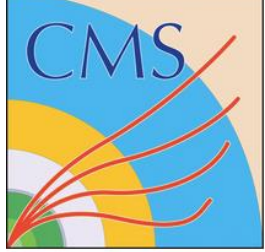


MEx/1 LV Power Distribution

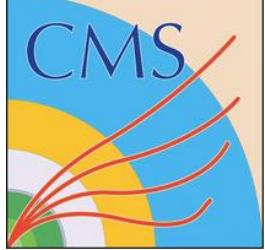
Armando Lanaro UW-Madison
CMS CSC-GEM Forward Muon Upgrade
Workshop
April 9-11, 2018



Useful infos from previous talks

- **overviews**

- Jan 12, 2018: “Updated LV currents in ME1/1” (Manuel Franco Sevilla)
https://indico.cern.ch/event/685462/contributions/2849362/attachments/1582165/2500534/18-01-12_manuelf_power_csc_upgrade.pdf
 - **Overview of current consumption in new electronics**
- April 6, 2018: “CSC –LV-YE_ALL Present” (Petr Levchenko)
https://indico.cern.ch/event/720076/contributions/2960085/attachments/1628499/2594478/CSC_LV_Status_YE_All.pdf
 - **Survey of current consumption in present system**



What are the changes in LS2-LS3

- ME1/1 (#72)
 - New xDCFEBs
 - New ALCT mezz (LX100)
 - New ODMB
 - Same OTMB
- ME1/23 (#144)
 - Same CFEB
 - New ALCT mezz (LX100)
 - ME1/2: no VTRx and GBTx off
 - ME1/3 gets the present ME1/1 ALCT mezz
 - Same DMB
 - Same TMB
- ME234/1 (#108)
 - New DCFEBs
 - New ALCT mezz (LX150T)
 - New ODMB
 - New OTMB
- ME23/2 (#144)
 - Same CFEB
 - New ALCT mezz (LX100)
 - No VTRx and GBTx off
 - Same DMB
 - Same TMB
- ME4/2 (#72)
 - Same ALL



New electronics current specs

M. Franco Sevilla (UCSB)

Total current per chamber

7/5 DCFEBs + ALCT	ME1/1		ME234/1		ME1234/23	
	D (7.0V)	A (7.0V)	D (7.0V)	A (7.0V)	D (7.0V)	A (7.0V)
Pre-LS1	9.8 A	5.5 A	9.9 A	5.5 A	9.9 A	4.8 A
LS1	34.6 A	16.5 A				
LS2	41.5 A	16.5 A	27.0 A	13.0 A	9.9 A	4.8 A

LVDB input

+ ~20%

+ ~2.7x

+ ~2.4x

No change?

Total current per (O)TMB/(O)DMB pair in peripheral crate

OTMB + ODMB	ME1/1		ME234/1		ME1234/23	
	6.0 V	4.0 V	6.0 V	4.0 V	6.0 V	4.0 V
Pre-LS1	1.5 A	3.7 A	1.5 A	3.7 A	1.5 A	3.7 A
LS1	4.1 A	9.0 A				
LS2-LS3	4.1 A	9.0 A	3.3 A	9.0 A	1.5 A	3.7 A

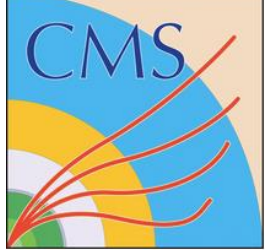
CRB input

No change?

+ ~2.2x

+ ~2.4x

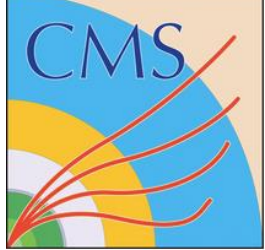
No change?



How power changes in LS2-LS3

- ME1/1 (#72)
 - New xDCFEBs **+3.2 W**
 - New ALCT mezz (LX100) **+4.1 W**
 - New ODMB **~power neutral**
 - Same OTMB
- ME234/1 (#108)
 - New DCFEBs **+18.7 W**
 - New ALCT mezz (LX150T) **+3.3 W**
 - New ODMB **+13 W**
 - New OTMB **+20 W**
- ME1/23 (#144)
 - Same CFEB
 - New ALCT mezz (LX100) **+0.5 W**
 - ME1/2: no VTRx and GBTx off
 - ME1/3 gets the present ME1/1 ALCT mezz
 - Same DMB
 - Same TMB
- ME23/2 (#144)
 - Same CFEB
 - New ALCT mezz (LX100) **+0.5 W**
 - No VTRx and GBTx off
 - Same DMB
 - Same TMB
- ME4/2 (#72)
 - Same ALL

