CONFIDENTIAL B

MT6771 AF introduction

Revision

Revision	Date	Description
V1.0	2017.12.26	The first version of AF document
V1.1	2018.01.23	•Add Hybrid AF and Point Light AF improvement •Add dynamic threshold example case

Improvement

Category	Description	Improved issue
Low contrast improvement	• Add dynamic threshold	• Flat scene
PD Improvement	•PD new core •Add dynamic Search Range	• PD performance
Face AF improvement	• Accuracy – Landmark extension	• Small face
	• Smoothness – FD tracking by PD	•FDAF trigger time
Hybrid AF improvement	•Dynamic weak threshold by LV	
	•Hybrid scene change	
	•Mid-low Confidence Handling	
Point light improvement	•PL core update	

Low contrast improvement

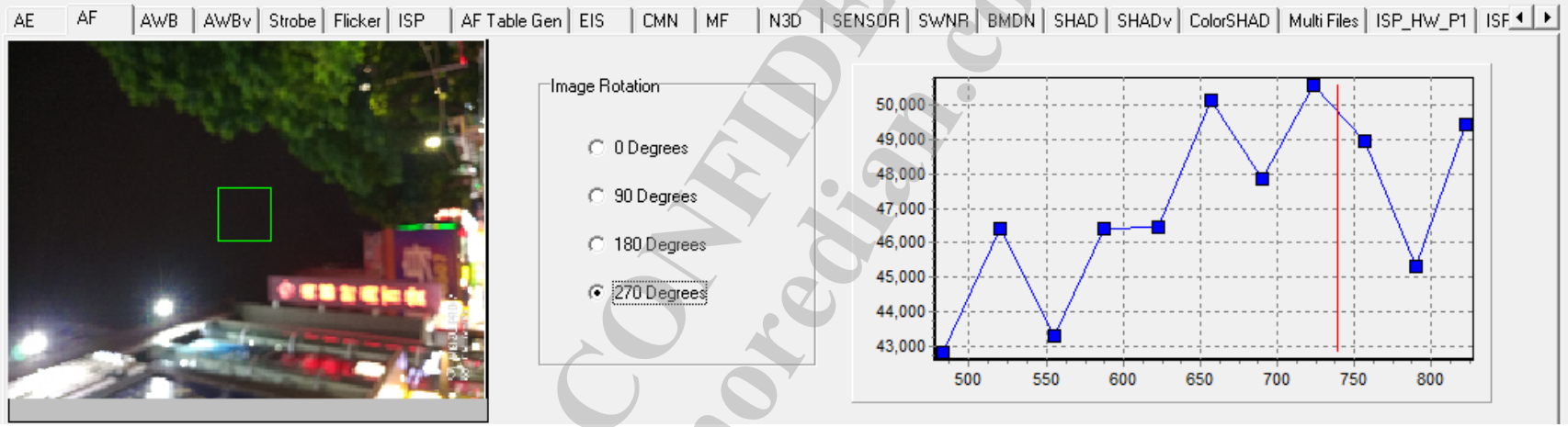
Dynamic threshold

- Concept
  - Each sample add to curve HW TH re-calculated a appropriate value for new curve
  - More control method for flat scene

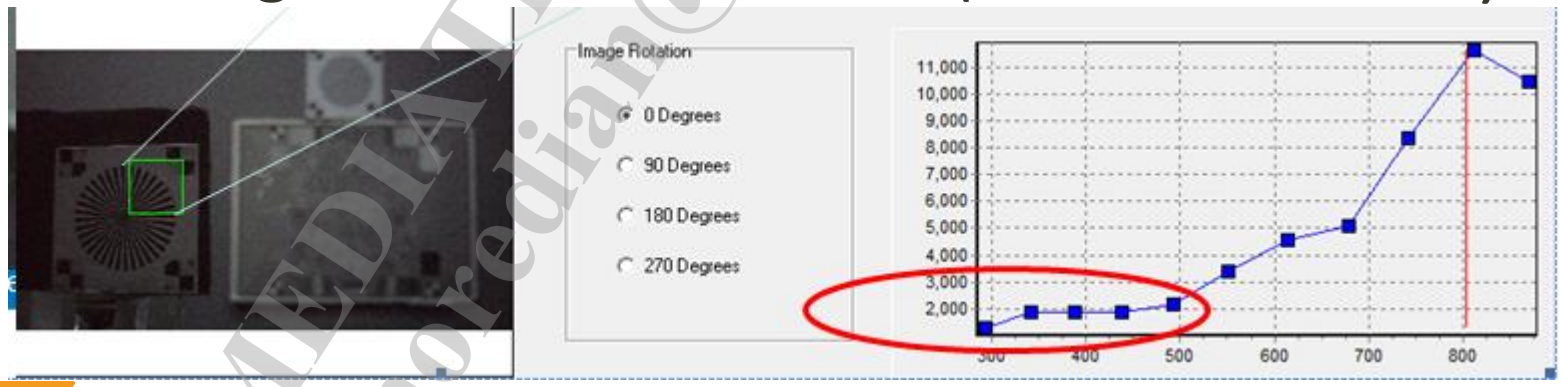
Version	Threshold type	Detail
AF v4.6	Fixed	Main/sub threshold from parameter directly
AF v5.0	Dynamic	Main/sub threshold is calculated by parameter each step

Some known AF issue from customer

- Flat scene move to false peak



- Converge at flat area of curve (local maximum)



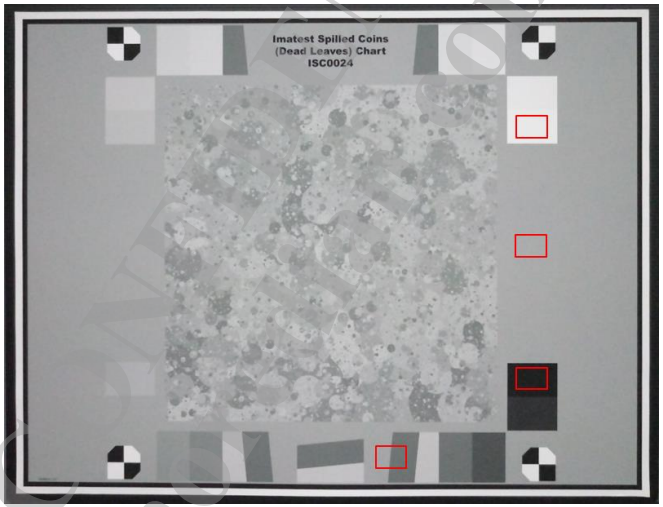
Previous solution

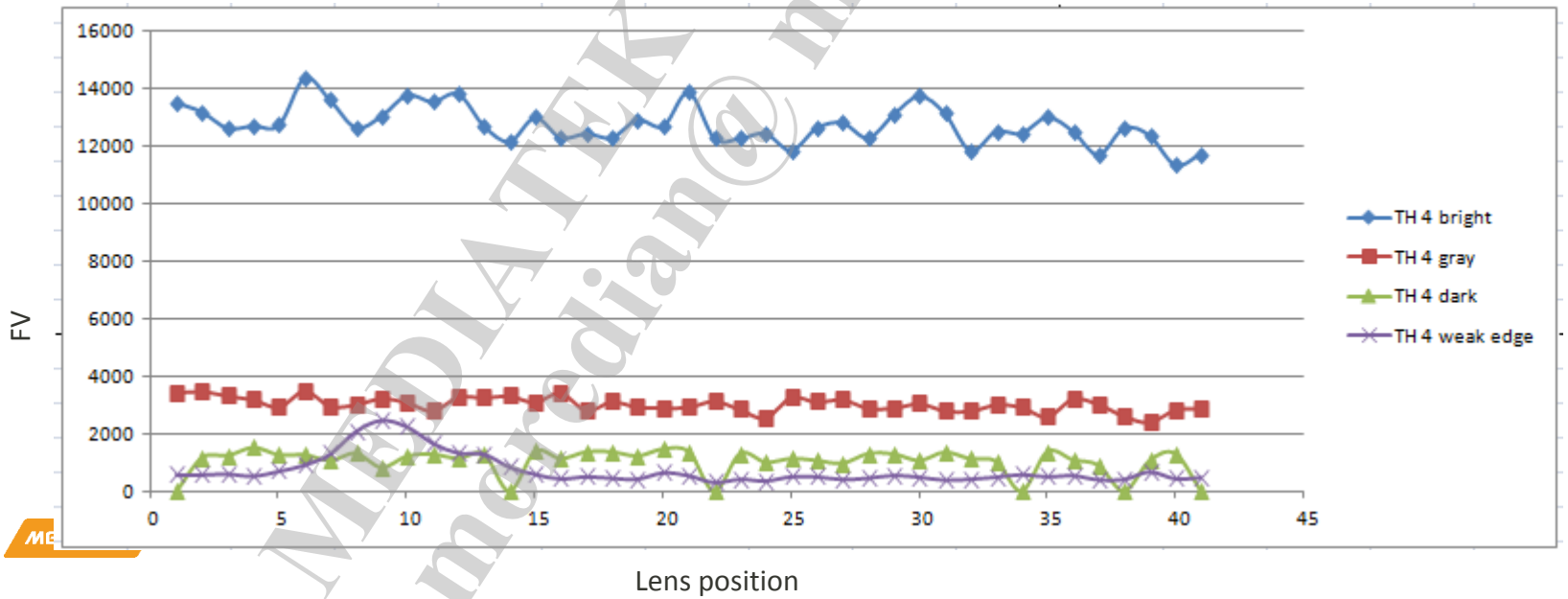
- Tuning AF parameters

```
//
// -------------------- sAF_TH --------------------
{
    8, // i4ISONum
    {100, 150, 200, 300, 400, 600, 800, 1600},

    // SGG1~7
{20, 19, 19, 19, 18, 18, 17, 16,
 29, 29, 29, 28, 28, 27, 27, 25,
 43, 42, 42, 42, 41, 41, 40, 39,
 62, 61, 61, 61, 60, 60, 59, 58,
 88, 88, 88, 88, 87, 87, 86, 85,
 126, 126, 126, 126, 125, 125, 125, 124,
 180, 180, 180, 180, 180, 179, 179, 179},

    // horizontal FV min. threshold
    {2000, 2000, 2000, 1000, 1000, 1000, 800, 800},

    // horizontal FV threshold
{2, 2, 2, 2, 2, 2, 2, 3},

    // horizontal FV min. threshold
    {2000, 2000, 2000, 1000, 1000, 1000, 800, 800},

    // horizontal FV threshold
{2, 2, 2, 2, 2, 2, 2, 3},

    // vertical FV min. threshold
    {2000, 2000, 2000, 1000, 1000, 1000, 800, 800},

    // vertical FV threshold
{2, 2, 2, 2, 2, 2, 2, 3},
},
```

Some trade off must happened

- Compare different FV curve of gray level flat area & weak edge area





Dynamic converge ratio threshold

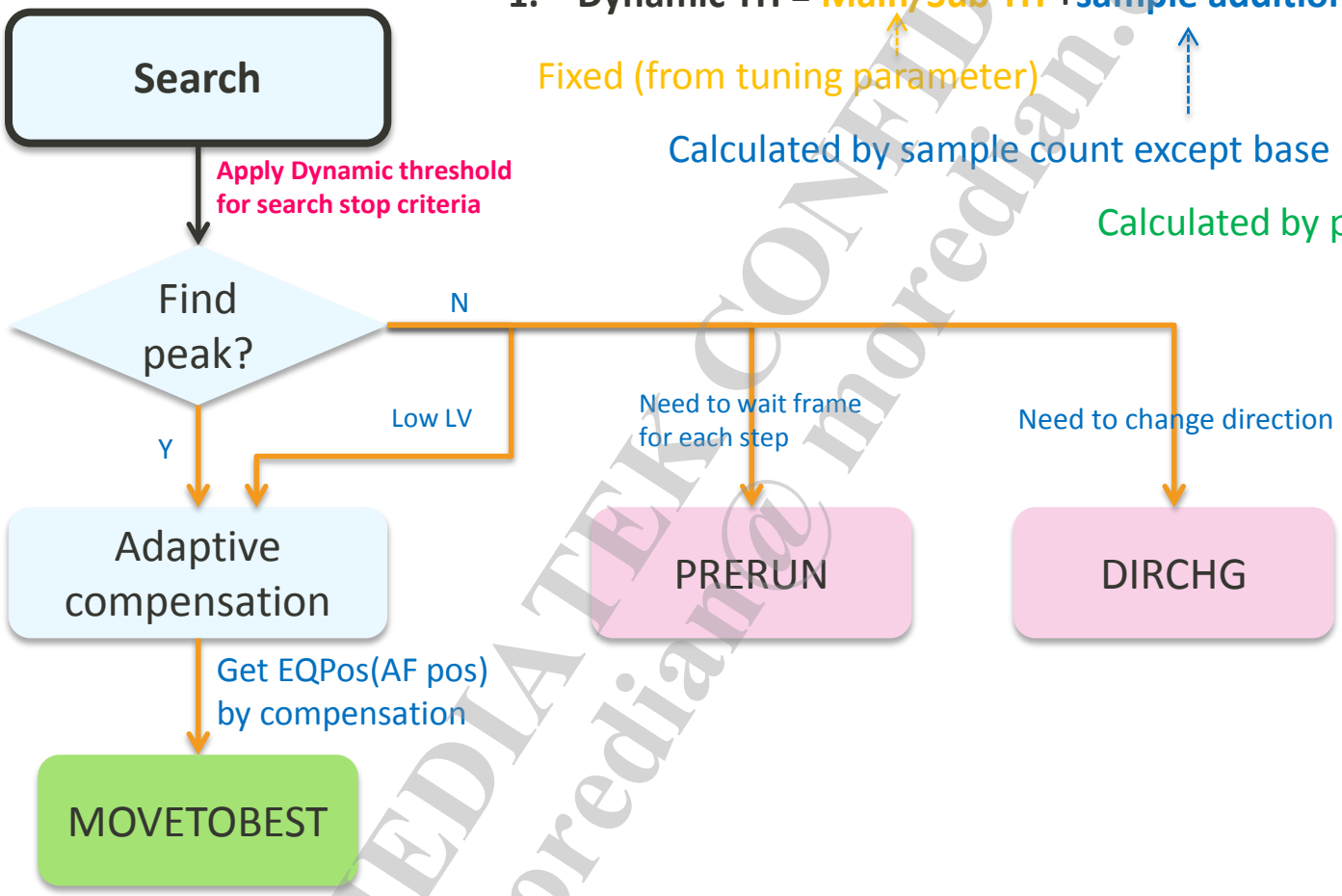
•Calculate threshold for AF search stop criteria each step

1. Dynamic TH = Main/Sub TH +sample additional TH+ Peak additional TH

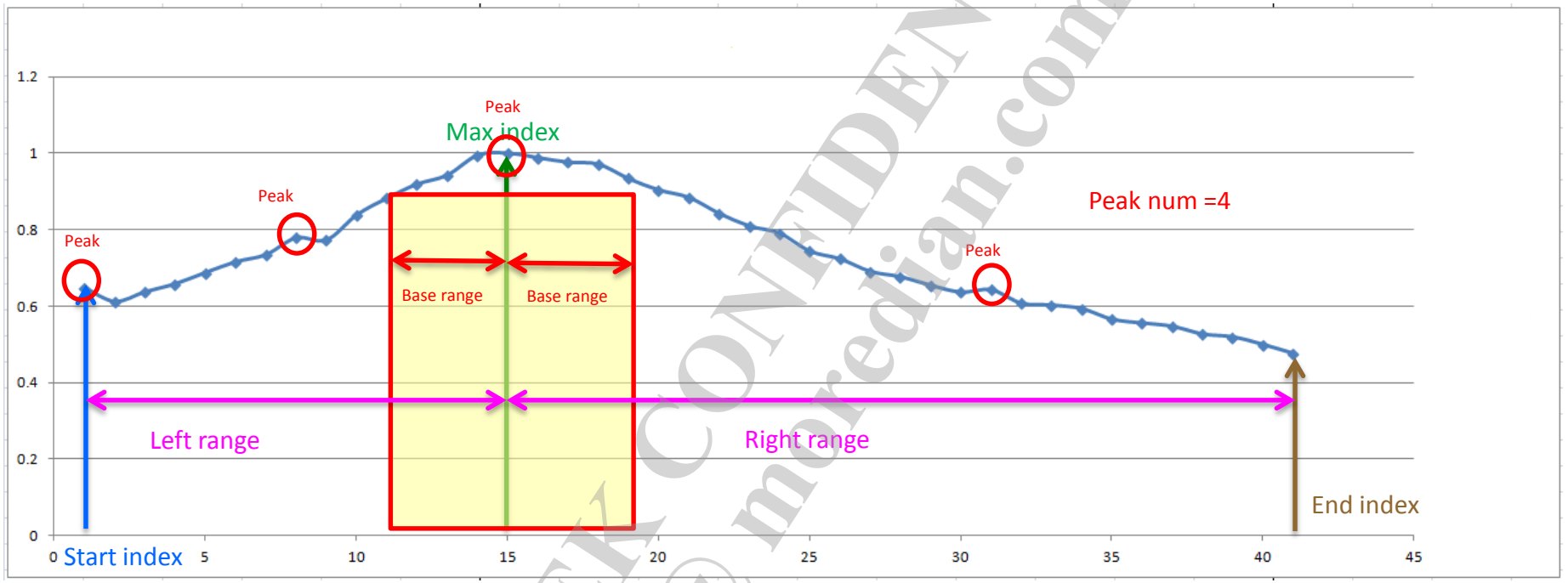
Fixed (from tuning parameter)

Calculated by sample count except base range

Calculated by peak num of search curve



Dynamic converge ratio threshold



Dynamic TH = Main/Sub TH + Sample additional TH + Peak additional TH

Sample additional TH = (Left(Right) range – Base range) * Ratio Per Sample

Peak additional TH = (Peaknum – Base peak) * Ratio Per Peak

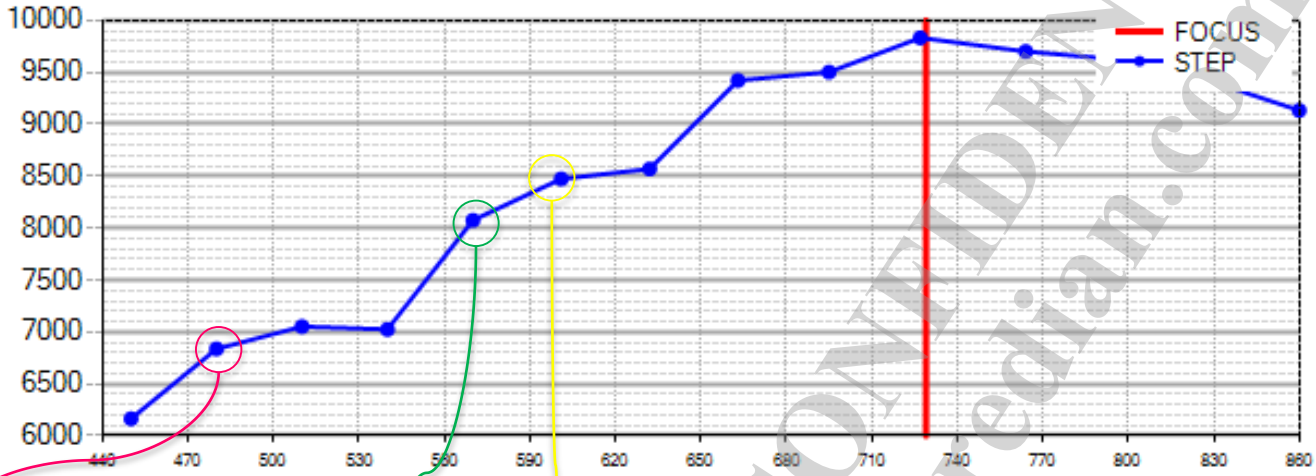
If Dynamic HW TH > TH limit , Dynamic HW TH = TH limit

For example, Tuning parameters as right bracket and above curve TH calculated as below:
Sample additional TH (Main)= (26 – 4) * 2 = 44
Sample additional TH (Sub)= (14 – 4) * 2 = 20
Peak additional TH = (4 – 1) * 3 = 9
Main TH = 15 + 44 + 9 = 68 > 50 → Main TH =50
Sub TH = 10 + 20 + 9 = 39

Tuning parameters

Ex:
Base range = 4
Ratio Per Sample = 2
Base peak = 1
Ratio Per Peak = 3
Threshold Limit = 50

Dynamic converge ratio threshold - ex



Ex:
Base range = 3
Ratio Per Sample = 3
Base peak = 1
Ratio Per Peak = 2
Threshold Limit = 50

Dynamic TH = Main/Sub TH + Sample additional TH + Peak additional TH

```
[DYTH]MaxIdx:0 CurrIdx:1  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:1 CurrIdx:1  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:2 CurrIdx:2  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:2 CurrIdx:3  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:4 CurrIdx:4  peak_num:2 RatioP:2 Ratio1:3  Ratio2:0 Mian_ratio:17 Sub_ratio:10
[DYTH]MaxIdx:5 CurrIdx:5  peak_num:2 RatioP:2 Ratio1:6  Ratio2:0 Mian_ratio:20 Sub_ratio:10
[DYTH]MaxIdx:6 CurrIdx:6  peak_num:2 RatioP:2 Ratio1:9  Ratio2:0 Mian_ratio:23 Sub_ratio:10
[DYTH]MaxIdx:7 CurrIdx:7  peak_num:2 RatioP:2 Ratio1:12 Ratio2:0 Mian_ratio:26 Sub_ratio:10
[DYTH]MaxIdx:8 CurrIdx:8  peak_num:2 RatioP:2 Ratio1:15 Ratio2:0 Mian_ratio:29 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:9  peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:10 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:11 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:12 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:13 peak_num:2 RatioP:2 Ratio1:18 Ratio2:3 Mian_ratio:32 Sub_ratio:13
```

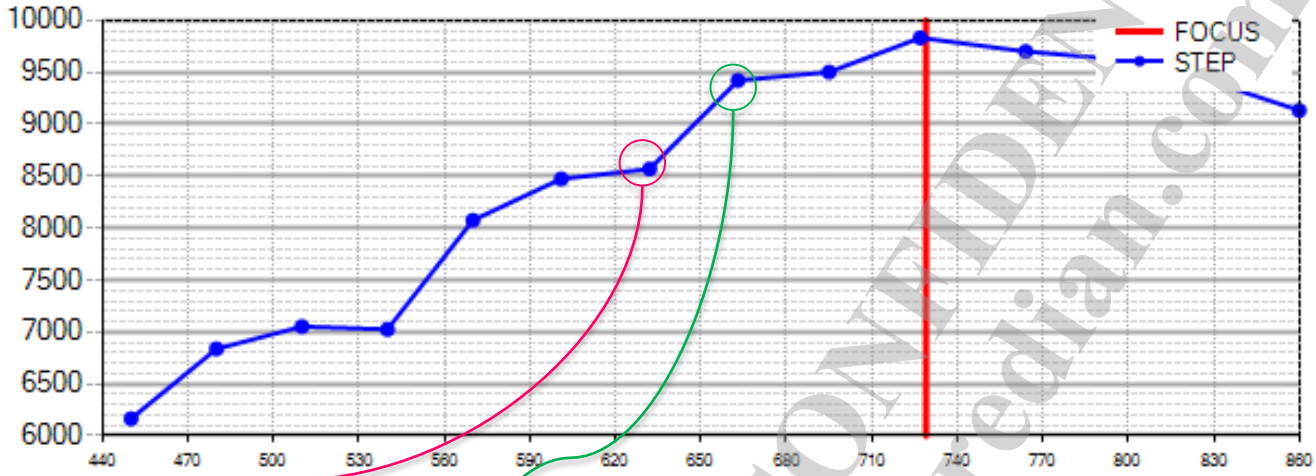
Left sample addi th Right sample addi th

Idx 1:
Main ratio = 12+ peak+sample
= 12+(1-1)*2+(0)* 3 =12
Sub ratio = 8+peak+sample
=8+(1-1)*2+0 = 8

Idx 4:
Main ratio = 12+ peak+sample
= 12+(2-1)*2+(4-3)* 3
=12+2+3 = 17
Sub ratio = 8+peak+sample
=8+(2-1)*2+0 = 10

Idx 5:
Main ratio = 12+ peak+sample
= 12+(2-1)*2+(5-3)* 3
=12+2+6= 20
Sub ratio = 8+peak+sample
=8+(2-1)*2+0 = 10

Dynamic converge ratio threshold - ex



Ex:
Base range = 3
Ratio Per Sample = 3
Base peak = 1
Ratio Per Peak = 2
Threshold Limit = 50

