
Innovative applications of Solid State Lighting in display field

Display System Division / LED Program / MPT
Hong Kong Applied Science and Technology Research Institute
(ASTRI, 香港應用科技研究院)

May 8, 2009

ASTRI Proprietary



Emerging LED Applications in Display Field

Large Sized (>10") LCD



NB



Monitor



LCD TV

Projection display



Companion



Embedded

Pico Projector



Pocket Projector

Pico-Projector

LED Projectors

Pico-Projector

Embedded

Brightness: 7-15 lm
Power: < 1W
Size: 5-10cc (module)



3M CES 2009

25mmx40mmx10mm
~10cc
7 lm@ 0.8W (LED)
VGA by displaytech

Stand-alone

Brightness: 10-30
Power: 3-5W
Size: <100cc (product)
Others:
- w/ battery
- w/o fan



Optoma PK101

50mmx105mmx17mm
~90cc
7 lm@ 2W (LED)
HVGA by TI

Mini-Pocket

Brightness: 50-100 lm
Power: ~20W
Size: 200-300cc(product)
Others:
- w/ fan
- w/ battery



Dell M109S

105mmx92mmx37mm
~360cc
50 lm@ 30-40W
SVGA by TI

Pocket

Brightness: >300 lm
Power: > 50W
Size: >600cc (product)
Others:
- Wall power



SAMSUNG P400

145mmx157mmx64mm
~1300cc
150 lm@ 50W
SVGA by TI

Pico-Projector Solutions

						
						
						
Laser + 2 uni-axial (MOEMS) Scanning Mirror	Laser + 1 bi-axial (MOEMS) Scanning Mirror	Laser + Special LCoS	Laser / LED + LCoS / LCD	Laser + Special DMD	LED + LCoS	LED + DLP(?)
					CES 2008	Feb./2008

□ Light Source:

LED, Laser or Mixed

□ Display Device:

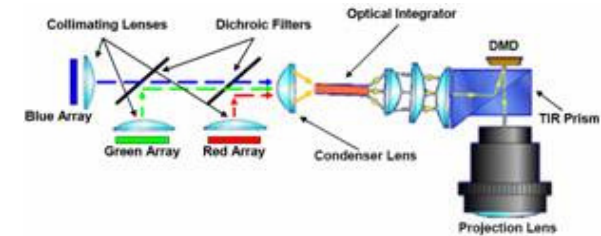
- (1). Microdisplay (DLP, LCoS, LCD)
- (2). MOEMS scanning mirror



Micro-display vs. Laser Scanning Pico Projectors

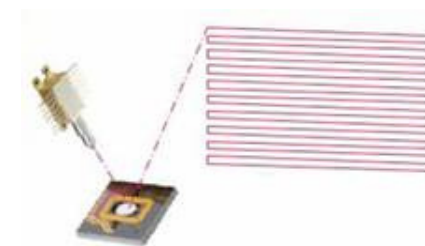
□ Micro-display

- Light Source: RGB LED, White LED
- Display Device: DLP, LCoS, LCD



□ Laser Scanning

- Light source: RGB laser
- Display Device: Un-axial or 2-axial MOEMS scanning mirror



	Micro-display	Laser Scanning
Pros.	<ol style="list-style-type: none"> 1. Time to market 2. Short term low cost 	<ol style="list-style-type: none"> 1. Simple optical component 2. High optical efficiency
Cons	<ol style="list-style-type: none"> 1. Complicated optical components 2. Low optical efficiency 	<ol style="list-style-type: none"> 1. Green Laser availability 2. Laser speckle, safety issue

Microdisplay Comparison

	LCD	DLP	LCoS
Panel efficiency (Color filter)	2% ~5%	23%	10%
Panel efficiency (field sequential)	12%~20%	70%	30%-50%
Light engine size	small	large	middle
Accessory electrics	normal	complicated	Less
Panel cost (USD)	Low	High	Middle
Supplier	- ILJIN (F/S) - Kopin - SONY - Epson	- TI	- DisplayTech (F/S) - Hymax - Holoeve (F/S) - SpatiaLight (F/S)

