LED Lighting in Theatre

(Not all LED lights are created equally)

GLEN MILLER

Introduction

- Glen Miller
  - President Theatre BC
  - Past President Deep Cove Stage
  - Resident Lighting Designer Deep Cove Stage

LED Lighting Agenda

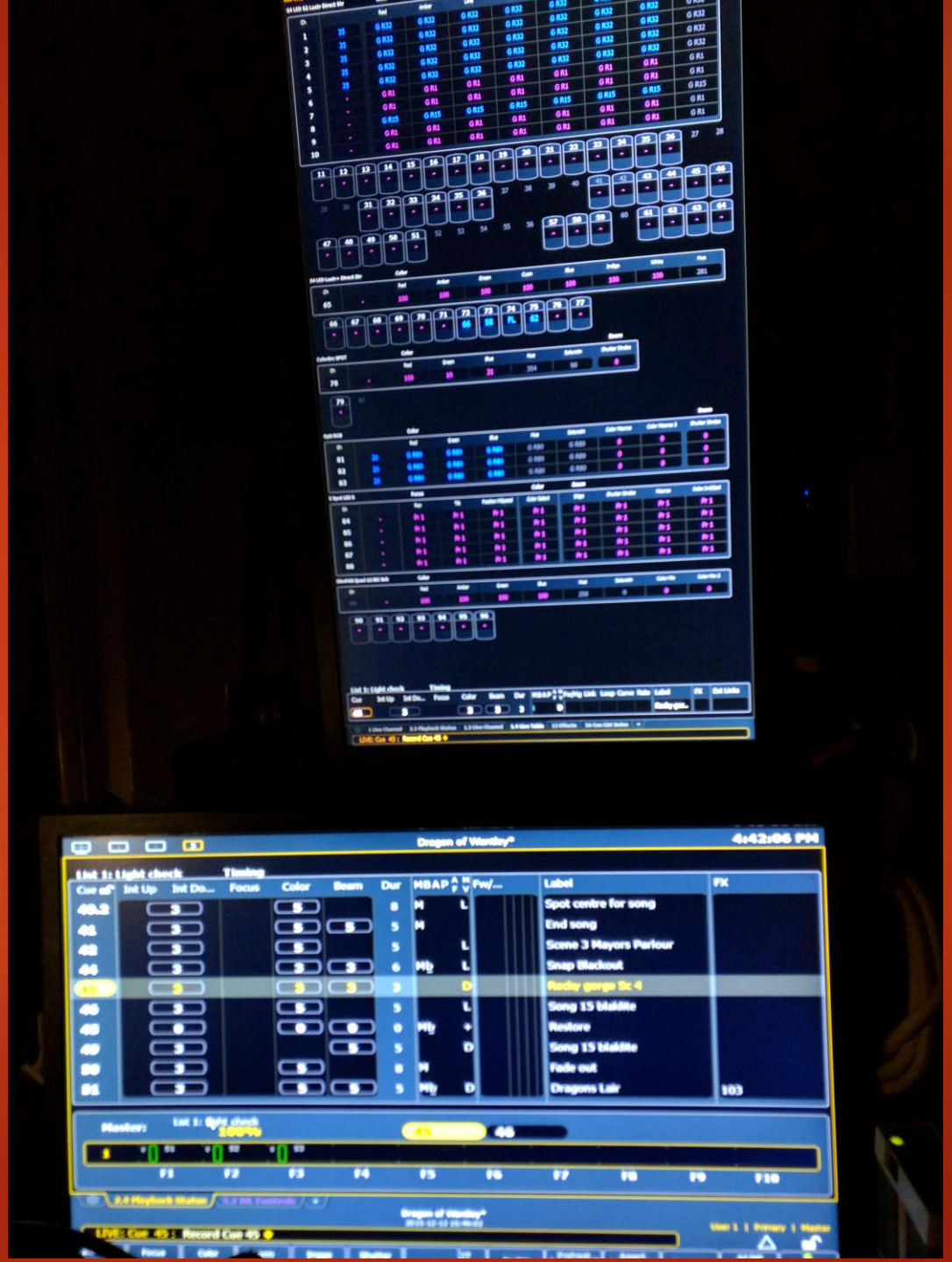
- Deep Cove Stage Goals and Objectives
- Deep Cove Stage plan
- Background on LED Lighting in the theatre
- Benefits
- Myths about power saving and payback
- Inrush current
- Electronic on board dimming (versus semiconductor dimming)
- Desk vs. DMX channels
- Experience with different instruments
- Preparing your theatre for LED
- Those little blue status lights (ambient light noise) and fan noise
- Colour mixing & colour path
- Budgeting gothcas
- What we found in practical application
- Is there still a place for traditional instruments

