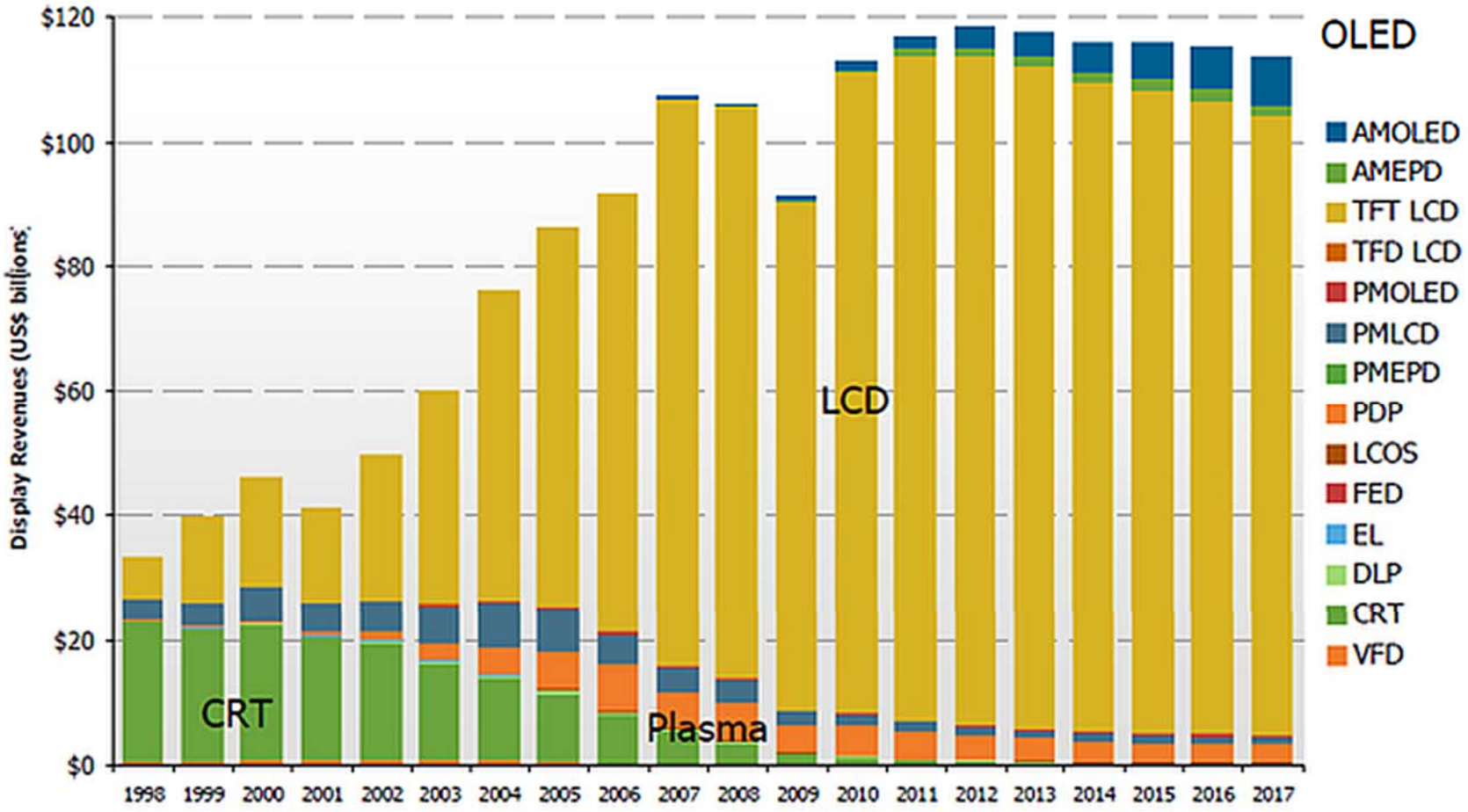
CRT, OLED and LFT (Luminance Feedback Technology) for the generation of pattern ERG and VEP

Jacques Charlier, David Boizier

Metrovision

Lille, France

Display market evolution



ISCEV standards

- Pattern ERG (2012 update)

« the mean luminance of the stimulus screen must be constant during checkerboard reversals (no transient luminance change) »

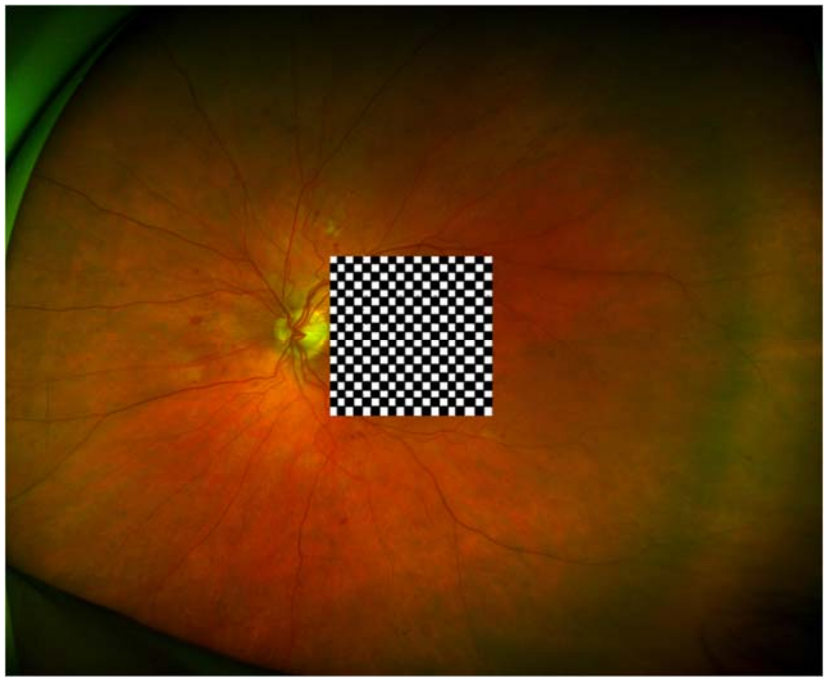
- Pattern reversal VEP (2016 update)