ASTRI's Pico-Projector

A. Pico-projection Module

□ RGB LED + Field Sequential LCoS

Size ~ 9cc / Resolution: VGA

□ White LED + Color Filter LCoS

Size ~ 6cc / Resolution: VGA



B. Standalone Projector

Size: 126mm*53mm*16mm (~106cc)

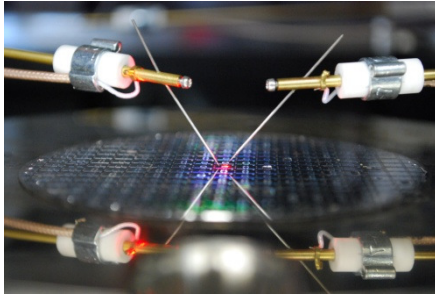


"Innovation Product Award"
of "2008 China SSL 2nd National Innovation Contest"

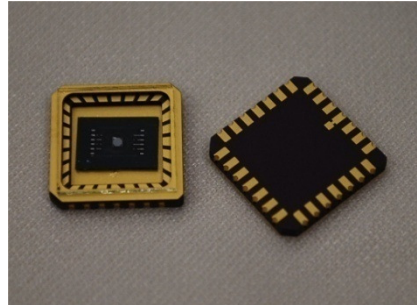
ASTRI Proprietary



ASTRI's MOEMS Laser Scanning Projection



Bi-axial scanning mirror



Laser scanning projection module (~6cc)

Target Application:

- Pico-projector
- Automotive HUD
- Wearable HMD
- Retinal scanning display (RSD)
- Interactive display
-



Original Image



Laser Scanned Image

LED Backlit LCD TV

LED BLU Technology Trend

■ **Y2004**

→ SONY lunched worldwide 1st LED BLU LCD TV



SONY 2004

■ **Y2005**

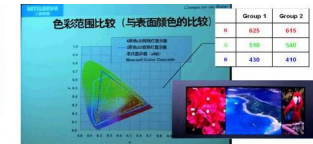
- High power LED dominate RD direction
- Large size LED BLU (Samsung 82", Osram: 102")
- Constant BLU
- Diversified LED BLU technologies

■ **Y2006**

- 2-D local dimming LED backlight
- Small-Middle power LED dominate RD direction



Sharp: CCFL + LED



Mitsubishi: 6 color LED



OMRO: 25mm LED backlight



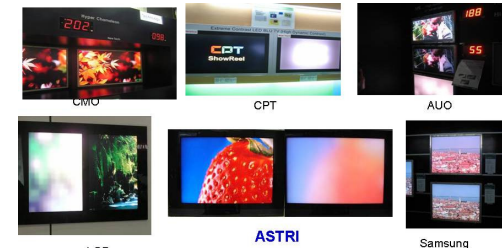
Samsung: Color filter less

■ **Y2007**

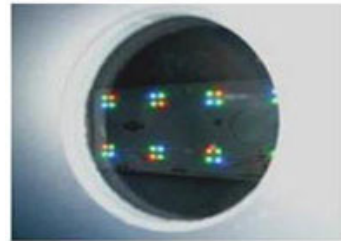
- 2-D local dimming LED backlight
- Thin LED BLU by 2nd optical lens & side emitting LED BLUS

■ **Y2008**

- Low cost RG-phosphorus white LED BLU
- Commercialized



Commercialized LED LCD TV



Sony Triluminos Technology
with red, green, and blue LEDs

Sony XR1 series

Size: 46" and 55"

1080p LCD HDTV

120Hz refresh rate

RGB LED backlight (72-dimming-zone for 46")

Price: ~5000USD for 46"

Sharp XS1 series

Size: 52" and 65"