Dynamic TH = Main/Sub TH + Sample additional TH + Peak additional TH

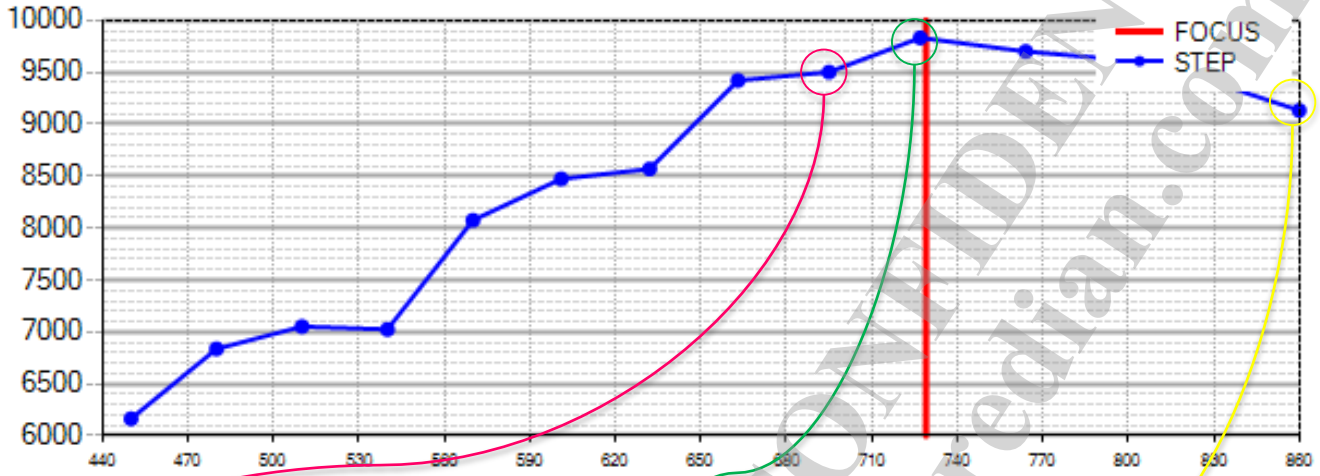
```
[DYTH]MaxIdx:0 CurrIdx:1  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:1 CurrIdx:1  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:2 CurrIdx:2  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:2 CurrIdx:3  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:4 CurrIdx:4  peak_num:2 RatioP:2 Ratio1:3  Ratio2:0 Mian_ratio:17 Sub_ratio:10
[DYTH]MaxIdx:5 CurrIdx:5  peak_num:2 RatioP:2 Ratio1:6  Ratio2:0 Mian_ratio:20 Sub_ratio:10
[DYTH]MaxIdx:6 CurrIdx:6  peak_num:2 RatioP:2 Ratio1:9  Ratio2:0 Mian_ratio:23 Sub_ratio:10
[DYTH]MaxIdx:7 CurrIdx:7  peak_num:2 RatioP:2 Ratio1:12 Ratio2:0 Mian_ratio:26 Sub_ratio:10
[DYTH]MaxIdx:8 CurrIdx:8  peak_num:2 RatioP:2 Ratio1:15 Ratio2:0 Mian_ratio:29 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:9  peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:10 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:11 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:12 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:13 peak_num:2 RatioP:2 Ratio1:18 Ratio2:3 Mian_ratio:32 Sub_ratio:13
```

Idx 6:
Main ratio = 12+ peak+sample
= 12+(2-1)*2+(6-3)* 3
=12+2+9= 23

Idx 7:
Main ratio = 12+ peak+sample
= 12+(2-1)*2+(7-3)* 3
=12+2+12 = 26

Left sample addi th Right sample addi th

Dynamic converge ratio threshold - ex



Ex:
Base range = 3
Ratio Per Sample = 3
Base peak = 1
Ratio Per Peak = 2
Threshold Limit = 50

Dynamic TH = Main/Sub TH + Sample additional TH + Peak additional TH

```
[DYTH]MaxIdx:0 CurrIdx:1  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:1 CurrIdx:1  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:2 CurrIdx:2  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:2 CurrIdx:3  peak_num:1 RatioP:0 Ratio1:0  Ratio2:0 Mian_ratio:12 Sub_ratio:8
[DYTH]MaxIdx:4 CurrIdx:4  peak_num:2 RatioP:2 Ratio1:3  Ratio2:0 Mian_ratio:17 Sub_ratio:10
[DYTH]MaxIdx:5 CurrIdx:5  peak_num:2 RatioP:2 Ratio1:6  Ratio2:0 Mian_ratio:20 Sub_ratio:10
[DYTH]MaxIdx:6 CurrIdx:6  peak_num:2 RatioP:2 Ratio1:9  Ratio2:0 Mian_ratio:23 Sub_ratio:10
[DYTH]MaxIdx:7 CurrIdx:7  peak_num:2 RatioP:2 Ratio1:12 Ratio2:0 Mian_ratio:26 Sub_ratio:10
[DYTH]MaxIdx:8 CurrIdx:8  peak_num:2 RatioP:2 Ratio1:15 Ratio2:0 Mian_ratio:29 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:9  peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:10 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:11 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:12 peak_num:2 RatioP:2 Ratio1:18 Ratio2:0 Mian_ratio:32 Sub_ratio:10
[DYTH]MaxIdx:9 CurrIdx:13 peak_num:2 RatioP:2 Ratio1:18 Ratio2:3 Mian_ratio:32 Sub_ratio:13
```

Left sample addi th Right sample addi th

Idx 8:
Main ratio = 12+ peak+sample
= 12+(2-1)*2+(8-3)* 3
=12+2+15= 29

Idx 9:
Main ratio = 12+ peak+sample
= 12+(2-1)*2+(9-3)* 3
=12+2+18 = 32

Idx 13:
Main ratio = 12+ peak+sample
= 12+(2-1)*2+(9-3)* 3
=12+2+18 = 32
Sub ratio = 8+peak+sample
=8+(2-1)*2+(4-3)*3 =13

Dynamic converge ratio threshold

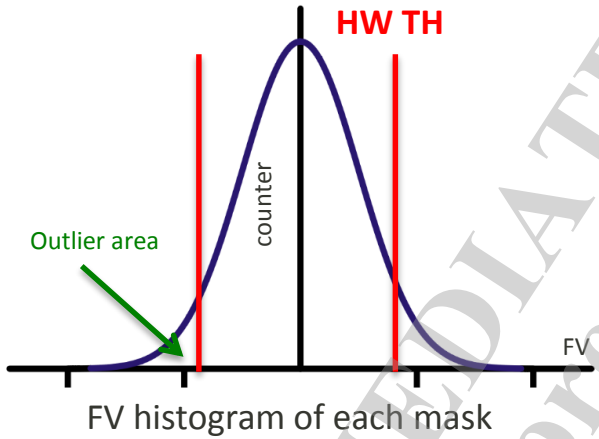
- Compatible with previous version
  - Configure base sample and base peak to very large
  - For example, configure to 30.

Base range = 30
Ratio Per Sample = 2
Base peak = 30
Ratio Per Peak = ~~3~~
Threshold Limit = 50

Dynamic TH = Main/Sub TH + Sample additional TH + Peak additional TH
Sample additional TH =0
Peak additional TH =0

Keep original threshold

New HW threshold- Calibration method



FV histogram of each mask

Get **max** of 6 patch's HW TH

Done

Previous method use average

New HW threshold-Calibration result compare

Previous

```
{
 8, // i4ISONum;
 {100, 200, 400, 800, 1600, 2400, 3200, 6400},

 // SGG1~7
 {{21, 20, 19, 18, 17, 11, 7, 6},
  {30, 29, 28, 27, 26, 19, 14, 11},
  {43, 42, 41, 40, 39, 32, 25, 21},
  {62, 61, 60, 59, 58, 51, 43, 37},
  {89, 88, 87, 87, 86, 78, 71, 64},
  {127, 126, 126, 125, 124, 118, 112, 106},
  {180, 180, 180, 179, 179, 175, 171, 167}},

 // horizontal FV1 min. threshold
 {2000, 2000, 2000, 1000, 1000, 1000, 800, 800},

 // horizontal FV1 threshold
 {2, 2, 2, 2, 3, 5, 6, 9},
```

New

```
8, // i4ISONum;
{100, 200, 400, 800, 1600, 2400, 3200, 6400},

// SGG1~7
{21, 20, 19, 18, 17, 11, 7, 6,
 30, 29, 28, 27, 26, 19, 14, 11,
 43, 42, 41, 40, 39, 32, 25, 21,
 62, 61, 60, 59, 58, 51, 43, 37,
 89, 88, 87, 87, 86, 78, 71, 64,
 127, 126, 126, 125, 124, 118, 112, 106,
 180, 180, 180, 179, 179, 175, 171, 167},

// horizontal FV1 min. threshold
{2000, 2000, 2000, 1000, 1000, 1000, 800, 800},

// horizontal FV1 threshold
{2, 3, 3, 4, 5, 6, 7, 10},
```

New threshold is not as critical as previous because of new HW function's smoothness. Although the value may be larger than before, It would not cause curve to become too flat.

Dynamic threshold tuning parameters

- Locate at i4Coefs[100]

```
//=============================================================================/
// name: m_i4DyBaseSample
// range: 0~30
// default: 3
// effect: While AF search sample(one side) larger than base sample, dynamic threshold will be raised.
//-----------------------------------------------------------------------------/
3,      // [30] m_i4DyBaseSample
//=============================================================================
// name: m_i4DyRatioPerSample
// range: 0~10
// default: 3
// effect: While AF search sample(one side) larger than base sample, dynamic threshold will be raised this ratio per over samples
//-----------------------------------------------------------------------------/
3,      // [31] m_i4DyRatioPerSample
//=============================================================================
// name: m_i4DyBasePeak
// range: 0~5
// default: 1
// effect: While AF search peak number larger than base peak number, dynamic threshold will be raised.
//-----------------------------------------------------------------------------/
1,      // [32] m_i4DyBasePeak
//=============================================================================/
// name: m_i4DyRatioPerPeak
// range: 0~10
// default: 2
// effect: While AF search peak number larger than base peak number, dynamic threshold will be this ratio per over peak number
//-----------------------------------------------------------------------------/
2,      // [33] m_i4DyRatioPerPeak
//=============================================================================/
// name: m_i4DyLimitTH
// range: 15~80
// default: 50
// effect: If dynamic threshold larger than limit the final threshold will be limit threshold
//-----------------------------------------------------------------------------/
50,     // [34] m_i4DyLimitTH
```

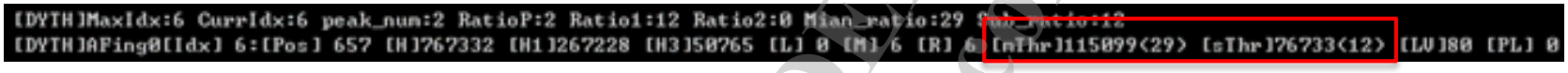
Base range(Base Sample) = 3
Ratio Per Sample = 3
Base peak = 1
Ratio Per Peak = 2
Threshold Limit = 50

- Default value for no parameters in NVRAM

```
m_i4DyBaseSample = (m_sAFNvram.i4Coefs[30]==0) ? 3   : clipValue(m_sAFNvram.i4Coefs[30], 0, 30);
m_i4DyRatioPerSample = (m_sAFNvram.i4Coefs[31]==0) ? 3   : clipValue(m_sAFNvram.i4Coefs[31], 0, 10);
m_i4DyBasePeak = (m_sAFNvram.i4Coefs[32]==0) ? 1   : clipValue(m_sAFNvram.i4Coefs[32], 0, 5);
m_i4DyRatioPerPeak = (m_sAFNvram.i4Coefs[33]==0) ? 2   : clipValue(m_sAFNvram.i4Coefs[33], 0, 10);
m_i4DyLimitTH = (m_sAFNvram.i4Coefs[34]==0) ? 50   : clipValue(m_sAFNvram.i4Coefs[34], 15, 80);
```

Dynamic threshold debug log

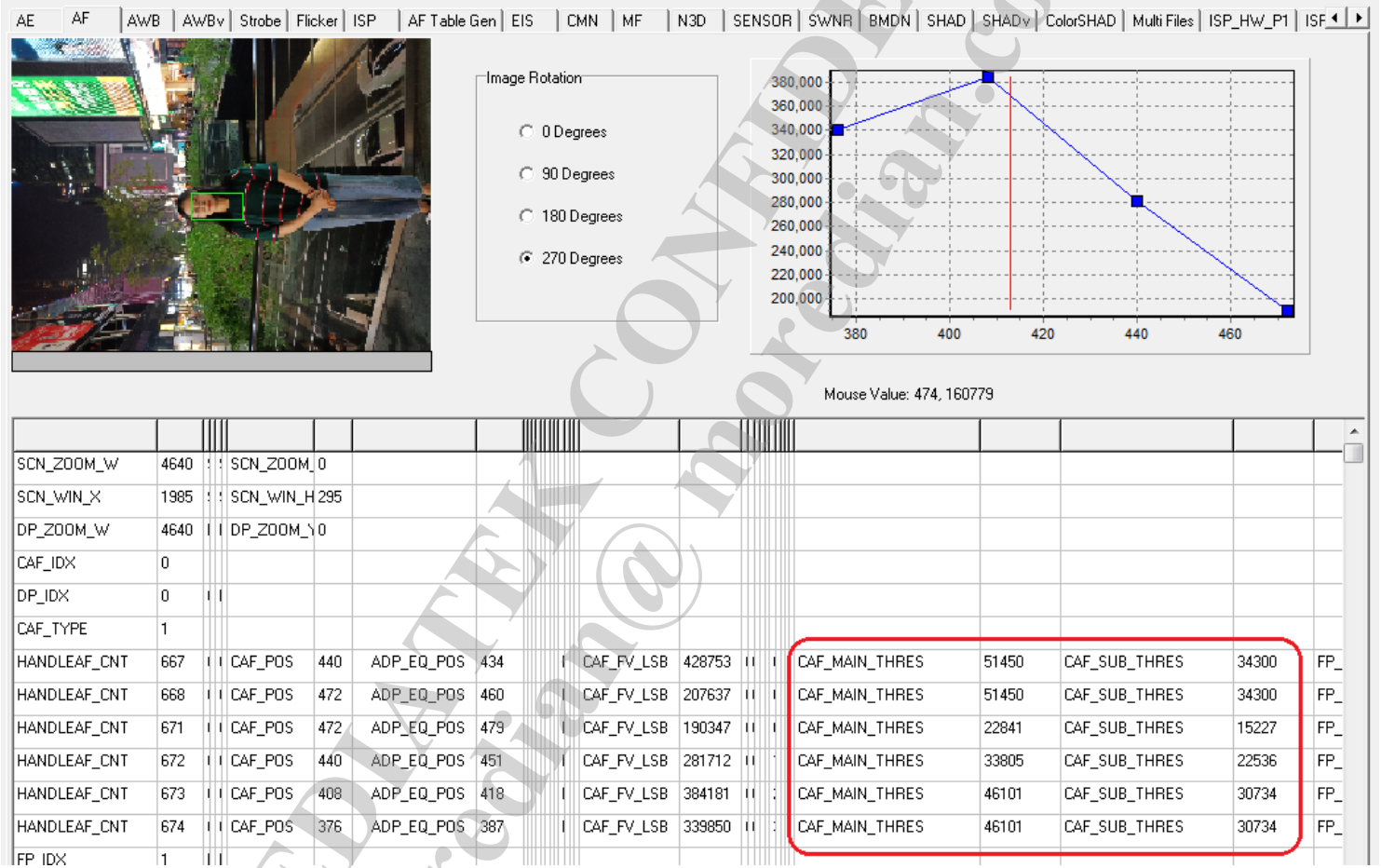
- Search keyword “DYTH”



[mThr] value <ratio> [sThr] value <ratio>

Dynamic threshold exif debug parser

- Original exif has included dynamic threshold info



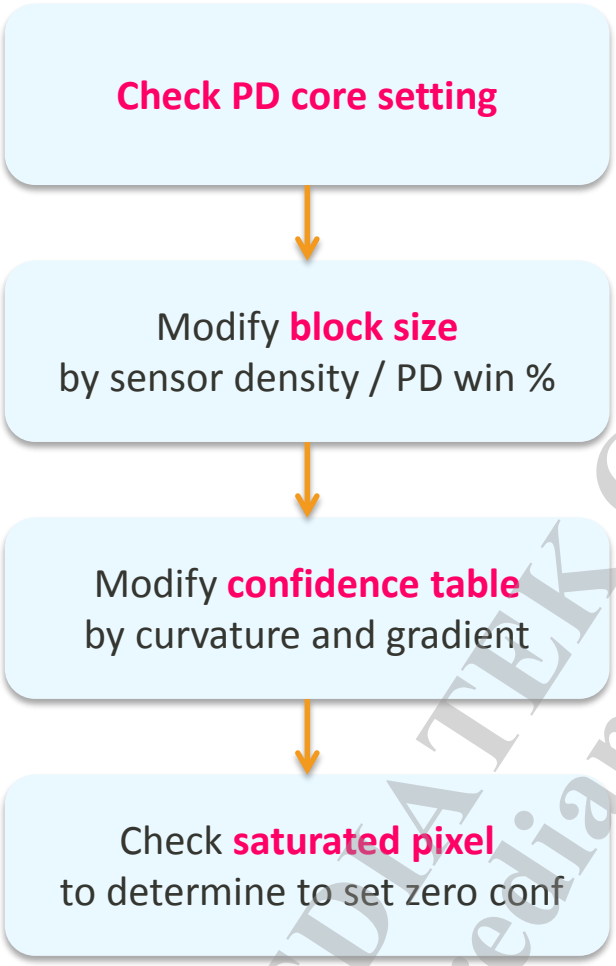
Update main/sub threshold each frame

PD improvement

PD core tuning introduction

- **PD core tuning**
  1. PD confidence is calculated by PD core library
     (MTK lib or sensor vendor lib like SONY lib)
  2. By MTK lib, there is some tuning guide to influence PD confidence value.

PD tuning flow



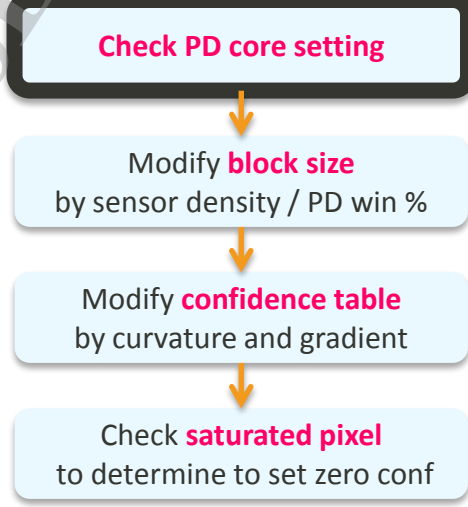
- **Check PD core setting**
  1. For AF v5.0 : enable new core
  2. For AF v5.0 new feature : enable dynamic search range

- **Modify block size**
  1. Modified by sensor density spec
  2. Tuning the percentage : PD win / image size

- **Modify confidence table**
  1. Tuning confidence table by gradient value
  2. Keep default similarity setting is recommended

- **Check saturated pixel**
  1. If saturated pixel number exceeds threshold, confidence will be set to zero.

Enabling New Core



- PD ALG 5.0 has two different cores. We strongly recommend using the new core.
- Parameter
  - 201 or 401 (enable): The new core is used.
    To set 201 or 401 depends on sensor density.
  - 0 (disable): The old core is used.

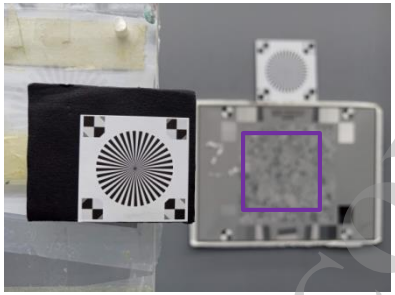
```
//------------------------------------------------------------------------------/
// Section: Enable New PD Core
// Description: Enable new PD core
//
// [19] name: m_i4DDKernEn
//    range: 0 (disable), 201, 401
//    default:
//         3P8: 201  (y_density=16)
//         OV13855: 401  (y_density=8)
//         IMX398: 401  (y_density=8)
//    constraints:
//    effect: as the description
//------------------------------------------------------------------------------/
401}, //[19]
```

- Example log

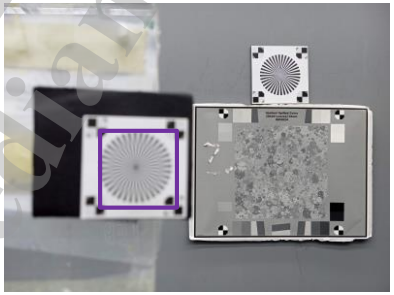
```
PdAlgo  : KenrEn = 1, DZFctr = 4, SmplFctr = 1
```

Dynamic Search Range

- The search range can be dynamically determined according to the current position, minimum position, and maximum position.
- The following problems can be alleviated.



The ideal PD value is very small (not within the search range).



The ideal PD value is very large (not within the search range).

- Parameter

```
//-----------------------------------------------------------------------------/
// Section: Dynamic Search Range (PD Core 5.0)
// Description: The search range will be dynamically determined according to current position,
//    min position, and max position.
//
// [17] name: m_i4DSREn
//    range: 0 to 1
//    default: 1  (enable)
//    constraints:
//    effect: as the description
//-----------------------------------------------------------------------------/
1, //[17]
```

- Example log

```
PdAlgo  : [DSR] En=1
```

```
PdAlgo  : [calSrchRng] Start=-12, End=28, En=1, MinPos=200, MaxPos=800
```

Check PD core setting

↓

Modify **block size** by sensor density / PD win %

↓

Modify **confidence table** by curvature and gradient

↓

Check **saturated pixel** to determine to set zero conf

Block Size

Modified by tuning Modified by sensor spec

- $Size_X = (Width_{RAW} \times M\,\%) / density_X$
  - E.g., $(4640 \times 12\,\%) / 16 = 34.8$
  - The largest multiple of 4 that is less than 34.8: 32
- $Size_Y = (Height_{RAW} \times N\,\%) / density_Y$
  - E.g., $(3488 \times 12\,\%) / 16 = 26.2$
  - The largest multiple of 4 that is less than 26.4: 24
- Parameter

```
//------------------------------------------------------------------------------/
// Section: PD Block Size
// Description: Determine PD block width and height
//
// i4FocusPDSizeX (width)
// i4FocusPDSizeY (height)
//    range: [0]  32 to (raw_width/x_density),  [0]  24 to (raw_height/y_density)
//    default:
//         3P8: SizeX=32,  SizeY=24 (x_density=16, y_density=16)
//         OV13855: SizeX=32,  SizeY=48 (x_density=16, y_density=8)
//         IMX258: SizeX=64,  SizeY=24  (x_density=8, y_density=16)
//         IMX398: SizeX=64,  SizeY=48 (x_density=8, y_density=8)
//    constraints: must be a multiplier of 4
//    effect: A large block takes longer computation time than a small block.
//------------------------------------------------------------------------------/
32,  // i4FocusPDSizeX
24,  // i4FocusPDSizeY
```

- Example log

```
PdAlgo  : m_tuningData.X = 32, m_tuningData.Y = 24
```

Check PD core setting

↓

Modify **block size** by sensor density / PD win %

↓

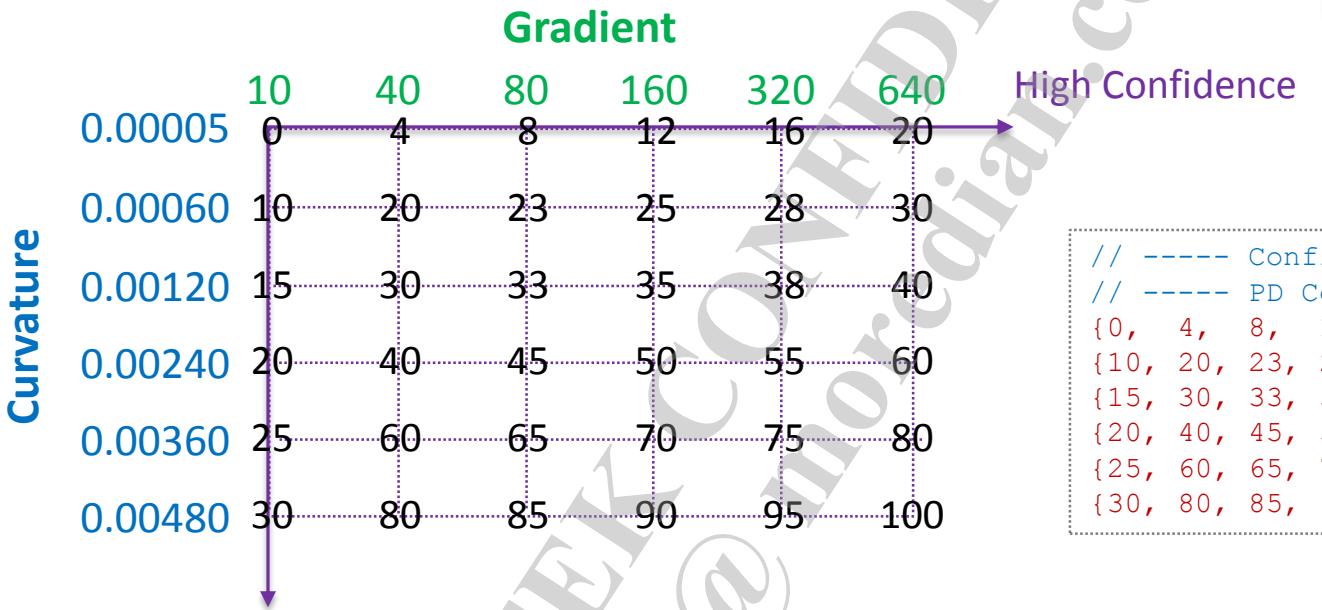
Modify **confidence table** by curvature and gradient

↓

Check **saturated pixel** to determine to set zero conf

Confidence Level

- The confidence is determined by the gradient and the curvature.



Check PD core setting

↓

Modify **block size** by sensor density / PD win %

↓

Modify **confidence table** by curvature and gradient

↓

Check **saturated pixel** to determine to set zero conf

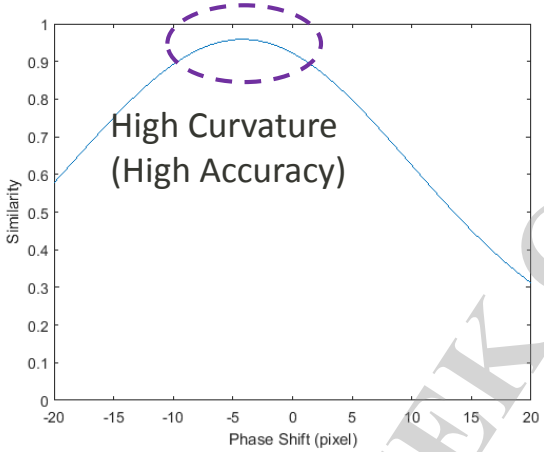
```
// ----- Confidence Table -----
// ----- PD Core 5.0  ----
{0,  4,  8,  12, 16, 20},
{10, 20, 23, 25, 28, 30},
{15, 30, 33, 35, 38, 40},
{20, 40, 45, 50, 55, 60},
{25, 60, 65, 70, 75, 80},
{30, 80, 85, 90, 95, 100}
```

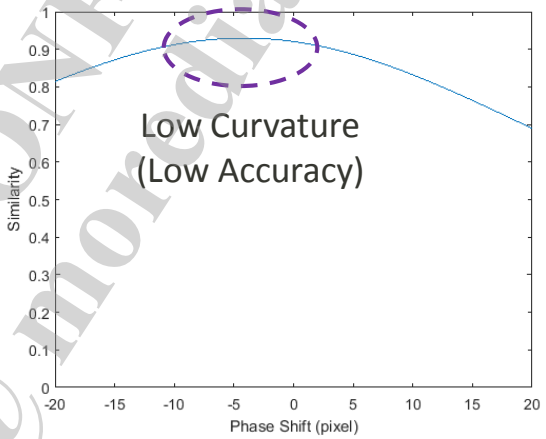
- The gradient and curvature thresholds can be adjusted.
- The higher the threshold, the lower the confidence.
- Example log

```
PdAlgo : [calConf] conf=36, curv=0.00124, grad=207, idx=(3,4), sat=0.00000
PdAlgo : [calConf] conf=86, curv=0.00405, grad=590, idx=(5,5), sat=0.00000
```

Curvature (1/2)

- The curvature of the similarity function is used as the primary index for determining the confidence.





