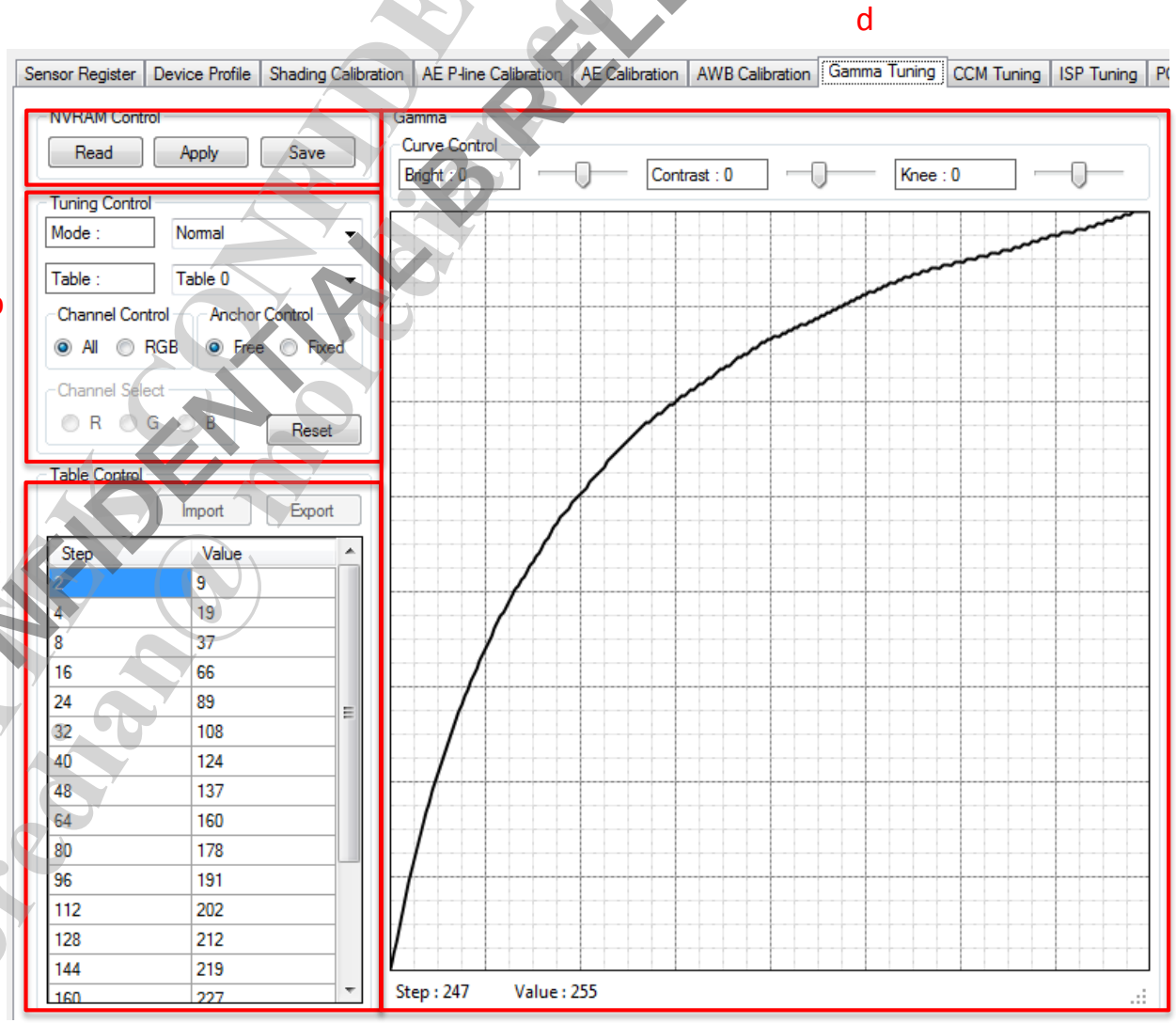
CONFIDENTIAL B

Basic Tuning Flow – Gamma/Color Calibration

Gamma calibration

- Introduction
  a) NVRAM I/O control
  b) Tuning control
    - Normal mode (0~4)
    - iVHDR mode (0~15)
    - Channel control for all channel or R/G/B channel
    - Anchor control for free count or fixed count list in following table
  c) Table anchor control
    - List 17 anchor for control gamma curve
  d) Curve finetune area
    - Drag the curve in area to finetune the Gamma result



Gamma calibration

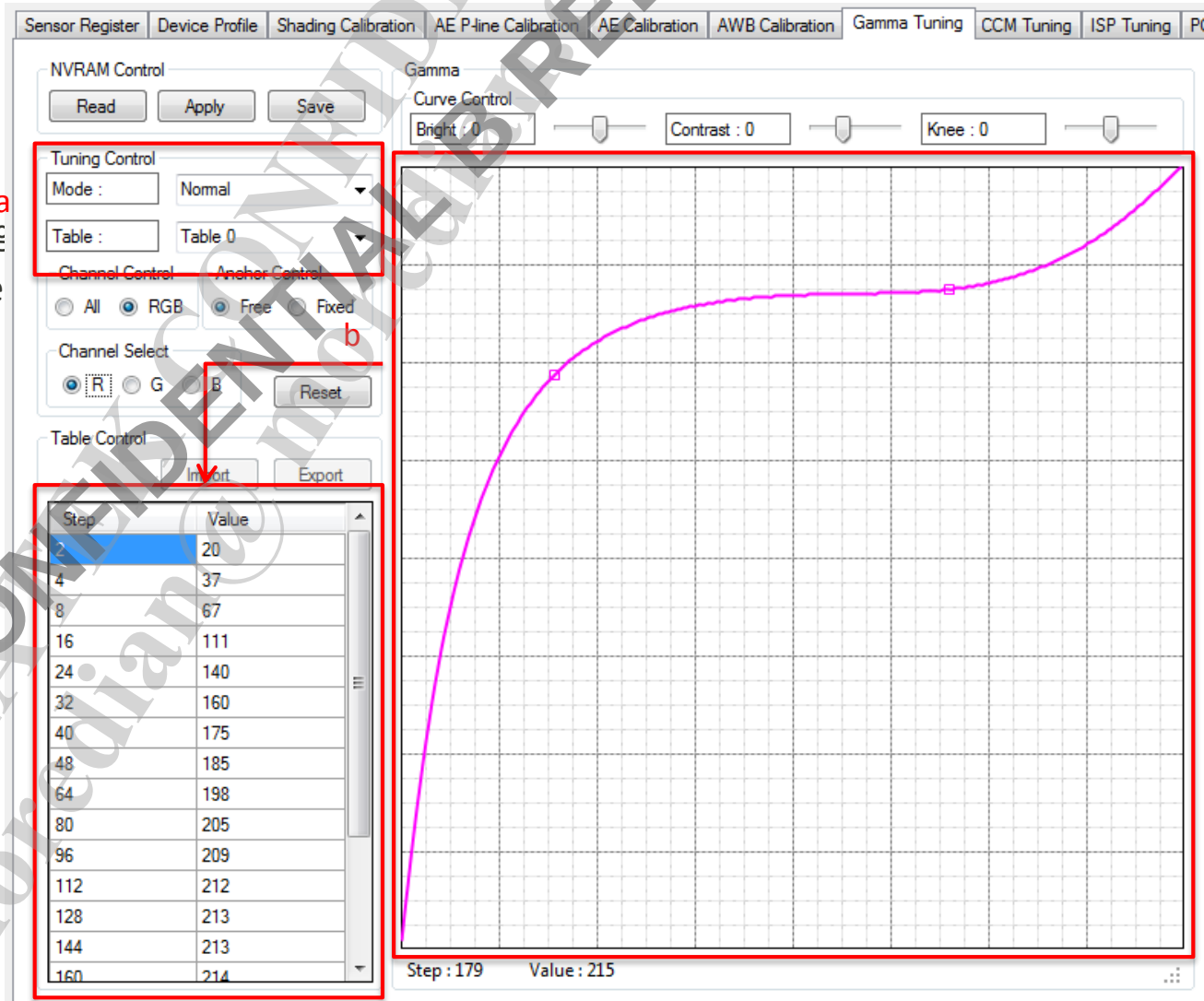
Tuning flow

a) Select “Mode” and “Table” you want to modify.