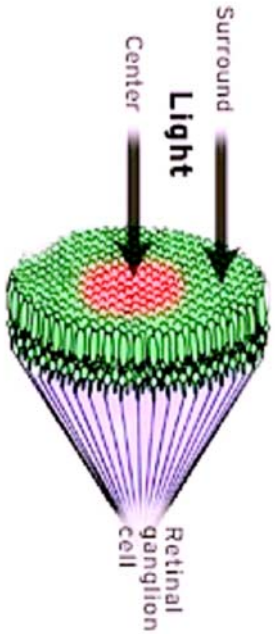
«no overall change in the luminance of the screen. Displays used for Standard VEP testing must be modified to avoid transient luminance artifacts »

- Pattern on-off VEP (2016 update)

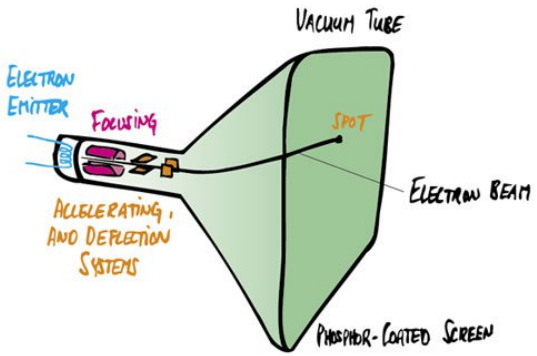
« the mean luminance of the diffuse background and the checkerboard must be identical with no change of luminance during the transition from pattern to diffuse blank screen »

Constant luminance





Cathode Tay Tube technology



Problems with Cathode Ray Tubes

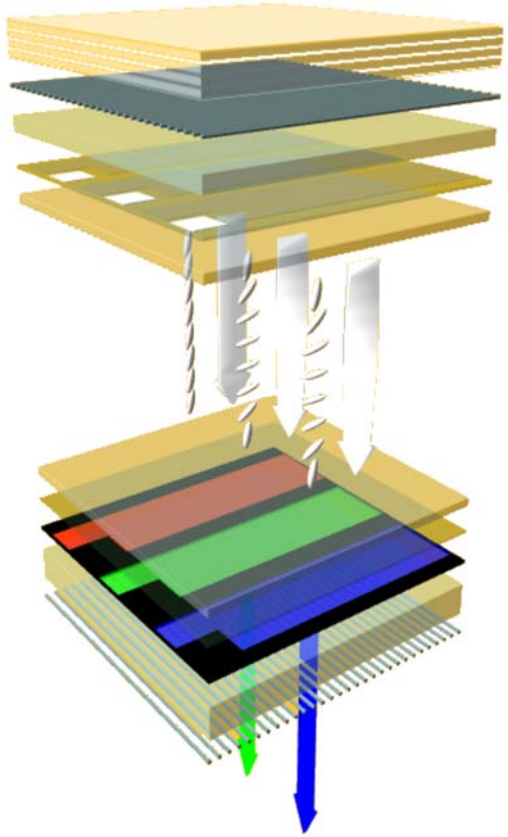
- No longer manufactured (> 10 years)
- Performance decline over years
- not compliant with ROHS European directive (*Restriction of Hazardous Substances)*
- Electrolytic capacitors

LCD

Light source
Polarizer
Transparent substrate
TFT cathode electrodes
Orientation layer

Liquid crystals

RM polymer layer
Orientation layer
Anode electrodes
Color filter
Transparent substrate
Analyzer



