泰克仪器在节目质量检测方面的应用

北京

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视频测试部

内容提要

- 节目质量检测仪器设置
- 摄像机的设置和检测
- 音频监测
- 辅助数据
- 4K视频的监测
- 基于文件的质量检测

仪器的后面板

音频选件
选件 **AD** 支持嵌入音频
和 AES/EBU 数字音频
模拟音频

选件 **DPE** 还可提供对
杜比数字和杜比 E
的支持

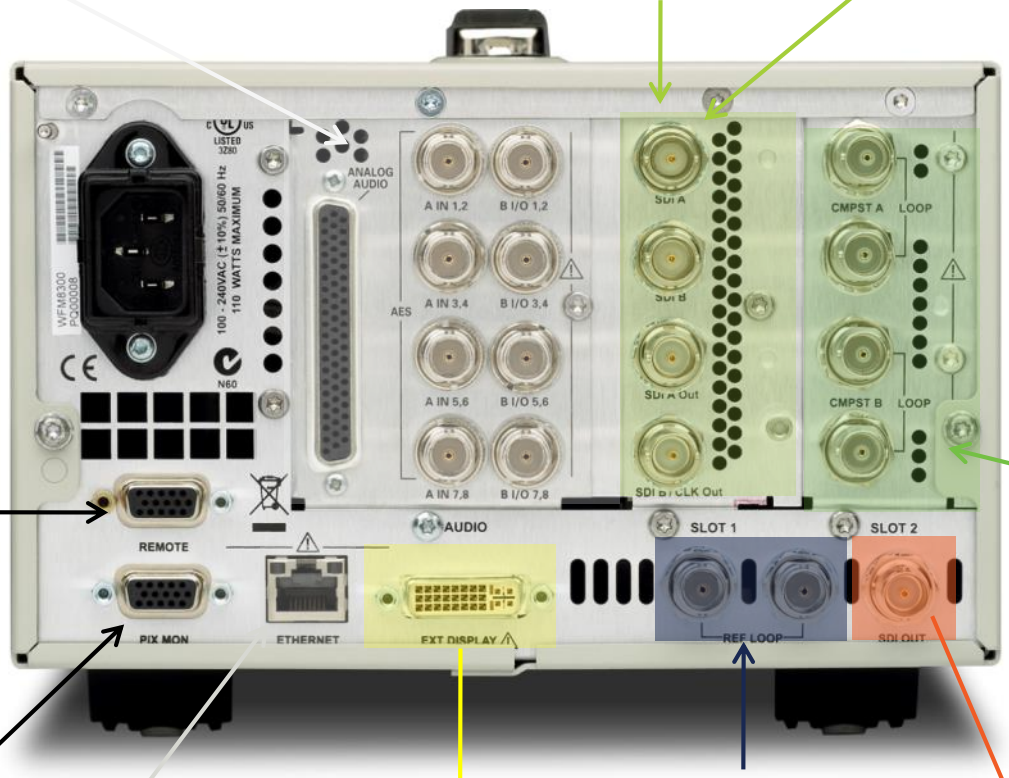
选件 **EYE/PHY3**
(WFM8200)

选件 **PHY**
(WFM8300)

2 路SDI 输入
标准配置支持
SD-SDI
HD-SDI
双链路

选件 **3G**
支持 3 Gb/s
1080p 50,59.94,60
YCbCr A 级和 B 级

SDI 输入（有源环通，
经由切换）



遥控端口
GPI/O, 预置调用

选件 **CPS**
还可支持 2 路复合输入
以及无源环通

模拟图像监视
RGB 或 YPbPr

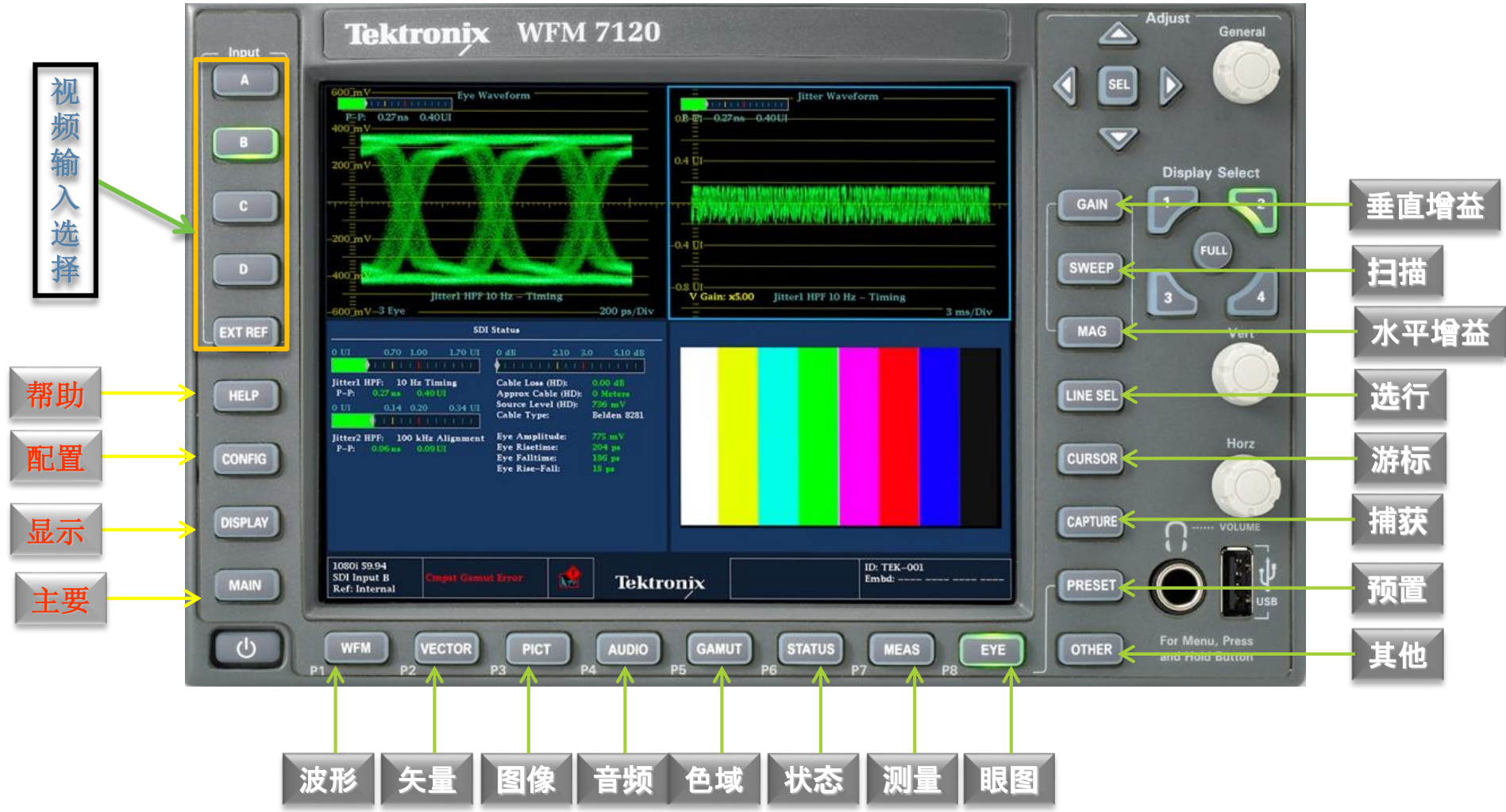
以太网端口

DVI 外接显示器
输出 1024x768

基准信号输入
支持黑场色同步
或者三电平同步信号

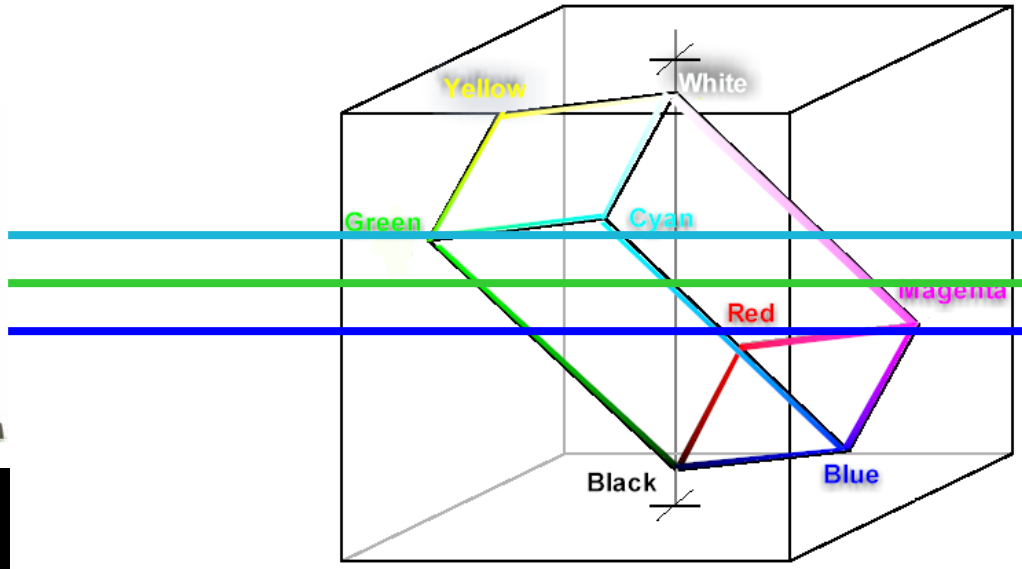
1 路SDI 输出（切换）
选件GEN（WFM8200）

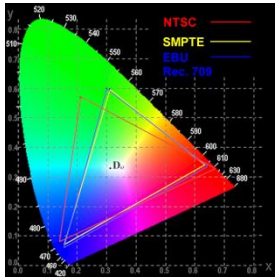
仪器的前面板

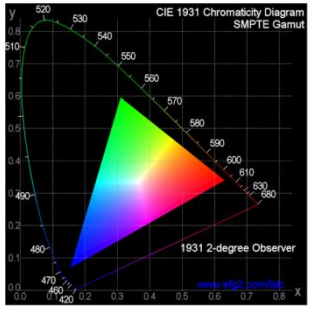

视频输入选择
帮助
配置
显示
主要
垂直增益
扫描
水平增益
选行
游标
捕获
预置
其他
波形
矢量
图像
音频
色域
状态
测量
眼图
Tektronix WFM 7120
Input
A
B
C
D
EXT REF
HELP
CONFIG
DISPLAY
MAIN
Adjust
General
SEL
Display Select
GAIN
SWEEP
MAG
LINE SEL
CURSOR
CAPTURE
PRESET
OTHER
FULL
Vert
Horz
VOLUME
USB
For Menu, Press and Hold Button
WFM
VECTOR
PICT
AUDIO
GAMUT
STATUS
MEAS
EYE
P1
P2
P3
P4
P5
P6
P7
P8
Eye Waveform
Jitter Waveform
SDI Status
Tektronix

准确的显示色域

---R’G’B’ 应是我们最关注的信号

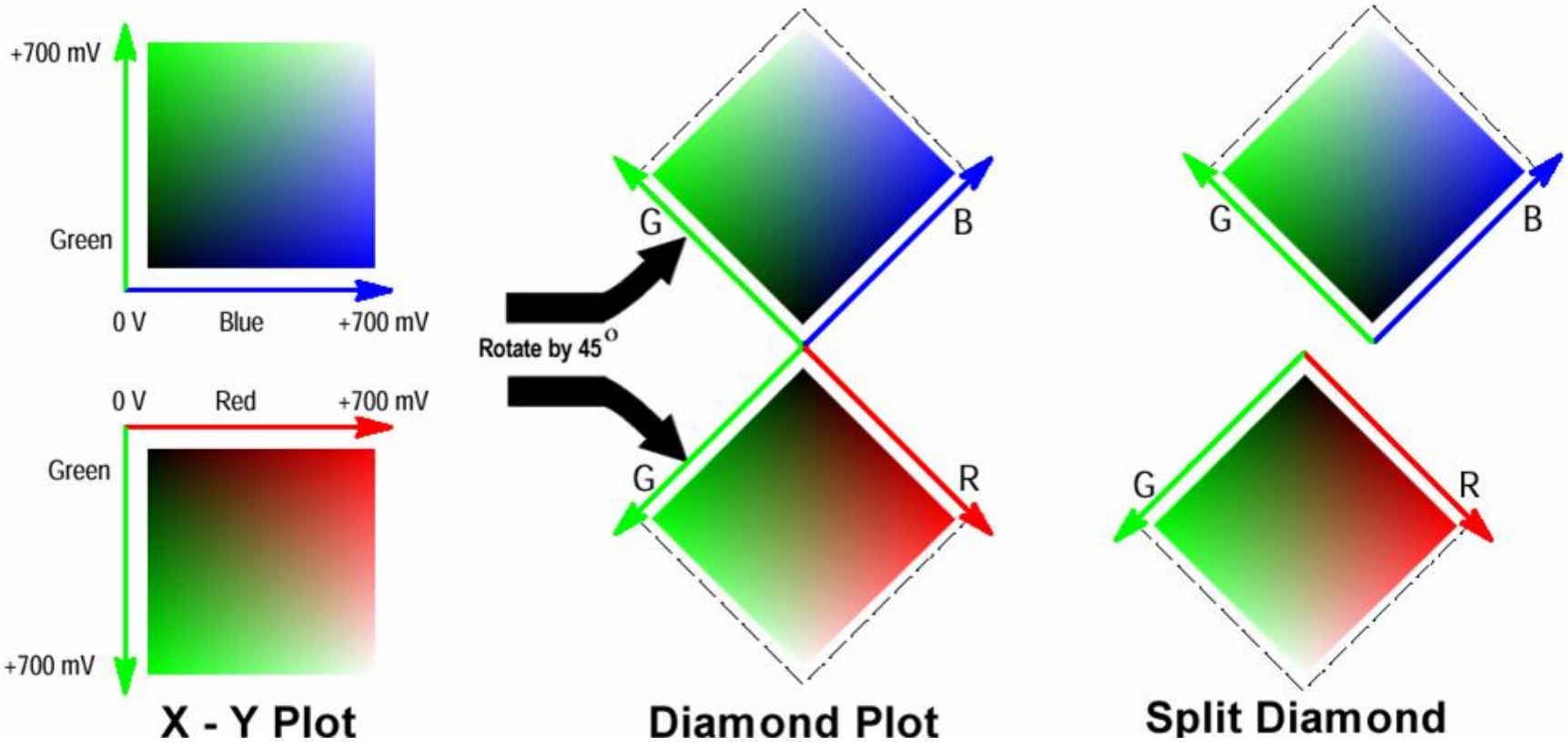




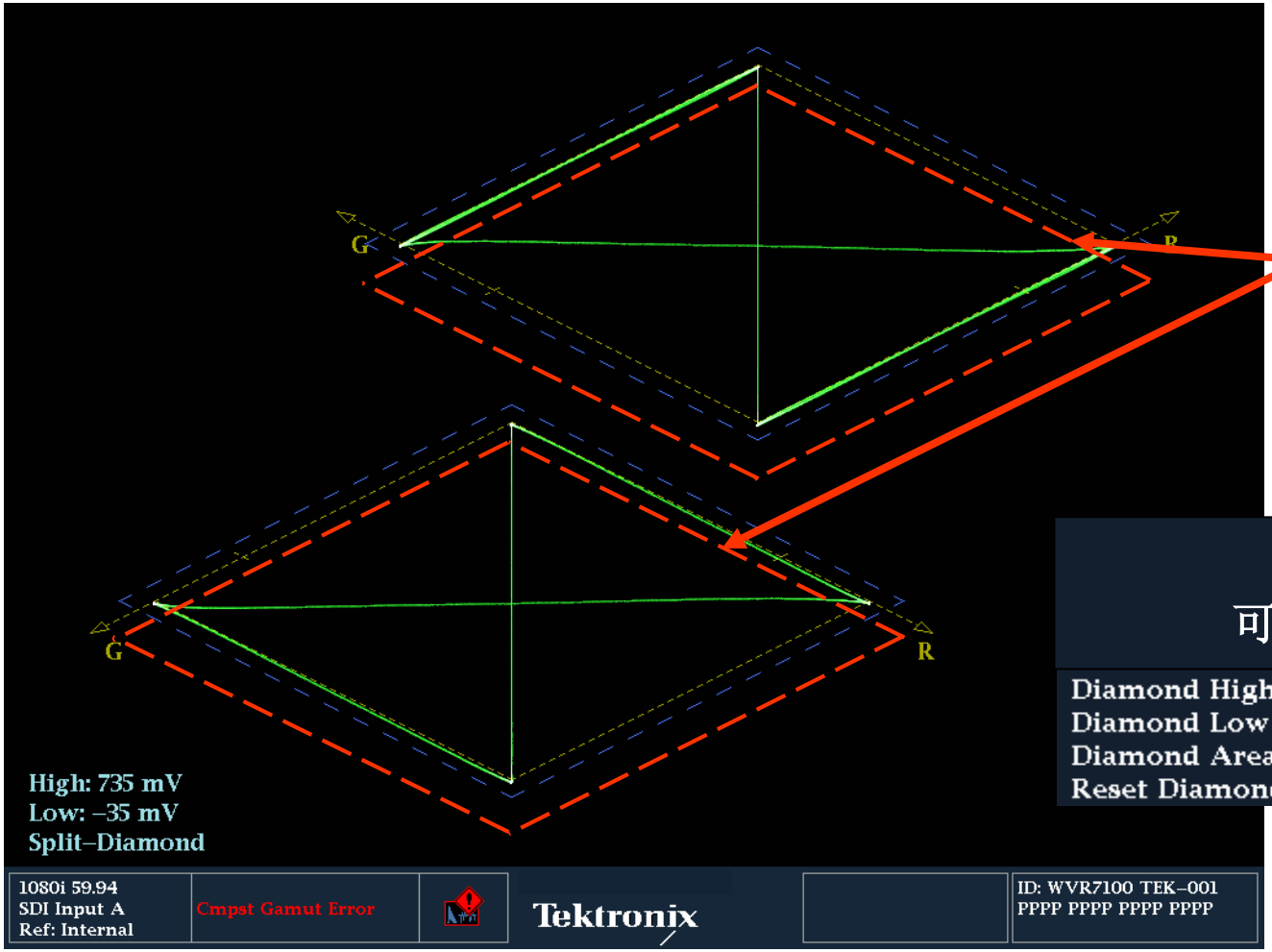


在所有合法的Y,PB,PR 信号中,只有25%左右是有效的

钻石显示的构成原理


+700 mV
Green
0 V
Blue
+700 mV
0 V
Red
+700 mV
Green
+700 mV
X - Y Plot
Rotate by 45°
G
B
G
R
Diamond Plot
G
B
G
R
Split Diamond

完美的显示色域的监视— 钻石显示

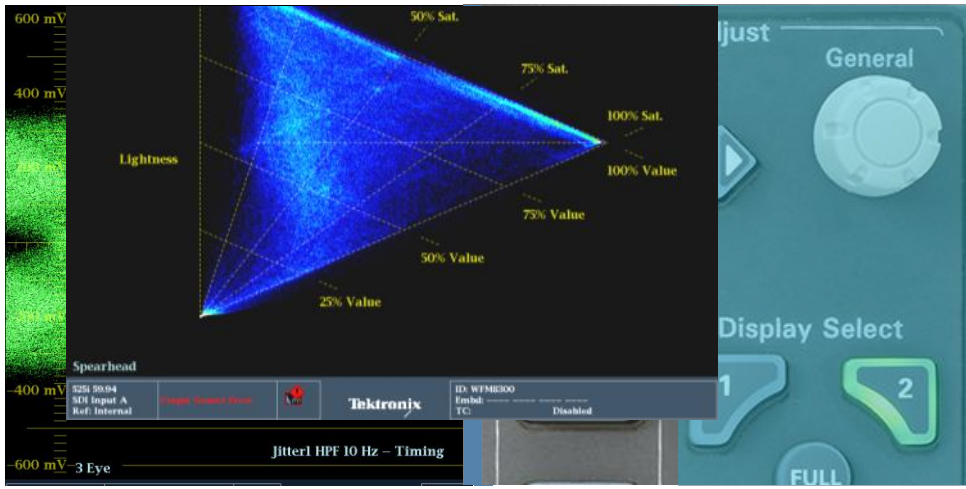


色域

配置菜单
可选择色域容限

Diamond High	735 mV
Diamond Low	–35 mV
Diamond Area	1 %
Reset Diamond Defaults	Press SEL

新型矛头显示



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HSV模型(HSB)

- *max(i)= R(i)、G(i)和 B(i)的最大值, 经过Gamma校验后的RGB。*
- *min(i) = R(i)、G(i)和 B(i)的最小值,经过Gamma校验后的RGB。*
- ***Value(色明度):*** ***V(i)*** *= max(i); R, G, 和 B单位*
- ***Saturation(饱和度):*** ***S(i)*** *= 100* [max(i) – min(i)]/max(i);* *单位 %*
- ***Hue(色相):*** *if max(i) = min(i) then H(i) = 0*

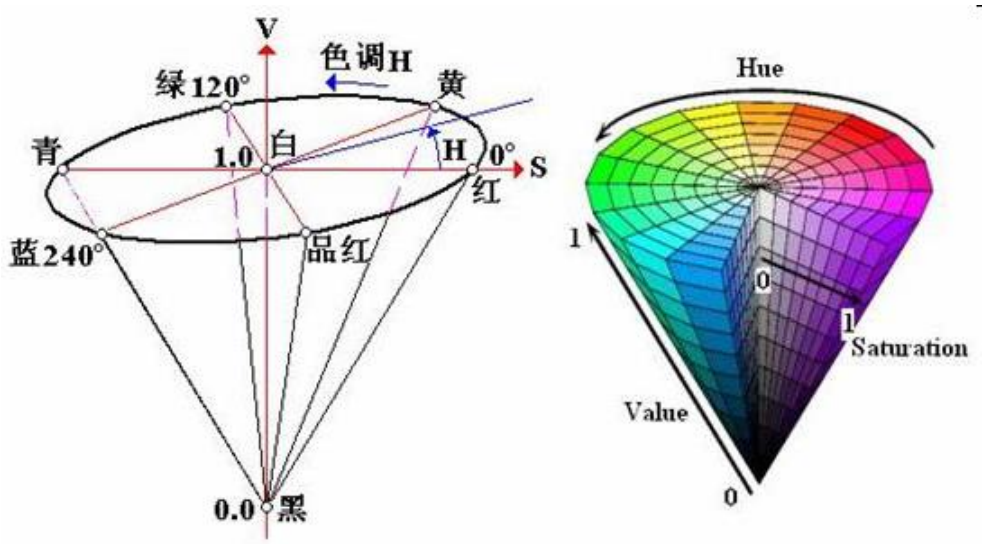
else if (max(i)= R(i)) & (G(i)>B(i)) then

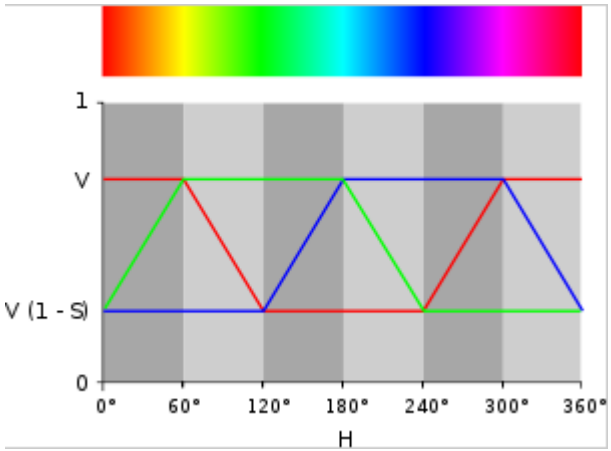
H(i) *= 60*[G(i) – B(i) / [max(i) – min(i)]*

else if (max(i)= R(i)) & (G(i)<B(i)) then

H(i) *= 360 + 60*[G(i) – B(i)]/ [max(i) – min(i)]*

HSV 彩色空间



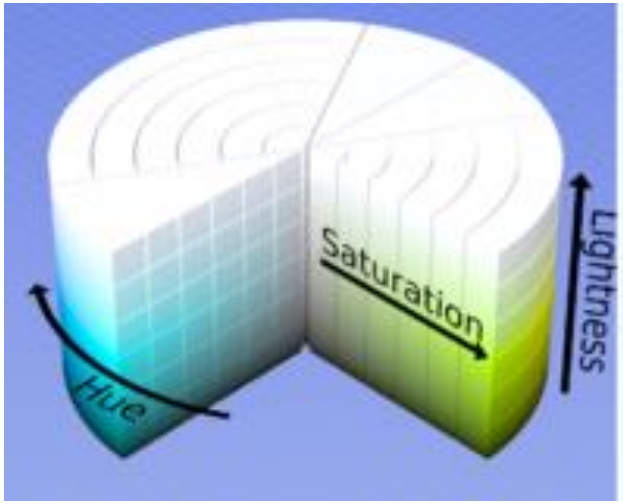


- *当min=0时，S=100%*
- *当R=G=B时，max=min，S=0%*
- *当R=700mv或者G=700mv或者B=700mv时，V=1*
- *当H=0度为R,当H=120度为G，当H=240度为蓝*

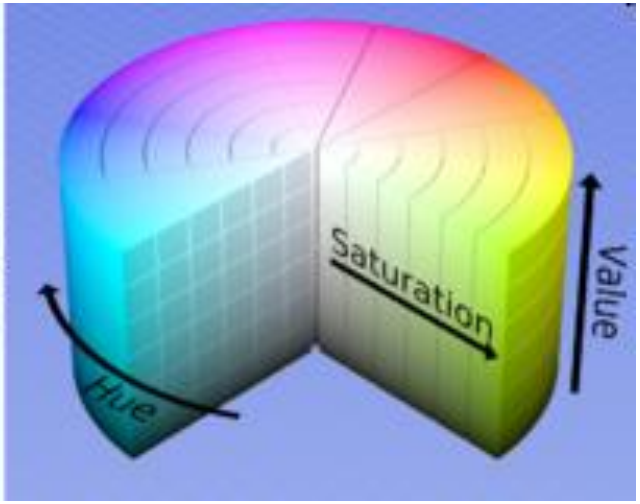
亮度

- ***Lightness(亮度):*** *L(i) = (max(i) + min(i))/2; max(i) 和 min(i) 从0mv到700mV*

- 从这个公式中可以知道对于单色时，max(i)=min(i)=R(i)=G(i)=B(i)=Y(i)，Lightness=Luminance. 对于100%的饱和度, max(i) = 700mV，min(i) = 0。Lightness=350, 350mV (50%), for each of the fully Saturated and full Value colors (100% color bar signal) across the video image.



HSL模型



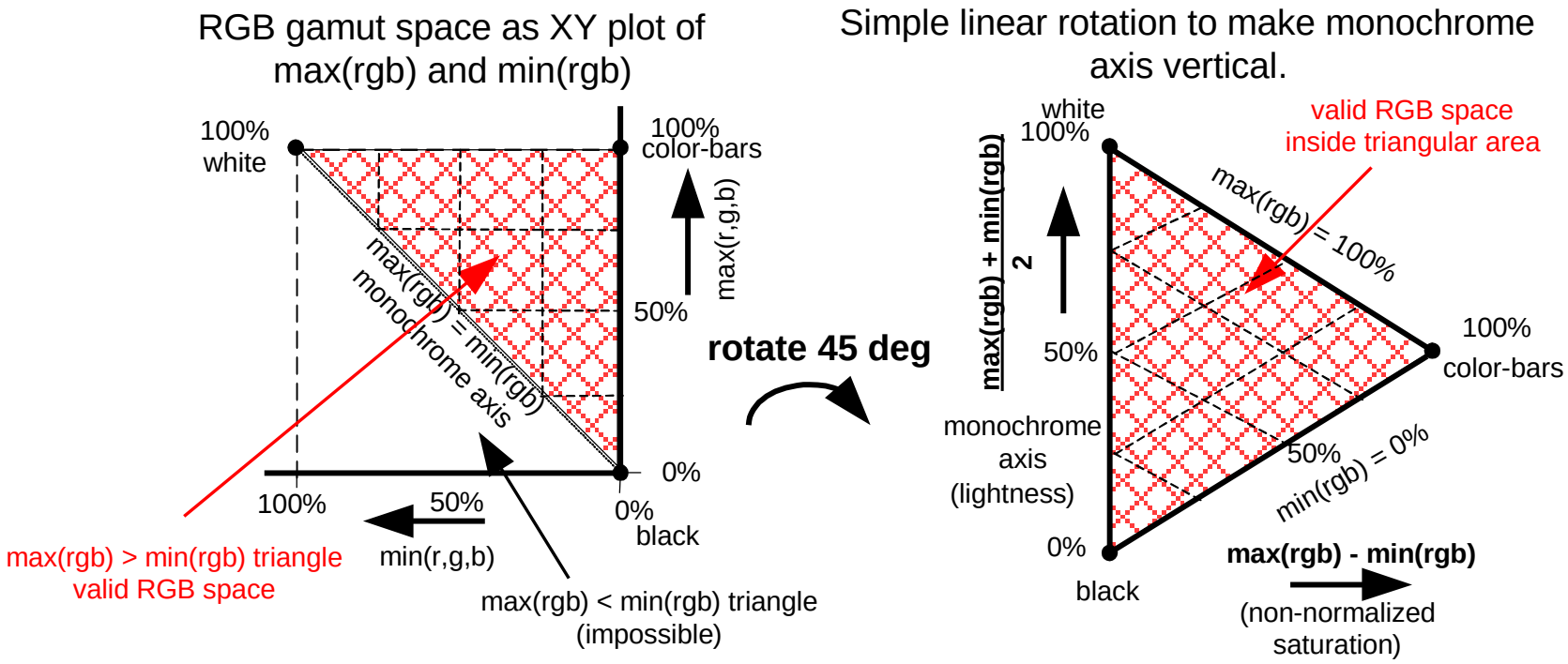
HSV模型

我们能否创建一种能够度量饱和度、色明度和亮度的新显示图形吗？

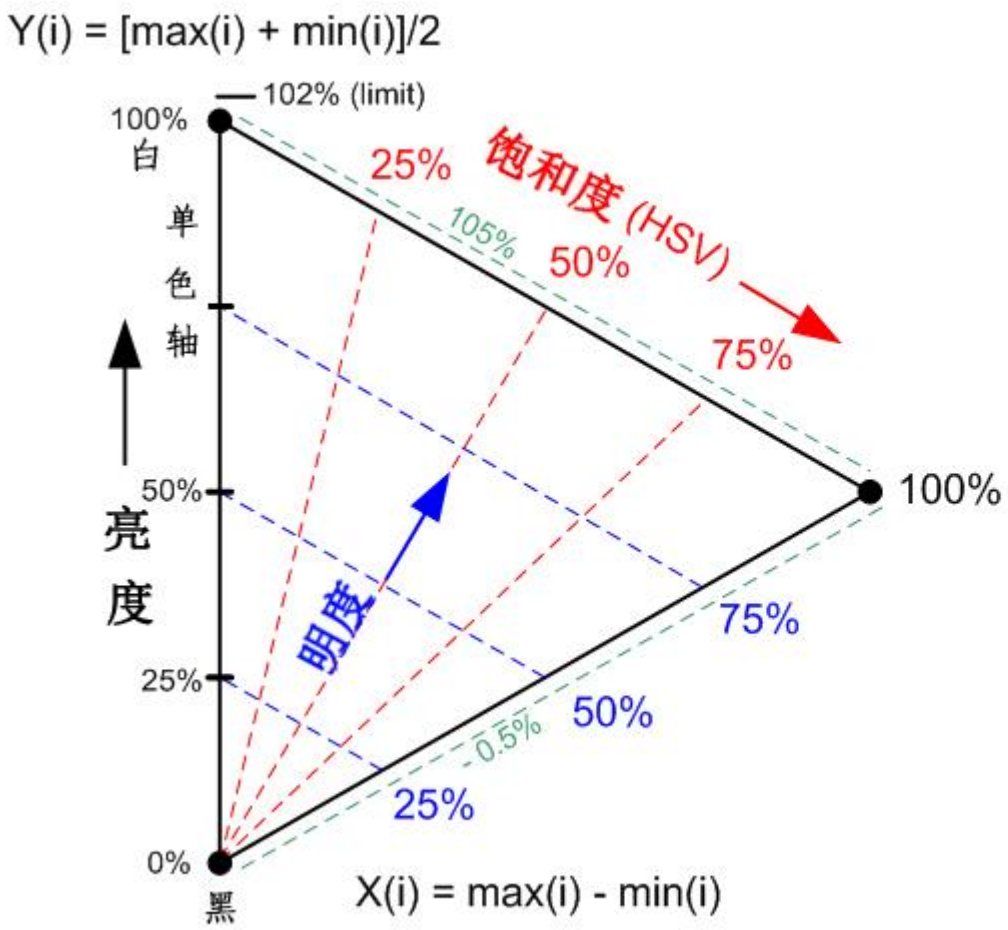
前提是：

1) 对于色域容限测试而言，我们关心的是 R, G, 和 B的最大值和最小值.

2) 在这种度量指示中将色明度以及饱和度表示为 R, G, 和 B的最大值和最小值的函数.



新型矢头显示
(彩色亮度、饱和度和色明度)



矢头三角形RGB色域空间：

max(i) = r(i)、g(i)、b(i) 的最大值；

min(i) = r(i)、g(i)、b(i) 的最小值；

均以mV为单位。该空间由3条线组成：

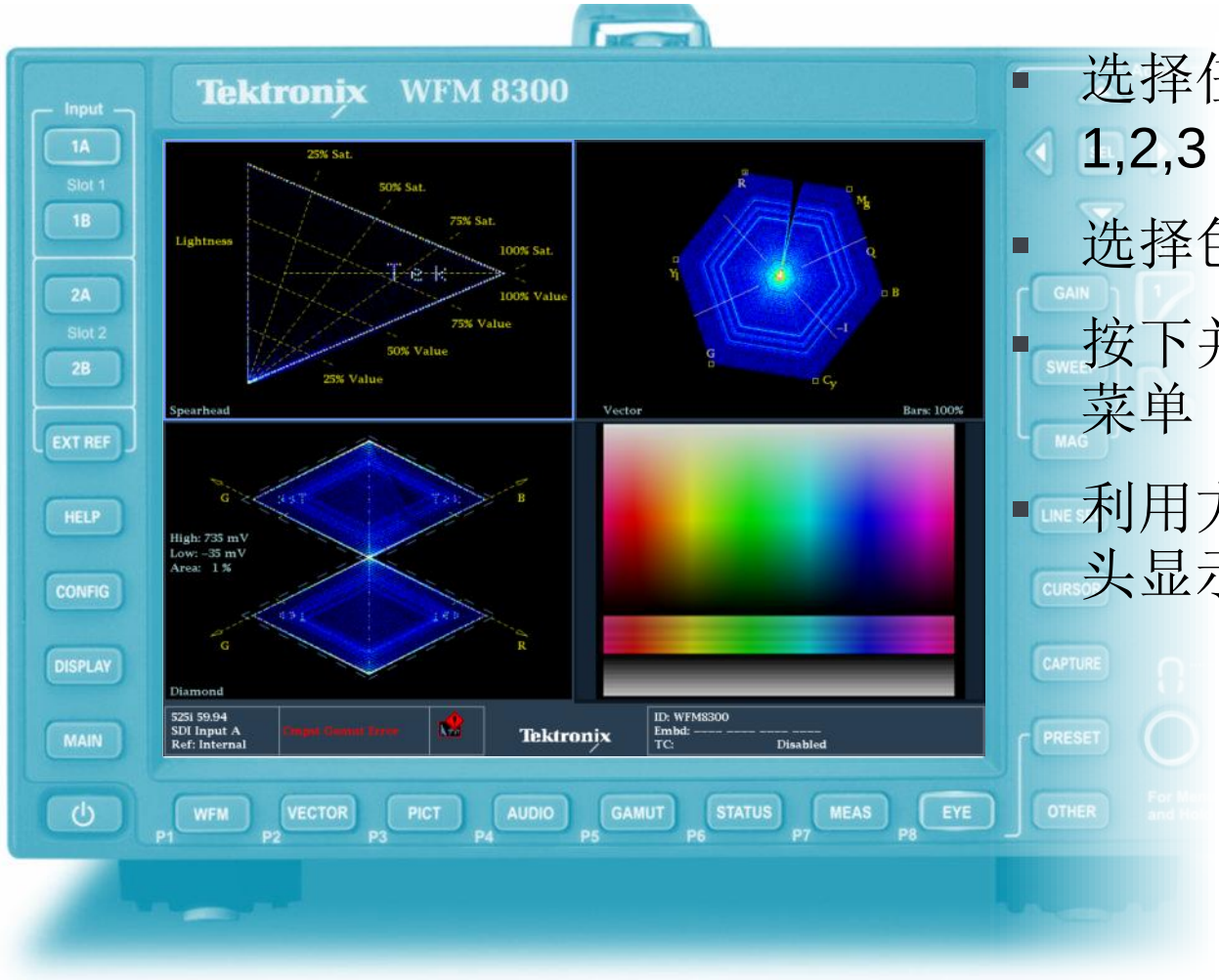
1) 垂直线（单色线）。在单色线上，
max(i) = min(i)，
即Y(i) = max(i) = min(i)，X(i) = 0.

2) 该线上为所有彩色的饱和度值为100%.
在该线上，min(i) = 0，max(i) = 0…700mV，
即Y(i) = max(i)/2，X(i) = max(i).
或者该线的方程为 y = x/2.

3) 该线上为所有彩色的明度值为100%.
在该线上，max(i) = 700mV，
min(i) = 0…700mV，
即Y(i) = 700mV/2 + min(i)/2，
X(i) = 700mV - min(i).
或者该线的方程为 y = -x/2 + 700mV.

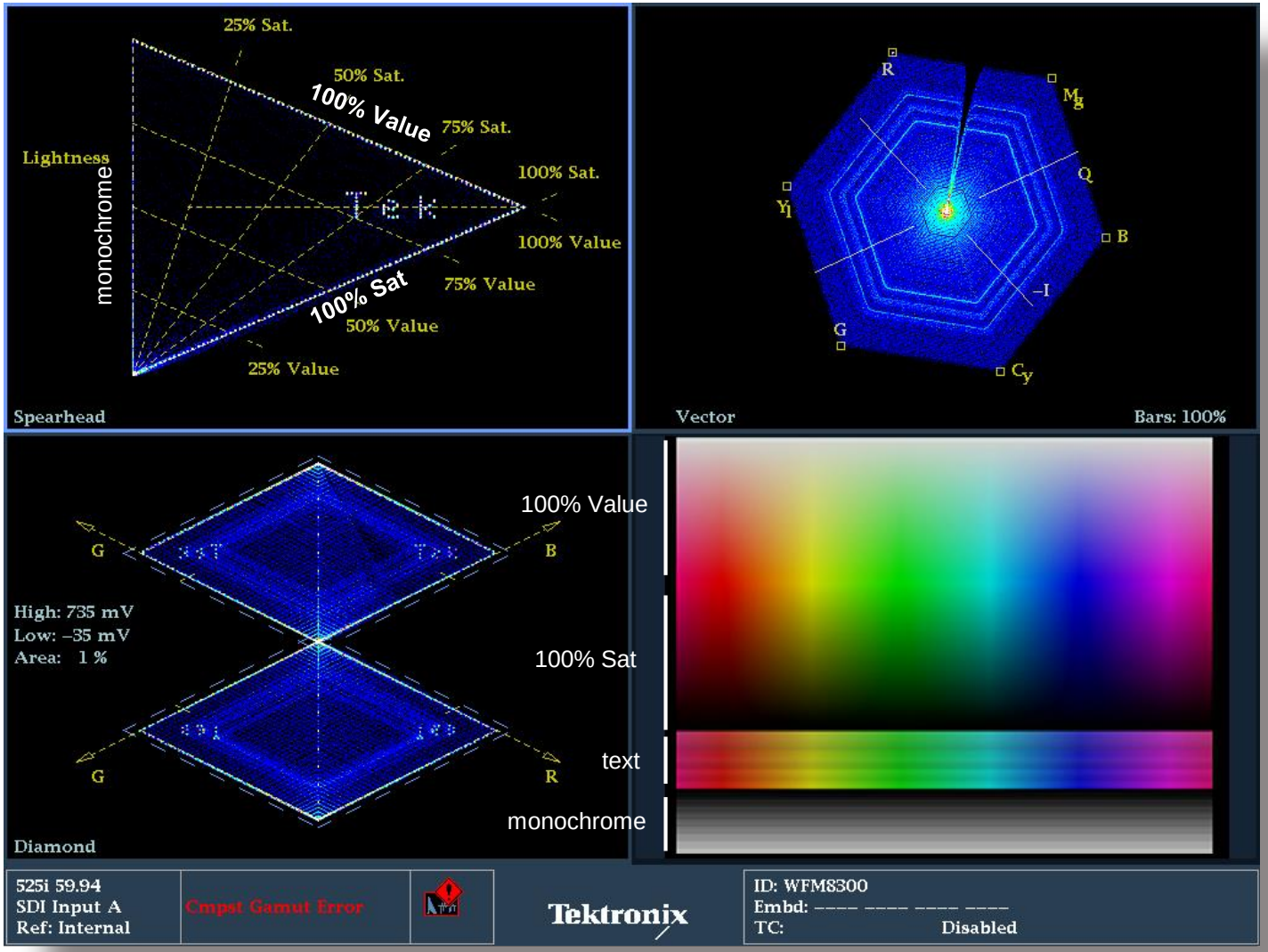
说明： 所有有效的rgb值r(i)、g(i)、b(i)（它们的数值在0…700mV范围内）均在这个矢头三角形色域空间内。所有无效的（即非法的）rgb值，即min(i) < 0，max(i) > 700mV，均在该矢头色域空间以外。可调整的色域检测阈值容限范围用绿色刻度线指示，即-0.5% 和105%.

