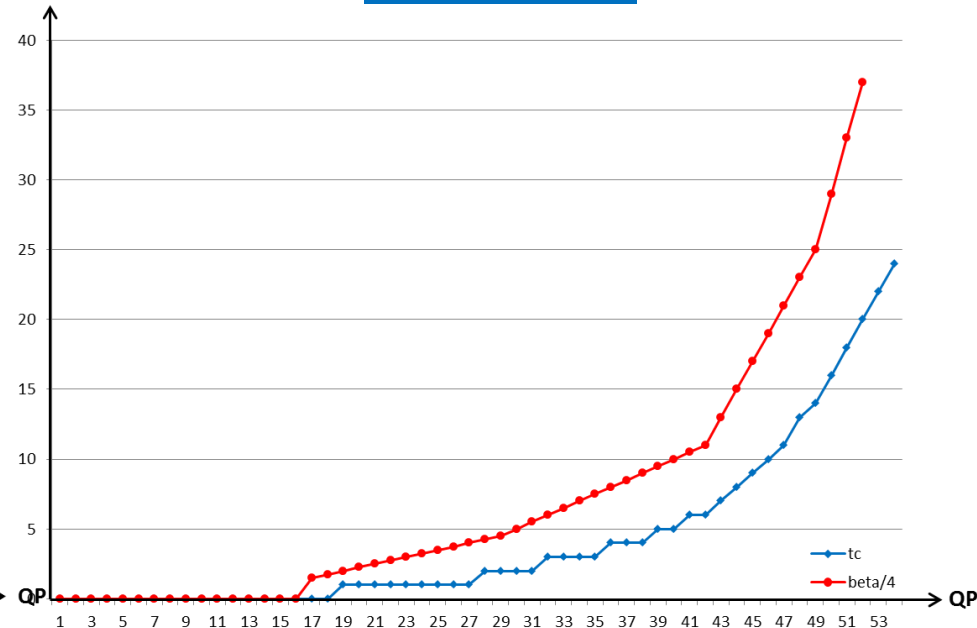 - — Current deblocking filter is not effective enough

Proposal-1

- Proposal-1: Modification on β table
  - blue line is tc; red line is β/4
  - **Proposal:** the changing rate of β has similar trend with the changing rate of tc to reflect quantization step.
  - No impact on common test conditions

HM7.0
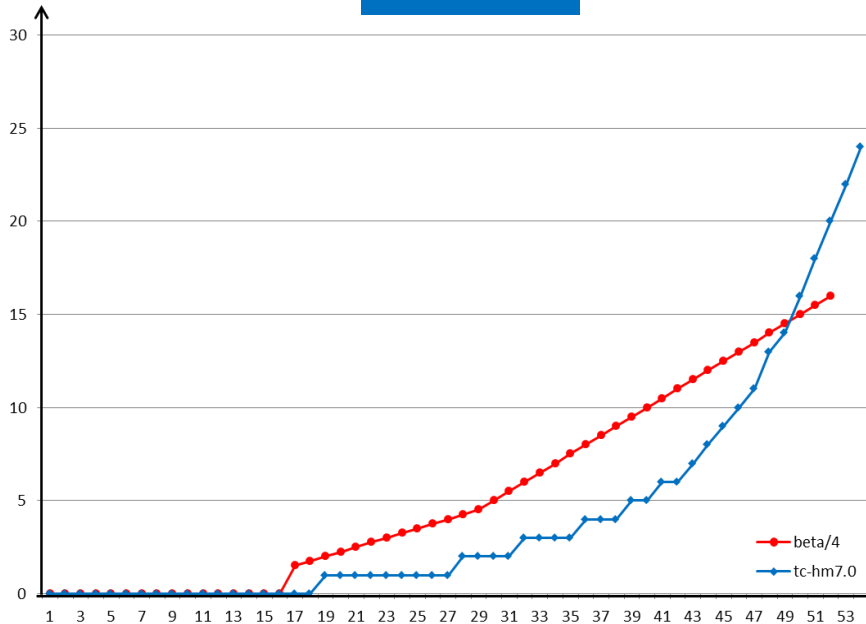
Proposal

Proposal-1

- Proposal-1: Modification on β table

HM7.0

Q	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
β	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	7	8
t_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Q	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
β	9	10	11	12	13	14	15	16	17	18	20	22	24	26	28	30	32	34	36
t_c	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4
Q	38	39	40	41	42	43	44	45	46	47	48	49	50	51					
β	38	40	42	44	46	48	50	52	54	56	58	60	62	64					
t_c	5	5	6	6	7	8	9	10	11	13	14	16	18	20	22	24			

