MT6771 MFNR Manual

2018/03

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- MFNR2.5 Flow Introduction
- MFNR2.5 Tool Operation Guide
- MFNR2.5 Tuning Guide

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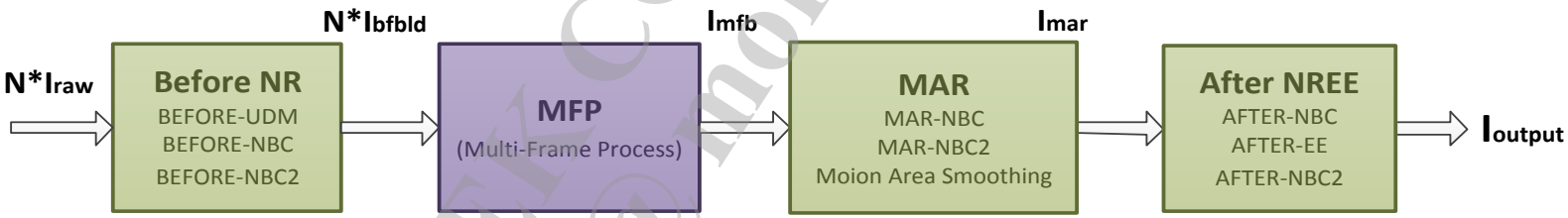
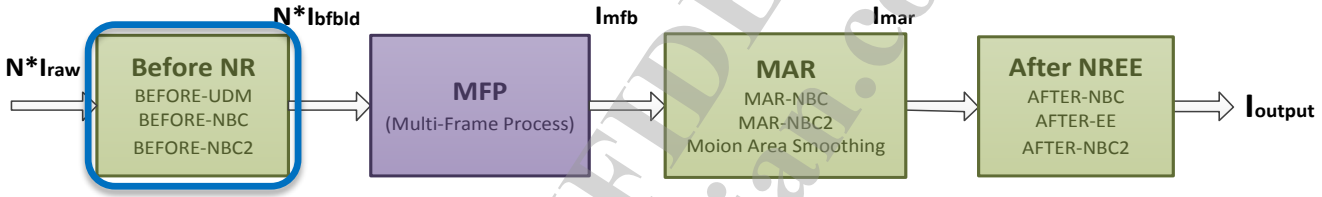
MFNR Flow Introduction

- **Objective**
  - Reduce noise by multi-frame blending
  - 15%~40% faster in Shot-to-JPG compared to MFNR2.0
- **Flow**



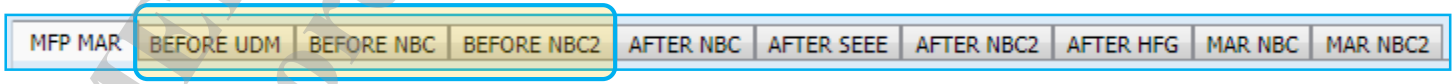
N*Iraw:	Input RAW files. In MT6771, N=2~6
N*Ibfbld:	Images prepared to do multi-frame blending
Imfb:	Multi-Frame blended Image
Imar:	Image after motion area refinement
Ioutput:	Image with After NR/EE

MFNR Flow Introduction

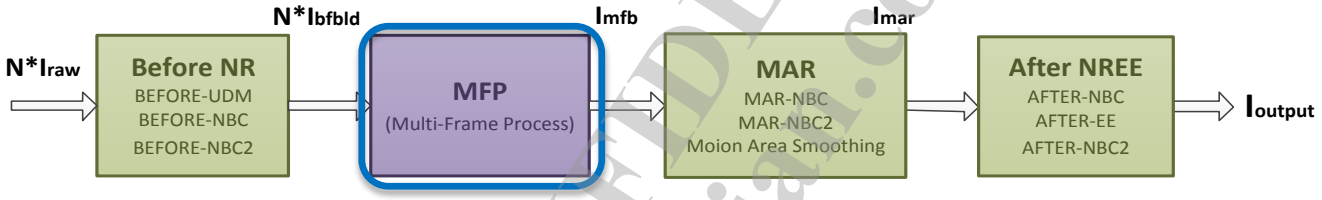


1. Before NR

- Convert RAW to YUV
- Noise pre-reduced to fit into MFP's capacity
- Remove impulse noise and bad pixels
- Relative Registers:
  - MFNR→ BEFORE-UDM / BEFORE-NBC / BEFORE-NBC2

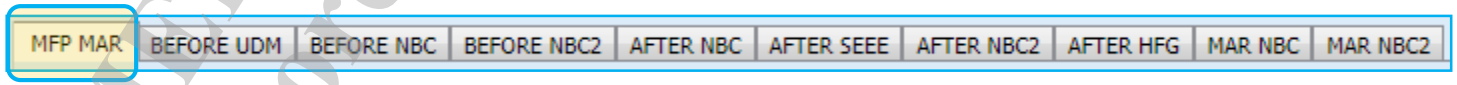


MFNR Flow Introduction

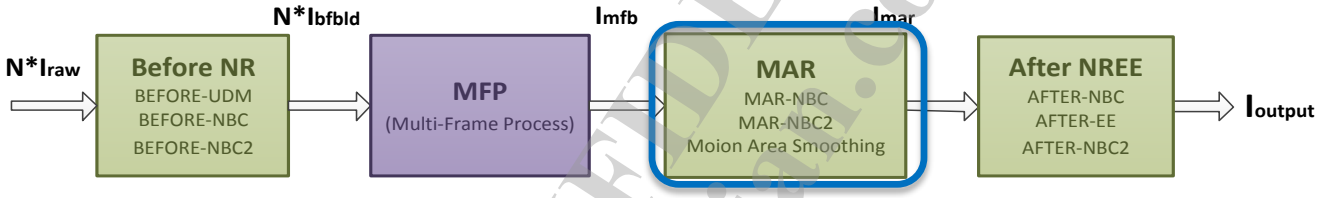


2. Multi-Frame Processing

- Compound all I_{bfbld} frames into one I_{mfb} frame
  - Reduce noise without losing details
  - Work on both luma and chroma noise
- Relative Registers:
  - MFNR → MFP/MAR

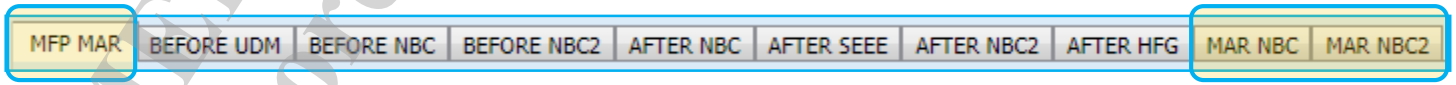


MFNR Flow Introduction

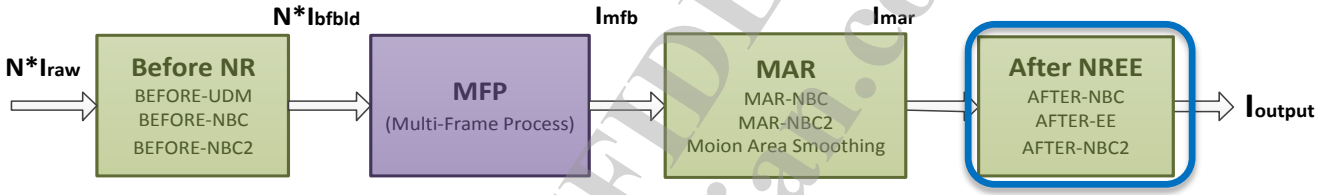


3. Motion Area Refinement

- Apply stronger NR against motion area
  - Remove motion occlusion noise left in MFB stage
  - Improve visual continuity between motion and static areas
- Relative Registers:
  - MFNR → MFP/MAR
  - MFNR → MAR-NBC / MAR-NBC2

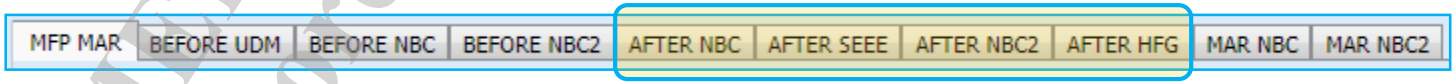


MFNR Flow Introduction



4. After NREE

- Apply AFTER-NBC/EE/NBC2/HFG:
  - Reduce low-frequency noise in advance
  - Improve image sharpness
  - Add random fine noise for boosting visually clarity
- Relative Registers:
  - MFNR → AFTER-NBC / AFTER-EE / AFTER-NBC2 / AFTER-HFG



