CONFIDENTIAL B

P40 NR1 Introduction & Usage

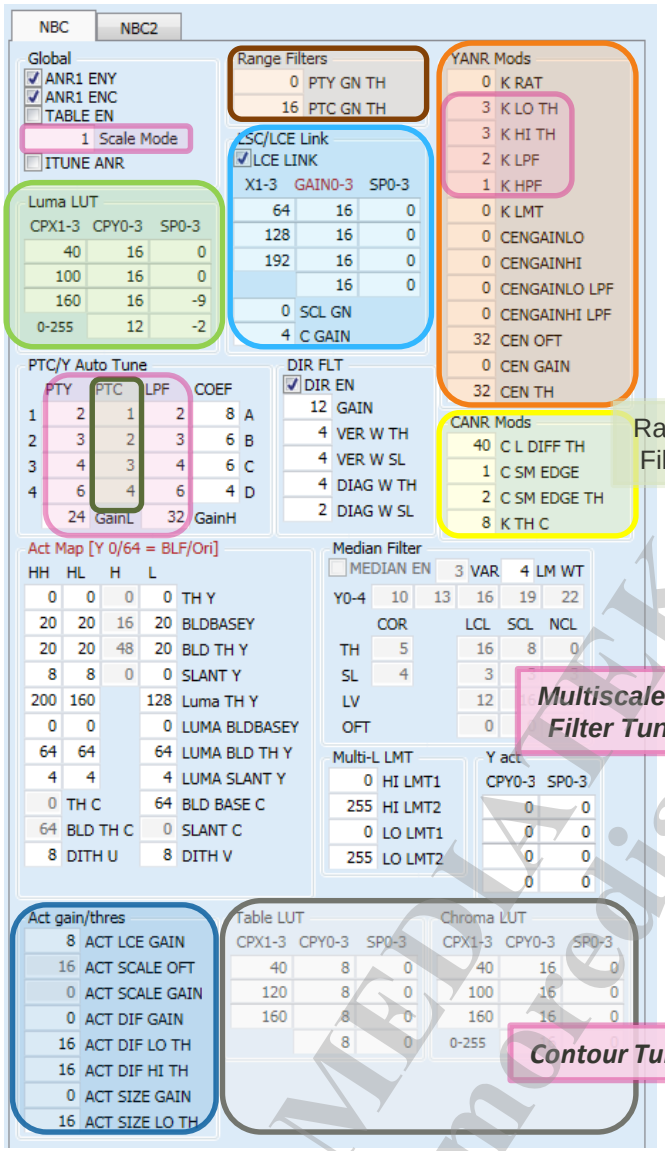
Outline

- P23 → P40 Change List
- Modifying items
  - Multiscale NR Filter Tuning – Content Aware
  - Contour Tuning