Used early estimations for LX100 ALCT current consumption 2.9A instead of 2.6A (just measured)



Power/disk present & future

Doing the math for on-chamber and peripheral crate power consumption

<LS2

ME1 (#108)

Available power = 43.2kW

Used power = ~25.4kW

ϵ (used capacity) = 59%

Maratons
(3.6 kW)
Present

12

YE1

ME2+ME3 (#108)

Available power = 28.8kW

Used power = ~18.2kW

ϵ = 63%

8

YE2

ME4 (#54)

Available power = 14.4kW

Used power = ~8.8kW

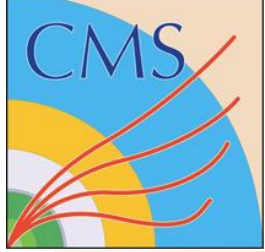
ϵ = 61%

4

YE3

Total for 2 endcaps

48



Power/disk present & future

Doing the math for on-chamber and peripheral crate power consumption

minimal

<LS2

>LS2

YE1

ME1 (#108)

Available power = 43.2kW
 Used power = ~25.4kW
 ϵ (used capacity) = 59%

Extra power needs/disk

On chamber +954 W
 Off chamber power neutral
 tot +954 W (+4%)

# Maratons (3.6 kW) Present	# Maratons Upgrade
12	12

YE2

ME2+ME3 (#108)

Available power = 28.8kW
 Used power = ~18.2kW
 ϵ = 63%

On chamber +3521 W
 Off chamber +1145 W
 tot +4666 W (+26%)

8	10
---	----

YE3

ME4 (#54)

Available power = 14.4kW
 Used power = ~8.8kW
 ϵ = 61%

On chamber +1743 W
 Off chamber +573 W
 tot +2316 W (+26%)

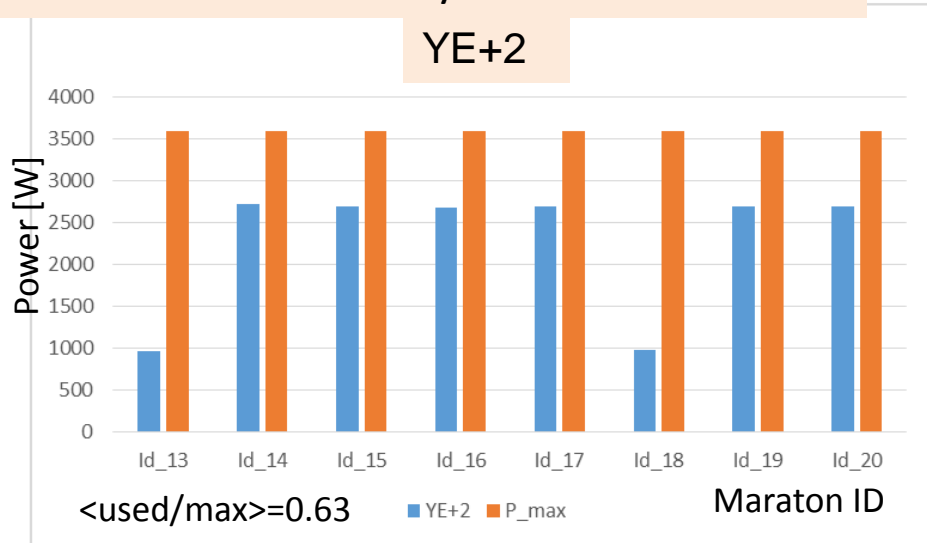
4	5
24	27

Total for 2 endcaps	48	54
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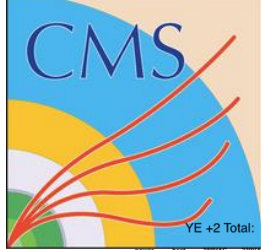
Power partitioning

Measurement done by P. Levchenko et al.



Focusing on YE2, YE3

- Even though there is a large headroom, power distribution is not equally partitioned (from Petr measurements)
- Several power units deliver $\sim 75\%$ of max power (–vs– an average of $\sim 62\%$)
 - 6/12 on YE1 (not shown)
 - 6/8 on YE2
 - 2/4 on YE3
- Accurate power calculation are being done (S. Lusin, B. Wang) in order to optimize power distribution
- Safety margin should be ~ 1.5 x to leverage uncertainty in current consumption (largest in ODMB) and/or firmware development
- This might end up in a higher number of additional Maraton units, e.g. **12**, in order to provide optimal balance.