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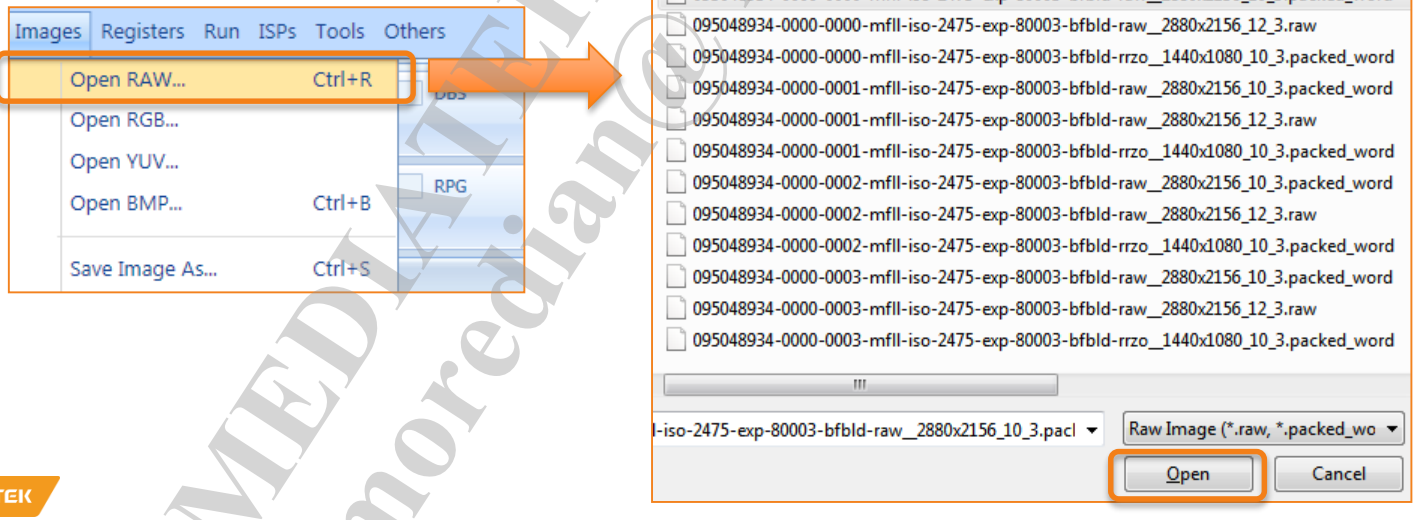
- MFNR2.5 Tuning Guide

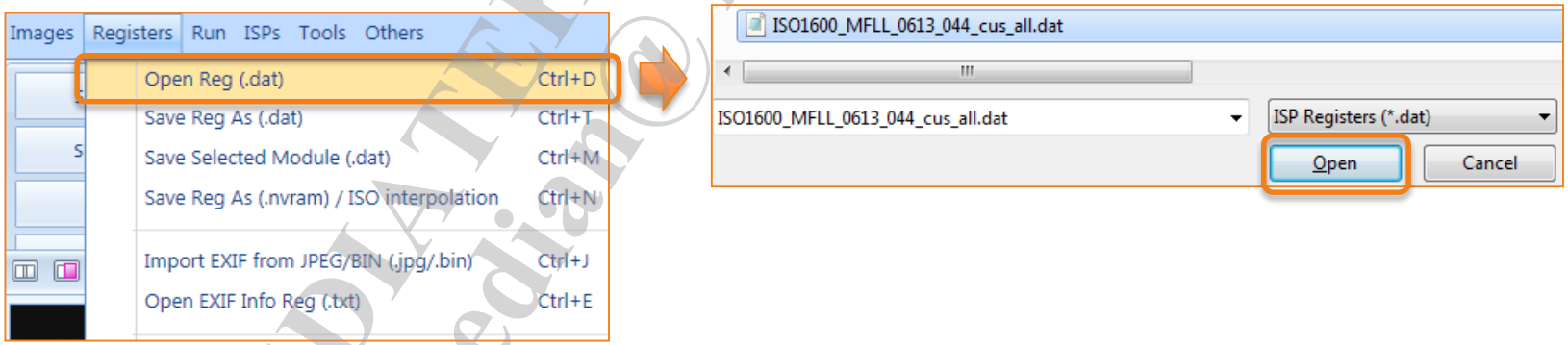
MFNR Tool Operation Guide

- Step1 (I): Load RAW files
  - Hot Key: CTRL + R
  - Make sure that all MFNR RAW files share the same name, followed by a serial number
  - Only the first one(*-0000-0000*.raw/packed_word) needs to be opened
  - EXIF/tuning /SDBLK with same file name will also be loaded automatically



MFNR Tool Operation Guide

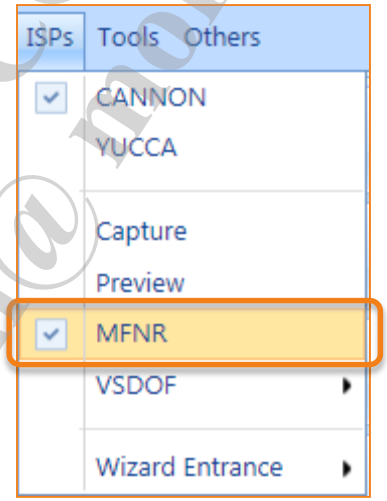
- Step1 (II): Load DAT Settings (optional)
  - Hot Key: CTRL + D
  - For loading pre-saved DAT file, make sure RAW is loaded first



MFNR Tool Operation Guide

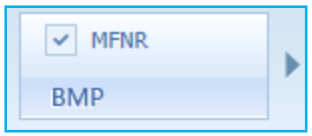
- Step2: Ensure MFNR flow is enabled
  - Menu -> ISPs -> ensure ”Multi-Frame Noise Reduction” is checked

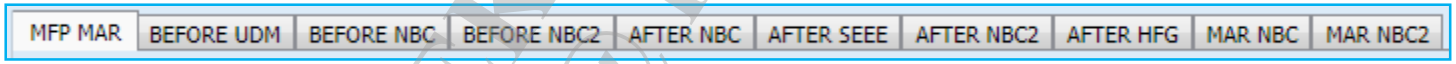
    (If RAW is shot in MFNR mode, it’ll auto-checked after RAW/JPG loaded, only confirmation needed)



MFNR Tool Operation Guide

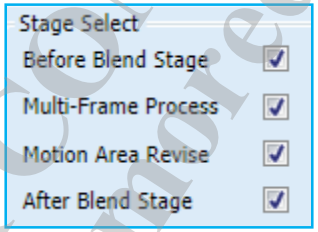
- Step3: Registers Checking/Tuning
  - MFNR related parameters are congregated into 10 tabs in MFNR page (Please refer following ”MFNR Tuning Guide” section for tuning)



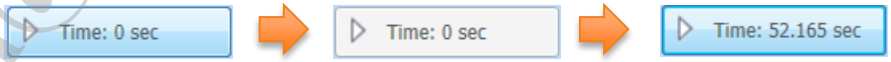


MFNR Tool Operation Guide

- Step4(I): Full Simulation
  - In MFP_MAR tab, make sure all MFNR stages are checked.



  - Press  button to run simulation (Hot Key: F2)
  - Check the running status:

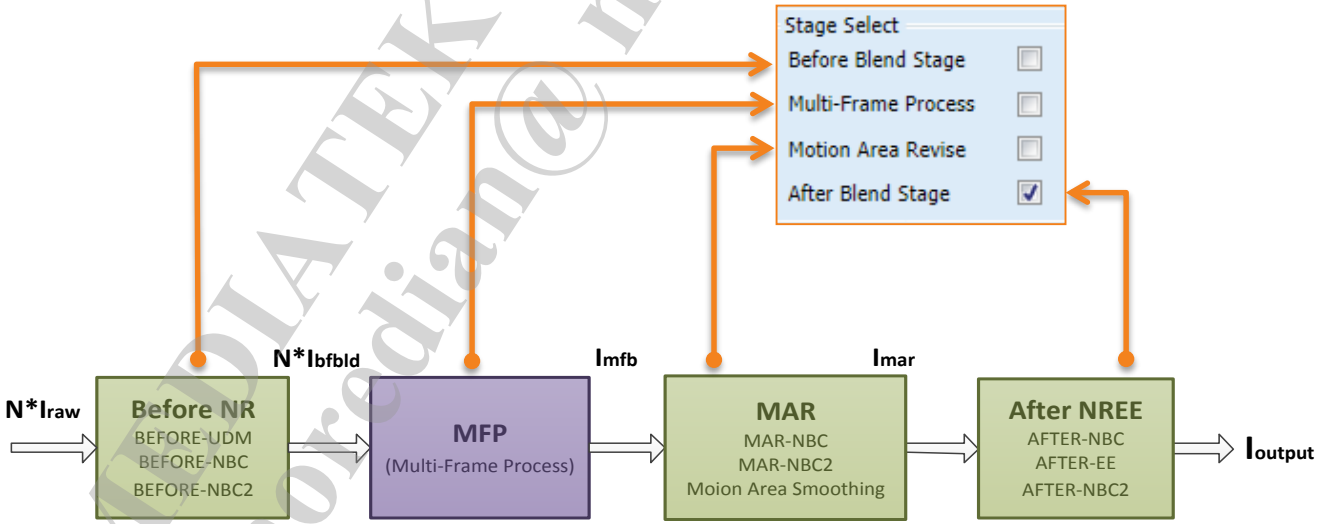


Before Run **Running** **Run Finished**

  - It takes about 4~12 minutes for full MFNR simulation.