如何使用矛头显示来进行色域测量.

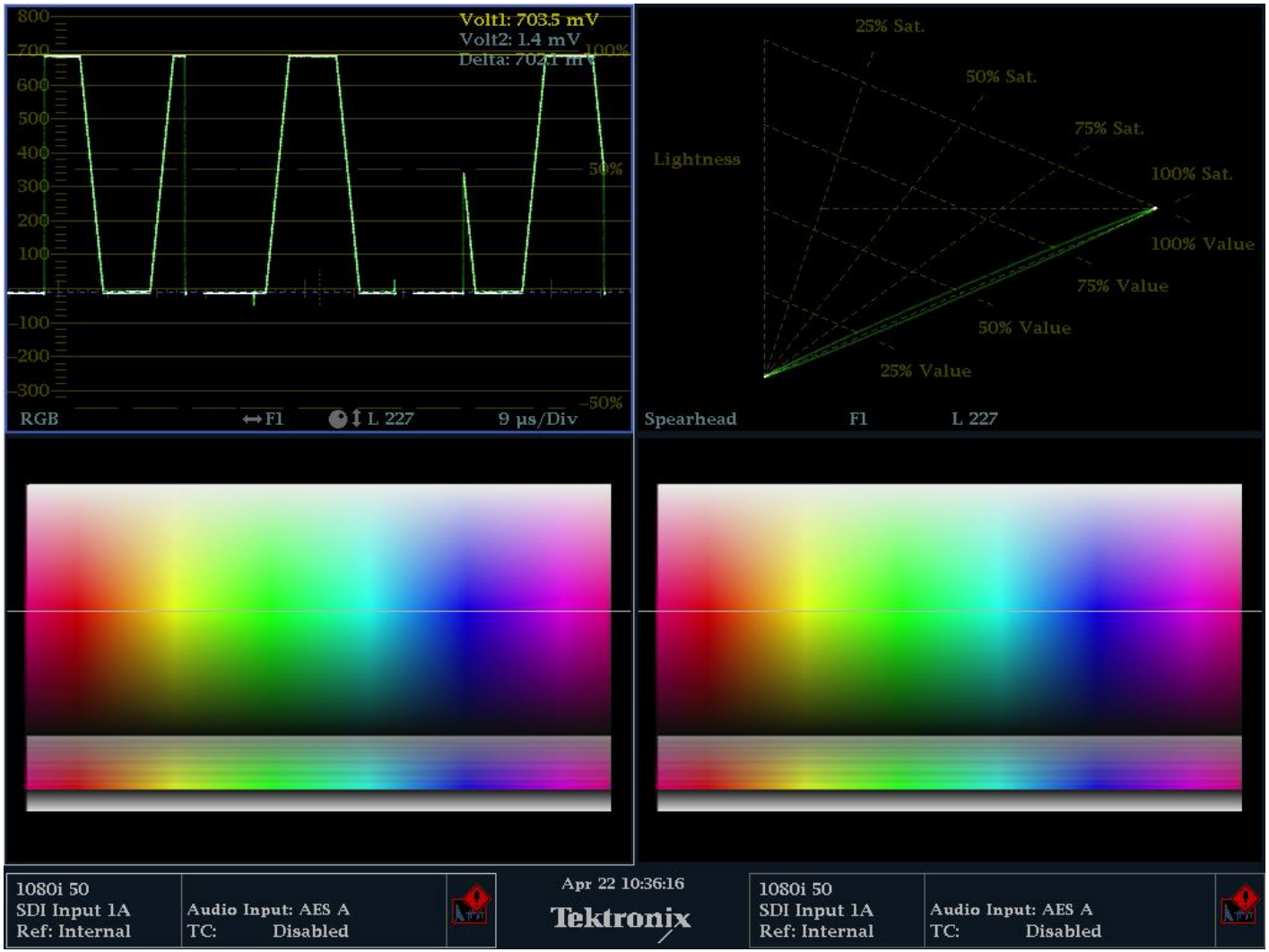


- 选择任一分屏显示 1,2,3 或 4
- 选择色域按扭
- 按下并保持色域按钮以加亮菜单
- 利用方向键或旋扭以选择矛头显示.

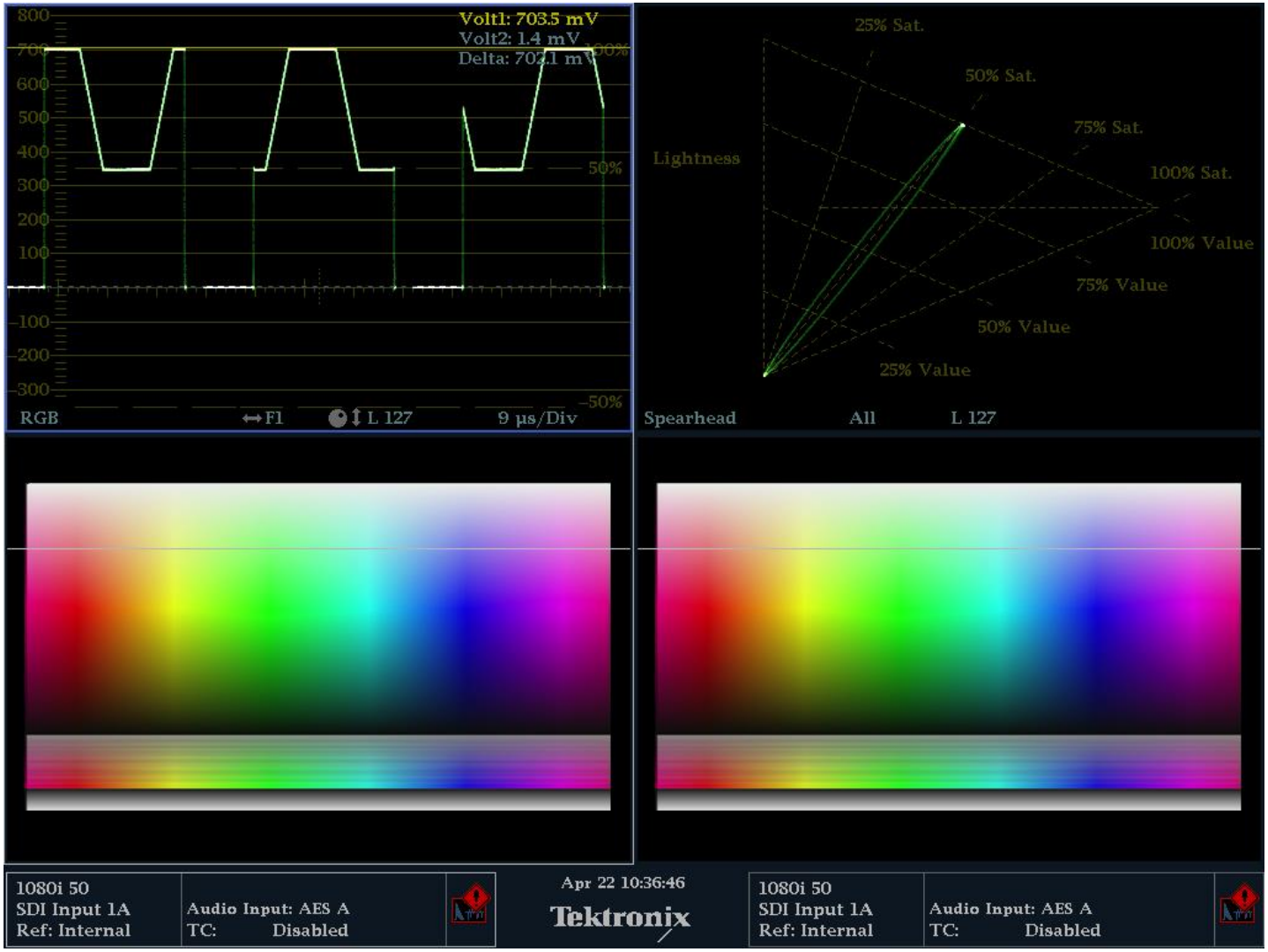
彩虹 (色调可变) 测试图案


25% Sat.
50% Sat.
100% Value
75% Sat.
100% Sat.
Lightness
monochrome
100% Value
75% Value
100% Sat
50% Value
25% Value
Spearhead
R
Mg
Q
Yl
B
–I
G
Cy
Vector
Bars: 100%
100% Value
G
B
High: 735 mV
Low: –35 mV
Area: 1 %
100% Sat
text
G
R
monochrome
Diamond
525i 59.94
SDI Input A
Ref: Internal
Cmpst Gamut Error
Tektronix
ID: WFM8300
Embd: ---- ---- ---- ----
TC: Disabled

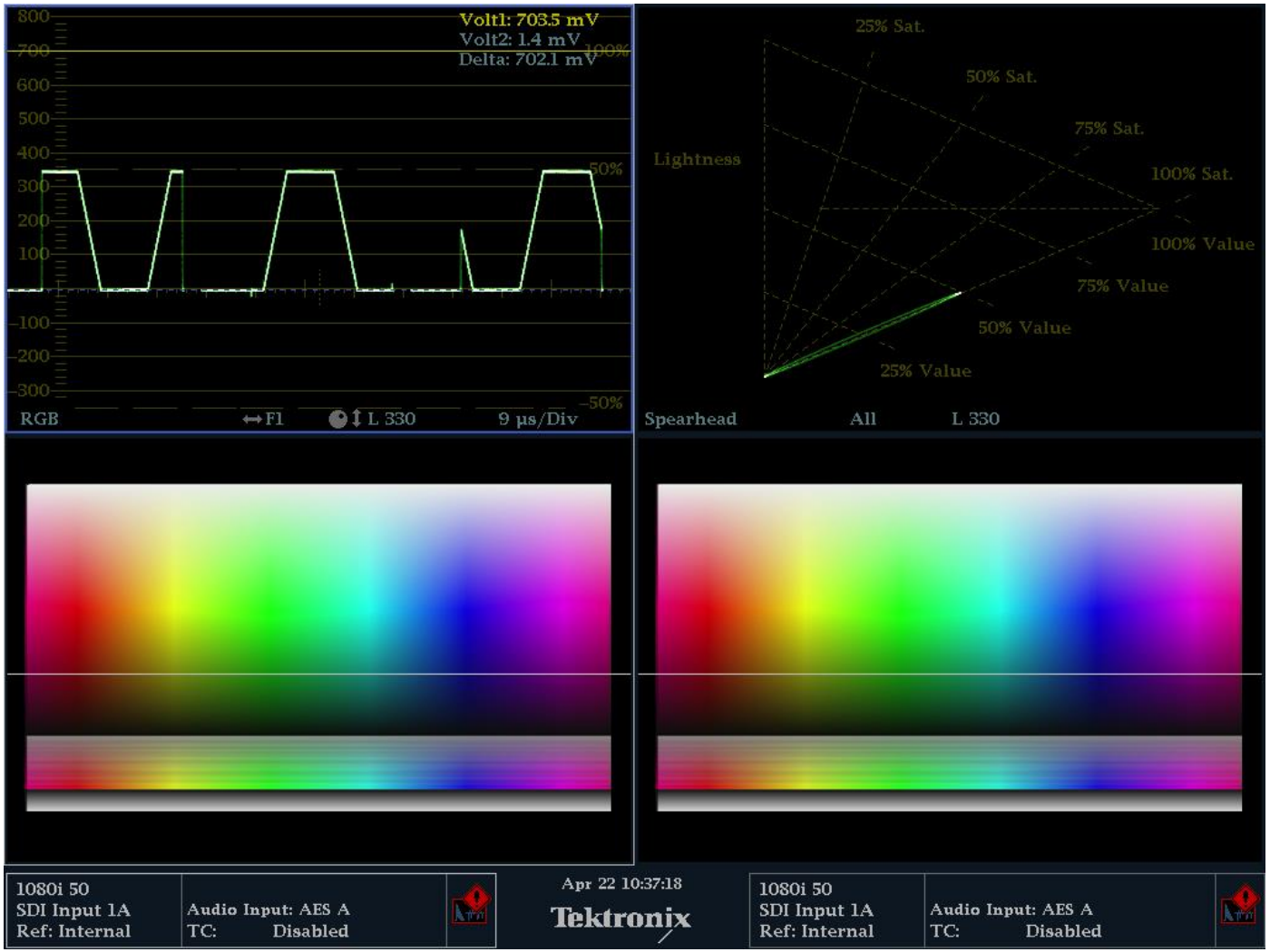
彩虹测试图案-100%饱和度，100%色度



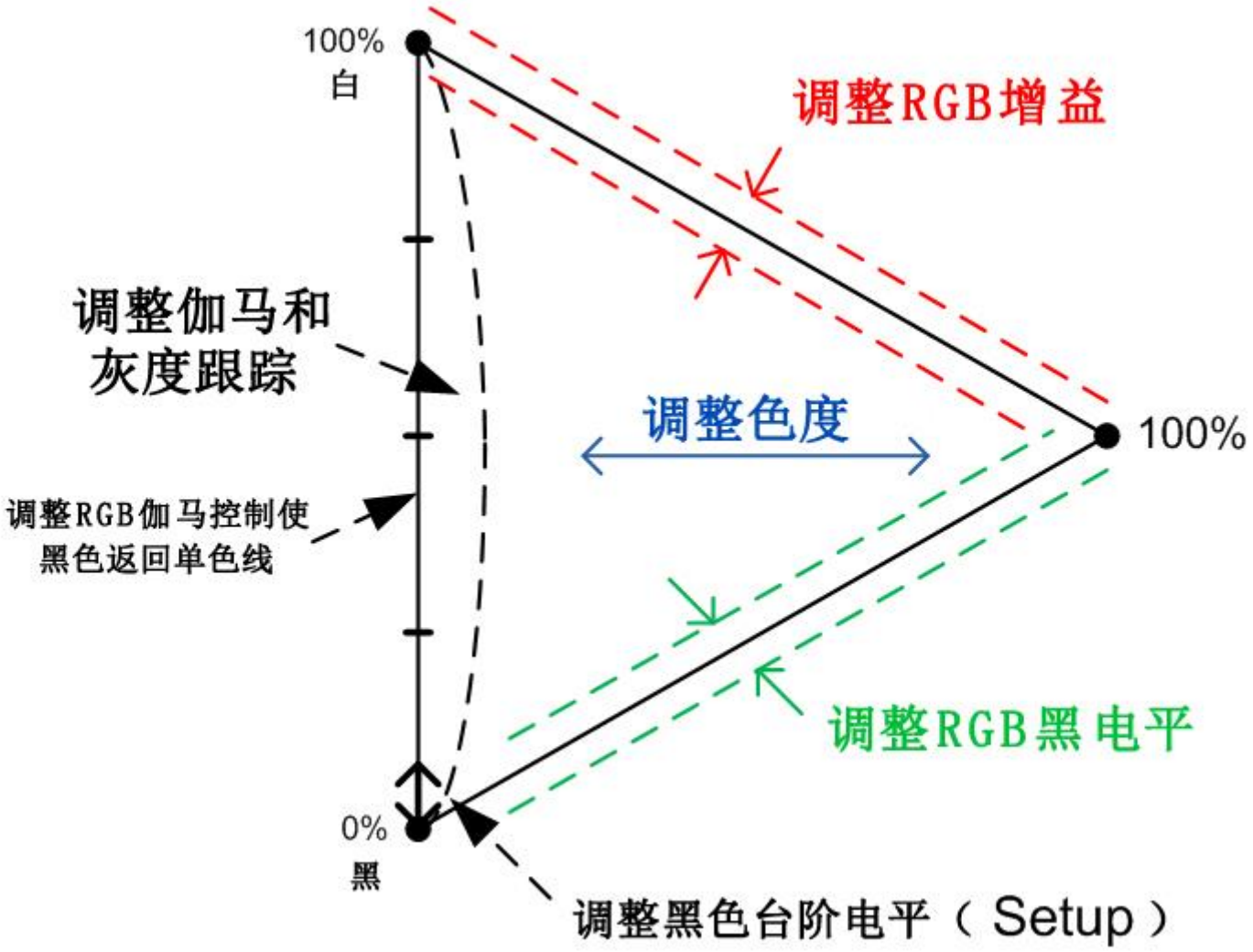
彩虹测试图案-50%饱和度，100%色度



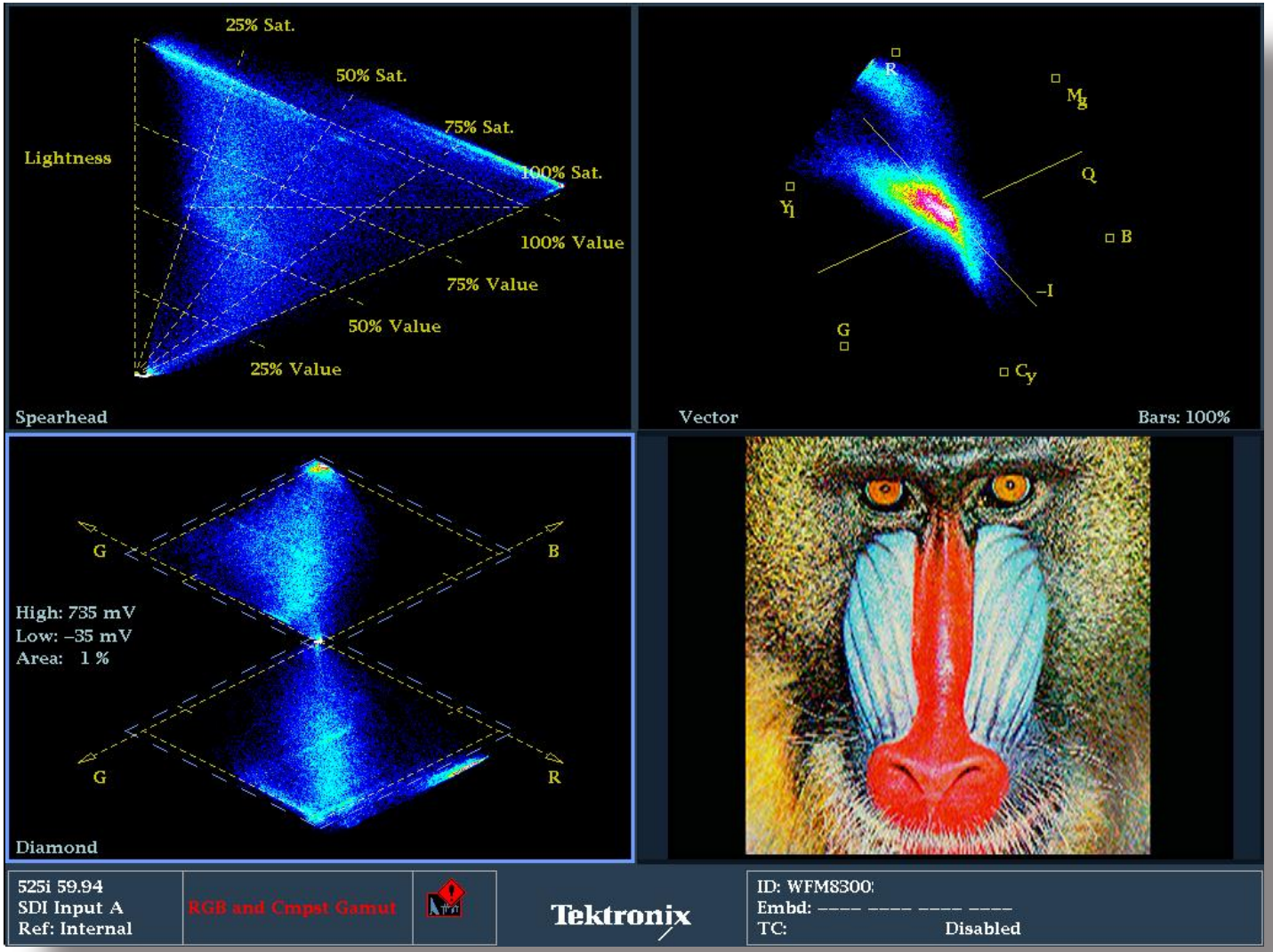
彩虹测试图案-100%饱和度，50%色度



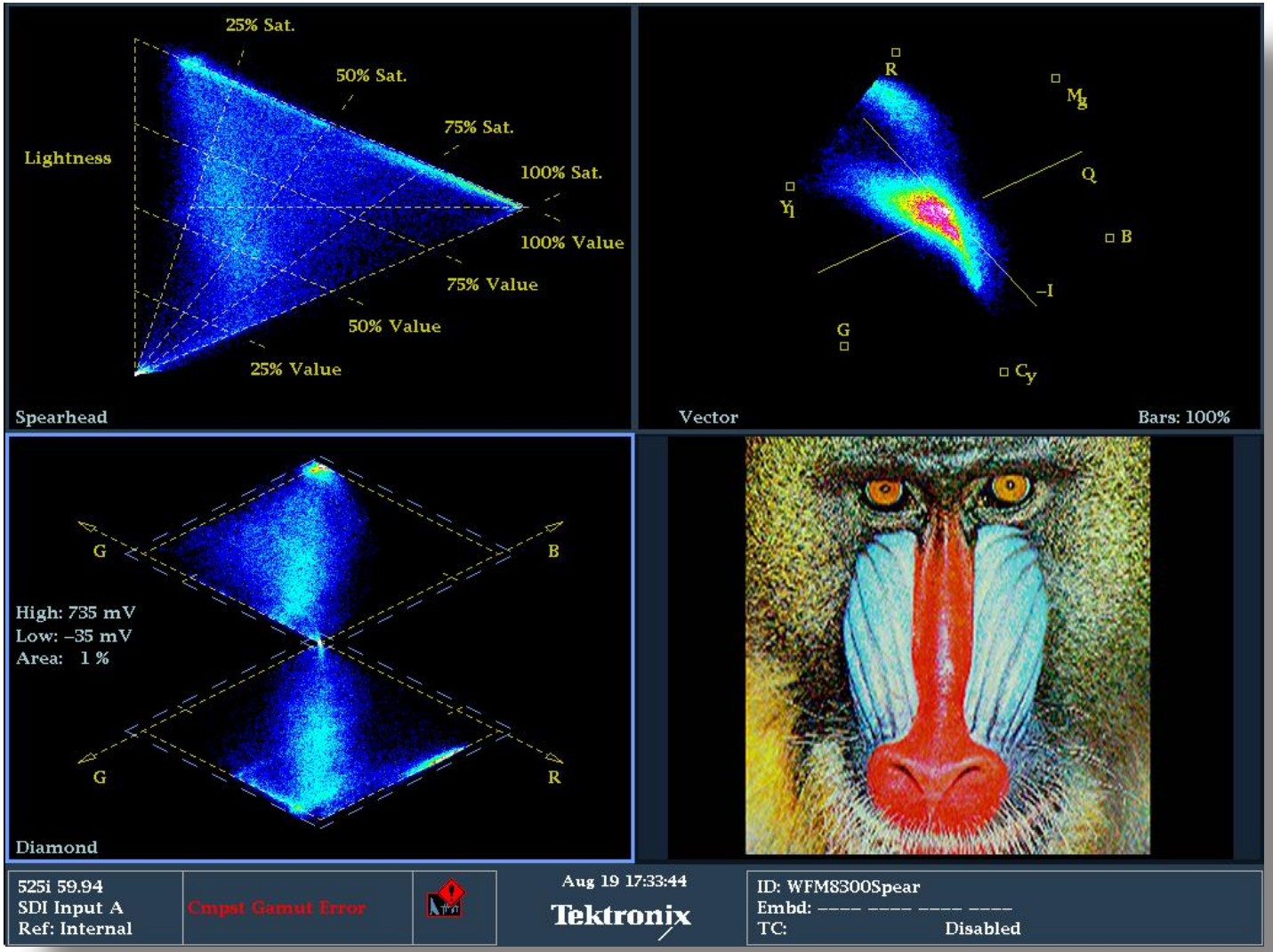
利用矛头显示进行彩色校正



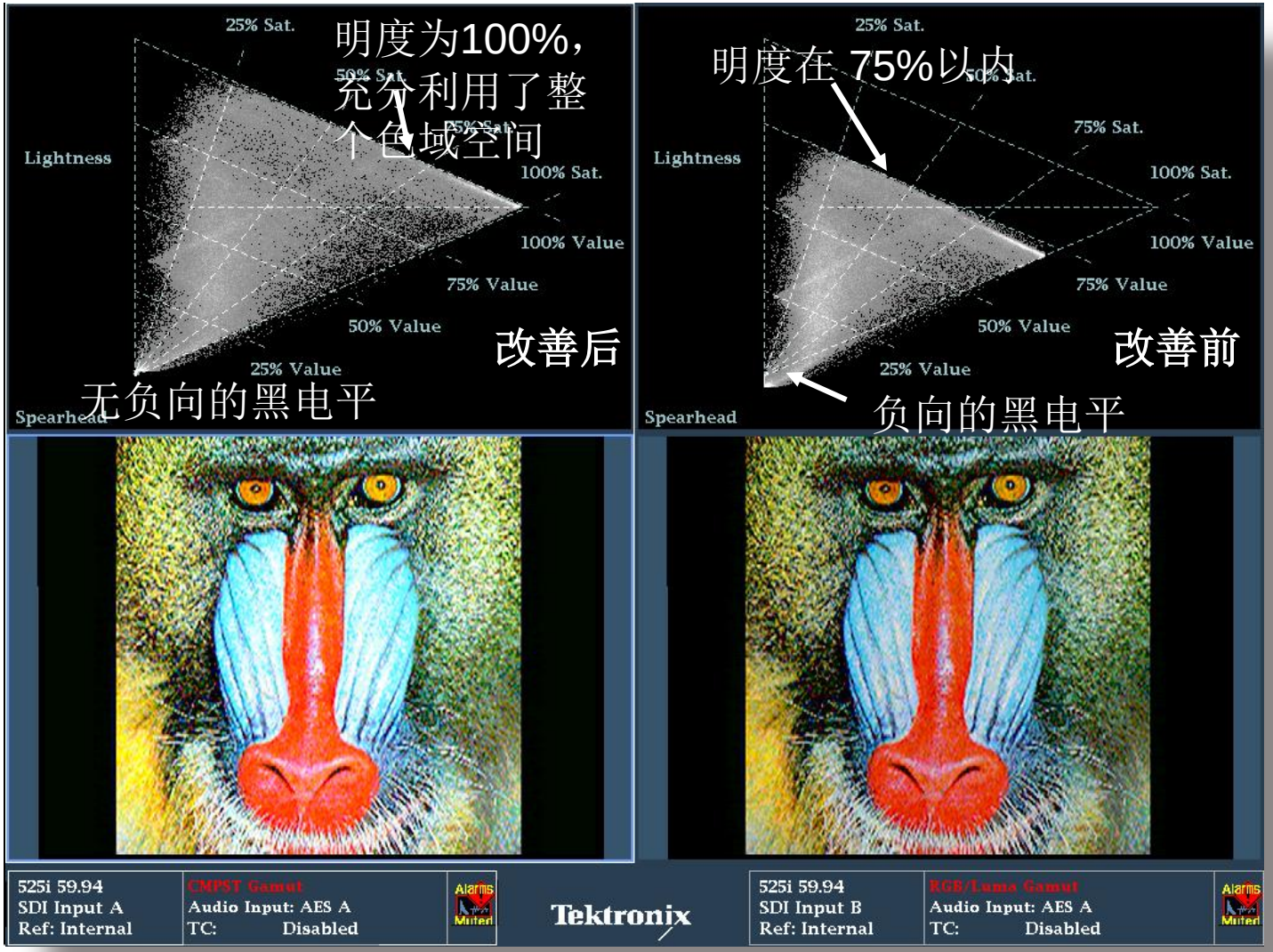
有黑增益和 RGB 增益色域错误的图像



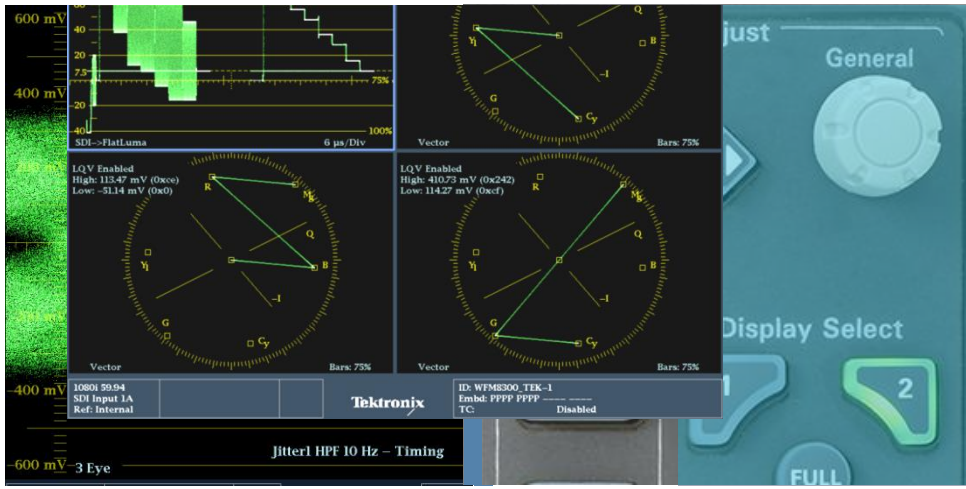
利用矛头显示彩色校正后的图像



利用矛头显示进一步改善后的图像



Luma Qualified Vector
（亮度等级矢量）



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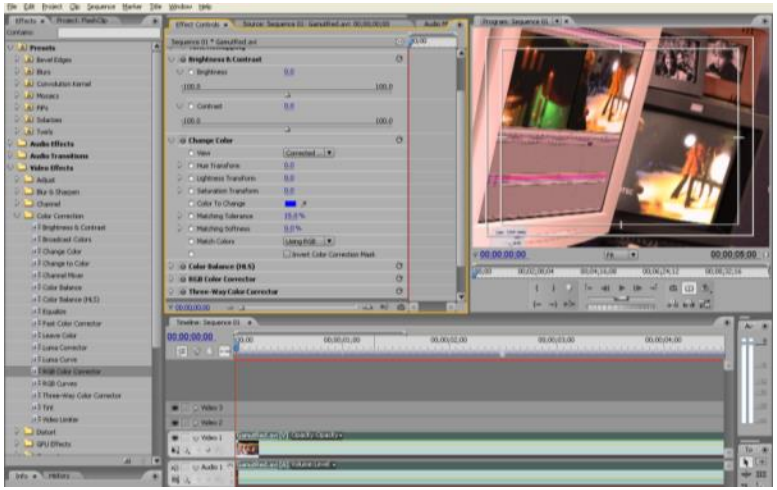
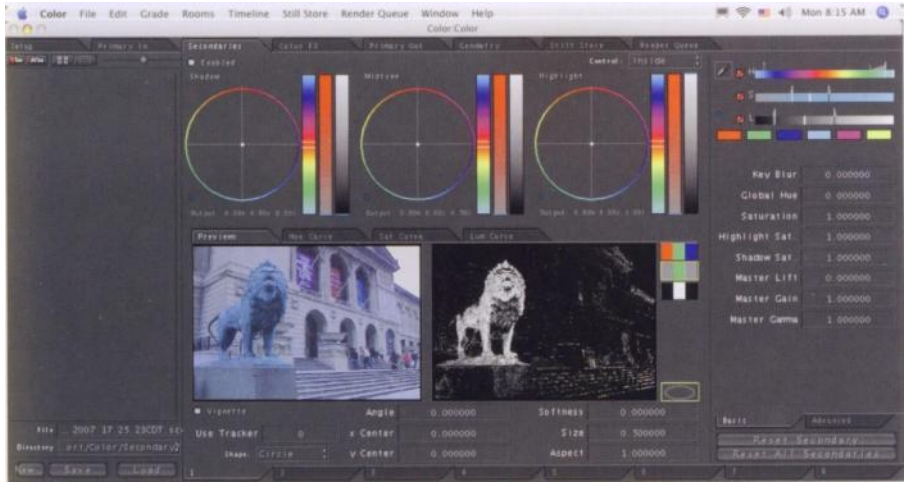
彩色校正



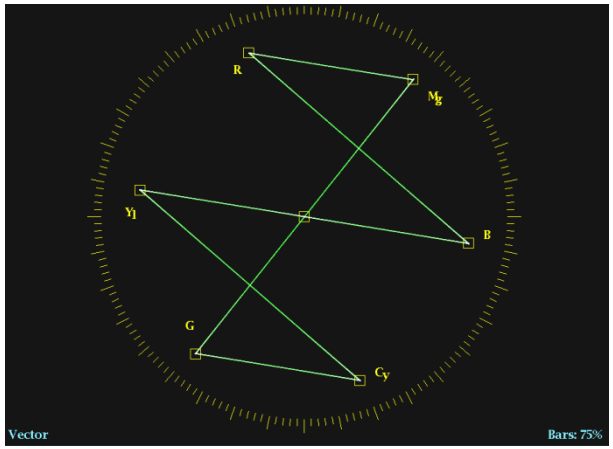
基色校正

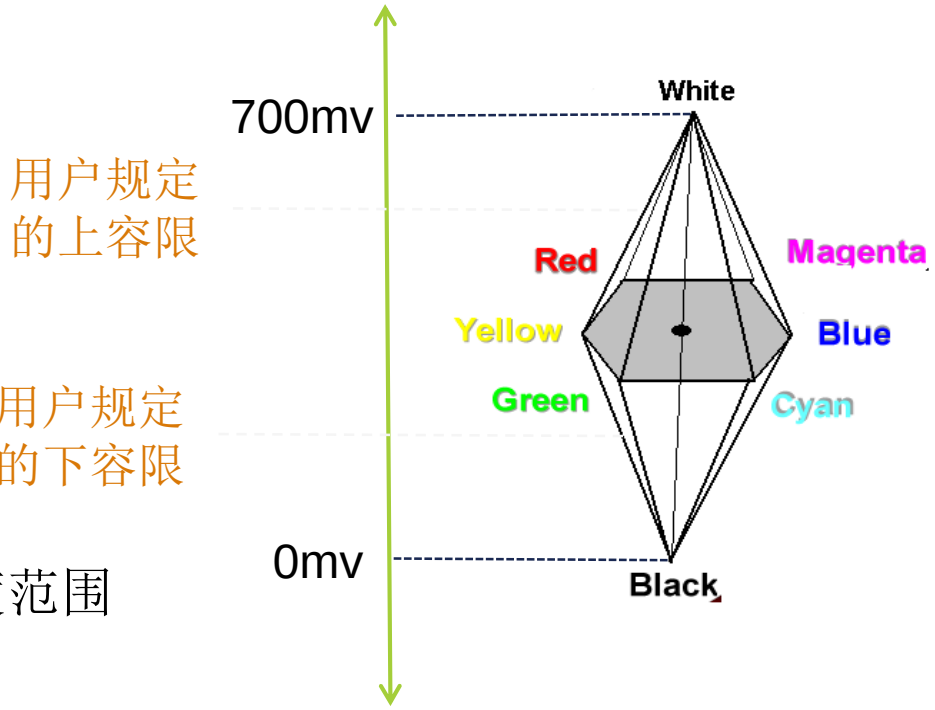


合成色校正

- 基色校正
  - 关注的是整个图像的彩色是否正确.
- 合成色校正
  - 关注的是特定区域或局部图像的彩色.
  - 以前通常是在拍摄之后“调整”图像的彩色
  - 大多数情况下是采用加亮方式以突出图像“信息”，调整特定区域的色调，等.
  - 关键区域: 肤色, 天空，草地，看起来应与真实情况一样

亮度合格矢量显示





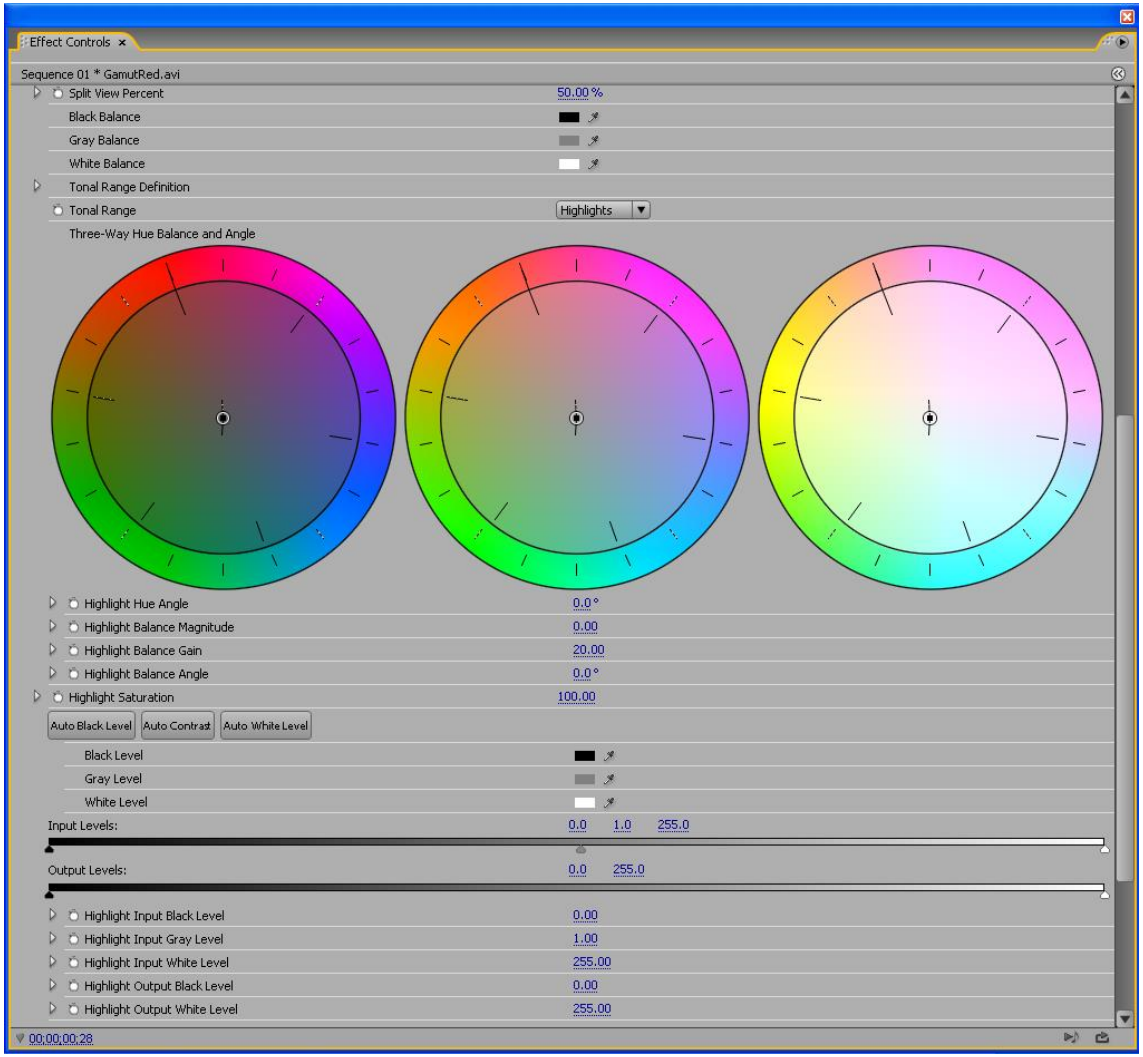
- 允许用户规定矢量显示的亮度范围
- 可调整的上、下容限
- 允许用户选择低、高和中间值以分隔某些亮度区域.