OLED

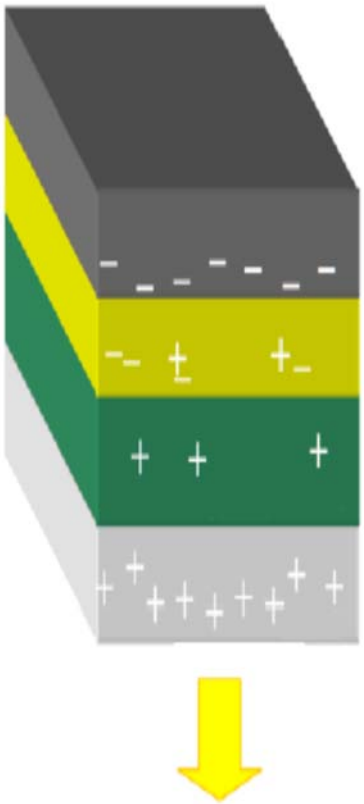
TFT cathode electrodes

Emissive polymer

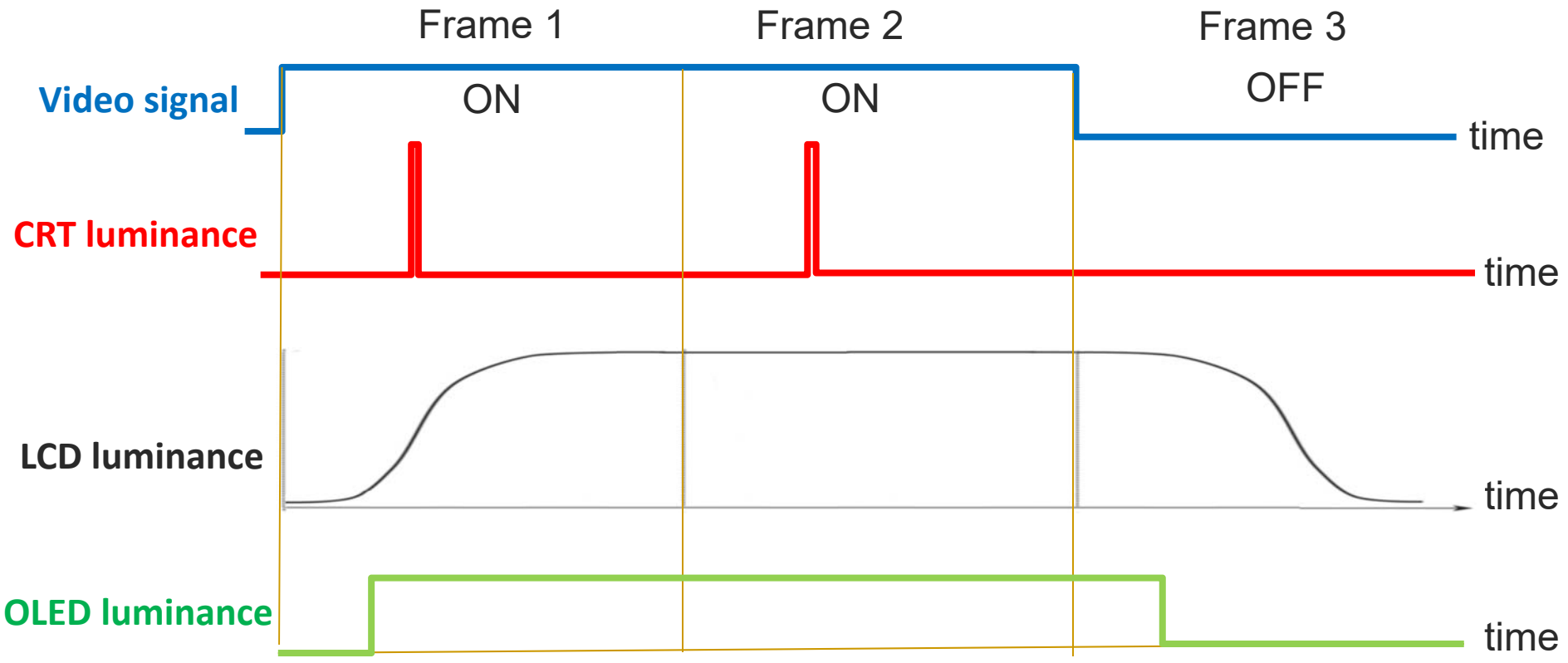
Conductive polymer

Anode electrodes

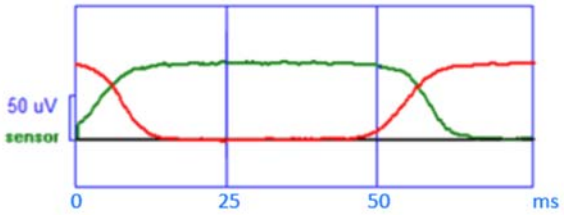
Transparent substrate



Response time (local)