b) Click the curve for gamma tuning, and the curve fitting will generate result in Table

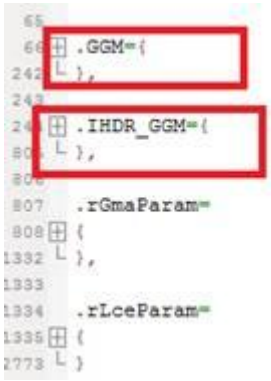
c) Click “Apply” for pushing data into phone.

d) Click ”Save” for saving data into NVRAM.



Gamma

camera_isp_tonemap_xxxxxmipiraw.h



MTK has 2 kind of gamma can use:

GGM: for normal mode gamma (include preview capture video share the same)

IHDR: for HDR mode

Gamma

*When setting is below: use only one fixed gamma

```
.rGmaParam=
{
        {   // Normal Preview
            eISP_FIXED_GMA_MODE,   // eGMAMode
```

Gamma will use GGM[0] array.
GGM[0] fix

*When setting is below: use dynamic gamma

```
.rGmaParam=
{
        {   // Normal Preview
            eISP DYNAMIC GMA MODE,   // eGMAMode
```

Gamma will use GGM[0][1][2] array.

GGM[1] normal →for indoor

GGM[2] enhance →for outdoor

GGM[3] night→for low light

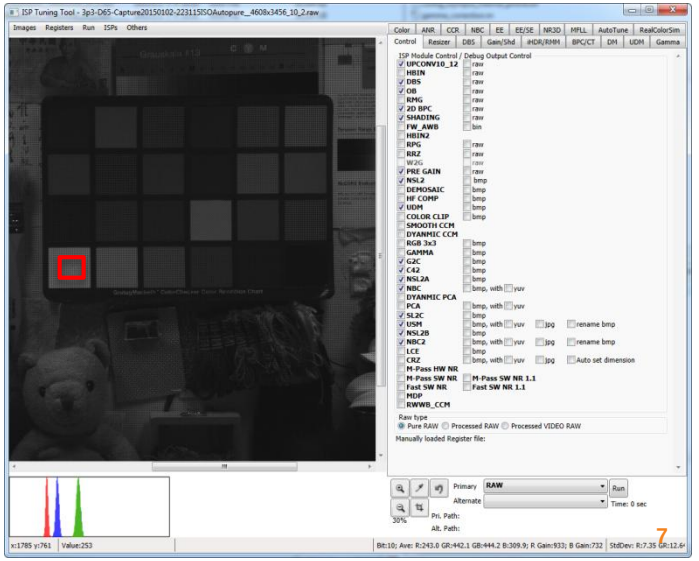
CCM calibration

Introduction

- Algorithm to adjust color correction on RGB domain provided by MTK.
- CCM is 3X3 matrix to change color saturation and reducing color error.
- Basically, CCM won't change the neutral color (gray still the same after CCM processing)
- There are two types of CCM :
  - Dynamic CCM : Provide 4 color temp. mapping matrix, so that it can based on current color to apply correct matrix
    1) D65
    2) DNP
    3) CWF
    4) TL84
  - Smooth CCM : Based on pre-defined several matrixes, it can generate dynamic matrix by AWB gain
    - In P60, Smooth CCM is default.

Before for CCM Calibration

- Complete LSC calibration.
- Complete Gamma calibration.
  - If Gamma is changed, please redo CCM calibration.
- Proper exposure
  - Patch #19: G < 350~550
- If AE/AWB/GAMMA/ DBS/OB is changed, we must verify CCM again.



CCM calibration

Introduction

a) NVRAM I/O control

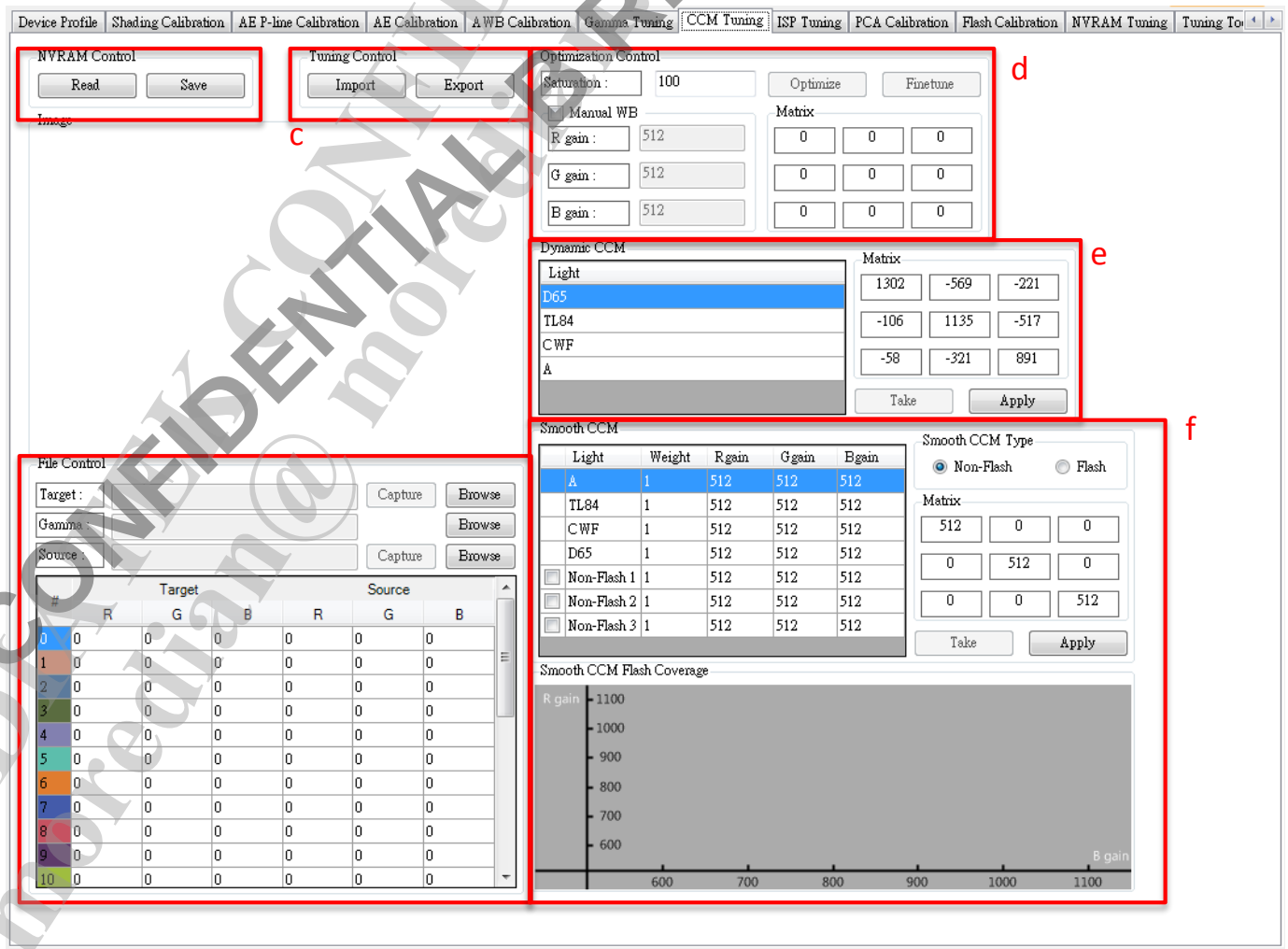
b) File control
- Target (Jpg or CSV)
- Gamma (CSV)
- Source (Raw)
- List all 24 color of target and source