如何在 WFM8300 上配置 LQV

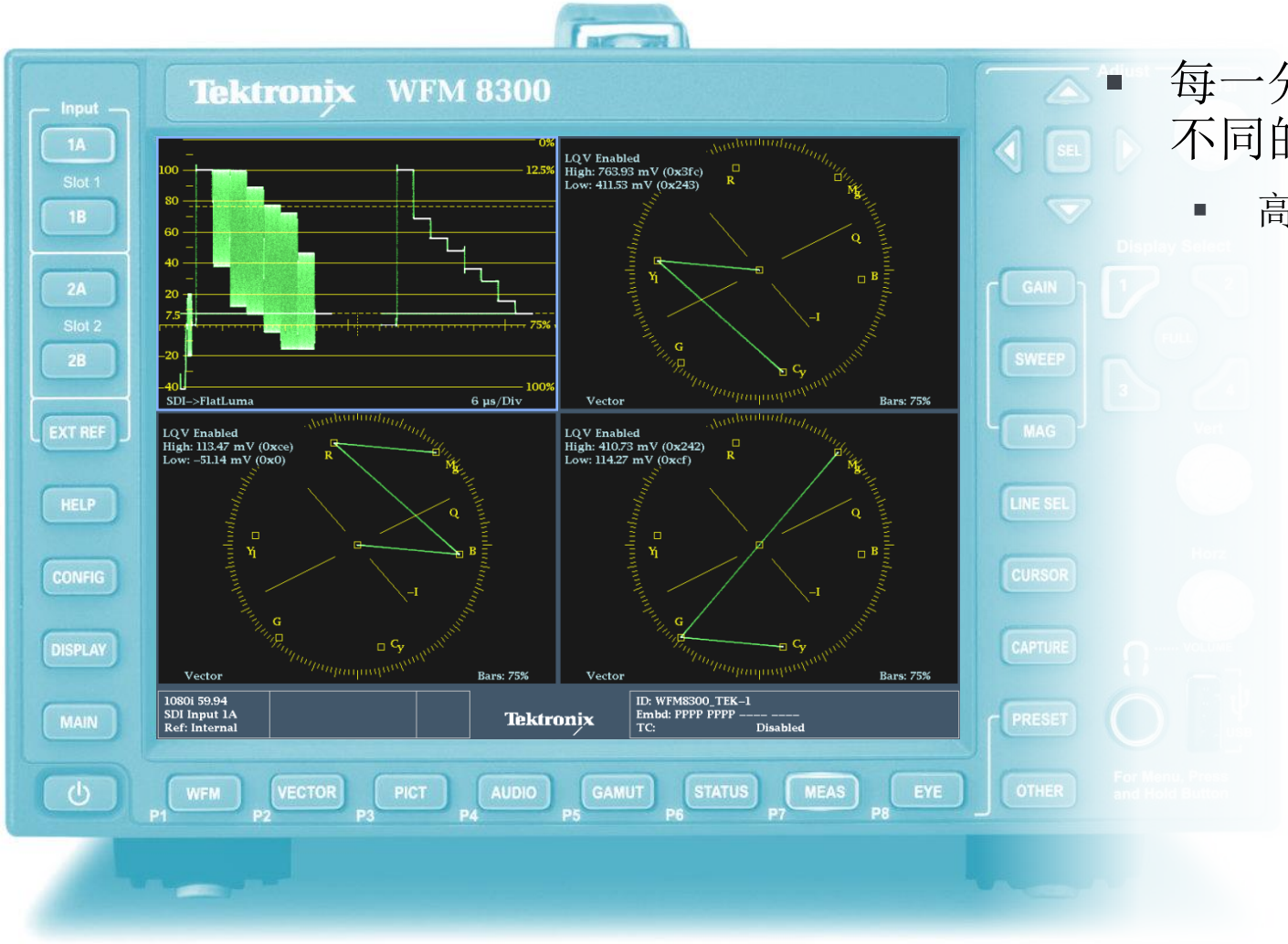
- 选择矢量显示
- 按下并保持 VECTOR 菜单
- 选择 LQV
- 进入上、下容限设置

彩色校正工具

- 利用这个彩色校正工具可以调整高光、中间调和暗调
- 可以将LQV 设置为3种不同的平铺区以显示特定的区域

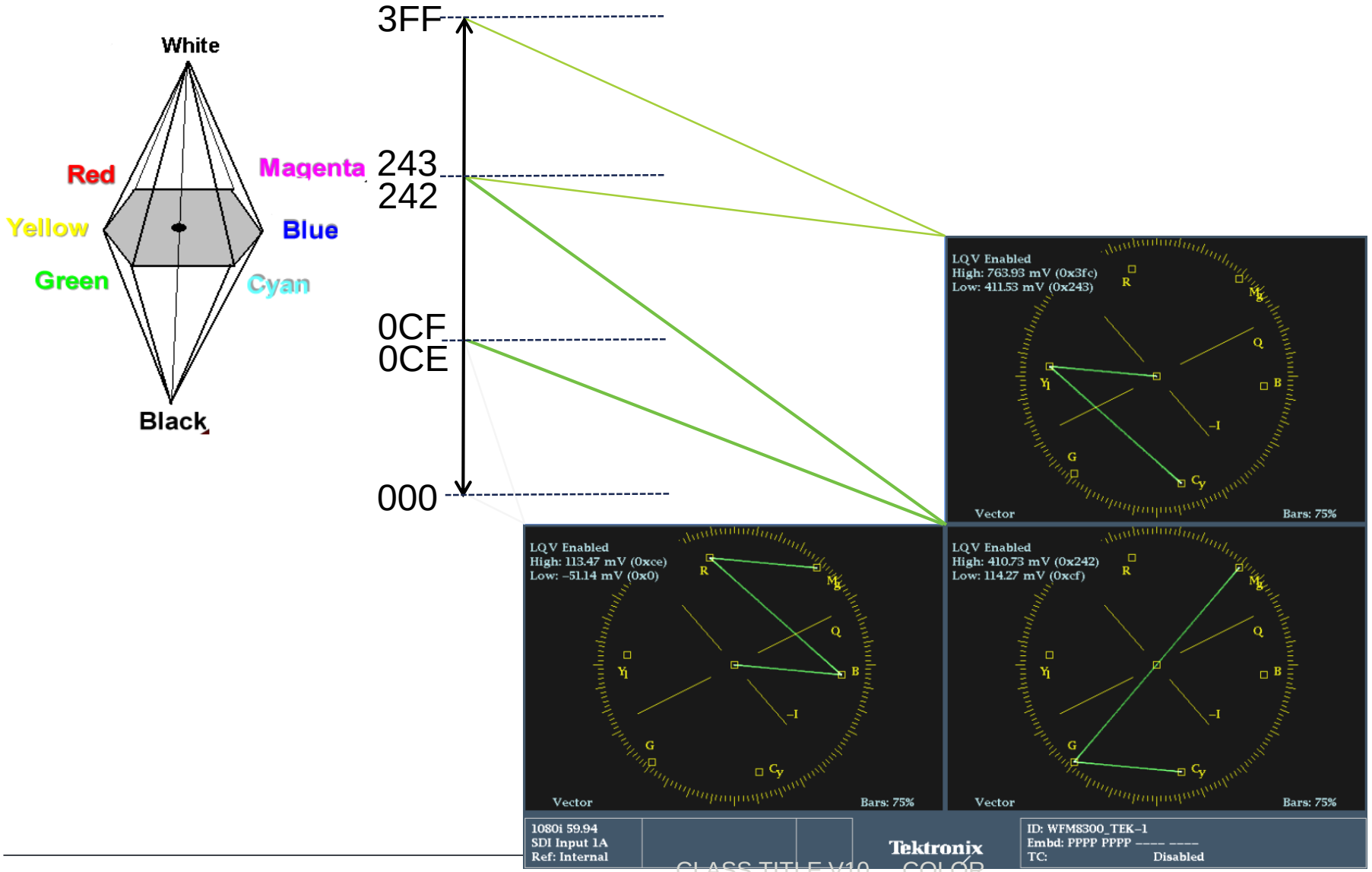


在 WFM8300 上使用 LQV

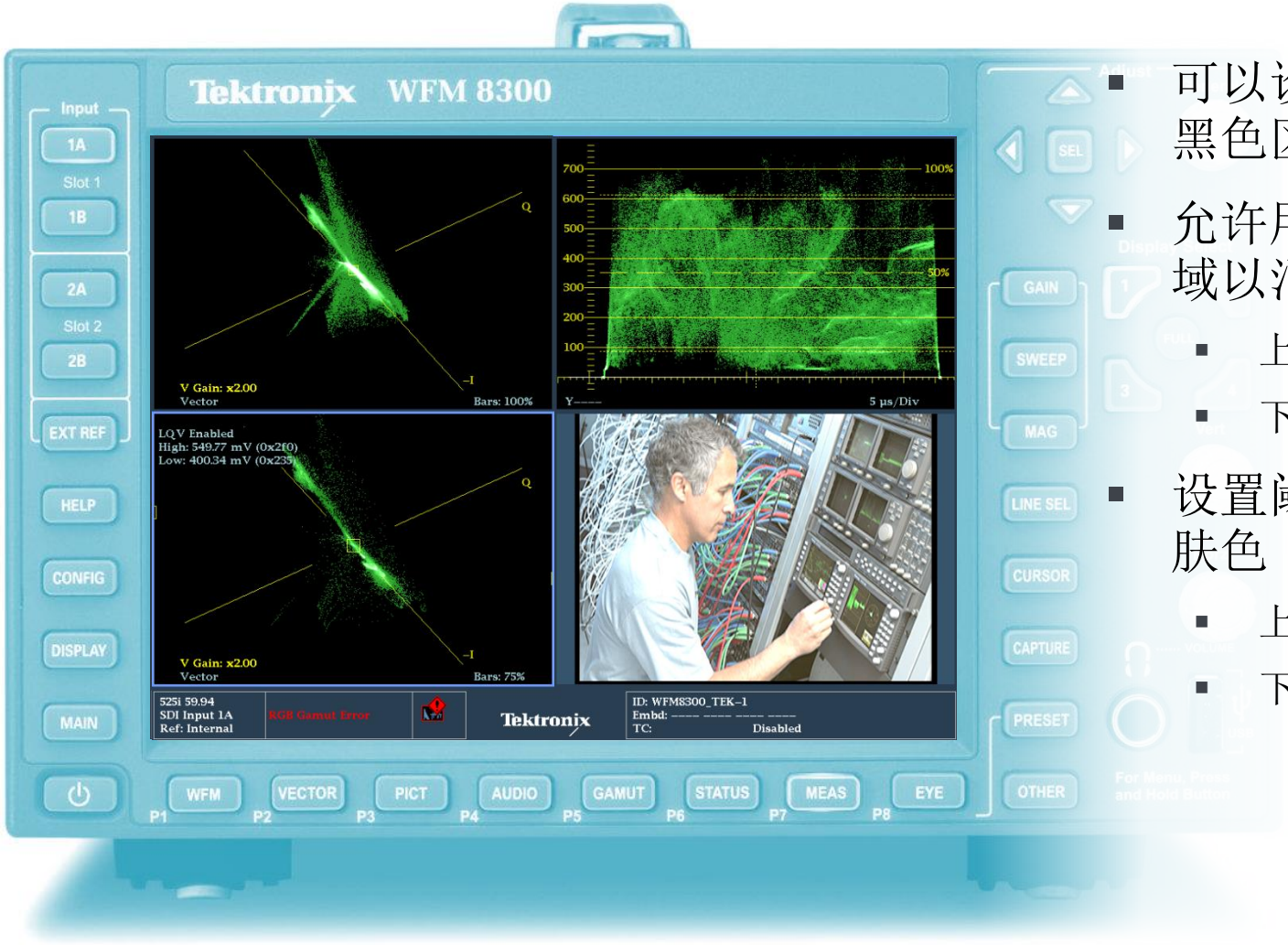


- 每一分屏均可配置为不同的阈值区
  - 高、低和中间值

亮度合格矢量容限


White
Red
Magenta
Yellow
Blue
Green
Cyan
Black
3FF
243
242
0CF
0CE
000
LQV Enabled
High: 763.93 mV (0x3fc)
Low: 411.53 mV (0x243)
Vector
Bars: 75%
LQV Enabled
High: 113.47 mV (0xce)
Low: -51.14 mV (0x0)
Vector
Bars: 75%
LQV Enabled
High: 410.73 mV (0x242)
Low: 114.27 mV (0xcf)
Vector
Bars: 75%
1080i 59.94
SDI Input 1A
Ref: Internal
Tektronix
ID: WFM8300_TEK-1
Embd: PPPP PPPP ----- -----
TC: Disabled

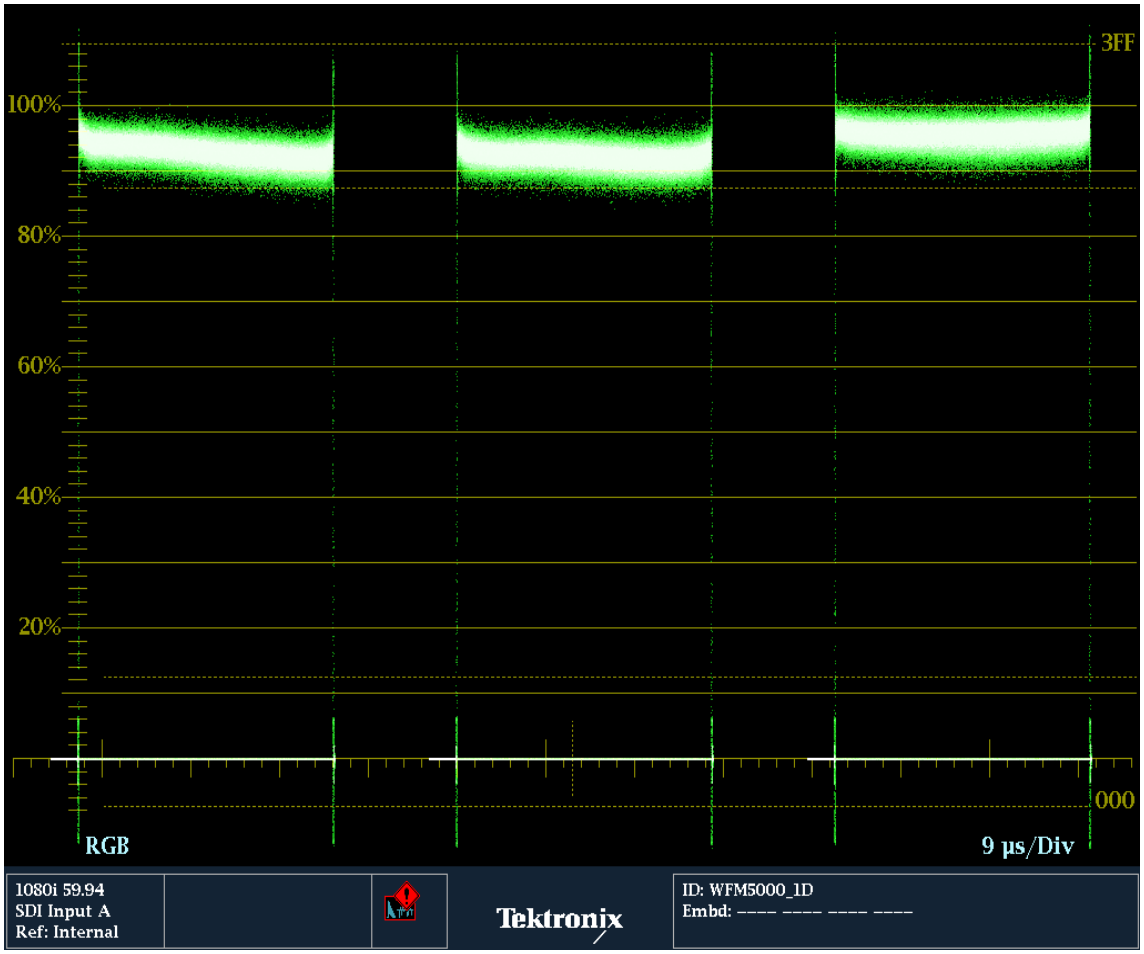
利用 LQV 改善图像



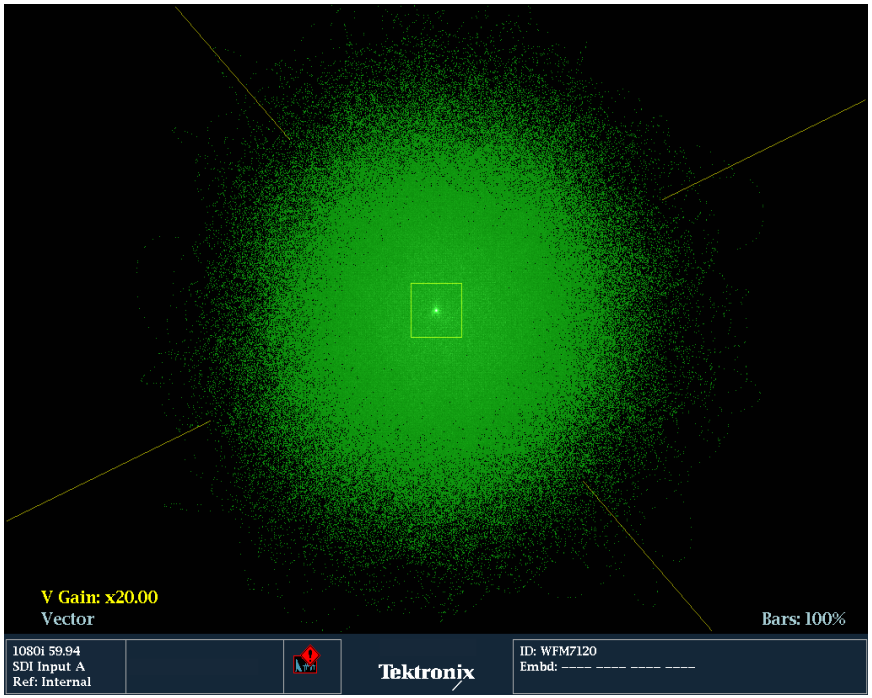
- 可以设置阈值以区分黑色区域
- 允许用户关注黑色区域以消除彩色偏差
  - 上容限 51mv
  - 下容限 -51mv
- 设置阈值以区分人的肤色
  - 上容限 500mv
  - 下容限 400mv

White Balance

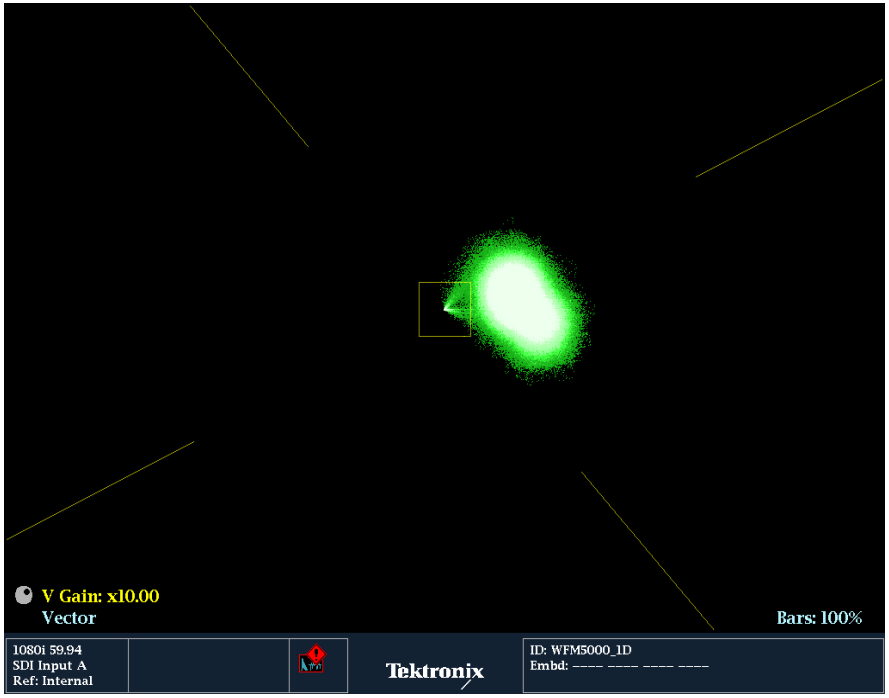
- RGB Parade on WFM5000 before white shading adjustment



Vector Display



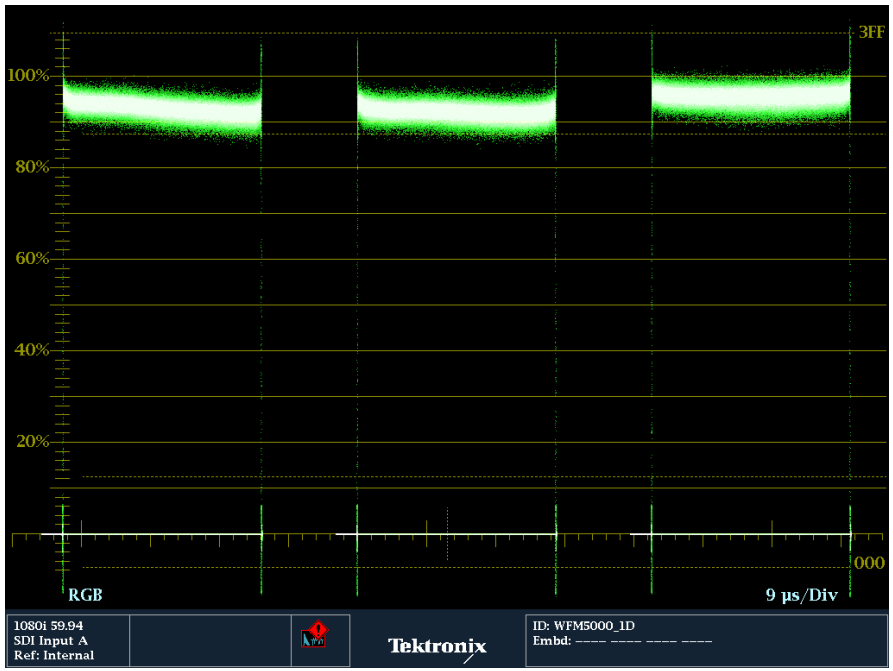
Vector 20X Gain of correctly adjusted white shaded camera

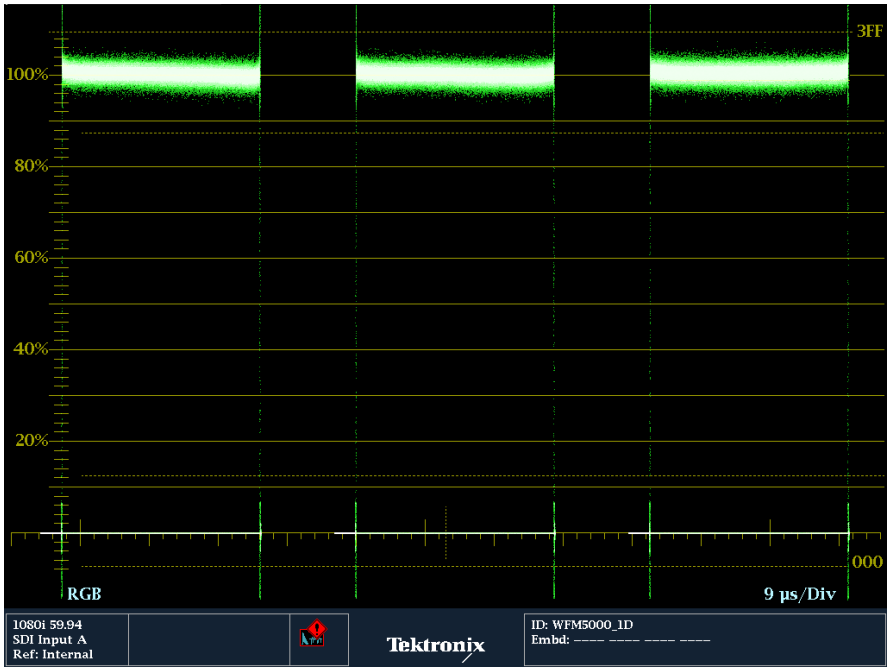


Vector Display with incorrectly adjusted output from the camera

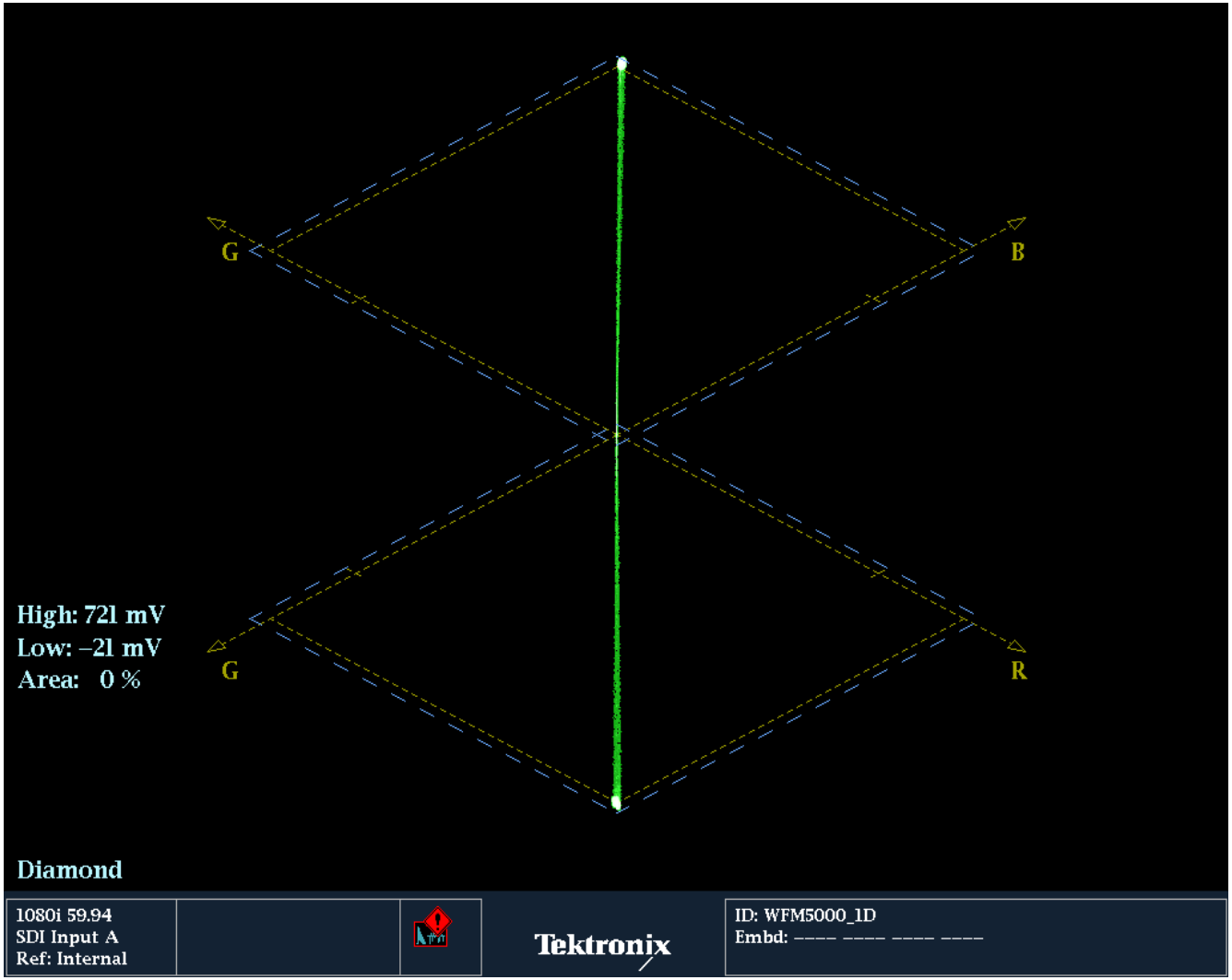
Completed White Balance Display

Before & After

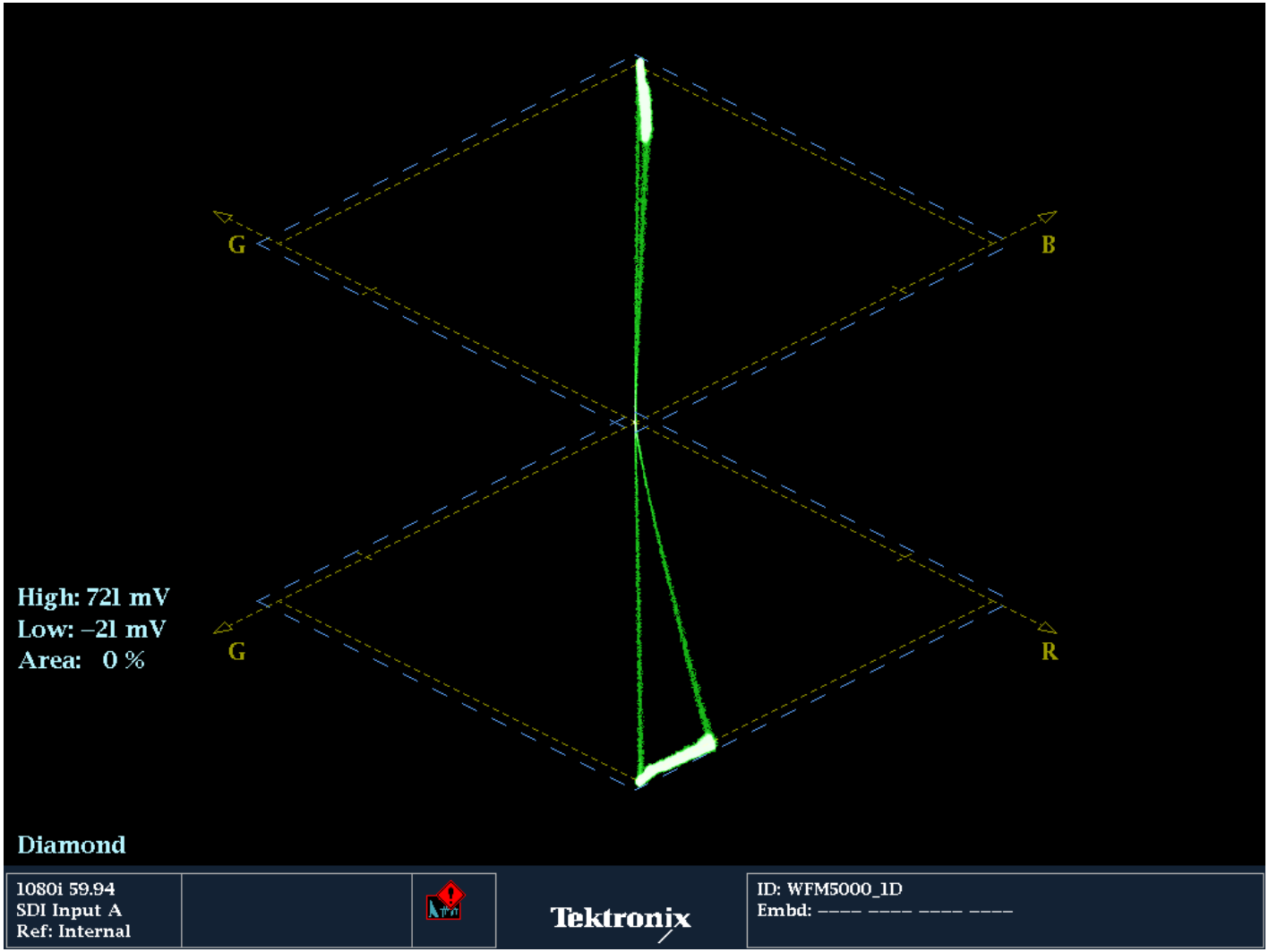




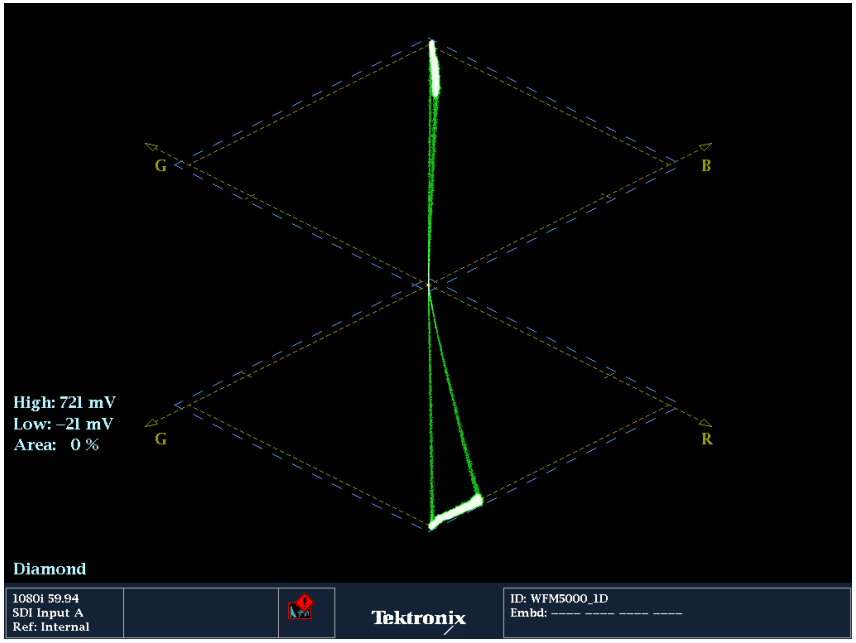
Diamond Display



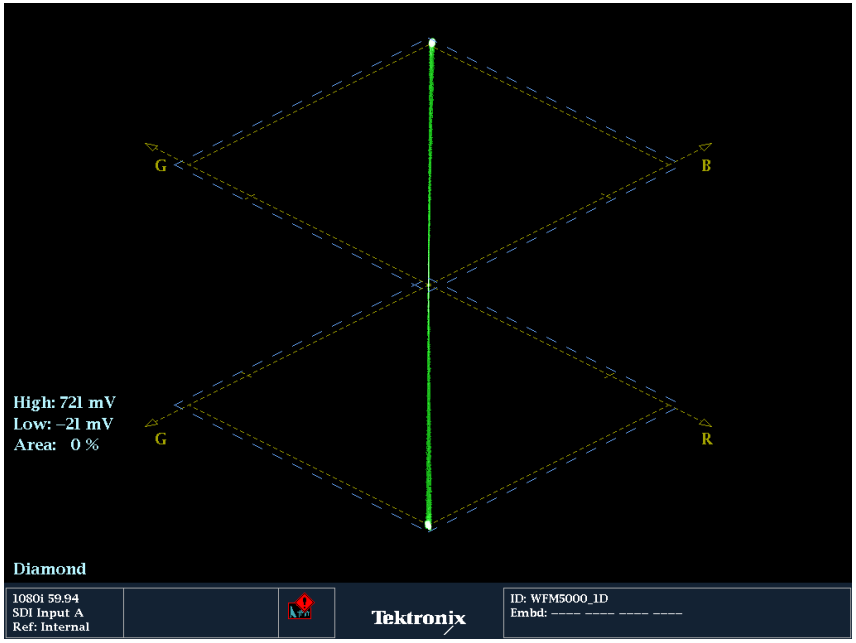
Diamond Display with Red Gain Imbalance



RBD Diamond Display Before and After

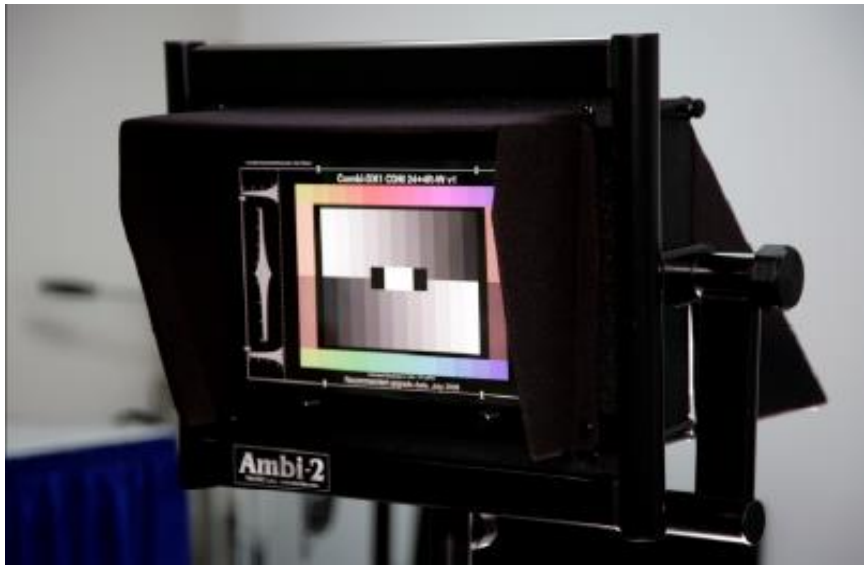


Before

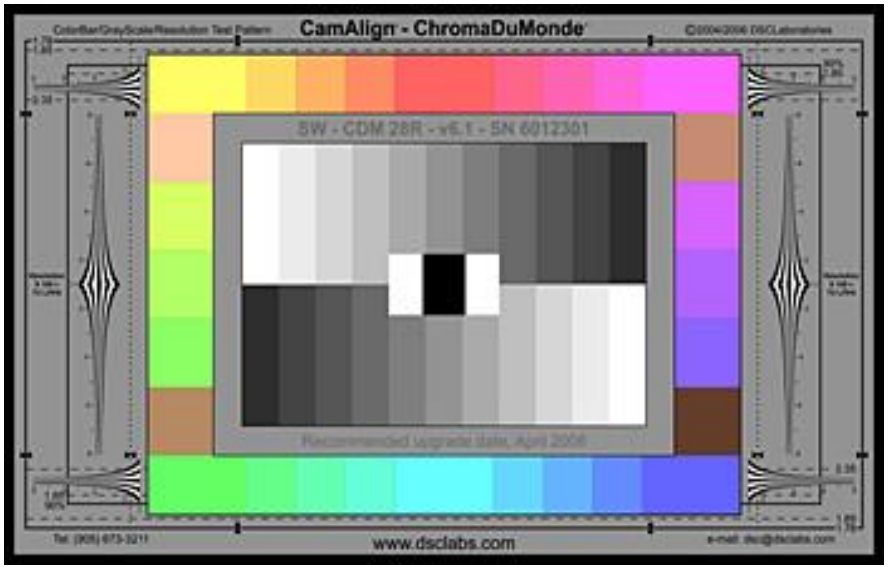


After

Setting Up Correct Colorimetry & Exposure

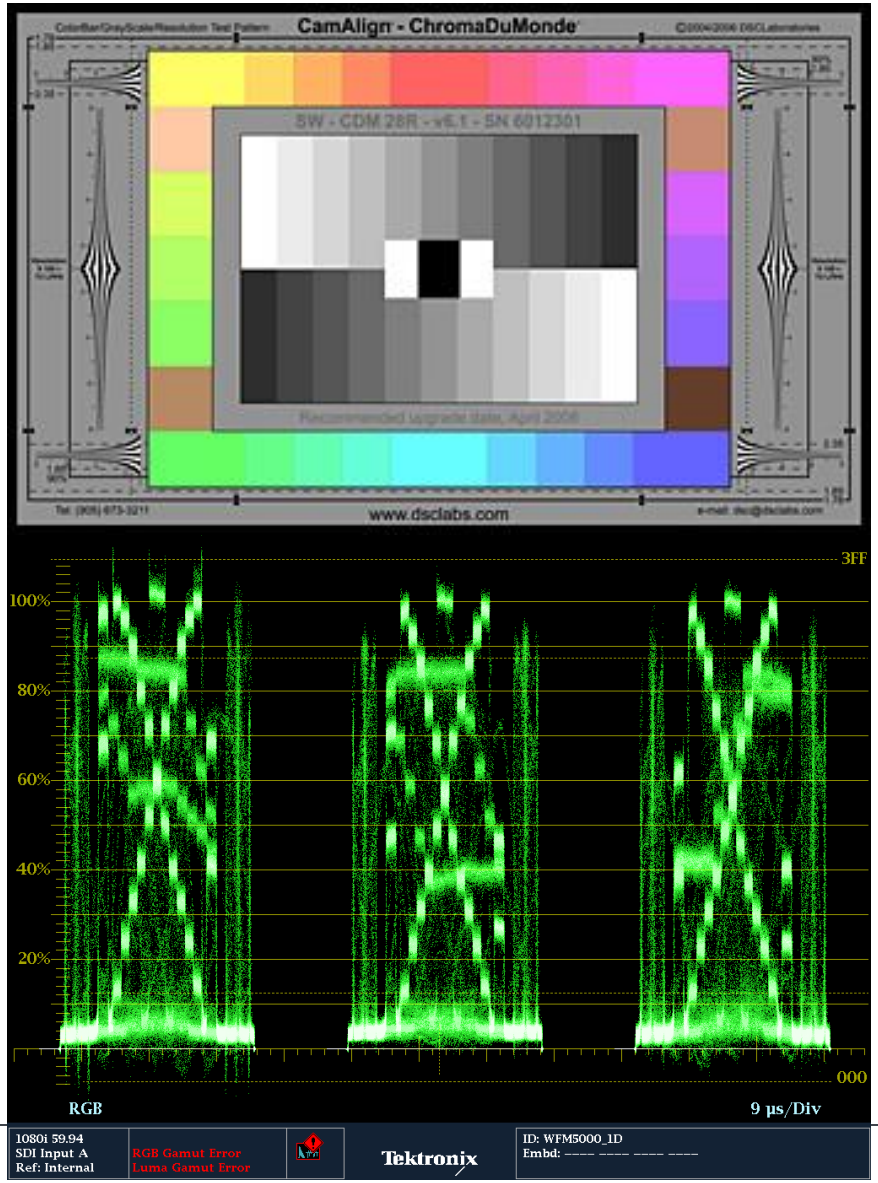


Ambi 2 with Combi (Rear Lit)