Proposal

Q	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
β	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	7	8
t_c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Q	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
β	9	10	11	12	13	14	15	16	17	18	20	22	24	26	28	30	32	34	36
t_c	1	1	1	1	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4
Q	38	39	40	41	42	43	44	45	46	47	48	49	50	51					
β	38	40	42	44	**52**	**60**	**68**	**76**	**84**	**92**	**100**	**116**	**132**	**148**					
t_c	5	5	6	6	7	8	9	10	11	13	14	16	18	20	22	24			

Proposal-2

- Proposal-2: Adaptive control on thresholds

- **HM7.0:**

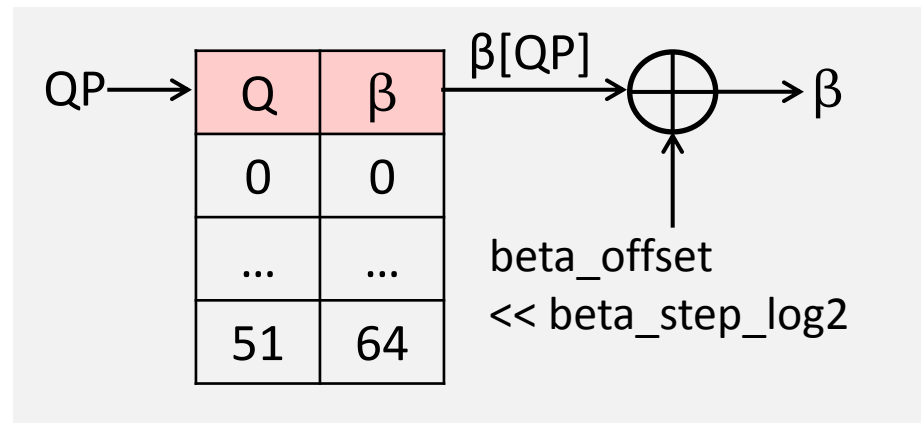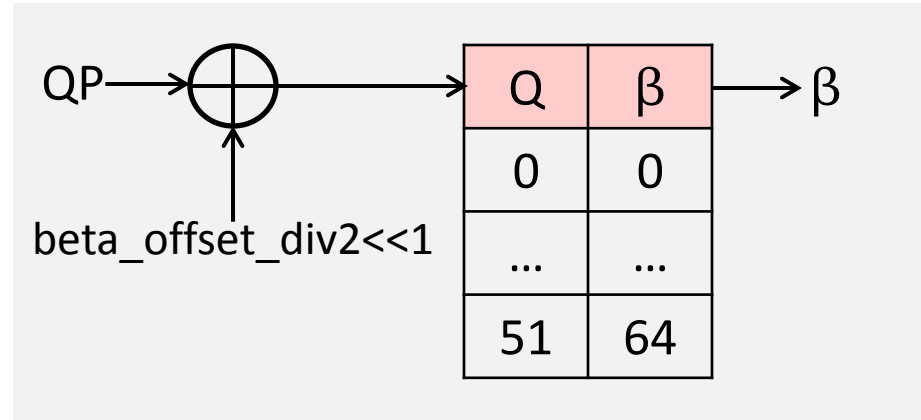Use beta_offset_div2 and tc_offset_div2 to adapt Q (position in LookUpTable)

- **Proposal:**

Adjust value of β/tc directly instead of Q

$$\beta = \beta[Q] + beta\_offset << beta\_step\_log2$$
$$tc = tc[Q] + tc\_offset << tc\_step\_log2$$

beta_step_log2 ∈ [0, 3] , tc_step_log2 ∈ [0, 2]
- For current table of HM7.0, available value range can be: β : [0, 168], tc : [0, 76]
- Base on proposal-1, available value range can be: β : [0, 252], tc : [0, 76]