c) Tuning control

d) Optimization control
- Optimize
- Finetune
- Manual WB

e) Dynamic CCM
- 4 light source with mapping matrix

f) Smooth CCM
- 2 types Smooth CCM with mapping matrix, weighting and RGB gain



CCM calibration

Import target file

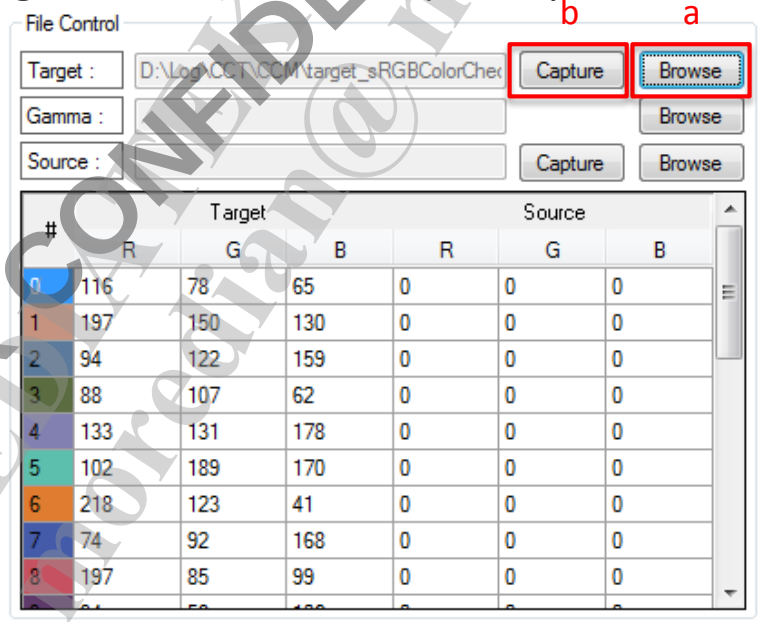
a) Click “Browse” for import files (Jpg or CSV)

b) Click “Capture” for taking picture instead of file import

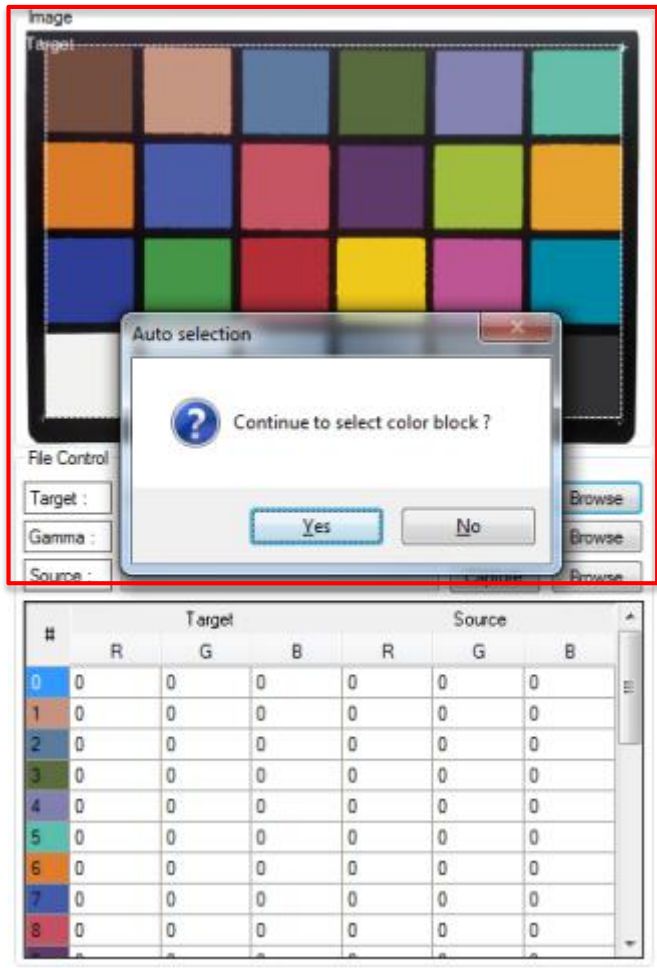
c) Picture will shown in “Image” area, then select a region including all “color checker”

