FMS UV Curing System Safety Review

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STAR FMS UV Curing Project Overview

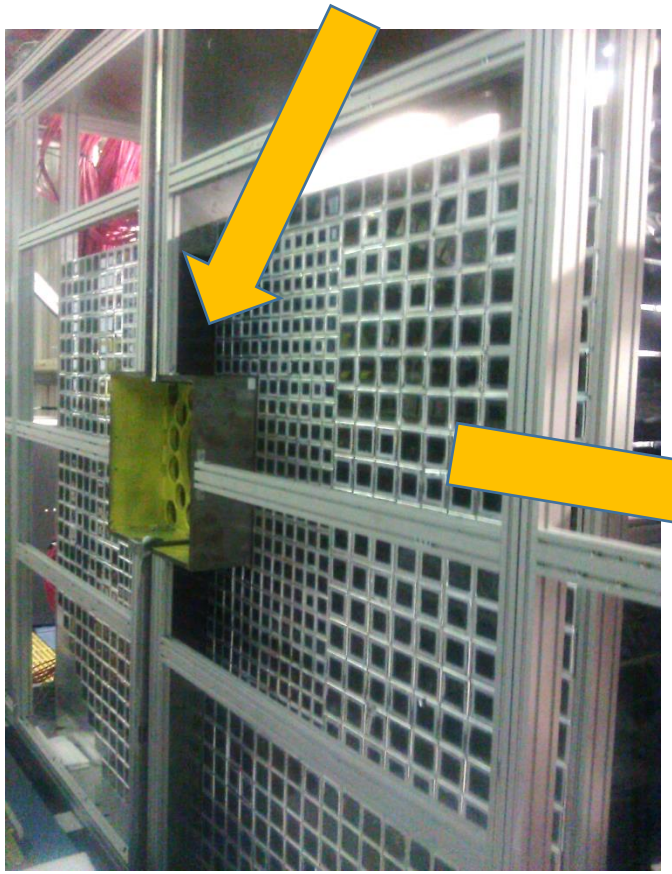
- FMS is a lead glass array of 1264 blocks of lead glass on STAR West mezzanine
- Previous runs resulted in heavy radiation damage to lead glass transparency due to formation of f-centers
- Disassembly of FMS in 2014-2015 for curing with sunlight enormous effort
- Damage equivalent to previous runs expected ~1/week during upcoming run
- STAR is building a UV system to ‘cure’ lead glass in situ for 2017 run

R&D

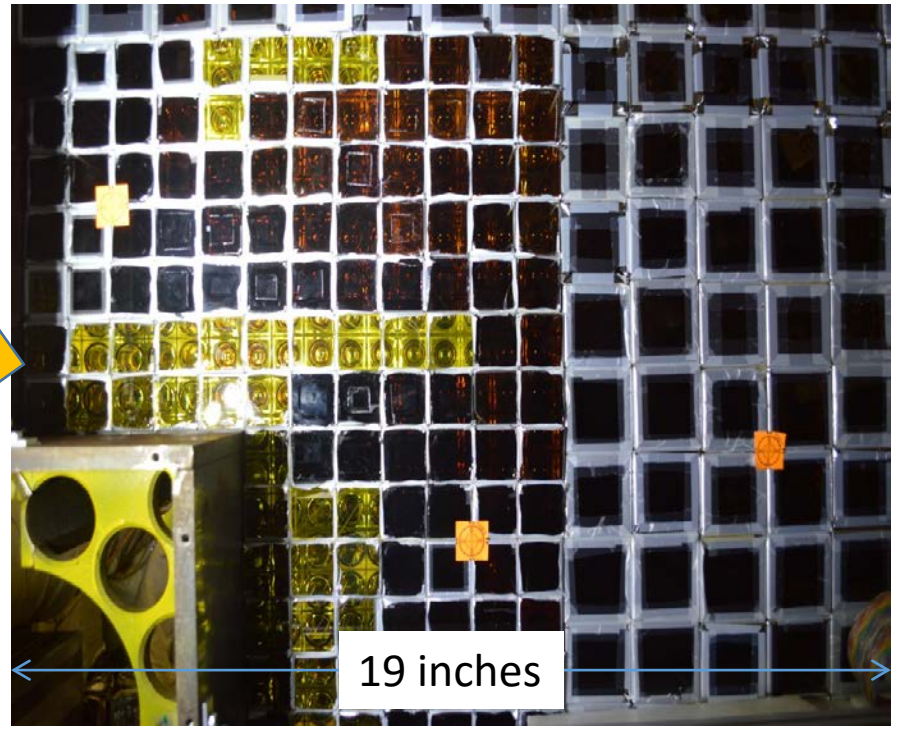
- Characterize lead glass damage
- Investigation of other methods for curing lead glass: JLAB
  - Florescent bulbs
  - Heat
- UV LEDs
- Specification of UV system for STAR FMS
- Specification of UV system components and implementation

Radiation Damage to Lead Glass

Off axis view of lead glass stack.
UV system must fit in this space
between the frame and glass.



Front View: Detail of lead glass darkening
Blocks are precisely square…they appear
uneven because they are wrapped in
aluminized mylar.

