INTERNAL USE

Contrast 2.0 Training Document

2018/02/09

Outline

- Contrast 2.0 = LCE 5.0 + DCE 1.0
  - LCE 5.0
  - DCE 1.0

Contrast 2.0 Policy

GMA

Global Tone

LCE

GMA

Local Tone

LCE

GMA

DCE

Contrast

Gamma only

GMA

The tone is increase : like dark side of the left-handed building and grove.

The contrast enhance : like cloud, grove and road.

Gamma + LCE

The tone is increase : like dark side of the left-handed building and grove.

The contrast enhance : like cloud, grove and road.

Gamma + LCE + DCE

LCE

GMA

DCE

The tone is increase :
like dark side of the left-handed building and grove.

The contrast enhance :
like cloud, grove and road.

LCE 5.0

Difference between *LCE 4.6* and *LCE 5.0*

- LCE
  - LCE Tone Curve more precisely
    [Hardware] Control point : 5 → 8
  - Reduce tuning effort :
    Manually generate Tone Curve
    → Automatically generate Tone Curve
  - Accurate Face Brightness Control
    LCE-AE link

Target increase

Target 1800
Strength 800

Target 2048
Strength 800

Target 2248
Strength 800

Target 1800

The brightness of whole picture is increasing while target increased.

Target 2048

The brightness of whole picture is increasing while target increased.

Target 2248

The brightness of whole picture is increasing while target increased.

Strength increase

Target 2048
Strength 639

Target 2048
Strength 800

Target 2048
Strength 1000

Strength 639

Bright part like cloud :
Brightness is increase
while Strength increase

Dark part like tree :
Brightness is decrease
while Strength increase

Strength 800

Bright part like cloud :
Brightness is increase
while Strength increase

Dark part like tree :
Brightness is decrease
while Strength increase

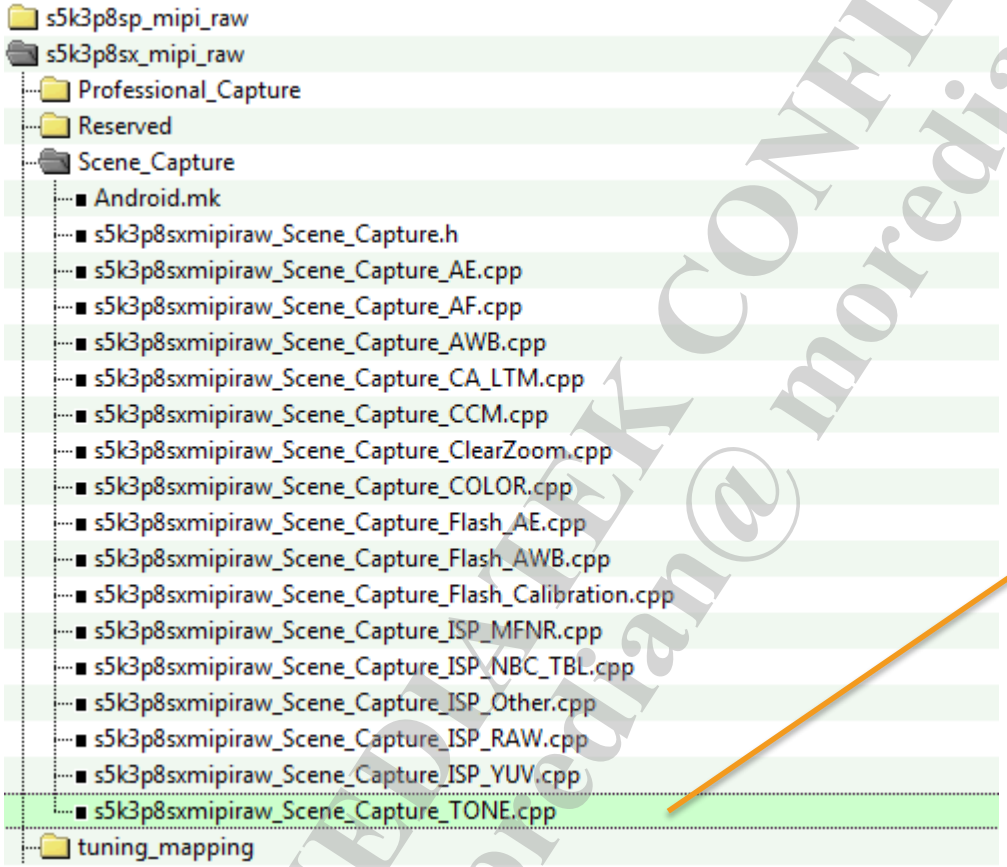
Strength 1000

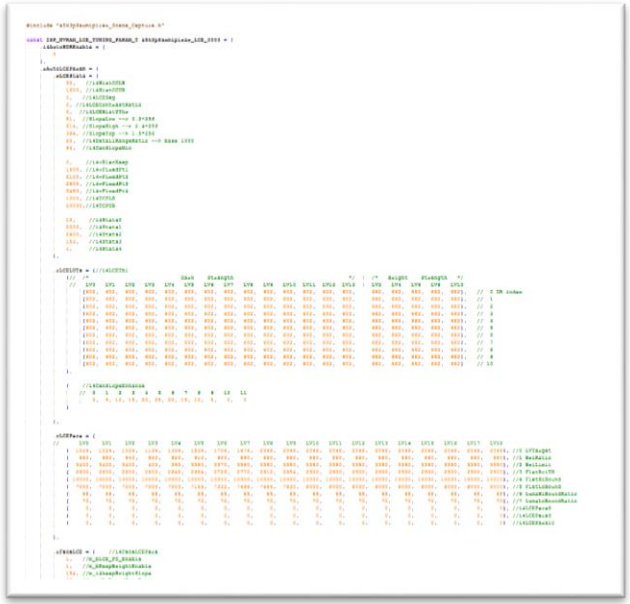
Bright part like cloud :
Brightness is increase
while Strength increase