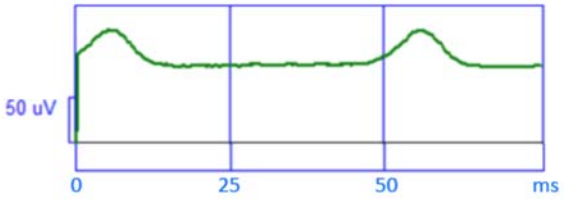


Origin of the luminance artefact



Black ➔ white

White ➔ black



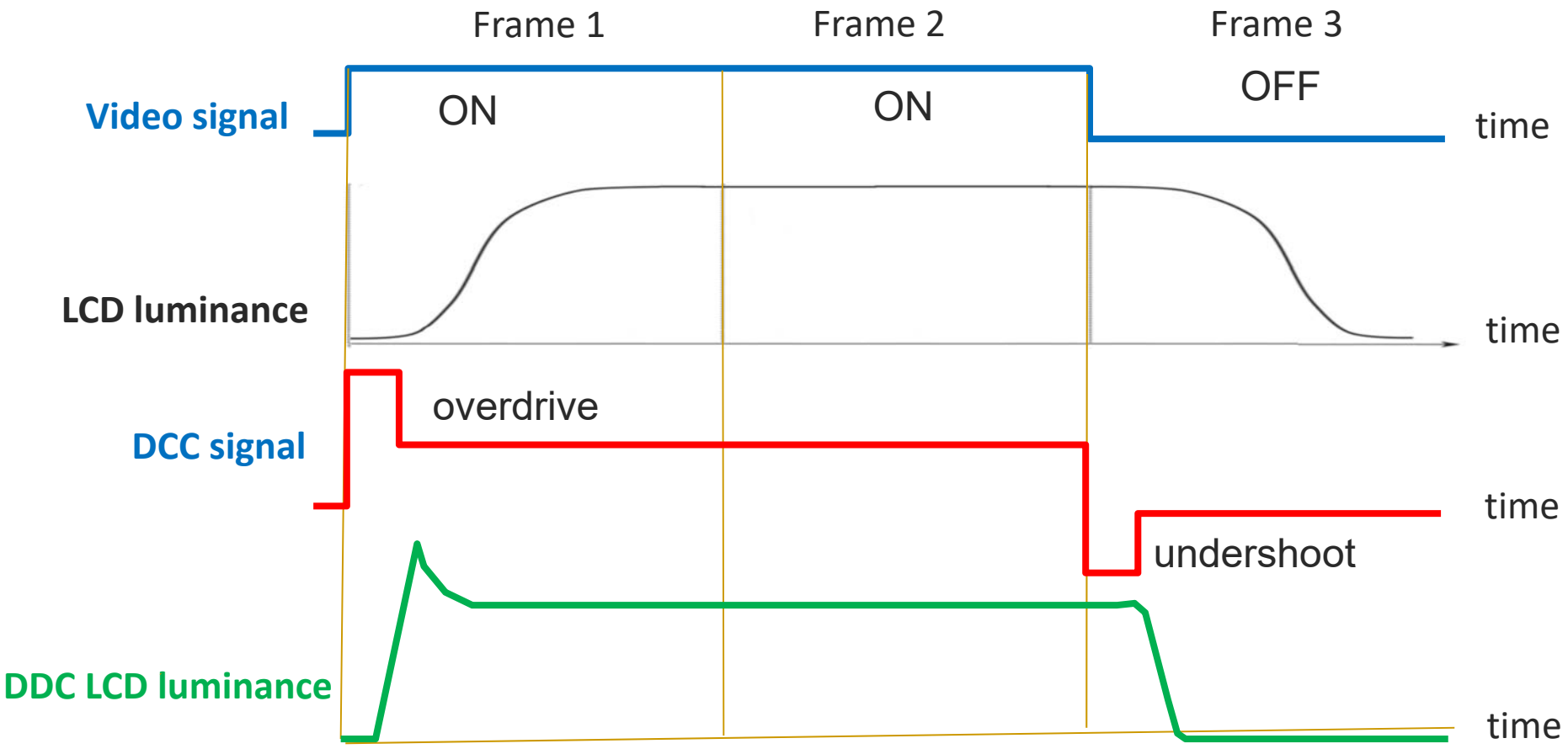
summation

Hasain & al (2009) Charlier (2011)

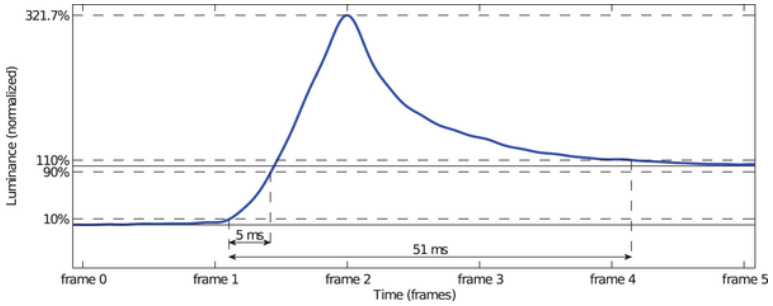
- Reduce contrast
- Use high frequency LCD monitors
- ….

Matsumoto & al (2011, 2013, 2014)

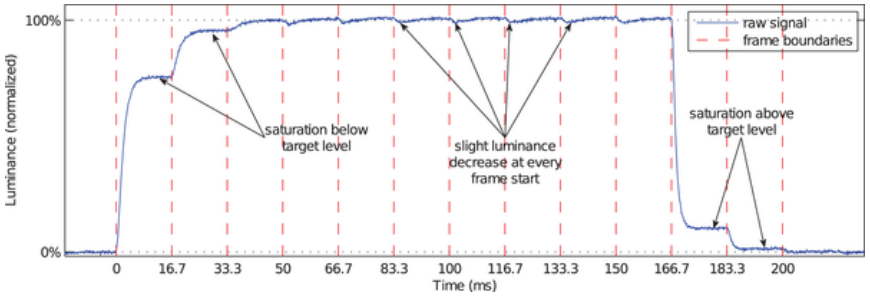
DCC (Dynamic Capacitance Compensation) technique