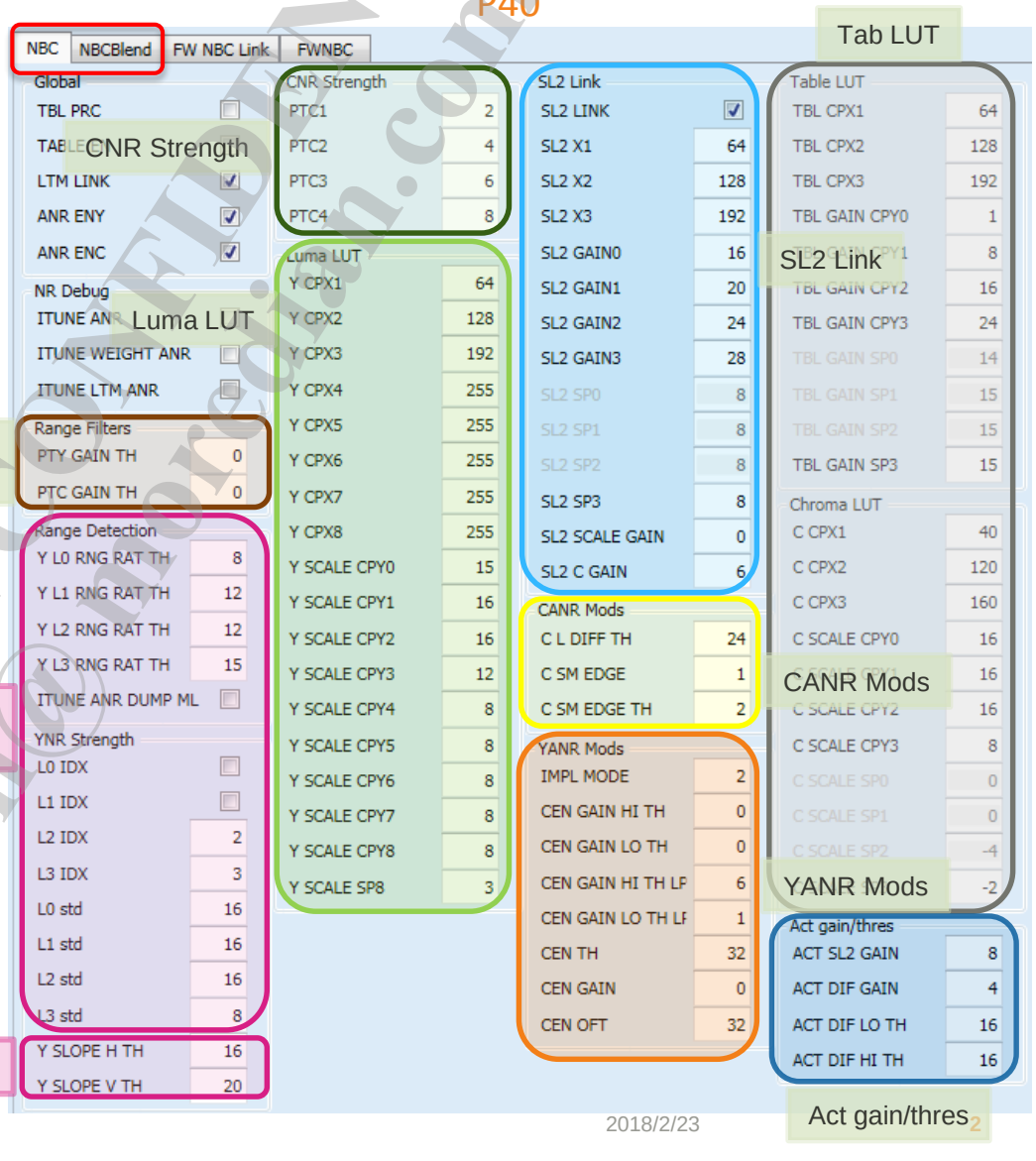
New Register

P23 NR1 ➡ P40 NR1

P23



P40



CNR Strength

Luma LUT

Range Filters

Multiscale NR Filter Tuning

Contour Tuning

Tab LUT

SL2 Link

CANR Mods

YANR Mods

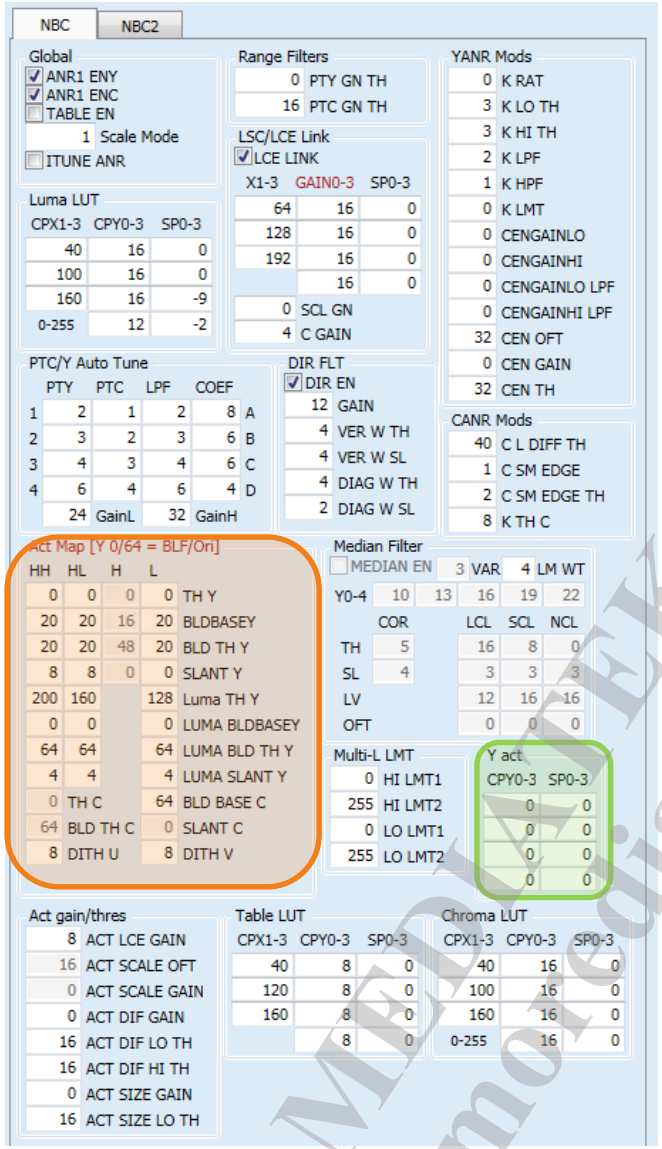
Act gain/thres2

2018/2/23

New Register

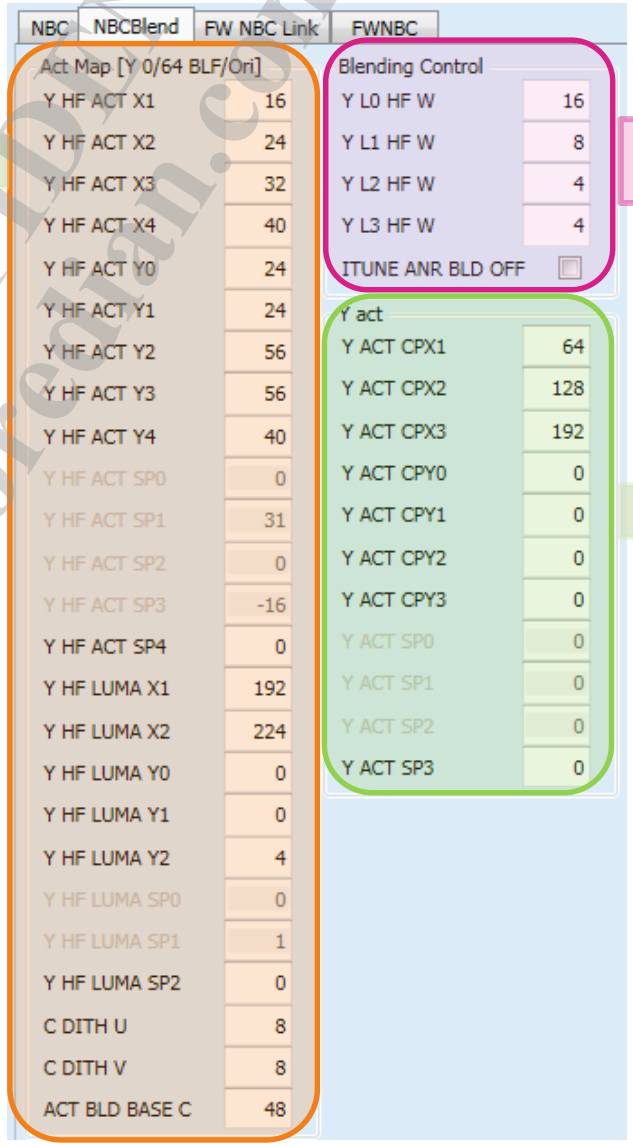
P23 NR1 ➡ P40 NR1

P23



P40

Act Map



Multiscale NR Filter Tuning

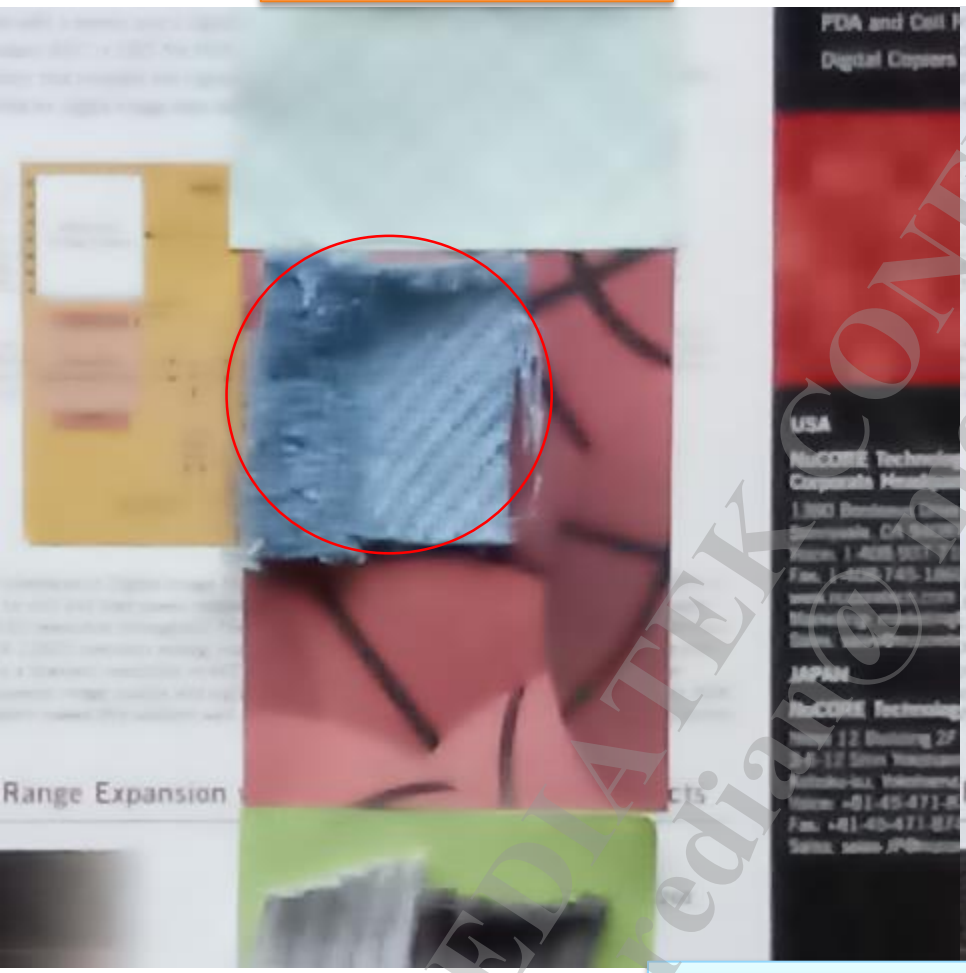
Y act

MULTISCALE NR FILTER TUNING – CONTENT AWARE

- **Luma**
- **Multiscale NR Filter Tuning**
- Contour Tuning

P23

w/o blending