Dark part like tree :
Brightness is decrease
while Strength increase

Tone Curve Generation

- [Sensor]_[Scenario]_TONE.cpp

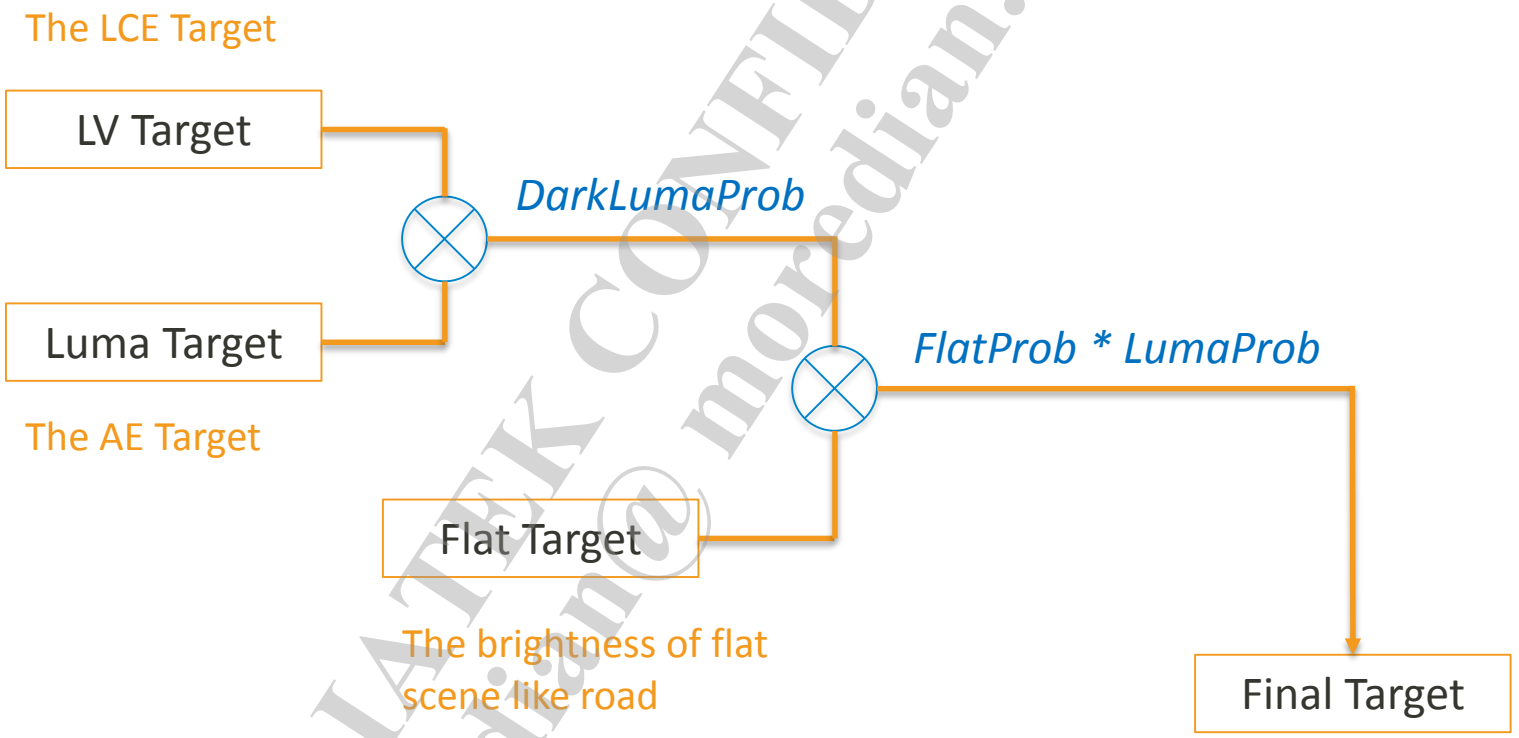




Target tuning

- LV Target
- Luma Target
- Flat Target

- DarkLumaProb
- FlatProb
- LumaProb



Target tuning

- LV Target
- Luma Target
- Flat Target

- DarkLumaProb
- FlatProb
- LumaProb

```
.rLCEPara = {
//      LV0    LV1    LV2    LV3    LV4    LV5    LV6    LV7    LV8    LV9    LV10   LV11   LV12   LV13   LV14   LV15   LV16   LV17   LV18
    {  1024,  1024,  1024,  1194,  1364,  1534,  1704,  1874,  2048,  2048,  2048,  2048,  2048,  2048,  2048,  2048,  2048,  2048,  2048}, //0 LVTarget
    {   950,   950,   940,   930,   920,   910,   900,   890,   880,   880,   880,   880,   880,   880,   880,   880,   880,   880,   880}, //1 BriRatio
    {  3400,  3400,  3400,   400,   390,  3380,  3370,  3360,  3350,  3350,  3350,  3350,  3350,  3350,  3350,  3350,  3350,  3350,  3350}, //2 BriLimit
    {  2600,  2600,  2600,  2600,  2642,  2684,  2726,  2770,  2812,  2854,  2900,  2900,  2900,  2900,  2900,  2900,  2900,  2900,  2900}, //3 FlatBriTH
    { 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000}, //4 FlatHiBound
    {  7000,  7000,  7000,  7000,  7000,  7166,  7332,  7498,  7664,  7830,  8000,  8000,  8000,  8000,  8000,  8000,  8000,  8000,  8000}, //5 FlatLoBound
    {    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85}, //6 LumaHiBoundRatio
    {    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70}, //7 LumaLoBoundRatio
    {     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0}, //i4LCEPara8
    {     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0}, //i4LCEPara9
    {     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0}  //i4LCEPara10
```

variable name: LVTarget
data range: 0 - 3700
The value to determine the brightness of LV Target