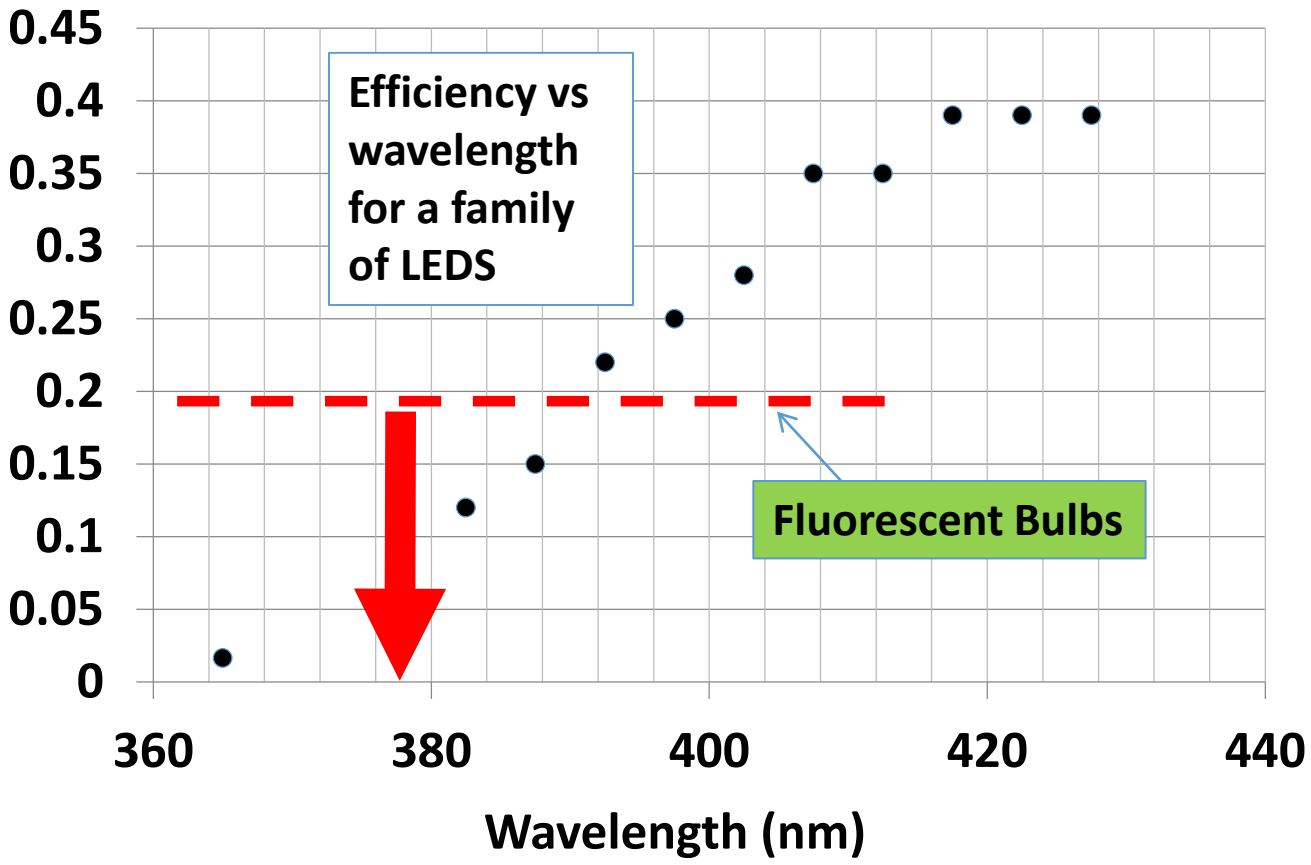


Clear 'radiation hard' glass appears yellow, but transparent
Damaged glass appears black in the worse areas and brown in less affected areas

UV LEDs vs Fluorescent Bulbs

UV LEDs are NOT as efficient as fluorescent bulbs below 390 nm, but waste heat from LEDs can be removed by backing plate and power supplies located outside enclosure