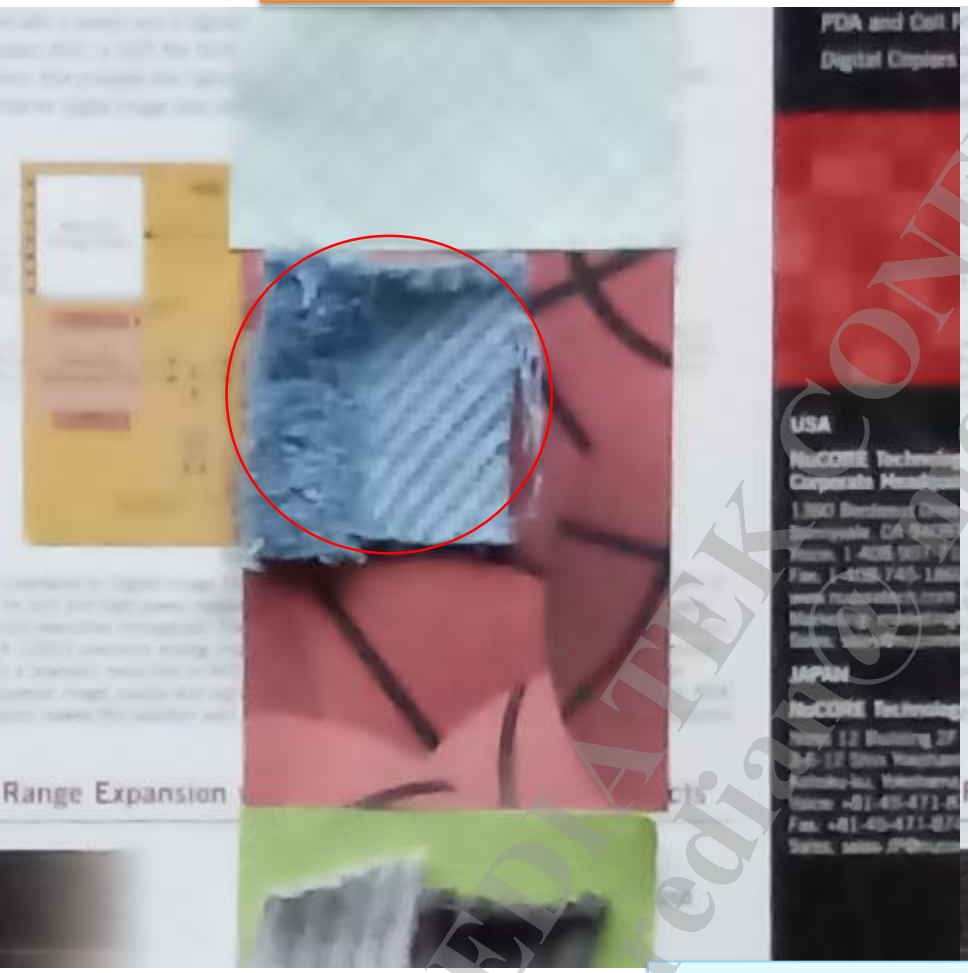


w/ blending

PTY: 10-19-28-41
50% constant blending

P40

w/o blending



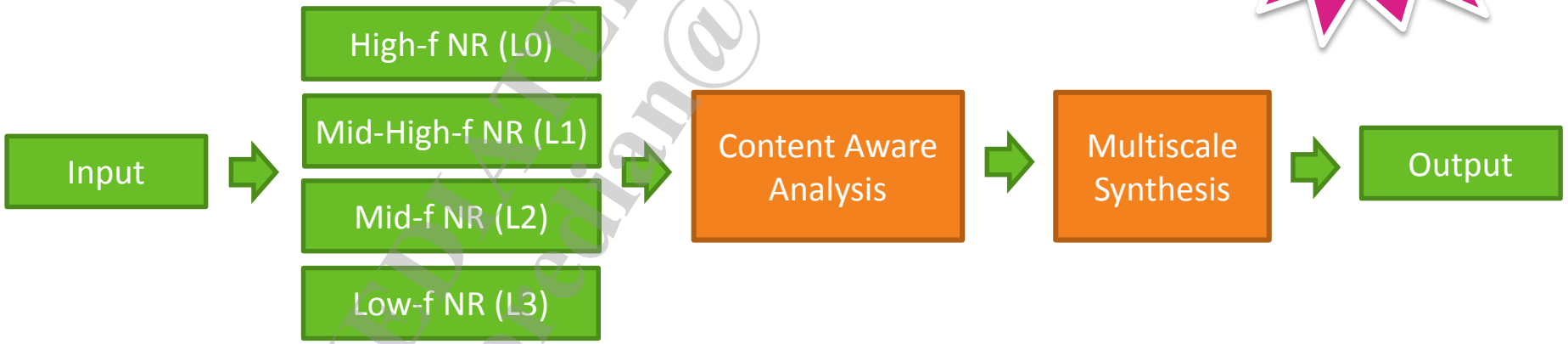
w/ blending

PTY: 10-19-28-41
50% constant blending

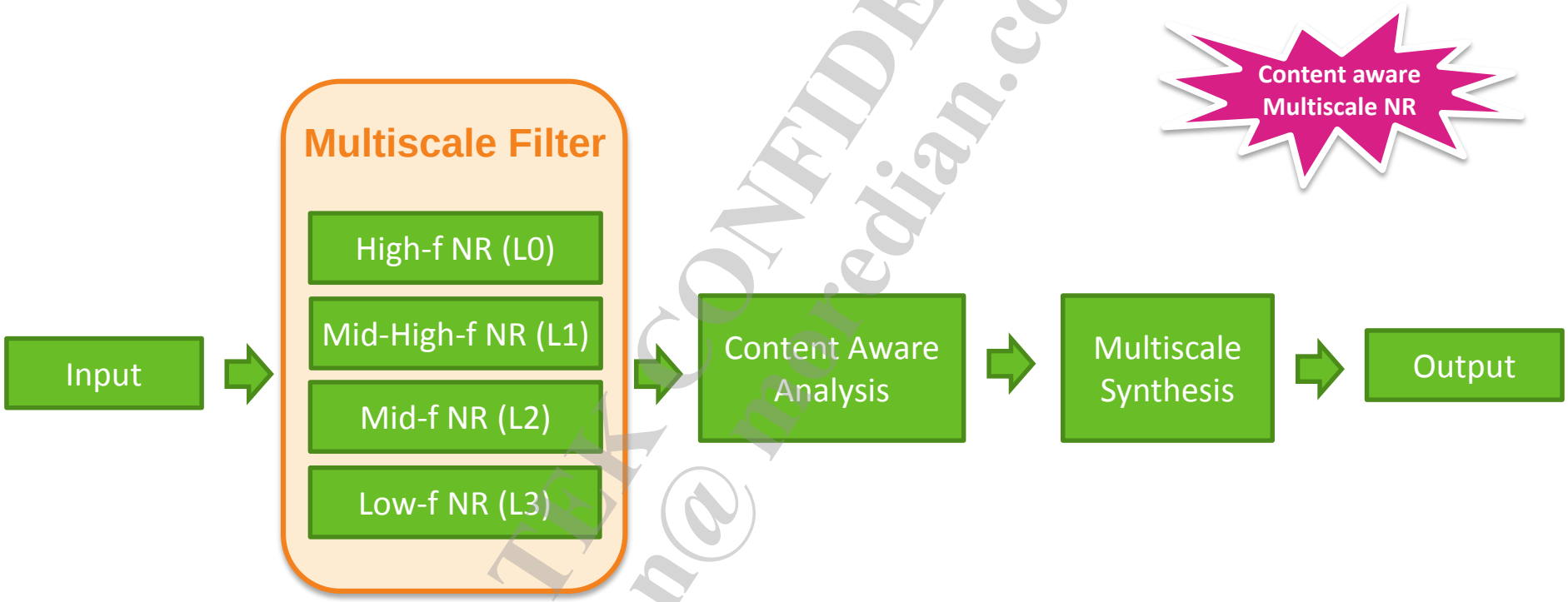
P23 → P40 Multiscale NR Filter Change

P23 Multiscale NR

P40 Multiscale NR



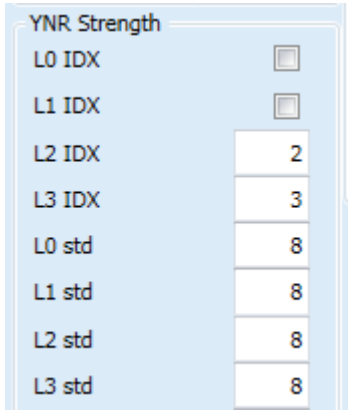
P40 Multiscale NR Filter Tuning



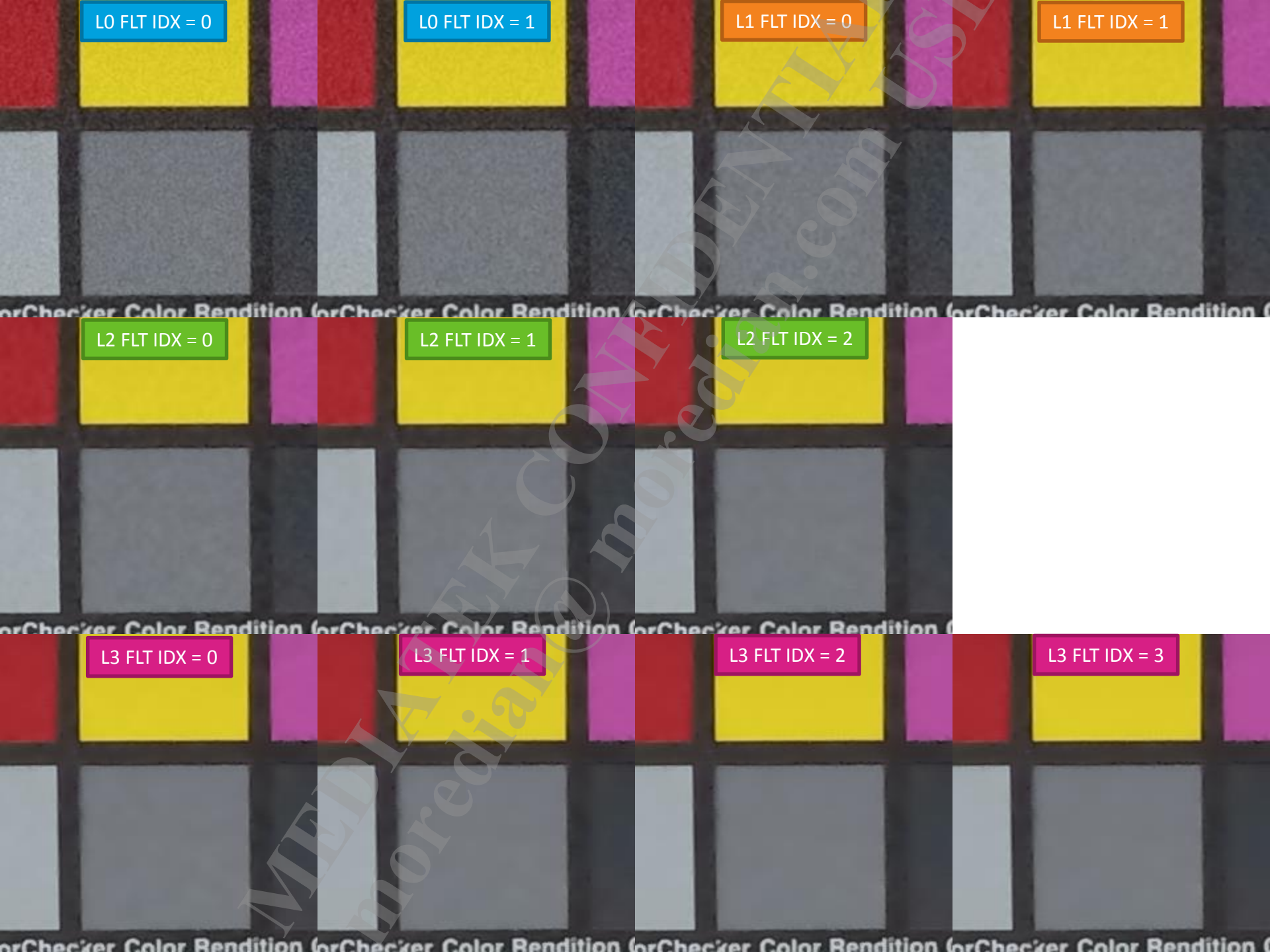
Multiscale Filter Tuning

- Total 11 Filters

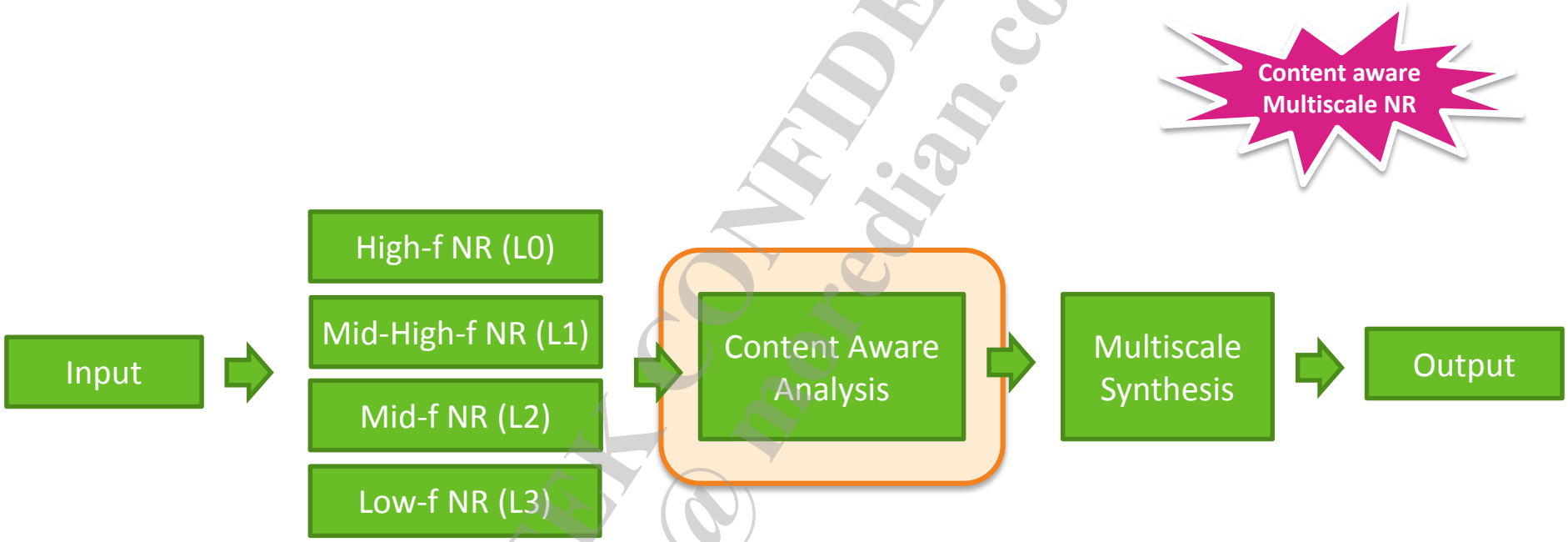
Register Name	Default	Description	Tuning
ANR_A_Y_FLT0_IDX	0	Filter L0 index	NR: 0~1, Value ↑, Frequency removal ↑ (Mainly for High-f)
ANR_A_Y_FLT1_IDX	0	Filter L1 index	NR:0~1, Value ↑, Frequency removal ↑ (Mainly for Mid-High-f)
ANR_A_Y_FLT2_IDX	2	Filter L2 index	NR:0~2, Value ↑, Frequency removal ↑ (Mainly for Mid-f)
ANR_A_Y_FLT3_IDX	3	Filter L3 index	NR:0~3, Value ↑, Frequency removal ↑ (Mainly for Low-f)
NR_A_Strength_L0_std	16	Strength of L0	Value ↑, Strength↑
NR_A_Strength_L1_std	16	Strength of L1	Value ↑, Strength↑
NR_A_Strength_L2_std	16	Strength of L2	Value ↑, Strength↑
NR_A_Strength_L3_std	8	Strength of L3	Value ↑, Strength↑