Check PD core setting

↓

Modify **block size**
by sensor density / PD win %

↓

Modify **confidence table**
by curvature and gradient

↓

Check **saturated pixel**
to determine to set zero conf

Curvature (2/2)

- Parameter

```
//-------------------------------------------------------------------------------/
// Section: Curvature Threshold (PD Core 5.0)
// Description: The curvature is compared with these thresholds.
//
//[5] name: m_fCurvThd[0]
//[6] name: m_fCurvThd[1]
//[7] name: m_fCurvThd[2]
//[8] name: m_fCurvThd[3]
//[9] name: m_fCurvThd[4]
//[10] name: m_fCurvThd[5]
//     range: 1 to 100000
//     default: [5] 5 [6]  60 [7] 120 [8] 240 [9] 360 [10] 480
//     constraints: The latter should be larger than the former.
//         [6] should be larger than [5]. [7] should be larger than [6].
//     effect: The higher the threshold, the lower the confidence.
//-------------------------------------------------------------------------------/
5, 60, 120, 240, 360, 480,  //[5] to [10]
```

Check PD core setting

↓

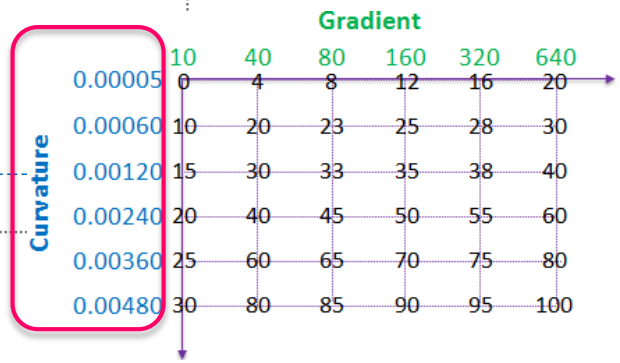
Modify **block size**
by sensor density / PD win %

↓

Modify **confidence table**
by curvature and gradient

↓

Check **saturated pixel**
to determine to set zero conf



- Example log

```
PdAlgo  : CurvThd = 0.00005 0.00060 0.00120 0.00240 0.00360 0.00480
```

```
PdAlgo : [calConf] conf=36, curv=0.00124, grad=207, idx=(3,4), sat=0.00000
PdAlgo : [calConf] conf=86, curv=0.00405, grad=590, idx=(5,5), sat=0.00000
```

Gradient

- The gradient is used as the secondary index for determining the confidence.

High Gradient

Low Gradient

Check PD core setting

Modify **block size** by sensor density / PD win %

Modify **confidence table** by curvature and gradient

Check **saturated pixel** to determine to set zero conf

- Parameter

```
//--------------------------------------------------------------------------/
// Section: Gradient Threshold (PD Core 5.0)
// Description: The gradient is compared with these thresholds.
//
//[11] name: m_i4GradThd[0]
//[12] name: m_i4GradThd[1]
//[13] name: m_i4GradThd[2]
//[14] name: m_i4GradThd[3]
//[15] name: m_i4GradThd[4]
//[16] name: m_i4GradThd[5]
//    range: 1 to 16368
//    default: [11] 10 [12] 40 [13] 80 [14] 160 [15] 320 [16] 640
//    constraints: The latter should be larger than the former.
//        [6] should be larger than [5]. [7] should be larger than [6].
//    effect: The higher the threshold, the lower the confidence.
//--------------------------------------------------------------------------/
10, 40, 80, 160, 320, 640,  //[11] to [16]
```

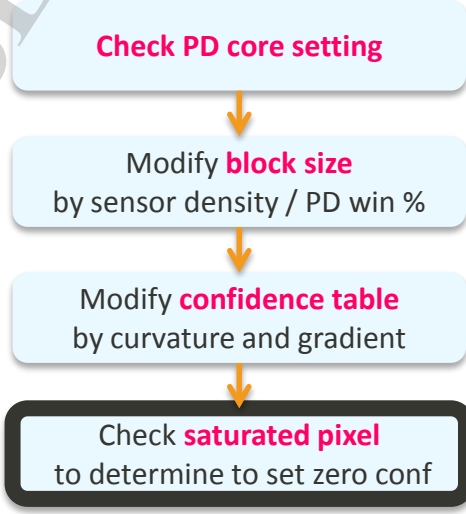
Curvature \ Gradient	10	40	80	160	320	640
0.00005	0	4	8	12	16	20
0.00060	10	20	23	25	28	30
0.00120	15	30	33	35	38	40
0.00240	20	40	45	50	55	60
0.00360	25	60	65	70	75	80
0.00480	30	80	85	90	95	100

- Example log

```
PdAlgo  : GradThd = 10 40 80 160 320 640
```

```
PdAlgo : [calConf] conf=36, curv=0.00124, grad=207, idx=(3,4), sat=0.00000
PdAlgo : [calConf] conf=86, curv=0.00405, grad=590, idx=(5,5), sat=0.00000
```

Saturation Level



- If the value of a pixel is larger than or equal to the saturation level, the pixel will be determined as a saturated pixel.

- Parameter

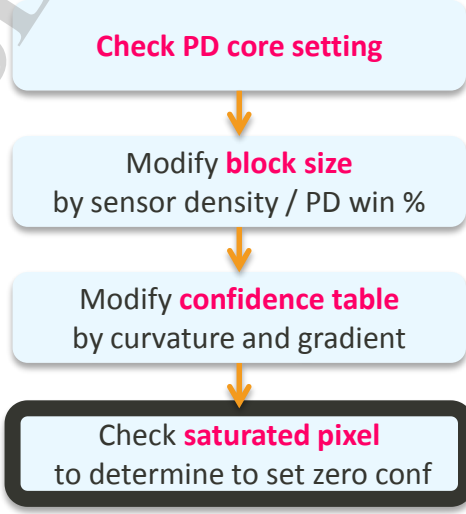
```
//------------------------------------------------------------------------------/
// Section: Saturation Level
// Description: If the value of a pixel is larger than or equal to the saturation level,
//    the pixel will be determined as a saturated pixel.
//
// name: i4SaturateLevel
//    range: 230 to 256
//    default: 240 (240/256)
//    constraints:
//    effect: as the description
//------------------------------------------------------------------------------/
240,  // i4SaturateLevel
```

- Example log

```
PdAlgo  : m_tuningData.SL = 240, m_tuningData.ST = 512
```

```
PdAlgo  : [sPDBlock] PD block = (2040, 1544, 576, 384), S var. = 268, S Cnt. = 201
```

Saturation Threshold



- If the percentage (= the number of saturated pixels / the number of all pixels) is larger than or equal to the threshold, the confidence level will be set to zero.
- The number of all pixels = $Size_X \times Size_Y$
- Parameter

```
//------------------------------------------------------------------------------/
// Section: Saturation Threshold
// Description: If the percentage (the number of saturated pixels over the number of pixels) is larger
//    than or equal to the threshold, the confidence level will be set to zero.
//
// name: i4SaturateThr
//    range: 1  to 512
//    default: 512 (100%)
//    constraints:
//    effect: as the description
//------------------------------------------------------------------------------/
512,  //i4SaturateThr
```

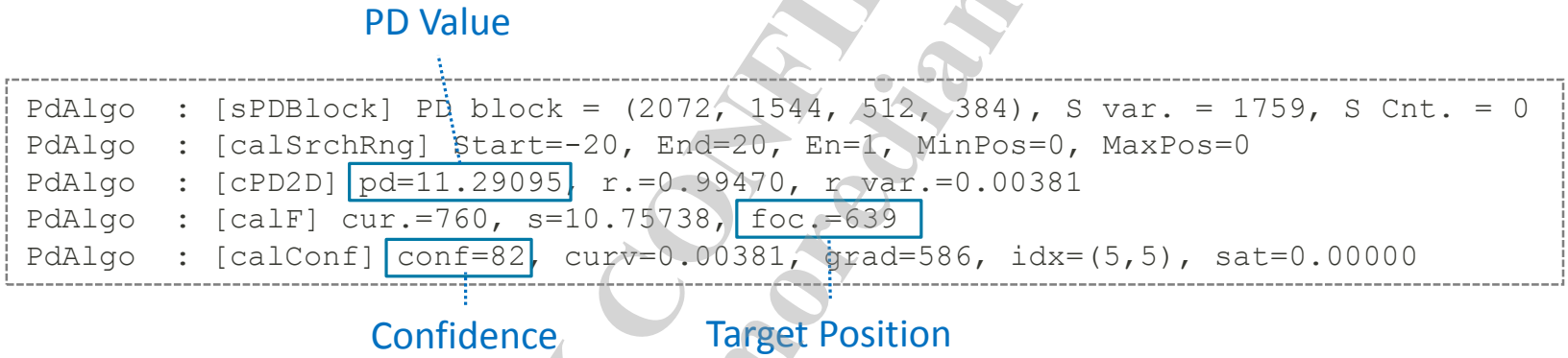
- Example log

```
PdAlgo  : m_tuningData.SL = 240, m_tuningData.ST = 512
```

```
PdAlgo  : [sPDBlock] PD block = (2040, 1544, 576, 384), S var. = 268, S Cnt. = 201
PdAlgo  : [calConf] conf=35, curv=0.00121, grad=204, idx=(3,4), sat=0.05815
```

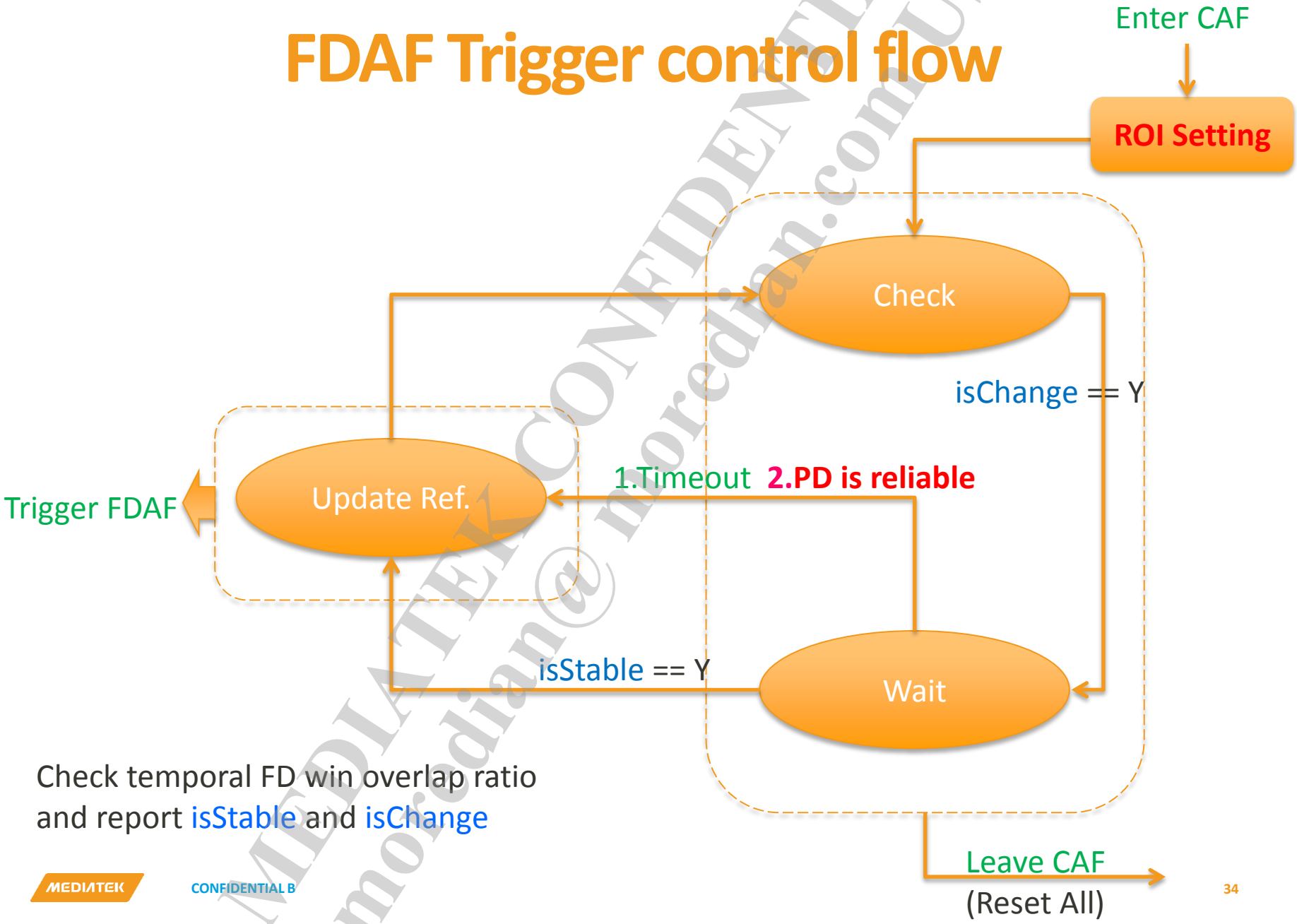
Log

- The log can be enabled via the following command.
  - adb shell setprop debug.pd.enable 1
- Example log



Face af improvement

FDAF Trigger control flow

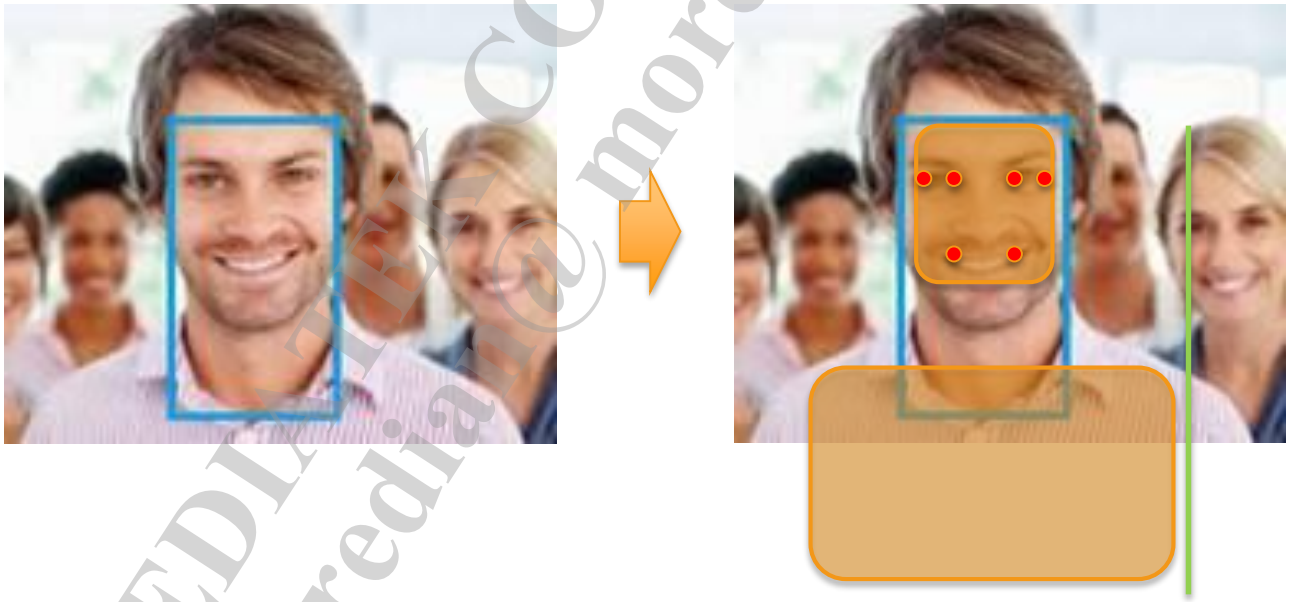


Check temporal FD win overlap ratio
and report isStable and isChange

Face AF v5.0 – ROI setting

- Accuracy

Face type	Ratio (of TG)	ROI (v5.0 new)	ROI (v4.6)
Small	<= 10%	**LM extension**	FD extension
Normal	> 10%	Finer LM selection	LM selection (6x6)



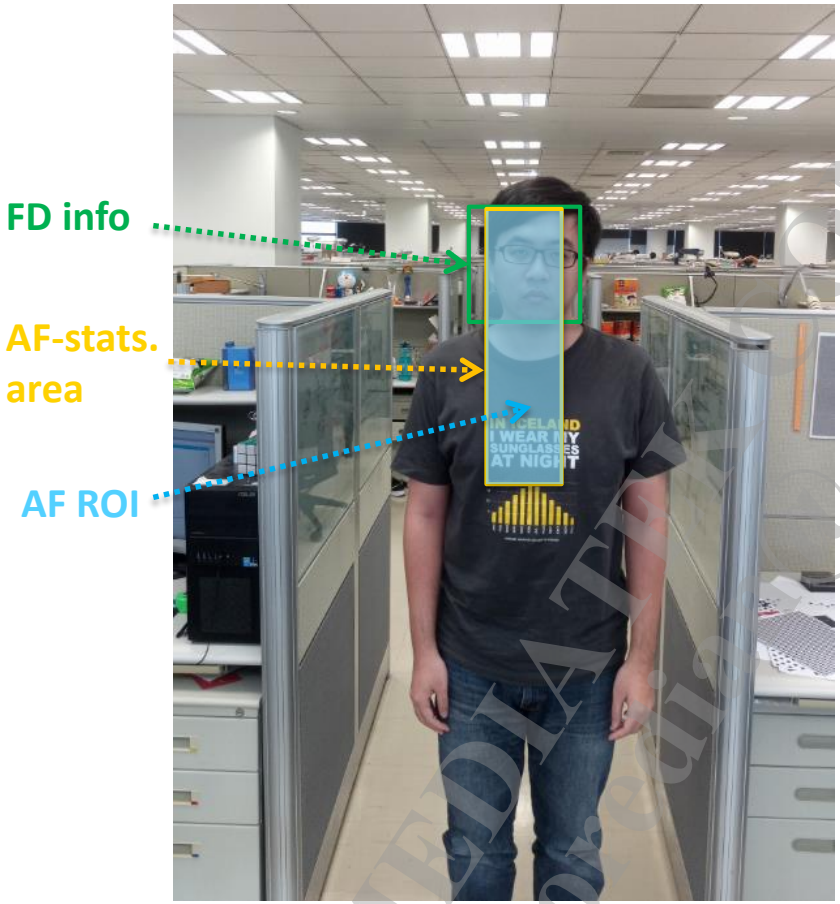
LM extension

FaceAF v4.6 [@P23]

FD info

AF-stats. area

AF ROI

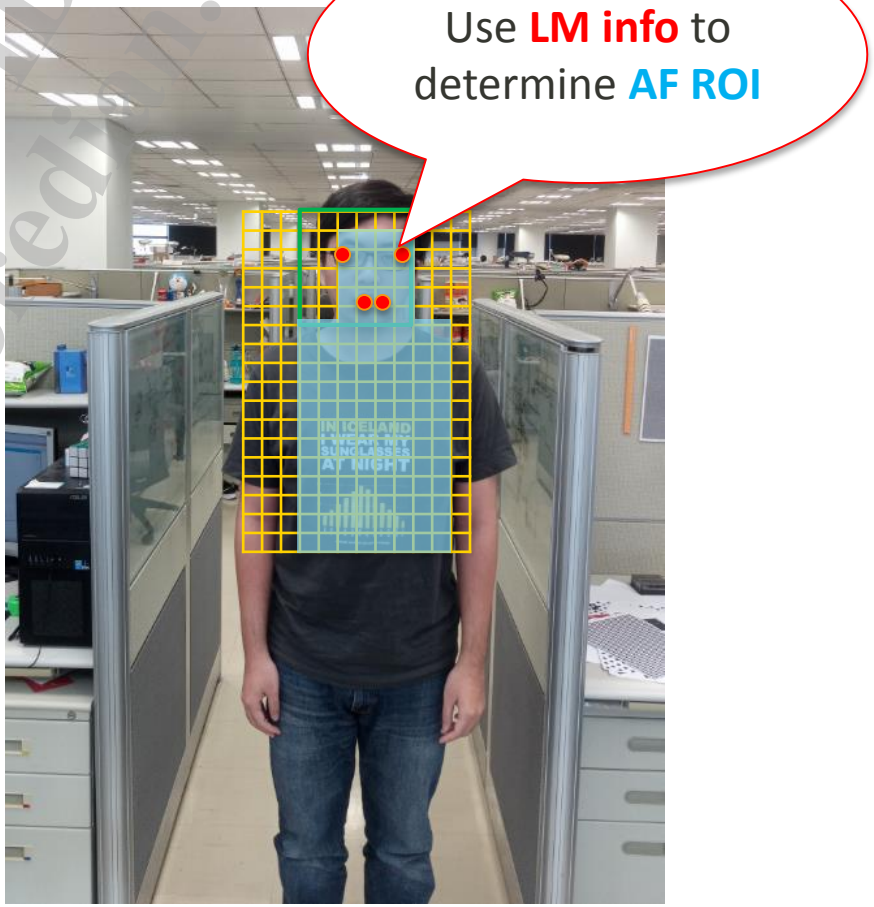


FaceAF v5.0 [@P40]

FD info + LM info

AF-stats. area

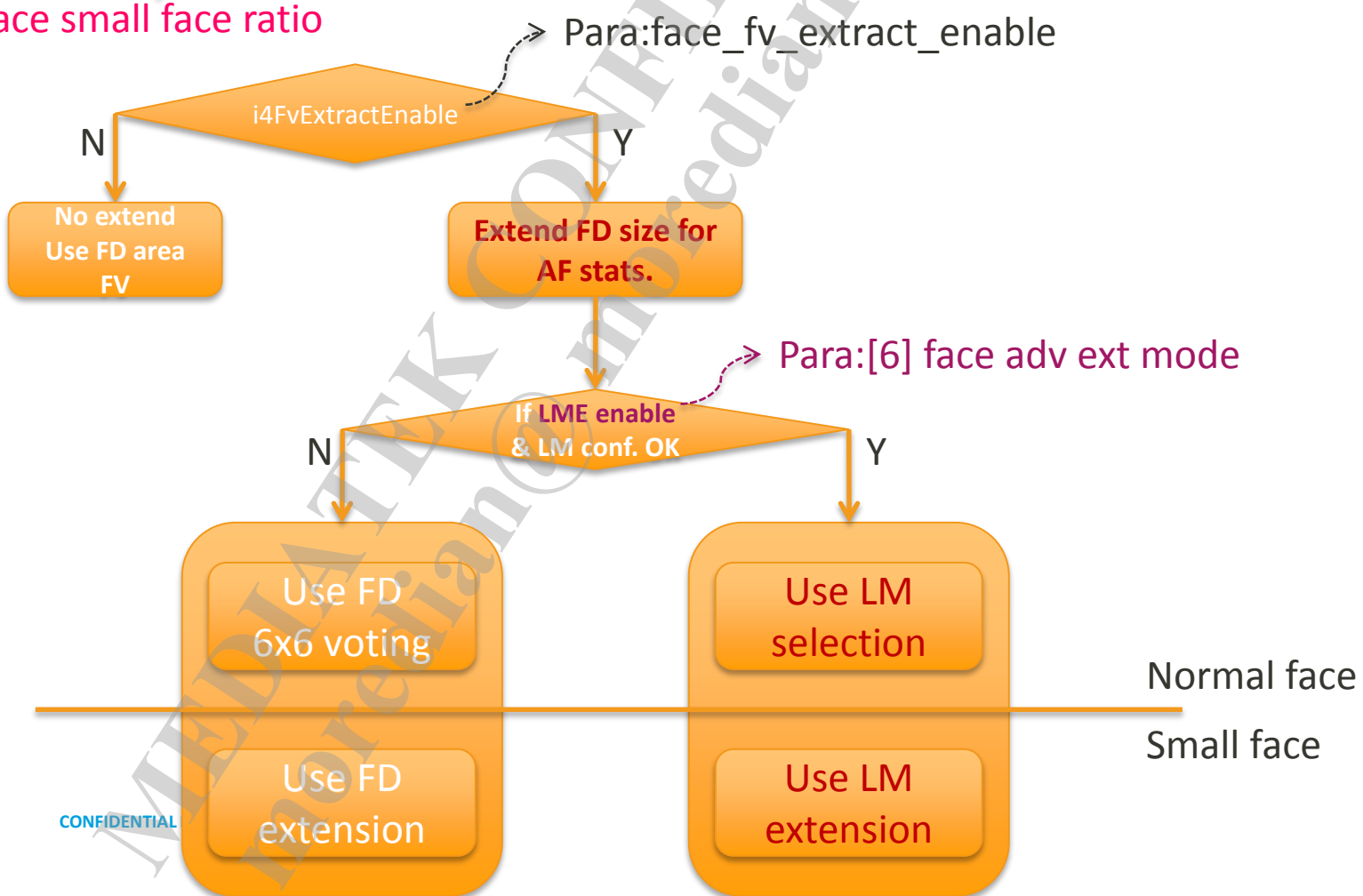
AF ROI



LM extension

Face type	Ratio (of TG)	ROI (v5.0 new)	ROI (v4.6)
Small	<= 10%	**LM extension**	FD extension
Normal	> 10%	Finer LM selection	LM selection (6x6)

Para: [7] face small face ratio



Face AF v5.0 – FDAF Trigger

Parameter Name	Description
[1] face_af_tracking_enable	Enable pd tracking for FaceAF (0:CAF, 1:PDAF, 2:TrackingAF)

- Smoothness
  - V4.6 – Need to wait for stable and then trigger FDAF
  - V5.0 – Trigger FDAF if PD is reliable
  - Fast trigger with smoothness approval by PD
- Face AF tracking
  - Enable : i4PDAFCoefs[1] set to 2
  - Once enable, it can work without other tuning.