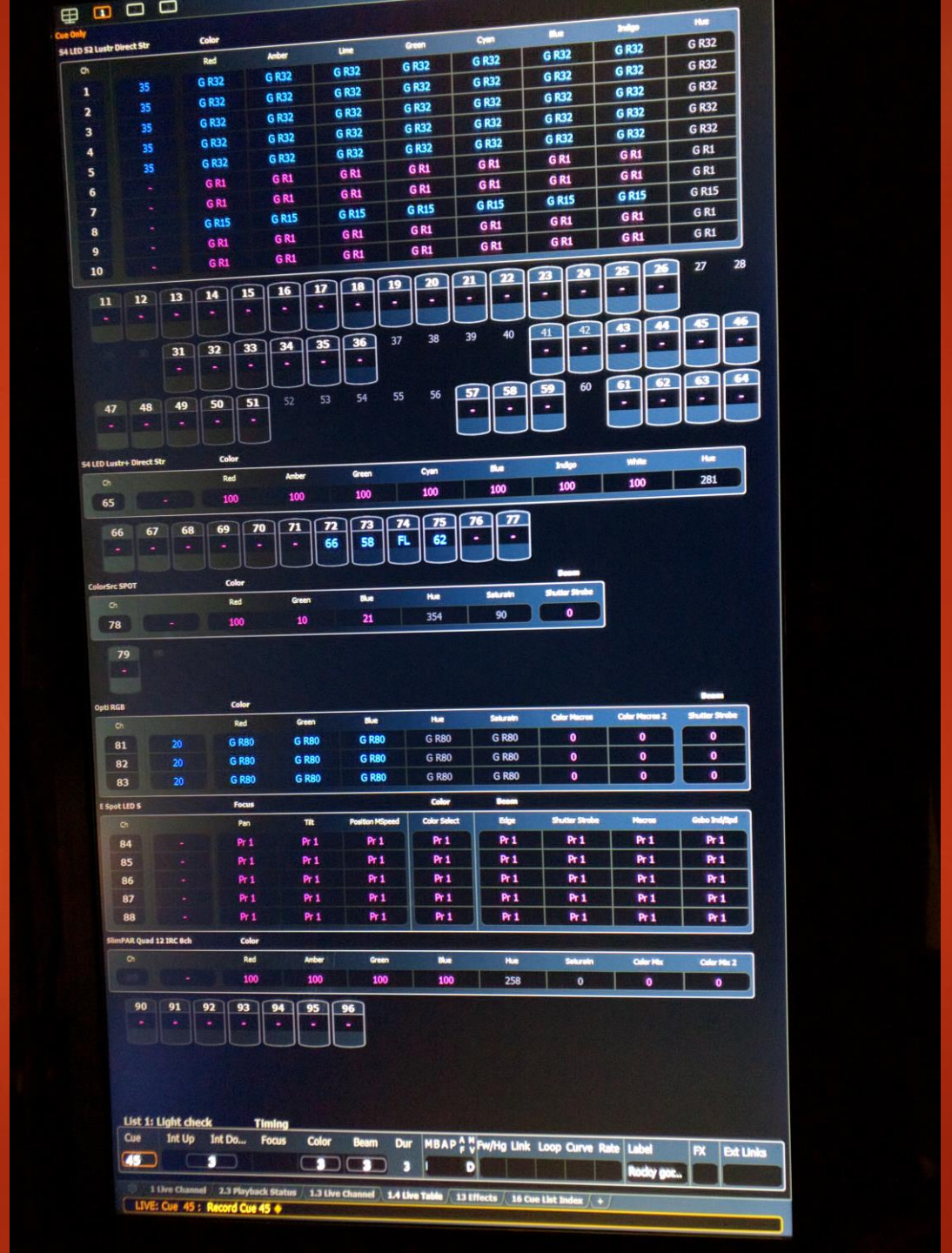
Deep Cove Stage Goals and Objectives

Safety

Ease of lighting hang

- Reduce use of extension ladder over house seats
- Reduce amount of light movement
- Reduce bulb replacement
- Establish solid house hang
- Have 20+ house specials
- LED Specials would be in situ
- Make it easier for other people to do lighting design and setup


Dragon of Wembley*
4:42:06 PM
List 1: Light check
Timing
Cue
Int Up
Int Do...
Focus
Color
Beam
Dur
MBAP
Fw/...
Label
FX
Spot centre for song
End song
Scene 3 Mayors Parlour
Snap Blackout
Song 15 blablite
Restore
Song 15 blablite
Fade out
Dragons Lair
Master:
100%
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10


Cue Only
S4 LED S2 Lustr Direct Str
Color
Red
Amber
Lime
Green
Cyan
Blue
Indigo
Hue
S4 LED Lustr+ Direct Str
White
ColorSrc SPOT
Beam
Shutter Strobe
Saturatn
Opti RGB
Color Macros
Color Macros 2
E Spot LED S
Focus
Pan
Tilt
Position MSpeed
Color Select
Edge
Macros
Gobo Ind/Spd
SlimPAR Quad 12 IRC 8ch
Color Mix
Color Mix 2
List 1: Light check
Timing
Cue
Int Up
Int Do...
Focus
Color
Beam
Dur
MBAP
Fw/Hg
Link
Loop
Curve
Rate
Label
FX
Ext Links
Rocky goe...
1 Live Channel
2.3 Playback Status
1.3 Live Channel
1.4 Live Table
13 Effects
16 Cue List Index
LIVE: Cue 45 : Record Cue 45

Deep Cove Stage Plan

- Starting point (from previous 3 years)
  - 5 Elation moving lights
  - 3 Elation Opti RGB par
  - Chauvet Slimpar Quad
  - ETC Ion Lighting board
- 10 Lustr Series 2 with Fresnel lens and EDLT lens for FOH Wash
- 10 Colorsource Par for back and top lighting
- 5 Microh Zoom Par (later changed plan due to noticeable flicker and colour gamut to purchase 5 additional Colorsource pars)
- 4 Colorsource spot for side accent lighting
- 26 remaining tungsten ETC Source 4 for specials
- Future: 2 Colorsource spot with I-Que and DMX Iris
- Shore power, 4 circuits with 1 toggle switch (for up to 6 circuits)