- Filter Characteristic:
  - L0: High-frequency Noise Reduction
  - L1: Mid-high-frequency Noise Reduction
  - L2: Mid-frequency Noise Reduction
  - L3: Low-frequency Noise Reduction



P40 Multiscale NR Filter Tuning



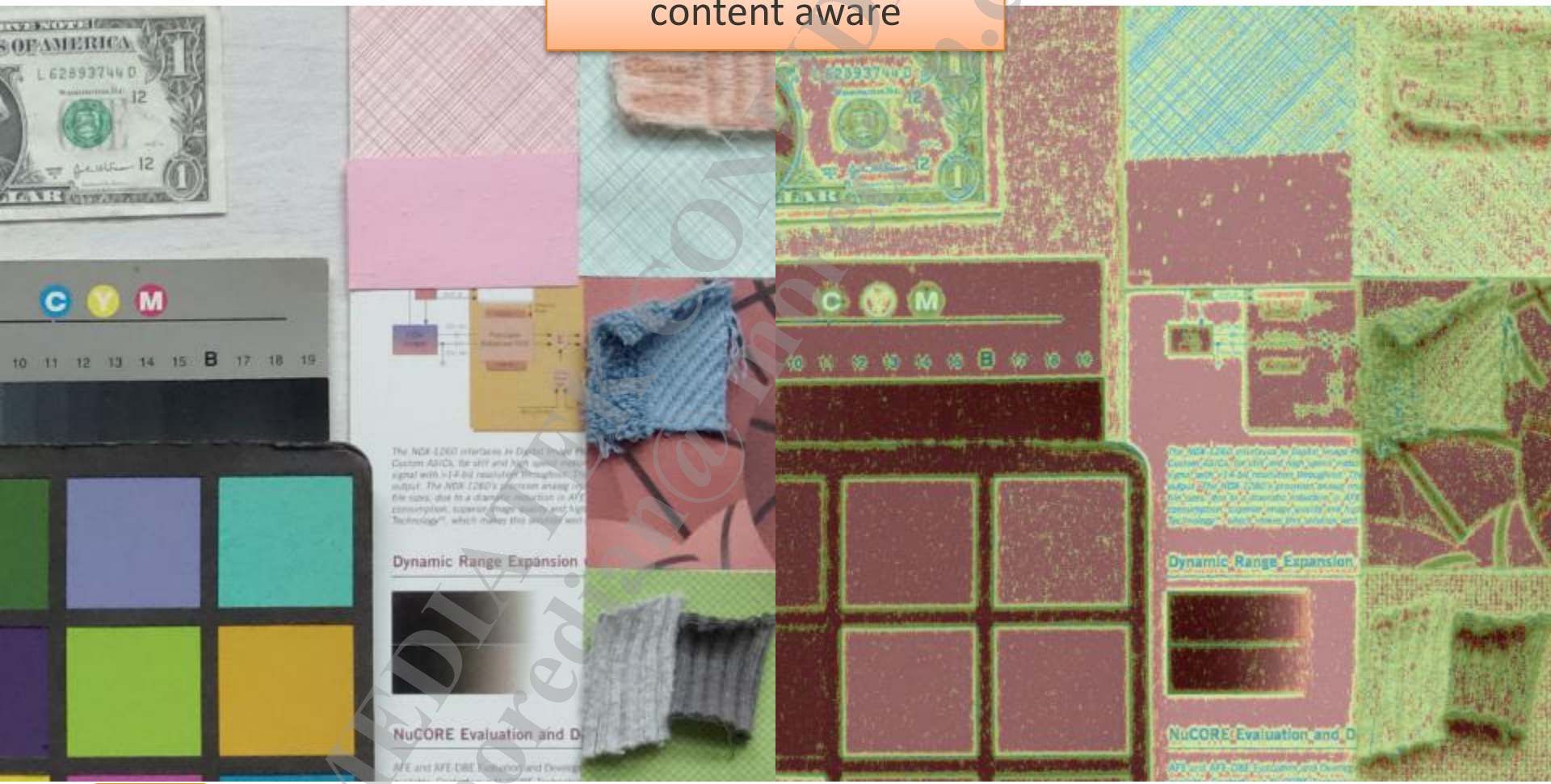
Content Aware Analysis

ITUNE ANR ☑

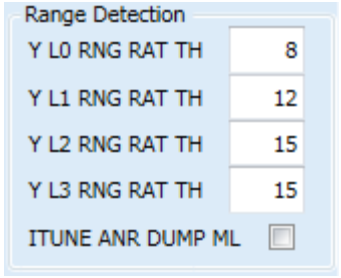
ITUNE ANR DUMP ML ☑

High Frequency NR ← L0 | L1 | L2 | L3 → *Low Frequency NR*

content aware



Content Aware Analysis



- Choose different scale depends on image content

Register Name	Default	Description	Tuning
ANR_Y_L0_RNG_RAT_TH	8	L0 select threshold	Suggest: 8 – 14 Value ↑, Cover Range↓ (keep more high-f detail) Value ↓, smooth peak noise
ANR_Y_L1_RNG_RAT_TH	12	L1 select threshold	Suggest: 8 – 14 Value ↑, Cover Range↓ (keep more mid-high-f detail) Value ↓, smooth peak noise
ANR_Y_L2_RNG_RAT_TH	15	L2 select threshold	Suggest: 8 – 15 Value ↑, Cover Range↓ Value ↓, smooth peak noise *Mainly for reduce noise in flat area
ANR_Y_L3_RNG_RAT_TH	15	L3 select threshold	Use 15 to protect content not to be smooth while L3 is used.
ITUNE_ANR_DUMP_ML	0	Output tuning ink map	1: Output tuning ink map