TUNING PARAMETER DESCRIPTION

Face AF - NVRAM

Name	Description	Default Value	Note
fd_win_percent	no-used		
fd_size_diff	no-used		
fd_detect_cnt	no-used		
fd_none_cnt	no-used		
face_fv_extract_enable	faceAF fv metering	1	
face_fv_extract_thr	voting threshold	50	

FDAF — Overview

Name	Description	Default Value	Note
[0] face_af_enable	Enable FaceAF v5.0	2	0~2
[1] face_af_tracking_enable	Enable pd tracking for FaceAF (0:CAF, 1:PDAF, 2:TrackingAF)	1	0~2
[2] face_reliable_weight	Add more detect cnt for reliable FD result (MTK FD only)	1	1~3
[3] face_detect_num	Face detected cnt > face_detect_num and stable, FD status = 1	3	3~20
[4] face_none_num	Face not detected cnt > face_none_num and stable, FD status = 0	3	3~20
[5] face_no_input_num	Face no input cnt > face_no_input_num, FD status = 0	30	3~20
[6] face adv ext mode	LM-faceAF(+2) , small face handling(+1)	3	0~15
[7] face small face ratio	Small face threshold ratio (%) of TG width, ex: default 10%	15	
[8] ~[10]	Keep default	0	

FDAF — Overview

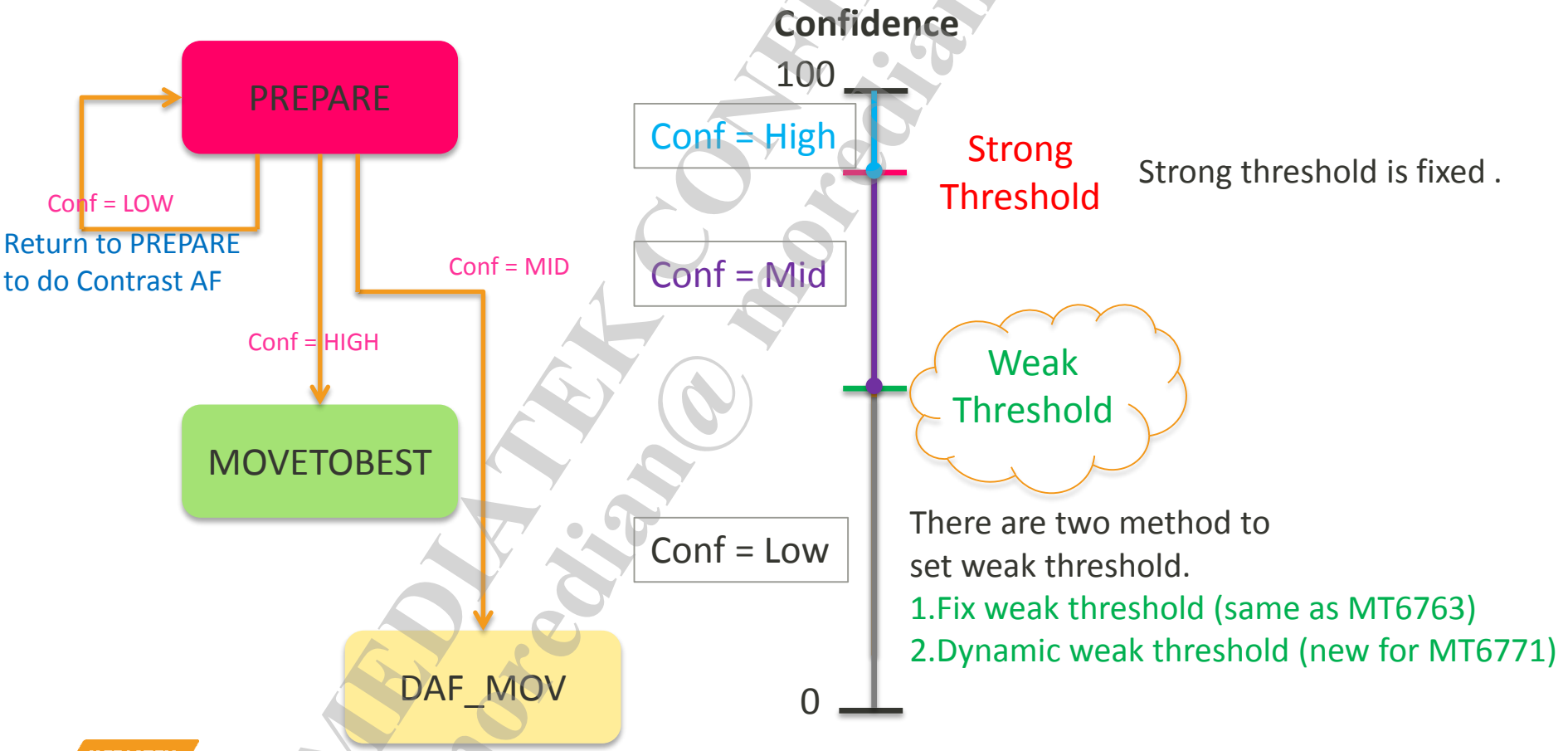
Name	Description	Default Value	Note
[11] change_mode	FD horizontal movement AF re-trigger	0	0 or 1
[12] change_threshold	FD change when ratio < change_threshold	70 (%)	1~99
[13] change_range	FD change check range, should >= change_num	3	3~20
[14] change_num	FD change check number, should <= change_range	3	3~20
[15] stable_mode	Reserved	0	0
[16] stable_threshold	FD stable when ratio > stable_threshold	80 (%)	1~99
[17] stable_range	FD stable check range, should >= stable_num	5	3~20
[18] stable_num	FD stable check number, should <= stable_range	5	3~20
[19] timeout_num	When FD unstable count > timeout_num, re-trigger AF	30	3~60
[20] ~ [30]	Reserved	0,0,0,0,0, 0,0,0,0,0,0,	

Hybrid AF improvement

DYNAMIC WEAK THRESHOLD BY LV

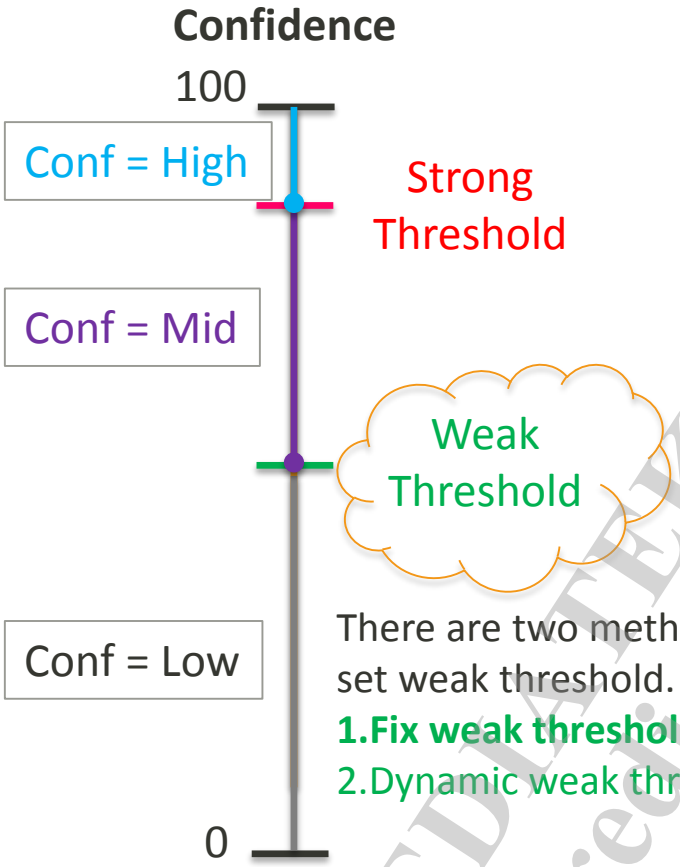
Dynamic Weak Threshold by LV

- Determine the next state by confidence level
  - There are two method to set weak threshold : **Fix and dynamic**



Dynamic Weak Threshold by LV - fixed

- Strong/weak threshold are fixed by parameter setting



There are two method to set weak threshold.

1.Fix weak threshold (same as MT6763)

2.Dynamic weak threshold (new for MT6771)

•Para @PDAF

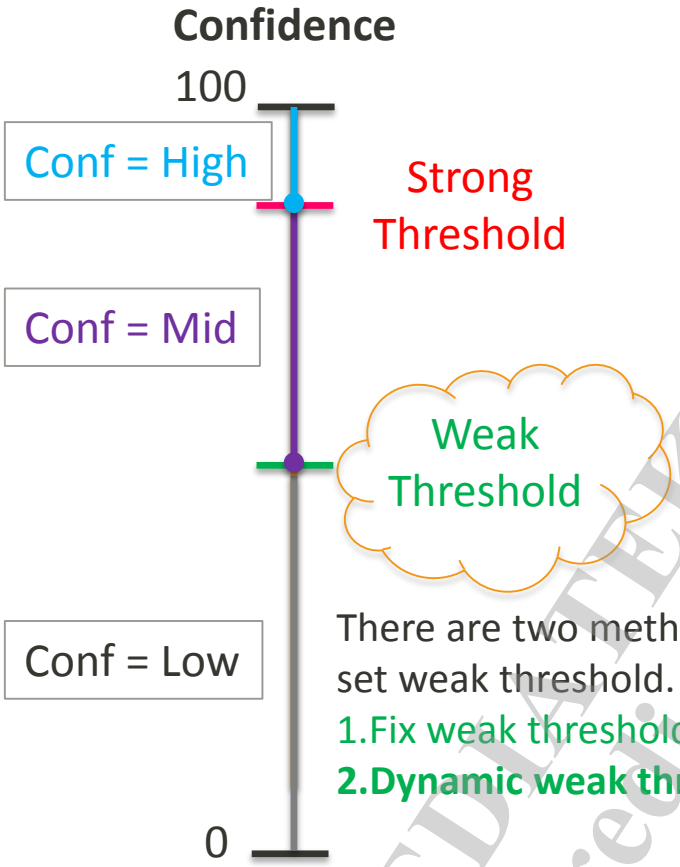
[2]	Confidence weak threshold for CAF
[3]	Confidence strong threshold for CAF
[4]	Confidence weak threshold for TAF
[5]	Confidence strong threshold for TAF

•CAF/TAF can apply different threshold

```
50,  //[2] pd_weak_caf
110, //[3] pd_strong_caf
50,  //[4] pd_weak_taf
110, //[5] pd_strong_taf
```

Dynamic Weak Threshold by LV - dynamic

- Strong/weak threshold are calculated by current LV



There are two method to set weak threshold.

1.Fix weak threshold (same as MT6763)

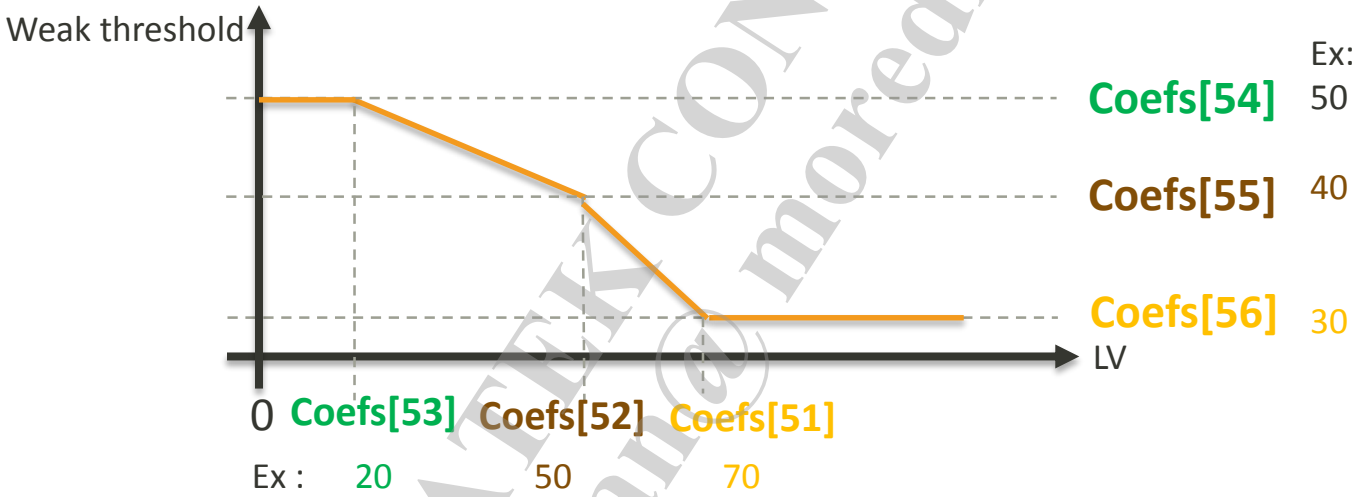
2.Dynamic weak threshold (new for MT6771)

•Para @PDAF

i4PDAFCoefs	Description
[51]	Dynamic weak threshold – Hight LV define
[52]	Dynamic weak threshold – Mid LV define
[53]	Dynamic weak threshold – Low LV define
[54]	Dynamic weak threshold at LV Hight
[55]	Dynamic weak threshold at LV Mid
[56]	Dynamic weak threshold at LV Low

DYNAMIC WEAK THRESHOLD BY LV

- Dynamic weak threshold can use lower confidence in outdoor and use higher confidence in night scene
- Once this section Config. Original fix weak trehsold coef[2] will lose effectiveness



If curLV < 20 : thr is 50
If 20 < curLV < 50 : thr is 50~40
If 50 < curLV < 70 : thr is 40~30
If 70 < curLV : thr is 30

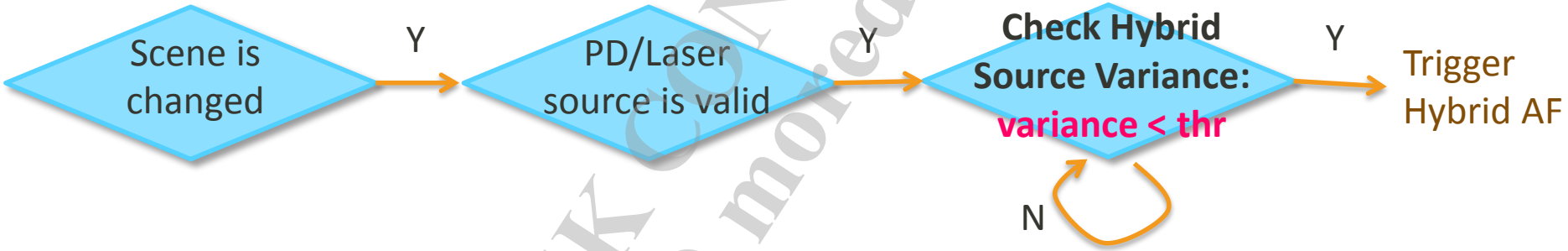
Hybrid AF – Dynamic Weak Threshold by LV

Name	Description	Default Value	Note
[51] pd_dynamic_weak_lv_high	Dynamic weak threshold – Hight LV define	70	
[52] pd_dynamic_weak_lv_mid	Dynamic weak threshold – Mid LV define	50	
[53] pd_dynamic_weak_lv_low	Dynamic weak threshold – Low LV define	20	
[54] pd_dynamic_weak_threshold_high	Dynamic weak threshold at LV Hight	30	
[55] pd_dynamic_weak_threshold_mid	Dynamic weak threshold at LV Mid	40	
[56] pd_dynamic_weak_threshold_low	Dynamic weak threshold at LV Low	50	

HYBRID SCENE CHANGE

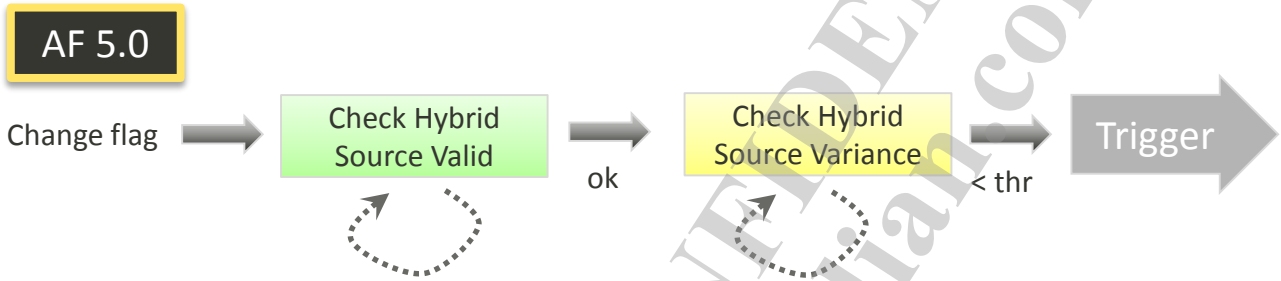
Hybrid scene change

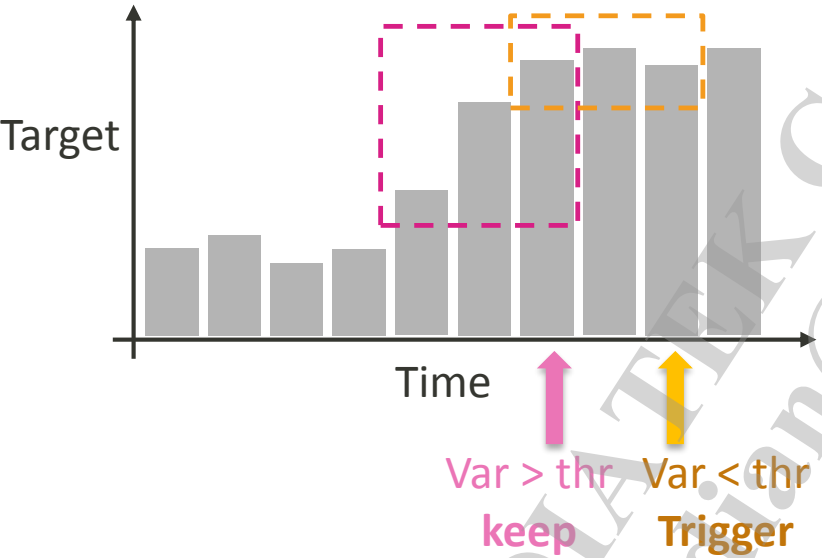
- In this state, scene change detection is the same to CDAF except hybrid scene change.
- Scene Change and Trigger



- **AF v5.0 change**
  - V5.0 : Use *variance* to check if scene change or not
  - V4.0 : Use *PD target difference*

Hybrid scene change





- **Check Hybrid Source Variance**
  1. Check last para@[44] frame target and get calculate variance
  2. AF trigger condition : check if variance is smaller than para@[45] (threshold) for last para@[44] frames.

[44] pd_trigger_variance_frame	Trigger variance check frame number
[45] pd_trigger_variance	Variance under this value will give trigger signal

Hybrid AF – Hybrid scene change

Name	Description	Default Value	Note
[21] pd_scene_enable	set 1 to let PD target change as scene change.	0	0 or 1
[22] pd_change_frame	increased this value to improve PDAF trigger stability ; decreased to improve sensitivity.	10	>0
[23] pd_change_thr	increased this value to improve PDAF trigger stability ; decreased toimprove sensitivity.	90	>=0
[24] pd_stable_frame	pd_stable_frame	10	>0
[25] pd_stable_thr	pd_stable_thr	90	>0
[26] pd_valid_confidence_chg	set what's confidence level data will use for PD scene change.	70	0~100
[27] pd_valid_confidence_stb	set what's confidence level data will use for PD scene stable.	70	0~100
[44] pd_trigger_variance_frame	Trigger variance check frame number	3	
[45] pd_trigger_variance	Variance under this value will give trigger signal	100	

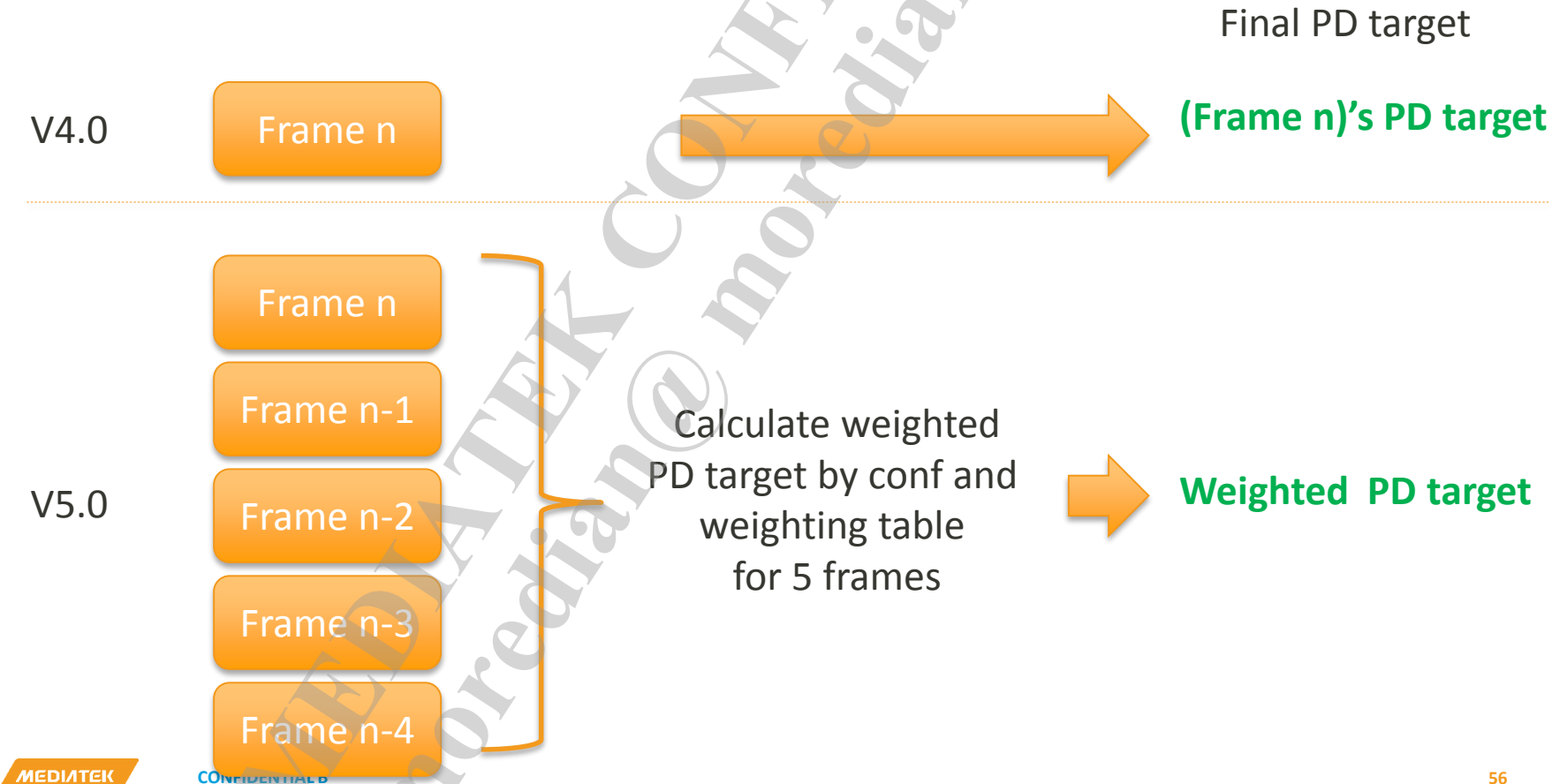
MID-LOW CONFIDENCE HANDLING

New item

- Weighted PD Target
- Adjust Speed by Defocus and Confidence
- Fit Peak Protection

Weighted PD Target

- Purpose
  - Apply weighted PD target by smooth frames



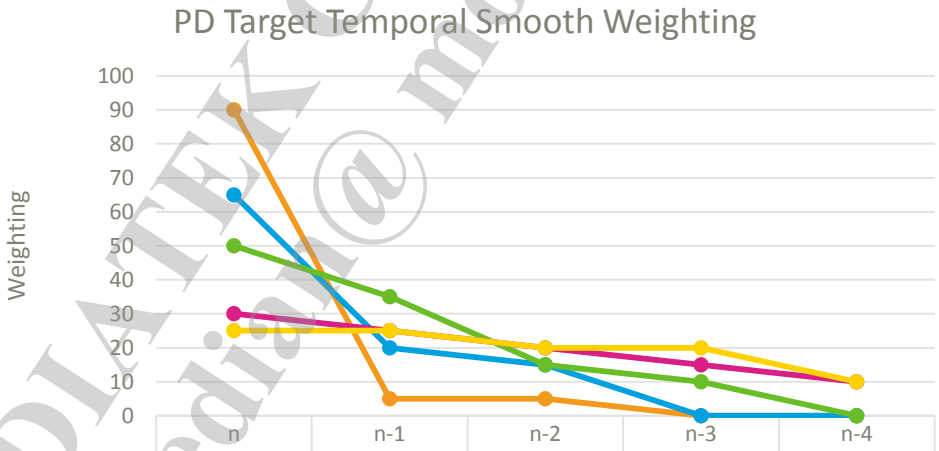
Weighted PD Target

- Weighted PD target calculation
  - Final weighting = **temporal weight** x confidence weight

Set value by parameter

By past 5 frame's confidence

  - Final PD target : tarPos * final weighting for 5 frames



	n	n-1	n-2	n-3	n-4
100~80	90	5	5	0	0
79~60	65	20	15	0	0
59~40	50	35	15	10	0
39~20	30	25	20	15	10
19~0	25	25	20	20	10

Weighted PD Target

- Weight table setting by parameter
  - Set a temporal smooth weight table for past 5 frame at each confidence level region.
  - The default value is the higher confidence the lower smooth weighting.