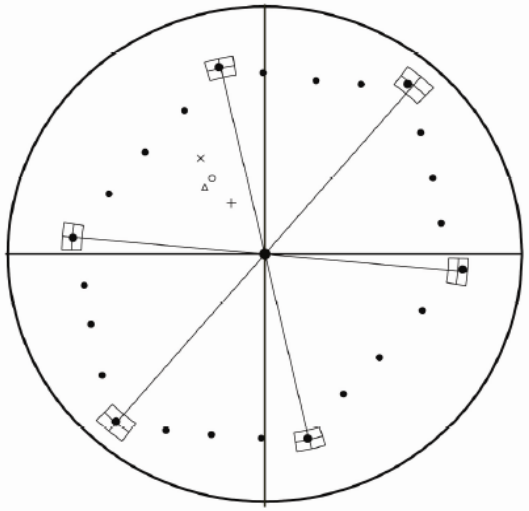
ChromaDuMonde (Front Lit)

11-Step ChromaDuMonde Chart



DSC Laboratories Calibrated HD Simulation

DSC Laboratories - Calibrated HD Simulation
ITU-R BT.709 (SMPTE 274M) Colors at 0.45 Gamma
For CamAlign Pattern - SRW - CDM28R #SRW6032310
Recommended upgrade date, April 2008

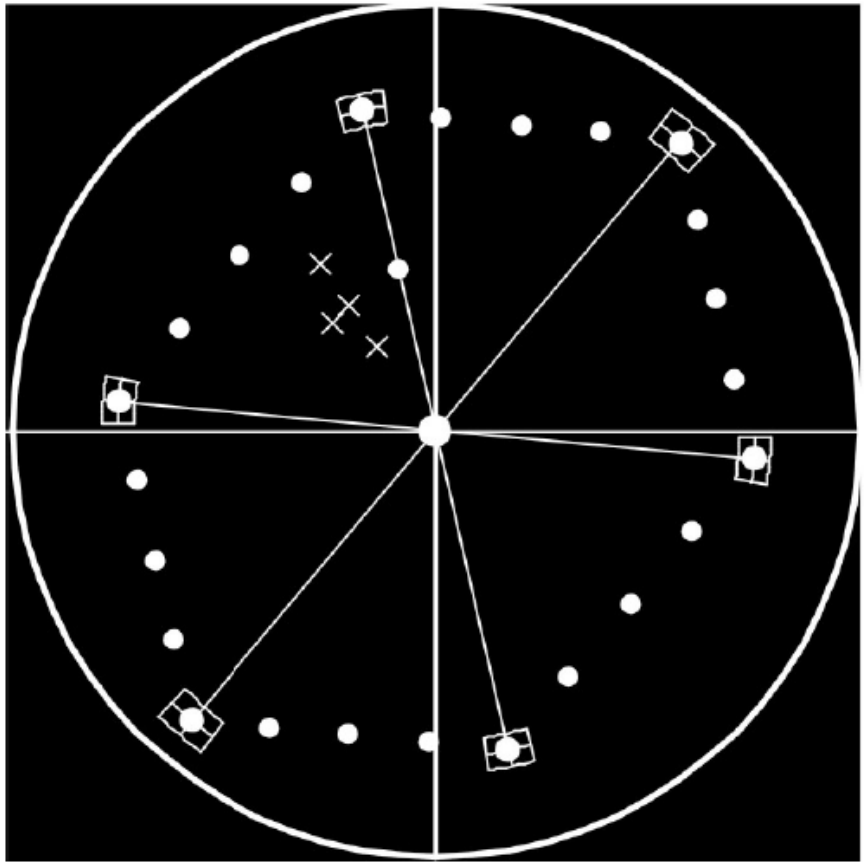


X Light Caucasia, O Medium Caucasian, + Medium Black, Δ Medium Asian

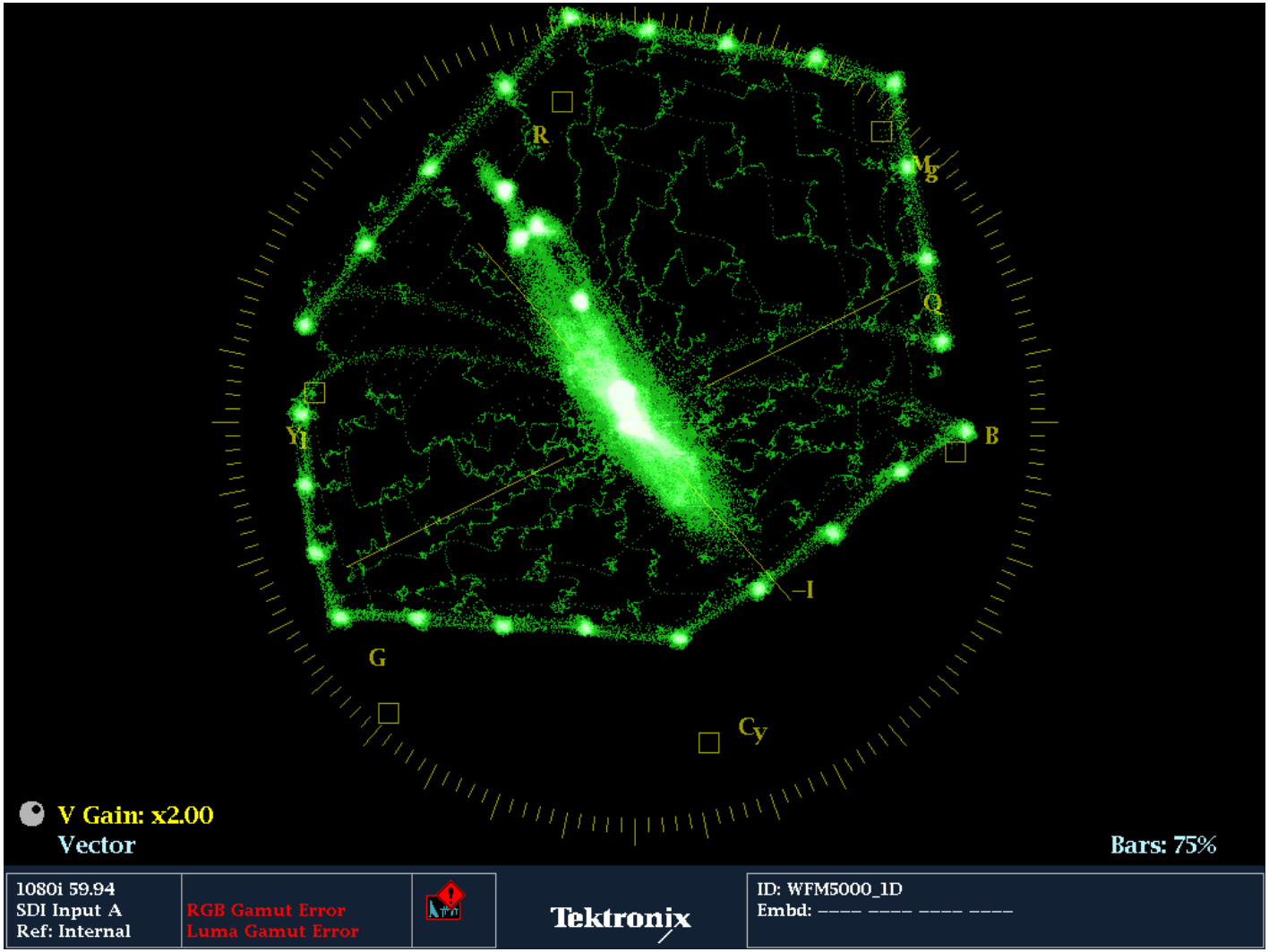
RGB signal levels of DSC Primary CamAlign Colors to 709 colorimetry

Data	Yellow	Cyan	Green	Magenta	Red	Blue
Red(mv)	557.16	275.41	278.81	562.85	562.98	280.16
Green(mv)	558.48	553.98	557.20	281.98	281.87	277.05
Blue(mv)	279.40	552.35	277.18	553.91	279.45	565.14
Luma(mv)	538.05	494.64	477.80	361.32	341.46	298.51
Chrm(mv)	279.83	285.28	332.59	329.53	289.16	288.32
Vector Angle	175.02	282.59	229.45	50.96	103.36	355.36

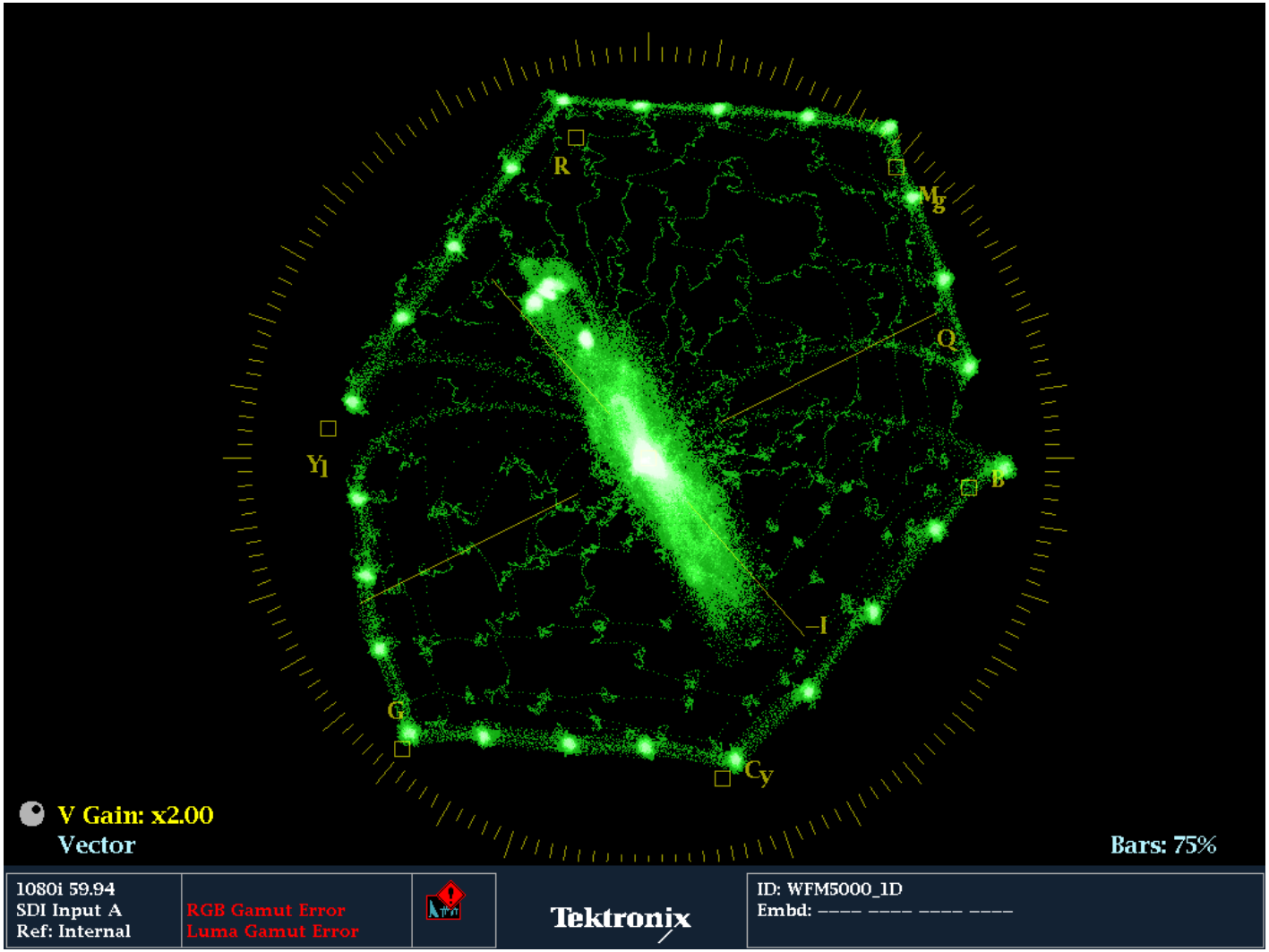
*For a calibrated simulation of this pattern for use on HD or SD vectorscopes, please contact:
Tel: (905) 673 3211 - www.dsclabs.com - e-mail: dsc@dsclabs.com



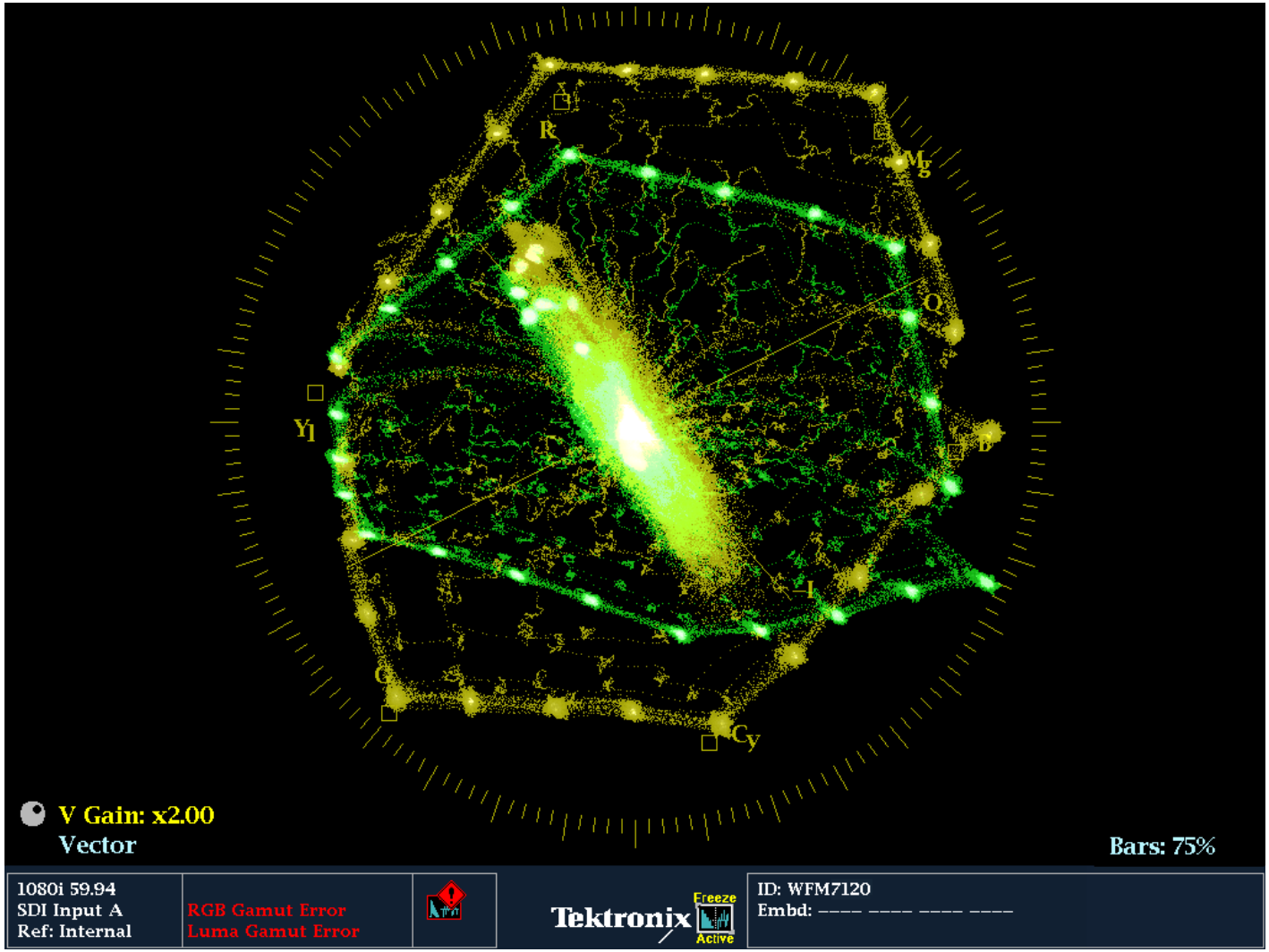
Default Camera Settings Before Alignment



Camera Output After Adjustments



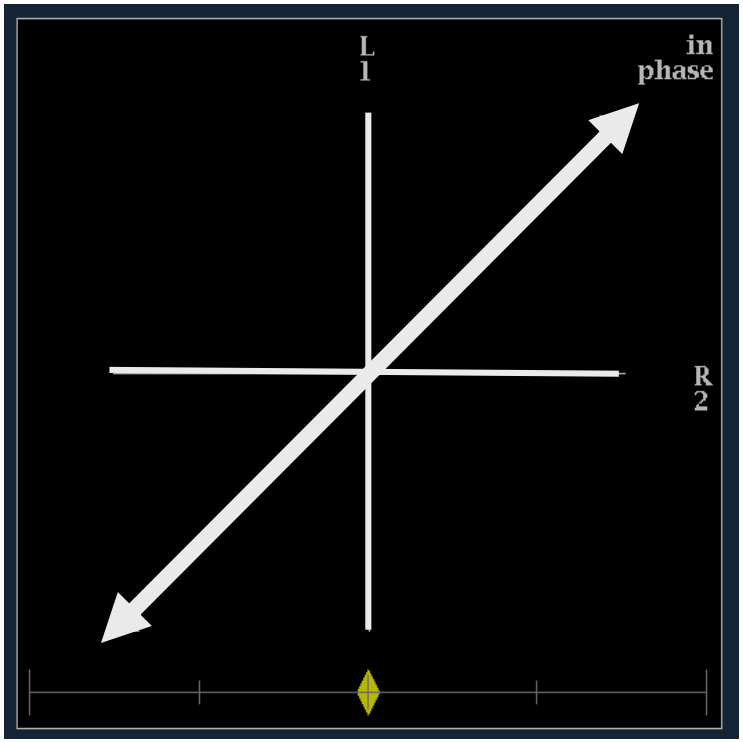
Camera Matching



Analog Lissajous Display

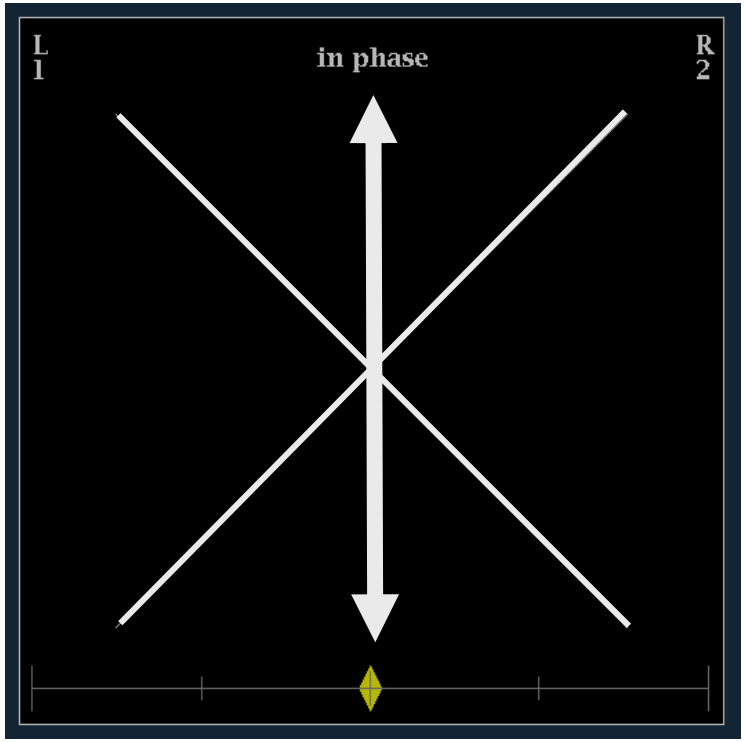
- Left and Right audio channels applied to X-Y display
  - Similar to vectorscope display

X-Y Display



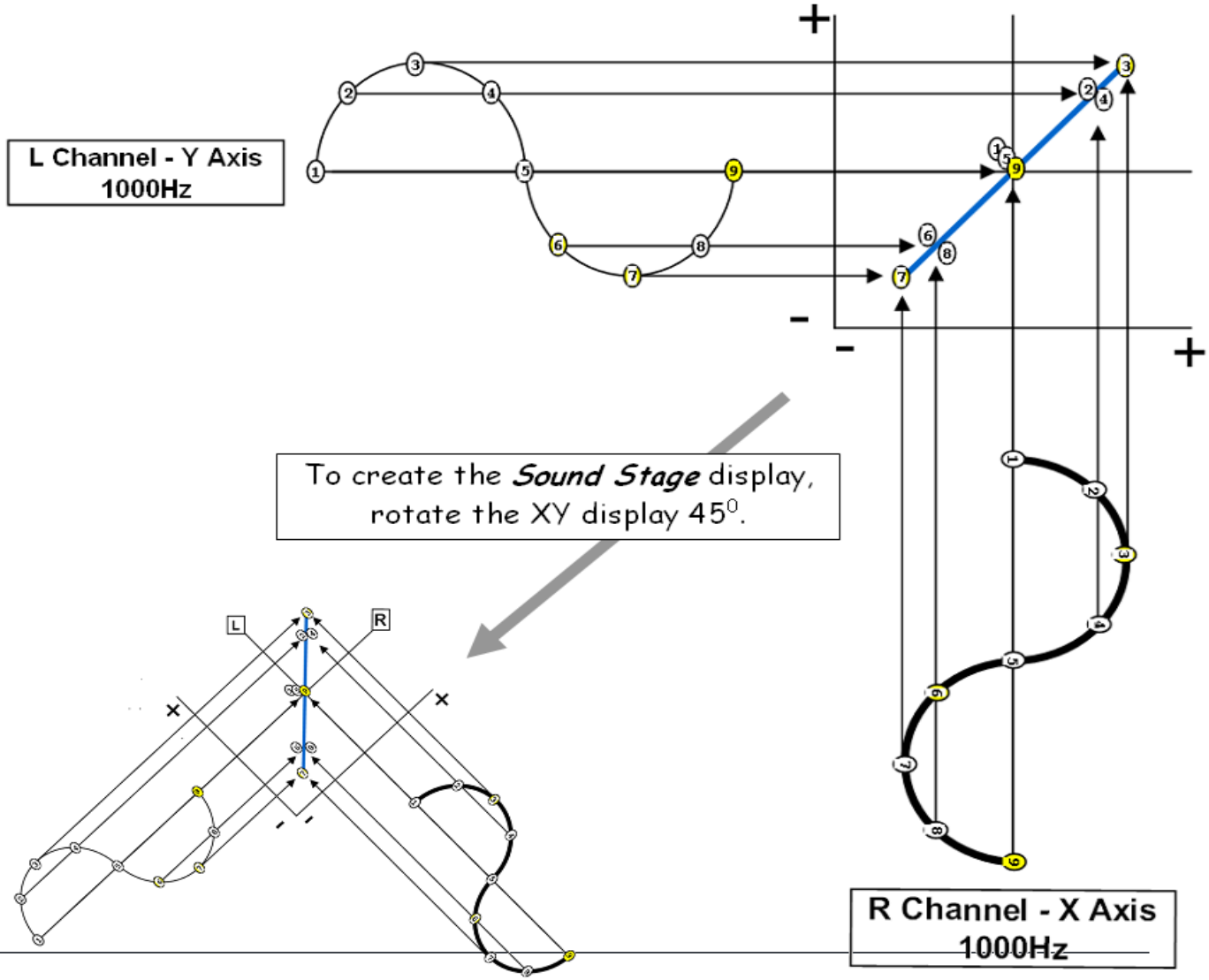
Rotate by 45°

Sound Stage Display



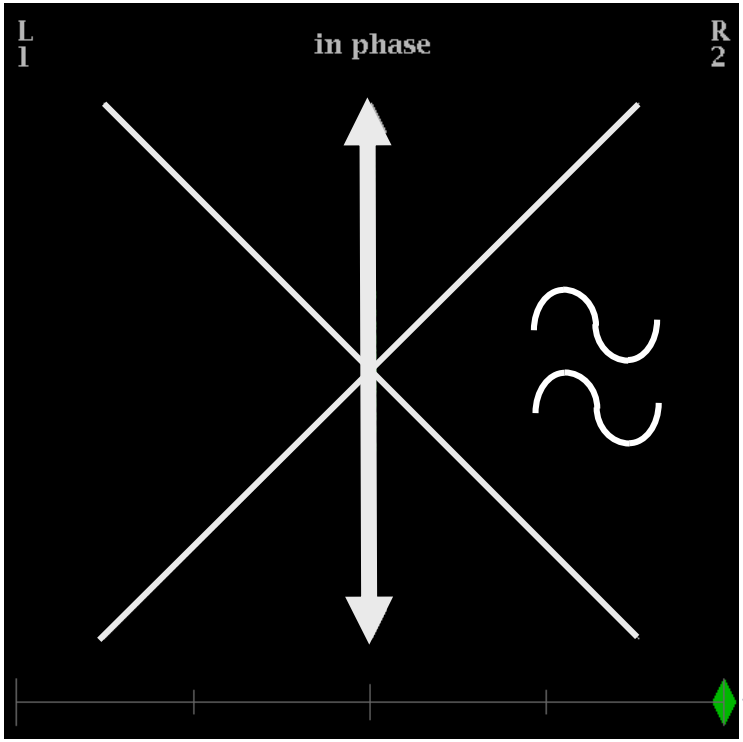
Analog Lissajous Display

- Left and Right audio channels applied to X-Y display



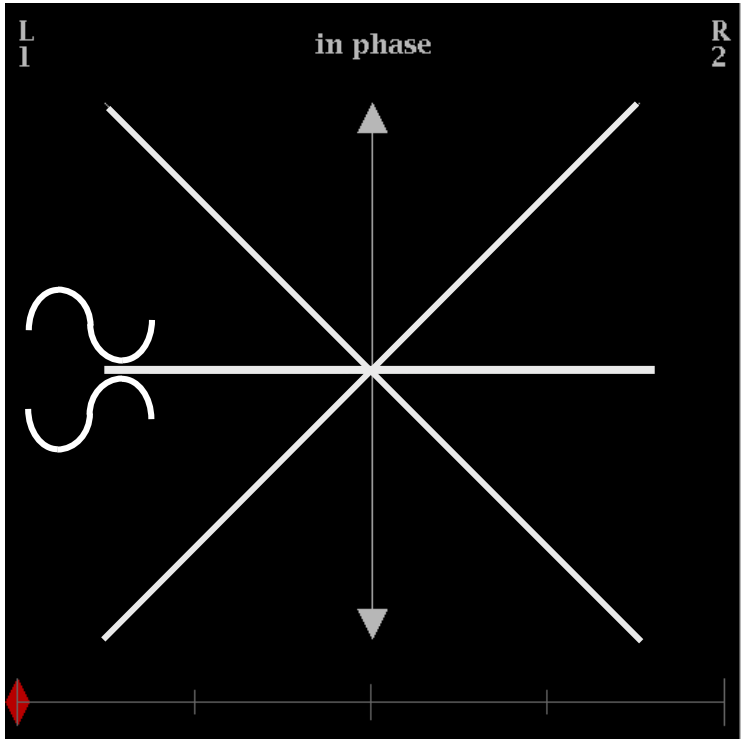
Analog Lissajous Display

Tone with equal amplitude and phase



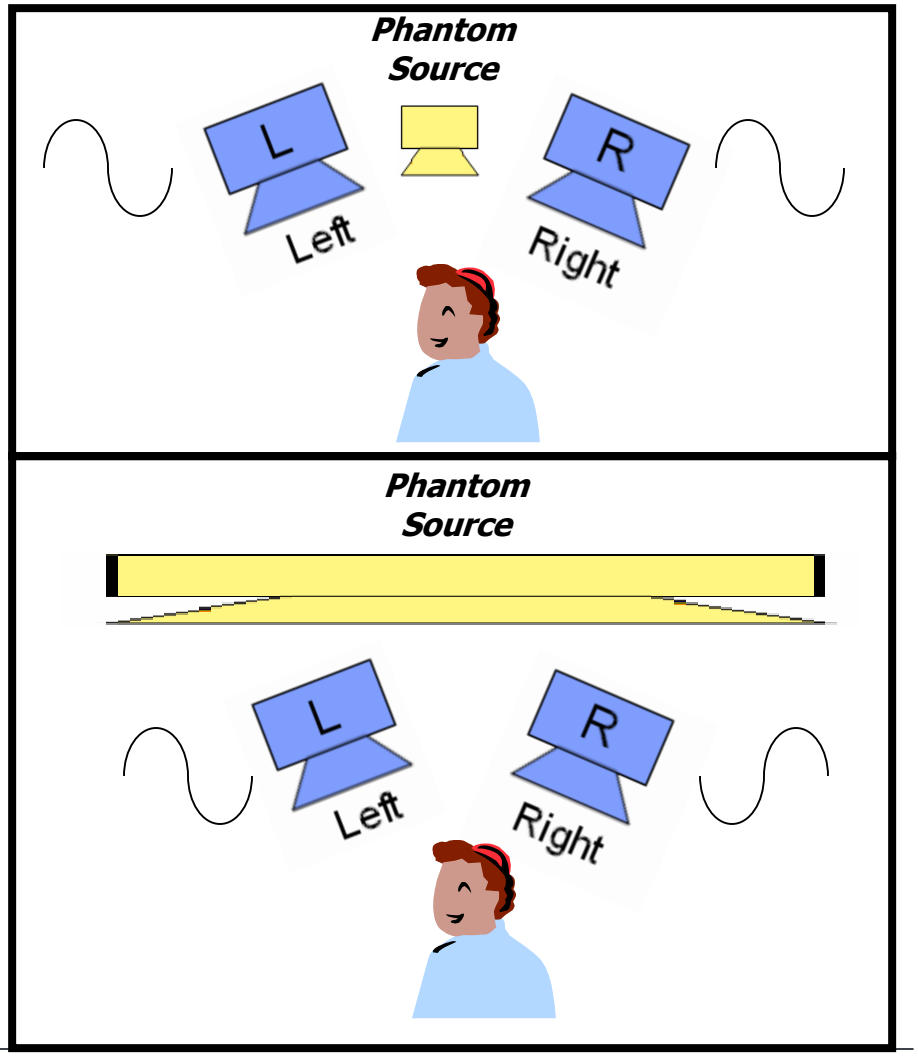
Phase Meter Indicates correlation between channels

Tone with equal amplitude and phase but with crossed polarity



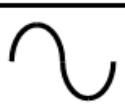
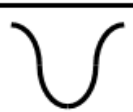
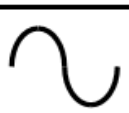
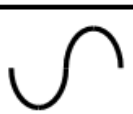
Analog Lissajous Display

- If Sound Phase Same Between Speakers
  - Phantom Source specific spot
  - In Phase - Correlation is +1
- If Sound Phase Different Between Speakers
  - Phantom Source not specific, rather is “smeared”
  - Sounds origin over an area
  - More difference in phase, the wider the area
  - 180 degrees out of phase, Correlation is -1



Analog Lissajous Display

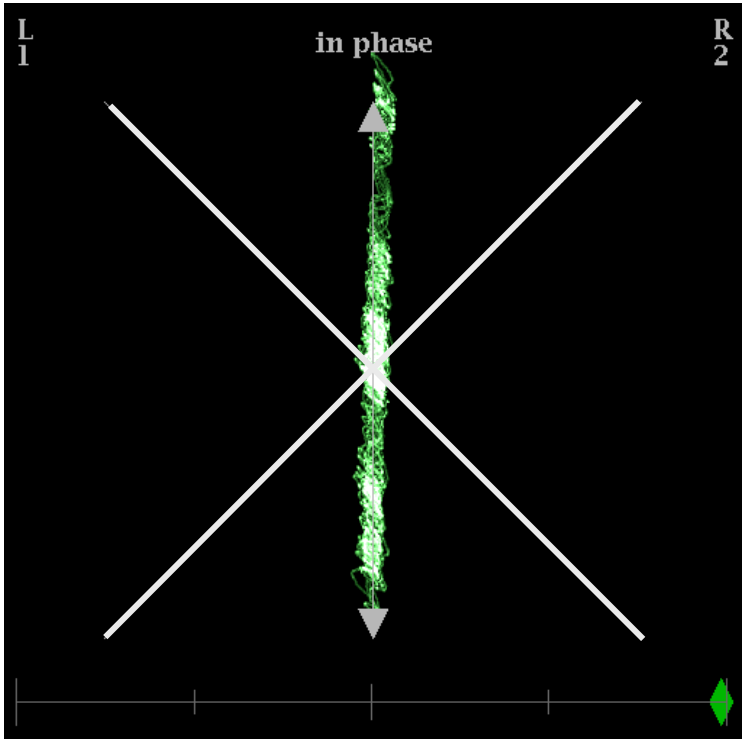
- Range of Correlation Values and Effects on Sound
- 0.0 can be ~90 or some totally different frequency

Correlation Value	Signal 1	Signal 2
+1.0 *0 Degrees Phase Shift*		
+0.9 to +1.0		
+0.2 to +0.9		
+0.2 to 0.0		
0.0 *90 Degrees Phase Shift*		
0.0 to -0.2		
-0.2 to -0.3		
-0.3 to -1.0		
-1.0 *180 Degrees Phase Shift*		

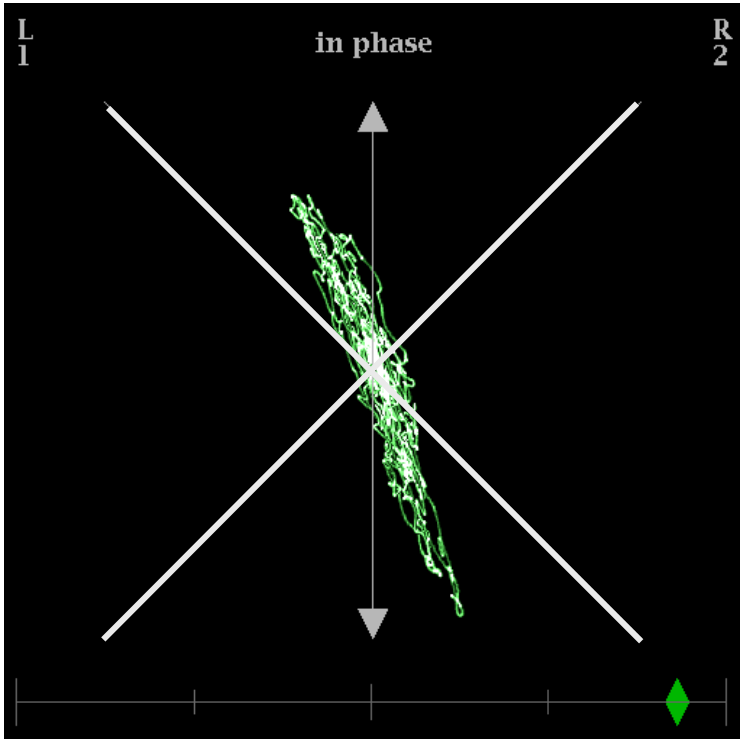
Correlation Value or Range	Typical Sound Impression
+ 1.0	Localized sound
+0.9 to +1.0	Localized sound
+0.2 to +0.9	Localized sound
+0.2 to 0.0	Diffuse, ambient sound or poor quality localized sound
0.0	Diffuse, ambient sound or poor quality localized sound
0.0 to -0.2	Diffuse, ambient sound or poor quality localized sound
-0.2 to -0.3	Diffuse, ambient sound or poor quality localized sound
-0.3 to -1.0	Poor quality sound
-1.0	Poor quality sound

Analog Lissajous Display

Stereo audio signal with equal channel signal strength and equal correlation

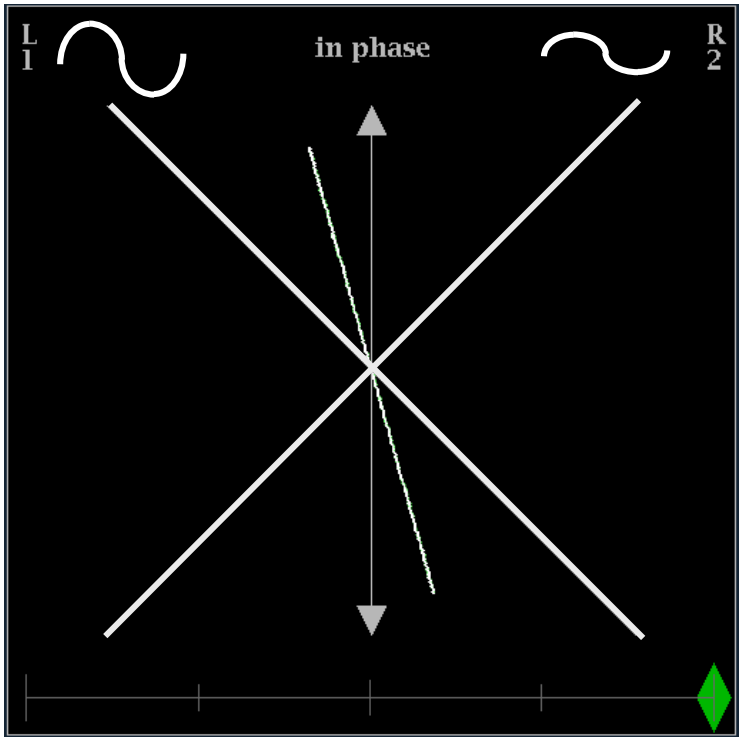


Stereo audio signal with stronger left cannel and equal correlation

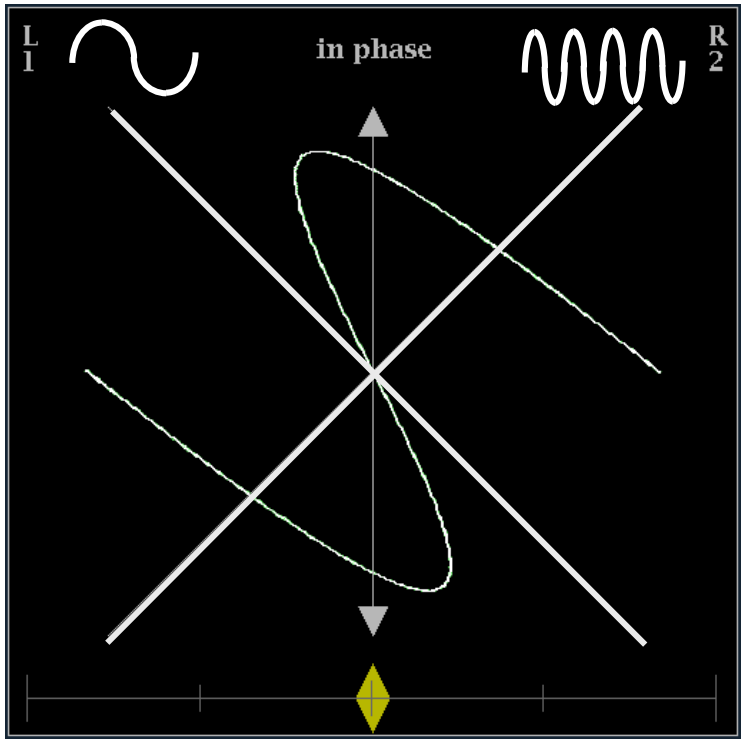


Analog Lissajous Display

The left channel's amplitude is greater than the right



The left and right channel signals are two different frequencies



什么是响度？

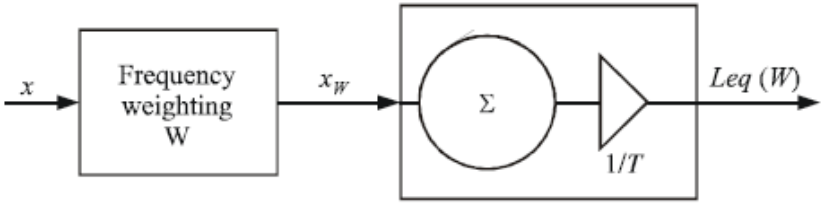
- 响度是一种主观的量度
  - 不同的人有不同的响度感受
- 就本质而言，响度是用来衡量音频信号物理强度的心理相关度.
- 可以使用不同的技术来得到音频信号总响度的相关度.
- 可以采用不同的滤波器来调整人耳感知响度的模型.
- 在以下应用场合必须测量人耳感知的响度
  - 广播电视环境
  - 音乐、话音和声响效果