Target tuning

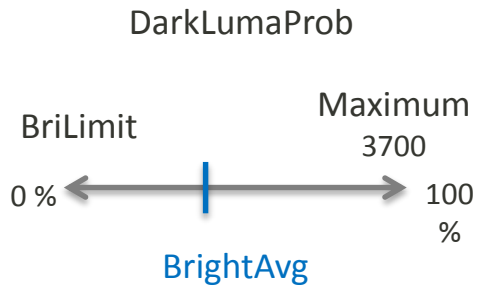
- LV Target
- Luma Target
- Flat Target

- DarkLumaProb
- FlatProb
- LumaProb

```
.rLCEPara = {
//      LV0    LV1    LV2    LV3    LV4    LV5    LV6    LV7    LV8    LV9    LV10   LV11   LV12   LV13   LV14   LV15   LV16   LV17   LV18
    {  1024,  1024,  1024,  1194,  1364,  1534,  1704,  1874,  2048,  2048,  2048,  2048,  2048,  2048,  2048,  2048,  2048,  2048}, //0 LVTarget
    {   950,   950,   940,   930,   920,   910,   900,   890,   880,   880,   880,   880,   880,   880,   880,   880,   880,   880}, //1 BriRatio
    {  3400,  3400,  3400,   400,   390,  3380,  3370,  3360,  3350,  3350,  3350,  3350,  3350,  3350,  3350,  3350,  3350,  3350}, //2 BriLimit
    {  2600,  2600,  2600,  2600,  2642,  2684,  2726,  2770,  2812,  2854,  2900,  2900,  2900,  2900,  2900,  2900,  2900,  2900}, //3 FlatBriTH
    { 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000}, //4 FlatHiBound
    {  7000,  7000,  7000,  7000,  7000,  7166,  7332,  7498,  7664,  7830,  8000,  8000,  8000,  8000,  8000,  8000,  8000,  8000}, //5 FlatLoBound
    {    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85}, //6 LumaHiBoundRatio
    {    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70}, //7 LumaLoBoundRatio
    {     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0}, //i4LCEPara8
    {     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0}, //i4LCEPara9
    {     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0}  //i4LCEPara10
```

variable name: BriRatio
data range: 0 - 1000
The value to determine the amount of dark-part light map to calculate the **BrightAvg** (average brightness of dark part)

variable name: BriLimit
data range: 0 - 3700
The value to determine the lower bound of DarkLumaProb



Target tuning

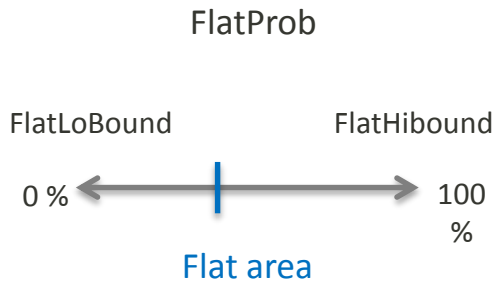
- LV Target
- Luma Target
- Flat Target
- DarkLumaProb
- FlatProb
- LumaProb

```
.rLCEPara = {
//      LV0    LV1    LV2    LV3    LV4    LV5    LV6    LV7    LV8    LV9    LV10   LV11   LV12   LV13   LV14   LV15   LV16   LV17   LV18
    {  1024,  1024,  1024,  1194,  1364,  1534,  1704,  1874,  2048,  2048,  2048,  2048,  2048,  2048,  2048,  2048,  2048,  2048}, //0 LVTarget
    {   950,   950,   940,   930,   920,   910,   900,   890,   880,   880,   880,   880,   880,   880,   880,   880,   880,   880}, //1 BriRatio
    {  3400,  3400,  3400,   400,   390,  3380,  3370,  3360,  3350,  3350,  3350,  3350,  3350,  3350,  3350,  3350,  3350,  3350}, //2 BriLimit
    {  2600,  2600,  2600,  2600,  2642,  2684,  2726,  2770,  2812,  2854,  2900,  2900,  2900,  2900,  2900,  2900,  2900,  2900}, //3 FlatBriTH
    { 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000}, //4 FlatHiBound
    {  7000,  7000,  7000,  7000,  7000,  7166,  7332,  7498,  7664,  7830,  8000,  8000,  8000,  8000,  8000,  8000,  8000,  8000}, //5 FlatLoBound
    {    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85}, //6 LumaHiBoundRatio
    {    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70}, //7 LumaLoBoundRatio
    {     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0}, //i4LCEPara8
    {     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0}, //i4LCEPara9
    {     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0}  //i4LCEPara10
```

variable name: FlatBriTH
data range: 0 – 3700
The brightness threshold to determine whether the flat case should consider

variable name: FlatHiBound
The upper bound of the flat area for FlatProb

variable name: FlatLoBound
The lower bound of the flat area for FlatProb



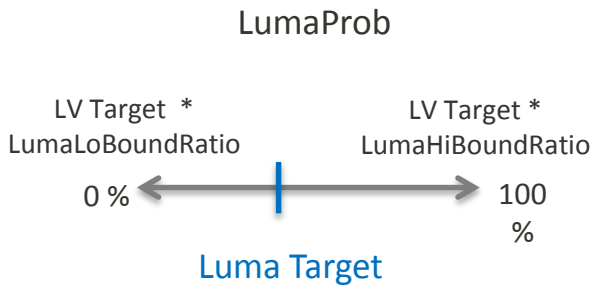
Target tuning

- LV Target
- Luma Target
- Flat Target
- DarkLumaProb
- FlatProb
- LumaProb

```
.rLCEPara = {
//      LV0    LV1    LV2    LV3    LV4    LV5    LV6    LV7    LV8    LV9    LV10   LV11   LV12   LV13   LV14   LV15   LV16   LV17   LV18
    {  1024,  1024,  1024,  1194,  1364,  1534,  1704,  1874,  2048,  2048,  2048,  2048,  2048,  2048,  2048,  2048,  2048,  2048}, //0 LVTarget
    {   950,   950,   940,   930,   920,   910,   900,   890,   880,   880,   880,   880,   880,   880,   880,   880,   880,   880}, //1 BriRatio
    {  3400,  3400,  3400,   400,   390,  3380,  3370,  3360,  3350,  3350,  3350,  3350,  3350,  3350,  3350,  3350,  3350,  3350}, //2 BriLimit
    {  2600,  2600,  2600,  2600,  2642,  2684,  2726,  2770,  2812,  2854,  2900,  2900,  2900,  2900,  2900,  2900,  2900,  2900}, //3 FlatBriTH
    { 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000}, //4 FlatHiBound
    {  7000,  7000,  7000,  7000,  7000,  7166,  7332,  7498,  7664,  7830,  8000,  8000,  8000,  8000,  8000,  8000,  8000,  8000}, //5 FlatLoBound
    {    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85,    85}, //6 LumaHiBoundRatio
    {    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70,    70}, //7 LumaLoBoundRatio
    {     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0}, //i4LCEPara8
    {     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0}, //i4LCEPara9
    {     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0}  //i4LCEPara10
```

variable name: LumaHiBoundRatio
data range: 0 - 100
The ratio to calculate upper bound of brightness for LumaProb

variable name: LumaLoBoundRatio
data range: 0 - 100
The ratio to calculate lower bound of brightness for LumaProb