i4PDAFCoefs	[46]	[47]	[48]	[49]	[50]
Confidence	100~80	79~60	59~40	39~20	19~0
Default	**1**	**1**	**2**	**2**	**3**
Ex: no smooth	1	1	1	1	1
Ex: smooth all	5	5	5	5	5

Table :
50 30 20 0 0

This table is fixed. Only selection by parameter

	N	N-1	N-2	N-3	N-4
1	100	0	0	0	0
2	70	20	10	0	0
3	50	30	20	0	0
4	40	30	20	10	0
5	25	25	20	20	10

PDAF – Weighted PD target

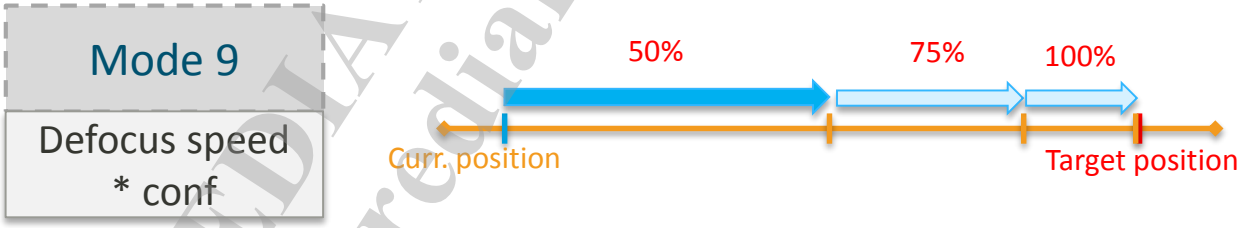
Name	Description	Default Value	Note
[46] pd_temp_smooth_conf_80_100	select a temporal smooth weighting table for each confidence level	1	1~5
[47] pd_temp_smooth_conf_60_79	select a temporal smooth weighting table for each confidence level	1	1~5
[48] pd_temp_smooth_conf_40_59	select a temporal smooth weighting table for each confidence level	2	1~5
[49] pd_temp_smooth_conf_20_49	select a temporal smooth weighting table for each confidence level	2	1~5
[50] pd_temp_smooth_conf_0_19	select a temporal smooth weighting table for each confidence level	3	1~5

```
        n,   n-1,  n-2, n-3, n-4
    +------------------------
(1)| 100,    0,    0,    0,    0, //temporal smooth lv1
(2)| 70,    20,    10,    0,    0, //temporal smooth lv2
(3)| 50,    30,    20,    0,    0, //temporal smooth lv3
(4)| 40,    30,    20,    10,    0, //temporal smooth lv4
(5)| 25,    25,    20,    20,    10, //temporal smooth lv5
```

Adjust Speed by Defocus and Confidence

- Purpose
  - Move large step when far away form target ; move quick when close to target
  - Add new moving mode – Mode 9

- Concept (Mode 9)
  - Final moving speed = defocus speed x confidence

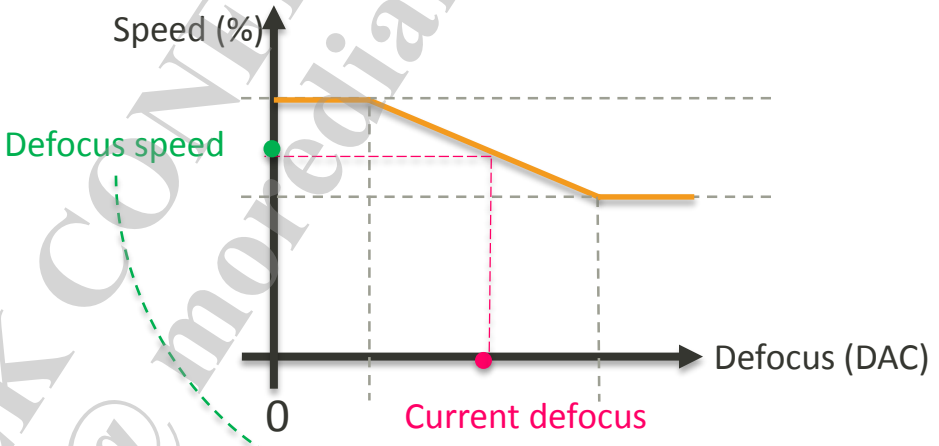


Adjust Speed by Defocus and Confidence

- Speed calculation

Get defocus speed by right curve

Calculate final speed by conf weighting

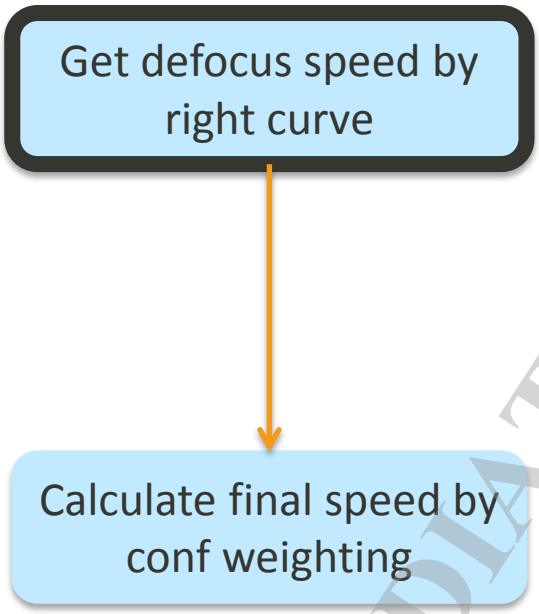


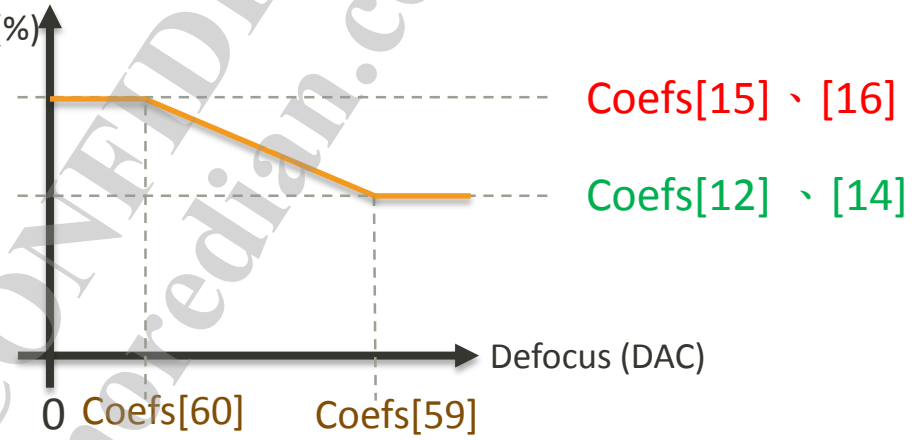
$$Final\ Speed = \frac{(100 - W) \times speed\ by\ defocus + W \times PD\ confidence}{100}$$

W : weighting , set by parameter

Adjust Speed by Defocus and Confidence

- Speed calculation

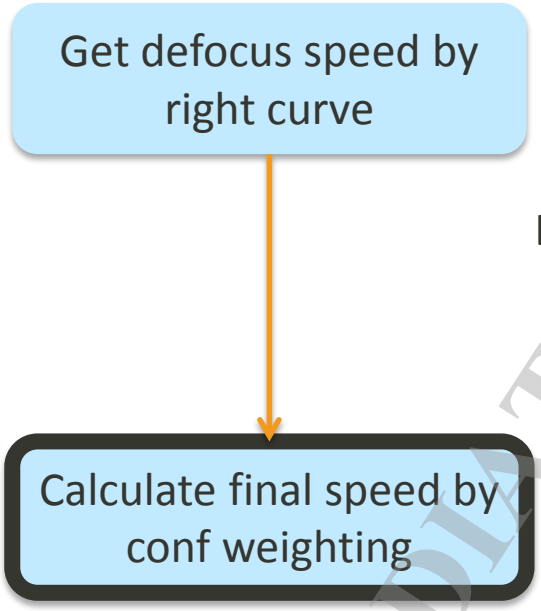




i4PDAFCoefs	Description	Default
[11]	Set moving speed mode 9 to enable. (inf direction)	9
[12]	speed for long defocus size (inf direction)	40
[13]	Set moving speed mode 9 to enable. (mac direction)	9
[14]	speed for long defocus size (mac direction)	40
[15]	speed for short defocus size (inf direction)	100
[16]	speed for short defocus size (mac direction)	100
[59]	Long defocus threshold (% of af table size)	50
[60]	short defocus threshold (% of af table size)	5

Adjust Speed by Defocus and Confidence

- Speed calculation



Let confidence weighting = W

$$Final\ Speed = \frac{(100 - W) \times speed\ by\ defocus + W \times PD\ confidence}{100}$$

i4PDAFCoefs	Description
[61] pd_move_speed_conf_weighting	Confidence weighting (1~100)

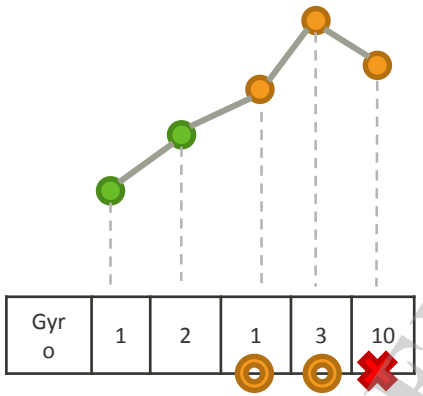
Adjust Speed by Defocus and Confidence

Name	Description	Default Value	Note
[11] pd_move_mode_inf	Set moving speed mode 9 to enable. (inf direction)	9	
[12] pd_move_speed_inf	speed for long defocus size (inf direction)	40	
[13] pd_move_mode_mac	Set moving speed mode 9 to enable. (mac direction)	9	
[14] pd_move_speed_mac	speed for long defocus size (mac direction)	40	
[15] pd_move_ext_inf	speed for short defocus size (inf direction)	100	
[16] pd_move_ext_mac	speed for short defocus size (mac direction)	100	
[59] pd_move_ext2	Long defocus threshold (% of af table size)	50	
[60] pd_move_ext3	short defocus threshold (% of af table size)	5	
[61] pd_move_speed_conf_weighting	Confidence weighting (1~100)	40	

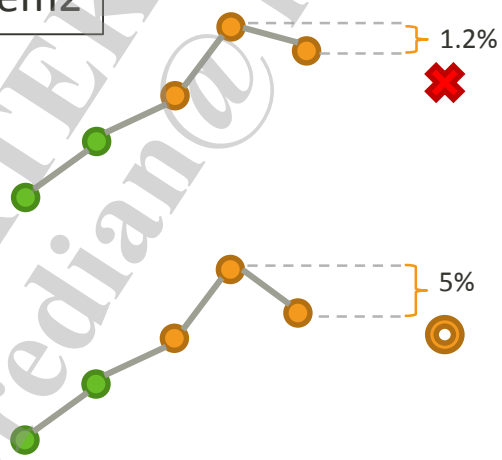
Fit Peak Protection

- Purpose
  - Check each condition when peak found, if not satisfy check item, keep finesearch
- Check item
  - Item1 : Gyro < threshold
  - Item2 : FV is not flat when mid-low confidence
  - Item3 : Position after adaptive damping compensation is normal

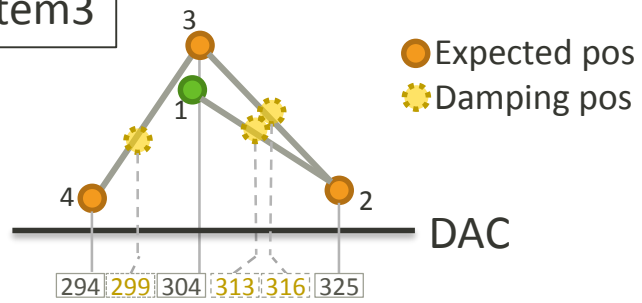
Item1



Item2



Item3

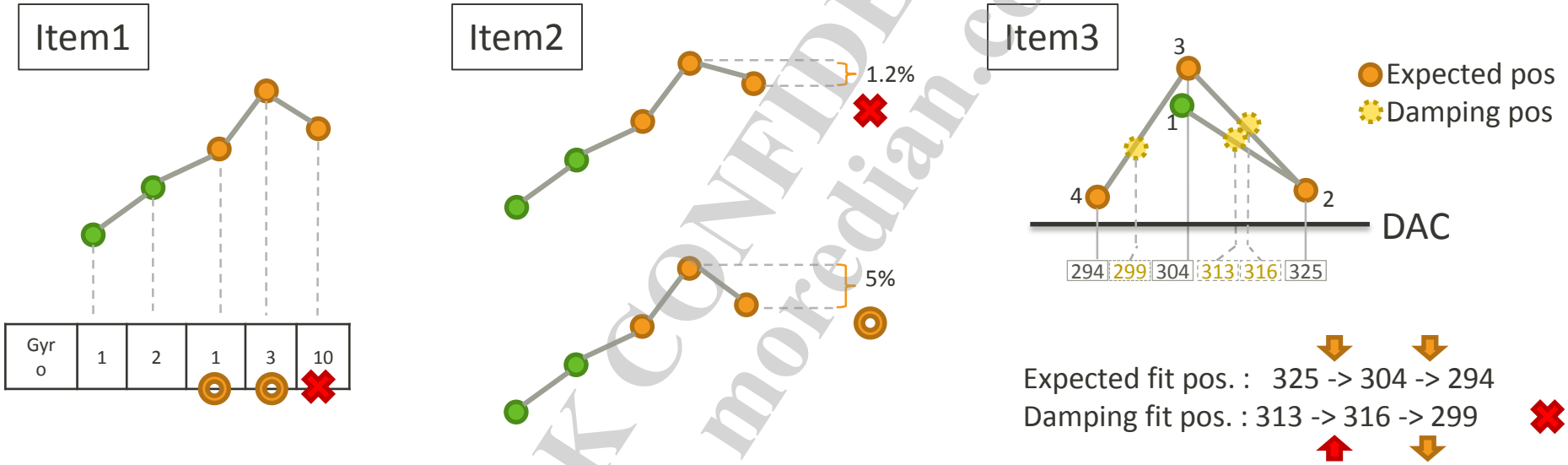


Expected fit pos. : 325 -> 304 -> 294

Damping fit pos. : 313 -> 316 -> 299

Fit Peak Protection

- Parameter



	i4HybridAFCoefs	Description	Default
Item2	[49] flat fv	FV protection ratio (0~100 %)	2
Item1	[64] gyro stable	Gyro stable protection	10
	[68] mid-low confidence	Mid-Low confidence threshold	50

FV protection function[49] active when confidence < mid-low confidence threshold[68]

Hybrid AF - Fit Peak Protection

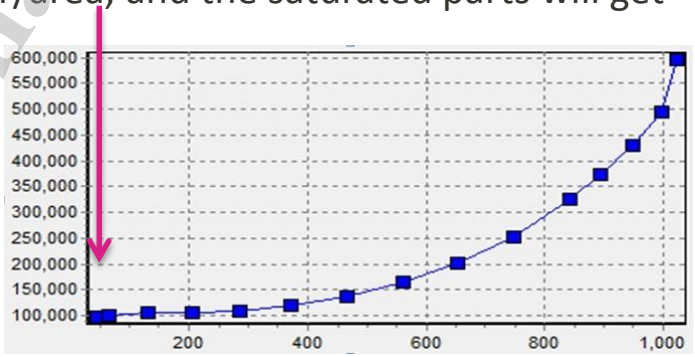
Name	Description	Default Value	Note
[49] flat fv	FV protection ratio (0~100 %)	2	
[64] gyro stable	Gyro stable protection	10	
[68] mid-low confidence	Mid-Low confidence threshold	50	

PLAF

CONCEPT INTRODUCTION

PLAF — Introduction

- Spatial sharpness image filter can generate focus value (FV) for auto focus (AF) to find best focus lens position.
- Since it is effective and simple, it is widely used in camera system.
- However, the point light (PL) scene can confuse it, and make AF miss-focused.
- PL scenes contain saturated (over-exposure) spots/bar/area, and the saturated parts will get bigger & bigger with image blur.
- It causes FV growing with image blur, and AF fail.

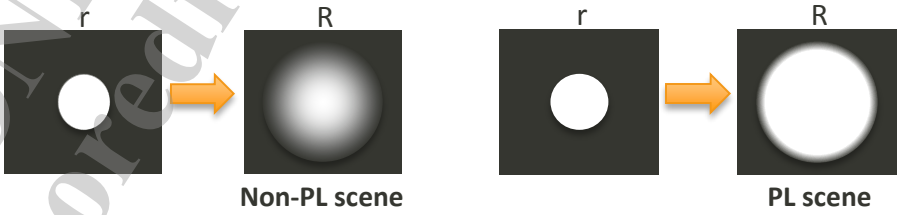


PL detector

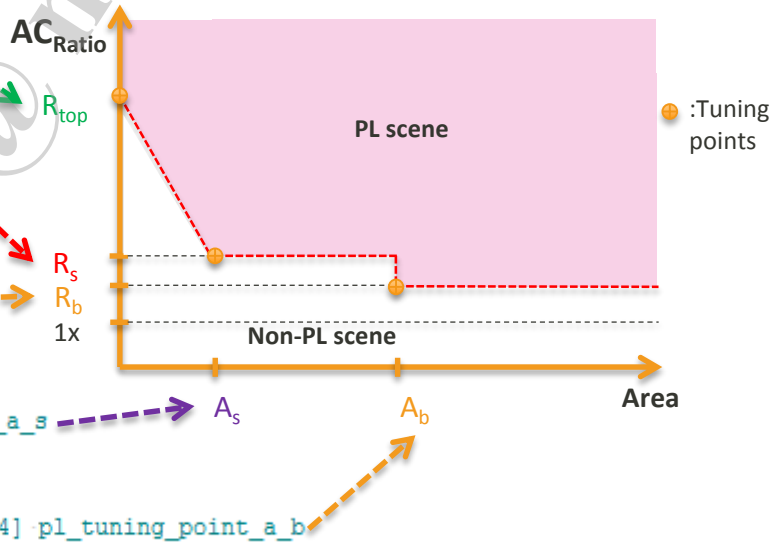
- **Detect PL scene**
  - Check the changes ratio of area when normal AF searching.
    - PL scene should have sufficient area changes ratio.
  - For realization, we use 32-histogram weighted result for area, and get the ratio.

AC_{Ratio} = Area(R) / Area(r)

Area = $Hist_{255}W_{255} + Hist_{248}W_{248}$ …

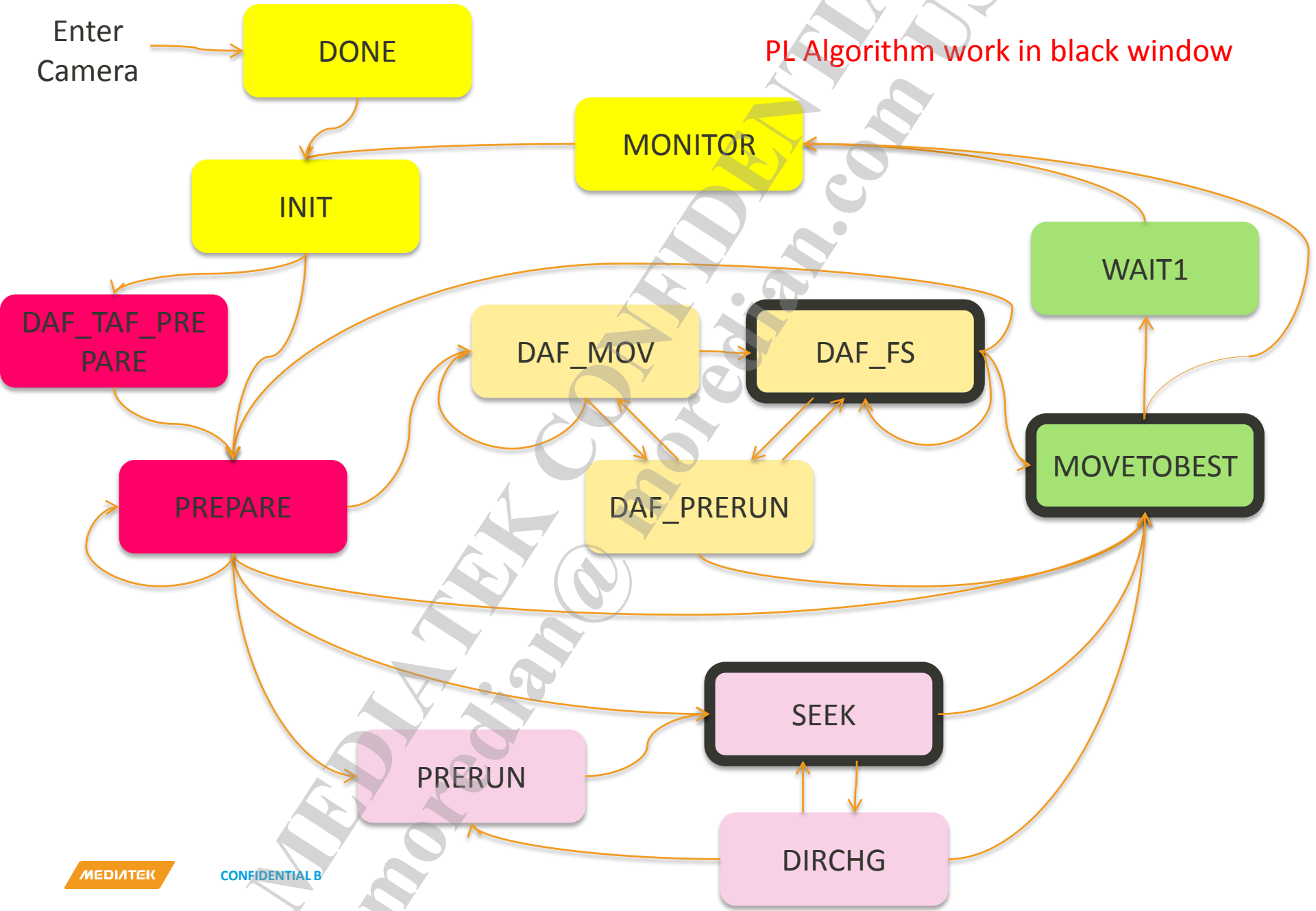



```
1000,        // [1] pl_tuning_point_r_top
 260,        // [3] pl_tuning_point_r_s
 140,        // [5] pl_tuning_point_r_b
2000000,     // [2] pl_tuning_point_a_s
4500000,     // [4] pl_tuning_point_a_b
```