Background

LED Lighting in the Theatre

- RGB breakup – cast multicoloured shadows
- Watch for bumpy dimming profile (flicker)
- Hot and fast in time. Some LED lights come on fast – at 10% equivalent to 30%
- Limited colour gamut, especially on RGB instruments (may be less important for back lighting).
  - Test light against common gel colours i.e. R02, R04, R65 etc.
- Less options for LED ellipsoidals
- Zoom pars give lots of flexibility for wash lights
- Need sufficient addressable channels on the board
- Some lights are 3 Pin DMX and some are 5 Pin
- Many cheap ‘disco’ options not suited for theatre
  - For example, RGB Breakup and flicker on dimming are not issues in a disco

Benefits

Some of the many benefits

- No filament sing
- Fire and forget house wash
- No gels
- No bulb replacement
- Reduced power consumption
- Reduced heat generation
- Unlimited colour selection!!

Myths about power

Power saving vs. Payback time

- Calculation based on 100 shows annually running full for 2 hours
- Based on current BC Hydro rate of $0.1073 per kWh
- Does not take into account threshold rate differences
- Does not take into account potential rate increases
- **Power savings are great – but the payback period is too long to use as purchase justification**

Item	Instrument	Wattage	kWh annually	Cost	Savings
			=(wattage*200)/1000	$0.1073 per kWh	
Baseline	Source 4	575	115	$ 12.34	
	Lustr	171	34.2	$ 3.67	$ 8.67
	ColorSource Spot	141	28.2	$ 3.03	$ 9.31
	ColorSource Par	90	18	$ 1.93	$ 10.41

Item	Instrument	Wattage	kWh annually	Cost	Savings	Price	Payback years
			=(wattage*200)/1000	$0.1073 per kWh			
Baseline	Source 4	575	115	$ 12.34			
	Lustr	171	34.2	$ 3.67	$ 8.67	$2,400.00	276.8
	ColorSource Spot	141	28.2	$ 3.03	$ 9.31	$1,400.00	150.3
	ColorSource Par	90	18	$ 1.93	$ 10.41	$ 700.00	67.3

Myths about power

Other factors in savings calculation

- Heat dissipation
- Bulb replacement
- Gel cost (minimal)

Myths about power

Other factors in savings calculation

- Bulb replacement
- 2000 Hours 575 W HPL bulb
- $50
- Lasts 10 years based on lit time 200 hours per year for this model
- $5 per year
- (Note 750 Watt high output bulbs rated 300 hours = $25 per year – standard 750 Watt rated 2000 hours)

Based on 575 W HPL Bulb

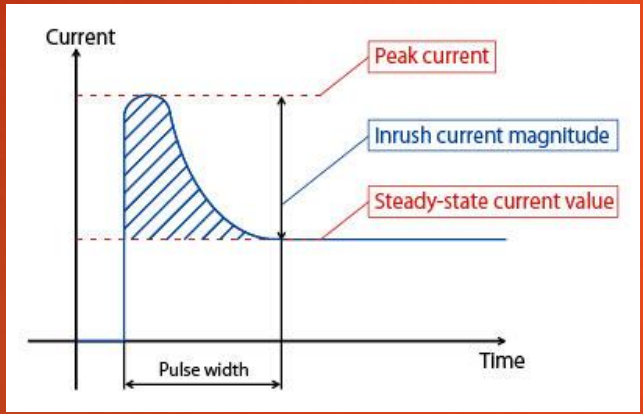
Item	Instrument	Wattage	kWh annually	Cost	Savings	575 W HPL	Price	Payback years
			=(wattage*200)/1000	$0.1073 per kWh				
Baseline	Source 4	575	115	$ 12.34				
	Lustr	171	34.2	$ 3.67	$ 8.67	$ 5.00	$2,400.00	175.6
	ColorSource Spot	141	28.2	$ 3.03	$ 9.31	$ 5.00	$1,400.00	97.8
	ColorSource Par	90	18	$ 1.93	$ 10.41	$ 5.00	$ 700.00	45.4

Based on 750 W HPL Bulb

Item	Instrument	Wattage	kWh annually	Cost	Savings	750 W HPL	Price	Payback years
			=(wattage*200)/1000	$0.1073 per kWh				
Baseline	Source 4	750	150	$ 16.10				
	Lustr	171	34.2	$ 3.67	$ 12.43	$ 25.00	$2,400.00	64.1
	ColorSource Spot	141	28.2	$ 3.03	$ 13.07	$ 25.00	$1,400.00	36.8
	ColorSource Par	90	18	$ 1.93	$ 14.16	$ 25.00	$ 700.00	17.9

Inrush current

Switch-on surge



- "Inrush current is the current that flows in a short time period just after the first switch on of a cold lamp on the grid voltage. With cold I mean that the lamp has been off for some time, enough to have the major capacitors and eventual coils empty with regard to energy" **
- Inrush current limiter
- Maximum number of lights per circuit

** (http://www.olino.org/us/articles/2013/10/22/inrush-current-for-led-light-bulbs, 2014).

Electronic dimming

Instruments do on-board electronic dimming

- DO NOT DIM LED INSTRUMENTS
  - although – Chauvet and others now make instruments that can be dimmed or using electronic on-board dimming
  - Difference in the behaviour of on board vs. standard dimming
- Provide non-dimmable circuit (Mains power)
- Do not use dimmer with a non-dim curve as this can be overridden by using DMX address directly and not channel