d) Click “Yes” for checking 24 sub-regions in “color checker” automatically

e) However, each sub-region can be modified separately



c



CCM calibration

- Import target file

e

File Control

Target : D:\CCM-Target.jpg Capture Browse

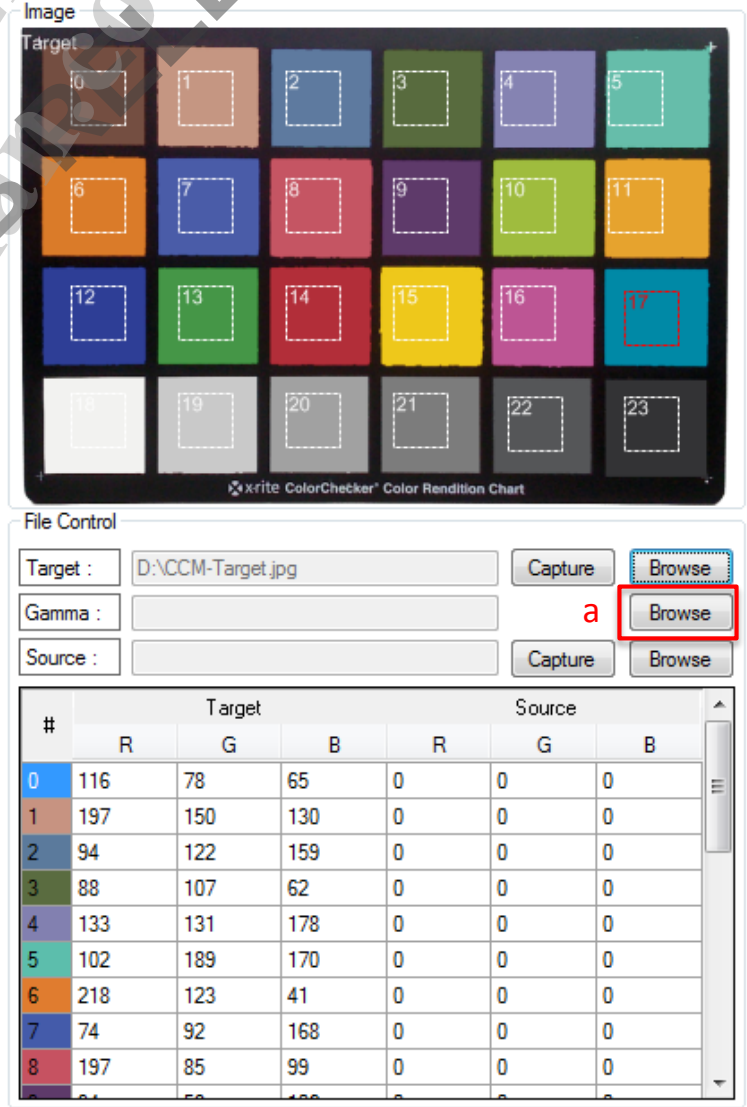
Gamma : Browse

Source : Capture Browse

#	Target			Source		
	R	G	B	R	G	B
0	116	78	65	0	0	0
1	197	150	130	0	0	0
2	94	122	159	0	0	0
3	88	107	62	0	0	0
4	133	131	178	0	0	0
5	102	189	170	0	0	0
6	218	123	41	0	0	0
7	74	92	168	0	0	0
8	197	85	99	0	0	0

CCM calibration

- Import Gamma file
  a) Click “Browse” for import gamma files (CSV/PAT)



CCM calibration

Import source file

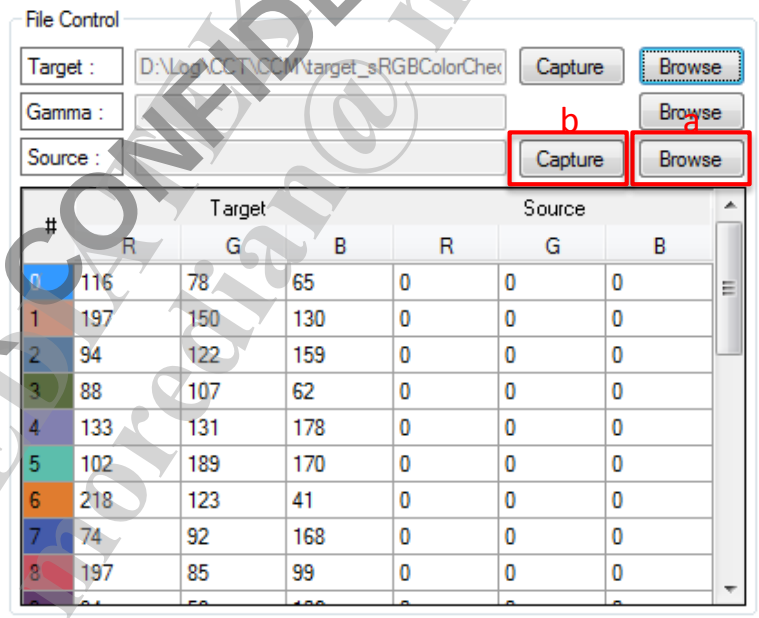
a) Click “Browse” for import files (Raw)

b) Click “Capture” for taking picture instead of file import

c) Picture will shown in “Image” area, then select a region including all “color checker”

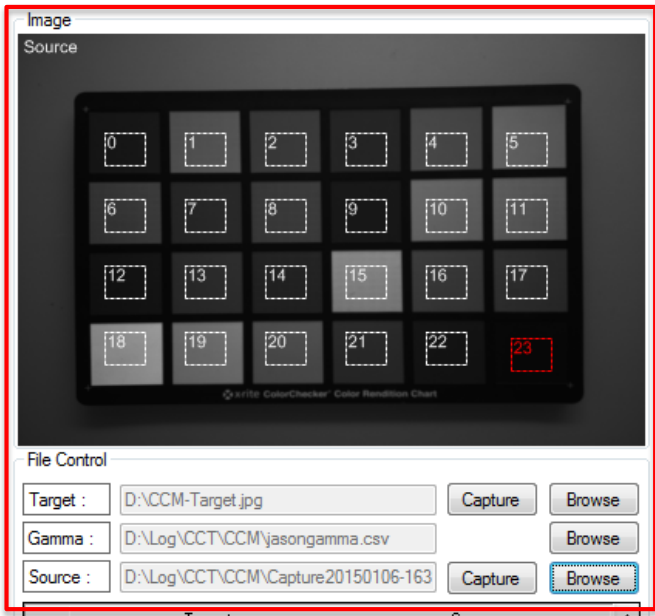
d) Click “Yes” for checking 24 sub-regions in “color checker” automatically

e) However, each sub-region can be modified separately



#	Target R	Target G	Target B	Source R	Source G	Source B
0	116	78	65	0	0	0
1	197	150	130	0	0	0
2	94	122	159	0	0	0
3	88	107	62	0	0	0
4	133	131	178	0	0	0
5	102	189	170	0	0	0
6	218	123	41	0	0	0
7	74	92	168	0	0	0
8	197	85	99	0	0	0

e

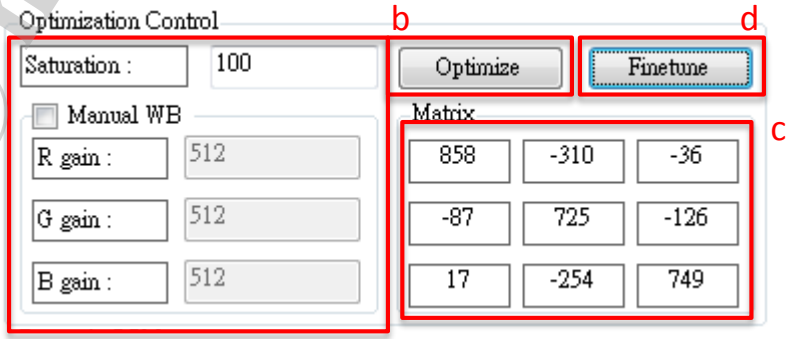


#	Target R	Target G	Target B	Source R	Source G	Source B
0	116	78	65	22.9	26.66	11.65
1	197	150	130	84.97	95.94	43.5
2	94	122	159	35.13	70.89	47.31
3	88	107	62	27.03	49.57	17.84
4	133	131	178	50.44	84.03	58.98
5	102	189	170	52.08	125.15	63.51
6	218	123	41	72.95	59.74	17.78
7	74	92	168	20.74	44.04	43.25
8	197	85	99	85.23	57.82	26.21

CCM calibration

Optimization

- After import target file/gamma/source file and select “color checker” area, “Optimize” button will be enabled.
- Flow
  a) Set saturation or manual WB for optimization setting.
  b) Click “Optimize” for calculating matrix
  c) Result will be fill in 3X3 text box
  d) If you want to finetune optimization result, click “Finetune” for detail tuning.