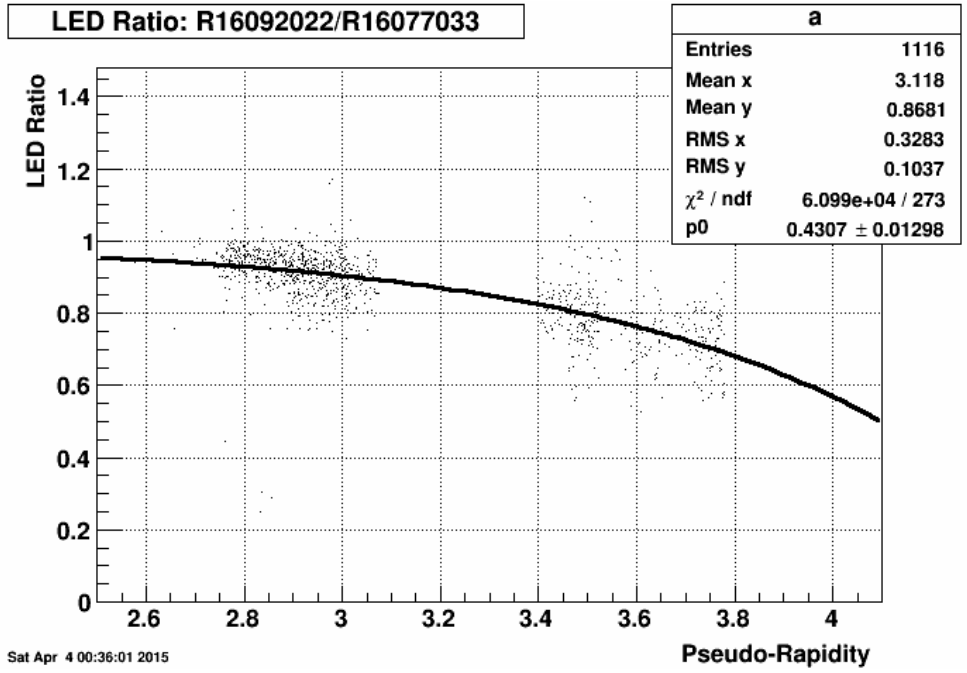
Efficiency= Optical/Electrical Power



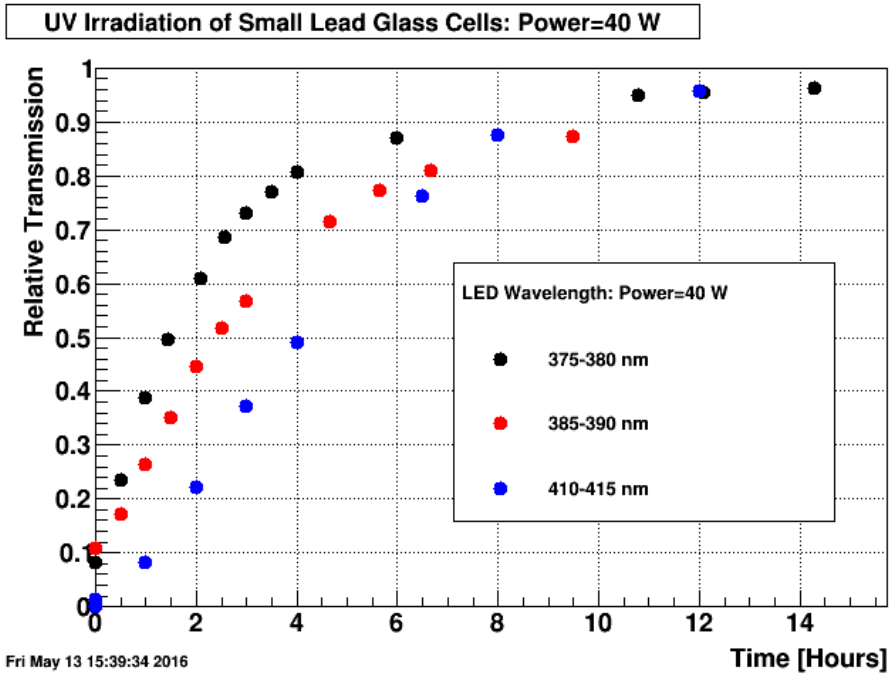
Choose 375-380 nm as most effective for budget
~ 10% efficiency