1080p LCD HDTV

120Hz refresh rate

RGB LED backlight (>1000 dimming-zones)

Price: ~12000USD for 52"



Commercialized LED LCD TV

13

Samsung 81F Series

Sizes: 40", 46", 52", 57"

Pixel Format: 1920 x 1080

60Hz refresh rate

White LED Backlight (64 dimming-zone for 40")

Price: \$2500 ~ \$8000



Samsung LExxF96BD

Size: 52" and 70"

Pixel Format: 1920 x 1080

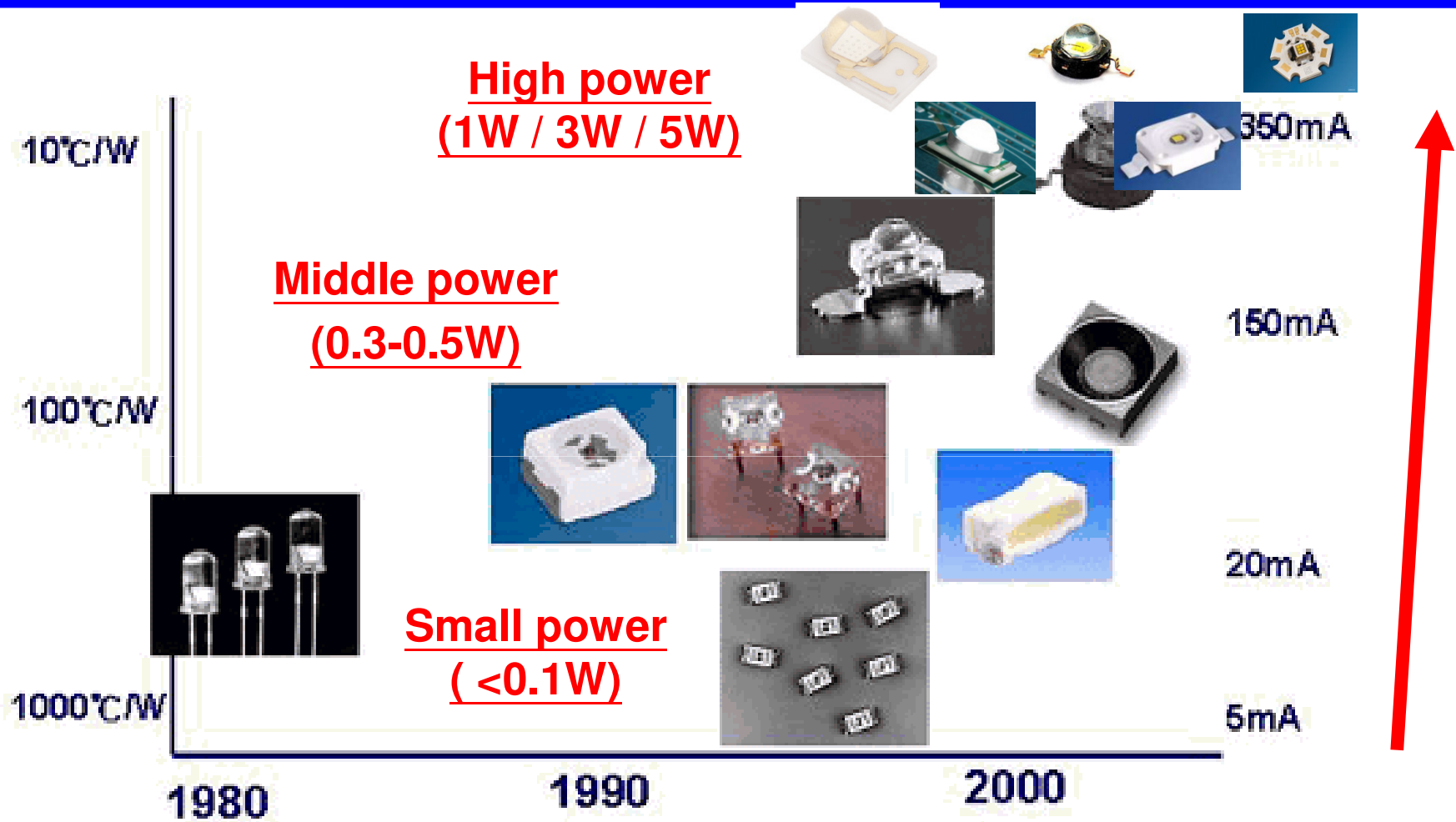
120Hz refresh rate

White LED backlight (96-dimming-zone for 52")