Pre-LS2 Configuration of YE2 & YE3

Power figures updated 30 May 06
Layout updated 27 Oct 07

YE +3 Total:

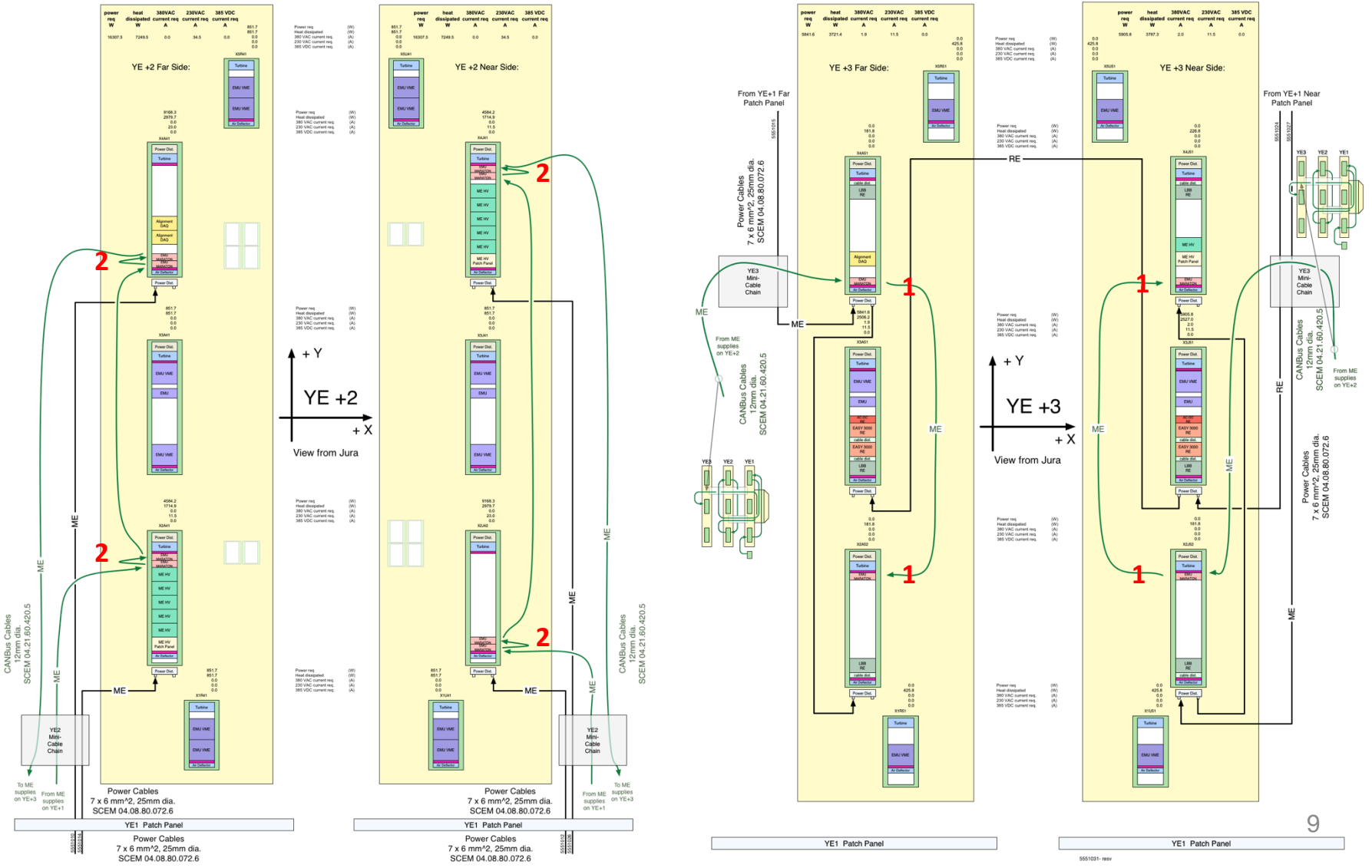
Power figures updated 30 May 06
Layout updated 28 Oct 13