LED Design Considerations

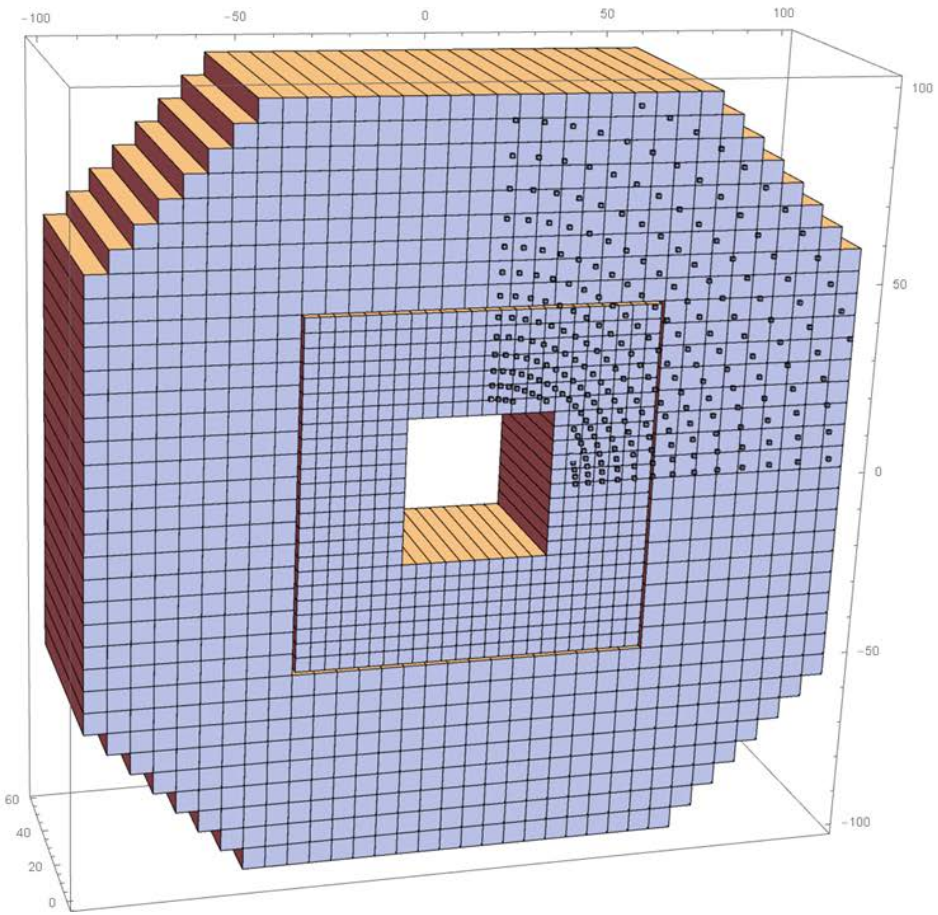
Radiation Damage Profile



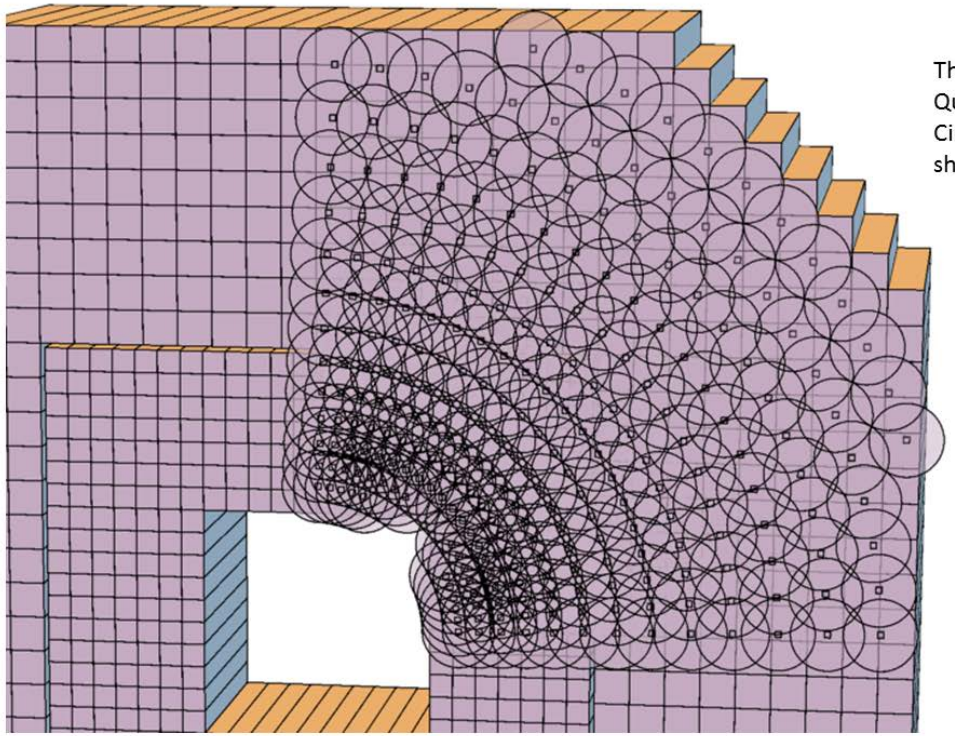
Curing Rate



LED Position Layout/Illumination