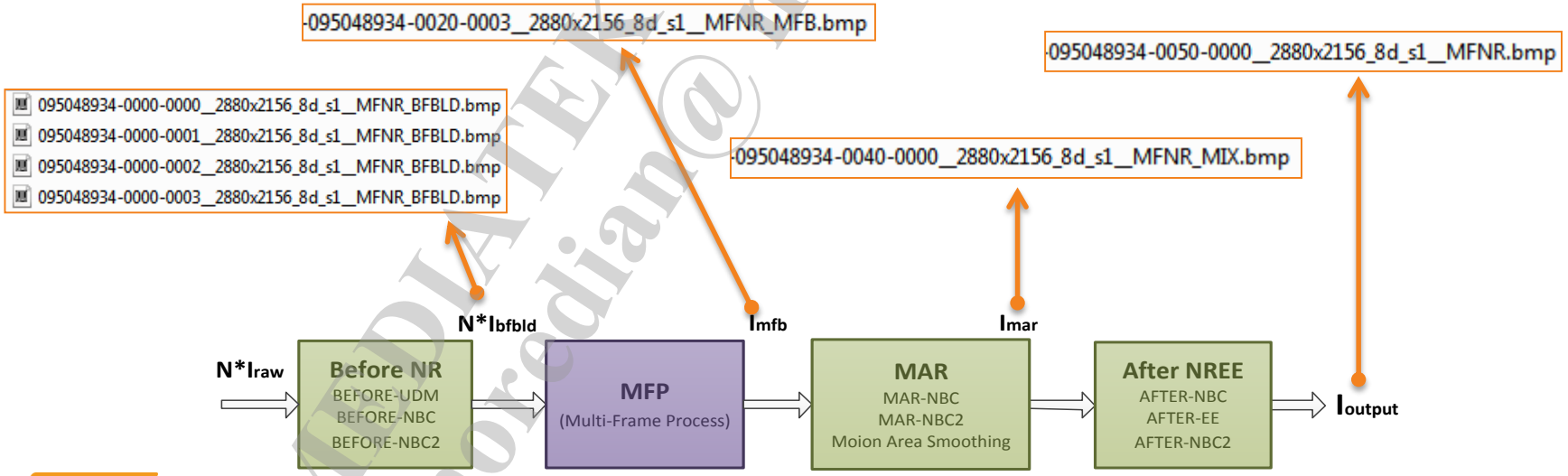
MFNR Tool Operation Guide

- Step4(II): Partial Simulation
  - Once full simulation is done, some stages can be skipped in next run if no register in these stages been changed.
    - **Ex:** If only AFTER-NBC/EE module are changed since previous run, Before/ MFP can be skipped in next run.



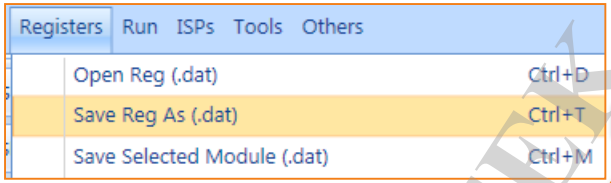
MFNR Tool Operation Guide

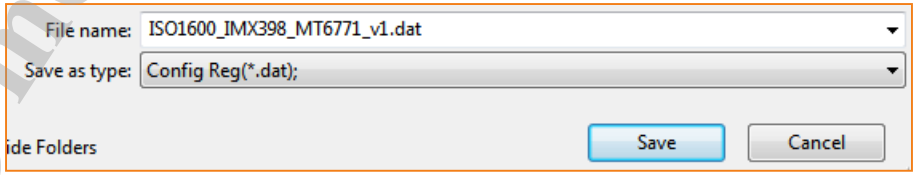
- Step5: Result Images Checking
  - Results are saved in “Results\” folder located in the same folder as the RAW files
  - Following bitmap files would be generated after simulating:

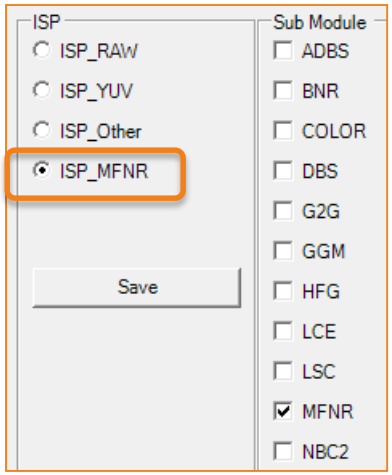


MFNR Tool Operation Guide

- Step6: Save tuning result as DAT file
  - Keep setting for next time tuning
  - Hot Key: CTRL + T
  - Can also save MFNR modules only. (CTRL + M)
  - Suggest to mark ISO/sensor/IC in DAT file name for recognizing

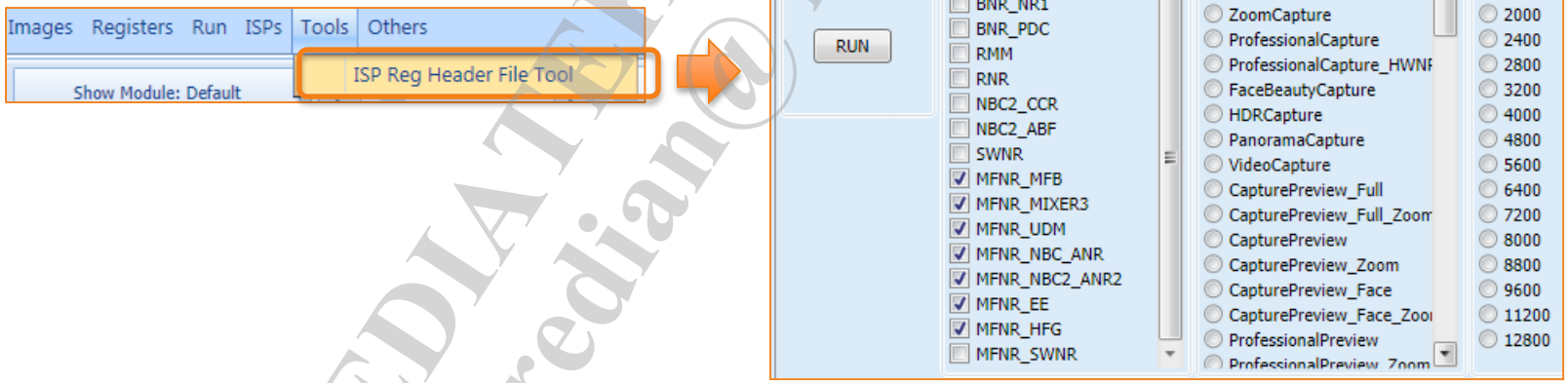






MFNR Tool Operation Guide

- Step7: Merge Settings to NVRAM
  - Please refer to ”Guideline_ISP_Reg_Header_File_Tool.pptx”



MFNR Tool Operation Guide

- Step8: Set frame-number in “XXX_$(scenario)_ISP_MFNR.cpp”
  - Set *capture_frame_number = blend_frame_number = 6* (max. frames)
  - Set *mfll_iso_th* = minimum MFNR enable ISO
  - There are 7 ISO thresholds for MFP frame-number mapping. Frame_num1~7 are individually mapping to iso_level1~7

```
// Gives N, for capturing N frames
capture_frame_number        :   6,
// Gives N, for N-frame blending. E.g.: N = 6, 6-frame blending, do blending 5 times.
blend_frame_number          :   6,
// Give 0 or 1, 0 for half size MC, 1 for full size MC
full_size_mc                :   1,
memc_bad_mv_range           :   255,
memc_bad_mv_rate_th         :   12707,
// The threshold of doing MFB or not
mfll_iso_th                 :   200,
// iso range for adaptive frame number mechanism
iso_level1                  :   200,
iso_level2                  :   300,
iso_level3                  :   400,
iso_level4                  :   600,
iso_level5                  :   800,
iso_level6                  :   2000,   // reserved for extension
iso_level7                  :   2000,   // reserved for extension
// at least to set blend frame number >= 2
frame_num1                  :   2,
frame_num2                  :   3,
frame_num3                  :   4,
frame_num4                  :   5,
frame_num5                  :   6,
frame_num6                  :   6,
frame_num7                  :   6,      // reserved for extension
```