CCM calibration

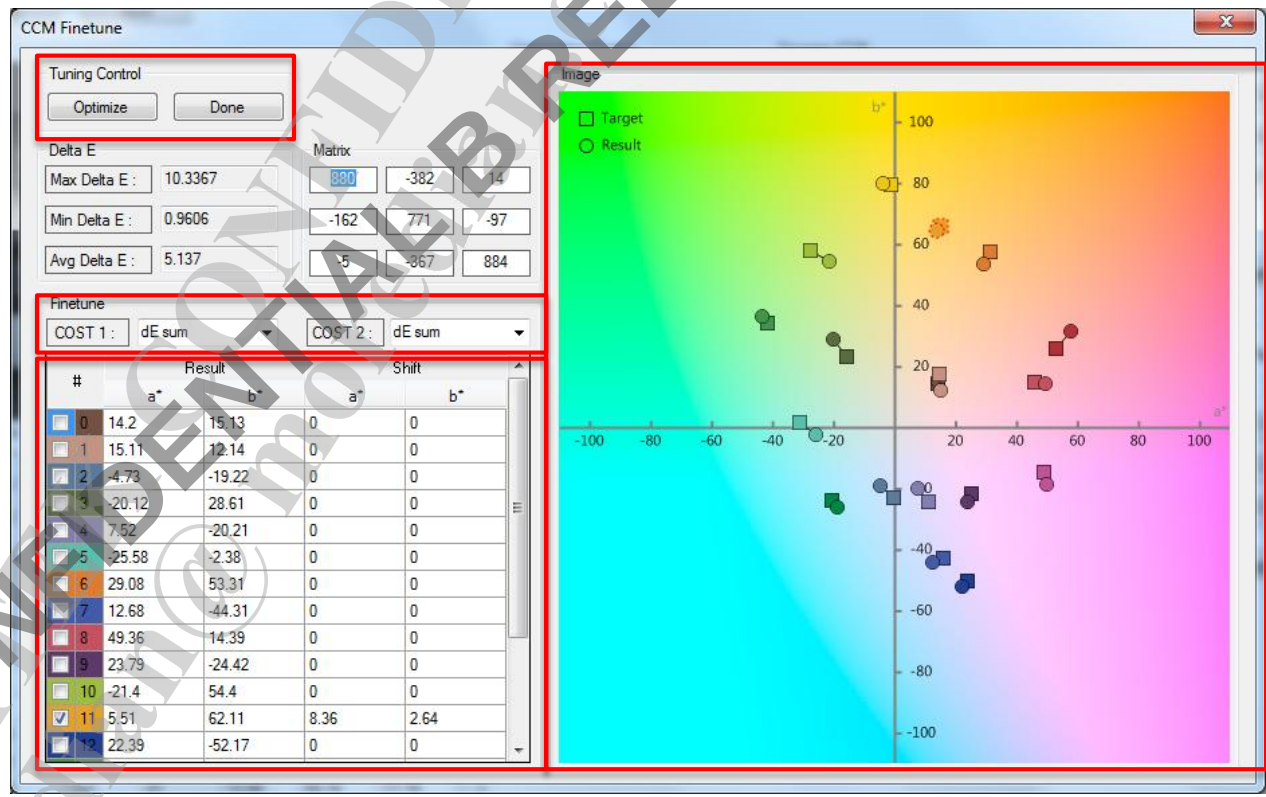
CCM finetune

a) Tuning control

b) COST function
- Formula of optimization

c) Data table
- Result data in a*b* domain
- Shift result for tuning in a*b* domain

d) Result image
- Target and optimization result shown in a*b* domain chart



a

b

c

d

CCM calibration

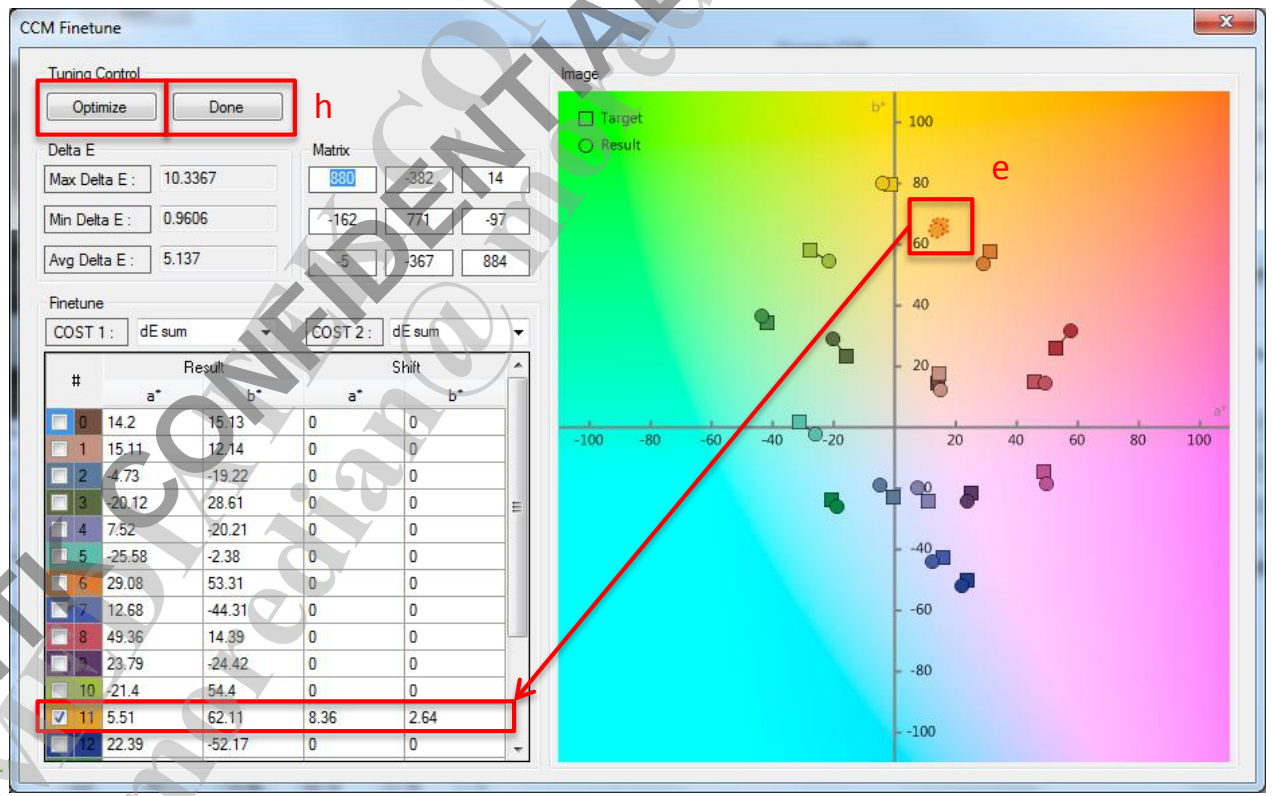
CCM finetune

e) Drag result point (circle) to the position you want to be.

f) Repeat e) until all points need to be modified have been shifted.

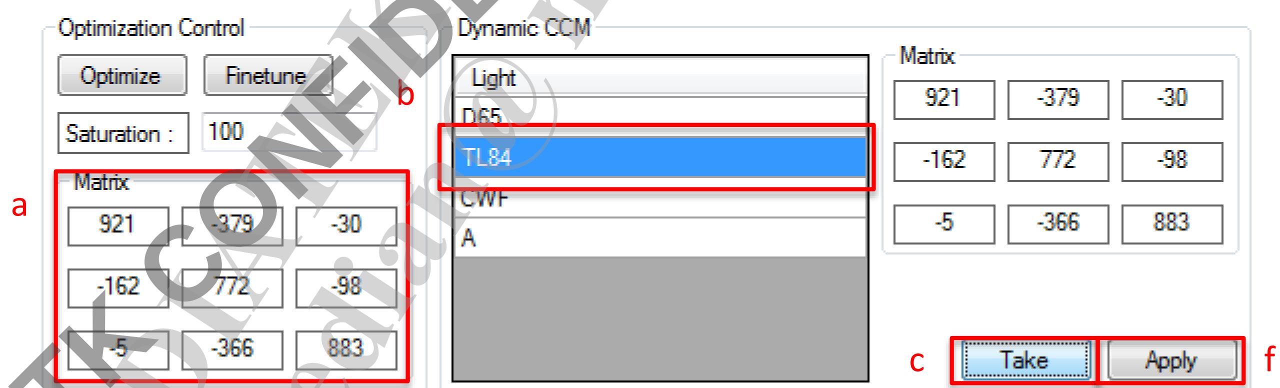
g) Click “Optimize” for re-calculating result.

h) Click “Done” for saving data to main CCM page.