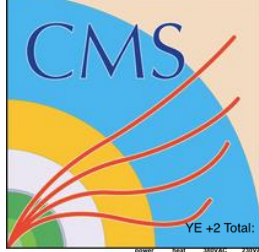
Not for crate and rack installation

Not for crate and rack installation

power req	heat	380VAC	230VAC	385 VDC
W	A	W	A	A
3814.9	1489.1	0.0	68.0	0.0

power req	heat	380VAC	230VAC	385 VDC
W	A	W	A	A
11247.5	7508.7	1.9	23.0	0.0





Post-LS2 Configuration of YE2 & YE3

maximal

Not for crate and rack installation

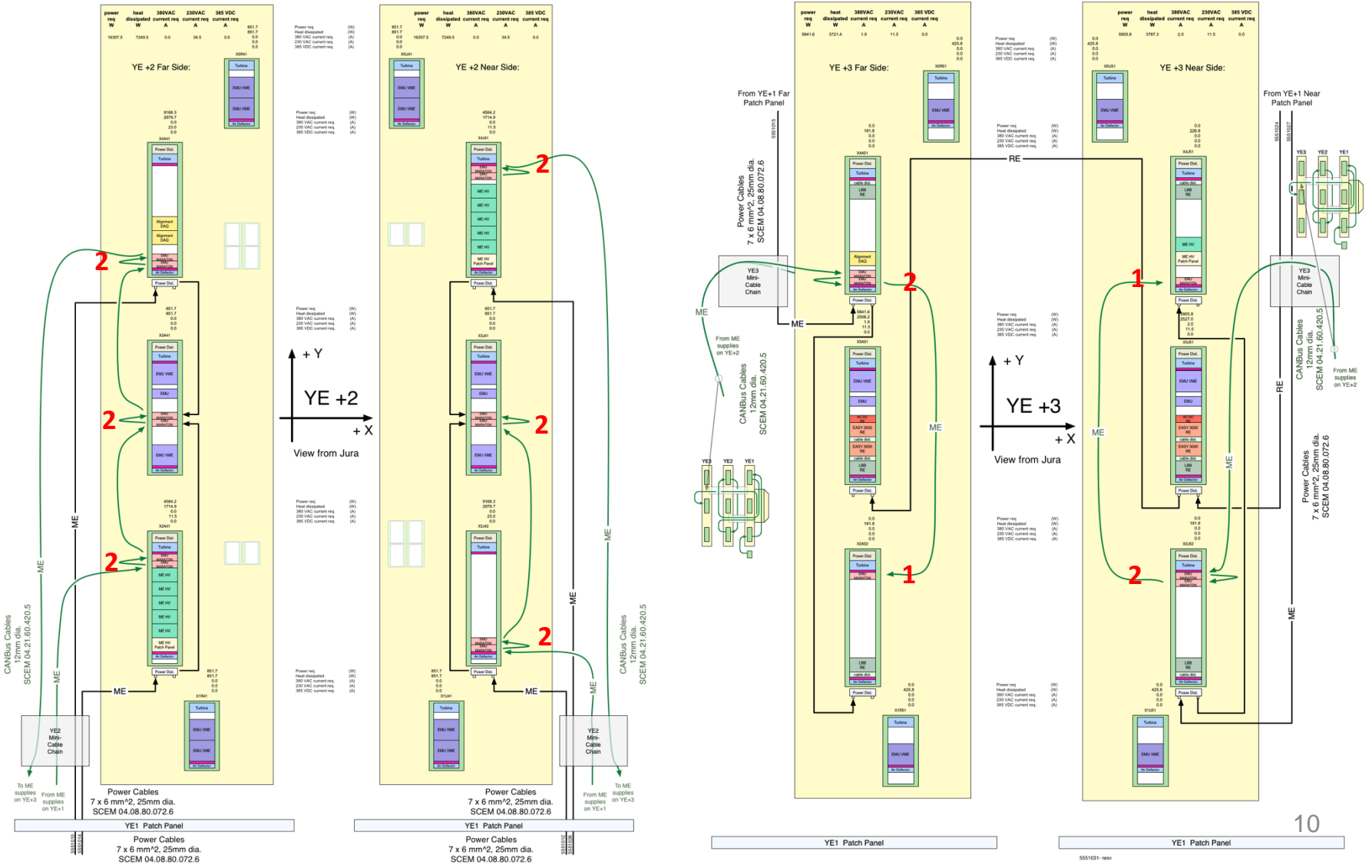
Not for crate and rack installation

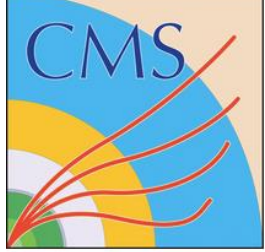
Power figures updated 30 May 06
Layout updated 28 Oct 13