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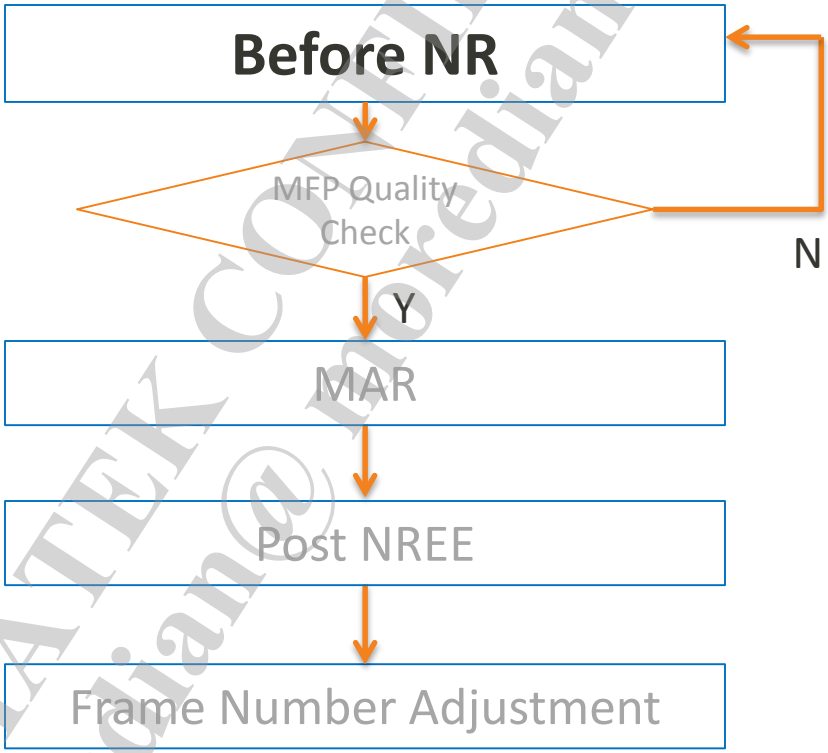
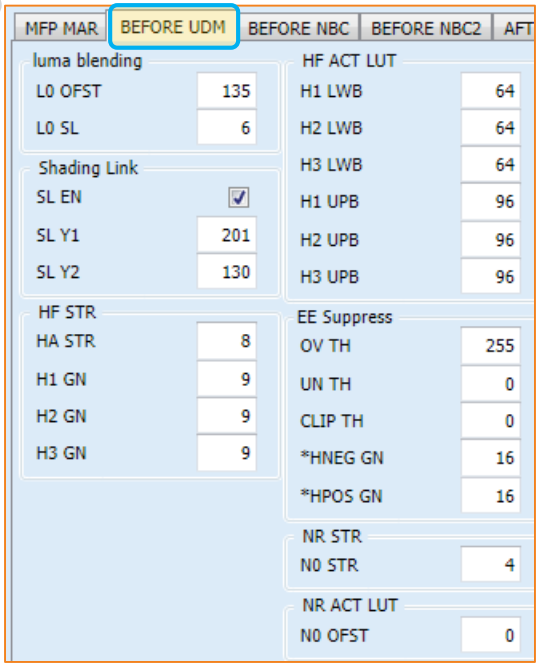
- **MFNR2.5 Tuning Guide**

MFNR Tuning Guide



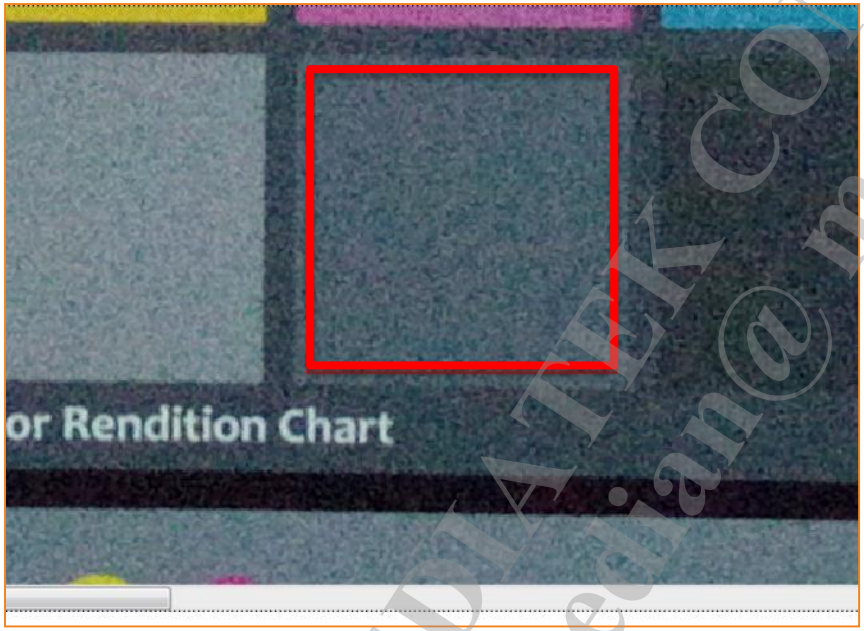
Before NR - STEP1: UDM

- Please refer to DM3.5 tuning guide for tuning.
- L0 OFST ↑ : Directional noise ↓
- SL Y1/Y2 ↓ : Corner region sharpness ↓
- HA/H1~H3 ↑: Sharpness ↑
- H1/2/3 LWB↑: Flat region noise ↓
- H1/2/3 UPB↑: Edge sharpness ↑
- N0 STR↑: Noise↓



Before NR - STEP 2

- Before tuning BEFORE-NBC, set **Y HF ACT Y0~4=64 and Y L0~3 HF W=16** to measure STD with NR off
- If the STD <= 8, keep the setting and go to MFP stage



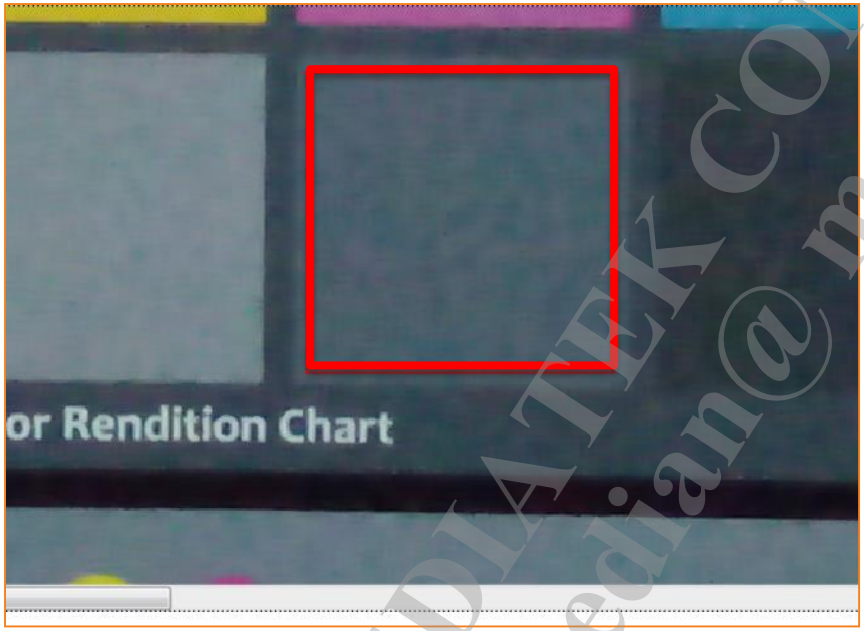
Y HF ACT Y0	64
Y HF ACT Y1	64
Y HF ACT Y2	64
Y HF ACT Y3	64
Y HF ACT Y4	64

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

Stddev:(Y,Cb,Cr)=(9.27, 0.81, 0.47)

Before NR - STEP 3

- Set **Y HF ACT Y0~4 = 0** (no blend to source), for checking pure NR result
- Adjust **L0~3 std** (NR strength), ensure the noise in flat region are all cleaned (include impulse noises)



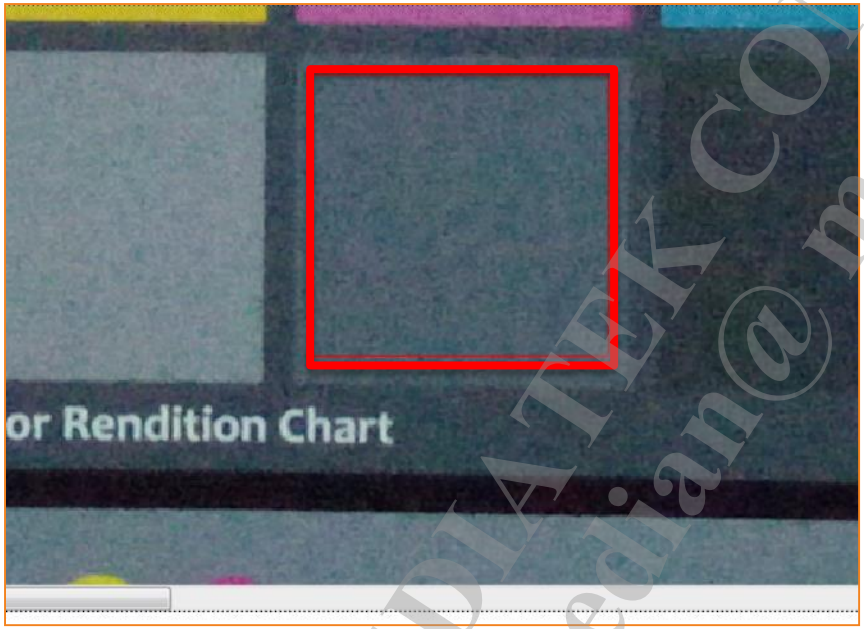
Y HF ACT Y0	0
Y HF ACT Y1	0
Y HF ACT Y2	0
Y HF ACT Y3	0
Y HF ACT Y4	0