Problems with DCC techniques



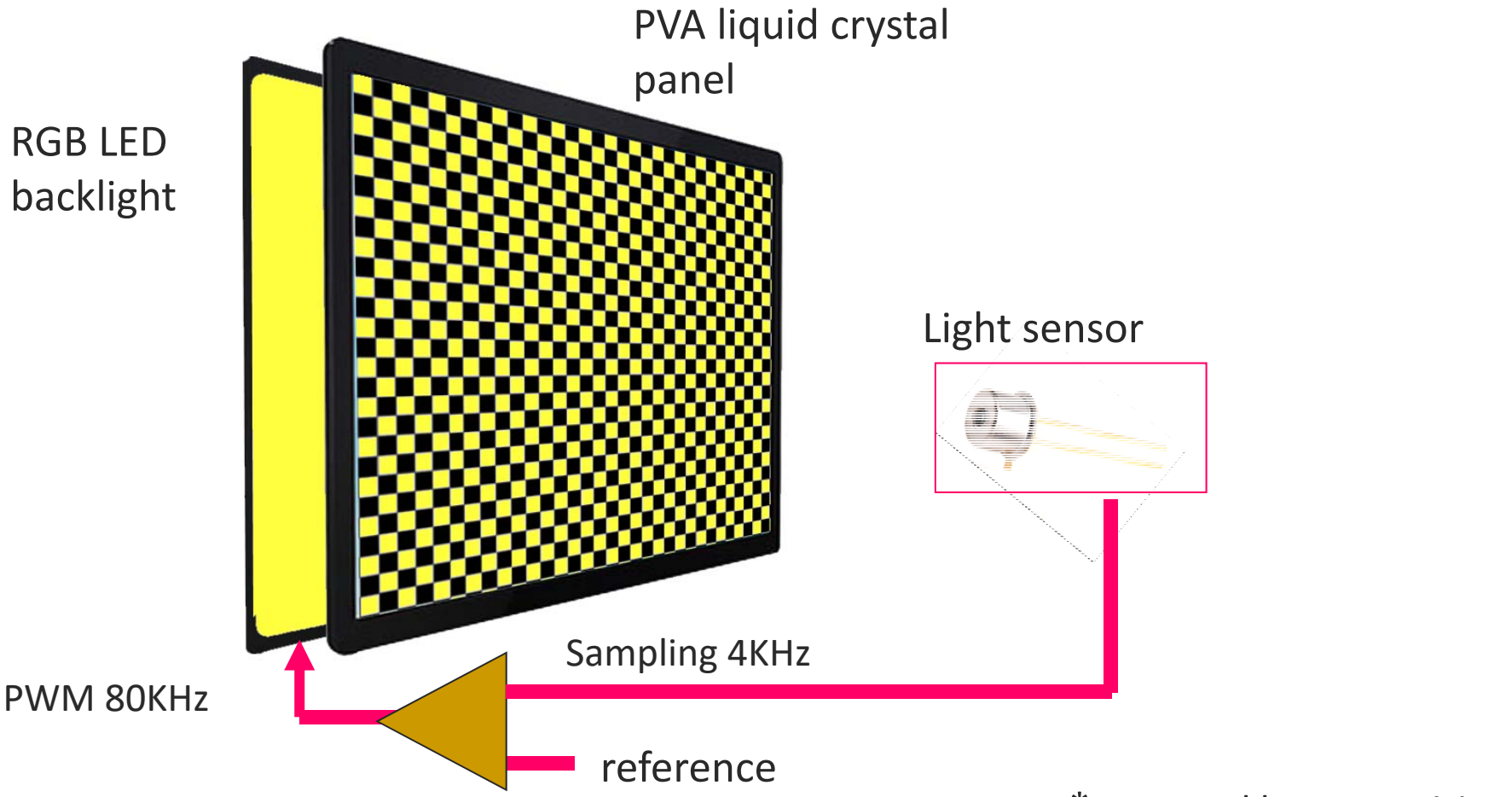
overshoot



Luminance stepping

Reference:
Elze T, Tanner TG (2012) Temporal Properties of Liquid Crystal Displays: Implications for Vision Science Experiments. PLOS ONE

Luminance Feedback Technology (LFT) (*)



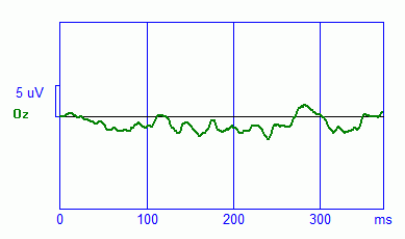
* Patented by Metrovision

Control of absence of luminance artefact

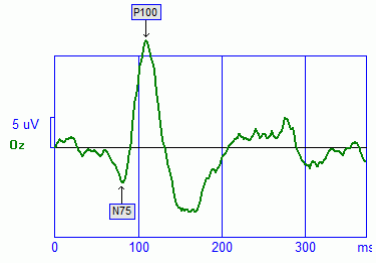
1. Record average response from light sensor connected to the amplifier

2. Record Pattern VEP with holographic diffuser

LFT
with holographic diffuser



LFT
Normal response



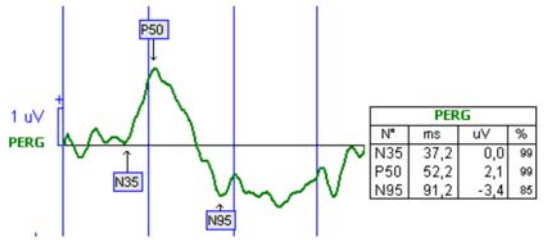
30 min checkerboard reversal

Test conditions

- Same angular size for pattern and field
- Distance 1 meter for CRT and LFT
- Distance 2.5 meters for OLED

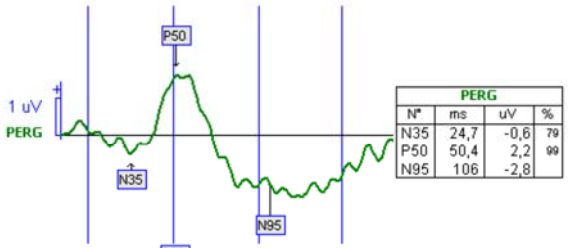
Results for pattern ERG

CRT



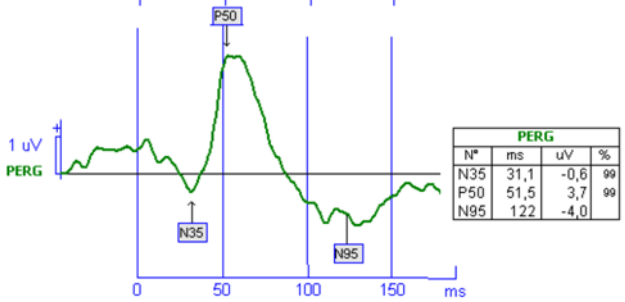
PERG			
N°	ms	uV	%
N35	37,2	0,0	99
P50	52,2	2,1	99
N95	91,2	-3,4	85