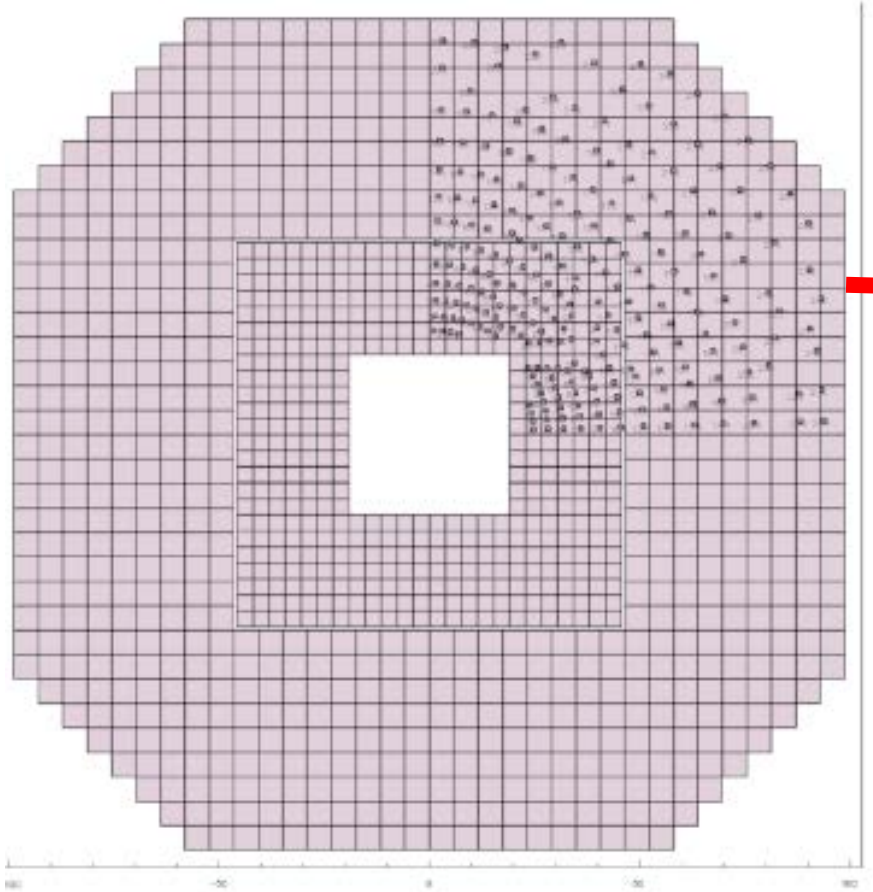
256 LED's
2.4 kW per ¼ detector



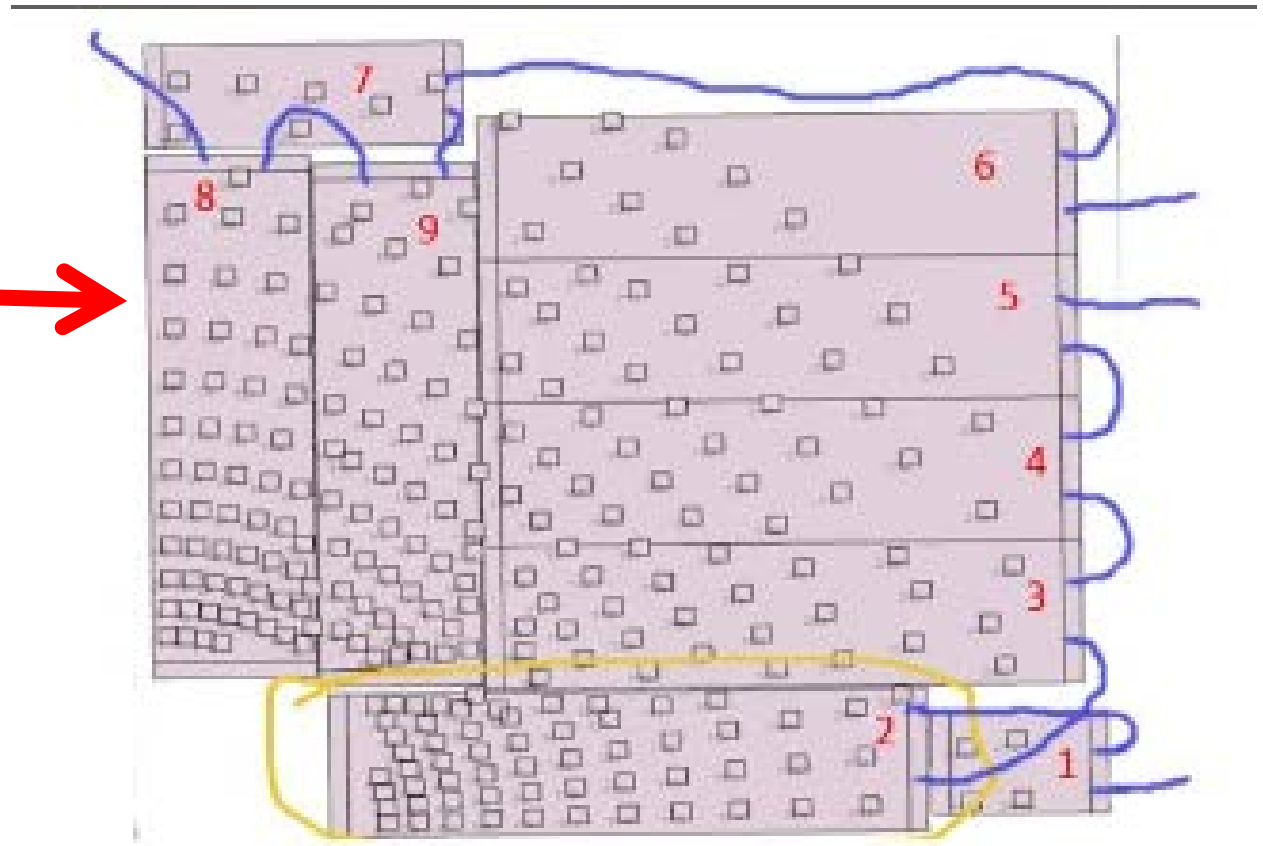
The Light pattern of a 256 LED Quadrant. (2.5 KW /Quadrant) Circles of 6 cm Radius are shown.