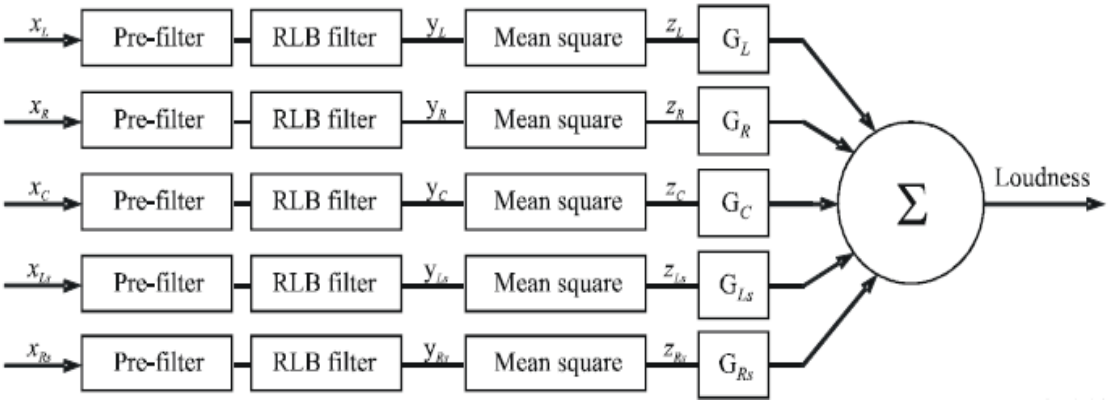
响度标准

- IEC 61672-1
  - 电声学声音电平表
- ITU-R.BS 1770
  - 测量音频节目响度和真实峰值音频电平的算法
- ITU –R.BS 1771
  - 响度和真实峰值指示表的需求
- ATSC A/85 RP
  - 确定和保持数字电视的音频响度的技术
- P/Loud 工作组
  - http://wiki.ebu.ch/loud/Main_Page
  - 选通测量
  - 包括 LFE

ITU-R BS 1770 标准介绍

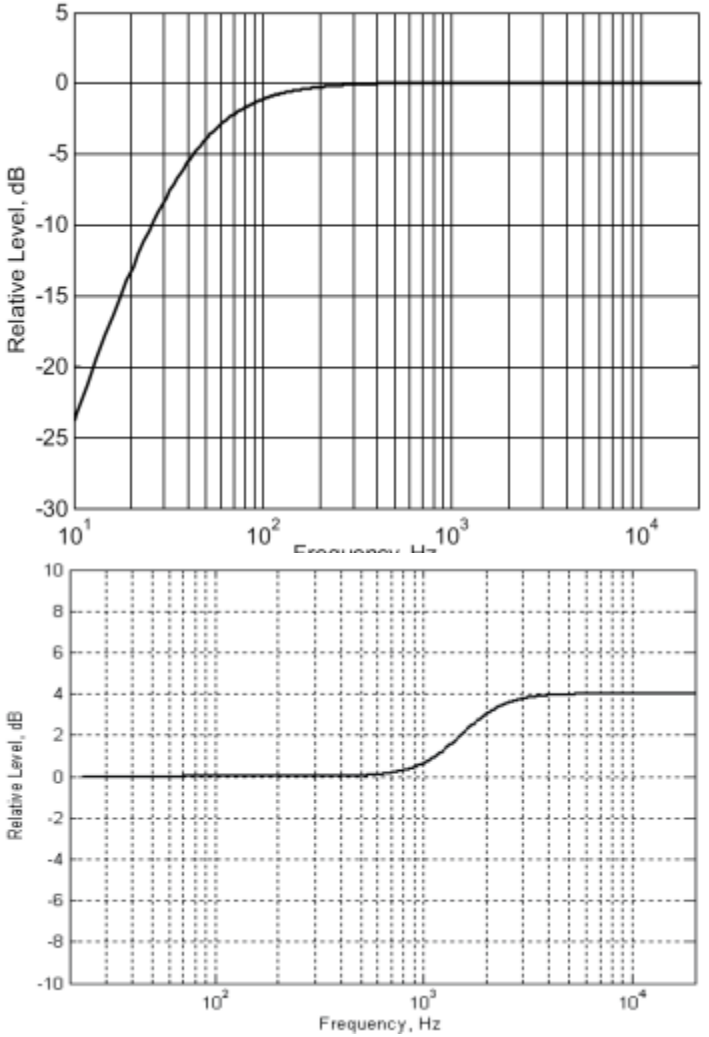
- ITU-R 单音响度
  - 测量 Leq(RLB) 加权均方值
  - 较低的计算复杂性
  - Leq(RLB) 提供了所有测试表的最佳性能
  - 简单的基于能量的响度
- Leq(RLB) 算法的设计
  - 高通滤波器
  - 能量对时间求和
- 多声道响度算法的设计
  - 简单的构件块
  - 可从 1 扩展至 N





Measuring Loudness

- ITU-R.BS 1770 Algorithms for audio programme loudness
- Uses RLB Filter
  - Simpler to implement



- Pre Filter
  - Accounts acoustic effects of the head
- Pre Filter and RLB Filter Combined
  - “K Weighting”

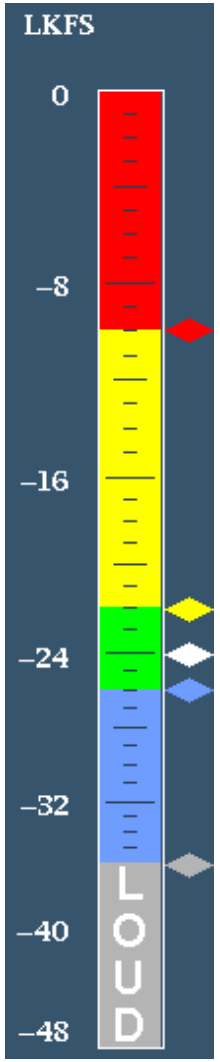
Loudness Measurement (LKFS)

$$\text{Loudness} = -0.691 + 10 \log_{10} \sum_{i}^{N} G_i . z_i \quad \text{(LKFS)}$$

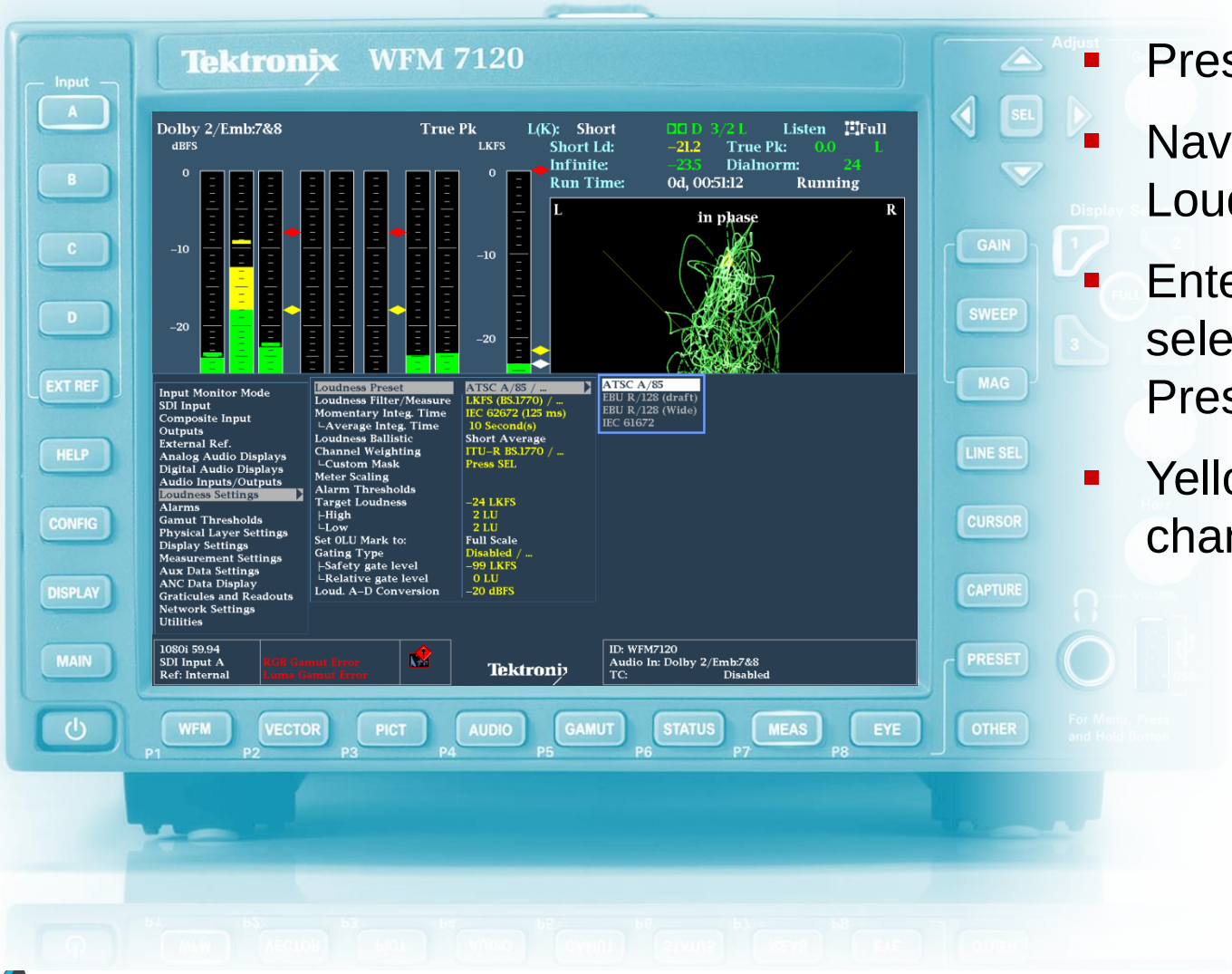
- Power Weighted Average Measurement from 1 to N Channels
- Definitions
  - i L, C ,R, Ls, Rs & N which is total number of channels
  - y_i Input signal filtered by pre-filter and RLB weighting curve
  - z Weighted Mean Square level
  - G Channel weighting

$$z_i = \frac{1}{T} \int_0^T y_i^2 dt$$

Channel	Weighting, G_i
Left (G_L)	1.0 (0 dB)
Right (G_R)	1.0 (0 dB)
Centre (G_C)	1.0 (0 dB)
Left surround (G_{Ls})	1.41 (~ +1.5 dB)
Right surround (G_{Rs})	1.41 (~ +1.5 dB)



WFM/ WVR Loudness Configuration

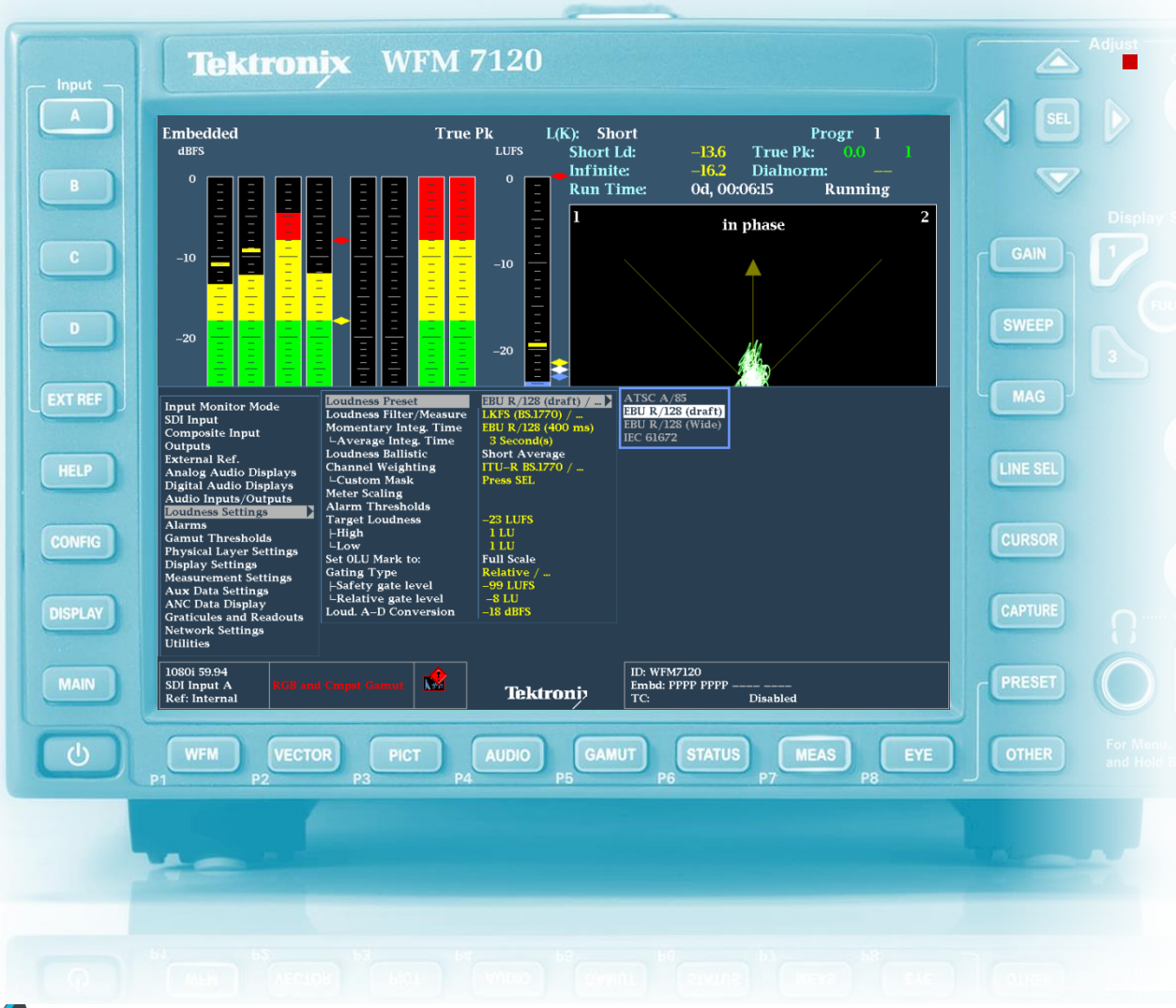


- Press Config button
- Navigate to Loudness Settings
- Enter sub menu and select Loudness Preset ATSC A/85
- Yellow text indicates changing of settings

WFM7/WVR Loudness ATSC A/85

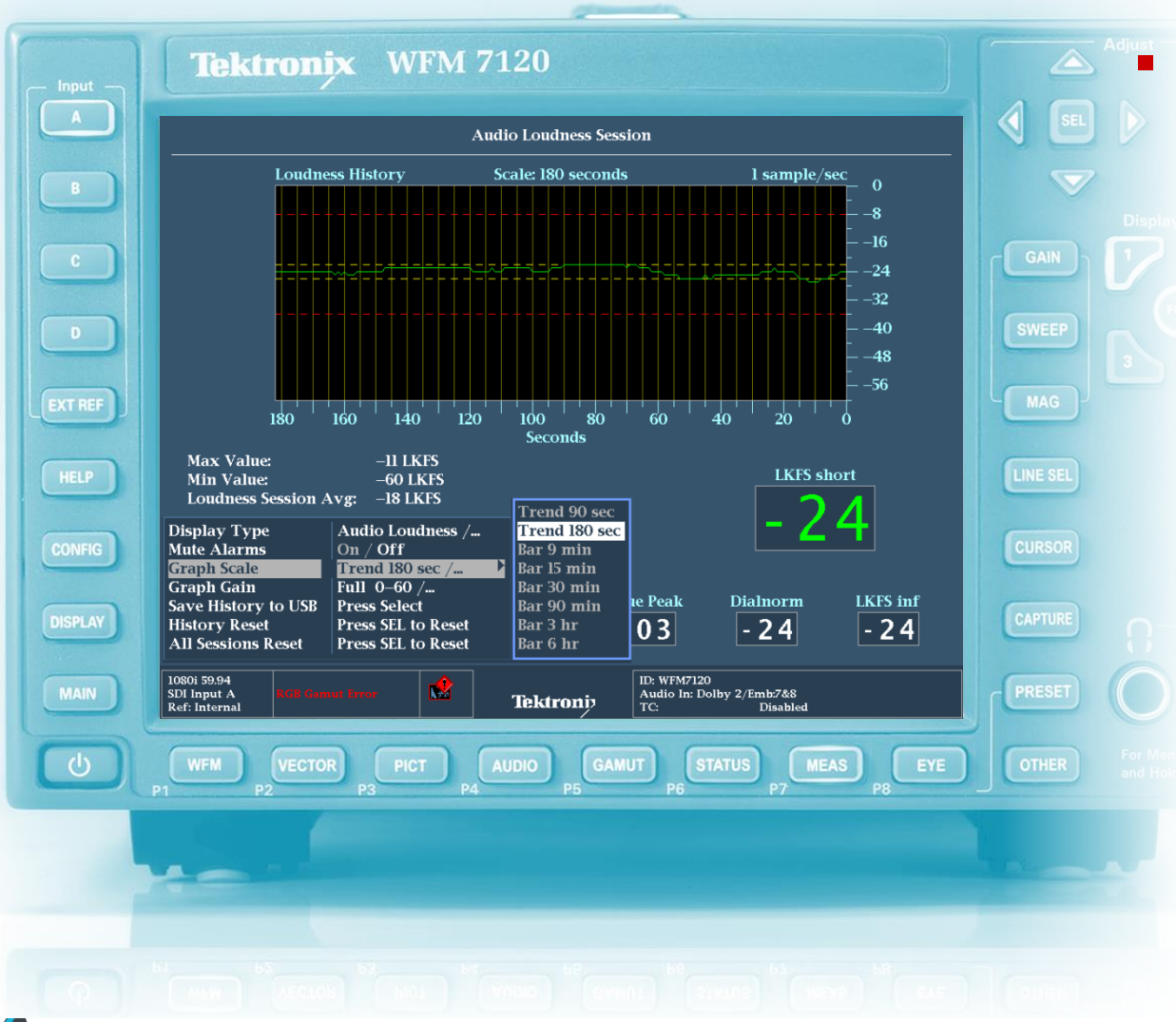
- ATSC A/85 Settings
  - Loudness Filter
    - LKFS ITU-R BS.1770
  - Average Short Duration
    - 10 seconds
  - Channel Weighting
    - ITU-R BS.1770
    - Surround channels weighted by +1.5dB
  - Target Loudness
  - -24LKFS & High/Low 2LU

WFM/WVR Loudness EBU R128 Preset



- EBU R128 Settings
  - Loudness Filter
    - LKFS ITU-R BS.1770
  - Average Short Duration
    - 3 seconds
  - Channel Weighting
    - ITU-R BS.1770
    - Surround channels weighted by +1.5dB
  - Target Loudness
    - -23LKFS & High/Low 1LU
  - Gating Measurement
    - Relative 8LU
    - Loudness Unit (LU)

WFM/WVR Loudness Session



- Loudness Chart

Logs Loudness value every second

Trend Chart

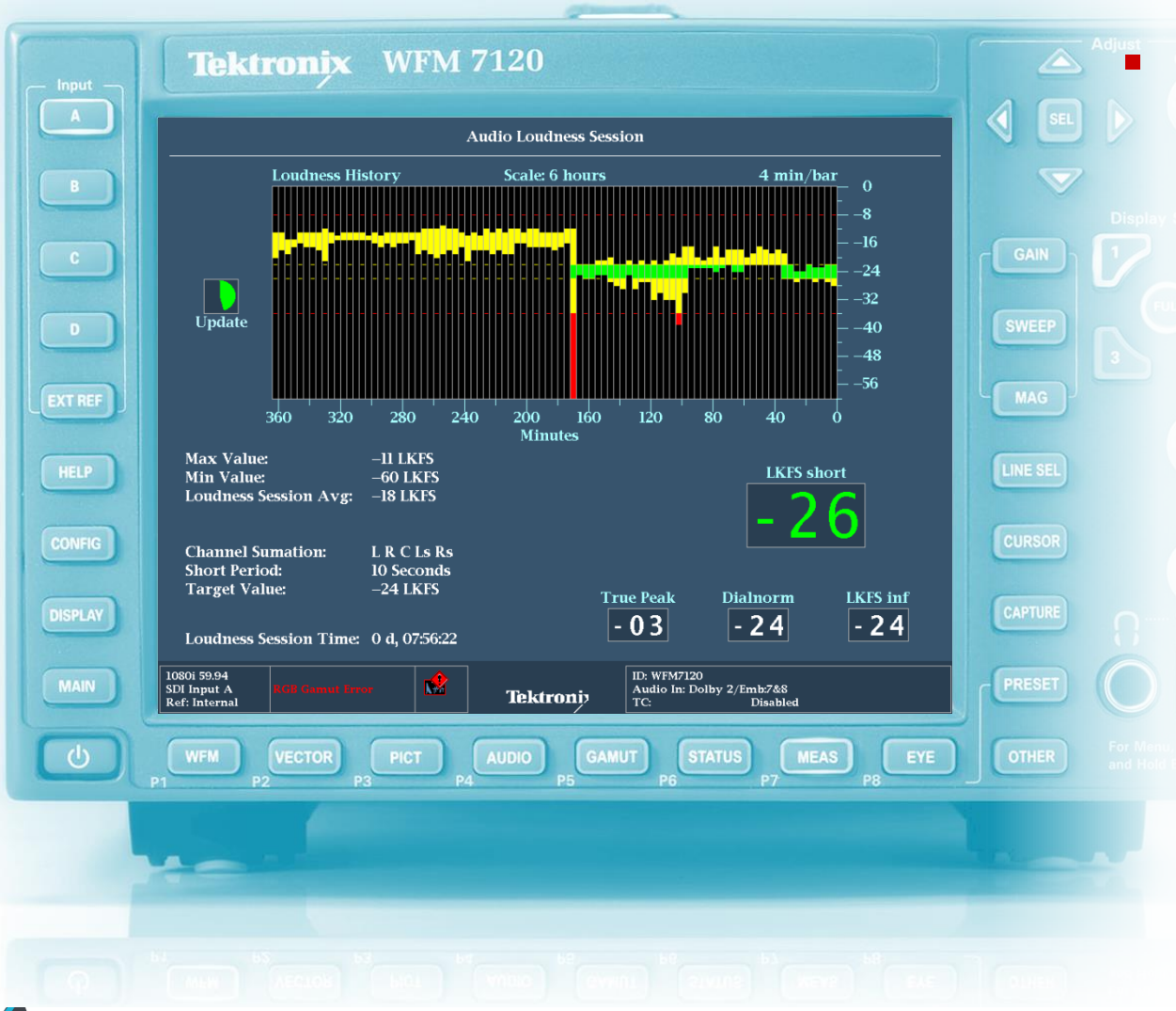
- 90 Seconds
- 180 Seconds

Bar Chart

- 9 minutes to 6 hours

Save Loudness value to USB or via network.

WFM/WVR Loudness Session



- Loudness Chart
  - Bar Chart
  - From 9 minutes to 6 hours
  - LKFS Short
  - LKFS Infinite
  - Dialnorm
  - True Peak
  - Max / Min Value LKFS
  - Summary Information
    - Channel Summation
    - Short Period
    - Target Loudness
  - Save Loudness Session to USB or via network.

杜比 E 定时 – 防护带测量

- 重要的是杜比 E 音频数据流必须与视频信号同步
- 杜比防护带区中没有效的杜比 E 数据流
- 允许在各节目素材间进行同步切换和编辑.
- 如果杜比 E 位置太早或太迟，可能会引起杜比 E 数据流的损坏并丢失数据段.
- RDD 6 Dolby® E 音频元数据串行比特流的使用说明和指南
  - 规定了元数据的起始位置

杜比定时测量 (625i 50)

场同步
参考点

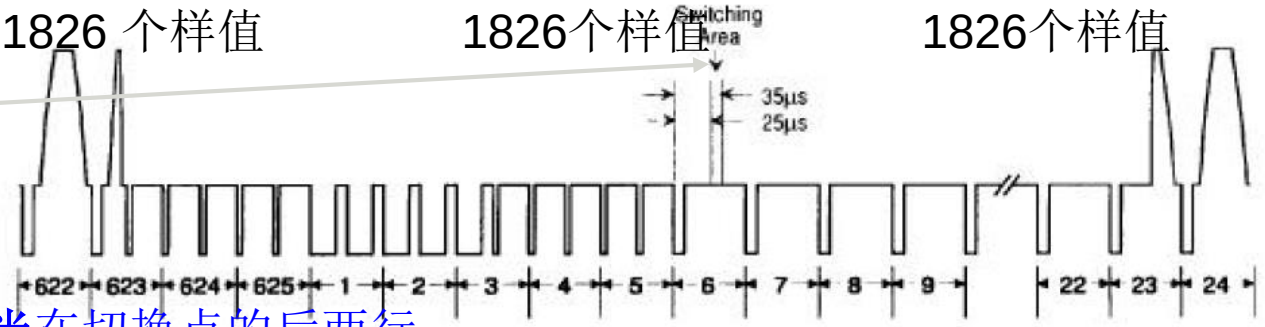
视频帧 N

场1 | 场 2 | 场 3 | 场 4

杜比 E 包 | 杜比 E 包 | 杜比 E 包 | 杜比 E 包

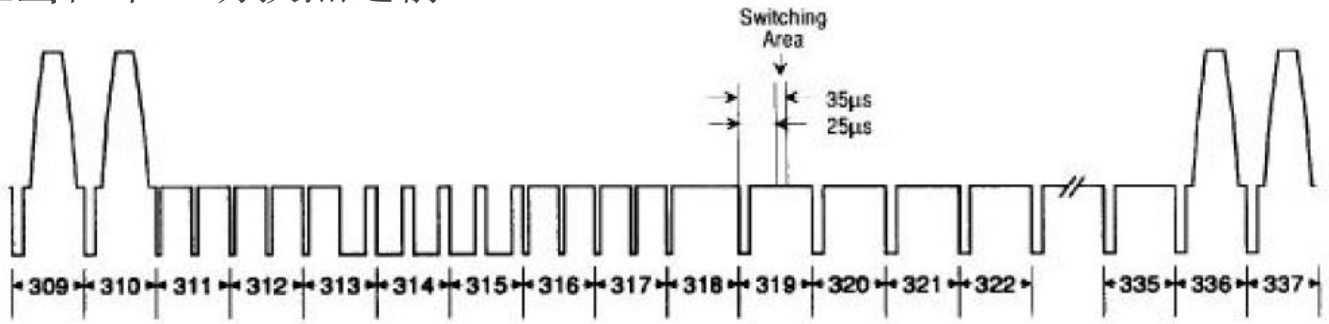
1826 个样值 | 1826个样值 | 1826个样值 | 1826个样值

视频切换点

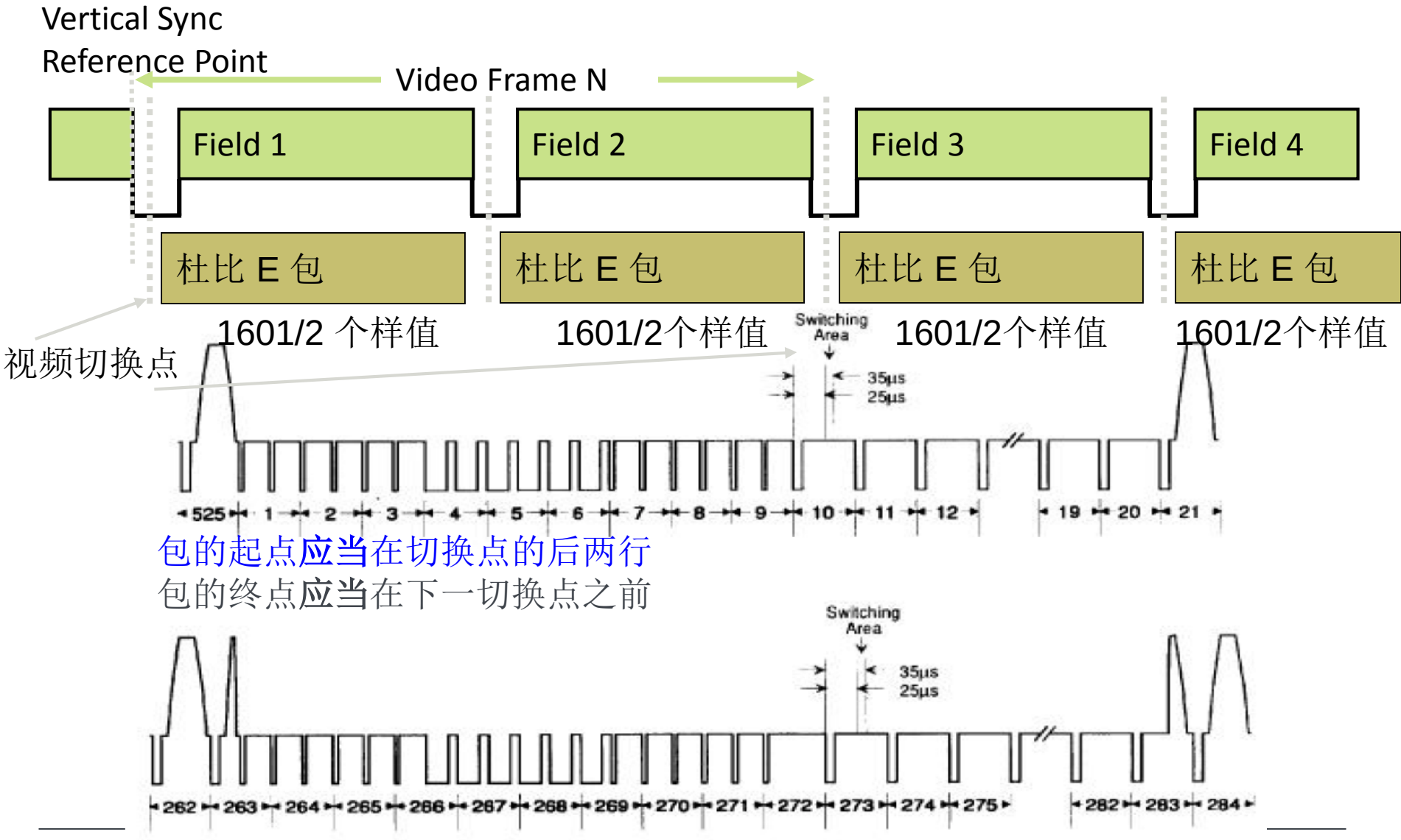


包的起点**应当**在切换点的后两行

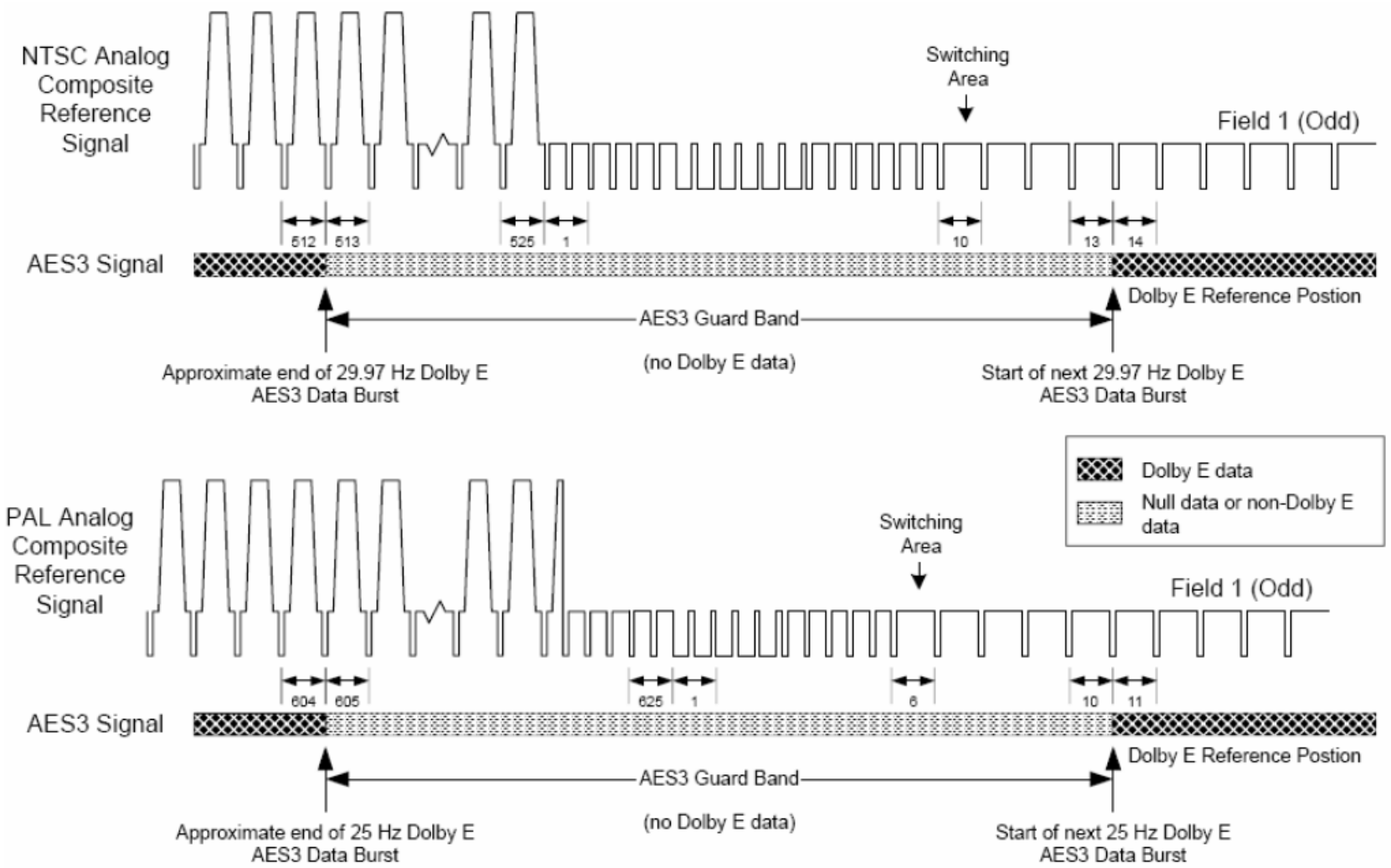
包的终点**应当**在下一切换点之前



杜比定时测量(525i 59.94)



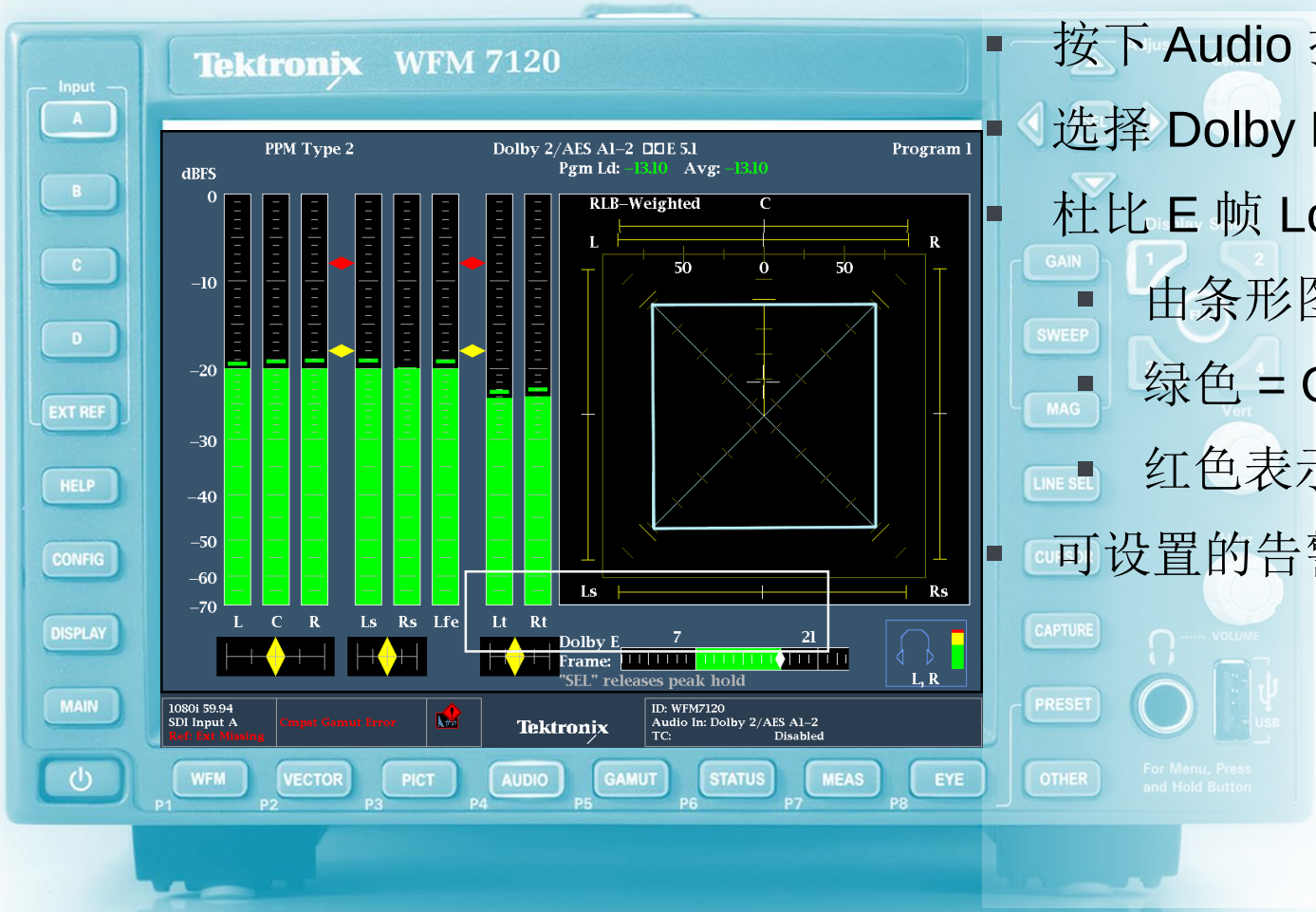
杜比E 防护带


NTSC Analog Composite Reference Signal
Switching Area
Field 1 (Odd)
512
513
525
1
10
13
14
AES3 Signal
Dolby E Reference Postion
AES3 Guard Band
(no Dolby E data)
Approximate end of 29.97 Hz Dolby E AES3 Data Burst
Start of next 29.97 Hz Dolby E AES3 Data Burst
Dolby E data
Null data or non-Dolby E data
PAL Analog Composite Reference Signal
Switching Area
Field 1 (Odd)
604
605
625
1
6
10
11
AES3 Signal
Dolby E Reference Postion
AES3 Guard Band
(no Dolby E data)
Approximate end of 25 Hz Dolby E AES3 Data Burst
Start of next 25 Hz Dolby E AES3 Data Burst

确定杜比防护带
利用杜比状态

- 按下 STATUS 按钮
- 选择 Dolby Status
- 杜比 E 帧 Loc.
  - 行 xx Fx （AES）
  - 行 xx Fx 和嵌入的样值
  - 可配置的告警容限
- 红色表示错误

确定杜比防护带
使用音频显示和设置容限



- 按下 Audio 按钮
- 选择 Dolby Preset (1-4)
- 杜比 E 帧 Loc.
  - 由条形图指示
  - 绿色 = OK
  - 红色表示错误
- 可设置的告警容限

杜比定时切换点（ RP168 标准）

标准	格式	切换行		行参考点后的切换区（μs）
		场 1,3	场 2,4	
SMPTE 170M	525i 59.94	10	273	30+/-5
ITU BT.470	625i 50	6	319	30+/-5
SMPTE 274M	1920x1080i	7	569	
SMPTE 274M	1920x1080p	7	--	
SMPTE296	1280x720p	7	--	

RDD 6 标准

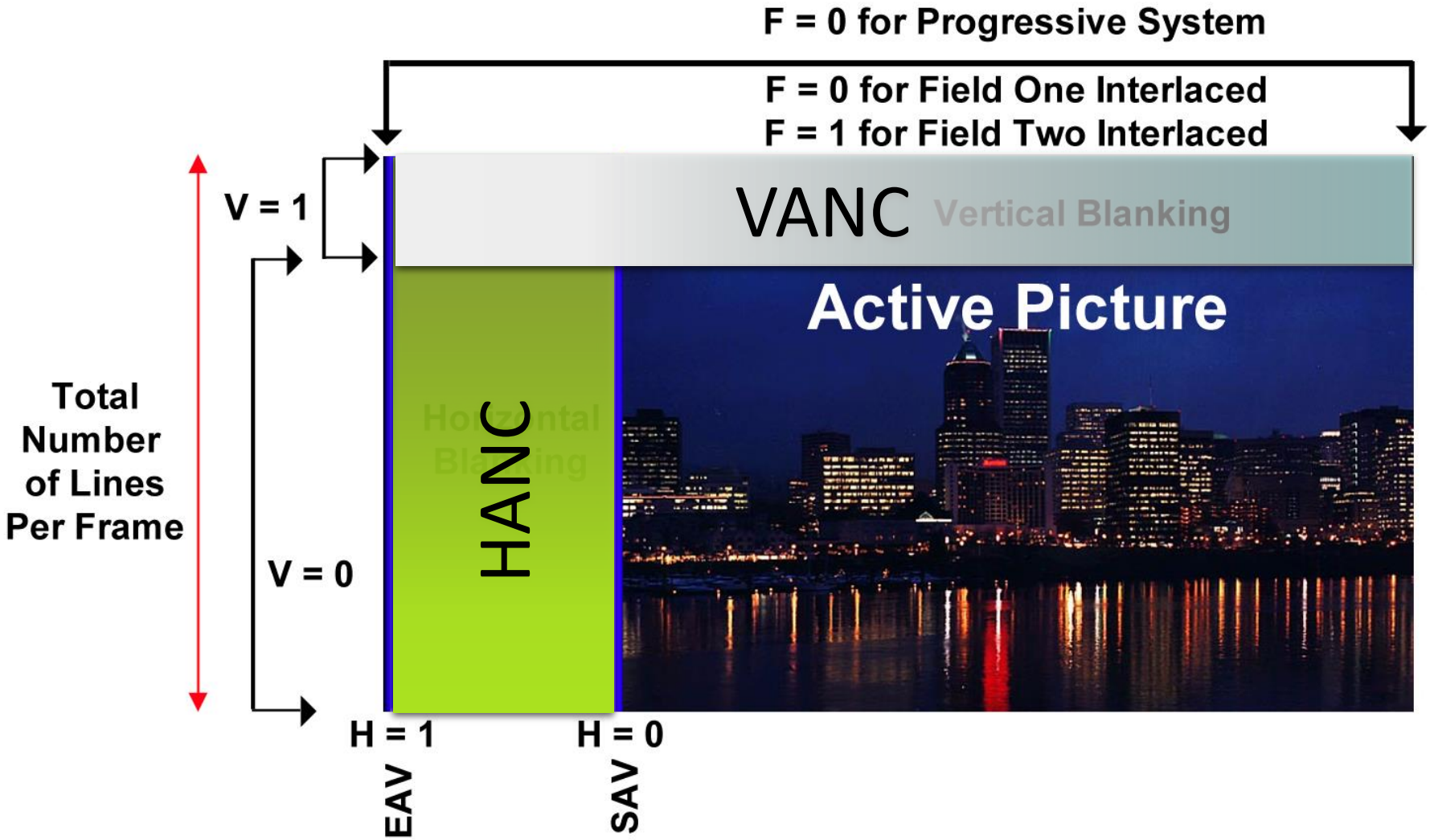
元数据的开始应当不早于场消隐切换点后第二行的起点，而不迟于与其关联的视频信号的场消隐区后一行的结束点.