L2: Reduce Noise in Flat Area

Y L0~ L3 RNG RAT TH: 8 - 12 - 12 - 15
L0~L3 std: 16 - 16 - 16 - 16

L2: Reduce Noise in Flat Area

Y L0~ L3 RNG RAT TH: 8 - 12 - 15 - 15
L0~L3 std: 16 - 16 - 32 - 16

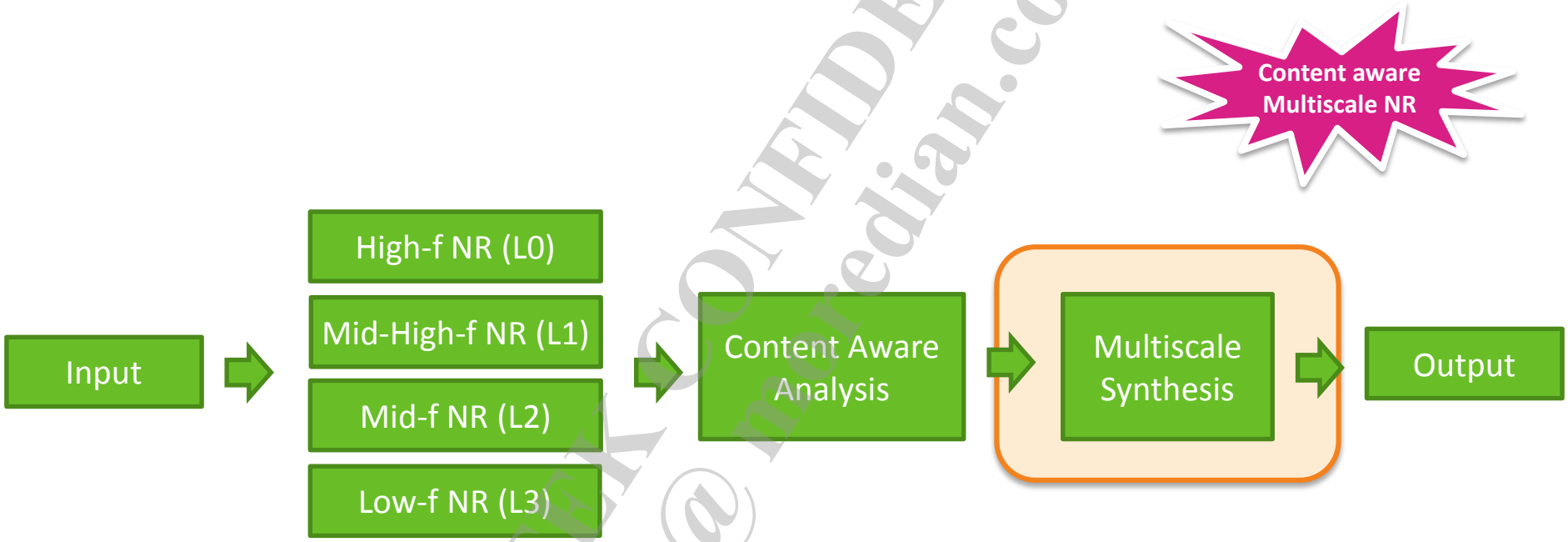
L1: Keep More Mid-High-f Content

Y L0~ L3 RNG RAT TH: 15 - 9 - 13 - 13
L0~L3 std: 16 - 16 - 16 - 16

L1: Keep More Mid-High-f Content

Y L0~ L3 RNG RAT TH: 15 - 13 - 13 - 13
L0~L3 std: 16 - 16 - 16 - 16

P40 Multiscale NR Filter Tuning

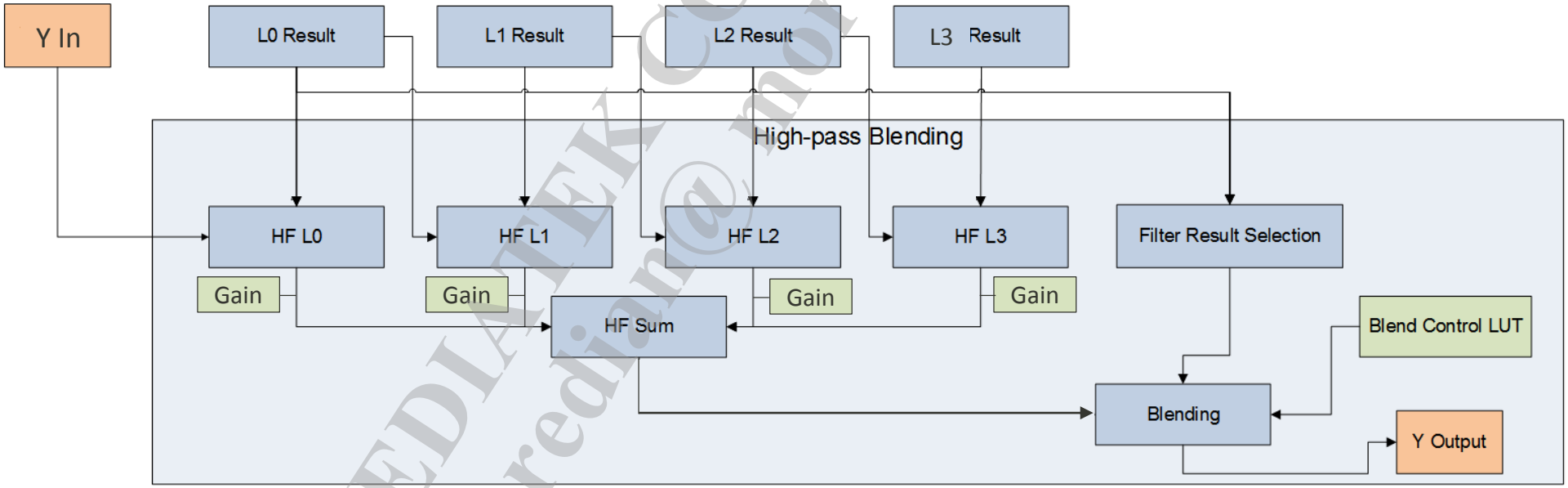


Multiscale Synthesis

Y L0 HF W	16
Y L1 HF W	8
Y L2 HF W	4
Y L3 HF W	4
ITUNE ANR BLD OFF	☑

P23	Register Name	Default	Description	Tuning
HH	ANR_Y_L0_HF_W	16	Luma L0 high-pass weight	Value↑, Blend more high-f grain noise
HL	ANR_Y_L1_HF_W	8	Luma L1 high-pass weight	Value↑, Blend more mid-High-f grain noise
L	ANR_Y_L2_HF_W	4	Luma L2 high-pass weight	Value↑, Blend more mid-f noise
	ANR_Y_L3_HF_W	4	Luma L3 high-pass weight	Value↑, Blend more low-f noise
	ITUNE_ANR_BLD_OFF	0	Disable blending for tuning	1: Blending off Easily observe NR result without blending

- Blending source from multiscale filter



Blending Ratio

- Ex: HF_ACT_Y4= 32,
  Y_HF_LUMA_Y0 = 0,
  Y_L0_HF_W = 16,

➔Blending ratio:
min((32+0),64)/64 * 16/16 = 0.5
(Blending 50% from source)

Value: 0~64

Act Map [Y 0/64 BLF/Ori]	
Y HF ACT X1	16
Y HF ACT X2	20
Y HF ACT X3	24
Y HF ACT X4	28
Y HF ACT Y0	32
Y HF ACT Y1	32
Y HF ACT Y2	32
Y HF ACT Y3	32
Y HF ACT Y4	32
Y HF ACT SP0	0
Y HF ACT SP1	0
Y HF ACT SP2	0
Y HF ACT SP3	0
Y HF ACT SP4	0
Y HF LUMA X1	0
Y HF LUMA X2	0
Y HF LUMA Y0	0
Y HF LUMA Y1	0
Y HF LUMA Y2	0
Y HF LUMA SP0	0
Y HF LUMA SP1	2
Y HF LUMA SP2	0