LFT



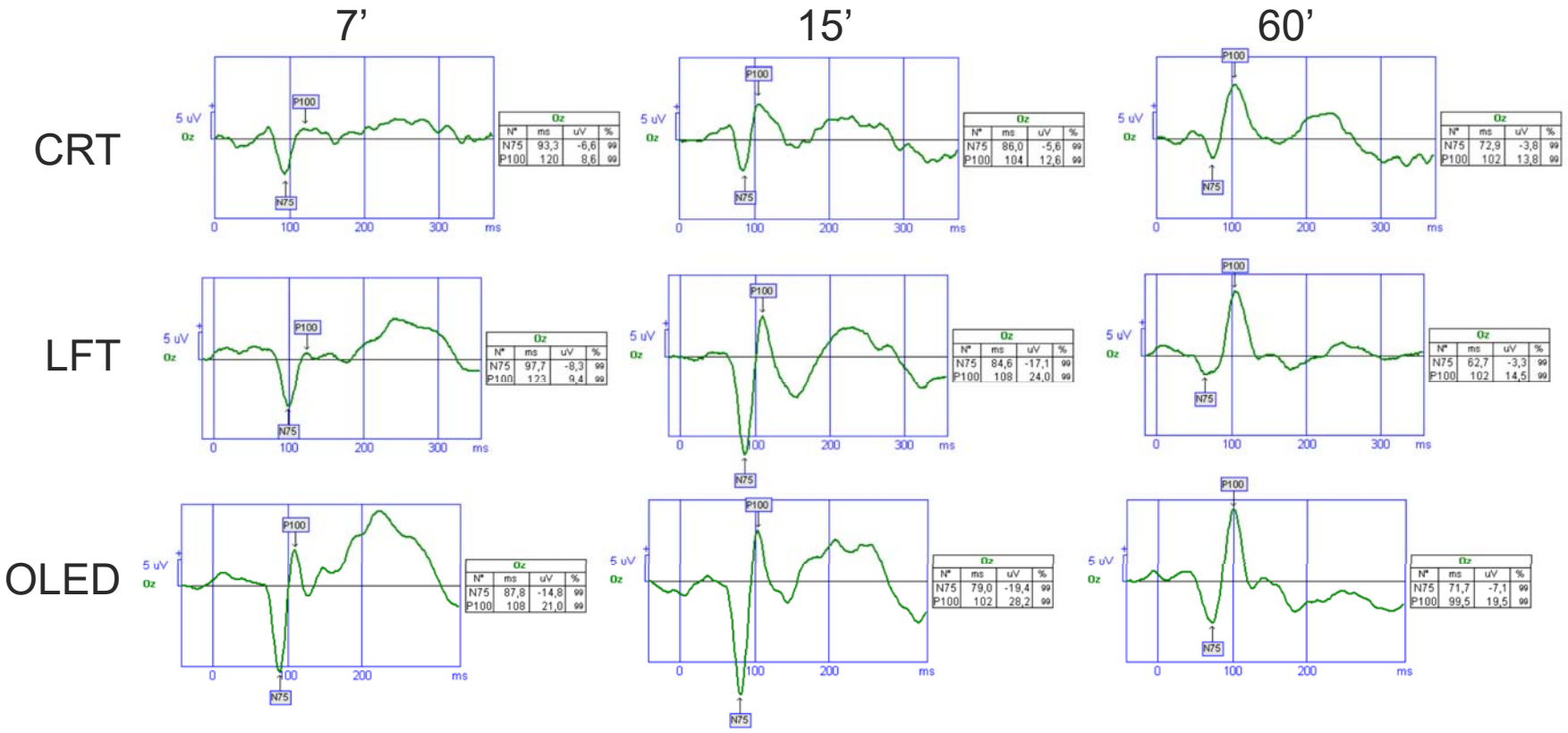
PERG			
N°	ms	uV	%
N35	24,7	-0,6	79
P50	50,4	2,2	99
N95	106	-2,8	

OLED



PERG			
N°	ms	uV	%
N35	31,1	-0,6	99
P50	51,5	3,7	99
N95	122	-4,0	

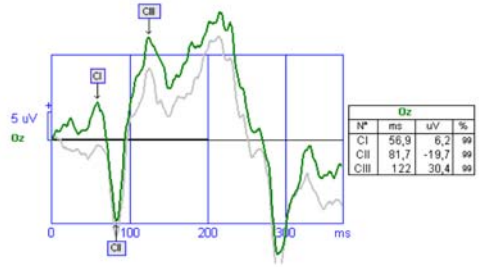
Results for pattern reversal VEP



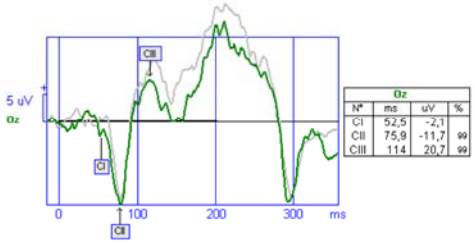
Results for pattern ON-OFF VEP

15’