	杜比 E 帧长度 (AES 帧)	杜比 E 参考定时 (+/- 40us)	行位置 (+/-1 行)	最迟行位置 (+/- 1)
576i50 (PAL)	1826	743us	11	30
1080i50			20	54

杜比 E 建议行位置

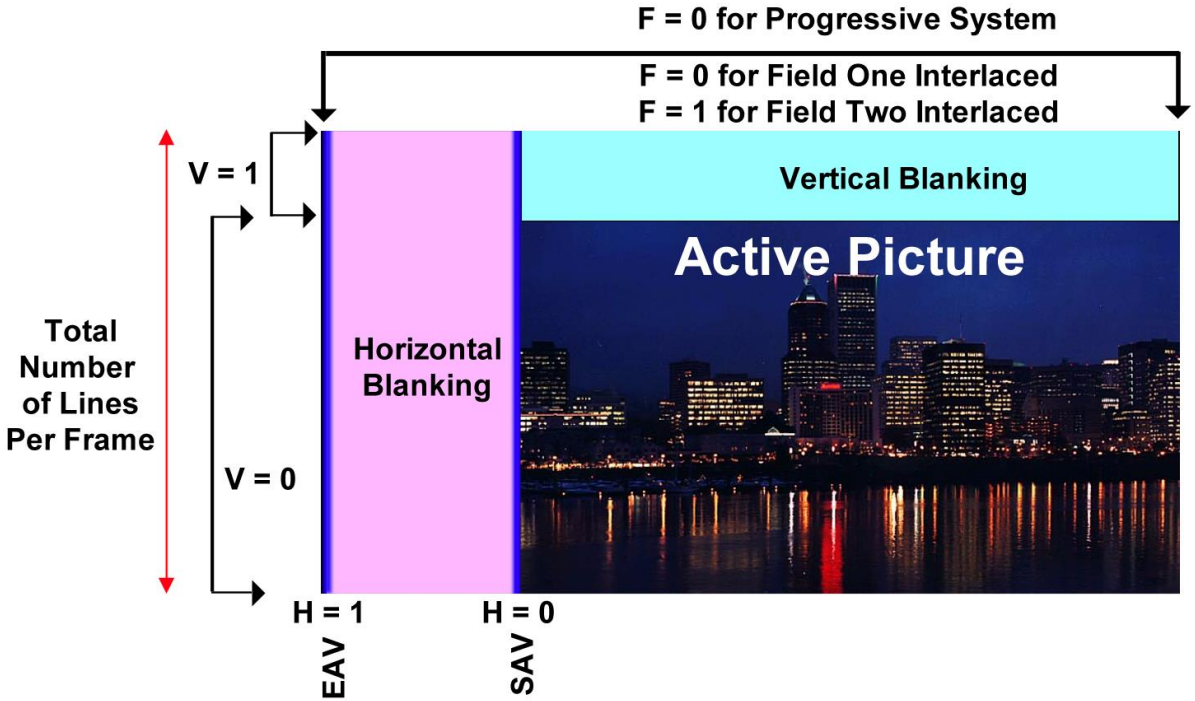
Format	Earliest Valid DE	Ideal DE -80µs	Ideal DE ±80µs	Ideal DE +80µs	Latest Valid DE
625i50	8	11	12	13	30
1080i 50	13	19	21	23	53
720p 50	17	25	28	31	70
µS	450	650	730	810	1860
525i 59.94	12	13	14	16	26
1080i 59.94	18	21	24	26	48
720p 59.94	23	28	32	35	63
µS	510	610	690	770	1400

辅助数据区

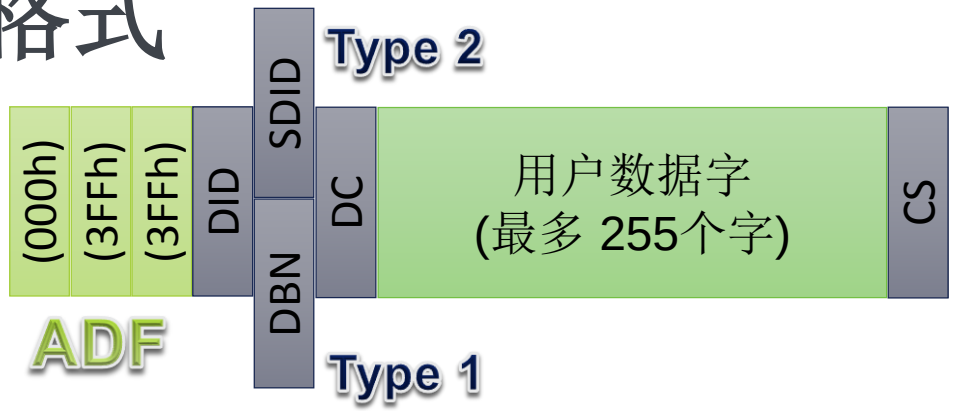

F = 0 for Progressive System
F = 0 for Field One Interlaced
F = 1 for Field Two Interlaced
V = 1
VANC
Vertical Blanking
Active Picture
Total Number of Lines Per Frame
HANC
V = 0
H = 1
EAV
H = 0
SAV

辅助数据

- SMPTE 291M – 附属数据包和空间格式
  - 规定了 ANC 数据包的格式
  - 规定了 ANC 数据的空间位置
- SMPTE RP291 – 指配了附属识别码的格式
  - 为各种 ANC 数据包规定了 DID 和 SDID



附属数据格式



- ADF – 附属数据标志　　000_h,$3FF_h$,$3FF_h$
- DID – 数据识别字,Bit 7=1, Type 1, Bit 7=0, Type 2
- DBN – 数据块序号 – 类型 I
- SDID – 补充数据识别字 – 类型 2
- DC – 数据计数
- 用户数据字，最多可为 255 个字
- CS – 校验和

SMPTE RP 291 Examples

- Defines a variety of standard DID and SDID used in Standards Today

Standard	Description	DID	DBN / SDID	插入位置
SMPTE 299M	HD 组1 音频数据包	E7h (2E7h)	**xxx / 00_h (200_h)**	HANC
SMPTE 272M	HD 组2 音频数据包	E6h (1E6h)	**xxx / 00_h (200_h)**	HANC
SMPTE 272M	HD 组3 音频数据包	E5h (1E5h)	**xxx / 00_h (200_h)**	HANC
SMPTE 272M	HD 组4 音频数据包	E4h (2E4h)	**xxx / 00_h (200_h)**	HANC
S2016-3	**AFD 和 (Bar Data)**	**41h (241h)**	**05h (205h)**	**VANC**
SMPTE 291M	**LTC Timecode**	**$F5_h$ ($2F5_h$)**	**00_h (200_h)**	**VANC**
SMPTE 352M	**Payload Identification**	**41_h (141_h)**	**01_h (101_h)**	**VANC**
RP188 VANC	**Timecode (ATC)**	**60_h (260_h)**	**60_h (260_h)**	**VANC**
RP196 HANC	**Timecode (LTC)**	**64_h(164_h)**	**64_h (164_h)**	**VANC**
RP196 HANC	**Timecode (VITC)**	**64_h (164_h)**	**$7F_h$ ($17F_h$)**	**VANC**
SMPTE 2020	**Dodby Metadata**	**45_h (50_h)**	**01_h -08_h**	**VANC**

辅助数据存放规则

场消隐切换行的行号

格式	525	525p	625	625p	1080i	1080p	720p
行序号	10, 273	10	6, 319	6	7, 569	7	7

格式	525	525p	625	625p	1080i	1080p	720p
SMPTE 272M SD 嵌入音频	HANC C'bY'C'rY* 第 9, 10, 272, 273 行不嵌入	---	HANC C'bY'C'rY' 第 5, 6, 318, 319 行不嵌入	---	---	---	---
SMPTE 299M HD 嵌入音频	---	---	---	---	仅 HANC C'b/C'r 第 7、569 行不嵌入	仅 HANC C'b/C'r 第 7 行不嵌入	仅 HANC C'b/C'r 第 7 行不嵌入
RP 165 EDH	SAV 之前 第 9、272 行	---	SAV 之前 第 5, 318 行	---	---	---	---
SMPTE 352	EAV 之后 第 13, 273 行	EAV 之后 第 13 行	EAV 之后 第 9, 322 行	EAV 后 第 9 行	EAV 之后 第 10、572行	EAV 之后 第 10 行	EAV 之后 第 10 行

附属数据查验器 - CaptureVu

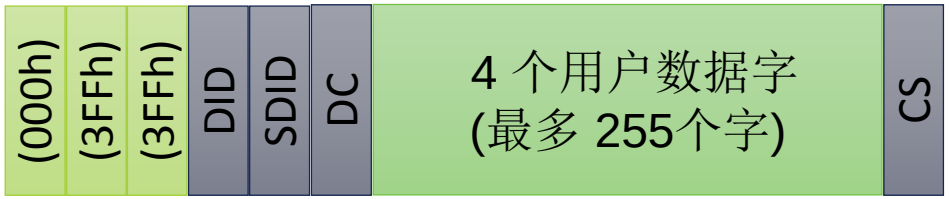
- CaptureVu
  - 能够捕获 1 帧数据
- 能够查看当前所有 ANC 数据中的每一 ANC 数据包

了解 ANC 数据举例

- **SMPTE 352M –** 视频有效负载识别
  - ADF 000_h, $3FF_h$, $3FF_h$
  - DID 241_h (41)
  - SDID 101_h (01)
  - DC
  - 4 个用户数据字
  - 校验和
  - **4** 个用户数据

  字包含如下信息

Type 2



比特位	字节 1	字节 2	字节 3	字节 4
Bit 7	**1**	隔行 **(0)** 或逐行 **(1)** 传输	保留字	保留字
Bit 6	**0**	隔行 **(0)** 或逐行 **(1)** 图像	**行 Y'/Y** 取样 **1920 (0)** 或 **2048 (1)**	保留字
Bit 5	**0**	保留字	保留字	保留字
Bit 4	**0**	保留字	保留字	动态范围 **100% (0h), 200% (1h), 400% (2h),** 保留 **(3h)**
Bit 3	**1**	图像速率 **(**参见 **SMPTE 352M** 表 **2)**	取样结构 **(**参见 **SMPTE 352M** 表 **3** 和 **NOTE 1)**	
Bit 2	**0**			保留字
Bit 1	**0**			比特位深 **8-bit (0h), 10-bit (1h), 12-bit (2h),** 保留 **(3h)**
Bit 0	**1**			

附属数据查验器 – SMPTE 352M

- SMPTE 352M 快速识别码流中的数据包
- 指示 ANC 数据包的行定位
- MAG 显示数据字节

视频屏幕报告解释 – SMPTE 352M

- 89_h
  - 1080- 行视频有效负载（ A级串行数据接口，标称值 2.97 Gb/s ）
- CA_h
  - C_h 逐行传输和逐行图像
  - A_h 60/1.001
- 00_h
  - 0_h 1920
  - 0_h 4:2:2 [默认] (Y/Cb/Cr)
- 01_h
  - 动态范围 100% (0h)
  - 比特位深 10-bit (1h)

AFD what is it

- AFD - Active Format Description – (not Active Format Descriptor) has been standardized by SMPTE, ATSC and CEA as a method of describing aspect ratio and picture characteristics of video signals.
- It is to be used by broadcasters to dynamically control how down-conversion equipment formats widescreen 16:9 pictures for 4:3 displays.
  - In-house Down convert from HD to SD
  - Set-Top-Box down convert and Display of HD as SD
- National Association of Broadcasters ***AFD*** Ready Initiative
  - www.nab.org/AFDReady

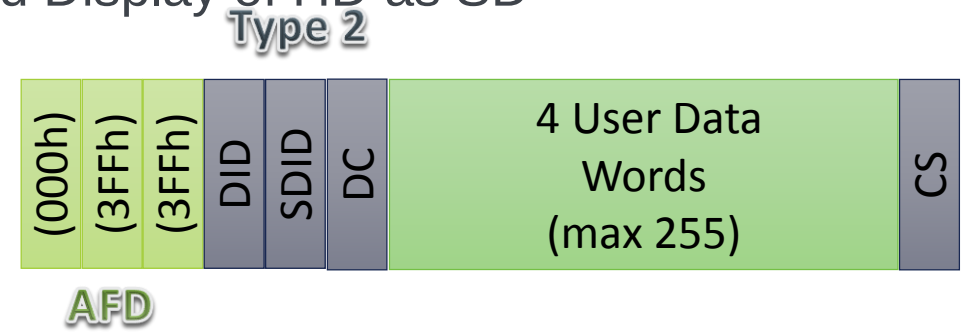
Standards Documents

- SMPTE 2016 – 1 Format for Active Format Description and Bar Data
- SMPTE 2016 – 2 Format for Pan-Scan Information
- SMPTE 2016 – 3 Vertical Ancillary Data Mapping of Active Format Description and Bar Data
- SMPTE 2016 – 4 Vertical Ancillary Data Mapping of Pan-Scan Information
- ATSC A/53 – AFD Carriage in MPEG2
- CEA-CEB16 – Digital Receiver Guidelines

Understanding ANC Data Example

- It is to be used by Broadcasters, CATV, and Satellite providers to dynamically control how down-conversion equipment formats widescreen 16:9 pictures for 4:3 displays.
  - In-house Down convert from HD to SD
  - Set-Top-Box down convert and Display of HD as SD

- **SMPTE 2016-3 – AFD**
  - ADF 000_h, $3FF_h$, $3FF_h$
  - DID 241_h (41)
  - SDID 205_h (05)
  - DC 108_h (08)
  - User Data 8 Words
  - Checksum



Understanding ANC Data Example

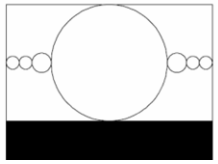
- **SMPTE 2016-3 – AFD**
- **8 Data Words carry following information**
  - b6-b3 AFD code data bits: a3, a2, a1, a0
  - b2 Aspect ratio (AR) of the coded frame: '1' = 16:9, '0' = 4:3

UDW	Function	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
1	AFD	$\overline{B8}$	P	0	a3	a2	a1	a0	AR	0	0
2	Reserved	$\overline{B8}$	P	0	0	0	0	0	0	0	0
3	Reserved	$\overline{B8}$	P	0	0	0	0	0	0	0	0
4	Bar Data Flags	$\overline{B8}$	P	Top	Bot	Left	Right	0	0	0	0
5	Bar Data Value 1	$\overline{B8}$	P	f15	f14	f13	f12	f11	f10	f9	f8
6	Bar Data Value 1	$\overline{B8}$	P	f7	f6	f5	f4	f3	f2	f1	f1
7	Bar Data Value 2	$\overline{B8}$	P	s15	s14	s13	s12	s11	s10	s9	S8
8	Bar Data Value 2	$\overline{B8}$	p	s7	s6	s5	s4	s3	s2	s1	s0

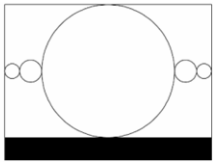
AFD a 4:3 coded frame

4:3 coded frame

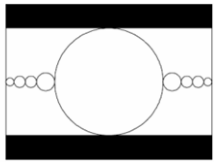
AFD = ‘0010’
Box 16:9 (top)



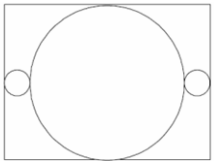
AFD = ‘0011’
Box 14:9 (top)



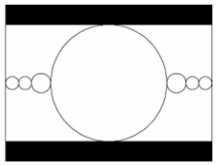
AFD = ‘0100’
Box >16:9 (center)



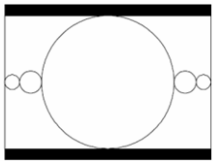
AFD = ‘1000’
Full frame



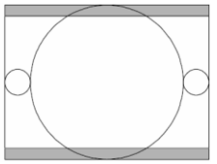
AFD = ‘1010’
16:9 (center)



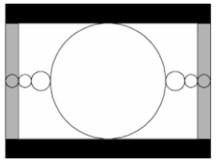
AFD = ‘1011’
14:9 (center)



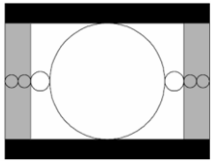
AFD = ‘1101’
4:3 (with alternative
14:9 center)



AFD = ‘1110’
16:9 (with alternative
14:9 center)

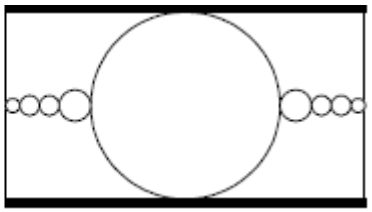


AFD = ‘1111’
16:9 (with alternative
4:3 center)

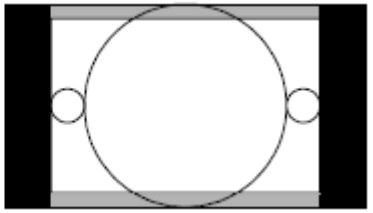


AFD a 16:9 coded frame

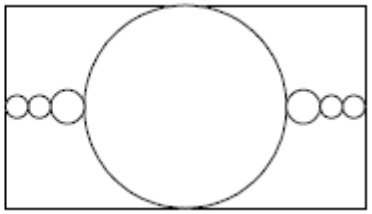
AFD = '0100'
Box >16:9 (center)



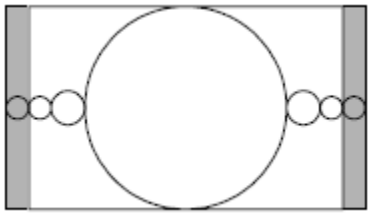
AFD = '1101'
4:3 (with alternative
14:9 center)



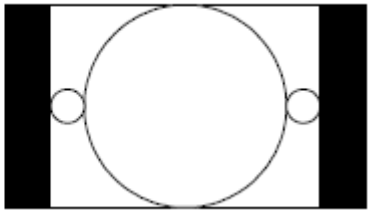
AFD = '1000'
Full frame



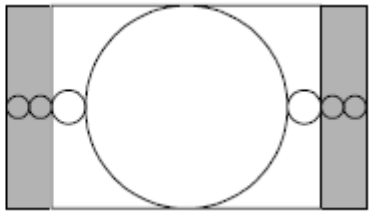
AFD = '1110'
16:9 (with alternative
14:9 center)



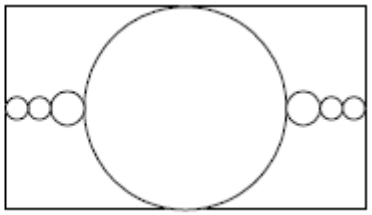
AFD = '1001'
4:3 (center)



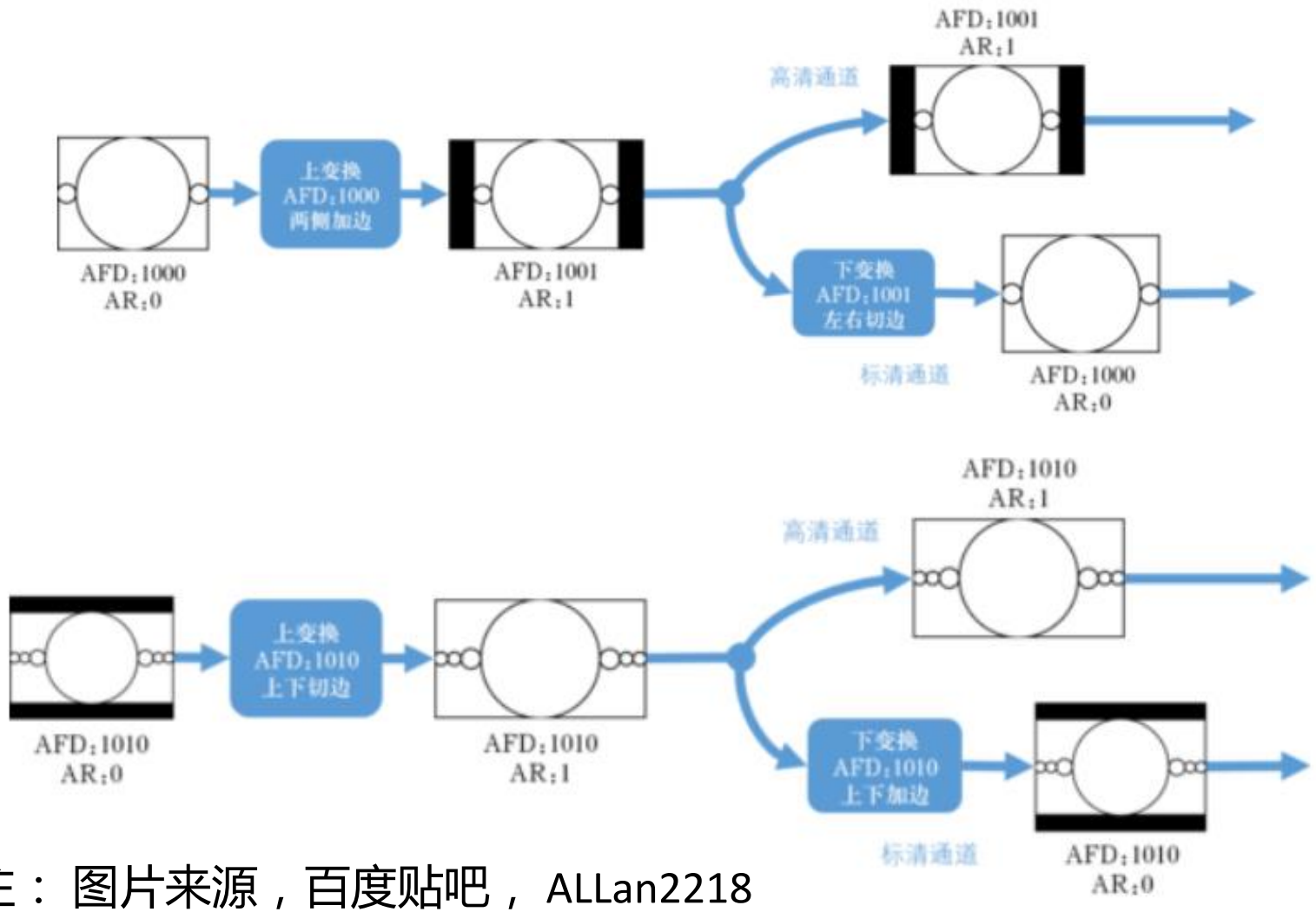
AFD = '1111'
16:9 (with alternative
4:3 center)



AFD = '1010'
16:9 (with complete
16:9 image protected)

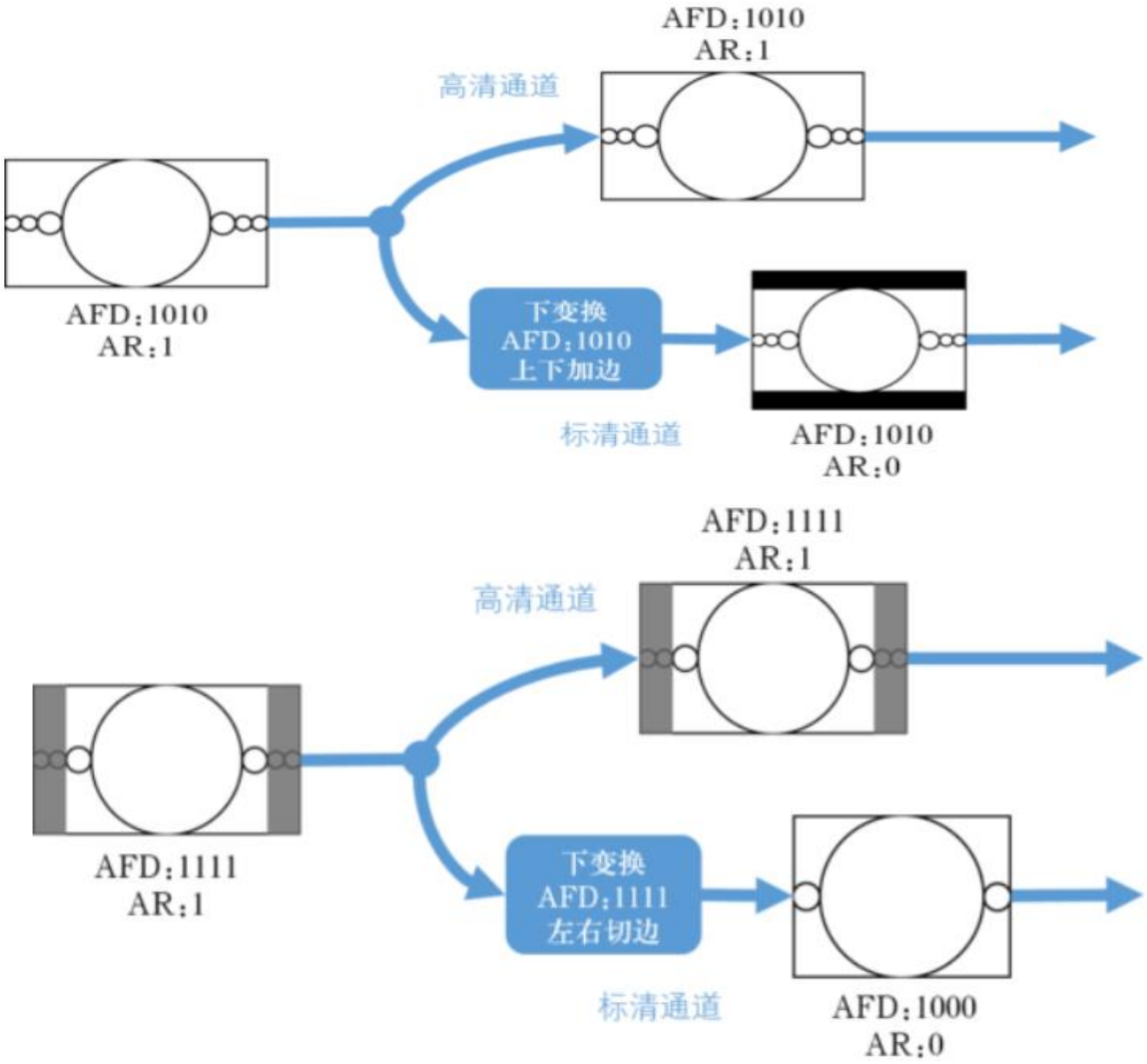


标清上变换高清



注： 图片来源，百度贴吧， ALLan2218
输出分离式高标清同播系统的幅型变换过程探讨

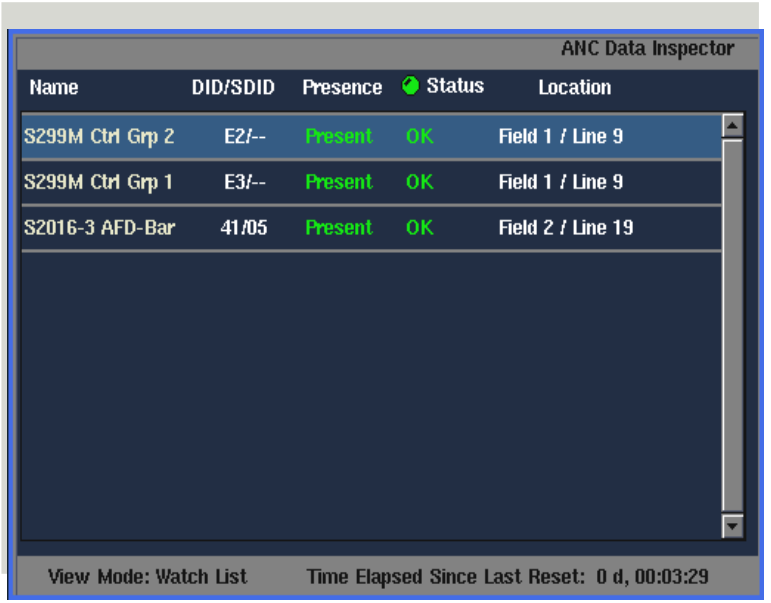
高清下变换标清



注： 图片来源同前一页PPT

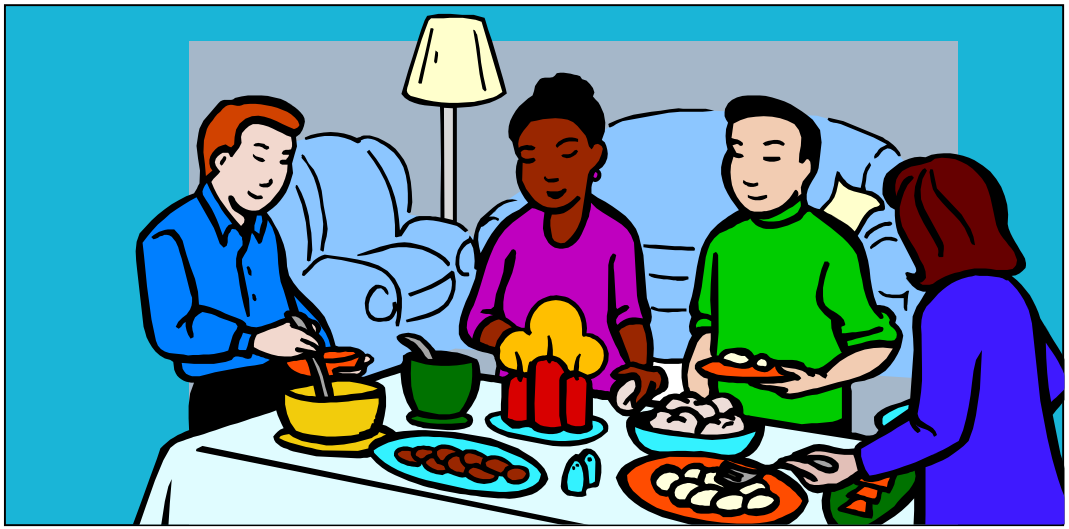
When things go wrong

- One of the Biggest things that goes wrong is multiple AFD codes being sent on different lines.
  - Content is received with AFD on it on line 9 (Center Cut) and you place AFD on it on line 11 (Letter Box). Now what's a Decoder going to do?
  - We can see what line or lines the ADF data is on.

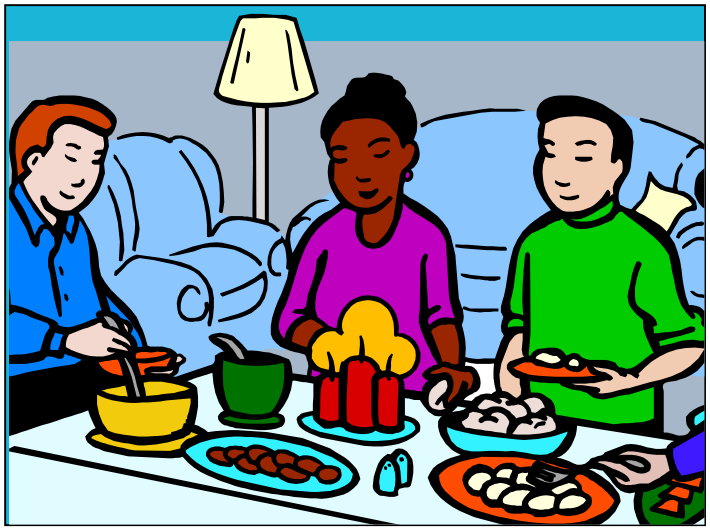


Center Cut on 16 x 9 material

- This shot should have been Letter Boxed not center cut
  - The person on the right is missing, they would be talking to someone off camera



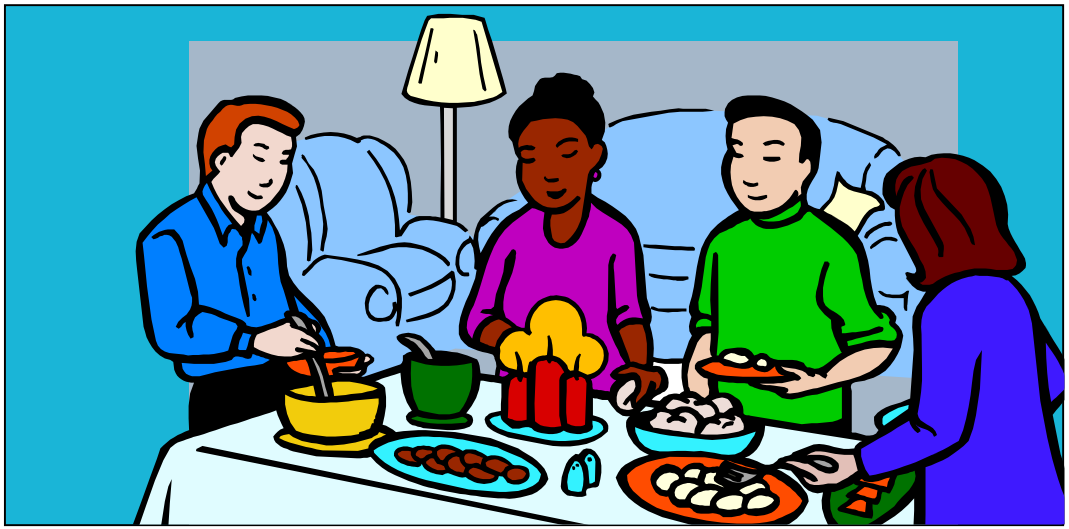
16 x 9 original HD



4 x 3 Center cut SD

Letter Boxed on 16 x 9 material

- This shot correctly Letter Boxed not center cut
  - The person on the right is not missing now



16 x 9 original HD

16 x 9 Letter Boxed SD

Center Cut on 4 x 3 material

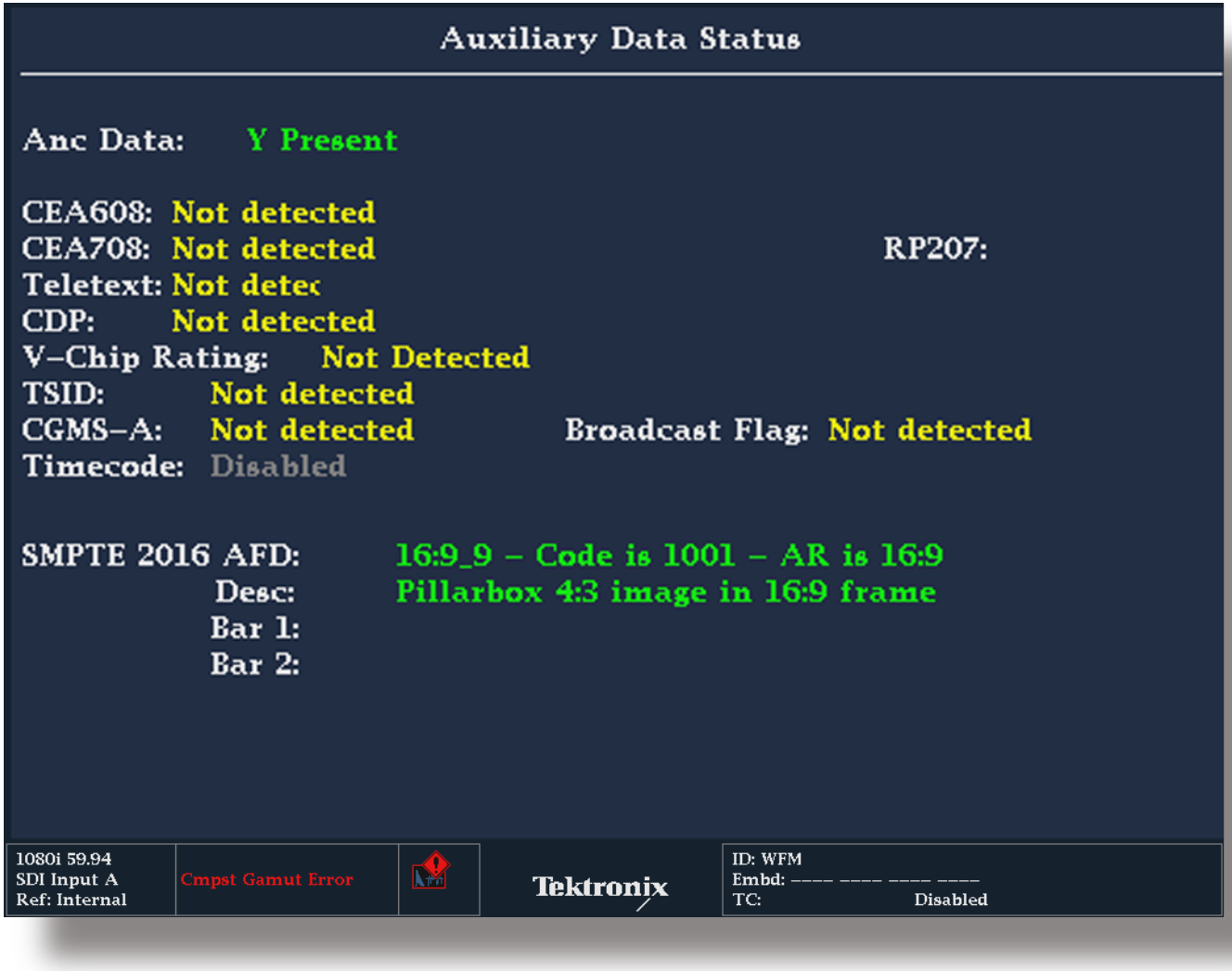
- This shot incorrectly Letter Boxed not center cut
  - The picture has black on all sides in the 4 x 3 Down convert