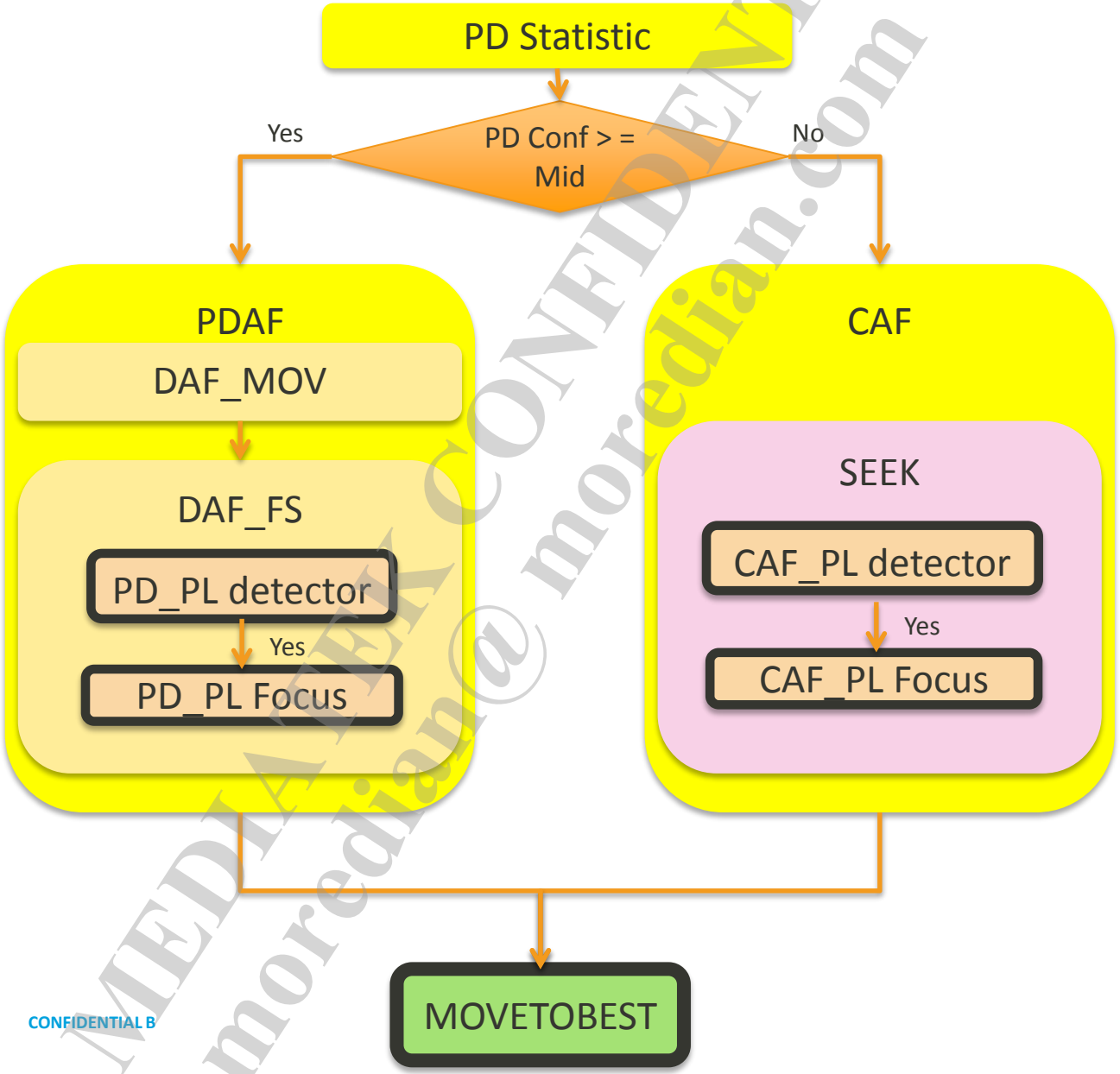


FLOW DESCRIPTION

AF state machine



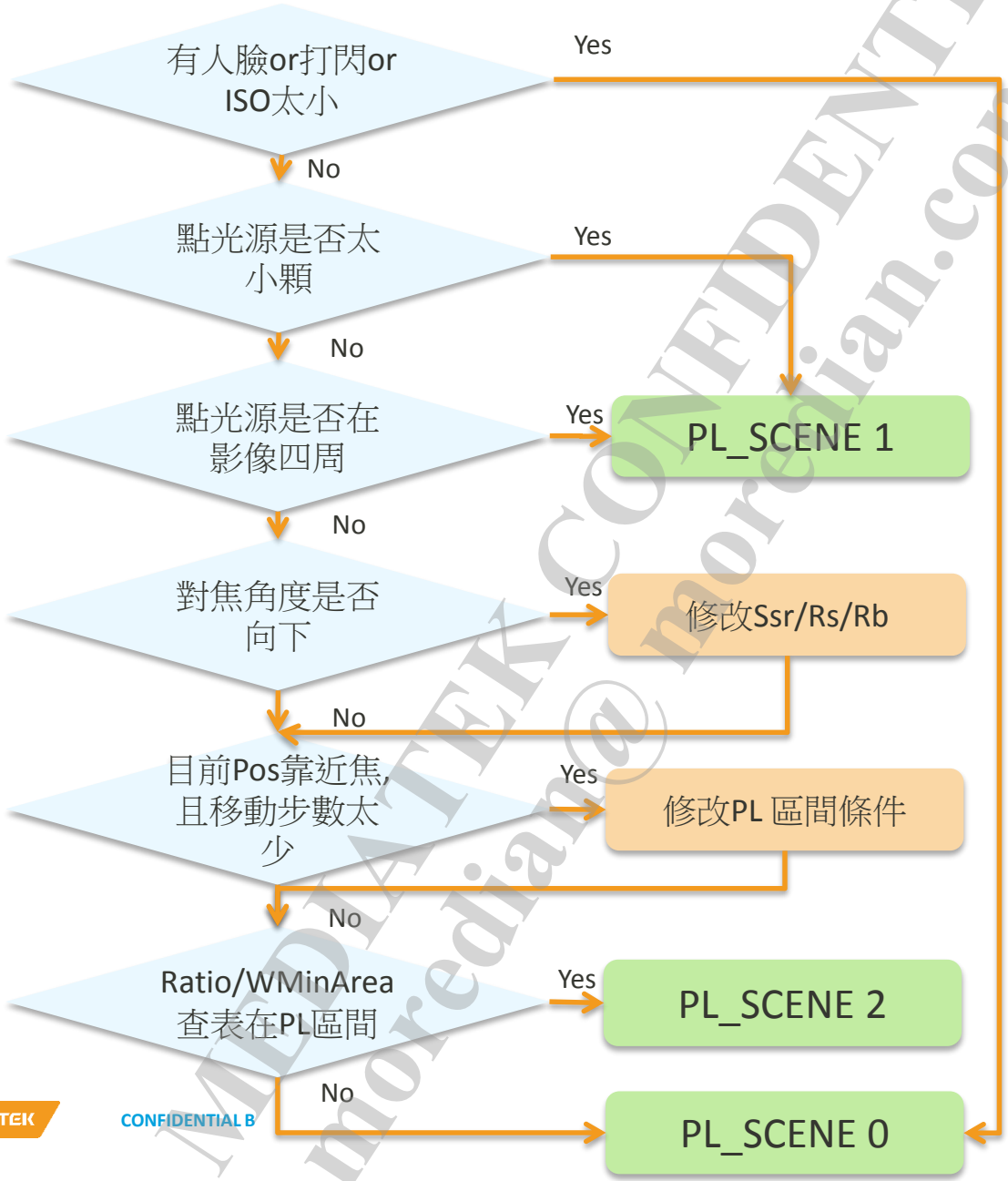
PL Algorithm Flow – Hybrid Mode



PL CAF CASE

PL detector – CAF Case

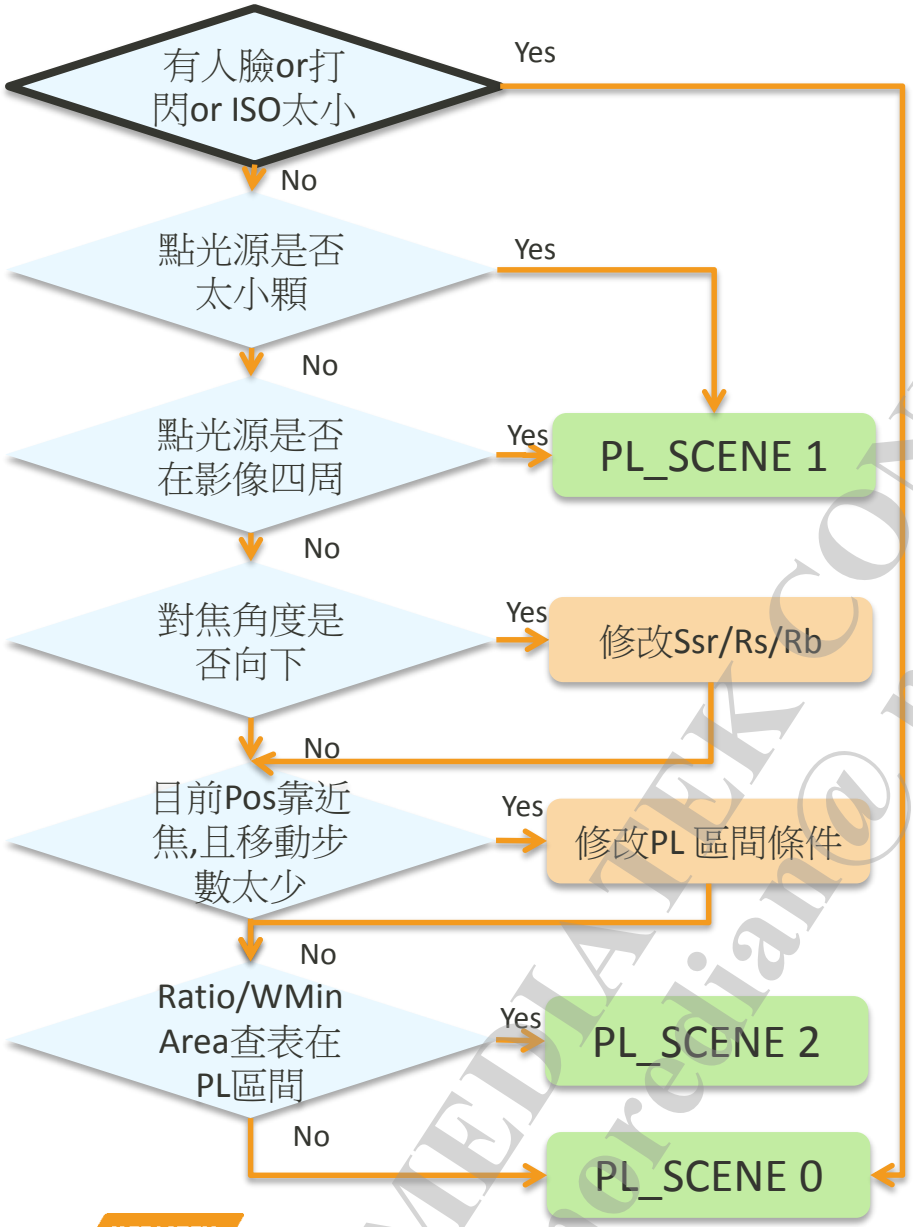
SEEK



PL_SCENE 0: Non-PL
PL_SCENE 1: PL abort
PL_SCENE 2: CAF PL
PL_SCENE 3: PDAF PL

PL detector – CAF Case

SEEK



打閃是否偵測點光源

i4PLAFCoefs[7]

[10]	PLAF will have no effect when flash on.	1

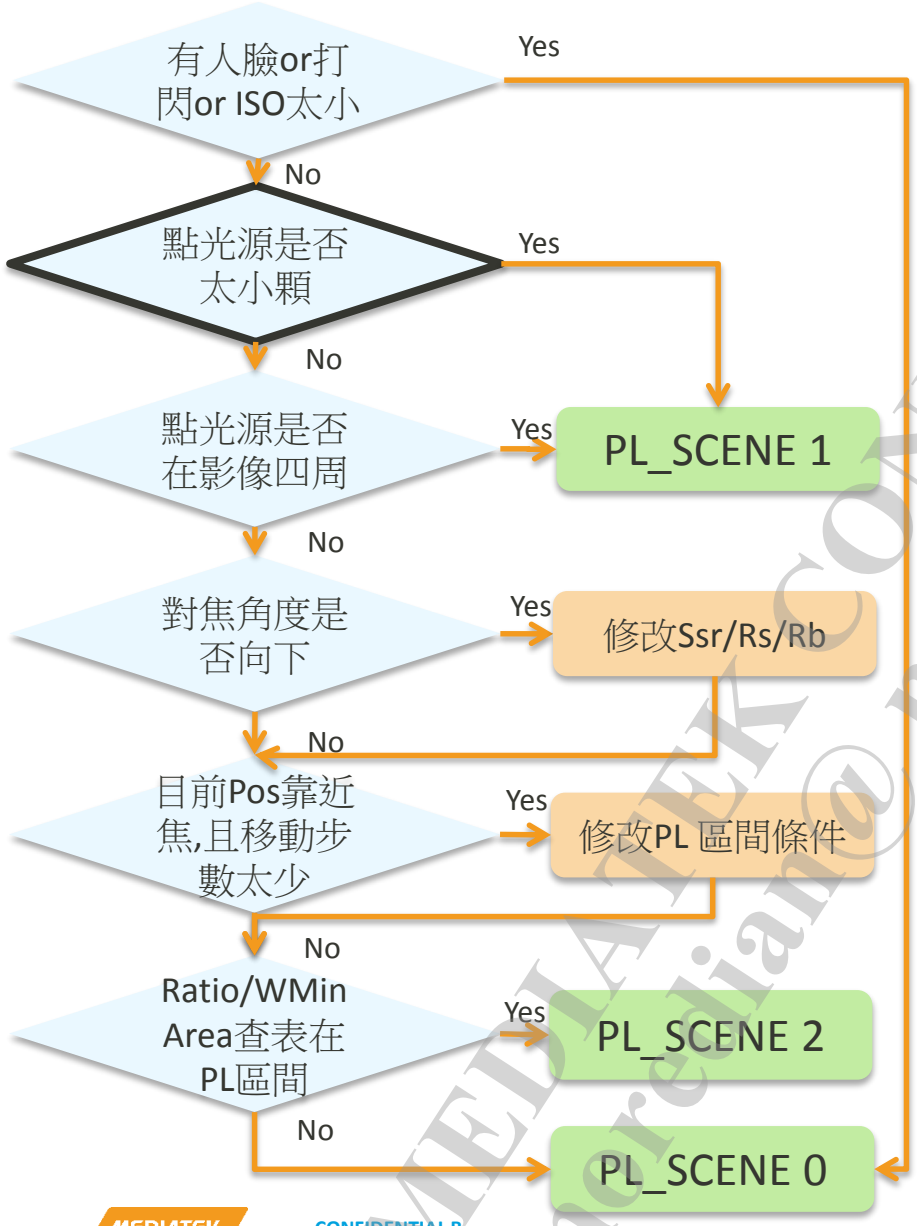
ISO TH調整參數

i4PLAFCoefs[7]

bit[0...3]	ISO threshold for TAF. (x100)	3 (ISO 300)
bit[4...7]	ISO threshold for CAF. (x100)	3 (ISO 300)

PL detector – CAF Case

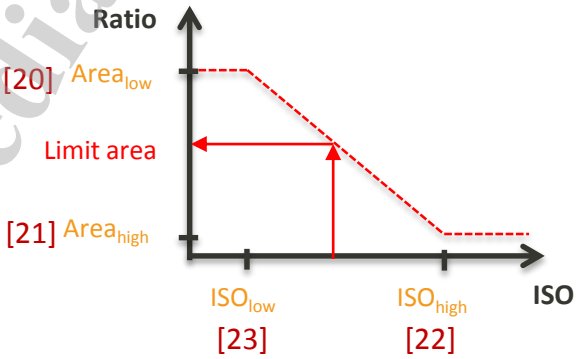
SEEK



如何判斷點光源太小顆

(PL_WMinArea<limitWArea && ISO<PLISOHigh) or
(PL_WMinArea<100 && ISO>PLISOHigh)

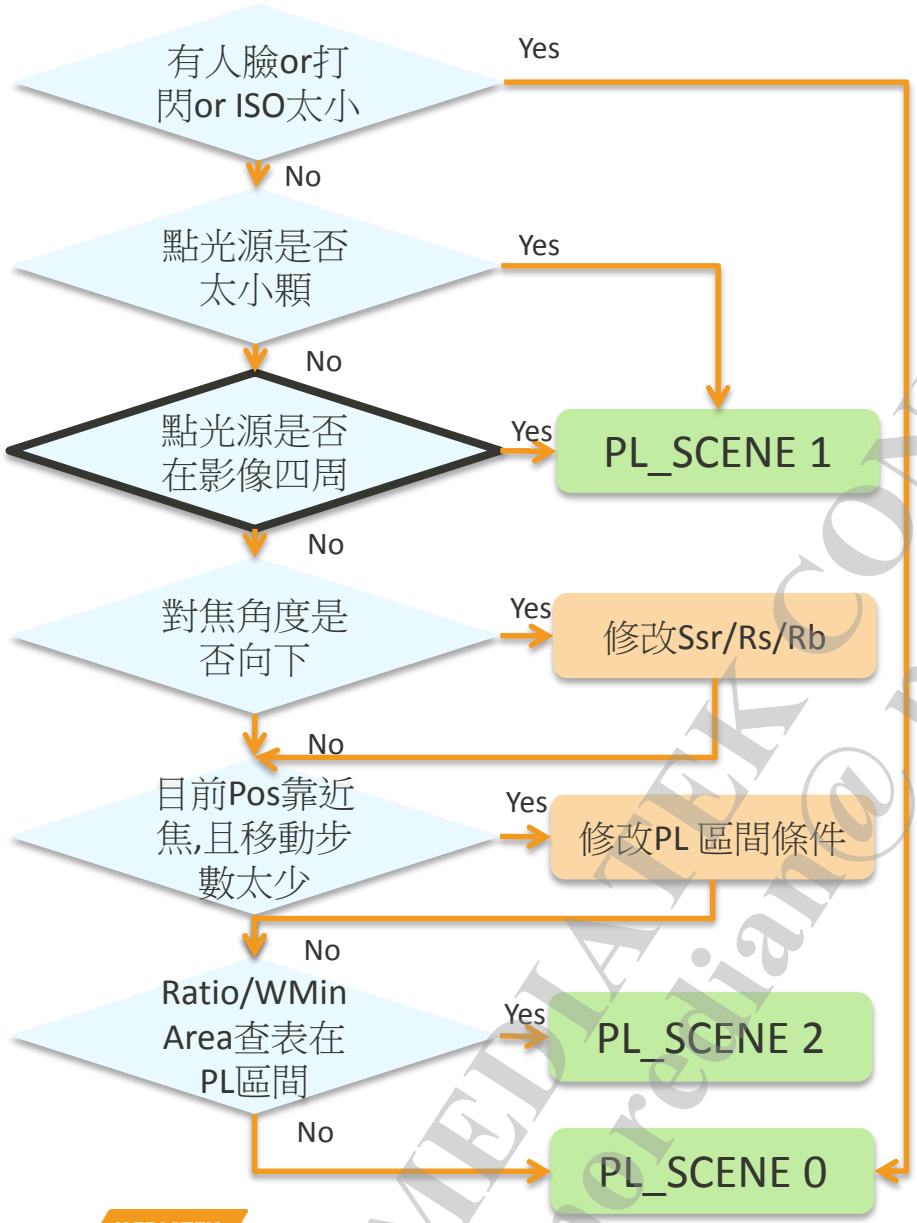
如何算limitWArea



i4PLAFCoefs[64]

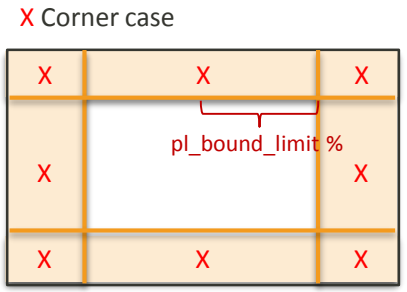
[20]	PlIsoHigh	**800**
[21]	PlIsoLow	100
[22]	PlAreaHigh	500
[23]	PlAreaLow	1000

PL detector – CAF Case



如何定義影像四周

中心點(x,y) +- 影像長寬一半的pl_bound_limit %
定義為中間

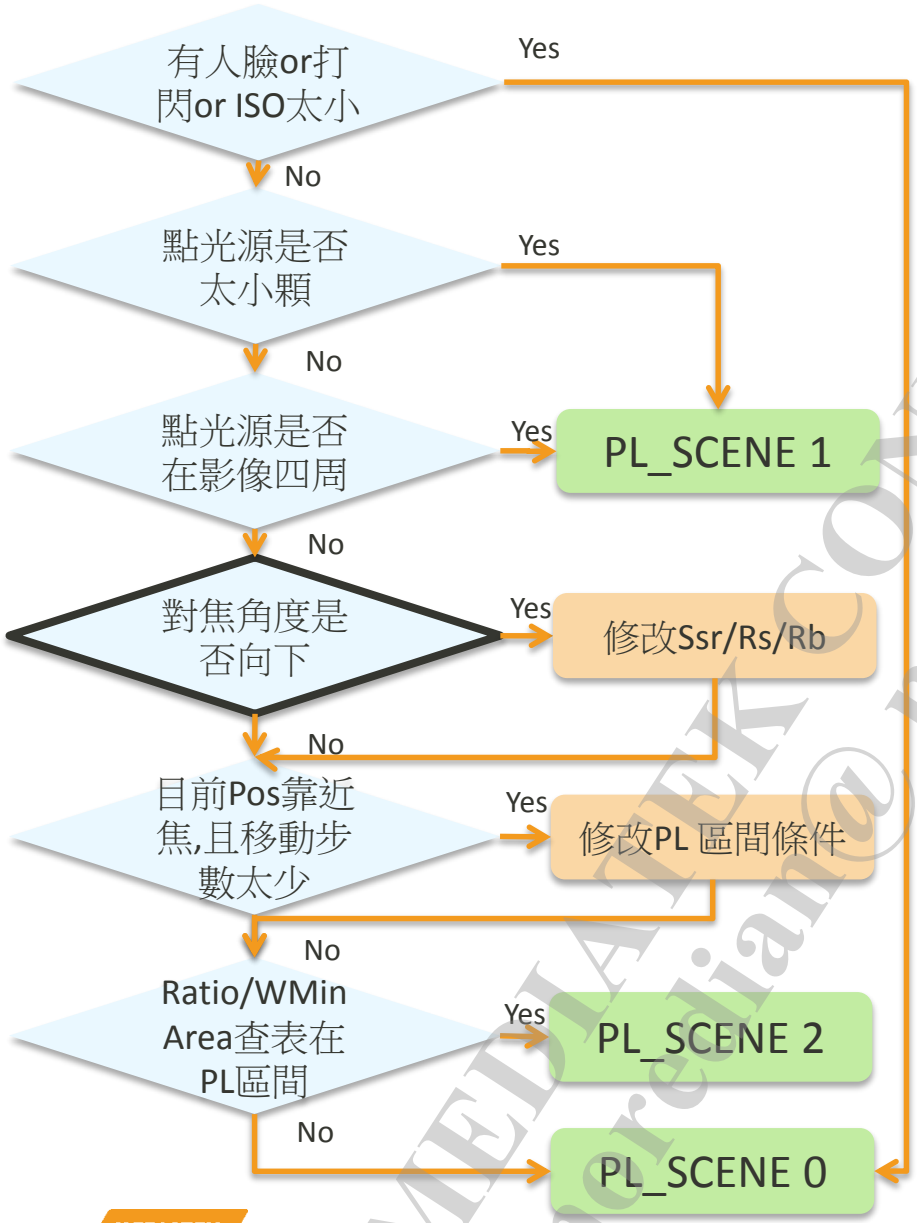


i4PLAFCoefs[64]

[6]	pl_bound_limit	70

PL detector – CAF Case

SEEK



對焦向下時,first pos 靠近焦,則abort
否則,提高進PL 區的難度 (提高Rs,Rb,Rtop)

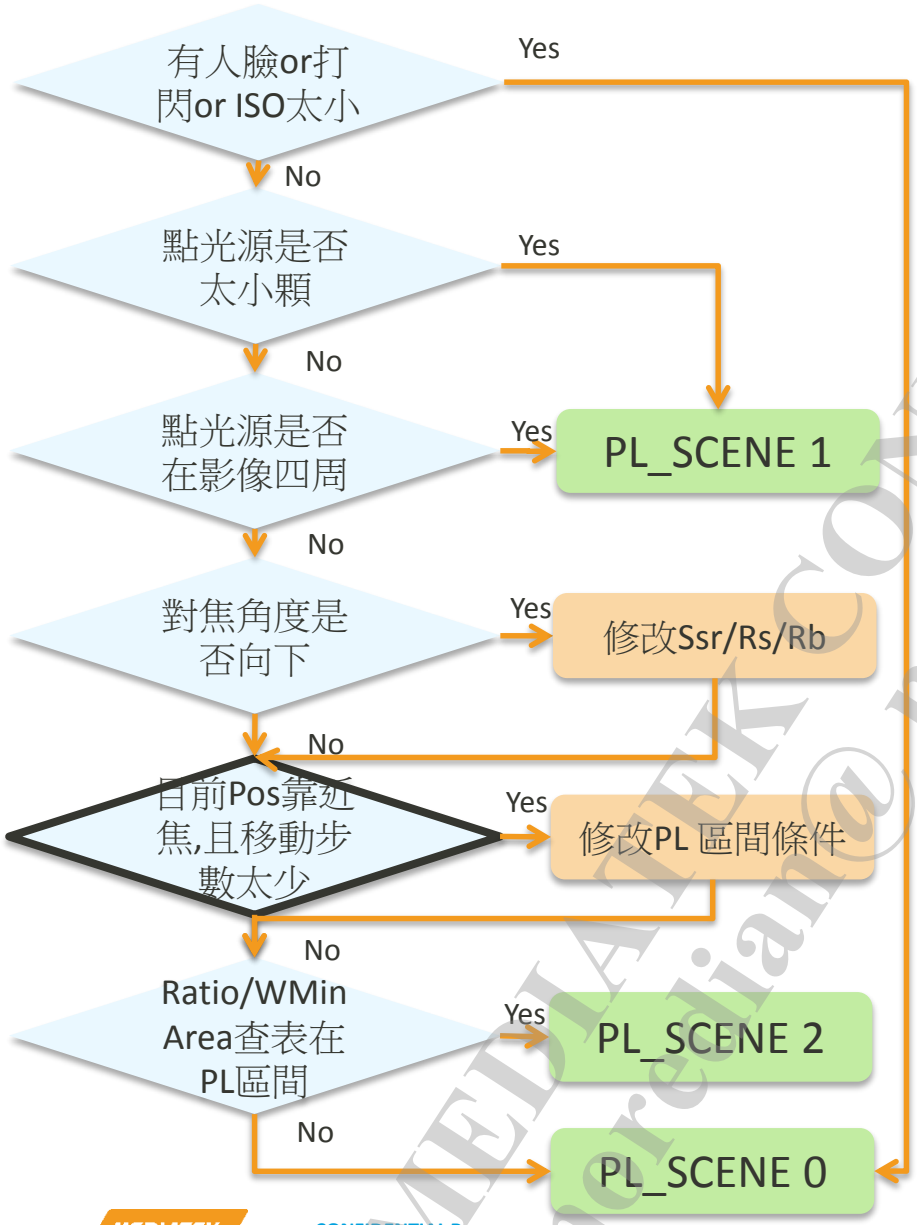
Rs = Rs * (10 + PLAF[12…15])/10
Rb= Rb * (10 + PLAF[12…15])/10
Rtop = Rtop * (10 + PLAF[12…15])/10

i4PLAFCoefs[7]

bit[12…15]	If the angle threshold is satisfied, this value determine how many times for raising PL detect line.	3 (1.3x)
bit[16…19]	Camera angle of depression threshold. x(-10)	4 (-40)