YE +2 Total:

power req	heat dissipated	380VAC current req	230VAC current req	385 VDC current req
W	W	A	A	A
32814.9	14889.1	0.0	88.0	0.0

power req	heat dissipated	380VAC current req	230VAC current req	385 VDC current req
W	W	A	A	A
22.0	0.0	0.0	0.0	0.0





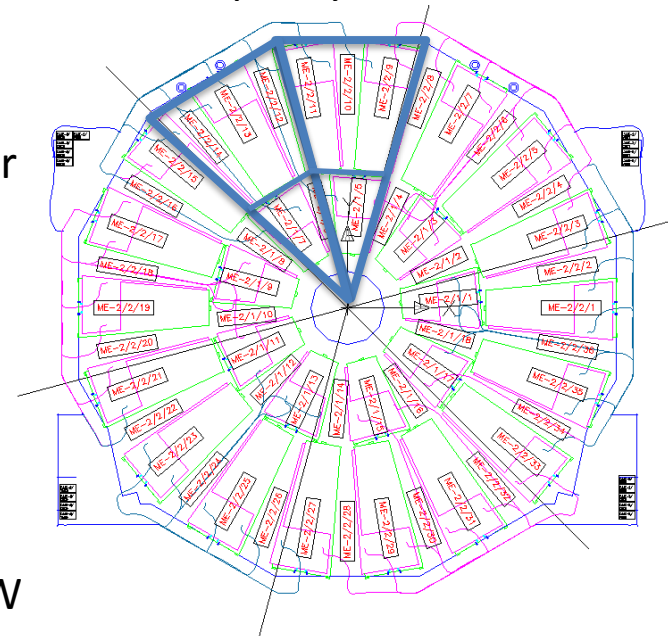
Power distribution model calculations

Baseline model used for ME1 upgrade expanded to ME2,3,4. Recall:

- YE1 total power increase was taken to be 45% (on&off chamber)
- Dropout voltage at each stage = 0.5V
- Power per ME1/1 chamber changed from ~110W to ~360W (LS1)
 - After LS2 will raise to ~410W
- With 4 additional Maratons system designed to run at ~70% of capacity
 - Measured ~60% (Petr et al.) – good margin

ME2,3,4

- Simplest repartitioning involves splitting inner & outer rings (prime/no prime LV input channels)
 - It allows to set voltage of upgraded channels independently
 - Upgraded LV regulator boards on inner chambers allows to take advantage of lower voltage requirements of new DCFEBs to offset increased voltage drop on cables
- Power per ME234/1 chamber will change from ~110W to ~280W (LS2)
- Present 8 mm² LV cable (AWG 18 wire) should be adequate (enough shield)