16 x 9 original HD
Pillar boxed
Produced in 4 x 3

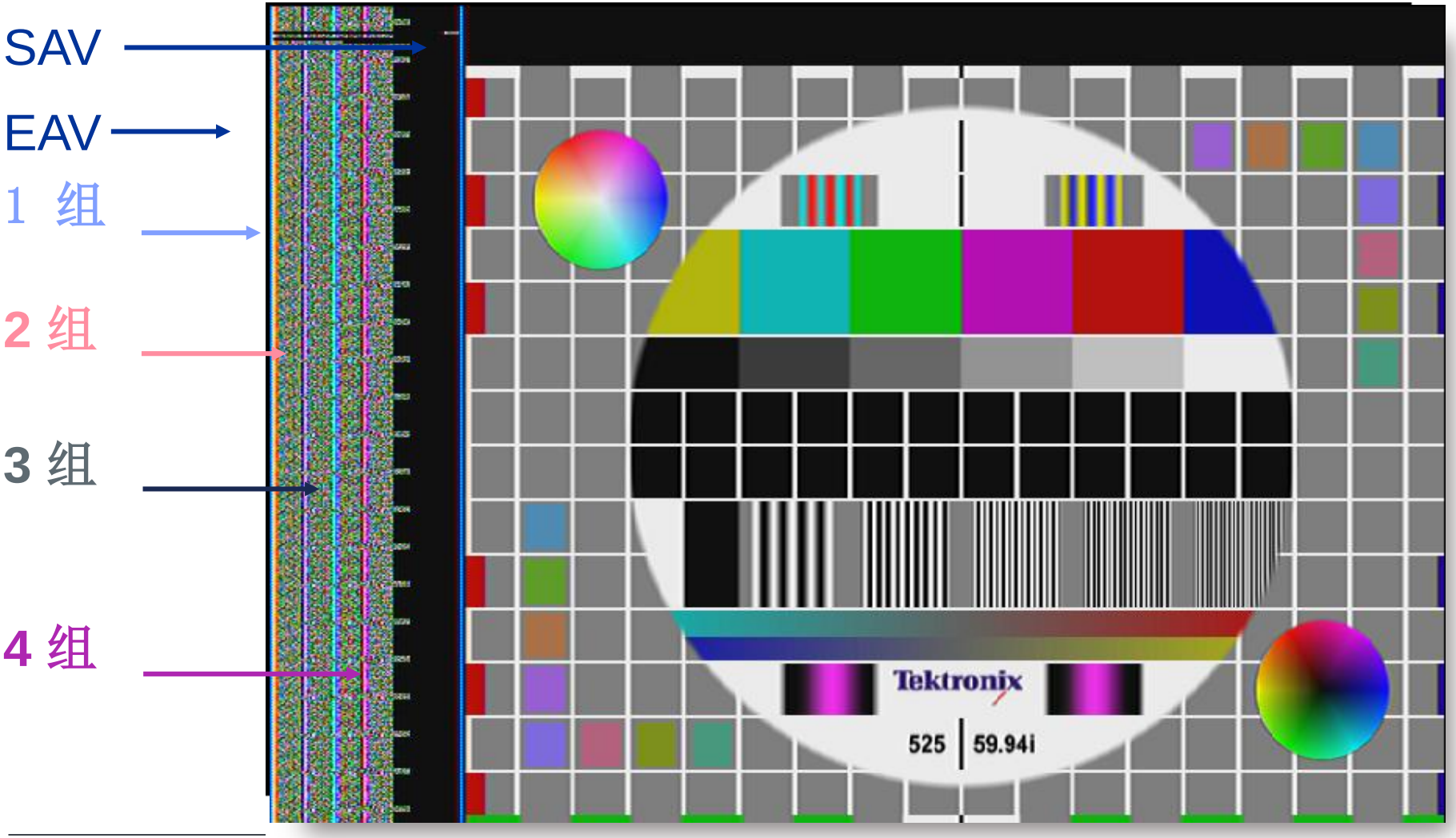
16 x 9 Letter Boxed SD

Waveform Monitor

Status Display



嵌入音频缓存（ SD）

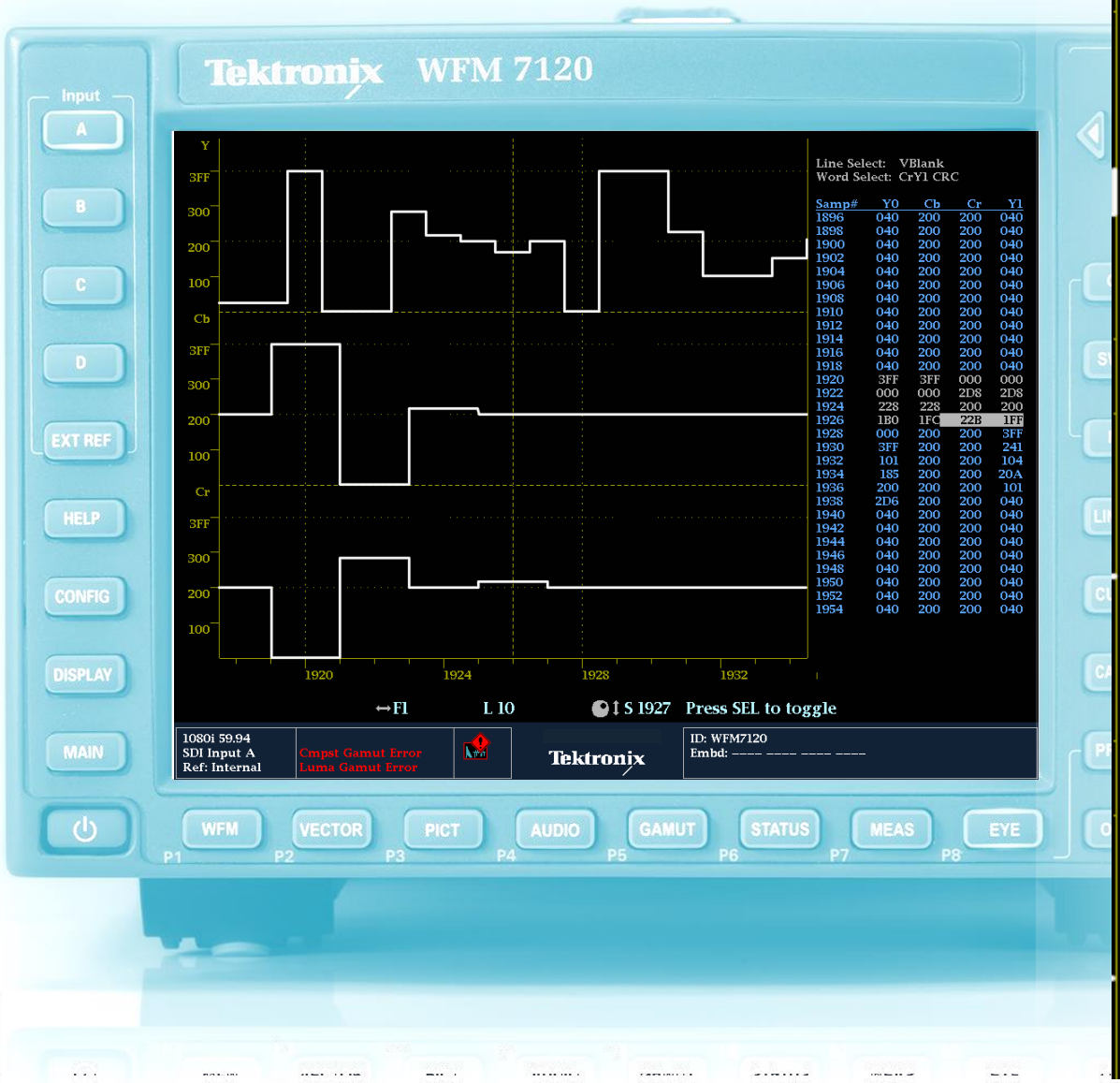


标清辅助数据的分析

Ancillary Data Analyzer — 270Mb 525-line (Auto detect) — F1 L200

F	Ln	Smpl	Type	Data	Interpretation
1	200	1440	EAV	3ff 000 000 274	<F1 L200><F=0,V=0,H=1>
1	200	1444	AES3	000 3ff 3ff 1fb 200 224	DID=1fb,DBN=200,DC=024
1	200	1450	DATA	180 1e0 211 10a 101 202	01 8f830 0000 | 02 14061 0000
1	200	1456	DATA	204 200 100 206 200 200	03 00000 0001 | 04 00000 0000
1	200	1462	DATA	260 1ae 211 2c2 178 203	01 8eb8c 0000 | 02 1de18 0000
1	200	1468	DATA	204 200 100 206 200 200	03 00000 0001 | 04 00000 0000
1	200	1474	DATA	1c8 17c 211 2f2 1e3 204	01 8df39 0000 | 02 278de 0000
1	200	1480	DATA	204 200 100 206 200 200	03 00000 0001 | 04 00000 0000
1	200	1486	CHKSUM	145	z# audio vucp z# audio vucp
1	200	1487	EMPTY	----------	
1	200	1712	SAV	3ff 000 000 200	<F1 L200><F=0,V=0,H=0>
1	200	0	VIDEO	----------	
1	201	1440	EAV	3ff 000 000 274	<F1 L201><F=0,V=0,H=1>
1	201	1444	AES3	000 3ff 3ff 1fb 200 224	DID=1fb,DBN=200,DC=024
1	201	1450	DATA	1a8 14c 211 1e2 23e 206	01 8d335 0000 | 02 30fbc 0000
1	201	1456	DATA	204 200 100 206 200 200	03 00000 0001 | 04 00000 0000
1	201	1462	DATA	210 11e 211 22a 287 207	01 8c782 0000 | 02 3a1c5 0000
1	201	1468	DATA	204 200 100 206 200 200	03 00000 0001 | 04 00000 0000
1	201	1474	DATA	100 2f0 111 29a 2b8 108	01 8bc20 0001 | 02 42e13 0001
1	201	1480	DATA	204 200 100 206 200 200	03 00000 0001 | 04 00000 0000
1	201	1486	CHKSUM	1ba	z# audio vucp z# audio vucp
1	201	1487	EMPTY	----------	

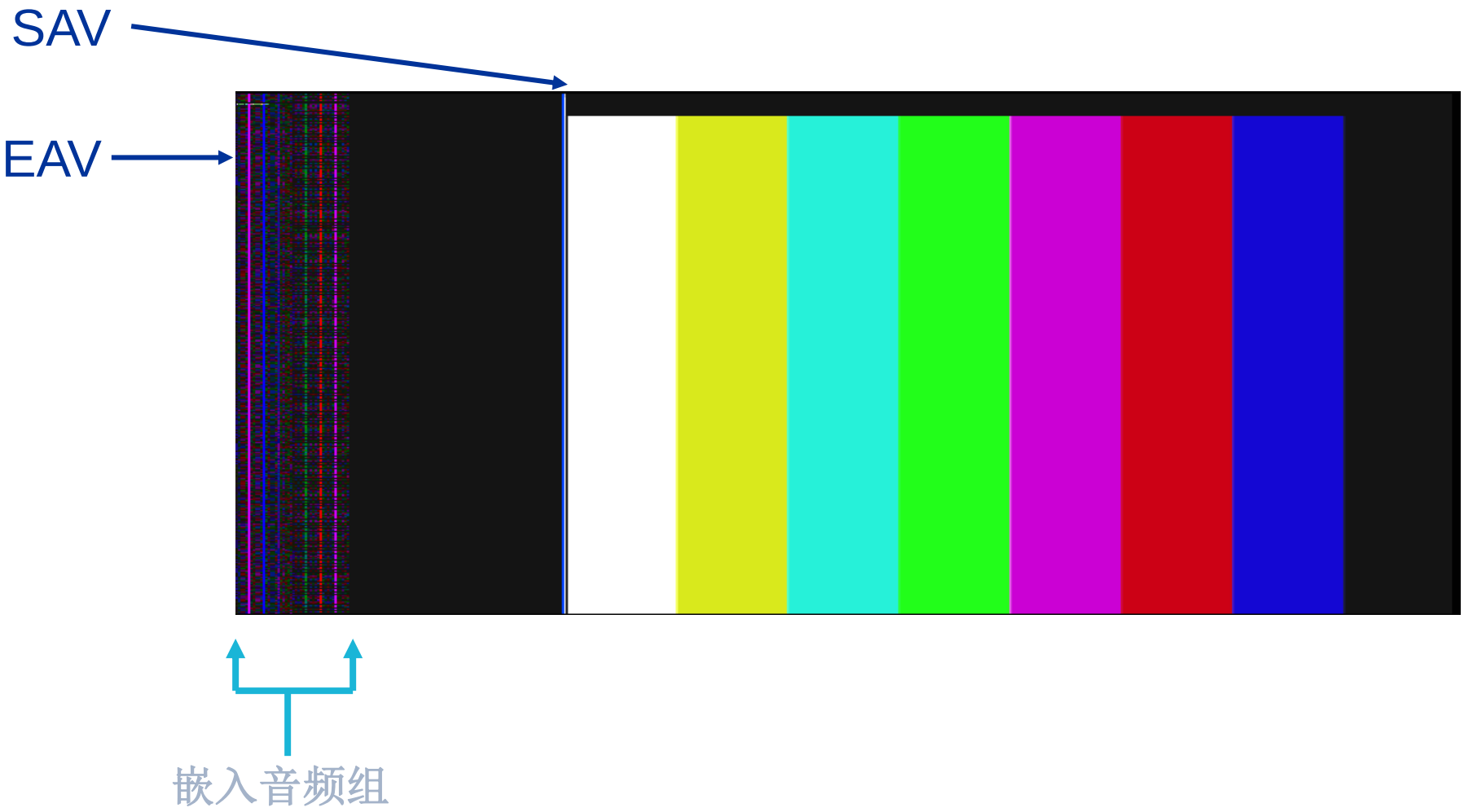
HD附属数据格式 – 数据表显示



Line Select: VBlank
Word Select: CrY1 CRC

Samp#	Y0	Cb	Cr	Y1
1896	040	200	200	040
1898	040	200	200	040
1900	040	200	200	040
1902	040	200	200	040
1904	040	200	200	040
1906	040	200	200	040
1908	040	200	200	040
1910	040	200	200	040
1912	040	200	200	040
1914	040	200	200	040
1916	040	200	200	040
1918	040	200	200	040
1920	3FF	3FF	000	000
1922	000	000	2D8	2D8
1924	228	228	200	200
1926	1B0	1FC	22B	1FF
1928	000	200	200	3FF
1930	3FF	200	200	241
1932	101	200	200	104
1934	185	200	200	20A
1936	200	200	200	101
1938	2D6	200	200	040
1940	040	200	200	040
1942	040	200	200	040
1944	040	200	200	040
1946	040	200	200	040
1948	040	200	200	040
1950	040	200	200	040
1952	040	200	200	040
1954	040	200	200	040

嵌入音频（HD）




Y
3FF
300
200
100
Cb
Line Select: VBlank
Word Select: Cr HBlank
Samp# Cb Y0 Cr Y1
1440 3FF 000 000 2D8
1444 200 040 200 040
1448 200 040 200 040
1452 200 040 200 040
1456 200 040 200 040
1460 200 040 200 040
1464 200 040 200 040
1468 200 040 200 040
1472 200 040 200 040
1476 200 040 200 040
1480 200 040 200 040
1484 200 040 200 000
1488 3FF 3FF 1FD 200
1492 224 200 200 200
1496 202 200 100 204
1500 200 100 206 200
1504 200 200 200 200
1508 202 200 100 204
1512 200 100 206 200
1516 200 200 200 200
1520 202 200 100 204
1524 200 100 206 200
1528 200 245 200 040
1532 200 040 200 040
1536 200 040 200 040
1540 200 040 200 040
1544 200 040 200 040
1548 200 040 200 040
1552 200 040 200 040
1512
Press SEL to toggle
ID: WFM7100_Q0154
Audio Input: Not Selected
CF019
625i 50
SDI Input A
Ref: Internal
EDH Alarm
RGB Gamut Error
Apr 02 18:21:20
Tektronix
ID: WFM7100_Q0154
Audio Input: Not Selected

附属数据查验器

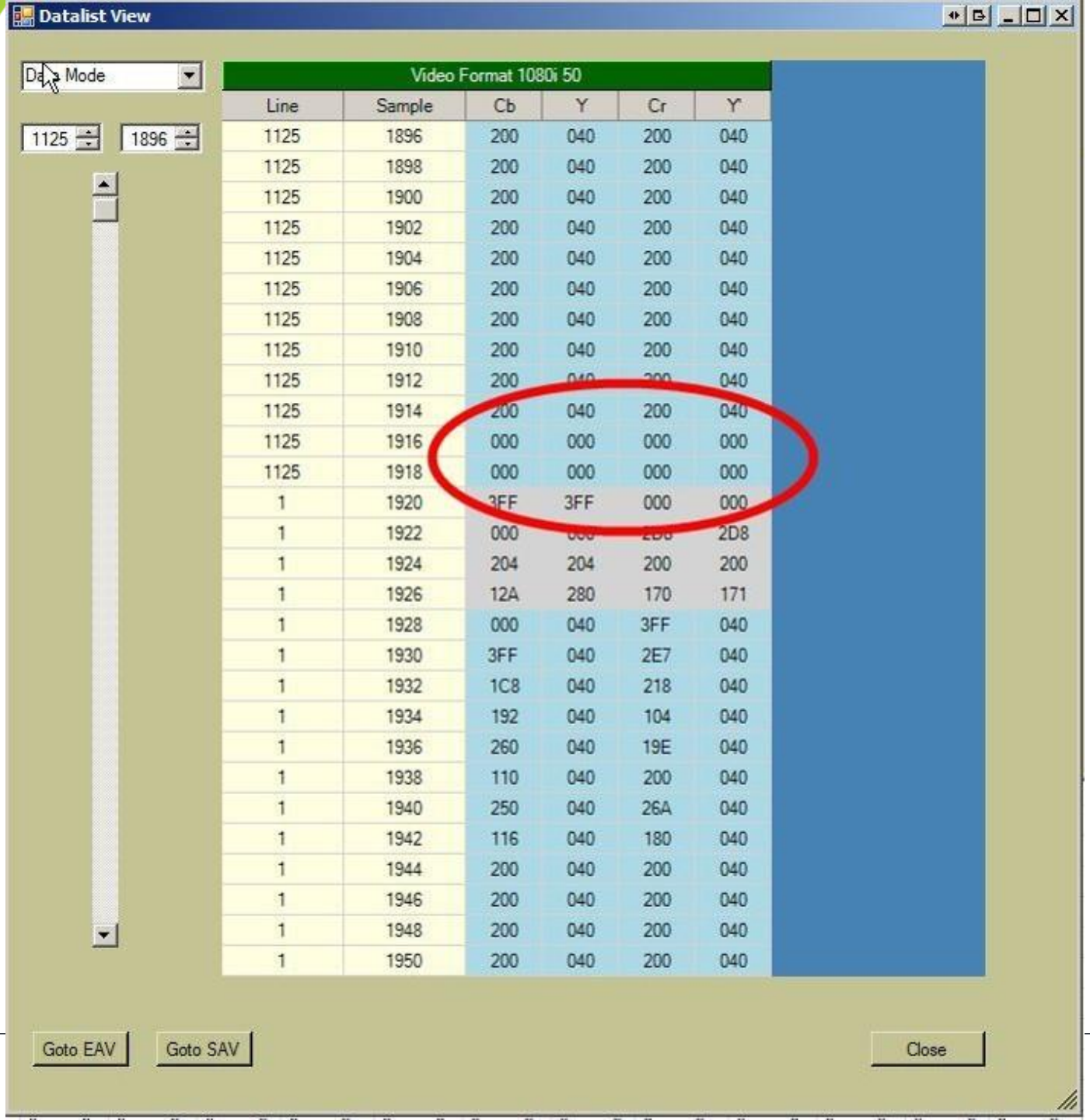
别当前信号中所
NC 数据

验

按钮

NC 数据包信息

TE RP291 标准支
NC 数据类型


Datalist View
Da Mode
1125
1896
Video Format 1080i 50
Line Sample Cb Y Cr Y'
1125 1896 200 040 200 040
1125 1898 200 040 200 040
1125 1900 200 040 200 040
1125 1902 200 040 200 040
1125 1904 200 040 200 040
1125 1906 200 040 200 040
1125 1908 200 040 200 040
1125 1910 200 040 200 040
1125 1912 200 040 200 040
1125 1914 200 040 200 040
1125 1916 000 000 000 000
1125 1918 000 000 000 000
1 1920 3FF 3FF 000 000
1 1922 000 2D8
1 1924 204 204 200 200
1 1926 12A 280 170 171
1 1928 000 040 3FF 040
1 1930 3FF 040 2E7 040
1 1932 1C8 040 218 040
1 1934 192 040 104 040
1 1936 260 040 19E 040
1 1938 110 040 200 040
1 1940 250 040 26A 040
1 1942 116 040 180 040
1 1944 200 040 200 040
1 1946 200 040 200 040
1 1948 200 040 200 040
1 1950 200 040 200 040
Goto EAV
Goto SAV
Close

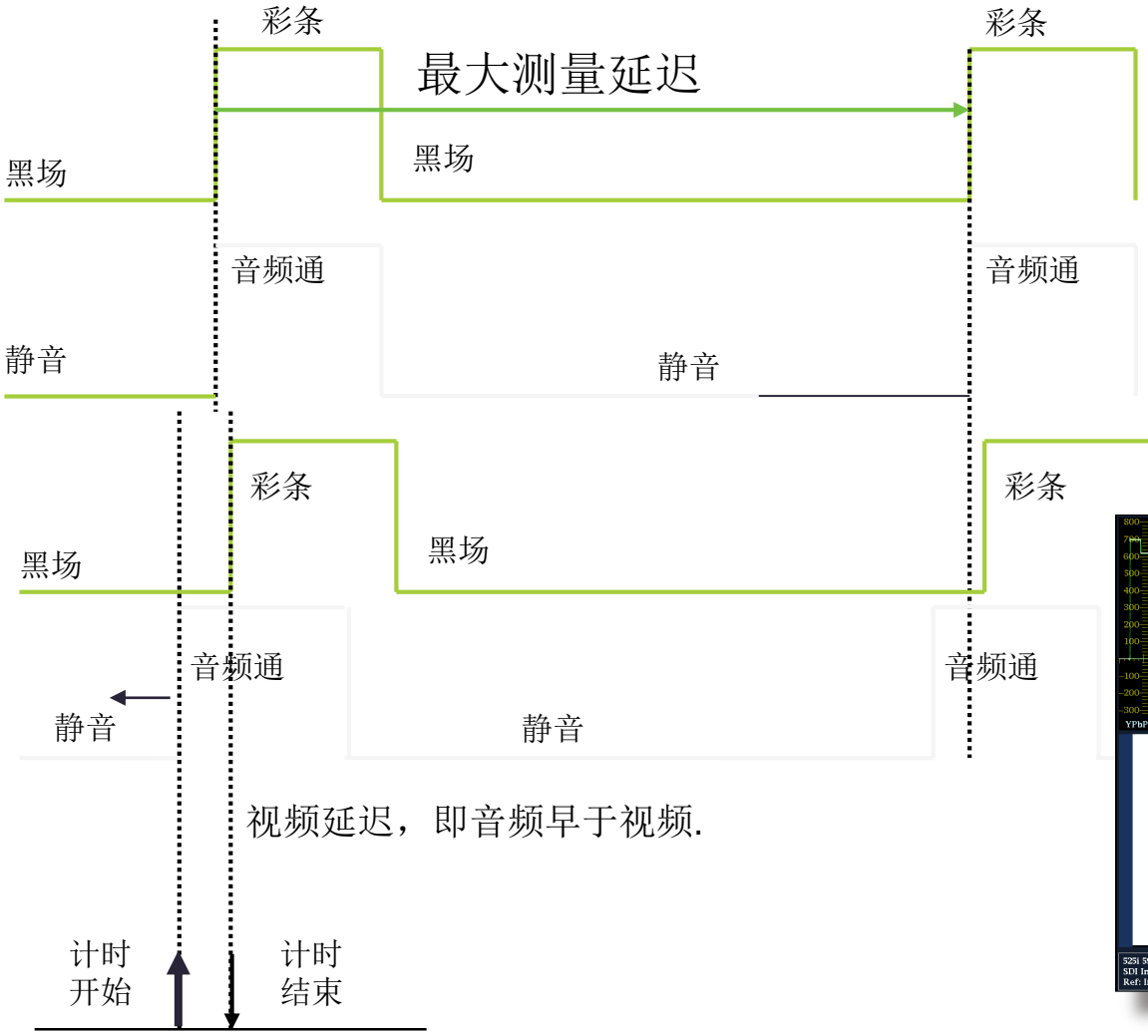
音视频延迟测量

Tektronix®

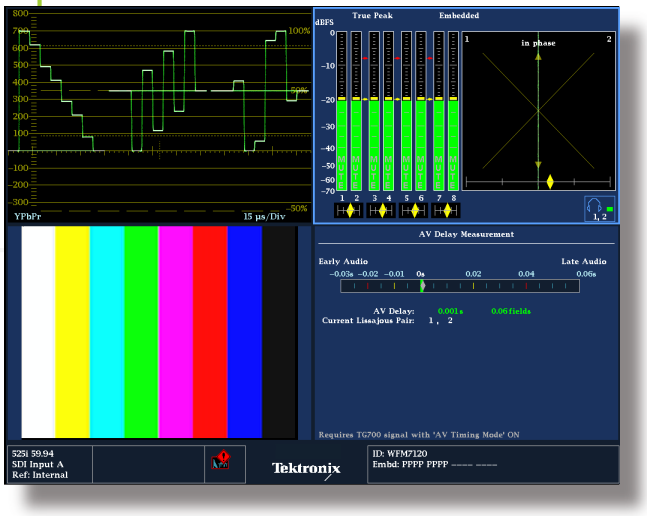
泰克公司 A/V 延迟测量

- 离线测试
- 使用来自TG700同步发生器的音频和视频测试信号
  - HDVG7 或 DVG7 模块
- Flash-pop 序列
- 支持模拟和数字音频
- 波形监视器
  - A/V 延迟测量
- 音视频相对延时
  - 音频相对于视频的延时应为＋20ms～-60ms（以视频为基准，音频超前为正，音频滞后为负）

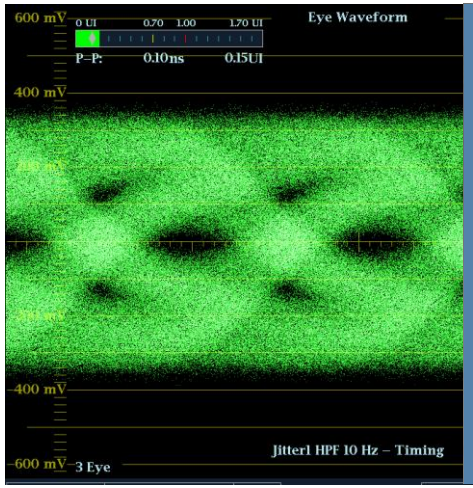
怎样测量音频/视频延迟



测试信号：当嵌入音频由静音转为有音频信号(-20dbfs) 时，视频信号也同时由黑场转为有效视频（彩条）



4K系统原理和测量



Tektronix®

Image Size Matters

Image Size Matters, How Many Pixels?

4 x HD (2048 or 1920x1080)

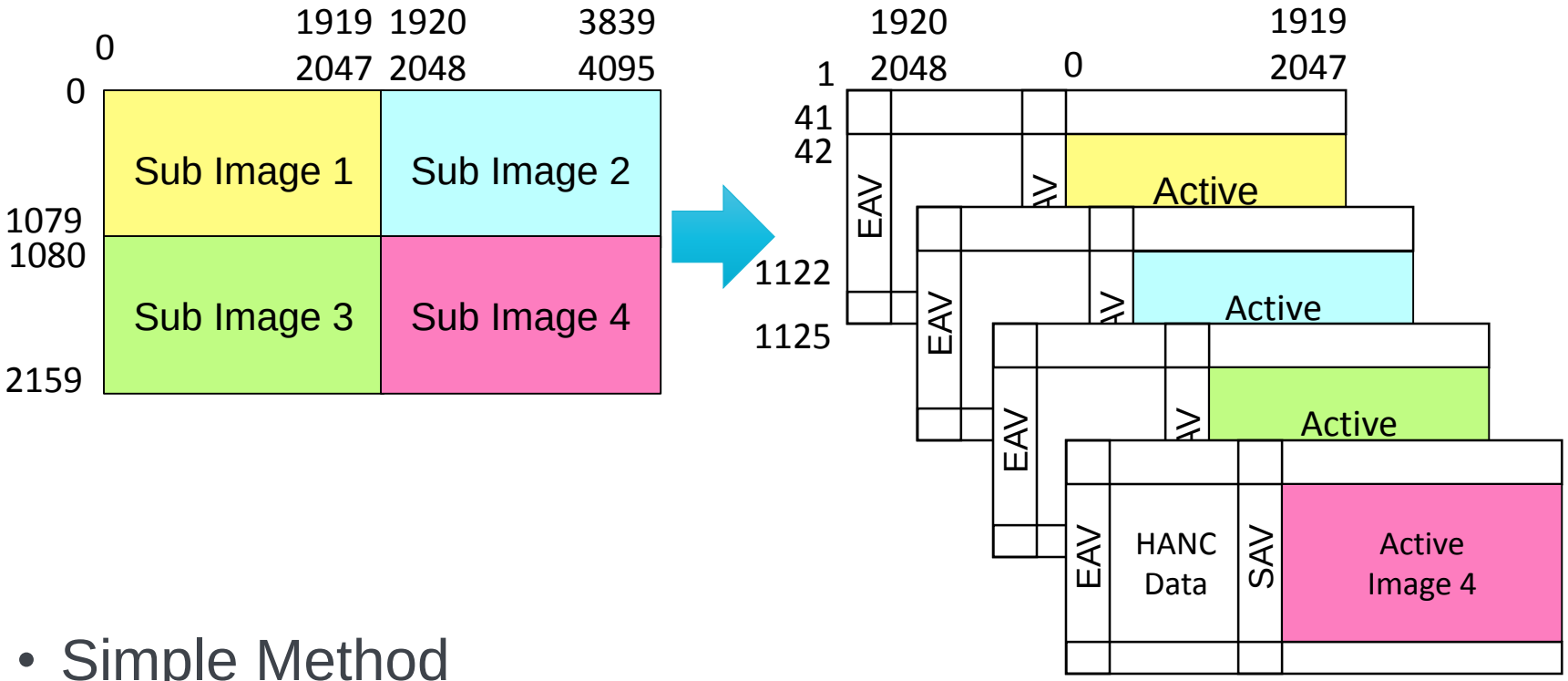
4K Standards

- 425-3 Image Format and Ancillary Data Mapping for the Dual Link 3 Gb/s Serial Interface
- 425-5 Image Format and Ancillary Data Mapping for the Quad Link 3 Gb/s Serial Interface
- 2036-1 Ultra High Definition Television — Image Parameter Values for Program Production
- 2048 2048x1080 and 4096x2160 Digital Cinematography Production Image Formats FS/709
- 2048-3 4096 × 2160 Digital Cinematography Production Image Formats FS/709 — Mapping into Multi-link 10 Gb/s Serial Signal/Data Interface
- 12Gb/s & 6Gb/s SMPTE Standards 2082/2081 in progress.

SMPTE Standards

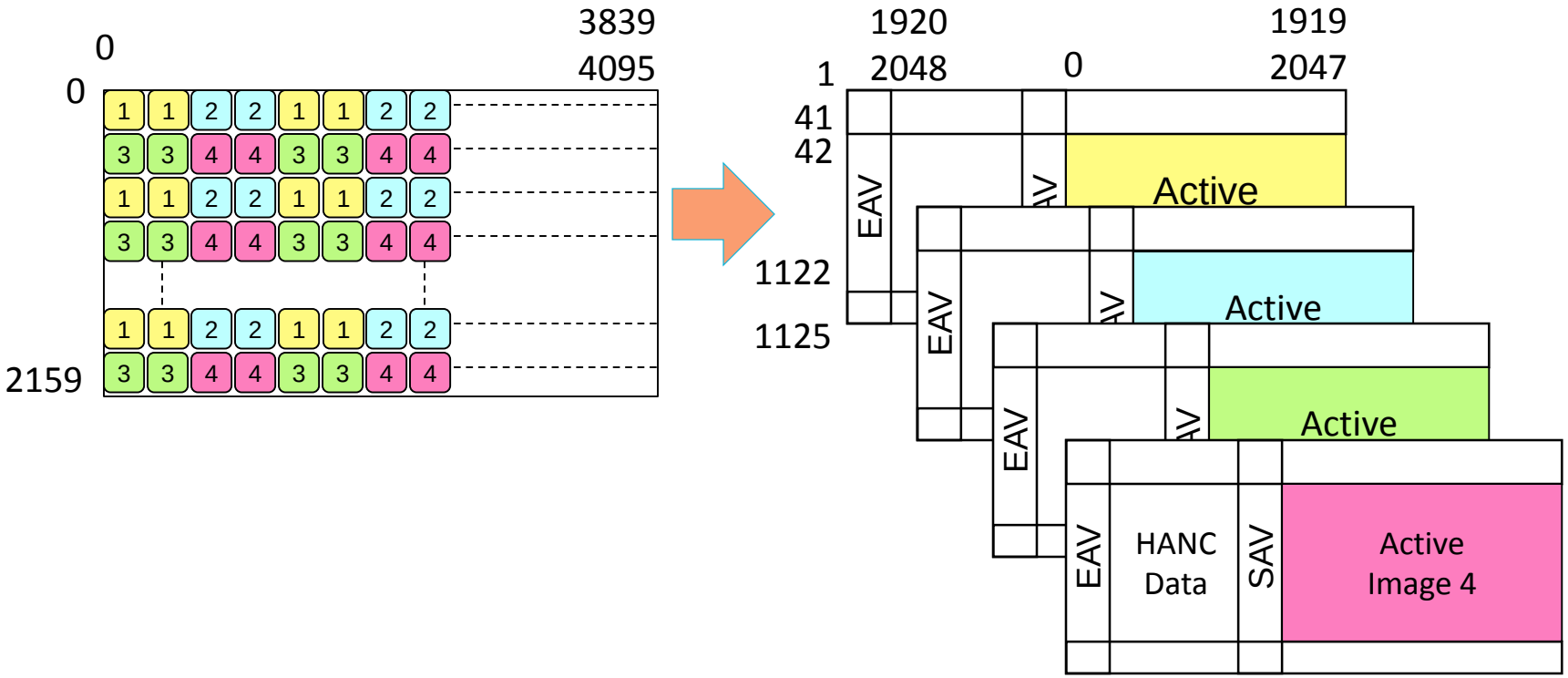
- SMPTE 425-5 Image Format and Ancillary Data Mapping for the Quad Link 3Gb/s Serial Interface
- Combines four 3G-SDI signals in Quad Link 3Gb/s
  - Link 1, Link 2, Link 3, Link 4
- Image Format 2160 Line
  - Uncompressed 10-bit or 12-bit
- Supports of 3840x2160 or 4096x2160
- Tile and Sample Interleaved modes
- Support of 352 Video Payload ID

Four Sub Images



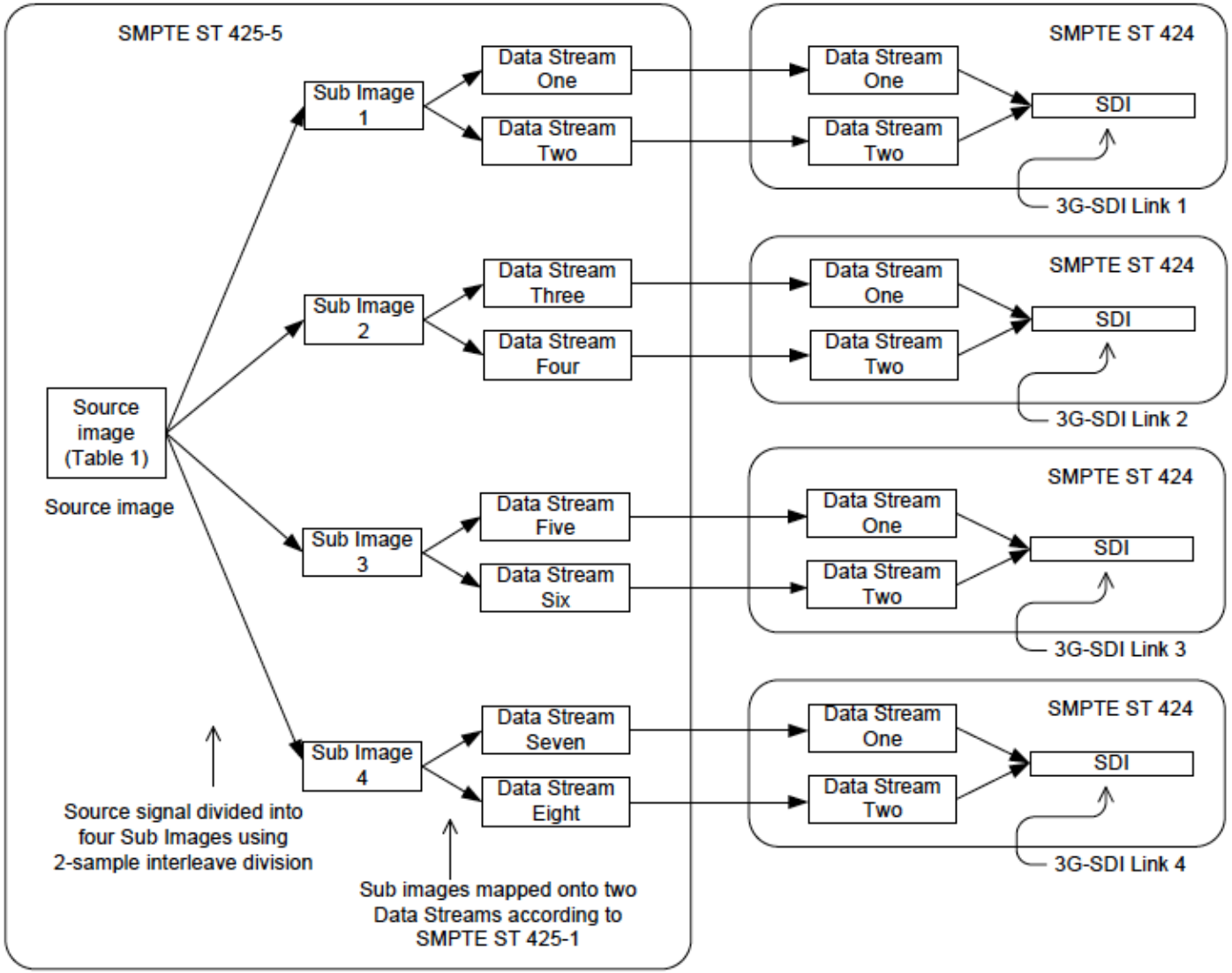
- Simple Method
- Need to ensure correct timing for alignment of Image.
- Requires large memory to store images.
- Used within post production and camera application.