FMS UV LED Layout

FMS Layout

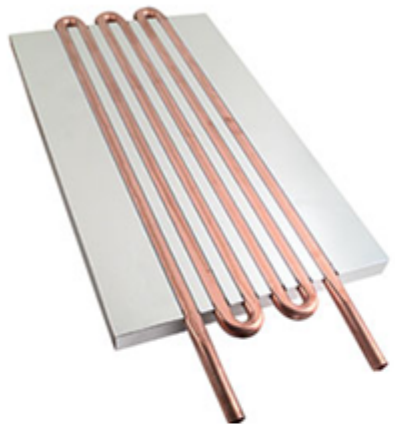


Quadrant Layout

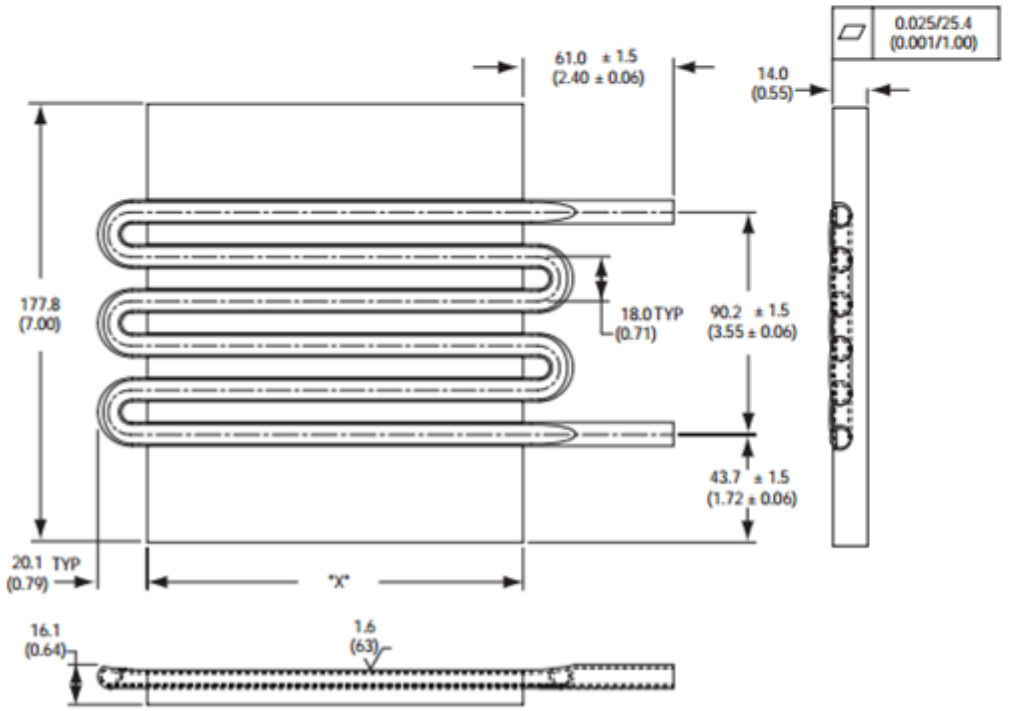


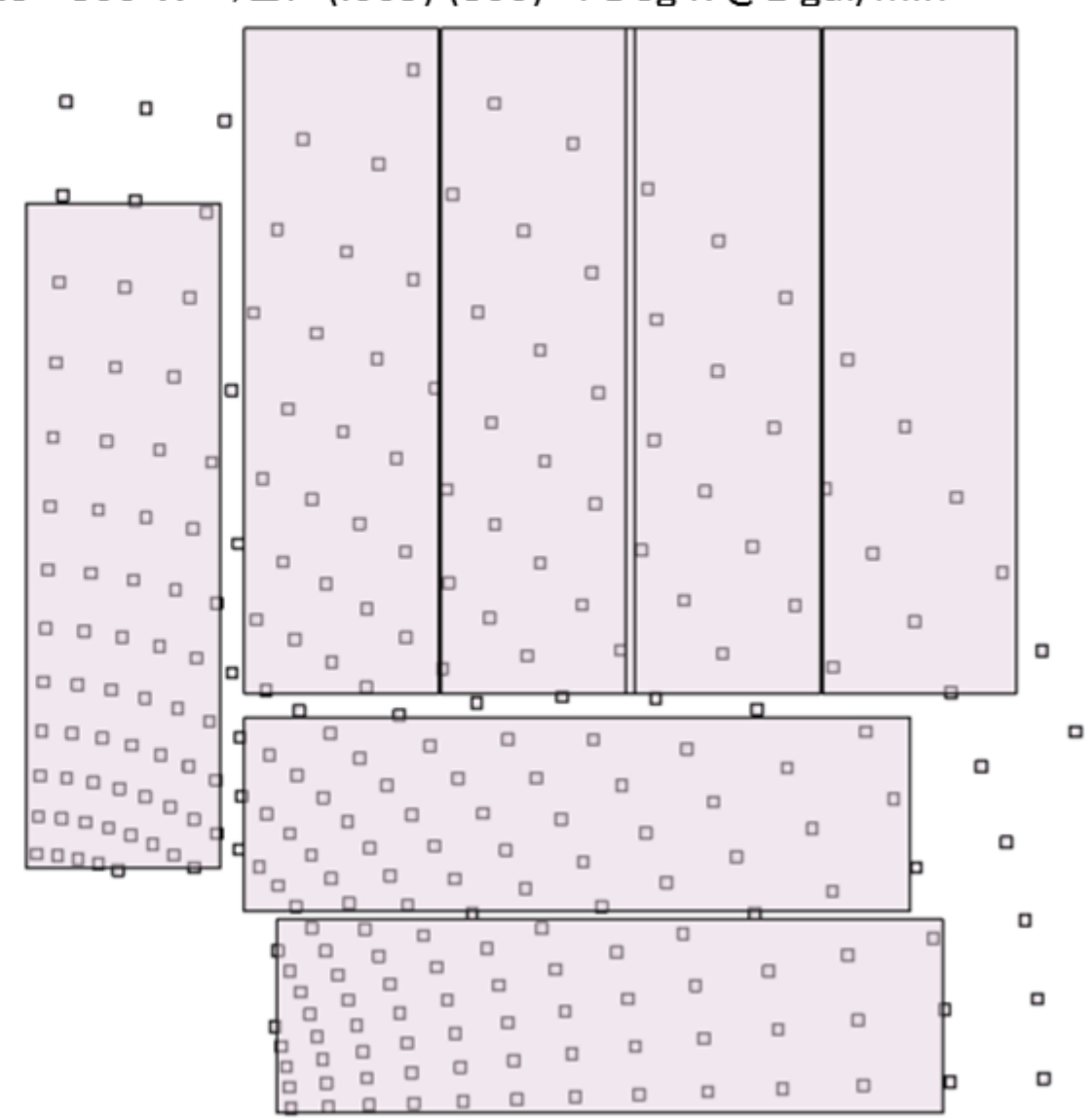
»Back to Tube Liquid Cold Plates

416301U00000G

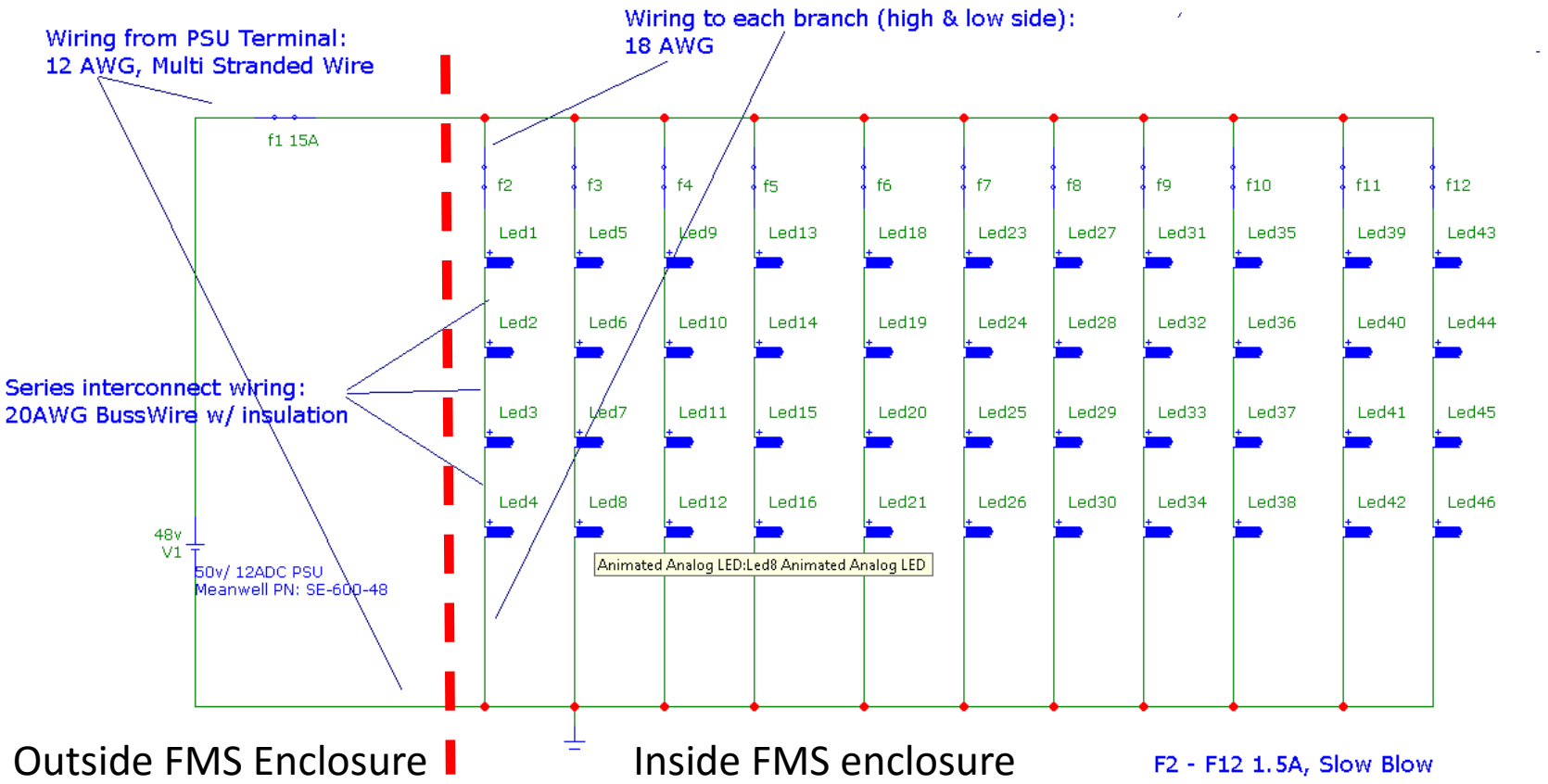


7 cold plates 1.4 cm thick
under a thinner copper plate
Power / plate 100-800 W/plate
Greatest heat load/plate = 800 W $\rightarrow \Delta T = (.005)\ (800) = 4$ Deg K @1 gal/min