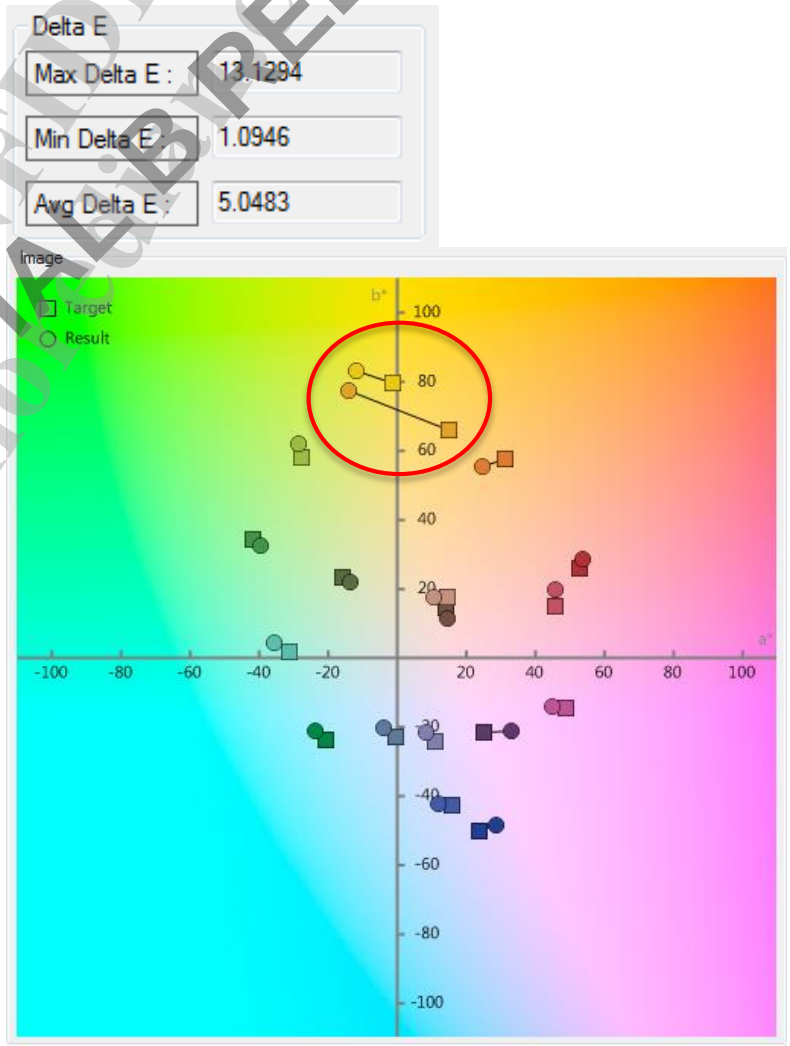
CCM calibration

- Dynamic CCM
  a) After optimization, matrix will fill in text boxes.
  b) Select destination light source.
  c) Click "Take" in Dynamic CCM group.
  d) Result matrix will be fill into mapping light source matrix.
  e) Repeat a) ~ d) until all light sources you want to modify have been changed.
  f) Click "Apply" in Dynamic CCM group for pushing data into phone.



Check CCM Calibration Result

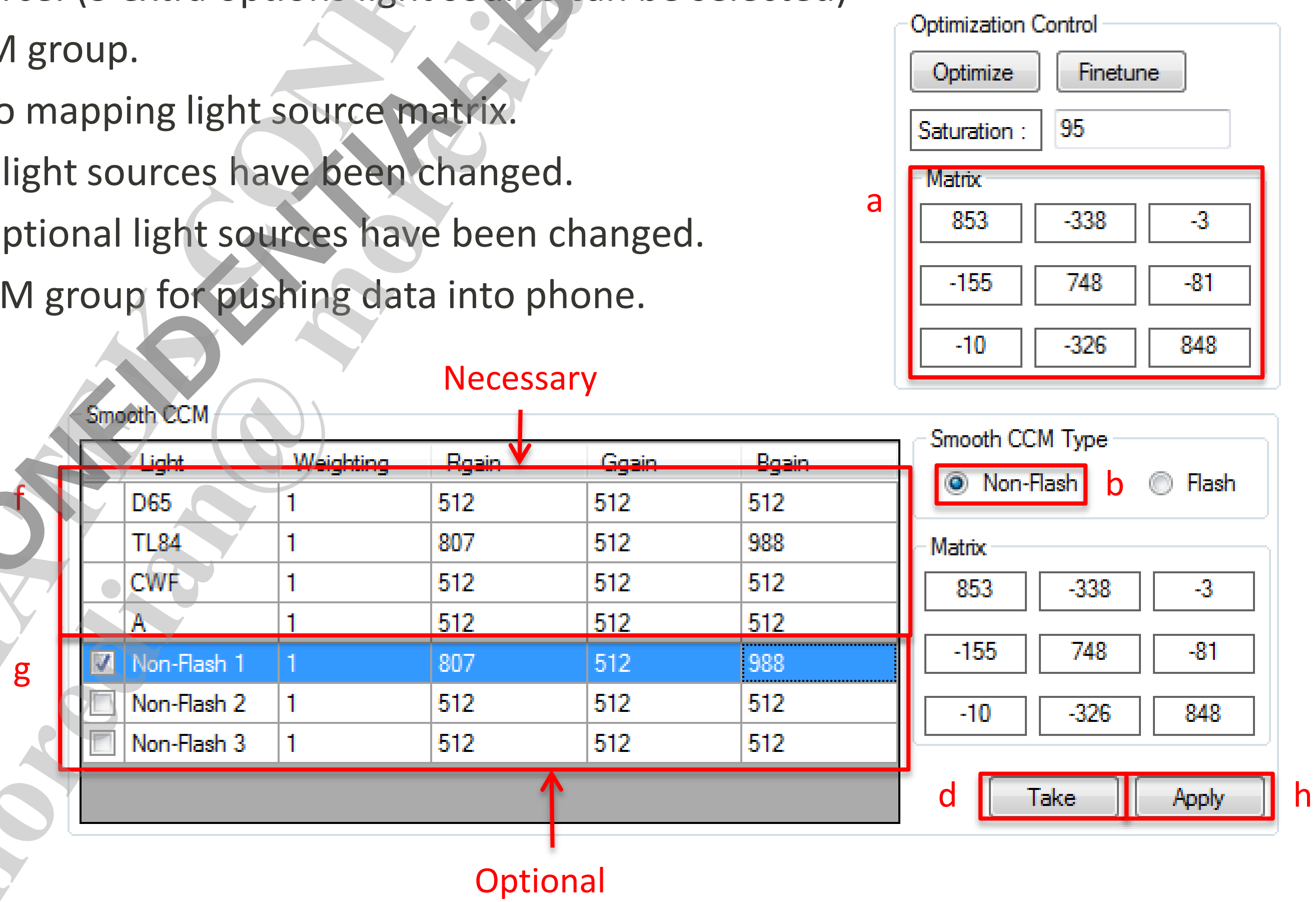
- Check point
  a) Avg Delta E < 10.
  b) Max Delta E < 20
  c) Color inverse.
- If check fail, please check
  - Source file
  - Gamma
  - Target data