~3500 USD for 52" TV

LG, Hisense and Toshiba also release LCD TV using white-light LED backlight.

Suitable LED for LCD TV BLU?

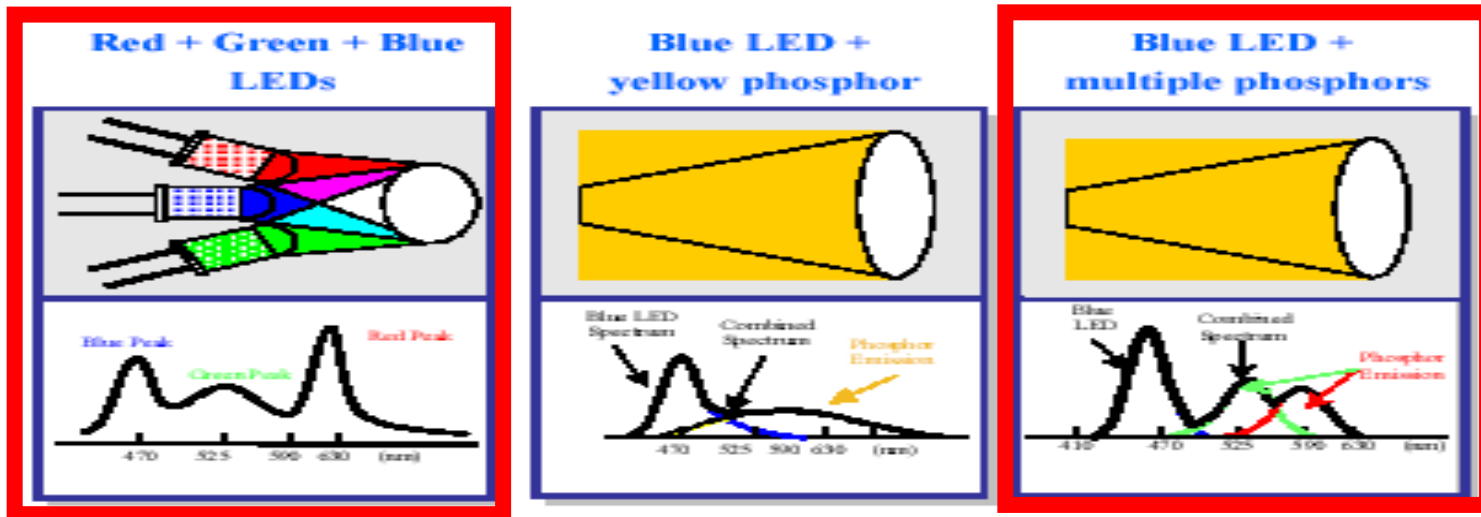


High power LED? Small or Middle power LED?
For LCD TV Backlight

ASTRI Proprietary



White LED vs. RGB LED



	RGB LED	White LED	RG-p White LED
Color Gamut	High (NTSC 90-110%)	Low (NTSC <70%)	Medium (NTSC 80-85%)
Efficiency	Low	High	Medium
BLU Cost	High (2.X-3.X)	Low (1.X)	Medium (1.X-2.X)
Others	Color Mixing RGB decay deviation		

RG-p White LED or RGB LED?