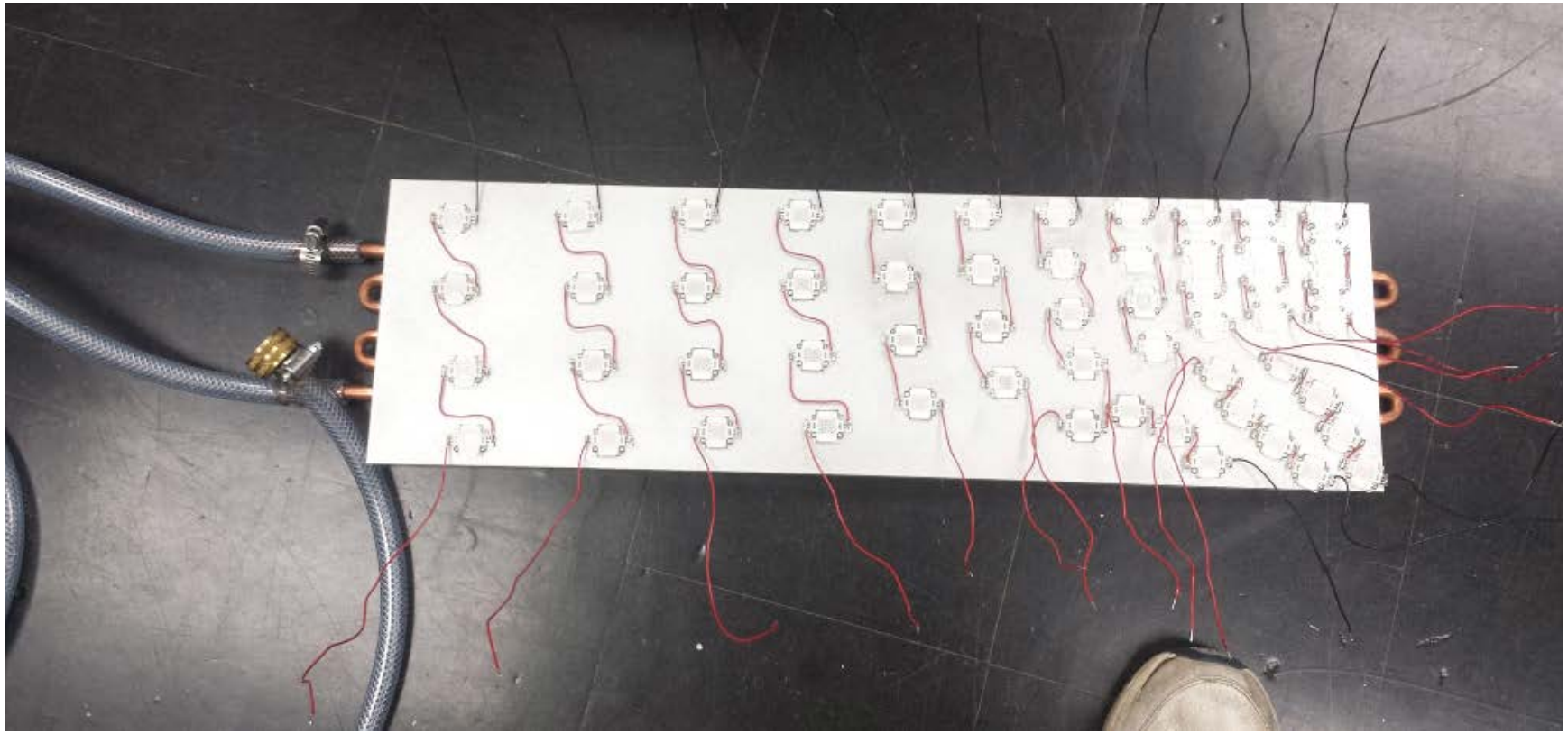




LED Wiring Diagram



Prototype for Cold Plate



~20 Power Supplies: 12*4*10W ~ 20 supplies x 500 Watts/supply = ~ 10 kW

SE-600-48
Supply V = 43-56V
Supply Current <12.5A
Supply output = 600 W
Efficiency = 0.88
Input = 12 A 115 VAC

Exterior to FMS Enclosure
Dissipates ~ 1kW total

Power Supply NOT UL tested
But electronics group
approves as very similar.
They do not run hot.