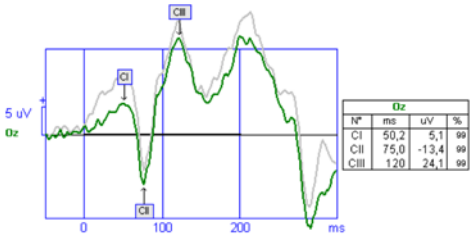
CRT



LFT



OLED



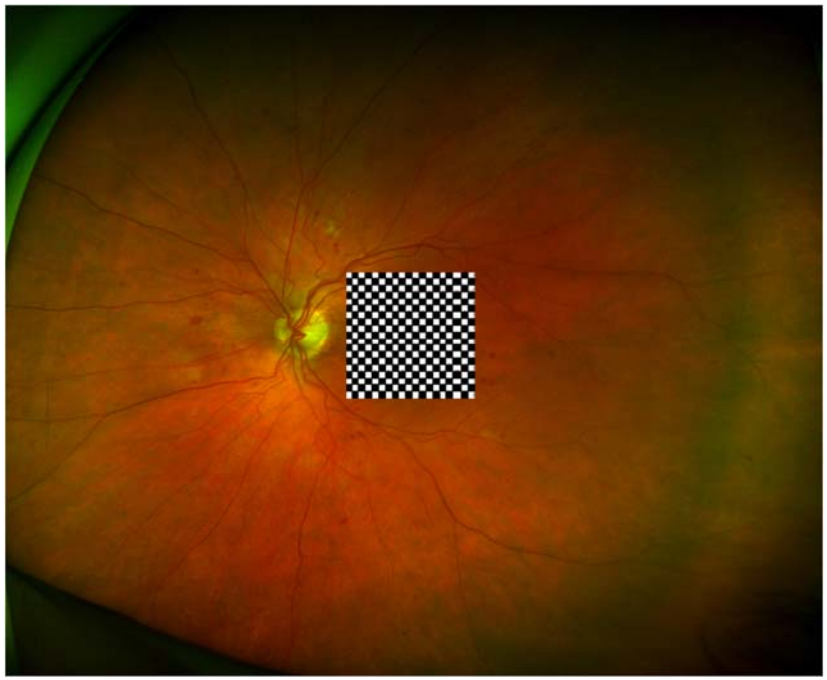
Comparison table

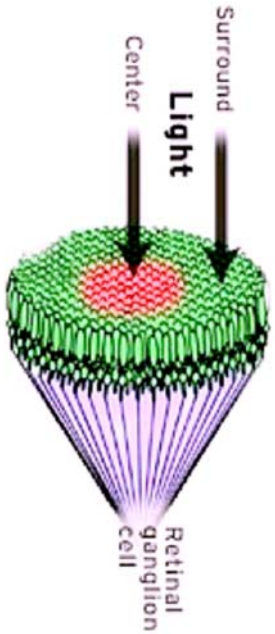
	CRT	OLED	Luminance Feedback **LFT**
Control of luminance	PARTIAL	PARTIAL	YES
Time delay	0 ms	40 to 50 ms	16 ms
Scanning time	12ms	8 ms	16 ms
Contrast	97%	100%	90%
Availability	yes	YES	YES
Sustainability	NO	???	YES

Is OLED a mature and stable technology?

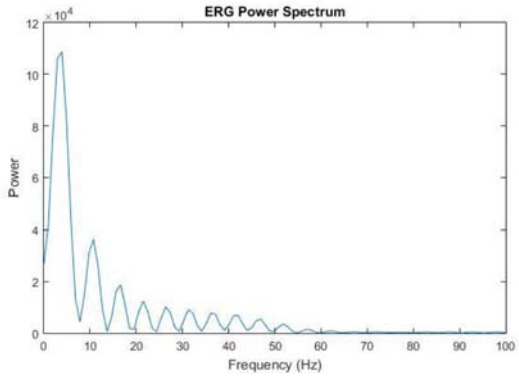
Thank you for your attention!!!!

Constant luminance: local or global?





Constant luminance: local or global?



Frequency plot of flash ERG

Transition velocity?

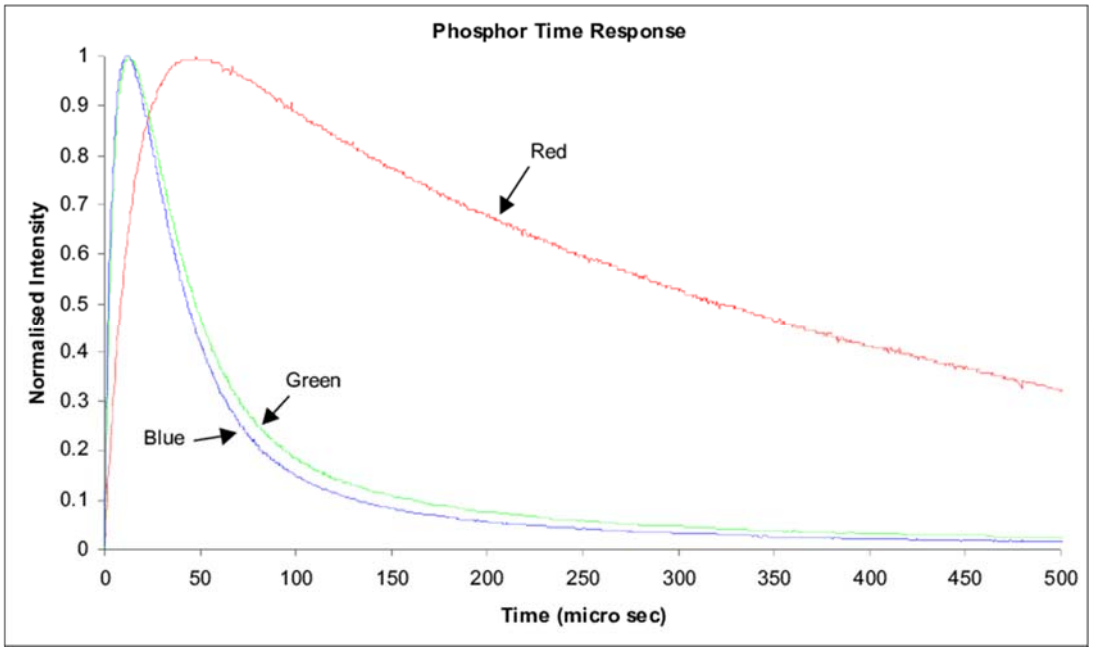
The pattern ERG in glaucoma: effect of pattern reversal time
Mierdel P, et al. Int Ophthalmol. 1992.