CCM calibration

➢ Smooth CCM (Non-Flash)

a) After optimization, matrix will fill in text boxes.
b) Click “Non-Flash” in Smooth CCM Type
c) Select destination light source. (3 extra options light source can be selected)
d) Click “Take” in Smooth CCM group.
e) Result matrix will be fill into mapping light source matrix.
f) Repeat a) ~ d) until 4 basic light sources have been changed.
g) Repeat a) ~ d) until other optional light sources have been changed.
h) Click “Apply” in Smooth CCM group for pushing data into phone.



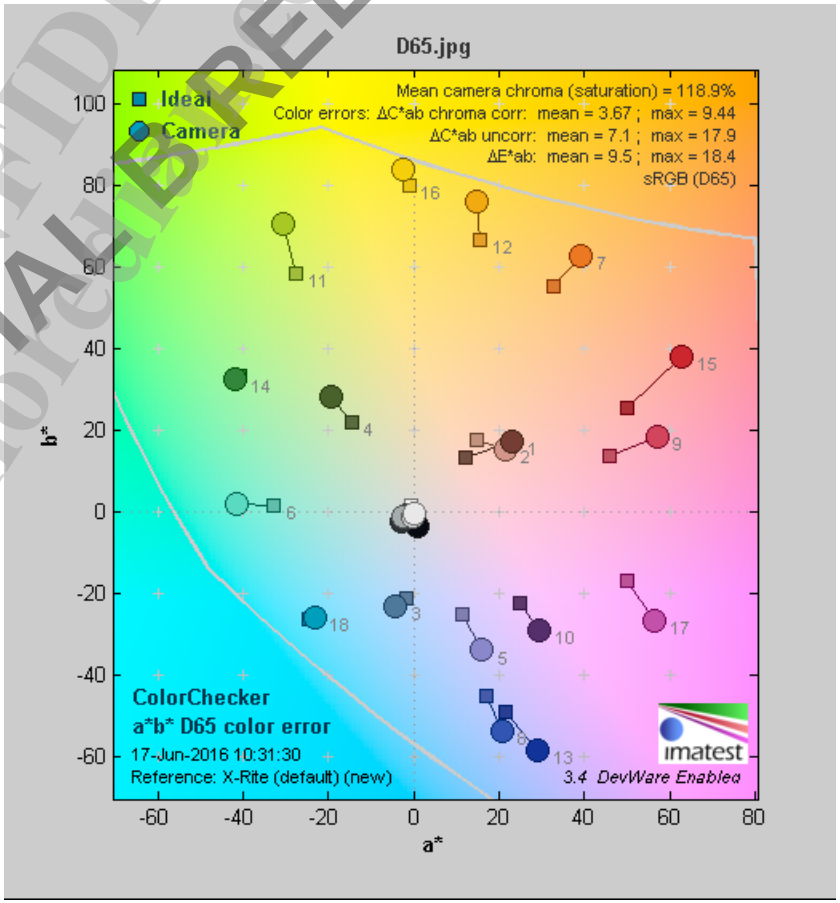
CCM calibration

Smooth CCM (Flash)

a) After optimization, matrix will fill in text boxes.
b) Click “Flash” in Smooth CCM Type
c) Select destination light source.
d) Click “Take” in Smooth CCM group.
e) Result matrix will be fill into mapping light source matrix.
f) Repeat a) ~ d) until 4 basic light sources have been changed.
g) Repeat a) ~ d) until 5 flash light sources have been changed.
h) Select 4 flash RGB gain that should cover as much area as possible
i) Click “Apply” in Smooth CCM group for pushing data into phone.

Smooth CCM Verification (1/2)

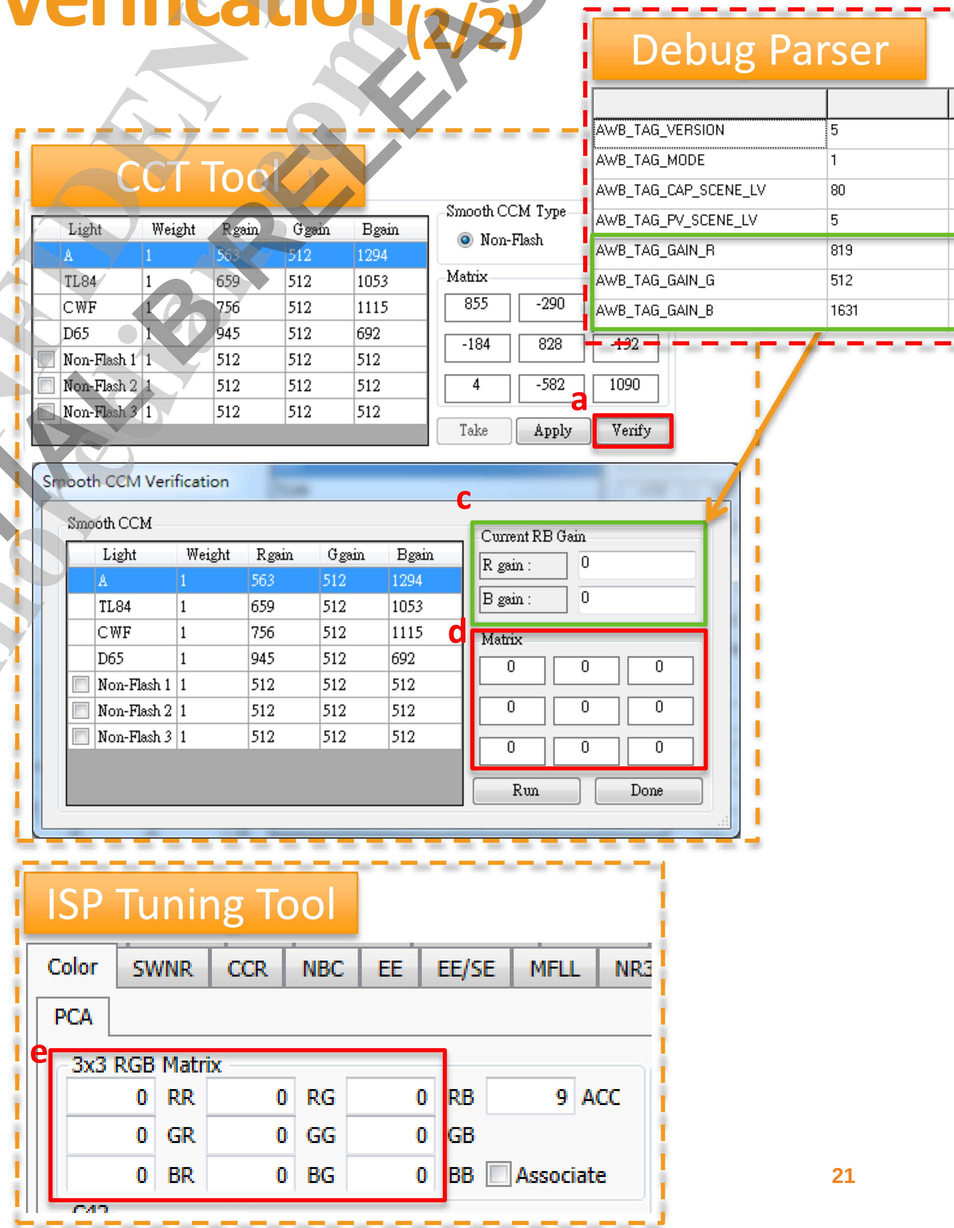
- Capture condition
  - Standard light box.
  - A/CWF/TL84/D65.
  - Color checker.
  - 30% FOV.
- Imatest
  - Check each light source.
  - @D65
    Saturation:110~120.
    dE*ab: mean < 10; max <20.