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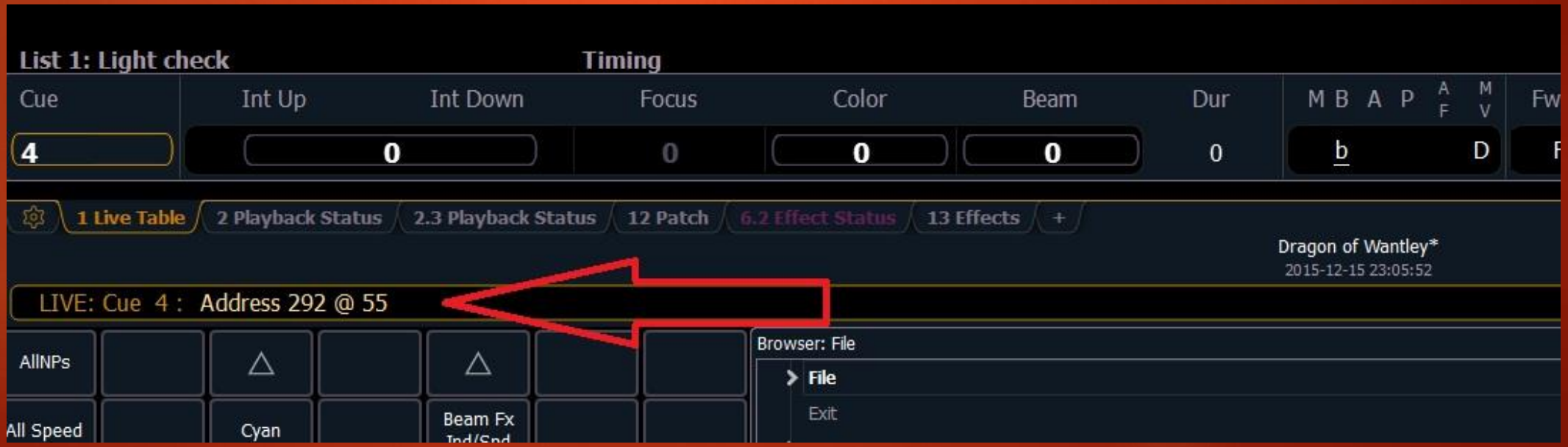
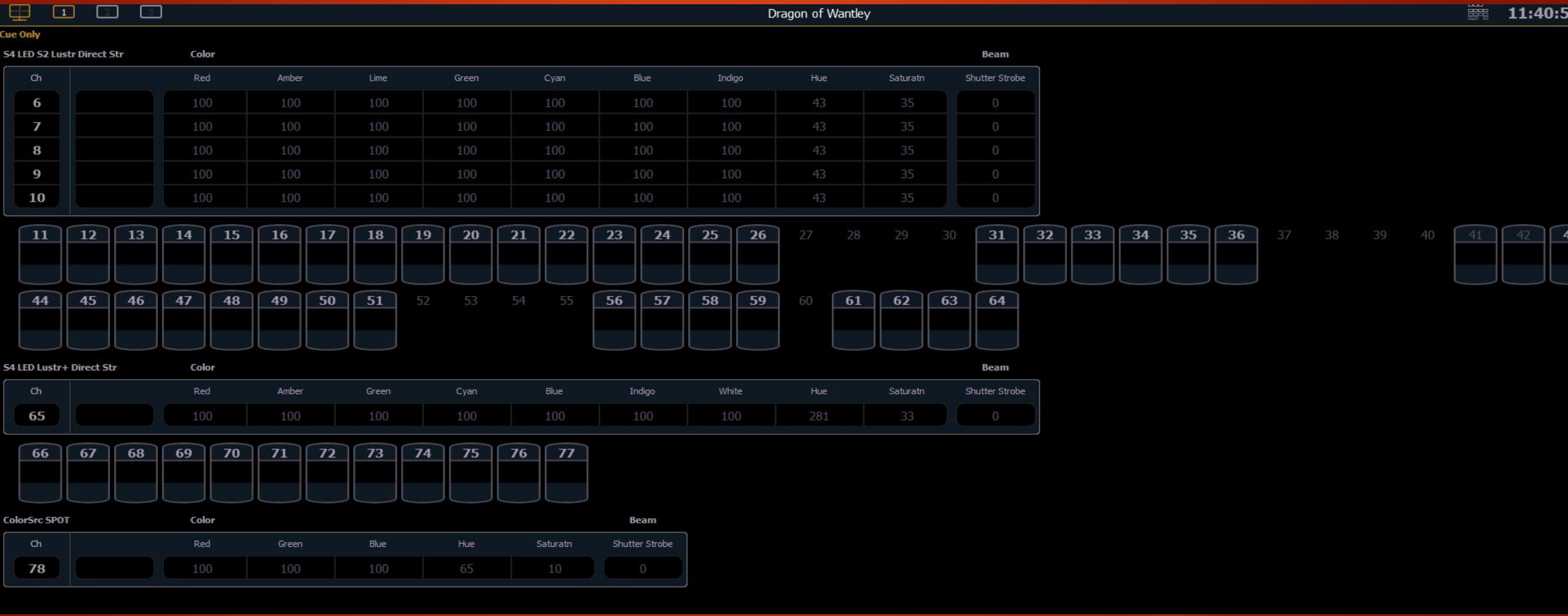