Strength tuning

- ❑ Dark Strength table : LV and DR idx
- ❑ Bright Strength table : LV and DR idx

```
.rLCELUTs = {//i4LCETbl
    {//  /*                                    Dark     Strangth                                           */  |  /*   Bright     Strength    */
     //    LV0     LV1     LV2     LV3     LV4     LV5     LV6     LV7     LV8     LV9     LV10    LV11    LV12    LV13   |  LV2     LV4     LV6     LV8     LV10
          {602,   602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,      682,    682,    682,    682,    682},    //  0 DR index
          {602,   602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,      682,    682,    682,    682,    682},    //  1
          {602,   602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,      682,    682,    682,    682,    682},    //  2
          {602,   602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,      682,    682,    682,    682,    682},    //  3
          {602,   602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,      682,    682,    682,    682,    682},    //  4
          {602,   602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,      682,    682,    682,    682,    682},    //  5
          {602,   602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,      682,    682,    682,    682,    682},    //  6
          {602,   602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,      682,    682,    682,    682,    682},    //  7
          {602,   602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,      682,    682,    682,    682,    682},    //  8
          {602,   602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,      682,    682,    682,    682,    682},    //  9
          {602,   602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,    602,      682,    682,    682,    682,    682}     // 10
    },
```

variable name: i4LCETb1
The Dark/Bright Strength table

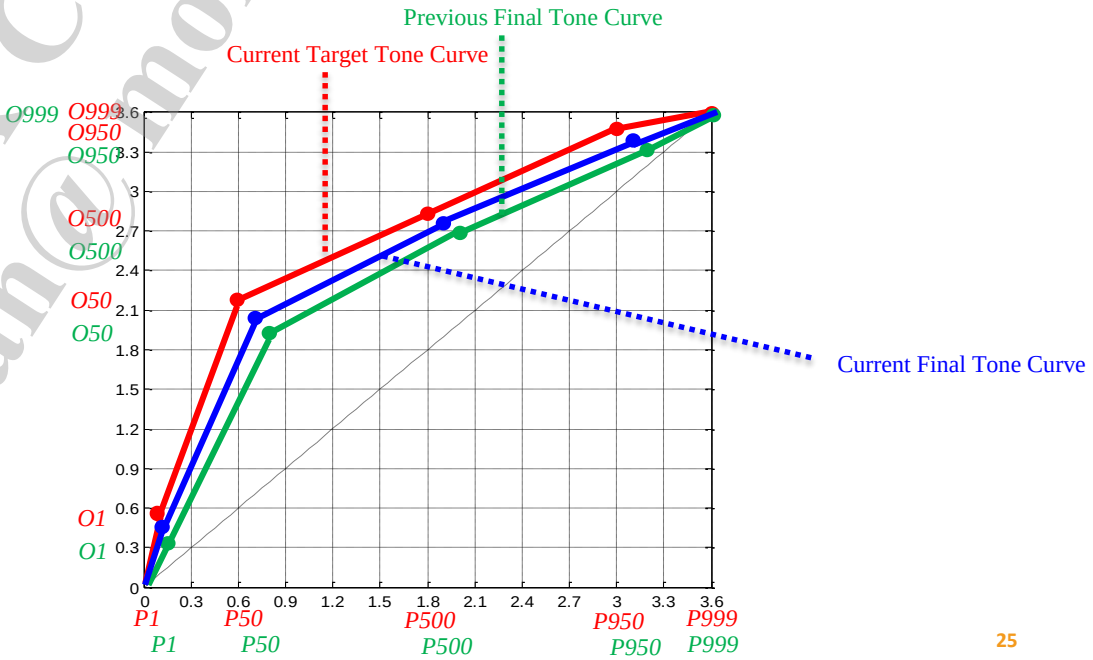
Smooth tuning

```
.rLCESmooth = {   // rLCESmooth
    70,
    3,
    3
},
```

variable name: rLCESmooth
data range: 0 - 100
Smooth ratio of LCE

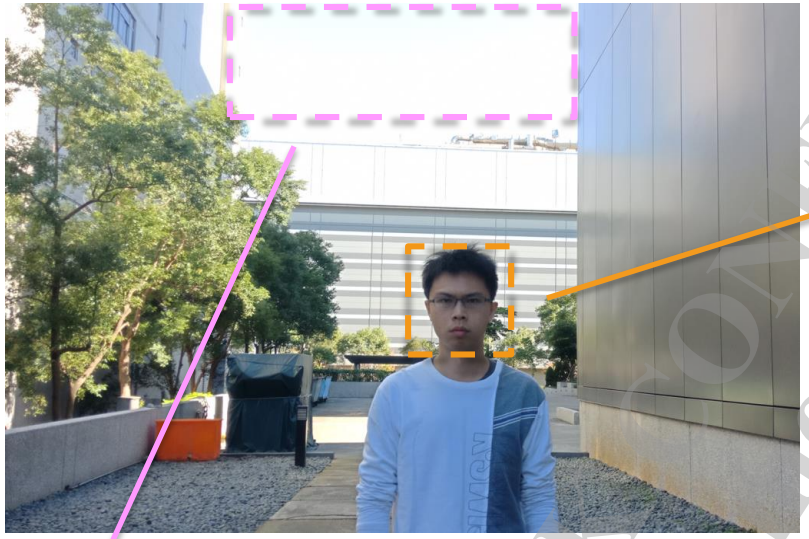
1. AE unstable, changed with same direction
2. AE unstable, changed with different direction
3. AE stable