L0 std	200
L1 std	132
L2 std	87
L3 std	60

Stddev:(Y,Cb,Cr)=(2.89, 0.24, 0.00)

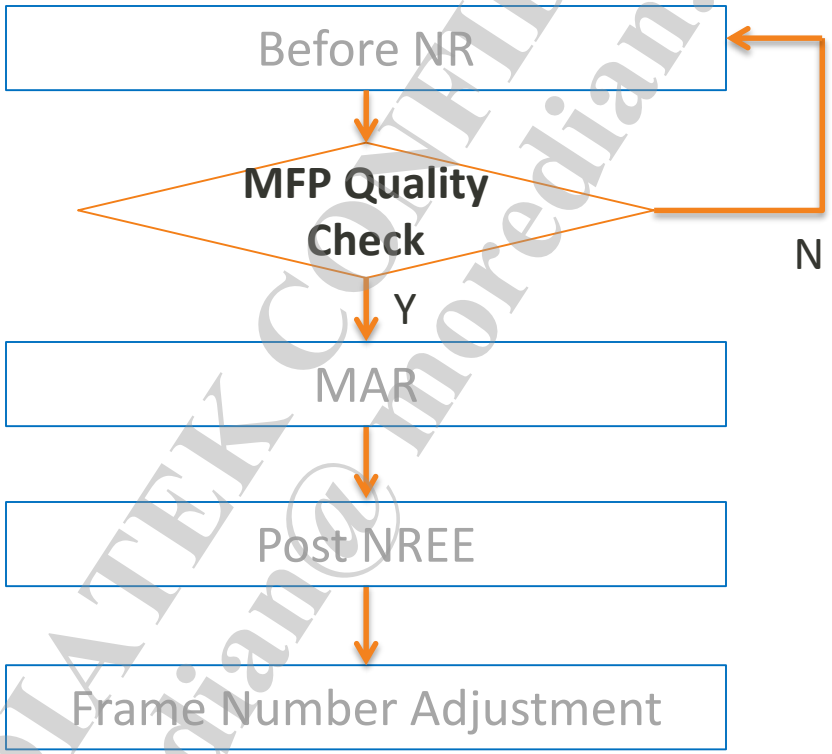
Before NR - STEP 4

- Increase **Y HF ACT Y0~4** to add noise/detail back, till the flat region STD = 8~9



Y HF ACT Y0	36
Y HF ACT Y1	36
Y HF ACT Y2	36
Y HF ACT Y3	36
Y HF ACT Y4	36

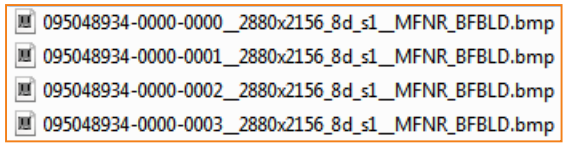
MFNR Tuning Guide



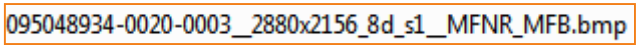
MFB Quality Check

Checkpoint:

- *I*$_{bfbld}$
  - Check if all images meets the STD requirement (8~9)
  - Check if brightness/color/ISO of all *I*$_{bfbld}$ are consistent



- *I*$_{mfb}$

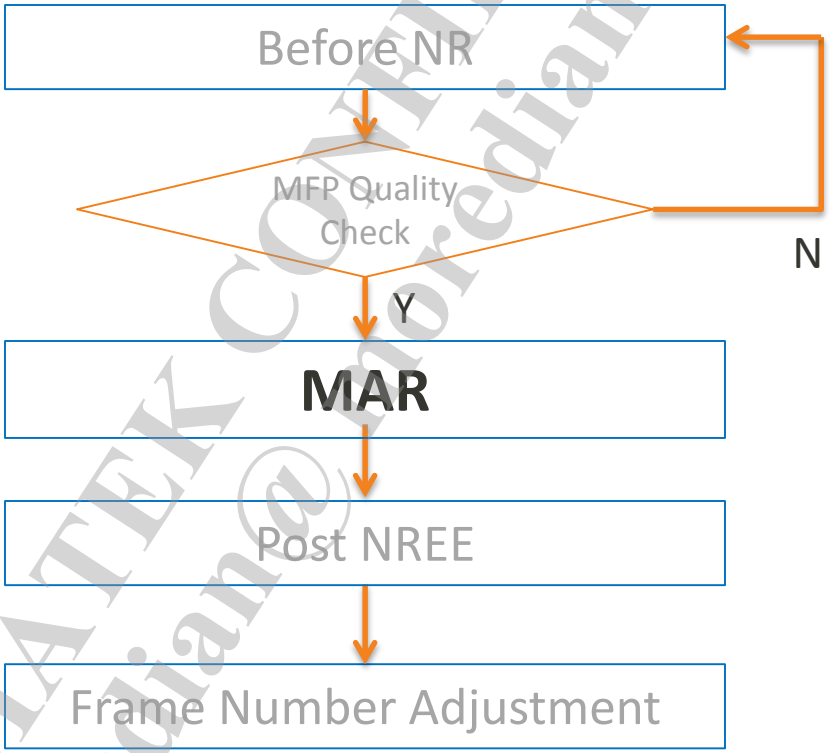


  - Ghost effect in motion area(kids, cars, sports, walkers, etc)
    - Decrease XXX_THH0~2 / Increase “n” value in MFB v2.0 Tuning Step2
    - Need to re-tune MFB/BeforeUDM/NBC by steps
  - Too much noise => Check the MFB weighting Map
    - Tune BEFORE-NBC/NBC2
    - Noise in motion area can be ignore here, MAR will take care later
    - Stronger corner Noise => BEFORE_NBC_LCE_GAIN2~3 / BEFORE_UDM_SL_Y2
    - Some slighter noise can also be handled by AFTER-NBC later
  - Lack of details
    - Lower UDM N0 / Higher UDM HT/HD
    - If details exist, just a little blurry, it can be enhanced by AFTER-EE later

MFB Quality Check

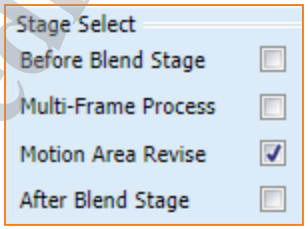
- **Weighting Map (BLD_W_OU.bmp)**
  - Keep higher MFB weighting in static region (map pixel value = 32*frame_number)
    =>Adjust BEFORE-NBC/NBC2
  - Keep lower weighting in moving region (map pixel value -> 0)
    =>Higher MFB CLIP TH1/2

MFNR Tuning Guide



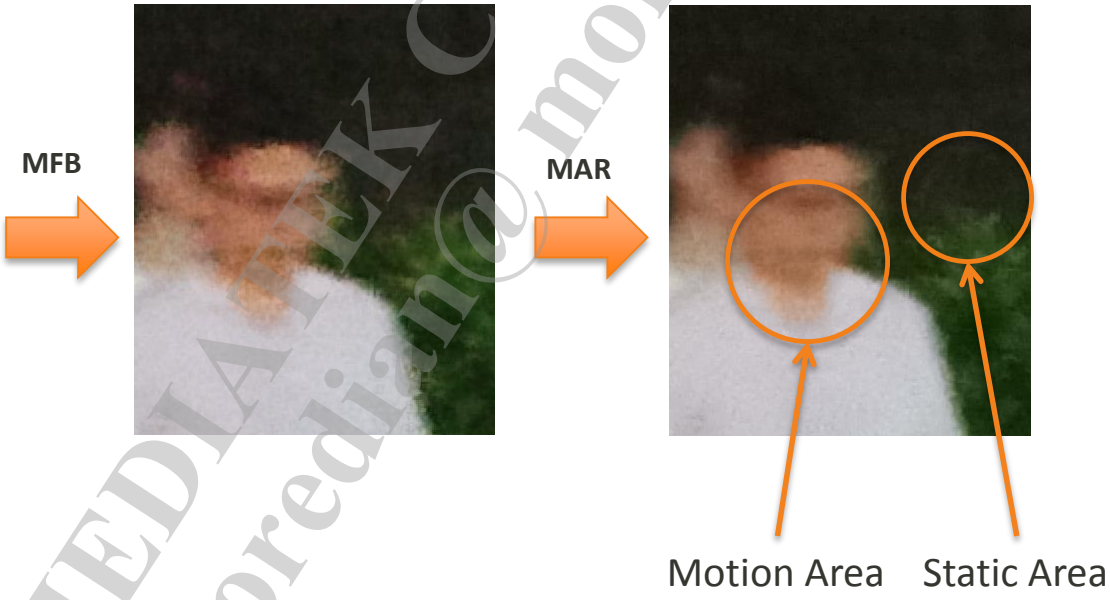
MAR Tuning

- **Goal:**
  - Motion noise left by MFB should be handled in MAR(Motion Area Refinement), to keep its noise level being consistent with the static area
- **Tuning Criteria:**
  - MAR NR/EE strength can be predicted by fine-tuned AFTER NR/EE setting
  - MAR-NBC/NBC2: check the motion noise level is similar to neighboring static area after MAR
  - MAR-EE: ≈ After-EE
- **Partial Run Setup:**