YE-2 IP View

Before

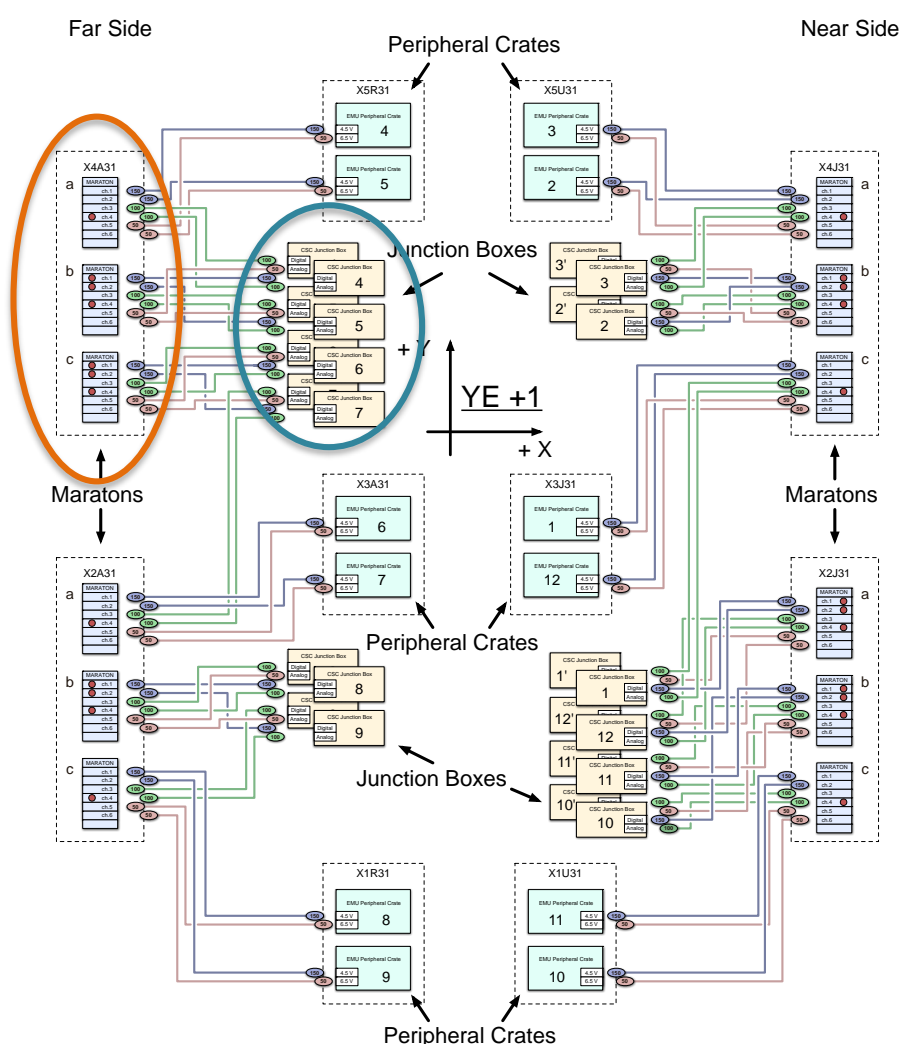
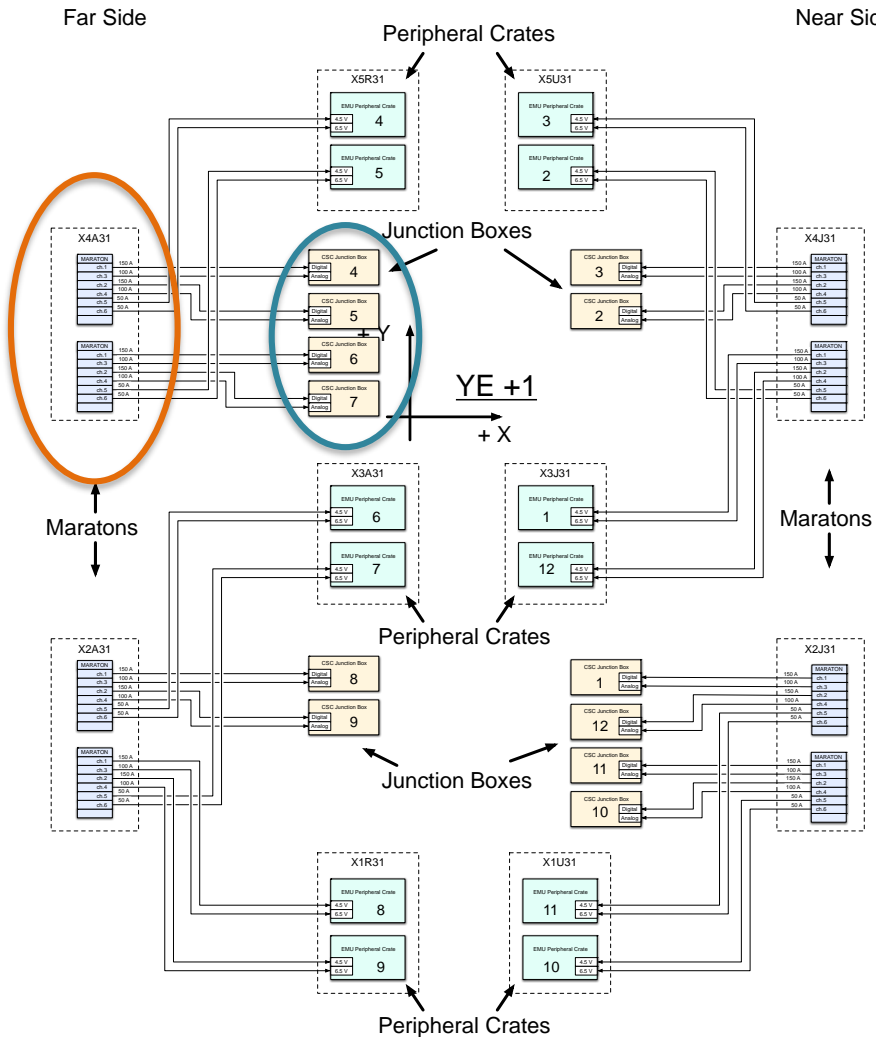
CSC LV Power Distribution
Maraton -> Junction Box & Peripheral Crate Cabling