All should be set 100 in the Scenario Capture



LCE 5.0 Improvement in FACE scene

LCE 4.6



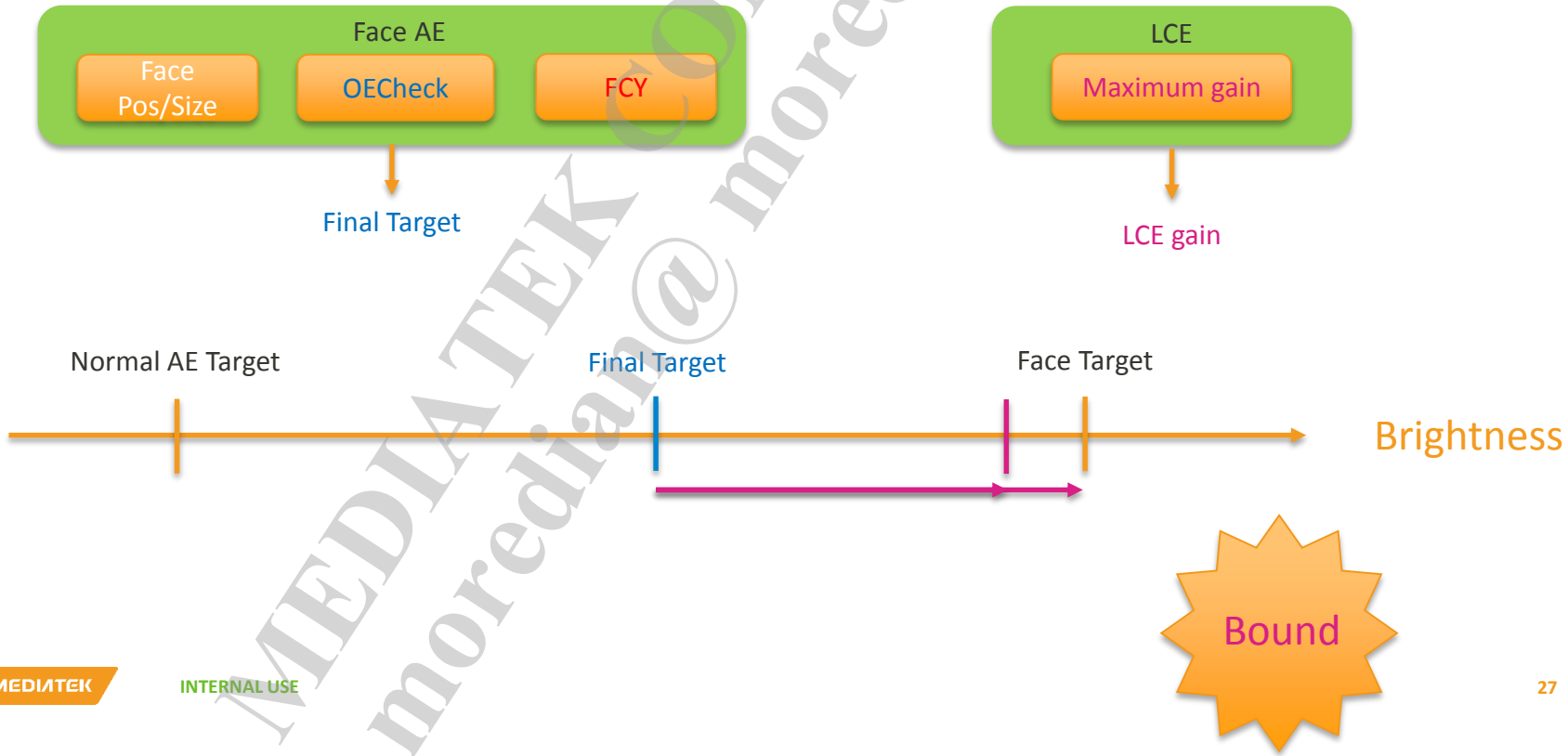
The brightness of face keeps.

LCE 5.0

Overexposure at background is improved, like sky and the building behind.

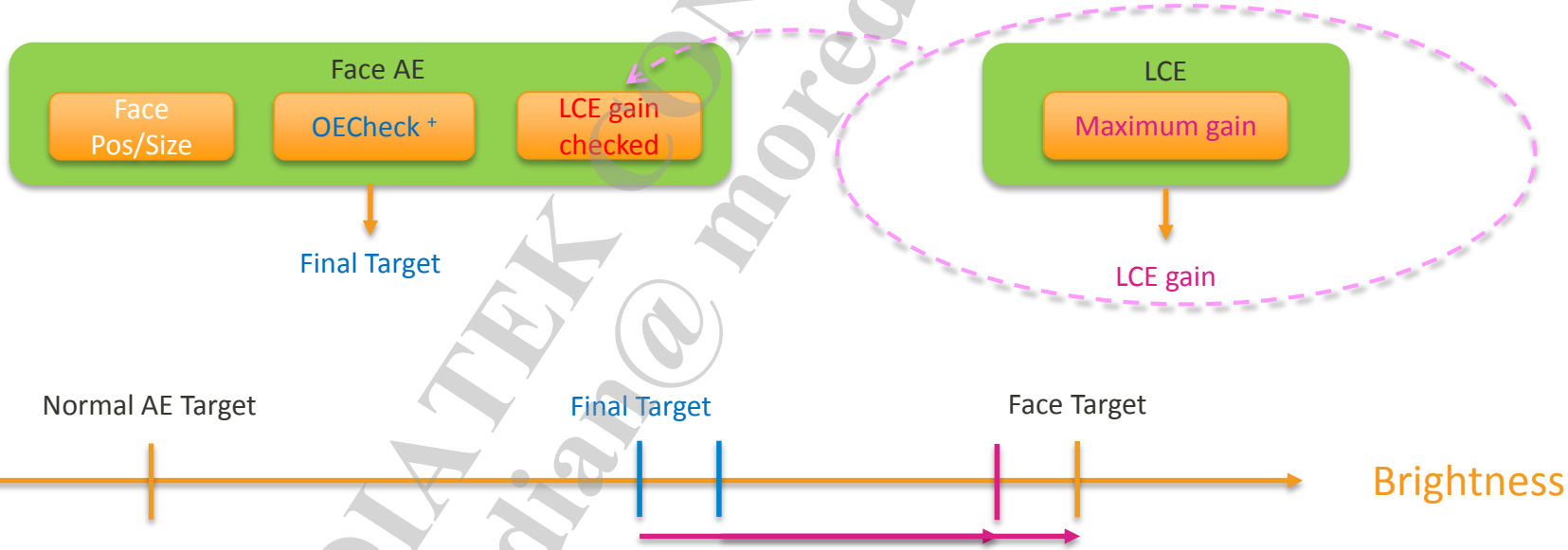
Accurate Face Brightness Control

- ISP 4.6
  - AE and LSE consider the face brightness separately.