Channels

Desk channels vs. DMX addresses



Channels

Desk channels vs. DMX addresses

Instrument testing

Micro Slimpar Quad Pro

Note Micro is a Canadian company based in Toronto. Products are made in Europe and China – may act as hedge against currency fluctuations

- The light is punchy
- It does not have a good colour range since it is only RGBA – certainly no match for the Lustr
- It has a bumpy dimming profile with significant flicker in the 5 – 30% range. We put a slow build curve on the channel patch and that helped a bit but there is no getting around it bumping on the way up. The down curve is pretty good though.
- **WAS NOT RECOMMENDED FOR DCSS**

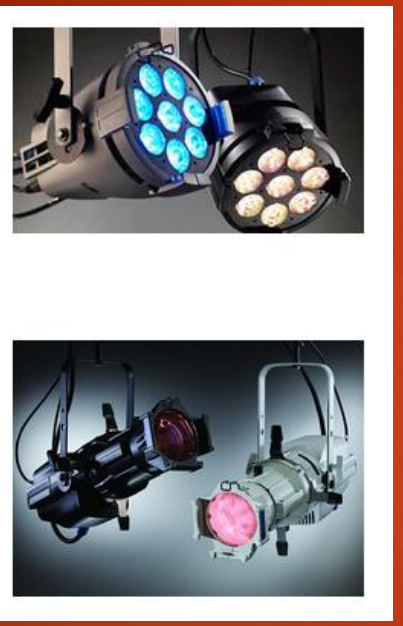
Instrument testing

Micro Quad Par Zoom

- This is a good PAR LED that will zoom in and out remotely. From above the deck at 17' single light will almost wash the entire stage.
- It does come on a bit hot in the 5 – 10% range, but can be compensated by using a slow build dimming profile
- It has a good colour range, although it is not as versatile as the ColourSource Par/Spot.
- Luminosity is good
- It is not flicker free
- The zoom feature will allow the creation of area lighting from the lighting board. While not necessarily used as a moving light feature, it could still be used for a scene transition to make an interesting effect.
- **WAS NOT RECOMMENDED FOR DCSS**

Instrument testing

ETC ColorSource Par and Spot



- The dimming profile is very smooth – flicker free
- The luminosity is good
- The diffusion lens were good for getting different shapes or expanding the throw of the light (including oblong shape)
- The colour gamut while not in the range of the ETC Source 4 Lustr, is very good. The saturated colours are very rich and the warm (i.e. Rosco 02 – 14) and cool colour (Rosco 60 – 70) provide good approximation of the gels. It was very strong in Billington Pink and Broadway Pink range (good musical show colours).
- We see the par version as very good for top and side lighting, and the Spot for tips and specials.
- **It was recommended for DCSS for (5) top lights to replace 10 fresnels, (5) backlight and (5) FOH wash for upstage.**
- **Recommended Spot version (4) for side lighting.**

Instrument testing

ETC Lustr Series 1 and 2

- We started with six of these lights and they are the best and almost only LED ellipsoid on the market (along with the ColourSource Spot which uses the same S4 barrel and lens tube).
- Our testing was done in relation to replacing the Source 4 tungsten FOH wash lights and we found that they provide 85 – 90% of the luminosity. We rarely run them at 100% as they are 750w instruments, so the difference in output is not a problem.
- There is a special lens called an Enhanced Defintion Lens Tube *recommended* for the S4 Lustr. The EDLT is a more efficient optic and this enhances two attributes of the beam:

  1) It can be focused more sharply.
  2) It is a brighter beam.

  Since some FOH positions tend to be a longer throw, the brighter beam can sometimes help that out. However, in our theatre our furthest FOH position has less than a 20' throw, so we recommended just a single EDLT for the existing Series 1 which will be used for specials and gobo effects.
- ***BEWARE FAN NOISE***
- **Recommended for main FOH wash – (10) units (repurposing 5 already purchased lights) and (5) with Fresnel lens.**
- **ETC Source 4 Lustr Series 1**
- We have one Series 1 LED, it was the original source 4 LED light. It has the same colour mixing as the series 2 but with less luminosity
- We could use these for specials, as the existing Series 1 works well for that. It is about $350 less than the Series 2. However, we recommend the ColorSource Spot for specials. Although it does not have the colour range of the Lustr it has more output and it much cheaper and does not require an expensive EDLT lens.

Instrument testing

ETC Selador Desire D22, D40, D60

- ETC bought light design from original developers
- In our experience we found that there was too much colour breakup to make it a useful wash light

Preparing your theatre for LED lighting

- Mains power (we call it Shore power because we are in Deep Cove)
- Switch off LED when not in use
  - Beware vampire power draw - $5.64 annually for 1 Lustr when light is not lit but instrument is powered on
- Also switch off LED as some moving lights occasionally go into a psychotic state and need to be powered off
- DMX cabling
- Power through connectors

Those little blue status lights and that hum
(but not filament sing)

- Not all devices have them
- Ambient light noise
- Can turn off permanently – not recommended
- Remote off by RDM

- ETC Lustr S1 and S2 have fan noise
- Can turn off using +7 config or fixture setting and lamp will override if it gets hot