ASTRI Proprietary



Direct Emitting LED BLU: 47" TV

LED	40 lm/W => 280W		80 lm/W => 140W		120 lm/W => 93W	
	LED No.	LMD*	LED No.	LMD	LED No.	LMD
20mA	4200		2100		1400	23.5
60mA	1400	23.5	700	35	467	41
150mA	560	37	280		187	
350mA	240		120		80	
700mA	120		60		40	

500-550 nits for LCD TV

LMD*: Light Mixing Distance, in mm



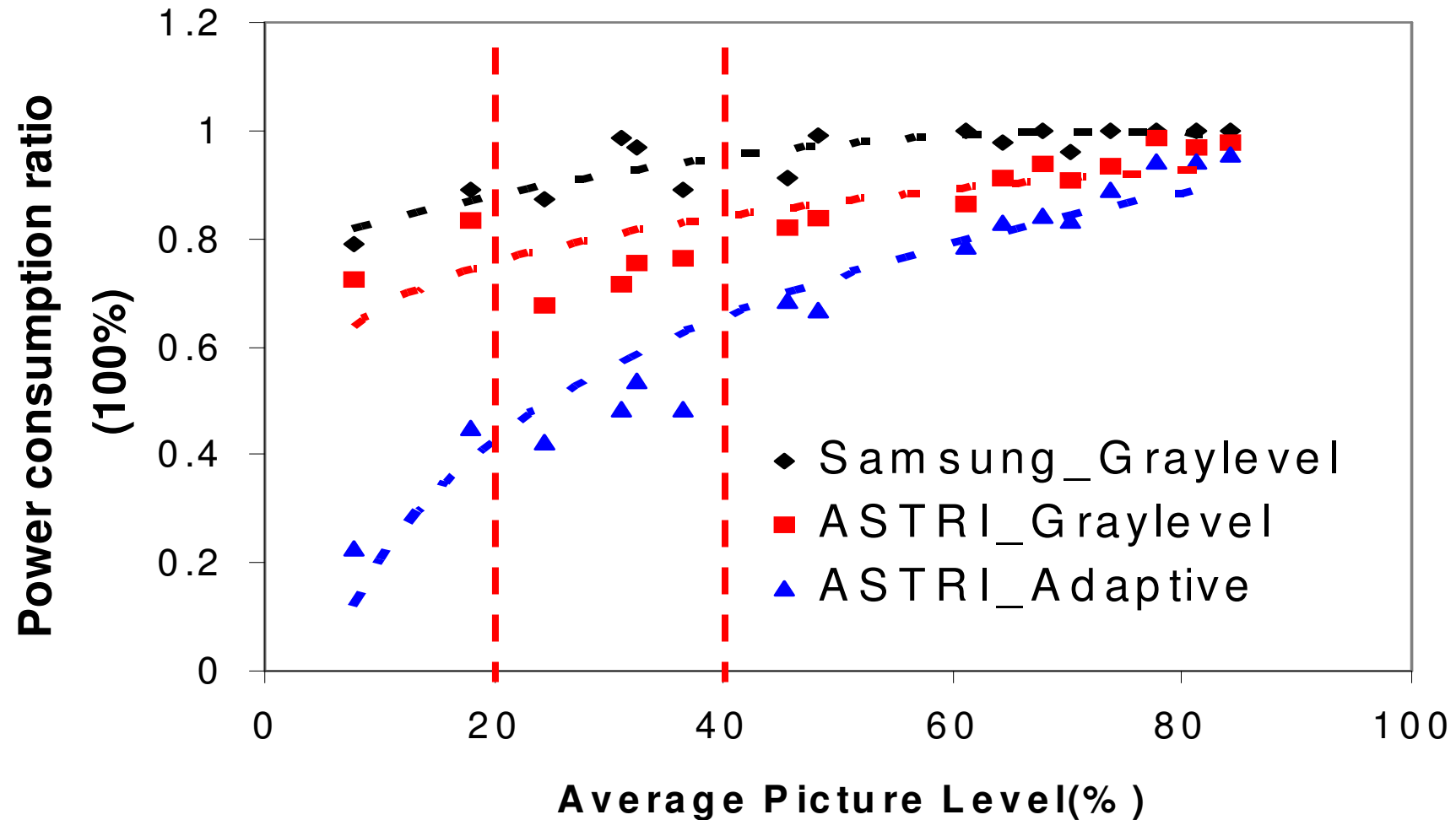
HDR Display: 2D Local Dimming Solutions ¹⁷