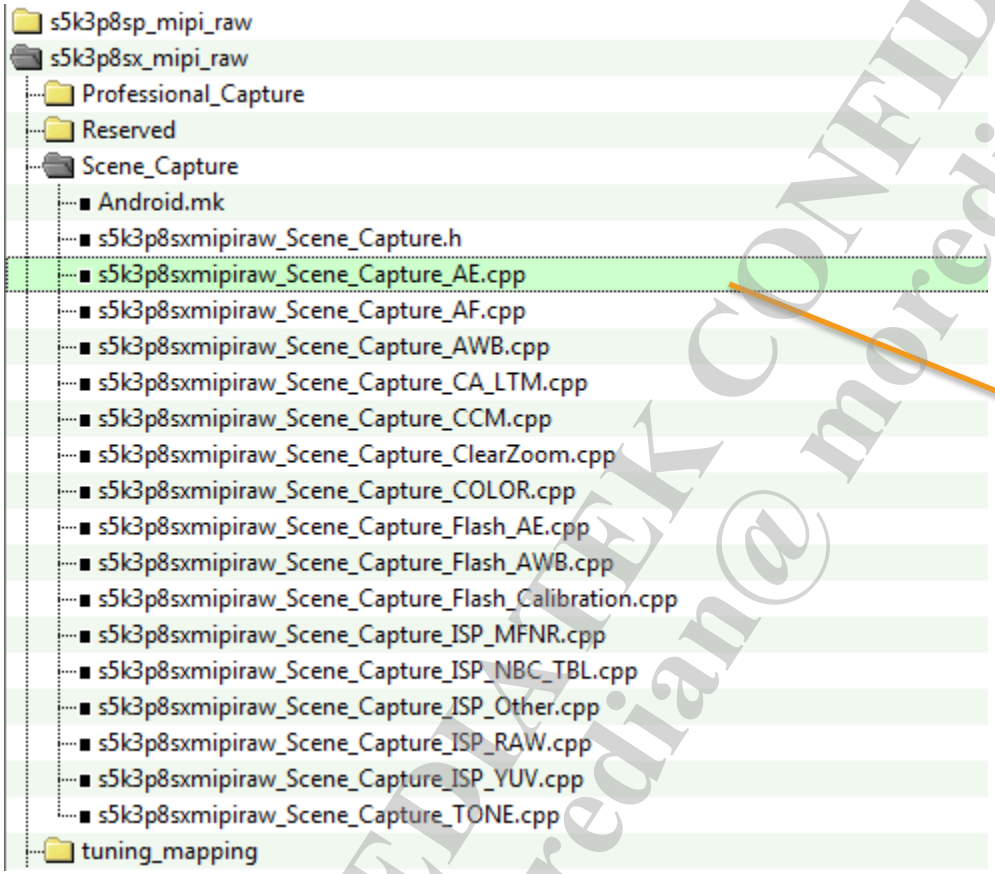
Accurate Face Brightness Control

- ISP 5.0
  - AE and LSE consider the face brightness simultaneously.
    → LCE-AE link



Accurate Face Brightness Control

- [Sensor]_[Scenario]_AE.cpp



LCE-AE link method

```
.rHistConfig = {
    0,
    30,
    200,
    300,
    0,
    1024,
    {1024, 1024, 13, 210, 200},
    {200, 300, 1024, 0, 141},
    {250, 400, 450, 450, 500}
},
```

variable name: LCE-AE link enable
data range: 0 / 1
The flag to disable/enable the LCE-AE link method

OE Check+

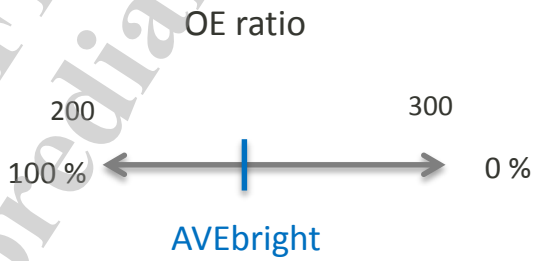
```
.rHistConfig = {
    0,
    30,
    200,
    300,
    0,
    1024,
    {1024, 1024, 13, 210, 200},
    {200, 300, 1024, 0, 141},
    {250, 400, 450, 450, 500}
},
```

variable name: bright part ratio
data range: 0 - 1000
The ratio to define the bright part to calculate AVEbright

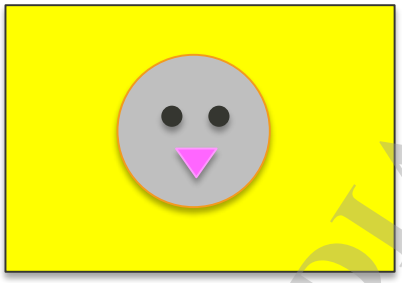
OE Check+

```
.rHistConfig = {
    0,
    30,
    200,
    300,
    0,
    1024,
    {1024, 1024, 13, 210, 200},
    {200, 300, 1024, 0, 141},
    {250, 400, 450, 450, 500}
},
```

variable name: OE table
The ratio table for determine OECheck ratio for mixing the face and normal target



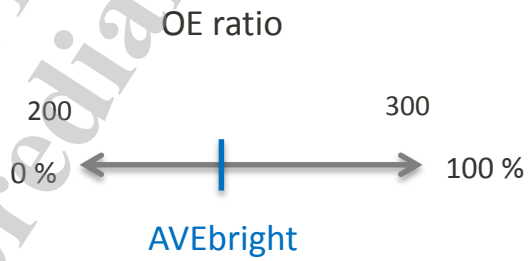
Normal AE Target should be mixed more



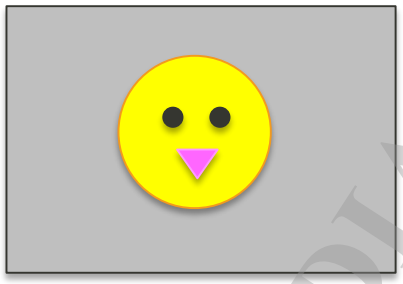
OE Check+

```
.rHistConfig = {
    0,
    30,
    200,
    300,
    0,
    1024,
    {1024, 1024, 13, 210, 200},
    {200, 300, 1024, 0, 141},
    {250, 400, 450, 450, 500}
},
```

variable name: inverse OE table
The ratio table for determine OECheck ratio for mixing the face and normal target



Normal AE Target should be mixed less



LCE Maximum Gain

```
.rHistConfig = {
    0,
    30,
    200,
    300,
    0,
    1024,
    {1024, 1024, 13, 210, 200},
    {200, 300, 1024, 0, 141},
    {250, 400, 450, 450, 500}
},
```