Picture parameter set

pic_parameter_set_rbsp( ) {	Descriptor
...	
if(deblocking_filter_control_present_flag) {	
deblocking_filter_override_enabled_flag	u(1)
pps_disable_deblocking_filter_flag	u(1)
if(!pps_disable_deblocking_filter_flag) {	
~~beta_offset_div2~~	~~se(v)~~
~~tc_offset_div2~~	~~se(v)~~
beta_offset	**se(v)**
tc_offset	**se(v)**
beta_step_log2	ue(v)
tc_step_log2	ue(v)
...	

Slice header syntax

slice_header( ) {	Descriptor
...	
if(deblocking_filter_override_flag) {	
slice_header_disable_deblocking_filter_flag	u(1)
if(!slice_header_disable_deblocking_filter_flag) {	
~~beta_offset_div2~~	~~se(v)~~
~~tc_offset_div2~~	~~se(v)~~
beta_offset	**se(v)**
tc_offset	**se(v)**
beta_step_log2	ue(v)
tc_step_log2	ue(v)
...	

beta_offset and **tc_offset** specify the default deblocking parameter offsets for β and tC (divided by $2^{beta\_step\_log2}$ and $2^{tc\_step\_log2}$)

beta_step_log2 and **tc_step_log2** specify the granularity for deblocking parameter offsets beta_offset and tc_offset.
beta_step_log2 shall be in the range of 0 to 3, and tc_step_log2 shall be in the range of 0 to 2.

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Proposal-2

- Proposal-2: Adaptive control without change on syntax

$$\beta = \beta[Q] + beta\_offset << beta\_step\_log2$$
$$tc = tc[Q] + tc\_offset << tc\_step\_log2$$

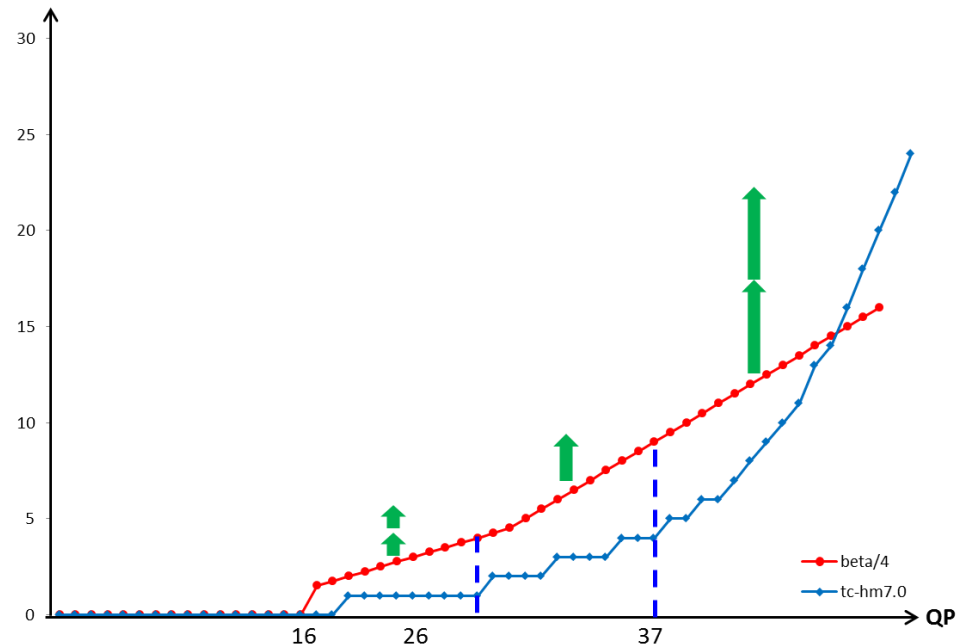|	Q∈[0,16)	Q∈[16,27)	Q∈[27,37)	Q∈[37,53]
beta_step_log2	0	1	2	3
tc_step_log2	0	0	1	2