PL detector – CAF Case

SEEK



(Cur_pos > Mid_pos) && (TotInd < PlShotStep)
步數少時,ratio變化可能較小,進PL的條件要變鬆

Mid_pos = 整個AF table *3/4

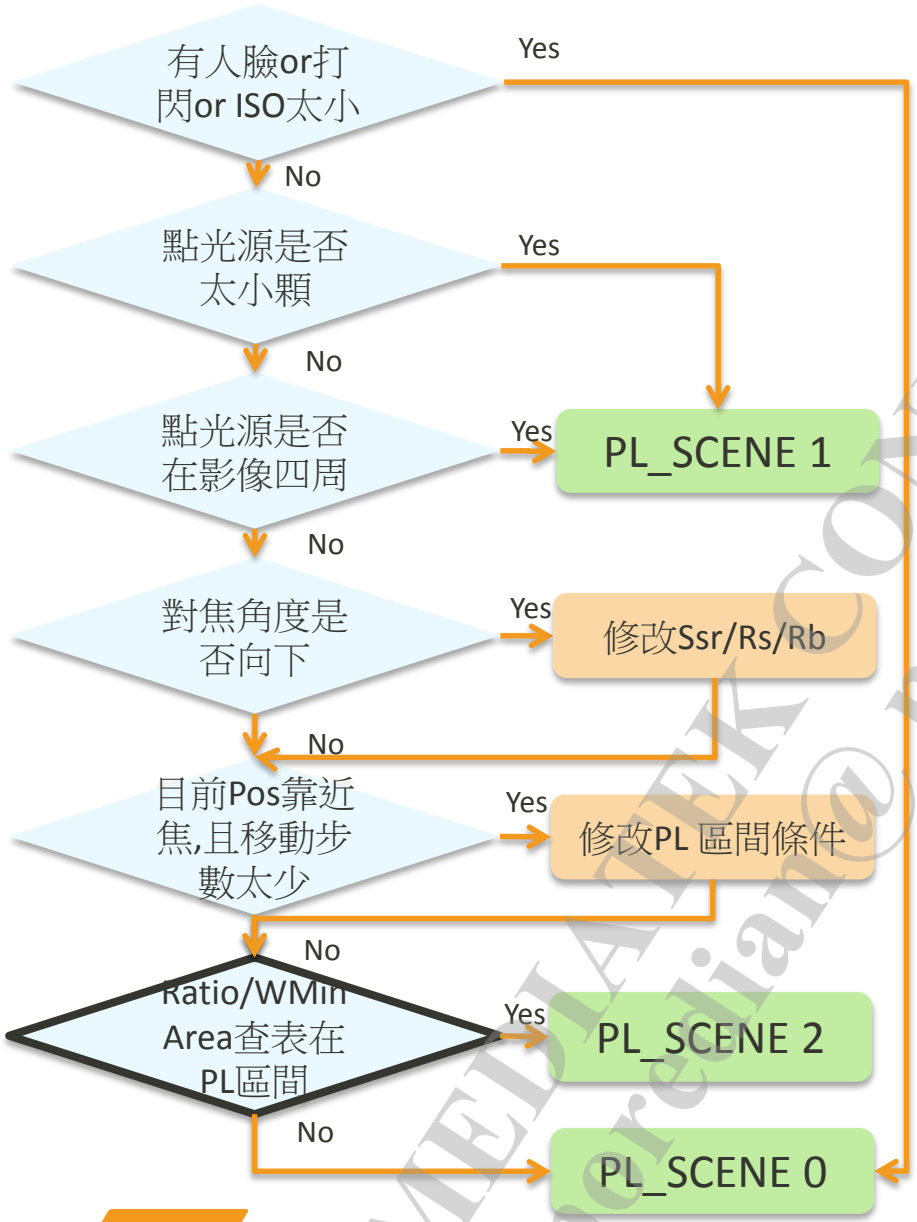
Rs = Rs * PlShortDca/100
Rb= Rb * PlShortDca/100
Rtop = Rtop * PlShortDca/100
最小不能小於PlShortStepRatio

i4PLAFCoefs[64]

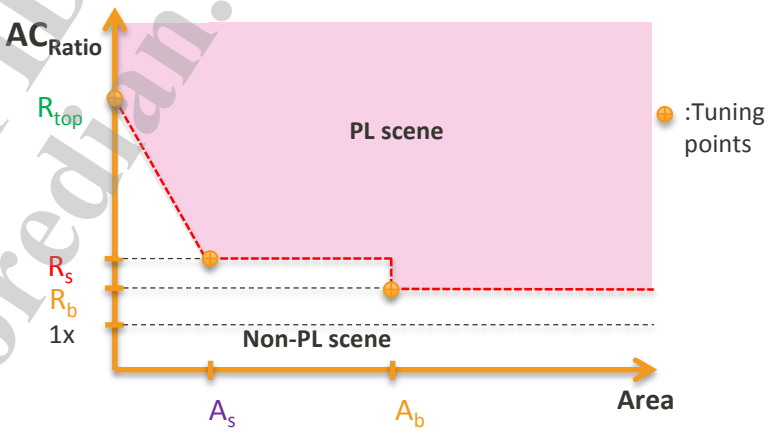
[14]	PlShortStepRatio	**110**
[15]	PlShortStep	4
[16]	PlShortDca	80

PL detector – CAF Case

SEEK



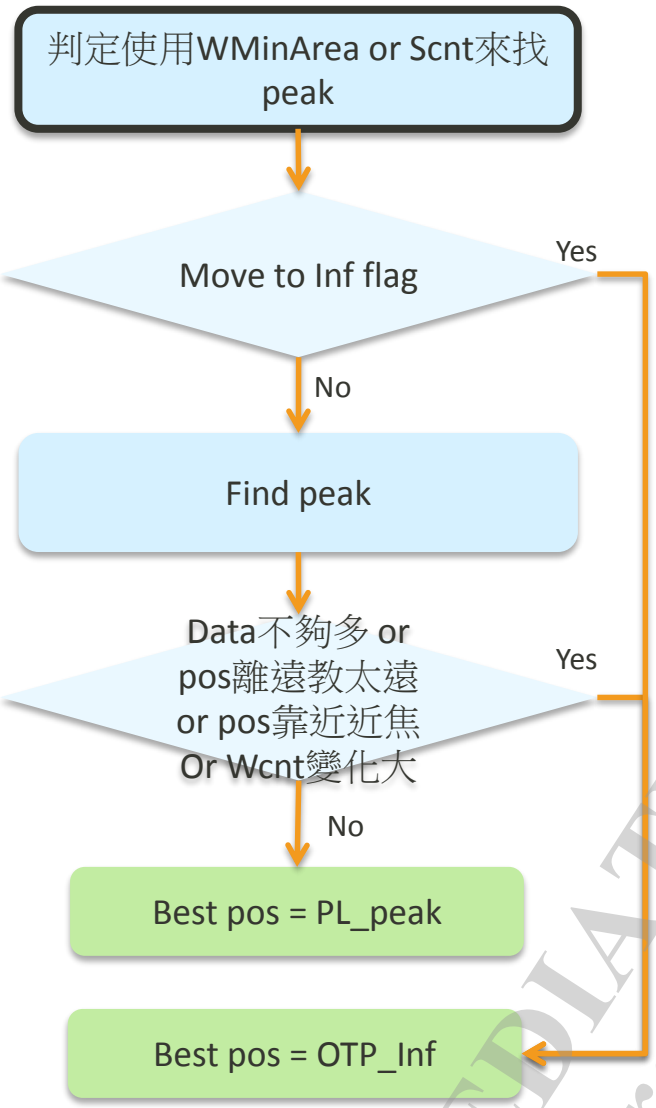
使用Ratio/MinArea查表判定是否為PL景



i4PLAFCoefs[64]

[1]	pl_tuning_point_r_top	**2500**
[2]	pl_tuning_point_**a_s**	2000000
[3]	pl_tuning_point_**r_s**	300
[4]	pl_tuning_point_**a_b**	8000000
[5]	pl_tuning_point_**r_b**	140

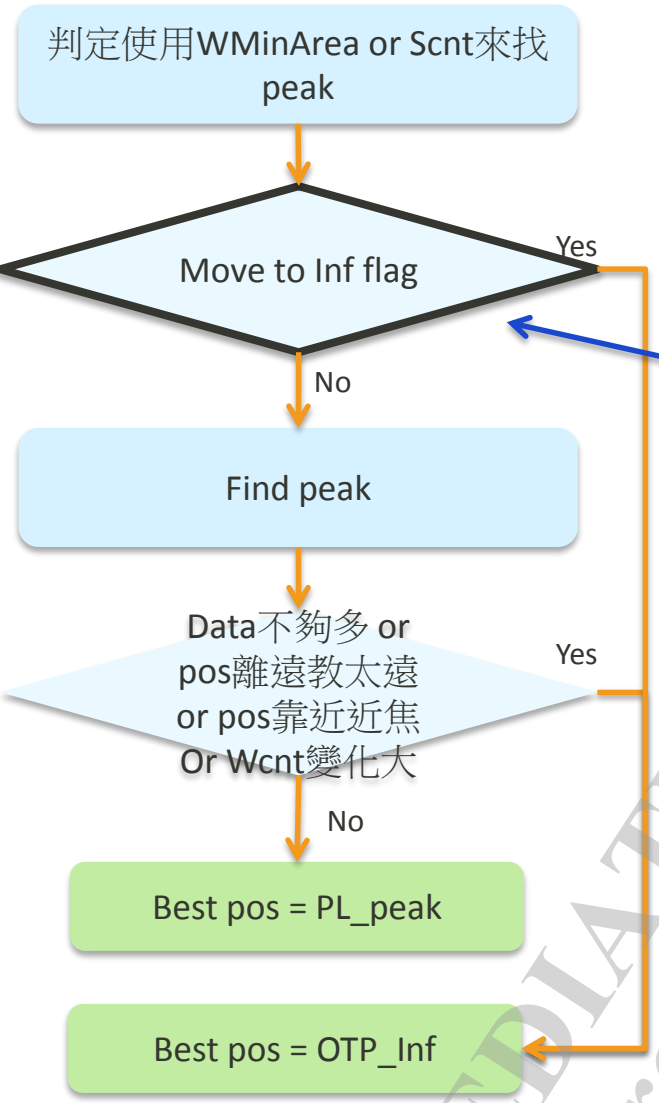
PL Focus – CAF Case



如何判定

Wmin_pos < TotMin_pos => 使用WminArea
Else => 使用Scnt
(挑選靠近遠焦的來用)

PL Focus – CAF Case

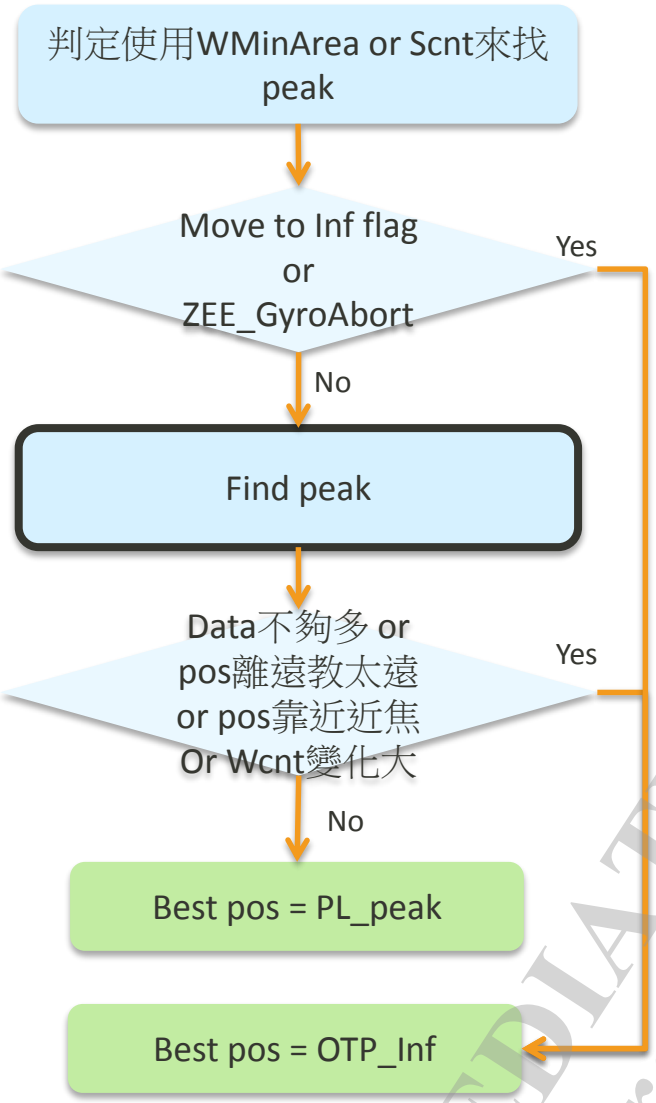


此tuning參數若設1,則偵測到是PL scene,就推OTP_Inf

i4PLAFCoefs[7]

bit[9]	Move to infinity directly if detect PL.	0

PL Focus – CAF Case

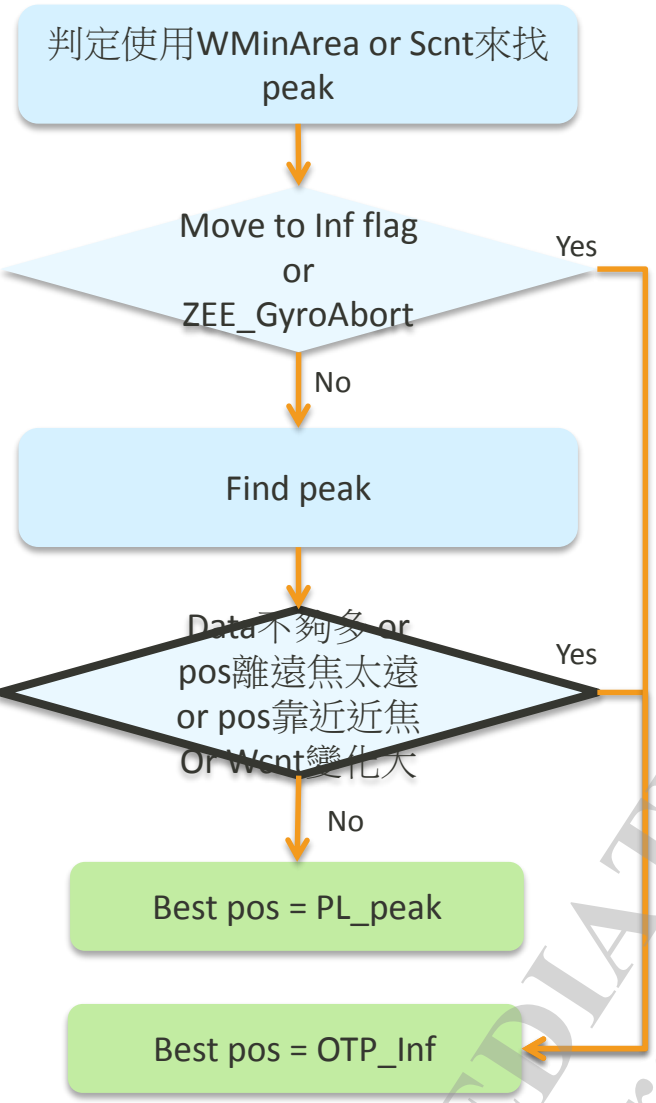


如何找到peaK

使用3點curve fitting

如果curve fitting pos < Inf_pos
則還是使用Inf_pos

PL Focus – CAF Case



如何判定

Pl_pos < far_pos (pos 離遠焦太遠)
Pl_pos>mid_pos (pos 離近焦太近)
PL_enableExt()&& (DiffWcnt >TotWcnt)

far_pos =(table第一步*(m_u4PlTolncFarTBLRat -1)+table最後步)/ m_u4PlTolncFarTBLRat

mid_pos =(table第一步*(m_u4PlTolncNearTBLRat -1)+table最後步)/ m_u4PlTolncNearTBLRat

PL_enableExt() = i4PLAFCoefs[7]bit 8

TotWcnt = MinUsableCnt* m_u4PlUsablCntTolncRat

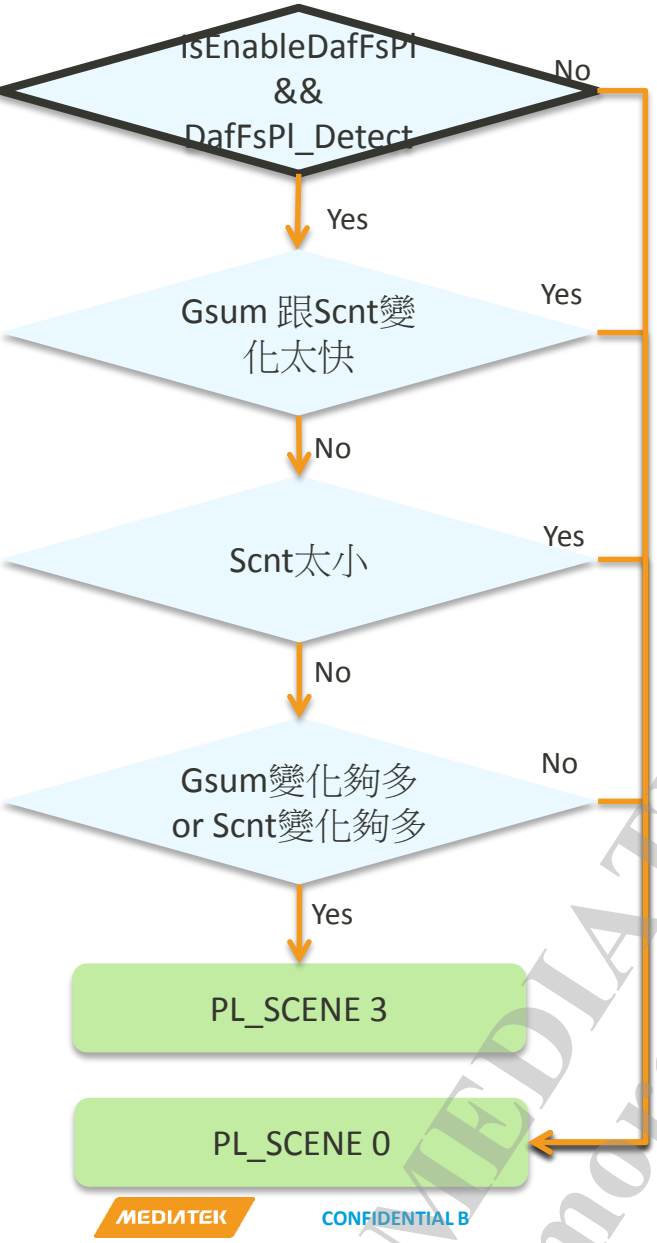
Inf_pos = OTP_pos + pl_temperature_error
(OTP可能K歪,所以手動加個shif值)

i4PLAFCoefs[64]

[11]	m_u4PlTolncFarTBLRat	4
[12]	m_u4PlTolncNearTBLRat	1
[17]	m_u4PlUsablCntTolncRat	10
[8]	pl_temperature_error	5

PL PD CASE

PL detector – PD Case



IsEnableDafFsPl = 沒人臉&& 角度不向下&& pos靠遠焦 && Conf 大於weak && ISO夠大 && 對焦框不在影像邊緣

DafFsPl_Detect = i4HybridAFCoefs [51] (default = 1)

角度tuning參數 i4PLAFCoefs[7]

bit[16...19]	Camera angle of depression threshold. x(-10)	4 (-40)

對焦bound參數 i4PLAFCoefs[64]

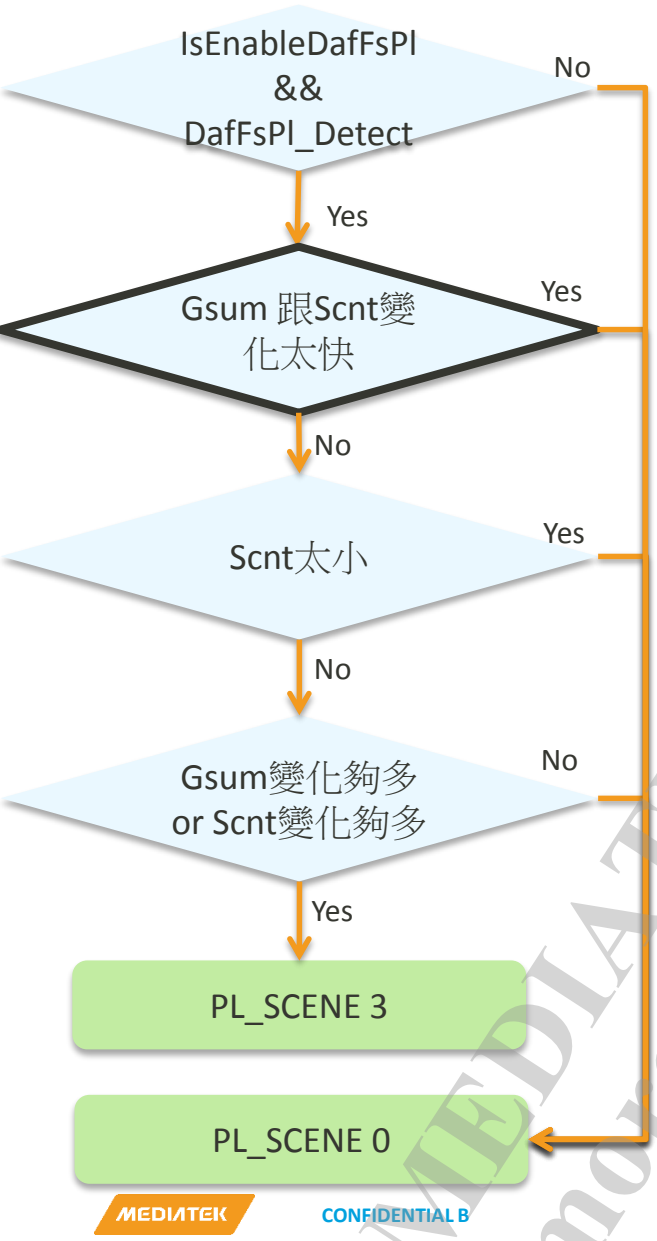
[6]	pl_bound_limit	70

ISO參數 i4PLAFCoefs[7]

[0...3]	ISO threshold for TAF. (x100)	3 (ISO 300)
bit[4...7]	ISO threshold for CAF. (x100)	3 (ISO 300)

PL_SCENE 0: Non-PL
PL_SCENE 1: PL abort
PL_SCENE 2: CAF PL
PL_SCENE 3: PDAF PL

PL detector – PD Case

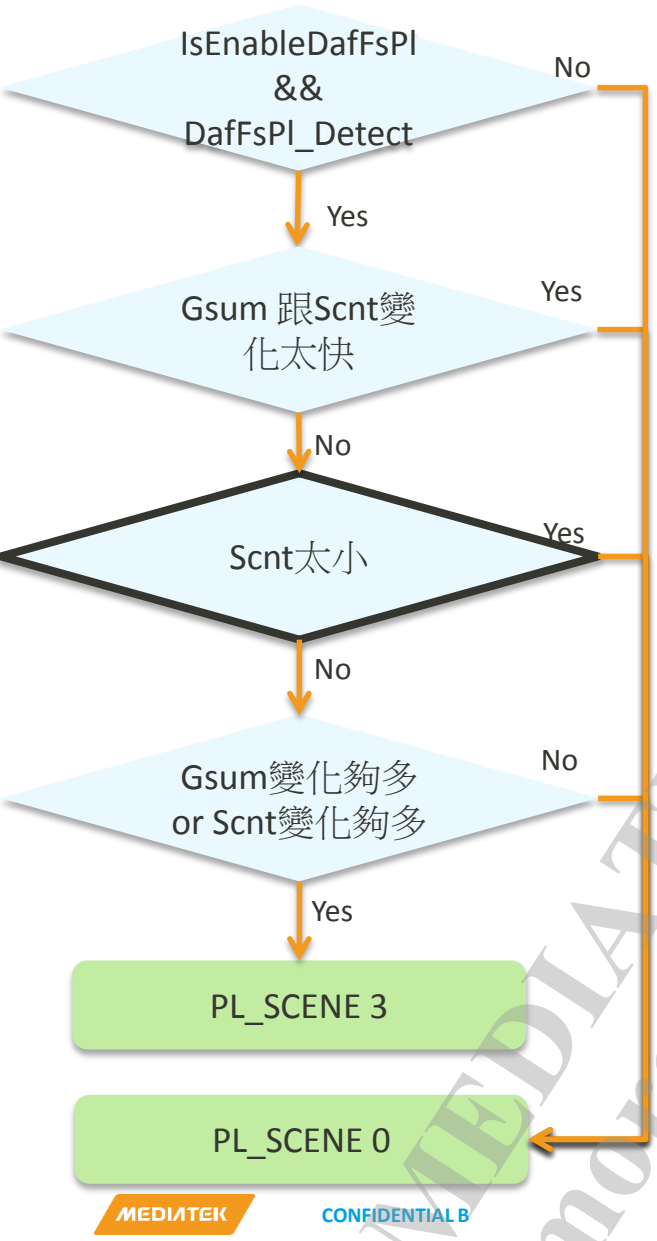


(Gsum[0]-Gsum[1])/Max_Gsum > abortGsum_TH &&
(Scnt[0]-GScnt[1])/Max_Scnt > abortScnt_TH

i4HybridAFCoefs[128]

[56]	Abnormal Gsum threshold	150
[57]	Abnormal SCnt threshold	150

PL detector – PD Case

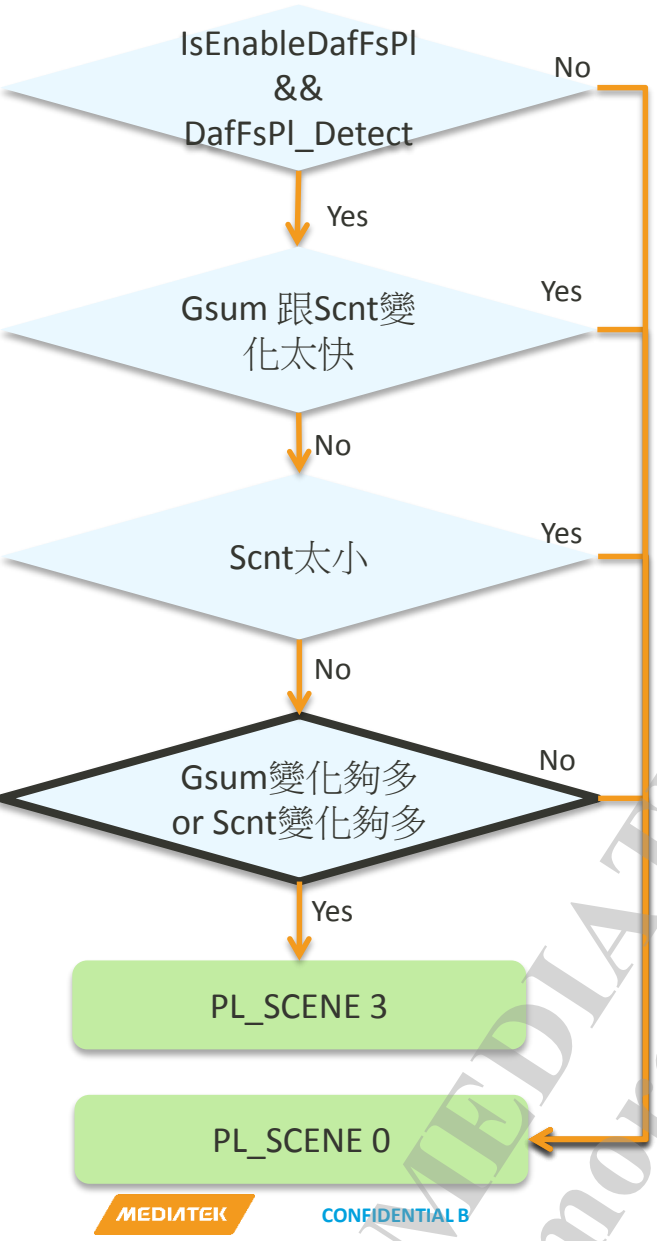


Pl_MinScnt < Pl_MinScnt_TH

i4HybridAFCoefs[128]

