

Endcap Muons – CSC Electronics CSC Electronics Upgrade – Overview and Open Questions

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CSC/GEM Electronics workshop, TAMU 09-Apr-2018





Overview

- LS2, "on chamber electronics"
- LS3, "off chamber electronics"
- Open questions
 - Not be be discussed exhaustively during this talk
 - Frames some goals for the week



CSC on-chamber electronics upgrades (LS2 Scope)





Schedule overview – LS2 upgrades

- Electronics boards
 - 570 DCFEBs
 - 120 LX150T ALCT mezzanines
 - 320 LX100 ALCT mezzanines
 - 120 LVDB boards
 - 120 OTMB boards



- Power and infrastructure
 - HV system for ME1/1
 - 36 LV junction boxes
 - 12 Maraton LV supplies
 - 216 optical fiber cables

	2017			2018				2019				2020				
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Opt. fibers LVDB5 DCFEB (+) DCFEB (-) ALCT-LX150T ALCT-LX100	Øn-oha	mber			Today	E	R			Start M	EX/1 irsta	lation				
LV system HV system OTMB	Off-¢ha	unber														
Color code		Design		Engin. P	rototype	Pr	re-produ	ction	Pr	oduction		Flo	bat	Inst	all. & Cor	nmiss.



CSC off-chamber electronics (L3 scope)

High data volumes/trigger rate require an increase in the bandwidth of links connecting electronics on the detector with the counting room

Data rates up to 3 Gbps at HL-LHC, current links are 1.6 Gbps

- Replace DAQ motherboards in peripheral crates
 - Upgrade output bandwidth
- Replace Front End Driver (FED) crates
 - µTCA or ATCA system
- Additional optical fiber connections
- Other electronics are not changed during upgrade

Current Electronics Configuration for CSC Readout
Trig
DI Board
DDU Board
DAQ Motherboard





Schedule: CSC ODMB



Schedule contingency is visible in floats between completion milestone and external "need-by" dates



Schedule: CSC FEDs

2016	2017	2018	2019	20	20	2021	2022	2023		2024	2025		2026	2027		2028	202	29
Q2 Q3 Q4	4 Q1 Q2 Q3 Q4	Q1 Q2 Q3 Q	14 Q1 Q2 Q3	Q4 Q1 Q2	Q3 Q4 Q1 Q	2 Q3 Q4 Q1	Q2 Q3 Q4	Q1 Q2 Q3	Q4	Q1 Q2 Q3 Q4	Q1 Q2 Q3 (Q4 Q1 (Q2 Q3 Q4	4 Q1 Q2 Q3	Q4 Q1 Q2	2 Q3 Q4	Q1 Q2	Q3 Q4
•													402.5	EM - ENDCAP	MUONS			
ANSF - CD	R Approve Cond	ceptual Design																
03	8-Aug-2017 + EM -	CSC R&D - Pre	liminary Design,	Requireme	nts and Interfac	es for the TD	R Complete			Λ								
1	5-Sep-2017* * CM	IS - HL-LHC Mu	on TDR Submitt	ed						Long	Chutdown							
	15-Dec-2017*		norove Prelimir	any Decign						Long	Snutdown	<u> </u>						
	10-Dec-2017			ary Design														
	12-Jan-2018 ,	CIVIS - ESR TO	or CSC On-Chan	nber Electro	nics CIVIS plar	ned date												
	19-Feb-2018*	, 🏅 CMS - Start	t of CSC ODMB	project														
	05-Mar-201	8* 🛔 CMS - Con	nmon ATCA Bac	kend Board	Prototypes Ava	lable for Ord	ering											
	26-Ju	un-2018 🔶 EM - 🕯	C\$C ODMB R&I	D: Optical tra	ansmitter and Fl	PGA specified	1											
		01-May-2	2019*, 🗙 CMS -	Start of CSC	Chamber Refu	rbishment for	r ME- Endcap											
		21-	Jun-2019 + EM	- CSC on-ch	amber electroni	cs Project Co	mplete											
		01-4			CSC Chamber	Pofurbichmou	t for ME+ En	dean										
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			14-Oct-2019	NSF - FDR	Approve Fina	i Design												
			01-Apr-2	2020*, † NS	F - MREFC Fun	ds Available												
				FM310210	SVT	: CSC - FLOA	T FOR ODME	PRR										
				01-F	eb-2021 + EM	PRR for OD	MB complete	4										
				0-Fe	b-2021*, 🛔 CM	S - PRR for C	SC ODMB (MS planned	d dat	e								
					0	7-Mar-2022*	CMS - Com	non ATCA Ba	acke	nd Boards Availab	e for Ordering							
				· · · · · <mark>· · · · · </mark> · · · · ·		22-Au	a-2022 + EM	EM CSC OF	омв	Project Complete								
						22-Au		CSC - All O	DME	boards ready for i	installation						mple	ato
					Float	EM20			OAT	for CSC EED road	for ESD				JU FE		inhie	ste
					FIUAL	FINISZ			UAT	IDF C3C FED Tead				10	'MS n	eeds	hy da	ate
							01-Feb-2023	• EM - ESF	tor	CSC FED system	complete					ccus	Ny ac	
							01-Feb-2023*,	CMS - ES	SR fo	or CSC ODMB and	FEDs CMO	nanned	date					
					(7 moi	nths)		02-Jan-202	24*,	LHC - Start ong	suutaown 3 (L	_S3)						
📑 🤜 Selec	t Milestone Tier		×		\ <i>`</i>	,				03-Jan-2025	EM - CSC - F	ED - Inte	gration	ompleted ready	for Installa	ation at P5		
V Displ	ay: Current Project's V	/alues								03-Jan-2025	EM - CSC FE	D Projec	t Complet	e				
Search										03-Jan-2025	EM - Endcap	Muons	oproject	t Complete				
0-1-161	,					FM3	310590					SVT	C FLOAT	for ODMB boa	rds ready	for installa	tion	
Code val	External DOF	-	_ _							EM320995		16		MS Need by da	te for: CS(CEED		
	External - DUE									1 1020330				inis Need by da				
	External App	alaratar								Floa	Det-202	EMS-N	leed by da	te for: CSC OD	MB boards	s to be inte	grated in	ito racks
	External Ever	eriment									Dct-2025*	CMS-N	leed by da	te for: CSC FEI	D system to	o be instal	ied in USC	C55
	External Mice								(1	0 mont	hs) ^{6-Mar-2}	026* 📩 🤇	CMS - Dete	ector closes at	P5			
	T4 Milestone -	Project Manager							1-		01	-Jul-202	6 + LHC -	End long shut	down 3 (LS	3)		
	T5 Milestone -	Sub-project Manan	ner i															
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				<u> </u>														