Capacity:
Larger value for high QPs

Flexibility:
Low QP: Fine grain adjustment
High QP: coarse grain adjustment

Experiment results

- **Proposal-1:** Modification on β table

Table 3-1: BD-rate with new table for high QPs = 37, 42, 47, 51vs. HM7.0

	All Intra Main			All Intra HE10				Low delay B Main			Low delay B HE10		
	Y	U	V	Y	U	V		Y	U	V	Y	U	V
Class A	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	Class A						
Class B	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	Class B	0.1%	0.7%	0.3%	-0.1%	-1.1%	-1.0%
Class C	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	Class C	-0.1%	0.5%	0.0%	-0.2%	0.2%	0.1%
Class D	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	Class D	0.0%	0.1%	0.1%	0.0%	0.2%	-3.1%
Class E	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	Class E	-0.2%	-0.1%	0.2%	0.0%	-1.2%	-0.9%
Class F	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	Class F	-0.1%	-1.6%	-0.6%	-0.1%	-0.9%	-0.1%
Overall	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	Overall	0.0%	0.0%	0.0%	-0.1%	-0.6%	-1.0%
	0.0%	-0.4%	0.1%	0.0%	0.0%	-0.1%		0.0%	-0.2%	-0.5%	-0.1%	-0.7%	-1.0%
Enc Time[%]	150%			102%			Enc Time[%]	103%			96%		
Dec Time[%]	103%			104%			Dec Time[%]	98%			109%		

	Random Access Main			Random Access HE10				Low delay P Main			Low delay P HE10		
	Y	U	V	Y	U	V		Y	U	V	Y	U	V
Class A	-0.3%	-0.7%	-1.1%	-0.1%	0.1%	0.8%	Class A						
Class B	-0.1%	-0.1%	0.4%	0.0%	0.1%	0.0%	Class B	-0.9%	0.0%	0.7%	-0.1%	0.3%	1.9%
Class C	-0.1%	0.0%	0.2%	-0.1%	0.5%	0.4%	Class C	-0.7%	0.2%	0.0%	-0.3%	-1.4%	0.4%
Class D	-0.1%	0.1%	-0.1%	0.0%	0.1%	0.2%	Class D	-0.8%	-0.1%	-1.9%	-0.7%	-0.7%	1.2%
Class E							Class E	-0.9%	0.3%	-0.8%	-0.4%	-0.9%	-0.1%
Class F	-0.1%	0.0%	0.1%	0.0%	0.0%	-0.1%	Class F	-0.3%	0.0%	-1.5%	-0.3%	-0.8%	0.1%
Overall	-0.1%	-0.2%	-0.1%	0.0%	0.2%	0.3%	Overall	-0.7%	0.1%	-0.6%	-0.3%	-0.6%	0.8%
	-0.1%	-0.2%	-0.3%	0.0%	0.2%	0.3%		-0.7%	0.2%	-0.5%	-0.3%	-0.4%	0.6%
Enc Time[%]	101%			98%			Enc Time[%]	104%			98%		
Dec Time[%]	99%			105%			Dec Time[%]	106%			103%		

Experiment results

- **Proposal-1:** Modification on β table

Sequence: riverbed, LP-Main, QP37

Experiment results

- **Proposal-2:** Adaptive control on thresholds
Sequence: riverbed, LP-Main, QP37

Conclusion

It is recommended to adopt proposed table and adaptive control methods:

✓ Proposed methods can deal with visible blocking artifacts

✓ Have no side influence on common test conditions

✓ Also, Proposed β table can contribute 0.0%(AI-Main, LB-Main) - 0.1%(RA-Main) -0.7%(LP-Main) gain.
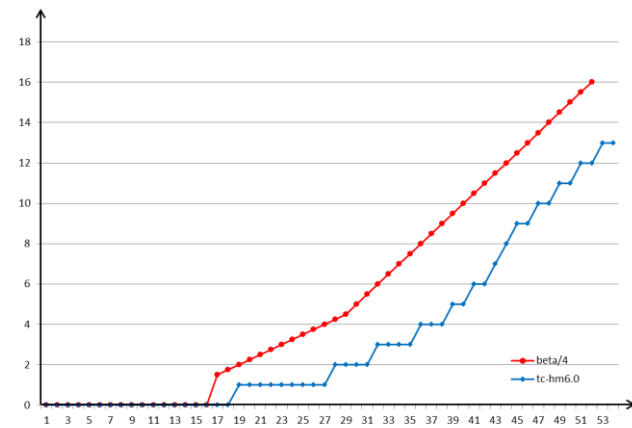
✓ WD is also tight and clean
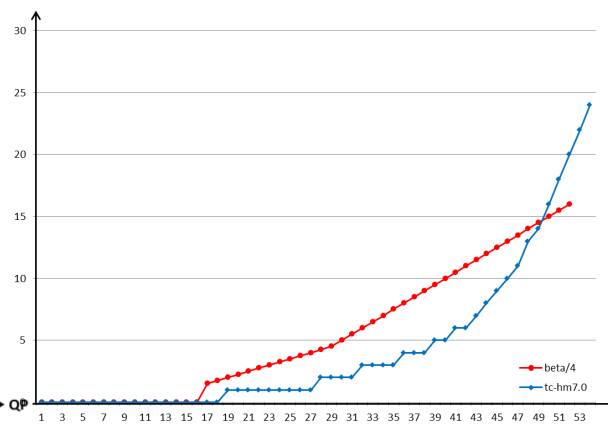
Thank TI for cross check

Appendix

Proposal-1: analysis

- Proposal-1: Modification on β table
  - blue line is tc; red line is β/4
  - Comparing with HM6.0, HM7.0 has bigger tc value for high QPs.
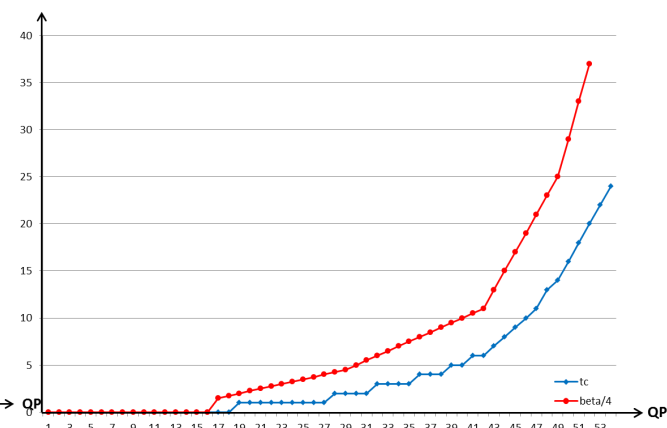 - Both β and tc will be checked for making decision on filtering. Therefore, higher β is desired for high QPs.

HM6.0   **HM7.0**   **Proposal**

Experiment results:

- **Objective(LB-Main with offset 13):**
  Proposed methods can improve Visual quality, while have little impact on Bitrate and PSNR.

Sequence	QP	Condition	Bitrate [kbps]	Ypsnr [dB]	Upsnr [dB]	Vpsnr [dB]
Riverbed	**37**	HM7.0	2851.39	31.71	38.13	40.90
		Proposal-**1**	2846.61	31.70	38.13	40.90
		Proposal-**2**-FIX	2849.35	31.70	38.13	40.89
DucksTakeOff	**37**	HM7.0	7590.24	27.72	31.56	35.97
		Proposal-**1**	7605.85	27.66	31.56	35.97
		Proposal-**2**-FIX	7610.22	27.66	31.56	35.97

Experiment results

Sequence	QP	Condition	Bitrate [kbps]	Ypsnr [dB]	Upsnr [dB]	Vpsnr [dB]
Riverbed	32	HM7.0	5852.75	34.62	39.03	41.43
		Proposal-1	5850.69	34.57	39.03	41.44
		Proposal-2-FIX	5850.13	34.61	39.03	41.43
DucksTakeOff	32	HM7.0	18569.44	30.29	32.63	36.60
		Proposal-1	18686.73	30.12	32.63	36.59
		Proposal-2-FIX	18593.41	30.24	32.63	36.60