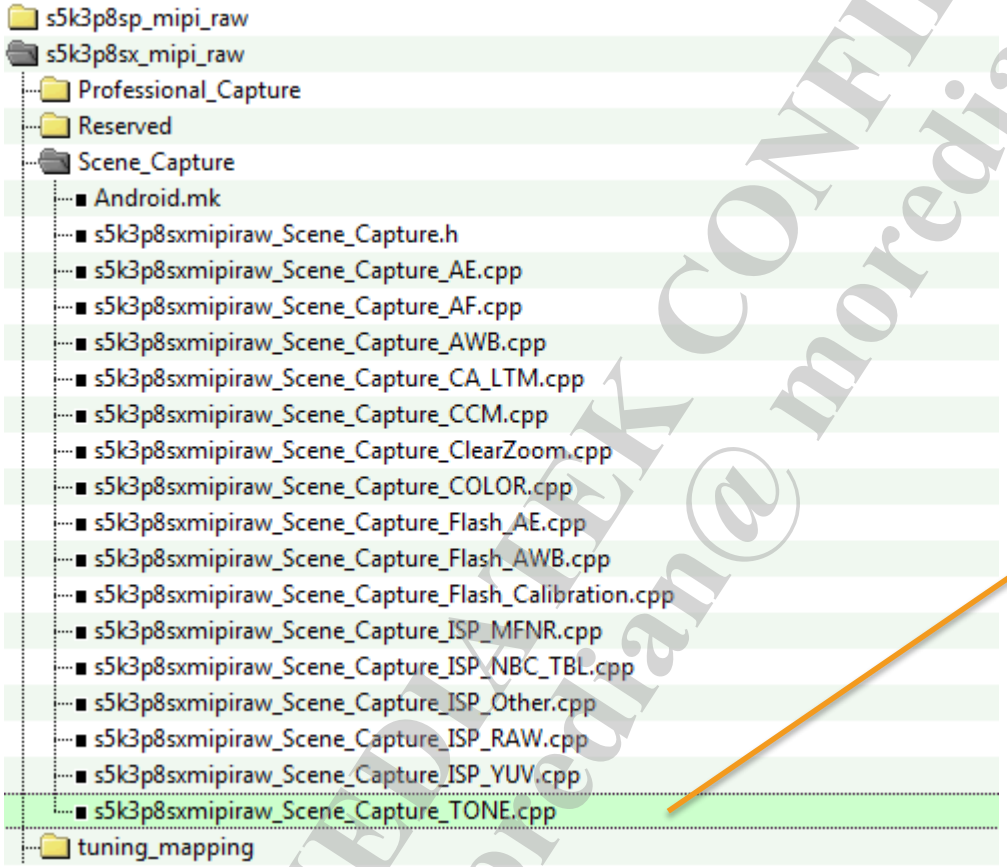
variable name: Maximum LCE gain table
The maximum LCE gain for face enhancement

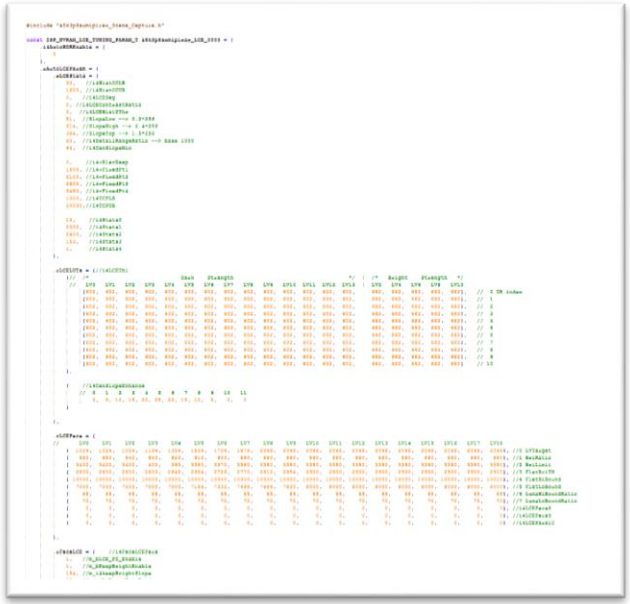
LV	0	5	10	15	18
Maximum LCE gain	250	400	450	450	500

DCE 1.0

Tone Curve Generation

- [Sensor]_[Scenario]_TONE.cpp





Strength tuning

- Dark Strength table : LV and DR idx
- Bright Strength table : LV and DR idx

```
{ //i4DCETbl1
  // DarkStrength                                    BrightStrength
  // LV0  LV2  LV4  LV6  LV8  LV10 LV12 LV14 LV16 LV0  LV2  LV4  LV6  LV8  LV10 LV12 LV14 LV16  TBD
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, //  0 DR index
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, //  1
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, //  2
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, //  3
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, //  4
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, //  5
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, //  6
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, //  7
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, //  8
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, //  9
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, // 10
```

variable name: i4DCETbl1
data range: 0 - 100
The Dark/Bright Strength table

Strength tuning

- Dark Strength table in face case : LV
- Bright Strength table in face case : LV

```
{ //i4DCETbl2
  // LV0     LV2    LV4    LV6    LV8   LV10   LV12   LV14   LV16    LV0    LV2    LV4    LV6    LV8   LV10   LV12   LV14   LV16   TBD
    {   0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0, 100}, // Face_DarkStrength : Face_BrightStrength
    {3300, 3300, 3300, 3300, 3300, 3300, 3300, 3300, 3300, 3500, 3500, 3500, 3500, 3500, 3500, 3500, 3500, 3500, 100}, // SkyDetectThr : SkyLimitThr
    {  20,    20,    20,    20,    20,    20,    20,    20,    20,    10,    10,    10,    10,    10,    10,    10,    10,    10, 100}, // SkyProtectOnThr : SkyProtectOffThr
    { 150,  150,  150,  150,  150,  150,  150,  150,  150,   80,   80,   80,   80,   80,   80,   80,   80,   80,   100}, // ContourLimitThr
    { 30,   30,   30,   30,   30,   30,   30,   30,   30,   80,   80,   80,   80,   80,   80,   80,   80,   80,   100}, // TBD
    { 30,   30,   30,   30,   30,   30,   30,   30,   30,   80,   80,   80,   80,   80,   80,   80,   80,   80,   100}, // TBD
    { 30,   30,   30,   30,   30,   30,   30,   30,   30,   80,   80,   80,   80,   80,   80,   80,   80,   80,   100}, // TBD
    { 30,   30,   30,   30,   30,   30,   30,   30,   30,   80,   80,   80,   80,   80,   80,   80,   80,   80,   100}, // TBD
    { 30,   30,   30,   30,   30,   30,   30,   30,   30,   80,   80,   80,   80,   80,   80,   80,   80,   80,   100}, // TBD
    { 30,   30,   30,   30,   30,   30,   30,   30,   30,   80,   80,   80,   80,   80,   80,   80,   80,   80,   100}, // TBD
    { 30,   30,   30,   30,   30,   30,   30,   30,   30,   80,   80,   80,   80,   80,   80,   80,   80,   80,   100}, // TBD
}
```