[54]	Fine search PL scnt min threshold	200

PL detector – PD Case



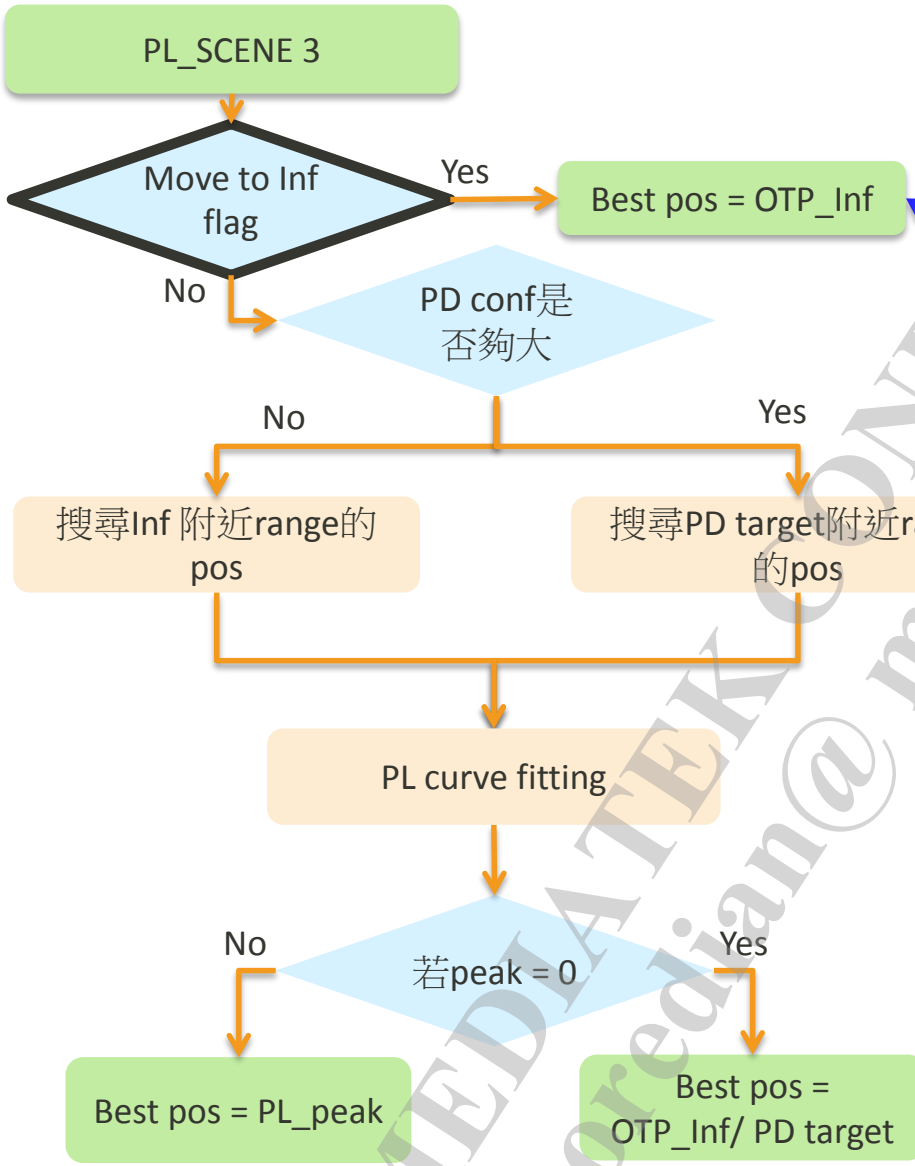
Diff_Gsum/Max_Gsum > Gsum_TH
Diff_Scnt/Max_Scnt > Scnt_TH

i4HybridAFCoefs[128]

[52]	Fine search PL gsum threshold	150
[53]	Fine search PL scnt threshold	200

PL Focus – PD Case

DAF_FS

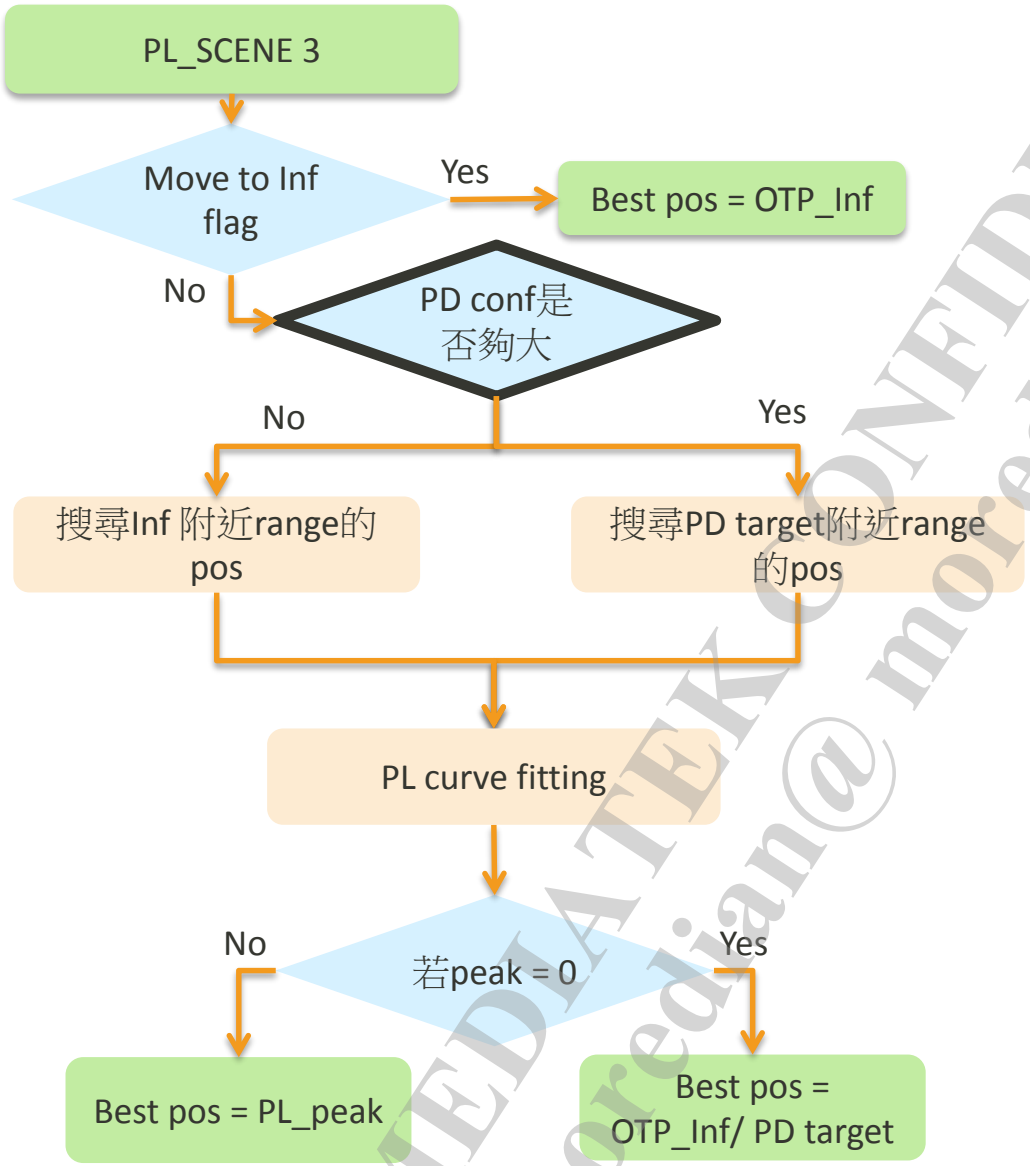


此tuning參數若設1,則偵測到是PL scene,就推OTP_Inf

i4PLAFCoefs[7]

bit[9]	Move to infinity directly if detect PL.	0

PL Focus – PD Case



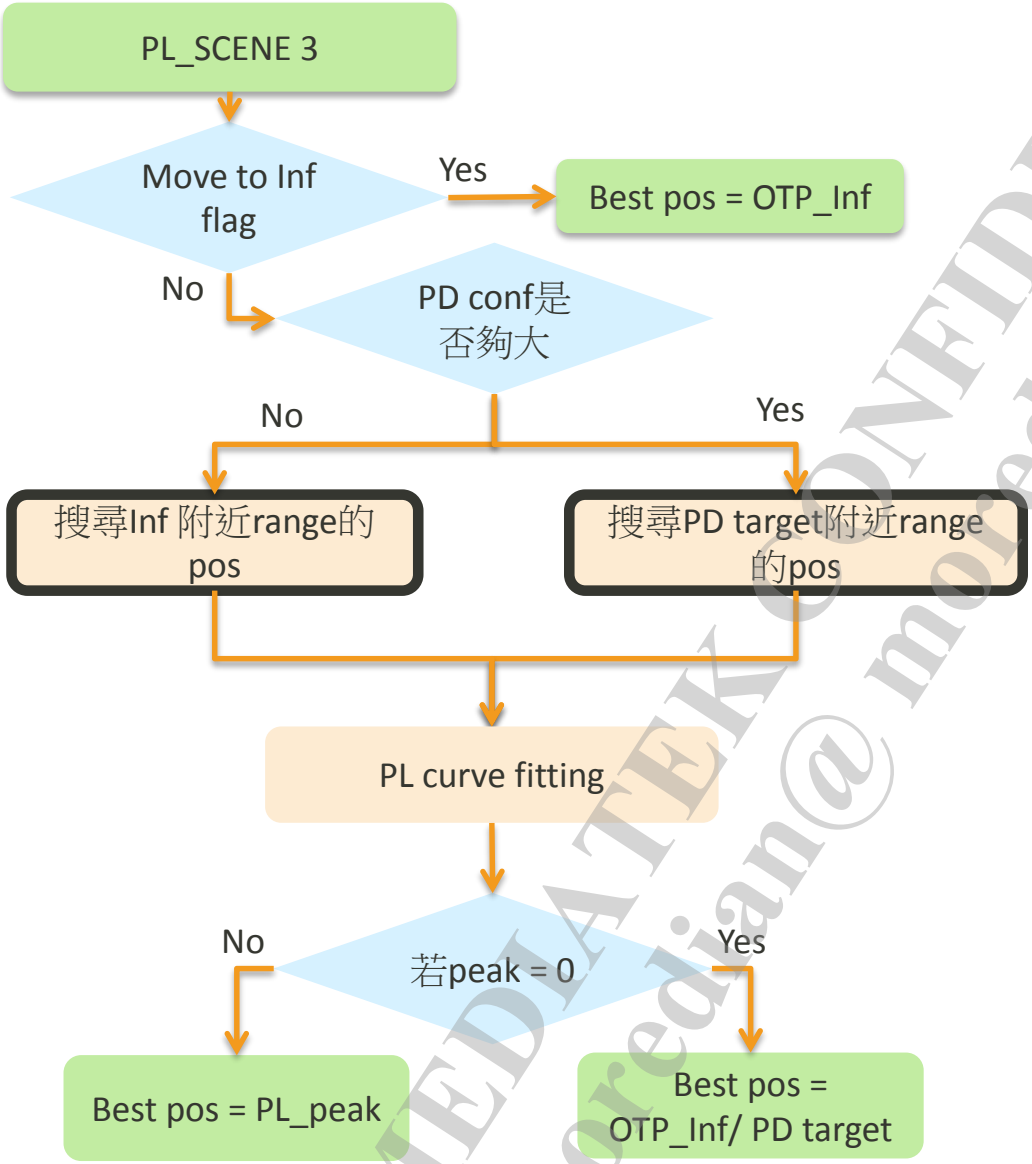
PD confidence > HbPl_PDconfTH 的frame個數 > HbPl_PDconfTH, 表示PD target可信, 可在PD target附近search 準焦點

若PD不可信,則在OTP Inf附近search準焦點

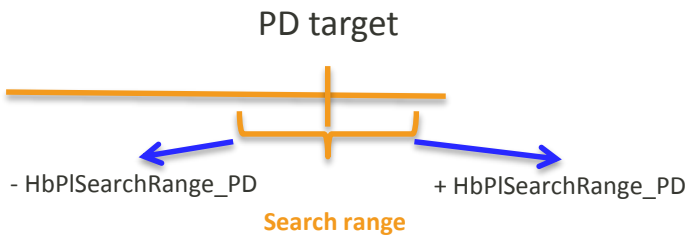
i4PLAFCoefs[64]

[29]	HbPl_PDconfTH	60
[30]	HbPl_PDCntTH	2

PL Focus – PD Case



在(PD target - HbPlSearchRange_PD, PD target +HbPlSearchRange_PD) 的range內search peak

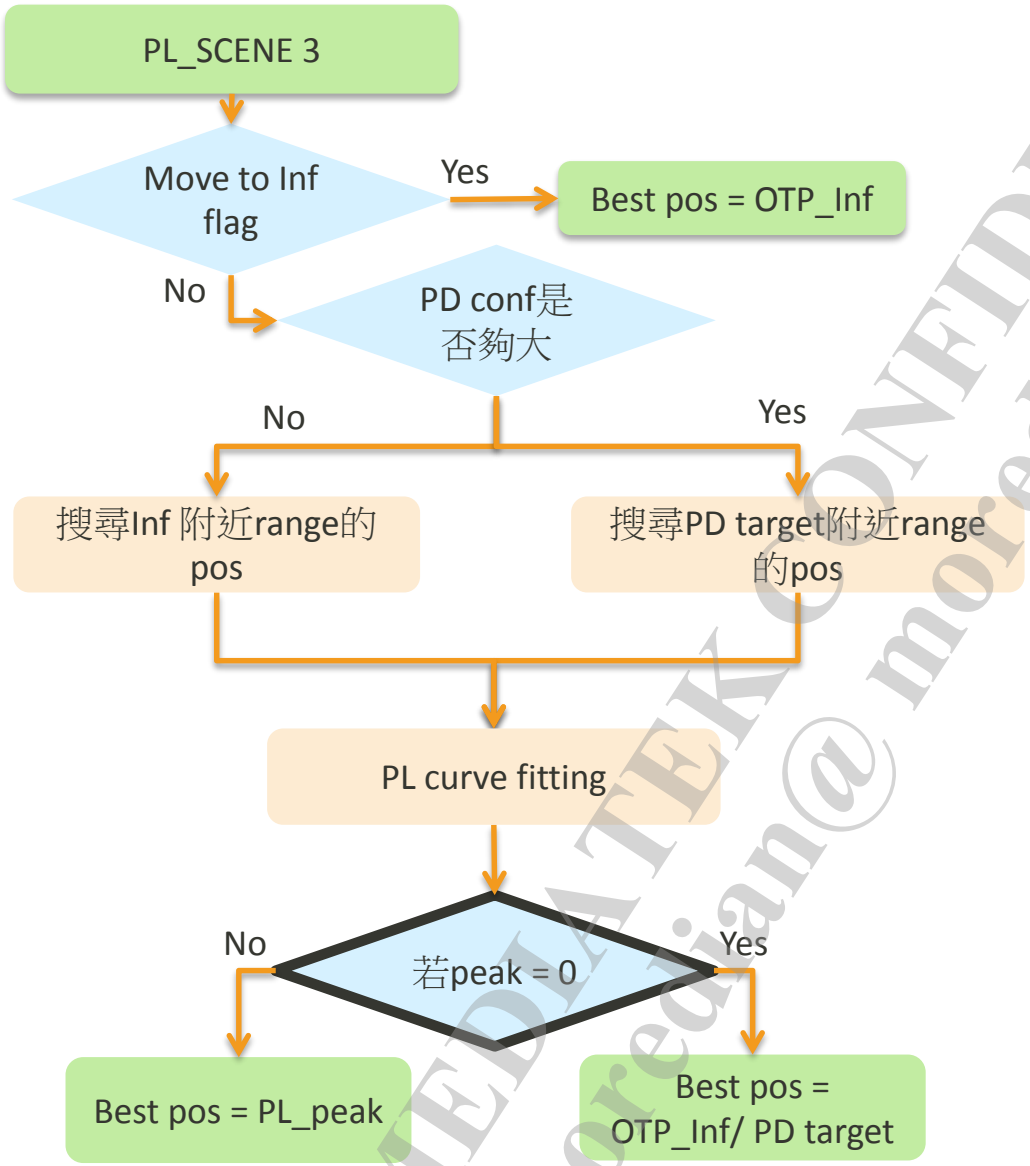


i4PLAFCoefs[64]

[27]	HbPlSearchRange_PD	40
[28]	HbPlSearchRange_Inf	60

PL Focus – PD Case

DAF_FS



若search range內所有data都沒有peak
-> lens推至OTP_Inf or PD target

若search range內有peak
-> lens推至PL_peak

TUNING PARAMETER DESCRIPTION

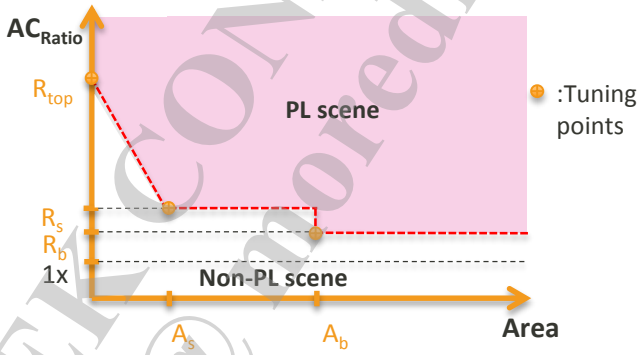
PLAF – Overview

i4HybridAFCoefs[128]

No	Description	Default
[51]	Fine search PL check	1
[52]	Fine search PL gsum threshold	150
[53]	Fine search PL scnt threshold	200
[54]	Fine search PL scnt min threshold	200
[55]	Fine search PL HW threshold	220
[56]	Abnormal Gsum threshold	150
[57]	Abnormal SCnt threshold	150
[58]	Daf Sample	3

PLAF – Overview

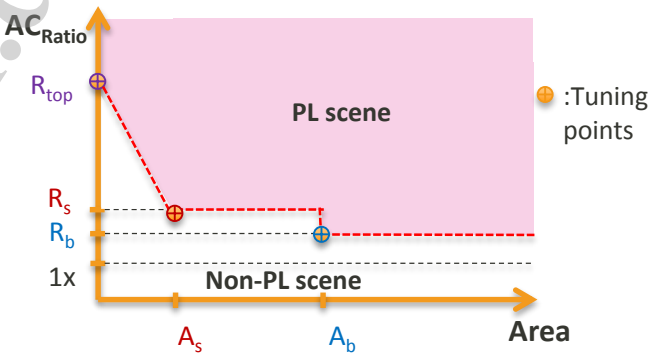
i4PLAFCoefs[64]

No	Name	Description	Default	Range
[0]	af_enable_pl	To enable PLAF or not.	1	0 or 1
[1]	pl_tuning_point_r_top	Tuning points for PL detector. 	2500	Detail
[2]	pl_tuning_point_a_s		2000000	
[3]	pl_tuning_point_r_s		300	
[4]	pl_tuning_point_a_b		8000000	
[5]	pl_tuning_point_r_b		140	
[6]	pl_bound_limit	Define boundary for corner case. PLAF will have no effect when af window in corner case.	70	40 to 100
[7]	pl_control_bit	PL control bit.	0x43C33	Detail
[8]	pl_temperature_error	To compensate OTP infinity error if OTP infinity is always not accurate.	5	-250 to 250
[9]	pl_abnormal_warea_th	Check abnormal scene by weighted area.	500	100 to 1000
[10]	pl_abnormal_tarea_th	Check abnormal scene by saturation count.	500	100 to 1000

PLAF — Customization Guideline (1/2)

i4PLAFCoefs[1] ~ i4PLAFCoefs[5]: pl_tuning_point_xx

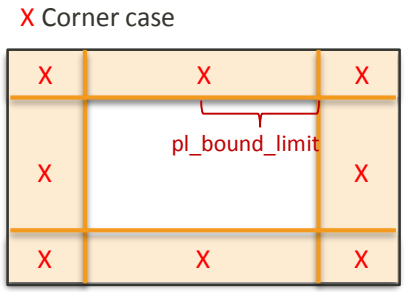
No	Name	Default	Range
[1]	pl_tuning_point_**r_top**	2500	pl_tuning_point_**r_s** to 4000
[2]	pl_tuning_point_**a_s**	2000000	0 to pl_tuning_point_**a_b**
[3]	pl_tuning_point_**r_s**	300	pl_tuning_point_**r_b** to pl_tuning_point_**r_top**
[4]	pl_tuning_point_**a_b**	8000000	pl_tuning_point_**a_s** to 4294967295 (0xffffffff)
[5]	pl_tuning_point_**r_b**	140	120 to pl_tuning_point_**r_s**



i4PLAFCoefs[6]: pl_bound_limit

- Define boundary for corner case(x). PLAF will have no effect when af window in corner case.
- Effect: The bigger the value is, the more effective area for PLAF. (the less corner cases happen.)
- Default: 70
- Range: 40 to 100

*It is not recommended to change value.



PLAF — Customization Guideline (2/2)

i4PLAFCoefs[7]: pl_control_bit = 0x33C33

Bit	Description	Default	Range
[0…3]	ISO threshold for TAF. (x100)	3 (ISO 300)	0 to 0xF
[4…7]	ISO threshold for CAF. (x100)	3 (ISO 300)	0 to 0xF
[8]	To enable PL extract method.	0	0 or 1
[9]	Move to infinity directly if detect PL.	0	0 or 1
[10]	PLAF will have no effect when flash on.	1	0 or 1
[11]	To enable new HW or not.	1	0 or 1
[12…15]	If the angle threshold is satisfied, this value determine how many times for raising PL detect line.	3 (1.3x)	0 to 0xF = 1x, 1.1x,1.2x,…2.5x
[16…19]	Camera angle of depression threshold. x(-10)	4 (-40)	0 to 0xF = 0, -10, -20, … -150.

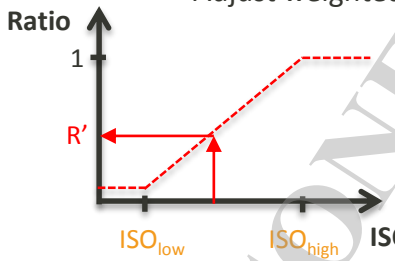
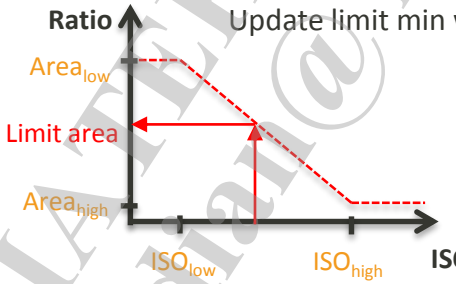
PLAF – Overview

i4PLAFCoefs[64]

No	Name	Description	Default	Range
[11]	m_u4PlTolncFarTBLRat	Decide DAC for far scene. (table[0]*(X-1) + table[N])/X	4	1 to 100
[12]	m_u4PlTolncNearTBLRat	Decide DAC for near scene. (table[0]*(X-1) + table[N])/X	1	1 to 100
[13]	m_u4PlSatCntTolncRat	For PLFv3.0 extraction.	20	1 to 100
[14]	m_u4PlShortStepRatio	Reduce PL detector ratio (*_m_u4PlShortDca_/100) if search step is less than _m_u4PlShortStep_. The final detector ratio should be greater than or equal to _m_u4PlShortStepRatio_. 走的步數少,area變化可能不夠大,所以降低進點光源的門檻值,但不能降到比m_u4PlShortStepRatio低	110	110 to 1000
[15]	m_u4PlShortStep		4	1 to 6
[16]	m_u4PlShortDca		80	50 to 100
[17]	m_u4PlUsablCntTolncRat	For PLFv3.0 extraction.	10	1 to 100
[18]	m_i4PlMinSatV	The minimum saturation count HW threshold.	160	
[19]	m_u4PlPfmUpdateSatTH	To per-frame update saturation count HW threshold.	1	0 or 1

PLAF – Overview

i4PLAFCoefs[64]

No	Name	Description	Default	Range
[20]	m_u4PlIsoHigh	Adjust weighted area by ISO value.  WArea = (Hist$_{255}$W$_{255}$ + Hist$_{248}$W$_{248}$ … Hist$_0$W$_0$) * **R'** *m_u4PlIsoHigh must be greater than m_u4PlIsoLow	800	0 to 1600
[21]	m_u4PlIsoLow		100	0 to 1600
[22]	m_u4PlAreaHigh	Update limit min weighted-area.  *m_u4PlAreaHigh must be less than or equal to m_u4PlAreaLow.	500	100 to 2000
[23]	m_u4PlAreaLow		1000	100 to 2000
[24]	m_u4PlOutlierCnt	Do not reference high brightness area if the count of [164~252] < outlier count.	<= 5	1 to 100

PLAF – Overview

i4PLAFCoefs[64]

No	Name	Description	Default	Range
[25]	HBPl_convThrInf	HBPl Scene go to fine search TH for Inf	PDAF[18]	0 to 200
[26]	HBPl_convThrMac	HBPl Scene go to fine search TH for Max	PDAF[19]	0 to 200
[27]	HbPlSearchRange_PD	HBPL fine search range – base on PD target	40	0 to 200
[28]	HbPlSearchRange_Inf	HBPL fine search range– base on OTP Inf	60	0 to 200
[29]	HbPl_PDconfTH	Use PD target do HBPl fine search central point confidence TH	60	0 to 100
[30]	HbPl_PDCntTH	Use PD target do HBPl fine search central point cont TH	2	0 to 30
[31]	HbPl_LVTH	HBPL detect LV TH	150	0 to 500
[32]	HbPl_PDWin	0: use spot window to do PLAF 1: use PD select window to do PLAF	1	0 or 1

everyday genius