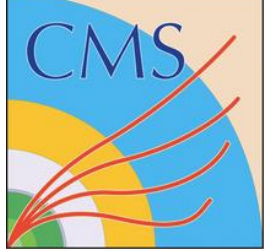
YE2 will be
~similar

After

CSC LV Power Distribution
Maraton -> Junction Box & Peripheral Crate Cabling
Upgraded ME 1/1 Configuration, Four-corners variant

View from Jura side
Revised 03 Oct 12





Other LV architecture parts

- **Junction Boxes in UXC**

- With 12 additional Maratons (8 for YE+-2 and 4 for YE+-3) the number of 18 JBs need to be doubled, that is 24 JBs for YE+-2 and 12 for YE+-3
- Design of new JBs similar to YE1's. Integration not expected to be an issue.
 - Layout is being finalized at UW and construction of 12mm phenolic panels for cabinet (maps 2,4 JBs) will follow. Assembly will be done at CERN. Funding OK
 - Procurement of JB components: fuse holders, miscellanea h/w is done at CERN



Pre-LS2 YE2,3 JB



Post-LS2 YE2,3 JB

- **Modification in USC**

- One additional Wiener OPFC per additional Maraton in S4F04 rack
 - Installation in present rack and rack cooling need to be evaluated
- New circuit breakers & new cabling required
 - This work is done by CMS personnel



Overall system upgrade summary

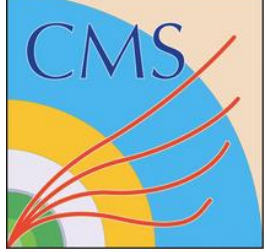
Upgrade requirements similar in scope to ME1/1 in LS1

- **What is needed:**

- Additional Wiener Maraton power units in UXC
 - DCFEBs, ALCT & new peripheral crate electronics have increased power requirements
- Number of power rectifier modules (OPFCs) in USC
 - One OPFC per Maraton
- Number of junction boxes
 - Cannot parallel Maraton outputs
- New on-chamber LV regulator boards (LVDB)
 - To provide new DCFEBs input voltage levels

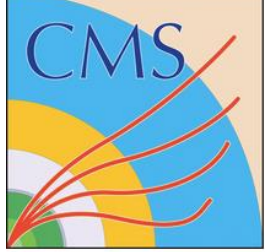
- **What is not needed:**

- Power cabling between USC and UXC through main cable chains
 - Spare conductor pairs exist in CSC primary power cables
- Power cabling in UXC through mini-cable chains
- New rack power distribution boxes
- New CANBus readout cabling
 - Existing serial chain is extendable
- New LV cables to ME234/1
 - Experience with ME1/1 shows 8mm² cable adequate



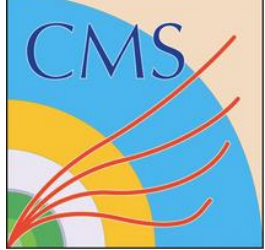
Conclusions

- YE2,3 detailed power calculations and distribution in progress (Lusin, Wang)
 - Follows model used for LS1 power upgrade
 - As-built power consumption of ME1/1 upgraded electronics is crucial to validate model and use it for LS2 system architecture
- YE1 additional power needs are marginal (+4%) and should be taken care by exiting system
- YE2,3 post LS2 power needs are similar to YE1 in LS1 and will require additional input power
- Number of additional Maratons needed is not yet determined: min 6, max 12



Backup

A word about DCFEB covers for
MEx/1



DCFEB covers for MEx/1

ME1/1 < LS1



ME1/1 > LS1



- Present DCFEB design with Finisar cover is OK for xDCFEB with VTTx (ME1/1) (Ben)
- For ME234/1 need to change design to allow space for new adaptor Finisar → VTT/Rx
- Construction will be done at CERN (like for old ME1/1) from bare Cu-sheets
- Need 540 covers, ~10kchf