variable name: i4DCETbl2[0] – Face DarkStrength/Face BrightStrength
data range: 0 - 100
The Dark/Bright Strength table

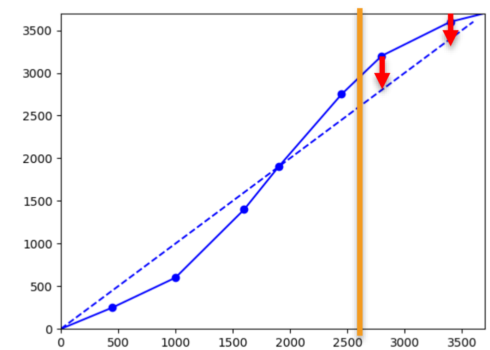
Sky constraint tuning

```
{ //i4DCETbl2
  // LV0    LV2    LV4    LV6    LV8   LV10   LV12   LV14   LV16    LV0    LV2    LV4    LV6    LV8   LV10   LV12   LV14   LV16  TBD
    {   0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,     0,  100}, // Face_DarkStrength : Face_BrightStrength
    {3300,  3300,  3300,  3300,  3300,  3300,  3300,  3300,  3300,  3500,  3500,  3500,  3500,  3500,  3500,  3500,  3500,  3500,  100}, // SkyDetectThr : SkyLimitThr
    {  20,    20,    20,    20,    20,    20,    20,    20,    20,    10,    10,    10,    10,    10,    10,    10,    10,    10,  100}, // SkyProtectOnThr : SkyProtectOffThr
    { 150,   150,   150,   150,   150,   150,   150,   150,   150,    80,    80,    80,    80,    80,    80,    80,    80,    80,  100}, // ContourLimitThr
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, // TBD
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, // TBD
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, // TBD
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, // TBD
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, // TBD
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, // TBD
    { 30,  30,  30,  30,  30,  30,  30,  30,  30,  80,  80,  80,  80,  80,  80,  80,  80,  80,  100}, // TBD
}
```

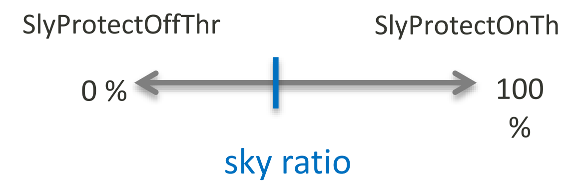
variable name: i4DCETbl2[1] – SkyLimitThr
data range: 0 – 3700
The brightness threshold to do the sky protection

variable name: i4DCETbl2[2] – SkyProtectOnThr
data range: 0 - 100
The upper bound ratio for Sky protect ratio

variable name: i4DCETbl2[2] – SkyProtectOffThr
data range: 0 – 100
The lower bound ratio for Sky protect ratio



Sky protect ratio

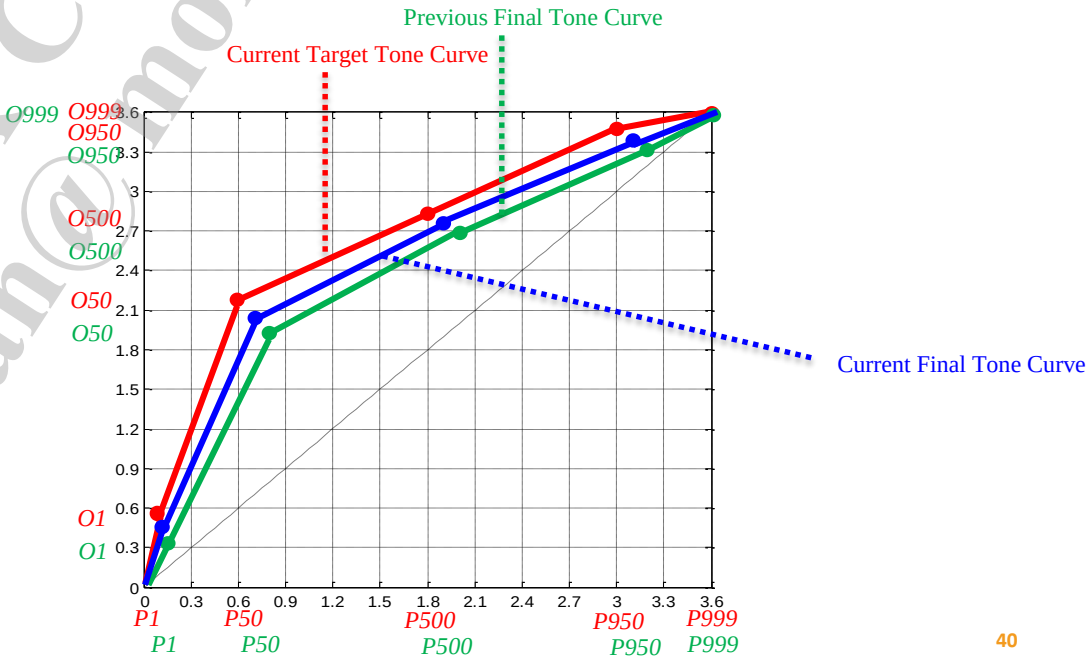


Smooth tuning

```
.rDceParam=
{
    30, // SmoothDCESpeed
```

variable name: SmoothDCESpeed
data range: 0 - 100
Smooth ratio of DCE

All should be set 100 in the Scenario Capture



everyday genius