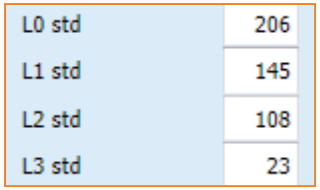
MAR – Tuning Criteria

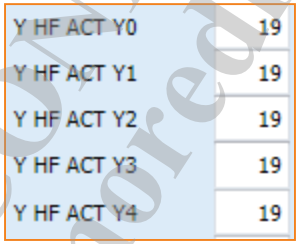
- MAR-NBC should only work on motion area.
- Make sure static area STD of “XXX_SINGLE.bmp” are similar to “XXX_MFB.bmp”

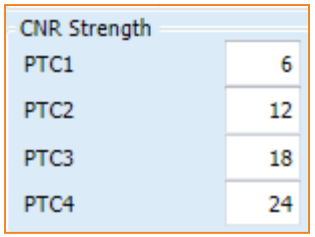


MAR – Tuning

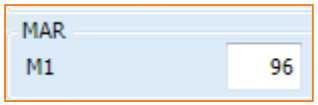
- MAR-NR Suggestion:
  - **Y/C Noise** ≈ (Total frame)^0.5 x [AFTER_NBC1 PTC1~4 / L0~3std]
  - **Y HF ACT Y0~4**:
    - ≈ (0.3~0.5) x (AFTER_NBC1)
    - Adjust to align STD(**Imfb**)
  - Other parameter:
    - ≈ (AFTER_NBC1/2)







- MAR_M1
  - Total frame = 4: M1 = 96
  - Total frame = 5: M1 = 117
  - Total frame = 6: M1 = 160

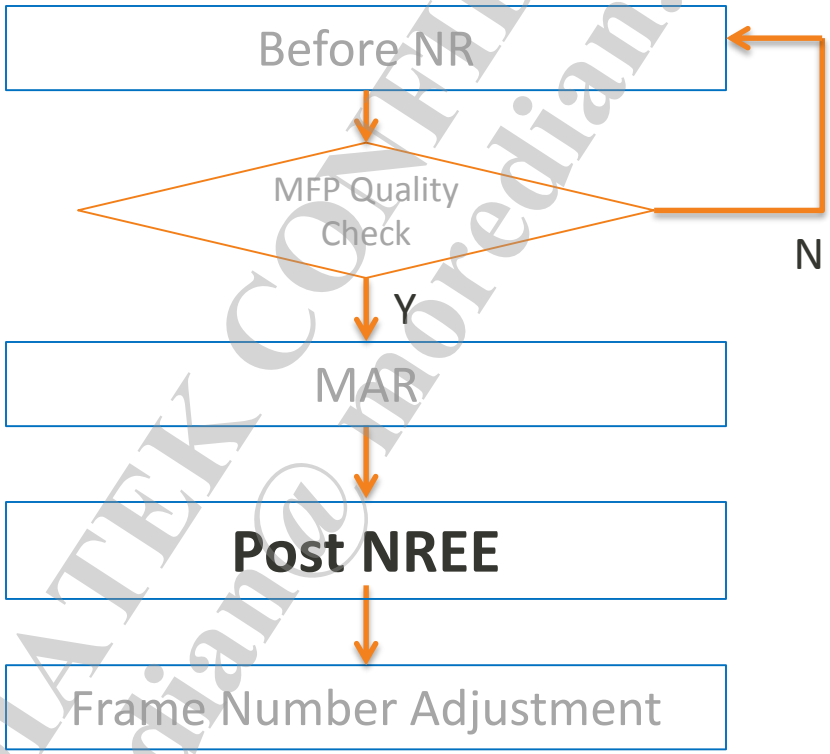


MAR – Result

MFB.bmp

MFNR_A.bmp

MFNR Tuning Guide



Post NREE - NBC

- Objective: STD in static area ≈ referenced photo
  - Similar to BEFORE-NBC tuning steps
  - **L0~3 std:** control Luma noise level
  - **PTC1~4**: control Chroma noise level
- Reduce low-frequency noise
  - Higher **L3 std**, lower **Y L3 HF W**

L0 std	60
L1 std	39
L2 std	27
L3 std	17

PTC1	4
PTC2	6
PTC3	8
PTC4	10

Post NREE - SEEE

- Objective: Final sharpness of edge and details ≈ referenced photo
  - By frequency: Adjust **H1~H3 GN**
  - By Edge index: Adjust **EE GLUT**

H1 GN	14
H2 GN	14
H3 GN	14

GLUT	
X1	0
X2	32
X3	64
X4	96
Y1	16
Y2	96
Y3	192
Y4	240
Y5	161

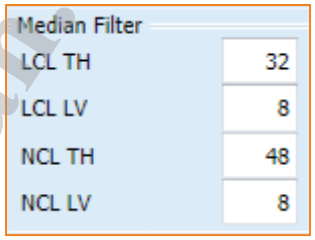
- Suppress ringing side-effect
  - Dial down **RESP CLIP**

RESP CLIP	16

- Please refer to SEEE4.0 Tuning Guide for advanced EE tuning

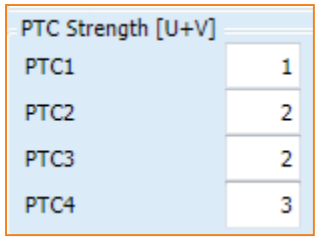
Post NREE - NBC2

- If impulse noises left in static area(sometimes they are raised by AFTER-EE), alleviate them by **LCL/NCL**



- Adjust **PTC1~4** for low-frequency chroma noise reduction

  (Ultra-low freq. chroma noise can be erased later by SWNR if needed)



Before AFTER NR/EE

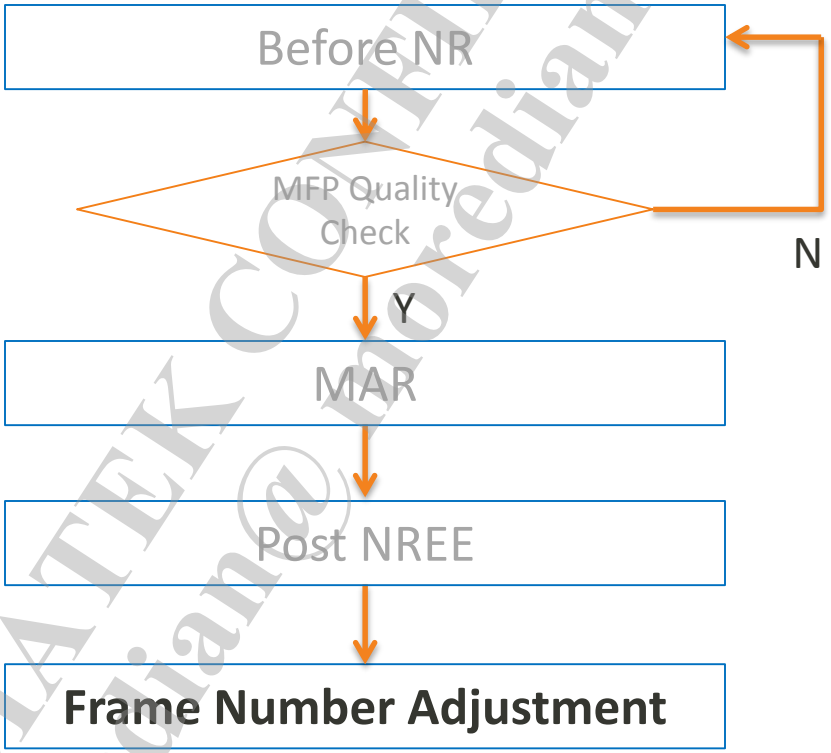
Post NREE - HFG

- Raise Noise STD to enhance visual clarity
  - Noise STD ≈ 0~16

Noise STD = 0

Noise STD = 16

MFNR Tuning Guide



ISO Adaptive Frame Number

- MFNR v2.0+, It's available to change frame number by shooting ISO
  - The more frame number, the better SNR of image
  - Low ISO: original noise is low, use less frame for shooting performance
  - High ISO: Gradually increase frame number for image quality