Colour mixing

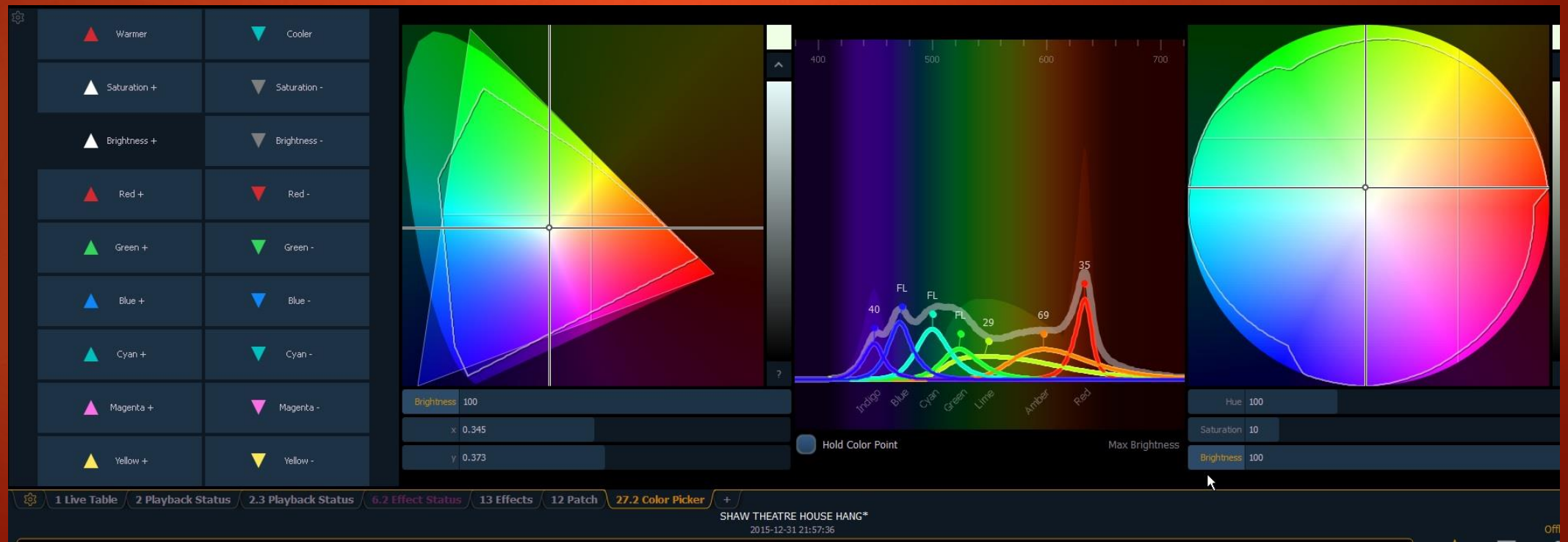
Think outside of gels

- Still tend to think in terms of gels

Colour mixing

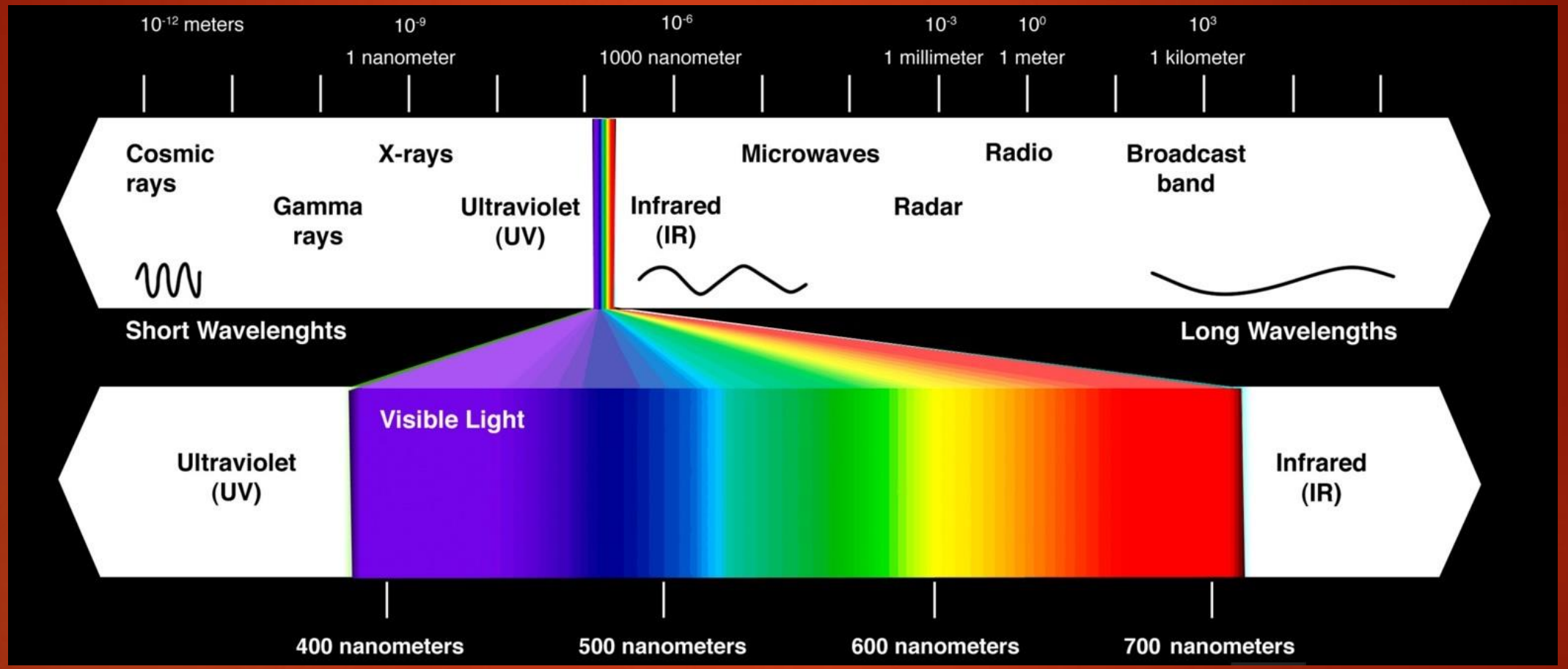
Think outside of gels

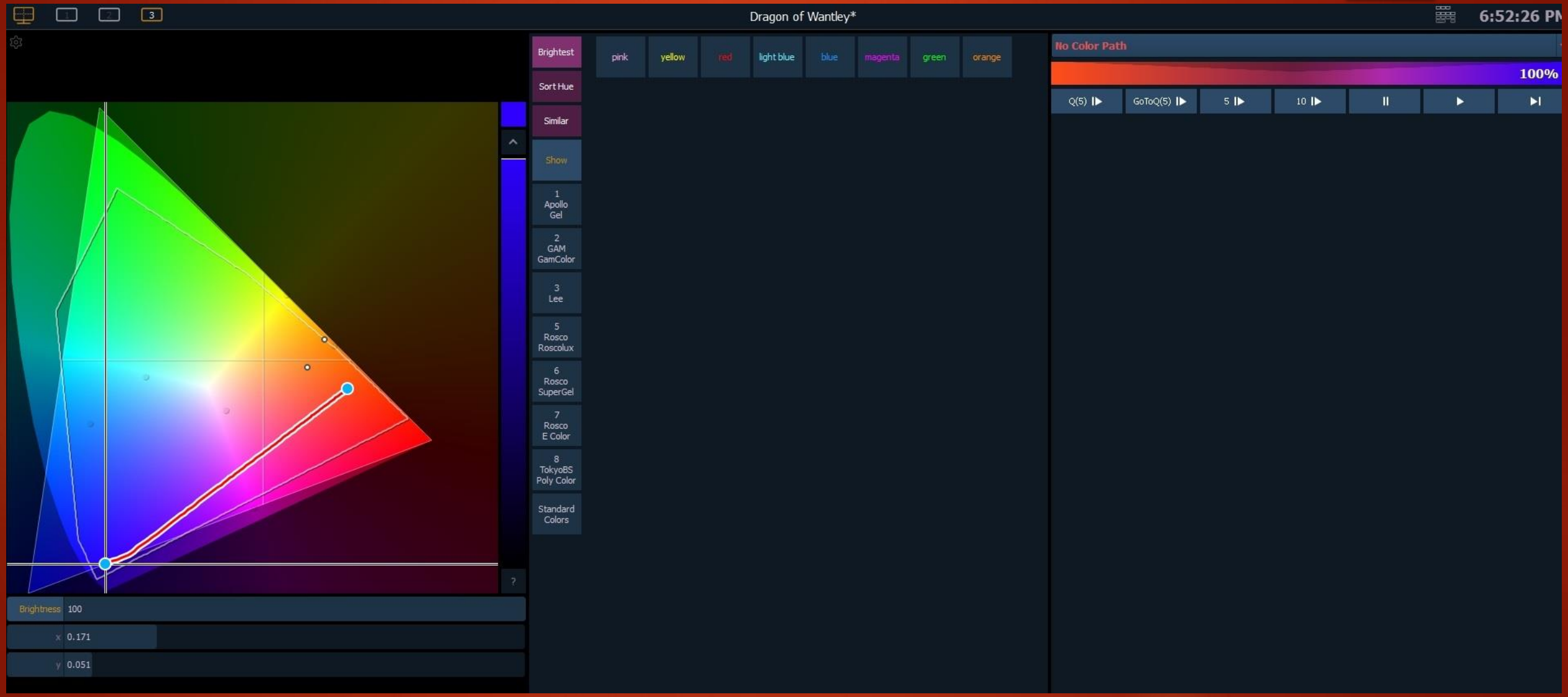
- Still tend to think in terms of gels

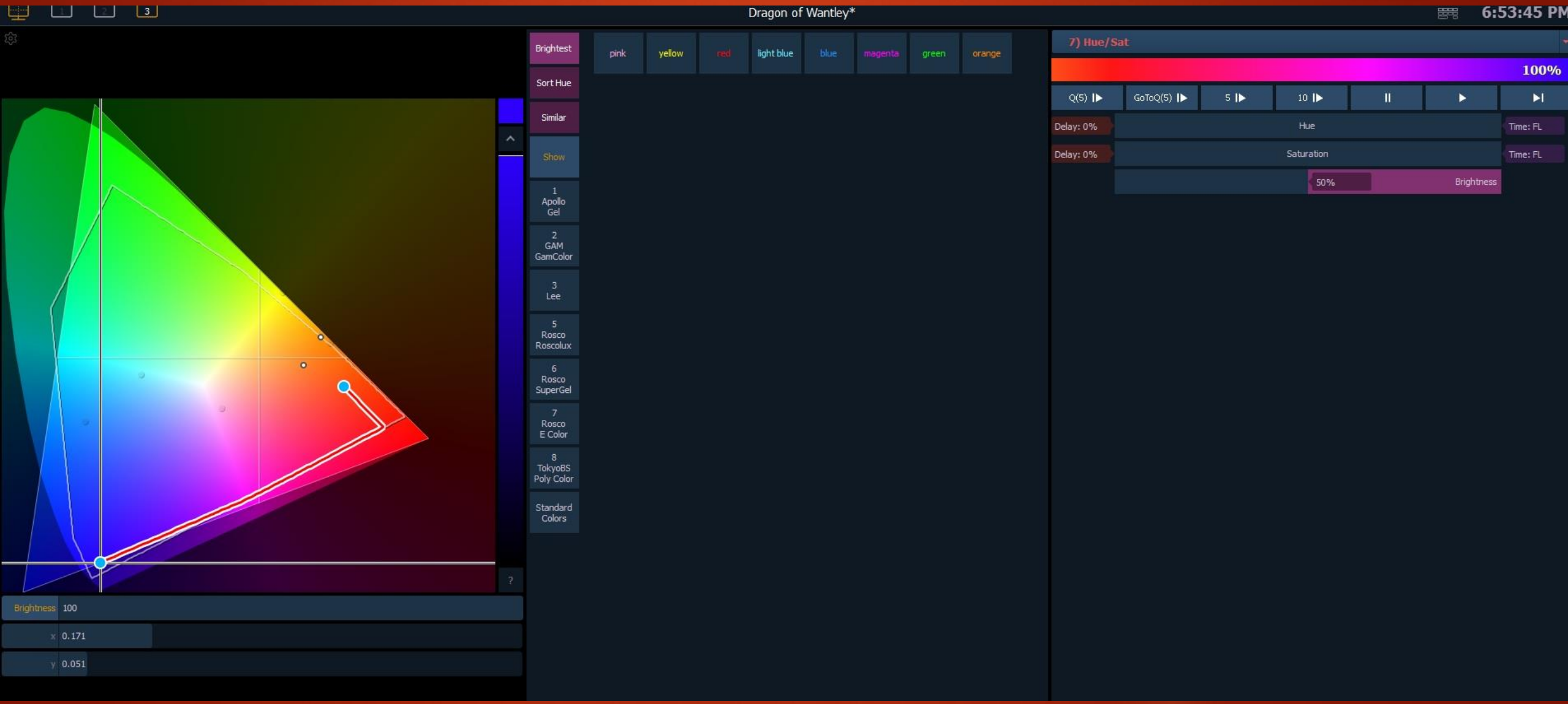


Colour path

- A daylight to night wash will take your LED through some funky colours
- Adjust colour path in lighting board


10^{-12} meters
10^{-9}
1 nanometer
10^{-6}
1000 nanometer
10^{-3}
1 millimeter
10^{0}
1 meter
10^{3}
1 kilometer
Cosmic rays
Gamma rays
X-rays
Ultraviolet (UV)
Infrared (IR)
Microwaves
Radar
Radio
Broadcast band
Short Wavelenghts
Long Wavelengths
Ultraviolet (UV)
Visible Light
Infrared (IR)
400 nanometers
500 nanometers
600 nanometers
700 nanometers


Dragon of Wantley*
6:52:26 PM
Brightest
pink
yellow
red
light blue
blue
magenta
green
orange
Sort Hue
Similar
Show
1 Apollo Gel
2 GAM GamColor
3 Lee
5 Rosco Roscolux
6 Rosco SuperGel
7 Rosco E Color
8 TokyoBS Poly Color
Standard Colors
No Color Path
100%