MEAN WELL

600W Single Output Power Supply

SE-600 series

■ Features :
- A C input active surge current limiting
- A C input range selected by switch
- Protections: Short circuit / Overload / Over voltage / Over temperature
- Forced air cooling by built-in DC fan
- High power density 4.9w/in³
- Built-in remote sense function
- U L approved
- Low cost
- 2 years warranty

SPECIFICATION

MODEL		SE-600-5	SE-600-12	SE-600-15	SE-600-24	SE-600-27	SE-600-36	SE-600-48
OUTPUT	DC VOLTAGE	5V	12V	15V	24V	27V	36V	48V
	RATED CURRENT	100A	50A	40A	25A	22.2A	16.6A	12.5A
	CURRENT RANGE	0 ~100A	0 ~50A	0 ~40A	0 ~25A	0 ~22.2A	0 ~16.6A	0 ~12.5A
	RATED POWER	500W	600W	600W	600W	599.4W	597.6W	600W
	RIPPLE & NOISE (max.) Note.2	150mVp-p	150mVp-p	150mVp-p	150mVp-p	150mVp-p	200mVp-p	200mVp-p
	VOLTAGE ADJ. RANGE	4.75 ~5.5V	10 ~13.5V	13.5 ~16.5V	22 ~26.4V	24 ~30V	32 ~40V	43 ~56V
	VOLTAGE TOLERANCE Note.3	±2.0%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%	±1.0%
	LINE REGULATION	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%
	LOAD REGULATION	±2.0%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%	±0.5%
	SETUP, RISE TIME	1000ms, 50ms/230VAC 1000ms, 50ms/115VAC at full load						
	HOLD UP TIME (Typ.)	20ms/230VAC 16ms/115VAC at full load						
INPUT	VOLTAGE RANGE	90 ~ 132VAC / 180 ~ 264VAC selected by switch 254 ~370VDC						
	FREQUENCY RANGE	47 ~63Hz						
	EFFICIENCY (Typ.)	78%	83%	84%	87%	87%	87%	88%
	AC CURRENT (Typ.)	12A/115VAC 7.5A/230VAC						
	INRUSH CURRENT (Typ.)	30A/115VAC 60A/230VAC						
	LEAKAGE CURRENT	<2.0mA /240VAC						
PROTECTION	OVERLOAD	105 ~ 125% rated output power						
		Protection type : Shut down o/p voltage, re-power on to recover						
	OVER VOLTAGE	5.75 ~6.3V	13.8 ~16.2V	18 ~21V	27.6 ~32.4V	31 ~36.5V	42 ~50V	57.6 ~67.2V
		Protection type : Shut down o/p voltage, re-power on to recover						
	OVER TEMPERATURE	85℃±5℃ (TSW1) detect on heatsink of power transistor						
		Protection type : Shut down o/p voltage, recovers automatically after temperature goes down						
ENVIRONMENT	WORKING TEMP.	-20 ~ +60℃ (Refer to output load derating curve)						
	WORKING HUMIDITY	20 ~ 90% RH non-condensing						
	STORAGE TEMP., HUMIDITY	-40 ~ +85℃, 10 ~ 95% RH						
	TEMP. COEFFICIENT	±0.05%/℃ (0 ~50℃)						
	VIBRATION	10 ~ 500Hz, 2G 10min./1cycle, 60min. each along X, Y, Z axes						
SAFETY & EMC	SAFETY STANDARDS	UL60950-1 approved						
	WITHSTAND VOLTAGE	I/P-O/P:3KVAC I/P-FG:1.5KVAC O/P-FG:0.5KVAC						
	ISOLATION RESISTANCE	I/P-O/P, I/P-FG, O/P-FG:100M Ohms/500VDC						
OTHERS	MTBF	197K hrs min. MIL-HDBK-217F (25℃)						
	DIMENSION	247*127*63.5mm (L*W*H)						
	PACKING	2.1Kg; 6pcs/13.4Kg/1.03CUFT						
NOTE	1. All parameters NOT specially mentioned are measured at 230VAC input, rated load and 25℃ of ambient temperature.							
	2. Ripple & noise are measured at 20MHz of bandwidth by using a 12" twisted pair-wire terminated with a 0.1uf & 47uf parallel capacitor.							
	3. Tolerance : includes set up tolerance, line regulation and load regulation.							

Water Cooling

- System designed for ~ 10kW 5kW per side North/South
- Efficiency of LEDs for conversion of light is ~10%
- Heat load: Q = 5000 W = 5000 J/sK
- C_w = 4.18 J/sK
- ΔT = 5 K
- Water flow = 5000 W/(4.18 J/sK * 5 K) = 239 cc/s (4 gal/min)
- If we divide this up into 10 panels of 500 Watts each, this means ~0.4 gal/minute for each panel.
- We will put some panels in series. The temperature rise of the panels will be fairly modest <10K
- Calculations of temperature rise by absorption of ~10% of light in lead glass pile indicates complete heat dissipation after 24 hours.

Power Distribution Units (4)

http://www.wti.com/p-238-nps-8h20-ats-2-network-power-switch-pdu-ats-20a-208v-8iec-c13.aspx

Interface Descriptions:	
Ethernet Port:	10/100Base-T, RJ45
Console Port:	(1) RJ45, RS232C
Power:	
Voltage:	200 - 250 VAC, 50/60 Hz
Power Distribution: **(80% Derated)**	3.2/4 kW
Power Outlets:	(8) IEC-60320-C13
Power Inlets:	(2) IEC-60320-C20
Input Feeds:	(2) 20 Amps (Primary - Secondary ATS)
Current:	Primary 20 Amps (16A Derated) or Secondary 20 Amps (16A Derated)
Power Input Cables:	Detachable, Sold Separately
Physical/Environmental:	
Size:	1.75"H x 19"W x 8.7"D (1U) (4.5 cm H x 48.3 cm W x 22.1 cm D)
Weight:	12 Lbs. (5.4 Kg) Shipping Weight
Operating Temperature:	32° to 122° F (0° C to 50° C)
Humidity:	10% to 90% RH
Mounting:	19" Rack Brackets Included
Agency Approvals:	
FCC, UL, CE	

Notes on Safety/Operations

- System will require expert operation regularly during run; approx. every two days for 1-3 hours for the 12 week run.
- Requires PMT HV off during UV operation

- STAR safety system (spiral lines) should alarm against fire/water leaks
- Requires High Temperature Shutoff of UV system
- Water cooling interlock of UV system