Sample Interleaved



- More complex multiplex of data
- Simpler memory configuration and less processing delay
- Used for transmission and encoding

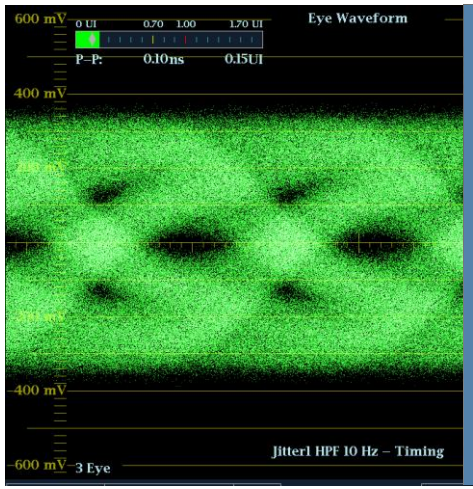
Mapping Overview of 2160 Source



SMPTE 2081 & 2082

- SMPTE 2081-1 6Gb/s Signal/Data Serial interface – Electrical
  - 594MHz or 594/1.001MHz
- SMPTE 2081-2 6Gb/s Signal/Data Serial interface – Optical
- SMPTE 2082-1 12Gb/s Signal/Data Serial interface – Electrical
  - 1188MHz or 1188/1.001MHz
- SMPTE 2082-2 12Gb/s Signal/Data Serial interface – Optical

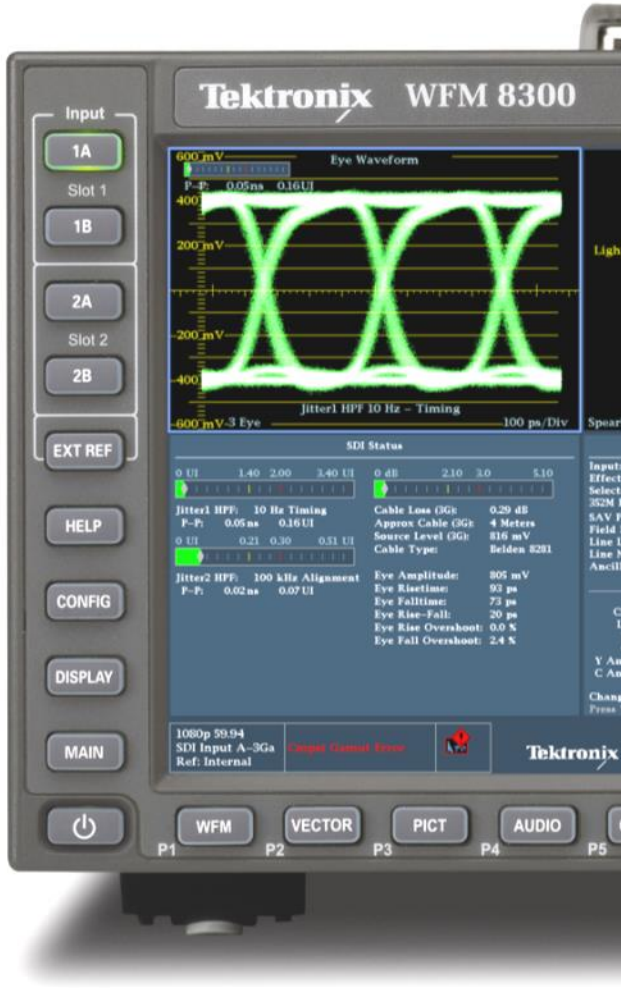
WFM/WVR8000 Series



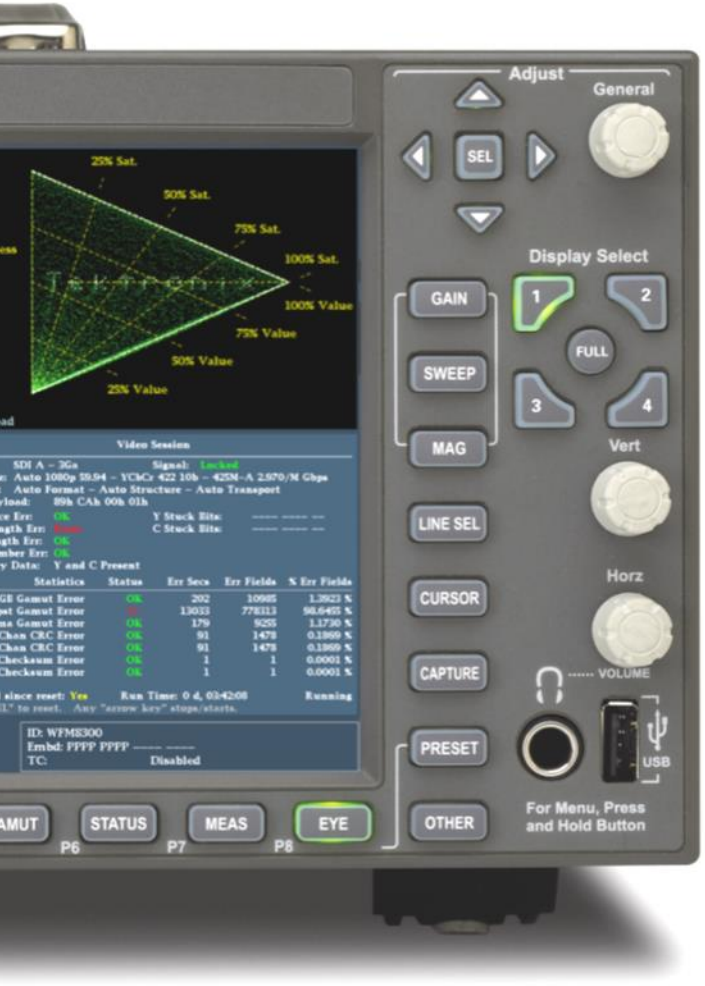
Tektronix®

8000 Series 4K Support

- 4K Option requires 3G and 2SDI option
- Allows customer to upgrade their current 8000 series product to 4K
- Combines 4 SDI inputs
  - Four HD-SDI
  - Four 3Gb/s Level A & B
- Combines Picture & Traces
- New Video Session display
- New Timing Display
- ANC Data monitored from Link 1 & 2
  - Embedded Audio

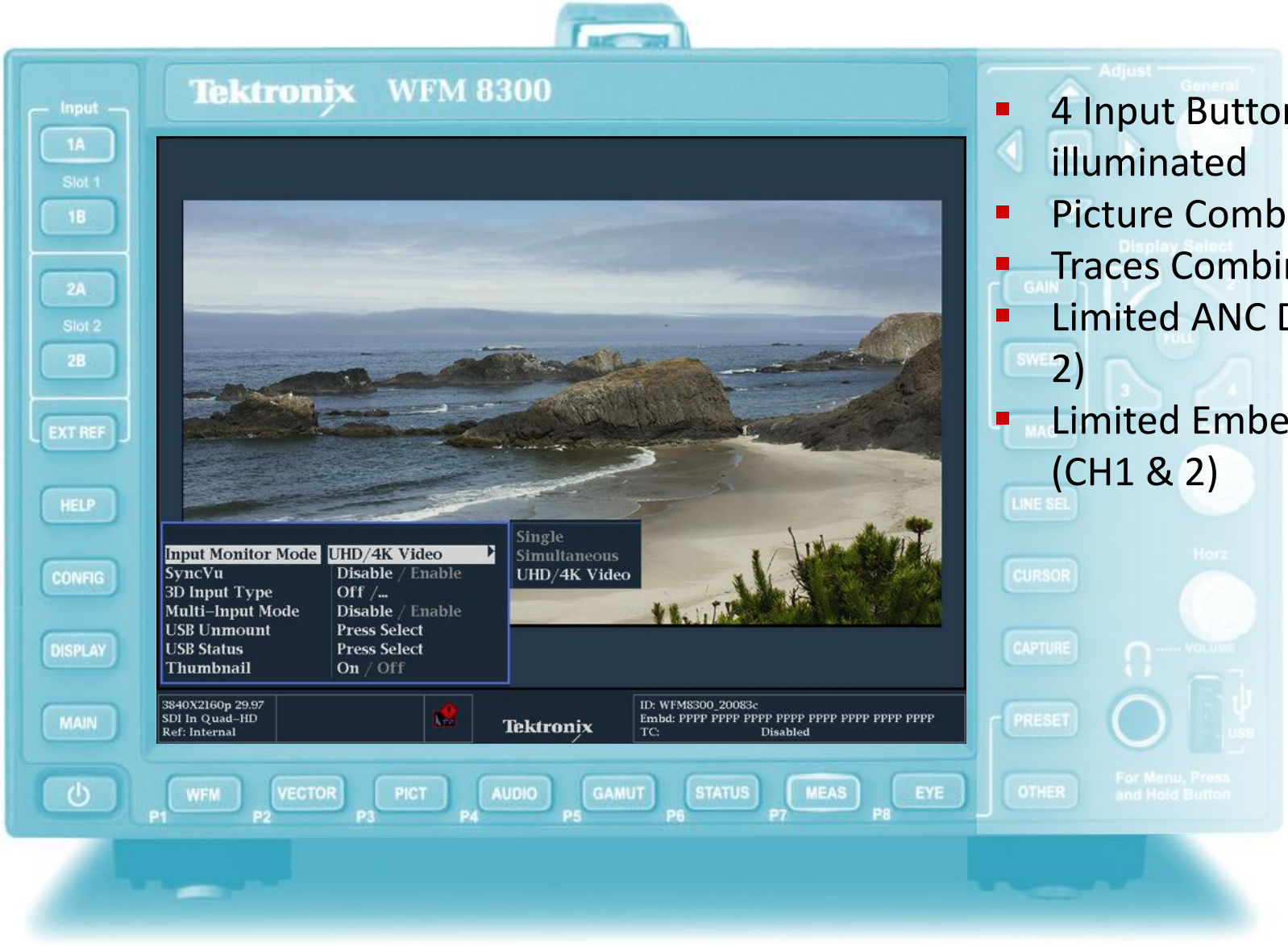


8000 Series 4K Requirements



- Needs 4 signals of the same format and timed together
- Need 4K option key installed
- Need 2SDI option
- Ideally correct VPID
- Maximum two traces available
- ANC Data from Channel 1 & 2
  - e.g. Embedded Audio
- Demo with TG8000 and 2 SDI7s

4K Monitoring



- 4 Input Buttons illuminated
- Picture Combined
- Traces Combined
- Limited ANC Data (CH1 & 2)
- Limited Embedded Audio (CH1 & 2)

4K Monitoring – 4 Tile

- Max 2 Trace Tiles
- Combined Picture

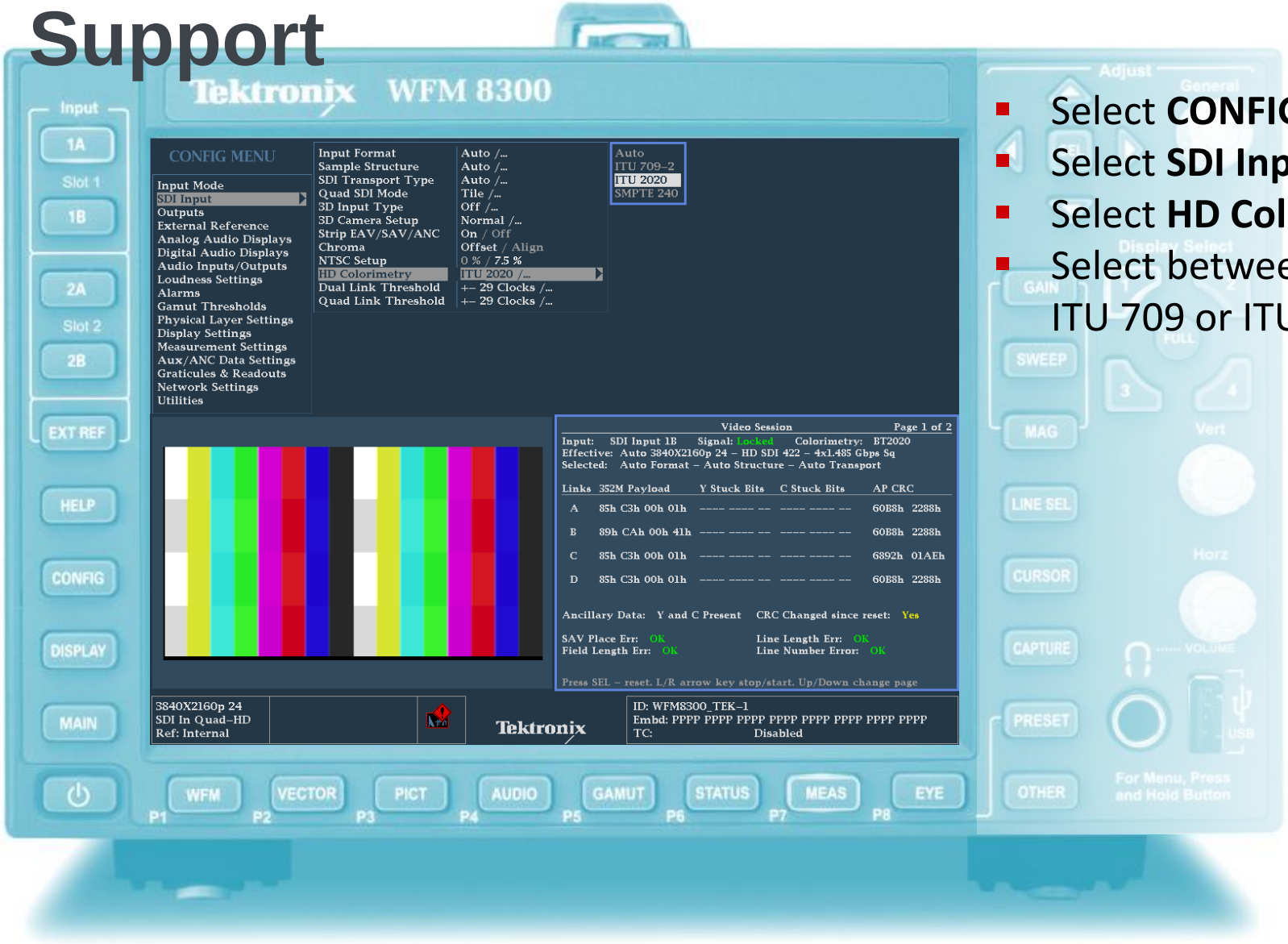
4K Monitoring – Video Session

- Select **Status** button
- Push & Hold **Status** to access menu
- Select **Display Type**
- Select **Video Session**
- Use **Up/Down Arrows** to select pages

4K Monitoring – Timing Display

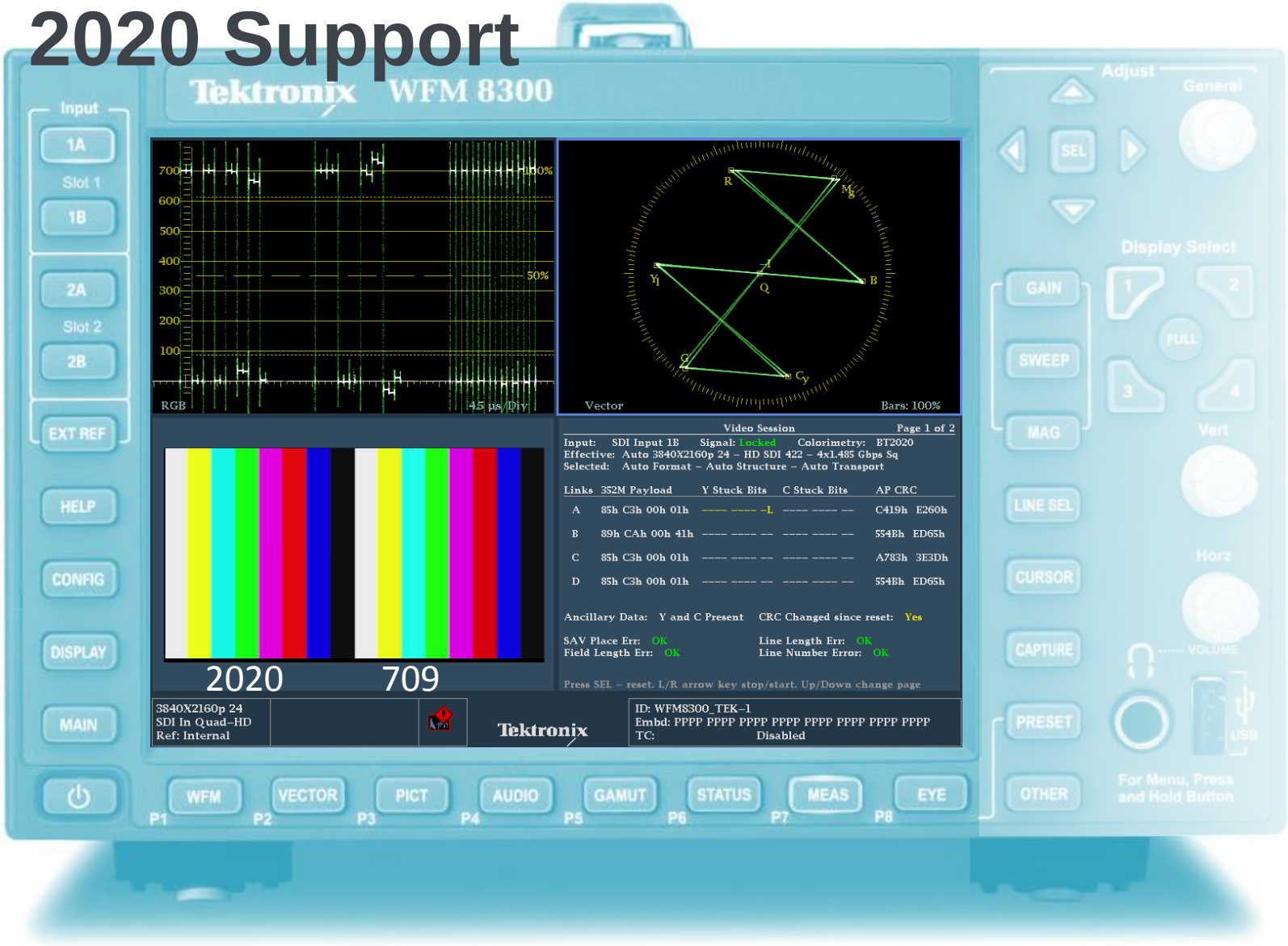
- Select **MEAS** button
- Push & Hold **MEAS** to access menu
- Select **Display Type**
- Select **Timing**
- Ensure **EXT** selected

4K Monitoring – ITU-R BT.2020 Support



- Select **CONFIG** button
- Select **SDI Input**
- Select **HD Colorimetry**
- Select between ITU 709 or ITU 2020

4K Monitoring – ITU-R BT 709 and 2020 Support

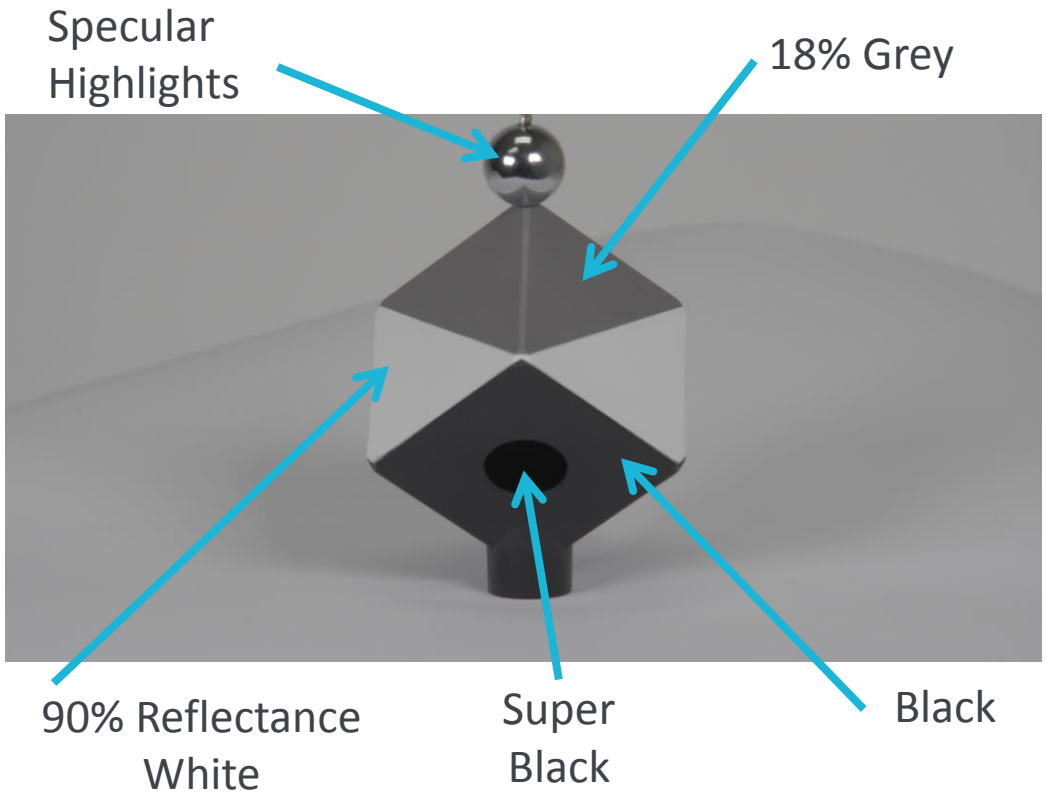


Capturing a Camera RAW image

Gamma	0% Black 10-bit Code-Value	%	18% Grey (20 nits illumination) 10-bit Code-Value	%	90% Reflectance 10-bit Code-Value	%
S Log 1	90	3	394	37.7	636	65
S Log 2	**90**	**3**	**347**	**32.3**	**582**	**59**
S Log 3	95	3.5	420	40.6	598	61
Log C Arri	134	3.5	400	38.4	569	58
C-Log Canon	128	7.3	351	32.8	614	63
V-Log	128	7.3	433	42	602	61
Red Log	95	4	468	46	671	69
BMD Film	95	4	400	38	743	78
ACES (proxy)	ND	ND	426	41.3	524	55
BT.709	64	0	423	41.0	940	100

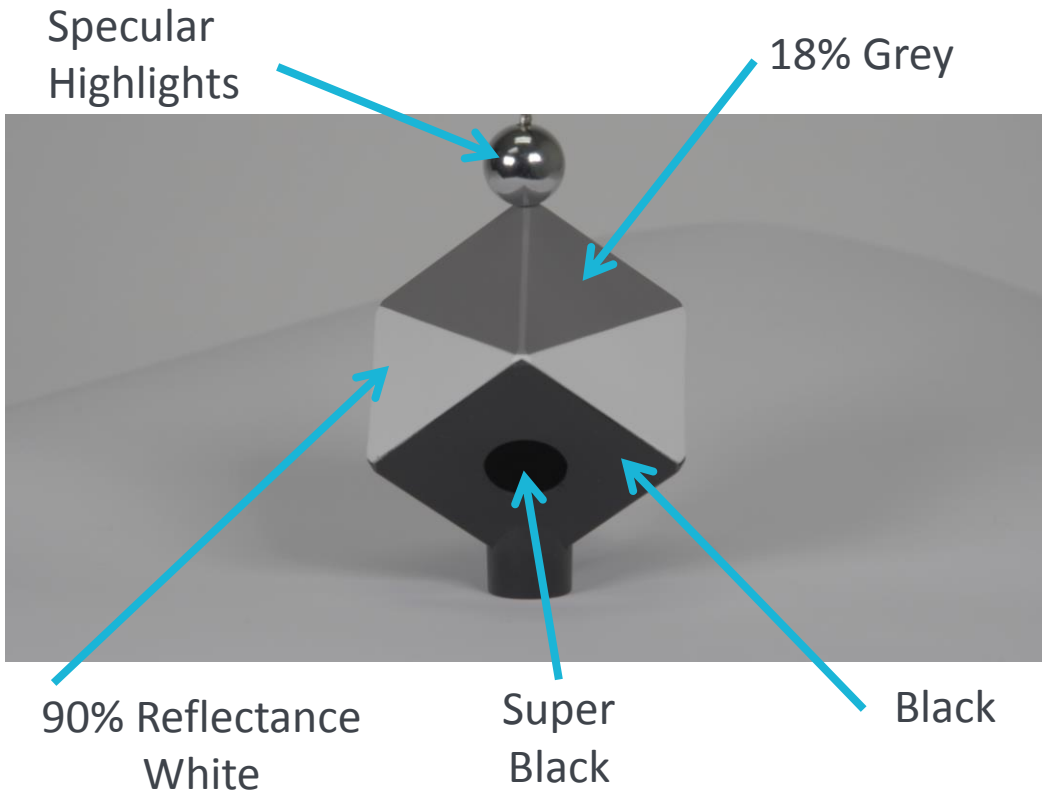
Capturing Camera RAW Footage

- Setup your test chart within the scene
- Adjust the lighting to evenly illuminate the chart
- Adjust the camera controls to set the levels
  - ISO/Gain, Iris, Shutter, White Balance



Capturing Camera RAW Footage

- Setup your test chart within the scene
- Adjust the lighting to evenly illuminate the chart
- Adjust the camera controls to set the levels
  - ISO/Gain, Iris, Shutter, White Balance

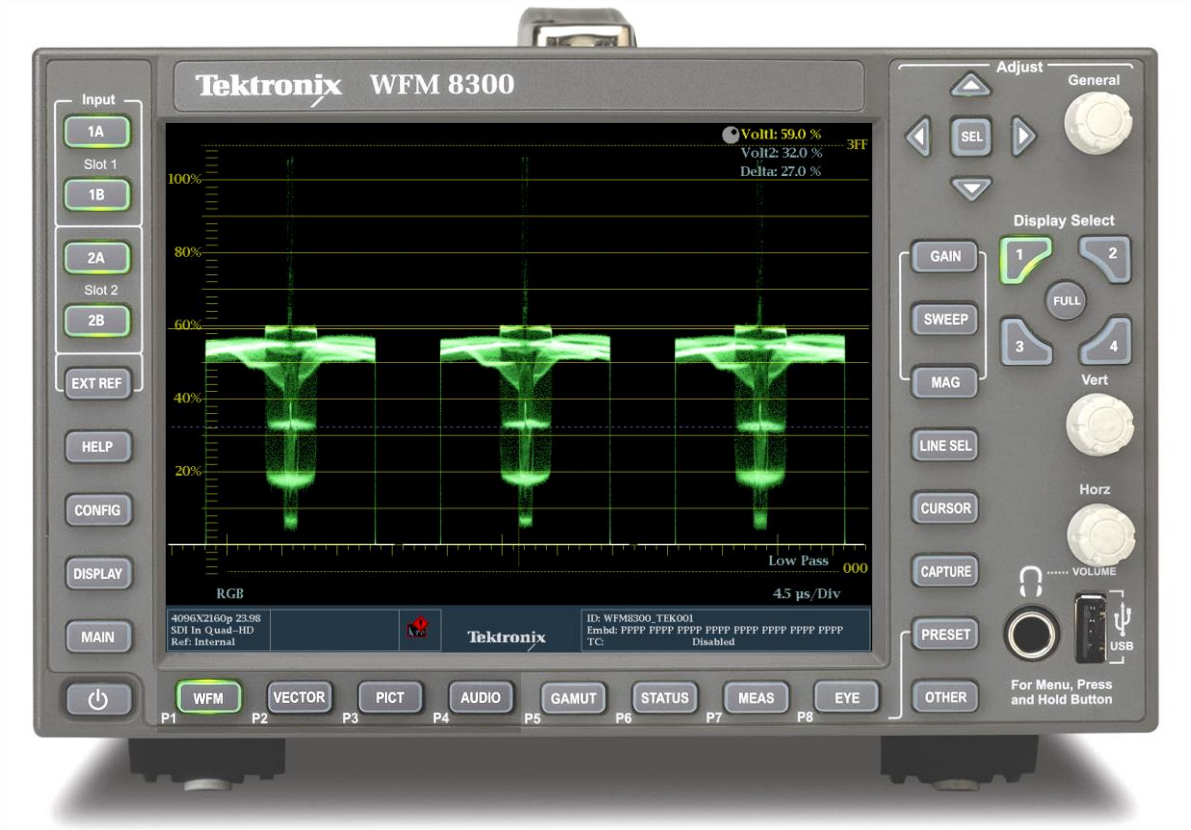


Capturing Camera RAW Footage

- WFM8300
  - Select Picture Display
  - RAW image
  - Low Contrast

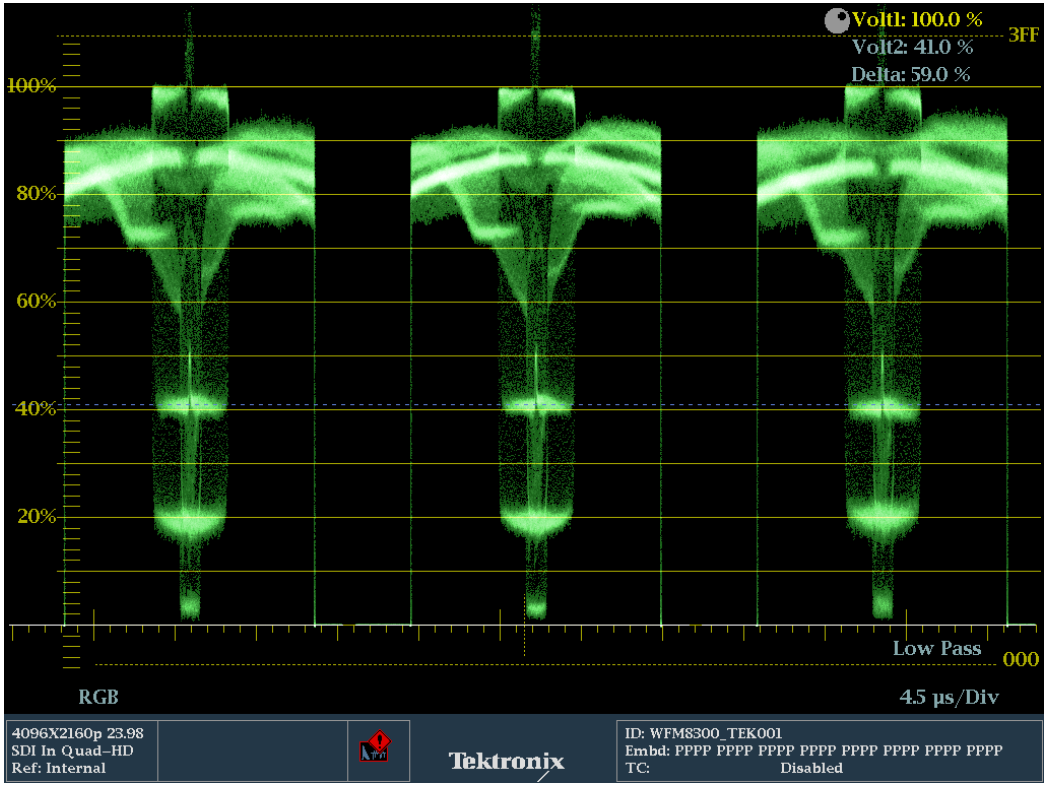
Capturing Camera RAW Footage

- WFM8300
  - Select Waveform
  - Select RGB Display
  - User Cursors
  - Configure for 100%
  - Adjust the cursors to the 59% and 32% levels for SLOG-2



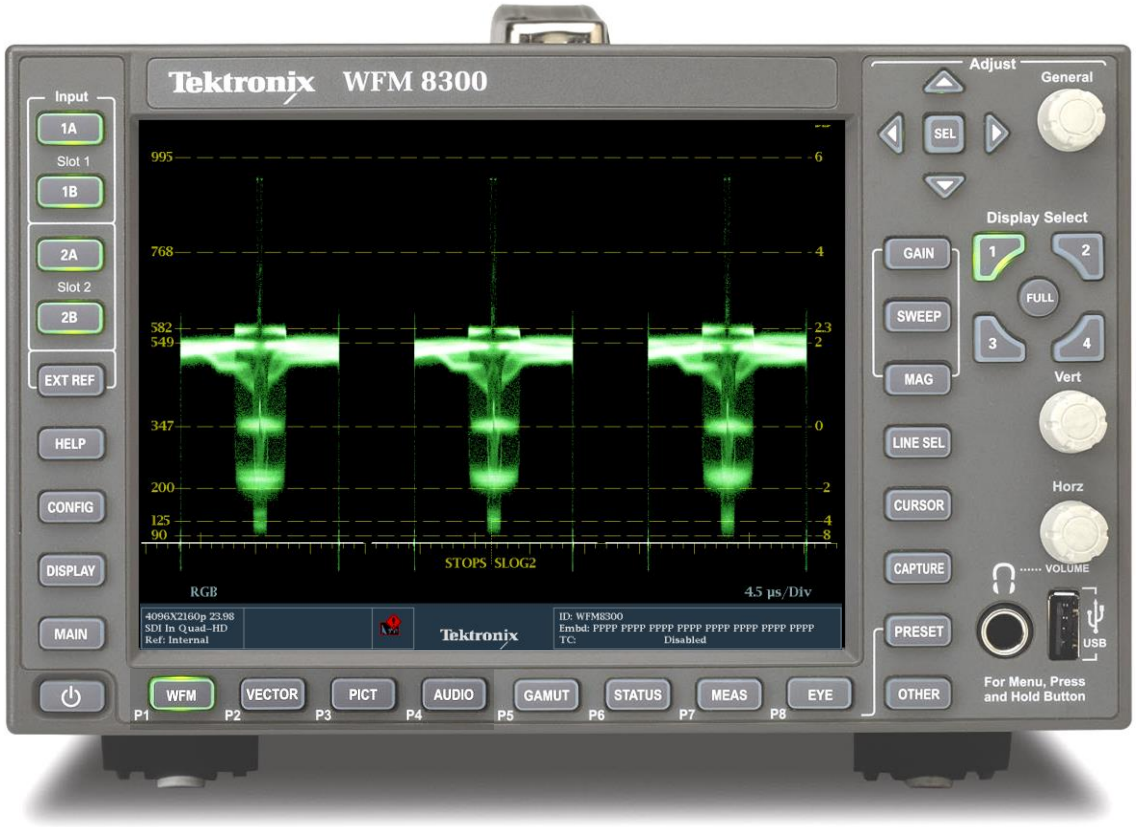
Editing Camera RAW Footage

- Using an Editing or Color Correction Application
- Adjust the video levels with the color correction tools
- Look Up Table
- White 90% reflectance to 100%
- Black Level to 0%
- 18% Grey to 41%



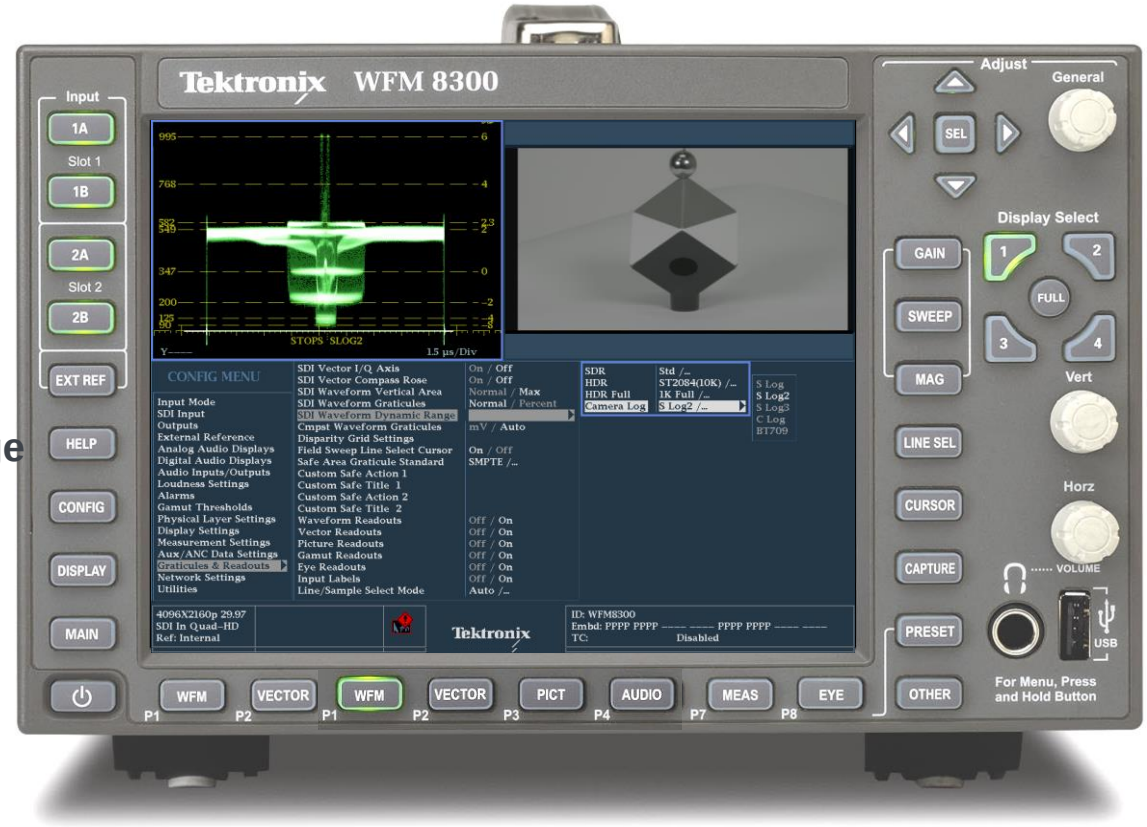
Option PROD supports HDR and Camera Log

- **Simplifies adjustment of Camera Log**
  - S Log
  - S Log2
  - S Log3
  - C Log
  - BT709
- **Setup levels to :-**
- 0 Stops for 18% grey
- 2.3 Stops for 90% Reflectance White



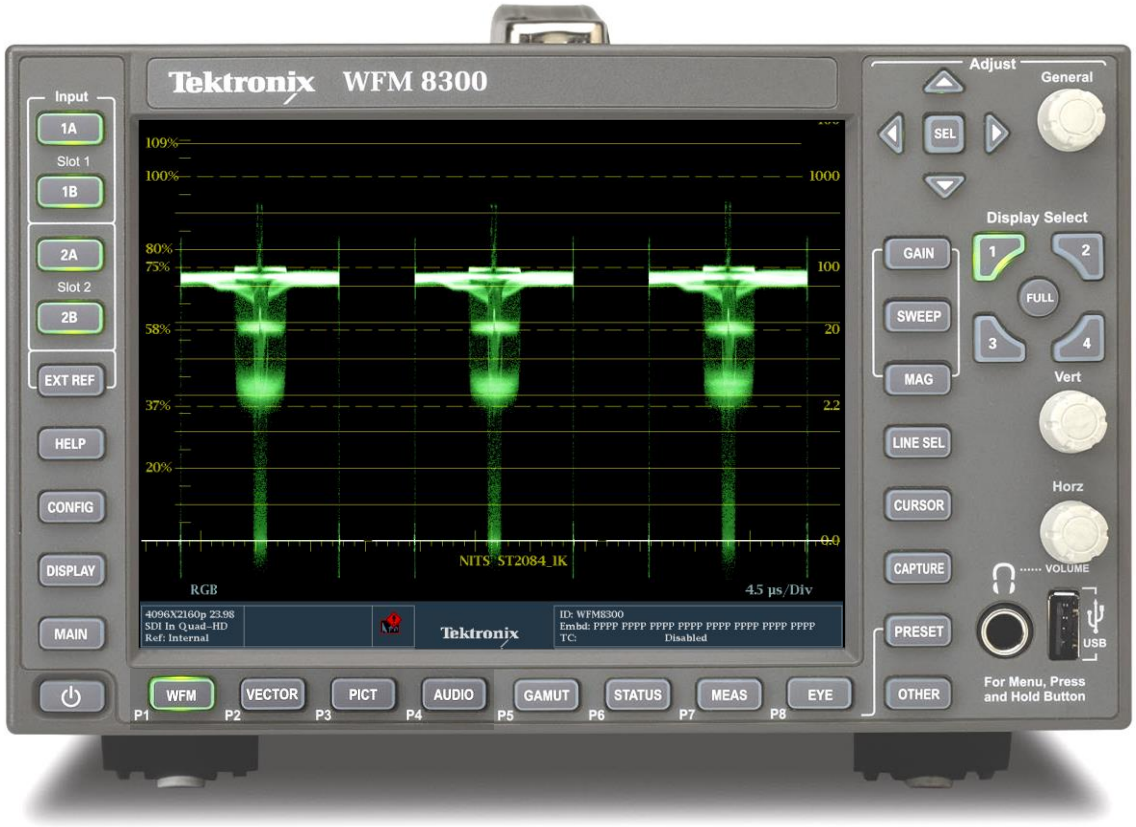
Camera Log Setup

- Push and Hold **WFM** button
  - Select **Dynamic Range**
  - Select **Camera Log**
- **CONFIG** Camera Log
  - **Graticules & Readouts**
  - **SDI Waveform Dynamic Range**
  - **Camera Log**
- Select
  - **S Log**
  - **S Log2**
  - **S Log3**
  - **C Log**
  - **BT 709**

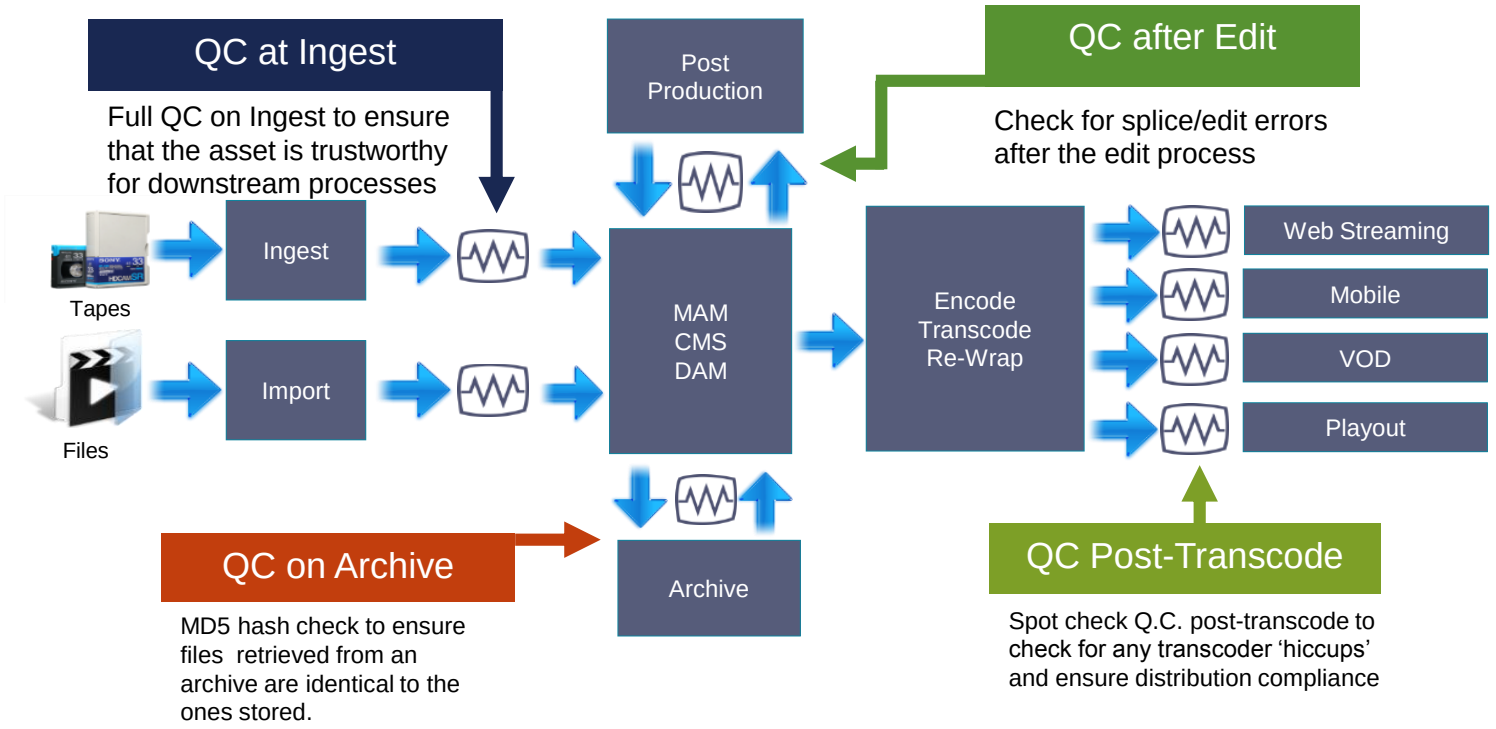


Option PROD supports HDR and Camera Log

- **Simplifies adjustment of HDR**
  - HLG(1200)
  - ST2084(1K)
  - ST2084(2K)
  - ST2084(4K)
  - ST2084(5K)
  - ST2084(10K)
- **Setup levels to NITS scale**
  - 100 NITS reference white
  - Latin (nitere = to shine)



QC in file based workflows



有关详细信息

- WFM 和 WVR 系列产品简介
- 应用文章
  - 标准清晰度和高清晰度视频测量指南
  - 环绕声音频监视
  - 串行数字信号的物理层测试
  - 利用 CaptureVu 查寻和分析数字视频信号（ Troubleshooting and Analyzing Digital V