Sequence	QP	Condition	Bitrate [kbps]	Ypsnr [dB]	Upsnr [dB]	Vpsnr [dB]
Riverbed	41	HM7.0	1555.01	29.54	37.78	40.63
		Proposal-1	1551.49	29.54	37.78	40.64
		Proposal-2-FIX	1552.91	29.54	37.78	40.63
DucksTakeOff	41	HM7.0	3713.40	25.98	30.94	35.67
		Proposal-1	3717.73	25.95	30.94	35.66
		Proposal-2-FIX	3717.62	25.94	30.94	35.66

DBLK in HEVC

$dp0 = | p_{2,0} - 2*p_{1,0} + p_{0,0} |$ $dq0 = | q_{2,0} - 2*q_{1,0} + q_{0,0} |$

p30	p20	p10	p00	q00	q10	q20	q30
p33	p23	p13	p03	q03	q13	q23	q33

$dp3 = | p_{2,3} - 2*p_{1,3} + p_{0,3} |$ $dq3 = | q_{2,3} - 2*q_{1,3} + q_{0,3} |$

$d = dp0 + dq0 + qp3 + dq3$
if (d < iBeta): decide filter on/off

Strong filter (p20/p10/p00/q00/q10/q20)

$$|p30 - p00| + |q30 - q00| < (beta/8)$$
$$\&\&$$
$$|dp0 + dq0| < (beta/8)$$
$$\&\&$$
$$|p00 - q00| < (Tc * 5 + 1) \gg 1$$

&&

$$|p33 - p03| + |q33 - q03| < (beta/8)$$
$$\&\&$$
$$|dp3 + dq3| < (beta/8)$$
$$\&\&$$
$$|p03 - q03| < (Tc * 5 + 1) \gg 1$$

$dp0 = | p_{2,0} - 2*p_{1,0} + p_{0,0} |$ $dq0 = | q_{2,0} - 2*q_{1,0} + q_{0,0} |$

p30	p20	p10	p00	q00	q10	q20	q30
p33	p23	p13	p03	q03	q13	q23	q33

$dp3 = | p_{2,3} - 2*p_{1,3} + p_{0,3} |$ $dq3 = | q_{2,3} - 2*q_{1,3} + q_{0,3} |$

Weak filter ON

$dp0 = | P_{2,0} - 2*P_{1,0} + P_{0,0} |$ $dq0 = | q_{2,0} - 2*q_{1,0} + q_{0,0} |$

delta = (9*(q00-p00) -3*(q10-p10) + 8)>>4 ;