Note: If AE/AWB/GAMMA/DBS/OB is changed, we must verify CCM again.

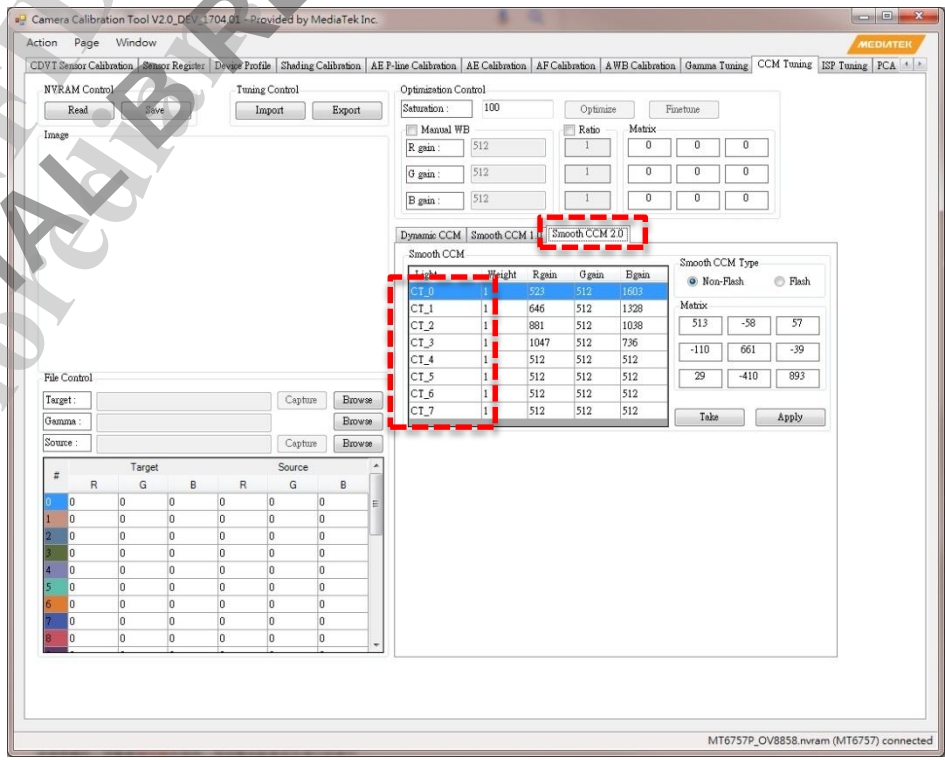
Smooth CCM Verification(2/2)

- Check CCM parameter
  a) Click ‘Verify’.
  b) Input ISP pre-gain w/o flare.
  c) Click ‘Run’.
  d) Result will show in text box.
  e) Use ISP tuning tool to check CCM from jpeg.
  f) The result should be nearly the same.
    - Difference between two matrix’ elements < 2



Smooth CCM 2.0

- Why Use Smooth CCM 2.0
  - Support More Light Source(up to 8)
  - More precise performance under CWF
- Calibration Method
  - Same as Smooth CCM 1.0



CCM calibration

- **Code path**
  - Path:
    vendor\mediatek\proprietary\custom*$project*\hal\imgsensor\ver2*$sensor*\camera_isp_colortbl_$sensor.h
  - Smooth CCM

```
const ISP_NVRAM_MULTI_CCM_STRUCT s5k3p9sxmipiraw_CCM_0000 = {
        .CCM_CT_valid_NUM = 5,
    .CCM_Coef = {1, 2, 2},
    .CCM_Reg=
    {
        {.set={//CT_00
            0x1FCD0260, 0x00001FD3, 0x02521FA1, 0x0000000D, 0x1E991FF8, 0x0000036F
        }},
        {.set={//CT_01
            0x1FCD0260, 0x00001FD3, 0x02521FA1, 0x0000000D, 0x1E991FF8, 0x0000036F
        }},
        {.set={//CT_02
            0x1F060322, 0x00001FD8, 0x02B21F7C, 0x00001FD2, 0x1EDD0005, 0x0000031E
        }},
        {.set={//CT_03
            0x1F060322, 0x00001FD8, 0x02B21F7C, 0x00001FD2, 0x1EDD0005, 0x0000031E
        }},
        {.set={//CT_04
            0x1E8203A9, 0x00001FD5, 0x02821FD3, 0x00001FAB, 0x1E840027, 0x00000355
        }},
        {.set={//CT_05
            0x00000000, 0x00000000, 0x00000000, 0x00000000, 0x00000000, 0x00000000
        }},
        {.set={//CT_06
            0x00000000, 0x00000000, 0x00000000, 0x00000000, 0x00000000, 0x00000000
        }},
        {.set={//CT_07
            0x00000000, 0x00000000, 0x00000000, 0x00000000, 0x00000000, 0x00000000
        }},
        {.set={//CT_08
            0x00000000, 0x00000000, 0x00000000, 0x00000000, 0x00000000, 0x00000000
        }},
        {.set={//CT_09
            0x00000000, 0x00000000, 0x00000000, 0x00000000, 0x00000000, 0x00000000
        }}
    },
```

```
.AWBGain=
{
    {//CT_01
        607,  // i4R
        512,  // i4G
        1265  // i4B
    },
    {//CT_01
        607,  // i4R
        512,  // i4G
        1265  // i4B
    },
    {//CT_03
        894,  // i4R
        512,  // i4G
        1036  // i4B
    },
    {//CT_03
        894,  // i4R
        512,  // i4G
        1036  // i4B
    },
    {//CT_04
        1182,  // i4R
        512,  // i4G
        647  // i4B
    },
    {//CT_05
        512,  // i4R
        512,  // i4G
        512  // i4B
    },
    {//CT_06
        512,  // i4R
        512,  // i4G
        512  // i4B
    },
    {//CT_07
        512,  // i4R
        512,  // i4G
        512  // i4B
    },
    {//CT_08
        512,  // i4R
        512,  // i4G
        512  // i4B
    },
    {//CT_09
        512,  // i4R
        512,  // i4G
        512  // i4B
    }
}
```

```
.Lv_Env={
    .u2Length = 6,
    .IDX_Partition =
    {-30, -10, 10, 50, 100, 120}
},
```

- In each CCM parameters file, we will have 6 sets of CCM for different LV, every set of CCM has 10 indexs for different CT. First of all, we can keep the same set of CCM at different LV.
- The LV threshold for CCM is in "camera_ISP_common_XXXmipiraw.h", this LV setting shares with ColorEngine.