Cortical potentials to pattern reversal and luminance onset under ramp stimulation conditions in glaucoma
Mierdel P, et al. Doc. Ophthalmol. 1992.

“The pattern-reversal stimulation in ramp mode yielded a significant difference between the glaucoma group and normal subjects.
The difference between groups with pattern reversal in step mode was not significant.”

	CRT	Optimized LCD	Luminance Feedback LFT	OLED
Control of luminance	Partial	Partial	YES	Partial
Local transition time	0.05 ms	5 ms	10 ms	0.1 ms
Scanning time	8 to 20 ms	16 ms	16 ms	8 ms
Contrast	97%	< 80%	90%	100%
Low luminance operation AO	NO	NO	YES	NO
Control of timing MfERG	NO	NO	YES	NO
Availability	NO	YES	YES	YES
Sustainability	NO	YES	YES	NO

Response time of CRT phosphors



Andrew J. Woods **Stanley S. L. Tan**
Characterising Sources of Ghosting in Time-Sequential Stereoscopic Video Displays

Proceedings of SPIE - The International Society for Optical Engineering 4660 June 2002

Comparison of LCD technologies

Table 1 Performance comparisons of four popular LCD modes

	TN mode	MVA mode	IPS mode	FFS mode
Transmittance (normalized to TN)	100%	70%–80%	70%–80%	88%–98%
On-axis contrast ratio	~1000:1	~5000:1	~2000:1	~2000:1
LC mixture	$+\Delta\varepsilon$	$-\Delta\varepsilon$	$+\Delta\varepsilon$ or $-\Delta\varepsilon$	$+\Delta\varepsilon$ or $-\Delta\varepsilon$
Viewing angle	Fair	Good	Excellent	Excellent
Response time	~5 ms	~5 ms	~10 ms	~10 ms
Touch panel	No	No	Yes	Yes
Applications	Wristwatches, signage, laptop computers	TV, desktop computers	Desktop computers, pads	Smartphones, pads, notebook computers

Abbreviations: FFS, fringe-field switching; IPS, in-plane switching; LCD, liquid crystal display; MVA, multi-domain vertical alignment; TN, twisted nematic; TV, television.

Liquid crystal display and organic light-emitting diode display: present status and future perspectives

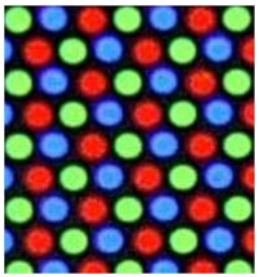
Hai-Wei Chen[1], Jiun-Haw Lee[2], Bo-Yen Lin[2], Stanley Chen[3] and Shin-Tson Wu[1]

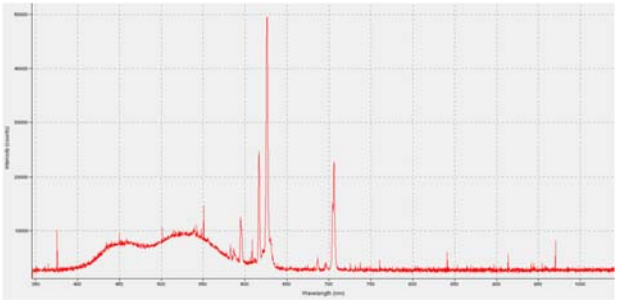
Light: Science & Applications (2018) 7, 17168; doi:10.1038/lsa.2017.168
Official journal of the CIOMP 2047-7538/18

www.nature.com/lsa

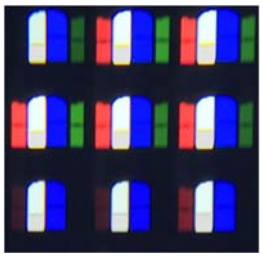
Spectral emission

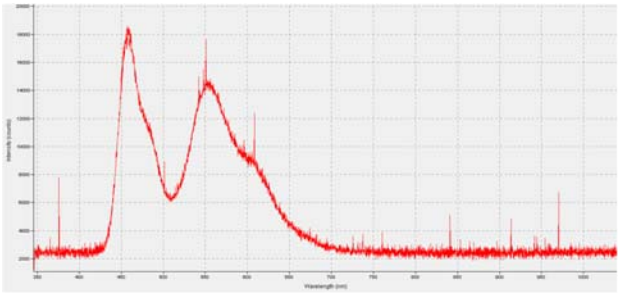
CRT
(MonPack3)



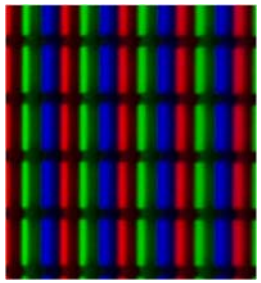


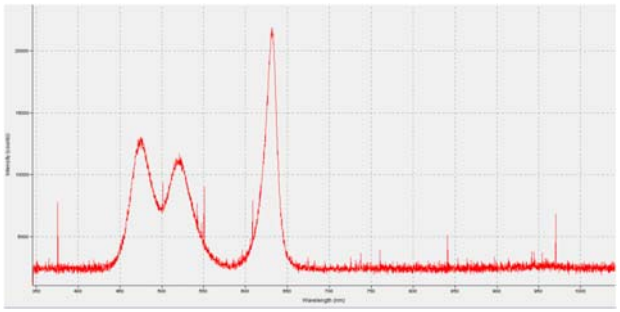
OLED





LFT
(MonPackONE)





Total results for pattern VEP