p30	p20	p10	p00	q00	q10	q20	q30
p33	p23	p13	p03	q03	q13	q23	q33

$dp3 =| P_{2,3} - 2*P_{1,3} + P_{0,3} |$ $dq3 = | q_{2,3} - 2*q_{1,3} + q_{0,3} |$
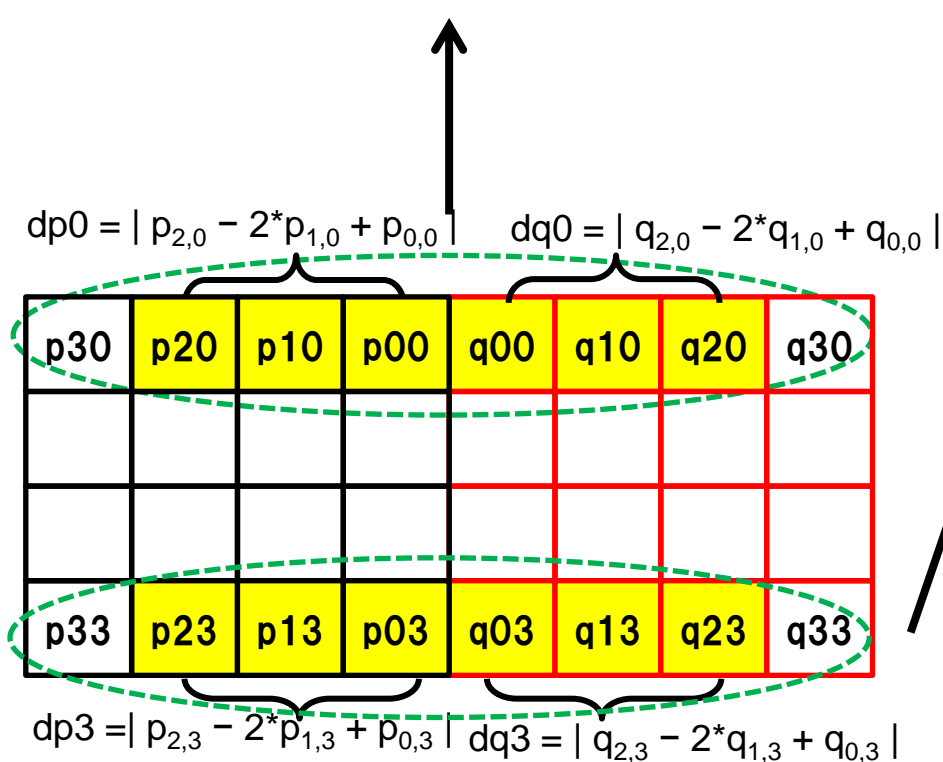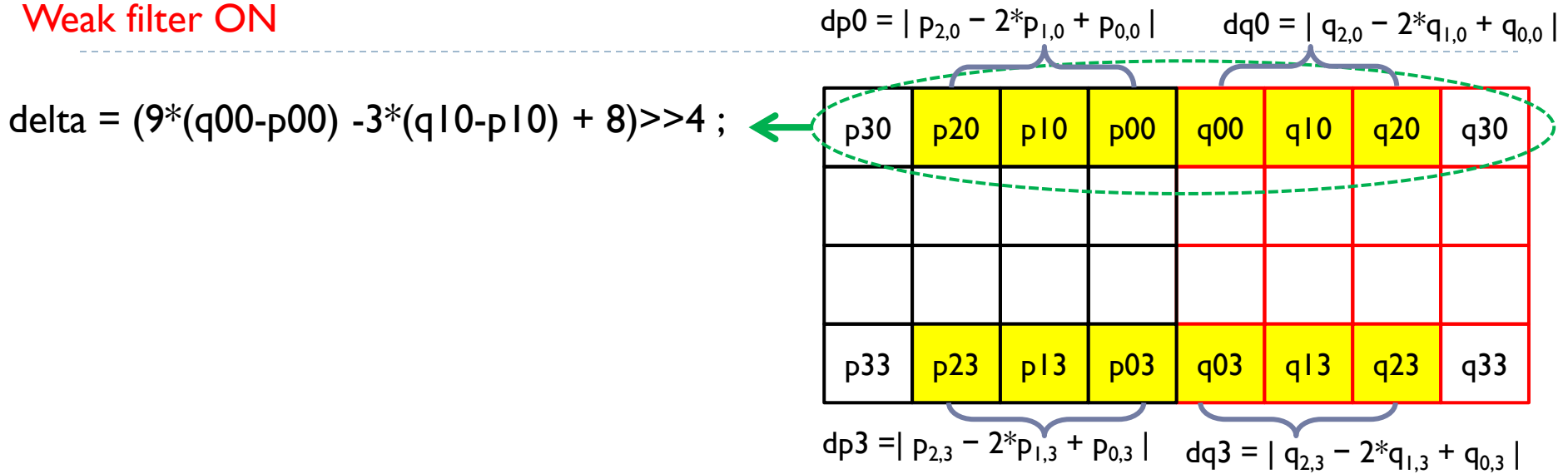
$|delta| < 10 * Tc$ ➡ Weak Filter p00 and q00

&&

$dp0 + dp3 < (beta + (beta \gg 1))/8$ Loose than strong(+0.5beta)

➡ Weak Filter p10

$|delta| < 10 * Tc$ ➡ Filter p00 and q00

&&

$dq0 + dq3 < (beta + (beta \gg 1))/8$

➡ Filter q10

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