- Replace Finisar optical transceivers on old DCFEBs from ME1/1?
- Background:
 - In Finisar's died in 2017 run not sure why
 - In CHARM rad testing, all Finisars were dead by ~20 kRrad

- Considerations:
 - Not pin compatible
 - $_{\odot}\,$ Would need adapter board to replace
 - Still need to unsolder old Finisars

 Possible damage to boards?
 - Swap logistics
 - $\circ\,$ Narrow time window
 - $\circ\,$ Radioactive boards









- How to implement GBTx communication for xDCFEBs in ME1/1?
 - Full duplex?
 - Affects the number of fibers , but don't need to decide until near LS3

Power down GTBx in Run 3?





- How to connect fiber inputs from GE2/1 to OTMBs for ME2/1?
 - Fiber from GE2/1→ME2/1, and then to the OTMB via a single 12-fiber bundle
 - o Latency? Fiber routing?
 - Bundle from GE2/1→PC, merge with ME2/1 bundle into one bundle that connects to a single MTP12 RX on the OTMB
 - \circ Requires custom fiber
 - Bundle from GE2/1→PC and connect to a second MTP12 RX on the OTMB
 - $_{\odot}$ Additional flavor of OTMB
 - No direct GEM—CSC connection
 - \circ Do everything in EMTF



YE1 disk



- Do we need to support legacy copper inputs on new OTMBs?
- Can improved LCT resolution from OTMB fitting algorithms help in triggering?
- How many spare fibers for OTMBs in ME2,3,4,/1?







- Which FPGA?
- Which optical transmitter?
 - What speed? Affects the number of links and the headroom
- Re-use (72) ODMBs from ME1/1 in ME3/1, ME4/1?
- How to program xDCFEB and ALCT FPGAs in ME1/1 – from ODMB or FED?

TDR design – assuming 6.4 Gbps links

Station	Max. data rate (Gbps)	# of Fiber	optical links occupation					
	baseline		Baseline HL-LHC	Ultimate HL-LHC				
ME1/1	4.3	4	21%	48%				
ME2/1	2.8	3	18%	41%				
ME3/1	1.6	2	16%	36%				
ME4/1	1.6	2	15%	34%				
ME1/2	0.3	1	20%	45%				
ME2/2	0.2	1	13%	29%				
ME3/2	0.2	1	15%	34%				
ME4/2	0.4	1	31%	70%				
ME1/3	0.1	1	2%	5%				



Which ATCA module to use for CSC FED?

- The balance of I/O and processing might differ from other CMS projects (e.g. trigger)
- Common with GEMs?

• How to partition system and route fibers?

- 360 legacy fibers + 540 new fibers = 900 fibers
- 60 peripheral crates

Do we need/want 2-way communication between ODMB and FED?

If so, how should it be implemented?



- Layout/routing of fibers on ME234/1
- DCFEB cover design cutout locations?





Charge/plans

This presentation merely introduced some of these question

- We have a few minutes for discussion now, but we can identify any topics for detailed discussion later in the workshop
- I will revisit these questions at the end of the workshop
 - \hfill Note any questions that have been resolved \checkmark
 - Probably add some new questions as well