Q(5)
GoToQ(5)
5
10
Brightness 100
x 0.171
y 0.051


Dragon of Wantley*
6:53:45 PM
Brightest
Sort Hue
Similar
Show
1 Apollo Gel
2 GAM GamColor
3 Lee
5 Rosco Roscolux
6 Rosco SuperGel
7 Rosco E Color
8 TokyoBS Poly Color
Standard Colors
pink
yellow
red
light blue
blue
magenta
green
orange
7) Hue/Sat
100%
Q(5)
GoToQ(5)
5
10
Delay: 0%
Hue
Time: FL
Delay: 0%
Saturation
Time: FL
50%
Brightness
Brightness 100
x 0.171
y 0.051

Budgeting gotchas

- Power through connectors $40+ per light depending on length
- DMX Cable $15+ per light depending on length
- Shore power (our theatre $2,000)
- LED lights when not in use consume 6 watts of power
- Lustr lights self terminate DMX but CS do not and need a terminator

What we found

Our experience in practical use

- Luminosity – replaced (20) 750w fixtures (Source 4s are usually 575w) with 10 LED. Noticed a drop although we rarely ran fixtures past 80%
- Compensate for difference by being able to select any colour and can select good warm white light say 5500K (daylight range 5500 – 6500)
- Original setup difficult – heavy instruments plus control cable and power through connectors took time to setup
- Lustr ETC lights are truly magical

Is there still a place for practical instruments

Many new theatres all LED

- Still want dimmers for practicals etc.
- Need a special – pop in a tungsten instrument easily
- LED Lights are heavy
- LED Lights are expensive, want to minimize their movement

Is there still a place for practical instruments

Many new theatres all LED

- Still want dimmers for practicals etc.
- Need a special – pop in a tungsten instrument easily
- LED Lights are heavy

Is there still a place for practical instruments

- Moving an LED requires also moving control cable (unless you have a ColorSource relay for wireless DMX and RDM)
- We have LED connected using power through connectors and DMX in chain. Not necessary but much cleaner install – makes them harder to move
- We see LED specials as being in situ

Recommendations

- Do not mix and match suppliers of the same type of lights (i.e. ellipsoidals, pars etc.)
- Beware of fan noise