Dimming solution	LED BLU	Ave Power Saving	NTSC %	Color Crosstalk	FPGA Cost
Graylevel	White/RGB	>30%	~70-90	No	1X
RGB	RGB	>50%	>105	Yes	1.2-1.5X
Adaptive	RGB	>40-50%	>105	No	1.2-1.5X

Adaptive: Proposed by ASTRI

Power Saving of 2-D Dimming



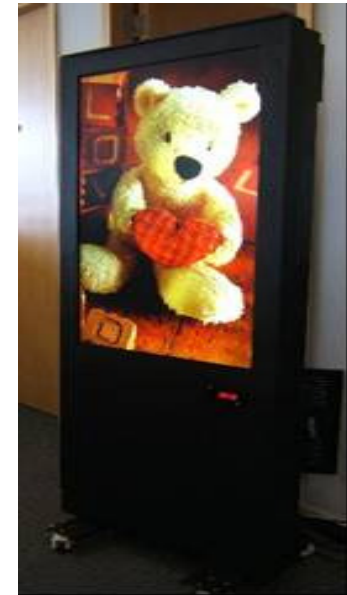
□ Samsung Gray Level: measured on LN-4081

ASTRI Proprietary



New HB Outdoor LCD Display Solution

- Combine HB LED backlight, 2D local dimming and readability image enhancement.
- High bright (1500-5000nits), sunlight readable
- Power saving: **>50%** of existing products



42" 1500nits HB BLU Power	
LED (full on)	470W
LED (dynamic)	W282
CCFL	605W

	LED Display	PDP	Traditional LCD (CCFL BLU)	ASTRI IPID
Resolution	Very low (20K-80K pixels/m ²)	High (>1M pixels/m ²)		
Brightness	High (>5000 nits)	Low (<1000 nits)	Low (<1500nits)	High (>5000 nits)
Power Consumption	High	High	High	Low (<50% Traditional LCD)
Cost (Estimated retail cost)	High (>20K US\$/m ² , P3.5)	Low (<4-6K US\$/m ²)		



ASTRI's Display System Division

LED BLU & HDR Display

Pico-Projector

SSL

MOEMS & Laser Scanning Projection

Interactive Display & Touch Sensing

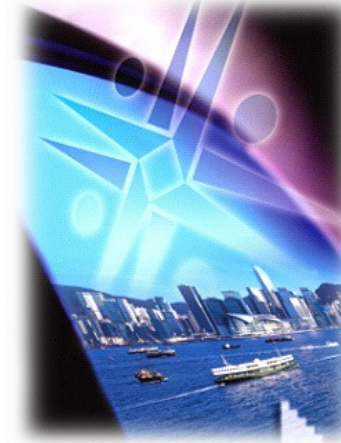
Innovative Application of Solid State Lighting in Display

Thanks

Contact us:

香港應用科技研究院有限公司(ASTRI)

www.astri.org



Contact	E-Mail	Phone No.	Project Items
Tsai Chen Jung (蔡振榮)	cztsai@astri.org	852-34062814	All
Chen Min (陳珉)	mchen@astri.org	852-34062823	HDR / LED BLU IPID
Ng Kwan Wah (吳均華)	kwng@astri.org	852-34062545	
Kenny CHAN (陳建龍)	kennychan@astri.org	852-34062989	Pico-Projector
Scott Chen (陳守龍)	scottchen@astri.org	852-34062988	MOEMS