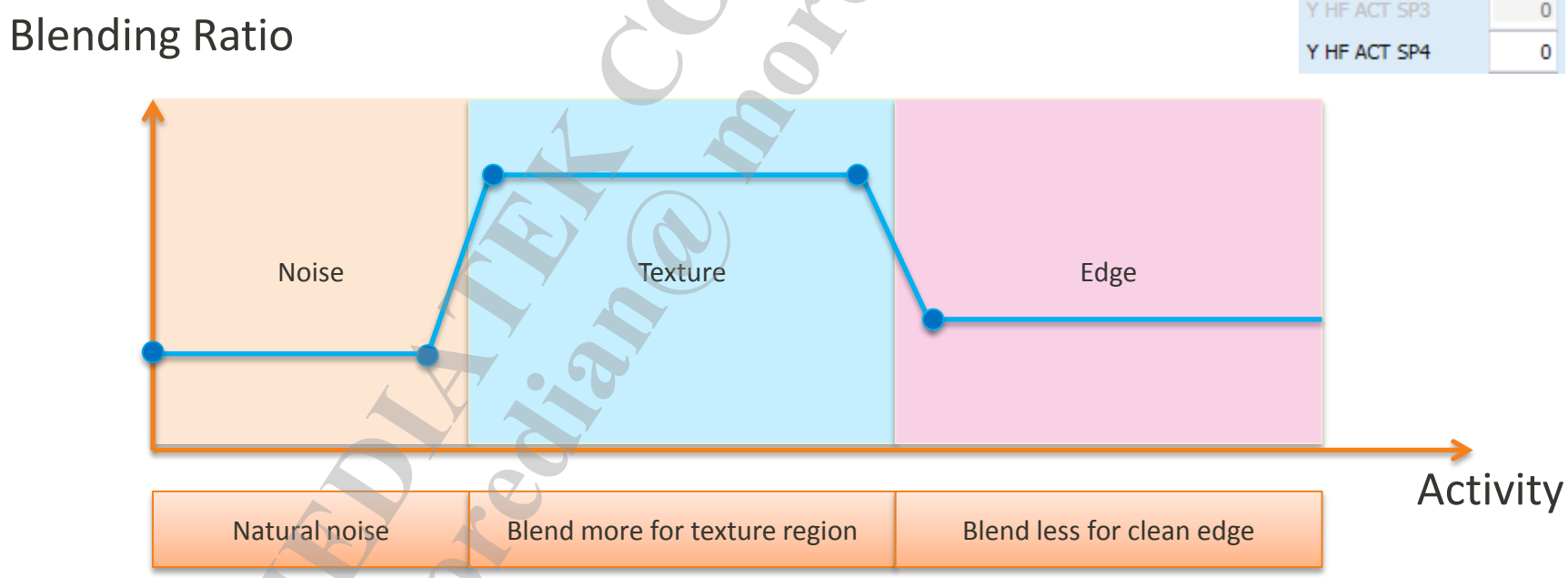
Value: 0~31

Blending Control	
Y L0 HF W	16
Y L1 HF W	16
Y L2 HF W	16
Y L3 HF W	16

Activity Blending LUT

Y HF ACT X1	16
Y HF ACT X2	20
Y HF ACT X3	24
Y HF ACT X4	28
Y HF ACT Y0	19
Y HF ACT Y1	19
Y HF ACT Y2	19
Y HF ACT Y3	19
Y HF ACT Y4	19
Y HF ACT SP0	0
Y HF ACT SP1	0
Y HF ACT SP2	0
Y HF ACT SP3	0
Y HF ACT SP4	0

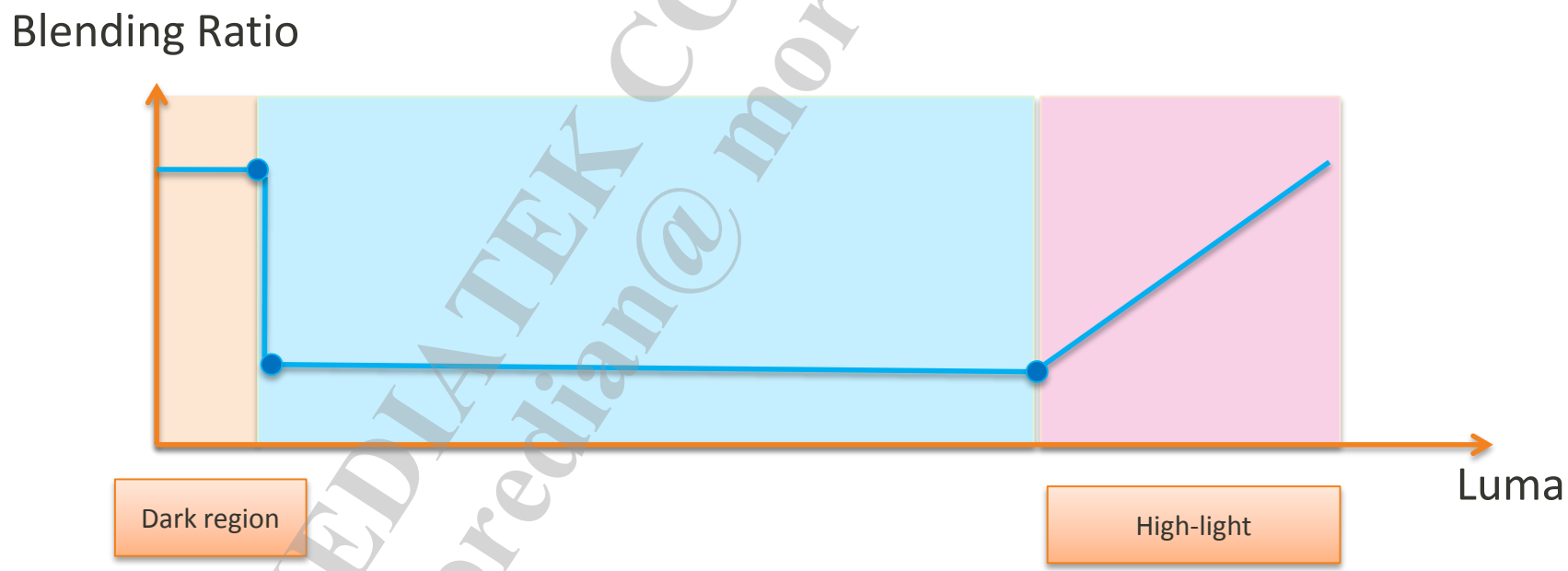
- 5 Control Points
- Blending low ratio on edge to avoid noisy
- Blending high ratio to keep texture