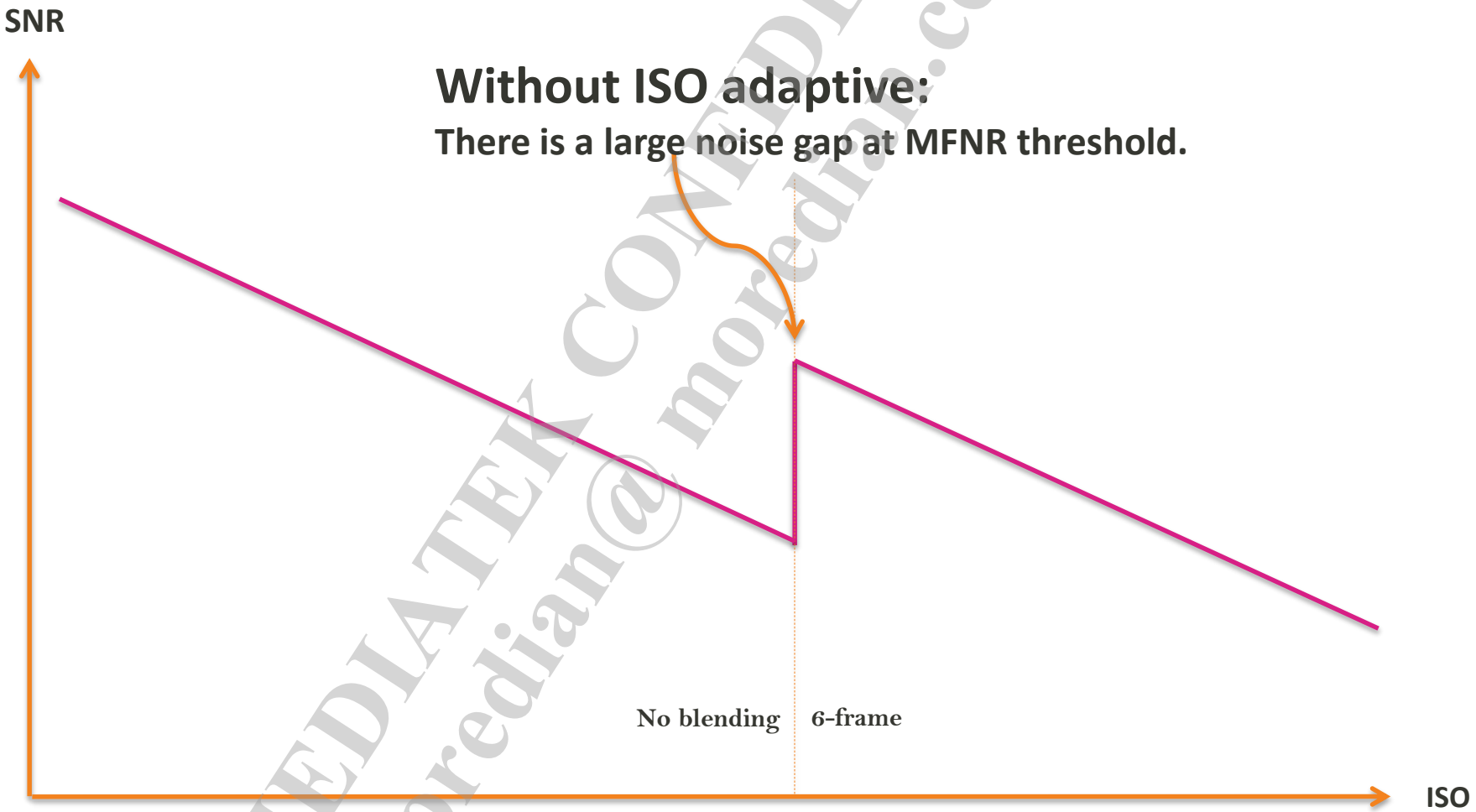
Comparison of different frame number MFNR result:

No blending

2-frame MFNR

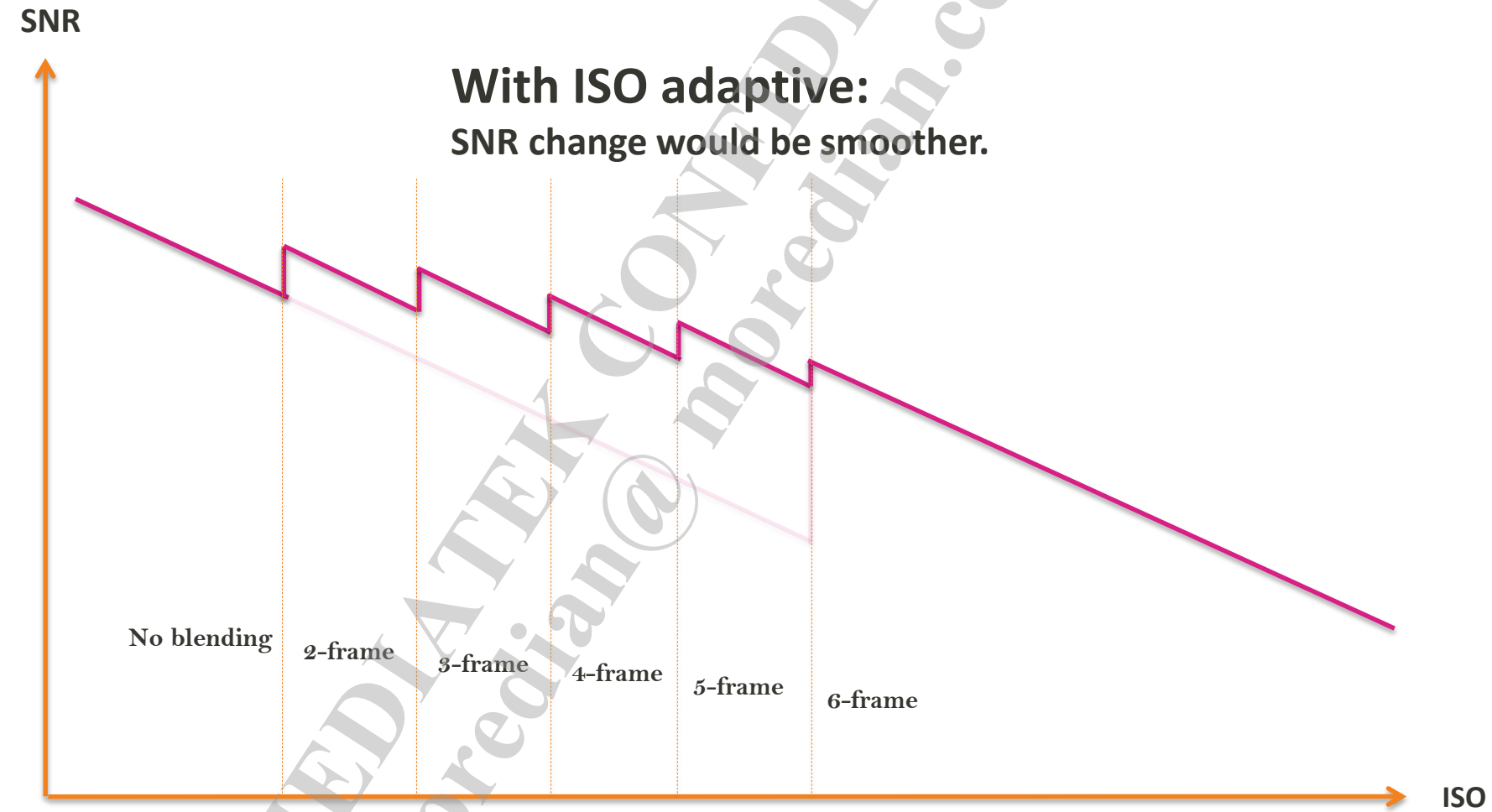
6-frame MFNR

ISO Adaptive Frame Number – Image Quality

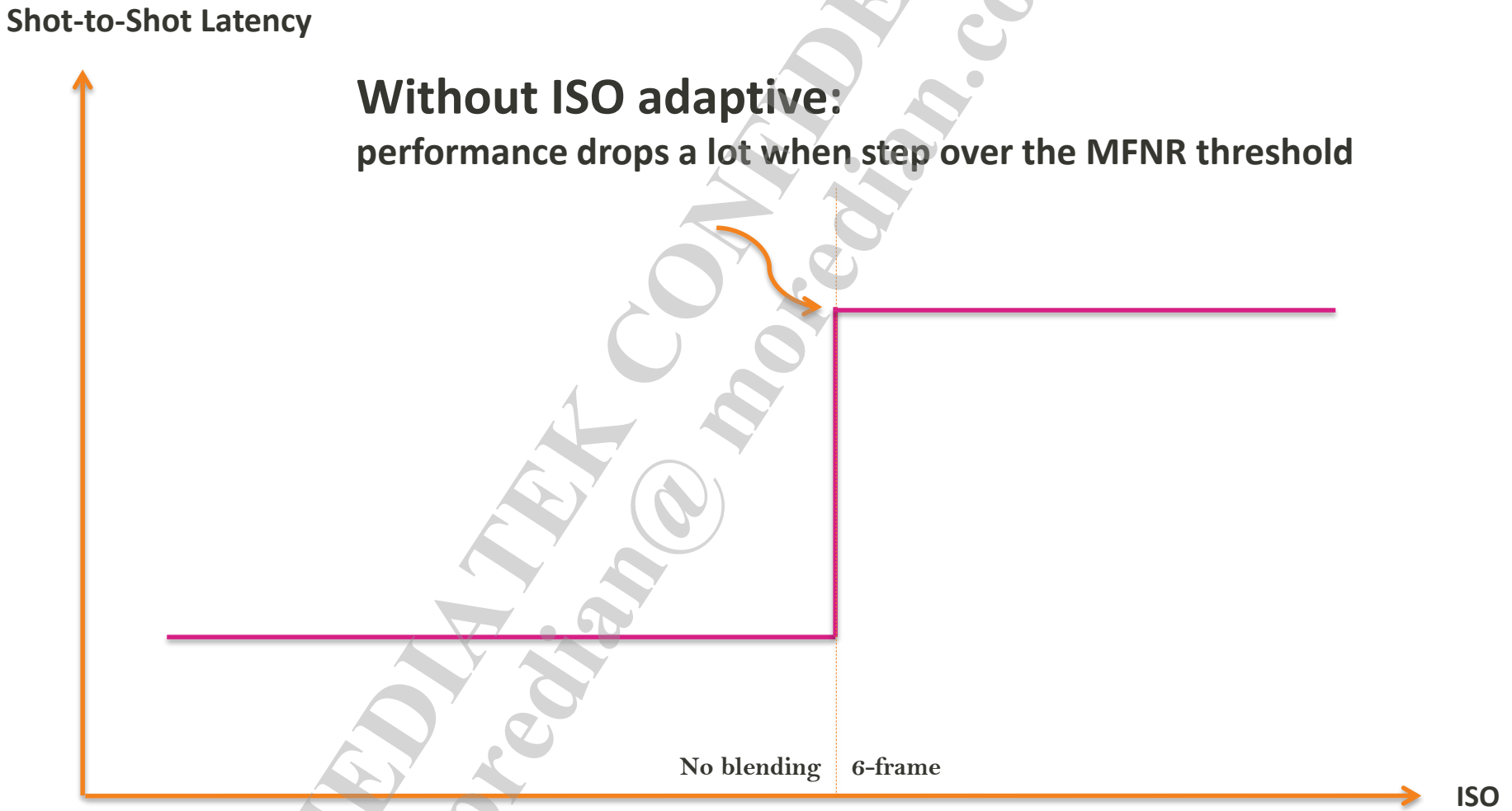


MEDIATEK

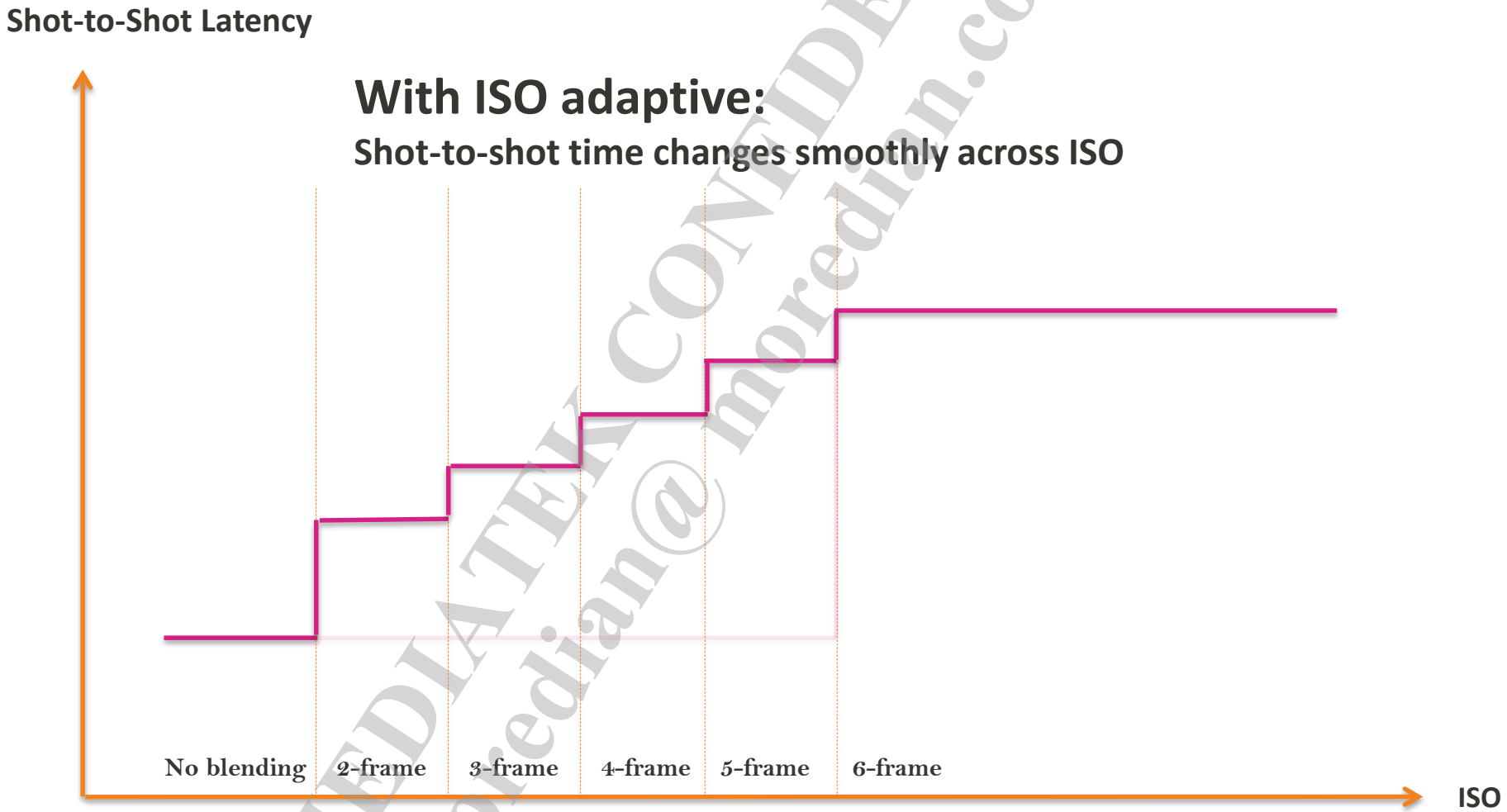
ISO Adaptive Frame Number – Image Quality



ISO Adaptive Frame Number – Performance

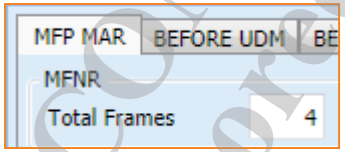


ISO Adaptive Frame Number – Performance



ISO Adaptive Frame Number – Simulation

- Set “Total Frame” value in tool for simulation



ISO Adaptive Frame Number – Tuning

- Initially MFNR should be tuned with the highest frame number.
- Once frame number falls, **AFTER-NBC** and **MAR_M1** need to be revised to keep the noise level consistency

- MAR_M1
  - Total frame = 4: M1 = 96
  - Total frame = 5: M1 = 117
  - Total frame = 6: M1 = 160

ISO Adaptive Frame Number – Tuning (AFTER-NBC1)

- **Y/C Noise** : NewValue ≈ OldValue x (OldFrameNum/NewFrameNum)^0.5
- **Y HF ACT Y0~4**: NewValue ≈ OldValue / (OldFrameNum/NewFrameNum)^(0.25~0.4)

Y HF ACT Y0	24
Y HF ACT Y1	24
Y HF ACT Y2	24
Y HF ACT Y3	24
Y HF ACT Y4	24

L0 std	60	PTC1	4
L1 std	39	PTC2	6
L2 std	27	PTC3	8
L3 std	17	PTC4	10

CEN GAIN HI TH	5
CEN GAIN LO TH	5
CEN GAIN HI TH LP	5
CEN GAIN LO TH LP	5

EX: AFTER-NBC in **6-frame** MFNR:

Y HF ACT = 45

Y Noise= 8

Down to **3-frame** MFNR:

Y HF ACT = 45 / (6/3)^0.25 = 38

Y Noise = 8 x (6/3)^0.5 = 11

FrameNum ↓ **Impulse NR**↑

everyday genius