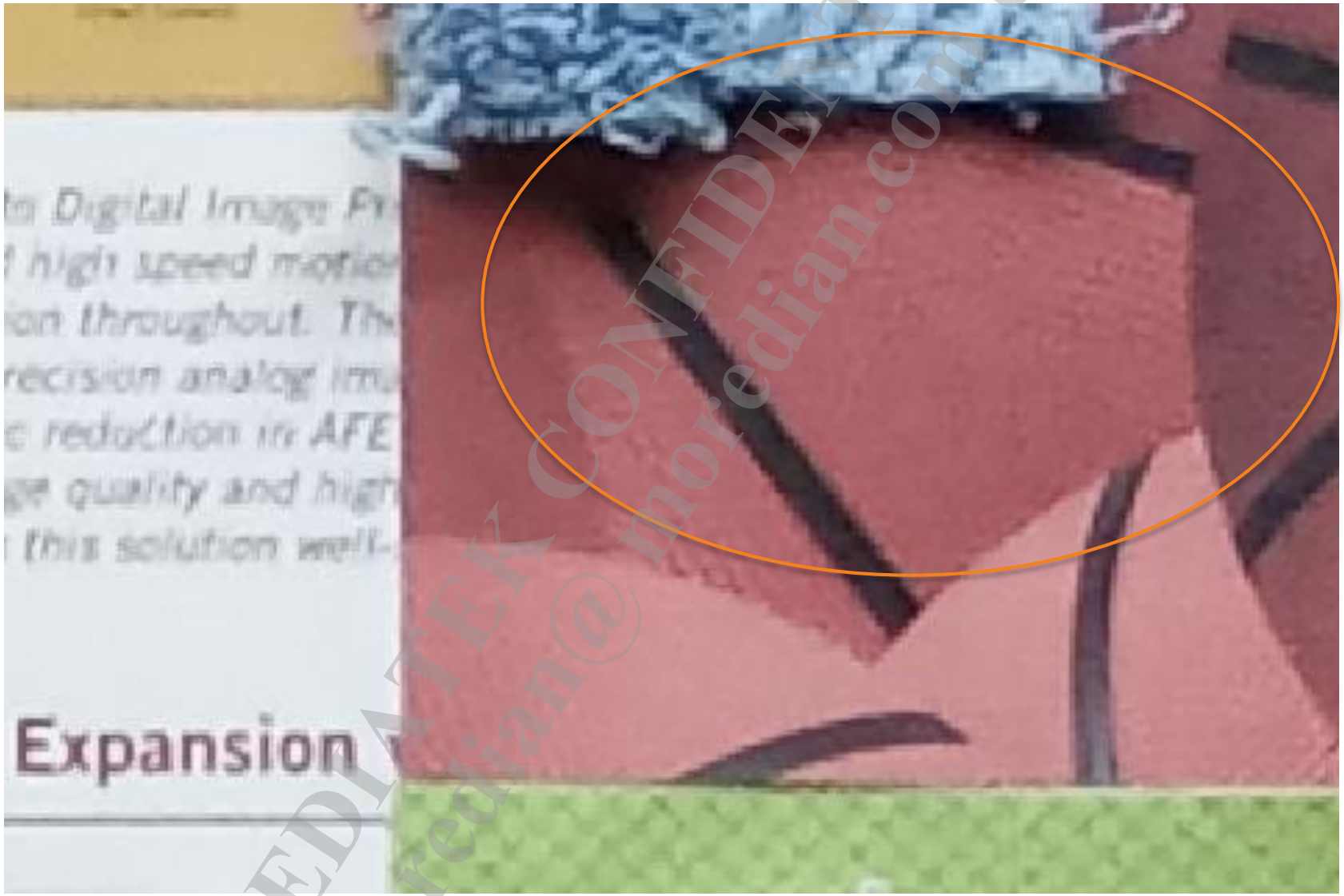
Luma Blending LUT

Y HF LUMA X1	0
Y HF LUMA X2	0
Y HF LUMA Y0	0
Y HF LUMA Y1	0
Y HF LUMA Y2	0
Y HF LUMA SP0	0
Y HF LUMA SP1	0
Y HF LUMA SP2	0

- 3 Control Points
- Blending for high-light region
- Blending for dark region

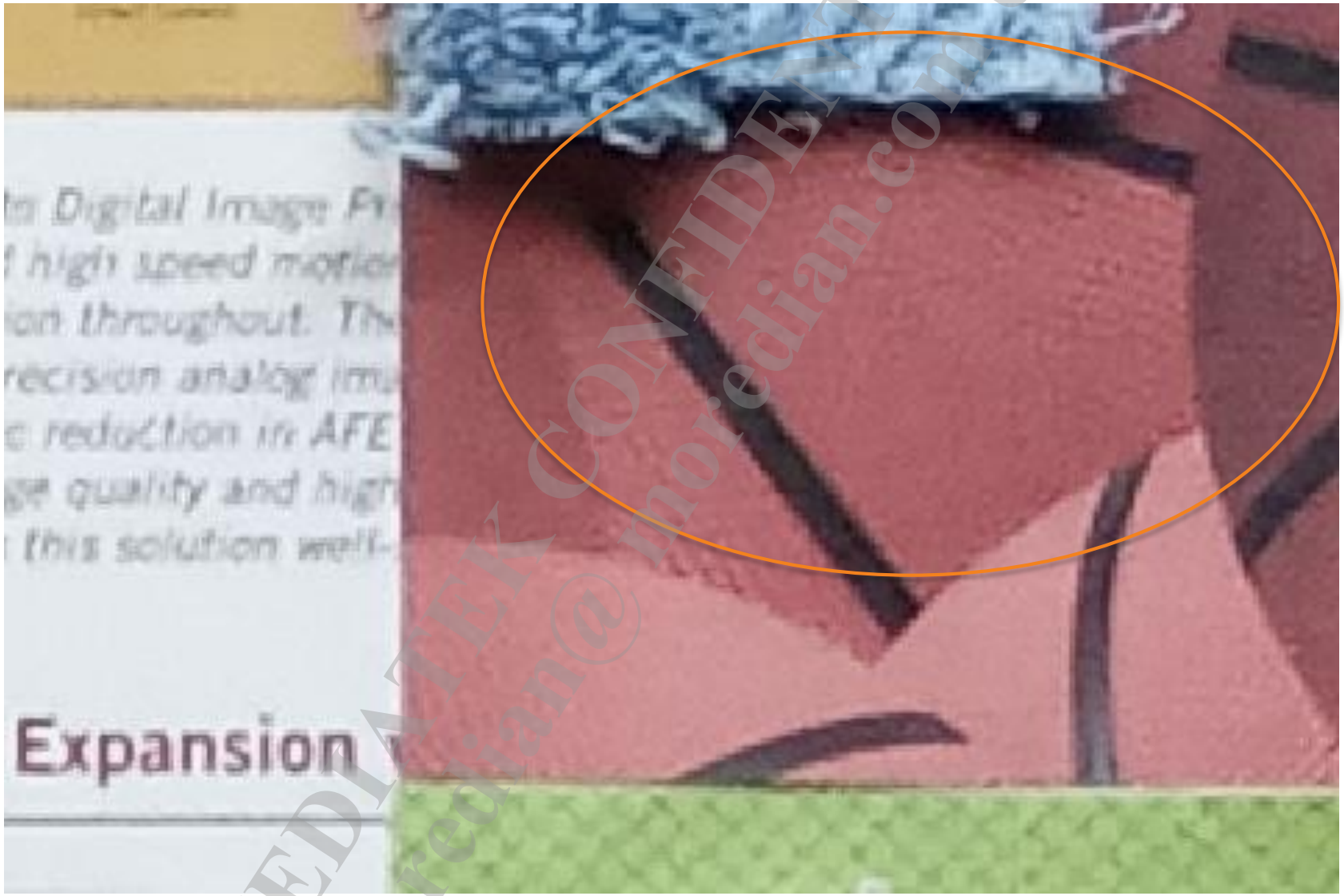


L0 HF W: Keep More high-f Detail



HF W: 7-7-7-0

L0 HF W: Keep More high-f Detail



HF W: 30-7-7-0

CONTOUR TUNING

Luma

Multiscale NR Filter Tuning

Contour Tuning

Contour Tuning

Y SLOPE H TH	8
Y SLOPE V TH	10

Register Name	Default	Description	Tuning
ANR_Y_SLOPE_V_TH	8	Luma vertical plane fitting threshold	The higher the smoother
ANR_Y_SLOPE_H_TH	10	Luma horizontal plane fitting threshold	The higher the smoother

- To reduce contour artifact
- Suggest Tuning
  - ANR_Y_SLOPE_H_TH ➔ 8
  - ANR_Y_SLOPE_V_TH ➔ 10 (ANR_Y_SLOPE_H_TH * 5 / 4)

Contour Tuning

Y SLOPE H TH = 4
Y SLOPE V TH = 5

– Contour Smoother
– Too Strong might Lose Edge

Contour Tuning

Y SLOPE H TH = 40
Y SLOPE V TH = 50

– Contour Smoother
– Too Strong might Lose Edge

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